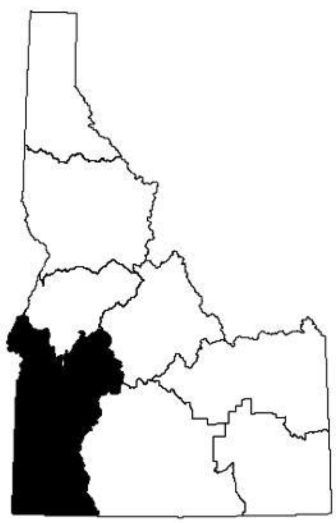
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME
FISHERIES MANAGEMENT ANNUAL REPORT

Ed Schriever, Director



SOUTHWEST REGION
2020

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SOUTH FORK BOISE RIVER RAINBOW TROUT STATUS

ABSTRACT

The South Fork Boise River (SFBR) downstream of Anderson Ranch Dam is a nationally-renowned tailwater trout fishery. The Idaho Department of Fish and Game staff has monitored Rainbow Trout *Oncorhynchus mykiss* populations in the SFBR every three years since 1994, with standardized transects having been established since 2006. In October of 2020, the trout population was assessed using mark-recapture electrofishing techniques. Partial log-likelihood population estimates of Rainbow Trout (± 90% CI) for all three sites combined was 1,310 ± 73 fish. While mark-recapture estimates have generally increased since 2006, variation in marking run catch rate, recapture efficiency and size-specific capture efficiency have led to wide confidence intervals. Further investigation and long term trend monitoring is needed to maintain the quality fishery in the SFBR.

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INTRODUCTION

The South Fork Boise River (SFBR) downstream from Anderson Ranch Dam is a nationally-renowned tailwater trout fishery. This river section was the first and only in the Idaho Department Fish and Game's (IDFG) Southwest Region to be managed under "Trophy Trout" regulations, with a 2-trout daily bag limit and 20-inch minimum length. As such, the trout populations in the SFBR have been monitored by IDFG staff every three years since 1994. These efforts have been accompanied by critical evaluations of electrofishing methodologies which have resulted in changes in techniques and equipment configuration. In 2006, sampling methods were changed from raft electrofishing to canoe electrofishing in order to increase sampling efficiency across size classes and obtain better population estimates. In addition, three 1-km sites were established within the historic survey boundaries for sampling. Kozfkay et al. (2010b) demonstrated a pronounced increase in electrofishing efficiency for all size groups of Rainbow Trout resulting from the change in sampling methodologies. In 2012, an additional mobile anode was added to the canoe electrofishing configuration, which resulted in further improvement in sampling efficiency, particularly for fish exceeding 350 mm (Butts et al. 2017).

The SFBR drainage has undergone dramatic changes over the past decade. In August of 2013, the Elk-Pony fire complex burned roughly 280,000 acres in the basin. These fires resulted in two separate large debris and sediment flow events that occurred on several tributaries. Notably, sediment flows at Pierce, Granite, Buffalo, and Little Fiddler creeks created large slack-water runs followed by new and more technical rapids, impacting both fish habitat and floating conditions for anglers. In 2014, the primary objective for IDFG regarding SFBR was to describe the extent of the effects of the sediment flows on fish populations and habitat. To address this, the triennial main-stem population assessment was rescheduled to 2014 rather than 2015, when it normally would have occurred. In 2017, a record snowpack and subsequent runoff further changed the SFBR. Runoff in mid-May exceeded 9,000 cfs at the Anderson Ranch Dam USGS gauge, the highest flows on record for this gauge. These high flows further scoured the sediment inputs from the 2013 slides, further decreasing the depth and length of the slack-water areas and decreasing the difficulty of the resulting rapids. Our objectives for the 2020 survey were to continue monitoring the SFBR trout population in accordance with our triennial rotation to generate population estimates and quantify size structure.

STUDY AREA

The SFBR originates in the Sawtooth National Forest, approximately 30 km east of Pine, Idaho. The upper SFBR is in IDFG Region 4, and flows southeast into Anderson Ranch Reservoir. Below Anderson Ranch Dam, the SFBR enters IDFG Region 3, and flows northwest into Arrowrock Reservoir. The tailwater fishery between Anderson Ranch Dam and Arrowrock Reservoir is supported by populations of wild Rainbow Trout *Oncorhynchus mykiss* and Mountain Whitefish *Prosopium williamsoni*. Bull Trout *Salvelinus confluentus* are present at low densities, kokanee *Oncorhynchus nerka* migrate upstream from Arrowrock Reservoir, and native nongame fish include Largescale Sucker *Catostomus macrocheilus*, Northern Pikeminnow *Ptychocheilus oregonensis* and sculpin *Cottus sp*.

Between Anderson Ranch Dam to its terminus into Arrowrock Reservoir, the SFBR is approximately 43-km long and consists of two recreationally distinct sections. The roaded section is approximately 16-km long and runs from Anderson Ranch Dam downstream to Danskin Bridge. This section has a public road and access along the entire reach, resulting in the most angling pressure. It is popular for both drift-boat and wade fishing. The canyon section is approximately 27-km long and runs from Danskin Bridge downstream to Neal Bridge. The canyon section has extremely limited access by foot or road because of high canyon walls and is accessible mostly by raft due to challenging whitewater in the section.

METHODS

In October 2020, Rainbow Trout abundance was estimated at three sites (Figure 45) within the roaded section of the SFBR a using mark-recapture techniques. Since 2018, Mountain Whitefish abundance has not been estimated during these triennial surveys. Due to the large number of Mountain Whitefish encountered during the survey, there was concern that efforts to net all whitefish during shocking runs was reducing capture efficiency of trout. Therefore, only trout were targeted during the 2020 survey. Fish were collected with a canoe electrofishing unit consisting of a 5.2-m Grumman aluminum canoe fitted with three mobile anodes connected to 15.2-m cables. The canoe served as the cathode and carried the generator, Midwest Lake Electrofishing Systems (MLES) Infinity electrofisher, and a live well for holding fish. Oxygen was introduced to the live well (2 L/min) through an air-stone. Pulsed direct current was produced by a 5,000-watt generator (Champion 5000). Settings were 25% duty cycle, 60 pulses per second, 300-400 volts, producing 1,000-2,000 watts.

Rainbow Trout and Bull Trout were sampled at the three sites during October 2020 (Figure 45). Marking runs were conducted at the upper and middle sites on October 22 and the lower site on October 23. Recapture runs at the upper and middle sites occurred on October 28 and at the lower site on October 29. Riffles formed the upper and lower reach boundaries. Flow was approximately 9.1 m^3/s. Crews consisted of twelve or thirteen people. Three people operated the mobile anodes, one person guided the canoe and operated the safety switch and controlled the output, the remaining eight or nine people were equipped with dip nets and captured stunned fish. Only trout were placed in the live well. When the live well was judged to be at capacity, the crew stopped at the nearest riffle to process fish.

Fish were marked with a 7-mm diameter hole from a standard paper punch with an upper, caudal fin punch. Only fish longer than 100 mm were marked. Fish were measured for total length (mm) and a subset was weighed (g). Fish were released 50-100 m upstream from the processing site to reduce the potential of movement out of the site or into areas still to be electrofished. During the recapture effort, all trout greater than 100 mm were captured and placed in the live well. Fish were examined for marks on the caudal fin. All fish were measured for total length (mm).

Site length was determined from 1:24,000 topographic maps. Ten wetted widths from each site were measured with a hand-held laser range finder (Leupold RX series). Site area was estimated by multiplying the calculated mean widths over a section by the section length. For braided channels, mean width was measured across the river excluding any distances across islands.

Fisheries Analysis + (FA+), software developed by Montana Fish, Wildlife, & Parks, was used to generate mark-recapture and electrofishing capture efficiency estimates (MFWP 2004). To account for selectivity of electrofishing gear, population estimates (N) were calculated using a partial log-likelihood estimation to fit the recapture data. A capture probability function of the form:

$$Eff = (exp(-5+\beta_1 L+ \beta_2 L^2)) /(1+ exp(-5+\beta_1 L+ \beta_2 L^2))$$

where *Eff* is the probability of capturing a fish of length *L*, and β_1 and β_2 are estimated parameters (MFWP 2004). Then *N* is estimated by length group where M is the number of fish marked by length group:

$$N = M / Eff$$

Population estimates (*N*) were calculated for each site separately and in addition, pooled for a comprehensive population estimate for comparison to surveys from previous years. Observed mortalities during the marking run were recorded and excluded from the population estimates.

The number of marked fish by site and recapture efficiency were also calculated to assess and compare the basic components of the 2020 survey to previous years. Recapture efficiency (R_{eff}) was simply calculated as:

$$R_{eff} = R/C$$

where *R* is the number of recaptures collected and *C* is the total number of fish collected during the recapture run. To characterize trends in Rainbow Trout size structure, proportional stock density (PSD) was calculated as described by Anderson and Neumann (1996), using 250 mm as stock size and 300 mm, 350 mm, and 400 mm as quality sizes.

RESULTS

A total of 787 Rainbow Trout were handled during marking and recapture runs at the three sites combined (Table 17). A total of 462 Rainbow Trout were marked during the marking runs and an additional 325 (118 of which were recaps) were collected during the recapture runs. Recapture efficiency for the upper site was 20%, while efficiency at the middle site was 19%, and the lower site was 37%. Mean recapture efficiency - the ratio of recaptured fish to captured fish during the recapture runs among sites - was 26% (Table 17). Partial log-likelihood population estimates (± 90% CI) for Rainbow Trout varied across trend sites, from 603 fish ± 87 at the upper site, 621 fish ± 96 at the middle site, and 319 fish ± 24 at the lower site. Estimated population size combined across all three sites (100-mm minimum length cutoff) was 1,310 fish ± 73 (Figure 46), or 1,226 fish ± 71 (225-mm minimum length cutoff; Figure 46). Rainbow Trout total length ranged from 116 to 591 mm (Figure 47). Rainbow Trout between 400 and 500 mm comprised 59% of the catch, while only 1% exceeded 500 mm. In 2020, the PSD-300, PSD-350, and PSD-400 all increased compared to the 2017 survey (Figure 48).

A total of 17 Bull Trout were captured, with eight fish marked and two recaptured. Bull Trout TL ranged from 360 to 572 mm (Figure 47). Due to low overall catch and recaptures, a population estimate was not generated for Bull Trout.

DISCUSSION

Partial log-likelihood population estimates generated from the mark-recapture exercise indicate that the overall Rainbow Trout population in the SFBR has been variable. From 2006 to 2012, the estimated population size (225-mm minimum length cutoff) held steady at approximately 950 fish. In 2014, following wildfires and debris flows, the population estimate decreased to 738, yet rebounded in 2017 to 1,420 fish. The 2020 population estimate decreased slightly to 1,310 fish (Figure 50). Size structure of the wild Rainbow Trout population has also changed through time (Figure 467). The 2017 survey (Cassinelli et al. 2018), observed a large cohort of fish between 250 and 350 mm, which is likely manifested in the large representation of fish 400 mm or greater (60% of the sampled fish) observed in the 2020 survey.

Compared to previous surveys, there was a notable decrease in fish less than 225 mm in 2020. As mentioned, the SFBR experienced wildfire and subsequent debris flows in 2013 and 2014. Wildfire and associated landscape-level disturbances are becoming increasingly prevalent in the intermountain West (Westerling et al. 2006), and their effects on salmonid populations has been relatively well studied (Rieman et al. 2003). Studies in Idaho (Rieman et al. 1995) and Montana (Sestrich et al. 2011) monitored populations pre and post-fire. Rieman et al. (1995) found that within one year, population levels had started to rebound, and within three years had recovered to pre-fire levels. Additionally, Rieman et al. (1995) observed temporary declines in abundance were especially pronounced in small (<75 mm) trout. Sestrich et al. (2011) hypothesized rapid recovery from post-fire declines to increased local recruitment or recolonization. When the 2014 population estimate is compared to the 2017 population estimate, the same pattern emerges. Debris flows in the SFBR contributed larger amounts of sediment and woody debris from adjacent tributaries. Subsequent pulse-flows from Bureau of Reclamation and high runoff in 2017 redistributed much of the newly introduced material. As a result, this may have led to an increase in available spawning substrate, which is at a premium in a relatively gravel-starved tailwater such as the SFBR. This may have produced a strong year class of trout, corresponding to the increase in small (> 225 mm) fish in 2017.The large cohort of fish ≈ 400 mm found in 2020 is likely that cohort aging through the population. However, attributing the current lack of small (> 225 mm) fish to one specific cause is difficult at best. Our current hypotheses (aside from sampling bias), include predation (due to the large cohort of ≈ 400 mm fish), competition or the population reaching carrying capacity. These are all purely speculative; however, and further evaluations are needed.

One principal tenet of mark-recapture estimates is that each individual is equally susceptible to capture. This can be affected by a myriad of factors, including fish size, gear biases, and survey methods. Larger fish have greater surface area thus are more susceptible to electrical impulses generated by electrofishing. Furthermore, large fish are more easily seen during electrofishing, are more easily differentiated to species (trout versus whitefish) and captured. As such, larger fish are more inherently susceptible to capture than smaller fish (Büttiker 1992; Bayley and Dowling 1993; Dolan and Miranda 2003; Peterson et al. 2004). Population estimates that do not account for length as a factor may introduce biases (Anderson 1995). The partial log-likelihood estimator we used takes fish length into account. The aforementioned population estimates are generated using a minimum length cutoff of 100 mm. While the partial log-likelihood estimator takes fish size into account, the model is still over-predicting capture efficiency of small fish compared to the observed data (Figure 49). If we generate population estimates based on a 225-mm minimum length cutoff, population estimates from 2006-2020 are slightly altered than those with a 100-mm minimum length cutoff. With a 225-mm minimum length cutoff, population estimates from 2006-2012 increased, in 2014 following wildfire and subsequent debris flows, the population estimate decreased. In 2017, the population estimate rebounded to higher than pre-disturbance levels (albeit with wide confidence intervals surrounding the estimate). In 2020, there was not a significant change in the population estimate (225-mm minimum length cutoff) at the 95% confidence level when compared to the 2017 estimate (Figure 50). Similarly to capture probability, recapture efficiencies of marked fish can also bias population estimates. In the SFBR, recapture efficiencies fluctuate across sample years and sites. The highest recapture efficiencies have historically occurred within the lower site, ranging from 11% to 52%. In 2020, the recapture efficiency in this site was 52% (Table 17). Overall average recapture efficiency since 2006 (all three sites combined) has been 21% and ranged from 12% to 36%. In 2020, our overall recapture efficiency was 36%.

Gear biases and survey methods and also affect population estimates. Surveys from 1997-2003 were conducted using raft electrofishing. Surveys since 2006 have been conducted using canoe electrofishing with two anodes, with a third anode added in 2012. Since switching to a canoe and two mobile anodes (2006-2012) mean recapture efficiency was 11.1% and increased with the addition of a third anode (2012-present; 19.6%). Since standardizing sampling methods and locations in 2006, we have also noticed a shift in size structure. This shift is primarily driven by a decrease in fish greater than 400 mm since 2012, but also (to a lesser degree) an increase in smaller fish.

Sampling crew variation (especially netters) and changes to trend sight habitat between sampling years can also impact recapture efficiencies. In an effort to limit variation in sampling efficiency due to netter bias, we've begun to be more selective in personnel conducting the surveys as well as utilizing more netters with the hope of missing fewer fish. Additionally, Mountain Whitefish are no longer sampled at the same time as trout, in an effort to minimize the number of trout that are missed due to efforts to capture whitefish. A realistic description of change in the SFBR Rainbow Trout population is likely best provided by a combination of mark-recapture and catch per unit effort (CPUE) comparisons with previous surveys.

Another index for evaluating trout populations in the SFBR is to compare trends in single-pass CPUE. As with population estimates, CPUE of the individual marking runs have also varied. The lowest single pass CPUE observed occurred in 2014, yet the mark-recapture estimate for that year was the third highest across all sample periods. Raw catch of individual recapture runs is typically lower than that of individual marking runs. The overall number of fish captured in the recapture run has been even more variable ranging from 42% to 71% (average 60%) of the total caught in the marking run during the nearly two decades of surveys. As such, CPUE of recapture runs has not been explicitly evaluated and compared against that of individual marking runs.

Finally, there are a number of environmental and abiotic factors that may affect changes in population estimates, including large scale landscape disturbances (wildfire and subsequent landslides), and variations in instream flow and temperature. We hypothesize the decrease of larger fish in the 2014 surveys is likely a result of mortality immediately following wildfire and poor water quality associated with heavy ash and sediment load during the debris flow events. The reduction of those larger fish in 2014 immediately following the wildfires could have been a direct result of the fire activity and subsequent sediment loads (Rieman et al. 2012), combined with increased water temperatures (Dunham et al. 2007). July-September water temperatures in 2013, recorded at the Neal Bridge USGS gauge, were the highest on record since the gauge began recording river temperature in 2011. This gauge is at the lower end of the drainage and increased water temperatures this low in the system were likely most influenced by warmer tributary inputs post-fire. Since the SFBR is a tailwater river, temperatures were likely less variable closer to the Anderson Ranch Dam outlet.

The lower raw catch observed in 2014 followed the large wildfires that occurred in the SFBR basin in 2013. Raw catch in 2014 was 49% lower than the pre-fire 2012 catch. These results were outlined in Butts et al. (2014) and concluded the SFBR Rainbow Trout population experienced a post-fire decline. However, despite the concern that there could be continued and prolonged post-fire effects on the fish population as previously observed in other systems (Meyer and Pierce 2003; Rieman et al. 2012), 2017 raw catch was only 1% lower than pre-fire (2012) raw catch and it appears that the wild Rainbow Trout population rebounded relatively quickly following the fires and subsequent landslides. Additional hydrologic conditions, including anthropogenic flushing flows (2015) and record runoff (2017) mobilized fine sediment, resorted spawning gravels and promoted riparian recruitment and revegetation likely contributed to the rapid recovery of the fishery.

The SFBR basin has experienced dynamic conditions over the last decade, including basin-wide wildfires, subsequent landslides and debris flows, and historically (post dam construction) high spring flows. These events have reshaped portions of the river, changing fish habitat in many areas. While the overall wild Rainbow Trout population appears healthy, there does appear to be some changes in size structure when compared to past years. The 2023 triennial sampling will provide further insight into trends in the size structure of the wild Rainbow Trout population in the SFBR.

RECOMMENDATIONS

1. Conduct single pass electrofishing surveys at three trend sites during fall 2021 to assess abundance and length distributions of Mountain Whitefish

2. Conduct mark-recapture estimates in the three adult trend sites during fall 2023 to assess abundance and length distributions of trout

Table 17. Number of fish, by species, collected during marking and recapture runs at each site in the South Fork Boise River, Idaho during October 2020 population assessments. Recapture efficiencies for Rainbow Trout were assessed in all three sites. Bull Trout population estimates were not calculated because of low sample size.

	Site		Marking run		Recapture run		
Year	Transect Length	Species	# Captured	# Marked	# Captured	# Marked	R/C
2020	Upper	Rainbow Trout	162	162	100	32	0.20
	1.03 km	Bull Trout	3	3	4	2	
	Middle	Rainbow Trout	131	128	105	24	0.19
	1.09 km	Bull Trout	3	3	1	0	
	Lower	Rainbow Trout	169	168	120	62	0.37
	0.99 km	Bull Trout	2	2	4	0	
	Total	Rainbow Trout	462	458	325	118	0.26
	3.11 km	Bull Trout	8	8	9	2	

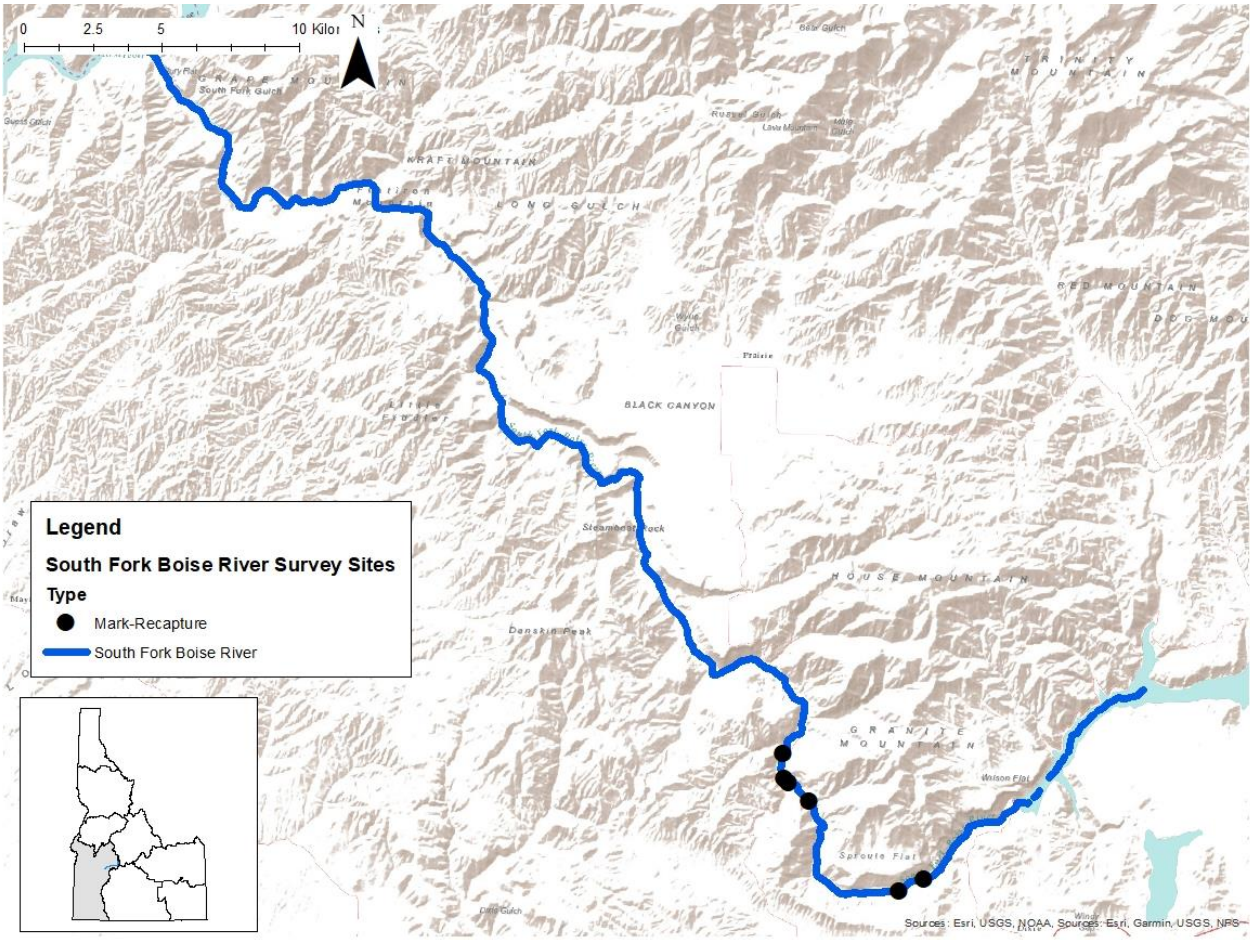

Figure 45. Map of South Fork Boise River and associated mark-recapture sites surveyed in 2020.

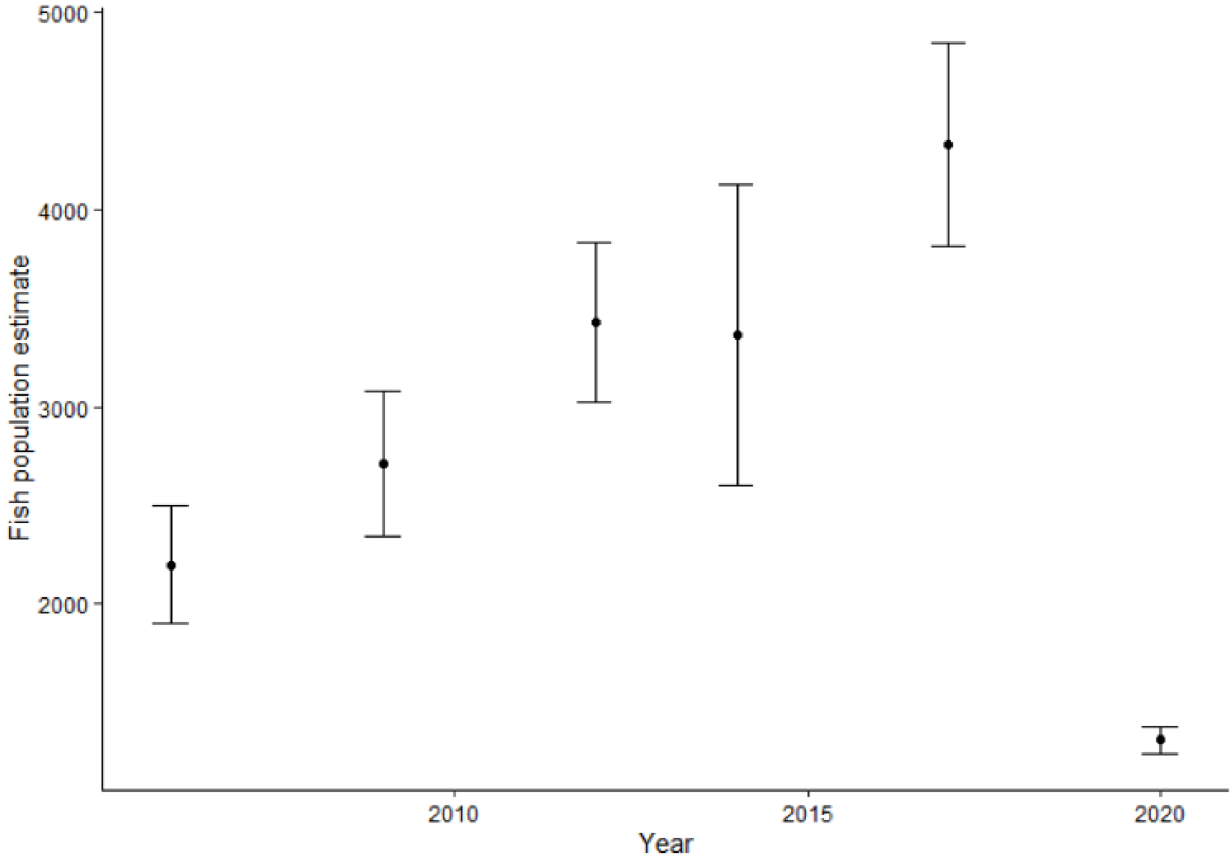

Figure 46. Partial log-likelihood population estimates and associated 95% confidence intervals for three mark/recapture sampling sites combined on the South Fork Boise River, Idaho below Anderson Ranch Dam (2006-2020). Estimates were generated with a 100-mm minimum length cutoff.

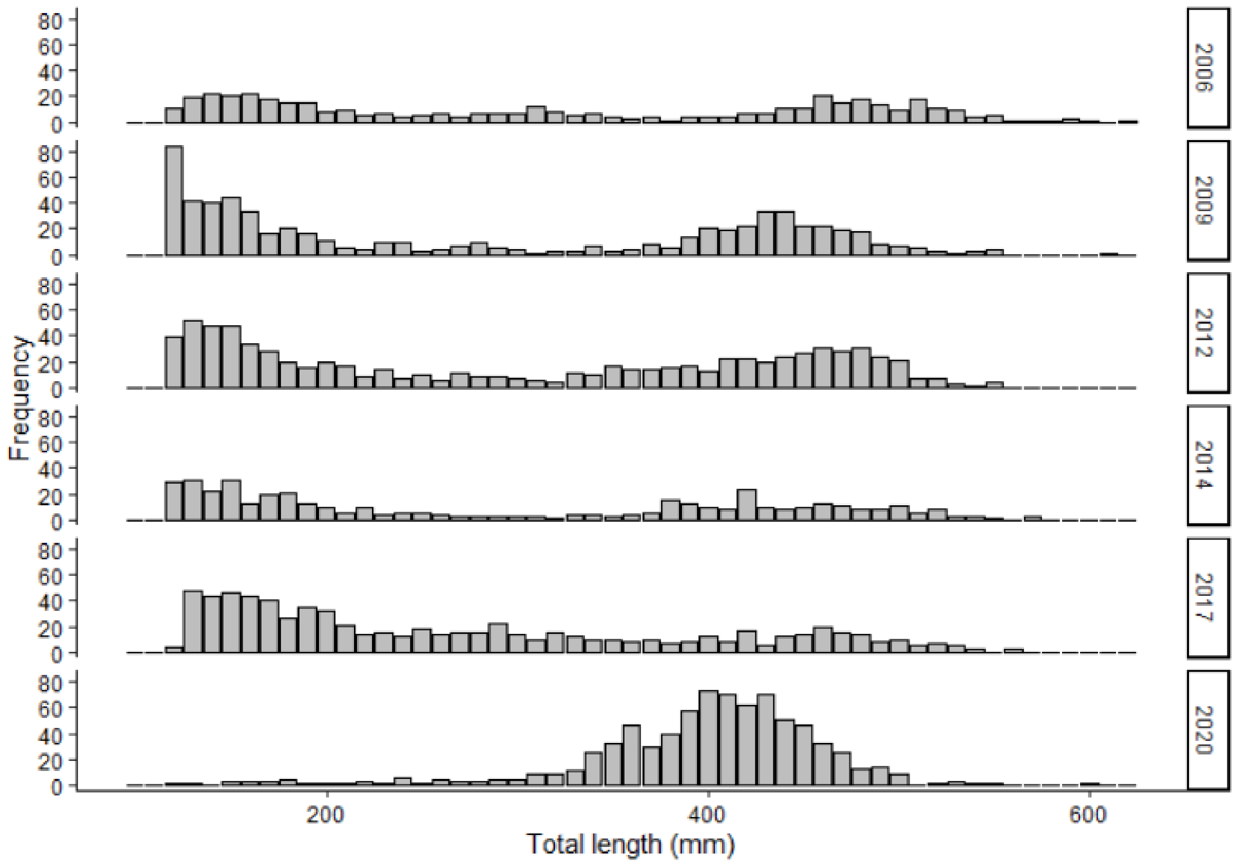

Figure 47. Length frequency histograms of Rainbow Trout ≥ 100 mm captured during population surveys at the South Fork Boise River below Anderson Ranch Dam from 2006-2020.

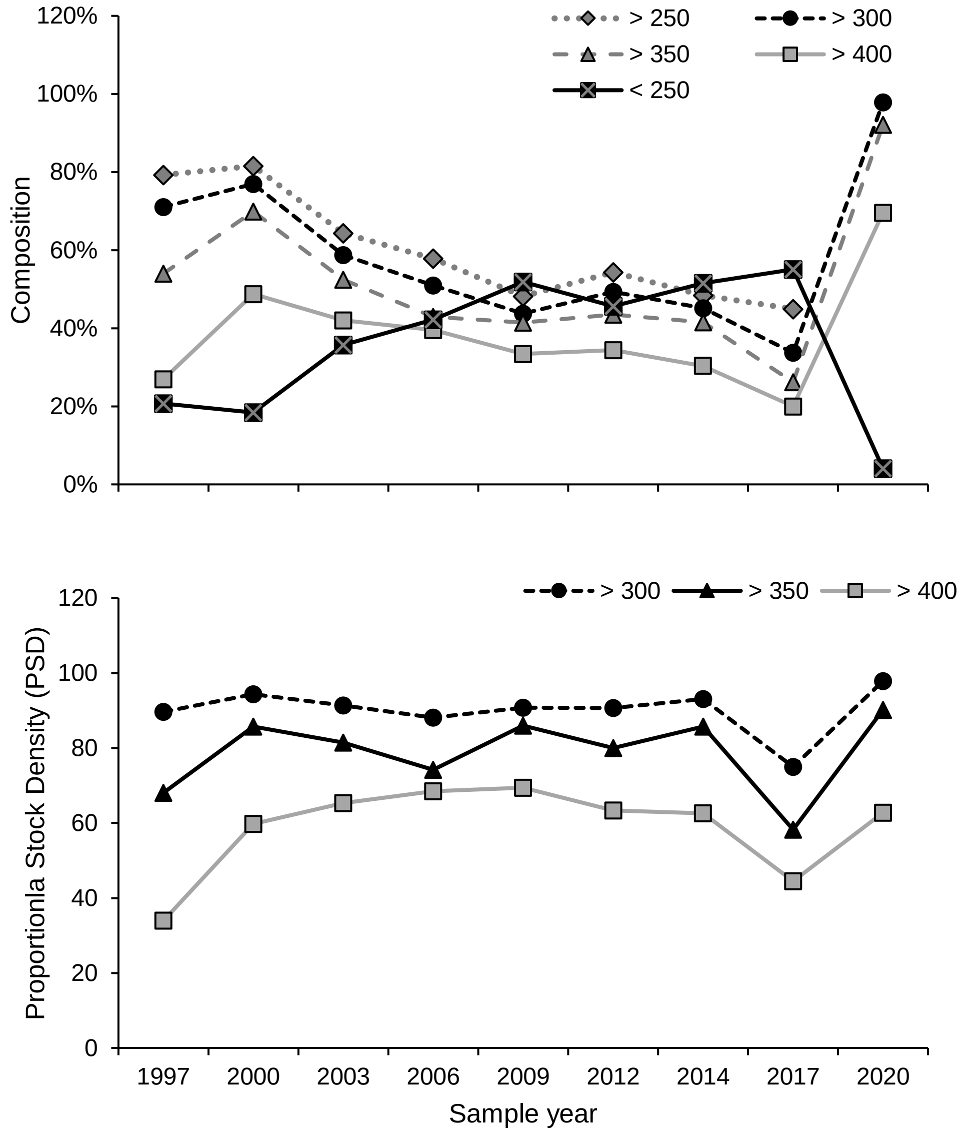

Figure 48. Percent composition and Proportional Stock Density (PSD) for Rainbow Trout of various size classes, collected during triennial mark-recapture surveys on the South Fork Boise River downstream from Andersen Ranch Dam from 1997 through 2020. For PSD calculations, 250 mm was used as stock size.

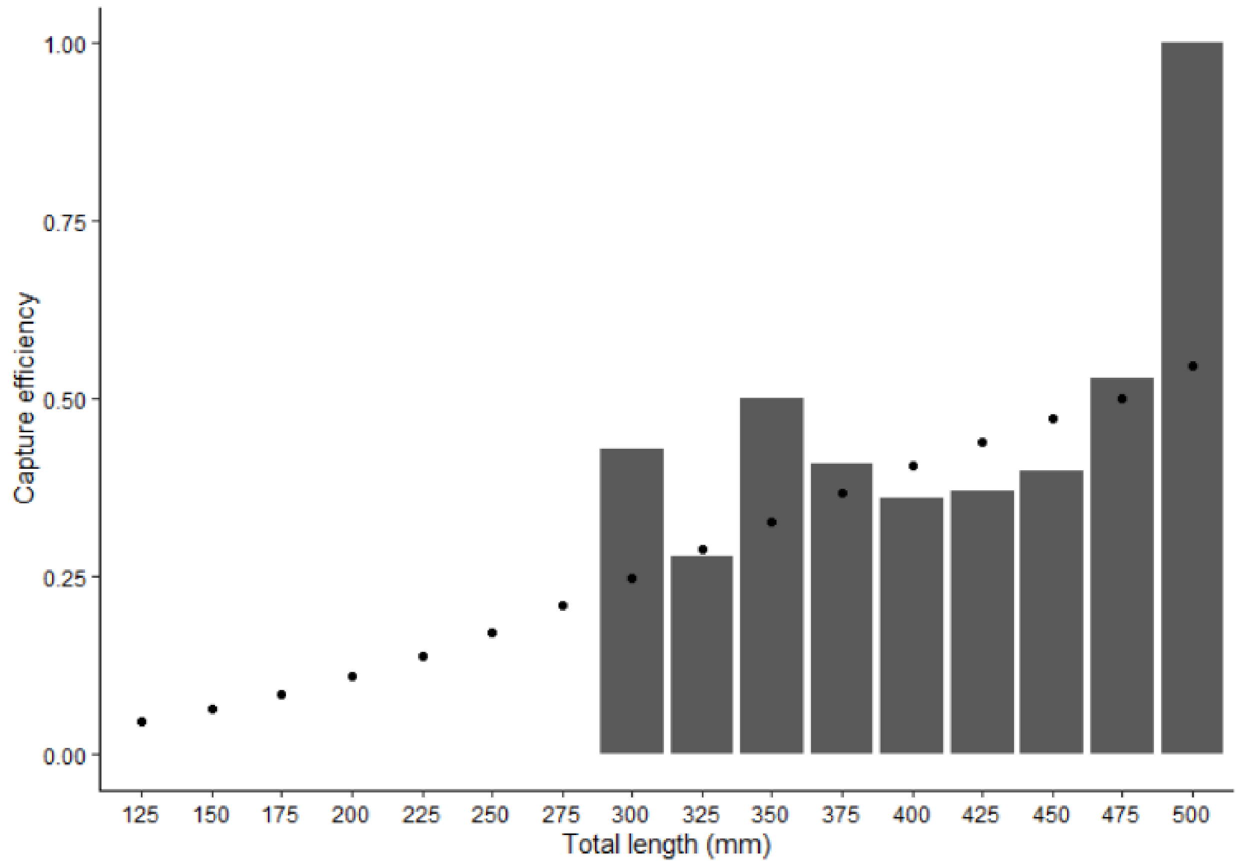

Figure 49. Observed (columns) and modeled (points) capture efficiency of Rainbow Trout by length category during population surveys at the South Fork Boise River below Anderson Ranch Dam in 2020.

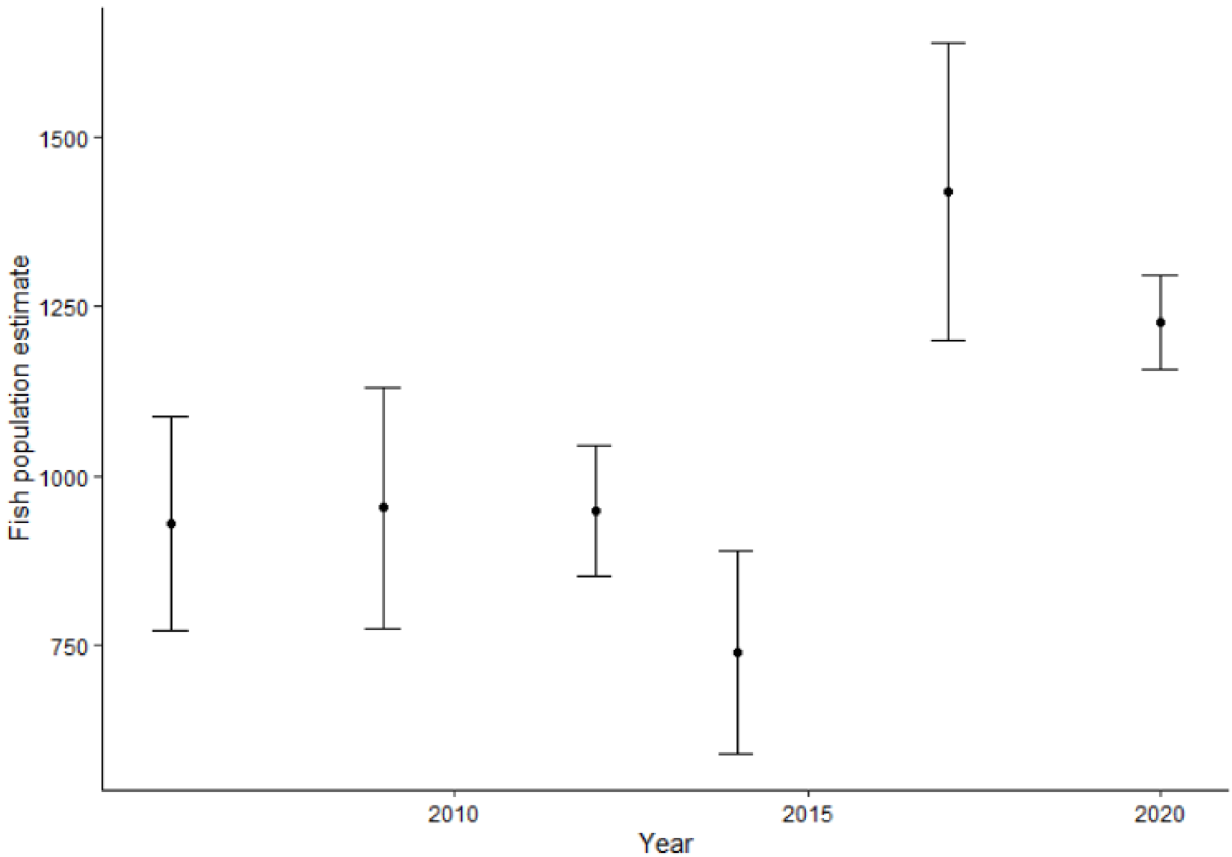

Figure 50. Partial log-likelihood population estimates and associated 95% confidence intervals for three mark/recapture sampling sites combined on the South Fork Boise River, Idaho below Anderson Ranch Dam (2006-2020). Estimates were generated with a 225-mm minimum length cutoff.