FISHERY MANAGEMENT INVESTIGATIONS

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ABSTRACT

An angler check station was operated at the Curlew boat ramp on six randomly chosen dates between June 6th and June 20th, 2020, to determine angler use of the Anderson Ranch Reservoir (ARR) fishery and progress toward achieving management objectives for the fishery. In total, 33 anglers were interviewed that fished for a combined total of 201 hours. Trip time averaged 5.2 hours per boat and varied between 1.5 – 8.5 hours. Mean kokanee *Oncorhynchus nerka* angler catch rate (± 90% CI) was 0.06 fish/h (± 0.04; *n* = 7) and mean harvested kokanee length was 433 mm (± 11). Angler fall Chinook Salmon *Oncorhynchus tshawytscha* catch and harvest rate was 0.02 fish/h (± 0.02; *n* = 2) and mean harvested fish length was 462 mm (± 35). Harvested fall Chinook Salmon consisted of entirely wild-origin fish.

September gill netting surveys were conducted to determine relative abundance and size structure trends in the kokanee population in Anderson Ranch Reservoir. Mean kokanee catch-per unit effort was 2.4 fish/net-night (± 0.8). Kokanee had a mean total length of 291mm (± 28). Chinook Salmon CPUE was 0.88 fish/net-night (± 0.31) and collected fish had a mean total length of 450 mm (± 15). Wild-origin Chinook Salmon made up 75% of our total Chinook Salmon sample. Management objectives for kokanee in Anderson Ranch Reservoir are only being partially met. Data suggests the population is continuing its downward trend in abundance and upward trend in size structure. However, it is likely that the population will begin to recover as spawning habitat condition improves from the runoff event that scoured the South Fork Boise River in 2017.

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INTRODUCTION

Kokanee salmon *Oncorhynchus nerka* exhibit multiple and often complex life history forms (Whitlock et al. 2014). Kokanee are semelparous salmon that feed and grow in lakes or reservoirs for 2.5 to 3.5 years before spawning in tributaries or along shorelines during fall before dying. Eggs incubate in the streambed or shoreline gravels until hatching in late winter and fry out-migrating to the lake or reservoir in the spring. Juvenile and adult kokanee are most associated with the pelagic zones of lakes and reservoirs (Foerster 1968), where they feed almost exclusively on zooplankton.

Management of kokanee fisheries is often complex because of the wide variation of population responses to system productivity, habitat, predation, and harvest (Paragamian 1995). These responses lead to changes in growth, fecundity, recruitment, age-at-maturity, and survival, which can vary substantially between year classes. Many kokanee populations in the western United States exhibit a strong density-dependent relationship between population size and mean body size (Rieman and Myers 1992; Rieman and Maolie 1995; Grover 2006). 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 Maolie 1995). The dichotomy between density and growth is an important component to kokanee management in most waters with examples of efforts to influence density, growth, and survival being well documented (Rieman and Myers 1992, McGurk 1999).

Kokanee provide an important recreational fishery in many waters of the western United States (Forester 1968; Paragamian 1995; Rieman and Maolie 1995), and have become increasingly popular with Idaho anglers over the past two decades. The popularity of kokanee fishing is reflected in angling magazines, social media, kokanee tournament requests, and online forums dedicated to kokanee fishing. The Idaho Department of Fish and Game (IDFG) has observed a notable increase in angler engagement regarding the management of kokanee fisheries across the state. Of these fisheries, reservoirs in the Boise River system make up some of the most popular fisheries in the state and their management receives increasingly high levels of scrutiny from anglers. This is expressly apparent in the uppermost reservoir in the system, Anderson Ranch Reservoir.

Anderson Ranch Reservoir (ARR) is a 22.5-km long Bureau of Reclamation (BOR) impoundment on the South Fork Boise River (SFBR) in Elmore County, Idaho. The dam spillway is at an elevation of 1,279 m above sea level and has a maximum storage capacity of 493,180 acre-feet with approximately 28,980 acre-feet of dead storage. The reservoir's maximum depth is approximately 91 m at full-pool. The primary uses of the reservoir are irrigation, hydroelectric-power production, and flood control. There are six publicly accessible boat ramps located throughout the reservoir at Castle Creek, Curlew Creek, Deer Creek, Elk Creek, Fall Creek, and near the town of Pine, ID. Traditionally, the Curlew Creek access receives the majority of use. The reservoir supports populations of Rainbow Trout *Oncorhynchus mykiss*, Smallmouth Bass *Micropterus dolomieu*, fall run Chinook Salmon *Oncorhynchus tshawytscha*, Yellow Perch *Perca flavescens* and Bull Trout *Salvelinus confluentus*. However, most anglers at ARR target kokanee, which are the focus of IDFG management efforts.

The kokanee fishery in ARR is managed by Idaho Department of Fish and Game (IDFG) as a harvest fishery with a daily bag-limit of 15 fish and a possession limit of 45 fish (i.e., three times the daily bag limit). Although other kokanee fisheries in the Boise River system (i.e., Lucky Peak and Arrowrock reservoirs) are largely dependent on hatchery stocking, Anderson Ranch Reservoir has historically been supported by wild kokanee recruitment in the reservoir's major tributaries (Rieman and Myers 1992). Unfortunately, effects from recent high runoff events have resulted in poor natural recruitment rate. As such, ARR has received annual supplementation of hatchery kokanee to support the fishery since 2016. The current management objectives for kokanee in ARR are to develop a model to evaluate kokanee escapement and recruitment. Additionally, management seeks to provide a kokanee fishery exhibiting catch rates of 0.5 fish/h with a mean harvested fish size ≥ 305 mm.

The objective of this study was to use fishery-dependent data to estimate overall angler effort, harvest rate, and mean harvested fish size during the peak kokanee angling period of June - July using an angler check-station. Additionally, fishery-independent data were collected using gill nets to describe size structure, growth, stock contribution, and relative abundance of kokanee in ARR. Secondary objectives for this study included monitoring of similar trends in the fall Chinook Salmon fishery at the reservoir.

METHODS

Angler Survey – Check Station

Angler effort and harvest of kokanee were determined at ARR using an angler check-station at the Curlew boat ramp located on the northeast portion of the reservoir near Pine, ID. This location was selected due to it being the most heavily used public access point. A total of six randomly selected check station dates including three weekdays and three weekend days were chosen for Curlew boat ramp between June 6th and June 20th, 2020. This timeframe coincided with previous data suggesting that June and July are the peak months for kokanee angling effort. The creel station was operated during AM (0900 – 1400 hours) and PM shifts (1200 – 1800 hours) by 1-2 personnel who interviewed all anglers leaving the reservoir to collect completed trip data. Anglers were questioned about the duration of their fishing trip, target species, number of anglers, total catch, and total harvest. All harvested fish were identified by species and measured for total length (mm) and weight (g).

Angler creel data were summarized by mean trip duration, catch, catch rate, harvest, and harvest rate. Mean catch and harvest rate, $\hat{R}_1$, was estimated using the ratio of means (ROM), where trip interviews were considered complete:

$$\hat{R}_1 = \frac{\sum_{i=1}^{n} c_i / n}{\sum_{i=1}^{n} e_i / n}$$

where $\hat{R}$ is the mean catch or harvest rate in fish/angler hour, c_i is the number of fish caught during the trip, and e_i is the length of the trip in hours (equation $\hat{R}_1$ from Pollock et al. (1994).

Gill Netting

The kokanee population was sampled using horizontally oriented gill nets in late-September 2020. This timeframe allowed the sampling of the population post-spawn which provided insight into the upcoming year's population demographics (Peterson et al. 2018). Gill nets were 48.8 m-long and 6.0 m-deep with 16 randomly positioned 3-m long panels of 12.7-, 19.0-, 25.4-,.38.1-, 50.8-, 76.2-, and 101.6-mm stretch mesh. Each mesh size was represented twice in each net. Sampling sites were stratified between three reservoir zones (i.e., upper, middle, and lower) and three nets were set at each site (n = 9; Figure 1). Each set of three gill nets were set in tandem to provide complete net coverage of the water column between 6 –24 m. Gill nets were set at dusk and net retrieval commenced the following day at dawn.

All collected fish were identified by species and measured for total length (mm) and weight (g). Sagittal otoliths were removed from all kokanee and Chinook Salmon collected and stored for length-at-age analysis (Branigan et. al 2019). Mean catch-per-unit-effort (CPUE; fish/net-night) was calculated to estimate relative abundance trends of kokanee and Chinook Salmon in ARR. Proportional size distribution (PSD) was calculated for each size class of kokanee collected.

RESULTS

Angler Survey – Check Station

In total, 42 anglers were interviewed during the study period, of which 33 were targeting kokanee and nine anglers were targeting Smallmouth Bass. Total kokanee angler effort was 201 hours with a mean total daily angler effort of 38.8 h (± 23.7) (± SE). Combined catch of kokanee was seven fish and total harvest was six fish. Trip length varied from 1.5 to 8.5 h with a mean of 5.22 ± 0.46 h. Catch rates for kokanee varied from 0 to 0.36 fish/h with a mean catch rate of 0.06 (± 0.04) (Figure 2). Total length of harvested kokanee varied from 392 to 465 mm with a mean length of 433 mm (± 11) (Figure 3). Proportional size distribution for harvested kokanee was 100 for quality (≥250 mm), 100 for preferred (≥300 mm), and 83 for memorable classification (≥400 mm). Anglers did not harvest any trophy-sized kokanee.

In addition to kokanee harvest, a total harvest of two fall Chinook Salmon was documented during angler creel surveys. Mean angler catch and harvest rate for Chinook Salmon was 0.2 ± 0.02 fish/h. No Chinook Salmon caught were reported as released; therefore, catch and harvest rates were identical. Total length of Chinook Salmon harvested varied from 427 to 497 mm with a mean length of 462 mm (± 35) (Figure 3). All harvested Chinook Salmon had intact adipose fins, suggesting 100% natural-origin fish.

Gill Netting

Gill netting effort during this investigation totaled nine net-nights. In total, 38 fish were collected during the survey. Catch was comprised of kokanee (n = 22), fall Chinook Salmon (*n* = 8), Northern Pikeminnow (*n* = 3), Largescale Sucker (*n* = 3), Rainbow Trout (*n* = 1), and Bull Trout (*n* = 1). Catch-per-unit effort (CPUE) for kokanee varied from 0 - 7 fish/net-night with a mean of 2.4 fish/net-night (± 0.8) (Figure 2). Kokanee lengths varied from 94 to 553 mm with a mean of 291 mm (± 28) (Figure 3). Sagittal otoliths were collected from all kokanee. Fish ages varied from 0 – 3. Mean lengths at age were 141 mm (± 11) (age-1), 341 mm (± 7) (age-2), and 507 mm (± 29) (age-3) The proportional size distribution of netted kokanee was 63 for preferred, 14 for memorable, and nine for trophy size classes.

A total of eight Chinook Salmon were collected during netting surveys and mean CPUE was 0.88 ± 0.31 fish/net-night (Figure 4). Fish length varied from 41 to 551 mm with a mean of 450 mm (± 15) (Figure 3). Otoliths were not collected from Chinook Salmon; therefore, age distribution of collected Chinook Salmon is unknown.

DISCUSSION

Angler Survey – Check Station

Based on the 2020 check station results, current management objectives for kokanee in ARR are only partially being met. While mean length of harvested fish continues to exceed management objective (TL ≥ 305 mm), angler catch rates are far below the objective of 0.5 fish/h. Survey results indicate that kokanee densities in ARR remain low, resulting in low catch rates by anglers and during netting surveys. Evidence suggests that natural recruitment of kokanee is limited in the upper Boise River system which is likely the result of high entrainment of juvenile kokanee during runoff events in 2017 and high levels of angler harvest of mature fish during that same year. Due to poor natural recruitment success following these events, regular stocking of hatchery-origin kokanee has occurred in ARR and these stockings may be supporting the harvest fishery. Methods to monitor trends in natural recruitment (e.g., pelagic fry trawls or instream fry traps) should be developed to evaluate whether fry are being produced and examine potential points of recruitment failure.

Mean angler catch rates for kokanee in 2020 decreased substantially from 2019 levels, while mean length increased. This trend is indicative of a large decline in total kokanee abundance. Age-3 kokanee generally comprise most of the fishery in ARR, and that trend continued in 2020. Low catch rates were likely an artifact of low kokanee recruitment during the 2017 spawn year: a result of high entrainment of juvenile fish following an exceptionally high spring runoff. High angler harvest of adult kokanee during the 2017 season may also have added to a lack of kokanee recruitment. Since approximately 200,000 hatchery Kokanee were stocked in 2017 it would stand to reason that this stocking event supported the fishery in 2020. As such, hatchery supplementation should continue in ARR until natural reproduction rates increase enough to maintain this fishery going forward.

Fall Chinook Salmon angler catch rates were lower in 2020 than in 2019. Catch rates have been decreasing consistently since 2018, which is likely an artifact of decreased stocking rates following the initial introduction of 35,000 fish in 2015. Only wild-origin Chinook Salmon were detected at angler check stations in 2020, which indicates natural reproduction is occurring in the reservoir, but the rate of which is unknown. Stocking of hatchery Chinook Salmon did not occur in 2020 in ARR and angler catch rates of wild-origin fish have remained relatively stable over time despite overall decreases in catch rates over time. Since Chinook Salmon generally recruit to the fishery at age-3, data collected in future angler surveys should shed light on the natural reproduction success in the reservoir as hatchery-origin fish begin to phase out of the fishery. Over time, a naturally sustained population of Fall Chinook Salmon could be available to anglers in ARR.

Gill Netting

Gill netting in 2020 occurred in the fall after the bulk of mature spawning-age kokanee vacated ARR. As such, surveys were meant to assess the relative abundance in younger year classes that represent the future of the fishery (Peterson et al. 2018). Kokanee CPUE decreased and mean length of collected fish increased in 2020 compared to 2019 surveys but are still well below catch rates in 2017 and 2018. This pattern suggests that densities of kokanee in ARR were heavily affected by the 2017 washout in the upper SFBR. Low numbers of age-1 and age-2 kokanee in our sample may indicate relatively weak year classes produced following high flow events. Future surveys will help determine the rate at which naturally occurring kokanee abundance recovers. In the meantime, hatchery supplementation of the population should continue to maintain the fishery.

Mean CPUE for Chinook Salmon declined 65% from 2019 surveys. In addition, the proportion of wild-origin fall Chinook Salmon observed during netting surveys was 75%, which represents a slight decrease from 2019 encounter rates. Declines in netting CPUE show a consistent reduction in the abundance of Chinook Salmon in ARR since 2019 highs. Stocking of approximately 5,000 to 10,000 hatchery Chinook Salmon into ARR occurred annually from 2016 to 2019 but has not occurred thereafter, which may explain some of the decline in catch rates. Although catch rates have declined, most fish encountered in net surveys and angler creel surveys are wild-origin, making it clear that natural recruitment of Chinook Salmon continues to occur in ARR and may support this fishery as hatchery-origin fish continue to phase-out over time. Future angler and netting surveys will shed light on wild fish recruitment success in the absence of continued supplemental stocking efforts. This data will be crucial to the management of ARR kokanee populations as increased Chinook Salmon abundance may negatively affect kokanee populations through increased predation.

The kokanee and fall Chinook Salmon fisheries in Anderson Ranch Reservoir are highly popular with anglers and although annual angling effort is high, demand continues to increase. The current trend monitoring and angler survey data suggests that this fishery has experienced significant declines, which is cause for concern. However, it is uncertain whether abundance declines will continue as the fishery recovers from high runoff events and angler overharvest. Through continued monitoring of angler catch and effort, population demographics, and trends over time, managers will better understand this complex fishery and improve the management of it to benefit the angling public.

RECOMMENDATIONS

1. Continue to stock hatchery-origin juvenile kokanee in ARR to supplement natural recruitment. Evaluate hatchery stock contribution to fishery using otolith thermal marking techniques.

2. Develop index netting program (i.e., fry trawling or instream fry trapping) to monitor stock contribution and natural recruitment of kokanee and Chinook Salmon to the fishery.

3. Continue annual fall index gill netting to monitor kokanee and Chinook Salmon relative abundance and demographics.

4. Continue to employ an annual angler index creel survey during June - July to determine if the fishery is meeting set management objectives of 0.5 fish/h of kokanee ≥305 mm.

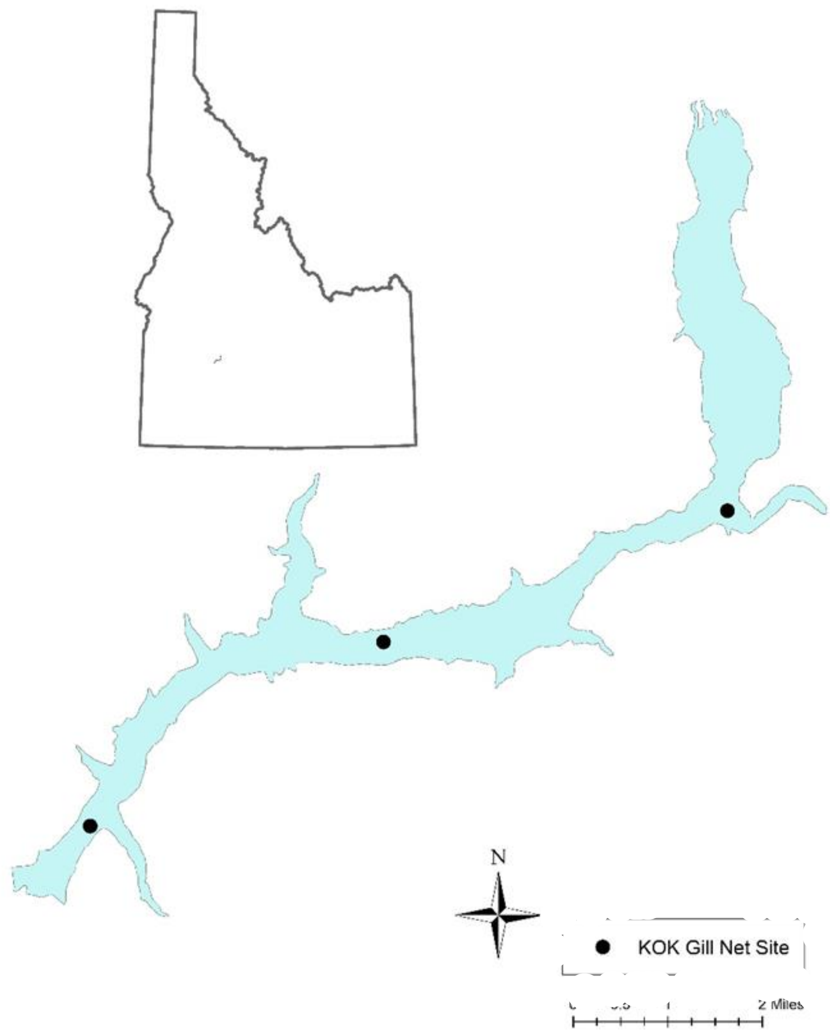

Figure 1. Lower, middle, and upper gill netting sites on Anderson Ranch Reservoir in September 2020.

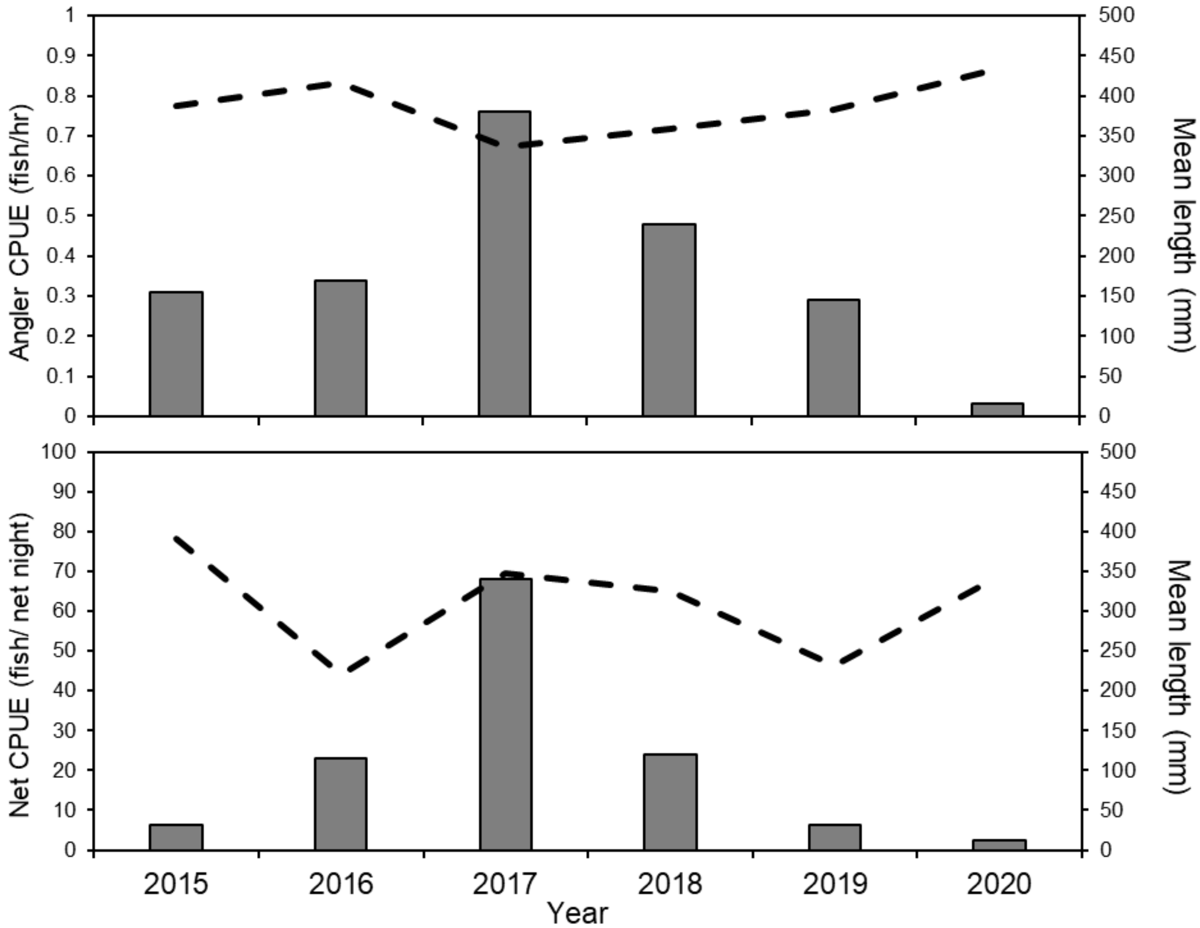

Figure 2. Catch-per-unit-effort (CPUE) for kokanee harvested by anglers (top panel) and collected during gill netting surveys (bottom panel) in Anderson Ranch Reservoir, Idaho from 2015 to 2020. The dashed line represents the mean total length (mm) of fish collected by their respective method.

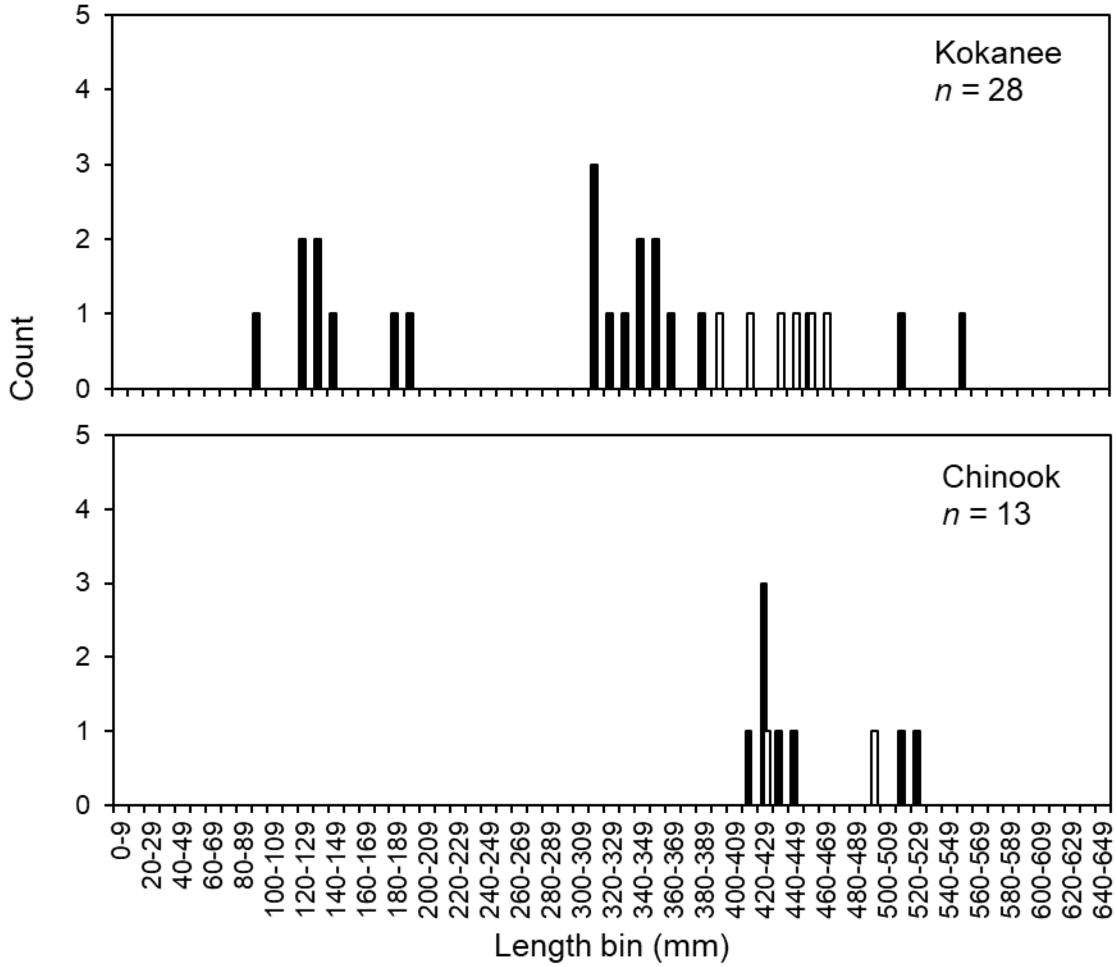

Figure 3. Length-frequency of kokanee (top panel) and Chinook Salmon (bottom panel) collected at angler check stations (white bars) and during gill netting surveys (black bars) at Anderson Ranch Reservoir in 2020.

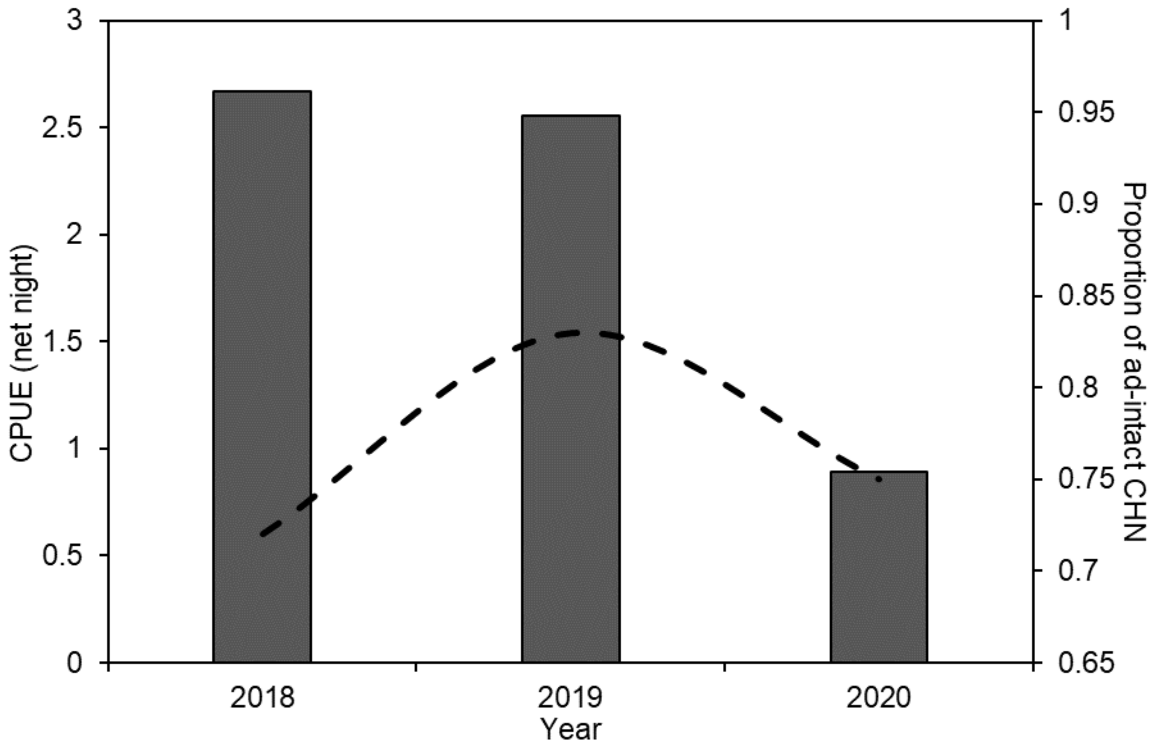

Figure 4. Catch-per-unit-effort (CPUE) for fall Chinook Salmon (CHN) collected during gill netting surveys on Anderson Ranch Reservoir in September 2020. Dashed line represents proportion of total catch with an intact adipose fin (i.e., wild origin).

SALMON FALLS CREEK RESERVOIR LOWLAND LAKE SURVEY

ABSTRACT

Salmon Falls Creek Reservoir (SFCR), built in 1910, is a 1,376-ha irrigation impoundment located on Salmon Falls Creek in Twin Falls County, Idaho and is owned and operated by the Salmon River Canal Company. Historically the reservoir has been managed as a mixed species fishery for Rainbow Trout *Oncorhynchus mykiss*, Walleye *Sander vitrius*, kokanee *Oncorhynchus nerka*, Yellow Perch *Perca flavescens*, Smallmouth Bass *Micropterus dolomieu*, and Black Crappie *Pomoxis nigromaculatus*. Currently, it is primarily recognized as one of only three sanctioned Walleye fisheries in Idaho. In 2020, a lowland lake survey was conducted. A total of 879 fish comprised of seven different species were sampled. Gamefish made up 99.2% of the total count of fish sampled with Walleye (53.1%), Rainbow Trout (25.6%) and Smallmouth Bass (14.7%) comprising the majority. Nongame fish (i.e., Largescale Sucker and Northern Pikeminnow) made up the remaining 0.8%. Proportional size distribution for Walleye, Rainbow Trout, and Smallmouth Bass was 10, 26, and 9, respectively and was relatively poor overall. Yellow Perch was the exception, which had a PSD of 98. Total length of sampled Walleye varied from 206 to 681 mm with 72.4% between 250 to 350 mm. Overall, Walleye and Smallmouth Bass appear to be declining in both size structure and relative weight. Continued monitoring and study of this important regional fishery is warranted.

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INTRODUCTION

Salmon Falls Creek Reservoir (SFCR), built in 1910, is an irrigation impoundment located on Salmon Falls Creek in Twin Falls County, Idaho and is owned and operated by the Salmon River Canal Company. The dam itself is 66 m high, 140 m long, and when the reservoir is full, impounds water 27 km upstream creating a 1,376-hectare reservoir. The dam and reservoir capture precipitation from a drainage basin of 4,200 km^2 found in both Nevada and Idaho. Much of the basin receives less than 25 cm of precipitation annually, while the mountainous areas may get up to 76 cm. The reservoir retains a large inactive storage capacity which helps maintain fish habitat, even in low water years. The reservoir has historically been managed as a mixed species fishery for Rainbow Trout *Oncorhynchus mykiss*, Walleye *Sander vitrius*, kokanee *Oncorhynchus nerka*, Yellow Perch *Perca flavescens*, Smallmouth Bass *Micropterus dolomieu*, and Black Crappie *Pomoxis nigromaculatus*. Since 2000, Idaho Department of Fish and Game (IDFG) has stocked the reservoir with primarily Rainbow Trout (7.2 million) and Walleye (7.6 million) in addition to other species (e.g., various trout hybrids and kokanee) in much lesser quantities to help maintain fishing opportunity for anglers. However, the reservoir is primarily recognized among anglers as a popular Walleye fishery. Additionally, it is one of only three IDFG authorized Walleye fisheries in Idaho.

In 2020, a standardized lowland lake survey was completed. While a variety of survey methodologies have been employed to evaluate specific fisheries in SFCR in the last 20 years (e.g., FWIN surveys, spring bass electrofishing surveys), this was the first standardized lowland lake survey conducted to evaluate the fish community as a whole. The survey was completed to gain a better understanding of species composition and relative abundance of the fish species found in the reservoir.

METHODS

Idaho Department of Fish and Game's (IDFG) standard fish sampling protocol of lowland lakes and reservoirs in Idaho survey (Lamansky and Meyer 2012) was referenced to design the survey in Salmon Falls Creek Reservoir. The reservoir was divided into three strata (i.e., upper, middle, and lower; Figure 5) and was sampled using boat electrofishing, trap nets, and gill nets. Sampling occurred between May 19^{h} and May 27th, 2023. Sampling locations were selected at random based on protocol guidelines. Sampled fish were identified to species and all fish were measured for total length (TL; ±1 mm). Weight (±1 g) was recorded for a subsample of each species. Spines were collected from a subsample of Walleye (n = 91) and Smallmouth Bass (n = 79) to evaluate age structure and estimate mortality and growth rates of these species.

A total of 18 sites, six per stratum (i.e., upper, middle, and lower) were electrofished (Appendix A, Figure 5). All electrofishing sites were sampled for approximately 600 s (i.e., power on time). A Midwest Lake Electrofishing System (MLES) Infinity Box System set at 25% duty cycle and 60-Hz frequency paired with Smith-Root, AUA-6 Anode arrays was used to apply electrical current to the water. Power output was standardized to 2,200 to 3,200 watts of pulsed DC power and was generated by a 7,000-watt Honda generator. Two individual netters attempted to collect all fish encountered with dip nets. Catch-per-unit-effort (CPUE) was standardized to fish per hour (fish/h) and was calculated for each individual electrofishing site. Then, mean CPUE was calculated for each stratum (e.g., upper, middle, lower) by dividing the sum of the calculated CPUE for each site by the number of sites surveyed (e.g., CPUE Site 1+CPUE2+……. +CPUE6/6 sites per strata = strata mean CPUE). Mean CPUE was also calculated for the entire reservoir in the same manner.

Trap nets were set at 18 locations, six per stratum (Appendix A, Figure 5). Trap nets possessed 23-m leads, 1-m x 2-m frames, crowfoot throats on the first and third of five loops, and 13 mm bar mesh. Nets were set perpendicular to the shoreline and allowed to fish overnight for at least 12 hours, which equaled one unit of trap net effort (net-night). CPUE was calculated for each individual net. Mean CPUE was also calculated for each stratum and for the total reservoir.

A total of three paired gill nets (i.e., one sinking and one floating) were set in each stratum of the reservoir for a total of 9 pairs of gill nets (Appendix A, Figure 5). Gill nets were eight-panel monofilament nets 1.8 m deep, 61.0 m long, with 7.6-m panels measuring 25-, 38-, 51-, 64-, 76-, 102-, 127-, and 152-mm stretched mesh. Nets were set perpendicular to the shoreline and allowed to soak overnight for at least 12 hours, which equaled one unit of gill net effort. CPUE was calculated for each individual net. Mean CPUE was then calculated for each stratum and for the reservoir as described above.

The relative weight (W_r) formula:

$$W_r = (W/W\_s) \times 100,$$

where W is the weight of the fish and W_s is the length-specific standard weight of the fish (Wege and Anderson 1978; Kolander et al. 1993; Neumann et al. 2012) was used to provide W_r estimates for Walleye, Rainbow Trout, Smallmouth Bass, and Yellow Perch. Proportional size distribution (PSD) was calculated based on the formula:

$$\text{PSD} = (\text{Number of fish} \geq \text{quality length})/(\text{Number of fish} \geq \text{stock length})$$

(Gablehouse 1984; Neumann et al. 2012) and was used to estimate PSD for Walleye (stock = 250 mm, quality = 380 mm), Rainbow Trout (stock = 250 mm, quality = 400 mm), Smallmouth Bass (stock = 180 mm, quality = 280 mm), and Yellow Perch (stock = 130 mm, quality = 200 mm). Age was estimated for Smallmouth Bass and Walleye from sectioned spines. A von Bertalanffy growth curve was calculated for Smallmouth Bass and Walleye

$$L_t = L_\infty \times (1 - e^{-K(t-t_0)}),$$

where L_t is the length of the fish at time t, L_∞ is the mean maximum length, K is the growth coefficient, and t_0 is the time when the length of the fish would theoretically equal 0 mm (von Bertalanffy 1938; Francis 1990; Quist et al. 2012). Mortality estimates were made for Walleye using the peak plus one method (Hoenig et. al 1983; Smith et. al 2012).

RESULTS

A combined total of 878 fish comprised of seven different species were sampled during the lowland lake survey at Salmon Falls Creek Reservoir (Figure 6). Gamefish (i.e., Brown Trout *Salmo trutta*, Rainbow Trout, Smallmouth Bass, Walleye, and Yellow Perch) made up 99.2% of the total count of fish sampled (Figure 6). Nongame fish, (i.e., Largescale Sucker *Catostomus macrocheilus* and Northern Pikeminnow *Ptychocheilus oregonsnsis* made up the remaining 0.8%.

A total of 299 fish were sampled during electrofishing surveys. Smallmouth Bass had the highest mean CPUE (± 90% CI) of 55.3 fish/h (± 30.5), followed by Rainbow Trout 25.6 fish/h (± 9.4), and Walleye 16.3 fish/h (± 9.6) (Figure 7). The upper section of the reservoir had the highest mean CPUE for both Smallmouth Bass (117.0 fish/h) and Walleye (32.0 fish/h) when compared to the middle and lower sections of the reservoir. For Rainbow Trout, the highest mean CPUE

(44.9 fish/h) was observed in the lower section of the reservoir. All remaining fish species sampled during electrofishing surveys had a mean CPUE of less than or equal to 1.0 fish/h.

Trap nets collected a total of 112 fish comprised of four species, which included Rainbow Trout, Smallmouth Bass, Walleye, and Yellow Perch. Walleye had the highest mean CPUE 4.6 fish/net-night (± 2.4), followed by Smallmouth Bass mean CPUE of 1.3 fish/net-night (± 0.8), Rainbow Trout mean CPUE of 0.3 fish/net-night (± 0.2), and Yellow Perch mean CPUE of 0.1 fish/net-night (±0.1) (Figure 8). Like the electrofishing surveys, trap net mean CPUE was highest in the upper section of the reservoir for both Walleye (7.2 fish/net-night) and Smallmouth Bass (2.8 fish/net-night) when compared to the middle and lower sections of the reservoir.

A total of 467 fish were sampled using gill nets. Walleye mean CPUE was highest at 9.4 fish/net-night (± 8.8), followed by Rainbow Trout and Yellow Perch with a mean CPUE of 2.1 fish/net-night (± 1.6), and 1.2 fish/net-night (± 2.5) respectively (Figure 9). Largescale Sucker, Northern Pikeminnow, and Smallmouth Bass all had a mean CPUE of < 0.5 fish/net-night. Mean CPUE for Walleye was highest in upper section of the reservoir (47.7 fish/net-night) when compared to the middle and lower sections of the reservoir. Mean CPUE for Rainbow Trout (7.0 fish/net-night) was highest in the upper section of the reservoir as well.

Proportional size distribution varied by species and was relatively poor to average with the exception of Yellow Perch which had a PSD of 98. Walleye PSD was 10, Smallmouth Bass PSD was 21, and Rainbow Trout PSD was 26 (Figure 10). Average W_r ranged from 85 to 104 among the sport fish sampled in our survey. Walleye, Smallmouth Bass, and Rainbow Trout had W_r values below the standard of 100 (Figure 11). Walleye had the lowest W_r with an average of 85. Conversely, Yellow Perch had an average W_r of 104. Total length for sampled Walleye varied from 220 to 681 mm with 77.5% between 250 to 350 mm (Figure 12) and an average length of 302 mm.

Walleye ages varied from two to nine years. A von Bertalanffy growth model was generated from the ageing data and length infinity ($L\infty$) was 643.9 mm (Figure 13). Additionally, Walleye total annual mortality (*A*) was calculated at 40.7% using a weighted catch curve and ages used for this analysis were assigned using an age-length key (Hoenig et. al 1983, Smith et al. 2012). Smallmouth Bass ages varied from one to nine years. A von Bertallanffy growth model was also generated for Smallmouth Bass from the ageing data and $L\infty$ was 393.5 mm (Figure 14).

DISCUSSION

In the past 20 years, various fisheries surveys (e.g., Fall Walleye Index Netting, forage fish, trout specific gill netting, and bass electrofishing) have been conducted on the reservoir, but this was the first lowland lake survey during that period. During this 20-year span, the fish community appears to have shifted. Most notably, there appears to be few forage fish (e.g., Yellow Perch, Crappie *Pomoxis sp.* and Spottail Shiner *Notropis hudsonius)* available that were present in historical surveys (Partridge et al. 2002). However, this decline in forage fish is not directly comparable as the reduction compares a forage fish seine survey completed in 2000 to the lowland lake survey completed in 2020. Regardless, the fisheries community in the reservoir now appears to be dominated by three predator fish species (i.e., Rainbow Trout, Smallmouth Bass, and Walleye), which made up a majority of the fish sampled during this survey. Additionally, the Walleye and Smallmouth Bass fisheries both appear to have experienced reductions in PSD and CPUE since 2007. The reductions should also be interpreted with caution as PSD and CPUE estimates compare results from a Fall Walleye Index Netting (FWIN) survey in 2007 and a bass-specific electrofishing survey in 2008 to our lowland lake survey in 2020. The reductions in PSD may be related to impaired growth from an over-abundance of predators competing for limited resources (e.g., forage fishes). The reduction in CPUE could possibly be explained by differences in sampling methodologies between survey types and (or) timing of the surveys (e.g., fall vs. spring, differences in fish behavior). Future standardized lowland lake surveys will provide additional context for the changes we observed in size structure and relative abundance.

Walleye PSD from the Ryan et al. (2008) survey declined from 54 in 2007 to 10 in the 2020 survey. Additionally, in 2007, 28 Walleye > 600 mm were sampled in the FWIN survey, while in 2020, only four Walleye > 600 mm were sampled in the lowland lake survey. Seventy-seven percent of Walleye sampled in 2020 were between 250 to 350 mm. Age and growth information estimated that Walleye from 250 to 350 mm could be anywhere from 3 to 9 years old, indicating slow growth. Stocking efforts (Walleye and Rainbow Trout) may have also added to the complexity of the situation. From 2000 to 2020 more than 7.6 million Walleye fry and more than 7.2 million Rainbow Trout (fry, fingerlings, and catchables) were stocked into the system. It is possible that stocking efforts, natural Walleye recruitment, and a reduction in forage base have all contributed to the reduced growth rates for Walleye. Similar to Walleye, we observed decreases in Smallmouth Bass CPUE and PSD, when compared to the most recent Smallmouth Bass electrofishing survey which took place in 2008 (Stanton et al. 2013). The lack of available forage and inter- and intra-specific competition are also likely the main drivers behind these declines.

Despite the abundant stocking of both Walleye and Trout from 2000 - 2020, the Rainbow Trout fishery appears to have changed very little when comparing data from the gill net portion of the survey in 2020 to the trout specific gill net survey that took place in 2008. A total of 12 floating gill-nets were set as part of the 2008 survey. Mean TL of Rainbow Trout was 360 mm and PSD was 39. Data from the gill net portion of the 2020 survey produced a mean TL of 376 mm and a PSD of 35 for Rainbow Trout. Additionally, evaluation of the length-frequency histogram indicates that multiple age classes of Rainbow Trout are present in the system and that a portion of the stocked trout are likely holding over for more than a year. Additional data is needed to determine if these fish are fingerling outplants (e.g., steelhead fingerlings) or catchable Rainbow Trout. An evaluation of age and growth for Rainbow Trout and a genetic analysis (e.g., parentage analysis) would help us determine the origin of these fish.

Further investigation into the changes in the fishery is warranted. Another standardized lowland lake survey should be conducted in 2023. This evaluation will provide additional insight when comparing findings to historical surveys but will also allow for comparison of surveys with identical methods (e.g., 2020 lowland lake survey vs. 2023 lowland lake survey). Furthermore, additional lowland lake surveys will allow managers to monitor how the fishery is currently functioning in terms of age-structure, growth rates, mortality rates, recruitment, and CPUE for the various fish species within the waterbody. Stocking of Walleye should be paused (in the short term) or significantly reduced until a follow-up survey can be conducted to evaluate how relative abundance of both the predator populations (e.g., Walleye, Smallmouth Bass, and Rainbow Trout) and prey base populations (e.g., Largescale Sucker, Northern Pikeminnow, Panfish, and Spottail Shiner) have responded to this proposed stocking reductions. As stated before, it is likely the extensive historical stocking has impacted the forage base and decreased growth rates, negatively. Also, an investigation into angler exploitation and use should be conducted to determine the effect, if any, anglers may or may not be having on these fisheries. These forthcoming surveys will assist in determining whether reduced stocking and angler harvest can effectively reduce predator abundance and increase prey base in this reservoir.

RECOMMENDATIONS

1. Complete another standardized lowland lake survey on the reservoir in 2023.

2. Significantly reduce Walleye stocking in the reservoir until relative abundance is determined in the next standardized survey. If CPUE significantly decreases, determine the appropriate stocking rates based off a literature review of stocking densities.

3. Determine the relative composition of wild-origin and hatchery-origin Walleye in the population.

4. Evaluate total angler use and exploitation for Walleye, Smallmouth Bass and Rainbow Trout using the Tag-You're-It program.

5. Evaluate Rainbow Trout age and growth. Also, collect genetic fin clips to determine the origin of the older age classes of Rainbow Trout (e.g., steelhead fingerlings vs. catchables).

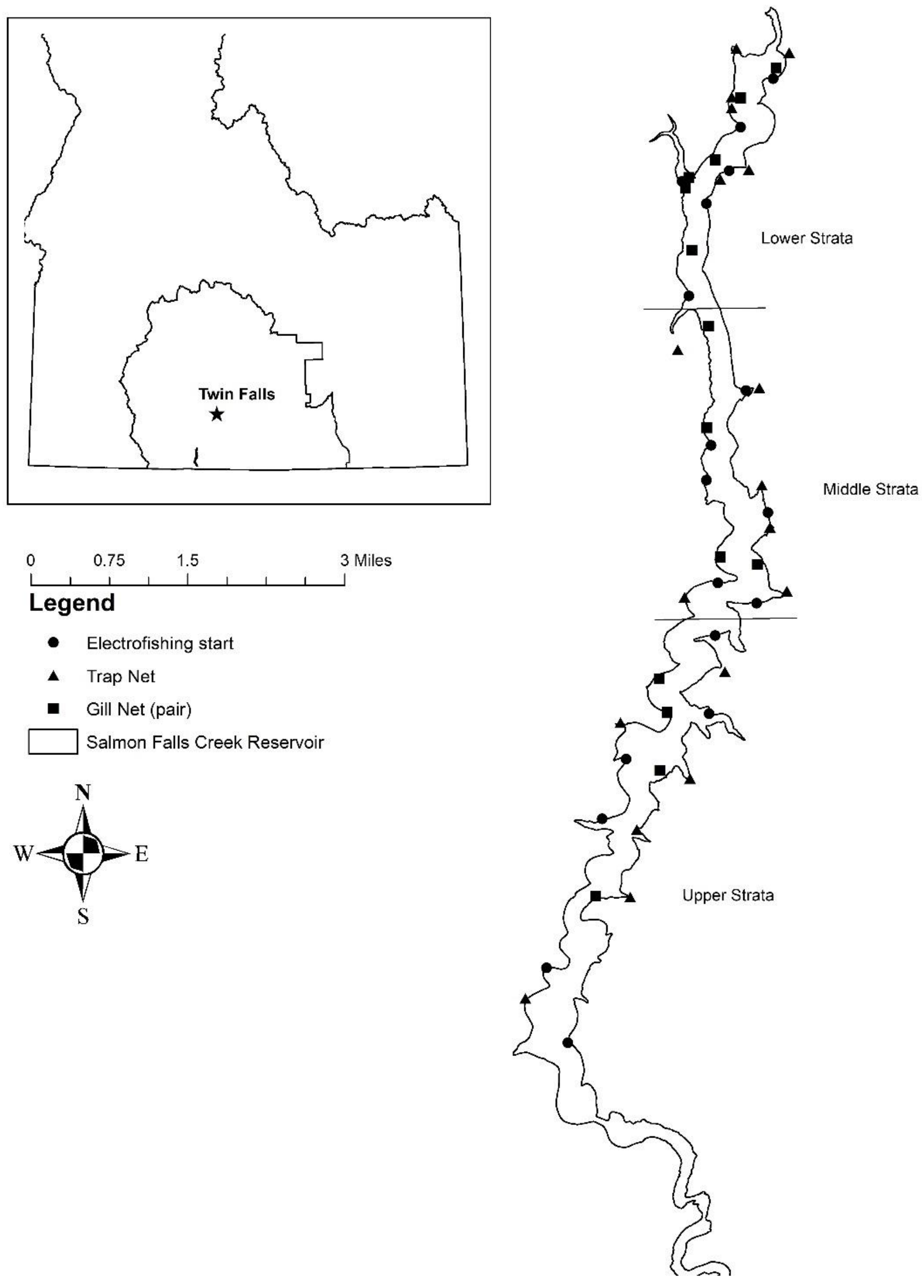

Figure 5. Map of Salmon Falls Creek Reservoir sampling locations that occurred in May 2020. Upper, middle, and lower boundaries are indicated by a solid black line. Gill net sites are indicated by a black square, trap net sites are indicated by a black triangle, and electrofishing sites are indicated by a black circle.

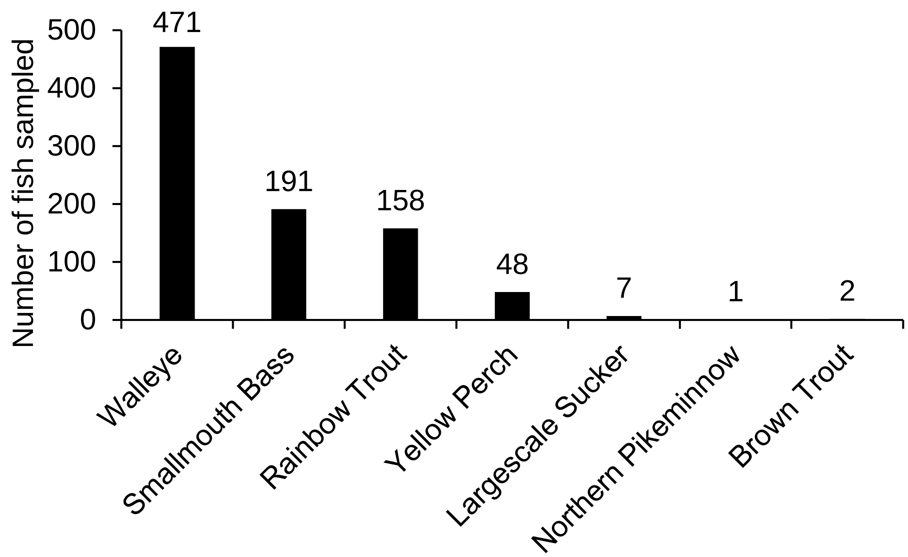

Figure 6. Estimated species composition for species sampled using electrofishing, gill net, and trap net surveys on SFCR, in May 2020.

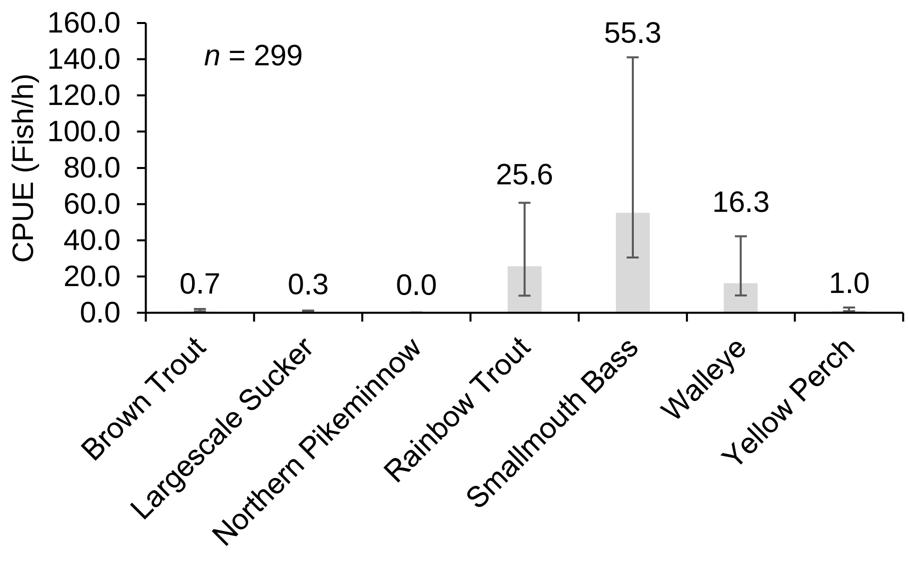

Figure 7. Calculated CPUE (fish/h) of each fish species sampled during electrofishing surveys on SFCR, in May 2020.

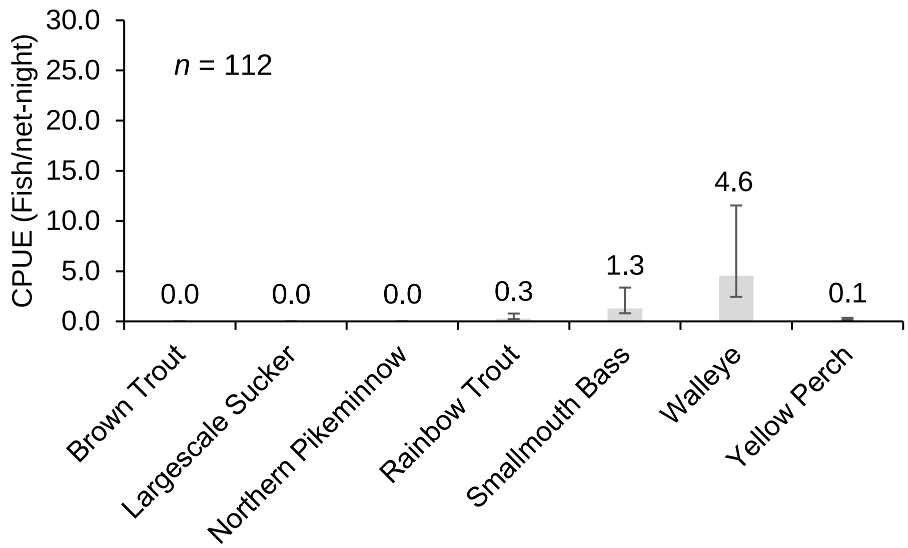

Figure 8. Calculated CPUE (fish/net-night) of each fish species sampled during trap net surveys on SFCR, in May 2020.

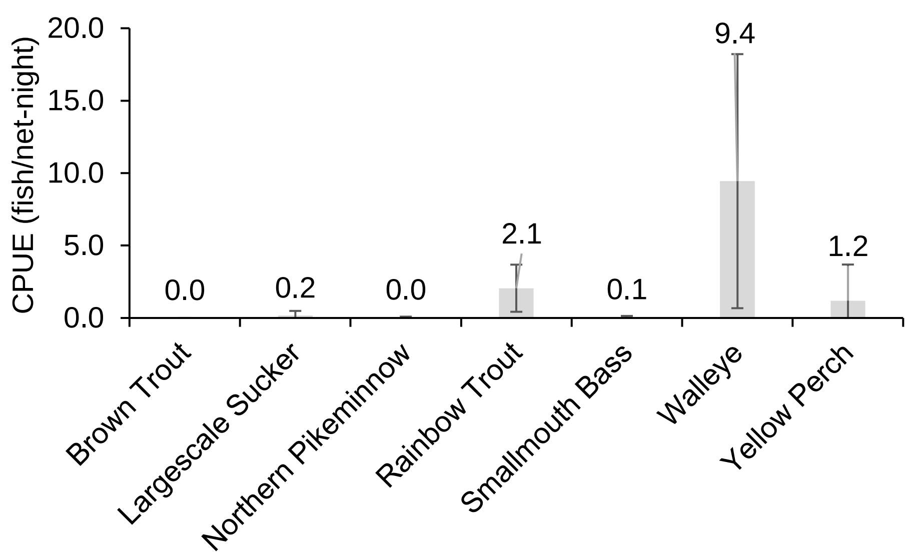

Figure 9. Calculated CPUE (fish/net-night) of each fish species during gill net surveys on SFCR, in May 2020.

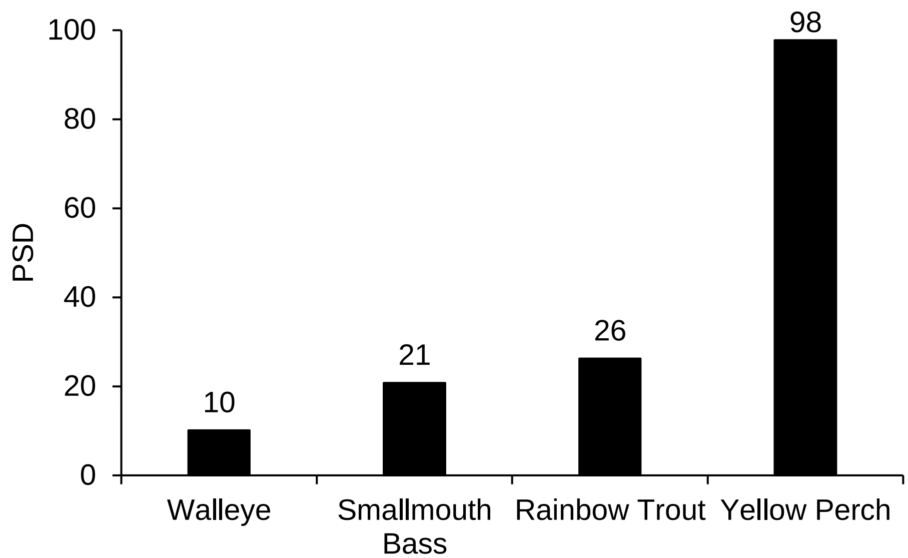

Figure 10. Proportional size distribution of selected game fish sampled during the lowland lake survey on SFCR, in May 2020. Sample sizes of stock length fish by species was 122, 130, 425, and 45 for Rainbow Trout, Smallmouth Bass, Walleye, and Yellow Perch, respectively.

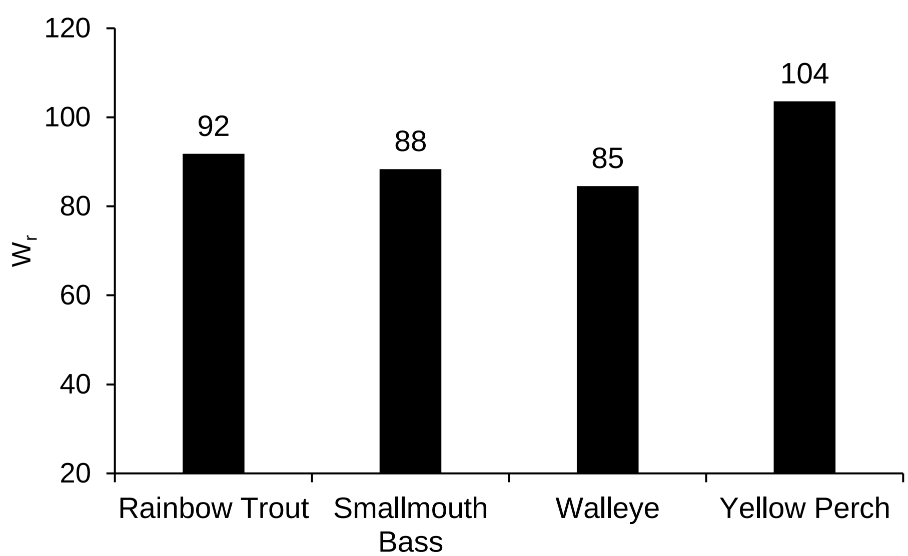

Figure 11. Relative weight of selected game fish sampled during the lowland lake survey on SFCR, in May 2020. Sample sizes by species were 100, 25, 129, and 36, for Rainbow Trout, Smallmouth Bass, Walleye, and Yellow Perch, respectively.

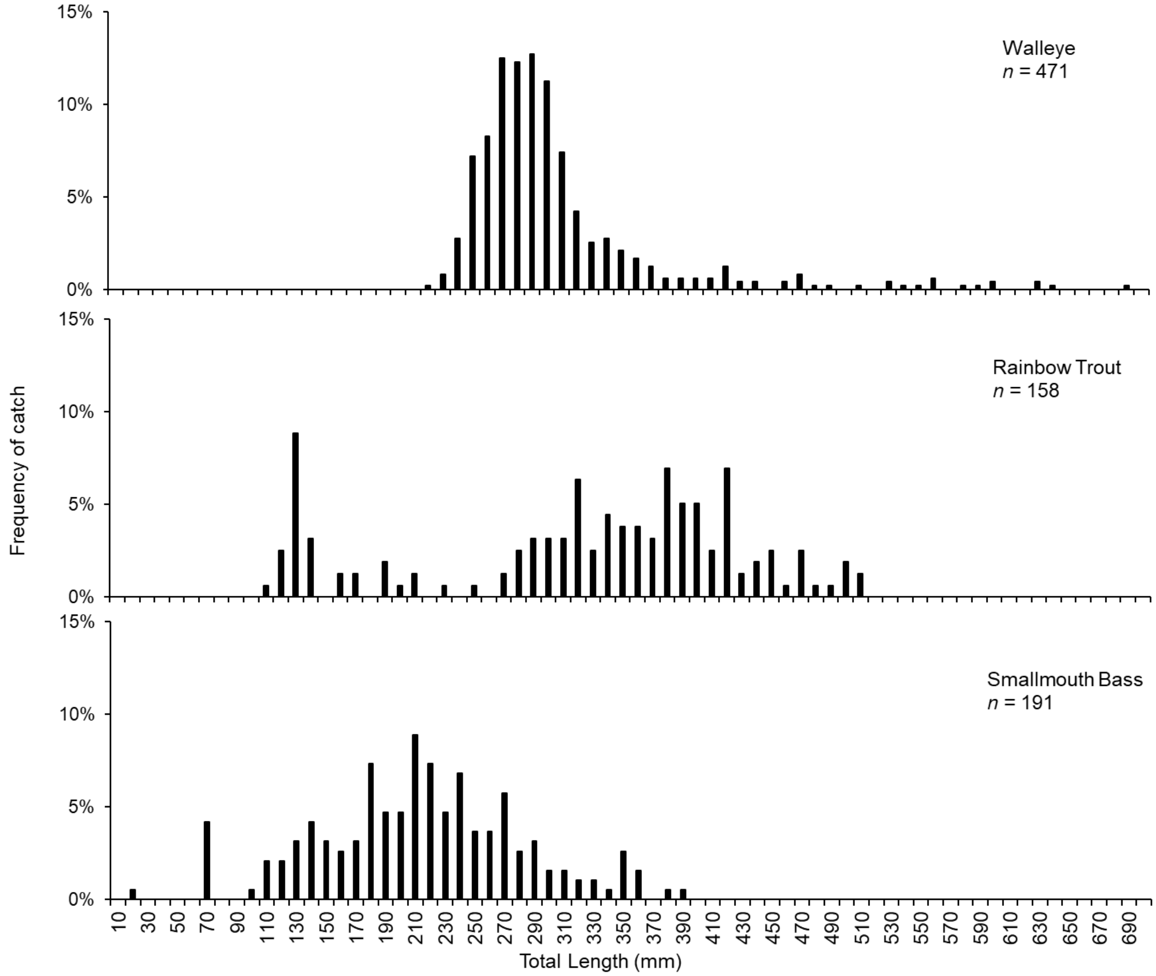

Figure 12. Length-frequency histograms for Walleye, Rainbow Trout, and Smallmouth Bass sampled during the lowland lake survey on SFCR, in May 2020. Sample size for each species is provided.

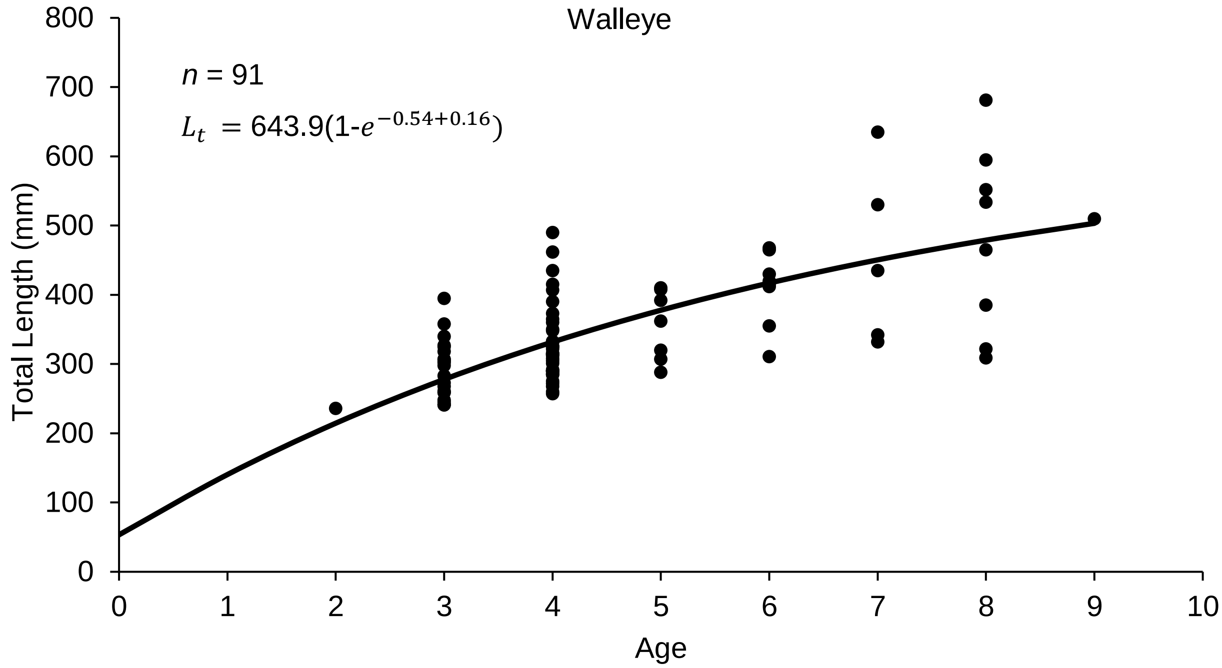

Figure 13. Von Bertalanffy growth estimate of Walleye sampled during the lowland lake survey on SFCR, in May 2020.

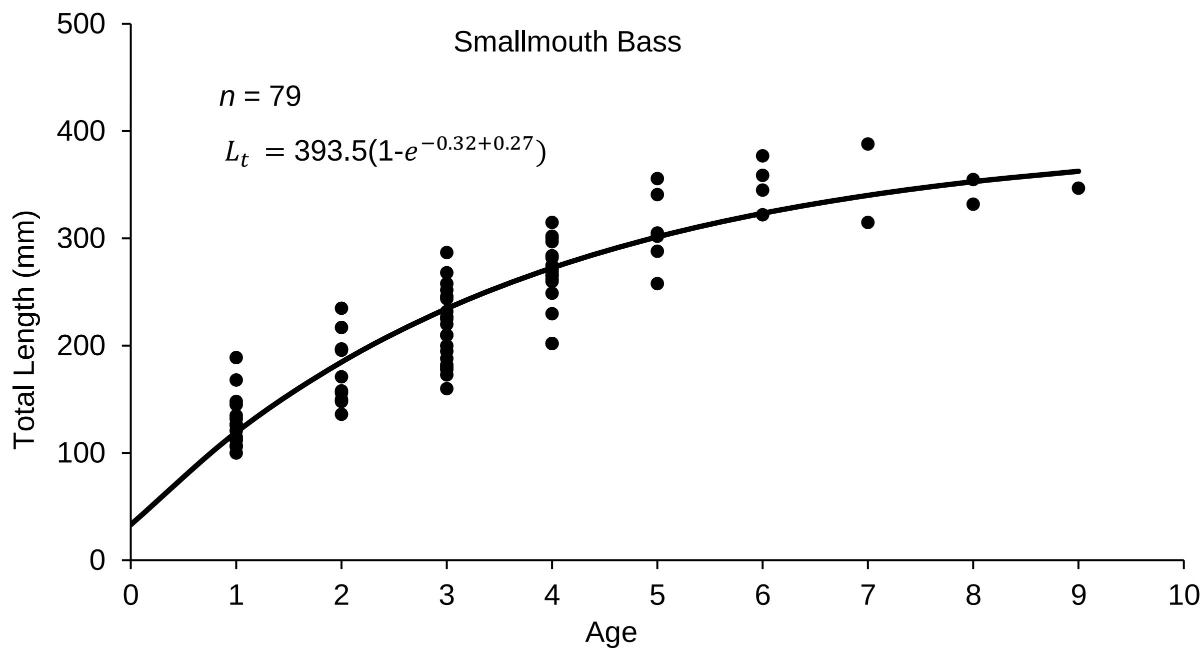

Figure 14. Von Bertalanffy growth estimate of Smallmouth Bass sampled during the lowland lake survey on LSFR, in May 2020.

REGIONAL EXPLOITATION EVALUATIONS

ABSTRACT

Understanding angler use and harvest rates remain integral to management of sportfishing opportunities throughout Idaho. With the initiation of the “Tag-You’re-It” Program, angler use and harvest rates have been evaluated in numerous regional waters since 2006. Data provided by this program allows managers to make informed decisions regarding stocking rates and harvest regulations for specific waters. Regional staff continue to use this program to collect tag-return data in wild fisheries and in waters regularly stocked by hatcheries. In 2019, 607 fish were tagged and released in 14 water bodies in the Magic Valley Region. Anglers reported 15 of these tagged fish after one year at large. Of the reported fish, anglers harvested 6. Total use estimates for waters studied in 2020 varied from 0 to 50% and exploitation rates varied from 0 to 14%. This tool will continue to be used to evaluate angler use and harvest of wild and hatchery fishes in the future.

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INTRODUCTION

Idaho Department of Fish and Game (IDFG) fish hatcheries are integral to managing sportfishing opportunities in Idaho. In 2020, the IDFG stocked approximately 820,000 hatchery-reared “catchable” sized Rainbow Trout (10 to12”; herein “catchables”) into 81 different waters throughout the Magic Valley Region. These stocked trout support a number of public fisheries and represent a significant proportion of angling opportunity throughout the region. In addition to opportunities provided via stocking, the Magic Valley Region is home to a multitude of naturally-sustained wild fisheries. Given the popularity of both wild and stocked fisheries, it is very important for managers to understand the levels of angler use and exploitation to inform both stocking rates and fishing regulations for specific fisheries. As such, angler use and exploitation are the most useful parameters for evaluating the effects of angler harvest of fish populations. In Idaho, the development of the IDFG “Tag-You’re-It” (TYI) program has allowed fisheries managers to estimate these rates with relative ease since 2006.

The TYI program was developed to estimate both angler use and harvest in fisheries. A subsample (i.e., 10% minimum) of stocked or captured fish are tagged with individually numbered, highly visible T-Bar anchor tags that include contact information for anglers to report their catch. Tagged fish are then released into a specific waterbody and allowed to mix with the untagged fish population. Exploitation and use rates are then calculated based on the proportion of tags reported by anglers, adjusted to account for species-specific tag-loss rates, tagging mortality rate, and angler-reporting rates (Meyer and Schill 2014). Since its inception, the TYI program has been widely used by IDFG biologists to better understand angler use and exploitation throughout the state, including fisheries in the Magic Valley Region.

The Magic Valley Region is home to a variety of popular coldwater fisheries regularly stocked by IDFG hatcheries. To inform these stocking efforts, hatchery fish are regularly tagged and released to estimate angler use and exploitation. In addition, wild fish are often tagged during survey efforts to gain additional understanding of angler use and harvest in wild fisheries. This study investigated the angler use and harvest rates in 14 fisheries throughout the Magic Valley Region for fish tagged in 2019. Information collected from these investigations will be used to inform management of these fisheries going forward.

METHODS

Tagging took place throughout the Magic Valley Region from May 2019 to October 2019. In total, 607 fish were tagged including 404 hatchery-origin Rainbow Trout *Oncorhynchus mykiss* from Hagerman State Hatchery, 92 were tiger muskellunge *Esox lucius* × *Esox masquinongy* from Hagerman State Hatchery, 50 were wild Bluegill *Lapomis macrochirus*, 48 were Cutthroat Trout *Oncorhynchus clarkia* from Mackay Hatchery, eight were Artic Grayling *Thymallus arcticus* from Mackay Hatchery and 4 were wild-origin Brown Trout *Salmo trutta* (Table 1). Wild fish were all collected via angling gear or electrofishing equipment. IDFG evaluated angler exploitation and use from angler returned T-bar anchor tags attached posterior to the dorsal fin. Tag loss, tagging mortality, and reporting rates were taken from McCormick and Meyer (2018).

Angler use and exploitation data was based on the anchor tags that were reported by anglers (for a detailed description of the angler tag reporting system used, see Meyer and Schill 2014). In short, anglers could report tags using the IDFG “Tag-You’re-It” phone hotline and website (developed specifically for this program), as well as in-person at IDFG offices or by mail. Anchor tags are labeled with “IDFG” and a tag reporting phone number on one side, with a unique tag number on the reverse side.

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

$$\mathrm{c}' = c/(\lambda(1 - Tagl)(1 - Tagm))$$

Finally, days-at-large of tagged trout that were eventually caught post-stocking was calculated by subtracting the stocking date from the reported catch date.

RESULTS AND DISCUSSION

Baker Lake

Baker Lake is a 3.5-hectare alpine lake located in Blaine County. The lake was sampled via angling gear in July 2019 to collect fish for tagging. This lake receives triennial stocking of Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* and Golden Trout *Oncorhynchus aguabonita*. A total of 4 Brown Trout were collected and tagged during the survey. No tags were reported by anglers after one-year post-release. Since no tags were returned, we were unable to describe the total use or exploitation of Brown Trout in Baker Lake. This is likely an underestimate due to the small sample size of tagged fish (n = 4) and lack of any returned tags. The lake receives a high number of recreational visitors annually, many of which fish during their visits. As such, additional tagging in Baker Lake is warranted to increase sample size and produce a reliable estimate of use and exploitation. Additionally, given the presence of Brown Trout in the Lake, additional stocking should be avoided as survival of stocked triploid Cutthroat Trout appears to be very low. Additional management action (e. g., rotenone, or manual gill net removal) should be considered to remove Brown Trout prior to continued Cutthroat Trout stocking.

Big Lookout Lake

Big Lookout Lake is a 3.6-hectare alpine lake located in Elmore County. The lake receives triennial stocking of approximately 1,000 Westslope Cutthroat Trout. Big Lookout Lake was sampled via angling gear in July 2019 to collect fish for tagging. A total of 4 Westslope Cutthroat Trout were tagged during the effort. Of these fish, one was reported by an angler but was not harvested. This resulted in use and exploitation estimates of 50% and 0%. These estimates are confounded due to low sample size. These estimates suggest the current stocking rates are sufficient to maintain this alpine lake fishery.

Blair Trail Fishing Pond

Blair Trail fishing pond is a 4-hectare family fishing water located in Elmore County. This waterbody receives frequent stocking of catchable Rainbow Trout during the early spring and fall seasons. A total of 99 fish were tagged at the hatchery prior to stocking in May 2019 to estimate use and exploitation rates. Of those tagged fish, one fish was reported as harvested following one-year at large. This suggests a use and exploitation rate of 2% in the fishery. Given the low level of use by anglers, spring stocking rates could likely be reduced, and those fish be reallocated to other waters within the region. To gain a more complete understanding of this fishery, tags should be placed into stocked Rainbow Trout released in the fall. This would be useful to determine if the fall outplants are utilized during the winter ice fishery.

Dog Creek Reservoir

Dog Creek Reservoir is a 21-hectare lowland lake located in Gooding County. The waterbody contains popular fisheries for a variety of sportfish species. To diversify these opportunities, IDFG has stocked tiger muskellunge in the lake annually since the early 2000's and harvest of this species is regulated under restrictive bag limits (2 fish, none under 40 inches). We tagged 92 tiger muskellunge prior to stocking in May 2019. After one year, no fish were reported by anglers suggesting that use of these fish is 0% within the first year following release. The low level of use by anglers is potentially due to the believed poor survival of tiger muskellunge in the water body based on infrequent reporting by anglers from previous stocking events. Long-term evaluation of tag-returns by anglers will be more informative as to the use of this fishery over time. Methods to improve stocked tiger muskellunge survival should also be evaluated.

Dunes Lake

Dunes Lake is a 40-hectare pond located in Owyhee County. The lake receives no supplemental stocking by hatcheries and contains a popular fishery for Largemouth Bass *Micropterus salmoides* and Bluegill. Currently, there are no limits on harvest of Bluegill in the pond and a trophy-bass regulation is in place (2 fish; none under 20-inches). To better understand use and exploitation of these species, 50 Bluegill were collected via electrofishing and tagged in June 2019. After one year, a total of 2 Bluegill were reported as caught and released. This resulted in a use estimate of 8% and an exploitation rate of 0%. Although this fishery sees a significant amount of use, most of this use is likely targeting bass given the quality fishery that exists. Future surveys should focus on use and exploitation of Largemouth Bass to gain a better picture of overall fishery utilization by the public.

Goat Lake

Goat Lake is a 2.1-hectare alpine lake located in Camas County. This lake receives triennial stocking of 1,000 fingerling Rainbow Trout and is managed under general harvest bag limits. In August 2019, a total of 15 Rainbow Trout were collected via angling gear and tagged to evaluate angler use and harvest. Of those fish tagged, 2 fish were reported by anglers, and one of those fish was harvested. These returns suggest a use rate of 27% and exploitation rate of 14%. Based on these results, use and harvest are moderate and the current stocking schedule is likely sufficient to maintain this fishery.

Independence Lakes

The Independence Lakes are a trio of alpine lakes located in Cassia County. Two of the three lakes are stocked regularly with Arctic Grayling *Thymallus articus* and Westslope Cutthroat Trout. The third lake, although stocked historically, is no longer stocked due to poor habitat and survival of stocked fish. The two stocked lakes are managed under general harvest regulations. In August 2019, a total of 1 Cutthroat Trout was collected via angling gear (CPUE = 0.66 fish/h) and tagged in the lower lake and an additional five Cutthroat Trout (CPUE = 0.7 fish/h) and eight Arctic Grayling (CPUE = 1.15 fish/h) were collected and tagged in the upper lake. Of those fish tagged, no fish were reported by anglers in either lake suggesting use and harvest rates are likely very low. However, due to small sample sizes, these are likely underestimates given the significant recreational use these lakes receive during the summer season. Additionally, angling survey catch rates suggest that the current stocking program is appropriate.

Norton Lakes

Upper and Lower Norton Lake are a pair of alpine lakes located in Blaine County. These lakes are accessible via the Norton Lakes Trailhead and receive a high number of visitors annually given their proximity to population centers and ease of access. IDFG stocks these lakes on a triennial basis with approximately 1,000 Rainbow Trout each. To assess the level of angler use and exploitation in these lakes, fish were collected via angling gear and tagged in August 2019. Eighteen fish were tagged in the upper lake, and an additional 13 fish were tagged in the lower lake and released. After one year, only one fish was reported by an angler in the lower lake suggesting a use estimate of 16%. No fish were reported from the upper lake. These estimates suggest that angler use of the Norton Lakes fishery is moderate and that current stocking rates are sufficient to maintain the fishery.

Mormon Reservoir

Mormon Reservoir is 635-hectare lowland lake located in Camas County. The waterbody contains a popular Rainbow Trout fishery and receives annual stocking of both fingerling and catchable hatchery Rainbow Trout. A total of 200 catchable Rainbow Trout were tagged prior to stocking in May 2019. One fish was reported by an angler as harvested, suggesting use and harvest rates in Mormon Reservoir are 1%. These estimates were likely confounded by poor water conditions in the reservoir. Low water levels were experienced shortly after stocking in June 2020 and this likely effected survival and subsequent angler catch rates. Future stocking should only occur when projected water conditions are more favorable to avoid poor survival of stocked trout.

Scotts Pond

Scotts Pond is a 0.2-hectare waterbody located in Jerome County. This pond was stocked in 2018 for the first time since 2003 to provide additional angling opportunities in the Jerome area. In 2019, two stocking events occurred in the pond in March and October. To establish the angler use for the waterbody throughout the year, IDFG tagged Rainbow Trout in both spring and fall stockings. A total of 25 Rainbow Trout were tagged in the spring and an additional 30 fish were tagged during the fall outplant. Of those fish tagged in the spring, three were reported by anglers, one of which was harvested. Of the trout tagged in the fall, two were reported as harvested by anglers. Based on tag returns, mean use and harvest rates for Scotts Pond were estimated to be 19% and 11%, respectively. These estimates suggest a moderate level of use by anglers and stocking rates are sufficient to support the fishery.

South Fork Ross Creek Lakes

South Fork Ross Creek Lake #2 and #3 are 3.2-hectare alpine lakes located in Camas County. Lake #2 is stocked with Westslope Cutthroat Trout and lake #3 is stocked with Rainbow Trout on a triennial basis. In August 2019, fish were collected in each lake via angling gear for tagging. In total, 23 Westslope Cutthroat Trout were tagged and released in lake #2 and an additional 4 cutthroat were tagged in lake #3. Additional tagging of 14 Rainbow x Cutthroat hybrids and 4 Rainbow Trout also took place in lake #3. Of the tagged fish in lake #2, one was reported by an angler and released which suggests use and harvest are 9% and 0% respectively. No tagged fish in lake # 3 were reported by anglers which suggests use and harvest are 0%. These estimates suggest use of this fishery is low and that stocking at the current rates are sufficient to maintain the opportunity.

RECOMMENDATIONS

1. Cease stocking in Baker Lake until Brown Trout can be removed. Reallocate Golden Trout to another lake within the region.

2. Maintain current stocking schedule in Big Lookout Lake.

3. Consider reducing the stocking rate in Blair Trail Pond if angler use does not increase. Also, tag fall outplants to determine use from that release group.

4. Re-evaluate rearing and stocking methods to improve Tiger muskie survival rate and return-to-creel at Dog Creek Reservoir.

5. Maintain current stocking schedule in Goat Lake.

6. Continue to investigate use and exploitation rates of Largemouth Bass in Dunes Lake.

7. Continue to investigate use and exploitation rates of trout and Grayling in Independence Lakes.

8. Maintain stocking schedule in Mormon Reservoir with stocking only occurring during favorable water years.

9. Maintain current stocking schedule in Scotts Pond.

10. Maintain current stocking schedule in South Fork Ross Creek Lakes.

Table 1. Summary of waterbodies where fish were tagged in 2019. Species, tagging date, number of fish tagged, number of reported tags, and estimates of angler use and exploitation are provided.

Waterbody	Species	Hatchery	Tagging date	Fish tagged	Reported/ Harvested	Angler use	Exploitation (μ)
Baker Lake	Brown Trout (Wild)	N/A	7/29/2019	4	0/0	0%	0%
Big Lookout Lake	3N Cutthroat trout	Mackay	7/25/2019	4	1/0	50%	0%
Blair Trail Reservoir	3N Rainbow Trout	Hagerman	5/7/2019	99	1/1	2%	2%
Dog Creek Reservoir	Tiger muskie	Hagerman	5/28/2019	92	0/0	0%	0%
Dunes Lake	Bluegill	N/A	6/11/2019	50	2/0	8%	0%
Goat Lake	Rainbow Trout	Mackay	8/21/2019	15	2/1	27%	14%
Independence Lake #1	3N Westslope Cutthroat	Mackay	8/8/2019	1	0/0	0%	0%
Independence Lake #2	Arctic Grayling	Mackay	8/7/2019	8	0/0	0%	0%
Independence Lake #2	3N Westslope Cutthroat	Mackay	8/7/2019	3	0/0	0%	0%
Upper Norton Lake	Rainbow Trout	Mackay	8/18/2019	18	1/0	0%	0%
Lower Norton Lake	Rainbow Trout	Mackay	8/18/2019	13	1/0	16%	0%
Mormon Reservoir	3N Rainbow Trout	Hagerman	5/7/2019	200	1/1	1%	1%
Scotts Pond	3N Rainbow Trout	Hagerman	3/27/2019	25	3/1	24%	8%
Scotts Pond	3N Rainbow Trout	Hagerman	10/11/2019	30	2/2	14%	14%
S. F. Ross Creek Lake #2	3N Westslope Cutthroat	Mackay	8/23/2019	23	1/0	9%	0%
S. F. Ross Creek Lake #3	3N Rainbow Trout	Mackay	8/22/2019	4	0/0	0%	0%
S. F. Ross Creek Lake #3	Rainbow X Cutthroat	Mackay	8/22/2019	14	0/0	0%	0%
S. F. Ross Creek Lake #3	3N Westslope Cutthroat	Mackay	8/22/2019	4	0/0	0%	0%

HIGH MOUNTAIN LAKES EVALUATIONS

ABSTRACT

High mountain lakes offer diverse angling opportunities in scenic areas and are an important contributor to the state's recreational economy. Surveys are conducted periodically at HMLs throughout the state to evaluate the status of each fishery. In 2020, a total of 12 alpine lakes were surveyed in the Magic Valley Region using gill nets, angling gear, or a combination of both methods. Surveys collected data on relative fish abundance and size structure in addition to lake characteristics and apparent recreational usage rates. Data collected from these surveys will inform the continued management of these fisheries and help to identify areas in which to improve or expand alpine lake fishing opportunities in the region.

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INTRODUCTION

In Idaho, high mountain lake (HML) anglers have consistently expressed high satisfaction with their experience (Koenig 2020). High mountain lakes offer diverse angling opportunities in scenic areas and are an important contributor to the state's recreational economy. Idaho Department of Fish and Game stocks a variety of species in alpine lakes throughout the Magic Valley Region including Rainbow Trout *Oncorhynchus mykiss*, Cutthroat Trout *Oncorhynchus clarkii*, and Arctic Grayling *Thymallus arcticus.* Surveys are conducted periodically at HMLs throughout the state to evaluate the status of each fishery. The data collected from these surveys provide information on lake productivity, fish species composition, relative abundance, fish size, body condition, relative amount of human use, and amphibian species' occurrence. This survey information guides our HML management program and helps identify the best use of hatchery resources.

METHODS

Alpine lakes were surveyed between July and September 2020. We visited 12 lakes including Bass Creek lakes, Big Lost Lake, Norton Lakes, Perkons Lake, Prairie Lakes, Titus Lake, Miner Lake, and Ross Lake #1. Lakes were chosen because they had never been sampled or had not been sampled within the last ten years. At each lake, we assessed fish and amphibian presence/absence, human use, and basic fish habitat characteristics. In lakes with suitable depths or that had been previously stocked, fish were sampled with hook-and-line angling, gill nets, or both. Gill nets were floating and/or sinking experimental nets, measuring 46 m long by 1.5 m deep, with 19-, 25-, 30-, 33-, 38-, and 48-mm bar mesh panels. Preferably, nets were set in the evening, perpendicular to shore, and fished overnight. Nets were pulled the following morning or as soon as possible thereafter. Catch-per-unit-effort (CPUE) was calculated by dividing catch by total angling effort in hours or for gill nets by the number of net-nights. Captured fish were identified to species and measured for total length (nearest mm). In some instances, weight (g) was also measured.

Habitat surveys assessed limnological and morphological characteristics of lakes, tributaries, and outlets. Maximum depth was estimated by sinking a weighted rope marked with 1-m increments into the observed deepest section of each lake. Surface water temperatures were recorded along the lakeshore at one point. A visual assessment of salmonid spawning habitat availability was conducted at each lake's shoreline, 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 such as the number and condition of campsites, number of fire rings, access trail conditions, trail distance and difficulty, and presence of litter. General levels of human use were categorized by Idaho Department of Fish and Game (IDFG) staff as rare, low, moderate, and high based on an overall assessment of the factors described above. Fish, habitat, amphibian, and use data were entered into a statewide database.

RESULTS AND DISCUSSION

Bass Creek Lakes

Bass Creek lakes are a pair of 0.9- and 1.3-hectare alpine lakes located in Camas County (43.74294, -115.00446). The lakes have a northern aspect and a surface elevation of 2,667 m. The area surrounding the Bass Creek lakes is primarily dense coniferous trees and talus slope. There is one observable inlet and one outlet in each lake. The upper lake received triennial stockings of 500 fingerling Rainbow Trout until 2006 and the lower lake received triennial stockings of Rainbow Trout until 2014. Based on human signs in the area, it is apparent that this lake receives a low level of use annually. Amphibians were not observed.

The Bass Creek lakes were surveyed using angling gear in July (2 angler-hours in each lake). A total of 8 Rainbow Trout were collected from the lower lake (CPUE = 4 fish/h) and no fish were observed in the upper lake. Fish varied in length from 241 to 300mm and mean length was 265 mm (± 8; 90%CI) The lower lake seems to support a healthy fishery that is naturally sustained as multiple age classes of trout were present despite no recent stocking history. Given the low amount of use it receives, natural reproduction can likely maintain this fishery and hatchery supplementation is unnecessary.

Big Lost Lake

Big Lost Lake is a 3.8-hectare alpine lake located in Blaine County (43.74389, -114.66242). The lake has a southeastern aspect, and the lake surface elevation is 2,793 m. The area surrounding Big Lost Lake is primarily sparse vegetation consisting of dead pine trees and talus slope. There are zero observable inlets or outlets and the lake does possess ample deep-water refugia for fish. Limited salmonid spawning habitat was observed. Big Lost Lake has received a triennial stocking of 500 Arctic Grayling since 1995 with periodic stocking of Cutthroat Trout prior to that. This lake is accessed from the Norton Lakes Trailhead. Signs of recreational use were moderate.

Big Lost Lake was surveyed using angling effort in July (4 angler-hours). No fish were collected during this effort, but recently planted fingerlings were observed. This lake may have winter-killed in 2017 due to harsh conditions experienced during that winter. In general, the fishery in Big Lost Lake is likely dependent on stocking due to the apparent lack of spawning habitat. As such, stocking should continue in Big Lost Lake to provide a unique angling opportunity for Arctic Grayling in the Boise River basin. The lake should be surveyed in another 3 to 5 years to evaluate whether Arctic Grayling stocking since 2017 has been successful in creating a fishery. Additional stocking of Arctic Grayling or other suited species (e.g., Golden Trout) may be warranted to improve the fishery and diversify fishing opportunities in the Magic Valley Region.

Miner Lake

Miner Lake is a 6.5-hectare alpine lake located in Blaine County (43.75920, -114.66557). The lake has a northern aspect, and the lake surface elevation is 2,675 m. The area surrounding Miner Lake is primarily sparse vegetation consisting of living coniferous trees and talus slope. There are zero observable inlets and one outlet with suitable spawning habitat, abundant large woody debris, and a maximum depth of 7 m. Miner Lake receives a triennial stocking of 500 Westslope Cutthroat Trout. A total of 10 Long-toed Salamanders were observed during amphibian surveys. This lake is accessed from the Prairie Lakes Trailhead. Signs of recreational use were moderate and other hikers were observed in the area during surveys.

Miner Lake was surveyed using angling effort in July (2 angler-hours). No fish were collected during this effort and no other fish were observed. The lake was last surveyed in 1996, during which time no fish were encountered. Given the abundance of Long-toed Salamanders and previous history of fishless surveys, it's unlikely this lake supports fish. Given its northerly aspect, this lake may be prone to winterkill and stocking should be discontinued.

Norton Lakes

Upper Norton and Lower Norton lakes are a pair of 1.4- and 2.1-hectare alpine lakes located in Blaine County (43.75196, -114.65644). The lakes have a southern aspect, and the lake surface elevation of the upper lake is 2,777 m and the lower lakes elevation is 2,733 m. The area surrounding the Norton lakes is primarily dense living coniferous trees and talus slope. There are zero observable inlets and one outlet in the upper lake and one inlet and outlet in the lower lake. Suitable spawning habitat exists in each lake as does abundant large woody debris. Both Norton lakes receive triennial stockings of 1,000 triploid Rainbow Trout. These lakes are accessed from the Norton lakes Trailhead and receive a very high level of use during the summer and early fall.

Both lakes were surveyed using angling effort in July (Upper = 3 angler-hours; Lower = 6 angler-hours). A total of 3 Rainbow Trout were collected from the upper lake (CPUE = 1 fish/h) and 19 Rainbow Trout were caught in the lower lake (CPUE = 3.2 fish/h). Mean length of fish collected from the upper lake was 266 mm (± 33; ± SE) and mean length in the lower lake was 242 mm (± 7). Based on fish size and catch rates, it appears that the stocked fish in Norton lakes grow quickly and have relatively high rates of survival. All fish collected in this survey were tagged with t-bar anchor tags to evaluate use and exploitation rates. This additional information will inform the need for increased stocking rates in the Norton lakes due to the level of recreational use they receive annually. Amphibians were not observed.

Perkons Lake

Perkons Lake is a 4.0-hectare alpine lake located in Camas County (43.75411, -114.97417). The lake has a northern aspect and a surface elevation of 2,656 m. The area surrounding Perkons Lake is primarily dense coniferous trees and talus slope. There are 2 observable inlets and one outlet with sufficient spawning habitat available. The lake receives triennial stockings of 500 fingerling Rainbow Trout. Based on human signs in the area, it is apparent that this lake receives a moderate level of use annually. The lake is accessible from the Perkons Creek Trailhead.

Perkons Lake was surveyed using angling gear in July (2 angler-hours). A total of 12 Rainbow Trout were collected from the lake via angling efforts (CPUE = 6 fish/h). Fish varied in length from 178 to 254 mm and mean length was 208 mm (± 7). The lake seems to support a healthy fishery as multiple age classes of fish were present. Given the amount of use it receives, triennial stocking of Rainbow Trout is likely sufficient to maintain this fishery going forward. Amphibians were not observed.

Prairie Lakes

The Prairie lakes are a trio of 0.4 to 3.3-hectare alpine lakes located in Blaine County (43.75224, -114.67922). The lakes all have southern aspects, with lake surface elevations between 2,654 and 2,658 m. The area surrounding the Prairie lakes is primarily sparse living coniferous trees and talus slope. There are two observable inlets and one outlet in the big lake and one inlet and outlet in each of the upper and lower lakes. Limited spawning habitat exists in all three lakes and fingerling trout were observed. The big lake receives triennial stockings of 500 triploid Rainbow Trout and the upper and lower lakes received a single stocking of hatchery

Rainbow Trout in 1988 and none thereafter. Based on human signs in the area, it is apparent that this group of lakes receives a relatively high level of use annually. Amphibians were not observed.

Both upper and lower lakes were surveyed using angling effort in July (upper = 2 angler-hours; lower = 2 angler-hours). A total of 6 Westslope Cutthroat Trout were collected from the upper lake (CPUE = 3 fish/h), with a mean length of 261 ± 16 mm (mean ± SE). A total of 9 Westslope Cutthroat Trout were caught in the lower lake (CPUE = 4.5 fish/h) with a mean length of 214 ± 11 mm. The big lake was surveyed using a single floating gill net (1 net-night). Gill nets collected eight Rainbow Trout (CPUE = 8 fish/night) with a mean length of 169 ± 5 mm.

Based on fish size and catch rates, it appears that the stocked fish in the big lake have relatively high rates of survival. The presence of Westslope Cutthroat Trout in the upper and lower lakes suggests that the population is naturally sustained as there are no recent stocking records for this waterbody. Additional investigation should take place to determine their origin in the system. Overall, this group of lakes support healthy fisheries and provide opportunities to anglers in the area.

South Fork Ross Creek Lake #1

South Fork Ross Creek Lake #1 is a 1.9-hectare alpine lake located in Camas County (43.75287, -115.03268). The lake has a north-eastern aspect and a surface elevation of 2,671 m. The area surrounding Ross Lake #1 is primarily talus slope. There is one observable inlet and one outlet with sufficient spawning habitat though no juvenile fish were observed during the survey to confirm use. The lake receives triennial stockings of 500 triploid Westslope Cutthroat Trout. Based on human signs in the area, it is apparent that this group receives a moderate level of use annually.

South Fork Ross Creek Lake #1 was surveyed using angling effort in July (3 angler-hours). A total of 47 Westslope Cutthroat Trout were collected from the lake via angling (CPUE = 15.6 fish/h). Fish length varied from 127 to 356 mm and mean length of fish was 288 mm (± 8). Multiple age classes were present in the lake and fish size and catch rates suggest that the stocked fish in the big lake have relatively high rates of survival. This fishery appears to be in good health and does not need adjustment from a management perspective.

Titus Lake

Titus Lake is a 0.9-hectare alpine lake located in Blaine County (43.85501, -114.71039). The lake has an eastern aspect and a surface elevation of 2,715 m. The area surrounding Titus Lake is primarily dense coniferous trees. There is no observable inlet and one outlet with no sufficient spawning habitat available. The lake received triennial stockings of 500 Yellowstone Cutthroat Trout, with a single Westslope Cutthroat Trout stocking up until 1996 but has not been stocked since. Based on human signs in the area, it is apparent that this group receives a high level of use annually. No amphibians were observed during the survey.

Titus Lake was surveyed using a single floating gill net in July (1 net-night). No fish were collected from the lake via netting efforts (CPUE = 0 fish/night). Given intermittent winterkill events, this lake was not stocked for over twenty years, and it appears that no natural reproduction occurs to support a wild fishery. The lake no longer supports a fishery but still receives a high amount of use annually given its accessibility and proximity to population centers (e.g., Ketchum, Hailey). It is suggested that no stocking occur in this waterbody.

RECOMMENDATIONS

1. Determine feasibility of stocking Golden Trout in Big Lost Lake.

2. Determine survival rate of stocked fish in Miner Lake, evaluate need for continued stocking.

3. Continue to evaluate use and exploitation of stocked fish in the Norton Lakes.

4. Maintain current stocking schedule in Perkons Lake.

5. Maintain current stocking rates in the Prairie Lakes, investigate source of Westslope Cutthroat in the system.

6. Maintain current stocking schedule in Ross Lake #1

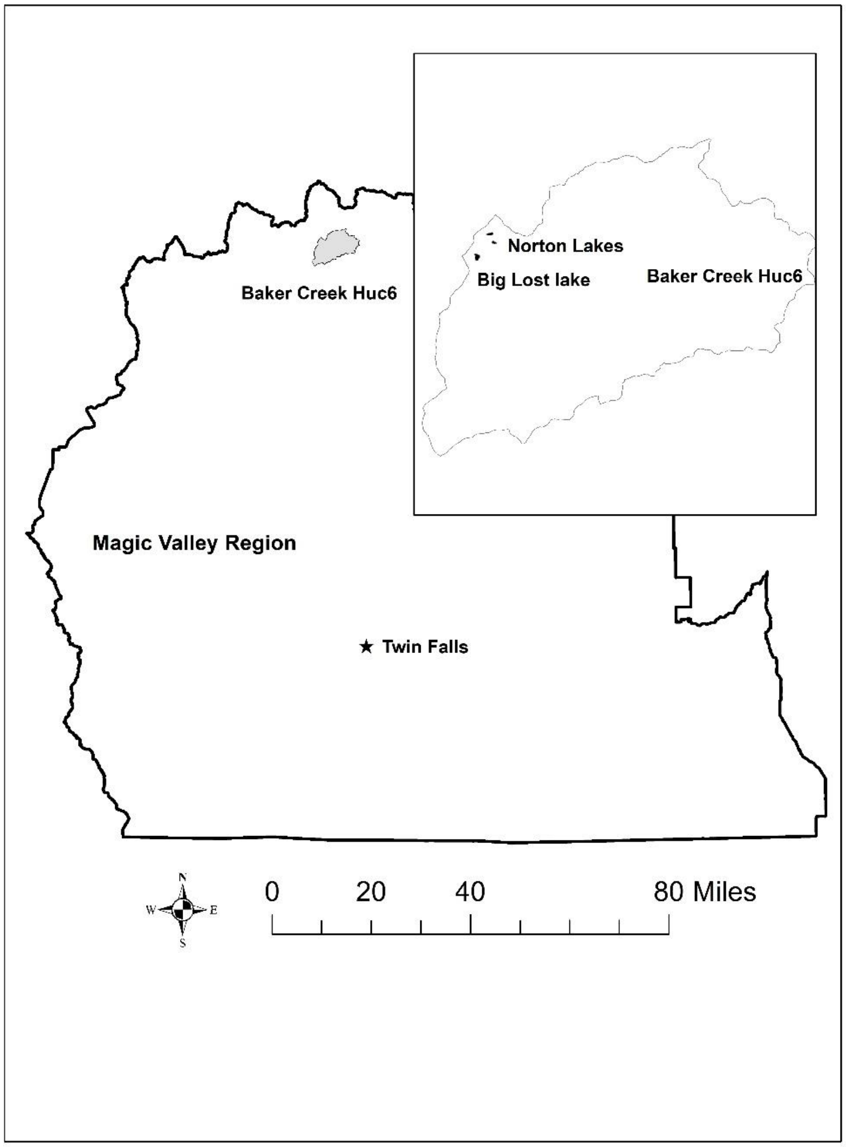

Figure 15. Alpine lakes sampled within the Baker Creek hydrologic unit code 6 during 2020.

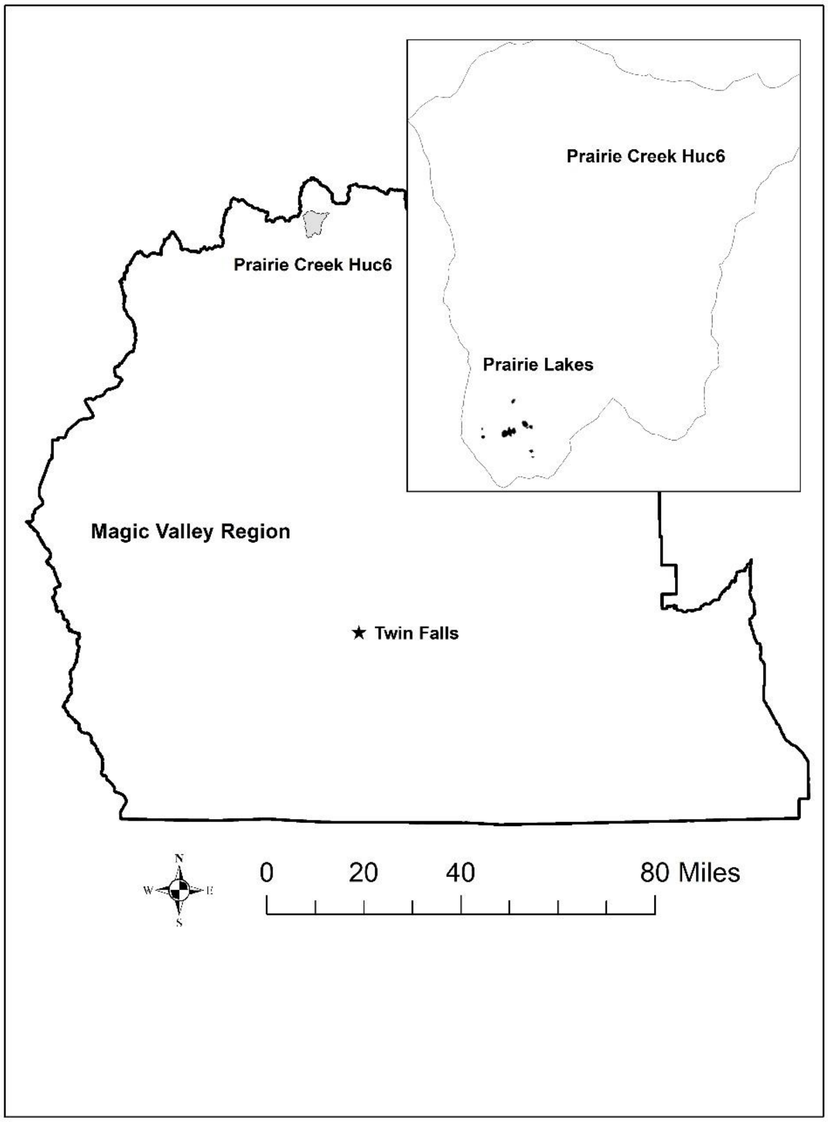

Figure 16. Alpine lakes sampled within the Prairie Creek hydrologic unit code 6 during 2020.

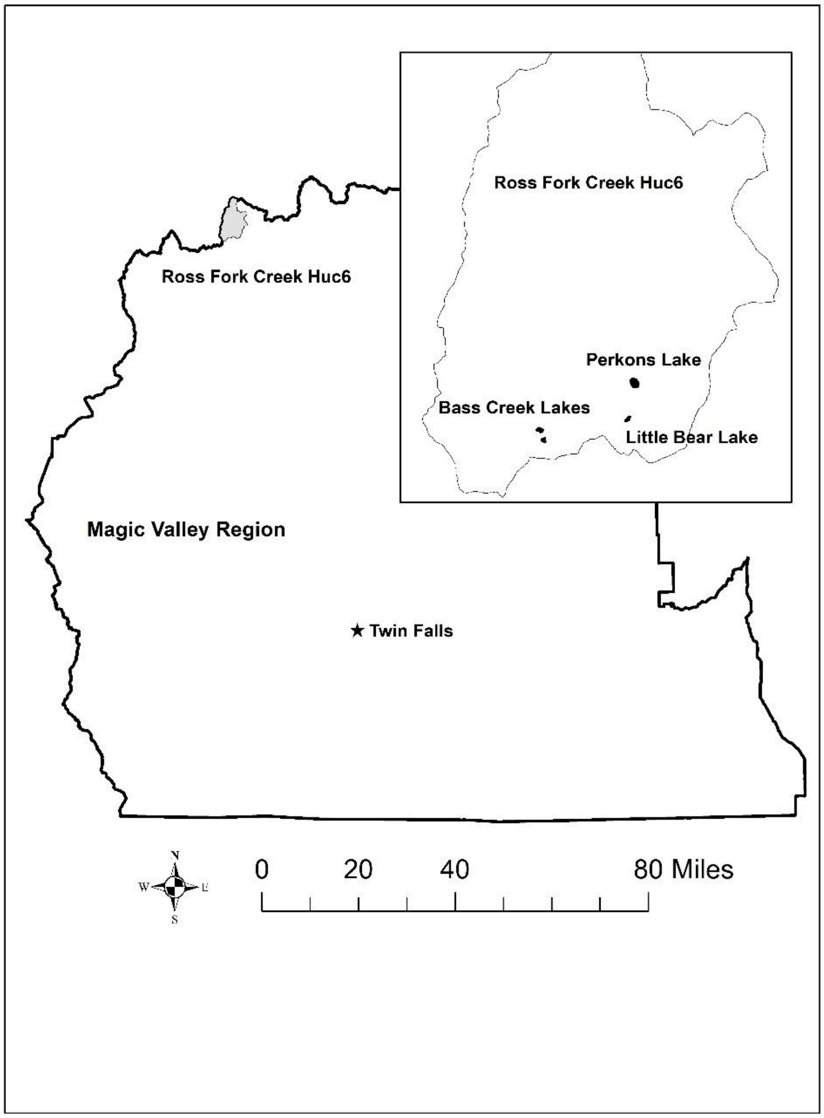

Figure 17. Alpine lakes sampled within the Ross Fork Creek hydrologic unit code 6 during 2020.

HEAGLE PARK POND ROTENONE APPLICATION

ABSTRACT

During the early spring of 2020, IDFG started to receive phone calls from concerned anglers regarding Common Goldfish *Carassius auratus* observations within Heagle Park Pond in Hailey, Idaho. In late March, IDFG staff investigated the pond and determined Fathead Minnow *Pimephales promelas* and Goldfish were present. While there is not a direct inflow/outflow from the Big Wood River, high flows from spring run-off consistently flood into and out of the pond, increasing the risk that these species could enter the system from the pond. Idaho Department of Fish and Game staff was unwilling to assume this risk of escape and possible establishment in nearby waters; and therefore, planned a piscicide application. The treatment was successfully completed in late September of 2020.

Author(s):

Michael P. Peterson
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INTRODUCTION

Heagle Park Pond is a 0.13-hectare water located in Blaine County within the City of Hailey Park. The pond was constructed as a park amenity and is filled with ground water through subsurface flow from the Big Wood River. Prior to the piscicide treatment, the only known species within the pond were hatchery Rainbow Trout *Oncorhynchus mykiss*, Fathead Minnow *Pimephales promelas*, and Common Goldfish *Carassius auratus*. Some anglers fish for Rainbow Trout at this pond; however, the small size of the pond and limited access for hatchery stocking trucks have limited development of this pond as a quality community fishery.

During the early spring of 2020, IDFG started to receive phone calls from concerned anglers regarding Common Goldfish observations within Heagle Park Pond. In late March, IDFG staff investigated the pond and determined Fathead Minnows and Goldfish were present. Fathead Minnow and Goldfish are bred and sold as bait or for aquaria. While Fathead Minnow has been observed previously within the basin (e.g., Magic Reservoir), Goldfish have not been sampled in the Big Wood River drainage. IDFG staff attempted to remove these species using a seine and electrofishing gear, with no success.

Nonnative fish present in Heagle Park Pond present a risk to the fisheries in the Big Wood River watershed. Fathead Minnow are native to the Mississippi River drainage and Great Lakes Region and are known to be highly prolific. It is not known if Fathead Minnow would have deleterious impacts to any fish and wildlife populations in Idaho. Goldfish are native to Eastern Asia and have been found extensively throughout North America resulting from both illegal and purposeful introductions. Goldfish may compete with native fish species and large populations may disturb fish habitats (USGS 2020). While there is not a direct inflow/outflow from the Big Wood River, high flows from spring run-off consistently flood into and out of the pond, increasing the risk that these species could enter the system from the pond. Idaho Department of Fish and Game staff was unwilling to assume this risk of escape and possible establishment in nearby waters; and therefore, planned the pond renovation.

The intent of this project was to kill and remove all fish from Heagle Park Pond utilizing a rotenone application. This action would eliminate the possibility that Fathead Minnow or Goldfish could establish a wild naturally reproducing population from this source. Heagle Park Pond is located within IDFG's Pest Management Area delineated in our National Pollutant Discharge Elimination System (NPDES) permit (IDG87BH20).

METHODS

Staff applied rotenone following the guidelines as outlined in the "Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management: Rotenone SOP Manual, 2nd Edition, published by the American Fisheries Society" (Finlayson et al. 2018). The pond was treated during late September 2020, while the water temperature was still relatively warm. The treatment area was within a park owned and managed by the City of Hailey, requiring coordination with City Park staff.

IDFG used Prenfish Toxicant™ (EPA Reg. No. 655-422), a liquid emulsifiable product with 5.0% rotenone as an active ingredient. Application rates and methods were in accordance with the piscicide label and NPDES permit. This product's label indicates that 4 ppm was sufficient to remove carp, a species biologically similar and closely related to Goldfish, in rich organic waters, therefore, that was the concentration used to treat the pond. In addition to the intended target species, this pond contained Fathead Minnow and has a moderately rich organic layer. The pond contained approximately 1 acre-foot of water (0.31 acres x 3.2' average depth). The total volume needed of Prenfish Toxicant™ (5.0% rotenone) to treat the pond was 1.35 gallons (5.11 L).

IDFG personnel, Joe Kozfkay, a licensed professional applicator (Idaho License #50519; expires September 2022) supervised and lead the piscicide loading and application process. The work area was cordoned off and staff used the appropriate PPE as required by the product label. The product was diluted 10:1 with water then applied to the entire pond in a systematic fashion with a boat mounted battery-powered sprayer. The sprayer was calibrated prior to treatment to ensure effective treatment and attainment of desired concentrations throughout the pond. The sprayer had a hand-held direct spray nozzle and a flow volume of 1.0 gal/min. The boat was propelled with an electric trolling motor at a rate of 1.85 miles per hour to ensure equal and adequate treatment concentrations. Due to the proximity of occupied houses, dipnets were used to remove dead fish, which were bagged and disposed of at the local landfill. Since there is no direct outflow to the pond, neutralizer was not needed, and the pond was allowed to detoxify naturally following the treatment. At the cooler temperatures that were observed, rotenone is known to completely decay within two weeks to one month. Sentinel fish were used a total of three times over the course of four weeks to determine whether toxicity had dropped below thresholds necessary to reintroduce fish to the pond.

RESULTS AND DISCUSSION

A post-treatment efficacy assessment was completed at Heagle Park Pond during October 2020. The treatment appeared to be effective, especially for the primary target species. Rainbow Trout, Goldfish and Fathead Minnow began to show signs of toxicity and appeared on the surface of the pond within minutes of the application. Visual estimates of Goldfish and Fathead Minnow approximated 5,000 to 7,000 individuals, respectively, as well as 30 Rainbow Trout and 1 Yellow Perch *Perca flavescens*. By late October, it was determined that it would be safe to re-initiate stocking of Rainbow Trout into the pond.

RECOMMENDATIONS

1. Re-initiate stocking of Rainbow Trout in Heagle Park Pond in the spring of 2021.

WARMWATER FISH TRANSFERS

ABSTRACT

Magic Valley region personnel transferred warmwater fish species into two waterbodies during 2020 with the intent of establishing new populations and to create a potential source population to rebuild, enhance, or establish new populations of Bluegill *Lepomis macrochirus*. We utilized boat electrofishing and trap nets to capture fish for transfer. We transferred 427 crappie *Pomoxis spp.* and 149 Bluegill. Future evaluations will be needed to help determine whether these translocation efforts were successful in establishing self-sustaining populations.

Author:

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INTRODUCTION

The Magic Valley Region contains 30 small public community fishing ponds as well as nearly 15 lowland reservoirs. These ponds and reservoirs offer a variety of angling options for both hatchery Rainbow Trout *Oncorhynchus mykiss* and several warmwater species. Hagerman State Fish Hatchery supplies Rainbow Trout regularly to many of the community-fishing ponds and lowland reservoirs. However, warmwater fish populations must depend on natural reproduction or transfers from other waters. Idaho Department of Fish and Game (IDFG) seeks to maintain adequate populations of warmwater fish in these community ponds and reservoirs for recreational angling.

During 2020, Lake Walcott was selected to try to establish a self-sustaining crappie *Pomoxis spp.* fishery within the Magic Valley Region. The lake currently has a productive Smallmouth Bass *Micropterus dolomieu* and Rainbow Trout fishery. The addition of crappies would add diversity and additional opportunity for anglers targeting panfish. Fisheries staff were also interested in trying to establish a new source population of Bluegill that could be used to re-build, enhance, or establish new populations in waterbodies throughout the region. The Twin Falls Canal Company worked with the department to dredge two existing settling ponds near the Cedar Draw public access site located south of Filer, ID in the Snake River Canyon. These ponds are currently closed to public access and provide a unique opportunity to try establishing a self-sustaining population of Bluegill.

METHODS

We used boat electrofishing and trap nets to capture warmwater fish for transfer during 2020. Fish were collected for transfers on three separate occasions between May 21 and August 4 using an electrofishing boat equipped with a Midwest Lake Electrofishing Systems (MLES) Infinity system. Bluegill were collected from Riley Pond and Dierkes Lake, while crappie were collected from CJ Strike Reservoir. The MLES unit set at 20% duty cycle and a 5000-watt Honda generator produced approximately 2,000 to 2,500 watts of pulsed DC power. Stunned fish were caught using dip nets, transferred to live cars, and held until enough were captured to fill a transport truck or trailer. Once loaded, fish were supplied with supplemental oxygen at 1.5 to 2 liters/minute. Five trap nets were also fished overnight to collect crappies in CJ Strike Reservoir (located in the Southwest Region) on May 21, 2020.

RESULTS

We captured and transferred a total of 129 Bluegill and 427 crappie (Table 2). Releases occurred in Lake Walcott and the Cedar Draw grow out pond. Due to an ongoing panfish evaluation at CJ Strike Reservoir, crappie transfers did not occur until late May, which may have been post-spawn. Additional crappie transfers should occur and be timed to collect pre-spawn adults for the best chance of population establishment. A standardized lowland lake survey should be performed in Lake Walcott within three years to determine whether young-of-the-year crappies are present within the waterbody.

The Cedar Draw grow out ponds were also stocked with Bluegill sourced from Riley Pond and Dierkes Lake. Numbers transferred from each waterbody can be found in Table 2. While working with the Twin Falls Canal Company to dredge these ponds, we requested that a primitive boat ramp be built in each pond to enable us to sample the waterbody with our electrofishing boat. Pond surveys should be conducted soon to determine whether this introduction was successful at establishing a self-sustaining Bluegill population, and whether densities are sufficient to be used as a source population for stocking other community ponds.

RECOMMENDATIONS

1. Continue to transfer crappie from CJ Strike Reservoir into Lake Walcott in 2021.

2. Evaluate whether crappie transfers result in a naturally reproducing population in Lake Walcott in 2023 by conducting a standardized lowland lake survey and determine whether relative abundance of crappies add harvest potential and diversity to the fishery.

3. Determine if Bluegill transferred to Cedar Draw Pond established a naturally reproducing population that can be used as a source population to re-build, enhance, or establish new populations of Bluegill throughout the region.

Table 2. Summary of Bluegill (BGL) and crappie capture and transfer efforts to Lake Walcott and the Cedar Draw grow out ponds during 2020.

Date Stocked	Collection method	Collecting Water	Receiving water	Species	Number	Mean length (mm)
5/22/20	Electrofishing and trap nets	CJ Strike Reservoir	Lake Walcott	crappies	427	243
5/26/20	Electrofishing	Riley Pond	Cedar Draw Pond	BLG	15	114
8/4/20	Electrofishing	Dierkies Lake	Cedar Draw Pond	BLG	114	100

RIVERS AND STREAMS EVALUATIONS

SILVER CREEK POPULATION TREND MONITORING

ABSTRACT

Silver Creek is a world-renowned fishery for Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo trutta*, and Brook Trout *Salvelinus fontinalis.* The fishery is managed using a variety of regulations to provide a diversity of angler opportunity and achieve specific management objectives. Periodic trend monitoring is conducted at Silver Creek every three years to evaluate trends in population demographics. In 2020, electrofishing surveys using mark-recapture methodology were implemented to continue this trend-monitoring program. In total, 2,245 trout were collected during surveys in three transects throughout Silver Creek. Species composition of our sample was 56% Brown Trout and 44% Rainbow Trout. Mean total length was 289 mm (± 12; SE) for Brown Trout and 296 mm (± 16) for Rainbow Trout. Total trout abundance (*TL* ≥ 100mm) in Silver Creek was estimated to be 2,391 fish/km (± 213). Species-specific abundance was estimated to be 1,065 fish/km (± 110) for Brown Trout and 1,480 fish/km (± 231) for Rainbow Trout. Overall, trout abundance in Silver Creek appears to be relatively stable to increasing in size. However, Brown Trout abundance in Silver Creek has continued to increase in comparison to previous years. Simultaneously, Rainbow Trout abundance has trended downward over the same period.

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INTRODUCTION

Silver Creek is a spring-fed tributary to the Little Wood River located in Blaine County, Idaho (Figure 18). The stream originates at the confluence of two major tributaries (Grove Creek and Stalker Creek) located on The Nature Conservancy's Silver Creek Preserve near Picabo, Idaho. From its origin, Silver Creek flows approximately 80 km (50 miles) through a patchwork of public and private inholdings before flowing into the Little Wood River near Richfield, Idaho. Land-use practices along Silver Creek are primarily recreation, irrigation-based farming, and livestock grazing.

Silver Creek contains a world-renowned fishery for Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta* with angler effort exceeding 25,000 hours annually (IDFG: unpublished information). The fishery also provides anglers with limited opportunity for Mountain Whitefish *Prosopium williamsoni*and Brook Trout *Salvelinus fontinalis*, although, these species are encountered infrequently. Common nongame fishes found in Silver Creek include Bridgelip Sucker *Catastomus columbianus*, Longnose Dace *Rhinichthys cataractae*, Speckled Dace *R. osculus*, Redside Shiner *Richardsonius balteatus*, and Wood River Sculpin *Cottus leiopomus*. Silver Creek is currently managed to provide a diversity of angling experiences by applying various fishing seasons/rules to five different sections. These sections use different combinations of slot-limit harvest restrictions, tackle restrictions, seasonal closures, and general regulations which separates the fishery into five distinct management sections.

Since 2001, Idaho Department of Fish and Game (IDFG) staff have used a triennial survey design at the three uppermost regulative sections to monitor Silver Creek. These special regulation sections include a section with a restrictive slot limit of 2 trout, with no harvest between 305 and 406 mm (Willows transect), and two fly-fishing only, catch-and-release sections, two of which are located on The Nature Conservancy (TNC) Silver Creek Preserve property (Stalker Creek and Cabin transect). Past surveys have also included the lower section of Silver Creek under general harvest regulations (6 fish/day: Priest Rapids transect); however it is not currently included in triennial surveys. Given the fisheries popularity and the avid angling constituency in the area, IDFG maintains this regular monitoring schedule to evaluate population trends and ensure the current regulations are producing the desired qualities within the fishery. As such, the objectives of this study were to continue these surveys to evaluate sport-fish demographics within Silver Creek and inform management decisions.

METHODS

Standardized mark-recapture surveys were conducted in three transects (i.e., TNC, RR Ranch, and Willows transects; Figure 18) in Silver Creek June to July 2020. Drift boat-mounted electrofishing gear was utilized to collect fish. Power was supplied by a 5,000-watt generator and standardized from 2750 to 3250 W based on conductivity (Miranda 2009). An Infinity model electrofishing control box applied electricity to the water (Midwest Lake Management, Inc., Polo, Missouri). Two netters were placed at the bow of the boat with dipnets and an attempt to capture all fish encountered was made. Both marking and recapture surveys took place during daylight hours. Marking surveys took place on June 23rd, 24th, and 25th, and recapture surveys were conducted in each transect exactly seven days following their respective marking runs (i.e., June 30th, July 1st, and July 2nd).

Captured fish were enumerated by species and measured for total length (mm) and weight (g). During marking runs, all captured trout exceeding 100 mm in total length were given a caudal fin mark using a standard 7-mm paper hole-punch. To account for potential inter-transect movements, fish from each sampling transect were given a unique mark. Fish captured in the TNC transect were given a mark to the upper caudal fin, RR Ranch fish were marked in the middle of the caudal fin, and Willows transect fish were given a lower caudal fin mark. During recapture runs, captured fish were enumerated, measured for total length, and examined for marks. If a marked fish was observed that information was recorded along with the caudal mark type. Otoliths were collected from up to five fish per 10-mm length-group for age-and-growth analysis. Fish were only euthanized for otolith collection during recapture runs as to not bias density estimates. In either mark or recapture runs, those fish not euthanized for structure collection were released 100 m upstream of processing sites to avoid immediately recapturing fish and biasing estimates.

Species composition was expressed as the percent of total catch from the marking run and was calculated by dividing the total number of each species captured by the total number of target species captured. Confidence intervals for these proportions were calculated using Fleiss (1981).

Fisheries Analysis + (FA+) software 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 maximum likelihood estimation to fit the recapture data. A capture probability function of the form

$$Eff = (exp(-5+\beta 1L+ \beta 2L2)) /(1+ exp(-5+\beta 1L+ \beta 2L2))$$

where *Eff* is the probability of capturing a fish of length L, and β1 and β2 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. In addition, data was pooled for a comprehensive population estimate expressed as total fish/km. 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 calculated as:

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

where *R* is the number of recaptures collected and I is the total number of fish collected during the recapture run. Relative weight (W_r) for individual trout (TL ≥ 120 mm) were estimated by using the following equation (Simpkins and Hubert, 1996):

$$Wr = W/Ws\ X\ 100$$

where W_r is the relative weight, *W* is the weight of fish (g), and *Ws* is the length specific standard weight. W_s was estimated using the following equation (Blackwell et al. 2000):

$$Log10(Ws) = a + b(Log10L)$$

where W_s is the length specific standard weight, *a* is the minimum relative standard weight, *b* is the maximum relative standard weight, and L is the individual fish length (mm). Otoliths were mounted in epoxy and cross sectioned through the nucleus using a low-speed saw. Ages were determined by one reader using a dissecting microscope observing otolith cross sections via transmitted light. Age-structure was summarized using an age-length key (Quist et al. 2012). Total annual mortality (*A*) was estimated using a Chapman-Robson estimator and peak-plus-one criterion (Smith et al. 2012). Individual trout growth rates were described by species using the von Bertallanffy growth model:

$$L_t = L_\infty \, [1 - e^{-k(t-t_0)}],$$

where L_t (mm) is length at time t, L_∞ is asymptotic length, k is growth coefficient, and t_o is the theoretical age when length is zero (Quist et al. 2012).

RESULTS

TNC Transect

In total, 237 Rainbow Trout (RBT), and 147 Brown Trout (BRN) were collected from the TNC transect during the marking run. An additional 185 RBT and 224 BRN were collected during the recapture run. Recaptures totaled eight for RBT and ten for BRN. The trout species composition of our sample was 53% RBT and 47% BRN. Estimated density (± 90% CI) of RBT (>100 mm) was 1,820 fish/km (± 445) and BRN density was estimated to be 1,186 fish/km (± 276). Total trout density was estimated to be 3,506 fish/km (± 646; Figure 19). Lengths varied from 50 to 432 mm for RBT and from 56 to 525 mm for BRN. Mean total length (± SE) was 247 mm (± 8) for RBT and 273 mm (± 7) for BRN in the TNC transect.

RR Ranch Transect

In total, 177 RBT, and 87 BRN were collected from the RR Ranch transect during the marking run. An additional 284 RBT and 180 BRN were collected during the recapture run including. Recaptures totaled 24 for RBT and 13 for BRN. Trout species composition of our sample was 64% RBT and 36% BRN. Estimated density (± 90% CI) of RBT (>100 mm) was 1,515 fish/km (± 292) and BRN density was estimated to be 697 fish/km (± 141). Total trout density was estimated to be 2,485 fish/km (± 446; Figure 19). Lengths varied from 135 to 492 mm for RBT and from 60 to 693 mm for BRN. Mean total length was 337 mm (± 7) for RBT and 339mm (± 7) for BRN in the RR Ranch transect.

Willows Transect

In total, 61 RBT, and 286 BRN were collected from the Willows transect during the marking run. An additional 80 RBT and 415 BRN were collected during the recapture run. Recaptures totaled 3 for RBT and 60 for BRN. Trout species composition of our sample was 17% RBT and 83% BRN. Estimated density (± 90% CI) of RBT (>100 mm) was 674 fish/km (± 295) and BRN density was estimated to be 1,368 fish/km (± 164). Total trout density was estimated to be 1,803 fish/km (± 198; Figure 19). Lengths varied from 75 to 452 mm for RBT and from 65to 603 mm for BRN. Mean total length was 297 mm (± 14) for RBT and 290 mm (± 6) for BRN in the Willows transect.

Combined Transects

A combined total of 475 RBT and 520 BRN were collected across all marking runs. An additional 549 RBT and 819 BRN were collected during all recapture runs. A total of 35 RBT and 83 BRN were recaptured across all recapture runs. Overall species composition across sampling transects was 43% RBT and 57% BRN. Estimated density (± 90% CI) of RBT (>100mm) was 1,480 fish/km (± 231) and BRN density was estimated to be 1,065 fish/km (± 111; Figure 20). Total trout density was estimated to be 2,391 fish/km (± 213). Mean total length was 296 mm (± 16) for RBT and 289 mm (± 12) for BRN in Silver Creek (Figure 21).

Age and Growth

Ageing structures were collected from 35 RBT and 34 BRN. Ages of RBT in our sample varied from 1 to 5 years and BRN ages varied from 1 to 10 years. Total annual mortality (*A*) was estimated to be 77% for RBT and 44% for BRN. The combined mortality estimate for trout in Silver Creek was 47%. Growth model results suggest that RBT have a theoretical maximum mean length (L_∞) of 780 mm and a growth coefficient (*K*) of 0.203. Brown Trout had a theoretical maximum mean length of 664 mm and a growth coefficient of 0.204 (Figure 22). Mean relative weight (*Wr*) was 83 ± 1 for RBT (>120mm) and 87 ± 2 for BRN (> 140mm) in Silver Creek. Capture efficiency across all transects was 6% for RBT and 21% for BRN.

DISCUSSION

The TNC transect is the uppermost transect in our 2020 surveys, and like the RR Ranch section, is regulated as catch-and-release, fly-fishing only. The TNC section is privately owned but open to the public and receives the highest amount of angler-use annually compared to the rest of Silver Creek (IDFG; unpublished information). Given their proximity and similar regulations, the fish community between TNC and RR Ranch is very similar albeit higher densities of fish in the TNC reach. When compared, the TNC reach had higher densities of juvenile fish suggesting this is an important rearing habitat for trout in Silver Creek. This density of juvenile fish has been observed in previous surveys as well (Megargle et al. 2016). The TNC reach also had the highest combined trout density and highest density of RBT compared to other transects. Both species have maintained relatively stable populations and community structure since regular surveys began in 2001, however, BRN abundance has slowly increased over time to its current level, which estimates suggest is approximately 50% of the total trout population in the TNC section. While these data do help to understand trends in trout abundance in Silver Creek, it is important to note that the 2020 TNC survey transect boundaries differed from previous surveys. In short, the 2020 survey mistakenly sampled habitats that differed in characteristics (e.g., deeper) downstream of the traditional boundaries and that may have skewed our estimates and resulted in a higher abundance estimate from previous surveys. As such, comparisons of 2020 estimates with previous surveys are tenuous. Future surveys should return to sample the long term transect boundaries.

The RR Ranch transect is the middle-most transect in the 2020 survey and is entirely privately held. As such, angler access to this reach is very limited and is regulated as catch-and-release only, fly-fishing only. The RR Ranch transect possessed the highest mean total lengths for both RBT and BRN among all transects surveyed in 2020. This is due to a relative lack of juvenile fish observed throughout the RR Ranch transect, especially for RBT. It is important to note that the RR Ranch transect had not been sampled prior to the 2020 survey as it is located on private land not accessible to the public. Landowner permission was granted to sample this reach in 2020 and it was surveyed instead of the transect traditionally surveyed in upper Stalker Creek. While data collected from the RR Ranch is beneficial toward better understanding of the Silver Creek trout community, future surveys should focus on publicly accessible waters including the traditional survey transect in Stalker Creek. This will allow for continuity of trend data from which inference can be drawn. If permissible by the RR Ranch landowner, additional surveys should be completed in this transect in the future to gain better understanding of the trout community system wide. An additional survey reach should also be developed in the Priest Rapids BLM access area for the same reasons.

Total density of both BRN and RBT increased across sampling transects compared to 2016 survey estimates. Despite the apparent increase observed between 2016 and 2020, mean density of Rainbow Trout has trend downward between 2001 and 2016 (Figure 20). Due to the differences referenced between the traditional transects and those sampled in 2020, the trend was not analyzed using the 2020 data. However, the trend will be analyzed using the traditional transects and 2023 data, moving forward. In contrast, mean density of Brown Trout continues to trend upwards over the last 20 years. Although a gradual shift in overall species composition is being observed, community composition in Silver Creek has remained relatively stable upstream of Highway 20 Bridge. However, Brown Trout continue to dominate the most downstream transect in our survey, the Willows transect. The Willows transect showed a wider distribution of BRN lengths including a higher density of juvenile and larger fish when compared to other transects. RBT densities were very low in the Willows and past surveys have shown a similar species composition heavily favoring BRN. This is likely due to habitat in the Willows being more favorable to BRN. The Willows section is also the only portion of Silver Creek included in our surveys that allows angler harvest (2 fish per day; none between 305mm to 406mm). Past angler exploitation estimates in this section are very low, however (IDFG: unpublished information). Limited harvest of larger fish, the current slot limit restriction on spawning-age fish, and lower overall fish densities may be the reason for the higher density of juvenile fish in this section. Whether the Willows act as a rearing area for BRN throughout Silver Creek is unknown as the Highway 20 Bridge diversion may act as a migration barrier to upstream movements. Regardless, it appears the current regulations are resulting in increased juvenile fish production in the Willows while still providing angling opportunity for trophy sized BRN in this section of Silver Creek.

Growth rates of trout in Silver Creek remain high with both RBT and BRN theoretical mean maximum lengths surpassing trophy-size thresholds. Despite growth potential, no RBT in our sample attained sizes exceeding 500mm. This is likely due to the relatively short-lived nature of RBT within Silver Creek, where no RBT surpassed age-5. Dissimilarly, BRN in Silver Creek regularly surpassed trophy-class lengths exceeding 600mm and 10-years of age. Brown Trout also had a lower total annual mortality rate (*A*). Total annual mortality for Brown Trout and Rainbow Trout was 44% and 77%, respectively. Rainbow Trout mortality rates in Silver Creek may be cause for concern, as they are exceptionally high for a trout population that experiences very little exploitation. Factors such as poor summer water conditions and increased avian predation may have resulted in the observed natural mortality rate, but the high RBT mortality estimates may also be inflated due to sampling design errors. A limited number of ageing structures were collected from both RBT and BRN during the 2020 survey. As such, associated analysis was not sufficient to estimate reliable annual mortality and individual growth estimates. Survey sampling design in 2023 will address this issue by collecting a more robust sample of ageing structures. This will help to obtain less biased estimates of trout growth and mortality in Silver Creek.

Collectively, Silver Creek maintains healthy wild BRN and RBT populations that grow quickly and are popular with anglers. While both species are still well-represented, a continual shift of compositions toward Brown Trout is occurring. Rainbow Trout have historically been a very important component of this fishery and evaluations of angler species preferences are needed to determine future management direction and objectives for the fishery. Additionally, opportunities to simplify regulations throughout Silver Creek should be evaluated to reduce public confusion surrounding current rule structure while still achieving management objectives of maintaining a quality trout fishery.

RECOMMENDATIONS

1. Continue triennial population monitoring in June 2023.

2. Continue surveys in original survey reaches including Stalker Creek, Cabin, and Willows transects. Develop survey transect in Priest Rapids and include in triennial sampling design going forward. Continue to survey RR Ranch transect every other survey or on an as-needed basis.

3. Evaluate angler use, exploitation, and species preferences throughout all Silver Creek survey transects including Priest Rapids.

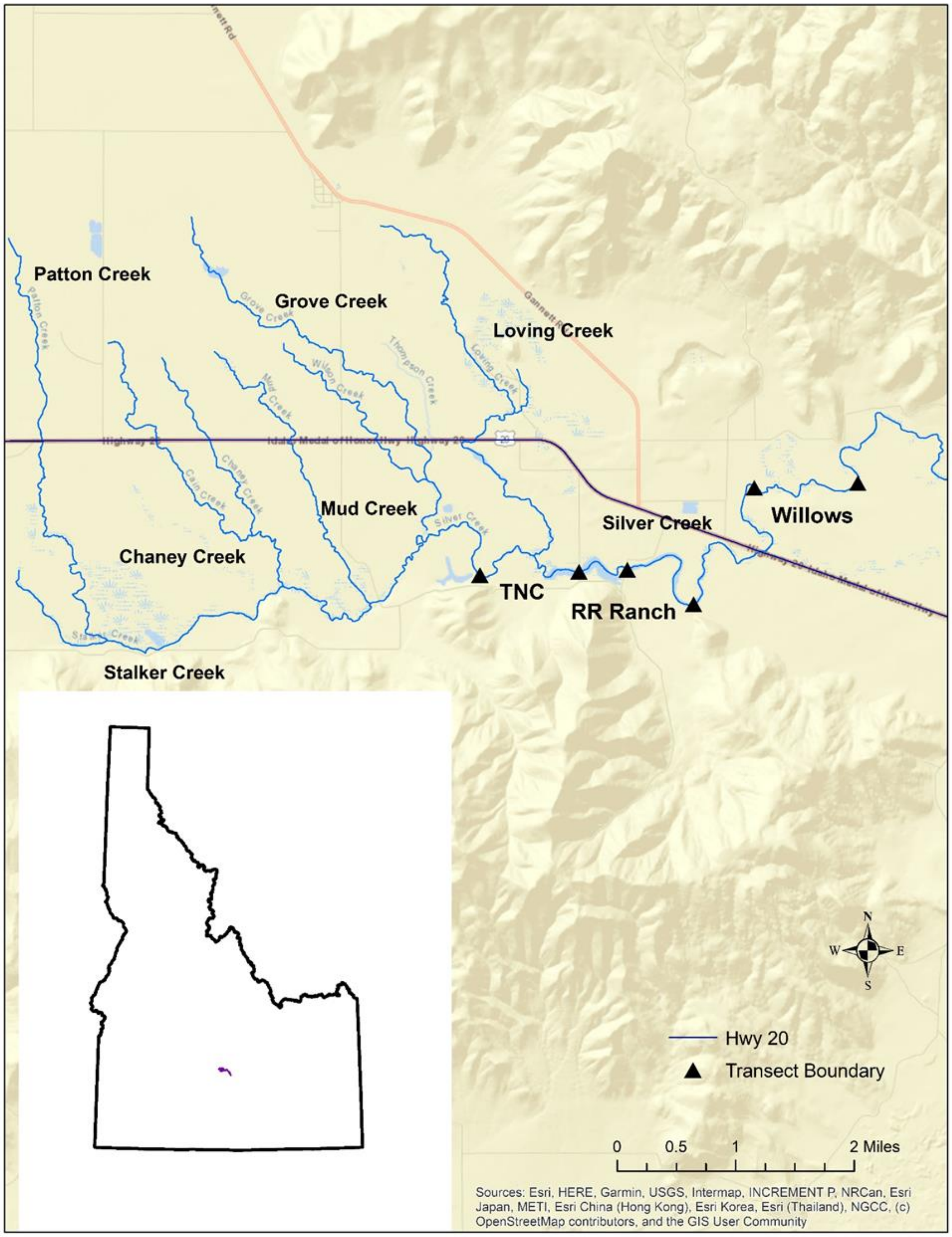

Figure 18. Silver Creek and associated tributaries surveyed in 2020. Upper and lower boundaries of transects (TNC, RR Ranch, and Willows) are indicated by triangles.

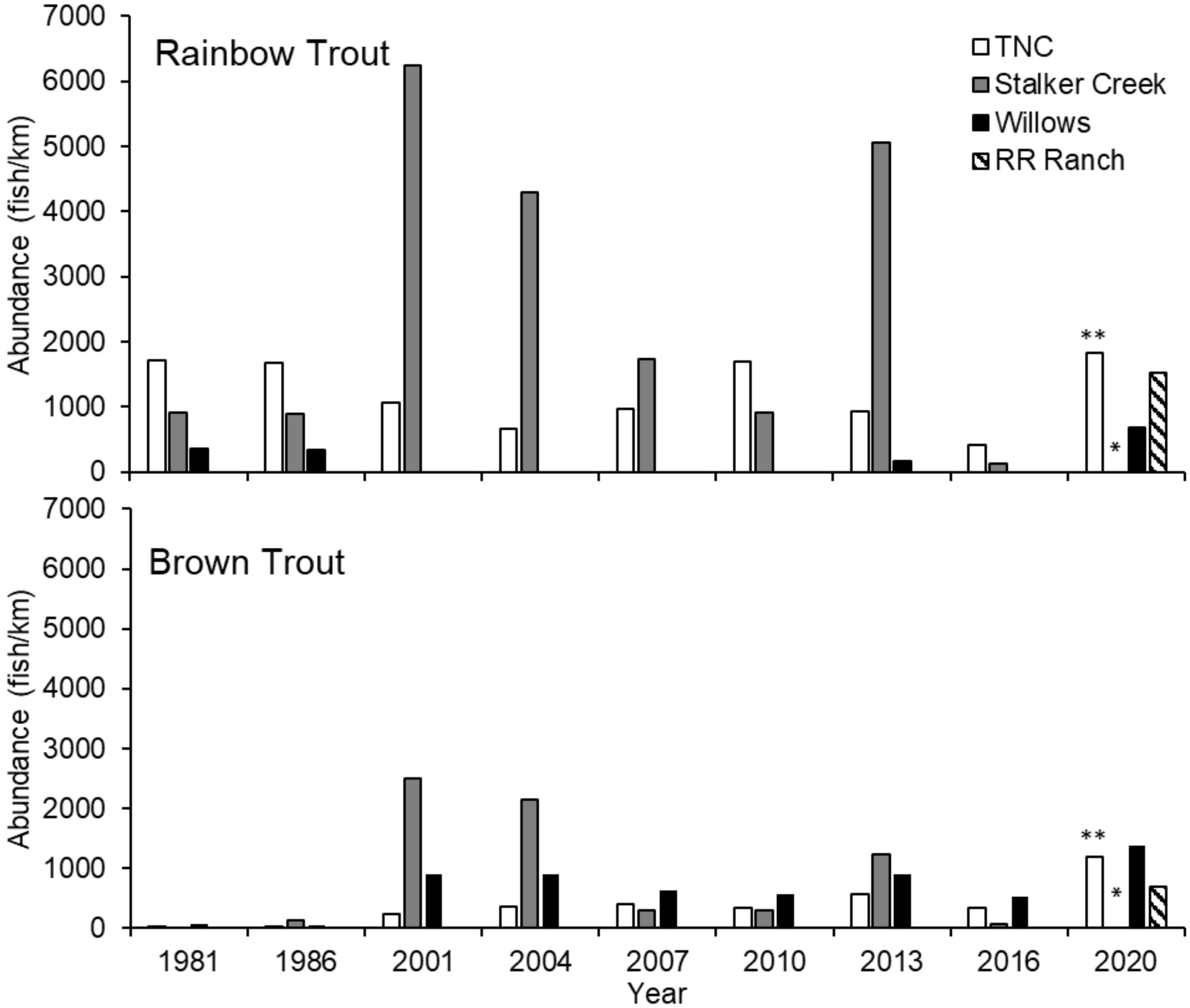

Figure 19. Rainbow Trout (top panel) and Brown Trout (bottom panel) density in three sampling transects on Silver Creek, Idaho from 1981 to 2020. Transects include the TNC (white bars), Stalker Creek (grey bars), Willows (black bars) and RR Ranch (dashed bars) transects. Single asterisks (*) denote the Stalker Creek transect that was not surveyed in 2020. Double asterisks (**) denote the 2020 TNC transect whose boundaries did not match previous surveys and is non comparable to previous results.

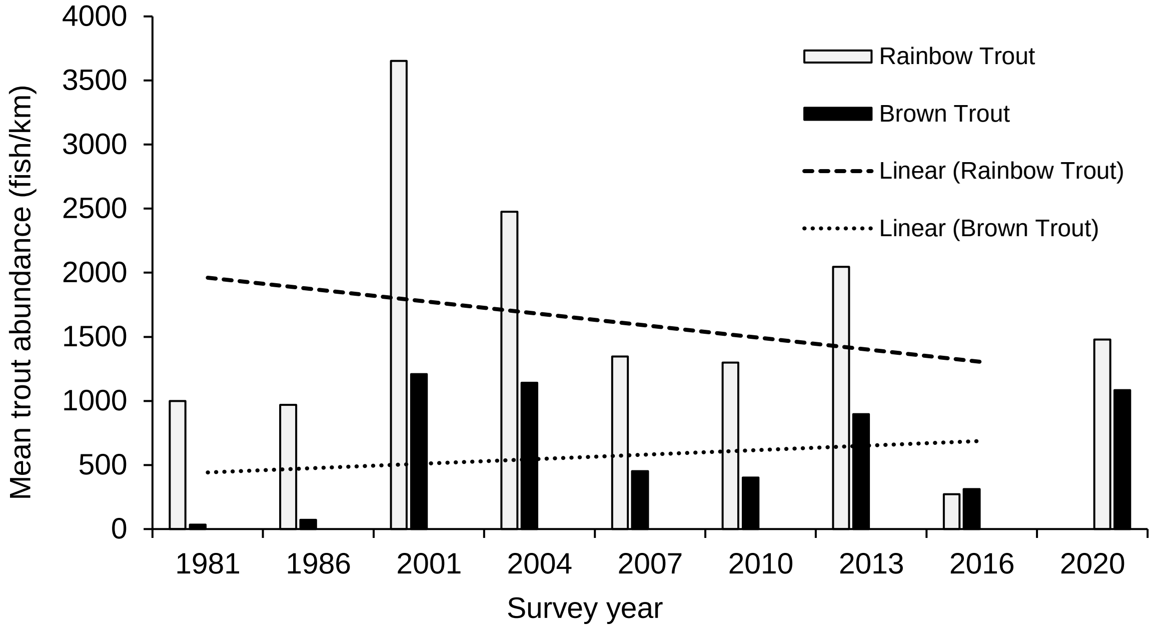

Figure 20. Mean density (fish/km) of Rainbow Trout (white bars) and Brown Trout (black bars) in Silver Creek, Idaho from 1981 to 2020. Estimates from 2020 surveys were not included in trendline estimation due to discrepancies in survey design from previous surveys.

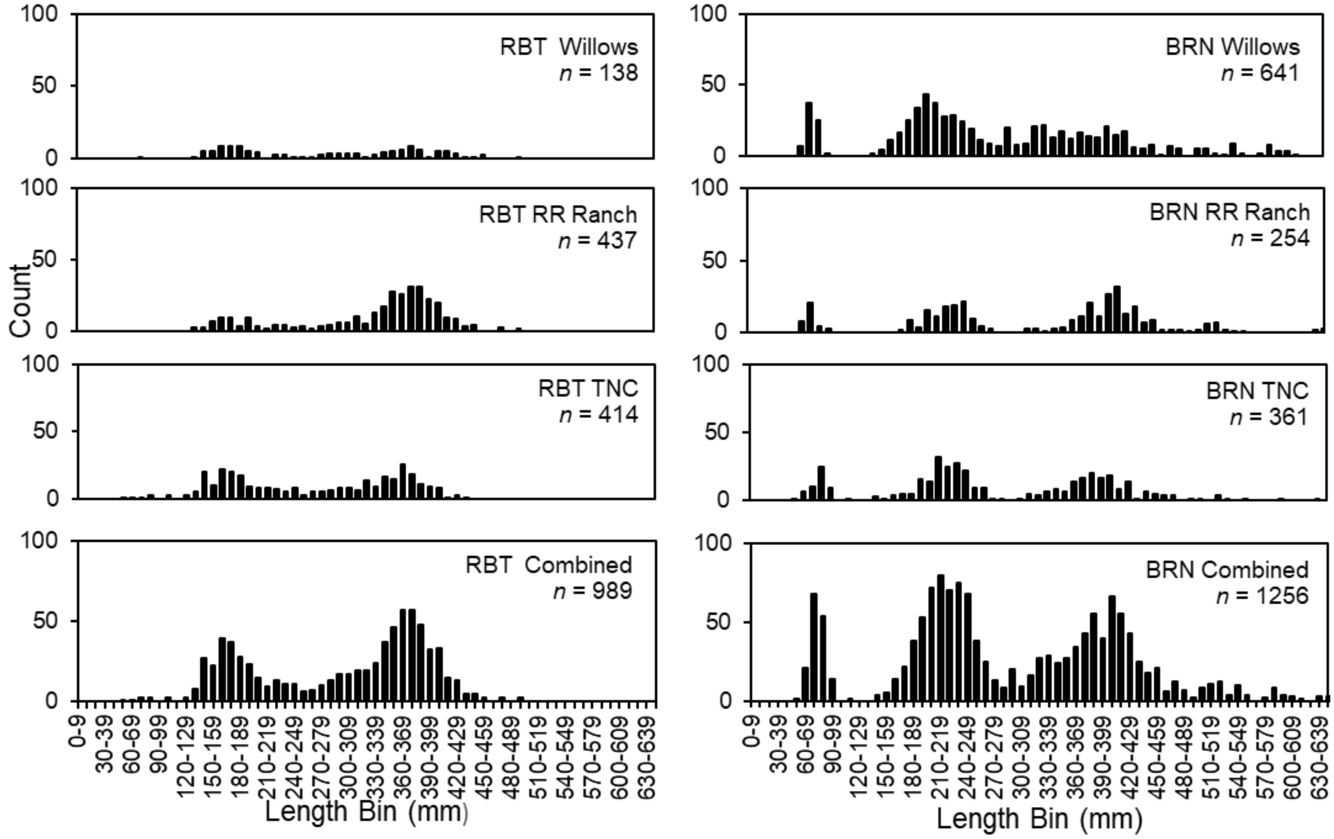

Figure 21. Length-frequency of Rainbow Trout (RBT) and Brown Trout (BRN) collected in Silver Creek, Idaho in 2020. Figures depict length distributions for the Nature Conservancy (TNC), RR Ranch (RR Ranch), Willows, and all transects combined.

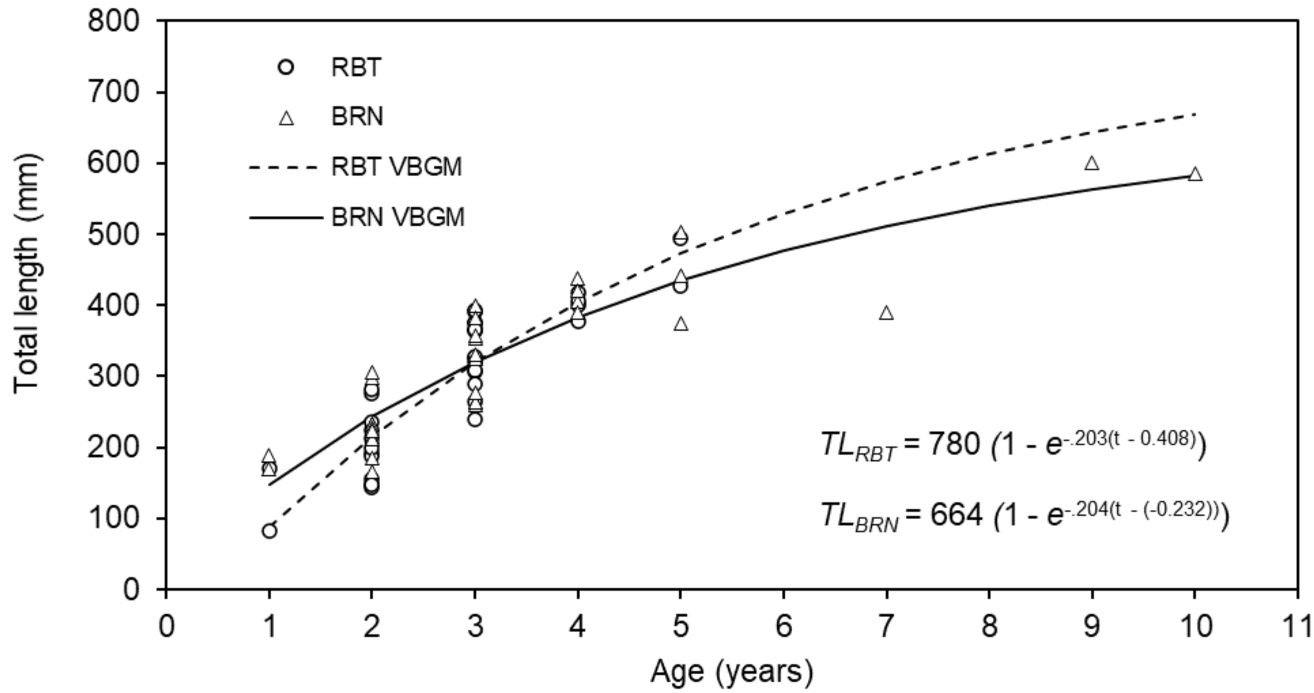

Figure 22. Lengths-at-age and Von Bertallanffy growth models (VBGM) for Rainbow Trout (RBT: circles; dashed line) and Brown Trout (BRN: triangles; solid line) collected in Silver Creek, Idaho in 2020. Associated VBGM equations are provided by species.

SOUTH FORK BOISE RIVER POPULATION TREND MONITORING

ABSTRACT

Standardized mark-recapture electrofishing surveys were conducted on the upper South Fork Boise River to monitor trends in Mountain Whitefish *Prosopium williamsonii*, Rainbow Trout *Oncorhynchus mykiss*, and Bull Trout *Salvelinus confluentus* populations. A total of 481 target specimens were collected during surveys, including 329 Mountain Whitefish (MWF), 122 Rainbow Trout (RBT), and 15 Bull Trout (BLT). Fish densities (mean fish/km ± SE) were estimated to be 696 ± 104 MWF/km (≥100mm;), 87 ± 20 RBT/km, and 4 ± 1 BLT/km. The overall density estimate for MWF was the highest since surveys began in 1991. Conversely, RBT density was its lowest on record. Data suggests significant levels of fish movement were occurring during the sampling period, and these movements may have affected capture efficiencies.

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INTRODUCTION

The South Fork Boise River (SFBR) is a popular trout fishery that flows approximately 160 km from its headwaters in the Boise Mountains through Elmore, Camas, and Boise counties. It is impounded by two reservoirs, Anderson Ranch Reservoir near its midpoint, and Arrowrock Reservoir at its terminus near its confluence with the Boise River. In general, the SFBR is divided into two distinct fisheries. The lower SFBR below Anderson Ranch Dam is a tail-water fishery primarily for trophy-sized Rainbow Trout *Oncorhynchus mykiss* and is managed by the Idaho Department of Fish and Game Southwest Region. The upper SFBR above Anderson Ranch Reservoir is managed as a mixed trout fishery for wild-origin and hatchery-raised Rainbow Trout. In addition, the upper SFBR contains populations of both Mountain Whitefish *Prosopium williamsonii* and Bull Trout *Salvelinus confluentus*, both of which are popular with anglers. This report chapter will focus on the upper SFBR.

The SFBR is an easily accessible trout fishery managed for a mix of wild- and hatchery-origin salmonids using two different sections of fishing bag limits. A majority of the river is easily accessible via the network of USFS roads running parallel to the river. The fishery in the 39-km reach of SFBR from the bridge at Pine, Idaho upstream to the Beaver Creek confluence is managed under statewide general fishing regulations (i.e., 6 trout any-size). The 16-km reach from Beaver Creek upstream to the Big Smoky Creek confluence is managed under special regulations (two trout ≥ 356 mm, artificial flies and lures only, single barbless hook only). The reach upstream from Big Smoky Creek, including all tributaries, is also managed with general statewide regulations. Both river sections managed under statewide general regulations are regularly supplemented with hatchery Rainbow Trout to provide harvest opportunities to anglers.

Traditionally, the upper SFBR was surveyed triennially to assess species composition and fish density trends to evaluate the efficacy of differing regulations. Unfortunately, the most recent survey in the SFBR occurred in 2011, which was prior to significant wildfire activity in the watershed (2013 Pony Fire). While detrimental effects on other fish species have been observed because of this fire (e.g., kokanee *Oncorhynchus nerka*; Megargle et al. 2016), the current status of sport fish populations in the upper SFBR was relatively unknown. As such, the objective of this sampling effort was to garner insight into the status of Rainbow Trout (RBT), Mountain Whitefish (MWF), and Bull Trout (BLT) populations in the watershed and evaluate fish regulation efficacy in the system.

METHODS

Standardized mark-recapture surveys were conducted in three long-term monitoring transects (i.e., lower, middle, and upper; Figure 23) in the upper SFBR in October 2020. Transects were selected to represent all three regulation areas in the upper SFBR. The upper and middle transects have been sampled regularly since 1990. The lower transect was added to the 2020 survey to better describe fish populations throughout the upper SFBR. Inflatable raft-mounted electrofishing equipment was utilized to collect fish. Power was supplied by a 5,000 W generator and standardized from 2750 to 3250 W based on conductivity (Miranda 2009). An Infinity model electrofishing control box applied electricity to the water (Midwest Lake Management, Inc., Polo, Missouri). One person operated the electrofishing unit from the raft, two people handled throwable handheld anodes, and seven netters followed the mobile anodes with dip nets to collect fish. Surveys took place in a downstream direction and an attempt to collect all fish encountered was made. Both marking and recapture surveys took place during daylight hours. Recapture surveys were conducted in each transect exactly seven days following their respective marking runs.

Captured fish were enumerated by species and measured for total length (mm) and weight (g). During marking runs, all captured trout exceeding 100 mm in total length were given a caudal fin mark using a standard seven mm paper hole-punch. To account for potential inter-transect movements, each sampling transect fish were given a unique mark. Fish captured in the upper transect were given a mark to the upper caudal fin, fish collected in the middle transect were marked in the middle of the caudal fin, and lower transect fish were given a lower caudal fin mark. During recapture runs, captured fish were enumerated, measured for total length, and examined for marks. If a marked fish was observed that information was recorded along with the caudal mark type. In either mark or recapture runs, those fish not euthanized for structure collection were released 100 m upstream of processing sites to avoid immediately recapturing fish and biasing estimates. Tissue samples were collected from a subset of the total Mountain Whitefish catch for genetic analysis.

Species composition was expressed as percent of total catch from the marking run, and was calculated by dividing the total number of each species captured by the total number of target species captured. Proportional confidence intervals were calculated using Fleiss (1981).

Fisheries Analysis + (FA+) software was used to generate mark-recapture and electrofishing capture efficiency estimates. To account for selectivity of electrofishing gear, population estimates (*N*) were calculated using a maximum likelihood estimation to fit the recapture data. A capture probability function of the form

$$Eff = (exp(-5+\beta1L+ \beta2L2)) /(1+ exp(-5+\beta1L+ \beta2L2))$$

where Eff is the probability of capturing a fish of length L, and β1 and β2 are estimated parameters (MFWP 2004). Then *N* is estimated by length group where M is the number of fish marked by length group:

$$N = M / Eff$$

Due to insufficient numbers of recaptures during our survey, transect specific density estimates could not be made. As such, data was pooled for a comprehensive population estimate expressed as # fish/km for the three species in question. 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 (Reff) was calculated as:

$$Reff = R/C$$

where *R* is the number of recaptures collected and C is the total number of fish collected during the recapture run. Relative weight (W_r) for individual fish were estimated by using the following equation (Simpkins and Hubert, 1996):

$$Wr = W/Ws\ X\ 100$$

where *Wr* is the relative weight, W is the weight of fish (g), and Ws is the length specific standard weight. *Ws* was estimated using the following equation (Blackwell et al. 2000, Neumann et al. 2012):

$$Log10(Ws) = a + b(Log10L)$$

where *Ws* is the length specific standard weight, a is the minimum relative standard weight, b is the maximum relative standard weight, and *L* is the individual fish length (mm).

RESULTS

Upper Transect

Four BLT were collected and marked in the upper transect during the initial marking run. During the recapture run, 10 BLT were collected, 2 of which were recaptured. Bull Trout lengths varied from 115 to 681 mm and mean length was 400 mm (± 38) (Figure 24; mean ± SE).
A total of 36 RBT were collected during the marking run. Of these, 35 fish were marked. Only three RBT were captured during the recapture run, one of which was a recapture. Rainbow Trout lengths varied from 96 to 382 mm with a mean length of 205 mm (± 22; Figure 24).

In total, 10 MWF were collected during the initial marking run, 5 of which were marked. During the recapture run, 108 fish were collected, 2 of which were recaptured. Total lengths varied from 83 to 474mm, and mean length was 314 mm (± 10; Figure 24). Catch composition changed substantially between mark and recapture surveys. During the marking run, BLT, RBT, and MWF composed 8%, 72%, and 20% of the total catch, respectively. Composition shifted to 8% (BLT), 3% (RBT), and 89% (MWF) during the recapture survey.

Middle Transect

Three BLT were collected and marked in the middle transect during the initial marking run. During the recapture run, 0 fish were collected. Bull Trout lengths varied from 190 to 233 mm and mean length was 195 mm (± 15) (Figure 24).

In total, 33 RBT were collected during the marking run and 32 were marked in the middle transect. No RBT were captured during the subsequent recapture run. Rainbow Trout lengths in the middle transect varied from 90 to 385mm with a mean length of 195 mm (± 15) (Figure 24).

A total of 34 MWF were collected and 27 were marked during the initial marking run. During the recapture run, 53 fish were collected, 8 of which were recaptures. Total lengths varied from 79 to 367 mm, and mean length was 230 mm (± 10) (Figure 24). During the marking run, BLT, RBT, and MWF composed 4%, 47%, and 49% of the total catch, respectively. Composition shifted to 0% (BLT), 0% (RBT), and 100% (MWF) during the recapture survey.

Lower Transect

In total, 23 RBT were collected and marked during the marking run in the lower transect. Forty-five RBT were captured during the subsequent recapture run, of which 10 were recaptures. Rainbow Trout lengths in the middle transect varied from 104 to 377 mm with a mean length of 248 mm (± 11) (Figure 24).

A total of 95 MWF were collected and 94 were marked during the initial marking run. During the recapture run, 47 fish were collected, 8 of which were recaptures. Total lengths varied from 96 to 401 mm, and mean length was 252 mm (± 8) (Figure 24). No BLT were encountered in the lower transect in either mark or recapture surveys. During the marking run, RBT and MWF composed 19%, and 81% of the total catch, respectively. Composition shifted to 49% (RBT) and 51% (MWF) during the recapture survey.

Combined Transects

Overall, BLT comprised 3% of our total catch in both mark and recapture runs. In total, 7 BLT were marked and 10 fish were encountered during recapture runs, 2 of which were recaptures. Fish lengths varied from 115mm to 681mm with a mean length of 366 mm (± 25). Mean *Wr* for BLT in our sample was 84 (± 12). Density of BLT (≥ 100 mm; ± 90% CI) in the upper SFBR was estimated to be 4 fish/km (± 1) (Figure 25). Capture efficiency for BLT across transects was 20%.

Rainbow Trout made up 28% of our total catch, almost all of which were wild-origin fish. A total of 80 fish were marked and 43 fish were collected in recapture runs. Of these, 13 fish were recaptured. Fish lengths varied from 90 to 385 mm with a mean length of 202 mm (± 8). Mean *Wr* of RBT in our sample was 82 ± 1. Density of RBT in the upper SFBR was estimated to be 87 fish/km (± 20) (Figure 25). Capture efficiency for RBT across transects was 43%.

Mountain Whitefish comprised 69% of our total catch. In total, 139 MWF were marked and an additional 208 were collected during the recapture run. Of these collected, 18 were recaptures resulting in a density estimate of 696 fish/km (± 104). Fish lengths varied from 79 to 474 mm with a mean length of 254 mm (± 5). Mean *Wr* for MWF in the upper SFBR was 91 (± 4) (Figure 25). Capture efficiency for MWF across transects was 16%.

DISCUSSION

According to our survey, MWF population estimates diverged substantially from density trends from 1991 to 2011. From 2001 to 2011, MWF density estimates have consistently trended downward reaching a record low in 2011.Conversely, MWF density estimates in 2020 exceeded their 2001 high (Figure 25). During our survey, MWF composed most of our sample, something that has not been observed in recent history. Additionally, total catch composition shifted to be overwhelmingly dominated by MWF between mark and recapture events in the upper and middle sampling transects. For example, in the upper and middle transects, MWF constituted 20% and 50% of the total catch, respectively. During the subsequent marking runs, compositions shifted to 90% in the upper transect and 100% in the middle transect. The opposite was true in the lower transect, where MWF catch decreased from 80% to 51% between surveys. Given that MWF are a fall spawning species, this observation may be an artifact of seasonal migration and schooling behavior associated with their spawning season since these surveys were conducted approximately 3 weeks later in the year than past surveys. This observation may also be an artifact of sampling efficiency increasing between mark and recapture runs (e.g., more proficient netters, better visibility etc.). As such, estimates reported here may be somewhat tenuous and in need of confirmation in future surveys to determine whether this was an outlier, or an actual indication of increasing population trend, reversing a long period of declines. Also, consideration should be given to the timing of sampling to avoid surveying during these periods of large-scale fish movement. Despite its relative shortcomings, data suggests that the MWF population is abundant, healthy, and successfully reproducing in the upper SFBR.

Rainbow Trout densities were estimated at a historic low in 2020. This result was surprising given historical trends (1991 to 2011) indicating its relative stability over time. Interestingly, while historic trends suggest RBT and MWF densities track consistently with each other, 2020 data shows an inverse relationship between the two species (Figure 25). The explanation for the observed relationship could be a result of sampling design in that surveys coincided with periods of RBT migration in the system. This would explain the large shifts in catch composition across transects where RBT vacated sampling reaches and were replaced by MWF. The observed shift highlights the importance of the timing of these surveys to maximize capture efficiency. Similarly, the upper and middle transects were originally established in close proximity to one another (Figure 23). As such, these two transects are very similar habitats and may not be providing a representative picture of the population throughout the system. Both transects had very similar results, and given the proximity of transects, survey results are likely very easily influenced by patterns and fish behavior like those we observed. Had the lower transect not been established and sampled for the first time in this year's survey, an estimate of RBT density would have been unobtainable given low recapture rates of RBT higher in the system. Additionally, had the new transect not been surveyed, RBT catch would have been extremely low. Most RBT were collected from the lower transect and as a result, density estimates from this survey are biased high.

If density estimates were truly representative of the current RBT population, it would indicate a substantial decline in RBT density since the last SFBR population survey in 2011. Given the 9-year hiatus from regular surveys in the area, it is difficult to speculate on the cause of this potential decline. However, observed trends could be the result of significant fire activity in 2013 (i.e., Pony Fire), and subsequent ash and debris flows in 2017 which resulted in habitat alterations in the SFBR watershed. The effects of this fire on other fish species have been documented previously. For example, density declines were documented in kokanee *Onchorhynchus nerka* that migrate annually from Anderson Ranch Reservoir into the SFBR to spawn. Declines in the kokanee population were attributable to wildfire-induced habitat alterations and reduction in suitable spawning habitat (Megargle et al. 2016). Although habitat in the upper SFBR has recovered substantially since 2013, years of poor habitat conditions may have led to declines in the SFBR wild RBT population allowing species like MWF to thrive due to their ability to utilize habitat conditions less suitable for trout. Regardless, investigations into the growth and mortality rates of these two species should be conducted during the next survey to determine whether the current fishing rules are appropriate. Additionally, wild trout should be tagged with T-bar anchor tags to evaluate angler use and exploitation rates in the upper SFBR to determine their potential effects on densities of these species.

Bull Trout were encountered infrequently in our surveys. They represented 3% of our overall catch and were only found in the upper and middle transects. Population density has only been estimated once in 2008 and our results suggest density has decreased since then from 60 fish/km to 4 fish/km. Declines are potentially the result of survey timing. Bull Trout are highly migratory in the SFBR and generally vacate mainstem and tributary environments for the reservoir in early September, post-spawn. This survey was conducted near the end of September, and BLT may have already migrated through the sampling reaches, causing our low BLT encounter rate. The data from our survey does not encompass natal BLT habitats and is therefore incomplete. While the mainstem population is apparently comprised of mature fish, we do not possess data regarding juvenile BLT in smaller tributary streams. (Figure 4). Additional study of BLT population status is warranted in this system to better understand BLT population structure system wide. A combination of tributary monitoring for juvenile BLT and mainstem adult BLT monitoring using the established kokanee weir would likely provide a more comprehensive assessment of BLT population status in the upper SFBR.

RECOMMENDATIONS

1. Maintain triennial survey schedule with the next survey taking place in fall 2023.

2. Collect aging structures from RBT and MWF to estimate mortality and growth rates.

3. Evaluate angler use and harvest of wild trout using the Tag-You're-It program.

4. Establish juvenile BLT monitoring sites in SFBR tributaries to evaluate trends in BLT recruitment.

5. Evaluate efficacy of using the kokanee weir in the upper SFBR to evaluate adult BLT population dynamics.

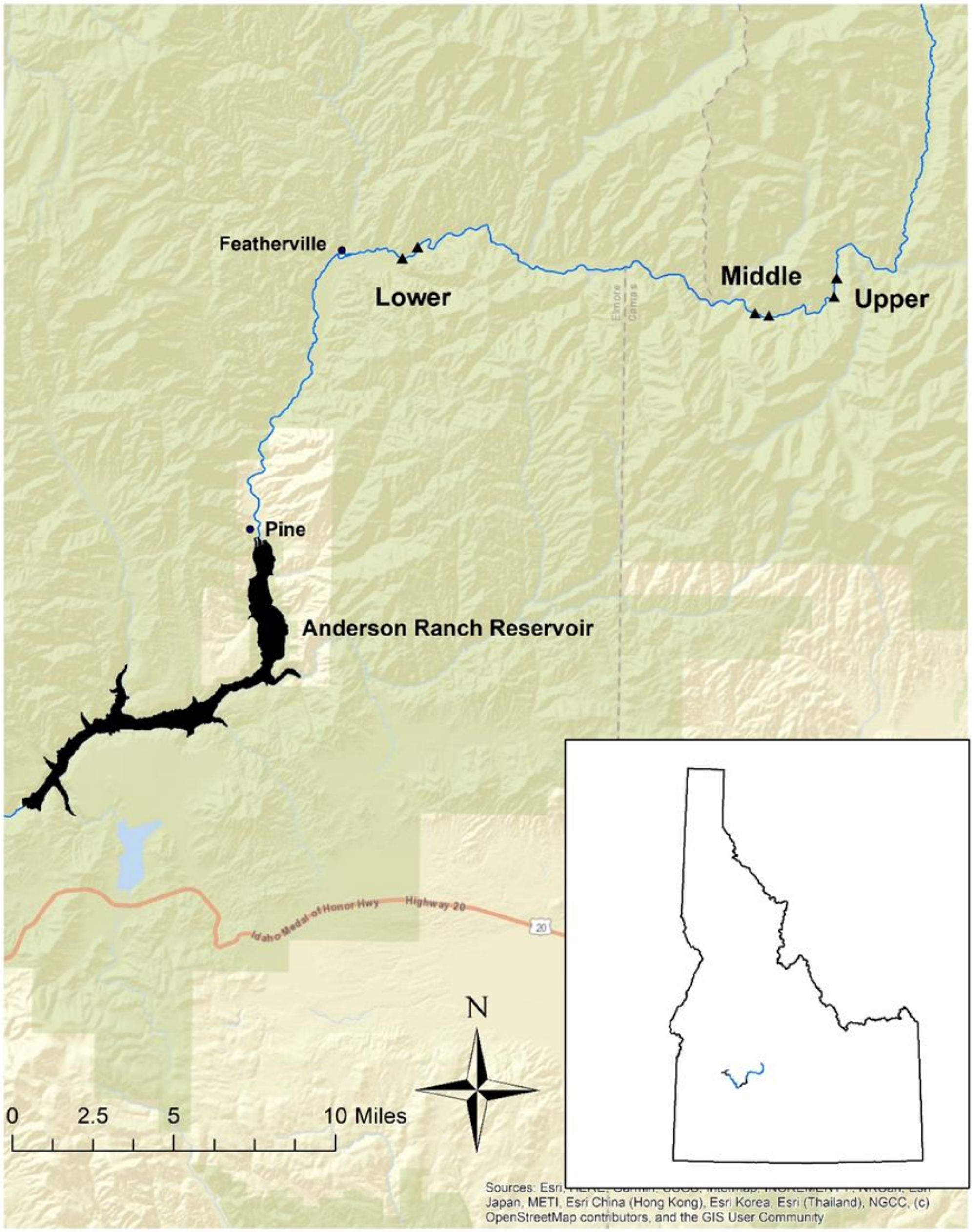

Figure 23. Transect boundaries for surveys completed in the South Fork Boise River in October 2020. Upper and lower boundaries for the upper, middle, and lower transects are indicated by black triangles.

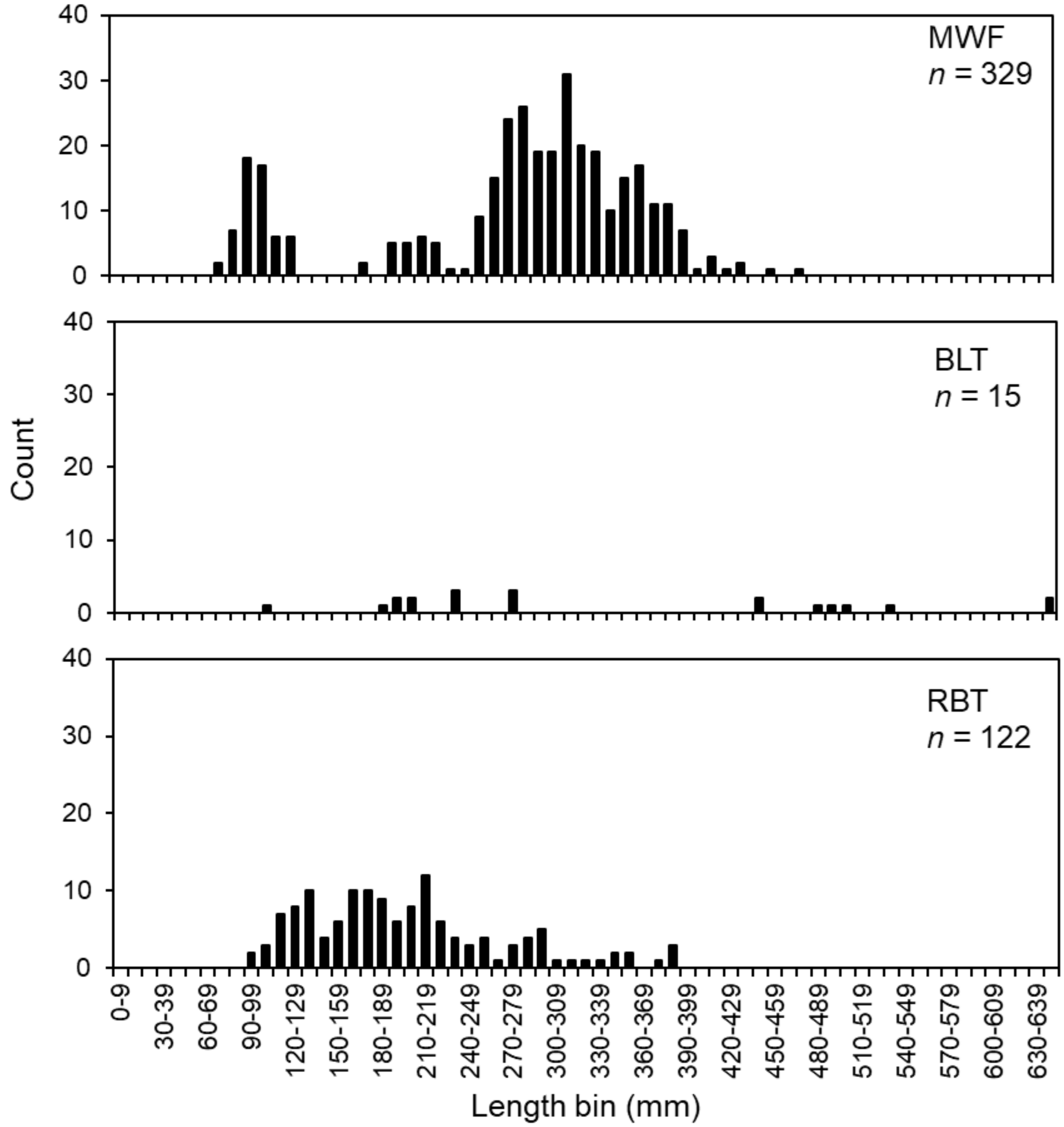

Figure 24. Length-frequency distributions of Mountain Whitefish (MWF, top panel), Bull Trout (BLT: middle panel), and Rainbow Trout (RBT; bottom panel) collected in fall 2020 surveys on the upper South Fork Boise River, Idaho. Sample sizes for each species are provided (*n*).

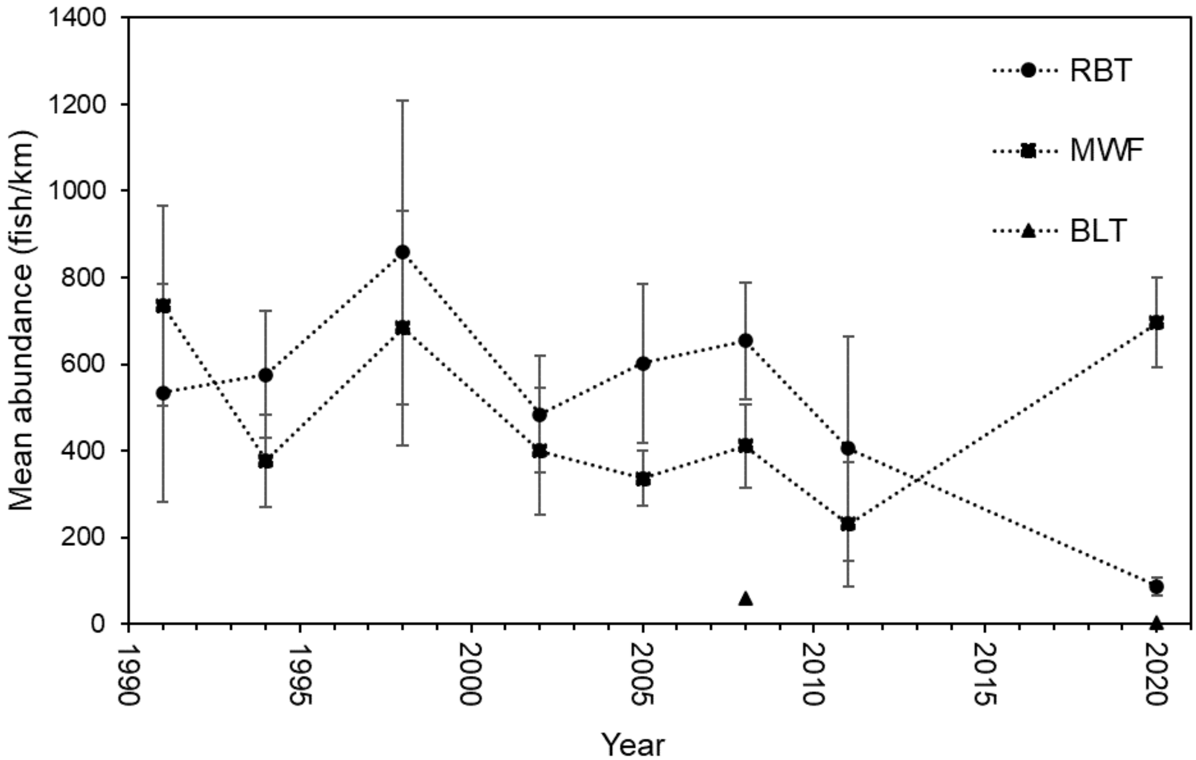

Figure 25. Estimates of mean density (fish/km) and 95% confidence intervals for Rainbow Trout (RBT: black circles), Mountain Whitefish (MWF; black squares), and Bull Trout (black triangles) collected from the South Fork Boise River from 1991 to 2020.

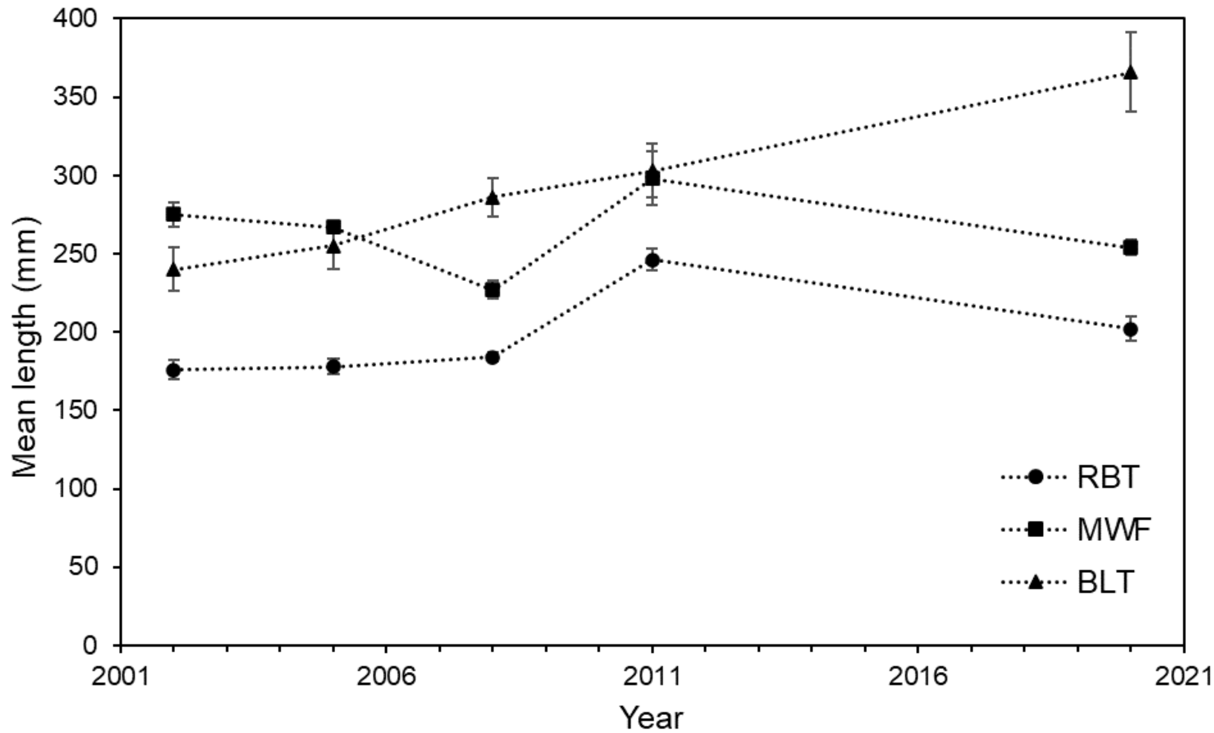

Figure 26. Estimates of mean total length (mm) and 95% confidence intervals for Rainbow Trout (RBT: black circles), Mountain Whitefish (MWF; black squares), and Bull Trout (black triangles) collected from the South Fork Boise River from 1991 to 2020.

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Appendix A. Sampling method, site name, and location of sampling included in 2020 fisheries surveys in the Magic Valley Region.

Waterbody	Method	Easting	Northing
Anderson Ranch Reservoir	Gill net	43.4178	-115.30049
Anderson Ranch Reservoir	Gill net	43.39578	-115.37244
Anderson Ranch Reservoir	Gill net	43.36791	-115.43333
Silver Creek (TNC start)	Electrofish	43.31439	-114.15224
Silver Creek (TNC end)	Electrofish	43.31482	-114.13566
Silver Creek (RR Ranch start)	Electrofish	43.31507	-114.12758
Silver Creek (RR Ranch end)	Electrofish	43.31087	-114.11647
Silver Creek (Willows start)	Electrofish	43.32511	-114.1063
Silver Creek (Willows end)	Electrofish	43.32558	-114.09796
South Fork Boise River (upper start)	Electrofish	43.60046	-114.95227
South Fork Boise River (upper end)	Electrofish	43.59204	-114.95381
South Fork Boise River (middle start)	Electrofish	43.58321	-114.99396
South Fork Boise River (middle end)	Electrofish	43.58424	-115.00248
South Fork Boise River (lower start)	Electrofish	43.61184	-115.21143
South Fork Boise River (lower end)	Electrofish	43.60677	-115.22065
Salmon Falls Creek Reservoir	Electrofish	42.06806	-114.76316
Salmon Falls Creek Reservoir	Electrofish	42.07827	-114.76777
Salmon Falls Creek Reservoir	Electrofish	42.09921	-114.75863
Salmon Falls Creek Reservoir	Electrofish	42.1076	-114.75473
Salmon Falls Creek Reservoir	Electrofish	42.11438	-114.73968
Salmon Falls Creek Reservoir	Electrofish	42.12527	-114.73917
Salmon Falls Creek Reservoir	Electrofish	42.12997	-114.73175
Salmon Falls Creek Reservoir	Electrofish	42.13256	-114.7391
Salmon Falls Creek Reservoir	Electrofish	42.14258	-114.73039
Salmon Falls Creek Reservoir	Electrofish	42.14669	-114.74206
Salmon Falls Creek Reservoir	Electrofish	42.15153	-114.74151
Salmon Falls Creek Reservoir	Electrofish	42.15933	-114.73548
Salmon Falls Creek Reservoir	Electrofish	42.17204	-114.74683
Salmon Falls Creek Reservoir	Electrofish	42.18495	-114.74433
Salmon Falls Creek Reservoir	Electrofish	42.18786	-114.74907
Salmon Falls Creek Reservoir	Electrofish	42.18963	-114.74038
Salmon Falls Creek Reservoir	Electrofish	42.1957	-114.73861
Salmon Falls Creek Reservoir	Electrofish	42.20261	-114.73293
Salmon Falls Creek Reservoir	Trap Net	42.20629	-114.73018
Salmon Falls Creek Reservoir	Trap Net	42.20653	-114.74002
Salmon Falls Creek Reservoir	Trap Net	42.19984	-114.74049
Salmon Falls Creek Reservoir	Trap Net	42.19436	-114.75224
Salmon Falls Creek Reservoir	Trap Net	42.19436	-114.75078
Salmon Falls Creek Reservoir	Trap Net	42.18988	-114.73672
Salmon Falls Creek Reservoir	Gill Net	42.19975	-114.73883
Salmon Falls Creek Reservoir	Gill Net	42.19105	-114.74303

Appendix A. (continued)

Waterbody	Method	Easting	Northing
Salmon Falls Creek Reservoir	Gill Net	42.18843	-114.74785
Salmon Falls Creek Reservoir	Gill Net	42.17835	-114.74664
Salmon Falls Creek Reservoir	Trap Net	42.16454	-114.74845
Salmon Falls Creek Reservoir	Trap Net	42.15975	-114.73297
Salmon Falls Creek Reservoir	Trap Net	42.14631	-114.73174
Salmon Falls Creek Reservoir	Trap Net	42.14055	-114.72989
Salmon Falls Creek Reservoir	Trap Net	42.13183	-114.72624
Salmon Falls Creek Reservoir	Trap Net	42.13036	-114.74519
Salmon Falls Creek Reservoir	Gill Net	42.15391	-114.74245
Salmon Falls Creek Reservoir	Gill Net	42.16801	-114.74293
Salmon Falls Creek Reservoir	Gill Net	42.13614	-114.7389
Salmon Falls Creek Reservoir	Gill Net	42.13532	-114.73192
Salmon Falls Creek Reservoir	Trap Net	42.1203	-114.73709
Salmon Falls Creek Reservoir	Trap Net	42.11262	-114.75606
Salmon Falls Creek Reservoir	Trap Net	42.1053	-114.7427
Salmon Falls Creek Reservoir	Trap Net	42.09793	-114.75215
Salmon Falls Creek Reservoir	Trap Net	42.08857	-114.75284
Salmon Falls Creek Reservoir	Trap Net	42.07392	-114.77143
Salmon Falls Creek Reservoir	Gill Net	42.11897	-114.74925
Salmon Falls Creek Reservoir	Gill Net	42.11433	-114.74751
Salmon Falls Creek Reservoir	Gill Net	42.10622	-114.74836
Salmon Falls Creek Reservoir	Gill Net	42.08848	-114.7592

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