FISHERY MANAGEMENT INVESTIGATIONS

# IDAHO DEPARTMENT OF FISH AND GAME
## FISHERY MANAGEMENT ANNUAL REPORT

**Virgil Moore, Director**

## UPPER SNAKE REGION

## 2013


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# 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 remain 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 Cutthroat, while Brook Trout may be more abundant due to increased stockings during 2008 and 2009. 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, and seem to be improving conditions. Future stocking rates should take into account contributions from natural reproduction and relative weights, and be adjusted accordingly until management goals are attained.

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## OBJECTIVES

To obtain current information on fish populations and limnological characteristics on Henrys Lake, and to develop appropriate management recommendations to benefit anglers.

## METHODS

### Population Monitoring

As part of routine population monitoring, we set gill nets at six standardized locations in Henrys Lake from May 9 - 20, 2013 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 examined all Yellowstone Cutthroat Trout handled through the year for adipose fin clips as part of our evaluation of natural reproduction. Beginning in the 1980's, 10% of all stocked Yellowstone Cutthroat Trout have been marked with an adipose fin clip prior to stocking (Appendix A). To estimate contributions to the Cutthroat Trout population from natural reproduction, we calculated the ratio of marked to unmarked fish collected in annual gill net surveys and the same ratio analysis for trout captured ascending the fish ladder on Hatchery Creek. Since 10% of all stocked fish are marked with an adipose clip, ratios around 10% in the at-large population would be expected in the absence of additional, un-marked fish (natural reproduction). When the ratio of marked fish is less than 10%, we assume that natural reproduction is adding to the 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 for Cutthroat Trout between the ages of 2 and 5. Based on the estimate of total mortality for Cutthroat, we partitioned out fishing mortality from natural mortality using the equation

$$\text{Total mortality} = \text{Fishing Mortality} + \text{Natural Mortality} - (F*N)$$

We derived an estimate of fishing mortality by using our population estimate derived from fin clip data and stocking records and the total harvest estimated in the creel survey below.

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.

## **Creel Survey**

We conducted a season-long creel survey, which ran from May 25 2013 through January 1, 2014. The fishing season was stratified into the opening weekend, the remainder of May (5 days), then two-week intervals through mid-November, when ice began to cover the lake. From mid-November through the close of the fishing season on Jan 1 was lumped into one period to represent the ice fishery. Effort was estimated using aerial counts on two randomly chosen weekend days and two randomly chosen weekdays during each strata. Aerial counts were used until mid-September, when angler effort diminished. From that point forward, ground-based interviews were able to intercept all anglers, and the interview data was used to replace aerial count data. Creel clerks interviewed anglers on two randomly chosen weekdays and two randomly chosen weekend days during each strata. Creel clerks collected information on the time anglers spent fishing, the number of anglers in the party, gear type, and fish both caught and harvested. When harvested fish were encountered, clerks measured fish for total length.

## 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 February 13 and March 13, 2012 (Figure 1). Holes were drilled in the ice with a gas-powered ice auger prior to sampling. We used a YSI model 550-A oxygen probe to collect dissolved oxygen readings at ice bottom and at subsequent one-meter intervals until the bottom of the lake was encountered. Dissolved oxygen mass is calculated from the dissolved oxygen probe's mg/L readings converted to total mass in $g/m^3$. This is a direct conversion from mg/L to $g/m^3$ (1000 L = $1m^3$). 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 $g/m^2$).

# RESULTS

## Population Monitoring

We collected 2,757 fish in 50 net nights of gill net effort. Catch composition was 17% Yellowstone Cutthroat Trout, 9% Brook Trout, 6% Hybrid Trout, and 67% Utah Chub (Figure 2). Yellowstone Cutthroat Trout ranged from 131 to 530 mm TL (mean: 352 mm, Figure 3), Hybrid Trout 232 to 695 mm (mean: 414 mm, Figure 4), and Brook Trout 165 to 540 mm (mean: 392 mm, Figure 5). Mean length at age three was 395, 436, and 426 mm, for Yellowstone Cutthroat Trout, Hybrid Trout, and Brook Trout, respectively (Table 1). Proportional stock density (PSD) was highest for Brook Trout (95) followed by Hybrid Trout (93) and Cutthroat Trout (82). Relative stock density (RSD-400) was highest for Brook Trout (64) followed by Hybrid Trout (49) and Cutthroat Trout (28) (Table 2). Mean relative weight ($W_r$) for all trout species (all sizes combined) ranged between 89 and 98 (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 89 and 98 (Figure 7). Catch curve analysis of Yellowstone Cutthroat Trout estimates mortality from age two to five at 75%.

We partitioned out total mortality (as determined through catch curve analysis) into naturally caused, and fishing (harvest) to get an understanding of the role of angler harvest and its relation to shaping our fish population. Once natural recruitment was accounted for, the standing population of adult (two-year old or older) trout in Henrys Lake is currently estimated at 750,000 fish, of which 53% (397,500) are Cutthroat based on the relative abundance of all trout. Angler harvest was 12,578 Cutthroat which results in an estimate of 3.1% for fishing mortality. Once fishing mortality is accounted for, the resulting equation estimates natural mortality at 74.2%. As such, harvest of Cutthroat Trout does not alter total mortality when compared to the high natural mortality rate.

Gill net catch rates for trout were highest for Yellowstone Cutthroat Trout at 9.6 fish per net night, followed by Brook Trout at 5.0, and Hybrid Trout at 3.4 fish per net night (Figure 8). The median catch rate of Utah Chub was 24.5 fish per net night (Figure 9) and more than doubled from the 2012 catch rate. Similarly, the mean gill net catch rate for chubs was the second-highest to date. Results from our gill net surveys showed 47 of 478 (10%) captured Yellowstone Cutthroat Trout were adipose-clipped (Table 3). However, when fish observed in the hatchery spawning run are included, the ratio decreases to 8% fin clipped Cutthroat (315 marked out of 3838 checked for marks). Yellowstone Cutthroat Trout gill net catch rate in 2013 was higher than the 21 year average catch rate (9.6 vs. 6.2), as was Brook Trout catch rate (5.0 vs. 1.9). Hybrid Trout gill net catch rate was not different than the long term average (3.4 vs. 3.8).

## Creel Survey

Creel clerks interviewed a total of 2,401 anglers over the course of the fishing season. Residents comprised 74% of the anglers, with nonresidents making up the remaining 26% of anglers. Total angling effort was estimated at 191,457 hours, which is above the long-term average of 131,000 hours. Angler catch rates exceeded our management objective of 0.7 fish per hour, and were estimated at 0.95 fish per hour, the highest they've been since 1983 (Figure 10). Angler catch was estimated at 175,761 fish, and harvest was estimated at 24,138 (Table 4). Overall release rates for fish caught were 86% (Table 5). Species composition of the anglers catch was 58% Cutthroat, 31% Hybrid Trout and 11% Brook Trout. Ice fishing, which ran from Nov 15 through Jan 1 resulted in 21,833 hours of angling effort, a catch of 25,657 trout, and harvest of 6,048 trout. Release rate during the ice fishery was 76%. Similarly, the opening week of fishing resulted in an estimated 27,220 hours of effort, 17,495 trout caught, and 4,023 trout harvested. Release rate during this opening week was 77%.

## Water Quality

Between February 13 and March 13, 2013, total dissolved oxygen diminished from 29.9 $g/m^2$ to 19.9 $g/m^2$ at the Pittsburgh Creek site, from 15.5 $g/m^2$ to 12.2 $g/m^2$ at the hatchery site, from 18.7 $g/m^2$ to 17.8 $g/m^2$ at the County dock, and from 22.4 $g/m^2$ to 16.2 $g/m^2$ at the Wild Rose site (Table 6). Depletion estimates predicted dissolved oxygen would remain above the level of concern throughout the winter (Figure 11). Based on predictions of dissolved oxygen depletion rates, aeration was not implemented.

# DISCUSSION

For the fourth year running, trout abundance in Henrys Lake is well above the long-term average as reflected in gill net catch rates. This increase in abundance, combined with a recent increase in Utah Chub abundance has resulted in decreased trout growth, both in length and in weight. For example, three-year old Cutthroat Trout in 2004 averaged 452 mm in length and 1,247 g in weight. In 2013, the same three-year old trout averaged 395 mm and 676 g – a loss of 13% in length and 45% in body weight. As shown in the mid-1980's when stocking rates exceeded 2.5 million trout annually, Henrys Lake demonstrates density-dependent growth.

When densities of fish get too high, food resources may become limited and insufficient to maintain fast growth rates. This observation is supported by the low relative weights, which are commonly used as a measure of available food resources. Flickinger and Bulow (1993) state that fish with relative weights close to 100 are in balance with their food supply. Fish with values below 85 are underweight and may be too abundant for their food supply. As shown previously, trout relative weights have been on a continual decline since the late 2000's, which is consistent with the increase in abundance reflected in gill net catch rates. Data collected in 2013 shows the first increase in relative weights since the mid-2000's. Although slight, this increase was reflected in the weights of all species of trout, suggesting management actions implemented in 2012 may be having an effect on trout weights. However, relative weights remain well below desired levels, and continued adaptive management will be necessary to improve the fishery. It's likely that if the current increasing trend in weights continues, it will still take several years before trout are back to a body condition that's desirable to anglers.

Some anglers are suggesting that the increased fishing season – which is primarily an ice fishery running from the end of November through January 1 has resulted in increased harvest, and that this harvest is the reason for the smaller fish size in Henrys. While it is unfortunate that the decline in fish growth became evident to anglers at about the same time the season length increased, the two are unrelated. Results from our year-around creel survey clearly show that angler harvest is low, and has a negligible effect on our fish population. Estimates of mortality that result from angler harvest do not add substantially to total mortality (less than a 1% increase in annual mortality). While it is possible that our estimates are an underrepresentation of the mortality associated with fishing (through hooking or handling mortality) it remains highly unlikely that angling is having an effect on the fish population at current levels. The lack of change in total mortality between the early 2000's, when fishing seasons were conservative is identical to that documented this year, again confirming the lack of impact from angling. Based on the results from the studies done to date, Henrys Lake could withstand substantially higher harvest levels than currently exist without negatively affecting the fish population.

To counteract the slowed growth rates in Henrys and to meet our size goals, fish abundance needs to be reduced. There are two mechanisms to do this – by reducing the number of fish entering the population through stocking, or by increasing angler harvest. While increasing harvest is an option, it is not supported fully by the angling community at this time. The current imbalance in fish size should be remedied and public support gauged prior to adjusting regulations, if at all. The more feasible solution is to continue stocking at a reduced level. Beginning in 2012, we reduced the number of stocked Cutthroat by approximately 500,000 annually. This has resulted in a reduction of over 1 million trout to date, and has created the first upswing in relative weights since the decline began in the mid-2000's. Stocking rates should be adjusted annually based on the ratio of marked fish in the population combined with gill net catch rate information and relative weight data.

## 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.

5. Conduct diet analysis of trout and chubs over the course of the ice-free periods. Particular attention should be placed on areas where diet overlaps between these species to ascertain potential for conflict.

6. Consider developing an invertebrate density monitoring program that could capture changes in forage species.

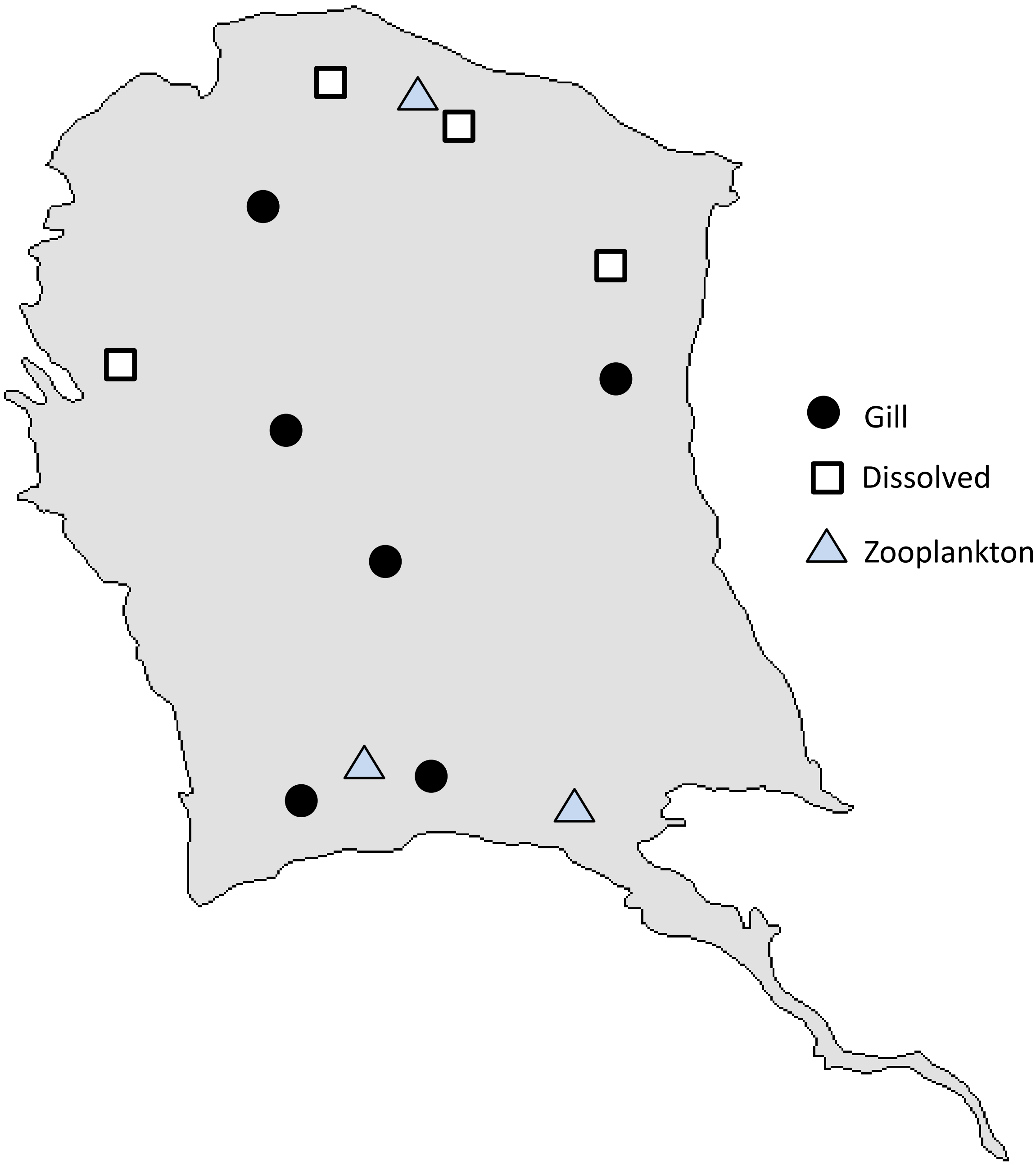


Figure 1. Spatial distribution of gill net, dissolved oxygen, and zooplankton monitoring sites in Henrys Lake, Idaho, 2013.

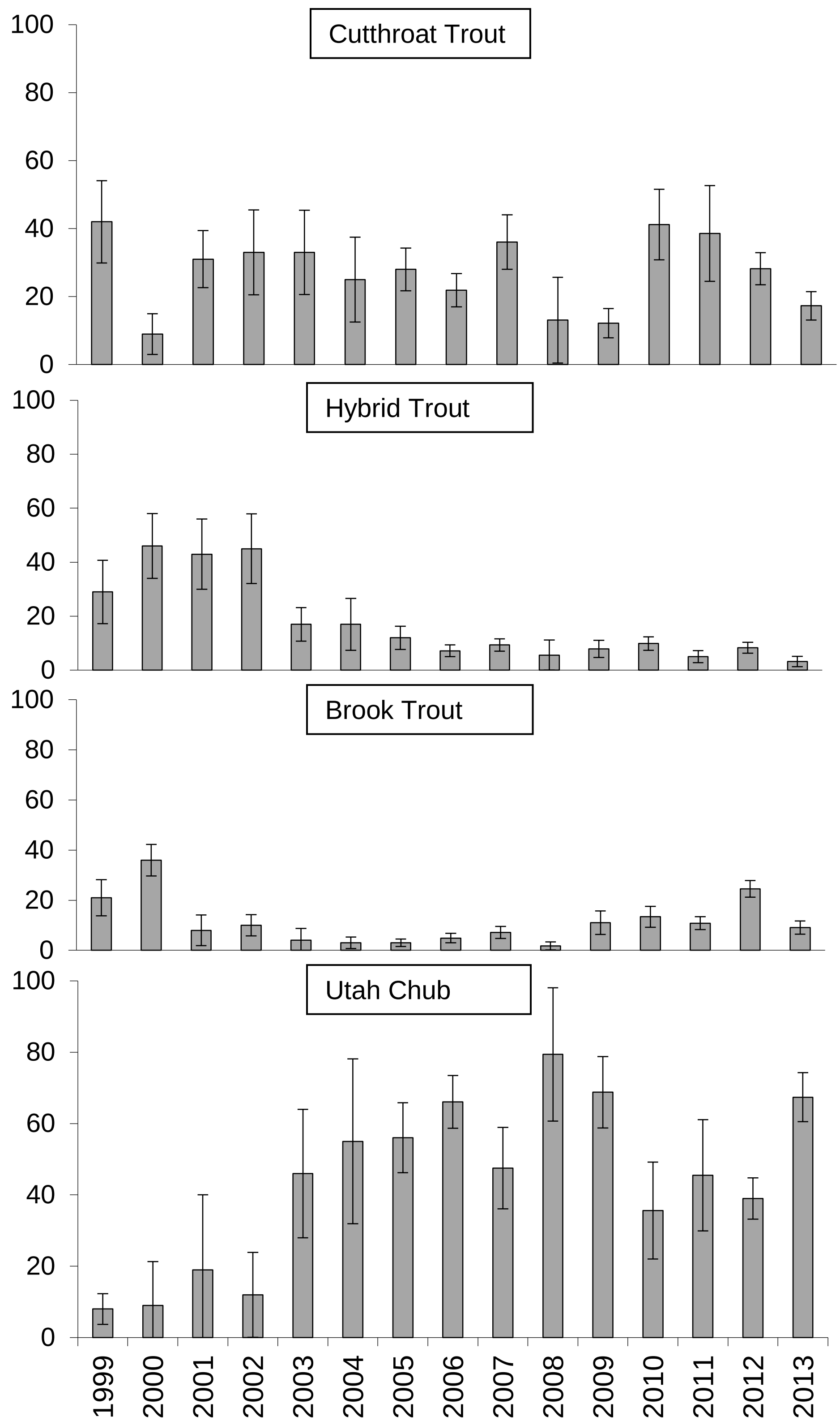


Figure 2. Relative abundance of Yellowstone Cutthroat Trout, Hybrid Trout, Brook Trout, and Utah Chub caught in gill nets in Henrys Lake, Idaho between 1999 and 2013. Error bars represent 90% confidence intervals.

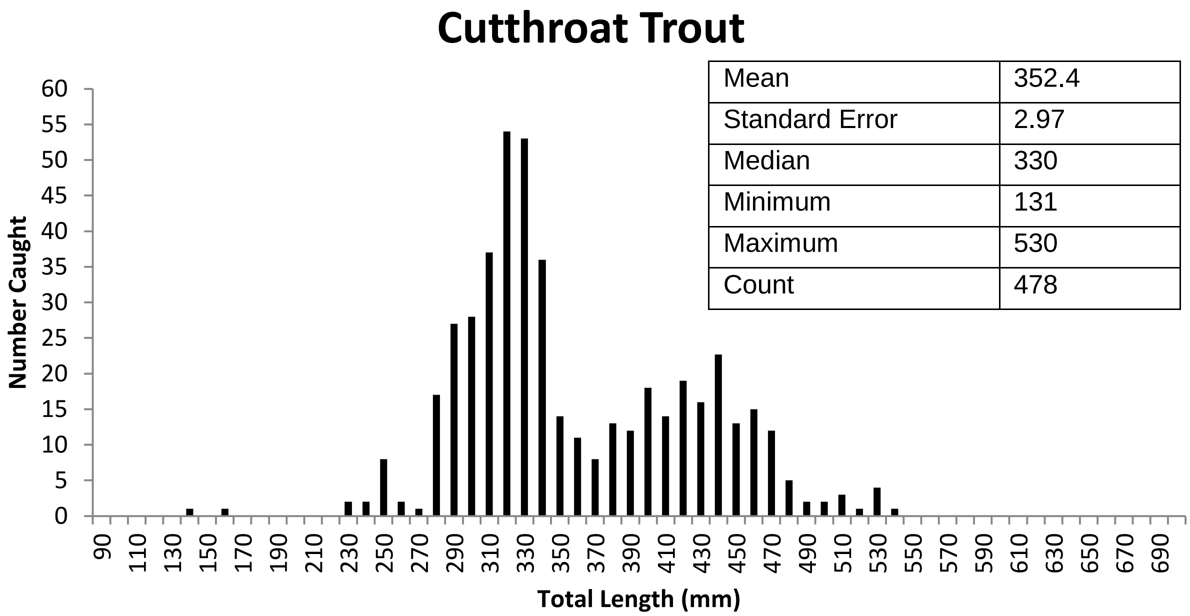


Figure 3. Yellowstone Cutthroat Trout length frequency distribution and total length statistics from gill nets set in Henrys Lake, Idaho, 2013.

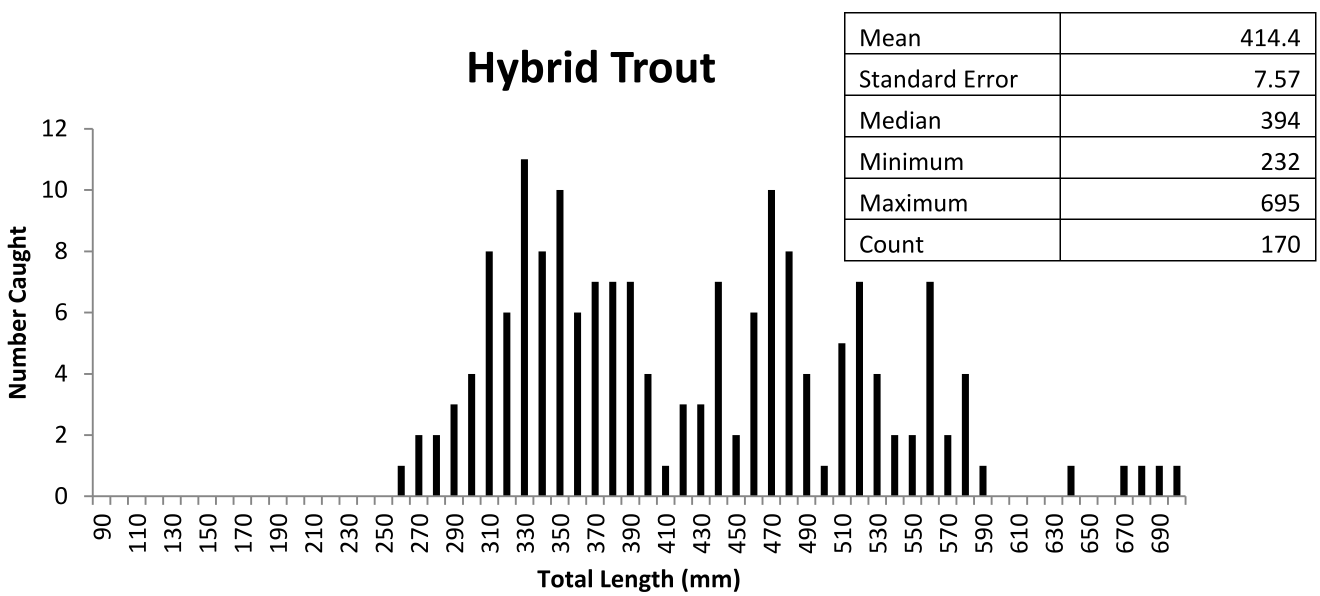


Figure 4. Hybrid Trout length frequency distribution and total length statistics from gill nets set in Henrys Lake, Idaho, 2013.

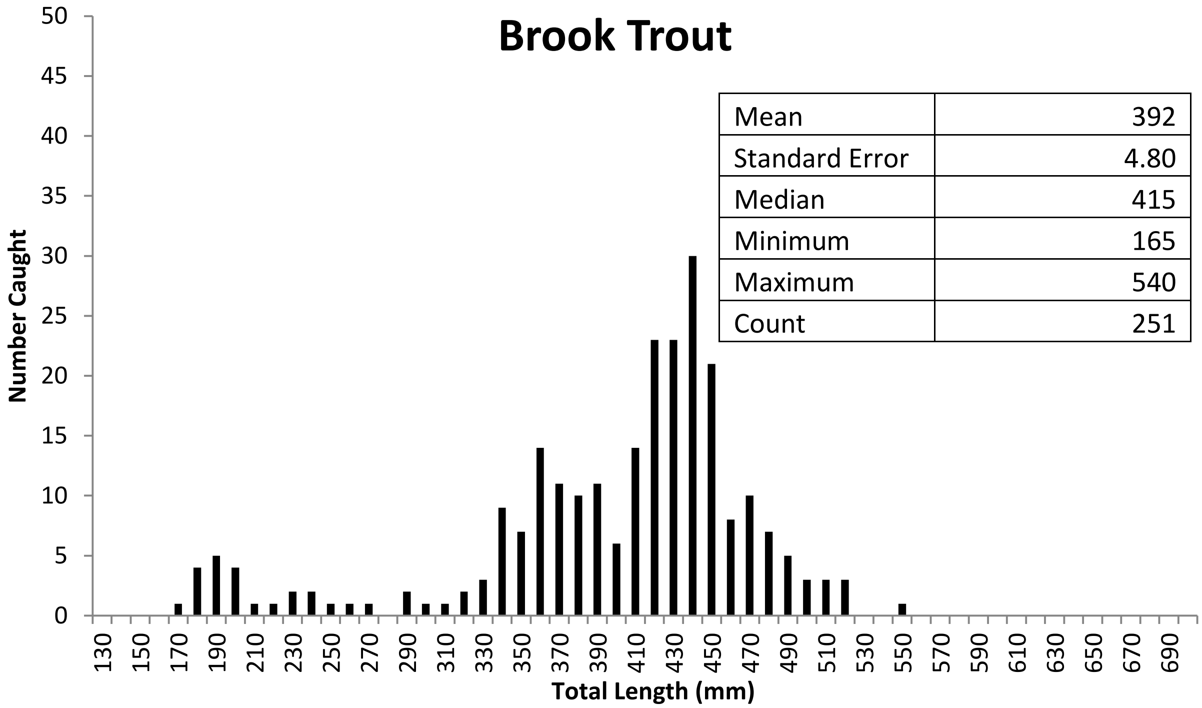


Figure 5. Brook Trout length frequency distribution and total length statistics from gill nets set in Henrys Lake, Idaho, 2013.

Table 1. Mean length at age data from trout caught with gill nets in Henrys Lake, Idaho 2013. Ages were estimated using otoliths.

| Species | Mean Length (mm) at Age | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Yellowstone Cutthroat Trout | 156 | 302 | 395 | 457 | 491 |
| (No. Analyzed) | (1) | (87) | (47) | (30) | (3) |
| Hybrid Trout | 265 | 324 | 436 | 529 | 610 |
| (No. Analyzed) | (1) | (57) | (31) | (31) | (4) |
| Brook Trout | 187 | 331 | 426 | 462 | 491 |
| (No. Analyzed) | (15) | (40) | (59) | (8) | (9) |

Table 2. 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 2013.

| | **Brook Trout** | **Hybrid Trout** | **Yellowstone Cutthroat Trout** |
|---|---|---|---|
| PSD | 95 | 93 | 82 |
| RSD-400 | 64 | 49 | 28 |
| RSD-500 | | | |
| | | | |
| ***$W_r$*** | | | |
| <200 mm | 86 | -- | 82 |
| 200 – 299 mm | 91 | 91 | 88 |
| 300 – 399 mm | 100 | 93 | 90 |
| >399 mm | 97 | 93 | 89 |
| Mean | 98 | 93 | 89 |

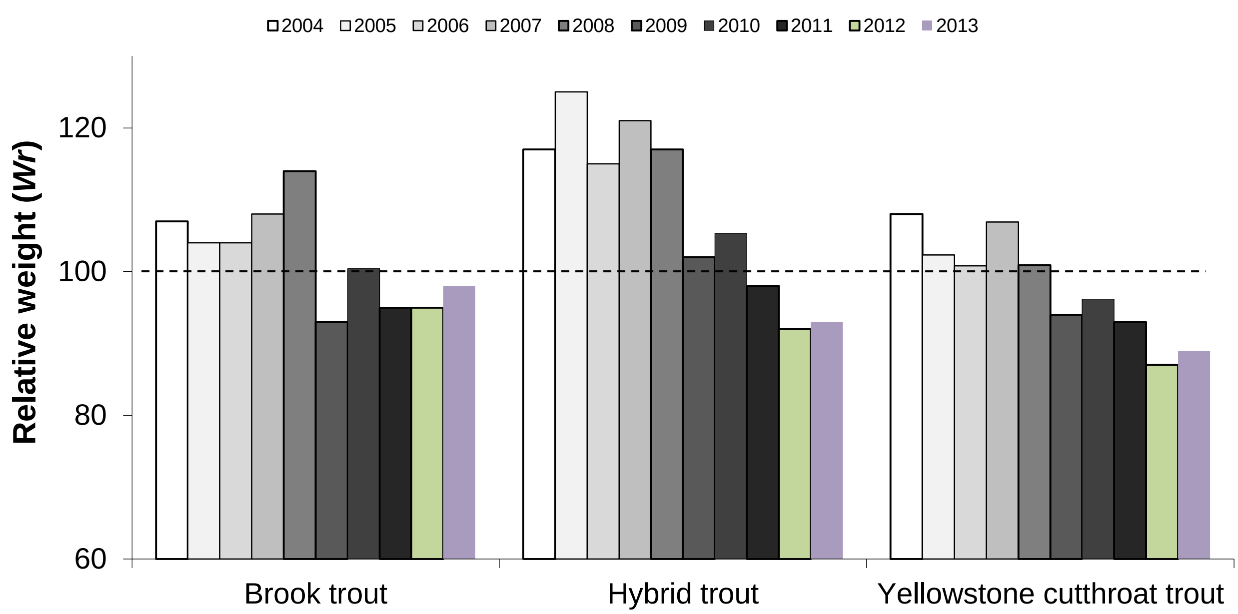


Figure 6. Mean relative weights ($W_r$) for Brook Trout, Hybrid Trout, and Yellowstone Cutthroat Trout in Henrys Lake, Idaho 2004-2013.

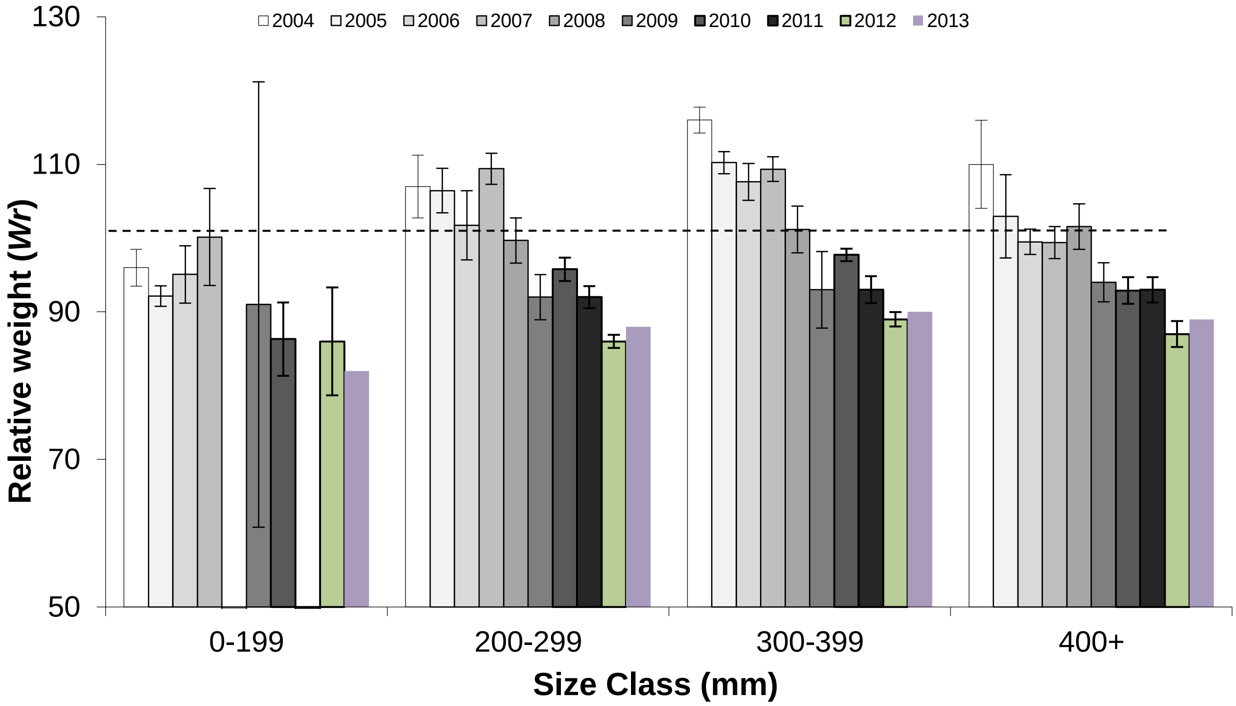


Figure 7. Relative weights ($W_r$) for four size classes (0 – 199 mm, 200 – 299 mm, 300 – 399 mm, and 400+ mm) of Yellowstone Cutthroat Trout in Henrys Lake, Idaho 2004-2013. Error bars represent 95% confidence intervals.

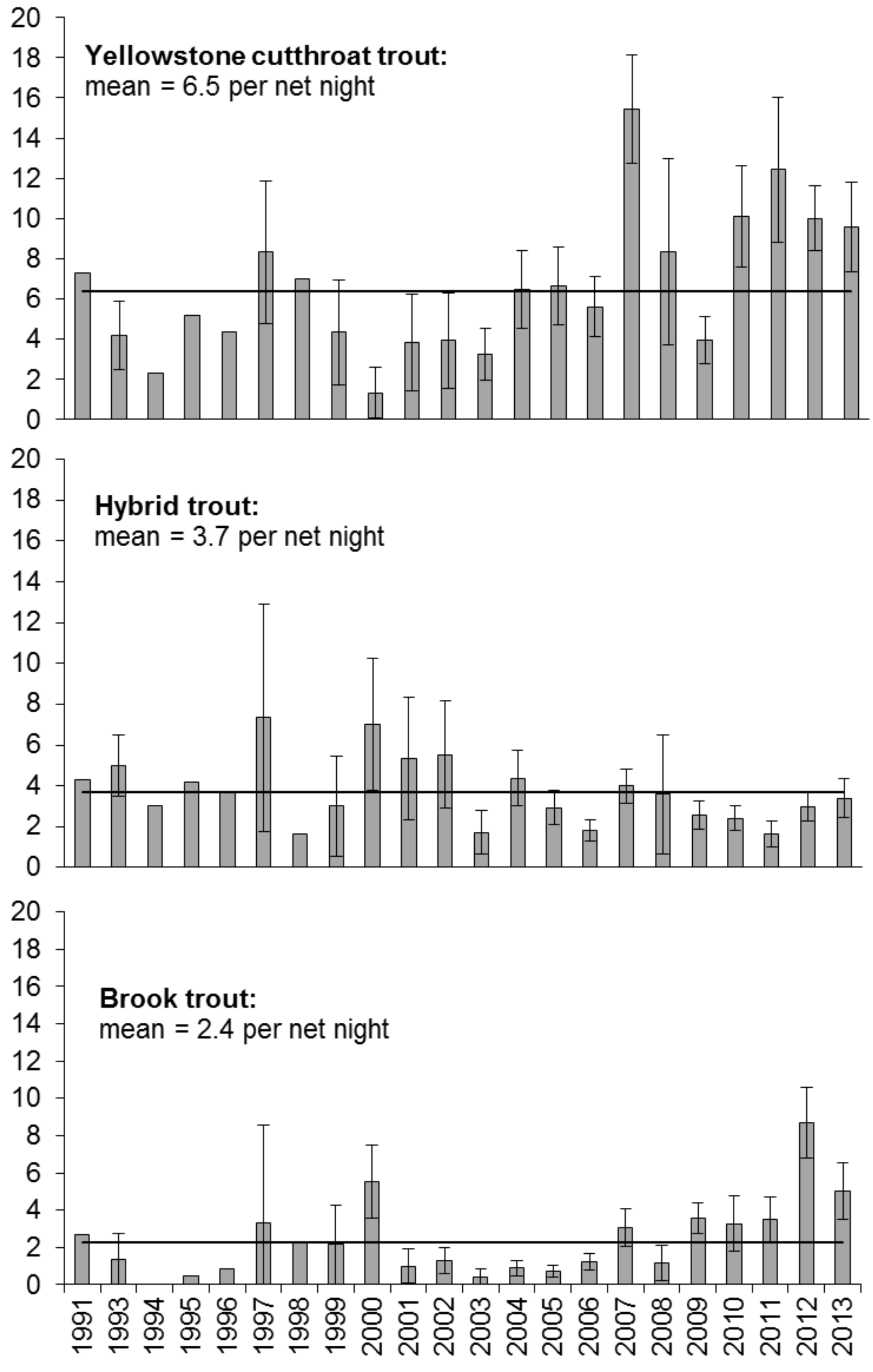


Figure 8. Gill net catch rates of Yellowstone Cutthroat Trout, Hybrid Trout, and Brook Trout from Henrys Lake, Idaho, 1991-2013. Error bars represent 95% confidence intervals. The solid line represents long term mean gill net catch rates.

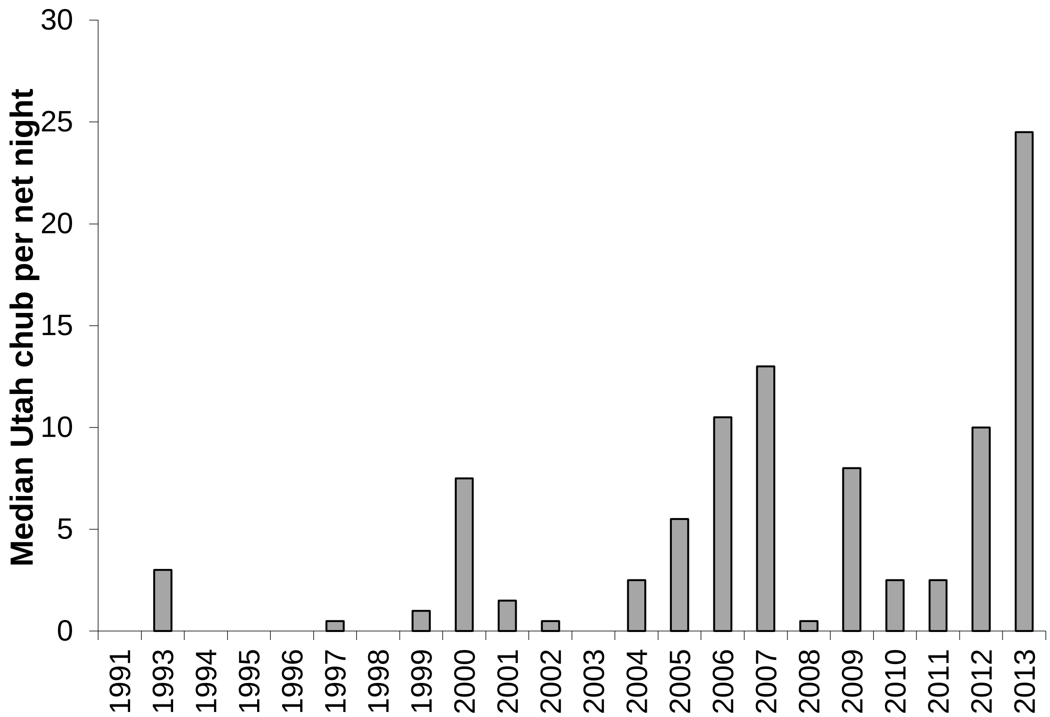


Figure 9. Median Utah Chub catch rates in gill nets set in Henrys Lake, Idaho, 1993-2013.

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% |
| 2013 | 75,600 | 3,360 | 268 | 8% | 478 | 47 | 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

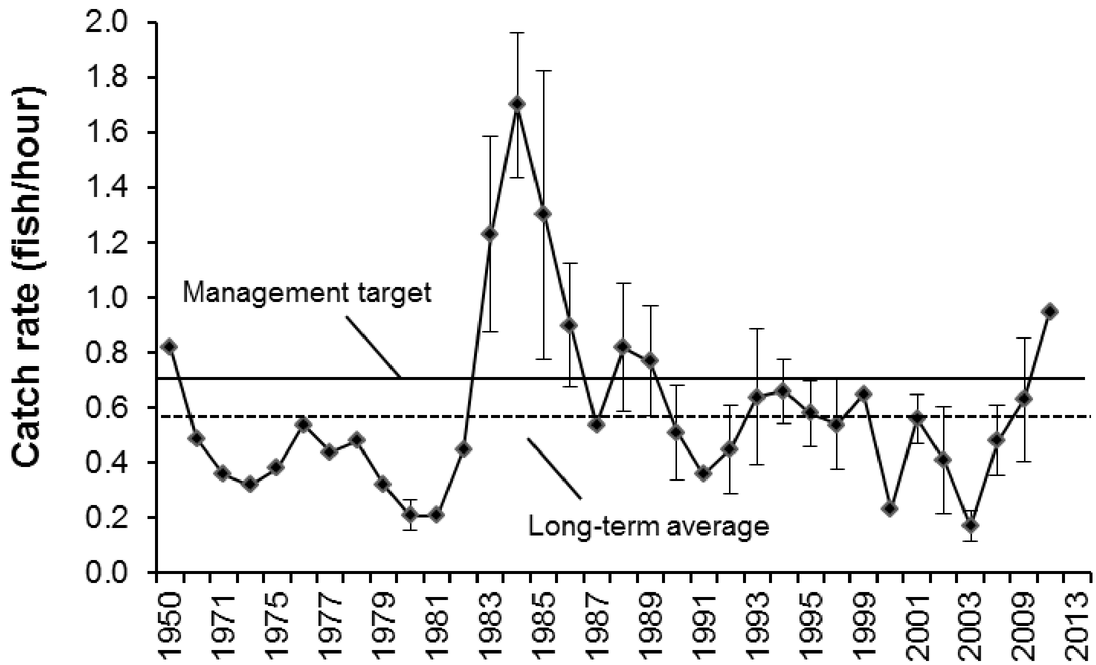


Figure 10. Angler catch rates (fish per hour) for Henrys Lake.

Table 4. Creel survey summary information for Henrys Lake, 2013.

| | Effort (hours) | | Catch Rate | Harvest Rate | Total | Total |
|---|---|---|---|---|---|---|
| | Boat | Bank | (f/h) | (f/h) | Caught | Harvested |
| 5-25 to 27 (open wknd) | 16835 | 4085 | 0.51 | 0.15 | 10292 | 3207 |
| 5-28 to 31 (May) | 4846 | 1454 | 1.20 | 0.12 | 7203 | 816 |
| June | 44479 | 8543 | 0.77 | 0.11 | 43830 | 6195 |
| July | 23209 | 4009 | 1.18 | 0.08 | 27568 | 2030 |
| August | 14821 | 1339 | 0.86 | 0.04 | 10784 | 559 |
| September | 15999 | 2965 | 1.17 | 0.06 | 24315 | 1243 |
| October | 20646 | 2960 | 1.27 | 0.13 | 20333 | 2885 |
| November 1-14 | 2979 | 454 | 0.74 | 0.19 | 5779 | 1157 |
| 11-15 to Jan 1 (Ice) | 0 | 21833 | 1.04 | 0.22 | 25657 | 6046 |
| Total | 143815 | 47641 | 0.95 | 0.12 | 175761 | 24138 |

Table 5. Historic creel data for Henrys Lake.

| Year | Effort | No. Caught | No. Harvested | Catch Rate (fish/hr) Harvest | Catch Rate (fish/hr) Total | % released |
|---|---|---|---|---|---|---|
| 1950 | 17008 | | 12246 | 0.72 | 0.82 | 12 |
| 1951 | 27947 | | 12302 | 0.44 | 0.49 | 12 |
| 1971 | 102233 | | 36720 | 0.36 | 0.36 | 0 |
| 1972 | 83800 | | 27038 | 0.32 | 0.32 | 0 |
| 1975 | 86304 | | 29914 | 0.35 | 0.38 | 10 |
| 1976 | 68109 | 36647 | 18650 | 0.27 | 0.54 | 49 |
| 1977 | 66139 | 29167 | 16466 | 0.25 | 0.44 | 44 |
| 1978 | 85304 | 40529 | 25510 | 0.3 | 0.48 | 37 |
| 1979 | 93921 | 29751 | 18728 | 0.2 | 0.32 | 37 |
| 1980 | 68446 | 14597 | 9262 | 0.14 | 0.21 | 37 |
| 1981 | 65918 | 14154 | 7471 | 0.11 | 0.21 | 47 |
| 1982 | 63273 | 28692 | 7071 | 0.11 | 0.45 | 75 |
| 1983 | 95996 | 121973 | 25447 | 0.23 | 1.23 | 81 |
| 1984 | 162878 | 270985 | 47017 | 0.29 | 1.7 | 83 |
| 1985 | 125666 | 159388 | 37921 | 0.3 | 1.3 | 76 |
| 1986 | 172772 | 154739 | 67681 | 0.39 | 0.9 | 55 |
| 1987 | 150234 | 81126 | 35712 | 0.24 | 0.54 | 56 |
| 1988 | 100479 | 81623 | 19503 | 0.2 | 0.82 | 76 |
| 1989 | 339986 | 262480 | 103736 | 0.31 | 0.77 | 60 |
| 1990 | 344245 | 174459 | 63139 | 0.18 | 0.51 | 64 |
| 1991 | 124376 | 50544 | 16127 | 0.13 | 0.36 | 68 |
| 1992 | 115526 | 52986 | 12192 | 0.11 | 0.45 | 72 |
| 1993 | 144267 | 92466 | 26710 | 0.18 | 0.64 | 71 |
| 1994 | 177826 | 116601 | 21008 | 0.12 | 0.66 | 82 |
| 1995 | 172646 | 99286 | 20627 | 0.12 | 0.58 | 79 |
| 1997 | 228952 | 127760 | 32415 | 0.25 | 0.54 | 74 |
| 1999 | 228000 | 148618 | 27355 | 0.12 | 0.65 | 72 |
| 2000 | | | | | 0.23 | |
| 2001 | 165825 | 93326 | 17759 | 0.11 | 0.56 | 81 |
| 2002 | | | | | 0.41 | |
| 2003 | 108511 | 16935 | 5353 | 0.05 | 0.17 | 68 |
| 2005 | 94783 | 45044 | 8991 | 0.1 | 0.48 | 80 |
| 2009 | 124613 | 78855 | 13788 | 0.11 | 0.63 | 83 |
| 2013 | 191457 | 175761 | 24138 | 0.12 | 0.95 | 86 |
| *Average* | *131170* | *96240* | *26500* | *0.23* | *0.59* | *57* |

Table 6. Dissolved oxygen (DO) (mg/l) levels recorded in Henrys Lake, Idaho winter monitoring 2012-2013.

| 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** | 2-13-13 | 22 | 43 | 10.64 | 10.13 | 9.1 | 4.89 | 29.9 |
| | 3-1-13 | 14 | 84 | | 9.52 | 7.29 | 4.08 | 24.9 |
| | 3-13-13 | 14 | 84 | | 8.54 | 5.55 | 3.08 | 20.0 |
| **County Boat Ramp** | 2-13-13 | 35 | 45 | 9.82 | 9.35 | 6.08 | 3.04 | 18.7 |
| | 3-1-13 | 31 | 58 | 9.53 | 8.51 | 4.49 | 3.98 | 18.4 |
| | 3-13-13 | 31 | 58 | | 7.76 | 5.73 | 3.72 | 17.8 |
| **Wild Rose** | 2-13-13 | 20 | 45 | 9.34 | 9.12 | 7.71 | 4.25 | 22.3 |
| | 3-1-13 | 21 | 58 | 9.18 | 9 | 6.01 | 2.7 | 18.0 |
| | 3-13-13 | 21 | 58 | | 9.45 | 5.82 | 2.7 | 16.5 |
| **Hatchery** | 2-13-13 | 27 | 44 | 9.3 | 8.31 | 4.37 | 2.05 | 15.5 |
| | 3-1-13 | 14 | 63 | 8.91 | 7.79 | 3.5 | 1.05 | 13.0 |
| | 3-13-13 | 14 | 63 | | 7.43 | 3.56 | 1.08 | 12.2 |

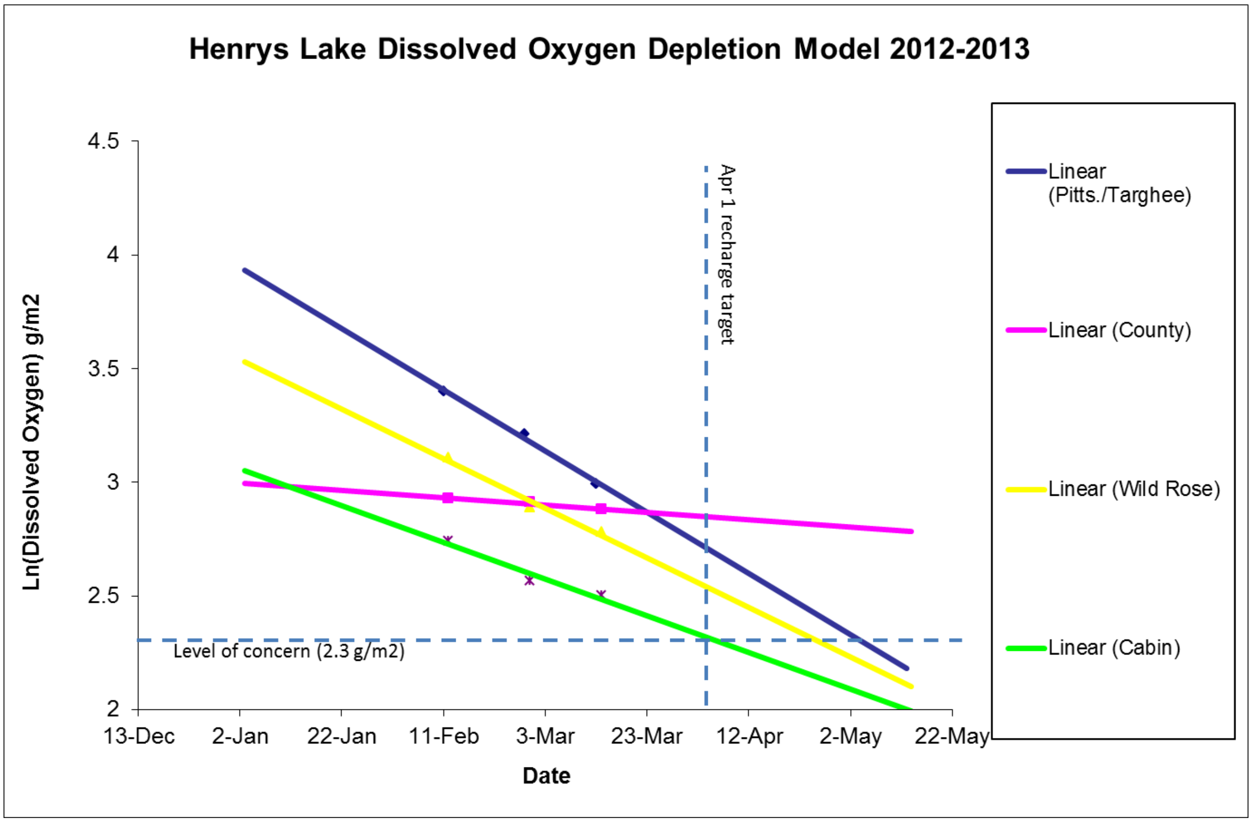


Figure 11. Dissolved oxygen depletion estimates from Henrys Lake, Idaho, 2012-2013

Appendix A. Historic annual stocking (*1,000) of Henrys Lake, Idaho, 1925 -2013.

| Year | Yellowstone Cutthroat Trout | Hybrid Trout | Brook Trout | Total trout |
|---|---|---|---|---|
| 1923 | 40 | 0 | 0 | 40 |
| 1924 | 0 | 0 | 0 | 0 |
| 1925 | 1 | 0 | 1 | 2 |
| 1926 | 140 | 0 | 0 | 140 |
| 1927 | 222 | 0 | 0 | 222 |
| 1928 | 116 | 0 | 0 | 116 |
| 1929 | 0 | 0 | 0 | 0 |
| 1930 | 0 | 0 | 0 | 0 |
| 1931 | 634 | 0 | 0 | 634 |
| 1932 | 170 | 0 | 0 | 170 |
| 1933 | 50 | 0 | 0 | 50 |
| 1934 | 980 | 0 | 0 | 980 |
| 1935 | 632 | 0 | 3 | 635 |
| 1936 | 0 | 0 | 0 | 0 |
| 1937 | 719 | 0 | 0 | 719 |
| 1938 | 753 | 0 | 0 | 753 |
| 1939 | 370 | 0 | 0 | 370 |
| 1940 | 750 | 0 | 0 | 750 |
| 1941 | 0 | 0 | 0 | 0 |
| 1942 | 1589 | 0 | 0 | 1589 |
| 1943 | 1665 | 0 | 0 | 1665 |
| 1944 | 1537 | 0 | 0 | 1537 |
| 1945 | 818 | 0 | 0 | 818 |
| 1946 | 1670 | 0 | 0 | 1670 |
| 1947 | 238 | 0 | 0 | 238 |
| 1948 | 584 | 0 | 0 | 584 |
| 1949 | 684 | 0 | 2 | 686 |
| 1950 | 779 | 5 | 6 | 790 |
| 1951 | 2070 | 0 | 0 | 2070 |
| 1952 | 610 | 8 | 0 | 618 |
| 1953 | 600 | 0 | 0 | 600 |
| 1954 | 1223 | 0 | 0 | 1223 |
| 1955 | 1243 | 0 | 0 | 1243 |
| 1956 | 985 | 0 | 0 | 985 |
| 1957 | 640 | 0 | 0 | 640 |
| 1958 | 534 | 0 | 0 | 534 |
| 1959 | 454 | 0 | 0 | 454 |
| 1960 | 1024 | 138 | 0 | 1162 |
| 1961 | 1570 | 390 | 0 | 1960 |
| 1962 | 1366 | 385 | 0 | 1751 |
| 1963 | 1300 | 565 | 0 | 1865 |
| 1964 | 1455 | 0 | 0 | 1455 |
| 1965 | 1755 | 0 | 0 | 1755 |
| 1966 | 1481 | 563 | 0 | 2044 |

Appendix A. cont.

| Year | Yellowstone Cutthroat Trout | Hybrid Trout | Brook Trout | Total trout |
|---|---|---|---|---|
| 1967 | 1159 | 448 | 0 | 1607 |
| 1968 | 847 | 132 | 0 | 979 |
| 1969 | 111 | 476 | 0 | 587 |
| 1970 | 391 | 133 | 0 | 524 |
| 1971 | 763 | 184 | 0 | 947 |
| 1972 | 834 | 0 | 0 | 834 |
| 1973 | 1145 | 0 | 0 | 1145 |
| 1974 | 1105 | 0 | 0 | 1105 |
| 1975 | 1024 | 0 | 101 | 1125 |
| 1976 | 862 | 200 | 167 | 1229 |
| 1977 | 825 | 200 | 137 | 1162 |
| 1978 | 946 | 179 | 89 | 1214 |
| 1979 | 1134 | 125 | 96 | 1355 |
| 1980 | 1040 | 32 | 91 | 1163 |
| 1981 | 2251 | 146 | 20 | 2417 |
| 1982 | 2442 | 242 | 18 | 2702 |
| 1983 | 2179 | 229 | 22 | 2429 |
| 1984 | 2041 | 135 | 0 | 2175 |
| 1985 | 995 | 33 | 111 | 1139 |
| 1986 | 989 | 292 | 0 | 1281 |
| 1987 | 663 | 256 | 0 | 919 |
| 1988 | 1011 | 312 | 0 | 1323 |
| 1989 | 1090 | 251 | 95 | 1436 |
| 1990 | 1001 | 200 | 157 | 1358 |
| 1991 | 1326 | 201 | 129 | 1656 |
| 1992 | 943 | 203 | 189 | 1336 |
| 1993 | 1060 | 217 | 112 | 1388 |
| 1994 | 1048 | 201 | 115 | 1363 |
| 1995 | 1381 | 144 | 136 | 1662 |
| 1996 | 661 | 200 | 196 | 1057 |
| 1997 | 1237 | 180 | 204 | 1621 |
| 1998 | 1047 | 204 | 207 | 1459 |
| 1999 | 1249 | 204 | 0 | 1453 |
| 2000 | 978 | 0 | 0 | 978 |
| 2001 | 991 | 135 | 0 | 1126 |
| 2002 | 1107 | 331 | 0 | 1438 |
| 2003 | 1634 | 264 | 99 | 1996 |
| 2004 | 921 | 38 | 117 | 1077 |
| 2005 | 851 | 201 | 152 | 1204 |
| 2006 | 1124 | 150 | 107 | 1381 |
| 2007 | 1394 | 146 | 104 | 1644 |
| 2008 | 1254 | 196 | 198 | 1648 |
| 2009 | 1382 | 220 | 171 | 1773 |
| 2010 | 1326 | 138 | 93 | 1557 |
| 2011 | 1127 | 205 | 100 | 1432 |
| 2012 | 768 | 221 | 101 | 1090 |

Appendix A. cont.

| Year | Yellowstone Cutthroat Trout | Hybrid Trout | Brook Trout | Total trout |
|---|---|---|---|---|
| 2013 | 756 | 213 | 110 | 1079 |

# ISLAND PARK RESERVOIR

## ABSTRACT

We used 30 standard experimental gill nets (14 floating, 16 sinking) to assess fish populations and relative abundance in Island Park Reservoir during June 2013. Mean catch (fish per net night) was 24.9 Utah Sucker *Catostomus ardens*, 13.3 Utah Chub *Gila atraria*, 5.4 Rainbow Trout *Oncorhynchus mykiss*, 0.5 Kokanee *O. nerka*, 0.2 Mountain Whitefish *Prosopium williamsoni*, and <0.1 Brook Trout. Mean relative weight ($W_r$) for Rainbow Trout and Kokanee was 90 and 91, respectively. We conducted a creel survey of anglers fishing the reservoir from Memorial Day weekend through the end of September. Angler effort was the highest recorded since the 1980's at 59,000 hours of effort with an overall catch rate of 0.68 fish per hour, the highest catch rate since 1980. We collected 60 pairs of Kokanee from the Henrys Lake Outlet, spawned them into unique family groups and placed their eyed eggs in four locations in Moose and Lucky Dog creeks. Our intent is to have these eggs hatch in an area that historically supported wild Kokanee production in the hopes of restoring that spawning run and improving the fishery in Island Park Reservoir.

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## OBJECTIVES

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 3 to June 7, 2013 for a total of 30 net nights (Figure 12; 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).

We conducted a creel survey from Memorial Day Weekend through the end of September, encompassing the bulk of angling effort on the reservoir. Two weekdays and two weekend days were selected during each two-week period to collect interview data from anglers. Clerks used a boat to contact anglers during their fishing trip and collect information on time spent fishing, as well as the number and species of fish both caught and harvested. Aerial surveys were used to collect counts of anglers fishing, which was then used to estimate lakewide effort. Total fish caught and harvested were estimated using catch and harvest rate data collected through interviews combined with effort estimates from aerial surveys.

We collected 59 pairs of Kokanee using backpack electrofishing gear from the Henrys Lake Outlet on September 12-13 to collect gametes which were then combined to produce viable fertilized eggs to be stocked in Moose Creek and Lucky Dog Creek (Appendix C). Eggs were reared in the Henrys Lake Hatchery facility until eye up, at which time they were moved to Vibert egg boxes placed in the respective creeks. A total of four locations were used to rear Kokanee until they voluntarily left the egg boxes. Genetic information was collected from all adult Kokanee, and will be used in Parental Based Tagging efforts in future years to evaluate the success of stocking locations.

## RESULTS

We collected 1,328 fish in 30 net nights of effort (44.3 fish/net night). Relative abundance of the gill net catch was dominated by Utah Sucker (56%), Utah Chub (30%), and Rainbow Trout (12%; Figure 13). Kokanee comprised 1% of the total catch, while Mountain Whitefish and Brook Trout accounted for less than 1% of the catch each. Catch rate (fish per net night) was highest for Utah Sucker (24.9), followed by Utah Chub (13.3), and Rainbow Trout (5.4; Figure 14; Appendix D). Rainbow Trout ranged in length from 173 to 558 mm TL (Figure 15), with a mean and median length of 356 mm and 330 mm (Figure 16). Proportional stock density (PSD) was 88, and RSD-400 and RSD-500 were 32 and 3, respectively (Table 7). Mean relative weight of Rainbow Trout was 90 (Table 7). Kokanee lengths ranged from 186 to 500 mm, with a mean and median length of 282 mm and 210 mm (Figure 17). Kokanee PSD was 75, while RSD-400 and RSD-500 were 38 and 13, respectively (Table 7). Mean relative weight of Kokanee was 91.

Creel clerks interviewed 688 anglers in 292 parties that when expanded represented an estimated 25,831 trips. Angler use was estimated at 59,636 hours for the year, while catch rates and harvest rates were estimated at 0.7 f/h and 0.4 f/h, respectively (Table 8). Rainbow Trout made up the bulk of angler catch, with anglers catching an estimated 36,646 rainbows and 635 Kokanee (Table 9). Harvest rates (the percentage of fish caught that were harvested) was 53% for Rainbow Trout and 76% for Kokanee. Of note, anglers also targeted crayfish, and harvested an estimated 2,723.

Kokanee egg boxes were placed in Lucky Dog and Moose creeks on October 17th. Egg boxes were monitored weekly, and fry hatched over the course of a month. At the time of this report, most fry had moved out of the incubators and into the wild.

## DISCUSSION

The gill net surveys conducted in 2013 are a continuation of the aggressive sampling effort started in 2012, and provide the baseline for future work. Similar to Henrys Lake, we plan to conduct extensive annual surveys on Island Park to dictate future management actions, using the gill net locations established in 2012. During 2013, gill net catch of Rainbow Trout was lower than in 2012, while Kokanee catch remained similar to 2012. Direct comparisons to gillnetting done prior to 2012 are hampered by differences in net numbers, survey timing and sampling protocol. Although little comparable data exists prior to 2012, gill net data collected on Island Park is comparable to nearby waters like Henrys Lake because survey techniques are similar. Gill net catch rates in Island Park are lower than those in Henrys by about 12 trout per net (18 per net in Henrys Lake vs six in Island Park), suggesting lower densities of trout in Island Park. Interestingly, angler catch rates on Island Park were similar to those on Henrys, even though the population appears to be much lower. It's possible that anglers are targeting areas that consistently hold fish such as Trudes Bay and Grizzly Springs, and are increasing their catch rates by doing so.

Angler catch rates were higher in 2013 than any prior survey since 1980, and are the sixth highest catch rates recorded since 1950. It's noteworthy that during many of the years when catch rates rivaled or exceeded those of 2013, Kokanee and Coho Salmon contributed to the catch, sometimes as much as 50% of the total catch. The current year's catch was supported almost entirely by Rainbow Trout. It's possible that improvements to reservoir carryover or environmental factors are contributing to the improvement in the fishery. However, if this was a major factor in fishing success, we would expect to see an improvement in the Kokanee fishery as well as the Rainbow fishery. Since that has not happened, it is possible that the shift in stocking practices that started in 2010 is having a measurable effect on the population. Prior to this date, IDFG stocked approximately 1 million fingerling (75 mm) trout annually. In 2010 and subsequent years, we shifted to stocking a larger (150 mm+) fingerling later in the fall, after irrigation withdrawals had subsided. This reduced the potential for entrainment through the existing screens on the power plant intake, and put hatchery fish in the reservoir during periods of limited withdraw as opposed to during the peak of water withdraw. While it is possible this has increased the number of trout in the reservoir, gill net catch remains low, confounding conclusions about the shift in stocking practices. In some years, stocking of catchable fish seems to enhance the fishery, but in other years, returns from tagged hatchery fish are low or nonexistent. It is possible that the combination of fingerling stockings combined with wild production may be supporting the bulk of the rainbow population in Island Park.

Additional evaluation is necessary to clarify the relationship between stocking practices and fish abundance.

The Kokanee spawning project has functioned as designed. Egg collection was successful and yielded nearly as many Kokanee as initially targeted (60 pair), although egg ripeness was a concern for fish used during the second day of the project. The egg incubators worked as designed, although icing in Moose Creek may have impacted the success of one incubator. We expect adult fish that resulted from these pairings to return to their spawn location as early as 2016, but more likely in 2017 as three-year old adults. Surveys should be conducted in the coming years to document the success of this project. If successful, this project may help reestablish the wild component of Kokanee in Island Park, and ultimately improve fishing for this highly desirable species.

## MANAGEMENT RECOMMENDATIONS

1. Continue annual gill net monitoring at 30 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/ eyed egg releases in these locations have established spawning runs.

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

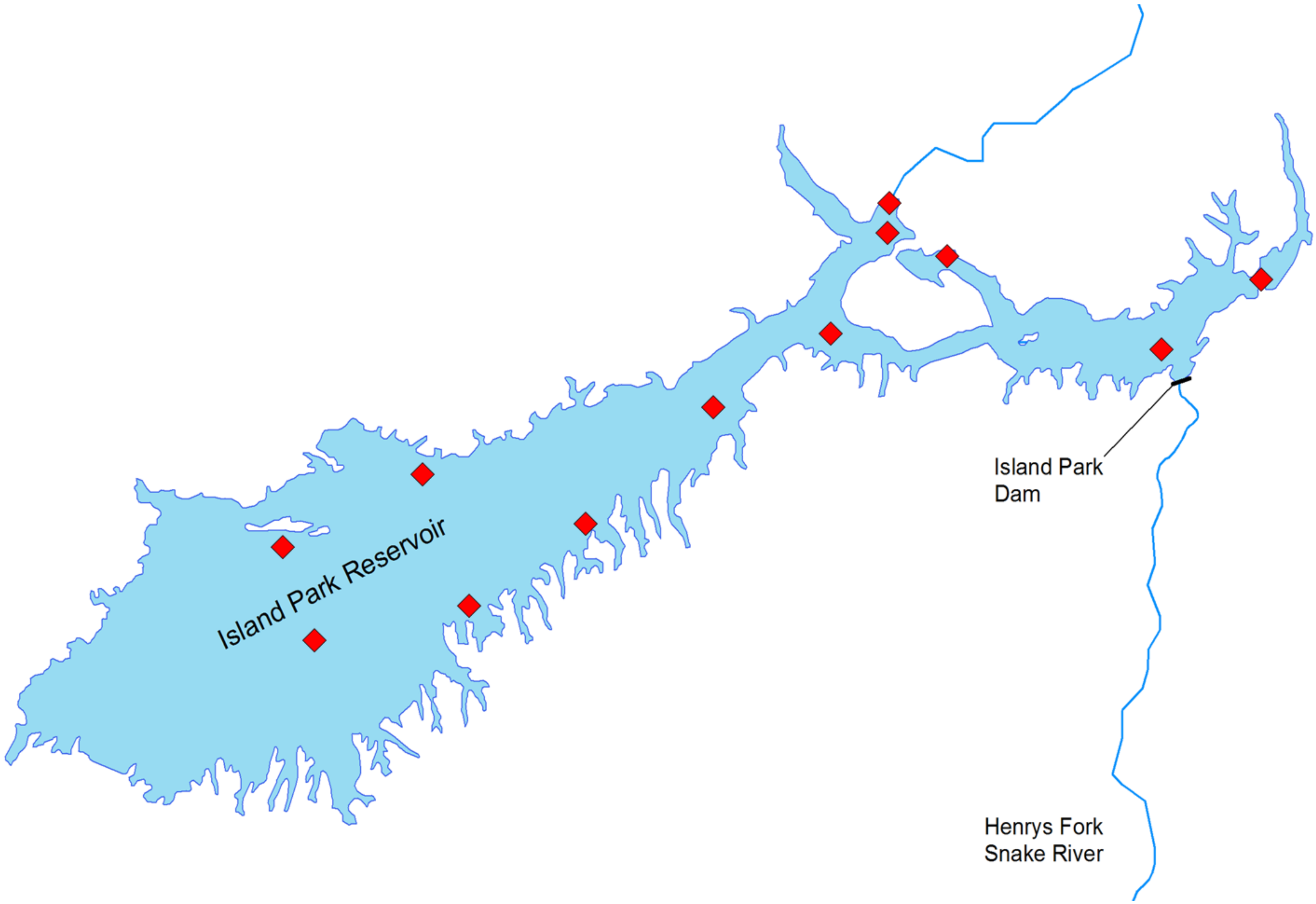


Figure 12. Location of gillnet sampling in Island Park Reservoir, Idaho, 2013.

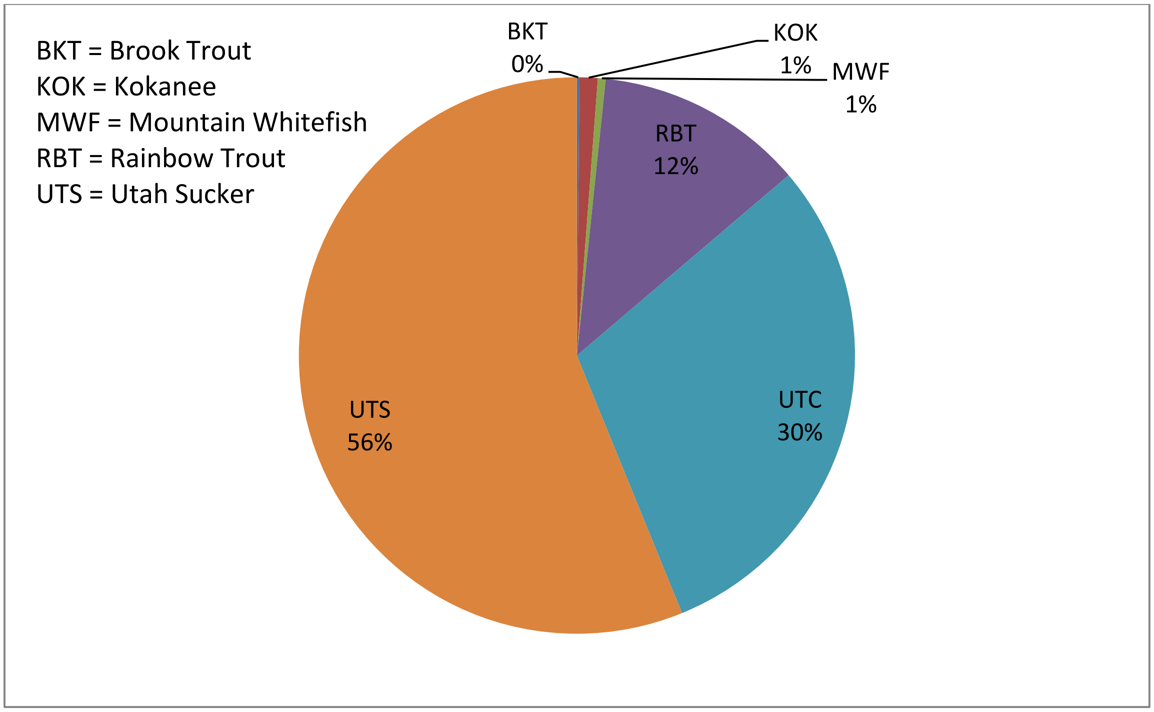


Figure 13. Species composition from gill nets set in Island Park Reservoir Idaho, June 2013.

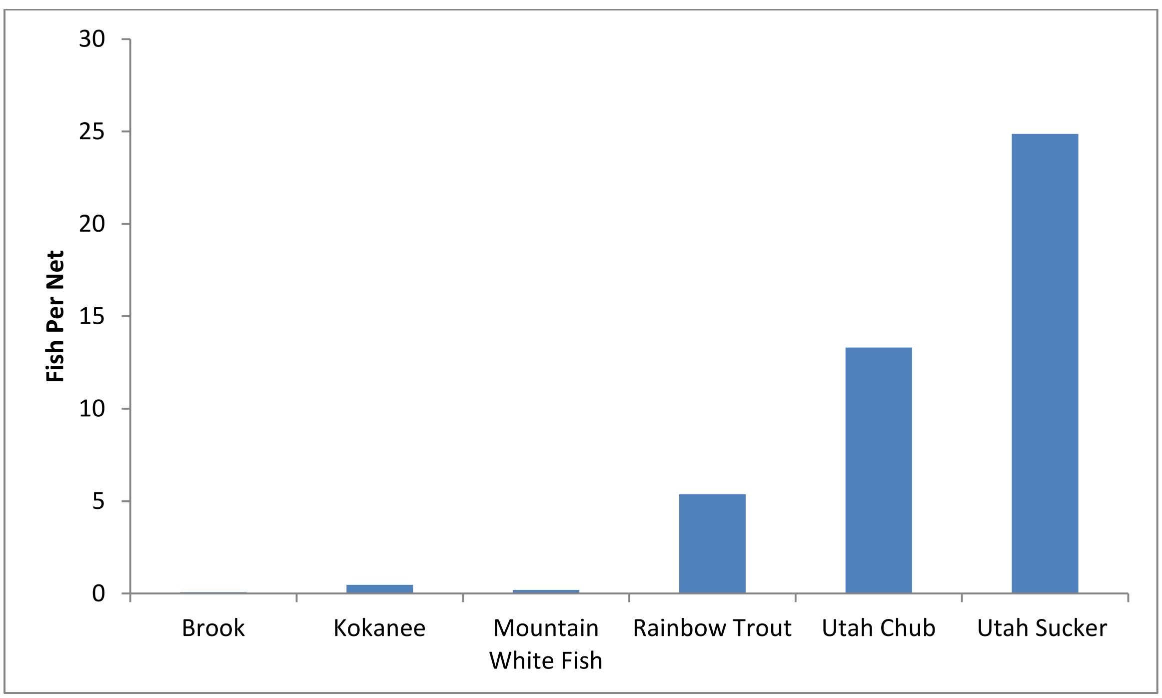


Figure 14. Gill net catch rate (fish per net night) from 36 nets set in Island Park Reservoir in 2013.

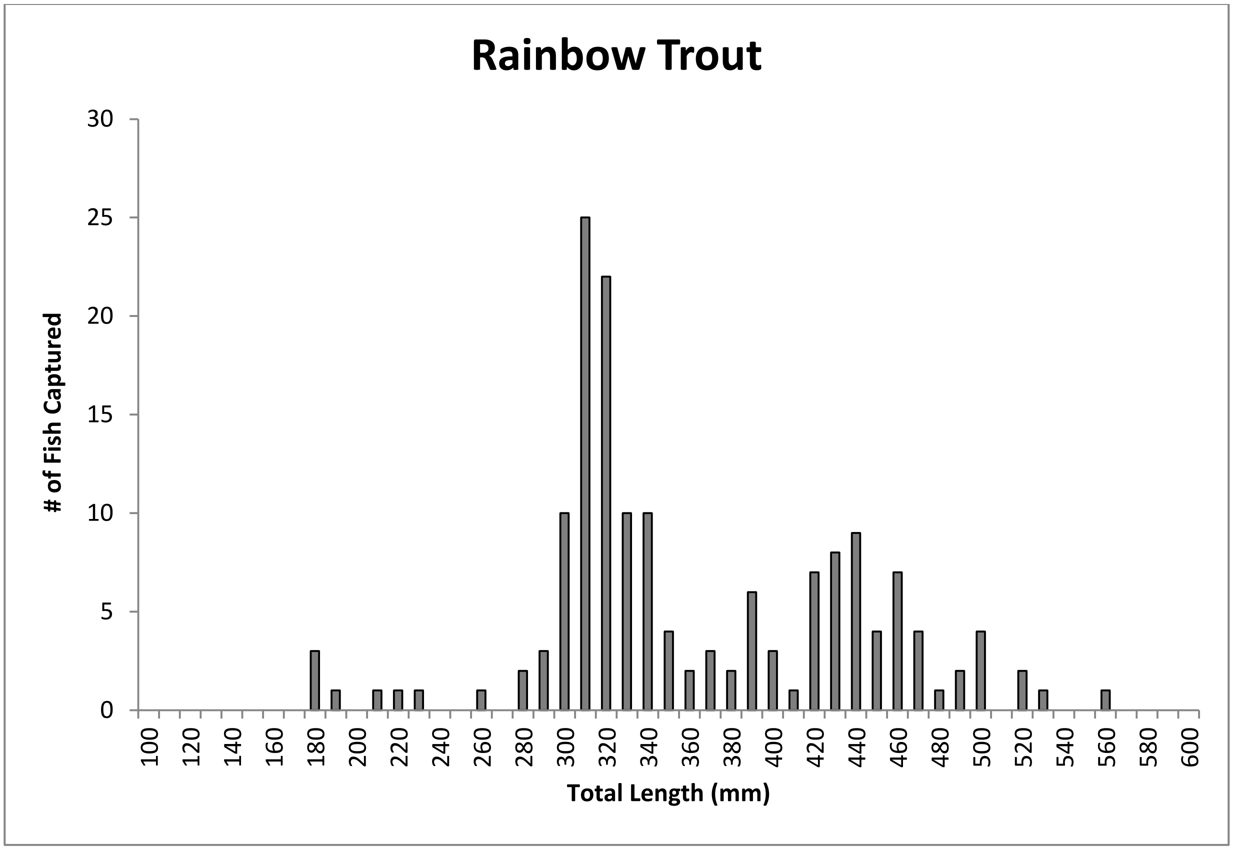


Figure 15. Length frequency of Rainbow Trout captured in gill nets in Island Park Reservoir in 2013.

Table 7. 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 2013. Sample size (*n*) for relative weight values is noted in parentheses.

| | **Rainbow Trout (*n*)** | **Kokanee (*n*)** |
|---|---|---|
| PSD | 88 | 75 |
| RSD-300 | - | 38 |
| RSD-400 | 32 | 13 |
| RSD-500 | 3 | - |
| | | |
| $\boldsymbol{W_r}$ | | |
| <200 mm | 82 (4) | 82 (6) |
| 200 – 299 mm | 94 (19) | 88 (3) |
| 300 – 399 mm | 93 (87) | 106 (2) |
| >399 mm | 83 (51) | 104 (3) |
| Mean | 90 | 91 |

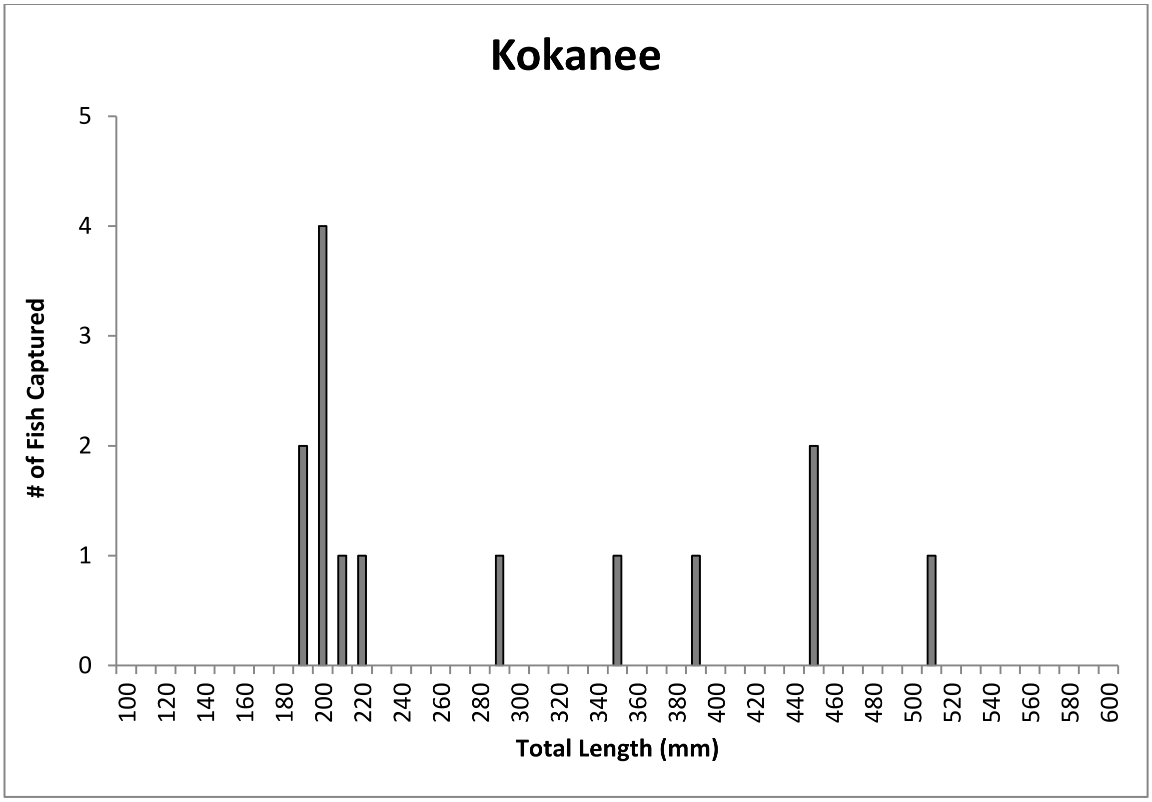


Figure 16. Length frequency of Kokanee captured in gill nets in Island Park Reservoir in 2013.

Table 8. Estimates of angler effort for Island Park Reservoir, 2013.

| BLOCK | BOAT ANGLER HOURS | RSE BOAT EFFORT | BANK ANGLER HOURS | RSE BANK EFFORT | TOTAL ANGLER HOURS | RSE TOTAL EFFORT |
|---|---|---|---|---|---|---|
| 1_MAY | 2504 | 0.1 | 1387 | 0.1 | 3891 | 0.1 |
| 2_JUN | 16007 | 0.2 | 3589 | 0.2 | 19596 | 0.2 |
| 3_JUL | 12591 | 0.6 | 4771 | 0.7 | 17362 | 0.6 |
| 4_AUG | 7430 | 0.7 | 3860 | 0.7 | 11289 | 0.7 |
| 5_SEP | 4018 | 1.1 | 3449 | 1.1 | 7467 | 1.1 |
| TOTAL | 42549 | 0.2 | 17057 | 0.3 | 59605 | 0.3 |

Table 9. Angler catch and harvest statistics for Island Park Reservoir, 2013.

| SPECIES | NUMBER HARVESTED | STD FOR NUMBER HARVESTED | RSE FOR NUMBER HARVESTED | NUMBER RELEASED | STD FOR NUMBER RELEASED | RSE FOR NUMBER RELEASED | NUMBER CAUGHT | STD FOR NUMBER CAUGHT | RSE FOR NUMBER CAUGHT |
|---|---|---|---|---|---|---|---|---|---|
| BROOK TROUT | 0 | 0.00 | . | 37 | 72.95 | 197.2 | 37 | 72.95 | 197.2 |
| UTAH CHUB | 0 | 0.00 | . | 120 | 637.66 | 531.4 | 120 | 637.66 | 531.4 |
| CRAYFISH | 2723 | 3824.71 | 140.5 | 0 | 0.00 | . | 2723 | 3824.71 | 140.5 |
| KOKANEE | 485 | 816.10 | 168.3 | 150 | 434.48 | 289.7 | 635 | 924.55 | 145.6 |
| MOUNTAIN WHITEFISH | 0 | 0.00 | . | 92 | 439.57 | 477.8 | 92 | 439.57 | 477.8 |
| RAINBOW TROUT | 19417 | 4204.14 | 21.7 | 17229 | 2591.67 | 15.0 | 36646 | 4938.78 | 13.5 |
| UTAH SUCKER | 116 | 469.64 | 404.9 | 123 | 504.62 | 410.3 | 239 | 689.34 | 288.4 |

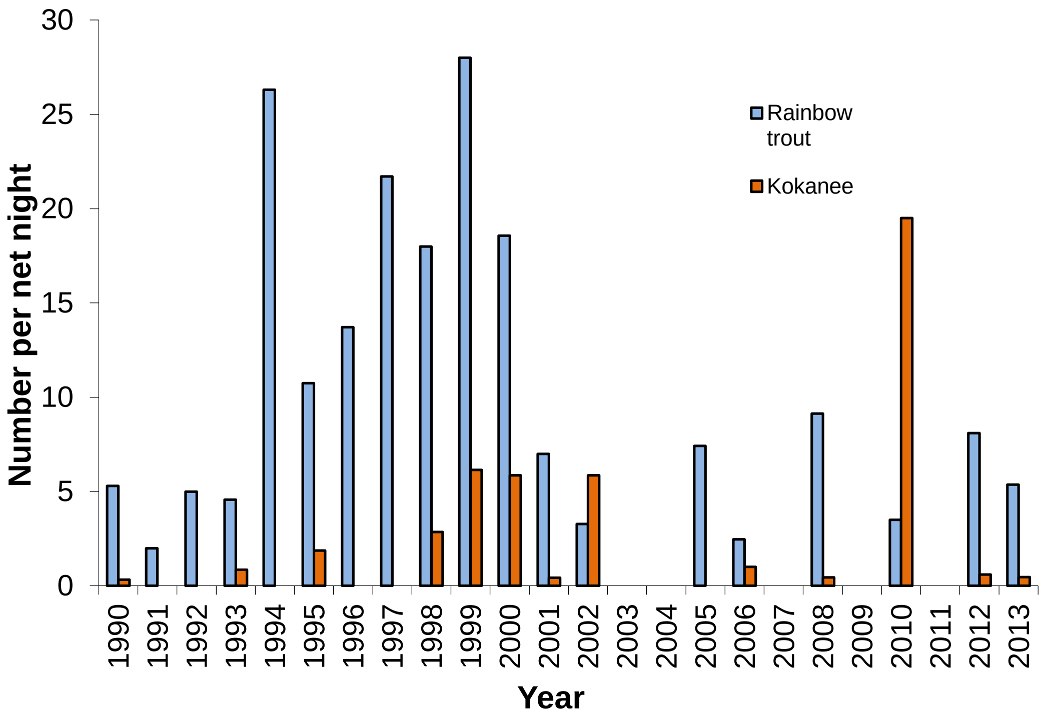


Figure 17. Gill net catch rate (fish per net night) of Kokanee and Rainbow Trout in Island Park Reservoir, from 1990 to 2013.

Appendix B. Gill net locations in Island Park Reservoir, 2013. 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. Annual Kokanee stocking in Island Park Reservoir, Moose Creek, and Big Springs Creek, 1944 – 2013.

| | **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 | |
| 2013 | 125,000 | | 62,500 | | 62,500 | |

Appendix D. Gill net catch statistics from Island Park Reservoir, 2013.

| Net # | Date Pulled | Net Location | Net Type | BKT | KOK | MTW | RBT | UTC | UTS |
|---|---|---|---|---|---|---|---|---|---|
| 6/3/2013 | 1 | Brush | Floater | 0 | 0 | 0 | 12 | 2 | 1 |
| 6/3/2013 | 2 | Dam | Sinker | 0 | 0 | 0 | 0 | 18 | 9 |
| 6/3/2013 | 3 | Bills Island (N) | Floater | 0 | 0 | 0 | 7 | 0 | 7 |
| 6/3/2013 | 4 | Lake Side | Floater | 0 | 0 | 0 | 15 | 0 | 2 |
| 6/3/2013 | 5 | Bills Island (W) | Sinker | 0 | 1 | 0 | 4 | 46 | 38 |
| 6/3/2013 | 6 | West Mouth | Sinker | 0 | 0 | 0 | 1 | 20 | 41 |
| 6/4/2013 | 7 | Trudes | Floater | 0 | 0 | 0 | 12 | 2 | 0 |
| 6/4/2013 | 8 | Goose Island | Sinker | 0 | 1 | 0 | 1 | 37 | 33 |
| 6/4/2013 | 9 | West End | Floater | 0 | 1 | 0 | 16 | 2 | 0 |
| 6/4/2013 | 10 | MP 25 | Sinker | 0 | 0 | 2 | 4 | 38 | 34 |
| 6/4/2013 | 11 | MP 56 | Floater | 0 | 0 | 0 | 8 | 5 | 2 |
| 6/4/2013 | 12 | Mill Creek | Sinker | 0 | 0 | 3 | 1 | 1 | 46 |
| 6/5/2013 | 13 | Brush Creek | Sinker | 0 | 0 | 0 | 3 | 19 | 89 |
| 6/5/2013 | 14 | Dam | Floater | 0 | 2 | 0 | 4 | 1 | 0 |
| 6/5/2013 | 15 | Bills Island | Sinker | 0 | 0 | 0 | 2 | 6 | 58 |
| 6/5/2013 | 16 | Bills Island (W) | Sinker | 0 | 1 | 0 | 11 | 5 | 22 |
| 6/5/2013 | 17 | West Mouth | Sinker | 0 | 1 | 0 | 0 | 36 | 27 |
| 6/5/2013 | 18 | Lake Side | Floater | 0 | 0 | 0 | 7 | 0 | 1 |
| 6/6/2013 | 19 | Mill Creek | Floater | 0 | 0 | 0 | 1 | 0 | 28 |
| 6/6/2013 | 20 | Trudes | Sinker | 0 | 1 | 1 | 9 | 24 | 42 |
| 6/6/2013 | 21 | Goose Island | Floater | 0 | 1 | 0 | 8 | 2 | 0 |
| 6/6/2013 | 22 | West End | Sinker | 0 | 4 | 0 | 1 | 55 | 27 |
| 6/6/2013 | 23 | MP 25 | Floater | 0 | 0 | 0 | 3 | 28 | 28 |
| 6/6/2013 | 24 | MP 56 | Sinker | 0 | 0 | 0 | 1 | 11 | 26 |
| 6/7/2013 | 25 | Bills Island | Floater | 1 | 0 | 0 | 7 | 1 | 20 |
| 6/7/2013 | 26 | Dam | Sinker | 0 | 1 | 0 | 0 | 16 | 35 |
| 6/7/2013 | 27 | Lake Side | Sinker | 0 | 0 | 0 | 2 | 4 | 47 |
| 6/7/2013 | 28 | Brush Creek | Floater | 0 | 0 | 0 | 11 | 0 | 11 |
| 6/7/2013 | 29 | West Mouth | Floater | 1 | 0 | 0 | 10 | 2 | 2 |
| 6/7/2013 | 30 | Bills Island (W) | Sinker | 0 | 0 | 0 | 0 | 18 | 70 |

## RIRIE RESERVOIR

## ABSTRACT

During 2013, we conducted our fourth annual fall Walleye *Sander vitreus* index netting (FWIN), and captured 10 Walleye (0.6 per net night), ranging in length from 207 mm to 686 mm, compared to 15 (0.8 per net night) in 2012. Compared to years past, larger Walleye were not caught as frequently, and smaller Walleye were more common. As in years past, Walleye still only represent less than 1% of the overall species composition in Ririe Reservoir. The gill net catch was dominated by Yellow Perch (62%), Utah Sucker (25%), and Utah Chub (9%). Our season-long creel survey started April 1, and ran through December. Anglers fished a total of 36,758 hours during the open water period. Overall catch rates were high during the open water fishery at 0.83 fish per hour, with the bulk of this catch rate supported by Rainbow Trout and Smallmouth Bass. When anglers were asked about removing the bass length limit (currently 300 mm) to improve growth, there were as many anglers who supported the current limit as those who would like to see the limit removed.

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# 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*, Yellowstone Cutthroat Trout *O. clarkii bouvieri*, Smallmouth Bass *Micropterus dolomieu*, and Yellow Perch *Perca flavescens*. Utah Chub *Gila atraria* and Utah Sucker *Catostomus ardens* are also found in Ririe Reservoir in relatively high numbers. In 2010, angler use was approximately 68,365 hours with a catch rate of 0.5 fish per hour (Schoby et al. 2012). Beginning in 1990, 70,000 juvenile Kokanee were stocked annually, with an increase to 210,000 annually in 2004 to improve catch rates and meet increased angler demand. Up until 2012, approximately 18,000 catchable Yellowstone Cutthroat Trout were stocked annually to provide angler opportunity. Following relatively poor performance of those fish, they were replaced by similar numbers of sterile Rainbow Trout. A self-sustaining population of Smallmouth Bass has developed from introductions into Ririe Reservoir that occurred 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, and only small numbers of Walleye are encountered in annual netting to date. These low catch rates suggest that the population is still small, but 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 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.

## OBJECTIVES

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 2013 marked the fourth year of FWIN to monitor trends in the Walleye population in Ririe Reservoir. From October 22-24, we set six 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 E).

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).

A creel survey was conducted from April 1 through the end of December. Methods are the same as outlined in the Henrys Lake chapter of this report.

## RESULTS

During 2013, the gill net catch was dominated by Yellow Perch (62% of the catch) and non-game fish, mainly Utah Sucker (25%) and Utah Chub (9%; Figure 20). Walleye comprised <1% of the relative abundance of our gill net catch. We captured 0.4 Walleye per net night (n = 10; Figure 21) that ranged in size from 207 to 686 mm (mean: 382 mm; Figure 22, Table 10), and had relative weights that ranged from 81 to 125 (mean: 99). Walleye PSD and RSD-P were 67 and 22 (Table 11). We analyzed diet of all Walleye captured; 5 stomachs were empty, while the remaining five samples contained Kokanee (two of five stomachs) and Yellow Perch (three of five stomachs). In prior years, only Kokanee were found in Walleye stomachs. Total weight of stomach contents ranged from 0 g to 24 g (mean: 7.2 g).

We captured 83 Yellow Perch per net night (n = 1,497; Figure 22) that ranged from 110 mm to 292 mm (mean: 169 mm; Figure 23), with PSD and RSD-P values of 16 and 3, respectively (Table 11). Yellow Perch relative weights were 89 for all fish combined. We captured 1.9 Kokanee per net night (n = 33) that ranged from 170 mm to 331 mm (mean: 256 mm; Figure 24), with PSD and RSD-P values of 96 and 38, respectively. Kokanee relative weights were 93 for all fish combined. We captured 0.7 Yellowstone Cutthroat Trout per net night (n = 13) that ranged from 316 mm to 386 mm (mean: 348 mm; Figure 25), with PSD and RSD-P values of 100 and 0, respectively. Yellowstone Cutthroat Trout relative weights were low, at 78 for all fish combined. We captured one Smallmouth Bass per net night (n = 20) that ranged from 207 mm to 421 mm (mean: 276 mm; Figure 26), with PSD and RSD-P values of 25 and 5, respectively. Smallmouth Bass relative weights were 94 for all fish combined. We captured 0.8 Rainbow Trout per net night (n = 14) that ranged from 302 mm to 393 mm (mean: 348 mm); PSD and RSD-P values for Rainbow Trout were 100 and 7, respectively. Rainbow Trout relative weights were 82 for all fish combined.

Creel clerks interviewed 731 anglers in 304 parties during the open water fishery (Table 12). Total angling effort for the survey period was estimate at 43,643 hours. Anglers primarily caught Rainbow Trout (35%) followed by Smallmouth Bass (33%), Kokanee (11%) and Yellow Perch (15%, Figure 27). Anglers harvested a higher proportion of their catch when legal (Figure 28). When anglers were asked if they supported removal of the current 300 mm minimum length limit on Smallmouth Bass, 32% of respondents supported the concept, 39% were neutral to the idea and 30% opposed the removal of the length limit.

## DISCUSSION

The fall of 2013 marked the fourth year of fall Walleye index netting and the first year we've seen a decline in Walleye catch to date. Further, based on length frequencies, it appears that the strong year class of Walleye that has been driving gill net catch rates may be in decline. We only caught one fish that was greater than 450 mm, while in years past, 70-85% of all Walleye caught were greater than 450 mm. Of note is the presence of smaller walleye, suggesting that reproduction continues to be low but successful. Stomach content analysis results showed a higher proportion of fish other than kokanee in stomachs. This may be due to the size difference between Walleye captured this year and those captured in prior years. Smaller Walleye may be occupying different habitat than adults, and selecting for the abundant Perch present in recent years, or the increase in Perch abundance may be influencing Walleye behavior.

Beginning in 2012, we stocked equal numbers of catchable Rainbow Trout and Yellowstone Cutthroat Trout to evaluate relative performance of both species. In 2013 only Rainbow Trout were stocked due to a shortage of Cutthroat from Jackson National Hatchery, which supplies finespot eggs to IDFG. Both species returned in equal abundance in 2013 gill netting efforts. However, creel results suggest that 95% of all trout caught were rainbows. This may be in part due to anglers not clearly identifying their catch, or recalling results different than they actually were, as anglers were asked to rely on memory when reporting released fish. It is also possible that Rainbow Trout perform better at recruiting to angling gear in a reservoir than Cutthroat do. Ball and Jeppson (1977) recommended stocking Rainbow Trout as opposed to Cutthroat Trout in Ririe due to "higher returns to the creel, excellent growth and condition and easier propagation". It is also possible that by stocking only rainbows through the fishing season that anglers were more likely to encounter them than the less abundant Cutthroat Trout. Regardless, it appears that sterile Rainbow Trout are providing a satisfactory fishery for anglers, and are also providing high return to creel. Based on creel results, anglers caught an estimated 14,128 Rainbow Trout. While some of these could be carryovers from the prior year, length frequency distributions suggest that few fish are persisting for a full year, and that the bulk of angler catch is supported by the current years stocking. If these are mostly this year's stocking, angler use of IDFG hatchery product may be as high as 73% annually (14,128 fish caught, 18,000 stocked). This is supported by results from the tag-your-it program that estimate adjusted exploitation of stocked hatchery fish at 75% (94% adjusted exploitation on one group of stocked fish, and 56% on the second group).

Yellow Perch abundance increased well above prior years as reflected in gill net catch from 2013. The bulk of this increase appears to be related to a strong year-class produced during the 2012 spawn. The high success of this year-class may be related to reservoir storage, as in 2012 the reservoir reached full pool by around March, which is the onset of the spawning period for Perch. Once the reservoir reached this level, it remained fairly constant, which may have benefitted recruitment of the perch population. Similar conditions did not exist in 2010 or 2013, and no strong year-classes have been identified from these years. Additional data and investigation is warranted to garner more concrete conclusions, and should be collected as possible in future years. Regardless, the strong year-class now working through the system should provide anglers with quality fishing in the coming years.

Based on results from this year's creel survey, it appears that anglers are catching good numbers of fish on the reservoir. Catch rates were among the highest recorded since 1993, while effort was about average over the same time period. Anglers harvested more rainbows than years past, primarily due to the switch in stocking practices. Kokanee appeared to be encountered in lesser abundance when compared to prior years, as reflected in the lower than average harvest of the species even though anglers harvested most (80%) of all captured Kokanee. Overall, it appears that Ririe continues to provide high catch rates for anglers, who in turn harvest many of the fish caught. Regulations appear to be functioning appropriately to provide anglers with a satisfying experience, although liberalizing the bass limit would provide additional opportunity for harvest-oriented anglers. It appears likely that a portion of the angling public would support this move, but others enjoy the protection the current rule provides, even if the benefits are biologically marginal or nonexistent.

## 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. Increase and evaluate stocking rates of Kokanee to provide maximum benefits to anglers.

4. Abandon stocking of Cutthroat Trout, and stock sterile Rainbow Trout.

5. Consider alternate means of sampling Kokanee populations to obtain larger sample sizes to better track trends over time.

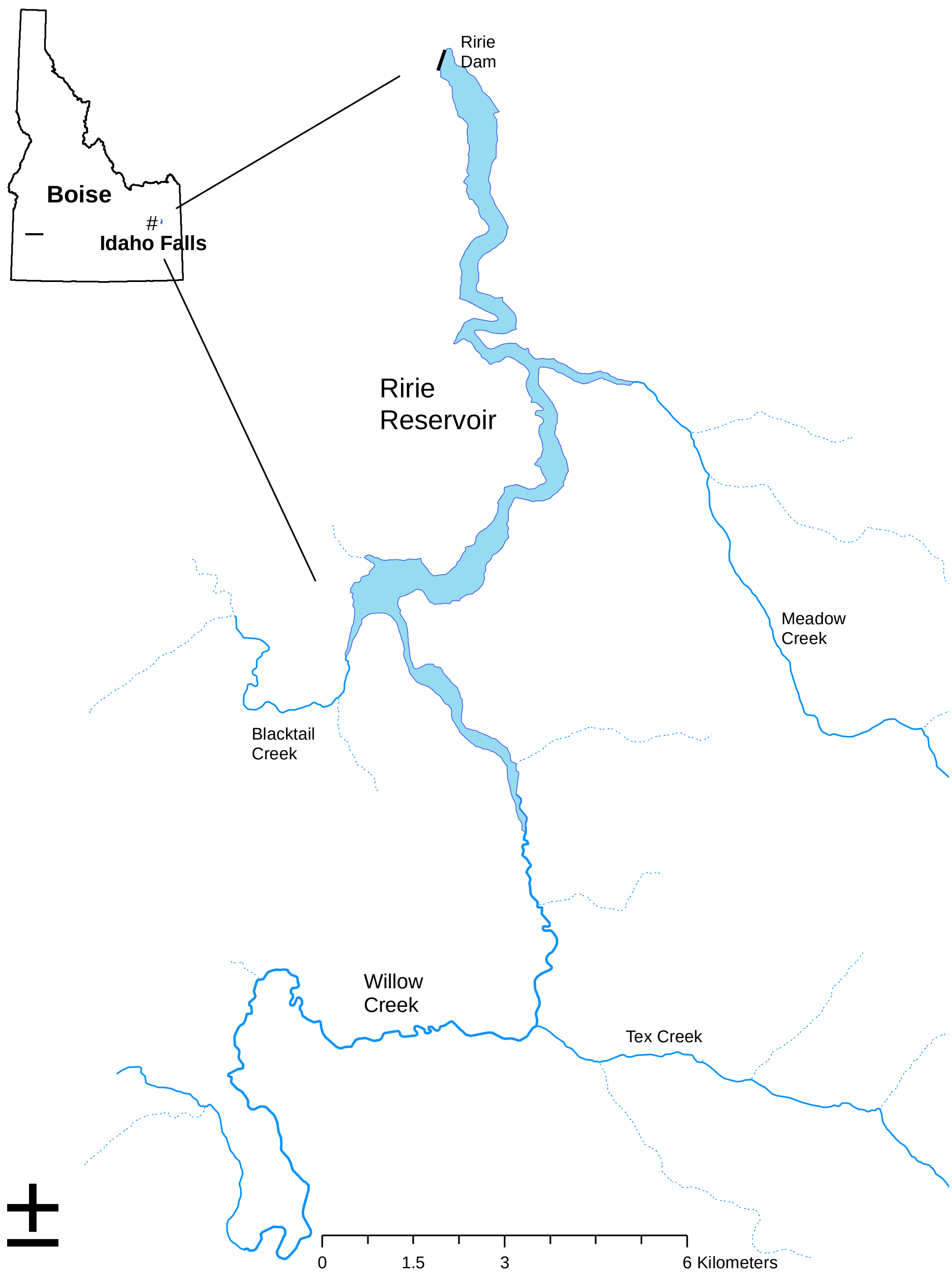


Figure 18. Location of Ririe Reservoir and major tributaries.

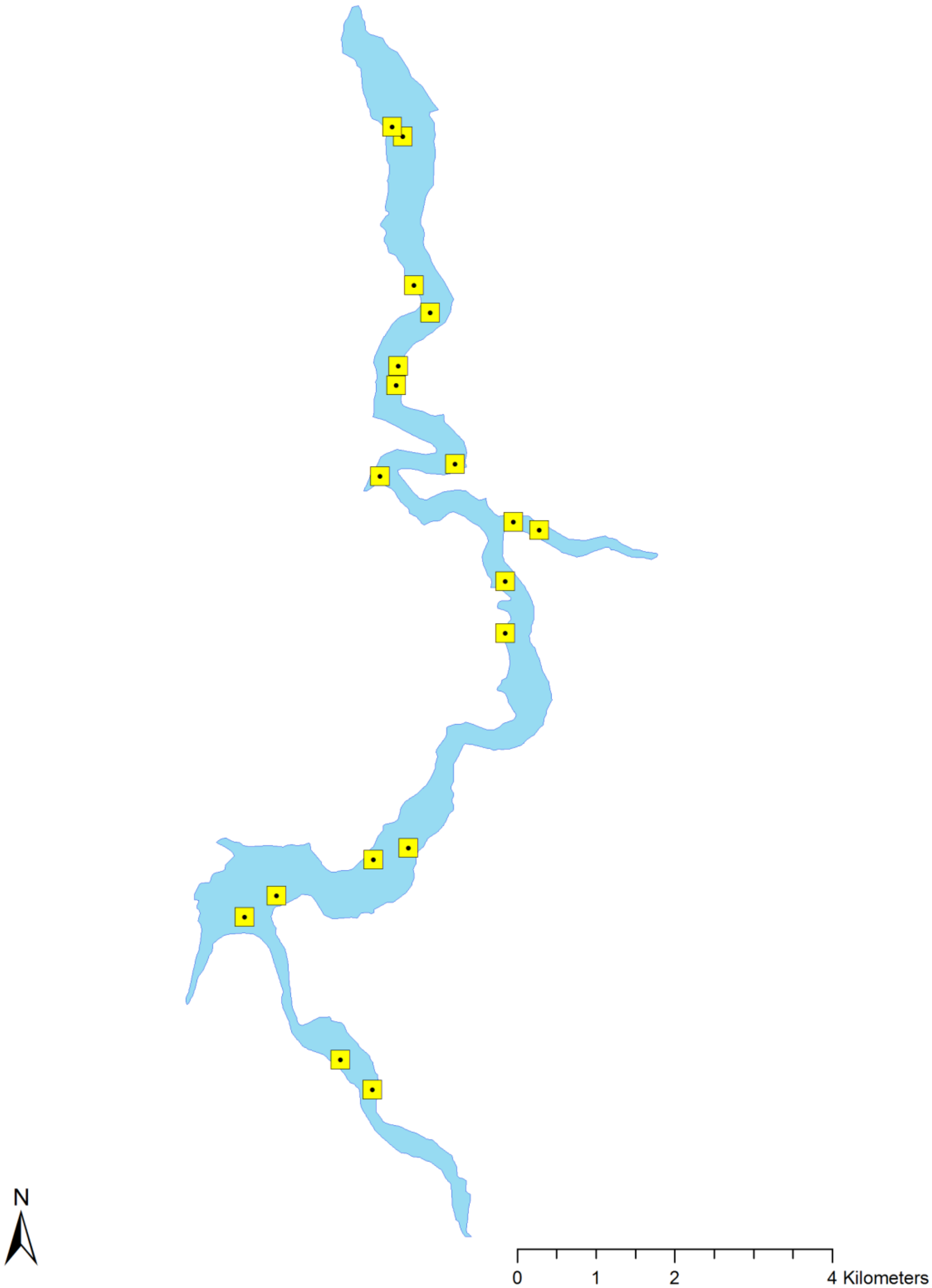


Figure 19. Location of 2013 fall Walleye index netting (FWIN) in Ririe Reservoir.

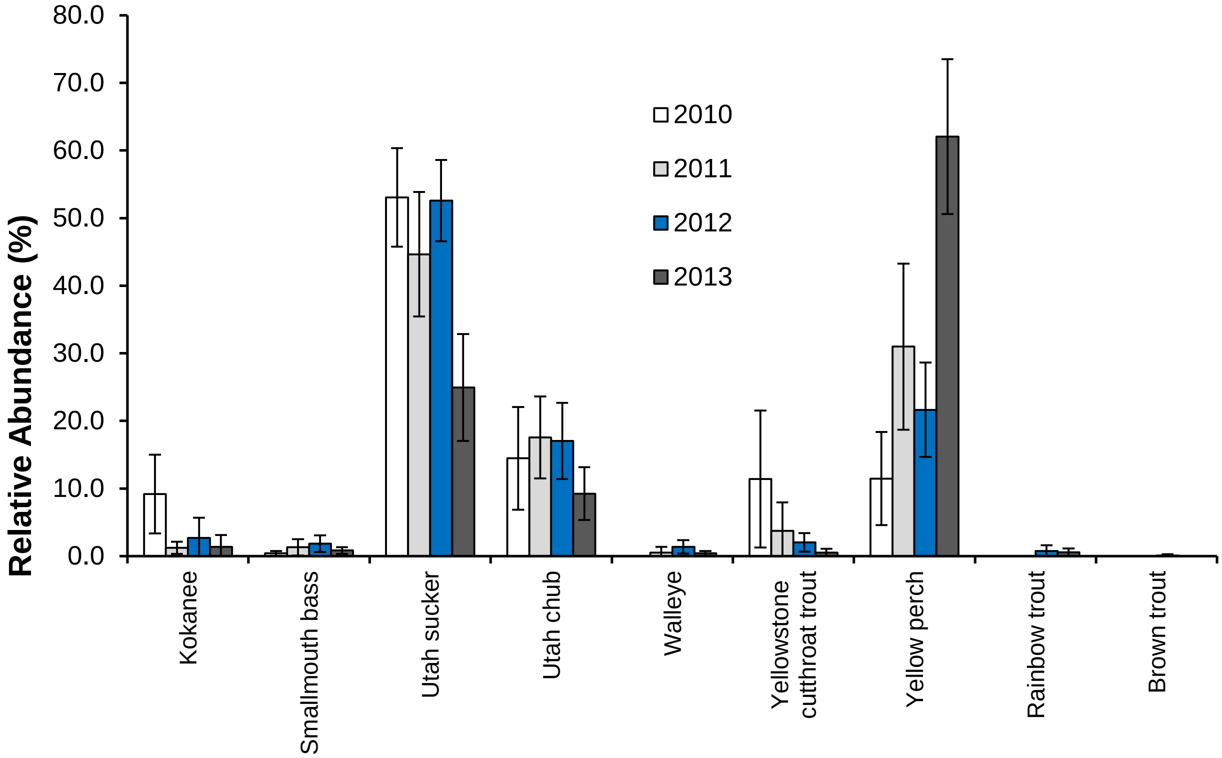


Figure 20. Relative abundance of fish caught during FWIN in Ririe Reservoir during 2010-2013. Error bars represent 90% confidence intervals.

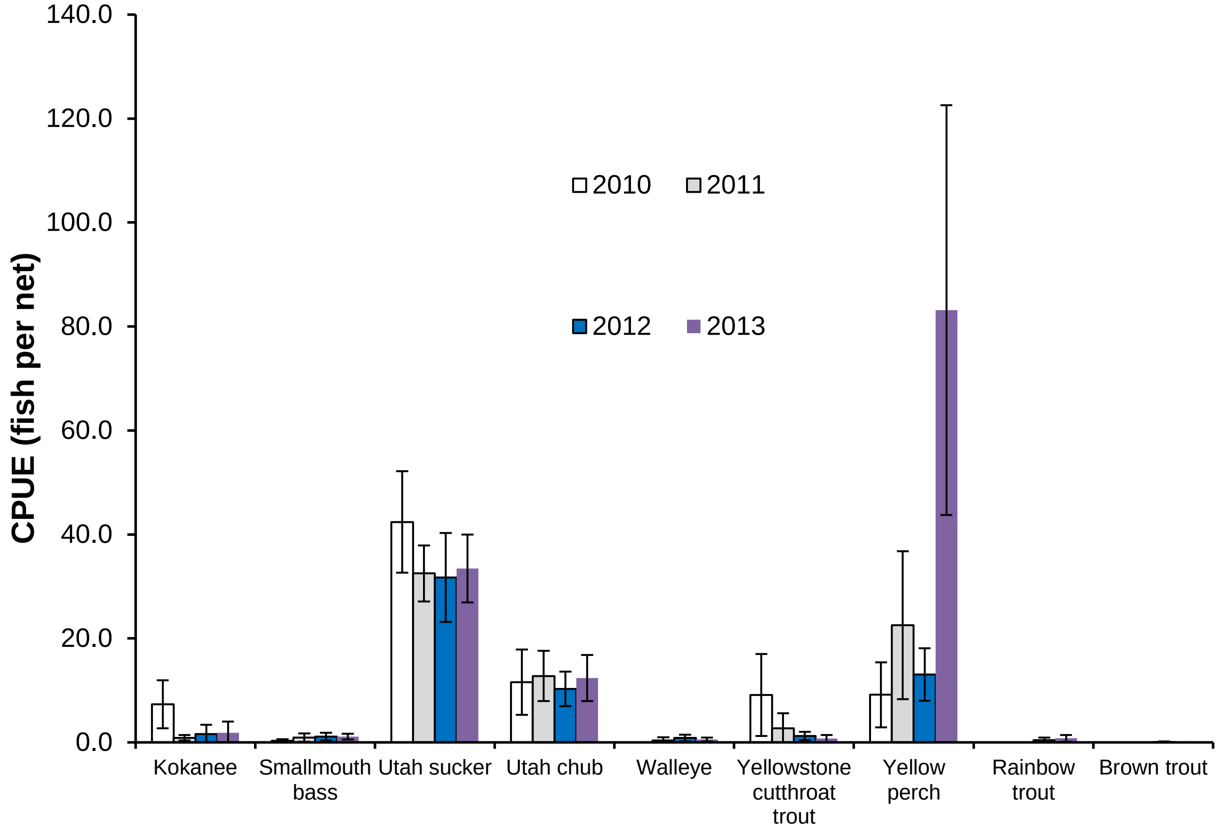


Figure 21. Catch-per-unit-effort (fish per net), for 18 net nights of FWIN in Ririe Reservoir, during 2010-2013. Error bars represent 95% confidence intervals.

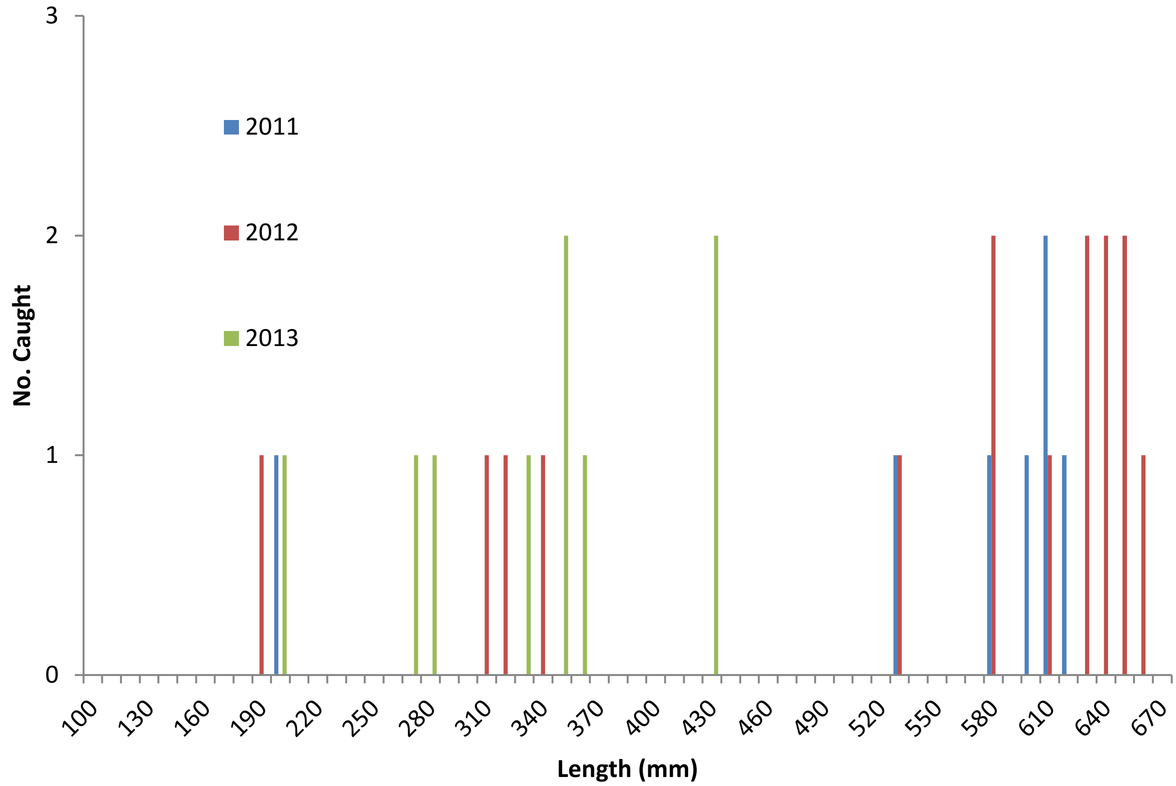


Figure 22. Length frequency of Walleye captured in Ririe Reservoir FWIN gillnetting 2011-2013.

Table 10. Summary statistics for Walleye captured during 2013 FWIN in Ririe Reservoir.

| Date | Net#-type | MeshSize | TL (mm) | Weight (g) | Sex | Maturity | SS_Wt (g) | Visceral Fat wt(g) | Gonad Wt (g) |
|---|---|---|---|---|---|---|---|---|---|
| 10/22/2013 | 3s | 64 | 340 | 439 | M | y | 23.45 | na | 12.37 |
| 10/22/2013 | 3s | 64 | 423 | 827 | F | n | 19.48 | 58.19 | 2.31 |
| 10/22/2013 | 4f | 76 | 348 | 411 | F | n | na | 15.8 | 1.90 |
| 10/22/2013 | 4f | 127 | 669 | 2939 | F | y | 1.53 | 140.31 | 170.18 |
| 10/22/2013 | 5s | 76 | 356 | 511 | M | unk | na | 25.59 | 5.69 |
| 10/22/2013 | 6f | 51 | 270 | 190 | F | n | na | na | 1.68 |
| 10/23/2013 | 1s | 64 | 332 | 342 | M | y | 2.04 | 5.77 | 6.83 |
| 10/23/2013 | 1s | 64 | 432 | 871 | F | y | 0.05 | 40.07 | 30.74 |
| 10/23/2013 | 2s | 38 | 207 | 90 | unk | n | 0.78 | na | na |
| 10/24/2013 | 3f | 51 | 272 | 194 | unk | n | 3.21 | na | na |

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

Table 11. Total length (mm) summary statistics for game fish captured during 2013 FWIN in Ririe Reservoir.

| | Kokanee | Smallmouth Bass | Walleye | Yellow Perch | Yellowstone Cutthroat Trout | Rainbow Trout |
|---|---|---|---|---|---|---|
| Mean | 256 | 276 | 372 | 169 | 348 | 348 |
| Median | 278 | 274 | 352 | 162 | 347 | 343 |
| Range | 161 | 214 | 479 | 182 | 70 | 91 |
| n | 33 | 20 | 10 | 1478 | 13 | 14 |
| PSD | 96 | 25 | 67 | 16 | 100 | 100 |
| RSD-P | 38 | 5 | 22 | 3 | 0 | 7 |
| Mean *Wr* | 93 | 94 | 99 | 89 | 78 | 82 |

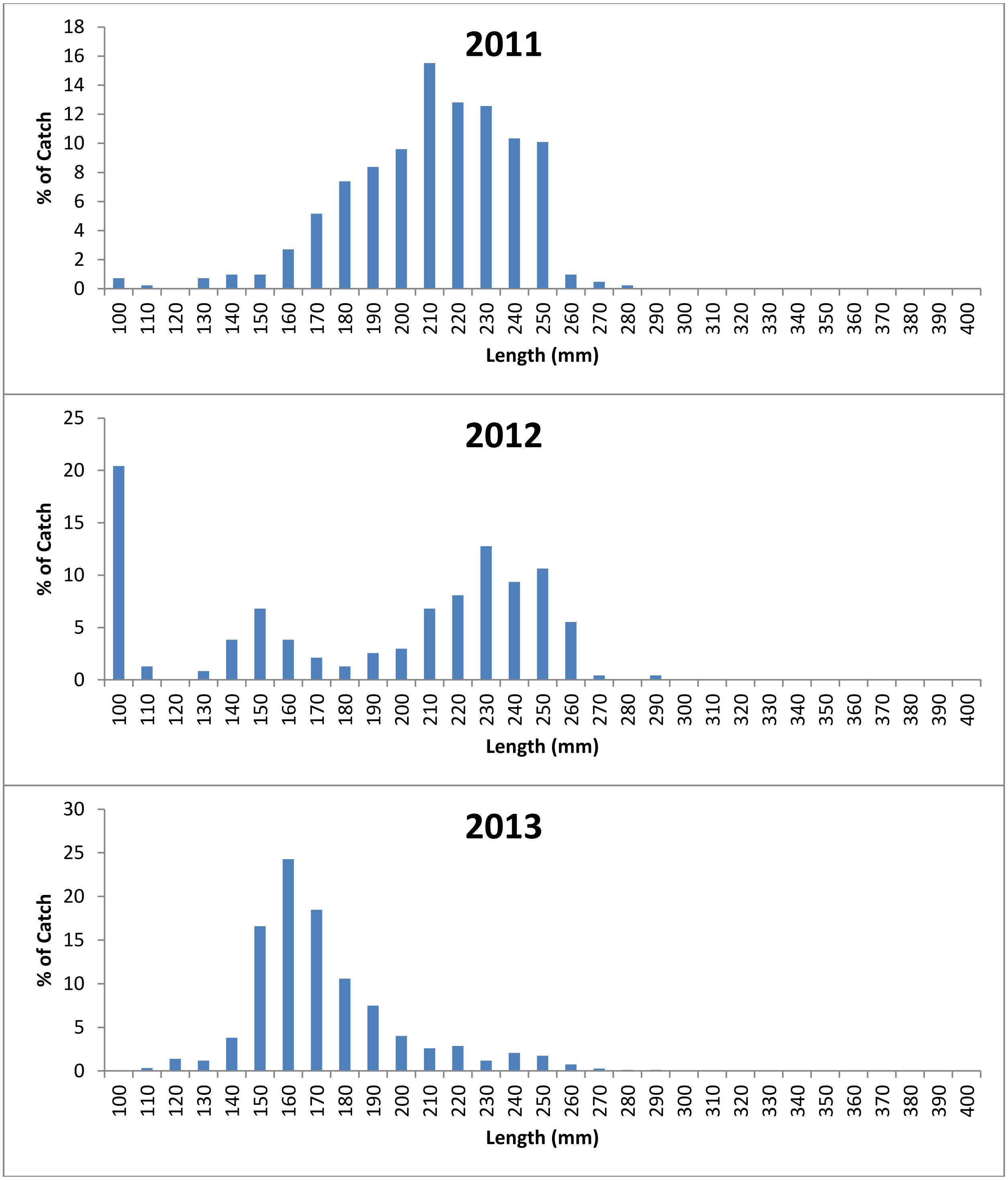


Figure 23 Length frequency of Yellow Perch captured during 2011-2013 FWIN in Ririe Reservoir.

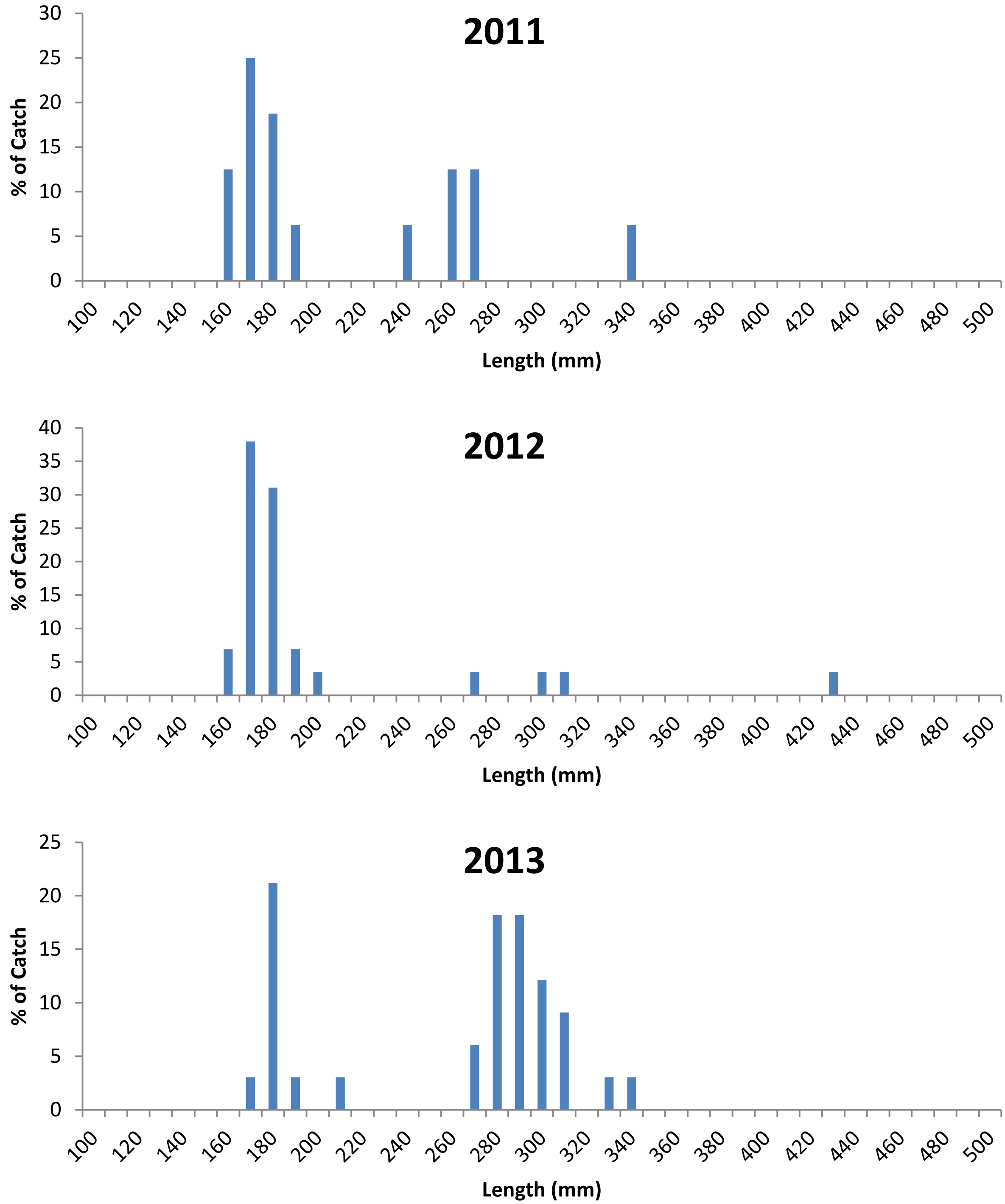


Figure 24. Length frequency of Kokanee captured during 2011-2013 FWIN in Ririe Reservoir.

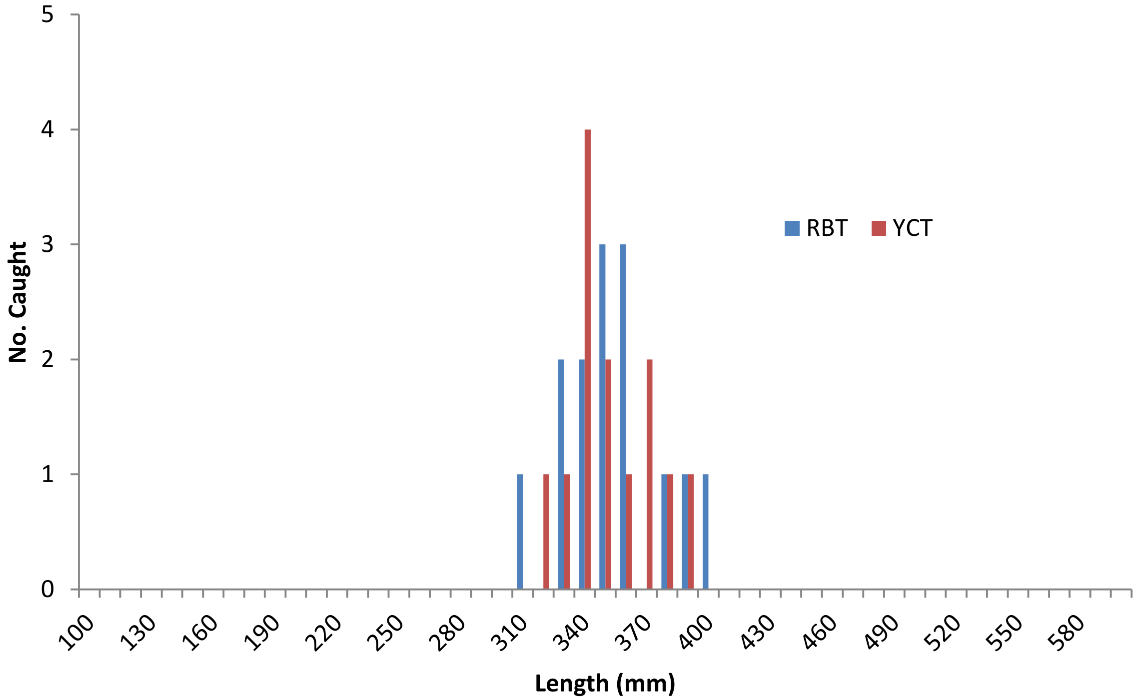


Figure 25. Length frequency of Rainbow and Yellowstone Cutthroat Trout captured during 2013 FWIN in Ririe Reservoir.

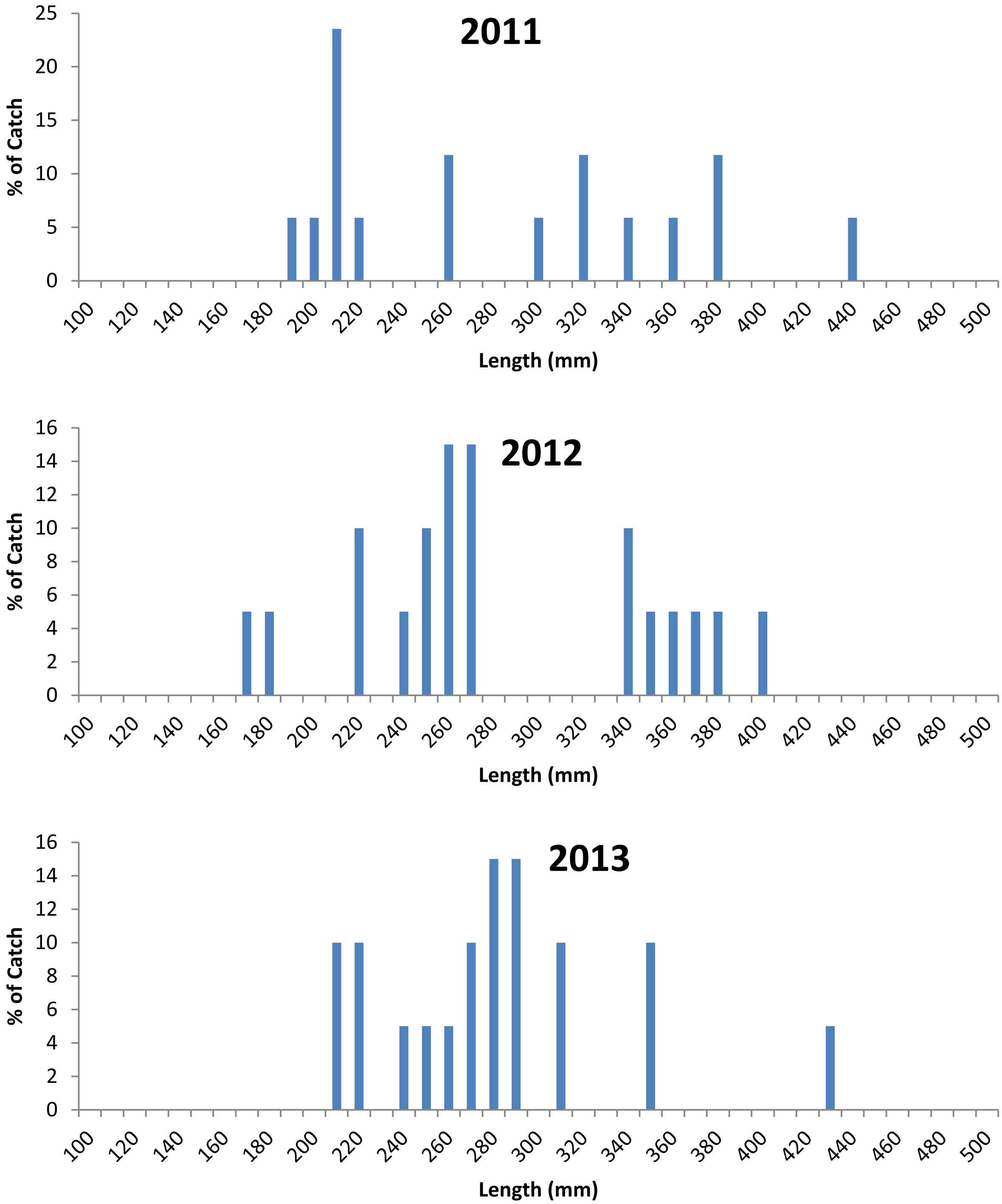


Figure 26. Length frequency of Smallmouth Bass captured during 2011-2013 FWIN in Ririe Reservoir.

Table 12. Angler catch statistics for Ririe Reservoir, 1993-2013.

| | 1993 | 2003 | 2005 | 2010 | 2013 |
|---|---|---|---|---|---|
| **Season Effort Total** | 56612 | 25981 | 43825 | 68364 | 43643 |
| **% Residents** | 98 | 96 | 96 | 97 | 96 |
| **% Nonresidents** | 2 | 4 | 4 | 3 | 4 |
| **# of Interviews** | 747 | 271 | 546 | 384 | 731 |
| **Anglers Per Interview** | 2.42 | 2.34 | 2.14 | 2.3 | 2.4 |
| **% Using Bait** | 100 | 45 | 60 | 61.6 | -- |
| **% Using Lures** | 0 | 55 | 40 | 37.5 | -- |
| **% Fly Fishing** | 0 | 0.5 | 0.1 | 0.9 | -- |
| **# of Completed Trips** | 337 | 43 | 216 | 334 | 304 |
| **Avg Trip Length** | 3.34 | 2.69 | 3 | 4 | -- |

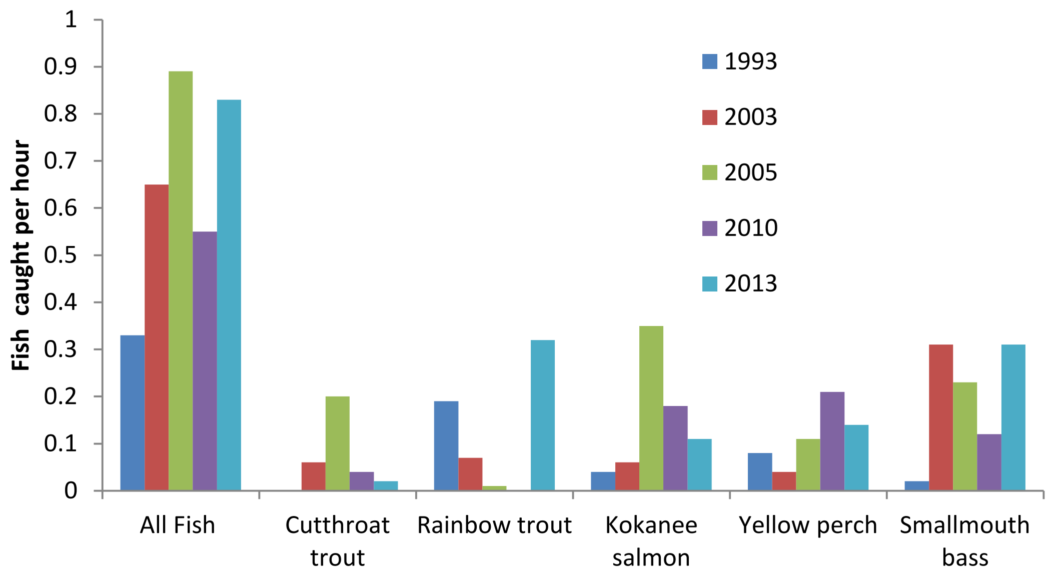


Figure 27. Angler catch rate (fish per hour) in Ririe Reservoir, 1993-2013.

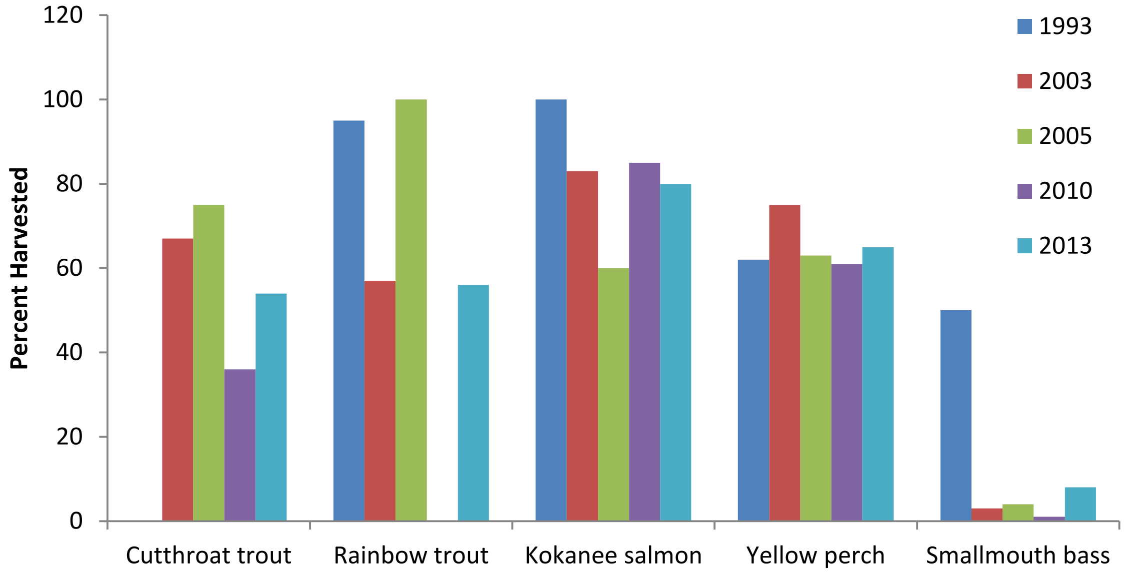


Figure 28.  The proportion of caught fish that were harvested in Ririe Reservoir 1993-2013.

Appendix E. Location of Ririe Reservoir fall Walleye index netting (FWIN) net locations during October 2013. 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 |

# MACKAY RESERVOIR

## ABSTRACT

We used thirty standard experimental gill nets (13 floating, 17 sinking) to assess fish populations and relative abundance in Mackay Reservoir during July 2013. Mean catch (fish per net night) was 25 Rainbow Trout, 24 Kokanee Salmon, one Mountain Whitefish and one Yellow Perch as well as lesser numbers of Brook Trout. Gill net catch rates for trout and Kokanee in Mackay Reservoir were among the highest in all reservoirs sampled in the Upper Snake Region during 2013, but proportional stock density and relative stock density values for Rainbow Trout were low when compared to other waters. Kokanee abundance is much higher than in prior years, and is likely tied to the increased reservoir carryover in recent years. The discovery of Yellow Perch is new this year, and the population was likely started by an illegal introduction.

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Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manager

## METHODS

We set 30 experimental gill nets (13 floating, 17 sinking) to assess trends in fish populations and to monitor relative abundance in Mackay Reservoir from July 23 -26 (Figure 29). Gill nets measured 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) and weights (g). We calculated gill net catch rates as fish per net night and also calculated 95% confidence intervals.

We calculated proportional stock density (PSD) and relative stock density (RSD) and relative weights to describe the size structure of fish populations in Mackay Reservoir, using the methods and equations described in the *Henrys Lake* chapter of this report. Kokanee PSD was calculated as the number of fish greater than or equal to 250 mm divided by the number greater than or equal to 200 mm, multiplied by 100. Kokanee RSD was calculated as the number of fish greater than or equal to 300 mm divided by the number greater than or equal to 200 mm, multiplied by 100, and reported as RSD-300. Other methods are available in the Henrys Lake chapter as outlined above.

## RESULTS

We collected 1,539 fish with 30 nights of gill net effort in Mackay Reservoir. Relative abundance was dominated by Rainbow Trout (48%) and Kokanee (47%), but also included 3% Mountain Whitefish, 1% Brook Trout and <1% Yellowstone Cutthroat Trout (Figure 30). Of note, we also caught five Yellow Perch, a species that has not been encountered in Mackay Reservoir prior to this survey. Gill net catch rates for Rainbow Trout were 25 fish per net (Figure 31), and captured rainbows ranged between 142 and 510 mm in length (mean: 292 mm, Figure 32). Relative weights were 80 for all Rainbow Trout greater than 200 mm, while PSD was 53 and RSD-400 was 9. Gill net catch rates for Kokanee were 24 fish per net night, and captured Kokanee ranged between 150 and 365 mm TL (mean of 225 mm). Relative weights were low at 82 for all Kokanee greater than 200 mm combined, while Kokanee PSD was 73 and RSD-300 was 10 (Table 13). Gill net catch rates were low for Mountain Whitefish at 1.4 fish per net night. Yellow Perch gill net catch rates were < 1 fish per net, and fish ranged in length from 186 to 226 mm. Reservoir drawdown levels have remained well above historic and recent levels since 2009 (Figure 33). Beginning in late 2009, reservoir levels retained at least 30% of capacity, whereas in years past, the reservoir has been drawn down much lower on a near annual basis.

## DISCUSSION

There is little historic gill net data from Mackay Reservoir. Gebhards sampled Mackay Reservoir with two gill nets in May 1962 (IDFG files) which yielded eight Rainbow Trout and two Mountain Whitefish. Mackay Reservoir was sampled with two gill nets on two occasions during May 1973 (Jeppson 1975). The first survey (May 15) was a short net set (3 hours and 15 minutes) which yielded one Rainbow Trout in each net. The second survey (May 20) was an overnight set which yielded 36.5 Rainbow Trout, six Brook Trout, 7.5 Mountain Whitefish, and 0.5 Kokanee per net. Jeppson (1975) also surveyed Mackay Reservoir during April 1974, and collected 22 Rainbow Trout, 11 Brook Trout, and 4 Mountain Whitefish per net night. The majority of the work conducted on Mackay Reservoir since Jeppson's gill netting has been angler surveys. Prior to this year's netting survey, the most recent survey occurred in 2008, and included six gill nets set overnight. Power analysis of these nets suggested that level of sampling was capable of detecting a 25% shift in rainbow populations. However, we believe that increased netting periodically should be used to establish baseline conditions that can be used in future comparisons. This survey serves as the first thorough, comprehensive gill netting effort to date, and should set the benchmark for future work.

Gill net catch rates have increased for all species since 2008. Rainbow Trout have increased by 40%, while Kokanee have increased nearly 300% over levels from 2008. It appears that there are two strong year classes of Kokanee working through the system right now. Relative weights for both Kokanee and Rainbow Trout were low, suggesting food resources are becoming limited as fish densities increase. Weight data was not collected in 2008 so comparisons to past data isn't possible. It's likely that the increase in fish abundance in Mackay is the result of better reservoir carryover since 2009. Prior to this date, Mackay Reservoir was drained to less than 5% of volume annually, which likely severely reduced or eliminated reservoir carryover of many fish. The shift in water management provides habitat that results in better carryover of fish, which is likely responsible for the increase in fish abundance in the current survey.

The catch of a new species of fish – Yellow Perch – is cause for concern. Prior to this species being detected, Mackay Reservoir supported a fairly healthy population of Rainbow Trout, Kokanee and native Mountain Whitefish. Most of these species rely on zooplankton either early in life, or in the case of Kokanee, throughout their life. While stockings of Rainbow Trout certainly contribute to fish abundance, natural reproduction of Rainbow Trout also contributes to the population while Kokanee are supported entirely by natural reproduction. The younger life stages of both these salmonids are dependent on zooplankton. The addition of another plankton feeding fish will likely increase competition for zooplankton, and contribute to either low relative weights, or in extreme conditions, cause increases in mortality. Mean zooplankton quality indexes in Mackay Reservoir have been in decline since the mid to late 2000's. An additional zooplanktivore in the reservoir will only serve to further reduce this now limited resource. Based on length frequencies, it appears there is only one size class of Perch, suggesting that Perch have not been present in the reservoir long enough to have reproduced, or that reproduction is somewhat limited. Future work should address Perch abundance and recruitment, and evaluate the impacts of this new species on Rainbow Trout and Kokanee.

## MANAGEMENT RECOMMENDATIONS

1. Collect statistically valid information on Kokanee by increasing net sampling to appropriate levels;

2. Continue robust sampling for the next two years to obtain accurate trend data on fish populations in Mackay, and to evaluate impacts on sport fish populations from Yellow Perch.

3. Consider liberalizing fishing regulations in future years if cropping of zooplankton continues as shown by slow growth and low relative weights.

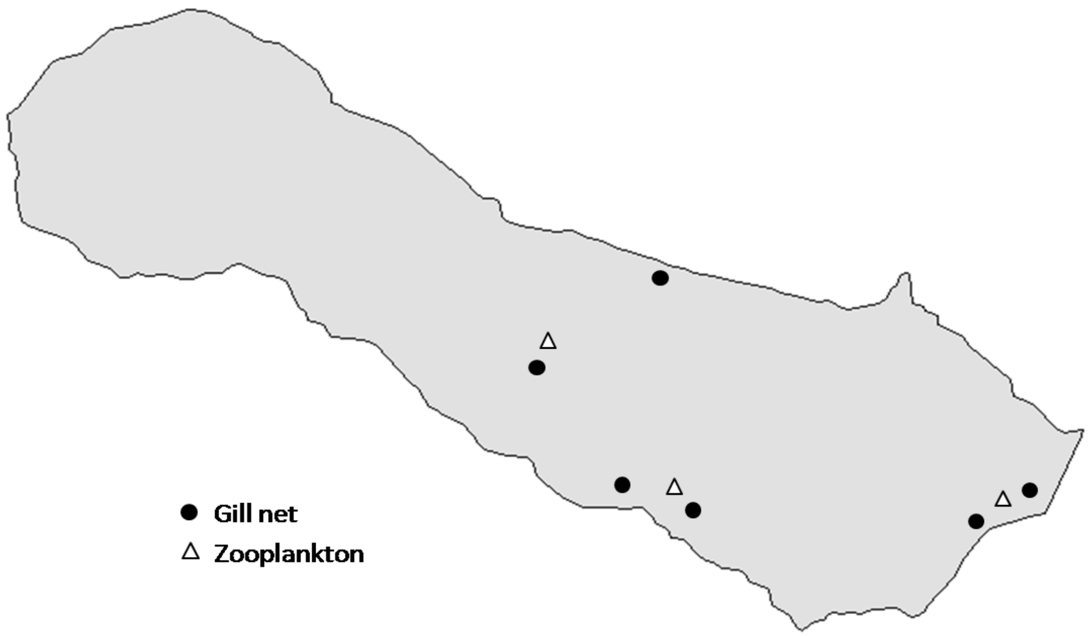



Figure 29. Gill net and zooplankton sample site locations in Mackay Reservoir, Idaho, 2013.

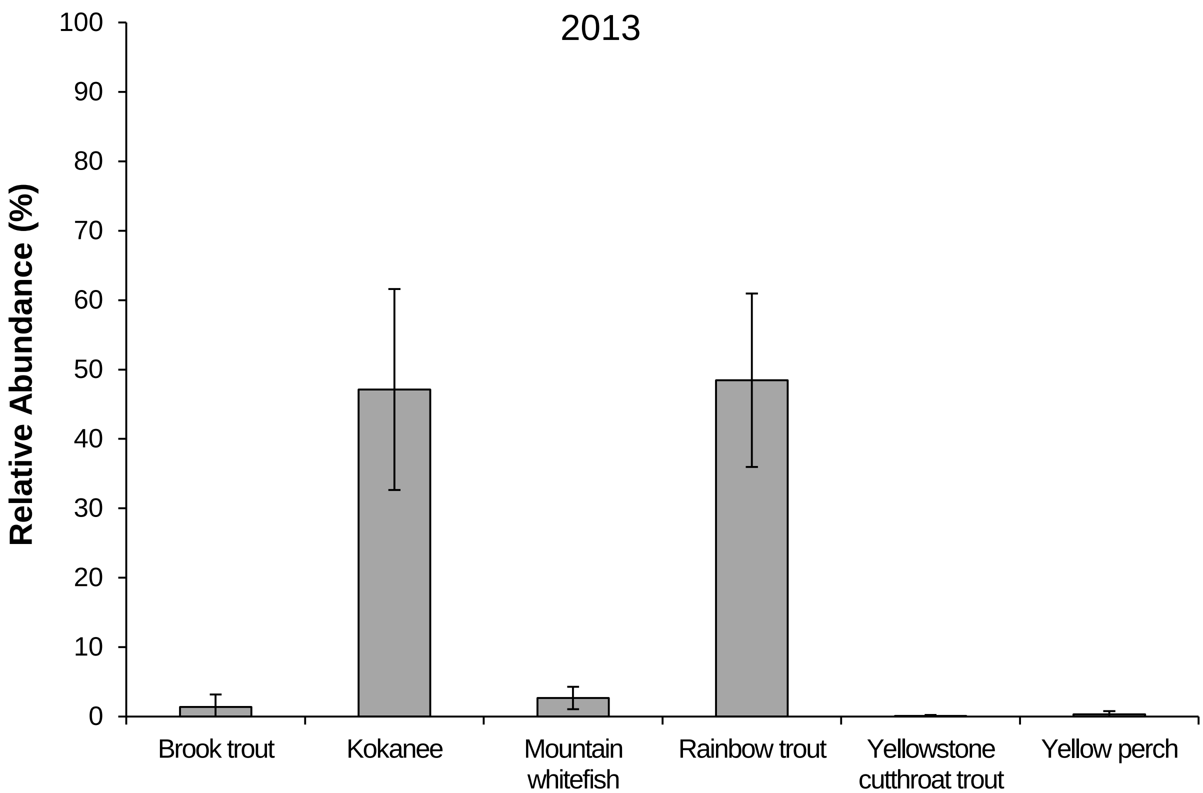



Figure 30. Species composition from gill nets set in Mackay Reservoir during 2013.

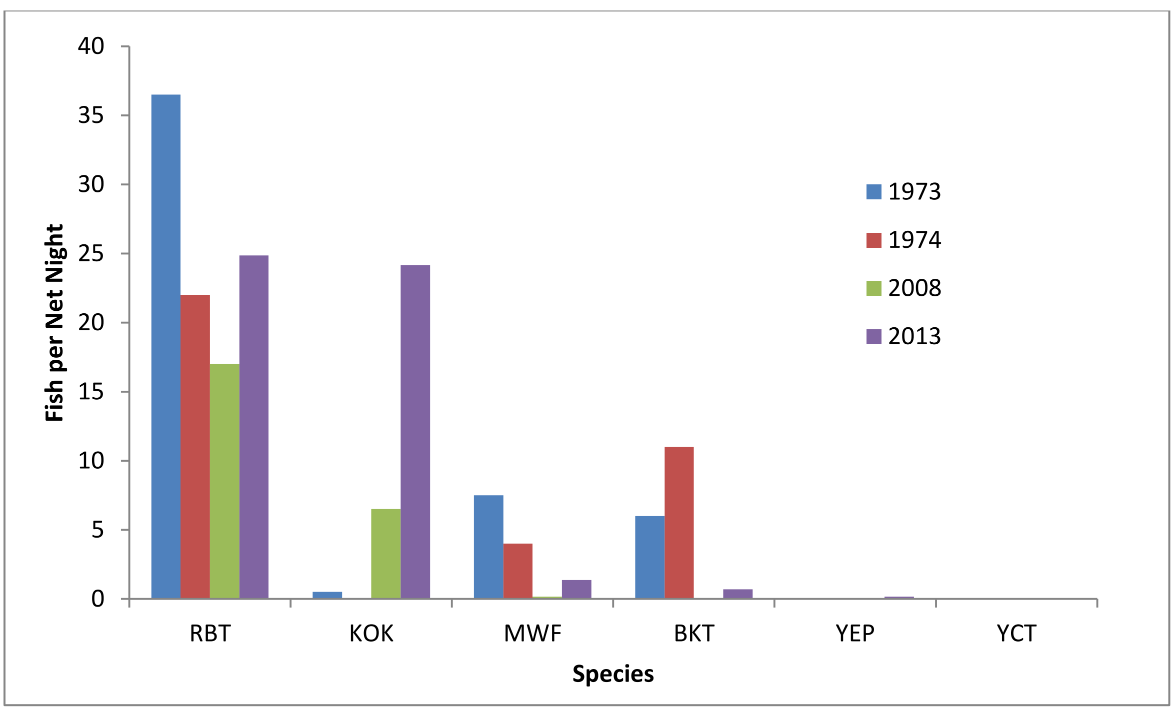
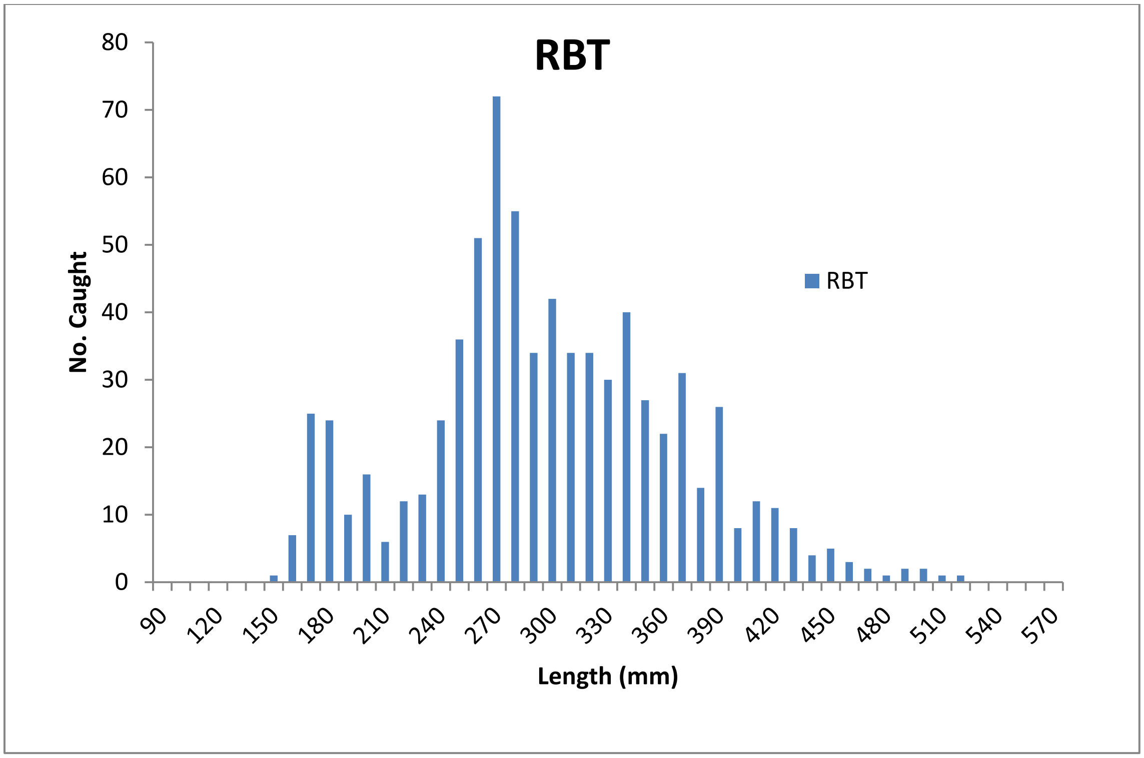



Figure 31. Gill net catch rates (fish per net night) in Mackay Reservoir, 1973-2013.



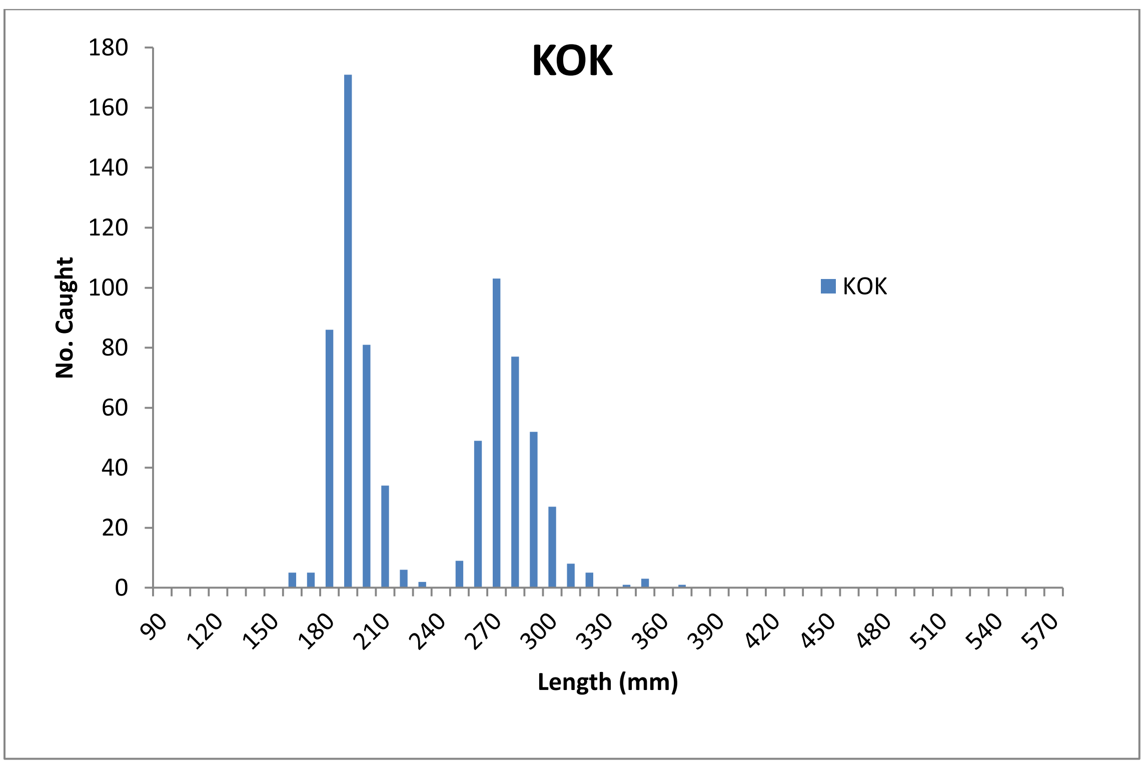




Figure 32. Length-frequency of Rainbow Trout and Kokanee captured with gill nets in Mackay Reservoir during 2013.

Table 13. Fish per net night (CPUE), proportional stock density (PSD), and relative stock density (RSD) of trout and Kokanee from waters in the Upper Snake Region during 2013.

| | Rainbow Trout | | | Kokanee | | |
|---|---|---|---|---|---|---|
| | CPUE | PSD | RSD-400 | CPUE | PSD | RSD-300 |
| Mackay Reservoir | 25.0 | 53 | 9 | 24.0 | 73 | 10 |
| Island Park Reservoir | 5.4 | 88 | 32 | 0.5 | 75 | 38 |
| | | | | | | |
| Ririe Reservoir | -- | -- | -- | 1.8 | 96 | 38 |
| *Yellowstone Cutthroat Trout* | 0.8 | 100 | 0 | | | |
| Henrys Lake | | | | | | |
| *Yellowstone Cutthroat Trout* | 9.6 | 82 | 28 | -- | -- | -- |
| *Hybrid Trout* | 3.4 | 93 | 49 | -- | -- | -- |
| *Brook Trout* | 5.0 | 95 | 64 | -- | -- | -- |

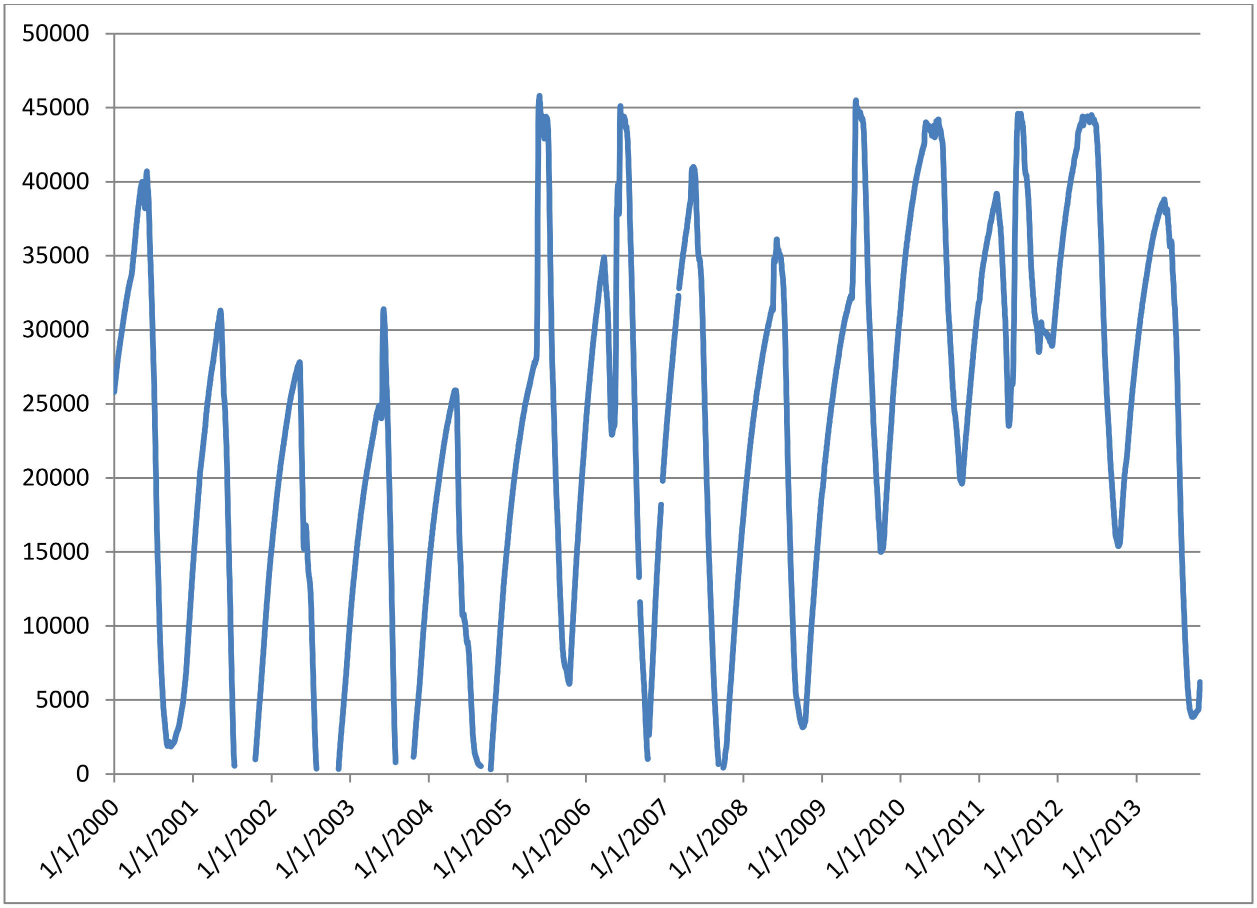



Figure 33. Reservoir storage in Mackay Reservoir, 2000 to 2013.

# RIVERS AND STREAMS

## SOUTH FORK SNAKE RIVER


### ABSTRACT

The South Fork Snake River supports an ecologically and economically significant population of native Yellowstone Cutthroat Trout (YCT). Trout abundances in the South Fork are near all-time highs with 1,499 trout/km at Lorenzo and 3,333 trout/km at Conant. YCT have exhibited a significant and increasing population trend since 2004 at both the Lorenzo and Conant monitoring reaches. During spring spawning runs we removed six Rainbow Trout (RBT) from Burns Creek at the weir and passed 888 YCT upstream with an estimated trap efficiency of 98%. Trapping efficiency at the Pine Creek weir was 89% where we passed 1,908 YCT and removed one RBT. We removed 23 RBT and passed 619 YCT at the Palisades Creek weir with 96% trapping efficiency. We initiated a radio-telemetry study on the South Fork by implanting 271 YCT, 41 Brown Trout (BNT), and 20 RBT with VHF radio transmitters between the mouth of the South Fork and Burns Creek. Through December 2013, we documented 20 of these fish as entrained into one of four different canal systems, and the movements from tagging locations averaged 2.9 river km. Linear regressions indicated spring maximum river flows since 2004 were significantly correlated with age-1 YCT the following year, but not age-1 RBT suggesting flows have not reached a level high enough to disrupt RBT spawning. We marked an additional 805 RBT with coded wire tags worth monetary rewards as part of the Angler Incentive Program. We had an 18% reduction in participating anglers but a 31% increase the number of fish turned in relative to 2012, indicating while fewer anglers are participating, those that do are effective at catching RBT. YCT marked with PIT tags continued to exhibit a high fidelity to spawning tributaries during spring spawning runs (99%) as well as fidelity to overwinter areas (74%) despite lengthy annual migrations. We continued efforts to convert an introgressed population of YCT and RBT back to a more pure YCT population in Palisades Creek upstream of the weir by removing 1,128 RBT from the stream. In Burns Creek we started manual removals of non-native trout and removed 38 BNT and 13 RBT from 3 km of Burns Creek upstream of the weir. The current management efforts on the South Fork are increasing the abundance and trend of YCT while anglers are enjoying some of the highest densities of trout to date.



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## INTRODUCTION

The South Fork Snake River, a tributary of the Henrys Fork Snake River in Eastern Idaho supports a robust population of wild trout including an important population of native Yellowstone Cutthroat Trout (YCT). Other trout present in the South Fork include Rainbow Trout (RBT) and Brown Trout (BNT). Since 2004, a three-pronged management approach has been used to accomplish the objectives outlined in the state fish management plan including preserving the genetic integrity and population viability of native Yellowstone Cutthroat Trout and limiting RBT (including hybrids) to less than 10% of the species composition of the catch at the Conant monitoring reach during annual fall electrofishing surveys (IDFG 2013). This report summarizes management and research activities on the South Fork Snake River in 2013. For a broader description of the South Fork Snake River and additional background information see Schoby et al. (2013).

## METHODS

The methodology for annually monitoring fish abundances and trends in the South Fork, operating and evaluating the tributary weirs, assessing the effects of spring flows on YCT and RBT recruitment, implementation and analysis of the South Fork Angler Incentive Program, analyses using PIT tag data, and the manual removal of RBT from Palisades Creek can be found in detail in Schoby et al. (2013). Monitoring sites can be found in Appendix F. Methods used in 2013 were identical to those outlined in the referenced report.

### Radio Telemetry

We initiated a five year telemetry study of trout movements in the South Fork during the summer of 2013. The focal point of the study was the middle portion of the South Fork near Heise, where nine large irrigation structures divert water from the river. We scaled the number of tags released per river km relative to the distance from this focal point of the study area. In order to do this, we first divided the river up into five strata: Confluence, Lorenzo, Center, Wolf, and Burns strata. The Center strata included all nine irrigation diversions. The strata were then separated into 1.6 km (1 mile) long river sections. The Confluence strata had six sections, there were four sections in the Lorenzo strata, 14 sections in the Center strata, five sections in the Wolf strata, and four sections in the Burns strata. We marked YCT, RBT, and BNT with two sizes of coded VHF radio transmitters. The larger transmitters were 12 x 53 mm, weighed 10 g in the air, and are expected to have a 528 d battery life with a 5 s burst rate for the signal. The smaller tags measured 9.1 x 30.1 mm, weighed 4.5 g in the air, and are expected to have a 441 d battery life with a 5 s burst rate. We placed 80% of the available transmitters in YCT, 15% in BNT, and 5% in RBT. These tags were then split among the five river strata as follows: 10% of the transmitters in the Confluence strata, 10% in the Lorenzo strata, 70% in the center strata, 7% in the Wolf strata, and 3% in the Burns strata. Since the strata were of unequal lengths the following is a breakdown of percent tags by 1.6 km river section: 2% per river section in the Confluence strata, 3% per section in the Lorenzo strata, 5% per section in the Center strata, 2% per section in the Wolf strata, and 1% per section in the Burns strata.

We used boat-mounted electrofishing gear to capture trout for tagging from June 24 to August 1, 2013. After radio tags were implanted, fish were released in the same river section they were captured. We surgically implanted radio transmitters into the body cavities of trout. Fish were measured to the nearest mm (total length) and weighed to the nearest g before being placed in an anesthetic bath. We weighed fish to ensure the transmitter used did not exceed 3% of the body weight of the fish (Brown et al. 1999). We anesthetized fish using MS-222 (YCT) or AQUI-S (RBT and BNT) in a cooler with 11.4 L (three gallons) of water and either 8 ml of 10 Molar MS-222 solution in water or 5 ml of 10 Molar AQUI-S solution in ethanol. Once fish lost equilibrium, we placed them belly up in a tray mounted above the cooler and we used a small battery-powered bilge pump attached to an adjustable sprinkler hose attachment to keep the gills flooded with water during the surgery. With one worker constantly flushing the gills with water, a second would make a short 2 – 3 cm incision in through the body wall of the belly anterior to the pelvic fins. We then inserted a grooved director through the incision and back near the vent to shield internal organs from damage. We then inserted a catheter needle through the body wall near the vent onto the groove director which we used to guide the point of the needle out through the incision anterior to the pelvic fins. Next we inserted the transmitter's antenna through the catheter needle and then removed the needle leaving the antenna trailing out of the fish. We used the antenna to gently pull the tag into the fish's body cavity. We also placed a PIT tag in the body cavity with the radio transmitter. Next, we used 3-0 nylon suture material to seal the incision using two to three sutures. We treated the incision and antenna wound with iodine and placed the fish in a bucket of fresh water for recovery. We recorded the following time intervals during each surgery: time to loss of equilibrium, surgery time, and recovery time (time to regain equilibrium). Once fish recovered equilibrium, we placed them in a holding cage secured in calm water. We held tagged fish in the holding cages for recovery until the following day when they were released.

We monitored fish locations weekly through October, and then twice monthly in November and December. Fish locations were recorded to the nearest 100 m using a hand-held GPS device during mobile tracking efforts. We used jet boats, rafts, and trucks to track along the river and adjacent canals. We hired a pilot to fly the network of associated canals twice in 2013, once in summer, and once when the canals were shut off in the fall. We also used fixed receiver stations to monitor tagged fish movements throughout the system and to help fill in information gaps between mobile tracking surveys. Fixed receivers stations were placed in six locations: downstream of the Lorenzo boat ramp in the Confluence strata, at the Reid Canal irrigation diversion, at the Great Feeder irrigation diversion, at the Eagle Rock Canal diversion, at the Anderson Canal diversion, and near the mouth of Mud Creek in the Burns Creek strata. Fixed stations all had two or three antennas searching a combination of upstream, downstream, and down canals for radio signals.

We recorded fish locations in an Access database which we used to summarize fish movements and final locations for 2013. We summarized fish movements by describing distance moved from the tagging location through December 2013 and the percentage of tagged fish entrained in the irrigation canal system. We did not correct for bias in the entrainment percentage caused by fish mortality, but plan to do so in coming years as more data become available for the analysis.

# RESULTS

## South Fork Population Monitoring

We captured 2,018 trout at the Lorenzo monitoring reach, including 297 YCT, 44 RBT, and 1,677 BNT. Our abundance estimates include age-1 and older YCT (≥102) and BNT (≥178). We estimated YCT densities at 299 (±72) fish/km and 1,200 (±121) BNT per kilometer (Table 14; Figure 34). The trend for YCT density estimates at Lorenzo over the duration of the dataset (1987 through 2013) has been stable as indicated by an intrinsic rate of change ($r$) = -0.02 which was not significantly different than zero at the $\alpha$ =0.10 level (F=2.08, df=16, P=0.17). The abundance of YCT at Lorenzo did decrease below the long-term average to a low of 76 YCT/km in 2005. Since 2005, YCT have experienced an increasing trend with a significantly positive intrinsic rate of growth, $r$ = 0.18 (F=67.20, df=6, P<0.001). The BNT population at Lorenzo has a significantly increasing trend over the duration of the dataset (1987 through 2013) with $r$ = 0.05 (F=23.511, df=18, P<0.001). Since 2004, after management actions changed on the South Fork, BNT abundance at Lorenzo have had a stable trend with r = -0.02 which was not significantly different than zero (F=0.15, df=8, P=0.71). We captured too few RBT to generate a population estimate using mark recapture techniques, but RBT did comprise 2.2% of the catch. Extrapolating 2.2% with the total trout estimate (1,499 trout/km) indicates RBT density is around 33 RBT/km at Lorenzo.

We captured a total of 3,191 trout at the Conant monitoring reach. This included 1,264 YCT, 1,047 RBT, and 880 BNT. We also captured one Kokanee salmon *O. nerka* that likely washed through Palisades Dam. We estimated there were 1,401 YCT/km (±159), 1,180 RBT/km (±344), and 752 BNT/km (±212) of age-1 and older trout (Table 15; Figure 35). We estimated the total trout density at 3,333 trout/km at Conant. Over the duration of the dataset at Conant (1982 through 2013), YCT have experienced a slightly negative trend (decreasing abundance) with a statistically significant intrinsic rate of growth $r$ = -0.03 (F=12.72, df=23, P=0.002). Since management changed to the three-pronged management approach in 2004, YCT at Conant have experienced a significantly positive trend with $r$ = 0.09 (F=11.70, df=9, P=0.009). Rainbow Trout have experienced a significantly positive trend at the Conant monitoring reach from 1982 through 2013 ($r$=0.11, F83.04, df=21, P<0.001). From 2004 through 2013 RBT continued to experience a statistically significant increase in abundance with an intrinsic rate of growth at $r$ = 0.12 (F=18.34, df=0, P=0.003). Brown Trout have exhibited a slightly positive (increasing) and significant trend over the period of data collection at Conan with $r$ = 0.02 (F=4.32, df=23, P=0.05). Since 2004, BNT at Conant have experienced a strongly increasing and significant population trend with $r$ = 0.12 (F=13.17, df=9, P=0.007).

## Weirs

From April 2 through July 2 we captured 904 migrating trout at the Burns Creek weir, including six RBT (three male and three female) and 441 male and 457 female YCT. At Burns Creek, 11% of the male YCT captured at the trap fell back over the weir and were recaptured at the fish trap during the same spawning season. Female YCT at Burns Creek fell back at a rate of 4%. We captured 50 fluvial-sized YCT upstream of the Burns Creek weir using backpack electrofishing gear. All of these fish were examined for marks. We found 49 of 50 were marked indicating they were handled at the fish weir. Thus, the 2013 trapping efficiency estimate for the Burns Creek weir was 98% (Table 16).

We operated the Pine Creek weir from April 5 through June 22, capturing a total of 1,909 fish of which only one was a RBT (female). The remainder included 584 male and 1,324 female YCT. The fallback rates were similar for both male and female Cutthroat Trout at 4% and 3%, respectively. Upstream of the weir, we again used backpack electrofishing units to collect a sample of fluvial-sized fish and caught a total of 36 YCT, of which 32 had marks, so the 2013 efficiency estimate for the Pine Creek weir was 89%.

At the Palisades Creek weir, we caught a total of 23 RBT including 12 males and 11 females. We also caught 260 male and 359 female YCT in the trap. Fallback rates for both male and female Cutthroat Trout were low (<1%). A screened irrigation diversion near the Palisades Creek weir that diverts fish from the canal back to the creek, thereby capturing out-migrating adult trout was used to generate a weir efficiency estimate. The trap was operated a little over one week, until a total of 52 fluvial-sized Cutthroat Trout had been captured. Most of these fish (50) had marks indicating they were captured at the weir during their upstream migration, so the 2013 Palisades Creek electric weir efficiency estimate was 96%. The Rainey Creek electric weir was not operated in 2013.

## Radio Telemetry

We radio tagged 332 trout in the South Fork Snake River in the summer of 2013 from the river's confluence upstream to Burns Creek, including 271 YCT, 41 BNT, and 20 RBT. We implanted radio transmitters into 27 YCT, four BNT, and three RBT in the Confluence strata. In the Lorenzo strata we tagged 28 YCT and six BNT. We did not catch any RBT of the appropriate size for tagging in the Lorenzo strata, so these tags were used in the Confluence strata instead. In the Center strata we tagged 189 YCT, 26 BNT, and 13 RBT. In the Wolf strata, we tagged 17 YCT, three BNT, and two RBT, and in the Burns strata we tagged ten YCT, two BNT, and two RBT. The overall average surgery time was 3:48. We observed four mortalities when returning the following day to release fish. These tags were placed in new fish in the same river section.

Uncorrected fish entrainment rates into canal and fish movements were generally low for the short duration of the telemetry study has occurred thus far. We recorded 20 radio-tagged fish being entrained into canal systems, including 18 YCT and 2 RBT. The total uncorrected entrainment rate was 6% and the breakdown is as follows: six in the Dry Bed Canal, eight in the Reid Canal, four in the Sunnydell Canal, and two in the Anderson Canal. Movements from tagging locations from August through December averaged 2.9 river km with a range from 0 to 13 river km.

## Spring Flows

Correlations between spring flows and trout recruitment yielded mixed results for YCT and RBT. A positive relationship between maximum spring flow was significantly correlated with YCT in the age-1 size group the following year (Figure 36; $F=8.30$, $df=7$, $P=0.03$). Examination of the residuals from this model indicated the data were normally distributed. Maximum spring flows, however, were not statistically correlated with age-1 RBT the following year (Figure 37; $F=0.66$, $df=8$, $P=0.44$).

## South Fork Angler Incentive Program

In 2013, we marked 805 RBT with coded wire tags (CWT) between Palisades Dam and Heise for the Angler Incentive Program. We tagged 530 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 156 anglers turned in 2,268 RBT in 2013. Overall, anglers turned in a median of three RBT and an average of nine RBT. Of the 2,268 RBT brought in to IDFG there were 69 tagged fish. The tag values and number that were turned in were $50 (40), $100 (23), $200 (four), one $500, and one $1,000 for a total of $6,600.

## PIT Tags

In 2013, we marked an additional 1,431 YCT with PIT tags bringing the total number of marked YCT released in the South Fork since 2008 to 16,182. The breakdown of tagging events in 2013 is as follows: Burns Cr Weir – 107 fish, Pine Cr Weir – 102 fish, Palisades Cr Weir – 93 fish, mainstem winter shocking – 373 fish, Lorenzo monitoring site – 213 fish, and Conant monitoring site – 543 fish. We recorded 731 recapture events during 2013.

Spawning stream fidelity was high (99%) for YCT recaptured at three major spawning tributaries of the South Fork. In 2013 we recaptured 286 YCT which had previously been observed at spawning tributaries during spring runs and had retained PIT tags, including 163 at Burns Creek, 108 at Pine Creek, and 15 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, from Burns Creek to Pine Creek, and from Pine Creek to Burns Creek.

Over-winter site fidelity was moderately high in 2013. We recaptured 19 YCT that had previously been captured during winter electrofishing efforts along the mainstem of the South Fork. Of these, five YCT were tagged in two or more river segments (each segment averaged 4.5 km in length) away from where they were recaptured in 2013. In each of these cases, the marked fish were found in 2013 in river segments upstream of those they were tagged in during previous years.

Spawning migrations for YCT in the South Fork can be lengthy and occur in both upstream and downstream directions. During the 2013 spawning run, we recaptured 152 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 22.8 km for YCT recaptured at Burns Creek, -1.6 river km for YCT recaptured at Pine Creek, and 15.6 river km for YCT recaptured at Palisades Creek (Table 17). The maximum downstream migration observed was 34.2 river km for a Pine Creek spawner and the maximum upstream migration observed was 47.6 river km for a YCT returning to Burns Creek.

## RBT Removals

We removed RBT from Palisades Creek during two single pass backpack electrofishing efforts. The first effort was conducted from August 5 through August 8, 2013. We marked YCT throughout the 10.5 km stretch of stream that electrofishing removals were conducted on August 1 and August 2. Any RBT captured during these marking efforts were removed and added to the total number of RBT removed during the following pass. Fish were marked in order to estimate capture efficiencies. Including RBT that were removed from Palisades Creek during the marking run, a total of 421 RBT were captured and removed. A total of 957 YCT were captured. Our capture efficiency during this first pass was an estimated 32%. A second pass was conducted September 16 – 19, 2013 with a different group of YCT marked on September 13, 2013. During the second pass, a total of 707 RBT were removed and 1,704 YCT were captured and released. For a complete summary of electrofishing removals on Palisades Creek, please refer to Kennedy et al. (In Prep).

We performed a single electrofishing pass on 3.0 river km of Burns Creek from the Burns Creek weir upstream to Hell Hole Canyon, removing RBT and BNT from this section of Burns Creek located upstream of our fish weir. We spot shocked sections of Burns Cr and marked YCT prior to the removal effort in order to estimate capture efficiency. During the spot shocking marking effort, we captured a total of 178 trout including eight BNT, three RBT, and 167 YCT. These BNT and RBT were removed. In addition to these 11 fish, we removed an additional 30 BNT and ten RBT during the complete electrofishing pass throughout the section of Burns Creek from the weir upstream to Hell Hole Canyon. During this complete single pass, we captured total of 988 YCT. We estimated our capture efficiency to be 68%. Due to the low number of non-native trout encountered during this first removal pass and our observed high electrofishing efficiency, we did not perform a second pass.

## DISCUSSION

### South Fork Population Monitoring

Trout abundances in the South Fork are exhibiting stable or increasing trends. For the third year in a row, total trout abundances at the Conant monitoring site are near record setting levels. The high trout abundance at Conant during the previous two years was primarily due to high abundance of young BNT (Garren et al. In Review). In 2013, total trout abundance remained near all-time high levels despite BNT abundance dropping over 15% from 2012. The difference was made up by an increase in YCT abundance. YCT have positively responded to the three-pronged management approach and the population has grown on average 9% per year since 2004. If population growth continues at this rate of recovery, we could expect YCT abundance to reach levels similar to what was observed in the 1980s in six or seven years. While YCT abundance recovers, however, the long-term persistence of the species in the South Fork is still threatened by RBT. Rainbow Trout have also experienced an increasing trend in abundance since 2004 and continue to hybridize and compete with YCT in the main river. While RBT population trends have been increasing since 2004, the rate of population growth has not been as high as would be expected if the three-pronged management approach was not occurring (IDFG Unpublished Data). While management efforts have limited 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 2013) have not yet been successful. Currently, RBT are 33% 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 threat to their persistence.

Trout populations in the lower river have also responded positively to management actions of the three-pronged management approach. Brown Trout have been the dominant species on the lower South Fork throughout the duration of our sampling efforts. Brown Trout populations at Lorenzo are currently stable around the long-term average for the monitoring site and YCT densities have increased since management actions changed in 2004. While extrapolations of RBT abundance suggest they had higher than average densities in 2013, their density remains low, comprising only 2% of the total catch at Lorenzo. The increase of RBT observed in 2013 may likely be due to sampling variability or errors caused by extrapolating instead of estimating RBT abundance. The latter was not possible due to low numbers of RBT handled during the survey. Regardless, Rainbow Trout in the lower river are present, but in low abundance.

## Weirs

Efforts to trap migratory trout in the spring at Burns, Pine, and Palisades creeks in 2013 were very successful with efficiencies exceeding 90% in all locations. The electric weirs at Pine Creek and Palisades Creek were operated at higher electrical settings in 2013 compared to 2012 based on recommendations from Larson et al. (2013) who reported injury rates at electrical weirs were low enough that they recommended increasing electrical settings to maximize capture efficiencies. Injury rates were again assessed in 2013. As expected, higher electrical settings did increase spinal injury rates, but were not high enough injury levels to adversely affect the spawning population (see Larson et al. (In Review) for a full report).

Trapping efficiencies had been adversely affected by the aggradation of gravel on the velocity barrier near the base of the waterfall at the Burns Creek weir in 2011 and 2012. Efforts to return the weir to a functional state by hiring a contractor to remove the gravel were unsuccessful in 2011 (Schoby et al. 2013). IDFG removed the material in 2012 (Garren et al. In Review). This effort was successful and no aggradation of gravel occurred on the Burns Creek weir in 2013. What differed in the two efforts was that the stream bed was returned to the original design elevation in 2012. Second, an eddy on the east side of the Burns Cr weir was filled in during 2012 restoration efforts. With the eddy filled in with larger substrate, there was no calm water on the velocity barrier providing an area for sediment to come out of suspension. Sediment, including gravel, was observed being transported downstream in the runoff of 2013, but was carried by the stream down over the weir and downstream past the next break in habitat types as opposed to depositing immediately below the weir as it had in prior years. Future efforts to maintain functionality of the Burns Creek weir are likely going to be required in high water years, and should focus on maintaining the designed elevation and lack of eddies on or adjacent to the velocity barrier.

The Rainey Creek electric weir was not operated in 2013 because stream modifications that affect weir function could not be accomplished prior to the spring runoff and spawning season. Trapping efforts in 2011 and 2012 yielded poor catches (Schoby et al. 2013, and Garren et al. In Review), and the poorly functioning weir likely blocked some YCT from migrating upstream in Rainey Creek. This was the primary reason trapping was not attempted in 2013. Instead, IDFG has been working with the Targhee National Forest to design a project that would result in increased flow through the Rainey Creek fish trap. Low flow velocities through the fish trap have been the limiting factor for catching trout (Schoby et al. 2013). In order to better design this project, we collected weekly stream discharge measurements through the spring run-off season in 2013 and provided these data to the Forest Service hydrologist for assistance in developing a solution to the flow challenges we face on Rainey Creek. We will continue helping to develop these stream modification plans and plan to finish the project prior to the 2014 spawning run.

The tributary weir program has been successful at limiting RBT expansion 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, and 651 RBT captured at the Burns, Pine, and Palisades creeks weirs, respectively. During the most recent three years (2011 through 2013) we removed 11, five, and 56 RBT from Burns, Pine, and Palisades creeks, respectively during the spawning runs (Table 16). That is an average reduction of 86% fewer RBT migrating into Burns, Pine, and Palisades creeks. The continued success of the tributary weir trapping program has also been identified as a key component for ensuring the long-term viability of YCT in the South Fork system (Van Kirk et al. 2010).

## Radio Telemetry

Uncorrected entrainment and movement rates were low during this initial portion of the radio telemetry study on the South Fork. The short duration of time that this report summarizes likely makes these entrainment and movement rates biased low compared to annual rates, as tagged fish were only present in the South Fork during the late summer and fall, and not during the spring and summer when the peak in irrigation delivery occurs. Furthermore, the entrainment rates are not corrected for fish mortality. Mortality rates of fish tagged with radio tags should be taken into consideration when assessing entrainment and movement. During the first few months of this study we did observed mortality in our group of tagged fish. Most causes of mortality could not be determined. We recovered 17 radio tags from fish that either died in or shed their tags in the main river. There are an additional two tags that we know are in the river and are not in a live fish. Thus, we know that we lose tagged fish through mortality. What we do not know is how many of the radio tags in the river that are deeper than can be accessed by wading and have not moved in several weeks, are also not associated with a live fish any longer. We will assess this in the spring of 2014 during low flow conditions. When the spring spawning migration starts, we will be able to discern which tags are still in live fish and we will use this percentage to estimate the annual mortality rate on our group of tagged fish. We can then use this rate to correct the entrainment rate estimate and re-assess fish movements. In 2014, we also plan on using a portion of radio tags with motion sensors to better assess instantaneous mortality rates with our tagged fish which will be necessary for making accurate corrections to account for bias in annual rates of entrainment and movements.

We currently know little concerning the magnitude of trout entrained into large canals which divert water from the South Fork Snake River. Entrainment is high enough on one local canal, the Dry Bed Canal, that a snagging fishery has become very popular among some local anglers each spring when the flows are shut off for maintenance activities. IDFG has conducted creel surveys on this fishery in the past and has documented a few hundred large trout (280 to 787) harvested annually by anglers (Schoby et al. 2014). These surveys as well as other electrofishing surveys (see Schoby et al. 2013) provide some insight into entrainment rates, but are limited by the fact that they only provide a snapshot in time. Fish that were entrained earlier through the irrigation season and passed through the canals into subsidiary canals and ditches were not represented and IDFG has virtually no entrainment data for the rest of the canals which shut down in the fall. This current study will better provide insight into entrainment into all of these canals throughout the season. In addition to entrainment, we will be able to determine if this entrainment is a sink for the population or if some of the entrained fish return to the South

Fork. Several ditches and canals return water to the Snake River, and thus provide opportunity for entrained fish to migrate back to the South Fork. In fact, in the winter of 2013-2014 we documented four radio-tagged fish (all YCT) in the lower portions of Texas slough. Texas slough is a bypass for water diverted in Reid Canal to be returned to the river via a natural side channel that connects the South Fork with the Henrys Fork Snake River 9 km upstream from the mouth of the South Fork, and the behavior of these tagged fish in the spring/summer of 2014 will be closely monitored.

In addition to learning about entrainment, the telemetry project will provide valuable insight into important habitats used in the lower South Fork, river spawning locations for the different species, seasonal movement patterns, and effects of river flow management on fish populations. An example of this is a change in river flows each fall when canals stop diverting water and river levels are lowered. In the fall of 2013 when flows were dropped, we identified one fish mortality due to stranding in a pool that went dry and documented four additional tagged fish trapped in isolated pools. Fish isolated in pools can survive through winter given sufficient hyporheic flow (B. High personal observation). Thus, this telemetry project will help describe the effect of quickly changing river flows.

## 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 or displace newly emerging fry. 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 2006) and that South Fork riverbed material is not mobilized until flow reach 736 $m^3/s$ (Hauer et al. 2004). While we could not detect a statistically significant correlation between maximum spring river flows and age-1 RBT abundance the following year, our dataset does not include high enough flows to adequately assess this possible relationship. Previous studies performed on the South Fork indicate flows in excess of 708 cm are required for geomorphic processes to start altering stream channels (Hauer et al. 2004) or providing the most benefit to YCT (Moller and Van Kirk 2003). Since 2004, we have not yet had flows that exceed this benchmark identified both by Hauer et al. (2004) and Moller and Van Kirk (2003).

## South Fork Angler Incentive Study

The South Fork Angler Incentive Program plays an important role in managing YCT in the South Fork. This Program provides a tool for outreach and education about the importance of native trout conservation in the South Fork. This, of itself, may be enough justification for how much benefit is derived given the program’s low operational costs. However, recent population modeling efforts for how RBT populations respond to different levels of harvest and different scenarios of spring flows, indicate the Angler Incentive Program as part of the three-pronged management efforts on the South Fork is one of the key factors that is limiting the rate of RBT population growth, and has the potential to cause a population decline if harvest levels are slightly increased (IDFG unpublished data).

Participation by anglers in the Angler Incentive Program has been decreasing despite increased winning odds. From 2010 to 2012 the number of anglers turning fish into the Angler Incentive Program dropped 72% from 683 anglers to 190 along with a 43% reduction in the number of fish turned in (Garren et al. in Review). The number of anglers participating declined further from 2012 to 2013 (from 190 anglers to 156, an 18% reduction). The number of fish turned in, however, increased 31% from 1,726 to 2,268 RBT. The median number of fish turned in per angler was the same for both 2012 and 2013 at three RBT, but the average was higher in 2013. Thus, there is a small number of South Fork anglers who are very successful at catching and harvesting RBT in the South Fork and participate in the Angler Incentive Program. We also suspect that there is an unknown number of fish harvested by anglers planning on participating in the program, but for various reasons never turn in harvest fish. In 2012, only 17% of the anglers observed by creel clerks in the field with harvested RBT later turned in fish heads for the incentive program even though the creel clerk reminded them of the program and encouraged participation (High et al. 2015). Thus, it is possible that the Angler Incentive Program is further affecting harvest rates beyond what we can calculate from the number of fish turned in or the number of people participating. While apparent participation has been declining since the start of the program, the odds of winning have been increasing. The odds of turning in a winning fish in 2010 were low (0.6%: Schoby et al. 2014). Winning odds have steadily increased from 0.6% in 2010, to 3.0% in 2013. Continued annual marking efforts will continue to increase winning odds which will likely increase angler participation.

## PIT Tags

Information collected from PIT tagged YCT indicates strong fidelity to both spawning tributaries as well as over-winter 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 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.

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 (High et al. 2011) 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.

In summary, the current status of the South Fork fishery is good. Anglers are enjoying near record trout abundances, YCT are abundant and are experiencing positive growth in numbers, and current research will help provide critical answers necessary to move management forward in coming years. However, YCT will continue to face risks to their continued persistence from a sympatric, robust RBT population and potentially from an increasing BNT population. In the face of these threats, YCT require active and adaptive management to maintain population viability.

## 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. Increase efforts that encourage anglers to participate in the Angler Incentive Program

4. Remove resident RBT from Palisades Creek for at least another year to determine if manual removal efforts reduce introgression rates. During future removal years, maintain the barrier to RBT movement at the Palisade Creek weir all summer and into fall to limit the chance of post-removal recolonization by nearby migrant Rainbow Trout.

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

6. Work with the US Bureau of Reclamation to better study how spring flows affect trout species composition and abundance with spring flows close to 708 $m^3/s$ (25,000 cfs) during RBT fry emergence.

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. Continue to assess entrainment rates into large irrigation canals using radio telemetry.

Table 14. Summary statistics from the Lorenzo monitoring site between 1987 and 2013 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 | 93.3 | 0.15 | 5 | 11 | 0 | 0.0 | | | | 437 | 435 | 51 | 11.7 | 784 | 99 | 0.06 | 607 | 642 | 61 | 9.5 | 1,329 | 66 | 0.05 |
| 2013 | 150 | 167 | 25 | 15 | 299 | 72.1 | 0.12 | 17 | 27 | 0 | 0.0 | | | | 838 | 714 | 108 | 15.1 | 1200 | 121 | 0.05 | 1,005 | 908 | 133 | 14.6 | | | |

Table 15. Summary statistics from the Conant monitoring site between 1982 and 2013 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 | 1,727 | 1,692 | 221 | 13.06 | | | |
| 2013 | 784 | 536 | 73 | 13.6 | 1,401 | 159 | 0.06 | 578 | 393 | 52 | 13.2 | 1,180 | 334 | 0.14 | 538 | 314 | 52 | 16.6 | 752 | 212 | 0.14 | 1900 | 1243 | 177 | 14.2 | | | |

Table 16. Summary tributary fish trap operation dates, efficiencies and catches from 2001 through 2013.

| Location and year | Weir type | Operation dates | Est. weir efficiency (%) | Catch | | |
|---|---|---|---|---|---|---|
| | | | | Cutthroat trout | Rainbow trout | Total |
| Burns Cr | | | | | | |
| 2001 | Floating panel | March 7 - July 20 | 16 | 3,156 | 3 | 3,159 |
| 2002 | Floating panel | March 23 - July 5 | | 1,898 | 46 | 1,944 |
| 2003 | Floating panel | March 28 - June 23 | 17-36 | 1,350 | 1 | 1,351 |
| 2004 | ND | ND | ND | ND | ND | ND |
| 2005 | ND | ND | ND | ND | ND | ND |
| 2006 | Mitsubishi | April 14 - June 30 | ND | 1,539 | 0 | 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 |
| 2013 | Fall/velocity | April 2 - July 2 | 98 | 888 | 6 | 894 |
| Pine Cr | | | | | | |
| 2001 | ND | ND | ND | ND | ND | ND |
| 2002 | Floating panel | April 2 - July 5 | ND | 202 | 14 | 216 |
| 2003 | 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 | ND | 2,817 | 40 | 2,857 |
| 2006 | 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 | ND | 115 | - | 115 |
| 2009 | Hard picket | April 6 - July 15 | 49 | 1,356 | 1 | 1,357 |
| 2010 | Electric | April 13 - July 6 | ND | 2,972 | 3 | 2,975 |
| 2011 | Electric | April 11 - July 9 | 49 | 1,509 | 1 | 1,510 |
| 2012 | Electric | March 28 - July 1 | ND | 1,427 | 3 | 1,430 |
| 2013 | Electric | April 5 - June 22 | 89 | 1,908 | 1 | 1,909 |
| Rainey Cr | | | | | | |
| 2001 | Floating panel | March 7 - July 6 | ND | 0 | 0 | 0 |
| 2002 | Floating panel | March 26 - June 27 | ND | 1 | 1 | 1 |
| 2003 | ND | ND | ND | ND | ND | ND |
| 2004 | ND | ND | ND | ND | ND | ND |
| 2005 | Hard picket | April 7 - June 29 | ND | 25 | 0 | 25 |
| 2006 | Hard picket | April 5 - June 30 | ND | 69 | 0 | 69 |
| 2007 | Hard picket | March 19 - June 30 | ND | 14 | 0 | 14 |
| 2008 | Hard picket | June19 - July 11 | ND | 14 | 0 | 14 |
| 2009 | Hard picket | April 7 - July 6 | ND | 23 | 0 | 23 |
| 2010 | Hard picket | April 13 - June 29 | ND | 145 | 1 | 146 |
| 2011 | Electric | March 28 - June 28 | ND | 0 | 0 | 0 |
| 2012 | Electric | April 18 - June 23 | ND | 7 | 0 | 7 |
| 2013 | ND | ND | ND | ND | ND | ND |
| Palisades Cr | | | | | | |
| 2001 | Floating panel | March 7 - July 20 | 10 | 491 | 160 | 651 |
| 2002 | Floating panel | March 22 - July 7 | ND | 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 | Mitsubishi | 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 | ND | 30 | 13 | 43 |
| 2012 | Electric | March 24 - July 2 | 88 | 232 | 20 | 252 |
| 2013 | Electric | April 5 - July 8 | 96 | 619 | 23 | 642 |

Table 17. Migration distances of PIT tagged Yellowstone Cutthroat Trout returning to Burns Creek, Pine Creek, and Palisades Creek in 2013.

| | | Overall distance range | | | Upstream migrants | | Downstream migrants | |
|---|---|---|---|---|---|---|---|---|
| **Spawning tributary** | **Avg. migration distance** | **upstream** | **downstream** | **n** | **Avg distance** | **n** | **Avg distance** | **n** |
| Burns Creek | 22.8 km | 47.6 km | -25.8 km | 12 | 25.7 km | 11 | -25.8 km | 1 |
| Pine Creek | -1.6 km | 40.4 km | -34.2 km | 112 | 24.0 km | 42 | -16.4 km | 70 |
| Palisades Creek | 15.6 km | 20.9 km | -3.4 km | 28 | 16.3 km | 27 | -3.4 km | 1 |

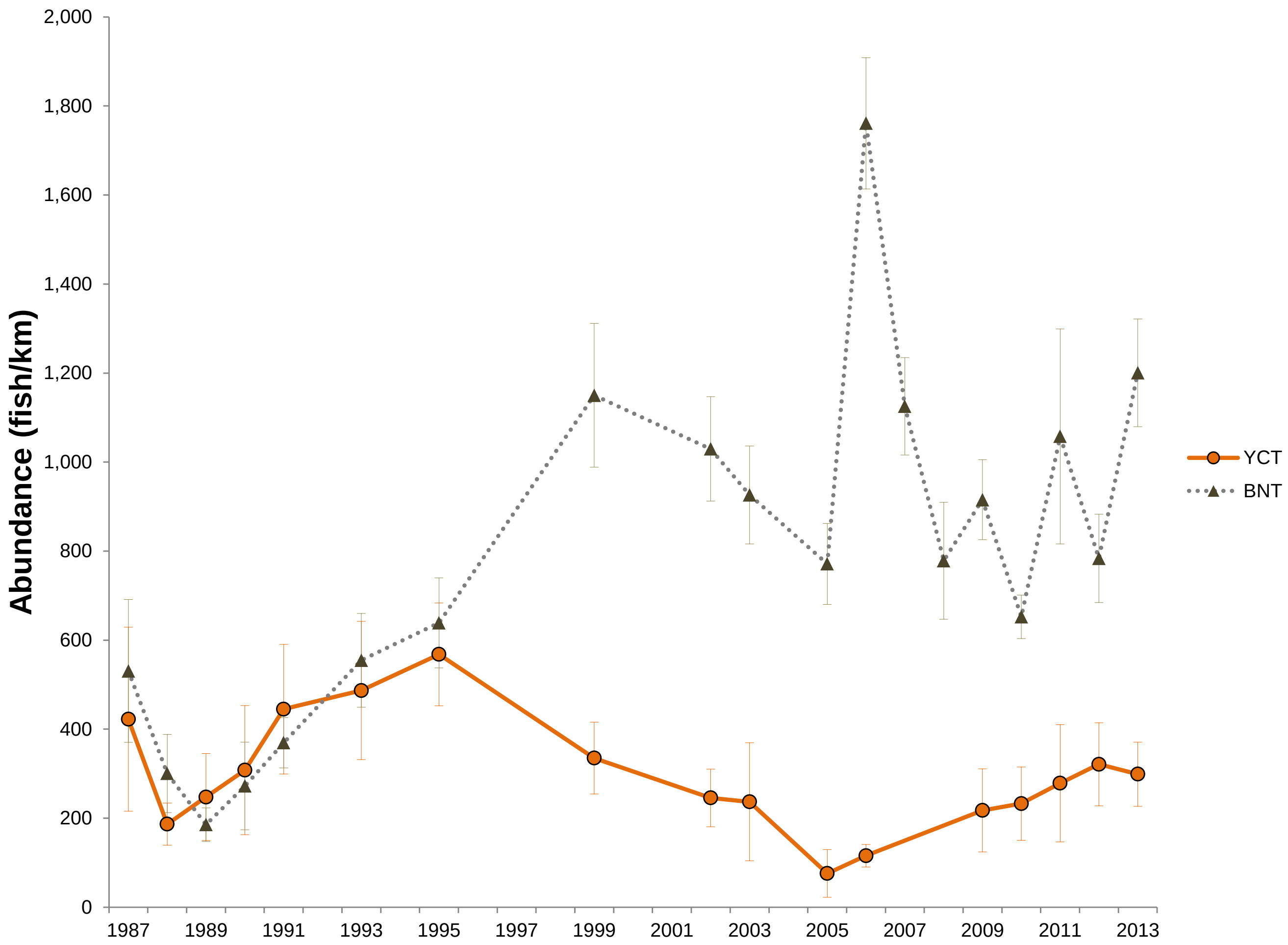


Figure 34. Abundance estimates and 95% confidence intervals for Yellowstone Cutthroat Trout (YCT) and Brown Trout (BNT) at the Lorenzo monitoring site on the South Fork Snake River from 1987 through 2013.

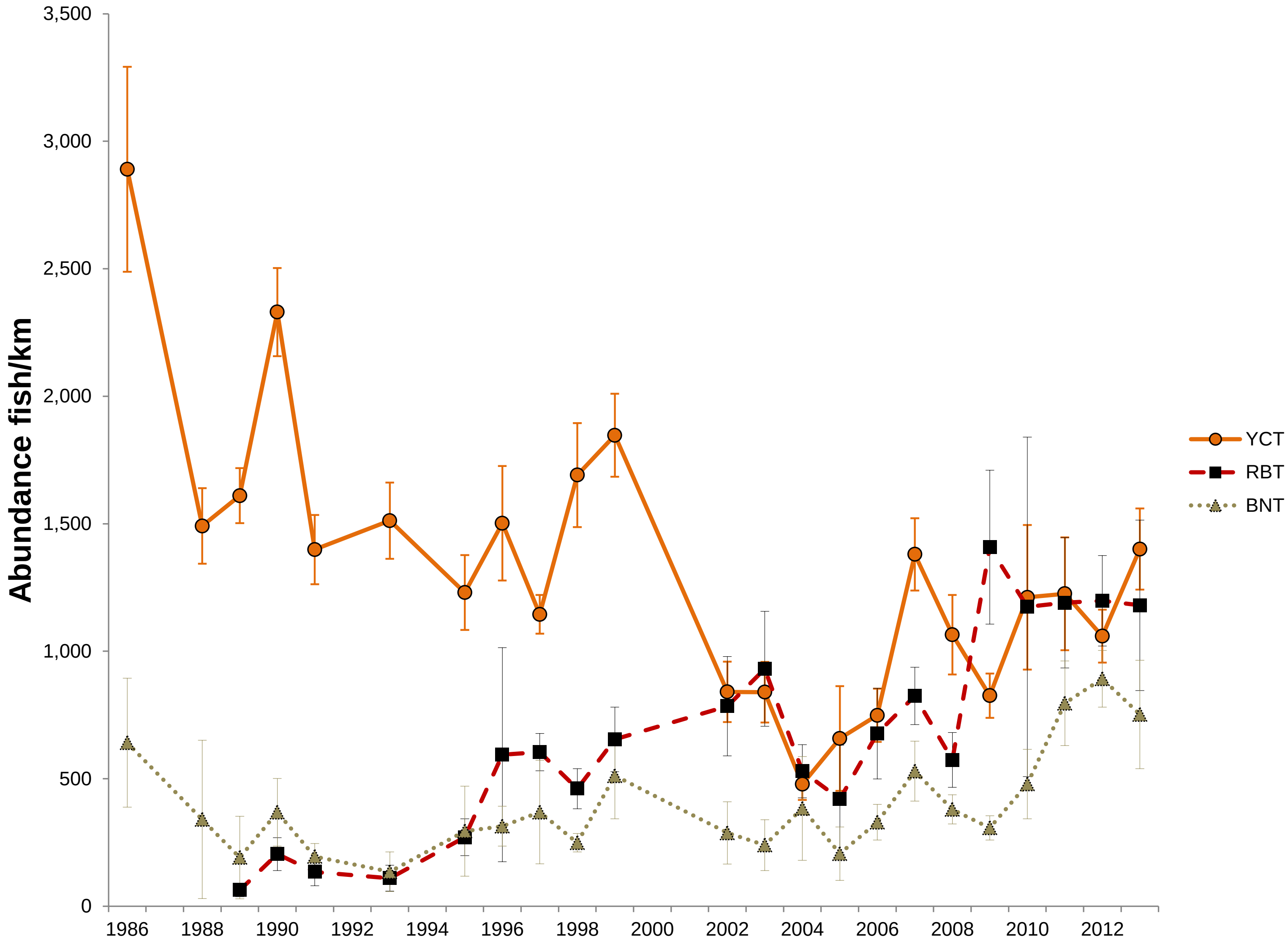


Figure 35. Abundance estimates and 95% confidence intervals for Yellowstone Cutthroat Trout (YCT) and Brown Trout (BNT) at the Conant monitoring site on the South Fork Snake River from 1986 through 2013.

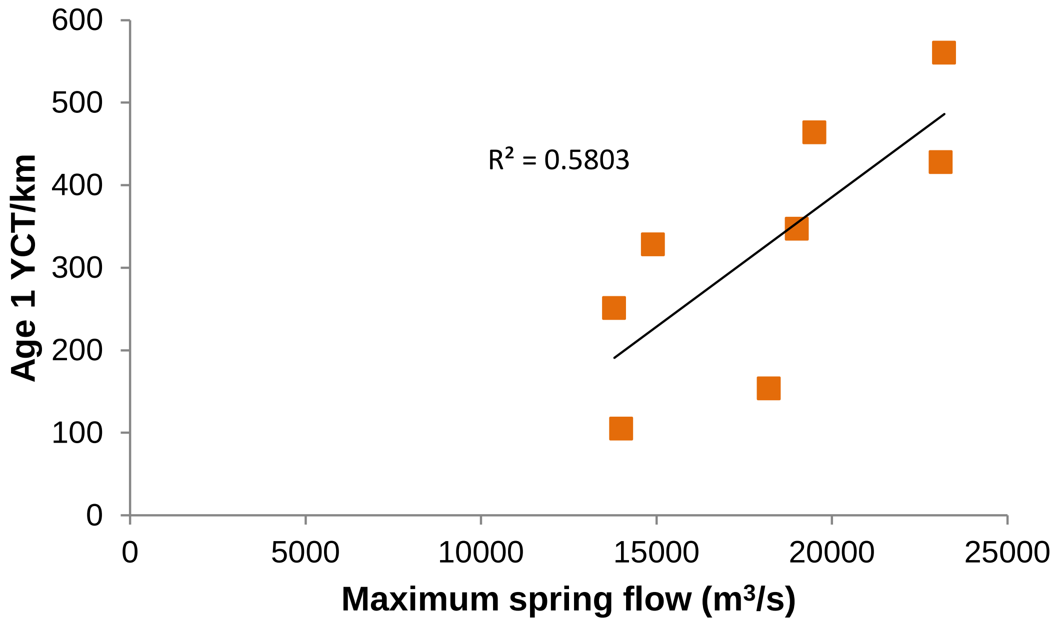


Figure 36. Linear regression with maximum spring flows regressed with age-1 Yellowstone Cutthroat Trout (YCT) the following year at the Conant monitoring site.

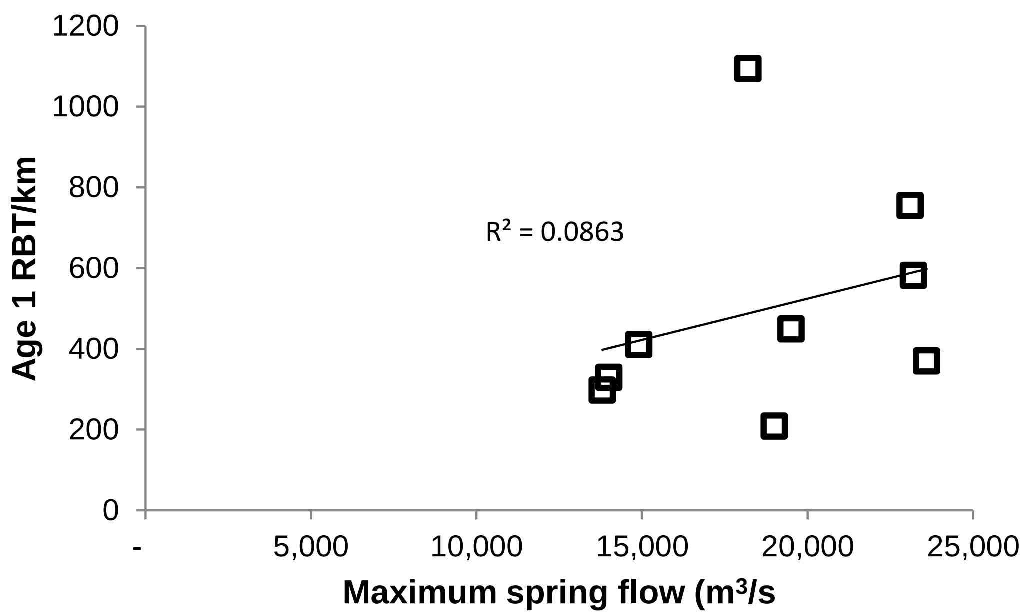


Figure 37. Linear regression with maximum spring flows regressed with age-1 Rainbow Trout (RBT) the following year at the Conant monitoring site.

Appendix F. 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 |

# SNAKE RIVER

## ABSTRACT

We used jet boat mounted and raft electrofishing equipment to assess fish populations in the Osgood reach of the Snake River during 2013. We estimated the overall salmonid density (all species collected, including Mountain Whitefish) at 910 fish/km (95% CI = 633 – 1,619), which was dominated by Brown Trout (65%), followed by Rainbow Trout (9%), Yellowstone Cutthroat Trout (1%), and Mountain Whitefish (25%). Proportional stock density (PSD) and relative stock density (RSD) values indicate that the Brown Trout population is well balanced with natural reproduction occurring, and that a trophy fishery exists. The Rainbow Trout population also appeared balanced, although the frequency of catchable sized Rainbow Trout decreased compared to recent surveys. IDFG stopped stocking larger, catchable sized Rainbow Trout in 2012, and replaced those fish with more numerous fingerling Rainbow Trout, which may account for some of this discrepancy in fish size. Conclusions about the Yellowstone Cutthroat Trout population were limited based on the low number of fish handled, although we observed multiple year classes and what appears to be excellent body condition based on relative weights (>100). Abiotic and biotic conditions in the Osgood reach are conducive to allow for fast growth of salmonids, with stocked fingerling trout growing approximately 330 mm in one full year. Angler use was monitored with a creel survey from May 28 through the end of October, and recorded over 9,000 hours of effort with seasonal catch rates of 0.35 fish per hour. Overall, the Osgood reach of the Snake River currently supports a quality trout fishery for both native and introduced trout, and is capable of supporting increased trout densities while continuing to provide a trophy component to anglers in the Idaho Falls area.

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# INTRODUCTION

The Snake River in Bonneville County provides an important fishery within the Idaho Department of Fish and Game's Upper Snake Region, with over 45,000 angler trips in 2003 (Grunder et al. 2004). In regards to angler spending activity in Bonneville County, ID, the mainstem Snake River was second only to the South Fork Snake River, with over $8.3 million in total angler spending in 2011 (IDFG *in press*). The Snake River in Bonneville County provides anglers an unique lotic fishery with a trophy Brown Trout component near the City of Idaho Falls.

The Snake River begins at the confluence of the Henrys Fork and South Fork Snake Rivers at the Menan Buttes, and flows approximately 56 km before reaching Idaho Falls (Figure 38). The Snake River near Idaho Falls is divided into distinct segments by four hydroelectric dams operated by Idaho Falls Power, which include the Upper Power Pool Dam, City Dam, Lower Power Pool Dam, and Gem State Dam, which is near the southern boundary of IDFG's Upper Snake Region. The absence of fish ladders at these structures prohibits upstream fish passage; downstream passage likely provides the only movement between these river reaches. The inundated portions of river created by these dams limit the amount of spawning habitat available for trout through this reach.

The Snake River in Bonneville County provides a fishery for a self-sustaining population of introduced Brown Trout, *Salmo trutta*, as well as wild and stocked hatchery fingerling Rainbow Trout, *Oncorhynchus mykiss*. The river also supports a wild population of native Yellowstone Cutthroat Trout, *O. clarkii bouvieri*, as well as introduced Smallmouth Bass, *Micropterus dolomieu*, and White Sturgeon *Acipenser transmontanus*. Other native species within this reach include Mountain Whitefish *Prosopium williamsoni*, Utah Sucker *Catostomus ardens,* Speckled Dace *Rhinichthys osculus*, Redside Shiner *Richardsonius balteatus*, and unidentified Sculpin species (*Cottus* spp). Despite its importance as a regional fishery and its close proximity to Idaho Falls, little previous research has been conducted on this reach of the Snake River.

# STUDY SITE

During 2013, we sampled the Snake River near Osgood, Idaho, just downstream of the border between Bonneville and Jefferson Counties, approximately 14 km upstream of Idaho Falls (Figure 39). The Osgood reach is bounded by an irrigation diversion dam just upstream of the County Line Road Bridge that serves the Great Western and Idaho canals and the Upper Power Pool Dam hydroelectric facility on the downstream end. The reach is characterized by a riverine, braided channel complex in the upper 5.8 km, while the lower 4.5 km is deeper with lower velocity due to the impoundment created by the hydroelectric facility. Widths vary in this reach from approximately 44 m to 215 m, creating diversity in stream depths, velocity and physical habitat. Stream flows in this reach are regulated by releases from upstream dams and characterized by base flows from November through March, with increasing flows in the spring, and peak flows generally observed in mid-June during the irrigation season (Appendix G). We sampled the free-flowing, riverine section of the Osgood reach, beginning at the top of the island just downstream of the County Line Road Bridge, and extended downstream 3.2 km to an irrigation return on the west bank (Appendix H).

## OBJECTIVES

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

1. Estimate abundance, species composition and size structure of trout populations in the Osgood reach of the Snake River.
2. Obtain estimates of angler use, catch and harvest for this section of river.

## METHODS

We used a jet boat mounted electrofishing unit to capture trout during multiple mark and recapture events in the Osgood reach of the Snake River between September 16 and October 15. When flows became too low to utilize the jet boat for electrofishing we used electrofishing rafts. We sampled on September 16, 19, 20, 21, and 25, and October 3, 4, 9, and 15. We identified all captured trout to species and measured total length (mm) and weighted to the nearest gram. We marked captured fish with a hole punch in the caudal fin during all surveys with the exception of October 15 (i.e. last sampling event), and used this mark to identify previously captured fish in our subsequent sampling events.

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

$$\hat{N} = \frac{\sum_{i=2}^{t} n_i M_i}{\sum_{i=2}^{t} m_i + 1}$$

where $t$ = number of sampling occasions; $n_i$ = number of fish caught in $i$th sample; $m_i$ = number of fish with marks caught in $i$th sample; and $M_i$ = number of marked fish present in the population for $i$th sample. We portioned the overall trout abundance estimate based on the proportion of each species handled, and used FA+ (Montana Fish, Wildlife and Parks 2004) for population estimates. We calculated proportional stock density (PSD) to describe the size structure of trout populations in the Osgood reach of the Snake River using the following equation

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

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

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

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

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

$$\log W_s = -5.194 + 3.098 \log TL$$

to calculate relative weights of Rainbow Trout, and

$$\log Ws = -5.192 + 3.086 \log TL$$

to calculate relative weights for Cutthroat Trout, and

$$\log W_s = -4.867 + 2.960 \log TL$$

for Brown Trout.

Beginning in 2012, we marked all fingerling trout stocked in the Osgood reach with an adipose fin clip to determine relative survival and contribution to the fishery as well as estimate wild production and growth. We looked at the ratio of marked to unmarked juvenile (<150 mm) fish in the fall survey to determine the percentage of the rainbow population that were derived from natural reproduction. Similarly, marked fish greater than 150 mm were assumed to have originated from the 2012 stocking, and the change in length between 75mm (the size at stocking in 2012) and the size at capture is indicative of growth over a full year in the system.

We conducted a creel survey, which ran from May 25 2013 through October 30, 2013. The fishing season was stratified into two-week intervals throughout the season. Effort was estimated using aerial counts on two randomly chosen weekend days and two randomly chosen weekdays during each strata. Creel clerks interviewed anglers on two randomly chosen weekdays and two randomly chosen weekend days during each strata. Creel clerks collected information on the time anglers spent fishing, the number of anglers in the party, residency, gear type, and fish both caught and harvested. When harvested fish were encountered, clerks identified to species and measured fish for total length. Effort estimates were derived by using the day length averaged over each month multiplied by the average instantaneous count for that month and then multiplied by the total days in that month. Seasonal effort estimates were then calculated by summing monthly estimates. Catch rates and harvest rates were estimated using data collected from interviews (total fish caught (or harvested) divided by total hours fished) averaged for each month. Estimates of fish caught and harvested were derived by multiplying the effort estimates by the monthly average catch rates and harvest rates. Season totals were calculated by summing monthly estimates.

## RESULTS

We collected 395 salmonids during nine electrofishing surveys in the Osgood reach of the Snake River, and estimated 2,913 salmonids >150 mm (95% CI = 2,026 – 5,180; Appendix I) throughout the survey reach, which equates to 910 salmonids per km. Species composition was 65% Brown Trout, 9% Rainbow Trout, 1% Yellowstone Cutthroat Trout and 25% Mountain Whitefish. Although we did not collect other species during our surveys, we did observe Utah Sucker, Redside Shiner, Speckled Dace, and Sculpin (unidentified *Cottus* spp.) Brown Trout ranged from 136 mm to 705 mm, with a mean total length of 318 mm and density of 592 fish per km and YAR of 6% (Figure 39; Table 18). PSD and RSD values indicate that Brown Trout are the most balanced of the three trout populations in the Osgood reach, with PSD and RSD-400 values of 44 and 23, respectively. RSD-500 of Brown Trout was 2. The overall relative weight for all Brown Trout combined was 104. Rainbow Trout ranged in size from 103 mm to 578 mm, with a mean total length of 358 mm and a density of 82 trout per km (Figure 40) and YAR of 17%. Rainbow Trout PSD, RSD-400, and RSD-500 values were 77, 45, and 13, respectively. Relative weights for all Rainbow Trout combined were 120. Yellowstone Cutthroat Trout ranged from 236 mm to 531 mm, with a mean total length of 428 mm and a density of 9 trout per km (Table 18). Yellowstone Cutthroat Trout PSD, RSD-400, and RSD-500 values were 75, 75, and 20, respectively. The YAR calculation for Cutthroat was 0, while relative weights were estimated at 112.

Based on analysis of length frequency figures, fish less than 150 mm were likely not fully recruited to the sampling gear. Brown Trout, the most abundant trout found in this reach, appear to recruit to electrofishing techniques once they have been in the system for a year with lengths that exceed 170 mm. Based on the length frequency, we assume Brown Trout from 170 mm to 330 mm were age-1 fish.

We captured four Rainbow Trout less than 150 mm, which could have originated from fingerling trout stocked on July 31 (45 days prior to the first electrofishing survey). Of these four fish, two were adipose-fin clipped, suggesting that half of the young trout encountered were of wild origin. Similarly, of the 26 Rainbow Trout captured that were over 150 mm but less than 475 mm, six were adipose-fin clipped, suggesting that 77% of Rainbow Trout greater than 150 mm were of wild origin. We used the length cutoff of 475 mm, as we encountered marked fish up to 456 mm in length, which had would have originated from the 2012 stocking event. Assuming a mean length of 75 mm at the time of stocking in 2012 (which is the default requested size), Rainbow Trout grew an average of 330 mm during the course of the year (Table 19).

Creel clerks interviewed 70 anglers representing 6,547 fishing trips. The average fishing trip length was relatively short, at 1.5 hours, for a total effort estimate of 9,810 hours of angling effort (Table 20). Effort estimates peaked in July with nearly 3,000 hours of effort, and tapered off later in the summer and into the fall. Monthly angler catch rates varied from a low of 0 to a high of 0.8 fish per hour, with a mean catch rate of 0.35 fish per hour. Harvest rates were proportionally high, at 0.24 fish per hour, suggesting this is a harvest-oriented fishery. Rainbow Trout were the species most often caught by anglers, representing 67% of the 2,723 fish caught. Brown Trout made up 31% of all fish caught, and Cutthroat added another 2% to the catch (Table 21). No non-resident anglers were encountered during the survey.

## DISCUSSION

Trout densities in the Osgood reach have more than tripled compared to the most recent (2011) survey (Schoby,et al, 2013). The higher densities we observed in 2012 were driven primarily from increases in the Brown Trout population. Rainbow Trout and Cutthroat populations also increased in density over the past two years, although less drastically than Brown Trout. Notably, Brown Trout have increased from 150 trout per km to 592 trout per km in the current survey. Similarly, Rainbow Trout increased from 61 fish per km to 82 fish per km, while Cutthroat Trout decreased from 16 fish per km to 9 fish per km. The current survey also estimated abundances of Mountain Whitefish, and found 228 fish per km. Large Brown Trout were common in the Osgood reach, as reflected in the high RSD-500 value. The RSD-500 for Brown Trout in the Osgood reach was similar to values we typically observe in the more well-known trophy fisheries on the South Fork or Henrys Fork Snake Rivers, suggesting a trophy component of the Brown Trout fishery exists within the Osgood reach. The largest trout encountered in the current survey was a 705 mm (28") Brown Trout. Although Brown Trout YAR was lower than in 2011, successful reproduction was still occurring but likely is limited and variable from year to year. YAR values should be viewed cautiously, as sampling efficiency of smaller sized (younger) fish appears to be low. As such, YAR values may not accurately characterize the magnitude of recruitment in this reach. However, based on the limited catch of young fish in the current survey coupled by the lack of suitable spawning habitat, it is likely that the fishery is recruitment limited.

Rainbow Trout showed an improved and balanced size structure compared to the 2011 survey. The shift towards a more balanced population may be somewhat expected given the shift in hatchery stocking practices. Beginning in 2012, IDFG switched from stocking 300 mm catchable sized Rainbow Trout to stocking 75 mm fingerling trout. This was precipitated by the observed fast growth and good body condition documented in the 2011 survey of the Osgood reach. This shift in stocking should account for more size variation in the rainbow population, and result in more balanced PSD values. Although population estimates show an increase in the Rainbow Trout population, length frequency analysis indicates that the population has deviated from that documented in 2011. Most notably is a lack of captured Rainbow Trout in the 300 to 400 mm range. In 2011, we stocked catchable sized Rainbow Trout, and those were most likely well-represented in the 2011 survey. With the shift in stocking practice, we did not encounter high numbers of the larger sized rainbows. Future surveys should continue to monitor Rainbow Trout populations to see if the shift in stocking successfully replaced larger sized hatchery Rainbow Trout. Similarly, the increased YAR calculation of 17% for Rainbow Trout may have been clouded somewhat by the presence of fingerling hatchery rainbows. Evidence of this is shown by the return of adipose-clipped fish less than 150 mm, which would be the size of fish we typically stock. We marked all 10,000 fingerling Rainbow Trout with an adipose fin clip prior to release to evaluate hatchery contributions and detect differences between hatchery and wild production. Fully 50% of the Rainbow Trout less than 150 mm were adipose-clipped fish, suggesting that natural recruitment is less than that represented by the YAR of 17%. However, the clip rate of 23% for fish greater than 200 mm suggests that either wild recruitment of Rainbow Trout is variable from year to year, or that overwinter survival of catchable-sized rainbows from years past are adding to the catch. Prior research by IDFG (High and Meyer, 2009) has shown that overwinter survival of catchable sized Rainbow Trout in fluvial systems is low. The lower portion of this river reach is similar to impoundments, which have been identified as being more suitable to catchable Rainbow Trout survival. Similar to Brown Trout recruitment, wild Rainbow Trout recruitment likely varies from year to year based on environmental conditions and habitat use. The influence of environmental conditions affecting year class strength and recruitment is common in nearby waters, and has been examined in depth on the Henrys Fork, particularly Box Canyon (Garren, 2006). On the Henrys Fork, first winter survival is directly related to winter flows, with higher flows resulting in higher survival of fish spawned that previous spring. It's likely that the higher volume of water released from Island Park Dam is better able to buffer ambient temperatures in the river below, as it's more difficult to change the temperature of a larger volume of water. As such, winter water temperatures do not fluctuate as much when flows are higher compared to lower flows. As a result, more fish survive their first winter when higher flows are present during the winter. Similar flow conditions likely affect recruitment in the Osgood reach as well, and should be evaluated.

The presence of juvenile Brown Trout and Rainbow Trout indicate that reproduction is occurring in the Osgood reach, and was supported by YAR calculations that show smaller fish were represented in the population. Unlike surveys from 2011, juvenile Cutthroat Trout were absent in the current survey (Schoby, 2013). Although juvenile Brown Trout and Rainbow Trout were captured, recruitment sufficient to support optimum densities in the adult population is likely limited, based on the minimal amount of available spawning habitat observed during our fall surveys in 2011. Further, relative weights of all trout are indicative of an over-abundant food supply (or concomitantly an under-utilized food supply). Flickenger and Bulow (1993) state that relative weights around 100 are considered normal, and that values well above this show an excess of food resources are present. Based on the high relative weight values observed in the current study, sufficient food resources exist in the Osgood reach to support increased densities of trout. The lower than desirable densities of trout and under-utilized food supply have resulted in fast growth in fish length in addition to the above average relative weights. Growth was estimated using the adipose-marked fish that had been in the system for one full year. Marked fish from 2012 averaged 330 mm of growth during the course of this year, which is exceptional, and again suggests food resources were not a limiting factor at the current salmonid densities. It is likely that quality spawning habitat is limited in this reach (Schoby, 2011), or that flows are impacting spawning success or recruitment. Alternatively, other factors such as entrainment may be contributing to the lack of sufficient recruitment.

Anglers took 6,537 fishing trips to the Osgood reach in 2013. Average trip length was short compared to typical angler trips on nearby waters. Heavy use by anglers despite the low catch rates, generally below what many anglers view as desirable, suggests angler find a high value in the fishery resource in the Osgood reach. Rainbow Trout dominated anglers catch, although population surveys show that they were found in lower abundance than Brown Trout. Brown Trout comprise 87% of the trout population, yet only account for 31% of the catch. In contrast, Rainbow Trout comprised 12% of the population, but provided 67% of the angler catch. Cutthroat Trout only compromised a small slice of the population and of the angler catch (1% of the population, 2% of the angler catch). Although found in lower abundance, Rainbow Trout provide an important and significant component of the recreational fishery in the Osgood reach.

Overall, the Osgood reach of the Snake River currently provides a desirable angling experience that is being utilized by resident anglers. The quality fishery and trophy component of the trout fishery in the Osgood reach and adjacent river reaches attracts large numbers of anglers, whose fishing-related spending then enhances the local economy. Although the existing fish densities are lower than in other nearby waters, it's likely that densities, particularly for wild-produced fish, can be improved with better flow management where possible, or through habitat improvements that result in increased recruitment. The shift in stocking practices towards a fingerling stocking of Rainbow Trout may have resulted in improvements to that component of the fishery as well. Additional research should focus on identifying the environmental variables responsible for variations in year class success. This information should then be used to improve in-stream conditions as possible.

## MANAGEMENT RECOMMENDATIONS

1. Continue to stock fingerling trout in this reach. Mark all fingerlings and continue to evaluate survival, growth and return to creel.

2. Continue periodic evaluation of the sport fish populations in this reach. Use results found here in management decisions for adjacent waters to improve those waters as well.

3. Consider increasing stocking rates and monitor relative weights of fish in future surveys. Use relative weights to evaluate stocking rates and adjust as necessary.

4. Collect subsample of trout for age and growth analysis; determine the first fully recruited age class for the sampling gear used

5. Determine factors that affect wild trout recruitment and implement methods to improve the recreational fishery.

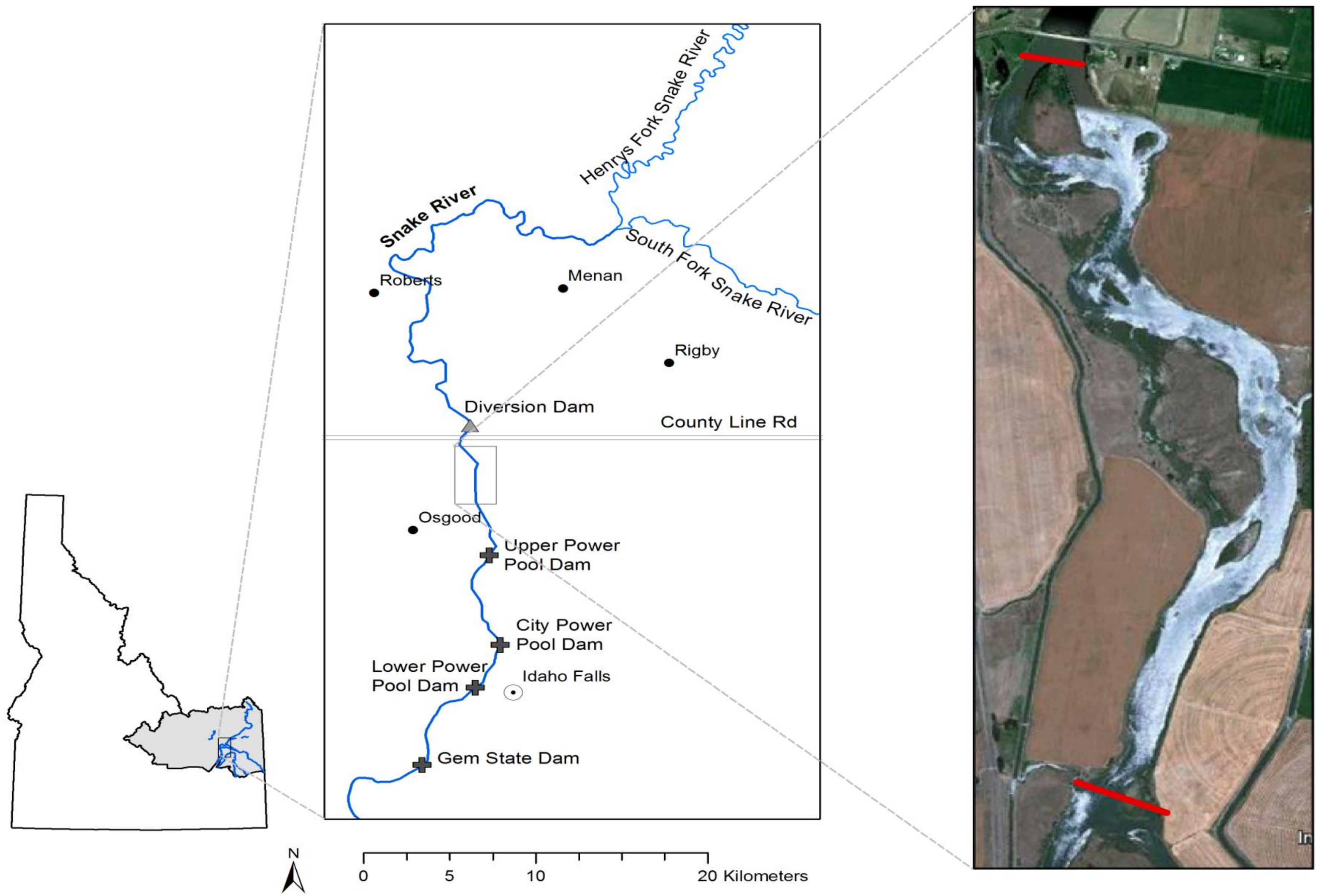



Figure 38. Map of the Snake River near Idaho Falls (middle pane) and the 2013 Osgood reach electrofishing site (right pane), with reach boundaries marked by the solid red line.

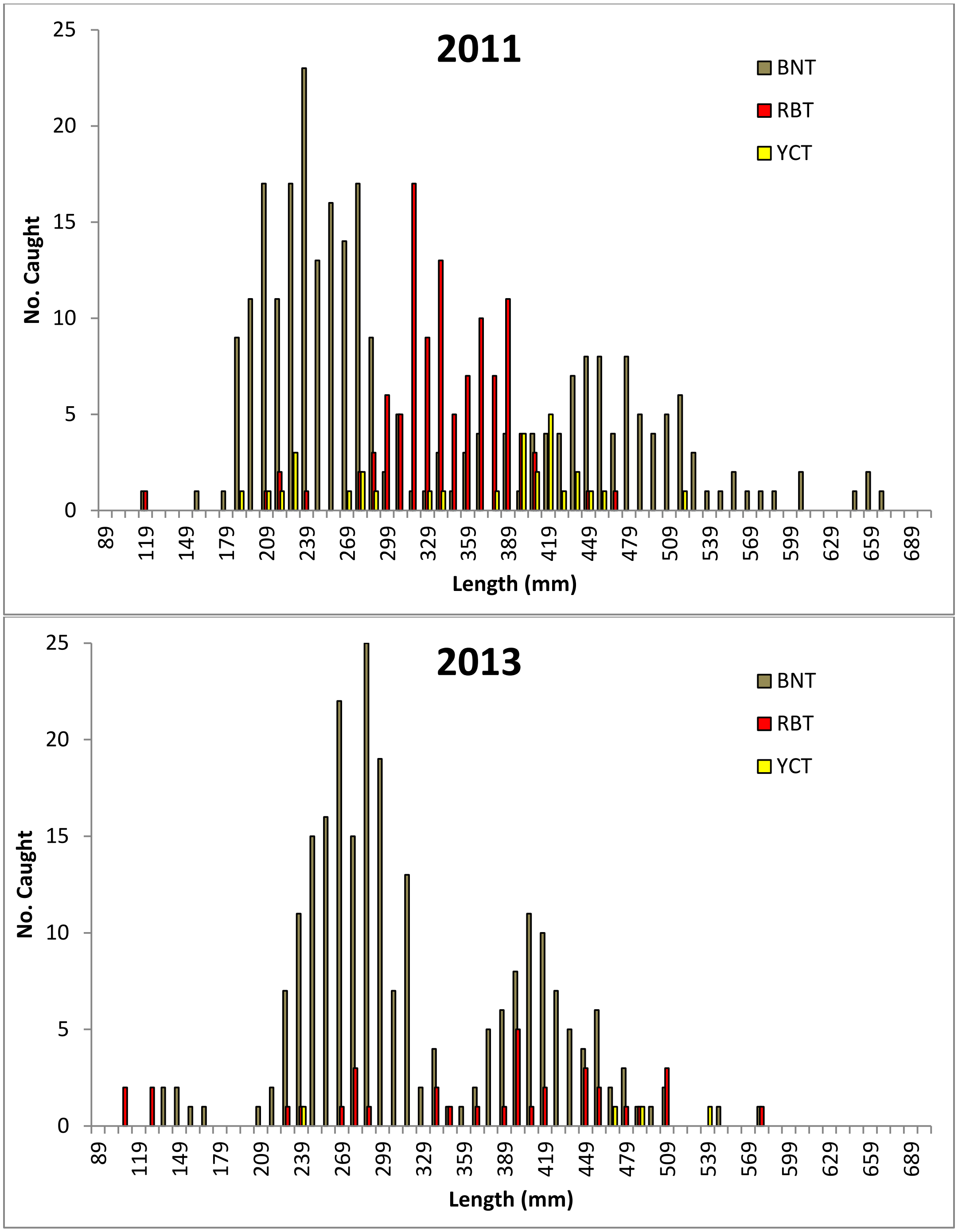



Figure 39. Length frequency distribution of Brown Trout (brown color), Rainbow Trout (red color), and Yellowstone Cutthroat Trout (yellow color) collected by electrofishing in the Osgood reach of the Snake River, Idaho, 2011 and 2013.

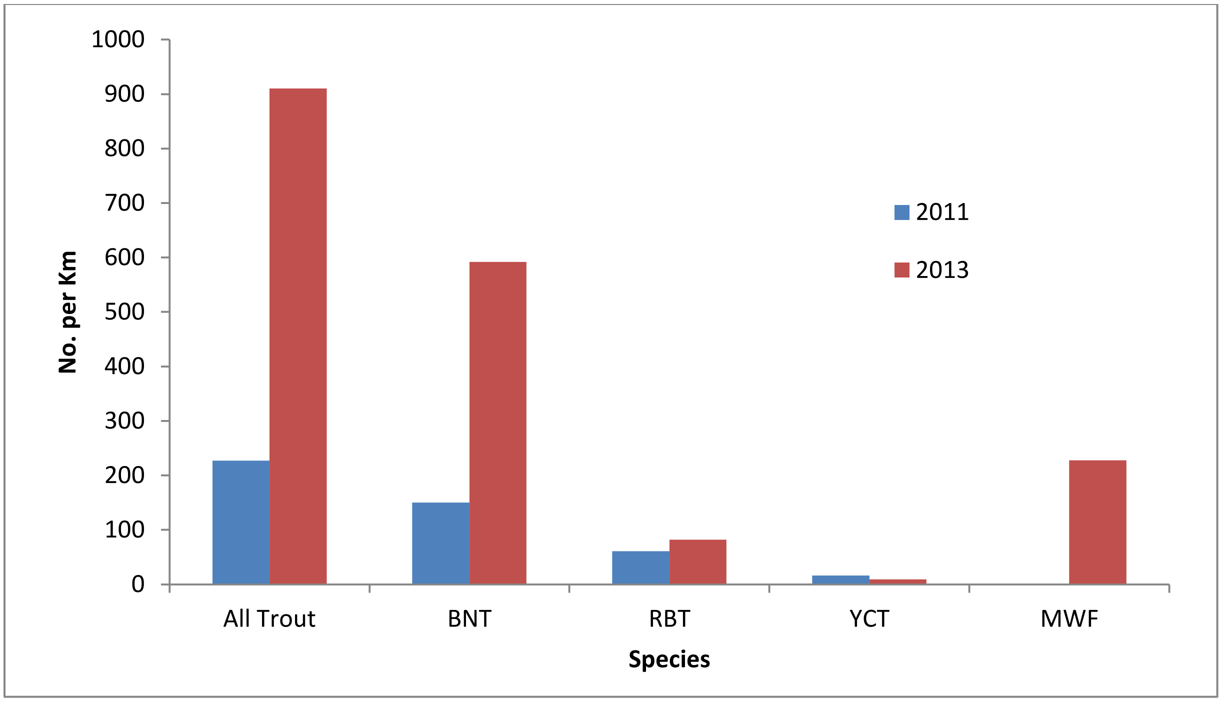



Figure 40. Trout abundance estimates (fish per km) from the Snake River at Osgood, 2011 and 2013.

Table 18. Trout population index summaries for the Snake River, Idaho 2013.

| Species | Mean Length (mm) | Median Length (mm) | Minimum Length (mm) | Maximum Length (mm) | PSD | RSD-400 | RSD-500 | YAR (%) | Density (No./km) |
|---|---|---|---|---|---|---|---|---|---|
| Brown Trout | 318 | 290 | 136 | 705 | 44 | 23 | 2 | 6 | 592 |
| Rainbow Trout | 358 | 394 | 103 | 578 | 77 | 45 | 13 | 17 | 82 |
| Yellowstone Cutthroat Trout | 428 | 473 | 236 | 531 | 75 | 75 | 25 | 0 | 9 |

Table 19. Length statistics for marked Rainbow Trout recaptured approximately one year after stocking in the Osgood reach of the Henrys Fork in 2013.

| | Size at Stocking (mean) | Mean Size at Recapture | Min Length at Recapture | Max Length at Recapture |
|---|---|---|---|---|
| RBT | 75 mm | 401 mm | 339 mm | 456 mm |

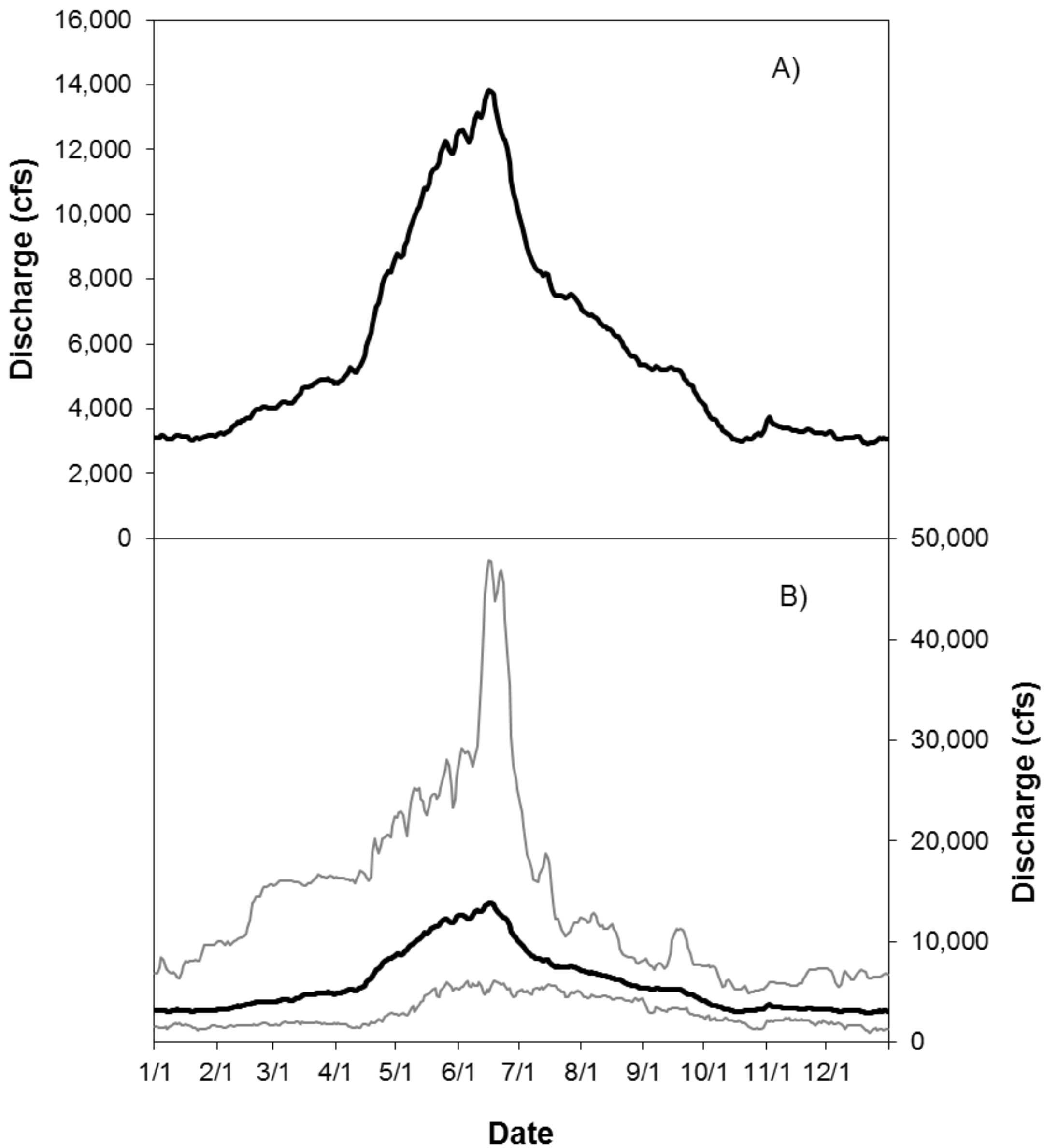
Table 20. Angler effort on the Osgood reach of the Snake River, 2013.

| | Average Instantaneous Count | Day Length (Hours) | No. of Days in Month | Effort (Hours) |
|---|---|---|---|---|
| May | 2 | 14.5 | 31 | 899 |
| June | 5 | 15.2 | 30 | 2280 |
| July | 6 | 14.8 | 31 | 2753 |
| Aug | 5 | 13.8 | 31 | 2139 |
| Sept | 1 | 12.5 | 30 | 375 |
| Oct | 4 | 11 | 31 | 1364 |
| Total | | | | 9810 |

Table 21. Angler catch statistics for the Osgood reach of the Snake River, 2013.

| | RBT | | | BNT | | | YCT | | |
|---|---|---|---|---|---|---|---|---|---|
| | Released | Harvested | Total | Released | Harvested | Total | Released | Harvested | Total |
| May | 90 | 602 | 692 | 0 | 0 | 0 | 0 | 0 | 0 |
| June | 0 | 0 | 0 | 524 | 0 | 524 | 0 | 0 | 0 |
| July | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| August | 171 | 214 | 385 | 257 | 0 | 257 | 0 | 0 | 0 |
| Sept | 0 | 23 | 23 | 41 | 0 | 41 | 23 | 0 | 23 |
| October | 41 | 682 | 723 | 0 | 27 | 27 | 27 | 0 | 27 |
| Total | 302 | 1521 | 1823 | 822 | 27 | 850 | 50 | 0 | 50 |

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



Appendix H. Locations (UTM) used in population surveys of the Snake River near Osgood, Idaho 2013. All locations used NAD-27 and are in Zone 12.

| | Easting | Northing |
|---|---|---|
| Start | 413889 | 4830842 |
| Stop | 414530 | 4828032 |

Appendix I. Mark-recapture data of Brown Trout (BNT), Rainbow Trout (RBT), and Yellowstone Cutthroat Trout (YCT) from electrofishing surveys of the Osgood Reach of the Snake River during 2013.

| | Number Caught (Ct) | | | | Number Recaptures (Rt) | | | | Marked Fish at Large - minus mortalities (Mt) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | BNT | RBT | YCT | MWF | BNT | RBT | YCT | MWF | BNT | RBT | YCT | MWF |
| **9/16/2013** | 7 | 2 | 0 | 6 | 0 | 0 | 0 | 0 | 7 | 2 | 0 | 4 |
| **9/19/2013** | 16 | 3 | 0 | 15 | 0 | 0 | 0 | 0 | 22 | 3 | 0 | 13 |
| **9/20/2013** | 42 | 8 | 2 | 12 | 1 | 0 | 0 | 0 | 63 | 11 | 2 | 25 |
| **9/21/2013** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 64 | 11 | 2 | 25 |
| **9/25/2013** | 9 | 4 | 0 | 17 | 0 | 0 | 0 | 0 | 73 | 13 | 2 | 31 |
| **10/3/2013** | 56 | 6 | 1 | 19 | 5 | 1 | 0 | 1 | 121 | 18 | 3 | 43 |
| **10/4/2013** | 32 | 4 | 0 | 2 | 0 | 1 | 0 | 0 | 153 | 21 | 3 | 45 |
| **10/9/2013** | 54 | 6 | 1 | 27 | 4 | 0 | 0 | 3 | 203 | 27 | 4 | 68 |
| **10/15/2013** | 26 | 2 | 0 | 15 | 1 | 0 | 0 | 1 | 228 | 29 | 4 | 82 |
| Sum | 243 | 35 | 4 | 113 | 11 | 2 | 0 | 5 | | | | |

## TETON RIVER

## ABSTRACT

The Teton River supports an important population of native Yellowstone Cutthroat Trout (YCT). Since trout abundance monitoring began in the 1980s, YCT experienced a declining trend through the early 2000's and have increased in abundance since that time. Rainbow Trout and Brook Trout have also been increasing in abundance particularly at the Nickerson monitoring reach where they had statistically significant positive intrinsic rates of population growth. Despite abundant non-native competitors, YCT continue to increase in abundance at both of the monitoring reaches. Total trout densities are at all-time highs in the Teton River with 1,462 trout/km at the Nickerson reach (nearly 300 trout/km more than the previous record) and 1,858 trout/km at the Breckenridge reach which was more than double the previous record high. We sampled a new reach of the Teton River in 2013 downstream from the Harrops Bridge access site. Total trout densities in this new site were also high at 1,571 trout/km, but the species composition was dominated by RBT (97%). The trend of decreasing YCT in the species composition and increasing RBT moving downstream in the Valley section of the Teton River from the Nickerson monitoring reach was even further evident with the addition of the Harrops reach.

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Regional Fisheries Manager

## INTRODUCTION

The Teton River, a tributary of the Henrys Fork Snake River in Eastern Idaho, supports a robust population of wild trout including an important population of native Yellowstone Cutthroat Trout (YCT). Other trout present in the Teton River include Rainbow Trout (RBT), Brook Trout (BKT), and Brown Trout (BNT). Since 1987, two reaches in the upper Teton River have been routinely sampled to monitor fish population trends. This report summarizes the 2013 Teton River population monitoring. For a broader description of the Teton River fish assemblage and factors contributing to observed trends in abundance and species composition see Schoby et al. (2013).

## OBJECTIVES

1. Determine if management actions in the Teton River drainage have resulted in increased abundances of YCT in the Teton River.
2. Determine if fish abundance and species composition downstream of Harrops Bridge is similar to the monitoring reaches upstream in the Teton River.

## METHODS

We estimated trout abundances by species at the Nickerson (Figure 41) and Breckenridge (Figure 42) monitoring reaches of the Teton River during the fall when river flows reached base levels. We also surveyed a new reach of the Teton River downstream of Harrops Bridge which we will refer to as the Harrops reach (Figure 43 and 44). We sampled the Nickerson monitoring reach September 3 and 9, the Breckenridge monitoring reach September 5 and 10, and the Harrops reach September 5 and 11. Sampling and abundance estimation techniques are described in Schoby et al. (2013). We assessed population trends at the monitoring reaches using an exponential model and the intrinsic rate of population change (r) as explained by Maxell (1999) using $\alpha=0.10$ to have more power to assess trends in abundance for these populations (Peterman 1990).

## RESULTS

We captured 1,701 trout at the Nickerson monitoring reach, including 299 YCT, 402 RBT, and 1,000 BKT. Our abundance estimates include YCT and RBT ≥100 mm, and BKT ≥150 mm. We estimated densities and 95% confidence intervals at 335 (±83) YCT per kilometer, 540 (±154) RBT per kilometer, and 833 (±148) BKT per kilometer in the Nickerson monitoring reach (Table 22; Figure 45). The total trout density estimate was 1,462 trout/km, which is more than 300 fish/km greater than the previous recorded high. Density estimates for YCT for the duration of the available dataset (1987 through 2013) have exhibited a U-shaped trend with a slightly negative intrinsic rate of change ($r = -0.03$) which was not statistically significant ($F=0.60$, $df=11$, $P=0.457$). Since harvest regulations changed from two YCT over 406 mm to catch-and-release in 2006, YCT have exhibited a positive and increasing trend in abundance ($r = 0.29$), but this trend was also not statistically significant ($F=4.97$, $df=3$, $P=0.156$).

Abundances of RBT and BKT in the Nickerson reach had similar trends for both the entire data set, and since regulations changed in 2006 for YCT with slightly positive and statistically significant increasing trends in abundance since 1991. Their trends since harvest regulations changed for YCT in 2006 were also positive, but were not statistically significant (Table 23; Figure 46).

We captured 1,683 trout at the Breckenridge monitoring reach, including 69 YCT, 1,326 RBT, 281 BKT, and seven Brown Trout. Our abundance estimates include YCT and RBT ≥100 mm, and BKT ≥150 mm. We estimated densities and 95% confidence intervals for YCT at 29 (±15) fish/km, 1,488 (±188) RBT per kilometer, and 415 (±181) BKT per kilometer (Table 23; Figure 47). The total trout estimate at Breckenridge was 1,858 trout/km which was more than double the previously recorded high for this reach. We could not estimate Brown Trout abundance due to low capture numbers of these trout. Density estimates for YCT at the Breckenridge monitoring reach from 1987 through 2013 have exhibited a slightly negative overall trend and a strongly positive trend since regulation changes were implemented in 2006. However, neither trend was statistically significant at the $\alpha$ = 0.10 level (Table 24). Rainbow Trout and BKT had positive values of intrinsic rates of change for both the 1987 through 2013 time frame and since 2006 (Figure 48). The post-2006 increasing trend in abundance for BKT was the only statistically significant trend observed for RBT and BKT ($r$=0.32; F=119.29, df=2, P=0.058).

Rainbow Trout were the dominant species observed in the Harrops reach, but YCT, BKT, and Brown Trout were also present. We captured a total of 1,953 fish including 12 YCT, 1,891 RBT, 47 BKT, and three Brown Trout. We estimated the abundance of trout with corresponding 95% confidence intervals at 4 YCT/km (±2), 1,568 RBT/km (±135), 113 BKT/km (±6). The total trout estimate in the Harrops reach was 1,571 trout/km. The species composition at the Harrops reach was 97% RBT, 2% BKT, 1% YCT, and 0.2% BNT.

## DISCUSSION

Trout populations are currently at or near all-time high densities in the Nickerson monitoring reach of the Teton River. The abundance of YCT is only slightly below the all-time high set in 1994 (379 YCT/km), while RBT and BKT densities are at all-time highs. YCT abundance declined precipitously from 1987 through 2003, but has recovered to levels similar to the mid-1980s. We could also not detect a significant increase in YCT since catch-and-release harvest regulations were implemented on the Teton River for YCT in 2006, but the interpretation of these results is confounded by a number of factors. First, the sample size available for testing the effect of catch-and-release regulations on YCT was small, and with a P-value close to a level deemed significant. It is likely that our ability to detect a significant trend will increase as we continue to monitor this population in coming years. Indeed, the addition of one additional fictional data point (in this exercise, we used the value from the 2007 estimate) to the existing dataset yielded a significant result. Thus, increasing sample size by continuing monitoring efforts will increase our statistical power. While catch-and-release regulations are known to affect fish populations (Thurow and Bjornn 1978; Anderson and Nehring 1984), habitat alterations (Moore and Gregory 1988; Riley and Fausch 2011), stream flows (Van Kirk and Jenkins 2005), and increased harvest pressure due to stocking hatchery fish (Petrosky and Bjornn 1988) also affect fish abundances. Several restoration projects along the Teton River and its tributaries have taken place over the past couple decades and likely positively affect the abundance of a fluvial species such as YCT (Schrader and Jones 2004) as well as nonnative trout abundance. The suite of confounding factors make teasing out the specific effect of catch-and-release regulations difficult. In general, trout anglers in eastern Idaho primarily practice catch and release, even in waters where harvest opportunities are available and sometimes encouraged (Schoby et al. 2013). Despite the limited effect of catch and release rules on shaping populations when anglers voluntarily release fish, catch-and-release regulations are valuable from a conservation and education standpoint. Restrictive regulations, including catch-and-release, highlight the emphasis that IDFG places on YCT management in the Teton River and raises awareness of the importance of YCT in their native habitat while still allowing anglers to enjoy pursuing YCT recreationally.

Abundances of Rainbow Trout and Brook Trout have increased at Nickerson over the last two plus decades. While the abundance of YCT has certainly increased since reaching the lowest observed densities in 2003 and appears to continue to be increasing, the long-term trend for YCT is unlike that for RBT and BKT at the same reach. Throughout the course of the dataset, RBT and BKT have experienced a significantly increasing trend in abundance. Habitat improvement projects, fish passage improvement projects, fish screens at major irrigation diversion points, restrictive harvest regulations, and favorable environmental factors are the likely reasons for the increasing trout abundance. Favorable (higher) stream flows in 2011 and 2012 are likely the reasons why record trout numbers were observed this year. Many of the major tributaries of the Teton River in Teton Valley are seasonally disconnected due to natural hydrography and irrigation diversion (Van Kirk and Jenkins 2005). With high water years like 2011, tributary streams are connected later into the summer season resulting in better connectivity for adult YCT to complete their spawning migrations and for YCT fry to out migrate to the main river. Furthermore, increased tributary flows results in increased productivity as more habitat becomes available and water temperatures are more favorable for all trout species (Bjornn 1971). The continued increase of nonnative trout abundance through various environmental and harvest pressure conditions suggests YCT will continue to face threats to their long-term persistence despite having rebounded to levels observed prior to their decline.

A recent high water year appears to have positively influenced trout population abundances in the Teton River. For reasons explained above, high water years have the potential to increase trout populations through high recruitment rates. This becomes evident once that year class becomes fully recruited to sampling gear. In 2013, we observed a strong year class for both RBT and BKT at both the Nickerson and Breckenridge monitoring reaches, while no such strong year class was detected for YCT. This does not necessarily mean that YCT recruitment was not good in 2011, rather it could result from young YCT continuing to rear in tributaries (Gresswell et al. 1994), and thus would not be present during our fall population surveys. Future surveys will help determine the effect of the 2011 water year on YCT, while we know that it positively impacted RBT and BKT in the Teton River.

The trend of decreasing abundances of YCT and increasing abundances of RBT as surveys progress downstream in the Teton Valley continued with an additional reach survey in 2013. This was the first time the Harrops reach (located in the lowest portion of the Valley) has been sampled. Just as YCT comprised less of the total catch in Breckenridge than Nickerson, YCT further comprised less of the total catch at the Harrops reach. Despite RBT increasing in dominance as you progress from the headwaters down to the Harrops reach in the upper river, this trend does not continue downstream into the middle (Canyon) or lower (Rexburg) river sections. YCT in the Teton River drainage seem to be separated into three metapopulations (Schrader and Jones 2004). The boundary between the metapopulation in the middle stretch of the drainage (Teton Canyon) and the upper river where the Nickerson, Breckenridge, and Harrops electrofishing sites are located is approximately 4.9 river miles downstream of the

Harrops electrofishing site at Felt Dam. Despite the proximity, the species composition in Teton Canyon is much different than that at Harrops, with roughly 80% YCT and 20% RBT in Teton Canyon (Schoby et al. 2013). Habitat conditions and flows are different between the metapopulations. In Teton Canyon (the middle portion of the drainage) most of the trout spawn in tributaries, particularly Bitch Creek (Schrader and Jones 2004) which is a large unaltered tributary draining the western slope of the Teton Range. It's a snowmelt driven system with highly variable spring flows. As such, the middle Teton section is dominated by a more natural hydrograph. Trout in the upper river (Teton Valley), also spawn in tributaries (Schrader and Jones 2004), but these tributaries are very similar to spring creeks with moderated spring flows, higher and more consistent summer flows, and moderated, consistent temperature regimes. These conditions are related to the hydrography of these seasonally connected streams as well as irrigation practices which both result in flows returning to the surface near the river (Van Kirk and Jenkins 2005) where most of the trout spawn (Schrader and Jones 2004). The spring creek type conditions in upper river spawning tributaries favor RBT production, while snowmelt driven systems similar to Bitch Creek favor YCT production (Moller and Van Kirk 2003; Van Kirk and Jenkins 2005). The relationship between flow regimes and species composition is strong and unregulated spring flows appear to be of considerable importance for maintaining YCT dominance in Teton Canyon and further downstream.

In summary, trout populations are at all-time highs in the Teton River in Teton Valley and Yellowstone Cutthroat Trout abundances are slowly increasing. The Rainbow Trout and Brook Trout populations, however, are also increasing and continue to pose threats to the persistence of YCT through hybridization and competition (Allendorf and Leary 1988; Hitt et al. 2003; Gunnell et al. 2008; Mulfeld et al. 2009; Seiler and Keeley 2007a; Seiler and Keeley 2007b).

Table 22. Electrofishing results from the Nickerson reach of the Teton River from 1987 through 2013.

| | Yellowstone cutthroat trout | | | | | | | Rainbow trout | | | | | | | Brook 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 | BKT/Km | SD | CV | M | C | R | R/C | trout/Km | SD | CV |
| 1987 | 145 | 177 | 15 | 0.08 | 319 | 97.1 | 0.16 | 25 | 15 | 1 | 0.07 | | | | 140 | 102 | 3 | 0.03 | | | | 310 | 294 | 19 | 0.06 | 859 | 207 | 0.12 |
| 1988 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1989 | 40 | | | | | | | 10 | | | | | | | 60 | | | | | | | 110 | | | | | | |
| 1990 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1991 | 90 | 96 | 8 | 0.1 | 281 | 136 | 0.25 | 47 | 39 | 6 | 0.2 | 55 | 28 | 0.26 | 63 | 65 | 4 | 0.1 | 120 | 88 | 0.37 | 200 | 200 | 18 | 0.09 | 496 | 110 | 0.11 |
| 1992 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1993 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1994 | 276 | 196 | 32 | 0.2 | 379 | 83 | 0.11 | 104 | 59 | 12 | 0.2 | 92 | 33 | 0.18 | 120 | 93 | 13 | 0.1 | 146 | 54 | 0.19 | 501 | 348 | 57 | 0.16 | 629 | 72 | 0.06 |
| 1995 | 241 | 165 | 54 | 0.3 | 140 | 17 | 0.06 | 23 | 4 | 1 | 0.3 | | | | 58 | 15 | 1 | 0.1 | | | | 322 | 184 | 56 | 0.30 | 210 | 24 | 0.06 |
| 1996 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1997 | 70 | 122 | 26 | 0.2 | 83 | 19 | 0.12 | 12 | 12 | 3 | 0.3 | | | | 48 | 29 | 4 | 0.1 | 44 | 30 | 0.35 | 130 | 163 | 33 | 0.2 | 172 | 32 | 0.10 |
| 1998 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1999 | 121 | 98 | 31 | 0.3 | 111 | 23 | 0.11 | 24 | 19 | 5 | 0.3 | 14 | 8 | 0.28 | 75 | 43 | 7 | 0.2 | 86 | 50 | 0.30 | 220 | 160 | 43 | 0.3 | 195 | 24 | 0.06 |
| 2000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2001 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2002 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2003 | 25 | 18 | 8 | 0.4 | 9 | 3 | 0.19 | 104 | 110 | 29 | 0.3 | 87 | 14 | 0.08 | 193 | 169 | 37 | 0.2 | 165 | 33 | 0.10 | 322 | 297 | 74 | 0.25 | 271 | 29 | 0.05 |
| 2004 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2005 | 24 | 61 | 5 | 0.1 | 44 | 27 | 0.31 | 107 | 145 | 21 | 0.1 | 161 | 29 | 0.09 | 150 | 191 | 32 | 0.2 | 152 | 30 | 0.10 | 282 | 397 | 58 | 0.1 | 338 | 36 | 0.05 |
| 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2007 | 64 | 73 | 18 | 0.2 | 43 | 14 | 0.16 | 212 | 150 | 41 | 0.3 | 155 | 22 | 0.07 | 382 | 236 | 33 | 0.1 | 460 | 135 | 0.15 | 662 | 460 | 93 | 0.20 | 691 | 80 | 0.06 |
| 2008 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2009 | 128 | 169 | 23 | 0.1 | 228 | 49 | 0.11 | 120 | 97 | 16 | 0.2 | 360 | 156 | 0.22 | 272 | 165 | 18 | 0.1 | 411 | 164 | 0.20 | 533 | 444 | 57 | 0.13 | 1,171 | 169 | 0.07 |
| 2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2011 | 116 | 156 | 24 | 0.2 | 165 | 30 | 0.09 | 61 | 81 | 9 | 0.1 | 87 | 44 | 0.26 | 209 | 227 | 24 | 0.1 | 330 | 112 | 0.17 | 386 | 465 | 57 | 0.12 | 764 | 84 | 0.06 |
| 2012 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2013 | 141 | 178 | 25 | 0.1 | 335 | 83 | 0.13 | 178 | 216 | 21 | 0.1 | 540 | 154 | 0.15 | 391 | 630 | 63 | 0.1 | 833 | 148 | 0.09 | 710 | 1,043 | 109 | 0.10 | 1,462 | 119 | 0.04 |

Table 23. Electrofishing results from the Breckenridge reach of the Teton River from 1987 through 2013.

| | Yellowstone cutthroat trout | | | | | | | Rainbow trout | | | | | | | Brook 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 | BKT/Km | SD | CV | M | C | R | R/C | trout/Km | SD | CV |
| 1987 | 41 | 29 | 4 | 0 | 50 | 34.4 | 0.35 | 214 | 94 | 6 | 0.06 | 433 | 282 | 0.33 | 51 | 13 | 0 | 0 | | | | 306 | 136 | 10 | 0.07 | 718 | 276 | 0.2 |
| 1988 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1989 | | | | | | | | 5 | | | | | | | 2 | | | | | | | 7 | | | | | | |
| 1990 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1991 | 5 | | | | | | | 12 | | | | | | | 1 | | | | | | | 18 | | | | | | |
| 1992 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1993 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1994 | 63 | 56 | 25 | 0 | 43 | 14 | 0 | 268 | 181 | 57 | 0.3 | 209 | 26 | 0.06 | 20 | 9 | 2 | 0.2 | | | | 351 | 246 | 84 | 0.34 | 273 | 28 | 0.05 |
| 1995 | 78 | 37 | 12 | 0 | 48 | 17 | 0 | 77 | 41 | 7 | 0.2 | 71 | 37 | 0.26 | 32 | 15 | 3 | 0.2 | | | | 187 | 93 | 22 | 0.24 | 152 | 34 | 0.12 |
| 1996 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1997 | 50 | 36 | 9 | 0 | 41 | 15 | 0 | 30 | 38 | 4 | 0.1 | 42 | 28 | 0.35 | 76 | 48 | 7 | 0.1 | 123 | 61 | 0.25 | 156 | 122 | 20 | 0.2 | 277 | 54 | 0.10 |
| 1998 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1999 | 66 | 58 | 17 | 0 | 64 | 17 | 0 | 55 | 41 | 6 | 0.1 | 99 | 50 | 0.26 | 29 | 17 | 2 | 0.1 | | | | 150 | 116 | 25 | 0.2 | 191 | 38 | 0.10 |
| 2000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2001 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2002 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2003 | 11 | 7 | 5 | 1 | 3 | 1 | 0 | 234 | 149 | 39 | 0.3 | 287 | 54 | 0.10 | 9 | 22 | 6 | 0.3 | 7 | 2 | 0.17 | 254 | 178 | 50 | 0.28 | 278 | 43 | 0.08 |
| 2004 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2005 | 25 | 12 | 5 | 0 | 11 | 5 | 0 | 136 | 137 | 13 | 0.1 | 485 | 183 | 0.19 | 15 | 8 | 1 | 0.1 | | | | 176 | 157 | 19 | 0.1 | 483 | 137 | 0.14 |
| 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2007 | 19 | 22 | 9 | 0 | 9 | 3 | 0 | 394 | 335 | 88 | 0.3 | 379 | 43 | 0.06 | 59 | 25 | 4 | 0.2 | 63 | 44 | 0.35 | 472 | 382 | 101 | 0.26 | 478 | 54 | 0.06 |
| 2008 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2009 | 38 | 26 | 11 | 0 | 18 | 6 | 0 | 240 | 245 | 45 | 0.2 | 285 | 36 | 0.06 | 60 | 48 | 5 | 0.1 | 101 | 67 | 0.34 | 339 | 319 | 61 | 0.19 | 477 | 61 | 0.06 |
| 2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2011 | 1 | 34 | 1 | 0 | | | | 93 | 132 | 7 | 0.1 | 372 | 161 | 0.22 | 52 | 31 | 2 | 0.1 | | | | 148 | 198 | 10 | 0.05 | 617 | 197 | 0.16 |
| 2012 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2013 | 43 | 35 | 11 | 0 | 29 | 15 | 0.26 | 616 | 781 | 74 | 0.1 | 1,486 | 188 | 0.06 | 113 | 151 | 12 | 0.1 | 415 | 181 | 0.22 | 787 | 985 | 97 | 0.10 | 1,858 | 193 | 0.05 |

Table 24. Linear regression results testing for significance in intrinsic rates of population change (r) at the α = 0.10 level for Yellowstone Cutthroat Trout (YCT), Rainbow Trout (RBT), and Brook Trout (BKT) at the Nickerson and Breckenridge reaches for two time frames, 1987 through 2013 and 2006 through 2013.

| | | **1987 - 2013** | | | | **2006 - 2013** | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Reach** | **Species** | ***r*** | **F** | **df** | **P** | ***r*** | **F** | **df** | **P** |
| Nickerson | YCT | -0.03 | 0.59 | 11 | 0.457 | 0.29 | 4.97 | 3 | 0.156 |
| Nickerson | RBT | **0.09** | **4.97** | **8** | **0.061** | 0.12 | 0.31 | 3 | 0.633 |
| Nickerson | BKT | **0.09** | **13.63** | **9** | **0.006** | 0.08 | 0.70 | 3 | 0.491 |
| Breckenridge | YCT | -0.06 | 2.88 | 9 | 0.128 | 0.18 | 13.36 | 2 | 0.17 |
| Breckenridge | RBT | 0.06 | 3.32 | 10 | 0.102 | 0.22 | 2.66 | 3 | 0.244 |
| Breckenridge | BKT | 0.10 | 0.64 | 4 | 0.482 | **0.32** | **119.29** | **2** | **0.058** |

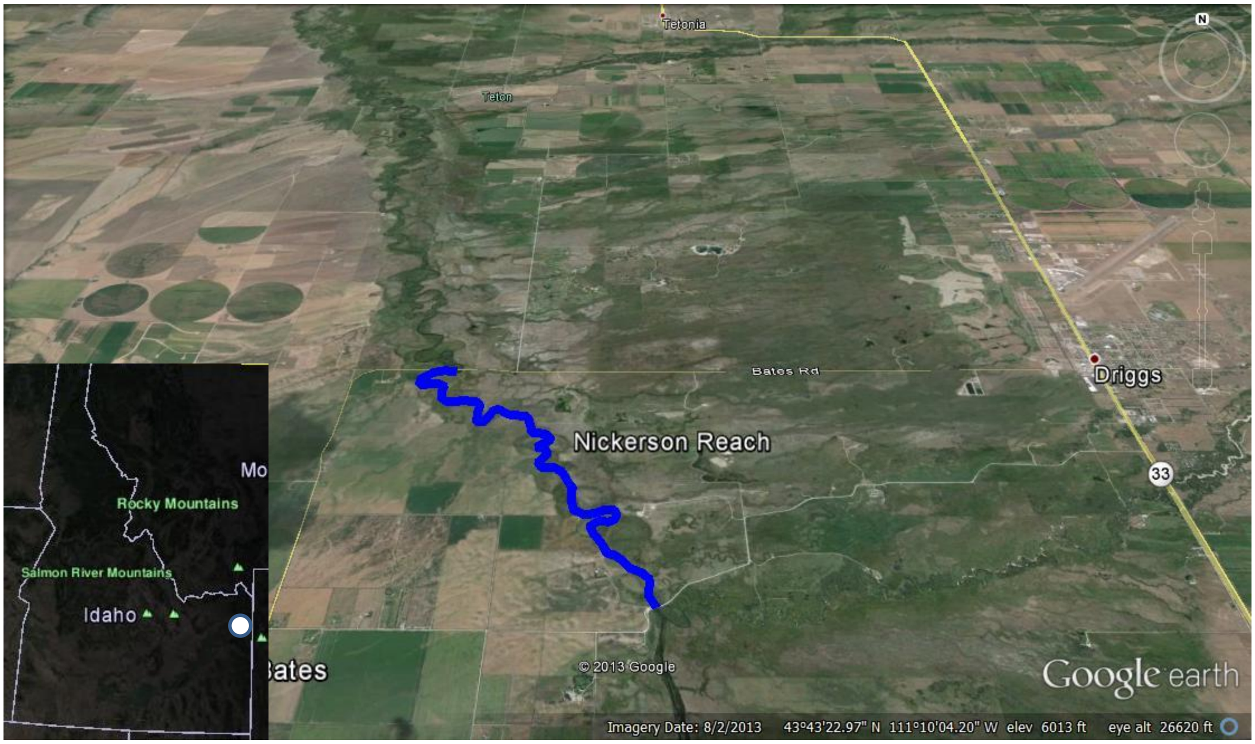


Figure 41. Map of the Nickerson monitoring reach in Teton Valley.

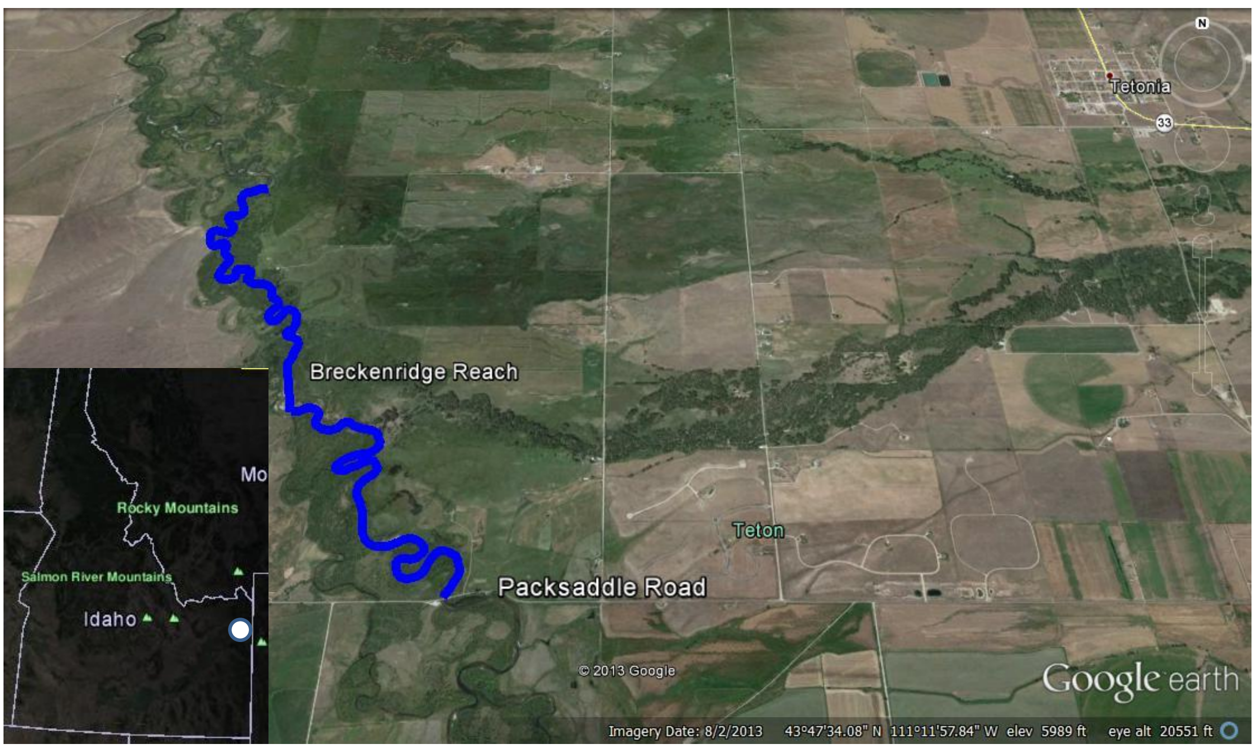


Figure 42. Map of the Breckenridge monitoring reach in Teton Valley.

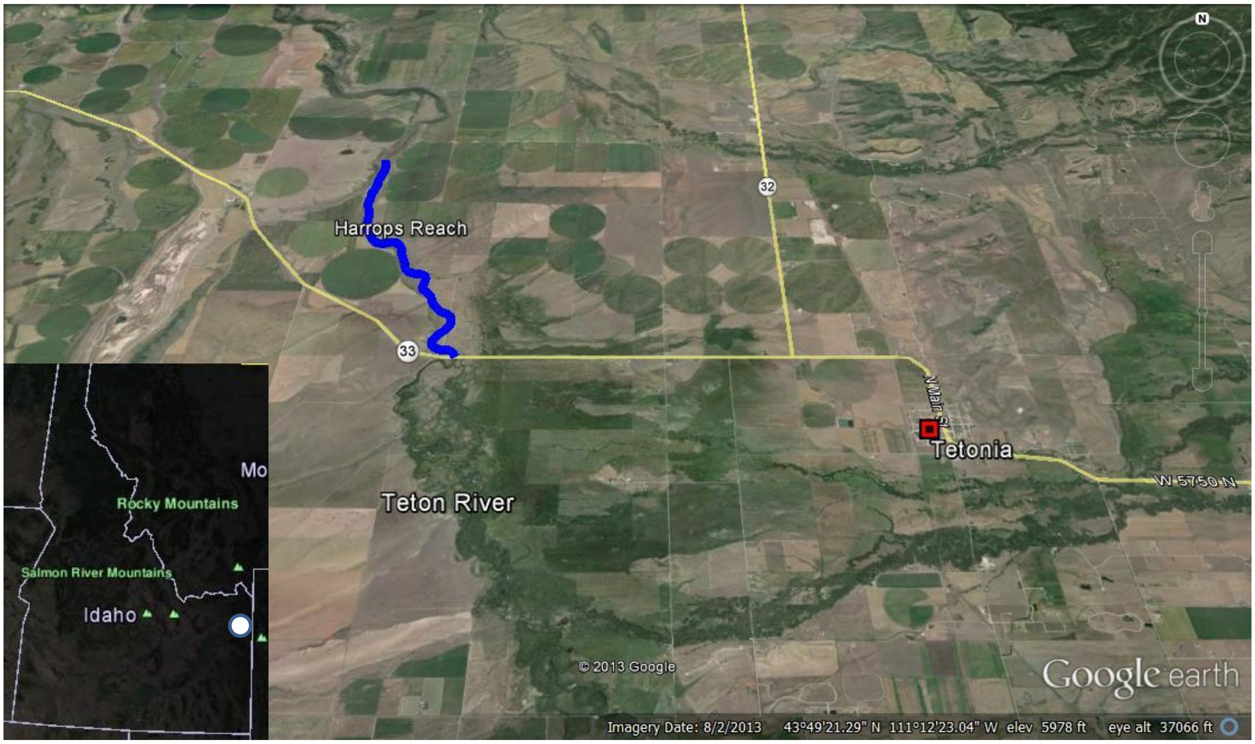


Figure 43. Map of the Harrops reach in Teton Valley.

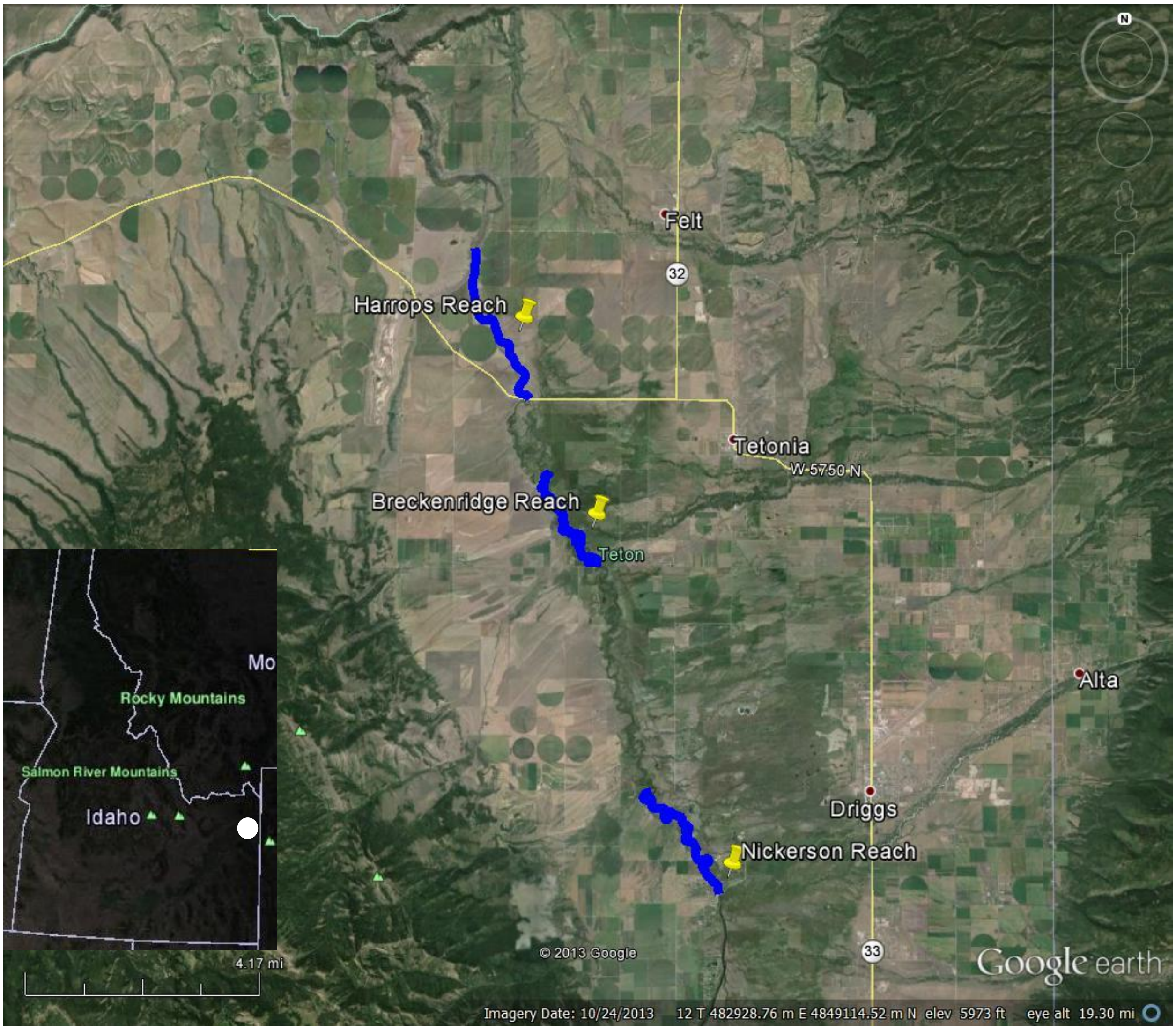


Figure 44. Map of the Nickerson, Breckenridge and Harrops electrofishing reaches in Teton Valley.

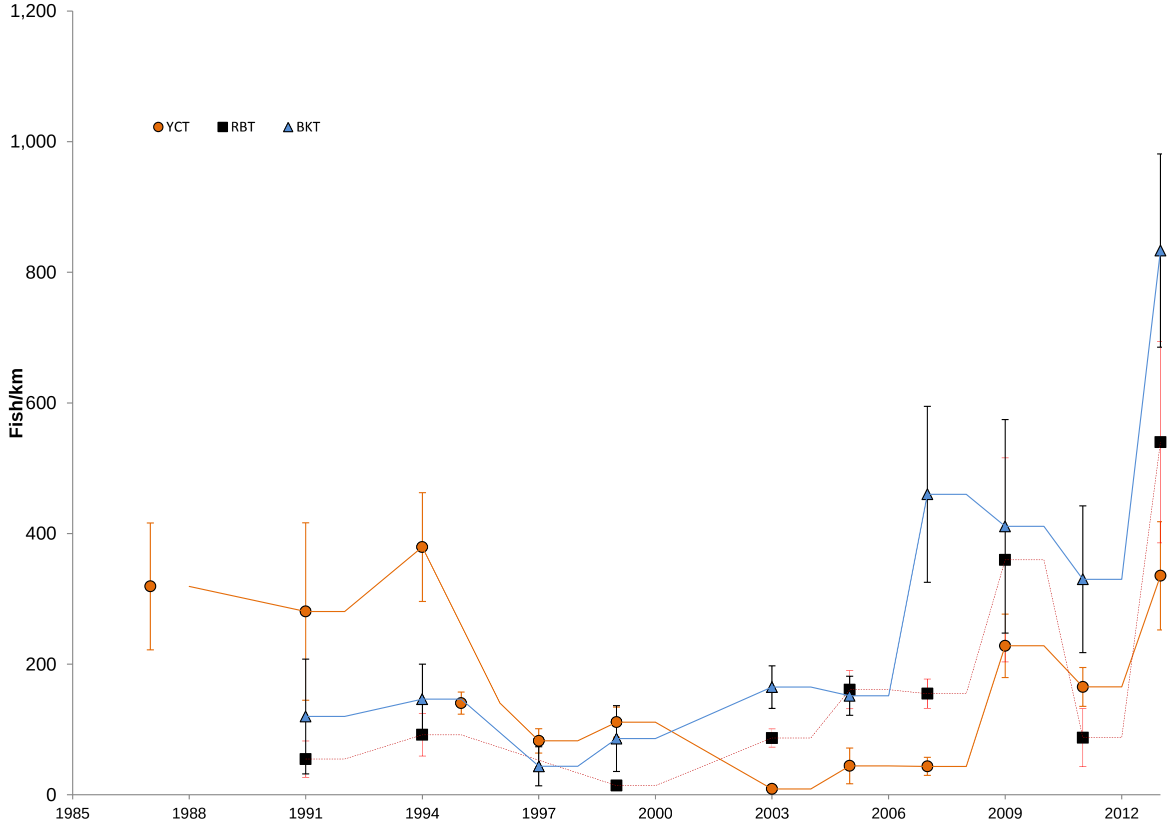


Figure 45. Abundance estimates and 95% confidence intervals for Yellowstone Cutthroat Trout (YCT), Rainbow Trout (RBT), and Brook Trout (BKT) in the Nickerson Reach of the Teton River from 1987 through 2013.

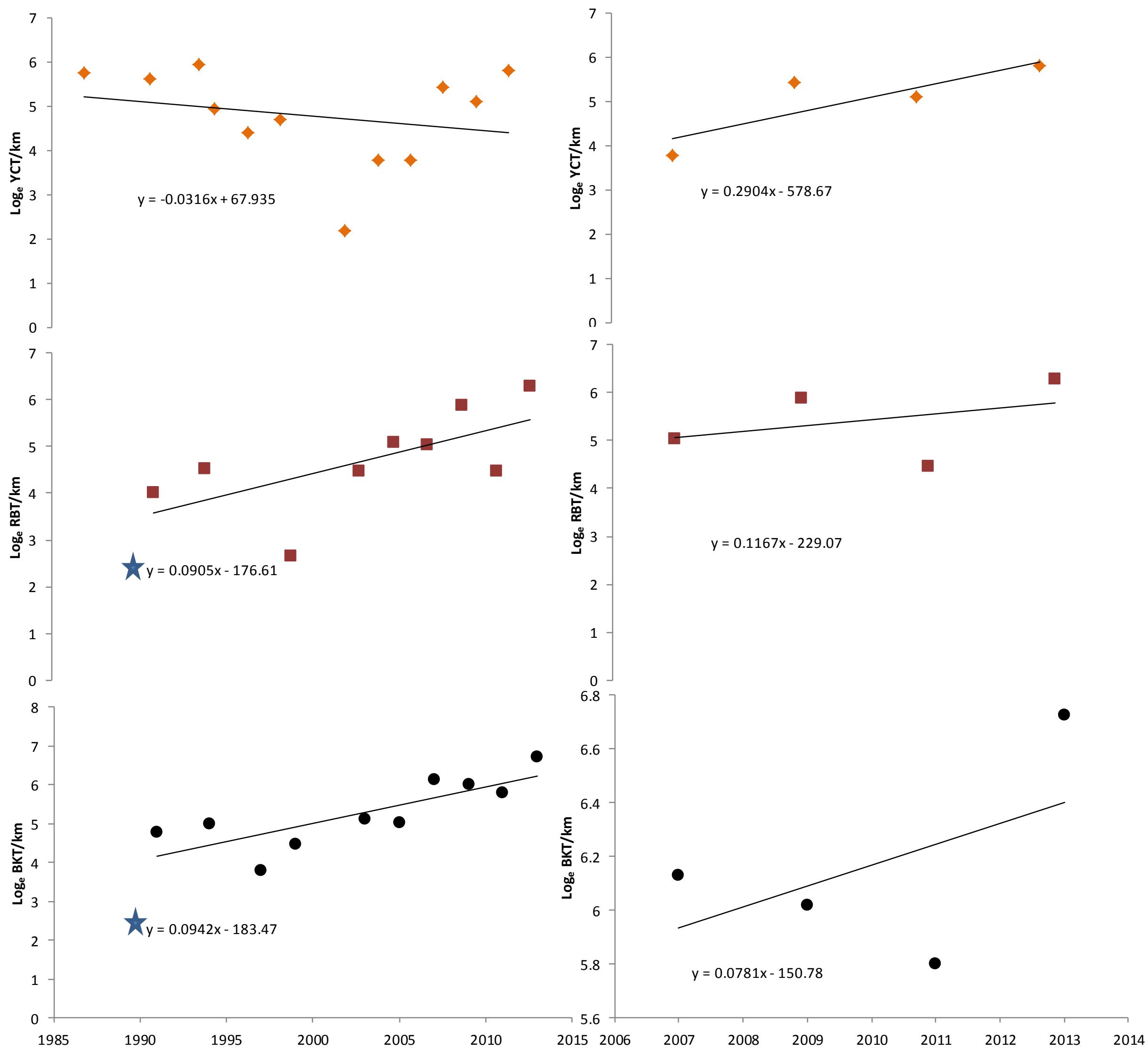


Figure 46. Linear regressions of the $Log_e$ fish/km estimate by year for Yellowstone Cutthroat Trout (YCT), Rainbow Trout (RBT), and Brook Trout (BKT) at the Nickerson reach, Teton River. The regressions on the left are for the entire dataset and the ones on the right are from 2006 through 2013. The slope of these regressions is equal to *r*, the intrinsic rate of population change. Statistically significant regressions at the α = 0.10 level are indicated by stars.

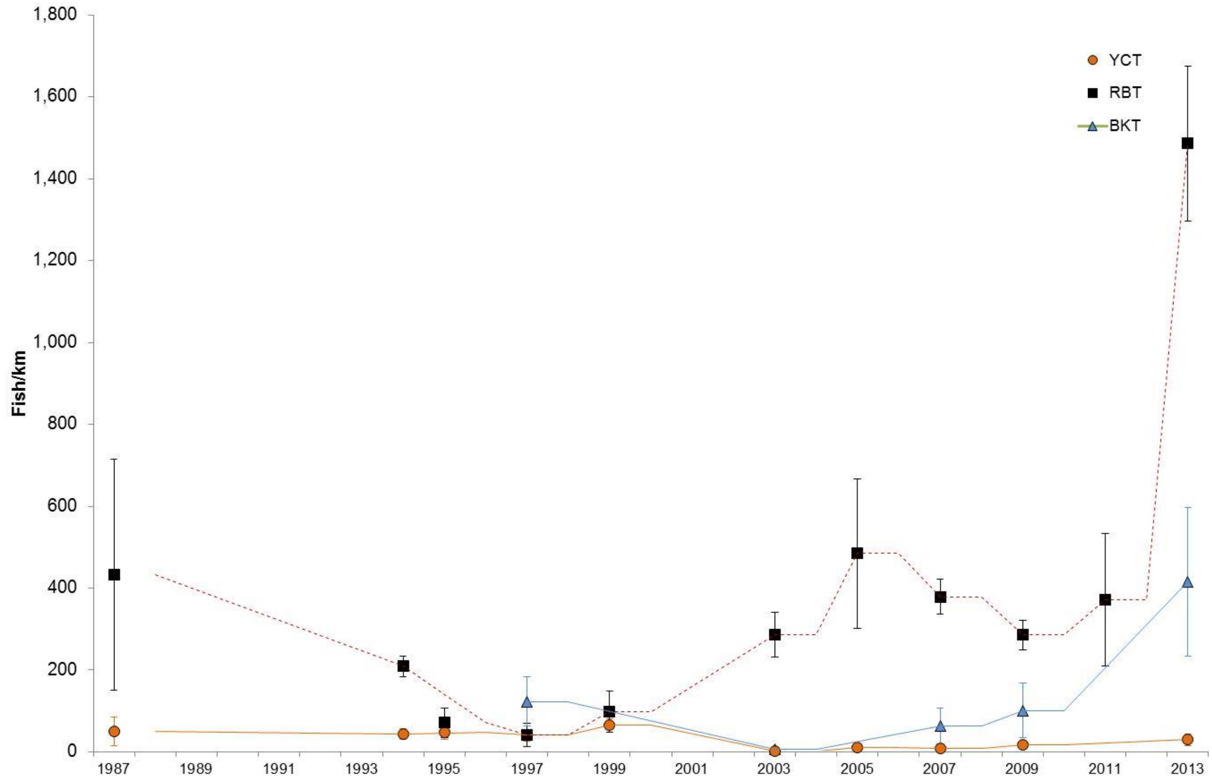


Figure 47. Abundance estimates and 95% confidence intervals for Yellowstone Cutthroat Trout (YCT), Rainbow Trout (RBT), and Brook Trout (BKT) in the Breckenridge Reach of the Teton River from 1987 through 2013.

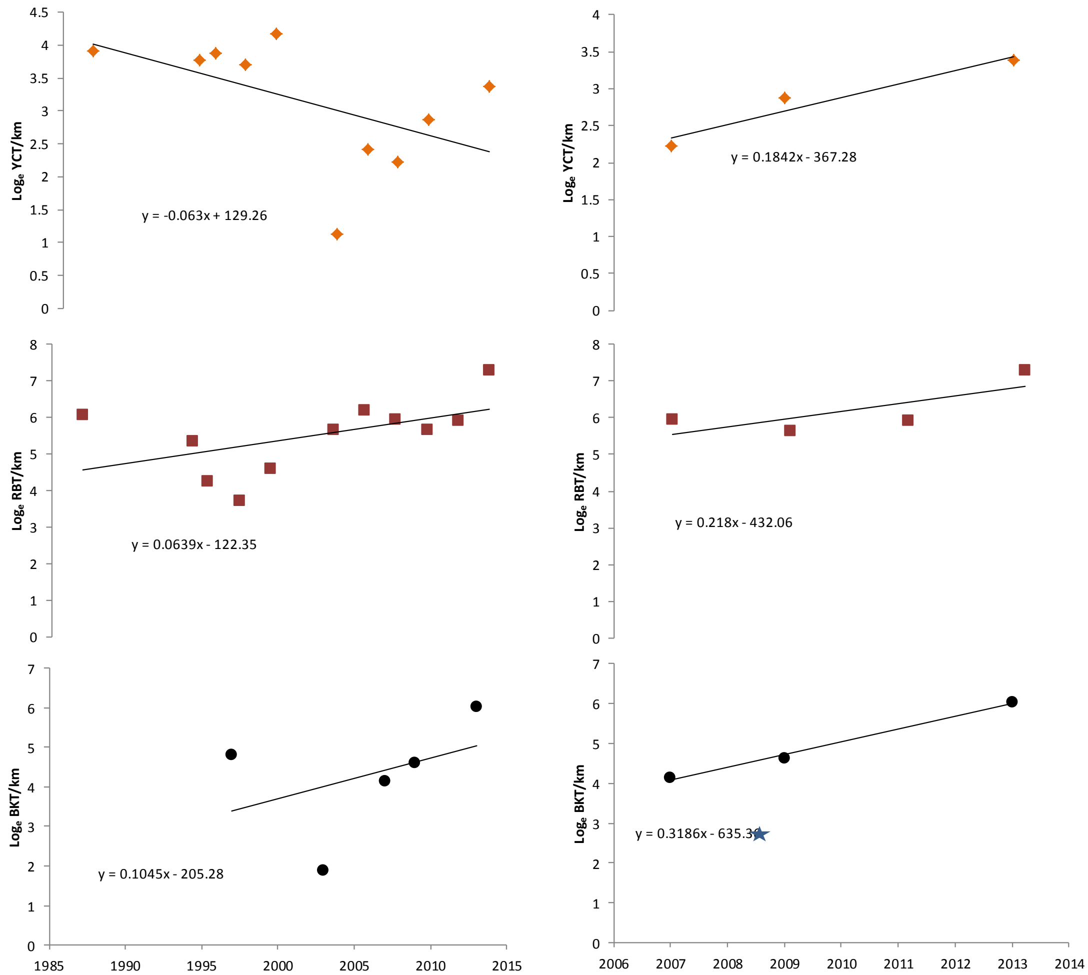


Figure 48. Linear regressions of the $Log_e$ fish/km estimate by year for Yellowstone Cutthroat Trout (YCT), Rainbow Trout (RBT), and Brook Trout (BKT) at the Breckenridge reach, Teton River. The regressions on the left are for the entire dataset and the ones on the right are from 2006 through 2013. The slope of these regressions is equal to *r*, the intrinsic rate of population change. No statistically significant relationships were detected at the alpha = 0.10 level.

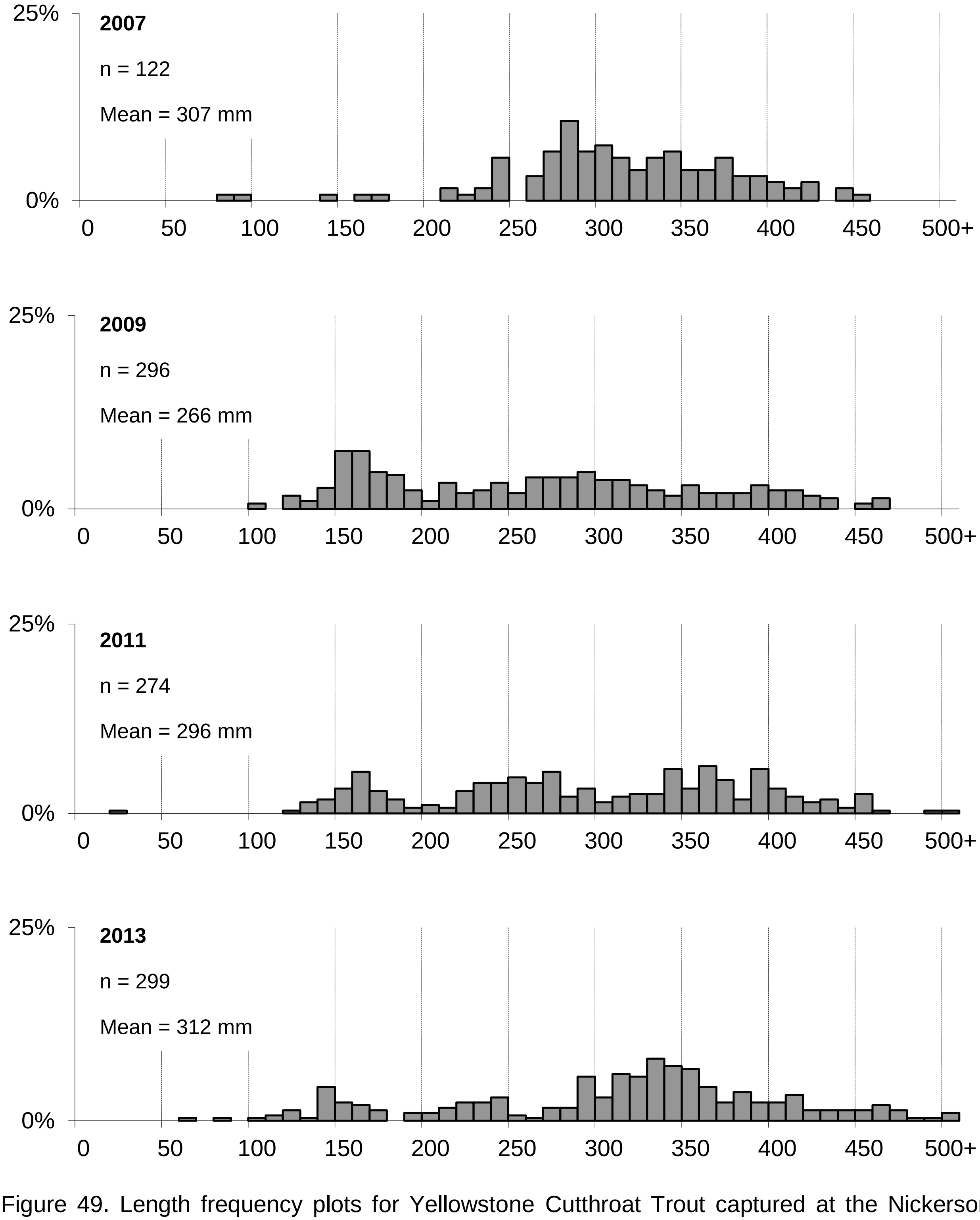


Figure 49. Length frequency plots for Yellowstone Cutthroat Trout captured at the Nickerson monitoring reach of the Teton River between 2007 and 2013.

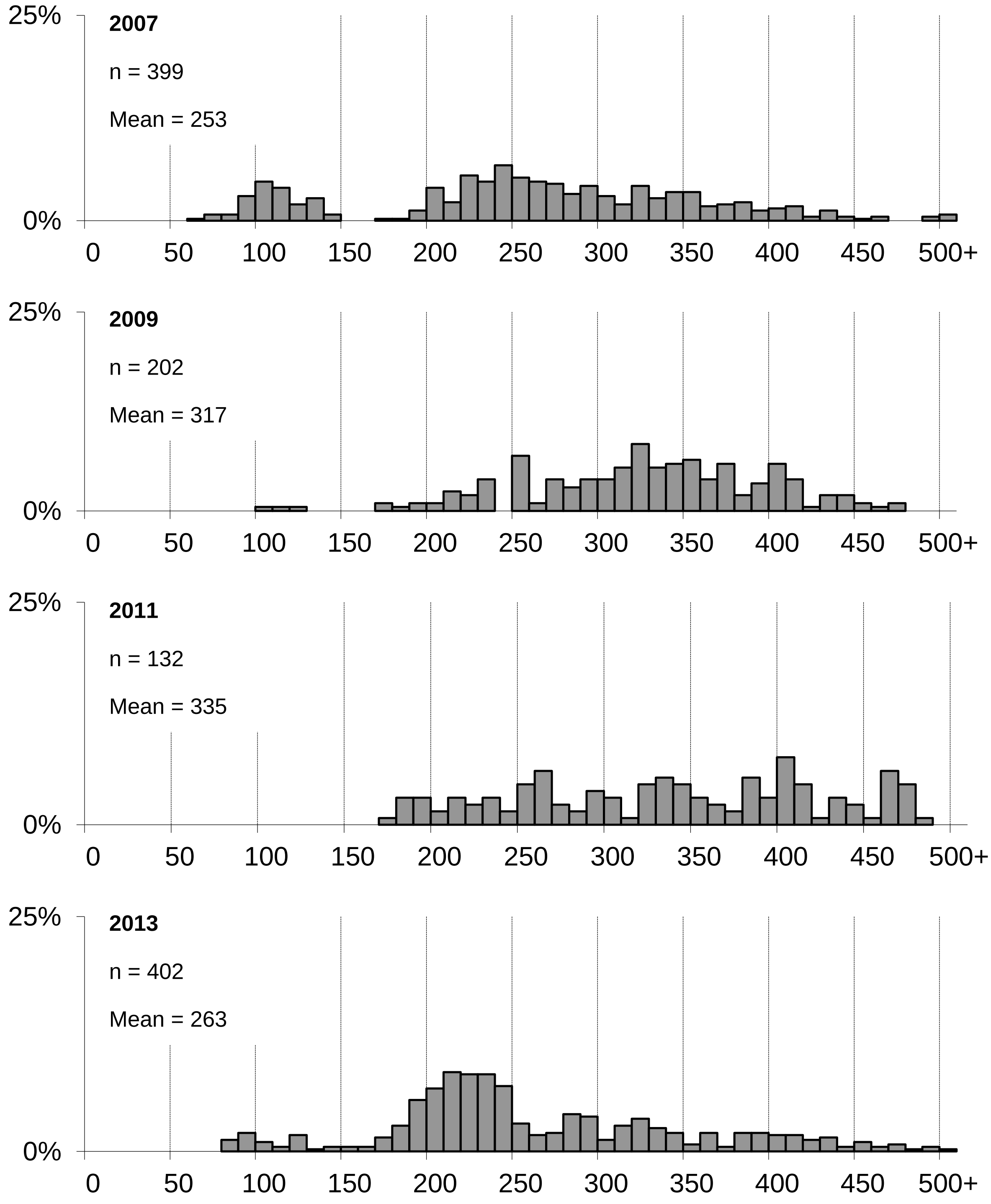


Figure 50. Length frequency plots for Rainbow Trout captured at the Nickerson monitoring reach of the Teton River between 2007 and 2013.

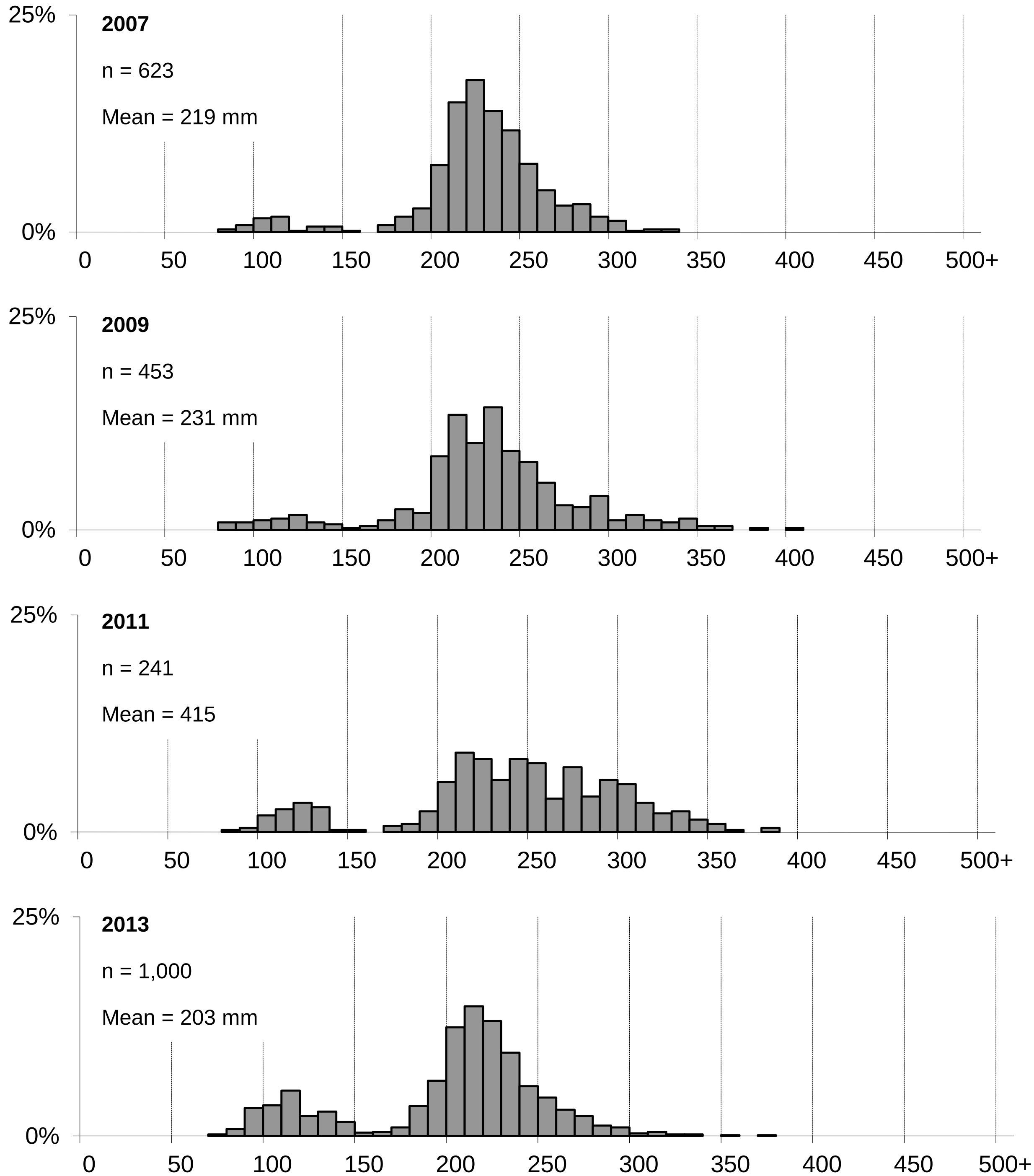


Figure 51. Length frequency plots for Brook Trout captured at the Nickerson monitoring reach of the Teton River between 2007 and 2013.

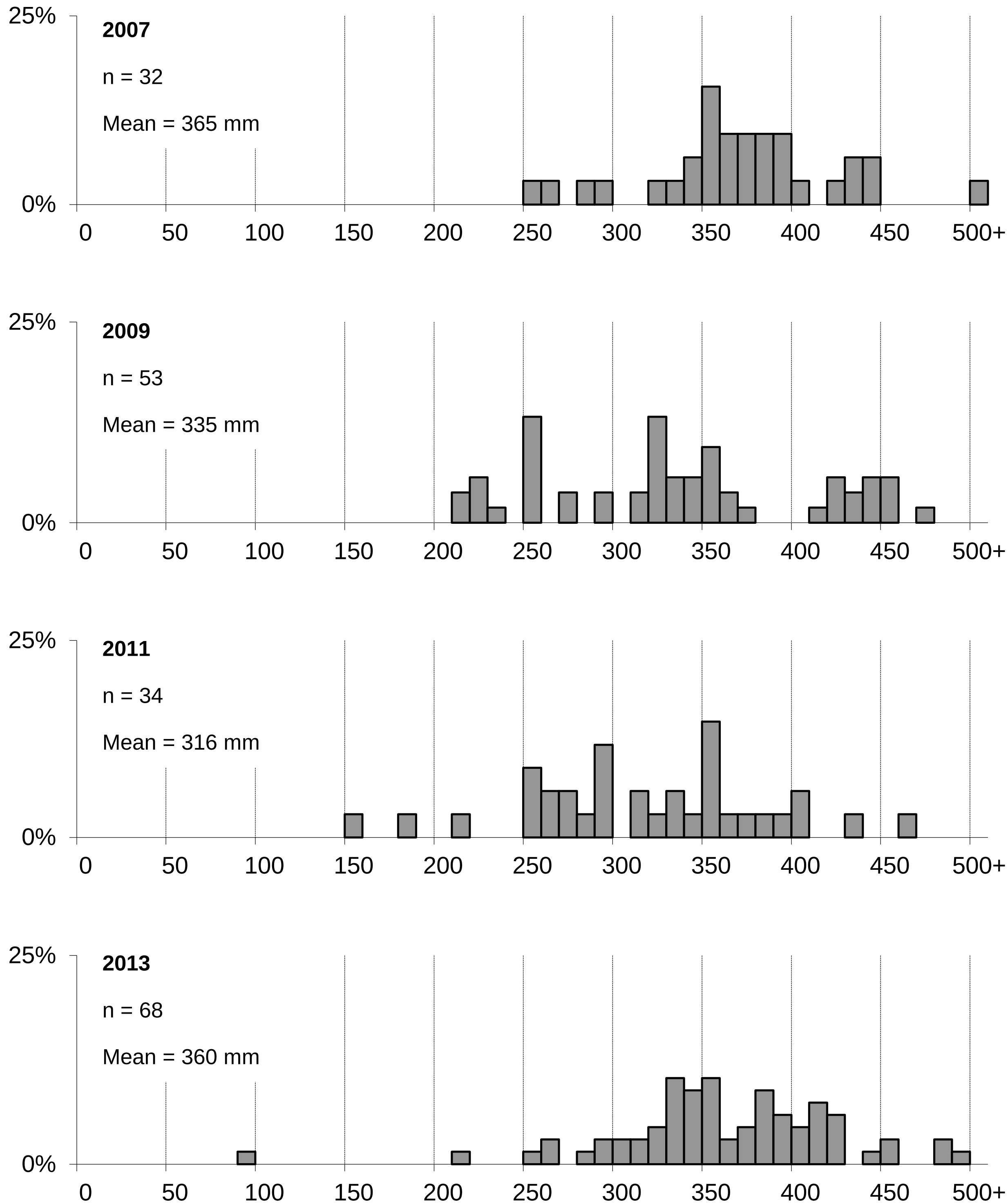


Figure 52. Length frequency plots for Yellowstone Cutthroat Trout captured at the Breckenridge monitoring reach of the Teton River between 2007 and 2013.

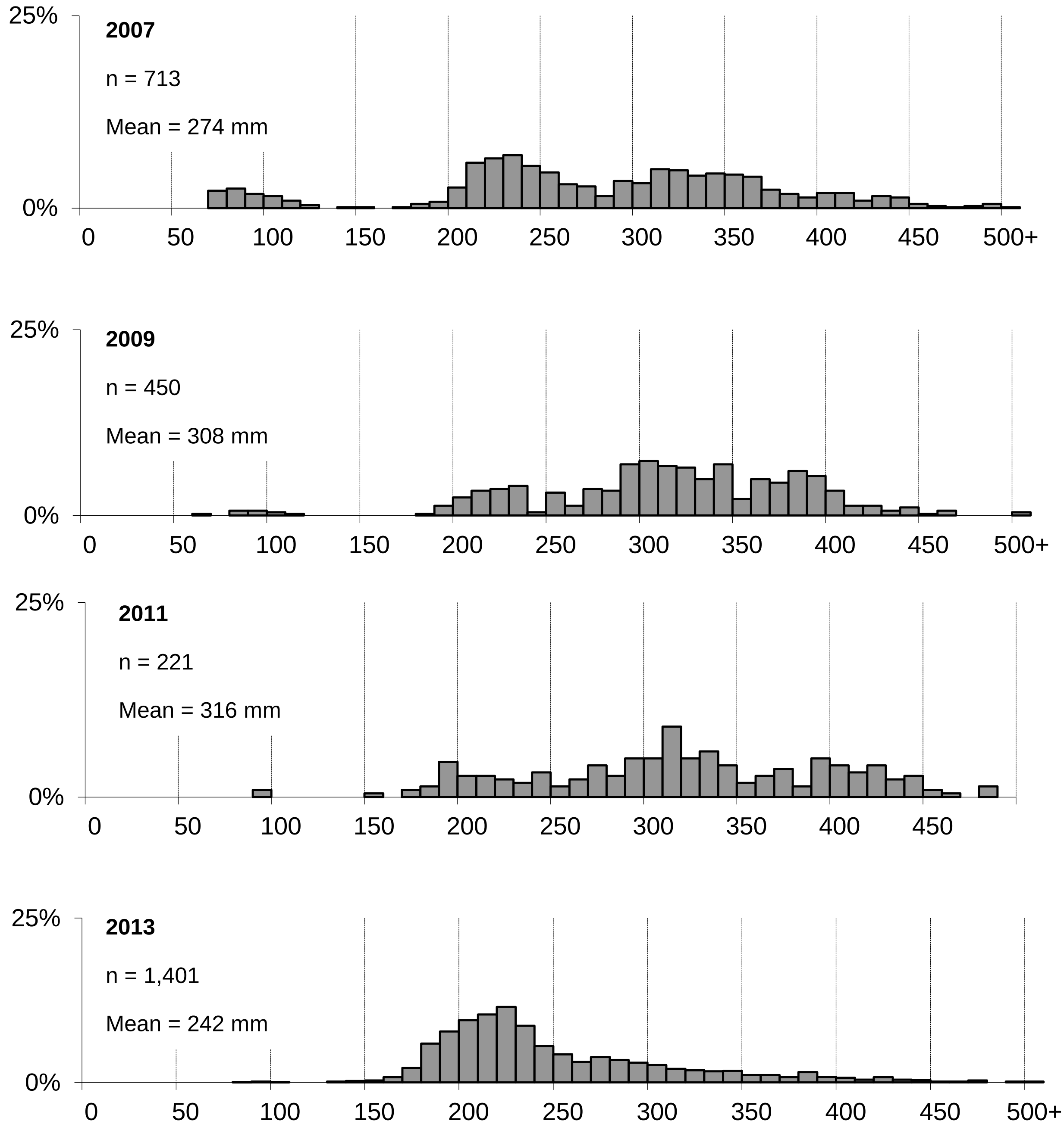


Figure 53. Length frequency plots for Rainbow Trout captured at the Breckenridge monitoring reach of the Teton River between 2007 and 2013.

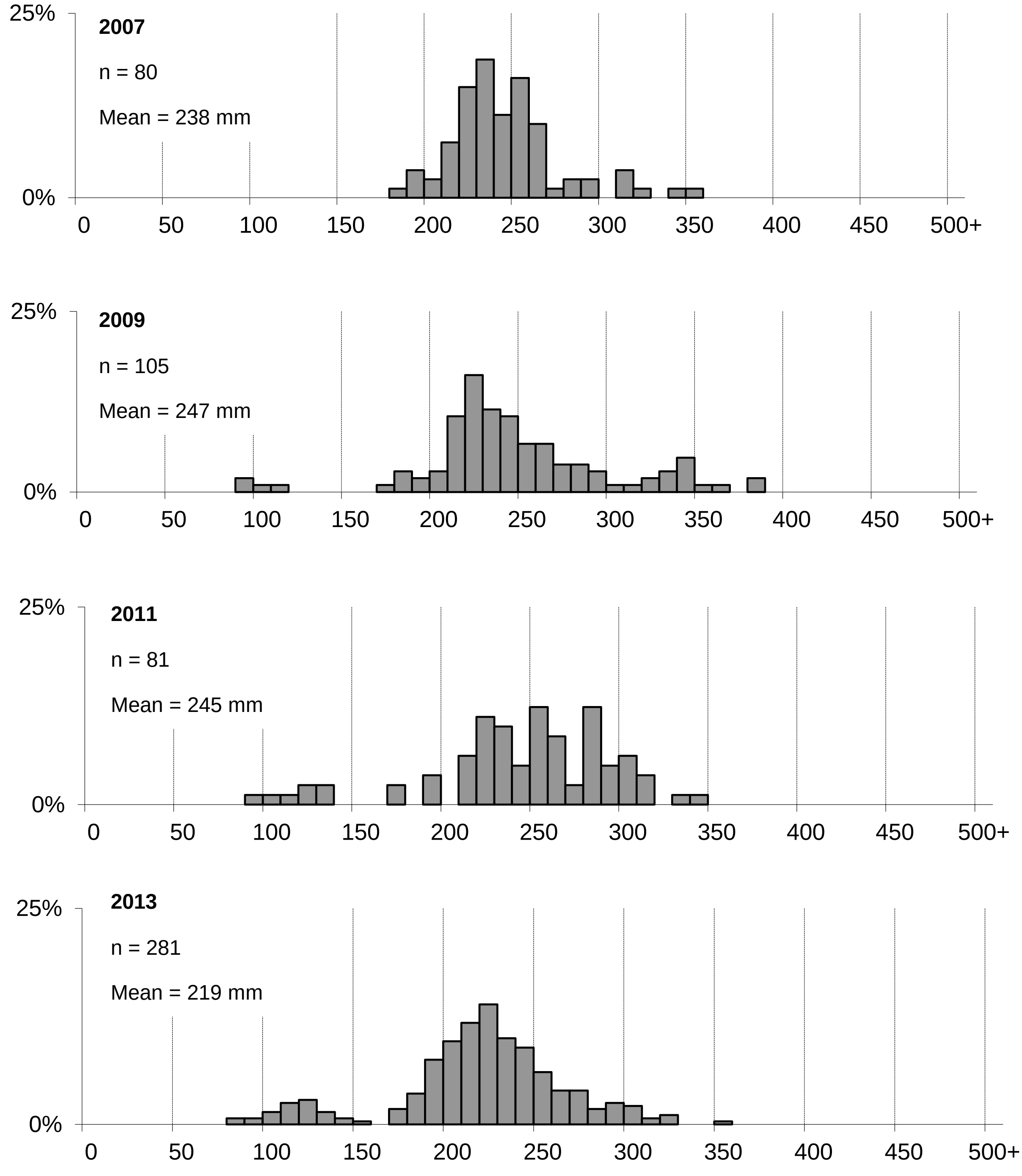


Figure 54. Length frequency plots for Brook Trout captured at the Breckenridge monitoring reach of the Teton River between 2007 and 2013.

## HENRYS FORK

## ABSTRACT

We used boat mounted electrofishing equipment to assess fish populations in the Box Canyon, Riverside, Stone Bridge and Henrys Lake Outlet reaches of the Henrys Fork Snake River during 2013. In Box Canyon, we estimated Rainbow Trout density at 3,881 fish/km. This estimate was substantially higher than the average density (1,829 trout/km) observed over the last 17 years as well as the estimate from 2012. This increase is likely tied to the higher winter flows observed in 2011, and possibly benefiting from increased connectivity and interaction with the Buffalo River, or other factors.

In the Riverside reach, we estimated 4,002 trout per km, which is the highest density of trout on the Henrys Fork. Trout populations have remained relatively stable based on the three estimates we have, dating back to 1987. It is likely that this reach may be an important rearing area for trout that later move to the Harriman Ranch or Box Canyon.

In the Stone Bridge reach, we estimated 1,329 trout per km (81% Rainbow Trout, 19% Brown Trout. Similar to the Riverside reach, trout populations in the Stone Bridge reach have remained relatively stable and continue to be dominated by smaller fish.

The Henrys Lake Outlet supports a robust population of Rainbow, Cutthroat, Hybrid and Brook Trout. We estimated overall trout densities at 436 trout per km, which is lower than most other areas on the Henrys Fork. However, the size structure of Rainbow Trout appears to be well balanced. Length frequencies of Cutthroat and Hybrid Trout suggest that these species likely originate in Henrys Lake, and emigrate to the Outlet as opposed to originating in the Outlet.

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## STUDY SITE

During 2013, we sampled the Box Canyon, Riverside, Stone Bridge and Henrys Lake Outlet reaches of the Henrys Fork Snake River 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 Riverside reach began 2.5 km downstream of the Riverside boat ramp and extended for 5.1 km, ending 0.5 km above the Hatchery Ford boat ramp. The Stone Bridge reach started 3.0 km downstream of the boat ramp and continued 4.6 km downstream, ending at the pilings from an old bridge crossing. The Henrys Lake Outlet reach started immediately below the fence crossing below the Highway 20 Bridge, and ended at the second fence crossing, approximately 7 km downstream. Coordinates for all mark-recapture transect boundaries are presented in Appendix J.

## OBJECTIVES

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

## METHODS

During 2013, we sampled all survey reaches using three electrofishing boats (two rafts, one drift boat) with the exception of the Henrys Lake Outlet, which used two boats. In the Box Canyon reach, we marked fish on May 13, and recaptured fish on May 20. Two passes per boat were made on each marking and recapture day for a total of 6 passes per day for both marking and recaptures. In the Riverside reach, we marked fish on June 11, 12 and 14, and recaptured fish on June 18. In the Stone Bridge reach, we marked fish on May 9 and 10 and recaptured fish on May 14. We marked fish in the Henrys Lake Outlet on August 6 and recaptured fish on August 9. One pass was completed in each reach by all boats on each marking and recapture day on the Outlet. 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.

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 (Dec 1 – Feb 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 2013 sampling based on mean winter stream flows observed during 2012 (December 2011 - February 2012). To validate this relationship, we determined age-2 Rainbow Trout abundance during the 2013 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 2013 was added to the flow vs. age-2 abundance regression model and this model will continue to be used in management of winter flow releases from Island Park Dam.

## RESULTS

### Box Canyon

We collected 2,296 trout during two 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 110 mm to 535 mm, with a mean and median total length of 294 mm and 278 mm, respectively (Figure 55; Appendix K). Rainbow Trout PSD and RSD-400 were 44 and 15, respectively (Table 25). We used the Log-likelihood Method (LLM) to estimate 14,358 Rainbow Trout >150 mm (95% CI = 13,207 – 15,509, cv = 0.04, Table 26, Appendix L) in the reach, which equates to 3,881 fish per km (Figure 56). 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 9% (Appendix L). Length-at-age estimates for two-year old Rainbow Trout were 278 mm (+/- 10.7 mm).

The regression model between winter flow (December-February) estimated an abundance of 3,927 age-2 Rainbow Trout in the 2013 survey based on winter flows that averaged 581 cfs. However, based on the length-based estimates of abundance our Log Likelihood model calculates, we estimated age-2 Rainbow Trout abundance at 8,477 fish in the Box Canyon during 2013 (Figure 57). In most years, 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.

### Riverside

We collected 1800 Rainbow Trout and one Brook Trout during four days of electrofishing in the Riverside reach of the Henrys Fork. Species composition of trout collected was 99% Rainbow Trout, and less than 1% Brook Trout. Rainbow Trout ranged between 58 mm and 565 mm (Figure 58), with a mean and median total length of 217 mm and 194 mm, respectively (Table 25). Rainbow Trout PSD and RSD-400 values were 27, and 5, respectively. We estimated 20,650 Rainbow Trout >150 mm for the reach (95% CI = 16,664 – 24,636; cv = 0.10), which equates to 4,002 Rainbow Trout per km (Table 26). Our efficiency rate (unadjusted for size selectivity) was 5%.

## Stone Bridge

We collected 1,081 trout during three days of electrofishing in the Stone Bridge reach of the Henrys Fork. Species composition of trout collected was 81% Rainbow Trout and 19% Brown Trout. Rainbow Trout ranged between 100 mm and 490 mm (Figure 59), with a mean and median total length of 284 mm and 270 mm, respectively (Table 25). Rainbow Trout PSD and RSD-400 values were 44 and 18, respectively. We estimated 5,223 Rainbow Trout >150 mm for the reach (95% CI = 4,254 – 6,192; cv = 0.09), which equates to 1,135 Rainbow Trout per km (Table 26; Figure 60). Our efficiency rate (unadjusted for size selectivity) was 10%. Brown Trout ranged between 135 mm and 534 mm (Figure 61), with a mean and median total length of 349 mm and 355 mm, respectively (Table 25). Brown Trout PSD and RSD-400 values were 79 and 42, respectively. We estimated 898 Brown Trout >150 mm for the reach (95% CI = 666 – 1,129; cv = 0.13), which equates to 195 Brown Trout per km (Table 26; Figure 62). Our efficiency rate (unadjusted for size selectivity) for Brown Trout was 17%.

## Henrys Lake Outlet

We collected 815 trout during two days of electrofishing in the Henrys Lake Outlet reach of the Henrys Fork. Species composition of trout collected was 76% Rainbow Trout, 16% Yellowstone Cutthroat Trout, 5% Brook Trout and 4% Hybrid Trout. Rainbow Trout ranged between 81 mm and 654 mm (Figure 63), with a mean and median total length of 240 mm and 226 mm, respectively (Table 25). Rainbow Trout PSD and RSD-400 values were 38 and 9, respectively. We estimated 1,280 Rainbow Trout >150 mm for the reach (95% CI = 1,011 – 1,548; cv = 0.11), which equates to 267 Rainbow Trout per km (Table 26; Figure 62). Our efficiency rate (unadjusted for size selectivity) was 22%. Yellowstone Cutthroat Trout ranged between 134 mm and 467 mm (Figure 61), with a mean and median total length of 361 mm and 350 mm, respectively (Table 25). Cutthroat Trout PSD and RSD-400 values were 99 and 34, respectively. We estimated 183 Cutthroat Trout >150 mm for the reach (95% CI = 132-234; cv = 0.14), which equates to 38 Cutthroat Trout per km (Table 26; Figure 62). Our efficiency rate (unadjusted for size selectivity) for Cutthroat Trout was 28%. No Mountain Whitefish were encountered during the 2013 survey.

## DISCUSSION

Estimates of Rainbow Trout abundance in 2013 in the Box Canyon were substantially higher than in 2012, higher than the long-term average, and higher than our flow model predicted they should be. It's likely that this is the result of a strong year class produced as a result of the high winter flows experienced during the winter of 2011, which was the highest recorded since 1999 at 581 cfs. Winter flows are tied closely to year class strength as shown by Garren (2006). However, flows can only account for part of the increase observed in 2013. Based on our regression of winter flows, the age-2 abundance of Rainbow Trout should have been approximately 4,000 fish, not the 8,400 fish observed in the population estimate. Two additional factors may be contributing to the unusually high densities. Entrainment of young Rainbow Trout through the Island Park Dam could result in more young fish in our population estimate, but this would be dependent on the severity of the drawdown. In 2012 (when young Rainbow Trout would have been vulnerable to entrainment), Island Park Reservoir was drawn down to 35,023 acre-feet, the lowest it's been drawn down since 2007. This low drawdown may be partially responsible for the increase in young fish abundance.  Secondly, additional recruitment may be adding to the population through the improved connection with the Buffalo River. The fish ladder connecting the Henrys Fork to the Buffalo River was improved in 2007, and Rainbow Trout now actively seek out the Buffalo for overwintering and during the spawning season. If additional fish are surviving through the winter and returning to the Henrys Fork or if fish spawning success/recruitment to the Henrys Fork has increased due to this ladder, we can expect the population to increase. It's likely that the better water year in 2011 increased natural reproduction above what we expected to see based on our models, and these progeny have now recruited to the Henrys Fork. PSD and RSD values, which are indicative of the size structure of the population are at their lowest point since the late 1990's, another period of increased production and higher populations of trout. This suggests density dependent growth is occurring in the Box Canyon reach. Indeed, when lengths of age-two trout from the current survey (278 mm) are compared to those from 2003 (mean length @ age-2 = 301 mm) and 2005 (mean length @ age-2 = 296 mm) when trout densities were lower, we see that lengths of same-aged fish have decreased by approximately 20 mm on average.

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). However, as outlined above, additional factors may now be influencing population densities. Although the model using winter flows to predict year class strength continues to be critical to managing the river, the model will have to be calibrated to incorporate variation in contributions from the Buffalo River if future years depart substantially from model predictions. Alternatively, additional research should focus on the reasons for model predictions departing from actual trout densities.

The trout population in the Riverside reach of the Henrys Fork is similar to the last estimate conducted in 2010 as well as the initial survey in 1987. As observed in 2010, this reach is dominated by smaller, younger fish, and may be an important rearing area for trout that eventually move upstream to the Harriman Ranch or Box Canyon. Given that this reach is dominated by small fish, combined with angler behavior and limited harvest in areas that are open to harvest, it is likely that the catch and release rules currently in place in this reach are unnecessary, and do not add additional protection to the fishery. However, a thorough analysis of public support should be conducted before embarking on any regulations changes on the Henrys Fork.

In the Stone Bridge reach of the Henrys Fork, both rainbow and Brown Trout densities were similar to previous years. No significant changes were observed in either population, although in general terms, rainbow densities were slightly lower than past years, and Brown Trout densities were slightly higher than past years. Brown Trout continue to increase their relative abundance in the Stone Bridge reach. Based on analysis of length frequencies, it appears that a strong year class of Rainbow Trout is working through the system. As in years past, this reach is dominated by smaller Rainbow Trout, although large fish are present. The length frequency for Brown Trout is reflective of a lightly exploited population, with no real decline in abundance at the larger end of the length spectrum even though current regulations place all harvest on the larger fish (those greater than 400 mm) in the population. Given the numerous spawning areas and connected nature of the Stone Bridge reach, it is likely that the size structure of all trout will fluctuate based on contributions from natural recruitment and the variation associated with year to year changes in this process as opposed to being driven by angler harvest practices at their current level.

The Henrys Lake Outlet reach contained a surprising density of trout, including some of the largest fish captured on the Henrys Fork in 2013. The reach is dominated by Rainbow Trout, which are supported entirely by natural reproduction. Much of this reproduction likely occurs from fish that move between the Henrys Fork and the Outlet, although some of the reproduction is likely occurring from resident trout in the Outlet itself. There is some evidence of natural recruitment from Yellowstone Cutthroat Trout as evident by smaller fish in the length frequency histogram, but much of the Cutthroat population is likely tied to fish emigrating from Henrys Lake during the spring. The length frequency shows a large portion of Cutthroat between 350 mm and 450 mm, which is consistent with the average length of trout in Henrys Lake. Anecdotal observations suggest that in some years during April and May, many fish from the lake end up below the Henrys Lake Dam. It's probable that these fish migrate downstream as temperatures warm, and distribute themselves throughout the Outlet. A similar size structure of Hybrid Trout suggests that they also follow this pattern. Regardless of origin, it appears that the season extension implemented in 2011 has not caused undue harm to this population, and has provided a unique opportunity to anglers during a time of year when opportunity is limited in that area. Noteworthy changes between the last survey on the Henrys Lake Outlet (1988, Elle and Corsi) is the reduced numbers of Brook Trout (roughly a threefold decrease) and the absence of Mountain Whitefish, which were the most abundant species found in 1988. Additional research should explore this anomaly as time permits.

## 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 (December, January and February) to age-0 trout survival.

3. Consider effects of regulations changes on fish populations in the river. Implement consistent regulations if socially acceptable, and biologically beneficial.

4. Explore distributions of Mountain Whitefish in the Henrys Lake Outlet and identify changes that may lead to reduced abundances of this species.

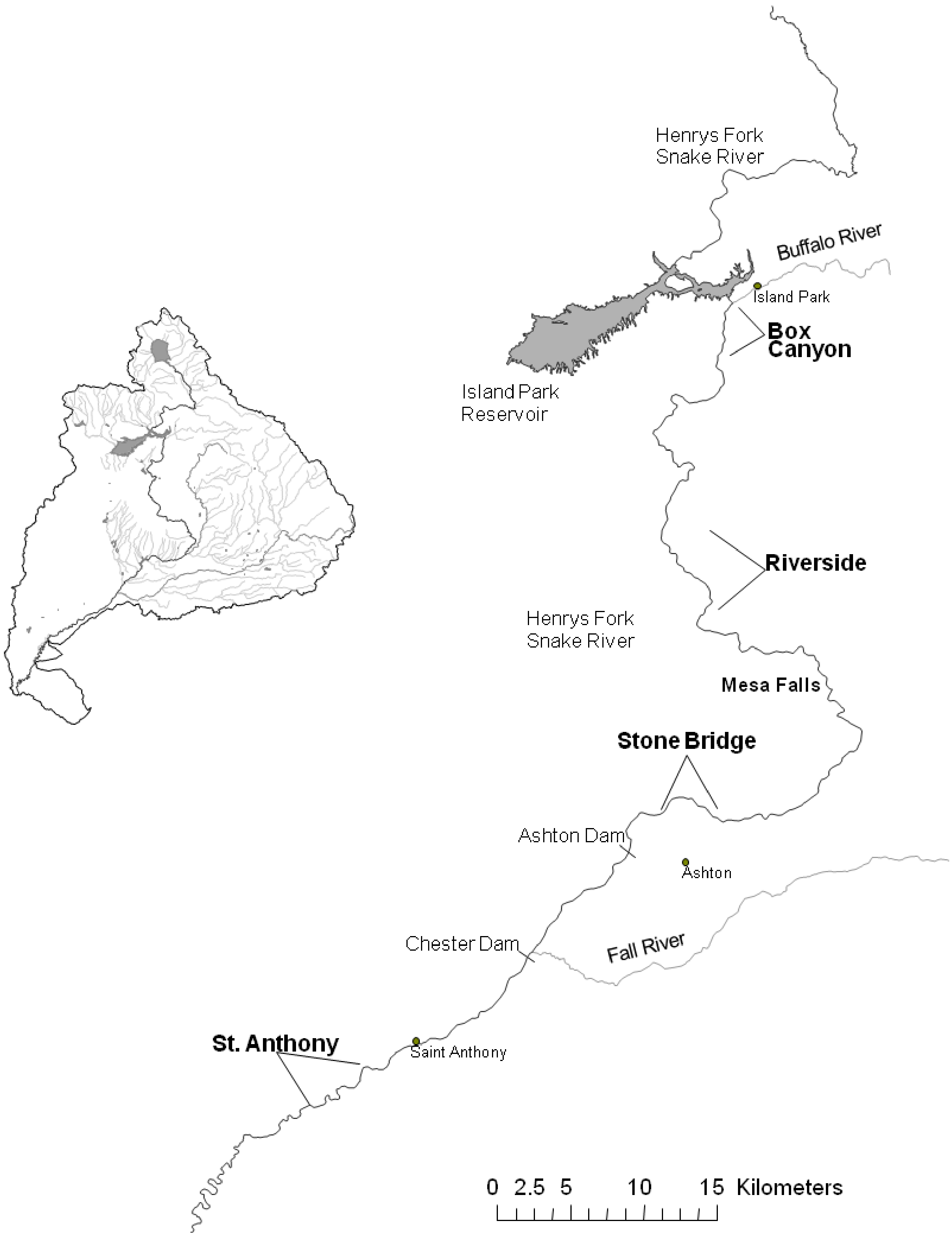


Figure 55. Map of the Henrys Fork Snake River watershed and electrofishing sample sites (Box Canyon, Riverside, Stone Bridge, and the Outlet) during 2013.

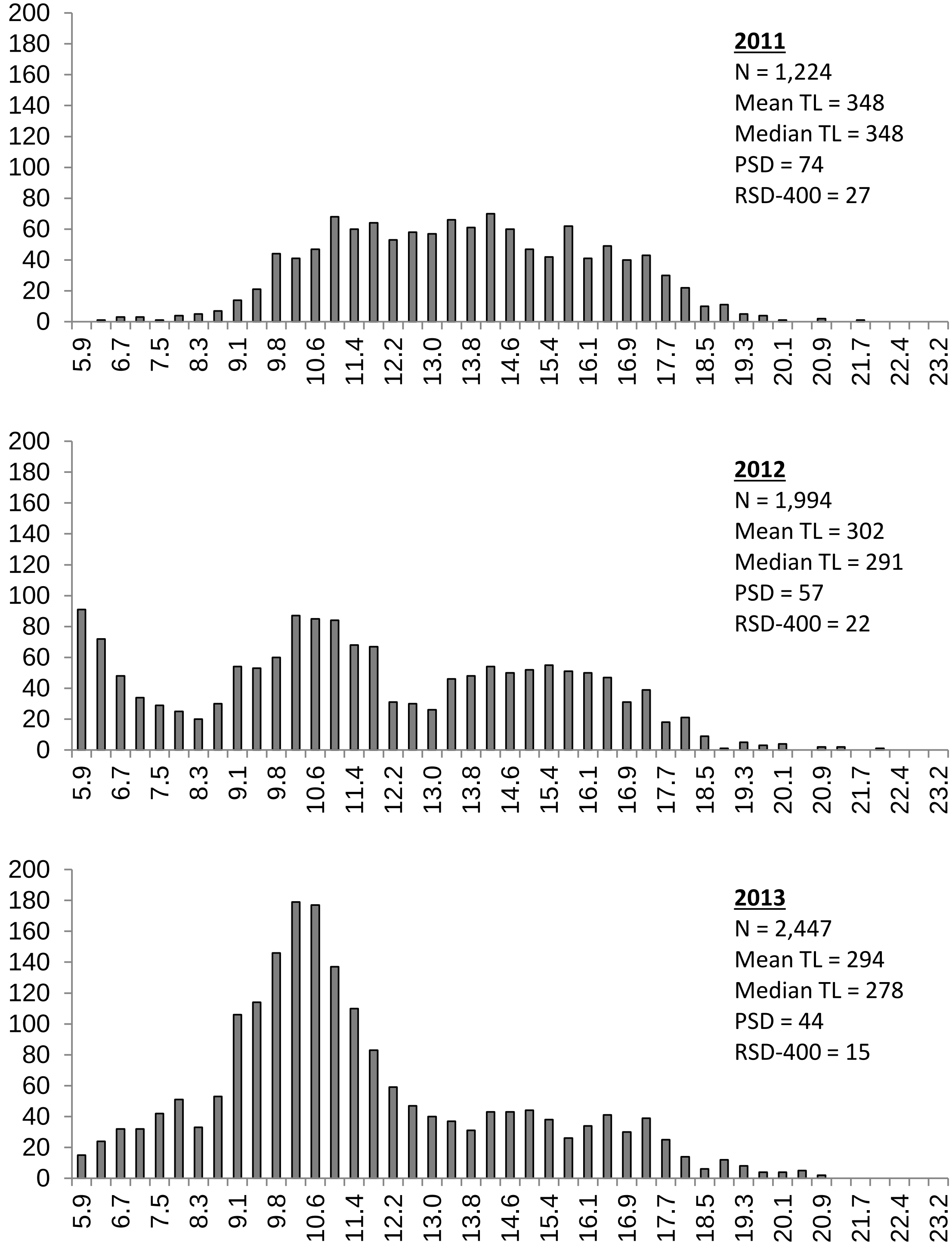


Figure 56. Length frequency distribution and total length statistics of Rainbow Trout collected by electrofishing in the Box Canyon reach of the Henrys Fork Snake River, Idaho, 2011 - 2013.

Table 25. Trout population index summaries for the Henrys Fork Snake River, Idaho 2013.

| River Reach | Mean Length (mm) | Median Length (mm) | PSD | RSD-400 | RSD-500 | Density (No./km) | Percent Species Composition |
|---|---|---|---|---|---|---|---|
| Box Canyon | | | | | | | |
| Rainbow Trout | 294 | 278 | 44 | 15 | 1 | 3,881 | 100 |
| Riverside | | | | | | | |
| Rainbow Trout | 217 | 194 | 27 | 5 | 0 | 4,002 | 100 |
| Stone Bridge | | | | | | | |
| Rainbow Trout | 284 | 270 | 44 | 18 | 0 | 1,135 | 81 |
| Brown Trout | 349 | 355 | 79 | 42 | 9 | 195 | 19 |
| Henrys Lake Outlet | | | | | | | |
| Rainbow Trout | 240 | 226 | 38 | 9 | 1 | 334 | 76 |
| Cutthroat Trout | 361 | 350 | 99 | 34 | 0 | 35 | 16 |
| Hybrid Trout | 345 | 366 | 85 | 39 | 1 | 10 | 4 |
| Brook Trout | 190 | 190 | 0 | 0 | 0 | 23 | 5 |

[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 26. Trout and whitefish population estimate summary from the Henrys Fork Snake River, Idaho during 2013. (RBT = Rainbow Trout, BNT = Brown Trout, YCT = Yellowstone Cutthroat Trout).

| River reach | No. marked | No. captured | No. recaptured | Population Estimate | Confidence Interval (+/- 95%) | Density (No./ km) | Discharge (cfs)[a] |
|---|---|---|---|---|---|---|---|
| Box Canyon | | | | | | | |
| -RBT | 1,115 | 1,301 | 120 | 14,358 | 1,151 | 3,881 | |
| Riverside | | | | | | | |
| -RBT | 1,000 | 646 | 34 | 20,650 | 3,986 | 4,002 | |
| Stone Bridge | | | | | | | |
| -RBT | 530 | 280 | 29 | 5,223 | 969 | 1,135 | |
| -BNT | 134 | 71 | 12 | 898 | 232 | 195 | |
| Outlet | | | | | | | |
| -RBT | 316 | 232 | 53 | 1,604 | 267 | 334 | |
| -YCT | 54 | 72 | 20 | 169 | 49 | 35 | |
| -HYB | 13 | 18 | 7 | 48 | 11 | 10 | |
| -BKT | 24 | 15 | 1 | 110 | -- | 23 | |

[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.

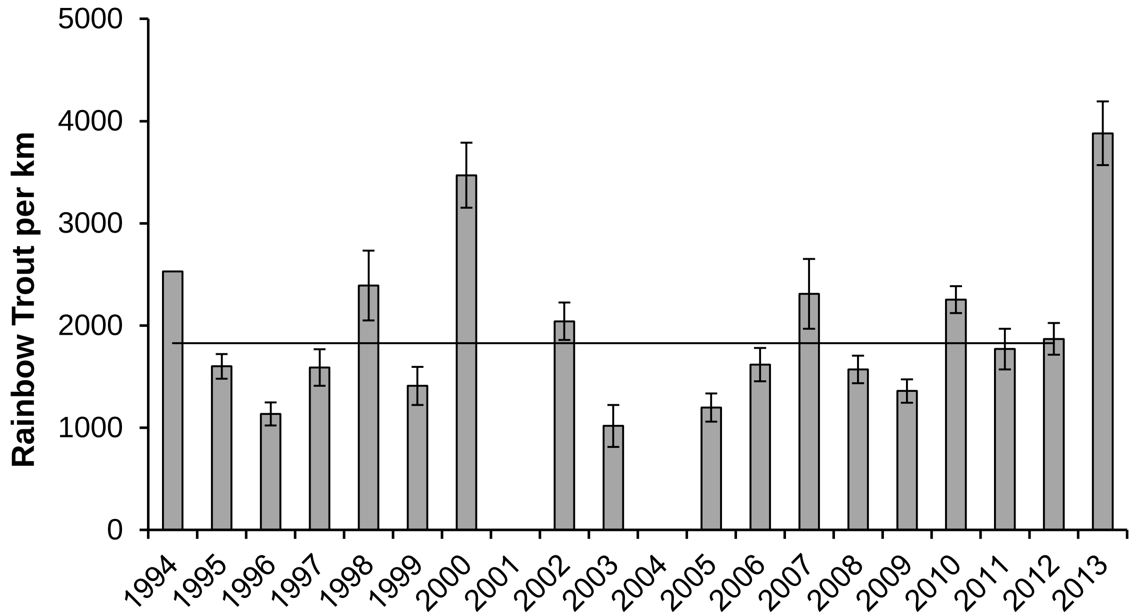


Figure 57. Rainbow Trout population estimates for the Box Canyon reach of the Henrys Fork Snake River, Idaho 1994 - 2013. Error bars represent 95% confidence intervals. The solid line represents the long-term average Rainbow Trout density, not including the current years' survey.

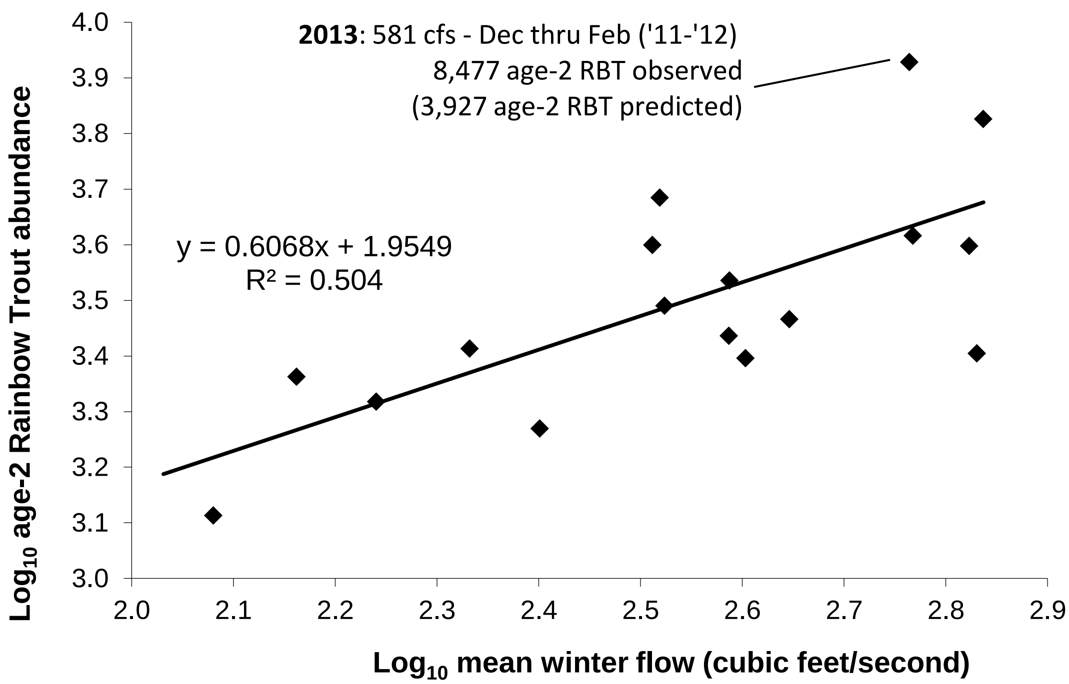


Figure 58. The relationship between age-2 Rainbow Trout abundance and mean winter flow (cfs) during the first winter of a fish's life from 1995 – 2013.

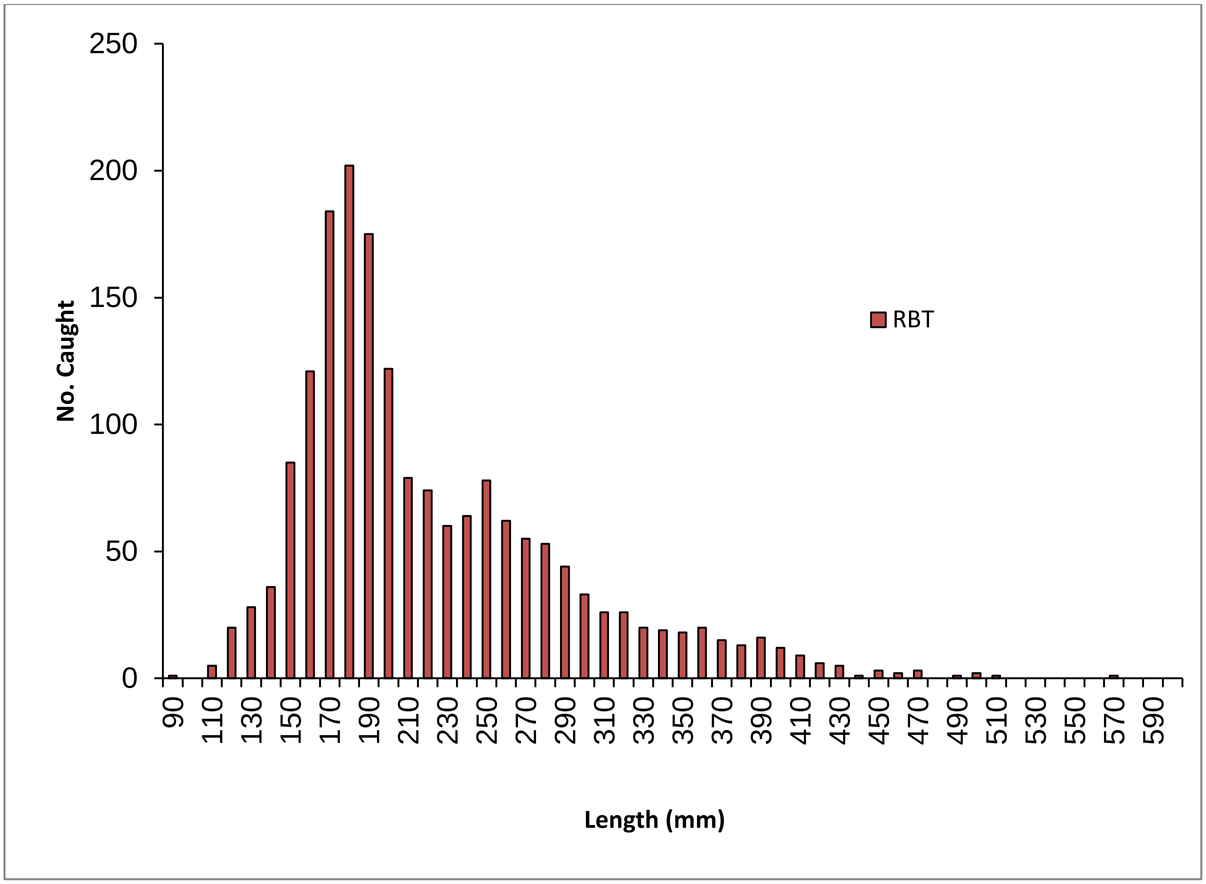


Figure 59. Length frequency of Rainbow Trout captured by electrofishing in the Riverside reach of the Henrys Fork Snake River, 2013.

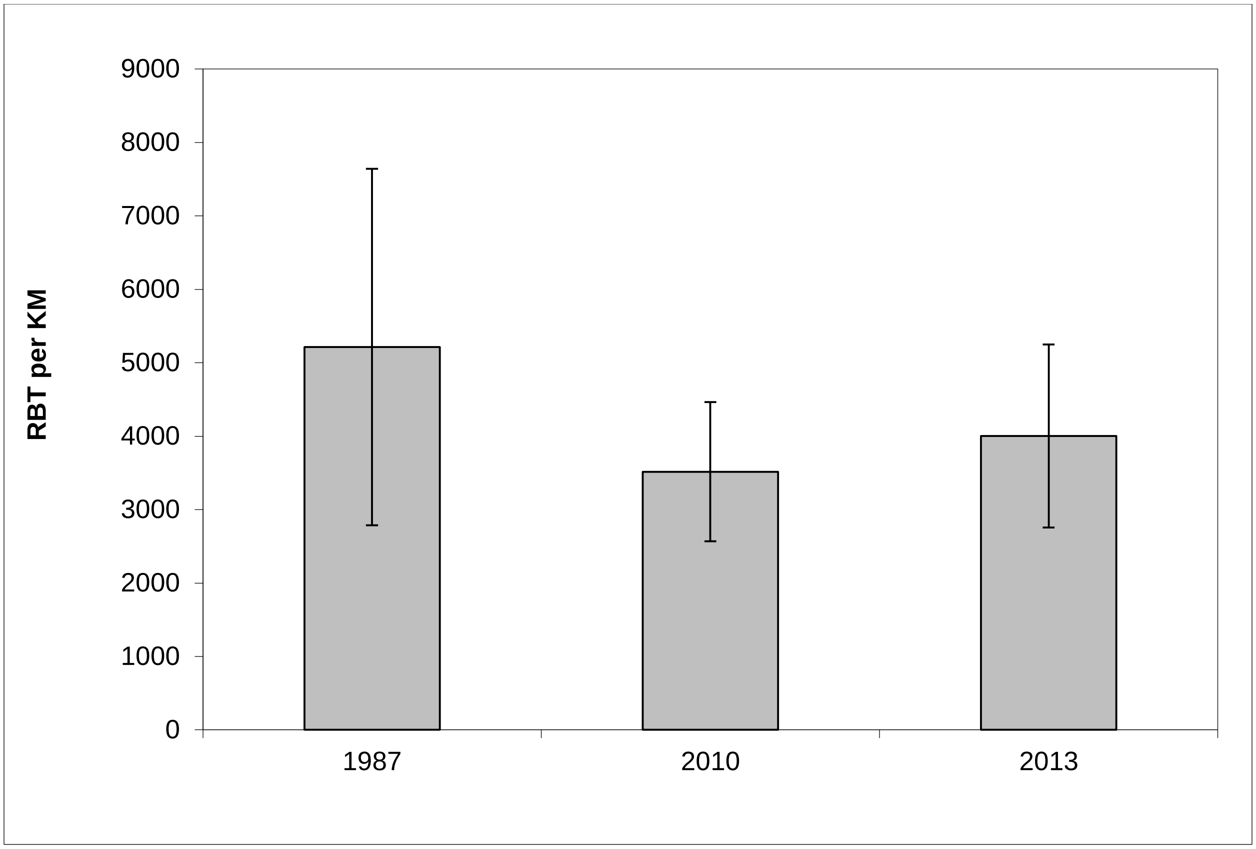


Figure 60. Trout abundance estimates (fish per km) in the Riverside reach of the Henrys Fork Snake River, 1987-2013. Error bars represent 95% confidence intervals.

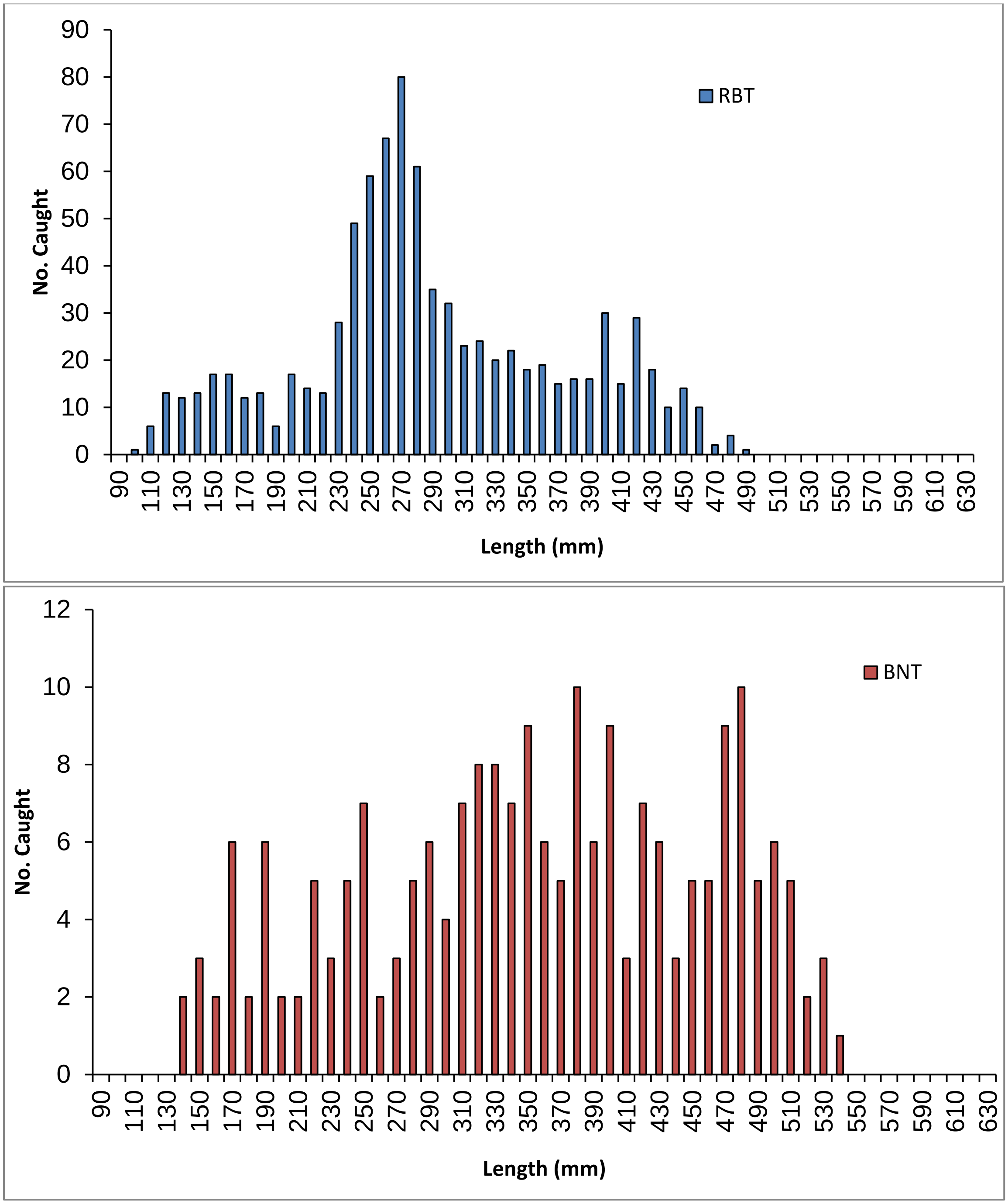


Figure 61. Length frequency of Rainbow Trout (top graph) and Brown Trout (bottom graph) captured by electrofishing in the Stone Bridge reach of the Henrys Fork Snake River, 2013.

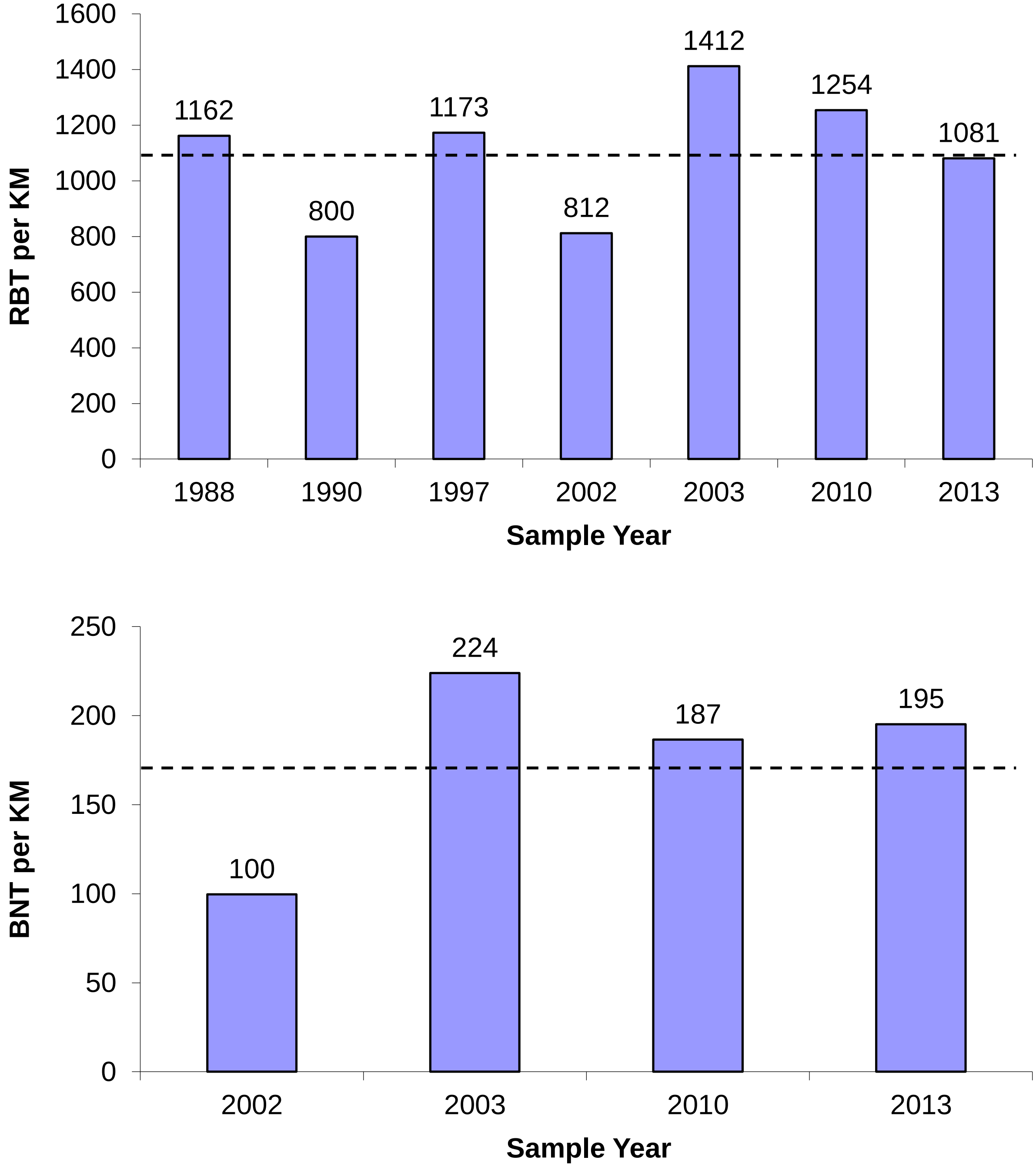


Figure 62. Rainbow Trout and Brown Trout estimates (fish per km) for the Stone Bridge reach of the Henrys Fork Snake River, 2002-2013.

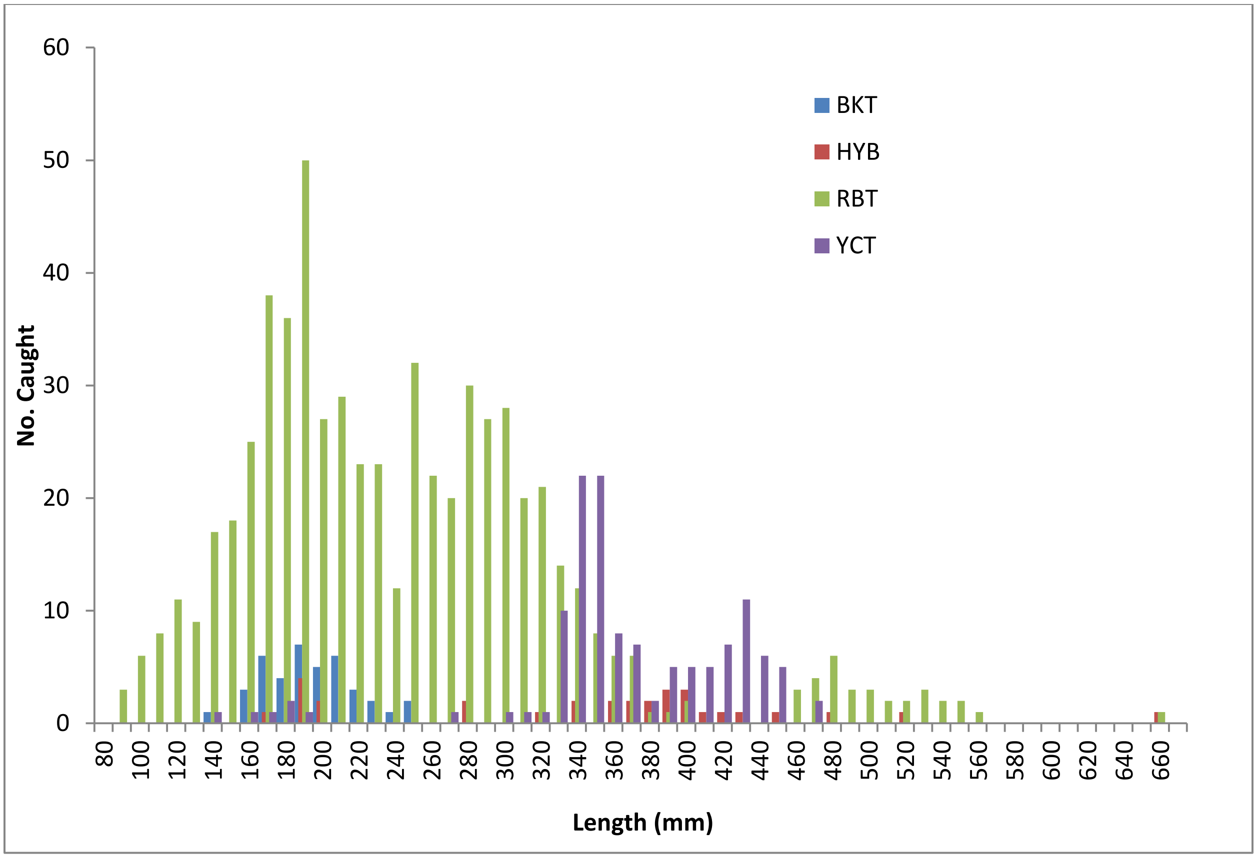


Figure 63. Length frequency for trout captured in the Henrys Lake Outlet of the Henrys Fork, 2013. BKT = Brook Trout, HYB = Hybrid Trout, RBT = Rainbow Trout and YCT = Yellowstone Cutthroat Trout.

Appendix J. Locations used in population surveys on the Henrys Fork Snake River, Idaho 2013. All locations used NAD27 and are in Zone 12.

| | Start | | Stop | |
|---|---|---|---|---|
| Reach | Easting | Northing | Easting | Northing |
| Box Canyon | 468677 | 4917703 | 467701 | 4914352 |
| Riverside | 464773 | 4899817 | 465657 | 4896509 |
| Stone Bridge | 470486 | 4882921 | 464168 | 4884320 |
| Henrys Lake Outlet | 473407 | 4936883 | 476327 | 4932445 |

Appendix K. 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, 1991-2013. 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 |
| 2013 | 2,072 | 295 | 110 - 535 | 43 | 16 | 1 |

Appendix L. 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, 1995-2013. 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 L. 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 |
| 2013 | 1115 | 1301 | 120 | 9 | 0.04 | 12,008 | 14,358 (13,207-15,509) | 3,881 (3,570-4129) | |

[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.

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