FISHERY MANAGEMENT INVESTIGATIONS

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REGION

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ABSTRACT

Angler effort and catch rates at Anderson Ranch Reservoir were estimated utilizing data collected from a roving creel survey at five boat ramps. We conducted creel surveys on six randomly chosen dates between June 1, 2019 and July 1, 2019. Collectively, 134 interviewed anglers totaled 2,454 hours of angling effort. Throughout the duration of the creel, 90% of anglers surveyed targeted kokanee *Oncorhynchus nerka*, 5% targeted any species, 4% targeted Smallmouth Bass *Micropterus dolomieu*, and 1% targeted Fall Chinook Salmon *Oncorhynchus tshawytscha*. Despite Rainbow Trout *Oncorhynchus mykiss* being present in angler catch, no angler identified trout as their target species. Kokanee and Chinook Salmon catch-per-unit-effort (CPUE) was 0.29 and 0.05 fish/h, respectively. Smallmouth Bass and Rainbow Trout CPUE was 0.6 and 0.03 fish/h, respectively. Mean TL (± 90% CI) of kokanee, Chinook, Rainbow Trout, and Smallmouth Bass from angler creel surveys were 382 (± 3), 357 (± 3), 370 (± 59), and 358 mm (± 15), respectively. Of the harvested kokanee, 48% were male and 30% were female, with the remaining classified as juvenile fish. The mean number of eggs per mature female (± 90% CI) kokanee was 1,193 (± 272). Additionally, 77% of Chinook encountered in the creel were determined to be of wild origin (adipose fin intact). No fin clipped kokanee were encountered.

In September of 2019, gill nets were utilized to capture kokanee and Chinook Salmon to determine stock contribution for both species and kokanee length-at-age information. Gill net CPUE for kokanee and Chinook was 6 and 3 fish/net-night, respectively. Kokanee TL ranged from 55 to 470 mm, with a mean of 232 mm (± 20). Chinook TL ranged from 75 to 475 mm, with a mean of 361 mm (± 19). Ventral fin clipped kokanee were marked as fingerlings prior to release, and were not observed in the catch. Mean TL of age-1, age-2, and age-3 kokanee was 194 (± 37), 293 (± 61), and 402 mm (± 16), respectively. Adipose fin clipped Chinook Salmon were marked prior to release, and represented 17% of Chinook Salmon caught in gill nets.

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INTRODUCTION

Kokanee salmon *Oncorhynchus nerka* exhibit multiple and often complex life history forms (Whitlock et al. 2018). Kokanee are semelparous salmon that feed and grow in lakes or reservoirs for 2.5 to 3.5 years, then spawn in tributaries or along shorelines during fall before subsequently dying. Eggs incubate in the streambed or shoreline gravels until hatching in late winter. Alevins remain in the gravel for several more weeks before emerging and migrating to the lake or reservoir in the spring. Fry commonly migrate directly to pelagic areas (Forester 1968), but can spend time feeding in the littoral habitats, particularly in lakes or reservoirs with pronounced littoral regions (Burgner 1991; Gemperle 1998). Juvenile and adult kokanee are most commonly associated with the pelagic zones of lakes and reservoirs, 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 tradeoff 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 interest in the management of kokanee fisheries across the state. The Boise River reservoirs are among the most popular kokanee fisheries in the state. Although the kokanee fisheries at Lucky Peak and Arrowrock reservoirs are dependent on hatchery stocking, the uppermost fishery – Anderson Ranch Reservoir (ANR) – has been historically supported by wild kokanee recruitment (Rieman and Myers, 1992).

ANR is a 22.5 km long, Bureau of Reclamation (BOR) impoundment on the South Fork Boise River (SFBR) in Elmore County, Idaho. Completed in 1950, its spillway crests at an elevation of 1,279 m above sea level. The reservoir has a maximum storage capacity of 413,100 acre-feet. Maximum depths reach approximately 91 m. The primary purpose of the dam is for irrigation, power production, and flood control. Recreational access management is controlled by the BOR and Boise National Forest. There are six boat ramps including Deer Creek, Pine, Fall Creek, Castle Creek, Curlew Creek, and Elk Creek. However, the Curlew Creek access receives the majority of angler use (Megargle et al. 2018). Most anglers fishing ANR target kokanee, but Rainbow Trout *Oncorhynchus mykiss*, Smallmouth Bass *Micropterus/ dolomieu*, Chinook Salmon *Oncorhynchus tshawytscha*, and Yellow Perch *Perca flavescens* are available in the reservoir. Bull Trout *Salvelinus confluentus* are present seasonally, but rarely targeted by anglers.

Idaho Department of Fish and Game primarily manages ANR as a kokanee harvest fishery with a 25-fish daily bag limit and a 75-fish possession limit (three-day bag limit). Recent forest fires (2013) and subsequent debris flows (2014) in the SFBR drainage temporarily compromised stream spawning habitat and substantially reduced kokanee recruitment to the reservoir in recent years. Because of these conditions, ANR has received annual supplementation of hatchery kokanee since 2016. The management objectives for ANR kokanee are to provide catch rates of 0.5 fish/h with mean sizes ≥ 305mm.

The primary objectives of this study are to determine trends in growth, catch rates, stock contribution, and relative abundance of kokanee in ANR. Secondary objectives for this study include monitoring similar trends in the Chinook Salmon fishery and catch rates of Smallmouth Bass at the reservoir.

METHODS

Angler Survey- Check Station

Creel surveys at boat ramps on ANR were used to collect angling data to index fisheries metrics. Creel data collection was similar that of the access-access survey design described by Pollock et al. (1994). Surveys were conducted in June 2019, based on previous creel data that suggested June was the peak month for kokanee angling effort (Megargle et al. 2016). Kokanee, Chinook Salmon, and Smallmouth Bass were the primary focus of the evaluation; however, data on all fish species encountered was recorded. Because of the design of the survey, results and inferences are limited to boat anglers.

Creel clerks were stationed at a single access site for each randomly selected creel day, to intercept anglers as they exited the fishery. Creel stations intercepted anglers at the Deer Creek, Curlew Creek, and Elk Creek boat launches surrounding ANR. Six dates, with three weekday and three weekend/holiday days were randomly selected during June of 2019. Two time periods were used: (1) an early (0800 - 1400 hours), and (2) a late (1400 - 2000 hours). Data collection focused on completed fishing trips. Each interview or contact was assigned a unique interview number for that day, based on the numerical order by which anglers were contacted. Number of anglers in a party, time fishing, target species, and the number of each species that were harvested or released was also recorded. Fishing method, gear type, total length (TL; nearest mm), and weight (g) of harvested fish were recorded. Mean angler CPUE $(\widehat{R_2})$ was estimated using the ratio of means (ROM), where trip interviews were considered complete:

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

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

Kokanee were processed on location to determine sex, maturity (mature vs. immature), and fecundity (eggs/female). Fecundity was estimated (± 90% CI) by counting eggs within a weighed subsample and expanding that value to the total egg weight (eggs/fish). Fecundity data was expressed as mean eggs per mature female.

Gill netting

Gill netting efforts in previous years occurred in July, and were intended to provide insight into the size and fecundity of the current spawning year class and relative abundance in an effort to determine potential for hatchery egg take supplementation. Because the annual creel occurs in June, gill netting in July is repetitive and unnecessary. Therefore, moving the gill netting effort to fall (when the current year's spawners have left the system) provides insight into the potential of the following year's fishery.

Gill netting was conducted at ANR September 27-29, 2019. Gill net sites were stratified along three sampling zones (Figure 1), referred to as lower, middle, and upper reservoir. Three nets were set in each sample location. Nets were set at dusk and retrieval started at dawn of the following day. Each set of gill nets were horizontally suspended with the float line of one net set at 6 m, 12 m, and 18.3 m depths. Each gill net measured 48.8 m in length and 6.0 m in depth. Gill nets contained 16 panels, each measuring 3.0 m in length. Nets consisted of eight different mesh sizes (12.7, 19.0, 25.4, 38.1, 50.8, 63.5, 76.2, 101.6 mm; stretch measure) with two panels of each mesh size randomly positioned throughout the net. Total length (mm), and weights (g) were taken on all fish encountered. Otoliths were removed on 37 kokanee (approximately 10 from each age/size class present) and length at age was determined (Branigan et al.2019).

In an effort to determine stock recruitment, all hatchery kokanee and Chinook stocked in ANR in 2015-17 were marked by clipping the pelvic fin and adipose fin, respectively. Kokanee were hand clipped by Region 4 staff at the Mackay Fish Hatchery in late April of each year. Chinook were hand clipped by Nampa Research staff prior to stocking each year. All kokanee and Chinook captured in gill nets at ANR were examined for the associated fin clip.

RESULTS

Angler Survey – Check Station

Collectively, 134 interviewed anglers totaled 2,454 hours of angling effort. Anglers interviewed consisted entirely of boat anglers. The mean daily kokanee angling effort in June of 2019 was 84 h (± 16). Throughout the duration of the creel, 90% of anglers identified as targeting kokanee, 5% identified as targeting any species, 4% were targeting Smallmouth Bass, and 1% targeted Chinook salmon. Despite Rainbow Trout being present in angler catch, no angler identified trout as their target species. Kokanee represented 94% of the species caught during the creel. Kokanee and Chinook Salmon CPUE was 0.29 and 0.05 fish/h, respectively. Smallmouth Bass and Rainbow Trout CPUE was 0.6 and 0.03 fish/h, respectively. Mean length of harvested kokanee, Chinook, Rainbow Trout, and Smallmouth Bass from angler creel surveys were 382 (± 3), 357 (± 3), 370 (± 59), and 358 mm (± 15), respectively. A total of 48% of kokanee harvested by anglers were male and 30% were female, with the remaining being classified as juvenile fish. The mean number of eggs per mature female kokanee was 1,193 eggs (± 272).

Gill Netting

At ANR, gill nets captured 56 kokanee, 23 Chinook, 2 Smallmouth Bass, 1 Rainbow trout, and 2 yellow perch. Gill net CPUE for kokanee and Chinook Salmon was six and three fish/net-night, respectively. Length of kokanee ranged from 55 to 470 mm (Figure 2), with a mean length of 232 mm (± 20). Length of Chinook ranged from 75 to 475 mm (Figure 2), with a mean length of 361 mm (± 19). Ventral fin clipped kokanee were marked as fingerling prior to release, but were not observed in the catch. Adipose fin clipped Chinook Salmon represented 17% of Chinook Salmon caught in gill nets (Figure 3). There were four age classes of kokanee represented in the gill net catch (Figure 4). Mean lengths at age-1 through age-3 was 194 (± 37), 293 (± 61), and 401 mm (± 16), respectively. There was only one otolith sample representing age four fish. Otoliths were also collected from a subsample of Chinook (n = 7). Two age classes were represented in the gill net catch (Figure 5). Mean lengths at age-3 and age-4 were 394 (± 27) and 450 mm (± 161), respectively.

DISCUSSION

Angler Survey – Check Station

Based on the 2019 check station results, kokanee management goals are partially met at ANR. Mean catch rates for kokanee between 2018 and 2019 have decreased, while mean lengths of harvested kokanee increased (Figure 6). This is not necessarily a good characteristic of the fisheries population dynamic, as it suggests that kokanee abundance in ANR continues to be low following the fishery collapse associated with the 2013 Pony Fire (Megargle and Stanton, 2016). Kokanee growth is density-dependent and the large fish size can be indicative of a low-density population (Rieman 1991). Consecutive years exhibiting reduced catch rates and increased mean harvest length may be symptomatic of a declining kokanee population.

Declines in kokanee abundance at ANR were not expected, as 2016 trawl netting estimated 1.7 million age-0 kokanee, which is relatively high compared to previous years. These age-0 kokanee were anticipated to be represented in the 2019 fishery as age-3 adults (Megargle et al. 2018). However, it is possible that many of the kokanee were either harvested, entrained, or both. This was based on increased spill from ANR dam during the spring of 2018 and increased catch rates recorded in both the 2017 and 2018 index creel (Thiessen et al. 2020). Results from the 2017 index creel also estimated the highest level of kokanee angling effort recorded at ANR since surveys began in 2015. Furthermore, mean lengths of harvested kokanee decreased in 2017 despite an increase in mean length of age-3 kokanee observed, suggesting a higher proportion of younger aged kokanee were part of the harvest.

Anderson Ranch Reservoir has a growing Smallmouth Bass fishery (Megargle and Stanton, 2020). Smallmouth Bass catch rates and mean lengths increased continually between 2014 to 2018, and were sustained in 2019 with 0.6 SMB/h and 358 mm, respectively. Despite growing popularity in the ANR bass fishery, anglers specifically targeting bass represented a small fraction of total anglers during creel survey efforts, where kokanee anglers made up the majority. Smallmouth Bass population dynamics at ANR are poorly understood. Collection of abundance, age, growth, and mortality data are needed to better inform management decisions regarding this population.

Chinook Salmon catch rates increased 200% at ANR between 2018 and 2019. This increase suggests that either abundance of Chinook in the reservoir have increased, or effort targeting the species have increased. No ad clipped Chinook Salmon were documented at check stations, suggesting that wild origin fish support the fishery. Additionally, creel interviews from 2019 documented anglers identifying as specifically targeting Chinook Salmon at ANR, for the first time.

Gill Netting

In 2019, gill-netting efforts transitioned from summer to fall netting in order to forecast the following year's fishery (Peterson et al. 2018). Fall gill netting occurs after spawners have vacated the reservoir. Overall kokanee CPUE decreased at ANR in 2019. This was expected since kokanee gear susceptibility increases with fish size. Mean length of kokanee collected also decreased in response to fewer adult fish being in the reservoir. Additional consecutive years utilizing this strategy are needed before any trend comparisons can be inferred.

Wild origin fish represented 83% of Chinook Salmon collected via gill netting, suggesting natural recruitment may be increasing, as CPUE increased from 2018 to 2019 (Thiessen et al. 2020). Along with increases in gill net and angler catch rates, mean Chinook Salmon age and lengths increased in 2019, suggesting Chinook Salmon in ANR were not experiencing prey resource limitations. An additional explanation for increasing CPUE, age, and size observed in

2019 is catch bias towards bigger fish associated with gill netting. The Chinook Salmon population will better recruit to gill nets as fish get older and therefore larger.

Despite Chinook Salmon stomach contents exclusively containing juvenile Yellow Perch, the potential to negatively affect kokanee abundance remains a concern if Chinook Salmon populations continue to increase. Although we have little evidence of kokanee predation, it will be important to continue monitoring Chinook Salmon recruitment given the high percentage of natural origin. Continued monitoring is needed to identify how increased angling pressure, harvest, population densities, entrainment, natural recruitment, and supplementation at ANR are affecting these species.

RECOMMENDATIONS

1. Evaluate and monitor stock contribution and natural recruitment of kokanee and Fall Chinook Salmon to the fishery.

2. Continue fall horizontal gill netting to monitor kokanee and Chinook Salmon relative abundances and growth rates.

3. Continue monitoring June harvest and angler effort using the index creel survey.
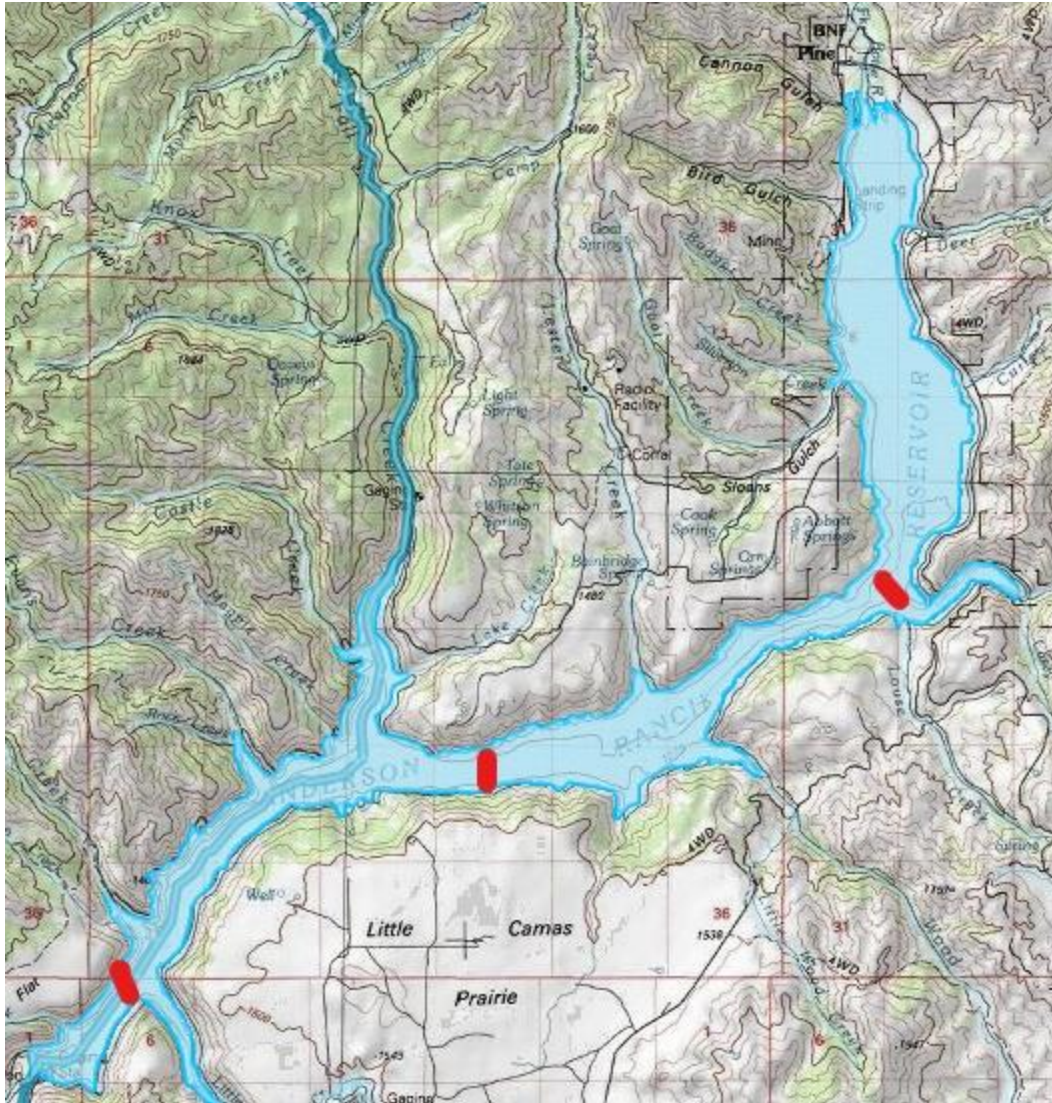
Figure 1.   Map of lower, middle, and upper gill net set locations on Anderson Ranch Reservoir in September 2019.
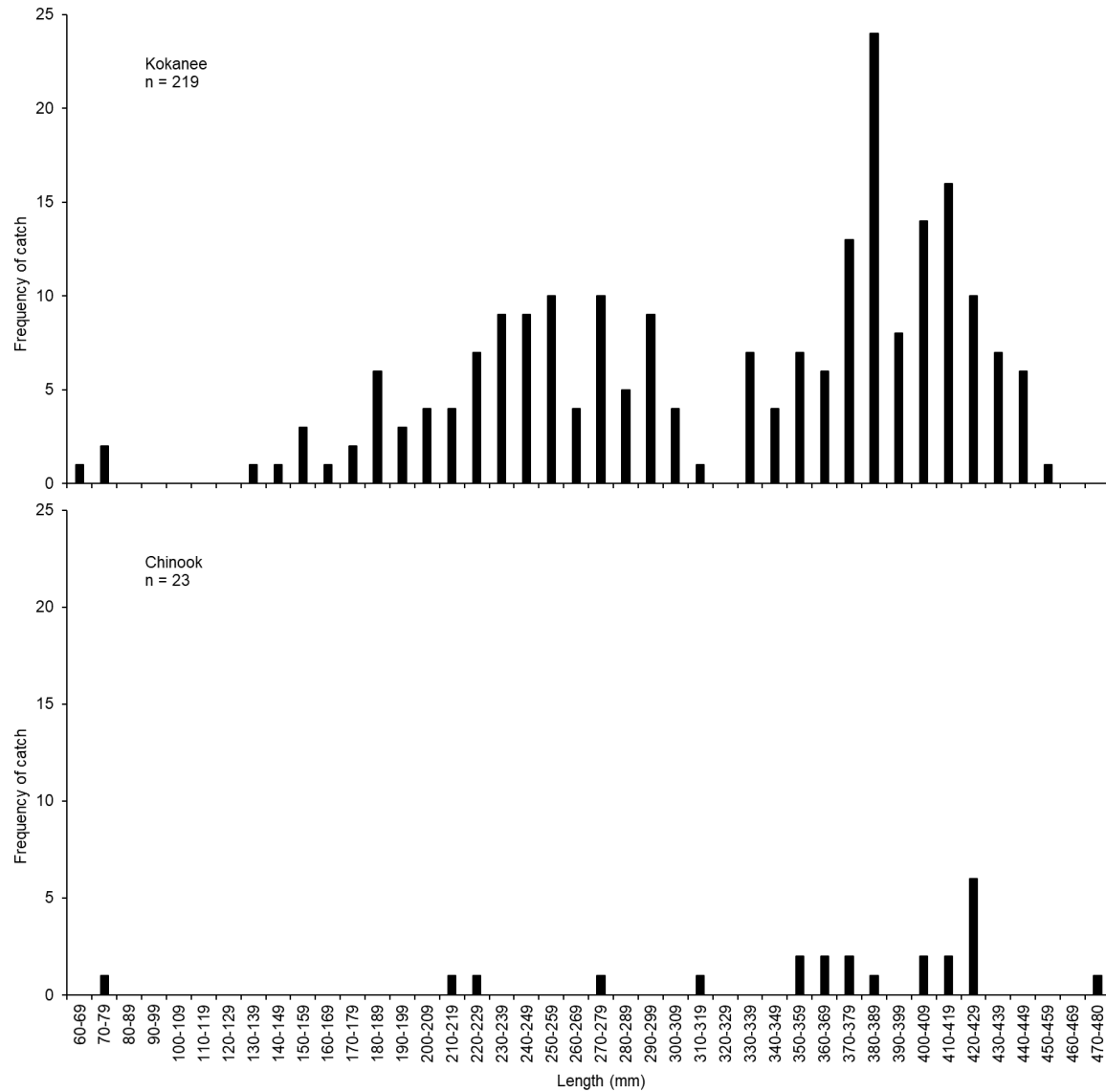
Figure 2.   Kokanee and Chinook Salmon length-frequency data generated from gill netting at Anderson Ranch Reservoir in September 2019.
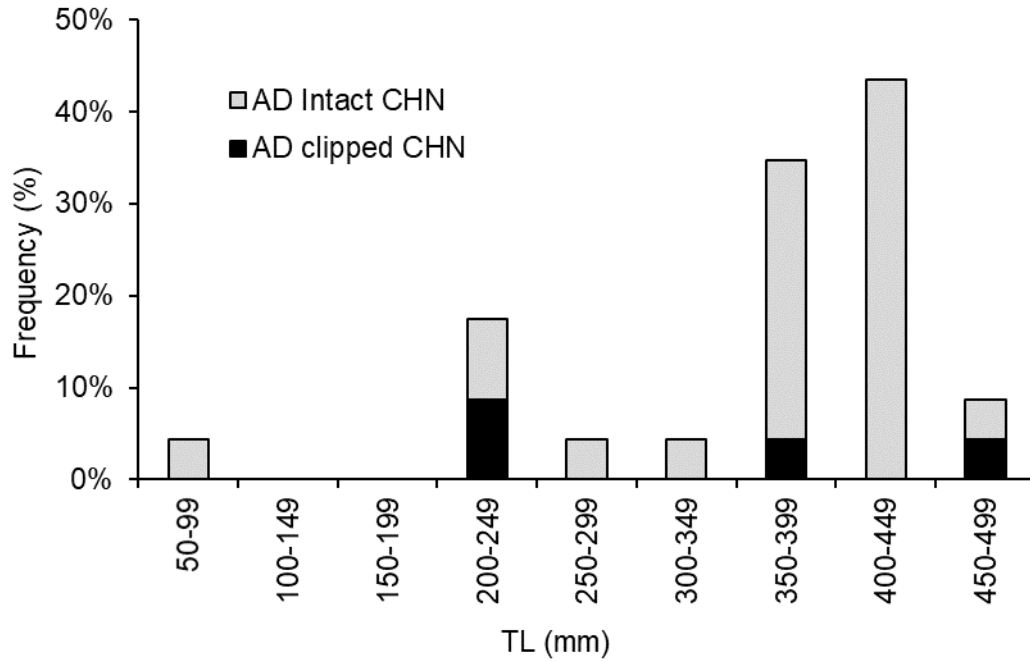
Figure 3.   Length-frequency distribution of Fall Chinook Salmon (n = 23) with the proportion of both adipose-intact and ad-clipped generated from gill netting at Anderson Ranch Reservoir in September 2019.

$$L_t = 501.06(1 - e^{-0.007+0.474})$$
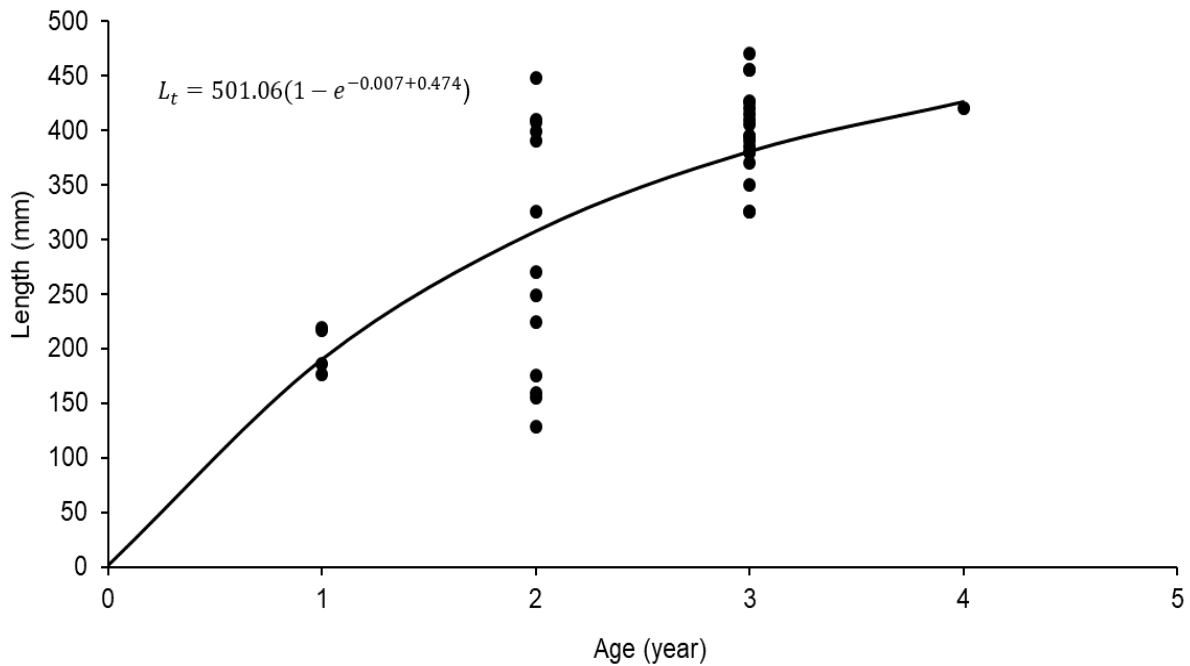
Figure 4.   Kokanee length-at-age (n = 36) from gill net captured fish in September 2019 at Anderson Ranch Reservoir.

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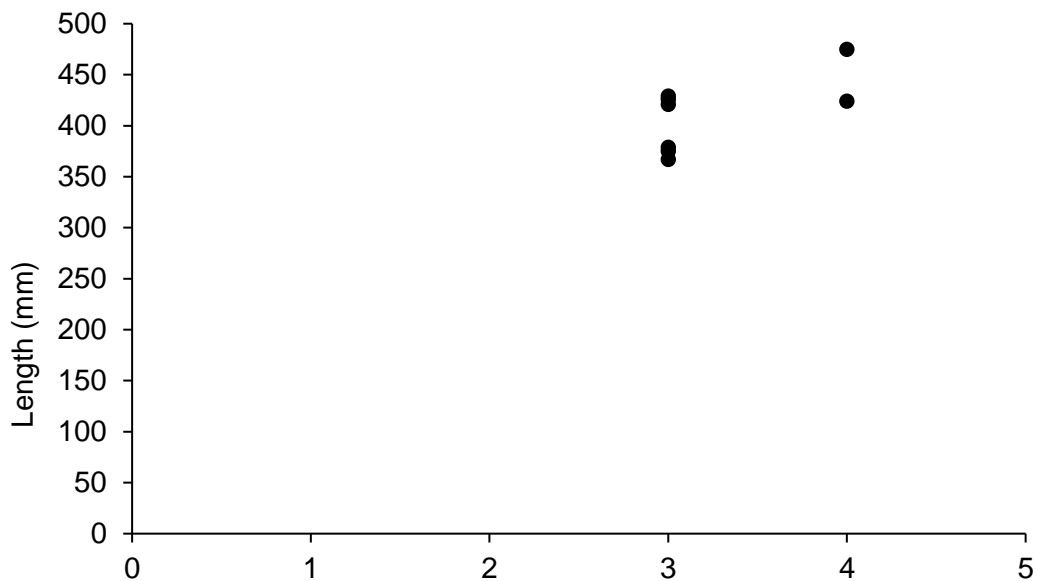
Figure 5.   Fall Chinook Salmon length-at-age (*n* = 9) from gill net captured fish in 2019 at Anderson Ranch Reservoir.
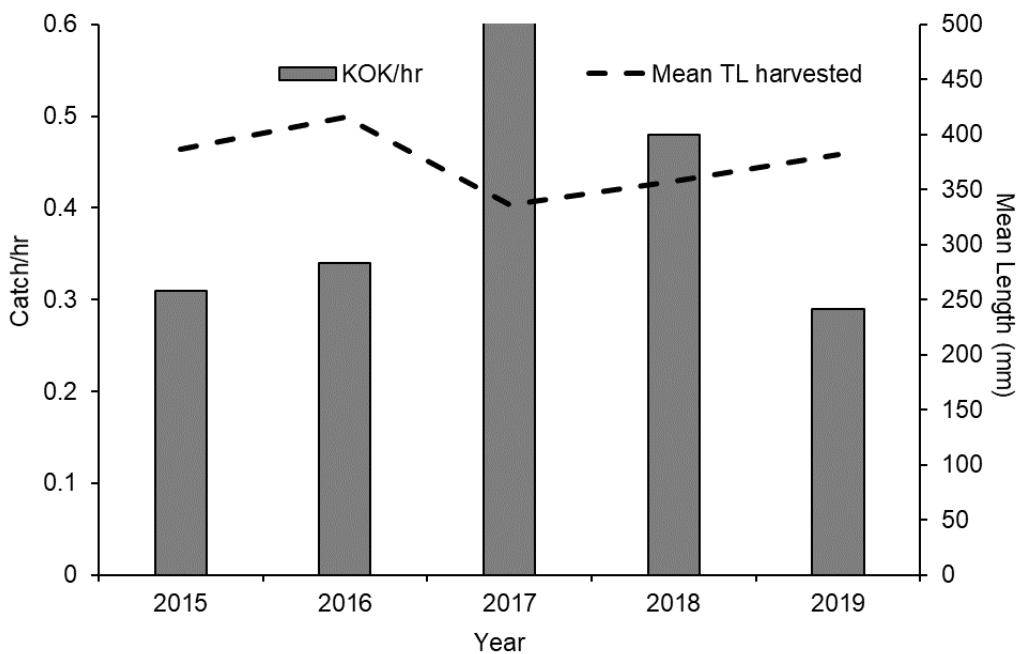
Figure 6.   Angler catch rates and mean harvested length of kokanee Salmon at Anderson Ranch Reservoir between 2015 and 2019.

MILNER RESERVOIR CATFISH EXPLOITATION

ABSTRACT

Milner Dam was retrofitted with an Idaho Power Company hydropower plant in 1987. After many efforts to establish fish populations and fisheries by stocking trout and various warmwater fish species, Idaho Power Company and Idaho Department of Fish and Game agreed to amend the mitigation agreement in 1997 to allow for the annual stocking of 20,000 Channel Catfish *Ictalurus punctatus*. This project evaluated the angler use and harvest, carryover success, reporting rate, and tag retention of Channel Catfish tagged with 70-mm coded dart tags. In total, 1,050 Channel Catfish were tagged in July each year from 2016 to 2018. Exploitation and total angler use across all study years (90% CI) was 0.09 (± 0.02) and 0.12 (± 0.01), respectively. Tag loss ranged from 0.26 to 0.31, and reporting rate averaged 0.74 (± 0.01) over the three-year study.

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INTRODUCTION

Milner Dam is an irrigation diversion completed in 1905, which provides water to the Milner-Gooding Canal, Twin Falls Canal, and North Side Canal systems. Construction of the dam created Milner Reservoir, a 1,760-hectare Snake River impoundment located near Burley, Idaho. Milner Dam was rapidly aging and almost decommissioned in the mid-1980s, before irrigators that owned the dam agreed to share management of the facility with Idaho Power Company (IPC). In trade for completing maintenance renovations, IPC obtained the rights to install a small hydroelectric generator and construct an additional hydropower plant immediately downstream of the existing Milner Dam. Retrofitting a hydropower generator dictated the requirement of a Federal Energy Regulatory Commission (FERC) permit.

The original Milner Dam FERC permit (1987) mandated IPC to mitigate fishery resource losses associated with the bypass reach below Milner Dam to the newer downriver power facility. An amendment in 1988 to the FERC agreement transferred the recreational fishery mitigation requirements from the bypass channel between the dam and hydropower plant to Milner Reservoir. The year following this amendment saw the introduction of a variety of sportfish including Rainbow Trout *Oncorhynchus mykiss*, Largemouth Bass *Micropterus salmoides*, Smallmouth Bass (SMB; *Micropterus dolomieu*), Black Crappie *Pomoxis nigromaculatus*, Bluegill *Lepomis macrochirus*, and Channel Catfish *Ictalurus punctatus*. Because water temperatures are seasonally too warm to sustain salmonids (Warren et al. 2001) the FERC agreement was amended in 1994 to include warm water fish habitat improvements focused on Smallmouth Bass. Subsequent evaluations did not support any further efforts towards building a bass fishery, despite catch rates of SMB increasing from 1993-1997 (Warren et al. 2001). Therefore, the FERC agreement was further amended in 1997 to reflect its current iteration, which outlines the stocking of 20,000 Channel Catfish annually into Milner Reservoir. Annual stocking was deemed necessary due to spring water temperatures being too cold to consistently sustain natural recruitment for Channel Catfish. Currently, all Channel Catfish released in Milner Reservoir are purchased from Fish Breeders of Idaho.

Presently, Milner Reservoir is a popular SMB fishery, but it also sustains Yellow Perch *Perca flavescens* and the occasional White Sturgeon *Acipenser transmontanus* entrained from Lake Walcott, upstream. In 2019, nine IDFG-permitted bass tournaments were held at the reservoir. The fishery also supports an overabundance of Common Carp *Cyprinus carpio*, with bow-anglers regularly observed on the reservoir.

IPC has expressed interest in eliminating stocking Channel Catfish in Milner Reservoir due to concerns of downriver impacts to native fishes, such as predation of juvenile White Sturgeon. The angler use of stocked Channel Catfish efforts in Milner Reservoir are currently unknown. Before Idaho Department of Fish and Game (IDFG) would consider amending the catfish stocking program at Milner Reservoir, the use of the fishery needs to be determined.

METHODS

Angler use of stocked Channel Catfish within Milner Reservoir is unknown. IDFG and IPC staff evaluated angler exploitation and use between 2016 and 2019 using 70 mm dart tags attached posterior to the dorsal spine. In total, 1,050 Channel Catfish were tagged each year of the evaluation. Annually, 525 Channel Catfish were tagged prior to their release in Milner Reservoir. An additional 525 Channel Catfish were collected and tagged from the reservoir utilizing baited hoop nets. Total lengths (TL) to the nearest mm and weights to the nearest g were taken on a subset of all tagging groups. Collectively, 18% of tagged fish received double tags with an additional 18% receiving $50 reward tags across all tagging groups and years.

Angler use and exploitation estimates were derived from the anchor tags 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 system or website, as well as at regional IDFG offices or by mail. Anchor tags were labeled with "IDFG" and a tag reporting phone number on one side, with a unique tag number on the reverse side.

Angler return rate (c) was 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 catfish caught by anglers for each year, by incorporating the angler tag reporting rate (λ); tag loss (*Tagl*) and tagging mortality (*Tagm = 0.001*; Hamel et al. 2012). Estimates were calculated for individual years using the formula from Meyer and Schill (2014):

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

Tag loss probability over time was determined using the discrete model suggested in McCormick and Meyer (2018):

$$P_a = \frac{n_A^{A\,A}}{n_A^{A\,A} + 2n_A^{A\,A}}$$

where $n_A^{A\,A}$ is the number of fish that were originally double tagged but were reported as having a single tag at the time of capture.

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

RESULTS/DISCUSSION

Exploitation and total angler use across all study years was 0.09 (± 0.02; 90% CI) and 0.12 (± 0.01), respectively (Figure 7). These findings suggest the Milner Reservoir cat-fishery is both harvest-oriented and underutilized. Additionally, reporting rate for catfish were high relative to other species across the state (Meyer et al. 2014), and averaged 0.74 (± 0.01) over the three-year study (Figure 8).

Carry-over rates between tagged fish from hoop nets and hatchery stocking events did not differ. Mean carry-over rate of all tagged Channel Catfish in Milner Reservoir was 0.01 (± 0.003; 90% CI), suggesting that winter mortality of hatchery stocked fish is high, or tag loss rates in catfish increase exponentially after 365 days-at-large. Tag loss across all years ranged from 0.26 to 0.3.

Mean Days-at-large of hoop-netted Channel Catfish are significantly greater than hatchery released fish (Figure 9). This difference was likely due to dispersal of hatchery-released fish over time as mean lengths of catfish from both collection methods did not differ (Figure 10), and tagged hatchery fish were also collected in hoop nets. Similarly, because hoop net efforts were annually conducted after hatchery stocking occurred, many of the fish encountered were presumably recently stocked fish from the current year.

Our findings suggest that annual stocking of Channel Catfish and limited carry-over rates appear to sustain the recreational sportfish requirements of the present FERC agreement. Additionally, the length-frequency histogram from hoop net captured catfish suggests a limited amount of natural recruitment is occurring (Figure 11). This study's ability to estimate tag loss, reporting rate, and tag returns outlines an adequate method for evaluating angler use and harvest of Channel Catfish. However, collecting age structures and confirming natural recruitment of Channel Catfish in Milner Reservoir would provide additional information about the fishery, and should be considered for future evaluations.

RECOMMENDATIONS

1. Prior to amending the current stocking intervals or changing mitigation, IDFG should evaluate natural recruitment, age, and growth dynamics of Channel Catfish in Milner Reservoir.
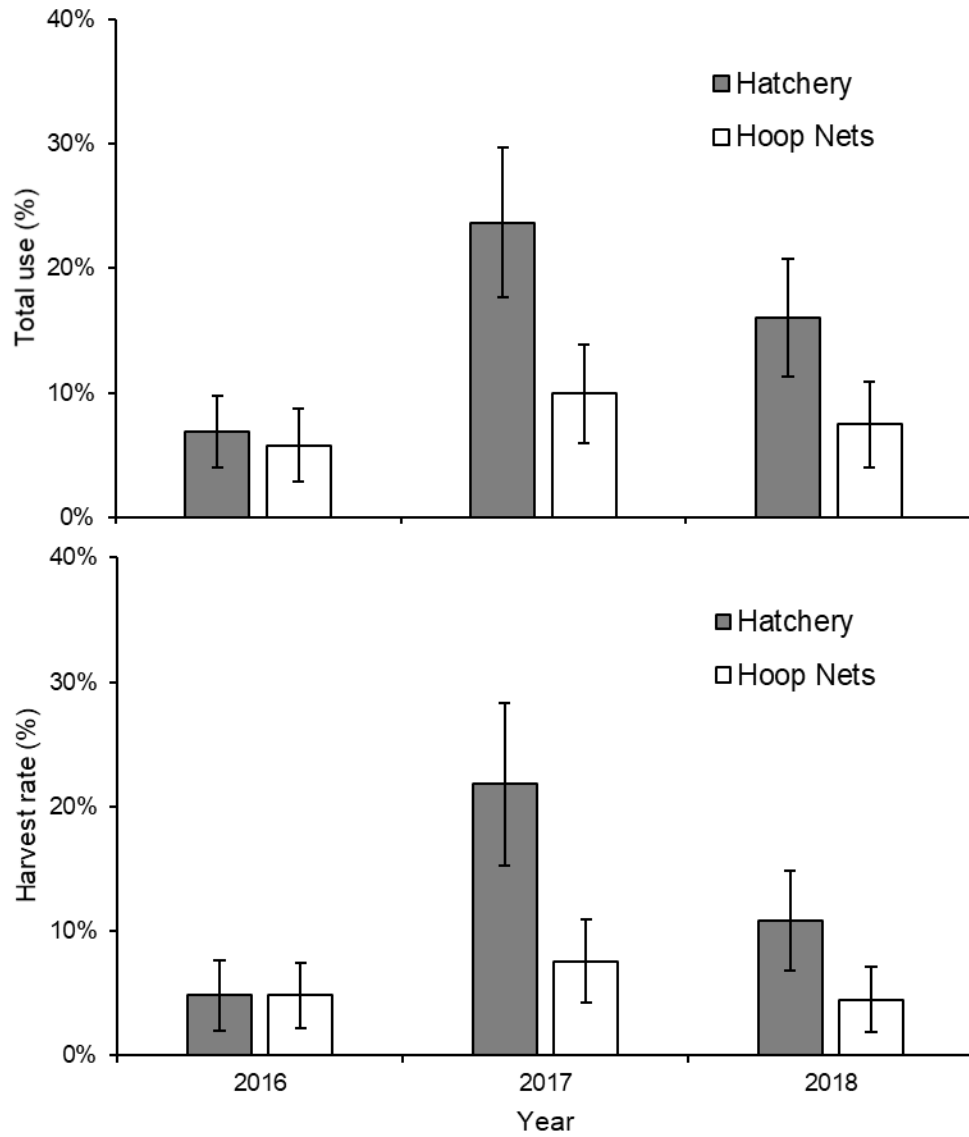
Figure 7.   Channel Catfish angler use and exploitation estimates from Milner Reservoir between 2016 and 2018, via angler self-reported coded dart tags ($n = 3,150$).
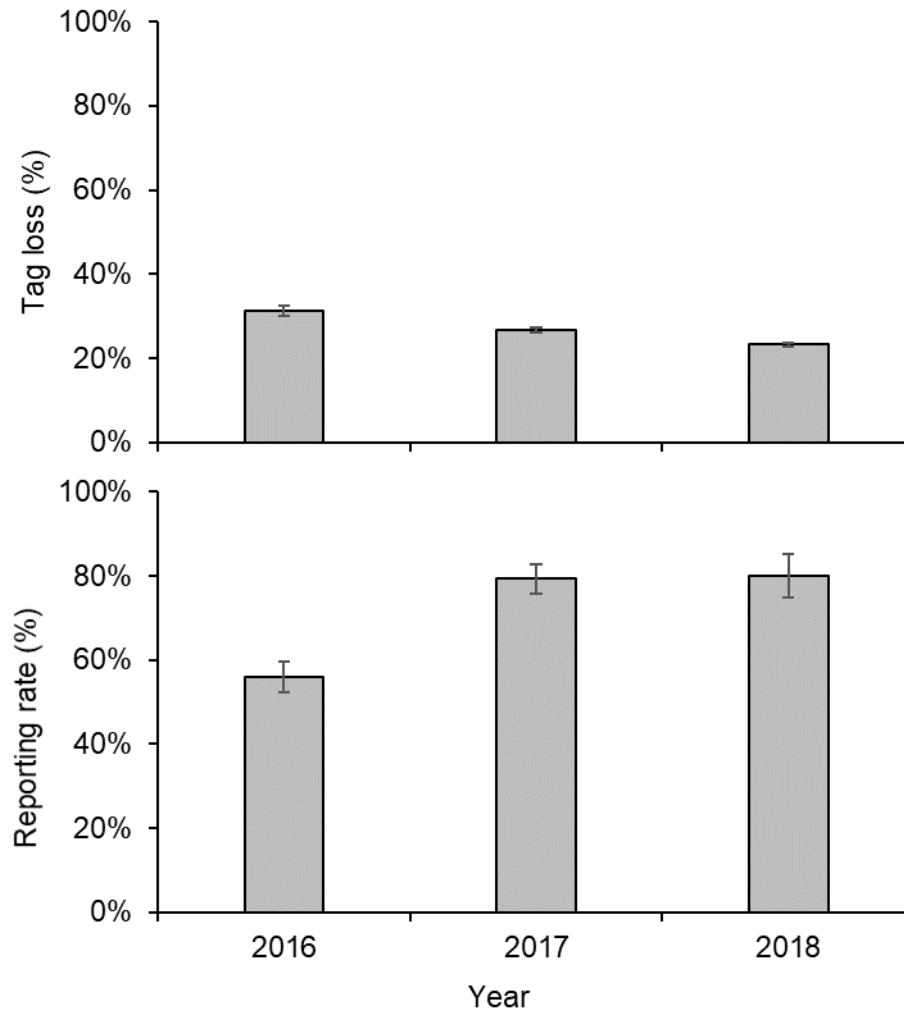
Figure 8.   Tag loss and reporting rates of dart-tagged Channel Catfish ($n = 3,150$) from Milner
              Reservoir between 2016 and 2018.
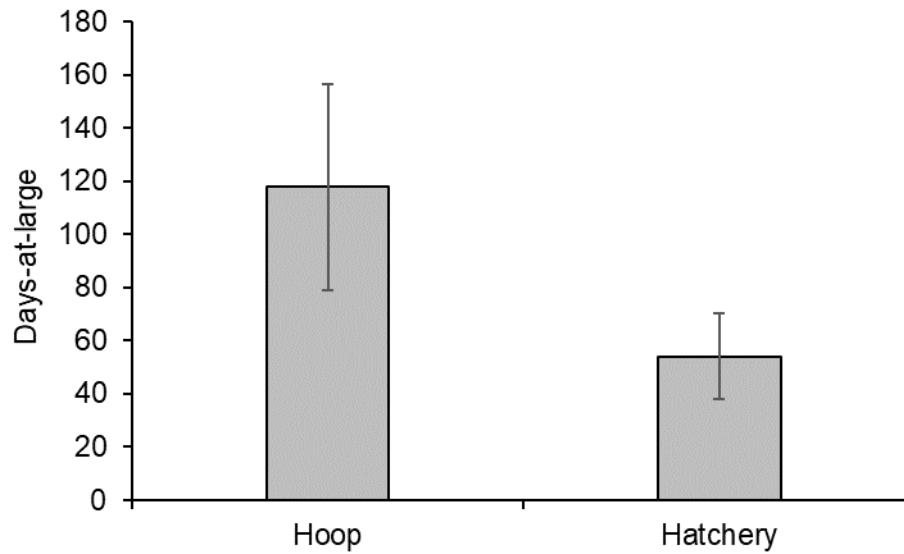
Figure 9.   Mean Days-at-large for two sources (hatchery-stocked and hoop net collections) of dart-tagged Channel Catfish in Milner Reservoir from 2016-2019.
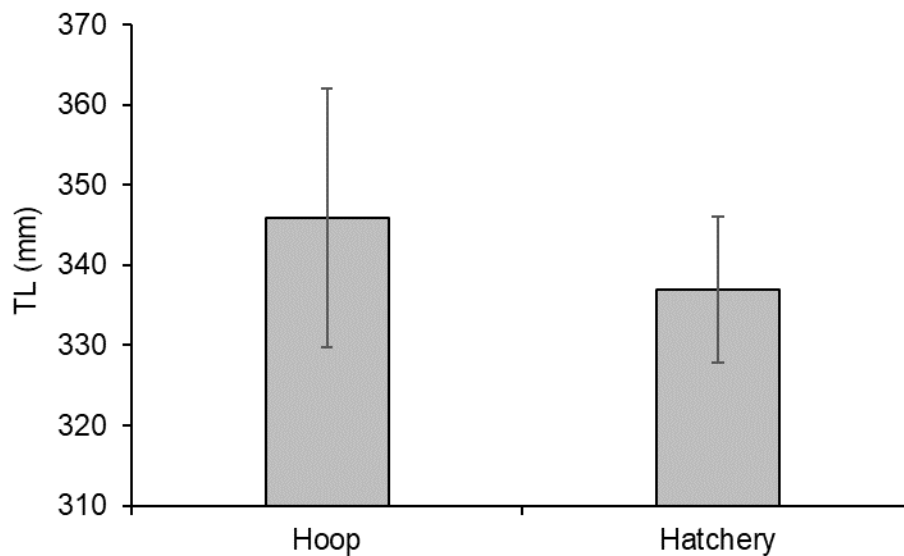
Figure 10.   Mean total length (mm) between hoop-netted (n = 52) and hatchery-sourced (n = 119) Channel Catfish in Milner Reservoir from 2016-2019, derived from angler-reported tagged fish.
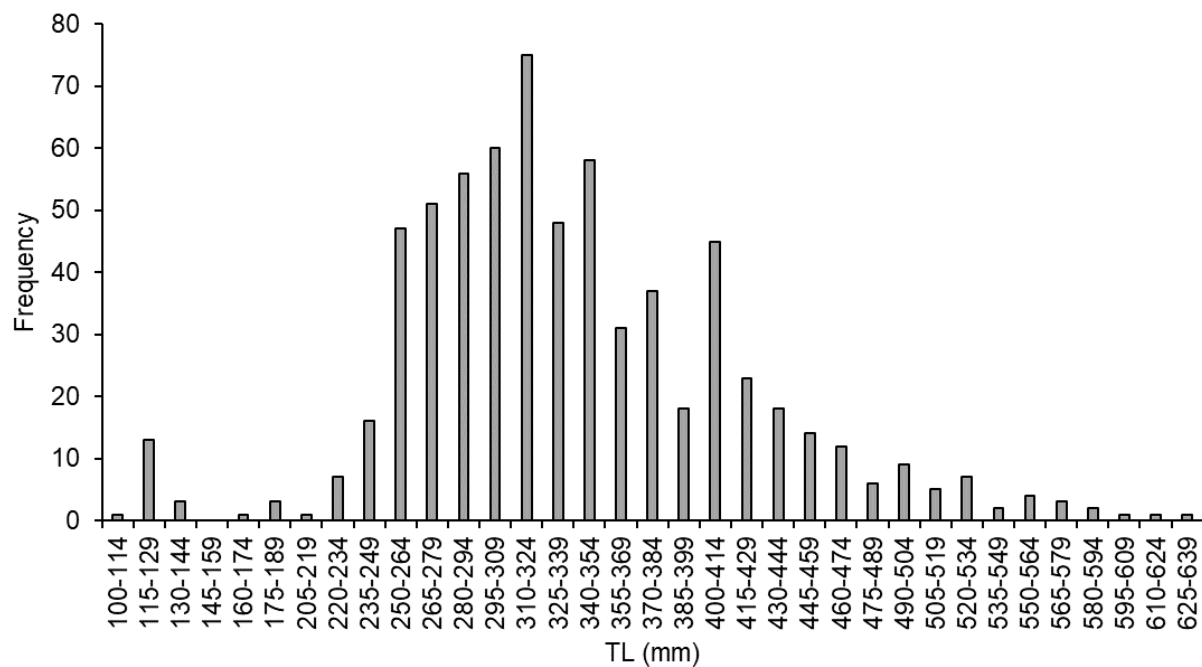
Figure 11.   Length-frequency histogram of Channel Catfish (*n* = 679) collected via hoop nets at Milner Reservoir, in August, from 2016-2018.

MOUNTAIN LAKES INVESTIGATIONS

ABSTRACT

Idaho Department of Fish and Game (IDFG) staff from the Magic Valley Region surveyed 25 alpine lakes during July and August 2019. Sampling occurred in the Cassia Creek, upper Big Wood River, and South Fork Boise River drainages including a tributary, Ross Fork Creek. Nine lakes had no fish, with three supporting amphibians. Whereas sixteen lakes supported fish and no amphibians. These lakes had not been surveyed recently or had never been surveyed by IDFG. A variety of fishery, amphibian, and use data was collected at each lake and used to describe fish and amphibian populations, habitat, and human use patterns. For stocked lakes, we compared fish survey results to stocking history and previous sampling efforts. Results from these surveys support several management recommendations.

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INTRODUCTION

In Idaho, high mountain lake anglers have consistently expressed high satisfaction with their experience (Koenig 2020). High mountain lakes offer diverse angling opportunities in highly scenic areas and are an important contributor to the state's recreational economy. Surveys are conducted periodically in high mountain lakes (HMLs) throughout the state to evaluate the current 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 stocking resources.

METHOD

Alpine lakes were surveyed between July 24th and August 28th, 2019 within the Cassia Creek, upper Big Wood River, and South Fork Boise River drainages. We visited 25 sampling sites (i.e. polygons on IDFG hydrography layer that we expected to be lentic habitats; hereafter lakes). Lakes were chosen because they either 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 (90% CI) 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. A list of gear types used and effort for each lake surveyed in 2019 can be found in Table 1.

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, 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

Twenty-five lakes were surveyed in 2019. Nine lakes had no fish, with three supporting amphibians, while 15 lakes supported fish and no amphibians. Only one lake supported both fish

and amphibians. All Magic Valley mountain lake names, GPS location, and database LLID, and IDFG stocking catalog numbers can be found on Appendix A.

Cassia Creek Lakes (Independence Lakes)

Independence lakes (1-4) are a closely grouped set of alpine lakes located at the head of the Cassia Creek Basin near Mount Independence, in the Albion Mountains, 12 km southeast of Oakley, ID (Figure 12). Independence Lake #1 and Lake #3 are periodically stocked with Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* (YCT), while Independence Lake #2 currently receives 1,000 YCT triennially (every three years) and 2,000 Arctic Grayling *Thymallus arcticus* (GRA) on even numbered years (i.e. 2014, 2016, 2018, etc.). There is a fourth lake resembling an ephemeral pond, which is not stocked. None of the Cassia Creek Basin lakes have been surveyed since 1996, despite regular IDFG visits for fish stocking efforts via backpacking. Independence Lakes appeared to have high human use based on trail conditions, established campsites, pioneered fire rings, and the quantity of litter observed during the survey.No amphibians were observed during this survey.

<ins>Independence Lake #1</ins>

A single 300 mm YCT was caught via gill netting (2 floating nets) at Independence Lake #1 for a CPUE of 1 fish/net night. The lake's maximum depth is 3 m, with a surface area of approximately 1.8 ha. Previous surveys by Warren et al. (2003) noted a gill net CPUE of 9 RBT/net night. These fish are thought to be from wild origin, based on the stocking history within the basin. The efforts from this survey noted far fewer fish, and no RBT in any of the Independence Lakes. With limited deep-water refugia it is likely thatthe lake recently experienced a winterkill. The one fish sampled in this effort was likely a fish entrained from the above lake. Arctic Grayling have been shown to tolerate winter hypoxic conditions better than trout in mountain lakes (Davis et al. 2019). The addition of 1,000 GRA on an even year rotation should be considered to increase fish within the lake.

<ins>Independence Lake #2</ins>

At Independence Lake #2, a total of 14 YCT and 14 GRA were captured via gill netting, for a catch rate of 7 fish/net night. Mean total length of gill netted YCT and GRA was 211 mm (± 16) and 163 mm (± 12), respectively. An additional seven total hours of angling effort at Independence Lake #2 yielded eight GRA and five YCT with catch rates of 1.1 GRA/h and 0.7 YCT/h, respectively. Based on length-frequency data (Figure 13) there are three age classes of GRA and two age classes of YCT represented in Independence Lake #2, which corresponds with recent stocking history. Due to relatively low abundance and high growth of YCT, YCT stocking should be switched from triennial to even years, to both increase fish numbers and match the stocking rotation of GRA throughout the region. Additionally, relatively high abundances and seemingly slow growth of GRA in both lakes suggests that reducing GRA stocking from 2,000 to 1,000 every other year is justified. The intent of these management changes is to increase YCT availability and GRA size structure in Independence Lake #2.

<ins>Independence Lakes #3 and #4</ins>

Independence lakes #3 and #4 were both surveyed with a single floating gill net. Both lakes are fishless and less than 3 m in maximum depth. The initial stocking events in both lakes of RBT occurred in 1980 by Bell (1981). Independence Lake #4 winterkills annually, and has not been stocked since the original efforts (Grunder et al. 1987). However, evaluations made five years after initial stocking in Independence Lake #3 observed relatively high growth rates (Olsen and Bell, 1987). It was not noted why growth rates were so high in Independence Lake #3, but

presumably various life stages of amphibians created an abundant prey source. Despite Independence Lakes #3 and #4 having a propensity to winterkill, amphibians have not been observed since their original investigations in 1962 (Olsen and Bell, 1987). The isolation and unique geographic occurrence of these mountain lakes make natural repatriation of amphibians unlikely. If IDFG-assisted amphibian repatriation efforts are of interest in the future, Independences Lakes #3 and #4 should be considered.

Upper Big Wood River Lakes

<u>Amber Lakes</u>

The Amber Lakes consist of three small cirque lakes located in the headwaters of the Big Wood River Drainage (Figure 14). The lakes are accessible by hiking trail for approximately 5 km from the trailhead at the confluence of the North Fork and the West Fork Big Wood River. The lakes were last investigated in 1996 (Warren et al. 2003).

The north Amber Lake, sometimes referred to as Amber Lake #1, is an alpine cirque lake in the headwaters of the North Fork Big Wood River. Surface elevation is 2,753 m and total surface area is approximately 0.9 ha when full. There are no stocking records. The lake was almost entirely desiccated during the previous two surveys. No fish have been observed in any survey. Several adult long-toed salamander *Ambystoma macrodactylum* were found along the shore between the water's edge and high water line. The lake appears to be inadequate for fish survival, as the lake more closely resembles an ephemeral pond.

The east Amber Lake, sometimes referred to Amber Lake #2, has a total surface area of about 0.3 ha when full. There are no records of the small lake ever being stocked with fish. The pond is too small and shallow to support fish. The lake was investigated for the presence of amphibians and several adult long-toed salamander were found near the shore.

The south Amber Lake, sometimes referred to as Amber Lake #3, has a surface elevation of 2,782 m and total surface area of 0.9 ha when full. It is stocked triennially with 500 Golden Trout *Oncorhynchus aquabonita* fry. There is no visible inflow and maximum depth does not exceed 6.5 m. Parts of the shoreline and the lake contained logs. The substrate consisted of boulder, cobble, gravel, and sand and there were no aquatic macrophytes observed. A floating gill net was soaked for 12 h, overnight. No fish were caught. Previous surveys did not observe fish, suggesting the lake cannot sustain trout. Similar to the previous survey, which sampled the lake immediately following a big winter in 1994-95 (Warren at al. 2003), this survey was completed the summer after a harsh winter in 2017-18 and between stocking schedules. It is likely both surveys encountered no fish due to winterkills from unusually harsh winters. Nonetheless, Amber Lake #3 appears to be at risk of winterkilling with some level of regularity. Davis et al. (2019) suggests stocking grayling in mountain lakes that regularly experience a winterkill through hypoxic conditions. Additionally, lakes prone to winterkill should be stocked more frequently with fewer fish in order to replenish fish stocks sooner after a die-off event. Therefore, stocking GRA on an even rotation to mitigate winterkill risks is recommended.

<u>Baker Lake</u>

Baker Lake is a cirque lake located in the headwaters of Baker Creek, a tributary to the upper Big Wood River (Figure 14). The lake has been stocked with Golden Trout fry intermittently since 1960 in an effort to produce a broodstock source for the species (Warren and Partridge, 1994). Efforts to sustain a broodstock egg take source were forfeited in 1992 after the presence of other trout species had crashed the Golden Trout population. Results from surveys in 1992 and 1993 indicated that WCT and RBT x WCT hybrids were the most prevalent fish in the lake

(Warren and Partridge, 1994). Brown Trout *Salmo trutta* (BRN) were also sampled in small numbers in both years. Baker Lake was again sampled in 1996 with similar catch and species composition to the previous surveys (Warren et al. 2003). Previous surveys also observed young-of-the-year trout fry in the outlet indicating that natural reproduction does occur.

Baker Lake was surveyed in coordination with the Nampa Fisheries Research Office as an effort to distribute T-anchor tags across mountain lakes statewide. A total of 13 hours of angling effort resulted in four Brown Trout (BRN) and a catch rate of 0.3 BRN/h fished. Mean total length of catch was 337 mm (± 27) and ranged from 245 to 440 mm. No other fish species or amphibians were encountered during this survey. Baker Lake is currently stocked every other year with 1,000 Golden Trout *Oncorhynchus mykiss aguabonita*. However, Golden Trout have yet to be observed in any survey from 1992 to the present, while also posing a risk for hybridizing with other potentially native *Oncorhynchus* species downstream of the lake. Therefore, it is recommended that the stocking of Golden Trout in Baker Lake be discontinued and replaced with triploid WCT, RBT, or YCT if available.

Baker Lake experiences extremely high use and angling pressure based on trail use, litter presence, angler encounters, officer observations, and frequency of citations (IDFG unpublished personal account: Officer Lee Garwood). Baker Lake still boasts remnant regulations meant to protect a Golden Trout broodstock source, which has failed. The current regulations restrict angler harvest to two trout daily and no trout under 508 mm. Additional restrictions include no use of bait and barbless hooks only. Despite these restrictive regulations, Baker Lake does not currently provide opportunity for Golden Trout, and underperforms as a fishery compared to other lakes in the basin (i.e. Norton Lakes). Additionally, there have been no trout exceeding 508 mm observed in any surveys.

Small numbers of BRN have been observed in past surveys at Baker Lake and it appears that BRN remain the predominant fishery. It is unclear how BRN got into Baker Lake, though Warren and Partridge (1994) suggest it was from an unauthorized stocking. The impacts of BRN presence in Baker Lake may also have negative impacts to downstream fisheries such as the Big Wood River (Thiessen et al. 2020). The presence of BRN in the headwaters of the Big Wood River pose a risk to existing native and wild fishes, as BRN can negatively affect native fish populations after introduction (Townsend, 1996). In addition, BRN invasions often correlate with lower gradient streams (Budy et al. 2008), similar to that of the lower portions of the Big Wood River. Furthermore, the current regulations (listed above) protect BRN from angler harvest. Collectively, an effort to suppress BRN in Baker Lake through liberalized harvest regulations and manual removal via gill netting is justified.

South Fork Boise River Lakes

The location of all South Fork Boise River Lakes, and specifically Rainbow and Trinity Creek Lakes are found in Figure 15.

Fiddle Lake

Fiddle Lake is a shallow cirque lake with a maximum depth of 3 m and surface elevation of 2,510 m. The lake has a northeast aspect and is densely surrounded by fir and pine trees, which combined with its relative shallowness increase the risk of winterkill potential. There are two flowing inlets and one outlet with none appearing to have suitable salmonid spawning habitat. Fiddle Lake has received a triennial stocking of 700 WCT since 1991, and was last sampled by Warren et al. (2001). All surveys suggest Fiddle Lake remains devoid of amphibian presence.

Fiddle Lake was surveyed via gillnetting (two net nights). No fish were encountered during the survey. However, many dead and decomposing WCT were observed on the lake bottom and around the shoreline suggesting the lake had winterkilled the previous winter. Due to the risk of winterkill, GRA should be evaluated to replace WCT in 2022, as they show a higher tolerance to hypoxic conditions in winterkill prone lakes (Davis et al. 2019).

Green Island Lake

Green Island Lake is the shortest hike from Trinity Lake Trailhead (2.3 km) and has a surface elevation of 2,434 m. The lake has a maximum depth of 4 m. There are two inlets feeding Green Island Lake; one consists of a 3-m wide creek that flows from the confluence of Big and Little Lookout lakes and Fiddle Lake, while the second consists of a spring upwelling at the base of Trinity Ridge on the north side of the lake. The creek inlet provides approximately 12 square meters of good salmonid spawning habitat.

Green Island Lake was sampled via hook and line angling. A total of four angling hours resulted in 15 trout captured with a mean total length of 210 mm (± 7; Figure 16). The combined trout catch rate was 4 trout/h. There were three trout species encountered during the survey, with RBT x WCT hybrid (67%), RBT (20%) and WCT (13%) representing the catch composition. Natural recruitment appears high based on observed spawning habitat and the apparent abundance of trout ranging from 150 to 250 mm. However, it is feasible that Green Island Lake receives fish emigrating from the upper basin lakes, which drain into the lake. Green Island Lake has not been stocked since 1982 and based on the findings of this survey should remain un-stocked. Additionally, adult Western Toad *Anaxyrus boreas* were present in the marshy outflow of the lake.

Big and Little Lookout lakes

Big Lookout Lake is the upper-most lake in the Trinity Creek Basin, with a surface elevation of 2,520 m. Big Lookout Lake is the largest surface area lake in the basin at 3.5 ha and has a maximum depth of 11 m. This is a cirque lake with no inlets and a single 3-m wide outlet. The lake shoreline near the outlet is heavily forested, while the shoreline adjacent to Trinity Mountain is comprised exclusively of boulders and scree. Little Lookout Lake is approximately 100 m down basin, and is a result of a shallow depression filled by the outlet stream of Big Lookout Lake. Little Lookout Lake has a maximum depth of 2 m and a surface elevation of 2,495 m. A marshy wetland, which is perched above a steep rock drop-off, creates the outlet of Little Lookout Lake. Trail use to the lakes appears high. Big Lookout Lake is currently stocked triennially with 1,000 WCT fingerlings; Little Lookout Lake is not currently stocked.

Big and Little Lookout Lakes were surveyed via hook and line angling. Westslope Cutthroat Trout were the only species encountered at Big Lookout Lake and RBT x WCT hybrids were the only species encountered at Little Lookout Lake. Four hours of angling effort at Big Lookout Lake resulted in 1.3 WCT/h ($n = 5$), with a mean total length of 319 mm (± 11). Two hours of angling effort at Little Lookout Lake resulted in eight RBT X WCT/h ($n = 16$), with a mean length of 192 mm (± 8). Based on the length frequencies observed in the catch (Figure 17), the stocking history of both lakes, and the estimated available spawning habitat, supports that Big Lookout Lake requires regular stocking to sustain a fishery, while Little Lookout Lake experiences high natural recruitment. With natural recruitment of WCT and WCT hybrids occurring at Little Lookout Lake and Green Island Lake, there is a lack of Rainbow Trout availability in the Upper Trinity Creek Basin. Triploid RBT and WCT have been shown to have similar performance when stocked in mountain lakes, and should be considered as an alternative to WCT in future stocking efforts at Big Lookout Lake (Cassinelli et al. 2018). Because of the apparent high use of the fishery, an increase in fish stocked or frequency of stocking is warranted at Big Lookout Lake. Furthermore,

adult and juvenile Northern Leopard Frog *Rana pipiens* were observed at Big and Little Lookout lakes, respectively.

Heart Lake

Heart Lake is an oligotrophic cirque lake at the east base of Trinity Mountain with a surface elevation of 2,483 m. Most of the shoreline is steep, rocky and timbered with one inlet and an outlet, neither of which appeared suitable for trout spawning. The lake's maximum depth is 23.7 m. The lake is reached by hiking approximately 3.8 km on a good trail from the Big Trinity Lake trailhead. Previous surveys estimated angler use of the lake as moderate (Warren et all. 2001). Stocking records indicate that Heart Lake has been stocked triennially with approximately 500 fingerling RBT since 1979, with occasional out-plantings of approximately 1,000 WCT.

Heart Lake was surveyed via hook and line angling. In total, three RBT were caught with two hours of angling effort, for a catch rate of 1.5 RBT/h. Total length of RBT encountered ranged from 243 to 400 mm, with a mean of 336 mm (± 47). Previous surveys documented both WCT and RBT x WCT hybrids in Heart Lake, despite very little to no spawning habitat (Warren et al. 2001). Additionally, public use appeared higher compared to previous surveys (Warren et al. 2001). Collectively, Heart Lake appears to be high use fishery, dependent on stocking, with low winterkill risk. Heart Lake represents the only RBT opportunity in the Trinity Creek Basin, and should be maintained.

Big Rainbow Lake

Big Rainbow Lake is the largest lake within the Rainbow Creek lakes complex. It is 5.1 ha in surface area, has a maximum depth of 23.5 m and an average depth of 10.2 m (Burmeister and Corley 1978). Lake elevation is 2,478 m. It can be reached either by an 8.4 km hike from the Big Trinity Lake trailhead, or by a 2.1-km hike from the Trinity Mountain trailhead. The Trinity Mountain trailhead is reached by hiking an additional 2.4 km along the lookout road from the locked gate at the base of the mountain. The lakeshore is predominately rocky and timbered with coniferous trees, a marshy area with willows, and a small pond next to it on the north side. There is a trail completely around the lake although parts of it are steep and traverse through dense timber. There was evidence of moderate camping and fishing activities around the lake. Two inlets observed on the south side of the lake had poor-to-marginal spawning habitat. The outlet on the north end of the lake was flowing and had approximately 3 m^2 of suitable spawning habitat. The previous two surveys suggested no spawning habitat was present in any wetted inlet or outlet (Warren et al. 2001, Burmeister and Corley 1978), thus it appears spawning habitat and potential for natural recruitment may have increased.

Big Rainbow Lake was surveyed via hook and line angling. Species composition consisted entirely of RBT ($n = 15$), with a mean TL of 240 mm (± 4). Five total hours of angling resulted in a CPUE of 3 RBT/h. Length frequencies (Figure 18) and stocking records (1,000 RBT triennially) suggest that there are two age classes represented in Big Rainbow Lake, despite the observed increase in spawning potential. Future surveys should focus on assessing whether continued stocking is required, or if natural recruitment can sustain the fishery. Additionally, species diversity is lacking in the Rainbow lakes, as all three fisheries exclusively provide opportunity for RBT. Changing Big Rainbow Lake from triploid RBT to triploid WCT is recommended, which would offer additional angling opportunity and help determine if RBT natural recruitment is occurring.

Middle Rainbow Lake

Middle Rainbow Lake is located between Big Rainbow and Little Rainbow lakes, which are 1.5 km southeast of Trinity Peak. The lake elevation is at 2,416 m. It can be reached from

either the Trinity Peak trailhead or the Big Trinity Lake trailhead by hiking an additional 0.5 km past Big Rainbow Lake on a good trail. There was evidence of frequent camping and fishing activity when investigated. The lake is 2.1 ha in surface area, and has a maximum depth of 11.2 m.

A single experimental sinking gill net set overnight sampled 16 Rainbow Trout, with a mean total length of 327 mm (± 21). Gill net catch rates from 1997 (15 RBT/net; Warren et al. 2001) were comparable to 2019. Previous surveys suggested Middle Rainbow Lake exhibited natural recruitment (Warren et al. 2001), despite appearing to lack suitable spawning habitat. There were two flowing inlets and one outlet with neither containing spawning habitat during this survey. Additionally, the size structure of the survey catch correlates with the current stocking schedule (last stocked in 2017) at Middle Rainbow Lake, suggesting the fishery is currently dependent on stocking. Fish encountered during the survey ranged from 226 to 570 mm, which is relatively larger than other alpine lakes. Stocking increased in 1997 from 500 to 1,000 RBT triennially, due to the lakes popularity and public use. The fishery does not warrant any management changes at this time.

Little Rainbow Lake

Little Rainbow Lake is 1.6 ha in surface area with a maximum depth of 11 m. It is the lowest lake in elevation within the Rainbow Creek basin at 2,375 m. Access is gained by hiking an additional 0.75 km past Middle Rainbow Lake on a good trail. It receives moderate camping and fishing pressure. The shoreline consists of coniferous trees, willows, and marsh making the lake difficult to fish from the bank. There was one flowing inlet and outlet, combining for approximately 50 m^2 of adequate spawning habitat. Based on IDFG records dating back to 1969, Little Rainbow Lake has not been stocked. A total of three angling hours resulted in a catch rate of 6 RBT/h (n = 30), with a mean total length of 187 mm (± 3) and none exceeding 225 mm. Results of the survey indicated that stocking salmonids is not needed to sustain a fishable population in Little Rainbow Lake. However, suppression efforts from biological control such as stocking Tiger Muskie *Esox masquinongy X Esox Lucius*, or manual removal via gill netting, may benefit the size structure of RBT in Little Rainbow Lake by reducing intraspecific competition.

Hideaway Lake

Hideaway Lake is a one-hectare lake located at the headwaters of Rainbow Creek, a tributary of the South Fork Boise River (Figure 15). Surface elevation of the lake is 2,550 m. The lake is located 3.5 km from a logging road crossing at Park's Creek or from the Big Lookout Trailhead. Based on trail use, debris, and camping availability, Hideaway Lake appears to have low to moderate use. The lake receives intermittent stockings of 500 WCT and GRA on even years (i.e. 2014, 2016, and 2018). Hideaway Lake was surveyed using a single floating gill net and three hours of hook and line angling. No fish were encountered during sampling. Although carcasses were not observed, Hideaway Lake may have winter-killed, likely due to the extreme winter conditions experienced in 2017-2018. Additionally, the lake has a northeast facing aspect and maximum depth of 6 m, increasing its risk of a winterkill. Subsequent stockings of both WCT and GRA are scheduled for 2020. Foregoing WCT stocking at Hideaway Lake may allow for GRA, which are more tolerant to hypoxic conditions, to establish. Hideaway Lake should be prioritized in the next round of Rainbow Creek mountain lake surveys to evaluate the status of the fishery further.

Trinity lakes

Big and Little Trinity lakes are drive-up mountain lakes located at the base of Trinity Mountain, northwest of the town of Pine, ID (Figure 15). Big Trinity Lake provides car camping opportunity by way of a U.S. Forest Service (USFS) campground surrounding approximately half

the lakeshore. Little Trinity Lake has primitive camping only, but is still a popular fishery due to its proximity to a USFS road (about 10m). Both lakes are stocked annually, with Big Trinity receiving 3,000 hatchery catchable Rainbow Trout *Onchoryhnchus mykiss* (HRBT) and 2,000 triploid Westslope Cutthroat Trout *Onchorynchus clarkia lewisi (*WCT) fingerling. Little Trinity receives 500 HRBT and 1,000 WCT fingerling. Big Trinity Lake has a maximum depth of 15 m, while Little Trinity Lake has a max depth of 12 m. Neither lake appears to have shoreline, inlet, or outlet spawning habitat, indicating these lakes are hatchery-stocking dependent.

Big and Little Trinity lakes were sampled via hook and line. Each lake received 2 angler hours of fishing effort. At Big Trinity Lake, 3 HRBT with a mean total length of 270 mm (±10) and 5 WCT with a mean total length of 211 (±25 mm) were collected. The catch rate of all trout at Big Trinity Lake was 4 fish/h. Little Trinity had a catch rate of 2 HRBT/h (n = 4) with a mean total length of 265 mm (± 9). No WCT were encountered at Little Trinity Lake.

To enhance species diversity, catchable HRBT and fingerling WCT have been stocked in Big and Little Trinity lakes since 1991 (Warren et al. 2001). Westslope Cutthroat Trout were infrequently observed during previous surveys, while catchable HRBT were consistently encountered (Warren et al. 2001). Triploid WCTs generally do not recruit to mountain lake fisheries as well when stocked on top of existing salmonid populations (Cassinelli et al. 2018). Our survey encountered a higher rate of WCT in Big Trinity than past surveys, which may be a result of increased angler use and harvest of catchable HRBT's in Big Trinity Lake based on anecdotal information from the area Conservation Officer. It may be feasible to provide species diversity in the basin by using catchable trout at one lake and fingerling WCT at another. However, if a lake is converted to one stocking program (i.e. catchable or fingerlings), default stocking should increase to mitigate the loss of fish from such a transition. Additionally, tagging catchable fish to estimate angler use and harvest will provide a better understanding of angler use at each lake and can inform which lake should receive catchable RBT and which lake should receive WCT fingerlings.

South Fork Ross Fork and Bear Creek lakes

The South Fork Ross Fork lakes are located in the headwaters of Ross Fork Creek, a tributary to the South Fork Boise River. These lakes are some of the more remote lakes in the region and are accessible by foot after a 16 km ATV trail to get to the trailhead. The trail to the summit is dirt bike accessible for expert riders; otherwise, it is a 6-km hike. Once at the summit, hike northwest on an unmarked rocky trail to South Fork Ross Fork Lake #4 (Figure 19). The remaining three lakes are located farther north and are accessed off trail (requires some bouldering). Each lake is separated approximately 1 km from the next, but are not equal in elevation. There are many smaller unnamed and unlabeled ephemeral ponds within the basin; which were investigated for amphibian presence. No amphibians were observed in the South Fork Ross Fork Creek Basin.

Goat and Two Point lakes are accessible by way of the Bear Creek jeep trail located north of the Methodist Church Camp, at the confluence of Bear Creek and the South Fork Boise River. Goat Lake ATV trail, which accesses both lakes, is a steep and rocky trail suited for very experienced riders. Both lakes require a 1 km hike after a 4-km ATV ride up Bear Creek and Goat Lake ATV trails. No amphibians were observed at either lake.

Geographically, the lakes are positioned in a way that makes them hard to identify. Thus, IDFG's database and the USFS trail signage are conflicting. This discrepancy appears to have resulted in mistaken stocking efforts, which may explain the cohabitation of WCT, RBT, and RBT X WCT in two of the four lakes, as none of the lakes flow into the other. In an effort to mitigate

such mistakes, IDFG staff will work with USFS to rectify lake names in the prospective databases, and on trail signage.

South Fork Ross Fork Lake #1

South Fork Ross Fork Lake #1 (SFRF #1) was surveyed via hook and line sampling in August of 2019. A total of 4 anglers fished for 6 hours, catching 52 WCT. Mean total length was 289 mm (± 8), with a catch rate of two WCT/h fished. Upon investigation, a large spring inlet that spans across the entirety of the scree slope to the southwest side of the lake, and snowmelt feed SFRF #1. The outlet is 2 m wide and contains approximately 6 m^2 of marginal to low quality spawning habitat. The flow, size, and low gradient of the outlet does pose a risk for emigration of stocked fish into the South Fork Boise River. Therefore, fish stocking in SFRF #1 should focus on sterile fish to prevent risk of hybridization. The abundance of fish sampled and the presence of a large spring suggest that winterkill risk is low in SFRF#1. There is no trail to the lake and thus angler use appears extremely low. The current stocking of 500 WCT appears to provide ample angling opportunity and despite the potential for natural recruitment, the fish size structure does not appear stunted.

South Fork Ross Fork Lake #2

South Fork Ross Fork Lake #2 is one of four lakes and several small ponds lying along a bench on the western side of South Fork Ross Fork Creek. It is a 2.0 ha lake with a surface elevation of t 2,669 m. It can be accessed by a trail that starts near Red Horse Mine, reached from the Bear Creek road near the South Fork Boise River. The lake is approximately 8.6 km from the trailhead. The lake has received 500 to 1,000 WCT triennially since 1969. Stocking records also indicate that the lake was stocked in 1965 and 1967 with 1,500 and 1,800 Rainbow Trout fry respectively. Due to the complex topography of the area, this lake may have been mistaken for one of the other Ross Fork lakes and stocked differently from what the stocking records indicate (Warren et al. 2003).

South Fork Ross Fork Lake #2 was surveyed with 20 angling hours of hook and line sampling. Unlike previous surveys, this survey only encountered WCT. In total, 32 WCT were caught for a catch rate of 1.6 WCT/ h. Mean total length of WCT was 304 mm (± 9). The outlet had approximately 20 m^2 of adequate spawning habitat, but the inlet was dry when surveyed. Some natural spawning occurs based on the observation of young-of-the-year trout fry in the outlet. However, natural recruitment is likely insignificant as the size structure of WCT collected in this survey reflects current stocking records. The lake appears to experience low use and angling pressure, with little sign of recent camping. Additionally, multiple juvenile Western Toad were observed in two adjacent ephemeral ponds, not directly connected to the lake.

South Fork Ross Fork Lake #3

South Fork Ross Fork Lake #3 is a 2.4-ha cirque lake located in the Ross Fork Basin, a tributary to the South Fork Boise River. Surface elevation of the lake is 2,620 m. It accessible by an unmarked trail heading north from South Fork Ross Fork Lake #4. Historic stocking records indicate the lake was stocked in 1965 and 1967 with 2,000 cutthroat trout fry. Currently, South Fork Ross Fork Lake #3 has been stocked triennially with 1,000 RBT since 2000 (Warren et al. 2003). The two inlets and one outlet observed had approximately 23 m of fair spawning habitat. Maximum lake depth observed was 23 m. Evidence indicates the lake receives moderate use by hikers, campers, and anglers.

South Fork Ross Fork Lake #3 was surveyed in August 2019 via 16 h of hook-and-line sampling. A total of 22 trout were caught including RBT, WCT, and RBTxWCT hybrids, for a catch

rate of 1.3 trout/h. Mean total length of trout across all species was 273 mm (± 13). Species composition RBT, WCT, and hybrid trout was 18%, 18% and 64%, respectively. Natural recruitment appears to be present, but insignificant. Current stocking strategies appear to provide adequate angling opportunity; therefore, no additional management recommendations are required.

South Fork Ross Fork Lake#4

Ross Fork Lake #4 is a 1.2-ha cirque lake located in the Ross Fork Basin, a tributary to the South Fork Boise River. Surface elevation of the lake is 2,620 m. It can be accessed by a good trail that starts near Red Horse Mine, which can be reached from the Bear Creek road from the South Fork Boise River. The lake is approximately 5.1 km from the trailhead. The lake was stocked with approximately 2,000 unspecified cutthroat fry in 1969 and 1971, according to historic stocking records. Currently, the lake is stocked triennially with 500 RBT, since 1973. The lake is frequently used because it is accessible by dirt bike.

South Fork Ross Fork Lake #4 was surveyed via a single floating gill net, set over night. No fish were observed, or collected during the survey. Columbia Spotted Frog *Rana pretiosa* were observed in the lake. The lake has a south-facing aspect and the maximum depth observed was 6 m, increasing its winterkill potential. It is likely that the 2017-18 winter, which was substantially harsher than average winters, resulted in a complete fishery die off. Future stockings to repopulate the fishery should consider GRA, as they have been shown to have higher tolerances to hypoxic conditions (Davis et al. 2019).

Goat Lake

Goat Lake is a cirque lake sitting at 2,665 m in elevation. Goat Lake is the headwater lake to Goat Creek, a tributary to Bear Creek, located in the upper South Fork Boise River watershed. The lake was surveyed via hook and line sampling. A total of 16 RBT were sampled with 8 h of angling effort, for a catch rate of 2 RBT/h. Mean total length of RBT was 277 mm (± 12). Upon investigation, a single spring was the only water source identified other than snowmelt. The outlet was 1 m wide and provided approximately 2 m^2 of poor spawning habitat. Goat Lake was last stocked in 2017, and receives 1,000 triploid RBT triennially. Based on the length frequency of RBT from this survey (Figure 20) and current stocking records, it appears that Goat Lake is dependent on stocking. Additionally, the lake appears to receive light to moderate use despite its proximity to an ATV trail. Management changes at Goat Lake are unwarranted, as the lake currently provides a stable fishery.

Two Point Lake

Two Point Lake is a small alpine cirque lake at the base of Two Point Peak, 500 m northeast of Goat Lake. The lake was originally stocked in 1985 and 1988 with 500 WCT in an effort to create a fishery, but was never revisited. Upon our investigation, the max depth of Two Point Lake is 1.5 m. No fish or amphibians were observed. Based on these results, the lake appears too shallow to sustain a fishery.

Johnson Creek Lake (Debt Lake)

Johnson Creek Lake is an ephemeral pond located in the northern-most basin of the South Fork Ross Fork Creek drainage. Due to a stocking database error, Johnson Creek Lake has been receiving 700 WCT triennially, originally allocated for Debt Lake, an alpine lake located in IDFG's Panhandle Region. It is unclear how long Johnson Creek Lake has been receiving Debt Lakes stocking allocations. This error has been resolved and the correct references to Johnson Creek

Lake can be found in Appendix A. Johnson Creek Lake is less than 2 m in maximum depth and does not sustain fish. Additionally, no amphibians were observed upon inspection.

RECOMMENDATIONS

1. Independence Lake #1- Add 1,000 GRA on an even year rotation.

2. Independence Lake #2- Switch stocking of YCT from triennial to even years. Reduce GRA stocking from 2,000 to 1,000.

3. Independence lakes #3 and #4- Do not stock due to winterkill risks.

4. Amber Lake #3- Discontinue stocking Golden Trout. Consider stocking 500 GRA on an even rotation to mitigate winterkill risks.

5. Baker Lake- Forego Golden Trout stocking and replace with triploid WCT, RBT, or YCT if available. Revert regulations to general regulations and increase stocking from 1,000 to 3,000 fish triennially.

6. Fiddle Lake- Switch WCT to GRA at Fiddle Lake to reduce winterkill risk and diversify angling opportunity within the Trinity Creek Basin.

7. Big Lookout Lake- Consider stocking triploid WCT and increase stocking from 1,000 to 2,000 triennially.

8. Heart Lake (Trinity Creek Basin) - Increase stocking from 1,000, to 2,000 triploid RBT triennially.

9. Rainbow Lake #1 (Big) - Switch RBT to triploid WCT to provide additional angling opportunity within the basin.

10. Rainbow Lake #3 (Little) - Manually suppress via gill netting.

11. Hideaway Lake- Eliminate WCT stocking.

12. Trinity Lakes- Tag 10% of catchable out-plants for both Big and Little Trinity to estimate angler use and harvest. Convert one lake to catchable RBT only, and the other to fingerling WCT only.

13. South Fork Ross Fork Lake #4- Consider switching to 500 GRA on an even year rotation, lowering winterkill risks associated with hypoxic conditions and to bolster angling diversity within the basin.

14. Johnson Creek Lake (Debt Lake) – Corrected-stocking error. Discontinue stocking due to annual winterkill.

Table 1.   Gear type and effort list of all Magic Valley Mountain Lakes surveyed in 2019.

Mountain Lake Name	Gear Type	Date Sampled (M/D/Y)	Effort (h, net night)
AMBER L #1 (North)*	Floating Gill Net	7/28/2019	1 net night
AMBER L #2 (East)	Floating Gill Net	7/28/2019	1 net night
AMBER L #3 (South)	Floating Gill Net	7/28/2019	1 net night
BAKER L*	Angling	7/29/2019	13 h
BIG LOOKOUT LAKE*	Angling	7/24/2019	4 h
BIG TRINITY LAKE*	Angling	7/24/2019	2 h
Johnson Creek Lake*	n/a	8/13/2019	n/a
FIDDLE LAKE*	Floating Gill Net	7/24/2019	2 net nights
GOAT LAKE*	Angling	8/8/2019	8 h
GREEN ISLAND LAKE	Angling	7/25/2019	4 h
HEART LAKE (TRINITY MOUNTAIN)*	Angling	7/30/2019	2 h
HIDEAWAY LAKE*	Sinking Gill Net	7/30/2019	1 net night
INDEPENDENCE LAKE #01	Floating Gill Net	8/5/2019	2 net nights
INDEPENDENCE LAKE #02*	Floating Gill Net	8/5/2019	3 net nights
INDEPENDENCE LAKE #03	Floating Gill Net	8/5/2019	1 net night
INDEPENDENCE LAKE #04	Floating Gill Net	8/5/2019	1 net night
LITTLE LOOKOUT	Angling	7/26/2019	2 h
LITTLE TRINITY LAKE*	Angling	7/24/2019	2 h
RAINBOW LAKE #1 (BIG)*	Angling	7/27/2019	5 h
RAINBOW LAKE #2 (MIDDLE)*	Sinking Gill Net	7/27/2019	1 net night
RAINBOW LAKE #3 (LITTLE)	Angling	7/27/2019	3 h
SF ROSS FORK CREEK L #01*	Angling	8/11/2019	24 h
SF ROSS FORK CREEK L #02*	Angling	8/12/2019	20 h
SF ROSS FORK CREEK L #03*	Angling	8/13/2019	16 h
SF ROSS FORK CREEK L #04*	Floating Gill Net	8/11/2019	1 net night
TWO POINT LAKE	n/a	8/8/2019	n/a

(*) currently stocked lakes
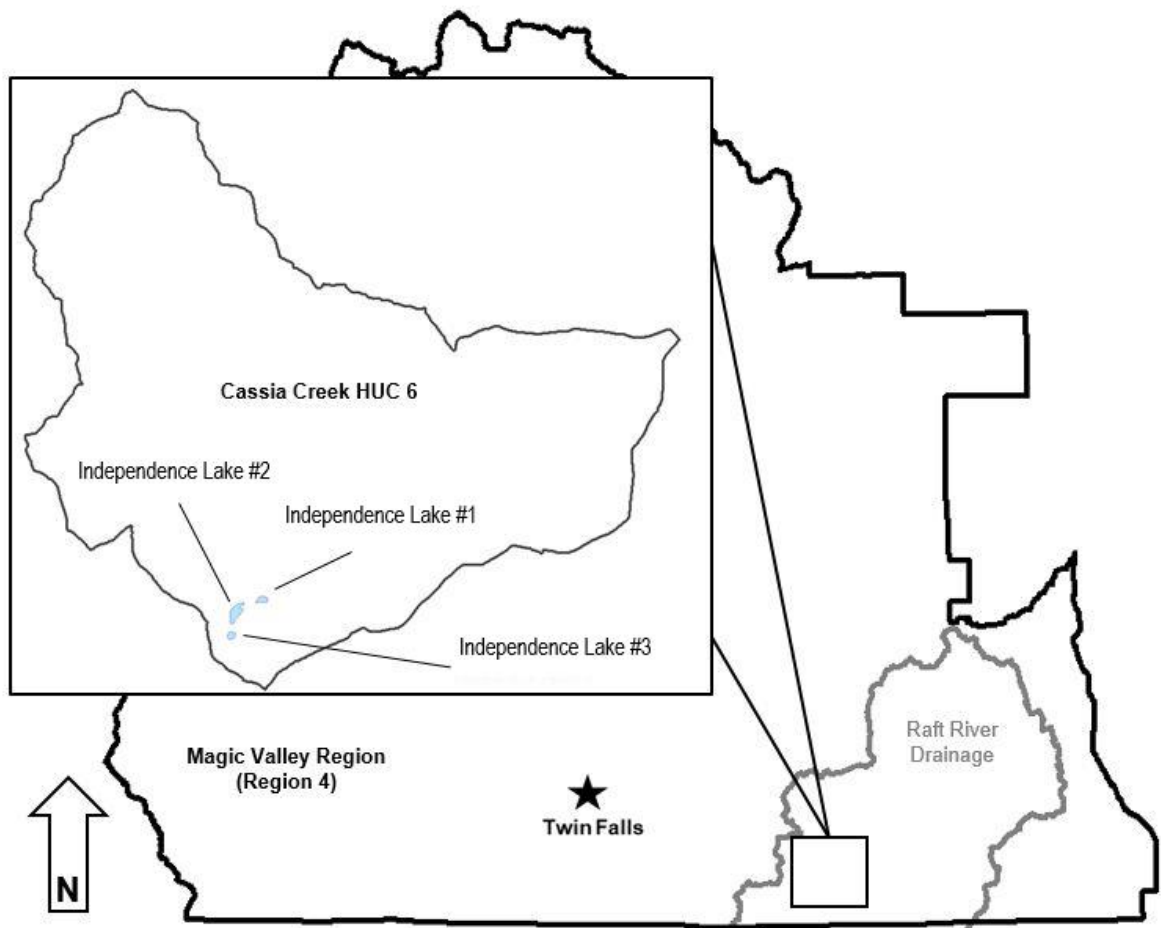
Figure 12.   Map of Cassia Creek HUC 6, Independence lakes 1-4. Independence Lake #4 is not shown on the map but is found south of Independence Lake #3.
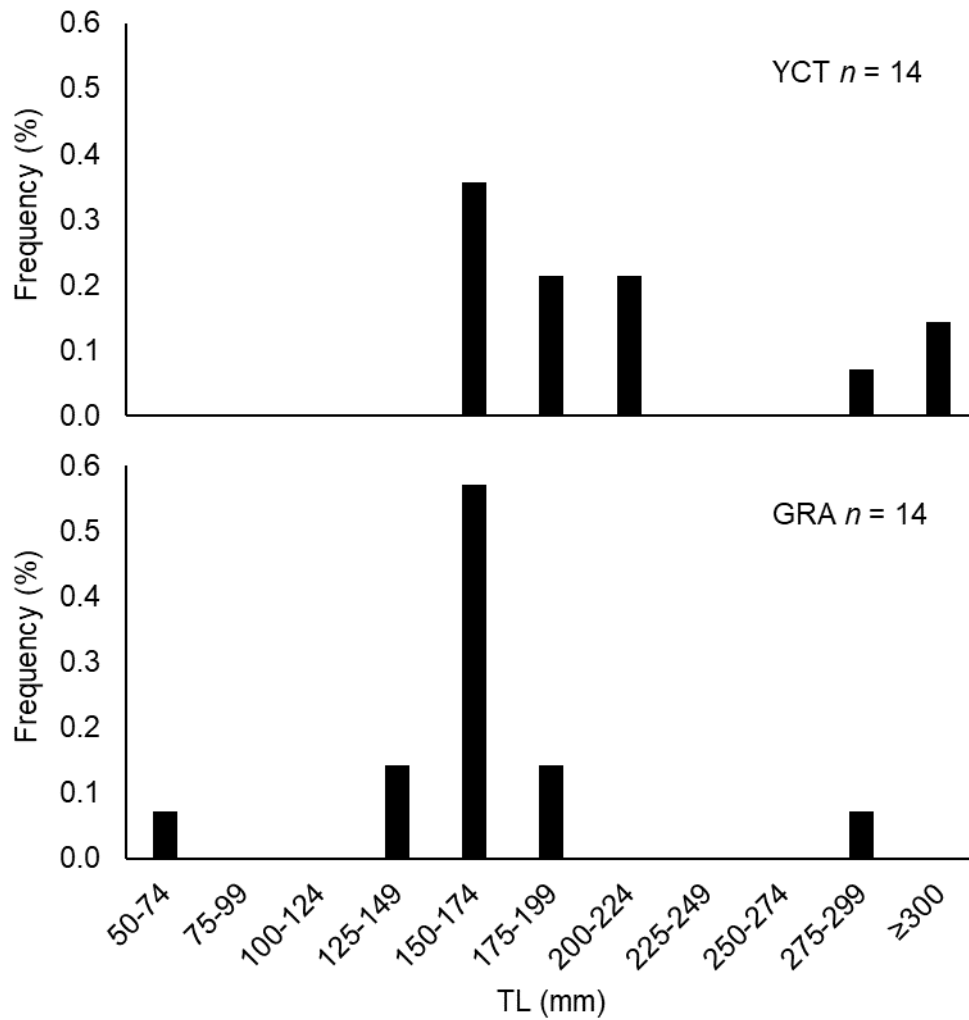
Figure 13.   Length-frequency histogram of both Yellowstone Cutthroat Trout (YCT) and Arctic Grayling (GRA) captured via gill netting at Independence Lake #2 in 2019.
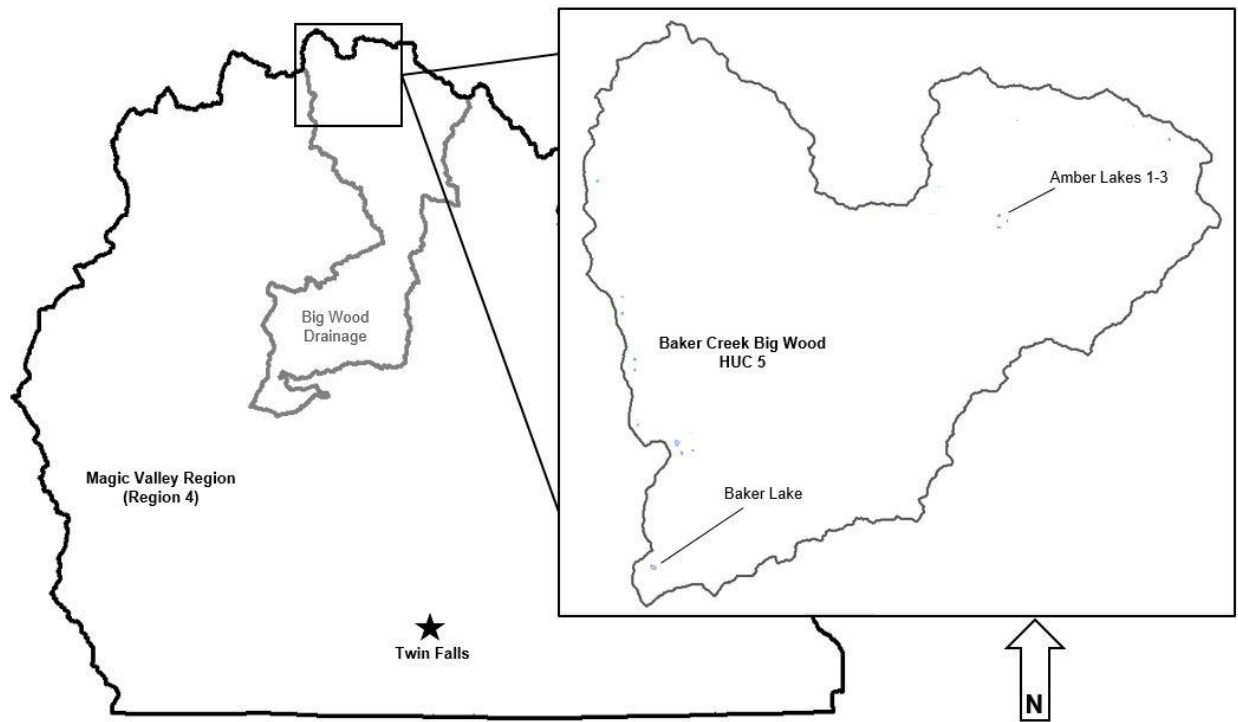
Figure 14.   Map of Amber Lakes and Baker Lake in Baker Creek Big Wood River HUC 5.
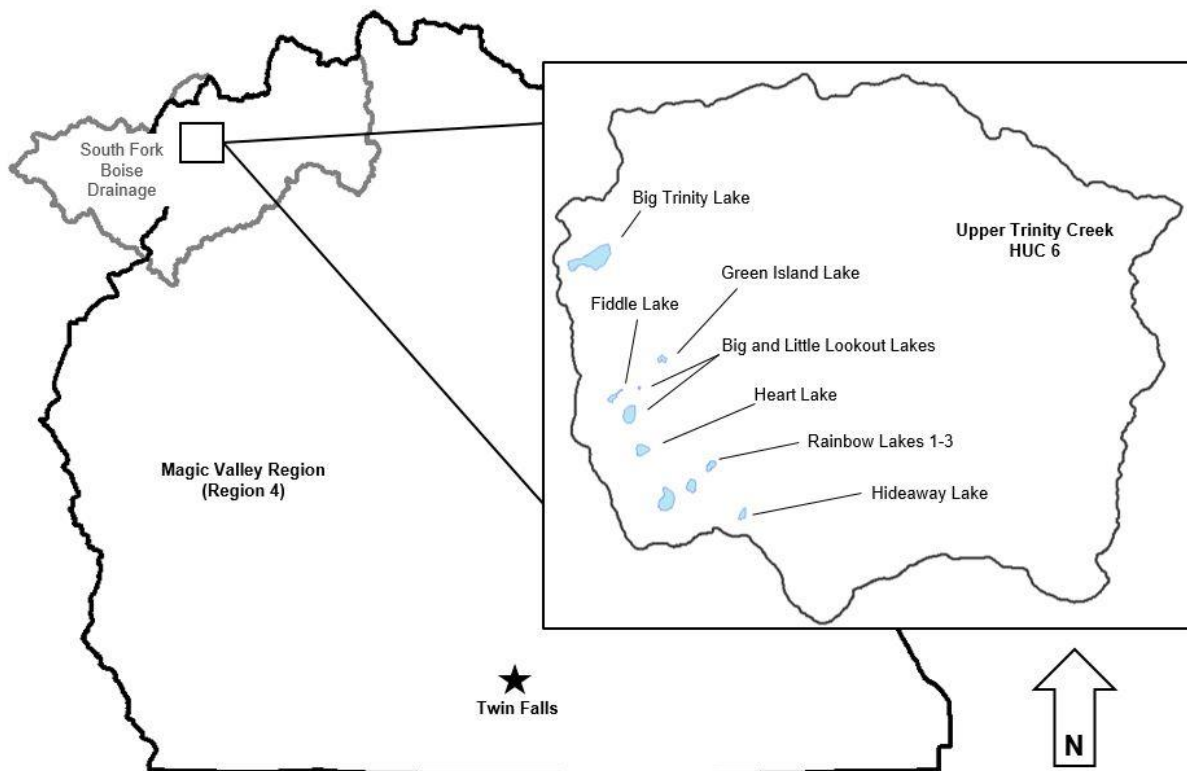
Figure 15.   Map of Trinity and Rainbow Basin lakes in Upper Trinity HUC 6.
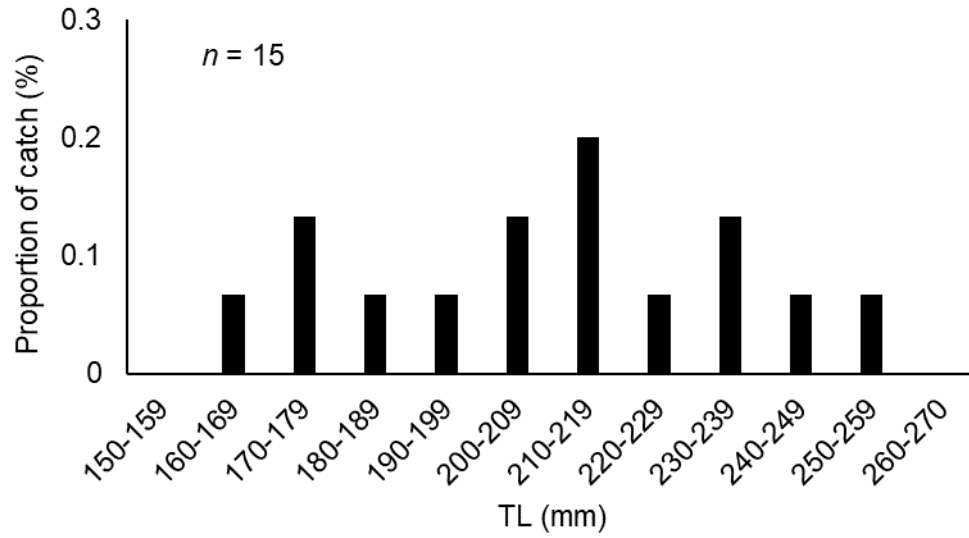
Figure 16.   Length-frequency distribution of combined Rainbow (RBT), Westslope Cutthroat (WCT), and RBT x WCT hybrid trout from 2019, at Green Island Lake.
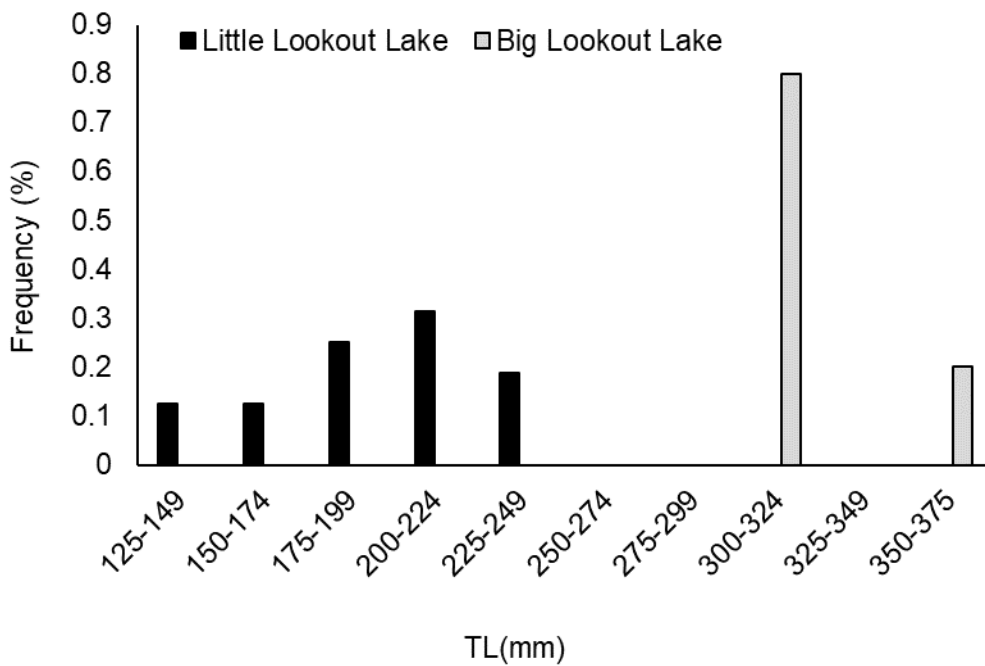
Figure 17.   Length-frequency distribution of combined Westslope Cutthroat Trout and Rainbow Trout x Cuthroat Trout hybrids from rod and reel angling in July 2019, at Big (*n* = 5) and Little (*n* = 16) Lookout lakes.
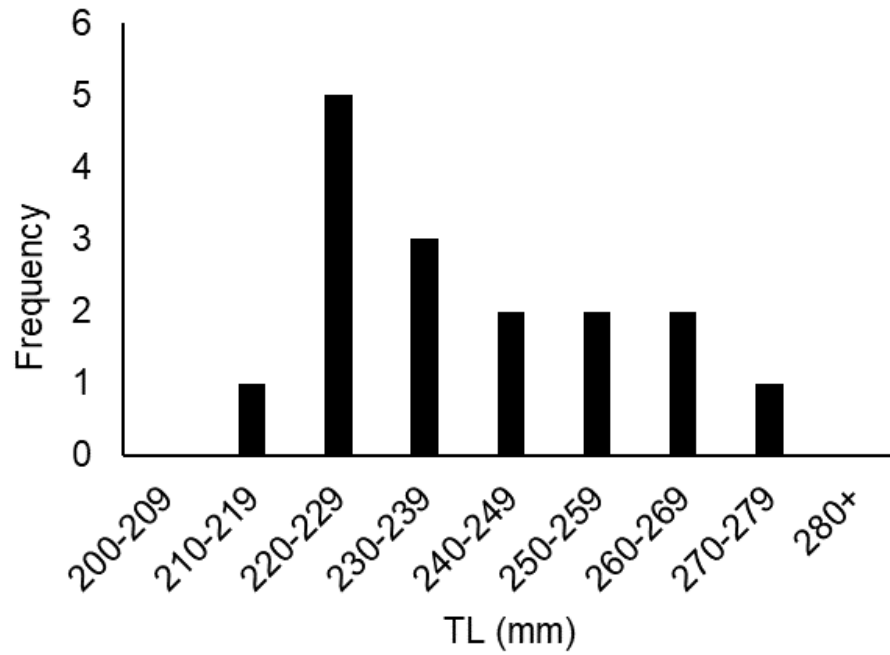
Figure 18.   Rainbow Trout length frequency distribution from hook and line angling in July 2019, at Big Rainbow Lake ($n = 15$).
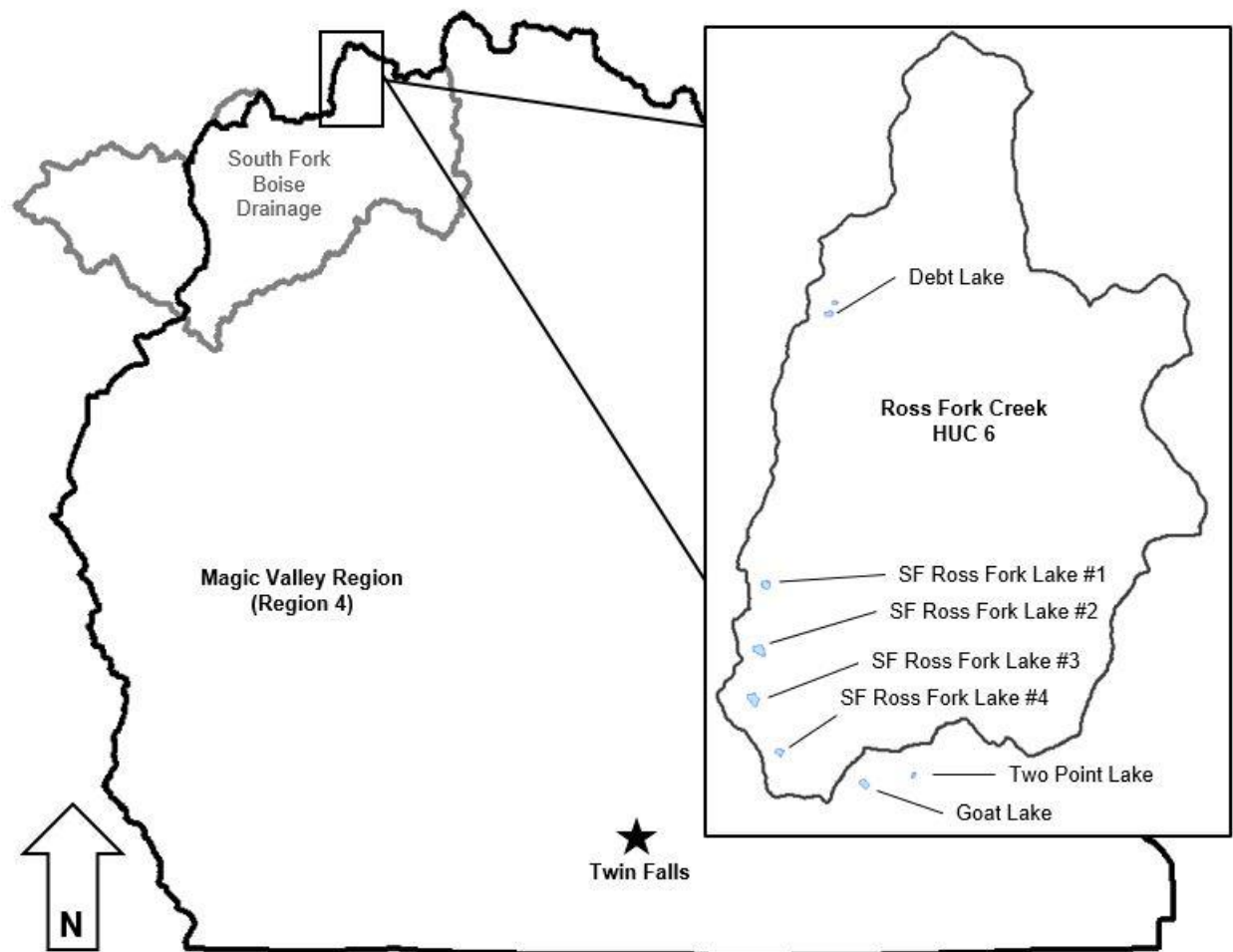
Figure 19. Map of Ross Fork Creek HUC 6 alpine lakes.
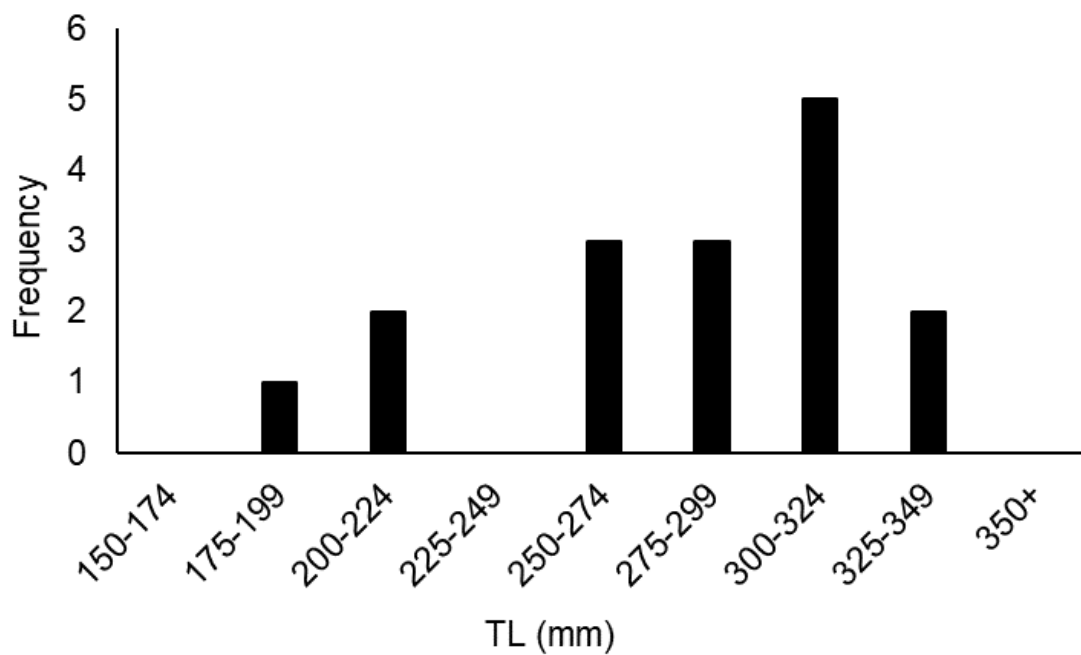
Figure 20.   Rainbow Trout length-frequency distribution (*n* = 16) at Goat Lake, from August 2019, captured via hook-and-line sampling.

REGIONAL EXPLOITATION EVALUATIONS

ABSTRACT

Idaho Department of Fish and Game hatcheries remain integral to managing coldwater sportfishing opportunities in Idaho. With the initiation of the "Tag-You're-It" Program, angler catch and harvest rates have been evaluated in numerous regional waters since 2006. Regional staff continue to use the program to collect tag return data for waters and stocking events that have previously not been evaluated. In total, 200 catchables were tagged and released in Freedom Park Pond in 2018. Of that, 70 tagged fish were reported, with 41 harvested. We will continue to use this tool to evaluate angler use and harvest of both wild and hatchery catchable trout in regional waters on an annual basis. This provides managers with a needed tool to make stocking adjustments to maximize angler use and harvest of hatchery catchable trout.

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INTRODUCTION

Idaho Department of Fish and Game (IDFG) hatcheries are integral to managing coldwater sportfishing opportunities in Idaho. The Magic Valley Region stocked approximately 320,000 "Catchable" sized Rainbow Trout (10-12"; herein "catchables") into 61 different waters in 2018. The majority of catchables stocked within the Magic Valley Region are reared at the Hagerman State Fish Hatchery. With the initiation of the Tag-You're-It program (Cassinelli 2013), angler catch and harvest rates have been evaluated in numerous regional waters since 2006.

Freedom Park Pond is a newly renovated community pond located in Burley, Idaho. Prior to its renovation, the pond was eliminated from the regional stocking rotation due to low returns and pelican predation exceeding 90% (Meyer et al. 2016). Renovations were completed using private donations, with project management coordinated through the City of Burley Chamber of Commerce. The project included reconnecting to a piped spring, dredging, and constructing a new head gate outflow system. Mean depth increased from 4 to 15' and mean August water temperatures decreased from 24 to 15°C, one year post-renovation. Initial post-renovation stockings at Freedom Park Pond were tagged to evaluate the immediate stocking needs of the fishery and to document a change in "return-to-creel". Tagged fish were released on May 24th, 2018.

METHODS

Angler use of stocked hatchery Rainbow Trout in Freedom Park Pond is unknown since the pond renovation was completed. IDFG evaluated angler exploitation and use using 70 mm t-bar anchor tags attached posterior to the dorsal fin. In total, 200 catchables were tagged and released. Tag loss, tagging mortality, and reporting rates were estimated 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 system or website (set up specifically for this program), as well as at regional 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 ($Tagl$) and tagging mortality ($Tagm$). Estimates were calculated for individual years using the formula from Meyer and Schill (2014):

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

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

RESULTS AND DISCUSSION

In total, 200 catchable hatchery Rainbow Trout were tagged and released in Freedom Park Pond in 2018. Of that, 70 tagged fish were reported with 41 harvested. The adjusted use and harvest estimates are 0.78 (± 0.04) and 0.45 (± 0.04), respectively. Mean days-at-large could not be calculated due to an adjacent city water main pipe containing chlorinated water bursting. This resulted in a complete fish kill of trout stocked in Freedom Park Pond. Had it not been for the fish kill, use and exploitation would likely have been higher than reported. Nonetheless, Freedom Park Pond experiences high angler use and harvest of hatchery Rainbow Trout. Due to the popularity of this fishery, stocking the pond on a bi-monthly basis is warranted with periodically monitoring the fishery using tagged fish.

RECOMMENDATION

1. Request bi-weekly stocking of 200 catchable trout from Hagerman State Hatchery.

RIVERS AND STREAMS INVESTIGATIONS

AMERICAN WHITE PELICAN PREDATION ON SILVER CREEK WILD TROUT

ABSTRACT

The first reports of American White Pelicans *Pelecanus erthrorhynchos* (hereafter "pelican(s)") foraging on trout in Silver Creek occurred in 2013. For several years thereafter, non-lethal hazing methods were utilized to deter pelican predation of trout in the creek. Though specific predation rates were not estimated, hazing efforts were thought to be ineffective due to insufficient intensity and scope. Continued angler concern related to possible effects of pelican predation on this world-class fishery led the department to specifically estimate predation rates. Beginning in the spring of 2018, we surgically implanted radio telemetry tags into Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta*, greater than 235 mm in total length, to determine if this technology could be used to estimate predation by pelicans and the colonial origin of pelicans utilizing Silver Creek. Results from 2018 tagging efforts indicated that pelicans consumed a minimum of 27% of the tagged trout in Silver Creek, and most of the retrieved tags were found on a nesting island at Lake Walcott, nearly 97 km southeast of Silver Creek. The study was continued and expanded in 2019 with the additional inclusion of floy-tagged trout collected via raft electrofishing, to estimate angler use and harvest rates. This modified design was utilized to evaluate pelican predation compared to angler use and harvest. Minimum pelican predation in 2019 was estimated at 37% (± 8). However, when tagging mortality, tag loss, and tag detection efficiency are accounted for, total adjusted predation rate was 53% (± 5). These values far exceeded angler use and harvest estimates of 24% (± 8) and 6% (± 2), respectively.

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INTRODUCTION

The abundance of American White Pelicans *Pelecanus erythrorhynchos* (hereafter "pelican(s)") has increased in recent decades in Idaho (Chiaramonte et al. 2019). The increases in pelican abundance are generally attributed to the discontinued use of organochlorine pesticides, such as DDT, and to the protections gained following the 1972 Migratory Bird Treaty Act. The increased abundance of pelicans has led to more conflicts between birds, recreational fisheries, and conservation of native fishes (Teuscher et al. 2015). Such conflicts have resulted in measurable exploitation of wild and hatchery trout, along with increased social anxiety towards pelicans across Idaho (Teuscher et al. 2015; Meyer et al. 2016).

Pelicans were first documented at Silver Creek in 2013, as a part of the IDFG statewide pelican survey. At the time, it was presumed that pelicans had a foraging range of less than 96 km. Despite Silver Creek being 93 km from the largest pelican colony in the state (Minidoka), relatively low counts of individuals suggested pelicans at Silver Creek were foraging in transit between loafing sites (Megargle et al. 2018). However, pelican counts steadily increased at Silver Creek since 2013, coinciding with stable pelican populations across Idaho (IDFG 2016). In addition, recent research indicated that pelicans exceed previously documented distances for foraging (Chiaramonte et al. 2019). Because of these recent findings, active hazing practices began in 2016 with minimal success (Megargle et al. 2018). Non-lethal pelican hazing is expensive relative to regional fisheries management budgets, and costs at Silver Creek have continued to increase, and exceeded $25,000 in 2018.

Methods for estimating such predation typically involve tagging fish and recovering those tags at bird nesting, roosting, or loafing areas. Such estimates are considered conservative if they do not account for consumed tags that are unrecovered (i.e., tag recovery efficiency). One approach to estimating tag recovery efficiency is by directly feeding birds with fish implanted with passive integrated transponder (PIT) tags and recovering tags deposited at nesting and roosting sites (Osterback et al. 2013; Scoppettone et al. 2014; Teuscher et al. 2015). However, efficiency estimates for PIT tag recoveries vary widely (Chiaramante et al. 2019). Such variability increases when evaluating wild fish, because active feeding of tagged fish to pelicans is not possible. Because radio telemetry tags have detection probabilities upwards of 90% and less detection variability (Chiaramonte et al. 2019), they are preferred for evaluating pelican predation of wild fish stocks. Similarly, the high detection probability of radio tags eliminates the need of a double tag to adjust for unrecovered tags.

Evaluating predation alone does not account for the total annual mortality experienced by a fish population. Estimates prior to documented pelican presence at Silver Creek suggest annual mortality of Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta* was approximately 45% (Schill, 1991). Determining whether pelican predation rates are compensatory or additive mortality necessitates some understanding of total trout mortality rates as well as angler use and harvest rates. The objectives of this study were to determine the predation rate of wild trout by pelicans, estimate angler use and harvest rates, and compare to 2018's findings that linked Silver Creek pelicans to the Lake Walcott colony. Additionally, we hoped to gain insight on how active non-lethal pelican hazing at Silver Creek affects predation of wild trout.

METHODS

Fish Collection

Wild trout were collected via drift boat electrofishing; using a Midwest Lake Electrofishing System (MLES) Infinity unit set at 24% duty cycle and approximately 2,200-2,800 watts of pulsed DC power. A 7,000-watt Honda generator was used to generate power. Catch results were reported as relative abundance and expressed as mean catch/unit effort (90% CI), and species composition (percent). Sampling was conducted trout from April 1 to May 10, 2019. All fish sampled were measured for total length (TL, mm) and weighed (g) prior to tagging.

Fish Tagging

Radio tags (MST-093 Lotek) were surgically implanted into the body cavity of 150 fish by making a small incision into the ventral wall anterior to the pelvic girdle (Hart and Summerfelt 1975). A grooved needle shield was inserted posteriorly past the pelvic girdle and a 6-gauge needle was inserted between the pelvic girdle and the anal vent. The shielded needle technique was used to protect internal organs, and direct the needle under the pelvic girdle and through the incision on the body wall (Ross and Kleiner 1982). The radio antenna was threaded through the needle so the antenna exited the hole made by the needle. While threading the antenna, the tag was inserted into the body cavity. The incision was closed using two or three sutures. Fish were placed in a livewell and allowed to recover for 15 minutes, which allowed monitoring of general health, prior to release. Radio tags were equipped with internal motion sensors to emit a mortality signal if the tag had not moved for 12 h, allowing for identification of fish mortalities due to predation or other causes, depending on location and detection history. Mortality signals emitted 24 h after release were assumed to be a result of the surgery and tagging process.

Implanted tags weighed 10 g. Previous studies utilized smaller tags for concern of exceeding 4% of body mass, which presumably would increase tagging mortality. However, during 2018 field studies, no additional mortality was noted in Silver Creek Trout when tag mass exceeded 4% (Thiessen et al. 2020). However, as a precaution, no tag was implanted in fish less than 235 mm in length to ensure that the tag did not exceed 8% of the fish's total body mass. We implanted tags in Rainbow Trout and Brown Trout so as to match their relative abundance in each reach. Tagged fish were released evenly across five study transects at a rate of 15 fish/ km.

The methods used to assess Angler use and expoitation may be found in the preceding chapter *'REGIONAL EXPLOITATION EVALUATIONS'* of this report. We tagged 37 Rainbow Trout (RBT) and 109 Brown Trout (BRN) with T-bar anchor (Floy™) tags during the 2019 investigation.

Radio Telemetry

To monitor survival, movement, and potential removal of radio-tagged fish by predators, fixed-station radio receivers (Lotek SRX-DL) were installed at three locations within the Picabo Valley (Figure 21). Additionally, a fixed-station radio receiver (SRX-DL) was installed at the Minidoka NWR pelican colony to detect the arrival of tagged fish. Receivers were programmed to scan tag-specific frequencies (e.g. 150.320, 149.320 MHz) every six seconds. Each fixed receiver utilized two, 1-m yogi antennas with four elements, which were positioned in directions to maximize coverage across the Silver Creek Drainage. Fixed telemetry stations consisted of a radio receiver powered by two 12V batteries housed in a lockable steel box, and maintained by a 24v solar panel ran through a DC power converter.

To evaluate detection coverage of fixed receivers at Silver Creek and variability in detection strengths of in-stream fish, out of water fish, and predated fish, we compared the range and mean detection strength of a tag at 25 randomly selected test locations using a paired t-test (α = 0.05). At all test locations, a 10-g tag (150.320.084) was extended 5 m above the ground using a pole. Time was recorded at all test locations to compare with the receiver's time stamp detection. All receivers were downloaded and cleared, followed by a second test at each location with the tag and antenna placed inside a hatchery trout carcass, which was subsequently placed inside a raw chicken carcass (to mimic predation). The range, mean, and standard errors were determined for each detection type, and compared with instream detections from all three Silver Creek fixed receiver sites. These comparisons were made from detection data recorded on the same day to reduce any bias associated with weather or frequency noise.

Data analysis

Minimum predation rate by pelicans (*Pred)* was calculated by dividing the number of radio tags recovered at the Walcott Pelican Colony by the number of radio tagged trout released in Silver Creek. Variances for these proportions (Thompson, 2012) were calculated using the formula:

$$Var(proportion) = \frac{P(1-P)}{n-1}$$

where *P* is the proportion of recovered tags and *n* is the number of stocked tags. Ninety percent confidence intervals were calculated using the formula

$$P \pm t = \sqrt{Var\,(P)}$$

where *t* is the upper *α*/2 point of the *t* distribution with *n* − 1 degrees of freedom (Thompson 2012).

Total predation rate by pelicans (*Pred_{total})* was calculated by adjusting the minimum predation rate to account for tag detection probability, tag loss, and tagging mortality using the formula:

$$Pred_{total} = \frac{Pred}{\phi(1-Tagl)(1-Tagm)}$$

where *Pred_{total}* is the total annual proportion of trout predated by pelicans, wherein ϕ is tag detection probability (Chiraramonte et al. 2019), *Tagl* is tag loss, and *Tagm* is tagging mortality.

RESULTS

The mean length (± 90% CI) of tagged RBT and BRN was 333 mm (± 9) and 354 mm (± 12), respectively. Length of tagged RBT and BRN did not significantly differ. Species composition for tagged fish (exceeding 235) mm was 41% (*n* = 61) RBT and 59% (*n* = 89) BRN. Electrofishing efforts had a species catch composition (all sizes) of 33% RBT (*n* = 93) and 67% BRN (*n* = 188).

Fifty-five tags were detected at the Walcott receiver location. No additional tags emitting mortality signals were detected in the Silver Creek watershed. An additional 28 tags remained unaccounted for post release, based on stationary receivers within Picabo Valley, ID (Figure 21). Collectively, the minimum predation rate of tagged trout in Silver Creek was 37% (*n* = 55). However, when tagging mortality, tag loss, and tag detection efficiency are accounted for, total

predation rate was 53% (± 5). When separated by species, total adjusted predation rate for RBT and BRN was 45% (± 7) and 59% (± 5), respectively. The mean length of predated RBT and BRN was 349 mm (± 18) and 355 mm (± 20), respectively (Figure 22). Length distributions of trout tagged and those predated did not significantly differ. Based on colony detections by tag release locations, the majority of pelican predation from 2018 and 2019 (n = 92) occurred in zone 2 and zone 4 (Figure 23).

The USDA Wildlife Services Idaho Office conducted 57 days of non-lethal pelican hazing at Silver Creek using a variety of strategies starting April 10, 2019. Costs associated with hazing pelicans approximated $25,000 for 2019.

DISCUSSION

The high pelican predation rates documented are likely due to Silver Creek's proximity to the Minidoka pelican colony, Idaho's largest colony (IDFG Fisheries Management Plan 2013) and relatively low habitat complexity. Our results suggest that pelicans are consuming Silver Creek's wild trout at a higher rate than previously documented state averages (18%; Meyer et al. 2016) and higher than observed in 2018. Previous statewide estimates utilized hatchery Rainbow Trout, which are thought to be naive and more susceptible to predation than wild trout (Berejikian 1995), found that Idaho waters less than 100 km from a pelican colony experienced the highest rates of pelican predation (Meyer et al. 2016). Silver Creek is 89 km from the Minidoka colony. Pelican predation rates estimated at Silver Creek in 2018 are minimum estimates, because tag detection probability, tag loss, and tagging mortality were not accounted for, whereas the current study accounts for those variables. Additionally, Silver Creek's relatively shallow, low gradient, clear spring water may allow for efficient pelican foraging.

Despite initial findings in 2018, pelicans appear to be feeding on RBT and BRN opportunistically. The 2018 prey selectivity findings may have been biased by disproportionately tagging RBT more than their relative abundance in the fishery. The current study tagged trout proportionately to their relative abundance in the fishery. This study's findings support previously documented behavioral observations, which characterized American White Pelican as generalist feeders (Brechtel 1986). However, monitoring pelican predation rates of individual trout species remains a crucial part of understanding whether mortality associated with predation is compensatory or additive, as natural mortality and harvest may differ among species. In general, RBT spend more time in shallow water and away from cover than BRN, theoretically making them more susceptible to avian predation than other salmonids (Matkowski 1989; Meyer et al. 2016). Pelicans exhibiting selective foraging behavior towards RBT would be concerning, considering that previous trend monitoring efforts at Silver Creek have documented a decrease in abundance of Rainbow Trout over the past decade (Megargle et al. 2018).

The overall length range of predated trout by pelicans in Silver Creek was similar to that found in other Idaho studies (235-400 mm; Teuscher et al. 2015; Meyer et al. 2016). Mean length of predated RBT and BRN did not significantly differ from the respective tagged and released trout. Similarly, mean length of predated RBT and BRN did not significantly differ. Multiple studies have evaluated pelican predation on hatchery trout and suggested size of released and predated trout do not differ (Meyer et al. 2016; Chiramonte et al. 2019). Although this study did not document prey size selection, pelicans have been documented to select for hatchery-sized wild trout following hatchery trout stocking efforts (Derby and Lovvern 1997).

Pelicans foraged throughout all reaches of Silver Creek where trout were captured, tagged, and released. Although 29% (n = 27) of all predated trout were released in Zone 4, there was no significant difference between predation rates across all zones (Figure 23). However, it is worth noting there is less human-caused disturbance to pelican foraging in Zone 4, as it is solely

accessible by boat or with landowner permission. Additionally, the landowner prohibits active hazing on the property in Zone 4. This eliminates the ability for hazers to deter pelican foraging, especially at night, due to the limited access. Because of this, Zone 4 often represents the majority of pelican observations (USDA Wildlife Services unpublished data). The other privately accessible zone (Zone 2) experiences substantial human disturbance associated with guided angling, which essentially dissuades pelicans from foraging within the zone.

Pelican predation on Silver Creek likely corresponds with pre-nesting and post-nesting caloric needs. Pelican presence at Silver Creek are highest in May (Table 2), when most pelicans are arriving to their summer breeding colonies and post-reproductive gestation has begun (Sovada et al. 2005). During nesting (June), both parents participate in egg incubation, which limits foraging to one parent at a time (Brown and Urban 1969). Peak hatch for American White Pelicans at the Lake Walcott colony generally occurs in early-July (IDFG 2016), allowing both parents to simultaneously forage again. August represents the highest caloric requirements for family groups of pelicans in Idaho, as fledgling chicks are nearly adult sized, but cannot fly. Fledgling chicks are capable of swimming and thus foraging successfully near their colony, which may slightly reduce the need for parental provisions. The results from this study support above life history and feeding characteristics of pelicans in Idaho, as peak predation on Silver Creek occurred during May and August of 2019 (Figure 24). In 2018, peak predation on Silver Creek occurred during July (Figure 24). Additionally, catastrophic vandalism in August 2019 resulted in approximately 2,000 mortalities (about half of the total brood) of unhatched eggs and hatchling chicks (IDFG Region 4 Enforcement, personal contact). This loss may have increased predation at Silver Creek in August, as many adult pelicans no longer had chicks to feed at the colony. Anecdotal information collected by local IDFG conservation Officers suggested abnormally high numbers of pelicans, loafing in August, at Carey Lake WMA, approximately 12 km to the east of Silver Creek.

Hazing strategies differed between 2018 and 2019. In 2018, the intensity of hazing efforts were doubled from April to June, compared to previous years, which resulted in low predation during that associated time (Figure 24). However, predation rates dramatically increased during the month of July after hazing efforts concluded. Because 2019 hazing efforts were limited by a $25,000 budget, the strategy was adjusted in an effort to maximize the hazer's presence on Silver Creek. For example, in 2018 USDA Wildlife Services provided two biologists to alternate day and night shifts every day for 37 days, between April 24 and June 14; while in 2019, a single biologist hazed pelicans as needed for 77 days between April 22 and July 15. Because hazing in 2019 relied on visually seeing pelicans prior to administering hazing efforts, all of the hazing occurred during daylight hours, which may have consequently reduced total pelican encounters (Table 2). Additionally, tag detection gaps at the Lake Walcott indicate pelicans are away from the colony between 0800 – 1100 h and 2200 – 0000 h, during a 24-h time period (Figure 25). The detection gaps at Lake Walcott suggest that pelicans are exhibiting early morning and nightly foraging behavior, as has been documented elsewhere (McMahon and Evans, 1992). Despite total pelican encounter rates decreasing in 2019, a lack of nocturnal hazing likely provided pelicans more opportunity to forage on Silver Creek compared to 2018 (Table 2). Collectively, the 2019 hazing strategy appears inferior as an increase total predation rate was documented (Figure 24).

Our results indicate that pelicans are predating on wild trout populations in Silver Creek at rates higher than previously documented in the state. This study suggests that hazing pelicans at Silver Creek early and often, as done in 2018, reduces predation more than less intense hazing over a longer duration, such as done in 2019. However, for both years, non-lethal hazing efforts appear to provide short-term relief, and overall have not substantially deterred pelicans from foraging on trout in Silver Creek. It is reasonable to assume that predation rates without active hazing would be even higher. However, and despite the high predation rates, wild trout populations in Silver Creek are thus far relatively robust and stable, meaning that these high observed predation rates have not caused additive declines in abundance or total biomass. While

stable populations are encouraging, pelicans are consuming or utilizing a much larger portion of the annual trout production than humans. Determining the optimal hazing intensity and cost was not an objective of this study; however, it is likely that additional increases in predation may lead to exceedance of a total mortality threshold at which point trout populations would be expected to decline. For this reason, it is important that hazing at intensities similar to 2018 be continued for the forseeable future or until more efficient hazing strategies are identified or the Minidoka Pelican colony is reduced to state objective.

RECOMMENDATIONS

1. Complete the triennial mark/recapture abundance estimates for trout and evaluate total annual mortality.

2. Continue hazing actively feeding pelicans at Silver Creek during spring foraging season.

3. Seek lethal take authority to reduce pelican predation rates.

Table 2.   American White Pelican hazing effort summary at Silver Creek, from 2016 to 2019.

Year	Month	Total Encounters	Dates	Total Days Present	Total Days Hazed
2016	May	577	May 13 - June 10	28	24
	Jun	132			
2017	May	535	May 10 - June 14	35	22
	Jun	28			
2018	Apr	558	April 14 - June 14	45	37
	May	1038			
	Jun	126			
2019	Apr	234	April 22 - June 15	77	77
	May	426			
	Jun	72			
	Jul	0			
Total		3726		185	160
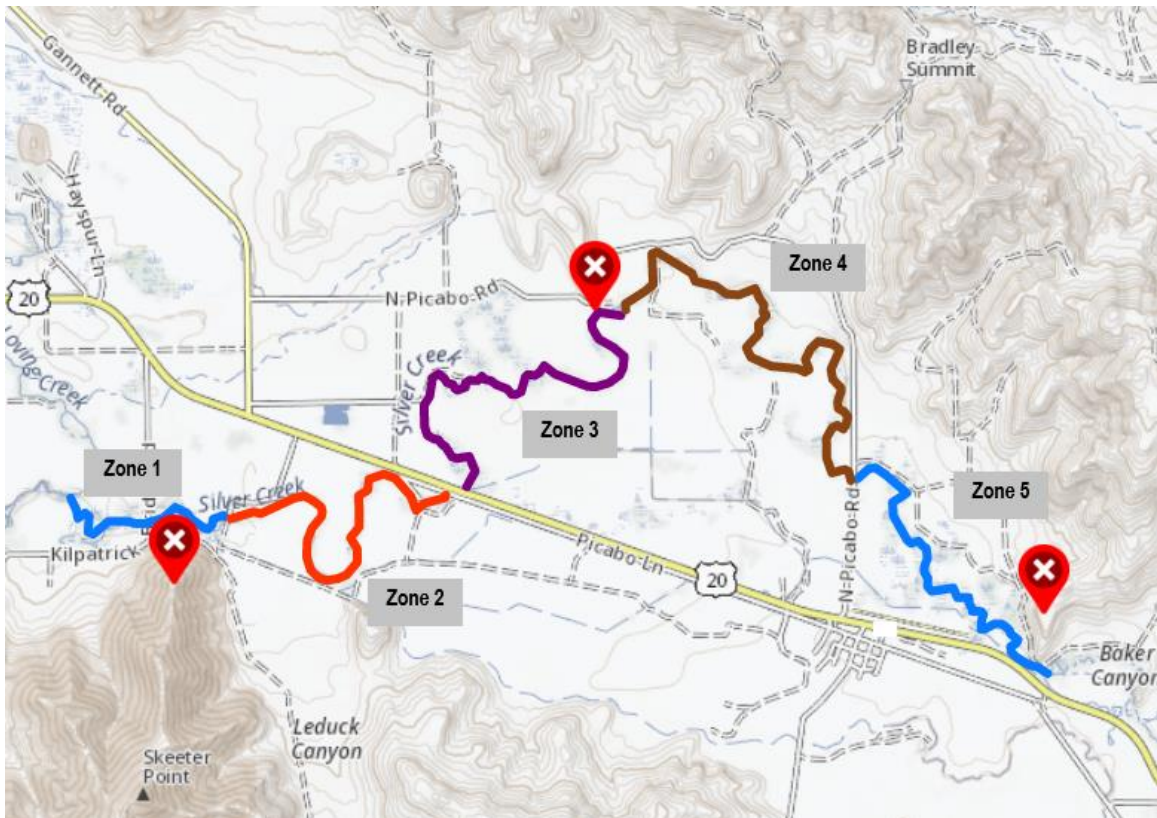
Figure 21.   Map of stationary receiver locations (indicated by red dots) used to detect radio telemetry tags in tagged wild trout and zones (differentiated by differing colors) on Silver Creek, ID for 2018 and 2019.

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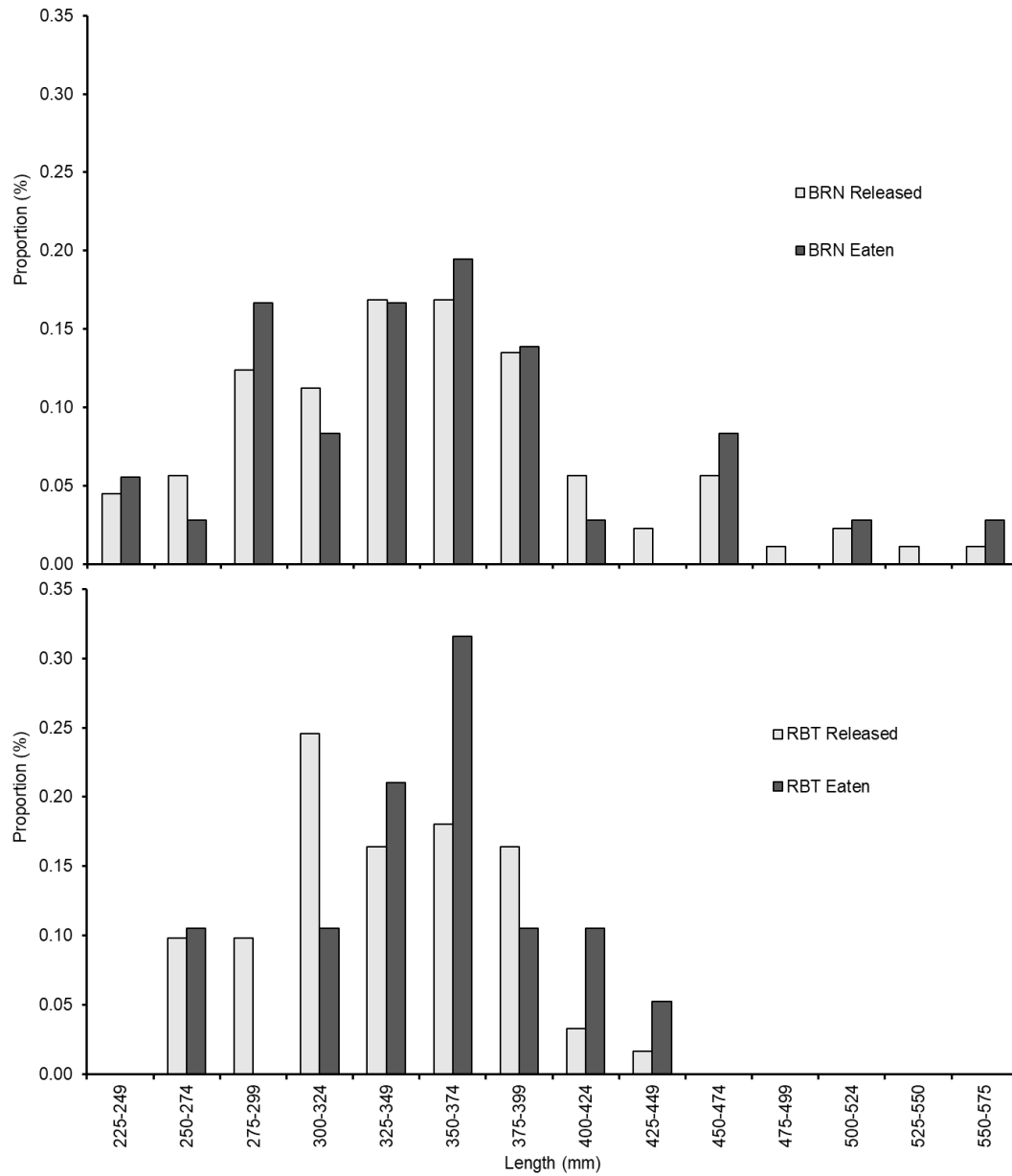
Figure 22. Length (TL) frequency distribution of radio tagged (*n* = 89) Brown Trout (BRN) and BRN eaten (*n* = 36); and radio tagged (*n* = 61) Rainbow Trout (RBT) and RBT eaten by pelicans; from Silver Creek and detected at the Lake Walcott Pelican Colony in 2019.
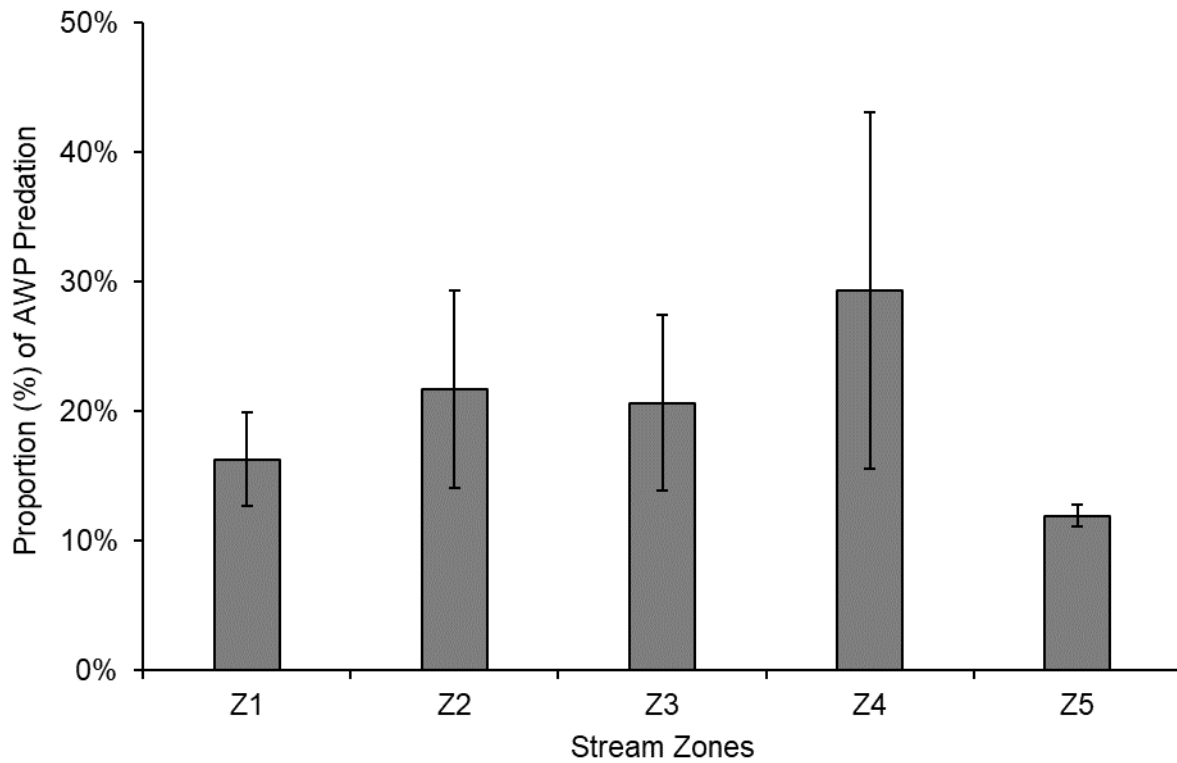
Figure 23. Proportion of pelican predation on wild trout (both species) in Silver Creek by study zone (see Figure 18), based on release locations of tagged trout.
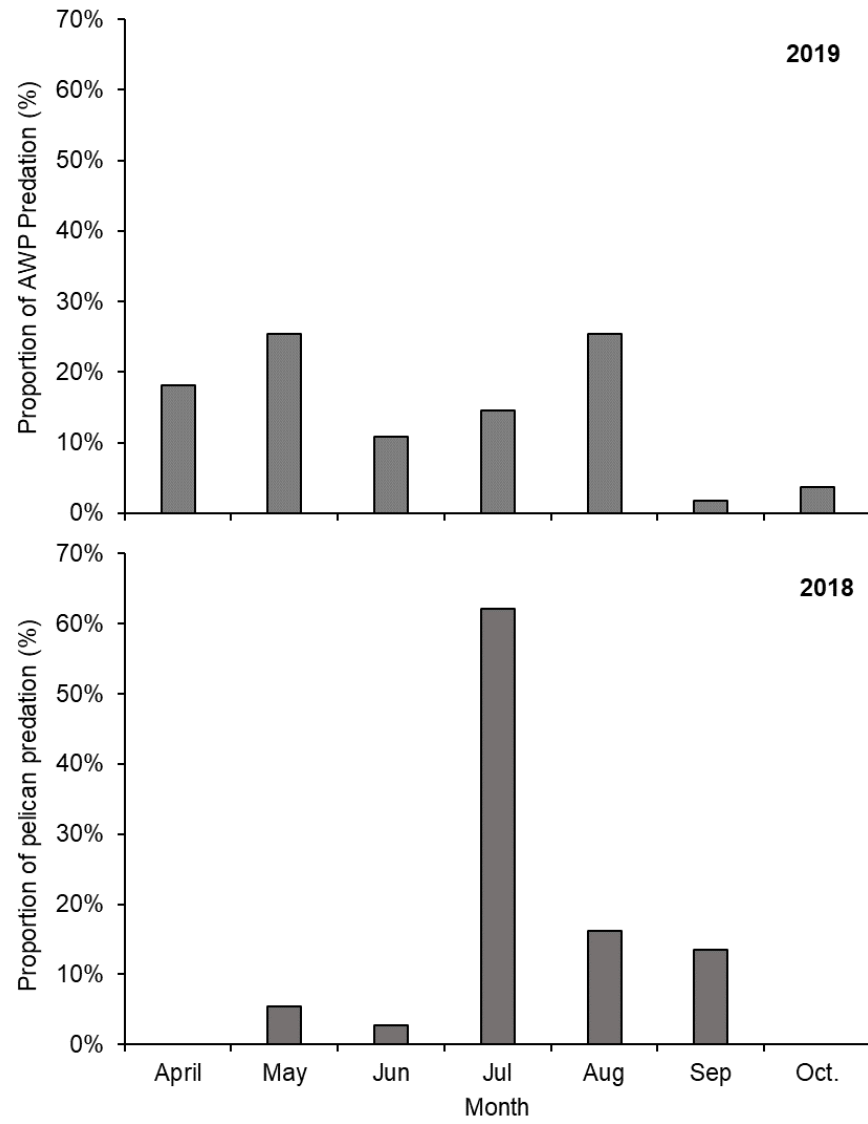
Figure 24.   Pelican predation on wild trout in Silver Creek by month, based on the date of initial tag detection at the Lake Walcott pelican colony in 2018 (*n* = 37) and 2019 (*n* = 55).
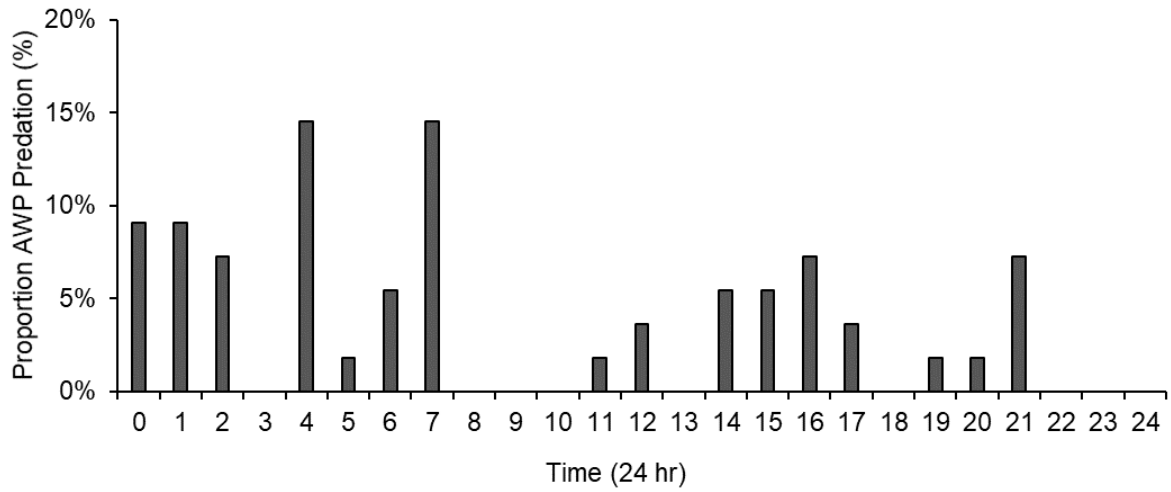
Figure 25.   Proportion of consumed wild trout detections from 2018 and 2019, at the Walcott Colony (*n* = 92) by hour of initial detection.

DEVIL'S CORRAL CREEK

ABSTRACT

To better understand the potential effects of the proposed Devil's Corral project on fishes, IDFG conducted a survey of the project area to improve understanding of the existing fish community. IDFG is aware of some of the details of the proposed Devil's Corral project, which has the potential to adversely affect the Rainbow Trout *Oncorhynchus mykiss* fishery in and adjacent to Devil's Corral Creek. In the 2019-2024 IDFG Fish Management Plan, there is specific management direction to "preserve aquatic habitat, quality of springs, and spawning and rearing access" in Devil's Corral Creek. The Devil's Corral project proposal specifically states that "we will dewater the channel", in reference to the south channel. Dewatering would eliminate the Rainbow Trout population in that channel, which is likely a fluvial trout population. The abundance of Rainbow Trout in Devil's Corral Creek is approximately 80-160 (> 100 mm in length).

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INTRODUCTION

The Idaho Department of Fish and Game (IDFG) often provides technical information to decision makers regarding activities that may affect fish and wildlife resources in the state. To better understand the potential effects of the proposed Devil's Corral project on fish, IDFG conducted a survey of the potentially affected area to assess the composition and abundance of the fish community. IDFG is aware of some of the details of the proposed Devil's Corral project, which has the potential to adversely affect the Rainbow Trout *Oncorhynchus mykiss* fishery in and adjacent to Devil's Corral Creek. The current proposal requests a year-round diversion of the entire south channel, approximately 30 cfs, for hydropower. The following summary describes potential impacts to this fishery.

Devil's Corral Creek is located four miles northeast of Twin Falls and is a tributary to the Snake River. There was no understanding of the fish community present prior to this survey.

METHODS

On April 18, 2019, IDFG staff used two backpack electrofishers and two additional netters to assess the fish community. Approximately 300 m of the south channel was surveyed, ending at the spring source. Some of the water was too deep to survey, and deep silt sediment prevented staff from surveying other sections of the channel. Captured species were measured (TL, mm) and genetic fin clips (caudal) were taken from all salmonids. Genetic samples were sent to the IDFG Eagle Genetics Lab for analysis.

RESULTS

The fish community sampled included Rainbow Trout, numerous Speckled Dace *Rhinichthys osculus*, and all life stages of Signal Crayfish *Pacifastacus leniusculu..* Where the channel could be electrofished, 16 Rainbow Trout were captured, ranging in size from 130 to 298 mm in length (Figure 26). Based on stream width and depth in the survey reach, capture efficiency of fish during this effort could have been as high as 50%, but was likely 25% or less (Meyer and High 2011). Assuming a capture efficiency of 25-50%, and considering that the entire spring is about 750 m in length (of which only 300 m was surveyed), the Rainbow Trout population abundance estimate is approximately 80-160 fish (> 100 mm in length). Genetic analysis indicated all fin clip samples were of coastal-origin Rainbow Trout origin.

DISCUSSION

If the Devil's Corral project diminishes but does not completely dewater the channel, the effect to the Rainbow Trout population from the channel reduction will depend on the proportion of the total flow removed and the resulting amount of channel restriction. While the project proposal plans for complete dewatering, the remaining portion of this document addresses likely impacts to the population if it is not completely dewatered, since the effect of complete dewatering would result in a loss of fish currently in that reach.

Several river otter *Lontra canadensis* have been observed in Devil's Corral Creek and river otter are known to feed on salmonids (Dolloff 1993). Avian predators, such as osprey *Pandion haliaetus*, belted kingfisher *Megaceryle alcyon*, and great blue heron *Ardea herodias*, also reside in the area. Many of the Rainbow Trout captured in Devil's Corral Creek were hiding in bulrushes and near boulders in the channel, which are concentrated along (but not restricted to) the shoreline. Any partial reduction in stream discharge would likely dewater current

streamside trout cover, perhaps increasing their vulnerability to mammalian and avian predation. Such partial dewatering may also negatively affect trout growth, since riparian vegetation provides terrestrial invertebrates to streams, which in turn furnishes prey to fishes (Nielsen 1992).

For several reasons IDFG considers it likely that the Rainbow Trout population in Devil's Corral Creek is fluvial in nature. The largest fish we captured, at 298 mm, is certainly capable of adopting a fluvial life history. Roth et al. (2019) found upstream migrating fluvial Cutthroat Trout in Idaho as small as 180 mm, in a much larger system than Devil's Corral Creek.

Second, the confluence of Devil's Corral with the Snake River is steep but likely not impassable by fluvial trout. On June 12, 2019, IDFG staff estimated gradient for Devil's Corral from the confluence (at the high water mark for the Snake River) upstream 58 meters, which encompassed the steep portion of the stream channel in its entirety. Total elevation rise was measured using a combination of a clinometer and a magnifying hand level; duplication was used to corroborate each elevation increment, which summed to 10.0 meters. Using 10 meters as the "rise" in elevation and 58 meters as the hypotenuse of a triangle, the "run" was estimated to be 57.1 meters, which translated to a stream slope of 18%. A study conducted in Idaho demonstrated that Brook Trout (< 20 cm in length) can ascend streams with slopes of 13% over a 67-m reach or slopes of 22% over a 14-m reach, and can ascend waterfalls up to 1.2 m in height (Adams et al. 2000). Rainbow Trout have a slightly higher critical swimming speed than Brook Trout (Kondratieff and Myrick 2006); they also likely have superior upstream migrating and jumping abilities. Taken collectively, it seems highly unlikely that the lower end of Devil's Corral is too steep for Rainbow Trout upstream passage. However, diversion of any amount of flow from this steep stretch of stream could influence the ability of Rainbow Trout to ascend upstream.

Third, the Rainbow Trout population in Devil's Corral is likely not large enough to persist without a fluvial connection with the Snake River. A guiding principle for assessing minimum viable population size is the 50/500 rule (Franklin 1980), which says that populations with an effective population size (N_e) of < 50 are at immediate risk of extinction because, in such small populations, inbreeding depression and demographic stochasticity can quickly push the population into extirpation. A conservative rule of thumb used by biologists is that N_e is usually about one-fifth of the total population size (Mace and Lande 1991), which for Devil's Corral would equate to a N_e of about 16-32. Alternatively, Meyer et al. (2014) found that in southern Idaho, adults comprised 22% of the total abundance of Redband Trout *O. m. gairdneri* populations. Combined with a total population size of approximately 80-160 fish, this would equate to an adult population size of approximately 18-35 fish. Estimates of N_e can also be approximated by assuming that N_e is 0.5–1.0 times the number of adult spawners in a trout population (Rieman and Allendorf 2001), which would produce a N_e estimate of 9-35 fish. Both estimates of N_e are extremely small, suggesting that emigration and immigration probably occur to counter inbreeding depression and demographic stochasticity threats, otherwise extirpation would likely have already occurred.

The fishery management emphasis for Devil's Corral Creek is to preserve aquatic habitat, quality of springs, and spawning and rearing access (IDFG 2019). The current understanding of the Devil's Corral project proposal specifically states that "we will dewater the channel", in reference to the south channel. Clearly, diverting the entire flow would eliminate the Rainbow Trout population in that channel, which is likely a fluvial trout population. IDFG will continue to work with project managers to better understand the proposed project and to develop project alternatives that meet conservation and management objectives for Devil's Corral Creek.
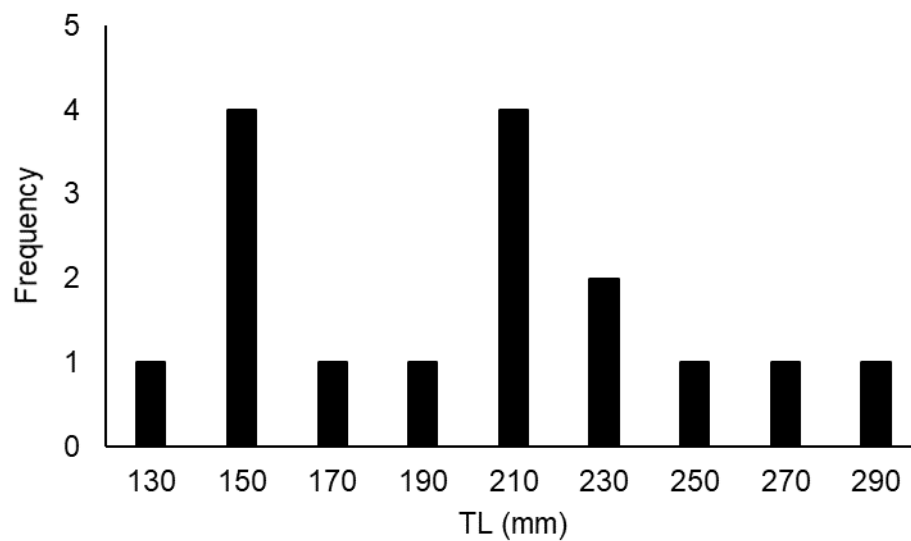
Figure 26.   Length-frequency distribution of Rainbow Trout captured in Devil's Corral on April 18, 2019 using two backpack electrofishers and two additional netters ($n = 16$).

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APPENDICES

Appendix A.   Magic Valley Mountain Lakes reference sheet.

Mountain Lake Name	Lat	Lon	LLID	IDFG Catalog #	HYPERLINK
Amber L. #1 (North)	43.839	-114.469	1144738438416		Amber Lakes
Amber L. #2 (East)	43.842	-114.474	1144688438392		Amber Lakes
Amber L. #3 (South)*	43.437	-114.474	1144738438365	11-0155	Amber Lakes
Baker L.*	43.691	-114.687	1146758436908	11-0150	Baker Lake
Bass Creek L. #01*	43.745	-115.012	1150034437406	10-0171	Bass Creek Lake #1
Bass Creek L. #02*	43.741	-115.003	1150048437429	10-0174	Bass Creek Lake #2
Big Lookout L.*	43.604	-115.422	1154219436037	10-0142	Big Lookout Lake
Big Lost L.*	43.744	-114.663	1146623437439	11-0153	Big Lost Lake
Big Trinity L.*	43.624	-115.429	1154300436233	10-0158	Big Trinity Lake
Boardman Creek L.*	43.525	-115.019	1150180435251	10-0165	Boardman Creek Lake
Boulder L. (upper)	43.841	-114.513	1145149438461		Boulder Lakes
Boulder L. (lower)	43.846	-114.509	1145090438459		Boulder Lakes
Box Canyon L. #1 (Lower)	43.719	-114.052	1140523437189	11-0111	Lower Box Canyon Lake
Box Canyon L. #2 (Upper)	43.729	-114.069	1140693437294		Upper Box Canyon Lake
Deadwood Creek L.*	43.531	-115.029	1150286435296	10-0166	Deadwood Creek Lake
Johnson Creek L.*	43.838	-114.972	1149715438374	10-0182	Johnson Creek Lake
Fiddle L.*	43.606	-115.425	1154250436056	10-0141	Fiddle Lake
Goat L.*	43.731	-115.008	1150077437304	10-0167	Goat Lake
Governors Punchbowl	43.898	-114.701	1147006438980		Governors Punchbowl
Green Creek L.*	43.581	-115.345	1153744435806	10-0133	Green Creek Lake
Green Island L.	43.611	-115.416	1154161436110		Green Island Lake
Heart L. (Trinity)*	43.599	-115.42	1154193435990	10-0153	Heart Lake
Heart Lake (Iron)*	43.545	-115.041	1150404435452	10-0164	Heart Lake
Hidden L.	43.741	-114.652	1146520437409		Hidden Lake
Hideaway L.*	43.591	-115.401	1154011435905	10-0127	Hideaway Lake
Hyndman L.	43.731	-114.119	1141189437300		Hyndman Lake

Mountain Lake Name	Lat	Lon	LLID	IDFG Catalog #	HYPERLINK
Independence L. #01	42.201	-113.662	1136617422013		Independence Lake #1
Independence L. #02*	42.119	-113.669	1136679421991	5-0224	Independence Lake #2
Independence L. #03	42.195	-113.669	1136690421951		Independence Lake #3
Independence L. #04	42.193	-113.671	1136708421927		
Joanne L.	43.749	-114.042	1140424437492		Joanne Lake
Laidlaw L. #01	43.759	-114.039	1140387437587		Laidlaw Lake #1
Lake Cleveland*	42.322	-113.651	1136502423215	5-0222	Lake Cleveland
Lake Creek Lake (Lower)	43.786	-114.322	1143219437866		
Lambert L. #01	43.761	-114.025	1140250437597		Lambert Lake #1
Lambert L. #02	43.763	-114.014	1140143437632		Lambert Lake #2
Little Bear L.*	43.746	-114.976	1149760437458	10-0169	Little Bear Lake
Little Lookout	43.607	-115.421	1154202436070		Little Lookout Lake
Little Lost L.*	43.739	-114.661	1146596437395	11-0152	Little Lost Lake
Little Trinity L.*	43.631	-115.432	1154330436298	10-0160	Little Trinity Lake
Mill L.	43.779	-114.641	1146398437787		Mill Lake
Miner L.*	43.759	-114.666	1146653437594	11-0164	Miner Lake
Nip-N-Tuck L.*	43.746	-114.041	1140395437459	11-0115	Nip N Tuck Lake
Norton L. #1 (Lower)*	43.749	-114.654	1146542437487	11-0160	Lower Norton Lake
Norton L. #2 (Upper)*	43.752	-114.656	1146562437519	11-0161	Upper Norton Lake
Paradise Lake	43.733	-114.846	1148464437332		Paradise Lake
Perkons L.*	43.754	-114.975	1149741437543	10-0170	Perkons Lake
Prairie Creek L. #1	43.758	-114.678	1146737437490		Prairie Lakes
Prairie Creek L. #2*	43.752	-114.679	1146792437523	11-0166	Prairie Lakes
Prairie Creek L. #3	43.754	-114.675	1146737437533		Prairie Lakes
Rainbow Lake #1 (Big)*	43.592	-115.415	1154148435920	10-0151	Rainbow Lake #1 Big Rainbow Lake
Rainbow Lake #2 (Middle)*	43.594	-115.411	1154101435944	10-0152	Rainbow Lake #2 Middle Rainbow Lake
Rainbow Lake #3 (Little)	43.597	-115.407	1154069435970		Rainbow Lake #3 Little Rainbow Lake

Appendix A (continued)

Mountain Lake Name	Lat	Lon	LLID	IDFG Catalog #	HYPERLINK
SF Ross Fork Creek L. #1*	43.764	-115.031	1150315437641	10-0176	South Fork Ross Fork Creek Lake #1
SF Ross Fork Creek L. #2*	43.753	-115.033	1150329437529	10-0177	South Fork Ross Fork Creek Lake #2
SF Ross Fork Creek L. #3*	43.745	-115.034	1150342437444	10-0178	South Fork Ross Fork Creek Lake #3
SF Ross Fork Creek L. #4*	43.736	-115.028	1150278437355	10-0179	South Fork Ross Fork Creek Lake #4
Silver L.	43.839	-114.549	1145489438386		Silver Lake
Smoky Dome L. (Boardman)	43.505	-114.948	1149479435047		Smoky Dome Lakes
Snowslide L. #1	43.739	-114.826	1148311437381		Snowslide Lakes
Snowslide L. #2	43.739	-114.828	1148279437390		Snowslide Lakes
Snowslide L. #3	43.738	-114.831	1148254437387		Snowslide Lakes
Titus L.	43.855	-114.711	1147104438551	11-0171	Titus Lake
Two Point L.	43.732	-114.996	1149960437319		Two Point Lake
Window L.*	43.855	-114.509	1145093438550	11-0156	Window Lake
Windy L.*	43.737	-114.042	1140417437369	11-0114	Windy Lake

(*) currently stocked lakes
Note. Only lakes with stocking history have an IDFG catalog #
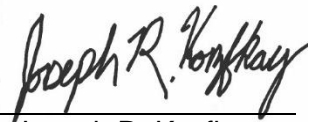
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