FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME

FISHERY MANAGEMENT ANNUAL REPORT

Virgil Moore, Director

UPPER SNAKE REGION

2011

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ABBREVIATIONS USED IN REPORT

BKT – brook trout
BLM – United State Bureau of Land Management
BNT – brown trout
BOR – United States Bureau of Reclamation
cfs – cubic feet per second
CI – confidence interval
cm - centimeter
cms – cubic meters per second
CPUE – catch-per-unit-effort
CWT – coded wire tag
DO – dissolved oxygen
ESA – federal Endangered Species Act
FWIN – fall walleye index netting
g - gram
ha - hectare
IDFG – Idaho Department of Fish and Game
JMP – Jim Moore Pond
km - kilometer
L - liter
m - meter
mg – milligram
mm – millimeter
µm - micrometer
n – sample size
PIT – passive integrated transponder tag
ppm – parts per million
PSD – Proportional Stock Density
RBT – rainbow trout
RSD-P – Relative Stock Density of preferred size fish
TL – total length
USFWS – United States Fish and Wildlife Service
USFS – United States Forest Service
USGS – United States Geological Survey
W_r – relative weight
W_s - standard weight
YAR – young-to-adult ratio
YCT – Yellowstone cutthroat trout
YSI – Yellow Springs Instruments
ZPR – zooplankton productivity ratio
ZQI – zooplankton quality index

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RIRIE RESERVOIR

ABSTRACT

The discovery of walleye *Sander vitreus* in Ririe Reservoir during 2008 prompted annual monitoring to determine the status of the walleye population and changes to the existing fishery. During 2011, we conducted our second annual fall walleye index netting (FWIN), and captured seven walleye, ranging from 200 mm to 620 mm, in 18 net nights of effort. Although 2011 was the first year that walleye were captured during fall walleye index netting, catch rates were the lowest of all species captured (0.4 fish per net). One walleye captured was age-0, with the remaining six being age-5. Our gill net catch was dominated by non-game fish (Utah sucker *Catostomus ardens* 45%, Utah chub *Gila atraria* 18%); the most abundant game fish in our net catch were yellow perch *Perca flavescens* (31%). Catch rate (fish per net night) was similar to 2010 for all species, except kokanee salmon *O. nerka*. Kokanee catch rates declined significantly from 7.3 in 2010 to 0.9 in 2011, but we believe this was related to reservoir water levels or other environmental factors rather than predation from walleye.

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INTRODUCTION

Ririe Reservoir is located on Willow Creek, approximately 32 km east of Idaho Falls (Figure 1). Ririe Dam was constructed in 1977, with the reservoir being filled to capacity for the first time in 1978. Ririe Reservoir is fed by approximately 153 km of streams in the Willow Creek drainage, and has a total storage capacity of 100,541 acre-feet. Ririe Reservoir is approximately 17 km long, and is less than 1.5 km wide along the entire length; with a surface area of approximately 631 ha (1,560 acres) and mean depth of 19.5 m. Ririe Reservoir is managed primarily for flood control and irrigation (BOR 2001).

Ririe Reservoir supports a popular fishery for kokanee salmon *Oncorhynchus nerka*, Yellowstone cutthroat trout *O. clarkii bouvieri*, smallmouth bass *Micropterus dolomieu*, and yellow perch *Perca flavescens*. Utah chub *Gila atraria* and Utah sucker *Catostomus ardens* are also found in Ririe Reservoir in relatively high numbers. In 2010, angler use was approximately 68,365 hours with a catch rate of 0.5 fish per hour (Schoby et al. 2012). Beginning in 1990, 70,000 juvenile kokanee were stocked annually, with an increase to 210,000 annually in 2004 to improve catch rates and meet increased angler demand. Following this increase in stocking, angler catch rates (fish per hour) of kokanee increased from 0.06 in 2003 to 0.18 in 2010. Approximately 18,000 catchable Yellowstone cutthroat trout are stocked annually to provide angler opportunity. A self-sustaining population of smallmouth bass has developed from introductions into Ririe Reservoir from 1984-1986. Smallmouth bass, although limited by the short growing season at this latitude and altitude, provide a diverse and popular angling opportunity for anglers in the Upper Snake Region. A popular yellow perch fishery is present as well, and the perch population has increased over the past five years likely due to increased spring reservoir levels (Schoby et al. 2010).

Walleye *Sander vitreus* were first documented in Ririe Reservoir in 2008 (Schoby et al. 2010), which prompted further investigations by IDFG fisheries personnel. Gill netting effort increased in 2008, followed by a telemetry study in 2009 and 2010 (Schoby et al. 2012). Fall walleye index netting (FWIN, Morgan 2002) was initiated in 2010 as an annual monitoring tool to document trends in the walleye population. No walleye were captured in 18 gill net nights of effort during 2010, indicating that the population is still small, although the threat of increasing abundance exists. The impact walleye may have on the existing fishery is unclear, but in Lake Roosevelt, Washington predation by introduced walleye accounted for a 31 - 39% loss of stocked kokanee (Baldwin and Polacek 2002). A similar reduction in the kokanee population in Ririe Reservoir would likely negatively impact angler catch rates on this popular fishery. Additionally, threats to native Yellowstone cutthroat trout that reside in the reservoir and upstream may be realized with an increase in the walleye population. Not only do walleye have the potential to impact Ririe Reservoir, but also may spread to other waters, including the Snake River and downstream reservoirs. Washington Department of Fish and Wildlife personnel have cited irrigation canals as the mechanism for walleye expansion from Banks Lake throughout the Columbia River basin. Additionally, in a study conducted to assess the potential for walleye introductions in Idaho (IDFG 1982), Ririe Reservoir was identified as having the biological suitability to sustain a healthy walleye population, but conflicts with maintaining the existing trout fishery were cited as the main reason for not introducing walleye into Ririe Reservoir.

OBJECTIVES

1. Use annual fall gill netting to describe population characteristics of walleye in Ririe Reservoir as a long-term monitoring tool and to monitor changes in abundances of other species in the presence of a new apex predator.

METHODS

The fall of 2011 marked the second year of FWIN to monitor trends in the walleye population in Ririe Reservoir. From October 25-27, we set 6 gill nets per night, for a total of 18 gill net nights of effort (Schoby et al. 2012). Based on the reservoir surface area, a sample size of 18 gill net nights annually is targeted, as described in the FWIN protocol (Morgan 2002). Gill nets were 61 m long x 1.8 m deep, and consist of eight panels (7.6 m long) containing 25 mm, 38 mm, 51 mm, 64 mm, 76 mm, 102 mm, 127 mm, and 152 mm stretched mesh. The reservoir was divided into three strata (north, middle, south), with 6 nets set randomly in each stratum (Figure 2). FWIN protocol recommends stratifying net sets between two depth strata (shallow: 2 – 5 m; deep: 5 - 15 m). Steep shoreline topography limits the amount of shallow water habitat in Ririe Reservoir; therefore we set a combination of floating and sinking gill nets over a variety of depths (Appendix A).

We identified all fish collected with gill nets to species and recorded total length for each fish (mm). Additionally, we recorded total length (mm), weight (g), sex, and maturity of all walleye captured, and collected otoliths and stomach samples for aging and diet analysis. We calculated proportional stock density (PSD) and relative stock density of preferred sized fish (RSD-P) for all game fish (Anderson and Neumann 1996). We used a *t*-test to test for differences (significance level $P < 0.05$) in gill net catch rate between years for each species.

RESULTS

During 2011, FWIN catch was dominated by non-game fish, mainly Utah sucker (45%) and Utah chub (18%; Figure 3). We captured 0.4 walleye per net night (n = 7; Figure 4) that ranged in size from 200 to 620 mm (mean: 540 mm; Figure 5, Table 1). Walleye comprised <1% of the relative abundance of our gill net catch, and had relative weights that ranged from 89 to 118 (mean: 106). Walleye PSD and RSD-P were both 100. Of the walleye captured during FWIN, six were age-5, while one age-0 was also collected (Table 1). We analyzed diet of the seven walleye captured; three stomachs were empty, while the remaining four samples contained kokanee. Kokanee were the only item found in the diet, with one individual kokanee identified in each stomach, ranging from 1.1 g to 12.3 g (mean: 6.3 g).

We captured 22.6 yellow perch per net night (n = 406; Figure 4) that ranged from 85 mm to 283 mm (mean: 214 mm; Figure 6), with PSD and RSD-P values of 73 and 12, respectively (Table 2). Yellow perch comprised 31% of the relative abundance of our gill net catch. We captured 2.7 Yellowstone cutthroat trout per net night (n = 49) that ranged from 211 mm to 460 mm (mean: 317 mm; Figure 7), with PSD and RSD-P values of 20 and 2, respectively. Yellowstone cutthroat trout comprised 4% of the relative abundance of our gill net catch. We captured 0.9 smallmouth bass per net night (n = 17) that ranged from 199 mm to 445 mm (mean: 286 mm), with PSD and RSD-P values of 47 and 24, respectively. Smallmouth bass comprised 1.3% of the relative abundance of our gill net catch. We captured 0.9 kokanee per net night (n = 16) that ranged from 167 mm to 347 mm (mean: 215 mm; Figure 8), with PSD and RSD-P values of 31 and 6, respectively. Kokanee comprised 1.2% of the relative abundance of our gill net catch.

In comparing species catch rates between 2010 and 2011, only kokanee showed a significant change. Kokanee catch rate significantly decreased from 7.3 fish per net in 2010 to 0.9 fish per net in 2011 ($t[34] = -2.91$, $p = 0.003$; Figure 4).

DISCUSSION

The fall of 2011 marked the second year of FWIN. Although we captured seven walleye in 2011 after catching zero in 2010, there was no significant difference in walleye catch rate, and at this point the walleye population remains relatively small. The presence of age-0 walleye indicates that walleye are successfully reproducing, although it appears that reproduction is not substantial. Although the sample of adult walleye was small (n=6), mean length at age-5 for males (535 mm) and females (609 mm) are in the 95th percentile of length at age for North American walleye populations (Quist et al. 2003) indicating fast growth and favorable growing conditions. This is further supported by the condition of walleye in Ririe Reservoir (mean relative weight = 106). Fast growth rates and large average size of walleye in Ririe Reservoir was expected, due to the lack of competition and a relatively large forage base.

Kokanee catch rates declined significantly between 2010 and 2011, and despite the presence of juvenile kokanee in walleye stomach samples, it is unlikely that such drastic declines in kokanee can be attributed solely to predation from a relatively small walleye population. The number of kokanee captured between 160 mm and 220 mm during 2011 was 6% of that seen in 2010, indicating a near total loss of this year class (Figure 8). Although walleye predation may have contributed in some degree to the decline in the kokanee catch, environmental conditions likely influenced kokanee survival more than predation. Heavy snowpack during 2011 resulted in prolonged high flows in Willow Creek, with inflows to Ririe Reservoir averaging nearly 1,500 cfs during May, when historic inflows average approximately 425 cfs. Increased inflow from Willow Creek may have increased turbidity within Ririe Reservoir. This may potentially make the transition between the hatchery and living in the reservoir difficult, and thereby decreased survival of newly stocked fish. On May 3, 2011, 210,000 juvenile kokanee were stocked in Ririe Reservoir at the Blacktail boat ramp, which is nearest the mouth of Willow Creek. Between May 1 and June 15, Ririe Reservoir outflows averaged 1,277 cfs, and peaked at 2,826 cfs; generally, reservoir outflows during this period range between 200 and 600 cfs. Increased outflows may have increased kokanee entrainment through Ririe Dam, and possibly resulted in increased mortality on this year class of kokanee.

As observed in 2010 (Schoby et al. 2012), low angler catch rates and low relative weights indicate that Yellowstone cutthroat trout stocked in Ririe Reservoir continue to perform poorly. Low Yellowstone cutthroat trout PSD (20) and RSD (2) values seen in 2011 further verify the poor performance of hatchery cutthroat trout in Ririe Reservoir. The initial shift from rainbow trout to Yellowstone cutthroat trout in 2003 was to protect the genetic integrity of pure cutthroat that reside upstream in Willow Creek and its tributaries. Improvements in sterile rainbow trout production may allow for the evaluation of alternate species that could potentially perform better than Yellowstone cutthroat trout, and should be evaluated as possible.

Continued FWIN will be useful in long-term monitoring of all species as the status of the walleye population changes. Also, biological information such as lengths and weight will be collected from all fish species captured, both game and non-game, as this data can be used to evaluate the impacts that walleye may have on these species.

MANAGEMENT RECOMMENDATIONS

1. Continue annual gill net monitoring (FWIN) to gather information on abundance, growth, mortality, reproduction, and foraging behavior of walleye.

2. Collect biological information on all fish (including non-game species) captured during FWIN monitoring to monitor impacts from walleye establishment.

3. Identify and evaluate alternative stocking strategies to increase survival of kokanee.

4. Stock equal amounts of both sterile rainbow trout and Yellowstone cutthroat trout to evaluate performance in the fishery. Adjust stocking program based on results from this study.

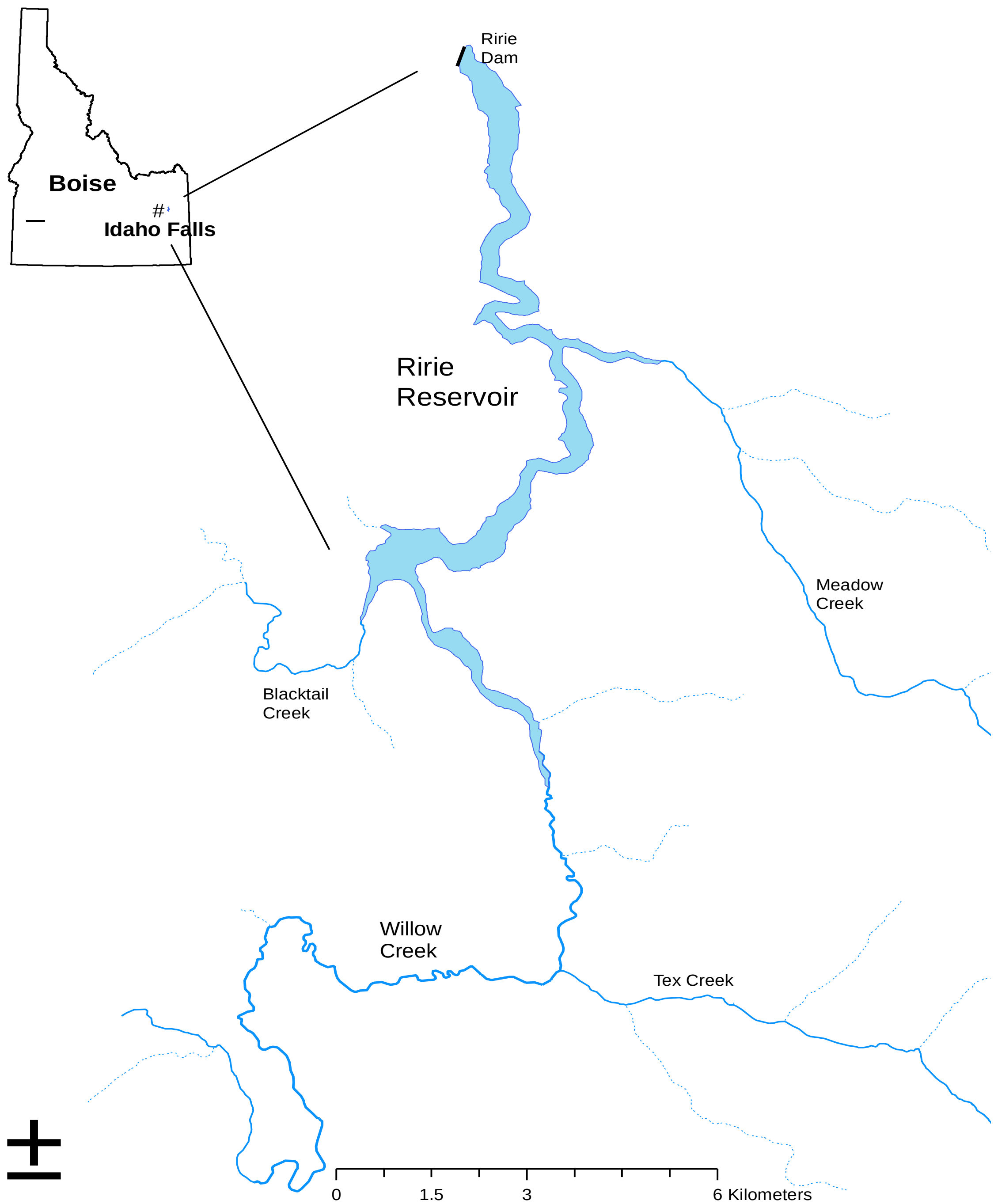

Figure 1. Location of Ririe Reservoir and major tributaries.

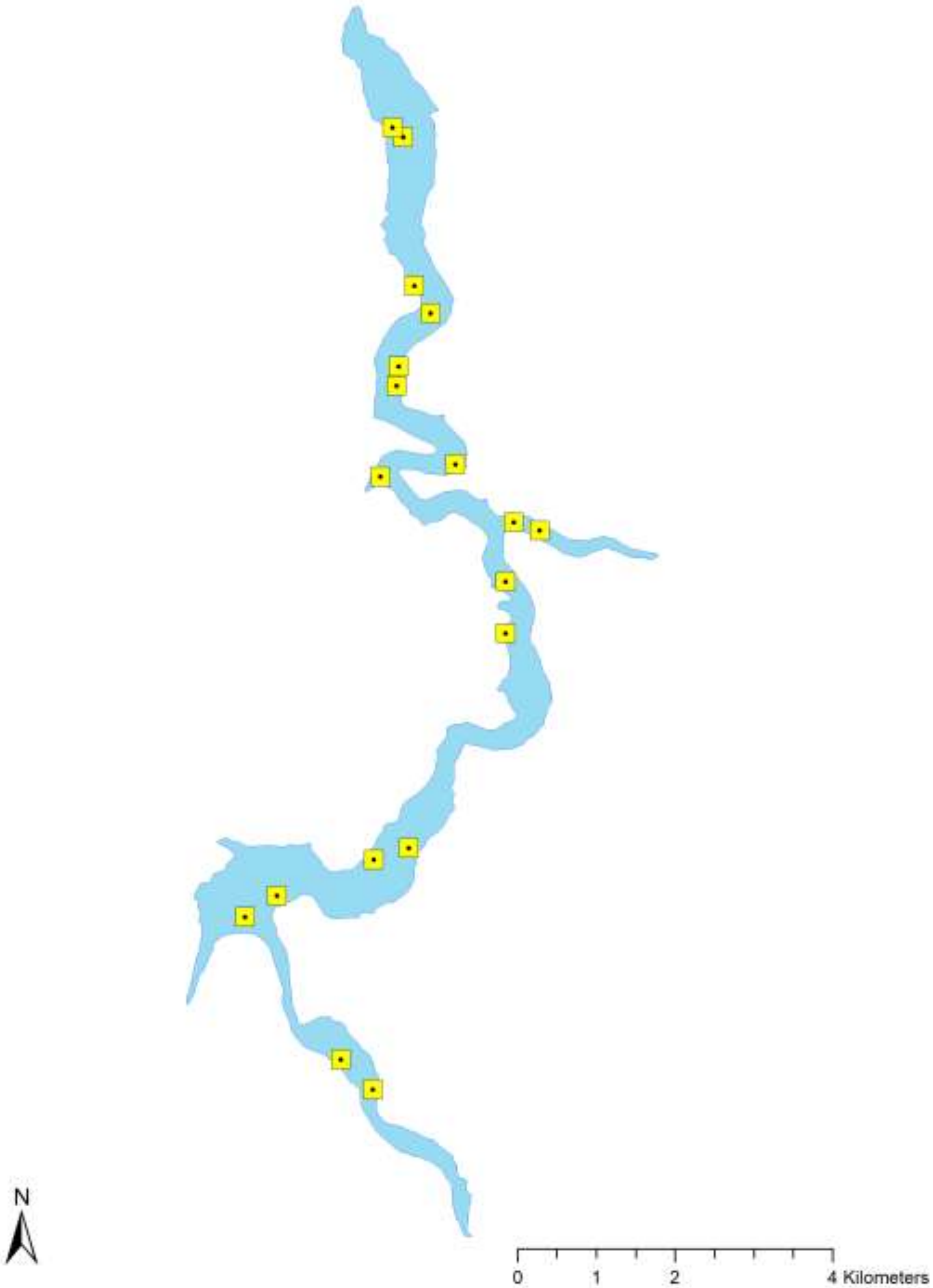

Figure 2. Location of 2011 fall walleye index netting (FWIN) in Ririe Reservoir.

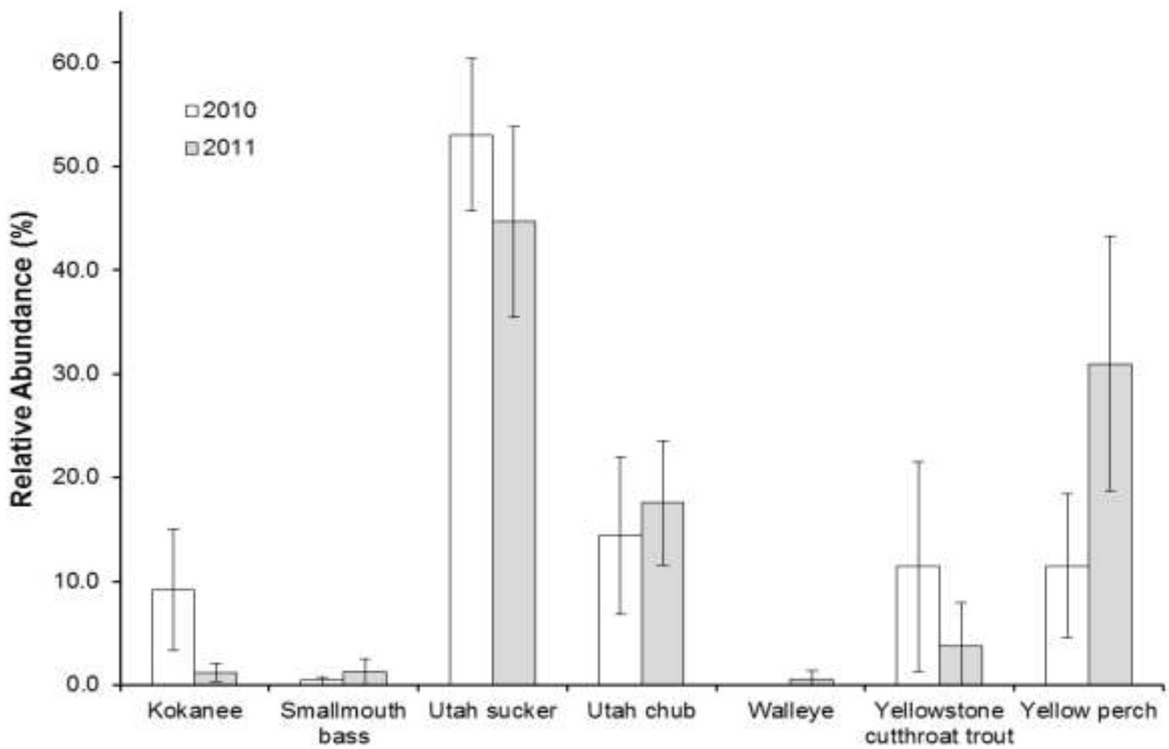

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Figure 3. Relative abundance of fish caught during FWIN in Ririe Reservoir during 2010 (open bars) and 2011 (solid bars). Error bars represent 90% confidence intervals.

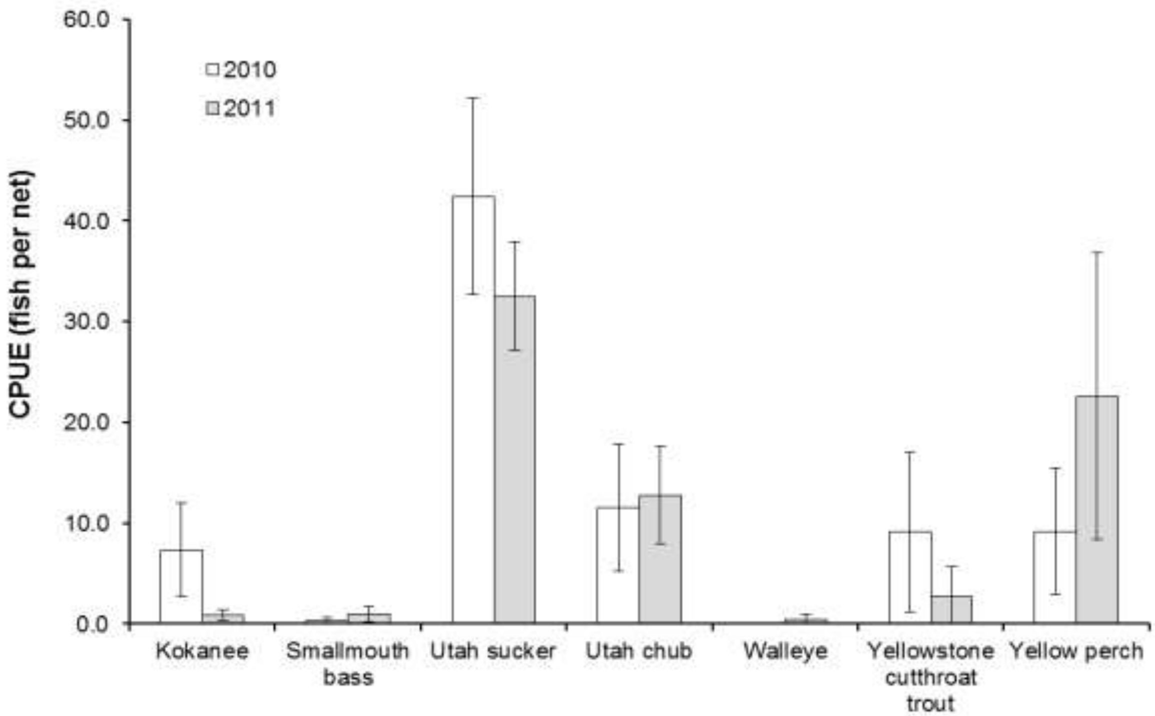

Figure 4. Catch per unit effort (fish per net), for 18 net nights of FWIN in Ririe Reservoir, during 2010 (open bars) and 2011 (solid bars). Error bars represent 95% confidence intervals.

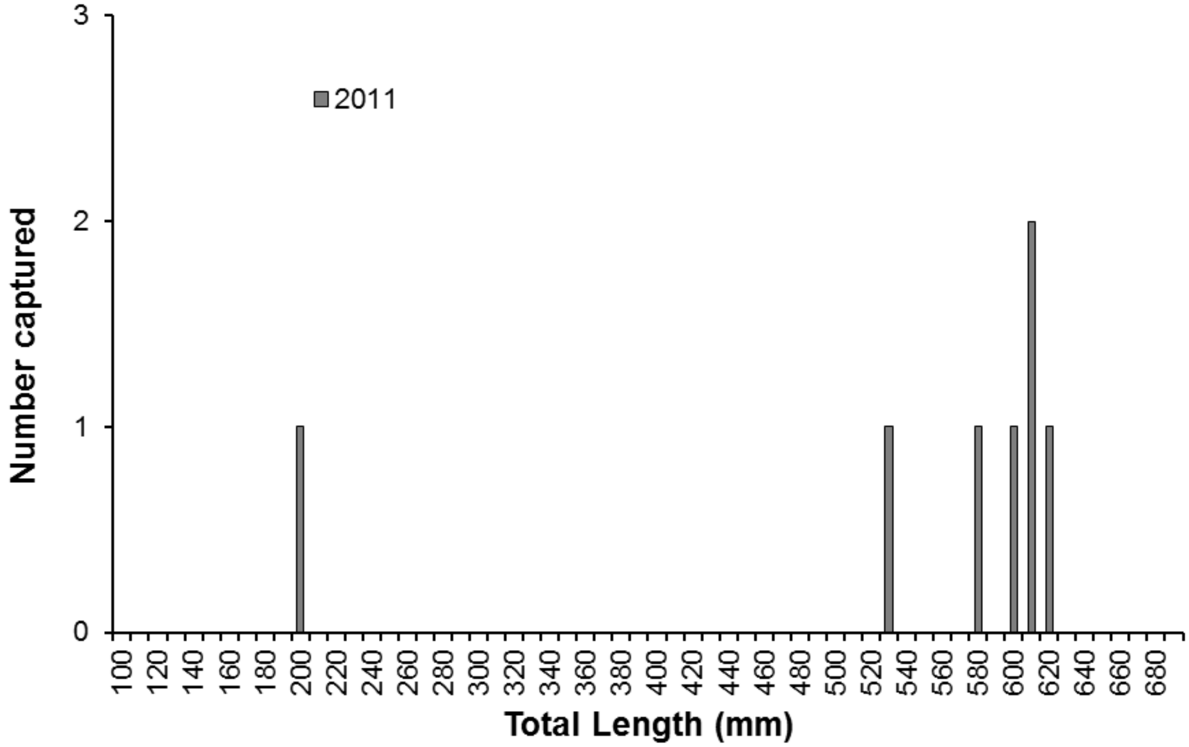

Figure 5. Length frequency of walleye captured during 2011 FWIN in Ririe Reservoir.

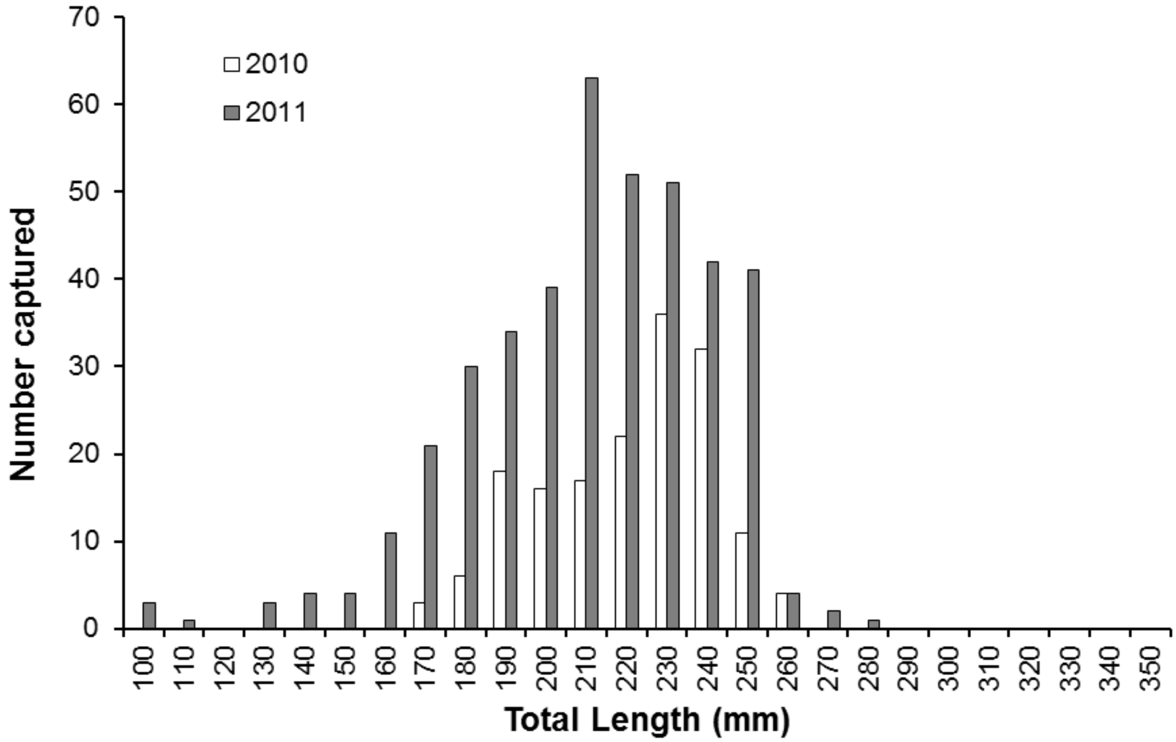

Figure 6. Length frequency of yellow perch captured during 2010 (open bars) and 2011 (solid bars) FWIN in Ririe Reservoir.

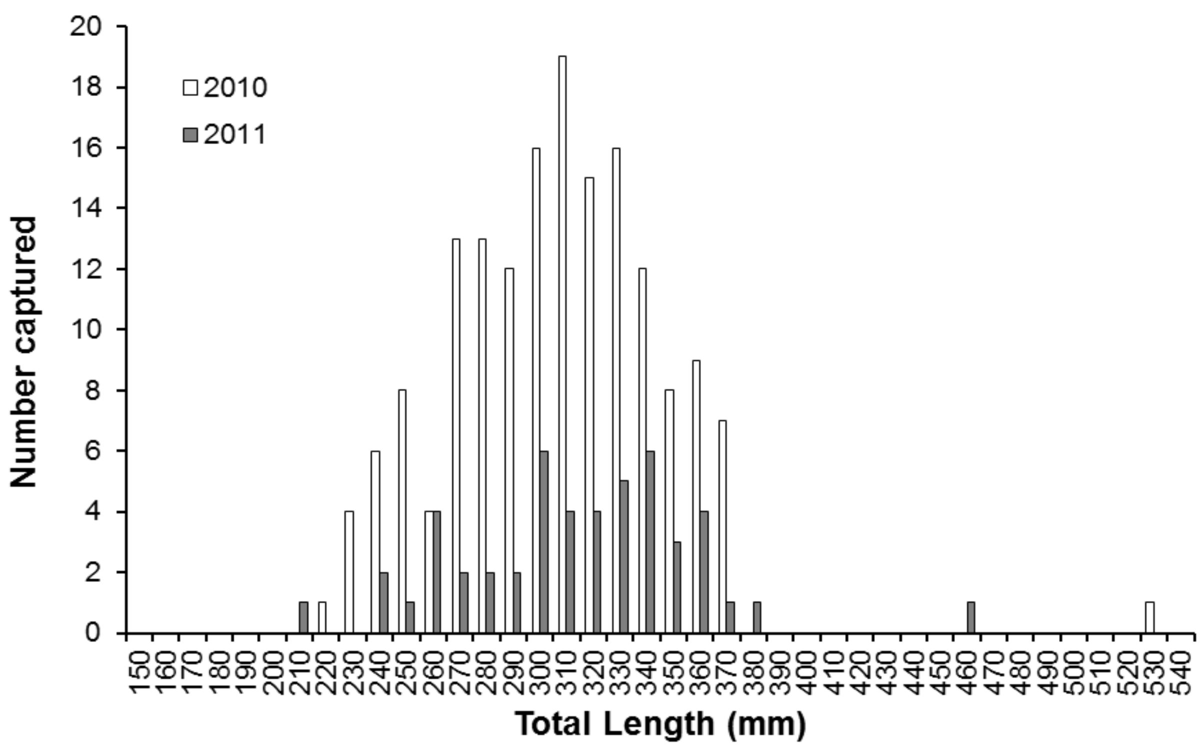

Figure 7. Length frequency of Yellowstone cutthroat trout captured during 2010 (open bars) and 2011 (solid bars) FWIN in Ririe Reservoir.

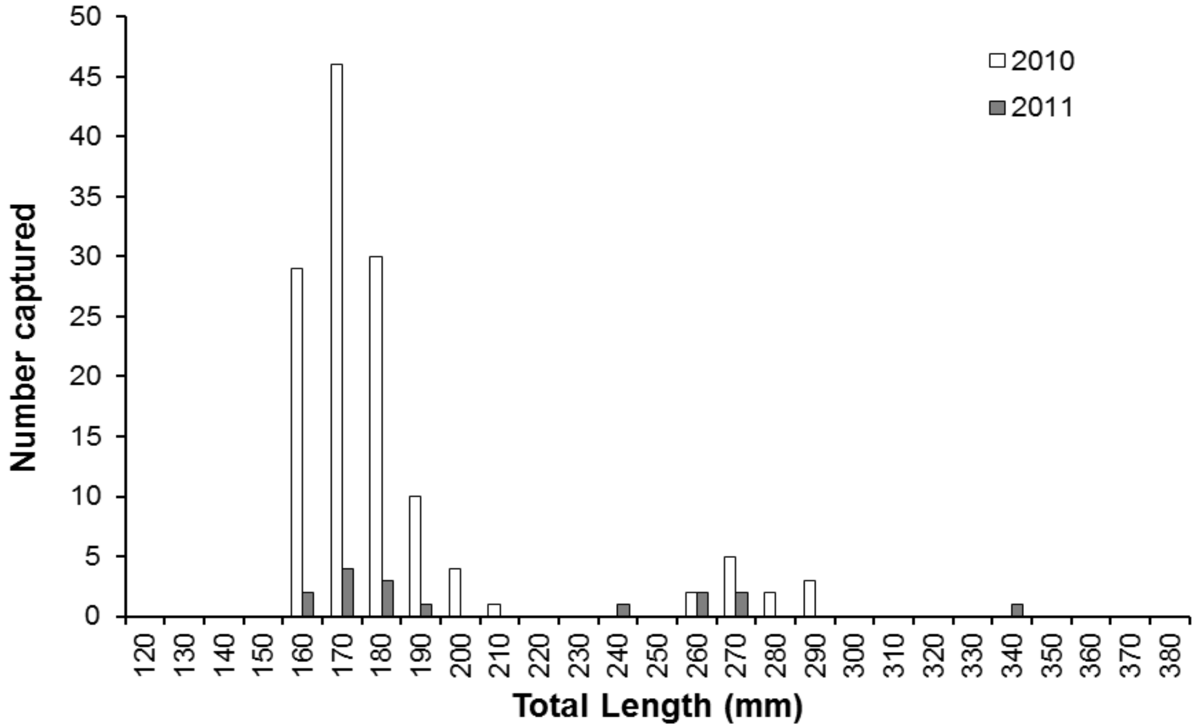

Figure 8. Length frequency of kokanee captured during 2010 (open bars) and 2011 (solid bars) FWIN in Ririe Reservoir.

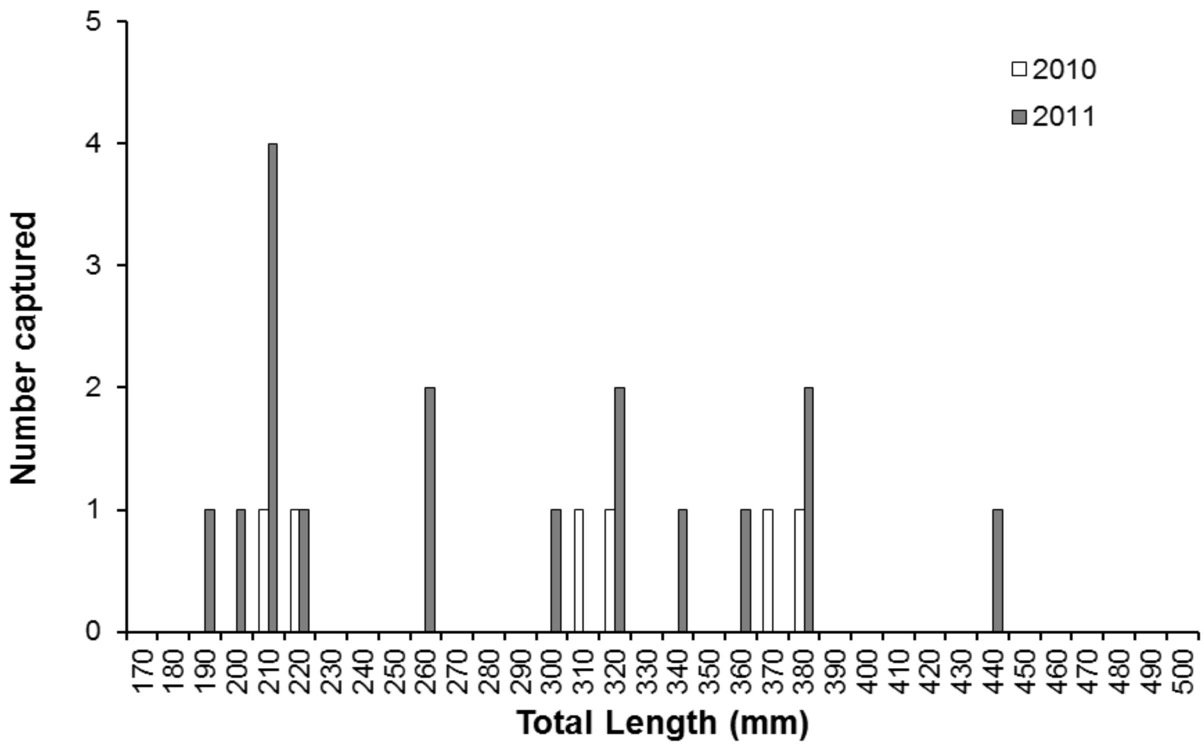

Figure 9. Length frequency of smallmouth bass captured during 2010 (open bars) and 2011 (solid bars) FWIN in Ririe Reservoir.

Table 1. Summary statistics for walleye captured during 2011 FWIN in Ririe Reservoir.

Date	ID #	Net number and type[a]	Total length (mm)	Weight (g)	Sex	Age	Relative weight (*Wr*)
10/26/2011	WLY1	2-F	616	3086	F	5	118
10/27/2011	WLY2	7-S	200	65	Unk	0	89
10/27/2011	WLY3	9-S	618	2677	F	5	101
10/27/2011	WLY4	9-S	585	2527	F	5	114
10/27/2011	WLY5	9-S	535	1758	M	5	105
10/27/2011	WLY6	9-S	620	2819	F	5	106
10/27/2011	WLY7	9-S	605	2692	F	5	109

[a] Net type: F= floating, S=sinking

Table 2. Total length (mm) summary statistics for game fish captured during 2011 FWIN in Ririe Reservoir.

	Kokanee	Smallmouth bass	Walleye	Yellowstone cutthroat trout	Yellow perch
Mean	215	286	540	317	214
Median	184	265	605	320	218
Range	167 - 347	199 – 445	200 - 620	211 – 460	85 – 283
n	16	17	7	49	406
PSD	31	47	100	20	73
RSD-P	6	24	100	2	12

JIM MOORE POND

ABSTRACT

We used experimental gill nets and trap nets on July 19-20, 2011 to sample the fish population in Jim Moore Pond (JMP). Sampling efforts were conducted to assess the fish community after the introduction of channel catfish *Ictalurus punctatus* in 2005, and determine if additional predator introductions were necessary to improve the quality of the yellow perch fishery. A total of 628 yellow perch with a mean total length (TL) of 119 mm were sampled in four gill net nights and three trap net nights of effort. Aged perch had a mean length of 132 mm at age 3, and a proportional stock density (PSD) value of 3. The high catch rates, slow growth, and low proportional stock density of yellow perch indicate that this population is overcrowded, a condition that has hindered the JMP fishery. We transplanted 99 adult brown trout *Salmo trutta* from the South Fork Snake River into JMP, in an effort to increase predation on yellow perch and improve the size structure of yellow perch in JMP.

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INTRODUCTION

Jim Moore Pond (JMP), formerly known as Roberts Gravel Pond, is a 20 ha (50-acre) pond located 3 km south of Roberts, Idaho. The pond was built by the Idaho Transportation Department in 1967 and purchased by the Idaho Department of Fish and Game (IDFG) in 1972. The maximum depth is 3 m and bottom substrate consists mostly of sand and silt. JMP is filled by groundwater and has no inlets or outlets. Dissolved oxygen levels as low as 0 mg/L in winter have been reported (Ball and Jeppson 1980) and to reduce the risk of winterkills, an electric aerator was installed in 1986 (Elle et al. 1987). Since installation, the frequency and extent of fish kills has been reduced but not eliminated. Over the years, numerous fish species have been introduced into JMP to provide recreational fishing opportunities. Rainbow trout *Oncorhynchus mykiss* are stocked on an annual basis to provide a put-and-take fishery, while brown trout *Salmo trutta*, brook trout *Salvelinus fontinalis,* bluegill sunfish *Lepomis macrochirus*, largemouth bass *Micropterus salmoides*, yellow perch, black crappie *Pomoxis nigromaculatus*, channel catfish *Ictalurus punctatus*, brown bullhead *I. nebulosus*, red-ear sunfish *L.microlophus*, and grass carp *Ctenopharyngodon idella* have been introduced with limited success (Elle and Corsi 1994; Corsi and Elle 1989; Corsi and Elle 1986). Utah suckers and Utah chubs were found in JMP up until 1982 (Corsi and Elle 1986). While various species have been introduced, most have not become established or provided a successful fishery. Other species, such as yellow perch, have become well established and provide high catch rates to anglers, although the average size is small.

The establishment of undesirable fish species (Utah sucker and Utah chub) as well as over-population and limited growth by yellow perch has historically been the biggest concern of the JMP fishery. Many strategies have been attempted to correct the problem with little to no success, including the use of rotenone in 1996. Despite chemical renovations, yellow perch again became well established. Angler reports indicated that yellow perch were again abundant in JMP by the early 2000's, when anglers were reporting high catch rates of small yellow perch. In 2007, yellow perch, with a mean length of 139 mm dominated the fishery, comprising 77% of the combined gill net and electrofishing catch. In an effort to reduce yellow perch numbers, increase average size, and to diversify angling opportunities, approximately 1,000 catchable size channel catfish were stocked into JMP in 2005, with additional stockings of 1,000 annually from 2007 through 2009. Sampling in 2011 was conducted to determine the status of the JMP fishery after the introduction of channel catfish, and to determine if increased and/or alternate predator introductions are necessary to improve the yellow perch fishery.

OBJECTIVES

To obtain current information on the fish population and limnological characteristics for fishery management decisions on JMP, and to develop appropriate management recommendations.

METHODS

We used two experimental gill nets, one floating and one sinking, and two trap nets to sample the fish community in JMP on July 19-20, 2011 (Figure 10). Gill nets measured 46 m X 2 m, with mesh sizes of 2 cm, 2.5 cm, 3 cm, 3.5 cm, 4 cm, and 5 cm bar mesh. Trap nets consisted of frames measuring 0.9 m X 1.8 m, with 1.2 cm mesh, and 23 m leads. Nets were set in the evening and retrieved the following morning. Net locations were chosen on site based on physical aspects of the pond as opposed to randomly selected beforehand to facilitate high catch rates.

We identified captured fish to species and recorded total length (TL) to the nearest mm and weighed to the nearest gram. We calculated catch rates (catch per unit effort [CPUE]) as fish per net night for each sampling method. We calculated relative weights (W_r) of all fish captured by dividing the measured weight of a sampled fish (g) by the standard weight (W_s) for that species and multiplied by 100. To calculate standard weight we used the formula

$$\log W_s = -5.386 + 3.230 \log TL$$

for yellow perch (Willis et al. 1991), and

$$\log W_s = -5.800 + 3.294 \log TL$$

for channel catfish (Brown et al. 1995).

We calculated proportional stock density (PSD) by dividing the number of quality-sized fish sampled divided by the number of stock-sized fish sampled multiplied by 100. For yellow perch, we used the following equation

$$PSD = \frac{\text{number } \geq 200 \text{ mm}}{\text{number} \geq 130 \text{ mm}} * 100$$

and for channel catfish we used

$$PSD = \frac{\text{number } \geq 410 \text{ mm}}{\text{number} \geq 280 \text{ mm}} * 100$$

We also calculated relative stock density of preferred sized fish (RSD-P) using the same equation, but replaced the numerator with fish greater than the preferred size. Preferred size of yellow perch and channel catfish are 250 mm and 610 mm, respectively (Anderson 1980). Additionally, we used an analysis of variance to compare the gill net catch rate of individual species between 2007 and 2011.

Sagittal otoliths were removed from 66 yellow perch for age and growth analysis. After removal, all otoliths were cleaned on a paper towel and stored in individually-labeled envelopes. Ages were estimated by counting annuli under a dissecting microscope at 40x power. Otoliths were submerged in water and read in whole view when clear, distinct growth rings were present. We sectioned, polished and read otoliths in cross-section view with transmitted light when the annuli were not distinct in whole view.

We collected zooplankton samples at three locations in JMP on August 5, 2011. We preserved zooplankton in denatured ethyl alcohol at a concentration of 1:1 (sample volume: alcohol). After ten days in alcohol, phytoplankton was removed from the samples by re-filtering through a 153 µm mesh sieve. The remaining zooplankton were blotted dry with a paper towel and weighed to the nearest 0.1 g. Biomass estimates were corrected for tow depth and reported in g/m. We measured competition for food (or cropping impacts by fish) using the zooplankton productivity ratio (ZPR) which is the ratio of preferred (750 µm) to usable (500 µm) zooplankton. We also calculated the zooplankton quality index (ZQI) to account for overall abundance of zooplankton using the formula ZQI = (500 µm + 750 µm) * ZPR (Teuscher 1999).

RESULTS AND DISCUSSION

We collected a total of 652 fish in four gill net nights and three trap net nights; one trap net failed to function properly and was omitted from our results. Overall, yellow perch dominated the combined net catch (96%), followed by channel catfish (3%), and rainbow trout (1%). Gill net CPUE was highest for yellow perch (11.5 fish/net) while only yellow perch were captured in trap nets (194 fish/net; Table 3). Yellow perch ranged from 95 mm to 249 mm, with a mean length of 119 mm (Figure 11). Average length of yellow perch in 2011 was the lowest observed since 1995 (Figure 12). Mean W_r of yellow perch was 94, while PSD and RSD-P were 3 and 0, respectively. Yellow perch mean length at age-3 was 132 mm, with limited growth between age-3 and age-5 (Table 4). The characteristics of the yellow perch population (high CPUE, small average size, low PSD and RSD-P values, and slow growth) in Jim Moore Pond observed in 2011 indicate overcrowding and are characteristic of what Lott et al. (1996) classified as low-quality perch fisheries.

Channel catfish ranged from 279 mm to 496 mm, with a mean length of 383 mm (Figure 13). Mean W_r of channel catfish was 108 while PSD and RSD-P were 50 and 0, respectively. The mean relative weight of channel catfish in JMP indicates that catfish are in good condition, but impacts to the yellow perch population have yet to be realized. This may be due to the small average size of channel catfish in JMP and the possible gape limitations of channel catfish as predators. Hill et al. (1995) indicate that fish were the most important component of the diet of channel catfish >410 mm, but were nearly non-existent in fish <410 mm. RSD-P (50) of catfish in JMP indicates that half of the population is >410 mm, which are likely fish from the earliest stocking events (2005 and 2007). Growth of channel catfish introduced into JMP was likely hampered by a limited amount of suitable forage, and individuals may just now be reaching a large enough size to successfully prey on yellow perch. Any future stockings of channel catfish (or other predators) should consider the size at stocking if effects on the yellow perch population are to be realized.

Compared to the 2007 survey of JMP, we observed a decrease in the gill net catch rate of yellow perch and rainbow trout during 2011 (Table 3); trap nets were not utilized in the 2007 survey therefore comparisons from this capture method cannot be made. The rainbow trout gill net catch rate decreased from 12.7 fish per net night to 1.3 (F [1,5] = 6.09, p = 0.05) and is likely related to differences in stocking between the two years. During 2007, 3,600 rainbow trout were stocked prior to sampling, while in 2011 only 2,100 were stocked prior to sampling. The yellow perch gill net catch rate decreased from 56.7 fish per net night to 11.5 (F [1,5] = 26.6, p = 0.004). Although the gill net catch rate decreased from 2007 to 2011, the high trap net catch rate combined with the decrease in average size indicates that the yellow perch population is still abundant, and previous predator introductions have not produced the desired results.

Zooplankton sampling in JMP yielded only a trace amounts (<0.01 g), therefore we were unable to make any estimates of ZQI or ZPR. The lack of zooplankton in JMP is likely another indicator that the pond is overpopulated with yellow perch, similar to the results of Mills and Forney's (1983) research which documented substantial impacts to the zooplankton community from yellow perch predation. A useful index of yellow perch abundance for future studies is to monitor zooplankton densities. An increase of zooplankton biomass would likely indicate a reduced yellow perch population in JMP.

Based on the findings of our 2011 sampling, we determined that previous introductions of channel catfish have failed to adequately reduce the yellow perch population to date.

Therefore, we transplanted 99 brown trout and 13 rainbow trout from the Lorenzo reach of the South Fork Snake River into JMP in October 2011. Trout were captured during a routine electrofishing survey and held in a livewell until being transported to JMP in a truck-mounted stocking tank. Adult brown trout, ranging from 355 mm to 650 mm (mean: 445 mm) were stocked into JMP in an effort to increase predator numbers in the pond. Rainbow trout (range: 210 - 489 mm; mean: 370 mm) were included in the JMP stocking as part of an ongoing effort in the South Fork Snake River to reduce hybridization with native Yellowstone cutthroat trout. Future sampling of JMP should include diet composition and condition of introduced brown trout to determine if they are preying upon yellow perch. If adult brown trout prey on yellow perch in significant numbers, metrics such as yellow perch catch rate should decrease, while mean length, W_r, length at age, and zooplankton abundance should increase.

MANAGEMENT RECOMMENDATIONS

1. Continue routine sampling efforts to assess fish community in JMP, with particular emphasis on determining changes to the yellow perch population. Consider estimating overall yellow perch biomass and use bioenergetics modeling to determine the amount of predators necessary to reduce the yellow perch population.

2. Supplement existing population of brown trout in JMP with approximately 100 additional adults in 2012. Implant a portion of future stocked brown trout with Floy tags and utilize existing statewide tag reporting system to estimate angler harvest of brown trout.

3. Continue monitoring zooplankton density and correlate with yellow perch density.

4. Analyze stomach contents of brown trout and channel catfish captured in future surveys to evaluate predation on yellow perch.

5. Implement creel survey to determine angler use, catch rates and preferences for the fishery in JMP. Results from this survey should help guide management direction in future years.

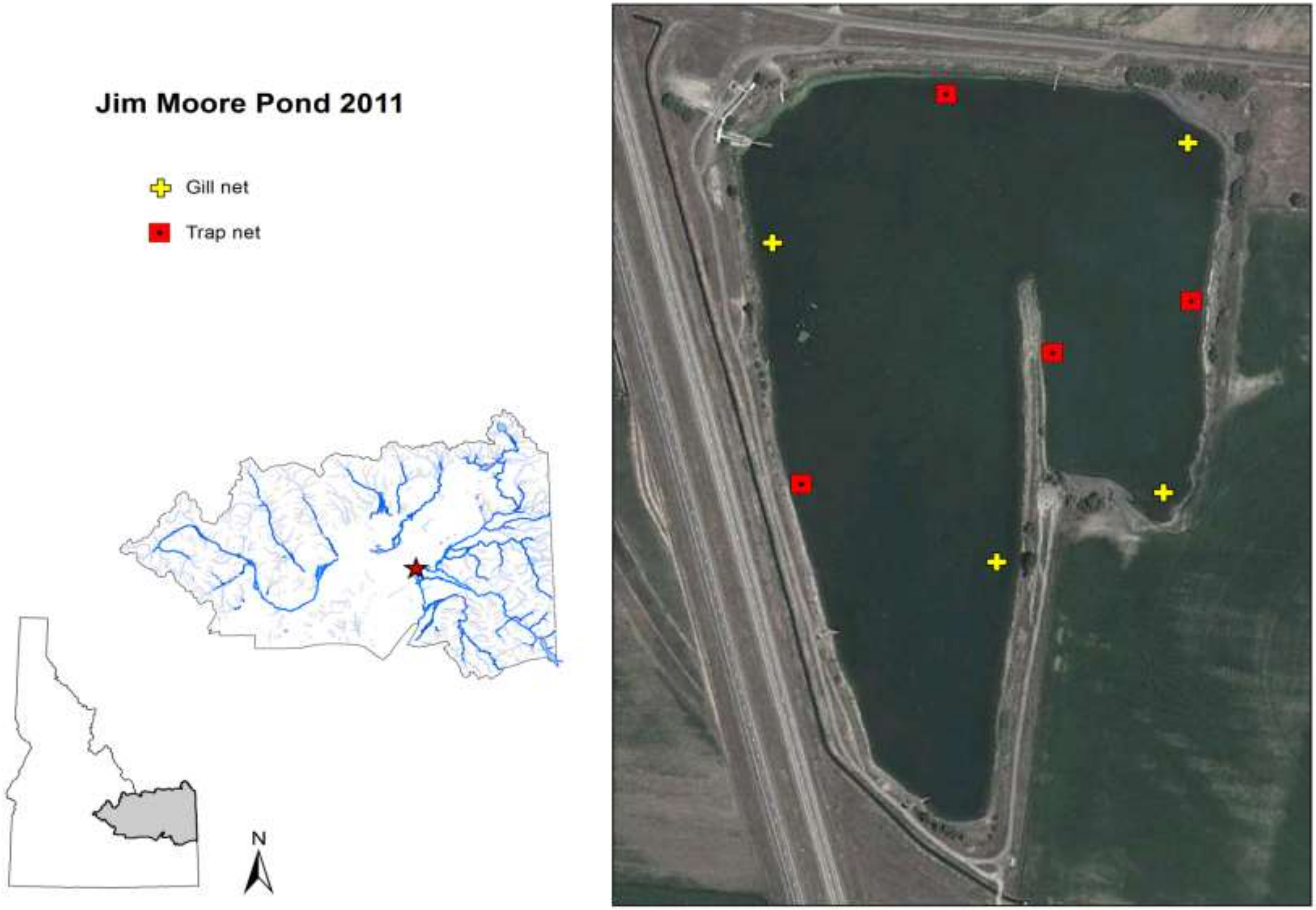

Figure 10. Location of gill nets and trap nets used to survey Jim Moore Pond during 2011.

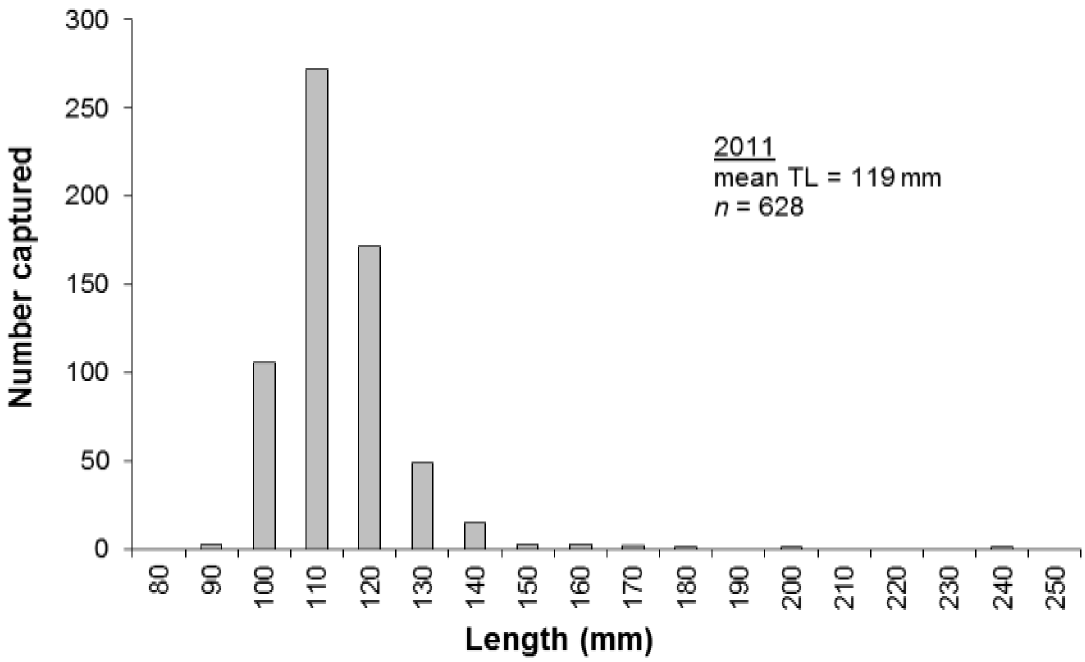

Figure 11. Length frequency of yellow perch captured in Jim Moore Pond with trap nets and gill nets on July 19-20, 2011.

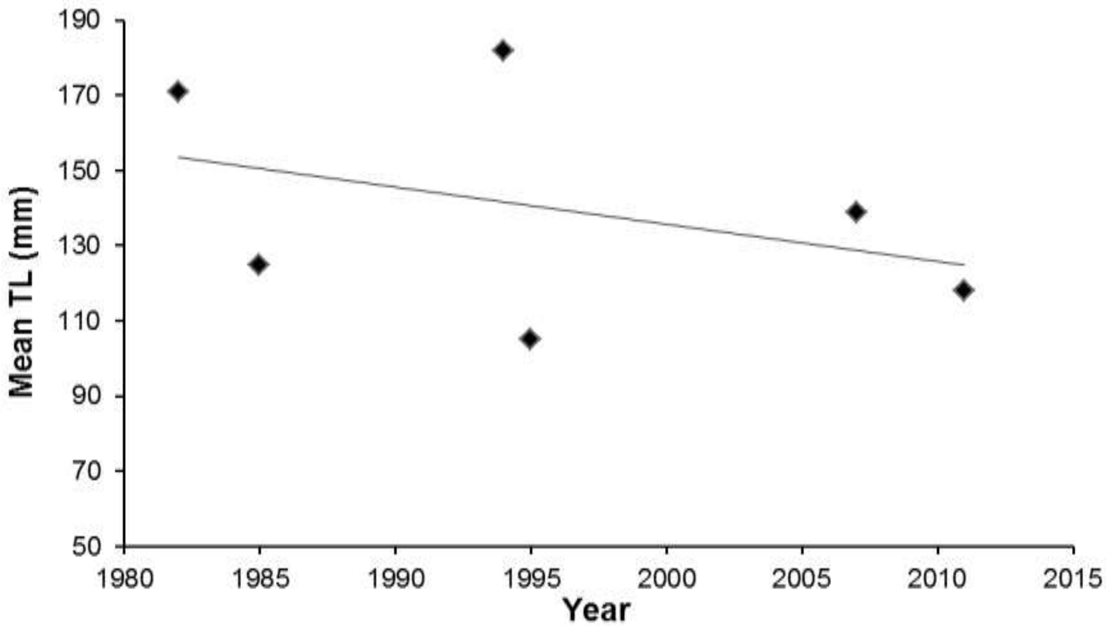

Figure 12. Mean total length (TL) of yellow perch in Jim Moore Pond, 1982-2011.

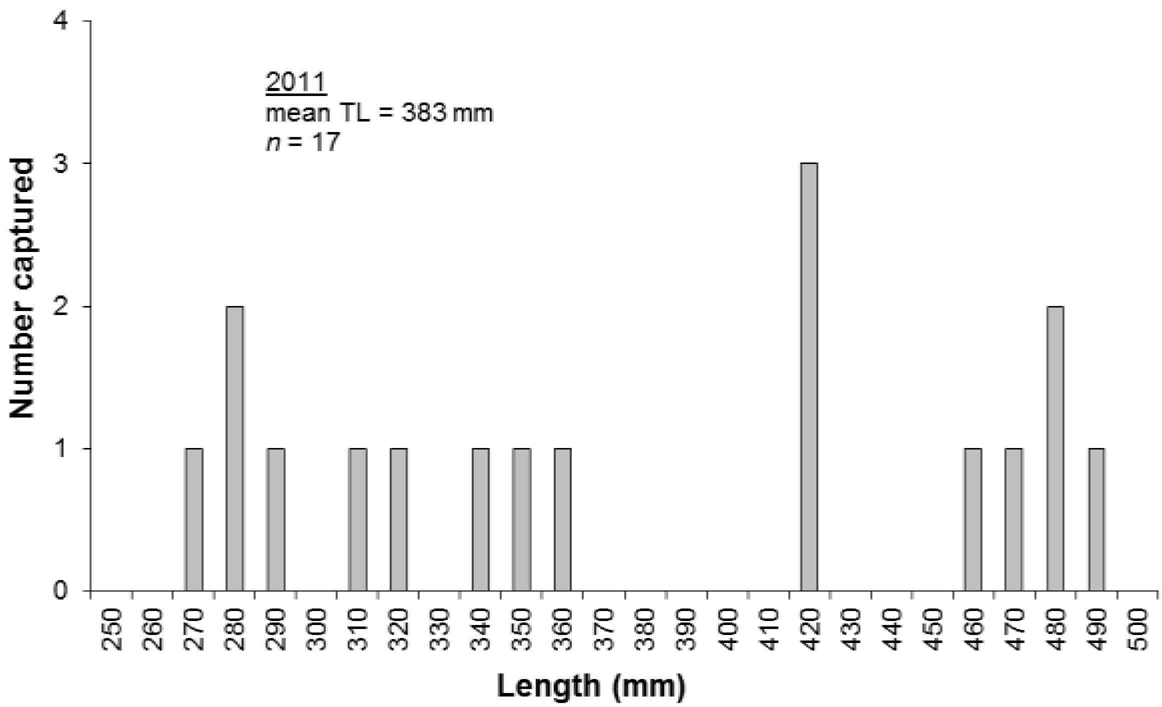

Figure 13. Length frequency of channel catfish captured in Jim Moore Pond with gill nets on July 19-20, 2011.

Table 3. Gill net and trap net catch statistics in Jim Moore Pond from 2007 and 2011.

	Yellow perch		Channel catfish		Rainbow trout	
	2007	2011	2007	2011	2007	2011
Gill net						
n	170	46	22	17	38	5
CPUE	56.7	11.5	7.3	4.3	12.7	1.3
Trap net						
n	--	582	--	0	--	0
CPUE	--	194.0	--	0	--	0

Table 4. Mean length at age data for yellow perch captured in gill nets and trap nets in Jim Moore Pond, 2011. All fish were aged using otoliths.

	Mean length at age (mm)				
Age	1	2	3	4	5
Length (mm)	96	122	132	194	206
No.	1	15	46	2	2

HENRYS LAKE

ABSTRACT

We used 30 standard experimental gill nets set at standard locations to assess fish populations and relative abundance during May 2011. Gill net catch rate for Yellowstone cutthroat trout (12.4) was above the 20 year average, while hybrid trout (rainbow trout x Yellowstone cutthroat trout) catch rate (1.6) was below the long term average. Brook trout catch rate (3.5) was significantly higher than the 20 year average (1.9). Mean relative weight (W_r) for all trout species averaged between 93 and 98 and continued on a downward trend since 2004. Median catch rate for Utah chub remained stable 2.5 from 2010 to 2011. Six percent (23 of 374) of gill net caught cutthroat trout were adipose clipped, indicating that natural reproduction is contributing to the Henrys Lake trout population.

We examined stomach contents from 872 trout to determine if trout in Henrys Lake are preying on Utah chub. Overall, fish comprised 16% of the trout diet by weight, compared to 13% in 2010 and <1% in 2004. Sculpin comprised the majority of identifiable fish prey in diet samples early in the season, while Utah chub were found in the diet in August through November. Utah chub were found in the diet of Yellowstone cutthroat trout and hybrid trout, but not brook trout. Trout in Henrys Lake appear to be utilizing juvenile chub as a seasonal food source, likely in the months after Utah chub hatch and when they are relatively abundant.

We performed a creel survey of the ice fishery that occurred from November 15, 2011 and January 1, 2012 and estimated 18,338 hours of effort with a total catch of 13,495 trout (0.74 trout/hour). Catch rate was highest for cutthroat trout (0.35 fish/hour), followed by brook trout (0.24 fish/hour) and hybrid trout (0.15 fish/hour). We estimated 2,708 trout harvested (1,234 cutthroat trout, 836 brook trout, and 638 hybrid trout), for a release rate of 80%.

We monitored dissolved oxygen levels to assess the possibility of a winterkill event from December 2010 through February 2011. Based on depletion estimates, we predicted dissolved oxygen levels would remain adequate for fish survival; therefore, we did not operate the aeration system during 2011.

The spawning operations at Henrys Lake facility produced over 1.5 million eyed Yellowstone cutthroat trout eggs and nearly 400,000 eyed hybrid trout eggs in 2011. Yellowstone cutthroat trout ascending the fish ladder to the hatchery averaged 455 mm total length (TL). Similar to the gill net survey, 137 of the 3,037 (5%) returning Yellowstone cutthroat trout checked at the hatchery were adipose clipped, further indicating that natural reproduction is contributing to the population within Henrys Lake.

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INTRODUCTION

Henrys Lake, located in eastern Idaho in the Greater Yellowstone Ecosystem, has provided a recreational trout fishery since the late 1800's (Van Kirk and Gamblin 2000). A dam was constructed on the outflow of the natural lake in 1924 to increase storage capacity for downstream irrigation. This dam increased total surface area to 2,630 ha, with a mean depth of 4 m. The now-inundated lower portions of tributary streams historically provided spawning habitat for adfluvial Yellowstone cutthroat trout, prompting concerns for recruitment limitations. To mitigate for this potential loss of recruitment, the Idaho Department of Fish and Game (IDFG) acquired a private hatchery on the shores of Henrys Lake and began a fingerling trout stocking program that continues today (Garren et al. 2008). The lake supports a robust fishery for native Yellowstone cutthroat trout, hybrid trout (rainbow trout x Yellowstone cutthroat trout) and brook trout, with an average of approximately 130,000 hours of annual angling effort. Surveys of Idaho's anglers show Henrys Lake to be the most popular lentic fishery in the state (IDFG 2001). Since 1929, IDFG has stocked a total of over 77 million Yellowstone cutthroat trout, 9 million hybrid trout and nearly 3 million brook trout. Stocking ratios averaged 84% Yellowstone cutthroat trout, 12% hybrid trout, and 4% brook trout from 1966 to 2010. Beginning in 1998, all hybrid trout were sterilized prior to release to reduce the potential for hybridization with native Yellowstone cutthroat trout. Although hybridization was not a concern with brook trout, only sterile fingerlings have been stocked since 1998 (with the exception of 50,000 fertile fish in 2003) to reduce the potential for naturally reproducing brook trout to compete with native salmonids.

Anglers view Henrys Lake as a quality fishery capable of producing large trout. As early as the mid-1970s, 70% of interviewed anglers preferred the option of catching large fish even if it meant keeping fewer fish (Coon 1978). Since that time, management of Henrys Lake has emphasized restrictive harvest consistent with providing a quality fishery as opposed to liberal bag limits that are more consistent with a yield fishery. In 1984, fisheries managers created specific, quantifiable objectives to measure angling success on Henrys Lake. Based on angler catch rate information and harvest data collected during creel surveys conducted between 1950 and 1984, managers thought it was possible to maintain catch rates of 0.7 trout per hour, with a size objective of 10% of harvested Yellowstone cutthroat trout exceeding 500 mm. These objectives remain in place today. To evaluate these objectives, annual gill net monitoring occurs in May, immediately after ice off and prior to the fishing season, while creel surveys are conducted on a three to five year basis.

STUDY SITE

Henrys Lake is located 1,973 m above sea level, between the Henrys Lake Mountains and the Centennial mountain range, approximately 29 km west of Yellowstone National Park. The lake is approximately 6.4 km long and 3.2 km wide, with a surface area of 2,630 ha. The outlet of Henrys Lake joins Big Springs Creek to form the headwaters of the Henrys Fork Snake River (Figure 14).

OBJECTIVES

To obtain current information on fish population and limnological characteristics for fishery management decisions on Henrys Lake, and to develop appropriate management recommendations.

METHODS

Population Monitoring

As part of routine population monitoring, we set gill nets at six standardized locations in Henrys Lake from May 22 to May 26, 2011 for a total of 30 net nights (Figure 14). Gill nets consisted of either floating or sinking types measuring 46 m by 2 m, with mesh sizes of 2 cm, 2.5 cm, 3 cm, 4 cm, 5 cm and 6 cm bar mesh. Nets were set at dusk and retrieved the following morning. We identified captured fish to species and recorded total lengths (TL). We calculated catch rates as fish per net night and also calculated 95% confidence intervals. We used a t-test to compare 2011 gill net catch rates, by species, to the 20-year average catch rate. We also used a Kruskal-Wallis one-way analysis of variance to analyze gill net catch rates of Utah chub, as this species demonstrates schooling behavior, and are likely not randomly distributed. Additionally, we analyzed gill net data from 2002 through 2010 to determine the relationship between gill net catch rate and the number of fish stocked two and three years prior. We used gill net catch data beginning in 2002 due to increased netting effort, and used an analysis of variance (ANOVA) to determine if stocking rates two years prior, three years prior, or two + three years prior was significantly related to gill net catch rate. All tests were considered significant at $\alpha < 0.05$.

We examined all captured Yellowstone cutthroat trout for adipose fin clips as part of our evaluation of natural reproduction. To estimate contributions to the cutthroat trout population from natural reproduction, we calculated the ratio of marked to unmarked fish collected in annual gill net surveys and the same ratio analysis for trout captured ascending the fish ladder on Hatchery Creek. Ten percent of all stocked Yellowstone cutthroat trout are marked with an adipose fin clip prior to stocking, therefore, a ratio of 10% or greater indicates low levels of natural reproduction.

We removed the sagittal otoliths of all trout caught in our gill nets for age and growth analysis. After removal, all otoliths were cleaned on a paper towel and stored in individually-labeled envelopes. Ages were estimated by counting annuli under a dissecting microscope at 40x power. Otoliths were submerged in water and read in whole view when clear, distinct growth rings were present. We sectioned, polished and read otoliths in cross-section view with transmitted light when the annuli were not distinct in whole view. Aged fish were then plotted against length using a scatter plot, and any outliers were selected, re-read, and the ages corroborated by two readers. We estimated survival from age two to age five by catch curve analysis for Yellowstone cutthroat trout and hybrid trout, while we estimated brook trout survival between age one and age five.

Relative weights (W_r) were calculated by dividing the actual weight of each fish (in grams) by a standard weight (W_s) for the same length for that species multiplied by 100 (Anderson and Neumann 1996). Relative weights were then averaged for each length class (< 200 mm, 200-299 mm, 300-399 mm and fish > 399 mm). We used the formula

$$\log W_s = -5.194 + 3.098 \log TL \text{ (Anderson 1980)}$$

to calculate relative weights of hybrid trout,

$$\log W_s = -5.189 + 3.099 \log TL$$

for cutthroat trout (Kruse and Hubert 1997) and

$$\log W_s = -5.186 + 3.103 \log TL$$

for brook trout (Hyatt and Hubert 2001).

We calculated proportional stock density (PSD) and relative stock density (RSD - 400) to describe the size structure of game fish populations in Henrys Lake. We calculated PSD for Yellowstone cutthroat trout, hybrid trout, and brook trout using the following equation:

$$PSD = \frac{\text{number } \geq 300 \text{ mm}}{\text{number} \geq 200 \text{ mm}} * 100$$

We calculated RSD-400 for Yellowstone cutthroat trout, hybrid trout, and brook trout using the following equation:

$$RSD\text{-}400 = \frac{\text{number } \geq 400 \text{ mm}}{\text{number} \geq 200 \text{ mm}} * 100$$

The criteria used for PSD and RSD-400 values for Yellowstone cutthroat trout, hybrid trout, and brook trout populations was based on past calculations and kept consistent for comparison purposes. This methodology is used on other regional waters to provide comparison between lakes and reservoirs throughout the Upper Snake Region. We also calculated RSD-500, using the same equation as above, but used the number of fish greater than 500 mm as the numerator.

Zooplankton samples were collected at three locations (Figure 14) on July 11. We preserved zooplankton in denatured ethyl alcohol at a concentration of 1:1 (sample volume: alcohol). After ten days in alcohol, phytoplankton were removed from the samples by re-filtering through a 153 µm mesh sieve. The remaining zooplankton were blotted dry with a paper towel and weighed to the nearest 0.1 g. Biomass estimates were corrected for tow depth and reported in g/m. We measured competition for food (or cropping impacts by fish) using the zooplankton productivity ratio (ZPR) which is the ratio of preferred (750 µm) to usable (500 µm) zooplankton. We also calculated the zooplankton quality index (ZQI) to account for overall abundance of zooplankton using the formula ZQI = (500 µm + 750 µm) * ZPR (Teuscher 1999).

Diet Analysis

We used gill nets to collect Yellowstone cutthroat trout, hybrid trout, and brook trout from the end of May through early November to analyze diet composition and assess predation on Utah chub by trout. We collected fish during standard population monitoring (May gill netting – 30 net nights), followed by 12 net nights at the end June and July, 11 net nights at the end of August, 18 net nights at the end of September, and 8 net nights in the beginning of November. A mix of floating and sinking nets were set at standard monitoring locations (Figure 14) at each monthly interval. All fish collected in gill nets were weighed (g) and measured (TL: mm), and all Yellowstone cutthroat trout were examined for adipose fin clips. Stomachs were removed, stored in individually labeled vials, and preserved with 10% formalin. To expedite processing time and increase the likelihood of encountering Utah chub in the diet, we prioritized the analysis of stomachs collected from fish greater than 375 mm, and processed samples from fish less than 375 mm as time permitted. For each stomach, we identified individual food items, separated items by genus and then counted and weighed each genus to the nearest gram. Identified food items were summarized as percent weight of the total diet and percent of the total contents by number. In instances where extremely high densities of a particular food item were encountered (i.e., Daphnia and occasionally scuds), we weighed and counted a sub-sample of the stomach contents and expanded the results to the total amount contained within the stomach. Diet contents were summarized by species and compared to results from 2004 (Garren et al. 2006) and 2010 (Schoby et al. 2012). We also examined monthly diet composition to determine seasonal changes in food preference, and compared diets from fish greater than and less than 375 mm to determine dietary shifts or increases in piscivory.

Creel Survey

We conducted a creel survey from November 15, 2011 through January 1, 2012 to collect effort, catch and harvest information from the season extension as a result of regulation changes enacted in 2011. We generated instantaneous counts using randomly selected dates and times, and counted anglers twice per day from a point overlooking the lake with the aid of binoculars and spotting scopes. Counts were completed within one half hour. Creel clerks interviewed anglers on two weekdays and two weekend days per two-week strata at access sites and by roving throughout the day to obtain method of fishing, time spent fishing, and number, species and length of fish caught. We analyzed data using standard methodology and the Idaho Department of Fish and Game creel census program.

Water Quality

We measured winter dissolved oxygen concentrations, snow depth, ice thickness and water temperatures at five established sampling sites (Pittsburg Creek, County Boat Dock, Wild Rose, Outlet, and Hatchery) on Henrys Lake between December 28, 2010 and February 25, 2011 (Figure 14). We measured conditions at the Hatchery site on December 28, 2011, January 7, January 20, and February 25, 2011, while the other four sites were sampled on December 29, 2010, January 7, and January 20, 2011. Unsafe ice conditions throughout the rest of lake prohibited additional sampling after January 20. Holes were drilled in the ice with a gas-powered ice auger prior to sampling. We used a YSI model 550-A oxygen probe to collect dissolved oxygen readings at ice bottom and at subsequent one-meter intervals until the bottom of the lake was encountered. Dissolved oxygen mass is calculated from the dissolved oxygen probe's mg/L readings converted to total mass in g/m^3. This is a direct conversion from mg/L to g/m^3 (1000 L = 1 m^3). The individual dissolved oxygen readings at each site are then summed to determine the total available oxygen within that sample site. To calculate this value, we used the following formula:

$$\text{Avg (ice bottom +1 m) + Sum (readings from 2 m to lake bottom) = total } O_2 \text{ mass}$$

The total mass of dissolved oxygen at each sample site is then expressed in g/m^2 (Barica and Mathias 1979). Data are then natural logarithm (ln*)* transformed for regression analysis. We used linear regression to estimate when oxygen levels would deplete to the critical threshold for fish survival (10.0 g/m^2).

Spawning Operation

We operated the Hatchery Creek fish ladder for the spring spawning run from February 22 through April 18. Fish ascending the ladder were identified to species and counted. We measured total length for a sub-sample (10%) of each group. All Yellowstone cutthroat trout were examined for the presence of adipose fins to evaluate natural reproduction. Yellowstone cutthroat trout were produced using ripe females spawned into seven-fish pools and fertilized with pooled milt from seven males. Hybrid trout were produced with Yellowstone cutthroat trout eggs from Henrys Lake and rainbow trout milt obtained from IDFG's Hayspur hatchery in Picabo, Idaho. Hybrid trout were sterilized by inducing a triploid condition using pressure to shock the eggs post-fertilization. Once hybrid trout eggs reached 47 minutes and 45 seconds post-fertilization, eggs were placed in the pressure treatment machine at 10,000 psi and held at this pressure for 5 minutes. A random sample of 60 hybrid fry was sent to the IDFG Eagle Fish Health Lab to test induction rates of sterilization. Hybrid trout eggs were shipped to Mackay Hatchery for hatching, rearing and subsequent release back into Henrys Lake and other Idaho waters. Additional fertile hybrid eggs were shipped to American Falls Hatchery for hatching, rearing, and subsequent release into Salmon Falls Reservoir. Yellowstone cutthroat trout eggs were shipped to Mackay for hatching, rearing and release back into Henrys Lake.

We collected ovarian fluids from all pooled egg lots of Yellowstone cutthroat trout to detect the presence of bacterial disease. We also collected 25 random viral samples from combined egg pools. A mixed-sex group of 60 adult Yellowstone cutthroat trout were sacrificed and sent to the Eagle Fish Health Laboratory for various disease testing, including bacterial kidney disease, whirling disease, and frunculosis. For more information on disease testing and results, contact the IDFG Fish Health Laboratory in Eagle, ID (1800 Trout Road, Eagle, ID 83616; [208] 939-2413).

Riparian Fencing and Fish Screening

Electric fencing has been in place along the selected reaches of the Henrys Lake shoreline and its tributaries since the early 1990's to protect riparian areas from grazing livestock. We installed fencing, solar panels, batteries, and connections during May 2011 at ten sites on Duck, Howard, Targhee, and Timber creeks. Fencing was also installed along the shoreline north and south of the county boat ramp. We routinely checked fencing during the summer and fall for proper voltage and function. Fences were let down and prepared for winter in November 2011.

Fish screens are located on eleven irrigation diversions on tributaries streams to Henrys Lake. Screens were routinely maintained, cleaned and checked for proper operation during the summer and fall months of 2011.

RESULTS

Population Monitoring

We collected 967 fish in 30 net nights of gill net effort. Catch composition was 39% Yellowstone cutthroat trout, 11% brook trout, 5% hybrid trout, and 46% Utah chub (Figure 15). Yellowstone cutthroat trout ranged from 217 to 530 mm TL (mean: 326 mm) (Figure 16), hybrid trout 300 to 670 mm (mean: 473 mm) (Figure 17), and brook trout 171 to 508 mm (mean: 316 mm) (Figure 18). Proportional stock density (PSD) was highest for hybrid trout (100) followed by cutthroat trout (62) and brook trout (45). Relative stock density (RSD-400) was highest for hybrid trout (73) followed by brook trout (40) and cutthroat trout (17) (Table 5). RSD-500 for hybrid trout was 38, and one (1) for brook trout and cutthroat trout. Mean W_r for all trout species (all sizes combined) ranged between 93 and 98 (Figure 19) and W_r of Yellowstone cutthroat trout size classes (0 - 199 mm, 200 – 299 mm, 300 – 399 mm, and >400 mm) ranged between 86 and 98 (Figure 20). Mean length-at-age three was 416, 452, and 433 mm, for Yellowstone cutthroat trout, hybrid trout, and brook trout, respectively (Table 6). Catch curve analysis of Yellowstone cutthroat trout estimated annual survival from age two to five at 21%. Hybrid trout survival from age two to five was 58%, while brook trout survival from age one to five was 46%.

Gill net catch rates for trout were highest for Yellowstone cutthroat trout at 12.4 fish per net night, followed by brook trout at 3.5, and hybrid trout at 1.6 fish per net night (Figure 21). The median catch rate of Utah chub was 2.5 fish per net night (Figure 22). Results from our May gill net surveys showed 23 of 374 (6%) Yellowstone cutthroat trout were adipose-clipped; additionally we observed a 7% adipose-clip rate (49 of 723) for cutthroat captured in our diet analysis gillnetting (see below for details) from June through November (Table 7). Yellowstone cutthroat trout gill net catch rate in 2011 was higher than the 20 year average catch rate (12.4 vs. 5.9; p=0.006), as was brook trout catch rate (3.5 vs. 1.9; p=0.039). Hybrid trout gill net catch rate was lower than the long term average (1.6 vs. 3.9; p<0.001). The median gill net catch rate of Utah chub did not differ between 2010 and 2011, but the 2011 catch was significantly lower than the median catch rates seen in 2006 (p=0.019) and 2007 (p=0.046). For Yellowstone cutthroat trout and hybrid trout, we found no significant relationship between gill net catch rate and stocking rate in years prior (2 years, 3 years, and 2+3 years combined), suggesting that natural reproduction may be clouding this relationship. Brook trout gill net catch rate was significantly related to prior years stocking rates (2 years prior: p=0.014; 3 years prior: p=0.022; and 2+3 years prior: p=0.010).

Zooplankton monitoring showed that preferred size zooplankton is not being cropped by fish (ZPR = 1.77) and that abundance of quality zooplankton is relatively high in Henrys Lake (ZQI = 0.90) (see *Regional Lakes Zooplankton chapter* for more details).

Diet Analysis

We collected stomach contents from 1,207 trout (722 Yellowstone cutthroat trout, 291 hybrid trout, and 194 brook trout) from Henrys Lake between May and November. To assess diet composition and predation on Utah chub, we analyzed 827 stomach samples (69% of total collected), 409 of which were collected from fish over 375 mm (94% of samples from fish >375 mm) (Table 4). Overall, diet composition (by weight) across all species, over the entire season, was dominated by leeches (29%), and followed by snails (17%), fish (16%), scuds (16%), and Daphnia (13%) (Table 9). Yellowstone cutthroat trout diet was dominated by Daphnia (30%), followed by scuds (21%), snails (16%), leeches (12%), and fish (10%). Brook trout diet was dominated by snails (47%), followed by leeches (16%), fish (15%), and scuds (14%). Hybrid trout diet was dominated by leeches (46%), followed by fish (20%), scuds (13%), and snails (10%).

Overall (all sizes of all species combined) we saw monthly changes in diet, with scuds, leeches, Daphnia, fish, and snails comprising the majority of the diet, in relatively even numbers in May (Figure 10). The percentage of leeches in the overall diet increased into July, as scuds, Daphnia, snails and fish decreased. From July into November, leeches decreased while fish and snails increased. As expected, fish comprised a larger portion of the diet of trout greater 375mm than trout less than 375 mm (Table 10).

Yellowstone cutthroat trout diet was dominated by scuds and Daphnia in May, with fish and scuds comprising the majority of the diet in June (Figure 24). Leeches and snails dominated the diet in July, while chironomids and Daphnia dominated in August. Snails and Daphnia, along with fish, dominated the September diet, with fish, snails, and scuds comprising the majority of the diet in November. For cutthroat trout smaller than 375 mm, Daphnia was an important food source for most of season, along with scuds early in the season (May – June), and with leeches dominating in June and July (Figure 24). Fish were rarely seen in the diet of Yellowstone cutthroat trout less than 375 mm. For cutthroat trout greater than 375 mm, fish were an important component of the diet in June, with little consumption mid-summer, and a large portion of the diet again in September and November. Scuds and Daphnia dominated in May, with leeches, snails, and chironomids important in June and July. Snails and scuds were also a large portion of the diet in September and November.

Hybrid trout diet was dominated by fish, leeches, and scuds in May, with leeches increasing in proportion in June and July (Figure 25). Fish, though comprising the highest portion of the diet in May, were a lesser but relatively stable part of the hybrid trout diet throughout the season. Leeches dominated the diet in July, while chironomids and snails were important in August. Snails and Daphnia, along with fish, dominated the September and November diet. For hybrid trout smaller than 375 mm, the May diet was composed entirely of scuds, while leeches dominated in June and July, and Daphnia became increasingly important from August through November (Figure 26). Fish were the second most abundant food item found in the diet of hybrid trout less than 375 mm in September and November. For hybrid trout greater than 375 mm, fish were found in the diet throughout the entire season, and comprised a significant portion of the diet in May. Aside from fish, leeches and scuds comprised the majority of the diet between May and July, upon which snails became an increasingly large portion of the diet from August through November.

Brook trout diet overall was dominated by snails and leeches (Figure 27). Snails were prevalent in May, and dominated the diet in September and November. Leeches dominated the diet in June and July. No brook trout samples were obtained in August netting, and no brook trout over 375 mm were collected in July. Fish were present in the diet of brook trout greater than and less 375 mm in May, but were not found in the diet in any other months.

Most fish found in the trout diet were unable to be identified, but of those identified, sculpin were most prevalent in the earlier samples (May through July), while Utah chub were not positively identified until August, and were also found in September and November diet samples (Table 11).

Creel Survey

We estimated 18,338 angler hours of effort with a total catch of 13,495 trout, for a catch rate of 0.74 fish per hour during the 48 day ice fishery (Table 12). Catch rates were highest for Yellowstone cutthroat trout (0.35 fish/h), followed by brook trout (0.24 fish/h) and hybrid trout (0.15 fish/h). We estimated 20% (2,708) of the total catch was harvested. Of the 2,708 fish harvested, catch composition was 45.6% (1,234) Yellowstone cutthroat trout, 30.8% (836) brook trout, and 23.6% (638) hybrid trout. Mean size was 453 mm, 430 mm, and 497 mm for harvested cutthroat, brook, and hybrid trout, respectively. Of the Yellowstone cutthroat trout harvested, 19% exceeded 500 mm, while 21% of the harvested hybrid trout were greater than 500 mm. Sixty-one percent (61%) of the harvested brook trout were greater than 430 mm. No fish greater than 600 mm of any species were harvested. The majority of anglers observed during the ice fishery on Henrys Lake were residents (91%).

Water Quality

Between December 29, 2010 and January 20, 2011, total DO diminished from 41.8 g/m^2 to 36.0 g/m^2 at the Pittsburgh Creek site, from 29.3 g/m^2 to 23.4 g/m^2 at the County dock, from 36.7 g/m^2 to 27.3 g/m^2 at Wild Rose, and from 23.3 g/m^2 to 19.9 g/m^2 at the Outlet (Table 13). Dissolved oxygen at the Hatchery site decreased from 36.5 g/m^2 to 26.3 g/m^2 from December 28, 2010 to February 25, 2011. Unsafe ice conditions prohibited data collection from sites other than the Hatchery after January 20. Depletion estimates based on readings taken between December 28 and January 20 predicted DO would remain above the level of concern throughout the winter (Figure 27), therefore aeration was not deployed.

Spawning Operation

We collected 3,037 Yellowstone cutthroat trout (1,999 males, 1,038 females) at the hatchery ladder between February 22 and April 18, 2011. Average length for Yellowstone cutthroat trout was 455 mm (males: 446 mm; females: 468 mm). Five percent (5%) (137/3,037) of the Yellowstone cutthroat trout captured at the hatchery ladder were adipose fin clipped (Table 14). Additionally, we captured 104 hybrid trout (100 males, 4 females) at the spawning ladder. Hybrid trout males averaged 567 mm. Species/sex composition at the Henrys Lake trap during 2011 included: Yellowstone cutthroat trout females 33%, Yellowstone cutthroat trout males 64%, hybrid males 3%, and hybrid females <1%.

We collected 2,292,452 eggs from 782 female Yellowstone cutthroat trout, for a mean fecundity of 2,932 eggs per female. Eyed Yellowstone cutthroat trout eggs totaled 1,529,063 for an overall eye-up rate of 67.3%. Cutthroat trout eye-up varied throughout the spawning season from a low of 50.2% in Lot 12 to a high of 79.6% in Lot 4. All of the eyed Yellowstone cutthroat eggs were shipped to the Mackay facility where they were hatched and reared. Subsequently, all Yellowstone cutthroat trout from the 2011 production were released back into Henrys Lake in the fall of 2011 (Table 14).

We collected 586,650 eggs from 201 female Yellowstone cutthroat trout (mean fecundity = 2,919 eggs per female) for hybrid trout production. Eyed hybrid trout eggs totaled 366,406 for an overall eye-up rate of 61.9 %. Lot 5 and Lot 9 eggs were treated to induce sterility. Four trays in Lot 5 did not meet proper pressure for the full five minutes and were therefore considered fertile and designated for Salmon Falls Reservoir. Hybrid eye-up was 57% in Lot 5 and 64.9% in Lot 9 sterile component. We shipped 318,750 of the hybrid eggs to Mackay for hatching, rearing, and subsequent release into Henrys Lake and 35,484 fertile hybrid eggs were shipped to American Falls for release into Salmon Falls Reservoir. Two spawn days were devoted to production of hybrid eggs during this year’s spawn take. Sterilization induction rates for the sterile hybrid production component indicated 100% (60/60) success for the triploid condition.

Historical species and sex composition from fish collected at the Henrys Lake fish ladder was evaluated from 2001 through 2011. The number of hybrid trout (both male and female) continues to decrease, with hybrid females now a rarity. The reduction in hybrid trout returning to the Henrys Lake hatchery is likely a result in improvements in sterilization process. For information regarding current and historical sex ratios and species composition of fish captured at the Henrys Lake fish ladder, see the *Resident Fish Hatcheries 2011 Annual Report* (Frew 2011).

Riparian Fencing and Fish Screening

Electric fencing functioned well during the year. Voltages remained high throughout the season and riparian infringements by cattle were rare. Spring flooding caused high water and shortages on many fences for a period of time in June, but the fences were mended and operating properly as soon as they could be.

One new barbed wire fence was installed near Duck Creek as part of an agreement with the landowner for installation of a riparian fence the year before. The fence was approximately 130 feet long and designed to exclude cattle.

The fish screens functioned well during the summer of 2011. Five new fish screens were installed this summer. Three fish screens were replaced on Duck Creek and two fish screens were replaced on Targhee Creek. These new structures will require less maintenance and will operate more efficiently. Fish screens on Targhee and Howard Creek that had been installed during the summer of 2008, and the screen installed during the summer of 2009 on Duck Creek functioned well and will be of benefit both to improved fry survival and facility labor costs.

DISCUSSION

Overall, the gill net catch rate of all species in 2011 was similar to that observed in 2010, and for the second year in a row both Yellowstone cutthroat trout and brook trout gill net catch were significantly greater than the long term average. Also similar to 2010, the hybrid trout gill net catch was less than the long term average. Hybrid trout (as well as cutthroat trout) net catch data may be influenced by misidentification of these two species, as smaller hybrids and larger cutthroat are continually under-represented in our sampling. Survival of brook trout and hybrid trout between age two and age five was high, and may be related to improvements in the sterilization of these two stocks. When sterilization is effective, it eliminates the stresses and associated mortality involved with annual spawning, thereby increasing the survival rate. This likely explains the increase in brook trout catch in recent surveys. Similar to the overall hybrid trout gill net catch, the survival estimate of hybrid trout is likely influenced by the proportion of larger aged fish identified as hybrids and the lack of smaller hybrids.

Although misidentification may somewhat alter the results of the net catch, the overall increase in Yellowstone cutthroat trout is likely related to natural reproduction, as suggested by the fin clip ratio observed in our gill net catch and at the hatchery ladder. As seen in 2009 and 2010, the ratio of clipped fish was again below 10%, which indicates that natural reproduction is contributing to this population. The continued decline in relative weights further indicates that the Yellowstone cutthroat population has increased to the point where food is becoming limited and condition has suffered. These factors, combined with consistent stocking rates over the past five years, indicate that the Yellowstone cutthroat trout population is likely at or near the highest densities ever observed in Henrys Lake.

We increased the sampling for our trout diet analysis during 2011 in response to the increase of fish found in trout diets in 2010, and to determine if seasonality played any role in increased utilization, particularly of Utah chub, as a food resource for trout. Overall, similar to 2010, fish in general are a larger part of the diet than seen in 2004, and may be a result of changes in diet due to decreased availability of other prey items. As noted earlier, increases primarily in cutthroat trout, but also brook trout, may have reached the point in which food resources are becoming limited, as evidenced by declining relative weights, and resulted in a shift in diet to items not previously utilized. Seasonal diet analysis identified sculpin as the primary fish prey species in the earlier half of the season, while Utah chub were identified in the later months (August through November). Utah chub generally spawn in late spring or early summer, when water temperatures reach or exceed 60°F degrees, with eggs hatching approximately 6-10 days after fertilization, depending on water temperature (Simpson and Wallace 1982). Therefore, juvenile Utah chub would likely be abundant in Henrys Lake beginning in July or August, which coincides with the increase in Utah chub in the trout diet (as well as the increase in unidentified fish prey items found in diet samples), from August through November. In addition to the increase in fish in the trout diet, we also saw an increased use of snails by all trout species. Snails were not found in the trout diet during 2004, but comprised 47%, 16%, and 10% of the brook trout, cutthroat trout, and hybrid trout diet, respectively, in 2011. If snails and fish represent less desirable food sources than those utilized in the early 2000's, this may further support the thought that trout densities are exceeding desirable levels.

The creel survey of the ice fishery from mid-November, 2011 through January 1, 2012 revealed that total anglers hours of effort over the 48 day period (18,338 hours) was less than the angler hours fished over opening weekend 2009 (20,482 hours). Similarly, more fish were harvested on the opening weekend of 2009 (3,095) than were harvested in the entire ice fishery of 2011 (2,708 fish). For all species, the average size of fish harvested in the ice fishery was nearly identical to that seen in the open water fishery in 2009. Although the average size of fish harvested in the two different seasons was similar, both were larger than the average size observed in our gill net catch. This is not unexpected, as anglers are actively releasing smaller fish and harvesting the larger portion of their catch, particularly in a fishery with limited harvest (2 fish bag limit) and trophy potential, such as Henrys Lake. The percent species composition of the angler catch was markedly different between the open water fishery of 2009 and the ice fishery of 2011. In the open water of 2009, hybrid trout comprised 41% of the total catch, brook trout only 10% of the catch, while cutthroat trout comprising the remaining 49% of the catch. During the ice fishery, cutthroat trout still comprised about half (47%) of the total catch, while hybrid trout comprised only 20% of the catch, and brook trout accounted for the remaining 32%. Brook trout and hybrid trout catch rate in our gill nets has not changed between 2009 and 2011, though the trend of brook trout comprising a larger portion of the angler catch during the ice fishery was also observed in 2010, indicating that brook trout may be more aggressive or feeding more actively under the ice. Overall, based on previous estimates of survival and the current stocking rates of all species, there is approximately 500,000 hatchery-origin trout in Henrys Lake at any given time plus whatever fish are of wild origin, therefore the harvest of 2,708 fish during the 2011 ice fishery is miniscule, and will not impact the overall population.

MANAGEMENT RECOMMENDATIONS

1. Continue annual gill net samples at 50 net nights of effort.

2. Collect otolith samples from all trout species; use for cohort analysis and estimates of mortality/year class strength and compare to previous years.

3. Continue winter dissolved oxygen monitoring, increase sampling to once every ten days, when possible, depending on ice conditions. Implement aeration when necessary.

4. Continue to monitor Utah chub densities and evaluate potential impacts to trout with increased densities of chubs.

5. Consider reductions to Yellowstone cutthroat trout stocking rates to account for natural reproduction and to reduce total trout biomass to more desirable levels.

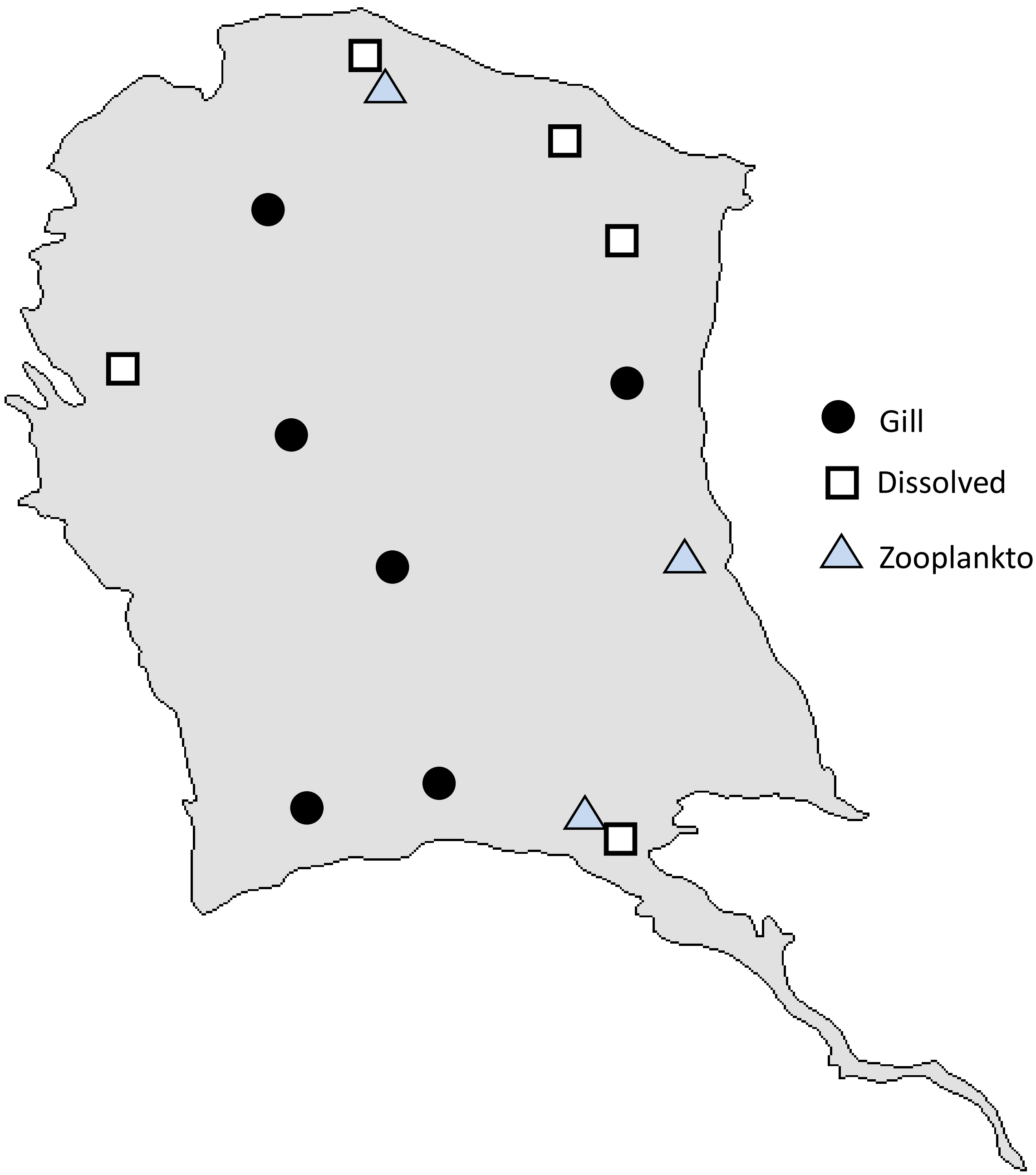

Figure 14. Spatial distribution of gill net, dissolved oxygen, and zooplankton monitoring sites in Henrys Lake, Idaho, 2011.

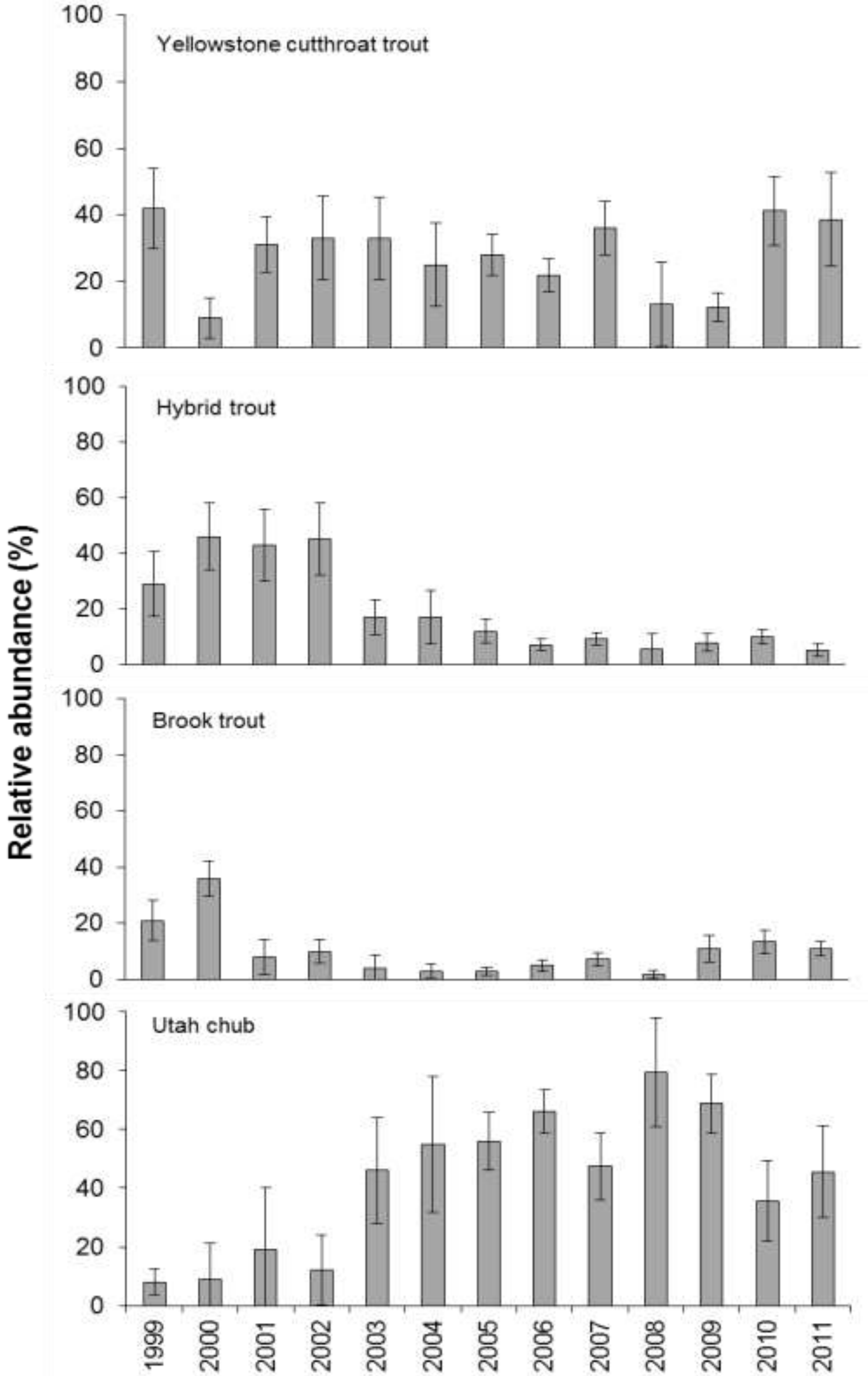

Figure 15. Relative abundance of Yellowstone cutthroat trout, hybrid trout, brook trout, and Utah chub caught in gill nets in Henrys Lake, Idaho between 1999 and 2011. Error bars represent 90% confidence intervals.

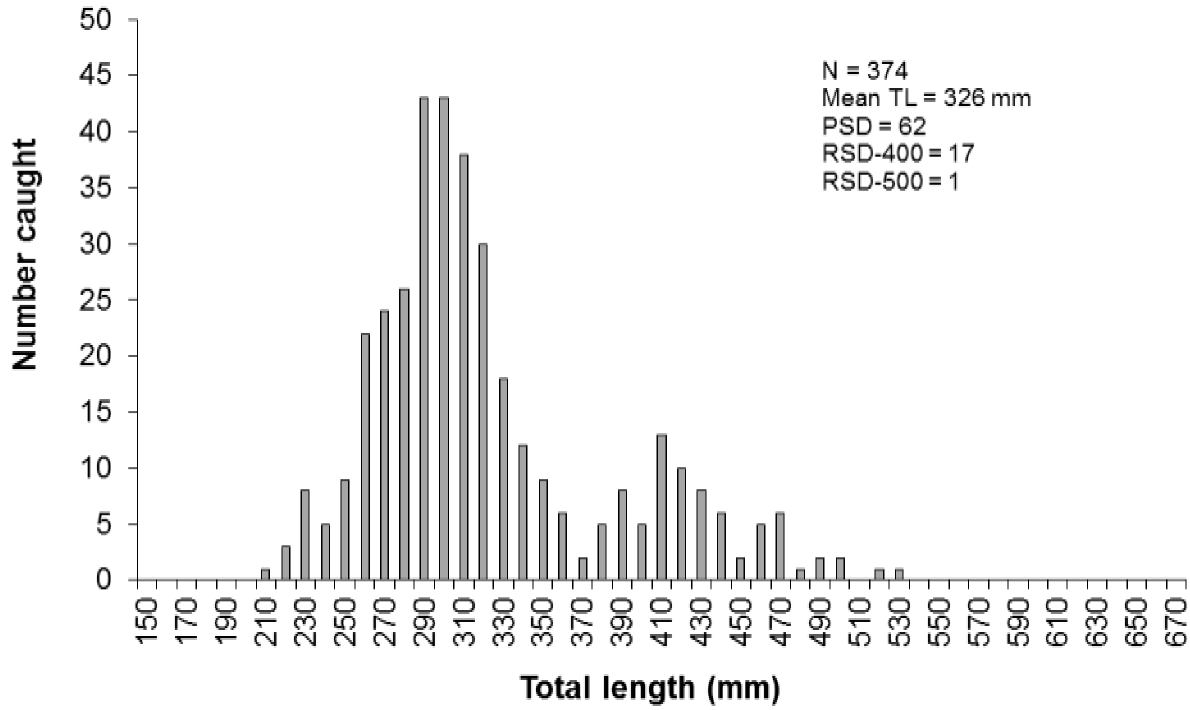

Figure 16. Yellowstone cutthroat trout length frequency distribution and total length statistics from gill nets set in Henrys Lake, Idaho, 2011.

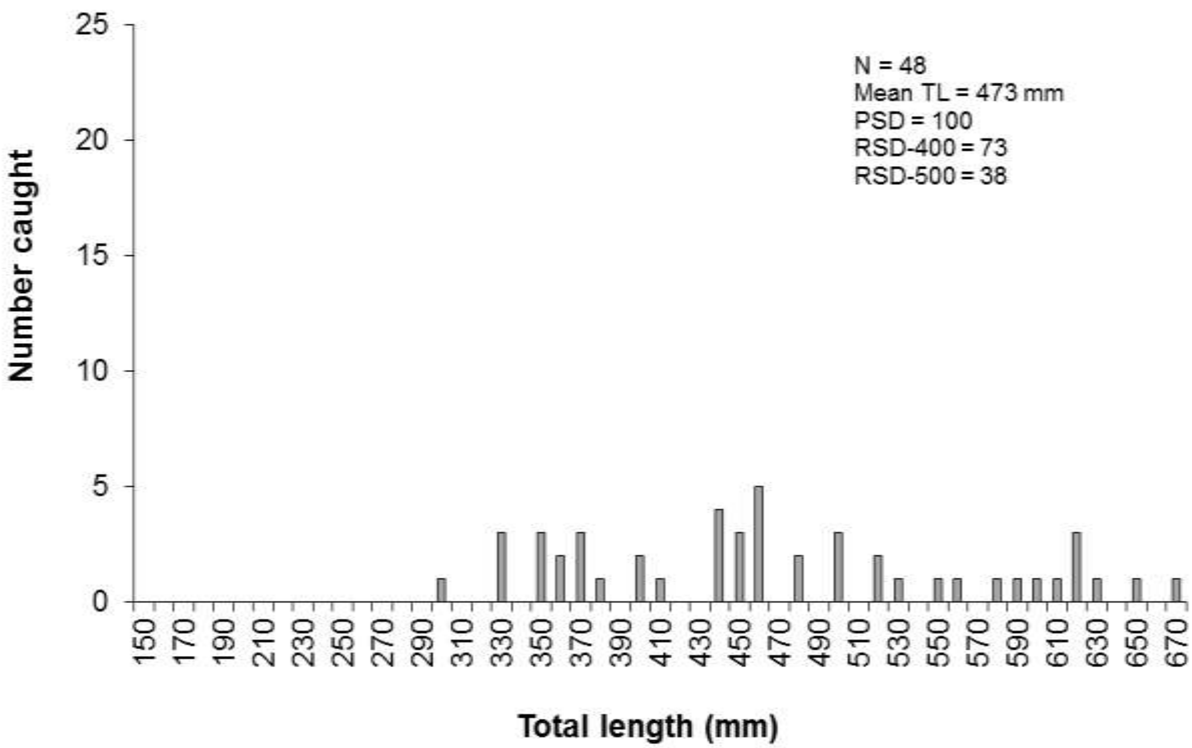

Figure 17. Hybrid trout length frequency distribution and total length statistics from gill nets set in Henrys Lake, Idaho, 2011.

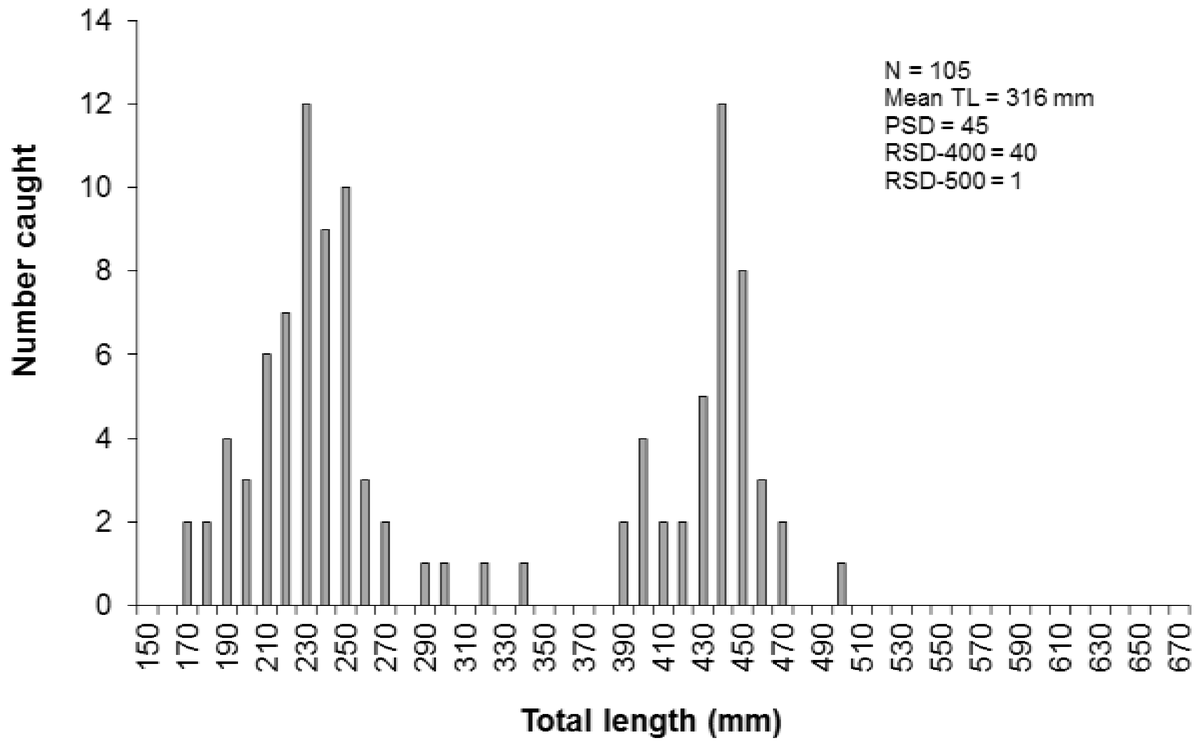

Figure 18. Brook trout length frequency distribution and total length statistics from gill nets set in Henrys Lake, Idaho, 2011.

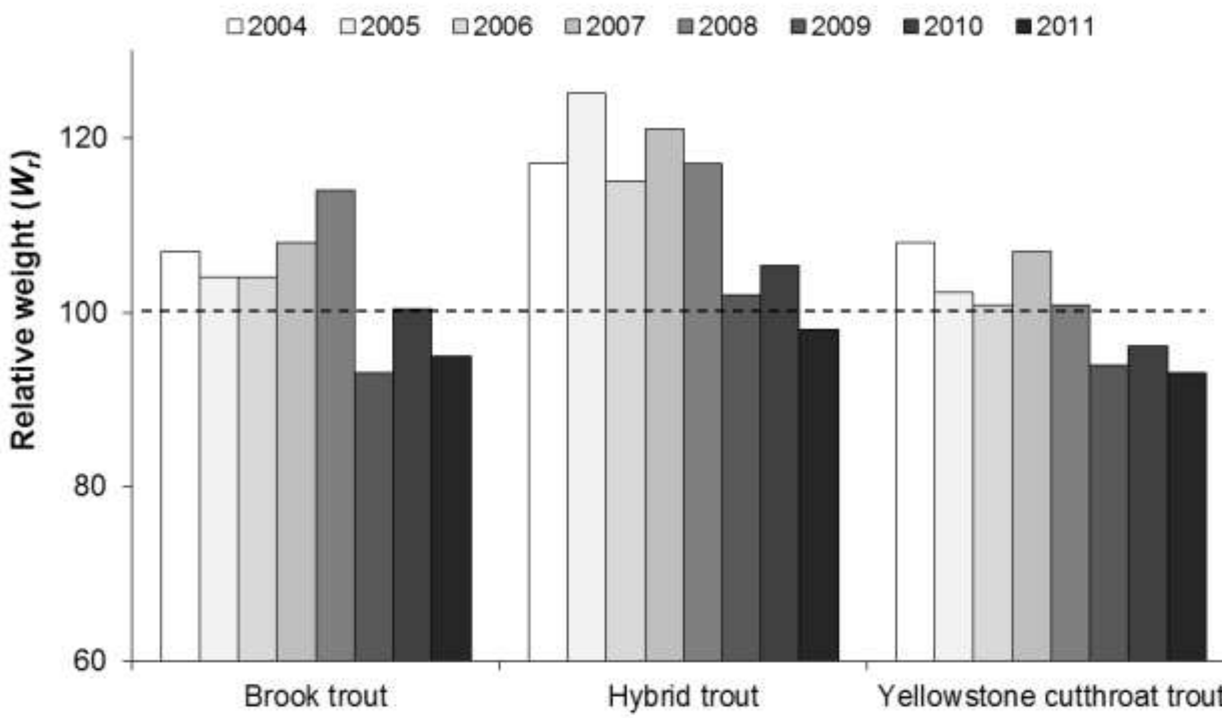

Figure 19. Mean relative weights (W_r) for brook trout, hybrid trout, and Yellowstone cutthroat trout in Henrys Lake, Idaho 2004-2011.

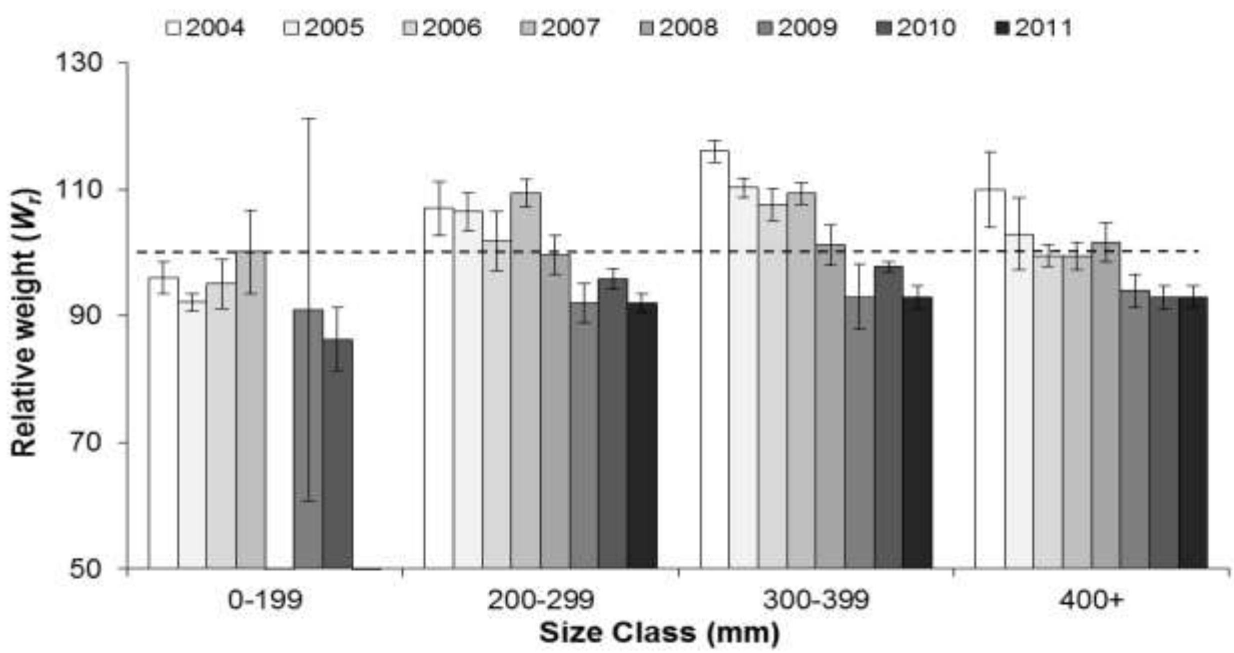

Figure 20. Relative weights (W_r) for four size classes (0 – 199 mm, 200 – 299 mm, 300 – 399 mm, and 400+ mm) of Yellowstone cutthroat trout in Henrys Lake, Idaho 2004-2011. Error bars represent 95% confidence intervals.

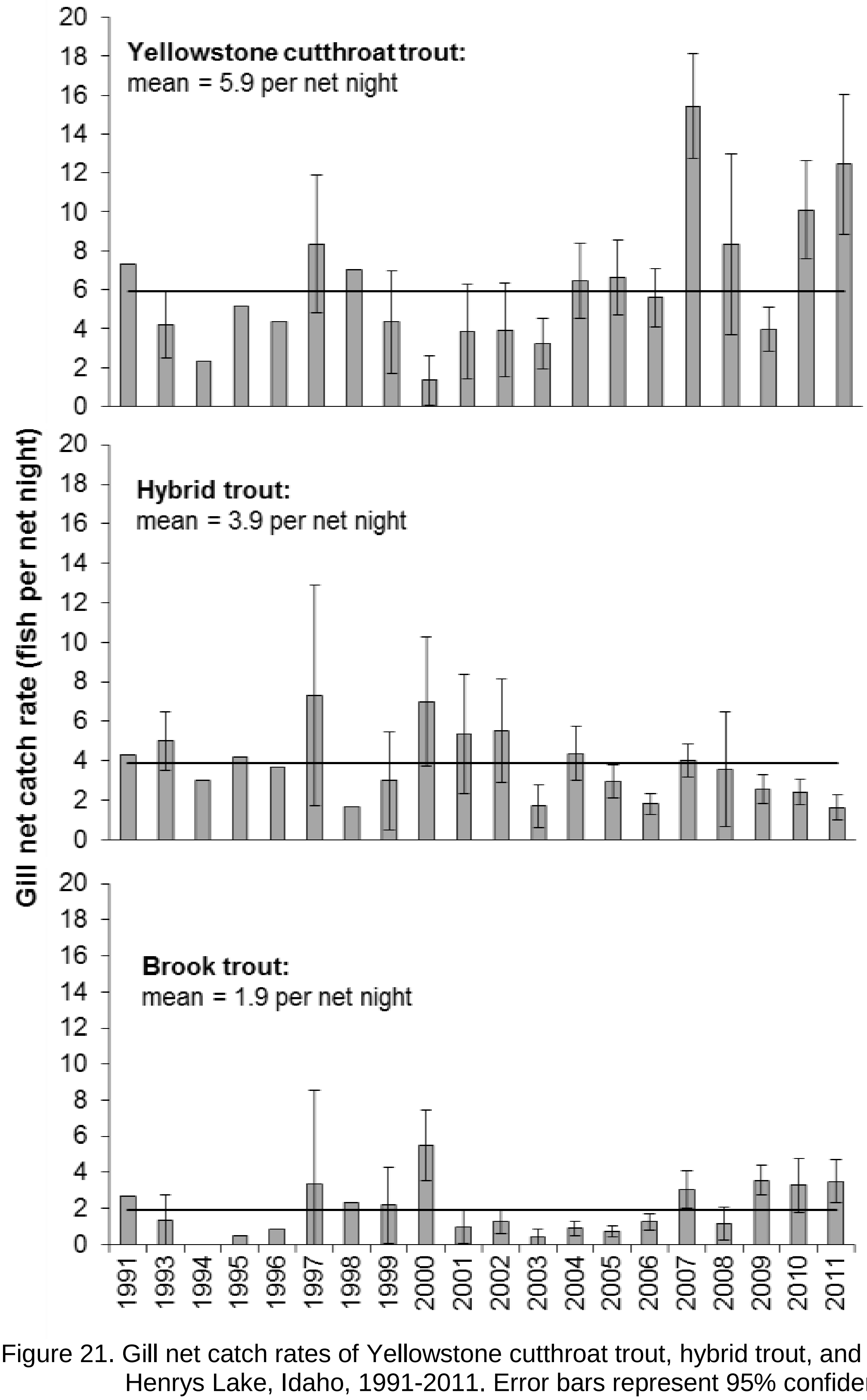

Figure 21. Gill net catch rates of Yellowstone cutthroat trout, hybrid trout, and brook trout from Henrys Lake, Idaho, 1991-2011. Error bars represent 95% confidence intervals. The solid line represents long term mean gill net catch rates.

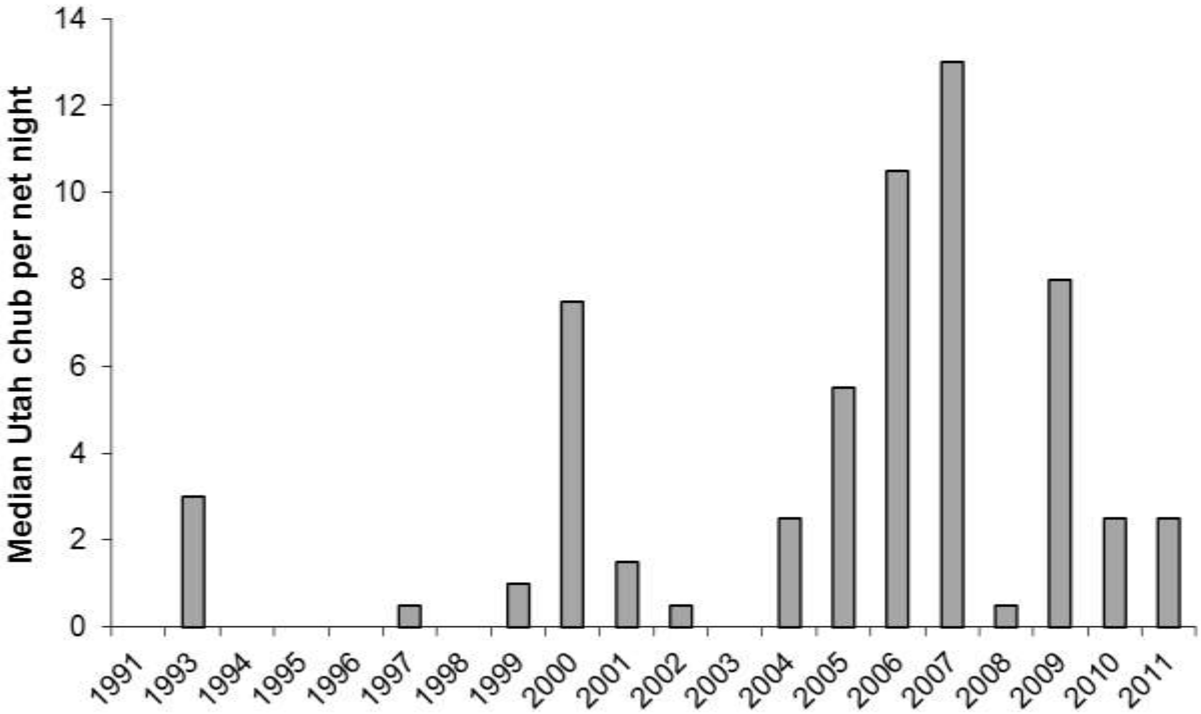

Figure 22. Median Utah chub catch rates in gill nets set in Henrys Lake, Idaho, 1993-2011.

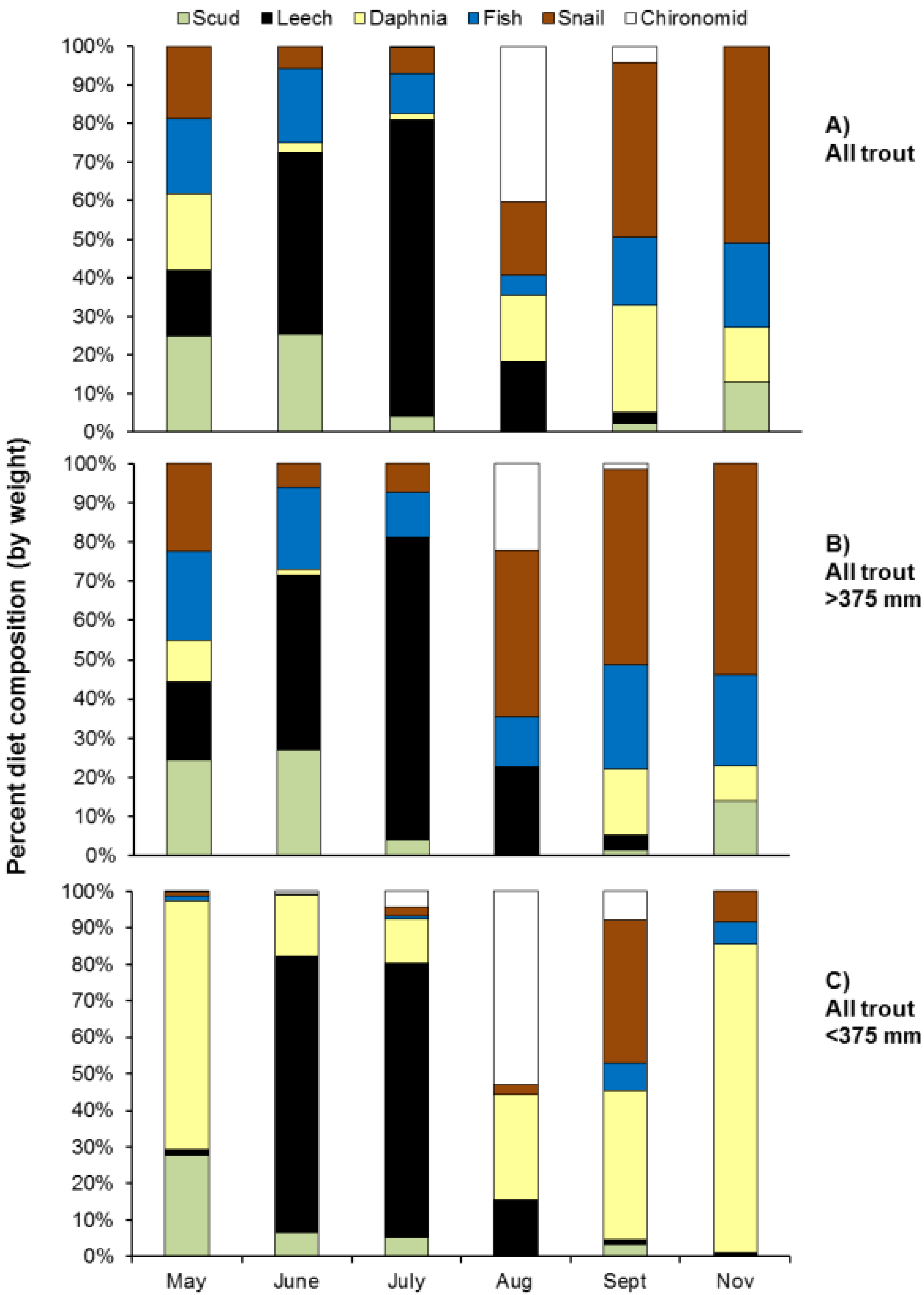

Figure 23. Diet composition of all trout (A), trout >375 mm (B), and trout <375 mm (C) from May through November, 2011, in Henrys Lake.

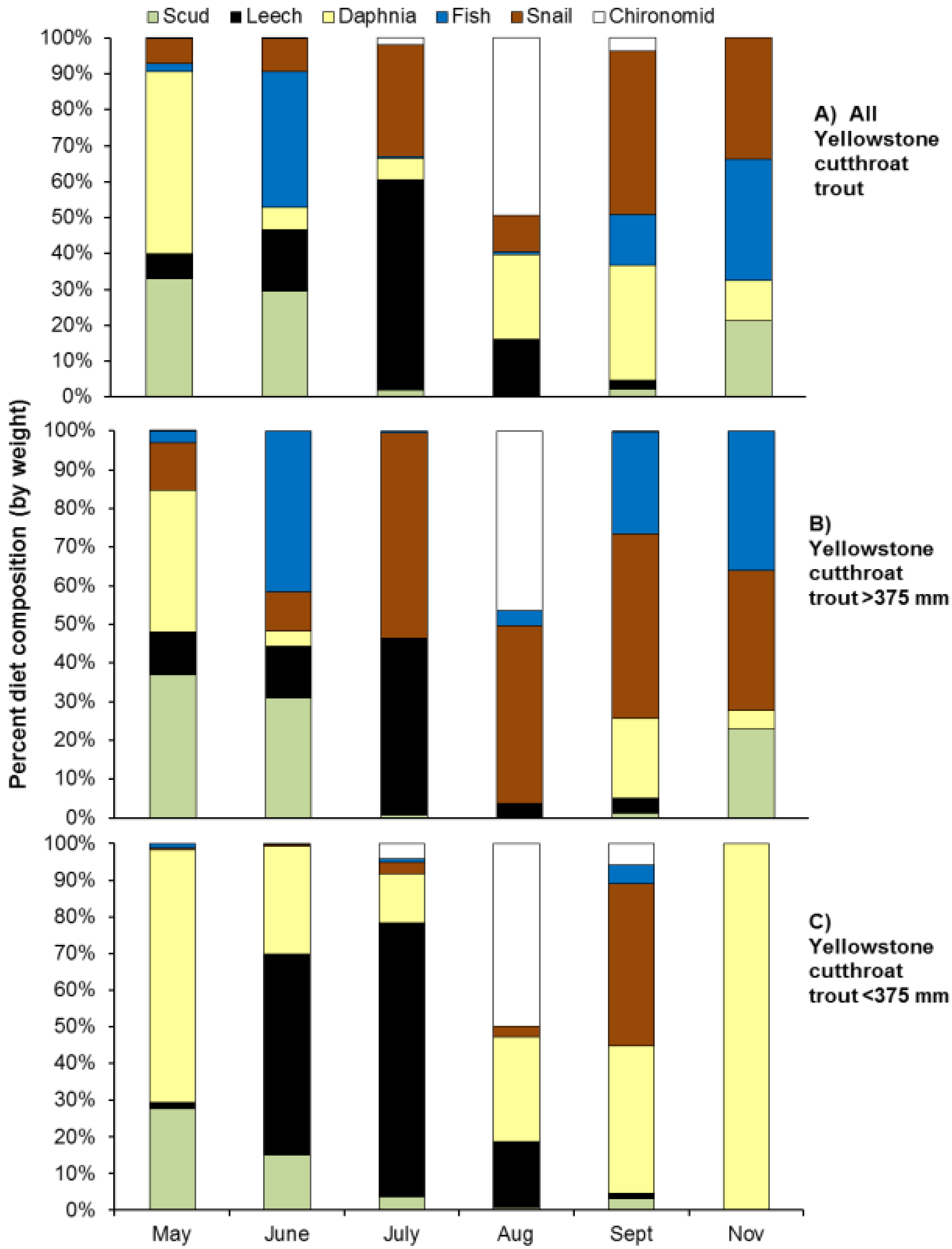

Figure 24. Diet composition of all Yellowstone cutthroat trout (A), Yellowstone cutthroat trout >375 mm (B), and Yellowstone cutthroat trout <375 mm (C) from May through November, 2011, in Henrys Lake.

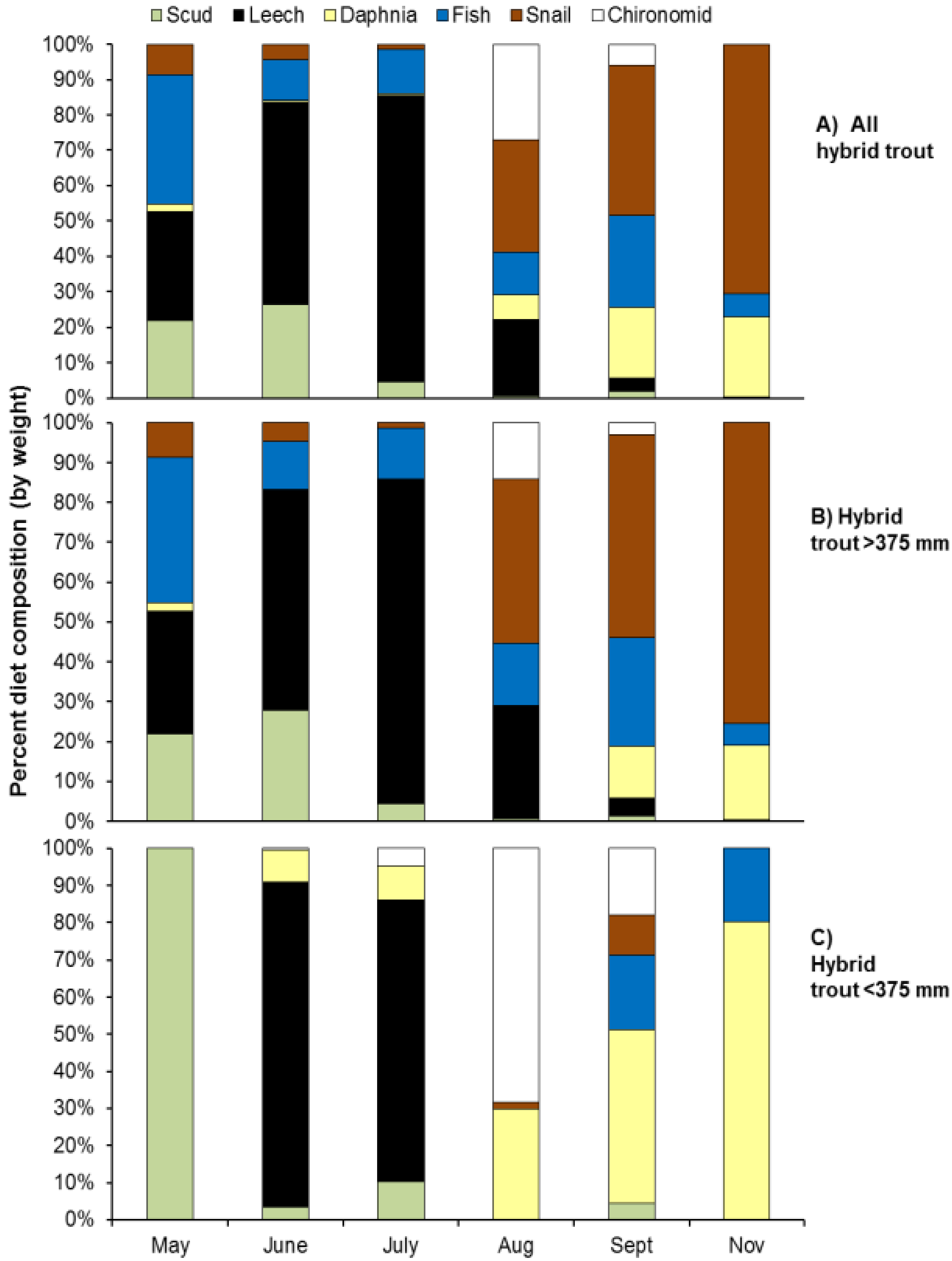

Figure 25. Diet composition of all hybrid trout (A), hybrid trout >375 mm (B), and hybrid trout <375 mm (C) from May through November, 2011, in Henrys Lake.

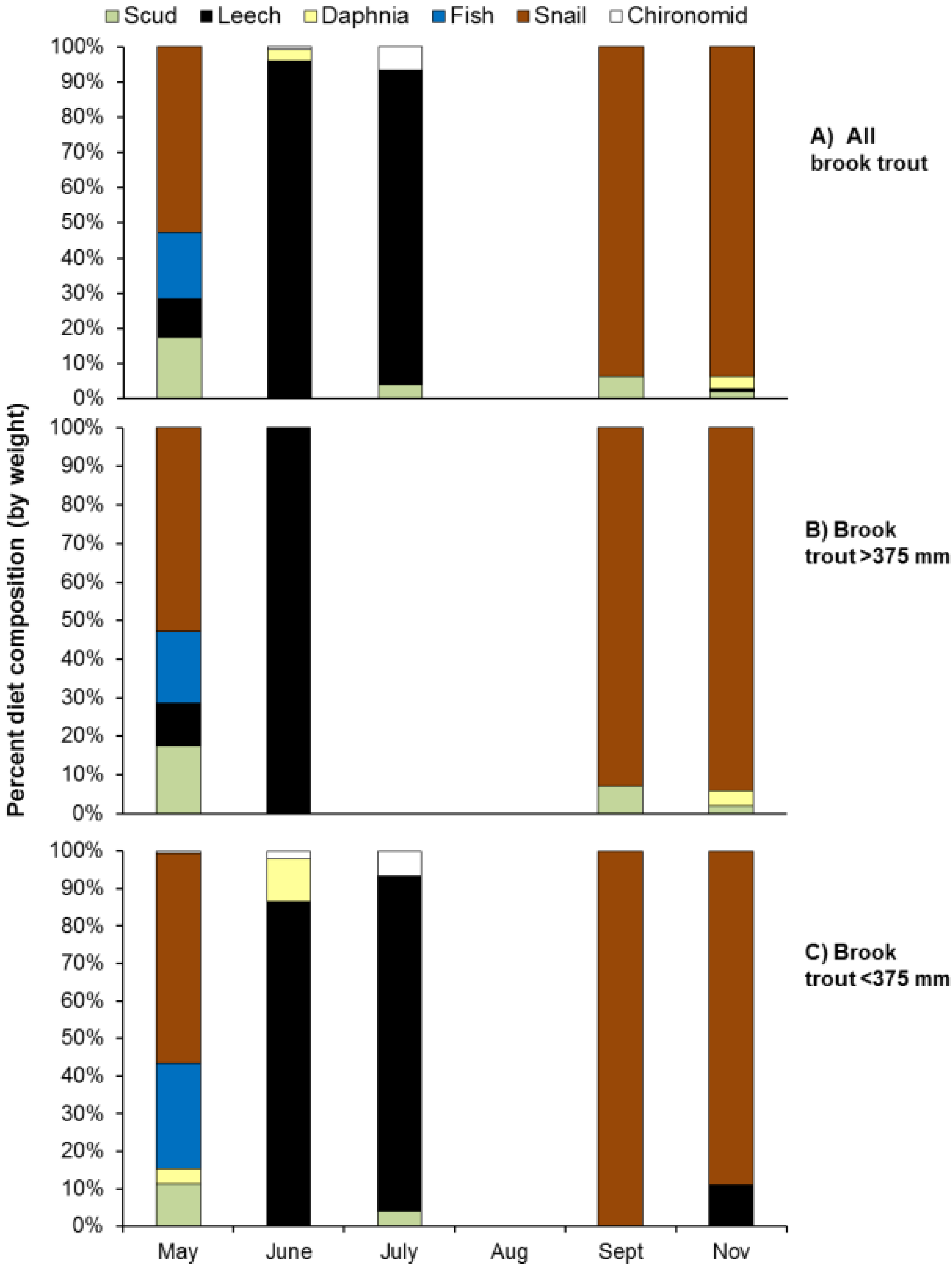

Figure 26. Diet composition of all brook trout (A), brook trout >375 mm (B), and brook trout <375 mm (C) from May through November, 2011, in Henrys Lake.

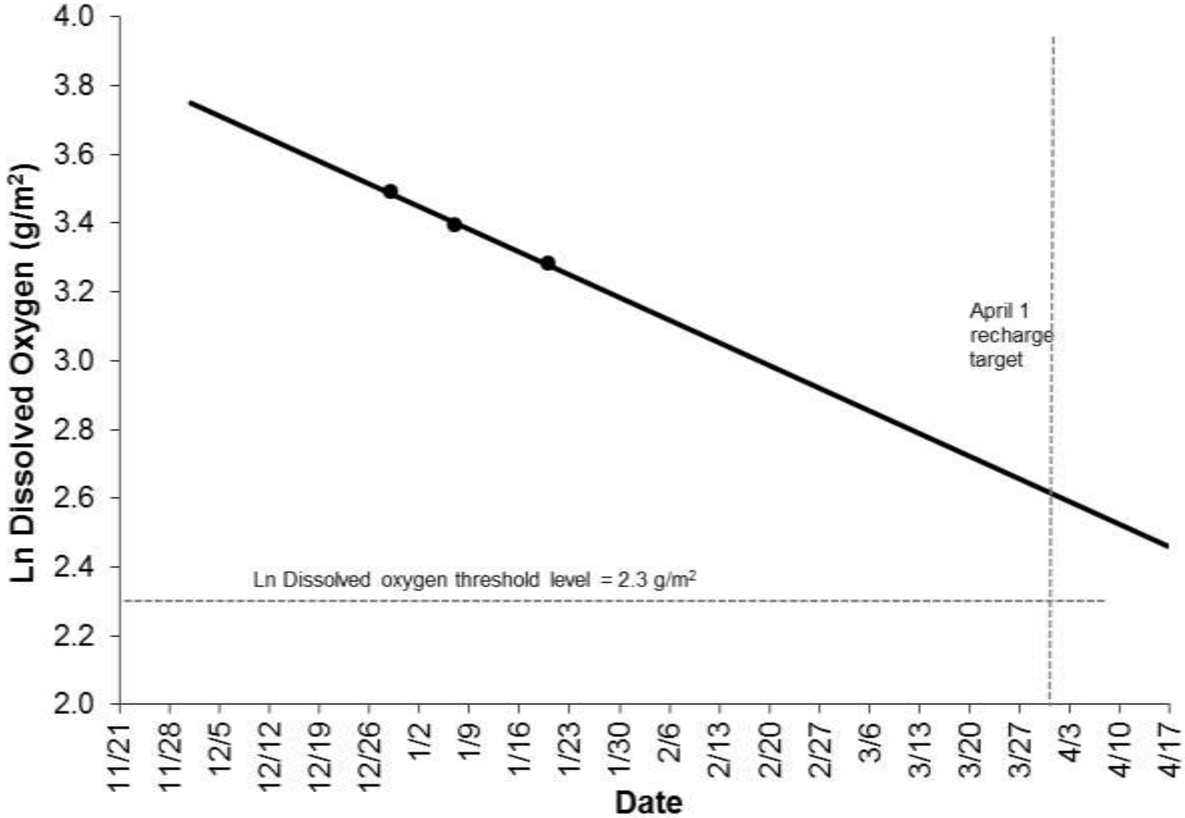

Figure 27. Mean dissolved oxygen from all sample locations and estimated lake-wide oxygen depletion rate for Henrys Lake, Idaho, 2010-2011

Table 5. Stock density indices (PSD and RSD-400) and relative weights (W_r) for all trout species collected with gill nets in Henrys Lake, Idaho 2011. Sample size (n) for relative weight values is noted in parentheses.

	Brook trout (*n*)	**Hybrid trout (*n*)**	**Yellowstone cutthroat trout (*n*)**
PSD	45	100	62
RSD-400	40	73	17
RSD-500	1	38	1
W_r			
<200 mm	89 (8)	--	--
200 – 299 mm	90 (53)	--	92 (141)
300 – 399 mm	96 (5)	103 (13)	93 (171)
>399 mm	106 (39)	106 (35)	93 (62)
Mean	95	98	93

Table 6. Mean length at age data from trout caught with gill nets in Henrys Lake, Idaho 2011. Ages were estimated using otoliths.

	Mean Length (mm) at Age				
Species	1	2	3	4	5
Yellowstone cutthroat trout	-	292	416	469	524
(No. Analyzed)	-	(107)	(36)	(10)	(1)
Hybrid trout	-	340	452	538	619
(No. Analyzed)	-	(5)	(24)	(4)	(10)
Brook trout	225	269	433	482	440
(No. Analyzed)	(35)	(12)	(27)	(2)	(1)

Table 7. Fin clipping data from Yellowstone cutthroat trout (YCT) stocked in Henrys Lake, Idaho. Annually, ten percent of stocked YCT receive an adipose fin clip. Fish returning to the Hatchery ladder and fish captured in annual gillnet surveys are examined for fin clips.

Year	No. Clipped	No. checked at Hatchery	No. detected	Percent clipped	No. checked in gillnets	No. detected	Percent clipped
1996	100,290	--	--	--	--	--	--
1997	123,690	178	5	3%	--	--	--
1998	104,740	--	--	--	--	--	--
1999	124,920	160	20	13%	--	--	--
2000	100,000	14	1	7%	--	--	--
2001	99,110	116	22	19%	--	--	--
2002	110,740	38	7	18%	--	--	--
2003	163,389	106	37	35%	273	47	17%
2004	92,100	--	--	--	323	28	8%
2005	85,124	2,138	629	29%	508[a]	55	11%
2006	100,000	2,455	944	39%	269[a]	20	8%
2007	139,400	--	--	--	770	70	9%
2008	125,451	4,890	629	13%	100	10	10%
2009	138,253	4,184	150	4%	91	9	10%
2010	132,563	4,253	90	2%	505	31	6%
2011	112,744	3,037	137	5%	1,097[b]	72	7%

[a] Includes fish from gill net samples and creel survey.
[b] Includes fish from annual spring gill net monitoring and fish collected in monthly stomach sample gill netting.

Table 8. Summary of monthly stomach samples collected (C), analyzed (A), and percent analyzed (%) from brook trout, hybrid trout, and Yellowstone cutthroat trout in Henrys Lake, May through November, 2011.

	May		**June**		**July**		**August**		**September**		**November**		**Total**	
	C	**A (%)**	**C**	**A (%)**	**C**	**A (%)**	**C**	**A (%)**	**C**	**A (%)**	**C**	**A (%)**	**C**	**A (%)**
Brook trout	105	62 (59)	65	34 (52)	4	4 (100)	0	0 (-)	13	12 (92)	7	7 (100)	194	119 (61)
>375mm	41	38 (93)	16	15 (94)	1	1 (100)	0	0 (-)	10	9 (90)	5	5 (100)	73	68 (93)
Hybrid trout	48	35 (73)	65	49 (75)	77	70 (91)	40	40 (100)	50	49 (98)	11	11 (100)	291	254 (87)
>375mm	36	34 (94)	46	43 (93)	52	49 (94)	25	25 (100)	27	26 (96)	10	10 (100)	196	187 (95)
Yellowstone cutthroat trout	374	182 (49)	107	41 (38)	70	60 (86)	50	50 (100)	105	105 (100)	16	16 (100)	722	454 (63)
>375mm	77	67 (87)	23	23 (100)	7	6 (86)	9	9 (100)	37	37 (100)	12	12 (100)	165	154 (93)
Total	527	279 (53)	237	124 (52)	151	134 (89)	90	90 (100)	168	166 (99)	34	34 (100)	1207	827 (69)
>375mm	154	139 (90)	85	81 (95)	60	56 (93)	34	34 (100)	74	72 (97)	27	27 (100)	434	409 (94)

Table 9. Diet composition for trout collected in Henrys Lake, Idaho, 2004-2011. Figures presented are percent of diet content by weight.

	Brook trout			**Hybrid trout**			**Yellowstone cutthroat trout**			**Total**		
	2004 n=29	2010 n=194	2011 n=119	2004 n=154	2010 n=129	2011 n=254	2004 n=233	2010 n=549	2011 n=454	2004 n=632	2010 n=872	2011 n=827
Scuds	41	4	14	41	9	13	22	23	21	31	14	16
Vegetation	0	1	0	0	0	0	0	0	1	0	0	1
Leech	1	23	16	0	66	46	0	16	12	0	36	29
Chironomid	56	10	0	47	3	1	71	5	4	55	5	2
Mayfly	0	0	0	0	0	0	0	0	0	0	0	0
Daphnia	2	5	1	12	11	3	6	46	30	8	24	13
Damsel	0	0	0	0	0	0	0	1	0	0	0	0
Fish	0	42	15	0	3	20	0	5	10	0	13	16
Fish egg	0	0	0	0	0	0	0	0	0	0	0	0
Bivalve	0	0	0	0	2	0	0	0	1	0	1	0
Snail	0	9	47	0	6	10	0	2	16	0	5	17
Caddis	0	4	2	0	0	0	1	0	1	5	1	1
Other	0	2	5	0	0	5	0	2	4	1	1	5

Table 10. Diet composition for trout <375 mm and >375 mm collected in Henrys Lake, Idaho, 2011. Figures presented are percent of diet content by weight.

	Brook trout		**Hybrid trout**		**Yellowstone cutthroat trout**		**Total**	
	<375 mm n=51	>375 mm n=68	<375 mm n=67	>375 mm n=187	<375 mm n=300	>375 mm n=154	<375 mm n=418	>375 mm n=409
Scuds	2	15	4	13	15	24	14	17
Vegetation	0	0	2	0	0	1	0	1
Leech	50	14	34	46	13	11	17	32
Chironomid	2	0	19	0	9	1	9	1
Mayfly	0	0	4	0	0	1	1	0
Daphnia	6	0	25	2	49	19	45	6
Damsel	1	0	0	0	0	0	0	0
Fish	4	16	5	21	2	15	2	18
Fish egg	0	0	0	0	0	0	0	0
Bivalve	0	0	0	0	0	1	0	0
Snail	16	48	3	10	8	22	8	19
Caddis	3	2	0	0	0	1	0	1
Other	16	5	4	5	3	4	4	5

Table 11. Fish identified in stomach samples (Sclp = sculpin, UTC = Utah chub, Unk = unknown) collected from brook trout (BKT), hybrid trout (HYB), and Yellowstone cutthroat trout (YCT), by month, in Henrys Lake, 2011.

	BKT			**HYB**			**YCT**			**Total**		
	Sclp	UTC	Unk	Sclp	UTC	Unk	Sclp	UTC	Unk	Sclp	UTC	Unk
May	5	0	7	11	0	8	0	0	9	16	0	24
June	0	0	0	2	0	5	2	0	2	4	0	7
July	0	0	0	16	0	0	0	0	5	16	0	5
August	0	0	0	0	2	2	0	0	2	0	2	4
September	0	0	0	2	1	5	2	1	11	4	2	16
November	0	0	0	0	1	4	1	3	10	1	4	14
Total	5	0	7	31	4	24	5	4	39	41	8	70

Table 12. Annual estimates of angler effort, catch and harvest collected from creel surveys on Henrys Lake, Idaho.

							Catch Composition			% Exceeding Goals			Mean Size (mm)			Residency (%)	
Year	Effort (*1,000)	No. Caught (*1,000)	No. Harvested (*1,000)	Total CR[a]	Harvest CR[a]	% Released	YCT	HYB	BKT	YCT (500 mm)	HYB (500 mm)	BKT (450 mm)	YCT	HYB	BKT	Res	Non Res
1950	17	--	12.3	0.82	0.72	12	77	0	23	--	--	--	--	--	--	--	--
1951	27.9	--	12.3	0.49	0.44	12	80	0	20	--	--	--	--	--	--	--	--
1971	102.2	--	36.7	0.36	0.36	0	70	14	16	--	--	--	--	--	--	--	--
1972	83.8	--	27	0.32	0.32	0	69	19	12	--	--	--	--	--	--	50	50
1975	86.3	--	29.9	0.38	0.35	10	89	0	11	--	--	--	--	--	--	49	51
1976	68.1	36.7	18.7	0.54	0.27	49	81	<1	19	2	--	2	426	--	371	50	50
1977	66.1	29.2	16.5	0.44	0.25	44	71	<1	29	4	--	4	420	339	362	50	50
1978	85.3	40.5	25.5	0.48	0.3	32	48	20	33	9	--	9	429	389	381	51	49
1979	93.9	29.8	18.7	0.32	0.2	37	35	42	24	11	8	6	452	456	378	53	47
1980	68.5	14.6	9.2	0.21	0.14	37	31	59	10	11	16	5	429	459	391	67	33
1981	65.9	14.2	7.5	0.21	0.11	47	30	54	16	13	11	19	445	450	389	--	--
1982	63.3	28.7	7.1	0.45	0.11	75	62	25	13	7	17	25	416	451	405	--	--
1983	96	122	25.4	1.23	0.23	81	84	9	7	3	14	17	388	448	392	64	36
1984	162.9	271	47	1.7	0.29	83	92	5	3	1	5	30	388	427	393	64	36
1985	125.7	159.4	37.9	1.3	0.3	76	92	4	4	0	0	0	378	416	364	60	40
1986	172.8	154.7	67.7	0.9	0.39	55	85	14	1	0	12	0	407	441	364	--	--
1987	150.2	81.1	35.7	0.54	0.24	56	60	34	6	5	26	3	436	447	371	--	--
1988	100.5	81.6	19.5	0.82	0.2	76	49	39	12	8	17	21	430	432	383	--	--
1989	340	262.5	103.7	0.77	0.31	60	50	45	5	4	11	10	404	435	387	--	--
1990	344.2	174.5	63.1	0.51	0.18	64	53	41	5	2	24	0	427	461	433	--	--
1991	124.4	50.5	16.1	0.36	0.13	68	49	49	2	21	35	20	460	473	369	--	--
1992	115.5	53	12.2	0.45	0.11	72	38	52	10	27	42	22	452	474	417	--	--
1993	144.3	92.5	26.7	0.64	0.18	71	76	21	3	7	35	23	410	485	382	--	--
1994	177.8	116.6	21	0.66	0.12	82	52	43	5	5	15	29	418	437	425	71	29
1995	172.6	99.3	20.6	0.58	0.12	79	37	60	3	9	21	27	434	442	432	65	35
1997	228.9	127.7	32.4	0.54	0.25	74	51	46	3	5	15	9	423	434	389	--	--
1999	228	148.6	27.3	0.65	0.12	72	22	65	13	8	12	16	442	447	405	--	--

Table 12. cont.

Year	Effort (*1,000)	No. Caught (*1,000)	No. Harvested (*1,000)	Total CR[a]	Harvest CR[a]	% Released	Catch Composition YCT	HYB	BKT	% Exceeding Goals YCT (500 mm)	HYB (500 mm)	BKT (450 mm)	Mean Size (mm) YCT	HYB	BKT	Residency (%) Res	Non Res
2001	165.8	93.3	17.7	0.56	0.11	81	35	58	7	12	57	43	447	503	452	--	--
2002	--	--	--	0.41	--	--	42	49	9	17	71	50	454	540	462	--	--
2003	108.5	16.9	5.4	0.17	0.05	68	45	51	4	18	65	82	476	543	464	68	32
2005	95	45	8.9	0.48	0.10	80	53	42	5	4	38	0	413	497	379	66	34
2009	124.6	78.9	13.8	0.63	0.11	83	49	41	10	5	50	55	450	502	419	75	25
2010[b]	3.8	5.6	0.8	1.48	0.21	86	52	15	33	15	39	33	469	509	425	92	8
2011[c]	18.3	13.5	2.7	0.74	0.15	80	47	20	32	19	21	61	453	497	430	91	9

[a] = Total catch rate and harvest rate expressed as fish per hour.
[b] = Creel survey conducted from 11/21/10 through 11/30/10.
[c] = Creel survey conducted from 11/15/11 through 1/1/12.

Table 13. Dissolved oxygen (DO) (mg/l) levels recorded in Henrys Lake, Idaho winter monitoring 2010-2011.

Location	Date	Snow depth (cm)	Ice thickness (cm)	DO Ice bottom	DO 1 meter	DO 2 meters	DO 3 meters	Total g/m^2
Pittsburg Creek	12/29/10	20	41	12.4	12.0	10.7	9.8	41.8
	1/7/11	18	35	12.8	12.3	11.2	10.2	42.7
	1/20/11	26	40	11.5	11.1	10.0	8.3	36.0
County Boat Ramp	12/29/10	25	36	11.2	10.9	9.6	7.6	29.3
	1/7/11	14	30	10.8	10.2	9.3	7.0	27.6
	1/20/11	27	36	10.2	9.4	7.9	4.9	23.4
Wild Rose	12/29/10	29	33	11.2	11.1	10.7	8.9	36.7
	1/7/11	10	30	10.8	10.4	9.9	7.4	32.4
	1/20/11	13	44	10.2	9.9	9.1	5.4	27.3
Outlet Bay	12/29/10	51	27	10.5	10.3	8.2	4.8	23.3
	1/7/11	13	42	11.0	10.1	6.6	1.5	18.7
	1/20/11	19	52	10.0	9.6	6.5	3.6	19.9
Hatchery	12/28/10	17	27	12.7	11.6	10.7	9.6	34.5
	1/7/11	8	37	10.8	10.2	9.6	8.1	32.6
	1/20/11	33	36	10.6	10.3	8.8	7.7	29.4
	2/25/11	na	na	10.7	9.9	8.2	5.6	26.3

Table 14. Summary of Yellowstone cutthroat trout (YCT), hybrid trout (HYB), and brook trout (BKT) stocked in Henrys Lake, 1996 – 2011.

Year	YCT Stocked (*1,000)	HYB Stocked (*1,000)	BKT Stocked (*1,000)	Total Stocked (*1,000)
1996	661	200	196	1057
1997	1237	180	204	1621
1998	1047	204	207	1459
1999	1249	204	0	1453
2000	978	0	0	978
2001	991	135	0	1126
2002	1107	331	0	1438
2003	1634	264	99	1996
2004	921	38	117	1077
2005	851	201	152	1204
2006	1124	150	107	1381
2007	1394	146	104	1644
2008	1254	196	198	1648
2009	1382	220	171	1773
2010	1326	138	93	1557
2011	1127	205	100	1432

ZOOPLANKTON MONITORING

ABSTRACT

We monitored zooplankton abundance and biomass to assess the forage resources and evaluate stocking rates where applicable in six regional lakes and reservoirs. We assessed the cropping impacts by fish using the zooplankton ratio method (ZPR) and determined that aside from Jim Moore Pond, preferred zooplankton are not being cropped by fish in any of the waters sampled. We used the zooplankton quality index (ZQI) to assess the overall abundance of preferred zooplankton, and similar to 2010, ZQI values in 2011 across the region were generally lower than in previous years. The limited amount of sampling, particularly in the larger lakes and reservoirs, may account for this variation, and future zooplankton monitoring efforts would likely benefit from increased sampling.

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INTRODUCTION

Zooplankton are vital to lake and reservoir ecosystems because they form the base of the aquatic food web and influence fish production. Dillon and Alexander (1996) showed that the presence of large zooplankton is directly linked to the success of fall hatchery trout fingerling stocking. However, fish stocking programs often fail to include basic zooplankton monitoring data as an evaluation of stocking rates. Zooplankton abundance data can be used to help evaluate hatchery trout stocking programs by estimating the relative production potential of a water body and the availability of preferred zooplankton as a food source for stocked fish.

METHODS

We collected zooplankton samples from six lakes and reservoirs throughout the Upper Snake Region during 2011 (Figure 28), following the protocol described by Teuscher (1999). We collected zooplankton samples between August 1 – 5 from Henrys Lake, Island Park Reservoir, Mackay Reservoir, Palisades Reservoir, Ririe Reservoir, and Jim Moore Pond. We did not sample Ashton Reservoir during 2011 as repairs to Ashton Dam resulted in the reservoir being drawn down during most of the season. During each sampling event, we collected samples from three locations within the lake or reservoir. We collected samples with three nets fitted with small (153 µm), medium (500 µm) and large (750 µm) mesh. We preserved zooplankton in denatured ethyl alcohol at a concentration of 1:1 (sample volume : alcohol). After ten days in alcohol, phytoplankton were removed from the samples by re-filtering through a 153 µm mesh sieve. The remaining zooplankton were blotted dry with a paper towel and weighed to the nearest 0.1 g. We weighed samples from each mesh size individually, and then combined to obtain an average zooplankton mass for each size of mesh. Biomass estimates were corrected for tow depth and reported in g/m. We estimated the relative production potential of each lake by estimating overall zooplankton biomass collected from the 153 µm net. We measured competition for food (or cropping impacts by fish) using the zooplankton productivity ratio (ZPR) which is the ratio of preferred (750 µm) to usable (500 µm) zooplankton. We also calculated the zooplankton quality index (ZQI) to account for overall abundance of zooplankton using the formula developed by Teuscher (1999):

ZQI = (500 µm: + 750 µm:) * ZPR

ZQI values obtained from zooplankton monitoring are used to assess stocking rates based on the recommendations from Teuscher (1999) (Table 15). We also examined zooplankton data (ZQI) from previous years to monitor trends in zooplankton abundance throughout the region and analyzed stocking data to determine if changes may be appropriate.

RESULTS AND DISCUSSION

Throughout the Upper Snake Region, mean zooplankton biomass from the 153 µm net ranged from <0.01 g/m (Jim Moore Pond) to 0.46 g/m (Island Park Reservoir) (Table 16). Teuscher (1999) recommends conservative stocking densities in water bodies with mean biomass estimates <0.10 g/m. During 2011, only Jim Moore Pond zooplankton biomass estimates were below 0.10 g/m. This is likely related to the large population of yellow perch in Jim Moore Pond (*see the Jim Moore Pond chapter of this report for more details*). ZPR values ranged from 0.35 (Palisades Reservoir) to 1.77 (Henrys Lake) (Table 16), which indicates that aside from Jim Moore Pond, preferred zooplankton are not being cropped by fish in any of the sampled water bodies throughout the region. ZQI values were highest for Henrys Lake and Island Park Reservoir and lowest in Palisades Reservoir (Table 16; Figure 29).

During 2011, Palisades Reservoir ZPR and ZQI values were the lowest in the region after being one of the highest in 2010; this shift was likely related to environmental conditions associated with fluctuations in reservoir levels and the timing of sampling in 2010, as noted by Schoby et. al (2012). Conversely, ZQI levels in Mackay Reservoir drastically increased from 2010, and were similar to what was observed in 2008 and 2009. It is unknown what caused the decline in 2010. Henrys Lake, Ririe Reservoir, and Island Park Reservoir ZQI values were similar to 2010, with Henrys Lake and Island Park Reservoir continuing to be two of the most productive water bodies in the Upper Snake Region. Similar to 2010, the 2011 ZQI's were considerably less than that observed in 2008 and 2009. The variability of zooplankton abundance from 2006 through 2011 may be related sampling methodology, and may require more intensive sampling of larger water bodies. Currently, three zooplankton tows are being collected with each mesh size in each water body, regardless of lake or reservoir size. Increased tows of each mesh size in larger water bodies may be necessary to more accurately describe the zooplankton community.

Stocking rates of regional waters are generally appropriate based on 2011 zooplankton monitoring. Currently Mackay Reservoir is primarily stocked with catchable trout, with 10,000 fingerling rainbow trout (8 fish/acre) stocked in 2011 to take advantage of good reservoir carryover and to replace catchable fish scheduled to be stocked in 2012. ZQI values indicate that Mackay Reservoir can support fingerling stockings between 75 and 150 fish/acre. Ririe Reservoir also is primarily stocked with catchable trout, but is also stocked with 200,000 to 300,000 kokanee fingerling annually. During 2011, 210,000 kokanee were stocked (140 fish/acre), which is appropriate based on the ZQI of 0.31. Island Park Reservoir was stocked with 169,000 rainbow trout fingerling, and 175,000 kokanee fingerling and fry in 2011 (49 fish/acre); ZQI observed in 2011 (0.53) indicate that Island Park Reservoir is capable of supporting fingerling stocking between 75 and 150 fish/acre. Henrys Lake was stocked with over 1.4 million fingerling trout in 2011 (220 fish/acre) while ZQI was 0.90, which is slightly below Teuschers' (1999) recommendation for stocking at this rate. Teuscher recommends stocking at 150 – 300 fingerling trout per acre when ZQI levels are >1.0, which indicates that the zooplankton in Henrys Lake may not be able to support trout stocking at the current rate. For more discussion on the trout population of Henrys Lake, see the *Henrys Lake* chapter of this report.

MANAGEMENT RECOMMENDATION

1. Examine historic zooplankton monitoring data to determine precision of ZQI estimates and consider altering methods, if necessary, to more accurately describe zooplankton populations in regional waters.

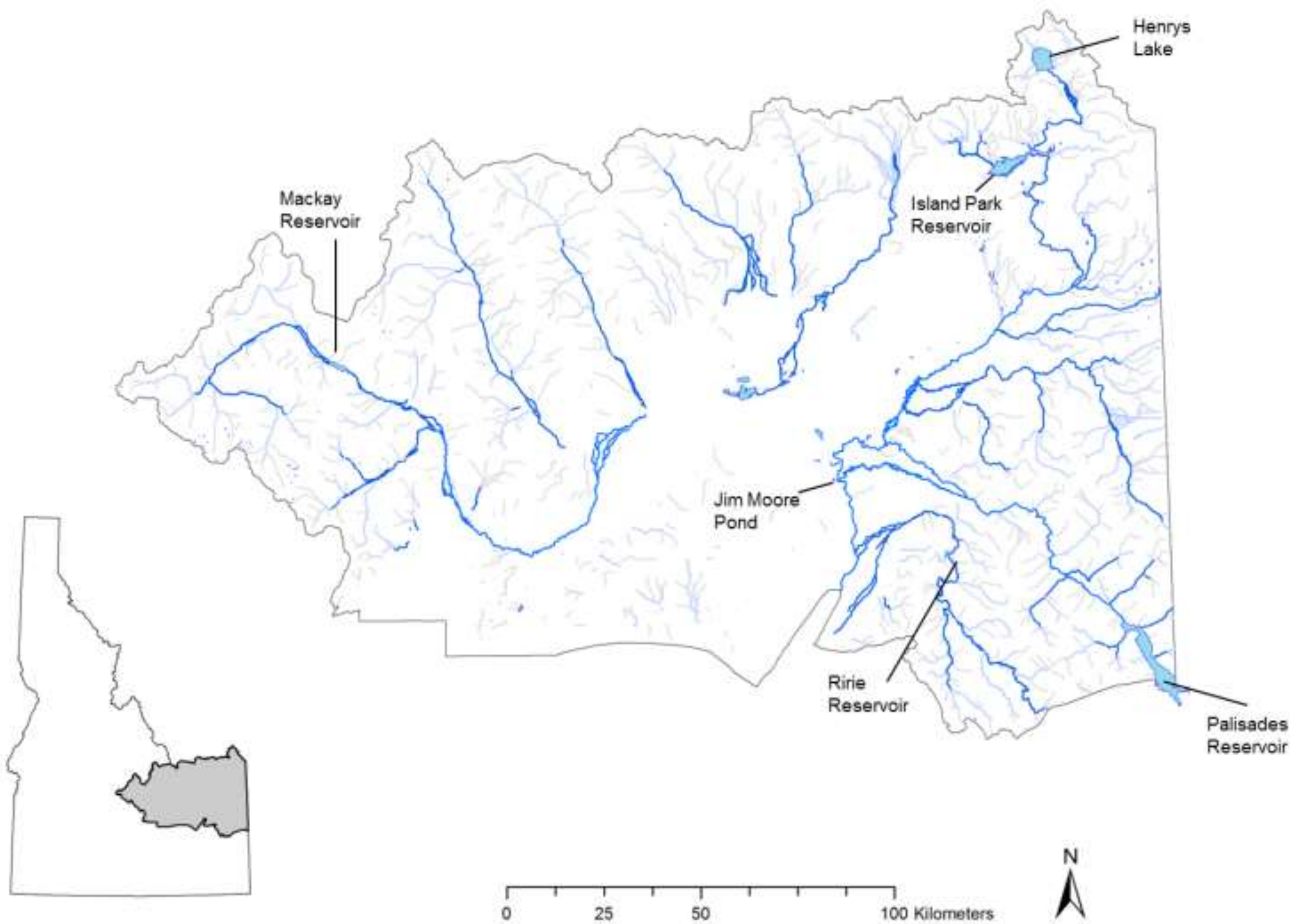

Figure 28. Upper Snake Region lakes and reservoirs where zooplankton samples were collected during 2011.

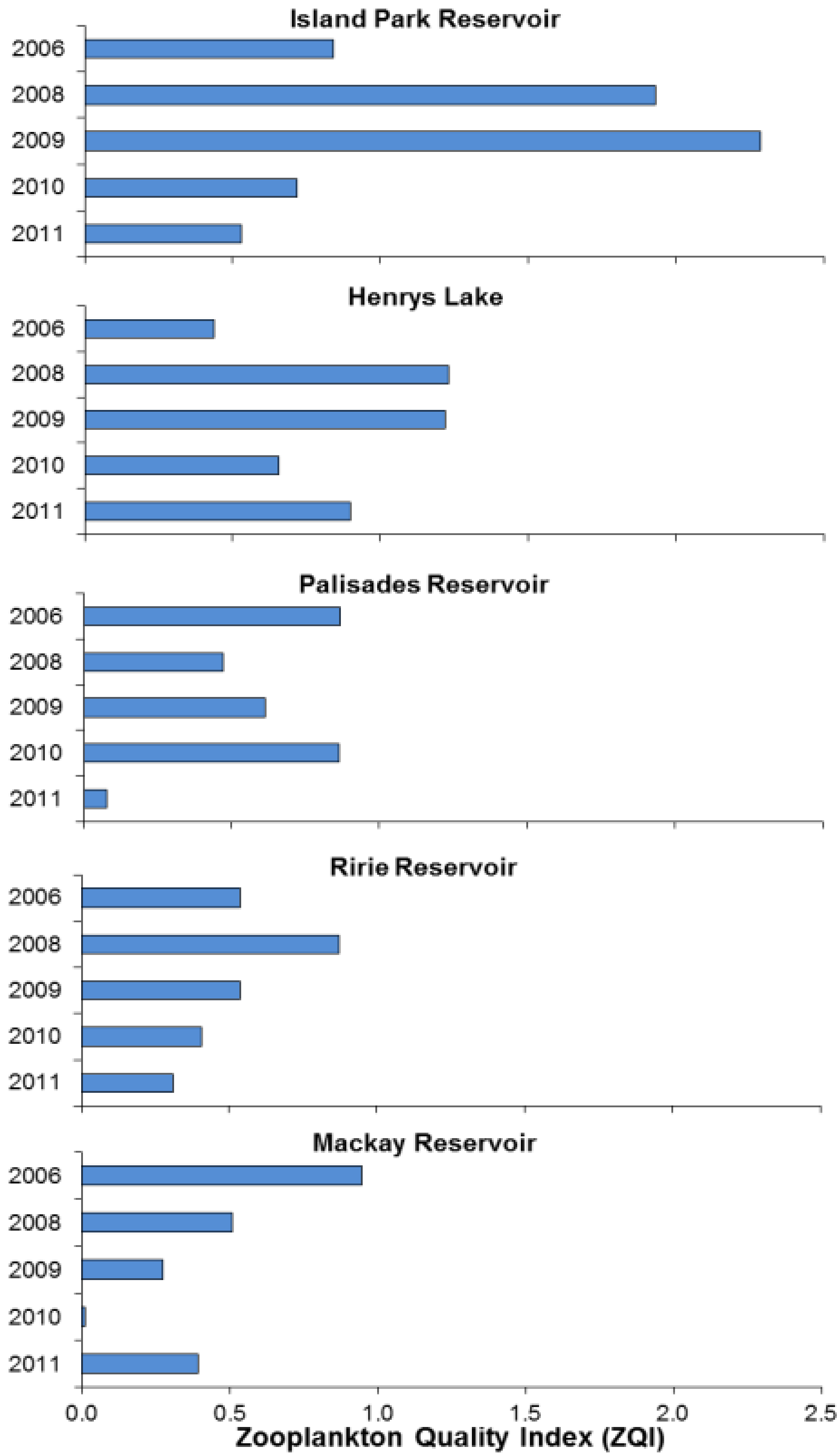

Figure 29. Zooplankton quality index (ZQI) values for lakes and reservoirs in the Upper Snake Region, from 2006 - 2011.

Table 15. Zooplankton quality index (ZQI) ratings and the recommended stocking rates from Teuscher (1999).

ZQI	Stocking recommendation
>1.0	High density fingerlings (150 – 300 per acre)
<1.0, >0.1	Moderate density fingerlings (75 – 150 per acre)
<0.1	Low density fingerlings (< 75 per acre) or stock catchables

Table 16. Mean zooplankton biomass (g/m) by mesh size, preferred to usable (750:500) zooplankton ratio (ZPR), and zooplankton quality index (ZQI = [500+750]*ZPR) for reservoirs in the Upper Snake Region of Idaho, July 2011.

	Net mesh (microns µm)				
Waterbody	153	500	750	ZPR	ZQI
Jim Moore Pond	T*	T*	T*	-	-
Henrys Lake	0.39	0.18	0.32	1.77	0.90
Island Park Reservoir	0.46	0.38	0.30	0.79	0.53
Mackay Reservoir	0.35	0.15	0.18	1.19	0.39
Palisades Reservoir	0.31	0.16	0.06	0.35	0.08
Ririe Reservoir	0.33	0.33	0.19	0.59	0.31

*T = trace - <0.01g or unmeasurable amount of zooplankton collected

HENRYS FORK

ABSTRACT

We used boat mounted electrofishing equipment to assess fish populations in the Box Canyon and Mack's Inn reaches of the Henrys Fork Snake River during 2011. In Box Canyon, we estimated rainbow trout density at 1,770 fish/km, a decrease of 21% from 2010. The 2011 rainbow trout estimate was not significantly different than the 16 year average (1,833 trout/km). Size indices (proportional stock density [PSD] and relative stock density [RSD-400]) indicate that the population is well balanced (74 and 27, respectively). The effects of winter flows on rainbow trout first-winter survival continue to be significantly related, and accurately predict age-2 abundance in our population estimates. Continued work with various stakeholders should emphasize increased winter flows to benefit trout when possible.

The trout population in the Mack's Inn reach, estimated at 2,210 fish per km, was likely overestimated due to the large influx of spawning rainbow trout between the marking and recapture runs. Species composition was 83% rainbow trout, 8% Yellowstone cutthroat trout 5% hybrid trout (rainbow trout x Yellowstone cutthroat trout), and 4% brook trout. The rainbow trout observed during our sampling were large fish (mean total length: 478, PSD: 99, RSD-400: 91, RSD-500: 59), which likely migrated from Island Park Reservoir to spawn. Yellowstone cutthroat trout, brook trout, and hybrid trout, which averaged 429 mm, 349 mm, and 516 mm respectively, likely originated in Henrys Lake and moved downstream with higher than normal outflows from Henry Lake. Future sampling should occur later in the season to more accurately represent what anglers may expect to encounter in this reach.

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INTRODUCTION

The Henrys Fork Snake River attracts anglers from throughout the nation. An economic survey conducted in 2003 showed that Fremont County, which encompasses most of the Henrys Fork drainage, ranked first out of the 44 counties in Idaho in terms of angler spending, and generated nearly $51 million for the local economy (Grunder et al. 2008). Similarly, an IDFG economic survey in 2011 estimated that anglers fished 165,236 days in Fremont County and spent nearly $62 million during angling trips (IDFG, *in press*).

The Henrys Fork Snake River forms at the confluence of Big Springs Creek and the Henrys Lake outlet, and flows approximately 25 km before reaching Island Park Dam. Below Island Park Dam, the Henrys Fork flows approximately 147 km before joining the South Fork Snake River to form the Snake River. The Henrys Fork above Island Park Reservoir provides a yield fishery primarily supported by stocked hatchery catchable rainbow trout and fingerling Yellowstone cutthroat trout and a limited fishery based on trout that move out of Henrys Lake or Island Park Reservoir. Management of the Henrys Fork downstream of Island Park Dam emphasizes wild, natural populations without hatchery supplementation. The Henrys Fork below Island Park Dam, particularly the Box Canyon and Harriman Ranch sections, support a world famous wild rainbow trout fishery.

Previous research has emphasized the importance of winter river flows to the survival of age-0 rainbow trout in the Box Canyon reach (Garren et al. 2006a, Mitro 1999). Higher winter flows in this reach results in significantly higher overwinter survival of juvenile trout and subsequent recruitment to the fishery below Island Park Reservoir. Implementation of a congressionally mandated Drought Management Plan has improved communications and planning regarding winter discharges. We will continue to work cooperatively with stakeholders to maximize wild trout survival, based on timing and magnitude of winter releases from Island Park Dam.

STUDY SITE

During 2011, we sampled the Box Canyon and Mack's Inn reaches of the Henrys Fork Snake River (Figure 30). The Box Canyon reach is sampled on an annual basis as part of our long term monitoring program for the Henrys Fork Snake River. The Box Canyon reach started below Island Park Dam at the confluence with the Buffalo River and extended downstream 3.7 km to the bottom of a large pool.

The Mack's Inn reach started just below the confluence of Big Springs Creek and the Henrys Lake Outlet and extended downstream 3.7 km, ending at the power line crossing approximately 1.7 km above the Highway 20 Bridge at Mack's Inn. The Mack's Inn reach was previously sampled in 2007 and 2004. Coordinates for all mark-recapture transect boundaries are presented in Appendix A.

OBJECTIVES

To obtain current information on fish population characteristics for fishery management decisions on the Henrys Fork Snake River, and to develop appropriate management recommendations.

1. Estimate abundance and size structure of wild trout populations in the Box Canyon and Mack's Inn reaches of the Henrys Fork Snake River.

2. Compare results from current survey to prior surveys and evaluate effectiveness of prior management decisions.

METHODS

During 2011, we used electrofishing methods similar to our 2010 surveys (Schoby et al 2012). Historically, we have used two drift boat mounted electrofishing units to sample fish populations throughout the Henrys Fork Snake River. To improve efficiency and reduce time spent sampling, we used three electrofishing boats (two rafts, one drift boat) in the Box Canyon reach. We marked fish on May 11, and recaptured fish on May 17. Two passes per boat were made on each marking and recapture day for a total of 6 passes per day for both marking and recaptures. In the Mack's Inn reach, we used two electrofishing rafts to mark fish on May 12, and recaptured fish on May 18. One pass was completed by both rafts on each marking and recapture day for a total of eight passes (four marking, for recapture). All trout encountered were collected, identified, measured for total length, and those exceeding 150 mm were marked with a hole punch in the caudal fin prior to release. Fish were not marked on the recapture date, but all fish previously marked were recorded as such.

In all reaches, we estimated densities for all trout > 150 mm using the Log-likelihood method in MR5 software (MR5; Montana Department of Fish, Wildlife, and Parks 1997). Proportional stock densities (PSD) were calculated as the number of individuals (by species) ≥ 300 mm / by the number ≥ 200 mm. Similarly, relative stock densities (RSD-400) used the same formula, with the numerator replaced by the number of fish > 400 mm (Anderson and Neumann 1996). Additionally, we used linear regression to examine the relationship between rainbow trout abundance and mean total length from 1994 to 2011.

We also evaluated the effectiveness of winter flow management by using linear regression to examine the relationship between age-2 rainbow trout abundance and mean winter (December 1 – February 28) stream flow (cubic feet per second [cfs]) in the Box Canyon reach of the Henrys Fork Snake River, as described by Garren et al (2006a). We log-transformed age-2 rainbow trout abundance and mean winter flow data from the past 14 surveys to establish the following relationship:

$$\log_{10} \text{age-2 rainbow trout abundance} = 0.5202 \log_{10} \text{winter stream flow} + 2.1514$$

Using this equation we predicted the expected abundance of age-2 rainbow trout in our 2011 sampling based on mean winter stream flows observed during 2010 (December 2009 - February 2010). To validate this relationship, we determined age-2 rainbow trout abundance during the 2011 electrofishing surveys by estimating the number of fish between 230 and 329 mm, which correlates to the lengths of age-2 trout in past surveys. Age-2 rainbow trout were determined to be the first year class fully recruited to the electrofishing gear (Garren 2006b). We then compared predicted and observed age-2 rainbow trout abundance in Box Canyon to evaluate the ability of the equation above to predict year class strength based on winter flow. Data from 2011 was added to the flow vs. age-2 abundance regression model and this model will continue to be used in negotiations of winter flow releases from Island Park Dam.

Additionally, similar to Garren et al. (2006a), we examined the relationship between monthly winter stream flow (November through March) and year class strength. We examined data from 1995 through 2011, and included an additional 7 years of data that has been collected since the initial evaluation by Garren. We used a best subset regression model to eliminate the effects of collinearity and determine the effects of mean monthly winter stream flow on trout abundance. Best subset analysis was used to determine which consecutive 2- and 3-month periods explained the most variation in annual age-2 trout abundance. This information will then be used to prioritize winter flow management in future years.

RESULTS

Box Canyon

We collected 1,298 trout during four days of electrofishing in the Box Canyon. Species composition of trout collected was 99.9% rainbow trout and <0.1% brook trout. Rainbow trout ranged in size from 111 mm to 550 mm, with a mean and median total length of 348 mm (Figure 31; Appendix B) which is 41 mm larger than the mean size in 2010. Rainbow trout PSD and RSD-400 were 74 and 27, respectively (Table 17). We used the Log-likelihood Method (LLM) to estimate 6,548 rainbow trout >150 mm (95% CI = 5,816 – 7,280, cv = 0.06, Table 18, Appendix C) in the reach, which equates to 1,770 fish per km (Figure 32). Our efficiency rate (ratio of marked fish during the recapture runs [R] to total fish captured on the recapture run [C]), unadjusted for size selectivity was 11% (Appendix C). We examined the relationship between rainbow trout density and mean total length over the past 17 years, and found a negative correlation (r^2=0.34), with average size decreasing as density increases (Figure 33).

The regression model between winter flow (December-February) estimated an abundance of 3,144 age-2 rainbow trout in the 2011 survey based on winter flows that averaged 387 cfs. Based on the length-based estimates of abundance our Log Likelihood model calculates, we estimated age-2 rainbow trout abundance at 3,433 fish in the Box Canyon during 2011 (Figure 34). This regression model accurately estimates the relative year class strength of rainbow trout using mean winter stream flow (r^2=0.51, n=15, P=0.0029; Figure 34) and is a useful tool to evaluate the effects of variable winter flows.

Best subset regression analysis of monthly winter stream flows and age-2 abundance identified January-February (r^2 = 0.59) and December, January, and February (r^2 = 0.59) as the respective 2- and 3- month periods that explained the most variation in age-2 trout abundance.

Mack's Inn

We collected 171 trout during two days of electrofishing in the Mack's Inn reach of the Henrys Fork. Species composition of trout collected was 83% rainbow trout, 8% Yellowstone cutthroat trout, 5% hybrid trout (rainbow x cutthroat trout), and 4% brook trout. Rainbow trout ranged between 85 mm and 578 mm (Figure 34), with a mean and median total length of 478 mm and 505 mm, respectively. Rainbow trout PSD, RSD-400, and RSD-500 values were 99, 91, and 59, respectively. Yellowstone cutthroat trout ranged between 245 mm and 504 mm (Figure 35), with a mean and median total length of 429 mm and 461 mm, respectively. Yellowstone cutthroat trout PSD, RSD-400, and RSD-500 values were 93, 64, and 7, respectively. Hybrid trout ranged between 435 mm and 615 mm (Figure 35), with a mean and median total length of 516 mm and 492 mm, respectively. Hybrid trout PSD, RSD-400, and RSD-500 values were 100, 100, and 33, respectively. Brook trout ranged between 290 mm and 435 mm (Figure 35), with a mean and median total length of 349 mm and 338 mm, respectively. Brook trout PSD, RSD-400, and RSD-500 values were 67, 33, and 0, respectively (Table 17). We estimated 2,210 trout >150 mm for the entire reach (95% CI = 825 – 5,335; cv = 0.49), which equates to 496 rainbow trout, 50 Yellowstone cutthroat trout, 28 hybrid trout, and 21 brook trout per km (Table 18). Our efficiency rate (unadjusted for size selectivity) was 2%.

DISCUSSION

During 2011, we further modified the methods used to estimate the trout population in Box Canyon in an effort to increase our efficiency. Previous electrofishing estimates in Box Canyon utilized two drift boats or rafts and were conducted over four days (two marking days and two recapture days), with two passes by each boat on each day, for a total of 16 electrofishing passes through Box Canyon. During 2010, a third electrofishing raft was added, and with two passes per day and multiple marking and recapture days, record numbers of fish were handled and the resulting estimate had the lowest coefficient of variation of any population estimate conducted in Box Canyon (Appendices B and C). Although the estimate conducted in 2010 was likely one of the most accurate conducted in Box Canyon, it still required four days of effort, and with the addition of the third boat, two additional people. During 2011, we continued the use of the third boat, but eliminated the second marking and recapture days, reducing the total number of electrofishing passes to 12. Using these techniques, we handled nearly the same amount of fish as in previous surveys, with a similar coefficient of variation (cv = 0.06), and conducted the estimate in only two days. Reducing the number of days necessary to conduct our estimates not only increases the efficiency of department personnel, it also reduces the potential impacts/conflicts with angler use on this popular stretch of river, which is now open to angling during our annual surveys. Based on these results, we feel the modifications made to the sampling techniques in Box Canyon should be adopted for future use.

Estimates of rainbow trout abundance in 2011 in the Box Canyon showed a decrease of 21% when compared to the high densities found in 2010, but did not differ from the long term average, and PSD and RSD values indicate that the population is well balanced. Although the density of rainbow trout was lower than in 2010, the average size increased by 41 mm. Average size of rainbow trout observed in our sampling is tied closely to the abundance of age-2 trout observed, which can strongly influence a statistic such as mean length. As seen in 2010, when the age-2 cohort was large, the average total length of trout handled in the sample reach decreased; conversely, in 2011, the relatively smaller age-2 cohort resulted in a larger average size of fish observed, as older (and larger) year classes were more prevalent in relation to the age-2 cohort. This relationship is evident when these two variables are regressed, but may not be a density dependent response of decreased growth, as much as a function of strong and weak year classes influencing the overall average size of rainbow trout. Future research should include length-at-age monitoring to determine the effects of population density on growth

Winter stream flows continue to be the main factor in determining rainbow trout abundance within the Box Canyon, as demonstrated by Garren et al. (2006a). Observed age-2 abundance (3,433) in 2011 was nearly identical to that predicted (3,144) from our regression model that incorporated flows during the winter of 2010 which would have affected age-2 fish in the 2011 survey. The minimal difference between the model prediction and direct observation of age-2 rainbow trout demonstrates the accuracy of this analysis tool. This model will continue to be used to evaluate the effects of winter flows on rainbow trout abundance and will be updated with future sampling results.

Best subset regression analysis identified stream flow during the months of December, January, and February as being most important to age-0 trout survival, based on age-2 abundance observed in electrofishing surveys. While this is contrary to previous work that suggests increased flows later in the winter increases juvenile trout survival (January 15 through March 31; Mitro 1999), observations used in our analysis range over 17 years of varying winter flow conditions as opposed to the relatively short duration of the 1999 study which was conducted over 4 years. Further, the 1999 study did not account for movement of juvenile trout outside of large study reaches and may have inaccurately described movements as mortality. Recent data suggests that movement of juvenile trout is common in the upper Henrys Fork during the winter (J. Derito, Henrys Fork Foundation; unpublished data) which may cloud results derived from study designs that do not look at overall year class strength after the effects of winter. Mitro (1999) also notes that the timing of loss of age-0 trout at Last Chance was related to discharge during the first half of winter and recommended timing increased flows to coincide with initial losses of age-0 trout, which occurred between November and December during low flow years, and between December and January during higher flow years. This is consistent with the results of our subset regression analysis, and supports increased flows during December. Biologically, increased flows earlier in the winter (i.e. December - February) make sense, as this coincides with the coldest months of the year. Smith and Griffith (1994) indicated that the early part of winter was critical for age-0 rainbow trout survival in the Henrys Fork, with nearly all of the mortality (95%) they observed occurring between October 21 and December 8, which suggests that flows as early as November may be critical to winter survival. Additionally, virtually all of the survivors of the early winter in Smith and Griffith's (1994) study survived the remainder of the winter. Though not expressed in any of these studies, early and mid-winter losses cannot be remediated by increasing flows later in the winter; ultimately, juvenile rainbow trout must survive the early portion of the winter to survive the remainder of the winter. Based on our findings combined with the results from these prior studies, we believe that prioritizing flow management during the early portion of the winter is critical to creating strong year classes of rainbow trout in the Henrys Fork.

The trout population estimate in the Mack's Inn reach of the Henrys Fork was double the last estimate conducted in 2007, but was likely influenced by migratory spawning rainbow trout that originated in Island Park Reservoir. The coefficient of variation (0.49) indicates that this estimate is not reliable, and is likely not reflective of the actual population found within this reach. Significant immigration into this reach likely affected our estimate, and was evident in our recapture run, where we captured 53% more rainbow trout than during the marking run, with very few recaptures (2%). Similarly, Garren et al. (2006c) also suggested that prior surveys in the Mack's Inn reach during May were influenced by migratory trout originating in Island Park Reservoir. We also found large Yellowstone cutthroat trout, brook trout, and hybrid trout, which based on size and appearance likely migrated downstream from Henrys Lake, through the Henrys Lake Outlet to the Mack's Inn reach of the Henrys Fork. PSD and RSD values in the Mack's Inn reach further substantiate a population dominated by larger fish, which was influenced by the presence of large, migratory fish during our sampling.

As evidenced by the length frequency distribution and PSD and RSD values, younger age classes of all species were lacking in the Mack's Inn reach in 2011. This is contrary to previous years (Garren et al. 2009), where younger age classes and more balanced populations were documented. The absence of juvenile fish in our 2011 survey may be related to flow conditions. Fluctuations in releases from Henrys Lake are primarily what affect the flows in this reach of the Henrys Fork, as Big Springs is relatively constant at approximately 200 cfs year around. During 2007, mean outflow from the Henrys Lake outlet was 18 cfs during the sampling period, while the flows during 2011 were over ten times that, averaging 207 cfs during the electrofishing survey. Flows of this magnitude were above bank-full conditions, creating deeper holes and inaccessible side channels, which likely influenced capture efficiency, particularly of smaller fish. Regardless of the cause of the inefficiencies encountered during 2011 sampling, future sampling in this reach should be conducted later in the season (June-July) to better represent what anglers can expect to encounter in this reach of river.

MANAGEMENT RECOMMENDATIONS

1. Continue annual population surveys in the Box Canyon to quantify population response to changes in the flow regime over time. Collect otoliths when population densities are high, and compare to prior surveys when growth was assessed during lower density periods to determine effects of density dependent growth.

2. Work with the irrigation community and other agencies to obtain increased winter flows out of Island Park Dam to benefit trout recruitment, stressing the importance of early winter flows to age-2 trout abundance.

3. Conduct future Mack's Inn sampling events later in the year (mid-June to early July) to better represent what anglers may expect to encounter in this reach.

4. Continue to work with partner agencies and organizations to develop studies that quantify the importance and use of tributaries by juvenile trout (Buffalo River, Thurmon Creek, etc) and downstream mainstem reaches (Riverside) and how they relate to abundance estimates in the Box Canyon.

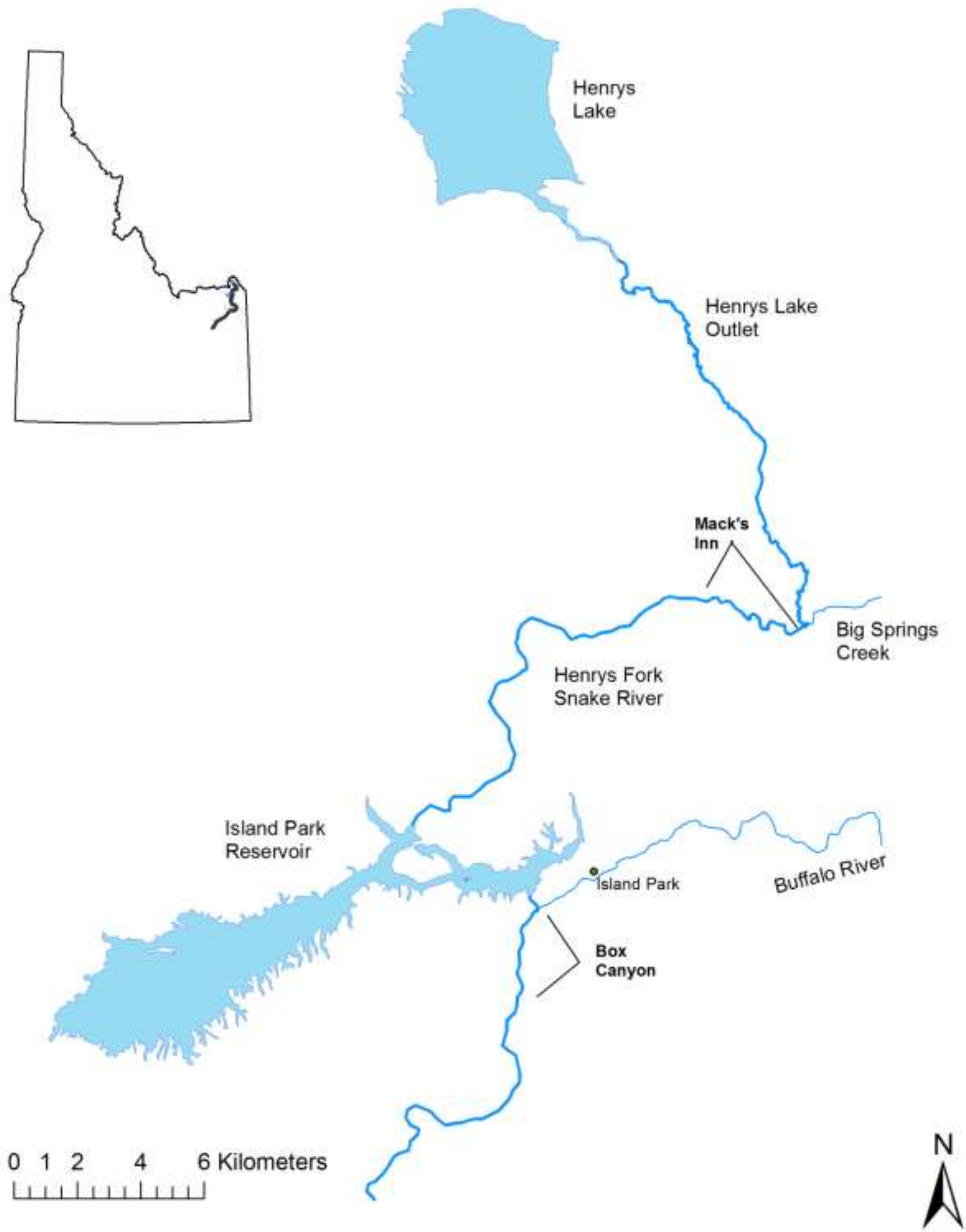

Figure 30. Map of the Henrys Fork Snake River watershed and electrofishing sample sites (Box Canyon and Mack's Inn) during 2011.

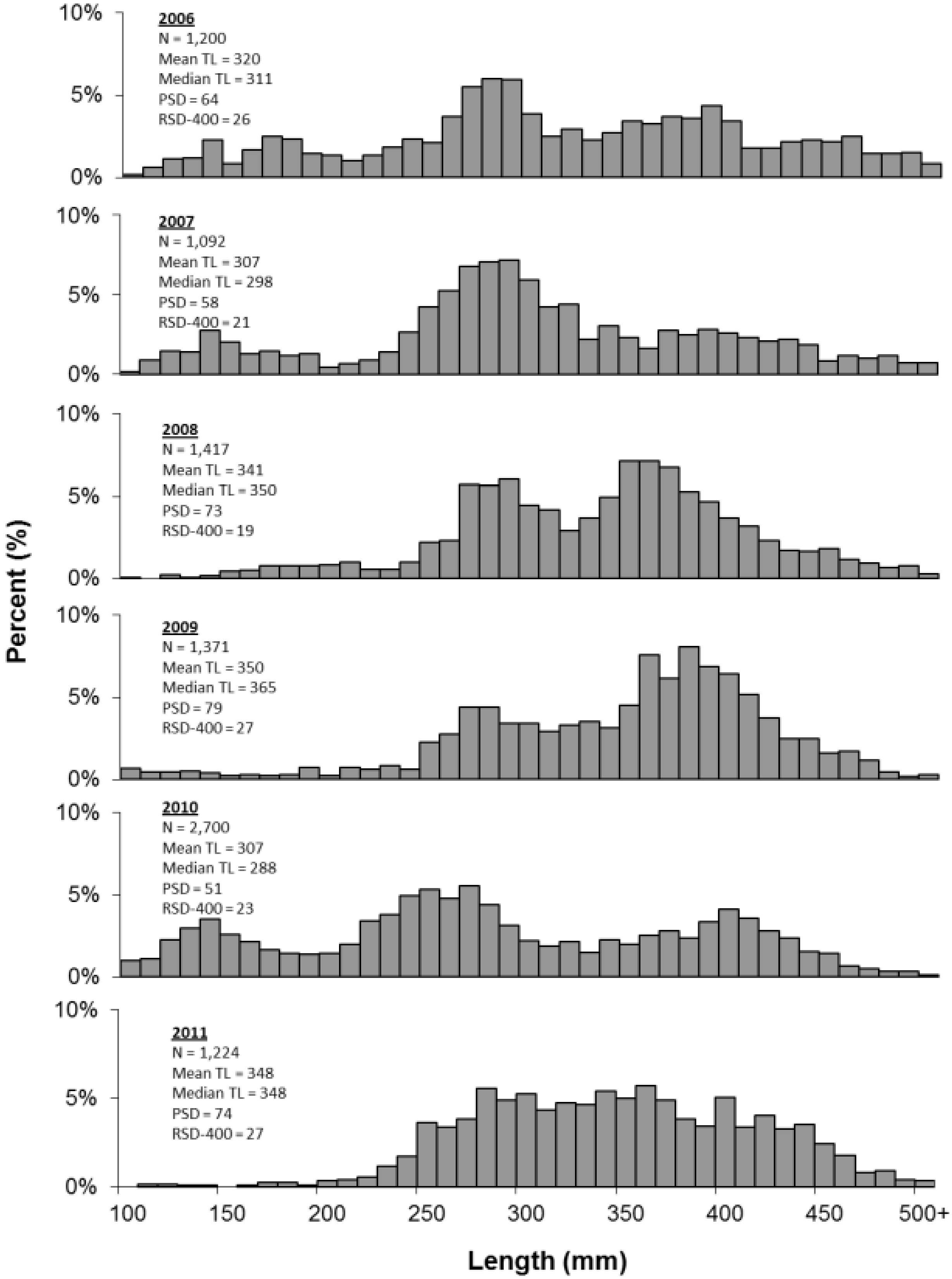

Figure 31. Length frequency distribution and total length statistics of rainbow trout collected by electrofishing in the Box Canyon reach of the Henrys Fork Snake River, Idaho, 2006 - 2011.

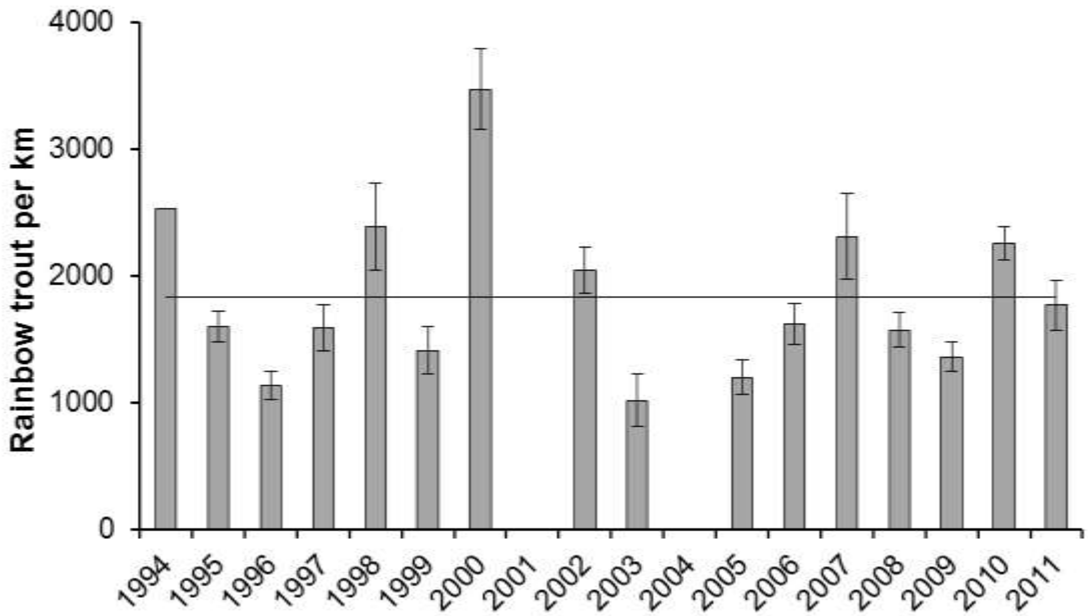

Figure 32. Rainbow trout population estimates for the Box Canyon reach of the Henrys Fork Snake River, Idaho 1994 to 2011. Error bars represent 95% confidence intervals. The solid line represents the long-term average rainbow trout density, not including the current years' survey.

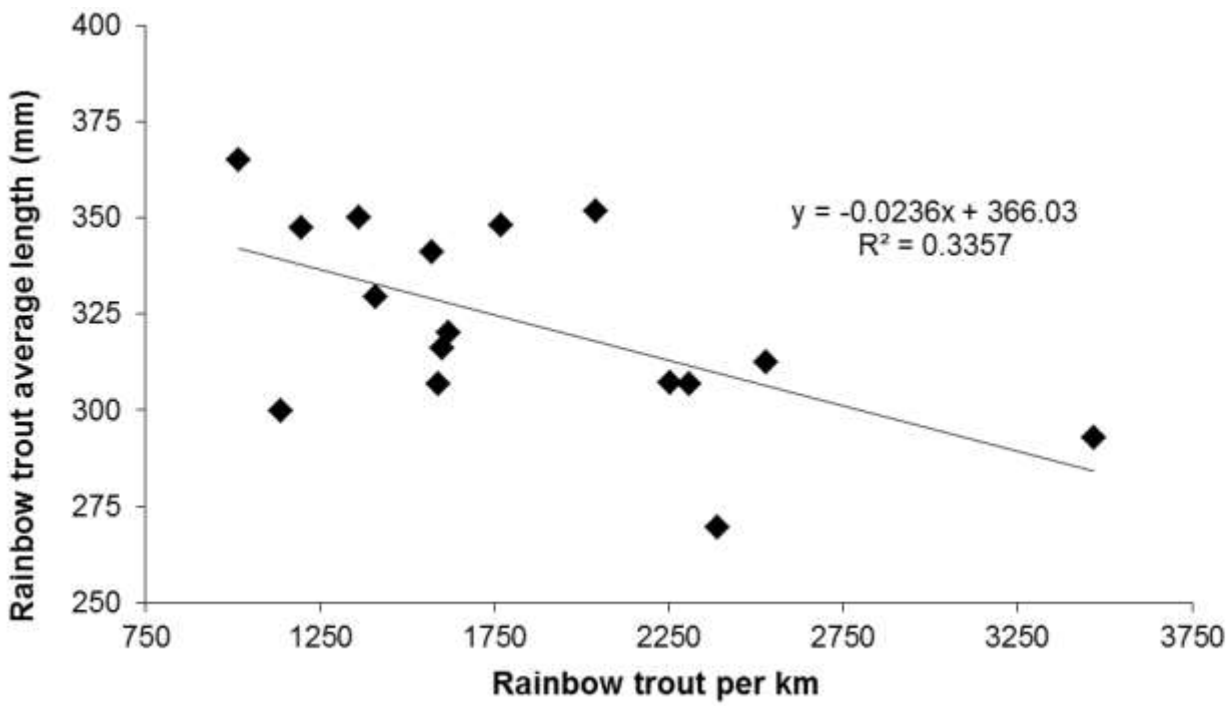

Figure 33. The relationship between rainbow trout density (fish per km) and average total length (mm) of rainbow trout in Box Canyon from 1994 – 2011; average length = -0.0236 trout per km + 366.03, (r^2=0.34).

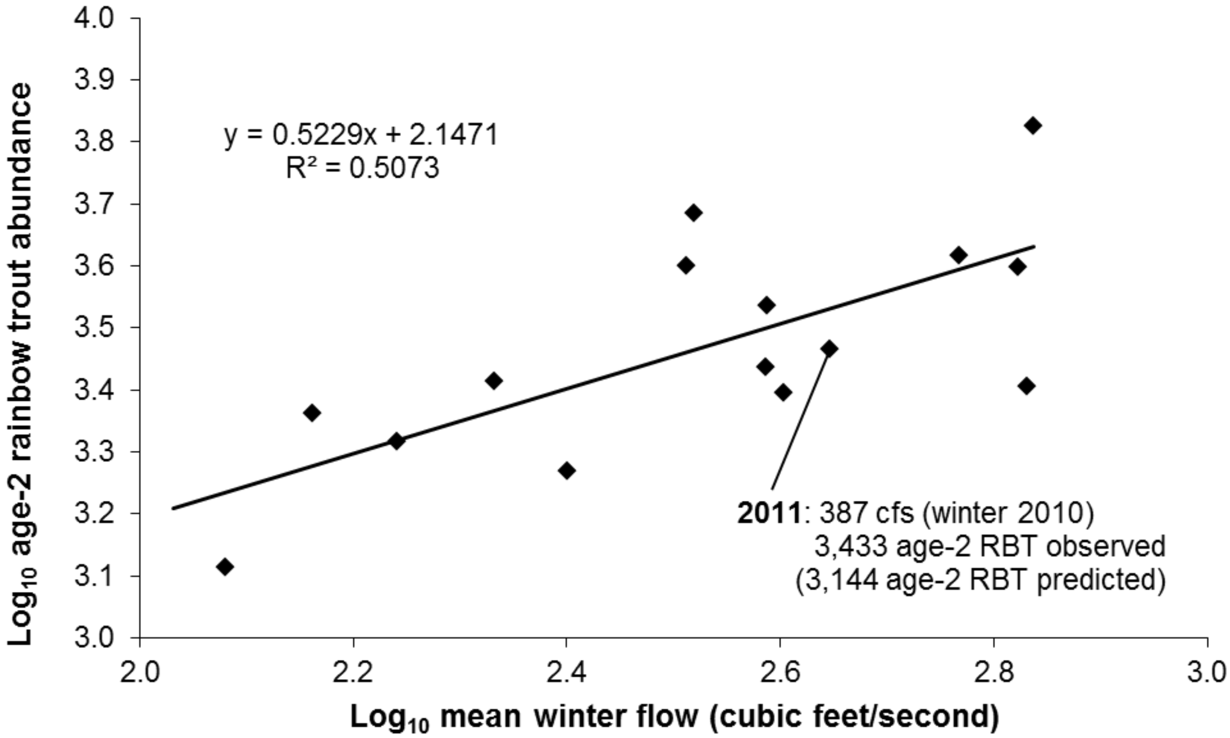

Figure 34. The relationship between age-2 rainbow trout abundance and mean winter flow (cfs) during the first winter of a fish's life from 1995 - 2011; $\log_{10}$ age-2 trout abundance = 0.5229 $\log_{10}$ flow (cfs) + 2.1471, (r^2=0.51; n=15, P=0.0029).

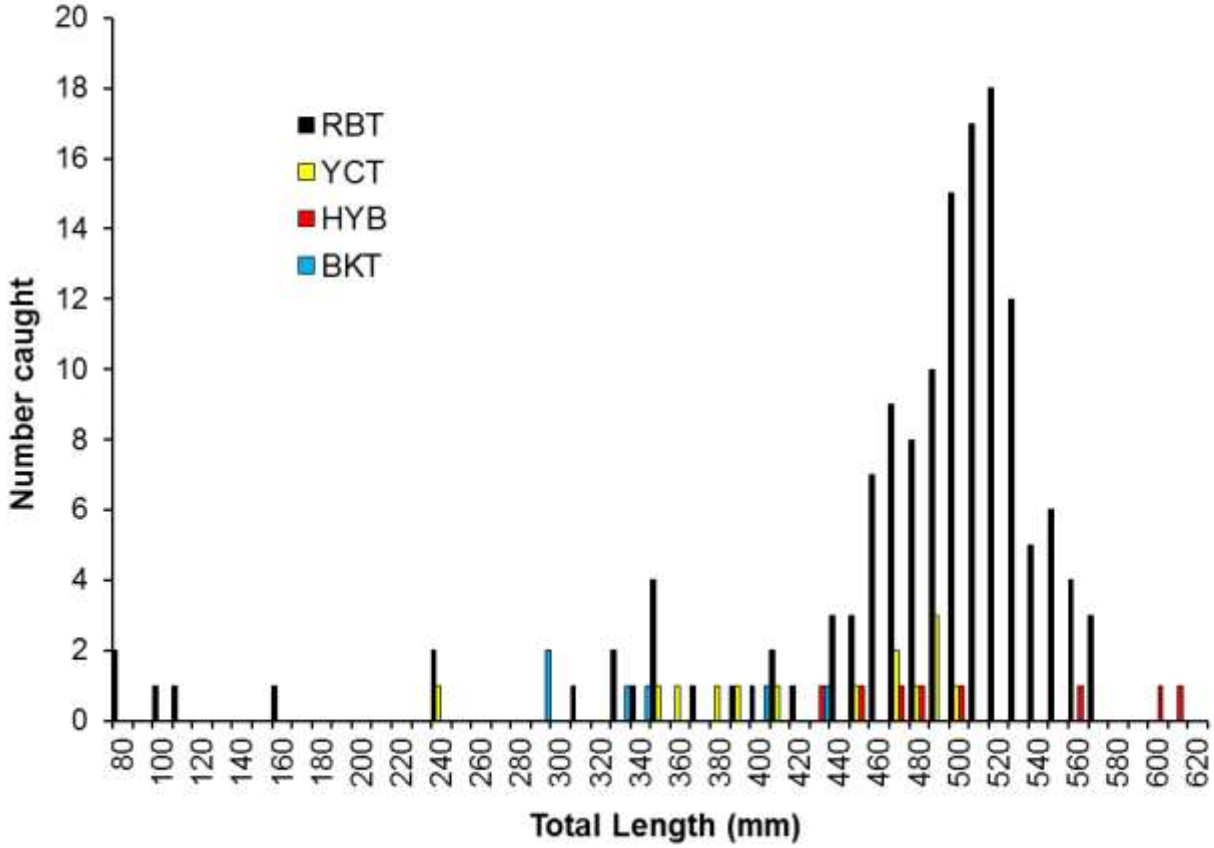

Figure 35. Length frequency distribution of rainbow trout (RBT = black bars), Yellowstone cutthroat trout (YCT = yellow bars), hybrid trout (HYB = red bars), and brook trout (BKT = blue bars) in the Mack's Inn reach of the Henrys Fork Snake River, Idaho, 2011.

Table 17. Trout population index summaries for the Henrys Fork Snake River, Idaho 2011.

River Reach	Mean Length (mm)	Median Length (mm)	PSD	RSD-400	RSD-500	Density (No./km)	Percent Species Composition
Box Canyon							
Rainbow trout	348	348	74	27	1	1,770	99.9
Mack's Inn							
Rainbow trout	478	505	99	91	59	496	83
Yellowstone cutthroat trout	429	461	93	64	7	50	8
Hybrid trout (RBT x YCT)	516	492	100	100	33	28	5
Brook trout	349	338	67	33	0	21	4

Table 18. Trout population estimate summary from the Henrys Fork Snake River, Idaho during 2011. (RBT = rainbow trout, YCT = Yellowstone cutthroat trout, BKT = brook trout, HYB = hybrid trout [RBT x YCT])

River reach	**No. marked**	**No. captured**	**No. recaptured**	**Population Estimate**	**Confidence Interval (+/- 95%)**	**Density (No./ km)**	**Discharge (cfs)[a]**
Box Canyon -RBT	639	652	74	6,548	5,816 - 7,280	1,770	1,159[b]
Mack's Inn							1,490[c]
-RBT	57	87	2	1,834	685 – 4,428	496	
-YCT[d]	6	8	0	183	68 – 443	50	
-HYB[d]	5	3	0	104	39 – 251	28	
-BKT[d]	3	3	0	77	29 - 187	21	

[a] Represents the mean discharge value between marking and recapture events.
[b] Data obtained from USGS gauge near Island Park Dam (13042500).
[c] Data obtained from USGS gauge below Coffeepot rapids near Macks Inn (13041010).
[d] Population estimate determined by partitioning total trout estimate, based on percent of species composition.

2011 Upper Snake Region Annual Fishery Management Report

River and Stream Surveys

SOUTH FORK SNAKE RIVER

ABSTRACT

The South Fork Snake River supports the strongest population of fluvial Yellowstone cutthroat trout (YCT) in Idaho. This report summarizes efforts to maintain YCT including protection of spawning tributaries, manipulation of river flows, and angler harvest of rainbow trout (RBT). Management action effects are evaluated annually at the Conant and Lorenzo reaches, where we conduct electrofishing surveys to determine relative abundance and population size. Total trout densities were at or near all-time highs with 1,770 trout/km (±300) at Lorenzo and 3,002 trout/km (±278) at Conant. Since 2004, YCT trends have significantly increased at Lorenzo and Conant, (r = 0.21 and r = 0.12, respectively) while brown trout populations have not changed (r = -.04 and r = 0.11 [with a confidence interval including zero], respectively). However, RBT at Conant have increased significantly since 2004 (r = 0.15). Utah sucker densities were estimated at 1,434 fish/km at Lorenzo. Weirs were operated on all four major South Fork spawning tributaries to remove RBT from YCT spawning runs. YCT were passed upstream (2,940) of weirs and 19 RBT were removed. High flows caused weir damage at Palisades and Burns creeks, but overall, the structures held up well during above normal run-off. An additional 600 RBT were marked with coded wire tags for the angler incentive study. High flows resulted in fewer RBT turned in than in 2010. We checked 1,919 RBT including 16 winning fish ($50 to $500 each). Retention of coded wire tags was 100% among 51 hatchery RBT held at Mackay Hatchery for 7 months post-marking. Recapture of YCT marked with passive integrated transponder (PIT) tags indicate high (99%) seasonal site and spawning stream fidelity. Straying among spawning streams was low (0.4%). Lengthy spawning migrations were observed in both upstream and downstream directions. South Fork YCT are increasing in abundance despite substantial threats to their persistence.

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INTRODUCTION

Yellowstone cutthroat trout are the native trout of the South Fork Snake River (South Fork). The river supports the strongest remaining fluvial population within their historical range in Idaho (Thurow et al. 1988; Van Kirk and Benjamin 2001; Meyer et al. 2006). Across the majority of the species range, Yellowstone cutthroat trout (YCT) have experienced dramatic reductions in abundance and distribution (Behnke 1992). In August 1998, conservation groups petitioned the United States Fish and Wildlife Service (USFWS) to list Yellowstone cutthroat trout under the Endangered Species Act (ESA). In February 2001, the listing petition was denied, and conservation groups filed a lawsuit in January 2004 which led to a 12-month review of the current status of YCT. The USFWS determined that YCT did not warrant listing under the ESA in February 2006 (USFWS 2006). However, YCT have continued to sustain declines in their abundance and distribution across their historical range (Koel et al. 2010).

The Idaho Department of Fish and Game (IDFG) altered fishery management on the South Fork in 2004 to benefit YCT conservation, and the effectiveness of current management efforts are evaluated primarily with data collected from two monitoring sites sampled each fall. Current management efforts can be described as being three-pronged. The first prong deals with spawning tributaries and involves using fish traps on four main tributaries to remove rainbow trout and hybrids from spawning runs. Rainbow trout and rainbow x cutthroat trout hybrids (hereafter collectively referred to as RBT) are identified as the biggest threat to the continued persistence of YCT in the South Fork (Moller and Van Kirk 2003, IDFG 2007; Van Kirk et al. 2010) because of risks through competition (Seiler and Keely 2007a) and hybridization (Henderson et. al 2000). The second management prong deals with flow manipulation. Previous research has indicated flows similar to a natural (unregulated) hydrograph in both timing and shape, benefit YCT recruitment while limiting recruitment of RBT (Moller and Van Kirk 2003). The third management prong involves increasing angler harvest of RBT in the main South Fork. All three management prongs are designed to achieve the same goal, which is the preservation of the genetic integrity of YCT in the South Fork and the population's long-term viability (IDFG 2007). Results from the annual electrofishing surveys of our two monitoring reaches are used to assess recruitment, population trend, and population densities which in turn are used to assess management effectiveness.

One key to the continued persistence of YCT in the South Fork is maintaining the four major spawning tributaries as refugia where YCT can spawn without risks of hybridization with rainbow trout. If RBT are allowed to invade the major spawning tributaries, then there may be little chance of securing long-term viability of YCT in the South Fork (Van Kirk et al. 2010). However, weirs alone can at best provide areas of refuge for cutthroat trout to spawn in the absence of rainbow trout, and cannot reverse the increase in rainbow trout in the river. IDFG started constructing weirs and fish traps on spawning tributaries in 1996 and have been manually removing RBT from spawning runs since 2001 to limit RBT invasion and hybridization with YCT. IDFG has been limited by the low effectiveness of previous weirs and traps during high flows (Schrader and Fredericks 2006a). Recent weir modifications of converting picket or floating weirs to electrical weirs and a waterfall/velocity barrier have increased our effectiveness in trapping migrating salmonids during high spring flows (High et al. 2011).

Anglers play a key role in YCT management efforts on the South Fork by increasing mortality on RBT, but annual exploitation rates have been low due largely to the prevalent catch and release ethic embraced by trout anglers. Exploitation rates have generally been less than 20% except for one year since 2004 (High et al. 2011; Schoby et al. 2010). Population modeling indicates exploitation must exceed 20% annually in combination with spring freshets and tributary spawning refugia to result in a decreasing RBT population in the South Fork (Van Kirk et al. 2010). In 2004, regulations changed on the South Fork, allowing year round fishing on the river along with no bag limits for RBT. This change resulted in a brief increase in harvest (Schrader and Fredericks 2006b). However, now that the regulations have been in place for several years, exploitation rates appear to have decreased. To counter this, we developed a program that provides an incentive for RBT harvest. A similar incentive program has successfully been implemented on Lake Pend Oreille to increase harvest rates of lake trout *Salvelinus namaycush* and rainbow trout (J. Fredericks pers. communication), and may prove beneficial on the South Fork, but needs to be evaluated to determine the impact to the fishery.

This report summarizes efforts to conserve YCT in the South Fork during 2011. A fluvial population of YCT continues to be supported by quality habitat in the South Fork, but its long-term viability is threatened by a large non-native RBT population, entrainment into irrigation diversions, and other factors.

OBJECTIVES

1. Determine whether management actions from the three-pronged management approach on the South Fork Snake River are helping to conserve YCT
2. Reduce hybridization risks by providing spawning refugia for YCT in the major spawning tributaries
3. Increase angler harvest rates of RBT in the South Fork
4. Work with BOR to obtain beneficial flows for cutthroat in the South Fork.
5. Determine if the RBT incentive program is increasing harvest rates

STUDY AREA

The Snake River originates in Yellowstone National Park and flows south through Grand Teton National Park and the Jackson Hole valley before turning west and flowing into Palisades Reservoir at the Idaho – Wyoming state line. The 106 km portion of the Snake River that runs from Palisades Dam to the confluence with the Henrys Fork is commonly referred to as the South Fork. Anglers and biologists divide the South Fork into three segments. The first segment, called the upper river, runs from Palisades Dam to Pine Creek through a relatively unconfined valley. The first 13 km of the upper river downstream of the dam is a simple channel. From this point, the river braids around numerous islands. All but one of the four main YCT spawning tributaries enters the South Fork in this upper river, including Palisades Creek, Rainey Creek, and Pine Creek (Figure 36). The second segment of the South Fork runs from Pine Creek downstream to Heise, and is commonly referred to as the canyon. Burns Creek, the fourth major YCT spawning tributary enters the South Fork in the canyon. The last segment of the South Fork runs from Heise to the confluence with the Henrys Fork, and is commonly referred to as the lower river. There are no major YCT spawning tributaries in the lower river, and while constant water temperatures from Palisades Dam moderate winter conditions in the upper and canyon sections, winter conditions in the lower river are usually more severe than upstream (Moller and Van Kirk 2003). The Conant and Lorenzo monitoring reaches of the South Fork are in the upper and lower river sections, respectively. In addition to native YCT, other salmonids in the South Fork include RBT, brown trout, and mountain whitefish (also native). Utah sucker, bluehead sucker *C. discobolus*, and mountain sucker *C. platyrhynchus* are the native catostomids in the South Fork.

METHODS

South Fork Population Monitoring

We estimated trout abundances at the Lorenzo and Conant monitoring reaches of the South Fork during the fall when river flows decreased after the main irrigation season ends. Estimates were calculated separately for each species and for all trout species combined and only included age 1 and older trout (see Schrader and Fredericks 2006a). We used the MR5 program (developed by the Montana Department of Fish, Wildlife, and Parks) to calculate population estimates and 95% confidence intervals (CIs) using the Log-likelihood method and 25 mm size groups. We assessed the trend of abundance estimates since the most recent regulation and management change in 2004. We used sample year as the independent variable and the $\log_e$-transformed abundance estimate (fish/km) as the dependent variable. The benefit of this analysis is the slope of the regression line fit to the $\log_e$-transformed abundance data is the intrinsic rates of change (r) for the population (Maxell 1999). We used $\alpha = 0.10$ to have more power to assess trends in these populations (Peterman 1990; Maxell 1999). Positive intrinsic rates of change ($r > 0$) indicate an increasing population and negative estimates of r indicate declining abundance in the population. We used linear regression to compare the abundance of the ratio of age 1 YCT to age 1 RBT at the Conant monitoring reach to the previous spring's maximum to minimum flow ratio to assess the impact of spring freshets on YCT and RBT recruitment. We attempted to estimate abundance of the separate sucker species at both monitoring reaches, but were unable to do so because of lack of recaptured individuals with marks at Conant. We used electrofishing gear mounted to a jet boat to capture fish during our surveys. We used pulsed direct current (DC) at 5 amps, 200 – 300 volts, 50% pulse width, and a frequency of 80 Hertz. Captured fish were identified to species and measured (total length). We marked captured fish with a hole punch in the caudal fin on our marking runs, and used this mark to identify previously captured fish in our recapture runs. We sampled the Lorenzo monitoring reach September 28-29 (marking runs) and October 11-12 (recapture runs). We sampled the Conant monitoring reach October 20-21 (marking runs) and October 27-28 (recapture runs).

Weirs

Three electric weirs and one combination waterfall/velocity barrier and associated traps were installed and operated at the four main spawning tributaries of the South Fork and maintained during the 2011 spring spawning run. Weir installation dates were selected as dates at least one day prior to the earliest dates RBT have been captured in the respective traps in previous years. Weirs were operated until July 12 (Burns Cr), July 9 (Pine Cr), June 28 (Rainey Cr), and June 15 (Palisades Cr). On June 15, a high flow event damaged the Palisades Creek electric weir by pulling the electrodes out of the concrete sill which necessitated shutting down the electric weir for the remainder (the majority) of the spawning run.

All fish captured at Burns, Pine, Rainey, and Palisades creeks were identified to species, sexed according to expression of milt or eggs or head morphology, and measured to the nearest mm (total length). Yellowstone cutthroat trout were marked with a PIT tag or a caudal fin punch and released upstream of the weir. We removed the adipose fin from cutthroat trout that received PIT tags as a secondary mark to evaluate tag loss and make future scanning for PIT tags more efficient. All cutthroat trout captured in the trap with adipose fin clips were scanned for PIT tags. RBT were removed from the runs, placed in a holding pen at the Palisades Canal screen yard, and later transported to the Victor kids (Trail Cr.) pond. Yellowstone cutthroat trout that fell back below the electric barrier or over the fall/velocity barrier and were captured again in the trap, as evidenced by having fresh marks (adipose fin clips or caudal fin punch) were noted to quantify fall back rates at each tributary trap.

We estimated efficiencies for the traps at Burns and Pine creeks by capturing trout upstream of the traps using backpack electrofishing units and noting the percentage of marked fish over 297 mm, indicating those YCT had been handled at the trap. We could not evaluate trap efficiencies at Rainey Creek or Palisades Creek because of the limited number of marked YCT passed upstream of the traps. Efficiencies were calculated as the number of cutthroat trout ≥ 297 mm with PIT tags or caudal fin punches divided by the total number of cutthroat trout ≥ 297 mm. The 297 mm length cutoff was identified because it was 1.96 standard errors less than the average total length of all YCT captured at the Burns and Pine creeks fish traps in 2011, and effectively eliminated skewing error resulting from resident YCT that typically are less than 297 mm.

South Fork Angler Incentive Study

In 2010, IDFG initiated the South Fork Angler Incentive Study to determine if monetary rewards and community service opportunity could increase harvest rates of RBT in the South Fork. During January and February 2010, 575 RBT were marked with coded wire tags (CWT) in the snout using five different six-digit numbers corresponding to the following monetary values: $50, $100, $200, $500, and $1,000. Rainbow trout were captured, tagged, and released from Palisades Dam downstream to Heise. The breakdown of the number of RBT marked with the different dollar amounts were as follows: $50-300, $100-200, $200-50, $500-20, and $1,000-5. With fewer than expected tag returns in 2010, an additional 600 RBT were marked with CWT in February 2011 using the same value groups at the same quantity, except for the $50 group which included 325 RBT in 2011. Anglers wishing to participate in the program were requested to turn in the heads of RBT to the IDFG regional office directly or via freezers placed at the Byington and Conant boat ramp areas. On the first Friday of every month, we scanned the heads that had been turned in for CWTs. When CWTs were found, the angler was notified to verify the address and inform them of the amount of money they would receive.

Retention of CWT by marked RBT was a concern for several reasons. First, this was the first time that the hand-held tagging tool used to mark RBT had been used in Idaho, and its efficacy had not previously been evaluated. Second, many of the return tags from 2010 were double length despite most of the RBT having received single length CWT. Thus, the effect of tag length on retention was a concern. Third, despite similar numbers of marked fish being released (anchor tags in 2009 and CWT in 2010) the return on CWT was much lower (Schoby et al. *In Press*). To address these concerns, we implemented a study of CWT retention at Mackay Hatchery using hatchery RBT. We believe tag loss could explain the lower than anticipated tag return rates experienced in 2010. We marked 51 hatchery RBT with CWT in their snouts on February 11. Test fish were anesthetized with MS-222, measured (TL), marked, and released in a circular tank. Regular length CWT were placed in the snouts of 25 test fish that had a mean TL of 216 mm (range 180 to 240 mm). Double length tags were placed in the snouts of 26 test fish that had a mean TL of 213 mm (range 186 to 250). PIT tags were placed in all trout to individually identify fish in either group, which would make identifying tag loss between groups possible. The presence of both CWT and PIT tags were checked monthly for 7 months. We planned on using a paired t-test to compare retention rates between regular and double length CWT, but determined the test was not warranted.

During the Angler Incentive Study, anglers not only could receive money for winning South Fork Snake River fish turned in, but they also had an opportunity to provide food to local families and individuals in need. Non-consumptive anglers who wished to participate in the program could harvest fish and donate their catch via the same channels used to turn in heads, but could also turn in the cleaned fish carcass which was in turn given to the Eastern Idaho Community Action Partnership to distribute to local people in need of food.

PIT Tags

In 2011, we again marked YCT with passive integrated transponder (PIT) tags in continuation of an effort started in 2008 to assess general movement patterns, spawning stream fidelity, spawning durations, river-wide population abundance, fish growth rates, and population growth rates. We marked YCT when handling fish during tributary weir operations, fall population surveys, weir efficiency surveys, and during winter electrofishing efforts that were part of the angler incentive study. We recorded the date, TL, and location for each PIT-tagged YCT. The presence of hook or bird scars was also noted. The sex of individual YCT was recorded when fish were PIT-tagged at a tributary weir. We removed the adipose fin on PIT-tagged fish to facilitate easier identification of marked individuals during recapture events and for the evaluation of tag loss.

We assessed spawning stream fidelity for PIT tagged YCT observed in tributaries and general habitat fidelity comparing recapture locations when recapture events occurred during the same time of year that original marking occurred. We described general movement patterns based on recapture data and quantified observed maximum migration distances, which are conservative distances. We quantified straying rates for YCT with more than one capture event in a tributary for separate spawning runs (multiple year recapture events), and we estimated the percentage of the YCT that spawned in tributaries in 2011 by dividing the number of YCT observed during spring spawning runs in South Fork tributaries by the number of YCT that were originally marked with PIT tags in the main stem of the South Fork.

RESULTS

South Fork Population Monitoring

We captured 999 trout at the Lorenzo monitoring reach, including 250 YCT, 29 RBT, 718 BNT, 1 lake trout, and 1 kokanee salmon. We also captured 366 Utah sucker (no bluehead sucker were observed). Our abundance estimates for age 1 and older YCT (≥102) and BNT (≥178) were 279 and 1,058 trout per kilometer, respectively (Table 19; Figure 37). Density estimates for YCT in 2011 were similar to available estimates back through 1999 based on overlapping 95% confidence intervals. Non-overlapping 95% confidence intervals indicated brown trout estimates from 2011 were significantly higher than the 2010 estimate (Figure 37). An abundance estimate for RBT has never been possible in the previous 16 surveys at Lorenzo due to the low number of RBT encountered. Like previous years, it was again not possible to estimate RBT abundance in 2011, as no marked fish were captured during the recapture runs. However, with a total trout estimate of 1,770 trout/km and RBT comprising 2.9% of the catch, we extrapolate a RBT estimate of 51 RBT/km in the Lorenzo reach in 2011. A Utah sucker estimate was possible in 2011 with 4 marked fish observed during the recapture runs. The density estimate for Utah sucker in the Lorenzo monitoring reach was 1,434 fish/km (95% confidence interval: 366 - 2,550). Since 2004, trends in YCT abundance at Lorenzo monitoring reach have been increasing (Figure 38). The intrinsic rate of change (r) for YCT at Lorenzo was positive and the 90% confidence interval did not include zero (r = 0.21, lower 90% r = 0.16, upper 90% r = 0.26). The intrinsic rate of change for BNT had a 90% confidence interval that included zero which indicated neither a positive or negative change in BNT abundance at Lorenzo (r = -0.04, lower 90% r = -0.18, upper 90% r = 0.09).

We captured a total of 2,375 trout at the Conant monitoring reach. This included 971 YCT, 742 RBT, 661 BNT, and 1 kokanee salmon. We captured a total of 59 Utah sucker and 1 bluehead sucker during the Conant survey. We estimated there were 1,225 YCT/km (±221), 1,190 RBT/km (±256), and 796 BNT/km (±166) of age-1 and older trout (Figure 39). The 2010 estimates for RBT and YCT per km were nearly identical to those from 2011 and statistically, there was no difference between these estimates as their 95% confidence intervals overlap. The total trout estimate of age-1 and older fish at Conant in 2011 was 3,002 trout/km and is the new all-time high estimate since our monitoring program began in 1986 (Table 20). We were not able to estimate abundance of Utah sucker as no marked fish were observed for this species during recapture events. The intrinsic rate of change for YCT at Conant was positive and had a confidence interval that did not include zero indicating abundance of YCT has increased at Conant since 2004 (r = 0.12, lower 90% r = 0.04, upper 90% r = 0.19). The intrinsic rate of change was positive for RBT at Conant as well indicating an increasing population since 2004 (r = 0.15, lower 90% r = 0.07, upper 90% r = 0.23). The post 2004 intrinsic rate of change for BNT at Conant did not show an increasing trend with r = 0.10 and associated 90% confidence bounds of 0.00 and 0.21.

We could not detect an effect of spring freshets on the ratio of age-1 YCT and RBT. The linear model regression the age-1 YCT: age 1 RBT against the previous years' max:min flow was not significant (F=0.048; df=5; p=0.837). This is evidenced by a flat trend line when these variables were plotted (Figure 40).

Weirs

At the Burns Creek weir, we captured 1,078 trout including 1,073 Yellowstone cutthroat trout and five rainbow trout (Table 21). By June 27, 50% of the YCT run had passed the Burns Creek trap. The observed YCT sex ratio at Burns Creek was 49% male, 51% female. While a total of 1,073 YCT were handled at the Burns Creek trap, 182 (20%) of the unique 891 YCT captured at the trap fell back downstream of the fall/velocity barrier and entered the trap again. We captured 52 fluvial YCT upstream of the fish trap on July 12. All but 5 of these fish were previously captured in the fish trap, yielding a trapping efficiency estimate of 90%.

We captured 1,836 YCT and one RBT at the Pine Creek electric weir (Table 21). On June 22, 50% of the YCT run had passed the Pine Creek trap. The observed sex ratio at Pine Creek was 27% male and 73% female. Of the 1,509 individual YCT observed at the Pine Creek trap, 327 (22%) fell back downstream through the electric barrier after being passed upstream, and were later captured again in the trap. On July 7, we captured 35 fluvial YCT in Pine Creek and West Fork Pine Creek upstream of the trap. Of these YCT, 17 were marked, indicating our trapping efficiency was 49%.

We did not capture any trout at the new Rainey Creek weir in 2011. Several suckers were observed trying to pass the electric barrier, but no fish entered the fish trap. A stray electrical field was documented in the trap at Rainey Creek which likely negatively affected fish movements. Trapping success may also have been affected during a high flow event in mid-June when the entire barrier and trap structure was submerged for three days. During these flows, fish may have swam around the structure and avoided the electric field and trap.

We captured 44 trout during the early portion of the run in Palisades Creek electric fish weir before the weir was damaged on June 15. Of the 44 fish captured, 13 were RBT and 31 were YCT. There were 30 individual YCT captured in the trap and one female swam downstream through the electric weir before re-entering the trap and being captured again. In this early part of the Palisades Creek YCT spawning run, 67% were male and 33% of the YCT were female.

South Fork Angler Incentive Study

During 2011, a total of 1,919 RBT were turned in for a potential reward compared to 3,048 RBT that were turned in during 2010. In 2011, 228 anglers participated in the incentive program compared to 683 anglers in 2010. Of the 1,919 RBT checked in 2011, 16 (0.8%) had CWT including 5-$50, 8-$100, 1-$200, and 2-$500 for a total of $2,250. This brought the total incentive expenditures for 2010 - 2011 to $4,550. Anglers turned in an average of 7.3 heads each time they came in, although the number ranged from 1 to 240 which was up from 2010 when the average was 3.5 heads per angler. Most winning anglers won once during the year, although one angler turned in three winning fish. Thirteen of the fourteen winning anglers were Idaho residents while the remaining one was from Maryland. Nearly half of the anglers that participated in the study (46%) used bait, and most of the anglers (83%) kept all of the RBT they caught. We believe the abnormally high flows during 2011 resulting from the large snowpack we received affected fishing effort on the South Fork, and was largely responsible for the reduction in rainbow trout turned in for analysis.

All test fish at Mackay Hatchery retained their CWT for the entire 7 month retention study. Tag retention was 100% for both the standard and double length tag groups. As such, we expect that a high proportion of CWT fish released to the wild also retained their tags. Tag loss is an unlikely factor contributing to the low number of reward fish encountered over the past two years.

PIT Tags

In 2011, we marked an additional 3,429 YCT with PIT tags bringing the total number of marked YCT released in the South Fork since 2008 to 12,815. We recorded 1,589 recapture events during 2011. We replaced lost tags on 337 of the 1,589 recaptured fish, indicating tag loss was 21%.

Most recapture events for individual PIT-tagged YCT (99%) occurred in the same area they were originally tagged (Table 22) when the recapture occurred during the same time of year (season) as the original tagging. There were 980 recapture events that occurred during the same season the YCT was originally tagged, i.e. the recapture occurred during fall sampling when the fish was originally tagged during fall sampling in a previous year or the recapture occurred a tributary weir and the fish was originally tagged at a weir, etc. Only 10 of the 980 recapture events from this group were found at different locations than where the original tagging occurred. All of these roaming fish (8) had recapture and initial tagging events during the winter (January – February) in the main river and the largest distance between initial tagging and later recapture locations was 17 river km.. The other two were YCT that strayed between tributaries during the spawning season.

Spawning tributary fidelity was nearly 100% for 486 PIT-tagged YCT recaptured at tributary weirs where they were originally tagged. There were two YCT that were captured during spawning runs in two different streams in 2010 and 2011. Both of these YCT that strayed were part of the Pine Creek spawning run in 2010 and were captured in the Burns Creek spawning run in 2011. Based on these two fish, stray rates were 0.4%.

Some evidence of lengthy migrations was apparent for fish marked and recaptured at different locations (Table 22). The Lorenzo monitoring site is the furthest downstream reach of the South Fork where YCT have been PIT tagged. During the 2011 spawning run, YCT that had originally been tagged in the Lorenzo reach were observed in both Burns and Pine creeks, distances of approximately 44 and 69 river km, respectively. Downstream migration during spring spawning runs was also observed at both Burns Creek and Pine Creek. Yellowstone cutthroat trout that were originally tagged from as far upstream as the Irwin area were observed in Burns Creek during the spawning run, which means these fish bypassed two suitable spawning tributaries and specifically selected for Burns Creek. Further, additional YCT from the Palisades Creek area were observed in the Pine Creek run, again selecting against two closer, upstream tributaries in preference for Pine Creek.

In 2011 we recaptured 1,067 YCT that had previously been marked with PIT tags and had retained their tags. Of these, 326 YCT were originally marked in the main stem of the South Fork prior to the 2011 spring spawning run. Nearly half (49% or 159) of YCT originally PIT tagged in the main stem of the South Fork were observed in a spawning tributary during the spring.

DISCUSSION

South Fork Population Monitoring

Trout abundances in the South Fork are at or near all-time highs, but non-native RBT continue to threaten the long-term persistence of native YCT. Trends in YCT abundance at both the lower and upper river monitoring reaches indicate YCT abundance has increased since the three-pronged management approach for YCT conservation was initiated in 2004. If the increasing YCT abundance trend continues, the YCT density at the Conant monitoring reach would equal the pre-1990 average of 1,973 YCT/km by 2019 and the YCT abundance at Lorenzo would exceed the pre-1990 average of 285 YCT/km in 2012. While increasing YCT abundance is encouraging for conservation efforts, RBT abundances have also increased, raising the potential for hybridization and competition between RBT and YCT to occur. An increasing YCT population helps accomplish the primary objective of preserving the genetic integrity and population viability for native YCT stated in the IDFG state fish management plan (IDFG 2007) because of reduced risks to the population due to genetic drift (Adkison 1995) and because of increased viability with increased abundance (Hilderbrand 2003). However, the primary threat to both the genetic integrity and population viability of YCT in the South Fork is non-native RBT, so an increasing population of RBT is cause for concern. Across their native range, YCT have not persisted as strong populations when RBT are abundant (Allendorf and Leary 1988; Hiltt et al. 2003; Gunnell et al. 2008; Mulfeld et al. 2009; Seiler and Keeley 2007a; Seiler and Keeley 2007b). A significantly increasing trend in RBT abundance at the Conant monitoring site may necessitate the future use of other management tools in addition to the three-pronged management approach to realize a declining RBT population.

While it is clear that the three-pronged management approach is benefitting YCT conservation (Van Kirk et al. 2010), favorable water conditions have likely played a role as well. Since 2004, the average annual discharge from the South Fork Snake River has been 80% or more of the 68 year average of 181 cm (6,382 cfs) in six of eight years, and exceeded it twice (2009 and 2011). In 2011, the average annual discharge was 143% of the long-term average (USGS 2012). These recent good water years likely resulted in increased recruitment of YCT in tributaries and the main river through an increase in the number of spawners (Herger et al.

1996), an increase in egg to fry survival (Moore and Gregory 1988), and an increase in overwinter survival (Schrader and Griswold 1992).

A non-significant test of the effect of spring freshets on the abundance of age 1 YCT and RBT is not surprising as the sample size is small. There were only 6 years of data available for this analysis, and only two years where the ratio of winter:spring flows exceeded our recommendation of 15:1. Additionally, spring freshets with the timing and magnitude indicated as beneficial for YCT by Moller and Van Kirk (2003) have not been realized in any of those years. Thus, it is too early to definitively determine the effect of spring freshets on relative recruitment of YCT. Regardless, pursuit of flows deemed beneficial to cutthroat trout should be aggressively pursued annually until this relationship can be better defined.

The significantly higher abundance estimate for brown trout at both the Conant and Lorenzo monitoring sites warrants attention, but is not cause for concern yet. Brown trout populations have been variable in the South Fork Snake River since sampling began in 1982. The variability in brown trout abundance has to date, been independent of RBT or YCT abundance. In other words, brown trout do not appear to be limiting populations of native YCT. While trends in both RBT and YCT have significantly increased since 2004, the trend for BNT was unchanged over the same time period albeit with considerable annual variability. Currently, the lack of a statistically significant increasing trend in brown trout abundance may not warrant management changes. However with brown trout abundance at an all-time high at the Conant monitoring reach, the population should be carefully monitored over the coming years as management changes may be required to reduce brown trout abundance if data indicate high brown trout abundance starts to negatively impact YCT population trends. Brown trout are not native to the South Fork, and have been shown to negatively impact native trout in other systems. The presence of BNT have been linked to declines of cutthroat trout abundance and/or distribution in Utah (Budy et al. 2007; Budy et al. 2008) and Montana (J. Wood, Montana Fish Wildlife and Parks, personal communication), and warrants further investigation.

<u>Weirs</u>

Challenging conditions with high spring flows, weir damage, and stray electric fields made trapping spawning runs in South Fork tributaries to remove RBT difficult, but also provided insight into ways to better manage these weirs in the future. While the high flows did damage the Palisades Creek electric weir causing it go offline for the majority of the run, and made trapping difficult and less efficient at the other tributaries, the traps were largely operational despite the adverse conditions. Picket or floating panel type weirs such as those used prior to the electric weirs and combination barrier would not have been functional at any of the tributaries in 2011. Our new designs, although challenged by adverse environmental conditions, did perform effectively for portions of the run. We also learned a lot about the required operation and maintenance for the new weir designs. Most of the problems experienced with the weirs in 2011 can be avoided or mitigated for. For example, the damage at Palisades Creek occurred because of two issues, both easily addressed in the coming years. First, the stop logs had been installed prior to runoff at the request of the Palisades Canal operators so that water could be diverted during low flows. Second, the electrodes were not anchored down sufficiently in the original or modified designs approved by the manufacturer, Smith-Root, Inc. These issues have been addressed. The Palisades Canal Company agrees that installing stop logs for diverting water into the canal will not be done until after run-off peaks, and Smith-Root, Inc. reviewed the damage and made it possible for all of the electrodes to be replaced and ensured they were more securely attached and sealed (Figure 41).

Stop logs were also in place at the Pine Creek electric weir throughout the spawning season. Willow clumps that washed from upstream areas stuck on the stop logs on the Pine Creek weir. We found some dead YCT tangled in the willow clumps facing upstream on the upstream boundary of the electric barrier. These dead YCT were not marked, and likely passed over the electric barrier but did not have enough swimming control to avoid the willow, which trapped and eventually killed these migrants. The settings used for the Pine Creek weir were similar to settings used in 2010 when trapping efficiencies were much higher. However, with the high flows experienced in 2011, the settings were not adequate and will be adjusted accordingly. Once done, we anticipate Pine Creek weir functioning properly and effectively.

The barrier at Burns Creek was subject to deposition of gravel in 2011, when over 0.5 m of material was deposited on the velocity barrier apron, which compromised the functionality of the velocity barrier. The waterfall continued to function, but trapping efficiency was 90% in 2011 compared to 100% in 2010 (Schoby et al. In Press). We hired a contractor to remove the sediment from the velocity barrier and proposed to evaluate the effectiveness of the weir again in 2012. We anticipate the removal of the deposited gravel will alleviate the problems experienced in 2011.

The stray electric field in the Rainey Creek weir is the most troublesome problem experienced in 2011. Smith-Root, Inc. has researched the site and proposed modifications to address the field that include adding metal to the trap area to ground out the stray electricity. The modifications will be implemented in 2012 and will be evaluated. Thus, while the 2011 spawning season trapping efforts on the South Fork tributaries were fraught with difficulties, we feel the underlying issues have been addressed which should result in more effective trapping in future high run-off years. Unfortunately, it is apparent that these weirs will require annual maintenance and adjustments to ensure proper function and performance.

South Fork Angler Incentive Study

Retention of CWT is not affecting success rates of South Fork anglers turning in winning fish for the Angler Incentive Study. With retention rates of 100% on our hatchery test fish, CWT retention is not a concern with fish released back into the wild population during the South Fork Angler Incentive Study. The hand-held multi-shot tagging tool appears to be an effective option for marking small numbers of fish. The advantage of using a hand-held tool instead of a machine is the portability of a hand-held unit and the fact that varying sizes of fish can be tagged at the same time because head molds are not necessary. Thus, a hand-held tagging tool is ideal for many field settings. The length of the CWT did not affect retention rates. Thus, the observation that many of the winning fish from the South Fork observed in 2010 had double length tags versus standard length tags was probably due to random chance. Since this retention study was not completed prior to marking additional RBT in the South Fork in 2011, all of the RBT marked with CWT received double length tags. However, standard length tags could be used in the future without adverse effects on retention.

Anglers' odds of turning in a RBT marked with a CWT from the South Fork increased from 0.6% to 0.8% after IDFG marked an additional 600 RBT in 2011. This makes biological sense and further provides evidence that tag loss did not occur in 2010. With an additional marking effort early in 2011, we doubled the number of RBT released in the South Fork marked with CWT. However, because tagging events were separated by a year, annual RBT mortality rates negatively affected how many marked RBT were still present in the South Fork in 2011. Annually mortality rates vary widely, but are often reported around 50% for stream-dwelling trout (Kwain 1981; Davies and Sloan 1986; and Smith and Griffith 1994). If rainbow trout in the South

Fork experience an annual mortality rate of 50%, we would expect an increase in anglers' odds of turning in a tagged rainbow somewhere around 50% with the additional 600 marked fish released in 2011. This was nearly observed (33% increase). If RBT tagged in 2010 with standard length tags had lost their tags, we likely would not have observed an increase in winner success rates.

Water conditions were high and muddy and were not conducive to angling on the South Fork Snake River for much of 2011 with an annual discharge 143% of normal during 2011 (USGS 2012). Fishing pressure appeared to be lower than normal on the South Fork from March through mid-August. As such, we believe that the number of trout turned in from the Angler Incentive Program does not accurately reflect the influence this program may be having on angler behavior. In order to truly assess the effect of this program, it should be extended through 2012 and verified with a yearlong creel survey to better compare harvest rates during implementation of the Angler Incentive Program to harvest rates prior to this program.

PIT Tags

Information collected from PIT tagged YCT indicates strong fidelity to both spawning tributaries as well as rearing and over-winter habitat. Yellowstone cutthroat trout in the South Fork have been captured during three different seasons annually since 2009, including winter main river sampling events, spring spawning runs at tributary weirs, and fall population monitoring surveys. Despite the differences in these three separate annual sampling events both spatially and temporally, the vast majority of recaptures (>99%) occur in the same area of the drainage cutthroat were originally marked in if the original tagging occurred in the same season. This doesn't mean that YCT in the South Fork are a sedentary species. Indeed, the recapture locations of PIT tagged YCT indicate that YCT utilize much if not all of the drainage, with documented upstream spawning migrations as far 75 km and downstream spawning migrations as far as 41 km in 2011. Rather, this information highlights how important connectivity and high quality habitat throughout the entire system are for the continued persistence of cutthroat trout. It also shows the need to manage the South Fork fishery as an entire system, and not as individual parts. These PIT tag recapture data may also provide ancillary evidence for why YCT densities are much lower in the lower river than in the canyon or upper river sections. Yellowstone cutthroat trout that were originally marked in the Lorenzo monitoring reach were observed in both tributaries where weirs were functional throughout the spawning run (Burns and Pine creeks). Half of these lower river YCT were documented repeat spawners in Burns and Pine creeks. With high site fidelity, YCT from the lower river exhibit potentially riskier life history strategies than those from the canyon or upper river sections because of lengthy migrations past numerous large unscreened irrigation diversions.

PIT tag recapture data also indicate at least half of the YCT in the South Fork spawn in tributaries. However, because of the limitations of determining whether fish actually did not enter a spawning tributary, the estimate of YCT population that are tributary spawners is biased low to some unknown amount. The primary cause of this bias is weir trapping efficiencies that are less than 100%. We could document YCT that did enter a spawning tributary, but a lack of detection could not be considered evidence that YCT did not enter a spawning tributary when some YCT are known to get past the weir without detection. Furthermore, our estimate of the proportion of YCT that spawn in tributaries could be biased low due to alternate year spawning. The analysis in this report was just for 2011. In coming years, with more recapture data at the tributary weirs, we will be able to estimate annual versus alternate year spawning rates. Despite the fact that the estimate of 49% of the South Fork YCT spawn in tributaries is biased low, this is still a substantial amount of the population and indicates the importance of tributary habitat for YCT. Post-spawning use of tributary habitat by fluvial YCT may be more than previously suspected. In late October 2011, we installed a remote PIT tag sensor near the mouth of Burns Creek to record movements of PIT tagged trout as they travel over the sensor. Despite not being activated until October 20, there were 28 fluvial YCT that were captured during the spring spawning run at the Burns Creek weir that were then recorded at the remote PIT tag array moving downstream . The last record was on December 15, which indicates cutthroat trout are residing in these tributaries much later than previously thought. In fact, some cutthroat may only use the main river for overwintering, and possibly reside in the tributaries for as much as eight months of the year. IDFG plans to install remote PIT tag arrays on the other spawning tributaries in 2012 and 2013 and will be able to further investigate tributary use by fluvial YCT as well as spawning durations, effects of tributary weirs on migration behavior, and outmigration timing of juvenile YCT.

Models to estimate river-wide population abundance and population growth require multiple years of data, which may be available for YCT in the South Fork Snake River as early as 2013. In order to maximize the results from this multi-year effort, PIT tag retention could be improved. In 2011, we estimated our overall tag loss rate at 21%. In 2010, the overall tag loss rate was 19% (Schoby et al. In Press). Much of the PIT tag loss occurs during spawning (Meyer et al. 2011). It is possible that PIT tags are expelled during the spawning process, along with eggs and/or milt. Tagging locations other than the body cavity should be evaluated.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor effects of spring freshets, the operation of tributary weirs, and angler harvest of RBT on South Fork Snake River RBT, YCT, and BNT populations and adjust management actions accordingly.

2. Continue to use tributary weirs to protect spawning YCT in South Fork tributaries from risks of hybridization and competition.

3. Use a creel survey in conjunction with the Angler Incentive Program to compare harvest rates of RBT with the Incentive Study to creel survey data from prior years.

4. Continue marking YCT with PIT tags in the South Fork drainage to assess spawning stream fidelity, spawning periodicity, tributary use and duration, general movement patterns, and population size and growth rates using an open population model.

5. Use PIT arrays, screw traps, electrofishing surveys, and seines to better assess entrainment rates through the Great Feeder Diversion in the Dry Bed Canal.

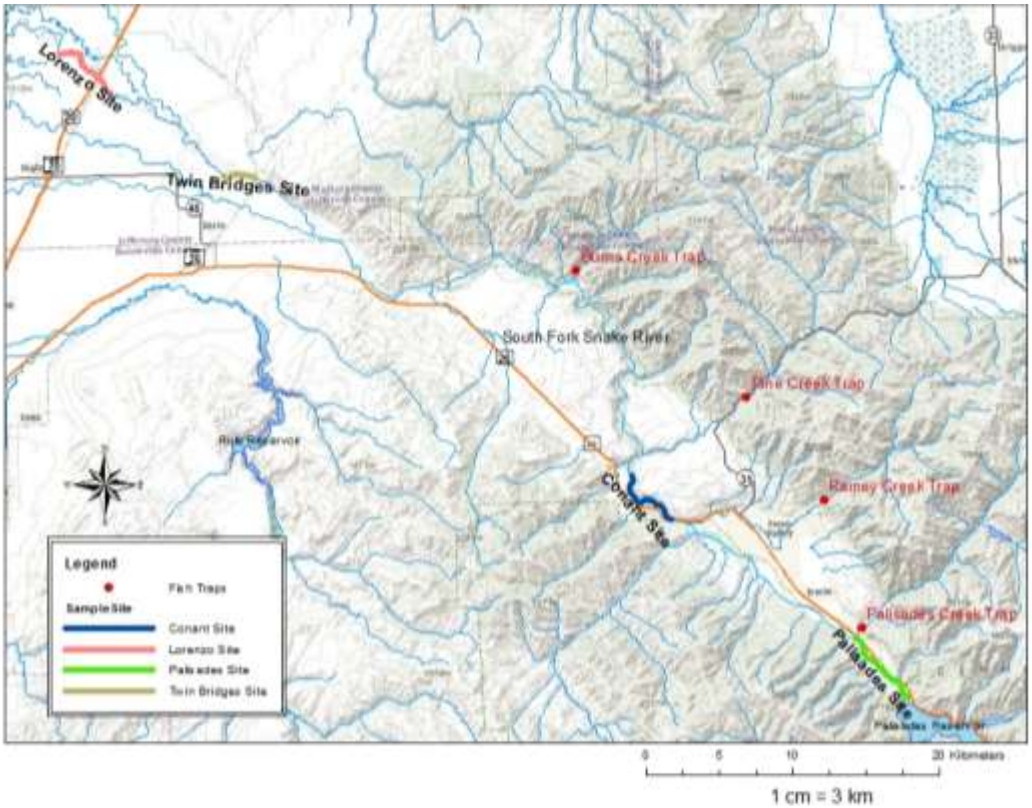

Figure 36. Locations of monitoring sites on the South Fork Snake River and weirs on tributaries.

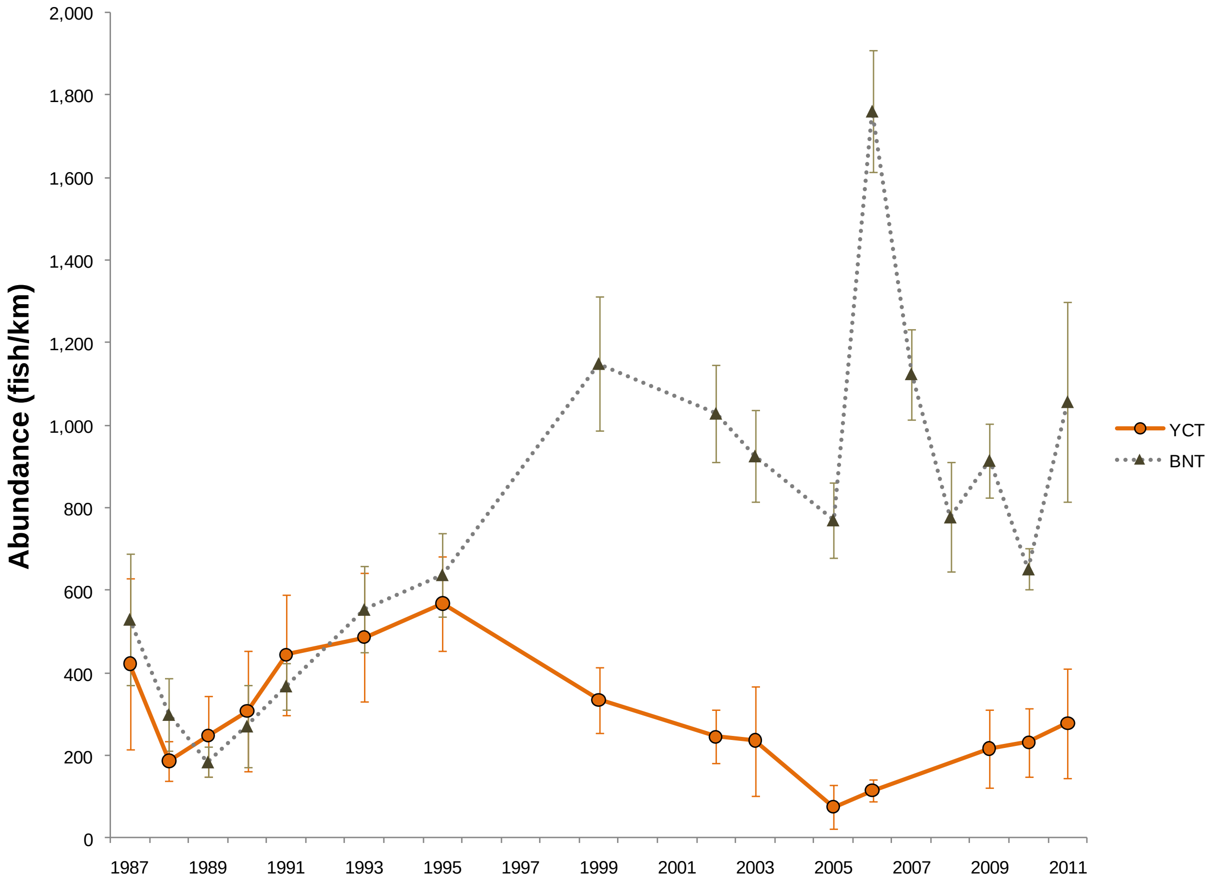

Figure 37. Estimated abundances of Yellowstone cutthroat trout (YCT) and brown trout (BNT) at the Lorenzo monitoring site on the South Fork Snake River from 1987 through 2011 with 95% confidence intervals.

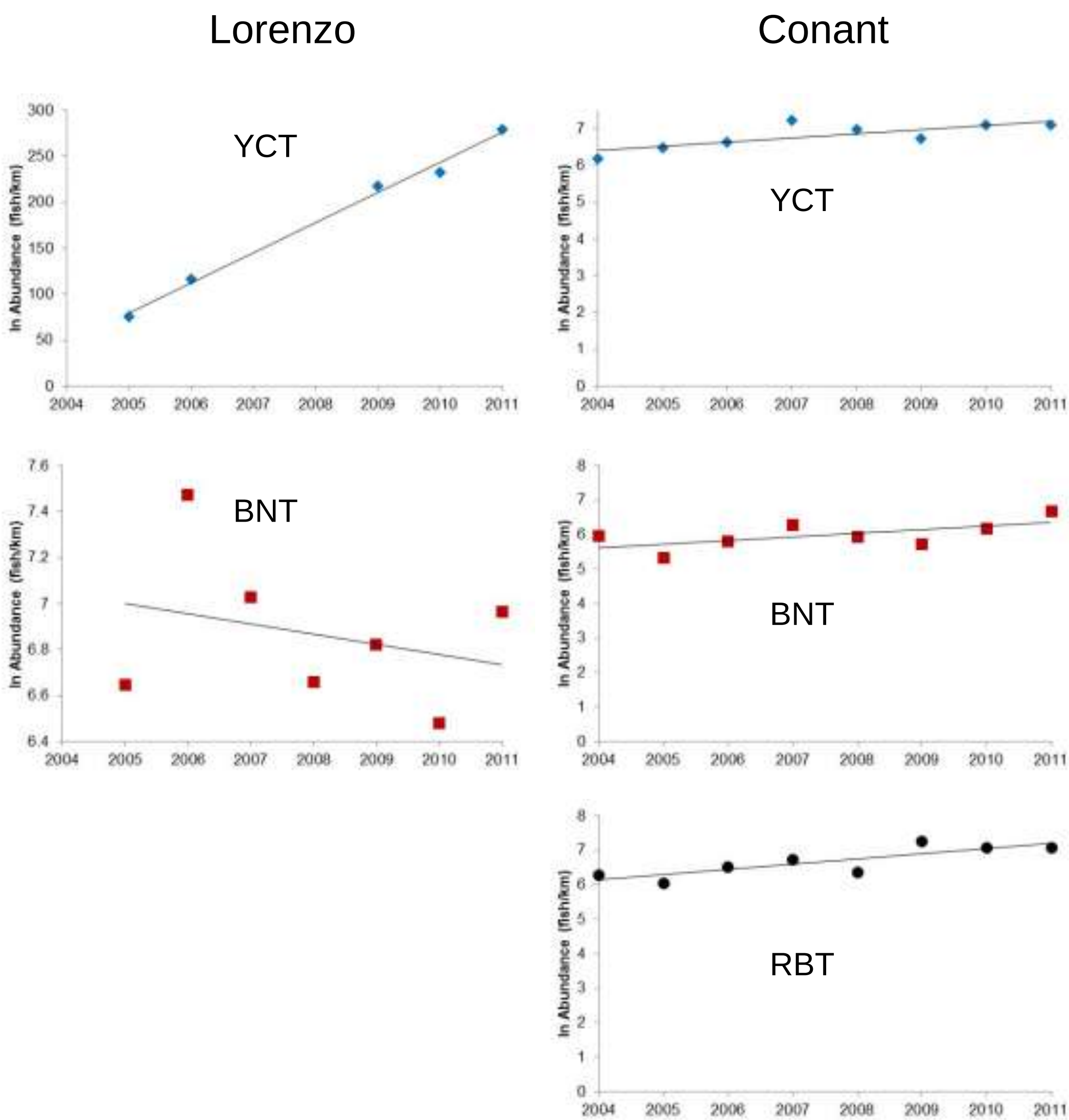

Figure 38. Linear regressions of $\log_e$-transformed abundance estimates for Yellowstone cutthroat trout (YCT), brown trout (BNT), and rainbow trout (RBT) and associated regression lines. The slopes of the regression lines are equivalent to the intrinsic rates of population change (*r*).

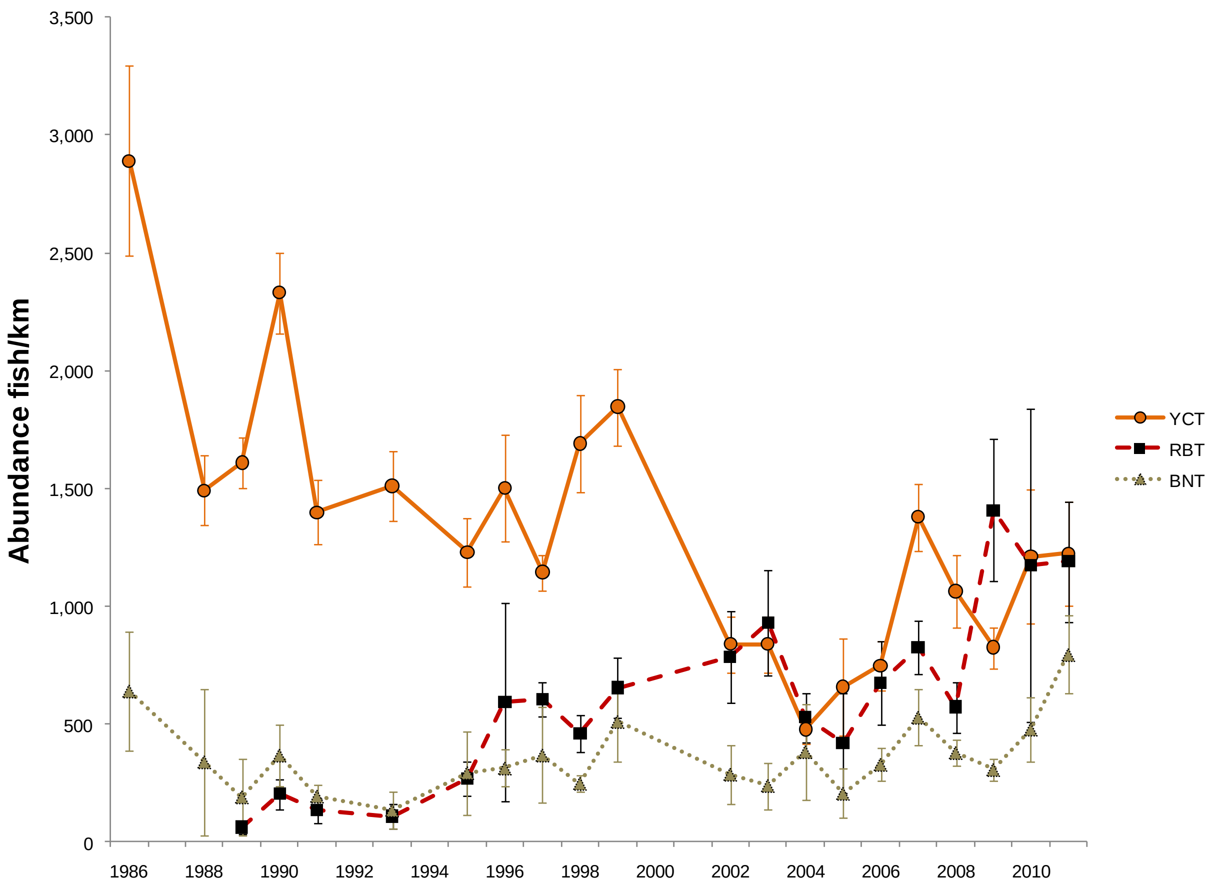

Figure 39. Estimated abundances of Yellowstone cutthroat trout (YCT), rainbow trout (RBT), and brown trout (BNT) at the Conant monitoring site on the South Fork Snake River from 1986 through 2011 with 95% confidence intervals.

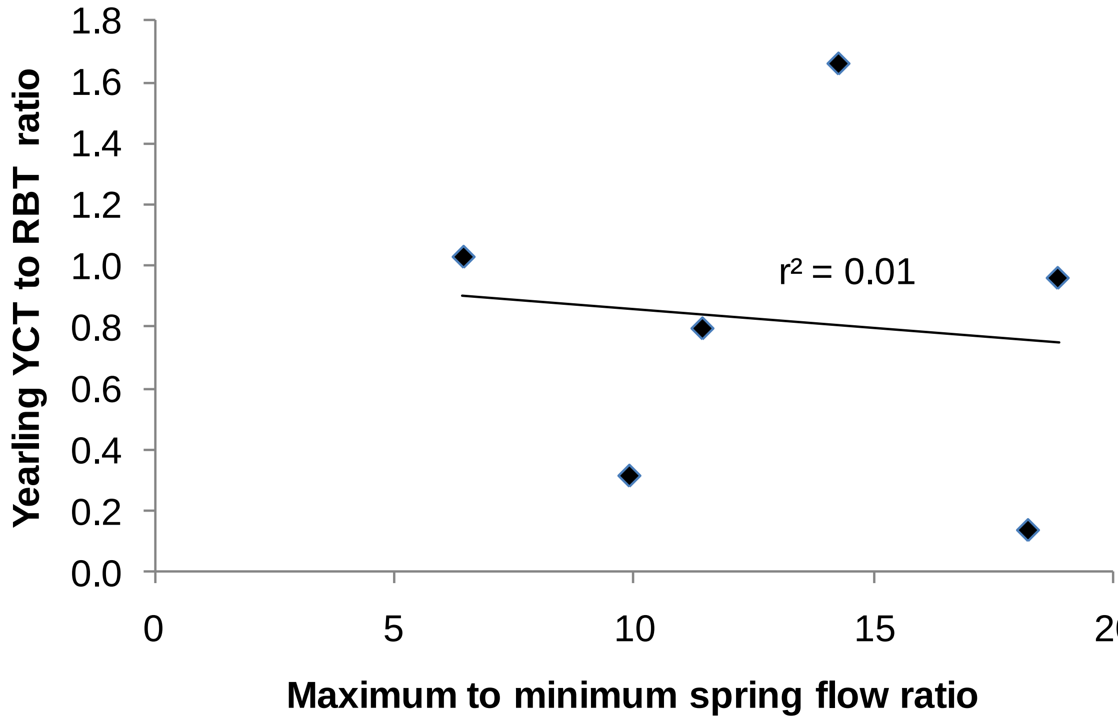

Figure 40. Yearling Yellowstone cutthroat trout (YCT) to yearling rainbow trout (RBT) ratios plotted against spring maximum to minimum river discharge ratios in the South Fork Snake River between 2004 and 2011 (2008 and 2010 excluded due to unavailable yearling estimates).

Figure 41. Newly repaired electrodes at the Palisade Creek electric weir after high spring flows pulled two electrodes out of the sill during the spawning run. The new electrodes are sealed on the edges with epoxy and secured with bolts into the concrete sill and walls.

Table 19. Summary statistics from the Lorenzo monitoring site between 1987 and 2011 on the South Fork Snake River.

	Yellowstone cutthroat trout							Rainbow trout							Brown trout							Total trout							
Year	M	C	R	R/C	YCT/Km	SD	CV	M	C	R	R/C	RBT/Km	SD	CV	M	C	R	R/C	BNT/Km	SD	CV	M	C	R	R/C	trout/Km	SD	CV	Mean Q (cms)
1987	146	63	6	9.5	422	207	0.25	2	0	0	0.0				225	102	12	11.8	531	160	0.15	380	168	18	10.7	970	99	0.10	64
1988	133	88	13	14.8	187	47	0.13	3	2	0	0.0				241	130	23	17.7	300	88	0.15	386	225	36	16.0	529	50	0.09	33
1989	119	74	13	17.6	248	98	0.20	1	2	0	0.0				199	97	22	22.7	185	38	0.10	377	204	35	17.2	677	60	0.09	25
1990	208	91	12	13.2	308	145	0.24	2	0	0	0.0				260	93	23	24.7	272	99	0.18	549	240	35	14.6	949	75	0.08	68
1991	199	175	17	9.7	445	146	0.17	0	6	0	0.0				319	234	47	20.1	369	56	0.08	560	474	64	13.5	953	67	0.07	71
1992																													
1993	144	201	18	9.0	487	155	0.16	6	8	0	0.0				238	270	27	10.0	555	105	0.10	420	531	45	8.5	1,213	74	0.06	57
1994																													
1995	264	196	22	11.2	568	116	0.10	4	5	0	0.0				325	341	41	12.0	639	101	0.08	677	731	66	9.0	1,587	73	0.05	36
1996																													
1997																													
1998																													
1999	194	163	26	16.0	335	81	0.12	3	4	0	0.0				500	588	55	9.4	1,150	161	0.07	711	798	82	10.3	1,485	74	0.05	67
2000																													
2001																													
2002	108	138	14	10.1	246	65	0.13	4	3	1	33.3				457	579	61	10.5	1,030	117	0.06	582	750	76	10.1	1,385	66	0.05	98
2003	90	81	11	13.6	237	133	0.29	2	2	0	0.0				557	432	61	14.1	926	110	0.06	668	593	72	12.1	1,184	61	0.05	81
2004																													
2005	37	47	4	8.5	76	54	0.36	5	2	0	0.0				440	486	67	13.8	771	91	0.06	641	569	71	12.5	2,030	96	0.05	78
2006	112	71	14	19.7	116	25	0.11	10	12	1	8.3				1154	933	140	15.0	1,761	148	0.04	1,326	1,064	155	14.6	2,116	77	0.04	
2007	90	41	2	4.9				17	6	0	0.0				764	446	67	15.0	1,125	110	0.05	888	525	69	13.1	1,504	70	0.05	131
2008	30	34	0	0.0				2	2	0	0.0				373	365	40	11.0	778	132	0.09	415	418	40	9.6	988	77	0.08	157
2009	77	110	10	9.1	218	93	0.22	13	10	1	10.0				603	739	104	14.1	915	90	0.05	718	916	117	12.8	1,236	53	0.04	92
2010	110	91	10	11.0	233	83	0.18	8	11	1	9.1				600	545	110	20.2	653	49	0.04	735	790	121	15.3	956	34	0.04	91
2011	134	126	12	9.5	279	132	0.24	12	17	0	0.0				323	365	27	7.4	1,058	241	0.12	495	544	39	7.2	1,770	153	0.09	107

Table 20. Summary statistics from the Conant monitoring site between 1982 and 2011 on the South Fork Snake River.

	Yellowstone cutthroat trout							Rainbow trout							Brown trout							Total trout							
Year	M	C	R	R/C	YCT/Km	SD	CV	M	C	R	R/C	RBT/Km	SD	CV	M	C	R	R/C	BNT/Km	SD	CV	M	C	R	R/C	trout/Km	SD	CV	Mean Q (cms)
1982					1,899							16							256										
1983																													
1984																													
1985																													
1986	1,170	546	70	12.8	2,890	402	0.07	32	16	2	12.5				183	105	8	7.6	1,034	408	0.20	1,385	667	80	0.12	2,351	236	0.10	102
1987	281							5							26							312							26
1988	1,100	561	98	17.5	1,491	148	0.05	41	18	1	5.6				113	46	4	8.7	548	500	0.47	1,254	625	103	0.16	1,836	88	0.05	103
1989	1,416	1,050	200	19.0	1,610	108	0.03	57	55	10	18.2	102	42	0.21	92	76	11	14.5	308	261	0.43	1,565	1,181	221	0.19	1,791	54	0.03	86
1990	1,733	1,522	317	20.8	2,330	173	0.04	113	109	14	12.8	330	104	0.16	173	117	12	10.3	594	214	0.18	2,019	1,748	343	0.20	2,984	89	0.03	101
1991	1,145	625	140	22.4	1,399	136	0.05	98	54	9	16.7	216	87	0.20	150	119	19	16.0	314	83	0.14	1,393	798	168	0.21	1,616	58	0.04	132
1992	595							34							76							705							60
1993	972	623	100	16.1	1,512	150	0.05	74	41	6	14.6	177	82	0.24	101	64	10	15.6	218	125	0.29	1,147	728	116	0.16	1,643	66	0.04	91
1994	853							87							110							1,050							52
1995	631	542	77	14.2	1,230	147	0.06	130	140	17	12.1	436	116	0.14	150	108	13	12.0	474	284	0.31	911	790	107	0.14	1,696	79	0.05	93
1996	707	548	72	13.1	1,502	225	0.08	155	111	5	4.5	958	677	0.36	212	124	18	14.5	506	126	0.13	1,074	783	95	0.12	2,292	131	0.06	107
1997	910	895	164	18.3	1,145	76	0.03	429	467	72	15.4	974	118	0.06	344	281	82	29.2	595	327	0.28	1,683	1,643	318	0.19	1,969	48	0.02	85
1998	674	682	61	8.9	1,691	204	0.06	216	247	26	10.5	743	127	0.09	257	216	49	22.7	401	58	0.07	1,147	1,145	136	0.12	2,191	79	0.04	110
1999	1,019	883	117	13.3	1,847	163	0.04	345	241	29	12.0	1,055	204	0.10	293	241	31	12.9	825	273	0.17	1,657	1,365	177	0.13	2,827	90	0.03	110
2000	797							260							133							1,190							91
2001	776							321							208							1,305							117
2002	495	394	50	12.7	841	119	0.07	295	257	24	9.3	1,265	314	0.13	111	104	9	8.7	463	197	0.22	901	755	83	0.11	1,803	81	0.05	72
2003	422	571	72	12.6	840	119	0.07	272	360	29	8.1	1,501	364	0.12	143	165	27	16.4	386	160	0.21	837	1,096	128	0.12	1,821	67	0.04	108
2004	315	379	51	13.5	478	61	0.07	227	304	29	9.5	854	168	0.10	169	202	22	10.9	618	328	0.27	711	885	102	0.12	1,441	62	0.04	114
2005	391	254	30	11.8	658	205	0.16	172	142	11	7.7	678	340	0.26	115	95	10	10.5	333	169	0.26	678	491	51	0.10	1,588	200	0.13	106
2006	423	365	54	14.8	749	104	0.07	289	251	23	9.2	1,092	287	0.13	215	223	31	13.9	531	113	0.11	927	839	108	0.13	1,938	80	0.04	
2007	784	568	72	12.7	1,380	142	0.05	565	361	52	14.4	1,329	182	0.07	404	289	50	17.3	854	189	0.11	1,753	1,218	174	0.14	2,713	87	0.03	116
2008	377	554	51	9.2	1,065	156	0.07	187	318	25	7.9	925	174	0.10	205	253	29	11.5	612	92	0.08	769	1,125	105	0.09	1,882	74	0.04	170
2009	623	489	90	18.4	826	87	0.05	475	425	34	8.0	2,270	486	0.11	261	219	42	19.2	495	77	0.08	1,359	1,133	166	0.15	2,276	80	0.04	98
2010	389	307	27	8.8	1,211	284	0.12	286	139	7	5.0	1,893	1,073	0.29	178	154	14	9.1	772	220	0.15	853	600	48	0.08	2,295	297	0.13	127
2011	609	429	70	16.3	1,225	221	0.09	448	311	28	9.0	1,919	412	0.11	357	300	29	9.7	1,283	267	0.11	1,414	1,040	127	0.12	3,002	142	0.05	99

Table 21. Summary tributary fish trap operation dates, efficiencies and catches from 2001 through 2011.

Location and year	Weir type	Operation dates	Estimated weir efficiency (%)[a]	Catch		
				Cutthroat trout	Rainbow trout	Total
Burns Creek						
2001[b]	Floating panel	March 7 - July 20	16	3,156	3	3,159
2002[b]	Floating panel	March 23 - July 5	NE[c]	1,898	46	1,944
2003[d]	Floating panel	March 28 - June 23	17-36	1,350	1	1,351
2004	ND[e]	ND	ND	ND	ND	ND
2005	ND	ND	ND	ND	ND	ND
2006	Mitsubishi	April 14 - June 30	NE	1,539		
2007	ND	ND	ND	ND	ND	ND
2008	ND	ND	ND	ND	ND	ND
2009	Fall/velocity	Apirl 9 - July 22	98	1,491	2	1,493
2010	Fall/velocity	March 26 - July 14	100	1,550	2	1,552
2011	Fall/velocity	March 23 - July 12	90	891	5	896
Pine Creek						
2001[b]	ND	ND	ND	ND	ND	ND
2002[b]	Floating panel	April 2 - July 5	NE	202	14	216
2003[f]	Floating panel	March 27 - June 12	40	328	7	335
2004	Hard picket	March 25 - June 28	98	2,143	27	2,170
2005	Hard picket	April 6 - June 30	NE	2,817	40	2,857
2006[g]	Mitsubishi	April 14 - April 18	ND	ND	ND	ND
2007	Mitsubishi	March 24 - June 30	20	481	2	483
2008	Hard picket	April 21 - July 8	NE	115	0	115
2009	Hard picket	Apirl 6 - July 15	49	1,356	1	1,357
2010	Electric	April 13 - July 6	NE	2,972	3	2,975
2011	Electric	April 11 - July 9	49	1,509	1	1,510
Rainey Creek						
2001[b]	Floating panel	March 7 - July 6	NE	0	0	0
2002[b]	Floating panel	March 26 - June 27	NE	1	0	1
2003	ND	ND	ND	ND	ND	ND
2004	ND	ND	ND	ND	ND	ND
2005	Hard picket	April 7 - June 29	NE	25	0	25
2006	Hard picket	April 5 - June 30	NE	69	3	72
2007	Hard picket	March 19 - June 30	NE	14	0	14
2008	Hard picket	June 19 - July 11	NE	14	0	14
2009	Hard picket	April 7 - July 6	NE	23	0	23
2010	Hard picket	April 13 - June 29	NE	145	1	146
2011	Electric	March 28 - June 28	NE	0	0	0
Palisades Creek						
2001[b]	Floating panel	March 7 - July 20	10	491	160	651
2002[b]	Floating panel	March 22 - July 7	NE	967	310	1,277
2003	Floating panel	March 24 - June 24	21 - 47	529	181	710
2004	ND	ND	ND	ND	ND	ND
2005	Mitsubishi	March 18 - June 30	91	1,071	301	1,372
2006	Mitsubishi	April 4 - June 30	13	336	52	388
2007	Electric	May 1 - July 28	98	737	20	757
2008	ND	ND	ND	ND	ND	ND
2009	Electric	May 12 - July 20	26	202	4	206
2010	Electric	March 19 - July 18	86	545	50	595
2011	Electric	April 7 - June 15	NE	30	13	43
Total by year						
2001				3,647	163	3,810
2002				3,068	370	3,438
2003				2,207	189	2,396
2004				2,143	27	2,170
2005				3,913	341	4,254
2006				1,944	55	460
2007				1,232	22	1,254
2008				129	0	129
2009				3,072	7	3,079
2010				5,212	56	5,268
2011				2,430	19	2,449
Grand Total				28,997	1,249	28,707

[a]Weir efficiency was estimated using several different methods
[b]From Host (2003)
[c]NE = no estimate
[d]Weir was shut down on June 10, but the trap was operated until June 23
[e]ND = no dat; weir either not built or not operated
[f]Weir was shut down early due to high cutthroat trout mortality
[g]Weir was destroyed during high runoff

Table 22. Summary of locations of Yellowstone cutthroat trout PIT-tagging and recapture locations in 2011. The numbers in parentheses indicate the number of recaptured cutthroat trout that were originally PIT tagged a previous year (2008 - 2010).

			Stream location when originally tagged						
Stream location	**# Marked**	**# Recaptured**	**Burns Cr Weir**	**Pine Cr Weir**	**Rainey Cr Weir**	**Palisades Cr Weir or Screenyard**	**Conant Monitoring Site**	**Lorenzo Monitoring Site**	**Main River Winter Electroshocking**
Burns Creek Weir	614	432	296 (161)	1 (1)	0	0	5 (4)	3 (3)	14 (5) [From Rattlesnake Point to Irwin)
Pine Creek Weir	1,277	673	0	413 (130)	0	0	71 (71)	2 (2)	37 (54) [From Rattlesnake Point to Palisades Cr)
Rainey Creek Weir	0	0	0	0	0	0	0	0	0
Palisades Creek Weir and screenyard trap	26	3	0	1 (1)	0	1 (0)	1 (1)	0	0
Lorenzo Fall Monitoring Site	237	26	3 (1)	0	0	0	0	21 (7)	0
Conant Fall Monitoring Site	809	284	1 (1)	14 (4)	0	3 (3)	177 (119)	0	8 (4) [From Dry Canyon to Irwin)
Main River Electrofishing (Angler Incentive Study winter marking)	466	143	4 (4)	24 (24)	0	3 (3)	20 (20)	0	51 (51) [From Rattlesnake Point to the dam)
Burns PIT tag array	0	28	28 (9)	24 (24)	0	3 (3)	20 (20)	0	51 (51) [From Rattlesnake Point to the dam)
Total	**3,429**	**1,589**	**332**	**452**	**0**	**7**	**274**	**26**	**160**

SNAKE RIVER

ABSTRACT

We used jet boat mounted electrofishing equipment to assess fish populations in the Osgood reach of the Snake River during 2011. We estimated the overall trout density (all species collected) at 227 fish/km (95% CI = 187 – 289), which was dominated by brown trout (66%), followed by rainbow trout (27%), and Yellowstone cutthroat trout (7%). Proportional stock density (PSD) and relative stock density (RSD) values indicate that the brown trout population is well balanced with natural reproduction occurring, and that a trophy fishery exists. The rainbow trout population was dominated by fish between 280 mm and 400 mm, some of which may be of hatchery origin. IDFG stocks approximately 1,250 catchable sized rainbow trout in this reach annually which would account for some of the rainbow trout observed in our survey, but the presence of juvenile rainbow trout indicates that natural reproduction is also occurring. Conclusions about the Yellowstone cutthroat trout population are limited based on the low number of fish handled, although we observed natural recruitment, multiple year classes and what appears to be excellent body condition. It appears that biological conditions in the Osgood reach are conducive to fast growth. Overall, it appears that the Osgood reach of the Snake River currently supports a quality trout fishery for both native and introduced trout, and is capable of supporting increased trout densities while continuing to provide a trophy component to anglers in the Idaho Falls area.

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INTRODUCTION

The Snake River in Bonneville County provides an important fishery within the Upper Snake Region, with over 45,000 angler trips in 2003 (Grunder et al. 2004). In regards to angler spending activity in Bonneville County, ID, the mainstem Snake River was second only to the South Fork Snake River, with over $8.3 million in estimated total angler spending in 2011 (IDFG *in press*).

The Snake River begins at the confluence of the Henrys Fork and South Fork Snake Rivers at the Menan Buttes, and flows approximately 56 km before reaching Idaho Falls (Figure 42). The Snake River near Idaho Falls is divided into distinct segments by four hydroelectric dams operated by Idaho Falls Power, which include the Upper Power Pool Dam, City Dam, Lower Power Pool Dam, and Gem State Dam, which marks the southern boundary of IDFG's Upper Snake Region. The absence of fish ladders at these structures prohibits upstream fish passage; downstream passage likely provides the only movement between these river reaches. The inundated portions of river created by these dams limit the amount of spawning habitat available for trout through this reach.

The Snake River in Bonneville County provides a fishery for a self-sustaining population of introduced brown trout as well as wild and stocked hatchery catchable rainbow trout. The river also supports a wild population of native Yellowstone cutthroat trout, as well as introduced smallmouth bass, and white sturgeon *Acipenser transmontanus*. Other native species within this reach include mountain whitefish, Utah sucker, speckled dace *Rhinichthys osculus*, redside shiner *Richardsonius balteatus*, and unidentified sculpin species (*Cottus* spp). Despite its importance as a regional fishery and its close proximity to Idaho Falls, little previous research has been conducted on this reach of the Snake River.

STUDY SITE

During 2011, we sampled the Snake River near the Osgood, Idaho area, just downstream of the border between Bonneville and Jefferson Counties, approximately 14 km upstream of Idaho Falls (Figure 42). The Osgood reach is bounded by an irrigation diversion dam just upstream of the County Line Road Bridge that serves the Great Western and Idaho canals and the Upper Power Pool Dam hydroelectric facility on the downstream end. The reach is characterized by a riverine, braided channel complex in the upper 5.8 km, while the lower 4.5 km is deeper with lower velocity due to the impoundment created by the hydroelectric facility. Widths vary in this reach from approximately 44 m to 215 m, creating a diversity stream depths and corresponding habitat. Stream flows in this reach are regulated by releases from upstream dams and characterized by base flows from November through March, with increasing flows in the spring, and peak flows generally observed in mid-June during the irrigation season (Appendix F). We sampled the riverine section of the Osgood reach, beginning at the top of the island just downstream of the County Line Road Bridge, and extended downstream 3.2 km to an irrigation return on the west bank (Figure 42, Appendix G).

OBJECTIVES

To obtain current information on trout population characteristics for fishery management decisions on the Snake River, and to develop appropriate management recommendations.

METHODS

We used a jet boat mounted electrofishing unit to capture trout during multiple mark and recapture events in the Osgood reach of the Snake River between September 15 and October 24. We sampled on September 15, 21, and 30, and October 4, 13, 18, and 24. We identified all captured trout to species and measured total length (mm). We marked captured fish with a hole punch in the caudal fin during all surveys with the exception of October 24, and used this mark to identify previously captured fish in our subsequent sampling events.

We estimated densities for all trout > 150 mm using the Schnabel multiple mark and recapture method (Schnabel 1938):

$$N = \frac{\sum(C_t M_t)}{\sum R_t + 1}$$

and then portioned the overall trout abundance estimate based on the proportion of each species handled. We calculated proportional stock density (PSD) to describe the size structure of trout populations in the Osgood reach of the Snake River using the following equation

$$PSD = \frac{\text{number } \geq 300 \text{ mm}}{\text{number} \geq 200 \text{ mm}} * 100$$

Similarly, we calculated relative stock densities of fish greater than 400 mm and 500 mm (RSD-400, RSD-500) using the same formula, with the numerator replaced by the number of fish > 400 mm and > 500 mm, respectively (Anderson and Neumann 1996). We also calculated the young-adult ratio (YAR) for brown trout, rainbow trout and cutthroat trout to obtain a relative measure of the reproductive success of each species (Reynolds and Babb 1978). We used the following equation for each species

$$YAR = \frac{\text{number } \leq 200 \text{ mm}}{\text{number} \geq 300 \text{ mm}} * 100$$

and expressed YAR as the proportion (in percent) of the population comprised by juveniles.

RESULTS AND DISCUSSION

We collected 407 trout during seven electrofishing surveys in the Osgood reach of the Snake River, and estimated 725 trout >150 mm (95% CI = 597 – 924; Appendix H) throughout the survey reach, which equates to 227 trout per km. Species composition of trout was 66% brown trout, 27% rainbow trout, and 7% Yellowstone cutthroat trout. Although we did not collect other species during our surveys, we did observe mountain whitefish, Utah sucker, redside shiner, speckled dace, and sculpin (unidentified *Cottus* spp.) Brown trout ranged from 113 mm to 780 mm, with a mean total length of 323 mm (Figure 43; Table 23). Rainbow trout ranged in size from 119 mm to 460 mm, with a mean total length of 336 mm, while Yellowstone cutthroat trout ranged from 185 mm to 519 mm, with a mean total length of 353 mm.

PSD and RSD values indicate that brown trout are the most balanced of the three trout populations in the Osgood reach, with PSD and RSD-400 values of 43 and 34, respectively. RSD-500 of brown trout was 11, which is considerably higher than RSD-500 values observed in any reach of the more well-known fisheries on the South Fork or Henrys Fork Snake Rivers, and indicates the trophy component of the fishery within the Osgood reach. Brown trout YAR was 22%, indicating that successful reproduction is occurring. Rainbow trout PSD, RSD-400, and RSD-500 values were 86, 5, and 0, respectively. A high PSD calculation was somewhat expected, as some of the rainbow trout within this reach appeared to be hatchery fish (based on observations of fin wear/damage) which are stocked as catchables (approximately 250 mm in length). Although the bulk of rainbow trout were between 280 mm and 400 mm, we saw evidence of multiple year classes of rainbows, indicating wild production. The low YAR calculation of 1% for rainbow trout (Table 23) indicates that natural reproduction is low for rainbow trout, but may have been clouded somewhat by the presence of catchable sized hatchery rainbows. Body condition of rainbow trout appeared to be above average although we did not specifically measure this metric. Yellowstone cutthroat trout PSD, RSD-400, and RSD-500 values were 69, 45, and 3, respectively, which indicates a balanced size structure, similar to brown trout. Cutthroat trout YAR was 5%, also indicating that some reproduction is occurring, but is limited in abundance. Based on the excellent body condition of all trout observed during this survey, it is likely food resources are under-utilized, and that this reach of the Snake River is capable of supporting increased densities of trout.

The presence of juvenile brown trout, Yellowstone cutthroat trout, and rainbow trout indicate that reproduction is occurring in the Osgood reach. However, recruitment sufficient to support optimum densities in the adult population is likely limited, based on the minimal amount of available spawning habitat observed during our fall surveys. The island complex located within the sample reach provides suitable spawning habitat as evidence by brown trout redds. We did not observe trout spawning elsewhere in this reach, nor did we observe areas with suitable spawning habitat outside of the braided island complex in our cursory look at habitat. Alternatively, other dynamics such as entrainment or other factors may be contributing to the lack of sufficient recruitment.

Overall, it appears that the Osgood reach of the Snake River currently provides a desirable angling experience. The quality fishery and trophy component of the trout fishery in the Osgood reach and adjacent river reaches attracts large numbers of anglers, whose fishing-related spending then enhances the local economy (Grunder, 2008). Although the existing fish densities are not as abundant as in other nearby and more famous waters, it’s likely that substantial improvements may be achieved with a shift in stocking practices or improvements to existing habitat. Densities of trout may increase by changing to fingerling trout stocking as opposed to catchable rainbow trout, which have been shown limited long-term survival in lotic systems (High and Meyer 2009). Based on body condition of trout, food resources are not in short supply, and should make a shift in size at stocking successful.

MANAGEMENT RECOMMENDATIONS

1. Change stocking from catchable rainbow trout to fingerling rainbow trout and Yellowstone cutthroat trout. Mark stocked fingerlings for future evaluation.

2. Estimate trout densities with future sampling in the next two to three years to evaluate changes in fish populations resulting from the shift in stocking practices. Include weight measurements in future sampling to determine relative weights of trout species throughout this reach of river.

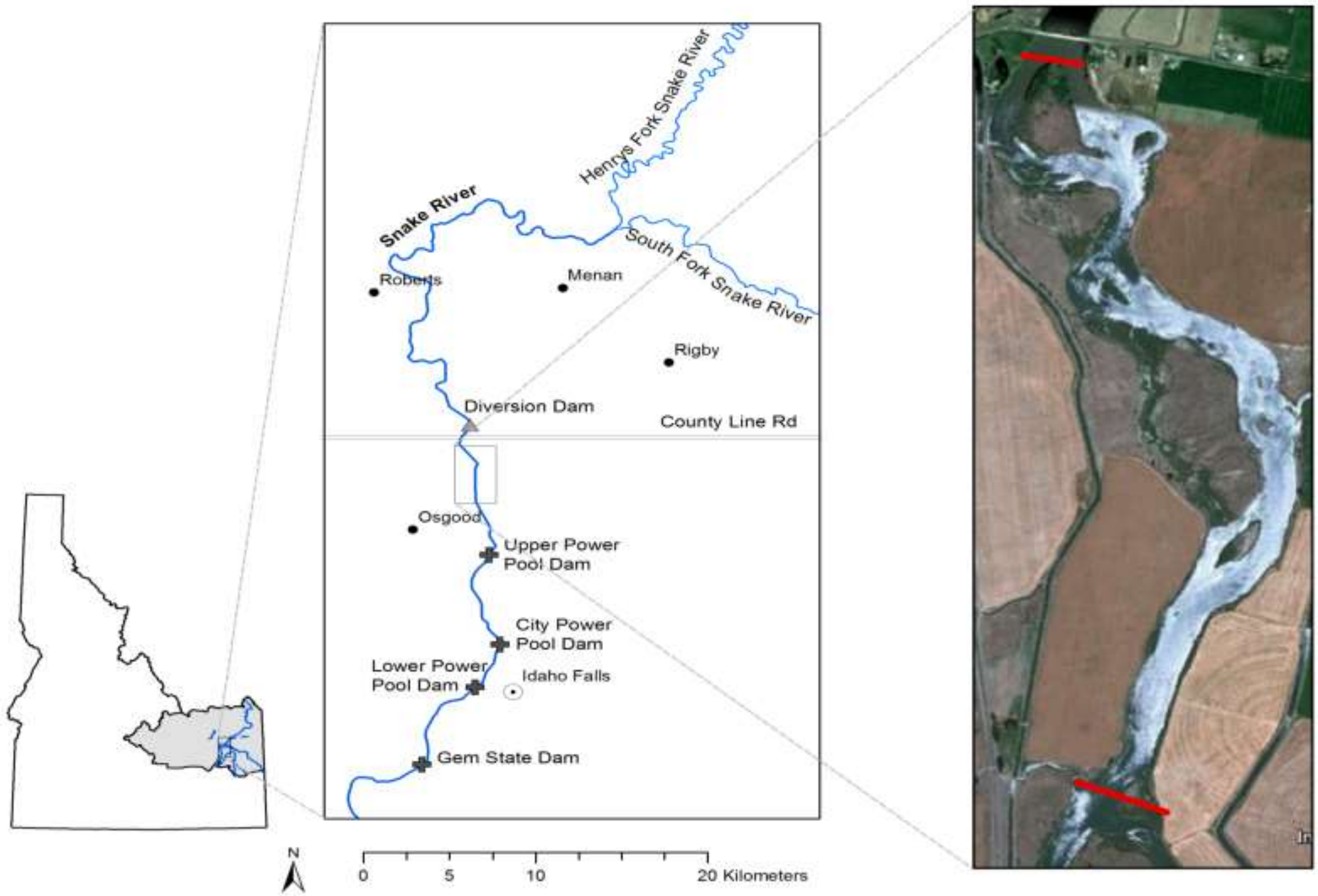

Figure 42. Map of the Snake River near Idaho Falls (middle pane) and the 2011 Osgood reach electrofishing site (right pane), with reach boundaries marked by the solid red line.

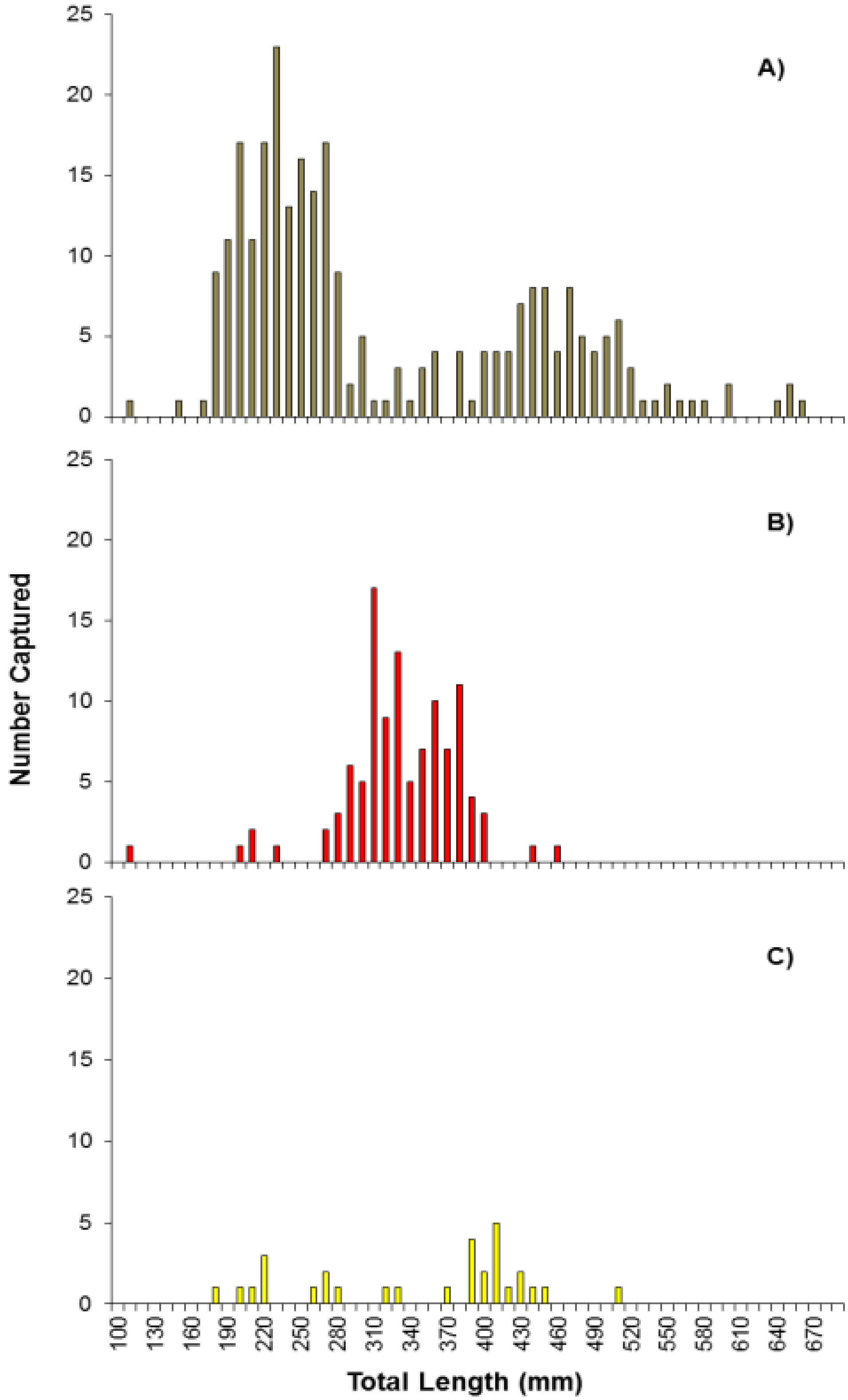

Figure 43. Length frequency distribution of brown trout (A), rainbow trout (B), and Yellowstone cutthroat trout (C) collected by electrofishing in the Osgood reach of the Snake River, Idaho, 2011.

Table 23. Trout population index summaries for the Snake River, Idaho 2011.

Species	Mean Length (mm)	Median Length (mm)	Minimum Length (mm)	Maximum Length (mm)	PSD	RSD-400	RSD-500	YAR (%)	Density (No./km)
Brown trout	323	270	113	780	43	34	11	22	150
Rainbow trout	336	333	119	460	86	5	0	1	61
Yellowstone cutthroat trout	353	396	185	519	69	45	3	5	16

MEYERS/CROOKED CREEK RENOVATION

ABSTRACT

Both Meyers Creek and Crooked Creek are located in the Medicine Lodge drainage and are in native Yellowstone cutthroat trout range, but until 2009 Myers Creek was dominated by brook trout, and only the upper 8.5 km of Crooked Creek contained an allopatric population of Yellowstone cutthroat trout. In the fall of 2009, we treated approximately 6.5 km of Myers Creek with rotenone to remove brook trout in preparation for reintroduction of Yellowstone cutthroat trout. Post-treatment electrofishing revealed one live brook trout in four sampling sites, indicating that the treatment was not completely successful at eradicating brook trout, but indicated the population was severely reduced. We marked fifty Yellowstone cutthroat trout, with an adipose fin clip and transplanted them from Crooked Creek into Meyers Creek. During 2011, we sampled three sites in Myers Creek and three sites in Crooked Creek to evaluate the success of the 2009 rotenone treatment and cutthroat trout reintroduction efforts. No brook trout were captured in any of the sample sites. Four Yellowstone cutthroat trout were found in the lowest electrofishing site in Myers Creek, but unlike 2010, transplanted cutthroat trout were not found in the middle or upper sites sampled. No Yellowstone cutthroat trout captured were marked, indicating that cutthroat trout are migrating from Crooked Creek into the lower end of Myers Creek. Future work should include increased monitoring in Myers Creek to determine if transplanted cutthroat trout have reproduced, and if additional Yellowstone cutthroat trout are necessary to establish this population, as well as examining the channelized reach for restoration potential.

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INTRODUCTION

Myers Creek originates in the Centennial mountain range of eastern Idaho, and is located in the Medicine Lodge Creek drainage. The streams within the Medicine Lodge drainage (and the four neighboring basins: Beaver-Camas, Birch, Little Lost and Big Lost) flow south and east, eventually sinking into the fractured basalts of the Snake River plain, and are collectively known as the Sinks drainages (Figure 44). It is believed that the Sinks drainages were last connected to each other via glacial Lake Terreton approximately 10,000 years ago. It appears that the only native fish in the Medicine Lodge drainage are shorthead sculpin *Cottus confusus,* mottled sculpin *C. bairdi*, and Yellowstone cutthroat trout, which likely entered from the Henrys Fork Snake River drainage within the last 10,000 years.

Previous fisheries work in the Myers Creek drainage by IDFG and the US Forest Service documented brook trout in most of Myers Creek and a native population of Yellowstone cutthroat trout in Crooked Creek. Brook trout were the only species found in the upper 4.5 km of Myers Creek (above the confluence with Crooked Creek). Below the confluence with Crooked Creek, Myers Creek contained Yellowstone cutthroat trout and brook trout. While brook trout were also present in Crooked Creek, they were only observed in the lower 0.5 km, near the confluence with Myers Creek. Sampling in the upper 9.0 km of Crooked Creek revealed only Yellowstone cutthroat trout. No brook trout were observed in the 9.0 km of stream above the diversion or within the channelized reach (lower 1km) of Crooked Creek, indicating that the channelized reach of Crooked Creek may act as a deterrent to brook trout migration. No other fish passage barriers were observed in Crooked Creek.

During the fall of 2009, we treated Crooked Creek and Myers Creek with rotenone to remove brook trout to aide in restoring the Yellowstone cutthroat trout population (High et al. 2011). After the rotenone treatment, we transplanted 50 Yellowstone cutthroat trout, ranging from 40 mm to 340 mm, from upper Crooked Creek into Myers Creek. All transplanted cutthroat trout had their adipose fin removed prior to release into Myers Creek to determine if fish collected in future sampling efforts were from the transplant or if they migrated from Crooked Creek or were spawned naturally. Monitoring efforts in Myers Creek and Crooked Creek since the rotenone treatment in 2009 (Schoby et al. 2012, High et al. 2011) indicate that the treatment was successful in removing brook trout from the drainage (none have been found since the first survey immediately after the rotenone treatment) and that Yellowstone cutthroat trout transplants into Myers Creek have survived, although reproduction has yet to be documented.

The objectives in 2011 were to confirm the eradication of brook trout from the drainage and determine the status of Yellowstone cutthroat trout in Myers Creek after reintroduction.

METHODS

We sampled three sites on Myers Creek and three sites on Crooked Creek on July 13, 2011 with a backpack electrofisher to evaluate the results of the 2009 rotenone treatment and Yellowstone cutthroat trout reintroduction. We sampled Myers Creek just above its confluence with Crooked Creek, near the Forest Service gate, and at the road crossing approximately 4.0 km upstream from Crooked Creek (Figure 45; Table 24). Sites ranged from 50 to 75 m (Table 24). We sampled Crooked Creek above and below the Myers Creek confluence, and at the road crossing above the channelized reach (near Heart Canyon) (Figure 45; Table 24).

RESULTS AND DISCUSSION

We did not find any brook trout in Myers Creek or Crooked Creek in the six sites sampled in 2011, and found Yellowstone cutthroat in one site in Myers Creek and in two of the sites in Crooked Creek (Table 25). The rotenone treatment in 2009 appears to have been successful in removing brook trout from both streams. Similar to 2010, during 2011 we found unmarked Yellowstone cutthroat trout that have moved into lower end of Myers Creek (site MC1) from Crooked Creek. Conversely, we did not find any cutthroat trout (marked or unmarked) in the middle or upper sites on Myers Creek, where transplanted fish were released in 2009 and observed during 2010 electrofishing surveys. While cutthroat trout are actively pioneering into the lower end of Myers Creek, we have not documented wild fish moving into the middle or upper reaches. The channelized lower reach of Myers Creek (~2.7 km), just upstream of the confluence with Crooked Creek, may be acting as a migration barrier. Restoring this to a functional stream channel may help future cutthroat trout pioneering efforts. Future electrofishing surveys in Myers Creek are needed to determine if previously transplanted fish have reproduced and if additional transplants from Crooked Creek are necessary to bolster the population as well as to document natural reproduction as it occurs.

MANAGEMENT RECOMMENDATIONS

1. Increase sample sites in 2012 to determine success of brook trout eradication and Yellowstone cutthroat trout reintroduction in Myers Creek. Particular emphasis should be given to expanding the amount of stream sampled.

2. Determine the fate of transplanted cutthroat trout to evaluate survival and effectiveness of this technique.

3. Continue Yellowstone cutthroat trout transplants from Crooked Creek into Myers Creek, as deemed necessary. Alternatively, moving Yellowstone cutthroat trout found in lower Myers Creek (electrofishing site MC1) above the channelized reach would increase cutthroat trout distribution throughout the drainage.

4. Examine potential for stream restoration within the channelized reach of Myers Creek.

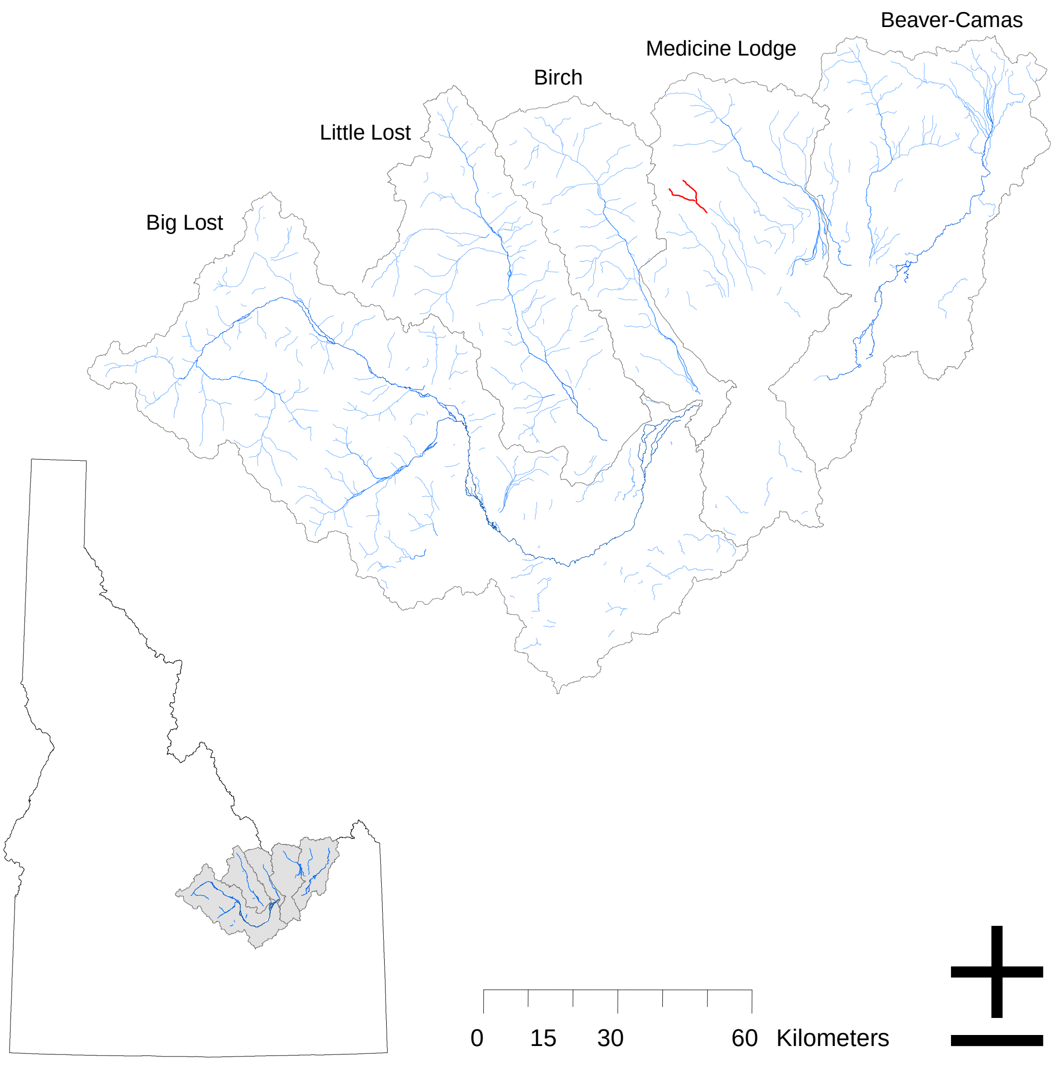

Figure 44. The Sinks drainages of Idaho, with Myers Creek and Crooked Creek highlighted in red.

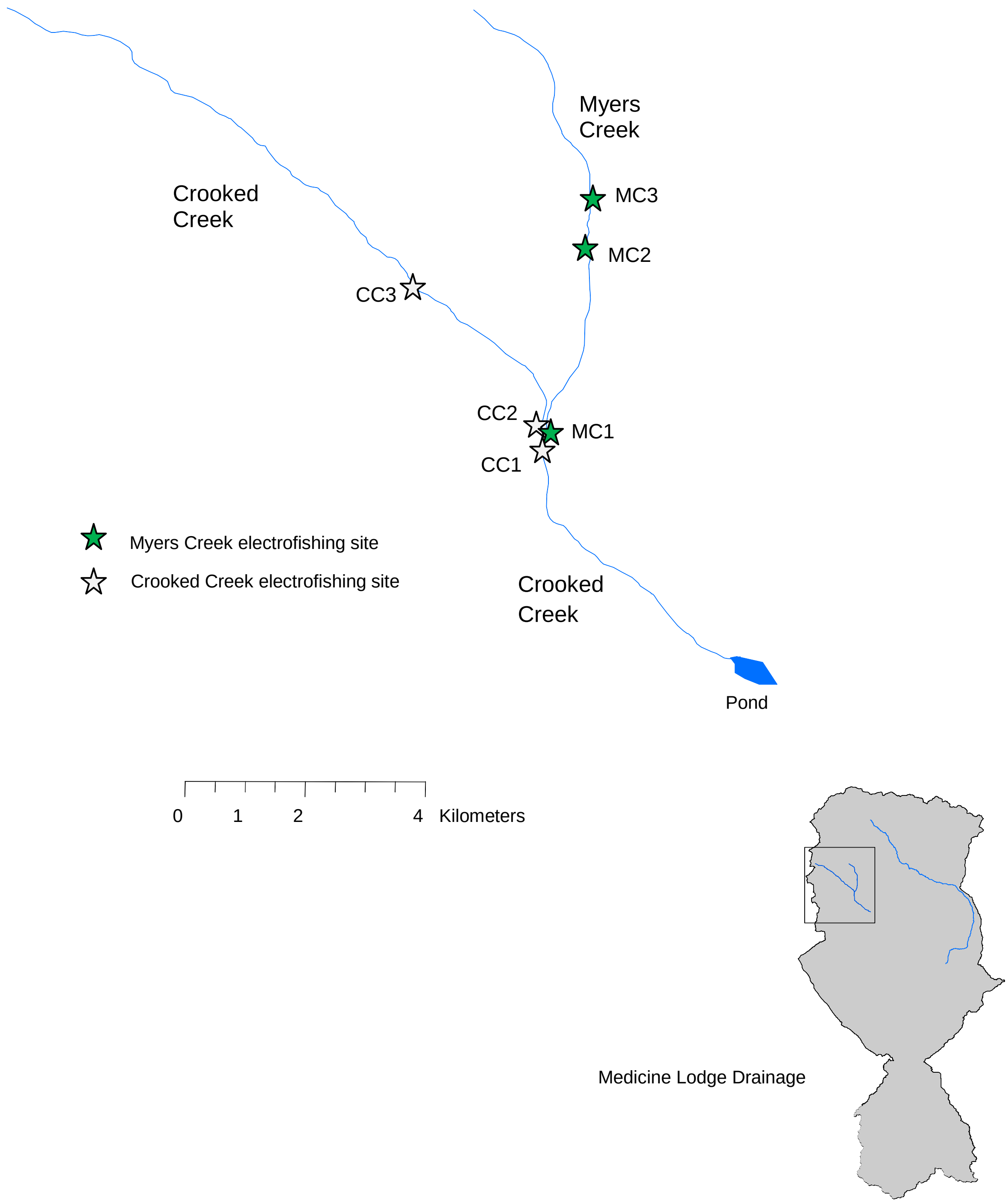

Figure 45. Electrofishing sample sites in Myers Creek and Crooked Creek, during 2011.

Table 24. Locations of electrofishing sample sites in Myers Creek and Crooked Creek, 2011.

Stream	Site number	Zone	UTM E	UTM N	Location	Site length (m)
Myers Creek	MC1	12	363127	4902235	Above Crooked Creek confluence	75
Myers Creek	MC2	12	363910	4904801	At Forest Service gate	50
Myers Creek	MC3	12	363977	4906341	Road crossing, ~4.0 km upstream	50
Crooked Creek	CC1	12	363086	4902120	Below Myers Creek confluence	100
Crooked Creek	CC2	12	363095	4902266	Above Myers Creek confluence	100
Crooked Creek	CC3	12	361570	4904217	Upper road crossing	50

Table 25. Survey results from Myers Creek and Crooked Creek electrofishing, 2011.

Stream	Site number	Fish present?	YCT present?	BKT present?	Number of fish captured	Mean total length (mm)	Total length (mm) range
Myers Creek	MC1	Yes	Yes	No	4	193	166 - 235
Myers Creek	MC2	No	No	No	0	--	--
Myers Creek	MC3	No	No	No	0	--	--
Crooked Creek	CC1	No	No	No	0	--	--
Crooked Creek	CC2	Yes	Yes	No	2	144	116 - 171
Crooked Creek	CC3	Yes	Yes	No	2	172	172 - 172

TETON RIVER

ABSTRACT

We estimated trout abundances of all age-1 and older trout using boat mounted electrofishing gear at five reaches on the Teton River in 2011 and compared abundances to prior years to determine trends over time. Two reaches in the Teton Valley (Nickerson and Breckenridge) are regularly sampled monitoring reaches. Densities of YCT were 165 fish/km at Nickerson and 62 fish/km at Breckenridge. Abundance of YCT at Nickerson has significantly increased since 2003 with an intrinsic rate of change, r = 0.37 and a 90% confidence interval that does not include zero. Trends in abundance for rainbow trout and brook trout have not exhibited a significantly increasing trend at Nickerson since 2003 with r = 0.04 and r = 0.12, respectively and both having confidence intervals that include zero. Abundance trends of YCT, rainbow trout, and brook trout at the Breckenrdige monitoring reach did not have increasing trends since 2003 as indicated by confidence intervals that all included zero and intrinsic rates of change of r = 0.25, r = 0.00, and r = 0.47, respectively. We also surveyed the Buxton, Rainier and South Fork Teton sites, which are infrequently surveyed. Similar increases in abundance of YCT were observed at both the Buxton reach (150 fish/km) and Rainier reach (118 fish/km) but the increases were not statistically significant. However, the abundance of YCT in the South Fork Teton reach was significantly higher than all previous density estimates and exhibited a consistent increase since 1993. Despite facing serious threats to continued persistence of YCT from non-native trout through competition and hybridization, migration barriers, and disconnected tributaries, these monitoring data indicate YCT populations can be preserved in the Teton River through relevant management and conservation efforts especially during good water years.

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INTRODUCTION

The Teton River in eastern Idaho supports a population of native Yellowstone cutthroat trout (YCT). Distribution of Yellowstone cutthroat trout has decreased across their native range resulting in river systems with healthy, fluvial life history strategies of YCT like those found in the Teton River, less common (Behnke 1992). The Idaho Department of Fish and Game (IDFG) currently manages the Teton River as a wild trout fishery with the objective of preserving the genetic integrity and population viability of YCT while maintaining quality recreational angling (IDFG 2007).

IDFG began monitoring trout populations in the Teton River in 1987. Prior to 2003, YCT had a long-time average density of 142 fish/km in the upper valley of the Teton River drainage with a high of 211 fish/km in the early 1990s after special regulations had been implemented for YCT (IDFG 2007). This historical fish density may have been influenced by stocked fish, and is possibly higher than we can expect under a wild trout management program. . Hatchery cutthroat trout fry were stocked into the Teton River by IDFG through 1991 and cutthroat trout estimates for the river included both wild and hatchery origin fish through the late 1990s. Regardless, the YCT population declined to less than 3 fish/km by 2003, but has continued to improve since (High et al. 2011). Other trout in the Teton River include brook trout, rainbow trout, brown trout, and mountain whitefish. As YCT numbers decreased through the 1990s the rainbow trout population increased. Non-native rainbow trout and brook trout are currently the dominant salmonid in the upper Teton River, excluding mountain whitefish.

Numerous anthropomorphic factors have negatively impacted native trout populations in the Teton River, including non-native trout stocking, mining, grazing, water diversion, water impoundment, and development. Of these, competition with non-native trout and water diversion are the major factors suppressing YCT abundance in the Teton River drainage. Research has documented the negative impacts brook trout have on sympatric populations of cutthroat trout primarily through competition (Griffith 1972; Peterson et al. 2004). In the Teton River, the effects of competition between YCT and non-native brook and rainbow trout appear to be most detrimental during the early life stage of YCT as evidenced by lower relative abundance of YCT in early spring compared to the prior fall in some Teton River tributaries (Koenig 2005). Many YCT in the Teton River are fluvial and migrate into tributaries to spawn (Schrader and Jones 2004). Connectivity of spawning tributaries to the main Teton River is necessary for fluvial YCT to complete their life cycle. The Teton River YCT population includes at least three metapopulations as indicated by their migratory behavior (Schrader and Jones 2004). The three metatpopulations are generally located in the lower river, the canyon, and upper river sections of the Teton River drainage. Interestingly, the strongest metapopulation in the Teton River is in the canyon section where the primary spawning tributary (Bitch Creek) is the only major tributary of the Teton River without an irrigation diversion and associated water withdrawals (Schrader and Brenden 2004). As such, Bitch Creek still maintains an unaltered hydrograph which has been shown to be beneficial for cutthroat trout while also being detrimental to invasive rainbow trout (Moller and Van Kirk 2003). In the lower Teton River metapopulation, large irrigation diversions impede upstream migration (Schrader and Jones 2004) and likely entrain many downstream migrants whereas instream flows due to irrigation withdrawals and natural losing reaches of tributaries in the upper Teton River limit connectivity between the river and tributaries there (Van Kirk and Jenkins 2005).

Despite substantial challenges and threats to their continued persistence, YCT in the Teton River have proven to be resilient and have increased in abundance during recent years, consistent with higher annual precipitation. Management and conservation efforts continue to be focused in the drainage by IDFG and other agencies and organizations to conserve this important YCT population that continues to exhibit all of life history strategies used by the sub-species in large river drainages (Behnke 1992). This report summarizes population monitoring efforts in 2011 used to assess effectiveness of management and conservation efforts.

OBJECTIVES

1. Determine population trends of trout at the two standard monitoring sites, Nickerson and Breckenridge

2. Determine if trout abundance at three additional sites are different from prior surveys

3. Use this information to guide management decisions over the coming years

METHODS

We surveyed trout populations at the Nickerson and Breckenridge monitoring reaches (Figure 46). The Nickerson reach is 5.8 km long, and averages 42 m wide. The Breckenridge reach is 4.9 km long and averages 26 m wide. We used a mark/recapture sampling design to estimate trout abundance in each reach, and marked fish at Nickerson on September 6 and again on September 8 followed by the recapture run September 13. We marked fish at Breckenridge on September 7 and performed the recapture run seven days later.

In addition to our regular monitoring reaches, we also sampled the Buxton, Rainier, and South Fork Teton reaches, again using a mark/recapture sampling design (Figure 46; Figure 47). The Buxton monitoring reach is 7.1 km long and is located immediately downstream of the Nickerson reach. The Rainier reach is 5.5 km long and located immediately downstream of the Buxton reach and ends at the upper end of the Breckenridge reach. We marked fish in the Buxton reach September 6 and 8, and in the Rainier reach September 7 and performed the recapture runs seven days after the initial marking run. The South Fork Teton reach is 3.8 km in length. We separated the first river kilometer of the South Fork Teton reach into a sub-section for which a mountain whitefish density was estimated. We marked fish on September 27 and performed the recapture run six days later.

Fish were captured using direct-current (DC) electrofishing gear (Coffelt VVP-15 powered by a Honda 5000 W generator) mounted in two drift boats operated in tandem through each section with one netter each. We used pulsed DC current through two boom-and-dangler anodes fixed to the bow while floating downstream. The boat hull was used as the cathode. We used pulsed direct current (DC) at 5 amps, 200 – 300 volts, 50% pulse width, and a frequency of 80 hertz. Captured fish were identified and measured (total length). We marked captured fish in the caudal fin with a hole punch on our marking runs, and used this mark to identify previously captured fish in our recapture runs. Several YCT and rainbow trout in each reach were marked with passive integrated transponder (PIT) tags as part of an ongoing study initiated in 2009. Fish abundance estimates for age-1 and older trout were calculated using MR5, a program developed by Montana Department of Fish, Wildlife, and Parks which uses the log-likelihood mark/recapture estimation technique explained by Zar (1984). We assumed capture probabilities did not vary with species, and estimated relative abundance using proportions of all individual trout captured (excluding recaptures). Although capture probabilities vary with fish length (Schill 1992; Reynolds 1996), length frequency distributions, and average fish lengths were estimated using all fish captured. We used linear regression to assess YCT, rainbow trout, and brook trout trends at the Nickerson and Breckenridge monitoring reaches with sample year as the independent variable and the $\log_e$-transformed abundance estimate (fish/km) as the dependent variable. The benefit of this analysis is the slope of the regression line fit to the $\log_e$-transformed abundance data is the intrinsic rates of change (*r*) for the population (Maxell 1999). We used α = 0.10 to have more power to assess trends in these populations (Peterman 1990; Maxell 1999). Positive intrinsic rates of change (*r* >0) indicate an increasing population and negative estimates of *r* indicate declining abundance in the population. Trout abundances at Rainier, Buxton, and the South Fork Teton reaches were compared with abundance estimates from 2009 or the previous sample at each respective reach by comparing 95% confidence intervals.

RESULTS

We captured 822 trout at the Nickerson monitoring reach including 250 YCT, 133 rainbow trout, and 439 brook trout (Table 26). Trout densities were estimated at 165 YCT/km, 87 trout/km for rainbow trout, and 330 trout/km for brook trout (Figure 48). Since 2003, density of YCT has increased at the Nickerson monitoring reach with an intrinsic rate of growth (*r*) = 0.37 and an associated 90% confidences range from 0.15 and 0.59 (Figure 49). The abundances of rainbow trout (RBT) and brook trout (BKT) since 2003 at the Nickerson monitoring reach have not exhibited positive or negative trends. At Nickerson, *r* for RBT was 0.04 with a lower 90% *r* = -0.20 and an upper 90% *r* = 0.28. The intrinsic rate of growth for BKT was 0.12 with a lower 90% *r* = -0.03 and an upper 90% *r* = 0.27.

At the Breckenridge monitoring reach we captured 339 trout including 34 YCT, 221 RBT, and 81 BKT and three brown trout. There were not enough recaptures to calculate density estimates for YCT or BKT separately. The RBT density was estimated to be 372 trout/km (Table 27; Figure 50). Combining catch for all trout species yielded a density estimate of 617 trout/km. We partitioned out abundance estimates for YCT and BKT by multiplying the total trout density estimate by respective species composition of the total catch. These extrapolated densities were 62 YCT/km, 407 RBT/km, and 148 BKT/km at Breckenridge. The extrapolated densities were used in the regression analyses for YCT and BKT. The intrinsic rate of growth of YCT at Breckenridge was 0.25 but the 90% confidence interval included zero (lower 90% *r* = -0.03, upper 90% *r* = 0.54). The abundance of RBT similarly have not exhibited an increasing trend since 2003 with r = 0.00 (lower 90% r = -0.10, upper 90% r = 0.09). Brook trout abundances also have not exhibited an increasing trend in the Breckenridge monitoring reach with *r* = 0.47 (lower 90% *r* = -0.05, upper 90% *r* = 1.00).

We captured 747 trout In the Buxton reach including 164 YCT, 239 RBT, and 344 BKT. Density estimates in the Buxton reach were 150 YTC/km, 195 RBT/km, and 234 BKT/km. The Buxton reach was most recently sampled in 2000. Overlapping 95% confidence intervals for the 2000 and 2011 estimates indicate densities of YCT were similar both years. However, RBT densities were significantly higher than they were in 2000, reaching levels previously observed in 1987, and BKT densities were significantly greater in 2011 than the only other estimate from 1991 (Figure 51).

We captured 570 trout at the Rainier reach including 120 YCT, 296 RBT, 15 BKT, and 3 brown trout. We estimated there were 118 YCT/km with a modified Peterson estimator and 371 RBT/km based on a log-likelihood analysis method. Based on species compositions of the total catch and the total trout modified Peterson estimate of 641 trout/km, we extrapolated the following trout abundances in the Rainier reach: 135 YCT/km, 333 RBT/km, 170 BKT/km, and three BNT/km. The modified Peterson estimate for YCT was similar to previous estimates from 1987, 2000, and 2009 based on overlapping 95% confidence intervals. The estimate for RBT was significantly higher in 2011 than 2009, and was the highest point estimate to date for this reach (Figure 52).

In the South Fork Teton River reach, we captured 242 trout including 205 YCT, 30 RBT and seven brown trout. In the sub-section of the reach, we captured 135 mountain whitefish. We estimated the density of YCT was 143 trout/km and the density of RBT was 19 trout/km (Figure 53). The estimate for mountain whitefish in the sub-section of the reach was 365 fish/km. The densities of YCT in the South Fork Teton reach have been increasing, and the estimate from 2011 was significantly higher than all three previous estimates based on non-overlapping 95% confidence intervals whereas the density of RBT has not changed over the same time period.

DISCUSSION

Nickerson and Breckenridge have been the standard IDFG monitoring reaches in the upper Teton River, or Teton Valley, since 1987. They represent two different types of main river habitat in the Teton Valley – each responding differently to environmental conditions – and they have different levels of fishing pressure. Fish population information from these two sections represents the most comprehensive and longest-running data set for the Teton River (Schrader and Brenden 2004; Garren et al. 2006). Relative cutthroat trout abundances at both monitoring reaches have been increasing since the low point in 2003, but we could only detect a significant increase in YCT at the Nickerson monitoring reach. We feel the estimates indicate YCT abundance is increasing and that the lack of statistical significance was likely due to the small sample size.

Trout abundances are not constant in the upper Teton River through Teton Valley, and suggest some areas may be more important than others for different species. For example, YCT trout abundance was highest in the Nickerson monitoring reach, the furthest upstream site sampled in 2011. From Nickerson downstream, YCT density steadily declined. This is likely due to the proximity of the sample reach to spawning tributaries. The major spawning tributaries in the Teton River are Teton Creek and Fox Creek (Koenig 2005). The confluence of Teton Creek with the Teton River is at the upstream site boundary for Nickerson, and the confluence of Fox Creek is 5.5 stream km upstream. Koenig (2005) also indicated Trail Creek and South Leigh Creek as YCT spawning tributaries used to a lesser extent than Teton or Fox creeks. Again, Trail Creek is located upstream of the Nickerson reach. South Leigh Creek joins the Teton River downstream of the Breckenridge monitoring reach which is the furthest downstream reach in the upper Teton River. The decreasing YCT densities in the Teton River from upstream (Nickerson) downstream through the Buxton, Rainier, and Breckenridge reaches could be explained by YCT recruitment occurring more from spawning tributaries than from main river spawning or by YCT selecting for habitat or environmental conditions found more in the upper river reaches in Teton Valley. The former seems more plausible. In 1999, Schrader and Jones (2004) documented the spawning locations of 10 YCT marked with radio telemetry tags in the upper Teton River and nine (90%) of these YCT spawned in a tributary instead of the main river with most (eight) of these spawning in Teton Creek. Brook trout also display similar trends in abundance with higher densities upstream in the valley than downstream. In the middle portion of the valley, brook trout densities in the Rainier reach have been highly variable between 1987 and 2011 ranging from a low of 33 BKT/km in 2000 to a high of 285 BKT/km in 2009. The estimate from 2011, 170 BKT/km, was in the upper middle portion of this range. The reasons for the wide fluctuations are likely tied to habitat conditions, spawning success, and BKT densities upstream. A large habitat restoration project was completed in the Rainier Reach by the Teton Regional Land Trust in 2009 which improved habitat for all trout, including BKT. Improved habitat quality likely influenced the recent high trout densities in the Rainier Reach, but the fluctuations are likely related to the proximity to spawning areas with many small spring creeks returning water to the main river in the upper portions of Teton Valley providing excellent spawning habitat for a fall spawning species like brook trout (Curry et al. 1995). Conversely, the abundance of RBT is higher in the lower portions of Teton Valley than it is in the upper portions. Proximity to spawning site may not entirely explain this trend for RBT as RBT readily use tributaries in the upper river for spawning, particularly Fox Creek (Koenig 2005) and utilize both tributaries and main river habitats for spawning at near equal proportions (Schrader and Jones 2004). A combination of factors likely affect distribution of RBT in Teton Valley including spawning location, habitat preferences (Cunjak and Green 1984), and competition due to densities of other trout species (Fausch 1988).

The abundance of YCT at our non-traditional sample reaches (Buxton, Rainier and South Fork Teton) sampled in 2011 all suggest a stable or growing YCT population in the Teton River, particularly in the lower Teton River. The South Fork Teton River supports one of the three metapopulations of YCT in the Teton River described by Schrader and Jones (2004), who indicate several irrigation diversions are likely migration barriers between the South Fork Teton River and upstream spawning areas in tributaries including Moody Creek. The fact that YCT abundance in the South Fork Teton River reach has increased bodes well for the Teton River YCT population as a whole. The abundance of YCT in the South Fork Teton River has certainly been benefitting from recent high water years. Since 2003, seven of the nine years have had flows in the Teton River exceeding 80% of the long-term average (USGS 2012) and four (44%) have exceeded 100% of the long-term average.

Teton River flows were higher than normal in 2011. The average flow for September in 2011 (399 cfs or 11.3 cms) was over 150% the long-term average at the South Leigh Creek USGS water gauge (USGS 2012). High flows caused some Teton Valley tributaries and the Teton River to remain connected for a longer period of time, including Teton Creek, Trail Creek, and South Leigh Creek, which are important Yellowstone cutthroat trout spawning tributaries (Koenig 2005; M. Lein; Friends of the Teton River; Pers. Communication). With connected, cool-water tributaries, some fish from the upper river may have remained or moved into tributaries from the main river during fall when sampling occurred. This may partly explain why all three trout abundance estimates were lower in 2011 than in 2009 at Nickerson. Thus, YCT abundance may continue to increase due to increased available spawning habitat in 2011 and the resulting increase in tributary production.

Brown trout have been observed in low abundance in the Teton Valley portion of the Teton River sporadically for a long time, but recent surveys have encountered brown trout more regularly. Brown trout were observed during the first electrofishing surveys in 1987 when a single 300 mm brown trout was observed in the Rainier Reach. Between this survey and 2005, only two more brown trout were observed, both upstream in the Nickerson Reach with a 770 mm brown trout caught in 1994 and a 525 mm brown trout in 2005. These early, infrequent catches of large brown trout were believed to be the result of illegal introductions (Schrader and Brenden 2004). Since 2005, brown trout have been observed during each survey at low abundance still and further downstream in the valley. Brown trout have not been observed in the Nickerson Reach since 2007 when four fish between 417 mm and 492 mm were captured. Three brown trout from 592 - 688 mm were caught in the Rainier Reach in 2009 just as three brown trout (208 – 403 mm) were also observed in 2011. Brown trout have been observed in every bi-annual electrofishing survey at the Breckenridge Reach (the furthest downstream reach in the valley) since 2007, including 5 brown trout in 2007 (278 – 517 mm), a 482 mm brown trout in 2009, and the three brown trout during 2011 (315 – 345 mm). The fact that the first small brown trout (<250 mm) ever captured in any of the Teton Valley electrofishing sites occurred during our most recent surveys is concerning. Future monitoring surveys will be helpful in determining if brown trout are successfully spawning in Teton Valley.

While YCT in the Teton River face numerous challenges and threats from competition with nonnative trout to river-tributary connectivity to climate change (Isaak et al. 2010), they continue to show resiliency and have increased in abundance in the Teton River. Management efforts should continue to address connectivity, habitat restoration, and competition. Management actions should be implemented strategically, and should prioritize Yellowstone cutthroat trout strongholds for the different metapopulations such as Teton Creek in the upper Teton River and Bitch Creek in the Teton Canyon.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor effects of management actions on Teton River trout populations by sampling the Nickerson and Breckenridge monitoring reaches regularly.

2. Assess YCT introgression rates with RBT throughout the Teton River metapopulations, particularly for YCT in the canyon and upper river sections.

3. Work with habitat biologists to identify priority restoration areas in the Teton River drainage.

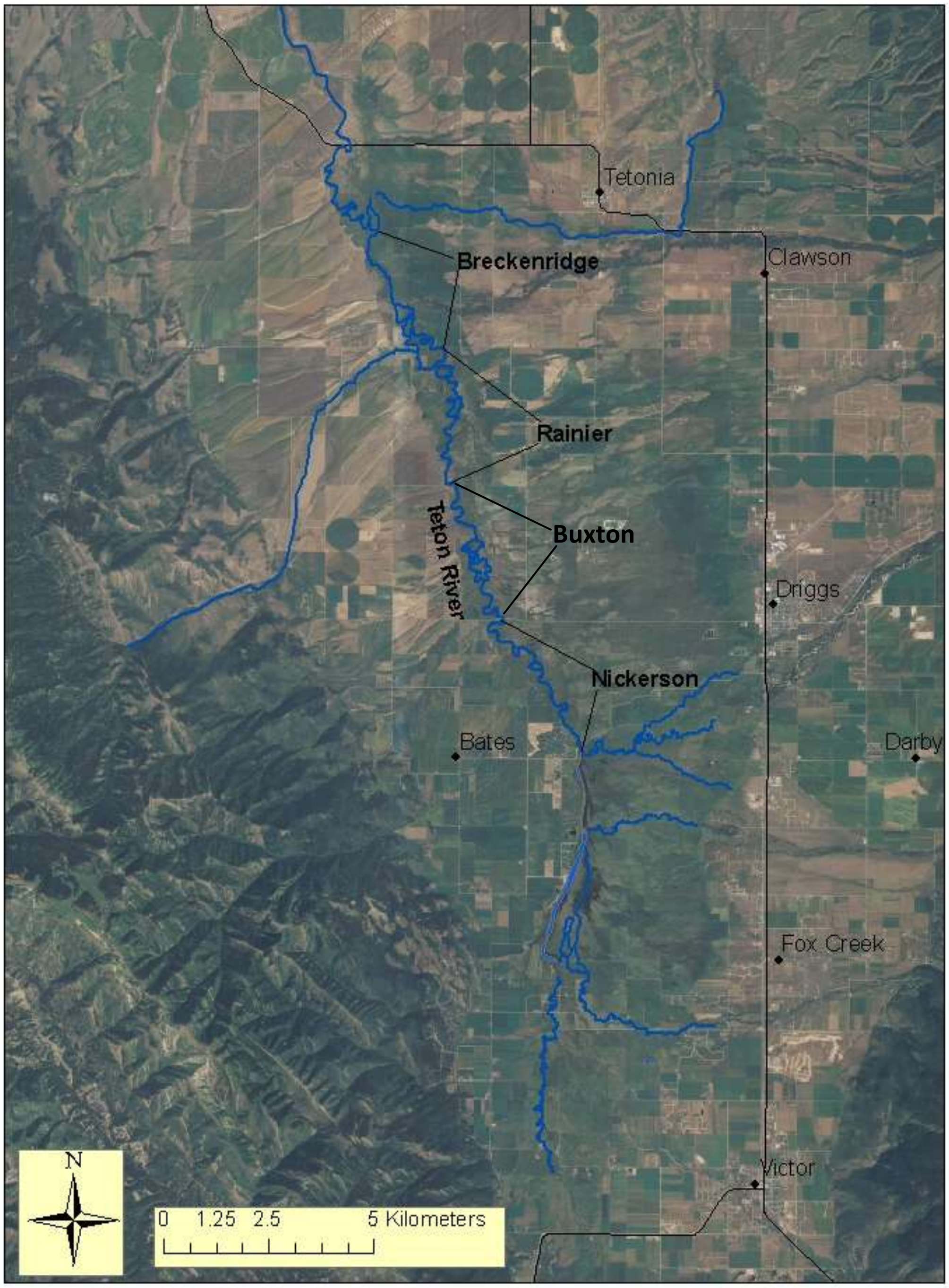

Figure 46. Teton Valley area map.

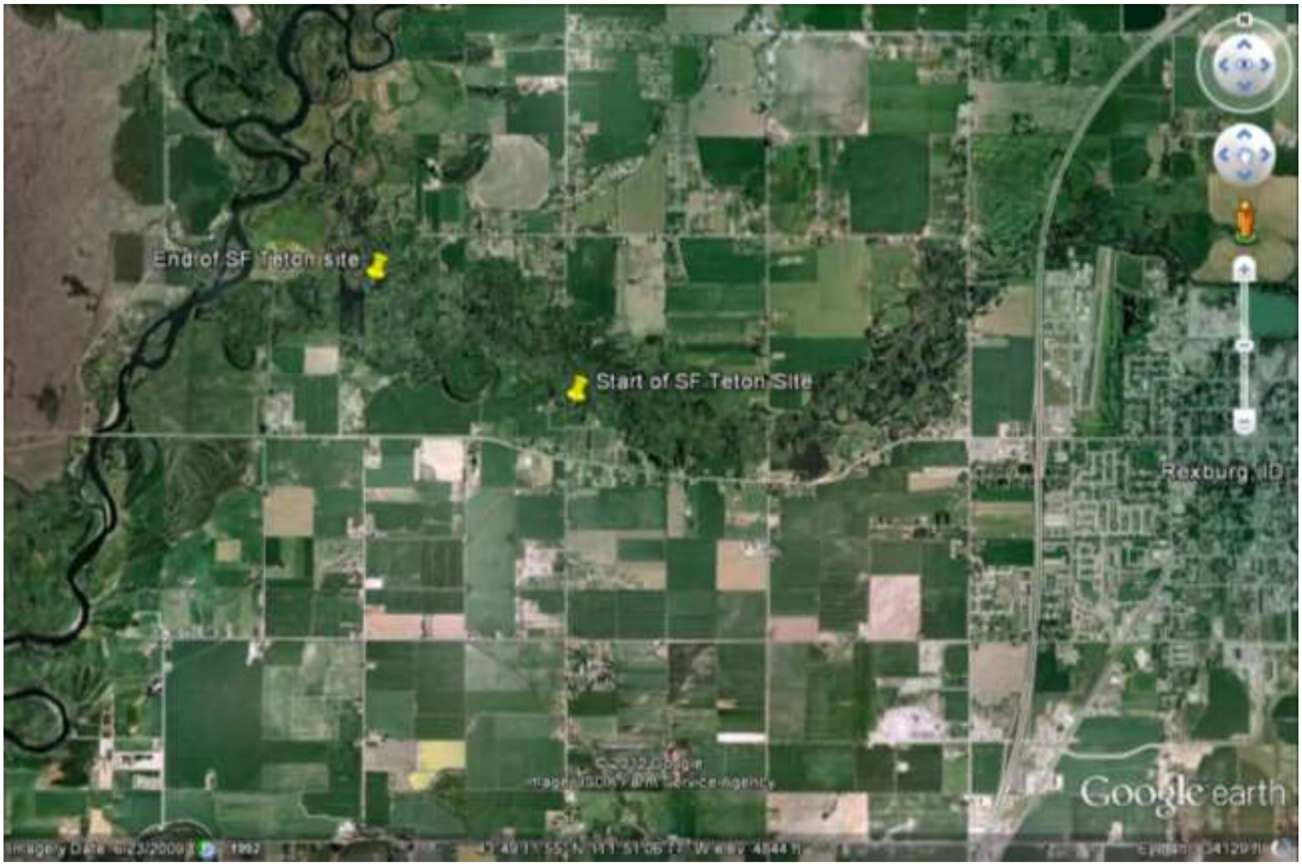

Figure 47. South Fork Teton River reach electrofishing site map.

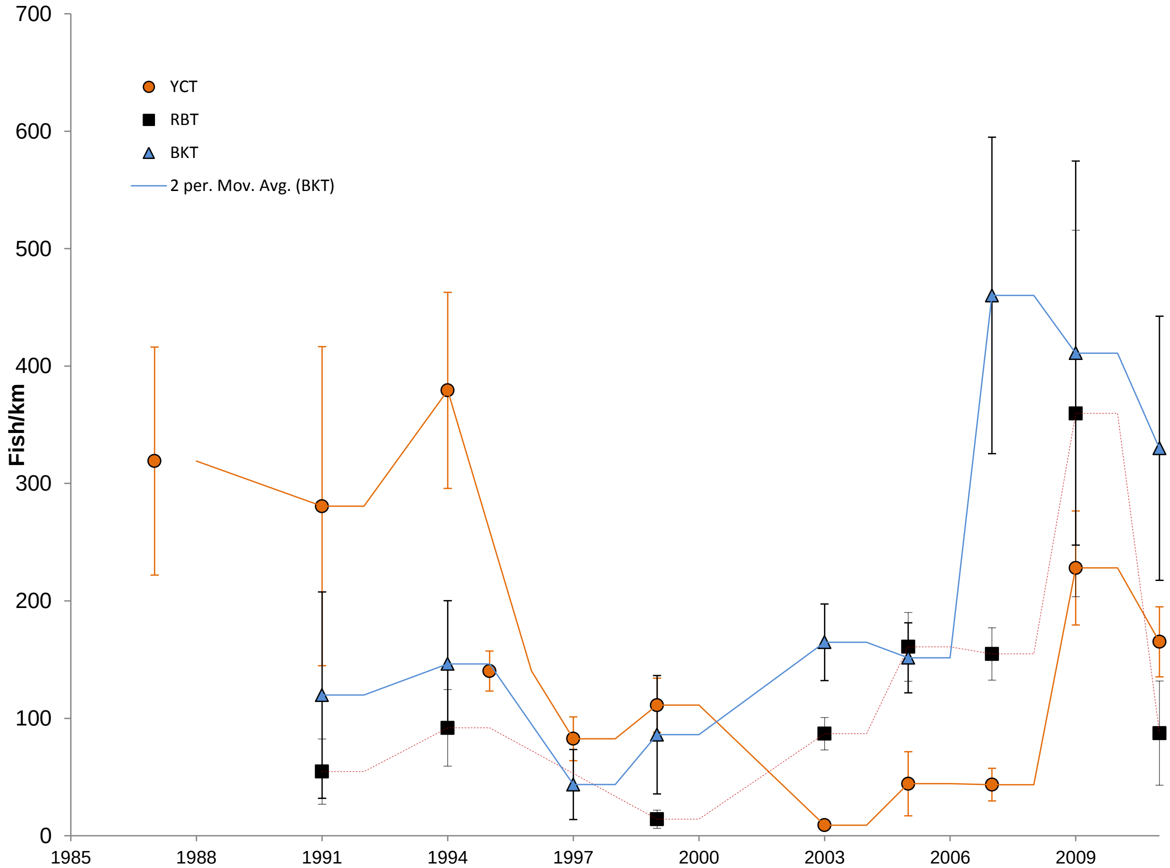

Figure 48. Estimates of Yellowstone cutthroat trout (YCT) rainbow trout (RBT), and brook trout (BKT) at the Nickerson monitoring site from 1987 through 2011 with 95% confidence intervals.

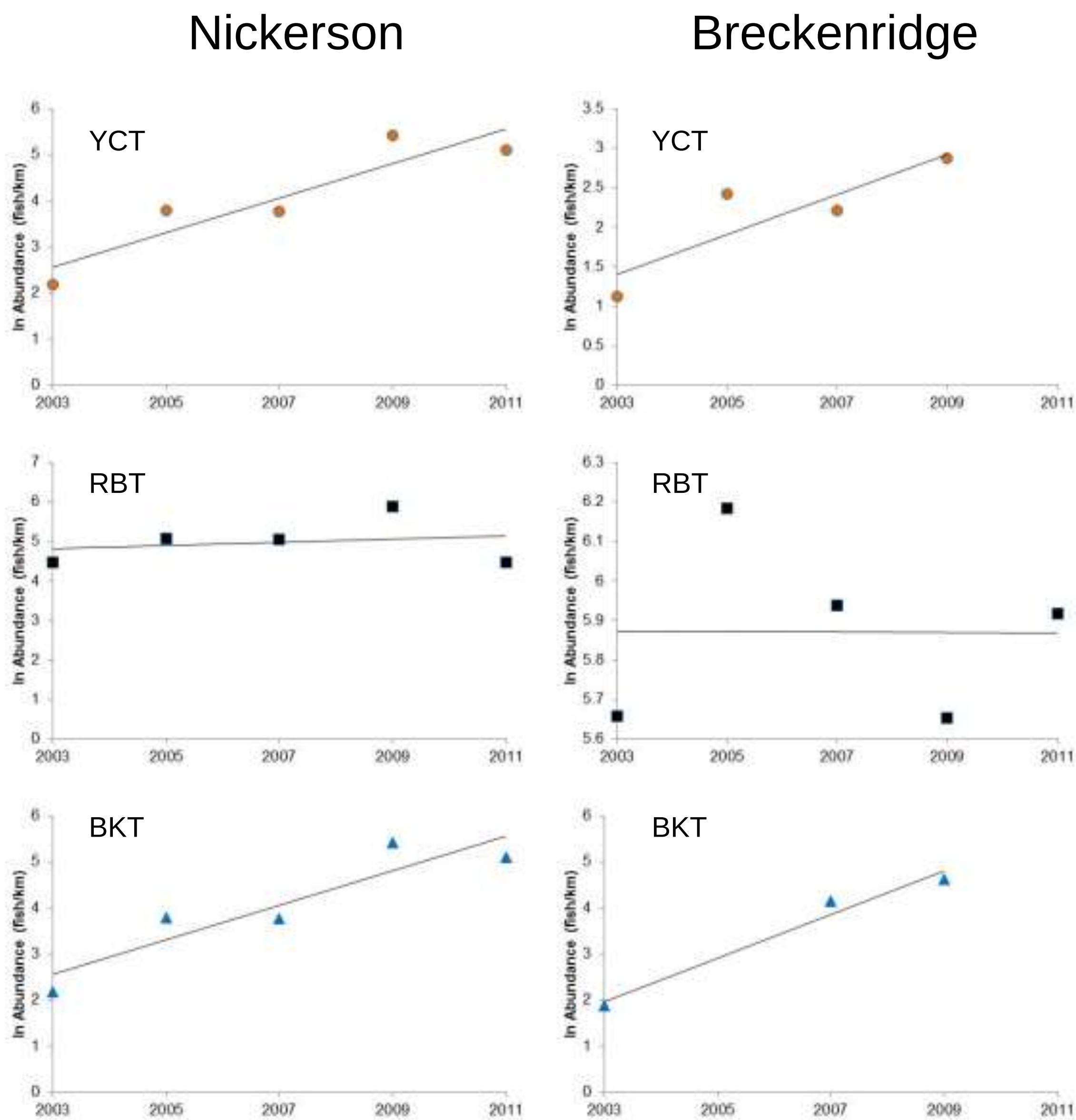

Figure 49. Linear regressions of $\log_e$-transformed abundance estimates for Yellowstone cutthroat trout (YCT), rainbow trout (RBT), and brook trout (BKT) and associated regression lines. The slopes of the regression lines are equivalent to the intrinsic rates of population change (*r*).

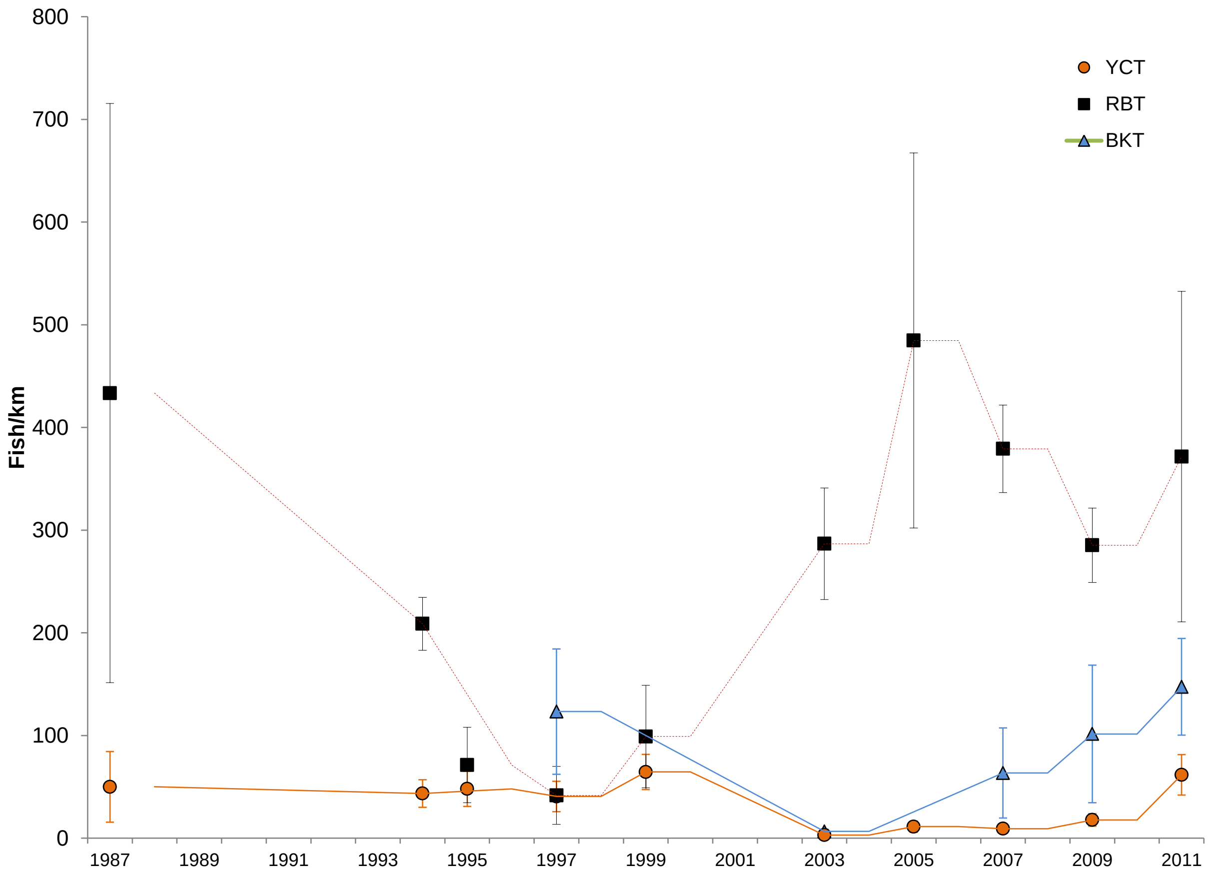

Figure 50. Estimates of Yellowstone cutthroat trout (YCT) rainbow trout (RBT), and brook trout (BKT) at the Breckenridge monitoring reach from 1987 through 2011 with 95% confidence intervals.

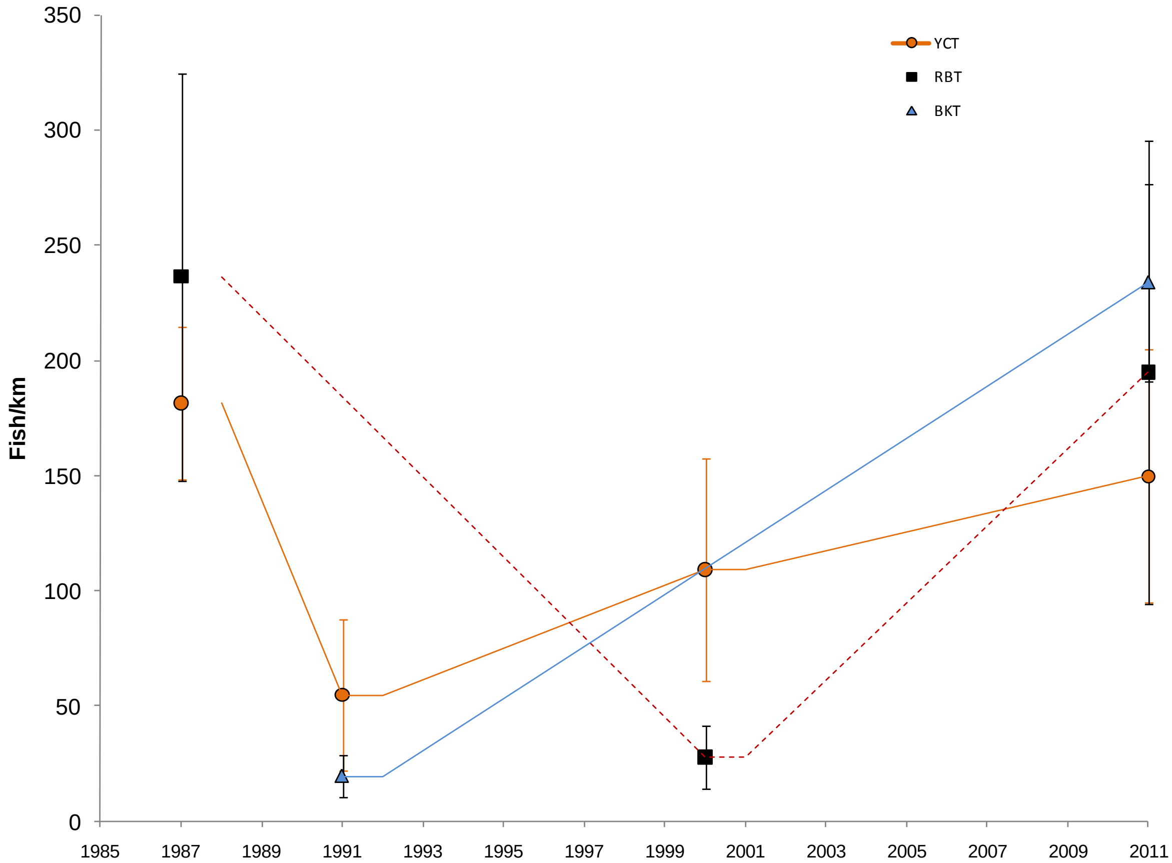

Figure 51. Estimates of Yellowstone cutthroat trout (YCT) rainbow trout (RBT), and brook trout (BKT) at the Buxton reach from 1987 through 2011 with 95% confidence intervals.

Figure 52. Estimates of Yellowstone cutthroat trout (YCT) rainbow trout (RBT), and brook trout (BKT) at the Rainier reach from 1987 through 2011 with 95% confidence intervals.

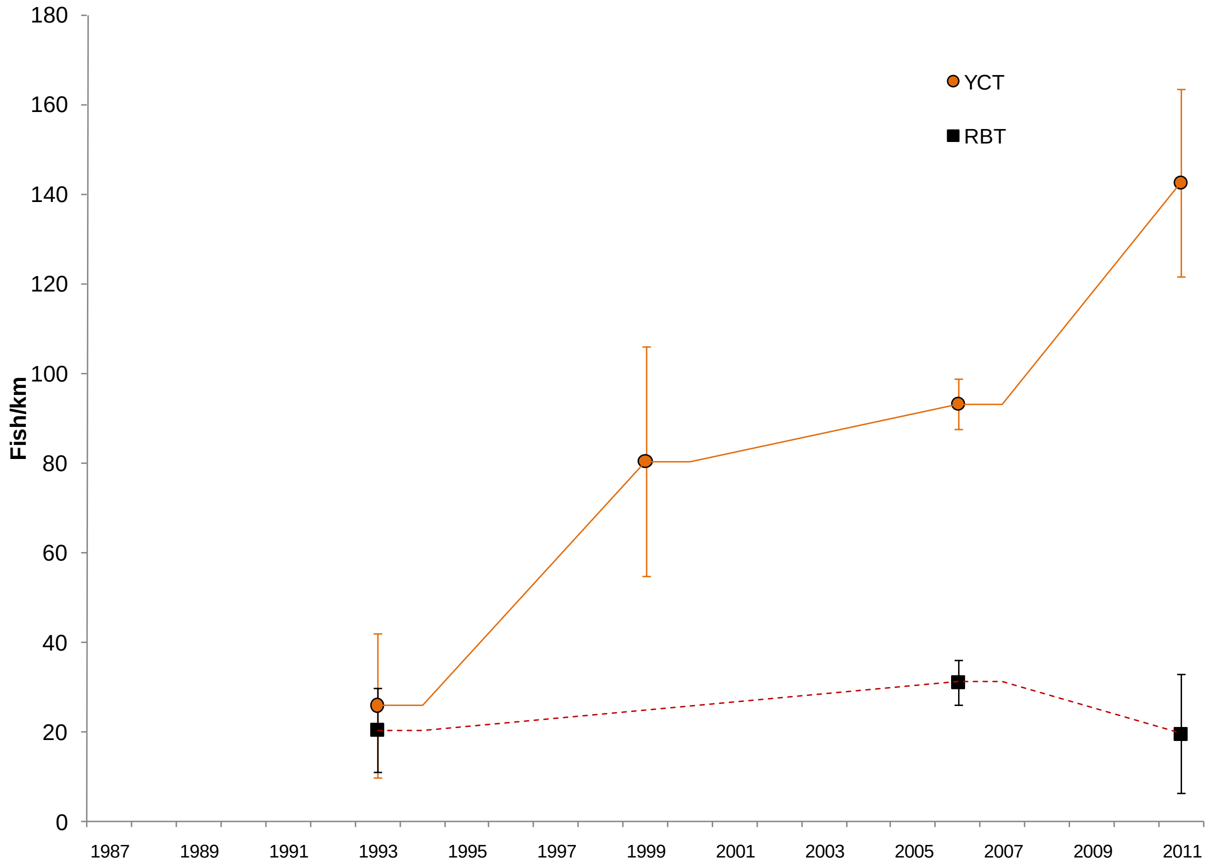

Figure 53. Estimates of Yellowstone cutthroat trout (YCT) and rainbow trout (RBT) at the South Fork Teton reach from 1993 through 2011 with 95% confidence intervals.

Table 26. Summary statistics from the Nickerson monitoring reach between 1987 and 2011 on the Teton River.

	Yellowstone cutthroat trout							Rainbow trout							Brook trout						
Year	M	C	R	R/C	YCT/Km	95%CI	CV	M	C	R	R/C	RBT/Km	95%CI	CV	M	C	R	R/C	BKT/Km	95%CI	CV
1987	145	177	15	0.08	319	97	0.16	25	15	1	0.07				140	102	3	0.03			
1988																					
1989	40							10							60						
1990																					
1991	90	96	8	0.08	281	136	0.25	47	39	6	0.15	87	44	0.26	63	65	4	0.06	191	140	0.37
1992																					
1993																					
1994	276	196	32	0.16	379	83	0.11	104	59	12	0.20	147	52	0.18	120	93	13	0.14	234	86	0.19
1995	241	165	54	0.33	140	17	0.06	23	4	1	0.25				58	15	1	0.07			
1996																					
1997	70	122	26	0.21	83	19	0.12	12	12	3	0.25				48	29	4	0.14	70	48	0.35
1998																					
1999	121	98	31	0.32	111	23	0.11	24	19	5	0.26	23	12	0.28	75	43	7	0.16	137	81	0.30
2000																					
2001																					
2002																					
2003	25	18	8	0.44	9	3	0.19	104	110	29	0.26	139	22	0.08	193	169	37	0.22	263	52	0.10
2004																					
2005	24	61	5	0.08	44	27	0.31	107	145	21	0.14	257	47	0.09	150	191	32	0.17	242	48	0.10
2006																					
2007	64	73	18	0.25	43	14	0.16	212	150	41	0.27	247	36	0.07	382	236	33	0.14	735	215	0.15
2008																					
2009	128	169	23	0.14	228	49	0.11	120	97	16	0.16	575	250	0.22	280	177	18	0.10	1,367	459	0.17
2010																					
2011	116	156	24	0.15	165	30	0.09	61	81	9	0.11	87	44	0.26	209	227	24	0.11	330	112	0.17

Table 27. Summary statistics from the Breckenridge monitoring reach between 1987 and 2011 on the Teton River.

	Yellowstone cutthroat trout							Rainbow trout							Brook trout						
Year	M	C	R	R/C	YCT/Km	95%CI	CV	M	C	R	R/C	RBT/Km	95%CI	CV	M	C	R	R/C	BKT/Km	95%CI	CV
1987	41	29	4	0.14	50	34	0.35	214	94	6	0.06	433	282.1	0.33	51	13	0	0.00			
1988																					
1989								5							2						
1990																					
1991	5							12							1						
1992																					
1993																					
1994	63	56	25	0.45	43	14	0.16	268	181	57	0.31	209	26	0.06	20	9	2	0.22			
1995	78	37	12	0.32	48	17	0.18	77	41	7	0.17	71	37	0.26	32	15	3	0.20			
1996																					
1997	50	36	9	0.25	41	15	0.18	30	38	4	0.11	42	28	0.35	76	48	7	0.15	123	61	0.25
1998																					
1999	66	58	17	0.29	64	17	0.14	55	41	6	0.15	99	50	0.26	29	17	2	0.12			
2000																					
2001																					
2002																					
2003	11	7	5	0.71	3	1	0.14	234	149	39	0.26	287	54	0.10	9	22	6	0.27	7	2	0.17
2004																					
2005	25	12	5	0.42	11	5	0.25	136	137	13	0.09	485	183	0.19	15	8	1	0.13			
2006																					
2007	19	22	9	0.41	9	3	0.16	394	335	88	0.26	379	43	0.06	59	25	4	0.16	63	44	0.35
2008																					
2009	38	26	11	0.42	18	6	0.17	240	245	45	0.18	285	36	0.06	60	48	5	0.10	101	67	0.34
2010																					
2011	1	34	1	0.03	62	20	0.14	93	132	7	0.05	372	161	0.22	52	31	2	0.06	148	47	0.16

LOST RIVER DRAINAGE STREAM SURVEYS

ABSTRACT

We electrofished 48 locations in the Little Lost River drainage in 2011 to determine species composition, estimate trout densities, and evaluate trends in abundance over time. We found no fish in 3 of our sites while 45 sites had fish present. Either rainbow trout, brook trout, bull trout *S. confluentus* or Yellowstone cutthroat trout were found in 43 sites where fish were present; two sites contained only sculpin spp. We found bull trout in 24 (50%) of our sample sites, 17 of which had bull trout in combination with brook trout, rainbow trout, cutthroat trout or bull trout x brook trout hybrids. Allopatric populations of bull trout were found in seven sites, located in Bunting Creek, Jackson Creek, Williams Creek, and Wet Creek, although other trout species were found in other sample sites in Wet Creek. Of the 48 sites sampled, 38 are part of the long-term fishery monitoring of Little Lost drainage and were last sampled in 2006, while 10 additional sites were surveyed to gain additional information throughout the drainage. Of the sites sampled in both 2006 and 2011, densities of age 1 and older trout have decreased in 46% of the sites, increased in 35% of the sites, and showed no change in 19% of the sites. We estimated bull trout abundance in all occupied streams in the Sawmill Creek drainage at 12,155 (11.2 bull trout >100 mm per 100 m), an increase from an estimated 7,741 (7.1 per 100 m) in 2006. Additionally, we have not observed any beneficial changes to the mean length of trout in the Little Lost drainage since limited harvest regulations were implemented in 1993.

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INTRODUCTION

The Little Lost River drainage contains primarily rainbow trout and bull trout *Salvelinus confluentus*, although brook trout are abundant in some areas, and Yellowstone cutthroat trout are present in some locations, mainly due to stocking activities. The Little Lost River has been managed for wild trout production since 1983, and under wild trout regulations (two trout harvest/possession limit) since 1993. Streams throughout the Little Lost River drainage are monitored on a five-year rotation to monitor trends in abundance and distribution in the fish populations. Additionally, we wanted to evaluate the effectiveness of the reduced bag limit established in 1993 on trout populations.

METHODS

We used backpack electrofishers on August 8-11, during low to moderate flow conditions (after spring runoff and before the onset of winter) to facilitate effective fish capture and standardization of sampling conditions. Six sample crews consisting of two to four people used multiple-pass depletion methods to estimate trout abundance. We identified all collected trout to species before measuring for total length and releasing at the completion of the collecting period. Sample reaches were 100 m in length in most instances but ranged from 50 to 200 m. Population estimates and 95% confidence intervals were estimated with MicroFish 3.0 (Van Deventer 2006) where appropriate. We used all trout species combined in our population estimates, and created species-specific density estimates by proportioning out densities based on relative abundance of the various species collected at each site. Capture efforts were focused on salmonids, but at each site where they occurred, nongame fish were captured and identified.

We used the methods described by High et al. (2008) to estimate bull trout abundance throughout the Sawmill Creek drainage. Additionally, we used this same methodology to estimate drainage wide abundance from our 2006 surveys and compare the two sampling events. This analysis was not intended for comparison to the estimate for the entire Little Lost drainage, as shown in High et al. (2008), as their analysis included data from 1997 to 2004, and included many more samples. Our intention is to use this methodology to compare bull trout abundance, based on observations of repeated sample sites as part of our five year monitoring program in the Sawmill Creek drainage, as this is the core occupied area in the Little Lost drainage.

To assess the effects of reduced bag limits associated with wild trout management regulations implemented in 1993, we examined total length statistics of trout collected pre-1993 to fish collected in our 2011 surveys. Based on the likelihood of angler use and the number of sites sampled, we compared trout length frequency distribution and mean total length data from sites sampled in the Sawmill Creek drainage in 1987 to 2011.

Stream samples in the Little Lost River drainage conducted in 2011 were a cooperative effort between the Upper Snake Region fisheries staff, Bureau of Land Management (BLM) and the United States Forest Service (USFS). The majority of sample locations were repeated sites used in long-term population monitoring by all agencies involved. Additional sites not identified as long-term monitoring sites were sampled by the USFS, and are included in this report. Three long-term monitoring sites on Badger Creek (site 2-A, 2-B, and 3) and a new site in Bunting Creek were sampled in 2010 by the USFS and are included in this report.

RESULTS AND DISCUSSION

Of the 48 stream surveys completed in the Little Lost River drainage (Figure 54), bull trout were present at 24 (50%) of the sites (Table 28). Allopatric populations of bull trout were found in Bunting Creek, Jackson Creek and Williams Creek. Three sites were sampled on Jackson Creek, where no sampling occurred in 2006. No fish were found in one site, while the other two sites contained only bull trout. Williams Creek, as seen in historic surveys, continues to support an allopatric population of bull trout. Two sites in Wet Creek also contained only bull trout, but rainbow trout, brook trout, and Yellowstone cutthroat trout were found in additional sample locations in Wet Creek. Bull trout were found in combination with brook trout in Mill Creek and Squaw Creek, and with brook trout and rainbow trout in Warm Creek, Summit Creek, and the Little Lost River. Bull trout were found in combination with rainbow trout in Smithie Fork. Hybrid trout (bull trout x brook trout), bull trout, and rainbow trout were found in Timber Creek, although brook trout were not observed. Bull trout, brook trout, and hybrids, as well as rainbow trout were found in Iron Creek and Sawmill Creek; Yellowstone cutthroat trout were also observed in Sawmill Creek. In Wet Creek we found rainbow trout, cutthroat trout, bull trout, and brook trout, but no hybrid trout. Bull trout densities ranged from 0.0 to 21.8 fish per $100m^2$. Bull trout densities have decreased in abundance compared to past surveys in 11 sample locations, while increases in abundance were observed in seven locations (Table 29). Bull trout density has remained similar to previous surveys in five sample sites.

Overall trout densities (fish per $100m^2$) ranged from 0.0 to 27.4 (Table 30). When compared to past surveys, 46% of sample locations showed a decrease in abundance of age-1 and older trout while 35% showed an increase in abundance, and 19% showed no change in abundance (Table 28; Appendix J). Ten sites had not previously been sampled, therefore had no basis for historical comparison. Trout density in the Sawmill Creek drainage decreased from an average of 12.4 trout >100mm per $100m^2$ in 2006 to 5.5 trout >100mm per $100m^2$ currently. Rainbow trout densities were highest in Deer Creek (mean: 21.7 fish >100mm per $100m^2$) but decreased from 2006 levels of 39.3 fish >100mm per $100m^2$. Trout density in Squaw Creek tripled from 9.4 fish per $100m^2$ in 2006 to 27 fish per $100m^2$ in 2011, while species composition shifted to 99% brook trout. Badger Creek trout density increased from 4.0 fish per $100m^2$ to 7.6 fish per $100m^2$. Density of bull trout, the only species found in Williams Creek, doubled from 4.5 fish per $100m^2$ in 2006 to 10.3 in 2011. Density in Wet Creek did not change between 2006 and 2011, averaging 6.2 and 5.7 fish per $100m^2$, respectively. Dry Creek trout density increased from 0.1 fish per $100m^2$ in 2006 to 0.5 in 2011, but the increase was likely attributed to the additional capture of only one or two fish. Yellowstone cutthroat trout were found in two of the sites sampled in Dry Creek, the result of introductions of this species in 2009 when approximately 20,000 fingerling cutthroat were stocked to establish a fish population here. However, only three cutthroat were found in three sample sites, all between 178 and 211 mm indicating that cutthroat introductions were unsuccessful at establishing a self-sustaining population.

Based on the work by High et al. (2008), 108.3 km of stream in the Sawmill Creek drainage are occupied by bull trout. We sampled 17 sites throughout the drainage, with 35% of our sampling occurring in 1st order streams, 24% in 2nd order streams, 12% in 3rd order streams, and 29% in 4th order streams. The combined sample length of all surveys was 1.7 km, or 1.5% of the total stream length in the Sawmill Creek drainage. Bull trout were captured in 14 (82%) of the sample sites. We estimated the overall bull trout abundance in 2011 throughout the Sawmill Creek drainage at 12,155 (±9,305) bull trout >100 mm. Mean linear density of bull trout in the Sawmill Creek drainage in 2011 was 11.2 bull trout per 100 m. Using the same techniques, we analyzed the data collected across 14 sample sites in the Sawmill Creek drainage in 2006.

Among stream reaches were sampled sites were located in 2006, 8% were in 1st order, 33% were in 2nd order, 16% were in 3rd order, and 42% were in 4th order. A total of 1.3 km was sampled in 2006, or 1.2% of the drainage. Bull trout were captured in 10 (83%) of the sample sites, resulting in a drainage wide estimate of 7,741 (±7,417) bull trout >100 mm. Mean linear density of bull trout in the Sawmill Creek drainage in 2006 was 7.1 bull trout per 100 m.

We used total length statistics of fish captured in our electrofishing surveys pre- (1987) and post- (2011) regulation change to determine if limited harvest regulations in the Little Lost River drainage have improved angling opportunities. The comparison of length-frequency distributions for brook trout, bull trout, and rainbow trout between 1987 and 2011 is similar; though unequal sample sizes confounds this comparison, we have not observed an increase in larger fish which would be desirable to anglers (Figure 55). Mean total length of brook trout, bull trout, and rainbow trout in the Sawmill Creek drainage in 2011 was 134, 160, and 174 mm, respectively (Table 32). Brook trout mean length was less than that observed in 1987, while rainbow trout mean length increased, and bull trout mean length did not change (Figure 56). Mean total length of all species was low, and have not improved to the point of providing quality angling. Additionally, the percentage of brook trout and bull trout greater than 300 mm has decreased from 1987 to 2011, while a small increase was observed in the percent of rainbow trout greater than 300 mm (Table 32). It is unlikely that the minor changes in length are in response to regulations, as angler pressure in the Little Lost drainage is relatively limited. Trout populations in the Little Lost River are likely more influenced by environmental factors such as stream flow and habitat conditions, than by angler harvest.

Electrofishing surveys have been conducted throughout the Little Lost River drainage by multiple agencies over the course of the past 25 years; therefore many discrepancies exist in the names of identical sampling locations. Garren et al. (2008) rectified sample site discrepancies and recommended repeatable sample locations, shown in Appendix K, which includes sites added in 2011.

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring sites identified in Appendix K on a five-year rotation.

2. Consider eliminating two trout harvest regulation and change to general stream season.

3. Work with partner agencies to identify and improve habitat conditions where possible.

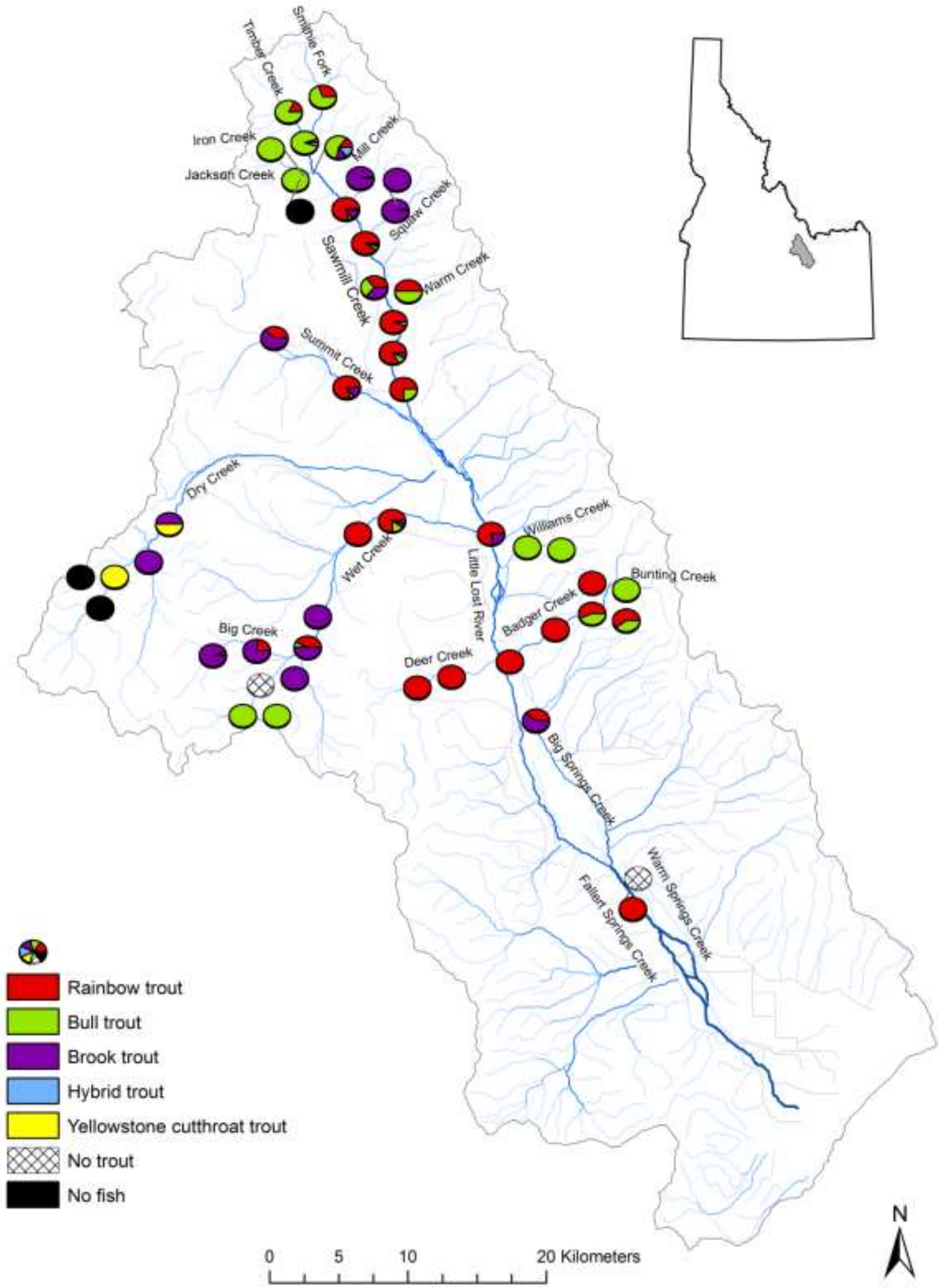


Figure 54. Sample locations and relative abundance from stream surveys conducted in 2011 in the Little Lost River drainage, Idaho.

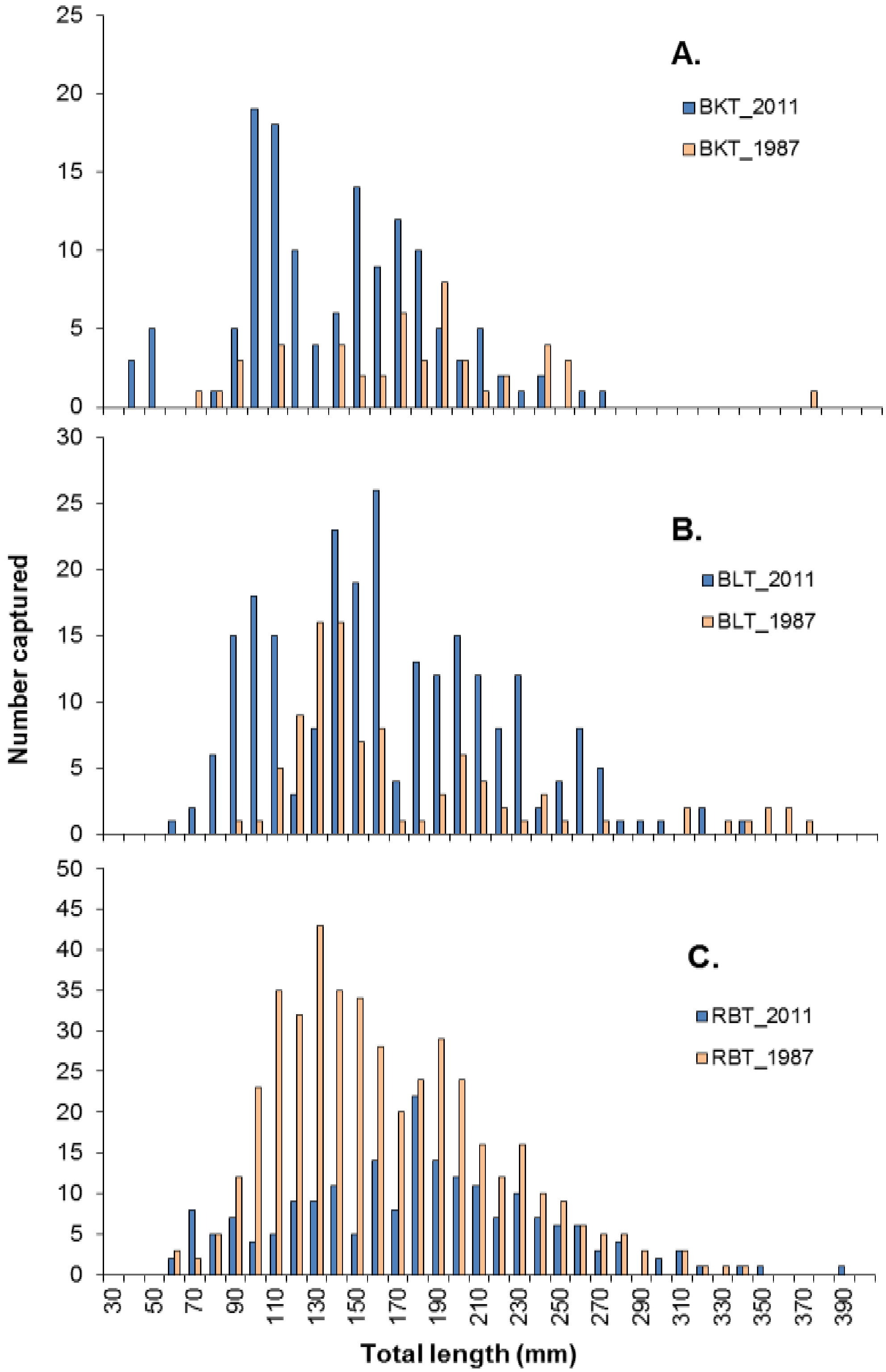


Figure 55. Length frequency distribution of A.) brook trout, B.) bull trout, and C.) rainbow trout captured in the Sawmill Creek drainage in 1987 (orange) and 2011 (blue).

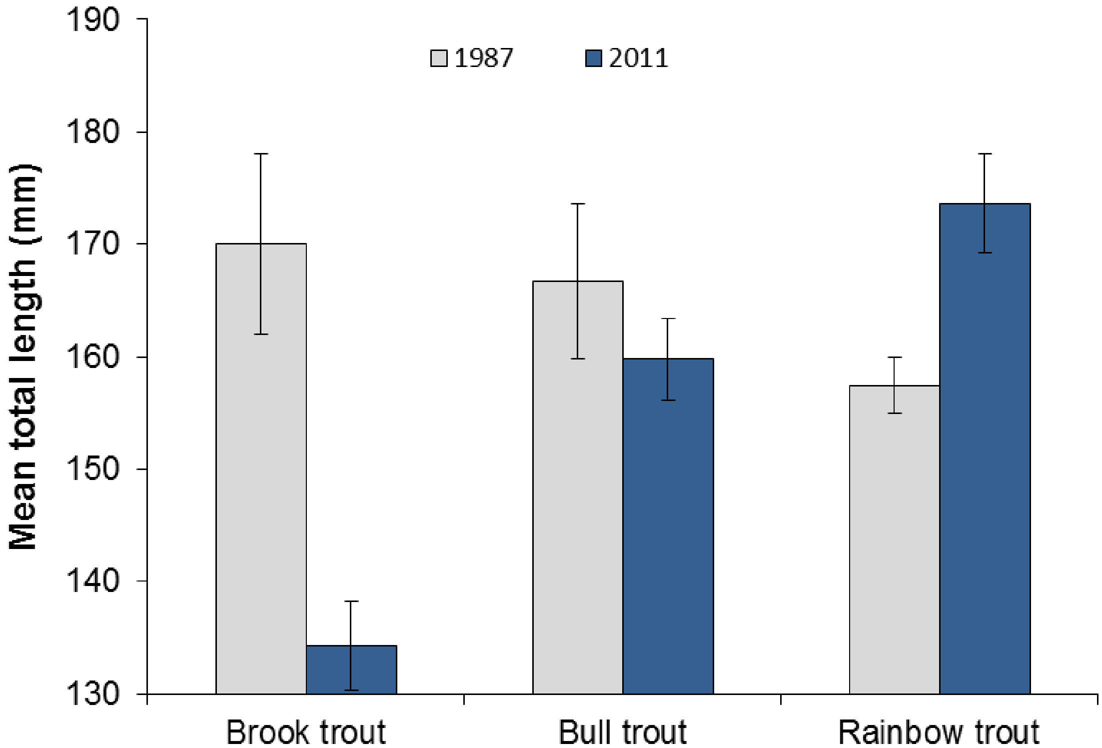


Figure 56. Mean total length (±95% confidence intervals) of brook trout, bull trout, and rainbow trout in the Sawmill Creek drainage, from 1987 and 2011.

Table 28. Summary statistics for streams sampled in the Little Lost River drainage, Idaho 2011, and population trends in relation to past monitoring surveys. Population trend comparisons are made to the results of the 2006 survey, unless otherwise noted.

Minor Drainage	No. Sites Sampled	No Fish	Fish Present	Trout Present	Native[a] and Nonnative Trout	Native[a] Trout Only	Density[b] (age 1 trout/100m^2)	Population Trend
Sawmill Canyon	17	1	16	16	12	2	0.9 – 27.0	Increase: 2 sites Decrease: 9 sites No change: 1 site No data: 5 sites[c]
Summit Creek	2	0	2	2	2	0	7.1 – 18.1	Increase: 2 sites
Dry Creek	5	2	3	3	0	0	0.3 – 0.7	Increase: 3 sites No data: 2 sites[c]
Wet Creek	10	0	10	9	2	2	0.0 – 15.6	Increase: 2 sites Decrease: 4 sites No change: 3 sites No data: 1 site[c]
Badger Creek[d]	5	0	5	5	2	0	3.3 – 17.6	Increase: 3 sites Decrease: 1 site No data: 1 site[c]
Deer Creek	2	0	2	2	0	0	16.0 – 27.4	Decrease:1 site No change: 1 site
Little Lost River	1	0	1	1	0	0	4.1	No change
Big Springs Creek	1	0	1	1	0	0	15.4	No change
Williams Creek	2	0	2	2	0	2	9.0 – 11.6	Increase: 1 site No data:1 site[c]
Fallert Springs Creek	1	0	1	1	0	0	0.2	Decrease[e]
Warm Springs Creek	1	0	1	0	0	0	0.0	Decrease[e]

[a] – Native trout are defined as bull trout in the Little Lost River drainage.
[b] – Density estimates are for age 1 and older trout, which are defined as all trout 70 mm in length or greater.
[c] – New sample site in 2011.
[d] – Includes data from USFS 2010 surveys.
[e] – Last survey conducted in 1987.

Table 29. Bull trout abundance and population trend from the Little Lost River, Idaho 2011.

Stream Location	Percent abundance bull trout	Percent abundance all other trout	Density[a] all trout	Bull trout density[a]	Bull trout density in 2006
Badger Creek 1	0	100	4.9	0.0	0.8
Badger Creek 2-A[b]	40	60	5.9	2.4	0.0
Badger Creek 2-B[b]	44	56	6.2	2.7	1.1
Badger Creek 3[b]	0	100	17.6	0.0	1.5
Bunting Cr[b]	100	0	13.0	13.0	--[c]
Iron Creek	57	43	3.3	1.9	2.3
Jackson Creek 1	100	0	21.8	21.8	--[c]
Jackson Creek 3	100	0	0.9	0.9	--[c]
Little Lost River 3	0	100	4.1	0.0	0.0[d,e]
Mill Creek	2	98	23.4	0.5	0.6
Sawmill Creek 1	25	75	2.2	0.6	0.0[d,f]
Sawmill Creek 2	10	90	2.7	0.3	0.3
Sawmill Creek 4	5	95	3.4	0.2	0.6
Sawmill Creek 5	5	95	4.7	0.2	0.4
Sawmill Creek 6	83	17	17.2	15.7	9.3
Smithie Fork	69	31	12.0	8.3	22.9
Squaw Creek	1	99	27.0	0.3	1.0
Summit Creek 4	5	95	7.1	0.4	0.0d
Timber Creek	90	10	9.3	8.4	7.9
Warm Creek 1	50	50	2.0	1.0	--[c]
Warm Creek 2	50	50	2.0	1.0	1.3
Wet Creek 2	100	0	0.8	0.8	--[g]
Wet Creek 3	15	85	9.8	1.5	0.6
Wet Creek 6	0	100	1.9	0.0	0.3
Wet Creek 7	7	93	3.8	0.3	0.4
Wet Creek 9	100	0	2.2	2.2	6.1
Williams Creek abv div	100	0	9.0	9.0	--[c]
Williams Creek 1	100	0	11.6	11.6	4.5

[a] - all densities are presented in fish per 100 m^2, and incorporate age 1 (>70 mm) and older fish.
[b] - USFS data from 2010 surveys.
[c] - New sample location added in 2011; no previous samples to compare.
[d] - No bull trout observed in the most recent previous survey (2006).
[e] - Bull trout last observed in this site in 2001 (0.2/100m^2).
[f] - Bull trout last observed in this site in 2001 (0.5/100m^2).
[g] - Last sampled in 1992 (1.2 fish/100m^2); no species data available.

Table 30. Stream locations sampled in the Little Lost River drainage during 2011.

Location	Site Name	Site Length (m)	Relative abundance[a] RBT	BLT	BKT	HYB	Other	Abundance Estimate Age 1[b] and older (+/- 95%)	All Trout (+/- 95%)	Density (Age 1[b] trout per 100m²)
Badger Cr	1	85	100					7 (7-8)	7 (7-8)	4.9
Badger Cr[c]	2-A	100	60	40				10 (9-11)	10 (9-11)	5.9
Badger Cr[c]	2-B	100	56	44				17 (15-19)	18 (16-20)	6.2
Badger Cr[c]	3	50	100					12 (10-14)	15 (13-17)	17.6
Badger Cr	Road Xing	200	100				SCL	16 (16-18)	16 (16-18)	3.3
Big Cr	1	100	23		77		SCL	38 (37-39)	44 (42-46)	14.3
Big Cr	2	100			100		SCL	43 (39-47)	44 (40-48)	15.6
Big Cr	beaver	87	5		95		SCL	44 (44-49)	45 (45-50)	15.0
Big Springs Cr	BLM	84	40		60		SCL	47 (45-49)	47 (45-49)	15.4
Bunting Cr[c]		50		100				9 (8-10)	9 (8-10)	13.0
Deer Cr	2	100	100				SCL	26 (22-30)	35 (25-45)	27.4
Deer Cr	3	72	100				SCL	13 (11–15)	18 (17-19)	16.0
Dry Cr	1 (Lower)	147			50		50[d]	2	2	0.4
Dry Cr	2 (Middle)	104			100			3	3	0.7
Dry Cr	3 (Upper)	164					100[d]	2	2	0.3
Dry Cr	Above falls 2	71		*No fish observed*				--	--	--
Dry Cr	Above falls 3	62		*No fish observed*				--	--	--
Iron Cr	(Lower)	102	14	57	14	14		10 (7-27)	10 (7-27)	3.3
Jackson Cr	1	50		100				17 (9-25)	18 (13-23)	21.8
Jackson Cr	2	50		*No fish observed*				--	--	--
Jackson Cr	3	50		100				1	1	0.9
Fallert Springs Cr	bridge	89	100				SCL	1	1	0.2
Little Lost River	3	128	78		22		SCL	37 (35-39)	37 (35-39)	4.1
Mill Creek	(Only)	100		2	98			144 (49-439)	228 (57-912)	23.4
Sawmill Cr	1	100	75	25			SCL	16 (14-18)	16 (14-18)	2.2
Sawmill Cr	2	100	83	10	7			29 (28-30)	29 (28-30)	2.7
Sawmill Cr	3	100	95			5	SCL	21 (17-25)	21 (17-25)	2.5
Sawmill Cr	4	160	90	5	2	2	SCL	43 (33-53)	47 (36-58)	3.4
Sawmill Cr	5	160	79	5	14	2	SCL	66 (54-78)	74 (58-90)	4.7
Sawmill Cr	6	100	17	83				149 (127-171)	149 (127-171)	17.2
Smithie Fork		100	31	69			SCL	51 (36-67)	51 (36-67)	12.0
Squaw Cr		100		1	99			77 (74-80)	111 (102-120)	27.0
Squaw Cr, NF	lower	100	2		98			50 (45-55)	50 (45-55)	24.9
Summit Cr	4	95	80	5	15		SCL	20 (20-20)	20 (20-20)	7.1
Summit Cr	5	119	38		62		SCL	57 (54-60)	57 (54-60)	18.1

Table 30 cont.

Location	Site Name	Site Length (m)	Relative abundance[a] RBT	BLT	BKT	HYB	Other	Abundance Estimate Age 1[b] and older (+/- 95%)	All Trout (+/- 95%)	Density (Age 1[b] trout per 100m²)
Timber Cr		127	5	90		5	SCL	43 (36-50)	44 (37-51)	9.3
Warm Cr	1	100	36	27	36			10 (10-12)	11 (11-14)	9.2
Warm Cr	2	85	50	50				3 (3-6)	4 (4-6)	2.0
Warm Springs Cr	lower	98		*None*			SCL	--	--	--
Wet Cr	2	102		100			SCL	2	2	0.8
Wet Cr	3	100	76	15	6		3[d], SCL	33 (32-34)	33 (32-34)	9.8
Wet Cr	4	130	100					11 (8-14)	11 (8-14)	3.1
Wet Cr	6	91			100		SCL	7 (5-9)	7 (5-9)	1.9
Wet Cr	7	80	43	7	50		SCL	14 (14-14)	14 (14-14)	3.8
Wet Cr	8	100		*None*			SCL	0	0	0
Wet Cr	9	140		100			SCL	9 (7-11)	9 (7-11)	2.2
Williams Cr	MIS 2011	95		100			SCL	12 (10-14)	12 (10-14)	11.6
Williams Cr	Abv div	100		100			SCL	7 (7-8)	7 (7-8)	9.0

[a] – Species definitions: RBT = rainbow trout; BLT = bull trout; BKT = brook trout; HYB = hybrid (bull x brook) trout; SCL = sculpin
[b] – Age 1 and older fish were defined as being any trout 70 mm in length or greater.
[c] – USFS data from 2010 surveys.
[d] – Yellowstone cutthroat trout

Table 31. Summary of total length statistics (mean, maximum, sample size[n], and percent greater than 300mm) of trout captured in the Sawmill Creek drainage during 1987 and 2011.

	Brook trout	Bull trout	Rainbow trout
1987			
Mean	170	167	157
Max	365	362	331
n	48	95	437
% >300mm	2.1	9.5	1.4
2011			
Mean	134	160	174
Max	261	331	385
n	136	237	198
% >300mm	0.0	1.3	3.5

APPENDICIES

Appendix A. Location of Ririe Reservoir fall walleye index netting (FWIN) net locations during October 2011. All coordinates are Zone 12, and WGS 84 datum.

DATE	NET	LAKE STRATA	E	N	NET TYPE
10/25/2011	1	North	440407	4821986	S
10/25/2011	2	North	440431	4822178	F
10/25/2011	3	North	440774	4822699	S
10/25/2011	4	North	440622	4822980	F
10/25/2011	5	North	440560	4824472	S
10/25/2011	6	North	440456	4824569	F
10/26/2011	7	Middle	441409	4819469	S
10/26/2011	8	Middle	441426	4819986	S
10/26/2011	9	Middle	441787	4820485	S
10/26/2011	10	Middle	441530	4820579	F
10/26/2011	11	Middle	440212	4821083	S
10/26/2011	12	Middle	440964	4821179	F
10/27/2011	13	South	439913	4814956	F
10/27/2011	14	South	439603	4815263	F
10/27/2011	15	South	438697	4816724	S
10/27/2011	16	South	439025	4816930	F
10/27/2011	17	South	440008	4817254	S
10/27/2011	18	South	440359	4817358	F

Appendix B. Locations used in population surveys on the Henrys Fork Snake River, Idaho 2011. All locations used NAD-27 and are in Zone 12.

	Start		Stop	
Reach	Easting	Northing	Easting	Northing
Box Canyon	468677	4917703	467701	4914352
Mack's Inn	477523	4926591	474953	4927455

Appendix C. Mean total length, length range, proportional stock density (PSD), and relative stock density (RSD-400 and RSD-500) of rainbow trout captured in the Box Canyon reach electrofishing reach, Henrys Fork Snake River, Idaho, 1995-2011. RSD-400 = (number ≥400 mm/ number ≥200 mm) x 100. RSD-500 = (number ≥500 mm/ number ≥200 mm) x 100.

Year	Number	Mean TL (mm)	Length Range (mm)	PSD	RSD-400	RSD-500
1991	711	293	71 – 675	65	46	9
1994	1,226	313	46 - 555	90	46	3
1995	1,590	316	35 – 630	61	30	1
1996	1,049	300	31 – 574	66	20	1
1997	1,272	307	72 – 630	47	14	1
1998	1,187	269	92 – 532	45	13	0
1999	874	330	80 – 573	63	16	1
2000	1,887	293	150 – 593	45	11	1
2002	1,111	352	100 – 600	75	28	0
2003	599	365	100 – 520	86	42	1
2005	1,064	347	93 – 595	76	44	2
2006	1,200	320	95 – 648	64	26	2
2007	1,092	307	91 – 555	58	21	2
2008	1,417	341	92 – 536	73	20	1
2009	1,371	350	80 – 587	79	27	1
2010	2,700	307	75 - 527	51	23	1
2011	1,224	348	111 - 550	74	27	1

Appendix D. Electrofishing mark-recapture statistics, efficiency (R/C), coefficient of variation (CV), Modified Peterson Method (MPM) and Log-Likelihood Method (LLM) population estimates (N) of age 1 and older rainbow trout (≥150 mm), and mean stream discharge (cfs) during the sample period for the Box Canyon reach, Henrys Fork Snake River, Idaho, 1995-2011. Confidence intervals (±95%) for population estimates are in parentheses.

Year	M[a]	C[a]	R[a]	R/C (%)	CV	N/reach MPM	N/reach LLM	N/km LLM	Discharge (cfs)
1995	982	644	104	16	0.04	6,037 (5,043-7,031)	5,922 (5,473-6,371)	1,601 (1,479-1,722)	2,330
1996	626	384	69	18	0.05	3,456 (2,770-4,142)	4,206 (3,789-4,623)	1,137 (1,024-1,250)	1,930
1997	859	424	68	16	0.06	5,296 (4,202-6,390)	5,881 (5,217-6,545)	1,589 (1,410-1,769)	1,810
1998	683	425	42	10	0.07	6,775 (4,937-8,613)	8,846 (7,580-10,112)	2,391 (2,049-2,733)	1,880
1999	595	315	38	12	0.07	4,844 (3,484-6,204)	5,215 (4,529-5,901)	1,409 (1,224-1,595)	1,920
2000	1,269	692	74	11	0.05	11,734 (9,317-14,151)	12,841 (11,665-14,017)	3,471 (3,153-3,788)	915
2002	1,050	511	81	16	0.05	6,574 (5,329-7,819)	7,556 (6,882-8,230)	2,042 (1,860-2,224	820
2003	427	167	20	12	0.10	3,472 (2,147-4,797)	3,767 (3,005-4,529)	1,018 (812-1,224)	339
2005	735	401	90	22	0.06	3,250 (2,703-3,797)	4,430 (3,922-4,938)	1,197 (1,060-1,334)	507
2006	887	356	61	17	0.05	5,112 (4,005-6,219)	5,986 (5,387-6,585)	1,618 (1,456-1,779)	1,783
2007	737	332	51	15	0.08	4,725 (3,598-5,852)	8,549 (7,288-9,810)	2,311 (1,970-2,652)	542
2008	887	615	93	15	0.04	5,818 (4,842–7,089)	5,812 (5,312-6,312)	1,571 (1,436–1,706)	894

Appendix D. cont.

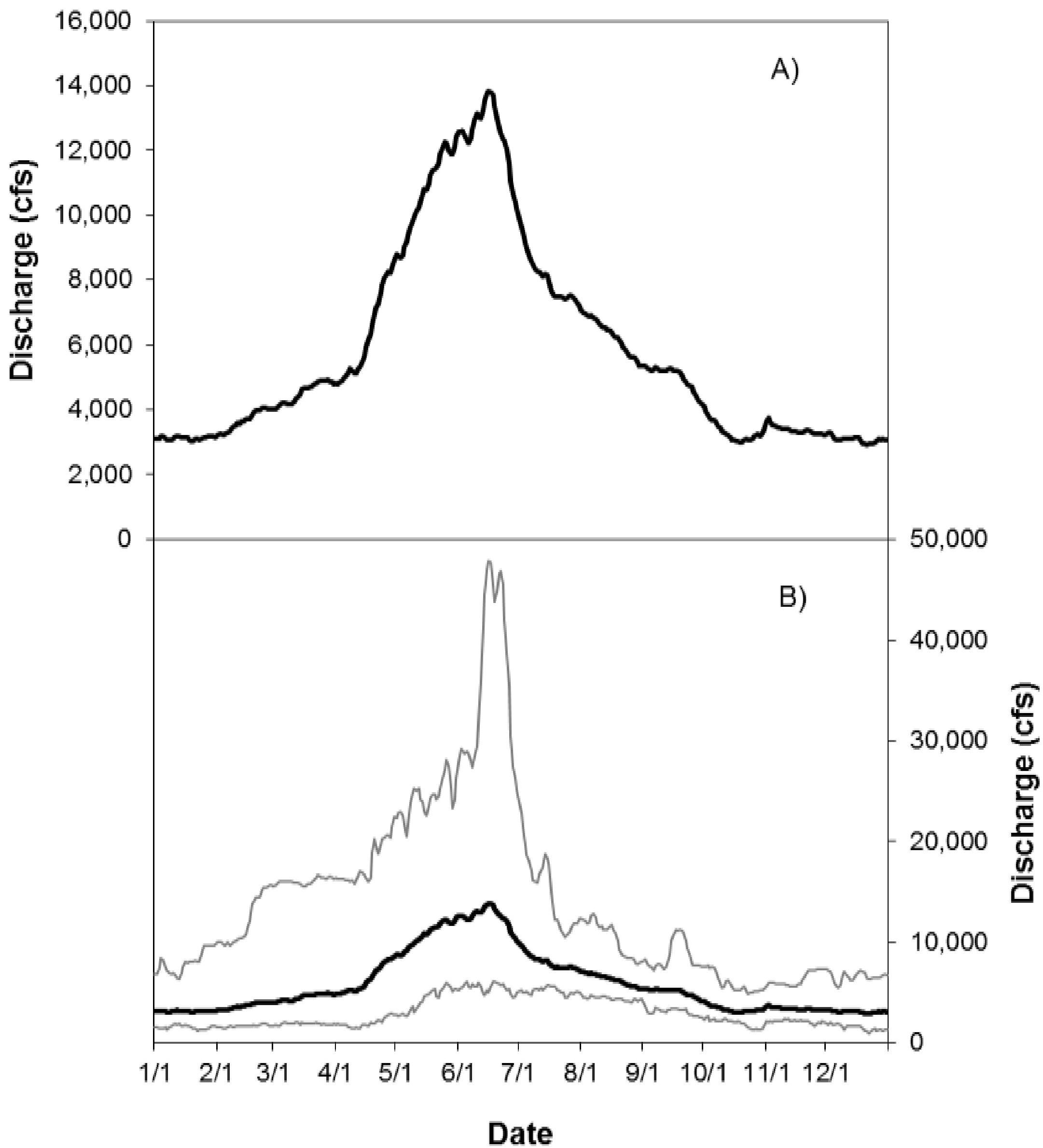
Year	M[a]	C[a]	R[a]	R/C (%)	CV	N/reach MPM	N/reach LLM	N/km LLM	Discharge (cfs)
2009	673	775	112	14	0.04	4,628 (3,910-5,540)	5,034 (4,610-5,458)	1,361 (1,246-1,476)	1,377
2010	1,309	1,292	262	20	0.03	6,439 (5,820-7,058)	8,341 (7,857-8,825)	2,254 (2,123-2,385)	626
2011	639	652	74	11	0.06	5,571 (4,516-6,988)	6,548 (5,816-7,280)	1,770 (1,572-1,968)	1,159

[a]M = number of fish marked on marking run; C = total number of fish captured on recapture run; R = number of recaptured fish on recapture run.

Appendix E. Locations of South Fork Snake River fish population monitoring sites, tributary weirs, and PIT tag arrays (WGS 84).

Site	Upstream boundary	Downstream boundary
Conant monitoring site	12T 467846 E 4810899 N	12T 465305 E 4814032 N
Lorenzo monitoring site	12T 430743 E 4841275 N	12T 428214 E 4844051 N
Burns Cr Weir	12T 462063 E 4827984 N	NA
Pine Cr Weir	12T 473373 E 4819000 N	NA
Palisades Cr Weir	12T 480668 E 4803039 N	NA
Burns Cr PIT array	12T 461795 E 4827725 N	NA

Appendix F. Stream flow data from the Osgood reach of the Snake River, from 1989 – 2010, measured at the USGS gauge (#13057155), approximately 3.0 km downstream of the County Line Road bridge, and 13.0 km upstream of Idaho Falls, ID. Mean daily discharge from 1989 to 2010 is represented by the black line (A); gray lines represent maximum and minimum discharge (B).



Appendix G. Locations (UTM) used in population surveys of the Snake River near Osgood, Idaho 2011. All locations used NAD-27 and are in Zone 12.

	Easting	Northing
Start	413889	4830842
Stop	414530	4828032

Appendix H. Mark-recapture data of brown trout (BNT), rainbow trout (RBT), and Yellowstone cutthroat trout (YCT) from electrofishing surveys of the Osgood Reach of the Snake River during 2011.

	Number caught (C)				Number recaptures (R)				Marked fish at large - minus mortalities (M)			
Sample date	**BNT**	**RBT**	**YCT**	**All trout (C_t)**	**BNT**	**RBT**	**YCT**	**All trout (R_t)**	**BNT**	**RBT**	**YCT**	**All trout (M_t)**
9/15	11	3	2	16	-	-	-	-	11	3	2	0
9/21	42	13	4	59	0	0	0	0	53	15	6	16
9/30	17	13	4	34	1	1	1	3	69	27	9	74
10/4	18	8	2	28	4	1	0	5	83	34	11	105
10/13	73	26	10	109	10	3	4	17	146	57	17	127
10/18	56	22	4	82	17	14	1	32	185	65	20	219
10/24	51	24	4	79	14	9	1	24	223	80	23	269
Sum	269	109	30	407	46	28	7	81	260	95	26	324

Appendix I. Electrofishing reach boundary UTMs in the WGS 84 datum.

Study reach	Upstream boundary	Downstream boundary
Nickerson	12T 486675 E 4838166 N	12T 484839 E 4841139 N
Breckenridge	12T 483128 E 4847608 N	12T 481805 E 4850358 N
Buxton	12T 484839 E 4841139 N	12T 483537 E 4844388 N
Rainier	12T 483537 E 4844388 N	12T 483128 E 4847608 N
South Fork Teton	12T 431031 E 4853195 N	12T 429477 E 4854137 N
South Fork sub-section	12T 431031 E 4853195 N	12T 430599 E 4853545 N

Appendix J. Historic data from the Little Lost River, Idaho. Sites located below were sampled in 2011 – however, some sites were sampled in 2010 and included here for comparison. Additional historical sites throughout the drainage exist, and can be found in USFS reports, the History and Status of Fishes in the Little Lost River Drainage, Idaho 1999 and in Bureau of Land Management Documents.

			Species Composition (%)				
Site	**Date**	**Fish/100m2[a]**	**RBT**	**BLT**	**BKT**	**HYB**	**Source**
Badger Cr *1*	1995	n/a	100				USFS
	1999	7.8	88	12			BLM
	2006	8.4	73	27			IDFG[b]
	2011	4.9	100				IDFG[b]
Badger Cr *2-A*	2006	2.1	100				IDFG[b]
	2010	5.9	60	40			USFS[c]
Badger Cr *2-B*	1987	26.3	96	4			IDFG
	1995	n/a	92	8			USFS
	2006	1.1	0	100			IDFG[b]
	2010	6.2	56	44			USFS[c]
Badger Cr *3*	1987	33.1	100				IDFG
	1995	64.1	94	6			USFS
	1997	44.4	100				USFS
	2006	4.4	67	33			IDFG[b]
	2010	17.6	100				USFS[c]
Big Cr *1*	1987	14.4	100				IDFG
	1994	8.0	81		19		USFS
	1996	n/a	86		14		USFS
	2006	10.3	88		12		IDFG[b]
	2011	14.3	23		77		IDFG[b]
Big Cr *2*	1996	n/a	37		63		USFS
	1999	55.6	1		99		USFS
	2002	6.0	67		33		USFS
	2006	15.7	47		53		IDFG[b]
	2011	15.6	0		100		IDFG[b]
Big Cr *3*	1994	33.6	52		48		USFS
	2006	45.5	26		74		IDFG[b]
Big Springs Cr	1987	20.1	94		6		USFS
	1993	20.9	80		20		USFS
	2001	6.0	36		64		BLM
	2006	14.3	34		66		IDFG[b]
	2011	15.4	40		60		IDFG[b]
Deer Cr *2*	1987	28.2	100				IDFG
	1992	20.7	100				USFS
	2006	28.0	100				IDFG[b]
	2011	27.4	100				IDFG[b]
Deer Cr *3*	1995	42.5	100				USFS
	2006	50.5	100				IDFG[b]
	2011	16.0	100				IDFG[b]
Dry Cr	2006	0.2			100		IDFG[b]

Appendix J cont.

Site	Date	Fish/100m2[a]	Species Composition (%) RBT	BLT	BKT	HYB	Source
1	2011	0.4			50	50[d]	IDFG[b]
Dry Cr *2*	1987	3.9			87[d]		IDFG
	1995	8.9			100		USFS
	2000	11.4[e]			98[d]		USFS
	2006	0.2			100		IDFG[b]
	2011	0.7			100		IDFG[b]
Dry Cr *3*	1995	0.0					USFS
	2006	0.0					IDFG[b]
	2011	0.3[d]					IDFG[b]
Iron Cr	1987	6.6	4	96			IDFG
	1995	10.1		100			USFS
	1996	n/a		100			USFS
	2000	14.3		98		2	USFS
	2006	4.3	46	54			IDFG[b]
	2011	3.3	14	57	14	14	IDFG[b]
Little Lost R *3*	1987	28.2	95	4	1		IDFG
	1992	14.3	96	3	1		USFS
	2001	4.0	96	4			BLM
	2006	3.8	100				IDFG[b]
	2011	4.1	78		22		IDFG[b]
Mill Cr	1995	20.0	12	36	52		USFS
	1997	20.7	3	4	93		USFS
	2006	12.3	16	5	79		IDFG[b]
	2011	23.4	0	2	98		IDFG[b]
Sawmill Cr *1*	1984	3.0	59	29	12		IDFG
	1985	1.6	22	22	56		IDFG
	1986	1.3	64	18	18		IDFG
	1987	2.2	68	14	18		IDFG
	1993	2.0	70	10	20		USFS
	1997	2.2	75	17	8		USFS
	2001	4.9	86	11	3		BLM
	2006	4.2	100				IDFG[b]
	2011	2.2	75	25			IDFG[b]
Sawmill Cr *2*	1984	4.1	80	7	13		IDFG
	1985	4.4	50	38	12		IDFG
	1986	3.7	50	36	14		IDFG
	1987	1.5	43		57		IDFG
	1993	6.6	93	5	2		USFS
	1997	3.5	93	7			USFS
	2001	3.7	78	3	19		BLM
	2006	8.2	97	3			IDFG[b]
	2011	2.7	83	10	7		IDFG[b]
Sawmill Cr *3*	1984	5.7	72	17	11		IDFG
	1985	3.7	48	41	11		IDFG
	1986	3.1	72	16	12		IDFG
	1987	6.2	77	6	17		IDFG

Appendix J. cont.

Site	Date	Fish/100m[2a]	Species Composition (%) RBT	BLT	BKT	HYB	Source
	1993	7.0	91		9		USFS
Sawmill Cr *3* (cont)	1997	5.7	90	3	8		USFS
	2006	13.4	100				IDFG[b]
	2011	2.5	95			5	IDFG[b]
Sawmill Cr *4*	1987	10.1	63	21	16		IDFG
	1995	8.1	93	3	4		USFS
	1997	6.4	87	3	11		USFS
	2006	15.1	90	4	3	3	IDFG[b]
	2011	3.4	83[d]	5	2	2	IDFG[b]
Sawmill Cr *5*	1987	7.8	51	33	16		IDFG
	1995	8.8	80	6	14		USFS
	1997	9.6	65		35		USFS
	2004	6.1	75	2	16	7	USFS
	2006	18.6	87	2	11		IDFG[b]
	2011	4.7	79	5	14	2	IDFG[b]
Sawmill Cr *6*	1987	3.9		100			IDFG
	1995	4.6	26	74			USFS
	1997	8.1	13	87			USFS
	2006	14.6	36	64			IDFG[b]
	2011	7.8	18	61		21	IDFG[b]
Smithie Fork	1995	28.4	7	93			USFS
	1997	20.1	3	97			USFS
	2006	27.2	15	84		1	IDFG[b]
	2011	12.0	31	69			IDFG[b]
Squaw Cr	1995	12.3	23	19	67		USFS
	1997	24.1	41	11	48		USFS
	2006	9.4		11	89		IDFG[b]
	2011	27.0		1	99		IDFG[b]
Summit Cr *4*	1987	26.4	82		18		BLM
	1992	16.0	91		9		BLM
	2006	5.6	94		6		IDFG[b]
	2011	7.1	80	5	15		IDFG[b]
Summit Cr *5*	2006	14.1	39		61		IDFG[b]
	2011	18.1	38		62		IDFG[b]
Timber Cr	1987	7.5		100			IDFG
	1995	5.0	17	83			USFS
	1997	7.0	5	95			USFS
	2000	16.2	13	87			USFS
	2001	16.5	12	88			USFS
	2004	6.5	20	80			USFS
	2006	12.0	32	66		2	IDFG[b]
	2011	9.3	5	90		5	IDFG[b]
Warm Cr	1995	6.7	100				USFS
	2006	5.3		75	25		IDFG[b]
	2011	2.0	50	50			IDFG[b]
Wet Cr	1987	6.9	97	3			IDFG

Appendix J cont.

Site	Date	Fish/100m[2a]	Species Composition (%) RBT	BLT	BKT	HYB	Source
3 Wet Cr *3* (cont)	1992	5.1	96	4			USFS
	2001	0.5	100				BLM
	2006	5.1	89	11			IDFG[b]
	2011	9.8	76[d]	15	6		IDFG[b]
Wet Cr *4*	1987	5.5	96	4			IDFG
	1992	5.9	100				USFS
	2001	4.9	95			1	BLM
	2006	3.3	100				IDFG[b]
	2011	3.1	100				IDFG[b]
Wet Cr *6*	1987	14.3	100				IDFG
	1992	5.2	100				USFS
	2001	5.7	100				BLM
	2006	4.0	92	8			IDFG[b]
	2011	1.9	0		100		IDFG[b]
Wet Cr *7*	1987	10.9	100				IDFG
	1992	5.7	100				USFS
	2006	5.8	88	6	6		IDFG[b]
	2011	3.8	43	7	50		IDFG[b]
Wet Cr *8*	1996	n/a	73	27			USFS
	2006	0.0					IDFG[b]
	2011	0.0					IDFG[b]
Wet Cr *9*	1995	11.3	30	70			USFS
	1996	11.4	28	72			USFS
	1999	12.5	9	91			USFS
	2001	6.9		100			USFS
	2002	1.6		100			USFS
	2004	0.3		100			USFS
	2006	6.1		100			IDFG[b]
	2011	2.2		100			IDFG[b]
Williams Cr *MIS 2011*	1995	10.4		100			USFS
	2000	4.5		100			USFS
	2004	12.7		100			USFS
	2006	4.5		100			IDFG[b]
	2011	11.6		100			IDFG[b]

[a] – includes estimates of all trout age 1 and older (70 mm and larger)
[b] - Sampling was a joint effort with IDFG, USFS and BLM
[c] – Sampled in 2010 by USFS
[d] – YCT present in survey
[e] – density estimated using length and width from 2006 survey

Appendix K. Stream sample locations (UTM NAD 83, Z 12) and other names used to describe locations reported previously in IDFG, USFS and BLM reports in the Little Lost River, Idaho. Asterisks (*) indicate new sample sites in 2011.

		UTM		
Stream	Site name	Easting	Northing	Previous Names
Badger Cr	1	324901	4882932	Lower, BLM 3.2 km above LLR
Badger Cr	2-A	328451	4884775	New sample location
Badger Cr	2-B	328052	4884163	USFS lower, near cabin in lower sect.
Badger Cr	3	329256	4886236	USFS in basin; 0.3 km above Bunting Cr
Badger Cr*	Road X-ing	321460	4880947	Below road crossing
Big Cr	1	305064	4881910	Up from road; 0.8 km above Wet Cr
Big Cr	2	303140	4882597	At forest boundary;
Big Cr	3	301332	4883054	USFS at trailhead; Big Cr upper
Big Cr*	Beaver	300006	4882168	Near old beaver pond, ~1.6 km up trail
Big Springs Cr	BLM	323197	4876616	Near rd crossing; 0.8 km above rd crossing
Bunting Cr*		330060	4885831	
Deer Cr	2	315974	4880159	BLM #2 (old BLM #3); 1.6 km below USFS boundary
Deer Cr	3	314705	4879306	At USFS boundary;
Dry Cr	1	297204	4891787	Dry Creek on BLM
Dry Cr	2	294562	4889179	150 m above USFS boundary
Dry Cr	3	293076	4887270	0.4 km above falls
Dry Cr*	Abv falls 2	292425	4886766	
Dry Cr*	Abv falls 3	291985	4885918	
Fallert Springs Cr*	Bridge	329750	4864370	Above Cedarville road (1987)
Iron Cr		303565	4916549	@ 0.5 km from mouth; Just above road
Jackson Cr*	1	307838	4916628	100m below Iron Cr road
Jackson Cr*	2	307562	4916377	250m above Iron Cr road
Jackson Cr*	3	307230	4916334	30m above old culvert
Little Lost R.	3	320575	4890208	Little Lost R. at Clyde Sch; Clyde campground
Mill Cr		312037	4915322	@ Mill Creek campground
Sawmill Cr	1	314492	4900927	BLM #3; above Mahog. Cr. Rd crossing
Sawmill Cr	2	313812	4903602	BLM #2; lower portion of upper exclosure
Sawmill Cr	3	313962	4906391	BLM #1; 2.4 km below Sawmill Cn Rd
Sawmill Cr	4	312106	4911572	Sawmill @ Guard Station;
Sawmill Cr	5	310796	4914062	Above Mill Creek; at Bear Creek
Sawmill Cr	6	309340	4920711	Sawmill at Moonshine Creek
Smithie Fork		309432	4921692	Just above Sawmill Rd. Bridge
Squaw Cr		314568	4913948	4.0 km above Sawmill Rd.
Squaw Cr, NF		314375	4913864	80m above confluence with Squaw Cr
Summit Cr	4	310454	4901155	BLM 4; Summit above Sawmill Rd
Summit Cr	5	305188	4904969	Summit Cr Campground
Timber Cr		308144	4918911	0.8 km above Little Lost River
Warm Cr*	1	313920	4908312	Lower, 100m below USFS boundary
Warm Cr	2	315100	4907991	0.4 km above Little Lost River
Warm Springs Cr*		330157	4864940	Below highway crossing
Wet Cr*	2	315436	4913864	BLM 6
Wet Cr	3	312270	4891470	BLM 5; 3.6 km below Squaw Creek
Wet Cr	4	310679	4890502	BLM 4; BLM 20; 2.0 km below Squaw Cr

Appendix K cont.

Stream	UTM			Previous Names
	Site name	Easting	Northing	
Wet Cr	6	307694	4883802	BLM 2; BLM 4; 0.8 km below BLM 1
Wet Cr	7	306942	4882287	BLM 1; 2.4 km below FS boundary
Wet Cr	8	303369	4879542	USFS above Coal Creek
Wet Cr	9	302016	4877726	0.5 km above Hilts Creek
Williams Cr		324481	4888936	Closest to 1.6 km above USFS boundary
Williams Cr*	Diversion	323015	4889154	150m above diversion

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