FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME

FISHERY MANAGEMENT ANNUAL REPORT

Cal Groen, Director

UPPER SNAKE REGION

2009

Brett High
Regional Fisheries Biologist
Greg Schoby
Regional Fisheries Biologist
Damon Keen
Regional Fisheries Biologist
Dan Garren
Regional Fisheries Manager

March 2011
IDFG 11-107

2009 Upper Snake Region Annual Fishery Management Report

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (CONT.)

2009 Upper Snake Region Annual Fishery Management Report

Lakes and Reservoirs Investigations

HENRYS LAKE

ABSTRACT

We used 23 standard experimental gill nets (12 sinking, 11 floating) set at locations to assess fish populations and relative abundance in Henrys Lake during May 2009. Gill net catch rates (fish per net night) for Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* and hybrid trout (rainbow trout *O. mykiss* x Yellowstone cutthroat trout) were 4.0 and 2.6 fish per net night, which is below the long term average of 5.7 and 4.0, respectively. Brook trout *Salvelinus fontinalis* catch rates were 3.6 fish per net night, which is above the long term average of 1.7 fish per net night. Relative weight (W_r) for trout species averaged between 93 and 102 and has declined compared to prior years. Median catch rate for Utah chub *Gila atraria* increased from 0.5 fish per net in 2008 to 8 fish per net in 2009. Ten percent (9 of 91) of gill net-caught cutthroat trout were adipose clipped, indicating low levels of natural reproduction in Henrys Lake. Zooplankton surveys documented a high abundance of preferred size zooplankton in Henrys Lake.

A creel survey estimated overall catch rates at 0.63 trout per hour, slightly below our management goal of 0.7 trout per hour. Hybrid trout and brook trout both met or exceeded our management goals for catch rate and size, while cutthroat trout failed to meet either goal.

Dissolved oxygen levels were monitored to assess the possibility of a winterkill event from December 2008 through March 2009. Based on depletion estimates, dissolved oxygen levels were predicted to remain adequate and we did not operate the aeration system.

Spawning operations at Henrys Lake produced over 2 million eyed Yellowstone cutthroat trout eggs and 600,000 eyed hybrid trout eggs. Sterility tests from Henrys Lake hybrid trout production indicate a 100% induction rate. Contrary to the results of the gill net survey, 150 of the 4,184 (4%) returning Yellowstone cutthroat trout checked at the hatchery were adipose clipped, indicating natural reproduction may be contributing to the population within Henrys Lake.

Riparian fencing was installed and maintained on Duck, Targhee, Howard and Timber creeks, as well as around the south and north side of the county boat dock. Fish screens were operated and maintained on 13 irrigation diversions on Howard, Targhee, and Duck creeks, and a new fish screens was installed on previously unscreened diversion on Duck Creek.

Authors:

Greg Schoby
Regional Fishery Biologist

Damon Keen
Regional Fishery Biologist

Dan Garren
Regional Fishery Manager

METHODS

Population Monitoring

As part of routine population monitoring, we set gill nets at six standardized locations (Figure 1) in Henrys Lake from May 17 to May 21, 2009 for a total of 23 net nights. Gill nets consisted of either floating or sinking types measuring 46 m by 2 m, with mesh sizes of 2 cm, 2.5 cm, 3 cm, 4 cm, 5 cm and 6 cm bar mesh. Nets were set at dusk and retrieved the following morning. We identified captured fish to species and recorded total lengths (TL). We calculated catch rates as fish per net night and also calculated 95% confidence intervals. We used a one-way analysis of variance (ANOVA) to detect differences in gill net catch rates in 2009 compared to previous years. We also used a Kruskal-Wallis one-way analysis of variance to analyze gill net catch rates of Utah chub, as this species demonstrates schooling behavior, and are likely not randomly distributed.

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

We removed the 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.

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 (rainbow trout x Yellowstone cutthroat 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) 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.

Zooplankton samples were collected at three standard locations (Targhee Creek, Outlet, and Wild Rose) (Figure 1) on July 29 and again on August 26. We preserved zooplankton in denatured ethyl alcohol at a concentration of 1:1 (sample volume : alcohol). After ten days in alcohol, phytoplanktons were removed from the samples by re-filtering through a 153: mesh sieve. The remaining zooplankton were blotted dry with a paper towel and weighed to the nearest 0.1 g. Biomass estimates were corrected for tow depth and reported in g/m. We measured competition for food (or cropping impacts by fish) using the zooplankton productivity ratio (ZPR) which is the ratio of preferred (750:) to usable (500:) zooplankton. We also calculated the zooplankton quality index (ZQI) to account for overall abundance of zooplankton using the formula ZQI = (500: + 750:) * ZPR (Teuscher 1999).

Creel Survey

Henrys Lake hatchery personnel conducted a creel survey throughout the fishing season to collect effort, catch and harvest information. We stratified the sample into eight periods to account for unequal angler effort through the season and to comply with previously used methodology. Survey methodology used the original seven strata established in previous surveys, which consisted of a three-day period on the opening weekend, a 19-day period following the opener, and five 28-day periods throughout the rest of the season. During 2009, we included an additional survey strata (30 days) to encompass the month of November. November surveys were not included in previous surveys as historically the fishing season had closed at the end of October. We conducted interviews on 30% of days in each stratum. We generated instantaneous counts using randomly selected dates and times, and counted anglers twice per day from a point overlooking the lake with the aid of binoculars and spotting scopes. A boat was subsequently used to count any anglers not visible from shore. Counts were completed within one half hour. Creel clerks interviewed anglers at access sites and by roving via boat throughout the day to obtain method of fishing, time spent fishing, and number, species and length of fish caught. We analyzed data using standard methodology and the Idaho Department of Fish and Game creel census program (McArthur 2005).

Water Quality

We measured winter dissolved oxygen concentrations, snow depth, ice thickness and water temperatures at five established sampling sites (Pittsburg Creek, County Boat Dock, Wild Rose, Outlet, and Hatchery) on Henrys Lake between December 2008 and March 2009 (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 O2 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). Upon determining the likelihood of reaching the critical dissolved oxygen threshold prior to the projected recharge date of April 1st, we can initiate aeration as needed.

Spawning Operation

We operated the Hatchery Creek fish ladder for the spring spawning run from February 18 through April 28. Fish ascending the ladder were identified to species and counted. We measured total length for a sub-sample (10%) of each group. Yellowstone cutthroat trout were produced using ripe females spawned into seven-fish pools and fertilized with pooled milt from seven males. Hybrid trout were produced with Yellowstone cutthroat trout eggs and Kamloops rainbow trout milt obtained from Hayspur Hatchery. Hybrid trout were sterilized by inducing a triploid condition using pressure to shock the eggs post-fertilization. Once hybrid trout eggs reached 47 minutes and 45 seconds post-fertilization, eggs were placed in the pressure treatment machine at 10,000 psi and held at this pressure for 5 minutes. A random sample of 60 hybrid fry was taken from the Mackay Hatchery and sent to the Eagle Fish Health Lab to test induction rates of sterilization. Hybrid trout eggs were shipped to Mackay and Ashton Hatcheries for hatching, rearing and subsequent release back into Henrys Lake and other Idaho waters. Yellowstone cutthroat trout eggs were shipped to Mackay for hatching, rearing and release back into Henrys Lake.

We collected ovarian fluids from all pooled egg lots of Yellowstone cutthroat trout to detect the presence of bacterial disease. We also collected 25 random viral samples from combined egg pools. A mixed-sex group of 60 adult Yellowstone cutthroat trout were sacrificed and sent to the Eagle Fish Health Laboratory for various disease testing, including bacterial kidney disease, whirling disease, and furunculosis.

Riparian Fencing and Fish Screening

Electric fencing has been in place at Henrys Lake since the early 1990's to protect riparian areas from grazing livestock. We stretched fencing and installed solar panels, batteries, and connections during May 2009 at ten sites on the tributaries of Henrys Lake. Two new riparian fences were installed along Duck Creek and Kelly Springs Creek. The fences were installed along previously unfenced riparian buffer areas. We routinely checked fencing during the summer and fall for proper voltage and function. Fences were let down and prepared for winter in November 2009.

Fish screens are located on eleven irrigation diversions on tributaries streams to Henrys Lake. Screens were routinely maintained, cleaned and checked for proper operation during the summer and fall months of 2009. One new modular screen was installed on Duck Creek at a diversion that was previously screened, but was dilapidated and no longer functional.

RESULTS

Population Monitoring

We collected 744 fish in 23 net nights of gill net effort. Catch composition was 12% Yellowstone cutthroat trout, 8% hybrid trout, 11% brook trout, and 69% Utah chub (Figure 2). Yellowstone cutthroat trout ranged from 152 to 512 mm TL (Figure 3), hybrid trout 230 to 585 mm (Figure 4), and brook trout 119 to 513 mm (Figure 5). Mean length at age-3 was 393 mm, 458 mm and 421 mm for Yellowstone cutthroat trout, hybrid trout and brook trout, respectively (Table 1). Proportional stock density (PSD) and RSD-400 were high for hybrid trout (98 and 88, respectively) and for cutthroat trout (79 and 56, respectively) (Table 2). Brook trout PSD and RSD-400 were lower at 40 and 33, respectively. Mean relative weights for all trout species ranged between 93 and 102 (Table 2). Relative weight of Yellowstone cutthroat trout, though still at acceptable levels, was the lowest observed since sampling began in 2004 (Figure 6). Gill net catch rates for trout were highest for Yellowstone cutthroat trout at 4.0 fish per net night, followed by brook trout at 3.6, and hybrid trout at 2.6 fish per net night (Figure 7). Yellowstone cutthroat trout catch rate was not significantly different when compared to the previous five years of catch rate data, aside from 2007, which is the highest gill net catch rate documented and is significantly higher than all other surveys. Similar to Yellowstone cutthroat trout, hybrid trout catch rates were not significantly different from the previous five years' catch rates. We did observe significant differences in the previous five years of brook trout catch rates, with 2009 being greater than all other years besides 2007 (ANOVA, $P < 0.001$). The mean number of Utah chub per net night was 22.3, down from 50.5 in 2008 while the median catch rate for Utah chub increased from 0.5 in 2008 to 8 in 2009 (Figure 8). Results from our gill net surveys showed 9 of 91 (10%) Yellowstone cutthroat trout were adipose-clipped (Table 3). Zooplankton monitoring showed that preferred size zooplankton is not being cropped by fish (ZPR = 1.28) and that abundance of quality zooplankton is high in Henrys Lake (ZQI = 2.11) (see *Regional Lakes Zooplankton chapter* for more details).

Creel Survey

Through our creel survey conducted from May through November 2009, we estimated that anglers spent 124,613 hours fishing Henrys Lake and caught 78,855 trout, for a catch rate of 0.63 fish per hour (Figure 9). Management target catch rates for hybrid trout (0.15 per hour) and brook trout (0.10 per hour) were met during 2009, with hybrid trout and brook trout catch rates at 0.16 and 0.10, respectively. Yellowstone cutthroat trout catch rates during 2009 were slightly below our management goal (0.37 vs. 0.45). We estimated 17% (13,788) of the total catch was harvested. Of the 13,788 fish harvested, catch composition was 49% (6,770) Yellowstone cutthroat trout, 41% (5,681) hybrid trout, and 10% (1,337) brook trout. Mean size of harvested fish was 450 mm, 502 mm, and 419 mm for cutthroat, hybrid, and brook trout, respectively. Of the Yellowstone cutthroat trout harvested, 5% exceeded 500 mm, which is below our management goal of 10%. However, 49% of the harvested hybrid trout were greater than 500 mm and 55% of harvested brook trout were greater than 430 mm, both of which exceed our management goals of 20% and 5% greater than their respective size categories. The majority of anglers fishing Henrys Lake were residents (75%). Gear type used was primarily bait (44%), followed by flies (33%) and lures (23%).

Water Quality

Total dissolved oxygen diminished from 49.1 g/m^2 to 43.9 g/m^2 at the Pittsburgh Creek site, 35.7 g/m^2 to 24.3 g/m^2 at the County dock, 42.6 g/m^2 to 33.4 g/m^2 at the Wild Rose site, 25.9 g/m^2 to 20.3 g/m^2 at the Outlet, and 37.0 g/m^2 to 30.8 g/m^2 at the Hatchery (Table 5). In the winter of 2008-2009, analysis of the dissolved oxygen depletion model predicted dissolved oxygen would remain above the level of concern throughout the winter (Figure 13), therefore aeration was not implemented.

Spawning Operation

We collected 4,680 Yellowstone cutthroat trout (2,824 males and 1,856 females) that entered the hatchery spawning ladder between February 18 and April 28, 2009. Yellowstone cutthroat trout lengths averaged 430 and 454 mm for males and females respectively, with a combined mean length of 442 mm. We also collected 286 hybrid trout (274 males and 12 females). Hybrid trout males and females total lengths averaged 518 mm and 470 mm, respectively, with a combined mean length of 494 mm.

We collected 3,867,705 green eggs from 1,392 Yellowstone cutthroat trout females for a mean fecundity of 2,779 eggs per female. Eyed Yellowstone cutthroat trout eggs totaled 2,087,872 for an overall eye-up rate of 76%. We shipped all eyed Yellowstone cutthroat trout eggs to Mackay Hatchery where they were hatched and reared.

We collected 811,200 green eggs from 312 female Yellowstone cutthroat trout for hybrid trout production. Eyed hybrid trout eggs totaled 603,226 for an overall eye-up rate of 74%. Lot 1 and part of Lot 2 eggs were treated to induce sterility. The other component of Lot 2 eggs were not treated to induce sterility and remained fertile as they were bound for Salmon Falls Reservoir. Hybrid eye-up was 77% in Lot 1 and 66% in Lot 2 sterile component and 76% Lot 2 fertile component. 355,645 of the hybrid eggs were shipped to Mackay for hatching, rearing, and subsequent release into Henrys Lake and 131,452 fertile and sterile hybrid eggs were shipped to American Falls for release into Salmon Falls Reservoir. Two spawn days were devoted to production of hybrid eggs during the 2009 spawn take. Sterilization induction rates for the sterile hybrid production component indicated 100% (60/60) success for the triploid condition.

Additional analysis and results are available in the IDFG Resident Fish Hatcheries 2009 Annual Report (IDFG 2010).

Riparian Fencing and Fish Screening

Electric fencing functioned well during the year and riparian infringements by cattle were rare. The fish screens also functioned well during the summer of 2009. The new screens on Targhee and Howard Creek that had been installed during the summer of 2008 especially functioned well and will be of benefit both to improved fry survival and facility labor costs.

One new modular screen was installed on Duck Creek at a location where an older, dilapidated screen had been in use. The location of the new screen was on the Taft property, near the mouth of Duck Creek. Funding for the replacement screen was provided through the Landowner Incentive Program, with contributions from the Henrys Lake Foundation and the IDFG. Screen fabrication and delivery was provided by the IDFG screen shop. Installation was completed by a private contractor.

DISCUSSION

Although late ice cover limited our ability to collect our target of 50 gill net nights, we were able to collect 23 net nights of effort and observe some differences in comparison to past surveys. While little differences were seen in Yellowstone cutthroat trout and hybrid trout gill net catch rates, brook trout catch rates in 2009 were the highest documented since 2000. Catch rates in 2000 followed three years of high brook trout stocking (1996-1998; ~200,000 juveniles annually). Brook trout stocking ceased in 1999, but was resumed in 2003 at approximately 100,000 juveniles annually. The benefits of resumed brook trout stocking were first observed in 2007 and continue to be seen in our 2009 gill net surveys, as well as in angler catch rates.

During the 2009 fishing season, we estimated overall catch rates at 0.63 fish per hour. Angler catch rates ranged from 0.4 to 1.3 fish per hour, and were not statistically below our management goal of 0.7 fish per angling hour. Overall catch rates in 2009 were the highest observed since 1999, and the second highest level recorded since 1994. Brook trout catch rates met our management goal of 0.1 fish per hour and greatly exceeded our management goal of 5% greater than 430 mm, with 55% of the brook trout harvested in 2009 greater than 430mm. Although both angler catch rate and gillnet catch rate in 2009 increased over previous surveys, there is little correlation between either of these variables and stocking rate of brook trout. Increased abundance and size of brook trout caught by anglers and gill nets may possibly be related to increased life span of sterile brook trout. Both catch rate and size management goals for hybrid trout were met with catch rates at 0.16 (goal: 0.15) and 49% of harvested hybrid trout exceeding 500 mm (goal: 20% >500 mm). Yellowstone cutthroat trout harvest failed to meet our catch rate goal (0.37 vs. goal: 0.45) or size goal established in our management plan (5% harvested > 500 mm vs. goal: 10% >500 mm). Based on stocking rates two years prior (626 fingerling trout per hectare), this is consistent with the findings of Garren et al. (2008); the possibility of meeting both of these objectives simultaneously does not exist. Additionally, considering the relatively low harvest rate of trout caught from Henrys Lake, using angler harvest data as a metric to evaluate our management goals (particularly size goals) may bias our evaluation. In the future, using other methods such as spring gill net data may be more useful in evaluating and setting management goals.

Utah chub continue to comprise the majority of the species composition in our gill net catch from Henrys Lake and our data indicate that the Utah chub population in Henrys Lake has increased over levels observed 10 – 15 years ago. Concerns over the increasing Utah chub population have focused on their potential impact to the trout fishery. Teuscher and Luecke (1996) documented significant declines in zooplankton biomass and kokanee growth as Utah chub densities increased. Previous research on Henrys Lake has documented some dietary overlap between Utah chub and trout (Garren 2006), primarily chironomids and scuds (by weight). Results from zooplankton surveys continue to rank Henrys Lake as one of the most productive lakes within the Upper Snake Region, and sampling has shown no signs of competition for preferred zooplankton forage. However, we have seen declines in trout relative weight. Between 2004 and 2008, mean relative weights of all trout species were consistently above 100, suggesting an overabundance of available food resources. However, during 2009 Yellowstone cutthroat trout and brook trout relative weights have dropped to 94 and 93, respectively. Hybrid trout relative weights, which averaged 119 from 2004 – 2008, dropped to 102 in 2009. While these relative weights are still at acceptable levels, continued declines may be an indication that food resources are more limited than in years past. As stated above, impacts to the zooplankton population have yet to be seen, but zooplankton comprised a relatively small portion of the diet for both trout and chubs (6% and 2%, respectively) during May sampling (Garren 2006). Future sampling throughout the summer may help determine changes in diet and reveal insight into competition for food resources between Utah chub and trout.

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, and implement aeration when necessary.

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

5. Examine stomach contents of trout to determine diet composition and possible predation on Utah chub.

Table 1. Mean length at age data from trout caught with gill nets in Henrys Lake, Idaho 2009. Ages were estimated using otoliths.

Species	Mean Length (mm) at Age			
	1	2	3	4
Yellowstone cutthroat trout	190	292	393	447
(No. Analyzed)	(1)	(16)	(53)	(11)
Hybrid trout	--	327	458	514
(No. Analyzed)	--	(6)	(43)	(10)
Brook trout	211	328	421	468
(No. Analyzed)	(48)	(7)	(20)	(3)

Table 2. Stock density indices (PSD and RSD-400) and relative weights (Wr) for all trout species collected with gill nets in Henrys Lake, Idaho 2009. Sample size (*n*) for relative weight values is noted in parentheses.

	Brook trout (*n*)	**Hybrid trout (*n*)**	**Yellowstone cutthroat trout (*n*)**
PSD	40	98	79
RSD-400	33	88	56
Wr			
<200 mm	87 (8)	--	91 (2)
200 – 299 mm	90 (43)	--	92 (19)
300 – 399 mm	98 (5)	102 (6)	93 (20)
>399 mm	100 (24)	102 (52)	94 (50)
Mean	93	102	94

Table 3. Fin clipping data from Yellowstone cutthroat trout (YCT) stocked in Henrys Lake, Idaho. Annually, ten percent of stocked YCT receive an adipose fin clip. Fish returning to the Hatchery ladder and fish captured in annual gill net surveys are examined for fin clips.

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

[a] Includes fish from gill net samples and creel survey.

Table 4. Dissolved oxygen (DO) (mg/l) levels recorded in Henrys Lake, Idaho winter monitoring 2008-2009.

Location	Date	Snow depth (in)	Ice depth (in)	DO Ice bottom	DO 1 meter	DO 2 meters	DO 3 meters	Total g/m^3
Pittsburg Creek	12/9/08	--	--	--	--	--	--	--
	12/22/08	10	9.5	11.1	10.9	11.5	10.8	49.1
	1/5/09	0	11	1413.0	11.4	11.1	9.1	45.8
	1/14/09	3	15	12.9	11.9	11.6	9.9	48.0
	1/29/09	4	22	14.4	13.4	11.9	8.2	43.9
County Boat Ramp	12/9/08	--	--	--	--	--	--	--
	12/22/08	6	14	11.8	11.3	10.6	9.3	35.7
	1/5/09	8	15	11.6	11.3	10.1	8.7	35.7
	1/14/09	1	18	11.9	10.1	9.3	7.3	31.8
	1/29/09	3	20	11.5	9.5	8.1	5.7	24.3
Wild Rose	12/9/08	--	--	--	--	--	--	--
	12/22/08	2	14	11.4	11.4	11.2	11.1	42.6
	1/5/09	10	15	11.9	11.3	11.1	10.4	39.4
	1/14/09	10	16	12.0	11.2	10.6	9.4	37.4
	1/29/09	13	17	12.0	11.1	10.1	7.7	33.4
Outlet Bay	12/9/08	--	--	--	--	--	--	--
	12/22/08	11	6.5	11.2	11.6	8.6	5.9	25.9
	1/5/09	8	12	11.2	10.4	6.7	4.6	22.1
	1/14/09	4	17	11.8	11.4	6.7	4.7	23.0
	1/29/09	4	21	11.8	10.5	5.3	3.8	20.3
Hatchery	12/9/08	0	6.5	11.1	12.0	12.0	9.3	32.8
	12/22/08	6	11	10.9	11.1	10.6	9.7	37.0
	1/5/09	10	13	12.4	11.8	11.2	9.6	39.5
	1/14/09	6	19	11.6	10.3	9.4	7.7	34.1
	1/29/09	6	19	11.6	10.1	8.7	6.9	30.8

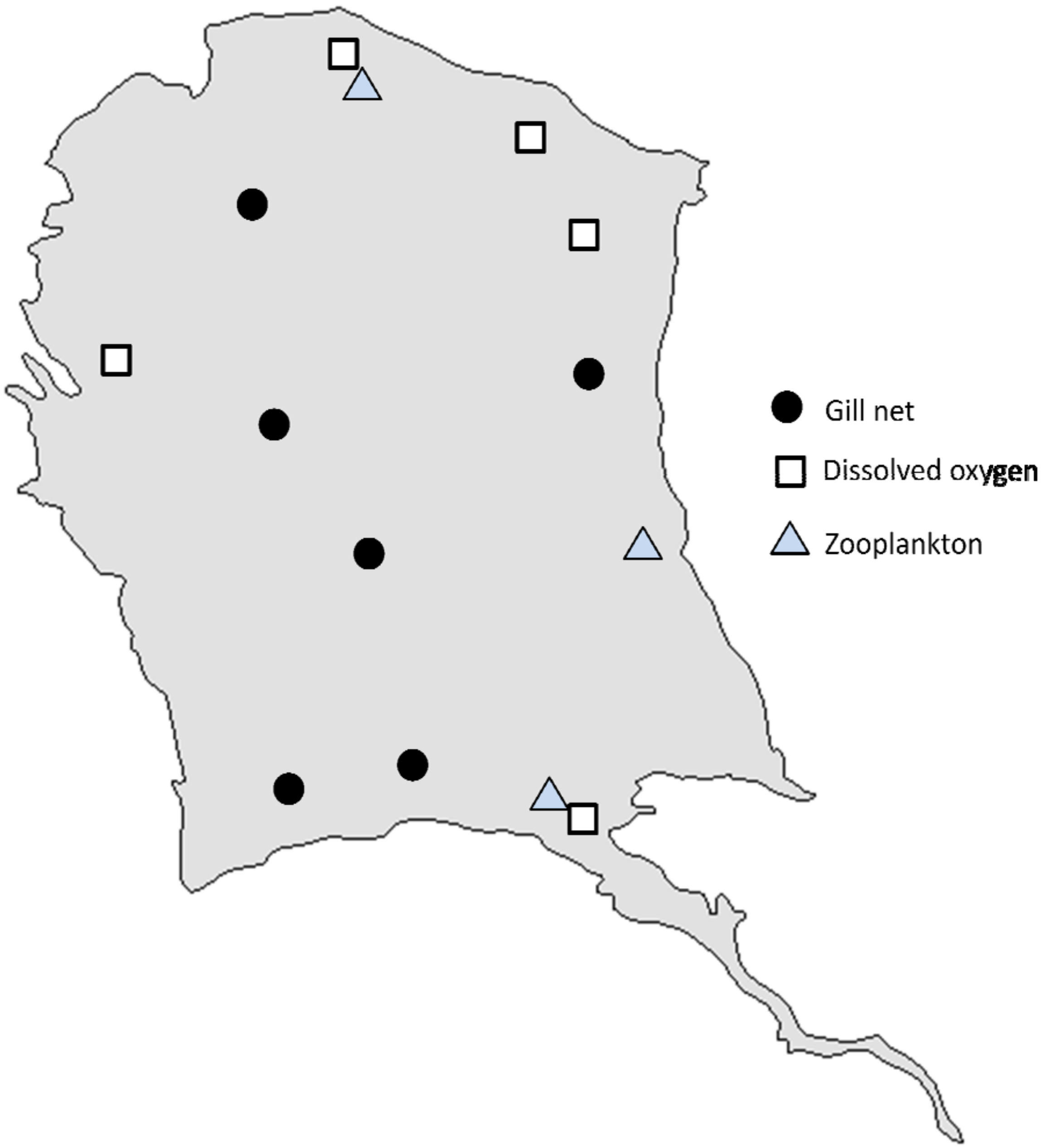

Figure 1. Spatial distribution of gill net, dissolved oxygen, and zooplankton monitoring sites in Henrys Lake, Idaho, 2009.

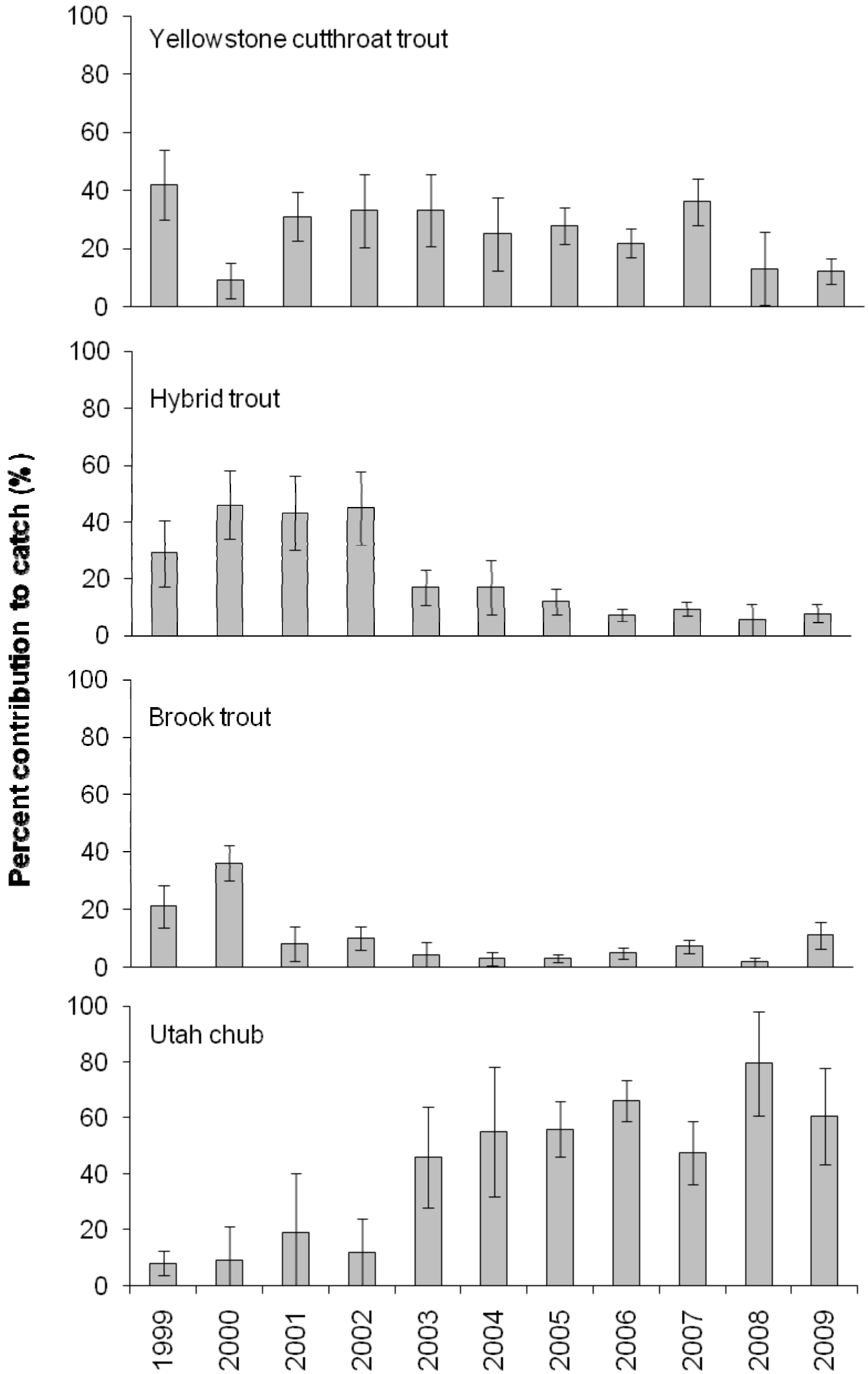

Figure 2. Relative abundance of Yellowstone cutthroat trout, hybrid trout, brook trout, and Utah chub caught in gill nets in Henrys Lake, Idaho between 1999 and 2009. Error bars represent 90% confidence intervals.

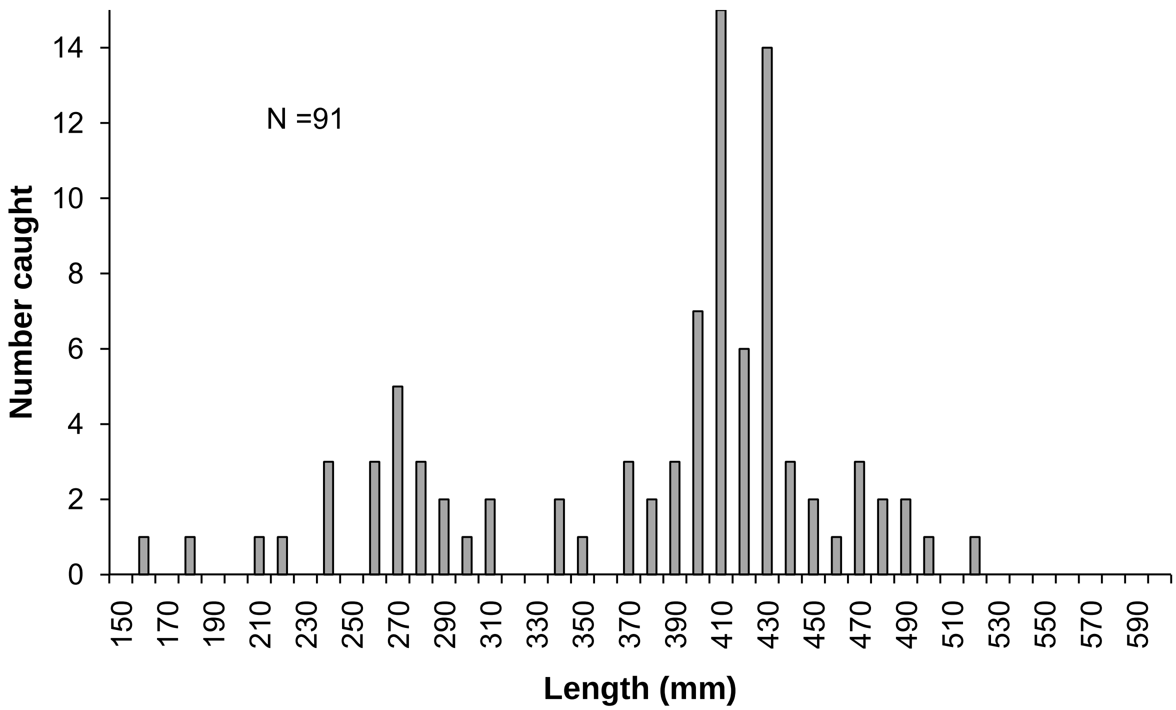

Figure 3. Yellowstone cutthroat trout length frequency distribution from gill nets set in Henrys Lake, Idaho, 2009.

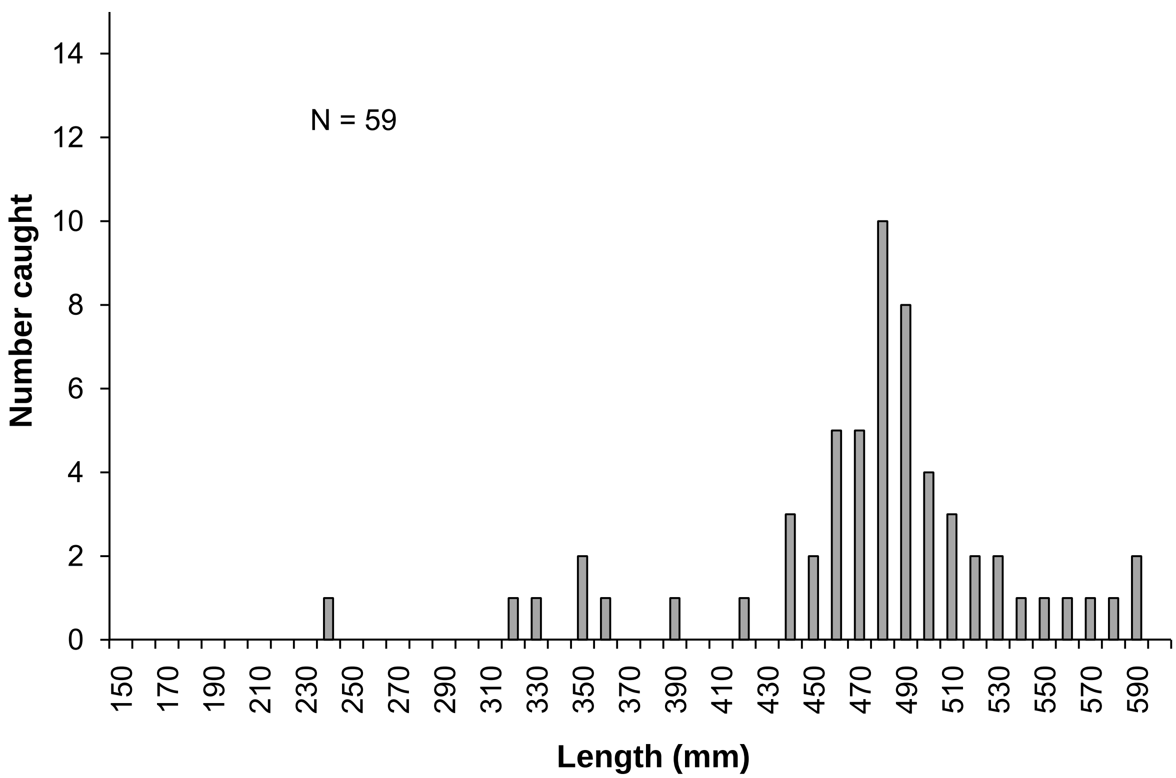

Figure 4. Hybrid trout length frequency distribution from gill nets set in Henrys Lake, Idaho, 2009.

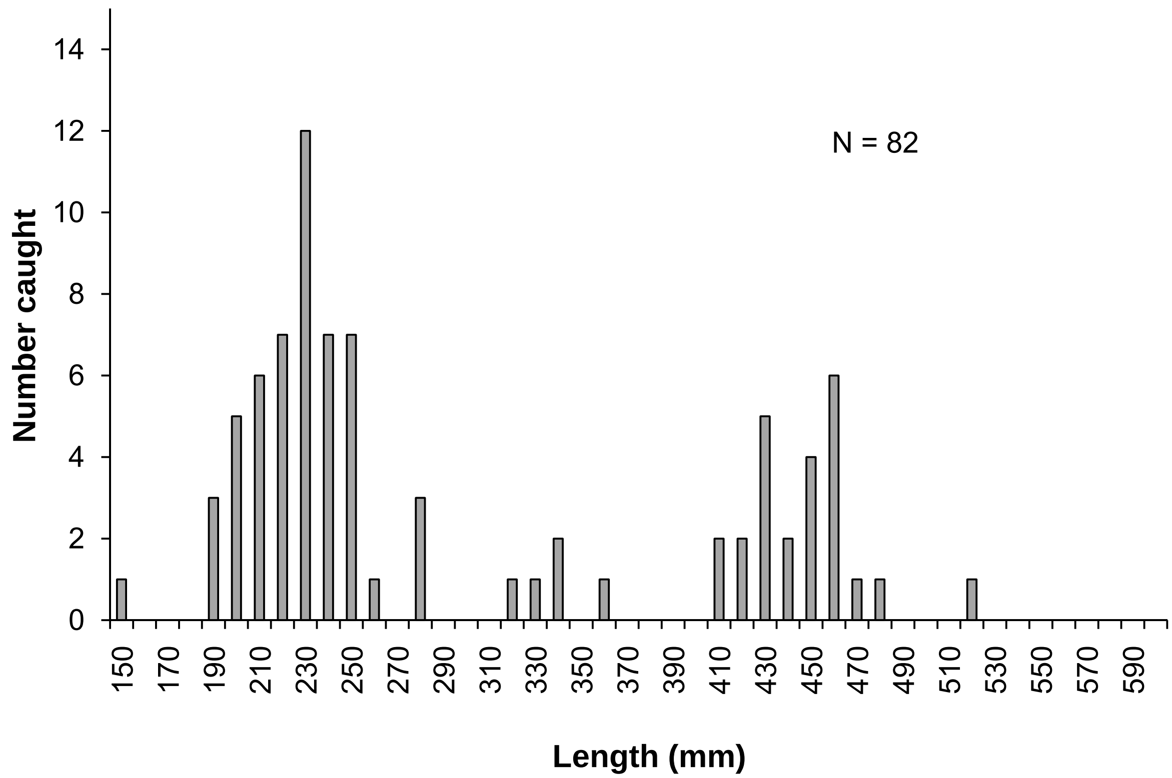

Figure 5. Brook trout length frequency distribution from gill nets set in Henrys Lake, Idaho, 2009.

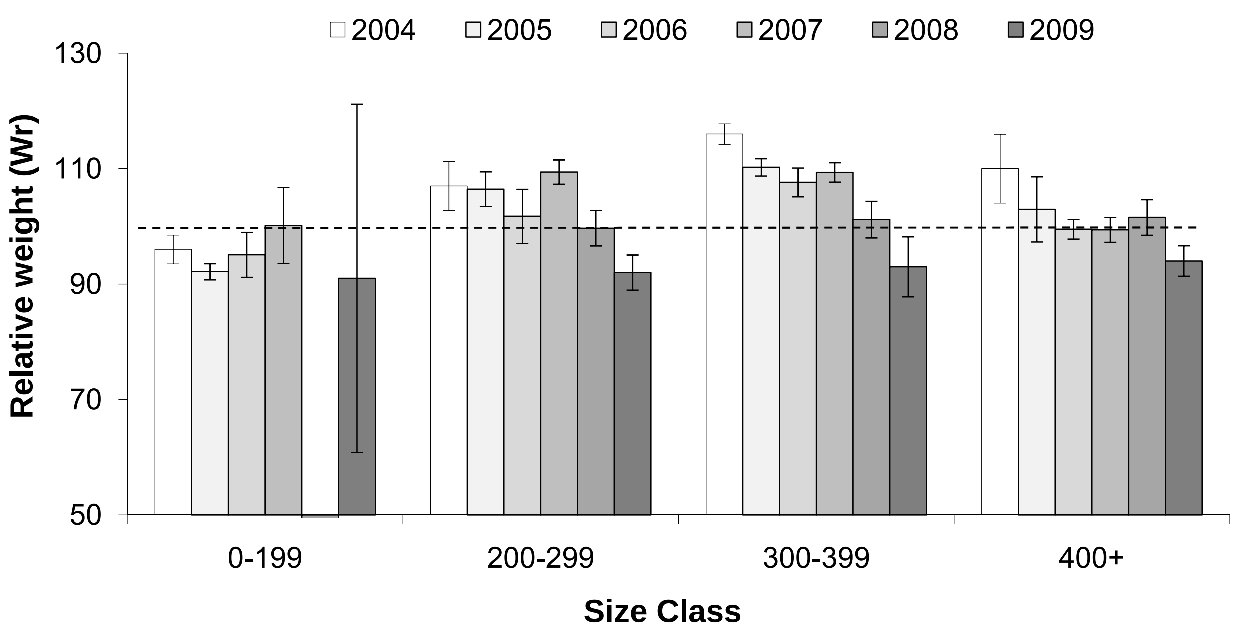

Figure 6. Relative weights (Wr) for Yellowstone cutthroat trout in Henrys Lake, Idaho 2004-2009. Error bars represent 95% confidence intervals.

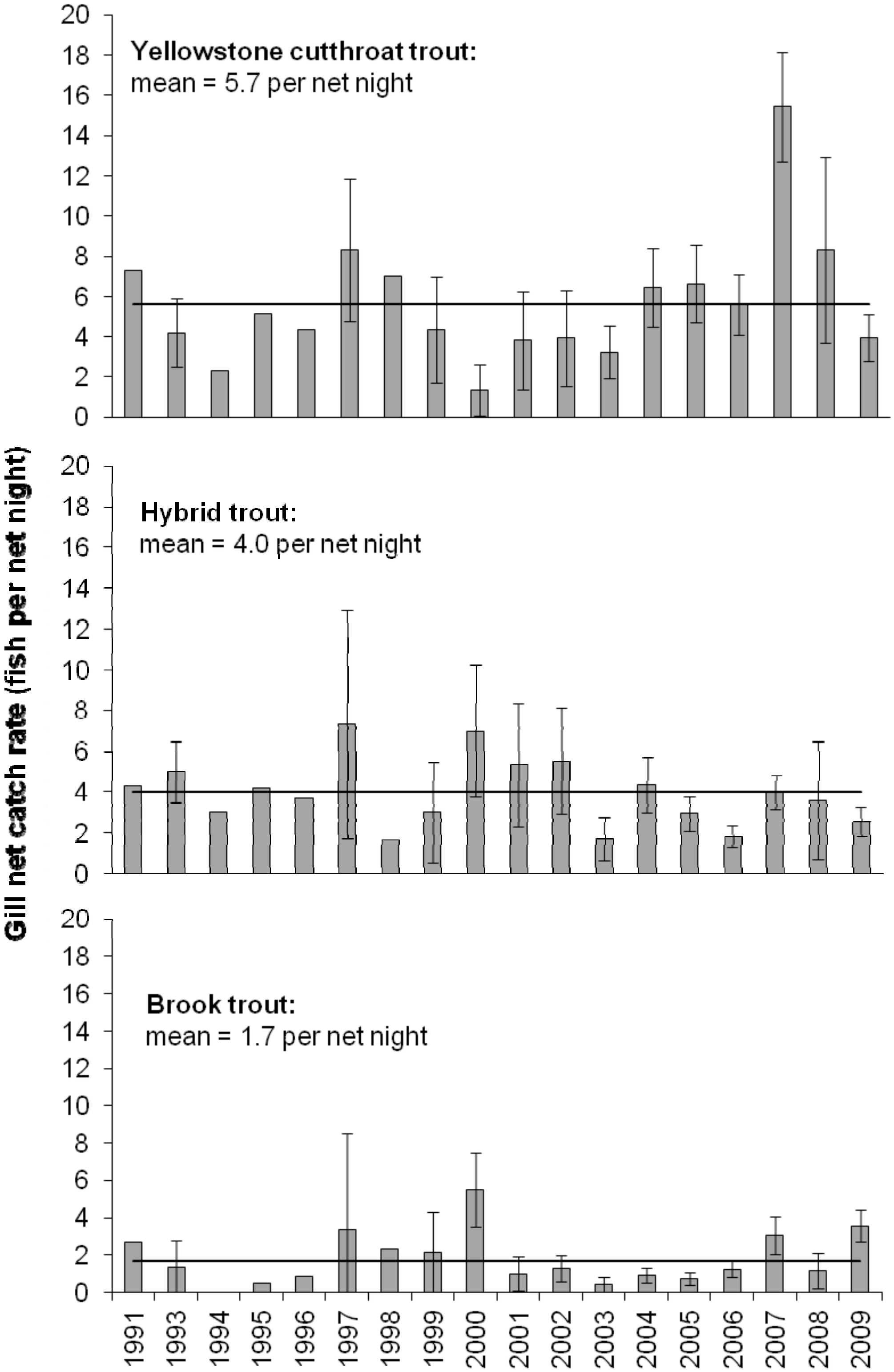

Figure 7. Gill net catch rates of Yellowstone cutthroat trout, hybrid trout, and brook trout from Henrys Lake, Idaho, 1991 to 2009. Error bars represent 95% confidence intervals. The solid line represents long term mean gill net catch rates.

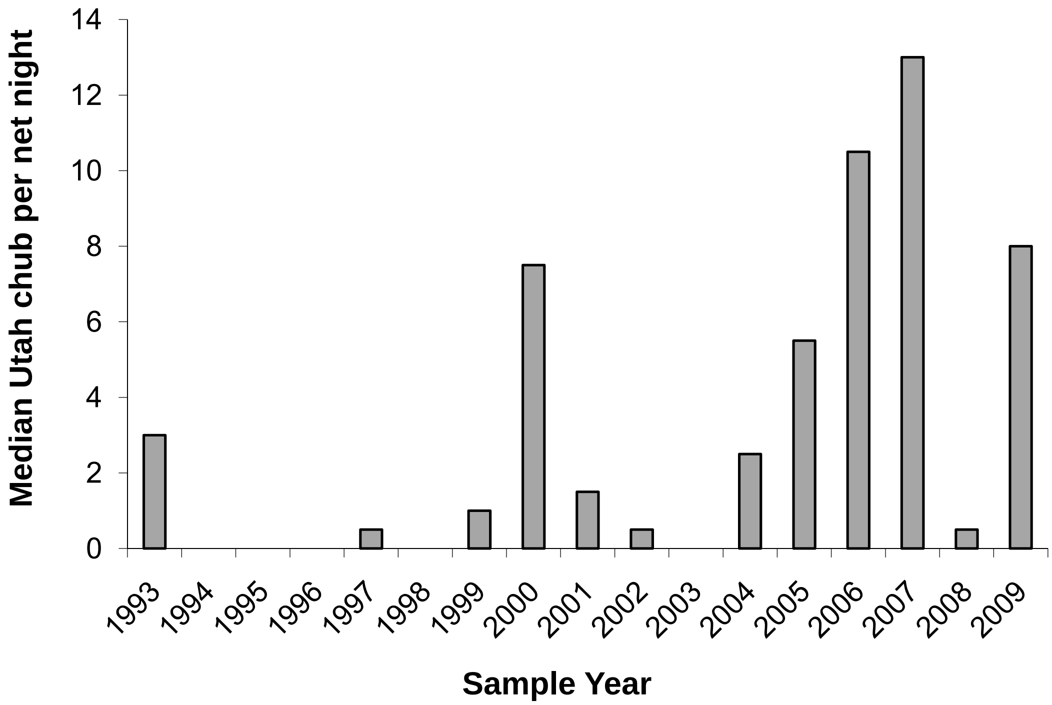

Figure 8. Median Utah chub catch rates in gill nets set in Henrys Lake, Idaho, 1993 to 2009.

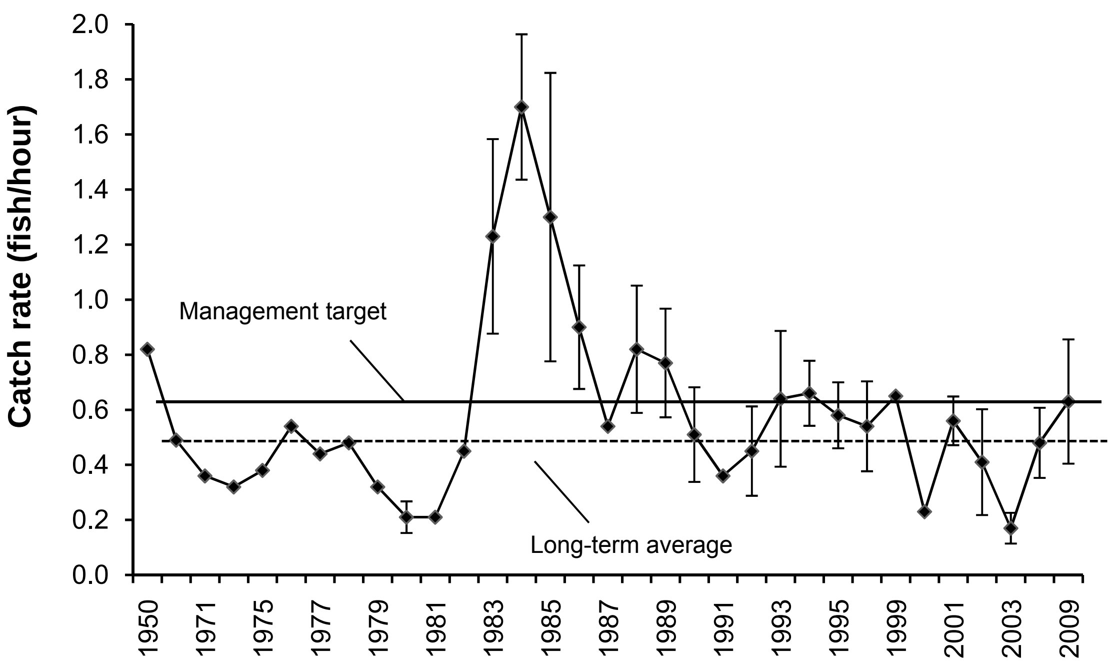

Figure 9. Angler catch rate (fish per hour) data collected from creel surveys between 1950 and 2009 from Henrys Lake. Error bars represent 95% confidence intervals. The solid horizontal line indicates the management target of catch rates at 0.7 fish per hour, while the dashed horizontal line is long-term average catch rate of 0.58 fish per hour.

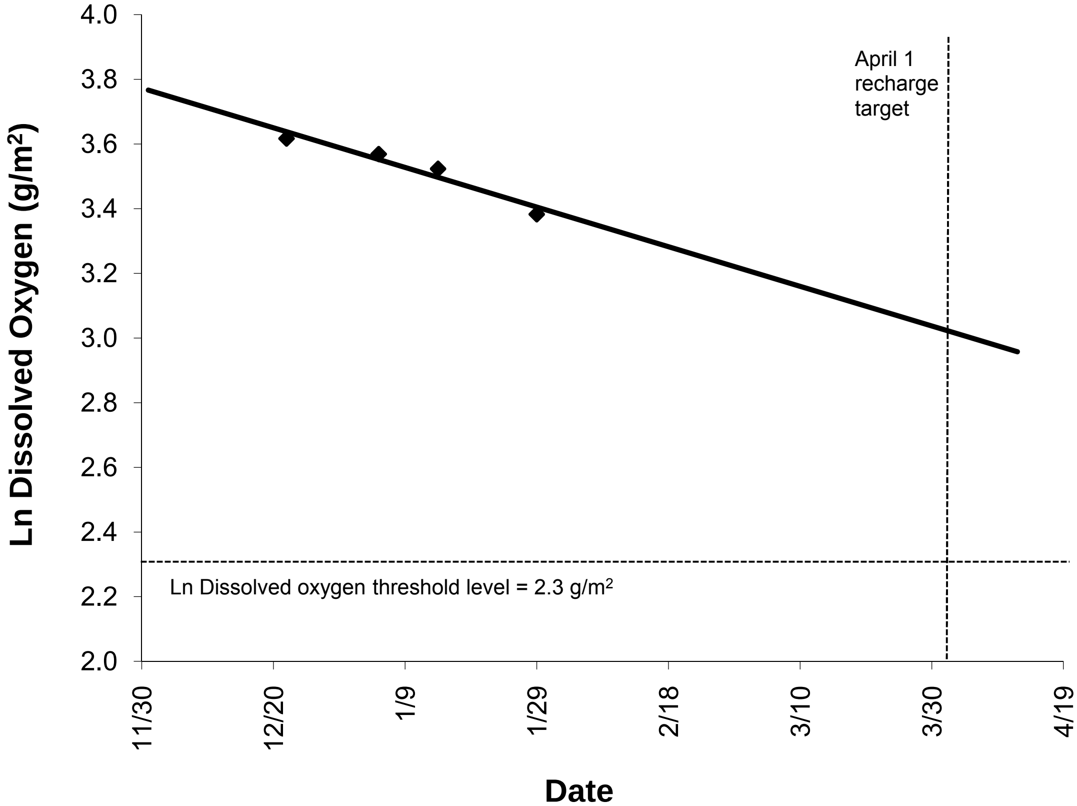

Figure 10. Mean dissolved oxygen from all sample locations and estimated lake-wide oxygen depletion rate for Henrys Lake, Idaho, 2008-2009.

Lakes and Reservoirs Investigations

RIRIE RESERVOIR

ABSTRACT

The discovery of walleye *Sander vitreus* in Ririe Reservoir during 2008 prompted increased sampling efforts throughout 2009, including telemetry research to define reservoir use, spawning locations and timing. During the spring of 2009, we used trap nets and electrofishing to capture walleye for transmitter implantation. Trap net catch rates were highest for Utah sucker *Catostomus ardens* and yellow perch *Perca flavescens* (10.6 and 10.0 fish per net night, respectively); only four walleye were captured in trap nets and catch rates were the lowest of all species captured (0.01 per net night). We captured an additional 16 walleye with 10 hours of electrofishing effort in or near the mouth of Willow Creek; no walleye were captured in other electrofishing areas although we surveyed along Ririe Dam and the mouth of Meadow Creek. The twenty walleye captured during the spring of 2009 were implanted with combined acoustic and radio transmitters to document movement patterns and identify spawning locations. Sexually mature walleye were documented migrating upstream in Willow Creek during April and May 2009, presumably for spawning activity. Tagged walleye were not observed in any shoreline concentrations within Ririe Reservoir during the spring, leading us to believe that currently, most walleye spawning activity occurs within Willow Creek. We monitored movement patterns throughout the summer and fall and used concentrations of tagged walleye to guide fall gill netting to capture and tag additional walleye. We used short (1-2 hour) experimental gill net sets during November and captured two additional walleye that were then implanted with transmitters. We will continue to track walleye through 2010. A complete review of Ririe Reservoir walleye telemetry data will be presented in the 2010 Annual Report.

Authors:

Greg Schoby
Regional Fishery Biologist

Dan Garren
Regional Fishery Manager

METHODS

We set eight trap nets in Ririe Reservoir (Figure 11) from April 1 to June 1, 2009 to collect illegally introduced walleye for use in a movement and habitat use study. We also used jet boat-mounted electrofishing gear to collect walleye from shoreline areas of Ririe Reservoir (near the dam, the Meadow Creek arm, and the Willow Creek arm including Willow Creek) on ten separate occasions, between April 20 and May 20, 2009. Additional walleye capture was attempted using gill nets for six days in November at locations where previously tagged walleye were concentrated (Figure 11). We used two experimental gill nets, set for 1-2 hours between checks, in an attempt to capture live walleye for transmitter implantation.

To determine habitat use and spawning location of walleye, we implanted combined acoustic and radio transmitters (model CH-16-25, Lotek Wireless Inc., Newmarket, ON) into 20 walleye during 2009. Transmitters were implanted using a surgical procedure similar to that described by Ross and Kleiner (1982). After surgery, walleye were held for 30 – 60 minutes to allow recovery before release. Each transmitter measured 50 mm in length, 16 mm in diameter, and weighed 24 g out of water. Battery life of each transmitter was approximately eight months. Each transmitter emitted an acoustic signal and radio signal, alternating between the two every five seconds. The acoustic signal operated at a frequency of 76.8 kHz, while the radio signal operated at 151.870 MHz.

Walleye were tracked on a weekly basis during the spring, and monthly throughout the summer and fall. Paired, boat-mounted omni-directional hydrophones were used for mobile tracking events. This system utilized MAPHOST software (Lotek Wireless Inc., Newmarket, ON), which allows simultaneous decoding of multiple signals and uses stereo hydrophones to provide direction of arrival of the transmitters' acoustic signal. Once tagged fish were located, transmitter ID, date, time, latitude and longitude, general location, lake depth at fish location, and lake surface temperature were recorded. A hand-held three element Yagi antenna was also used to search for tagged walleye in lotic environments or when tags were presumed to be above the waterline. Preliminary telemetry data from walleye tagged during 2009 is included in this report; a detailed analysis of walleye telemetry data from 2009 and 2010 will be provided in the 2010 annual report.

RESULTS

We collected 11,061 fish in 471 trap net nights of effort. Species composition was dominated by Utah sucker (45%) and yellow perch (43%), followed by Utah chub (10%) and Yellowstone cutthroat trout (2%) (Figure 12). Smallmouth bass *Micropterus dolomieu* and walleye comprised only 0.12% and 0.04% of the total catch, respectively. Trap net catch rates (fish/net night) were highest for Utah sucker (10.6) and yellow perch (10.0) (Table 5). We collected four walleye with trap nets (0.01/net night) that were then used for the telemetry study. Yellow perch (N = 4,702) ranged from 70 to 327 mm in total length (Figure 13; Table 6), with a mean total length of 195 mm. We collected weights from 694 yellow perch ranging from 70 to 312 mm total length (mean = 193 mm). Mean relative weight for yellow perch was 98. Yellowstone cutthroat trout (N = 256) ranged from 231 to 490 mm (Figure 14; Table 6), with a mean total length of 338 mm. Smallmouth bass (N = 13) ranged from 242 to 386 mm, with a mean total length of 315 mm. Walleye (N = 4) ranged from 439 to 500 mm, with a mean total length of 457 mm.

We collected 16 walleye by electrofishing throughout the lower 2 miles of Willow Creek and along shoreline areas of Ririe Reservoir near the mouth of Willow Creek in 6.5 hours of electrofishing. An additional 3.6 hours of electrofishing within the Meadow Creek arm of Ririe Reservoir and along Ririe Dam (areas we thought walleye may concentrate) did not produce any walleye.

Twenty walleye were tagged between April 20 and May 13 (spring) and two additional walleye were tagged on November 24 (fall) (Figure 15). Of the 20 walleye tagged during the spring, 16 were captured by electrofishing and 4 were captured in trap nets. Spring tagged walleye averaged 450 mm in total length (range: 402 - 511 mm) and weighed an average of 890 g (range: 545 – 1550 g). Walleye captured and tagged in the spring of 2009 migrated into the lower end of Willow Creek in early to mid-April and returned to the reservoir by mid-May. Walleye used various areas of the reservoir throughout the summer, but were predominantly found in the southern (up-reservoir) half of the reservoir. In early November, two tagged walleye were located at the mouth of the Meadow Creek arm of the reservoir. Two experimental nets set at this location over three days failed to capture any walleye. In mid-November four tagged walleye were concentrated north of Meadow Creek near the power line crossing. Three days of two experimental gill net sets yielded three walleye. One of the three captured walleye had been previously tagged; two were unmarked fish and were implanted with transmitters. Fall tagged walleye averaged 471 mm in total length (range: 465 - 476 mm) and weighed an average of 1075 g (range: 1050 – 1100 g).

DISCUSSION

Preliminary telemetry results indicate that walleye spawning activity is occurring within the lower mile of Willow Creek. We captured sexually mature walleye in or near the mouth of Willow Creek between April 20 and May 13. We captured one walleye approximately 1 mile up Willow Creek from the reservoir, near the mouth of Bear Creek. We did not observe any concentrations of tagged walleye along the reservoir shoreline to indicate that spawning may be occurring in these areas, but this may be biased since all tagged walleye were captured either in the Willow Creek arm of the reservoir or within Willow Creek itself. We were unable to collect walleye during the spring spawning season anywhere other than in the vicinity of Willow Creek. Trap nets proved to be an inefficient method of capture for walleye in Ririe Reservoir, as evidenced by net catch rates observed in the spring of 2009. As evidenced by electrofishing results, walleye are actively migrating into Willow Creek during April and May, but trap net catch rates were low. We believe that walleye migrating to Willow Creek are not following the shoreline, but are using deeper water in the Willow Creek channel, making trap net capture inefficient. Electrofishing capture was difficult due to limited visibility and increased flows during spring runoff within Willow Creek, but proved to be the most effective manner of walleye capture. A complete analysis of telemetry data collected from walleye during 2009 and 2010 will be available in the 2010 annual report.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor reservoir use by walleye and identify spawning locations using telemetry.

2. Implement annual walleye monitoring (Ontario protocol: fall walleye index netting [FWIN]) to gather information on abundance, growth, mortality, reproduction, and diet.

3. Evaluate potential options to limit walleye reproduction in Willow Creek.

4. Educate anglers on walleye movement patterns, concentrations, and importance of angler harvest to help limit the possible impacts to the existing fishery.

Table 5. Catch rates (catch per unit effort [CPUE]) and total number caught for all species collected from Ririe Reservoir in 471 trap net nights during 2009.

	Utah sucker	Yellow perch	Utah chub	Cutthroat trout	Smallmouth bass	Walleye
CPUE	10.6	10.0	2.3	0.5	0.03	0.01
n	4,981	4,702	1,105	256	13	4

Table 6. Total length (mm) summary statistics for all trap net caught game fish in Ririe Reservoir during 2009.

	Yellowstone cutthroat trout	Smallmouth bass	Walleye	Yellow perch
Mean	338	315	457	195
Median	335	319	445	198
Range	231 - 490	242 - 386	439 - 500	70 - 327
n	256	13	4	4,702

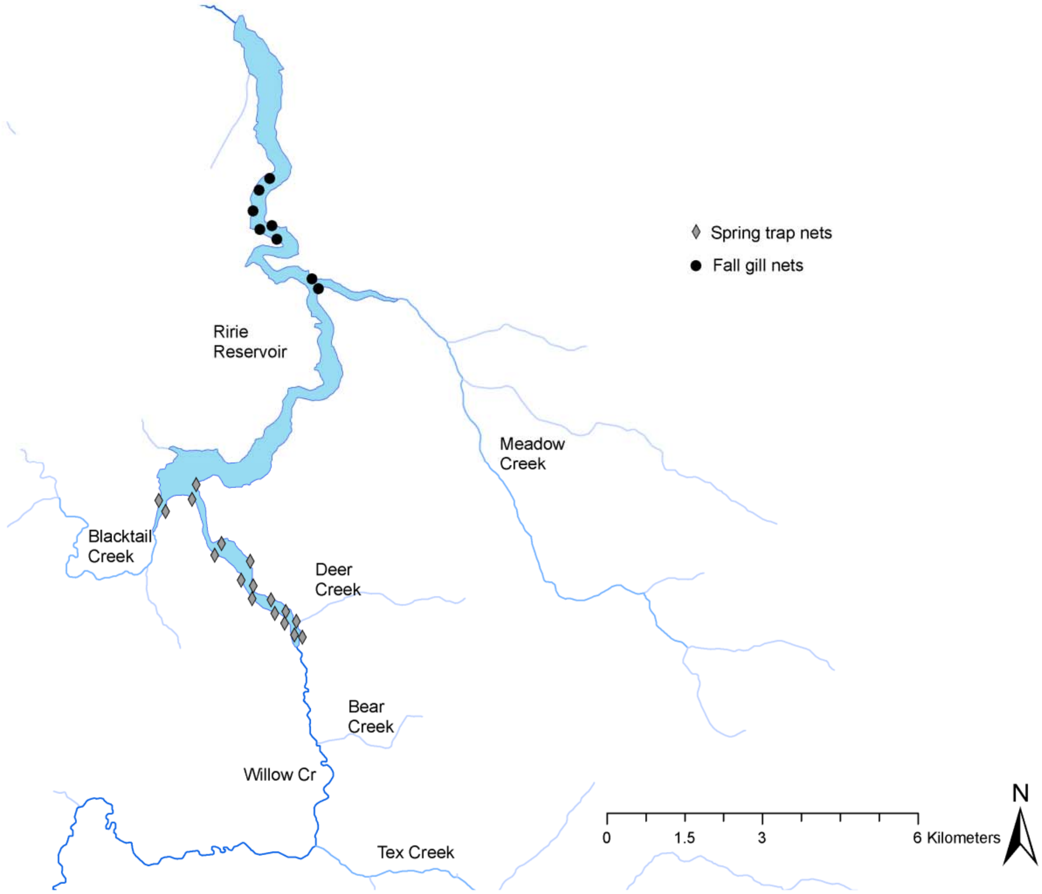

Figure 11. Locations of spring trap net and fall gill net sample sites in Ririe Reservoir, 2009.

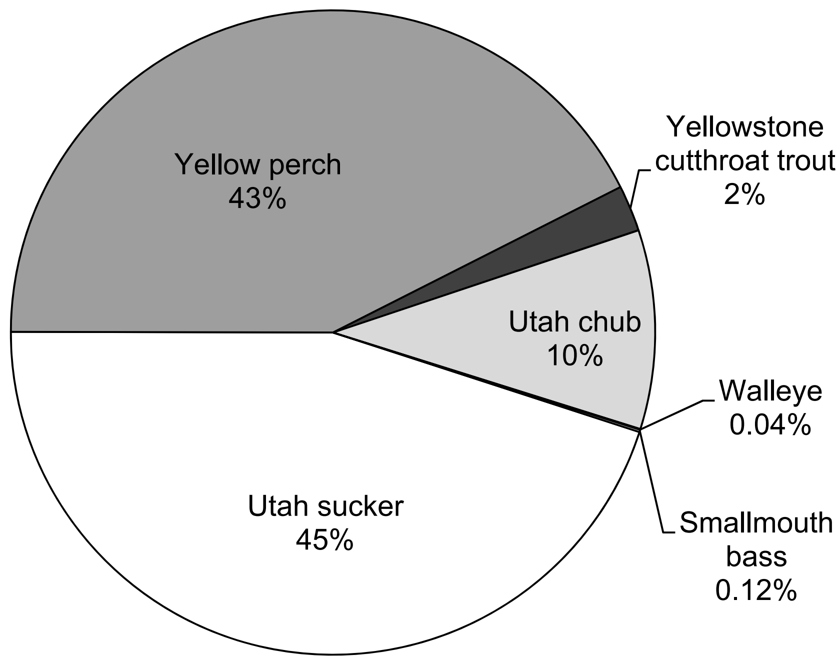

Figure 12. Species composition of fish caught in trap nets in Ririe Reservoir, spring 2009.

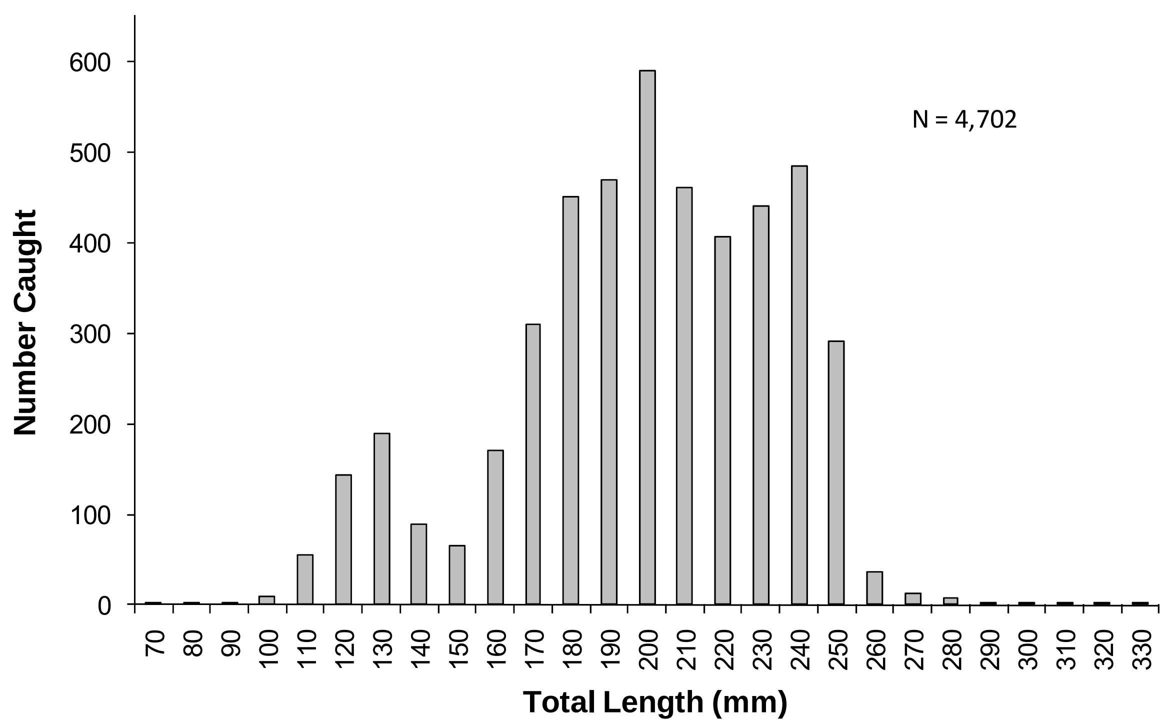

Figure 13. Length frequency of yellow perch collected in trap nets in Ririe Reservoir, 2009.

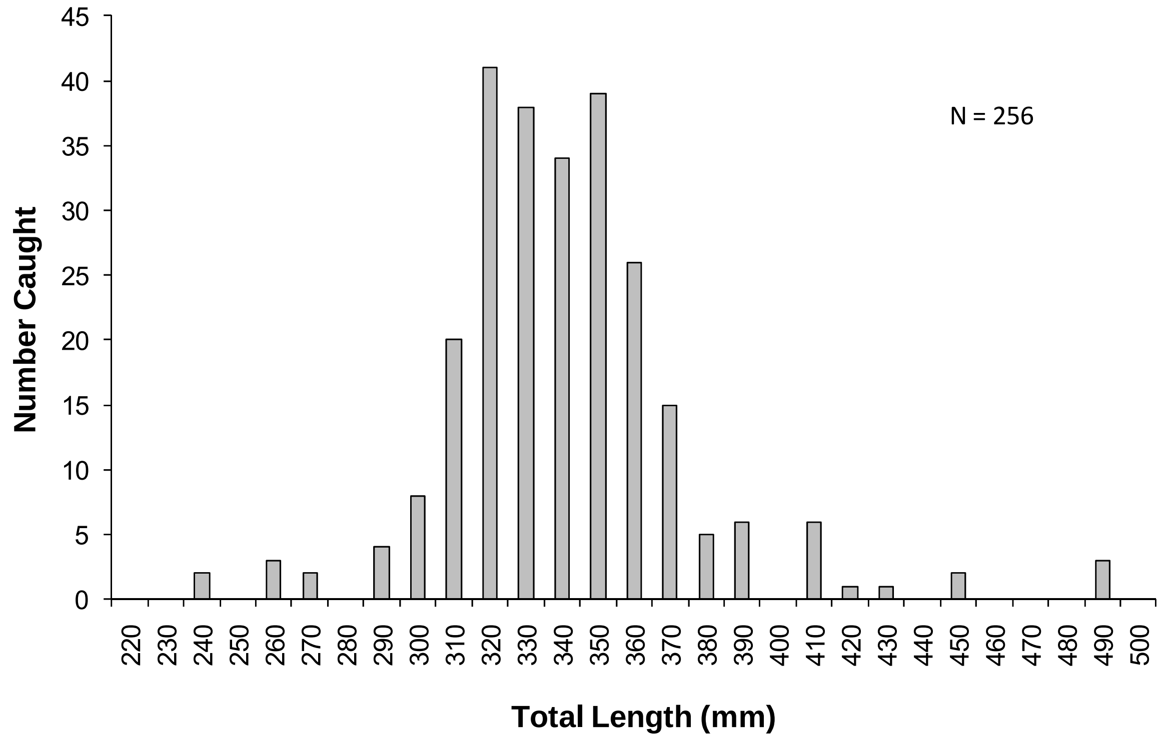

Figure 14. Length frequency of Yellowstone cutthroat trout collected in trap nets in Ririe Reservoir, 2009.

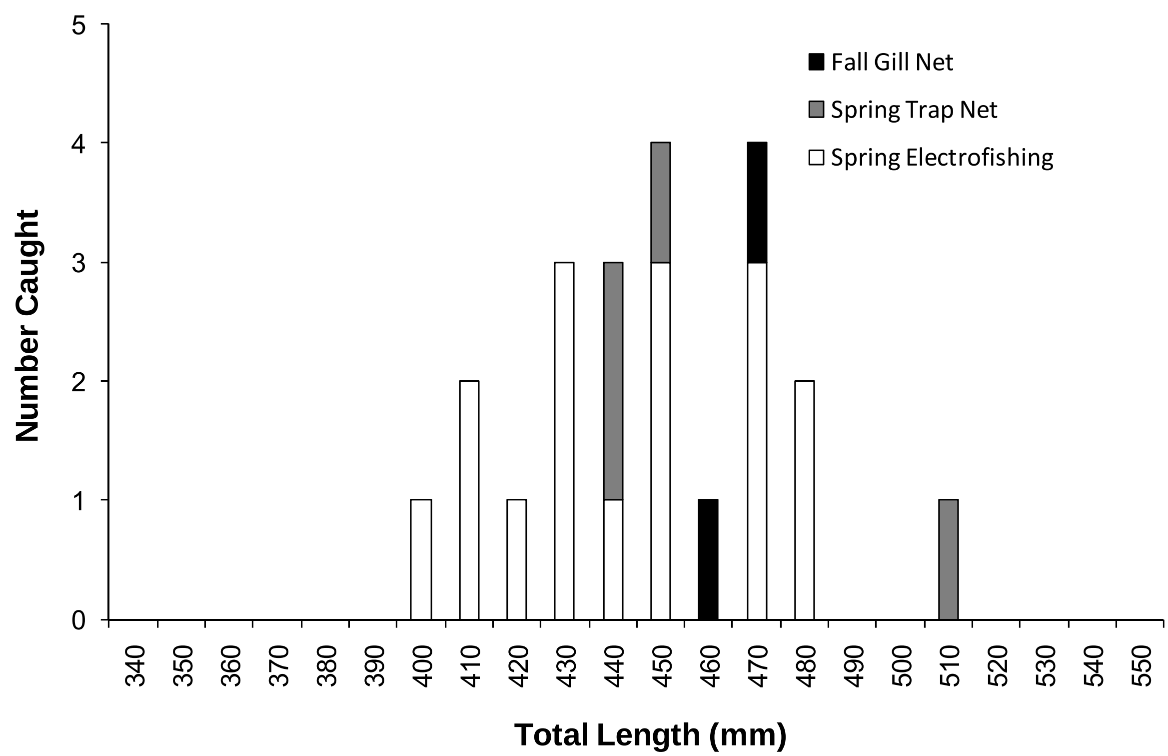

Figure 15. Length frequency of walleye implanted with combined acoustic and radio transmitters, by collection method, in Ririe Reservoir, 2009.

2009 Upper Snake Region Annual Fishery Management Report

Lakes and Reservoirs Investigations

ZOOPLANKTON MONITORING

ABSTRACT

We monitored zooplankton abundance and biomass to assess the forage resources in seven regional lakes and reservoirs. Zooplankton biomass and abundance were compared to past data to examine trends within the region and to evaluate our stocking densities in these waters. We assessed the cropping impacts by fish using the zooplankton ratio method (ZPR) and determined that preferred zooplankton are not being cropped by fish in any of the seven waters sampled. We used the zooplankton quality index (ZQI) to assess the overall abundance of preferred zooplankton and determine the appropriate stocking rate based on these data. Currently, the stocking rate of the lakes and reservoirs in which we monitored zooplankton appears adequate. Some water bodies may be able to support increased stocking rates based on forage availability, but other factors, such as water levels may affect survival of stocked fish more so than zooplankton abundance.

Authors:

Greg Schoby
Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manger

INTRODUCTION

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

METHODS

We collected zooplankton samples from seven lakes and reservoirs throughout the Upper Snake Region during 2009 (Figure 16), following the protocol described by Teuscher (1999). We collected zooplankton samples twice between early July and late August on Henrys Lake, Gem Lake, Island Park Reservoir, Mackay Reservoir, Palisades Reservoir and Ririe Reservoir. We only sampled Ashton Reservoir once, on July 20. During each sampling event, we collected samples from three locations within the lake or reservoir. We collected samples with three nets fitted with small (153:), medium (500:) and large (750:) mesh. We preserved zooplankton in denatured ethyl alcohol at a concentration of 1:1 (sample volume : alcohol). After ten days in alcohol, phytoplankton were removed from the samples by re-filtering through a 153: mesh sieve. The remaining zooplankton were blotted dry with a paper towel and weighed to the nearest 0.1 g. Biomass estimates were corrected for tow depth and reported in g/m. We estimated the relative production potential of each lake by estimating overall zooplankton biomass collected from the 153: net. We measured competition for food (or cropping impacts by fish) using the zooplankton productivity ratio (ZPR) which is the ratio of preferred (750:) to usable (500:) zooplankton. We also calculated the zooplankton quality index (ZQI) to account for overall abundance of zooplankton using the formula developed by Teuscher (1999):

ZQI = (500: + 750:) * ZPR

ZQI values obtained from zooplankton monitoring are used to assess stocking rates based on the recommendations from Teuscher (1999) (Table 7). We also examined zooplankton data (ZQI) from previous years to monitor trends in zooplankton abundance throughout the region and analyzed stocking data to determine if changes may be appropriate.

RESULTS AND DISCUSSION

Throughout the Upper Snake Region, mean zooplankton biomass from the 153: net ranged from 0.06 g/m (Gem Lake) to 1.06 g/m (Island Park Reservoir) (Table 8). Teuscher (1999) recommends conservative stocking densities in water bodies with mean biomass estimates < 0.10 g/m. During 2009, only Gem Lake zooplankton biomass estimates were below 0.10 g/m. ZPR values ranged from 0.50 (Mackay Reservoir) to 1.15 (Gem Lake) (Table 8), which indicates that preferred zooplankton are not being cropped by fish in any of the samples water bodies throughout the region. ZQI values were highest for Island Park Reservoir and Henrys Lake, and lowest for Gem Lake and Ashton Reservoir (Table 8; Figure 17).

ZQI values for Gem Lake and Ashton Reservoir were the lowest observed during 2009 (Figure 17). During 2008, Gem Lake was not sampled and Ashton Reservoir had the lowest observed ZQI value in the region. During 2006, ZQI values for both Ashton Reservoir and Gem Lake were below 0.10, indicating that fingerling stockings would likely be unsuccessful. The low retention time in both these water bodies limits the amount of zooplankton available and ultimately the success of fingerling trout stocking. Currently, Ashton Reservoir and Gem Lake are stocked with catchable rainbow trout and are managed as a yield fishery under general regulations, which is appropriate based on zooplankton monitoring data.

Mackay, Ririe, and Palisades Reservoirs have consistently shown moderate zooplankton levels (Figure 17). Mackay Reservoir ZQI values have averaged 0.57 from 2006 through 2009, with 0.95 observed in 2006 and 0.27 in 2009. Recommended stocking densities for ZQI values in this range are between 75 and 150 fingerling trout per acre. In the past five years, fry and fingerling stocking has been limited, with 25,500 kokanee fingerling (19 per acre) stocked in 2009 and limited rainbow trout fry and fingerling (<10 per acre) prior to that. Currently, the majority of the stocking in Mackay Reservoir is catchable rainbow trout, as frequent reservoir draw downs have impacted survival of stocked fry and fingerling. ZQI levels in Ririe Reservoir were similar to Mackay, ranging from 0.54 to 0.87 (mean: 0.65). Stocking levels of kokanee fingerling and fry for the past five years have ranged from 139 to 217 fish per acre, which may be slightly high for the observed zooplankton levels, but angler reports indicate that kokanee stocking has supported a successful fishery the past few years. During 2010 a creel survey will be conducted on Ririe Reservoir and results will be compared to past stocking events to correlate angler catch rates with kokanee stocking rates. Palisades Reservoir ZQI ranged from 0.47 to 0.87 (mean: 0.65) between 2006 and 2009. Palisades Reservoir is stocked annually with 250,000 fingerling Yellowstone cutthroat trout (16 per acre) and 60,000 catchable Yellowstone cutthroat trout. Prior to that, 196,000 fingerling cutthroat trout (12 per acre) and 76,000 catchable cutthroat trout were stocked in 2005. With the forage base indicated by our zooplankton surveys, Palisades Reservoir could support heavier stocking of fingerlings. However, historically low return to creel rates of hatchery fish combined with annual extreme fluctuations in reservoir levels may make additional stockings unwarranted.

Henrys Lake and Island Park Reservoir have historically been considered the two most productive water bodies in the Upper Snake Region, and recent zooplankton monitoring supports this claim (Figure 17). Of all the water bodies sampled within the region, ZQI values were highest in Island Park Reservoir and Henrys Lake during 2008 and 2009. Average ZQI values between 2006 and 2009 are 1.69 and 0.96 for Island Park Reservoir and Henrys Lake, respectively, which indicates both can support fingerling trout stocking densities between 150 and 300 fish per acre. Over the past five years, Henrys Lake has been stocked at an average rate of 236 fish per acre (range: 185 – 273), which is appropriate based on zooplankton monitoring data. During this same time period, Island Park Reservoir stocking has averaged 136 fish per acre (range: 76 – 194). Based on zooplankton data, stocking rates in Island Park Reservoir could be increased, but survival of stocked fish may be impacted by reservoir drawdowns.

Table 7. Zooplankton quality index (ZQI) ratings and the recommended stocking rates from Teuscher (1999).

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

Table 8. Mean zooplankton biomass (g/m) by mesh size, preferred to usable (750:500) zooplankton ratio (ZPR), and zooplankton quality index (ZQI = [500+750]*ZPR) for reservoirs in the Upper Snake Region of Idaho, 2009.

	Net mesh (microns)				
Waterbody	153	500	750	ZPR	ZQI
Ashton Reservoir	0.48	0.15	0.11	0.73	0.19
Gem Lake*	0.06	0.04	0.04	1.15	0.10
Henrys Lake	0.88	0.77	0.66	0.86	1.22
Island Park Reservoir	1.06	1.41	1.22	0.87	2.29
Mackay Reservoir	0.64	0.36	0.18	0.50	0.27
Palisades Reservoir	0.93	0.57	0.37	0.65	0.61
Ririe Reservoir	0.84	0.57	0.34	0.59	0.54

*discrepancies in calculated ZPR and ZQI values are due to rounding 500 and 750 mesh tow values

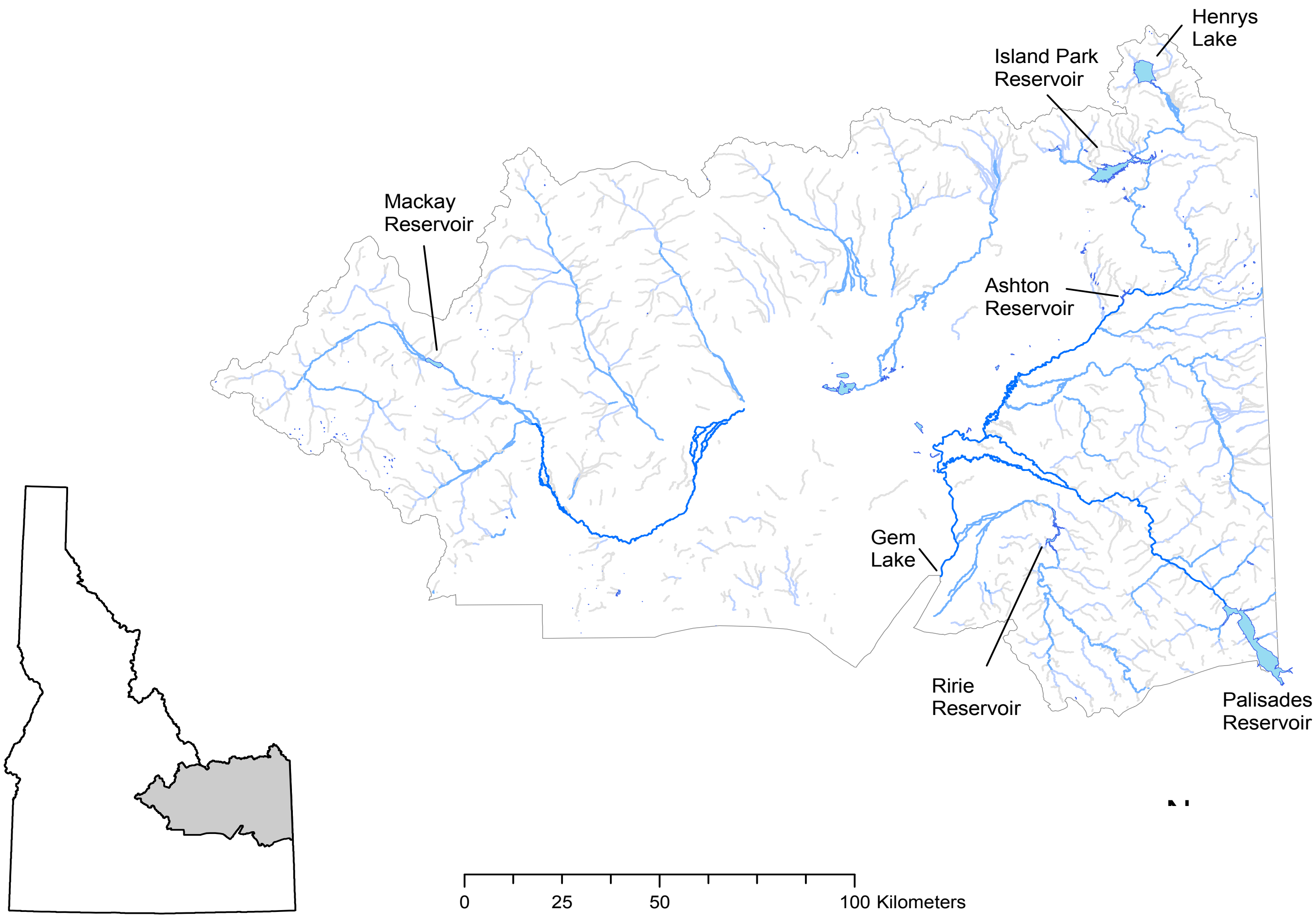

Figure 16. Upper Snake Region lakes and reservoirs where zooplankton samples were collected during 2009.

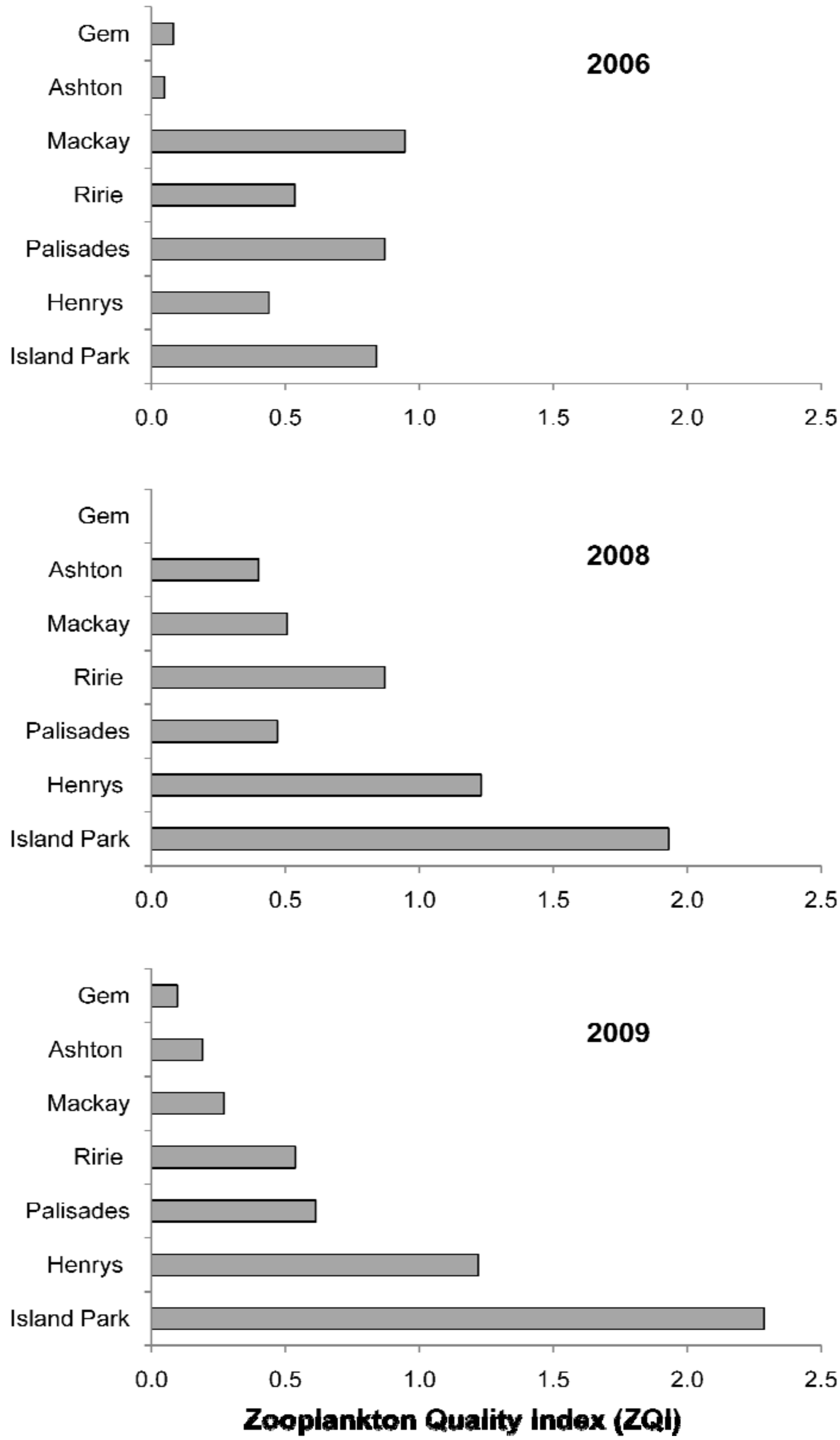

Figure 17. Zooplankton quality index (ZQI) values for lakes and reservoirs in the Upper Snake Region, from 2006 - 2009.

Lakes and Reservoirs Investigations

PASSIVE INTEGRATED TRANSPONDER TAG RETENTION STUDY

ABSTRACT

We tested three different tagging locations on Yellowstone cutthroat trout from Henrys Lake to determine what tagging location would result in the highest PIT tag retention. Fish were marked and held in separate groups at the Henrys Lake Hatchery for 50 days. Four groups were included in the study of 50 fish each, including a control group. The three different treatment groups received 12 mm PIT tags in the dorsal musculature, the opercle musculature, or the body cavity. Mortality observed during the study was similar for both treatment and control groups at an average of 17%. PIT tag retention rates were highest for the dorsal musculature group at 100%, followed by 92% for the body cavity group, and 82% for the opercle musculature group. Placing PIT tags in the dorsal musculature may be a better option than the body cavity for increasing PIT tag retention in resident cutthroat trout species.

Authors:

Brett High
Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manager

INTRODUCTION AND METHODS

Since 2008, we have been involved with a large scale Yellowstone cutthroat trout movement, spawning habit, abundance, and survival study using Passive Integrated Transponder (PIT) tags. We mark approximately 5,000 Yellowstone cutthroat trout (YCT) annually in the South Fork Snake River. All data to be included in the study are obtained through recapture events. PIT tag retention is critical to maximize study effectiveness and to obtain precision in our various metrics. To date, we have placed PIT tags in the body cavity as recommended for salmonids by the PIT tag advisory committee of the Columbia Basin Fish and Wildlife Authority (1999). We have observed 10 to 20% annual PIT tag loss rates for YCT marked in the South Fork Snake River, with higher loss rates for post-spawn adults similar to what has been reported in other studies (High et al. 2008; Bateman et al. 2009). Dieterman and Hoxmeier (2009) observed high rates of PIT tag retention for salmonids when PIT tags were placed in the dorsal musculature. Other researchers have had success with placing PIT tags in the opercle musculature (Schoby et al. 2006). Our objective was to assess short-term retention rates of PIT tags by YCT when PIT tags were placed in the dorsal musculature, opercle musculature, and body cavity.

We used electrofishing gear and pulsed DC current to capture YCT from Henrys Lake. Captured fish were transported to the Henrys Lake Hatchery where they were anaesthetized and measured to total length (mm). Four groups of 50 YCT were included in the study and each group was held separately from the others at the hatchery. One group was used as a control, and was only anaesthetized and measured. The three treatment groups were PIT-tagged with 12 mm tags in the opercle muscle, the dorsal musculature posterior to the dorsal fin, or the body cavity anterior to the pelvic fins using 12 gauge hypodermic needles. All fish were held for 50 d from October 30 through December 18.

RESULTS

Mortality ranged from 14% to 24% over the 50 d holding period. The control, dorsal, and opercle groups all experienced 14% mortality while the body cavity group experienced 24% mortality. Retention rates were highest for the dorsal group with 100% retention and were lowest for the opercle group at 82%. The body cavity group had 92% PIT tag retention rate (Figure 1).

DISCUSSION

Our results were similar to Dieterman and Hoxmeier (2009) who also observed higher retention rates when PIT tags were placed in the dorsal musculature as opposed to abdominal implants. Although other researchers have experienced high retention rates when PIT tags were placed in the opercle muscle, we did not. We observed large sores on the majority of the opercle group around the injection site which we believe led to the high loss rates. Our results indicate the dorsal musculature may be a suitable location for PIT tagging studies on resident cutthroat trout for maximizing PIT tag retention. However, further studies should be performed to assess retention rates through the spawning period when PIT tags are placed at different locations.

In addition to increasing retention rates, researchers must also take human safety into account when planning studies using PIT tags in game fish. Traditional PIT tags are encapsulated with glass. If traditional PIT tags are placed in the musculature of fish that end up as table fare, serious health problems may result if tags are ingested. PIT tags made with plastic instead of glass are currently available as a new product and may ameliorate the concern of placing PIT tags in game fish musculature.

Another concern that faces researchers using PIT tags is tagging mortality. Mortality of test and control adult cutthroat trout used in this study was higher than similar PIT tag laboratory studies where younger salmonids were used. Age-0 Atlantic salmon *Salmo salar*, brown trout *S. trutta*, and chinook salmon *O. tshawytscha* all demonstrated mortality rates of less than 5% when 12 mm PIT tags were placed in their body cavities (Gries and Letcher 2002; Dare 2003; and Acolas et al. 2007). Contrary to these results, we found 24% mortality for adult trout marked in the abdominal cavity during our study. Hatchery personnel described the mortality that we observed for all of our test groups as normal given the age of the fish and the time of year the study was conducted (D. Keen, Regional Fisheries Biologist; pers. communication). However, we recommend more research be directed at the effect of placing PIT tags in the body cavity of adult resident salmonids on their survival. Although our test group that received PIT tags in the body cavity did experience a relatively higher mortality rate than other tagging methods, our sample size was small and estimates of mortality from this small group may not be accurate. Given the paucity of PIT tag studies on adult resident salmonids, we feel more research is needed to determine if placing PIT tags in adult trout body cavities increases mortality.

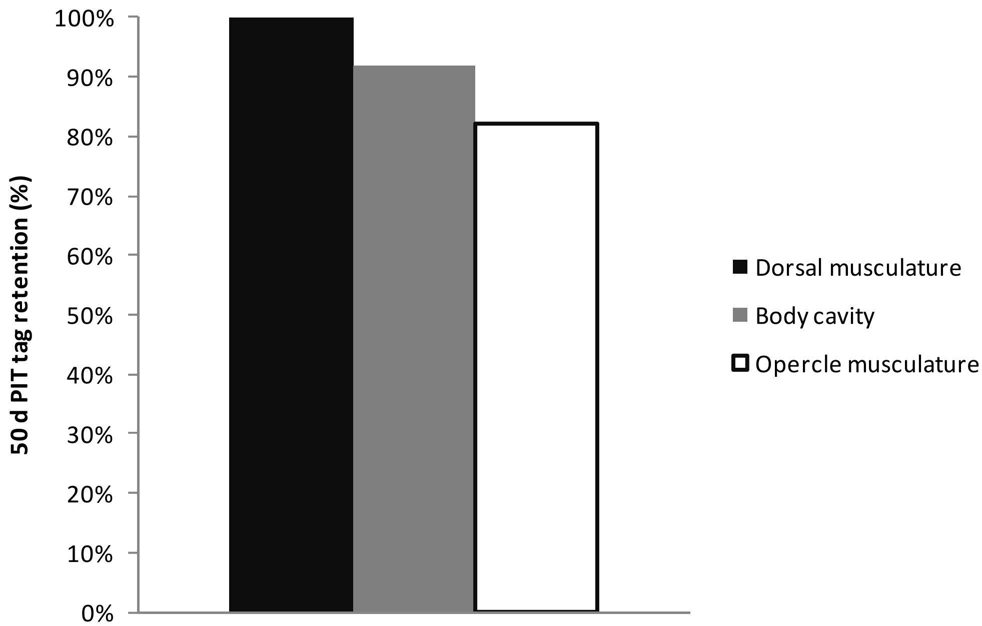

Figure 18. PIT tag retention rate for groups of test fish tagged in the dorsal musculature, the body cavity, and the opercle musculature.

Rivers and Streams Investigations

STREAM RENOVATION – CROOKED AND MYERS CREEKS

ABSTRACT

Both Myers Creek and Crooked Creek are located within the native range of Yellowstone cutthroat trout in the Medicine Lodge drainage. Although the two creeks are connected to each other, they historically did not connect to other waters. Myers Creek currently supports nonnative brook trout while Crooked Creek supports Yellowstone cutthroat trout. We treated Myers Creek with rotenone to remove brook trout in preparation for reintroduction of native Yellowstone cutthroat trout. On September 2, 2009, we used rotenone to treat approximately 6.5 km of Myers Creek, as well as one acre-foot of water remaining in the irrigation pond at the terminus of Myers Creek. We observed live fish in our sentinel cages after the initial treatment, and implemented a second treatment with a higher dosage of rotenone the same day. Following the second treatment, we observed several hundred dead brook trout. Post-treatment electrofishing revealed one live brook trout in four sampling sites, indicating that the treatment was not successful at completely eradicating brook trout, but indicated the population was severely reduced from previous levels. We transplanted Yellowstone cutthroat trout from Crooked Creek to re-establish a cutthroat trout population within Myers Creek. Future work includes monitoring Myers Creek to determine if Yellowstone cutthroat trout can become established when brook trout populations are reduced.

Author:

Greg Schoby
Regional Fishery Biologist

Dan Garren
Regional Fishery Manager

INTRODUCTION

Myers Creek originates in the Centennial mountain range of eastern Idaho, and is located in the Medicine Lodge Creek drainage. The streams within the Medicine Lodge drainage (and the four neighboring basins: Beaver-Camas, Birch, Little Lost and Big Lost) flow south and east, eventually sinking into the fractured basalts of the Snake River plain, and are collectively known as the Sinks drainages (Figure 19). It is believed that the Sinks drainages were last connected to each other via glacial Lake Terreton approximately 10,000 years ago. It appears that the only native fish in the Medicine Lodge drainage are shorthead sculpin *Cottus confusus,* mottled sculpin *C. bairdi*, and Yellowstone cutthroat trout which likely entered from the Henrys Fork Snake River drainage within the last 10,000 years.

Recently, Myers Creek has terminated in the desert outside of Terreton, Idaho, and has not connected to other any other streams. Modifications have been made to the Myers Creek stream channel, as well as its major tributary, Crooked Creek, for delivery of irrigation water to fields in the lower end of the valley. Approximately 3 km of Myers Creek, just upstream from its confluence with Crooked Creek, have been channelized and moved to the north-east side of the drainage to improve delivery of irrigation water to the valley bottom (Figure 20). Crooked Creek historically has dewatered before its confluence with Myers Creek. To deliver additional water to Myers Creek for irrigation, the lower 1 km of Crooked Creek has been channelized (Figure 20). Currently, Myers Creek terminates in a small irrigation impoundment, from which water is pumped for irrigation purposes.

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

METHODS

Myers Creek was treated on September 2, 2009 with rotenone to remove brook trout in preparation for reintroduction of native Yellowstone cutthroat trout. We used existing diversion structures and historic stream channels to reduce the amount of steam kilometers necessary for treatment. Two days prior to the rotenone treatment, we diverted the lower end of Crooked Creek from the existing channelized reach into its historic channel (Figure 20). This separated the connection between Crooked Creek and Myers Creek, as Crooked Creek water flowed approximately 400 meters in its historic channel before sinking into the desert soils. We diverted Myers Creek into an irrigation diversion located just upstream of its confluence with Crooked Creek. Water in this diversion flowed approximately 1 km before drying. After water manipulations, Myers Creek flowed 6.5 km before terminating. By manipulating the water in Crooked Creek and Myers Creek, we dried 5.5 km of Myers Creek and eliminated the need to treat this reach, and reduced the volume of the pond at the bottom of the system.

We established 3 rotenone treatment stations throughout the 6.5 km of Myers Creek, located approximately 2.7 km apart (Figure 20). We measured stream flows at the three proposed treatment sites on September 1, 2009, the day prior to the rotenone treatment. Flow was calculated at 1.2 cubic feet per second (cfs) at the headwaters site (station 1), 5.5 cfs at the middle site (station 2), and 3.4 cfs at the lower site (station 3). Drip cans were constructed using 5-gallon water jugs, as described in *Planning and executing successful rotenone and antimycin projects (AFS workshop proceedings)*. Each 5-gallon drip can was loaded with the appropriate amount of liquid rotenone to provide 1.0 ppm to the stream over a 4-h treatment, based on steam flow at each drip station (Finlayson, et al. 2000). We used rotenone concentrations for the next highest whole cfs value to ensure complete brook trout eradication. For example, at station 1, where stream flow was 1.2 cfs, we used 0.216 g of rotenone in the 5-gallon drip can to provide 1.0 ppm rotenone to 2 cfs of stream. Two backpack sprayers were also used in the treatment – one working near the headwaters in several springs, and one near the confluence with Crooked Creek, covering all standing water and seepage areas. Caged brook trout were placed in sentinel cages at three instream locations to test the effectiveness of the rotenone treatment. Caged brook trout were located above the middle drip station, above the lower drip stations, and at the bottom of the Myers Creek ditch. We measured the volume of water in the irrigation pond at the bottom of Myers Creek at 0.926 acre-feet (40,330 ft^3) on September 1, 2009, after dewatering occurred. The pond was treated with a backpack sprayer loaded with a 10% concentration of rotenone and applied using two people and a canoe.

We sampled four sites on Myers Creek on October 21, 2009 with a back pack electrofisher to evaluate the success of the rotenone treatment (Figure 21). We sampled two locations above and below the middle drip station (Forest Service gate), and two locations above and below the confluence of Crooked Creek (Table 9). Survey reaches varied between 100 and 200 meters. Sites were selected based on densities of brook trout observed in these areas during 2008 (IDFG files).

RESULTS AND DISCUSSION

The rotenone treatment of Myers Creek was initiated at 1130 h and lasted until 1545 h on September 2, 2009. Caged brook trout began to show signs of rotenone exposure within two and a half hours of initiating the treatment, and death occurred in some, but not all caged fish. Other dead brook trout were observed while walking the stream sections between drip stations, but live fish were also observed. Based on these observations, it was unlikely that a thorough kill was achieved in this operation and a second treatment was initiated. The second treatment began at 1600 h and lasted until 2100 h. The additional inputs of spring water between station 1 and station 2 increased the stream flow in Myers Creek from 1.2 cfs to 5.5 cfs at the respective stations. We failed to account for this increase in water and believe that the dosage in station 1 during the first treatment, although increased to 1.0 ppm for 2 cfs of stream, may have been insufficient to provide a complete kill of brook trout. To ensure complete eradication of brook trout, all drip stations were loaded to apply 1.0 ppm rotenone to 6 cfs during the second treatment. Spring and seep areas near the headwaters and the confluence with Crooked Creek were treated with backpack sprayers during the second treatment as well. The pond was not treated during the second application, as electrofishing after the first treatment did not yield any fish.

We used backpack electrofishers to evaluate the effectiveness of our rotenone treatment, and did not detect any brook trout in Myers Creek above or below the Forest Service gate (drip station 2). We did not observe any fish while electrofishing 200 meters of Myers Creek below the confluence with Crooked Creek. However, we collected one Yellowstone cutthroat trout and one brook trout while electrofishing 125 meters of Myers Creek immediately upstream of its confluence with Crooked Creek. Previous surveys of Myers Creek have not documented Yellowstone cutthroat trout, which indicates that cutthroat trout migrated into the lower reaches of Myers Creek from Crooked Creek after the rotenone treatment. The presence of brook trout also indicates that the rotenone treatment was not completely successful. Although one brook trout was collected in one of the four electrofishing sites, the lack of brook trout in the other three sites indicates that the brook trout population in Myers Creek, although not completely eradicated, was severely reduced by the rotenone treatment. Based on this information, we proceeded with to collect Yellowstone cutthroat trout from Crooked Creek and stock them into Myers Creek. On October 21, we transplanted 50 Yellowstone cutthroat trout, ranging from 40 mm to 340 mm, from Crooked Creek into Myers Creek. We clipped the adipose fin from all cutthroat trout released into Myers Creek to determine if cutthroat trout collected in future sampling efforts are from the transplant or if they have migrated from Crooked Creek. During 2010, we will sample Myers Creek again to determine the effectiveness of the rotenone treatment and Yellowstone cutthroat trout transplanting and to monitor expansions in the brook trout population, should they occur.

Table 9. Locations of rotenone drip stations and electrofishing sample sites in the Myers Creek Yellowstone cutthroat trout restoration project.

	Zone	UTM E	UTM N	Location
Drip Stations				
1	12	363512	4907236	Upper
2	12	363905	4904888	Middle
3	12	363435	4902661	Lower
Electrofishing sites				
1	12	363910	4904871	Above drip station 2
2	12	363896	4904730	Below drip station 2
3	12	363127	4902235	Above Crooked Creek confluence
4	12	363086	4902120	Below Crooked Creek confluence

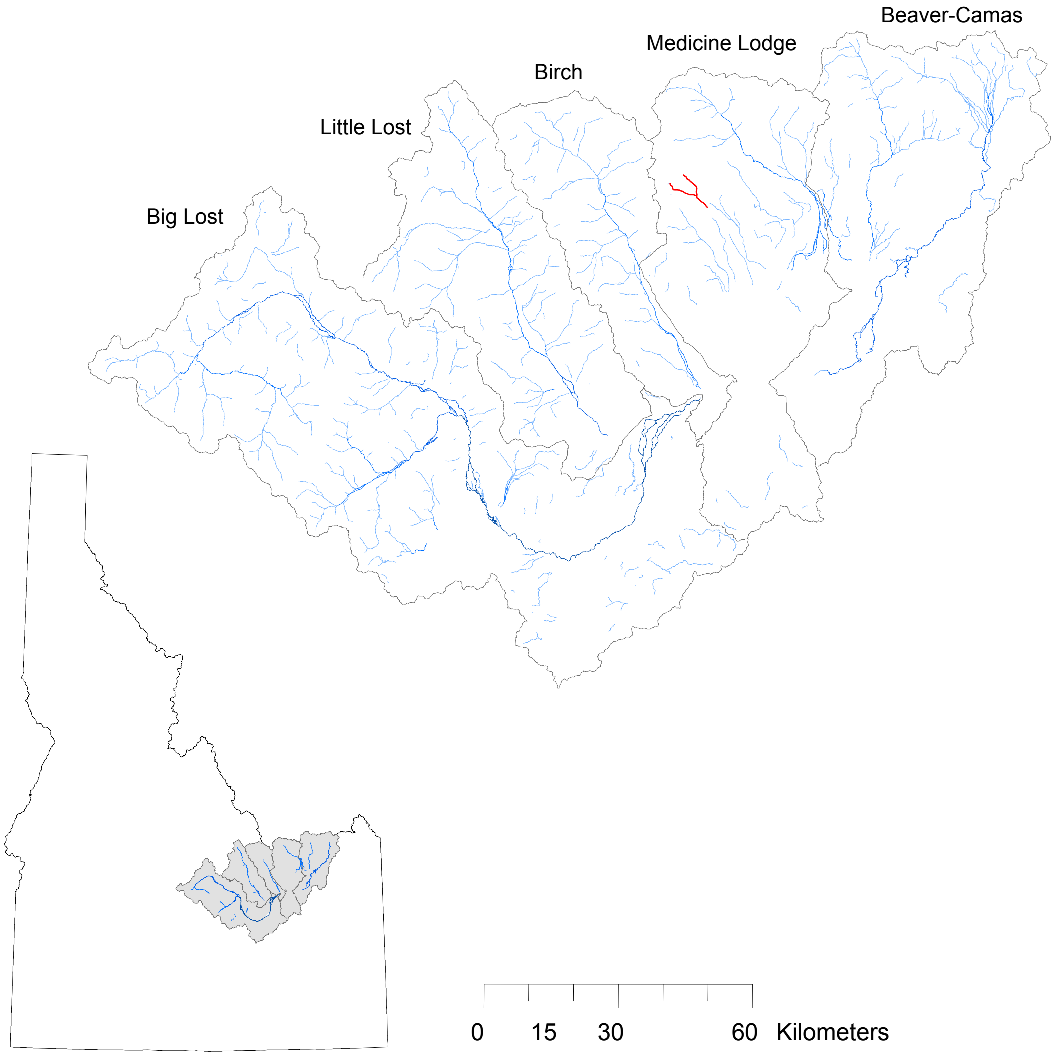

Figure 19. The Sinks drainages of Idaho. Myers Creek and Crooked Creek are highlighted in red.

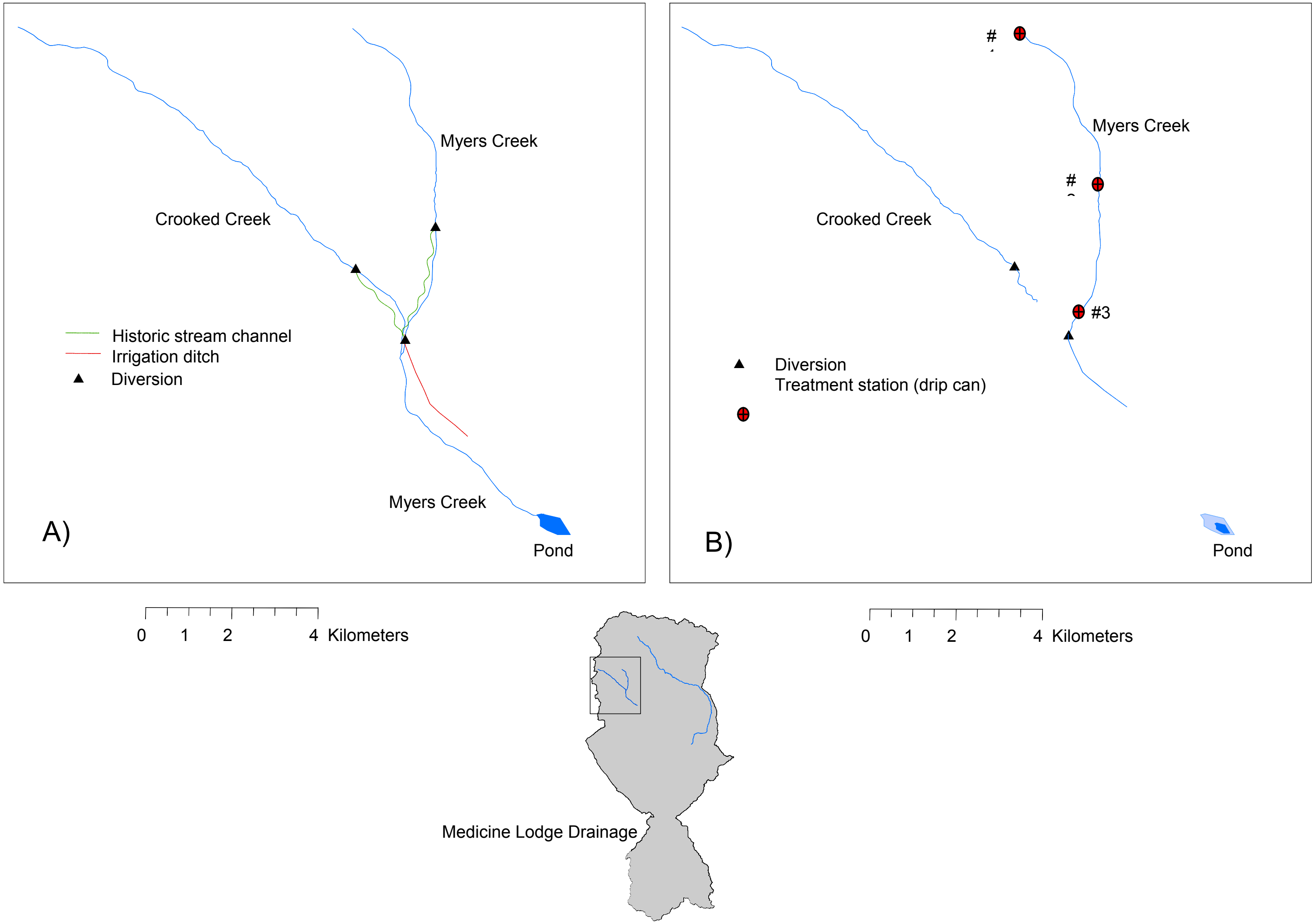

Figure 20. Historic and current location of water within Myers Creek and Crooked Creek (A). Location of Myers Creek and Crooked Creek after water manipulations for rotenone treatment (B).

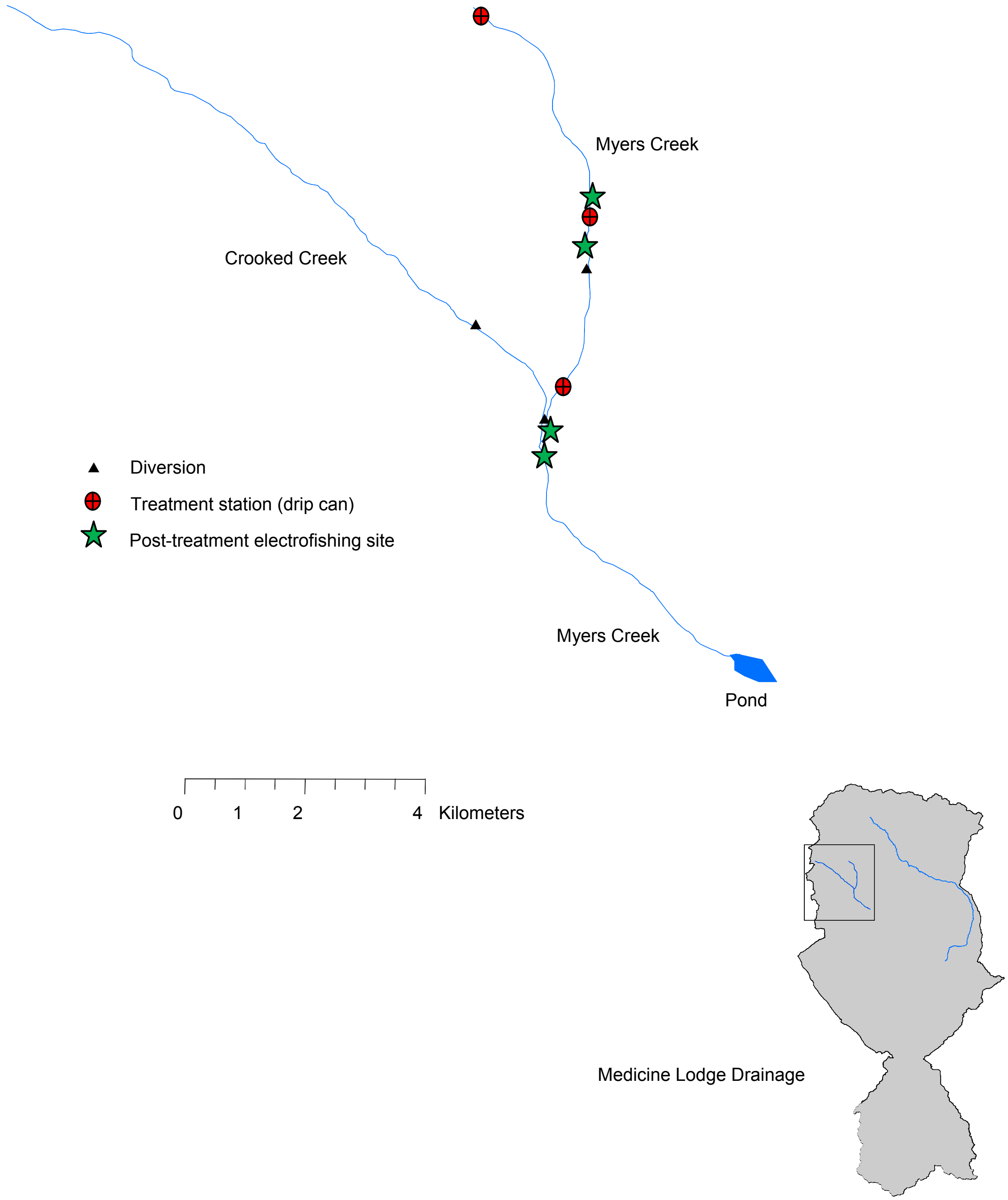

Figure 21. Post rotenone treatment electrofishing sample locations within the Myers Creek drainage.

Rivers and Streams Investigations

BIG LOST RIVER

ABSTRACT

The Big Lost River is an isolated stream system located along the northern rim of the Snake River Plain in south central Idaho that contains an endemic species of mountain whitefish *Prosopium williamsoni*. During 2009, we estimated abundance of whitefish in a previously dewatered reach of river and found the highest densities observed in any of the recent sample locations within the Big Lost River drainage. We estimated densities of whitefish below the Blaine Diversion on the lower Big Lost at 549 whitefish > 200mm per kilometer. We also examined two factors that may be limiting whitefish survival – whirling disease and predation by rainbow trout. We attempted to collect juvenile whitefish for whirling disease testing, but were unsuccessful in our collection efforts due to a scarcity of newly emerged mountain whitefish. We collected stomach samples from rainbow trout to determine if predation may be limiting the recovery of mountain whitefish. Although rainbow trout did demonstrate some degree of piscivory, we were unable to confirm that the fish consumed by rainbow trout were mountain whitefish. It is unlikely that predation by rainbow trout is a major limiting factor in the recovery of mountain whitefish.

Authors:

Greg Schoby
Regional Fishery Biologist

Dan Garren
Regional Fishery Manager

INTRODUCTION

The Big Lost River is an isolated stream system located along the northern rim of the Snake River Plain in south central Idaho (Figure 22). The river originates in the mountains of central Idaho and flows in a southerly direction where it naturally sinks into the lava flows of the Snake River Plain. Although the river system is isolated and currently supports rainbow trout, Yellowstone cutthroat trout, brook trout, and sculpin species, the only salmonid native to the Big Lost River is the mountain whitefish. Recent research has shown that these fish are an endemic form of mountain whitefish (Gamett 2009). Fishery population monitoring from 2002-2005 documented a decline in abundance and distribution of mountain whitefish in the Big Lost River. Factors such as habitat alteration (channelization, grazing), irrigation (entrainment, barriers, dewatering, changes in flow regime), non-native fish interactions (competition and predation), disease and exploitation have all been identified as possible contributors to the decline in mountain whitefish. To address the decline in abundance and to expedite recovery efforts, the Idaho Department of Fish and Game (IDFG) developed the Mountain Whitefish Conservation and Management Plan for the Big Lost River Drainage, Idaho (IDFG 2007). The intent of this document is to ensure the mountain whitefish population in the Big Lost River drainage persists through natural and anthropogenic events at levels capable of providing a recreational fishery. Included in this plan was a list of potential threats to the persistence of mountain whitefish and goals for recovering the species.

During 2009, we assessed the population status of mountain whitefish in the Big Lost River between the Blaine and Moore Diversions, and examined potential threats outlined in The *Mountain Whitefish Conservation and Management Plan for the Big Lost River Drainage*, including whirling disease and predation. Although dewatering below the Blaine Diversion has preventing mountain whitefish from occupying this reach on a perennial basis, this reach of the Big Lost River has been watered during 2008 and 2009. Efforts during 2009 were to determine if mountain whitefish have reestablished within this reach of the Big Lost River. MacConnell and Vincent (2002) reported that mountain whitefish were susceptible to whirling disease and that some suffered direct mortality when exposed to the *Myxobolus cerebralis* parasite. More recent work in Colorado by G. Schisler (personal communication cited in Gregory 2009) appears to indicate that whitefish mortality due to whirling disease may be more acute than chronic. Previous studies in the Big Lost River did not detect *M. cerebralis* in mountain whitefish (IDFG, unpublished data) however, given the indications that Triactinomyxon (TAM) attacks may cause acute mortality it is possible that *M. cerebralis* could be impacting the population and yet not be detected in older fish. To determine if whirling disease is affecting the mountain whitefish in the Big Lost River, we attempted to collect newly hatched young-of-the-year (YOY) for disease testing. We also conducted a survey of the stomachs taken from rainbow trout in 2009 to determine if predation may be limiting the recovery of mountain whitefish below Mackay Dam.

METHODS

We estimated salmonid abundance in the lower Big Lost River near the Blaine Diversion using a canoe electrofisher on April 28, 2009 (Figure 23). Sampling occurred during low flow conditions (prior to irrigation demand and increased releases from Mackay Dam) to facilitate effective fish capture and standardization of sampling conditions. The sample reach was approximately 750 m in length. One sample crew consisting of eight people conducted a two-pass depletion to obtain an estimate of salmonid abundance. We used the following equation by Seber and LeCren (1967) to estimate salmonid abundance:

$$N = \frac{C_1^2}{(C_1 - C_2)}$$

where N = population estimate, C_1 = number of fish caught on pass one, and C_2 = number of fish caught on pass two.

To test for whirling disease, we attempted to collect YOY mountain whitefish from the lower Big Lost River immediately below Mackay Dam, and in the upper river near the Bartlett Point Bridge (Figure 22). Locations were based on previous work which documented spawning in these areas (IDFG files). Surveys occurred on March 27, April 8, and April 23, and consisted of two individuals visually searching stream margins and other areas of slower stream flow for newly emerged fry. When fry were observed, they were captured with handheld dip nets and returned to the laboratory for identification and testing.

To determine if predation may be a factor limiting abundance of mountain whitefish in the Big Lost River, we collected stomach samples from adult rainbow trout on July 21, 2009. Adult rainbow trout were collected from 2.2 km of the Big Lost River, from Mackay Dam downstream to the IDFG access, using a raft-mounted electrofishing unit. Rainbow trout were sacrificed and stomach contents were removed in the laboratory for analysis. We did not complete a comprehensive diet analysis of rainbow trout, but stomach contents were examined to determine the presence of juvenile whitefish. Aquatic insects observed in the diet were classified to order and noted as present within the diet.

RESULTS

We collected 824 salmonids during the two-pass depletion estimate in the Blaine reach of the Big Lost River. Species composition of captured fish was 49% mountain whitefish, 32% brook trout, and 19% rainbow trout. Mountain whitefish size structure was dominated by fish between 200 mm and 310 mm, while brook trout size structure was dominated by younger fish <230 mm (Figure 24). Rainbow trout size structure was dominated by smaller fish (<300 mm) although some larger adults between 360 mm and 440 mm were observed (Figure 24). Mountain whitefish averaged 271 mm total length (range: 140 – 372 mm), brook trout averaged 137 mm (range: 80 – 279 mm), and rainbow trout averaged 193 mm (range: 81 – 437 mm). Population estimates for mountain whitefish over 200 mm derived for this reach were 409 fish (95% CI 403 – 416) or 4.3 mountain whitefish per 100 m^2 (549 per km). Population estimates for brook trout over 150 mm were 142 fish (95% CI 55 – 230) or 1.5 brook trout per 100 m^2 (191 per km). Population estimates for rainbow trout over 150 mm for this reach were 88 fish (95% CI 84 –93) or 0.9 rainbow trout per 100 m^2 (119 per km).

We were unable to collect any YOY mountain whitefish in seven hours of sampling. Ten YOY salmonids (~20 mm TL) were collected from the Big Lost River below Mackay Dam on March 27, 2009. Laboratory analysis later determined the collected specimens to be brook trout. Additional juvenile brook trout were collected on subsequent sampling events, but no juvenile mountain whitefish were observed or collected.

We collected stomach samples from 32 rainbow trout, ranging from 196 to 394 mm (mean: 316 mm) total length and 78 to 665 g (mean: 381 g) mass. One rainbow trout stomach sample included one unidentified juvenile fish, measuring approximately 25 mm. Eleven additional samples contained fish scales, for a total of 38% of all stomach samples containing some sort of fish parts. All rainbow trout stomach samples included *Ephemeroptera* nymphs and *Diptera* larva. Fifty-six percent of all rainbow trout stomach samples contained *Trichoptera* larva, pupa, or adults, while 16% of diets examined contained *Plecoptera* nymphs or adults. To a lesser extent, snails (*Gastropoda*) and scuds (*Amphipoda*) were present in 9% and 6%, respectively, of the rainbow trout stomachs examined. All rainbow trout stomach samples examined contained large amounts of aquatic macrophytes.

DISCUSSION

The reach of the Big Lost River below the Blaine diversion had not previously been sampled because it has regularly been dry during the winter, when reduced flows from Mackay Reservoir limit the amount of water reaching this far downstream. In the past, this reach was not considered capable of supporting mountain whitefish. However, during the fall of 2008 and the winter of 2009 this reach remained watered throughout the year. Sampling during the spring of 2009 revealed the highest density of adult whitefish observed in recent history in any of the sampled reaches of the Big Lost River (Garren et al. 2009). The presence of whitefish below the Blaine diversion also documents downstream movement into this river reach when watered, and further validates the construction of the fish ladder at the Blaine diversion completed in the fall of 2008. Whitefish that seasonally move into this reach will now be able to use the passage facility to migrate upstream past the Blaine diversion when flows in this reach subside.

Although we were unable to capture YOY mountain whitefish for whirling disease testing during 2009, we believe that this warrants further research. Continued evaluation of juvenile whitefish emergence timing and collection methods, as well as determining specific spawning locations during the previous fall would aide in collection efforts. The complete lack of juvenile whitefish does support the theory that whitefish do not produce successful year classes of young every year. It is more likely that the species has successful spawns more sporadically, when environmental conditions become more favorable.

The presence of one juvenile fish observed in rainbow trout stomach samples, and the presence of scales in several other samples indicates that rainbow trout in Big Lost River do exhibit some degree of piscivory, but it is unknown what population level impacts this may have on mountain whitefish. We were unable to identify the one fish found in our stomach samples, but it appeared smaller (~25 mm) than would be expected of mountain whitefish at this time of year. Previous work in the Big Lost River found that age-0 mountain whitefish below Mackay Dam averaged 114 mm TL in August (IDFG files), indicating that the fish collected in the rainbow trout diet sample was likely not a mountain whitefish, but possibly a juvenile rainbow trout. While the presence of scales also suggests that rainbow trout in the Big Lost River do consume other fish, the amount of scales found in stomach samples represents a relatively small portion of the overall diet, as aquatic insects were by far the most numerous food items found in rainbow trout stomach samples. Overall, 38% of the rainbow trout diet samples collected contained either fish or scales, but the amount of fish parts in the overall diet was relatively minimal, leading us to believe that predation by rainbow trout is likely not a limiting factor in the recovery of mountain whitefish.

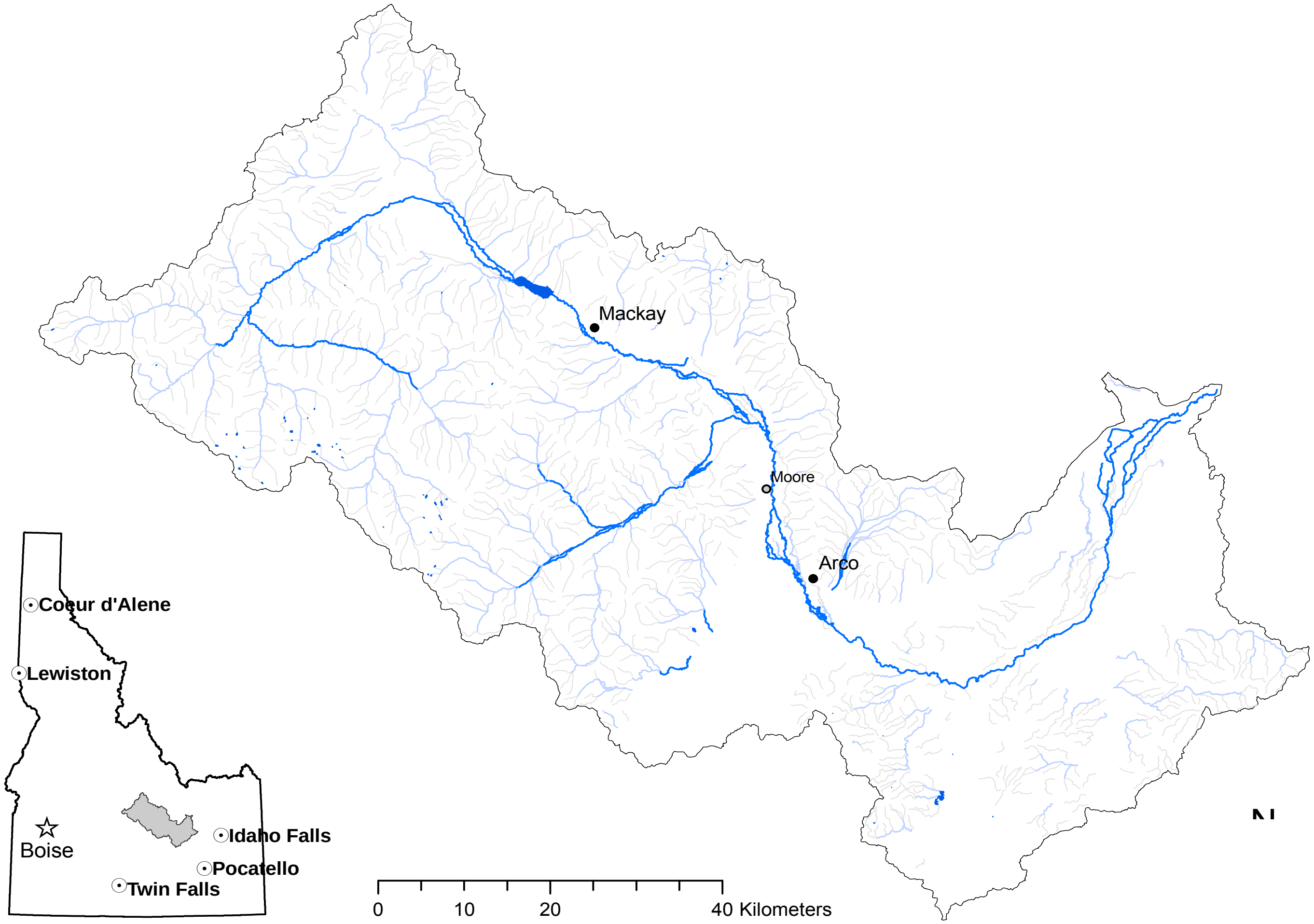

Figure 22. The Big Lost River drainage, Idaho.

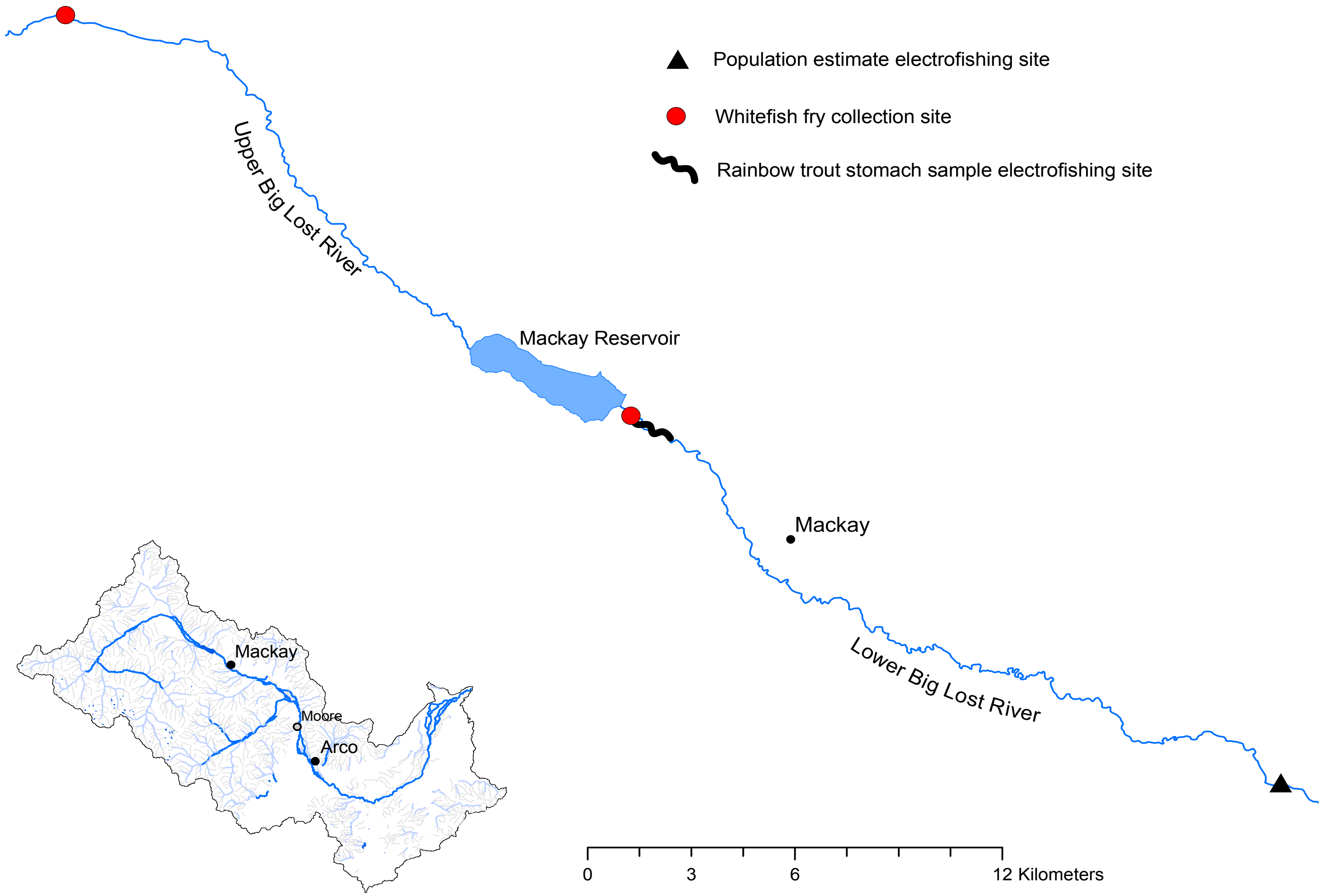

Figure 23. Sample sites in the Big Lost River during 2009.

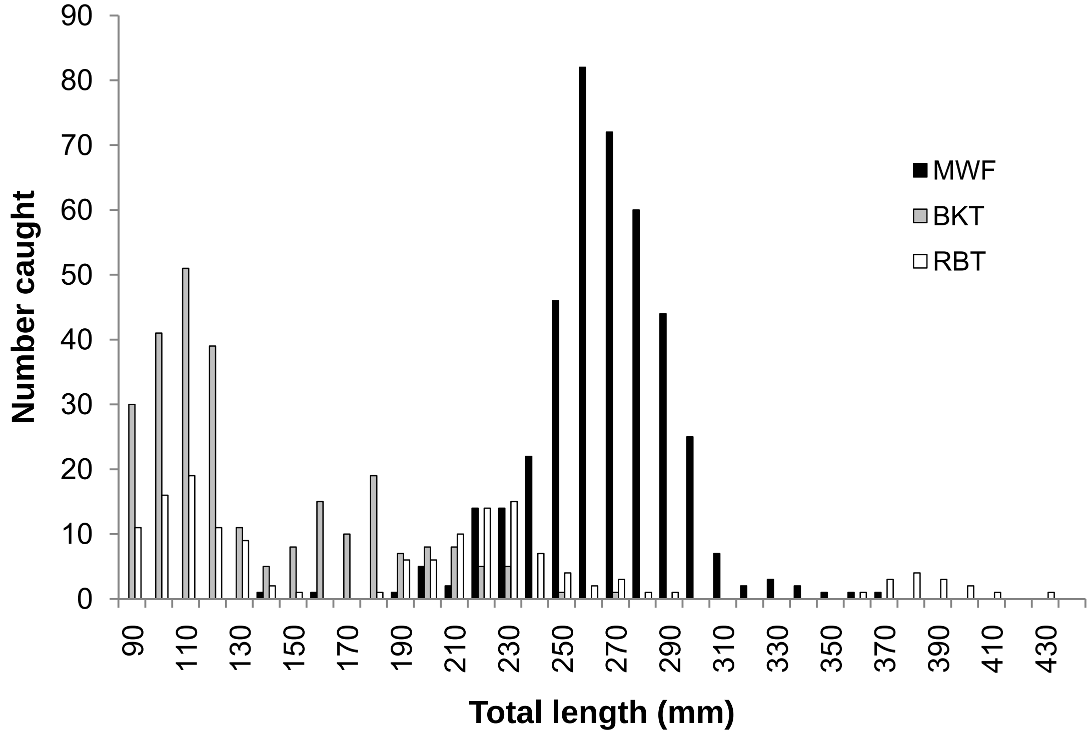

Figure 24. Length frequency distribution of mountain whitefish (black bars), brook trout (grey bars), and rainbow trout (open bars) collected from the Big Lost River below the Blaine Diversion, during 2009 electrofishing two-pass depletion population estimates.

2009 Upper Snake Region Annual Fishery Management Report

Rivers and Streams Investigations

HENRYS FORK

ABSTRACT

We used boat mounted electrofishing equipment to assess fish populations in the Box Canyon, Vernon, and Chester reaches of the Henrys Fork in May 2009 and the St. Anthony reach in October 2009. In Box Canyon, we estimated densities of rainbow trout at 1,361 fish/km, which continues a downward trend that started in 2007. Size indices (proportional stock density [PSD] and relative stock density [RSD-400]) indicate that the population is well balanced (79 and 27, respectively). Using the previously established relationship between winter stream flow and age-2 abundance, we were able to accurately predict the abundance of age-2 rainbow trout in the Box Canyon.

The trout population in the Vernon reach, estimated at 615 fish per km (84% rainbow trout, 15% brown trout), has remained relatively stable since 2005. Similar to previous surveys, the Vernon reach is dominated by adult fish (rainbow trout: PSD = 87, RSD-400 = 66; brown trout: PSD =98, RSD-400 = 73), with very few juveniles detected in our sampling.

The trout population in the Chester reach is on an increasing trend, from 457 trout per km in 2003 to 625 trout per km in 2009, although increases have not been statistically significant. Rainbow trout comprised 76% of the trout species composition while brown trout comprised 23%. Similar to the Vernon reach, the brown trout (PSD = 100, RSD-400 = 76) and rainbow trout (PSD = 95, RSD-400 = 60) in the Chester reach is dominated by adult fish.

The St. Anthony reach showed the biggest improvement in trout densities from previous surveys; we estimated 1,139 trout per km in 2009, up from 301 trout per km in 2004. This reach was dominated by brown trout (85%), with rainbow trout comprising 15% of the total trout species composition.

Authors:

Greg Schoby
Regional Fishery Biologist

Dan Garren
Regional Fishery Manager

METHODS

We used two drift boat mounted electrofishers to assess fish populations in the Box Canyon, Vernon, Chester, and St. Anthony reaches of the Henrys Fork in 2009. In Box Canyon, we marked fish on May 11-12 followed by a seven day rest and two days of recapture (May 18-19). Two passes per boat per day were used on all marking and recapture efforts in the Box Canyon. The Box Canyon reach started below Island Park Dam at the confluence with the Buffalo River and extended downstream 3.7 km to the bottom of a large pool. In the Vernon reach, we marked fish on May 6 and May 8 and recaptured fish on May 14-15. During the marking run, we made two passes with both electrofishing boats on May 6; we conducted only one pass on May 8. We made a single pass with both boats on each of the recapture days (May 14-15). The Vernon reach started at the Vernon boat ramp and continued downstream 4.4 km to the Chester backwaters. In the Chester reach, we marked fish on May 5 and May 8 and recaptured fish on May 13. During the marking run, we completed two passes on May 5, with an additional single pass by each boat on May 8. Two passes were completed by both boats during the recapture run on May 13. The Chester reach started just below Chester Dam and extended downstream 5.7 km to the backwaters above the Fun Farm Bridge. We surveyed the St. Anthony reach during the fall, using two electrofishing rafts with one day of marking (October 15) following by a single recapture day (October 22). We made one pass with both boats on both the marking and recapture runs. Coordinates for all mark-recapture transect boundaries are presented in Appendix A. All trout encountered were collected, identified to species, measured for total length, and those exceeding 150 mm were marked with a hole punch in the caudal fin prior to release. Fish were not marked on the recapture run, but all fish previously marked were recorded as such.

We estimated densities for all trout > 150 mm using the Log-likelihood method in MR5 software (MR5; Montana Department of Fish, Wildlife, and Parks 1997). Proportional stock densities (PSD) were calculated as the number of each species ≥ 300 mm / by the number of each species ≥ 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 used linear regression to examine the relationship between age-2 rainbow trout abundance and winter stream flow (cubic feet per second [cfs]) in the Box Canyon reach of the Henrys Fork Snake River, as described by Garren et al (2006). The relationship between winter flows and year class strength has been used in negotiations with water managers to obtain flows that are beneficial for fish in the Henrys Fork. We log-transformed age-2 rainbow trout abundance and mean winter flow data from the past 12 sample years to establish the following relationship:

$$\log_{10} \text{age-2 rainbow trout abundance} = 0.5276 \log_{10} \text{winter stream flow} + 2.1206$$

Using this equation we predicted the expected abundance of age-2 rainbow trout based on mean winter stream flows observed during 2008 (December 2007, January/February 2008). To validate this relationship, we determined age-2 rainbow trout abundance during the 2009 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 2006). 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 2009 was added to this regression model and will be used to predict future year class strength based on mean winter stream flows.

RESULTS

Box Canyon

We collected 1,524 trout over four days of electrofishing in the Box Canyon. Species composition of trout collected was 99% rainbow trout and 1% brook trout. Rainbow trout ranged in size from 80 mm to 587 mm, with a mean and median total length of 350 mm and 365 mm, respectively (Figure 26; Appendix B). Rainbow trout PSD and RSD-400 were 79 and 27, respectively (Table 10). We used the Log-likelihood Method (LLM) to estimate our population and found 5,034 rainbow trout >150 mm (95% CI = 4,610 – 5,458, cv = 0.08, Table 11, Appendix C) in the reach, which equates to 1,361 fish per km (Figure 27). Our efficiency rate (unadjusted for size selectivity) was 14% (Appendix C). Based on mean winter stream flows for 2008 (175 cfs), the regression model predicted 2,014 age-2 rainbow trout during the 2009 survey (Figure 28). We partitioned the mark-recapture rainbow trout population estimate based on past length-at-age models and estimated 2,078 age-2 rainbow trout in the Box Canyon during 2009.

Vernon to Chester Backwaters

We collected 504 trout during four days of electrofishing in the Vernon reach of the Henrys Fork. Species composition was 84% rainbow trout, 15% brown trout, and 1% brook trout (Figure 29). Our efficiency rate (unadjusted for size selectivity) for all trout was 16%. Rainbow trout and brown trout stock density indices were high, with PSD values of 87 and 98, respectively, and RSD-400 values of 66 and 73, respectively (Table 10). Rainbow trout ranged between 110 mm and 615 mm (Figure 30), with a mean and median total length of 387 mm and 415 mm, respectively (Table 10). Brown trout ranged between 145 mm and 591 mm (Figure 31), with a mean and median total length of 411 mm and 432 mm, respectively (Table 10). Due to a low number of brown trout recaptures (n= 2), we combined mark-recapture data for brown trout and rainbow trout to obtain a population estimate and partitioned the estimate based on the percent species composition of fish handled during electrofishing. We estimated 2,705 trout (rainbow and brown) >150 mm for the reach (95% CI = 2,047 – 3,193; cv = 0.09), which equates to 523 rainbow trout and 92 brown trout per km (Table 10). The trout population in the Vernon reach has remained relatively stable over the past five years, ranging between 580 and 665 trout per km from 2005 to 2009 (Figure 32).

Chester Dam to Fun Farm Bridge Backwaters

We collected 637 trout over three days of electrofishing in the Chester reach of the Henrys Fork Snake River. Species composition of trout collected was 76% rainbow trout, 23% brown trout, <1% Yellowstone cutthroat trout and <1% brook trout (Figure 29). Our efficiency rate (unadjusted for size selectivity) was 12%. Rainbow trout ranged in size from 120 mm to 530 mm, with a mean and median total length of 399 mm and 410 mm, respectively (Figure 33).

Rainbow trout PSD and RSD-400 were 95 and 60, respectively (Table 10). Brown trout ranged between 135 mm and 590 mm (Figure 34), with a mean and median total length of 428 mm and 430 mm, respectively (Table 10). Brown trout PSD and RSD-400 were 100 and 76. We used the Log-likelihood method to estimate 3,187 rainbow trout >150 mm (95% CI = 2,521 – 3,853, cv = 0.11) in the reach, which equates to 559 fish per km. We used the Log-likelihood method to estimate 412 brown trout >150 mm (95% CI = 287 – 537, cv = 0.16) in the reach, which equates to 72 fish per km. Overall, we estimated the trout population in the Chester reach at 625 trout per km (Figure 35).

St. Anthony Railroad Bridge to Parker-Salem Bridge

We collected 642 trout over two days of electrofishing in the St. Anthony reach of the Henrys Fork Snake River. Species composition of trout collected was 85% brown trout, 15% rainbow trout and <1% Yellowstone cutthroat trout (Figure 29). Our efficiency rate (unadjusted for size selectivity) was 5%. Brown trout ranged between 138 mm and 600 mm (Figure 36), with a mean and median total length of 307 mm and 262 mm, respectively. Rainbow trout ranged in size from 172 mm to 491 mm, with a mean and median total length of 363 mm and 392 mm, respectively (Figure 37). Rainbow trout size structure indices were high, with PSD values and RSD-400 values of 79 and 45, respectively. Brown trout PSD and RSD-400 values were low, 44 and 20, respectively. Due to a low number of rainbow trout recaptures (n=1), we combined mark-recapture data for brown trout and rainbow trout to obtain a population estimate and then partitioned the estimate based on the percent species composition observed during electrofishing. We estimated 7,971 trout (rainbow and brown trout) >150 mm for the reach (95% CI = 4,799 – 8,929; cv = 0.13), which equates to 968 brown trout and 171 rainbow trout per km. The trout population in the St. Anthony reach, estimated at 1,139 trout per km, has increased by nearly four times the previous estimate of 301 trout per km, in 2004 (Figure 38).

DISCUSSION

Estimates of trout abundance in Box Canyon show a decrease in density when compared to 2008 and the current estimate is below the 13 year average. The trout population in Box Canyon appears to be in a downward trend since 2007; however, the length-frequency distribution shows a relatively strong year class of age-3 fish. This is corroborated by the PSD and RSD-400 values observed in 2009 (79 and 27, respectively), which is reflective of a balanced population with both juvenile and adult fish present. Declines in the overall population can be directly linked to declines in the age-2 portion of the population consistent with observations of winter flows during the winter of 2007/2008 which were low.

Age-2 rainbow trout abundance continues to be strongly related to mean winter stream flow within the Box Canyon, as demonstrated by Mitro (1999) and Garren et al. (2006). The regression model between winter stream flow and age-2 rainbow trout abundance predicted 2,014 age-2 rainbow trout during 2009; the electrofishing survey during 2009 yielded an estimated 2,078 age-2 rainbow trout. We incorporated the data from 2009 into the model to help improve the effectiveness and utility of this tool. Using all available sampling and stream flow data from 1995 through 2009, the model demonstrates the significant relationship between mean winter stream flow and age-2 rainbow trout abundance (r^2=0.53, n=13, P=0.0046). This model will continue to be used to predict age-2 rainbow trout abundance and will be updated with future sampling results. Stream flows during the winter of 2009 averaged 324 cfs, indicating that a relatively strong year class of age-2 rainbow trout (approximately 2,800) should be observed in 2010. Results from this model will be useful in flow negotiations during future winters.

Fish densities in the lower reaches of the Henrys Fork (Vernon and Chester) have remained relatively stable in both sample reaches. The Vernon reach population estimates have been similar since 2005, while the Chester trout population appears to be on an increasing trend since 2003. Both reaches continue to be dominated by larger fish, as RSD-400 values for brown trout and rainbow trout in both reaches remain high. Previous studies of the Vernon and Chester reaches (Garren et al. 2009; 2008; 2007; 2006) have also documented the lack of juvenile fish within these reaches, indicating poor recruitment and/or recruitment from areas outside the sample reach, and cautioned that adult abundance may be reduced in subsequent years. With stable to increasing trout populations in both of these reaches over the past 5 – 7 years, it is unlikely that recruitment is limited, but more likely that we don’t fully understand the juvenile distribution throughout these reaches. Garren et al. (2006) documented several significant spawning areas below Chester Dam, indicating that spawning occurs within this reach, but it is unknown why juvenile abundance continually appears so low in surveys of this reach. We hypothesize that recruitment originates from areas outside of our sample reach, such as the Fall River drainage. Methods used to document this connection have included otolith microchemistry but to date have proven ineffective.

Although trout population estimates in the Vernon and Chester reaches of the Henrys Fork have remained stable or slightly increased, we have observed shifts in species composition. As noted by Garren et al. (2009) in the Chester reach, brown trout have continued to increase in relative abundance in the three lower reaches (Vernon, Chester, and St. Anthony) surveyed in 2009. This is most evident in the St. Anthony reach where brown trout have increased from 46% of the trout species composition in 1999 to 85% in 2009. It is unclear what impact this may have on the fishery in the lower Henrys Fork. Along with the increase in relative abundance of brown trout, total trout abundance has also increased significantly since 2004. One contributing factor may be the timing of our surveys. The 2009 survey was conducted in the fall, while the 2004 survey was completed in the spring. It is possible our fall survey was influenced by migrating, spawning brown trout. While this is a possibility, the length frequency distribution indicates the majority of the brown trout observed were younger, pre-spawn fish (<300 mm). Further, the rainbow trout estimate within this reach increased at the same rate as brown trout, indicating that the fall estimate is not likely overly biased by spawning brown trout. Seasonal habitat conditions within this reach may be more suitable in the fall than the spring, resulting in the differences documented in 2009. Future efforts should address this disparity.

MANAGEMENT RECOMMENDATIONS

1. Continue annual population surveys in the Box Canyon to quantify population response to changes in the flow regime over time and use data to evaluate relationship between flows and fish abundance.

2. Work with the irrigation community and other agencies to obtain flows to benefit the trout population. Use our data to lead discussions on the best way to manage the timing and magnitude of stream flows to maximize benefits to the fishery.

3. Investigate potential for immigration of juvenile trout from areas outside of the Henrys Fork into the Vernon and Chester reaches.

4. Monitor trout population abundances in the lower river to document changes following implementation of canal screens on the Last Chance and Crosscut canals.

5. Increase frequency of monitoring in the St. Anthony reach to document changes in trout abundance, and collect otolith samples for use in age, growth, and cohort analysis.

6. Implement collection of fish weights to develop relative weight indices.

Table 10. Trout population index summaries for the Henrys Fork Snake River, Idaho 2009.

River Reach	Mean Length (mm)	Median Length (mm)	PSD	RSD-400	RSD-500	Density (No./km)	Percent Species Composition
Box Canyon							
Rainbow trout	350	365	79	27	1	1,361	99
Vernon							
Rainbow trout	387	415	87	66	15	523	85
Brown trout	411	432	98	73	12	92	15
Chester							
Rainbow trout	399	410	95	60	2	559	76
Brown trout	428	430	100	76	8	72	23
St. Anthony							
Rainbow trout	363	392	79	45	0	171	15
Brown trout	307	262	44	20	5	968	85

Table 11. Trout population estimate summary from the Henrys Fork Snake River, Idaho.

River reach	Number Marked	Number Captured	Number Recaptured	Population Estimate	Confidence Interval (+/- 95%)	Density (No./km)	Discharge (cfs)[a]
Box Canyon							
Rainbow trout	673	775	112	5,034	4,610 – 5,458	1,361	1,323[b]
Vernon							
All trout	310	171	28	2,705	2,228 – 3,182	615	3,044[c]
Rainbow trout	257	148	26	-	-	-	
Brown trout	51	22	2	-	-	-	
Chester							
All trout	304	332	40	-	-	-	4,549[d]
Rainbow trout	233	244	27	3,187	2,521 – 3,853	559	
Brown trout	66	74	13	412	287 – 537	72	
St. Anthony							
All trout	340	301	14	7,971	4,799 – 8,929	1,139	1,379[d]
Rainbow trout	60	37	1	-	-	-	
Brown trout	278	260	13	-	-	-	

[a] Represents the mean discharge value between marking and recapture events.
[b] Data obtained from USGS gauge near Island Park Dam (13042500)
[c] Data obtained from USGS gauge near Ashton Dam (13046000)
[d] Data obtained from USGS gauge near St. Anthony (13050500)

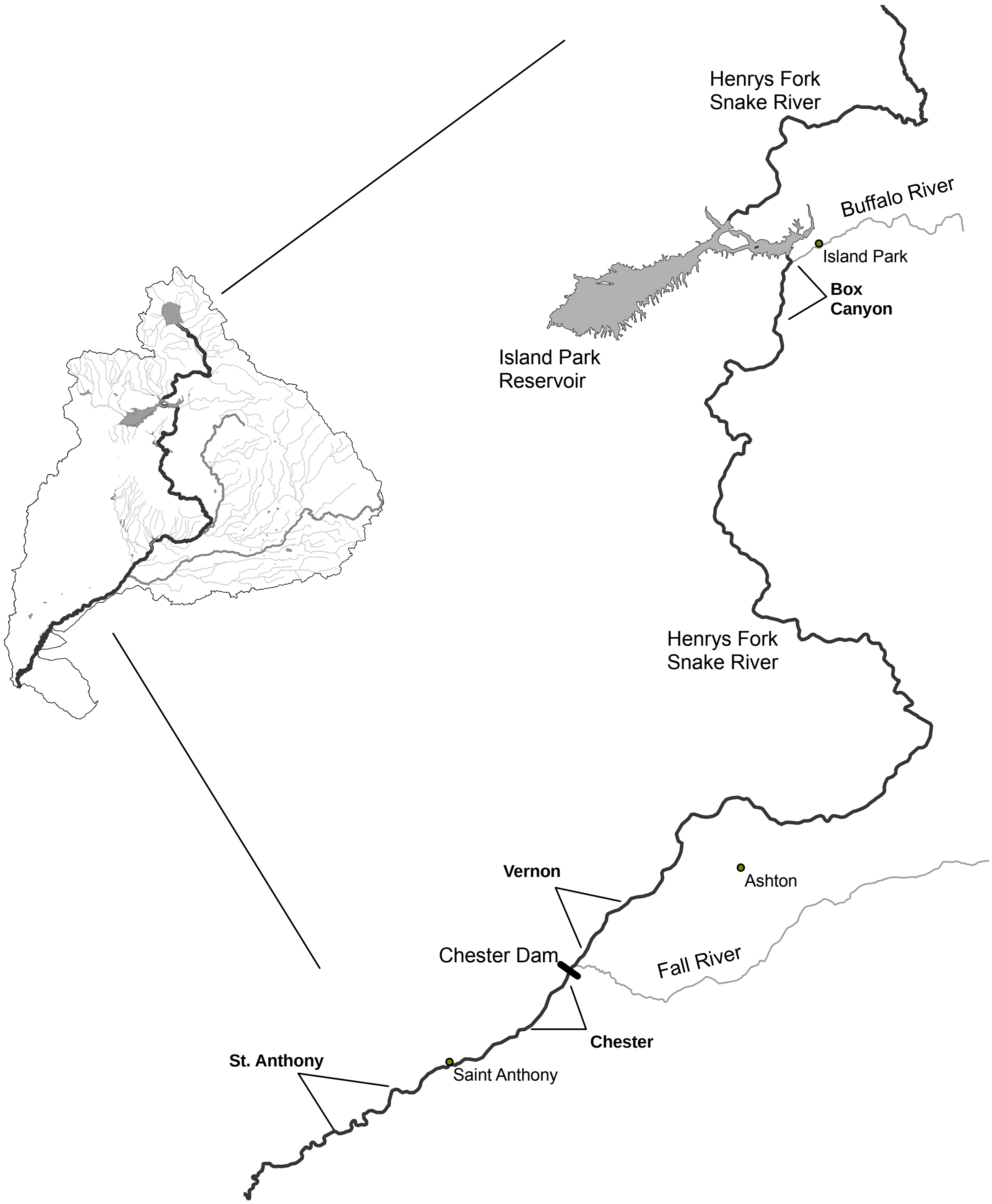

Figure 25. Map of the Henrys Fork Snake River watershed and electrofishing sample sites (Box Canyon, Vernon, Chester, and St. Anthony) during 2009.

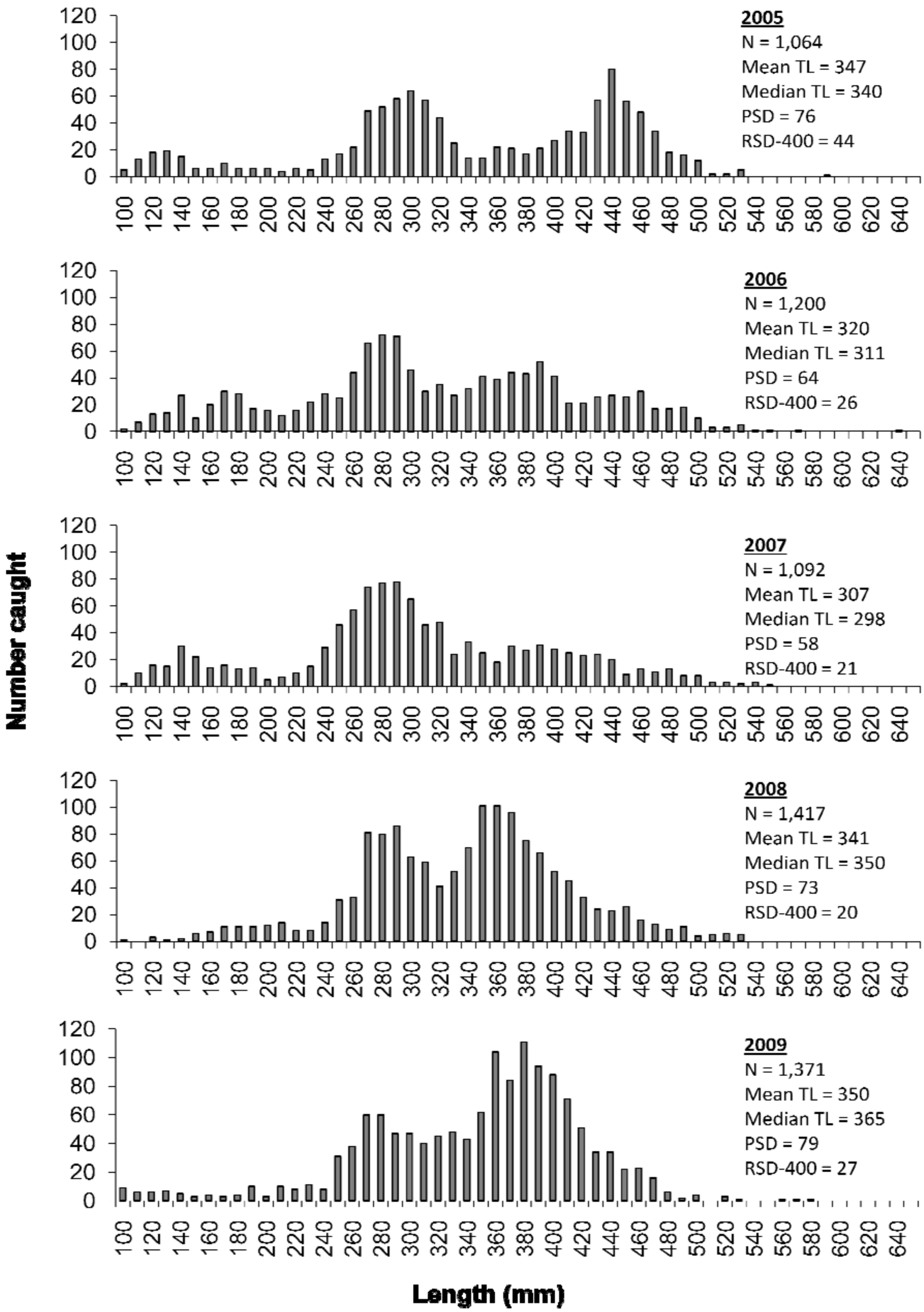

Figure 26. Length frequency distribution of rainbow trout collected by electrofishing in the Box Canyon reach of the Henrys Fork Snake River, Idaho, 2005 - 2009.

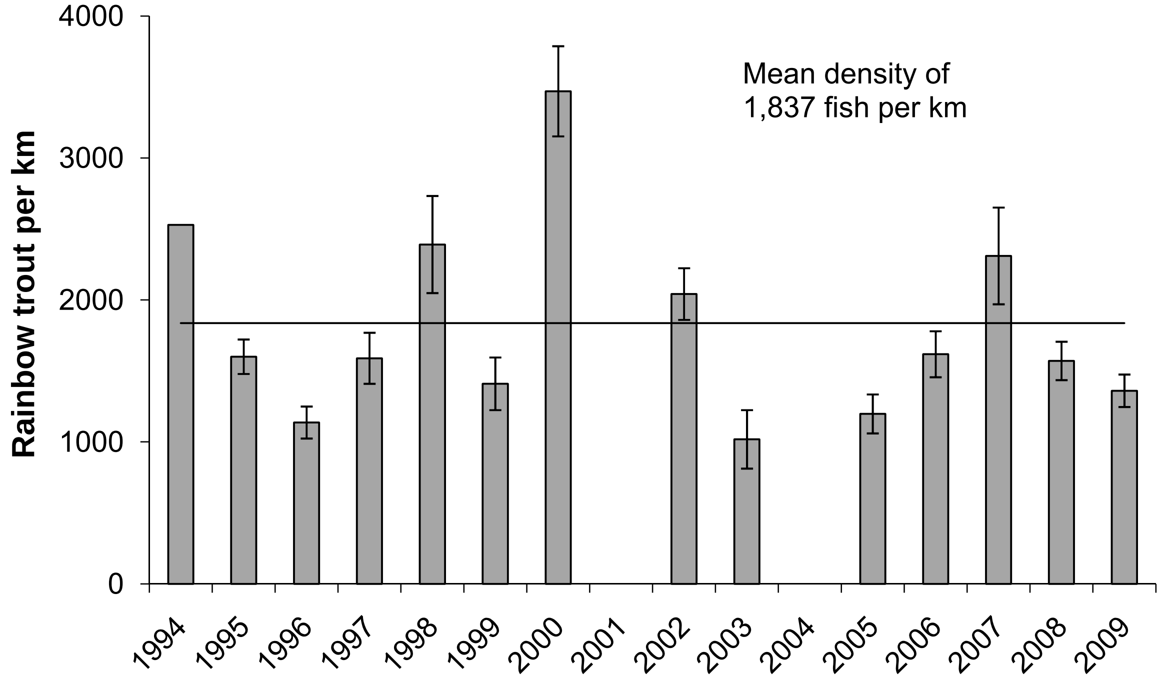

Figure 27. Rainbow trout population estimates for the Box Canyon reach of the Henrys Fork Snake River, Idaho 1994 to 2009. Error bars represent 95% confidence intervals. The solid line represents the long-term average rainbow trout density, not including the current years' survey.

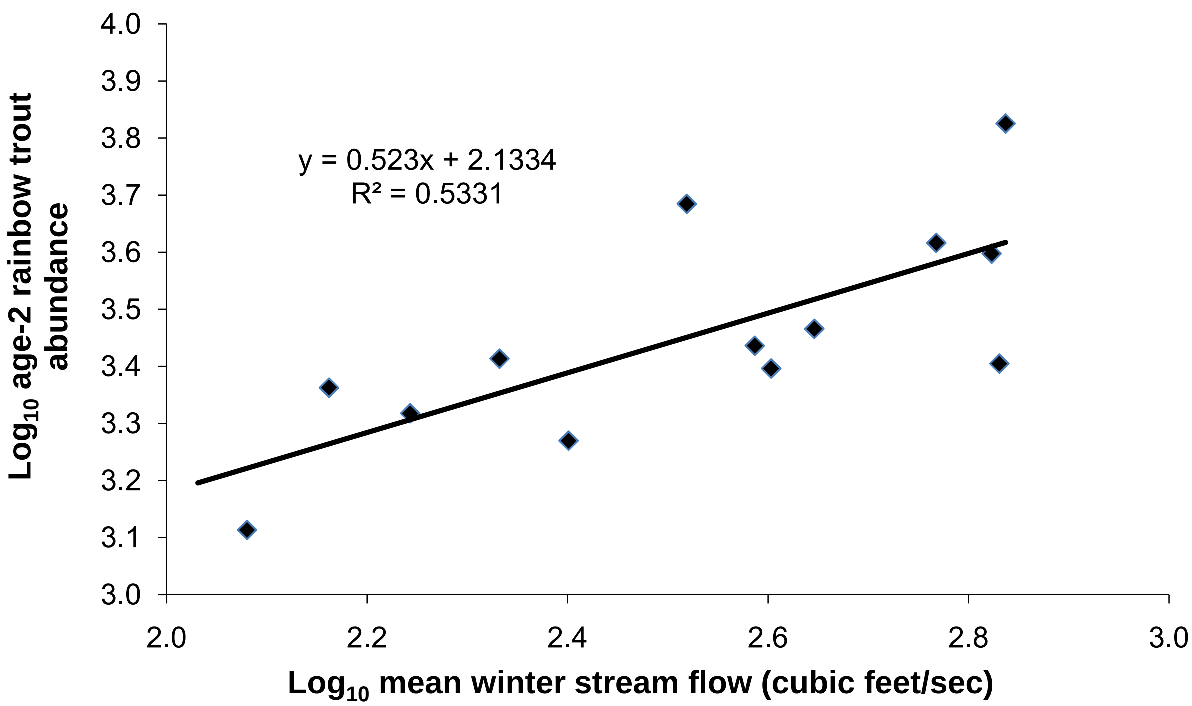

Figure 28. The relationship between age-2 rainbow trout abundance and mean winter flow (cfs) during the first winter of a fish's life from 1995 - 2009; $\log_{10}$ age-2 trout abundance = 0.523 $\log_{10}$ flow (cfs) + 2.1334, (r^2=0.53; n=13, P=0.0046).

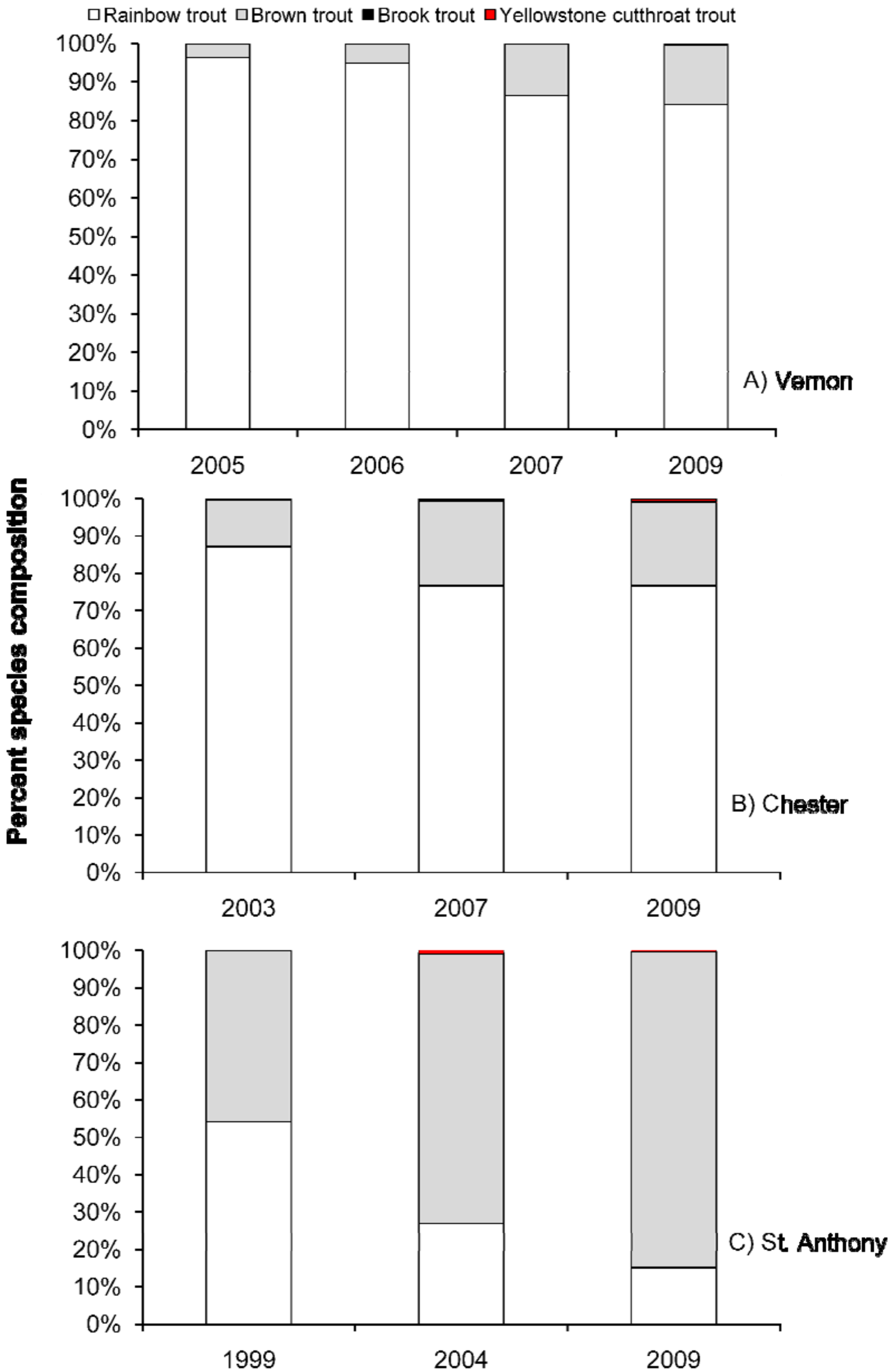

Figure 29. Trout species composition in the Vernon (A), Chester (B), and St. Anthony (C) reaches of the Henrys Fork Snake River.

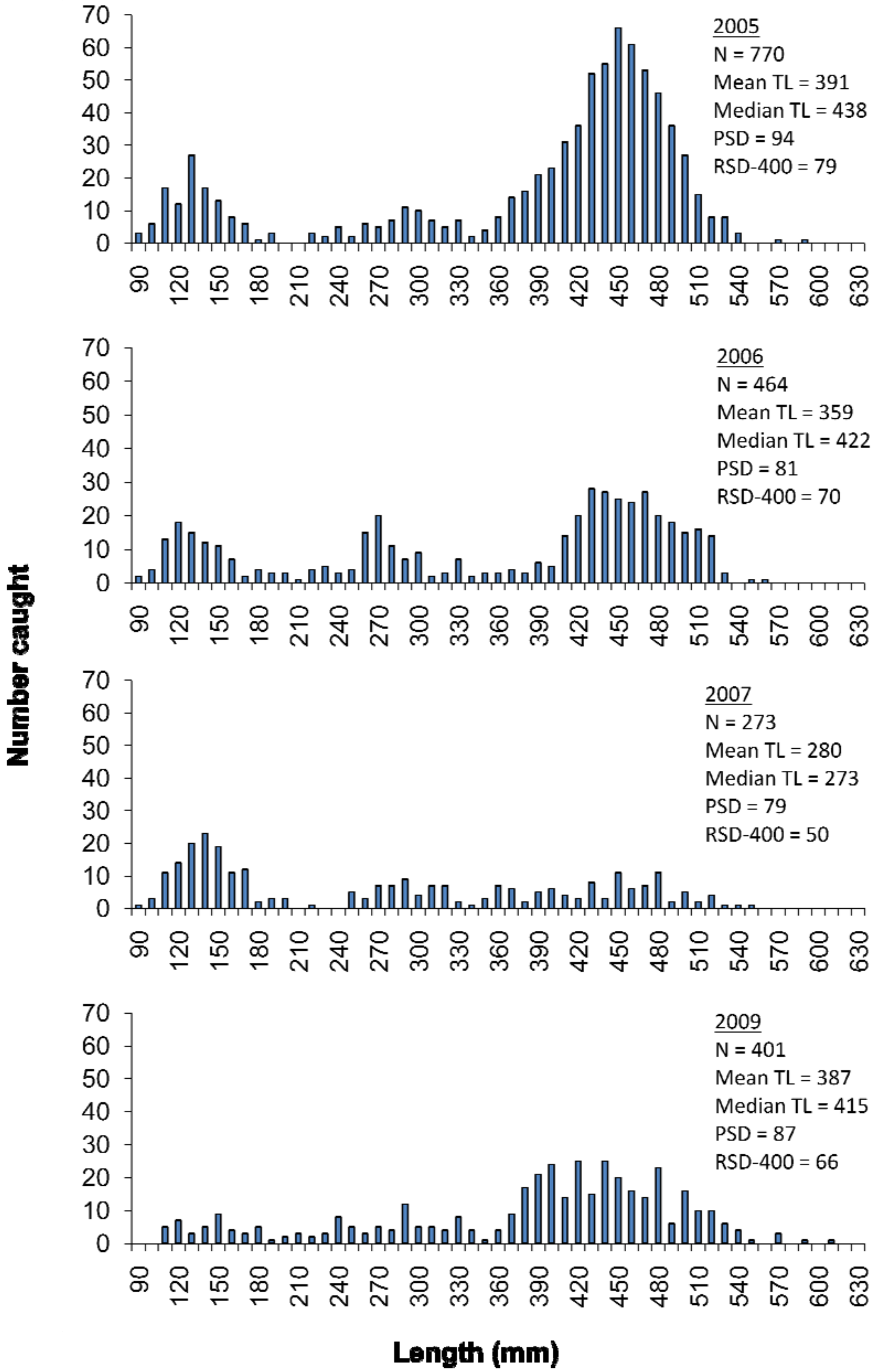

Figure 30. Length frequency distribution of rainbow trout in the Vernon reach of the Henrys Fork Snake River, Idaho, 2005 - 2009.

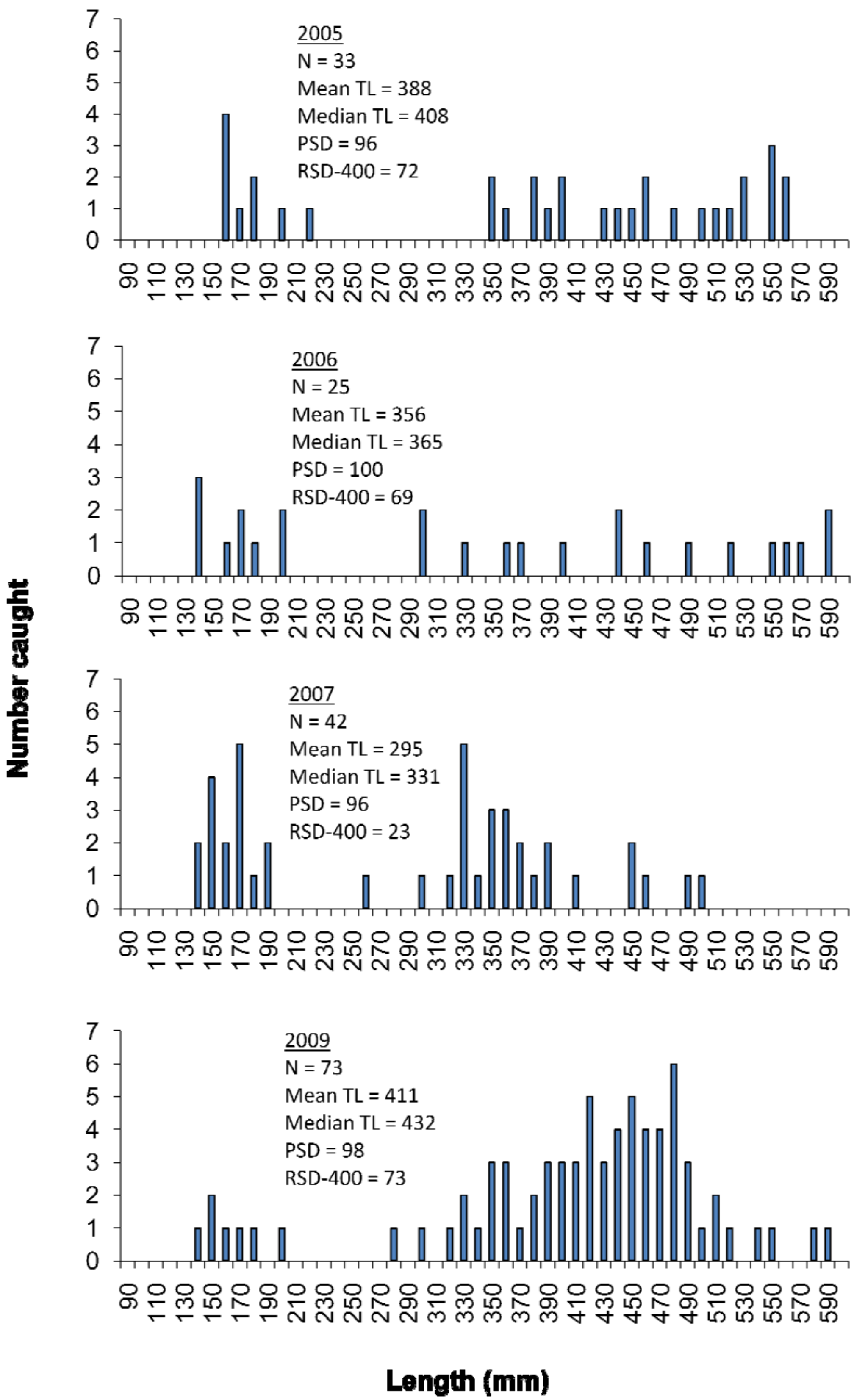

Figure 31. Length frequency distribution of brown trout in the Vernon reach of the Henrys Fork Snake River, Idaho, 2005 - 2009.

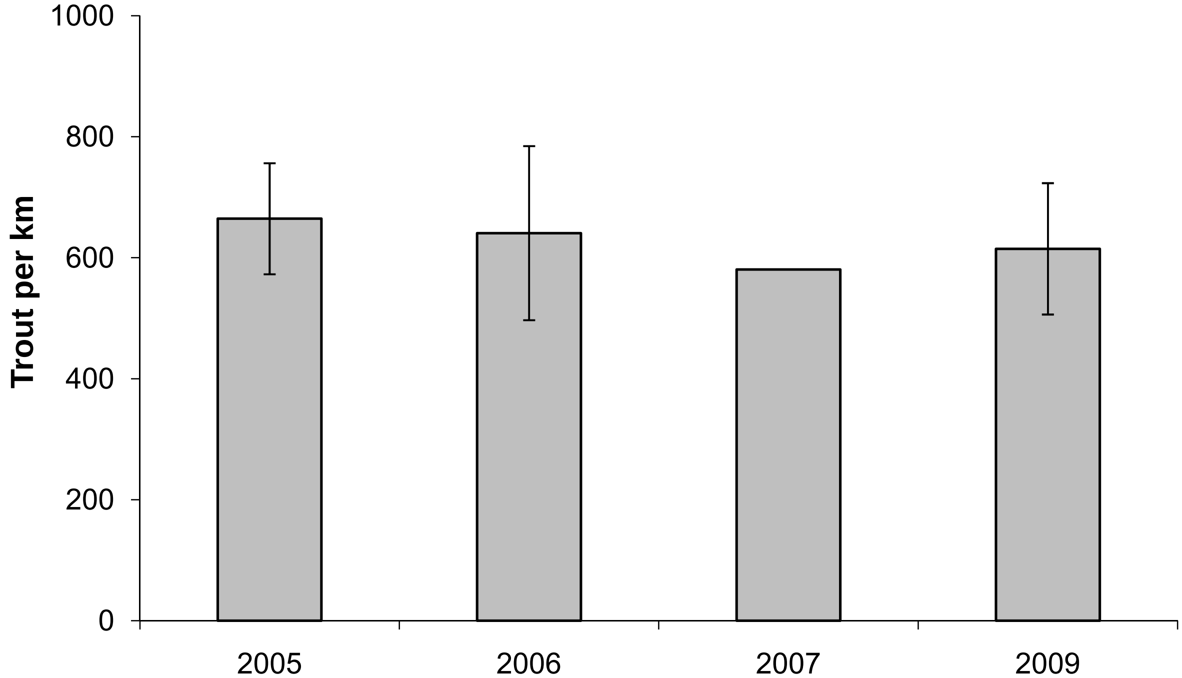

Figure 32. Trout population (rainbow and brown trout combined) estimates (Log-likelihood method) for the Vernon reach of the Henrys Fork Snake River, Idaho 2005 through 2009. Error bars represent 95% confidence intervals. Low numbers of recaptures during the 2007 estimate prohibited calculation by the Log-likelihood method, therefore the modified Peterson estimate is presented without error bars.

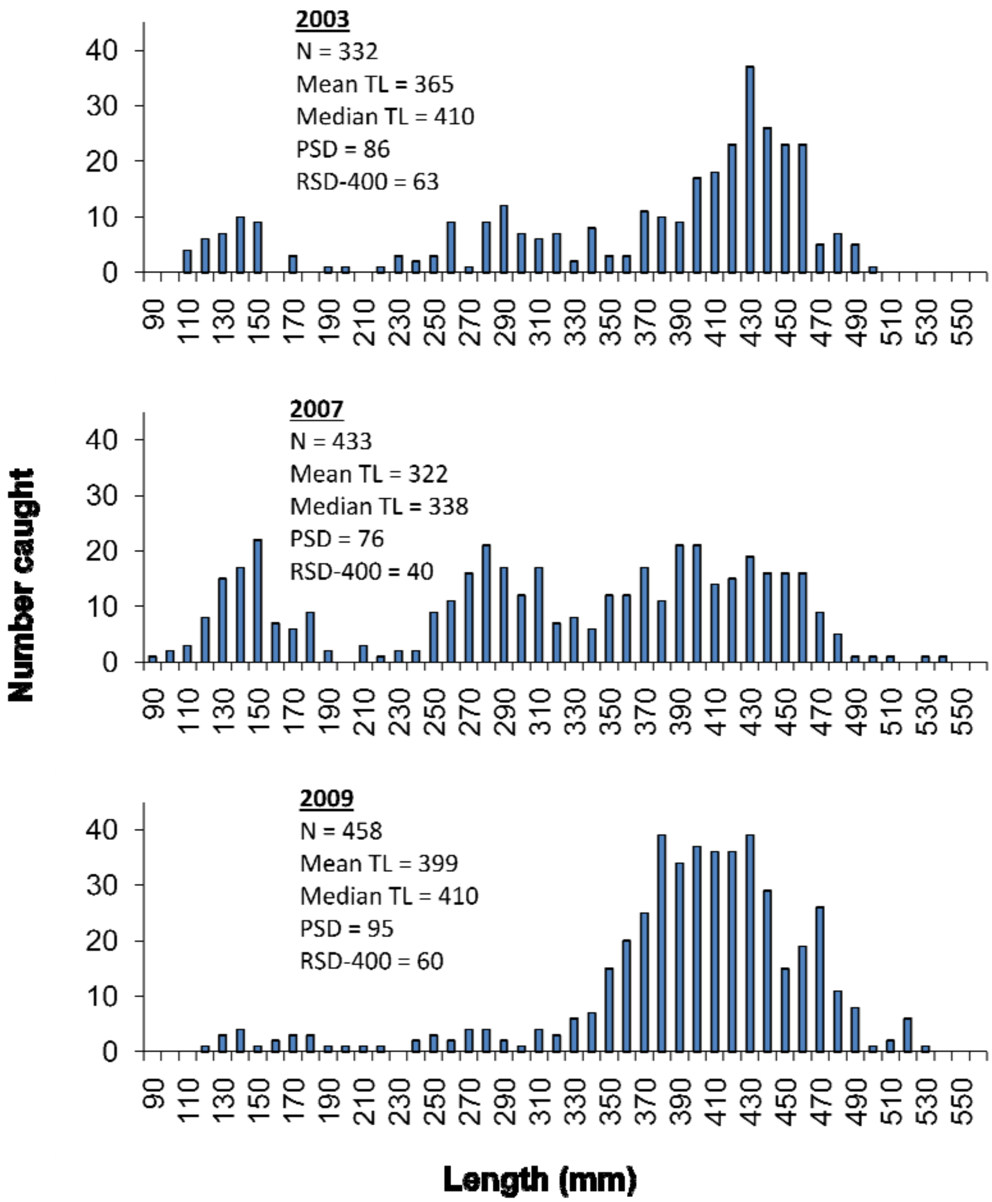

Figure 33. Length frequency distribution of rainbow trout in the Chester reach of the Henrys Fork Snake River, Idaho, 2003 - 2009.

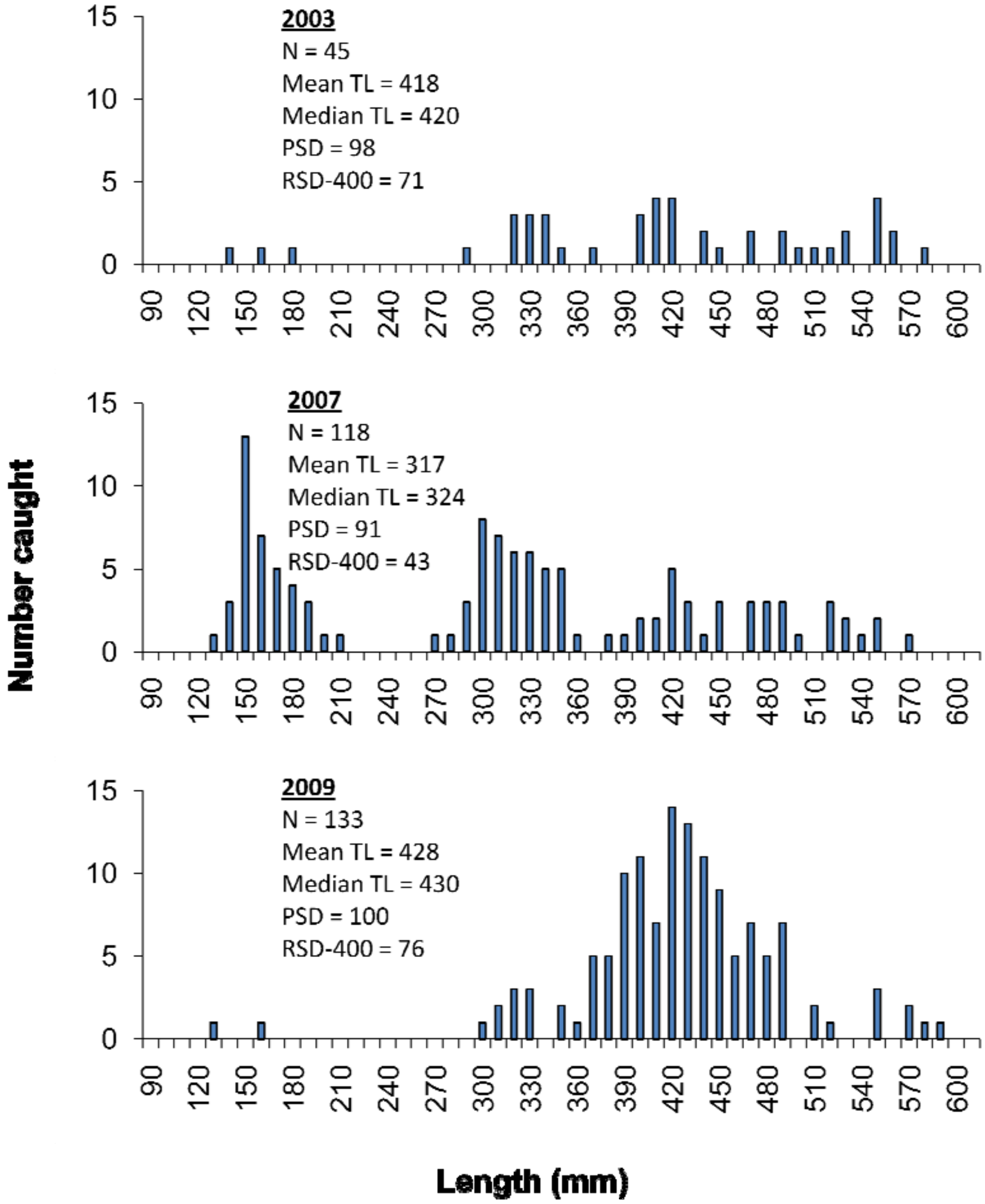

Figure 34. Length frequency distribution of brown trout in the Chester reach of the Henrys Fork Snake River, Idaho, 2003 - 2009.

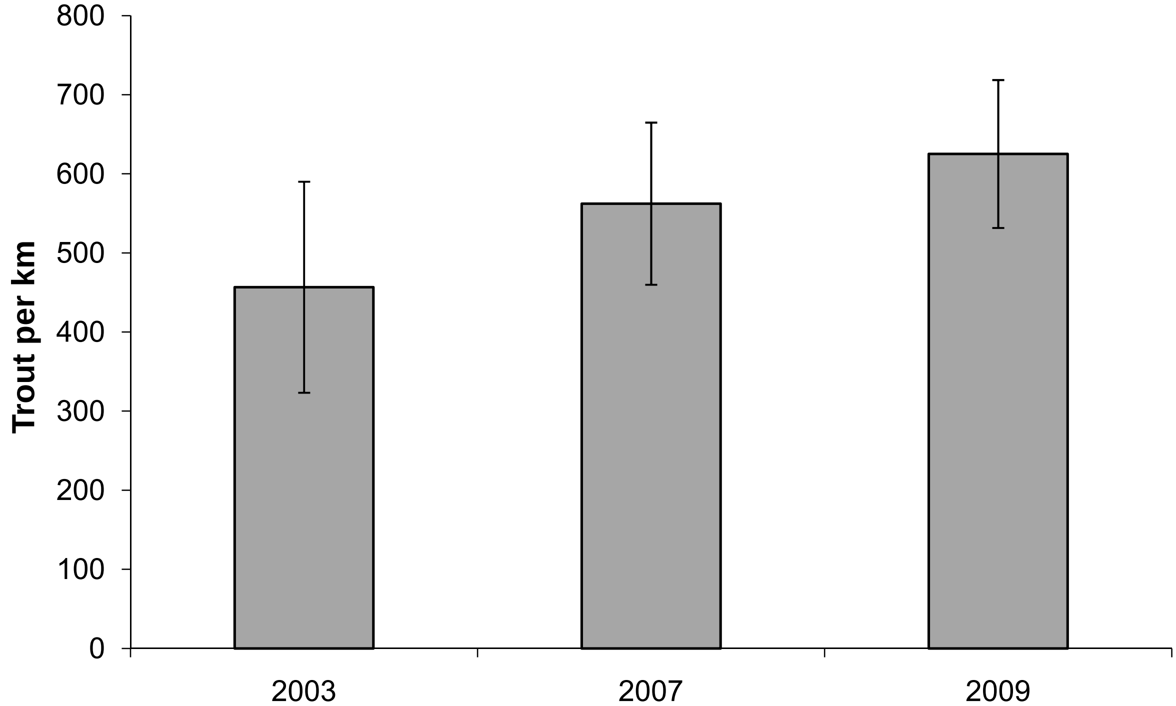

Figure 35. Trout population (rainbow and brown trout combined) estimates (Log-likelihood method) for the Chester reach of the Henrys Fork Snake River, Idaho 2003 through 2009. Error bars represent 95% confidence intervals.

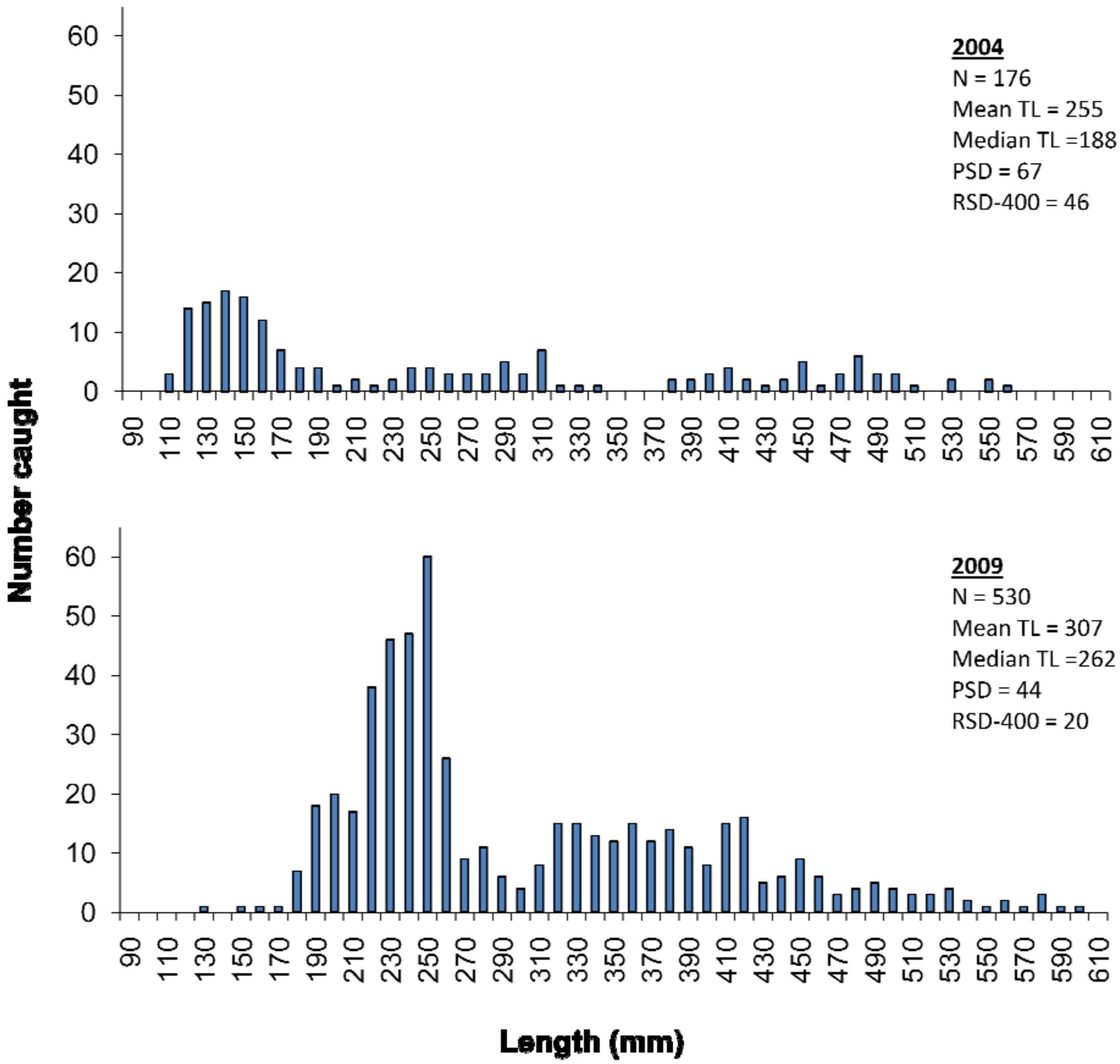

Figure 36. Length frequency distribution of brown trout in the St. Anthony reach of the Henrys Fork Snake River, Idaho, 2004 and 2009.

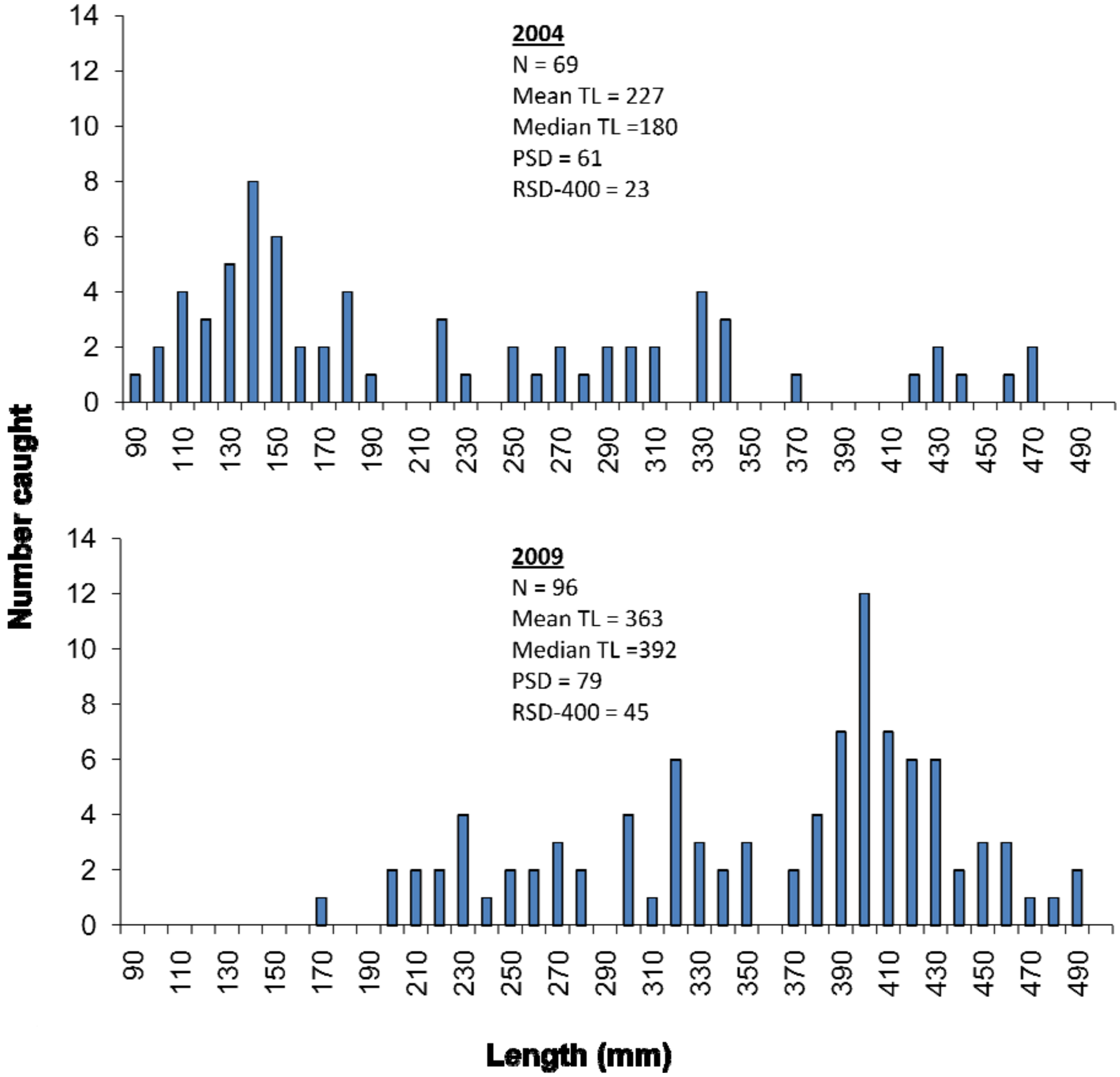

Figure 37. Length frequency distribution of rainbow trout in the St. Anthony reach of the Henrys Fork Snake River, Idaho, 2004 and 2009.

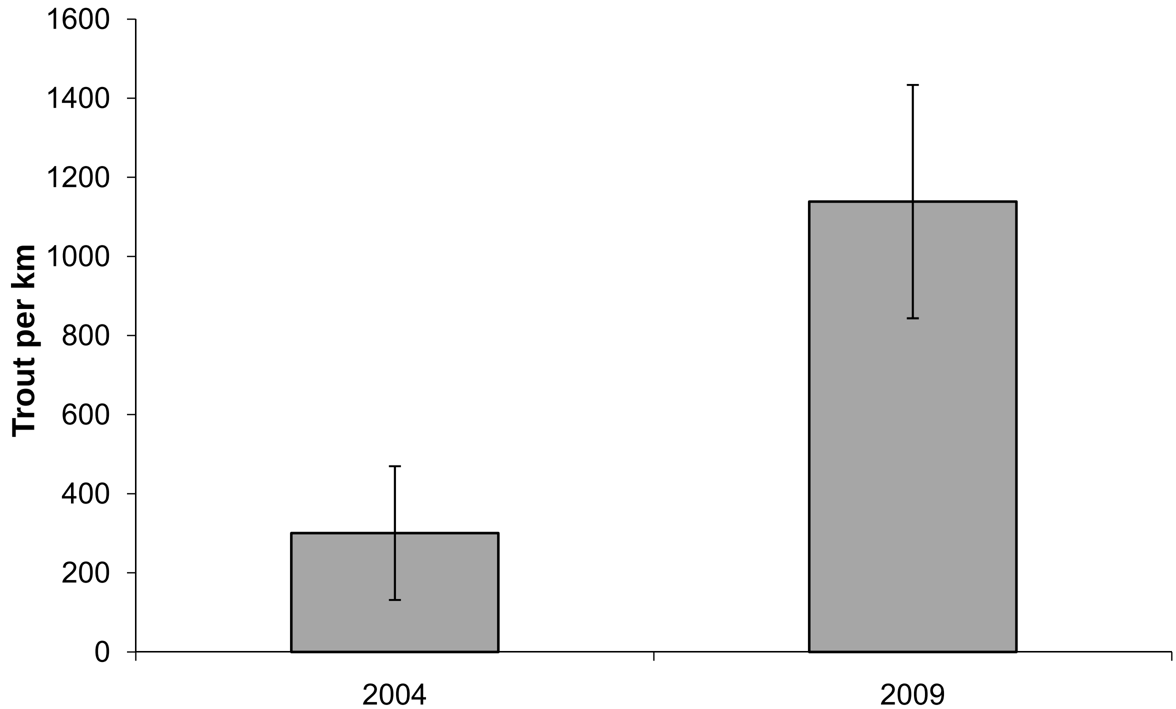

Figure 38. Trout population (rainbow and brown trout combined) estimates (Log-likelihood method) for the St. Anthony reach of the Henrys Fork Snake River, Idaho, 2004 and 2009. Error bars represent 95% confidence intervals.

2009 Upper Snake Region Annual Fishery Management Report

Rivers and Streams Investigations

TETON RIVER

ABSTRACT

We estimated trout abundances of age-1 and older trout using boat mounted electrofishing gear at four reaches on the Teton River in 2009. Two reaches in the Teton Valley (Nickerson and Breckenridge) are regularly sampled monitoring reaches. A third reach, Rainier, was also sampled in Teton Valley, and one reach (Parkinson) was sampled in Teton Canyon. The Rainier and Parkinson reaches were last sampled in 2000 and 1999, respectively. We estimated total trout abundance to be 1,171 fish/km at the Nickerson reach which represented a 170% increase from 2007. Estimates for all three trout species including Yellowstone cutthroat trout, rainbow trout and brook trout increased in abundance at the Nickerson reach between 2007 and 2009. We estimated there were 477 fish/km in the Breckenridge monitoring reach in 2009 which was similar to estimates from 2007 and 2005. Abundance of rainbow trout at the Breckenridge reach declined from 2007 to 2009 while abundance of Yellowstone cutthroat trout and brook trout increased. In the Rainier reach, we estimated trout abundance to be 389 fish/km which was a 174% increase over the 2000 estimate. Abundance of Yellowstone cutthroat trout, rainbow trout, and brook trout all increased between 2000 and 2009 at the Rainier reach. In Teton canyon, we estimated trout abundance to be 185 trout/km which was a 32% decrease from the 1999 estimate. However, this decline was not significant at the $\alpha = 0.05$ level. Overall, densities of Yellowstone cutthroat trout in the Teton River were high relative to recent surveys, and total trout densities were close to all-time high densities since monitoring began in 1987 for the Teton Valley sites. Trout populations in the Teton River appear healthy, Yellowstone cutthroat trout abundance is increasing in the upper valley, and cutthroat trout remain the dominant species in the Teton Canyon.

Authors:

Brett High
Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manager

INTRODUCTION

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

IDFG began monitoring trout populations in the Teton River in 1987. Prior to 2003, YCT had a long-time average density of 142 fish/km in the upper valley of the Teton River drainage with a high of 211 fish/km in the early 1990s after protective regulations had been implemented for YCT (IDFG 2007). The YCT population declined to less than 3 fish/km by 2003, but had improved to 11 fish/km in 2005 and 9 fish/km in 2007 (High and Garren 2008). Other trout in the Teton River include brook trout, rainbow trout, brown trout and mountain whitefish. As YCT numbers decreased through the 1990s the rainbow trout population increased. Non-native rainbow trout and brook trout are currently the dominant salmonids in the upper Teton River excluding mountain whitefish. Prior to wild trout management in the Teton River in 1994, IDFG supplemented trout populations with hatchery catchable and fingerling rainbow trout. Catchable rainbow trout were stocked into the Teton River through 1994.

Numerous anthropomorphic factors have negatively impacted native trout populations in the Teton River, including non-native trout stocking, mining, grazing, water diversion, water impoundment, and development. The construction and disastrous failure of Teton Dam in 1975 severely affected the middle and lower sections of the Teton River. Numerous landslides occurred in more than 20 km of the canyon section (mid-portion) of the Teton River that was inundated and then quickly drawn down when the dam collapsed. Riffle-pool habitat was changed to long, deep, slow pools punctuated by short rapids and riparian vegetation has yet to recover. The lower river below the Teton Dam site splits into the 37 km long South Fork Teton and 52 km North Fork Teton, both of which have been degraded by siltation, channelization, and water diversion structures. Although no impoundments exist in the upper (valley) section of the river, riparian habitat, stream widths and flows have been altered by grazing and water diversions. Van Kirk and Jenkins (2005) have identified flow alteration as a limiting factor for YCT. Tributary streams are largely diverted for agriculture during summer months, with flow returning to the main river later in the year as springs that originate in the valley. The enhancement of spring flows later in summer and fall has altered the hydrology of the Teton River, which now favor rainbow trout production more than YCT production. Although habitat alteration has occurred, conservation efforts have been implemented by several groups to benefit YCT. IDFG hopes to continue to work collaboratively with groups like Friends of the Teton River, the Teton Regional Land Trust, and Trout Unlimited to improve habitat in the Teton River and increase YCT abundance. The effectiveness of habitat improvement projects can be assessed by monitoring fish population trends. This report summarizes our monitoring efforts completed in 2009.

OBJECTIVES

1. Monitor trout abundance and species composition at the two standard monitoring sites, Nickerson and Breckenridge

2. Estimate trout abundance at two additional sites

3. Work with Friends of the Teton River to initiate a long-term Passive Integrated Transponder (PIT) tagging study on YCT

METHODS

We surveyed trout populations at Nickerson and Breckenridge monitoring sites (Figure 39). Nickerson and Breckenridge have been the standard Idaho Department of Fish and Game (IDFG) monitoring reaches in the upper Teton River, or Teton Valley, since 1987. They represent two different types of main river habitat in the Teton Valley – each responding differently to environmental conditions – and they have different levels of fishing pressure. Fish population information from these two sections represents the most comprehensive and longest-running data set for the Teton River (Schrader and Brenden 2004; Garren et al. 2006). The Nickerson section is 5.8 km long, and averages 42 m wide. The Breckenridge section is 4.9 km long and averages 26 m wide. We used a mark/recapture sampling design to estimate trout abundance in these reaches, and marked fish at Nickerson on November 8, 2009 followed by a six day rest prior to the recapture run. We marked fish at Breckenridge on November 10, 2009 and performed the recapture run after a six day rest. Locations for each sample reach are provided in Appendix D.

In addition to our regular monitoring reaches, we also sampled the Rainier and Parkinson reaches using a mark/recapture sampling design (Figure 40). The Rainier section is 5.5 km long and averages 37 m wide. It is located immediately upstream of the Breckenridge section. We marked fish in the Rainier reach September 9 and performed the recapture run after a six day rest. The Parkinson section is 5.6 km in length with a mean width of 30.5 m. We marked fish on September 17 and performed the recapture run six days later.

Fish were captured using direct-current (DC) electrofishing gear (Coffelt VVP-15 powered by a Honda 5000 W generator) mounted in two drift boats operated in tandem through each section. We used pulsed DC current through two boom-and-dangler anodes fixed to the bow while floating downstream. The boat hull was used as the cathode. VVP settings and conductivity readings were similar to past years (Garren et al. 2006). We used two drift boats outfitted with electrofishing gear during each sampling run.

We attempted to capture all trout encountered. After capture, fish were anesthetized, identified, and measured to the nearest millimeter for total length. Trout less than 150 mm (generally age-0) were not marked as they are not efficiently recruited to the gear. Age-1 and older fish were marked with a caudal fin hole punch and released back to the general area of capture. We placed a PIT tag in the body cavity of all YCT we captured that were ≥100mm. Electrofishing data were analyzed using the computer program Mark Recapture 5.0 (MR5; Montana Department of Fish, Wildlife, and Parks 1997). General statistical procedures were conducted according to Zar (1984).

We assumed capture probabilities did not vary with species, and calculated relative abundance using proportions of all individual trout captured (excluding recaptures). Although capture probabilities vary with fish length (Schill 1992; Reynolds 1996), population size structures (length frequency distributions) and average fish lengths were estimated using all fish captured. Abundance was estimated using two methods in the MR5 computer program. The log-likelihood method was preferred over the modified Peterson method if modeled efficiency curves were acceptable, i.e. there were enough recapture events per size group to adequately model capture efficiency. With adequate models, the log-likelihood method accounts for variance in capture efficiency due to fish length, which yields more accurate abundance estimates. In 2009, we used the log-likelihood method when total recaptures were greater than 12.

RESULTS

We captured 928 trout at the Nickerson monitoring site including 274 YCT, 202 rainbow trout, and 452 brook trout. Our capture efficiencies were 14%, 16% and 10% for YCT, rainbow trout, and brook trout, respectively. The abundance estimate for YCT was 228 trout/km, 360 trout/km for rainbow trout, and 856 trout/km for brook trout (Figure 41).

We captured 609 trout at the Breckenridge monitoring including 53 YCT, 450 RBT, and 105 BKT. We also captured a single large male brown trout. Capture efficiencies at Breckenridge ranged from a low of 3% for BKT to a high 12% for YCT. The capture efficiency for RBT was 8%. We estimated trout abundance at Breckenridge to be 18 YCT /km, 285 RBT/km, and 101BKT/km (Figure 42).

We captured 868 trout at the Rainier reach including 148 YCT, 443 RBT, and 187 BKT. We also captured two large male brown trout. Capture efficiencies were 26%. 30%, and 5% for YCT, RBT, and BKT, respectively. The density estimate for YCT was 81 YCT/km, 240 trout/km for rainbow trout and 285 trout/km for brook trout (Figure 43).

We captured 342 trout at the Parkinson reach including 267 YCT and 75 RBT with capture efficiencies of 26% and 21%, respectively. We estimated YCT abundance at 149 trout/km and RBT at 38 trout/km (Figure 44). Densities of trout in the Parkinson reach were similar to estimates prior to 2003 while estimates of trout densities of the other three reaches, all in Teton Valley, have generally increased since 2003 (Figure 45).

DISCUSSION

At the Nickerson monitoring reach, we found abundance of all trout species had increased when compared to 2007 abundance estimates. Estimates for YCT showed a statistically significant increase from 43 YCT/km in 2007 to 228 YCT/km in 2009. The current state fish management plan places emphasis on efforts to increase the Teton River cutthroat trout population (IDFG 2007). With an increasing trend in cutthroat trout at the Nickerson monitoring reach over the last six years, our results indicate we are successfully achieving our goal of increasing the abundance of Yellowstone cutthroat trout in the Teton River. Rainbow trout also increased significantly in the Nickerson reach from 155 trout/km in 2007 to 360 trout/km in 2009, and no change in brook trout abundance was detected between 2007 and 2009 at the Nickerson reach.

Estimates for brook trout and Yellowstone cutthroat trout in the Breckenridge monitoring site were not significantly different than 2007 estimates. Brook trout densities in the

Breckenridge reach may have reached carrying capacity as no difference in abundance has been detected at this reach since monitoring began in 1987. Ever since cutthroat trout numbers hit an all-time low in abundance in 2003, cutthroat trout numbers at Breckenridge have been slow to rebound, unlike those in the Nickerson reach upstream. The reason for this is unknown, but is possibly related to distance to spawning tributaries and habitat conditions. The two main spawning tributaries for Yellowstone cutthroat trout in Teton Valley are Teton Creek and Fox Creek. The confluence of Teton Creek is at the upstream boundary of the Nickerson monitoring reach, but is approximately 22 river km upstream from the Breckenridge reach. Fox Creek is even further upstream. As the cutthroat trout population recovers in Teton Valley, it is likely that there is suitable habitat for individuals dispersing from spawning tributaries in the main river near spawning tributaries. As the cutthroat trout population continues to increase, we should observe more cutthroat trout in the Breckenridge reach as trout dispersing from nursery areas may need to travel further distances to find unoccupied suitable habitat. The reason for the decline in rainbow trout abundance at the Breckenridge reach between 2007 and 2009 is also unknown. Factors affecting rainbow trout declines at Breckenridge may be related to environmental effects or spawning conditions. Rainbow trout spawning is limited during average and above-average run-off years, which 2008 was.

Trout densities in the Rainier reach are high relative to prior survey estimates, and may be influenced by recent habitat improvement projects (Baldigo et al. 2010). Local landowners in cooperation with the Teton Regional Land Trust performed intense bank modification work within the Rainier reach to improve riparian habitat. Severely eroding banks were restored by resloping and revegetating the modified bank with riparian plant species that will naturally increase the integrity of the bank and reduce erosion and sediment input into the Teton River. Large woody debris and bank barbs were also incorporated in the habitat improvement project. During our electofishing survey, numerous trout were captured along these restored banks. Although improvements to habitat has likely affected trout abundance in the Rainier reach, trout densities were likely influenced by environmental conditions and river wide trends in populations (Moore and Gregory 1988). The most recent previous sample of the Rainier reach was performed in 2000. With few samples, it is difficult to conclude how much of an effect habitat improvements have influenced trout population abundance in the Rainier reach. Current abundance estimates of trout are at an all-time high for the Rainier reach, and habitat improvement has likely played a role.

The Parkinson Reach has been infrequently surveyed in the past. Prior to the current survey, we have only successfully estimated Yellowstone cutthrout trout densities on one other occasion. Although higher than the current estimate, the estimate of Yellowstone cutthroat trout abundance from 1999 did not differ statistically. The same was true for rainbow trout. Total rainbow trout density (including hatchery fish) dropped signficantly between 1992 and 1999 after rainbow trout were no longer stocked into the river beginning in 1994. Much of the decrease in the rainbow trout abundance between 1992 and 1999 is probably explained by the absence of hatchery rainbow trout, although limited natural recruitment may also be a factor. Rainbow trout in the Teton River tend to spawn primarily in the main river (Schrader and Jones 2004), and habitat conditions in the Teton River canyon have been degraded by the Teton Dam flood which likely limits recruitment for trout that spawn in the main river. Similar to abundance estimates, species composition for rainbow and cutthroat trout between 1999 and 2009 did not seem to change. Yellowstone cutthroat trout remain the dominant trout in the Parkinson Reach. Yelllowsone cutthroat trout in the Teton Canyon are supported primarily by Bitch Creek which serves as the primary spawning tributary. Canyon Creek is also utlilized by spawners, but not at the level Bitch Creek is (Schrader and Jones 2004). Bitch Creek is currently an unaltered connected tributary of the Teton River, and is likely the driver for a healthy Yellowstone cutthroat trout population in the Teton River canyon. Bitch Creek should receive priority consideration during future management efforts to protect cutthroat trout in the Teton River.

ACKNOWLEDGEMENTS

IDFG employees Chuck Traughber, Greg Schoby, Andrew Sorensen, Devin Merrit, Tony Imthurn, and Nathan Fincher assisted with field surveys. Volunteers from Friends of the Teton River including Lyn Benjamin, Mike Lein, Anna Lindstedt, Amy Verbatim, Ty Mack, and Dave Abbott also helped with field surveys as well as Tamara Sperber and Wray Landon, volunteers from the Teton Regional Land Trust. Keith Drake also volunteered to assist with field surveys.

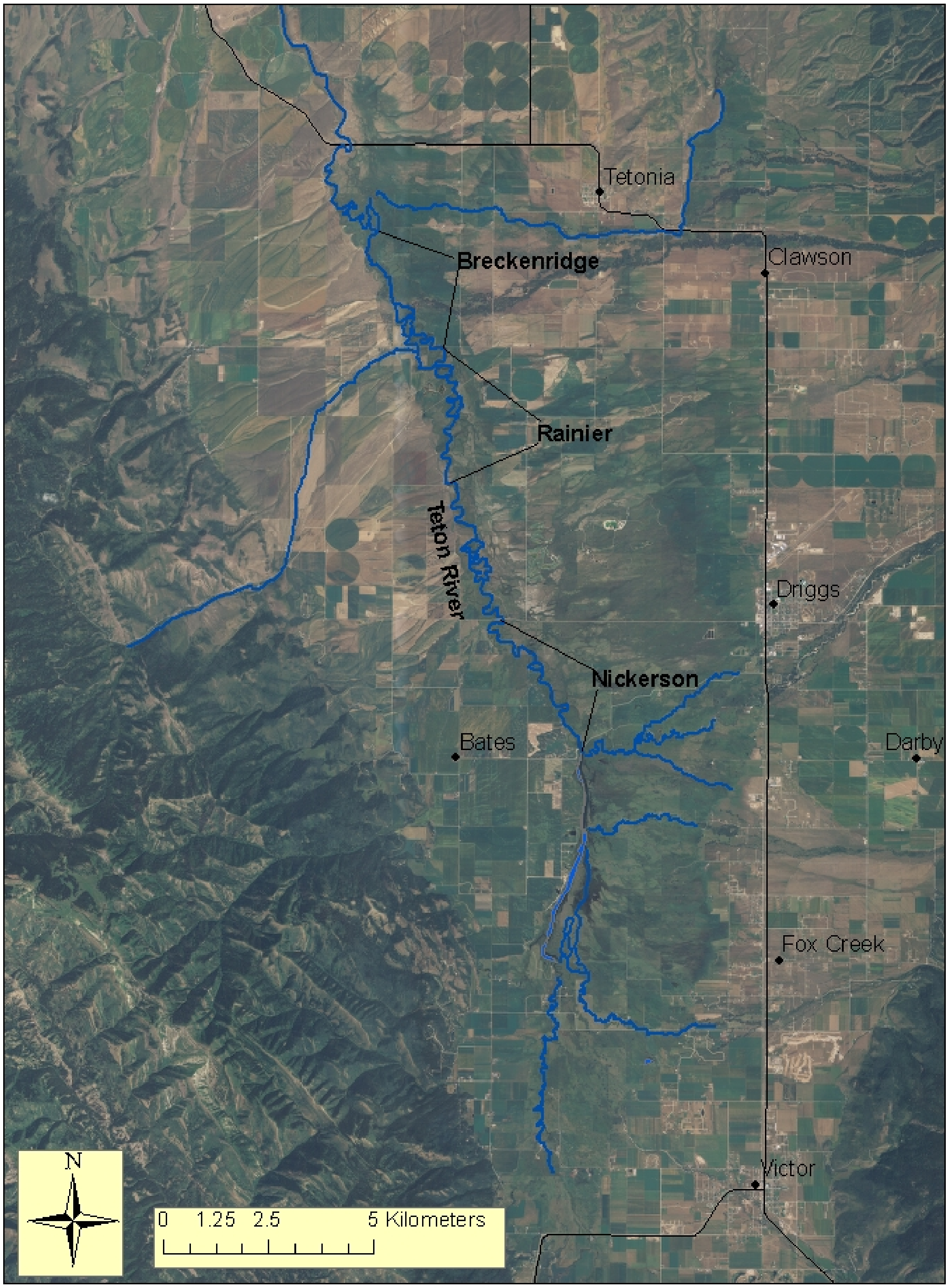

Figure 39. Teton Valley area map.

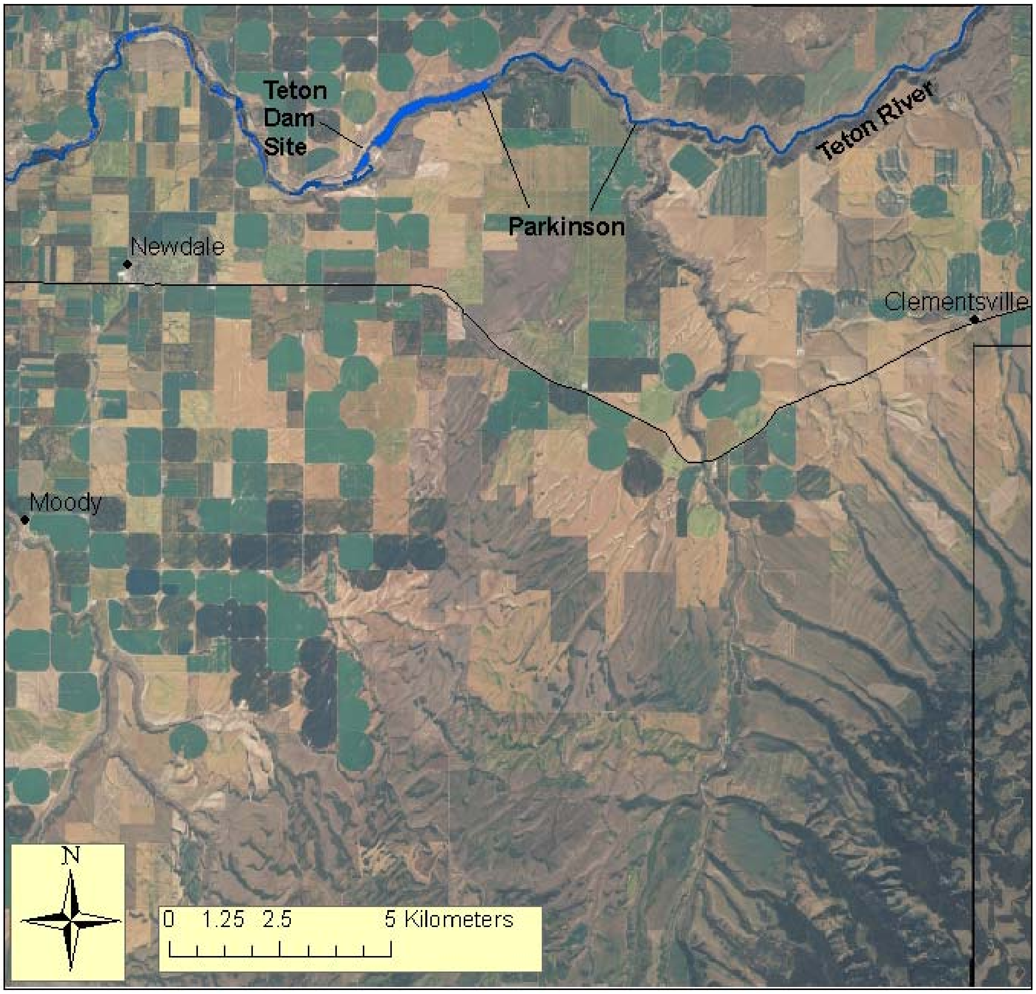

Figure 40. Parkinson monitoring site map.

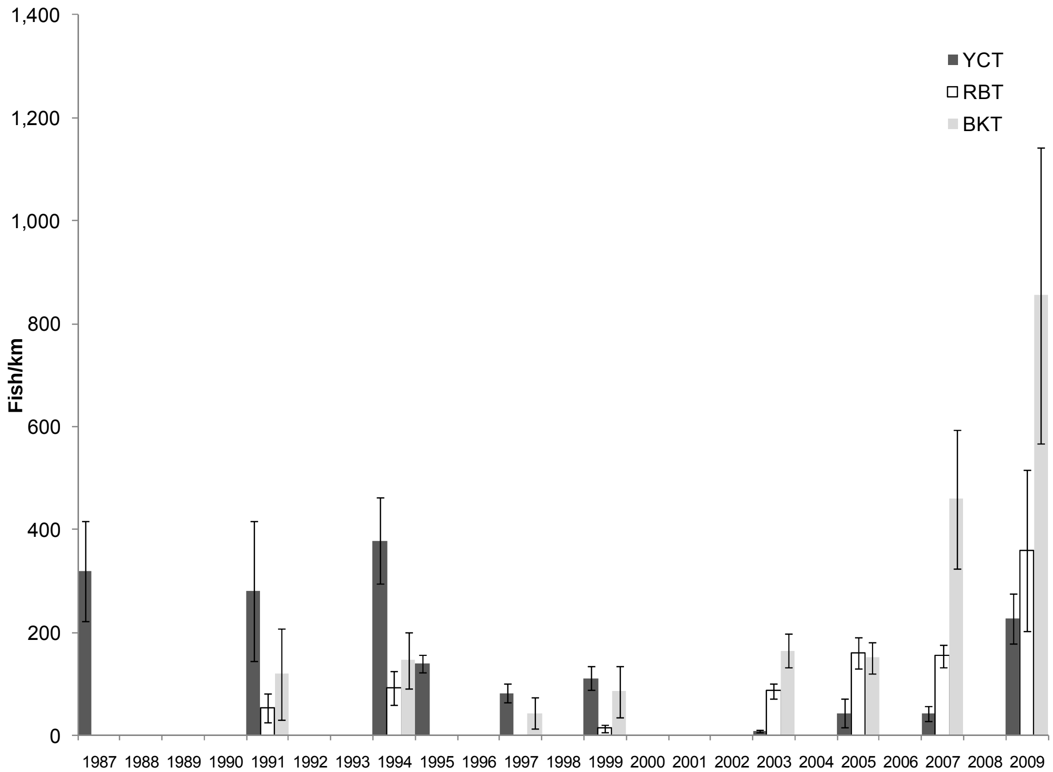

Figure 41. Estimates of Yellowstone cutthroat trout (YCT) rainbow trout (RBT), and brook trout (BKT) at the Nickerson monitoring site with 95% confidence intervals.

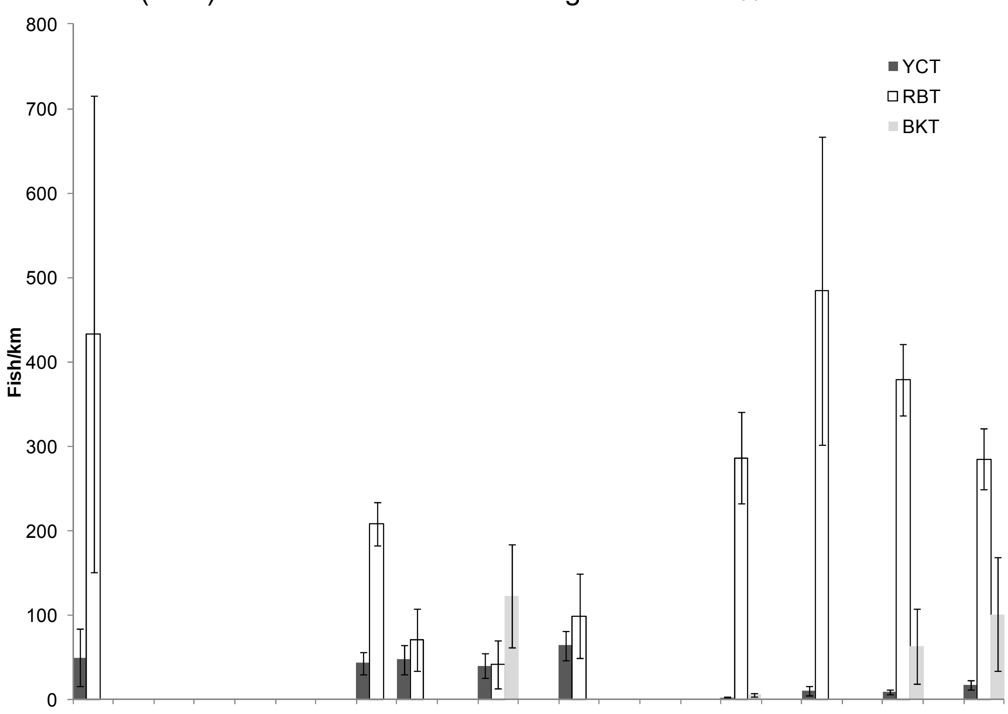

Figure 42. Estimates of Yellowstone cutthroat trout (YCT) rainbow trout (RBT), and brook trout (BKT) at the Breckenridge monitoring site with 95% confidence intervals.

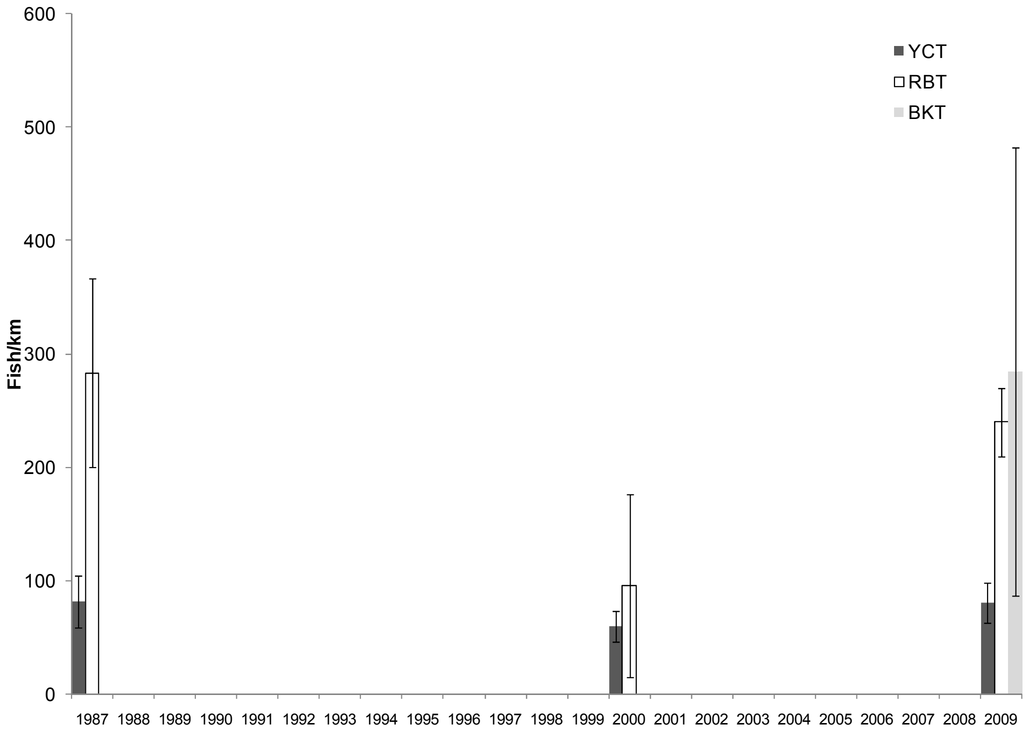

Figure 43. Estimates of Yellowstone cutthroat trout (YCT) rainbow trout (RBT), and brook trout (BKT) at the Rainier monitoring site with 95% confidence intervals.

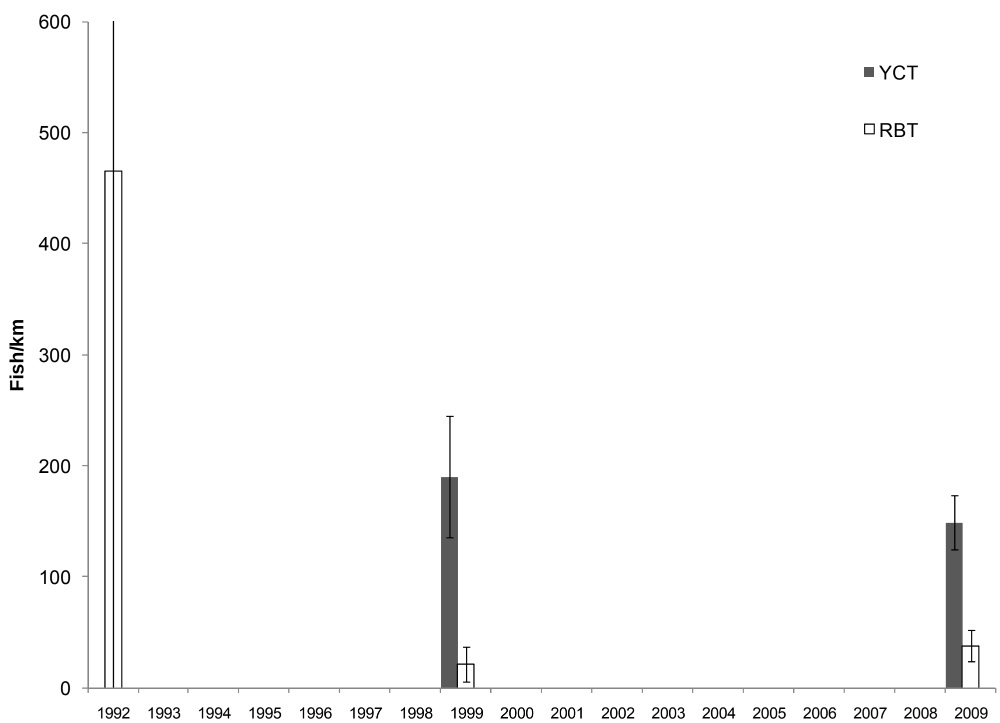

Figure 44. Estimates of Yellowstone cutthroat trout (YCT) rainbow trout (RBT), and brook trout (BKT) at the Parkinson monitoring site with 95% confidence intervals.

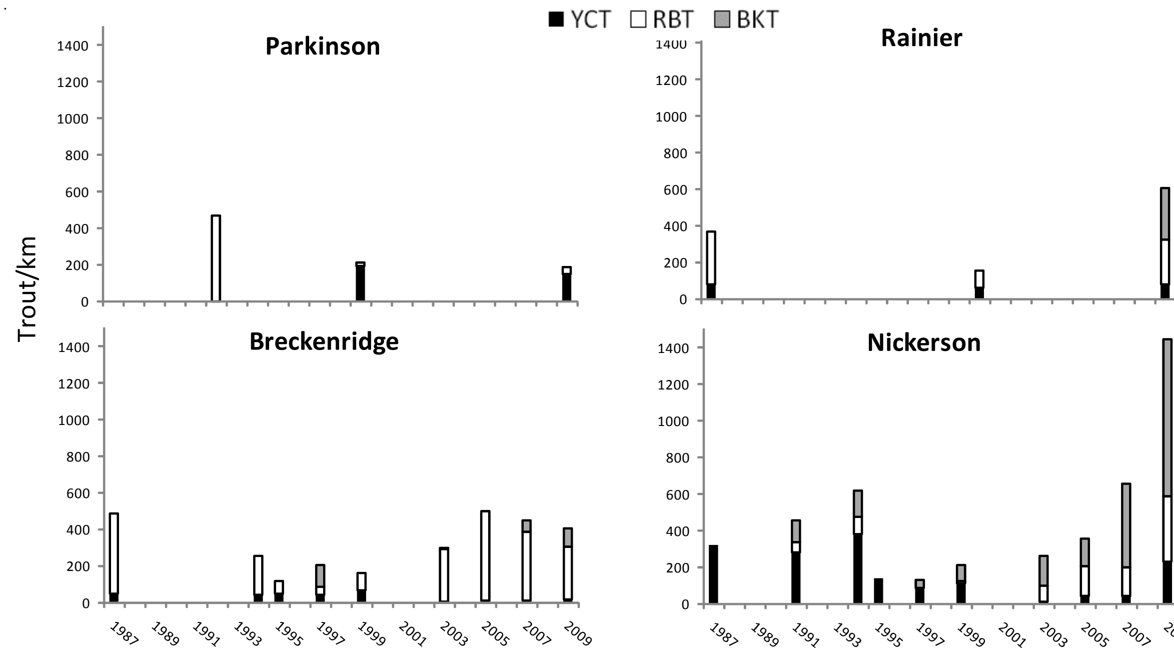

Figure 45. Species composition for Yellowstone cutthroat trout (YCT), rainbow trout (RBT), and brook trout (BKT) at the four surveyed reaches in the Teton River from 1987 through 2009. Species composition is based on abundance estimates.

2009 Upper Snake Region Annual Fishery Management Report

Rivers and Streams Investigations

SOUTH FORK SNAKE RIVER

ABSTRACT

Staff completed a creel survey on the Dry Bed snag fishery to estimate angler harvest and to observe entrainment into this canal. Effort was 525 hours during the Dry Bed snagging season and 787 trout were harvested including 150 Yellowstone cutthroat trout (YCT), 543 brown trout and 94 rainbow trout (RBT).

Four tributary traps were operated to stop nonnative rainbow trout spawning migration. A total of 3,081 trout were captured and removed. Trap efficiencies were estimated at 98%, 49%, and 26% at Burns, Pine, and Palisades creeks, respectively. We did not estimate efficiency at Rainey Creek.

Burns Creek was surveyed with backpack electrofishers. Lower densities of YCT were found at trend sites surveyed above our weir compared to previous surveys in 2000. We did not capture rainbow trout above the weir, but found RBT densities downstream to be similar to past estimates suggesting the Burns Weir may be effective at limiting RBT invasion.

Angler exploitation of rainbow trout was estimated using anchor tags and voluntary tag return data. Exploitation was 13%, which is lower than past years. We estimate anglers caught 27% of the RBT in the South Fork Snake River during 2009, but approximately 50% were released.

Trout abundance estimated in the Conant and Lorenzo monitoring reaches on the South Fork were 2,514 trout/km and 1,133 trout/km respectively, both of which were among the highest densities recorded. Rainbow trout density at Conant was significantly higher than YCT for the first time, comprising 55% of captured trout. Age 1 RBT increased 240% from 2007.

PIT tags were placed in YCT to assess spawning site fidelity, estimate mortality and recruitment rates, identify repeat spawning periodicity, and to study general movement of YCT in the South Fork and tributaries. We have marked 5,141 YCT with PIT tags since 2008 and have recorded 598 recaptures, mainly at fish traps operated on spawning tributaries. YCT from the lower river were observed at three of four spawning tributaries upstream demonstrating the importance of these areas to the population of YCT.

Authors:

Brett High
Regional Fisheries Biologist

Dan Garren
Regional Fisheries Manager

INTRODUCTION

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

The South Fork Snake River YCT population is both ecologically and economically important. Yellowstone cutthroat trout are widely known among anglers as a trout that are easy to catch (Griffith 1993; Thurow et al. 1988) and have a strong tendency to take dry flies. A substantial YCT fishery has developed on the South Fork, which generated approximately $12 million in local income and supported an estimated 341 jobs in 2004 (Loomis 2005).

While Meyer et al. (1996) considered the YCT population in the South Fork healthy, recent abundance estimates have declined from previously documented abundances (Moore and Schill 1984; Schoby et al. 2010) due to many factors including hybridization with non-native rainbow trout. Hybridization has been blamed for YCT declines across their native range (Krueger and May 1991; Leary et al. 1995). Yellowstone cutthroat trout and rainbow trout (RBT) are closely related taxonomically and have similar life-histories. The spawn timing of RBT occurs slightly before YCT, which typically spawn during the descending limb of the spring hyrdrograph peak. However, spatial and temporal overlap of RBT and YCT spawning has been documented in the main river and spawning tributaries of the South Fork Snake River (Henderson et al. 2000). Currently, YCT and RBT select for similar spawning habitat in the main river (side channels), and in tributaries RBT tend to spawn in the lower reaches while YCT migrate further upstream (Henderson et al. 2000; Meyer et al. 2006). Hybridization and competition with rainbow trout has been identified as the biggest threat to the persistence of Yellowstone cutthroat trout in the South Fork (IDFG 2007).

Non-native RBT have been stocked in the South Fork from the 1880s through 1981, but comprised only a small portion of the species composition until recently (Moore and Schill 1984; Schoby et al. 2010). Through 1981, catchable-sized fertile RBT were stocked at various locations and a wild run of RBT had become established in one of the major cutthroat trout spawning tributaries - Palisades Creek - by 1982 (Moore and Schill 1984). River-wide densities of RBT remained low through the early 1990s (Schrader et al. 2002), but increased in abundance with a concurrent decline in YCT from the mid-1990s through 2003 (Garren et al. 2006). Rainbow x cutthroat hybrid trout (hereafter included with RBT) abundances have also increased. The threat of hybridization to YCT populations is substantial (Thurow et al. 1988; Clancy 1988) because offspring from a RBT x YCT cross are fertile (Henderson et al. 2000), and the temporal segregation in RBT and YCT spawning is decreased when hybrids are present (Henderson et al. 2000; De Rito 2004).

Releases from Palisades Dam that resemble a natural hydrograph for a snow melt driven system have been shown to benefit YCT while adversely affecting rainbow trout (Moller and Van Kirk 2003). The impacts of this natural-shaped hydrograph are more pronounced after low winter flows. Palisades Reservoir is operated as a flood control/irrigation storage reservoir and alters a natural hydrograph by increasing late winter flows to make room for spring runoff, thereby diminishing the spring run-off peak and increasing the summer flows. In other words, the altered hydrograph tends to be smoothed relative to the natural snowmelt hydrograph. Moller and Van Kirk (2003) recommend a natural-shaped spring peak hydrograph that is at least 15 times higher than the prior winter's minimum flow to improve YCT recruitment relative to rainbow trout in the South Fork Snake River.

Palisades Reservoir also stores water for several irrigation companies that divert water from the river below. One of the canals, the Dry Bed, is an old side channel that has been fitted with a head gate. The Dry Bed can divert up to 5,000 cfs (often more than half of the total river flow) during the irrigation season and runs stock water through the winter. Canal operators dry up the Dry Bed annually in April for maintenance before the irrigation season. IDFG allows anglers to snag fish during this time, but maintains a 6 trout daily bag limit. Although the fishery is popular with local anglers, IDFG has not monitored angler effort or harvest during this fishery.

To address the increasing RBT population and decreasing YCT population, IDFG altered the fisheries management program for the South Fork in 2004. The current management goal is to ensure YCT are the dominant trout in the South Fork (IDFG 2007), and the approach is three-pronged. The first component deals with reducing RBT abundance through harvest, the second component involves maintaining tributaries as YCT spawning strongholds, and the third component deals with shaping flows to benefit YCT. Conservation of the South Fork Yellowstone cutthroat trout population is the focus of our management program, and our efforts during 2009 are summarized in this report.

OBJECTIVES

1. Summarize a creel survey on the Dry Bed Canal during snagging season.
2. Operate fish traps in Burns, Pine, Rainey, and Palisades creeks to maintain YCT stronghold areas.
3. Resample historic monitoring sites on Burns Creek.
4. Estimate annual exploitation for rainbow trout in the South Fork Snake River.
5. Monitor relative abundance and density of South Fork Snake River trout populations.
6. Evaluate effectiveness of flows released to benefiting YCT.
7. Continue YCT PIT tagging study.

STUDY AREA

The Snake River originates in Yellowstone National Park and flows south through Grand Teton National Park and the Jackson Hole valley before turning west and flowing into Palisades Reservoir at the Idaho – Wyoming state line. The 106 km portion of the Snake River that runs from Palisades Dam to the confluence with the Henrys Fork is commonly referred to as the South Fork. Anglers and biologists divide the South Fork into three segments. The first, called the upper river, runs from Palisades Dam to Pine Creek through a relatively unconfined valley. The first 13 km of the upper river downstream of the dam is a simple channel. From this point, the river braids around numerous islands. All but one of the four main YCT spawning tributaries enter the South Fork in this upper river, including Palisades Creek, Rainey Creek, and Pine

Creek (Figure 45). The second segment of the South Fork runs from Pine Creek downstream to Heise, and is commonly referred to as the Canyon. Burns Creek, the fourth major YCT spawning tributary enters the South Fork in the Canyon. The last segment of the South Fork runs from Heise to the confluence with the Henrys Fork, and is commonly referred to as the lower river. There are no major YCT spawning tributaries in the lower river, and while constant water temperatures from Palisades Dam moderate winter conditions in the upper and canyon sections, winter conditions in the lower river are usually more severe than upstream (Moller and Van Kirk 2003). The Conant and Lorenzo monitoring reaches of the South Fork are in the upper river and lower river sections, respectively.

METHODS

Dry Bed Creel

An access point creel survey was conducted on the Dry Bed Canal during the snagging season from April 1 through April 4, which corresponded to the majority of the snagging season. After April 4, water levels in the few remaining pools dropped low enough that anglers had fished out the pools or fish had otherwise died. Total effort, catch, and species composition was estimated based on completed trip surveys. Analysis was completed using the simple combination survey method as explained by Pollock et al. (1994). We completed one instantaneous count on each of three days using fixed-winged aircraft and by driving along the dry bed in a vehicle and counting anglers on one day. Instantaneous counts showed creel clerks would be most likely to encounter anglers upstream of the bridge at 4500 East at two to three locations. Two clerks were stationed at these locations from 8:00 am to 6:00 pm (approximately 75% of daylight hours), and interviewed anglers as they concluded their fishing trips. Creel clerks asked anglers how long they fished, how many fish they caught by species, how many trout they harvested (by species), and collected fish lengths on harvested trout. Daily fishing effort was calculated by multiplying the instantaneous count value by the fishing day length. Total fishing effort was calculated by summing daily fishing effort estimates for all four days. The catch rate for all trout species combined was estimated by dividing total trout caught by the total hours spent snagging. The harvest rate for all trout species combined was estimated similar to catch, but total trout caught was replaced by total trout harvested. We then multiplied the catch rate and total effort estimate to calculate total trout caught. Likewise, we multiplied our harvest rate and effort to obtain an estimate of the total number of trout harvested. Variance estimates for total catch, total harvest, and total fishing effort was calculated by averaging the daily values of variance for the respective statistic of interest.

Weirs

Migration barriers and traps were installed at all four of the main spawning tributaries of the South Fork and maintained during the spring spawning run. The Burns Creek trap was used in conjunction with a combination fall and velocity barrier and was operated from April 9 through July 22. We used a picket weir at the Pine Creek fish trap. The Pine Creek weir was installed April 6 and was removed July 15. A picket weir was also used at the Rainey Creek fish trap, which was installed on April 7 and removed on July 6. An electrical barrier was used at the Palisades Creek fish trap from May 12 through July 20.

All fish captured at Burns, Pine, Rainey, and Palisades creeks were identified to species, sexed according to expression of milt or eggs or head morphology, and measured to the nearest mm (total length). Yellowstone cutthroat trout were marked with a PIT tag or a caudal fin punch and released upstream of the weir. We removed the adipose fin from cutthroat trout that received PIT tags as a secondary mark to evaluate tag loss and make scanning for PIT tags more efficient. All cutthroat trout captured in the trap with adipose fin clips were scanned for PIT tags. Rainbow trout and rainbow x cutthroat trout hybrids were removed from the runs, placed in a holding pen at the Palisades Canal screen yard, and later transported to the Victor kids pond where anglers were likely to catch the fish.

We estimated efficiencies for the traps at Burns, Pine, and Palisades creeks using backpack electrofishing units to capture trout upstream of the Burns Creek and Pine Creek traps, and we used a secondary trap on the Palisades Canal screen bypass to estimate trap efficiency at Palisades Creek. Too few trout (n=23) were marked at the Rainey Creek trap to allow for trap efficiency evaluation. The Palisades Canal bypass trap was operated from April 20 to September 20. Efficiencies were calculated as the number of cutthroat trout ≥ 273 mm with PIT tags or caudal fin punches divided by the total number of cutthroat trout ≥ 273 mm. The 273 mm length cutoff was identified as two standard deviations less than the average total length of all cutthroat trout captured at fish traps in 2009, and effectively eliminates skewing error resulting from resident YCT.

Tributary Monitoring

We sampled two locations on Burns Creek (Figure 45) using backpack electrofishing units at a similar time (November 20) as the sites were sampled during surveys conducted in 2000. We used multiple pass depletions and estimated densities of fish/100m^2 and corresponding 95% confidence intervals using Microfish (Van Deventer and Platts 1985). Two passes were used to deplete the lower site and three passes were completed on the upper site.

Rainbow Trout Exploitation

We estimated the annual exploitation rate of rainbow trout in the South Fork using anchor tags and voluntary tag return data from anglers. None of the anchor tags had a monetary value associated with returning the tag (non-reward tags). Tag return data were entered into a South Fork-specific formula that accounts for angler non-reporting and tag loss to estimate exploitation as developed and described by Meyer et al. (2009). We marked rainbow trout on February 19, 20, 26, and 27. Fish were captured using boat-mounted electrofishing gear and drift boats from Palisades Dam downstream to Wolf Flat (Figure 45). Captured rainbow trout were anaesthetized, measured to the nearest mm (total length), and the release location and date were recorded. We calculated an adjusted exploitation rate accounting for 6% tag loss observed in South Fork rainbow trout in 2006 (Meyer et al. 2008), 0% marking mortality, and a volunteer reporting rate of 48% estimated for South Fork Snake River anglers in 2007 (Meyer et al. 2008).

South Fork Population Monitoring

We sampled the Lorenzo and Conant monitoring reaches of the South Fork during the fall to estimate trout abundance. Estimates were calculated for each species and only included age I and older trout (Schrader and Fredericks 2006a). We used a jet boat outfitted with electrofishing gear and pulsed DC current to capture fish. We collected trout in the Lorenzo reach over two days (September 21 and 22) for marking followed by a seven day rest and a two day recapture event. At the Conant reach, we collected trout over three days (October 6 - 8) for marking followed by a five day rest and a two day recapture event. We attempted to capture all trout encountered. Trout were identified to species and measured to the nearest mm (total length). Fish captured during the marking runs that were large enough to be included in population estimates (YCT≥102 mm, RBT≥152 mm, and brown trout BNT≥178 mm) were marked with a hole punch in the caudal fin for identification during recapture runs. Additionally, all YCT captured were marked with a passive integrated transponder (PIT) tag and a corresponding adipose clip as a secondary mark to evaluate tag loss. Abundance estimates and 95% confidence intervals were calculated using the log-likelihood method in Montana Department of Fish Wildlife and Park's software Mark/Recapture for windows or MR 5.0 (MFWP 1997). The log-likelihood method adjusts estimates based on modeled capture efficiencies, which differ by fish size (Schill 1992). Abundance estimates were standardized to fish per kilometer for comparison with estimates collected since 1986. As with most mark - recapture surveys, we assumed the population was closed, the probability of capture was the same for individual fish for each run, fish did not lose their marks, marked fish mixed randomly with unmarked fish, and the marks were recognized properly (Ricker 1975).

We monitor YCT and RBT recruitment to gauge the effectiveness of managed spring flows aimed to benefit YCT. Age 0 fish are not recruited to our electrofishing gear; therefore, we use the abundance of age 1 YCT (102-254 mm) and RBT (152-279 mm) to evaluate the effects of spring flows during the year spawning occurred on that year class.

PIT Tags

This is the second year of a multi-year study designed to individually identify YCT in the South Fork using PIT tags to assess spawning site fidelity, estimate mortality rates and recruitment rates, identify repeat spawning periodicity, and general movement of YCT in the South Fork and its tributaries. Our goal is to mark 5,000 YCT annually. We use all opportunities when YCT are captured to mark new fish and collect recapture data, including winter electrofishing efforts while marking RBT, at fish traps operated during the spring, and during fall monitoring surveys on the main river. We placed PIT tags in the body cavity of YCT and removed the adipose fin as a secondary mark. When YCT are marked with PIT tags or when previously PIT-tagged YCT are recaptured, the date, location, and total length to the nearest mm are recorded. We provide a summary of the number of YCT PIT-tagged to date according to location, as well as where our recaptures have occurred, and provide some tag loss data.

RESULTS

Dry Bed Creel

During the four days of the creel survey we collected 152 completed trip interviews and observed 516 harvested trout. The composition of the observed harvest was 19% Yellowstone cutthroat trout, 69% brown trout, and 12% rainbow trout. Anglers reported 355 hours of fishing effort. We estimated total fishing effort and 95% confidence interval (CI) at 1,335 hours (±3.0). The total catch rate and 95% CI was 1.76 fish per hour (±8.7) and the total estimated harvest rate and 95% CI was 1.5 (±8.7) fish per hour. We estimated total harvest for the snagging season at 1,971 trout with an upper 95% CI of 17,140 fish. Assuming harvest composition of the total catch was similar to observed harvest composition, we estimate 375 Yellowstone cutthroat trout, 1,360 brown trout, and 236 rainbow trout were harvested during the Dry Bed snagging season.

Weirs

We captured 1,495 trout at the Burns Creek trap including 1,491 Yellowstone cutthroat trout, two rainbow trout, and two brown trout. The first trout was captured on April 23 and trout were caught through July 8. On June 19, 50% of the Yellowstone cutthroat trout run had passed the Burns Creek trap (Figure 47). We captured 54 Yellowstone cutthroat trout ≥273 mm using backpack electrofishing units on July 1, and 53 had PIT tags or caudal fin punches. Trap efficiency was estimated to be 98% (Table 12).

We captured 1,356 YCT and 1 RBT trout at Pine Creek. The weir was inoperable from April 21 through June 8 due to high water and debris. Trout were captured immediately after the picket weir was reinstalled on June 9, and trout were caught through June 23. By June 15, 50% of the captured cutthroat trout had passed the trap (Figure 48). We used backpack electrofishing units to capture 66 cutthroat trout ≥273 mm upstream of the picket weir. Of these, 34 were marked indicating our trapping efficiency at Pine Creek was 49% (Table 12).

We removed the pickets from the Rainey Creek weir from May 20 through June 3 due to high water and debris (Figure 46). Three Yellowstone cutthroat trout were captured before the pickets were pulled, and the remaining 20 were captured after the weir was reinstalled at the Rainey Creek trap. We captured trout between April 29 and June 30. Fifty percent of the observed cutthroat trout run at Rainey Creek passed the trap site by June 22 (Figure 49).

We captured 202 YCT and 4 RBT trout at the Palisades Creek trap between June 3 and July 10. Fifty percent of the observed cutthroat trout run passed the Palisades Creek fish trap by June 26 (Figure 50). We captured 172 fish ≥273 mm at the Palisades canal bypass trap. Of these, 44 were marked with PIT tags or caudal punches at the Palisades Creek trap, yielding a trap efficiency estimate of 26% (Table 12).

Tributary Monitoring

We estimated there were 2.0, 1.6, and 1.9 Yellowstone cutthroat trout, brown trout, and rainbow trout per 100 m^2, respectively at the lower monitoring site on Burns Creek (Figure 51). The estimated density of Yellowstone cutthroat trout and brown trout at the upper Burns Creek monitoring site was 2.1 and 0.5 fish/100m^2 (Figure 52). We did not capture rainbow trout at the upper Burns Creek site although they were present in the 2000 survey.

Rainbow Trout Exploitation

We tagged and released 497 rainbow trout with anchor tags during four days of electrofishing in February. Following tagging, we received 59 reports of anglers catching tagged RBT through September. We did not receive catch reports after September. Of the 59 reported catches, 29 (49%) were harvested. We estimated an adjusted annual exploitation rate of 13% for RBT in the South Fork Snake River.

South Fork Population Monitoring

We captured a total of 1,529 trout at the Lorenzo monitoring reach, including 177 YCT, 22 RBT, and 1,330 BNT, and were able to estimate YCT abundance at this location for the first time since 2006. We estimated our sampling efficiency at 9% for YCT, 10% for RBT, and 14% for BNT. Our abundance estimates for age 1 and older YCT (≥102 mm) and BNT (≥178 mm) were 218 and 915 trout per kilometer, respectively (Figure 53). Density estimates for YCT in 2009 were similar to available estimates back to 1999. Overlapping 95% confidence intervals indicated brown trout estimates from 2009 were similar to estimates from the previous two years. The all-time high brown trout estimate from 2006 was significantly higher than the 2009 brown trout estimates as indicated by non-overlapping 95% confidence intervals (Figure 53). An abundance estimate for RBT has never been possible in any of the previous 14 surveys at Lorenzo, and was again not possible for RBT with only 1 marked fish captured during the recapture run in 2009.

We captured a total of 2,405 trout at the Conant monitoring reach. This included 1,031 YCT, 894 RBT, and 480 BNT. Our sampling efficiency was 18% for YCT, 8% for RBT, and 19% for BNT. We estimated there were 826 YCT/km, 1,408 RBT/km, and 307 BNT/km of age 1 and older trout. The total trout abundance at Conant (2,541 trout/km) approached our all-time high estimate of 3,013 trout/km from 1999. Fifty-five percent of the total trout abundance at Conant consisted of rainbow trout. Estimated densities of RBT at Conant were 245% greater than the 574 RBT/km estimate in 2008 (Figure 54). Most of these rainbow trout were yearling fish, with an estimated density of 1,094 age 1 RBT/km which also was a significant increase from the previous available age 1 RBT estimate from 2007 (Figure 55). The ratio of age 1 YCT to age 1 RBT was 0.1 for the 2008 recruitment class indicating rainbow trout are recruiting to the population at a much higher rate than cutthroat trout (Figure 56).

PIT Tags

We started using PIT tags in the South Fork in the fall of 2008 when we marked 937 YCT. During 2009, we marked an additional 4,204 YCT including 628 during winter electrofishing efforts, 2,545 YCT at tributary traps, and 1,031YCT during fall monitoring surveys at Lorenzo and Conant (Table 13). We have recaptured 598 marked YCT to date. Many of these recaptures were at tributary traps where individuals fell back downstream over the fish trap where they were first marked days earlier. We captured 181 YCT at locations different than where they were originally tagged. We captured YCT that had been previously PIT tagged at a different location at all places we captured YCT in 2009, including monitoring reaches, tributary traps, and the main river during RBT marking events. Most of the 181 YCT recaptures were found at one of our four tributary fish traps (Figure 57). Although we only marked 63 YCT at the Lorenzo monitoring reach in 2008, individuals from this group were observed during the spring of 2009 at all of the tributary weirs except Palisades Creek, where we had low capture efficiencies. This included the Rainey Creek weir where we only captured 23 YCT and is 84 river km upstream. Similarly, YCT that were tagged in the Conant monitoring reach in 2008 were also observed at all of the tributary weirs except Rainey Creek. This indicates that YCT migrated both upstream and downstream to spawning tributaries. We calculated an overall PIT tag loss rate of 10%, although actual loss ranged from 0 to 28% (Table 13).

DISCUSSION

Dry Bed Creel

The Dry Bed Canal snagging fishery draws a substantial crowd annually during early April. The fishery is short-lived, and generally lasts only a few days. We estimated over 1,335 hours of effort were expended and 1,971 trout were harvested during our four day creel survey. The fish accounted for in the Dry Bed snagging fishery are trout that have been entrained through the Great Feeder Diversion and are considered a loss to the South Fork. Although the total number of trout entrained through the Great Feeder is unknown, we believe the fish harvested during the Dry Bed snagging season represents a fraction of the total entrained trout. The Dry Bed is a large feeder canal that thirteen large canals are supplied by. Trout entrained into the Dry Bed are also entrained into the auxiliary canals and perish when the auxiliary canals are dried at the end of the irrigation season each fall. Reports of entrained fish from canals supplied by the Great Feeder have been obtained dozens of mile from the Dry Bed. For obvious reasons, these trout are not included in the creel survey estimates. Furthermore, only adult trout are represented in the creel survey as most anglers would not keep small trout due to the six trout daily bag limit on the fishery. This hypothesis is supported by observations from biologists and creel clerks who have observed numerous pools with hundreds of dead fingerling trout. While 1,971 harvested adult trout may seem relatively small, it represents almost one and one quarter mile of the fish present at the Lorenzo reach, i.e. minimum estimates from the Dry Bed snagging fishery is analogous to anglers wiping out all age 1 and older trout for a mile of river at Lorenzo. When compared to the most recent creel survey data for the lower South Fork, estimated trout harvest from the 2009 snagging season on the Dry Bed was over seven times (x7.1) the total estimated harvest by anglers on the South Fork from Twin Bridges to the confluence in 2005 (Schrader and Fredericks 2006b). Furthermore, the 1,971 harvested trout is a highly conservative estimate of fish lost from the South Fork through entrainment into the Dry Bed. Our estimate does not include trout entrained through the Great Feeder Diversion and lost through irrigation during the summer months and in the fall, when the 13 major canals fed by the Dry Bed are shut off. Thus, the Dry Bed likely acts as a major annual sink for South Fork trout populations that should be quantified.

Weirs

This was the first time since 2002 that traps were installed and maintained on all four major South Fork spawning tributaries. Effective trapping of rainbow trout is critical to maintain tributaries as strongholds for YCT. Picket weirs have proven ineffective at capturing rainbow trout in South Fork tributaries during years with normal or above average runoff, as was the case in 2009. We had to remove the pickets and frames in both picket weirs (Pine and Rainey creeks) when flows peaked which was the time when we expected to start catching rainbow trout. To address this problem, both Pine Creek and Rainey Creek picket weirs will be converted to electrical barriers in the coming year. Modifications to the Pine Creek weir started September 15, and the electrical barrier will be operational by the next trapping season. We have proposed to move the Rainey Creek trap lower down the drainage to the U. S. Forest Service's Swan Valley Work Station. Construction is set to begin for this project September 15, 2010.

This was the first season that the modified fish trap at Burns Creek was used. The 61 cm vertical drop onto a 3.7 m cement slab sloped to create a velocity barrier to migrating trout, proved effective at forcing trout into the adjacent trap. While we conservatively estimated trapping efficiency at 98%, it was likely 100% effective. This is because the one unmarked trout observed during our efficiency sampling was potentially one of a dozen fish that were accidently released upstream of the barrier without a caudal punch mark. We observed several fish unsuccessfully challenge the barrier. No trout were observed successfully swimming all the way up the velocity barrier to the foot of the fall where they could have attempted a 61 cm jump from fast moving water shallower than the depth of their bodies. In short, the new design is highly successful at blocking upstream movement of trout during the spring.

This was also the first season that a permanent electric barrier was used at Palisades Creek. A temporary electric mat was used in 2007 with an efficiency of 98% (High et al. 2008a). We experienced lower efficiency in 2009 for various reasons. First, construction was not completed until May, and it is likely that most of the rainbow trout and some of the Yellowstone cutthroat trout had already passed the trap site by the time the electrical barrier was turned on. Second, once the electric barrier was turned on, a design flaw became apparent that caused stray electricity to enter the fish trap necessitating the frequency and waveform to be turned down which reduced our efficiency. Third, a gravel bar developed on top of the electrodes causing the electric field around the electrodes to be dampened and distorted. The spring 2010 trapping season will provide a better opportunity to assess the effectiveness of using an electric barrier at Palisades Creek in a variety of flow and gravel deposition situations.

Tributary Monitoring

Densities of Yellowstone cutthroat trout in Burns Creek were lower than estimates from 2000, and spring trapping efforts appear to be helping preserve cutthroat trout from invasions of rainbow trout. Rainbow trout densities were similar to those from 2000 at the lower site which is downstream from the Burns Creek fish trap. No rainbow trout were observed at the upper monitoring site, upstream of the fish trap while they were observed at this site in 2000. This may indicate that trapping efforts are successfully limiting rainbow trout invasion into Burns Creek.

Rainbow Trout Exploitation

The annual exploitation rate of 13% on rainbow trout in the South Fork Snake River was the lowest we have observed since the river was open to year around fishing with no limits on rainbow trout in 2004. We estimate 27% of the rainbow trout population was caught in 2009, but most of the captured rainbow trout were released. Exploitation has averaged 20% (ranging from 13 to 24%; Schoby et al. 2010). High discharge from Palisades Dam during April reduced anglers' ability to capture rainbow trout during the spawn when they are more vulnerable to angling. In combination with successful spring freshets, exploitation level exceeding 20% are expected to benefit Yellowstone cutthroat trout. Benefits of increased exploitation levels are greater when combined with spring flows that mimic the natural hydrograph (Van Kirk et al. 2010). Increasing exploitation levels above what was documented in the current year are critical to controlling RBT in the South Fork.

South Fork Population Monitoring

Overall, trout abundance at both Lorenzo and Conant are among the highest densities we have encountered. However, species composition currently does not meet our goal of <10% RBT in the population at the Conant monitoring reach. This is the first year rainbow trout abundance was significantly higher than native Yellowstone cutthroat trout at Conant since monitoring began in 1982 and is cause for concern. Spring flows have been linked to trout abundances in the South Fork with spring "freshets" that mimic a natural hydrograph having a negative effect on rainbow trout while positively affecting cutthroat trout abundances (Moller and Van Kirk 2003). Age 1 rainbow trout captured during electrofishing surveys were spawned in the spring of 2008. With age 1 rainbow trout comprising the majority of the total RBT estimate, recruitment was not hindered by flows in 2008. Moller and Van Kirk (2003) recommend a spring freshet with a maximum to minimum flow rate ≥15:1. The maximum to minimum flow ratio for the spring freshet of 2008 exceeded this target with a ratio of 22.6:1 (Schoby et al. 2010). It is possible that not only the magnitude, but also the timing of the spring freshet impacts effectiveness. Since 2004, we've experienced lower effectiveness of negatively impacting rainbow trout recruitment when the peak of the spring freshet occurred later than June 1 (Figure 13). It is also possible that potential benefits of the 2008 spring freshet in terms of reduced rainbow trout recruitment were offset by increased recruitment of rainbow trout from Palisades Creek, since the fish trap at Palisades Creek was not operated in 2008. However, we cannot quantify rainbow trout recruitment from Palisades Creek in 2008.

PIT Tags

The PIT tag marking program is already providing valuable movement data for YCT in the South Fork. In the fall of 2008, we marked 63 YCT at the Lorenzo monitoring site. Despite this small sample size, we recaptured individuals from this group at all of the tributary fish traps except Palisades Creek. There are 84 river km between the Lorenzo monitoring site and the fish trap on Rainey Creek and numerous unscreened diversions, including the Great Feeder headgate, the diversion for the Dry Bed Canal. We also received one report from an individual who caught a PIT-tagged YCT in a canal in Idaho Falls, but the PIT tag was lost. That particular fish likely originated in the South Fork, as that is the only location in the region that PIT tags are being used. The canal that the tagged YCT was caught out of is supplied by the Anderson Canal, which is a diversion near the Great Feeder. Based on the limited movement data acquired to date, the risk of entrainment of Yellowstone cutthroat trout from the lower river that spawn in the four main tributaries of the South Fork may be a significant factor adding to overall mortality.

Despite an estimate tag loss rate of 10%, we recaptured 20% of the YCT that were PIT-tagged in 2008 during our 2009 monitoring survey. This suggests Yellowstone cutthroat trout in the Conant monitoring site exhibit site fidelity, or are returning to the same stretch of river to stage for winter. High site fidelity was also observed for Bonneville cutthroat trout *O. clarkii utah* by Budy et al. (2007) in the Logan River system of northern Utah.

The amount of PIT tag loss we observed was discouraging. The overall average loss rate of 10% is similar to other studies where resident trout were tagged in the body cavity (High et al. 2008b). Our data corroborates other studies that showed increased PIT tag loss during the spawning season from resident trout tagged in the body cavity (High et al. 2008b; Bateman et al. 2009; Dieterman and Hoxmeier 2009). We recaptured post-spawn YCT at the Palisades Canal bypass trap, where we observed 28% tag loss rate. Alternate tagging locations or methods should be explored.

Yellowstone cutthroat trout in the South Fork continue to face obstacles to long-term persistence. The three-pronged management approach aimed at assisting this conservation-reliant species can be effective when all three prongs are effectively implemented (Van Kirk et al. 2010). We have observed beneficial spring freshets in 2004 and 2007, but not in other years. Successful flow management is needed more frequently to stem the increase in rainbow trout recruitment. The timing of the spring freshets should be further evaluated to improve effectiveness. Modifications to tributary weirs and traps continue to improve effectiveness of maintaining strongholds of Yellowstone cutthroat trout. However, modifications to the Pine Creek and Rainey Creek traps need to be completed to allow for trapping in high run-off conditions. Mainstem harvest of rainbow trout has increased from levels prior to 2004, but there is room for improvement. , Exploitation of rainbow trout needs to be increased to deal with the large year class of rainbow trout entering the population from the 2008 spawning season, possibly through exploring alternate methods to increase angler harvest. With adaptive management, continued monitoring, and increases in rainbow trout harvest, the South Fork will continue to support a healthy population of Yellowstone cutthroat trout.

Table 12. Summary tributary fish trap operation dates, efficiencies and catches from 2001 through 2009.

Location and year	Weir type	Operation dates	Estimated weir efficiency (%)[a]	Catch: Cutthroat trout	Catch: Rainbow trout	Catch: Total
Burns Creek						
2001[b]	Floating panel	March 7 - July 20	16	3,156	3	3,159
2002[b]	Floating panel	March 23 - Jul 5	NE[c]	1,898	46	1,944
2003[d]	Floating panel	March 28 - June 23	17-36	1,350	1	1,351
2004	ND[e]	ND	ND	ND	ND	ND
2005	ND	ND	ND	ND	ND	ND
2006	Mitsubishi	April 14 - June 30	NE	1,539		
2007	ND	ND	ND	ND	ND	ND
2008	ND	ND	ND	ND	ND	ND
2009	Fall/velocity	Apirl 9 - July 22	98	1,491	2	1,493
Pine Creek						
2001[b]	ND	ND	ND	ND	ND	ND
2002[b]	Floating panel	April 2 - July 5	NE	202	14	216
2003[f]	Floating panel	March 27 - June 12	40	328	7	335
2004	Hard picket	March 25 - June 28	98	2,143	27	2,170
2005	Hard picket	April 6 - June 30	NE	2,817	40	2,857
2006[g]	Mitsubishi	April 14 - April 18	ND	ND	ND	ND
2007	Mitsubishi	March 24 - June 30	20	481	2	483
2008	Hard picket	April 21 - July 8	NE	115	0	115
2009	Hard picket	Apirl 6 - July 15	49	1,356	1	1,357
Rainey Creek						
2001[b]	Floating panel	March 7 - July 6	NE	0	0	0
2002[b]	Floating panel	March 26 - June 27	NE	1	0	1
2003	ND	ND	ND	ND	ND	ND
2004	ND	ND	ND	ND	ND	ND
2005	Hard picket	April 7 - June 29	NE	25	0	25
2006	Hard picket	April 5 - June 30	NE	69	3	72
2007	Hard picket	March 19 - June 30	NE	14	0	14
2008	Hard picket	June 19 - July 11	NE	14	0	14
2009	Hard picket	April 7 - July 6	NE	23	0	23
Palisades Creek						
2001[b]	Floating panel	March 7 - July 20	10	491	160	651
2002[b]	Floating panel	March 22 - July 7	NE	967	310	1,277
2003	Floating panel	March 24 - June 24	21 - 47	529	181	710
2004	ND	ND	ND	ND	ND	ND
2005	Mitsubishi	March 18 - June 30	91	1,071	301	1,372
2006	Mitsubishi	April 4 - June 30	13	336	52	388
2007	Electric	May 1 - July 28	98	737	20	757
2008	ND	ND	ND	ND	ND	ND
2009	Electric	May 12 - July 20	26	202	4	206
Total by year						
2001				3,647	163	3,810
2002				3,068	370	3,438
2003				2,207	189	2,396
2004				2,143	27	2,170
2005				3,913	341	4,254
2006				1,944	55	460
2007				1,232	22	1,254
2008				129	0	129
2009				3,072	7	3,079
Grand Total				21,355	1,174	20,990

[a]Weir efficiency was estimated using several different methods

[b]From Host (2003)

[c]NE = no estimate

[d]Weir was shut down on June 10, but the trap was operated until June 23

[e]ND = no dat; weir either not built or not operated

[f]Weir was shut down early due to high cutthroat trout mortality

[g]Weir was destroyed during high runoff

Table 13. Summary of the number of Yellowstone cutthroat trout marked with PIT tags in 2008 and 2009, recapture information, and PIT tag loss rates. Older recaptures refer to recapture events that took place more than 10 days after the fish was originally marked.

			Summary of recapture data				
				Older	Recaptures	Lost	Loss
Location	**Tagged in 2008**	**Tagged in 2009**	**Recaptures**	**Recaptures**	**tagged elsewhere**	**tags**	**rate**
Burns Trap	0	1059	103	31	7	10	9%
Conant	874	855	302	177	22	38	11%
Lorenzo	63	176	12	2	1	1	8%
Palisades Screen bypass	0	162	34	9	34	13	28%
Palisades Trap	0	166	30	16	15	0	0%
Pine Trap	0	1139	93	79	78	3	3%
Rainey Trap	0	19	1	1	1	0	0%
Main River winter shocking	0	628	23	23	23	0	0%
Total	**937**	**4204**	**598**	**338**	**181**	**65**	**10%**

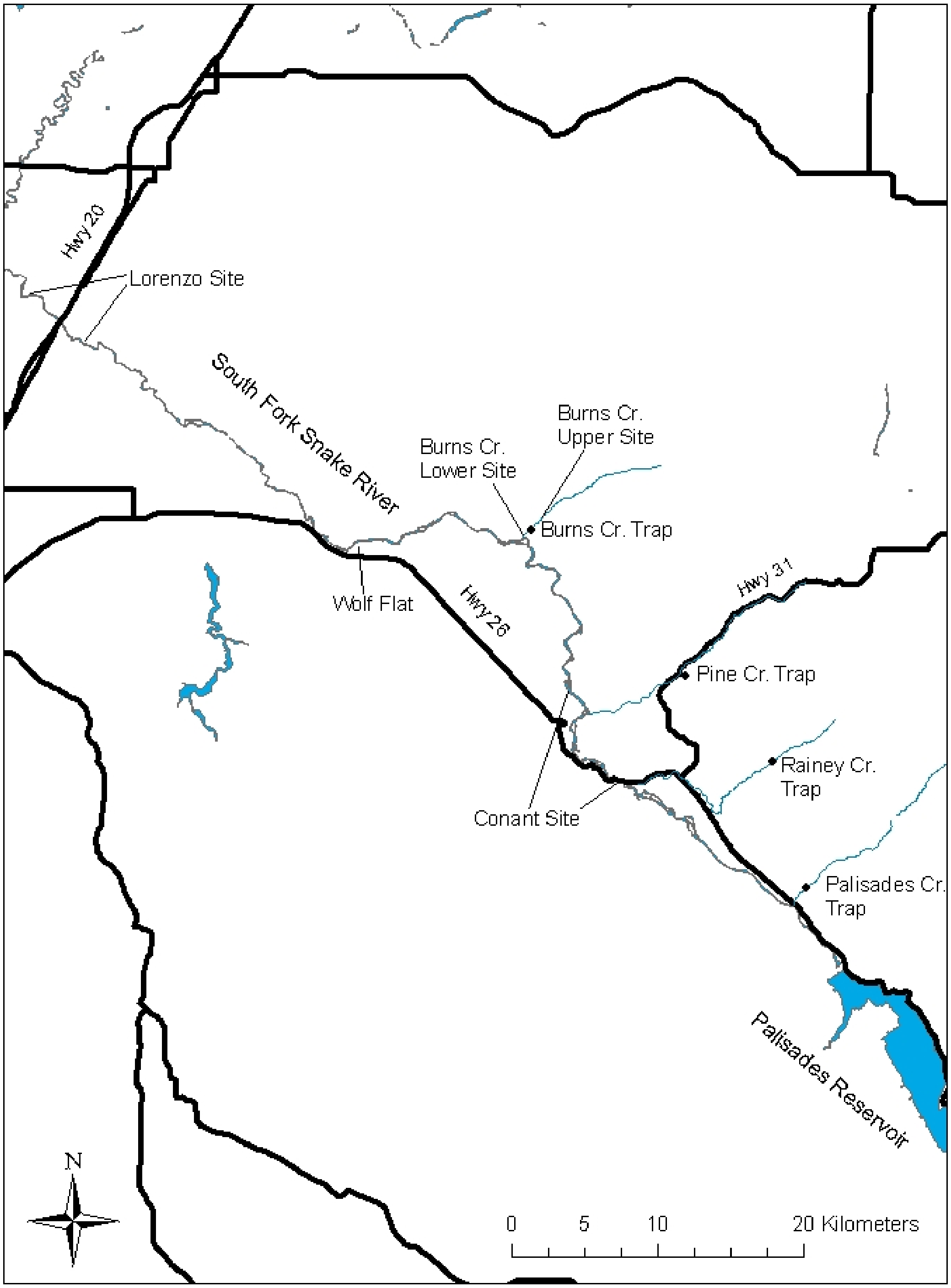

Figure 45. Map depicting the South Fork Snake River, Idaho.

Figure 46. High water at the Rainey Creek weir on May 19.

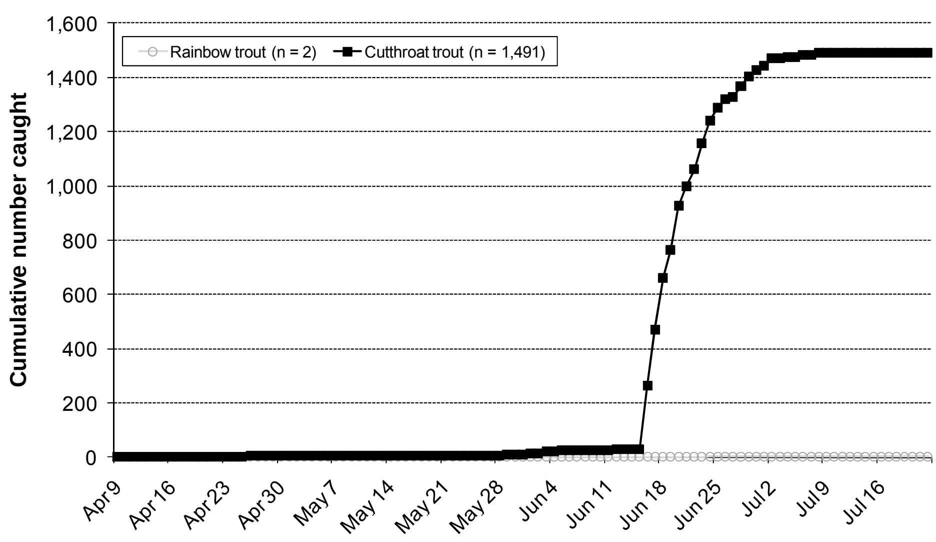

Figure 47. Cumulative passage times of Yellowstone cutthroat trout and rainbow trout at the Burns Creek fish trap.

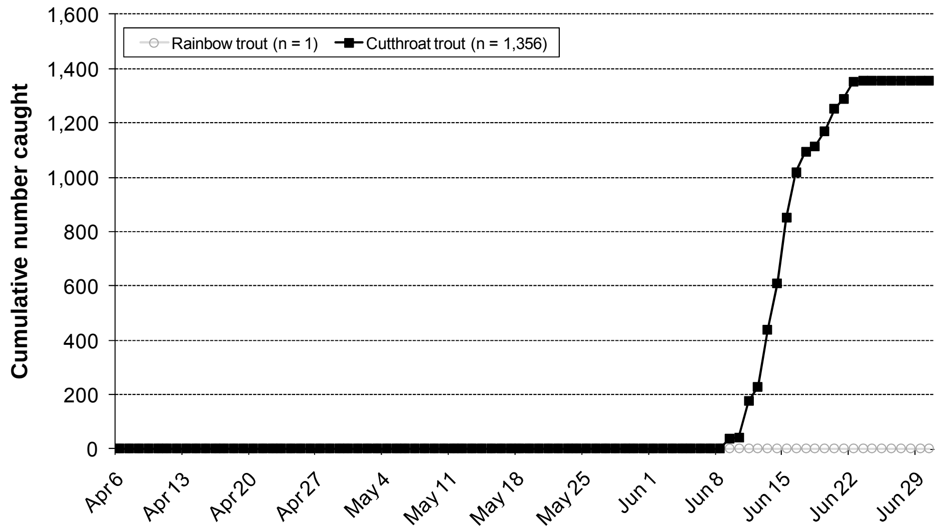

Figure 48. Cumulative passage times of Yellowstone cutthroat trout and rainbow trout at the Pine Creek fish trap.

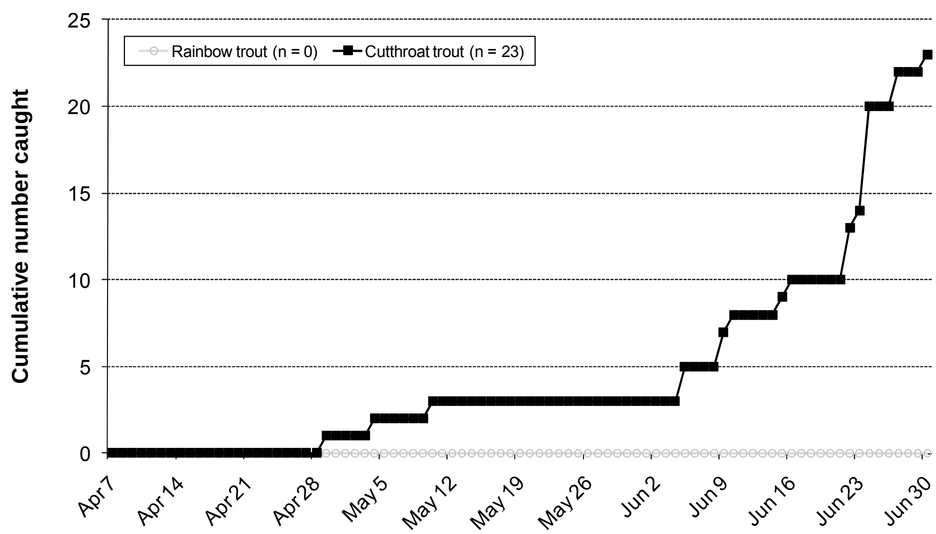

Figure 49. Cumulative passage times of Yellowstone cutthroat trout at the Rainey Creek fish trap.

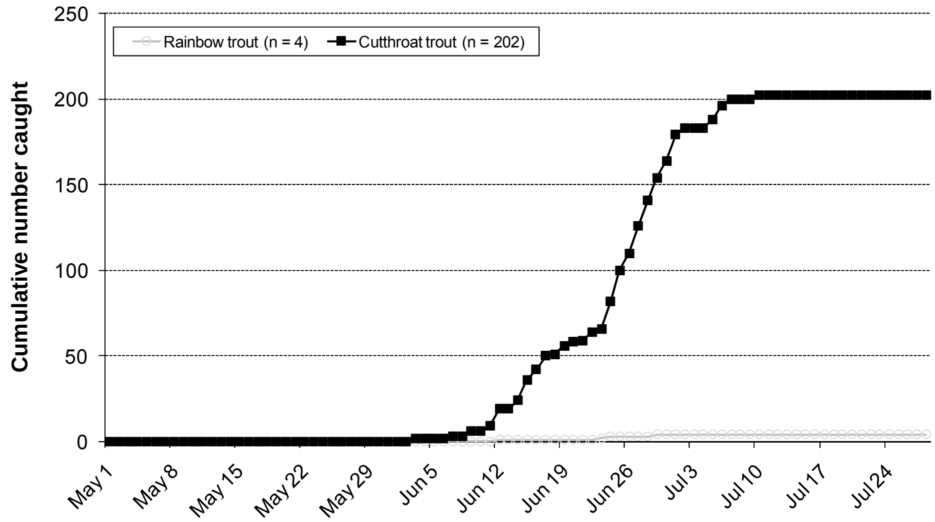

Figure 50. Cumulative passage times of Yellowstone cutthroat trout and rainbow trout at the Palisades Creek fish trap.

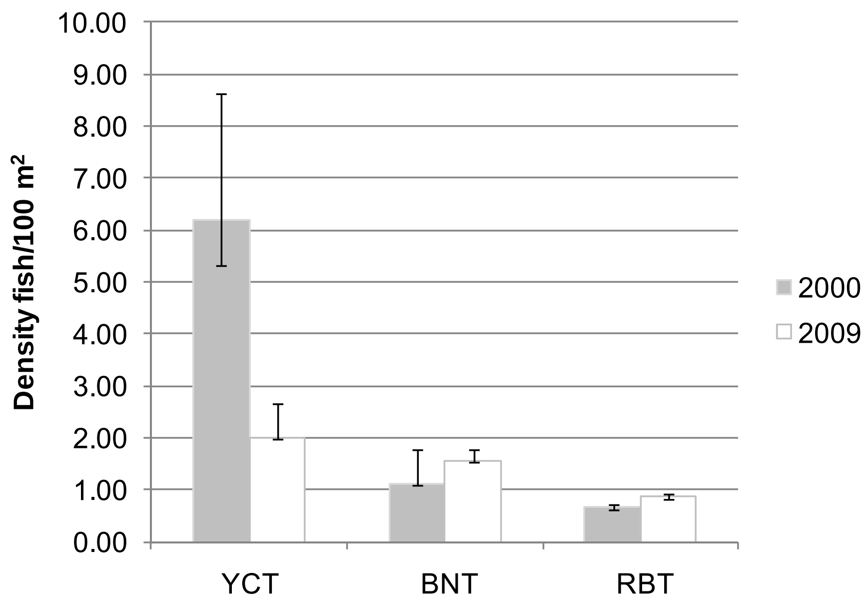

Figure 51. Estimated densities of Yellowstone cutthroat trout (YCT) brown trout (BNT), and rainbow trout (RBT) at the lower monitoring site on Burns Creek in 2000 and 2009 with 95% confidence intervals.

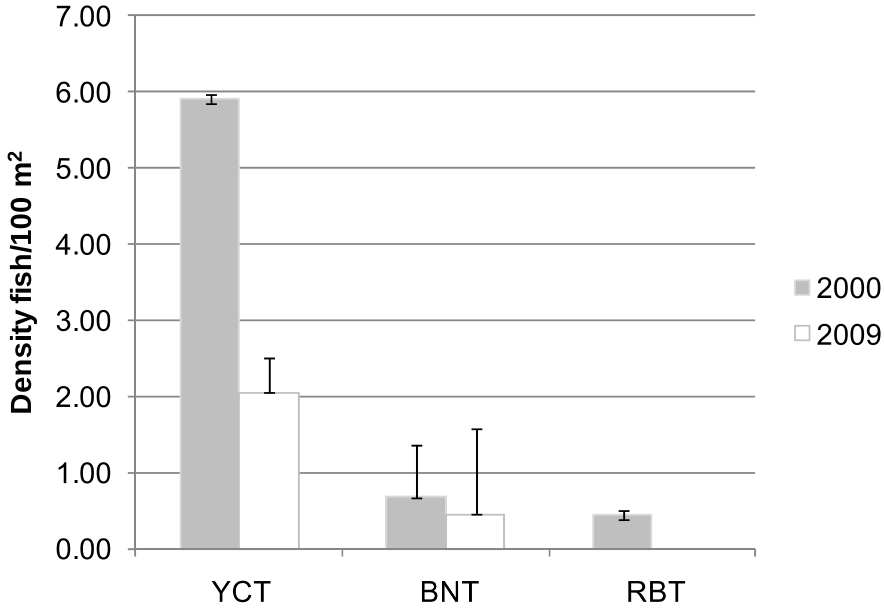

Figure 52. Estimated densities of Yellowstone cutthroat trout (YCT) brown trout (BNT), and rainbow trout (RBT) at the upper monitoring site on Burns Creek in 2000 and 2009 with 95% confidence intervals.

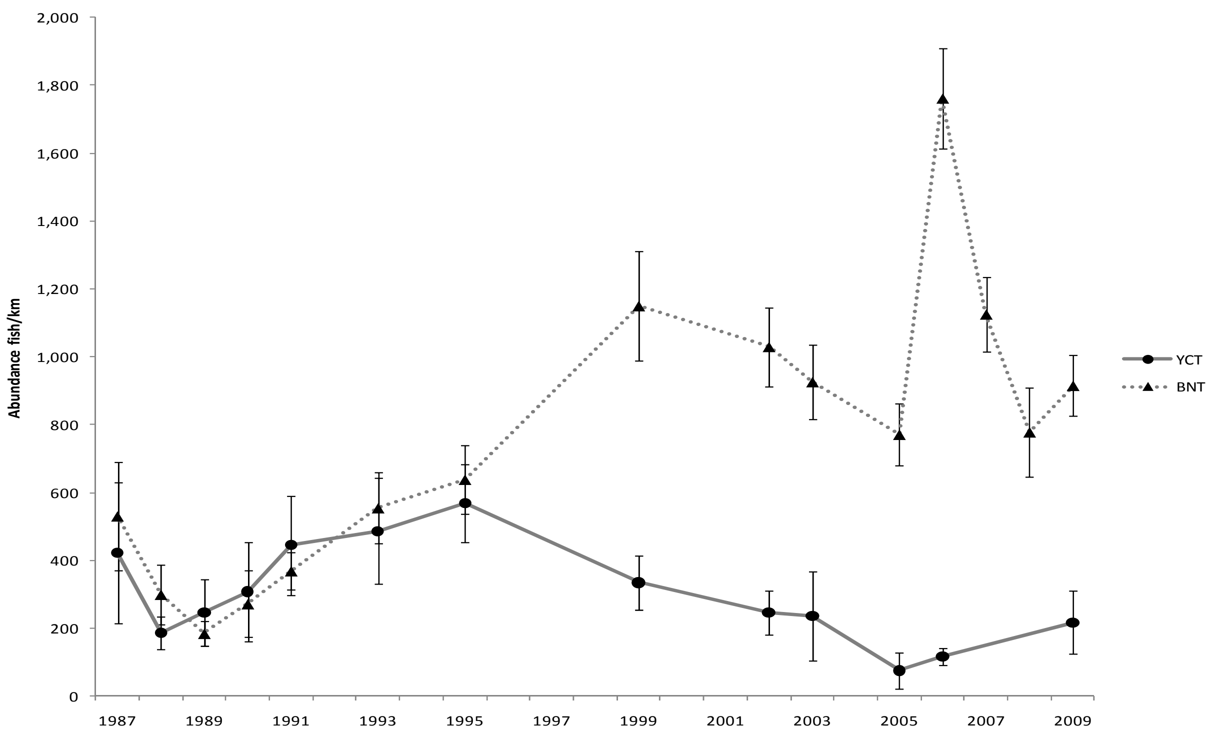

Figure 53. Estimated abundances of Yellowstone cutthroat trout (YCT) brown trout (BNT) at the Lorenzo monitoring site on the South Fork Snake River from 1987 through 2009 with 95% confidence intervals.

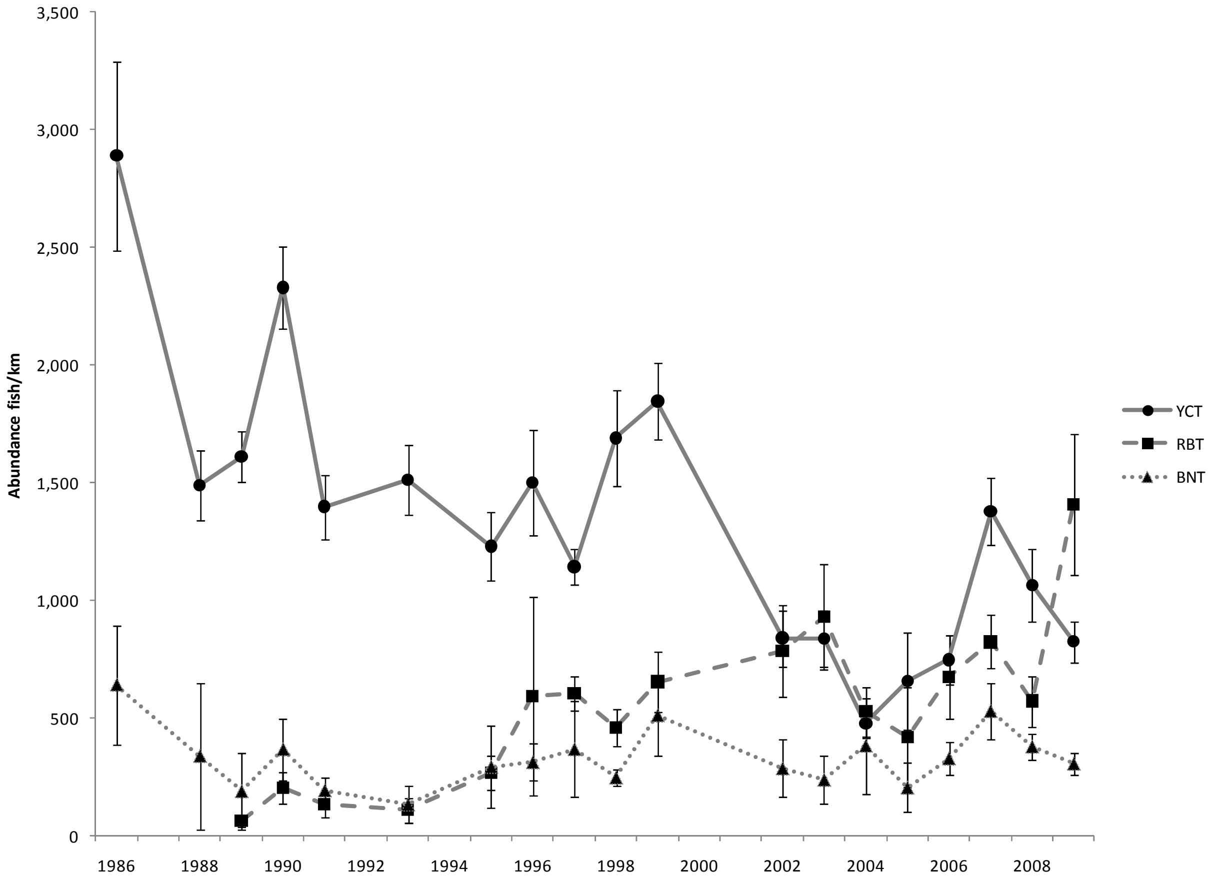

Figure 54. Estimated abundances of Yellowstone cutthroat trout (YCT), rainbow trout (RBT), and brown trout (BNT) at the Conant monitoring site on the South Fork Snake River from 1986 through 2009 with 95% confidence intervals.

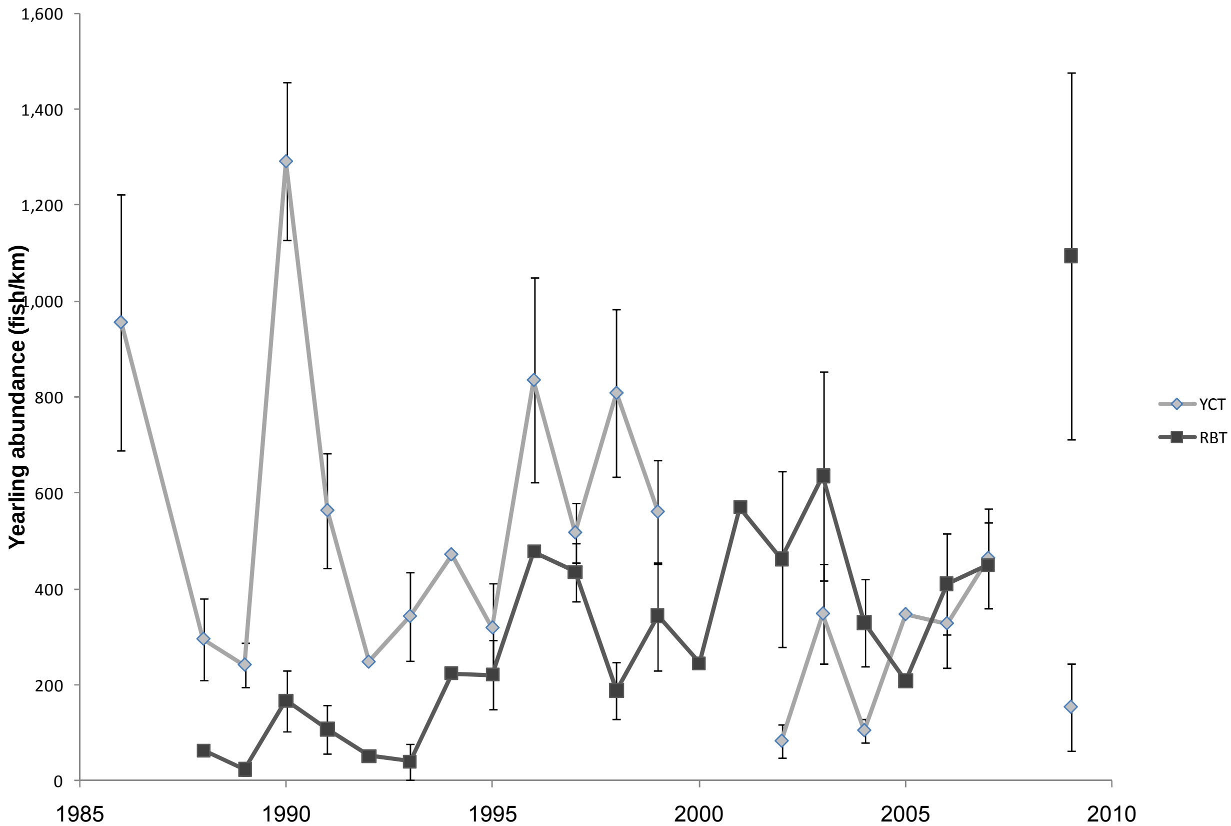

Figure 55. Estimated abundances of age 1 Yellowstone cutthroat trout (YCT) and rainbow trout (RBT) at the Conant monitoring site on the South Fork Snake River from 1986 through 2009 with 95% confidence intervals.

Figure 56. Ratio of age 1 Yellowstone cutthroat trout (YCT) to age 1 rainbow trout (RBT) at the Conant monitoring reach by recruitment year.

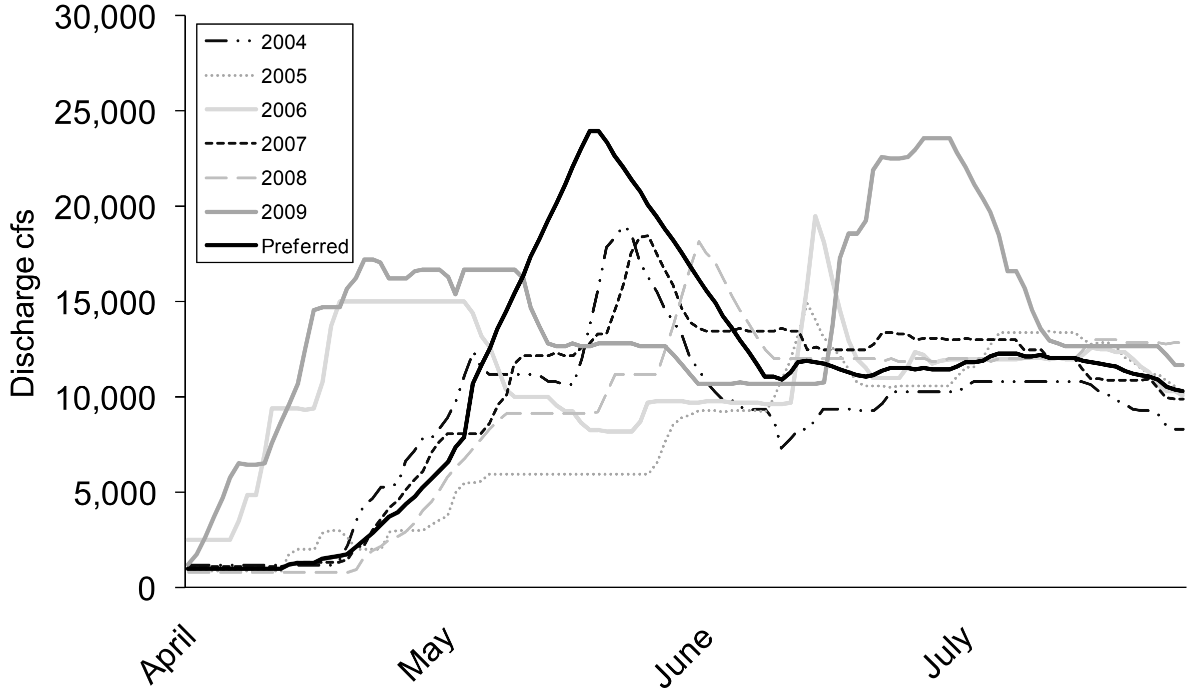

Figure 57. Spring freshet flow discharges from Palisades Dam from 2004 through 2009. Darker lines indicate years when rainbow trout recruitment was low and the preferred spring freshet magnitude and timing and lighter lines indicate years when rainbow trout recruitment was high. The effect of the 2009 flows cannot be evaluated until the fall of 2010.

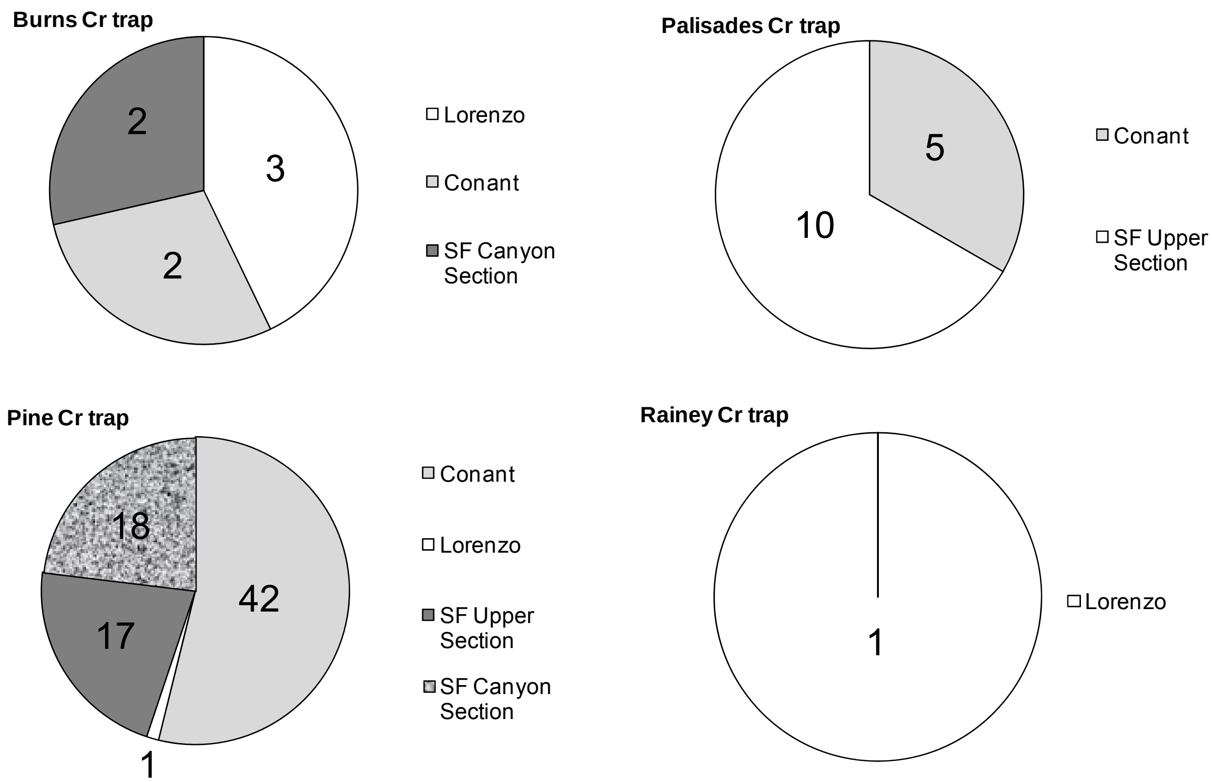

Figure 58. Summary of original tagging location of previously PIT-tagged Yellowstone cutthroat trout recaptured the four South Fork Snake River tributary fish traps during the spring spawning run.

APPENDICIES

Appendix A. Locations used in population surveys on the Henrys Fork Snake River, Idaho 2009. All locations used NAD-27 and are in Zone 12.

	Start		Stop	
Reach	Easting	Northing	Easting	Northing
Box Canyon	468,677	4,917,703	467,701	4,914,352
Vernon	457,035	4,878,096	454,189	4,875,005
Chester	453,206	4,874,049	450,375	4,870,372
St. Anthony	442,187	4,866,559	437,660	4,864,150

Appendix B. Mean total length, length range, proportional stock density (PSD), and relative stock density (RSD-400 and RSD-500) of rainbow trout captured in the Box Canyon reach electrofishing reach, Henrys Fork Snake River, Idaho, 1995-2009.

Year	Number of rainbow trout	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

Appendix C. Electrofishing mark-recapture statistics, efficiency (R/C), population estimates (N) of age 1 and older rainbow trout (≥150 mm) (MPM = Modified Peterson Method; LLM = Log-Likelihood Method), and stream discharge (cfs) during the sample period for the Box Canyon reach, Henrys Fork Snake River, Idaho, 1995-2009. Confidence intervals (±95%) for population estimates are in parentheses.

Year	M[a]	C[a]	R[a]	R/C (%)	N/reach MPM	N/reach LLM	N/km LLM	Discharge (cfs)
1995	982	644	104	16	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	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	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	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	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	11,734 (9,317-14,151)	12,841 (11,665-14,017)	3,471 (3,153-3,788)	1,210
2002	1,050	511	81	16	6,574 (5,329-7,819)	7,556 (6,882-8,230)	2,042 (1,860-2,224	763
2003	427	167	20	12	3,472 (2,147-4,797)	3,767 (3,005-4,529)	1,018 (812-1,224)	348
2005	735	401	90	22	3,250 (2,703-3,797)	4,430 (3,922-4,938)	1,197 (1,060-1,334)	496
2006	887	356	61	17	5,112 (4,005-6,219)	5,986 (5,387-6,585)	1,618 (1,456-1,779)	1,690
2007	737	332	51	15	4,725 (3,598-5,852)	8,549 (7,288-9,810)	2,311 (1,970-2,652)	1,695
2008	887	615	93	15	5,818 (4,842–7,089)	5,812 (5,312-6,312)	1,571 (1,436–1,706)	1,300
2009	673	775	112	14	4,628 (3,910-5,540)	5,034 (4,610-5,458)	1,361 (1,246-1,476)	1,323

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

Appendix D. Study reach boundary UTMs.

Study reach	Upstream boundary	Downstream boundary
Nickerson	12T 486675 E 4838166 N	12T 484839 E 4841139 N
Breckenridge	12T 483128 E 4847608 N	12T 481805 E4850358 N
Rainier	12T 483537 E 4844388 N	12T 483128 E 4847608 N
Parkinson	12T 462622 E 4862729 N	12T 458550 E 4863225 N

Appendix E. Coordinates and lengths for the Burns Creek monitoring sites (downstream boundary):

Lower site – UTM 12T 461715 E 4827645 N (76 m)
Upper site - UTM 12T 462800 E 4828594 N (86 m)

LITERATURE CITED

Acolas, M. L., J. M. Roussel, J. M. Lebel, and J. L. Baglinière. 2007. Laboratory experiment on survival, growth, and tag retention following PIT injection into the body cavity of juvenile brown trout (*Salmo trutta*). Fisheries Research 86:280-284.

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

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

Baldigo, B. P., A. G. Ernst, D. R. Warren, and S. J. Miller. 2010. Variable responses of fish assemblages, habitat, and stability to natural-channel-design restoration in Catskill Mountain streams. Transactions of the American Fisheries Society 139:449-467.

Bateman, D. S., R. E. Gresswell, and A. M. Berger. 2009. Passive Integrated Transponder Tag retention rates in headwater populations of coastal cutthroat trout. North American Journal of Fisheries Management 29:653-657.

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

Behnke, R.J. 1992. Native trout of western North America. American Fisheries Society Monograph No. 6, Bethesda, Maryland.

Budy, P., G. P. Thiede, and P. McHugh. 2007. Quantification of the vital rates, abundance, and status of a critical, endemic population of Bonneville cutthroat trout. North American Journal of Fisheries Management 27:593-604.

Clancy, C. G. 1988. Effects of dewatering on spawning by Yellowstone cutthroat trout in tributaries to the Yellowstone River, Montana. Pages 37-43 *in* R. E. Gresswell, editor. Status and management of interior stocks of cutthroat trout. American Fisheries Society, Symposium 4, Bethesda, Maryland.

Columbia Basin Fish and Wildlife Authority. 1999. PIT tag marking procedure manual. Version 2.0. http://php.ptagis.org/wiki/images/e/ed/MPM.pdf

Dare, M. R. 2003. Mortality and long-term retention of Passive Integrated Transponder tags by spring chinook salmon. North American Journal of Fisheries Management 23:1,015-1,019

De Rito Jr., J. N. 2004. Assement of reproductive isolation between Yellowstone cutthroat trout and rainbow trout in the Yellowstone River, Montana. Master's thesis. Montana State University. Bozeman, MT.

Dieterman, D. J. and R. J. H. Hoxmeier. 2009. Instream evaluation of passive integrated transponder retention in brook trout and brown trout: Effects of season, anatomical placement, and fish length. North American Journal of Fisheries Management 29:109-115.

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

Finlayson, B. J., R. A. Schnick, R. L. Cailteux, L. DeMong, W. D. Horton, W. McClay, C. W. Thompson, and G. J. Tichacek. 2000. Rotenone use in fisheries management: administrative and technical guidelines manual. American Fisheries Society, Bethesda, Maryland.

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

Gamett, B. L. 2009. An overview of mountain whitefish in the Lost Streams of Idaho. USDA Forest Service, Mackay, Idaho.

Garren, D., B. L. Gamett, and J. Fredericks. 2009. The current status of mountain whitefish in the Big Lost River basin, Idaho (2007-2009). Idaho Department of Fish and Game, Boise.

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

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

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

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

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

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

Gregory, J. S. 2009. Summary of actions to protect and restore mountain whitefish in the Big Lost River Drainage. Status Report of Projects Conducted to Benefit Mountain Whitefish in the Big Lost River basin, Idaho. Trout Unlimited, Idaho Falls, Idaho and USDA Forest Service, Mackay, Idaho.

Gries, G. and B. H. Letcher. 2002. Tag retention and survival of Age-0 Atlantic salmon following surgical implantation with Passive Integrated Transponder Tags. North American Journal of Fisheries Management 22:219-222.

Griffith, J. S. 1993. Coldwater streams. Pages 405-425 *in* C. C. Kohler and W. A. Hubert, editors. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

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

High, B., W. C. Schrader, D. Garren, and J. Fredericks. 2008a. South Fork Snake River investigations. 2007 Annual Job Performance Report # 08-134. F-71-R-30. Idaho Department of Fish and Game. Boise.

High, B. C. Sullivan, N. Gastelecutto, and K. Meyer. 2008b. Wild trout studies. 2007 Annual Job Performance Report # 08-04. F-73-R-30. Idaho Department of Fish and Game, Boise.

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

Idaho Department of Fish and Game. 2007. Fisheries Management Plan 2007 – 2012. Boise, ID.

Idaho Department of Fish and Game. 2007. Mountain Whitefish Conservation and Management Plan for the Big Lost River Drainage, Idaho. Idaho Department of Fish and Game, Boise.

Idaho Department of Fish and Game. 2010. Resident Fish Hatcheries 2009 Annual Report. Report No. 10-106. Idaho Department of Fish and Game, Boise.

Krueger, C. C., and B. May. 1991. Ecological and genetic effects of salmonid introductions in North America. Canadian Journal of Fisheries and Aquatic Sciences 48 (supplement):66-77.

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

Leary, R.F., F.W. Allendorf, and G.K. Sage. 1995. Hybridization and introgression between introduced and native fish. Pages 91-101 in H.L. Schramm, Jr., and R.G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society, Symposium 15, Bethesda, Maryland.

Loomis, J. 2005. The economic values of recreational fishing and boating to visitors and communities along the upper Snake River. Final Report to Trout Unlimited and Henrys Fork Foundation, Colorado State University, Fort Collins.

MacConnell, E. and E. R. Vincent. 2002. The effects of Myxobolus cerebralis on the salmonid host. Pages 95 – 107 in J. L. Bartholomew and J. C. Wilson, editors. Whirling disease: reviews and current topics. American Fisheries Society, Symposium 29, Bethesda, Maryland.

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

Meyer, K. A., J. A. Lamansky, and F. S. Elle. 2008. Lakes and reservoir research. Annual Job Performance Report #08-12. F-73-R-19. Idaho Department of Fish and Game, Boise.

Meyer, K. A., J. A. Lamansky, and F. S. Elle. 2009. Lakes and reservoir research. Annual Job Performance Report #09-11. F-73-R-29. Idaho Department of Fish and Game, Bosie.

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

Moller, S., and R. Van Kirk. 2003. Hydrologic alteration and its effect on trout recruitment in the South Fork Snake River. Project Completion Report for Idaho Department of Fish and Game, Idaho State University, Pocatello.

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

Moore, K. M. S., and S. V. Gregory. 1988. Response of young-of-the-year cutthroat trout to manipulation of habitat structure in a small stream. Transactions of the American Fisheries Society. 117:162-170.

Moore, V., and D. Schill. 1984. South Fork Snake River fisheries investigations. Job Completion Report, Project F-73-R-5. Idaho Department of Fish and Game. Boise.

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

Reynolds, J.B. 1996. Electrofishing. Pages 221-254 in B. Murphy and D. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada, Bulletin 191, Ottawa.

Ross, M. J., and C. F. Kleiner. 1982. Shielded-needle technique for surgically implanting radio-frequency transmitters in fish. Progressive Fish Culturist 44: 41-43.

Schill, D.J. 1992. Statewide data summary. Idaho Department of Fish and Game, Wild Trout Investigations Job Performance Report, Project F-73-R-13, Boise.

Schoby, G. P. 2006. Home range analysis of bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Ocorhynchus clarki lewisi*) in the Upper Salmon River Basin, Idaho. Master's Thesis. Idaho State University. Pocatello, Idaho.

Scoby, G., B. High, D. Keen, and D. Garren. 2010. Fishery management annual report: Upper Snake Region 2008. Report #10-107. Idaho Department of Fish and Game. Boise.

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

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

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

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

Schrader, W.C., M. Gamblin, T.J. Herron, and B.A. Rich. 2002. Regional fisheries management investigations. 1995 Job Performance Report, Project F-71-R-20. Idaho Department of Fish and Game. Boise.

Seber, G. A. F. and E. D. LeCren. 1967. Estimating population parameters from catches large relative to the population. Journal of Animal Ecology 36:641–643

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

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

Thurow, R.F., C.E. Corsi, and V.K. Moore. 1988. Status, ecology and management of Yellowstone cutthroat trout in the upper Snake River drainage, Idaho. Pages 25-36 in R.E. Greswell, editor. Status and management of interior stocks of cutthroat trout. American Fisheries Society, Symposium 4, Bethesda, Maryland.

USFWS 2006. http://frwebgate3.access.gpo.gov/cgi-bin/PDFgate.cgi?WAISdocID=2187144897+1+2+0&WAISaction=retrieve

Van Deventer, J.S. and W.S. Platts. 1985**.** A computer software system for entering, managing, and analyzing fish capture data from streams. Research Note INT-352, Intermountain Forestry and Range Research Station. U.S.D.A. Forest Service. Ogden, UT.

Van Kirk, R.W., and L. Benjamin. 2001. Status and conservation of salmonids in relation to hydrologic integrity in the Greater Yellowstone Ecosystem. Western North American Naturalist 61:359-374.

Van Kirk, R. W, L. Battle, and W. C. Schrader. 2010. Modelling competition and hybridization between native cutthroat trout and nonnative rainbow and hybrid trout. Journal of Biological Dynamics 4:158-175.

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

Zar, J.H. 1984. Biostatistical analysis, 2nd edition. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Prepared by:

Dan Garren
Regional Fishery Manager

Greg Schoby
Regional Fishery Biologist

Brent High
Regional Fishery Biologist

Damon Keen
Regional Fishery Biologist

Approved by:
IDAHO DEPARTMENT OF FISH AND GAME

Edward B. Schriever, Chief
Fisheries Bureau

State Fishery Manager