FISHERY MANAGEMENT INVESTIGATIONS

# SOUTH FORK SNAKE RIVER INVESTIGATIONS

**2003 Annual Report**

**Period Covered: October 2002 to September 2003**

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**TABLE OF CONTENTS**

**Page**

ABSTRACT 1
INTRODUCTION ..... 4
OBJECTIVES 6
METHODS AND STUDY AREA ..... 7
Electrofishing.....7
Creel Survey..... 9
Exploitation and Pre-season Stock Abundance.....11
Angler Education and Outreach.....12
Tributary Weirs and Weir Evaluation.....12
Palisades Canal Trap.....14
Otolith Microchemistry.....14
RESULTS 15
Electrofishing.....15
Conant.....15
Lorenzo.....16
Creel Survey..... 17
Exploitation and Pre-season Stock Abundance.....19
Upper River Cutthroat Trout..... 19
Upper River Rainbow Trout.....20
Upper River Brown Trout.....20
Angler Education and Outreach.....20
Tributary Weirs and Weir Evaluation.....21
Burns Creek.....21
Pine Creek.....21
Palisades Creek..... 22
Palisades Canal Trap.....23
Otolith Microchemistry.....23
DISCUSSION 24
RECOMMENDATIONS ..... 27
ACKNOWLEDGMENTS ..... 28
LITERATURE CITED ..... 29
TABLES 31
FIGURES 40
APPENDICES 66

## ABSTRACT

To assess the direct effects of hydrologic regime on trout populations in the South Fork Snake River, we subcontracted to Idaho State University the compiling of all hydrological data, reconstructing natural (unregulated) flows, assessing differences in regulated and natural flow regimes, investigating relationships among trout population metrics and hydrologic variables, and recommending flow management objectives to the U.S. Bureau of Reclamation. These results and recommendations, which are presented in a separate document (Moller and Van Kirk 2003), complement the recently completed Ecologically Based System Management research (Hauer et al. 2004). In this document, we present the historical fish population metrics to better understand factors limiting Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* and favoring rainbow *O. mykiss* and hybrid trout *O. clarkii x mykiss*. We also present current results from our 2003 electrofishing, creel survey, exploitation assessment, tributary fish weirs, tributary outmigration, and otolith microchemistry investigations.

At the Conant section, we captured a total of 1,962 trout during four days of electrofishing in October. Relative abundance was 47.1% cutthroat trout, 33.4% rainbow trout and hybrid rainbow x cutthroat trout combined, and 19.5% brown trout *Salmo trutta*. For age 1 and older fish, estimated densities were 840 cutthroat trout/km, 931 rainbow and hybrid trout/km, 240 brown trout/km, and 1,785 fish/km for all trout species combined. For age 1 (yearling) fish, estimated densities were 348 cutthroat trout/km, 636 rainbow and hybrid trout/km, and 94 brown trout/km. The cutthroat to rainbow and hybrid trout recruitment ratio was 0.5, and the cutthroat to brown trout recruitment ratio was 3.7. For all fish, mean total length was 327 mm for cutthroat trout, 298 mm for rainbow and hybrid trout, 270 mm for brown trout, and 306 mm for all species combined. Quality stock density (QSD) was 5.6% for cutthroat trout, 19.1% for rainbow and hybrid trout, 29.2% for brown trout, and 14.0% for all species combined.

At the Lorenzo section, we captured a total of 1,217 trout during four days of electrofishing in September. Relative abundance was 13.2% cutthroat trout, 0.3% rainbow and hybrid trout, 86.4% brown trout, and 0.1% lake trout. For age 1 and older fish, estimated densities were 237 cutthroat trout/km, 926 brown trout/km, and 1,184 fish/km for all trout species combined. Rainbow and hybrid trout density estimates were not possible due to the small sample size. For age 1 (yearling) fish, estimated densities were 70 cutthroat trout/km and 465 brown trout/km. The cutthroat to brown trout recruitment ratio was 0.1. For all fish, mean total length was 332 mm for cutthroat trout, 296 mm for brown trout, and 301 mm for all species combined. Quality stock density (QSD) was 2.6% for cutthroat trout, 17.3% for brown trout, and 15.1% for all species combined. For age 1 and older fish, the length-weight regression for cutthroat trout was Weight = 0.000006 x $\text{Length}^{3.0962}$, and the regression for brown trout was Weight = 0.000006 x $\text{Length}^{3.0727}$.

For the first time since 1979, a fully stratified, roving-type creel survey was conducted on the entire South Fork Snake River throughout 2003. Of 4,143 anglers interviewed, 33% were not residents of Idaho and 15% were guided. The proportion of hours fished by gear type was 15% bait, 13% lures, and 71% artificial flies. Estimated total effort was 216,181 h. Slightly more than half of the effort (53%) occurred during weekdays, and 79% was by anglers using boats. Average time spent fishing was 4.9 h. We estimated anglers caught 149,946 fish and harvested 8,977 fish – or 6% of the catch. Boat anglers using flies caught the most fish overall. Relative catch composition from the interviews (n = 8,637 fish) was 37% cutthroat trout, 14% rainbow and hybrid trout, 38% brown trout, 10% mountain whitefish, and 1% other species. Estimated harvest composition was 3% cutthroat trout, 56% rainbow and hybrid trout, 33% brown trout, 7%

mountain whitefish, and <1% fish of other species. The estimated overall catch rate was 0.69 fish/h – up from the 0.53 fish/h observed in 1979. However, in the upper river the catch rate was 0.64 fish/h during the summer – just over half the 1.12 fish/h observed in 1996 and down from the 0.90 fish/h observed in 1982 before special regulations. The decline in catch rate may be due to the decline in cutthroat trout density and the increase in less catchable rainbow and hybrid trout.

Less restrictive harvest regulations, an intensive angler education and outreach campaign, and increased numbers of fish led to five times more rainbow and hybrid trout harvested (5,070 fish) in 2003 than in any previous survey year. Local resident, unguided anglers using boats and bait harvested the most rainbow and hybrid trout. However, only 24% of the anglers catching rainbow or hybrid trout actually kept one or more of them. We estimate 18-24% of the rainbow and hybrid trout caught were kept. Opinion survey respondents generally valued cutthroat trout over other trout species, supported management efforts to maintain the cutthroat trout fishery, and supported possible regulation changes that would increase harvest opportunity for rainbow and hybrid trout and decrease harvest opportunity for cutthroat trout.

Using extrapolations of pre-season stock abundance, estimated exploitation of fish ≥203 mm was 0.3% for cutthroat trout, 12.1% for rainbow and hybrid trout, and 8.2% for brown trout. For fish ≥406 mm, exploitation was 1.7% for cutthroat trout, 18.9% for rainbow and hybrid trout, and 11.4% for brown trout. Using $10 reward tags on fish ≥406 mm, and assuming a 50% angler reporting rate, estimated exploitation was 14% for cutthroat trout, 10% for rainbow and hybrid trout, and 17% for brown trout. Exploitation of ≥203 mm rainbow and hybrid trout was 5% using reward tags. We define two stocks because of harvest regulation differences between the taxa. Although rainbow and hybrid trout harvest has increased significantly, additional exploitation – probably triple the current rate on adult spawners – is needed to control the growing population.

The Rainey Creek fish weir was not operated in 2003 due to low flows. We trapped a total of 2,396 trout at the Burns Creek, Pine Creek, and Palisades Creek weirs from late March to June. Most were cutthroat trout – with 1,350 at Burns Creek, 328 at Pine Creek, and 529 at Palisades Creek. The remainder was rainbow and hybrid trout – one at Burns Creek, seven at Pine Creek, and 181 at Palisades Creek. Trapped rainbow and hybrid trout were relocated to family fishing waters. Weir efficiencies were low as estimated by several different methods – from 16.9 to 35.5% at Burns Creek, 40.4% at Pine Creek, and from 21.1 to 47.4% at Palisades Creek. The low efficiencies were due to weir structural and design problems. In addition, the Burns Creek and Pine Creek weirs were shut down early due to high cutthroat trout mortality. Significant weir improvements are needed to effectively remove rainbow and hybrid trout from these important cutthroat trout spawning tributaries.

For all weirs combined, cutthroat trout were caught between March 28 and June 22, and rainbow and hybrid trout were caught between March 31 and June 16. However, over 90% of the cutthroat trout were caught after June 2 at each weir site. Trapped fish ranged in size from 160 to over 500 mm, but about 99% of the cutthroat trout were over 300 mm at each weir site. In general, the Palisades Creek weir differed from the other weirs in having larger fish, greater numbers of rainbow and hybrid trout, and greater numbers of cutthroat trout migrating in April and May that could potentially hybridize with rainbow and hybrid trout.

We trapped a total of 668 age 1 and older trout moving downstream into the Palisades Canal fish screen from late March to early August. Eighty-five percent were cutthroat trout and fifteen percent were rainbow and hybrid trout. Of the 420 fish less than 120 mm – considered to

be age 1 – 96% were cutthroat trout and 4% were rainbow and hybrid trout. They hatched the previous summer and overwintered in Palisades Creek. Of the 149 fish considered to be age 2 and older juvenile fish, 62% were cutthroat trout between 120 and 279 mm and 38% were rainbow and hybrid trout between 120 and 249 mm. In contrast, thousands of age 0 juvenile trout (taxa unknown) were caught later in the summer after hatching. Of the 99 fish considered to be post-spawning adults, 68% were cutthroat trout larger than 279 mm and 32% were rainbow and hybrid trout larger than 249 mm.

To ascertain if otolith microchemistry is a viable tool to identify trout spawning and rearing strategies, we collected water samples and had them analyzed by an independent lab. Strontium:calcium ratios were slightly higher – and magnesium:calcium ratios were slightly lower – in main river water samples (n = 5) compared to tributary water samples (n = 10). Unfortunately, the overall differences between main river and tributary values were too small to use otolith microchemistry as a research tool. It might be possible to distinguish fish produced in the main river from those produced in West Pine and Rainey creeks, but it would not be possible to distinguish main river fish from those produced in Burns, Pine, or Palisades creeks.

Rotary-drum fish screens were operated and maintained on irrigation diversions in Palisades and Burns creeks from late March to November. Unknown numbers of outmigrating fish were saved.

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## INTRODUCTION

The South Fork Snake River supports an ecologically and economically important population of native Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri*. This population is 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., in review). Despite the overall health of cutthroat trout in the South Fork Snake River, an increasing population of non-native rainbow trout *O. mykiss* and rainbow x cutthroat hybrid trout *O. mykiss x O. clarkii* poses risks to future cutthroat trout productivity and stability. Perhaps the greatest risk is through hybridization. Genetic introgression from non-indigenous rainbow trout is well documented and can be serious (Behnke 1992; Leary et al. 1995). Hybrid trout, which are fertile, can also backcross with both cutthroat and rainbow trout in the South Fork Snake River (Henderson et al. 2000; Schrader et al. 2002). Hereafter, unless stated otherwise, "rainbow trout" will refer to rainbow and hybrid trout combined.

From a fishery management perspective, relatively low densities of cutthroat trout in the lower reach of the South Fork Snake River are also a concern. It is possible that these low densities result from adverse environmental conditions such as unfavorable flow regimes, loss of fish to irrigation canals, or a decline in habitat quality. All three of these conditions are primarily a result of management of reservoirs and diversions in the Snake River system for storage and delivery of irrigation water. Van Kirk and Benjamin (2001) found that the lower South Fork Snake River experiences a much greater degree of hydrologic alteration than does the upper river.

Because the hydrologic regime is the primary driver of ecological processes in large gravel-bed rivers such as the South Fork Snake River, and because the South Fork Snake River is flow-regulated, the ecological effects of hydrologic regime and alteration on this river have received increased attention in recent years. The continuation of the current drought – beginning in 2000 and perhaps the most severe on record – has only heightened that attention. Schrader and Griswold (1994) identified winter habitat preferences of juvenile salmonids and recommended a minimum winter flow of 1,500 cfs to sustain the fishery. Merigliano (1997) found that the decreased magnitude and frequency of spring flood events have limited cottonwood recruitment. The Flathead Lake Biological Station recently completed a study of channel morphology and stream ecology as it relates to flow regimes (Hauer et al. 2004). Funded by the U.S. Bureau of Reclamation (BOR), the results of this study were used to develop Ecologically Based System Management (EBSM) objectives to maintain and enhance ecological processes in the river and floodplain downstream of Palisades Dam. Although these studies address hydrologic, geomorphic, and riparian processes that have long-term effects on fish habitat and therefore on fish populations, none of the studies to date have addressed the direct effects of hydrologic regime on fish populations in the South Fork Snake River. This was a major goal of this study, and the research was sub-contracted to Dr. Rob Van Kirk at Idaho State University (Moller and Van Kirk 2003).

South Fork Snake River fishing regulation decisions by the Idaho Department of Fish and Game (IDFG) are predicated on reliable and current estimates of fish population parameters – such as density and fish size – as well as fishing-related parameters – such as angler effort, catch rates, and exploitation. Fish populations have been monitored by IDFG electrofishing since 1986. Creel surveys have been used sporadically to collect data from anglers since the 1960s. Following creel surveys in 1979 (Moore 1980) and 1982 (Moore and Schill 1984), special regulations were implemented in 1984 to restrict cutthroat trout harvest to

two fish, none between 10-16 inches, in a limited portion of the river (Appendix A). Based on the success of these special regulations, they were extended upstream to Palisades Dam in 1988 and throughout all eastern Idaho streams in 1990 – including the lower South Fork Snake River and all South Fork Snake River tributaries. In 1992, the rules were extended to all trout species – including rainbow trout – in the main river but not in tributaries. The last creel survey was conducted in 1996 (Schrader et al. 2003) and, combined with the 1998 petition to list Yellowstone cutthroat trout as a protected species under the federal Endangered Species Act, led to emergency rule changes in 1999. These changes removed rainbow trout (and later hybrid trout) from all special regulations, returning them to the general six fish bag limit with no size restrictions. In 2000, the slot limit for cutthroat and brown trout *Salmo trutta* was replaced by a minimum size restriction.

Both cutthroat and rainbow trout spawn in the main river and tributaries. However, research using radiotelemetry in 1996 and 1997 showed that most cutthroat trout spawn in the tributaries whereas most rainbow trout spawn in the main river (Henderson et al. 2000). We investigated using otolith microchemistry to provide better information on the origin of trout in the main river. Otolith microchemistry is a powerful new tool that uses the otolith chemical composition to determine the water chemistry to which a fish was exposed throughout its life. Assuming the water chemistry is sufficiently different between the main river and the tributaries – and possibly between tributaries – the otolith can be used to identify where and when a fish was spawned, hatched, and reared. The practical implication for the South Fork Snake River is that we would be able to collect a large, random sample of fish at large and then determine the proportion using the main river or tributaries – and possibly which tributary. It would also be possible to determine outmigration timing for fish produced in tributaries, i.e. did the fish leave in the spring or fall, and did it leave as age 0, age 1, or older? Compared to radiotelemetry, otolith microchemistry would provide a much larger sample size at much less expense and, combined with aging information and cohort analysis, could help determine the factors contributing to strong and weak year-classes.

Practically speaking, restricting main river spawning to limit hybridization is beyond the control of IDFG. However, by restricting spawning in the major tributaries – i.e. Palisades, Rainey, Pine, and Burns creeks – the genetic integrity of a large component of the South Fork Snake River cutthroat trout population can be insured. Fish trapping and collection facilities (weirs) are typically used to restrict fish spawning migrations. The first weir structure was built at Rainey Creek in 1996-1997, with weir panels installed in 2000. The next weir was built at Palisades Creek in 1998-1999, followed by Burns Creek in 2000 and Pine Creek in 2001. Host (2003) began trapping at all the weirs except Pine Creek in 2001. Trapping began at the Pine Creek weir in 2002.

All the structures that have been built, except Pine Creek, serve a dual purpose. Besides trapping adult spawners moving upstream, each weir also serves as an irrigation diversion dam with screening to pass juvenile fish and post-spawners moving downstream. The structures have also allowed accurate measurement of decreed water and have prevented streambed alterations to obtain that water. The Pine Creek weir was constructed and is operated solely for capturing upstream migrating fish.

All the weirs are checkpoints that allow sorting and removal of rainbow trout. The weir program was not designed to eliminate rainbow trout but rather to maintain core, genetically pure populations of cutthroat trout. A key component to the program's success is the ability to accurately distinguish cutthroat from rainbow trout using visual or phenotypic characteristics – generally red throat markings, white fin tips, and spotting patterns. Genetic tissue samples

taken and analyzed in 2000-2002 showed that with training, fisheries personnel could minimize the genetic contribution of rainbow trout to less than 1% of the upstream migrants (Host 2003).

This annual report, combined with Moller and Van Kirk (2003), summarizes South Fork Snake River fishery investigations conducted in 2003. BOR funding was granted several years prior to this to help formulate a biological basis for flow management – primarily through their Snake River Resources Review process. At the same time, a number of IDFG fishery objectives and programs were being implemented through the 2001-2006 Fisheries Management Plan (IDFG 2001). The current focus of both agencies is to preserve the unique native cutthroat trout fishery and to conserve the genetic integrity and population viability of cutthroat trout populations within BOR operational constraints. To this end, both agencies have cooperated since 2000 in developing a three-pronged management program – flow management in the main river, harvest management in the main river and tributaries, and escapement management in selected tributaries. Our research objectives were formulated with this emphasis in mind.

## OBJECTIVES

1. Continue to monitor South Fork Snake River trout populations.
2. Estimate effort, catch, and harvest over the 2003 fishing season.
3. Estimate trout exploitation over the 2003 fishing season.
4. Initiate angler education and outreach program to increase exploitation of rainbow trout. Gauge support for the program.
5. Operate fish weirs on Burns, Pine, Rainey, and Palisades creeks. Assess upstream migration timing and size of spawning trout. Evaluate weir efficiency.
6. Assess downstream migration timing and size of juvenile and post-spawning trout in Palisades Creek.
7. Investigate the potential use of otolith microchemistry to quantify cutthroat and rainbow trout spawning strategies.
8. Operate rotary drum fish screens on irrigation diversions in Palisades and Burns creeks.
9. Identify cutthroat trout conservation and management options, particularly as related to increasing rainbow trout.

The following additional objectives were part of the project grant but were subcontracted to Dr. Rob Van Kirk, Idaho State University (Moller and Van Kirk 2003):

1. Compile historical hydrologic data and reconstruct natural (unregulated) flows for the South Fork Snake River.
2. Assess differences in regulated and natural flow regimes.
3. Investigate relationships among trout population metrics and hydrologic variables. Recommend flow management objectives.
4. Investigate stock-recruitment relationships.

## METHODS AND STUDY AREA

### Electrofishing

Trout populations in the South Fork Snake River have been monitored using electrofishing since 1986. Four river sections have been sampled (Figure 1): Palisades (5.0 km, 39.50 ha), Conant (4.9 km, 34.79 ha), Twin Bridges (2.9 km, 19.14 ha), and Lorenzo (4.8 km, 22.08 ha). However, only the Conant section has been sampled every year, a portion of which was sampled in 1982 as well (Moore and Schill 1984). During 2003, the Conant section was electrofished on October 8, 9, 15, and 16, and the Lorenzo section was electrofished on September 18, 19, 24, and 26. The upper or lower half of a section was sampled each day. At Conant, flows varied from 87.2 to 141.6 $m^3/s$ (3,080 to 5,000 $ft^3/s$) at the Irwin gage (USGS, provisional data; Appendix B). At Lorenzo, flows varied from 65.1 to 90.6 $m^3/s$ (2,300 to 3,200 $ft^3/s$) at the Lorenzo gage (USGS, provisional data; Appendix C). Roughly 70.8 $m^3/s$ (2,500 $ft^3/s$) is needed at either section for safe boat operation and efficient sampling.

Fish were captured using direct-current (DC) electrofishing gear (Coffelt VVP-15 powered by a Honda 5000 W generator) mounted in a jet boat. We used pulsed DC current through two boom-and-dangler anodes fixed to the bow while driving downstream. The boat hull was the cathode. Similar to previous years, the VVP settings were at 175-225 V, 5-6 A, 20% pulse width, and 60 Hz (pulses per second). Water conductivity ranged from 174 to 207 µmhos/cm.

We attempted to capture all species and sizes of trout. Fish were anesthetized and identified, and total length (TL) was measured to the nearest millimeter. Age 0 fish – generally cutthroat trout less than 102 mm, rainbow trout less than 152 mm, and brown trout less than 178 mm – were not marked as they are not efficiently recruited to the gear. Age 1 and older fish were marked with a caudal fin punch and released.

We attempted to collect fixed stratified subsamples (10 fish per 25 mm length group) of each species on the recapture runs at Lorenzo. A total of 209 fish were collected (61 cutthroat, 2 rainbow, and 146 brown trout). Individual fish were placed in labeled Zip-lock bags, put on dry ice immediately, and frozen in an ordinary chest freezer at the end of the day. In the lab, fish were weighed to the nearest gram to develop length-weight relationships. They were also re-measured (to the nearest mm, TL) to estimate freezer shrinkage. Gonads were examined to determine sex and maturity for all species, and mature brown trout female gonads were extracted to estimate fecundity. Otoliths and dorsal fin rays were extracted for age and growth analysis and to develop age-length keys (Devries and Frie 1996). Only length-weight relationships are reported here – results for freezer shrinkage, sex and maturity, fecundity, and age and growth will be reported in the future. Scale and stomach samples were collected and provided to graduate students of Dr. Ernest Keeley (Idaho State University). During marking runs at Conant and Lorenzo, we also provided live cutthroat and rainbow trout to these graduate students. After photographing the fish, they excised fin clips for genetic analysis and pumped stomach contents for diet analysis. They marked fish using our standard caudal punch and released them unharmed into the river section.

We compiled historical trout population metrics dating back to 1986 for the Conant section and 1987 for the Lorenzo section. Although some electrofishing data exists for other sections (Palisades, Dry Canyon, and Twin Bridges), we chose the longest running data sets to

represent populations in the upper river (Conant, above Heise) and lower river (Lorenzo, below Heise). All metrics were provided to Idaho State University for regression analysis with flow variables (Moller and Van Kirk 2003). All electrofishing data were entered and analyzed using the computer program Mark Recapture 5.0 (MR5; Montana Department of Fish, Wildlife, and Parks 1997). Other kinds of data, such as paired lengths and weights, were entered and analyzed using Microsoft Excel. General statistical analysis was conducted according to Zar (1984).

We assumed capture probabilities did not vary with species, and relative abundance was estimated using the proportions of all trout captured. Although capture probabilities vary with fish length (Schill 1992), we assumed that variability was similar among sections and years. Population size structures (length frequency distributions) and average fish lengths were estimated using all sizes of fish captured. Quality stock density (QSD) was estimated by dividing the number of fish captured ≥406 mm by the number ≥203 mm, multiplied by 100. All these statistics were calculated for each section and year after excluding recaptured fish.

Density was estimated using two methods in the MR5 computer program. Results from the log-likelihood method were used over the modified Petersen method if modeled efficiency curves were acceptable (termcode = 1 and at least one of two chi-square p-values > 0.05). Following the nomenclature of Ricker (1975), sample efficiency, *E*, is defined as:

$$E = \frac{R}{C} \tag{1}$$

where *C* = number of fish sampled on recapture runs and examined for marks and *R* = number of recaptured marks in that sample. The log-likelihood method models sample efficiency (or capture probability) with fish length, thereby accounting for the size-selectivity of the electrofishing gear. The log-likelihood estimate of fish abundance, $\hat{N}_i$, for each 25.4 mm size group, *i*, was:

$$\hat{N}_i = \frac{M_i}{E_i} \tag{2}$$

where, for each size group *i*, $M_i$ = number of fish marked on marking runs and $E_i$ = modeled efficiency. The overall estimate of abundance was the sum of the individual estimates. The log-likelihood estimated variance for each 25.4 mm size group, *i*, was according to Seber (1973):

$$\mathrm{var}\left[\hat{N}i\right] = \frac{(Mi+1)(Ci+1)(Mi-Ri)(Ci-Ri)}{(Ri+1)^2(Ri+2)} \tag{3}$$

where the terms are the same as before. The overall variance was the sum of the individual estimates. We used Chapman's modification of the Petersen method if the log-likelihood method was rejected. The overall estimate of abundance, $\hat{N}$, was estimated as:

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1 \tag{4}$$

where the terms are the same as before. The overall variance was also according to Seber (1973):

$$\mathrm{var}\left[\hat{N}\right] = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)} \tag{5}$$

where the terms are the same as before. For either method, the 95% confidence interval for the overall abundance estimate was calculated as:

$$\hat{N} \pm 1.96\sqrt{\mathrm{var}\,\hat{N}} \tag{6}$$

We estimated fish density by dividing the abundance estimate by the electrofishing reach length to calculate fish per kilometer. The density variance estimate was calculated similarly.

Following Ricker (1975), we made five general assumptions needed for valid mark-recapture estimates. First, we assumed the population was closed, i.e. no mortality, recruitment, immigration, or emigration. Though electrofishing reaches were not blocked at each end, we assumed fish did not move beyond natural habitat boundaries between marking and recapture runs. Second, we assumed that marked fish were as vulnerable to subsequent electrofishing as unmarked fish, i.e. capturing and marking them did not affect their catchability. Third, the marked fish did not lose their mark. Fourth, the marked fish became randomly mixed with the unmarked fish. And fifth, all marks were recognized and recorded correctly.

## Creel Survey

A fully stratified, roving-type creel survey was conducted on the entire South Fork Snake River from January 4, 2003, to January 2, 2004. We surveyed anglers fishing from Palisades Dam down to the confluence with the Henrys Fork Snake River (101.1 km), but we did not include any tributaries. Moore (1980) last surveyed the entire river in 1979-1980 (March 3, 1979, to February 29, 1980; hereafter “1979”). Other fully stratified surveys were conducted in the upper river above Heise (64.4 km) from the fishing opener in late May to mid-September in 1982 (Moore and Schill 1984) and 1996 (Schrader et al. 2003).

The 2003 creel survey was stratified essentially the same as previous surveys. Moore (1980) stratified the river into seven unequal-length sections in 1979 because of differences in angler access and fishing seasons (Table 1). Angler access has improved and fishing seasons and bag limits have varied in these sections since then (Appendix A). Section one extends 11.9

km from Palisades Dam downstream to the footbridge abutments near Irwin. Section two extends 16.4 km from the abutments to Granite Creek. Section three extends 15.8 km from Granite Creek to Black Canyon. Section four extends 20.3 km from Black Canyon to the Heise cable or gaging station. Section five extends 6.1 km from the cable to the Heise Road Bridge. Section six extends 6.6 km from the Heise Road Bridge to Twin Bridges (or the Archer-Ririe Highway Bridge). Section seven extends 24.0 km from Twin Bridges to the Henrys Fork Snake River confluence. Moore (1980) and Moore and Schill (1984) provide detailed descriptions of these seven sections.

The 2003 creel survey was also stratified temporally by two-week intervals, by day type (weekday versus weekend day/holiday), and by day period (morning versus afternoon/evening). Previous surveys differed only in that they were stratified by morning, afternoon, and evening. We attempted 12 angler counts in each two-week interval that always started on Saturday (total n = 312 counts). One-half of the counts were done on weekdays, with the remainder done on weekend days/holidays. For survey purposes, holidays included President's Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Thanksgiving, Christmas, and New Year's Day. Specific count days were selected at random except that the opening day of fishing season in sections one to four (May 24, 2003) was included. To save time and cost, two counts – one for each day period – were conducted each count day. The morning count time was selected at random and always started after sunrise. The afternoon/evening count time was the morning time plus half of the average interval day length. However, it always started no later than 45 minutes before sunset. Morning was before midday and afternoon/evening was after midday. Midday was roughly 12:30 pm Mountain Standard Time, or 1:30 pm Daylight Savings Time (Figure 2). A fishing day was considered to be from sunrise to sunset. Sunrise, sunset, and midday (sun at its highest point) times, and day length data (sunrise to sunset), were obtained from the Internet (http://www.mindspring.com). Average day length for each interval was calculated using these data. A sampling calendar adapted from the Internet (http://www.sunrisesunset.com) was distributed to the pilots and creel clerks.

Finally, like previous surveys, the 2003 creel survey was stratified by angler type, i.e. power boat, float boat, or bank. Powerboat and float boat anglers were those using a boat whether they were fishing from the boat or the bank. Power (motorized) boaters were anglers using a boat with any type of motor attached regardless of how it was being used (i.e. actually fishing with the motor running, or transportation to a bank fishing location, or transportation upstream so they could fish floating downstream). Float (non-motorized) boaters were predominantly in Mackenzie drift boats, but were also in canoes, rafts, and other types of watercraft. Because of difficulties analyzing the data by angler type, power and float boat anglers were eventually combined as "boat anglers".

Data collection methods were essentially the same as previous surveys. We counted anglers using a jet boat or fixed-wing aircraft, but sometimes by vehicle. Counts generally began at Palisades Dam and always continued through all seven sections. We also counted fun boaters (not fishing) and jet skiers. Anglers were interviewed as often as practical on both count and non-count days. We generally used a jet boat to interview anglers, but we also used vehicles – particularly along roadways and at boat ramps. We tried to interview at least one or more anglers for each combined stratum that we had counted an angler (e.g. a bank angler in section four during a weekday morning in interval ten). We recorded standard creel information for each angler party: residence, type of angler (power boat, float boat, bank), trip completed, hours fished by terminal gear type (bait, lure, fly), number of fish kept and released by species, and length (TL) of fish kept by species. We also recorded if anglers were guided and if fishing licenses were checked.

The raw data were entered and analyzed using standard algorithms in the IDFG Creel Census System computer program (McArthur 1993). As reported by Schrader et al. (2003), raw data from 1996 and 1982 (Moore and Schill 1984), but not 1979, were entered into the program so that comparative analyses could be performed.

## Exploitation and Pre-season Stock Abundance

We used two methods to estimate trout exploitation over the 2003 fishing season (May 24 to November 30) in the upper South Fork Snake River (64 km). First, we tagged fish prior to the season opener. Exploitation was calculated as the number of tag returns divided by the number of fish initially tagged (Ricker 1975). We assumed that tagged fish did not move into the lower river below Heise, that no tags were lost, and that tagging did not affect their survival or catchability. Each tag returned was worth $10, and participating anglers were sent follow up letters. We publicized the program using return and reward information printed on the tag, posting signs at the boat ramps, and contacting anglers during the creel survey.

Fish were tagged at eight sites spaced at eight river kilometer intervals, except the Conant electrofishing section was excluded (site 4; Figure 3). We used our standard boat electrofishing gear to capture fish over four days between April 22 and May 17. Captured fish were anesthetized, identified, and measured to the nearest millimeter (TL). Floy T-bar anchor tags were inserted into the posterior base of the dorsal fin. Although our primary objective was to tag fish, we generally recorded all the fish caught to estimate relative abundance throughout the upper river. Because legal cutthroat trout sample size was a problem, particularly downstream, we sometimes focused on capturing them exclusively.

From 36 to 57 trout were tagged at each site, for a total of 369 fish (76 cutthroat, 185 rainbow, and 108 brown trout; Table 2). However, anglers removed the tag but did not kill five fish, leaving 364 tagged fish at large (74 cutthroat, 184 rainbow, and 106 brown trout). Only legal-sized cutthroat and brown trout ($\geq$406 mm), and larger-sized rainbow trout ($\geq$203 mm), were tagged. The largest fish tagged was 580 mm for cutthroat trout, 655 mm for brown trout, and 566 mm for rainbow trout. Ripe and spent rainbow trout were observed on redds, particularly just below the dam. An additional 49 cutthroat trout were tagged at the tributary weirs (34 at Palisades Creek, 2 at Burns Creek, and 13 at Pine Creek) between May 20 and June 6, but are excluded as none returned from anglers (one was found in an irrigated field). Whether any of these fish survived spawning is not known.

Our second method to estimate trout exploitation was to use the harvest estimate from the creel survey (sections 1-4 combined) divided by a pre-season estimate of fish stock abundance. We define two stocks for each taxa, one being fish $\geq$203 mm (the standard stock) and the other being fish $\geq$406 mm (the quality stock). These are the same fish lengths we used to define Quality Stock Density (QSD). We define two stocks because of different harvest regulations – only two cutthroat or brown trout of quality size could be legally harvested during 2003, whereas six rainbow trout of any size could be kept. During 2003, most rainbow trout checked in the creel were $\geq$203 mm; only one rainbow trout was less than 203 mm.

Because fish are not uniformly distributed, we used a technique incorporating our past electrofishing data to extrapolate fish stock abundance in the upper river. We began recording electrofishing VVP time in 1996, and we divided the number of individual fish caught by this

VVP time to calculate catch per unit effort (CPUE) for each year. Stock density estimates (fish/km) for the same years (1996-2000 and 2003) and sections (Conant n = 6, Lorenzo n = 3, Twin Bridges n = 1, Palisades n = 1) were then regressed on CPUE while forcing the intercept through zero (Figures 4 and 5). For each stock, this provided species-specific models to predict pre-season densities at each of the eight sites sampled in 2003 using CPUE (Tables 3 and 4). Predicted densities were averaged between sites, multiplied by the distance between sites (8 km), and summed to calculate total stock abundance.

## Angler Education and Outreach

During 2003, we developed a multi-faceted outreach program to inform and educate anglers regarding the status of cutthroat trout and to promote harvesting rainbow trout to conserve cutthroat trout. Our effort consisted of written materials, signs, reward pins, news media stories, public presentations and meetings, and an angler opinion questionnaire.

We produced an informational brochure that was made available to anglers at major boat ramps, local sporting goods stores, the Eastern Idaho Fly Tying Expo, the Eastern Idaho State Fair, and local fishing clubs. We also encouraged outfitters to provide copies of the brochure to clients. To improve angler's fish identification skills, we produced and made available at the same locations a fish identification card that depicted the distinguishing characteristics of cutthroat, rainbow, and hybrid trout. In addition, we developed and posted signs at the major boat ramp kiosks that contained the same information. Finally, we developed a metal pin (for hats or fishing vests) that was given to anglers who were checked during our creel survey and had harvested a rainbow trout.

We met with and gave presentations to numerous local groups including the Upper Snake River Cutthroats (local chapter of Trout Unlimited and Federation of Fly Fishers), the Upper Snake River Fly Fishers (local chapter of Federation of Fly Fishers), the Region 6 Wildlife Council, local Chambers of Commerce, and outfitters and guides. We also held public meetings throughout the region to present an overview of the status of the South Fork Snake River fishery and to describe the role anglers could play in conserving cutthroat trout.

We used a questionnaire to survey angler opinions on South Fork Snake River fisheries management. The survey was intended to gage public support for various regulation change alternatives as well as to assess support for cutthroat trout conservation. Anglers contacted during the creel survey were asked if they were willing to take a few minutes to respond to the written questionnaire. If willing, the questionnaire was completed on site and collected by the creel clerk.

## Tributary Weirs and Weir Evaluation

We operated fish weirs at Burns, Pine, and Palisades creeks during 2003 (Figure 6). We did not operate the Rainey Creek weir because, during drought years such as 2003, stream dewatering at five irrigation head gates below the weir severely limits upstream and downstream fish migration (Miller and Roby 1957; Moore 1980; Moore and Schill 1984; Meyer and Gregory 1994; Host 2003). Host (2003) provides a complete description of the weirs and trap facilities. Each weir had resistance board, floating weir panels (Ironwood Specialties,

http://www.fishtraps.com). To resolve structural problems encountered at Pine Creek the previous year, we replaced the wooden resistance boards with 30.5 cm plastic pipe filled with Styrofoam. These floated the panels adequately until May 24, when they submerged completely under high water until June 1. Also at Pine Creek, we installed temporary sand bags in a small side channel that carries water around the main weir during high runoff.

The Burns Creek weir was installed on March 28 and the weir panels were removed on June 10, but we continued operating the fish trap until June 23. The Pine Creek weir was installed on March 27 and removed on June 12. The Palisades Creek weir was installed on March 24 and removed on June 24. The weirs were generally checked daily. All captured fish were anesthetized and identified with a random sample measured (TL) and squeezed for gender determination. Cutthroat trout were marked with a temporary caudal fin punch so they would not be counted twice and were released above the weir to spawn. Rainbow trout were loaded into an aerated fish tank and hauled to family fishing waters.

We estimated weir or trap efficiency using three different methods. First, we occasionally released marked cutthroat trout below instead of above the weirs. The proportion of all marked fish released that returned to the trap box within the next few days was the first estimate of weir efficiency. Marked cutthroat trout had the standard caudal fin punch. We assumed that all marked fish would continue to migrate upstream after being released. This method was similar to the one used in 2001 except Host (2003) used jaw tags. Second, we snorkeled and electrofished in spawning areas above the Burns and Palisades weirs at the peak of the spawning run. The proportion of marked to all (marked and unmarked) cutthroat trout we observed on redds was the second estimate of weir efficiency. Only larger cutthroat trout (approximately greater than 300 mm) were counted. We assumed these larger fish were fluvial, i.e. they had migrated upstream from the main river to spawn. Third, to further evaluate the Palisades Creek weir, we trapped a sample of post-spawners returning downstream through the bypass pipe at the Palisades Canal fish screen (see below). The proportion of marked to total cutthroat trout (marked and unmarked) caught was the third estimate of weir efficiency. We assumed the larger (approximately greater than 300 mm) post-spawn fish were fluvial, had migrated upstream, spawned, and were returning downstream when they were caught. As the Palisades Canal entrains some but not all of the post-spawners, we further assumed that marked and unmarked fish were a random sample of all returning cutthroat trout. Statistically, this implies that the proportion of marked to total fish in our sample was an unbiased estimate of the proportion of marked fish in the total population. Unlike Host (2003) who evaluated the genetics of outmigrating fry, our goal in using all these methods was to evaluate the physical effectiveness of the floating weirs to block and trap upstream migrating fish.

Streamflows are not currently measured at any South Fork Snake River tributary. However, we used the difference between main river flows measured at the USGS Heise and Irwin gages as a surrogate for flows in the tributaries (Moller and Van Kirk 2003). This provided a single hydrograph to compare with our fish trapping results to help evaluate the weirs. There is a one-day lag time between tributary flows and flows measured at Heise (Rob Van Kirk, personal communication). Water temperature was measured with a hand-held thermometer when we checked each weir.

## Palisades Canal Trap

We operated a downstream migrant trap at the Palisades Canal fish screen during 2003 to: 1) trap juvenile fish for run timing and size information, and 2) trap adult post-spawning fish to evaluate the Palisades Creek weir. Fish were trapped as they moved downstream through the screen bypass pipe. We used the same methods and trap box used in 1996 by Der Hovanisian (1997). As the Palisades Canal entrains some but not all of the downstream migrants, we assumed that the trapped fish were a random sample of all fish moving down Palisades Creek. We did not adjust trap numbers for screen or trap efficiency.

The trap was installed on March 24, checked as often as practical (generally daily from mid-May to mid-July), and removed on August 1. We also installed the new Palisades Canal head gates, blocked the bypass channel above the old head gate, dropped the rotary-drum fish screens, and started operating the Palisades Creek fish weir on March 24. All trapped fish were anesthetized, identified, measured (TL), and examined for marks. All fish except rainbow trout were released downstream. Rainbow trout were loaded into an aerated fish tank and hauled to family fishing waters.

## Otolith Microchemistry

We collected 13 water samples using sterile equipment and standard protocols on August 20, 2002. Equipment was borrowed and protocols were obtained from the U.S. Forest Service Intermountain Laboratory, Boise (Donna Horan, personal communication). Nine samples were collected in tributaries – two at the Burns Creek weir, two at the Pine Creek weir, three at the Rainey Creek weir, and two at the Palisades Creek weir. Four samples were collected in the main river – two at the Lorenzo boat ramp in the lower South Fork Snake River below Heise, and two at the Conant boat ramp in the upper river above Heise. Water temperatures at the time of collection were 12$^{o}$C in Rainey Creek, 15$^{o}$C in the remaining tributaries, and 18$^{o}$C in the main river.

Two additional water samples were collected using the same equipment and protocols on June 29, 2002, by another IDFG fisheries research project (Kevin Meyer, personal communication). One was in a tributary – the West Fork of Pine Creek. The other was in the main river – at the Irwin boat ramp in the upper river above Heise. Water temperatures at the time of collection are unknown.

Water samples were kept cool over night and shipped the next day to the Montana State University Soil Testing Laboratory, Bozeman (Julie Armstrong, personal communication). Each sample was analyzed the following day for concentrations (mg/L) of strontium, calcium, barium, manganese, and magnesium at a cost of $13.75 per sample. The method detection limit (MDL) was 0.03-0.05 mg/L for calcium and magnesium, 0.001-0.002 mg/L for barium, and 0.001 mg/L for manganese and strontium.

To ascertain if otolith microchemistry is a viable tool in the South Fork Snake River, atomic ratios of the analyzed elements were used to compare main river and tributary water chemistry. A two- to three-fold difference in any given ratio between main river and tributary water samples was needed (Donna Horan, U.S. Forest Service Intermountain Laboratory, personal communication). Atomic ratios – which are derived on a molar rather than a weight

basis – were calculated between all the elements and calcium. For example, the strontium:calcium ratio is the moles of strontium in the sample compared to the moles of calcium in the sample. It is not the ratio of the elemental weights or concentrations (i.e. mg/L) in the sample. The number of moles (or gram atomic weight) of an element in the sample is calculated by dividing the elemental weight (mg, from the concentration) by the atomic weight (g) of the element, then dividing again by 1,000.

## RESULTS

### Electrofishing

#### Conant

We captured a total of 1,962 trout during four days of electrofishing in October 2003. Relative abundance was 47.1% cutthroat trout, 33.4% rainbow trout, and 19.5% brown trout (Figure 7, Appendix D). No lake trout or kokanee were captured, and less than 1% of the cutthroat trout was of hatchery origin from Palisades Reservoir. Cutthroat trout relative abundance was the lowest recorded since electrofishing began in the1980s (Figure 8).

The 2003 cutthroat trout length frequency distribution shows a relatively weak group of age 1 fish (about 100 to 250 mm) but stronger than in 2002 (Figure 9; Appendix D). Age 2 and older cutthroat trout (>250 mm) are well represented. In contrast, relatively strong groups of age 1 rainbow trout (about 150 to 280 mm) and brown trout (about 180 to 280 mm) were observed. However, none of the age 1 groups were as strong as in the past. Ages were approximated from overall frequency distributions and will be validated with otoliths or dorsal fin rays in the future (Figure 10).

Mean total length was 327 mm for cutthroat trout, 298 mm for rainbow trout, 270 mm for brown trout, and 306 mm for all trout species combined (Figure 9; Appendix D). Quality stock density was 5.6% for cutthroat trout, 19.1% for rainbow trout, 29.2% for brown trout, and 14.0% for all trout species combined. Mean total length, quality stock density, and sample size were within ranges observed in previous years.

Overall sample efficiencies (*R*/*C)* were similar to previous years and ranged from 8.1% for rainbow trout to 12.6% for cutthroat trout (Appendix D). For age 1 and older fish, estimated densities were 840 cutthroat trout/km, 931 rainbow trout/km, 240 brown trout/km, and 1,785 fish/km for all trout species combined (Figure 11; Appendix D). The cutthroat trout estimate is not significantly different from 2002 but is the lowest recorded since electrofishing began in the 1980s. The rainbow trout estimate is not significantly different from 2002 but is the highest recorded. For the first time at Conant, we estimated more rainbow than cutthroat trout – although 95% confidence intervals overlap. The brown trout estimate is not significantly different from 2002 and is within the range of previous years.

For age 1 (yearling) fish, estimated densities were 348 cutthroat trout/km, 636 rainbow trout/km, and 94 brown trout/km, for a combined total of 1,078 fish/km (Appendix D). The cutthroat to rainbow trout recruitment ratio was 0.5, i.e. about two rainbow trout were recruited for every cutthroat trout. Although higher than 2002, the ratio is far below the range of 1.2 to 9.9

observed in 1989-1999. The cutthroat to brown trout recruitment ratio was 3.7, i.e. almost four cutthroat trout were recruited for every brown trout. Yearling relative abundance in the catch was 31.1% cutthroat trout, 45.2% rainbow trout, and 23.6% brown trout.

**Lorenzo**

We captured a total of 1,217 trout during four days of electrofishing in September 2003. Relative abundance was 13.2% cutthroat trout, 0.3% rainbow trout, 86.4% brown trout, and 0.1% lake trout (Figure 7, Appendix E). No kokanee were captured, and none of the cutthroat trout was of hatchery origin from Palisades Reservoir. Like Conant, cutthroat trout relative abundance was the lowest recorded since electrofishing began in the1980s (Figure 8).

The 2003 cutthroat trout length frequency distribution shows a relatively weak group of age 1 fish (about 100 to 250 mm) but stronger than in 2002 (Figure 12; Appendix E). Age 2 and older cutthroat trout (>250 mm) are well represented. In contrast, a relatively strong group of age 1 brown trout (about 180 to 280 mm) was observed, but not as strong as in the past. Ages were approximated from overall frequency distributions and will be validated with otoliths or dorsal fin rays in the future (Figure 10).

Mean total length was 332 mm for cutthroat trout, 353 mm for rainbow trout, 296 mm for brown trout, and 301 mm for all trout species combined (Figure 12; Appendix E). Quality stock density was 2.6% for cutthroat trout, 0.0% for rainbow trout, 17.3% for brown trout, and 15.1% for all trout species combined. Mean total length, quality stock density, and sample size were within ranges observed in previous years. For age 1 and older fish, the length-weight regression for cutthroat trout was Weight = 0.000006 x Length $^{3.0962}$, and the regression for brown trout was Weight = 0.000006 x Length $^{3.0727}$ (Figure 13).

Excluding rainbow trout, overall sample efficiencies (*R/C*) were similar to previous years and ranged from 13.6% for cutthroat trout to 14.1% for brown trout (Appendix E). For age 1 and older fish, estimated densities were 237 cutthroat trout/km, 926 brown trout/km, and 1,184 fish/km for all trout species combined (Figure 14; Appendix E). Similar to previous years, only four rainbow trout were captured and a density estimate was not possible. Although cutthroat trout continue a downward trend observed since 1995, and brown trout are down slightly from 1999, estimates for both species are within the range of previous years and are not significantly different from 2002.

For age 1 (yearling) fish, estimated densities were 70 cutthroat trout/km and 465 brown trout/km, for a combined total of 534 fish/km (Appendix E). The cutthroat to rainbow trout recruitment ratio was not calculated because no yearling rainbow trout were captured. The cutthroat to brown trout recruitment ratio was 0.1, i.e. almost ten brown trout were recruited for every cutthroat trout. Although the ratio has not changed since 1999, it is still below the range of 0.2 to 1.5 observed in 1987-1995. Yearling relative abundance in the catch was 4.4% cutthroat trout and 95.6% brown trout.

## Creel Survey

Creel survey results for 2003 are presented for the upper South Fork Snake River (sections 1-4) over the summer period (May 24 to September 12, intervals 11-18) as well as the entire river over the entire year. This was done to better compare our results with the most recent surveys conducted in the upper river during the summers of 1996 and 1982.

### Upper River Over the Summer

We conducted 856 interviews representing 1,848 anglers in the upper river over the summer (Table 5). We also conducted 84 angler counts by fixed-wing aircraft. No interval had fewer than 7 or more than 12 instantaneous counts.

Of the anglers interviewed, 44% were non-residents and 19% were guided (Table 5). Because many anglers use more than one type of terminal gear when fishing, we used total time fished with each gear from the interviews for comparisons. Of 5,469.5 h reported fished, the proportion of bait angler hours was 12%, the proportion of lure angler hours was 13%, and the proportion of fly angler hours was 75%.

Estimated total effort was 143,413 h (Table 5). Slightly more than half, or 55%, occurred during weekdays. The remaining 45% occurred on weekend days or holidays. Boat angler effort, i.e. those using either a power or float boat, was 124,633 h or 87% of the total effort. Conversely, bank angler effort was 18,774 h or 13%. Overall, average time spent fishing was 5.1 h. Section two had the highest effort at 51,860 h whereas section one had the lowest at 22,117 h (Appendix F). Interval fourteen, beginning July 5, had the highest effort at 33,558 h whereas interval twelve, beginning June 7, had the lowest at 7,482 h.

Estimated total catch was 91,074 fish (Table 5). Total catch includes both harvested and released fish. Section four had the highest catch at 33,740 fish whereas section three had the lowest at 15,279 fish (Appendix F). Interval thirteen, beginning June 21, had the highest catch at 27,105 fish whereas interval twelve, beginning June 7, had the lowest at 4,140 fish. Overall, boat anglers using flies caught the most fish. Based on the interviews, boat anglers caught 92% and bank anglers caught 8% (Table 5). Fly anglers caught 72%, followed by lure anglers 12%, bait anglers 9%, and combo anglers 7%.

Catch composition from the interviews (n = 3,402 fish) was: 48% cutthroat trout, 20% rainbow trout, 21% brown trout, 10% mountain whitefish, and 1% other species (Table 5). Based on these proportions, we estimate 43,898 cutthroat trout, 18,397 rainbow trout, 19,217 brown trout, 8,743 mountain whitefish, and 820 fish of other species were caught.

Estimated total harvest was 6,335 fish or 7% of the catch (Table 5). We estimate 93% of all fish caught were released. We did not account for hooking mortality in estimating harvest. Section one had the highest harvest at 2,536 fish whereas section three had the lowest at 374 fish (Appendix F). Interval eleven, beginning May 24, had the highest harvest at 1,802 fish whereas interval sixteen, beginning August 2, had the lowest at 187 fish. Overall, boat anglers using bait harvested the most fish. Based on the interviews, boat anglers harvested 74% and bank anglers harvested 26% (Table 5). Bait anglers harvested 30%, followed by fly anglers 29%, lure anglers 24%, and combo anglers 17%.

Harvest composition estimated from the computer program was: 2% cutthroat trout, 72% rainbow trout, 24% brown trout, 2% mountain whitefish, and <1% other species (Table 5). The harvest estimates were 104 cutthroat trout, 4,560 rainbow trout, 1,508 brown trout, 146 mountain whitefish, and 15 fish of other species. Of the fish caught, anglers kept less than one percent of the cutthroat trout, twenty-five percent of the rainbow trout, eight percent of the brown trout, two percent of the mountain whitefish, and two percent of other species. Section one had the highest cutthroat trout harvest at 96 fish, as did interval twelve, beginning June 7, at 81 fish (Appendix F). Section two had the highest rainbow trout harvest at 1,989 fish, as did interval eleven, beginning May 24, at 1,325 fish. Section one had the highest brown trout harvest at 1,060 fish, as did interval eighteen, beginning August 30, at 433 fish.

The estimated overall catch rate was 0.64 fish/h and the estimated harvest rate was 0.04 fish/h (Table 5). These rates were calculated by dividing the total catch or harvest by total effort. Section four had the highest catch rate at 0.88 fish/h whereas section three had the lowest at 0.49 fish/h (Appendix F). Interval thirteen, beginning June 21, had the highest catch rate at 0.85 fish/h whereas interval sixteen, beginning August 2, had the lowest at 0.40 fish/h.

**Entire River Over the Entire Year**

We conducted 2,101 interviews representing 4,143 anglers in the entire river over the entire year (Table 6). We also conducted 287 angler counts – 149 by fixed-wing aircraft, 130 by boat, and 8 by vehicle. This was 25 short of our goal of 312 angler counts. No interval had fewer than 5 or more than 14 instantaneous counts.

Of the anglers interviewed, 33% were non-residents and 15% were guided (Table 6). Over half the anglers came from the two counties adjacent to the river – 44% from Bonneville County and 7% from Jefferson County – followed by 8% from the state of Utah and 6% from the state of Wyoming (Appendix F). Overall, anglers came from 21 of 44 Idaho counties, 42 states besides Idaho, the District of Columbia, and 6 foreign countries. Because many anglers use more than one type of terminal gear when fishing, we used total time fished with each gear from the interviews for comparisons. Of 11,267.5 h reported fished, the proportion of bait angler hours was 15%, the proportion of lure angler hours was 13%, and the proportion of fly angler hours was 71% (Table 6).

Estimated total effort was 216,181 h (95% CI $\pm$16,630 h; Table 6). Slightly more than half, or 53%, occurred during weekdays. The remaining 47% occurred on weekend days or holidays. Boat angler effort, i.e. those using either a power or float boat, was 170,228 h or 79% of the total effort. Conversely, bank angler effort was 45,943 h or 21%. Overall, average time spent fishing was 4.9 h. Section two had the highest effort at 57,922 h whereas section six had the lowest at 15,028 h (Appendix F). Interval fourteen, beginning July 5, had the highest effort at 36,447 h whereas interval twenty-six, beginning December 20, had the lowest at 161 h (Figures 15 and 16).

Estimated total catch was 149,946 fish (95% CI $\pm$16,913 fish; Table 6). Total catch includes both harvested and released fish. Section four had the highest catch at 39,817 fish whereas section five had the lowest at 14,012 fish (Appendix F). Interval thirteen, beginning June 21, had the highest catch at 30,137 fish whereas interval twenty-six, beginning December 20, had the lowest at 95 fish (Figures 17 and 18). Overall, boat anglers using flies caught the

most fish. Based on the interviews, boat anglers caught 77% and bank anglers caught 23% (Table 6). Fly anglers caught 68%, followed by bait anglers 14%, lure anglers 12%, and combo anglers 6%.

Catch composition from the interviews (n = 8,637 fish) was: 37% cutthroat trout, 14% rainbow trout, 38% brown trout, 10% mountain whitefish, and 1% other species (Table 6). Based on these proportions, we estimate 55,930 cutthroat trout, 20,842 rainbow trout, 56,979 brown trout, 15,294 mountain whitefish, and 900 fish of other species were caught.

Estimated total harvest was 8,977 fish (95% CI ±2,348 fish) or 6% of the catch (Table 6). We estimate 94% of all fish caught were released. We did not account for hooking mortality in estimating harvest. Section one had the highest harvest at 3,068 fish whereas section three had the lowest at 394 fish (Appendix F). Interval eleven, beginning May 24, had the highest harvest at 1,871 fish whereas intervals two, three, eight, and twenty-six had the lowest at no fish (Figures 19 and 20). Overall, boat and bank anglers harvested equal numbers of fish, and bait anglers harvested the most fish. Based on the interviews, boat anglers harvested 50% and bank anglers harvested 50% (Table 6). Bait anglers harvested 43%, followed by fly anglers 26%, lure anglers 20%, and combo anglers 11%.

Harvest composition estimated from the computer program was: 3% cutthroat trout, 56% rainbow trout, 33% brown trout, 7% mountain whitefish, and <1% other species (Table 6). The harvest estimates were 286 cutthroat trout, 5,070 rainbow trout, 2,920 brown trout, 660 mountain whitefish, and 38 fish of other species. Of the fish caught, anglers kept one percent of the cutthroat trout, twenty-four percent of the rainbow trout, five percent of the brown trout, four percent of the mountain whitefish, and four percent of other species. Section one had the highest cutthroat trout harvest at 114 fish, as did interval twelve, beginning June 7, at 87 fish (Figure 21; Appendix F). Section two had the highest rainbow trout harvest at 1,989 fish, as did interval eleven, beginning May 24, at 1,394 fish. Section one had the highest brown trout harvest at 1,467 fish, as did interval eighteen, beginning August 30, at 447 fish.

The estimated overall catch rate was 0.69 fish/h and the estimated harvest rate was 0.04 fish/h (Table 6). These rates were calculated by dividing the total catch or harvest by total effort. Section six had the highest catch rate at 0.99 fish/h whereas section three had the lowest at 0.46 fish/h (Appendix F). Interval twenty-four, beginning November 22, had the highest catch rate at 1.97 fish/h whereas interval eight, beginning April 12, had the lowest at 0.44 fish/h.

## Exploitation and Pre-season Stock Abundance

### Upper River Cutthroat Trout

Using reward tags, estimated exploitation of cutthroat trout ≥406 mm over the entire 2003 fishing season was 6.8%. This is based on 5 tag returns from 74 fish at large (Table 2). Assuming an angler reporting rate of 50% would double the exploitation rate to about 14%.

Using the CPUE models, estimated pre-season stock abundance of cutthroat trout ≥203 mm was 42,447 fish (Table 3), estimated harvest was 140 fish, and estimated exploitation of the standard stock was 0.3%. Estimated pre-season stock abundance of cutthroat trout ≥406 mm was 5,359 fish (Table 4), estimated harvest was 93 fish, and estimated exploitation of the quality

stock was 1.7%. The harvest estimates were derived by multiplying total harvest in the upper river (140 fish) by the proportion of fish measured in the creel that were ≥203 mm (100.0%) or ≥406 mm (66.7%). These proportions include fish from the upper and lower river due to low sample size (n = 15); those less than 406 mm (5 fish) were illegal harvest.

**Upper River Rainbow Trout**

Using reward tags, estimated exploitation of rainbow trout ≥203 mm over the entire 2003 fishing season was 2.7%. This is based on 5 tag returns from 184 fish at large (Table 2). Estimated exploitation of rainbow trout ≥406 mm was 5.3% based on the same 5 tag returns from 95 fish at large. Assuming an angler reporting rate of 50% would double the ≥203 mm exploitation rate to about 5% and the ≥406 mm exploitation rate to about 10%. No tags were returned from fish <406 mm.

Using the CPUE models, estimated pre-season stock abundance of rainbow trout ≥203 mm was 38,866 fish (Table 3), estimated harvest was 4,703 fish, and estimated exploitation of the standard stock was 12.1%. Estimated pre-season stock abundance of rainbow trout ≥406 mm was 12,439 fish (Table 4), estimated harvest was 2,352 fish, and estimated exploitation of the quality stock was 18.9%. The harvest estimates were derived by multiplying total harvest in the upper river (4,734 fish) by the proportion of fish measured in the creel that were ≥203 mm (99.3%) or ≥406 mm (49.7%). These proportions were from measured fish from the upper river only (n = 153).

**Upper River Brown Trout**

Using reward tags, estimated exploitation of brown trout ≥406 mm over the entire 2003 fishing season was 8.5%. This is based on 9 tag returns from 106 fish at large (Table 2). Assuming an angler reporting rate of 50% would double the exploitation rate to about 17%.

Using the CPUE models, estimated pre-season stock abundance of brown trout ≥203 mm was 24,558 fish (Table 3), estimated harvest was 2,003 fish, and estimated exploitation of the standard stock was 8.2%. Estimated pre-season stock abundance of brown trout ≥406 mm was 16,638 fish (Table 4), estimated harvest was 1,903 fish, and estimated exploitation of the quality stock was 11.4%. The harvest estimates were derived by multiplying total harvest in the upper river (2,003 fish) by the proportion of fish measured in the creel that were ≥203 mm (100.0%) or ≥406 mm (95.0%). These proportions were from measured fish from the upper river only (n = 80); those less than 406 mm (4 fish) were illegal harvest.

## Angler Education and Outreach

The angler opinion questionnaire generally indicated the respondents valued cutthroat trout and supported management efforts to maintain the cutthroat trout fishery (Table 7). About 92% of the survey respondents said it was “very important” or “moderately important” to be able to fish for cutthroat trout in the South Fork Snake River. Based on the responses, cutthroat trout were the most important fish, followed closely by brown trout. When asked to rank the four

game fish available (cutthroat trout, brown trout, rainbow trout, and mountain whitefish) from highest importance (indicated by a 1) to lowest importance (indicated by a 4), the mean rank for cutthroat trout was 1.63, followed by brown trout (1.68), rainbow trout (2.50), and mountain whitefish (3.60). Furthermore, when given a choice between managing for cutthroat or rainbow trout, 89% of the respondents said they would manage for cutthroat trout, knowing that would ultimately mean fewer rainbow trout. Finally, 82% of the respondents said they would harvest a rainbow trout if they thought that would help the cutthroat trout population.

Anglers also supported possible future regulation changes that would increase harvest opportunity for rainbow trout and decrease harvest opportunity for cutthroat trout. About 81% of the respondents said they would support catch-and-release regulations for cutthroat trout, and 74% said they would support a year round season to increase harvest opportunity for spawning rainbow trout.

## Tributary Weirs and Weir Evaluation

### Burns Creek

From March 28 to June 23, 2003, we trapped a total of 1,351 trout at the Burns Creek weir, of which one fish or 0.1% was a rainbow trout and 1,350 fish or 99.9% were cutthroat trout (Table 8; Figure 23). The single female rainbow trout was caught June 16 and was a questionable hybrid. The 288 female, 230 male, and 832 unclassified cutthroat trout were caught between March 31 and June 22 with the midpoint of the run on June 14.

The estimated weir or trap efficiency of the floating weir was 16.9% using mark-recapture and 35.5% using snorkeling (Table 8). Of 71 marked cutthroat trout released below the weir, 12 fish (16.9%) were recaptured in the trap. We observed 31 cutthroat and no rainbow trout on redds while snorkeling on June 16, of which 11 fish (35.5%) were marked. It is likely unmarked fish swam between the pickets or moved upstream after the weir panels were removed on June 10. We removed the panels early due to high cutthroat trout mortality but continued running the trap until June 23. From June 6 to 10, we counted 91 cutthroat trout trapped between the weir panels and dam boards. Of these, 84 had died – many of which were gilled in the pickets trying to move upstream – and they were not included in the total count. Fish were also observed jumping over the end of the pickets.

The trapped rainbow trout was 400 mm (TL, Figure 24). Cutthroat trout ranged in size from 170 to 480 mm, but 98.3% were greater than 300 mm. Their mean total length was 369 mm (n = 520).

### Pine Creek

From March 27 to June 12, 2003, we trapped a total of 335 trout at the Pine Creek weir, of which seven fish or 2.1% were rainbow trout and 328 fish or 97.9% were cutthroat trout (Table 8). The two female, four male, and one unclassified rainbow trout were caught between April 21 and June 8 with the midpoint of the run on June 4 (Figure 25). The 174 female, 100

male, and 54 unclassified cutthroat trout were caught between March 28 and June 11 with the midpoint of the run on June 8.

The estimated weir or trap efficiency of the floating weir was 40.4% using mark-recapture (Table 8). Of 52 marked cutthroat trout released below the weir, 21 fish (40.4%) were recaptured in the trap. It is likely unmarked fish swam between the pickets, swam by the weir when it was submerged by high water on May 24-June 1, or moved upstream after the weir panels were removed on June 12. We removed the weir early due to high cutthroat trout mortality. From June 4 to 11, we counted 68 cutthroat trout trapped between the weir panels and dam boards. Of these, 23 had died – many of which were gilled in the pickets trying to move upstream – and they were not included in the total count. Like Burns Creek, fish were also observed jumping over the end of the pickets.

Trapped rainbow trout ranged in size from 390 to 460 mm (TL, Figure 26). Cutthroat trout ranged from 240 to 480 mm, but 99.3% were greater than 300 mm. Mean total length was 425 mm (n = 7) for rainbow trout and 382 mm (n = 276) for cutthroat trout.

**Palisades Creek**

From March 24 to June 24, 2003, we trapped a total of 710 trout at the Palisades Creek weir, of which 181 fish or 25.5% were rainbow trout and 529 fish or 74.5% were cutthroat trout (Table 8). The 77 female, 51 male, and 53 unclassified rainbow trout were caught between March 31 and June 11 with the midpoint of the run on April 25 (Figure 27). The 264 female, 204 male, and 61 unclassified cutthroat trout were caught between April 10 and June 21 with the midpoint of the run on June 9.

The estimated weir or trap efficiency of the floating weir was 47.4% using mark-recapture, 21.1% using snorkeling and electrofishing, and 37.3% using the Palisades Canal downstream trap (Table 8). Of 57 marked cutthroat trout released below the weir, 27 fish (47.4%) were recaptured in the trap. We observed 19 cutthroat trout on redds while snorkeling and electrofishing on June 20-23, of which 4 fish (21.1%) were marked. Four spawning rainbow trout were also observed. Of 67 post-spawning cutthroat trout caught in the downstream trap (see below), 25 fish (37.3%) were marked. Another 32 post-spawning rainbow trout were also caught. Like the other weirs, it is likely unmarked fish swam between the pickets and were observed jumping over the end of the pickets. Unlike the other weirs, we did not remove the Palisades Creek weir early as cutthroat trout mortality was low. From June 9 to 20, we counted 7 dead cutthroat trout on the weir panels. These were not included in the total count and were believed to be post-spawners (several were marked).

Trapped rainbow trout ranged in size from 160 to over 500 mm, but 97.8% were greater than 300 mm (TL, Figure 28). Cutthroat trout ranged from 280 to over 500 mm, but 99.6% were greater than 300 mm. Mean total length was 418 mm (n = 181) for rainbow trout and 390 mm (n = 472) for cutthroat trout.

## Palisades Canal Trap

From March 24 to August 1, 2003, we caught a total of 668 age 1 and older fish at the Palisades Canal trap, of which 103 (15.4%) were rainbow trout and 565 (84.6%) were cutthroat trout. Two small brown trout (less than 225 mm, TL), three mountain whitefish, and several sculpins were also caught. We pulled the trap shortly after catching large numbers of age 0 cutthroat or rainbow trout (about 10 mm, TL) on July 22. These recently emerged fry were not counted or measured as they numbered in the thousands.

Of the total catch, 15 rainbow trout (2.2%) and 405 cutthroat trout (60.6%) were less than 120 mm and were considered age 1 or yearlings (Figures 29 and 30). They likely hatched the previous summer, reared, and overwintered in Palisades Creek. Most migrated in late May and throughout June with runoff. Another 56 rainbow trout between 120 and 249 mm (8.4%) and 93 cutthroat trout between 120 and 279 mm (13.9%) were considered age 2 and older juveniles (Figures 31 and 32). Most migrated in late May at the beginning of runoff, but less so than yearlings. Using timing and sizes of sexually mature fish caught at the Palisades Creek weir (Figures 27 and 28), 32 rainbow trout larger than 249 mm (4.8%) and 67 cutthroat trout larger than 279 mm (10.0%) were considered adult post-spawners (Figures 33 and 34). Most post-spawning rainbow trout were caught in mid- to late-May whereas most cutthroat trout were caught in mid-June to mid-July. Not all the post-spawning cutthroat trout were marked – only 25 fish (37.3%) had the caudal fin punch used at the weir.

Overall, trapped rainbow trout ranged in size from 60 to 480 mm and cutthroat trout ranged from 40 to 440 mm (TL). Mean total length was 219 mm (n = 103) for rainbow trout and 128 mm (n = 565) for cutthroat trout.

## Otolith Microchemistry

Chemical analysis of the water samples revealed strontium concentrations ranging from 0.117 to 0.237 mg/L in the tributaries (n = 10) and from 0.201 to 0.254 mg/L in the main river (n = 5). Calcium concentrations ranged from 39.4 to 51.2 mg/L in the tributaries and from 36.5 to 46.7 mg/L in the main river. Barium concentrations ranged from 0.020 to 0.060 mg/L in the tributaries and from 0.040 to 0.050 mg/L in the main river. Manganese concentrations ranged from <0.001 to 0.024 mg/L in the tributaries and from <0.002 to 0.005 mg/L in the main river. Magnesium concentrations ranged from 11.7 to 14.1 mg/L in the tributaries and from 8.38 to 10.50 mg/L in the main river.

Strontium:calcium ratios were slightly higher – and magnesium:calcium ratios were slightly lower – in the main river water samples compared to the tributary water samples (Figure 35). Unfortunately for both ratios, the overall differences between main river and tributary values were too small to further pursue otolith microchemistry as a management tool in the South Fork Snake River. It might be possible to distinguish fish produced in the main river from those produced in West Pine and Rainey creeks, but it would not be possible to distinguish main river fish from those produced in Burns, Pine, or Palisades creeks.

Overall, strontium:calcium ratios ranged from 0.0011 to 0.0024 in the tributaries and from 0.0025 to 0.0026 in the main river. Magnesium:calcium ratios ranged from 0.4151 to 0.4894 in the tributaries and from 0.3707 to 0.4242 in the main river. Manganese:calcium ratios

averaged 0.0001, and barium:calcium ratios averaged 0.0003, in both the tributaries and the main river – too low to be of practical use. Overall, they ranged from 0.0000 to 0.0004.

## DISCUSSION

The native Yellowstone cutthroat trout population in the South Fork Snake River has declined as evidenced by the downward trend of most of the population metrics reported here. The decline seems unrelated to harvest. Cutthroat trout were lightly exploited during the 2003 fishery. Exploitation rates were two to fourteen percent for fish ≥406 mm, depending on how they were calculated, and less than one percent for fish ≥203 mm.

Assuming hooking mortality and natural mortality have held constant over the years, the minimal harvest suggests that the decline is related to recruitment. At both Conant and Lorenzo, cutthroat trout recruitment has declined since 2000, both in absolute numbers and as a percentage of all age 1 trout. A variety of factors could limit cutthroat trout recruitment, and the lack of relationship between spawning stock and the number of recruits suggests the factors are probably density-independent (Moller and Van Kirk 2003). Cutthroat trout recruitment appears to be a function of environmental or other density-independent factors rather than the size of the spawning stock.

After analyzing historical South Fork Snake River trout population metrics and hydrologic data, Moller and Van Kirk (2003) concluded that main river hydrologic conditions during spawning and juvenile trout first-summer growth periods explained more variability in trout recruitment than any other group of hydrologic variables, including first-winter discharge. In particular, hydrologic alteration in the main river explained more variability in trout recruitment than did the actual magnitude of discharge. This is in contrast to Schrader and Griswold (1994) who assumed that first-winter discharge limited trout recruitment through winter habitat availability. Moller and Van Kirk (2003) showed that cutthroat trout recruitment was highest following water years in which the maximum/minimum flow ratio was high; the runoff peak was high, sharp, and short in duration; and spawning tributary discharge was high. Jumps in rainbow trout recruitment followed years in which the maximum/minimum flow ratio was low and the runoff peak was relatively low, flat, and long in duration. Maximum flow was that during spring runoff when cutthroat and rainbow trout are spawning; minimum flow was that during the previous winter.

Moller and Van Kirk (2003) suggested that the declining cutthroat trout population can be explained by three density-independent factors limiting their recruitment: tributary flows, main river hydrologic conditions, and increasing rainbow trout abundance. Tributary flows affect cutthroat trout recruitment directly and are beyond our ability to control. Main river hydrologic regimes affect cutthroat trout recruitment both directly (i.e. first-summer growth period) and indirectly by their effect on rainbow trout recruitment. Increasing rainbow trout abundance affects cutthroat trout recruitment directly (i.e. hybridization, competition) and perhaps indirectly through mechanisms not yet identified. This research has led to a shift in focus away from the long-held belief that winter flows limit juvenile cutthroat trout survival to a focus on flow shape and controlling rainbow trout recruitment.

Whereas BOR manages flows within their operational constraints and IDFG manages trout populations with public input, both agencies have initiated a three-pronged management strategy to conserve and rebuild the cutthroat trout population. The three components are

harvest management in the main river and tributaries, flow management in the main river, and escapement management in the four important spawning tributaries.

*Harvest Management*

Over 5,000 rainbow trout were harvested in 2003 – five times more than in any previous survey year – and rainbow trout were more than half of the 2003 total harvest. The increase in rainbow trout harvest can be attributed to a combination of greater abundance compared to past years, relaxed harvest regulations that were implemented in 1999, and an intensive angler education and outreach campaign that we initiated in 2003. In 1979, when rainbow trout were not very common in the river, about 1,000 rainbow trout were harvested for about 3% of the total harvest (Moore 1980). However, about half of the total rainbow trout catch and harvest in 1979 was hatchery fish planted in the lower river – a practice discontinued after 1981. Hatchery fish were planted because the South Fork Snake River fishery was harvest-oriented at that time. Subtracting out these hatchery fish, perhaps ten times more wild rainbow trout were harvested in 2003 compared to 1979.

Our harvest management strategy has been successful from a social standpoint and the increase in rainbow trout harvest is encouraging. However, from a biological standpoint we need additional harvest and angler follow through – particularly by fly anglers, non-residents, and those using guide services. Most anglers were willing to harvest on principle – about 82% of our opinion survey respondents said they would harvest rainbow trout if they thought that would help the cutthroat trout population. Why most anglers did not follow through is not known – only 24% of the anglers catching rainbow trout actually kept one or more of them. Overall, we estimate 18-24% of the rainbow trout caught were actually kept. It is possible our extensive education and outreach campaign missed the majority of anglers. But this seems unlikely.

Using reward tags and extrapolations of pre-season stock abundance from our CPUE models, we estimate rainbow trout exploitation was 5-12% for the standard stock (≥203 mm) and 10-19% for the quality stock (≥406 mm). We believe these rates need to triple to around 40-60% – and perhaps higher – before recruitment overfishing will occur and effective control is realized. If anglers kept another two rainbow trout for every one they kept in 2003 – perhaps keeping 60-75% of their catch – our 40-60% exploitation goal could be achieved. Assuming our pre-season stock abundance estimates were accurate, tripling the ≥203 mm rainbow trout harvest estimate in the upper river (from about 4,700 to 15,000 fish) would yield approximately 40% exploitation. If anglers had kept every rainbow trout they caught in the upper river during 2003 (21,000 fish), the ≥203 mm rainbow trout exploitation estimate would have been 54%. Tripling the ≥406 mm rainbow trout harvest estimate (from about 2,400 to 7,500 fish) would yield approximately 60% exploitation on the spawning stock.

Higher rainbow trout exploitation seems reasonable and attainable given the history of the South Fork Snake River. Moore and Schill (1984) concluded that 62% exploitation on age 4 and older cutthroat trout during 1979 led to overharvest and a decline in the fishery. About 22,000 cutthroat trout were harvested in 1979 – more than four times the rainbow trout harvested in 2003. Further, 92% of the rainbow trout caught were kept in 1979 compared to 18-24% in 2003.

To continue monitoring our harvest management program, a more accurate and precise method than reward tags – and a less labor intensive method than electrofishing and creel

surveys – is needed to estimate exploitation. We adjusted our reward tag estimates by assumed but unknown angler reporting rates, but we did not adjust for tag loss or tag-induced mortality. IDFG research is currently being conducted on these adjustments (Art Butts, IDFG, personal communication).

*Flow Management*

We refer the reader to Moller and Van Kirk (2003) for a complete discussion of flow-related research and management objectives specific to trout populations in the South Fork Snake River. In general, to favor cutthroat trout and control rainbow trout, future maximum/minimum flow ratios should be 15 or higher with high and sharp runoff peaks. We recommend that this objective be implemented starting in water year 2004. We also refer the reader to Hauer et al. (2004) for a complete discussion of flow-related Ecologically Based System Management (EBSM) objectives to maintain and enhance ecological processes in the river and floodplain.

*Escapement Management*

Weir or trap efficiencies were low (less than 50%) at the Burns, Pine, and Palisades creek weirs during 2003 as measured by several different methods. In addition, the Burns and Pine creek weirs were shut down early due to high pre-spawn cutthroat trout mortality. The low efficiencies and high mortality are due to weir structural and design problems, particularly in the weir panels. These problems need to be resolved before operating the weirs in the future. It should be noted that the weirs have been operated during drought and low-water conditions since their inception in 2001. The problems we encountered during 2003 will certainly be magnified when hydrologic conditions return to normal.

We emphasize that all the weir structures that have been built, except Pine Creek, serve other important purposes. The Pine Creek weir was constructed and is operated solely for capturing upstream migrating fish. Besides trapping adult spawners moving upstream, the other weirs serve as irrigation diversion dams with screening to pass juvenile fish and post-spawners moving downstream. The structures have allowed accurate measurement of decreed water and have prevented streambed alterations to obtain that water. All the weirs have provided a valuable opportunity to highlight the importance of native cutthroat trout conservation. Not surprisingly, the structures have generated significant interest from the angling and non-angling public. With our cooperators, we have constructed and placed educational signs at the highly visible weir sites. These signs are designed to explain the purpose and importance of using the weirs to maintain healthy populations of native cutthroat trout.

*The South Fork Snake River Fishery*

Over the last half-century, the nature and composition of the South Fork Snake River fishery has changed. The fishery that was once dominated by harvest-oriented anglers using bait has evolved to one dominated by catch-and-release anglers using flies. Almost 20% of anglers now use guide services. In 1979, about 92% of all anglers were residents of Idaho –

79% from the three counties adjacent to the river (Bonneville, Jefferson, and Madison) – and 8% were non-residents from 19 states (Moore 1980). By 2003 about 67% were Idaho residents – 55% from the three adjacent counties – and 33% were non-residents from 42 states, the District of Columbia, and six foreign countries. The fishery has become less-harvest oriented and more cosmopolitan with national and world-wide acclaim. It is likely that these trends will continue and that they will present new challenges to balance fishery, water, and land resource competing demands.

From a fishery management perspective, it is ironic that a well-intentioned catch-and-release ethic may be an obstacle to rebuilding cutthroat trout in the future, i.e. convincing anglers to harvest more rainbow trout. The fishery is no longer dominated by native cutthroat trout – as was the case in mid-1960s when they were 97% of the catch or in the mid-1990s when they were 71% (Table 9). In 2003 they were only 37% of the catch and the fishery – for the first time – was dominated by non-native rainbow and brown trout. Coinciding with this declining catch composition has been the recent decline in total catch and catch rate. In the upper river from 1996 to 2003, total catch and catch rate during the summer declined by almost half. Further, the 0.64 fish/h catch rate in 2003 was less than the 0.90 fish/h in 1982 before special regulations. The decline in total catch and catch rate is partly because rainbow and brown trout are less catchable than cutthroat trout, partly because there were fewer total fish in the river, and perhaps partly because of unknown reasons.

IDFG is committed to conserving and rebuilding the wild, native cutthroat trout fishery in the South Fork Snake River. Judging from responses to our angler opinion survey, most South Fork Snake River anglers support this goal. Survey respondents generally valued cutthroat trout over other trout species, supported management efforts to maintain the cutthroat trout fishery, and supported possible regulation changes that would increase harvest opportunity for rainbow trout and decrease harvest opportunity for cutthroat trout. Hopefully, our goal will be achieved in the future with our three-pronged management program.

## RECOMMENDATIONS

1. Continue to monitor South Fork Snake River trout populations.
2. Increase harvest opportunity for rainbow trout.
3. Repeat the fully randomized creel survey and rainbow trout exploitation estimates to evaluate the angler education and outreach campaign.
4. Eliminate harvest opportunity for cutthroat trout.
5. Implement flow management objectives recommended by Moller and Van Kirk (2003) and Hauer et al. (2004). Encourage BOR to provide spring flushing flows even if the tradeoff is slightly lower winter flows. Monitor the physical effects of flushing flows on rainbow trout redds using radiotelemetry.
6. Modify tributary fish weirs to improve weir efficiency. Develop evaluation objectives.
7. Continue to operate rotary drum fish screens on irrigation diversions in Palisades and Burns creeks.

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# TABLES

Table 1. Standard creel survey sections in the South Fork Snake River, Idaho, as defined by Moore (1980).

| Section | Boundaries | Distance (km) | Area (ha) |
|---|---|---|---|
| 1 | Palisades Dam to foot bridge abutments near Irwin | 11.9 | 89.2 |
| 2 | Irwin abutments to Granite Creek | 16.4 | 123.0 |
| 3 | Granite Creek to Black Canyon | 15.8 | 118.5 |
| 4 | Black Canyon to Heise cable (gaging station) | 20.3 | 152.2 |
| 5 | Heise cable to Heise Bridge | 6.1 | 45.8 |
| 6 | Heise Bridge to Twin Bridges (Archer-Ririe Bridge) | 6.6 | 49.5 |
| 7 | Twin Bridges to Henrys Fork confluence | 24.0 | 180.0 |
| Total | Palisades Dam to Henrys Fork confluence | 101.1 | 758.2 |

Table 2. Number of fish marked with Floy tags (tagged), number of known tags removed by anglers without killing the fish (clipped), and number of known tagged fish harvested by anglers (kept) in the upper South Fork Snake River, Idaho, 2003. Sites were spaced at 8 km intervals beginning at Palisades Dam (site 1) and ending at the Heise cable (site 9).

| | Cutthroat trout ≥406 mm[a] | | | Rainbow trout ≥203 mm | | | Rainbow trout ≥406 mm | | | Brown trout ≥406 mm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | Tagged | Clipped | Kept | Tagged | Clipped | Kept | Tagged | Clipped | Kept | Tagged | Clipped | Kept | Total tagged |
| 1 | 20 | 0 | 3 | 23 | 0 | 3 | 23 | 0 | 3 | 10 | 0 | 2 | 53 |
| 2 | 20 | 0 | 2 | 19 | 0 | 0 | 14 | 0 | 0 | 7 | 0 | 1 | 46 |
| 3 | 7 | 0 | 0 | 30 | 0 | 1 | 17 | 0 | 1 | 9 | 0 | 1 | 46 |
| 4 | ND[b] | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 5 | 4 | 0 | 0 | 26 | 1 | 0 | 16 | 1 | 0 | 9 | 0 | 1 | 39 |
| 6 | 6 | 0 | 0 | 27 | 0 | 1 | 14 | 0 | 1 | 11 | 0 | 0 | 44 |
| 7 | 8 | 0 | 0 | 29 | 0 | 0 | 6 | 0 | 0 | 11 | 0 | 0 | 48 |
| 8 | 3 | 1 | 0 | 21 | 0 | 0 | 2 | 0 | 0 | 12 | 2 | 0 | 36 |
| 9 | 8 | 1 | 0 | 10 | 0 | 0 | 4 | 0 | 0 | 39 | 0 | 4 | 57 |
| Total | 76 | 2 | 5 | 185 | 1 | 5 | 96 | 1 | 5 | 108 | 2 | 9 | 369 |

[a] Includes hatchery cutthroat trout.
[b] ND = no data.

Table 3. Predicted pre-season stock density (N/km, from CPUE model) and total abundance (N) of trout ≥203 mm in the upper South Fork Snake River, Idaho, 2003. Sites were spaced at 8 km intervals beginning at Palisades Dam (site 1) and ending at the Heise cable (site 9).

| Site | VVP shock time (min) | Cutthroat trout[a] | | | | | Rainbow trout | | | | | Brown trout | | | | | Total N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Catch | % | CPUE (fish/ min) | N/km | N | Catch | % | CPUE (fish/ min) | N/km | N | Catch | % | CPUE (fish/ min) | N/km | N | |
| 1 | 23.10 | 25 | 19.1 | 1.08 | 414 | | 46 | 35.1 | 1.99 | 1,094 | | 60 | 45.8 | 2.60 | 927 | | |
| 2 | 19.93 | 28 | 43.8 | 1.40 | 538 | 3,809 | 28 | 43.8 | 1.40 | 772 | 7,461 | 8 | 12.5 | 0.40 | 143 | 4,279 | 15,549 |
| 3 | 27.22 | 38 | 43.2 | 1.40 | 535 | 4,290 | 39 | 44.3 | 1.43 | 787 | 6,234 | 11 | 12.5 | 0.40 | 144 | 1,149 | 11,674 |
| 4 | ND[b] | ND | ND | ND | ND | 4,582 | ND | ND | ND | ND | 4,635 | ND | ND | ND | ND | 1,198 | 10,415 |
| 5 | 20.68 | 33 | 58.9 | 1.60 | 611 | 4,582 | 14 | 25.0 | 0.68 | 372 | 4,635 | 9 | 16.1 | 0.44 | 155 | 1,198 | 10,415 |
| 6 | 19.30 | 24 | 35.3 | 1.24 | 476 | 4,348 | 17 | 25.0 | 0.88 | 484 | 3,422 | 27 | 39.7 | 1.40 | 499 | 2,617 | 10,388 |
| 7 | 20.58 | 56 | 43.8 | 2.72 | 1,042 | 6,072 | 31 | 24.2 | 1.51 | 827 | 5,244 | 41 | 32.0 | 1.99 | 711 | 4,838 | 16,154 |
| 8 | ND | ND | ND | ND | ND | 7,382 | ND | ND | ND | ND | 3,616 | ND | ND | ND | ND | 4,640 | 15,638 |
| 9 | 50.02 | 105 | 60.0 | 2.10 | 804 | 7,382 | 7 | 4.0 | 0.14 | 77 | 3,616 | 63 | 36.0 | 1.26 | 449 | 4,640 | 15,638 |
| Total | 180.83 | 309 | | | | 42,447 | 182 | | | | 38,866 | 219 | | | | 24,558 | 105,871 |

[a] Includes hatchery cutthroat trout.
[b] ND = no data.

Table 4. Predicted pre-season stock density (N/km, from CPUE model) and total abundance (N) of trout ≥406 mm in the upper South Fork Snake River, Idaho, 2003. Sites were spaced at 8 km intervals beginning at Palisades Dam (site 1) and ending at the Heise cable (site 9).

| Site | VVP shock time (min) | Cutthroat trout[a] | | | | | Rainbow trout | | | | | Brown trout | | | | | Total N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Catch | % | CPUE (fish/ min) | N/km | N | Catch | % | CPUE (fish/ min) | N/km | N | Catch | % | CPUE (fish/ min) | N/km | N | |
| 1 | 23.10 | 16 | 14.7 | 0.69 | 214 | | 37 | 33.9 | 1.60 | 622 | | 56 | 51.4 | 2.42 | 988 | | |
| 2 | 19.93 | 15 | 34.9 | 0.75 | 233 | 1,790 | 21 | 48.8 | 1.05 | 409 | 4,126 | 7 | 16.3 | 0.35 | 143 | 4,523 | 10,439 |
| 3 | 27.22 | 6 | 17.1 | 0.22 | 68 | 1,205 | 20 | 57.1 | 0.73 | 285 | 2,779 | 9 | 25.7 | 0.33 | 135 | 1,111 | 5,095 |
| 4 | ND[b] | ND | ND | ND | ND | 333 | ND | ND | ND | ND | 1,593 | ND | ND | ND | ND | 775 | 2,701 |
| 5 | 20.68 | 1 | 10.0 | 0.05 | 15 | 333 | 6 | 60.0 | 0.29 | 113 | 1,593 | 3 | 30.0 | 0.15 | 59 | 775 | 2,701 |
| 6 | 19.30 | 1 | 9.1 | 0.05 | 16 | 124 | 5 | 45.5 | 0.26 | 101 | 853 | 5 | 45.5 | 0.26 | 106 | 659 | 1,636 |
| 7 | 20.58 | 7 | 20.0 | 0.34 | 105 | 485 | 4 | 11.4 | 0.19 | 75 | 705 | 24 | 68.6 | 1.17 | 475 | 2,322 | 3,512 |
| 8 | ND | ND | ND | ND | ND | 545 | ND | ND | ND | ND | 395 | ND | ND | ND | ND | 3,236 | 4,176 |
| 9 | 50.02 | 5 | 10.2 | 0.10 | 31 | 545 | 3 | 6.1 | 0.06 | 23 | 395 | 41 | 83.7 | 0.82 | 334 | 3,236 | 4,176 |
| Total | 180.83 | 51 | | | | 5,359 | 96 | | | | 12,439 | 145 | | | | 16,638 | 34,436 |

[a] Includes hatchery cutthroat trout.
[b] ND = no data.

Table 5. Summary of creel survey statistics for the upper (sections 1-4) South Fork Snake River, Idaho, from the season opener to mid-September 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), and 2003 (present study).

| Year | Number of interviews | Number of anglers interviewed | Non-resident anglers (%)[a] | Guided anglers (%)[a] | Effort by boat anglers (%)[b] | Effort by bank anglers (%)[b] | Bait angler hours (%)[a] | Lure angler hours (%)[a] | Fly angler hours (%)[a] |
|---|---|---|---|---|---|---|---|---|---|
| 1982 | 1,266 | 2,229 | 12 | 2 | 40 | 60 | 64 | 16 | 20 |
| 1996 | 1,750 | 1,750 | 21 | 9 | 81 | 19 | 38 | 10 | 52 |
| 2003 | 856 | 1,848 | 44 | 19 | 87 | 13 | 12 | 13 | 75 |

| Year | Total effort (h)[b] | Average time per trip (h)[a] | Weekday effort (%)[b] | Catch rate (fish/h)[b] | Total catch[b] | Harvest rate (fish/h)[b] | Total harvest[b] | Released (%)[b] |
|---|---|---|---|---|---|---|---|---|
| 1982 | 53,170 | 3.6 | 47 | 0.90 | 47,730 | 0.53 | 27,937 | 41 |
| 1996 | 169,142 | 3.3 | 54 | 1.12 | 188,989 | 0.03 | 4,568 | 98 |
| 2003 | 143,413 | 5.1 | 55 | 0.64 | 91,074 | 0.04 | 6,335 | 93 |

| | Catch composition (%), with total in parentheses[a] | | | | | Harvest composition (%), with total in parentheses[b] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | YCT[c] | RBT[c] | BRN[c] | MWF[c] | Other | YCT[c] | RBT[c] | BRN[c] | MWF[c] | Other |
| 1982 | 68 | 1 | 9 | 20 | 2 | 63 | 2 | 12 | 20 | 2 |
| | (32,456) | (477) | (4,295) | (9,546) | (955) | (17,603) | (585) | (3,404) | (5,631) | (627) |
| 1996 | 71 | 7 | 12 | 10 | 1 | 54 | 20 | 25 | 0 | 3 |
| | (134,182) | (13,229) | (22,679) | (18,899) | (1,890) | (2,484) | (894) | (1,132) | (0) | (126) |
| 2003 | 48 | 20 | 21 | 10 | 1 | 2 | 72 | 24 | 2 | <1 |
| | (43,898) | (18,397) | (19,217) | (8,743) | (820) | (104) | (4,560) | (1,508) | (146) | (15) |

| | Catch composition (%)[a] | | | Harvest composition (%)[a] | | |
|---|---|---|---|---|---|---|
| Year | Boat | Bank | Sample (n) | Boat | Bank | Sample (n) |
| 1982 | 48 | 52 | 4,116 | 32 | 68 | 2,528 |
| 1996 | 75 | 25 | 4,782 | 46 | 54 | 157 |
| 2003 | 92 | 8 | 3,402 | 74 | 26 | 211 |

| | Catch composition (%)[a] | | | | Harvest composition (%)[a] | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Bait | Lures | Flies | Combo | Bait | Lures | Flies | Combo |
| 1982 | 44 | 16 | 39 | <1 | 60 | 16 | 24 | <1 |
| 1996 | 32 | 7 | 60 | 1 | 68 | 9 | 20 | 3 |
| 2003 | 9 | 12 | 72 | 7 | 30 | 24 | 29 | 17 |

[a] From angler interviews.
[b] From stratified estimates.
[c] YCT = wild and hatchery cutthroat trout; RBT = wild and hatchery rainbow trout; BRN = brown trout; MWF = mountain whitefish.

Table 6. Summary of creel survey statistics for the entire South Fork Snake River, Idaho, for the entire years of 1979 (Moore 1980) and 2003 (present study).

| Year | Number of interviews | Number of anglers interviewed | Non-resident anglers (%)[a] | Guided anglers (%)[a] | Effort by boat anglers (%)[b] | Effort by bank anglers (%)[b] | Bait angler hours (%)[a] | Lure angler hours (%)[a] | Fly angler hours (%)[a] |
|---|---|---|---|---|---|---|---|---|---|
| 1979 | NR[c] | 2,754 | 8 | NR | 47 | 53 | 48 | 19 | 33 |
| 2003 | 2,101 | 4,143 | 33 | 15 | 79 | 21 | 15 | 13 | 71 |

| Year | Total effort (h)[b] | Average time per trip (h)[a] | Weekday effort (%)[b] | Catch rate (fish/h)[b] | Total catch[b] | Harvest rate (fish/h)[b] | Total harvest[b] | Released (%)[b] |
|---|---|---|---|---|---|---|---|---|
| 1979 | 88,830 | NR | NR | 0.53 | 46,824 | 0.34 | 30,585 | 35 |
| 2003 | 216,181 | 4.9 | 53 | 0.69 | 149,946 | 0.04 | 8,977 | 94 |

| Year | Catch composition (%), with total in parentheses[a] | | | | | Harvest composition (%), with total in parentheses[b] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | YCT[d] | RBT[d] | BRN[d] | MWF[d] | Other | YCT[d] | RBT[d] | BRN[d] | MWF[d] | Other |
| 1979 | 73 (33,426) | 2 (1,196) | 7 (3,315) | 18 (4,353) | <1 (256) | 72 (22,230) | 4 (1,099) | 9 (2,761) | 14 (8,631) | <1 (142) |
| 2003 | 37 (55,930) | 14 (20,842) | 38 (56,979) | 10 (15,294) | 1 (900) | 3 (286) | 56 (5,070) | 33 (2,920) | 7 (660) | <1 (38) |

| Year | Catch composition (%)[a] | | | Harvest composition (%)[a] | | |
|---|---|---|---|---|---|---|
| | Boat | Bank | Sample (n) | Boat | Bank | Sample (n) |
| 1979 | 57[e] | 43[e] | NR | 47[e] | 53[e] | NR |
| 2003 | 77 | 23 | 8,637 | 50 | 50 | 426 |

| Year | Catch composition (%)[a] | | | | Harvest composition (%)[a] | | | |
|---|---|---|---|---|---|---|---|---|
| | Bait | Lures | Flies | Combo | Bait | Lures | Flies | Combo |
| 1979 | NR | NR | NR | NR | NR | NR | NR | NR |
| 2003 | 14 | 12 | 68 | 6 | 43 | 20 | 26 | 11 |

[a] From angler interviews.
[b] From stratified estimates.
[c] NR = not reported.
[d] YCT = wild and hatchery cutthroat trout; RBT = wild and hatchery rainbow trout; BRN = brown trout; MWF = mountain whitefish.
[e] Trout only.

Table 7. Opinion survey and summarized responses of anglers fishing the South Fork Snake River, Idaho, during the 2003 creel survey.

The South Fork Snake River supports one of the largest remaining populations of native Yellowstone cutthroat trout. These fish are now threatened by hybridization with, and replacement by an expanding rainbow trout population. Increasing rainbow harvest is the most efficient and likely the most effective means of protecting cutthroat trout, but is entirely dependent on anglers to make it happen. We need your help in determining what fishery management actions are acceptable to conserve Yellowstone cutthroat trout in the South Fork Snake River. Please take a few minutes to answer the following questions:

1) How important is it to you to be able to fish for cutthroat trout on the South Fork? (n = 169)

   Very (56%) Moderately (36%) Not at all (2%) No opinion (5%)

2) Please rank what species you prefer to catch in the South Fork Snake River (1 is highest, 4 is lowest) (n = 131, values represent average of all responses)

   1.63 Cutthroat 1.68 Brown trout 2.50 Rainbow 3.60 Whitefish

3) Would you support a year-round season from Palisades Dam to the Heise Cable to allow harvest of rainbow trout in the spring? (n = 168)

   Yes (74%) No (15%) Not sure (10%)

4) Would you support more restrictive regulations for cutthroat in the SFSR?

   Catch and release: (n = 156) Yes (81%) No (19%)
   Two fish, none under 20 inches: (n = 138) Yes (77%) No (23%)

5) Would you harvest a rainbow trout if you thought it was helping the cutthroat population? (n = 162)

   Yes (82%) No (9%) Not sure (7%)

6) Would you support managing brown trout with:

   General limit (6 fish, no minimum size)? (n = 148) Yes (51%) No (49%)
   A 20" minimum size? (n = 131) Yes (72%) No (28%)

7) How many days do you fish the South Fork per year? (n = 162)

   0-1 (2%) 2-5 (9%) 6-10 (15%) More than 10 (74%)

8) Are you fishing with a guide or have you fished with a guide this year? (n = 166)

   Yes (6%) No (94%)

9) When you fish the South Fork, what percentage of the time do you use: (n = 156; percentages indicate most frequent method)

   28% Bait 53% Flies 19% Lures

10) If you managed the South Fork, what would your priority be? (choose only one) (n = 163)

   (89%) Manage the South Fork for cutthroat, knowing that it means reduced opportunity to catch rainbow trout
   (11%) Manage the South Fork for rainbows, knowing it means the likely loss of the cutthroat fishery.

Table 8. Summary of the fish weirs operated in tributaries of the South Fork Snake River, Idaho, 2001-2003. Streams are listed going up the drainage.

| Location and year | Weir type | Operation dates | Estimated weir efficiency (%)[a] | Catch | | |
|---|---|---|---|---|---|---|
| | | | | Cutthroat trout | Rainbow trout | Total |
| Burns Creek: | | | | | | |
| 2001[b] | Floating panel | Mar 7 - Jul 20 | 15.9 | 3,156 | 3 | 3,159 |
| 2002[b] | Floating panel | Mar 23 - Jul 5 | NE[c] | 1,898 | 16 | 1,914 |
| 2003 | Floating panel | Mar 28 - Jun 23[d] | 16.9 – 35.5 | 1,350 | 1 | 1,351 |
| Pine Creek: | | | | | | |
| 2001[b] | ND[e] | ND | ND | ND | ND | ND |
| 2002[b] | Floating panel | Apr 2 - Jul 5 | NE | 202 | 14 | 216 |
| 2003 | Floating panel | Mar 27 - Jun 12 | 40.4 | 328 | 7 | 335 |
| Rainey Creek: | | | | | | |
| 2001[b] | Floating panel | Mar 7 - Jul 6 | NE | 0 | 0 | 0 |
| 2002[b] | Floating panel | Mar 26 - Jun 27 | NE | 1 | 0 | 1 |
| 2003 | ND | ND | ND | ND | ND | ND |
| Palisades Creek: | | | | | | |
| 2001[b] | Floating panel | Mar 7 - Jul 20 | 10.1 | 491 | 160 | 651 |
| 2002[b] | Floating panel | Mar 22 - Jul 7 | NE | 967 | 310 | 1,277 |
| 2003 | Floating panel | Mar 24 - Jun 24 | 21.1 – 47.4 | 529 | 181 | 710 |
| Total: | | | | 8,922 | 692 | 9,614 |

[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 data; weir either not built or not operated.

Table 9. Historical creel survey statistics for the South Fork Snake River, Idaho, 1966-2003 (from Moore 1980, Moore and Schill 1984, Schrader et al. 2003, and present study).

| Year | Effort (h) | Catch rate (fish/h) | Total catch | Catch composition (%) | | | | | Area & time |
|---|---|---|---|---|---|---|---|---|---|
| | | | | YCT[a] | RBT[a] | BRN[a] | MWF[a] | Other | |
| 1966 | 77,000 | 0.50 | 38,500 | 97 | | <1 | 3 | <1 | Dam - Heise<br>Jun 1 - Oct 31 |
| 1969 | 16,809 | 0.42 | 7,060 | 75 | | 1 | 24 | | Black Canyon - Heise<br>May 30 - Nov 30 |
| 1970 | 17,377[b] | 0.56 | 9,731 | 85 | 1 | 6 | 8 | <1 | Dam - Black Canyon<br>May 1 - Nov 30 |
| 1972 | 33,390 | 0.51 | 17,029 | 75 | 3 | 2 | 20 | <1 | Dam - Heise<br>Jul 1 - Sep 30 |
| 1973 | ND[c] | 0.32 | ND | 56 | <1 | 6 | 37 | | Dam - Henrys Fork<br>Jan 1 - Dec 31 |
| 1979 | 88,830 | 0.43 | 38,197 | 72 | 4 | 9 | 15 | <1 | Dam - Henrys Fork<br>Mar 3 - Feb 29 |
| 1982 | 64,355 | 0.80 | 51,604 | 66 | <1 | 9 | 23 | 2 | Dam - Heise<br>Apr 1 - Sep 17 |
| 1996 | 169,142 | 1.12 | 188,989 | 71 | 7 | 12 | 10 | <1 | Dam - Heise<br>May 25 – Sep 13 |
| 2003 | 216,181 | 0.69 | 149,946 | 37 | 14 | 38 | 10 | 1 | Dam - Henrys Fork<br>Jan 1 - Dec 31 |

[a] YCT = cutthroat trout; RBT = rainbow trout; BRN = brown trout; MWF = mountain whitefish.
[b] Under-estimate due to techniques used (Moore, 1980).
[c] ND = no data; no estimate.

# FIGURES

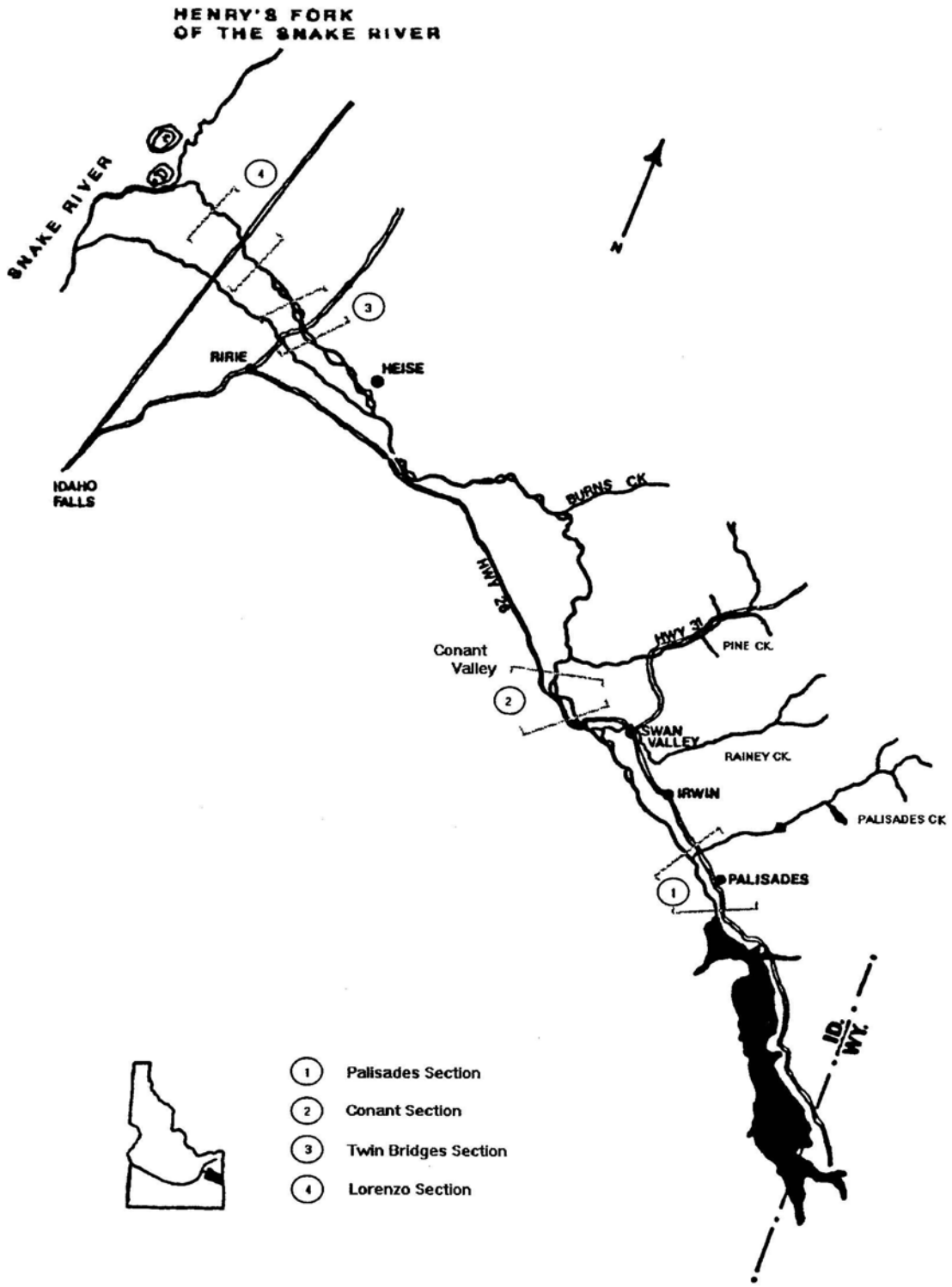



Figure 1. Map of South Fork Snake River, Idaho, showing standard electrofishing sections and the four major spawning tributaries.

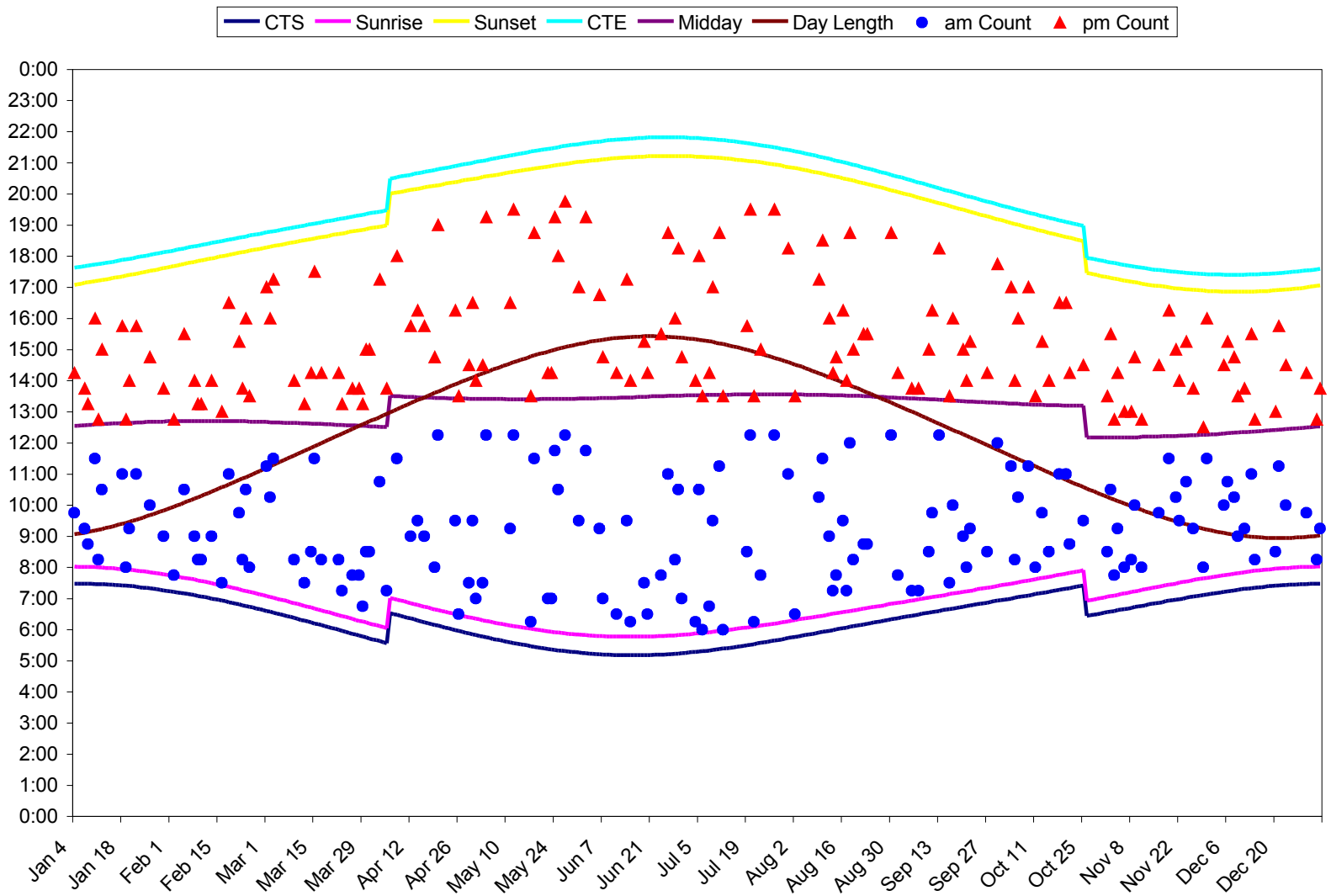



Figure 2. Morning (am, blue) and afternoon/evening (pm, red) scheduled count times (n = 312) for the 2003 creel survey, South Fork Snake River, Idaho. CTS = start of civil twilight; CTE = end of civil twilight; midday = sun at its highest point; day length = sunrise to sunset.

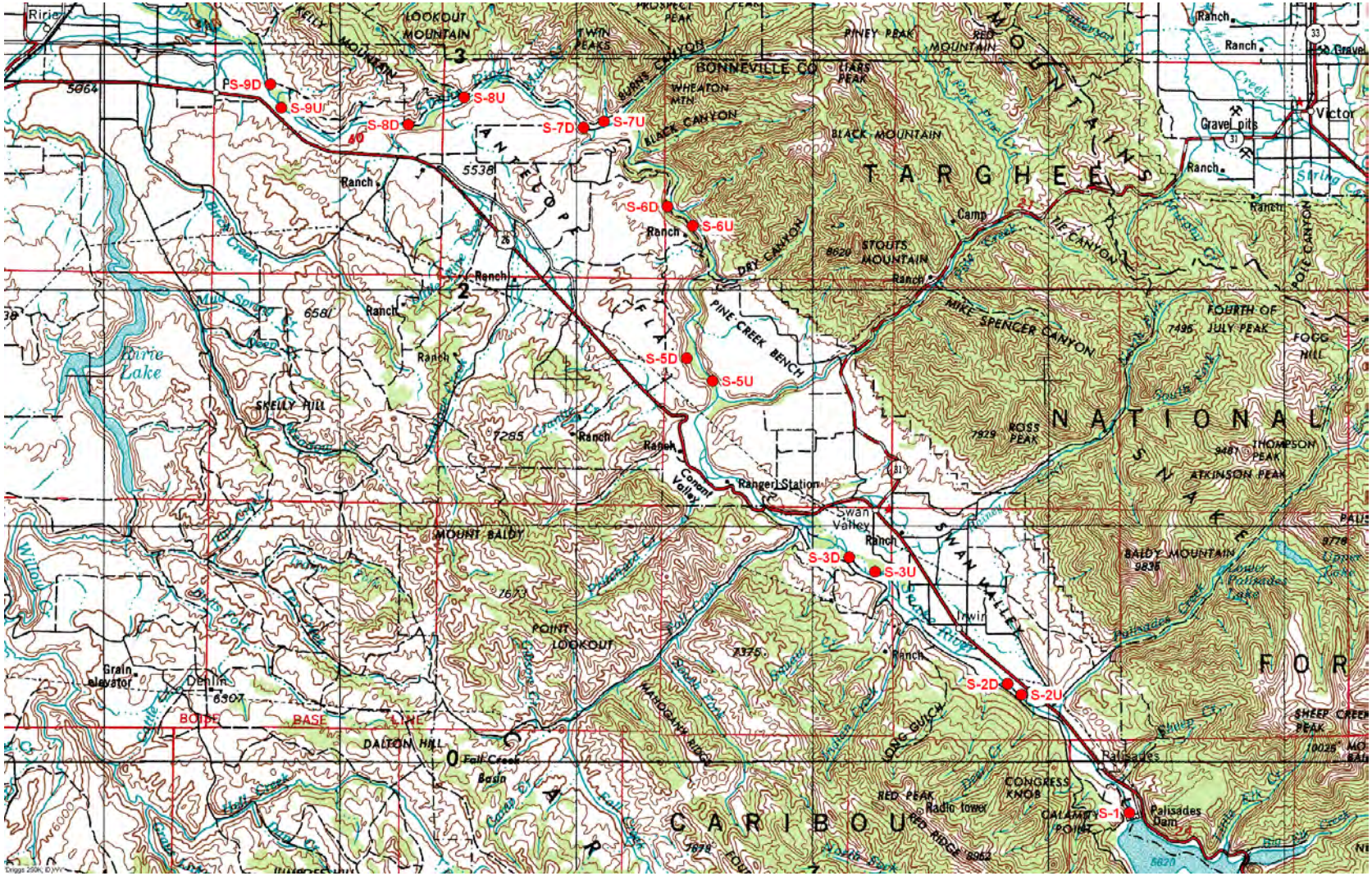



Figure 3. Location of the eight sites sampled for exploitation tagging and pre-season stock abundance in the upper South Fork Snake River, Idaho, 2003. One site (S-4) was in the Conant electrofishing section and was not sampled. Sites were spaced at 8 km intervals beginning at Palisades Dam (S-1) and ending at the Heise cable (S-9). U = upstream starting point; D = downstream ending point.

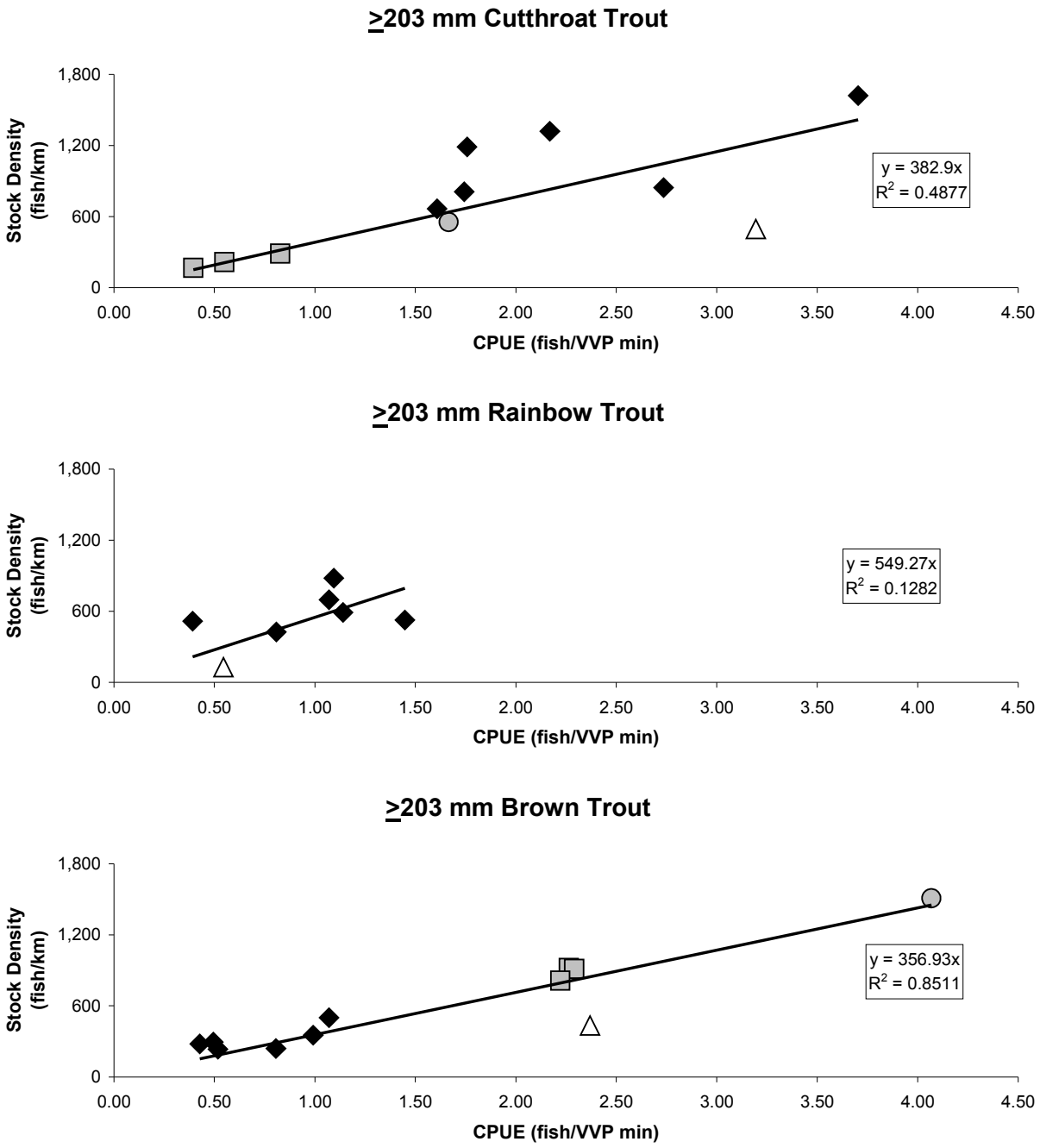



Figure 4. Linear regressions of ≥203 mm cutthroat (top), rainbow (middle), and brown trout (bottom) estimated stock density (fish/km) on electrofishing catch per unit effort (CPUE), South Fork Snake River, Idaho, 1996-2000 and 2003. All intercepts were forced through zero. Black diamonds are the Conant section (n = 6 years), gray boxes are the Lorenzo section (n = 3 years), gray circles are the Twin Bridges section (n = 1 year), and white triangles are the Palisades section (n = 1 year).

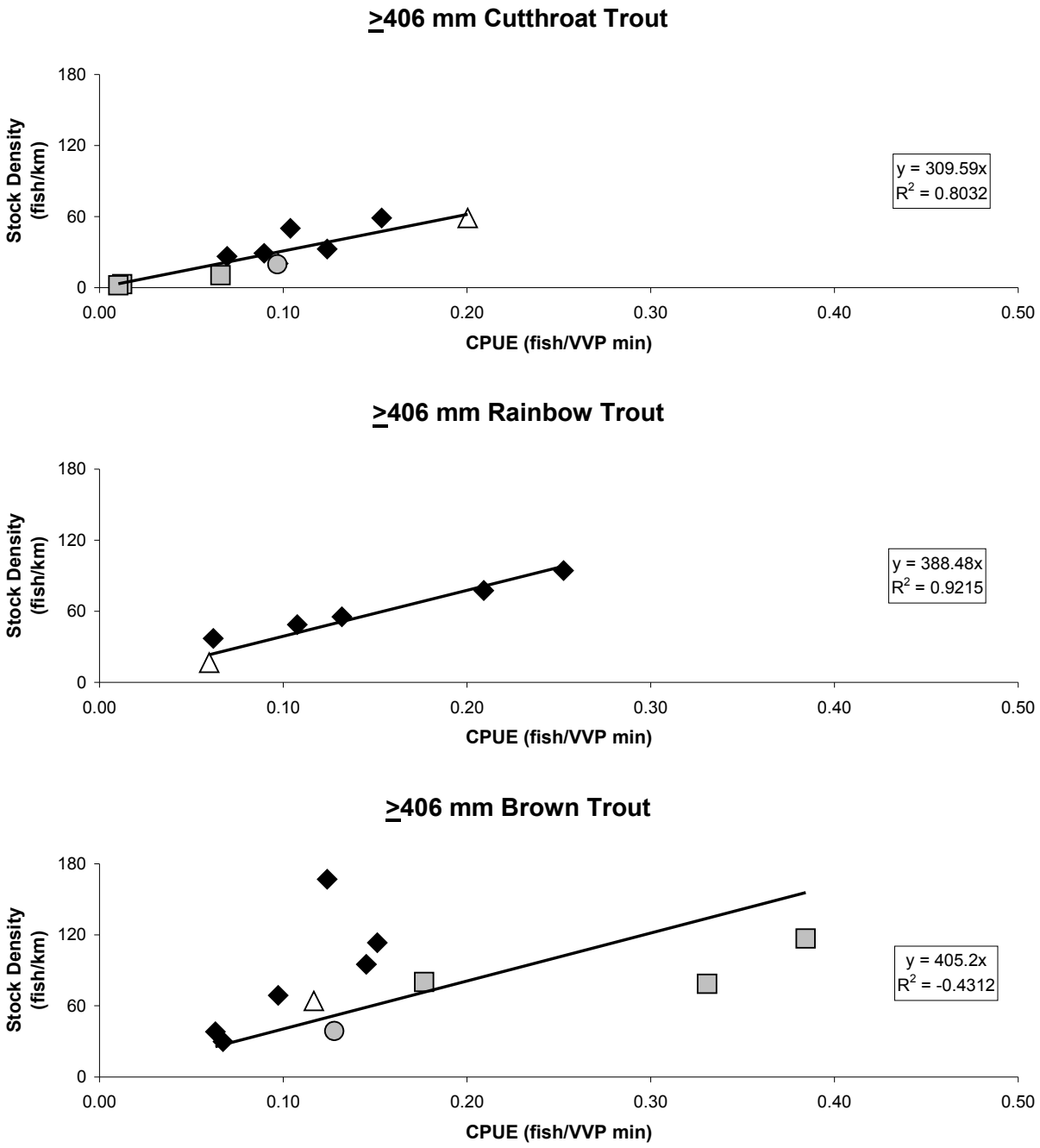


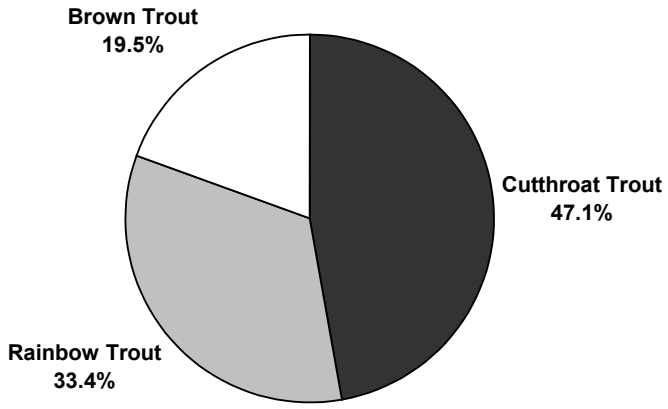

Figure 5. Linear regressions of ≥406 mm cutthroat (top), rainbow (middle), and brown trout (bottom) estimated stock density (fish/km) on electrofishing catch per unit effort (CPUE), South Fork Snake River, Idaho, 1996-2000 and 2003. All intercepts were forced through zero. Black diamonds are the Conant section (n = 6 years), gray boxes are the Lorenzo section (n = 3 years), gray circles are the Twin Bridges section (n = 1 year), and white triangles are the Palisades section (n = 1 year).

Rainey Creek

Palisades Creek

Figure 6. Photos of the four fish weirs located in spawning tributaries of the South Fork Snake River, Idaho. Burns Creek photo taken May 18, 2001. Pine Creek photo taken June 15, 2002. Rainey Creek and Palisades Creek photos taken April 18, 2001.

## Conant Section




## Lorenzo Section

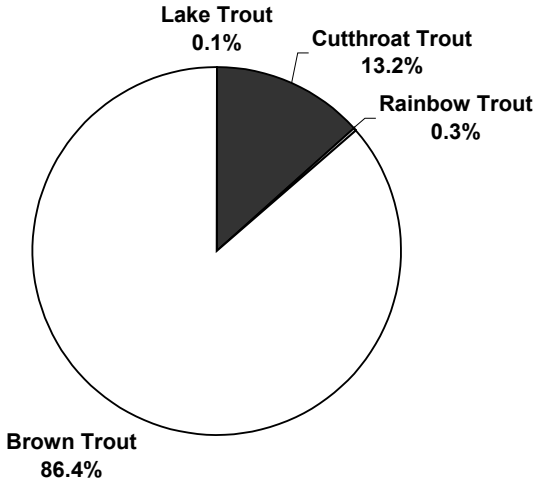



Figure 7. Trout species composition and relative abundance at the Conant (top, n = 1,962) and Lorenzo (bottom, n = 1,217) electrofishing sections, South Fork Snake River, Idaho, 2003.

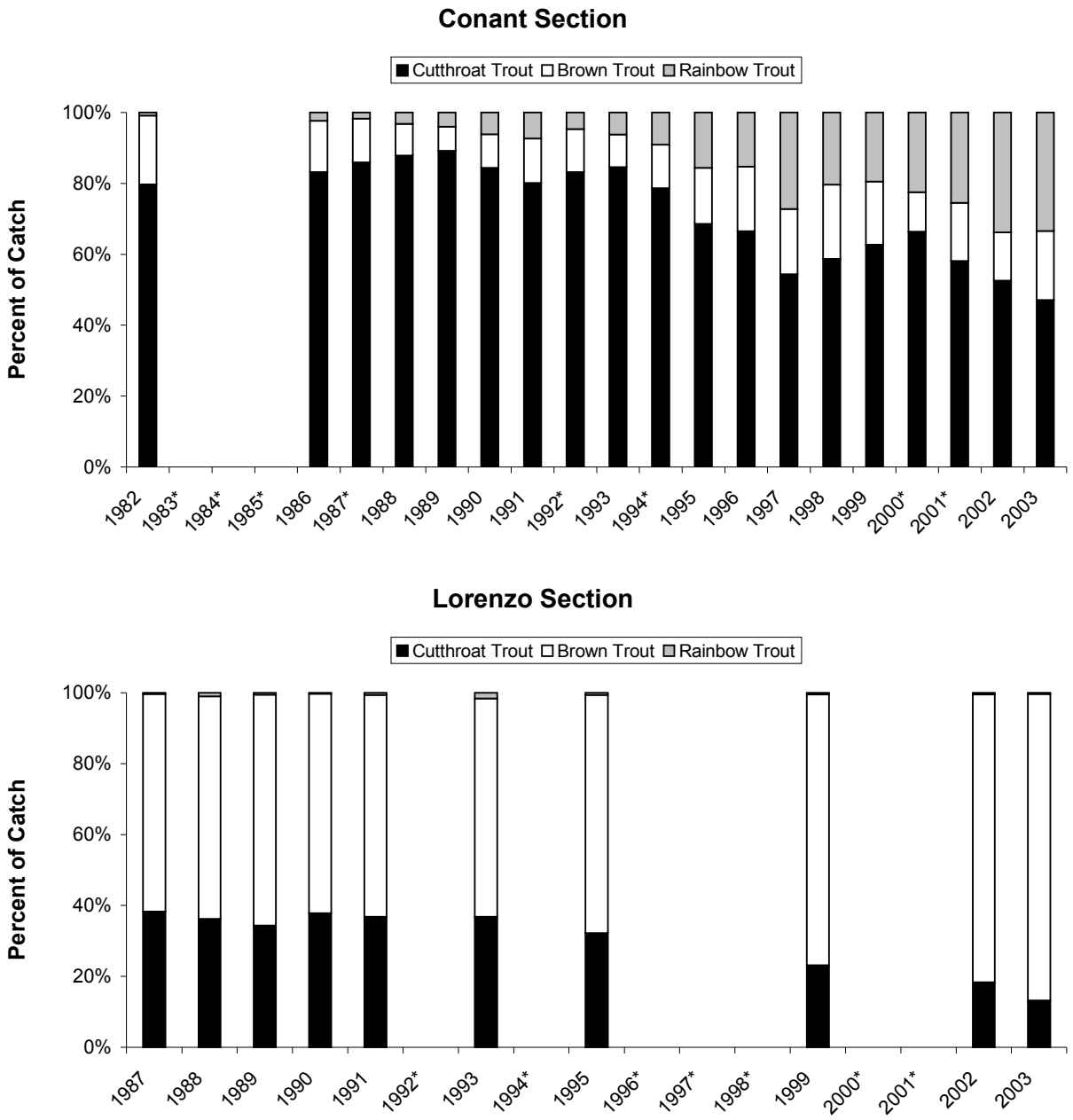



Figure 8. Relative abundance trends for all sizes of trout at the Conant (top) and Lorenzo (bottom) electrofishing sections, South Fork Snake River, Idaho, 1982 to 2003. Data for 1982 are from Moore and Schill (1984). Asterisks indicate years when there was no sampling.

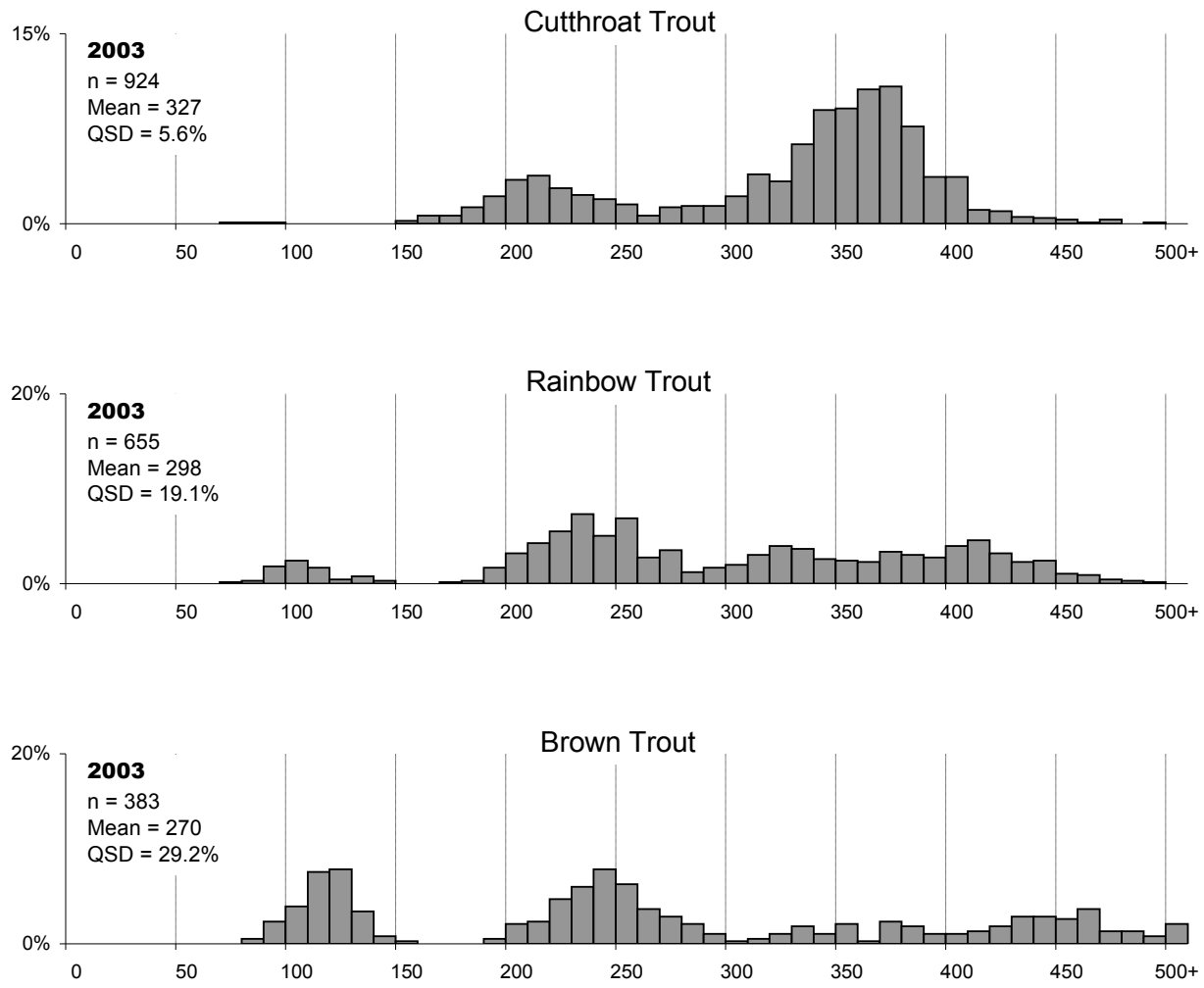



Figure 9. Length frequency distributions (TL, mm) of cutthroat (top), rainbow (middle), and brown trout (bottom) captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 2003. Total individual fish captured during mark (*M*) and recapture (*C* – *R*) runs equals n.

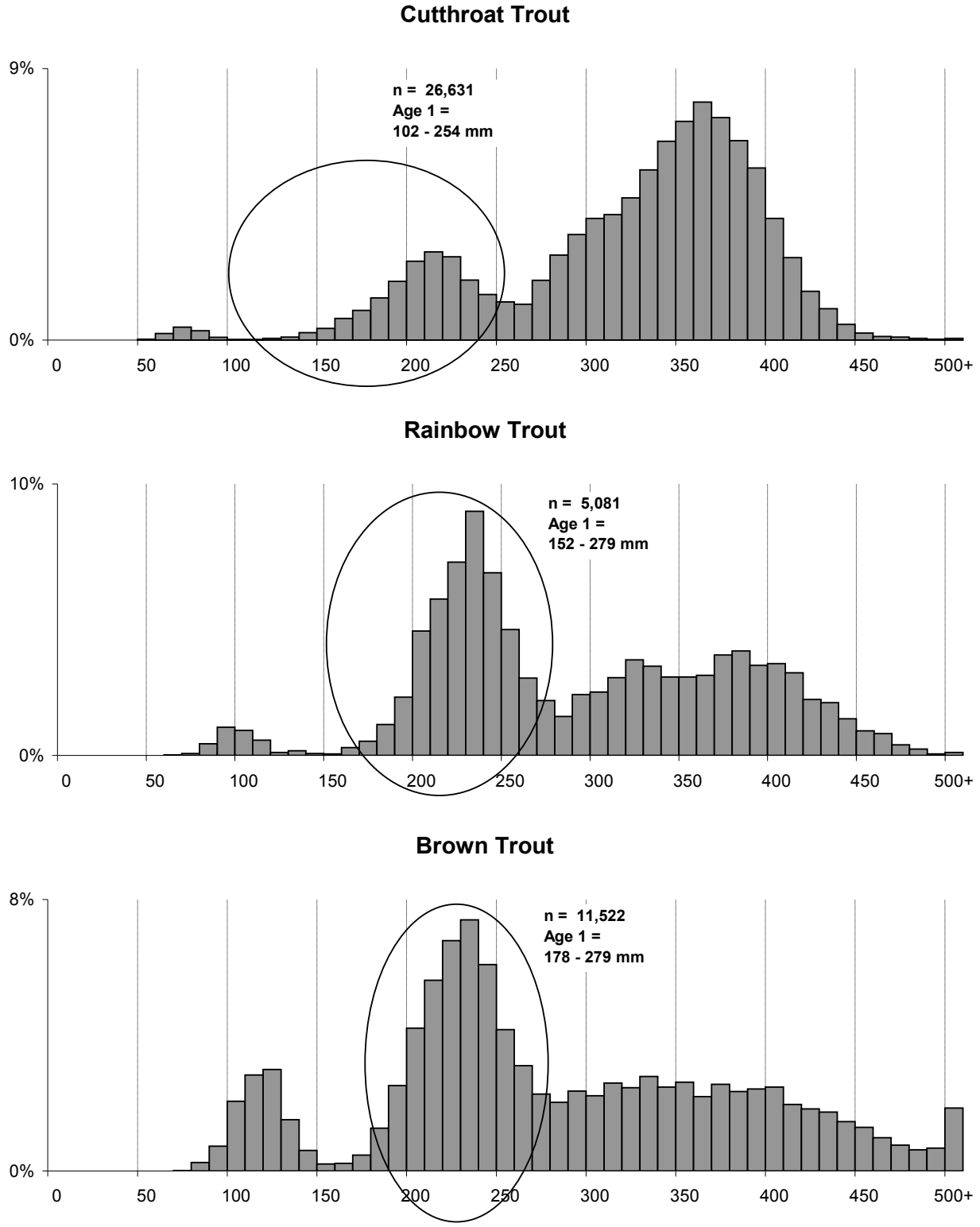



Figure 10. Overall length frequency distributions (TL, mm) of cutthroat (top), rainbow (middle), and brown trout (bottom) showing approximated age 1 fish, Conant and Lorenzo sections combined, South Fork Snake River, Idaho, 1986-2003.

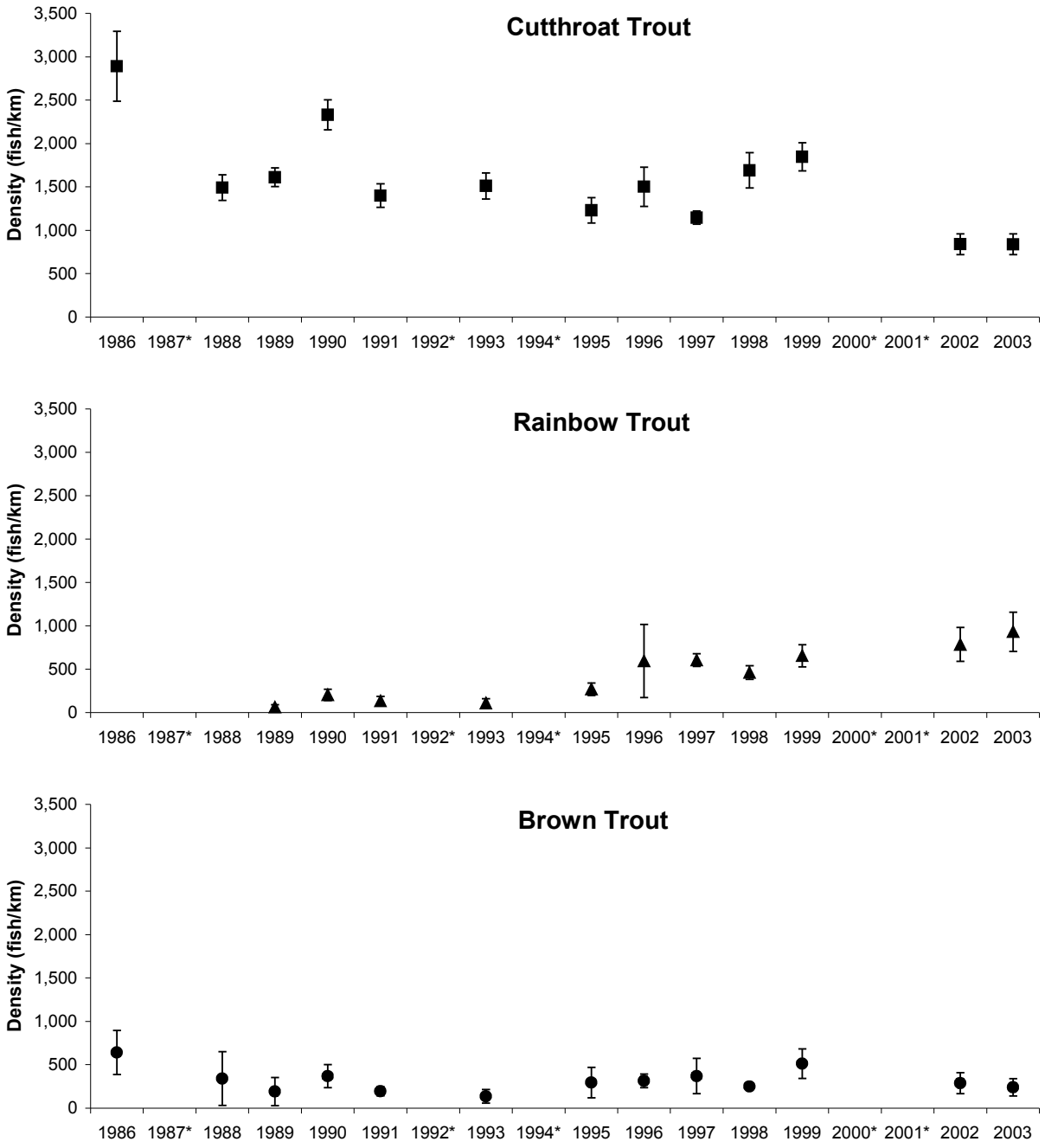



Figure 11. Density trends for age 1 and older cutthroat (top, ≥102 mm), rainbow (middle, ≥152 mm), and brown trout (bottom, ≥178 mm) at the Conant electrofishing section, South Fork Snake River, Idaho, October and November 1986-2003. Confidence intervals are at 95%. Asterisks indicate years when no estimate was possible.

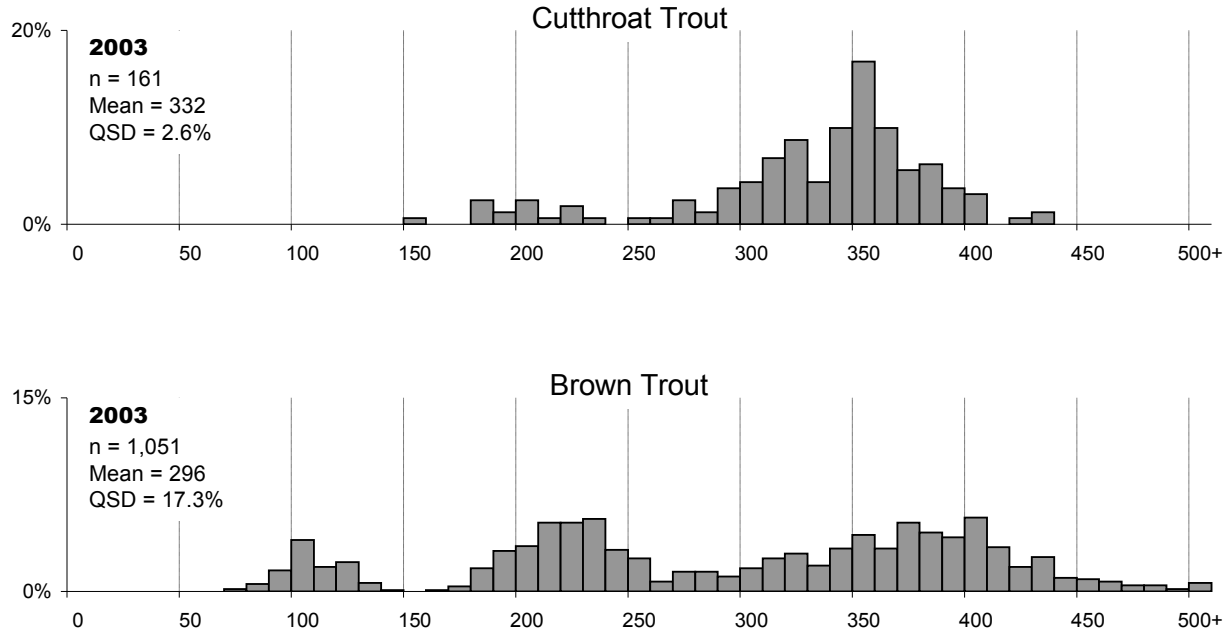



Figure 12. Length frequency distributions (TL, mm) of cutthroat (top) and brown trout (bottom) captured in the fall at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 2003. Total individual fish captured during mark (*M*) and recapture (*C* – *R*) runs equals n.

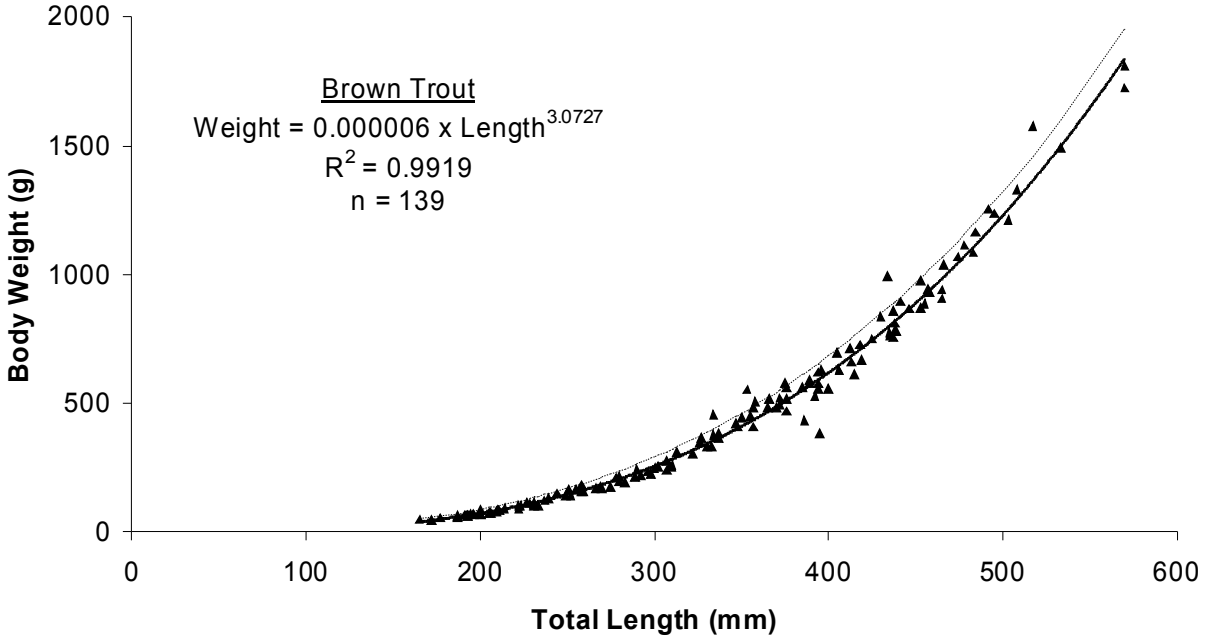



Figure 13. Regression of fish weight (g) on total length (mm) for cutthroat (top) and brown trout (bottom) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, September 2003. Dashed line is standard weight. Age 0 fish were not included.

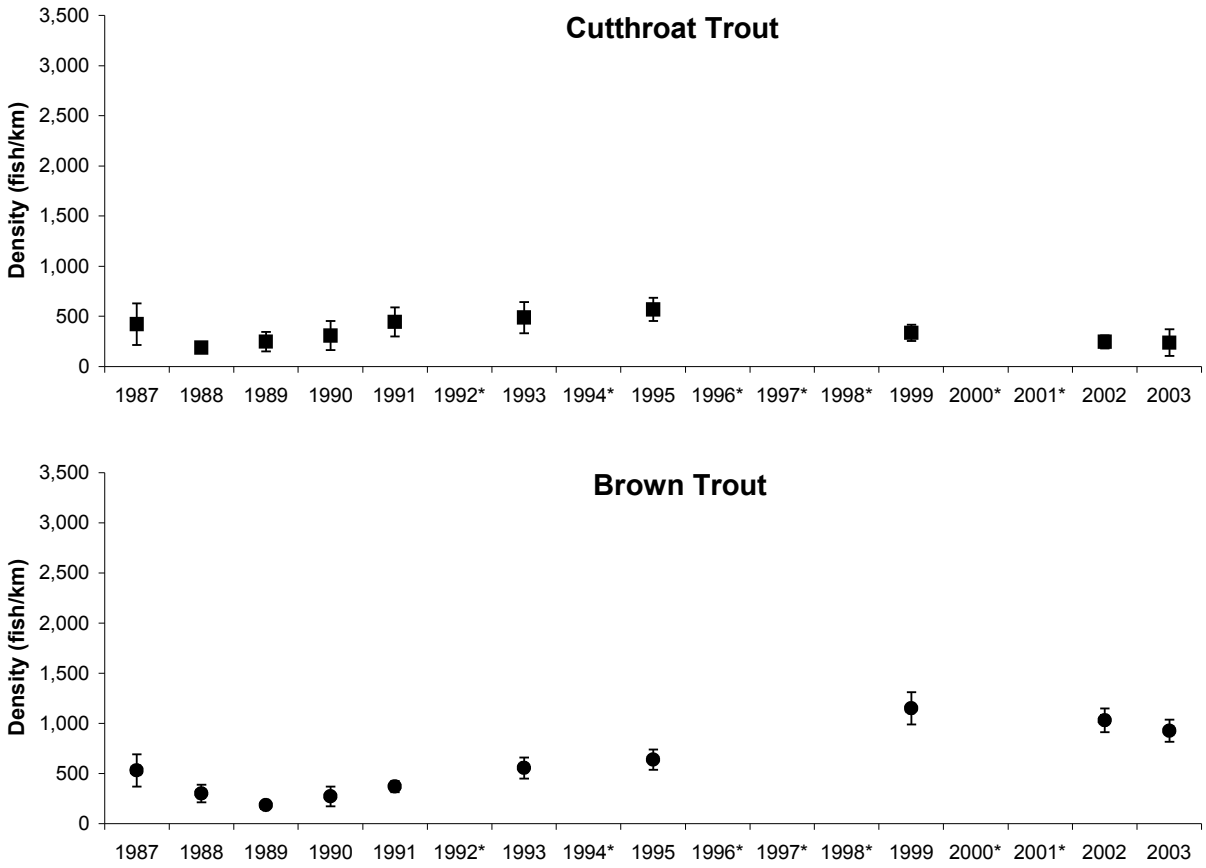



Figure 14. Density trends for age 1 and older cutthroat (top, ≥102 mm) and brown trout (bottom, ≥178 mm) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, September and October 1987-2003. Confidence intervals are at 95%. Asterisks indicate years when no estimate was possible.

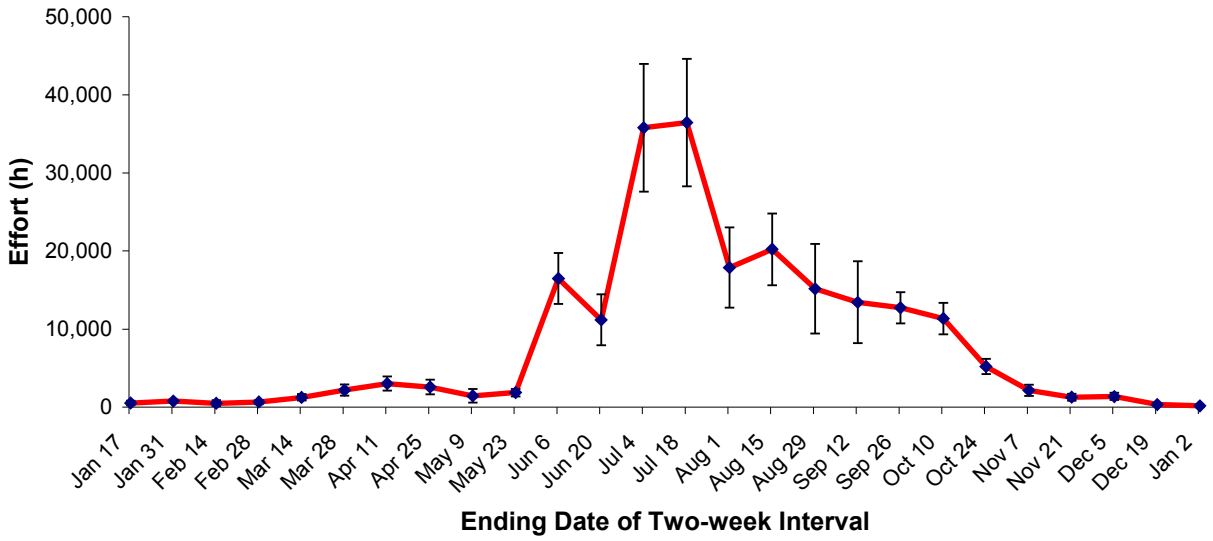



Figure 15. Estimated angler effort (h) by sampling interval in the South Fork Snake River, Idaho, during 2003. Confidence intervals are at 95%.

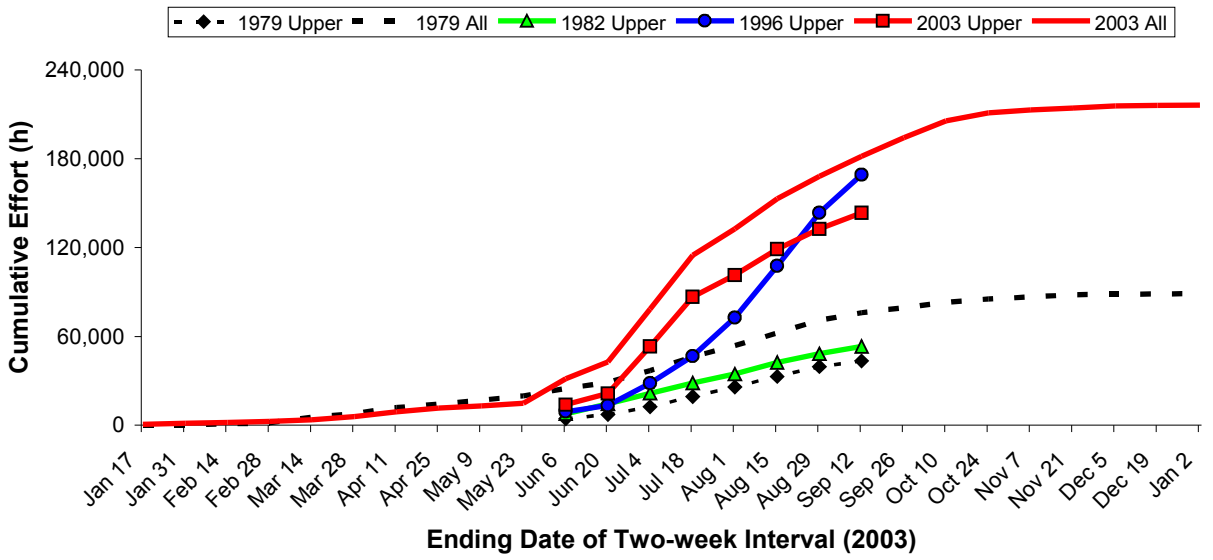



Figure 16. Estimated cumulative effort (h) in the South Fork Snake River, Idaho, during 1979 (Moore 1980), 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), and 2003 (present study). Only the upper river above Heise (sections 1-4) was surveyed during the summer in 1982 and 1996; all sections were surveyed throughout the year in 1979 and 2003.

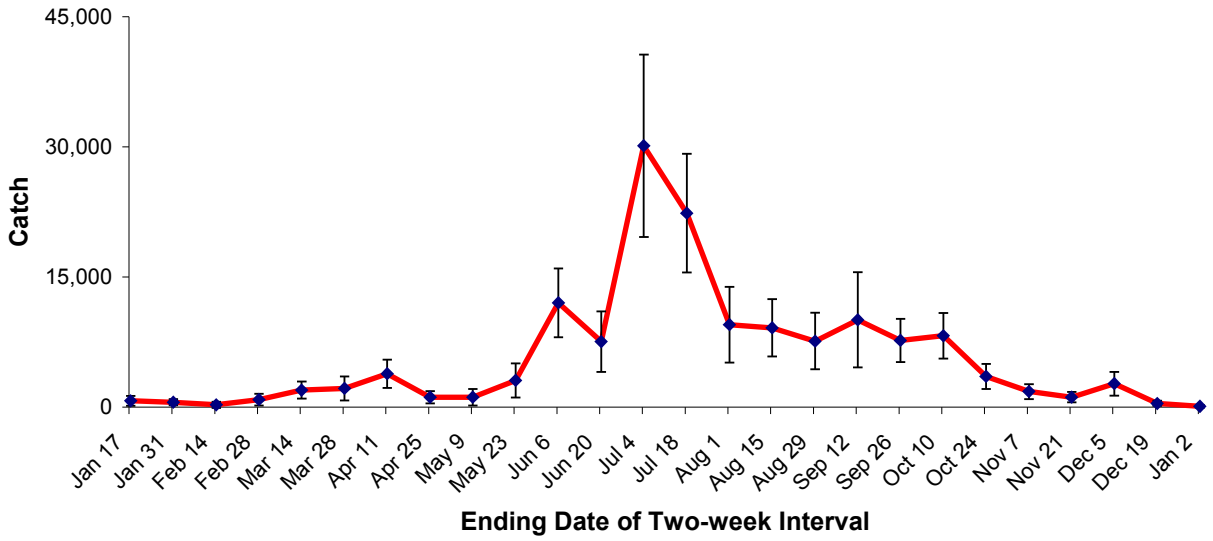



Figure 17. Estimated catch by sampling interval in the South Fork Snake River, Idaho, during 2003. Confidence intervals are at 95%.

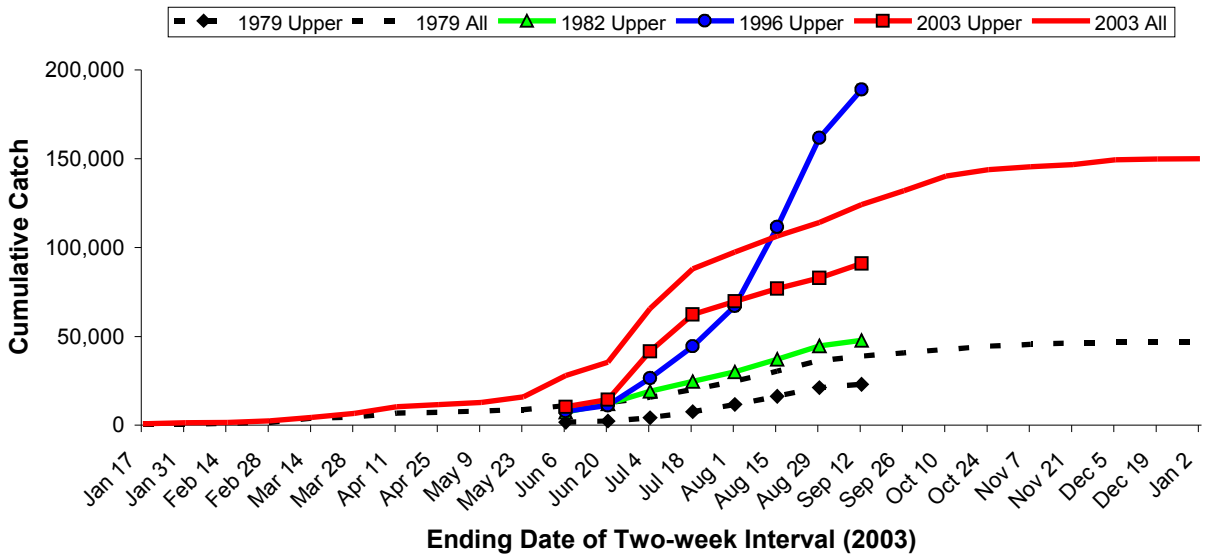



Figure 18. Estimated cumulative catch in the South Fork Snake River, Idaho, during 1979 (Moore 1980), 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), and 2003 (present study). Only the upper river above Heise (sections 1-4) was surveyed during the summer in 1982 and 1996; all sections were surveyed throughout the year in 1979 and 2003.

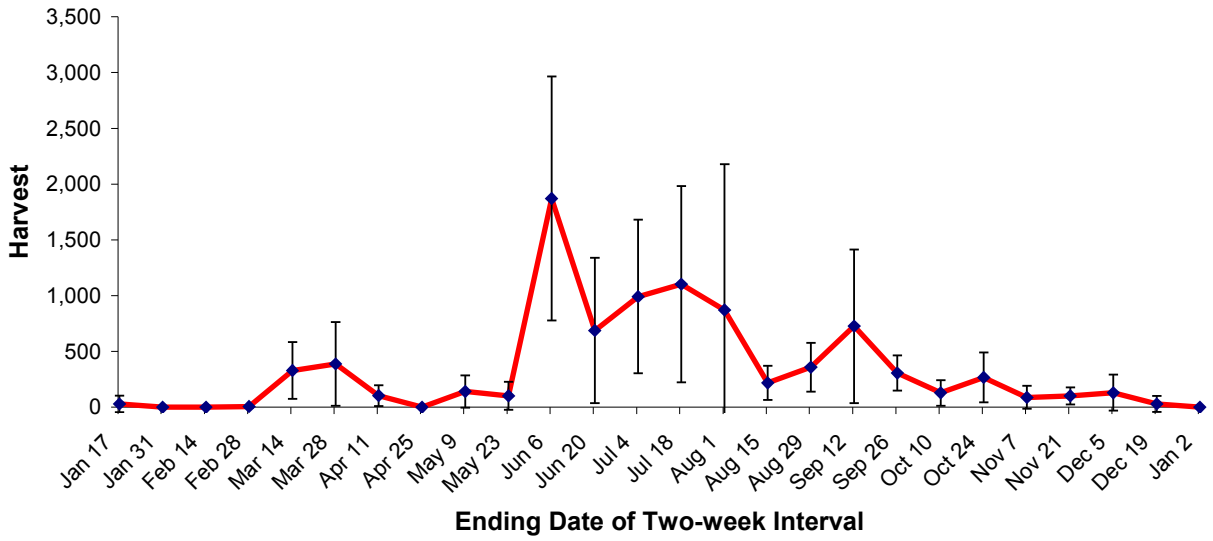



Figure 19. Estimated harvest by sampling interval in the South Fork Snake River, Idaho, during 2003. Confidence intervals are at 95%.

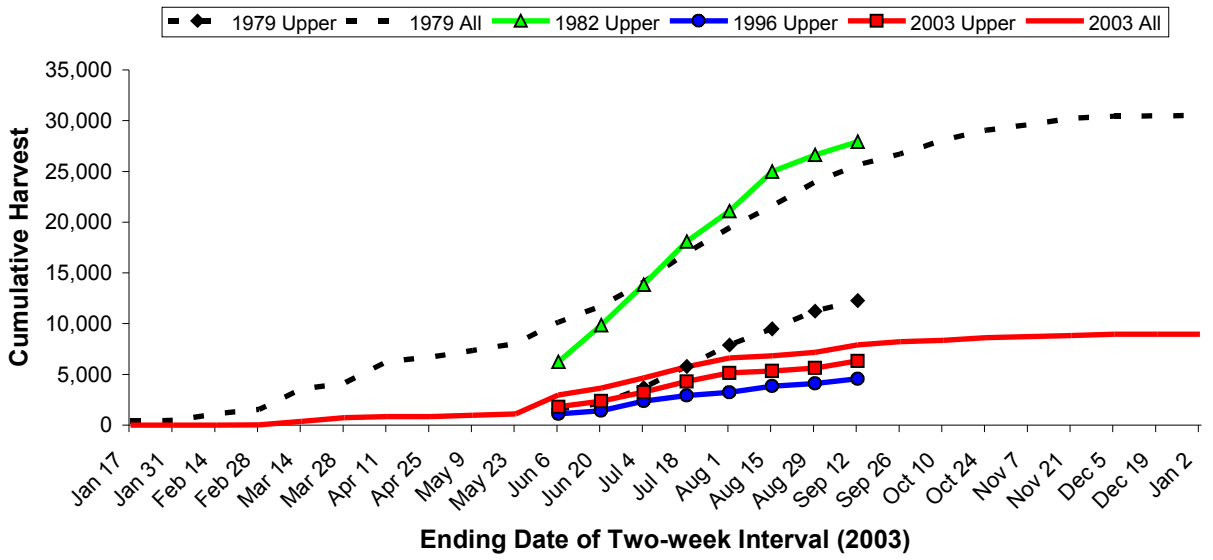



Figure 20. Estimated cumulative harvest in the South Fork Snake River, Idaho, during 1979 (Moore 1980), 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), and 2003 (present study). Only the upper river above Heise (sections 1-4) was surveyed during the summer in 1982 and 1996; all sections were surveyed throughout the year in 1979 and 2003.

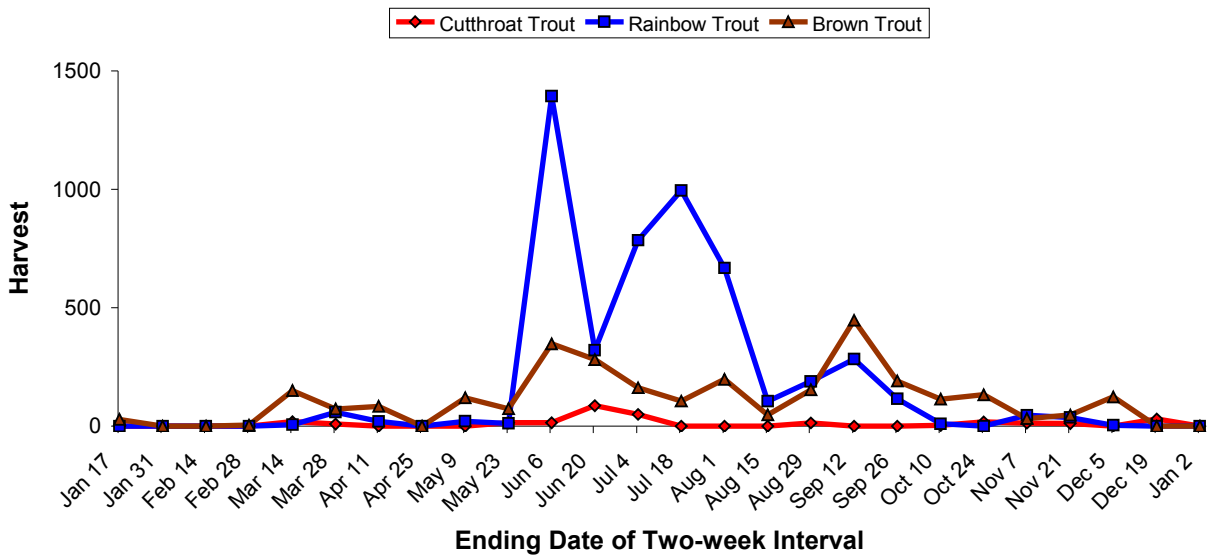



Figure 21. Estimated cutthroat, rainbow, and brown trout harvest by sampling interval in the South Fork Snake River, Idaho, during 2003.

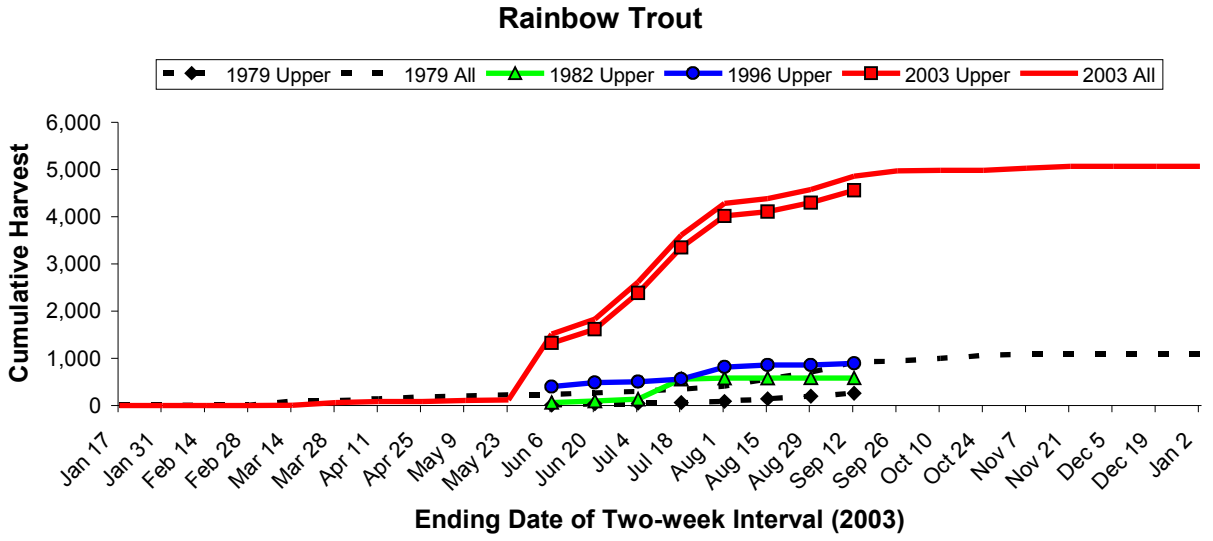



Figure 22. Estimated cumulative rainbow trout harvest in the South Fork Snake River, Idaho, during 1979 (Moore 1980), 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), and 2003 (present study). Only the upper river above Heise (sections 1-4) was surveyed during the summer in 1982 and 1996; all sections were surveyed throughout the year in 1979 and 2003.

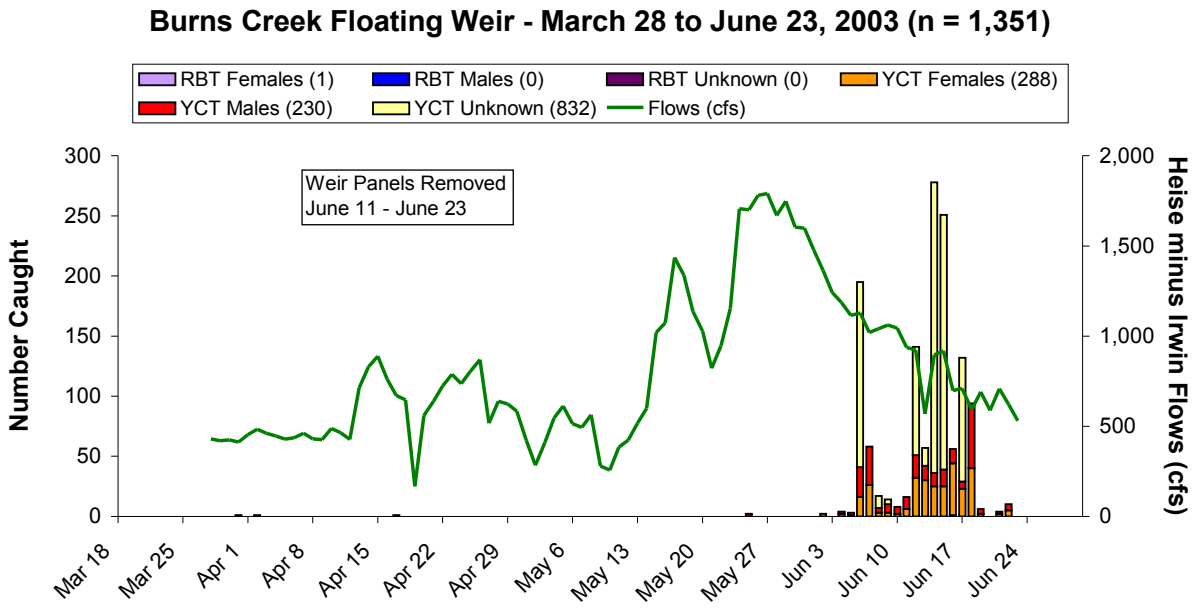



Figure 23. Number of fish caught, run timing, and estimated hydrograph at the Burns Creek weir, South Fork Snake River, Idaho, 2003. RBT = rainbow trout; YCT = cutthroat trout. Bars are stacked.

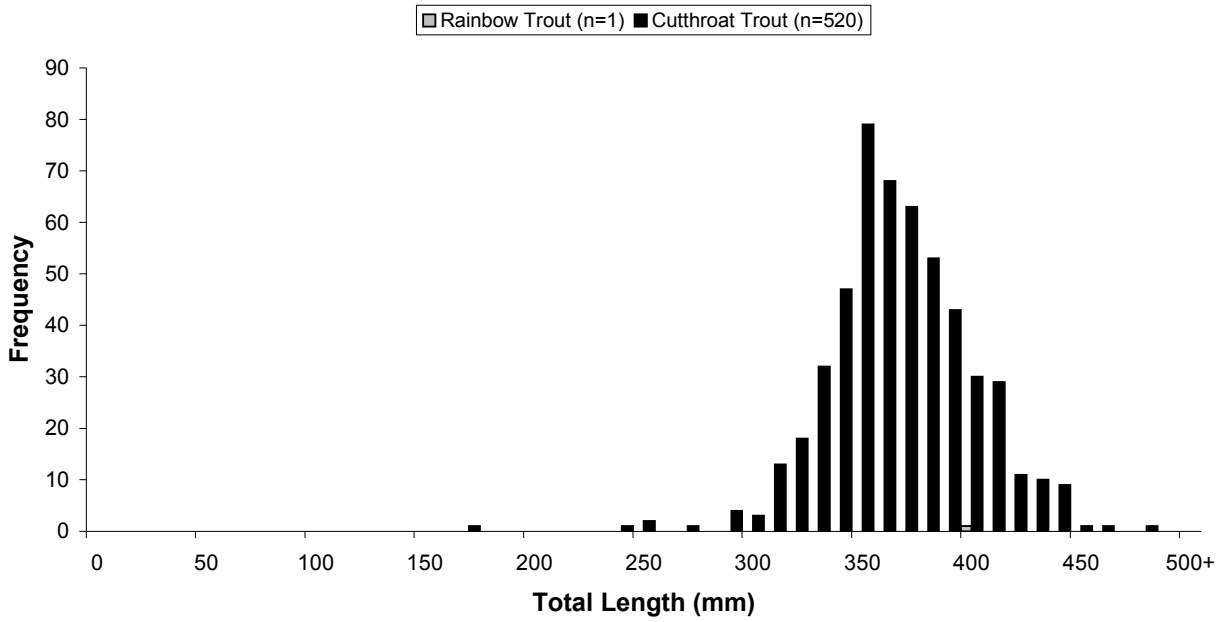



Figure 24. Length frequency distribution of rainbow and cutthroat trout sampled at the Burns Creek weir, South Fork Snake River, Idaho, 2003.

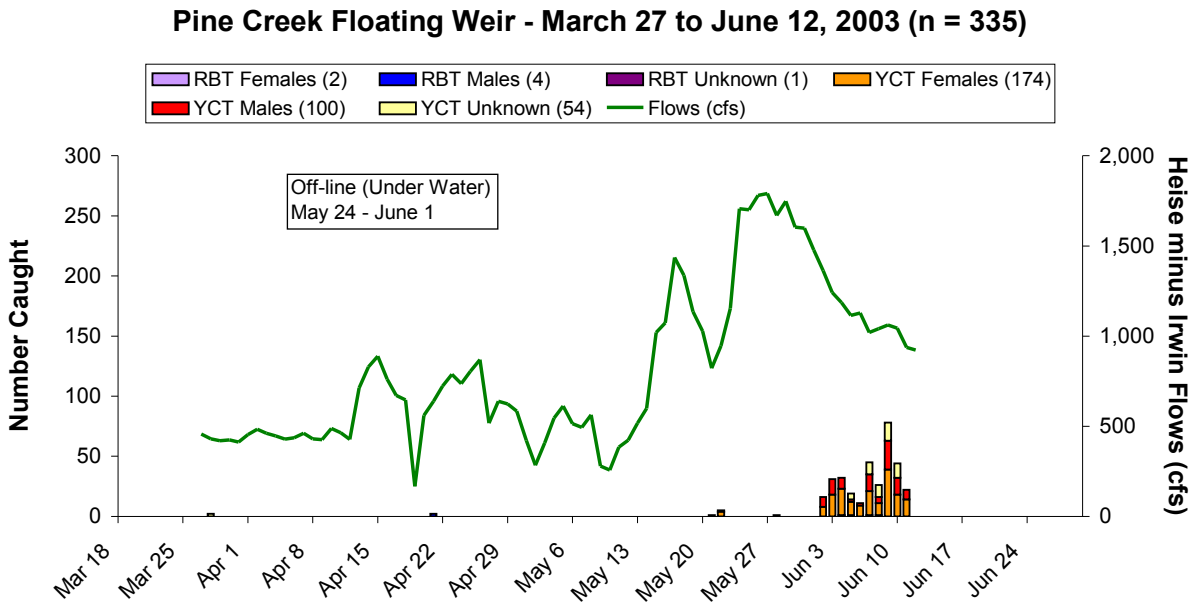



Figure 25. Number of fish caught, run timing, and estimated hydrograph at the Pine Creek weir, South Fork Snake River, Idaho, 2003. RBT = rainbow trout; YCT = cutthroat trout. Bars are stacked.

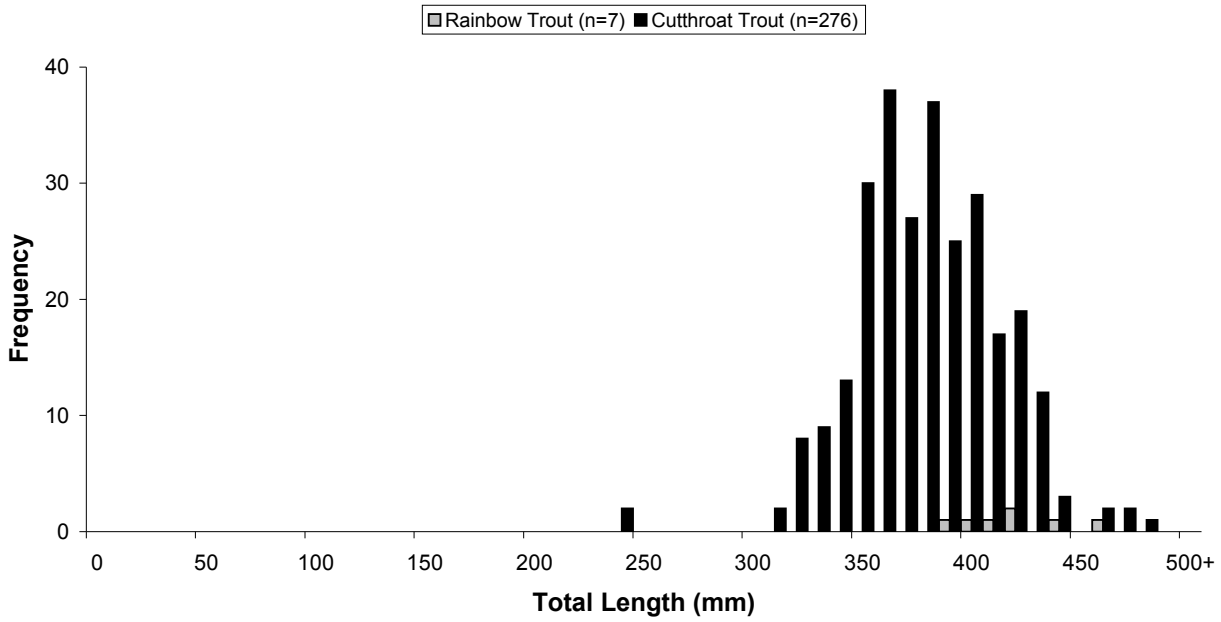



Figure 26. Length frequency distribution of rainbow and cutthroat trout sampled at the Pine Creek weir, South Fork Snake River, Idaho, 2003.

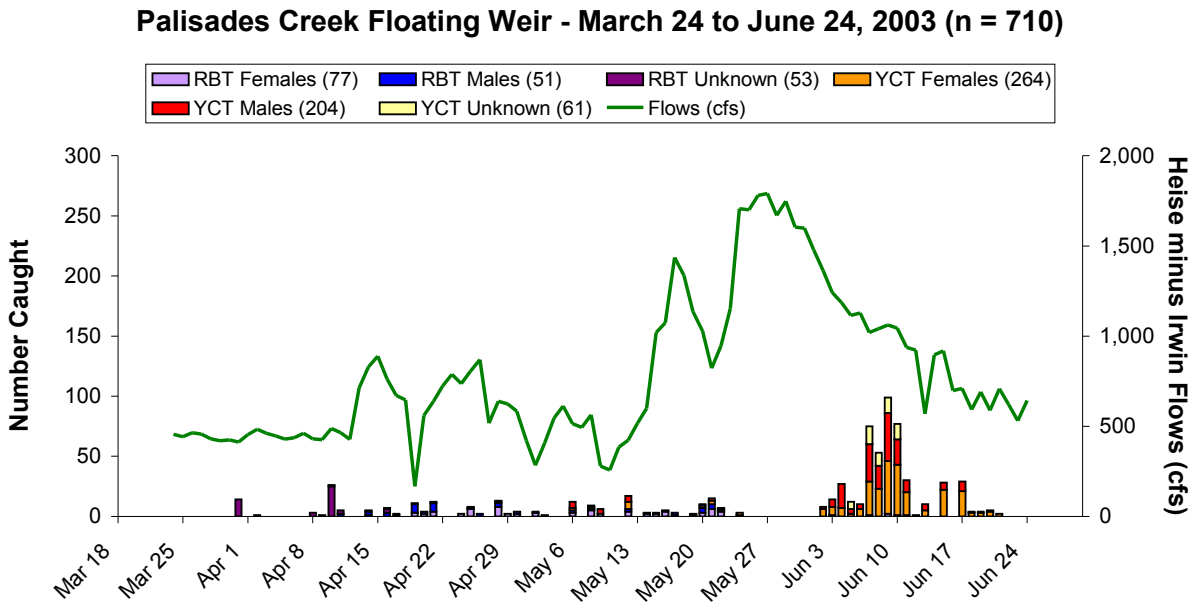



Figure 27. Number of fish caught, run timing, and estimated hydrograph at the Palisades Creek weir, South Fork Snake River, Idaho, 2003. RBT = rainbow trout; YCT = cutthroat trout. Bars are stacked.

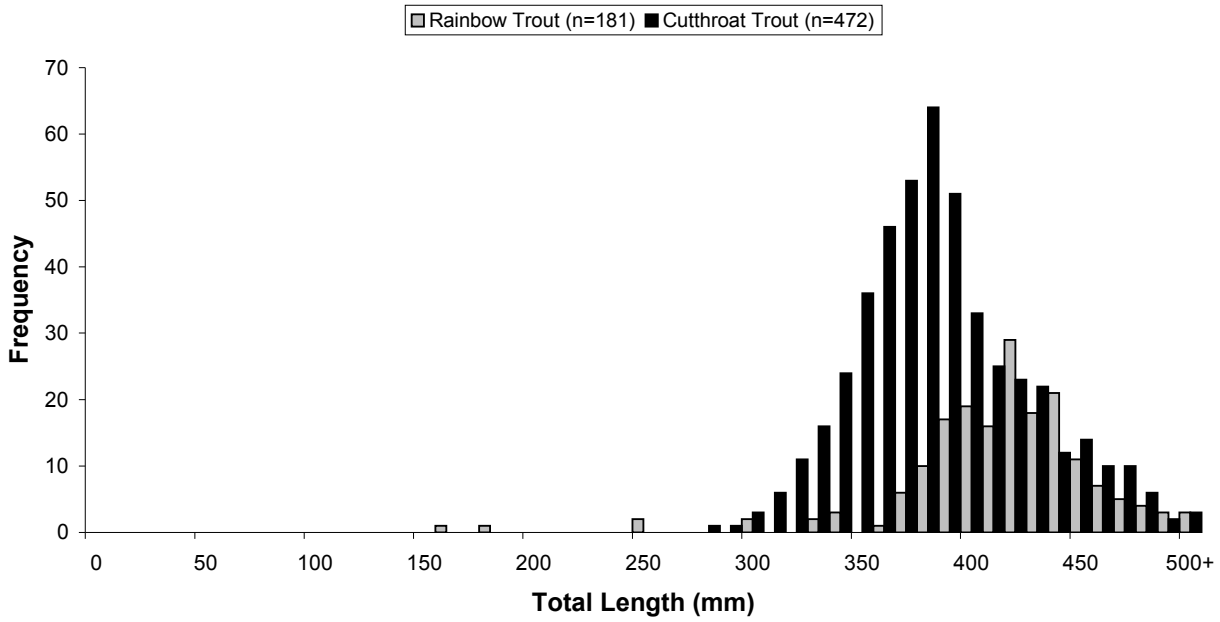



Figure 28. Length frequency distribution of rainbow and cutthroat trout sampled at the Palisades Creek weir, South Fork Snake River, Idaho, 2003.

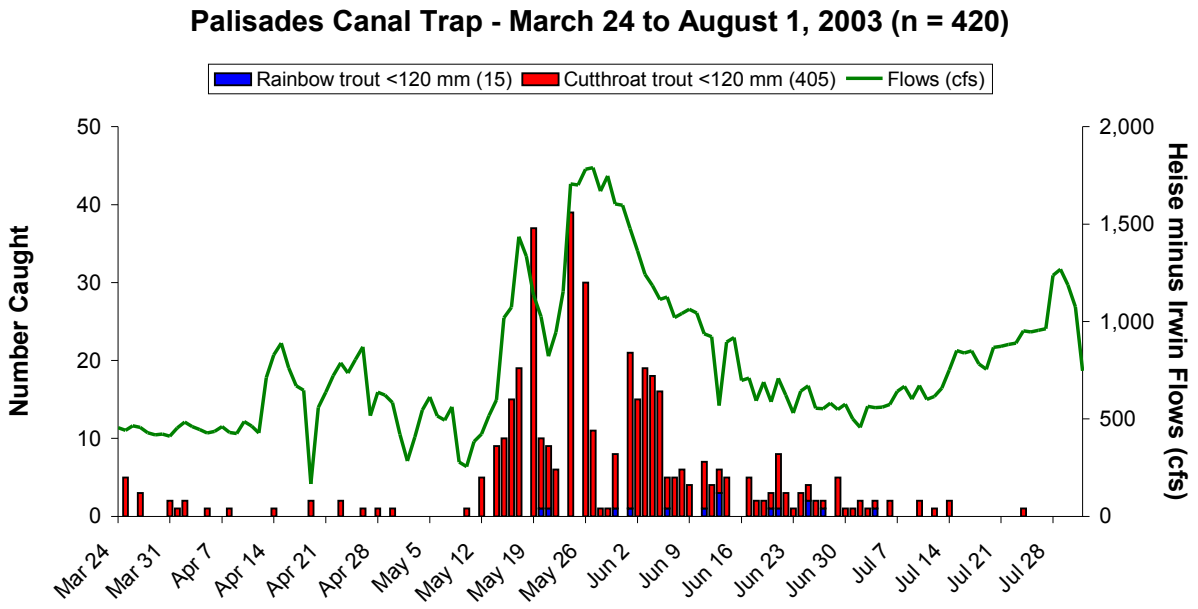



Figure 29. Number of yearling rainbow trout (<120 mm) and cutthroat trout (<120 mm) caught, run timing, and estimated hydrograph at the Palisades Canal trap, South Fork Snake River, Idaho, 2003. Bars are stacked.

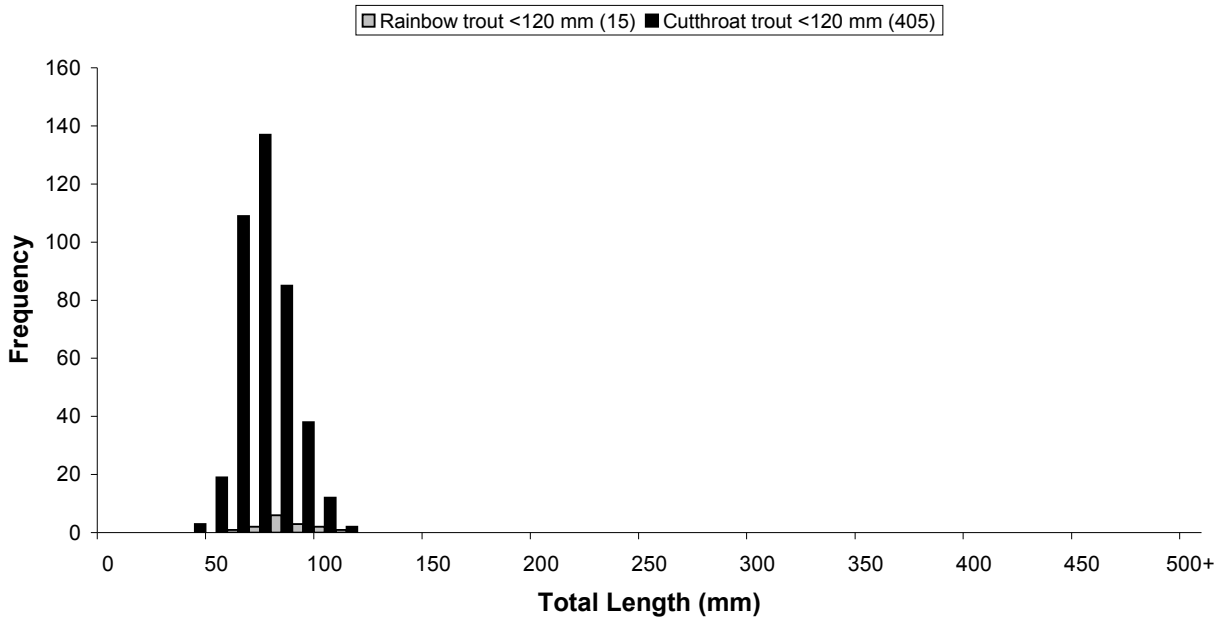



Figure 30. Length frequency distribution of yearling rainbow trout (<120 mm) and cutthroat trout (<120 mm) sampled at the Palisades Canal trap, South Fork Snake River, Idaho, 2003.

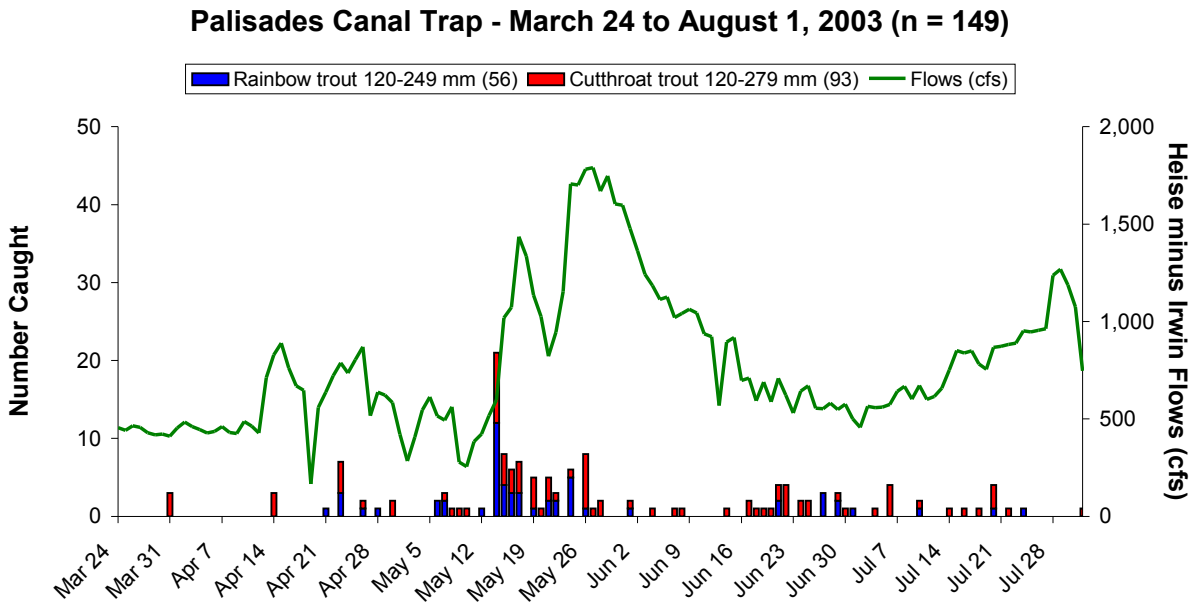



Figure 31. Number of juvenile rainbow trout (120-249 mm) and cutthroat trout (120-279 mm) caught, run timing, and estimated hydrograph at the Palisades Canal trap, South Fork Snake River, Idaho, 2003. Bars are stacked.

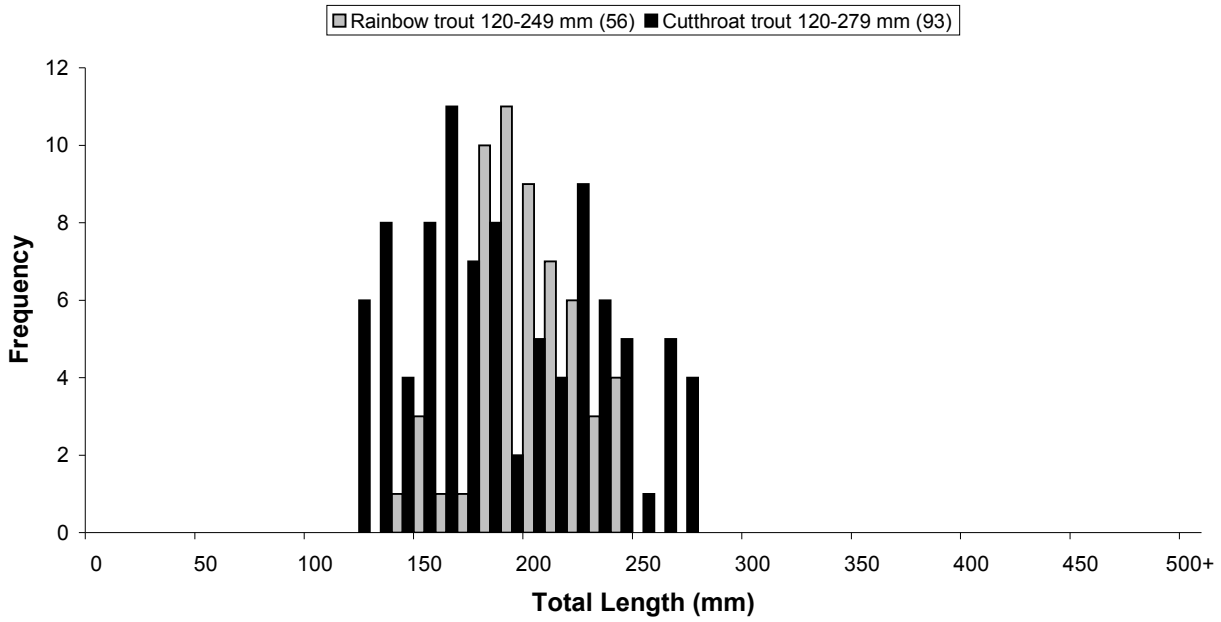



Figure 32. Length frequency distribution of juvenile rainbow trout (120-249 mm) and cutthroat trout (120-279 mm) sampled at the Palisades Canal trap, South Fork Snake River, Idaho, 2003.

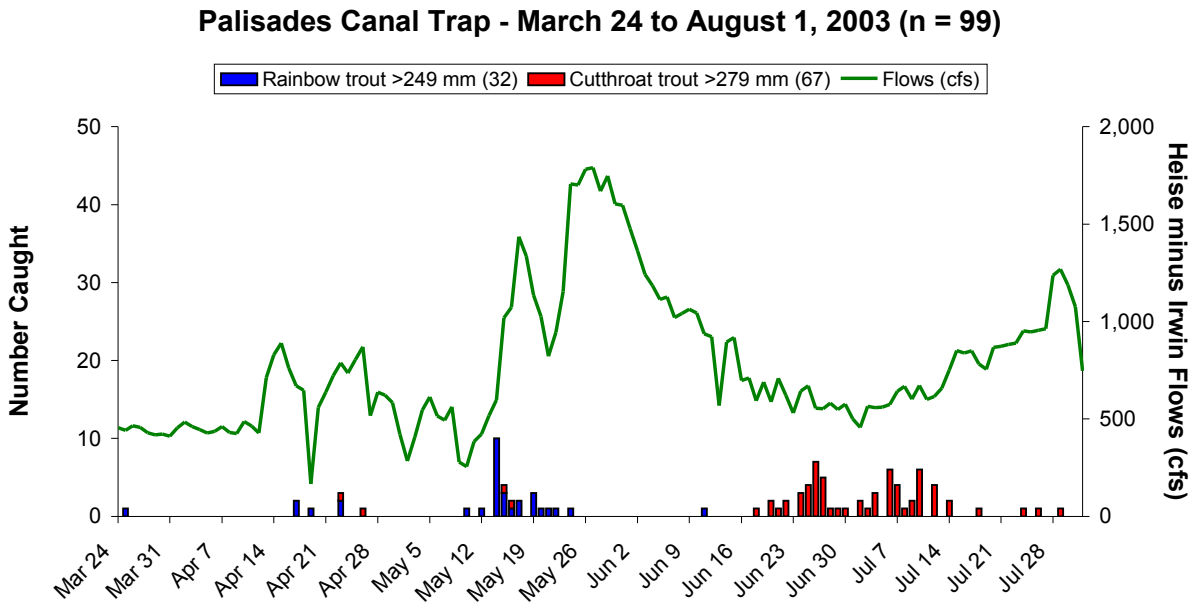



Figure 33. Number of post-spawning rainbow trout (>249 mm) and cutthroat trout (>279 mm) caught, run timing, and estimated hydrograph at the Palisades Canal trap, South Fork Snake River, Idaho, 2003. Bars are stacked.

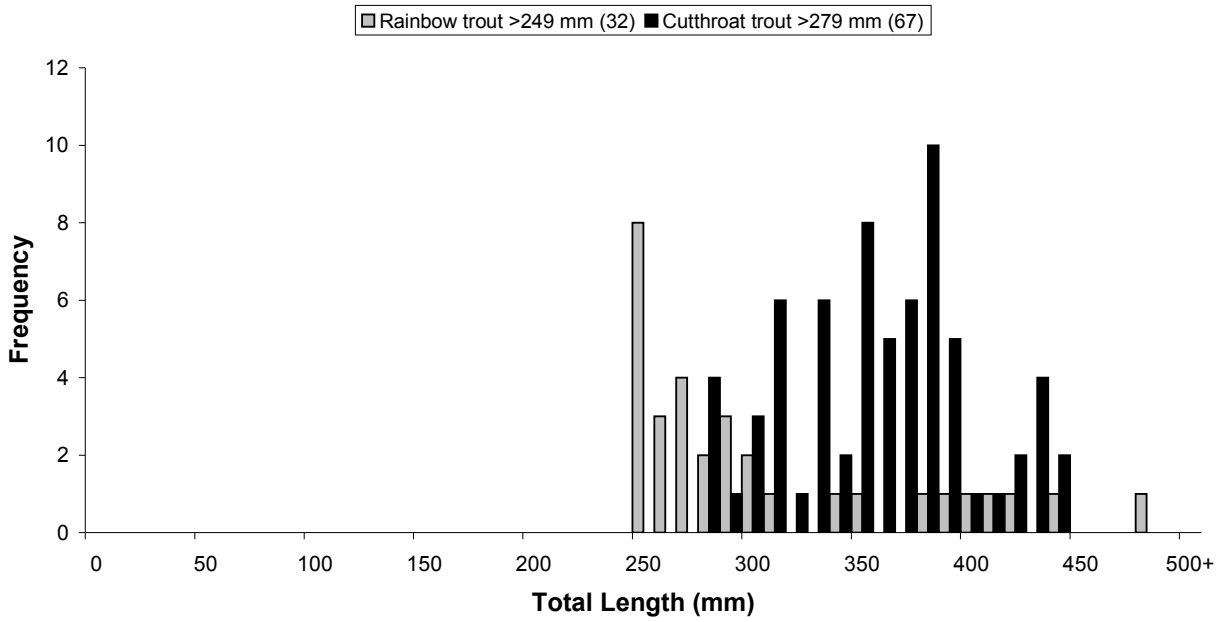



Figure 34. Length frequency distribution of post-spawning rainbow trout (>249 mm) and cutthroat trout (>279 mm) sampled at the Palisades Canal trap, South Fork Snake River, Idaho, 2003.

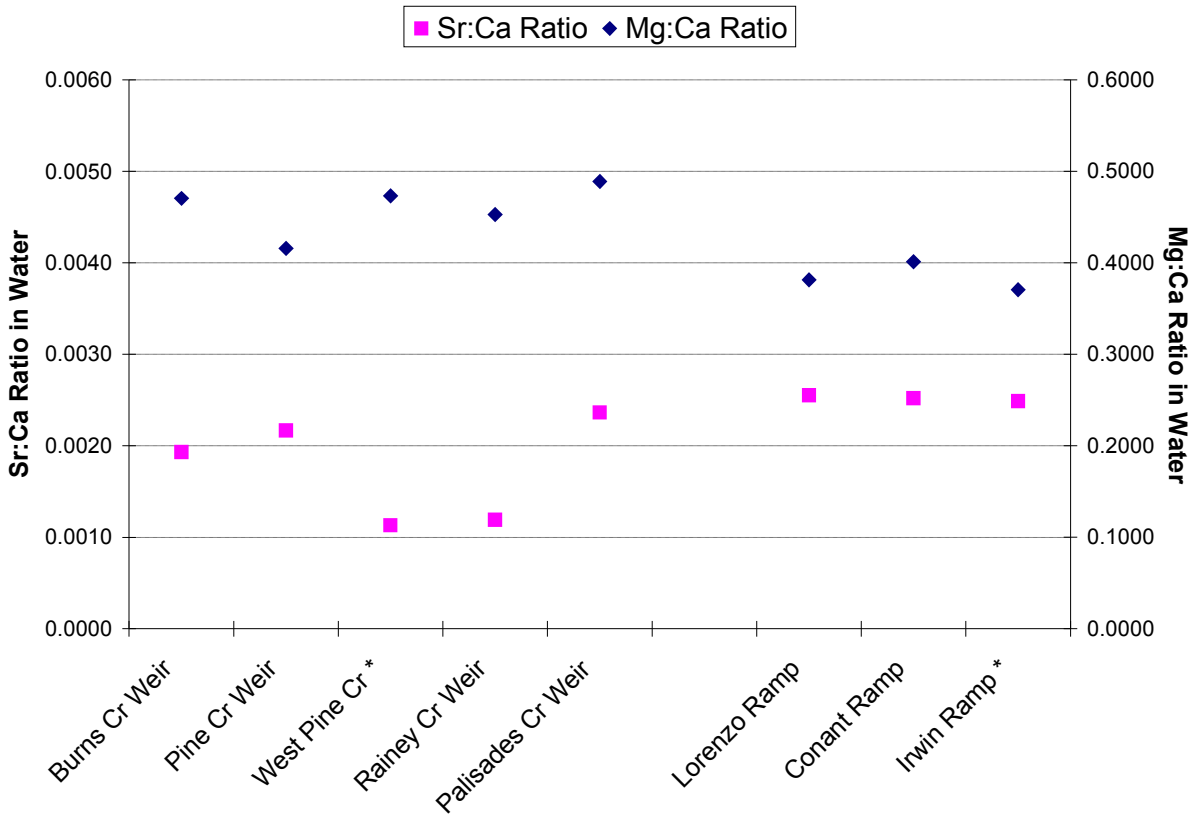



Figure 35. Strontium:calcium and magnesium:calcium ratios from water samples collected in spawning tributaries and at main river boat ramps, South Fork Snake River, Idaho, 2002. Asterisks denote samples collected by another IDFG fisheries research project. Sites are listed going upstream.

# APPENDICES

Appendix A. South Fork Snake River, Idaho, fishing regulations 1970-2003.

| Year | Season | Trout bag & size limit | Special |
|---|---|---|---|
| 1970 | May 30 - Nov 30 | 7 lb. + 1 fish, not to exceed 15 fish | Whitefish open 3/1 to 4/30 Irwin to Dam; Mouth to Heise cable open all year |
| 1971 | May 29 - Nov 30 | Same | Same |
| 1972 | May 27 - Nov 30 | 7 lb. + 1 fish, not to exceed 10 fish | Same |
| 1973 | May 26 - Nov 30 | Same | All species open 3/1 to 9/30 Irwin to Dam; Mouth to Heise cable open all year |
| 1974 | May 25 - Nov 30 | 10 fish, not more than 2 exceeding 14” | Same |
| 1975 | May 24 - Nov 30 | Same | Same |
| 1976 | May 29 - Nov 30 | 10 fish, not more than 5 exceeding 12”, and not more than 2 exceeding 18” | Same |
| 1977 | May 28 - Nov 30 | 6 fish, only 2 over 16” | Same, except dam tailrace closed |
| 1978 | May 27 - Nov 30 | Same | Dam tailrace closed; all species open 5/27 to 9/30 Irwin to Dam; Mouth to Heise cable open 5/27 to 12/31 |
| 1979 | May 26 - Nov 30 | Same | Dam tailrace closed; all species open 4/1 to 9/30 Irwin to Dam; Mouth to Heise cable open all year |
| 1980 | May 24 - Nov 30 | Same | Same |
| 1981 | May 23 - Nov 30 | Same | Same |
| 1982 | May 29 - Nov 30 | Same | Same, except open 9/1 to 11/30 within 100 yards of Burns Creek |
| 1983 | May 28 - Nov 30 | Same | Same |
| 1984 | May 26 - Nov 30 | Same, except Heise cable to Irwin only 2 CT, none between 10-16” | Same |
| 1985 | May 25 - Nov 30 | Same, except added hybrids | Same |
| 1986-1987 | May 24/23-Nov 30 | Same | Same |
| 1988-1989 | May 28/27-Nov 30 | 6 fish, only 2 over 16”; except Heise cable to Dam only 2 CT or HYB, none between 10-16” | Mouth to Heise cable open all year; open 9/1 - 11/30 within 100 yards of Burns Creek |
| 1990-1991 | May 26/25-Nov 30 | 6 fish (except only 2 CT or HYB, none between 8-16”, on all rivers and streams) | Mouth to Heise cable open all year |
| 1992-1993 | May 23/29-Nov 30 | 2 fish, none between 8-16” | Same |
| 1994-1995 | May 28/27-Nov 30 | Same | Same |
| 1996-1997 | May 25/24-Nov 30 | Same | Same |
| 1998 | May 23 - Nov 30 | Same | Same |
| 1999 | May 29 - Nov 30 | 6 fish (except only 2 CT, HYB, or BRN, none between 8-16”) | Same |
| 2000-2001 | May 27/26-Nov 30 | 6 fish (except only 2 CT or BRN, none under 16”) | Same |
| 2002-2003 | May 25/24-Nov 30 | Same | Same |

Appendix B. Sampling dates, flows, and catch rates at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2003. Flows were recorded at the USGS Irwin gage.

| Sampling dates | Range of flows ($m^3/s$) | Range of flows ($ft^3/s$) | Mean flow ($m^3/s$) | Catch rate (trout/day)[a] |
|---|---|---|---|---|
| 11/4,5, 6, 7,20 1986 | 100.3-107.0 | 3,540-3,780 | 101.7 | 413 |
| 11/5,6 1987[b,c] | 24.6-26.6 | 869-941 | 25.6 | 174 |
| 10/3,4,11 1988 | 102.0-105.1 | 3,600-3,710 | 103.5 | 630 |
| 10/18,19,27 1989 | 84.7-86.7 | 2,990-3,060 | 86.0 | 930 |
| 10/11,12,18 1990 | 98.8-104.5 | 3,490-3,690 | 100.8 | 1,292 |
| 10/7,8,15 1991 | 127.2-135.7 | 4,490-4,790 | 131.7 | 741 |
| 10/14 1992[b] | 60.3 | 2,130 | 60.3 | 719 |
| 10/13,14,21,22 1993 | 74.2-108.2 | 2,620-3,820 | 90.9 | 481 |
| 10/7,11,14 1994[b] | 34.6-69.1 | 1,220-2,440 | 52.4 | 368 |
| 10/5,6,12,13 1995 | 72.8-115.8 | 2,570-4,090 | 93.2 | 436 |
| 10/3,4,10,11 1996 | 106.5-107.3 | 3,760-3,790 | 106.9 | 472 |
| 10/16,17,23,27 1997[d] | 70.0-99.1 | 2,470-3,500 | 84.5 | 851 |
| 10/7,8,14,15 1998 | 91.5-126.6 | 3,230-4,470 | 109.6 | 593 |
| 10/13,14,20,21 1999 | 101.1-118.1 | 3,570-4,170 | 109.6 | 763 |
| 10/19,26 2000[b] | 87.8-95.2 | 3,100-3,360 | 91.5 | 603 |
| 10/4,5 2001[b] | 117.2-117.5 | 4,140-4,150 | 117.4 | 669 |
| 10/3,4,10,11 2002 | 68.0-72.8 | 2,400-2,570 | 71.6 | 423 |
| 10/8,9,15,16 2003 | 87.2-141.6 | 3,080-5,000 | 107.9 | 523 |

[a] Includes recaptured fish; catch rate = ($M$ + $C$) / number days sampled.
[b] No recapture runs due to low flows.
[c] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[d] Major habitat changes with spring, 1997, runoff.

Appendix C. Sampling dates, flows, and catch rates at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2003. Flows were recorded at the USGS Lorenzo gage.

| Sampling dates | Range of flows ($m^3/s$) | Range of flows ($ft^3/s$) | Mean flow ($m^3/s$) | Catch rate (trout/day)[a] |
|---|---|---|---|---|
| 9/29,30; 10/7 1987 | 58.6-69.7 | 2,070-2,460 | 64.5 | 183 |
| 10/4,6,11 1988 | 30.9-34.3 | 1,090-1,210 | 33.1 | 205 |
| 10/13,16,23 1989 | 24.7-25.5 | 871-899 | 25.1 | 197 |
| 10/3,4,10 1990 | 49.8-79.0 | 1,760-2,790 | 67.7 | 265 |
| 9/18,19,30 1991 | 60.3-77.3 | 2,130-2,730 | 71.5 | 346 |
| 9/23,27; 10/4,7 1993 | 46.2-71.9 | 1,630-2,540 | 56.6 | 244 |
| 10/2,4,10,11 1995 | 27.4-45.0 | 967-1,590 | 36.1 | 358 |
| 9/28,29; 10/6,7 1999[b] | 49.6-86.7 | 1,750-3,060 | 67.0 | 378 |
| 9/17,18,24,26 2002 | 73.9-122.3 | 2,610-4,320 | 97.8 | 335 |
| 9/18,19,24,26 2003 | 65.1-90.6 | 2,300-3,200 | 81.4 | 322 |

[a] Includes recaptured fish; catch rate = ($M$ + $C$) / number days sampled.
[b] Major habitat changes with spring, 1997, runoff.

Appendix D. Mark-recapture statistics and length frequency distributions for the Conant electrofishing section, South Fork Snake River, Idaho, 1982-2003.

Appendix D-1. Trout species composition and relative abundance (percent of catch) at the Conant electrofishing section, South Fork Snake River, Idaho, 1982 and 1986-2003. Age 1 cutthroat trout are 102-254 mm, age 1 rainbow trout are 152-279 mm, and age 1 brown trout are 178-279 mm. Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs are in parentheses.

| | Cutthroat trout[a] | | Rainbow trout | | Brown trout | | Lake trout | Kokanee | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | All | Age 1 | All | Age 1 | All | Age 1 | All | All | All | Age 1 |
| 1982[b,c] | 79.0 (181) | ND[d] | 0.9 (2) | ND | 19.2 (44) | ND | 0.9 (2) | 0.0 (0) | 100.0 (229) | ND |
| 1986[c] | 83.1 (1,647) | 59.7 (191) | 2.4 (47) | 4.7 (15) | 14.4 (285) | 35.6 (114) | 0.2 (4) | 0.0 (0) | 100.0 (1,983) | 100.0 (320) |
| 1987[c,e,f] | 85.9 (299) | 87.6 (85) | 1.7 (6) | 2.1 (2) | 12.4 (43) | 10.3 (10) | 0.0 (0) | 0.0 (0) | 100.0 (348) | 100.0 (97) |
| 1988 | 87.8 (1,570) | 54.2 (115) | 3.2 (58) | 9.0 (19) | 8.9 (159) | 36.8 (78) | 0.1 (1) | 0.0 (0) | 100.0 (1,788) | 100.0 (212) |
| 1989 | 89.2 (2,291) | 66.5 (165) | 4.0 (103) | 14.9 (37) | 6.8 (175) | 18.5 (46) | 0.0 (0) | 0.0 (0) | 100.0 (2,569) | 100.0 (248) |
| 1990 | 84.3 (2,978) | 71.7 (849) | 6.1 (216) | 12.2 (145) | 9.5 (335) | 16.0 (190) | 0.1 (4) | 0.0 (0) | 100.0 (3,533) | 100.0 (1,184) |
| 1991 | 80.1 (1,646) | 51.2 (290) | 7.3 (150) | 18.4 (104) | 12.6 (259) | 30.4 (172) | 0.0 (0) | 0.0 (0) | 100.0 (2,055) | 100.0 (566) |
| 1992[e] | 83.2 (598) | 62.2 (115) | 4.7 (34) | 11.4 (21) | 12.1 (87) | 26.5 (49) | 0.0 (0) | 0.0 (0) | 100.0 (719) | 100.0 (185) |
| 1993 | 84.6 (1,528) | 54.5 (109) | 6.3 (113) | 13.5 (27) | 9.2 (166) | 32.0 (64) | 0.0 (0) | 0.0 (0) | 100.0 (1,807) | 100.0 (200) |
| 1994[e] | 78.5 (867) | 70.4 (357) | 9.1 (100) | 12.4 (63) | 12.3 (136) | 17.2 (87) | 0.0 (0) | 0.1 (1) | 100.0 (1,104) | 100.0 (507) |
| 1995 | 68.6 (1,121) | 31.4 (150) | 15.7 (256) | 36.5 (174) | 15.8 (258) | 32.1 (153) | 0.0 (0) | 0.0 (0) | 100.0 (1,635) | 100.0 (477) |
| 1996 | 66.4 (1,190) | 49.9 (371) | 15.3 (274) | 23.5 (175) | 18.1 (325) | 26.6 (198) | 0.1 (1) | 0.1 (1) | 100.0 (1,791) | 100.0 (744) |
| 1997[g] | 54.3 (1,676) | 34.6 (489) | 27.2 (840) | 40.7 (575) | 18.4 (567) | 24.6 (348) | 0.0 (1) | 0.1 (2) | 100.0 (3,086) | 100.0 (1,412) |
| 1998 | 58.7 (1,312) | 56.0 (424) | 20.3 (454) | 15.2 (115) | 21.0 (469) | 28.8 (218) | 0.0 (1) | 0.0 (0) | 100.0 (2,236) | 100.0 (757) |
| 1999 | 62.7 (1,803) | 36.6 (269) | 19.5 (560) | 28.3 (208) | 17.8 (513) | 35.0 (257) | 0.0 (0) | 0.0 (0) | 100.0 (2,876) | 100.0 (734) |
| 2000[e] | 66.4 (800) | 42.8 (110) | 22.5 (271) | 38.1 (98) | 11.1 (134) | 19.1 (49) | 0.0 (0) | 0.0 (0) | 100.0 (1,205) | 100.0 (257) |
| 2001[e] | 58.1 (778) | 36.4 (122) | 25.5 (341) | 37.3 (125) | 16.4 (219) | 26.3 (88) | 0.0 (0) | 0.0 (0) | 100.0 (1,338) | 100.0 (335) |
| 2002 | 52.5 (845) | 14.4 (44) | 33.8 (543) | 65.6 (200) | 13.6 (219) | 20.0 (61) | 0.1 (1) | 0.0 (0) | 100.0 (1,608) | 100.0 (305) |
| 2003 | 47.1 (924) | 31.1 (183) | 33.4 (655) | 45.2 (266) | 19.5 (383) | 23.6 (139) | 0.0 (0) | 0.0 (0) | 100.0 (1,962) | 100.0 (588) |

[a] Includes hatchery cutthroat trout.
[b] Only 1.9 km of larger 4.9 km section was electrofished; data from Moore and Schill (1984).
[c] Electrofishing conducted in early November rather than October.
[d] ND = no data.
[e] No recapture runs due to low flows.
[f] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[g] Major habitat changes with spring, 1997, runoff.

Appendix D-2. Mean total length and quality stock density (QSD) of trout captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2003. Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs equals n. QSD = (number ≥406 mm / number ≥203 mm) x 100.

| | Cutthroat trout[a] | | | Rainbow trout | | | Brown trout | | | All trout[b] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | n | Mean (mm) | QSD (%) | n | Mean (mm) | QSD (%) | n | Mean (mm) | QSD (%) | n | Mean (mm) | QSD (%) |
| 1986[c] | 1,647 | 330 | 8.5 | 47 | 308 | 11.4 | 285 | 337 | 29.0 | 1,983 | 330 | 11.5 |
| 1987[c,d,e] | 299 | 298 | 14.9 | 6 | 262 | 0.0 | 43 | 249 | 11.5 | 348 | 292 | 14.3 |
| 1988 | 1,570 | 338 | 5.6 | 58 | 327 | 12.3 | 159 | 309 | 22.8 | 1,788 | 335 | 7.3 |
| 1989 | 2,291 | 354 | 8.8 | 103 | 323 | 20.6 | 175 | 343 | 38.5 | 2,569 | 351 | 11.2 |
| 1990 | 2,978 | 319 | 8.4 | 216 | 269 | 13.3 | 335 | 266 | 20.4 | 3,533 | 310 | 9.7 |
| 1991 | 1,646 | 332 | 11.2 | 150 | 252 | 6.6 | 259 | 275 | 14.1 | 2,055 | 320 | 11.3 |
| 1992[d] | 598 | 333 | 9.0 | 34 | 283 | 2.9 | 87 | 264 | 6.6 | 719 | 323 | 8.4 |
| 1993 | 1,528 | 351 | 15.3 | 113 | 341 | 18.2 | 166 | 329 | 34.2 | 1,807 | 348 | 17.2 |
| 1994[d] | 867 | 298 | 11.2 | 100 | 251 | 13.4 | 136 | 237 | 7.4 | 1,104 | 287 | 10.9 |
| 1995 | 1,121 | 350 | 21.2 | 256 | 278 | 10.5 | 258 | 287 | 15.8 | 1,635 | 328 | 18.7 |
| 1996 | 1,190 | 311 | 8.7 | 274 | 262 | 6.6 | 325 | 284 | 12.7 | 1,791 | 297 | 9.2 |
| 1997[f] | 1,676 | 291 | 4.5 | 840 | 263 | 4.3 | 567 | 275 | 12.5 | 3,086 | 279 | 6.0 |
| 1998 | 1,312 | 296 | 4.8 | 454 | 318 | 13.3 | 469 | 279 | 8.4 | 2,236 | 297 | 7.4 |
| 1999 | 1,803 | 309 | 2.6 | 560 | 313 | 11.6 | 513 | 293 | 9.1 | 2,876 | 307 | 5.5 |
| 2000[d] | 800 | 315 | 2.3 | 271 | 307 | 13.8 | 134 | 312 | 12.8 | 1,205 | 312 | 6.0 |
| 2001[d] | 778 | 312 | 1.8 | 341 | 304 | 16.9 | 219 | 311 | 17.6 | 1,338 | 310 | 8.2 |
| 2002 | 845 | 338 | 4.0 | 543 | 326 | 23.6 | 219 | 339 | 34.0 | 1,608 | 334 | 14.4 |
| 2003 | 924 | 327 | 5.6 | 655 | 298 | 19.1 | 383 | 270 | 29.2 | 1,962 | 306 | 14.0 |

[a] Includes hatchery cutthroat trout.
[b] Includes other trout, i.e. lake trout and kokanee.
[c] Electrofishing conducted in early November rather than October.
[d] No recapture runs due to low flows.
[e] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[f] Major habitat changes with spring, 1997, runoff.

Appendix D-3. Mark-recapture statistics for age 1 and older cutthroat trout (≥102 mm), rainbow trout (≥152 mm), brown trout (≥178 mm), and all trout (≥102 mm) at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2003. Cases where $R \leq 3$ and unbiased density estimates are not possible (Ricker 1975) are highlighted.

| | Cutthroat trout[a] | | | | Rainbow trout | | | | Brown trout | | | | All trout[b] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | *M*[c] | *C*[c] | *R*[c] | *R/C* (%) | *M* | *C* | *R* | *R/C* (%) | *M* | *C* | *R* | *R/C* (%) | *M* | *C* | *R* | *R/C* (%) |
| 1986[d] | 1,170 | 546 | 70 | 12.8 | 32 | 16 | 2 | 12.5 | 183 | 105 | 8 | 7.6 | 1,392 | 669 | 80 | 12.0 |
| 1987[d,e,f] | 281 | ND[e] | ND | ND | 5 | ND | ND | ND | 26 | ND | ND | ND | 329 | ND | ND | ND |
| 1988 | 1,100 | 561 | 98 | 17.5 | 41 | 18 | 1 | 5.6 | 113 | 46 | 4 | 8.7 | 1,256 | 628 | 103 | 16.4 |
| 1989 | 1,416 | 1,050 | 200 | 19.0 | 57 | 55 | 10 | 18.2 | 92 | 76 | 11 | 14.5 | 1,578 | 1,184 | 221 | 18.7 |
| 1990 | 1,733 | 1,522 | 317 | 20.8 | 113 | 109 | 14 | 12.8 | 173 | 117 | 12 | 10.3 | 2,062 | 1,766 | 343 | 19.4 |
| 1991 | 1,145 | 625 | 140 | 22.4 | 98 | 54 | 9 | 16.7 | 150 | 119 | 19 | 16.0 | 1,402 | 799 | 168 | 21.0 |
| 1992[e] | 595 | ND | ND | ND | 34 | ND | ND | ND | 76 | ND | ND | ND | 716 | ND | ND | ND |
| 1993 | 972 | 623 | 100 | 16.1 | 74 | 41 | 6 | 14.6 | 101 | 64 | 10 | 15.6 | 1,154 | 730 | 116 | 15.9 |
| 1994[e] | 853 | ND | ND | ND | 87 | ND | ND | ND | 110 | ND | ND | ND | 1,077 | ND | ND | ND |
| 1995 | 631 | 542 | 77 | 14.2 | 130 | 140 | 17 | 12.1 | 150 | 108 | 13 | 12.0 | 914 | 800 | 107 | 13.4 |
| 1996 | 707 | 548 | 72 | 13.1 | 155 | 111 | 5 | 4.5 | 212 | 124 | 18 | 14.5 | 1,082 | 788 | 95 | 12.1 |
| 1997[g] | 910 | 895 | 164 | 18.3 | 429 | 467 | 72 | 15.4 | 344 | 281 | 82 | 29.2 | 1,695 | 1,668 | 319 | 19.1 |
| 1998 | 674 | 682 | 61 | 8.9 | 216 | 247 | 26 | 10.5 | 257 | 216 | 49 | 22.7 | 1,164 | 1,175 | 136 | 11.6 |
| 1999 | 1,019 | 883 | 117 | 13.3 | 345 | 241 | 29 | 12.0 | 293 | 241 | 31 | 12.9 | 1,661 | 1,370 | 177 | 12.9 |
| 2000[e] | 797 | ND | ND | ND | 260 | ND | ND | ND | 133 | ND | ND | ND | 1,195 | ND | ND | ND |
| 2001[e] | 776 | ND | ND | ND | 321 | ND | ND | ND | 208 | ND | ND | ND | 1,322 | ND | ND | ND |
| 2002 | 495 | 394 | 50 | 12.7 | 295 | 257 | 24 | 9.3 | 111 | 104 | 9 | 8.7 | 908 | 764 | 83 | 10.9 |
| 2003 | 422 | 571 | 72 | 12.6 | 272 | 360 | 29 | 8.1 | 143 | 165 | 27 | 16.4 | 861 | 1,195 | 128 | 10.7 |

[a] Includes hatchery cutthroat trout.
[b] Includes other trout, i.e. lake trout and kokanee.
[c] *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.
[d] Electrofishing conducted in early November rather than October.
[e] No recapture runs due to low flows; ND = no data.
[f] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[g] Major habitat changes with spring, 1997, runoff.

Appendix D-4. Estimated abundance (N) of age 1 and older cutthroat trout (≥102 mm), rainbow trout (≥152 mm), brown trout (≥178 mm), and all trout (≥102 mm) at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2003. Confidence intervals (±95%) are in parentheses. Cases where $R \leq 3$ and unbiased estimates are not possible (Ricker 1975) are highlighted.

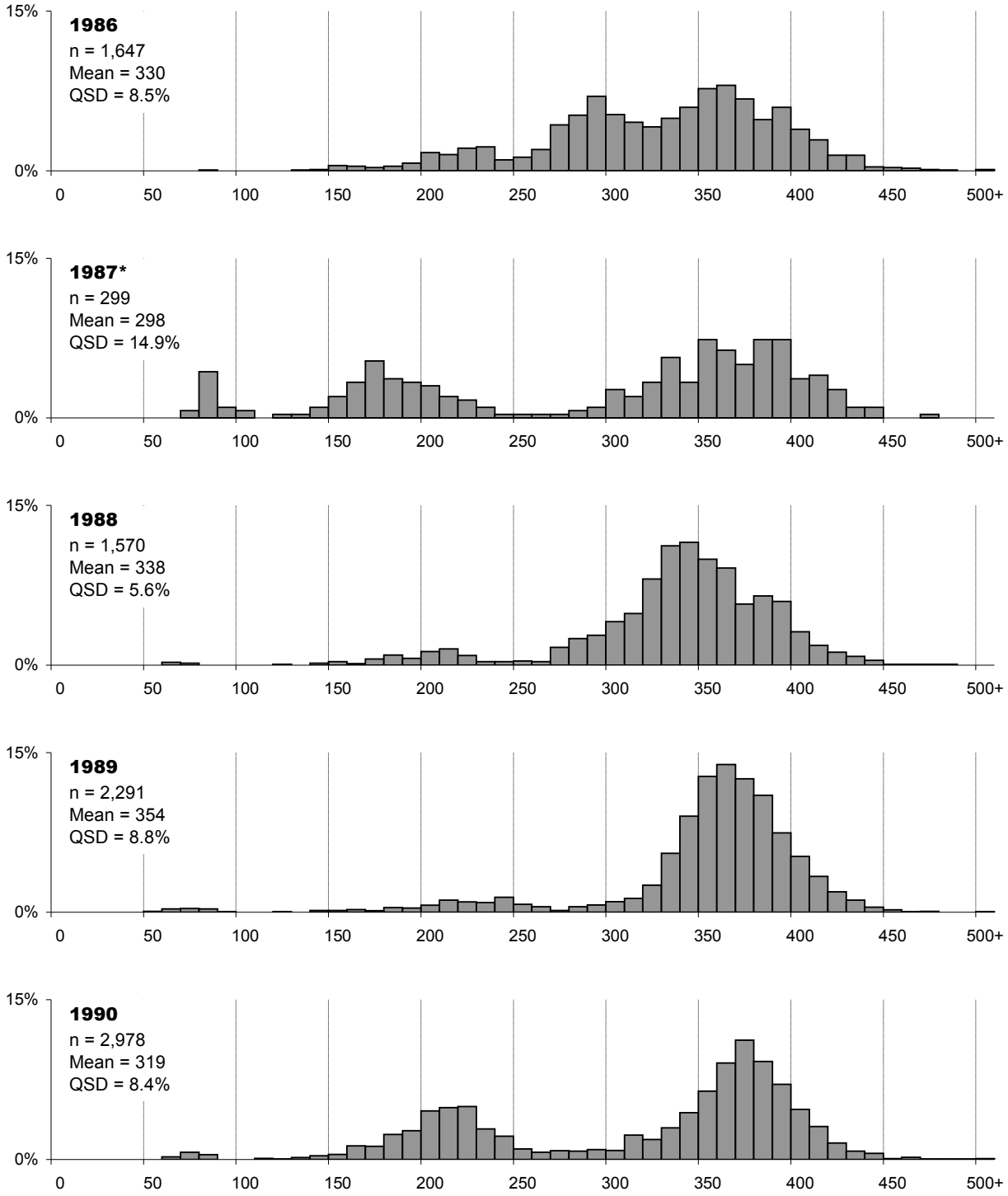
| | Cutthroat trout[a] | | Rainbow trout | | Brown trout | | All trout[b] | |
|---|---|---|---|---|---|---|---|---|
| Year | N/section | N/km | N/section | N/km | N/section | N/km | N/section | N/km |
| 1986[c] | 14,162 (1,970) | 2,890 (402) | NUE[d] | NUE | 3,142 (1,239) | 641 (253) | 13,935 (1,192) | 2,844 (243) |
| 1987[c,e,f] | NE[e] | NE | NE | NE | NE | NE | NE | NE |
| 1988 | 7,307 (726) | 1,491 (148) | NUE | NUE | 1,667 (1,521) | 340 (310) | 9,005 (851) | 1,838 (174) |
| 1989 | 7,890 (528) | 1,610 (108) | 310 (128) | 63 (26) | 937 (794) | 191 (162) | 8,788 (514) | 1,793 (105) |
| 1990 | 11,418 (846) | 2,330 (173) | 1,002 (316) | 204 (64) | 1,806 (650) | 369 (133) | 14,633 (853) | 2,986 (174) |
| 1991 | 6,854 (665) | 1,399 (136) | 658 (264) | 134 (54) | 954 (252) | 195 (52) | 7,920 (562) | 1,616 (115) |
| 1992[e] | NE | NE | NE | NE | NE | NE | NE | NE |
| 1993 | 7,409 (734) | 1,512 (150) | 538 (250) | 110 (51) | 662 (380) | 135 (78) | 8,058 (635) | 1,644 (130) |
| 1994[e] | NE | NE | NE | NE | NE | NE | NE | NE |
| 1995 | 6,028 (719) | 1,230 (147) | 1,325 (354) | 270 (72) | 1,442 (863) | 294 (176) | 8,349 (767) | 1,704 (156) |
| 1996 | 7,360 (1,101) | 1,502 (225) | 2,911[g] (2,058) | 594[g] (420) | 1,537 (383) | 314 (78) | 11,233 (1,254) | 2,292 (256) |
| 1997[h] | 5,609 (373) | 1,145 (76) | 2,962 (358) | 604 (73) | 1,808 (995) | 369 (203) | 9,659 (458) | 1,971 (93) |
| 1998 | 8,286 (999) | 1,691 (204) | 2,258 (385) | 461 (79) | 1,219 (176) | 249 (36) | 10,770 (763) | 2,198 (156) |
| 1999 | 9,051 (798) | 1,847 (163) | 3,207 (621) | 654 (127) | 2,507 (829) | 512 (169) | 13,873 (868) | 2,831 (177) |
| 2000[e] | NE | NE | NE | NE | NE | NE | NE | NE |
| 2001[e] | NE | NE | NE | NE | NE | NE | NE | NE |
| 2002 | 4,119 (582) | 841 (119) | 3,845 (956) | 785 (195) | 1,409 (600) | 288 (122) | 8,845 (783) | 1,805 (160) |
| 2003 | 4,114 (583) | 840 (119) | 4,563 (1,106) | 931 (226) | 1,174 (487) | 240 (99) | 8,745 (642) | 1,785 (131) |

[a] Includes hatchery cutthroat trout.
[b] Includes other trout, i.e. lake trout and kokanee.
[c] Electrofishing conducted in early November rather than October.
[d] NUE = unbiased estimate not possible as $R \leq 3$.
[e] No recapture runs due to low flows; NE = no estimate.
[f] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[g] Modified Peterson rather than log-likelihood estimate.
[h] Major habitat changes with spring, 1997, runoff.

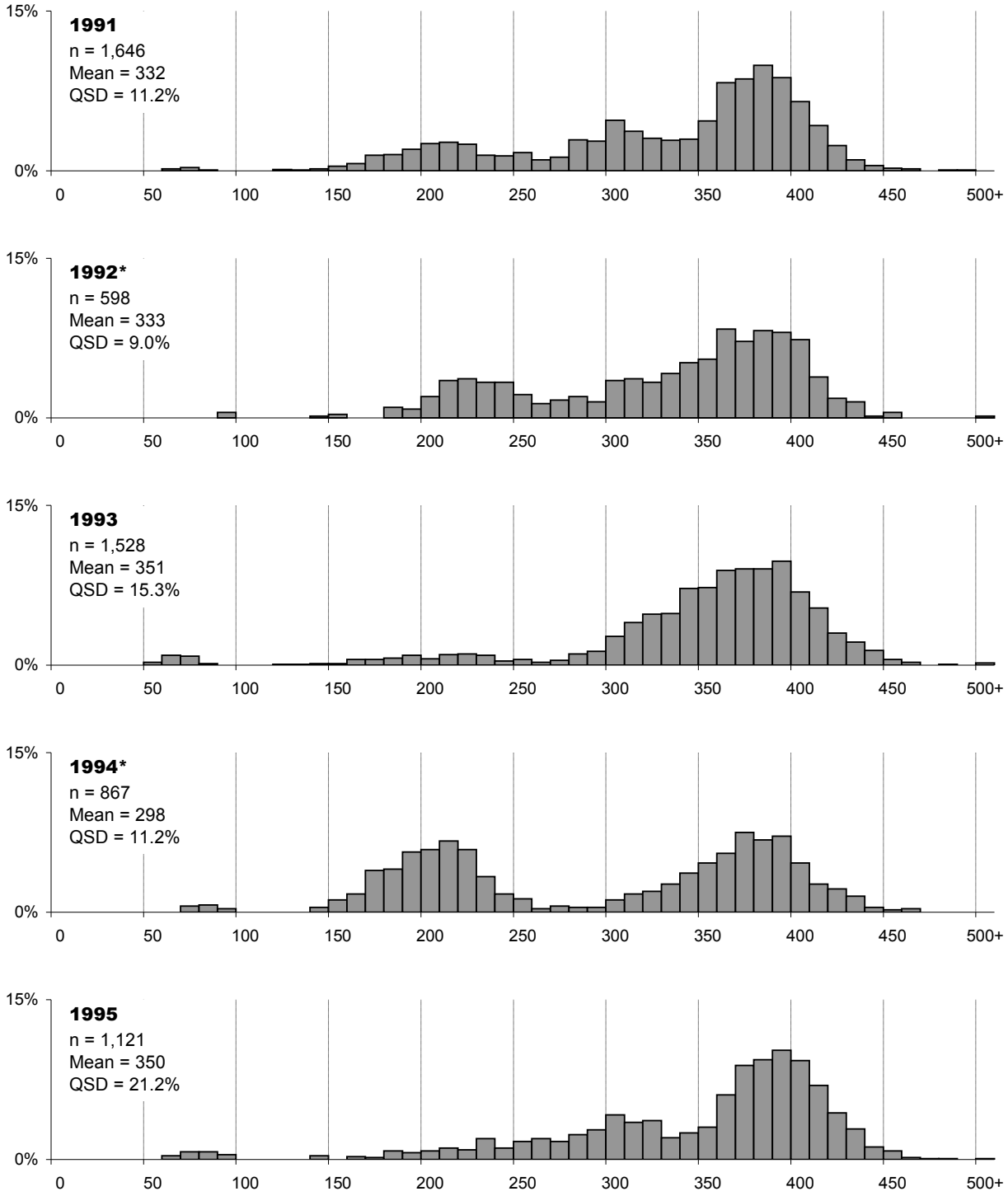
Appendix D-5. Estimated abundance (N) of age 1 cutthroat trout (102-254 mm), rainbow trout (152-279 mm), brown trout (178-279 mm), and all trout combined at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2003. Confidence intervals (±95%) are in parentheses. Cases where estimates are not possible are highlighted.

| Year | Cutthroat trout | | Rainbow trout | | Brown trout | | All trout (sum) | | Cutthroat trout N / rainbow trout N | Cutthroat trout N / brown trout N |
|---|---|---|---|---|---|---|---|---|---|---|
| | N/section | N/km | N/section | N/km | N/section | N/km | N/section | N/km | | |
| 1986[a] | 4,683 (1,313) | 956 (268) | NE[b] | NE | 1,930 (1,172) | 394 (239) | 6,613 | 1,350 | NE | 2.4 |
| 1987[a,c,d] | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| 1988 | 1,448 (412) | 296 (84) | NE | NE | 1,197 (1,441) | 244 (294) | 2,645 | 540 | NE | 1.2 |
| 1989 | 1,184 (221) | 242 (45) | 120 (66) | 24 (14) | 97 (43) | 20 (9) | 1,401 | 286 | 9.9 | 12.2 |
| 1990 | 6,328 (806) | 1,291 (165) | 819 (310) | 167 (63) | 1,407 (571) | 287 (116) | 8,554 | 1,746 | 7.7 | 4.5 |
| 1991 | 2,762 (584) | 564 (119) | 526 (250) | 107 (51) | 689 (202) | 141 (41) | 3,977 | 812 | 5.3 | 4.0 |
| 1992[c] | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| 1993 | 1,680 (448) | 343 (91) | 198 (180) | 40 (37) | 214 (109) | 44 (22) | 2,092 | 427 | 8.5 | 7.9 |
| 1994[c] | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| 1995 | 1,563 (450) | 319 (92) | 1,083 (350) | 221 (71) | 688 (238) | 140 (49) | 3,334 | 680 | 1.4 | 2.3 |
| 1996 | 4,093 (1,046) | 835 (213) | NE | | 1,049 (325) | 214 (66) | 5,142 | 1,049 | NE | 3.9 |
| 1997[e] | 2,535 (306) | 517 (62) | 2,136 (299) | 436 (61) | 719 (78) | 147 (16) | 5,390 | 1,100 | 1.2 | 3.5 |
| 1998 | 3,961 (854) | 808 (174) | 921 (293) | 188 (60) | 656 (126) | 134 (26) | 5,538 | 1,130 | 4.3 | 6.0 |
| 1999 | 2,748 (525) | 561 (107) | 1,685 (550) | 344 (112) | 1,069 (246) | 218 (50) | 5,502 | 1,123 | 1.6 | 2.6 |
| 2000[c] | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| 2001[c] | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| 2002 | 406 (171) | 83 (35) | 2,268 (893) | 463 (182) | 579 (340) | 118 (69) | 3,253 | 664 | 0.2 | 0.7 |
| 2003 | 1,707 (515) | 348 (105) | 3,116 (1,069) | 636 (218) | 459 (104) | 94 (21) | 5,282 | 1,078 | 0.5 | 3.7 |

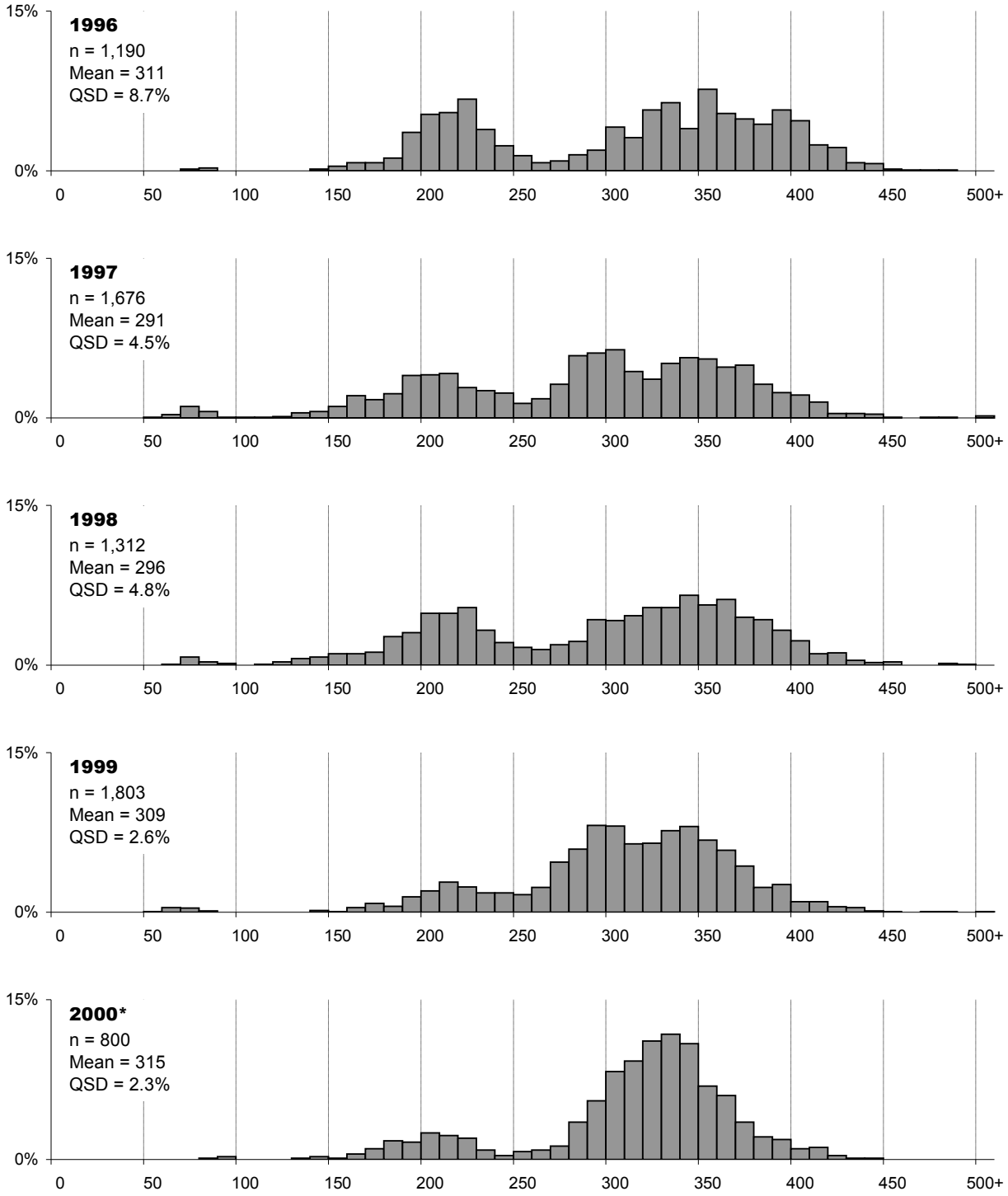
[a] Electrofishing conducted in early November rather than October.
[b] NE = no estimate.
[c] No recapture runs due to low flows.
[d] Only 3.2 km of larger 4.9 km section was electrofished with drift boat.
[e] Major habitat changes with spring, 1997, runoff.



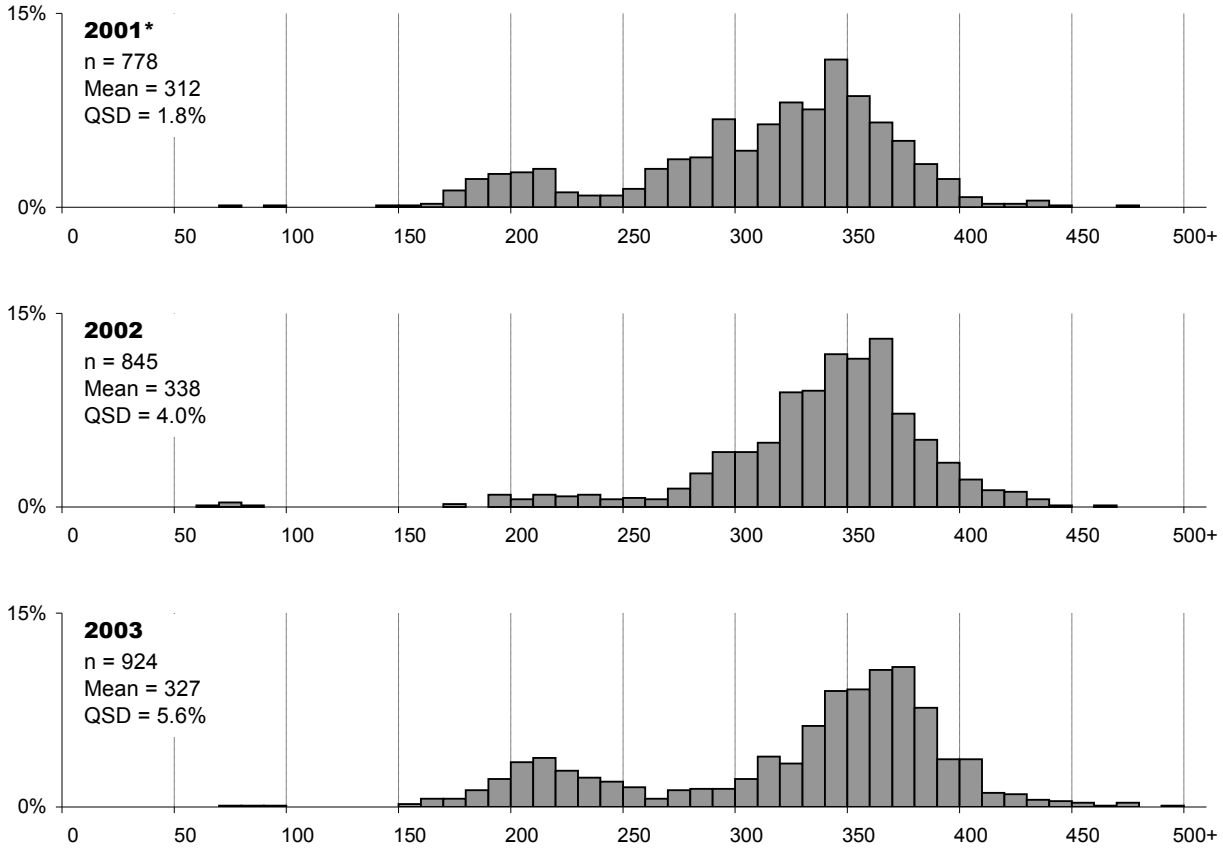

Appendix D-6. Length frequency distributions (TL, mm) of cutthroat trout captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2003. Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs equals n. Asterisks denote years lacking recapture runs.



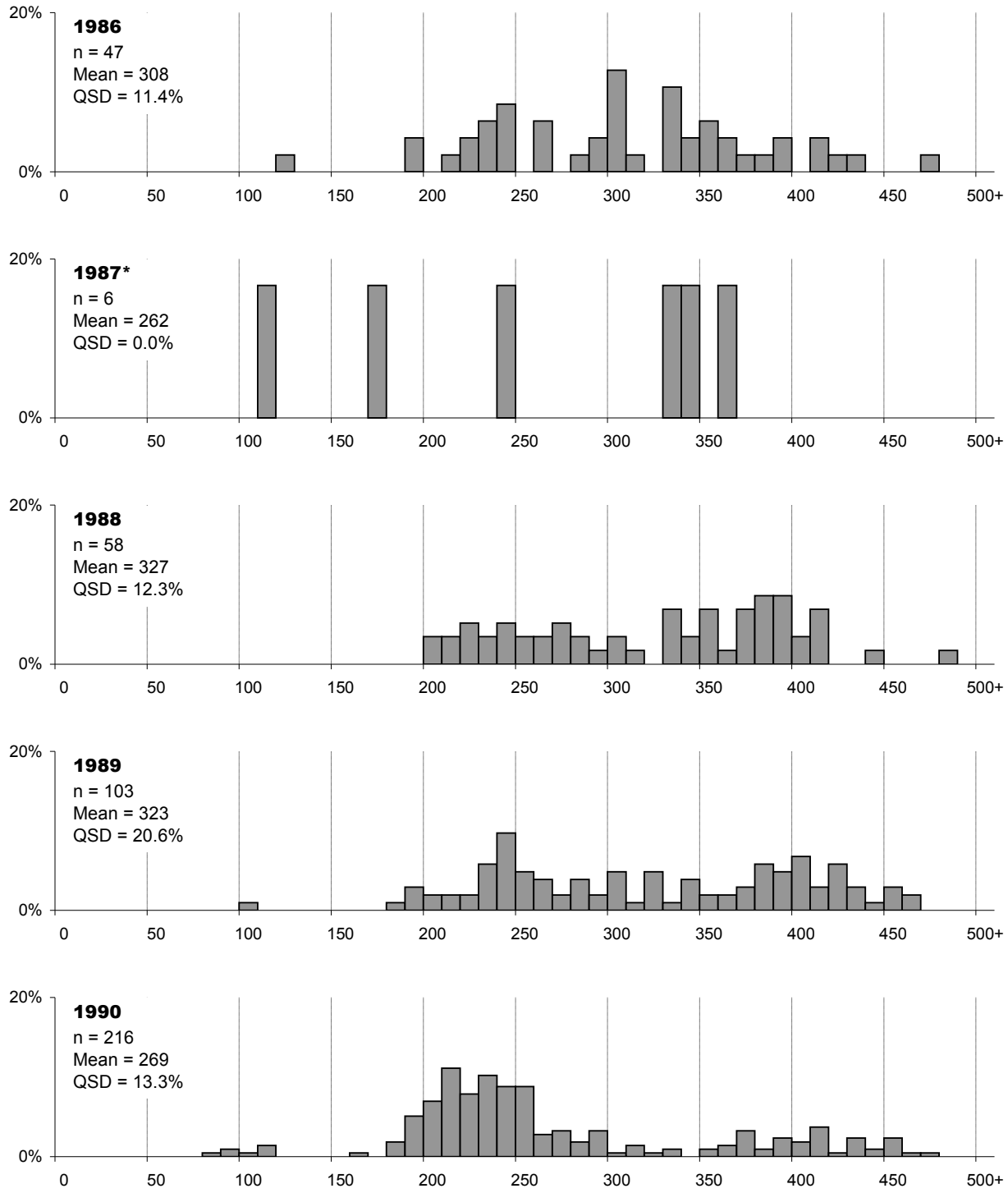

Appendix D-6. Continued.



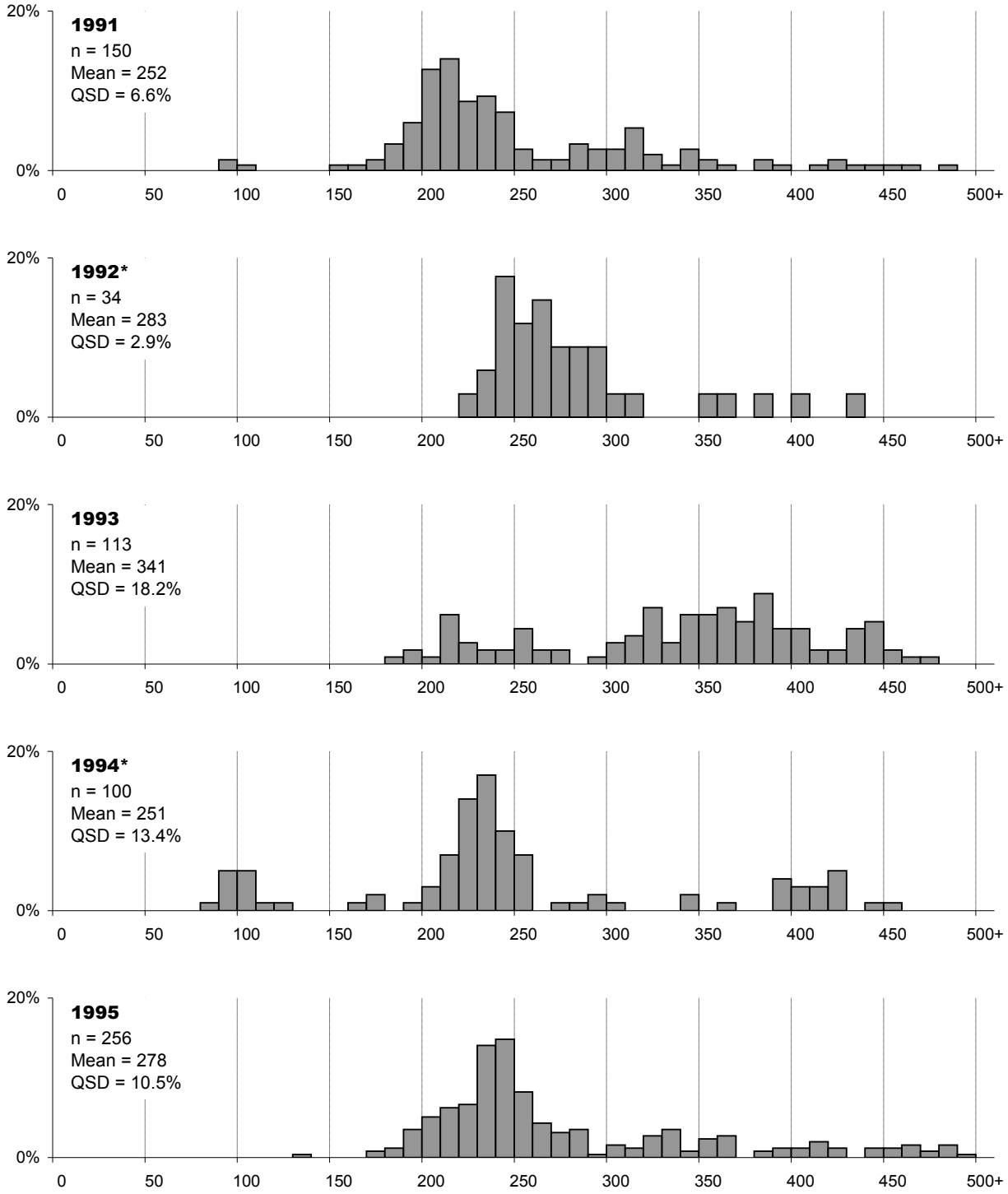

Appendix D-6. Continued.



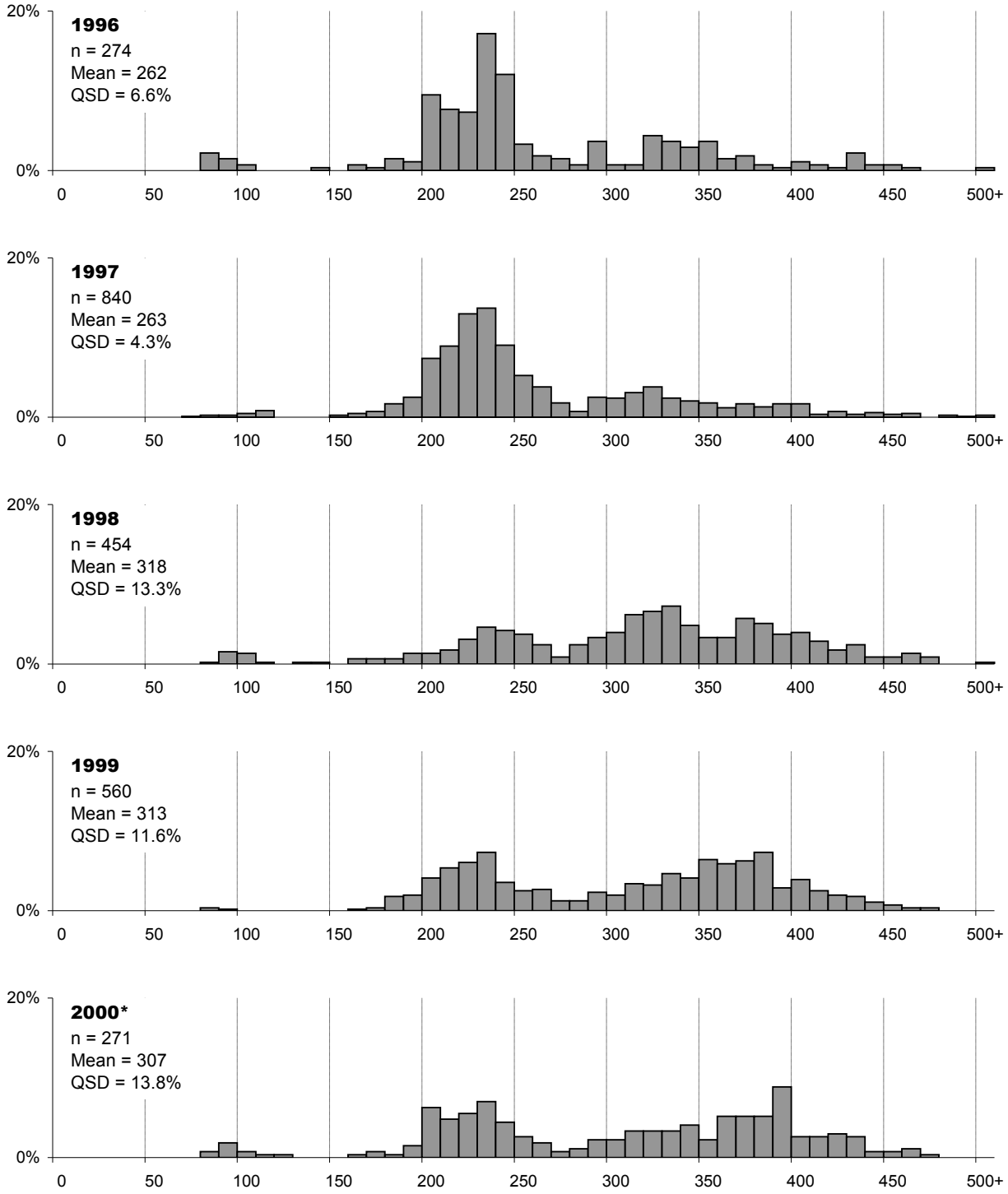

Appendix D-6. Continued.



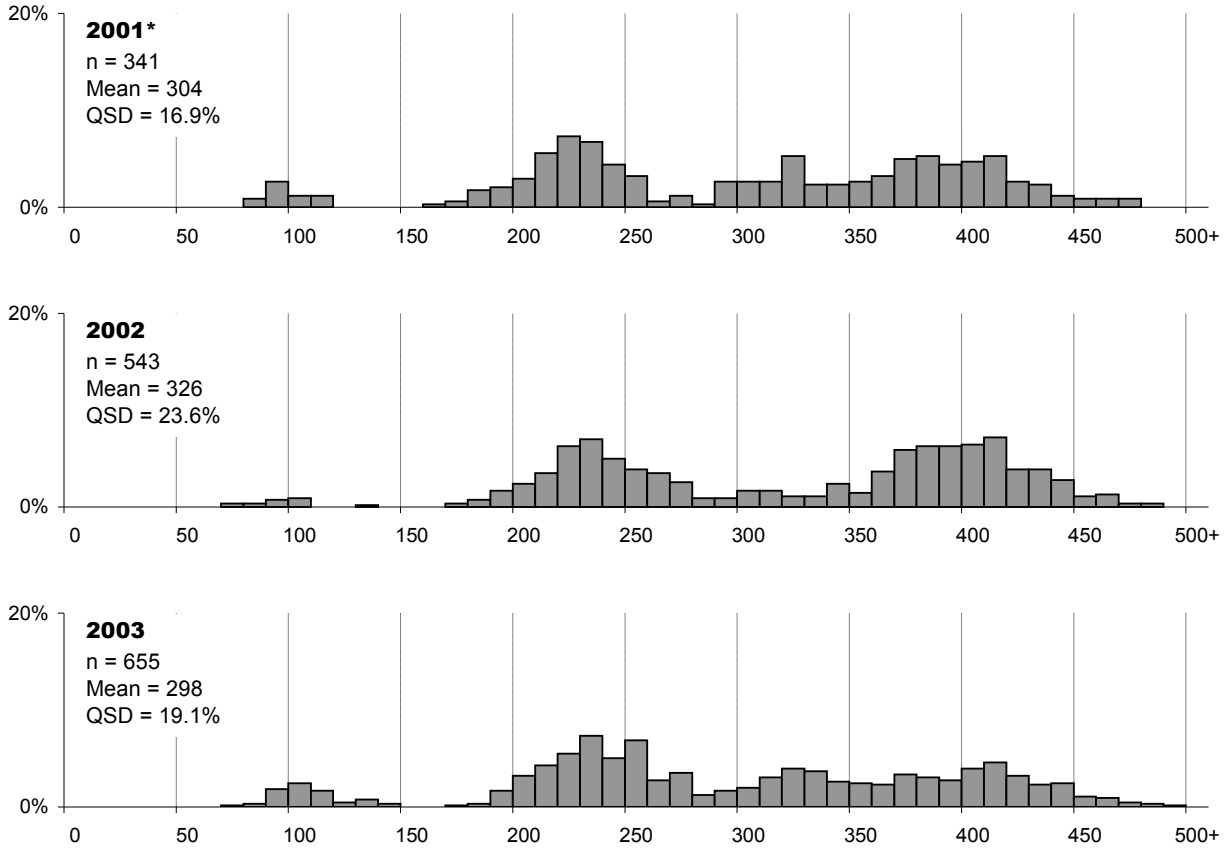

Appendix D-7. Length frequency distributions (TL, mm) of rainbow trout captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2003. Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs equals n. Asterisks denote years lacking recapture runs.



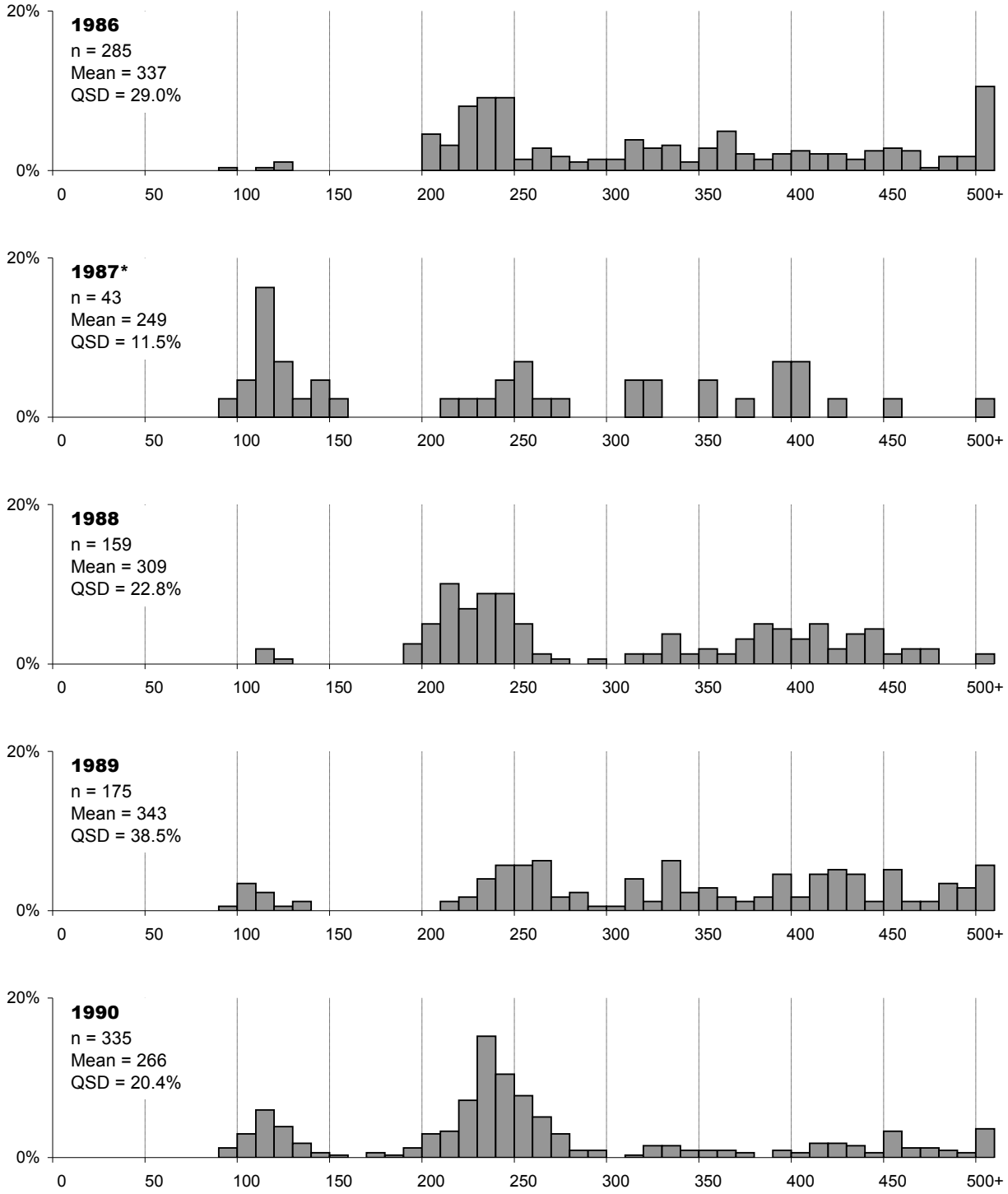

Appendix D-7. Continued.



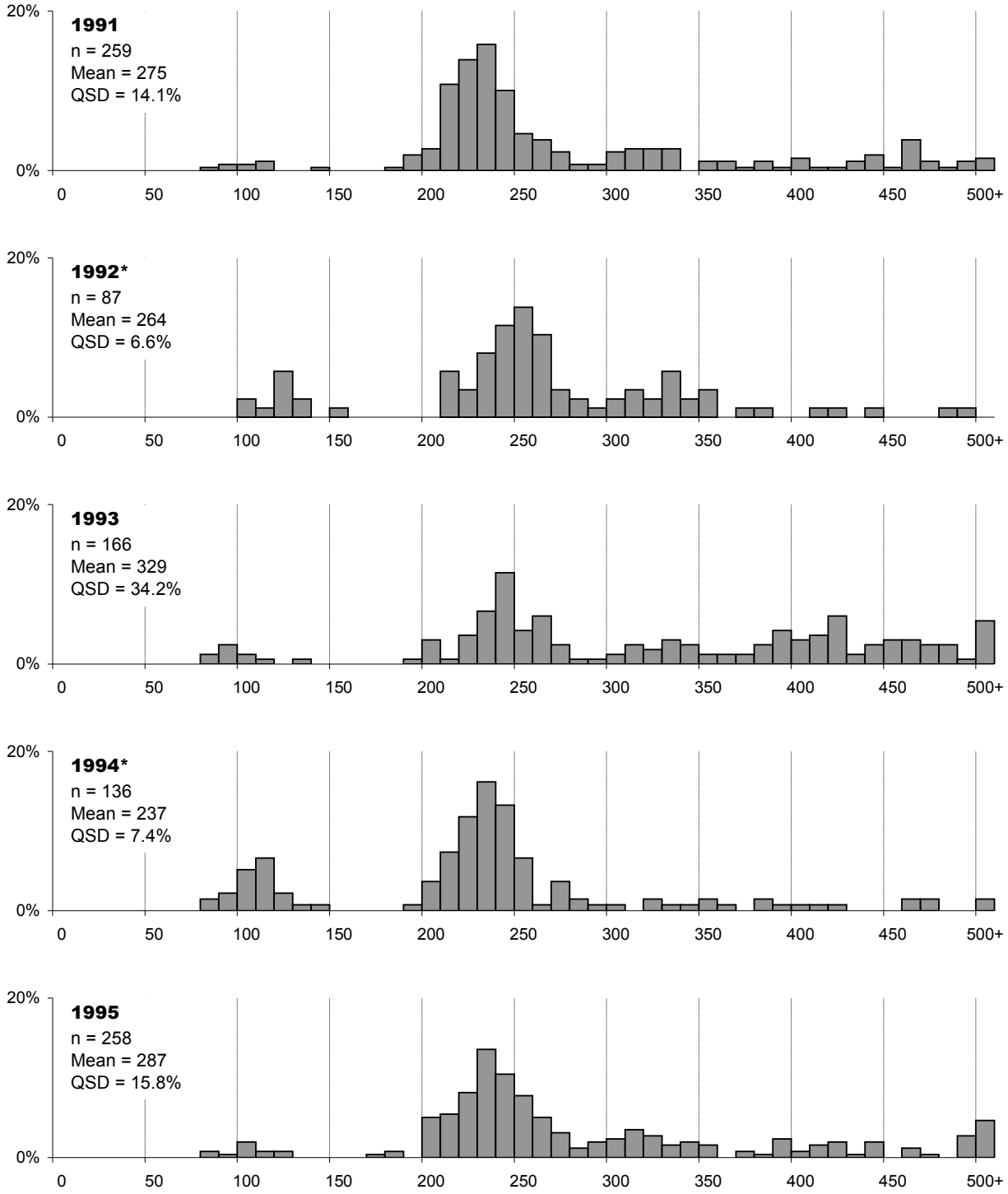

Appendix D-7. Continued.



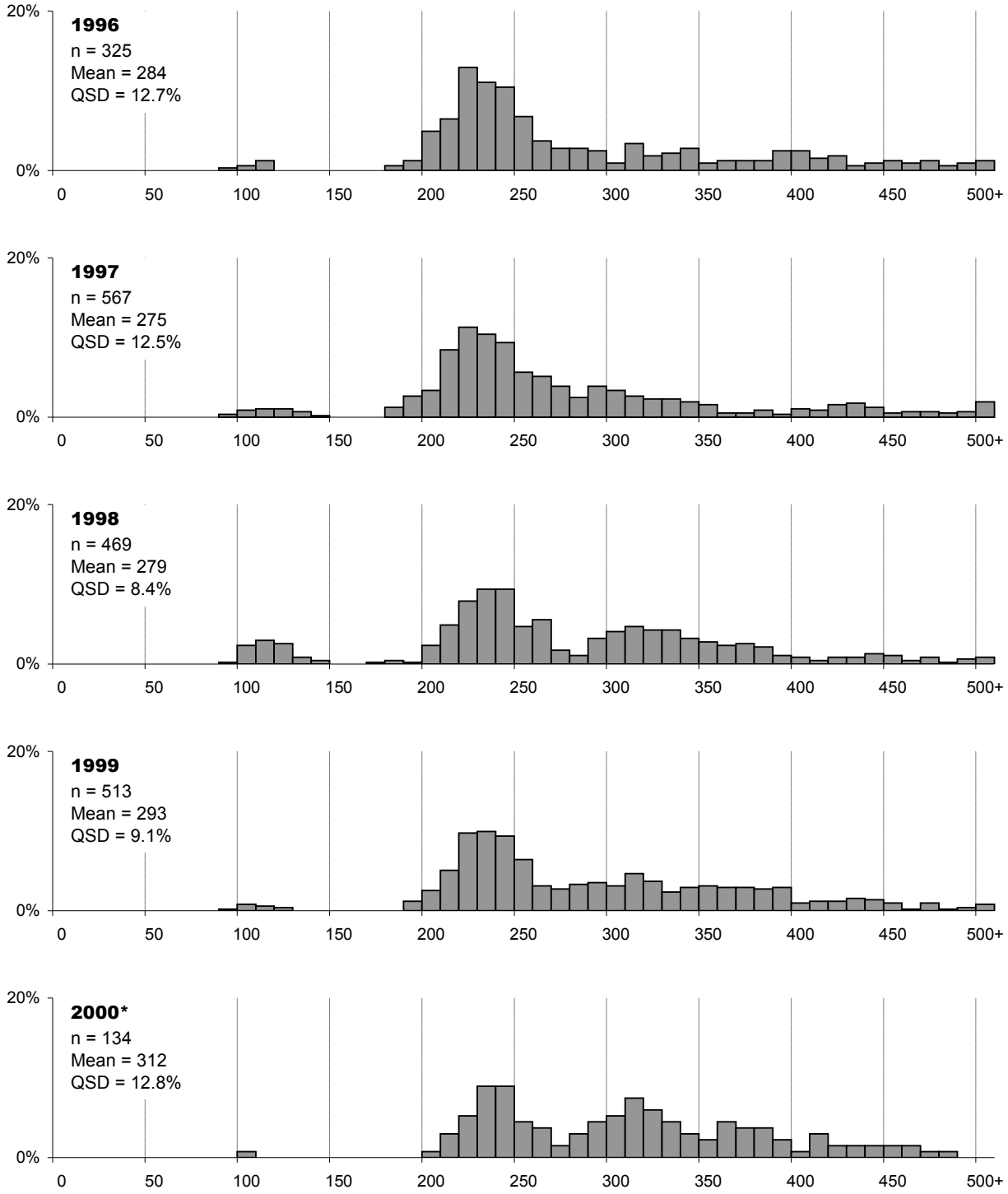

Appendix D-7. Continued.



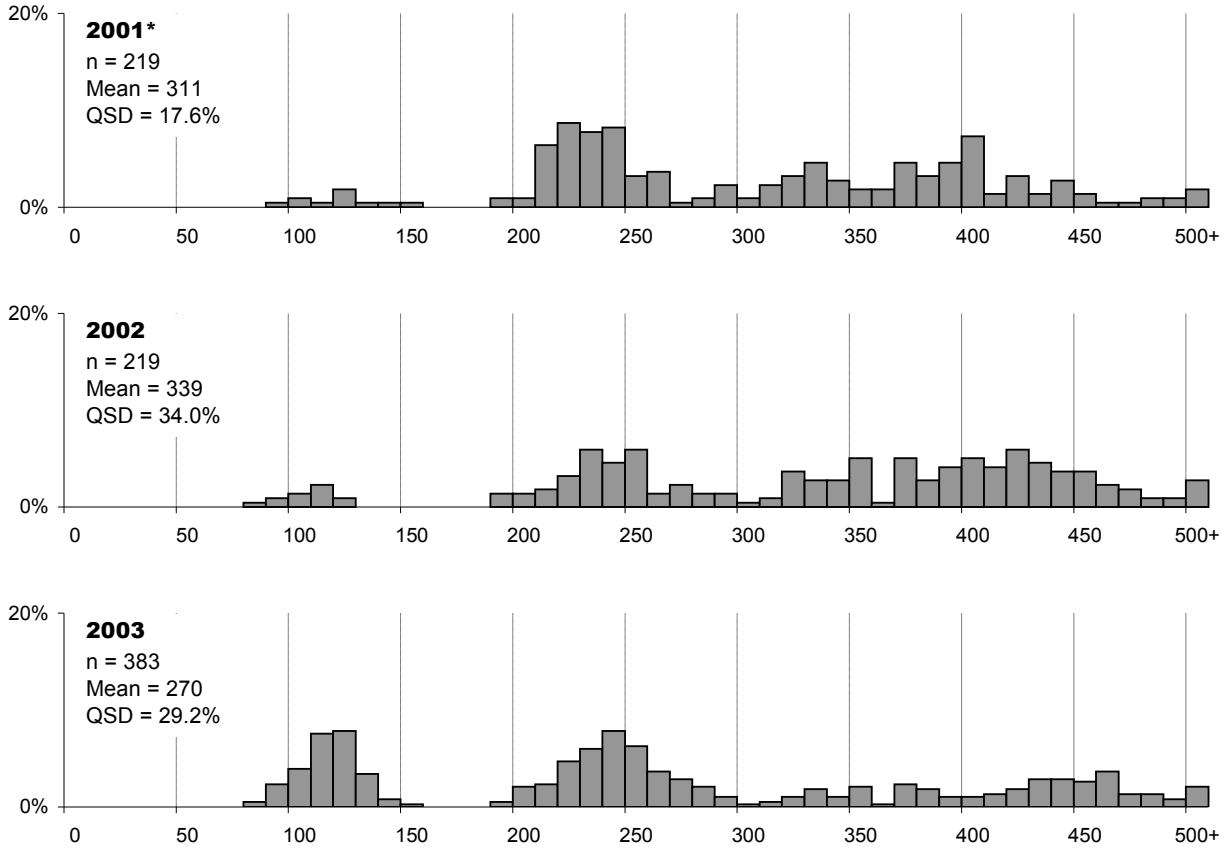

Appendix D-8. Length frequency distributions (TL, mm) of brown trout captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2003. Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs equals n. Asterisks denote years lacking recapture runs.




Appendix D-8. Continued.




Appendix D-8. Continued.




Appendix D-8. Continued.

Appendix E. Mark-recapture statistics and length frequency distributions for the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2003.

Appendix E-1. Trout species composition and relative abundance (percent of catch) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2003 (excluding years not sampled). Age 1 cutthroat trout are 102-254 mm, age 1 rainbow trout are 152-279 mm, and age 1 brown trout are 178-279 mm. Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs are in parentheses.

| | Cutthroat trout[a] | | Rainbow trout | | Brown trout | | Lake trout | Kokanee | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | All | Age 1 | All | Age 1 | All | Age 1 | All | All | All | Age 1 |
| 1987 | 38.3 (203) | 17.1 (18) | 0.4 (2) | 1.0 (1) | 61.3 (325) | 81.9 (86) | 0.0 (0) | 0.0 (0) | 100.0 (530) | 100.0 (105) |
| 1988 | 36.3 (210) | 11.9 (20) | 1.0 (6) | 0.0 (0) | 62.7 (363) | 88.1 (148) | 0.0 (0) | 0.0 (0) | 100.0 (579) | 100.0 (168) |
| 1989 | 34.4 (191) | 28.1 (32) | 0.5 (3) | 0.9 (1) | 65.1 (362) | 71.1 (81) | 0.0 (0) | 0.0 (0) | 100.0 (556) | 100.0 (114) |
| 1990 | 37.8 (288) | 41.7 (133) | 0.3 (2) | 0.0 (0) | 61.9 (471) | 58.3 (186) | 0.0 (0) | 0.0 (0) | 100.0 (761) | 100.0 (319) |
| 1991 | 36.8 (359) | 20.9 (110) | 0.6 (6) | 0.4 (2) | 62.6 (610) | 78.7 (414) | 0.0 (0) | 0.0 (0) | 100.0 (975) | 100.0 (526) |
| 1993 | 36.8 (342) | 6.7 (21) | 1.6 (15) | 2.2 (7) | 61.6 (572) | 91.1 (285) | 0.0 (0) | 0.0 (0) | 100.0 (929) | 100.0 (313) |
| 1995 | 32.3 (441) | 15.0 (68) | 0.7 (9) | 0.2 (1) | 67.1 (917) | 84.7 (383) | 0.0 (0) | 0.0 (0) | 100.0 (1,367) | 100.0 (452) |
| 1999[b] | 23.1 (331) | 4.9 (28) | 0.5 (7) | 0.2 (1) | 76.4 (1,093) | 94.9 (541) | 0.0 (0) | 0.0 (0) | 100.0 (1,431) | 100.0 (570) |
| 2002 | 18.4 (232) | 7.6 (19) | 0.5 (6) | 0.4 (1) | 81.2 (1,026) | 92.0 (229) | 0.0 (0) | 0.0 (0) | 100.0 (1,264) | 100.0 (249) |
| 2003 | 13.2 (161) | 4.4 (16) | 0.3 (4) | 0.0 (0) | 86.4 (1,051) | 95.6 (346) | 0.1 (1) | 0.0 (0) | 100.0 (1,217) | 100.0 (362) |

[a] Includes hatchery cutthroat trout.
[b] Major habitat changes with spring, 1997, runoff.

Appendix E-2. Mean total length and quality stock density (QSD) of trout captured in the fall at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2003 (excluding years not sampled). Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs equals n. QSD = (number ≥406 mm / number ≥203 mm) x 100.

| | Cutthroat trout[a] | | | Rainbow trout | | | Brown trout | | | All trout[b] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | n | Mean (mm) | QSD (%) | n | Mean (mm) | QSD (%) | n | Mean (mm) | QSD (%) | n | Mean (mm) | QSD (%) |
| 1987 | 203 | 325 | 6.1 | 2 | 290 | 0.0 | 325 | 329 | 19.6 | 530 | 327 | 14.3 |
| 1988 | 210 | 332 | 9.9 | 6 | 311 | 0.0 | 363 | 309 | 22.0 | 579 | 317 | 17.2 |
| 1989 | 191 | 331 | 19.2 | 3 | 341 | 0.0 | 362 | 301 | 35.2 | 556 | 311 | 28.7 |
| 1990 | 288 | 297 | 9.9 | 2 | 512 | 100.0 | 471 | 257 | 23.2 | 761 | 273 | 17.4 |
| 1991 | 359 | 301 | 12.9 | 6 | 303 | 0.0 | 610 | 232 | 10.1 | 975 | 258 | 11.2 |
| 1993 | 342 | 325 | 5.3 | 15 | 294 | 15.4 | 572 | 261 | 13.1 | 929 | 285 | 9.9 |
| 1995 | 441 | 317 | 13.7 | 9 | 325 | 11.1 | 917 | 234 | 15.4 | 1,367 | 261 | 14.6 |
| 1999[c] | 331 | 334 | 8.0 | 7 | 350 | 0.0 | 1,093 | 272 | 7.8 | 1,431 | 287 | 7.8 |
| 2002 | 232 | 316 | 2.3 | 6 | 340 | 16.7 | 1,026 | 321 | 14.4 | 1,264 | 321 | 12.1 |
| 2003 | 161 | 332 | 2.6 | 4 | 353 | 0.0 | 1,051 | 296 | 17.3 | 1,217 | 301 | 15.1 |

[a] Includes hatchery cutthroat trout.
[b] Includes other trout, i.e. lake trout and kokanee.
[c] Major habitat changes with spring, 1997, runoff.

Appendix E-3. Mark-recapture statistics for age-1 and older cutthroat trout (≥102 mm), rainbow trout (≥152 mm), brown trout (≥178 mm), and all trout (≥102 mm) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2003 (excluding years not sampled). Cases where $R \leq 3$ and unbiased density estimates are not possible (Ricker 1975) are highlighted.

| | Cutthroat trout[a] | | | | Rainbow trout | | | | Brown trout | | | | All trout[b] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | *M*[c] | *C*[c] | *R*[c] | *R/C* (%) | *M* | *C* | *R* | *R/C* (%) | *M* | *C* | *R* | *R/C* (%) | *M* | *C* | *R* | *R/C* (%) |
| 1987 | 146 | 63 | 6 | 9.5 | 2 | 0 | 0 | 0.0 | 225 | 102 | 12 | 11.8 | 380 | 168 | 18 | 10.7 |
| 1988 | 133 | 88 | 13 | 14.8 | 3 | 2 | 0 | 0.0 | 241 | 130 | 23 | 17.7 | 386 | 225 | 36 | 16.0 |
| 1989 | 119 | 74 | 13 | 17.6 | 1 | 2 | 0 | 0.0 | 199 | 97 | 22 | 22.7 | 377 | 204 | 35 | 17.2 |
| 1990 | 208 | 91 | 12 | 13.2 | 2 | 0 | 0 | 0.0 | 260 | 93 | 23 | 24.7 | 549 | 240 | 35 | 14.6 |
| 1991 | 199 | 175 | 17 | 9.7 | 0 | 6 | 0 | 0.0 | 319 | 234 | 47 | 20.1 | 560 | 474 | 64 | 13.5 |
| 1993 | 144 | 201 | 18 | 9.0 | 6 | 8 | 0 | 0.0 | 238 | 270 | 27 | 10.0 | 420 | 531 | 45 | 8.5 |
| 1995 | 264 | 196 | 22 | 11.2 | 4 | 5 | 0 | 0.0 | 325 | 341 | 41 | 12.0 | 677 | 731 | 66 | 9.0 |
| 1999[d] | 194 | 163 | 26 | 16.0 | 3 | 4 | 0 | 0.0 | 500 | 588 | 55 | 9.4 | 711 | 798 | 82 | 10.3 |
| 2002 | 108 | 138 | 14 | 10.1 | 4 | 3 | 1 | 33.3 | 457 | 579 | 61 | 10.5 | 582 | 750 | 76 | 10.1 |
| 2003 | 90 | 81 | 11 | 13.6 | 2 | 2 | 0 | 0.0 | 557 | 432 | 61 | 14.1 | 668 | 593 | 72 | 12.1 |

[a] Includes hatchery cutthroat trout.
[b] Includes other trout, i.e. lake trout and kokanee.
[c] *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.
[d] Major habitat changes with spring, 1997, runoff.

Appendix E-4. Estimated abundance (N) of age 1 and older cutthroat trout (≥102 mm), rainbow trout (≥152 mm), brown trout (≥178 mm), and all trout (≥102 mm) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2003 (excluding years not sampled). Confidence intervals (±95%) are in parentheses. Cases where $R \leq 3$ and unbiased estimates are not possible (Ricker 1975) are highlighted.

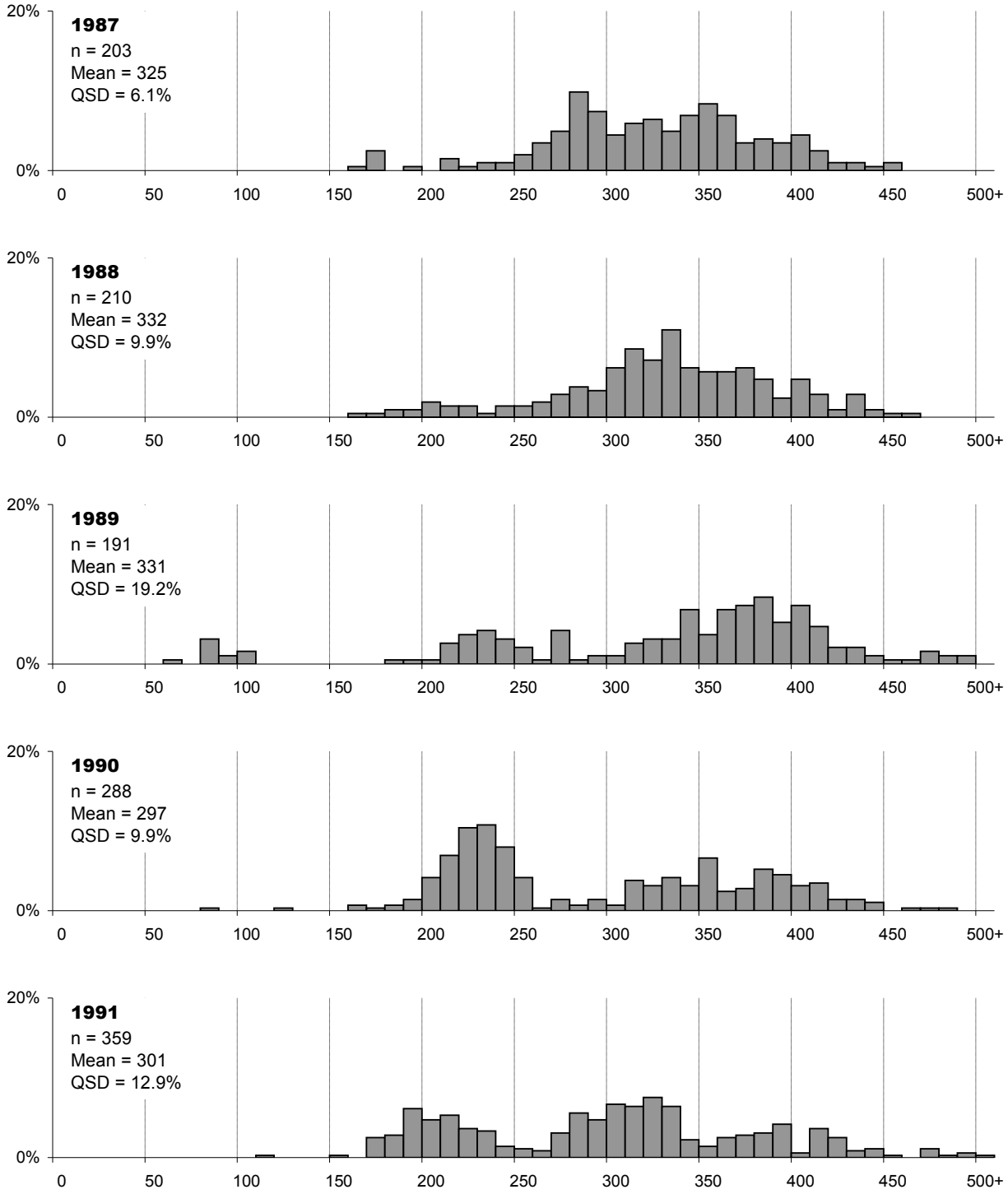
| Year | Cutthroat trout[a] | | Rainbow trout | | Brown trout | | All trout[b] | |
|---|---|---|---|---|---|---|---|---|
| | N/section | N/km | N/section | N/km | N/section | N/km | N/section | N/km |
| 1987 | 2,027 (992) | 422 (207) | NUE[c] | NUE | 2,548 (769) | 531 (160) | 4,657 (933) | 970 (194) |
| 1988 | 896 (227) | 187 (47) | NUE | NUE | 1,442 (421) | 300 (88) | 2,539 (468) | 529 (98) |
| 1989 | 1,188 (468) | 248 (98) | NUE | NUE | 890 (181) | 185 (38) | 3,250 (565) | 677 (118) |
| 1990 | 1,478[d] (695) | 308[d] (145) | NUE | NUE | 1,307 (473) | 272 (99) | 4,554 (706) | 949 (147) |
| 1991 | 2,136 (699) | 445 (146) | NUE | NUE | 1,773 (270) | 369 (56) | 4,575 (626) | 953 (130) |
| 1993 | 2,337 (744) | 487 (155) | NUE | NUE | 2,663 (506) | 555 (105) | 5,822 (700) | 1,213 (146) |
| 1995 | 2,727 (555) | 568 (116) | NUE | NUE | 3,066 (486) | 639 (101) | 7,617 (687) | 1,587 (143) |
| 1999[e] | 1,608 (388) | 335 (81) | NUE | NUE | 5,520 (774) | 1,150 (161) | 7,130 (699) | 1,485 (146) |
| 2002 | 1,179 (311) | 246 (65) | NUE | NUE | 4,942 (563) | 1,030 (117) | 6,650 (625) | 1,385 (130) |
| 2003 | 1,137 (636) | 237 (133) | NUE | NUE | 4,446 (529) | 926 (110) | 5,683 (574) | 1,184 (120) |

[a] Includes hatchery cutthroat trout.
[b] Includes other trout, i.e. lake trout and kokanee.
[c] NUE = unbiased estimate not possible as $R \leq 3$.
[d] Modified Peterson rather than log-likelihood estimate.
[e] Major habitat changes with spring, 1997, runoff.

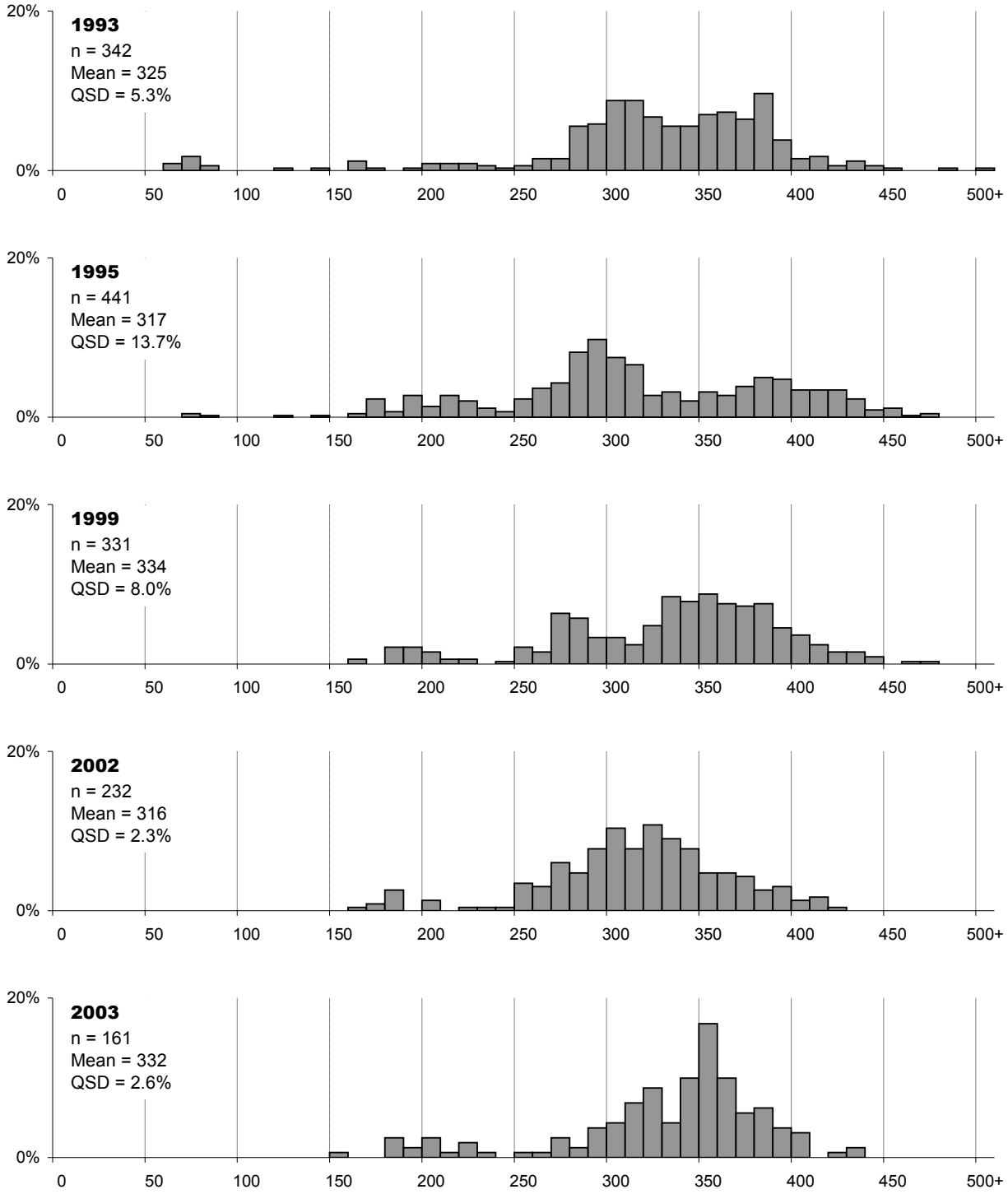
Appendix E-5. Estimated abundance (N) of age 1 cutthroat trout (102-254 mm), rainbow trout (152-279 mm), brown trout (178-279 mm), and all trout combined at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2003 (excluding years not sampled). Confidence intervals (±95%) are in parentheses. Cases where estimates are not possible are highlighted.

| | Cutthroat trout | | Rainbow trout | | Brown trout | | All trout (sum) | | Cutthroat trout N / rainbow trout N | Cutthroat trout N / brown trout N |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | N/section | N/km | N/section | N/km | N/section | N/km | N/section | N/km | | |
| 1987 | 469 (494) | 98 (103) | NE[a] | NE | 1,206 (668) | 251 (139) | 1,675 | 349 | NE | 0.4 |
| 1988 | 98 (59) | 20 (12) | NE | NE | 618 (184) | 129 (38) | 716 | 149 | NE | 0.2 |
| 1989 | 470 (383) | 98 (80) | NE | NE | 310 (110) | 65 (23) | 780 | 163 | NE | 1.5 |
| 1990 | NE | NE | NE | NE | 700 (168) | 146 (35) | 700 | 146 | NE | NE |
| 1991 | 680 (269) | 142 (56) | NE | NE | 1,499 (243) | 312 (51) | 2,179 | 454 | NE | 0.5 |
| 1993 | 378 (269) | 79 (56) | NE | NE | 1,706 (396) | 355 (83) | 2,084 | 434 | NE | 0.2 |
| 1995 | 841 (316) | 175 (66) | NE | NE | 2,003 (352) | 417 (73) | 2,844 | 593 | NE | 0.4 |
| 1999[b] | 298 (188) | 62 (39) | NE | NE | 3,154 (588) | 657 (123) | 3,452 | 719 | NE | 0.1 |
| 2002 | 213 (146) | 44 (30) | NE | NE | 1,827 (433) | 381 (90) | 2,040 | 425 | NE | 0.1 |
| 2003 | 334 (471) | 70 (98) | NE | NE | 2,230 (459) | 465 (96) | 2,564 | 534 | NE | 0.1 |

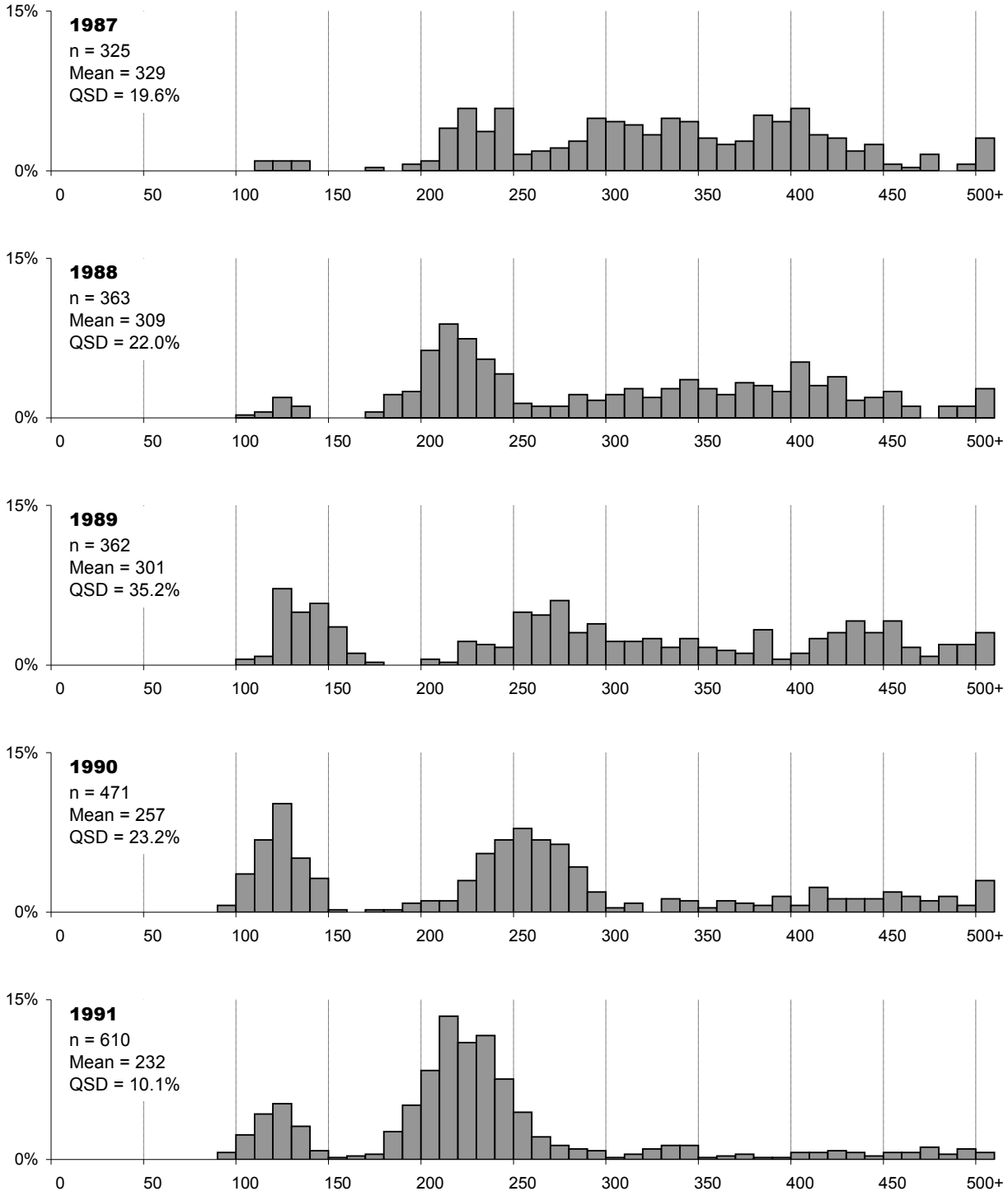
[a] NE = no estimate.
[b] Major habitat changes with spring, 1997, runoff.



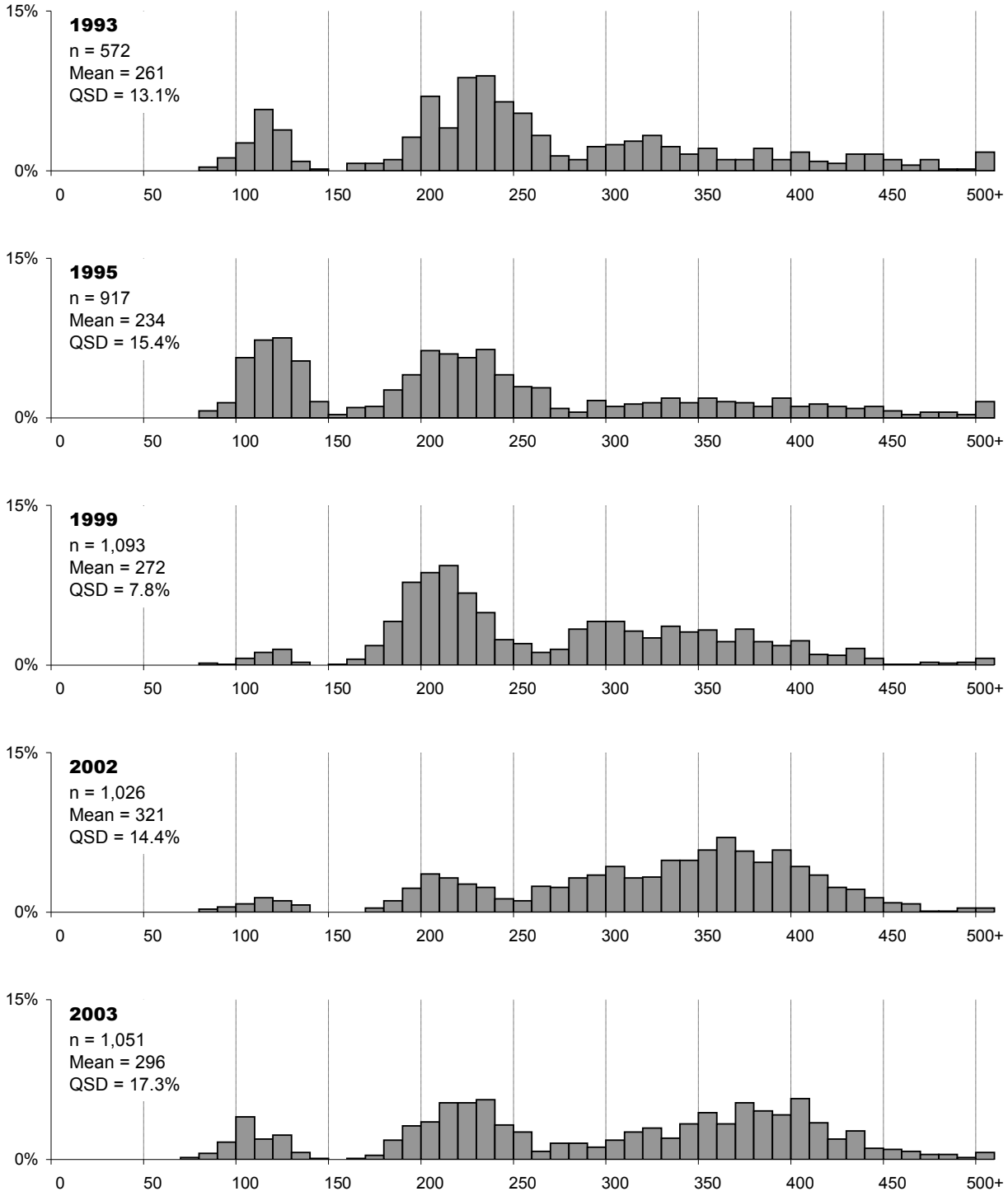

Appendix E-6. Length frequency distributions (TL, mm) of cutthroat trout captured in the fall at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2003 (excluding years not sampled). Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs equals n. Asterisks denote years lacking recapture runs.




Appendix E-6. Continued.




Appendix E-7. Length frequency distributions (TL, mm) of brown trout captured in the fall at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2003 (excluding years not sampled). Total individual fish captured during mark (*M*) and recapture (*C* - *R*) runs equals n. Asterisks denote years lacking recapture runs.




Appendix E-7. Continued.

Appendix F. Creel survey statistics for the South Fork Snake River, Idaho, 2003.

Appendix F-1. Estimated effort (h) by section and two-week interval, South Fork Snake River, Idaho, 2003. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

| Interval number | Beginning date | Section 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Jan 4 | ND[a] | ND | ND | ND | 123 | 193 | 214 | 530 |
| 2 | Jan 18 | ND | ND | ND | ND | 414 | 250 | 109 | 773 |
| 3 | Feb 1 | ND | ND | ND | ND | 217 | 214 | 81 | 512 |
| 4 | Feb 15 | ND | ND | ND | ND | 212 | 158 | 295 | 665 |
| 5 | Mar 1 | ND | ND | ND | ND | 506 | 253 | 514 | 1,273 |
| 6 | Mar 15 | ND | ND | ND | ND | 729 | 546 | 921 | 2,196 |
| 7 | Mar 29 | ND | ND | ND | ND | 1,002 | 1,066 | 965 | 3,033 |
| 8 | Apr 12 | ND | ND | ND | ND | 619 | 1,379 | 585 | 2,583 |
| 9 | Apr 26 | ND | ND | ND | ND | 322 | 587 | 558 | 1,467 |
| 10 | May 10 | ND | ND | ND | ND | 595 | 764 | 511 | 1,870 |
| 11 | May 24 | 6,189 | 3,074 | 1,946 | 2,672 | 1,326 | 456 | 829 | 16,492 |
| 12 | Jun 7 | 1,922 | 2,568 | 809 | 2,183 | 961 | 1,200 | 1,560 | 11,203 |
| 13 | Jun 21 | 2,184 | 8,544 | 8,413 | 12,627 | 1,737 | 1,033 | 1,247 | 35,785 |
| 14 | Jul 5 | 4,052 | 14,877 | 8,118 | 6,511 | 1,357 | 865 | 667 | 36,447 |
| 15 | Jul 19 | 2,474 | 6,739 | 2,022 | 3,535 | 1,238 | 665 | 1,218 | 17,891 |
| 16 | Aug 2 | 1,895 | 6,754 | 3,684 | 5,248 | 602 | 644 | 1,395 | 20,222 |
| 17 | Aug 16 | 1,271 | 6,026 | 3,389 | 2,780 | 424 | 301 | 976 | 15,167 |
| 18 | Aug 30 | 2,130 | 3,278 | 2,559 | 2,940 | 566 | 737 | 1,227 | 13,437 |
| 19 | Sep 13 | 1,489 | 2,299 | 1,882 | 3,561 | 973 | 1,249 | 1,288 | 12,741 |
| 20 | Sep 27 | 1,427 | 1,655 | 1,725 | 2,941 | 397 | 1,242 | 1,962 | 11,349 |
| 21 | Oct 11 | 766 | 1,069 | 595 | 790 | 384 | 546 | 1,068 | 5,218 |
| 22 | Oct 25 | 318 | 422 | 123 | 464 | 221 | 226 | 391 | 2,165 |
| 23 | Nov 8 | 233 | 269 | 39 | 385 | 88 | 130 | 140 | 1,284 |
| 24 | Nov 22 | 88 | 348 | 0 | 244 | 173 | 218 | 304 | 1,375 |
| 25 | Dec 6 | ND | ND | ND | ND | 159 | 93 | 90 | 342 |
| 26 | Dec 20 | ND | ND | ND | ND | 27 | 13 | 121 | 161 |
| Total | | 26,438 | 57,922 | 35,304 | 46,881 | 15,372 | 15,028 | 19,236 | 216,181 |
| 95% CI | | ±4,544 | ±10,925 | ±7,338 | ±7,995 | ±2,136 | ±2,334 | ±2,966 | ±16,630 |

[a] ND = no data; season closed.

Appendix F-2. Estimated catch by section and two-week interval, South Fork Snake River, Idaho, 2003. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

| Interval number | Beginning date | Section 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Jan 4 | ND[a] | ND | ND | ND | 184 | 147 | 398 | 729 |
| 2 | Jan 18 | ND | ND | ND | ND | 416 | 163 | 0 | 579 |
| 3 | Feb 1 | ND | ND | ND | ND | 155 | 109 | 15 | 279 |
| 4 | Feb 15 | ND | ND | ND | ND | 178 | 279 | 412 | 869 |
| 5 | Mar 1 | ND | ND | ND | ND | 862 | 262 | 850 | 1,974 |
| 6 | Mar 15 | ND | ND | ND | ND | 576 | 447 | 1,141 | 2,164 |
| 7 | Mar 29 | ND | ND | ND | ND | 1,645 | 1,032 | 1,175 | 3,852 |
| 8 | Apr 12 | ND | ND | ND | ND | 247 | 529 | 370 | 1,146 |
| 9 | Apr 26 | ND | ND | ND | ND | 361 | 322 | 468 | 1,151 |
| 10 | May 10 | ND | ND | ND | ND | 1,610 | 1,124 | 355 | 3,089 |
| 11 | May 24 | 6,177 | 874 | 1,244 | 1,985 | 715 | 339 | 695 | 12,029 |
| 12 | Jun 7 | 1,114 | 1,168 | 0 | 1,858 | 772 | 2,117 | 533 | 7,562 |
| 13 | Jun 21 | 1,270 | 4,519 | 5,698 | 15,618 | 1,375 | 1,424 | 233 | 30,137 |
| 14 | Jul 5 | 1,866 | 10,550 | 3,939 | 4,464 | 1,016 | 447 | 77 | 22,359 |
| 15 | Jul 19 | 992 | 4,208 | 0 | 2,254 | 1,342 | 357 | 360 | 9,513 |
| 16 | Aug 2 | 360 | 1,445 | 1,577 | 3,637 | 457 | 752 | 918 | 9,146 |
| 17 | Aug 16 | 249 | 2,295 | 1,958 | 1,618 | 161 | 192 | 1,134 | 7,607 |
| 18 | Aug 30 | 3,292 | 1,676 | 863 | 2,306 | 365 | 487 | 1,083 | 10,072 |
| 19 | Sep 13 | 959 | 1,239 | 285 | 1,873 | 574 | 1,432 | 1,333 | 7,695 |
| 20 | Sep 27 | 634 | 0 | 498 | 2,586 | 324 | 1,511 | 2,677 | 8,230 |
| 21 | Oct 11 | 584 | 712 | 0 | 0 | 205 | 757 | 1,296 | 3,554 |
| 22 | Oct 25 | 322 | 0 | 197 | 595 | 159 | 253 | 275 | 1,801 |
| 23 | Nov 8 | 296 | 35 | 104 | 328 | 30 | 246 | 124 | 1,163 |
| 24 | Nov 22 | 89 | 1,237 | 0 | 695 | 111 | 21 | 558 | 2,711 |
| 25 | Dec 6 | ND | ND | ND | ND | 172 | 168 | 100 | 440 |
| 26 | Dec 20 | ND | ND | ND | ND | 0 | 7 | 88 | 95 |
| Total | | 18,204 | 29,958 | 16,363 | 39,817 | 14,012 | 14,924 | 16,668 | 149,946 |
| 95% CI | | ±6,037 | ±7,803 | ±5,082 | ±11,012 | ±3,196 | ±4,385 | ±3,494 | ±16,913 |

[a] ND = no data; season closed.

Appendix F-3. Estimated harvest by section and two-week interval, South Fork Snake River, Idaho, 2003. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

| Interval number | Beginning date | Section 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Jan 4 | ND[a] | ND | ND | ND | 0 | 29 | 0 | 29 |
| 2 | Jan 18 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 3 | Feb 1 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 4 | Feb 15 | ND | ND | ND | ND | 0 | 5 | 0 | 5 |
| 5 | Mar 1 | ND | ND | ND | ND | 150 | 58 | 121 | 329 |
| 6 | Mar 15 | ND | ND | ND | ND | 166 | 132 | 89 | 387 |
| 7 | Mar 29 | ND | ND | ND | ND | 32 | 42 | 30 | 104 |
| 8 | Apr 12 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 9 | Apr 26 | ND | ND | ND | ND | 40 | 35 | 66 | 141 |
| 10 | May 10 | ND | ND | ND | ND | 49 | 39 | 14 | 102 |
| 11 | May 24 | 1,221 | 353 | 103 | 125 | 69 | 0 | 0 | 1,871 |
| 12 | Jun 7 | 242 | 262 | 0 | 66 | 65 | 33 | 20 | 688 |
| 13 | Jun 21 | 119 | 135 | 110 | 507 | 121 | 0 | 0 | 992 |
| 14 | Jul 5 | 267 | 471 | 125 | 193 | 47 | 0 | 0 | 1,103 |
| 15 | Jul 19 | 74 | 773 | 0 | 0 | 0 | 24 | 0 | 871 |
| 16 | Aug 2 | 45 | 64 | 0 | 78 | 14 | 0 | 17 | 218 |
| 17 | Aug 16 | 22 | 74 | 36 | 176 | 0 | 6 | 45 | 359 |
| 18 | Aug 30 | 546 | 92 | 0 | 56 | 0 | 0 | 32 | 726 |
| 19 | Sep 13 | 267 | 0 | 0 | 39 | 0 | 0 | 0 | 306 |
| 20 | Sep 27 | 69 | 0 | 0 | 0 | 19 | 41 | 0 | 129 |
| 21 | Oct 11 | 110 | 102 | 0 | 0 | 0 | 40 | 15 | 267 |
| 22 | Oct 25 | 35 | 0 | 0 | 13 | 0 | 41 | 0 | 89 |
| 23 | Nov 8 | 40 | 7 | 20 | 17 | 0 | 17 | 0 | 101 |
| 24 | Nov 22 | 11 | 0 | 0 | 83 | 0 | 0 | 36 | 130 |
| 25 | Dec 6 | ND | ND | ND | ND | 30 | 0 | 0 | 30 |
| 26 | Dec 20 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| Total | | 3,068 | 2,333 | 394 | 1,353 | 802 | 542 | 485 | 8,977 |
| 95% CI | | ±1,242 | ±1,709 | ±233 | ±801 | ±437 | ±320 | ±248 | ±2,348 |

[a] ND = no data; season closed.

Appendix F-4. Estimated cutthroat trout harvest by section and two-week interval, South Fork Snake River, Idaho, 2003. The upper river (sections 1-4), summer season (intervals 11-18) is shaded. Results include hatchery cutthroat trout flushed from Palisades Reservoir.

| Interval number | Beginning date | Section 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Jan 4 | ND[a] | ND | ND | ND | 0 | 0 | 0 | 0 |
| 2 | Jan 18 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 3 | Feb 1 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 4 | Feb 15 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 5 | Mar 1 | ND | ND | ND | ND | 0 | 19 | 0 | 19 |
| 6 | Mar 15 | ND | ND | ND | ND | 0 | 0 | 9 | 9 |
| 7 | Mar 29 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 8 | Apr 12 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 9 | Apr 26 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 10 | May 10 | ND | ND | ND | ND | 12 | 3 | 0 | 15 |
| 11 | May 24 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| 12 | Jun 7 | 81 | 0 | 0 | 0 | 6 | 0 | 0 | 87 |
| 13 | Jun 21 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 50 |
| 14 | Jul 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | Jul 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | Aug 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | Aug 16 | 0 | 8 | 0 | 0 | 0 | 6 | 0 | 14 |
| 18 | Aug 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Sep 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Sep 27 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| 21 | Oct 11 | 11 | 0 | 0 | 0 | 0 | 0 | 7 | 18 |
| 22 | Oct 25 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 13 |
| 23 | Nov 8 | 6 | 0 | 3 | 2 | 0 | 0 | 0 | 11 |
| 24 | Nov 22 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 25 | Dec 6 | ND | ND | ND | ND | 30 | 0 | 0 | 30 |
| 26 | Dec 20 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| Total | | 114 | 8 | 3 | 15 | 102 | 28 | 16 | 286 |
| 95% CI | | ±158 | ±5 | ±7 | ±25 | ±113 | ±55 | ±26 | ±206 |

[a] ND = no data; season closed.

Appendix F-5. Estimated rainbow trout harvest by section and two-week interval, South Fork Snake River, Idaho, 2003. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

| Interval number | Beginning date | Section 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Jan 4 | ND[a] | ND | ND | ND | 0 | 0 | 0 | 0 |
| 2 | Jan 18 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 3 | Feb 1 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 4 | Feb 15 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 5 | Mar 1 | ND | ND | ND | ND | 6 | 0 | 0 | 6 |
| 6 | Mar 15 | ND | ND | ND | ND | 27 | 23 | 9 | 59 |
| 7 | Mar 29 | ND | ND | ND | ND | 0 | 20 | 0 | 20 |
| 8 | Apr 12 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 9 | Apr 26 | ND | ND | ND | ND | 14 | 7 | 0 | 21 |
| 10 | May 10 | ND | ND | ND | ND | 12 | 0 | 0 | 12 |
| 11 | May 24 | 799 | 331 | 70 | 125 | 69 | 0 | 0 | 1,394 |
| 12 | Jun 7 | 0 | 262 | 0 | 28 | 6 | 25 | 0 | 321 |
| 13 | Jun 21 | 40 | 111 | 110 | 507 | 17 | 0 | 0 | 785 |
| 14 | Jul 5 | 222 | 471 | 78 | 193 | 31 | 0 | 0 | 995 |
| 15 | Jul 19 | 37 | 631 | 0 | 0 | 0 | 0 | 0 | 668 |
| 16 | Aug 2 | 0 | 43 | 0 | 48 | 14 | 0 | 0 | 105 |
| 17 | Aug 16 | 0 | 56 | 36 | 97 | 0 | 0 | 0 | 189 |
| 18 | Aug 30 | 138 | 84 | 0 | 43 | 0 | 0 | 18 | 283 |
| 19 | Sep 13 | 76 | 0 | 0 | 39 | 0 | 0 | 0 | 115 |
| 20 | Sep 27 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 10 |
| 21 | Oct 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | Oct 25 | 18 | 0 | 0 | 0 | 0 | 28 | 0 | 46 |
| 23 | Nov 8 | 6 | 0 | 16 | 15 | 0 | 0 | 0 | 37 |
| 24 | Nov 22 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 4 |
| 25 | Dec 6 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 26 | Dec 20 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| Total | | 1,338 | 1,989 | 310 | 1,097 | 206 | 103 | 27 | 5,070 |
| 95% CI | | ±800 | ±1,585 | ±220 | ±764 | ±114 | ±98 | ±37 | ±1,951 |

[a] ND = no data; season closed.

Appendix F-6. Estimated brown trout harvest by section and two-week interval, South Fork Snake River, Idaho, 2003. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

| Interval number | Beginning date | Section 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Jan 4 | ND[a] | ND | ND | ND | 0 | 29 | 0 | 29 |
| 2 | Jan 18 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 3 | Feb 1 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 4 | Feb 15 | ND | ND | ND | ND | 0 | 5 | 0 | 5 |
| 5 | Mar 1 | ND | ND | ND | ND | 29 | 0 | 121 | 150 |
| 6 | Mar 15 | ND | ND | ND | ND | 0 | 16 | 57 | 73 |
| 7 | Mar 29 | ND | ND | ND | ND | 32 | 22 | 30 | 84 |
| 8 | Apr 12 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 9 | Apr 26 | ND | ND | ND | ND | 26 | 28 | 66 | 120 |
| 10 | May 10 | ND | ND | ND | ND | 24 | 36 | 14 | 74 |
| 11 | May 24 | 293 | 23 | 32 | 0 | 0 | 0 | 0 | 348 |
| 12 | Jun 7 | 161 | 0 | 0 | 38 | 54 | 8 | 20 | 281 |
| 13 | Jun 21 | 78 | 28 | 0 | 0 | 56 | 0 | 0 | 162 |
| 14 | Jul 5 | 45 | 0 | 46 | 0 | 15 | 0 | 0 | 106 |
| 15 | Jul 19 | 37 | 137 | 0 | 0 | 0 | 24 | 0 | 198 |
| 16 | Aug 2 | 16 | 0 | 0 | 32 | 0 | 0 | 0 | 48 |
| 17 | Aug 16 | 22 | 8 | 0 | 79 | 0 | 0 | 45 | 154 |
| 18 | Aug 30 | 408 | 10 | 0 | 15 | 0 | 0 | 14 | 447 |
| 19 | Sep 13 | 191 | 0 | 0 | 0 | 0 | 0 | 0 | 191 |
| 20 | Sep 27 | 69 | 0 | 0 | 0 | 4 | 41 | 0 | 114 |
| 21 | Oct 11 | 99 | 0 | 0 | 0 | 0 | 27 | 7 | 133 |
| 22 | Oct 25 | 18 | 0 | 0 | 0 | 0 | 14 | 0 | 32 |
| 23 | Nov 8 | 23 | 7 | 0 | 0 | 0 | 17 | 0 | 47 |
| 24 | Nov 22 | 7 | 0 | 0 | 81 | 0 | 0 | 36 | 124 |
| 25 | Dec 6 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| 26 | Dec 20 | ND | ND | ND | ND | 0 | 0 | 0 | 0 |
| Total | | 1,467 | 213 | 78 | 245 | 240 | 267 | 410 | 2,920 |
| 95% CI | | ±743 | ±305 | ±123 | ±186 | ±167 | ±180 | ±221 | ±897 |

[a] ND = no data; season closed.

Appendix F-7. Estimated catch rate (catch divided by effort) by section and two-week interval, South Fork Snake River, Idaho, 2003. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

| Interval number | Beginning date | Section 1 | 2 | 3 | 4 | 5 | 6 | 7 | Overall |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Jan 4 | ND[a] | ND | ND | ND | 1.50 | 0.76 | 1.86 | 1.38 |
| 2 | Jan 18 | ND | ND | ND | ND | 1.00 | 0.65 | 0.00 | 0.75 |
| 3 | Feb 1 | ND | ND | ND | ND | 0.71 | 0.51 | 0.19 | 0.54 |
| 4 | Feb 15 | ND | ND | ND | ND | 0.84 | 1.77 | 1.40 | 1.31 |
| 5 | Mar 1 | ND | ND | ND | ND | 1.70 | 1.04 | 1.65 | 1.55 |
| 6 | Mar 15 | ND | ND | ND | ND | 0.79 | 0.82 | 1.24 | 0.99 |
| 7 | Mar 29 | ND | ND | ND | ND | 1.64 | 0.97 | 1.22 | 1.27 |
| 8 | Apr 12 | ND | ND | ND | ND | 0.40 | 0.38 | 0.63 | 0.44 |
| 9 | Apr 26 | ND | ND | ND | ND | 1.12 | 0.55 | 0.84 | 0.78 |
| 10 | May 10 | ND | ND | ND | ND | 2.71 | 1.47 | 0.69 | 1.65 |
| 11 | May 24 | 1.00 | 0.28 | 0.64 | 0.74 | 0.54 | 0.74 | 0.84 | 0.73 |
| 12 | Jun 7 | 0.58 | 0.45 | 0.00 | 0.85 | 0.80 | 1.76 | 0.34 | 0.67 |
| 13 | Jun 21 | 0.58 | 0.53 | 0.68 | 1.24 | 0.79 | 1.38 | 0.19 | 0.84 |
| 14 | Jul 5 | 0.46 | 0.71 | 0.49 | 0.69 | 0.75 | 0.52 | 0.12 | 0.61 |
| 15 | Jul 19 | 0.40 | 0.62 | 0.00 | 0.64 | 1.08 | 0.54 | 0.30 | 0.53 |
| 16 | Aug 2 | 0.19 | 0.21 | 0.43 | 0.69 | 0.76 | 1.17 | 0.66 | 0.45 |
| 17 | Aug 16 | 0.20 | 0.38 | 0.58 | 0.58 | 0.38 | 0.64 | 1.16 | 0.50 |
| 18 | Aug 30 | 1.55 | 0.51 | 0.34 | 0.78 | 0.64 | 0.66 | 0.88 | 0.75 |
| 19 | Sep 13 | 0.64 | 0.54 | 0.15 | 0.53 | 0.59 | 1.15 | 1.03 | 0.60 |
| 20 | Sep 27 | 0.44 | 0.00 | 0.29 | 0.88 | 0.82 | 1.22 | 1.36 | 0.73 |
| 21 | Oct 11 | 0.76 | 0.67 | 0.00 | 0.00 | 0.53 | 1.39 | 1.21 | 0.68 |
| 22 | Oct 25 | 1.01 | 0.00 | 1.60 | 1.28 | 0.72 | 1.12 | 0.70 | 0.83 |
| 23 | Nov 8 | 1.27 | 0.13 | 2.67 | 0.85 | 0.34 | 1.89 | 0.89 | 0.91 |
| 24 | Nov 22 | 1.01 | 3.55 | NE[b] | 2.85 | 0.64 | 0.10 | 1.84 | 1.97 |
| 25 | Dec 6 | ND | ND | ND | ND | 1.08 | 1.81 | 1.11 | 1.29 |
| 26 | Dec 20 | ND | ND | ND | ND | 0.00 | 0.54 | 0.73 | 0.59 |
| Overall | | 0.69 | 0.52 | 0.46 | 0.85 | 0.91 | 0.99 | 0.87 | 0.69 |

[a] ND = no data; season closed.
[b] NE = no effort observed.

Appendix F-8. Residency and overall ranking of a sample of anglers interviewed for the 2003 creel survey, South Fork Snake River, Idaho. Residents came from 21 of 44 Idaho counties. Non-residents came from 42 states, the District of Columbia, and 6 foreign countries. Data from 1979 are presented for comparison (Moore 1980).

| | | 2003 | | | 1979 | | |
|---|---|---|---|---|---|---|---|
| Residency | Abbreviation | Interviews | Percent | Rank | Interviews | Percent | Rank |
| Idaho County: | | | | | | | |
| Bonneville | 8B | 1,750 | 43.73% | 1 | 1,288 | 59.91% | 1 |
| Jefferson | 1J | 278 | 6.95% | 3 | 309 | 14.37% | 2 |
| Teton | 1T | 172 | 4.30% | 5 | 22 | 1.02% | 8 |
| Madison | 1M | 159 | 3.97% | 6 | 98 | 4.56% | 4 |
| Bannock | 1B | 118 | 2.95% | 8 | 109 | 5.07% | 3 |
| Bingham | 4B | 50 | 1.25% | 10 | 98 | 4.56% | 4 |
| Ada | 1A | 47 | 1.17% | 11 | 16 | 0.74% | 9 |
| Bear Lake | 2B | 23 | 0.57% | 18 | | | |
| Fremont | 2F | 22 | 0.55% | 19 | 7 | 0.33% | 11 |
| Blaine | 5B | 16 | 0.40% | 25 | | | |
| Cassia | 4C | 15 | 0.37% | 27 | | | |
| Twin Falls | 2T | 10 | 0.25% | 35 | | | |
| Franklin | 1F | 9 | 0.22% | 37 | | | |
| Camas | 1C | 8 | 0.20% | 38 | | | |
| Canyon | 2C | 5 | 0.12% | 47 | | | |
| Caribou | 3C | 5 | 0.12% | 47 | | | |
| Jerome | 2J | 2 | 0.05% | 58 | | | |
| Kootenai | K | 2 | 0.05% | 58 | | | |
| Washington | W | 2 | 0.05% | 58 | | | |
| Latah | 1L | 1 | 0.02% | 63 | | | |
| Payette | 1P | 1 | 0.02% | 63 | | | |
| Others Combined | | None | None | None | 31 | 1.44% | |
| Sub total: | | 2,695 | 67.34% | | 1,978 | 92.00% | |
| State: | | | | | | | |
| Utah | UT | 336 | 8.40% | 2 | 48 | 2.23% | 7 |
| Wyoming | WY | 249 | 6.22% | 4 | | | |
| California | CA | 143 | 3.57% | 7 | 54 | 2.51% | 6 |
| Colorado | CO | 57 | 1.42% | 9 | 15 | 0.70% | 10 |
| Montana | MT | 40 | 1.00% | 12 | | | |
| Texas | TX | 40 | 1.00% | 12 | | | |
| Washington | WA | 36 | 0.90% | 14 | | | |
| Arizona | AZ | 33 | 0.82% | 15 | | | |
| North Carolina | NC | 31 | 0.77% | 16 | | | |
| Oregon | OR | 29 | 0.72% | 17 | | | |
| Michigan | MI | 21 | 0.52% | 20 | | | |
| Florida | FL | 20 | 0.50% | 21 | | | |
| Nevada | NV | 20 | 0.50% | 21 | | | |

Appendix F-8. Continued.

| Residency | Abbreviation | 2003 Interviews | 2003 Percent | 2003 Rank | 1979 Interviews | 1979 Percent | 1979 Rank |
|---|---|---|---|---|---|---|---|
| State (continued): | | | | | | | |
| Georgia | GA | 19 | 0.47% | 23 | | | |
| Ohio | OH | 17 | 0.42% | 24 | | | |
| New York | NY | 16 | 0.40% | 25 | | | |
| Illinois | IL | 15 | 0.37% | 27 | | | |
| Missouri | MO | 14 | 0.35% | 29 | | | |
| Wisconsin | WI | 14 | 0.35% | 29 | | | |
| Massachusetts | MA | 12 | 0.30% | 31 | | | |
| Connecticut | CT | 11 | 0.27% | 32 | | | |
| Minnesota | MN | 11 | 0.27% | 32 | | | |
| Pennsylvania | PA | 11 | 0.27% | 32 | | | |
| Tennessee | TN | 10 | 0.25% | 35 | | | |
| New Jersey | NJ | 8 | 0.20% | 38 | | | |
| Oklahoma | OK | 8 | 0.20% | 38 | | | |
| Alabama | AL | 7 | 0.17% | 41 | | | |
| New Mexico | NM | 7 | 0.17% | 41 | | | |
| Virginia | VA | 7 | 0.17% | 41 | | | |
| Iowa | IA | 6 | 0.15% | 44 | | | |
| South Carolina | SC | 6 | 0.15% | 44 | | | |
| Kentucky | KY | 5 | 0.12% | 47 | | | |
| Maryland | MD | 5 | 0.12% | 47 | | | |
| Alaska | AK | 4 | 0.10% | 51 | | | |
| District of Columbia | DC | 4 | 0.10% | 51 | | | |
| Indiana | IN | 4 | 0.10% | 51 | | | |
| Maine | ME | 4 | 0.10% | 51 | | | |
| Nebraska | NE | 4 | 0.10% | 51 | | | |
| South Dakota | SD | 3 | 0.07% | 57 | | | |
| Hawaii | HI | 2 | 0.05% | 58 | | | |
| Mississippi | MS | 1 | 0.02% | 63 | | | |
| New Hampshire | NH | 1 | 0.02% | 63 | | | |
| Rhode Island | RI | 1 | 0.02% | 63 | | | |
| Others Combined | | None | None | None | 55 | 2.56% | |
| Sub total: | | 1,292 | 32.28% | | 172 | 8.00% | |
| Country: | | | | | | | |
| Canada | | 6 | 0.15% | 44 | | | |
| United Kingdom | | 4 | 0.10% | 51 | | | |
| France | | 2 | 0.05% | 58 | | | |
| Bahamas | | 1 | 0.02% | 63 | | | |
| Italy | | 1 | 0.02% | 63 | | | |
| Russia | | 1 | 0.02% | 63 | | | |
| Sub total: | | 15 | 0.37% | | | | |
| Grand total: | | 4,002 | 100.00% | | 2,150 | 100.00% | |

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