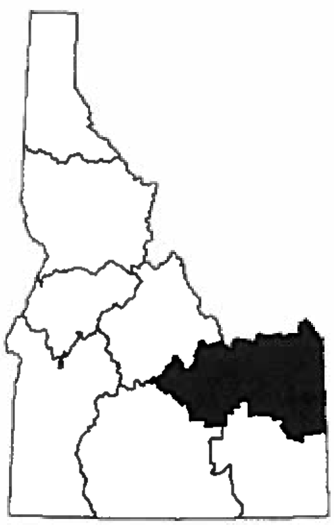
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME
FISHERY MANAGEMENT ANNUAL REPORT

Virgil Moore, Director



UPPER SNAKE REGION

2012

Brett High
Regional Fisheries Biologist
Greg Schoby
Regional Fisheries Biologist
Jessica Buelow
Regional Fisheries Biologist
Dan Garren
Regional Fisheries Manager

December 2014
IDFG #14-104

2012 Upper Snake Region Annual Fisheries Management Report

Table of Contents

LAKES AND RESERVOIRS

2012 Upper Snake Region Annual Fishery Management Report

LAKES AND RESERVOIRS

Henrys Lake

ABSTRACT

We used 50 gill net nights of effort to evaluate the trout population in Henrys Lake, and found that Yellowstone Cutthroat Trout and Brook Trout have increased well above their long-term abundance. Better environmental conditions (wetter water years) combined with 20 years of habitat improvement projects may have increased natural recruitment for these species. Hybrid Trout, the only fish known to be fully sterile and incapable of reproducing, were found at densities near their long-term average. Utah Chub abundance appears to have increased as well. The increase in total fish abundance has slowed growth through competition for limited food resources. Stocking rates have been reduced to counter increased natural reproduction. Future stocking rates should take into account contributions from natural reproduction and relative weights, and be adjusted accordingly until management goals are attained.

Authors:

Greg Schoby
Regional Fisheries Biologist

Jessica Beulow
Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manager

INTRODUCTION

Henrys Lake, located in eastern Idaho in the Greater Yellowstone Ecosystem, has provided a recreational trout fishery since the late 1800s (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 *Oncorhynchus clarkii bouvieri*, 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 *O. mykiss* x Yellowstone Cutthroat Trout) and Brook Trout *Salvelinus fontinalis*, 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). 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.

METHODS

Population Monitoring

As part of routine population monitoring, we set gill nets at six standardized locations in Henrys Lake from May 4 - 24, 2012 for a total of 50 net nights (Figure 1). 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 2012 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 *Gila atraria*, as this species demonstrates schooling behavior, and are likely not randomly distributed.

We examined all Yellowstone Cutthroat Trout captured in our gill net monitoring for adipose fin clips as part of our evaluation of natural reproduction. Similarly, all Yellowstone Cutthroat Trout ascending the spawning ladder at Henrys Lake hatchery were examined for the presence of adipose fins as well. We then calculated the ratio of marked to unmarked fish. Beginning in the mid-1990's, ten percent of all stocked Yellowstone Cutthroat Trout have been marked with an adipose fin clip prior to stocking, therefore, a ratio of 10% or greater indicates low levels of natural reproduction, while a ratio of less than 10% adipose clipped Cutthroat Trout in our catch indicates that natural reproduction is contributing to the overall population.

We removed the saggital 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 mortality by catch curve analysis on Cutthroat Trout from age two to 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 and RSD-500) 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.

We collected zooplankton samples at three locations on July 24 (Figure 1). 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: 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:) to usable (500:) zooplankton. We also calculated the zooplankton quality index (ZQI) to account for overall abundance of zooplankton using the formula ZQI = (500: + 750:) * ZPR (Teuscher 1999).

Water Quality

We measured winter dissolved oxygen concentrations, snow depth, ice thickness and water temperatures at four established sampling sites (Pittsburg Creek, County Boat Dock, Wild Rose, and Hatchery) on Henrys Lake between December 19, 2011 and January 28, 2012 (Figure 1). We measured conditions at the Hatchery site on December 19, 2011, January 4, and January 24, 2012, while the other three sites were sampled on January 4, and January 24 2012. 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. Difficulties with the dissolved oxygen meter prohibited additional sampling after January. 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 = 1m^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:

Avg (ice bottom+1m) + Sum (readings from 2m to lake bottom) = total O_2 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).

Several habitat enhancement projects were completed on and around Henrys Lake during 2012, including diversion screen management, riparian fence operation, and physical habitat improvements. Additionally, surveys designed to estimate lake-wide pelican use were implemented, as was a wader disinfectant program throughout the Island Park Caldera. Details on these projects can be found in the Henrys Lake Annual Hatchery Report (in press).

RESULTS

Population Monitoring

We collected 1,775 fish in 50 net nights of gill net effort. Catch composition was 28% Yellowstone Cutthroat Trout, 25% Brook Trout, 8% Hybrid Trout, and 39% Utah Chub (Figure 2). Yellowstone Cutthroat Trout ranged from 156 to 612 mm TL (mean: 328 mm) (Figure 3), Hybrid Trout 159 to 681 mm (mean: 435 mm) (Figure 4), and Brook Trout 129 to 555 mm (mean: 360 mm) (Figure 5). Proportional stock density (PSD) was highest for Hybrid Trout (91) followed by Brook Trout (81) and Cutthroat Trout (59). Relative stock density (RSD-400) was highest for Hybrid Trout (68) followed by Brook Trout (30) and Cutthroat Trout (14) (Table 1). RSD-500 for Hybrid Trout was 28, followed by Brook Trout (5) and Cutthroat Trout (1). Mean W_r for all trout species (all sizes combined) ranged between 87 and 95 (Figure 6) 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 89 (Figure 7). Mean length at age three was 402, 470, and 434 mm, for Yellowstone Cutthroat Trout, Hybrid Trout, and Brook Trout, respectively (Table 2). Catch curve analysis of Yellowstone Cutthroat Trout estimates mortality from age two to five at 68%, while Brook Trout mortality from age two to five was 57%. Hybrid Trout mortality from age three to six was 53%.

Gill net catch rates for trout were highest for Yellowstone Cutthroat Trout at 10.0 fish per net night, followed by Brook Trout at 8.7, and Hybrid Trout at 3.0 fish per net night (Figure 8). The median catch rate of Utah Chub was 10.0 fish per net night (Figure 9). Results from our gill net surveys showed 52 of 500 (10%) captured Yellowstone Cutthroat Trout were adipose-clipped, while 7% of hatchery-run cutthroat were clipped for an overall rate of 8% adipose fin clipped cutthroat (Table 3). Yellowstone Cutthroat Trout gill net catch rate in 2012 was higher than the 21 year average catch rate (10.0 vs. 6.2; p=0.0085), as was Brook Trout catch rate (8.7 vs. 1.9; p=0.0001). Hybrid Trout gill net catch rate was not significantly different than the long term average (3.0 vs. 3.8; p=0.1833). The median gill net catch rate of Utah Chub did not differ between 2012 and 2011, but the 2012 catch was significantly higher than the median catch rate in 2010 (p=0.0009). The 2012 Utah Chub median catch rate was not significantly different than any other of the past 5 years.

Zooplankton monitoring indicates that preferred size zooplankton is being cropped by fish (ZPR = 0.36) and that abundance of quality zooplankton is limited in Henrys Lake (ZQI = 0.08). Overall, zooplankton abundance in Henrys Lake in 2012 was the lowest observed since monitoring began in 2006 (see *Regional Lakes Zooplankton chapter* for more details), and is likely related to the increases in all fish species observed in recent years.

Water Quality

Between December 19, 2011 and January 28, 2012, total dissolved oxygen diminished from 47.2 g/m^2 to 36.8 g/m^2 at the Pittsburgh Creek site, from 40.5 g/m^2 to 35.0 g/m^2 at the hatchery site, from 44.6 g/m^2 to 39.4 g/m^2 at the County dock, and from 51.6.3 g/m^2 to 45.4 g/m^2 at the Wild Rose site (Table 4). Depletion estimates predicted dissolved oxygen would remain above the level of concern throughout the winter (Figure 10). As a result, aeration was not deployed.

DISCUSSION

For the third year in a row, the gill net catch of Yellowstone Cutthroat Trout has been above the long term average, indicating that the Cutthroat Trout population in Henrys Lake is increasing. This is likely due to natural reproduction, as the ratio of adipose clipped Cutthroat Trout observed in both the gill net catch and at the hatchery ladder was again below 10% (combined). Along with higher than average gill net catch rates, the relative weight of Yellowstone Cutthroat Trout in Henrys Lake continues to decline, indicating that the overall Cutthroat Trout population is larger than the lake can support with the current food base and may result in angler catches of less than desirable fish size. Additionally, stock density indices

(PSD, RSD-400) were the lowest observed since the beginning of our intensive gill net monitoring (2004). The increase in natural reproduction and its contribution to the Henrys Lake Cutthroat Trout population is likely a result of habitat improvement projects in lake tributaries, such as passage improvements, irrigation canal screening, and riparian fencing. As the benefits of these projects are realized, it may require a more adaptive lake stocking strategy to sustain the quality of angling experience that anglers have come to expect from Henrys Lake. Based on the current catch rates and fish condition, we recommend decreasing the current stocking rate and adopting an adaptive stocking strategy based on the 3 year average fin clip ratio combined with information on relative weights. This adaptive stocking strategy should continue until size goals for the lake are met.

Brook Trout gill net catch rate in 2012 was the highest observed (8.7 fish/net) and over 400% greater than the long term average. This increase cannot be fully explained based on stocking rates. Although slightly higher than normal, the 30% increase in Brook Trout stocked over the past five years likely doesn't account for the 400% increase in abundance. It's more likely that some fertile Brook Trout that originated from hatchery stockings or wild fish in tributaries have contributed to the lake-wide population. Not only did we capture a large number of Brook Trout, but stock density indices were high indicating that 2013 should provide excellent opportunity for anglers to catch large Brook Trout. The potential increase in natural reproduction of Brook Trout should be evaluated in the coming years.

Hybrid Trout gill net catch remains below the long term average, but is trending towards this average. Length frequency of Hybrid Trout suggests that smaller fish are under-represented in our catch, which may be related to misidentification. Interestingly, Hybrid Trout are the only species present that are known to be sterile, and subsist solely from stocking. They are also the only species close to their long-term average abundance. All other species are well above this benchmark, and are potentially being supported by natural reproduction.

The continued decline in relative weights of all sizes and species of trout in Henrys suggests that food resources are found in limited abundances, particularly when compared to a decade ago. Confounding this is the increase in Utah Chub abundance. Trout may now be facing shortages in food supply as a result of natural reproduction and competition with other trout or between trout and chubs. Regardless, additional information on the interworking and forage preferences of these species may help steer management in the coming years. Reducing the total number of fish present will help condition factors improve. Continual evaluation of natural reproduction and an adaptive stocking strategy are warranted, and should be continued for the foreseeable future.

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, increasing the frequency to once every 10 days, and implement aeration when necessary.

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

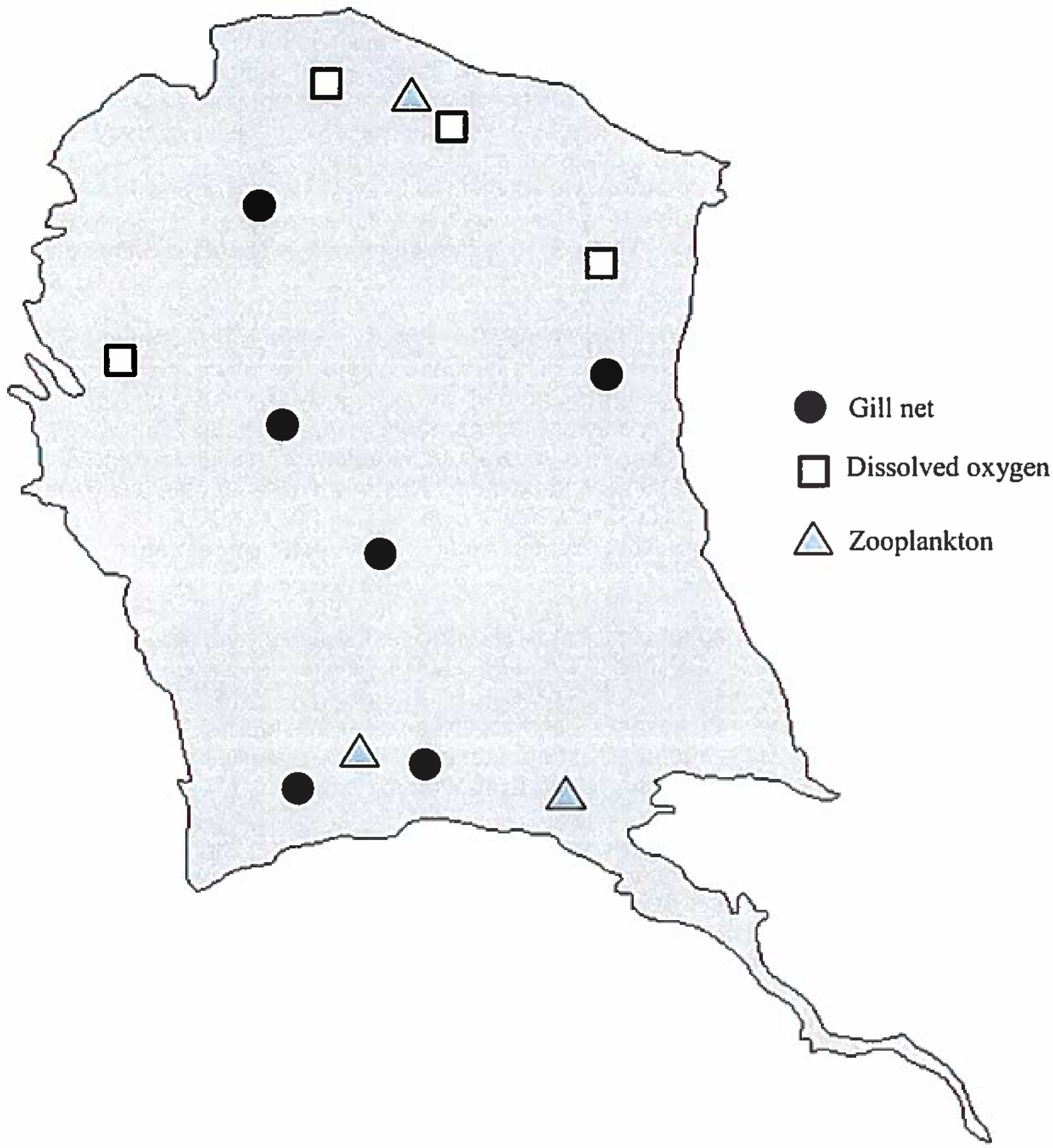


Figure 1. Spatial distribution of gill net, dissolved oxygen, and zooplankton monitoring sites in Henrys Lake, Idaho, 2012.

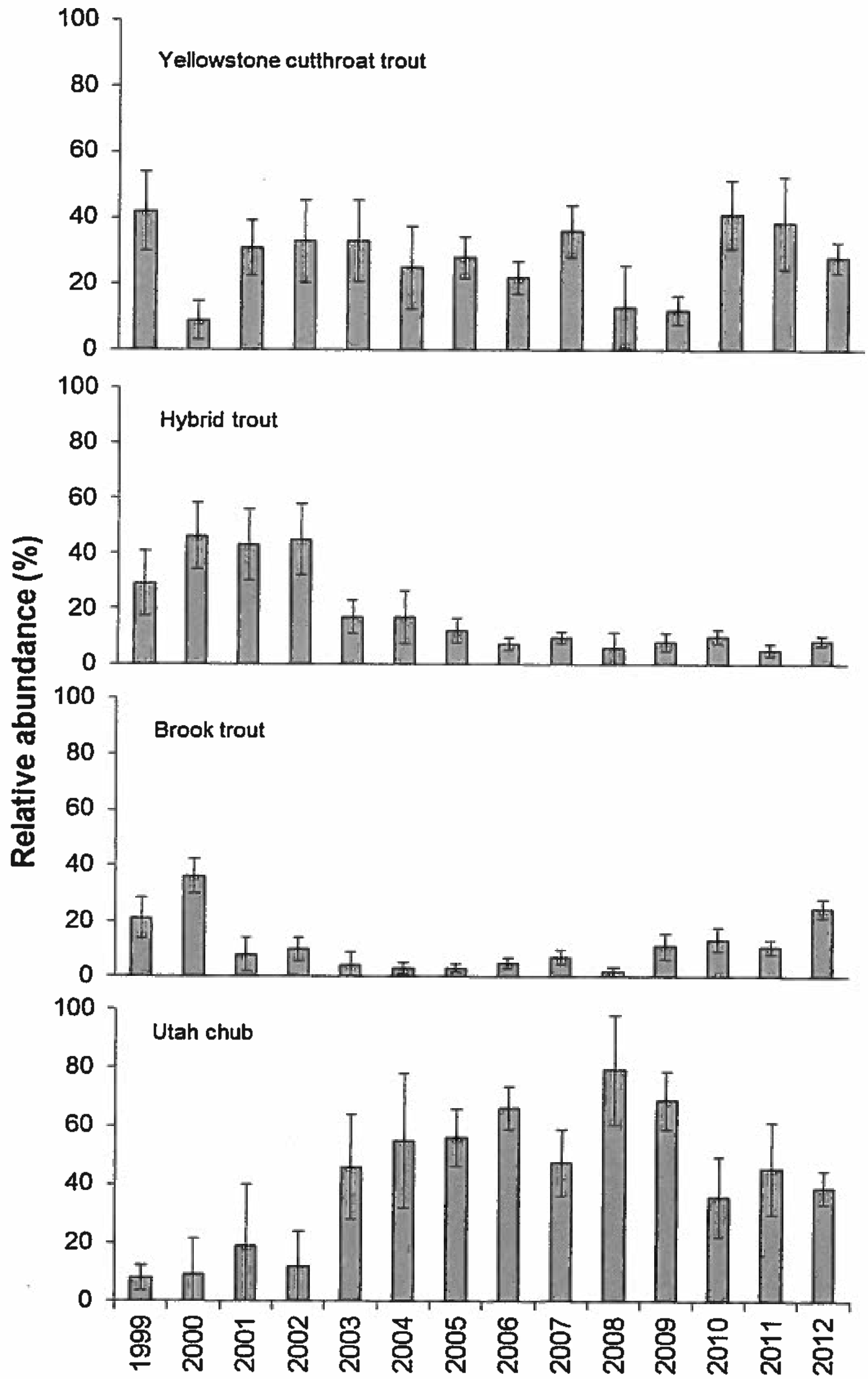


Figure 2. Relative abundance of Yellowstone Cutthroat Trout, Hybrid Trout, Brook Trout, and Utah Chub caught in gill nets in Henrys Lake, Idaho between 1999 and 2012. Error bars represent 90% confidence intervals.

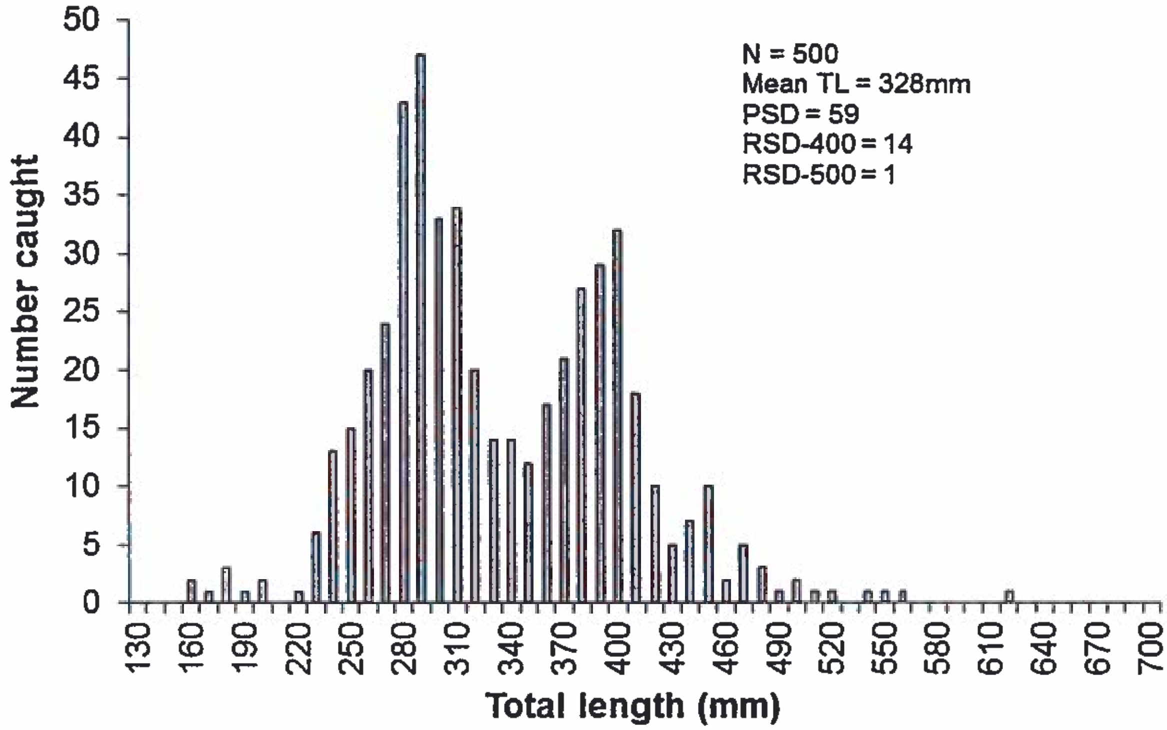


Figure 3. Yellowstone Cutthroat Trout length frequency distribution and total length statistics from gill nets set in Henrys Lake, Idaho, 2012.

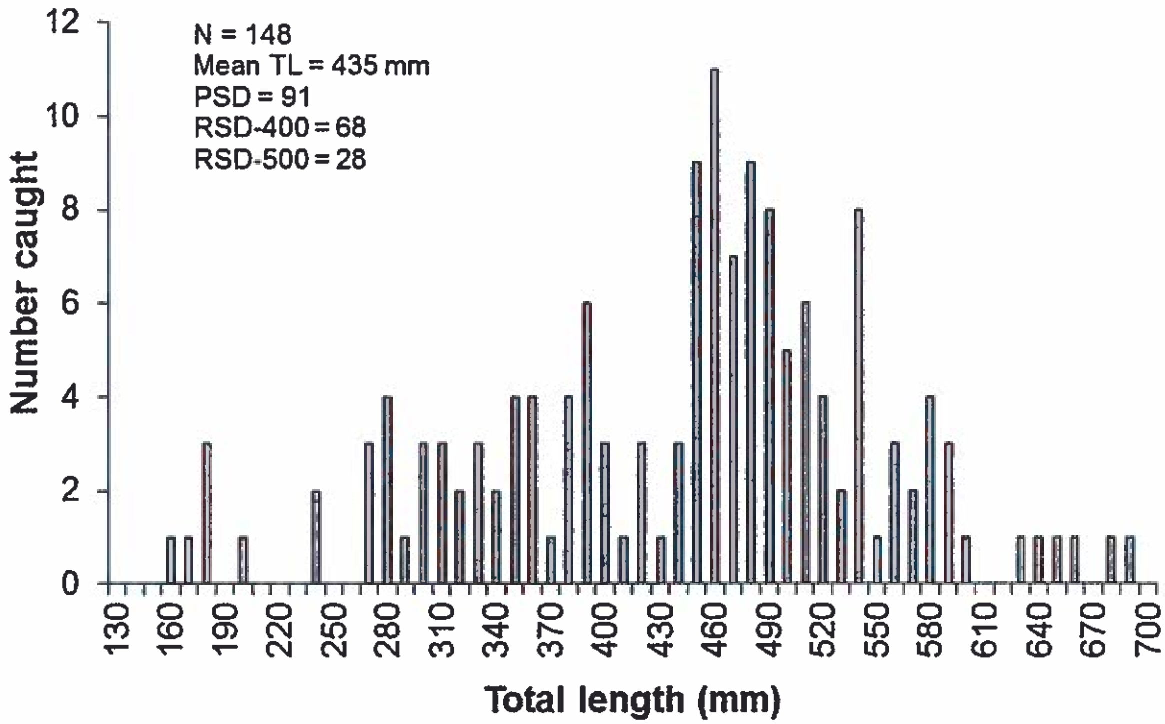


Figure 4. Hybrid Trout length frequency distribution and total length statistics from gill nets set in Henrys Lake, Idaho, 2012.

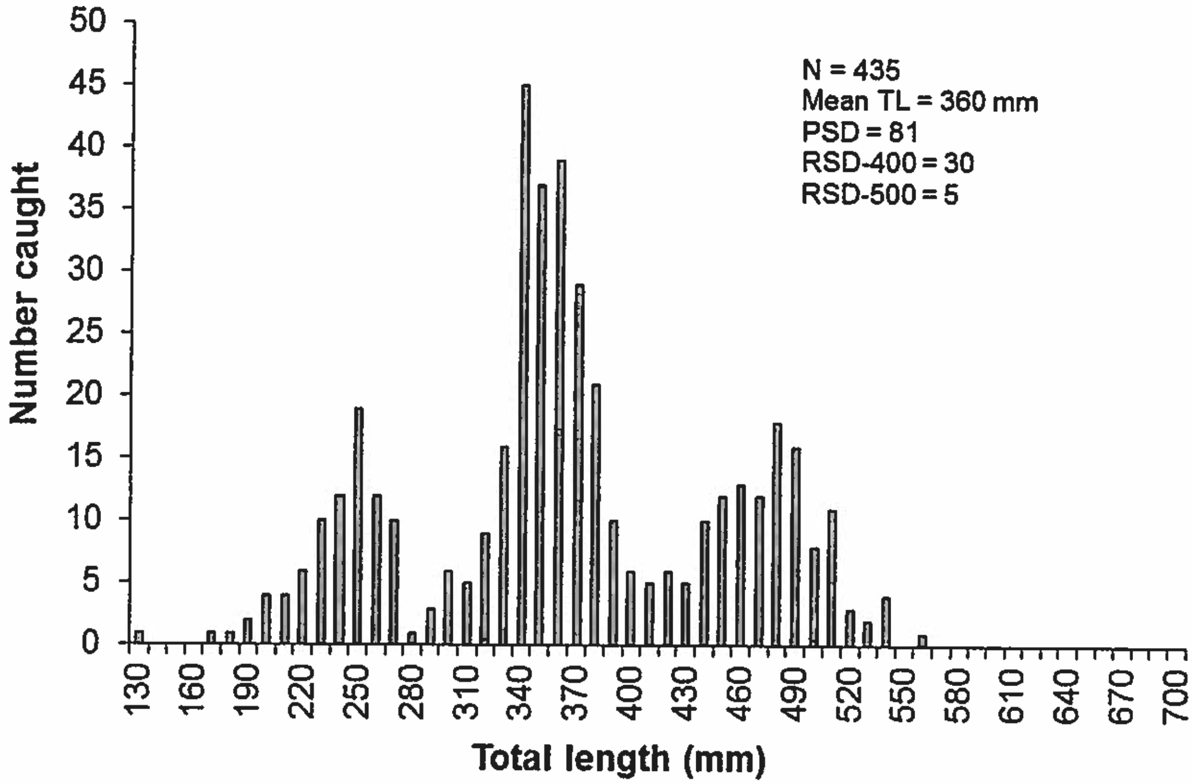


Figure 5. Brook Trout length frequency distribution and total length statistics from gill nets set in Henrys Lake, Idaho, 2012.

Table 1. Stock density indices (PSD, RSD-400, and RSD-500) and relative weights (W_r) for all trout species collected with gill nets in Henrys Lake, Idaho 2012. Sample size (*n*) for relative weight values is noted in parentheses.

	Brook Trout (*n*)	**Hybrid Trout (*n*)**	**Yellowstone Cutthroat Trout (*n*)**
PSD	81	91	59
RSD-400	30	68	14
RSD-500	5	28	1
W_r			
<200 mm	75 (7)	89 (6)	86 (9)
200 – 299 mm	89 (83)	90 (13)	86 (202)
300 – 399 mm	94 (217)	92 (32)	89 (220)
>399 mm	102 (126)	92 (97)	87 (69)
Mean	95	92	87

Table 2. Mean length at age data from trout caught with gill nets in Henrys Lake, Idaho 2012. Ages were estimated using otoliths.

Species	Mean Length (mm) at Age				
	1	2	3	4	5
Yellowstone Cutthroat Trout	184	278	402	484	541
(No. Analyzed)	(9)	(47)	(35)	(9)	(4)
Hybrid Trout	227	353	470	557	655
(No. Analyzed)	(11)	(32)	(47)	(9)	(5)
Brook Trout	246	345	434	474	500
(No. Analyzed)	(42)	(37)	(17)	(40)	(2)

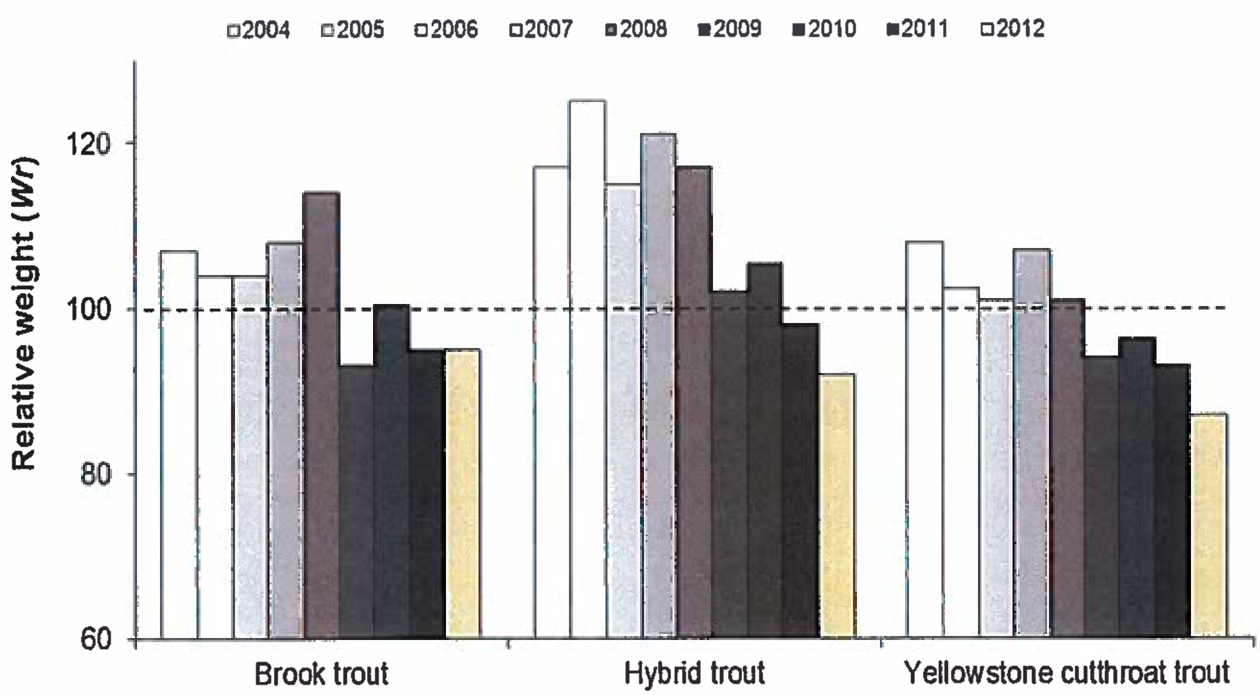


Figure 6. Mean relative weights (W_r) for Brook Trout, Hybrid Trout, and Yellowstone Cutthroat Trout in Henrys Lake, Idaho 2004-2012.

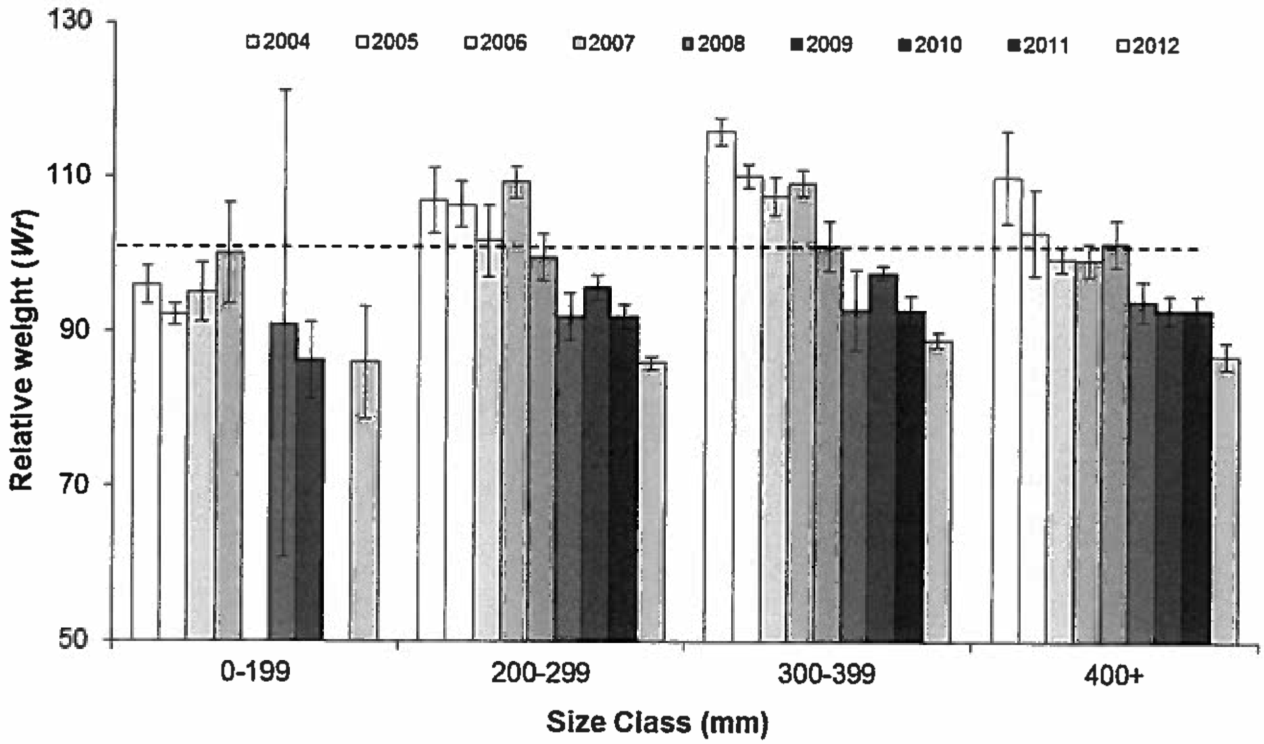


Figure 7. Relative weights (W_r) for four size classes (0 – 199 mm, 200 – 299 mm, 300 – 399 mm, and 400+ mm) of Yellowstone Cutthroat Trout in Henrys Lake, Idaho 2004-2012. Error bars represent 95% confidence intervals.

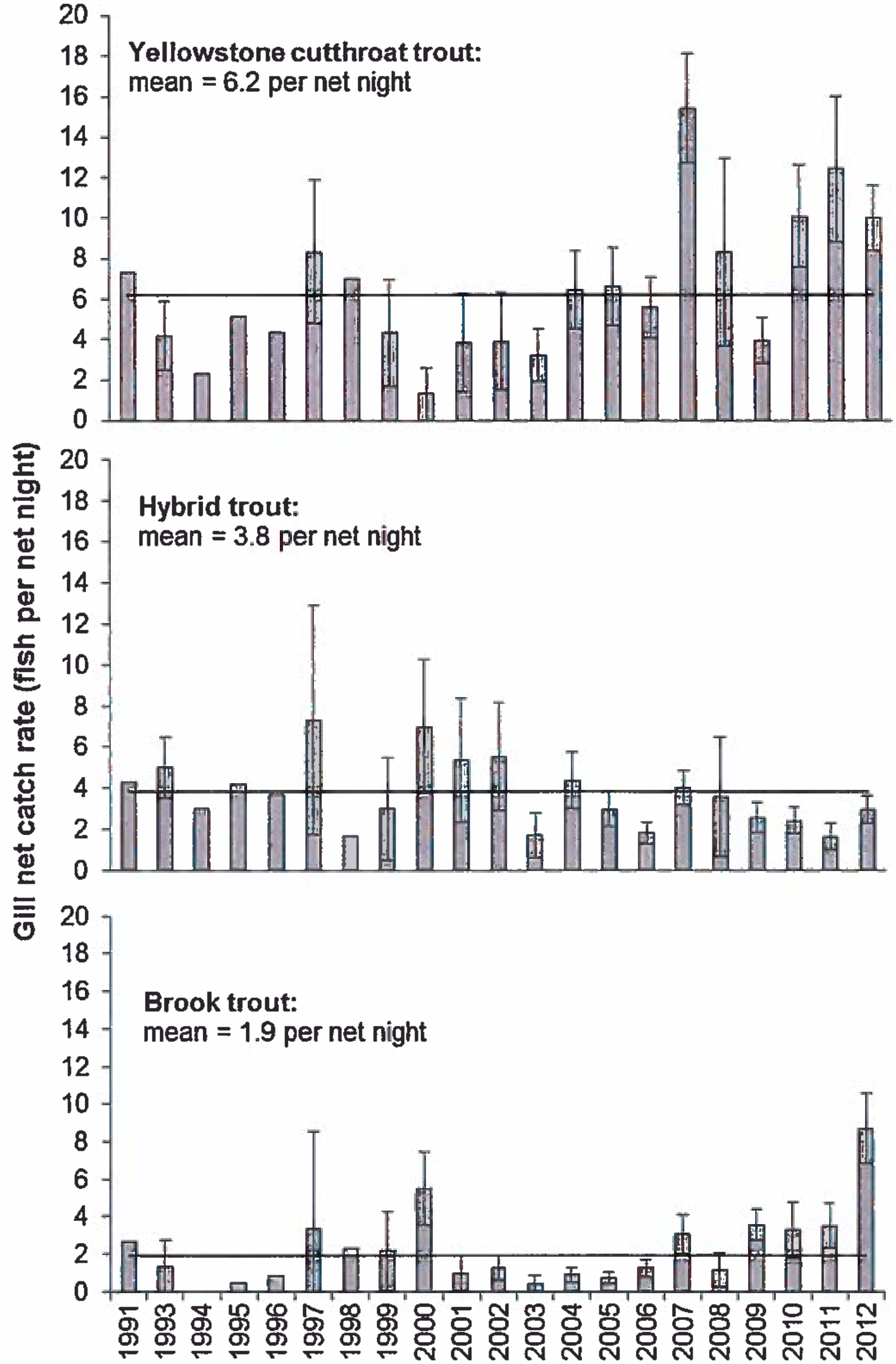


Figure 8. Gill net catch rates of Yellowstone Cutthroat Trout, Hybrid Trout, and Brook Trout from Henrys Lake, Idaho, 1991-2012. Error bars represent 95% confidence intervals. The solid line represents long term mean gill net catch rates.

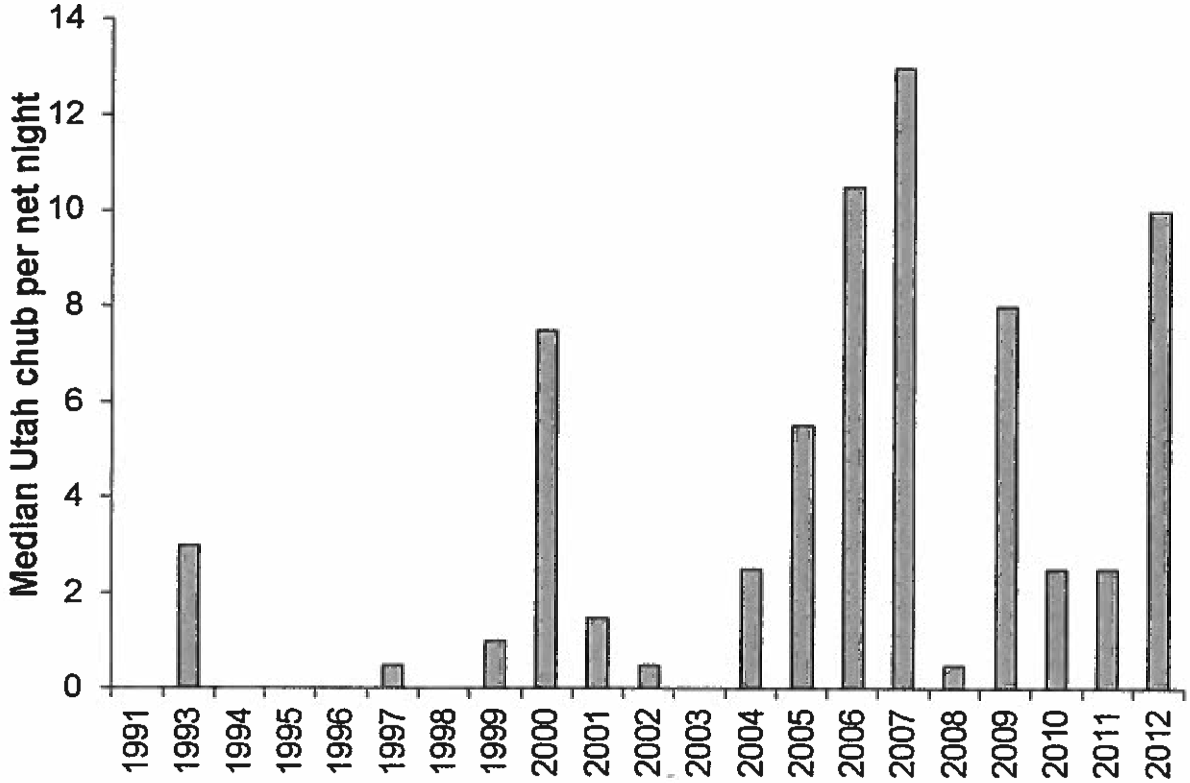


Figure 9. Median Utah Chub catch rates in gill nets set in Henrys Lake, Idaho, 1993-2012.

Table 3. Fin clip 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	Overall percent clipped
1996	100,290	--	--	--	--	--	--	--
1997	123,690	178	5	3%	--	--	--	3%
1998	104,740	--	--	--	--	--	--	--
1999	124,920	160	20	13%	--	--	--	13%
2000	100,000	14	1	7%	--	--	--	7%
2001	99,110	116	22	19%	--	--	--	19%
2002	110,740	38	7	18%	--	--	--	18%
2003	163,389	106	37	35%	273	47	17%	22%
2004	92,100	--	--	--	323	28	8%	9%
2005	85,124	2,138	629	29%	508[a]	55	11%	26%
2006	100,000	2,455	944	39%	269[a]	20	8%	35%
2007	139,400	--	--	--	770	70	9%	9%
2008	125,451	4,890	629	13%	100	10	10%	13%
2009	138,253	4,184	150	4%	91	9	10%	4%
2010	132,563	4,253	90	2%	505	31	6%	3%
2011	112,744	3,037	137	5%	1,097[b]	72	7%	5%
2012	75,890	2,880	215	7%	500	52	10%	8%

[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 4. Dissolved oxygen (DO) (mg/l) levels recorded in Henrys Lake, Idaho winter monitoring 2011-2012.

Location	Date	Snow depth (cm)	Ice thickness (cm)	DO Ice bottom	DO 1 meter	DO 2 meters	DO 3 meters	Total g/m^3
Pittsburg Creek	1/4/12	24	44	13.5	12.9	12.3	9.4	47.2
	1/24/12	20	58	12.1	12.1	8.4	6.0	36.8
County Boat Ramp	1/4/12	17	49	14.2	14.0	13.2	12.9	44.5
	1/24/12	25	50	13.0	13.0	12.4	10.3	39.4
Wild Rose	1/4/12	10	63	13.9	13.6	12.9	12.8	51.6
	1/24/12	20	55	13.4	13.4	12.9	12.1	45.4
Hatchery	12/19/11	2	45	12.0	11.5	11.4	11.2	40.5
	1/4/12	8	49	13.4	12.5	12.2	11.3	43.5
	1/24/12	24	55	11.9	11.9	11.6	8.4	35.0

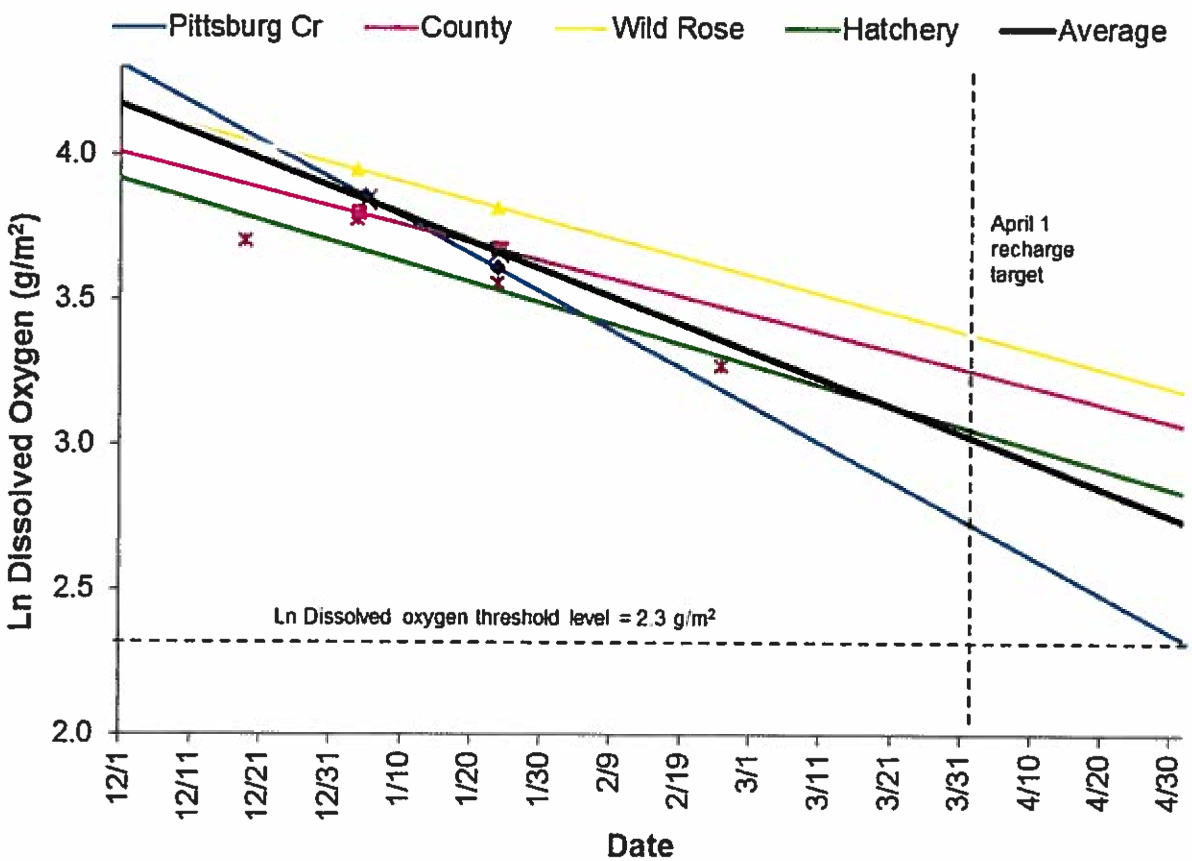


Figure 10. Dissolved oxygen depletion estimates from Henrys Lake, Idaho, 2011-2012

Island Park Reservoir

ABSTRACT

We used 36 standard experimental gill nets (18 floating, 18 sinking) to assess fish populations and relative abundance in Island Park Reservoir during June 2012. Mean catch (fish per net night) was 21.3 Utah Sucker *Catostomus ardens*, 13.0 Utah Chub *Gila atraria*, 8.1 Rainbow Trout *Oncorhynchus mykiss*, 0.6 Kokanee Salmon *O. nerka*, 0.3 Mountain Whitefish *Prosopium williamsoni*, and <0.1 Yellowstone Cutthroat Trout *O. clarkii bouvieri*. Mean relative weight (W_r) for Rainbow Trout and Kokanee was 89 and 104, respectively. Additionally, we surveyed Moose Creek and Lucky Dog Creek to determine if juvenile stocking in 2009 has resulted in Kokanee spawning activity in this tributary; no Kokanee were observed in either tributary.

Authors:

Greg Schoby
Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manager

INTRODUCTION

Island Park Reservoir has been recognized as a quality recreational fishery since the early 1950's, supporting as much as 176,000 hours of angling effort annually, with catch rates averaging 0.45 fish per hour. Rainbow Trout *Oncorhynchus mykiss* have provided the bulk of angler catch, with Kokanee Salmon *O. nerka*, Brook Trout *Salvelinus fontinalis*, Mountain Whitefish *Prosopium williamsoni* and Yellowstone Cutthroat Trout *O. clarkii bouvieri* adding to the creel. Supplemental stockings have played a large role in the management of the reservoir fishery, which is primarily supported by hatchery releases of Rainbow Trout and Kokanee Salmon, although some spawning by both occurs in the Henrys Fork Snake River upstream of the reservoir. Annual Rainbow Trout fingerling stockings have averaged 467,000 over the past 71 years and have been as high as 2.5 million fish in 1959. Nearly 120,000 Kokanee were stocked into Island Park Reservoir in 1944-1945, followed by 144,000 stocked into Moose Creek in 1957. These initial stockings resulted in a self-sustaining spawning run of Kokanee in Moose Creek, upon which IDFG established a Kokanee trapping facility to collect eggs for stocking in other waters. The Moose Creek Kokanee trap was operated intermittently between 1963 and 1975, with over 5 million eggs collected in 1969. Between 1976 and 1979, Island Park Reservoir was drawn down to near record levels on two occasions, and treated with rotenone during the 1979 draw down. Annual Kokanee fry stocking of nearly 500,000 fish in 1981, 1982, and 1984 re-established the run, and trapping at Moose Creek resumed in 1987, though most fish were passed over the trap and allowed to spawn naturally. The trap was operated again in 1990 and 1991, but low numbers of fish were captured. Drought conditions and low populations prohibited trap operations in 1992-1994. In 1995, over 200,000 eggs were again collected at the Moose Creek trap, but future trap operations were ceased due to low returns combined with the identification of other egg sources (Deadwood Reservoir). The trap was installed once again in 2003, but too few fish were captured to provide the necessary egg collection, so all were passed over the trap to spawn naturally.

Historically, the proliferation of non-game fish, primarily Utah Chub *Gila atraria* and Utah Sucker *Catostomus ardens*, had been blamed for declines in the sport fishery in Island Park Reservoir. Several rotenone projects had been undertaken to reduce overall non-game fish abundance and improve angler catch rates. The efficacy of these treatments was questioned as early as 1982, when Ball et al. (1982) observed that the three chemical rehabilitations of Island Park Reservoir over the previous 25 years had not been successful at permanent or long-term eradication of non-game species, and improvements in the trout fishery had been the result of increased stocking levels, especially noticeable with the large introductions of catchable rainbow. Ball et al. (1982) further noted that the observed declines in the Rainbow Trout fishery two to four years after treatment are the result of decreased levels of hatchery inputs and are not due to the increase in chub and sucker densities. The most recent chemical treatment of the reservoir, conducted in 1992, yielded similar results, with catch rates not improving upon levels prior to the treatment (Gamblin 2002). More recently, Garren et al (2008) found that non-game fish exceed pre-rotenone treatment levels within five years following treatments and that angler catch rates within five years following rotenone treatments were not significantly different than catch rates prior to treatments, suggesting that rotenone treatments have no effect on improving angler catch rate.

Island Park Reservoir is operated as an irrigation storage reservoir for agricultural users downstream, and is therefore subject to fluctuations in annual water levels. Reservoir storage normally begins at the close of irrigation season in October, and lasts until demand for water increases, typically in late May or early June. Fall reservoir storage levels can fluctuate from the lowest storage level recorded of 270 acre-feet in 1992, to nearly 90% full (121,561 acre-feet), as seen in 1997. Recent analysis of reservoir storage indicates that water storage is related to gill net catch rates. Garren et al (2008) found a significant relationship between reservoir carryover and salmonid gill net catch rate the following year by examining spring gill net catch and the previous years' reservoir level; years following low reservoir storage typically show a reduction in sport fish densities in gill nets. Although the relationship between carryover and gill net catch rates has been identified, it is unclear what exactly is impacting salmonid populations: increased mortality due to lost habitat associated with drawdowns, or entrainment through the dam due to increased outflow. Maiolie and Elam (1998) documented Kokanee losses as high as 90% of the entire Dworshak Reservoir population due to entrainment, and explained this loss due to Kokanee distribution throughout the reservoir. During their research, congregations of all age-classes of Kokanee were found near Dworshak Dam, making them susceptible to entrainment due to high volumes of water being released through the dam. Consistent with the observed decline in Kokanee populations, Island Park Dam was modified in 1994 with a new intake structure to facilitate power generation as part of the Island Park Hydroelectric Project (Ecosystems Research Institute 1994), thereby altering the location of water withdrawals from the reservoir. Although both intake structures are located at the reservoir bottom, the hydroelectric intake is 206m east of the pre-1994 intake structure, and closer to the river channel. The hydroelectric facility is capable of handling up to 960 cfs. Therefore throughout most of the year, the entire outflow is being routed through the hydroelectric facility intake. To prevent entrainment, the hydroelectric intake structure features wedge wire screens with 9.5 mm openings. National Marine Fisheries Service (NMFS) screening criteria requires screen mesh with openings no larger than 2.4 mm to prevent passage of juvenile salmonids (NMFS 2011). Although this criterion is designed for anadromous fishes, it is the only reviewed criteria for juvenile salmonids, and has been implemented in non-anadromous waters for screening juvenile salmonids. Additionally, the approach velocities near the hydroelectric intake are unknown, and blockage to any area of the screen could result in areas of increased velocity that may increase the likelihood of entrainment or impingement. Based on the current screen design, entrainment or impingement of juvenile Kokanee is a possible source of mortality. Surveys of the Henrys Fork Snake River immediately below Island Park Dam have documented Kokanee, indicating that some size classes are able to pass though the screened intake, and recent gill netting in Island Park Reservoir (Schoby et al. 2012) found high net catch rates of Kokanee in the deep water in front of Island Park dam, in the proximity of the existing water intake structures.

Although drought, reservoir levels and other environmental conditions may have impacted Kokanee since the early 1990's, the alteration of intake facilities may be substantially inhibiting the re-establishment of the Island Park Reservoir Kokanee fishery. In response to low Kokanee catch rates, and to lessen the potential impacts of entrainment and possibly establish self-sustaining spawning runs, IDFG altered its stocking practices in 2009. Historically, juvenile Kokanee have been stocked directly into Island Park Reservoir between May and June, when inflow and outflow from the reservoir is increasing. This may contribute to the potential for entrainment as Kokanee may actively follow river currents while migrating downstream (Fraley and Clancey 1988). Beginning in 2009, IDFG released half (approximately 125,000) of the annual Kokanee stocking directly into Island Park Reservoir, with the remaining releases split between Big Springs Creek and Moose Creek (Figure 11; Appendix A). Tributary releases are intended to reduce downstream migration through the reservoir and to allow Kokanee to imprint on tributaries to establish spawning runs in these locations.

STUDY AREA

Island Park Reservoir (IPR) is located on the Henrys Fork of the Snake River 40 km north of Ashton, Idaho and 150 km upstream from the confluence with the South Fork of the Snake River (Figure 5). Island Park Dam is a 23 m high earth-fill rock-faced structure operated by the United States Bureau of Reclamation to provide water for irrigation in Fremont and Madison Counties. At gross pool capacity (143,430 acre feet), the reservoir covers 3,388 hectares and has a shoreline of about 97 km. Since first filling in 1939, the minimum storage was 270 acre-feet, occurring in 1992. Runoff and numerous springs supply water to streams entering the reservoir. Maximum storage generally occurs in May and June. Thereafter, gradual drawdown through the summer and fall lowers the reservoir to varying degrees, depending upon irrigation needs. Ice generally covers the reservoir from December to May. The drainage area upstream from the dam is 774 square km, varying in elevation from 1,920 to 3,017 meters. Approximately 25 km upstream of Island Park Dam, Moose Creek joins the Henrys Fork Snake River, just downstream of the confluence of the Henrys Lake outlet and Big Springs Creek. Moose Creek is approximately 13 km long, and flows from numerous spring sources, including Lucky Dog Creek.

OBJECTIVE

To obtain current information on fish populations and limnological characteristics for fishery management decisions on Island Park Reservoir and its tributaries, and to develop appropriate management recommendations.

METHODS

As part of routine population monitoring, we set gill nets in Island Park Reservoir from June 11 to June 20, 2012 for a total of 36 net nights (Figure 11; Appendix B). 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: mm) and weights (g). We calculated relative abundance as well as catch per unit effort (CPUE: fish per net night, ±95% confidence intervals).

To determine if the 2009 juvenile Kokanee releases in Moose Creek resulted in the re-establishment of spawning runs in this tributary, various segments of Moose Creek and Lucky Dog Creek were surveyed by IDFG personnel and volunteers for the presence of spawning Kokanee. Surveys consisted of walking stream reaches to visually document adult Kokanee presence and/or spawning activity. From August 30 through October 1, 2012, approximately 1,000 meters of Moose Creek, 4.5 km upstream from its confluence with the Henrys Fork Snake River, was surveyed on a weekly basis by a local volunteer living on Moose Creek. This volunteer also surveyed approximately 600 meters of Lucky Dog Cr (300 m upstream and 300 m downstream of the Fish Creek Road crossing) on a weekly basis. Additionally, 8 km of Moose Creek, from the Chick Creek Road crossing to the Henrys Fork confluence, was walked by IDFG personnel on September 5, 2012.

RESULTS

We collected 1,558 fish in 36 net nights of effort (43.3 fish/net night). Overall net catch (relative abundance) was dominated by Utah Sucker (49.2%), Utah Chub (30.0%), and Rainbow Trout (18.8%; Figure 13). Kokanee comprised 1.3% of the total catch, while Mountain Whitefish and Yellowstone Cutthroat Trout accounted for less than 1% of the catch each. Catch rate (CPUE: fish per net night) was highest for Utah Sucker (21.3), followed by Utah Chub (13.0), and Rainbow Trout (8.1; Figure 14; Appendix C). Of the game species captured, Rainbow Trout ranged from 154 to 583 mm TL (Figure 15), with a mean and median length of 343 mm and 326 mm. Proportional stock density (PSD) was 84, and RSD-400 and RSD-500 were 20 and 6, respectively (Table 5). Mean relative weight of Rainbow Trout was 89 (Table 5). Kokanee lengths ranged from 184 to 475 mm, with a mean and median length of 333 mm and 362 mm (Figure 16). Kokanee PSD was 83, while RSD-300 and RSD-400 were 78 and 23, respectively (Table 5). Mean relative weight of Kokanee was 104 (Table 5).

No Kokanee were observed in any surveys in Moose Creek or Lucky Dog Creek, indicating that juvenile releases in Moose Creek have not resulted in the re-establishment of this spawning run.

DISCUSSION

The gill net surveys conducted in 2012 mark the most extensive sampling of Island Park Reservoir, and provide the baseline for future work. Similar to Henrys Lake, we plan to conduct extensive annual surveys to dictate future management actions, using the gill net locations established in 2012. During 2012, gill net catch of Rainbow Trout was higher than in 2010, while Kokanee was lower. This is likely due to differences in sampling protocol, as 2010 netting was directed at assessing Kokanee depth distribution near Island Park Dam (Schoby et al 2012). The 2012 gill net catch was very similar to that of 2008, but differences between those surveys should also be noted. Gill net surveys in 2008 were conducted in the fall, and utilized only floating nets, which may artificially inflate the catch rate of Rainbow Trout. Additionally, comparisons to catch rate data prior to 2006 should be viewed cautiously, as sampling consisted of two to eight net nights, making detection of actual changes in the fish population difficult due to the inherent variability in gill net catch. Increased, structured gill netting in the future will help provide valid data that can be used to guide management actions in Island Park Reservoir.

Kokanee surveys in Moose Creek did not document any spawning activity, indicating that juveniles stocked in 2009 did not return to this tributary. It is unclear why juvenile releases into Moose Creek have failed to establish spawning runs, but reports from grizzly bear monitoring activity by IDFG personnel indicates that spawning Kokanee are abundant in the Henrys Lake Outlet and are being utilized as a food source for bears. Future work should include monitoring of this spawning population and potentially use this as an egg source to re-establish spawning runs in Moose Creek and Lucky Dog Creek.

MANAGEMENT RECOMMENDATIONS

1. Continue annual gill net monitoring at 36 night nets to evaluate the Island Park Reservoir fishery.

2. Continue Kokanee spawner surveys in Moose Creek and Big Springs Creek to monitor trends in adult abundance and determine if juvenile releases in these locations have established spawning runs.

3. Consider using Kokanee from the Henrys Lake Outlet to establish a spawning population in Moose Creek, either through adult releases or egg collection and incubation in Moose Creek.

4. Conduct a creel survey on Island Park Reservoir to assess angler use, catch, and harvest.

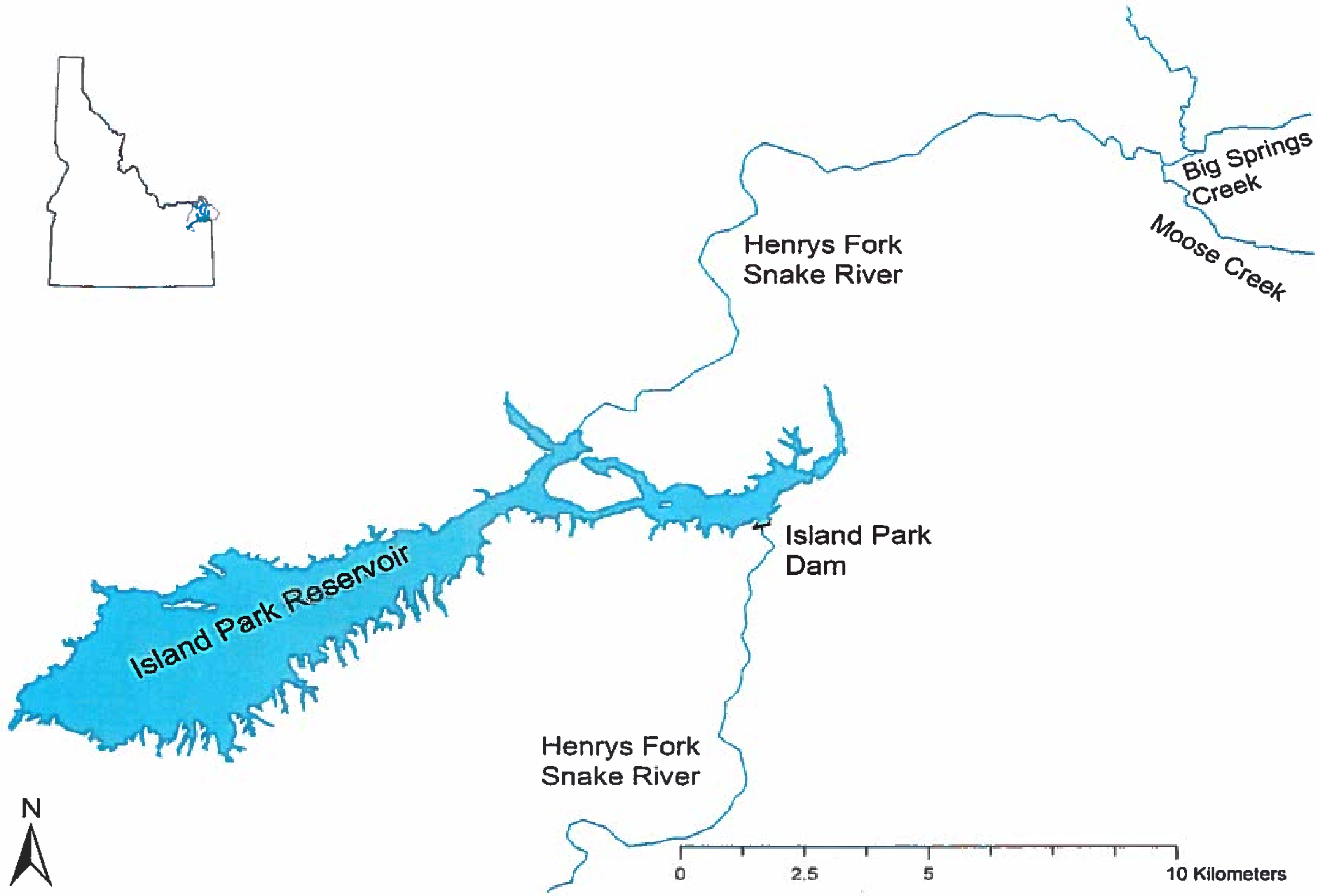


Figure 11. Island Park Reservoir, Idaho.

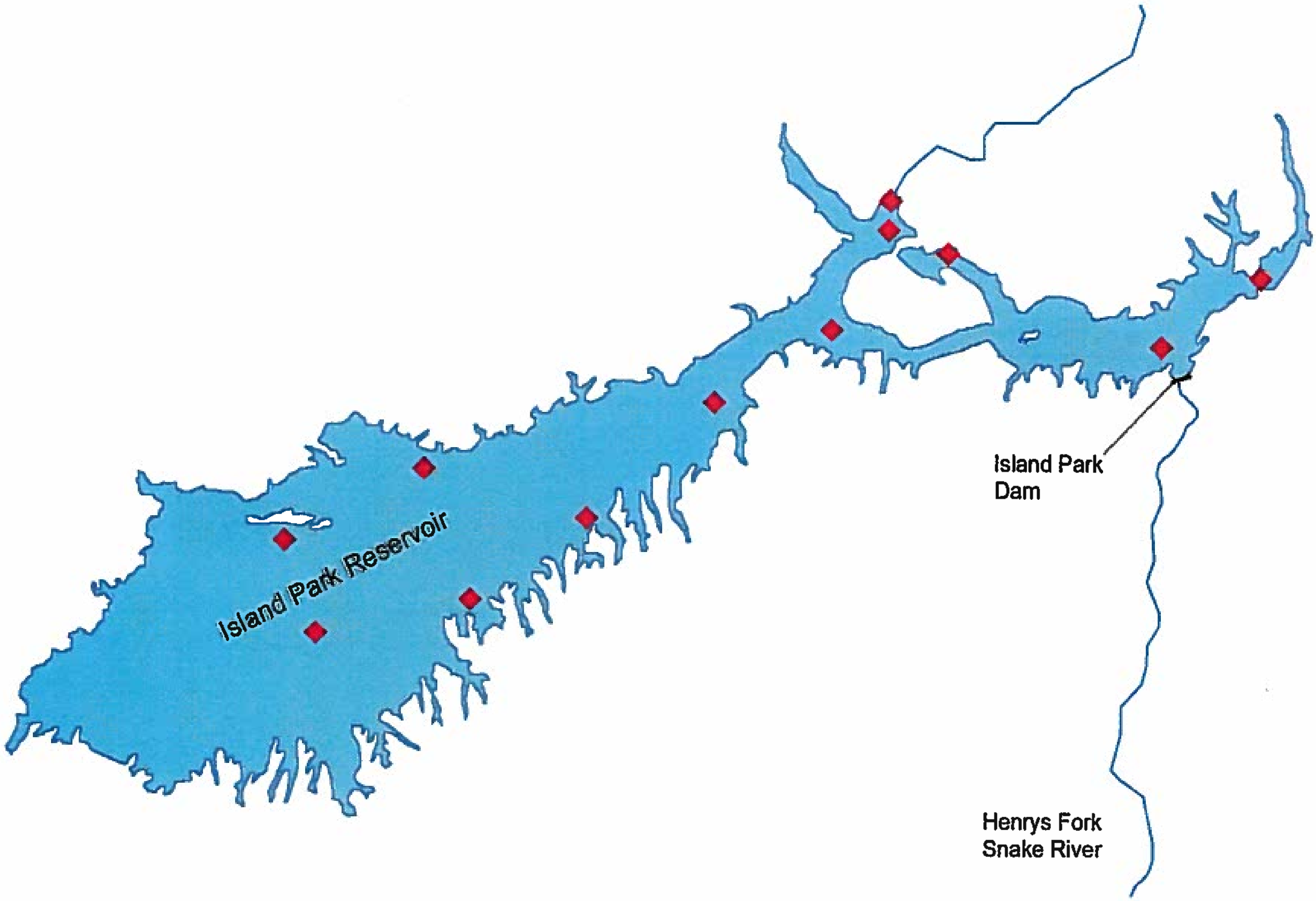


Figure 12. Location of gillnet sampling in Island Park Reservoir, Idaho, 2012.

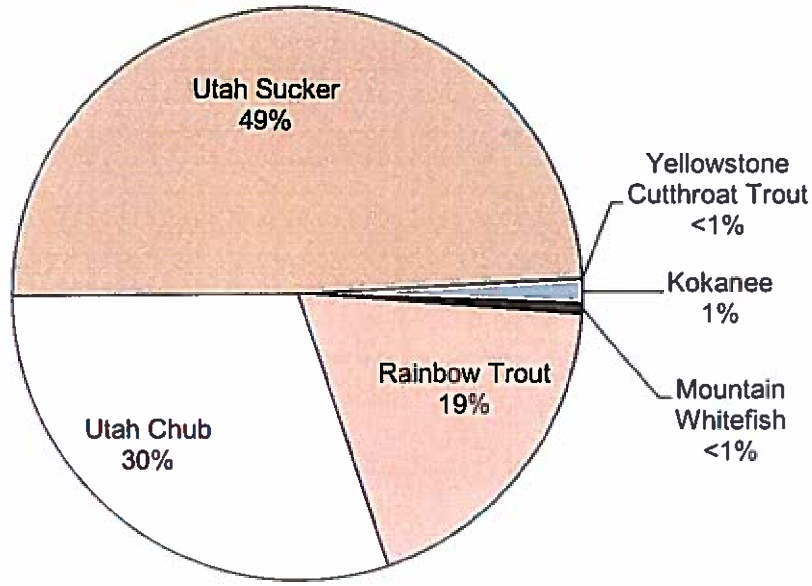


Figure 13. Species composition from gill nets set in Island Park Reservoir Idaho, June 2012.

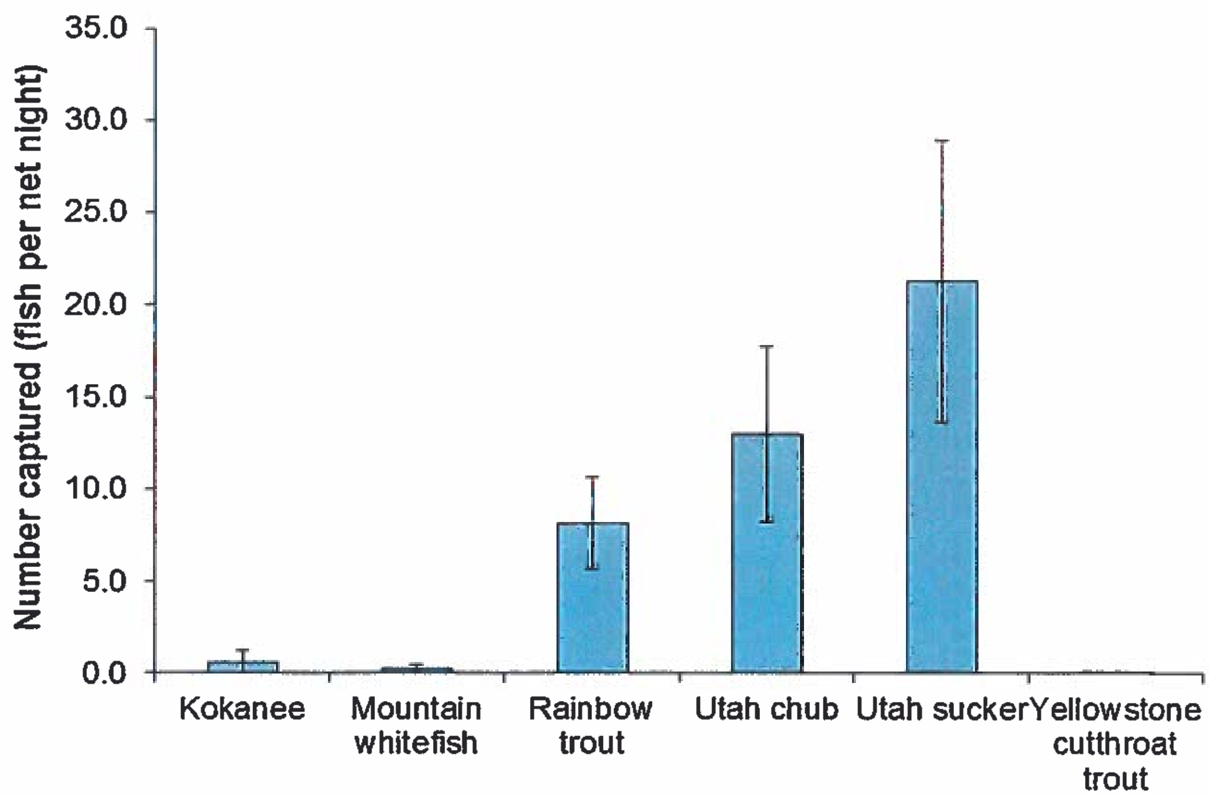


Figure 14. Gill net catch rate (fish per net night) from 36 nets set in Island Park Reservoir in 2012. Error Bars represent 95% confidence intervals.

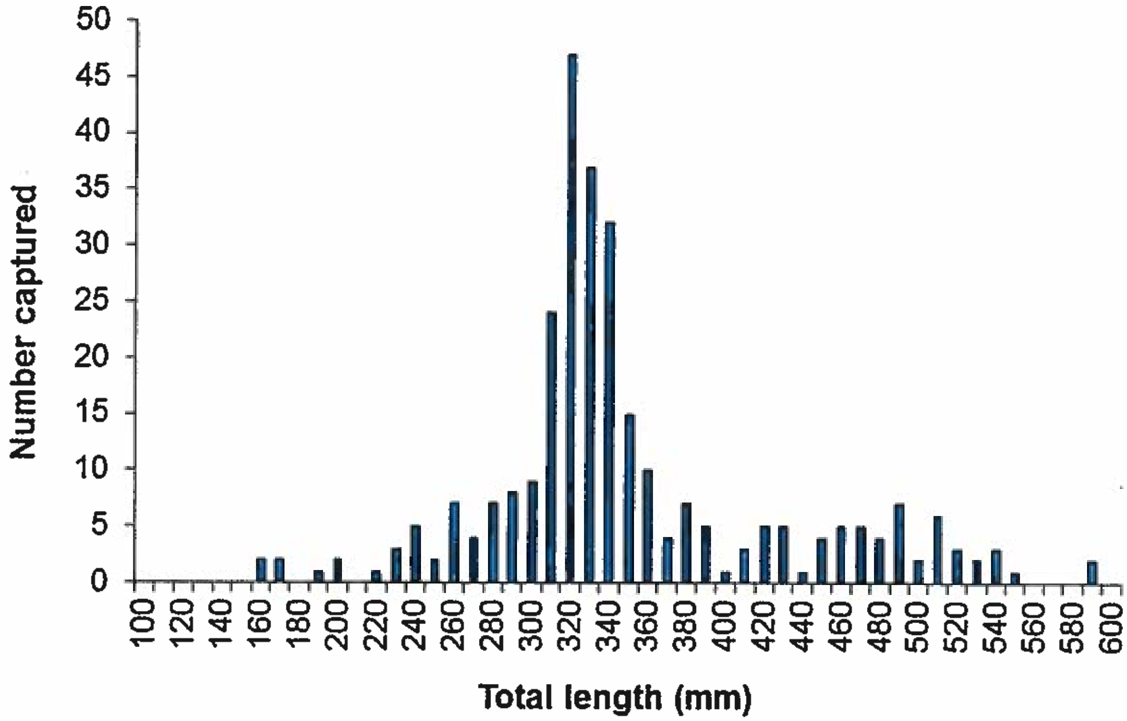


Figure 15. Length frequency of Rainbow Trout captured in gill nets in Island Park Reservoir in 2012.

Table 5. Stock density indices (PSD: proportional stock density and RSD: relative stock density) and relative weights (W_r) for Rainbow Trout and Kokanee collected with gill nets in Island Park Reservoir, Idaho 2012. Sample size (*n*) for relative weight values is noted in parentheses.

	Rainbow Trout (*n*)	Kokanee (*n*)
PSD	84	83
RSD-300	-	78
RSD-400	20	28
RSD-500	6	-
W_r		
<200 mm	88 (7)	91 (3)
200 – 299 mm	84 (46)	90 (4)
300 – 399 mm	92 (182)	109 (9)
>399 mm	85 (58)	116 (5)
Mean	89	104

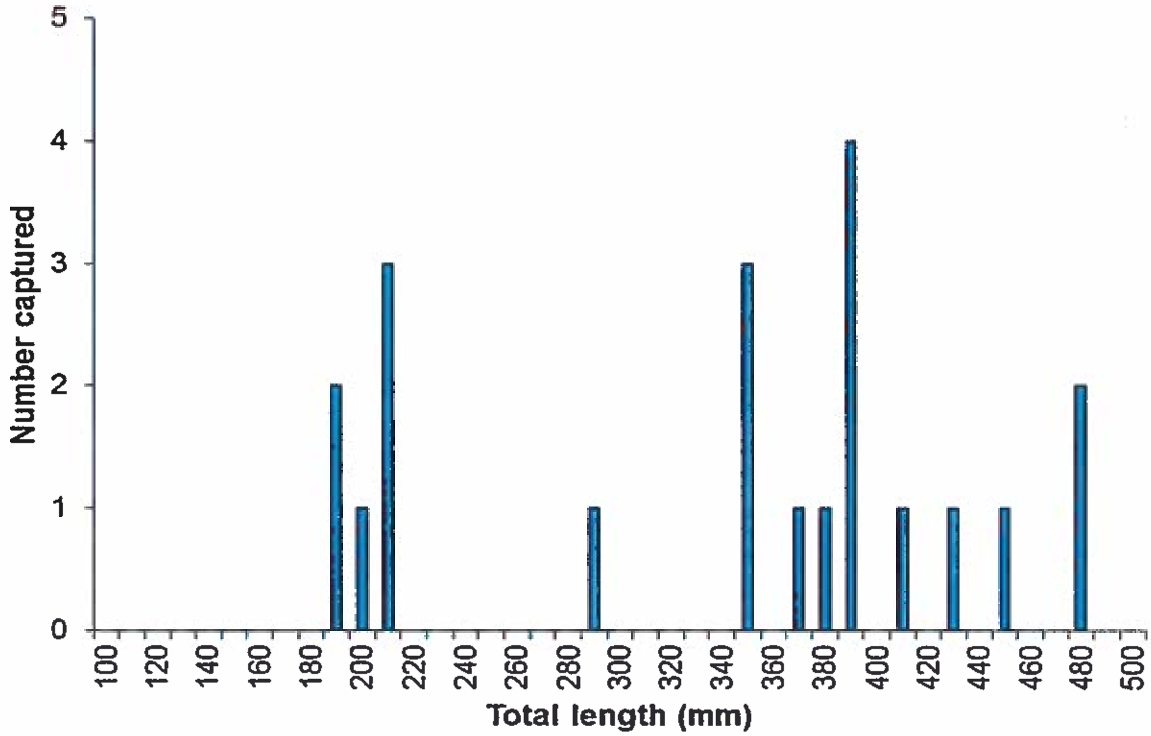


Figure 16. Length frequency of Kokanee captured in gill nets in Island Park Reservoir in 2012.

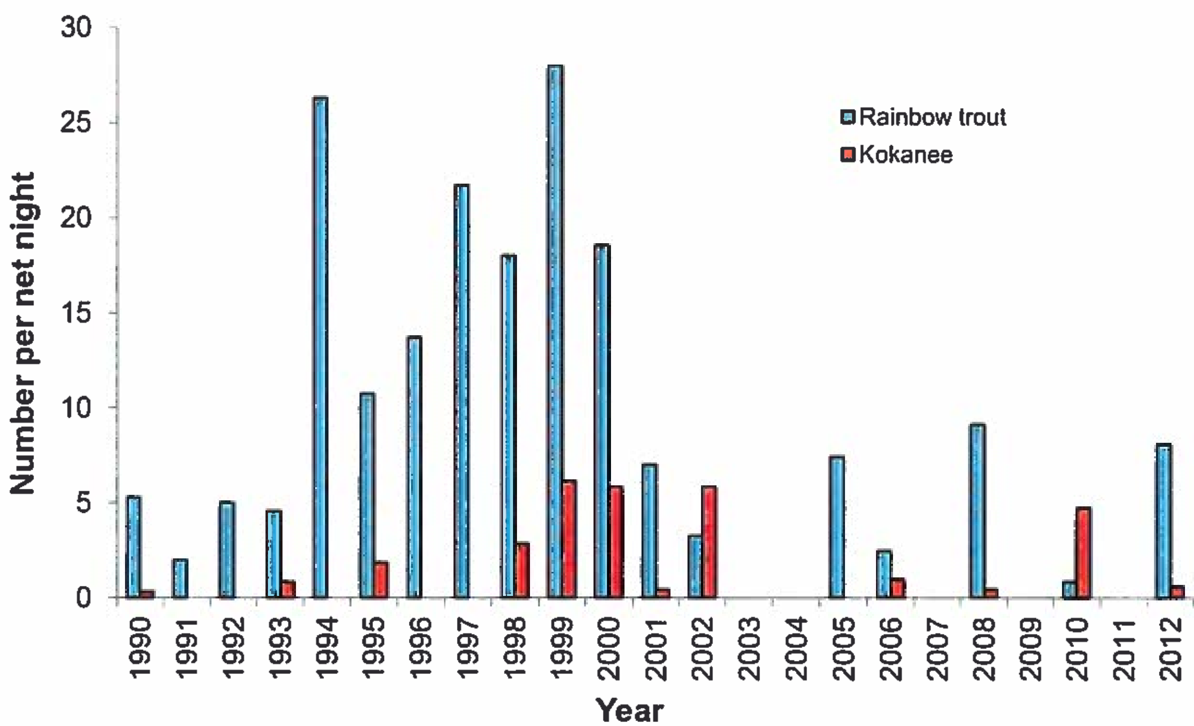


Figure 17. Gill net catch rate (fish per net night) of Kokanee and Rainbow Trout in Island Park Reservoir, from 1990 to 2012.

Appendix A. Annual Kokanee stocking in Island Park Reservoir, Moose Creek, and Big Springs Creek, 1944 – 2012.

	Island Park Reservoir		Moose Creek		Big Springs Creek	
Year	Fingerling	Fry	Fingerling	Fry	Fingerling	Fry
1944	67,770					
1945	51,510					
1968	360,000			107,724		
1969	200,000					
1981				503,198		
1982				199,800		
1984				760,300		
1985	833,690					
1988				104,720		25,200
1989				233,020		
1990	189,00		167,850			
1991	104,745		20,000	135,660		
1992	142,142		115,905			63,000
1993	200,624					
1994	596,250					
1995	500,000					
1996	5,000		419,100			
1997	554,315					
1998	125,304					
1999	41,600		304,807			
2000			579,128			
2001	474,640					
2002	402,648					
2003	30,000					
2004	203,695					
2005	248,000					
2006	418,575					
2007	620,760					
2008		223,040				
2009	125,875		62,938		62,938	
2010	108,575		54,287		54,287	
2011	54,515		59,955		59,955	
2012	120,391		65,400		65,400	

Appendix B. Gill net locations in Island Park Reservoir, 2012. All coordinates used NAD27 and are in Zone 12.

Location	UTM E	UTM N
Goose Island	456712	4916812
West End	457181	4915789
MP25	459241	4915685
Trudes	458721	4917667
MP56	460864	4916686
West Mouth	462368	4918437
Bills Island West	463725	4919296
Lakeside	464751	4920435
Mill Cr	466325	4921491
Bills Island	465499	4919897
Dam	467871	4918662
Brush	469648	4919391

Appendix C. Gill net catch statistics from Island Park Reservoir, 2012.

Net #	Date	Location	Net Type	Rainbow Trout	Kokanee	Utah Chub	Mountain Whitefish	Utah Sucker	Yellowstone Cutthroat Trout
1	6/11/12	Goose Island	Floating	33	2	3	0	0	0
2	6/11/12	West End	Sinking	2	0	30	0	45	0
3	6/11/12	MP25	Floating	13	1	11	1	6	0
4	6/11/12	Trudes	Sinking	2	0	43	0	13	0
5	6/11/12	MP56	Floating	12	0	3	0	0	0
6	6/11/12	W-Mouth	Sinking	1	0	15	0	38	0
7	6/11/12	Bill Isl. West	Floating	3	0	17	0	18	0
8	6/12/12	Brush	Floating	8	0	30	0	40	0
9	6/12/12	Dam	Sinking	0	2	3	0	17	0
10	6/12/12	Bill's Island	Floating	13	0	1	0	24	0
11	6/12/12	Mill Cr.	Sinking	1	0	11	3	41	0
12	6/12/12	Lakeside	Sinking	0	0	2	1	22	0
13	6/12/12	Bill Isl. West	Floating	3	0	1	0	12	0
14	6/12/12	W-Mouth	Floating	9	0	0	0	2	0
15	6/13/12	Goose Island	Sinking	3	11	13	0	15	0
16	6/13/12	West End	Floating	23	3	5	0	1	0
17	6/13/12	MP25	Sinking	4	0	21	1	24	0
18	6/13/12	Trudes	Floating	14	0	2	0	1	0
19	6/13/12	MP56	Sinking	16	0	31	1	39	0
20	6/13/12	W-Mouth	Floating	8	0	2	0	0	0
21	6/13/12	Bill Isl. West	Sinking	0	1	13	1	22	0
22	6/14/12	Brush	Sinking	7	0	58	1	100	0
23	6/14/12	Dam	Floating	8	0	1	0	0	0
24	6/14/12	Bill's Island	Sinking	9	0	14	0	23	0
25	6/14/12	Mill Cr.	Floating	2	0	0	0	16	0
26	6/14/12	Lakeside	Floating	11	0	0	0	1	1
27	6/20/12	Goose Island	Floating	17	0	14	0	0	0
28	6/20/12	West End	Sinking	1	0	47	0	37	0
29	6/20/12	MP25	Floating	21	0	26	0	30	0
30	6/20/12	Trudes	Sinking	3	0	19	0	19	0

Net #	Date	Location	Net Type	Rainbow Trout	Kokanee	Utah Chub	Mountain Whitefish	Utah Sucker	Yellowstone Cutthroat Trout
31	6/20/12	MP56	Floating	17	0	4	0	2	0
32	6/20/12	Mill Cr.	Sinking	2	0	10	0	33	0
33	6/20/12	Lakeside	Sinking	4	0	1	0	19	0
34	6/20/12	Bill's Island	Floating	11	0	0	0	4	0
35	6/20/12	Dam	Sinking	4	1	12	0	95	0
36	6/20/12	Brush	Floating	8	0	4	0	8	0
Total				293	21	467	9	767	1
			CPUE	8.1	0.6	13.0	0.3	21.3	<0.1
			Relative abundance (%)	18.8	1.3	30.0	0.6	49.2	<0.1

Ririe Reservoir

ABSTRACT

During 2012, we conducted our third annual fall Walleye *Sander vitreus* index netting (FWIN), and captured 15 Walleye (0.8 per net night), ranging from 190 mm to 661 mm, compared to seven (0.4 per net night) in 2011. Although the observation of multiple age classes and the increase in Walleye catch rate suggests that this population may be increasing, Walleye still only represent less than 2% of the overall species composition in Ririe Reservoir. The gill net catch was dominated by Utah Sucker *Catostomus ardens* (53%), Yellow Perch *Perca flavescens* (22%), and Utah Chub *Gila atraria* (17%) as well as Kokanee Salmon (3%), Rainbow Trout (1%) and Yellowstone Cutthroat Trout (1%).

Authors:

Greg Schoby
Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manager

INTRODUCTION

Ririe Reservoir is located on Willow Creek, approximately 32 km east of Idaho Falls (Figure 18). 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 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*, Rainbow Trout *O. mykiss*, 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. Both Yellowstone Cutthroat Trout and Rainbow Trout have been 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 in Ririe Reservoir, 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 in Ririe Reservoir. 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). Not only do Walleye have the potential to impact existing fisheries in Ririe Reservoir, but also may have the ability to 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.

OBJECTIVE

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 2012 marked the third year of FWIN to monitor trends in the Walleye population in Ririe Reservoir. From October 24-26, we set 6 gill nets per night, for a total of 18 gill net nights of effort. Netting effort was based on FWIN protocol recommendations for water body size (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 19). FWIN protocol recommends stratifying net sets between two depth strata (shallow: 2 - 5m; 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 D).

We identified all fish collected with gill nets to species and recorded total length (mm) and weight (g). Additionally, we recorded 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 2012, FWIN catch was dominated by non-game fish, mainly Utah Sucker (53%) and Utah Chub (17%; Figure 20). Walleye comprised 1% of the relative abundance of our gill net catch. We captured 0.8 Walleye per net night (n = 15; Figure 21) that ranged in size from 190 to 661 mm (mean: 533 mm; Figure 22, Table 6), and had relative weights that ranged from 90 to 116 (mean: 105). Walleye PSD and RSD-P were both 79 (Table 7). Of the Walleye captured during FWIN, 11 were age-5 or older (either the 2005 or 2007 yearclass), while four age-1 Walleye were captured, and one age-0 was also collected (Table 6). We analyzed diet of 14 Walleye captured; 11 stomachs were empty, while three samples contained Kokanee or unidentifiable fish parts.

We captured 13.1 Yellow Perch per net night (n = 235; Figure 21) that ranged from 85 mm to 292 mm (mean: 191 mm; Figure 23), with PSD and RSD-P values of 73 and 22, respectively (Table 7). Yellow Perch comprised 22% of the relative abundance of our gill net catch. We captured 1.6 Kokanee per net night (n = 29) that ranged from 165 mm to 438 mm (mean: 200 mm; Figure 24), with PSD and RSD-P values of 14 and 10, respectively. Kokanee comprised 3% of the relative abundance of our gill net catch. We captured 1.2 Yellowstone Cutthroat Trout per net night (n = 22) that ranged from 251 mm to 426 mm (mean: 325 mm; Figure 25), with PSD and RSD-P values of 23 and 0, respectively. Yellowstone Cutthroat Trout comprised 2% of the relative abundance of our gill net catch. We captured 1.1 Smallmouth Bass per net night (n = 20) that ranged from 177 mm to 403 mm (mean: 288 mm; Figure 26), with PSD and RSD-P values of 37 and 26, respectively. Smallmouth Bass comprised 2% of the relative abundance of our gill net catch. We captured 0.4 Rainbow Trout per net night (n = 8) that ranged from 300 mm to 371 mm (mean: 339 mm); PSD and RSD-P values for Rainbow Trout were 100 and 0, respectively, as no Rainbow Trout > 400 mm were captured. Rainbow Trout comprised <1% of the relative abundance of our gill net catch. Additionally, we captured one Brown Trout that measured 630 mm in our gill nets.

DISCUSSION

The fall of 2012 marked the third year of fall Walleye index netting and the third year where an increase in Walleye was documented. Much of this increase can be attributed to one or two strong yearclasses of Walleye, most likely from the 2005 or 2007 spawn year. Although largely driven by these strong yearclasses, there is evidence of natural reproduction as seen by the scarce but present number of younger fish. Reproduction has been documented, but success and recruitment to older year classes appears to be low. Stomach content analysis showed a high proportion of Kokanee in stomachs that had fish, but most stomachs were empty. Although abundance as reflected in gill net catch is increasing, the overlapping confidence bounds of our estimates suggest the increase is not statistically significant. Regardless, this new population bears additional monitoring in the coming years.

We started stocking sterile Rainbow Trout in 2012 as part of an evaluation of performance and return to the creel. Anglers have complained about the poor performance of Cutthroat Trout once stocked, and this poor performance was reflected in population metrics like relative weights. Yellowstone Cutthroat Trout were first stocked in 2005 to replace fertile Rainbow Trout that had been stocked into Ririe for decades prior to 2005 in an attempt to alleviate the potential for interbreeding and hybridization with native cutthroat in the tributaries upstream. Beginning in 2012, we stocked equal numbers of catchable Rainbow Trout and Yellowstone Cutthroat Trout to evaluate relative performance of both species. Gill net catch rates showed that cutthroat were caught at a higher rate than rainbows (22 YCT and 8 RBT). However, results may be skewed by the seven years prior, where only cutthroat were stocked. This may have resulted in more cutthroat being present in the reservoir if survival for more than one year is occurring, and influencing return rates. Additional analysis should continue in the coming years.

Overall, it appears that gill net catch rates remain fairly constant when compared to data collected since the implementation of the FWIN protocol. We did not detect any statistical changes in catch rates or for relative abundances of any fish species in the reservoir this year. This suggests that at current levels, Walleye have not altered the fish community. However, like many species in many different systems, there may be a series of environmental factors that align to cause greater success in Walleye reproduction. If this predatory species did increase in abundance substantially, there could be additional impacts that have not been detected at the current low level of abundance. Additional monitoring is warranted, until population trends of Walleye stabilize, and impacts can better be judged.

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.

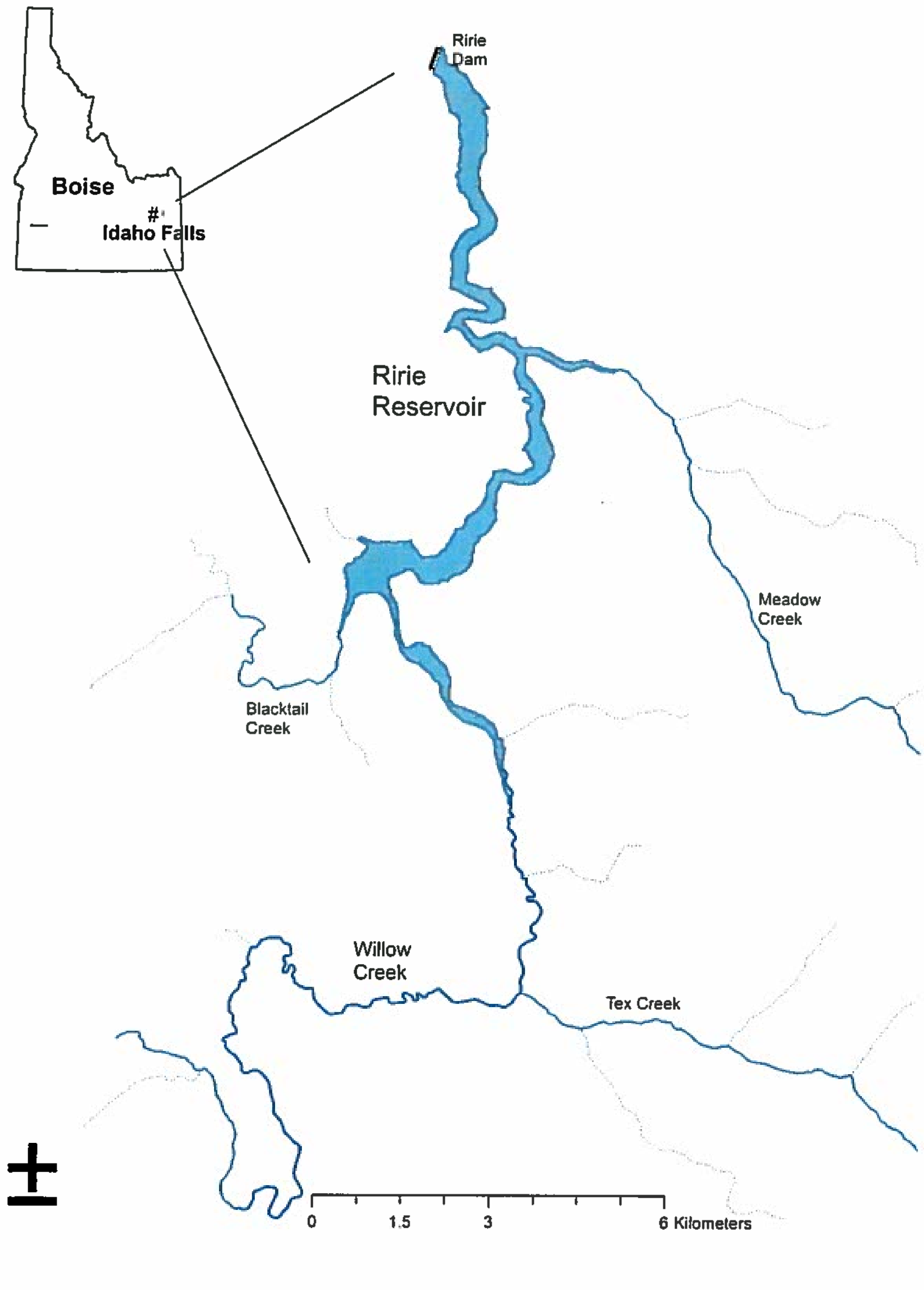


Figure 18. Location of Ririe Reservoir and major tributaries.

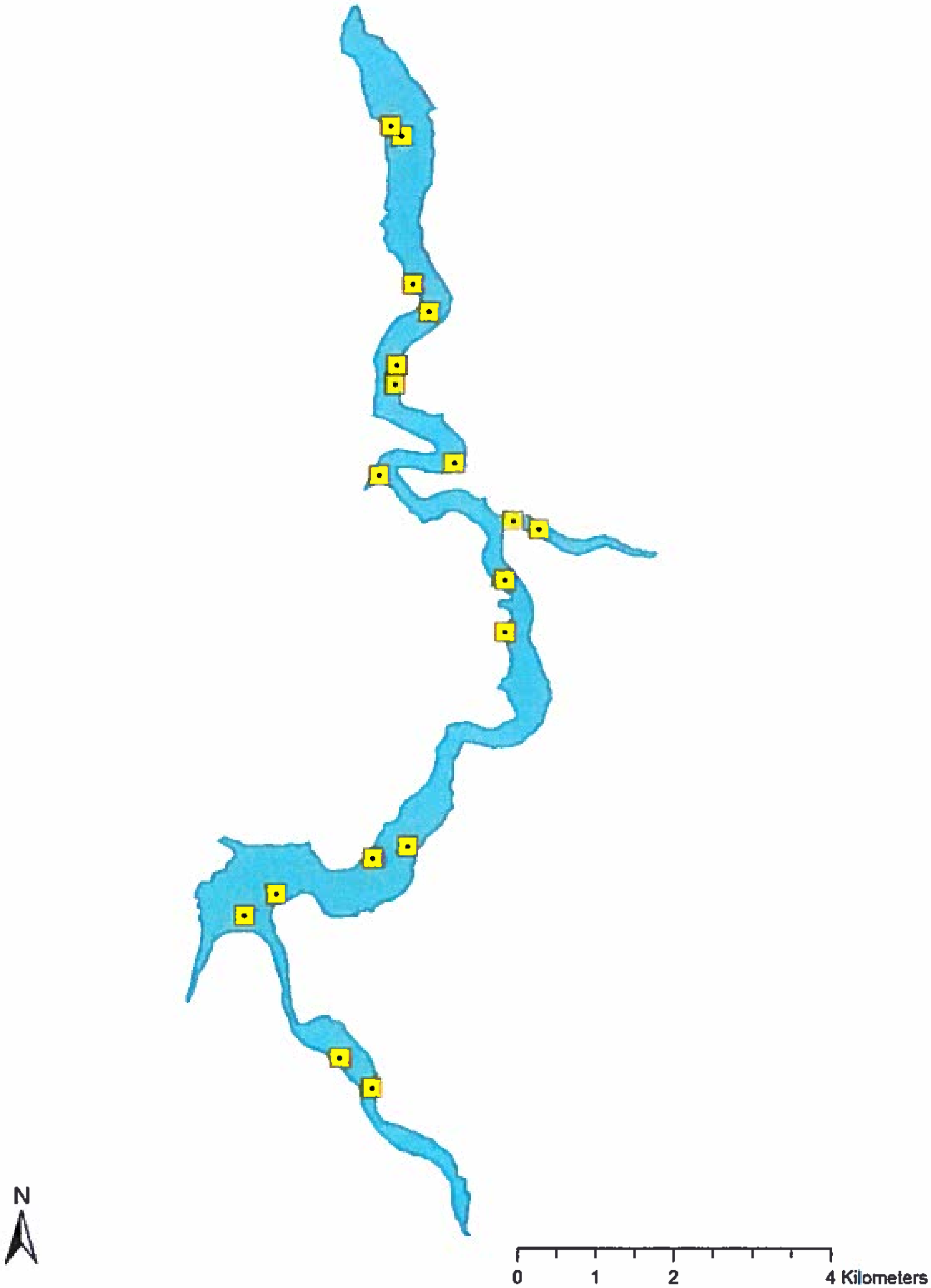


Figure 19. Location of 2012 fall Walleye index netting (FWIN) in Ririe Reservoir.

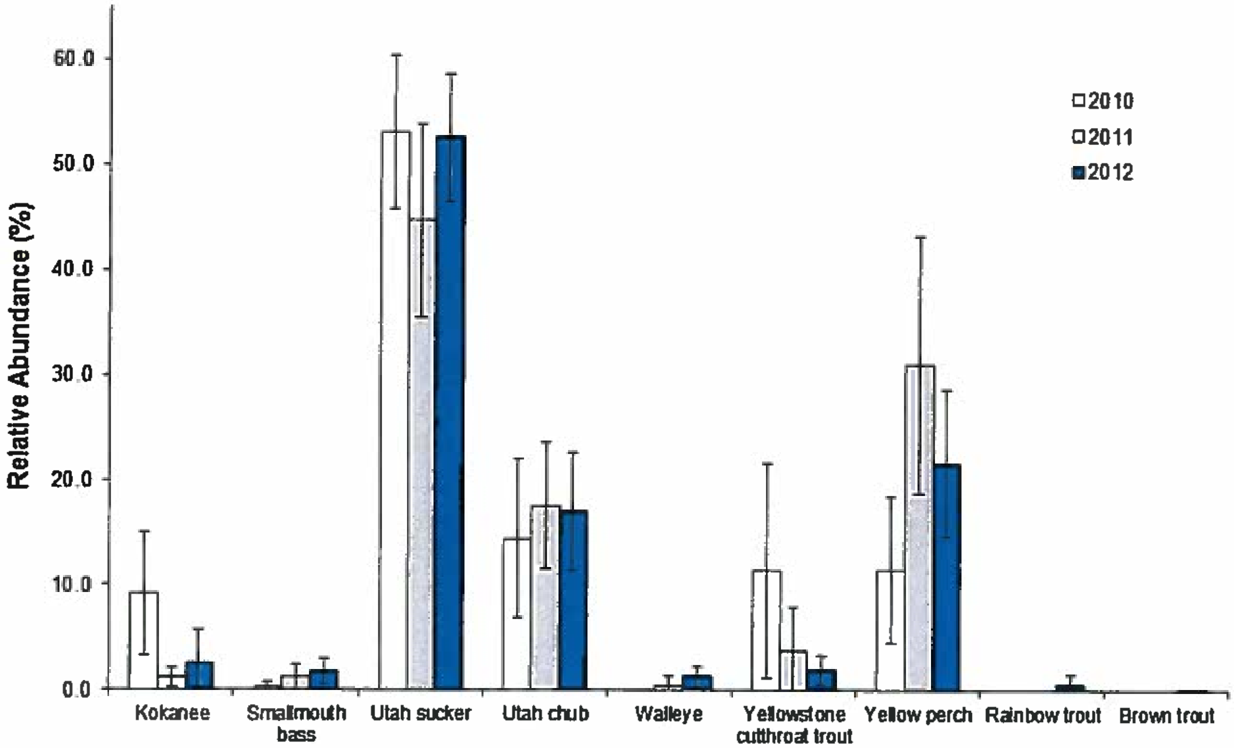


Figure 20. Relative abundance of fish caught during FWIN in Ririe Reservoir during 2010-2012. Error bars represent 90% confidence intervals.

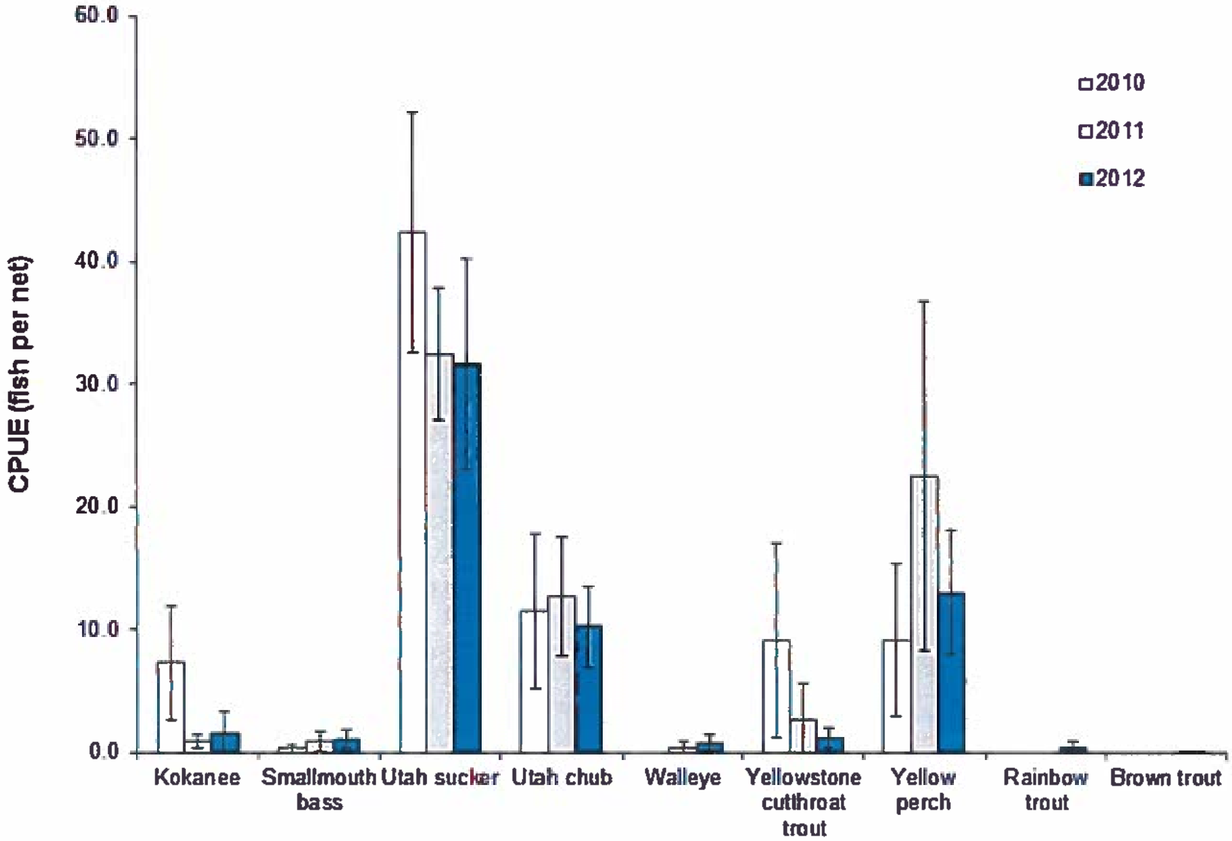


Figure 21. Catch per unit effort (fish per net), for 18 net nights of FWIN in Ririe Reservoir, during 2010-2012. Error bars represent 95% confidence intervals.

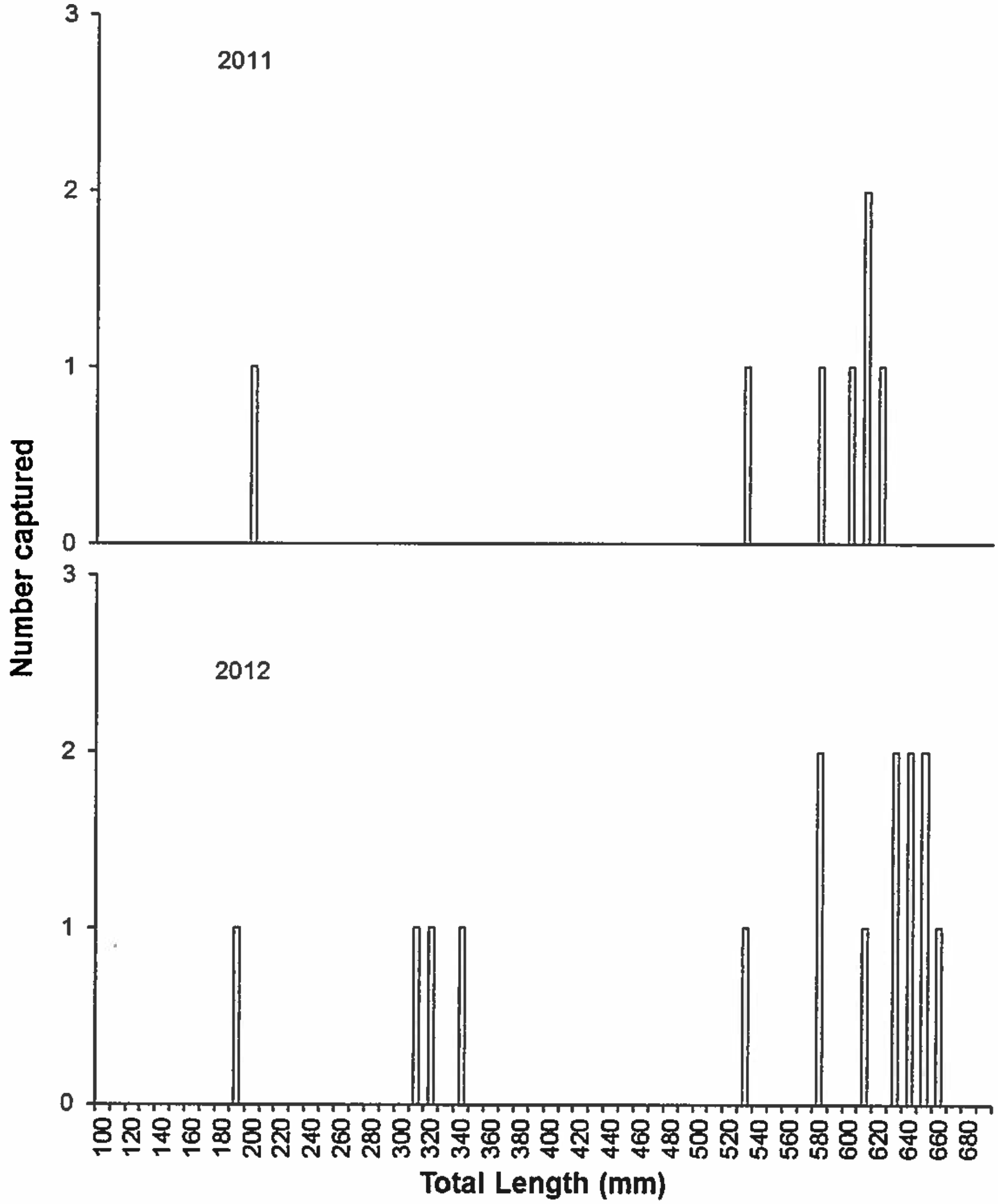


Figure 22. Length frequency of Walleye captured during 2011 (top) and 2012 (bottom) FWIN in Ririe Reservoir. Although sampling occurred in 2010, no Walleye were caught, so no length frequency could be displayed for that year.

Table 6. Summary statistics for Walleye captured during 2012 FWIN in Ririe Reservoir.

Date	Net number and type[a]	Total length (mm)	Weight (g)	Sex	Age	Relative weight (*Wr*)
10/24/2012	1-S	341	366	M	1	92
10/24/2012	1-S	310	332	F	1	113
10/24/2012	2-F	655	3392	F	7	107
10/25/2012	3-F	190	56	--	0	90
10/25/2012	1-F	322	365	M	1	110
10/25/2012	4-S	537	1906	M	5	113
10/25/2012	4-S	585	2584	M	5	116
10/25/2012	1-F	615	2534	F	5	97
10/25/2012	4-S	635	2692	F	5	93
10/25/2012	2-S	640	3219	F	7	109
10/25/2012	4-S	645	3129	F	7	103
10/25/2012	4-S	650	3128	F	7	101
10/25/2012	2-S	661	3683	F	5	112
10/26/2012	1-S	582	2387	M	5	109
10/26/2012	1-S	631	3180	F	7	113

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

Table 7. Total length (mm) summary statistics for game fish captured during 2012 FWIN in Ririe Reservoir.

	Kokanee	Smallmouth Bass	Walleye	Yellow Perch	Yellowstone Cutthroat Trout	Rainbow Trout
Mean	200	288	533	191	325	339
Median	181	272	615	215	321	343
Range	165 - 438	177 - 403	190 - 661	85 - 292	251 - 426	300 - 371
n	29	20	15	235	22	8
PSD	14	37	79	73	23	0
RSD-P	10	26	79	22	0	0
Mean *Wr*	86	92	105	88	77	84

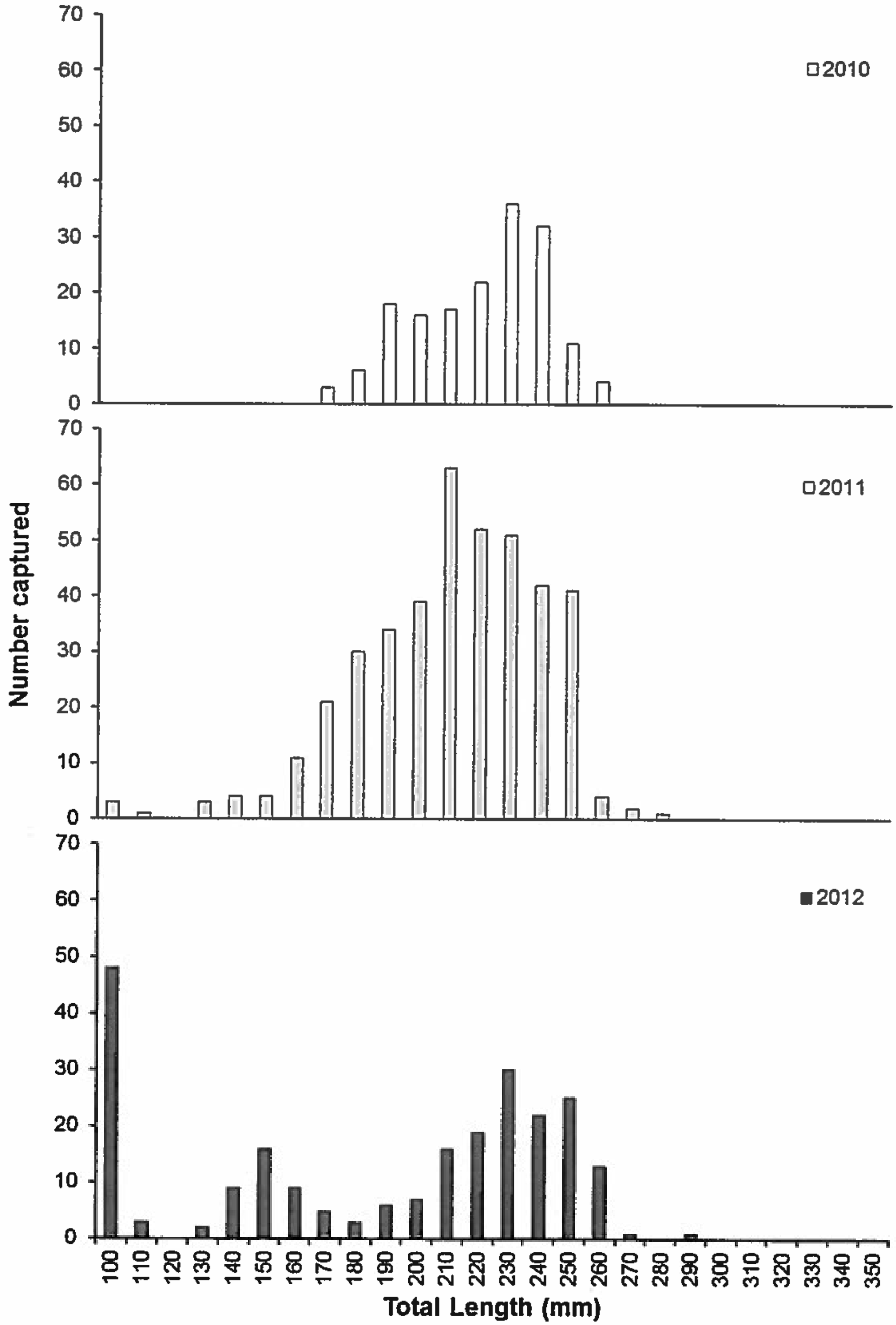


Figure 23. Length frequency of Yellow Perch captured during 2010-2012 FWIN in Ririe Reservoir.

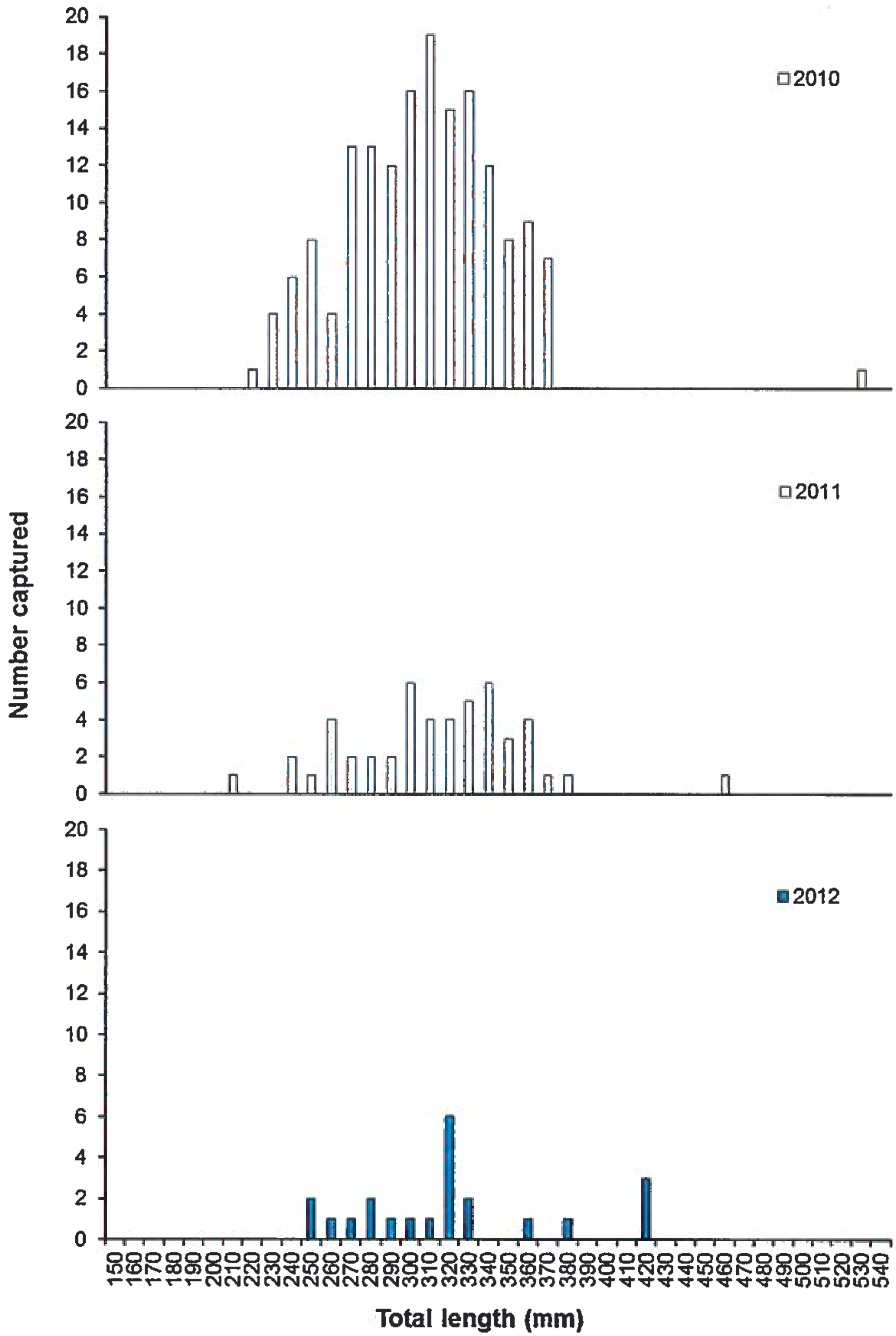


Figure 24. Length frequency of Kokanee captured during 2010-2012 FWIN in Ririe Reservoir.

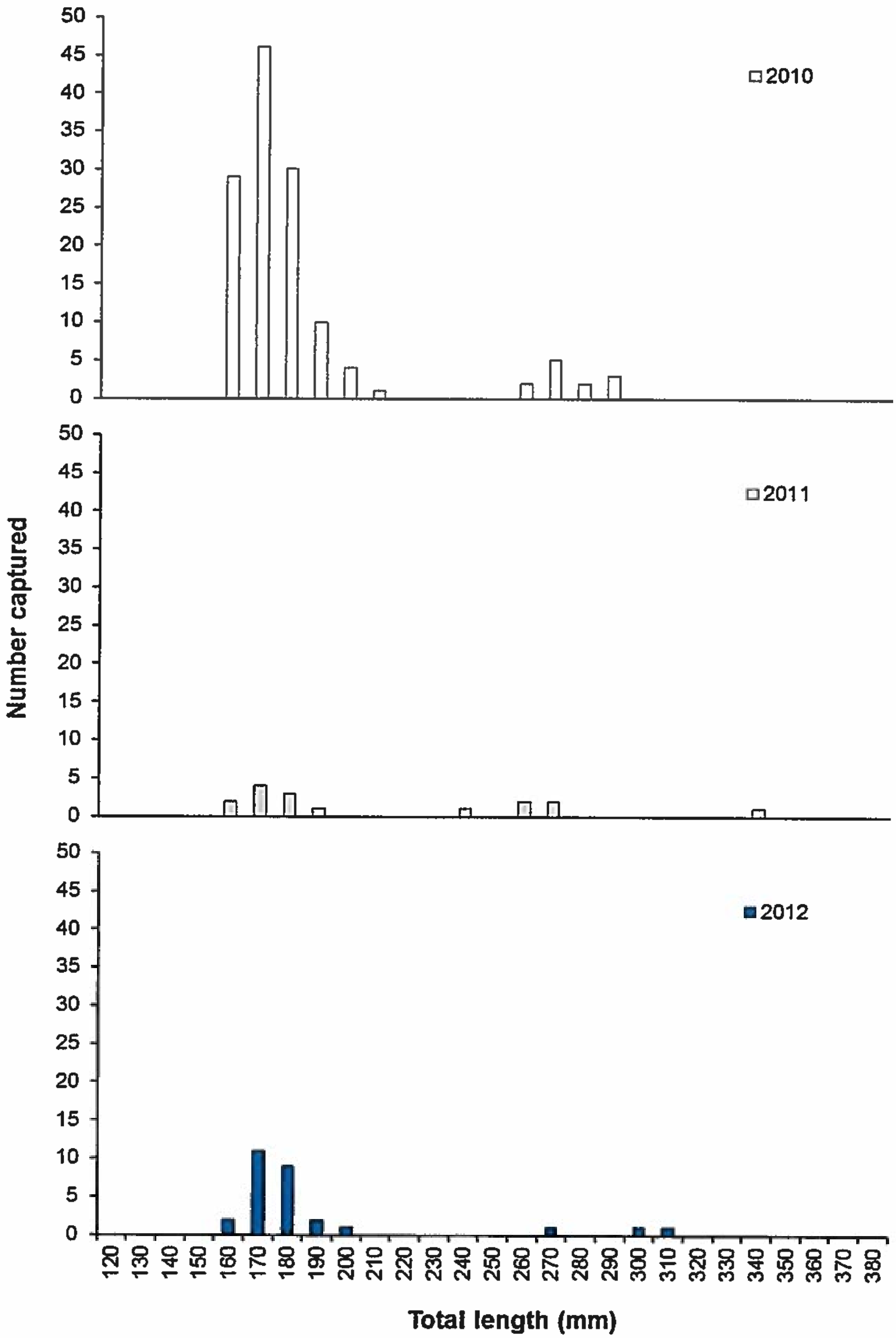


Figure 25. Length frequency of Yellowstone Cutthroat Trout captured during 2010-2012 FWIN in Ririe Reservoir.

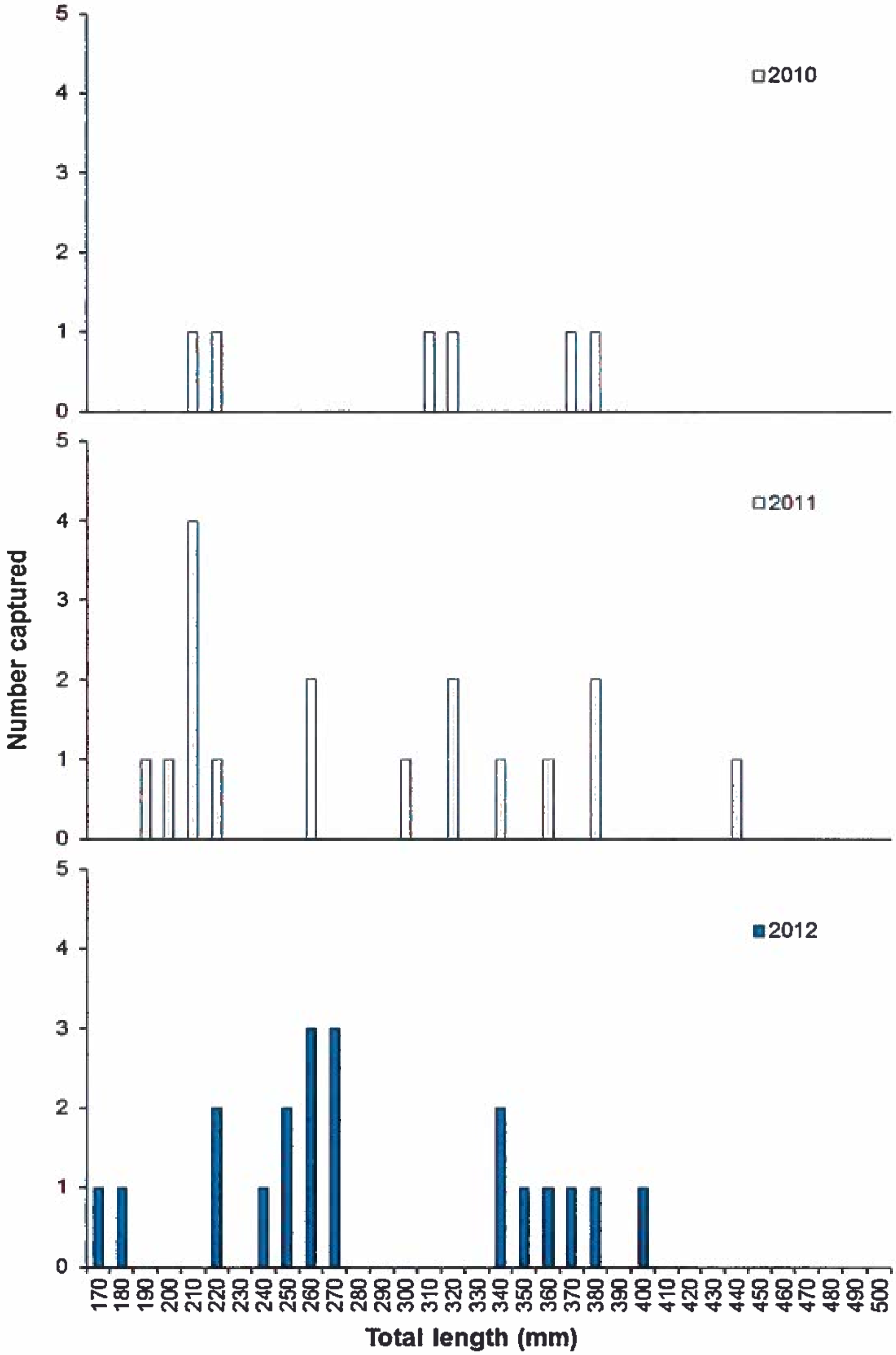


Figure 26. Length frequency of Smallmouth Bass captured during 2010-2012 FWIN in Ririe Reservoir.

Appendix D. Location of Ririe Reservoir fall Walleye index netting (FWIN) net locations during October 2012. All coordinates are Zone 12, and WGS 84 datum.

DATE	NET	LAKE STRATA	E	N	NET TYPE
10/24/2012	1	North	440405	4824582	S
10/24/2012	2	North	440499	4824239	F
10/24/2012	3	North	440330	4825470	F
10/24/2012	4	North	440785	4823957	S
10/24/2012	5	North	440049	4825659	S
10/24/2012	6	North	440830	4824365	F
10/25/2012	7	Middle	440476	4822064	F
10/25/2012	8	Middle	441828	4820396	S
10/25/2012	9	Middle	441658	4820616	F
10/25/2012	10	Middle	440250	4822326	S
10/25/2012	11	Middle	441017	4821403	F
10/25/2012	12	Middle	440107	4821081	F
10/26/2012	13	South	441358	4818545	S
10/26/2012	14	South	438950	4816275	S
10/26/2012	15	South	438535	4816593	F
10/26/2012	16	South	440949	4818431	F
10/26/2012	17	South	439318	4815656	F
10/26/2012	18	South	438288	4816784	S

Jim Moore Pond

ABSTRACT

We used experimental gill nets and trap nets on July 2-4, 2012 to sample the fish population in Jim Moore Pond (JMP). Sampling efforts were conducted to assess the status of the fish community, particularly Yellow Perch, in response to the introduction of Brown Trout *Salmo trutta* in 2011, and previous introductions of Channel Catfish *Ictalurus punctatus*. We sampled a total of 1,334 Yellow Perch, ranging from 66 mm to 234 mm in total length (mean = 115 mm). The small mean size of perch suggests that predator introductions have not sufficiently altered the size structure of the Yellow Perch community. The continued high catch rates for anglers, slow growth of perch, and low proportional stock density of Yellow Perch indicate that this population is overcrowded, a condition that has hindered the JMP fishery in the past. We transplanted an additional 70 adult Brown Trout from the South Fork Snake River into JMP in an effort to increase predation on Yellow Perch, although in the future, additional alternate predator species introductions should be considered.

Authors:

Greg Schoby

Regional Fisheries Biologist

Dan Garren

Regional Fisheries Manager

INTRODUCTION

Jim Moore Pond (JMP), formerly known as Roberts Gravel Pond, is a 50-acre pond located 3km 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. Over the years, numerous fish species have been introduced into JMP to provide recreational fishing opportunities. Rainbow Trout are stocked on an annual basis to provide a put-and-take fishery, while Brown Trout *Salmo trutta*, Brook Trout, 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 *Catostomus ardens* and Utah Chubs *Gila atraria* were found in JMP up until 1982 (Corsi and Elle 1986). While various species have been introduced, most have not created a successful recreational fishery. Other species, such as Yellow Perch, have become well established and provide high catch rates to anglers, although the average size is small. Despite their small size, Yellow Perch provide a consistent, high catch rate fishery popular with some anglers and found in limited supply in the Upper Snake Region.

The establishment of undesirable fish species as well as overpopulation and limited growth by Yellow Perch continue to be the biggest concern of the Jim Moore Pond fishery. Over the years, 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 a few years following the 1996 rotenone treatment. Anglers reported high catch rates of small perch during the early 2000's, indicating that Yellow Perch were again abundant in Jim Moore Pond. In 2007, Yellow Perch with a mean length of 139 mm dominated the fishery, comprising 77% of the combined gillnet 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 determined that Channel Catfish introductions were unsuccessful in reducing the Yellow Perch population to the point of increasing individual growth. Therefore 99 Brown Trout were introduced into JMP to help increase predation on smaller perch (Schoby et al. 2013). Sampling in 2012 was conducted to determine the status of the Jim Moore Pond fishery after the introduction of Brown Trout, and to determine if increased and/or alternate predator introductions are necessary to improve the Yellow Perch fishery.

OBJECTIVE

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

METHODS

We used four experimental gill nets (two floating and two sinking), and three trap nets to sample the fish community in JMP on July 2-4, 2012 (Figure 27). 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 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.

We identified captured fish to species and recorded total length (TL) to the nearest mm and weighed to the nearest gram; we subsampled the Yellow Perch catch, collecting length and weight measurements from approximately half of the catch. 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),

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

for Channel Catfish (Brown et al. 1995),

$$\log W_s = -4.898 + 2.990 \log TL$$

for Rainbow Trout (Simpkins and Hubert 1996), and

$$\log W_s = -5.422 + 3.194 \log TL$$

for Brown Trout (Hyatt and Hubert 2001).

We calculated proportional stock density (PSD) of Yellow Perch by dividing the number of quality sized fish (≥ 200 mm) sampled by the number of stock sized fish (≥ 130 mm) sampled multiplied by 100. We also calculated relative stock density of preferred sized Yellow Perch (RSD-P) using the same equation, but replaced the numerator with fish greater than the preferred size (≥ 250 mm) (Anderson 1980).

We removed saggital otoliths from 65 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 analyzed the stomach contents of all Brown Trout captured in gill nets that could not be released alive. Diet analyses were conducted primarily to determine if Brown Trout in Jim Moore Pond were utilizing Yellow Perch as a food source, but all items in the diet were identified, counted, and weighed to the nearest gram (g).

We collected zooplankton samples at three locations in JMP on July 25, 2012, with three nets fitted with small (153:), medium (500:) and large (750:) mesh. 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: 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:) to usable (500:) zooplankton. We also calculated the zooplankton quality index (ZQI) to account for overall abundance of zooplankton using the formula ZQI = (500: + 750:) * ZPR (Teuscher 1999).

RESULTS

We collected a total of 1,401 fish in eight gill net nights and six trap net nights. Overall, Yellow Perch dominated the combined net catch (95%; n = 1,334), followed by Rainbow Trout (2%; n = 32), Brown Trout (1%; n = 17), Goldfish *Carassius auratus* (1%; n = 14), and Channel Catfish (<1%; n = 6). Gill net CPUE was highest for Rainbow Trout (4.0 per net), followed by Brown Trout (2.1 per net), Yellow Perch (2.0 per net), Goldfish (1.8 per net), and Channel Catfish (0.8 per net). Yellow Perch were the only species captured in trap nets (219.3 per net; Table 8).

We measured total length and weight of 658 individual Yellow Perch (49% of the catch), which ranged from 66 mm to 234 mm, with a mean length of 115 mm (Figure 28). Mean W_r of Yellow Perch was 80, while PSD and RSD-P were 1 and 0, respectively. Average length of Yellow Perch in 2012 was the lowest observed since 1995 (Figure 29). We observed Yellow Perch from age 1 through age 8; mean length at age 3 was 144 mm (Table 9; Figure 30).

Channel Catfish ranged from 331 mm to 550 mm, with a mean length of 460 mm (Figure 31). Mean W_r of Channel Catfish was 108. Rainbow Trout in JMP ranged from 187 mm to 465 mm, (mean TL: 278 mm), with a mean W_r of 76. Brown Trout ranged from 408 mm to 635 mm, (mean TL: 484 mm), with a mean W_r of 72.

Stomach samples from 17 Brown Trout were analyzed, 13 of which were empty. Of the four with food items, two contained only trace invertebrate remains. Of the two samples containing identifiable food items, one contained a juvenile Yellow Perch weighing 0.97 g (~65 mm TL), and the other contained a dragonfly (*Odonata* spp.) nymph, weighing 1.64 g.

Zooplankton sampling in JMP yielded only trace amounts (<0.01 g) in the medium and large mesh tows, therefore we were unable to make any estimates of ZQI or ZPR. Mean zooplankton in the 153 mesh net tows was 0.11 g/m.

DISCUSSION

The Yellow Perch population in Jim Moore Pond in 2012 appeared to be very similar to that in 2011 (high CPUE, small average size, low PSD and RSD-P values, and slow growth (Schoby et al. 2013). The average size of Yellow Perch remains low, but may be improved by reducing densities of perch. This can be accomplished by increasing angler harvest, through the addition of more predator fish, or by partial chemical treatments. All methods should be scoped with the public before implementation.

The introduction of Brown Trout has not yet reduced the Yellow Perch population, which is not unexpected given the short time frame and limited number of Brown Trout stocked. It is unlikely that 99 Brown Trout would consume enough Yellow Perch to realize a decrease in the perch population in less than one year. To supplement the Brown Trout stocked in 2011, we moved an additional 70 adult Brown Trout into JMP in the fall of 2012, ranging from 360 mm to 570 mm (mean: 460 mm), in an effort to increase predator abundance in the pond. We also moved 530 Rainbow Trout (range: 65 - 482 mm; mean: 291 mm) from the South Fork into JMP as part of an ongoing effort reduce hybridization with native Yellowstone Cutthroat Trout in the South Fork.

Stomach sample contents from Brown Trout collected in JMP in 2012 indicate that predation on Yellow Perch is low. Only one Brown Trout of 17 collected was observed to have fed on perch. Also, Brown Trout *Wr* was low (72) considering the abundant food source in the form of small Yellow Perch. Alternate predator species, particularly sterile options such as Tiger Muskellunge (Northern Pike *Esox lucius* x Muskellunge *E. masquinongy*) or Tiger Trout (Brook Trout x Brown Trout), should be considered for introduction to reduce the Yellow Perch population. While the introduction of Tiger Muskellunge would likely be more efficient at reducing the Yellow Perch population, it could also potentially impact the current Rainbow Trout catchable stocking program; public opinion should be sought prior to any future predator introductions that may impact the current trout stocking program.

MANAGEMENT RECOMMENDATIONS

1. Continue focused sampling efforts to assess fish community in Jim Moore Pond, 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. Continue to work towards finding a means to reduce abundance and improve the size structure of perch.

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 potential on Yellow Perch.

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

6. Consider alternate predator species introductions in Jim Moore Pond.

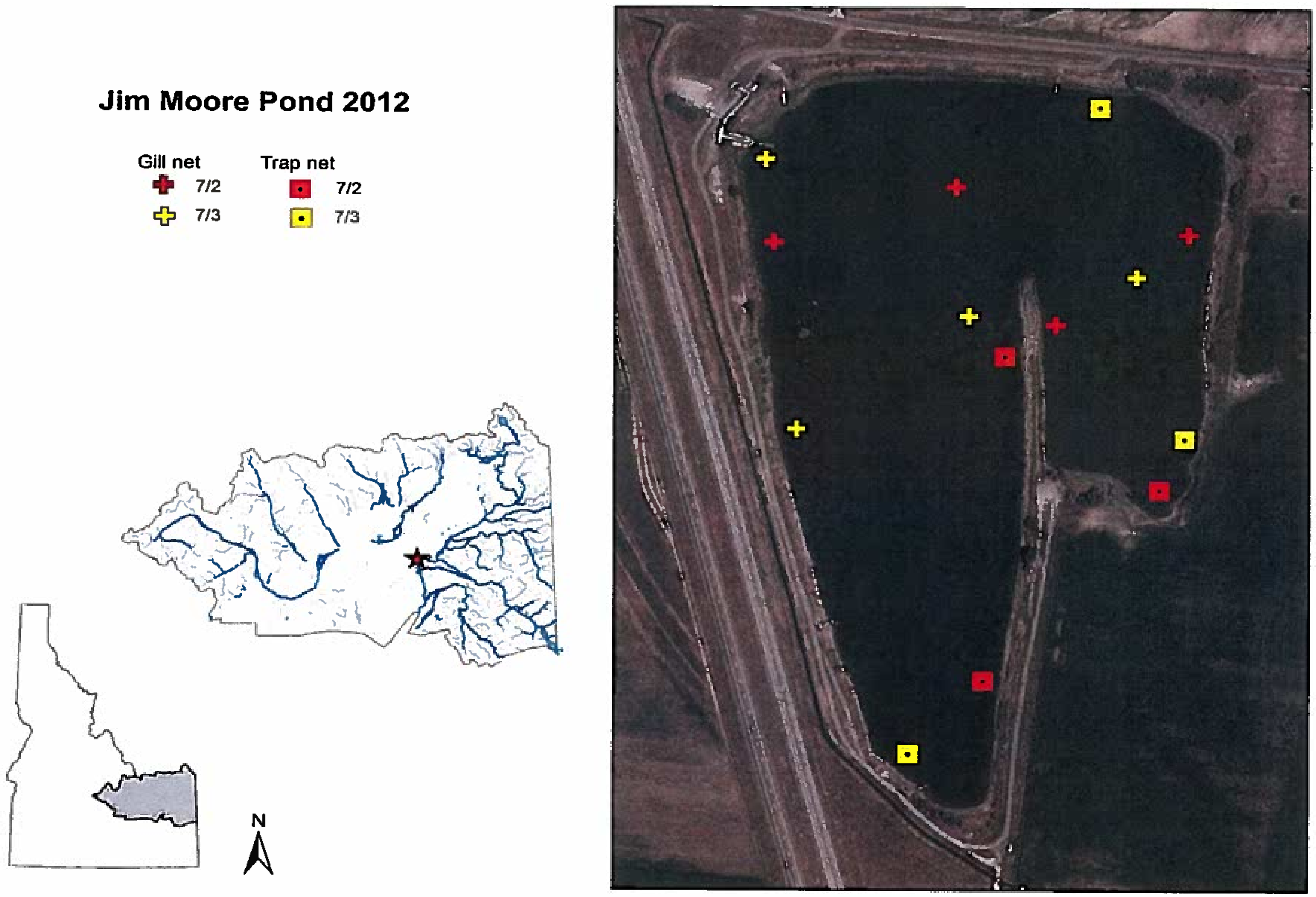


Figure 27. Location of gill nets and trap nets used to survey Jim Moore Pond during 2012.

Table 8. Gill net and trap net catch statistics in Jim Moore Pond from 2007, 2011, and 2012.

	Yellow Perch			Channel Catfish			Rainbow Trout			Brown Trout
	2007	*2011*	*2012*	*2007*	*2011*	*2012*	*2007*	*2011*	*2012*	*2012*
Gill net										
n	170	46	16	22	17	6	38	5	32	17
CPUE	56.7	11.5	2.0	7.3	4.3	0.8	12.7	1.3	4.0	2.1
Trap net										
n	--	582	1316	--	0	0	--	0	0	0
CPUE	--	194.0	219.3	--	0	0	--	0	0	0

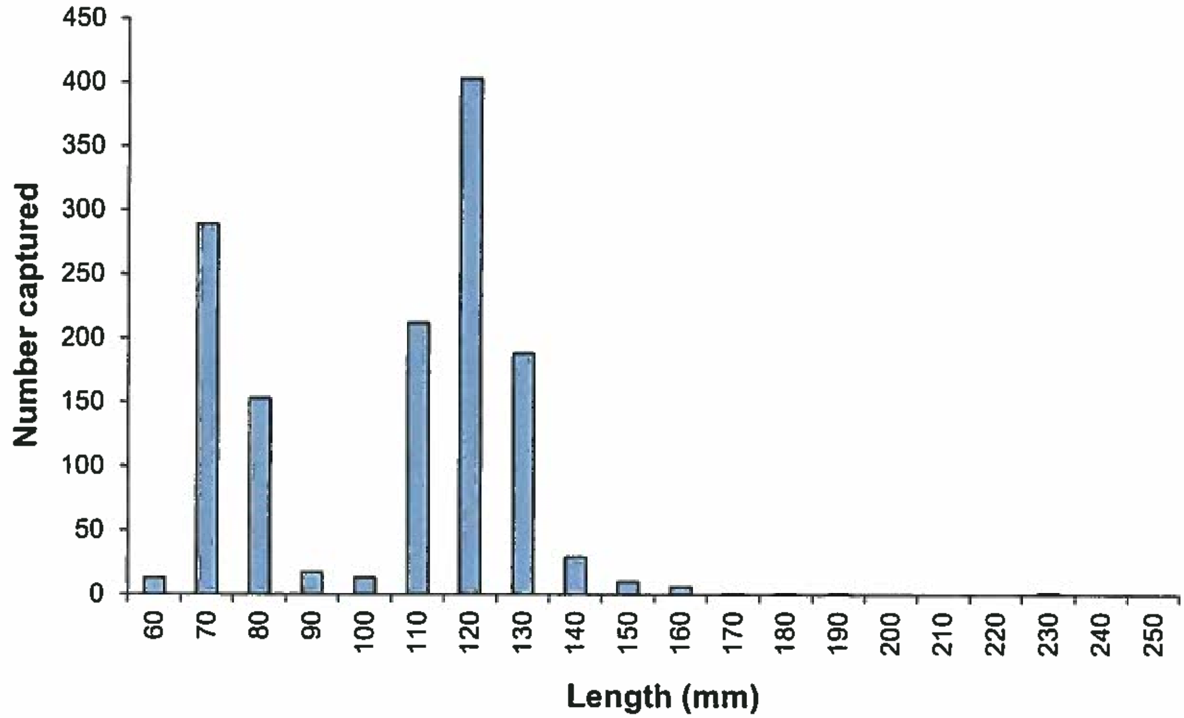


Figure 28. Length frequency of Yellow Perch captured in Jim Moore Pond with trap nets and gill nets on July 3-4, 2012.

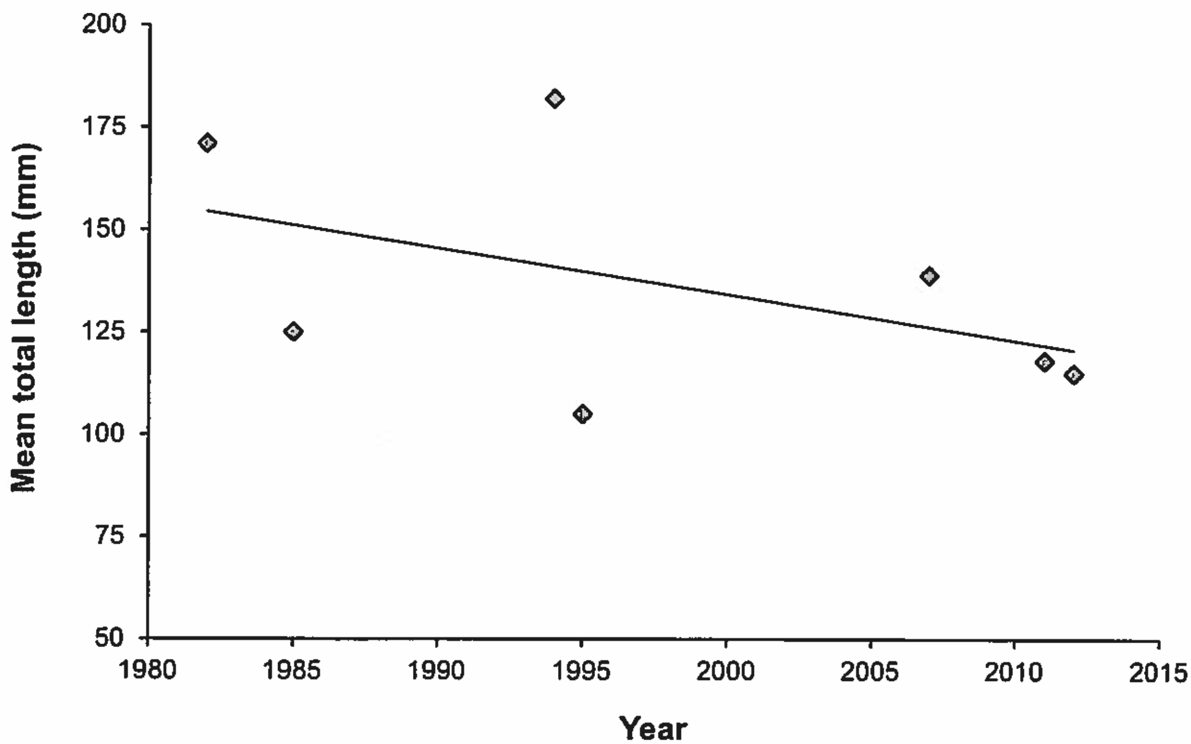


Figure 29. Mean total length (TL) of Yellow Perch in Jim Moore Pond, 1982-2012.

Table 9. Mean length at age data for Yellow Perch captured in gill nets and trap nets in Jim Moore Pond, 2011 and 2012. All fish were aged using otoliths.

	Mean length at age (mm)				
Age	1	2	3	4	5
2011					
Length (mm)	96	122	132	194	206
No.	1	15	46	2	2
2012					
Length (mm)	78	113	144	163	163
No.	22	9	21	5	1

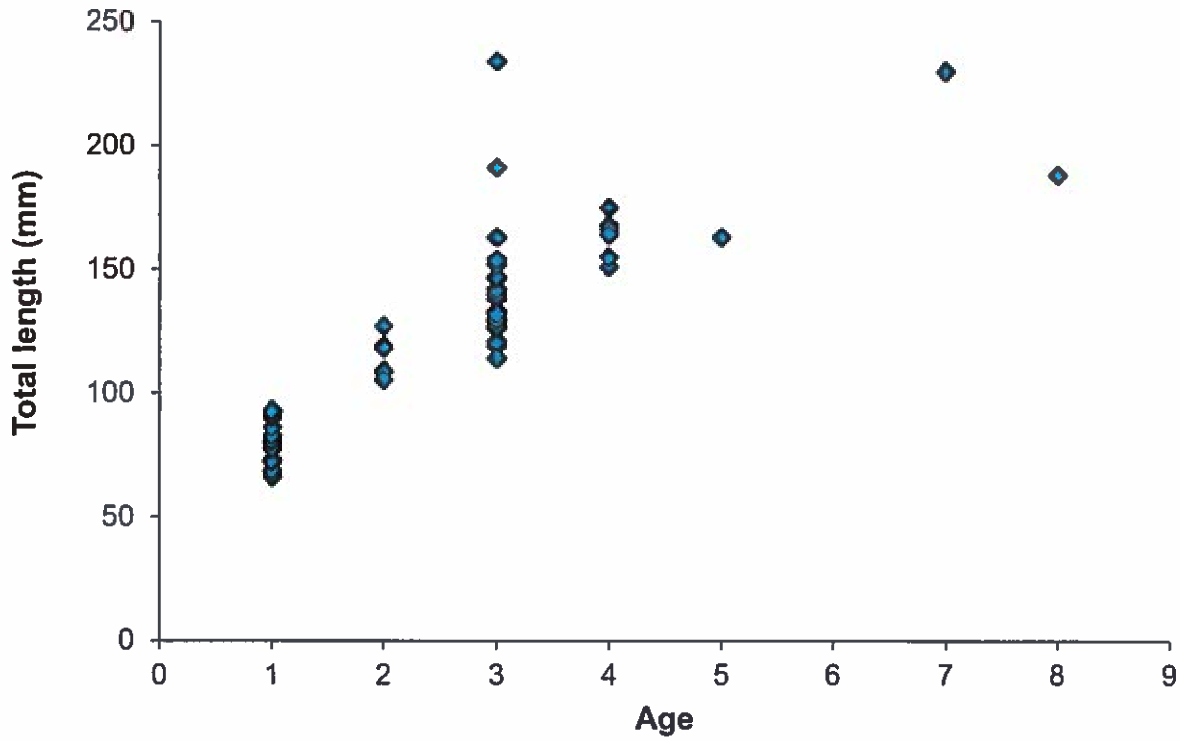


Figure 30. Length at age distribution of Yellow Perch collected from Jim Moore Pond, 2012.

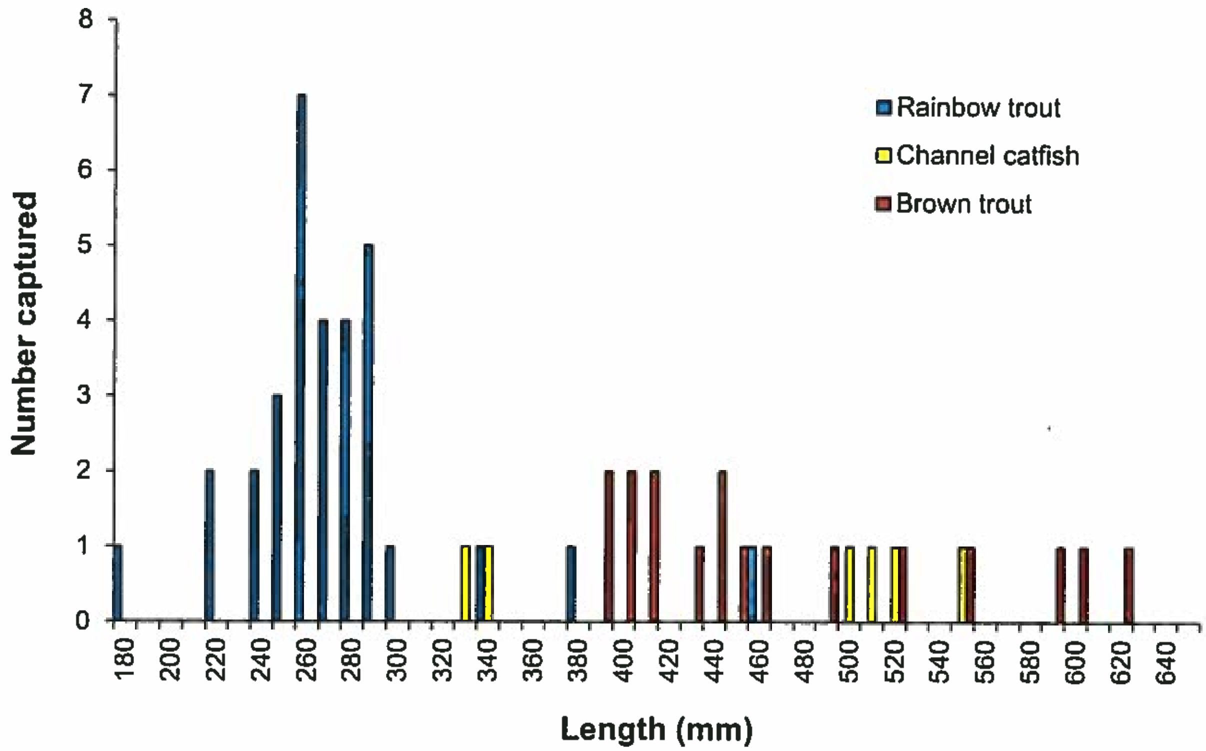


Figure 31. Length frequency of Rainbow Trout, Channel Catfish, and Brown Trout captured in Jim Moore Pond on July 2-4, 2012.

Zooplankton Monitoring

ABSTRACT

We monitored zooplankton abundance and biomass to assess the forage resources and evaluate stocking rates where applicable in seven regional lakes and reservoirs. We assessed the cropping impacts by fish using the zooplankton ratio method (ZPR) and determined that aside from in 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 2011, ZQI values in 2012 across the region were generally lower than in previous years. Additionally, we examined the variation in historic zooplankton data and determined that the limited amount of sampling, particularly in the larger lakes and reservoirs, may make changes in zooplankton abundance undetectable, and future monitoring efforts would likely benefit from increased sampling.

Authors:

Greg Schoby
Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manager

INTRODUCTION

Zooplankton are vital to lake and reservoir ecosystems because they form the base of the aquatic food web and influence fish growth. 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 seven lakes and reservoirs throughout the Upper Snake Region during 2012 (Figure 32), following the protocol described by Teuscher (1999). We collected zooplankton samples between July 24 – 27 from Henrys Lake, Island Park Reservoir, Mackay Reservoir, Palisades Reservoir, Ririe Reservoir, Gem Lake, and Jim Moore Pond. We did not sample Ashton Reservoir during 2012 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 different locations spread around the lake or reservoir. We collected samples with three nets fitted with small (153:), medium (500:) and large (750:) 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: 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 estimated the relative production potential of each lake by estimating overall zooplankton biomass collected from the 153: net. We measured competition for food (or cropping impacts by fish) using the zooplankton productivity ratio (ZPR) which is the ratio of preferred (750:) to usable (500:) zooplankton. We also calculated the zooplankton quality index (ZQI) to account for overall abundance of zooplankton using the formula developed by Teuscher (1999):

$$ZQI = (500: + 750:) * ZPR$$

ZQI values obtained from zooplankton monitoring are used to assess stocking rates based on the recommendations from Teuscher (1999) (Table 10). Additionally, we calculated 95% confidence intervals for zooplankton data (ZQI) from previous years to determine if the current levels of zooplankton sampling were adequate to detect changes in zooplankton abundance throughout the region.

RESULTS AND DISCUSSION

Throughout the Upper Snake Region, mean zooplankton biomass from the 153: net ranged from 0.02 g/m (Gem Lake) to 0.41 g/m (Island Park Reservoir) (Table 11). Teuscher (1999) recommends conservative fingerling stocking densities in water bodies with mean biomass estimates <0.10 g/m, as the necessary forage to support higher densities is lacking. During 2012, Gem Lake zooplankton biomass estimates were below 0.10 g/m and Jim Moore Pond was only slightly above (0.11 g/m). Past zooplankton monitoring in Gem Lake has consistently shown low biomass and is likely related to the low retention time of this run-of-the-river

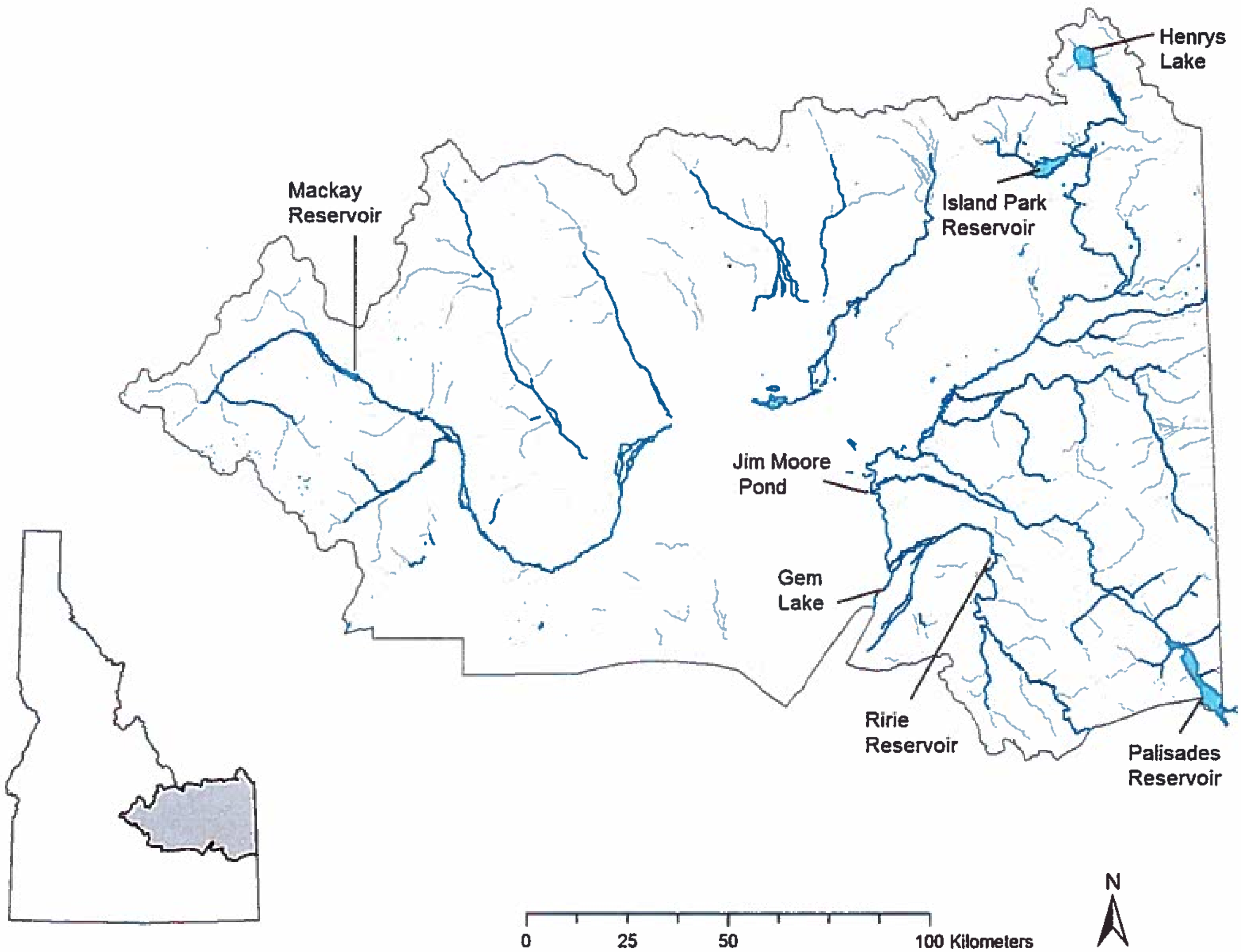


Figure 32. Zooplankton sample locations in the Upper Snake Region, 2012.

Table 10. 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 11. 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 2012.

	Net mesh (microns)				
Waterbody	153	500	750	ZPR	ZQI
Gem Lake	0.02	T*	T*	-	-
Henrys Lake	0.39	0.16	0.06	0.36	0.08
Island Park Reservoir	0.41	0.37	0.16	0.42	0.22
Jim Moore Pond	0.11	T*	T*	-	-
Mackay Reservoir	0.21	0.06	0.03	0.46	0.04
Palisades Reservoir	0.24	0.13	0.06	0.49	0.09
Ririe Reservoir	0.14	0.09	0.05	0.53	0.07

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

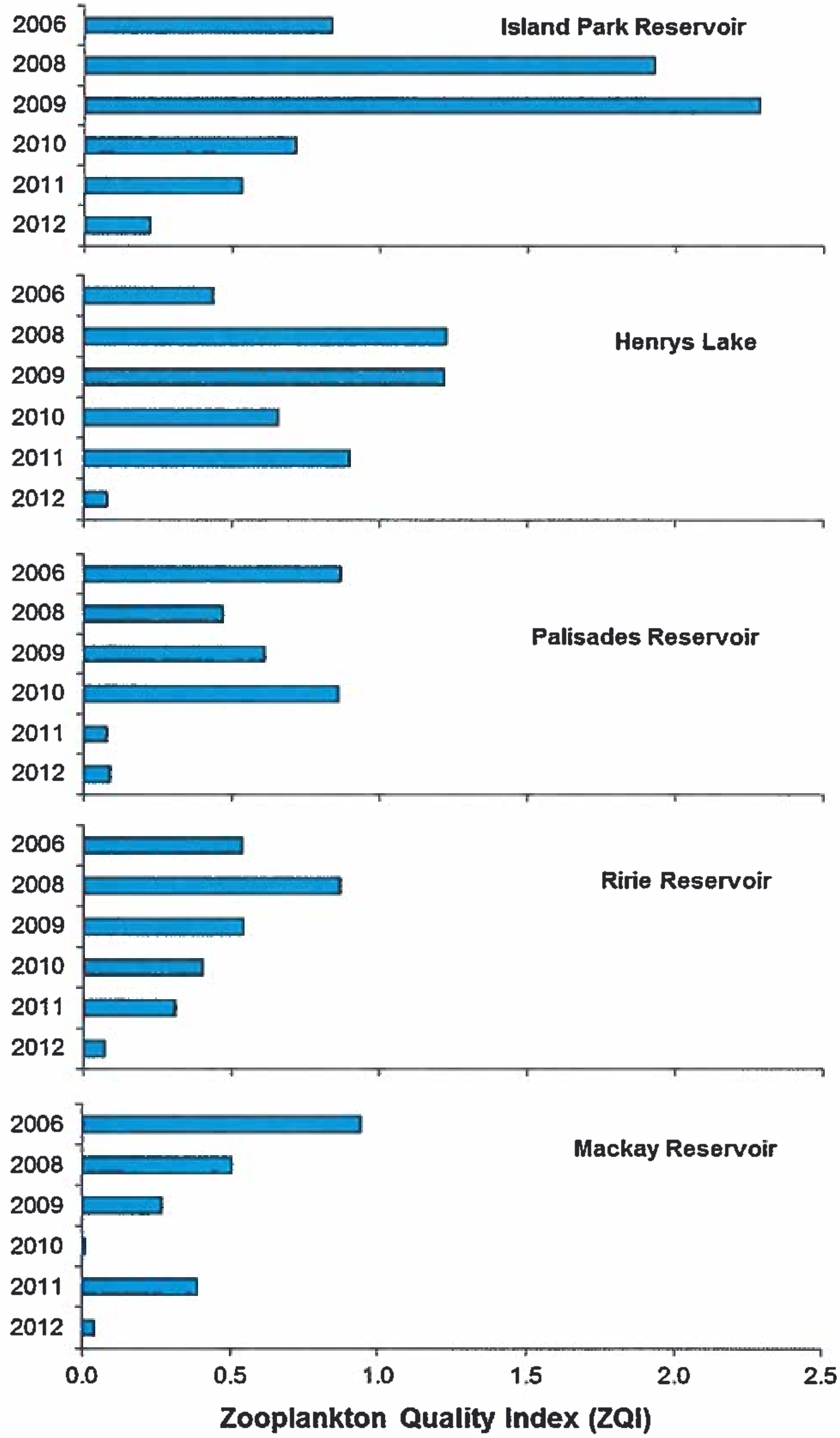


Figure 33. Zooplankton quality index (ZQI) values for lakes and reservoirs in the Upper Snake Region, from 2006 - 2012.

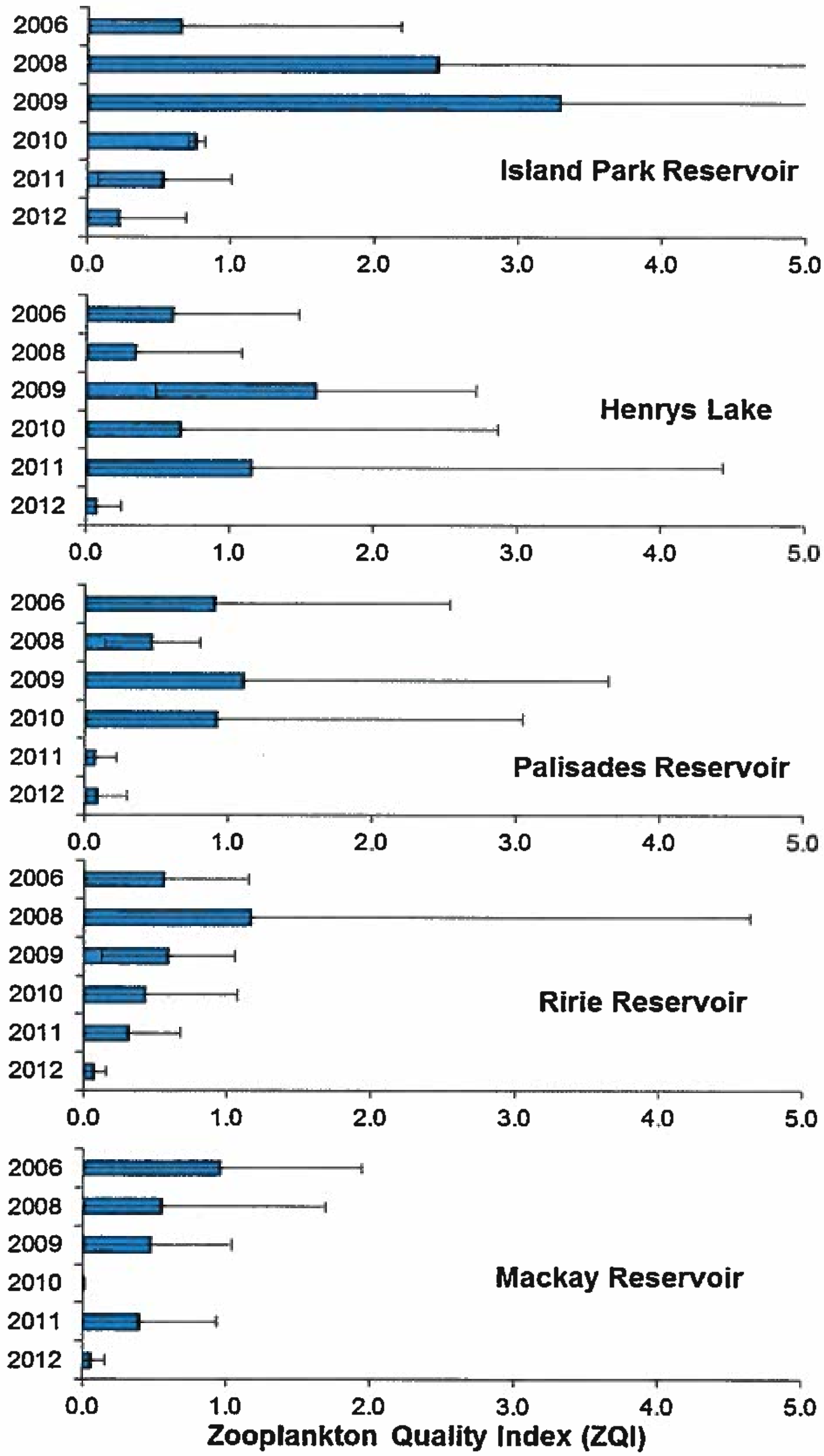


Figure 34. Zooplankton quality index (ZQI) values, with 95% confidence intervals, for lakes and reservoirs in the Upper Snake Region, from 2006 - 2012.

2012 Upper Snake Region Annual Fisheries Management Report

RIVERS AND STREAMS

Henrys Fork

ABSTRACT

We used boat mounted electrofishing equipment to assess fish populations in the Box Canyon, Vernon, and Chester reaches of the Henrys Fork Snake River during 2012. In Box Canyon, we estimated Rainbow Trout density at 1,869 fish/km. The 2012 Rainbow Trout estimate was not significantly different than the average density (1,829 trout/km) observed over the last 17 years. Size indices (proportional stock density [PSD] and relative stock density [RSD-400]) indicate that the population is well balanced (57 and 22, 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.

In the Vernon reach, we estimated 550 trout per km (79% Rainbow Trout, 19% Brown Trout), and 903 Mountain Whitefish per km. Trout populations have remained relatively stable since 2005, while whitefish have shown an increase from 2006. Similar to previous surveys, the Vernon reach is dominated by adult fish (Rainbow Trout: PSD = 89, RSD-400 = 72; Brown Trout: PSD = 93, RSD-400 = 78), with very few juveniles detected in our sampling.

In the Chester reach, we estimated 523 trout per km (80% Rainbow Trout, 20% Brown Trout), and 1,106 Mountain Whitefish per km. Similar to the Vernon reach, trout populations in the Chester reach have remained relatively stable and continue to be dominated by adult fish (Rainbow Trout: PSD = 86, RSD-400 = 60; Brown Trout: PSD = 82, RSD-400 = 62).

Authors:

Greg Schoby
Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manager

INTRODUCTION

The Henrys Fork Snake River attracts anglers from throughout the nation. An economic survey conducted in 2003 showed that Fremont County, which encompasses a large portion 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. Downstream of the Harriman Ranch, the Henrys Fork flows over Mesa Falls and is joined by the Warm River, before it is impounded by Ashton Dam. Brown Trout are present in the Henrys Fork downstream of Mesa Falls, and increase in numbers in downstream reaches, eventually dominating the species composition in and around the town of St. Anthony.

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 among interested parties 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 2012, we sampled the Box Canyon, Vernon, and Chester reaches of the Henrys Fork Snake River (Figure 35). 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 Vernon reach started at the Vernon boat ramp and continued downstream 4.4 km to the Chester backwaters. The Chester reach started just below Chester Dam and extended downstream 5.7 km to the backwaters above the Fun Farm Bridge. Coordinates for all mark-recapture transect boundaries are presented in Appendix E.

OBJECTIVES

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

2. Estimate abundance and size structure of the wild trout population in the Box Canyon, and the wild trout and Mountain Whitefish populations in the Vernon and Chester reaches of the Henrys Fork Snake River.

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

METHODS

During 2012, we sampled all survey reaches using three electrofishing boats (two rafts, one drift boat). In the Box Canyon reach, we marked fish on May 9, and recaptured fish on May 16. Two passes per boat were made on each marking and recapture day for a total of six passes per day for both marking and recaptures. In the Vernon and Chester reaches, we marked fish on May 7 and May 8, and recaptured fish on May 14 and May 15. One pass was completed in each reach by all three boats on each marking and recapture day for a total of 12 passes (six marking, six 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. Additionally, we collected, measured, and marked all Mountain Whitefish greater than 200 mm in the Vernon and Chester reaches to estimate their abundance. 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 Fisheries Analysis+ software (FA+; Montana Fish, Wildlife, and Parks 2004). 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).

We also evaluated the effectiveness of winter flows by using linear regression to examine the relationship between age-2 Rainbow Trout abundance and mean winter (November 30 – 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 2012 sampling based on mean winter stream flows observed during 2011 (December 2010 - February 2011). To validate this relationship, we determined age-2 Rainbow Trout abundance during the 2012 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 2012 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.

RESULTS

Box Canyon

We collected 2,023 trout during four days of electrofishing in the Box Canyon. Species composition of trout collected was 99% Rainbow Trout and 1% Brook Trout. Rainbow Trout ranged in size from 77 mm to 560 mm, with a mean and median total length of 302 mm and 291 mm, respectively (Figure 36; Appendix F). Rainbow Trout PSD and RSD-400 were 57 and 22, respectively (Table12). We used the Log-likelihood Method (LLM) to estimate 6,915 Rainbow Trout >150 mm (95% CI = 6,339 – 7,491, cv = 0.04, Table 13, Appendix G) in the reach, which equates to 1,869 fish per km (Figure 37). 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 13% (Appendix G).

The regression model between winter flow (December-February) estimated an abundance of 2,929 age-2 Rainbow Trout in the 2012 survey based on winter flows that averaged 334 cfs. Based on the length-based estimates of abundance our Log Likelihood model calculates, we estimated age-2 Rainbow Trout abundance at 3,093 fish in the Box Canyon during 2011 (Figure 38). This regression model accurately estimates the relative year class strength of Rainbow Trout using mean winter stream flow (r^2=0.51, F(1,14)=14.4, p=0.0019) and is a useful tool to evaluate the effects of variable winter flows.

Vernon

We collected 774 trout and 710 Mountain Whitefish during four days of electrofishing in the Vernon reach of the Henrys Fork. Species composition of trout collected was 79% Rainbow Trout, 19% Brown Trout, 1% Brook Trout, and <1% Yellowstone Cutthroat Trout. Rainbow Trout ranged between 78 mm and 625 mm (Figure 39), with a mean and median total length of 312 mm and 364 mm, respectively (Table 12). Rainbow Trout PSD, RSD-400, and RSD-500 values were 89, 72, and 21, respectively. We estimated 2,117 Rainbow Trout >150 mm for the reach (95% CI = 1,747 – 2,487; cv = 0.09), which equates to 481 Rainbow Trout per km (Table 13). Our efficiency rate (unadjusted for size selectivity) was 10%. Brown Trout ranged between 107 mm and 603 mm (Figure 39), with a mean and median total length of 391 mm and 442 mm, respectively (Table 12). Brown Trout PSD, RSD-400, and RSD-500 values of 93, 78, and 30, respectively. We estimated 305 Brown Trout >150 mm for the reach (95% CI = 197 – 413; cv = 0.18), which equates to 69 Brown Trout per km (Table 13; Figure 40). Our efficiency rate (unadjusted for size selectivity) for Brown Trout was 20%. Mountain Whitefish ranged from 110 to 549 mm (Figure 39), with a mean and median total length of 385 and 390 mm. We estimated 3,971 Mountain Whitefish >200 mm for the entire reach (95% CI = 2,900 – 5,042; cv = 0.14), which equates to 903 Mountain Whitefish per km (Table 13; Figure 40).

Chester

We collected 823 trout and 769 Mountain Whitefish during four days of electrofishing in the Chester reach of the Henrys Fork. Species composition of trout collected was 79% Rainbow Trout, 20% Brown Trout, <1% Brook Trout, and <1% Yellowstone Cutthroat Trout. Rainbow Trout ranged between 102 mm and 570 mm (Figure 41), with a mean and median total length of 383 mm and 400 mm, respectively (Table 12). Rainbow Trout PSD, RSD-400, and RSD-500 values were 86, 60, and 5, respectively. We estimated 2,626 Rainbow Trout >150 mm for the reach (95% CI = 2,279 – 2,973; cv = 0.07), which equates to 461 Rainbow Trout per km (Table 13; Figure 42). Our efficiency rate (unadjusted for size selectivity) was 10%. Brown Trout ranged between 110 mm and 564 mm (Figure 41), with a mean and median total length of 368 mm and 402 mm, respectively (Table 12). Brown Trout PSD, RSD-400, and RSD-500 values of 82, 62, and 17, respectively. We estimated 356 Brown Trout >150 mm for the reach (95% CI = 273 – 439; cv = 0.12), which equates to 62 Brown Trout per km (Table 13; Figure 42). Our efficiency rate (unadjusted for size selectivity) for Brown Trout was 24%. Mountain Whitefish ranged between 114 mm and 530 mm (Figure 41), with a mean and median total length of 391 mm and 407 mm, respectively. We estimated 6,303 Mountain Whitefish >200 mm for the entire reach (95% CI = 4,600 – 8,006; cv = 0.14), which equates to 1,106 Mountain Whitefish per km (Table 13; Figure 42).

DISCUSSION

Estimates of Rainbow Trout abundance in 2012 in the Box Canyon did not differ from 2011 or the long term average. The PSD and RSD values indicate that the population is well balanced, and is consistent with what we expect to see based on recent winter flows. PSD and average size were lower than 2011, likely the result of a large portion of the Rainbow Trout being age-2 fish. 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. 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 (3,093) in 2012 was nearly identical to that predicted (2,929) from our regression model that incorporated flows during the winter of 2011 which would have affected age-2 fish in the 2012 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.

The trout population in the Vernon reach of the Henrys Fork is similar to the last estimate conducted in 2009, but marked the first year in which we were able to conduct separate log-likelihood estimates of rainbow and Brown Trout abundance. Previous estimates were limited by the number of Brown Trout marked and recaptured, and required log-likelihood estimates of both species combined and followed partitioning based on percent species composition. The increase in the number of Brown Trout handled may be an indication of an increase in this population, although it should be noted that we used somewhat different methods than past surveys of the Vernon reach, which may have increased our Brown Trout catch. During 2012, we adopted similar survey methods (utilizing three electrofishing boats/rafts) to those that we have used in the Box Canyon the past three years, which may have contributed to the increased Brown Trout catch. However, we did not observe an increase in the overall number or capture efficiency of Rainbow Trout utilizing these new methods, which indicates that Brown Trout in this reach may be increasing. Similar to previous years, the Vernon reach continues to support, on average, some of the largest trout in any reach of the Henrys Fork, with a large portion of the population exceeding 500 mm (Appendix H). Mountain Whitefish in this reach have increased in abundance from levels seen in 2002 and 2006, but we were unable to detect differences from our most recent estimate in 2007.

In the Chester reach of the Henrys Fork, trout and whitefish populations were similar to previous years. Like the Vernon reach, the average size of trout in the Chester reach remains large, with a significant portion of the population in excess of 500 mm (Appendix I). Previous surveys of both the Vernon and Chester reach have documented similar characteristics of these populations and expressed concerns of limited recruitment (Garren et al. 2006). The trend of large trout dominating both of these river reaches and the apparent lack of juvenile fish has been observed in all surveys, but with 4-5 surveys conducted over the past decade, we have failed to observe a reduction in adult abundance. Densities within these reaches of the Henrys Fork have remained stable throughout our sampling efforts, indicating that recruitment is not limited, but likely is occurring in areas outside of these reaches. Future research should focus on identifying these areas so that appropriate protective measures can be implemented as needed.

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-0 trout survival.

3. Work to identify where reproduction and recruitment occur in the Vernon and Chester reaches.

4. Work to identify what factors govern population abundances in the lower river.

5. Assess impacts to fish populations below Ashton Dam that may have occurred as a result of the repair work to Ashton Dam.

6. 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.

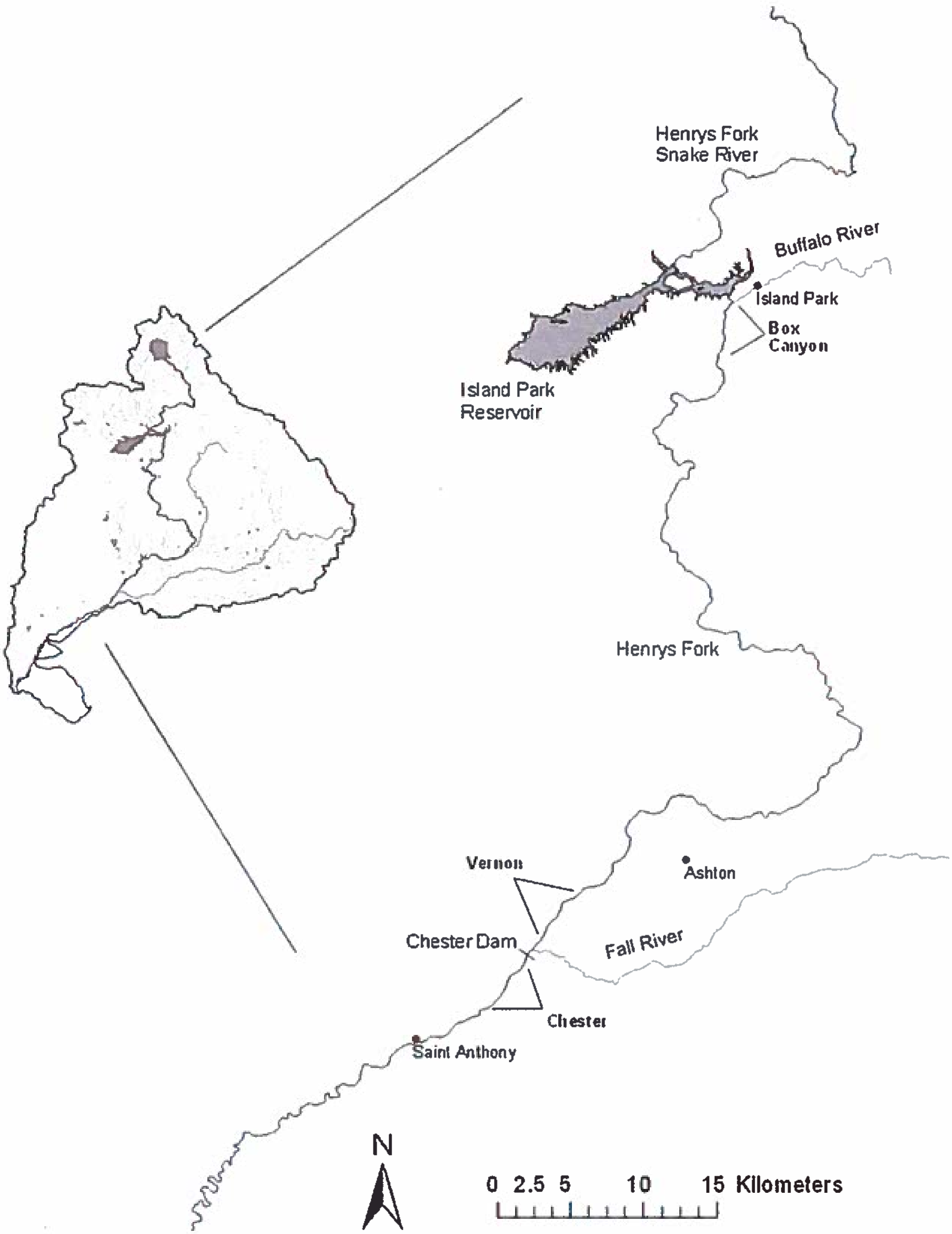


Figure 35. Map of the Henrys Fork Snake River watershed and electrofishing sample sites (Box Canyon, Vernon, and Chester) during 2012.

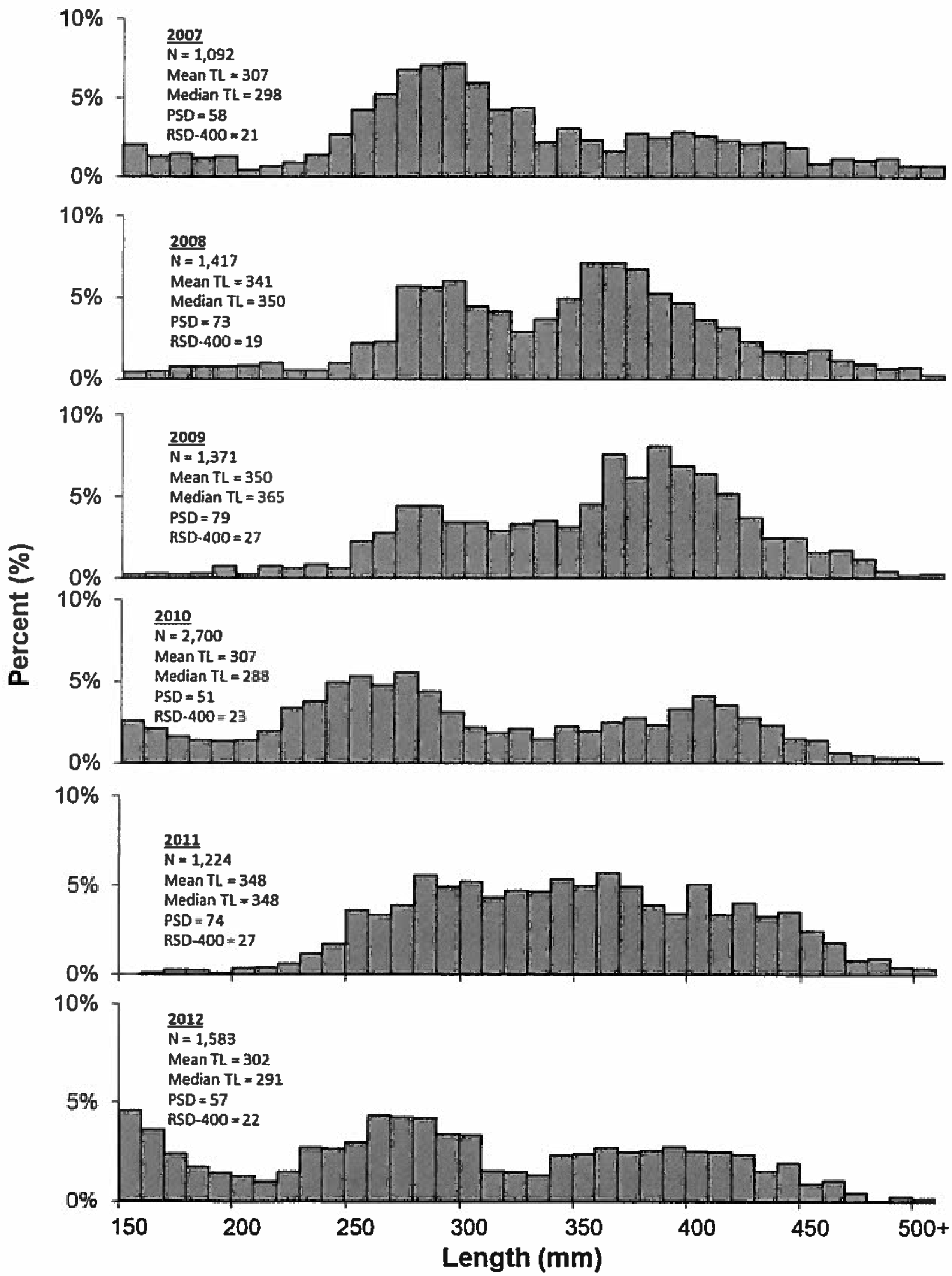


Figure 36. Length frequency distribution and total length statistics of Rainbow Trout collected by electrofishing in the Box Canyon reach of the Henrys Fork Snake River, Idaho, 2007 - 2012.

Table 12. Trout population index summaries for the Henrys Fork Snake River, Idaho 2012.

River Reach	Mean Length (mm)	Median Length (mm)	PSD	RSD-400	RSD-500	Density (No./km)	Percent Species Composition
Box Canyon							
Rainbow Trout	302	291	57	22	1	1,869	98.6[a]
Vernon							
Rainbow Trout	408	429	89	72	21	481	79.1[b]
Brown Trout	391	442	93	78	30	69	19.4
Chester							
Rainbow Trout	383	400	86	60	5	461	79.2[c]
Brown Trout	368	402	82	62	17	62	20.2

[a] = Brook Trout represented 1.4% of the trout composition

[b] = Brook Trout and Yellowstone Cutthroat Trout represented 0.9% and 0.6% of the trout composition, respectively.

[c] = Brook Trout and Yellowstone Cutthroat Trout represented 0.4% and 0.1% of the trout composition, respectively.

Table 13. Trout and whitefish population estimate summary from the Henrys Fork Snake River, Idaho during 2012. (RBT = Rainbow Trout, BNT = Brown Trout, MWF = Mountain Whitefish).

River reach	No. marked	No. captured	No. recaptured	Population Estimate	Confidence Interval (+/- 95%)	Density (No./ km)	Discharge (cfs)[a]
Box Canyon							
-RBT	793	901	116	6,915	6,339 - 7,491	1,869	911[b]
Vernon							2,480[c]
-RBT	205	235	23	2,117	1,747 – 2,487	481	
-BNT	47	69	14	305	197 – 413	69	
-MWF	232	218	15	3,971	2,900 – 5,042	903	
Chester							2,480[c]
-RBT	250	365	36	2,626	2,279 – 2,973	461	
-BNT	69	104	25	356	273 – 439	62	
-MWF	265	344	15	6,304	4,601 – 8,007	1,106	

[a] Represents the mean discharge value between marking and recapture events.

[b] Data obtained from USGS gauge (13042500) near Island Park Dam.

[c] Data obtained from USGS gauge (13046000) below Ashton Dam.

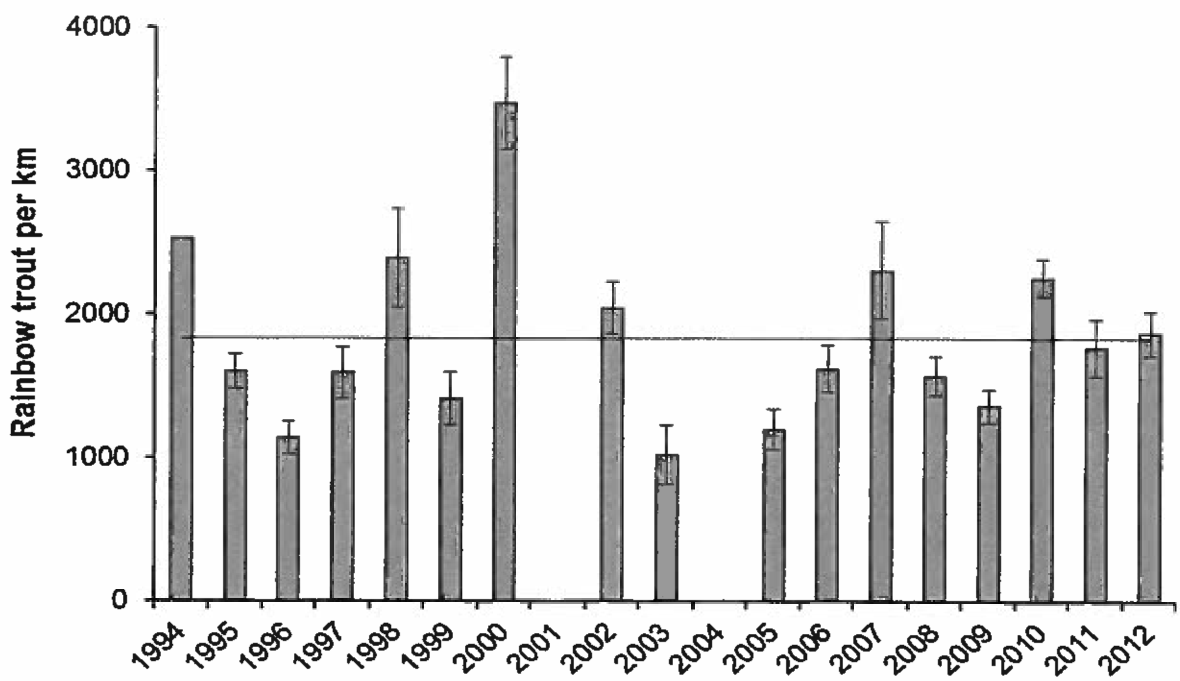


Figure 37. Rainbow Trout population estimates for the Box Canyon reach of the Henrys Fork Snake River, Idaho 1994 - 2012. Error bars represent 95% confidence intervals. The solid line represents the long-term average Rainbow Trout density, not including the current years' survey.

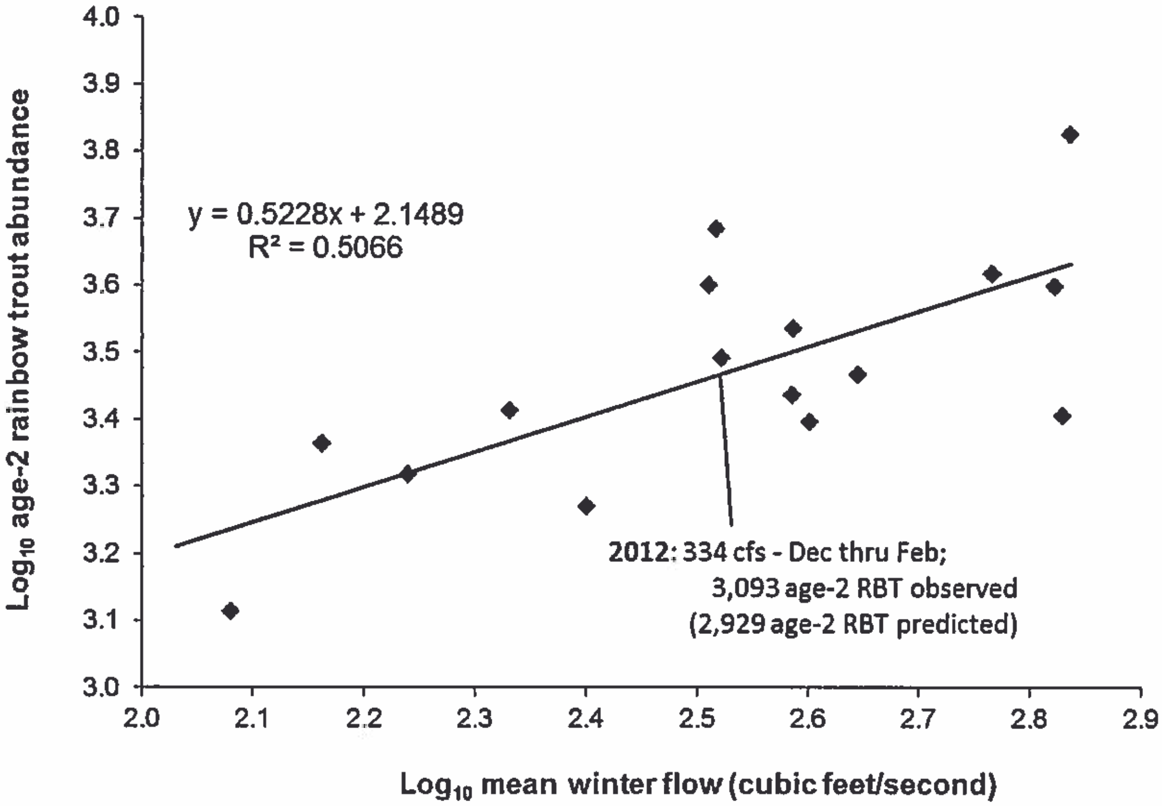


Figure 38. The relationship between age-2 Rainbow Trout abundance and mean winter flow (cfs) during the first winter of a fish's life from 1995 – 2012 in the Box Canyon reach of the Henrys Fork Snake River; $\log_{10}$ age-2 trout abundance = 0.5228 $\log_{10}$ flow (cfs) + 2.1489, (r^2=0.51, F(1,14)=14.4, p=0.0019).

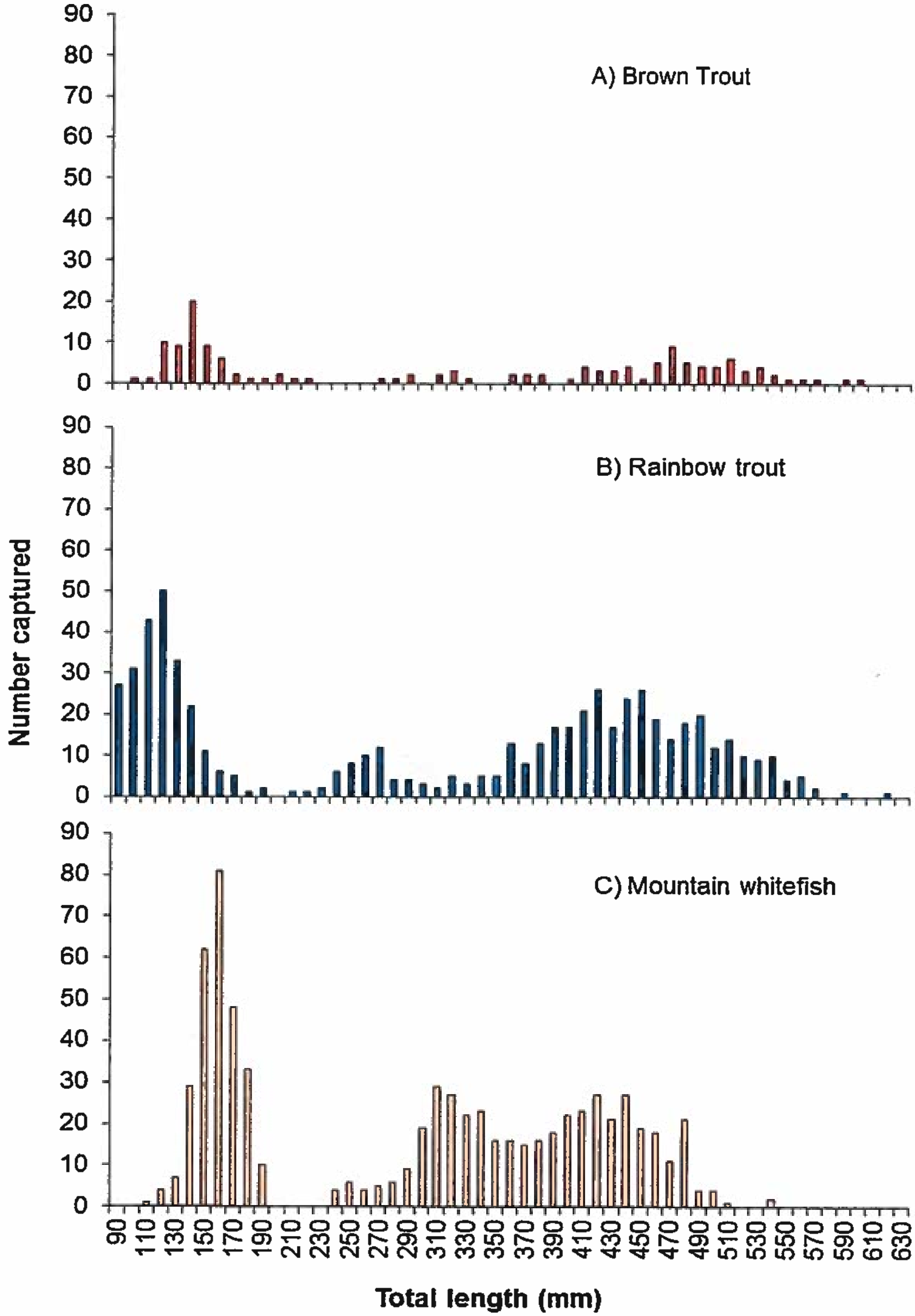


Figure 39. Length frequency of A) Brown Trout, B) Rainbow Trout, and C) Mountain Whitefish captured by electrofishing in the Vernon reach of the Henrys Fork Snake River, 2012.

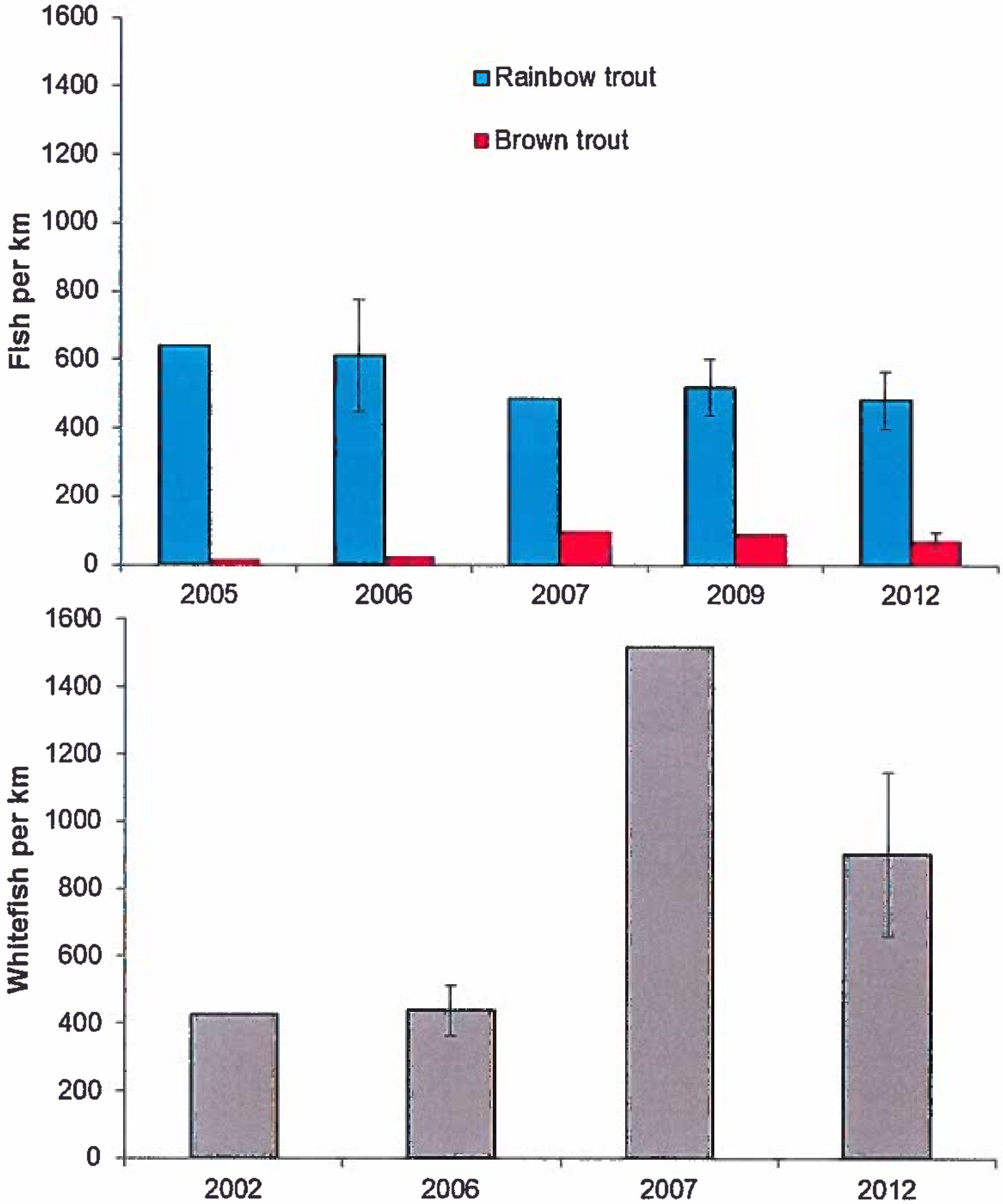


Figure 40. Trout (rainbow and brown) and Mountain Whitefish estimates (fish per km) in the Vernon reach of the Henrys Fork Snake River, 2002-2012. Error bars represent 95% confidence intervals. Low numbers of recaptures in some years prohibited calculation by the log-likelihood method, therefore the modified Peterson estimate is presented without error bars.

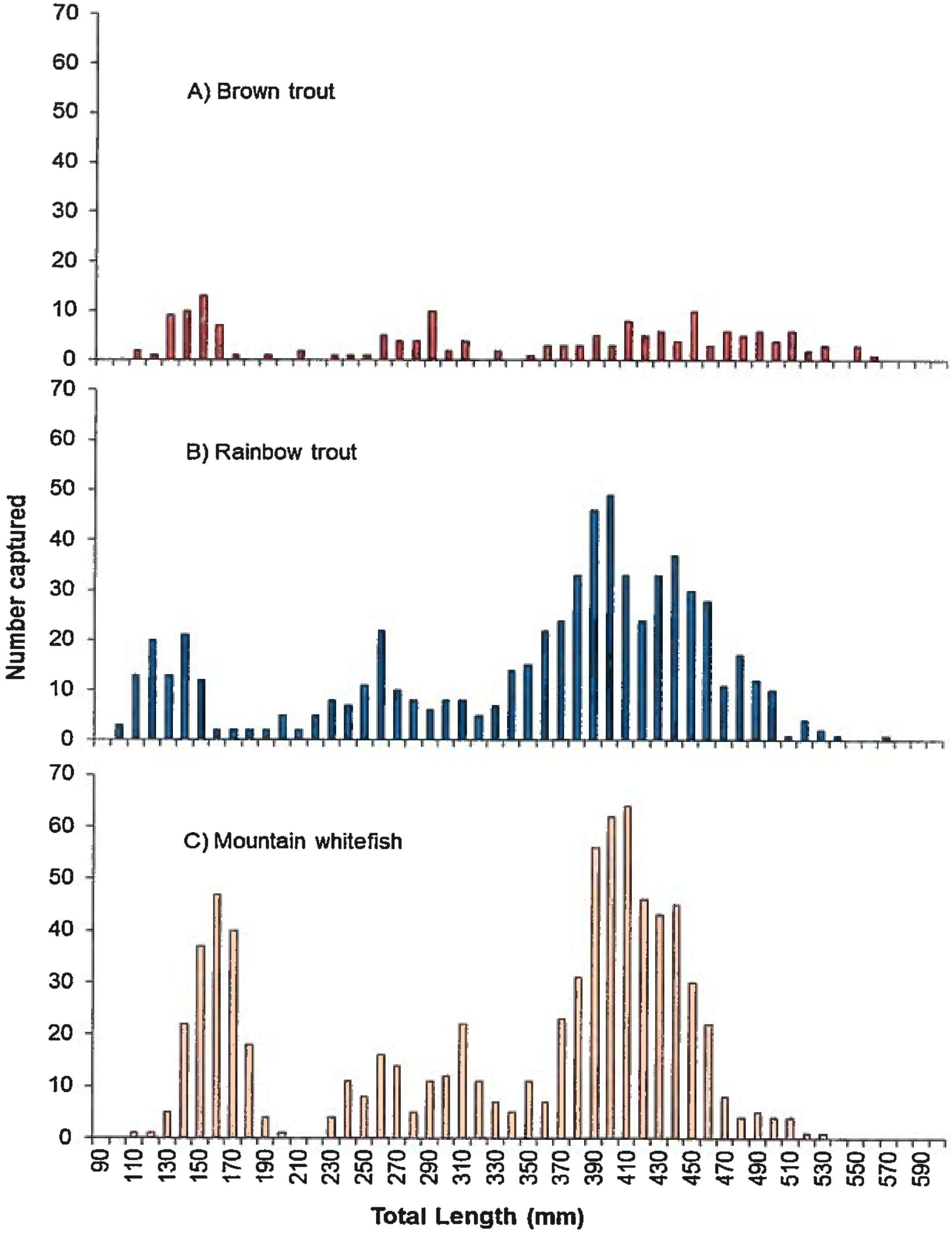


Figure 41. Length frequency of A) Brown Trout, B) Rainbow Trout, and C) Mountain Whitefish captured by electrofishing in the Chester reach of the Henrys Fork Snake River, 2012.

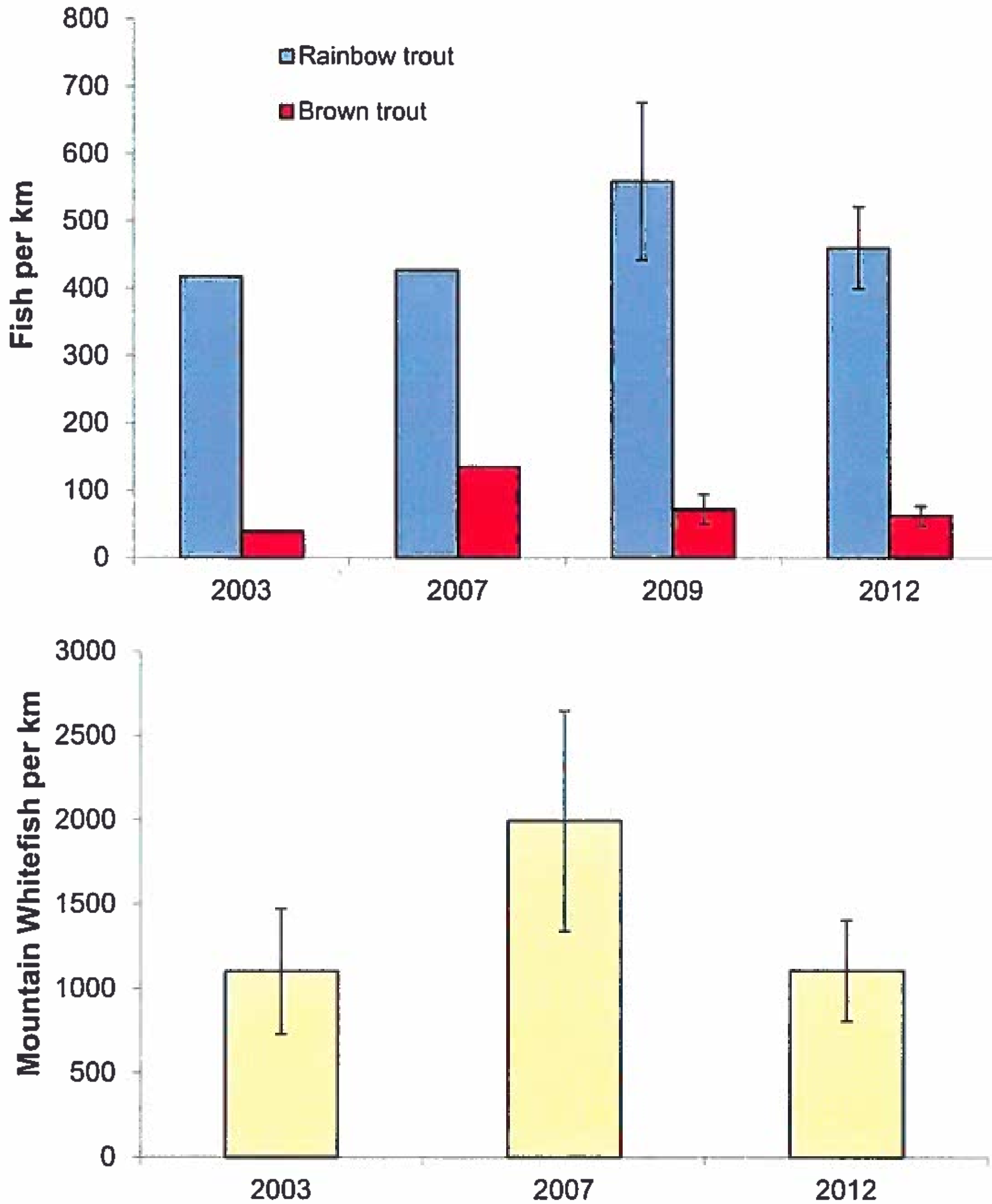


Figure 42. Rainbow Trout, Brown Trout, and Mountain Whitefish estimates (fish per km) for the Chester reach of the Henrys Fork Snake River, 2003-2012. Error bars represent 95% confidence intervals. Low numbers of recaptures in some years prohibited calculation by the log-likelihood method, therefore the modified Peterson estimate is presented without error bars.

Appendix E. Locations used in population surveys on the Henrys Fork Snake River, Idaho 2012. All locations used NAD27 and are in Zone 12.

	Start		Stop	
Reach	Easting	Northing	Easting	Northing
Box Canyon	468677	4917703	467701	4914352
Vernon	457092	4878151	454184	4875043
Chester	453182	4873986	451042	4871020

Appendix F. 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 electrofishing reach, Henrys Fork Snake River, Idaho, 1991-2012. 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
2012	1,583	302	77 – 560	57	22	1

Appendix G. 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, 1995-2012. 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
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

Appendix G. Cont.

Year	M[a]	C[a]	R[a]	R/C (%)	CV	N/reach MPM	N/reach LLM	N/km LLM	Discharge (cfs)
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
2012	793	901	116	13	0.04	6,120 (5,178-7,313)	6,915 (6,339-7,491)	1,869 (1,713-2,025)	911

[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 H. Mean total length, length range, proportional stock density (PSD), and relative stock density (RSD-400 and RSD-500) of Rainbow Trout and Brown Trout captured in the Vernon electrofishing reach, Henrys Fork Snake River, Idaho, 2005-2012. RSD-400 = (number ≥400 mm/ number ≥200 mm) x 100. RSD-500 = (number ≥500 mm/ number ≥200 mm) x 100.

Rainbow Trout						
Year	Number	Mean TL (mm)	Length Range (mm)	PSD	RSD-400	RSD-500
2005	770	391	83 – 593	94	79	10
2006	464	359	89 - 562	81	70	14
2007	273	280	90 – 559	79	50	9
2009	401	387	110 – 615	87	66	15
2012	623	408	78 – 625	89	72	21

Brown Trout						
Year	Number	Mean TL (mm)	Length Range (mm)	PSD	RSD-400	RSD-500
2005	33	388	160 – 561	96	72	40
2006	25	356	140 - 597	100	69	38
2007	42	295	140 – 505	96	23	4
2009	73	411	145 – 591	98	73	12
2012	143	391	107 – 603	93	78	30

Appendix I. 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 trout (≥150 mm), and mean stream discharge (cfs) during the sample period for the Vernon reach, Henrys Fork Snake River, Idaho, 2005-2012. Confidence intervals (±95%) for population estimates are in parentheses.

Rainbow Trout									
Year	M[a]	C[a]	R[a]	R/C (%)	CV	N/reach MPM	N/reach LLM	N/km LLM	Discharge (cfs)
2005	386	385	84	22	0.08	1,756 (1,461-2,148)	2,725 (2,323-3,127)	640 (549-731)	2,119
2006	236	185	20	11	0.14	2,098 (1,422-3,276)	2,689 (1,964-3,414)	611 (446-,776)	4,231
2007	108	98	4	4	--	2,157 (987-5,136)	NA	NA	1,726
2009	257	148	26	18	0.09	1,423 (1,024-2,080)	1,976 (1,612-2,340)	520 (437-603)	3,073
2012	205	235	23	10	0.09	2,025 (1,402-3,072)	2,117 (1,747-2,487)	481 (397-565)	2,501

Brown Trout									
Year	M[a]	C[a]	R[a]	R/C (%)	CV	N/reach MPM	N/reach LLM	N/km LLM	Discharge (cfs)
2005	14	15	4	27	0.35	47 (25-110)	2,818 (3,922-4,938)	640 (1,060-1,334)	2,119
2006	7	15	1	7	0.55	63 (21-124)	NA	NA	4,231
2007	22	18	1	6	0.55	218 (73-425)	NA	NA	1,726
2009	51	22	2	9	0.47	398 (160-959)	NA	NA	3,073
2012	47	69	14	20	0.18	223 (146-373)	305 (197-413)	69 (44-94)	2,501

[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 J. Mean total length, length range, proportional stock density (PSD), and relative stock density (RSD-400 and RSD-500) of Rainbow Trout and Brown Trout captured in the Chester electrofishing reach, Henrys Fork Snake River, Idaho, 2003-2012. RSD-400 = (number ≥400 mm/ number ≥200 mm) x 100. RSD-500 = (number ≥500 mm/ number ≥200 mm) x 100.

Rainbow Trout						
Year	Number	Mean TL (mm)	Length Range (mm)	PSD	RSD-400	RSD-500
2003	332	365	110 – 500	86	63	0
2007	433	322	90 – 542	76	40	1
2009	458	399	120 – 530	95	60	2
2012	648	383	102 – 570	86	60	5

Brown Trout						
Year	Number	Mean TL (mm)	Length Range (mm)	PSD	RSD-400	RSD-500
2003	45	418	148 – 580	98	71	29
2007	118	317	130 – 575	91	43	12
2009	133	428	135 – 590	100	76	8
2012	170	368	110 – 564	82	62	17

Appendix K. 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 Chester reach, Henrys Fork Snake River, Idaho, 2003-2012. Confidence intervals (±95%) for population estimates are in parentheses.

Rainbow Trout									
Year	M[a]	C[a]	R[a]	R/C (%)	CV	N/reach MPM	N/reach LLM	N/km LLM	Discharge (cfs)
2003	80	225	7	3	0.21	2,216 (1,168-4,624)	2,555 (1,512-3,598)	448 (265-631)	1,406
2007	195	201	9	4	0.23	3,958 (2,231-7,678)	5,973 (3,313-8,633)	1,048 (581-1,515)	1,703
2009	233	244	27	11	0.10	2,047 (1,458-3,000)	3,539 (2,822-4,256)	621 (495-747)	3,006
2012	250	365	36	10	0.07	2,482 (1,841-3,457)	2,626 (2,279-2,973)	461 (400-522)	2,501

Brown Trout									
Year	M[a]	C[a]	R[a]	R/C (%)	CV	N/reach MPM	N/reach LLM	N/km LLM	Discharge (cfs)
2003	12	16	3	19	0.40	54 (26-133)	NA	NA	1,406
2007	47	79	12	15	0.14	294 (184-518)	256 (188-324)	45 (33-57)	1,703
2009	66	79	13	18	0.15	382 (243-656)	412 (287-537)	72 (50-94)	3,006
2012	69	104	25	24	0.12	282 (205-411)	356 (273-439)	62 (47-77)	2,501

[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.

Big Lost River

ABSTRACT

We conducted electrofishing surveys in 25 reaches of the Big Lost River drainage to estimate population densities, compare changes in densities to past surveys, evaluate species composition and to obtain relative abundance data for Mountain Whitefish and trout populations. Overall abundance of trout in the Upper Big Lost River is similar to or better than that documented in surveys in the 1980's. However, in all areas with few exceptions, trout abundances have generally decreased over densities found in our most recent 2007 survey. Mountain Whitefish populations in the Big Lost River have shown an increase in abundance compared to population sampling conducted from 2002-2005, but in most instances, abundance remains below highs documented in the 1980's. Yellowstone Cutthroat Trout, which were first stocked in 2000, appear to have developed naturally-reproducing populations, as evidence by young cutthroat and Hybrid Trout.

Authors:

Greg Schoby

Regional Fisheries Biologist

Dan Garren

Regional Fisheries Manager

STUDY SITE

A thorough description of the Big Lost River drainage can be found in the 2007 Idaho Fish and Game Annual Fisheries Management Report, Upper Snake Region (Garren, 2010).

OBJECTIVES

1. To obtain current information on fish population characteristics in the Big Lost River and its tributaries and to develop appropriate management recommendations.

2. Estimate abundance distribution and size structure of the trout and Mountain Whitefish populations in the Big Lost River drainage.

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

METHODS

We conducted mark-recapture population estimates of all trout and Mountain Whitefish present in all main stem Big Lost River sample sites. We used a canoe electrofishing set up (see Garren, 2010) with pulsed DC current to sample the Campground and Blaine diversion reaches in the Big Lost River below Mackay Reservoir during April 2012. We marked fish at these sites on April 17, followed by a recapture electrofishing event on April 18. Due to increased flows from Mackay Reservoir, we were unable to sample two of the four monitoring sites we normally sample below Mackay Dam. We sampled the Bartlett Point site with two electrofishing rafts, marking fish on August 29 and recapturing fish on August 30. All trout and whitefish encountered were collected, identified, and measured for total length. Similar to the sites downstream of Mackay Dam, all trout greater than 150 mm and all whitefish greater than 200 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. We estimated densities for all trout > 150 mm using the Log-likelihood method in Fisheries Analysis+ software (FA+; Montana Fish, Wildlife, and Parks 2004).

In the upper Big Lost River tributaries, we primarily used backpack electrofishing units to sample most sites (18) but also used a canoe electrofishing set up to sample four of the larger tributaries (North Fork (two sites), East Fork (two sites)). We repeated sample reaches from past years where possible. Where this was not possible, we selected sites to capture spatial and/or major landscape impacts such as major tributaries, etc. Reach lengths were between 100 and 300 m, and incorporated a riffle or other barrier at the beginning and end of each section. Two to three passes were made with the electrofishers, with density estimates obtained from depletions. Density estimates (fish per 100 m^2) were calculated and compared to past years data.

RESULTS

Blaine diversion

We collected 626 fish in the Blaine diversion reach of the Big Lost River. Species composition was 48% Brook Trout, 31% Rainbow Trout, and 21% Mountain Whitefish. Brook Trout ranged from 88 to 348 mm (Figure 43a), while Rainbow Trout ranged from 90 to 540 mm (Figure 43b). Mountain Whitefish ranged from 126 to 411 mm (Figure 43c). In the Blaine diversion reach, we estimated 333 Brook Trout >150 mm (mean TL: 200 mm), which equates to 447 Brook Trout per km (95% CI: 274 – 392; cv = 0.18, Table 14). We estimated a total of 251 Rainbow Trout >150 mm (mean TL: 342 mm) in the Blaine diversion reach (337 per km; 95% CI: 227 - 275; cv = 0.10; Table 15) and 344 Mountain Whitefish >200 mm (mean TL: 293 mm; 462 per km; 95% CI: 194 – 494; cv = 0.44; Table 16).

Campground

We collected 1,022 fish in the campground reach of the Big Lost River. Species composition was 96% Rainbow Trout, 3% Mountain Whitefish, <1% Brook Trout, and <1% Yellowstone Cutthroat Trout. Rainbow Trout ranged from 70 to 465 mm (Figure 44a), while whitefish ranged from 375 to 445 mm, and Brook Trout ranged from 134 to 300 mm (Figure 44b). We estimated 2,207 Rainbow Trout >150 mm (mean TL: 342 mm; 2,855 per km, 95% CI: 2,082 – 2,332; cv = 0.06), and 42 Mountain Whitefish >200 mm (mean TL: 405 mm; 58 per km, 95% CI: 27 – 82; cv = 0.25) in the campground reach (Table 14).

Big Lost River at Bartlett Point

We collected 421 fish in the Bartlett Point reach of the Big Lost River. Species composition was 52% Mountain Whitefish, 27% Rainbow Trout, 20% Yellowstone Cutthroat Trout, and <1% Brook Trout. Seven percent of the total species abundance was comprised of hybrid (rainbow x cutthroat) trout, which were included with Rainbow Trout in the overall species composition, as well as the population estimate and length-frequency distribution. Mountain Whitefish ranged from 87 to 436 mm (Figure 45a), while Rainbow Trout ranged from 105 to 468 mm (Figure 45b), and Yellowstone Cutthroat Trout ranged from 117 to 468 mm (Figure 45c). We estimated 446 Mountain Whitefish >200 mm (mean TL: 348 mm; 138 per km, 95% CI: 395 – 497; cv = 0.11), 219 Rainbow Trout >150 mm (mean TL: 322 mm; 68 per km, 95% CI: 190 – 248; cv = 0.13), and 157 Yellowstone Cutthroat Trout (mean TL: 350 mm; 49 per km, 95% CI: 130 – 184; cv = 0.17).

Lower North Fork (Mouth to Summit Creek Section)

We collected 15 salmonids during two depletion runs in the lower North Fork of the Big Lost River. Species composition was 40% Rainbow Trout, 27% Mountain Whitefish, 20% cutthroat and 13% Brook Trout. We estimated salmonid densities in the lower North Fork at 0.5 fish per 100 m^2, which is down from 2007 at 3.7 fish per 100 m^2. However, the density of trout greater than 150 mm is the same for 2007 and 2012 (0.39 fish per 100 m^2). Rainbow Trout ranged in size from 100 mm to 446 mm with 17% juvenile fish (<150 mm). Brook Trout ranged from 120 mm to 145 mm and Yellowstone Cutthroat Trout ranged from 295 mm to 335 mm.

Density of Mountain Whitefish >200 mm was estimated at 0.13 fish per 100 m^2. Mountain Whitefish ranged from 245 mm to 375 mm; Mountain Whitefish were not observed in 2007.

Middle North Fork (Bartlett Cr to Grasshopper Cr)

We collected 48 trout in two electrofishing depletion passes on the middle reach of the North Fork of the Big Lost River. Species composition was 69% Brook Trout, 18% Yellowstone Cutthroat Trout, 8% Hybrid Trout (rainbow x cutthroat), and 2% Rainbow Trout. Trout density estimates were considerably lower at 2.0 fish per 100 m^2 than in 2007 (37.5 fish per 100 m^2), but were similar to 2003 (3.1 fish per 100 m^2). Density of trout > 150 mm was estimated at 0.62 fish per 100 m^2, which is less than both 2007 and 2003 (2.1 and 2.6 fish per 100 m^2, respectively). Brook Trout ranged in size from 61 mm to 278 mm, with 68% being juvenile fish. Yellowstone Cutthroat Trout were not found in previous samples, but were found in low densities in 2012 (0.34 per 100 m^2). Cutthroat Trout ranged from 82 mm to 326 mm; four larger (233 – 326 mm) Cutthroat Trout were identified as hatchery fish, while the presence of five juvenile (82 – 109 mm) Cutthroat Trout indicates that reproduction is occurring. Only one Rainbow Trout (153 mm) was observed, and six trout ranging from 91 mm to 226 mm were identified as hybrids (cutthroat x rainbow), further indicating that reproduction is occurring. No Mountain Whitefish were captured, and sculpin were noted as present.

Upper North Fork

We collected 86 trout in two electrofishing passes on the upper North Fork. As seen in previous surveys, this reach is dominated by Brook Trout (99%), with one cutthroat also being captured. Trout density has increased over both the 2007 and 2003 estimates (4.8 trout per 100 m^2 in 2012, compared to 3.7 and 1.6 in 2007 and 2003, respectively). Despite this increase, the density remained below the 1986 estimate of 27.6 trout per 100 m^2. Brook Trout ranged from 55 to 250 mm, with 63% juvenile fish. One juvenile Cutthroat Trout, measuring 140 mm, was captured. No Mountain Whitefish were captured, and sculpin were present.

Summit Creek (Downstream of Phi Kappa Campground)

We collected 72 trout during two depletion runs on Summit Creek. Species composition was 86% Brook Trout and 14% Rainbow Trout. We estimated 5.7 fish per 100 m^2 in 2012 (Table 17), down from 28.9 fish per 100 m^2 in 2007. Density of trout >150 mm also decreased from 2007 (5.7 fish per 100 m^2, compared to 8.2 fish per 100 m^2 in 2007). Brook Trout ranged from 61 mm to 245 mm, with 73% juvenile fish. Rainbow Trout ranged from 92 mm to 260 mm, with 56% juvenile fish. No Mountain Whitefish were captured, although they have been found here previously. Sculpin were present in this reach.

Kane Creek

We collected 102 trout in two electrofishing passes in Kane Creek. Species composition was 95% Brook Trout, 3% Hybrid Trout, and 2% Rainbow Trout. Trout densities were 7.3 trout per 100 m^2, which was a decrease from 2007 (12.2 fish per 100 m^2) but an increase compared to 2003 (5.1 fish per 100 m^2). Densities of trout greater than 150 mm were about half of that observed in 2007, and were estimated at 2.3 fish per 100 m^2. Brook Trout ranged in size from 40 mm to 240 mm, with 68% juvenile fish. Two Rainbow Trout were captured (80 mm and 210 mm). Three Hybrid Trout (rainbow x cutthroat) were captured, ranging from 135 mm to 220 mm;

no Cutthroat Trout were captured. Similar to 2003 and 2007, no Mountain Whitefish were captured, but sculpin were present.

Wildhorse Creek

We collected 276 salmonids in two separate reaches in the Wildhorse Creek drainage. Overall species composition was 79% Brook Trout, 12% Rainbow Trout, 9% Mountain Whitefish, and <1% Yellowstone Cutthroat Trout. Trout densities showed a decrease from levels recorded in 2007 (4.8 fish per 100 m^2 in 2012 compared to 7.2 fish per 100 m^2 in 2007), but remained above 2003 levels (3.6 fish per 100 m^2). Densities of trout greater than 150 mm were also less than 2007, and were estimated at 1.7 fish per 100 m^2. Brook Trout ranged in size from 34 mm to 227 mm, with 76% juvenile fish. Rainbow Trout ranged in size from 195 mm to 362 mm; no juvenile Rainbow Trout were observed and the majority (86%) of the Rainbow Trout captured were of hatchery origin. The Mountain Whitefish population, estimated at 1.05 fish per 100 m^2, continues to increase in this reach. Overall densities of Mountain Whitefish > 200 mm were estimated at 0.27 fish per 100 m^2, which is an increase in abundance compared to 2007 (0.08 fish per 100 m2), and 2003 when no Mountain Whitefish were found. The majority (96%) of whitefish were found in the lower Wildhorse Creek site.

Fall Creek

We collected 4 salmonids in two electrofishing passes in the Fall Creek reach. Species composition was 50% Brook Trout, 25% Rainbow Trout and 25% Mountain Whitefish. Salmonid densities were down from those recorded in 2007 (0.5 fish per 100 m^2 in 2012, compared to 2.5 fish per 100 m^2 in 2007). Densities of trout greater than 150 mm were also down from 2007 and were estimated at 0.38 fish per 100 m^2. The Brook Trout were 101 mm and 161mm, the Rainbow Trout was 237 mm and the Mountain Whitefish was 180 mm. Rainbow Trout were absent in 2007 but were present in the 2003 and 2012 survey. Similar to 2007, Mountain Whitefish were present in low densities, which were not found in 2003.

Lower East Fork

We collected 146 salmonids in two electrofishing reaches in the lower East Fork (East Fork at Whitworths and at Fox Creek). Overall species composition was 36% Brook Trout, 35% Mountain Whitefish, 16% Yellowstone Cutthroat Trout, and 12% Rainbow Trout. Overall trout abundance was estimated at 1.6 fish per 100 m^2, and has decreased from previous levels (5.2 fish per 100m^2 in 2007). Densities of trout greater than 150 mm have decreased from 3.6 fish per 100 m^2 in 2007, to 0.9 in 2012, while whitefish have remained stable. Densities of Mountain Whitefish in these combined reaches averaged 1.2 fish per 100 m^2, which was similar to 2007 (1.3) and an increase over the 2003 estimate of 0.18. Brook Trout ranged in size from 66 mm to 267 mm, with 38% juvenile fish. Mountain Whitefish ranged in size from 153 mm to 400 mm, with 78% juvenile fish. Yellowstone Cutthroat Trout ranged in size from 83 mm to 280 mm, with 58% juvenile fish. Rainbow Trout ranged in size from 105 mm to 423 mm, with 24% juvenile fish. Two Hybrid Trout were also captured, and sculpin were also present.

Upper East Fork

We collected 124 trout in two electrofishing reaches in the Upper East Fork (East Fork at Burma and East Fork at the Swamps). Overall, we estimated the trout density of both sites combined at 25.8 fish per 100 m^2, which was similar to the past two estimates (31.7 and 24.5 fish per 100 m^2 in 2007 and 2003, respectively). However, densities and composition varied markedly between the two sites; therefore we will present them separately. At the Burma survey site, species composition was 58% hatchery Rainbow Trout, 38% Brook Trout, 8% Rainbow Trout and 3% Yellowstone Cutthroat Trout. Trout density in this reach was 17.6 fish per 100 m^2, with 12.4 fish >150 mm per 100 m^2. Hatchery Rainbow Trout ranged from 187 mm to 295 mm, while wild Rainbow Trout ranged from 91 mm to 266 mm, with 33% juveniles. Brook Trout ranged in size from 78 mm to 263 mm, with 44% juvenile fish. Yellowstone Cutthroat Trout ranged from 178 mm to 216 mm.

In the Swamps survey reach, Brook Trout were the only salmonid captured, which we estimated at 34.1 fish per 100 m^2. We estimated 24.5 Brook Trout >150 mm per 100 m^2. Brook Trout ranged in size from 83 mm to 215 mm, with 18% juvenile fish. No Mountain Whitefish were captured at either site, but sculpin were present in both.

Lower Starhope Creek (West Fork Big Lost River)

We collected 53 trout in the Cow Camp (middle) Starhope electrofishing site. The lower site (above the bridge on Forest Road 135) was not sampled due to malfunctions with the canoe electrofishing equipment. Species composition was 75% Brook Trout and 25% Yellowstone Cutthroat Trout. We estimated trout density at 2.7 fish per 100 m^2. Trout densities have continued to decline since 2003 (9.3 fish per 100 m^2) and 2007 (6.5 fish per 100 m^2), but remained above the 1986 density estimate of 1.5 fish per 100 m^2. Densities of trout greater than 150 mm were also below 2003 estimates, but similar to 2007 at 0.4 fish per 100 m^2. Brook Trout ranged in size from 50 mm to 215 mm, with 94% juvenile fish. Yellowstone Cutthroat Trout ranged in size from 73 mm to 425 mm, with 57% juvenile fish. One of the 13 Yellowstone Cutthroat Trout captured was of hatchery origin. No Mountain Whitefish or sculpin were captured.

Upper Starhope Creek (West Fork Big Lost River - Loop Road)

We collected 101 trout in three electrofishing passes in the upper Starhope reach. Species composition was 31% Brook Trout and 69% Yellowstone Cutthroat Trout. Yellowstone cutthroat density was heavily influenced by the presence of hatchery Cutthroat Trout; 69 of the 70 Cutthroat Trout captured were of hatchery origin. Overall trout density was 6.0 fish per 100 m^2; densities were only about 25% of those recorded in 2007 (20.0 fish per 100 m^2), and less than half of that seen in 2003 (12.7 fish per 100 m^2). Densities of trout greater than 150 mm were 4.4 fish per 100 m^2, also a decrease from the 2007 estimate of 7.2 fish per 100 m^2. Brook Trout ranged in size from 44 mm to 202 mm, with 76% juvenile fish. Hatchery Yellowstone Cutthroat Trout ranged in size from 219 mm to 359 mm, while the one wild Yellowstone Cutthroat Trout captured was 130 mm, indicating that natural reproduction is occurring. No Mountain Whitefish were captured, but sculpin were present.

Broad Canyon Creek

We collected 51 trout in two electrofishing passes in Broad Canyon Creek. Species composition was 96% Brook Trout, 2% Rainbow Trout, and 2% Yellowstone Cutthroat Trout. Trout densities were approximately 25% of those recorded in 2007 (8.5 fish per 100 m^2 in 2012 compared to 40.8 fish per 100 m^2 in 2007). Densities of trout greater than 150 mm also declined from the 2007 estimates of 9.1 fish 100 m^2 to 2.0 fish per 100 m^2. Brook Trout ranged in size from 45 mm to 303 mm, with 69% juvenile fish. One Yellowstone Cutthroat Trout and one Rainbow Trout were captured, measuring 73 and 125 mm, respectively. No Mountain Whitefish were captured, but sculpin were noted as present.

Muldoon Canyon Creek

We collected 50 Brook Trout in two electrofishing passes in Muldoon Canyon Creek; no other salmonids were captured. Trout densities were estimated at 5.1 trout per 100 m^2, and were only about 25% of those recorded in 2003 and 2007 (19.3 and 21.3 fish per 100 m^2, respectively). Densities of trout greater than 150 mm were estimated at 0.2 fish per 100 m^2. Brook Trout ranged in size from 43 mm to 187 mm, with 95% juvenile fish. No Mountain Whitefish were captured, but sculpin were present.

Lake Creek

We collected 308 trout in two electrofishing passes in Lake Creek. Species composition was 98% Brook Trout and 2% Yellowstone Cutthroat Trout. Trout densities, estimated at 39.2 fish per 100 m2, were less than those recorded in 2003 and 2007 (56.6 and 57.8 fish per 100 m^2, respectively), but were still relatively high compared to other sample sites throughout the Big Lost drainage in 2012. Densities of trout greater than 150 mm were estimated at 8.0 fish per 100 m^2. Brook Trout ranged in size from 37 mm to 266 mm, with 73% juvenile fish. Yellowstone Cutthroat Trout ranged in size from 60 mm to 127 mm, and one Hybrid Trout (rainbow x cutthroat) measuring 113 mm was captured. No Mountain Whitefish or sculpin were captured.

Antelope Creek (Lower, Middle and Upper reaches)

We collected 210 trout in three electrofishing reaches in Antelope Creek. Species composition was 73% Brook Trout, 26% Rainbow Trout, and 1% hybrid (rainbow x Cutthroat Trout). Trout densities were about half of what was observed in 2007 (5.8 fish per 100 m^2 in 2012 compared to 11.1 in 2007). Densities were highest in our middle sample reach. Densities of trout greater than 150 mm were estimated at 2.7 fish per 100 m^2, similar to that seen in 2007 (2.6). Brook Trout ranged in size from 38 mm to 281 mm, with 56% juvenile fish. Rainbow Trout ranged in size from 48 mm to 396 mm, with 51% juvenile fish. No Mountain Whitefish were captured, but sculpin were present.

Cherry Creek

We collected 147 trout in three electrofishing passes in Cherry Creek. Species composition was 93% Brook Trout, 3% Cutthroat Trout, 3% Hybrid Trout (rainbow x cutthroat), and 2% Rainbow Trout. Trout densities were 52.3 fish per 100 m^2, similar to the 45.9 observed in 2007. Densities of trout greater than 150 mm were estimated at 18.2 fish per 100 m^2, twice that seen in 2007 (7.1 fish per 100 m^2). Brook Trout ranged in size from 50 mm to 220 mm, with 66% juvenile fish. Cutthroat Trout ranged from 135 mm to 175 mm, while Hybrid Trout ranged from 120 mm to 170 mm, each with 50% juveniles. Rainbow Trout ranged in size from 150 mm to 180 mm. No Mountain Whitefish were captured, but sculpin were present.

Iron Bog Creek

We collected 27 trout in two electrofishing passes in Iron Bog Creek. Species composition was 96% Brook Trout and 4% Rainbow Trout. Trout densities were 4.5 fish per 100 m^2. Densities of trout greater than 150 mm were estimated at 3.0 fish per 100 m^2. Densities of all trout (and all sizes) were approximately 30% of what was observed in 2007. Brook Trout ranged in size from 50 mm to 250 mm, with 29% juvenile fish. One Rainbow Trout was captured, measuring 235 mm. No Mountain Whitefish were captured, but sculpin were present.

DISCUSSION

Overall abundance of trout in the Upper Big Lost River is similar to or better than that documented in surveys in the 1980's. However, in all areas except the Antelope Creek drainage and it's tributaries, densities were lower than our 2007 surveys. In particular, juvenile trout abundances have generally decreased over recent surveys. Fluctuations in trout densities throughout the drainage may be attributed to a combination of factors, including winter snow pack and precipitation, habitat improvements such as improved range management, and resulting stream temperatures. Most notably was the large snowpack and resulting runoff from 2011 that may have influenced year-class strength from 2011, and created a lack of smaller fish in 2012 surveys.

Stockings of Cutthroat Trout, which began in 2000, continue to supplement the existing Rainbow Trout and Brook Trout fishery in the Upper Big Lost River, and these fish have now migrated throughout the drainage. It was previously suspected that whirling disease may be suppressing trout populations, and that Cutthroat Trout may be more resistant to infections. Stockings have only occurred in the West Fork, but Cutthroat Trout are now found throughout the entire Big Lost River Drainage, down through Mackay Reservoir and downstream as far as Antelope Creek. Natural reproduction is occurring, and may eventually aid Cutthroat Trout in becoming a significant component to the fishery. The persistence of all three trout species in the drainage and the abundance of juvenile fish encountered during the past decade suggest that whirling disease, which was suspected to have population level effects in the 1990's, is currently not impacting the population substantially. It's probable that population level fluctuations are more likely tied to environmental conditions such as flows as opposed to whirling disease.

Mountain Whitefish populations in the Big Lost River have increased in abundance compared to population sampling conducted in the early 2000's, but in most instances, abundance remains below highs documented in the 1980's. We found Mountain Whitefish at three of four sites where they were found in 2007, and two sites where they were not present in 2007. Densities of Mountain Whitefish have increased in two sites and remain similar to recent surveys in two sites. Overall, it appears that Mountain Whitefish are persisting throughout the Big Lost drainage, and populations appear to be much more abundant than they were a decade ago.

MANAGEMENT RECOMMENDATIONS

1. Estimate drainage-wide abundances of Mountain Whitefish as possible. Design future studies to address total abundance of whitefish.

2. Develop methods to estimate drainage wide abundances of all trout species (EMAP approach)

3. Periodically monitor trout populations and angler use in the Big Lost River above Mackay Dam to evaluate natural reproduction, distribution and contribution to the fishery.

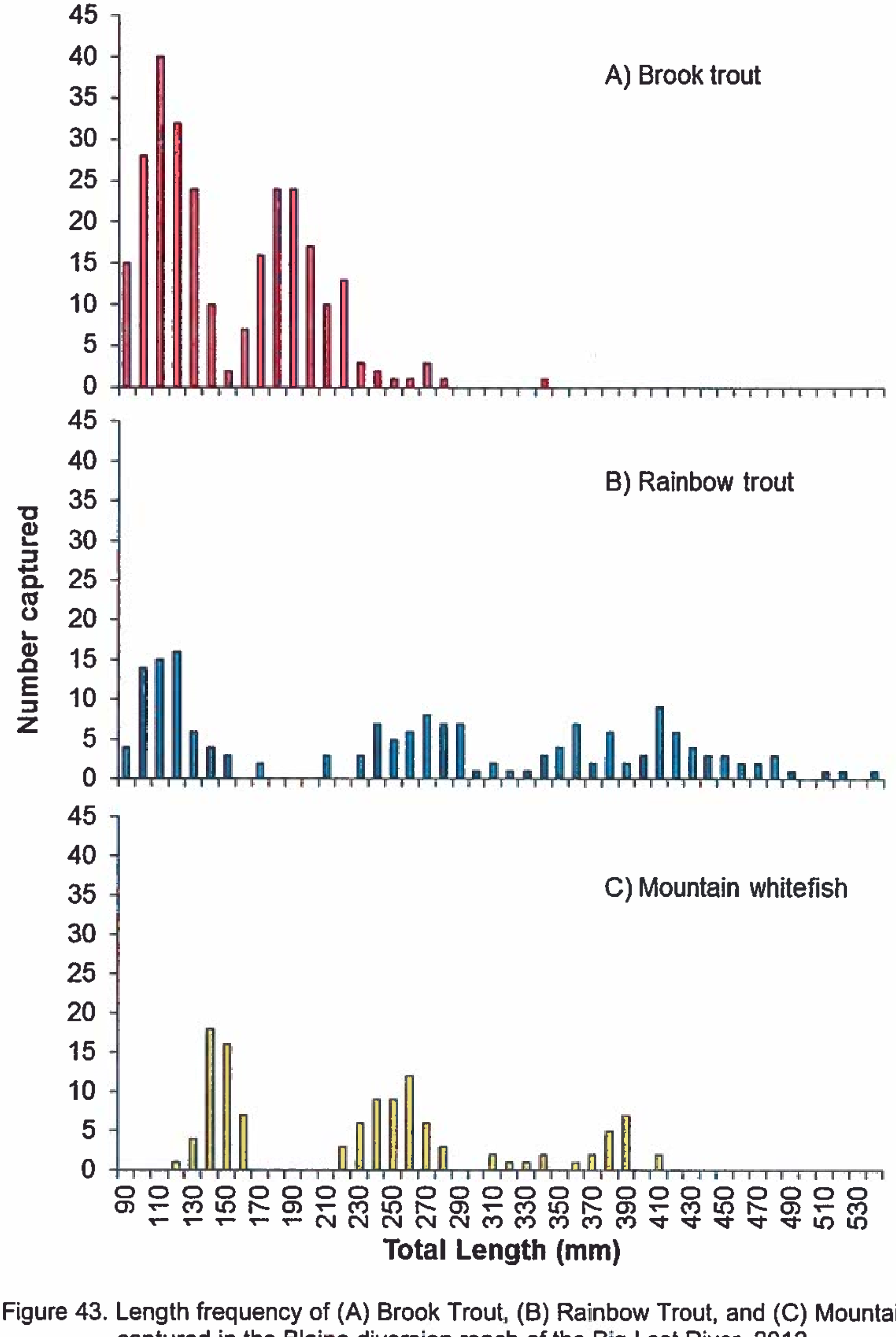


Figure 43. Length frequency of (A) Brook Trout, (B) Rainbow Trout, and (C) Mountain Whitefish captured in the Blaine diversion reach of the Big Lost River, 2012.

Table 14. Trout and whitefish population estimate summary from main stem Big Lost River sample sites during 2012. (BKT = Brook Trout, MWF = Mountain Whitefish, RBT = Rainbow Trout, YCT = Yellowstone Cutthroat Trout).

River reach	No. marked	No. captured	No. recaptured	Population Estimate	Confidence Interval (+/- 95%)	Density (No./ km)	Discharge (cfs)[a]
Blaine							174[b]
-RBT	69	80	30	251	227 – 275	337	
-BKT	79	62	16	333	274 – 392	447	
-MWF	32	50	11	344	194 – 494	462	
Campground							174[b]
-RBT	334	524	97	2,207	2,802 – 2,332	2,855	
-MWF	18	17	7	42	27 – 82	58	
Bartlett Point							224[c]
-RBT	52	55	16	219	190 – 248	68	
-YCT	42	37	12	157	130 – 184	49	
-MWF	98	116	29	446	395 – 397	138	

[a] Represents the mean discharge value between marking and recapture events.
[b] Data obtained from USGS gauge (13127000) below Mackay Reservoir near Mackay.
[c] Data obtained from USGS gauge (13120500) at Howell Ranch near Chilly.

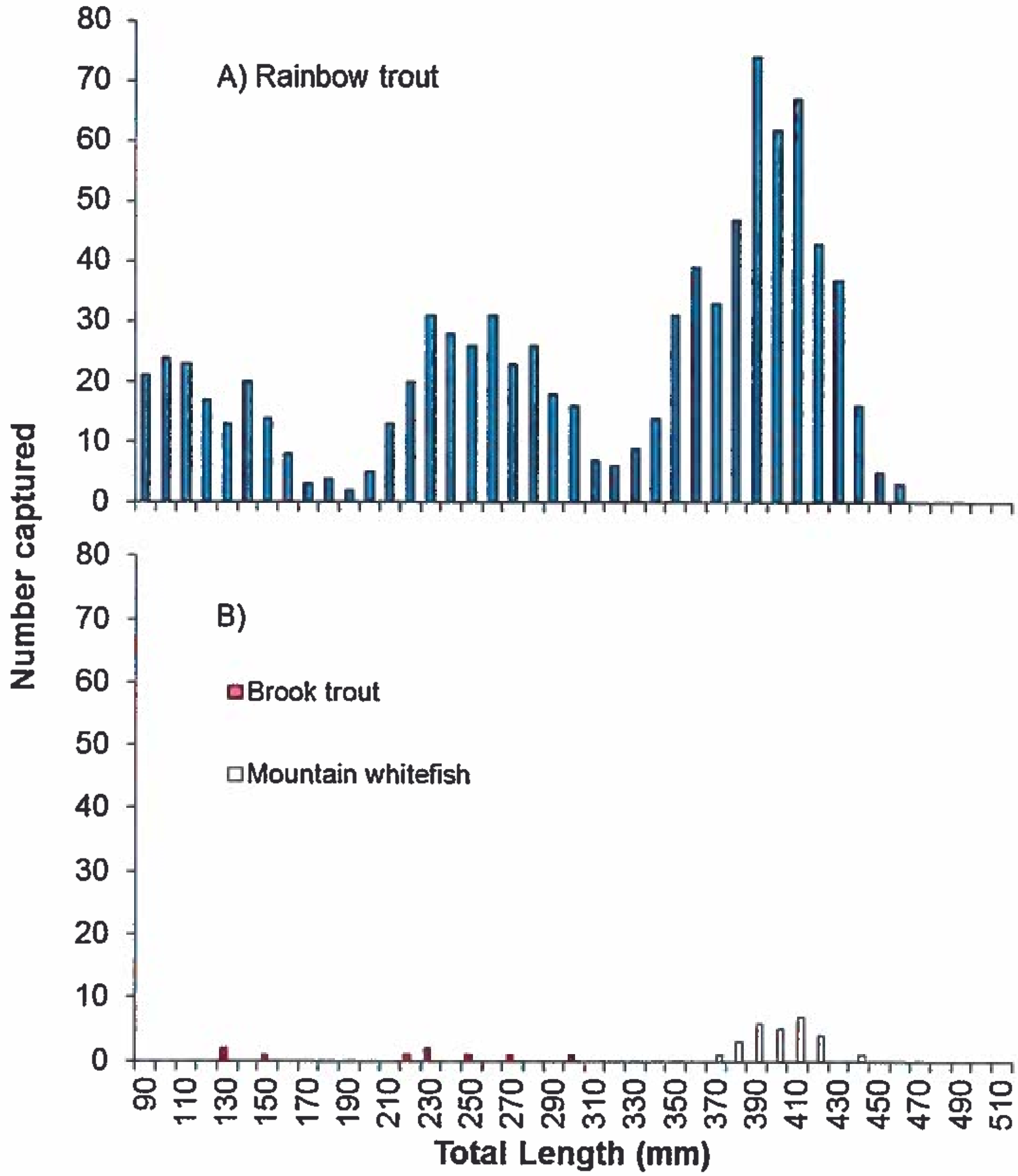


Figure 44. Length frequency of (A) Rainbow Trout and (B) Brook Trout and Mountain Whitefish in the campground reach of the Big Lost River, 2012.

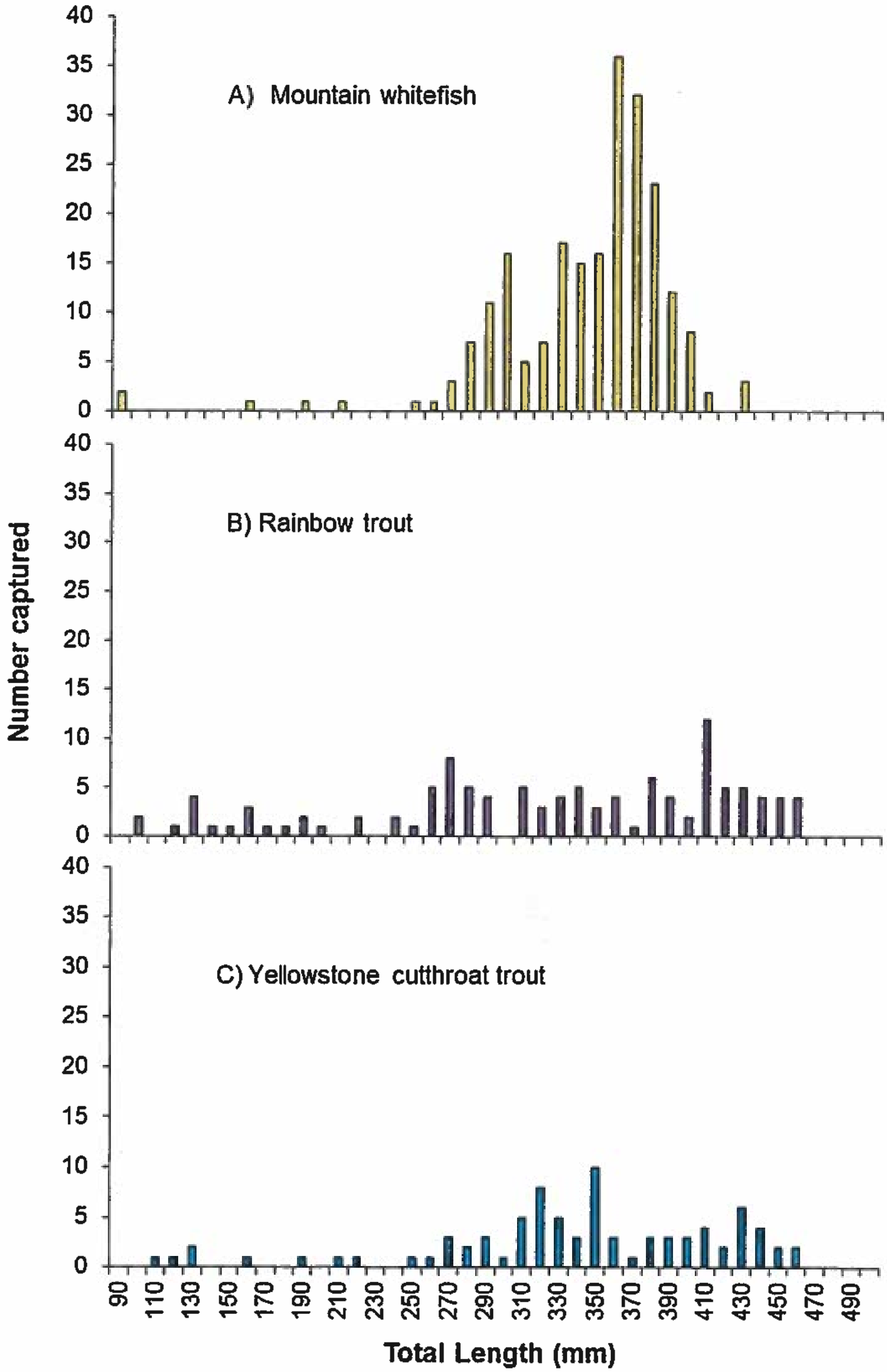


Figure 45. Length frequency of (A) Mountain Whitefish, (B) Rainbow Trout, and (C) Yellowstone Cutthroat Trout in the Bartlett Point reach of the Big Lost River, 2012.

Table 15. Density estimates (fish per 100 m^2) for historic sample reaches of the Big Lost River, Idaho. Estimates are means for a given stream when more than one site was sampled in a given year.

Location	Drainage	Sample Year	Density (fish / 100 m^2) All trout	Trout > 150 mm	RBT > 150 mm	BKT > 150 mm
Lower Big Lost River Mainstem	Main	1987[a]	–	16.71	16.71	0.0
		1991	–	7.55	6.72	0.83
		2002	–	8.04	7.02	1.02
		2007	–	6.66	5.76	0.90
		2012				
Upper Big Lost River Mainstem	Main	1988	1.41	1.29	1.18	0.11
		1990	1.23	1.10	1.08	0.02
		2003	1.15	0.43	0.37	0.06
		2007	0.03	0.0	0.0	0.0
		2012				
North Fork Big Lost River	North Fork	1986	13.23	1.76	0.33	1.43
		1996	14.70	8.35	0.50	7.85
		2003	2.07	1.33	0.94	0.39
		2007	14.06	0.92	0.42	0.46
		2012	2.39	0.86	0.07	0.70
Summit Creek	North Fork	1986	27.15	5.75	0.25	5.45
		1996	11.75	10.45	0	10.45
		2003	14.40	4.73	0.68	4.05
		2007	28.87	8.16	0.80	7.35
		2012	5.73	2.15	0.40	1.75
Wildhorse Creek	East Fork	1986	4.35	0.55	0.15	0.40
		2003	3.12	0.95	0.12	0.83
		2007	7.03	3.95	0.44	3.44
		2012	4.82	1.71	0.07	0.94
Lower East Fork	East Fork	1986	1.85	0.35	0.26	0.09
		1990	1.46	1.46	0.73	0.73
		2003	3.01	1.92	1.28	0.64
		2007	5.19	3.64	1.77	1.76
		2012	1.63	0.90	0.26	0.43
Upper East Fork	East Fork	1986	33.85	23.91	9.58	14.33
		1996	9.05	9.05	3.35	5.70
		2003	24.5	12.70	2.10	10.60
		2007	31.62	18.63	2.63	14.61
		2012	26.82	18.47	0.68	13.62
West Fork (Starhope Creek)	West Fork	1986	4.94	1.06	0.05	1.01
		2003	10.07	4.35	0.18	4.17
		2007	11.0	2.73	0.01	2.18
		2012	4.31	2.42	0.00	0.34
Muldoon Canyon Creek	West Fork	1986	9.70	2.90	0.10	2.80
		1996	4.25	3.62	0	3.62
		2003	19.4	4.05	0	4.05
		2007	21.25	3.02	0	2.29
		2012	5.05	0.20	0	0.20
Lake Creek	West Fork	1986	19.80	8.20	0.60	7.60
		1996	10.30	8.90	0	8.90
		2003	56.6	22.9	0	22.9
		2007	57.77	13.69	0	13.3
		2012	39.16	7.99	0	7.99

[a] – 1987 sample only included the Campground section, which is the highest density area for the lower mainstem reach.

Table 16. Mountain Whitefish abundance in the Big Lost River Drainage, Idaho as determined from electrofishing surveys.

Location	Year Sampled	Source	Length Sampled (meters)	Mean Width (meters)	Population estimate (fish > 200 mm)	Fish / 100 m^2	Fish per km
Desert	1970's	Overton					
	2003	USFS	0[a]	0[a]	0[a]	0[a]	0[a]
Big Lost @ Arco	1987	IDFG	490	9.1	262 (198-365)	5.2	473
	2002	USFS	0[a]	0[a]	0[a]	0[a]	0[a]
Big Lost @ Blaine diversion	2009	IDFG+USFS	745	12.8	409 (402-414)	4.3	549
	2012	IDFG+USFS	745	12.1	344 (49-639)	3.8	462
Big Lost @ Leslie	1991	IDFG	4,000	15	48 (35-57)	0.1	12
	2002	IDFG	1,000	18	1[b]	<0.01[b]	1[b]
	2007	IDFG	1,000	18	70 (42-98)	0.4	70
Big Lost @ Mackay	1987	IDFG	1,238	24.2	NE[c]	NE[c]	NE[c]
	1991	IDFG	800	37.4	280 (176-507)	0.9	350
	2002	IDFG	1,000	20.6	45 (27-64)	0.2	45
	2007	IDFG	944	17.0	61 (36-86)	0.4	65
	2012	IDFG+USFS	773	20.1	42 (27-82)	0.3	58
Big Lost @ Bartlett Pt	1986	IDFG	1,500	13.4	285[d]	1.4[d]	190[d]
	1988	IDFG	2,239	17.0	423 (336-550)	1.1	189
	1990	IDFG	2,240	17.0	219	0.6	98
	1996	IDFG	3,001	19.9	1,322	2.2	441
	2003	IDFG+USFS	180	19.5	9 (8-15)	2.6	50
	2007	IDFG	158	19.1	1 (No CI's)	0.03	6.3
	2012	IDFG+USFS	3,228	16.5	446 (395-497)	0.84	138
East Fork - Whitworth	1986	IDFG	1,243	13.8	825 (617-1,162)	4.8	664
	1990	IDFG	1,375	12.4	65	0.4	47.3
	1996	IDFG	924	12.4	84	0.7	91
	2003	IDFG+USFS	115	11.2	1	0.1	8.7
	2007	IDFG	119.5	13.2	41 (39-43)	2.6	343.1
	2012	IDFG+USFS	198	10.3	8 (5-11)	0.4	40.4
East Fork – Fox Creek	1986	IDFG	1,162	11.8	717 (549-977)	5.2	617
	1990	IDFG	1,209	11.3	51	0.4	43
	1996	IDFG	1,273	11.6	17[e]	0.1	14.2

Table 16. Cont.

Location	Year Sampled	Source	Length Sampled (meters)	Mean Width (meters)	Population estimate (fish > 200 mm)	Fish / 100 m^2	Fish per km
	2003	IDFG+USFS	100	10.6	0	0	0
	2007	IDFG	149.5	9.7	0	0	0
	2012	IDFG+USFS	362	12.6	3 (3-6)	0.1	8.3
West Fork – Bridge	1986	IDFG	1,364	16.1	1,480 (758-4,191)	6.7	1,085
	2003	IDFG+USFS	100	14.7	0	0	0
	2007	IDFG	211	15.4	0	0	0
West Fork – Cow Camp	1986	IDFG	1,440	10.5	344 (250-504)	2.2	239
	2003	IDFG+USFS	130	8.5	0	0	0
	2007	IDFG	122	9.0	0	0	0
	2012	IDFG+USFS	248	9.8	0	0	0
North Fork – Forest Boundary	1986	IDFG	1,140	10.5	362 (281-485)	3.0	318
	2003	IDFG+USFS	300	8	0	0	0
	2007	IDFG	153	10	0	0	0
	2012	IDFG+USFS	328	9.4	4 (2-6)	0.1	12.2
Wildhorse Cr (Lower section)	1986	IDFG	55	6	0	0	0
	2003	IDFG+USFS	200	10	0	0	0
	2007	IDFG	197	9	0	0	0
	2012	IDFG+USFS	197	10.3	0	0	0
Wildhorse Cr (Upper Sect)	1986	IDFG	213	7	0	0	0
	2003	IDFG+USFS	200	7	0	0	0
	2007	IDFG	300	6.5	3 (No CI's)	0.2	10
	2012	IDFG+USFS	300	10.3	0	0	0
Antelope Cr – Wood Canyon	1987	IDFG	64	5.1	0	0	0
	1991	IDFG	569	6.7	0	0	0
	2003	USFS	200	5.9	0	0	0
	2007	IDFG	272	6.3	0	0	0
	2012	USFS	190	6.2	0	0	0

[a] – Sampled, but no water present.
[b] – Numerous fry present, but not collected.
[c] – Whitefish present, but not estimated.
[d]- Only completed marking run. Figures presented are actual fish present, not a population estimate (would likely be higher).
[e] – No population estimate made – figures presented are actual fish present.

Table 17. Salmonid densities found in the Big Lost River, Idaho during 2012 electrofishing samples.

			Density (# per 100 m^2)					
Location	Drainage	Length (m)	All Salmonid	Trout > 150 mm	RBT > 150 mm	BKT > 150 mm	MWF > 200 mm	YCT > 150 mm
Big Lost at Blaine	Main	745	12.7	6.47	2.78	3.69	3.82	0.00
Big Lost at Campground	Main	773	31.0	14.36	14.20	0.13	0.27	0.03
Big Lost at Bartlett Point	Main	3,228	2.28	0.79	0.41	0.01	0.84	0.29
Lower North Fork	North	328	0.49	0.32	0.16	0.06	0.13	0.10
Mid North Fork	North	300	1.97	0.62	0.08[a]	0.39	0.00	0.15[b]
Upper North Fork	North	311	4.83	1.65	0.00	1.65	0.00	0.00
Summit Creek	North	300	5.73	2.15	0.40	1.50	0.00	0.00
Kane Creek	North	208	7.34	2.29	0.20[a]	2.09	0.00	0.00
Lower Wildhorse Creek	East	197	3.60	1.73	1.33[b]	0.30	0.54	0.10
Upper Wildhorse Creek	East	300	7.73	1.69	0.10	1.59	0.00	0.00
Fall Creek	East	113	0.51	0.26	0.13	0.13	0.00	0.00
Lower East Fork (Whitworth)	East	198	3.96	0.93	0.44[a]	0.24	0.39	0.24
Lower East Fork (Fox Creek)	East	362	1.73	0.85	0.13	0.61	0.07	0.11
East Fork @ Burma	East	171	17.58	12.40	9.24[b]	2.70	0.00	0.45
East Fork @ Swamps	East	71	34.05	24.54	0.00	24.54	0.00	0.00
Mid Starhope Creek (Cow Camp)	West	248	2.67	0.41	0.00	0.33	0.00	0.16[b]
Upper Starhope Creek	West	266	5.96	4.43	0.00	0.35	0.00	4.07[b]
Broad Canyon Creek	West	164	8.52	1.98	0.00	1.98	0.00	0.00
Muldoon Creek	West	150	5.05	0.20	0.00	0.20	0.00	0.00
Lake Creek	West	166	39.16	7.99	0.00	7.99	0.00	0.00
Lower Antelope Creek	Antelope	190	3.92	2.38	0.77	1.70	0.00	0.00
Middle Antelope Creek	Antelope	148	9.83	4.12	1.76	2.37	0.00	0.00
Upper Antelope Creek	Antelope	269	4.65	1.55	0.00	1.55	0.00	0.00
Cherry Creek	Antelope	127	52.28	18.17	1.60[a]	16.26	0.00	0.64
Iron Bog Creek	Antelope	120	4.46	2.98	0.17	2.81	0.00	0.00
Alder Creek	Lower BL	100	32.64	8.09	0.00	8.09	0.00	0.00
Pass Creek	Lower BL	100	10.80	8.00	0.00	8.00	0.00	0.00

[a] - Includes hybrid (rainbow x cutthroat) trout
[b] – Includes hatchery trout

South Fork Snake River

ABSTRACT

The South Fork Snake River supports an important population of native Yellowstone Cutthroat Trout (YCT). Abundance of YCT at the Lorenzo monitoring site has increased significantly in recent years to 321 YCT/km. Total trout densities at Conant are near all-times highs at 3,149 trout/km due to increases in Brown Trout abundance which was correlated to river flows, air temperatures, and adult spawner abundance. Abundance of YCT and Rainbow Trout (RBT), have remained static and similar from 2010 through 2012 at Conant. Tributary weirs were operated on all four major spawning tributaries in 2012. We passed 2,162 YCT upstream and removed 23 RBT from spawning tributaries. Anglers fished 385,152 hours on the South Fork during 2012, catching 370,497 trout with an overall catch rate of 0.92 fish/hour. Anglers harvested 43,288 fish, 65% of which were RBT. Anglers turned in 1,726 RBT for the Angler Incentive Program, including 37 tagged fish worth $3,650. However, based on comparisons between creel interviews and later analysis of incentive submissions, only 17% of anglers who harvested RBT turned them in to IDFG. Harvest of RBT increased more than their increase in abundance between 2005 and 2012, suggesting that the angler incentive program may be effective at increasing overall Rainbow Trout exploitation. In 2012, an additional 2,838 YCT were marked with PIT tags to obtain information on general movements of cutthroat. This brings the total number of PIT tagged cutthroat in the South Fork to 14,751. We observed high spawning stream fidelity (99.5%), and many YCT in 2012 in the tributaries were annual spawners (42 – 66%). High overwinter area site fidelity was also observed along with lengthy annual migrations to spawning tributaries (-37.5 to 85.7 km). Efforts to remove RBT from Palisades Creek upstream of the fish trap to reduce hybridization and competition between YCT and RBT are proving successful. In Burns Creek, RBT and Brown Trout are distributed two to three km upstream of the fish trap, and an estimated 1,615 YCT were present in Burns and Little Burns creeks. Electrofishing surveys in Fall Creek documented an abundance of Brook Trout (20 – 68 fish/100 m) which had not been documented before.

Authors:

Brett High

Regional Fisheries Biologist

Dan Garren

Regional Fisheries Manager

INTRODUCTION and STUDY AREA

A thorough portrayal of the South Fork study area can be found in the 2011 Upper Snake Region Annual Report (Schoby et al. 2013).

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. Describe general annual movement patterns of YCT within the South Fork drainage.
5. Work with BOR to obtain beneficial flows for cutthroat in the South Fork.
6. Determine if the RBT incentive program is increasing harvest rates

METHODS

South Fork Population Monitoring

We estimated trout abundances at the Lorenzo and Conant monitoring reaches during the fall when river flows decreased after the main irrigation season ends. 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, mm). 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 17-18 (marking runs) and September 24 -25 (recapture runs). We sampled the Conant monitoring reach October 9-11 (marking runs) and October 15-17 (recapture runs). 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 2006b). 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 post-2004 for each trout species by calculating the intrinsic rates of change (*r*). 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 rate 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). We assessed factors affecting age 1 BNT abundance using Multiple Linear Regression with age 1 BNT/km at Conant as the dependent variable with several river flow and air temperature independent variables including the average, maximum, minimum, and variability of both river flows and air temperature as well as adult spawner BNT abundance. We used simple linear regression to identify correlations between age 1 BNT and monthly statistics for river flow and minimum air temperatures from 1985 through 2012. The monthly summary statistics included average, minimum, maximum, and variance. The monthly statistics most strongly correlated in these simple linear regressions were used in the multiple linear regression analysis. We used a Best Subset Regression to determine the order for which parameters to include in the models. The number of parameters were increased by one for each successive multiple linear regression model used and corresponding adjusted R^2 values and P values were used to determine which model produced the best fit. The residuals of the best model were analyzed with a normal probability plot to determine if the data used in the model were normally distributed.

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 2012 spring spawning run. Weirs were installed in late March prior to spring spawning runs. Weirs were operated until July 11 (Burns Cr), July 1 (Pine Cr), June 23 (Rainey Cr), and July 2 (Palisades Cr).

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 used backpack electrofishing units to capture fluvial YCT upstream of the fish weirs on Burns and Pine creeks during the spawning season to estimate trap efficiencies. However, the number of fluvial YCT that we captured in Pine Creek was low, and did not allow for an efficiency estimate. We also could not evaluate trap efficiencies at Rainey Creek because of the limited number of marked YCT passed upstream there. Efficiencies for the Burns Creek and Palisades Creek weirs were calculated as the number of Cutthroat Trout ≥ 283 mm with PIT tags or caudal fin punches divided by the total number of Cutthroat Trout ≥ 283 mm captured. The length cutoffs, used to discriminate between fluvial and resident fish, have previously been calculated specific for each year. Since the cutoffs have been similar from year to year, we averaged the yearly length cutoffs for 2009 through 2012 to form a standard cutoff length (283 mm) to be used for all the South Fork tributaries. The yearly length cutoffs were identified by subtracting 1.96 standard deviations from the mean TL of YCT caught at the weirs during each respective year, and effectively eliminated skewing error resulting from erroneously including resident YCT in the efficiency calculations.

We described run size, timing, and fallback rates at weirs for each of the four spawning tributaries, excluding fallback rates at Rainey Creek due to small run size. Total run sizes were the sum of new YCT captures at the weirs and were calculated for each sex. The run timing was described for each tributary by determining the date when 50% of the spawning run of YCT had been passed upstream of the weir. We monitored fall back rates so we could exclude those fish from run-size calculations, which produce a more accurate picture of the spawning run. Fall back rates were calculated for each tributary weir by summing the total of freshly marked (ad-clipped or fin punch in the tail) observed daily at the traps, divided by the total run size which did not include fish that fell back and re-ascended into the traps.

Creel Survey

We conducted a creel survey on the South Fork during the entire calendar year of 2012 to estimate annual effort, catch, and harvest. Monthly estimates of catch, effort, and harvest were generated for the South Fork Snake River during 2012 using an Access – Access design with completed trip data and an Access – Roving Design with incomplete trip data (Pollock et al. 1994). We also estimated the number and average duration of fishing trips on the South Fork on a monthly basis for comparison to prior surveys. Estimates for total catch, effort, and harvest were the sum of the completed trip estimates and the incomplete trip estimates by month.

We divided the year into two week intervals. From January through March and November through December creel clerks interviewed anglers at river access sites four times during each two week time interval - two weekdays and two weekend days or holidays. During the remainder of the year, when angler effort was higher, clerks conducted interviews six times per two week time interval (three weekdays and three weekend/holiday days). The days selected for creel interviews were selected randomly using a random number generator. We divided the river into three segments to allow creel clerks the ability to cover an entire segment during a creel work shift. These sections were the upper river from Palisades Dam downstream to the Conant boat access, the canyon section from Conant downstream to the Heise Bridge and the lower river section from the Heise Bridge downstream to the confluence with the Henrys Fork Snake River. The river section selected for each creel day was determined by randomly assigning the first day in January for both the weekdays and weekend/holiday strata and systematically going through each river section for each strata for the remainder of the year (i.e., each section was equally weighted). Creel interviews were conducted during daylight hours, and days were divided into three periods, the AM period from sunrise to 11:00 AM, the noon period from 11:00 AM to 4:00 PM, and the PM period from 4:00 PM to sunset. These three time periods were weighted with the following probabilities to maximize the number angler interviews: 15% for the AM period, 40% for the noon period, and 45% for the PM period. Creel clerks were instructed to be at designated access points in the designated river section throughout the creel shift. There were four to five designated access sites where clerks conducted interviews. Creel clerks were given a schedule with a set amount of time to be spent at each site before moving to the next access point (Pollock et al. 1994). The time designated for each site was weighted by how much angler use occurred there, i.e. clerks worked at popular boat ramps longer than at roadside bank angler access sites. The primary goal was to collect completed trip data from anglers leaving the access sites, but clerks also collected incomplete trip data from anglers who were still fishing when the survey period ended. Creel clerks randomized which of the designated access sites to start at each day and which direction to move through the sites by rolling a numbered game die.

Effort was estimated by counting anglers fishing in a given river section, and then expanding this to the remaining river sections during low use periods (Jan-Apr and Nov/Dec). Expanding use data was accomplished by weighting river use based on documented use collected in the IDFG 2005 creel survey (Schrader and Fredericks 2006a). The 2005 creel survey divided the river into 7 sections. The 2005 sections 1 and 2 corresponded to the current survey's upper river section, the 2005 sections 3 through 5 corresponded to the current survey's canyon section, and the 2005 sections 6 and 7 corresponded to the current survey's lower river section. We divided the estimated 2005 combined fishing effort during the Jan-Apr and Nov/Dec time periods for the respective corresponding river sections by the total for all river sections for that time period. The percentages were then used to weight angler counts so that counts from a single section could be expanded to the other two river sections. These expanded efforts were only necessary during the low effort periods (Jan-Apr and Nov/Dec). Effort counts during the remainder of the year were obtained using a fixed wing airplane and pilot to collect instantaneous counts of anglers for the entire river. Counts were done on one weekday and one weekend/holiday during each two-week interval. The days and flight start times were selected randomly using a random number generator.

Spring Flows

We assessed the effect of high spring flows on juvenile YCT and RBT in the South Fork using general linear models. We used the maximum spring flow as the independent variable with age 1 abundances of YCT and RBT in the Conant monitoring site the following year as the dependent variables. The maximum spring flows were the maximum daily flows between March 1 and June 30 for each year measured at the Irwin gauge station. Age 1 abundance of YCT in Conant were identified as trout measuring from 102-254 mm total length and Age 1 RBT were 152-279 mm total length (See Schrader and Fredericks 2006a). We set $\alpha=0.10$, and the null hypothesis was flows would have no effect on age 1 YCT or age 1 RBT abundance the following year. When no age 1 abundance estimate was available, that year was not included in the analysis. Thus, for the nine year time period, there were seven samples for YCT and eight for RBT used in the models.

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. This study involved marking Rainbow Trout and hybrids with a coded wire tag in the snout of the fish, and having anglers who harvest rainbows return the fish or fish head to IDFG for analysis. Tags were batch marked, and each mark had a corresponding monetary value associated with it that varied from $50 to $1,000. During mid-winter 2012, additional RBT were marked with coded wire tags (CWT) in the snout to augment the number of marked RBT in the South Fork and increase anglers' odds of catching a marked RBT. Rainbow Trout were captured using the same methods outlined above. Captured Rainbow Trout were checked for the presence of an existing CWT using a hand-held antenna. If a tag was detected, the fish was released to avoid double-tagging. Rainbow Trout were measured to the nearest mm (TL), marked with a double length (2.2 mm) section of CWT, checked again with the hand-held antenna to very tag placement, and released back to the South Fork. Five different six-digit number combinations were used, and corresponded to the following monetary values: $50, $100, $200, $500, and $1,000. We marked RBT from the South Fork between Palisades Dam and Heise from January 30, 2012 through February 27, 2012. We maintained freezers at the Conant and Byington boat ramps from May through October to make it easier for anglers to submit fish to the program on-site through the heavy summer use months. Anglers were also encouraged to submit RBT to the regional office of the Upper Snake Region. On the first Friday of every month, we scanned the heads that had been turned in for the incentive program. When CWTs were found, the angler was notified to verify the address and inform them of the amount of money they would receive.

We summarized the number of RBT turned in to the Angler Incentive Program for the year of 2012 by angler type (bait vs. non-bait angler) and by state of residency. We calculated the median number of RBT turned in by angler type and the overall median and overall average number of RBT turned in for all angler types. We also estimated the proportion of South Fork anglers that harvested RBT, but did not turn them in to the IDFG for the Angler Incentive Program by calculating the percentage of anglers who harvested RBT and were interviewed by creel clerks that later turned in RBT to the IDFG Angler Incentive Program.

PIT Tags

In 2012, 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 to evaluate PIT tag loss.

We estimated spawning stream fidelity for PIT tagged YCT observed in tributaries and general site fidelity comparing recapture locations when recapture events occurred during the same time of year that original marking occurred. For general site fidelity, we divided the South Fork into 15 river segments from Palisades Dam downstream to Heise which average 4.5 km in length. We assessed spawning periodicity based on recapture events at tributary weirs. We described general movement patterns based on recapture data both from sampling events including electrofishing surveys and tributary weirs as well as those passive events when marked fish were recorded by PIT tag arrays newly installed in Burns, Pine, and Palisades creek. We quantified observed maximum migration distances, which are conservative straight line river distances. We quantified straying rates for all YCT with multiple capture events in tributaries for separate spawning runs (multiple year recapture events).

South Fork Tributary Population Monitoring

In 2012, we sampled Palisades Creek, Burns Creek, and Fall Creek to manually remove RBT, monitor YCT population distribution and abundance, and to investigate a report of Brook Trout presence. We continued efforts to manually remove RBT from Palisades Creek upstream of the fish weir using single pass backpack electrofishing. We quantified capture efficiency in Palisades Creek by marking and releasing a number of YCT throughout the 9.5 km reach prior to the single pass removal. Any RBT that we captured during this marking run were removed and included in the total for the removal effort. Efficiency was estimated by the number of marked fish that were recaptured during the survey. We evaluated our accuracy of phenotypic species identification in the field by analyzing genetic samples from 30 fish from each 0.8 km of stream. While identifying fish species in the field we recorded phenotypic attributes (i.e. the number of spots on the head, the presence of a slash under the jaw, presence of white fin tips, etc.) and used the genetic results to determine which phenotypic trait(s) were most reliable when identifying species. The Palisades Creek work is a collaborative research/management effort conducted by regional staff and research staff from Nampa Research. The full report on the Palisades Creek project is not reported here, but are published by Larson et al. 2013.

We assessed RBT and BNT distribution in tributaries and calculated a population estimate of YCT for the Burns Canyon Sub-watershed in Burns Creek upstream of the weir using multiple pass depletion backpack electrofishing surveys. We sampled 13 sites in Burns and Little Burns creeks spaced approximately 1 km apart. Multiple-pass depletion estimates were calculated using fish >100 mm at five of the 13 sample site (Figure 47). The remaining 8 sites were sampled with single pass electrofishing. We used linear regression to relate population estimates to single pass catch and used this relationship to generate estimates for the single pass sites as explained by Meyer (1999). To extrapolate for a sub-watershed-wide estimate, we first identified the total lengths of stream in the sub-watershed with fish present by stream order (Strahler 1964). Next, we standardized the YCT abundance by fish/100 m by calculating the mean abundance and variance for all survey sites within each separate stream order. We then multiplied the stream order-specific mean YCT abundance for each stream order by the total number of 100-m reaches within the corresponding stream order. Finally, we summed the abundance and variance estimates for all stream orders to obtain a total abundance estimate with a 95% confidence bound (see Meyer et al. 2006).

We sampled three sites in Fall Creek to verify the presence of the only Brook Trout population to be documented in the South Fork Snake River drainage below Palisades Dam (Figure 48). All three sites were sampled using multiple pass depletion techniques to estimate fish abundance ≥100 mm for each fish species using Microfish.

RESULTS

South Fork Population Monitoring

We captured 1,188 trout at the Lorenzo monitoring reach, including 230 YCT, 16 RBT, and 942 BNT. We also captured 619 mountain whitefish. Our abundance estimates include age 1 and older YCT (≥102) and BNT (≥178). We estimated YCT densities at 321 (±93) fish/km and 784 (±99) BNT per kilometer (Table 18; Figure 49). Density estimates for YCT at Lorenzo have been steadily increasing since 2005. YCT at Lorenzo have had a positive intrinsic rate of change since 2005 (r = 0.20) indicating the population has been increasing since 2005. The BNT population over the same time frame has been fairly stable with an intrinsic rate of change close to zero (r = -0.05). An abundance estimate for RBT has not been possible in the Lorenzo monitoring surveys due to the low number of RBT encountered. However, the total trout estimate for 2012 was 1,329 trout/km and RBT comprised 1.3% of the catch. An extrapolation from these two statistics yields a rough estimate of 17 RBT/km in the Lorenzo reach in 2012 which is slightly higher than the 10 year average of 14 RBT/km for 2002-2012. Mountain whitefish were abundant in the Lorenzo monitoring reach with an estimate of 1,512 fish/km (95% CI: 619 – 3,066).

We captured a total of 3,448 trout at the Conant monitoring reach. This included 1,233 YCT, 990 RBT, and 1,225 BNT. We captured a total of 577 mountain whitefish during the Conant survey. We estimated there were 1,059 YCT/km (±104), 1,198 RBT/km (±177), and 892 BNT/km (±111) of age 1 and older trout (Table 19; Figure 50). The 2010 through 2012 estimates for RBT and YCT per km did not differ statistically. Brown Trout have increased in abundance at Conant annually since 2009. The mean abundance of BNT from 1982 through 2009 at Conant was 334 BNT/km. The 2012 estimate for BNT at Conant was more than double this long-term average, and BNT now approach densities of both YCT and RBT in this reach. The density of YCT at Conant since 2004 has been slowly increasing as indicated by a positive intrinsic rate of change (r = 0.09). Rainbow Trout and BNT populations have also experienced increasing trends at Conant since 2004 with r = 0.13 for each species for that time frame. We estimated Mountain whitefish abundance in the Conant monitoring reach at 2,857 fish/km (±4,395). Observations of bird scars from 2008 through 2012 have been minimal (Table 20).

Age-1 Brown Trout abundance was correlated with flows, temperature, and adult BNT abundance. Using simple linear regressions, the monthly statistics with the strongest correlation values included the monthly minimum flows from October through December (positive correlation), the May maximum flow (positive correlation), the average February minimum air temperatures (negative correlation), the August minimum air temperatures (negative correlation), and age 2 and older BNT abundance the prior year (positive correlation). Since there were three months of fall flows correlated with age 1 BNT abundance, we combined the months of October through December and used the average minimum monthly flow for each year. These five parameters were ranked as follows by the Best Subset Regression: the average February minimum air temperature, the average minimum monthly flows from October through December, the minimum August daily air temperature, the abundance of age 2 and older BNT the previous year, and the maximum May river flows. All Multiple Linear Regression models were significant at the α=0.05 level. The adjusted R2 values increased with each successive addition of a new parameter, excluding the last one (the maximum May flows). Thus, the best model included the other four parameters (Table 21). We did not discover unusual patterns when we examined the residuals for this model.

Weirs

We captured 496 YCT and no RBT in 2012 at the Burns Creek weir (Table 22). By June 12, 50% of the YCT run had passed the Burns Creek trap. The observed YCT sex ratio at Burns Creek was 48% male, 52% female. While we handled a total of 496 YCT at the Burns Creek trap, 15 (3%) YCT captured at the trap fell back downstream of the fall/velocity barrier and entered the trap again. Most (13) of these fallback YCT were males. We captured 52 fluvial YCT upstream of the fish trap on July 12. All but five of these fish were previously captured in the fish trap, yielding a trapping efficiency estimate of 90%.

We captured 1,427 YCT and three RBT at the Pine Creek weir in 2012 (Table 22). Half of the YCT run had passed the weir by June 6. Overall, 63% of the YCT were female. The fallback rate of YCT at Pine Creek in 2012 was 7% (99 fish). Most of the YCT that fell back (64) were female. We were not able to capture enough fish upstream of the Pine Creek weir in 2012 to estimate trap efficiency.

We only captured seven YCT at the Rainey Creek weir, including three males and four females. Half of these fish had passed the weir by June 4 and none of them fell back to re-enter the trap later.

At the Palisades Creek weir, we captured 232 YCT and 20 RBT in 2012. By June 19, half of the spawning run of YCT had passed the Palisades Creek weir. Most (62%) of the YCT were female. Only 2% (five YCT including two males and three females) fell back through the Palisades Weir after being passed upstream and later entered the trap a second time. We captured 25 fluvial YCT in the bypass trap of the Palisades Canal screen-yard and 22 were marked indicating they were captured at the Palisades Creek weir earlier. The estimated trap efficiency for 2012 was 88%.

Creel Survey

South Fork angler effort was estimated at 385,152 hours for the 2012 season. Anglers fishing from boats made up 86% of this effort. Overall, most angling effort (92%) occurred from May through October (Table 23). The number of angler trips also followed this trend with 88% of the 282,103 angler trips occurring from May through October (Table 24). Angler trips were also longer during these months, averaging 3.4 hours compared to 2.0 hours for January through April and November through December. Most anglers were fly-fishing (71%), but anglers fishing with lures (16%) and bait anglers (13%) were also represented.

Anglers caught an estimated 370,497 trout in 2012, including 116,450 YCT, 85,451 RBT, and 168,596 BNT. Anglers also caught 37,490 MWF (Table 25). The overall catch rate for anglers on the South Fork in 2012 was 0.92 fish/hour.

Harvest composition was dominated by RBT. A total of 43,288 trout were harvested in 2012 of which 65% or 28,282 were RBT (Table 25). Monthly harvest rates were highest during March, May, and October with an average of 0.17 harvested fish per angler trip. Harvest during the remainder of the year averaged 0.03 harvest fish per angler trip (Table 25). Angler catch and harvest increased over the previous creel survey estimates for all species except Mountain Whitefish (Table 26).

Spring Flows

The general linear models correlating maximum spring flows with age-1 abundance for YCT and RBT yielded different results. Maximum spring flows significantly affected the abundance of age 1 YCT in the Conant monitoring site the following year (Figure 51; F=7.341, df=6, P=0.04). However, no statistical evidence indicated maximum spring flows affected age 1 RBT abundance the following year (F=0.232, df=7, P=0.65).

South Fork Angler Incentive Program

In 2012, we marked 860 RBT with CWT between Palisades Dam and Heise for the Angler Incentive Program. We tagged 585 RBT with $50 tags, 200 with $100 tags, 50 with $200 tags, 20 with $500 tags, and 5 fish with $1,000 tags. A total of 190 anglers turned in 1,726 RBT in 2012. Overall, anglers turned in a median of 3 RBT and an average of 9 RBT. Of the 1,726 RBT brought in to IDFG there were 37 tagged fish. The tag values and number that were turned in were $50 (21), $100 (12), $200 (two), and two $500 for a total of $3,650. Anglers who fished with bait generally turned in more fish than non-bait anglers, turning in a median of four RBT (range one to 196) compared to a median of two RBT turned in (range one to 168) for non-bait anglers. Non-resident anglers who turned in fish for the Angler Incentive Program used bait in similar proportion as resident anglers. Most (126) of the anglers participating in the Angler Incentive Program in 2012 did not use bait and they turned in 904 fish (52%). There were 822 fish (48% of all fish turned in) turned in by 64 anglers who did report using bait.

Creel clerks obtained fishing license numbers from 23 anglers who, when interviewed in 2012 along the river during the creel survey, had RBT in possession. Of these, four anglers (17%) later submitted RBT to the Angler Incentive Program, the majority of anglers who harvested RBT on the South Fork in 2012 did not participate in the Angler Incentive Program.

PIT Tags

In 2012, we marked an additional 2,838 YCT with PIT tags bringing the total number of marked YCT released in the South Fork since 2008 to 14,751. The breakdown of tagging events in 2012 is as follows: Burns Cr Weir – 393 fish, Pine Cr Weir – 687, Rainey Cr Weir – nine, Palisades Cr Weir – 191, mainstem winter shocking – 493, Palisades and Burns creeks tributaries – 429, Lorenzo monitoring site – 203, and Conant monitoring site – 433. We recorded 2,093 recapture events during 2012.

Spawning stream fidelity was high (99.5%) for YCT recaptured at the four major spawning tributaries of the South Fork. In 2012 we recaptured 560 YCT which had previously been observed at spawning tributaries during spring runs and had retained PIT tags, including 279 at Burns Creek, 249 at Pine Creek, one at Rainey Creek, and 31 at Palisades Creek. All but three fish were observed returning to the same spawning tributary. The three fish that strayed moved from Palisades Creek to Pine Creek (two fish) and from Pine Creek to Burns Creek (one fish). Repeat spawning was estimated at 59%, 66%, and 42% for yearly spawners at Burns, Pine, and Palisades creeks, respectively. The single recapture at Rainey Creek was also captured the previous year at Rainey Creek. Alternate year spawners comprised 19% of the recaptures at Burns Creek and 33% at Pine Creek, and 58% at Palisades Creek. A few fish were observed in the 2012 spawning run for the first time in three years (1% or three fish at Burns Creek, and 1% or two fish at Pine Creek).

Overwinter site fidelity was high, similar to spawning stream fidelity. In 2012, we recaptured 39 YCT that had previously been captured during winter electrofishing efforts along the mainstem of the South Fork. All except one of the 39 recaptured YCT (97%) were caught in the same or adjacent river segment in 2012 as they were observed in during previous winters dating back as early as 2009. The one exception had been captured twice, once in 2009 and again 2012 approximately 18 km and three river segments upstream from the original point of capture.

Spawning migrations for YCT in the South Fork can be lengthy and occur in both upstream and downstream directions. Through the 2012 spawning run, we have recaptured 745 PIT-tagged YCT at the four South Fork tributary spawning weirs which had originally been tagged at locations other than the spawning weirs. The average distance from the tagging location to the spawning tributary weirs were 0.5 km for YCT recaptured at Burns Creek, -2.1 river km for YCT recaptured at Pine Creek, 32.0 km for YCT recaptured at Rainey Creek, and 14.8 river km for YCT recaptured at Palisades Creek (Table 27). The maximum downstream migration observed was 37.5 river km for a Burns Creek spawner and the maximum upstream migration observed was 85.7 river km for the YCT returning to Rainey Creek with a PIT tag.

South Fork Tributary Population Monitoring

Brown Trout and Rainbow Trout abundance and distribution in the Burns Creek sub-watershed were restricted to within 2 – 3 km upstream of the fish trap. Brown Trout and/or RBT were only captured in the first two sample sites in Burns Creek. There were too few sites with BNT and/or RBT present to effectively extrapolate a sub-watershed wide estimate in Burns Creek.

We estimate there were 1,615 (±466) YCT ≥100 mm in Burns Creek and Little Burns Creek upstream of the fish trap in 2012. There were six sample sites in 2nd order stream sections of the Burns and Little Burns creek with an average YCT density of 7.5 YCT ≥100 mm per 100 m. There were four sample sites in 3rd order stream sections of Burns Creek with an average YCT density of 21.9 YCT ≥100 mm / 100 m. Within Burns Creek and Little Burns Creek, first order stream sections were fishless, second order stream sections with fish included approximately 5,680 m, and there were approximately 5,442 stream m of third order stream sections with fish present. The remaining three survey sites in 1st order stream sections did not have fish present.

We documented the presence of Brook Trout in Fall Creek upstream of Fall Creek Falls. Brook Trout were abundant (>20 brook trout/100 m) in all three sites sampled and dominated species composition in Site 1, the site closest to the mouth (Table 28). Yellowstone Cutthroat Trout were also present and abundant at all sites with abundances ranging from 32 to 283 fish/100 m. Brook Trout densities ranged from 20 to 68 fish/100 m.

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. For a third consecutive year, RBT and YCT density estimates remained similar, around 1,200 fish per kilometer. While management efforts have stalled the RBT population growth rate, efforts to cause a decrease in RBT abundance to mid-1990 levels (no more than 10% species composition) as stated in the state Fisheries Management Plan (IDFG 2012) have not been successful. Currently, RBT are 29% of the species composition at the Conant monitoring site. 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). Yellowstone Cutthroat Trout are still abundant in the South Fork at the Conant monitoring site, but RBT continue to pose a significant threat to their persistence.

Another possible threat to YCT in the South Fork is a burgeoning BNT population. The near record estimates of trout at the Conant monitoring reach the last two years have been the result of increasing numbers of BNT. While YCT and RBT numbers have been stable from 2010 through 2012, BNT have doubled their long-term average. This is the first time BNT have exhibited an increasing trend in abundance at both this scale and duration in the upper South Fork. Brown Trout in the South Fork had two very successful recruitment years in 2009 and 2010. We found that minimum fall river flows (Oct. through Dec.), average minimum February air temperatures, minimum August air temperatures, and the abundance of Brown Trout spawners were all correlated with abundance of age 1 BNT accounting for over half of the variation in age 1 BNT abundance. Based on this analysis we would predict that BNT would have more successful spawning years when lower minimum August air temperatures are followed by relatively high river flows from October through December, cold minimum air temperatures in February, and a high number of Brown Trout adults were present during the spawn. These statistics may be due to chance, but may partly be explained biologically. Since brown trout spawn in the main river, it makes sense that higher flows during spawning season would benefit Brown Trout recruitment. Likewise, cool August water temperatures close to their thermal optimum likely benefit Brown Trout fitness just prior to a spawn. Cooler temperatures in February likely increase the time that Brown Trout eggs and sac fry remain in the gravel, thereby causing emergence to occur later in the year when productivity increases. Further studies would be necessary to determine if this results in increased fry survival and recruitment. If conditions that result in high Brown Trout recruitment occur on a more frequent basis in coming years, Brown Trout abundance will likely continue to increase and interactions between BNT on YCT should be evaluated. Abundant BNT have been linked to declines in abundance and/or distributions of Cutthroat Trout in Utah (Budy et al. 2007; Budy et al. 2008).

Weirs

All four tributary weirs and traps were operated in 2012, each with their own set of challenges. High spring flows in 2011 mobilized a lot of substrate in Burns Creek, such that a gravel bar formed on top of the velocity barrier leaving only the short waterfall as the only barrier to force migrating fish up the ladder and into the trap. The decreased trapping efficiency from

2011 (90% compared to 100% in 2010; Table 22) indicated the waterfall alone is not enough to effectively block migrating trout, meaning the gravel bar should be removed. IDFG hired a contractor to perform this site maintenance in the fall of 2011 which included re-grading the stream bed downstream of the barrier to the original designed elevation. Unfortunately, the contractor did not remove the gravel downstream of the weir to the original designed elevation. Because of this, water velocities were lower in the stream immediately downstream of the Burns Creek weir in the spring of 2012. Although the spring flows peaked at a much lower level in 2012 than in 2011, a gravel bar formed once again on the velocity barrier. Again, with the velocity barrier negated by a gravel bar, the weir efficiencies were lower than desired. In the fall of 2012, we again removed the gravel from the velocity barrier and returned the streambed below the structure to a level that increased flow velocities below the weir. The effects of this most recent maintenance effort will be evaluated in the spring run of 2013.

The Pine Creek electric weir was the least problematic weir to operate in 2012, and likely had the highest trapping efficiency. However, an efficiency estimate was not available in 2012 due to spawning YCT out-migrating earlier in 2012 than in previous years. Water levels were lower overall than in recent years, and may have affected YCT spawning behavior. While the 2012 Pine Creek trap efficiency is unknown, we have yet to document a 100% effective weir at Pine Creek. The area where efficiency could most likely be improved at this site is electric waveform modification. In 2012, Nampa Research initiated an investigation on the effects of the electric weirs on spinal injury of migrating YCT with the assistance of Dr. Jim Reynolds. This work is reported in Larson et al. 2013. Results from this study will be extremely helpful for determining appropriate levels of electric weir settings to maximize efficiency without causing unnecessary spinal injuries. Larson et al. (2013) reports evidence suggests electric weirs do cause low levels of spinal injuries, mostly compressions and misalignments, but the low level of spinal injury is not expected to impact the YCT population. Their recommendation is to increase electric weir field settings to maximize weir effectiveness.

The Rainey Creek electric weir has proven to be the most problematic weir in recent years due to stray electric fields and limited water velocities through the fish trap. A stray electric field was present in the fish trap throughout the 2011 spawning run, and was thought to be negatively impacting catch rates. Based on recommendations from Smith-Root, Inc. we installed sheet metal along the entire inside wall of the fishway to address the problem with the stray electric field. This modification successfully lowered the electricity in the fish trap. Trap efficiency has also been limited by the formation of a sand bar upstream of the trap way that effectively limits flows through the trap. We installed an electric pump to pump water out through the funnel trap at the trap entrance partway through the 2012 spring run. It was obvious that attractive flows were an issue, as fish started coming into the trap the first day the pump was in operation. We operated the pump as much as possible for the remainder of the spawning run, but only captured a total of seven YCT. Compared to the catch of 146 YCT in 2010, it is clear that the Rainey Creek weir is not operating at an appropriate level. IDFG is working with the Caribou-Targhee National Forest hydrologist to come up with options to modify the upstream channel at the site to increase flows through the fish trap. Without these modifications and in the absence of Rainbow Trout, caution should be used when operating the Rainey Creek trap to avoid blocking cutthroat use of this important spawning tributary.

The Palisades Creek electric weir was repaired after the damage from 2011 (see Schoby et al. 2013). Future weir damage in similar high flows can be avoided, but will require cooperation and coordination with the Palisades Creek Canal water users. In 2012, the efficiency of the electric weir was good (88%), but could be improved. Here again, the research conducted by the Nampa Research crew will result in increased efficiencies at the Palisades

Creek weir through maximizing the electrical output settings for the best trapping efficiency without harming fish (Larson et al. 2013).

The tributary weir program has been successful at limiting RBT invasion into the four major YCT spawning tributaries of the South Fork Snake River. Evidence of this success is the number of RBT encountered at each of the tributary weirs each spring. During the first three years of operation there were 50, 48, zero, and 651 RBT captured at the Burns, Pine, Rainey, and Palisades creeks weirs, respectively. During the most recent three years (2010 through 2012) we removed seven, seven, one, and 83 RBT from Burns, Pine, Rainey, and Palisades creeks, respectively during the spawning runs (Table 22). That is an average reduction of 86% fewer RBT migrating into Burns, Pine, and Palisades creeks.

Creel Survey

Compared to the most recent creel surveys on the Henrys Fork Snake River (54,888 hours; IDFG unpublished data) and Henrys Lake (124, 613 hours; High et al. 2011), the other major fisheries in the Upper Snake Region, anglers spent the most hours fishing the South Fork in 2012 (385,152 hours). Annual estimates of angler effort, catch, and harvest are all substantially higher in 2012 than estimates from the only previous year-long creel survey for the entire river in 2005. Estimates for effort and catch increased about 65% more than the 2005 estimates. This is reflective of the 61% increase in YCT abundance between 2005 and 2012 estimates of YCT at Conant. Interestingly, while Rainbow Trout abundance increased by 185% between 2005 and 2012, harvest on rainbows increased 321%. Similarly, Brown Trout abundance increased 332% while harvest increased 697%. The reason for the overall increase in harvest is likely a function of several factors, including increased abundances of trout (i.e. increased opportunity to harvest), increased fishing pressure, more educational outreach, and increased angler buy-in on YCT management efforts including the Angler Incentive Program. However, increased fishing pressure likely had the least impact of these factors as its increase was disproportional to the increases in harvest.

Catch rates were higher in 2012 (0.92 fish/hour) than in 2005 (0.69 fish/hour; Schrader and Fredericks 2006a). The increase in catch rates is likely due to the increased abundance of trout. Overall, the 2012 trout densities were twice the 2005 densities at the Conant monitoring and 30% higher than the 2005 density at the Lorenzo monitoring reach. Angler types for both the 2005 and 2012 were very similar with most anglers fishing the South Fork from boats using fly tackle. Composition of fly, lure, and bait anglers between the 2005 and 2012 creel surveys were nearly identical.

Spring Flows

Increases in spring flows benefit YCT recruitment, but are not necessarily correlated with reduced RBT recruitment. Since 2004, increases in maximum spring flows are significantly correlated with increasing abundance of age 1 YCT the following year. Flows during these years ranged from 396 to 668 m^3/s. The relationship between higher maximum spring flows and higher age 1 YCT recruitment are likely related the fact that YCT use increasing spring flows as a spawning cue (Thurow and King 1994; Henderson et al. 2000). Tributary flows are also likely related to the significant relationship between spring flows and age 1 YCT abundance as years with higher flow releases from Palisades Dam are typically years with higher snowpack and increased tributary flows which benefit YCT recruitment in spawning tributaries (Varley and Gresswell 1988). The abundance of age 1 RBT was not significantly correlated with flows, suggesting maximum flows did not reach levels sufficient to mobilize gravel in the river bed and thus disturb developing embryos. This finding corroborates previous studies on the South Fork that indicated spring flows in 2005 peaking at 422 m^3/s were not sufficient to move small radio transmitters placed in RBT redds (Schrader and Fredericks 2006a) and that South Fork riverbed material is not mobilized until flow reach 736 m^3/s (Hauer et al. 2004).

Previous analyses have not found significant relationships between age 1 trout abundance and spring flows the prior year, but these analyses used different parameters. An analysis comparing age 1 YCT and age 1 RBT abundance to the previous spring's maximum: minimum flow ratio did not yield significant results (Schoby et al. 2013). Indeed, when an additional year of data was added to this dataset, and the analysis was rerun, results were again not-significant. Maximum spring flows were used for the analysis in this report because recent efforts to model trout populations in the South Fork have indicated maximum spring flows affect trout populations more than the ratio of maximum spring flows to the prior winter's base flow (IDFG unpublished data).

South Fork Angler Incentive Study

The South Fork Angler Incentive Program may benefit the South Fork YCT population more from an outreach/education standpoint than through biologically meaningful reductions in hybridization or competition with RBT. There were 3,048 RBT turned in to IDFG the first year of the program in 2010 by 683 anglers (Schoby et al. 2014). In 2012, we had a 72% reduction in angler participation in the South Fork Incentive Program and a 43% reduction in the number of RBT turned in to IDFG compared to 2010. Although angler participation in the program may have decreased, creel clerks conducting interviews sometimes asked anglers if they were aware of the Angler Incentive Program, though this was not part of the formal interview. The clerks reported that many of those people when asked if they knew about the Angler Incentive Program, indicated they were. Thus, the existence of the program does bring awareness to conservation efforts for Yellowstone Cutthroat Trout and does become a point of discussion among professional fishing guide groups, between guides and their clients, and among other anglers.

Many anglers are harvesting RBT but not turning fish in to IDFG to check for CWT in the Angler Incentive Program. It appears over 80% of anglers who harvest RBT on the South Fork do not participate in the Angler Incentive Program. While this estimate is based on a small sample size (23 anglers), the number of Rainbow Trout estimated as harvested in the creel survey lends credence to the thought that few anglers actively participate in the Angler Incentive Program. The total number of fish turned in to IDFG for the Angler Incentive Program (1,726) was 6% of the 2012 total annual harvest estimate of RBT, which is similar to our estimate of the percent of anglers who participate in the Angler Incentive Study. For some unknown reason, the Angler Incentive Program is not encouraging many anglers to turn in harvested fish. While many South Fork anglers may not turn in their catch to IDFG, the Angler Incentive Program does appear to be encouraging harvest as the RBT harvest estimate for 2012 was increased substantially more than the increase in abundance of RBT between 2005 and 2012.

PIT Tags

Information collected from PIT tagged YCT indicates strong fidelity to both spawning tributaries as well as overwinter habitat. Yellowstone Cutthroat Trout have been captured during three different seasons annually since 2009, including winter mainstem 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 occur in the same area of the drainage cutthroat were originally marked in if the original tagging occurred in the same season.

Spawning periodicity among the South Fork's YCT tributary spawners is variable. Most fluvial YCT spawn annually in the South Fork's major spawning tributaries, but PIT tag recapture data indicates some fish exhibit an alternate year spawning cycle. However, some of these "apparent" alternate year spawners may be YCT that somehow migrated past tributary weirs during the spawning season. We know we had low capture efficiency at Palisades Creek in 2011 since the electric weir was damaged and inoperable shortly after the spawning run started. This is likely the reason why the PIT tag data suggests Palisades Creek was the only tributary where alternate year spawners outnumbered annual spawners. As we continue to improve the operation of tributary weirs and certainly with the addition of fixed PIT tag arrays on Burns, Pine, and Palisades creeks, we will obtain better estimates of spawning periodicity for fluvial YCT in the South Fork in the future. For now, however, it appears most fluvial YCT spawn annually with some spawning alternately or even less regularly. This diversity in spawning frequency has been observed elsewhere for YCT including Yellowstone Lake (Bulkley 1961; Jones et al. 1985).

The maximum observed spawning migrations for YCT in the South Fork indicate these fluvial fish travel long distances in both upstream and downstream directions and highlights the importance of connected and high quality habitat throughout the drainage. 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 have been observed in Burns, Pine, and Rainey creeks during spawning migrations and/or fish observed in these spawning tributaries are later observed in the Lorenzo monitoring reach. 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.

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. Remove resident RBT from Palisades Creek for at least two more years to determine if manual removal efforts reduce introgression rates.

4. Remove resident RBT and BNT from Burns Creek upstream of the fish trap using backpack electrofishing similar to Palisades Creek.

5. Assess the distribution and abundance of Brook Trout in Fall Creek and suitability of habitat for a chemical fish removal treatment or alternate methods of improving cutthroat abundance.

6. Consider alternate methods to reduce Rainbow Trout abundance. Evaluate public support for more aggressive RBT management actions in the mainstem South Fork such as relocating RBT from spawning beds to area kids fishing ponds using electrofishing.

7. 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.

8. Assess entrainment rates through the Great Feeder Diversion in the Dry Bed Canal using a PIT array and radio telemetry.

Table 18. Summary statistics from the Lorenzo monitoring site between 1987 and 2012 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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
2012	134	106	10	9.43	321.042	93.3	0.15	5	11	0	0.0				437	435	51	11.7	783.75	99.3	0.06	607	642	61	9.5	1,329	66	0.05

Table 19. Summary statistics from the Conant monitoring site between 1982 and 2012 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	BRN/Km	x SD	CV	M	C	R	R/C	trout/Km	SD	CV
1982					1,899							26							412									
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	641	253	0.20	1,385	667	80	0.12	2,351	236	0.10
1987	281							5							26							312						
1988	1,100	561	98	17.5	1,491	148	0.05	41	18	1	5.6				113	46	4	8.7	340	310	0.47	1,254	625	103	0.16	1,836	88	0.05
1989	1,416	1,050	200	19.0	1,610	108	0.03	57	55	10	18.2	63	26	0.21	92	76	11	14.5	191	162	0.43	1,565	1,181	221	0.19	1,791	54	0.03
1990	1,733	1,522	317	20.8	2,330	173	0.04	113	109	14	12.8	204	64	0.16	173	117	12	10.3	369	133	0.18	2,019	1,748	343	0.20	2,984	89	0.03
1991	1,145	625	140	22.4	1,399	136	0.05	98	54	9	16.7	134	54	0.20	150	119	19	16.0	195	52	0.14	1,393	798	168	0.21	1,616	58	0.04
1992	595							34							76							705						
1993	972	623	100	16.1	1,512	150	0.05	74	41	6	14.6	110	51	0.24	101	64	10	15.6	135	78	0.29	1,147	728	116	0.16	1,643	66	0.04
1994	853							87							110							1,050						
1995	631	542	77	14.2	1,230	147	0.06	130	140	17	12.1	270	72	0.14	150	108	13	12.0	294	176	0.31	911	790	107	0.14	1,696	79	0.05
1996	707	548	72	13.1	1,502	225	0.08	155	111	5	4.5	594	420	0.36	212	124	18	14.5	314	78	0.13	1,074	783	95	0.12	2,292	131	0.06
1997	910	895	164	18.3	1,145	76	0.03	429	467	72	15.4	604	73	0.06	344	281	82	29.2	369	203	0.28	1,683	1,643	318	0.19	1,969	48	0.02
1998	674	682	61	8.9	1,691	204	0.06	216	247	26	10.5	461	79	0.09	257	216	49	22.7	249	36	0.07	1,147	1,145	136	0.12	2,191	79	0.04
1999	1,019	883	117	13.3	1,847	163	0.04	345	241	29	12.0	654	127	0.10	293	241	31	12.9	512	169	0.17	1,657	1,365	177	0.13	2,827	90	0.03
2000	797							260							133							1,190						
2001	776							321							208							1,305						
2002	495	394	50	12.7	841	119	0.07	295	257	24	9.3	785	195	0.13	111	104	9	8.7	288	122	0.22	901	755	83	0.11	1,803	81	0.05
2003	422	571	72	12.6	840	119	0.07	272	360	29	8.1	931	226	0.12	143	165	27	16.4	240	99	0.21	837	1,096	128	0.12	1,821	67	0.04
2004	315	379	51	13.5	478	61	0.07	227	304	29	9.5	530	104	0.10	169	202	22	10.9	383	204	0.27	711	885	102	0.12	1,441	62	0.04
2005	391	254	30	11.8	658	205	0.16	172	142	11	7.7	421	211	0.26	115	95	10	10.5	206	105	0.26	678	491	51	0.10	1,588	200	0.13
2006	423	365	54	14.8	749	104	0.07	289	251	23	9.2	677	178	0.13	215	223	31	13.9	329	70	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	825	113	0.07	404	289	50	17.3	530	117	0.11	1,753	1,218	174	0.14	2,713	87	0.03
2008	377	554	51	9.2	1,065	156	0.07	187	318	25	7.9	574	108	0.10	205	253	29	11.5	380	57	0.08	769	1,125	105	0.09	1,882	74	0.04
2009	623	489	90	18.4	826	87	0.05	475	425	34	8.0	1,408	302	0.11	261	219	42	19.2	307	48	0.08	1,359	1,133	166	0.15	2,276	80	0.04
2010	389	307	27	8.8	1,211	284	0.12	286	139	7	5.0	1,174	666	0.29	178	154	14	9.1	479	136	0.15	853	600	48	0.08	2,295	297	0.13
2011	609	429	70	16.3	1,225	221	0.09	448	311	28	9.0	1,190	256	0.11	357	300	29	9.7	796	166	0.11	1,414	1,040	127	0.12	3,002	142	0.05
2012	721	601	102	17	1,059	104	0.05	445	518	44	8.49	1,198	177	0.08	561	573	75	13.1	892	111	0.06							

Table 20. Observations of fish with bird scars in the South Fork Snake River from 2008 through 2012 during annual Yellowstone Cutthroat Trout PIT tagging efforts and fall population surveys at the Conant monitoring site.

	PIT tagged fish		Fish captured at Conant	
Year	# tagged	# with bird scars	# fish	# with bird scars
2008	938	5	1,804	2
2009	4,207	5	2,407	7
2010	3,890	11	1,682	2
2011	3,790	35	1,371	1
2012	2,842	0	4,086	3

Table 21. Multiple Linear Regression model results investigating correlations between river flows, air temperatures, and Brown Trout spawner abundance with age-1 Brown Trout abundance at the Conant monitoring site between 1985 and 2012. The model with four parameters was selected as the best model.

Predictor variables	DF	F	P	adjusted R^2
1. Average February air temperatures	25	11.98	0.002	0.3051
1. Average February air temperatures 2. Average minimum river flows from October through December	25	10.44	0.0006	0.4303
1. Average February air temperatures 2. Average minimum river flows from October through December 3. Minimum August air temperatures	25	9	0.0004	0.4899
1. Average February air temperatures 2. Average minimum river flows from October through December 3. Minimum August air temperatures 4. Abundance of age 2 and older Brown Trout	19	6.37	0.0034	0.5304
1. Average February air temperatures 2. Average minimum river flows from October through December 3. Minimum August air temperatures 4. Abundance of age 2 and older Brown Trout 5. Maximum May river flows	19	4.76	0.0094	0.4977

Table 22. Summary tributary fish trap operation dates, efficiencies and catches from 2001 through 2012.

Location and year	Weir type	Operation dates	Estimated weir efficiency (%)[a]	Catch: Cutthroat trout	Catch: Rainbow trout	Catch: 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	April 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
2012	Fall/velocity	March 24 - July 11	90	496	0	496
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	April 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
2012	Electric	March 28 - July 1	NE	1,427	3	1,430
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
2012	Electric	April 18 - June 23	NE	7	0	7
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
2012	Electric	March 24 - July 2	88	232	20	252
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
2012				2,162	23	2,185
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 23. Estimated monthly angler fishing effort estimates and associated relative standard errors for the South Fork Snake River, 2012.

	Boat		Bank		TOTAL	
Block	hours	RSE	hours	RSE	hours	RSE
January	753	73.4	3,678	28.8	4,431	26
February	1,313	45.4	2,782	57.8	4,095	29.1
March	2,020	44.2	7,484	23.7	9,504	23.8
April	1,304	61.6	3,766	29.8	5,071	30.2
May	15,887	14.4	3,905	12.8	19,792	14.1
June	38,672	12.7	6,291	12.8	44,964	12.7
July	59,106	7.6	8,751	4.6	67,856	7.1
August	81,292	12.6	4,434	7.1	85,726	12.3
September	96,957	14.5	5,058	10.7	102,015	14.3
October	29,679	10.1	4,910	12.3	34,590	10.4
November	4,364	12.9	971	14	5,335	13.1
December	0	NA	1,774	40	1,774	40
TOTAL	331,347		53,804		385,153	

Table 24. Estimated number and duration of angler trips to the South Fork Snake River in 2012 based on creel interview data collected from anglers who were still fishing at the time of the interview (incomplete trip) and from anglers who had finished fishing for the day (completed trip).

	Incomplete Trips		Complete Trips		Combined Trips	
Block	Total Trips	Mean Length (hr)	Total Trips	Mean Length (hr)	Total Trips	Mean Length (hr)
January	3,649	1.21	2,374	1.87	6,023	1.54
February	3,342	1.23	1,489	2.75	4,831	1.99
March	7,715	1.23	2,224	4.27	9,939	2.75
April	3,857	1.31	2,061	2.46	5,918	1.89
May	11,729	1.62	4,333	4.57	16,062	3.10
June	29,693	1.51	9,428	4.77	39,121	3.14
July	31,976	2.12	11,953	5.68	43,929	3.90
August	34,063	2.52	17,197	4.99	51,260	3.76
September	50,772	2.01	18,934	5.39	69,706	3.70
October	19,084	1.81	8,506	4.07	27,590	2.94
November	3,880	1.38	1,707	3.13	5,587	2.26
December	806	2.20	1,331	1.33	2,137	1.77

Table 25. Annual catch and harvest statistics for the South Fork Snake River, 2012.

	Yellowstone cutthroat trout		Rainbow trout		Brown trout		Mountain whitefish		Sucker sp.	
	Catch	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest
ANNUAL TOTALS	116,450	114	85,451	28,282	168,596	15,006	37,490	352	5,014	-

Table 26. Total annual fishing effort and estimates of catch and harvest for Yellowstone Cutthroat Trout (YCT), Rainbow Trout including hybrids (RBT), Brown Trout (BNT), and Mountain Whitefish (MWF) during 2005 and 2012.

	Catch				Harvest				
Year	YCT	RBT	BNT	MWF	YCT	RBT	BNT	MWF	Effort
2005	68,718	25,524	64,792	37,304	23	6,718	1,883	788	233,009 h
2012	116,450	85,451	168,596	37,490	114	21,642	15,006	352	385,153 h
% Change	69%	235%	160%	0%	396%	222%	697%	-55%	65%

Table 27. Summary of known minimum spawning migrations of Yellowstone Cutthroat Trout in the South Fork Snake River from tagging sites in the main river to one of the four major spawning tributaries (2008 through 2012).

		Overall distance range			Upstream migrants		Downstream migrants	
Spawning tributary	Avg. migration distance	upstream	downstream	n	Avg. distance	n	Avg. distance	n
Burns Creek	0.5 km	49.5 km	-37.5 km	59	23.8 km	27	-19.1 km	32
Pine Creek	-2.1 km	72.4 km	-34.7 km	592	17.8 km	246	-16.3 km	346
Rainey Creek	32.0 km	85.7 km	NA	6	32.0 km	6	NA	NA
Palisades Creek	14.8 km	56.2 km	-2.4 km	88	19.1 km	73	-1.5 km	15

Table 28. Catches and density estimates for Yellowstone Cutthroat Trout (YCT) and Brook Trout (BKT) ≥100 mm at three backpack electrofishing sites in Fall Creek, tributary of the South Fork Snake River, 2012.

	YCT catch by pass			YCT density		BKT catch by pass			BKT density	
Site	1	2	3	fish/100 m	95% CI	1	2	3	fish/100 m	95% CI
Fall Creek #1	32	0	-	32	-	39	0	-	39	-
Fall Creek #2	37	1	-	38	(38-38)	19	1	-	20	(20-20)
Fall Creek #3	217	33	28	283	(278-289)	36	12	12	68	(60-80)

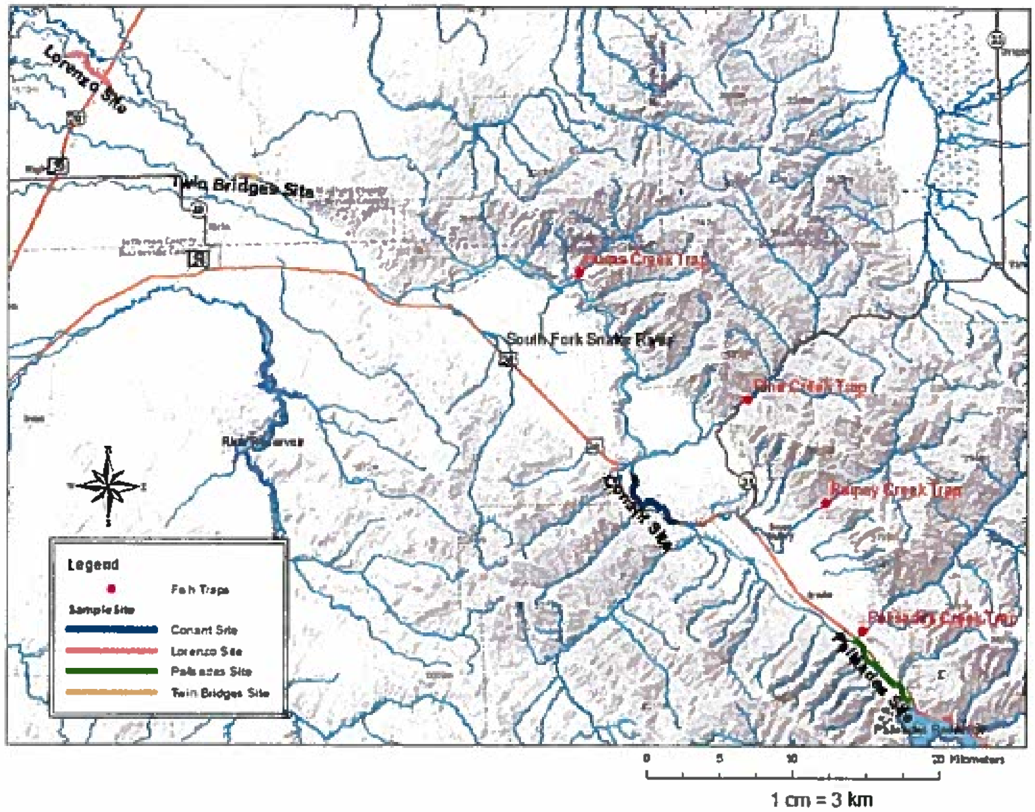


Figure 46. Locations of monitoring sites on the South Fork Snake River and weirs on tributaries.

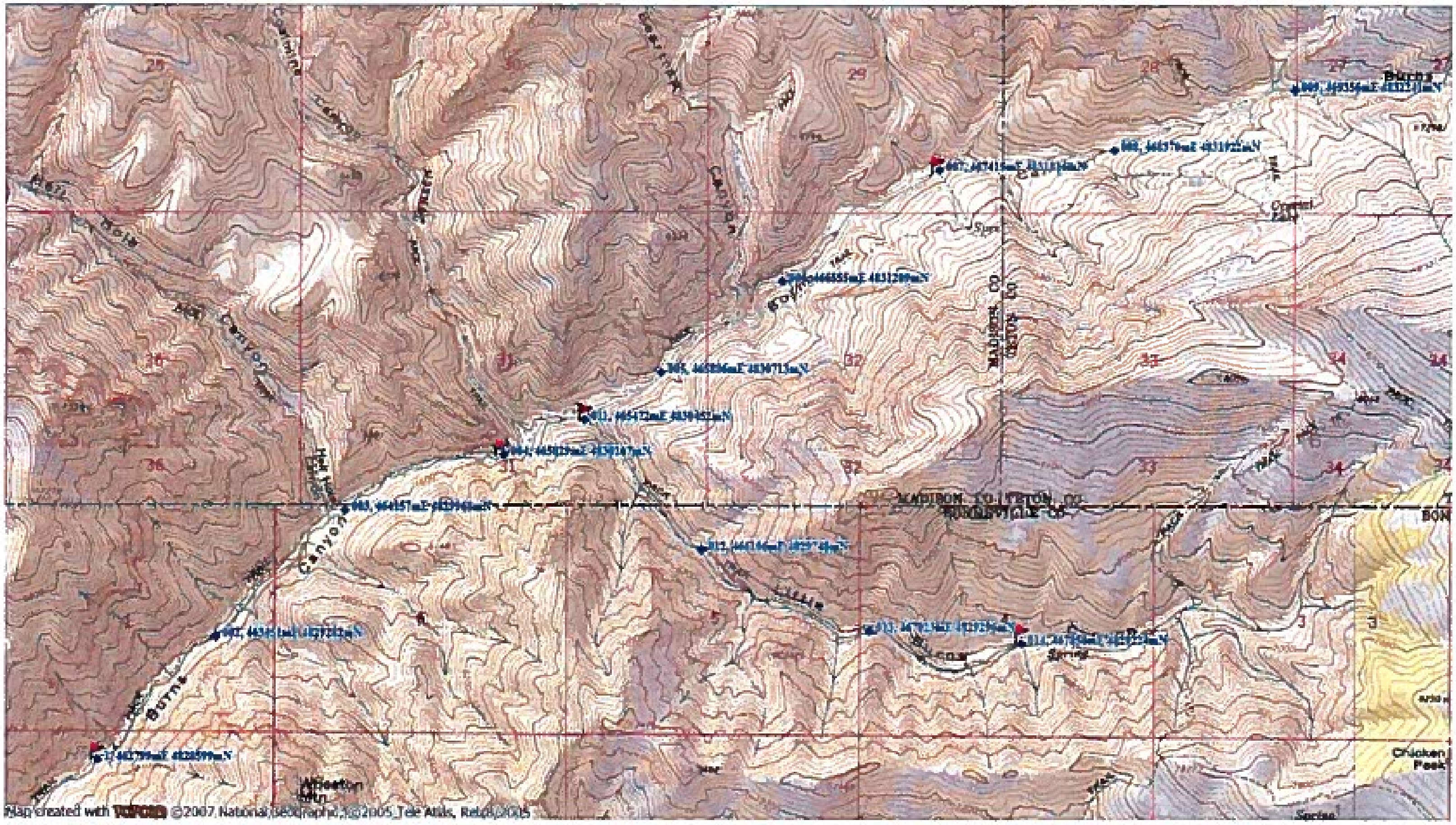


Figure 47. Backpack electrofishing survey site numbers and UTM coordinates in Burns Creek and Little Burns Creek, South Fork Snake River drainage. Sites marked with red flags indicate multiple-pass depletion sites, while non-marked sites were sampled with a single pass.

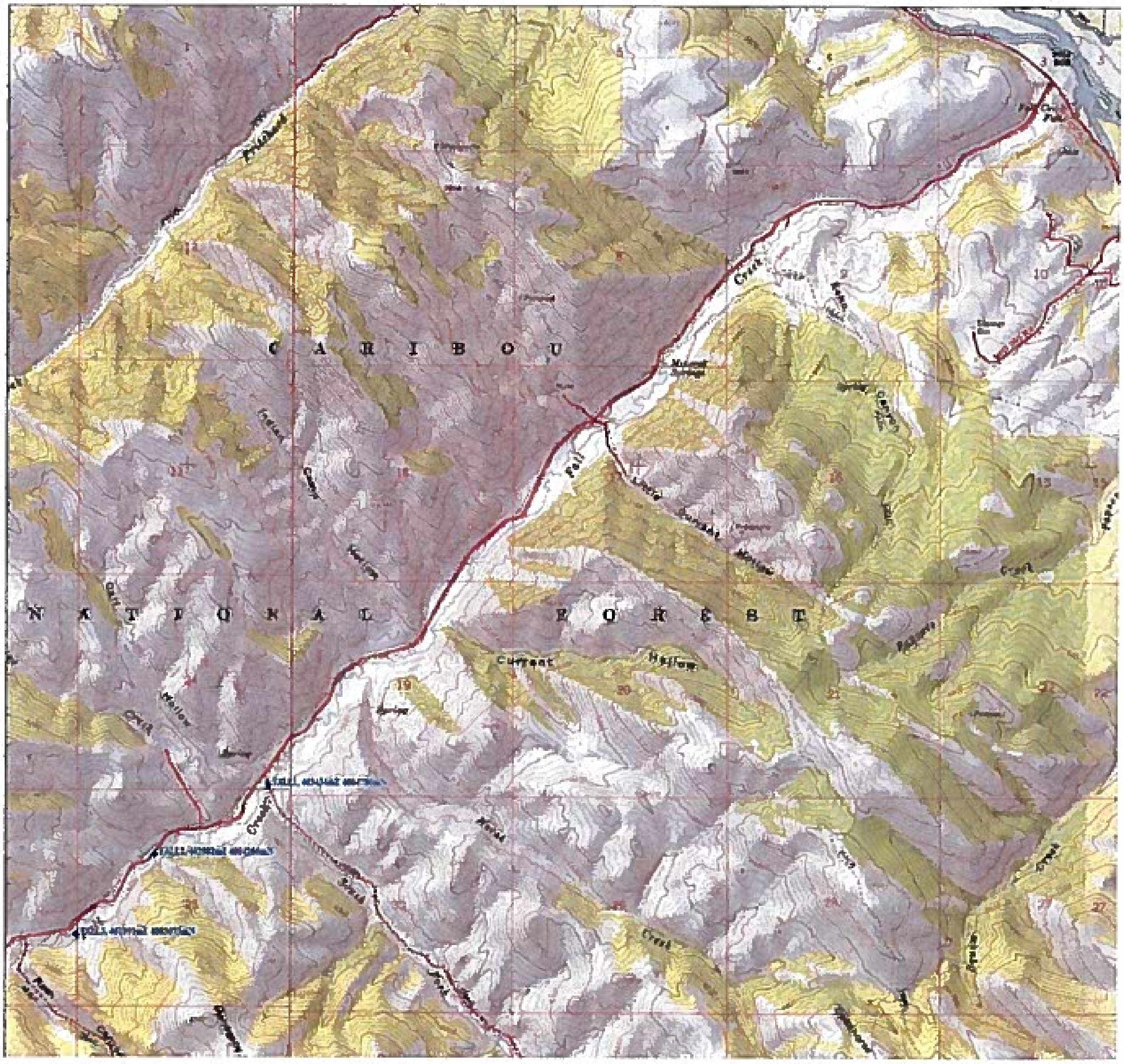


Figure 48. Location of three multiple-pass depletion sites surveyed in Fall Creek in 2012.

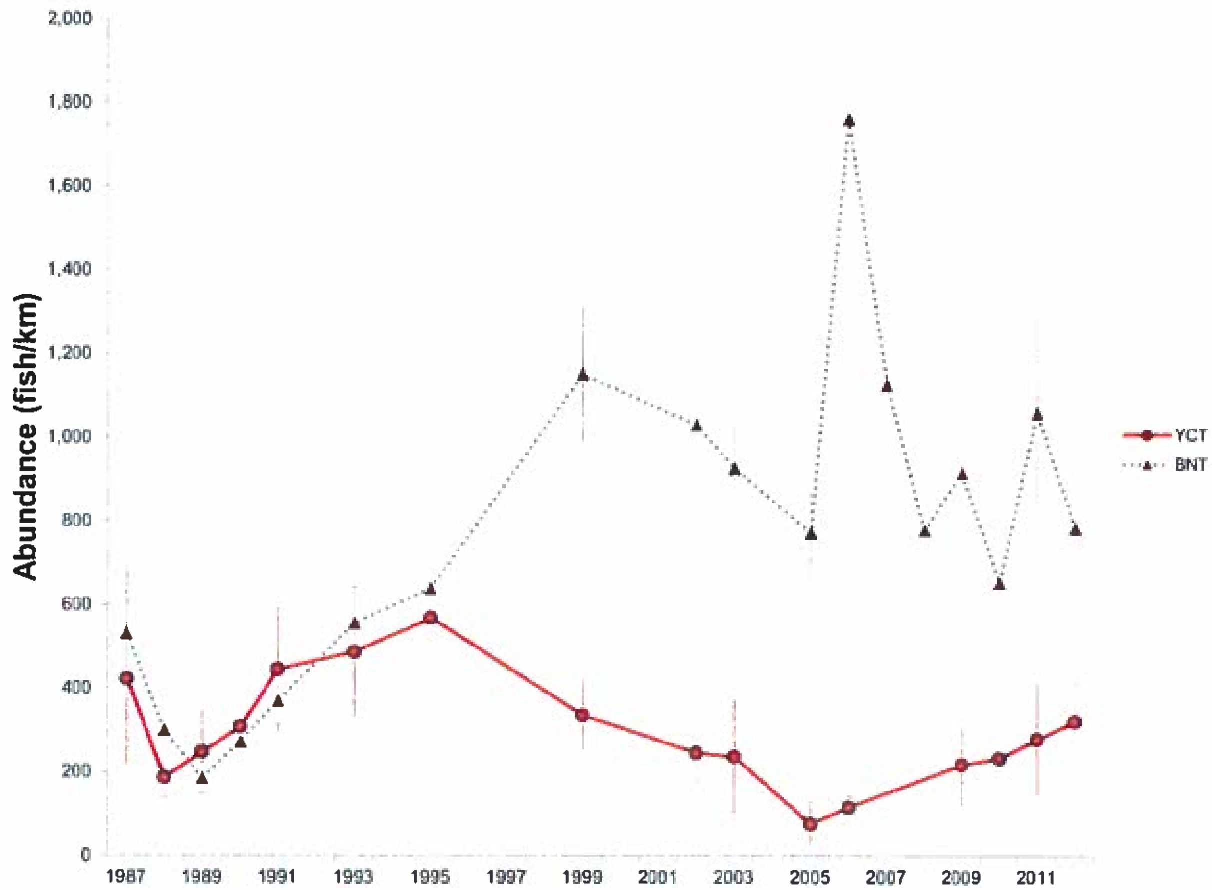


Figure 49. Estimated abundances of Yellowstone Cutthroat Trout (YCT) and Brown Trout (BNT) at the Lorenzo monitoring site on the South Fork Snake River from 1987 through 2012 with 95% confidence intervals

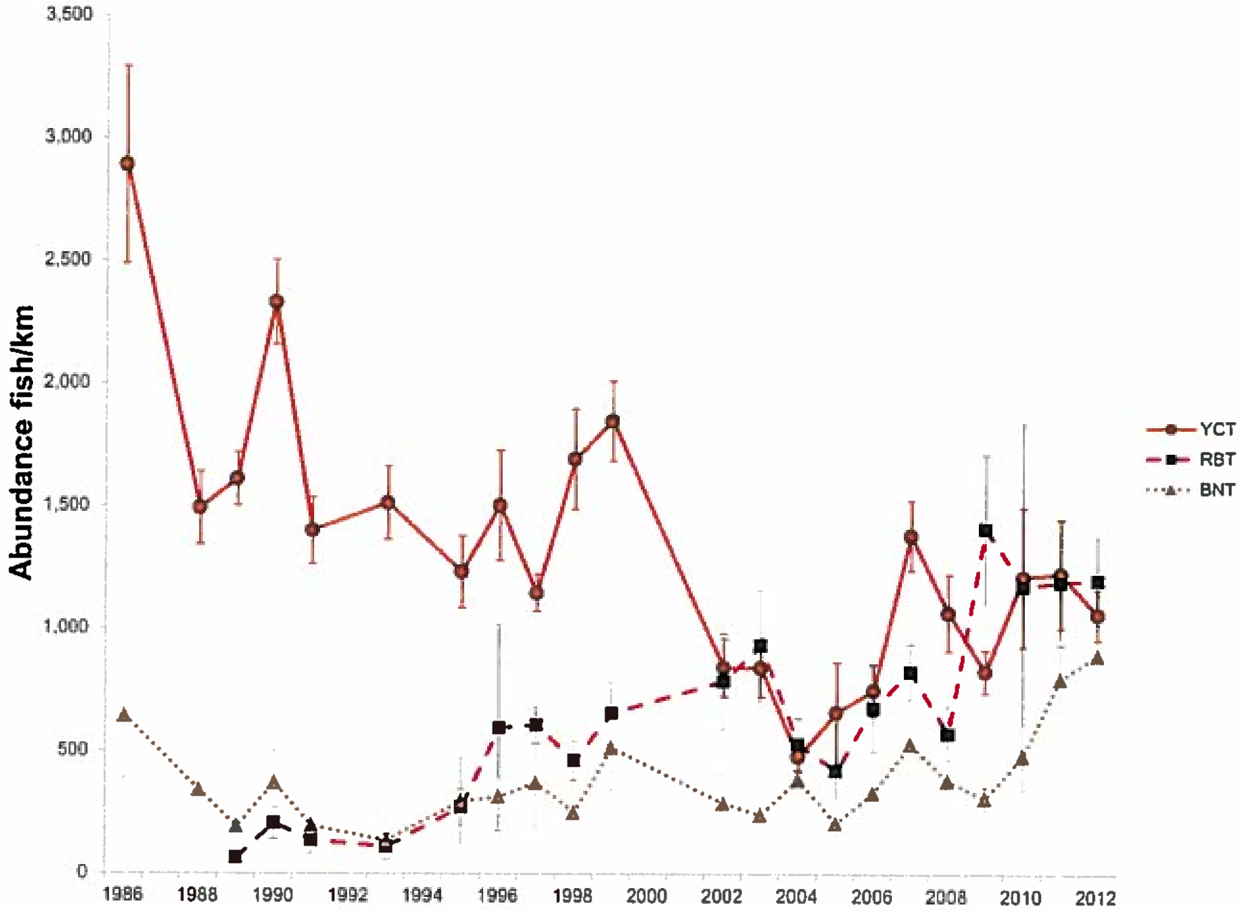


Figure 50. Estimated abundances of Yellowstone Cutthroat Trout (YCT), Rainbow Trout (RBT), and Brown Trout (BNT) at the Conant monitoring site on the South Fork Snake River from 1986 through 2012 with 95% confidence intervals.

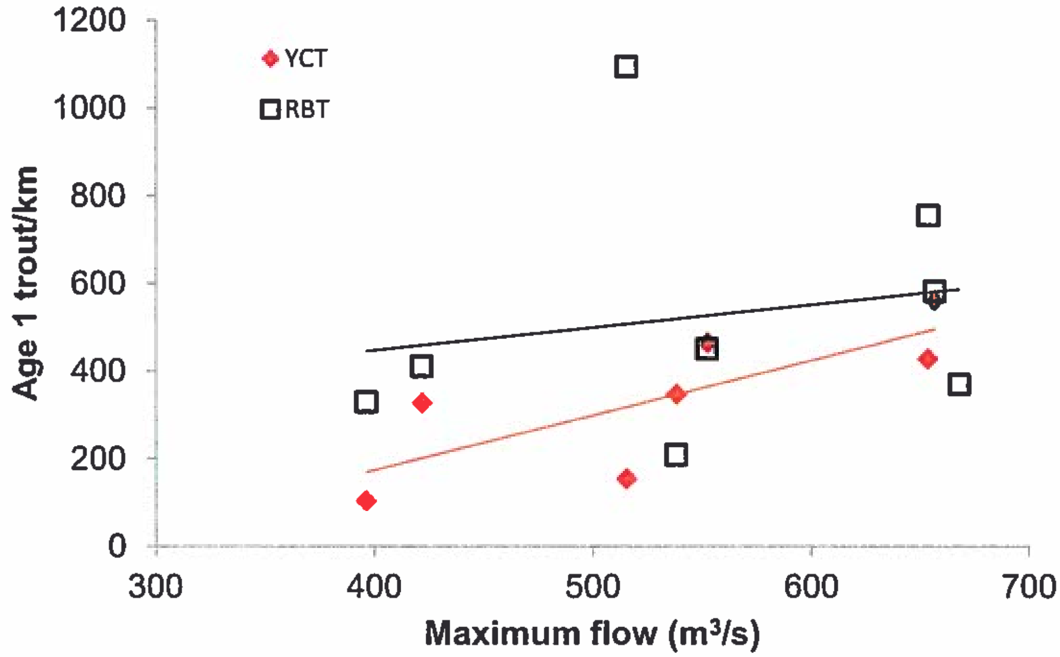


Figure 51. Correlation between age 1 Yellowstone Cutthroat Trout (YCT) and age 1 Rainbow Trout (RBT) abundance at the Conant monitoring site in the South Fork Snake River and maximum river flows the spring they were spawned.

Appendix L. 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

Teton River

ABSTRACT

The Teton River in eastern Idaho supports an ecologically important population of Yellowstone cutthroat trout (YCT). In 2012, the Idaho Department of Fish and Game sampled Bitch Creek, the largest tributary of the Teton River, using raft electrofishing gear and hook-and-line techniques in a mark/recapture estimate of abundance. The density of YCT in the upper portion of Bitch Creek was estimated at 291 YCT/km (95% CI = +/- 227). We estimated there were 695 YCT/km (±238) in the canyon section of Bitch Creek using a hook-and-line mark/recapture methodology. The abundance estimate of mountain whitefish in the canyon section was 410 fish/km. Rainbow trout and rainbow x cutthroat hybrid trout were observed in both the trestle and canyon sections (trestle section: 3 RBT in 2.3 km, canyon section: 19 RBT in 2.4 km). This corresponds to approximately 3 RBT/km in the trestle section and 29 RBT/km in the canyon section. All RBT observed were removed during both marking and recapture runs. The abundances of YCT in Bitch Creek were two to four times higher than upriver in Teton Valley, suggesting Bitch Creek is an important resource for cutthroat trout in the Teton drainage. A mark/recapture abundance survey was attempted in the Teton River's canyon section from Felt Dam downstream to the old Teton Dam site, but we were unable to calculate an abundance estimate due to low capture efficiencies. We marked 255 YCT and 51 RBT in the Teton River with Passive Integrated Transponder (PIT) tags to collect broad scale movements, which will help described the role Bitch Creek plays for the Teton Canyon metapopulation. Two new PIT arrays will be installed prior to the 2013 spawning run to collect movement information.

Authors:

Brett High
Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manager

INTRODUCTION

The Teton River in eastern Idaho supports the strongest riverine population of native Yellowstone cutthroat trout in the Henrys Fork basin. Schrader and Jones (2004) identified three major metapopulations of Yellowstone cutthroat trout (YCT) in the Teton River, including the lower Teton River (North Fork Teton River and South Fork Teton River, including Moody Creek), the Teton Canyon (Teton River from North Fork/South Fork Teton River split upstream past Badger Creek), and the Upper Teton River (Figure 52; Teton Valley). The upper river in Teton Valley is a sinuous low gradient stream with substantial groundwater influence (Van Kirk and Jenkins 2005) causing it to resemble a spring creek. The canyon section is the middle section of the Teton River which enters a constricted gorge that is approximately 30 river km in length. The Teton Dam site is at the downstream end of this canyon. The Teton Canyon metapopulation likely has the most YCT, but there are few population estimates for adult YCT within this reach and these estimates are difficult to obtain (Schrader and Brenden 2004). Much of the main river habitat within the Teton Canyon section of the river has been altered by the Teton Flood (Schrader 2004). Most of the spawning habitat for YCT in the Teton Canyon section of river is likely found in Bitch Creek, the largest tributary of the Teton River which is currently in good functional condition. The lower river below the Teton Dam is heavily degraded as a result of the Teton Dam failure and channelization projects following this event. In addition to native YCT, other salmonids in the Teton River include RBT, brown trout, brook trout and mountain whitefish (MWF) (also native).

Rainbow trout are not native to the Teton River, but have been stocked into the river and many of its tributaries to provide additional recreational and harvest opportunity beginning at least by 1968 and continued through 1994. Rainbow trout (RBT) were stocked as fry, fingerling, and catchable-sized trout. Rainbow trout readily hybridize with YCT and spawn with both rainbow trout and rainbow x cutthroat trout hybrids (collectively referred to as RBT for the remainder of this report). Fish surveys in Teton Canyon have documented RBT since the 1980's, but surveys in Bitch Creek have usually not documented RBT as being present. However, these surveys generally occur well upstream of the confluence of Bitch Creek and the Teton River. No surveys have been conducted between rkm 2 and 13 of lower Bitch Creek until this year.

Yellowstone cutthroat trout in the Teton River face numerous threats to their continued persistence beyond hybridization and competition with RBT. These include climate change, disease (most notably black spot disease), riparian and agricultural development, and water storage/regulation within the Teton River basin (BOR 2012).

In 2012, we conducted fish density and composition surveys in both Bitch Creek and the Teton River in the canyon section. This report summarizes these survey efforts.

OBJECTIVES

1. Determine the abundance and distribution of YCT and RBT in Bitch Creek
2. Determine if electrofishing could effectively reduce RBT abundance in Bitch Creek
3. Determine YCT and RBT abundance in the canyon section of the Teton River

METHODS

Initial plans for electrofishing Bitch Creek included using small rafts to perform two sampling passes through the 16 river km from the railroad trestle crossing down to the confluence with the Teton River. Due to hazardous whitewater conditions, this plan was dropped. We sampled a shorter section of Bitch Creek with raft electrofishing gear, and a downstream section within the roadless canyon portion of Bitch Creek using a hook-and-line mark/recapture study.

We electrofished a 2.3 km section of Bitch Creek immediately upstream of the highway 32 bridge (trestle section) on July 9 and 12, 2012. We used two rafts and mark/recapture techniques to estimate trout abundance. All trout were identified, measured to the nearest mm (total length), and marked with a hole punch in the caudal fin. We also marked YCT with half-duplex 24 mm Passive Integrated Transponder (PIT) tags and removed the adipose fin from these YCT as a secondary mark. Combined with fixed station receivers, PIT tags were used to describe broad scale movements of trout captured in Bitch Creek and the main river. 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 Modified Peterson's Estimator. We removed all RBT we captured during either marking or recapture runs. Because rainbow trout were removed when encountered, a mark recapture estimate of abundance was not possible. We did attempt an abundance estimate by calculating the ratio of cutthroat trout to rainbow trout in the catch, and then applied that proportion to the cutthroat estimate to obtain a first-order estimate of rainbow trout abundance.

We used mark/recapture methods in the less accessible canyon section of Bitch Creek downstream of the trestle section where fish were captured via hook-and-line sampling. Two separate and adjacent reaches were sampled in the canyon, totaling 2.4 km in length. We calculated estimates using Modified Peterson's Estimator. We calculated a MWF estimate for a 1.6 km sub-portion of the canyon section. We removed all RBT that were captured during both the marking and recapture efforts.

We also attempted a hook-and-line population survey in the Teton River from Felt Dam downstream to the Teton Dam site. A marking run from Felt Dam to Spring Hollow was conducted September 20 and from Spring Hollow to the old Teton Dam site September 21. A recapture run was conducted from Felt Dam to Spring Hollow September 27. No marked fish were recaptured in this first recapture run effort so we marked additional fish during the September 27 sampling event. A final sampling event occurred October 8, again from Felt Dam to Spring Hollow, and again no marked fish were captured. As a result, we were unable to calculate population estimates for this section.

RESULTS

We captured 110 YCT at the trestle section on Bitch Creek, including 53 YCT during the marking run and 61 YCT during the recapture run (four were recaptures, Table 29). We also captured three RBT, all during the recapture run. The average size of YCT captured was 314 mm and ranged from 160 - 440 mm (Figure 53). We estimated YCT density (fish/km) at 291 (95% CI = 68-519, Figure 54) in Bitch Creek in the trestle section. We caught three RBT that ranged in size from 248 – 485 mm. We estimated RBT densities at approximately 3 fish/km using the species composition of the catch (3% RBT) relative to the YCT composition and YCT estimate. Mountain whitefish were also captured at this site.

In the canyon section of Bitch Creek, we captured 420 YCT with an average length of 264 mm that ranged from 85 – 435 mm (Figure 55). The estimate (and 95% CI) for YCT in the canyon section was 695 (457 – 933) YCT/km. We captured and removed 12 RBT from this reach. These RBT ranged in size from 165 – 395 mm in length, and averaged 298 mm. We estimate there was roughly 29 RBT/km in the canyon section of Bitch Creek. We captured 99 MWF which averaged 326 mm TL and ranged from 215 – 415 mm (Figure 56). We estimated the MWF population density and 95% CI for the canyon section as 410 (99 – 1,211) MWF/km.

We caught 354 YCT, 77 RBT, and five brook trout in the Teton River between Felt Dam and the old Teton Dam site during hook-and-line surveys from September 20 through October 8. During these efforts, a total of 255 YCT and 51 RBT were marked with PIT tags.

DISCUSSION

Densities of native Yellowstone cutthroat trout in Bitch Creek are higher than any other location sampled to date in the Teton River. With densities around 700 YCT/km in the canyon section, Bitch Creek YCT densities are more than four times higher than our highest estimate on the mainstem river during 2011 (Schoby et al. 2013). Although less than the canyon section, densities of YCT at the trestle section of Bitch Creek were near 300 YCT/km, which is still nearly twice the highest densities found in 2011 in the mainstem Teton River (Schoby et al. 2013). While black spot disease is common throughout the Teton River drainage, fish that are heavily infected are most often found in the main river from the Teton River canyon. During the surveys in Bitch Creek, there were numerous YCT observed that were heavily infected with black spot disease, similar to fish commonly observed in the main river. These heavily infected fish were larger individuals that were likely fluvial fish migrating into Bitch Creek to spawn. These results corroborate the telemetry findings of Schrader and Jones (2004) who indicated Bitch Creek as an important tributary for the YCT that are part of the metapopulation from Teton Canyon.

Movements of both YCT and RBT from the main river in Teton Canyon into Bitch Creek will be better understood with PIT data in coming years. While efforts to obtain a population estimate in Teton Canyon were unsuccessful, we were able to mark over 300 trout with PIT tags. A pair of new PIT tag arrays in Bitch Creek will be operational throughout 2013. Data from these PIT-tagged fish will help determine the importance of Bitch Creek as a spawning tributary, as well as provide information on run timing, spawning duration, and spawning frequency.

Although rainbow trout appear to have a firm presence in Bitch Creek, it is unknown if their presence is a new addition to the species composition or if their abundance and/or distribution is increasing. Rainbows have been documented at the mouth of Bitch Creek since the 1970's (IDFG, file data). No sampling has occurred prior to this years sample above the mouth, but sampling efforts in the headwaters of Bitch Creek have not confirmed the presence of rainbow trout. Given the importance of Bitch Creek as a spawning tributary for YCT, continued monitoring within this reach is warranted. The abundance and distribution of RBT in Bitch Creek should be monitored closely, as the Teton Canyon YCT metapopulation is likely the strongest in the Teton River drainage, and Bitch Creek may play a significant role in the persistence of this population segment.

Catch rates for hook-and-line sampling in Bitch Creek were high which resulted in population estimates with similar confidence intervals and sampling efficiencies as electrofishing surveys. The canyon section of Bitch Creek is hard to access and is too large to efficiently sample using backpack electrofishing gear. It is also not feasible to float electrofishing rafts down to the canyon section of Bitch Creek. Hook-and-line surveys appear to be a suitable alternative for collecting population data in Bitch Creek.

While catch rates were also relatively high in the Teton River, capture efficiencies were too low to enable a population estimate. The survey effort in 2012 included a lengthy section of river. It is possible that focusing a similar amount of effort on a much shorter section of river may result in higher capture efficiencies. However, to maintain catch rates, fishing pressure should be spread out temporally. A multiple mark, multiple recapture study design may work for such an effort.

MANAGEMENT RECOMMENDATIONS

1. Determine the range of RBT distribution upstream in Bitch Creek.

2. Monitor the abundance of RBT in Bitch Creek and control abundances by re-sampling the trestle and canyon sections periodically and removing all rainbow trout encountered.

3. Refine and repeat hook-and-line mark recapture techniques to sample YCT abundance in a short section (3-4 km) of the Teton River between Felt and Spring Hollow.

Table 29. Summary statistics from the Bitch Creek and Teton River sites surveyed in 2012.

	Yellowstone cutthroat trout						
Reach	M	C	R	R/C	YCT/km	95% CI	CV
Bitch Cr - trestle section	53	57	4	0.07	291	223	0.39
Bitch Cr - canyon section	260	186	26	0.14	695	±238	0.17
Teton River	354	NA	NA	NA	NA	NA	NA
	Rainbow trout						
	M	C	R	R/C	RBT/km	95% CI	CV
Bitch Cr - trestle section	0	3	NA	NA	NA	NA	NA
Bitch Cr - canyon section	11	7	NA	NA	NA	NA	NA
Teton River	77	NA	NA	NA	NA	NA	NA
	Mountain whitefish						
	M	C	R	R/C	MWF/km	95% CI	CV
Bitch Cr - canyon subsection	42	60	3	0.05	410	±801	0.43

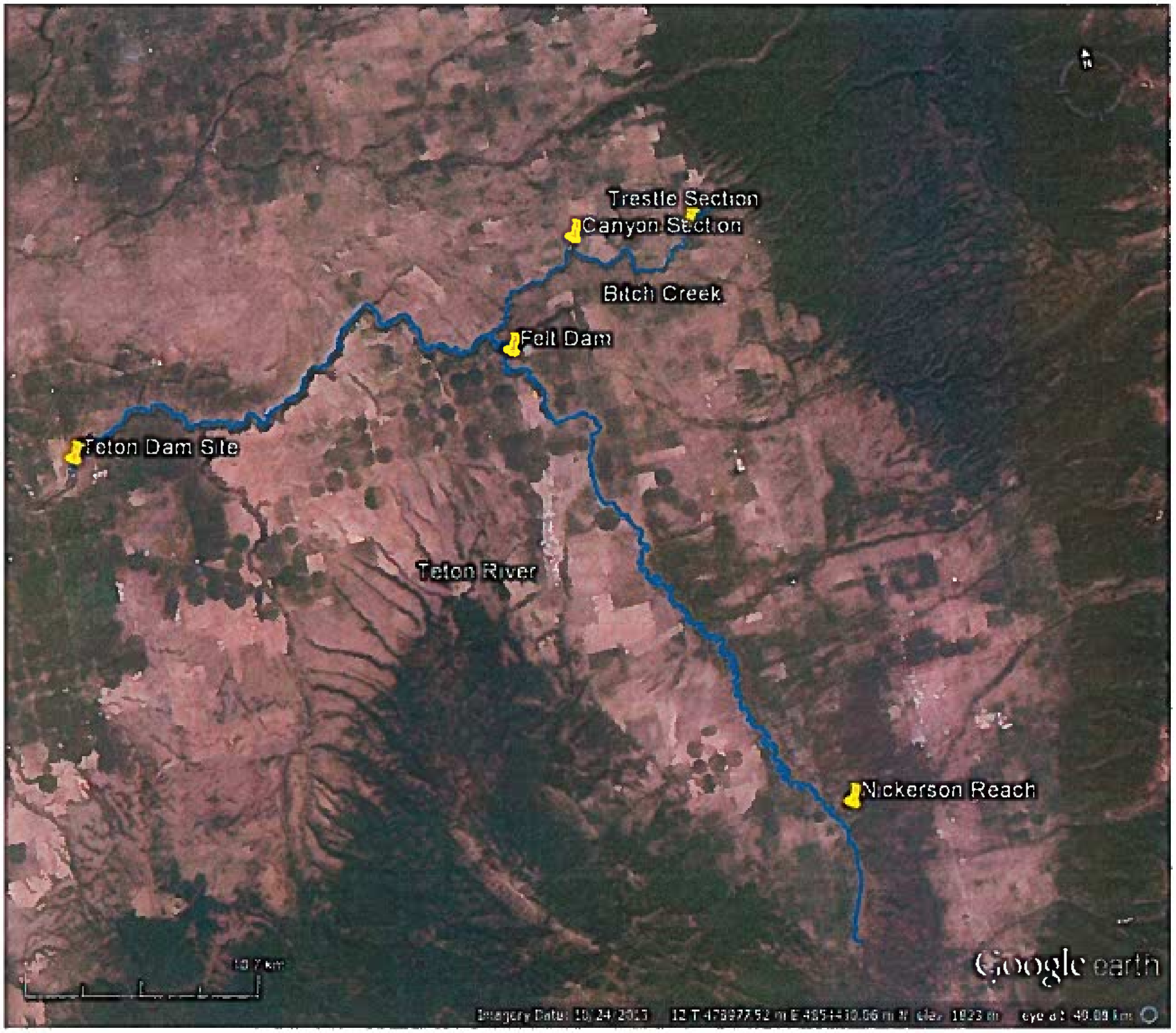


Figure 52. Locations of survey sites on Bitch Creek and the Teton River.

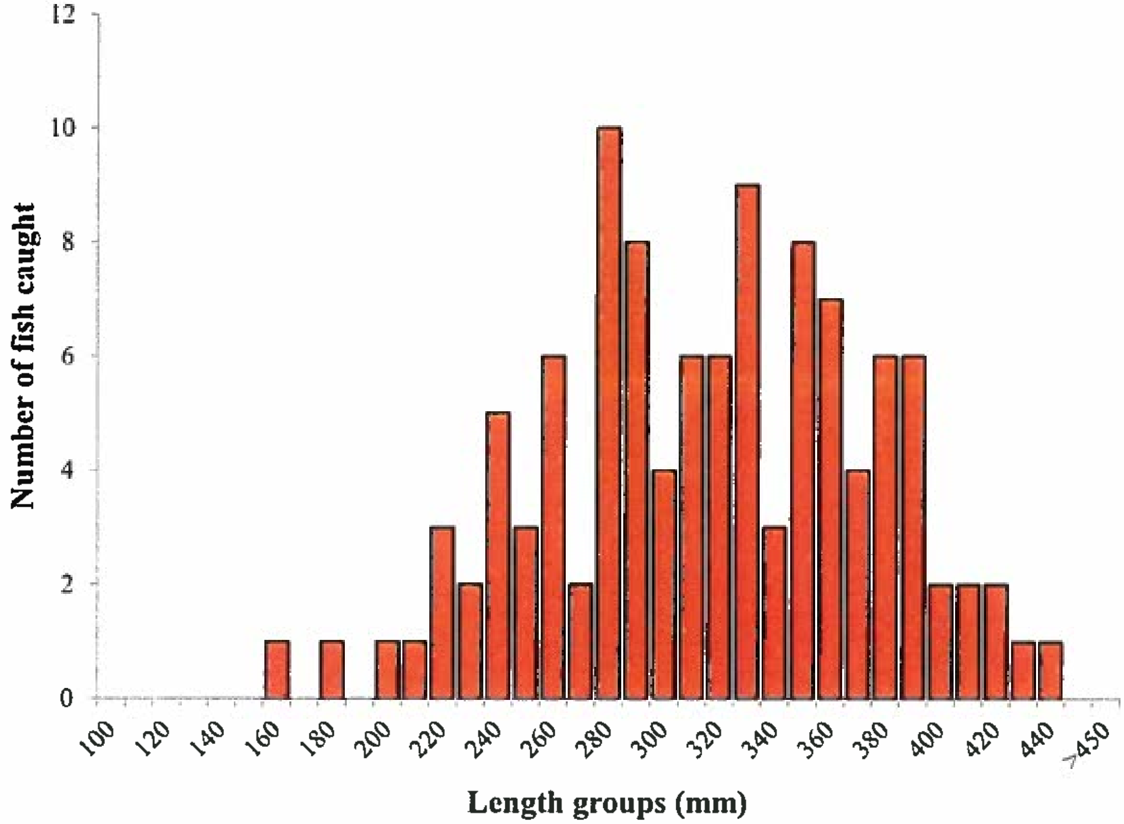


Figure 53. Length frequencies of Yellowstone Cutthroat Trout caught in Bitch Creek at the trestle section, 2012.

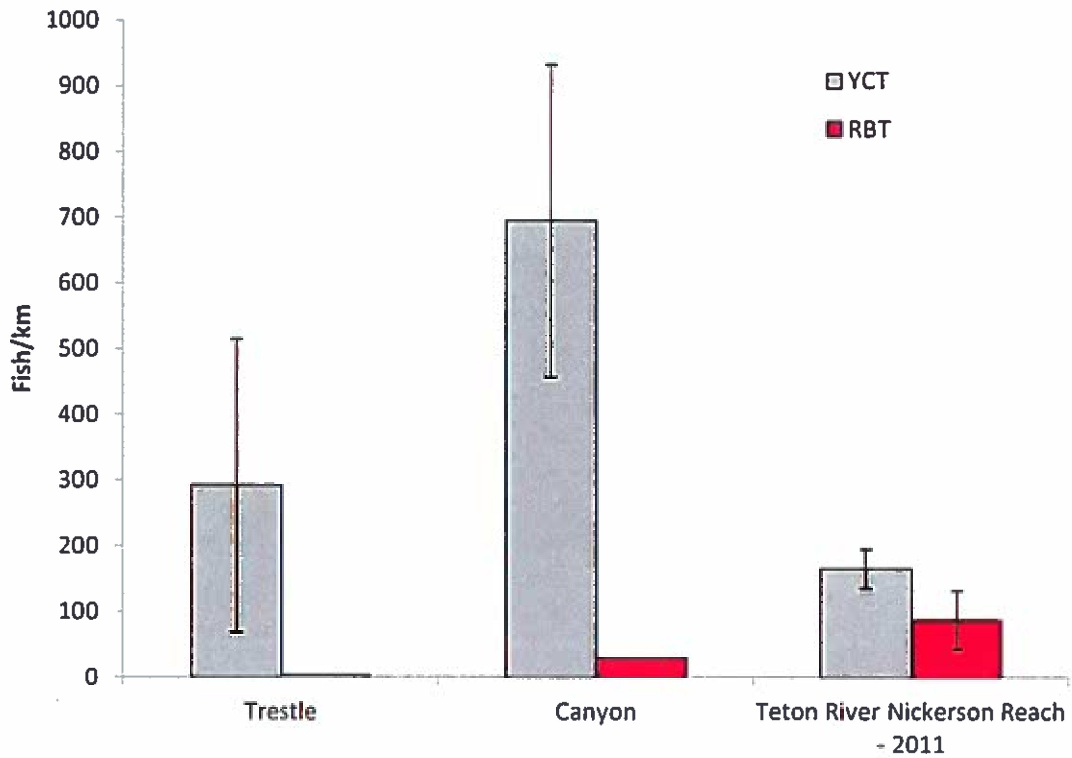


Figure 54. Density estimates for Yellowstone Cutthroat Trout (YCT) and Rainbow Trout, including hybrids (RBT) in Bitch Creek at the trestle and canyon sections in 2012 compared to the Nickerson monitoring reach of the Teton River (2011).

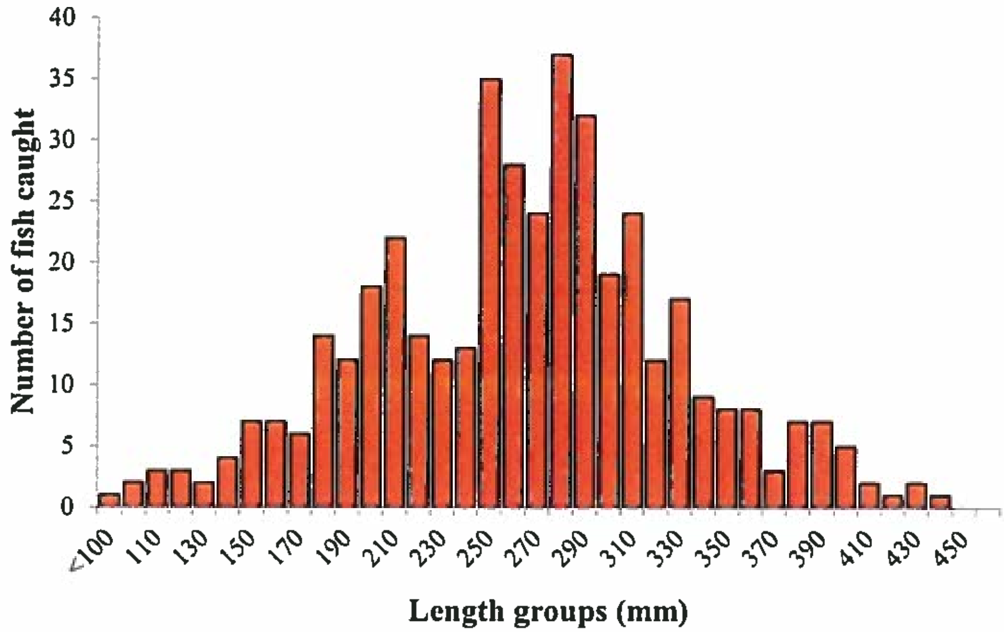


Figure 55. Length frequencies of Yellowstone Cutthroat Trout caught in Bitch Creek at the canyon section sampling site, 2012.

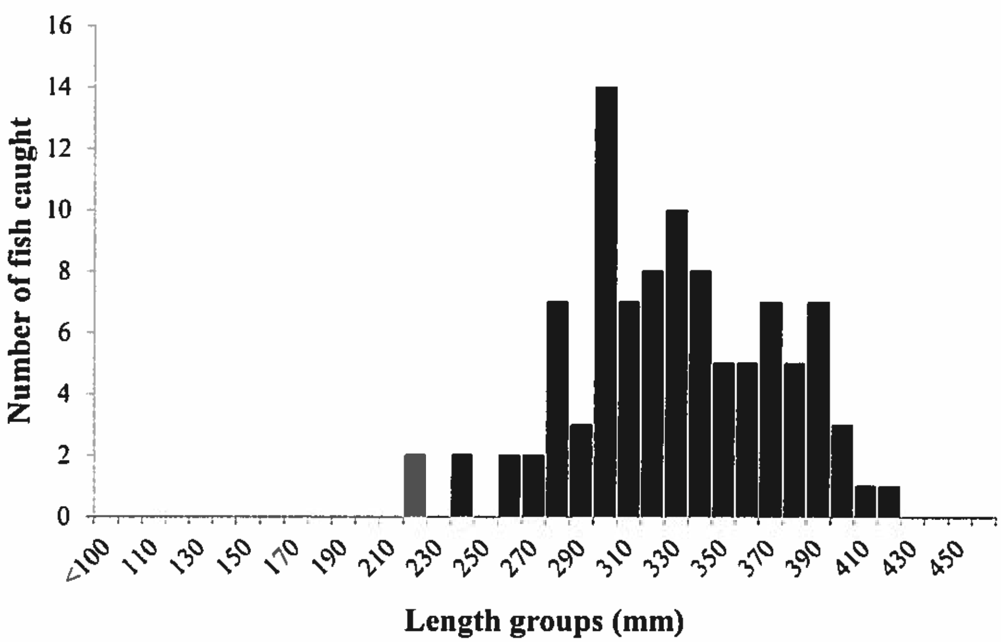


Figure 56. Length frequencies of Mountain Whitefish caught in Bitch Creek in a 1.6 km subsection of the canyon section, 2012.

Appendix M. Survey boundary coordinates for Bitch Creek and Teton River fish population 2012 survey sites (WGS 84).

Site	Downstream boundary	Upstream boundary
Bitch Creek - trestle section	12T 485598 E 4865070 N	12T 486915 E 4865900 N
Bitch Creek - canyon section	12T 479959 E 4865393 N	12T 481543 E 4865975 N
Teton River	12T 458433 E 4863365 N	12T 477051 E 4861635 N

LITERATURE CITED

Allendorf, F. W. and R. F. Leary. 1988. Conservation and distribution of genetic variation in a polytypic species, the Cutthroat Trout. Conservation biology 2:170-184.

Anderson, R.O. 1980. Proportional stock density (PSD) and relative weight (Wr): interpretive indices for fish populations and communities. Pages 27-33 in S. Gloss and B. Shupp, editors. Practical fisheries management: more with less in the 1980's. American Fisheries Society, New York Chapter, Ithaca, New York.

Anderson, R.O., and R.M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447-482 *in* B.R. Murphy and D. W. Willis, ed. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Baldwin, C. and M. Polacek. 2002. Evaluation of limiting factors of stocked kokanee and rainbow trout in Lake Roosevelt, Washington. Inland Fish Investigations, Washington Department of Fish and Wildlife.

Ball, K. and P. Jeppson. 1980. Regional Fishery Management Investigations. Idaho Department of Fish and Game, Job Performance Report. Project F-71-R-5.

Ball, K., V. Moore, and J. Curran. 1982. Regional Fishery Management Investigations, Job Performance Report, Project F-71-R-6. Idaho Department of Fish and Game, Boise.

Barica, J., and J. A. Mathias. 1979. Oxygen depletion and winterkill risk in small prairie lakes under extended ice cover. Journal of Fisheries Research Board of Canada 36: 980-986.

Bureau of Reclamation 2012. Henrys Fork Basin Study new surface storage alternatives. Technical Series Report # PN-HFS-002. http://www.usbr.gov/pn/programs/studies/idaho/henrysfork/techrept/interim/appb.pdf Last revised 3/15/2013.

Brown, M.L., F. Jaramillo Jr., D.M. Gatlin III, and B.R. Murphy. 1995. A revised standard weight (Ws) equation for channel catfish. Journal of Freshwater Ecology 10:295-302.

Budy, P., G. P. Thiede, E. S. Hansen, and J. Wood. 2007. Logan River whirling disease study: factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah. 2006 Annual Report to Utah Division of Wildlife Resources. Sport Fish Restoration. Grant number XIII. Project F-47-R. UTCFWRU 2007:1-46.

Budy, P., G. P. Thiede, J. Wood, S. Seidel, and Stephen Bennett. 2008. Logan River whirling disease study: factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah. 2006 Annual Report to Utah Division of Wildlife Resources. Sport Fish Restoration. Grant number XIII. Project F-47-R. UTCFWRU 2008:1-66.

Bulkley, R. V. 1961. Fluctuations in age composition in growth rate of Cutthroat Trout in Yellowstone Lake. U.S. Fish and Wildlife Service Research Report 54.

Bureau of Reclamation, 2001. Ririe Reservoir Resource Management Plan. U.S. Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Snake River Area Office, Boise, Idaho.

Coon, J.C. 1978. Lake and reservoir investigations. Federal aid to fish and wildlife restoration 1978 Annual Performance Report program F-53-R-12. Idaho Department of Fish and Game, Boise.

Corsi, C. and S. Elle. 1986. Regional Fishery Management Investigations. Idaho Department of Fish and Game, Job Performance Report. Project F-71-R-10.

Corsi, C. and S. Elle. 1989. Regional Fisheries Management Investigations. Idaho Department of Fish and Game, Job Performance Report. Project F-71-R-12.

Dillon, J. C. and C. B. Alexander. 1996. Hatchery trout evaluations. Job Performance Report, Project F-73-R-18. Idaho Department of Fish and Game, Boise.

Ecosystems Research Institute. 1994. Operations and Procedures Plan Maintenance and Mitigation Island Park Hydroelectric Project, FERC No. 2973.

Elle, S. and C. Corsi. 1994. Regional Fisheries Management Investigations. Idaho Department of Fish and Game, Job Performance Report. Project F-71-R-13.

Elle, S., C. Corsi, and D. Aslett. 1987. Regional Fishery Management Investigations. Idaho Department of Fish and Game, Job Performance Report. Project F-71-R-11.

Flickinger, S.A. and F.J Bulow. 1993. Small impoundments. Pages 469 – 492 in C.C. Kohler and W.A. Hubert, editors. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

Gamblin, M., T.J. Herron, B.A. Rich, and W.C. Schrader. 2002. Regional Fisheries Management Investigations, Upper Snake Region. 1994 Job Performance Report, Program F-71-R-19. Idaho Department of Fish and Game, Boise.

Garren, D., J. Fredericks, R. Van Kirk, and D. Keen. 2008. Evaluating the success of fingerling trout stocking in Henrys Lake, Idaho. Pages 427-437 *in* M.S. Allen, S. Sammons, and M.J. Maciena, editors. Balancing fisheries management and water uses for impounded river systems. American Fisheries Society, Symposium 62, Bethesda, Maryland.

Garren, D., J. Fredericks, and D. Keen. 2009. Fishery management annual report, Upper Snake Region 2007. Report #09-111. Idaho Department of Fish and Game, Boise.

Garren, D., W.C. Schrader, D. Keen, and J. Fredericks. 2006c. Regional fisheries management investigations. 2002 Job Performance Report, Project F-71-R-27. Report #03-32. Idaho Department of Fish and Game, Boise.

Garren, D., W.C. Schrader, D. Keen, and J. Fredericks. 2006a. Regional fisheries management investigations. 2003 Annual Performance Report, Project F-71-R-28. Report #04-25. Idaho Department of Fish and Game, Boise.

Garren, D., W.C. Schrader, D. Keen, and J. Fredericks. 2006. Fishery management annual report, Upper Snake Region 2004. Report No. 05-15. Idaho Department of Fish and Game, Boise.

Garren, D., W.C. Schrader, D. Keen, and J. Fredericks. 2006. Fishery management annual report, 2005 Upper Snake Region. Report #06-38. Idaho Department of Fish and Game, Boise.

Garren, D., W.C. Schrader, D. Keen, and J. Fredericks. 2008. Fishery management annual report, Upper Snake Region 2006. Report No. 08-102. Idaho Department of Fish and Game, Boise.

Grunder, S.A., T.J. McArthur, S. Clark, and V.K. Moore. 2008. Idaho Department of Fish and Game 2003 Economic Survey Report. Report #08-129. Idaho Department of Fish and Game, Boise.

Gunnell, K. M. K. Tada, F. A. Hawthorne, E. R. Keeley, and M. B. Ptacek. 2008. Geographic patterns of introgressive hybridization between Yellowstone Cutthroat Trout (Oncorhynchus clarkia bouvieri) and introduced Rainbow Trout (O. mykiss) in the South Fork of the Snake River watershed, Idaho. Conservation Genetics 9:49-64.

Hauer, F. R., M. S. Lorang, D. Whited, and P. Matson. 2004. Ecologically Based Systems Management (EBSM) The Snake River – Palisades Dam to Henrys Fork. Final Report to the US Bureau of Reclamation, Boise, Idaho. Flathead Lake Biological Station, Division of Biological Sciences, The University of Montana, Polson, Montana. pp. 133.

Henderson, R., J.L. Kershner, and C.A. Toline. 2000. Timing and location of spawning by nonnative wild Rainbow Trout and native Cutthroat Trout in the South Fork Snake River, Idaho, with implications for hybridization. North American Journal of Fisheries Management 20:584-596.

High, B., G. Schoby, D. Keen, and D. Garren. 2009. Fishery management annual report: Upper Snake Region 2011. IDFG 11-107. Idaho Department of Fish and Game. Boise.

High, B., G. Schoby, D. Keen, and D. Garren. 2011. Fishery management annual report, Upper Snake Region 2009. Report No. 11-107. Idaho Department of Fish and Game, Boise.

Hyatt, M.W., and W.A. Hubert. 2001. Proposed standard-weight equations for brook trout. North American Journal of Fisheries Management 21:253-254.

IDFG. 1982. Evaluation of walleye for an expanded distribution in Idaho. Idaho Department of Fish and Game, Boise.

IDFG 2001. 2001-2006 Fisheries Management Plan. Idaho Department of Fish and Game, Boise.

IDFG. 2012. Resident Fish Hatcheries 2011 Annual Report. Report No. xx-xx. Idaho Department of Fish and Game, Boise.

IDFG. *In press.* 2011 Angler Economic Survey. Idaho Department of Fish and Game, Boise.

Irving, R.B. 1953. Ecology of the cutthroat trout, (Salmo clarki Richardson), in Henrys Lake, Idaho. Master's Thesis, Utah State Agricultural College, Logan.

Jeppson, P. 1973. Henrys Lake Fishery Investigation, 1972 Job Completion Report. Volume 31, Article 39. Idaho Department of Fish and Game, Boise

Jones, R.D., D.G. Carty, R.E. Gresswell, K.A. Gunther., L.D. Lentsch, and J. Mohrman. 1985. Fishery and aquatic management program in Yellowstone Nataional Park. U.S. Fish and Wildlife Service Technical Report for 1984, Yellowstone National Park, Wyoming.

Kruse, C.G., and W.A. Hubert. 1997. Proposed standard weight (W_s) equations for interior cutthroat trout. North American Journal of Fisheries Management 17:784-790.

Larson, E. I., K. A. Meyer, B. High, M. R. Campbell, C. L. Sullivan, and D. J. Schill. 2013. Wild trout evaluations: electric weir fish injury, Cutthroat Trout stream purification, and pelican predation. Report #13-03. Idaho Department of Fish and Game, Boise.

Maxell, B. A. 1999. A power analysis on the monitoring of Bull Trout stocks using redd counts. North American Journal of Fisheries Management 19:860-866.

Maiolie, M., and S. Elam. 1998. Kokanee entrainment losses at Dworshak Reservoir; Dworshak Dam Impacts Assessment and Fisheries Investigation Project. 1996 Annual Report, Project No. 198709900. Bonneville Power Administration, Portland, Oregon.

Meyer, K. A. 1999. Using single-pass electrofishing along with multi-pass removals. Research Brief 99-01. Idaho Department of Fish and Game. Boise, ID.

Meyer, K.A., D.J. Schill, J.A. Lamansky, M.R. Campbell, and C.M. Cegelski. 2006. Status of Yellowstone Cutthroat Trout in Idaho. Transactions of the American Fisheries Society 135:1329-1347.

Mitro, M.G. 1999. Sampling and analysis techniques and their applications for estimating recruitment of juvenile rainbow trout in the Henrys Fork of the Snake River, Idaho. PhD thesis, Montana State University, Bozeman.

Montana Department of Fish, Wildlife, and Parks. 1997. Mark recapture for Windows, version 5.0. Montana Department of Fish, Wildlife, and Parks, Helena.

Morgan, G.E. 2002. Manual of Instructions – Fall Walleye Index Netting (FWIN). Percid Community Synthesis Diagnostics and Sampling Standards Working Group. Ontario Ministry of Natural Resources, Peterborough.

NMFS (National Marine Fisheries Service). 2011. Anadromous salmonid passage facility design. NMFS, Northwest Region, Portland, Oregon.

Peterman, R. M. 1990. Statistical power analysis can improve fisheries research and management. Canadian Journal of Fisheries and Aquatic Sciences 47:2-15.

Pollock, K. H., C. M. Jones, and T. L. Brown. 1994. Angler survey methods and their applications in fisheries management. American Fisheries Society Special Publication 25.

Quist, M.C., C.S. Guy, R.D. Schultz, and J.L Stephen. 2003. Latitudinal comparisons of walleye growth in North America and factors influencing growth of walleyes in Kansas reservoirs. North American Journal of Fisheries Management 23:677-692.

Rieman, B.E., and D.L. Myers. 1992. Influence of fish density and relative productivity on the growth of kokanee in ten oligotrophic lakes and reservoirs in Idaho. Transactions of the American Fisheries Society 121:178-191.

Schoby, G., B. High, D. Keen, and D. Garren. 2010. Fishery Management Annual Report, Upper Snake Region 2008. Idaho Department of Fish and Game, Boise.

Schoby, G., B. High, J. Beulow, and D. Garren. 2012. Fishery Management Annual Report, Upper Snake Region 2010. Idaho Department of Fish and Game, Boise.

Schoby, G., B. High, J. Frye, and D. Garren. 2013. Fishery Management Annual Report, Upper Snake Region 2011. Idaho Department of Fish and Game, No. 13-117.

Schrader, W. C. 2004. Teton River investigations – Part I: Fish population surveys 25 years after Teton Dam. Idaho Department of Fish and Game Report #04-44, Boise, Idaho.

Schrader, W.C., and K.R. Brenden. 2004. Teton River investigations – Part II: Fish population surveys 25 years after Teton Dam. Idaho Department of Fish and Game Report #04-38, Boise, Idaho.

Schrader, W.C., and M.D. Jones. 2004. Teton River investigations – Part III: Fish movements and life history 25 years after Teton Dam. Idaho Department of Fish and Game Report #04-45, Boise, Idaho.

Schrader, W.C., and J. Fredericks. 2006a. South Fork Snake River investigations. 2005 Annual Job Performance Report 06-50. Idaho Department of Fish and Game. Boise.

Schrader, W.C., and J. Fredericks. 2006b. South Fork Snake River investigations. 2003 Annual Job Performance Report 06-20. Project F-71-R-28. Idaho Department of Fish and Game. Boise.

Seiler, S. M. and E. R. Keeley. 2007a. A comparison of aggressive and foraging behavior between juvenile Cutthroat Trout, Rainbow Trout, and F1 hybrids. Animal Behaviour 74:1805-1812.

Seiler, S. M. and E. R. Keeley. 2007b. Morphological and swimming stamina differences between Yellowstone Cutthroat Trout (Oncorhynchus clarkia bouvieri), Rainbow Trout (Oncorhynchus mykiss), and their hybrids. Canadian Journal of Fisheries and Aquatic Sciences 64:127-135).

Simpkins, D.G., and W.A. Hubert. 1996. Proposed revision of the standard-weight equation for rainbow trout. Journal of Freshwater Ecology 11:319-325.

Smith, R.W., and J.S. Griffith. 1994. Survival of rainbow trout during their first winter in the Henrys Fork of the Snake River, Idaho. Transactions of the American Fisheries Society 123:747-756.

Spateholts, R.L. 1984. Ecology of naturalized and introduced stocks of brook trout in Henry's Lake, Idaho. Master's Thesis, Idaho State University, Pocatello.

Strahler, A. N. 1964. Quantitative geomorphology of drainage basins and channel networks. Section 4-2 in V. T. Chow, editor. Handbook of applied hydrology. McGraw-Hill, New York.

Teuscher, D. 1999. A simple method for monitoring zooplankton forage and evaluating flatwater stocking programs. Fisheries Research Brief, Idaho Department of Fish and Game, No. 99-02.

Teuscher, D., and C. Luecke. 1996. Competition between kokanees and Utah chub in Flaming Gorge Reservoir, Utah–Wyoming. Transactions of the American Fisheries Society 125:505-511.

Thurow, R. F. and J. G. King. 1994. Attributes of Yellowstone Cutthroat Trout redds in a tributary of the Snake River, Idaho. Transactions of the American Fisheries Society 123:37-50.

Van Kirk, R.W., and M. Gamblin. 2000. History of fisheries management in the upper Henry's Fork watershed. Intermountain Journal of Sciences 6:263-284.

Van Kirk, R., and A. Jenkins. 2005. Hydrologic alteration in the upper Teton watershed and its implications for cutthroat trout restoration. Project Completion Report, Friends of the Teton River, Driggs, Idaho.

Varley, J. D. and R. E. Gresswell. 1988. Ecologoy, status, and management of the Yellowstone cutthroat trout. American Fisheries Society Symposium 4:13-24.

Willis, D.W., C.S. Guy, and B.R. Murphy. 1991. Development and evaluation of a proposed standard weight (Ws) equation for yellow perch. North American Journal of Fisheries Management 11:374-380.

Prepared by:

Dan Garren
Regional Fisheries Manager

Greg Schoby
Regional Fisheries Biologist

Brett High
Regional Fisheries Biologist

Jessica Buelow
Regional Fisheries Biologist

Approved by:
IDAHO DEPARTMENT OF FISH AND GAME

Edward B. Schriever, Chief
Fisheries Bureau

Jeff Dillon
State Fishery Manager