FISHERY MANAGEMENT INVESTIGATIONS

SOUTH FORK SNAKE RIVER INVESTIGATIONS

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ABSTRACT

At the Conant section in the upper South Fork Snake River, we captured a total of 1,310 trout during four days of electrofishing in October 2005. Relative abundance was 47.9% cutthroat trout *Oncorhynchus clarkii bouvieri*, 26.7% rainbow trout *O. mykiss* and hybrid rainbow x cutthroat trout *O. mykiss x O. clarkii* combined, and 25.3% brown trout *Salmo trutta*. One lake trout *Salvelinus namaycush* was also caught. For age 1 and older fish, estimated densities were 658 cutthroat trout/km, 421 rainbow and hybrid trout/km, and 206 brown trout/km for a total of 1,285 fish/km. For age 1 (yearling) fish, estimated densities using cohort analysis were 347 cutthroat trout/km, 209 rainbow and hybrid trout/km, and 34 brown trout/km for a total of 589 fish/km. The cutthroat to rainbow and hybrid trout recruitment ratio was 1.7, and the cutthroat to brown trout recruitment ratio was 10.3. Over all fish sizes, mean total length was 322 mm for cutthroat trout, 295 mm for rainbow and hybrid trout, 247 mm for brown trout, and 296 mm for all species combined. Quality stock density (QSD) was 14.0% for cutthroat trout, 24.3% for rainbow and hybrid trout, 21.7% for brown trout, and 18.3% for all species combined.

At the Lorenzo section in the lower South Fork Snake River, we captured a total of 1,168 trout during four days of electrofishing in September 2005. Relative abundance was 6.9% cutthroat trout, 0.6% rainbow and hybrid trout, and 92.5% brown trout. For age 1 and older fish, estimated densities were 76 cutthroat trout/km and 771 brown trout/km for a total of 1,285 fish/km. Rainbow and hybrid trout density estimates were not possible due to the small sample size. For age 1 (yearling) fish, brown trout estimated density was 384 fish/km. Cutthroat trout and rainbow and hybrid trout density estimates were not possible due to the small sample size. Over all fish sizes, mean total length was 333 mm for cutthroat trout, 285 mm for brown trout, and 288 mm for all species combined. Quality stock density (QSD) was 10.7% for cutthroat trout, 18.1% for brown trout, and 17.3% for all species combined.

Partly to assess the 2004 fishing regulation changes, we conducted a fully stratified, roving-type creel survey on the entire South Fork Snake River throughout 2005. Of 3,542 anglers interviewed, 30% were not residents of Idaho and 16% were guided. The proportion of reported hours fished by gear type was 17% bait, 14% lures, and 68% artificial flies. Estimated total effort was 233,009 h. Slightly more than half of the effort (54%) occurred during weekdays, and 81% was by anglers using boats. Average time spent fishing was 3.8 h/d. We estimated anglers caught 196,339 fish and harvested 9,424 fish – or 5% of the catch. Overall, boat anglers using flies caught the most fish but boat anglers using bait harvested the most fish. Relative catch composition from the interviews (n = 9,651 fish) was 35% cutthroat trout, 13% rainbow and hybrid trout, 33% brown trout, 19% mountain whitefish, and <1% other species. Estimated harvest composition was <1% cutthroat trout, 71% rainbow and hybrid trout, 20% brown trout, 8% mountain whitefish, and <1% fish of other species. We estimate anglers caught and harvested, respectively, 68,437 and 23 cutthroat trout, 25,938 and 6,718 rainbow and hybrid trout, 64,246 and 1,883 brown trout, 37,351 and 788 mountain whitefish, and 366 and 12 fish of other species. Rainbow and hybrid trout harvest increased by 1,648 fish or 33% from 2003 to 2005, and about a quarter of anglers are now willing to harvest them. The overall catch rate was 0.84 fish/h – up from the 0.69 fish/h in 2003 and 0.53 fish/h in 1979. The catch rate in the upper river was 0.78 fish/h during the summer – up from the 0.64 fish/h in 2003 but down from the 1.12 fish/h in 1996 and the 0.90 fish/h observed in 1982.

Using extrapolations of pre-season stock abundance in the upper river, estimated annual exploitation of fish ≥203 mm was 20.6% for rainbow and hybrid trout and 7.2% for brown trout.

For fish ≥406 mm, exploitation was 43.3% for rainbow and hybrid trout and 9.0% for brown trout. We define two stocks because of harvest regulation differences between the taxa. Cutthroat trout exploitation was low because they could not be legally harvested; however some illegal harvest was known to occur. Although rainbow and hybrid trout exploitation has doubled since 2003, we hope to increase these rates further to around 40 and 60% by continuing our angler outreach and education campaign. This goal would have been achieved if anglers had kept every rainbow and hybrid trout they caught during 2005.

The Burns Creek fish weir was not operated in 2005. We trapped a total of 4,254 trout at the Pine Creek, Rainey Creek, and Palisades Creek weirs. Most were cutthroat trout – with 2,817 at Pine Creek, 25 at Rainey Creek, and 1,071 at Palisades Creek. The remainder was rainbow and hybrid trout – 40 at Pine Creek, none at Rainey Creek, and 301 at Palisades Creek – and these fish were relocated to family fishing waters. Cutthroat trout were caught between April 15 and June 30, and rainbow and hybrid trout were caught between March 22 and June 22. The estimated efficiency of the refurbished Mitsubishi floating weir at Palisades Creek was 90.5%. We did not estimate efficiency at the other two picket weirs but believe it was greater than 90%.

None of the twenty rainbow trout redds that were radio-tagged in the upper river were disrupted by the June 15, 2005, peak flow of 422.1 m^3/s (14,900 ft^3/s) released from Palisades Dam. One radio tag in the Rainey Creek side channel could not be located and was presumed to have malfunctioned. Orange-colored rocks used to mark each redd were completely covered with algae in November, were difficult to relocate, and proved unreliable to assess gravel movement. They did help, however, in retrieving each radio tag.

Two mathematical indices, the *YCT Index* and the *Hydro Index*, were developed by Dr. Rob Van Kirk, Idaho State University, to evaluate South Fork Snake River flow management in terms of annual cutthroat trout recruitment relative to rainbow and hybrid trout recruitment. Because the two indices are significantly and positively correlated ($P = 0.0239$, $r^2 = 0.645$, $n =$ 17 years), an increase in the *Hydro Index* should result in an improved *YCT Index*. The 2005 *YCT Index* was 1.483 – the highest recorded since 1999 – and the *Hydro Index* was 2.168 – the second highest recorded since 1998. These results were in large part due to the 538.2 m^3/s (19,000 ft^3/s) freshet provided on May 23, 2004. The 2005 recruit class is the first to experience modified flow management – particularly the spring freshet – in both its year of spawn, 2004, and its second year, 2005.

We operated and maintained rotary-drum fish screens in Burns and Palisades creek irrigation diversions from early spring to late fall. Unknown numbers of outmigrating cutthroat trout fry and post-spawners have been prevented from being entrained since screen construction.

These results are discussed in relation to our three-pronged, collaborative effort to restore and conserve the South Fork Snake River cutthroat trout population.

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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). The cutthroat trout fishery generated approximately $12 million in local income and supported 341 jobs in 2004 (Loomis 2005). Despite the overall health of cutthroat trout in the river, a 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). To date, rainbow and hybrid trout have increased only in the upper river and its associated tributaries, whereas few rainbow and hybrid trout occur in the lower river (Schrader and Fredericks 2006; Garren et al. 2006). 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 river are also a concern. It is possible that these low densities reflect 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) and Moller and Van Kirk (2003) found that the lower South Fork Snake River has a much greater degree of hydrologic alteration than does the upper river. However, this alteration is not believed to cause the low cutthroat trout densities observed there.

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 this river is flow-regulated, the ecological effects of hydrologic regime and alteration 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 42.5 m^3/s (1,500 ft^3/s) to sustain the fishery. Merigliano (1997) found that the decreased magnitude and frequency of spring flood events have limited cottonwood recruitment.

Moller and Van Kirk (2003) studied the effects of hydrologic alteration on trout recruitment. They found that flow characteristics during spawning and juvenile trout first-summer growth periods explained more variability in recruitment than did any other group of hydrologic variables, including winter flow. They observed jumps in rainbow trout recruitment following water years in which the maximum to minimum flow ratio was low and the hydrograph had a relatively low, flat, long-duration peak. In contrast, cutthroat trout recruitment was high following water years in which the maximum to minimum flow ratio was high, tributary discharge was high, and the peak was short in duration, high, and sharp. To increase cutthroat trout recruitment relative to rainbow trout recruitment, they recommended changing water management to provide higher, sharper, and shorter flood peaks and higher maximum to minimum flow ratios. Hauer et al. (2004) looked at the bigger picture and studied channel morphology and stream ecology as it relates to flow regimes. The results of these two studies have been used by BOR to develop ecologically-based flow management objectives that were

initiated in the winter and spring of 2003-2004. For example, one objective is to exceed a maximum to minimum flow ratio of 15. Within legally mandated and complex operational constraints, the overall goal was to enhance ecological processes in the river and floodplain downstream of Palisades Dam – with an emphasis on restoring and conserving cutthroat trout.

The mechanisms driving differential recruitment success described by Moller and Van Kirk (2003) are unknown. Rainbow trout spawn during April and May and it is possible that high flows after spawning scour redds – thereby reducing egg-to-fry survival. But it is also possible that higher maximum to minimum flow ratios can cause other recruitment-related problems. These might include increased physiological stress prior to spawning, reduced available spawning habitat, or fry displacement and decreased fry survival – all of which could contribute to lower rainbow trout recruitment relative to cutthroat trout. Higher flow ratios might also induce more cutthroat trout to migrate into tributaries to spawn.

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 upper 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. There were few rainbow trout at the time, and the extension was intended to improve the brown trout fishery. However, the 1996 creel survey results (Schrader et al. 2003), combined with the 1998 petition to list Yellowstone cutthroat trout as a threatened species under the federal Endangered Species Act, led to emergency rule changes in 1999. This 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. In 2004, extensive rule changes were implemented in the main river and its tributaries following the 2003 creel survey (Schrader and Fredericks 2006). All limits were removed for rainbow trout, only catch-and-release was allowed for cutthroat trout, and the fishing season in the upper river was extended year round to allow harvest of rainbow trout spawners. Brown trout regulations remained the same. In addition, spawning closures on Palisades and Rainey creeks were added to those already in place on Pine and Burns creeks.

Both cutthroat and rainbow trout spawn in the spring in the main river as well as the 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). Practically speaking, restricting spawning in the main river 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 from the South Fork Snake River 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 summarizes South Fork Snake River fishery investigations conducted in 2005. BOR began Ecologically Based System Management (EBSM) operations on the South Fork Snake River in water year 2004 following flow-related research in 2002-2003 (Moller and Van Kirk 2003; Hauer et al. 2004; Schrader and Fredericks 2006). IDFG also began flow evaluations and continued biological monitoring of cutthroat trout during water year 2004 (Garren et al. 2006), although fishery recruitment resulting from 2004 operations could not be measured until the following water year 2005 (present study). 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 enhance the river ecosystem upon which it depends within BOR operational constraints. To this end, both agencies have cooperated since 2000 in running 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 monitoring and research objectives were formulated with this emphasis in mind.

OBJECTIVES

1. Continue to monitor South Fork Snake River trout populations by electrofishing.
2. Estimate effort, catch, and harvest over the 2005 fishing season.
3. Estimate trout exploitation over the 2005 fishing season.
4. Re-design and operate fish weirs in Pine, Rainey, and Palisades creeks to maintain genetically pure spawning populations of cutthroat trout. Estimate weir efficiency at Palisades Creek. Monitor escapement and upstream migration timing.
5. Assess rainbow trout redd disruption and gravel movement caused by the June 15, 2005, freshet (422.1 m^3/s or 14,900 ft^3/s).
6. Assess age 1 trout recruitment following the May 23, 2004, freshet (538.2 m^3/s or 19,000 ft^3/s).
7. Operate rotary drum fish screens on irrigation diversions in Palisades and Burns creeks.
8. Evaluate the cutthroat trout conservation and management program, particularly as related to increasing rainbow trout.

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 2005, the Conant section was electrofished on October 4, 6, 12, and 13, and the Lorenzo section was electrofished on September 21, 22, 28, and 29. The upper or lower half of a section was sampled each day. At Conant, flows varied from 90.5 to 127.9 m^3/s (3,196 to 4,516 ft^3/s) at the Irwin gage (USGS, provisional data; Appendix B). At Lorenzo, flows varied from 67.8 to 87.0 m^3/s (2,392 to 3,071 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 150-200 V, 5-6 A, 20% pulse width, and 60 Hz (pulses per second). Water conductivity was not measured.

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.

All electrofishing data were entered and analyzed using the computer program Mark Recapture 5.0 (MR5; Montana Department of Fish, Wildlife, and Parks 1997). Additional analysis was performed 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 or size (Schill 1992), we assumed that variability was similar among sections. 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 $\geq$406 mm by the number $\geq$203 mm, multiplied by 100. These statistics were calculated for each section and species 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 the 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) by 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 model 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 section 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 sections 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

We conducted a creel survey in 2005 both to assess the 2004 regulation changes and to compare the results with similar surveys conducted in the past. We used a fully stratified, roving-type creel survey on the entire South Fork Snake River from January 1 to December 30. 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. Schrader and Fredericks (2006) last surveyed the entire river in 2003 (January 4, 2003, to January 2, 2004), and Moore (1980) 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 2005 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 2005 creel survey was also stratified temporally by two-week intervals and by day type (weekday versus weekend day/holiday). Previous surveys differed only in that they were also stratified by day period (e.g. morning, afternoon, and evening). We attempted six angler counts in each two-week interval that always started on Saturday (total n = 156 counts; Figure 2). This was half the number attempted in 2003 (n = 312; Schrader and Fredericks 2006). 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, Thanksgiving, and Christmas. Specific count days and times were selected at random. In contrast to previous surveys, we did not include the opening day of fishing season because there was none – the season in sections one to four was eliminated in 2004. All counts were on separate days. 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 2005 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 fixed-wing aircraft, but sometimes by using a jet boat or 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 angler counts (e.g. a bank angler in section four during a weekday 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 1982 (Moore and Schill 1984), but not 1979 (Moore 1980), were entered into the program so that comparative analyses could be performed.

Exploitation and Pre-season Stock Abundance

We used harvest estimates from the creel survey divided by estimates of pre-season fish stock abundance to estimate exploitation rates over the 2005 fishing season (January 1 to December 30) in the upper river (sections 1-4, 64 km). We define two stocks for each taxon, 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 brown trout of quality size could be legally harvested during 2005, whereas unlimited rainbow trout of any size could be kept. We did not attempt to calculate an exploitation rate for cutthroat trout because harvest was closed.

Because fish are not uniformly distributed, we used a technique developed in 2003 to estimate or extrapolate pre-season fish stock abundance throughout the upper river. In short, for each taxon, Schrader and Fredericks (2006) used linear models to regress stock density estimates (fish/km) on catch per unit effort (CPUE) while forcing the intercept through zero. CPUE was the recorded VVP time during fall electrofishing in 1996-2000 and 2003. On May 4-6, 2005, nine sites spaced at eight river kilometer intervals were sampled using our standard boat electrofishing gear (Figure 3). Sites sampled in 2005 were at the same location as those sampled in 2003. Captured fish were anesthetized, identified, and measured to the nearest millimeter (TL). For each taxon and stock, the linear models were used to predict pre-season densities at each site using recorded CPUE (Figures 4 and 5). Predicted densities were averaged between sites, multiplied by the distance between sites (8 km), and summed to calculate total stock abundance.

Tributary Weirs and Weir Evaluation

We operated fish weirs at Pine, Rainey, and Palisades creeks but not at Burns Creek during 2005. Host (2003) describes each weir and trap facility, but the weir panels were replaced starting in 2004 after poor weir efficiency and high cutthroat trout mortality were observed in 2003 (Garren et al. 2006; Schrader and Fredericks 2006). At Pine Creek (Figure 6) and at Rainey Creek (Figure 7), we replaced the resistance board, floating weir panels (Ironwood Specialties, http://www.fishtraps.com/) with “hard” panels constructed with aluminum frames and 1.27 cm diameter electrical conduit pickets. Also at Pine Creek, we installed a temporary picket weir in a small side channel that carries water around the main weir during high runoff. At Palisades Creek, we replaced the old floating weir panels with Mitsubishi floating weir panels that were salvaged and refurbished from the Blackfoot River weir (Figure 8).

The Pine Creek weir was installed on April 6 and removed on June 30. Pickets were pulled and the weir was off-line May 17-23 and June 1 because of high water. The Rainey Creek weir was installed on April 7 and removed on June 29. Pickets were pulled and the weir was off-line May 17-18 because of high water. The Palisades Creek weir was installed on March 18 and removed on June 30. All weirs were generally checked on a daily basis. Captured fish were identified and squeezed for gender determination. Cutthroat trout were released above the weir to spawn, and rainbow trout were loaded into an aerated fish tank and hauled to kids fishing ponds. In contrast to past years, captured fish were not anesthetized or measured.

We did not estimate weir or trap efficiency at Pine Creek or Rainey Creek. Similar to 2003, we estimated weir efficiency at Palisades Creek by marking all cutthroat trout released above the weir with a temporary caudal fin punch. We trapped a sample of post-spawning fish – defined as fish larger than 279 mm (Schrader and Fredericks 2006) – returning downstream in the Palisades Canal screen bypass. The bypass trap was operated from April 12 to July 14 except for the period May 2-16 when the canal was shut off. The proportion of marked to all cutthroat trout trapped was the weir efficiency. We assumed all the unmarked fish larger than 279 mm caught in the bypass were fluvial, had migrated upstream, spawned, and were returning downstream. As the Palisades Canal entrains some but not all post-spawning fish, we further assumed that the trapped fish were a random sample of all returning fish. Statistically, this implies that the proportion of marked fish in our sample was a valid estimate of the proportion in the total population. Unlike Host (2003) who evaluated the genetics of outmigrating fry, our goal was to evaluate the physical effectiveness of the refurbished Mitsubishi weir 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 discharge measured at the USGS Heise and Irwin gages as a surrogate for discharge in the tributaries (Moller and Van Kirk 2003). This provided a single hydrograph to compare with our fish trapping results. Water temperature was also measured with a hand-held thermometer when we checked each weir.

Rainbow Trout Redd Radio Telemetry

Like 2004 (Garren et al. 2006), we tested two different methods to assess rainbow trout redd disruption and gravel movement caused by the 2005 spring freshet. One used a radio transmitter or tag planted within the redd. Another used colored markers placed around the redd. Visual assessment was not possible because of turbidity and water depth during high flows. Radio transmitters (ATS model F1835) were roughly the size of spawning gravel, weighed 15 g, and had external whip antennas. Their frequencies ranged from 151.803 to 151.994 MHz. Each had a mortality switch that operated in reverse – the pulse rate would double from 30 to 60 ppm if the tag moved. The pulse rate would revert back to 30 ppm after three days of non-movement. We developed a special pipe tool to plant each tag approximately 10 cm into the redd pillow. The whip antenna extruded from the surface of the redd. Finally, three orange-painted rocks, roughly the size of baseballs, were placed on top of and around the redd in a triangle.

Twenty rainbow trout redds were radio-tagged and marked between Palisades Dam and the Swan Valley highway bridge (Figure 9). Each redd was geo-referenced using a hand-held GPS receiver (Garmin Model 12) with estimated positional error of 10 m. Going downstream in the main river, ten redds were just below the dam spillway, three were at Sheep Creek, three at Indian Creek, and two at Squaw Creek. Another redd was radio-tagged in a side channel at Squaw Creek, and the final redd was in the Rainey Creek side channel. Redds were tagged at various flows throughout the spawning season – from 85.0 to 170.0 m^3/s (3,000 to 6,000 ft^3/s) on April 19 to May 23. In contrast to 2004, radio tags were not monitored as flow levels changed around the 422.1 m^3/s (14,900 ft^3/s) peak on June 15, 2005. Tags were recovered and markers were inspected approximately five months later on November 1 (6 tags) and November 11 (13 tags). The single tag in the Rainey Creek side channel could not be located and was presumed to have malfunctioned.

Flow Monitoring Indices

Two mathematical indices were developed by Dr. Rob Van Kirk, Idaho State University, to evaluate South Fork Snake River flow management in terms of annual cutthroat trout recruitment relative to rainbow trout recruitment (Appendix B). Both indices are based on empirical data and are a distillation and simplification of previous analytical work conducted by Moller and Van Kirk (2003). The Yellowstone cutthroat trout index (*YCT Index*) – developed using cutthroat and rainbow trout recruitment parameters measured at the Conant electrofishing section – is expressed as:

$$YCTIndex = 3.083 \times 10^{-4}(YCT) - 2.359 \times 10^{-4}(RBT) + 2.559(\%YCT) + 0.1 \qquad (7)$$

where *YCT* is the age 1 (or yearling) cutthroat trout abundance estimate for the entire section, *RBT* is the age 1 rainbow trout abundance estimate, and *%YCT* is the percent age 1 cutthroat trout in the electrofishing catch out of all age 1 trout. The variable *%YCT* is expressed as a fraction rather than as a percent, e.g. 0.1 instead of 10%.

The hydrologic index (*Hydro Index*) was developed from a set of five variables describing hydrologic conditions as measured at the USGS Heise gage. It is expressed as:

$$\begin{aligned} HydroIndex &= -5.051(Spawn\ alt) + 0.1818(Spawn\ max/min) - 1.742(1st\ growth\ alt) \\ &+ 0.1363(2nd\ spring\ max/min) - 3.183(2nd\ spring\ alt) + 4 \end{aligned} \tag{8}$$

where *Spawn alt* is the mean daily absolute hydrologic alteration over the spawning period, *Spawn max/min* is the ratio of maximum flow during spawning to previous winter minimum flow, *1st growth alt* is the mean daily absolute hydrologic alteration over the first summer, *2nd spring max/min* is the same as *Spawn max/min* but calculated over the fish's second spring, and *2nd spring alt* is the same as *Spawn alt* but calculated over the spring of the fish's second year.

The two indices are significantly and positively correlated (P = 0.0239, r^2 = 0.645, n = 17) for recruitment years 1986 through 2003, excluding 1987 for which abundance data were unavailable (Appendix B). Our flow management goal, in cooperation with BOR, is to increase the *Hydro Index* which should result in an improved *YCT Index*.

Fish Screens

We operated and maintained rotary-drum fish screens in Burns and Palisades creek irrigation diversions from early spring to late fall. The small, single screen in Fullmer's ditch near Burns Creek was constructed in 1979. The large, four rotary-drum complex in the Palisades Canal was constructed by BOR in 1994. Two of these drums and their associated gear boxes at Palisades were rebuilt by the IDFG anadromous screen shop in Salmon, Idaho, during late 2005. Unknown numbers of outmigrating cutthroat trout fry and post-spawners have been prevented from being entrained at the diversions since construction.

RESULTS

Electrofishing

Conant

We captured a total of 1,310 trout during four days of electrofishing. Relative abundance was 47.9% cutthroat trout, 26.7% rainbow trout, 25.3% brown trout, and 0.1% lake trout *Salvelinus namaycush* (Figure 10, Appendix B). No kokanee *Oncorhynchus nerka* were captured, and less than 1% of the cutthroat trout was of hatchery origin from Palisades Reservoir.

Length frequency distributions show a relatively strong group of age 1 cutthroat trout (about 100 to 250 mm) but not as strong as age 1 rainbow trout (about 150 to 280 mm) or brown trout (about 180 to 280 mm; Figure 11; Appendix D). However, this is probably due to the size-selectivity of the sample gear. Strong groups of age 0 rainbow trout (<150 mm) and brown trout (<180 mm) are also evident. Ages were approximated from overall frequency distributions (Figure 12).

Mean total length was 322 mm for cutthroat trout, 295 mm for rainbow trout, 247 mm for brown trout, and 296 mm for all trout species combined (Figure 11; Appendix B and D). Quality stock density was 14.0% for cutthroat trout, 24.3% for rainbow trout, 21.7% for brown trout, and 18.3% for all trout species combined.

Cutthroat trout sample efficiency (*R/C*) over all size groups was 11.8% and was the second lowest on record (Appendix B). Rainbow trout efficiency was 7.7% and was the third lowest on record. Brown trout efficiency was 10.5% and was within the range of previous years. For age 1 and older fish, estimated densities were 658 cutthroat trout/km, 421 rainbow trout/km, and 206 brown trout/km for a combined total of 1,285 fish/km (Figure 13). The log-likelihood model did not produce reliable estimates so all were calculated using the modified-Peterson method.

Age 1 (yearling) fish densities could not be estimated directly because of too few recaptures and the inability to use the log-likelihood model. However, we used cohort analysis to calculate densities indirectly using average annual survival rates of 65% for cutthroat trout, 40% for rainbow trout, and 45% for brown trout. Survival rates were calculated using two different methods and averaged over all years for which we had sufficient data. Calculated densities were 347 cutthroat trout/km, 209 rainbow trout/km, and 34 brown trout/km for a combined total of 589 fish/km. The cutthroat to rainbow trout recruitment ratio was 1.7, i.e. about seventeen cutthroat trout were recruited for every ten rainbow trout. The cutthroat to brown trout recruitment ratio was 10.3. Yearling relative abundance in the electrofishing catch was 43.0% cutthroat trout, 34.8% rainbow trout, and 22.2% brown trout (Appendix B).

Lorenzo

We captured a total of 1,168 trout during four days of electrofishing. Relative abundance was 6.9% cutthroat trout, 0.6% rainbow trout, and 92.5% brown trout (Figure 10, Appendix C). No lake trout or kokanee were captured, and none of the cutthroat trout was of hatchery origin from Palisades Reservoir.

The cutthroat trout length frequency distribution shows a relatively strong group of age 1 fish (about 100 to 250 mm) but sample size was small (Figure 14; Appendix D). Similarly, strong groups of age 0 (<180 mm) and age 1 (about 180 to 280 mm) brown trout are evident. Only seven rainbow trout were captured and they were excluded from analysis. Ages were approximated from overall frequency distributions (Figure 12).

Mean total length was 333 mm for cutthroat trout, 285 mm for brown trout, and 288 mm for all trout species combined (Figure 14; Appendix C and D). Quality stock density was 10.7% for cutthroat trout, 18.1% for brown trout, and 17.3% for all trout species combined.

Cutthroat trout sample efficiency (*R/C*) over all size groups was 8.5% and was the lowest on record (Appendix C). Brown trout efficiency was 13.8% and was within the range of previous years. For age 1 and older fish, estimated densities were 76 cutthroat trout/km and 771 brown trout/km for a combined total of 847 fish/km (Figure 15). Similar to previous years, a density estimate was not possible for rainbow trout. The log-likelihood model did not produce a reliable estimate for cutthroat trout so it was calculated using the modified-Peterson method.

Age 1 (yearling) cutthroat trout densities could not be estimated directly because of too few recaptures and the inability to use the log-likelihood model. We could not use cohort

analysis because sampling was not conducted in 2004. The estimated density of age 1 brown trout was 384 fish/km (Appendix C). Yearling relative abundance in the electrofishing catch was 4.9% cutthroat trout, 1.3% rainbow trout, and 93.8% brown trout.

Creel Survey

Creel survey results for 2005 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 1982 and 1996 surveys, which were conducted only in the upper river during the summer.

Upper River Over the Summer

We conducted 496 interviews representing 1,077 anglers in the upper river over the summer (Table 2). We also conducted 44 angler counts by fixed-wing aircraft. No interval had fewer than 4 or more than 6 instantaneous counts.

Of the anglers interviewed, 39% were non-residents and 25% were guided (Table 2). 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 2,912 h reported fished, the proportion of bait angler hours was 10%, the proportion of lure angler hours was 12%, and the proportion of fly angler hours was 77%.

Estimated total effort was 115,689 h (Table 2). Slightly more than half, or 58%, occurred during weekdays. The remaining 42% occurred on weekend days or holidays. Boat angler effort, i.e. those using either a power or float boat, was 105,535 h or 91% of the total effort. Conversely, bank angler effort was 10,160 h or 9%. Overall, average time spent fishing was 3.3 h/d. Section two had the highest effort at 41,584 h whereas section one had the lowest at 18,041 h (Appendix E). Interval fifteen, beginning July 16, had the highest effort at 22,300 h whereas interval twelve, beginning June 4, had the lowest at 7,678 h.

Estimated total catch was 89,673 fish (Table 2). Total catch includes both harvested and released fish. Section two had the highest catch at 38,433 fish whereas section three had the lowest at 8,773 fish (Appendix E). Interval seventeen, beginning August 13, had the highest catch at 19,436 fish whereas interval fourteen, beginning July 2, had the lowest at 6,303 fish. Overall, boat anglers using flies caught the most fish. Based on the interviews, boat anglers caught 94% and bank anglers caught 6% (Table 2). Fly anglers caught 78%, followed by lure anglers 8%, combo anglers 7%, and bait anglers 6%.

Catch composition from the interviews (n = 2,618 fish) was: 46% cutthroat trout, 16% rainbow trout, 16% brown trout, 22% mountain whitefish, and <1% other species (Table 2). Based on these proportions, we estimated about 41,411 cutthroat trout, 14,763 rainbow trout, 14,112 brown trout, 19,353 mountain whitefish, and 34 fish of other species were caught.

Estimated total harvest was 4,178 fish or 5% of the catch (Table 2). We estimate 95% of all fish caught were released. We did not account for hooking mortality in estimating harvest. Section two had the highest harvest at 2,582 fish whereas section three had the lowest at 190 fish (Appendix E). Interval eleven, beginning May 21, had the highest harvest at 1,453 fish whereas interval twelve, beginning June 4, had the lowest at 71 fish. Overall, boat anglers using flies harvested the most fish. Based on the interviews, boat anglers harvested 83% and bank

anglers harvested 17% (Table 2). Fly anglers harvested 47%, followed by bait anglers 22%, combo anglers 17%, and lure anglers 13%.

Harvest composition estimated from the computer program was: 82% rainbow trout, 16% brown trout, and 2% mountain whitefish (Table 2). No cutthroat trout or fish of other species were harvested. The harvest estimates were 3,414 rainbow trout, 666 brown trout, and 98 mountain whitefish. Of the fish caught, anglers kept twenty-three percent of the rainbow trout, five percent of the brown trout, and one percent of the mountain whitefish. Section two had the highest rainbow trout harvest at 2,258 fish, as did interval eleven, beginning May 21, at 1,309 fish (Appendix E). Section two had the highest brown trout harvest at 282 fish, as did interval thirteen, beginning June 18, at 173 fish.

The estimated catch rate was 0.78 fish/h and the harvest rate was 0.04 fish/h (Table 2). These rates were calculated by dividing the total catch or harvest by total effort. Section two had the highest catch rate at 0.92 fish/h whereas section three had the lowest at 0.43 fish/h (Appendix E). Interval seventeen, beginning August 16, had the highest catch rate at 0.97 fish/h whereas interval twelve, beginning June 7, had the lowest at 0.48 fish/h.

Entire River Over the Entire Year

We conducted 1,746 interviews representing 3,542 anglers in the entire river over the entire year (Table 3). We also conducted 137 angler counts – all but two were by fixed-wing aircraft. This was 19 short of our goal of 156 angler counts. No interval had fewer than 3 or more than 7 instantaneous counts.

Of the anglers interviewed, 30% were non-residents and 16% were guided (Table 3). Over half the anglers came from the two counties adjacent to the river – 43% from Bonneville County and 11% from Jefferson County – followed by 7% from the state of Wyoming and 6% from the state of Utah (Appendix E). Overall, anglers came from 19 of 44 Idaho counties, 39 states besides Idaho, the District of Columbia, and 3 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 9,198 h reported fished, the proportion of bait angler hours was 17%, the proportion of lure angler hours was 14%, and the proportion of fly angler hours was 68% (Table 3).

Estimated total effort was 233,009 h (Table 3). Slightly more than half, or 54%, occurred during weekdays. The remaining 46% occurred on weekend days or holidays. Boat angler effort, i.e. those using either a power or float boat, was 189,666 h or 81% of the total effort. Conversely, bank angler effort was 43,352 h or 19%. Overall, average time spent fishing was 3.8 h/d. Section two had the highest effort at 63,694 h whereas section six had the lowest at 14,780 h (Appendix E). Interval thirteen, beginning June 18, had the highest effort at 31,269 h whereas interval twenty-five, beginning December 3, had the lowest at 36 h (Figures 16 and 17).

Estimated total catch was 196,339 fish (Table 3). Total catch includes both harvested and released fish. Section two had the highest catch at 64,688 fish whereas section six had the lowest at 11,379 fish (Appendix E). Interval sixteen, beginning July 30, had the highest catch at 24,184 fish whereas interval twenty-five, beginning December 3, had the lowest at 33 fish (Figures 18 and 19). Overall, boat anglers using flies caught the most fish. Based on the interviews, boat anglers caught 75% and bank anglers caught 25% (Table 3). Fly anglers caught 62%, followed by bait and lure anglers at 15% each, and combo anglers 8%.

Catch composition from the interviews (n = 9,651 fish) was: 35% cutthroat trout, 13% rainbow trout, 33% brown trout, 19% mountain whitefish, and <1% other species (Table 3). Based on these proportions, we estimate 68,437 cutthroat trout, 25,938 rainbow trout, 64,246 brown trout, 37,351 mountain whitefish, and 366 fish of other species were caught.

Estimated total harvest was 9,424 fish or 5% of the catch (Table 3). We estimate 95% of all fish caught were released. We did not account for hooking mortality in estimating harvest. Section two had the highest harvest at 4,598 fish whereas section five had the lowest at 265 fish (Appendix E). Interval eleven, beginning May 21, had the highest harvest at 1,557 fish whereas interval twenty-five, beginning December 3, had the lowest at no fish (Figures 20 and 21). Overall, boat anglers using bait harvested the most fish. Based on the interviews, boat anglers harvested 56% and bank anglers harvested 44% (Table 3). Bait anglers harvested 40%, followed by fly anglers 28%, lure anglers 19%, and combo anglers 14%.

Harvest composition estimated from the computer program was: <1% cutthroat trout, 71% rainbow trout, 20% brown trout, 8% mountain whitefish, and <1% other species (Table 3). The harvest estimates were 23 cutthroat trout, 6,718 rainbow trout, 1,883 brown trout, 788 mountain whitefish, and 12 fish of other species. Of the fish caught, anglers kept less than one percent of the cutthroat trout, twenty-six percent of the rainbow trout, three percent of the brown trout, two percent of the mountain whitefish, and three percent of other species. The only cutthroat trout harvested (illegally) were in section seven during interval thirteen, which began June 18 (Figures 22 and 23; Appendix E). Section two had the highest rainbow trout harvest at 3,367 fish, as did interval eleven, beginning May 21, at 1,309 fish (Figures 24 and 25; Appendix E). Section two had the highest brown trout harvest at 536 fish, as did interval thirteen, beginning June 18, at 272 fish (Figures 26 and 27; Appendix E).

The estimated overall catch rate was 0.84 fish/h and the harvest rate was 0.04 fish/h (Table 3). These rates were calculated by dividing the total catch or harvest by total effort. Section two had the highest catch rate at 1.02 fish/h whereas section three had the lowest at 0.50 fish/h (Appendix E). Interval four, beginning February 12, had the highest catch rate at 3.19 fish/h whereas interval twenty-two, beginning October 22, had the lowest at 0.45 fish/h.

Exploitation and Pre-season Stock Abundance

Upper River Cutthroat Trout

No cutthroat trout were harvested in the upper river during 2005 and exploitation was zero. Estimated pre-season stock abundance of cutthroat trout ≥203 mm was 21,484 fish (Table 4) and, for cutthroat trout ≥406 mm, was 3,426 fish (Table 5).

Upper River Rainbow Trout

Estimated pre-season stock abundance of rainbow trout ≥203 mm was 31,274 fish (Table 4), estimated harvest was 6,441 fish, and estimated exploitation of the standard stock was 20.6%. Estimated pre-season stock abundance of rainbow trout ≥406 mm was 6,621 fish (Table 5), estimated harvest was 2,868 fish, and estimated exploitation of the quality stock was 43.3%. The harvest estimates were derived by multiplying total harvest in the upper river (6,505

fish) by the proportion of fish measured in the creel that were ≥203 mm (99.0%) or ≥406 mm (44.1%). These proportions were from all rainbow trout measured in 2003 (n = 188) and 2005 (n = 320) combined (Figure 28).

Upper River Brown Trout

Estimated pre-season stock abundance of brown trout ≥203 mm was 16,612 fish (Table 4), estimated harvest was 1,197 fish, and estimated exploitation of the standard stock was 7.2%. Estimated pre-season stock abundance of brown trout ≥406 mm was 11,150 fish (Table 5), estimated harvest was 1,003 fish, and estimated exploitation of the quality stock was 9.0%. The harvest estimates were derived by multiplying total harvest in the upper river (1,197 fish) by the proportion of fish measured in the creel that were ≥203 mm (100.0%) or ≥406 mm (83.8%). These proportions were from all brown trout measured in 2003 (n = 135) and 2005 (n = 112) combined (Figure 28). Brown trout less than 406 mm (40 fish or 16.2%) were illegal harvest.

Tributary Weirs and Weir Evaluation

We removed 341 rainbow trout and passed 3,913 cutthroat trout upstream to spawn, for a total 4,254 fish trapped, at three South Fork Snake River tributary weirs. Of the rainbow trout, 11.7% were caught at Pine Creek, none were caught at Rainey Creek, and 88.3% were caught at Palisades Creek. Of the cutthroat trout, 72.0% were caught at Pine Creek, 0.6% at Rainey Creek, and 27.4% at Palisades Creek. The Burns Creek weir was not operated during 2005.

Pine Creek

From April 6 to June 30, we trapped a total of 2,857 trout at the Pine Creek weir, of which 40 fish or 1.4% were rainbow trout and 2,817 fish or 98.6% were cutthroat trout (Table 6; Figure 29). Eleven additional mountain whitefish were also caught. The 27 male and 13 female rainbow trout were caught between April 26 and June 20, and the midpoint of the run was May 31. The 1,076 male and 1,741 female cutthroat trout were caught between April 19 and June 24, and the midpoint of the run was June 9. The efficiency of the “hard” picket weir was not estimated in 2005.

Rainey Creek

From April 7 to June 29, we trapped a total of 25 cutthroat trout and no rainbow trout at the Rainey Creek weir (Table 6; Figure 29). The 11 male and 14 female cutthroat trout were caught between May 11 and June 17, and the midpoint of the run was May 23. The efficiency of the “hard” picket weir was not estimated in 2005.

Palisades Creek

From March 18 to June 30, we trapped a total of 1,372 trout at the Palisades Creek weir, of which 301 fish or 21.9% were rainbow trout and 1,071 fish or 78.1% were cutthroat trout (Table 6; Figure 29). Five additional mountain whitefish and one lake trout (330 mm, TL) were

also caught. The 144 male and 157 female rainbow trout were caught between March 22 and June 22, and the midpoint of the run was May 19. The 358 male and 713 female cutthroat trout were caught between April 15 and June 30, and the midpoint of the run was June 13. The estimated efficiency of the refurbished Mitsubishi floating weir was 90.5%. This is based on 800 post-spawning cutthroat trout caught in the Palisades screen bypass trap, of which 724 fish were marked and 76 fish were unmarked. Another 82 rainbow trout were also caught, but not all were post-spawners. Based on a sample of ten rainbow trout collected June 15-24, four fish or 40% were spent, two fish or 20% were ripe and had not spawned, and four fish or 40% were immature.

Rainbow Trout Redd Radio Telemetry

No rainbow trout redds were disrupted by the June 15, 2005, peak flow of 422.1 m^3/s (14,900 ft^3/s) – each radio tag was in its redd and showed no signs of movement when retrieved in November (Appendix F). Although three tags were beeping fast when retrieved, none had moved and each had probably malfunctioned. One tag in the Rainey Creek side channel could not be located and was also presumed to have malfunctioned. The orange-colored marker rocks were completely covered with algae in November, were difficult to relocate, and proved unreliable to assess gravel movement. They did help, however, in retrieving each radio tag.

Flow Monitoring Indices

The 2005 *YCT Index* was 1.483 – the highest recorded since 1999 (Figure 30). Age 1 fish abundance could not be estimated directly for the variables *YCT* and *RBT* because too few yearlings were recaptured and the log-likelihood model failed. Therefore we used cohort analysis to calculate abundance indirectly using average annual survival rates of 65% for cutthroat trout and 40% for rainbow trout. Survival rates were calculated using two different methods and averaged over all years for which we had sufficient data. The inability to estimate yearling abundance directly is not unprecedented – cohort analysis was used for several years of missing data to develop the index (Appendix B) – and the 2005 *YCT Index* value may change with additional cohort data.

The 2005 *Hydro Index* was 2.168 – down slightly from 2004 but still the second highest recorded since 1998 (Figure 31). This was in large part due to the 538.2 m^3/s (19,000 ft^3/s) freshet provided on May 23, 2004 (Rob Van Kirk, personal communication). The 2005 recruit class is the first to experience modified flow management – particularly the spring freshet – in both its year of spawn, 2004, and its second year, 2005. Consequently, the 2005 data point fell very close to the predicted index line (Figure 32).

DISCUSSION

Management of the South Fork Snake River is currently centered on maintaining the wild, native Yellowstone cutthroat trout fishery. The river gained fame for its high catch rates and the aggressive cutthroat trout's willingness to take dry flies. Unfortunately, recent years have seen a decrease in the cutthroat trout population corresponding to an increase in the rainbow trout population. This raised concerns that, in addition to the risk of losing a unique native trout fishery, a potential consequence of a shift to a rainbow trout dominated fishery was a decline in catch rates. The 1998 petition to list Yellowstone cutthroat trout as a threatened

species under the federal Endangered Species Act – which was subsequently denied in 2001 but later challenged in court – has only heightened these concerns. In response, IDFG and its partners, including BOR, have led a three-pronged, collaborative effort to restore and conserve the cutthroat trout population. This includes: 1) encouraging anglers to harvest rainbow trout while reducing harvest of cutthroat trout; 2) manipulating flows in the main river to the detriment of rainbow trout but to the benefit of cutthroat trout; and 3) controlling hybridization in critical cutthroat trout spawning tributaries by the use of fish weirs.

Our 2005 monitoring suggests that the effort is working. First, cutthroat trout abundance, recruitment, and size structure have improved at our standard electrofishing section in the upper river. From 2004 to 2005, age 1 and older cutthroat trout density increased 37% and relative abundance increased 7%. For recruitment, age 1 cutthroat trout density increased more than three-fold, or 231% using cohort analysis, and relative abundance increased 18%. These are the first increases in cutthroat trout that we have observed since 1999 – although the 2005 age 1 and older estimate of 658 fish/km is still less than half the long-term average of 1,431 fish/km. Cutthroat trout QSD also increased slightly from 13 to 14% – but this is a big improvement in the number of quality-sized fish since 2001, when a record low 2% was recorded.

Second, rainbow trout abundance and recruitment have declined in the upper river for two years in a row. From 2003 to 2005, age 1 and older rainbow trout density decreased by over half, 55%, and relative abundance decreased 7%. However, the 2005 estimate of 421 fish/km is near the long-term average of 443 fish/km but above our goal of 200 fish/km. For recruitment, age 1 rainbow trout density decreased 67%, using cohort analysis, and relative abundance decreased 10%. As a result, the ratio of cutthroat trout recruits to rainbow trout recruits was 1.7 in 2005 – the best since 1.6 was recorded in 1999 – and our *YCT Index* was at its highest level since 1999.

Third, with increasing cutthroat trout – and despite decreasing rainbow trout – summer catch rates in the upper river climbed from 0.64 fish/h in 2003 to 0.78 fish/h in 2005. Total effort, total catch, and total harvest, however, declined over the same time period.

To what extent each of our three management actions – increasing rainbow trout harvest, manipulating main river flows, or restricting rainbow trout spawning in tributaries – has contributed to these encouraging results is not known. Cutthroat trout fishing mortality, i.e. harvest and exploitation, has been minimal, and if we assume hooking mortality and natural mortality have held constant over the years, then the decline followed by the improvement in the cutthroat trout population must be driven by recruitment. Fundamentally, we suggest that the improvement is due to better recruitment since 2003, which coincides with declining rainbow trout recruitment over the same time period.

The lack of relationship between spawning stock and the number of recruits suggests that the factors limiting cutthroat trout are probably density-independent (Moller and Van Kirk 2003). In other words, cutthroat trout recruitment in the South Fork Snake River appears to be a function of environmental or other density-independent factors rather than the size of the spawning stock. Koel et al. (2005) concluded that the recent collapse of adfluvial cutthroat trout in Yellowstone Lake, Wyoming, was due to a combination of three density-independent factors: whirling disease, current drought conditions, and an increasing number of piscivorous lake trout. The first two would limit cutthroat trout recruitment whereas lake trout would increase natural mortality on all age classes. The causative agent for whirling disease, *Myxobolus cerebralis*, was discovered in the South Fork Snake River in 1995 (Schrader et al. 2002), but it would be difficult to argue this was a significant factor in the recent decline of cutthroat trout given that the

rainbow trout population was expanding. Rainbow trout are generally believed to be more susceptible to whirling disease than other trout taxa (Hedrick et al. 1999).

In contrast to Koel et al. (2005), Moller and Van Kirk (2003) suggest that the recent decline in fluvial cutthroat trout in the South Fork Snake River can be explained by three density-independent factors – all which limit their recruitment: 1) poor tributary flows, 2) poor main river hydrologic conditions, and 3) increasing rainbow trout abundance. Tributary flows affect cutthroat trout recruitment directly by providing the preferred spawning and rearing habitat (Henderson et al. 2000). Unfortunately, tributary flows are beyond our ability to control – hence, are not included in our management actions – and none of the tributaries are gaged. But our general observations at the weirs during 2003-2005 were that spring and summer flows were greatly improved compared to the earlier drought years of 2000-2002. This likely improved egg and fry survival and provided better migration conditions to the main river – ultimately contributing to improved recruitment.

Main river hydrologic conditions – which is one of our management actions in cooperation with BOR – affect cutthroat trout recruitment both directly (e.g. first-summer growth period) and indirectly by its effect on rainbow trout recruitment (Moller and Van Kirk 2003). This new understanding has led to a shift in focus away from the long-held belief that winter discharge limits juvenile cutthroat trout survival to a focus on flow shape and controlling rainbow trout recruitment. The improved hydrologic conditions provided in 2004 by BOR – i.e. the more naturally shaped and less altered hydrograph – probably contributed to the increase in cutthroat trout recruitment along with the decrease in rainbow trout recruitment observed in 2005. By managing the flow regime and providing a sharp and high spring freshet, the maximum to minimum flow ratio exceeded 15:1 – which has been the generally agreed-upon goal. As a result, the *YCT Index* improved. After sliding downward from 1998 to a record low in 2002, the *YCT Index* increased in 2005 to its highest level since 1999. The *Hydrologic Index*, although down slightly in 2005, was greatly improved during the 2003-2005 recruitment period (water years 2002-2005) compared to the previous 1999-2002 recruitment period (water years 1998-2002). This initial response to modified flow management suggests that it may have been successful in reversing the invasion of rainbow trout that has been occurring since the mid-1980s.

Increasing rainbow trout abundance affects cutthroat trout recruitment directly (e.g. through hybridization and competition) and perhaps indirectly through mechanisms not yet identified. The management action to increase rainbow trout harvest was formulated with this in mind. We believe that this action has been successful, although it is difficult to evaluate in the field. Rainbow trout harvest increased 33% - from 5,070 fish in 2003 to 6,718 fish in 2005, or an additional 1,648 fish. Almost all of the additional harvest was in the upper river during winter and spring – during the time rainbow trout are spawning – which was the result of the 2004 rule changes. Because of these changes, and combined with no bag or size limits, rainbow trout exploitation has doubled. Using reward tags and extrapolations of pre-season stock abundance from CPUE models, Schrader and Fredericks (2006) estimated rainbow trout exploitation was 5-12% for the standard stock ($\geq$203 mm) and 10-19% for the quality stock ($\geq$406 mm) in 2003. By 2005 these rates doubled to 21% for the standard stock and 43% for the quality stock. We hope to increase these rates further to around 40 and 60% by continuing our angler outreach and education campaign. This goal would have been achieved if anglers had kept every rainbow trout they caught in 2005 – roughly 26,000 fish.

As might be expected, and by several different measures, we are also seeing modest but increasing angler acceptance of harvesting rainbow trout. Based on our creel survey

interviews, anglers kept 18% of the rainbow trout they caught in 2003 and 28% in 2005. Based on our catch and harvest estimates, they kept 24% of the rainbow catch in 2003 and 26% in 2005. Of the 512 angler parties that were interviewed during 2003 that had caught one or more rainbow trout, 122 of them, or 24%, kept one or more fish. Of the 521 parties that caught one or more rainbow trout in 2005, 134 of them, or 26%, kept one or more fish. In sum, about a quarter of South Fork Snake River anglers are now willing to harvest rainbow trout. The challenge is to convince the other three-quarters to do likewise.

Our final management action – controlling hybridization in key spawning tributaries by the use of fish weirs – was designed to conserve the genetic integrity of a large portion of the cutthroat trout population. The program was not intended to eliminate rainbow trout from the South Fork Snake River, nor was it designed to contribute to cutthroat trout recruitment directly – although it may free up more spawning habitat that would otherwise be used by rainbow trout. It is possible that the weirs may actually suppress cutthroat trout recruitment by delaying spawning time or obstructing passage. But we have no evidence to support this possibility. Although some rainbow trout spawners are removed from the system, we suspect that this has had little effect on overall rainbow trout abundance or recruitment.

Given the challenges of operating the fish weirs, the effectiveness of this management action is unknown. Ultimately, the weirs are intended to maintain core, genetically pure populations of cutthroat trout in the South Fork Snake River. We will need to define and measure the effectiveness of this program in upcoming years. This can be done in a variety of ways. Host (2003) examined cutthroat trout alleles in outmigrating fry and concluded that the program was successful in 2001 and 2002, but the author had difficulty obtaining adequate samples during these drought years. We had hoped to consistently achieve 90% or greater weir efficiency, but given high-water events (typically in the middle of the night), liability issues, mechanical breakdowns, and other unforeseen and uncontrollable hindrances to weir operation, we do not believe this objective is realistic. A proportion of 99% or more cutthroat trout caught at a weir, perhaps for three years in a row, would suggest that the risk of introgression is minimal. If a weir has been successful over time, it stands to reason that the proportion of cutthroat trout caught would steadily increase. For 2005, those proportions were 98.6% at Pine Creek, 100.0% at Rainey Creek, and 78.1% at Palisades Creek. Because each weir is unique and has a different cost to benefit ratio, the decision might be to operate the Palisades weir annually but the others periodically.

The recent improvements in the South Fork Snake River cutthroat trout population cannot be attributed to the minor reduction in harvest and exploitation following new catch-and-release rules implemented in 2004. Likewise, Schrader and Fredericks (2006) concluded that the decline in cutthroat trout in the early 2000s could not be attributed to overharvest. They estimated only 286 cutthroat trout were harvested in the entire river in 2003, which was further reduced to 23 illegal fish by 2005. Standard and quality stocks of cutthroat trout in the upper river were lightly exploited both years – exploitation rates were less than two percent using extrapolations of pre-season stock abundance from our CPUE models. Using reward tags in 2003, however, Schrader and Fredericks (2006) estimated that exploitation of quality cutthroat trout was at least seven percent – and perhaps fourteen percent after accounting for angler reporting rates. Still, it is doubtful that reducing this higher but relatively minor exploitation of large, spawning fish to less than two percent could account for the improvements to the cutthroat trout population that we have observed. Although harvest and exploitation in 2004 is unknown, they were likely similar to 2005.

This conclusion is in stark contrast to the major improvements observed following special rules enacted twenty years earlier in 1984. Over 22,000 cutthroat trout were harvested annually prior to 1984 (Moore 1980), and exploitation of age 4 and older cutthroat trout in the upper river was estimated to be about 62% using scale analysis (Moore and Schill 1984). Following special regulations, summer harvest in the upper river was reduced by at least 86% by 1996 (Schrader et al. 2003) and by over 99% by 2003 (Schrader and Fredericks 2006). These authors also discuss how the nature and composition of the South Fork Snake River fishery has changed in these twenty years. The fishery that was once dominated by local, harvest-oriented anglers using bait has evolved to a fishery dominated by more cosmopolitan, catch-and-release anglers using flies. This has, in fact, been our most challenging obstacle in convincing more anglers to harvest more rainbow trout.

Unfortunately, the differences between the 2004 and 2005 cutthroat and rainbow trout density estimates in the upper river are not statistically significant because their 95% confidence intervals overlap. This implies that the improvements we describe above may not be real. However, we believe that the population trends in the upper river are headed in the right direction and we will continue monitoring our three-pronged management program.

Monitoring results at our standard electrofishing section in the lower river were less encouraging. From 2003 to 2005, age 1 and older cutthroat trout density declined 68% and relative abundance declined 6%. The 2005 cutthroat trout density estimate of 76 fish/km is about a fifth of the long-term average of 323 fish/km. However, we and others believe that different factors limit recruitment in this portion of the river – primarily irrigation diversion entrainment and lack of tributary spawning habitat (Moller and Van Kirk 2003). Because there are no spawning tributaries in the lower river, recruitment is probably derived from the upper river. As juveniles migrate downstream and near-shore they are susceptible to entrainment. But it is not clear how these may have changed that would account for the recent decline. Unlike the upper river, rainbow trout are sparse in the lower river and are not believed to be responsible for the recent decline in cutthroat trout. Very few rainbow trout are found in the lower river – for hydrologic reasons described by Moller and Van Kirk (2003). As usual, they were less than one percent of our electrofishing catch in 2005.

RECOMMENDATIONS

1. Continue to implement flow management objectives recommended by EBSM (Hauer et al. 2004) and by Moller and Van Kirk (2003). Encourage BOR to provide spring flushing flows in 2006 even if the tradeoff is slightly lower winter flows.
2. Continue to monitor South Fork Snake River trout populations by electrofishing in 2006. Estimate pre-season stock abundance in the spring and sample the Conant and Lorenzo sections in the fall.
3. Estimate rainbow trout exploitation using reward tags in 2006.
4. Continue to inform and educate anglers regarding benefits to cutthroat trout by harvesting rainbow trout.
5. Modify tributary fish weirs to improve weir efficiency and operate all fish weirs in 2006. Develop evaluation objectives.
6. Continue to operate and maintain 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. Summary of creel survey statistics for the upper (sections 1-4) South Fork Snake River, Idaho, from late May to mid-September 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), 2003 (Schrader and Fredericks 2006), and 2005 (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
2005	496	1,077	39	25	91	9	10	12	77

Year	Total effort (h)[b]	Average time per trip (h/d)[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
2005	115,689	3.3	58	0.78	89,673	0.04	4,178	95

Year	Catch composition (%), with total in parentheses[a]					Harvest composition (%), with total in parentheses[b]				
	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)
2005	46	16	16	22	<1	0	82	16	2	0
	(41,411)	(14,763)	(14,112)	(19,353)	(34)	(0)	(3,414)	(666)	(98)	(0)

Year	Catch composition (%)[a]			Harvest composition (%)[a]		
	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
2005	94	6	2,618	83	17	139

Year	Catch composition (%)[a]				Harvest composition (%)[a]			
	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
2005	6	8	78	7	22	13	47	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 3. Summary of creel survey statistics for the entire South Fork Snake River, Idaho, for the entire years of 1979 (Moore 1980), 2003 (Schrader and Fredericks 2006), and 2005 (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
2005	1,746	3,542	30	16	81	19	17	14	68

Year	Total effort (h)[b]	Average time per trip (h/d)[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
2005	233,009	3.8	54	0.84	196,339	0.04	9,424	95

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	2	7	18	<1	72	4	9	14	<1
	(33,426)	(1,196)	(3,315)	(4,353)	(256)	(22,230)	(1,099)	(2,761)	(8,631)	(142)
2003	37	14	38	10	1	3	56	33	7	<1
	(55,930)	(20,842)	(56,979)	(15,294)	(900)	(286)	(5,070)	(2,920)	(660)	(38)
2005	35	13	33	19	<1	<1	71	20	8	<1
	(68,437)	(25,938)	(64,246)	(37,351)	(366)	(23)	(6,718)	(1,883)	(788)	(12)

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
2005	75	25	9,651	56	44	533

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
2005	15	15	62	8	40	19	28	14

[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 4. 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, 2005. 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	39.18	14	15.7	0.36	137		58	65.2	1.48	813		17	19.1	0.43	155		
2	30.88	18	26.1	0.58	223	1,440	45	65.2	1.46	800	6,454	6	8.7	0.19	69	897	8,790
3	39.22	32	41.0	0.82	312	2,142	38	48.7	0.97	532	5,330	8	10.3	0.20	73	569	8,041
4	32.15	21	27.3	0.65	250	2,250	31	40.3	0.96	530	4,247	25	32.5	0.78	278	1,401	7,899
5	32.62	36	52.2	1.10	423	2,691	12	17.4	0.37	202	2,927	21	30.4	0.64	230	2,029	7,647
6	36.42	40	37.4	1.10	421	3,373	39	36.4	1.07	588	3,161	28	26.2	0.77	274	2,017	8,551
7	31.12	31	35.2	1.00	381	3,208	28	31.8	0.90	494	4,330	29	33.0	0.93	333	2,428	9,966
8	31.27	31	32.3	0.99	380	3,044	16	16.7	0.51	281	3,101	49	51.0	1.57	559	3,568	9,714
9	62.38	74	47.7	1.19	454	3,335	17	11.0	0.27	150	1,723	64	41.3	1.03	366	3,702	8,761
Total	335.23	297				21,484	284				31,274	247				16,612	69,370

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

Table 5. 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, 2005. 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	39.18	7	12.3	0.18	55		42	73.7	1.07	416		8	14.0	0.20	83		
2	30.88	10	41.7	0.32	100	622	9	37.5	0.29	113	2,118	5	20.8	0.16	66	593	3,334
3	39.22	11	36.7	0.28	87	748	11	36.7	0.28	109	889	8	26.7	0.20	83	593	2,230
4	32.15	5	16.1	0.16	48	540	12	38.7	0.37	145	1,016	14	45.2	0.44	176	1,036	2,592
5	32.62	6	25.0	0.18	57	420	5	20.8	0.15	60	818	13	54.2	0.40	162	1,352	2,590
6	36.42	4	13.8	0.11	34	364	9	31.0	0.25	96	622	16	55.2	0.44	178	1,358	2,344
7	31.12	1	4.2	0.03	10	176	6	25.0	0.19	75	684	17	70.8	0.55	221	1,598	2,457
8	31.27	3	9.7	0.10	30	159	1	3.2	0.03	12	349	27	87.1	0.86	350	2,285	2,793
9	62.38	14	26.4	0.22	69	397	3	5.7	0.05	19	124	36	67.9	0.58	234	2,335	2,856
Total	335.23	61				3,426	98				6,621	144				11,150	21,197

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

Table 6. Summary of fish weirs operated in tributaries of the South Fork Snake River, Idaho, 2001-2005. 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:						
1[b]	Floating panel	Mar 7 - Jul 20	15.9	3,156	3	3,159
2[b]	Floating panel	Mar 23 - Jul 5	NE[c]	1,898	16	1,914
3	Floating panel	Mar 28 – Jun 23[d]	16.9 – 35.5	1,350	1	1,351
4	ND[e]	ND	ND	ND	ND	ND
5	ND	ND	ND	ND	ND	ND
Pine Creek:						
1[b]	ND	ND	ND	ND	ND	ND
2[b]	Floating panel	Apr 2 - Jul 5	NE	202	14	216
3	Floating panel	Mar 27 - Jun 12[f]	40.4	328	7	335
4	Hard picket	Mar 25 - Jun 28	98.1	2,143	27	2,170
5	Hard picket	Apr 6 - Jun 30	NE	2,817	40	2,857
Rainey Creek:						
1[b]	Floating panel	Mar 7 - Jul 6	NE	0	0	0
2[b]	Floating panel	Mar 26 - Jun 27	NE	1	0	1
3	ND	ND	ND	ND	ND	ND
4	ND	ND	ND	ND	ND	ND
5	Hard picket	Apr 7 - Jun 29	NE	25	0	25
Palisades Creek:						
1[b]	Floating panel	Mar 7 - Jul 20	10.1	491	160	651
2[b]	Floating panel	Mar 22 - Jul 7	NE	967	310	1,277
3	Floating panel	Mar 24 - Jun 24	21.1 – 47.4	529	181	710
4	ND	ND	ND	ND	ND	ND
5	Mitsubishi	Mar 18 - Jun 30	90.5	1,071	301	1,372
Total:				14,978	1,060	16,038

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

Table 7. Historical creel survey statistics for the South Fork Snake River, Idaho, 1966-1982 (Moore 1980; Moore and Schill 1984), 1996 (Schrader et al. 2003), 2003 (Schrader and Fredericks 2006), and 2005 (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 Jun 1 - Oct 31
1969	16,809	0.42	7,060	75		1	24		Black Canyon - Heise May 30 - Nov 30
1970	17,377[b]	0.56	9,731	85	1	6	8	<1	Dam - Black Canyon May 1 - Nov 30
1972	33,390	0.51	17,029	75	3	2	20	<1	Dam - Heise Jul 1 - Sep 30
1973	ND[c]	0.32	ND	56	<1	6	37		Dam - Henrys Fork Jan 1 - Dec 31
1979	88,830	0.43	38,197	72	4	9	15	<1	Dam - Henrys Fork Mar 3 - Feb 29
1982	64,355	0.80	51,604	66	<1	9	23	2	Dam - Heise Apr 1 - Sep 17
1996	169,142	1.12	188,989	71	7	12	10	<1	Dam - Heise May 25 – Sep 13
2003	216,181	0.69	149,946	37	14	38	10	1	Dam - Henrys Fork Jan 4 - Dec 31
2005	233,009	0.84	196,339	35	13	33	19	<1	Dam - Henrys Fork Jan 1 - Dec 30

[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

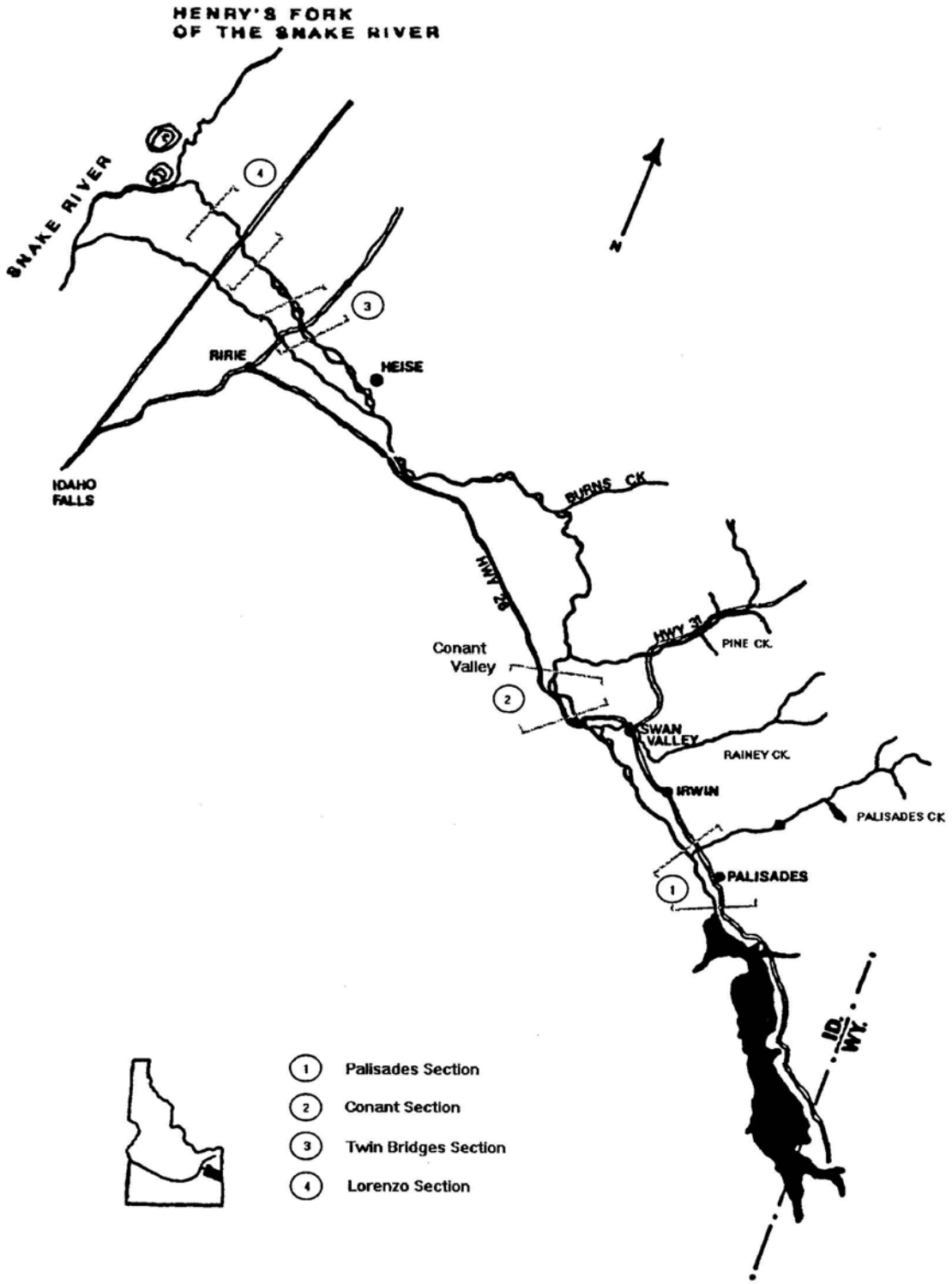


Figure 1. Map of South Fork Snake River, Idaho, showing standard electrofishing sections and the four major spawning tributaries.

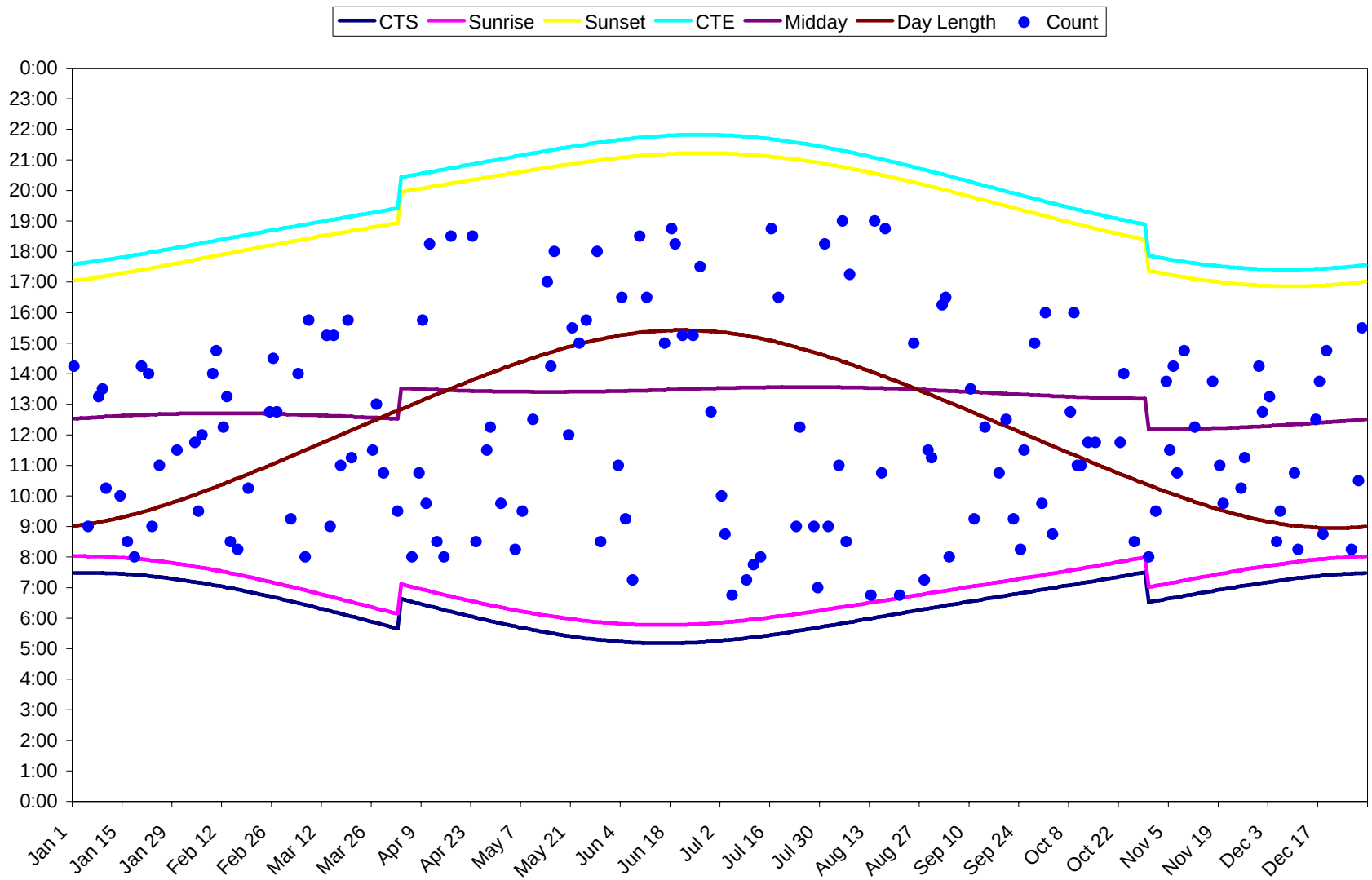


Figure 2. Scheduled count times (n = 156) for the 2005 creel survey, South Fork Snake River, Idaho. CTS = start of civil twilight; CTE = end of civil twilight; midday = sun at its highest point; day length = sunrise to sunset.

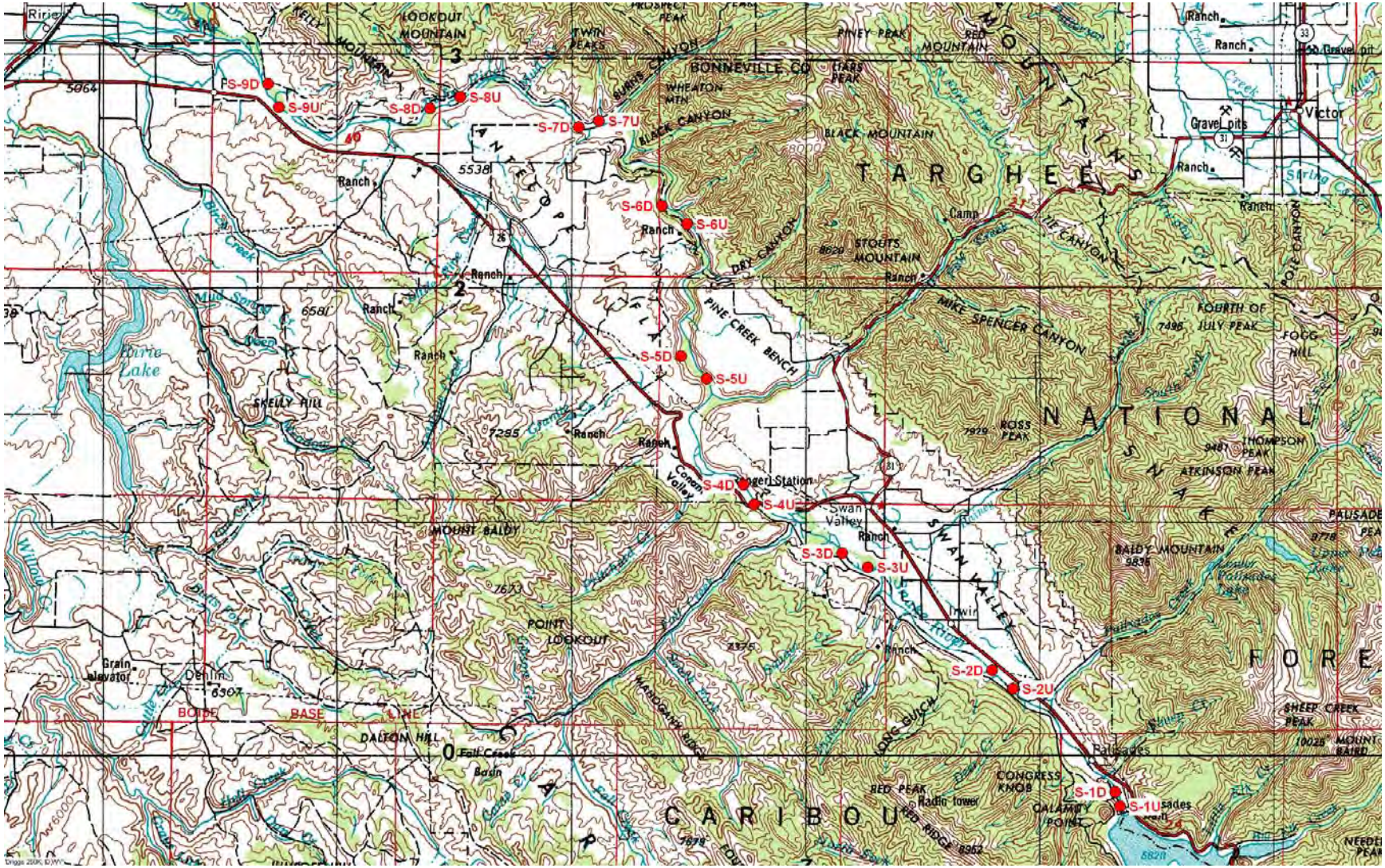


Figure 3. Location of the nine sites sampled for pre-season stock abundance in the upper South Fork Snake River, Idaho, 2005. Sites were spaced at 8 km intervals beginning at Palisades Dam (S-1) and ending at the Heise cable (S-9). U = upstream starting point; D = downstream ending point.

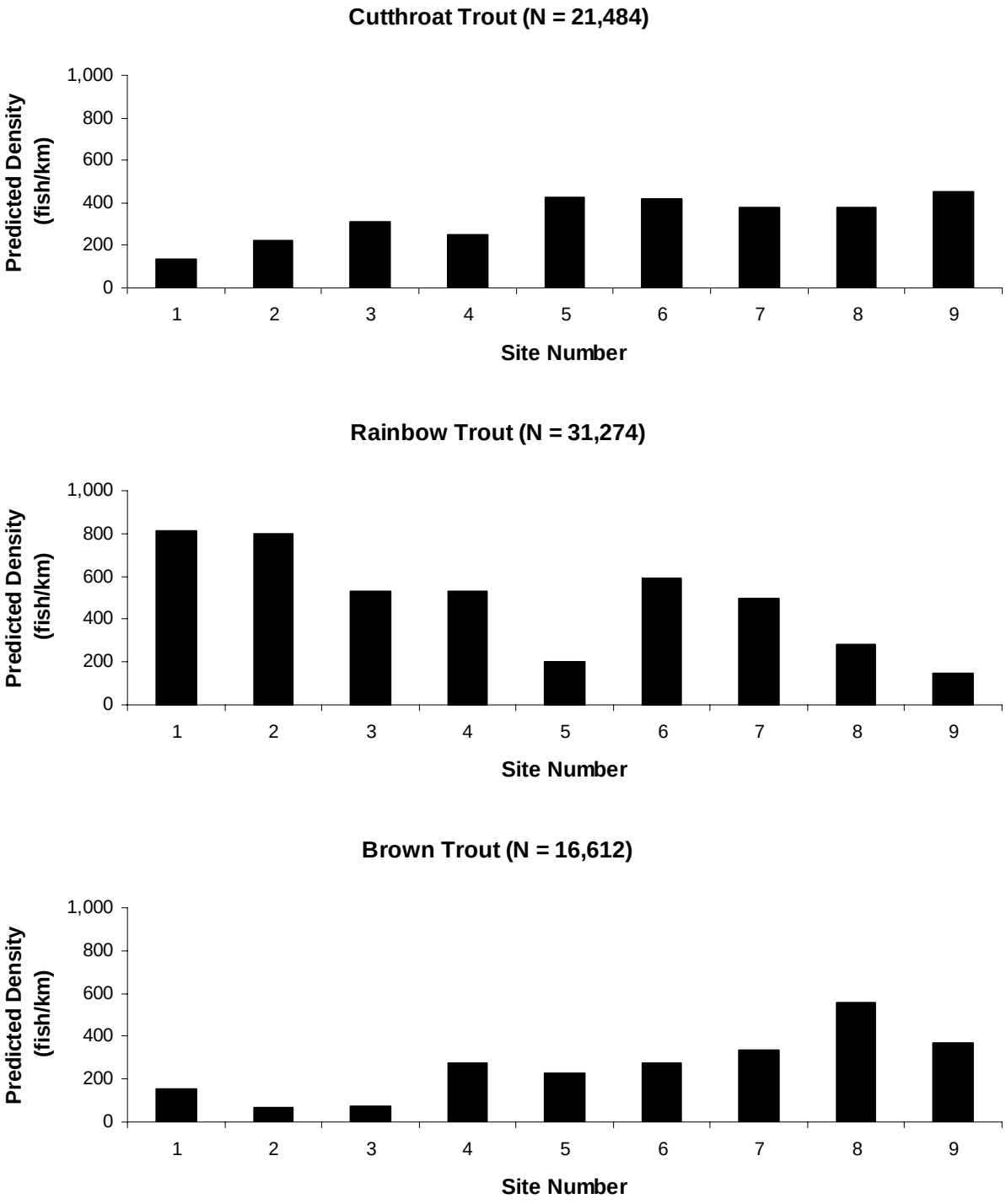


Figure 4. Predicted stock densities of ≥203 mm cutthroat, rainbow, and brown trout in the upper South Fork Snake River, Idaho, May 4-6, 2005. Site 1 is at Palisades Dam, site 9 is near the Heise cable. N is estimated overall stock abundance.

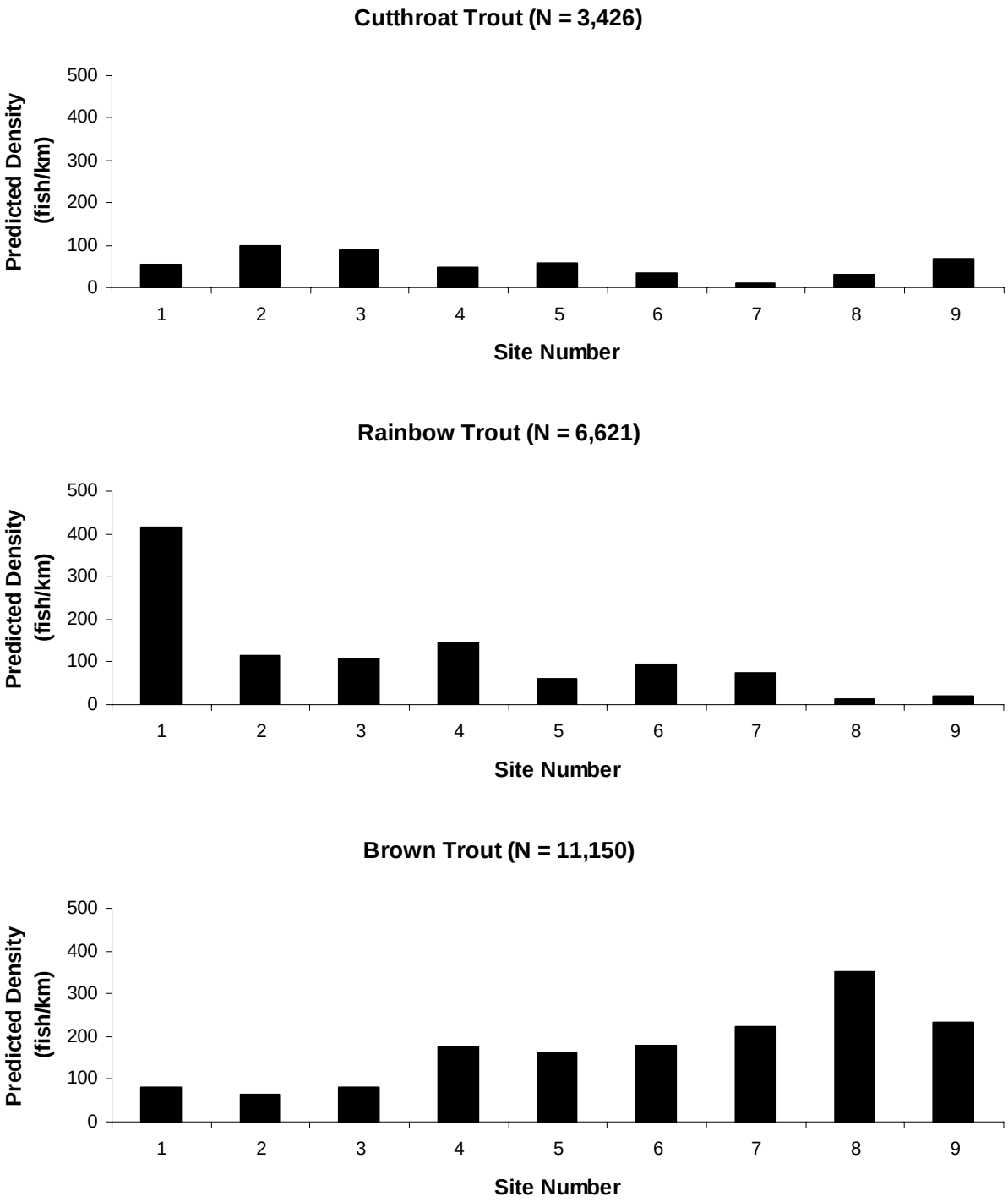


Figure 5. Predicted stock densities of ≥406 mm cutthroat, rainbow, and brown trout in the upper South Fork Snake River, Idaho, May 4-6, 2005. Site 1 is at Palisades Dam, site 9 is near the Heise cable. N is estimated overall stock abundance.

Figure 6. Photos of the Pine Creek fish weir with old floating panels (top photo, June 15, 2002) and new “hard” picket panels (bottom photo, May 9, 2005), South Fork Snake River, Idaho.

Figure 7. Photos of the Rainey Creek fish weir with old floating panels (top photo, April 18, 2001) and new “hard” picket panels (bottom photo, May 9, 2005), South Fork Snake River, Idaho.

Figure 8. Photos of the Palisades Creek fish weir with old floating panels (top photo, May 18, 2001) and new Mitsubishi floating panels (bottom photo, May 9, 2005), South Fork Snake River, Idaho.

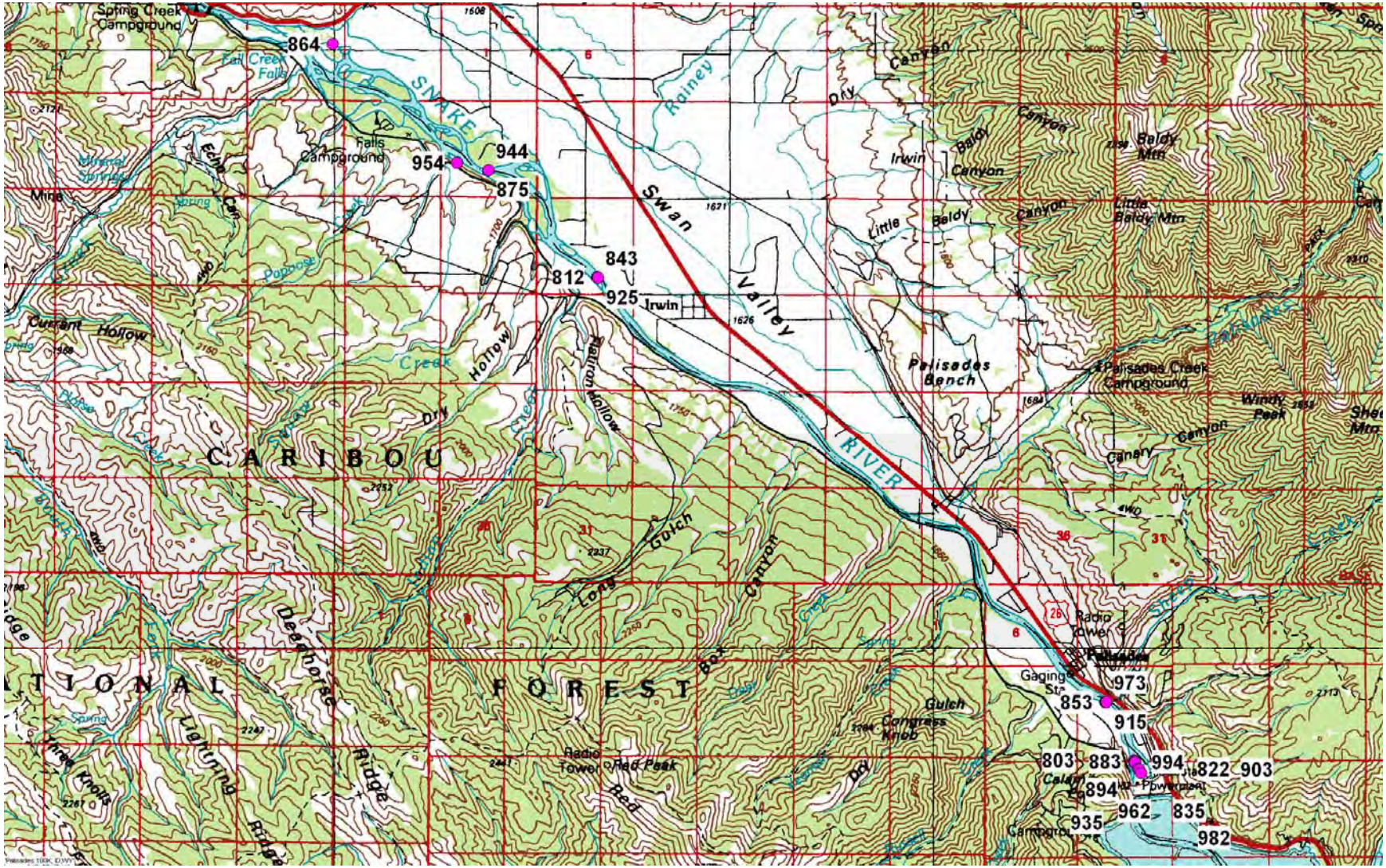
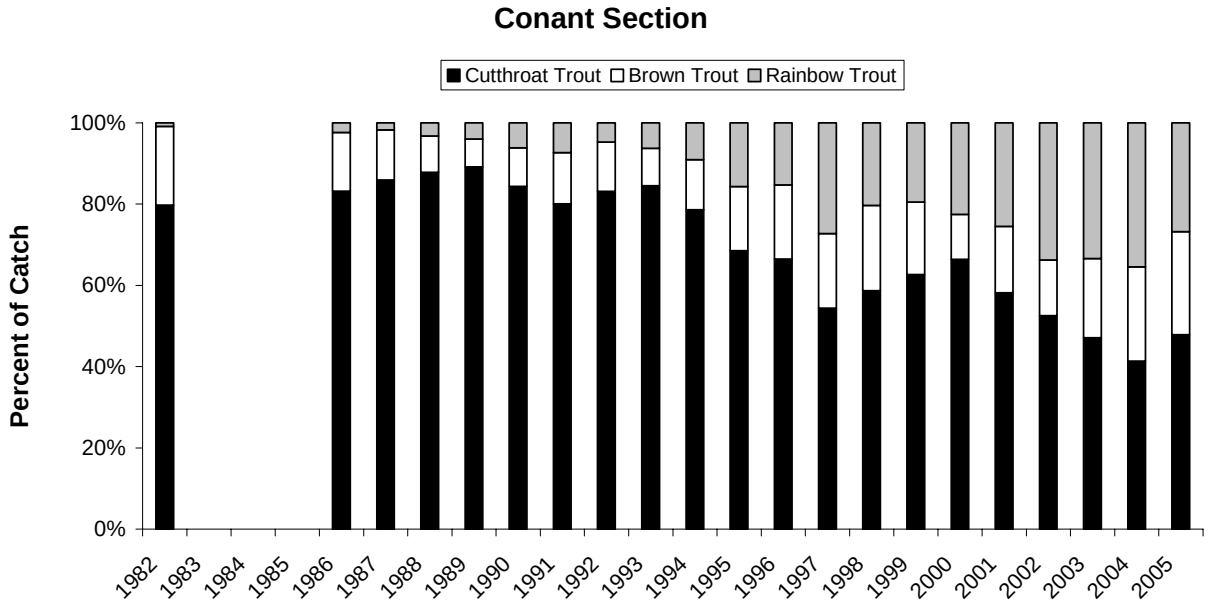


Figure 9. Location of 20 rainbow trout redds that were radio-tagged in the upper South Fork Snake River, Idaho, 2005. Numbers are radio transmitter frequencies (KHz) on the 151 MHz band.



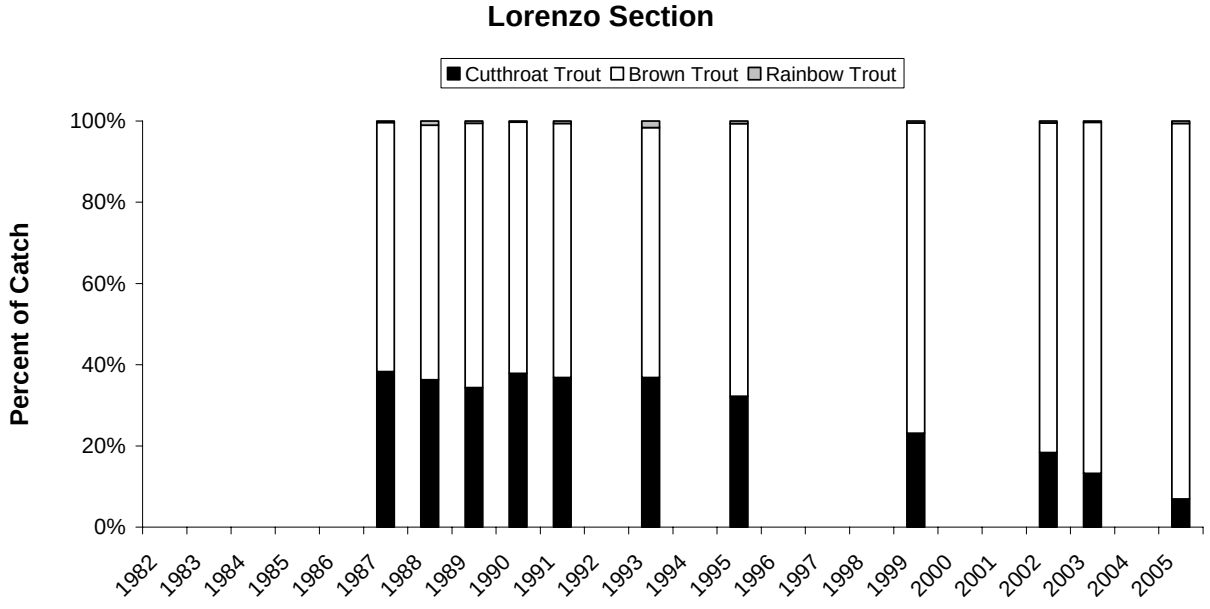


Figure 10. Relative abundance trends for all sizes of trout at the Conant (top) and Lorenzo (bottom) electrofishing sections, South Fork Snake River, Idaho, 1982 to 2005. Data for 1982 are from Moore and Schill (1984).

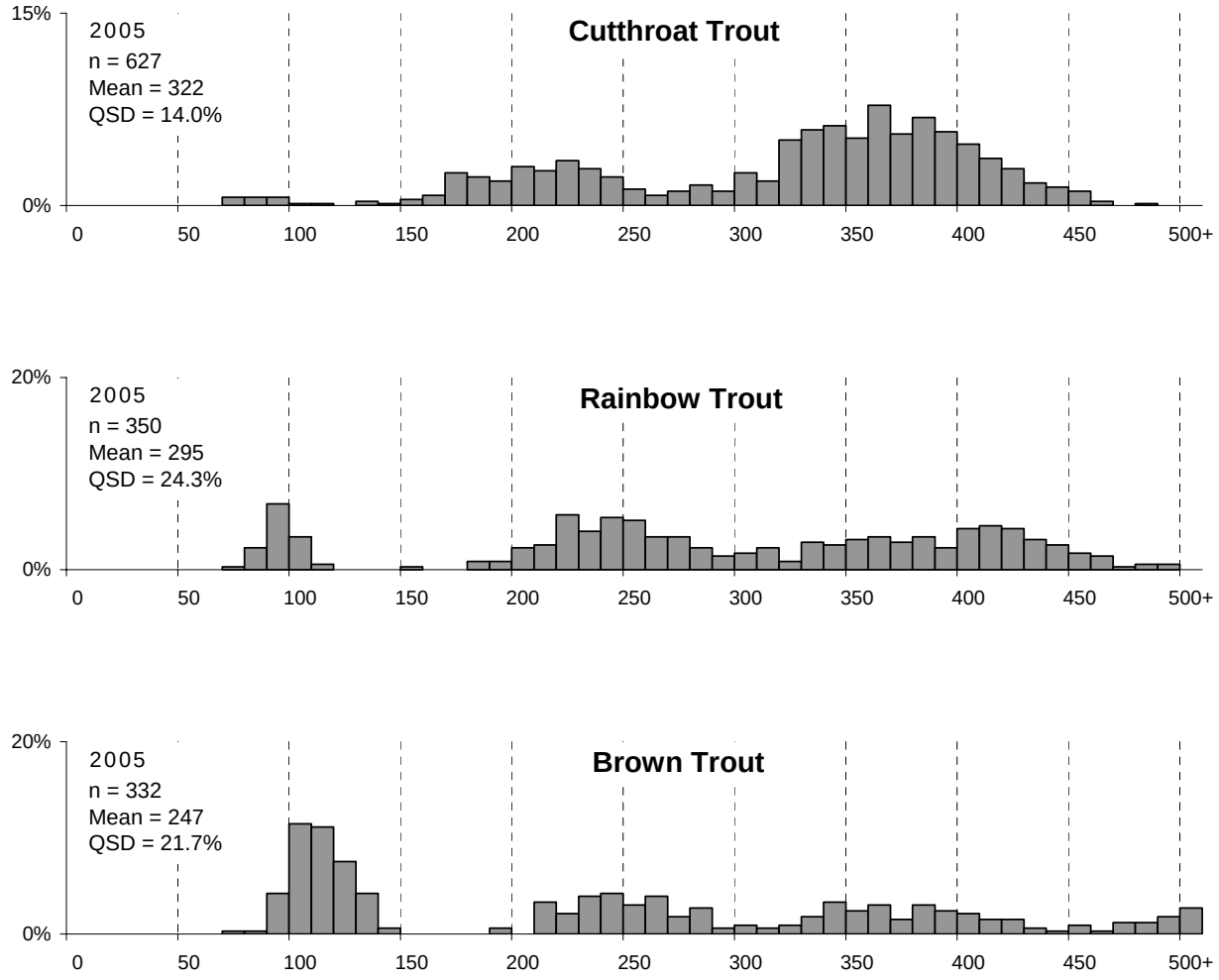


Figure 11. Length frequency distributions (TL, mm) of cutthroat (top), rainbow (middle), and brown trout (bottom) captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 2005. Total individual fish captured during electrofishing equals n.

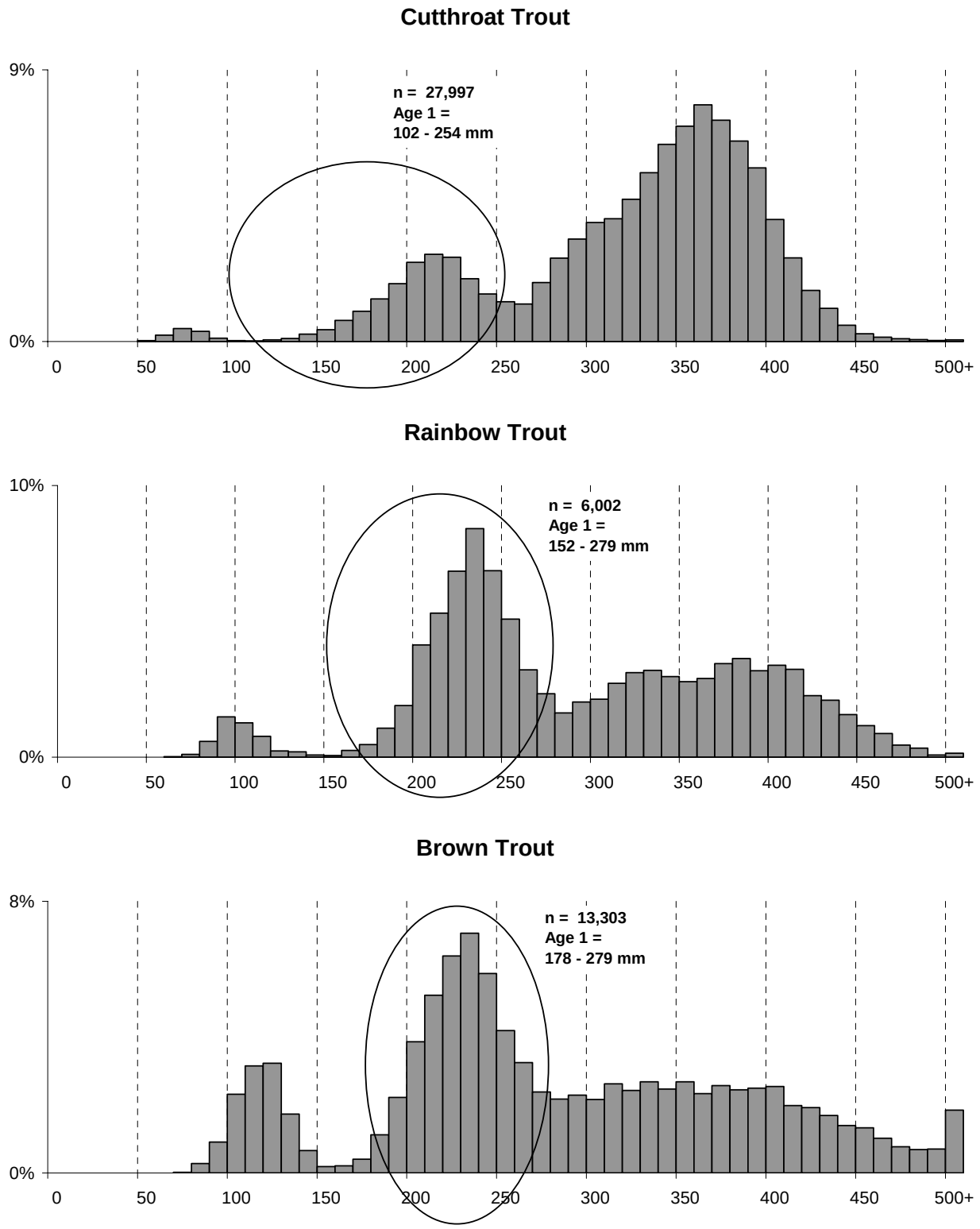


Figure 12. Overall length frequency distributions (TL, mm) of cutthroat (top), rainbow (middle), and brown trout (bottom) showing approximated age 1 fish, Conant and Lorenzo sections combined, South Fork Snake River, Idaho, 1986-2005.

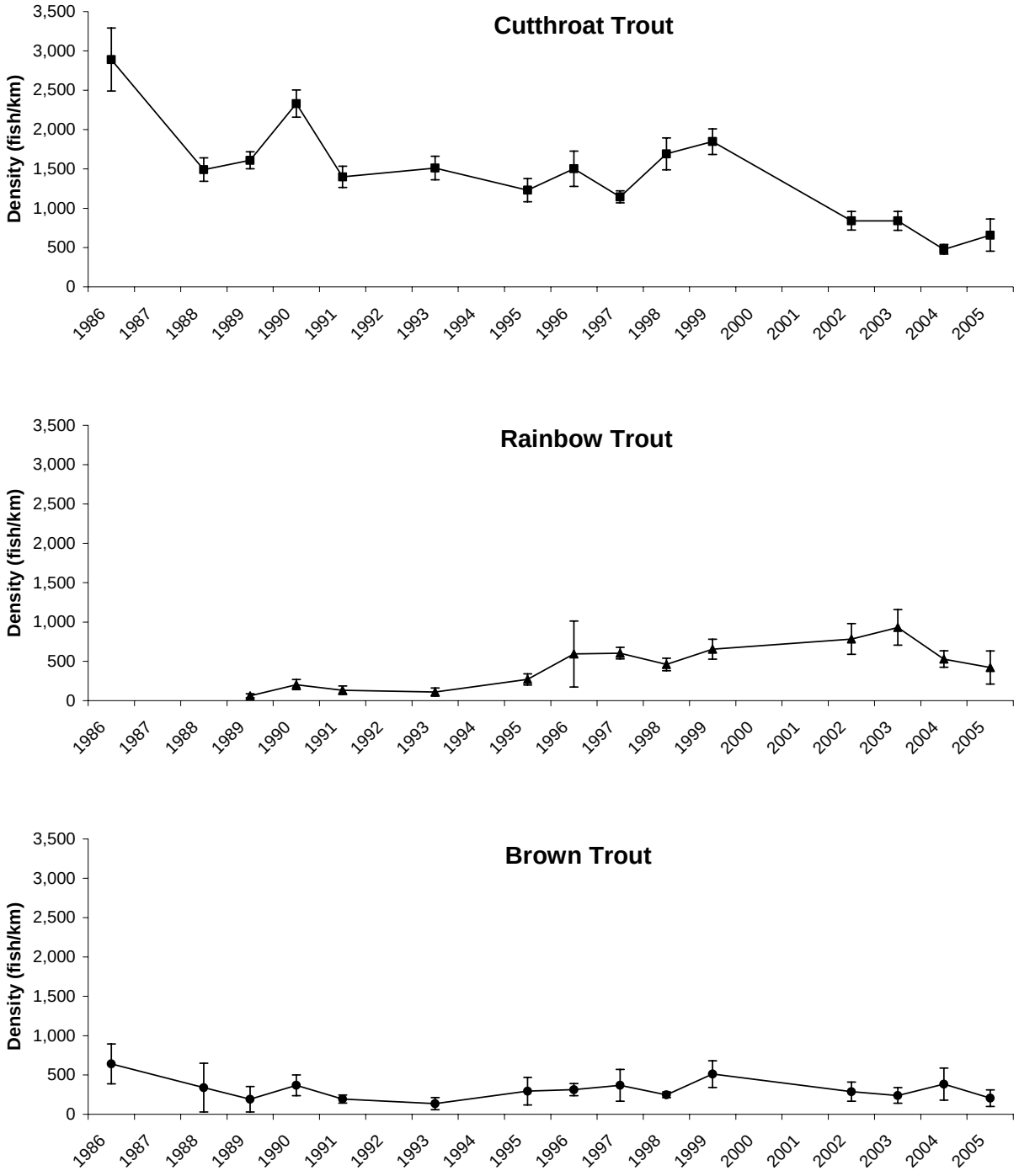


Figure 13. Density trends for age 1 and older cutthroat (top, ≥102 mm), rainbow (middle, ≥152 mm), and brown trout (bottom, ≥178 mm) at the Conant electrofishing section, South Fork Snake River, Idaho, October and November 1986-2005. Confidence intervals are at 95%.

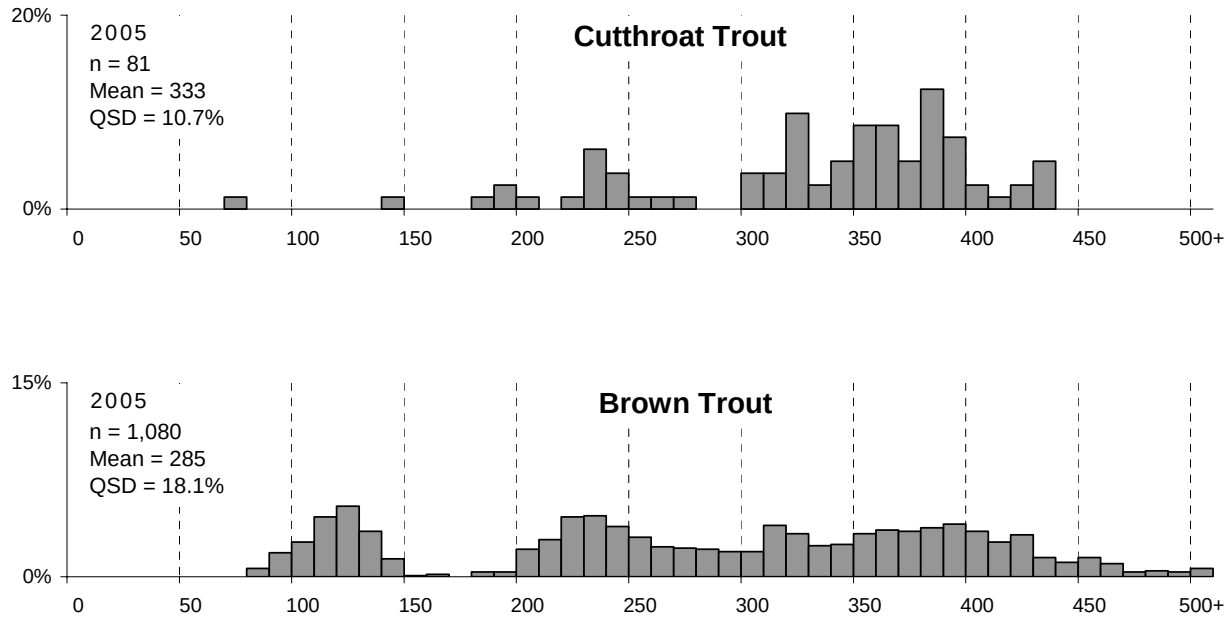


Figure 14. Length frequency distributions (TL, mm) of cutthroat (top) and brown trout (bottom) captured in the fall at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 2005. Total individual fish captured during electrofishing equals n.

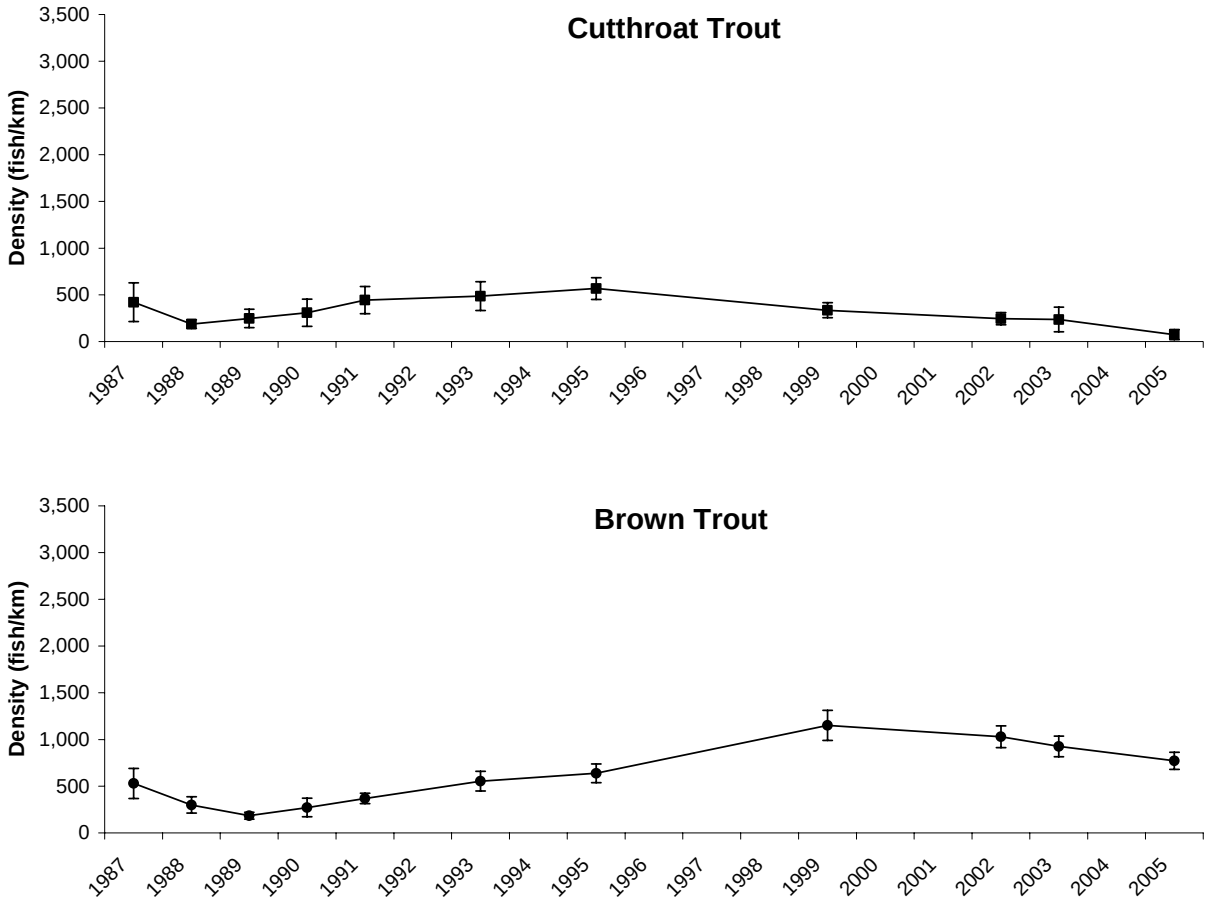


Figure 15. Density trends for age 1 and older cutthroat (top, ≥102 mm) and brown trout (bottom, ≥178 mm) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, September and October 1987-2005. Confidence intervals are at 95%.

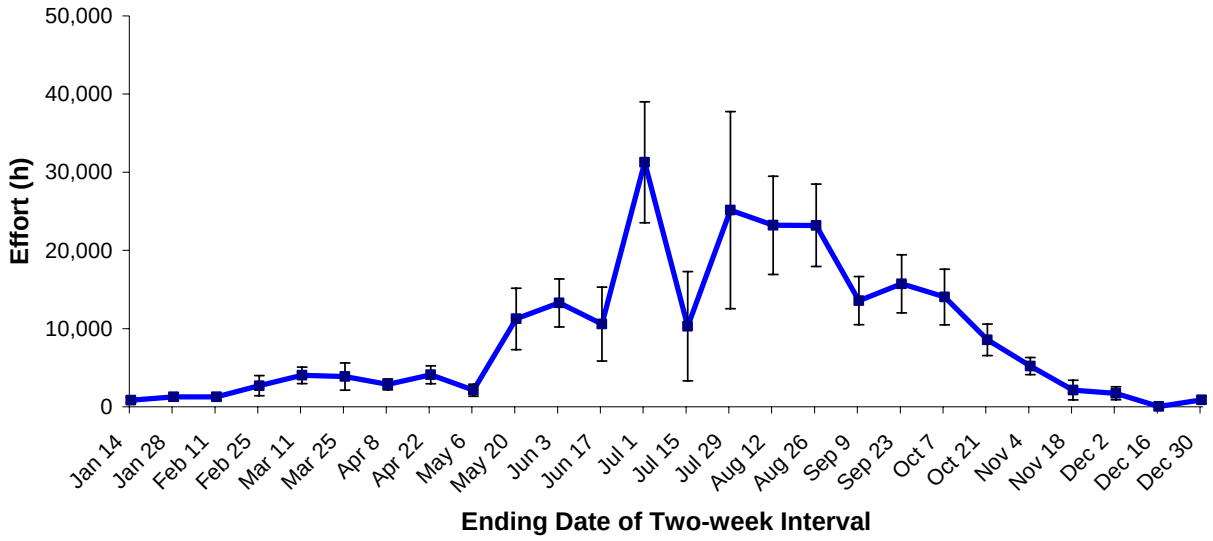


Figure 16. Estimated angler effort (h) by sampling interval in the South Fork Snake River, Idaho, during 2005. Confidence intervals are at 95%.

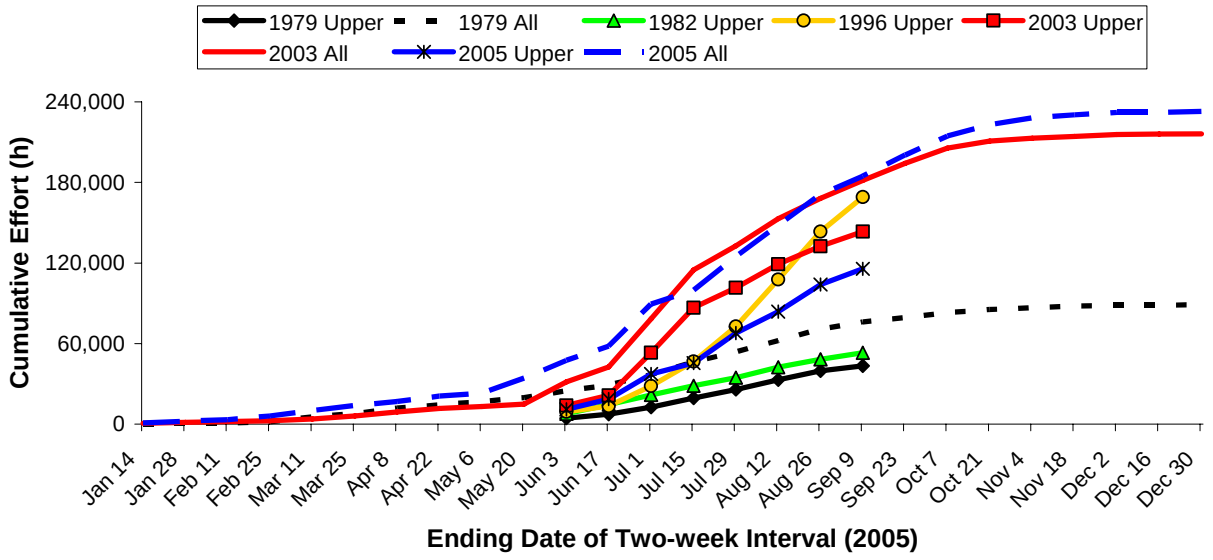


Figure 17. Estimated cumulative effort (h) in the South Fork Snake River, Idaho, during 1979 (Moore 1980), 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), 2003 (Schrader and Fredericks 2006), and 2005 (present study). Only the upper river above Heise (sections 1-4) was surveyed during the summer in 1982 and 1996; all sections were surveyed throughout the year in 1979, 2003, and 2005.

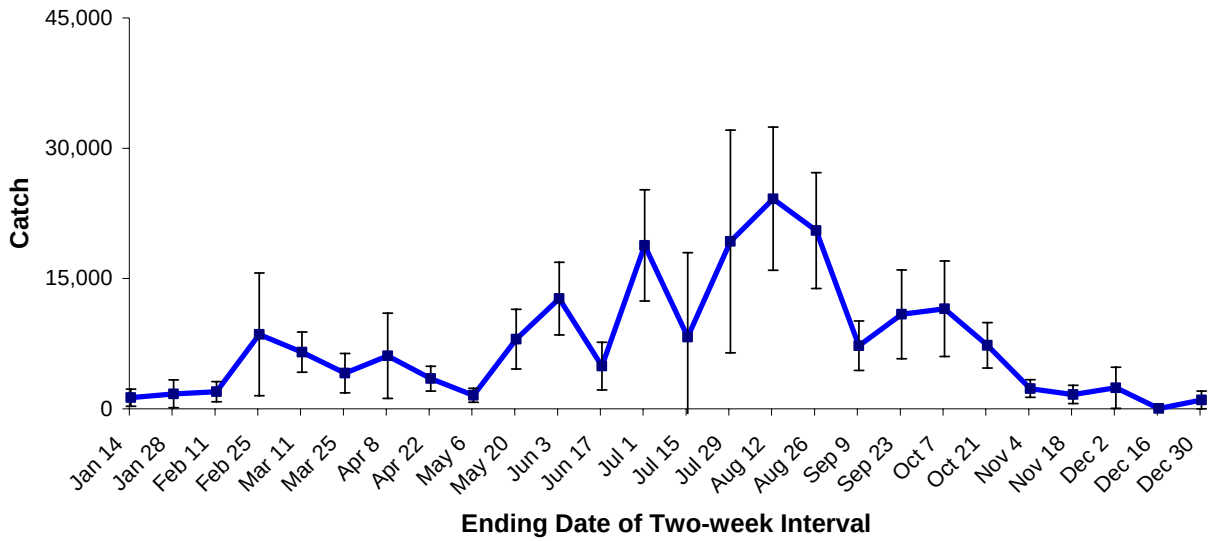


Figure 18. Estimated catch by sampling interval in the South Fork Snake River, Idaho, during 2005. Confidence intervals are at 95%.

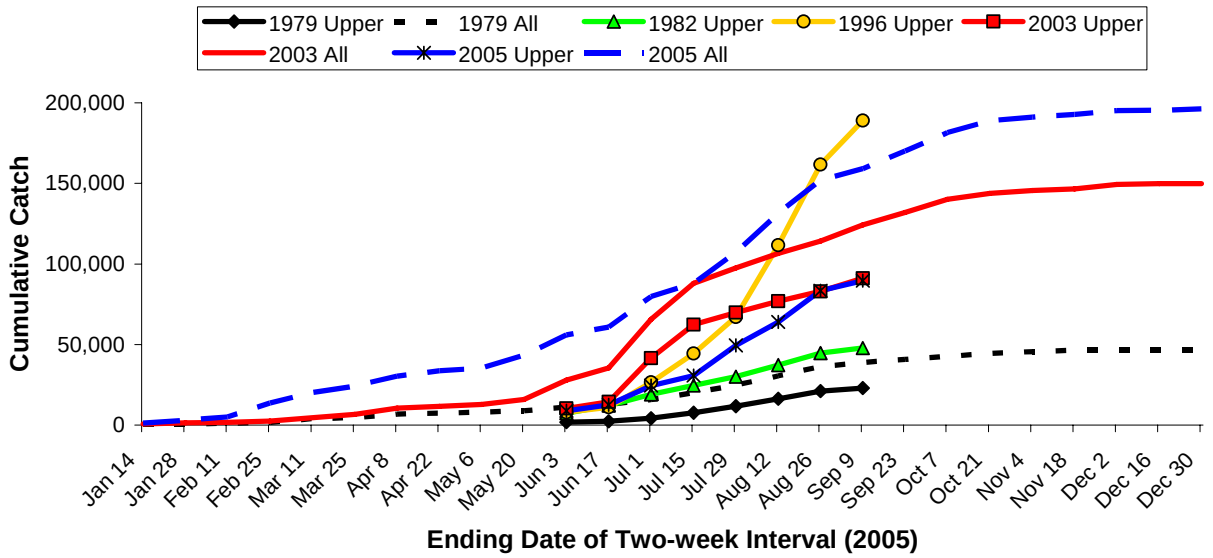


Figure 19. Estimated cumulative catch in the South Fork Snake River, Idaho, during 1979 (Moore 1980), 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), 2003 (Schrader and Fredericks 2006), and 2005 (present study). Only the upper river above Heise (sections 1-4) was surveyed during the summer in 1982 and 1996; all sections were surveyed throughout the year in 1979, 2003, and 2005.

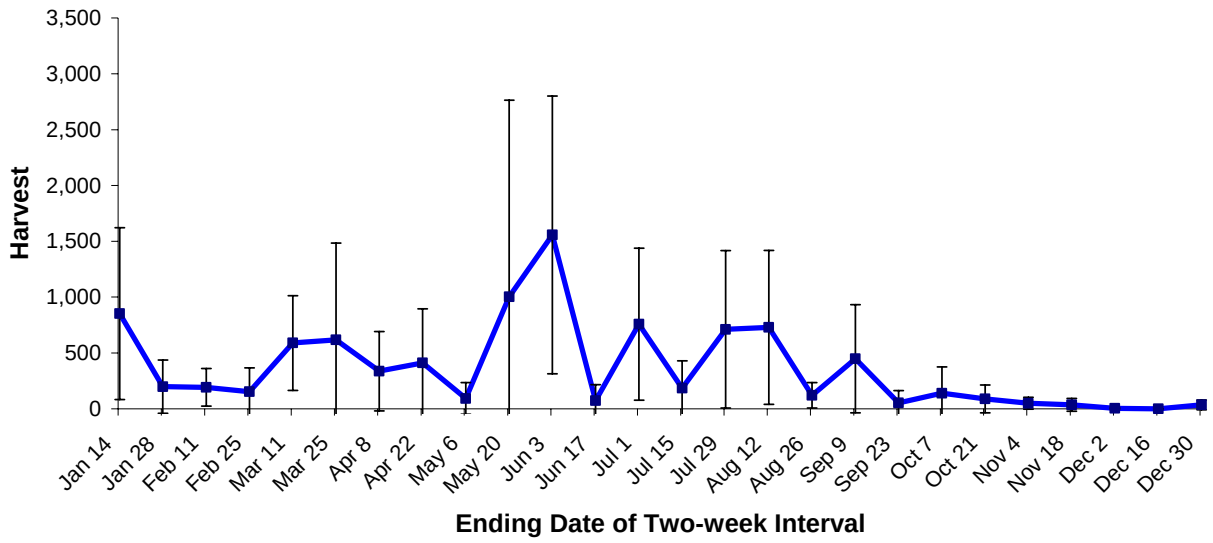


Figure 20. Estimated harvest by sampling interval in the South Fork Snake River, Idaho, during 2005. Confidence intervals are at 95%.

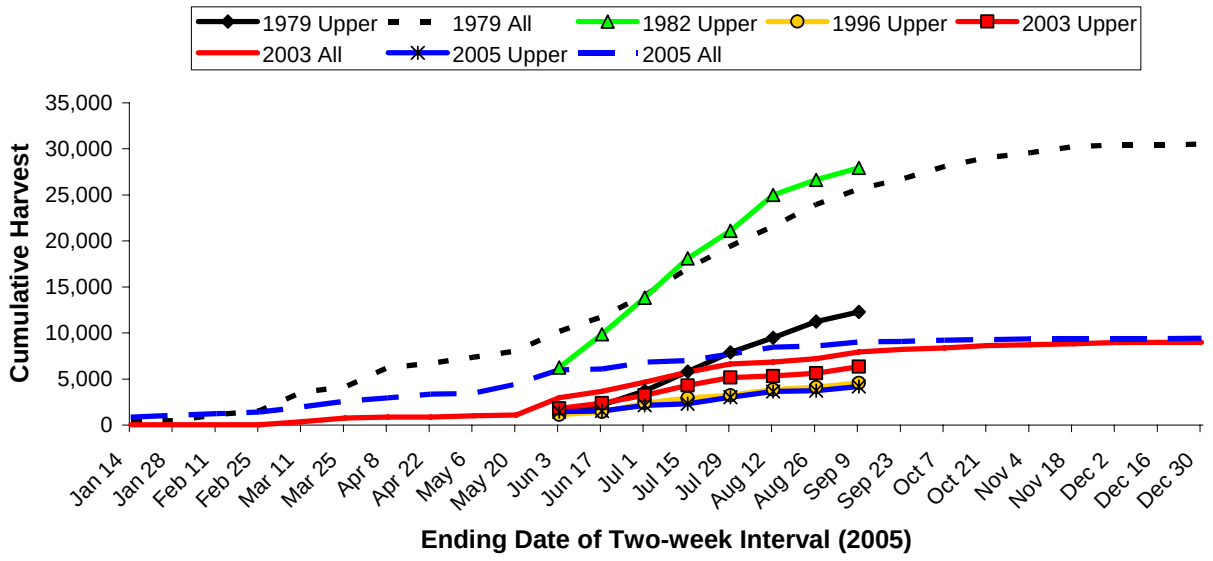


Figure 21. Estimated cumulative harvest in the South Fork Snake River, Idaho, during 1979 (Moore 1980), 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), 2003 (Schrader and Fredericks 2006), and 2005 (present study). Only the upper river above Heise (sections 1-4) was surveyed during the summer in 1982 and 1996; all sections were surveyed throughout the year in 1979, 2003, and 2005.

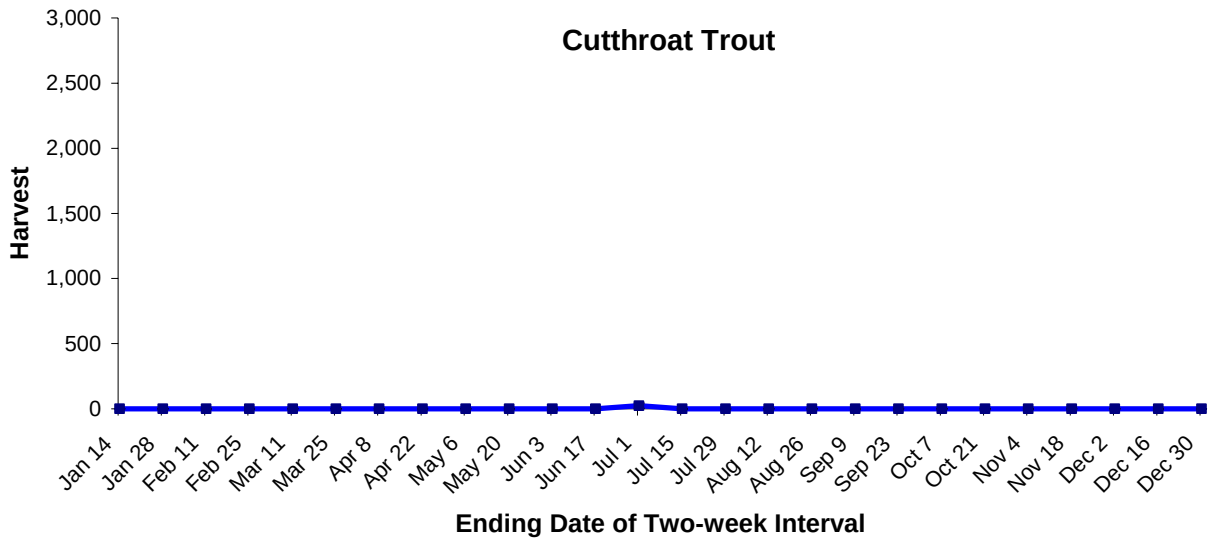


Figure 22. Estimated cutthroat trout harvest by sampling interval in the South Fork Snake River, Idaho, during 2005. Confidence intervals are at 95%.

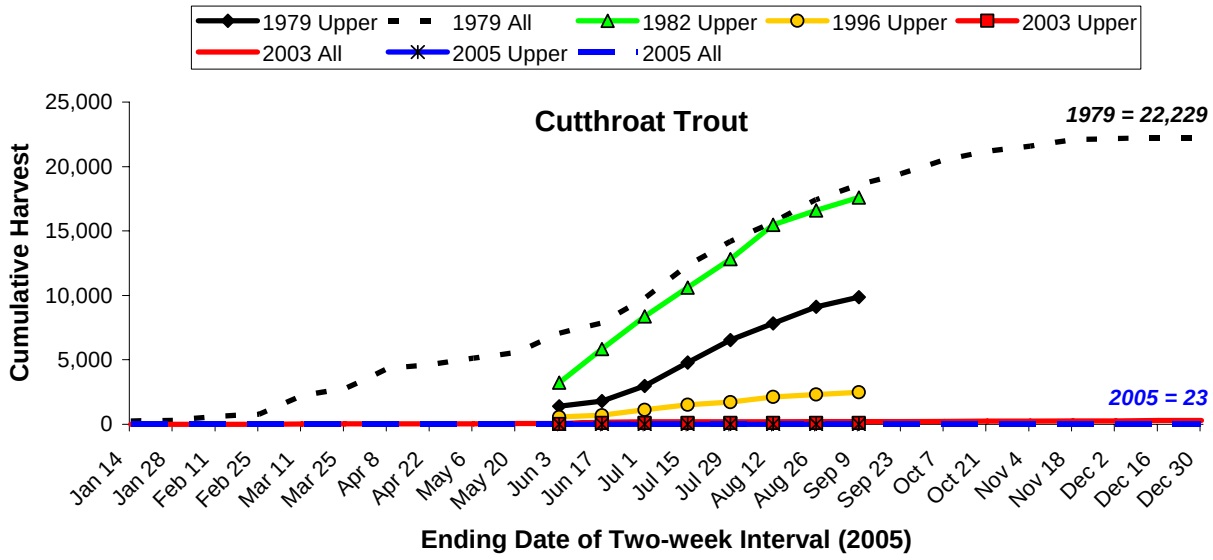


Figure 23. Estimated cumulative cutthroat trout harvest in the South Fork Snake River, Idaho, during 1979 (Moore 1980), 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), 2003 (Schrader and Fredericks 2006), and 2005 (present study). Only the upper river above Heise (sections 1-4) was surveyed during the summer in 1982 and 1996; all sections were surveyed throughout the year in 1979, 2003, and 2005.

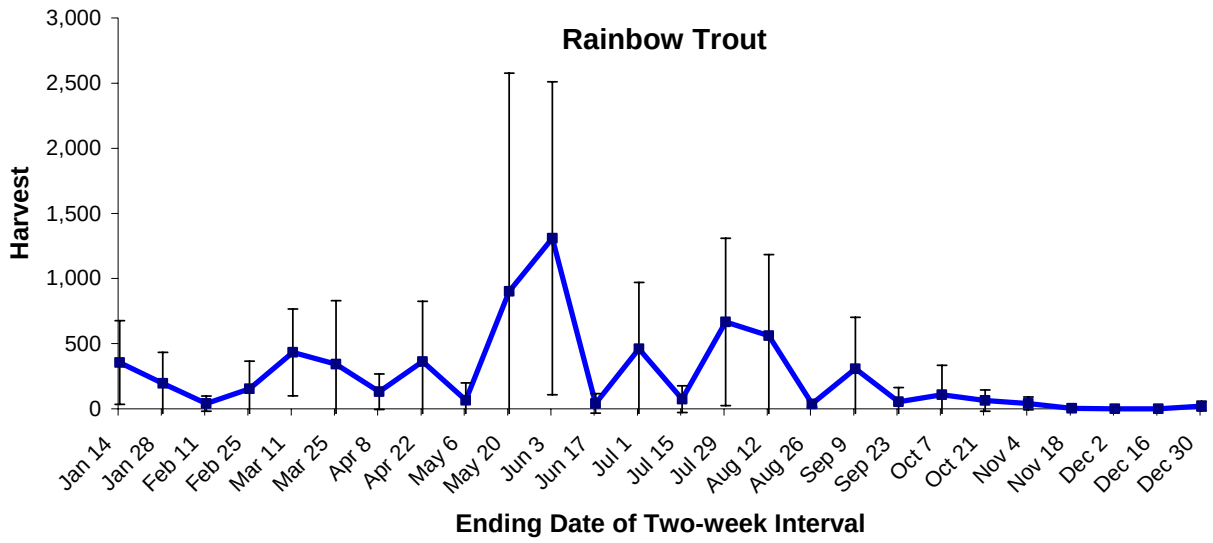


Figure 24. Estimated rainbow trout harvest by sampling interval in the South Fork Snake River, Idaho, during 2005. Confidence intervals are at 95%.

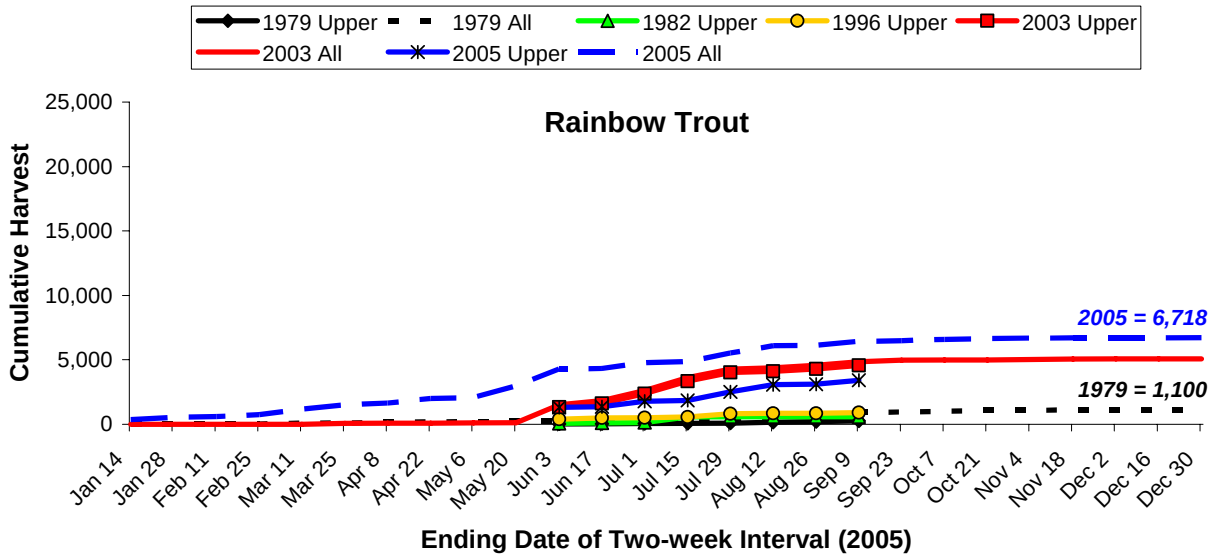


Figure 25. Estimated cumulative rainbow trout harvest in the South Fork Snake River, Idaho, during 1979 (Moore 1980), 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), 2003 (Schrader and Fredericks 2006), and 2005 (present study). Only the upper river above Heise (sections 1-4) was surveyed during the summer in 1982 and 1996; all sections were surveyed throughout the year in 1979, 2003, and 2005.

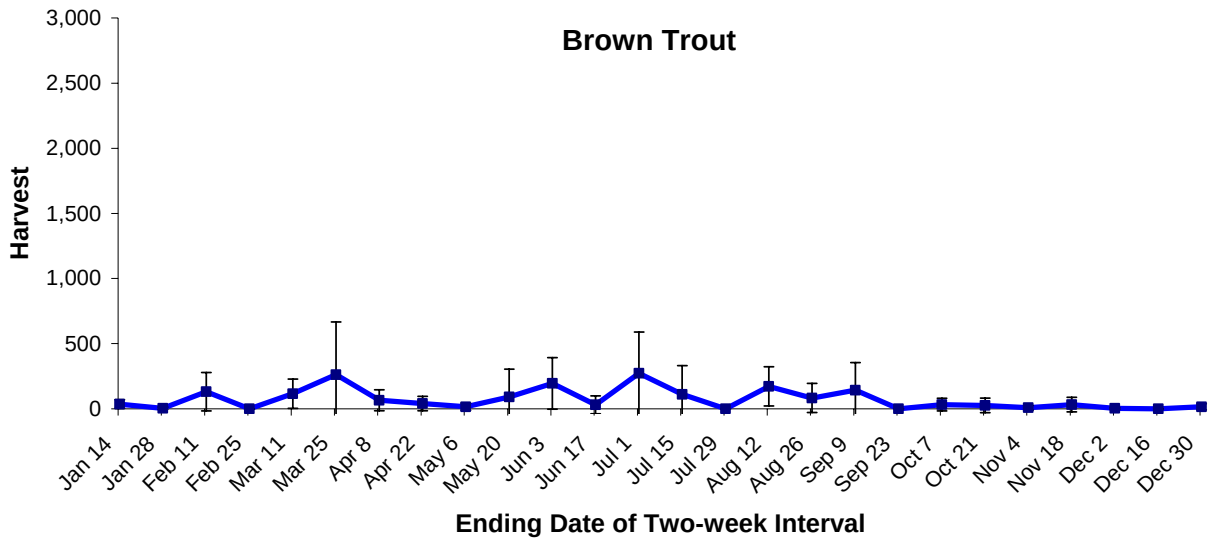


Figure 26. Estimated brown trout harvest by sampling interval in the South Fork Snake River, Idaho, during 2005. Confidence intervals are at 95%.

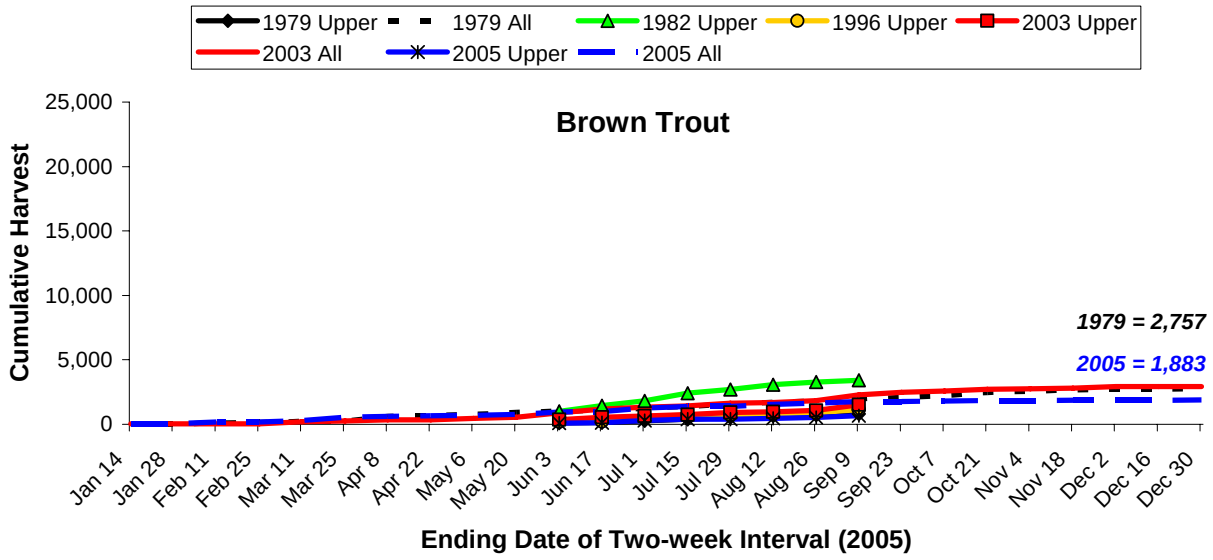


Figure 27. Estimated cumulative brown trout harvest in the South Fork Snake River, Idaho, during 1979 (Moore 1980), 1982 (Moore and Schill 1984), 1996 (Schrader et al. 2003), 2003 (Schrader and Fredericks 2006), and 2005 (present study). Only the upper river above Heise (sections 1-4) was surveyed during the summer in 1982 and 1996; all sections were surveyed throughout the year in 1979, 2003, and 2005.

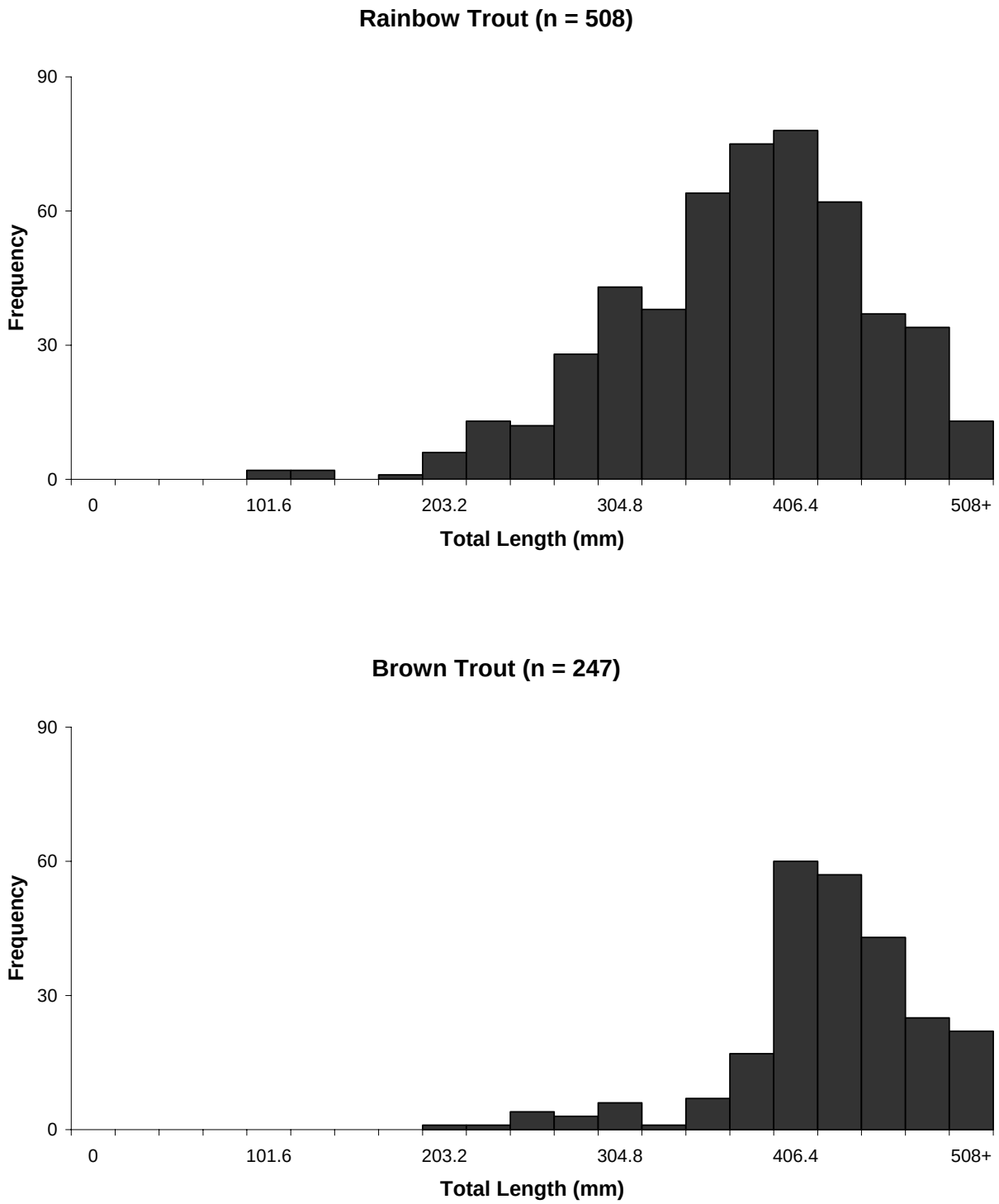


Figure 28. Length frequency distributions of rainbow trout (top) and brown trout (bottom) harvested by anglers and measured during creel surveys, South Fork Snake River, Idaho, 2003 (Schrader and Fredericks 2006) and 2005 (present study) combined. Data are from the entire river. Brown trout less than 406 mm are illegal harvest.

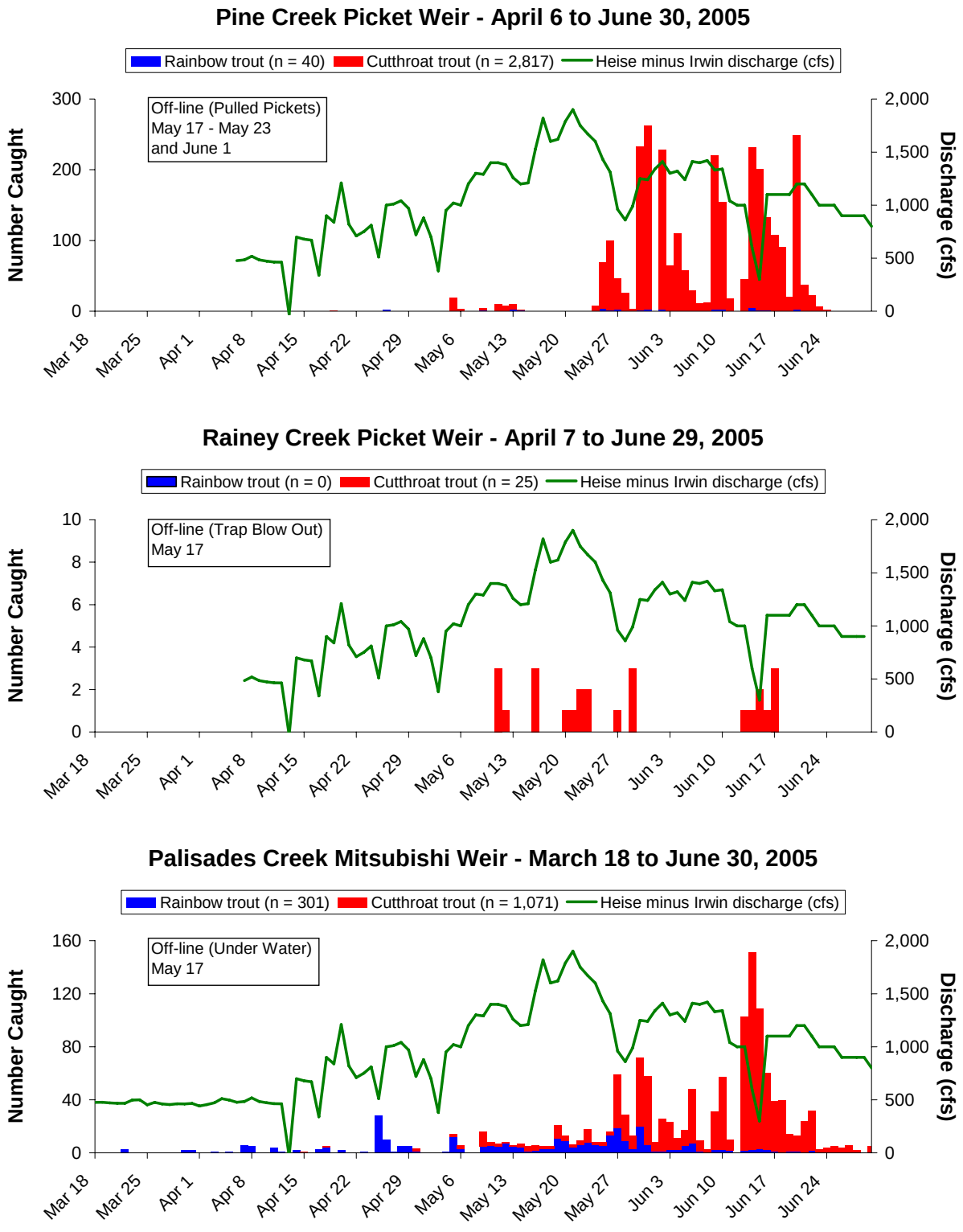


Figure 29. Number of fish caught, run timing, and hydrograph at the Pine Creek (top), Rainey Creek (middle), and Palisades Creek (bottom) weirs, South Fork Snake River, Idaho, 2005. Note different scales and bars are stacked.

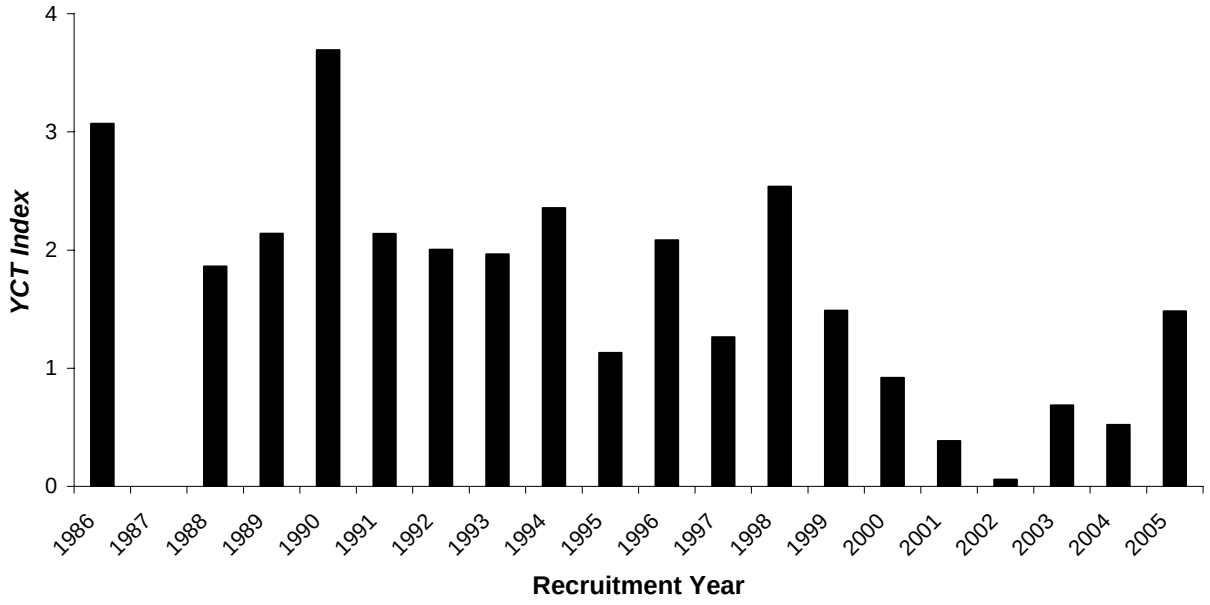


Figure 30. Values for the *YCT Index* calculated at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2005, except 1987 when recruitment data were unavailable.

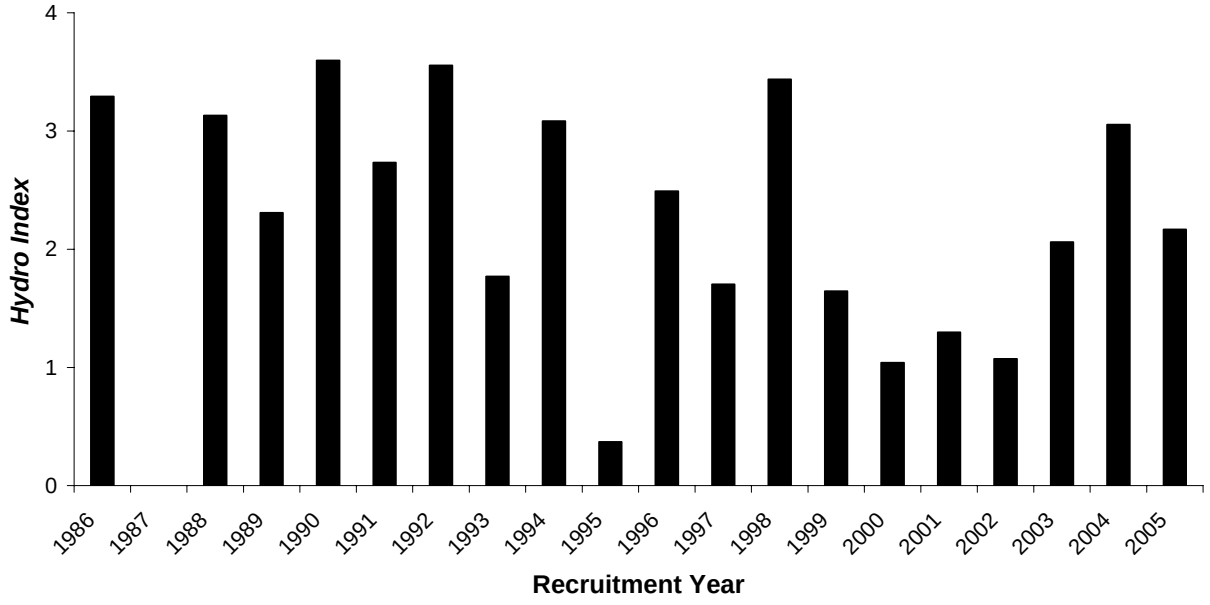


Figure 31. Values for the *Hydro Index* calculated at the USGS Heise gage, South Fork Snake River, Idaho, 1986-2005, except 1987 when fish data were unavailable.

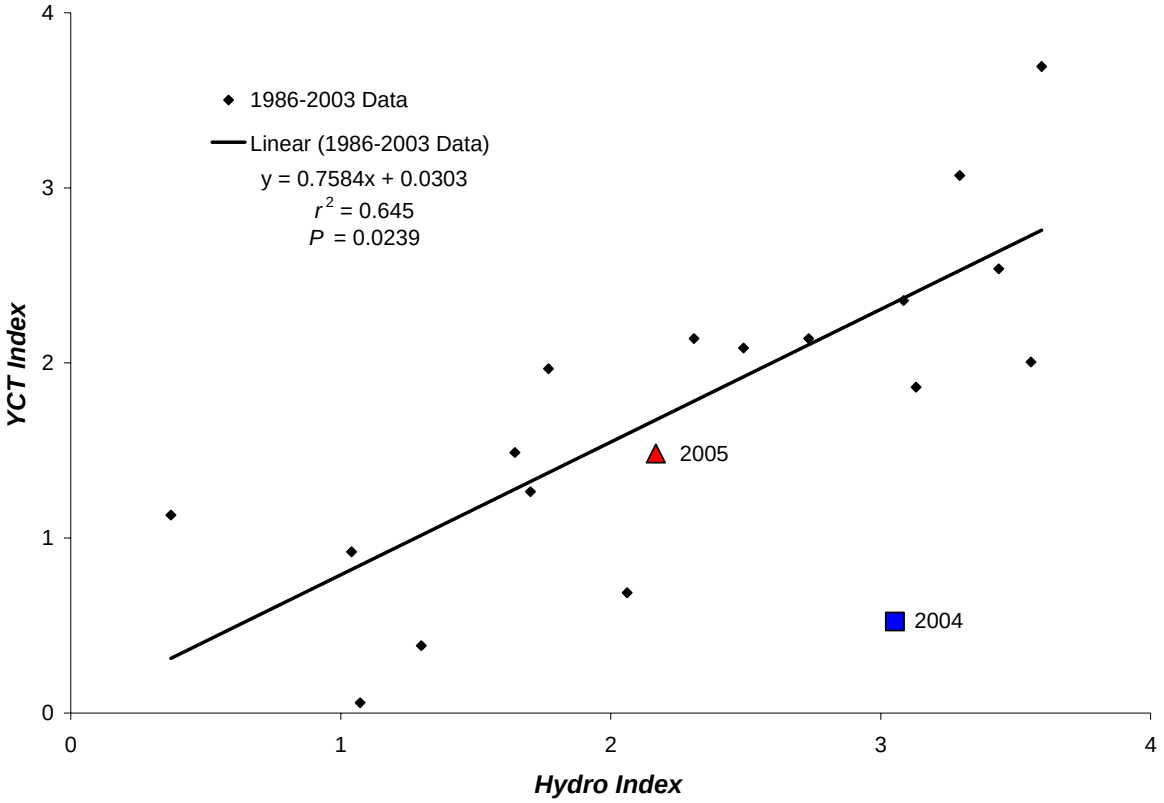


Figure 32. Relationship between the variables *YCT Index* and *Hydro Index*, South Fork Snake River, Idaho, 1986-2003, except 1987 when fish data were unavailable. The 2004 and 2005 data points followed modified flow management by BOR.

APPENDICES

Appendix A. Summary of South Fork Snake River, Idaho, fishing regulations 1970-2005.

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
2004-2005	Jan 1-Dec 31	No harvest CT; no limits RB or HYB; 2 BRN, none under 16”	Entire river open all year

Appendix B. Calculation of South Fork Snake River indices by Dr. Rob Van Kirk, Idaho State University, Pocatello, Idaho.

The Yellowstone cutthroat trout index was calculated using rainbow trout (RBT) and cutthroat trout (YCT) recruitment parameters estimated in the Conant electrofishing section during recruitment years 1986-2003. These parameters, based on age 1 or yearling fish electrofished in the fall, are assumed to reflect overall recruitment into the upper South Fork Snake River fishery above Heise. Recruitment values for years in which abundance estimates were unavailable were back-calculated by following cohorts through the population using observed mortality rates. This resulted in data for every year in the range 1986-2003 except 1987. The recruitment parameters calculated were:

YCT	Estimate of yearling YCT abundance
RBT	Estimate of yearling RBT abundance
%YCT	Percent yearling YCT in catch (as a fraction) out of all trout yearlings
%RBT	Percent yearling RBT in catch (as a fraction) out of all trout yearlings
YCT/RBT	Ratio of %YCT in catch to %RBT in catch (estimate of #YCT/#RBT)
YCT/(YCT + RBT)	Percent yearling YCT in catch (as a fraction) out of all *Oncorhynchus*

Abundance estimates were made using the maximum likelihood method for mark-recapture data. Each parameter was then scaled by subtracting its mean and dividing by its standard deviation over the sampled years. A Kolmogorov-Smirnov test was then used to test the null hypothesis that the sample of each variable came from a population that was normally distributed with mean 0 and variance 1. The null hypothesis could not be rejected for all six variables. Next, we determined the largest subset of the six variables whose members had correlations among each other of $r^2<0.5$. This set contained *YCT*, *RBT*, and *%YCT* and was considered to be the best set of uncorrelated variables on which to base an index of YCT status. The eliminated variables were moderately to highly correlated with one another and with *%YCT*. Principal Components Analysis (PCA) was then performed on the subset of three to determine the linear combination of the *YCT*, *RBT*, and *%YCT* that resulted in the highest differentiation among the 1986-2003 data points. The resulting linear combination, along with a translation (constant) term to make the value strictly positive, provided an index of overall strength of YCT recruitment in the South Fork. The coefficients were rescaled by dividing by the standard deviations to produce coefficients to be applied to the recruitment variables in their original units. The resulting *YCT Index* is:

$$YCTIndex = 3.083\times10^{-4}(YCT) - 2.359\times10^{-4}(RBT) + 2.559(\%YCT) + 0.1$$

where *%YCT* is expressed as a fraction rather than as a percent (e.g. 0.1 instead of 10%).

The hydrologic index was developed from a set of eight hydrologic variables describing hydrologic conditions in the main South Fork Snake River as measured at the Heise gage. These eight variables were chosen from a set of 29 such variables (see Moller and Van Kirk 2003) by performing simple and multiple linear regression of *YCT*, *RBT*, *%YCT*, and *YCT/RBT*, respectively, as functions of the hydrologic variables. Of the 29, only those hydrologic variables that appeared with regression coefficients significantly different from zero in one-, two- and three-variable regressions were selected. The resulting group of eight variables thus represented hydrologic conditions that explained variability in the various recruitment variables across the time period 1986-2003. These eight hydrologic variables were:

Spawn alt	Mean daily absolute hydrologic alteration over the spawning period
Spawn max/min	Ratio of maximum during spawning to previous winter minimum flow
1st growth alt	Mean daily absolute hydrologic alteration over the 1st summer
2nd spring alt	Same as *Spawn alt* but calculated over the spring of the fish's second year
2nd spring datemax	Date of maximum flow during the fish's second year
2nd spring max/min	Same as *Spawn max/min* but calculated over the fish's second spring
2nd growth alt	Same as *1st growth alt* but calculated over the fish's second summer
2nd WY alt	Mean daily absolute hydrologic alteration over the water year in which the fish was sampled as a yearling (1 year old plus a few months)

From this set of eight, *2nd growth alt* was eliminated because it was highly correlated (r = 0.999) with *1st growth alt*. The remaining variables were scaled and tested for normality as described above. All variables were found to be normally distributed from the K-S test results. Canonical correlation analysis (CCA) was then performed with the *YCT Index* as the dependent variable and this set of seven hydrologic variables as the independent variable vector. In this special case of one dependent variable, CCA determines the linear combination of the independent variables that results in a single index of maximum correlation with the dependent variable. A backwards stepwise procedure was used to eliminate variables to obtain the best correlation. Initially, all seven independent variables were included, and we recorded the *P*-value associated with the null hypothesis that the dependent variable is not a linear function of the linear combination of the independent variables. At each step, the variable with the smallest coefficient absolute value in the linear combination was eliminated and the process repeated until the null hypothesis could be rejected with the smallest *P*-value. The resulting linear combination, along with a translation (constant) term to make the value strictly positive, provided an index of hydrologic conditions positively correlated with the *YCT Index*. The coefficients were rescaled by dividing by the standard deviations to produce coefficients to be applied to the hydrologic variables in their original units. The resulting hydrologic index (*Hydro Index*) is:

$$HydroIndex = -5.051(Spawn\ alt) + 0.1818(Spawn\ max/min) - 1.742(1st\ growth\ alt)$$
$$+ 0.1363(2nd\ spring\ max/min) - 3.183(2nd\ spring\ alt) + 4$$

Not surprisingly, this index reflects the conclusions made in Moller and Van Kirk (2003) that favorable conditions for YCT relative to RBT occurred when hydrologic alteration was low and max/min ratios were high during the year in which the fish were spawned and reared. In addition, the index shows these same dependences (although weighted somewhat less) on hydrologic conditions during the fish's second year of life. The *YCT Index* was significantly and positively correlated with this *Hydro Index* (P = 0.0239, r^2 = 0.645).

After determining this hydrologic index, we performed an identical procedure starting with a set of ten independent hydrologic variables that included the seven used above plus three additional variables measuring hydrologic conditions in the South Fork spawning tributaries (combined discharge) that were identified during the regression analysis has having significant effects on *YCT/RBT*, which was the only recruitment variable depending significantly on tributary hydrology. These three independent variables were:

Tspawn mean	Mean discharge in tributaries during spawning season
Tgrowth max	Maximum discharge in tributaries during the fish's first summer
Tgrowth mean	Mean discharge in the tributaries during the fish's first summer.

During the stepwise elimination process, all three of these variables were eliminated, leaving the same linear combination as was obtained above. Thus, we infer that the *YCT Index*

is less sensitive to hydrologic conditions in the tributaries than in the main river, despite significant dependence of the single variable *YCT/RBT* on tributary hydrology. It is possible that if *YCT/RBT* had been retained in the development of the YCT index, the tributary dependence would have appeared in the hydrologic index. However, the correlation of *YCT/RBT* with other recruitment variables led to multicollinearity in the PCA used to determine the *YCT Index*, thus making its inclusion statistically invalid. So, we determined that the *YCT Index* and *Hydro Index* given above represent the best metrics on which to base success of flow management at Palisades Dam in increasing the overall status of YCT relative to RBT.

Appendix C.

Mark-recapture statistics for the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2005.

Appendix C-1. Sampling dates, flows, and catch rates at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2005. 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
10/4,6,12,14 2004	112.7-114.7	3,980-4,050	113.5	423
10/4,6,12,13 2005	90.5-127.9[e]	3,196-4,516[e]	105.6[e]	340

[a] Includes recaptured fish; catch rate = total trout caught / 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.
[e] Provisional data.

Appendix C-2. Trout species composition and relative abundance (percent of catch) at the Conant electrofishing section, South Fork Snake River, Idaho, 1982 and 1986-2005. 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 electrofishing is in parentheses.

Year	Cutthroat trout[a]		Rainbow trout		Brown trout		Lake trout	Kokanee	Total	
	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)
2004	41.4 (658)	25.2 (141)	35.4 (564)	44.9 (251)	23.2 (369)	29.9 (167)	0.0 (0)	0.0 (0)	100.0 (1,591)	100.0 (559)
2005	47.9 (627)	43.0 (147)	26.7 (350)	34.8 (119)	25.3 (332)	22.2 (76)	0.1 (1)	0.0 (0)	100.0 (1,310)	100.0 (342)

[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 C-3. Mean total length and quality stock density (QSD) of trout captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2005. Total individual fish captured during electrofishing equals *n*. QSD = (number ≥406 mm / number ≥203 mm) x 100.

Year	Cutthroat trout[a]			Rainbow trout			Brown trout			All trout[b]		
	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
2004	658	324	13.3	564	294	23.7	369	314	23.9	1,591	311	19.4
2005	627	322	14.0	350	295	24.3	332	247	21.7	1,310	296	18.3

[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 C-4. Mark-recapture statistics for age 1 and older cutthroat trout (≥102 mm), rainbow trout (≥152 mm), and brown trout (≥178 mm) at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2005. Cases where *R*≤3 and unbiased density estimates are not possible (Ricker 1975) are highlighted.

Year	Cutthroat trout[a]				Rainbow trout				Brown trout			
	M[b]	*C*[b]	*R*[b]	*R/C* (%)	*M*	*C*	*R*	*R/C* (%)	*M*	*C*	*R*	*R/C* (%)
1986[c]	1,170	546	70	12.8	32	16	2	12.5	183	105	8	7.6
1987[c,d,e]	281	ND[d]	ND	ND	5	ND	ND	ND	26	ND	ND	ND
1988	1,100	561	98	17.5	41	18	1	5.6	113	46	4	8.7
1989	1,416	1,050	200	19.0	57	55	10	18.2	92	76	11	14.5
1990	1,733	1,522	317	20.8	113	109	14	12.8	173	117	12	10.3
1991	1,145	625	140	22.4	98	54	9	16.7	150	119	19	16.0
1992[d]	595	ND	ND	ND	34	ND	ND	ND	76	ND	ND	ND
1993	972	623	100	16.1	74	41	6	14.6	101	64	10	15.6
1994[d]	853	ND	ND	ND	87	ND	ND	ND	110	ND	ND	ND
1995	631	542	77	14.2	130	140	17	12.1	150	108	13	12.0
1996	707	548	72	13.1	155	111	5	4.5	212	124	18	14.5
1997[f]	910	895	164	18.3	429	467	72	15.4	344	281	82	29.2
1998	674	682	61	8.9	216	247	26	10.5	257	216	49	22.7
1999	1,019	883	117	13.3	345	241	29	12.0	293	241	31	12.9
2000[d]	797	ND	ND	ND	260	ND	ND	ND	133	ND	ND	ND
2001[d]	776	ND	ND	ND	321	ND	ND	ND	208	ND	ND	ND
2002	495	394	50	12.7	295	257	24	9.3	111	104	9	8.7
2003	422	571	72	12.6	272	360	29	8.1	143	165	27	16.4
2004	315	379	51	13.5	227	304	29	9.5	169	202	22	10.9
2005	391	254	30	11.8	172	142	11	7.7	115	95	10	10.5

[a] Includes hatchery cutthroat trout.
[b] *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.
[c] Electrofishing conducted in early November rather than October.
[d] No recapture runs due to low flows; ND = no data.
[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 C-5. Estimated abundance (*N*) of age 1 and older cutthroat trout (≥102 mm), rainbow trout (≥152 mm), and brown trout (≥178 mm) at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2005. Confidence intervals (±95%) are in parentheses. Cases where *R*≤3 and unbiased estimates are not possible (Ricker 1975) are highlighted.

Year	Cutthroat trout[a]		Rainbow trout		Brown trout		Total	
	N/section	*N*/km	*N*/section	*N*/km	*N*/section	*N*/km	*N*/section	*N*/km
1986[b]	14,162 (1,970)	2,890 (402)	NUE[c]	NUE	3,142 (1,239)	641 (253)	17,304	3,531
1987[b,d,e]	NE[d]	NE	NE	NE	NE	NE	NE	NE
1988	7,307 (726)	1,491 (148)	NUE	NUE	1,667 (1,521)	340 (310)	8,974	1,831
1989	7,890 (528)	1,610 (108)	310 (128)	63 (26)	937 (794)	191 (162)	9,137	1,865
1990	11,418 (846)	2,330 (173)	1,002 (316)	204 (64)	1,806 (650)	369 (133)	14,226	2,903
1991	6,854 (665)	1,399 (136)	658 (264)	134 (54)	954 (252)	195 (52)	8,466	1,728
1992[d]	NE	NE	NE	NE	NE	NE	NE	NE
1993	7,409 (734)	1,512 (150)	538 (250)	110 (51)	662 (380)	135 (78)	8,609	1,757
1994[d]	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)	8,795	1,795
1996	7,360 (1,101)	1,502 (225)	2,911[f] (2,058)	594[f] (420)	1,537 (383)	314 (78)	11,808	2,410
1997[g]	5,609 (373)	1,145 (76)	2,962 (358)	604 (73)	1,808 (995)	369 (203)	10,379	2,118
1998	8,286 (999)	1,691 (204)	2,258 (385)	461 (79)	1,219 (176)	249 (36)	11,763	2,401
1999	9,051 (798)	1,847 (163)	3,207 (621)	654 (127)	2,507 (829)	512 (169)	14,765	3,013
2000[d]	NE	NE	NE	NE	NE	NE	NE	NE
2001[d]	NE	NE	NE	NE	NE	NE	NE	NE
2002	4,119 (582)	841 (119)	3,845 (956)	785 (195)	1,409 (600)	288 (122)	9,373	1,913
2003	4,114 (583)	840 (119)	4,563 (1,106)	931 (226)	1,174 (487)	240 (99)	9,851	2,010
2004	2,344 (301)	478 (61)	2,595 (511)	530 (104)	1,879 (998)	383 (204)	6,818	1,391
2005	3,224[f] (1,005)	658[f] (205)	2,061[f] (1,035)	421[f] (211)	1,011[f] (513)	206[f] (105)	6,296	1,285

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

Appendix C-6. Estimated abundance (*N*) of age 1 cutthroat trout (102-254 mm), rainbow trout (152-279 mm), and brown trout (178-279 mm) at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2005. Confidence intervals (±95%) are in parentheses. Cases where estimates are not possible are highlighted.

Year	Cutthroat trout		Rainbow trout		Brown trout		Total		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
2004	514 (121)	105 (25)	1,617 (445)	330 (91)	682 (192)	139 (39)	2,813	574	0.3	0.8
2005	1,700[f]	347[f]	1,023[f]	209[f]	165[f]	34[f]	2,888[f]	589[f]	1.7[f]	10.3[f]

[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.
[f] Estimated using cohort analysis.

Appendix D.

Mark-recapture statistics for the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2005.

Appendix D-1. Sampling dates, flows, and catch rates at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2005. 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
9/21,22,28,29 2005	67.8-87.0[c]	2,392-3,071[c]	78.1[c]	310

[a] Includes recaptured fish; catch rate = total trout caught / number days sampled.
[b] Major habitat changes with spring, 1997, runoff.
[c] Provisional data.

Appendix D-2. Trout species composition and relative abundance (percent of catch) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2005 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 electrofishing is in parentheses.

Year	Cutthroat trout[a]		Rainbow trout		Brown trout		Lake trout	Kokanee	Total	
	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)
2005	6.9 (81)	4.9 (15)	0.6 (7)	1.3 (4)	92.5 (1,080)	93.8 (287)	0.0 (0)	0.0 (0)	100.0 (1,168)	100.0 (306)

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

Appendix D-3. Mean total length and quality stock density (QSD) of trout captured in the fall at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2005 excluding years not sampled. Total individual fish captured during electrofishing equals *n*. QSD = (number ≥406 mm / number ≥203 mm) x 100.

Year	Cutthroat trout[a]			Rainbow trout			Brown trout			All trout[b]		
	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
2005	81	333	10.7	7	294	0.0	1,080	285	18.1	1,168	288	17.3

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

Appendix D-4. Mark-recapture statistics for age-1 and older cutthroat trout (≥102 mm), rainbow trout (≥152 mm), and brown trout (≥178 mm) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2005 excluding years not sampled. Cases where *R*≤3 and unbiased density estimates are not possible (Ricker 1975) are highlighted.

Year	Cutthroat trout[a]				Rainbow trout				Brown trout			
	M[b]	*C*[b]	*R*[b]	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
1988	133	88	13	14.8	3	2	0	0.0	241	130	23	17.7
1989	119	74	13	17.6	1	2	0	0.0	199	97	22	22.7
1990	208	91	12	13.2	2	0	0	0.0	260	93	23	24.7
1991	199	175	17	9.7	0	6	0	0.0	319	234	47	20.1
1993	144	201	18	9.0	6	8	0	0.0	238	270	27	10.0
1995	264	196	22	11.2	4	5	0	0.0	325	341	41	12.0
1999[c]	194	163	26	16.0	3	4	0	0.0	500	588	55	9.4
2002	108	138	14	10.1	4	3	1	33.3	457	579	61	10.5
2003	90	81	11	13.6	2	2	0	0.0	557	432	61	14.1
2005	37	47	4	8.5	5	2	0	0.0	440	486	67	13.8

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

Appendix D-5. Estimated abundance (*N*) of age 1 and older cutthroat trout (≥102 mm), rainbow trout (≥152 mm), and brown trout (≥178 mm) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2005 excluding years not sampled. Confidence intervals (±95%) are in parentheses. Cases where *R*≤3 and unbiased estimates are not possible (Ricker 1975) are highlighted.

Year	Cutthroat trout[a]		Rainbow trout		Brown trout		Total	
	N/section	*N*/km	*N*/section	*N*/km	*N*/section	*N*/km	*N*/section	*N*/km
1987	2,027 (992)	422 (207)	NUE[b]	NUE	2,548 (769)	531 (160)	4,575	953
1988	896 (227)	187 (47)	NUE	NUE	1,442 (421)	300 (88)	2,338	487
1989	1,188 (468)	248 (98)	NUE	NUE	890 (181)	185 (38)	2,078	433
1990	1,478[c] (695)	308[c] (145)	NUE	NUE	1,307 (473)	272 (99)	2,785	580
1991	2,136 (699)	445 (146)	NUE	NUE	1,773 (270)	369 (56)	3,909	814
1993	2,337 (744)	487 (155)	NUE	NUE	2,663 (506)	555 (105)	5,000	1,042
1995	2,727 (555)	568 (116)	NUE	NUE	3,066 (486)	639 (101)	5,793	1,207
1999[d]	1,608 (388)	335 (81)	NUE	NUE	5,520 (774)	1,150 (161)	7,128	1,485
2002	1,179 (311)	246 (65)	NUE	NUE	4,942 (563)	1,030 (117)	6,121	1,275
2003	1,137 (636)	237 (133)	NUE	NUE	4,446 (529)	926 (110)	5,583	1,163
2005	364[c] (258)	76[c] (54)	NUE	NUE	3,702 (437)	771 (91)	4,066	847

[a] Includes hatchery cutthroat trout.
[b] NUE = unbiased estimate not possible as *R*≤3.
[c] Modified Peterson rather than log-likelihood estimate.
[d] Major habitat changes with spring, 1997, runoff.

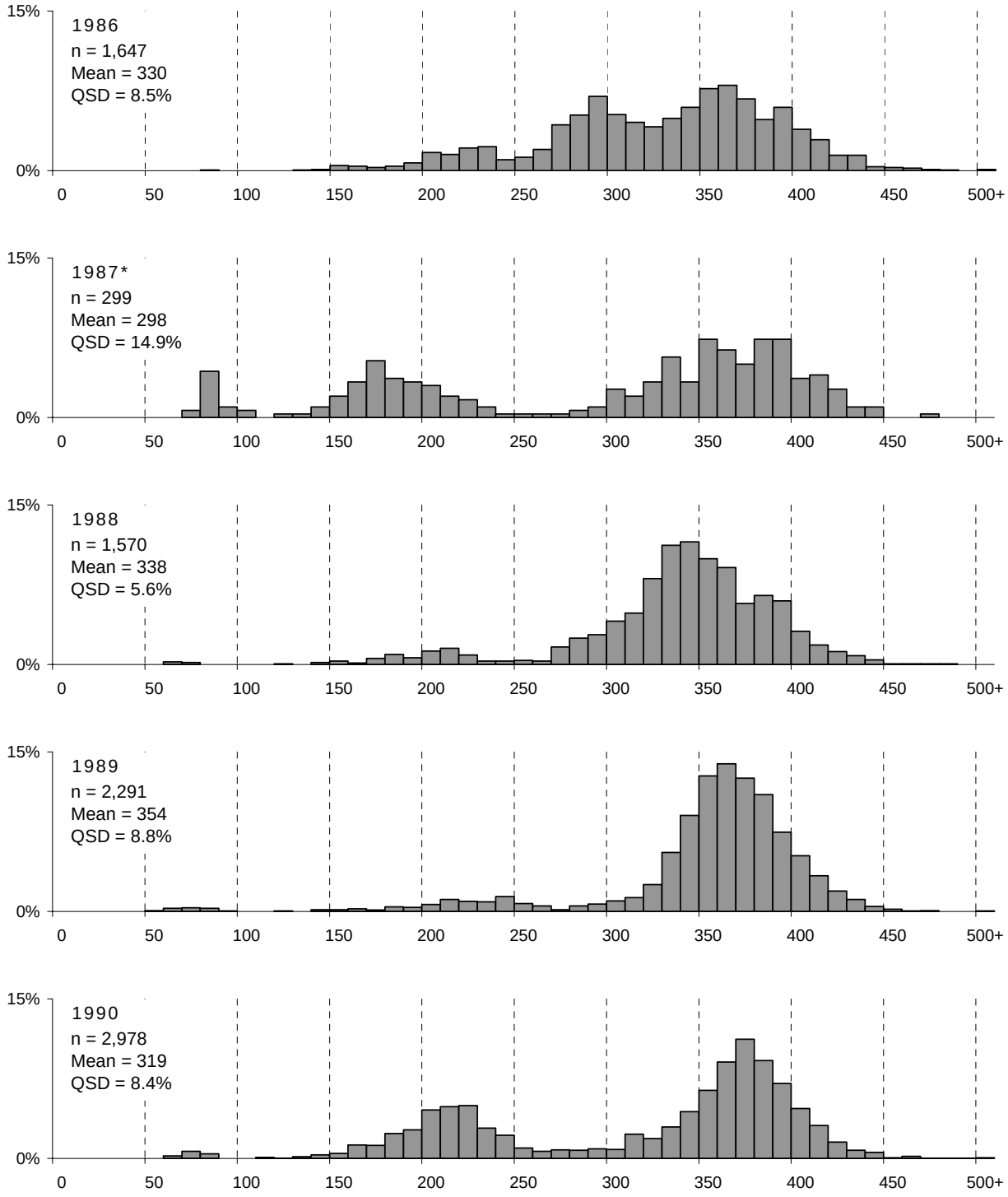
Appendix D-6. Estimated abundance (*N*) of age 1 cutthroat trout (102-254 mm), rainbow trout (152-279 mm), and brown trout (178-279 mm) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2005 excluding years not sampled. Confidence intervals (±95%) are in parentheses. Cases where estimates are not possible are highlighted.

Year	Cutthroat trout		Rainbow trout		Brown trout		Total		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		
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
2005	NE	NE	NE	NE	1,841 (393)	384 (82)	1,841	384	NE	NE

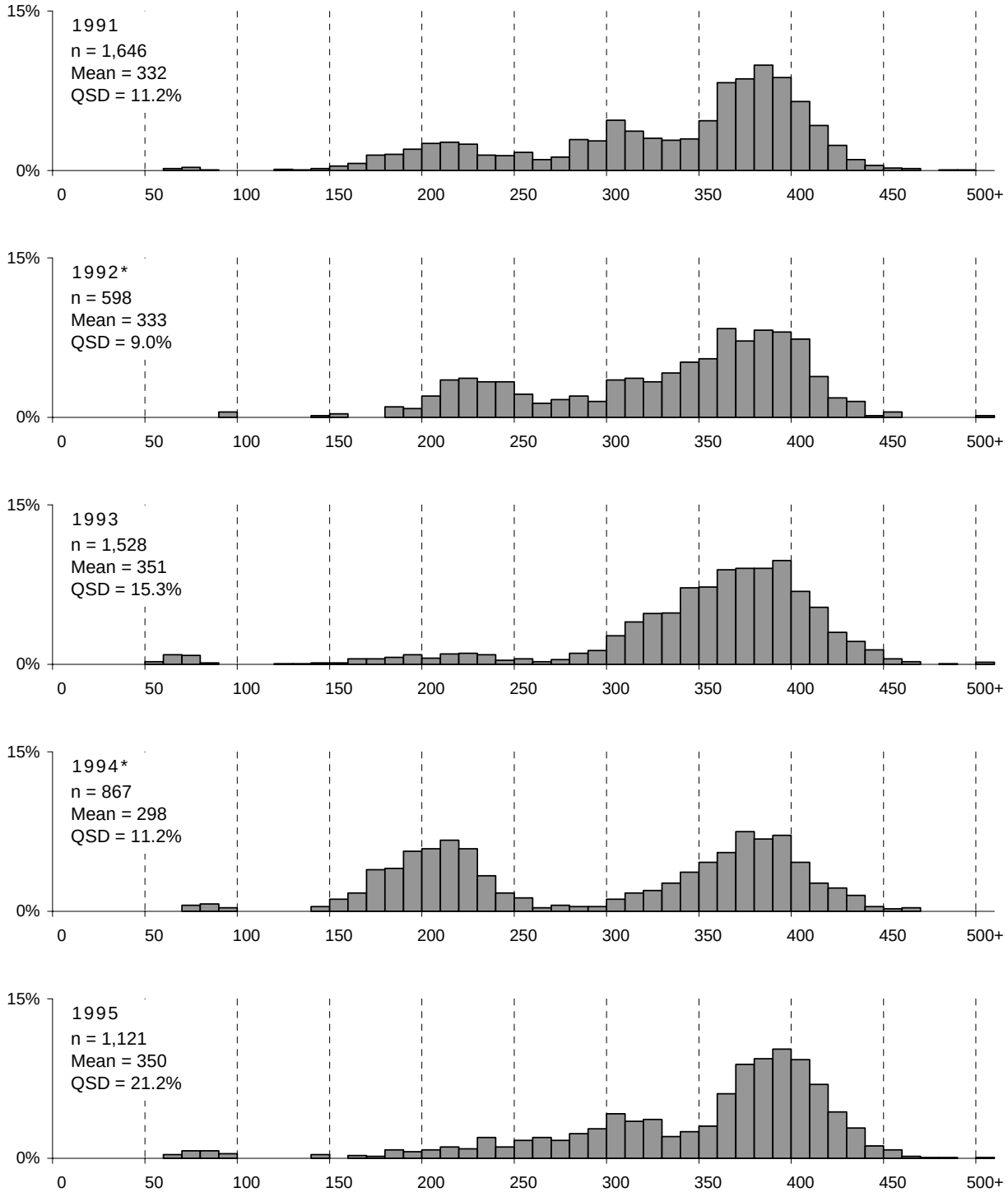
[a] NE = no estimate.
[b] Major habitat changes with spring, 1997, runoff.

Appendix E.

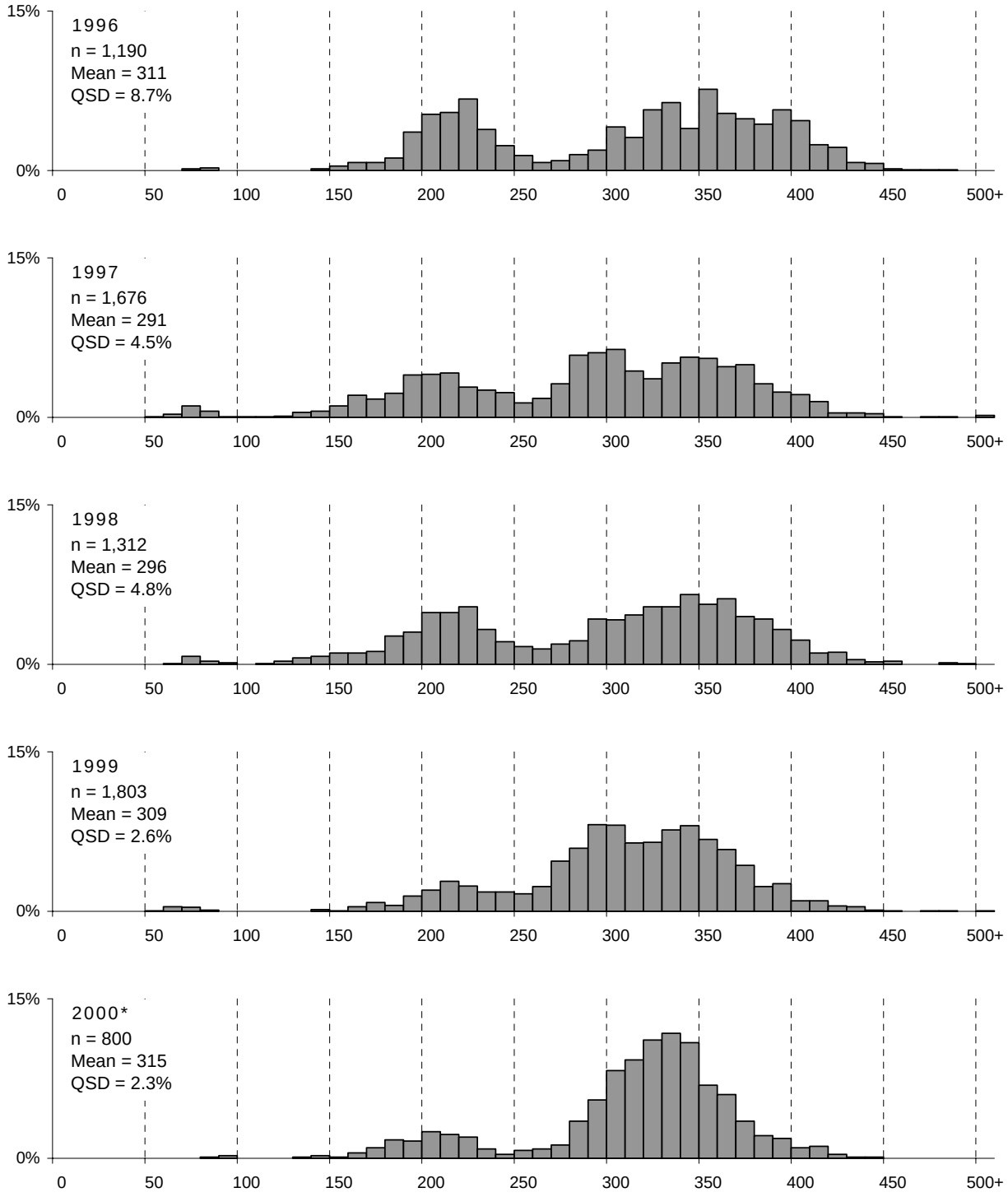
Length frequency distributions for the Conant and Lorenzo electrofishing sections, South Fork Snake River, Idaho, 1986-2005.



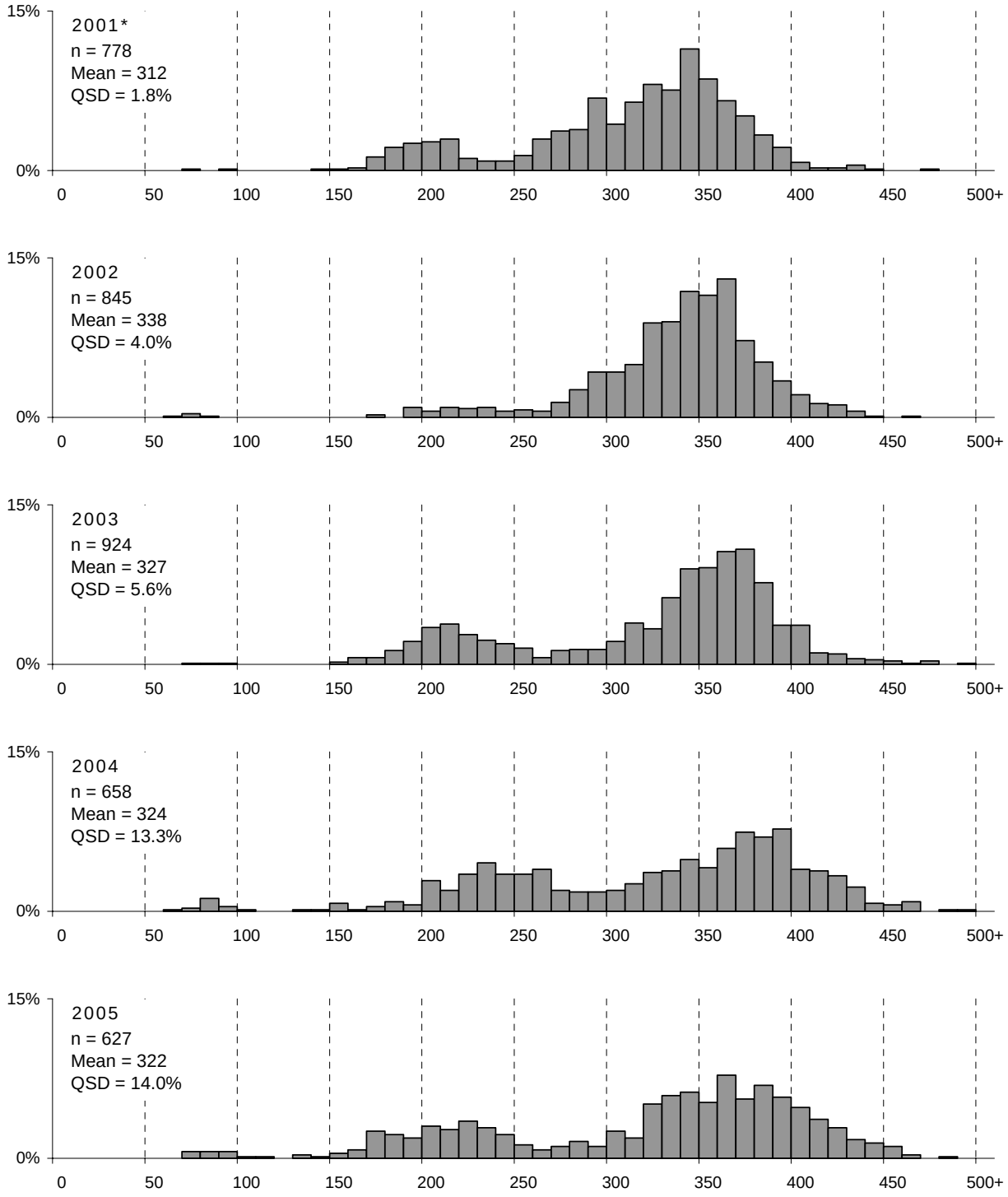
Appendix E-1. Length frequency distributions (TL, mm) of cutthroat trout captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2005. Total individual fish captured during electrofishing equals *n*. Asterisks denote years lacking recapture runs.



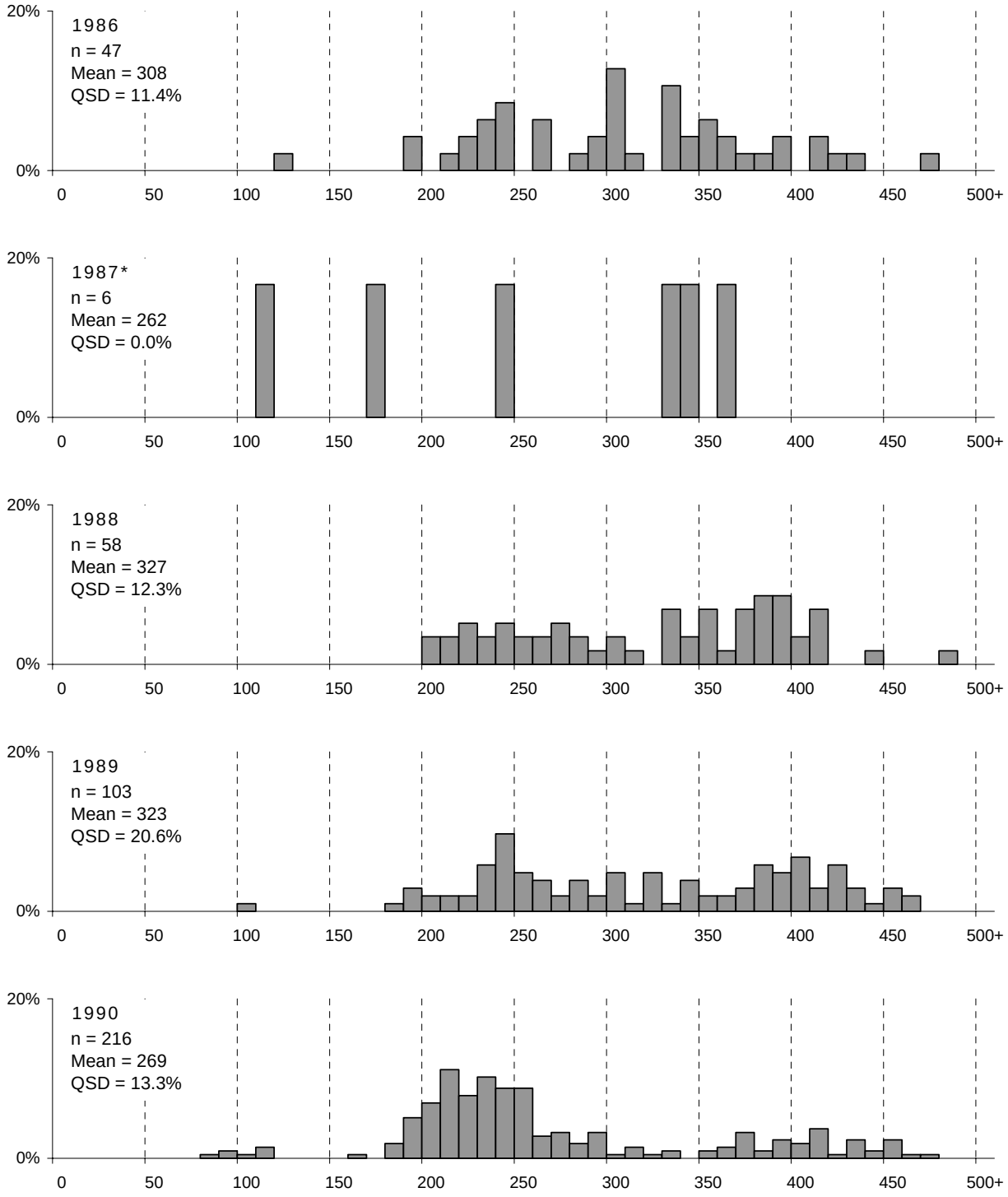
Appendix E-1. Continued.



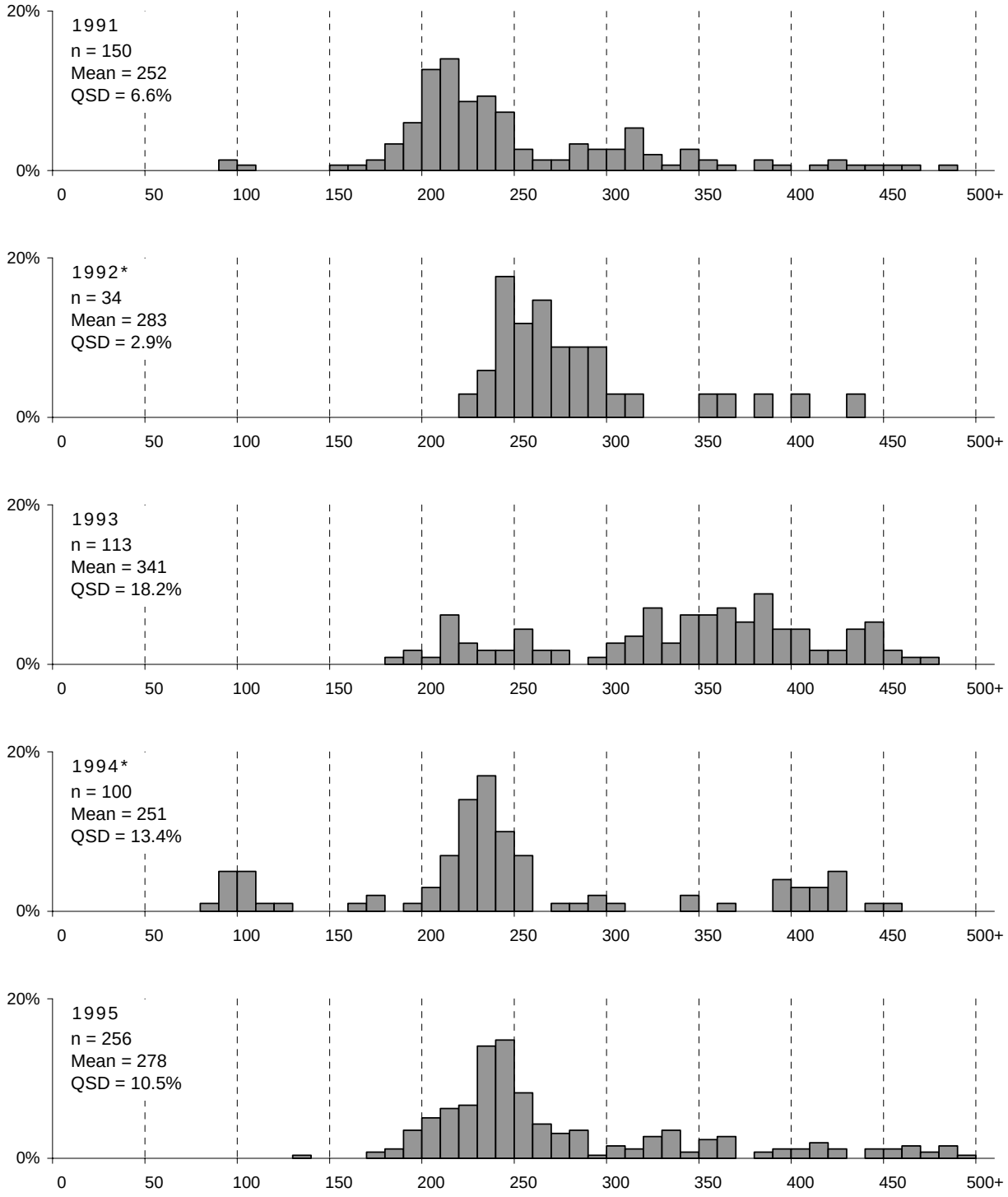
Appendix E-1. Continued.



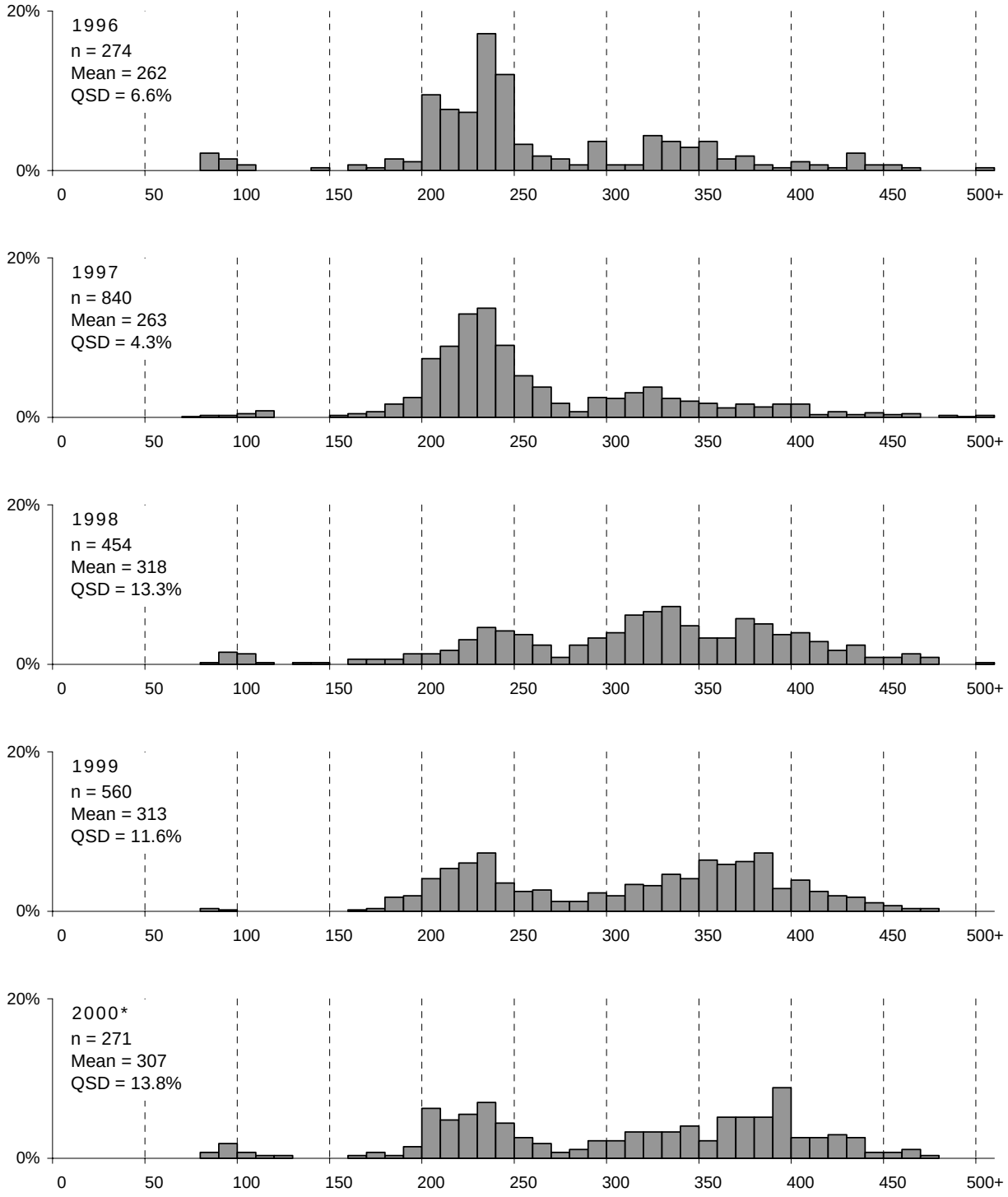
Appendix E-1. Continued.



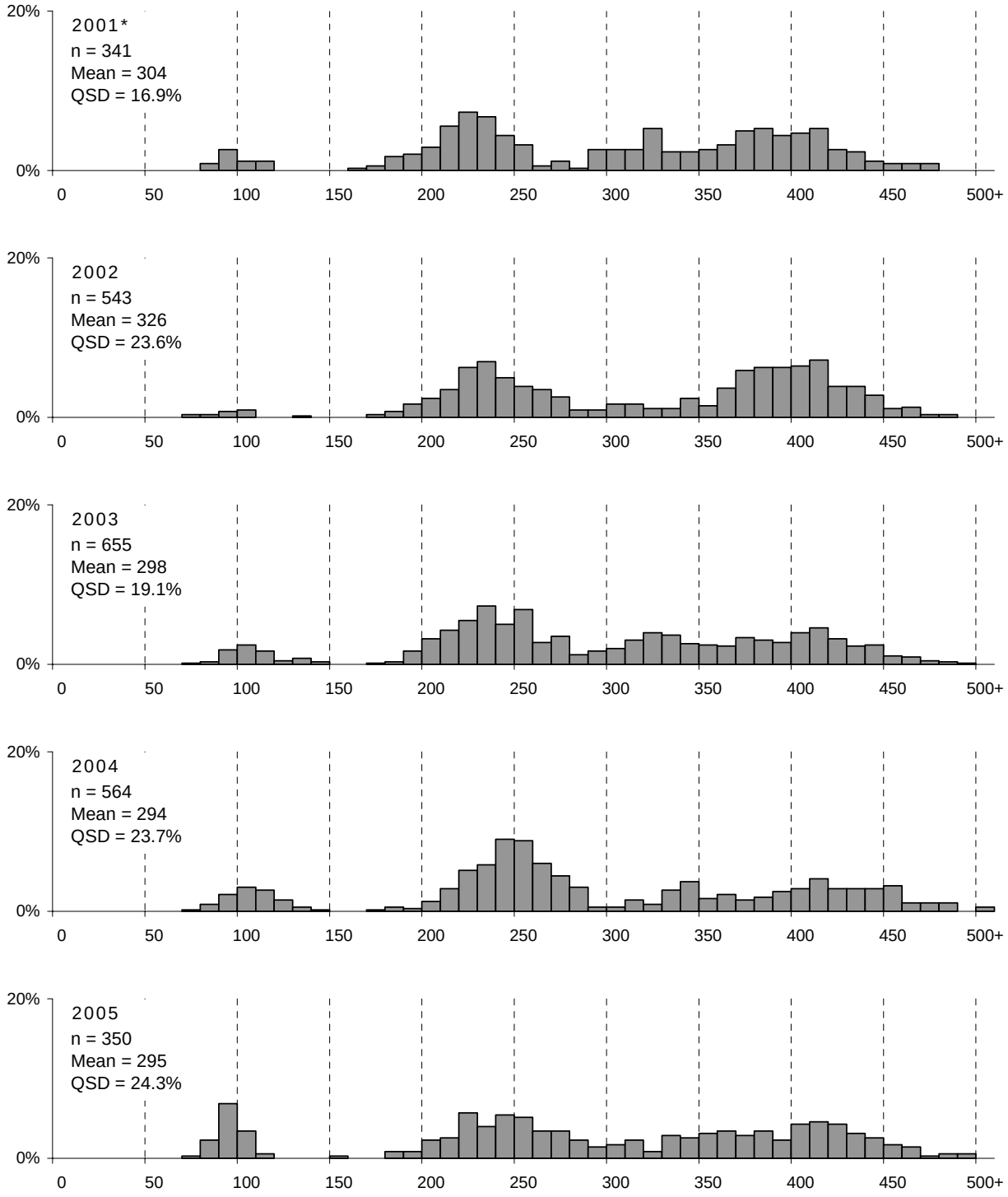
Appendix E-2. Length frequency distributions (TL, mm) of rainbow trout captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2005. Total individual fish captured during electrofishing equals *n*. Asterisks denote years lacking recapture runs.



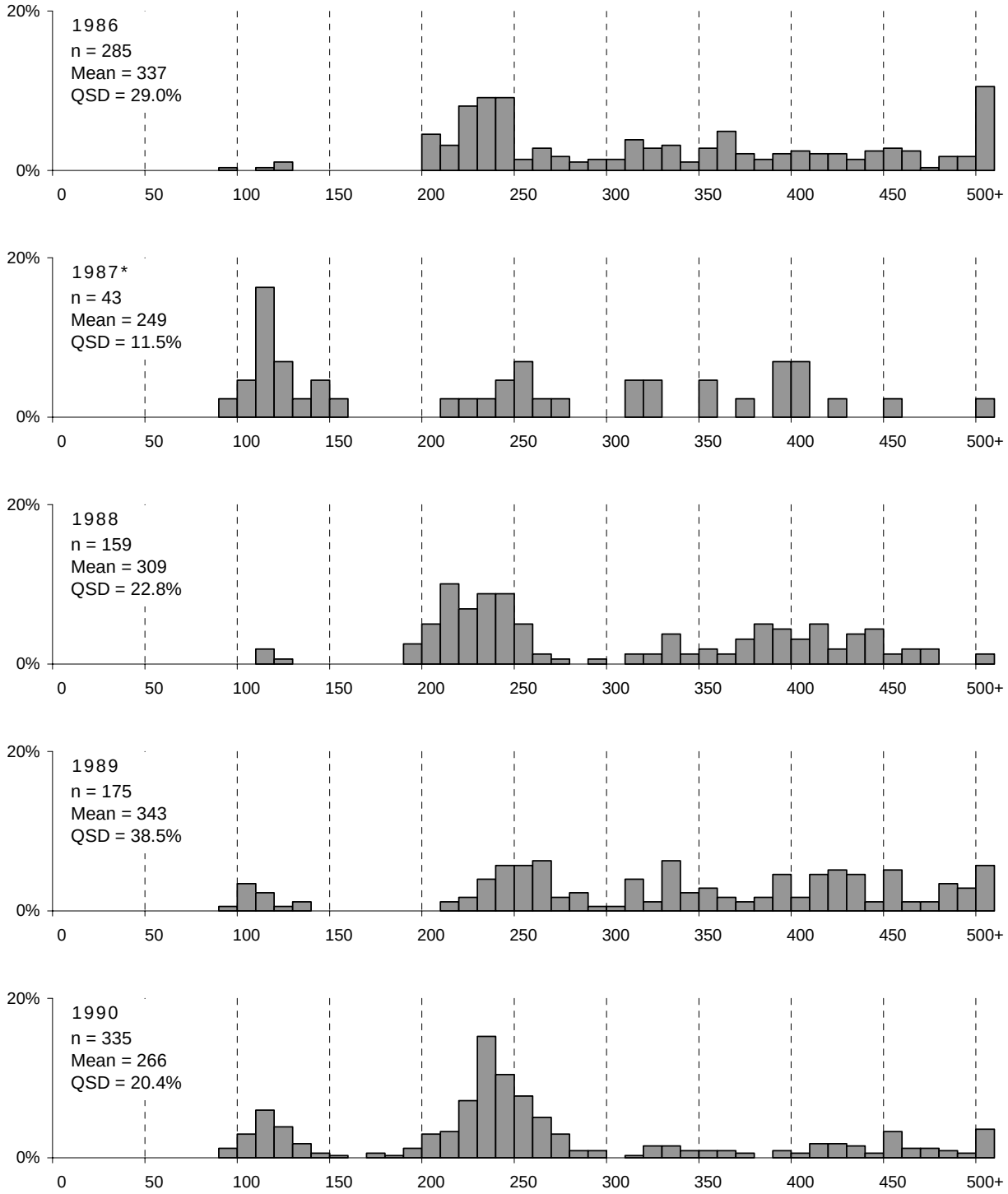
Appendix E-2. Continued.



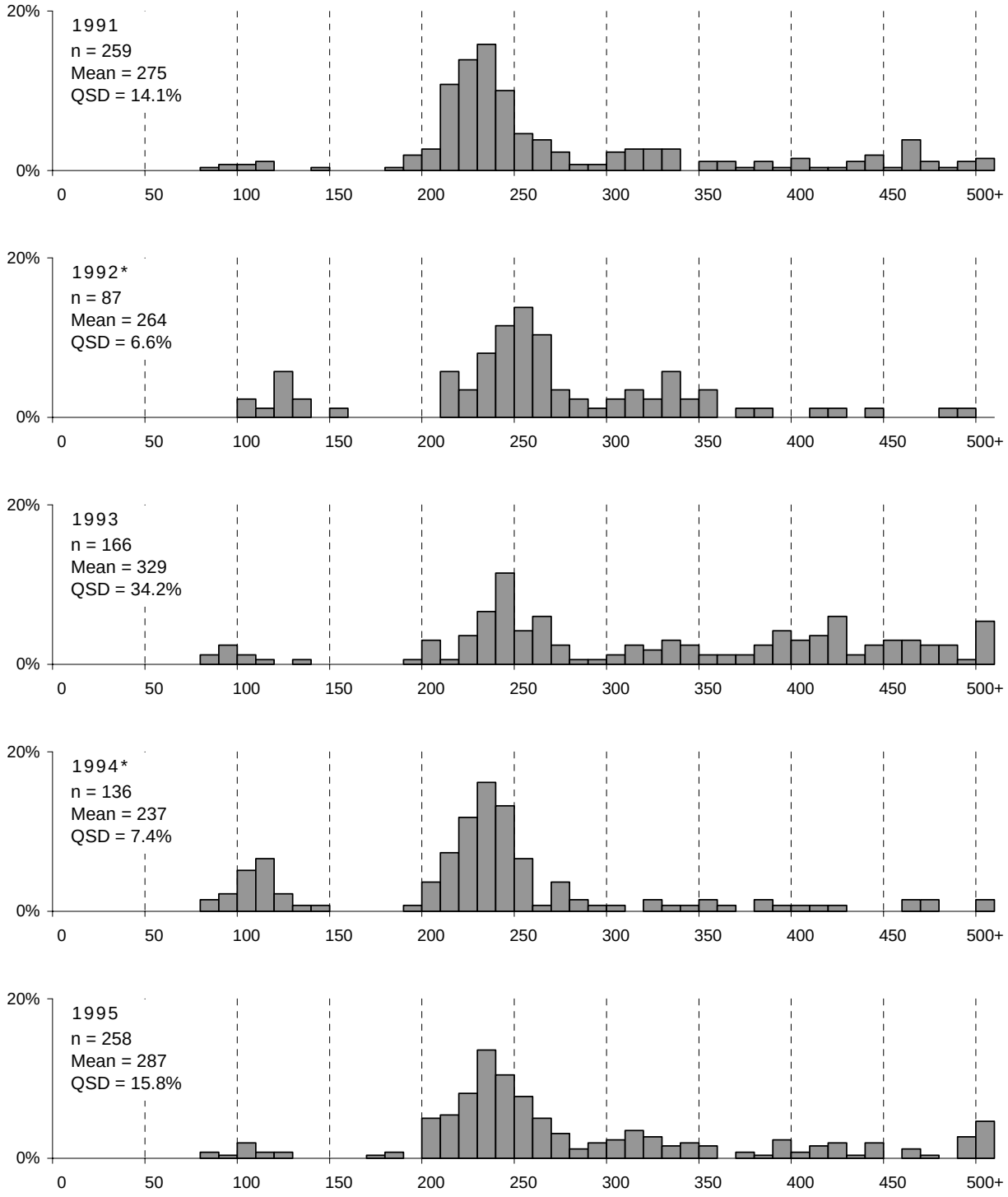
Appendix E-2. Continued.



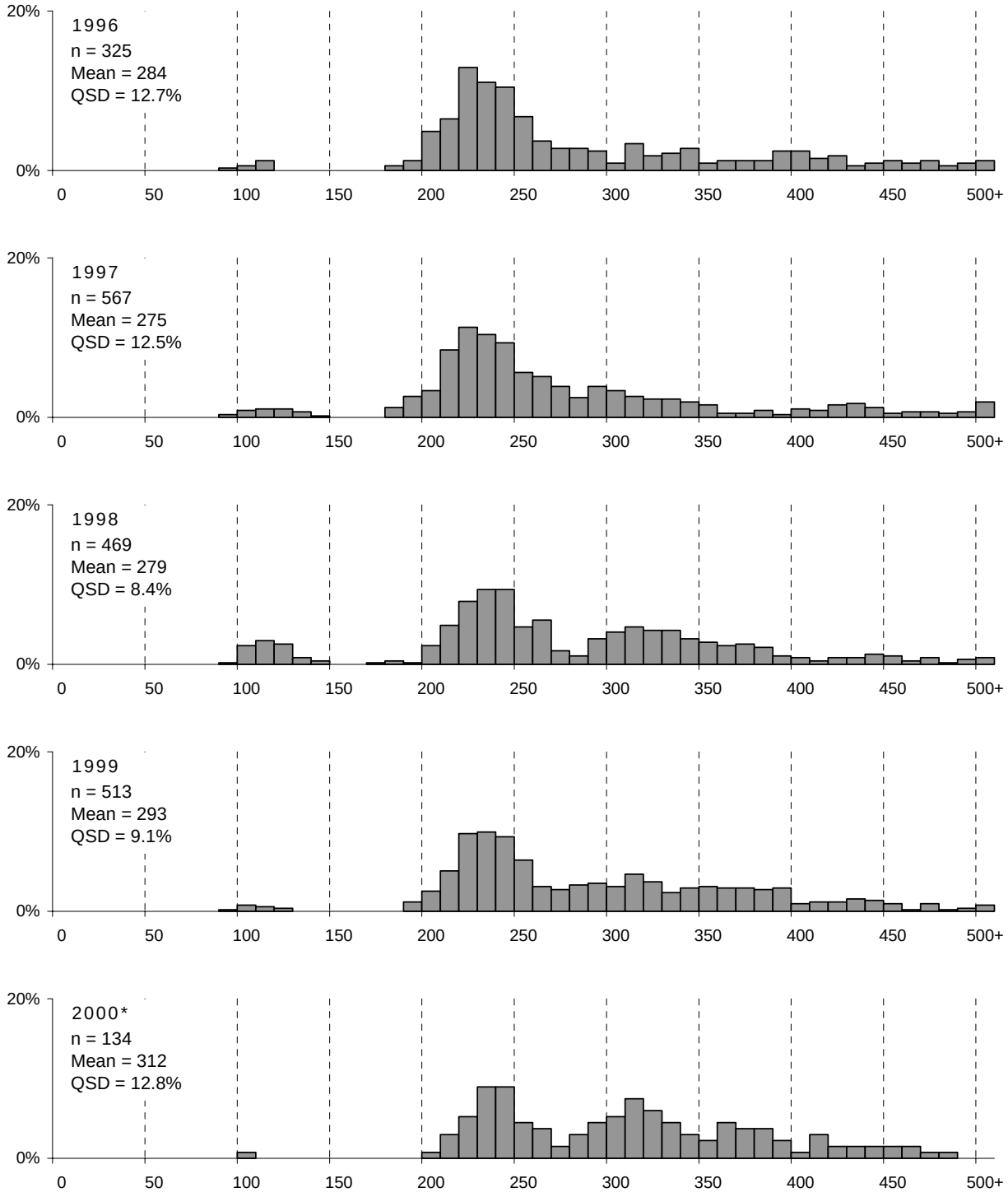
Appendix E-2. Continued.



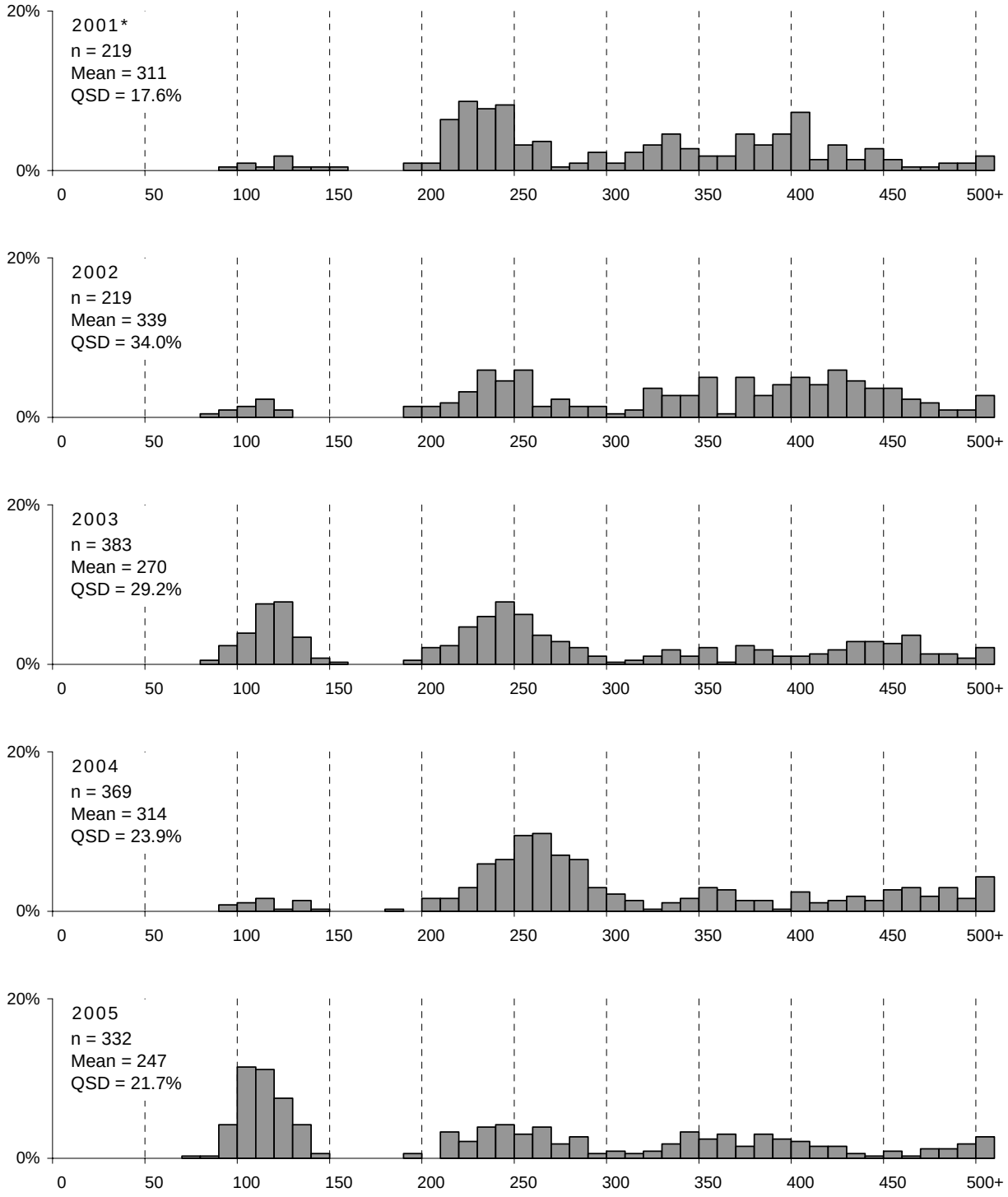
Appendix E-3. Length frequency distributions (TL, mm) of brown trout captured in the fall at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2005. Total individual fish captured during electrofishing equals *n*. Asterisks denote years lacking recapture runs.



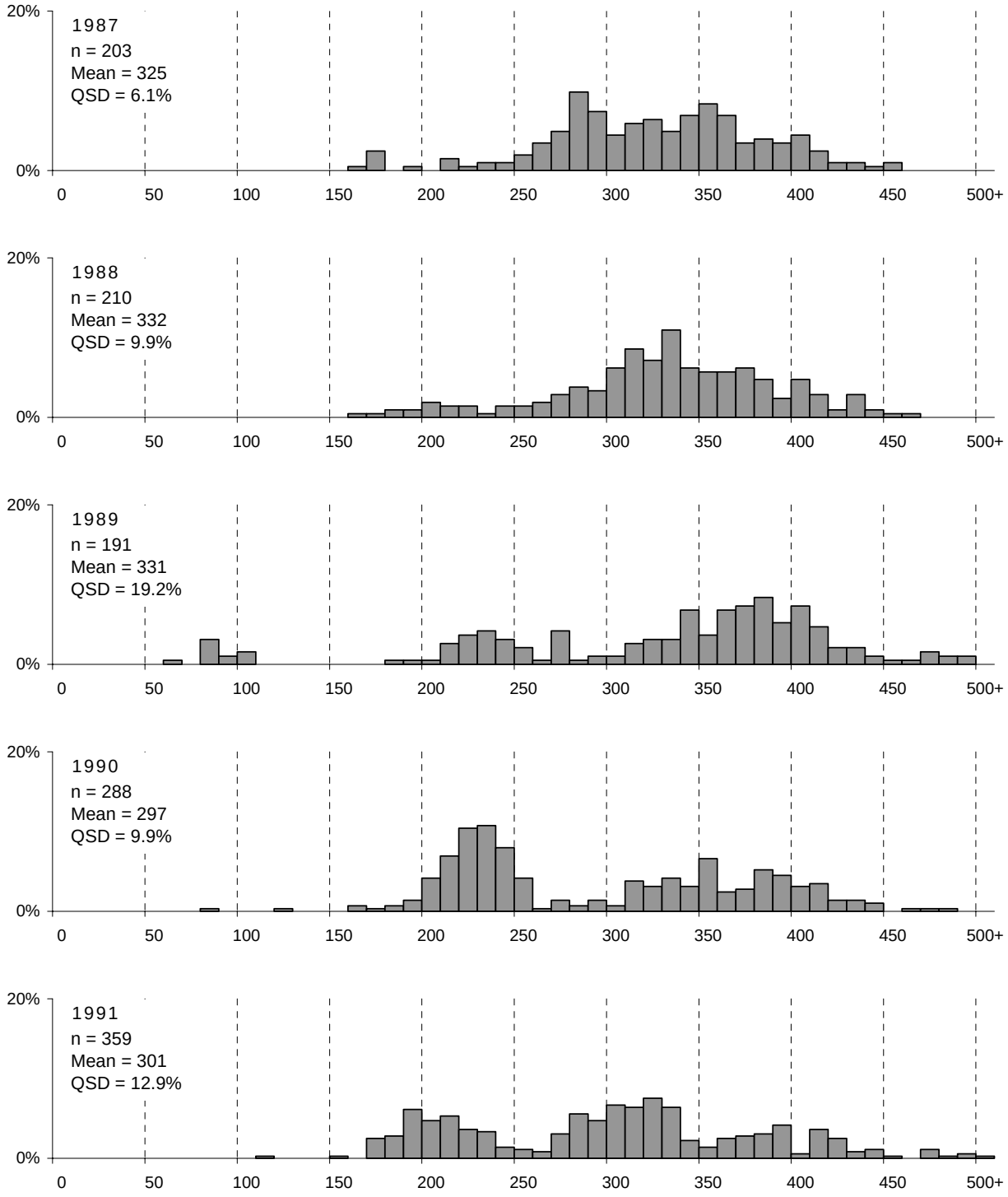
Appendix E-3. Continued.



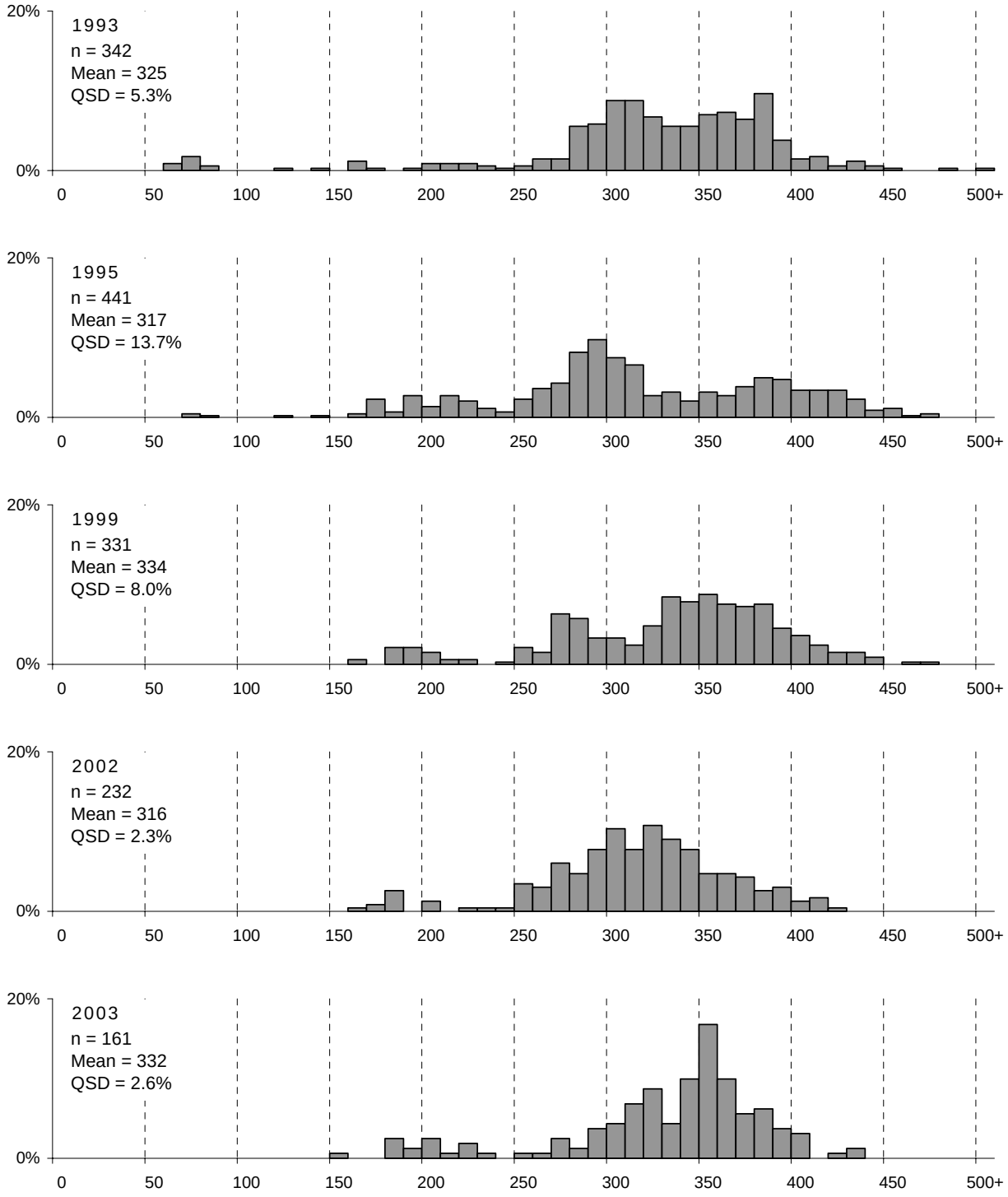
Appendix E-3. Continued.



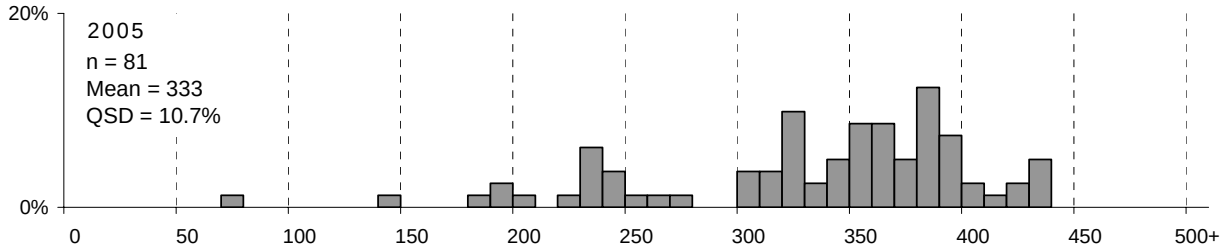
Appendix E-3. Continued.



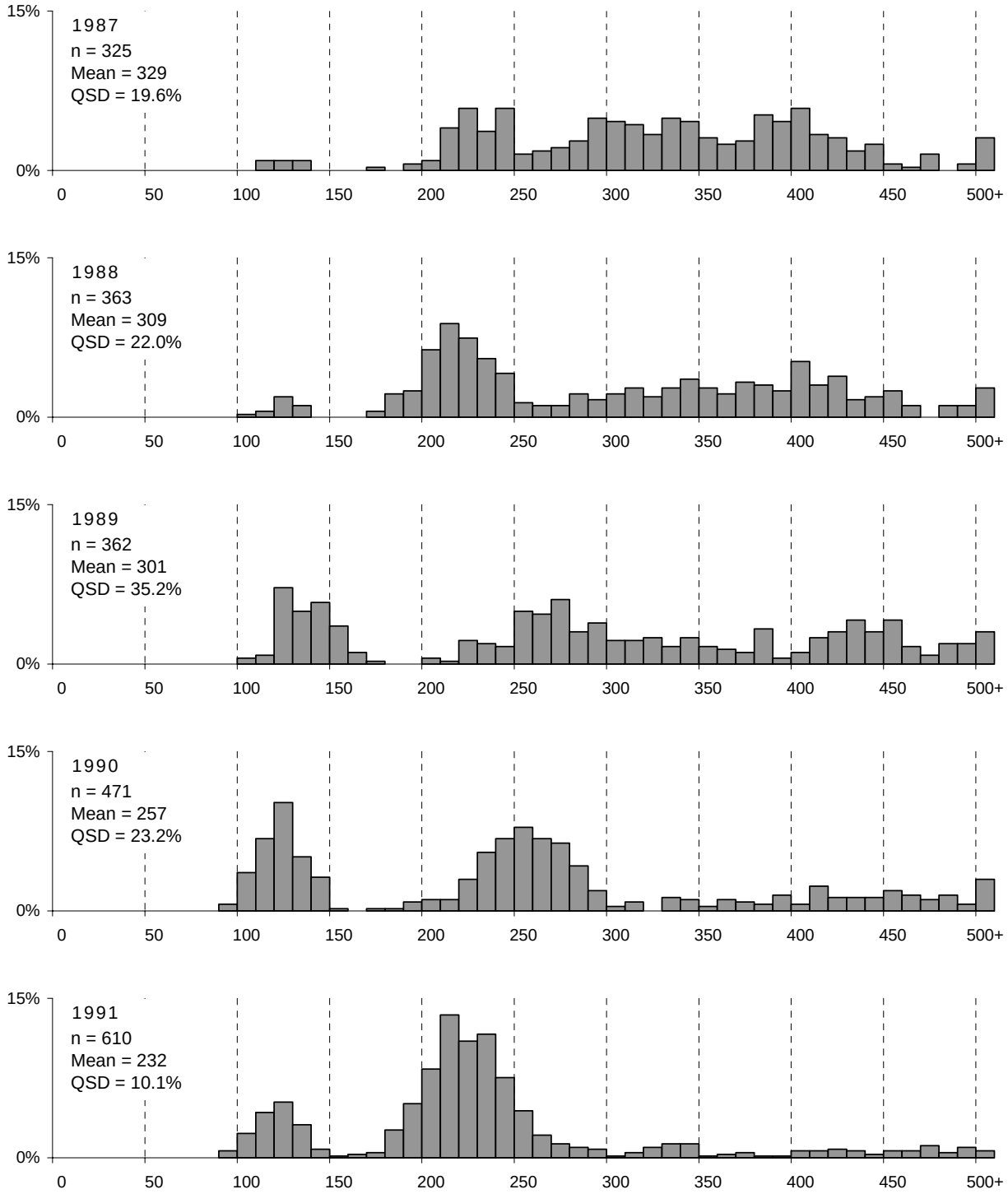
Appendix E-4. Length frequency distributions (TL, mm) of cutthroat trout captured in the fall at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2005 excluding years not sampled. Total individual fish captured during electrofishing equals *n*. Asterisks denote years lacking recapture runs.



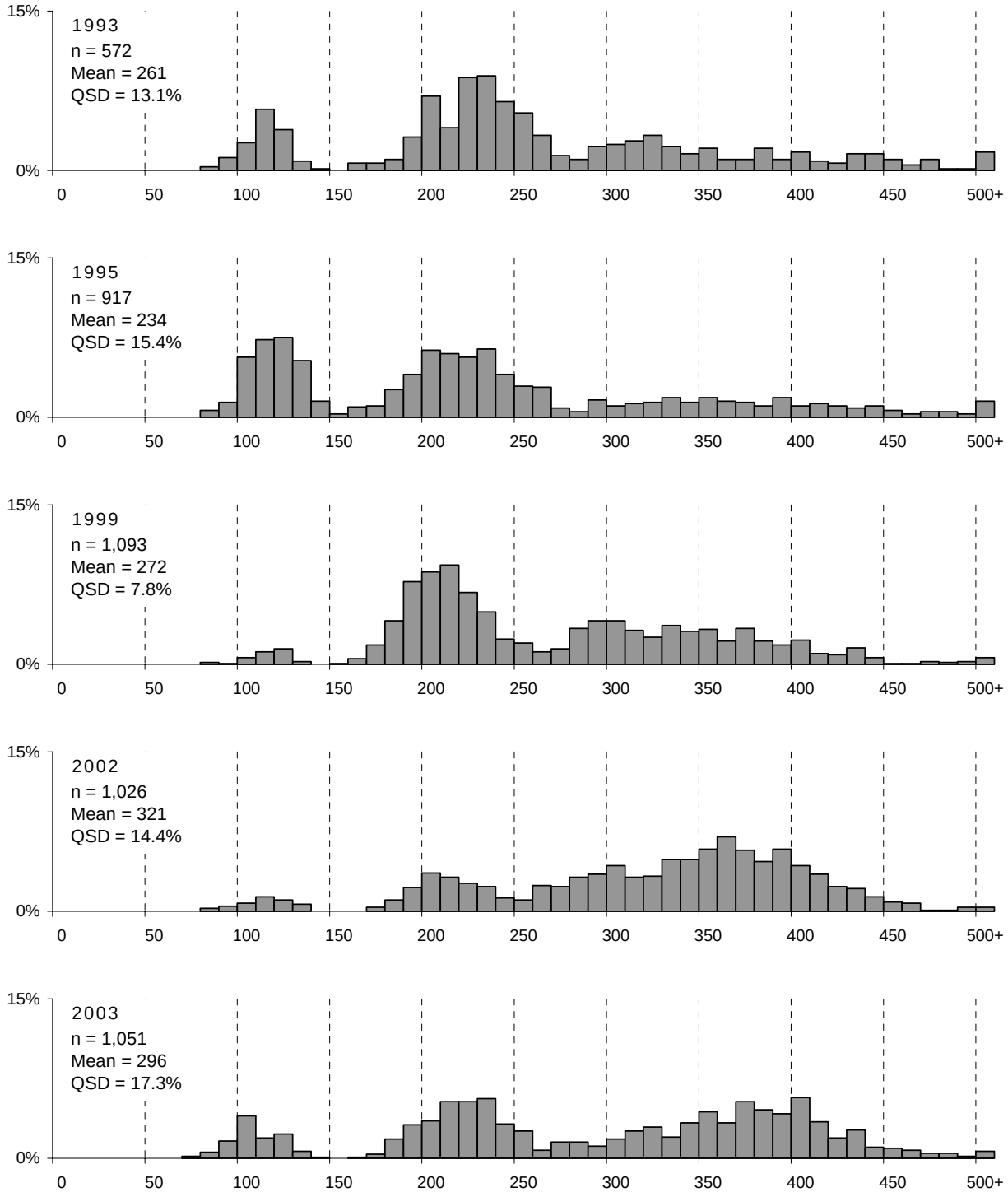
Appendix E-4. Continued.



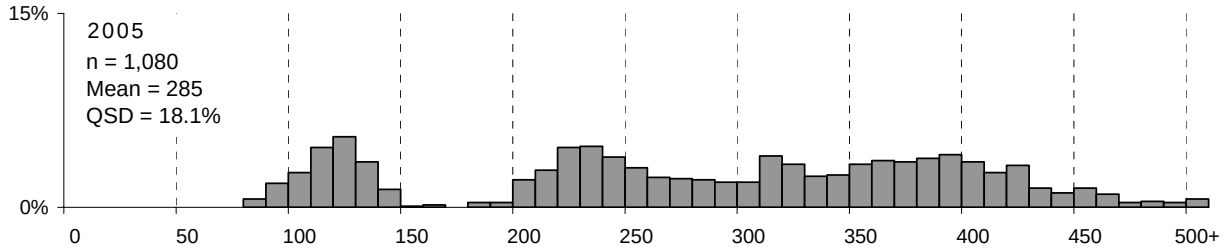
Appendix E-4. Continued.



Appendix E-5. Length frequency distributions (TL, mm) of brown trout captured in the fall at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2005 excluding years not sampled. Total individual fish captured during electrofishing equals *n*. Asterisks denote years lacking recapture runs.



Appendix E-5. Continued.



Appendix E-5. Continued.

Appendix F.

Creel survey statistics for the South Fork Snake River, Idaho, 2005.

Appendix F-1. Estimated effort (h) by section and two-week interval, South Fork Snake River, Idaho, 2005. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

Interval number	Ending date	Section 1	2	3	4	5	6	7	Total
1	Jan 14	98	250	152	24	37	115	152	828
2	Jan 28	165	70	57	438	222	234	63	1,249
3	Feb 11	101	134	20	228	80	376	315	1,254
4	Feb 25	107	598	101	763	288	262	567	2,686
5	Mar 11	227	1,254	45	1,111	402	477	500	4,016
6	Mar 25	386	1,334	0	599	305	418	812	3,854
7	Apr 8	374	485	264	867	340	238	289	2,857
8	Apr 22	627	621	349	689	403	698	708	4,095
9	May 6	244	216	75	668	254	300	358	2,115
10	May 20	1,910	2,890	293	1,346	790	1,083	2,926	11,238
11	Jun 3	2,094	4,929	1,291	2,617	879	613	859	13,282
12	Jun 17	951	2,839	296	3,592	682	716	1,503	10,579
13	Jul 1	3,618	5,965	2,912	6,281	1,950	2,351	8,192	31,269
14	Jul 15	653	1,436	1,462	4,506	835	495	907	10,294
15	Jul 29	2,762	6,645	3,594	9,299	606	625	1,621	25,152
16	Aug 12	2,112	7,353	2,874	3,697	1,816	2,015	3,353	23,220
17	Aug 26	1,753	8,604	3,917	5,829	1,156	555	1,386	23,200
18	Sep 9	4,098	3,813	1,929	1,968	536	433	796	13,573
19	Sep 23	1,373	4,270	5,449	870	1,336	797	1,626	15,721
20	Oct 7	2,245	4,803	3,173	1,780	826	314	893	14,034
21	Oct 21	1,317	2,471	644	1,211	280	930	1,711	8,564
22	Nov 4	833	1,601	364	479	510	500	905	5,192
23	Nov 18	196	661	255	595	255	98	65	2,125
24	Dec 2	62	300	196	626	350	56	128	1,718
25	Dec 16	0	0	0	0	0	24	12	36
26	Dec 30	42	152	54	81	382	57	90	858
Total		28,348	63,694	29,766	50,164	15,520	14,780	30,737	233,009
95% CI		±5,369	±9,605	±4,759	±14,680	±2,304	±2,815	±7,912	±20,858

Appendix F-2. Estimated catch by section and two-week interval, South Fork Snake River, Idaho, 2005. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

Interval number	Ending date	Section 1	2	3	4	5	6	7	Total
1	Jan 14	163	1029	0	17	21	16	30	1,276
2	Jan 28	177	189	0	1063	253	0	42	1,724
3	Feb 11	0	609	0	753	178	125	307	1,972
4	Feb 25	239	3928	0	2833	669	471	433	8,573
5	Mar 11	243	1897	0	2286	560	1537	0	6,523
6	Mar 25	257	1388	0	1357	79	338	687	4,106
7	Apr 8	0	1015	297	1627	2805	0	347	6,091
8	Apr 22	1081	667	0	0	235	779	702	3,464
9	May 6	243	19	0	235	129	469	452	1,547
10	May 20	1947	1552	0	886	293	861	2477	8,016
11	Jun 3	1569	4804	1071	1418	1815	588	1429	12,694
12	Jun 17	523	1298	0	1844	496	268	473	4,902
13	Jul 1	4040	6082	389	1335	973	0	6002	18,821
14	Jul 15	32	426	208	5637	1014	540	391	8,248
15	Jul 29	811	5695	4219	8070	297	175	0	19,267
16	Aug 12	3248	7682	0	3532	1490	3398	4834	24,184
17	Aug 26	737	10748	2256	5695	580	517	0	20,533
18	Sep 9	2701	1698	630	1275	344	199	408	7,255
19	Sep 23	1381	4182	4037	278	419	252	335	10,884
20	Oct 7	3442	4869	1141	1599	463	0	0	11,514
21	Oct 21	990	3070	646	0	0	504	2093	7,303
22	Nov 4	152	1142	0	0	575	87	372	2,328
23	Nov 18	176	393	94	446	351	150	35	1,645
24	Dec 2	57	189	0	1856	319	0	0	2,421
25	Dec 16	0	0	0	0	0	33	0	33
26	Dec 30	11	117	0	27	743	72	45	1,015
Total		24,220	64,688	14,988	44,069	15,101	11,379	21,894	196,339
95% CI		±6,853	±13,985	±4,303	±16,320	±5,528	±3,614	±7,123	±24,935

Appendix F-3. Estimated harvest by section and two-week interval, South Fork Snake River, Idaho, 2005. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

Interval number	Ending date	Section 1	2	3	4	5	6	7	Total
1	Jan 14	0	852	0	0	0	0	0	852
2	Jan 28	133	41	0	24	0	0	0	198
3	Feb 11	0	97	0	42	22	31	0	192
4	Feb 25	0	152	0	0	0	0	0	152
5	Mar 11	0	430	0	145	14	0	0	589
6	Mar 25	43	82	0	142	11	338	0	616
7	Apr 8	0	190	50	53	43	0	0	336
8	Apr 22	337	74	0	0	0	0	0	411
9	May 6	66	0	0	16	11	0	0	93
10	May 20	953	49	0	0	0	0	0	1,002
11	Jun 3	447	950	56	0	35	0	69	1,557
12	Jun 17	13	0	0	58	2	0	0	73
13	Jul 1	80	467	0	65	0	0	145	757
14	Jul 15	2	53	2	104	24	0	0	185
15	Jul 29	187	392	132	0	0	0	0	711
16	Aug 12	103	516	0	0	17	36	57	729
17	Aug 26	0	20	0	83	17	0	0	120
18	Sep 9	86	184	0	178	0	0	0	448
19	Sep 23	0	0	53	0	0	0	0	53
20	Oct 7	96	0	0	21	23	0	0	140
21	Oct 21	51	12	25	0	0	0	0	88
22	Nov 4	0	34	0	0	15	0	0	49
23	Nov 18	8	0	0	23	0	0	4	35
24	Dec 2	3	0	0	0	0	0	0	3
25	Dec 16	0	0	0	0	0	0	0	0
26	Dec 30	1	3	0	0	31	0	0	35
Total		2,609	4,598	318	954	265	405	275	9,424
95% CI		±1,986	±1,863	±225	±528	±151	±842	±254	±2,922

Appendix F-4. Estimated cutthroat trout harvest by section and two-week interval, South Fork Snake River, Idaho, 2005. The upper river (sections 1-4), summer season (intervals 11-18) is shaded. Results include hatchery cutthroat trout flushed from Palisades Reservoir.

Interval number	Ending date	Section 1	2	3	4	5	6	7	Total
1	Jan 14	0	0	0	0	0	0	0	0
2	Jan 28	0	0	0	0	0	0	0	0
3	Feb 11	0	0	0	0	0	0	0	0
4	Feb 25	0	0	0	0	0	0	0	0
5	Mar 11	0	0	0	0	0	0	0	0
6	Mar 25	0	0	0	0	0	0	0	0
7	Apr 8	0	0	0	0	0	0	0	0
8	Apr 22	0	0	0	0	0	0	0	0
9	May 6	0	0	0	0	0	0	0	0
10	May 20	0	0	0	0	0	0	0	0
11	Jun 3	0	0	0	0	0	0	0	0
12	Jun 17	0	0	0	0	0	0	0	0
13	Jul 1	0	0	0	0	0	0	23	23
14	Jul 15	0	0	0	0	0	0	0	0
15	Jul 29	0	0	0	0	0	0	0	0
16	Aug 12	0	0	0	0	0	0	0	0
17	Aug 26	0	0	0	0	0	0	0	0
18	Sep 9	0	0	0	0	0	0	0	0
19	Sep 23	0	0	0	0	0	0	0	0
20	Oct 7	0	0	0	0	0	0	0	0
21	Oct 21	0	0	0	0	0	0	0	0
22	Nov 4	0	0	0	0	0	0	0	0
23	Nov 18	0	0	0	0	0	0	0	0
24	Dec 2	0	0	0	0	0	0	0	0
25	Dec 16	0	0	0	0	0	0	0	0
26	Dec 30	0	0	0	0	0	0	0	0
Total		0	0	0	0	0	0	23	23
95% CI		0	0	0	0	0	0	±20	±20

Appendix F-5. Estimated rainbow trout harvest by section and two-week interval, South Fork Snake River, Idaho, 2005. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

Interval number	Ending date	Section 1	2	3	4	5	6	7	Total
1	Jan 14	0	355	0	0	0	0	0	355
2	Jan 28	133	38	0	24	0	0	0	195
3	Feb 11	0	0	0	40	0	0	0	40
4	Feb 25	0	152	0	0	0	0	0	152
5	Mar 11	0	300	0	133	0	0	0	433
6	Mar 25	22	57	0	128	0	135	0	342
7	Apr 8	0	50	50	31	0	0	0	131
8	Apr 22	300	62	0	0	0	0	0	362
9	May 6	57	0	0	8	0	0	0	65
10	May 20	853	49	0	0	0	0	0	902
11	Jun 3	394	893	22	0	0	0	0	1,309
12	Jun 17	13	0	0	28	0	0	0	41
13	Jul 1	39	350	0	48	0	0	23	460
14	Jul 15	2	53	2	0	17	0	0	74
15	Jul 29	187	347	132	0	0	0	0	666
16	Aug 12	103	457	0	0	0	0	0	560
17	Aug 26	0	0	0	37	0	0	0	37
18	Sep 9	0	158	0	149	0	0	0	307
19	Sep 23	0	0	53	0	0	0	0	53
20	Oct 7	96	0	0	0	11	0	0	107
21	Oct 21	26	12	25	0	0	0	0	63
22	Nov 4	0	34	0	0	7	0	0	41
23	Nov 18	3	0	0	0	0	0	0	3
24	Dec 2	0	0	0	0	0	0	0	0
25	Dec 16	0	0	0	0	0	0	0	0
26	Dec 30	0	0	0	0	20	0	0	20
Total		2,228	3,367	284	626	55	135	23	6,718
95% CI		±1,886	±1,545	±214	±421	±55	±441	±20	±2,523

Appendix F-6. Estimated brown trout harvest by section and two-week interval, South Fork Snake River, Idaho, 2005. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

Interval number	Ending date	Section 1	2	3	4	5	6	7	Total
1	Jan 14	0	36	0	0	0	0	0	36
2	Jan 28	0	4	0	0	0	0	0	4
3	Feb 11	0	97	0	3	0	31	0	131
4	Feb 25	0	0	0	0	0	0	0	0
5	Mar 11	0	90	0	12	14	0	0	116
6	Mar 25	22	13	0	13	11	203	0	262
7	Apr 8	0	0	0	23	43	0	0	66
8	Apr 22	30	11	0	0	0	0	0	41
9	May 6	4	0	0	0	11	0	0	15
10	May 20	91	0	0	0	0	0	0	91
11	Jun 3	0	57	34	0	35	0	69	195
12	Jun 17	0	0	0	28	2	0	0	30
13	Jul 1	39	117	0	17	0	0	99	272
14	Jul 15	0	0	0	104	7	0	0	111
15	Jul 29	0	0	0	0	0	0	0	0
16	Aug 12	0	62	0	0	17	36	57	172
17	Aug 26	0	20	0	46	17	0	0	83
18	Sep 9	86	26	0	30	0	0	0	142
19	Sep 23	0	0	0	0	0	0	0	0
20	Oct 7	0	0	0	21	11	0	0	32
21	Oct 21	26	0	0	0	0	0	0	26
22	Nov 4	0	0	0	0	8	0	0	8
23	Nov 18	5	0	0	23	0	0	4	32
24	Dec 2	3	0	0	0	0	0	0	3
25	Dec 16	0	0	0	0	0	0	0	0
26	Dec 30	1	3	0	0	11	0	0	15
Total		307	536	34	320	187	270	229	1,883
95% CI		±313	±349	±58	±273	±128	±408	±236	±733

Appendix F-7. Estimated catch rate (catch divided by effort) by section and two-week interval, South Fork Snake River, Idaho, 2005. The upper river (sections 1-4), summer season (intervals 11-18) is shaded.

Interval number	Ending date	Section 1	2	3	4	5	6	7	Overall
1	Jan 14	1.66	4.12	0.00	0.71	0.57	0.14	0.20	1.54
2	Jan 28	1.07	2.70	0.00	2.43	1.14	0.00	0.67	1.38
3	Feb 11	0.00	4.54	0.00	3.30	2.23	0.33	0.97	1.57
4	Feb 25	2.23	6.57	0.00	3.71	2.32	1.80	0.76	3.19
5	Mar 11	1.07	1.51	0.00	2.06	1.39	3.22	0.00	1.62
6	Mar 25	0.67	1.04	NE[a]	2.27	0.26	0.81	0.85	1.07
7	Apr 8	0.00	2.09	1.13	1.88	8.25	0.00	1.20	2.13
8	Apr 22	1.72	1.07	0.00	0.00	0.58	1.12	0.99	0.85
9	May 6	1.00	0.09	0.00	0.35	0.51	1.56	1.26	0.73
10	May 20	1.02	0.54	0.00	0.66	0.37	0.80	0.85	0.71
11	Jun 3	0.75	0.97	0.83	0.54	2.06	0.96	1.66	0.96
12	Jun 17	0.55	0.46	0.00	0.51	0.73	0.37	0.31	0.46
13	Jul 1	1.12	1.02	0.13	0.21	0.50	0.00	0.73	0.60
14	Jul 15	0.05	0.30	0.14	1.25	1.21	1.09	0.43	0.80
15	Jul 29	0.29	0.86	1.17	0.87	0.49	0.28	0.00	0.77
16	Aug 12	1.54	1.04	0.00	0.96	0.82	1.69	1.44	1.04
17	Aug 26	0.42	1.25	0.58	0.98	0.50	0.93	0.00	0.89
18	Sep 9	0.66	0.45	0.33	0.65	0.64	0.46	0.51	0.53
19	Sep 23	1.01	0.98	0.74	0.32	0.31	0.32	0.21	0.69
20	Oct 7	1.53	1.01	0.36	0.90	0.56	0.00	0.00	0.82
21	Oct 21	0.75	1.24	1.00	0.00	0.00	0.54	1.22	0.85
22	Nov 4	0.18	0.71	0.00	0.00	1.13	0.17	0.41	0.45
23	Nov 18	0.90	0.59	0.37	0.75	1.38	1.53	0.54	0.77
24	Dec 2	0.92	0.63	0.00	2.96	0.91	0.00	0.00	1.41
25	Dec 16	NE	NE	NE	NE	NE	1.38	0.00	0.92
26	Dec 30	0.26	0.77	0.00	0.33	1.95	1.26	0.50	1.18
Overall		0.85	1.02	0.50	0.88	0.97	0.77	0.71	0.84

[a] NE = no effort observed.

Appendix F-8. Residency and overall ranking of a sample of anglers interviewed for the 2005 creel survey, South Fork Snake River, Idaho. Residents came from 19 of 44 Idaho counties. Non-residents came from 39 states, the District of Columbia, and 3 foreign countries. Data from 2003 (Schrader and Fredericks 2006) and 1979 (Moore 1980) are presented for comparison.

	2005			2003			1979		
Residency	Rank	Number	Percent	Rank	Number	Percent	Rank	Number	Percent
Idaho County:									
Bonneville	1	1496	43.16%	1	1,750	43.73%	1	1,288	59.91%
Jefferson	2	393	11.34%	3	278	6.95%	2	309	14.37%
Teton	5	165	4.76%	5	172	4.30%	8	22	1.02%
Madison	6	141	4.07%	6	159	3.97%	4	98	4.56%
Bannock	9	55	1.59%	8	118	2.95%	3	109	5.07%
Bingham	9	55	1.59%	10	50	1.25%	4	98	4.56%
Ada	11	43	1.24%	11	47	1.17%	9	16	0.74%
Fremont	12	40	1.15%	19	22	0.55%	11	7	0.33%
Twin Falls	26	11	0.32%	35	10	0.25%			
Blaine	27	10	0.29%	25	16	0.40%			
Clark	35	6	0.17%						
Camas	42	4	0.12%	38	8	0.20%			
Power	42	4	0.12%						
Caribou	47	2	0.06%	47	5	0.12%			
Custer	47	2	0.06%						
Kootenai	47	2	0.06%	58	2	0.05%			
Lemhi	47	2	0.06%						
Payette	47	2	0.06%	63	1	0.02%			
Cassia	59	1	0.03%	27	15	0.37%			
Bear Lake				18	23	0.57%			
Franklin				37	9	0.22%			
Canyon				47	5	0.12%			
Jerome				58	2	0.05%			
Washington				58	2	0.05%			
Latah				63	1	0.02%			
Others Combined	None	None	None	None	None	None		31	1.44%
Sub total:		2,434	70.23%		2,695	67.34%		1,978	92.00%
State:									
Wyoming	3	250	7.21%	4	249	6.22%			
Utah	4	207	5.97%	2	336	8.40%	7	48	2.23%
California	7	138	3.98%	7	143	3.57%	6	54	2.51%
Texas	8	67	1.93%	12	40	1.00%			
Colorado	13	38	1.10%	9	57	1.42%	10	15	0.70%
Washington	14	24	0.69%	14	36	0.90%			
Georgia	15	21	0.61%	23	19	0.47%			
South Carolina	15	21	0.61%	44	6	0.15%			

Appendix F-8. Continued.

Residency	2005 Rank	2005 Number	2005 Percent	2003 Rank	2003 Number	2003 Percent	1979 Rank	1979 Number	1979 Percent
State (continued):									
Michigan	17	20	0.58%	20	21	0.52%			
New York	17	20	0.58%	25	16	0.40%			
Ohio	19	17	0.49%	24	17	0.42%			
Alabama	20	16	0.46%	41	7	0.17%			
North Carolina	20	16	0.46%	16	31	0.77%			
Tennessee	22	15	0.43%	35	10	0.25%			
Montana	23	13	0.38%	12	40	1.00%			
Massachusetts	24	12	0.35%	31	12	0.30%			
New Jersey	24	12	0.35%	38	8	0.20%			
Connecticut	27	10	0.29%	32	11	0.27%			
Florida	27	10	0.29%	21	20	0.50%			
Pennsylvania	27	10	0.29%	32	11	0.27%			
Arizona	31	9	0.26%	15	33	0.82%			
Oregon	31	9	0.26%	17	29	0.72%			
Wisconsin	33	8	0.23%	29	14	0.35%			
South Dakota	34	7	0.20%	57	3	0.07%			
Kentucky	35	6	0.17%	47	5	0.12%			
Nevada	35	6	0.17%	21	20	0.50%			
North Dakota	35	6	0.17%						
Oklahoma	35	6	0.17%	38	8	0.20%			
Kansas	40	5	0.14%						
New Mexico	40	5	0.14%	41	7	0.17%			
Alaska	42	4	0.12%	51	4	0.10%			
Arkansas	42	4	0.12%						
Nebraska	46	3	0.09%	51	4	0.10%			
District of Columbia	47	2	0.06%	51	4	0.10%			
Hawaii	47	2	0.06%	58	2	0.05%			
Maryland	47	2	0.06%	47	5	0.12%			
Missouri	47	2	0.06%	29	14	0.35%			
New Hampshire	47	2	0.06%	63	1	0.02%			
Virginia	47	2	0.06%	41	7	0.17%			
Louisiana	59	1	0.03%						
Illinois				27	15	0.37%			
Minnesota				32	11	0.27%			
Iowa				44	6	0.15%			
Indiana				51	4	0.10%			
Maine				51	4	0.10%			
Mississippi				63	1	0.02%			
Rhode Island				63	1	0.02%			
Others Combined								55	2.56%
Sub total:		1,028	29.66%		1,292	32.28%		172	8.00%

Appendix F-8. Continued.

Residency	2005 Rank	2005 Number	2005 Percent	2003 Rank	2003 Number	2003 Percent	1979 Rank	1979 Number	1979 Percent
Country:									
Denmark	47	2	0.06%						
Canada	59	1	0.03%	44	6	0.15%			
France	59	1	0.03%	58	2	0.05%			
United Kingdom				51	4	0.10%			
Bahamas				63	1	0.02%			
Italy				63	1	0.02%			
Russia				63	1	0.02%			
Sub total:		4	0.12%		15	0.37%			
Grand total:		3,466	100.00%		4,002	100.00%		2,150	100.00%

Appendix G. Radio telemetry data for the 2005 freshet, South Fork Snake River, Idaho.

Redd #	Location	Date & Time	Freq (MHz)	Activity	Flow (ft^3/s)	Notes
1	Dam Power House	4/19/2005 14:10	151.822	Installed	3,000	Fish on redd
1	Dam Power House	5/18/2005 14:00	151.822	Slow	6,000	
1	Dam Power House	11/10/2005 14:00	151.822	Slow	800	Removed tag, no move; 2 rocks OK, 1 gone; 7" water
2	Dam Power House	4/19/2005 14:20	151.903	Installed	3,000	No fish, but good redd
2	Dam Power House	5/18/2005 14:00	151.903	Slow	6,000	
2	Dam Power House	11/10/2005 14:10	151.903	Slow	800	Removed tag, no move; 3 rocks OK; 13" water
3	Dam Power House	4/19/2005 14:35	151.935	Installed	3,000	Just below cable, no fish on redd
3	Dam Power House	5/18/2005 14:00	151.935	Slow	6,000	
3	Dam Power House	11/10/2005 14:15	151.935	Fast	800	Removed tag, no move; 2 rocks OK, 1 gone; 17" water
4	Dam Willow Hole	4/19/2005 15:45	151.803	Installed	3,000	No fish on redd
4	Dam Willow Hole	11/10/2005 12:35	151.803	Slow	800	Removed tag, no move; 2 rocks OK, 1 gone; 13" water
5	Dam Willow Hole	4/19/2005 15:15	151.835	Installed	3,000	No fish on redd
5	Dam Willow Hole	11/10/2005 13:05	151.835	Slow	800	Removed tag, no move; 1 rock buried, 2 gone; extra gravel, 12" water
6	Dam Willow Hole	4/19/2005 15:00	151.883	Installed	3,000	No fish on redd
6	Dam Willow Hole	11/10/2005 12:45	151.883	Slow	800	Removed tag, no move; 3 rocks OK; 9" water
7	Dam Willow Hole	4/19/2005 15:10	151.894	Installed	3,000	No fish on redd
7	Dam Willow Hole	11/10/2005 12:55	151.894	Slow	800	Removed tag, no move; 1 rock OK, 2 gone; 10" water

Appendix G. Continued.

Redd #	Location	Date & Time	Freq (MHz)	Activity	Flow (ft^3/s)	Notes
8	Dam Willow Hole	4/19/2005 16:00	151.962	Installed	3,000	No fish on redd
8	Dam Willow Hole	11/10/2005 13:20	151.962	Slow	800	Removed tag, no move; 2 rocks OK, 1 gone; 14" water
9	Dam Willow Hole	4/19/2005 15:20	151.982	Installed	3,000	No fish on redd
9	Dam Willow Hole	11/10/2005 13:30	151.982	Slow	800	Removed tag, no move; 1 rock OK, 2 gone; 7" water
10	Dam Willow Hole	4/19/2005 15:35	151.994	Installed	3,000	No fish on redd
10	Dam Willow Hole	11/10/2005 13:40	151.994	Slow	800	Removed tag, no move; 2 rocks OK, 1 gone; 7" water
11	Sheep Cr Main	5/18/2005 13:35	151.853	Installed	6,000	
11	Sheep Cr Main	11/10/2005 15:00	151.853	Slow	800	Removed tag, no move; 3 rocks OK; dry
12	Sheep Cr Main	5/18/2005 13:30	151.915	Installed	6,000	
12	Sheep Cr Main	11/10/2005 15:05	151.915	Slow	800	Removed tag, no move; 3 rocks gone; dry
13	Sheep Cr Main	5/18/2005 13:40	151.973	Installed	6,000	Caught 4 RBT on redds
13	Sheep Cr Main	11/10/2005 14:55	151.973	Slow	800	Removed tag, no move; 3 rocks OK; dry
14	Indian Cr Main	5/18/2005 12:40	151.812	Installed	6,000	Caught 7 RBT on redds
14	Indian Cr Main	11/1/2005 14:30	151.812	Slow	1,250	Removed tag, no move; 2 rocks OK, 1 gone; 1" water
15	Indian Cr Main	5/18/2005 12:30	151.843	Installed	6,000	
15	Indian Cr Main	11/1/2005 14:40	151.843	Slow	1,250	Removed tag, no move; 2 rocks OK, 1 move; extra gravel, dry

Appendix G. Continued.

Redd #	Location	Date & Time	Freq (MHz)	Activity	Flow (ft^3/s)	Notes
16	Indian Cr Main	5/18/2005 15:30	151.925	Installed	6,000	
16	Indian Cr Main	11/1/2005 14:45	151.925	Slow	1,250	Removed tag, no move; 1 rock OK, 2 move; dry
17	Squaw Cr Main	5/18/2005 16:00	151.875	Installed	6,000	
17	Squaw Cr Main	11/1/2005 13:50	151.875	Slow	1,250	Removed tag, no move; 1 rock OK, 1 move, 1 gone; 6" water
18	Squaw Cr Main	5/18/2005 11:00	151.944	Installed	6,000	
18	Squaw Cr Main	11/1/2005 14:00	151.944	Fast	1,250	Removed tag, no move; 2 rocks OK, 1 move; 6" water
19	Squaw Cr Channels	5/23/2005 12:00	151.954	Installed	6,000	Installed by Trapper
19	Squaw Cr Channels	11/1/2005 15:10	151.954	Fast	1,250	Removed tag, no move; 3 rocks OK; dry
20	Rainey Cr Channel	4/19/2005 12:35	151.864	Installed	3,000	Test dig?
20	Rainey Cr Channel	5/18/2005 10:30	151.864	Fast	6,000	
20	Rainey Cr Channel	11/1/2005 15:30	151.864	Not found	1,250	Tag not found
20	Rainey Cr Channel	11/25/2005 10:00	151.864	Not found	800	Tag not found

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