FISHERY MANAGEMENT INVESTIGATIONS

SOUTH FORK SNAKE RIVER INVESTIGATIONS

2007 Annual Report

Period Covered: October 2006 to September 2007

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ABSTRACT

At the Conant section in the upper South Fork Snake River, we captured a total of 2,842 trout during four days of electrofishing in October 2007. Relative abundance in the catch was 45.3% cutthroat trout *Oncorhynchus clarkii bouvieri*, 31.0% rainbow trout *O. mykiss* and hybrid rainbow x cutthroat trout *O. mykiss x O. clarkii* combined, 23.6% brown trout *Salmo trutta*, and <1% other trout species. For age-1 and older fish, estimated densities were 1,380 cutthroat trout/km, 825 rainbow and hybrid trout/km, and 530 brown trout/km for a total of 2,734 fish/km. For age-1 (yearling) fish, estimated densities were 464 cutthroat trout/km, 450 rainbow and hybrid trout/km, and 297 brown trout/km for a total of 1,211 fish/km. Over all fish sizes, mean total length was 322 mm for cutthroat trout, 306 mm for rainbow and hybrid trout, 288 mm for brown trout, and 309 mm for all species combined. Quality stock density (QSD) was 12.1% for cutthroat trout, 20.0% for rainbow and hybrid trout, 13.7% for brown trout, and 15.0% for all species combined.

At the Lorenzo section in the lower river, we captured a total of 1,378 trout during four days of electrofishing in September 2007. Relative abundance in the catch was 9.3% cutthroat trout, 1.7% rainbow and hybrid trout, and 89.0% brown trout. For age-1 and older fish, density estimates could not be calculated for cutthroat trout and rainbow and hybrid trout due to small sample sizes, but estimated densities for brown trout were 1,125 brown trout/km. For age-1 (yearling) fish, estimated densities for brown trout were 310 trout/km. Over all fish sizes, mean total length was 300 mm for cutthroat trout, 318 mm for brown trout, and 315 mm for both species combined. Quality stock density (QSD) was 12.7% for cutthroat trout, 15.5% for brown trout, and 15.3% for both species combined.

A total of 129,137 trout ≥203 mm and 33,143 trout ≥406 mm were estimated to be in the upper river above Heise during May 2007. For fish ≥203 mm, 36.2% or 43,805 were cutthroat trout, 31.7% or 49,145 were rainbow and hybrid trout, and 32.1% or 36,187 were brown trout. For fish ≥406 mm, 21.7% or 6,520 were cutthroat trout, 36.9% or 10,575 were rainbow and hybrid trout, and 41.4% or 16,047 were brown trout. In general, spring-time densities of cutthroat trout ≥203 mm were slightly higher – and densities of cutthroat trout ≥406 mm were slightly lower – as we sampled from the dam downstream. Densities of both ≥203 mm and ≥406 mm rainbow and hybrid trout were highest upstream and gradually declined to near zero as we sampled downstream. Densities of both ≥203 mm and ≥406 mm brown trout were lowest upstream and gradually increased as we sampled downstream. Compared to the other trout taxa, cutthroat trout were more uniformly distributed throughout the upper river.

Estimated annual exploitation of rainbow and hybrid trout from May 4, 2007, to February 22, 2008, in the upper river above Heise was 13.4%. Estimates were derived using reward and non-reward Floy tag returns by anglers and were adjusted for angler compliance, natural tag loss, tag removal by anglers, and assumed tag-induced mortality rates. The unadjusted exploitation rate was 5.9%. Estimated harvest of rainbow and hybrid trout was 6,585 fish ≥203 mm and 1,417 fish ≥406 mm. Although rainbow and hybrid trout exploitation has increased since 2003, we hope to increase these rates further to 40-60% by continuing our angler outreach and education campaign.

During the 2007 spring spawning run, we trapped a total of 1,254 trout at Rainey, Pine, and Palisades creeks. No rainbow and hybrid trout were caught at Rainey Creek, two were caught at Pine Creek, and 20 were caught at Palisades Creek. These rainbow and hybrid trout

were removed from the system. The remainder of fish trapped at the weirs were cutthroat trout – with 14 fish at Rainey Creek, 481 fish at Pine Creek, and 737 fish at Palisades Creek. Cutthroat trout were caught between March 31 and July 25 with run midpoints ranging from May 18 to June 14. At Palisades Creek, 55% of the rainbow and hybrid trout were females, but only 20 were captured due to a late weir start-up date. At Palisades Creek and Pine Creek weirs, 61.2 to 66.2% of the cutthroat trout were females. We did not estimate efficiency at the Rainey Creek hard picket weir, but we believe it was low largely because it was off-line for the first half of May. We used a single pass electrofishing survey upstream of the Pine Creek weir to estimate efficiency of the weir which was 22.8%.

A temporary electrical barrier was installed at Palisades Creek to determine if an electrical field could efficiently divert migrating cutthroat, rainbow, and hybrid trout through the fishway and trap. An electric mat with 3 electrodes woven in was secured on the sill of the weir structure at Palisades Creek with sandbags. The weir was operated from May 1 through July 28, 2007. Trapping efficiency was estimated by trapping fluvial trout (trout >279 mm TL) at the Palisades diversion screen bypass as fish migrated back downstream to the South Fork Snake River. The estimated trapping efficiency of the electrical barrier was 98.1%, which is as high an efficiency as has been estimated for any of the tributary weirs. Of the 466 fluvial cutthroat trout that were captured at the Palisades diversion bypass trap, only 9 were unmarked.

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.

Our results are compared to previous years and 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. 2006). 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 above Heise and its associated tributaries, whereas few rainbow and hybrid trout occur in the lower river (Schrader and Fredericks 2006a, 2006b; 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 two relatively recent drought periods – the first in 1987-1994 and the second in 2000-2005, 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 in the South Fork Snake River. 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 sharp increases 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) also studied channel morphology and stream ecology as it relates to flow regimes. The results of these two studies have been used by the U.S. Bureau of Reclamation (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 cause other recruitment-related problems. These might include increased physiological stress prior to spawning, reduced available spawning habitat, or displacement of fry 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 2006a). 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 in 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. In addition, Palisades and Burns creeks have fish screens to pass juvenile fish and post-spawners moving downstream. The weir structures have 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).

Another key component of the weir program is the efficiency of the weirs. Since 1996 different weir types, including hard picket weirs and self-cleaning floating weirs and Mitsubishi weirs, have been used with varying degrees of success. High flows and associated debris during peak flow events have caused frequent failing of all types of weirs used through 2006. During low and moderate snowpack years, both hard picket and Mitsubishi weirs have operated at efficiencies exceeding 90% at Pine and Palisades creeks, respectively. However, during years with high run-off, estimated efficiencies at these same weirs have been less than 20%. Overall, estimated efficiencies have been low, averaging less than 40%.

Electrical barriers have the potential to functionally block upstream migrations despite elevated streamflow and debris associated with high flows. Electric barriers have been used in fisheries since the 1950s when fishery managers in the great lakes region were attempting to limit sea lamprey *Petromyzon marinus* spawning in tributaries (McLain 1957). Currently, electrical barriers are commonly used to limit noxious species range expansion (Stokstad 2003; Clarkson 2004), to confine species in desired locations (Maceina et al. 1999), and for capturing migrating fish (Palmisano and Burger 1988). The weir at Palisades Creek provided an ideal location to test a temporary electrical barrier in the spring of 2007 because of land ownership and existing availability of electricity at the site.

This annual report summarizes South Fork Snake River fishery investigations conducted in 2007. 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 2006a). 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 (Schrader and Fredericks 2006b). 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. Monitor relative abundance, density, and size and stock structures of South Fork Snake River trout populations.
2. Estimate rainbow trout exploitation and harvest in the upper river above Heise over the fishing season.
3. Evaluate age-1 cutthroat and rainbow trout recruitment following modified flow management by BOR in water years 2005 and 2006.
4. Operate fish weirs in Pine, Rainey, and Palisades creeks to maintain genetically pure spawning populations of cutthroat trout.
5. Evaluate efficiency of electrical barrier at Palisades Creek.
6. Operate rotary drum fish screens on irrigation diversions in Palisades and Burns creeks.
7. Evaluate the overall cutthroat trout conservation and management program.

METHODS AND STUDY AREA

Fall Population Monitoring

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 2007, the Conant section was electrofished on October 1,2,7, and 8, and the Lorenzo section was electrofished on September 17, 18, 24, and 25. The upper or lower half of a section was sampled each day. At Conant, flows ranged from 86.4 to 163.7 m^3/s (3,050 to 5,780 ft^3/s) at the Irwin gage (USGS, provisional data; Appendix B). At Lorenzo, flows ranged from 122.1 to 134.8 m^3/s (4,310 to 4,760 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 200-250 V, 5-6 A, 20% pulse width, and 90 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 – which were 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. Ages were approximated from overall length frequency distributions (Figure 2).

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:

$$E = \frac{R}{C} \quad (1)$$

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:

$$\hat{N}_i = \frac{M_i}{E_i} \quad (2)$$

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):

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

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:

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

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

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

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

$$\hat{N} \pm 1.96\sqrt{\mathrm{var}\,\hat{N}} \quad (6)$$

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.

Spring Stock Assessment and Distribution

We repeated methods used in 2003, 2005, and 2006 to estimate or extrapolate total stock abundance and distribution in the upper 64 km of the South Fork Snake River from Heise to Palisades Dam (Schrader and Fredericks 2006a, 2006b). Like past years, two stocks of cutthroat, rainbow, and brown trout are defined: fish $\geq$203 mm are the standard stock and fish $\geq$406 mm are the quality stock. These are the same lengths used to define quality stock density. Nine sites were sampled using standard boat electrofishing gear on May 2-4, 2007 (Figure 3). A second boat was used for processing fish. The sites were spaced at eight river kilometer intervals and were at the same locations sampled in 2003 ,2005, and 2006. Flows were 229.7 m^3/s (8,110 ft^3/s) as measured at the Irwin gage (USGS provisional data). Captured fish were anesthetized, identified, and measured to the nearest millimeter (TL). Linear regression models developed in 2003 were used to predict fish densities at each site using recorded CPUE. Predicted densities were averaged between sites, multiplied by the distance between sites, and summed to calculate total stock abundance in the upper river.

Rainbow Trout Exploitation and Harvest

As part of a statewide IDFG exploitation research project (Butts et al. 2007), we estimated annual rainbow trout exploitation in the upper river above Heise from May 4, 2007, to February 22, 2008. Rates of exploitation, angler compliance, and tag loss were estimated using a combination of reward and non-reward tag returns. Fish were tagged during our stock assessment electrofishing in May, 2007, as described above, except that two additional sites – one at Sheep Creek and one at Indian Creek – were electrofished exclusively to tag fish. From 18 to 129 rainbow trout ≥203 mm were tagged at each site for a total of 517 fish. These included from 2 to 79 rainbow trout ≥406 mm at each site, for a total of 153 fish of this size. Over all sites, the smallest fish tagged was 230 mm and the largest was 593 mm. Ripe and spent rainbow trout were observed on redds, particularly just below the dam.

Floy T-bar external anchor tags were inserted into the fish at the base of the dorsal fin. Tags were fluorescent orange, 70 mm in total length with 51 mm of tubing, and were treated with algaecide. Each tag was labeled on two sides with one side stating the IDFG toll-free automated hotline number and the other side with a unique tag number and reward amount if applicable. To assess tag loss, a sub-sample of non-reward-tagged fish and all reward-tagged fish were double-tagged with an additional non-reward tag. We assumed tagged fish did not move into the lower river below Heise and that catchability was equal for tagged and untagged fish. Butts et al. (2007) provide a detailed description of the program and how it was publicized to anglers.

The unadjusted exploitation rate, u , is calculated according to Ricker (1975):

$$u = \frac{R_s}{M_s} \tag{7}$$

where R_s is the number of standard tags recovered from fish that are harvested, and M_s is the number of fish tagged with standard tags. For this study, "standard" tags are defined as non-reward tags.

The high-reward method is used to calculate the tag reporting rate, λ, or angler compliance (Pollock et al. 2001, with slightly different notation):

$$\lambda = \frac{R_s M_h}{M_s R_h} \tag{8}$$

where R_s and M_s are as before, M_h is the number of fish tagged with high-reward tags, and R_h is the number of high-reward tags reported from fish that are harvested. For this study, "high-reward" tags had values of $100 or $200. We assumed that angler compliance would be equal and 100% for each of these values, i.e. all anglers catching and keeping high-reward tagged fish would report the tag. Dividing u by λ gives the exploitation rate adjusted for angler compliance.

Additional adjustments can be incorporated to account for tag loss. For this study, we differentiate between "natural" tag loss, in which case tags do not hold and become unattached from the fish by natural processes, and "angler-induced" tag loss, in which case anglers remove the tags, generally by clipping them off, before releasing the fish. The rate of natural tag loss, Tag_n , is estimated by double-tagging and can be expressed as:

$$Tag_n = \frac{R_d'}{R_d} \quad (9)$$

where R_d' is the number of double-tagged fish for which a single tag was recovered, whether harvested or not – i.e. one tag was lost – and R_d is the total number of double-tagged fish reported, whether by one or both tags. Note that both R_d' and R_d can include high-reward tagged fish and angler compliance is not an issue. The rate of tag removal by anglers, Tag_r , can be expressed as:

$$Tag_r = \frac{\left(R_r'/\lambda\right)}{M_s} \quad (10)$$

where R_r' is the number of released fish that had standard tags removed by anglers, i.e. the fish was released untagged, and M_s and λ are as before. Note that because anglers report the tags that are removed, their recoveries are adjusted for compliance. We assume compliance is equal for anglers harvesting or releasing fish.

A final adjustment can be incorporated to account for the tag-induced mortality rate, Tag_m. We assumed 15% tagging mortality for T-bar external anchor tags.

Taken together, the adjusted exploitation rate, u', can be expressed as (adapted from Slipke and Maceina 2000):

$$u' = \frac{u}{\lambda\left(1 - Tag_n\right)\left(1 - Tag_r\right)\left(1 - Tag_m\right)} \quad (11)$$

where the terms are defined previously.

Unlike 2003 and 2005, we could not estimate exploitation rates for cutthroat, rainbow, or brown trout in 2007 by dividing total harvest (as determined from a creel survey), by total stock abundance. This is because we did not conduct a creel survey in 2007. However, total harvest of rainbow trout was estimated by multiplying the exploitation rate, which was derived from tagging, by total stock abundance, which was derived from CPUE models.

Modified Flows and Recruitment

A mathematical index was 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 (Schrader and Fredericks 2006b). The index is based on empirical data and is 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:

$$YCT\ Index = 3.083 \times 10^{-4}(YCT) - 2.359 \times 10^{-4}(RBT) + 2.559(\%YCT) + 0.1 \qquad (12)$$

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%.

We introduce a second simple metric to evaluate recruitment in relation to modified flow management. The cutthroat to rainbow trout recruitment ratio, *Recruit Ratio*, is expressed as:

$$Recruit\ Ratio = \frac{YCT}{RBT} \qquad (14)$$

where *YCT* and *RBT* are as before. Our fishery management goal is for the ratio to be greater than one, i.e. more cutthroat than rainbow trout recruits.

Tributary Weirs

We operated, or attempted to operate, three of the four tributary fish weirs during 2007. Going upstream in the drainage, they include facilities at Pine, Rainey, and Palisades creeks – each located near the confluence with the South Fork Snake River (Figure 1). Host (2003) describes each weir and trap facility, but the old floating weir panels were replaced beginning in 2004 after poor weir efficiency and high cutthroat trout mortality were observed in 2003 (Schrader and Fredericks 2006a, 2006b; Garren et al. 2006). In 2007, we used Mitsubishi floating weir panels and hard picket weirs at Pine and Rainey creeks (Figure 4). These panels were salvaged and refurbished from the Blackfoot River weir. 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 Rainey Creek, we used "hard" weir panels constructed with aluminum frames and 1.27 cm diameter electrical conduit pickets. A temporary electric mat was tested at Palisades Creek to determine if it could function as a weir to divert migrating cutthroat and rainbow trout through the fishway (Figure 4).

The Pine Creek weir was installed on March 24 but the floating panels were submerged April 30 through May 3. The Floating weir panel were replaced June 7 with hard pickets as several fish were observed migrating past the floating weir. The Rainey Creek weir was installed on March 19 and removed on June 30. Pickets were pulled and the weir was off-line April 29 through May 15 because of high water. The Palisades Creek electric mat was installed on March 24 and was electrified May 1. The electric mat was operated through July 28 and removed. One of the two pulsators for the electric mat faulted on May 18, but was repaired the same day. 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.

We estimated trap efficiency at Pine and Palisades creeks. We did not estimate weir or trap efficiency at Rainey Creek. Similar to estimation techniques in past years, we estimated efficiency by marking all cutthroat trout released above the weir with a temporary upper caudal fin punch. At Pine Creek two single-pass electrofishing surveys were employed to compare marked to unmarked ratios of fluvial fish upstream of the weir. Fluvial fish were defined as fish larger than 279 mm (Schrader and Fredericks 2006a). The total number of marked fluvial fish divided by the total number of fluvial fish captured while electrofishing was calculated to estimate weir efficiency at Pine Creek.

Trapping efficiency at Palisades Creek was estimated to determine the effectiveness of the electrical mat forcing migrating cutthroat and rainbow trout into the fishway. At Palisades Creek we trapped a sample of post-spawning fish fluvial fish returning downstream in the Palisades Canal screen bypass. The bypass trap was operated from May 2 to July 28 and checked on a daily basis. 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.

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.

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. Unknown numbers of outmigrating cutthroat trout fry and post-spawners have been prevented from being entrained at the diversions since construction.

RESULTS

Fall Population Monitoring

Conant

We captured a total of 2,842 trout during four days of electrofishing. Relative abundance in the catch was 45.3% cutthroat trout, 31% rainbow trout, 23.6% brown trout, and <1% other trout species (Figure 5, Appendix B). A single 294 mm brook trout *Salvelinus fontinalis* was observed during electrofishing surveys at Conant. 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 6). However, this may be due to the size-selectivity of the sample gear or age-1 cutthroat trout rearing in tributaries. Mean total length was 322 mm for cutthroat trout, 306 mm for rainbow trout, 288 mm for brown trout, and 309 mm for all trout species combined (Figure 6; Appendix B). Quality stock density was 12.1% for cutthroat trout, 20% for rainbow trout, 13.7% for brown trout, and 15.0% for all trout species combined. Estimated densities of age-1 and older fish were 1,380 cutthroat trout/km, 825 rainbow trout/km, and 530 brown trout/km for a combined total of 2,734 fish/km (Figure 7; Appendix B). Cutthroat trout sample efficiency (*R/C*) over all sizes was 12.7%. This was within the range of previous years, as was rainbow trout efficiency at 14.4% and brown trout efficiency at 17.3%. Estimated densities of age-1 fish, our measure of recruitment, were 464 cutthroat trout/km, 450 rainbow trout/km, and 297 brown trout/km for a combined total of 1,211 fish/km (Figure 8; Appendix B). The cutthroat to rainbow trout recruitment ratio was 1.0, i.e. 1 cutthroat trout was recruited for every rainbow trout recruit (Figure 9). The cutthroat to brown trout recruitment ratio was 1.6. Yearling relative abundance in the catch was 25.5% cutthroat trout, 39.3% rainbow trout, and 35.2% brown trout.

Lorenzo

We captured a total of 1,378 trout during four days of electrofishing. Relative abundance in the catch was 9.3% cutthroat trout, 1.7% rainbow trout, and 89.0% brown trout (Figure 5, Appendix C). 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 10). Similarly, a very strong group of age-1 brown trout (about 180 to 280 mm) is evident. Only twenty-three rainbow trout were captured and they were not analyzed. Mean total length was 300 mm for cutthroat trout, 318 mm for brown trout, and 315 mm for both trout species combined (Figure 10; Appendix C). Quality stock density was 12.7% for cutthroat trout, 15.5% for brown trout, and 15.3% for both trout species combined. Estimated densities of age-1 and older brown trout was 1,125 brown trout/km (Figure 11; Appendix C). Sample efficiency (*R/C*) over all sizes for brown trout was 15.0% and was within the range of previous years. Similar to previous years, a density estimate was not possible for rainbow trout due to the small sample size. A density estimate was also not possible for cutthroat trout. Estimated densities of age-1 fish, our measure of recruitment, was 310 brown trout/km (Figure 12; Appendix C). Yearling relative abundance in the yearling catch was 16.2% cutthroat trout, 3.3% rainbow trout, and 80.5% brown trout.

Spring Stock Assessment and Distribution

For fish ≥203 mm, a total of 129,137 trout were estimated to be in the upper river above Heise on May 4, 2007 (Table 1). Of these, 36.2% or 43,805 fish were cutthroat trout, 31.7% or 49,145 fish were rainbow trout, and 32.1% or 36,187 fish were brown trout. For fish ≥406 mm, a total of 33,143 trout were estimated to be in the upper river above Heise on May 4, 2007 (Table 2). Of these, 21.7% or 6,520 fish were cutthroat trout, 36.9% or 10,575 fish were rainbow trout, and 41.4% or 16,047 fish were brown trout. In general, spring-time densities of cutthroat trout ≥203 mm were slightly higher – and densities of cutthroat trout ≥406 mm were slightly lower – as we sampled downstream (Figure 13). Spring-time densities of both ≥203 mm and ≥406 mm rainbow trout were highest upstream and gradually declined to near zero as we sampled downstream (Figure 14). In contrast, spring-time densities of both ≥203 mm and ≥406 mm brown trout were lowest upstream and gradually increased as we sampled downstream (Figure 15). Compared to the other trout taxa, cutthroat trout were more uniformly distributed throughout the upper river.

Rainbow Trout Exploitation and Harvest

Exploitation

The unadjusted exploitation rate for rainbow trout was estimated to be 5.9%. This is based on 74 fish with standard tags that were reported from 456 fish at large. The tag return rate, λ, or angler compliance was estimated to be 62%. The rate of natural tag loss, Tag_n, was 16.2% based on 12 single tags recovered, R_d', from 74 known double-tagged fish that were reported, R_d. The rate of tag removal by anglers, Tag_r, was estimated to be 39.1%. This is based on anglers removing 18 standard tags without killing the fish, R_r', from 456 fish at large, M_s, and adjusting for angler compliance, λ, at 62%. The tagging mortality rate, Tag_m, was assumed to be 15% (Meyer et al. in review). Using the above values, the adjusted exploitation rate for rainbow trout, *u*, was estimated to be 13.4%.

This annual exploitation rate, and the harvest estimates below, reported for 2007 apply to much of the 2007 fishing season (May 4 to February 22), but does not include much of the spawning season when anglers target rainbow trout on redds. The values are applicable to the upper river above Heise (64 km). A total of $1,960 was paid in rewards for South Fork Snake River tag returns over this time period.

Harvest

Estimated harvest of rainbow trout ≥203 mm was 6,585 fish using the total stock abundance estimate of 49,145 fish (Table 1) and the adjusted exploitation rate of 13.4%. Estimated harvest of rainbow trout ≥406 mm was 1,417 fish using the total stock abundance estimate of 10,575 fish (Table 2) and the adjusted exploitation rate of 13.4%. Total estimated harvest of rainbow trout (all sites) was 8,002 fish.

Modified Flows and Recruitment

During 2006, a peak flow of 523.9 m^3/s or 18,500 ft^3/s was recorded on May 26 at the USGS Irwin gage (Figure 16). The maximum to minimum flow ratio was 11.4, as measured at the USGS Heise gage from March 23 to July 6.

The *YCT Index* was 0.933 (Figure 17). As reported above, the *Recruit Ratio* was 1.0 (Figure 9).

Tributary Weirs

We removed 22 rainbow trout and passed 1,232 cutthroat trout upstream to spawn, for a combined total of 1,254 fish trapped, at the three South Fork Snake River tributary weirs (Table 3). Of the rainbow trout, 9.0% were caught at Pine Creek, 91.0% were caught at Palisades Creek, and no rainbow trout were caught at Rainey Creek. Of the cutthroat trout, 1.1% were caught at Rainey Creek, 39.0% at Pine Creek, and 59.8% at Palisades Creek.

Pine Creek

The Pine Creek Mitsubishi weir was installed March 24, 2007. On April 30 the floating weir became submerged and remained offline through May 3. During the first week of June, a number of spawners were observed between the weir and the check boards of the diversion indicating the weir was not functioning. On June 7th, the floating Mitsubishi weir was replaced with hard pickets. There were 483 fish trapped at Pine Creek, but only two were rainbow trout and both were female (Table 3; Figure 18). The 163 males and 318 female cutthroat trout were caught between March 28 and June 14 and the midpoint was June 10. The observed sex ratio was 1.0 male to 1.9 females, or 66.1% females (n=481). Weir efficiency at Pine Creek was estimated at 19.7%. During single-pass electrofishing surveys on June 18 and 21, a total of 71 fluvial fish were captured and 14 had been marked at the trap.

Rainey Creek

From March 19 to June 30, 2007, we trapped a total of 14 trout at the Rainey Creek weir, all 14 fish were cutthroat trout (Table 3). Fish were missed when the weir was off-line April 29 through May 15. The 12 male and 2 female cutthroat trout were caught between March 31 and May 29, and the midpoint was May (Table 5: Figure 19). Too few fish were captured to report sex ratios. We did not estimate the efficiency of the "hard" picket weir during 2007, although it was likely low.

Palisades Creek

An electrical mat was installed March 14, 2007 on the downstream edge of the sill for the Palisades Creek weir structure, but was pulled March 20 due to high flows. On March 24 the mat was installed again and sandbags were alternately placed and blown out through the end of the month. By May 1, the mat was stabilized and electricity was supplied. The electric weir remained operational through July 28. On May 18 one of the two pulsators malfunctioned but was repaired the same day. From May 1 to July 28, 2007, we trapped a total of 757 trout at Palisades Creek, of which 20 fish or 2.6% were rainbow trout and 737 fish or 97.4% were cutthroat trout (Table 3).

The 9 male and 11 female rainbow trout were caught between May 4 and June 20, and the midpoint was May 16 (Table 4; Figure 20). The observed sex ratio was 1.0 male to 1.4 females, or 55.0% females (n=20 fish). The 286 male and 451 female cutthroat trout were caught between May 17 and July 25, and the midpoint was June 14 (Table 5: Figure 20). The observed sex ratio was 1.0 male to 1.6 females, or 61.2% females (n=737 fish). The estimated efficiency of the electrified mat functioning as a weir was 98.1% (Table 3) based on 475 post-spawning cutthroat trout caught in the Palisades Canal screen bypass trap, of which 466 fish were marked and 9 fish were unmarked. The total cutthroat trout run size was estimated to be 751 fish based on the number of marked fish released above the weir (M=737 fish) divided by the weir efficiency (R/C=98.1%). Forty four rainbow trout of all sizes were also caught in the bypass trap, but trap efficiencies for rainbow trout was not assessed because we missed the rainbow trout spawning migration starting the weir on May 1.

DISCUSSION

Population Monitoring

Compared to 2006 (Schrader and Fredericks 2008), age-1 and older cutthroat trout increased 84% at Conant (Figure 7). This increase was statistically significant with non-overlapping 95% confidence intervals for 2006 and 2007. However, natural variability is expected in abundances from year to year. Interestingly, the 2007 density estimate of 1,380 fish/km at Conant was close to the long-term average – 1,388 fish/km at Conant (n=17 years). Age-1 and older cutthroat trout have not exceeded this average since 1999, partly due to extended drought. Although cutthroat trout densities near the long-term average at Conant is encouraging, apparent cutthroat densities at Lorenzo are not. We were unable to estimate abundance of cutthroat trout at Lorenzo. Cutthroat catch has typically been low at Lorenzo during electrofishing surveys, but 2007 catch was only 51% of the long term average of 251 (n=12 years). We do not expect the recent upward trend to continue and the 2006 to 2007 rate because of poor tributary flows for spawning cutthroat during the spring of 2007.

Concomitant with increasing cutthroat densities at Conant, age-1 and older rainbow trout also increased by 22% (Figure 7). The increase at Conant from 2006 to 2007 was not statistically significant at the $\alpha=0.05$ level. The 2006 rainbow trout density estimate of 825 fish/km at Conant is nearly twice their long-term average of 484 fish/km (n=14 years) despite the fact that the average has been increasing as well. This is an unfortunate reversal of the decreasing trend that began in 2004 and extended to 2005.

Age-1 and older brown trout increased 61% at Conant (for the second consecutive year) but decreased 36% at Lorenzo (Figures 7 and 11). The increase from 2006 to 2007 at Conant was statistically significant ($\alpha=0.05$), as well as the decrease in brown trout abundance at Lorenzo. The 2007 brown trout density estimate of 854 fish/km at Conant was still nearly twice their long-term average of 529 fish/km (n=17 years), and their overall trend has been increasing.

Compared to 2006 (Schrader and Fredericks 2008), yearling cutthroat trout at Conant increased 41%, yearling rainbow trout increased 9%, and yearling brown trout increased 36% (Figure 8). Further, the cutthroat trout estimate of 464 fish/km was above their long-term average of 435 fish/km (n=21 years including cohort analysis) – which has not been the case since 1999. The rainbow trout estimate of 450 fish/km was also above their long-term average of 283 fish/km (n=20 years). The ratio of yearling cutthroat to yearling rainbow trout was 1.0, which was a rare occurrence since 1999. The brown trout estimate of 297 fish/km was above their long-term average of 165 fish/km (n=21 years), and their trend has been increasing.

At Lorenzo, yearling brown trout decreased 74% compared to 2006 (Schrader and Fredericks 2007). A yearling cutthroat trout density estimate was not possible in 2007 due to the small sample size. The yearling brown trout decrease from 2006 to 2007 was statistically significant but a stable recruitment trend has not been evident. The 2007 brown trout estimate of 310 fish/km is the lowest on record since 1990 but was close to the long-term average of 389 fish/km (n=13 years). The fact that we could not calculate a cutthroat trout estimate for Lorenzo in 2007 despite the sharp increase of age-1 cutthroat at Conant further indicates cutthroat are not heavily produced at Lorenzo, but are likely recruited from upstream sources (Schrader and Fredericks 2006b).

Spring electrofishing efforts resulted in estimates of 129,137 trout ≥203 mm in upper river above Heise on May 4, 2007. This estimate was 113% of the spring 2006 estimate (Schrader and Fredericks 2007), 187% of the 2005 estimate (Schrader and Fredericks 2006b), and 122% of the 2003 estimate (Schrader and Fredericks 2006a). For cutthroat trout ≥203 mm, the estimate of 43,805 trout in 2007 was 138% of the 2006 estimate, 209% of the 2005 estimate, and 104% of the estimate for 2003. For rainbow trout ≥203 mm, the estimate of 49,145 trout in 2007 was 97% of the 2006 estimate, 159% of the 2005 estimate, and 289% of the 2003 estimate. For brown trout ≥203, the estimate of 36,187 in 2007 trout was 114% of the 2006 estimate, 213% of the 2005 estimate, and 145% of the estimate for 2003. Similar trends were observed for fish ≥406 mm total length.

The adjusted exploitation rate for rainbow trout, *u'*, was estimated to be 13.4% for the time period of May 4, 2007 through February 22, 2008. Much of the harvest of rainbow trout in the South Fork Snake River occurs during the spawning season while anglers are fishing for rainbow trout on redds (typically the months of March and April). If the full spawning season was included for the analysis, the exploitation rate of rainbow trout in the South Fork Snake River during 2007 would likely be similar to the 20.6% reported in 2005 (Schrader and Fredericks 2006b). The 2007 harvest estimate of 6,585 fish is an underestimate of the true annual harvest, but still exceeds harvest levels in 2005 (6,441 fish).

Modified Flows and Recruitment

Four freshets have been provided by BOR since the need for modified flow management was recognized by Moller and Van Kirk (2003) and Hauer et al. (2004). A peak flow of 538.1 m^3/s (19,000 ft^3/s) was recorded on May 25, 2007 – compared with 552.4 m^3/s (19,500 ft^3/s) on June 16, 2006, 422.1 m^3/s (14,900 ft^3/s) on June 15, 2005, and 538.2 m^3/s (19,000 ft^3/s) on May 23, 2004 – at the USGS Irwin gage (Figure 16). Maximum to minimum flow ratios, measured at the USGS Heise gage from March 23 to July 6, were 11.4 in 2007 – compared to 6.4 in 2006, 11.4 in 2005, and 14.3 in 2004. None of these flow ratios were fifteen or greater, the generally agreed upon goal (Rob Van Kirk, personal communication).

The 2007*YCT Index* was 0.933 – up from the 2006 index but still below the average index value (1.5) over the last 21 years (Figure 17). The bottom five index values have all occurred since 2001, including 2006. The higher *YCT Index* for 2007 is because cutthroat trout recruitment was above average.

The *Recruit Ratio* at Conant was 1.0 in 2007 – compared to 0.8 in 2006. Excluding the year of cohort analysis (2005) the ratio of 1.0 was the highest it has been since 1999, but still below the long-term average of 2.9. Similar to the *YCT Index*, the bottom six *Recruit Ratio* values have all occurred since 2000. The general pattern of the *Recruit Ratio* is similar to the general pattern of the *YCT Index* over the last 20 years (Figure 17). This would be expected as the underlying data to calculate either metric is fundamentally the same.

Tributary Weirs

The tributary weir program was not very effective at removing rainbow trout during 2007 due to runoff conditions– particularly bedload and debris movement that wreaked havoc with the weir panels. The timing of weir operation at Palisades Creek also decreased our effectiveness of removing rainbow trout spawners, but was extremely effective during the later cutthroat trout run.

The number of rainbow and cutthroat trout caught at Rainey Creek – and presumably their total run size – has always been and continues to be the lowest of the four tributaries monitored. This is primarily due to dewatering of the stream channel at several irrigation diversions below the weir site (Moore and Schill 1984).

No rainbow trout had been trapped prior to 2006 at Rainey Creek, and none were caught in 2007. However, with a total catch of only 14 trout, strong conclusions cannot be made about run compositions and timing at Rainey Creek in 2007. The Rainey Creek weir, similar to all other South Fork Snake River tributary weirs, has proven ineffective during high flows. Again, the weir was offline in 2007 during peak run-off periods. While weir efficiency was not evaluated at Rainey Creek in 2007, it is likely that fish were missed while the weir was offline. The current weir location at Rainey Creek and weir design should be re-evaluated to determine if modifications could increase trapping success during normal and above normal flows.

The 757 trout trapped at the Palisades Creek weir during 2007 was near the average for the period of record (858, n=5 years), although the rainbow trout spawning run was largely missed (Table 3). However, of the three tributaries that weirs were operated on in 2007, most rainbow trout were caught at Palisades Creek. In the past as rainbow trout catch has exceeded 300 fish and comprised 18% of the run (Schrader and Fredericks 2006). For this reason, operating the Palisades Creek weir has been our highest priority. The number of cutthroat trout caught in Palisades Creek has always been moderately large – from 300 to over 1,000 fish – but not as large as Burns or Pine creeks. However, total catch of cutthroat trout in 2007, estimated to be 751, was lower. The catch was lower because the electric mat was not functional until May 1.

Once the electric mat was supplied with power, nearly every migrating trout was forced into the fishway at Palisades Creek in 2007. We estimated a trapping efficiency of 98.1% based on the ratio of marked fluvial cutthroat trout returning to the South Fork Snake River that were caught in the bypass for the irrigation diversion. This high efficiency is likely an underestimate, as trapping of the diversion bypass began when the mat was electrified, which was a little late in the run. Of the 9 unmarked fluvial fish captured in the bypass, 3 were caught during the first 20 days of trapping, and may have been early running cutthroat trout that passed the weir site prior to electrification. Regardless of the precision of the efficiency estimate, the estimate was as high as we have ever recorded at a tributary weir on the South Fork Snake River. It appears likely that electric barriers may be operated more efficiently than hard structures. Future evaluations will be necessary to determine if electrical weirs can continue to function at high water flows.

RECOMMENDATIONS

1. Continue to implement flow management objectives recommended by EBSM (Hauer et al. 2004) and by Moller and Van Kirk (2003). For 2008, encourage BOR to provide a higher spring flushing flow – greater than 566.6 m^3/s (20,000 ft^3/s) – and a higher maximum to minimum flow ratio – greater than 15.0 – even if the tradeoff is slightly lower winter flows.
2. Continue to monitor South Fork Snake River trout populations by electrofishing in 2008.

3. Continue to estimate rainbow trout exploitation using reward tags in 2008.
4. Continue to inform and educate anglers regarding benefits to cutthroat trout by harvesting rainbow trout.
5. Continue to operate tributary weirs and modify Palisades Creek with a permanent electrical weir system.
6. Continue to operate and maintain rotary drum fish screens on irrigation diversions in Palisades and Burns creeks.
7. Re-evaluate weirs at Pine and Rainey creeks for modifications to increase trapping efficiencies at all flows and effectiveness at high flows.

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TABLES

Table 1. Predicted stock density (N/km, from CPUE model) and total abundance (N) of trout ≥203 mm in the upper South Fork Snake River, Idaho, May 2-4, 2007. Sites were spaced at 8 km intervals beginning at Palisades Dam (site 1) and ending at the Heise cable (site 9).

Site	VWP 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	37.72	8	5.6	0.21	81		129	90.8	3.42	1,879		5	3.5	0.13	47		
2	31.45	20	29.0	0.64	243	1,299	44	63.8	1.40	768	10,588	5	7.2	0.16	57	416	12,303
3	29.13	46	43.0	1.58	605	3,392	49	45.8	1.68	924	6,769	12	11.2	0.41	147	815	10,976
4	31.00	41	29.1	1.32	506	4,444	46	32.6	1.48	815	6,956	54	38.3	1.74	622	3,075	14,475
5	37.62	101	64.7	2.68	1,028	6,138	28	17.9	0.74	409	4,896	27	17.3	0.72	256	3,512	14,545
6	35.08	92	43.0	2.62	1,004	8,129	58	27.1	1.65	908	5,268	64	29.9	1.82	651	3,629	17,026
7	31.22	67	37.9	2.15	822	7,304	39	22.0	1.25	686	6,377	71	40.1	2.27	812	5,852	19,532
8	29.88	59	29.4	1.97	756	6,311	28	13.9	0.94	515	4,803	114	56.7	3.81	1,362	8,694	19,808
9	27.67	68	38.2	2.46	941	6,788	18	10.1	0.65	357	3,488	92	51.7	3.33	1,187	10,194	20,470
Total	290.77	502				43,805	439				49,145	444				36,187	129,137

[a] Includes hatchery cutthroat trout.

Table 2. Predicted stock density (N/km, from CPUE model) and total abundance (N) of trout ≥406 mm in the upper South Fork Snake River, Idaho, May 2-4, 2007. Sites were spaced at 8 km intervals beginning at Palisades Dam (site 1) and ending at the Heise cable (site 9).

Site	VWP 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	37.72	7	7.7	0.19	57		79	86.8	2.09	814		5	5.5	0.13	54		
2	31.45	15	42.9	0.48	148	820	15	42.9	0.48	185	3,996	5	14.3	0.16	64	473	5,289
3	29.13	20	33.3	0.69	213	1,441	29	48.3	1.00	387	2,288	11	18.3	0.38	153	870	4,598
4	31.00	12	32.4	0.39	120	1,329	5	13.5	0.16	63	1,797	20	54.1	0.65	261	1,658	4,785
5	37.62	11	30.6	0.29	91	841	5	13.9	0.13	52	457	20	55.6	0.53	215	1,907	3,206
6	35.08	3	7.9	0.09	26	468	8	21.1	0.23	89	561	27	71.1	0.77	312	2,109	3,138
7	31.22	12	20.7	0.38	119	582	7	12.1	0.22	87	703	39	67.2	1.25	506	3,272	4,557
8	29.88	3	10.7	0.10	31	600	3	10.7	0.10	39	504	22	78.6	0.74	298	3,218	4,323
9	27.67	7	21.9	0.25	78	438	2	6.3	0.07	28	268	23	71.9	0.83	337	2,541	3,247
Total	290.77	90				6,520	153				10,575	172				16,047	33,143

[a] Includes hatchery cutthroat trout.

Table 3. Summary of fish weirs operated in tributaries of the South Fork Snake River, Idaho, 2001-2007. Streams are listed going up the drainage.

Year	Weir type	Operation dates	Estimated weir efficiency (%)[a]	Catch		
				Rainbow trout	Cutthroat trout	Total
			Burns Creek			
2001[b]	Floating panel	Mar 7 - Jul 20	15.9	3	3,156	3,159
2002[b]	Floating panel	Mar 23 - Jul 5	NE[c]	16	1,898	1,914
2003[d]	Floating panel	Mar 28 - Jun 23	16.9 – 35.5	1	1,350	1,351
2004	ND[e]	ND	ND	ND	ND	ND
2005	ND	ND	ND	ND	ND	ND
2006	Mitsubishi	Apr 14 - Jun 30	NE	3	1,539	1,542
2007	ND	ND	ND	ND	ND	ND
			Pine Creek			
2001[b]	ND	ND	ND	ND	ND	ND
2002[b]	Floating panel	Apr 2 - Jul 5	NE	14	202	216
2003[f]	Floating panel	Mar 27 - Jun 12	40.4	7	328	335
2004	Hard picket	Mar 25 - Jun 28	98.1	27	2,143	2,170
2005	Hard picket	Apr 6 - Jun 30	NE	40	2,817	2,857
2006[g]	Mitsubishi	Apr 14 - Apr 18	ND	ND	ND	ND
2007	Mitsubishi/Hard picket	Mar 24 - Jun 30	19.7	2	481	483
			Rainey Creek			
2001[b]	Floating panel	Mar 7 - Jul 6	NE	0	0	0
2002[b]	Floating panel	Mar 26 - Jun 27	NE	0	1	1
2003	ND	ND	ND	ND	ND	ND
2004	ND	ND	ND	ND	ND	ND
2005	Hard picket	Apr 7 - Jun 29	NE	0	25	25
2006	Hard picket	Apr 5 - Jun 30	NE	3	69	72
2007	Hard picket	Mar 19 - Jun 30	NE	0	14	14
			Palisades Creek			
2001[b]	Floating panel	Mar 7 - Jul 20	10.1	160	491	651
2002[b]	Floating panel	Mar 22 - Jul 7	NE	310	967	1,277
2003	Floating panel	Mar 24 - Jun 24	21.1 – 47.4	181	529	710
2004	ND	ND	ND	ND	ND	ND
2005	Mitsubishi	Mar 18 - Jun 30	90.5	301	1,071	1,372
2006	Mitsubishi	Apr 4 - Jun 30	12.8	52	336	388
2007	Electric mat	May 1 - Jul 28	98.1	20	737	757
Total by year:						
2001[b]				163	3,647	3,810
2002[b]				340	3,068	3,408
2003				189	2,207	2,396
2004				27	2,143	2,170
2005				341	3,913	4,254
2006				58	1,944	2,002
2007				22	1,232	1,254
Grand total:				1,140	18,154	19,294

[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.
[g] Weir was destroyed during high runoff.

Table 4. Rainbow trout timing of arrival at fish weirs operated in the South Fork Snake River, Idaho, 2001-2007. Streams are listed going up the drainage.

Year	Weir type	Operation dates	Date first fish caught	Median date (50% caught)	Date last fish caught	Total fish caught
			Burns Creek			
2001[a]	Floating panel	Mar 7 - Jul 20	May 27	May 28	May 28	3
2002[a]	Floating panel	Mar 23 - Jul 5	Apr 15	Apr 30	May 27	16
2003[b]	Floating panel	Mar 28 - Jun 23	Jun 16	Jun 16	Jun 16	1
2004	ND[c]	ND	ND	ND	ND	ND
2005	ND	ND	ND	ND	ND	ND
2006	Mitsubishi	Apr 14 - Jun 30	May 15	May 25	May 25	3
2007	ND	ND	ND	ND	ND	ND
Over all years:		Mar 7 - Jul 20	Apr 15	May 3	Jun 16	23
			Pine Creek			
2001[a]	ND	ND	ND	ND	ND	ND
2002[a]	Floating panel	Apr 2 - Jul 5	May 12	May 12	Jun 13	14
2003[d]	Floating panel	Mar 27 - Jun 12	Apr 21	Jun 4	Jun 8	7
2004	Hard picket	Mar 25 - Jun 28	Apr 22	May 17	Jun 22	27
2005	Hard picket	Apr 6 - Jun 30	Apr 26	May 31	Jun 20	40
2006[e]	Mitsubishi	Apr 14 - Apr 18	ND	ND	ND	ND
2007	Mitsubishi/Hard picket	Mar 24 - Jun 30	Mar 28	Mar 28	May 6	2
Over all years:		Mar 24 - Jul 5	Mar 28	May 20	Jun 22	90
			Rainey Creek			
2001[a]	Floating panel	Mar 7 - Jul 6	ND	ND	ND	0
2002[a]	Floating panel	Mar 26 - Jun 27	ND	ND	ND	0
2003	ND	ND	ND	ND	ND	ND
2004	ND	ND	ND	ND	ND	ND
2005	Hard picket	Apr 7 - Jun 29	ND	ND	ND	0
2006	Hard picket	Apr 5 - Jun 30	May 28	May 31	May 31	3
2007	Hard picket	Mar 19 - Jun 30	ND	ND	ND	ND
Over all years:		Mar 7 - Jul 6	May 28	May 31	May 31	3
			Palisades Creek			
2001[a]	Floating panel	Mar 7 - Jul 20	Mar 27	May 8	Jul 9	160
2002[a]	Floating panel	Mar 22 - Jul 7	Mar 26	May 18	Jun 16	310
2003	Floating panel	Mar 24 - Jun 24	Mar 31	Apr 25	Jun 11	181
2004	ND	ND	ND	ND	ND	ND
2005	Mitsubishi	Mar 18 - Jun 30	Mar 22	May 19	Jun 22	301
2006	Mitsubishi	Apr 4 - Jun 30	Apr 14	May 15	Jun 7	52
2007	Electric mat	May 1 - Jul 28	May 4	May 16	Jun 20	20
Over all years:		Mar 7 - Jul 28	Mar 22	May 9	Jul 9	1,024
Overall:		Mar 7 - Jul 20	Mar 22	May 16	Jul 9	1,140

[a] From Host (2003).
[b] Weir was shut down on June 10, but the trap was operated until June 23.
[c] ND = no data; weir either not built or not operated, or no fish captured.
[d] Weir was shut down early due to high cutthroat trout mortality.
[e] Weir was destroyed during high runoff.

Table 5. Cutthroat trout timing of arrival at fish weirs operated in the South Fork Snake River, Idaho, 2001-2007. Streams are listed going up the drainage.

Year	Weir type	Operation dates	Date first fish caught	Median date (50% caught)	Date last fish caught	Total fish caught
			Burns Creek			
2001[a]	Floating panel	Mar 7 - Jul 20	May 13	Jun 9	Jul 9	3,156
2002[a]	Floating panel	Mar 23 - Jul 5	Apr 29	Jun 12	Jul 5	1,898
2003[b]	Floating panel	Mar 28 - Jun 23	Mar 31	Jun 14	Jun 22	1,350
2004	ND[c]	ND	ND	ND	ND	ND
2005	ND	ND	ND	ND	ND	ND
2006	Mitsubishi	Apr 14 - Jun 30	Apr 22	Jun 10	Jun 27	1,539
2007	ND	ND	ND	ND	ND	ND
Over all years:		Mar 7 - Jul 20	Mar 31	Jun 11	Jul 9	7,943
			Pine Creek			
2001[a]	ND	ND	ND	ND	ND	ND
2002[a]	Floating panel	Apr 2 - Jul 5	May 12	Jun 17	Jul 5	202
2003[d]	Floating panel	Mar 27 - Jun 12	Mar 28	Jun 8	Jun 11	328
2004	Hard picket	Mar 25 - Jun 28	Apr 14	Jun 3	Jun 25	2,143
2005	Hard picket	Apr 6 - Jun 30	Apr 19	Jun 9	Jun 24	2,817
2006[e]	Mitsubishi	Apr 14 - Apr 18	ND	ND	ND	ND
2007	Mitsubishi/Hard picket	Mar 24 - Jun 20	Mar 28	Jun 10	Jun 14	481
Over all years:		Mar 24 - Jul 5	Mar 28	Jun 11	Jul 5	5,971
			Rainey Creek			
2001[a]	Floating panel	Mar 7 - Jul 6	ND	ND	ND	0
2002[a]	Floating panel	Mar 26 - Jun 27	ND	ND	ND	1
2003	ND	ND	ND	ND	ND	ND
2004	ND	ND	ND	ND	ND	ND
2005	Hard picket	Apr 7 - Jun 29	May 11	May 23	Jun 17	25
2006	Hard picket	Apr 5 - Jun 30	May 28	Jun 7	Jun 21	69
2007	Hard picket	Mar 19 - Jun 30	Mar 31	May 18	May 29	14
Over all years:		Mar 7 - Jul 6	Mar 31	May 26	Jun 21	109
			Palisades Creek			
2001[a]	Floating panel	Mar 7 - Jul 20	Apr 27	Jun 17	Jul 13	491
2002[a]	Floating panel	Mar 22 - Jul 7	May 11	Jun 15	Jul 7	967
2003	Floating panel	Mar 24 - Jun 24	Apr 10	Jun 9	Jun 21	529
2004	ND	ND	ND	ND	ND	ND
2005	Mitsubishi	Mar 18 - Jun 30	Apr 15	Jun 13	Jun 30	1,071
2006	Mitsubishi	Apr 4 - Jun 30	Apr 22	Jun 10	Jun 30	336
2007	Electric mat	May 1 - Jul 28	May 17	Jun 14	Jul 25	737
Over all years:		Mar 7 - Jul 20	Apr 10	Jun 13	Jul 25	4,131
Overall:		Mar 7 - Jul 20	Mar 28	Jun 10	Jul 13	18,154

[a] From Host (2003).
[b] Weir was shut down on June 10, but the trap was operated until June 23.
[c] ND = no data; weir either not built or not operated, or no fish captured.
[d] Weir was shut down early due to high cutthroat trout mortality.
[e] Weir was destroyed during high runoff.

FIGURES

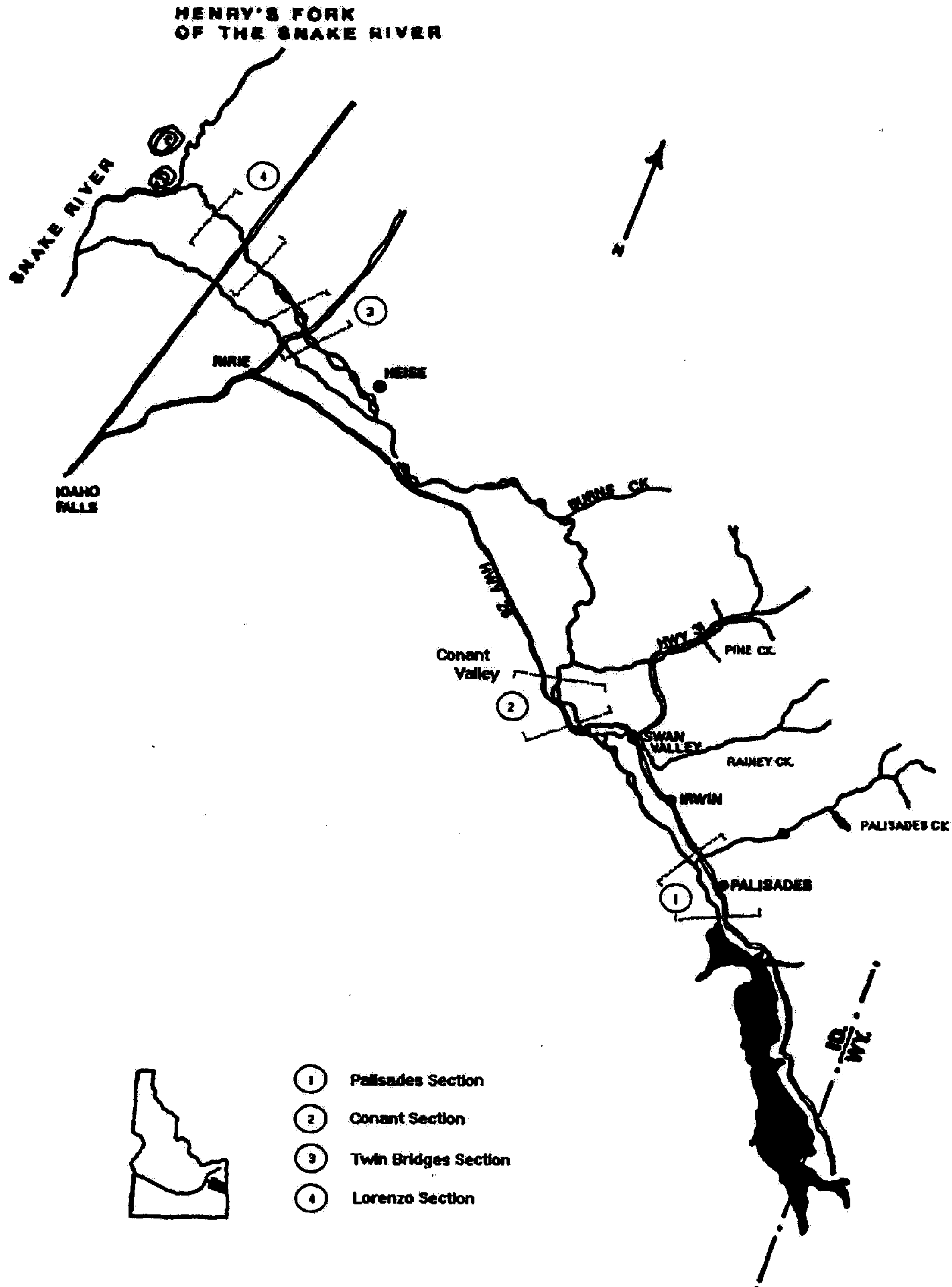


Figure 1. Map of South Fork Snake River, Idaho, showing standard electrofishing sections and the four major spawning tributaries.

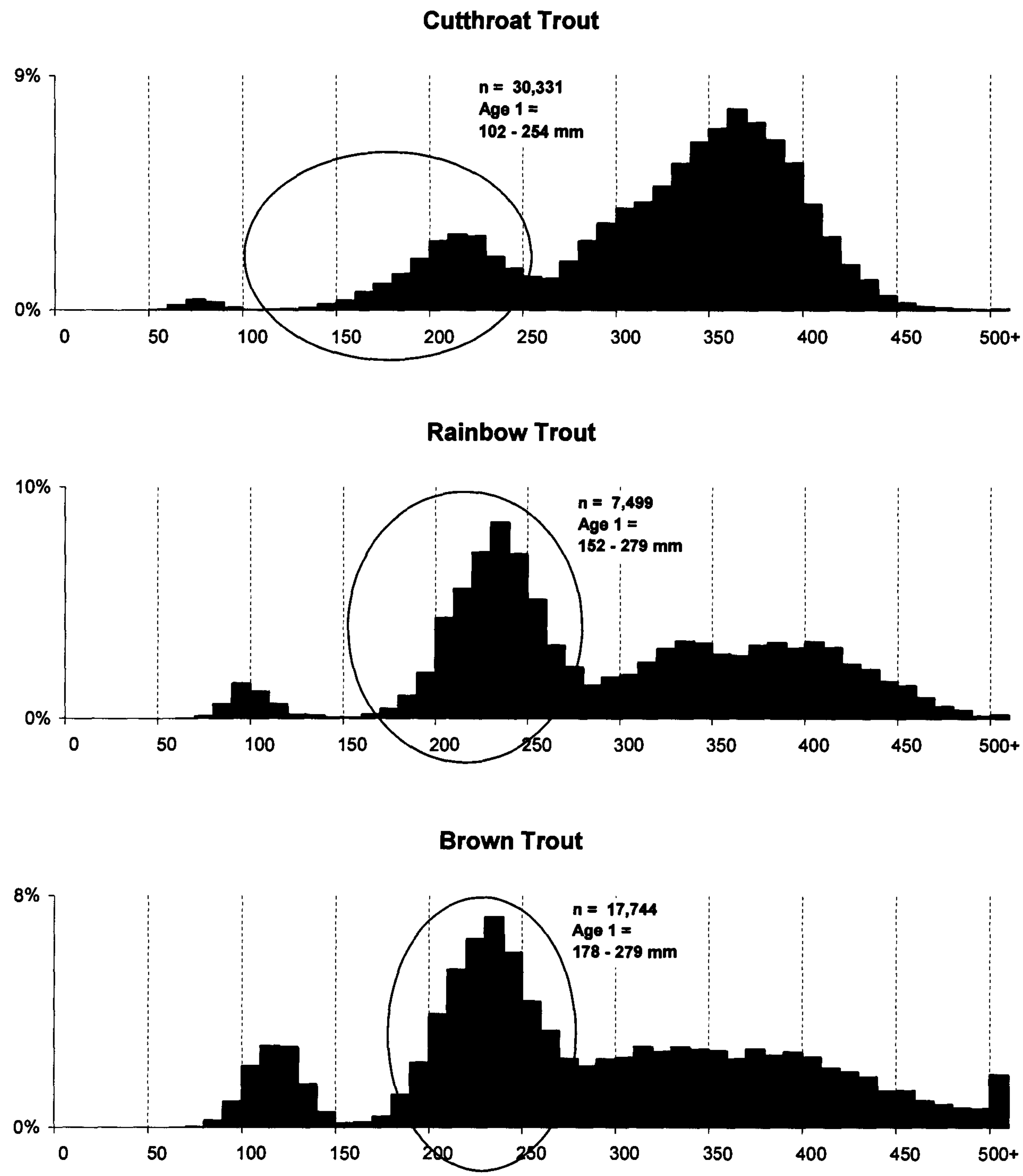


Figure 2. Overall length frequency distributions (TL, mm) of cutthroat (top), rainbow (middle), and brown trout (bottom) showing approximated age-1 fish, South Fork Snake River, Idaho, September-November 1986-2007. Fish from the Conant and Lorenzo electrofishing sections were combined. Total individual fish captured during electrofishing equals *n*.

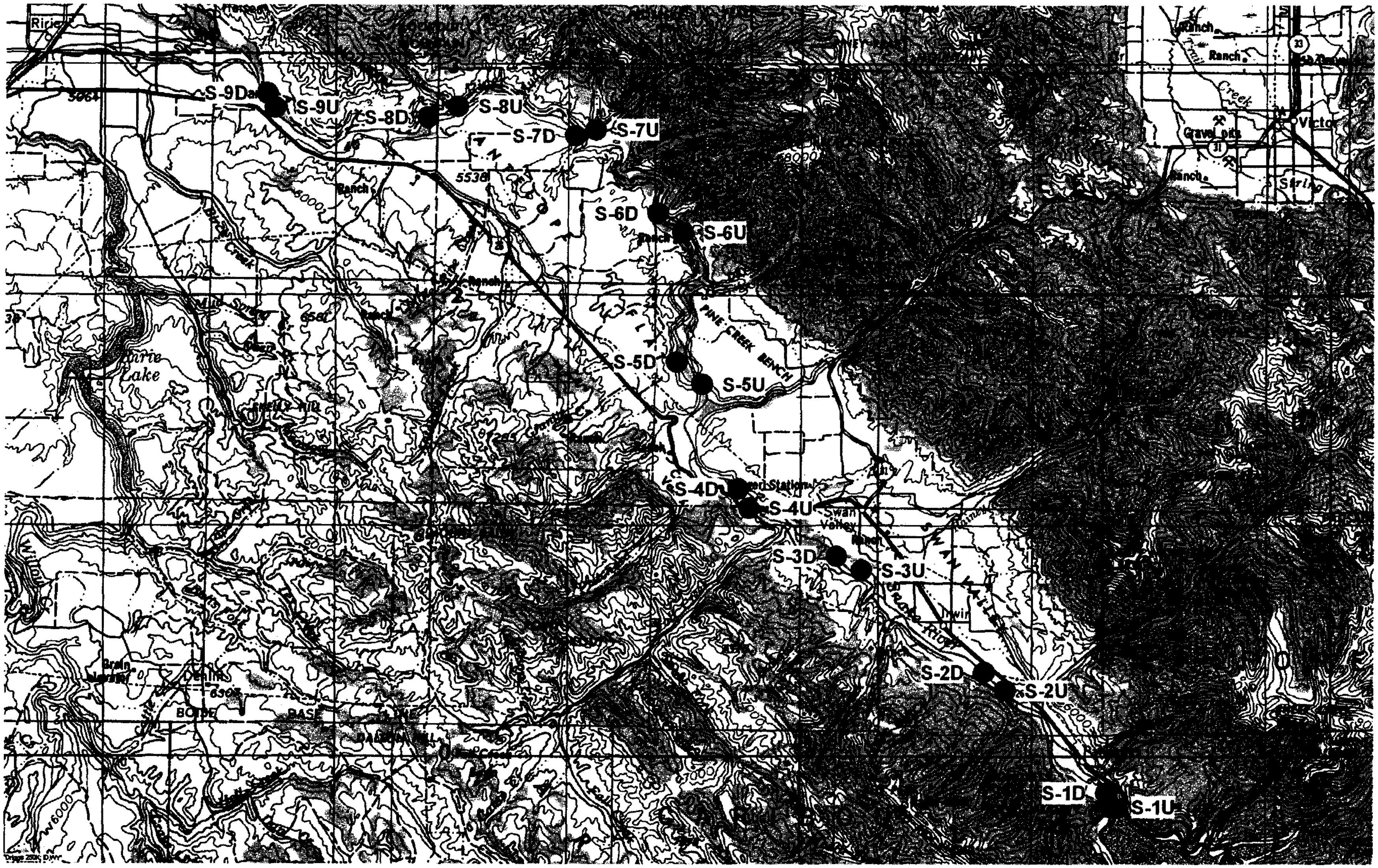


Figure 3. Location of the nine sites sampled for total stock abundance in the upper South Fork Snake River, Idaho, May 2-4, 2007. Sites were spaced at 8 km intervals beginning at Palisades Dam (S-1) and ending at the Heise cable (S-9). U = upstream starting point; D = downstream ending point.

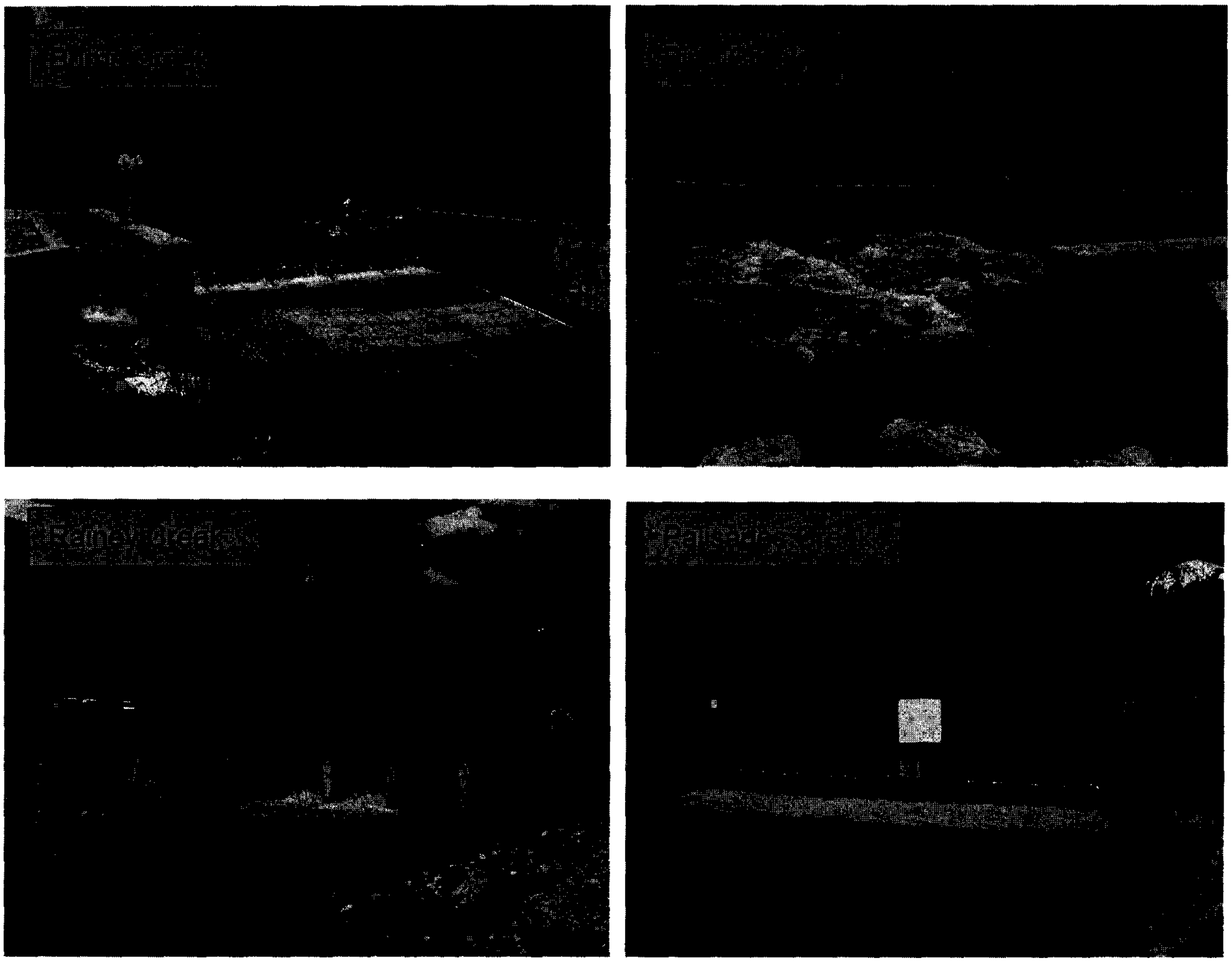
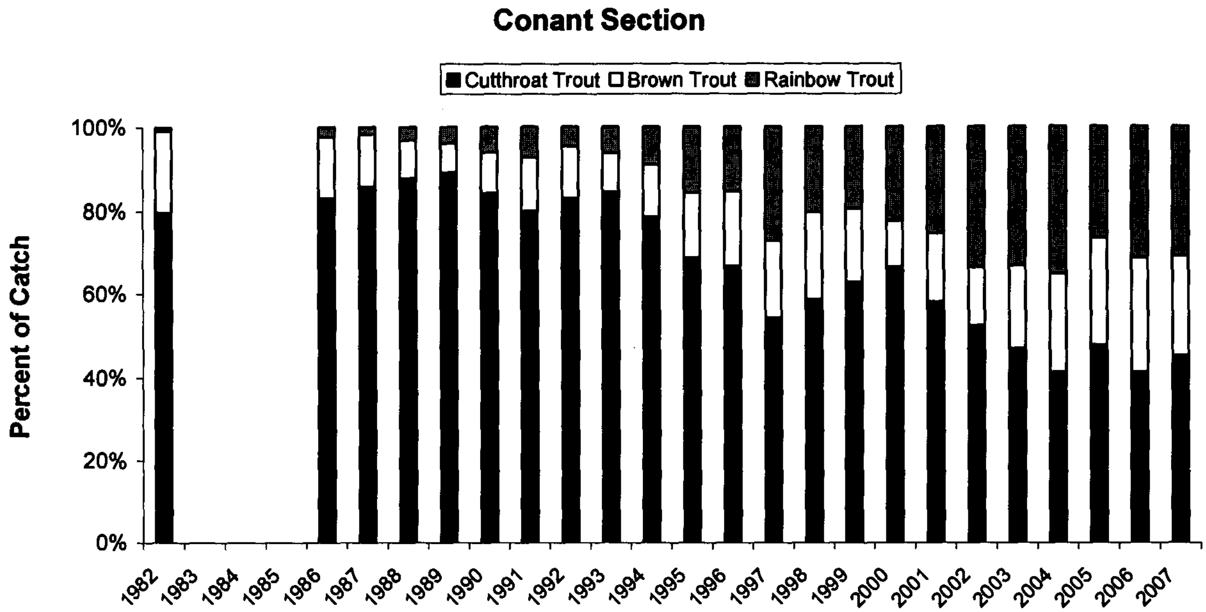


Figure 4. Photos of the four fish weirs in spawning tributaries of the South Fork Snake River, Idaho. Photos were taken in 2007 at Pine and Palisades creeks and in 2006 at Burns and Rainey creeks.



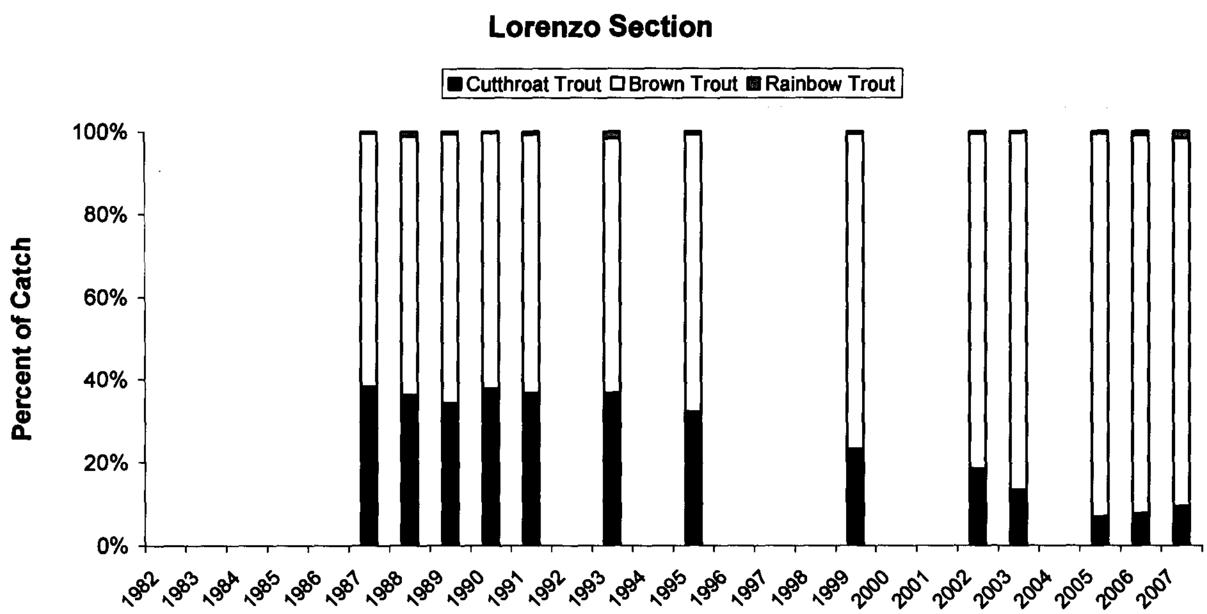


Figure 5. Relative abundance trends for all sizes of trout captured at the Conant (top) and Lorenzo (bottom) electrofishing sections, South Fork Snake River, Idaho, 1982 to 2007. Data for 1982 are from Moore and Schill (1984).

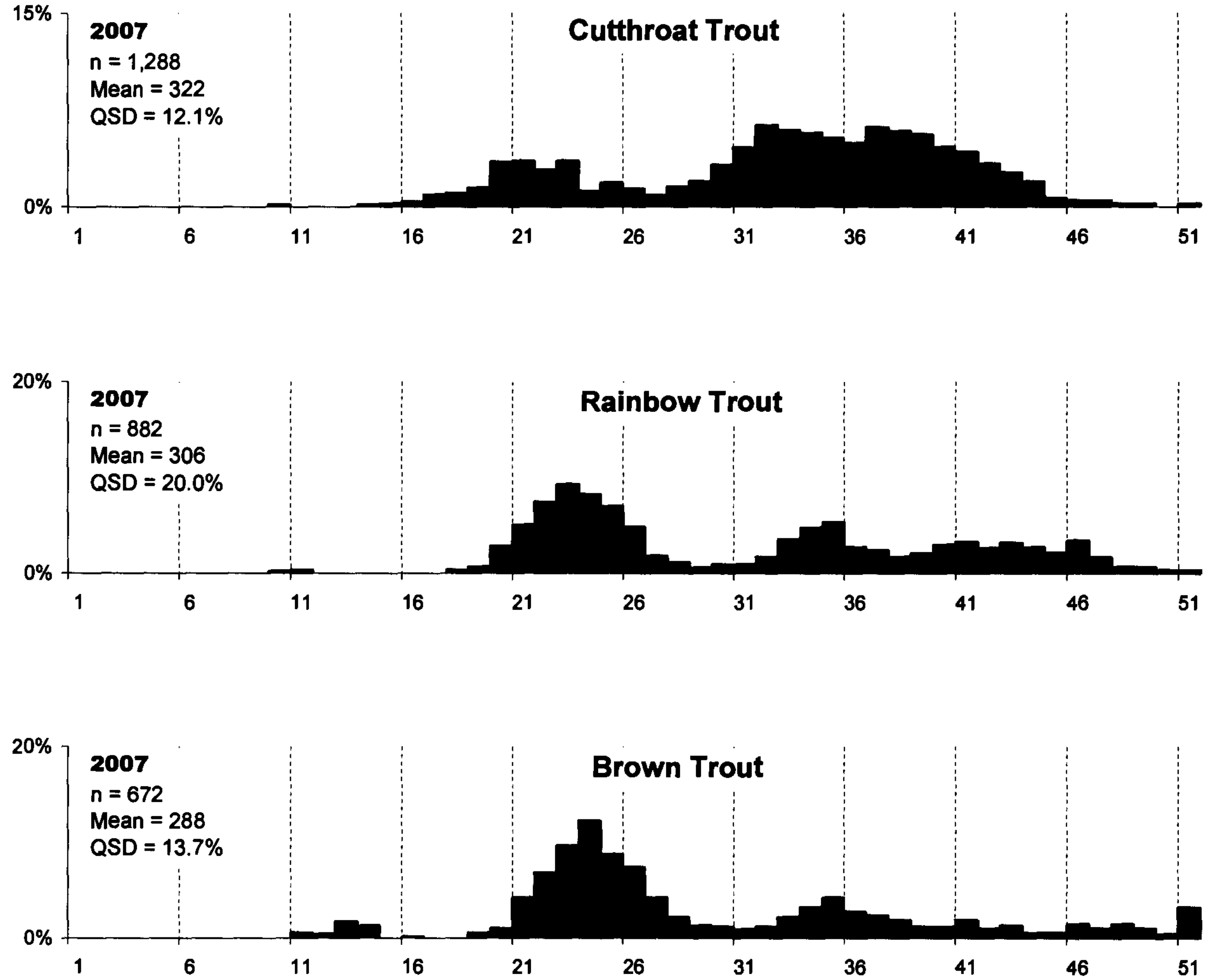


Figure 6. Length frequency distributions (TL, mm) of cutthroat (top), rainbow (middle), and brown trout (bottom) captured at the Conant electrofishing section, South Fork Snake River, Idaho, October 2007. Total individual fish captured during electrofishing equals *n*.

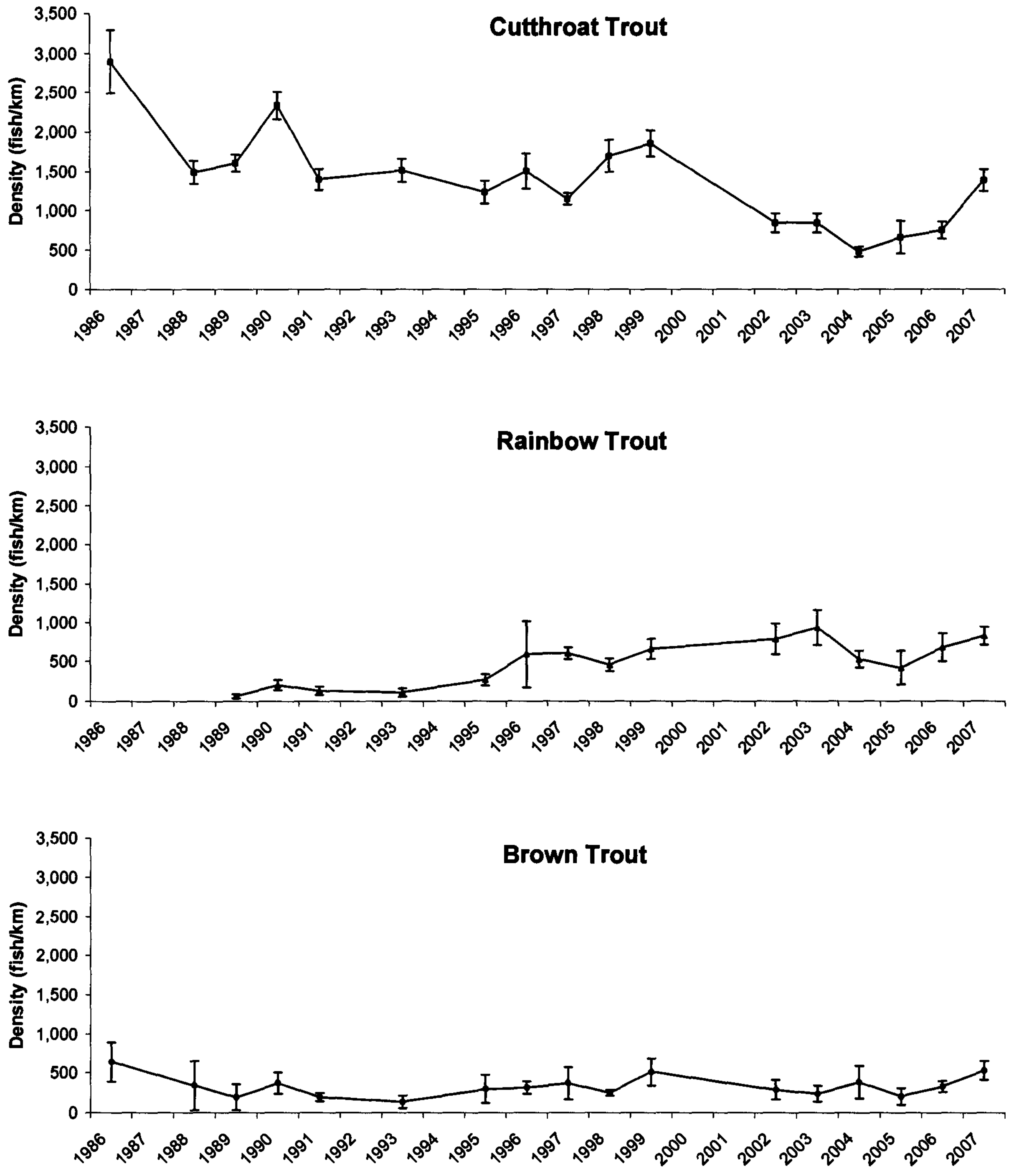


Figure 7. Density trends for age-1 and older cutthroat (≥102 mm, top), rainbow (≥152 mm, middle), and brown trout (≥178 mm, bottom) at the Conant electrofishing section, South Fork Snake River, Idaho, October-November 1986-2007. Confidence intervals are at 95%.

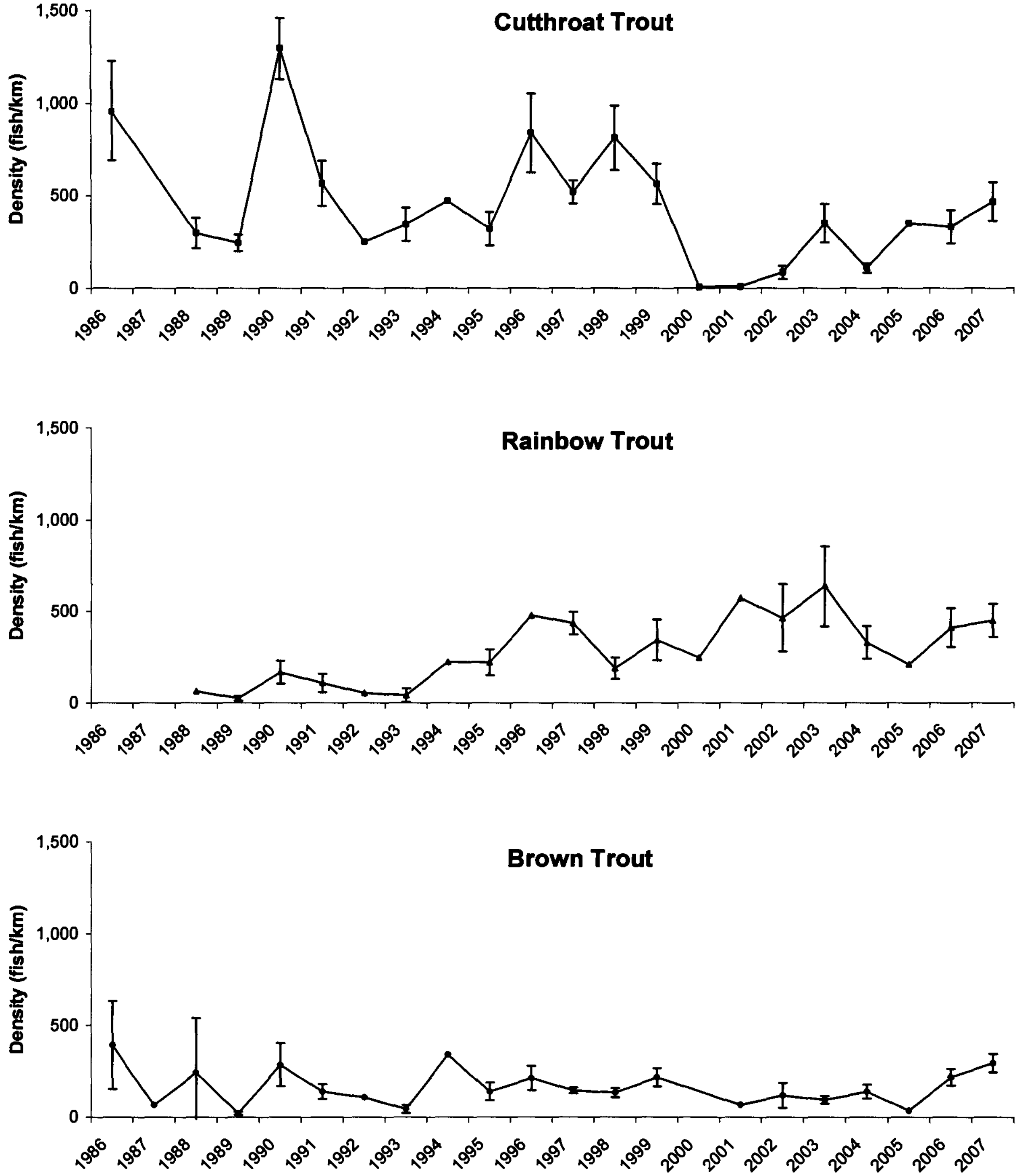
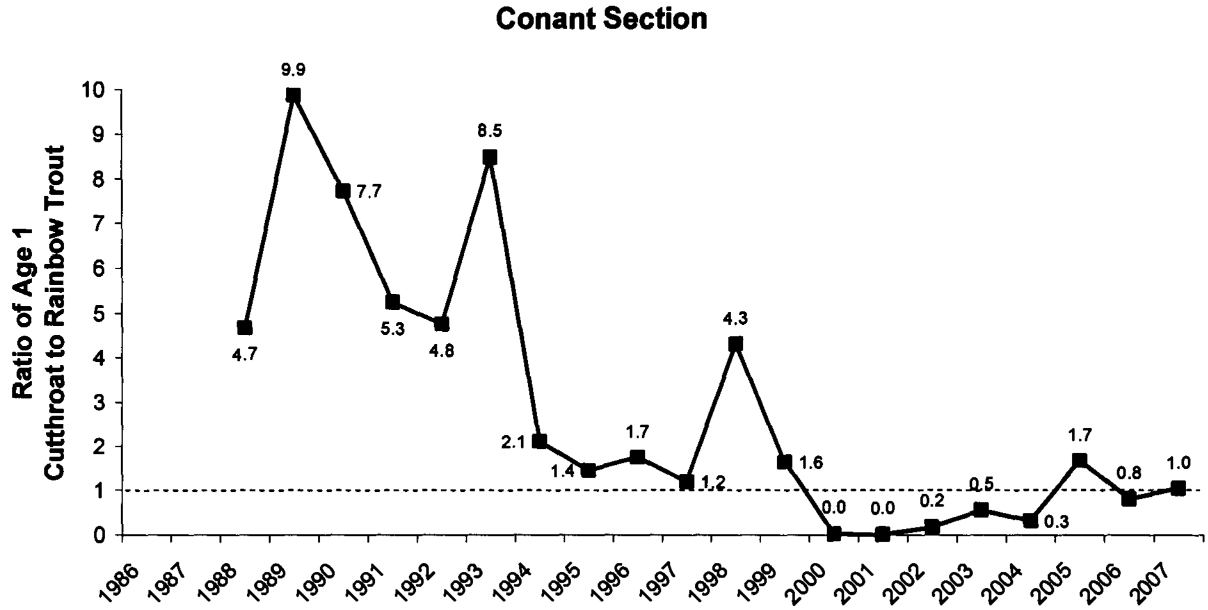


Figure 8. Density trends for age-1 cutthroat (102-254 mm, top), rainbow (152-279 mm, middle), and brown trout (178-279 mm, bottom) at the Conant electrofishing section, South Fork Snake River, Idaho, October-November 1986-2007. Points lacking 95% confidence intervals were estimated using cohort analysis (Moller and Van Kirk 2003).



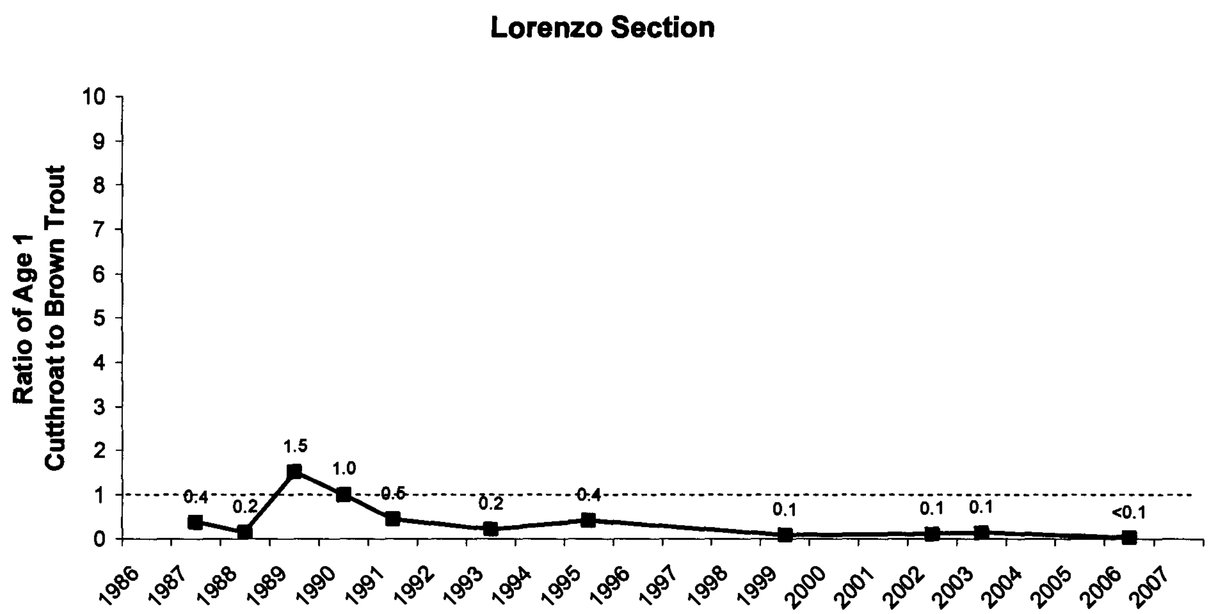


Figure 9. Trends in the ratio of age-1 cutthroat (102-254 mm) to rainbow trout (152-279 mm) at the Conant electrofishing section (top), and in the ratio of age-1 cutthroat to brown trout (178-279 mm) at the Lorenzo electrofishing section (bottom), South Fork Snake River, Idaho, September-November 1986-2007. Ratios are based on estimated densities. An estimate of age-1 cutthroat trout at Lorenzo in 2007 was not available. Dashed line indicates equal number of recruits with the management goal to be above the line.

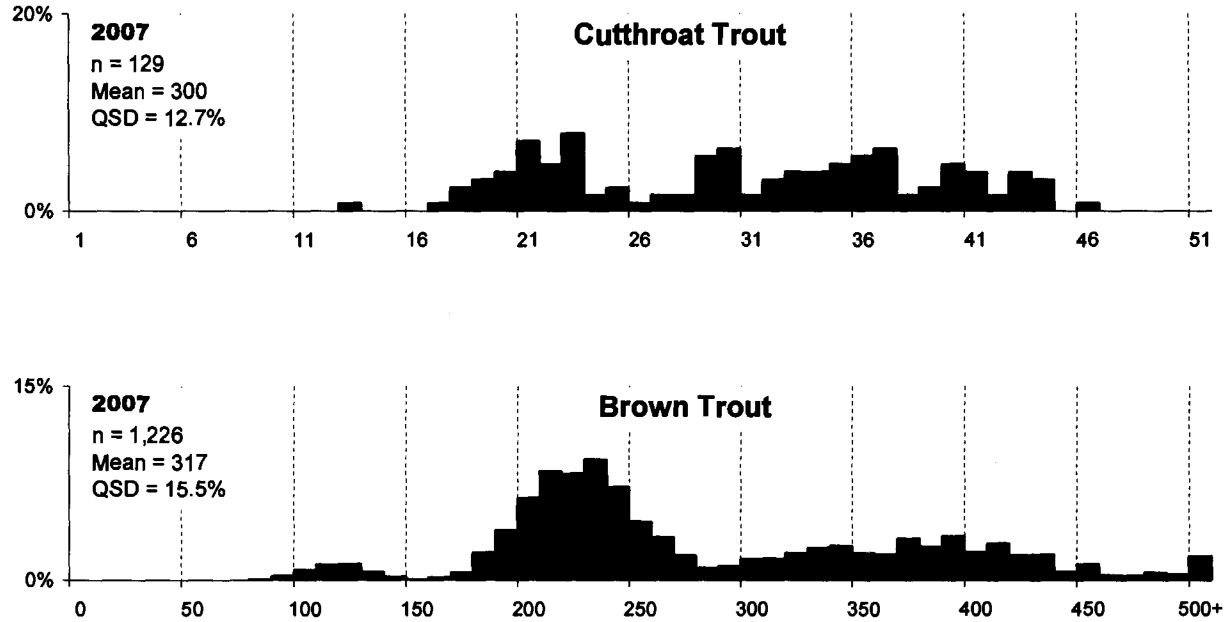


Figure 10. Length frequency distributions (TL, mm) of cutthroat (top) and brown trout (bottom) captured at the Lorenzo electrofishing section, South Fork Snake River, Idaho, September 2007. Total individual fish captured during electrofishing equals *n*.

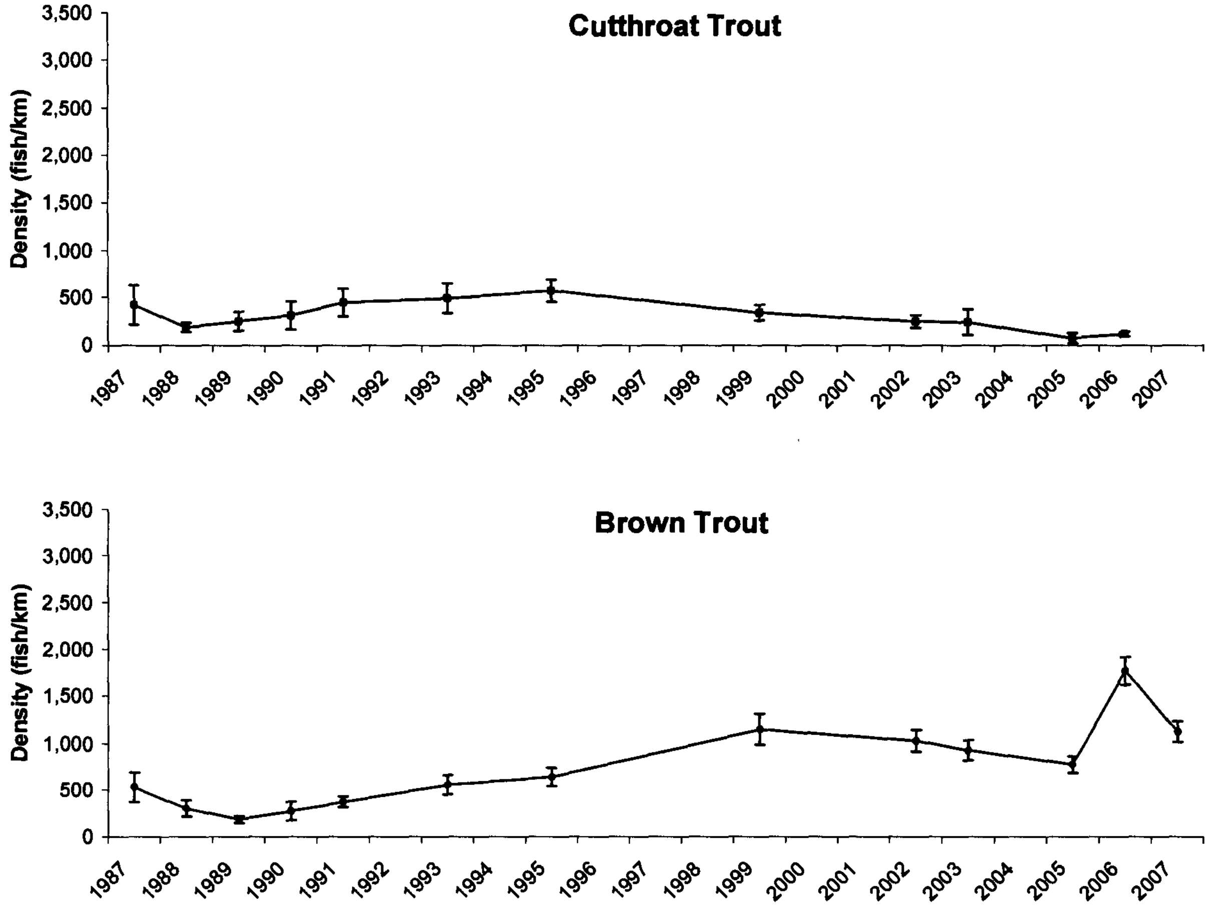
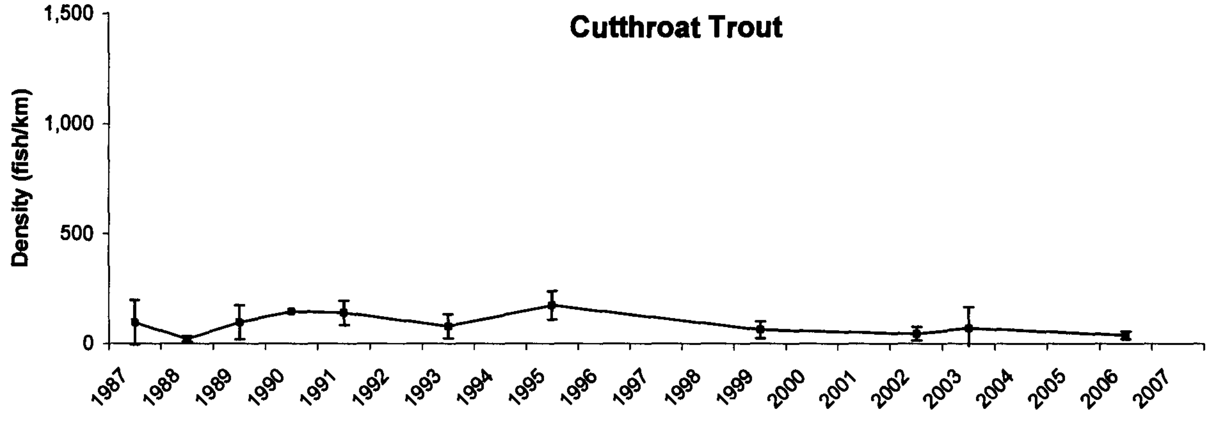


Figure 11. Density trends for age-1 and older cutthroat ≥102 mm, top) and brown trout (≥178 mm, bottom) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, September-October 1987-2007. Confidence intervals are at 95%. No estimate was available for cutthroat trout in 2007.



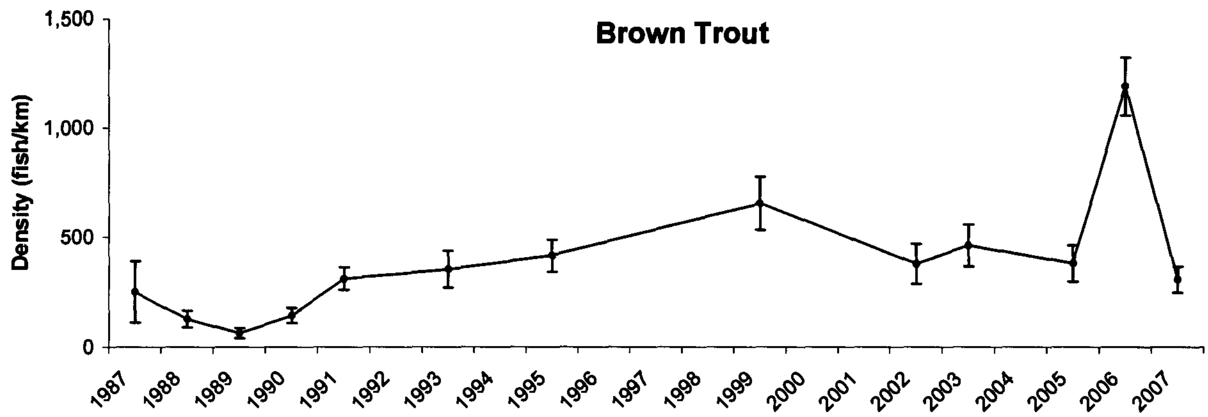
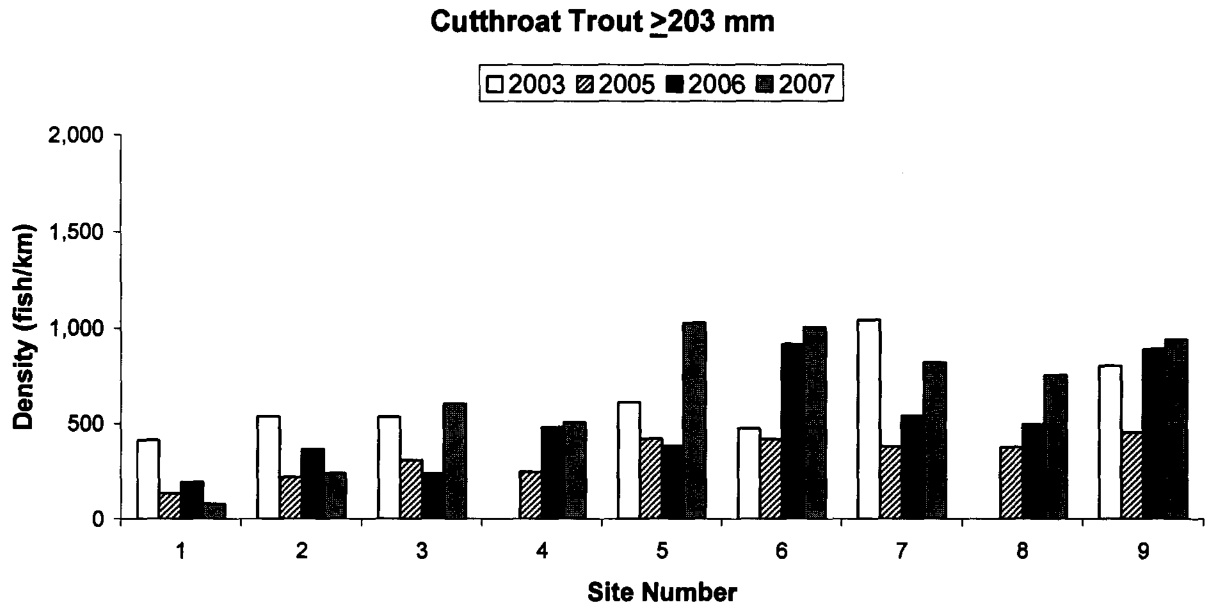


Figure 12. Density trends for age-1 cutthroat (102-254 mm, top) and brown trout (178-279 mm, bottom) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, September-October 1987-2007. Points lacking 95% confidence intervals were estimated using cohort analysis (Moller and Van Kirk 2003). An estimate for cutthroat trout in 2007 was not available.



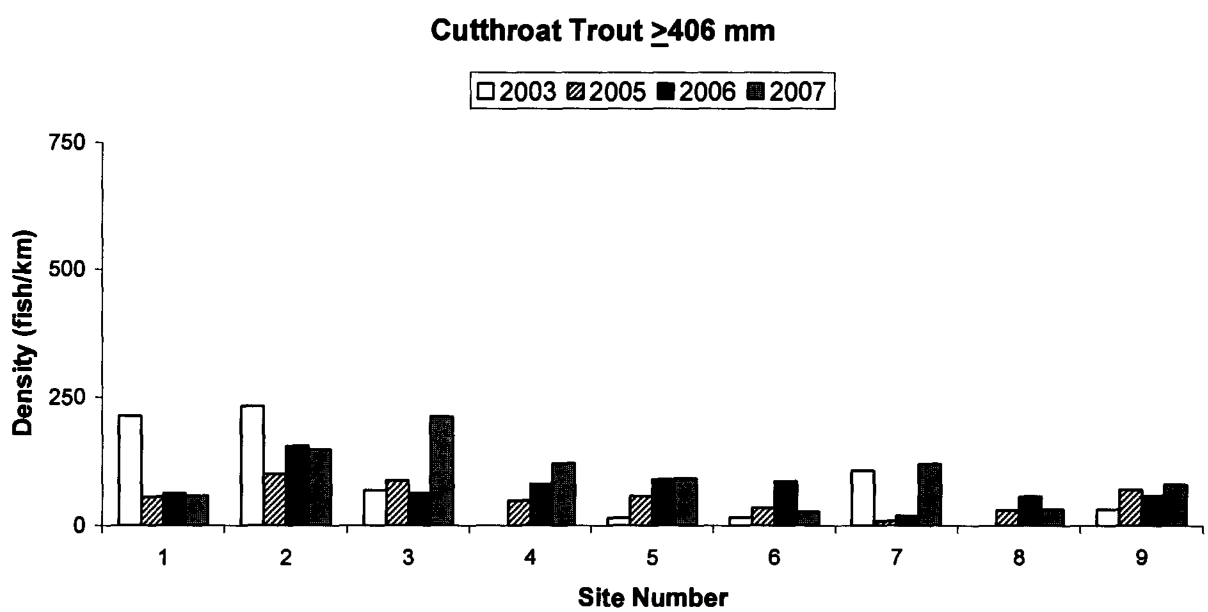
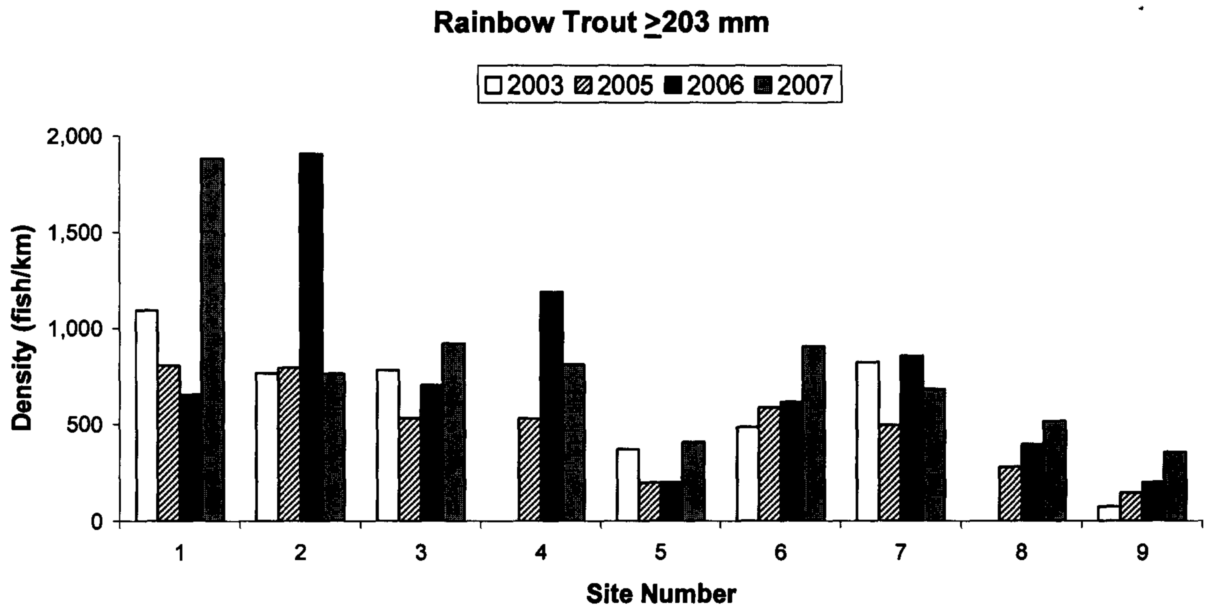


Figure 13. Estimated spring-time densities of cutthroat trout ≥203 mm (top) and ≥406 mm (bottom) in the upper South Fork Snake River, Idaho, 2003-2007. Estimates are from CPUE models for which confidence intervals are unavailable. Site 1 is at Palisades Dam, site 9 is near the Heise cable. Note difference in scale.



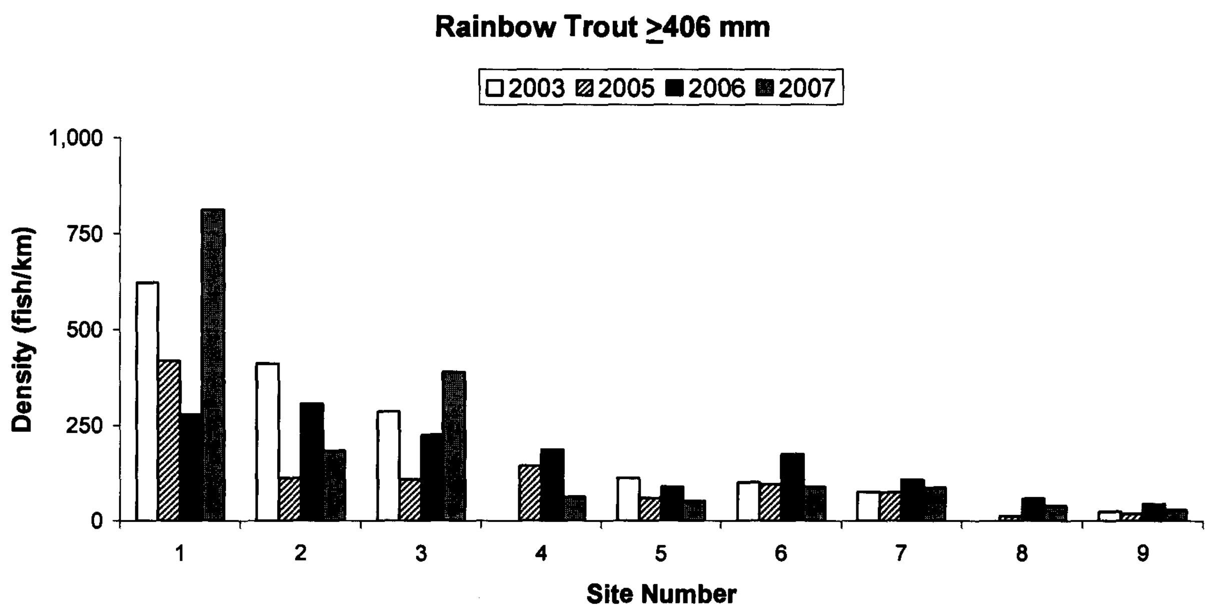
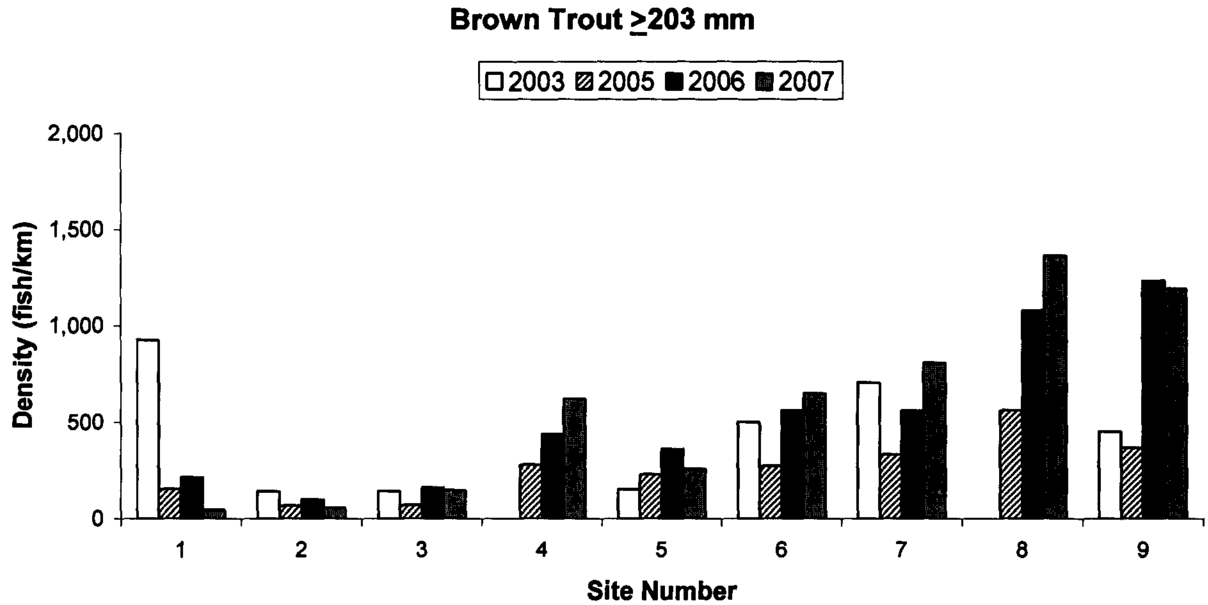


Figure 14. Estimated spring-time densities of rainbow trout ≥203 mm (top) and ≥406 mm (bottom) in the upper South Fork Snake River, Idaho, 2003-2007. Estimates are from CPUE models for which confidence intervals are unavailable. Site 1 is at Palisades Dam, site 9 is near the Heise cable. Note difference in scale.



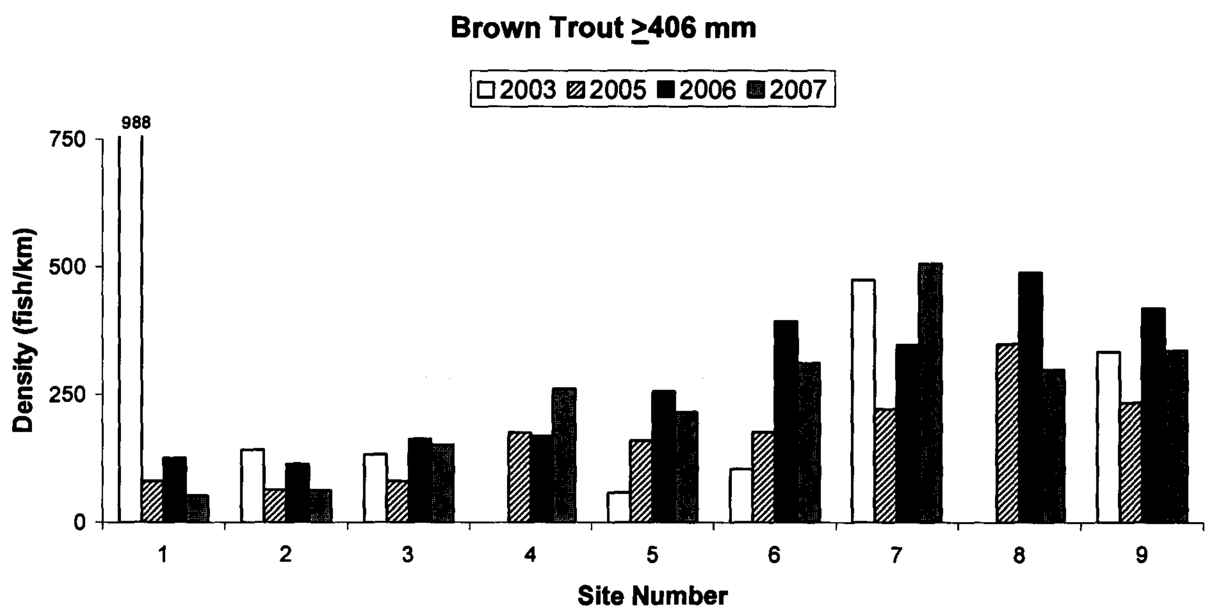


Figure 15. Estimated spring-time densities of brown trout ≥203 mm (top) and ≥406 mm (bottom) in the upper South Fork Snake River, Idaho, 2003-2007. Estimates are from CPUE models for which confidence intervals are unavailable. Site 1 is at Palisades Dam, site 9 is near the Heise cable. Note difference in scale.

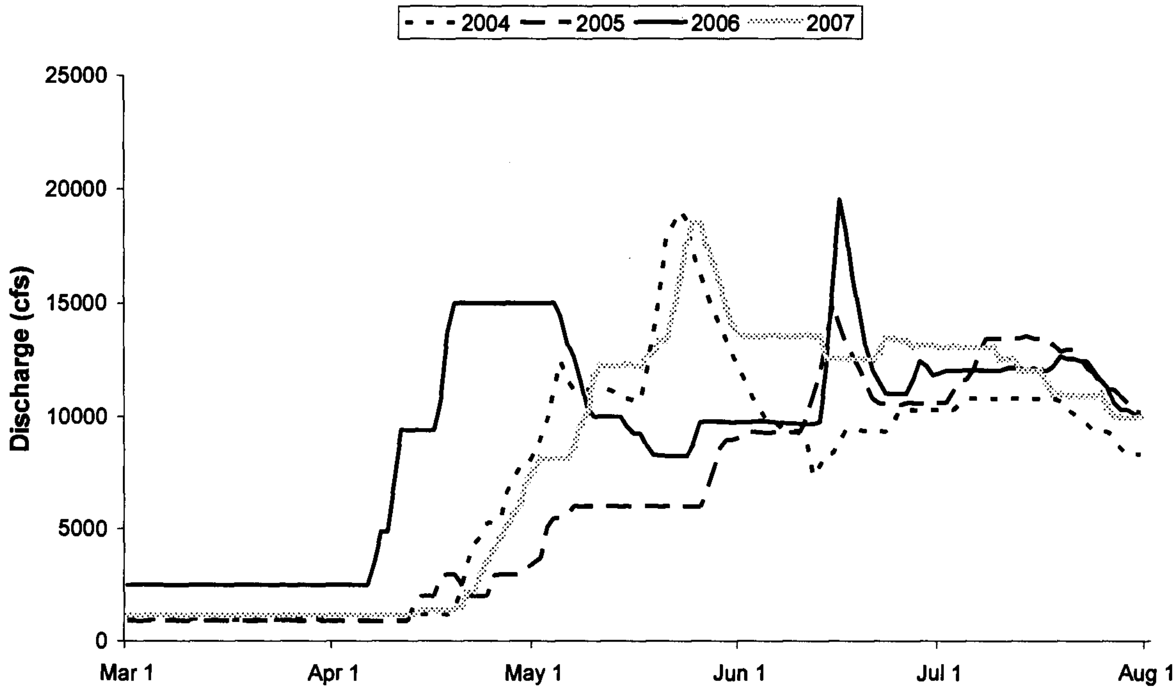


Figure 16. Hydrographs at the USGS Irwin gage depicting managed flow regimes in the South Fork Snake River, Idaho, 2004-2007.

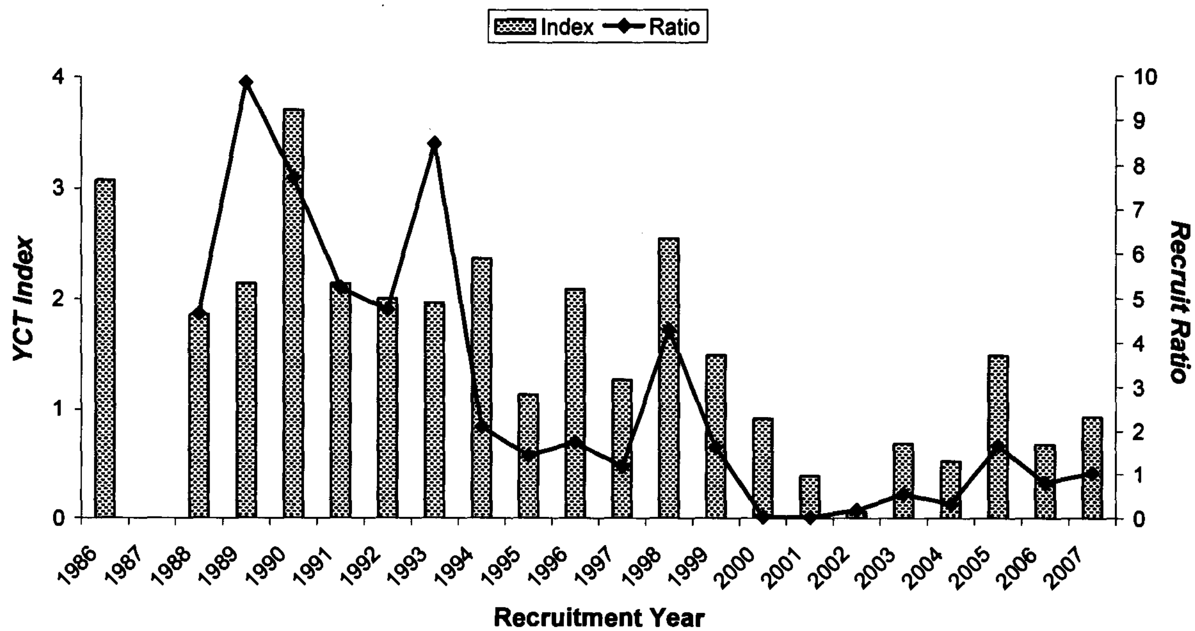


Figure 17. Values for the *YCT Index* calculated at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2007, except 1987 when recruitment data were unavailable. The *Recruit Ratio*, or the ratio of estimated age-1 cutthroat (102-254 mm) to rainbow trout (152-279 mm), is plotted for comparison.

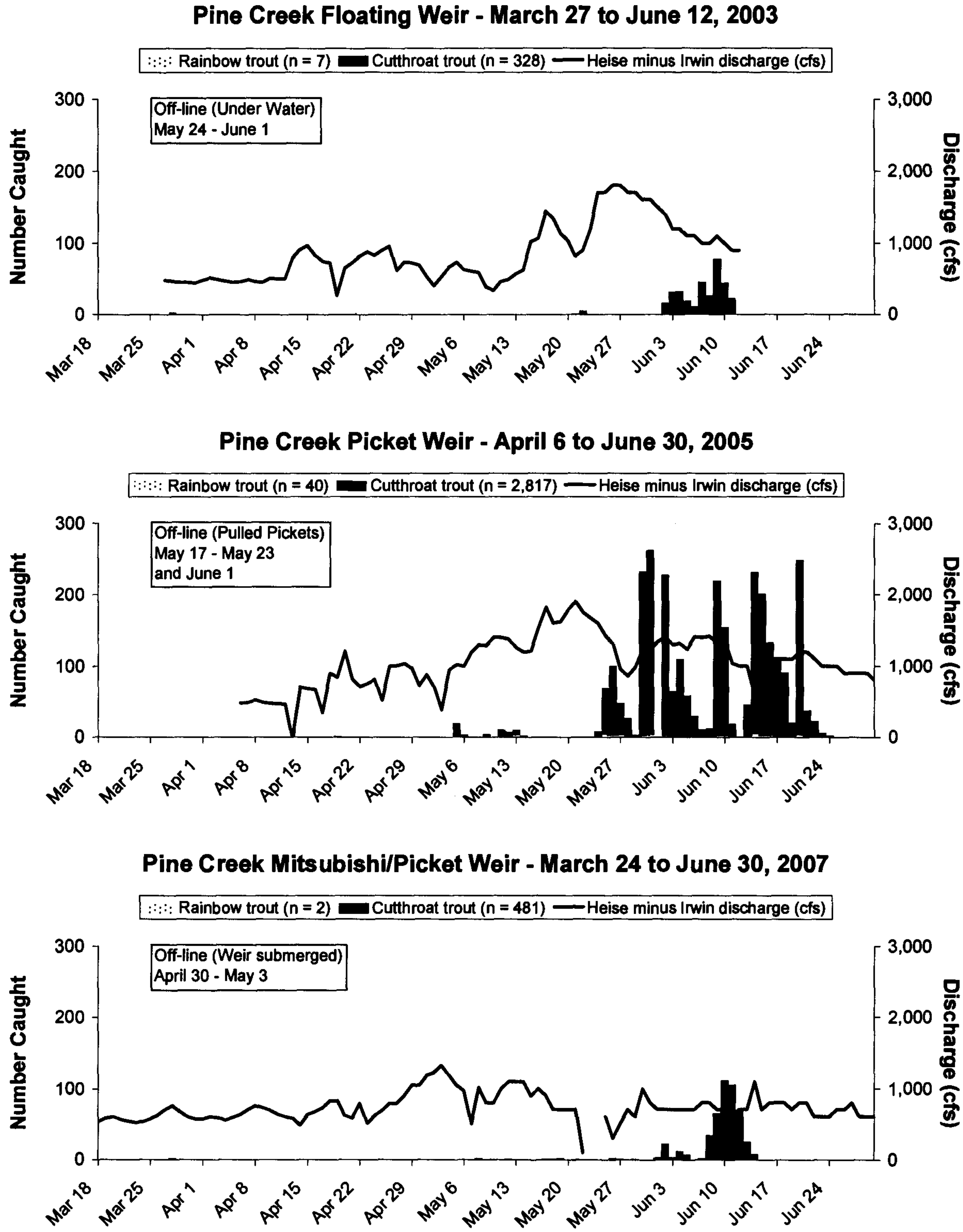


Figure 18. Number of fish caught, run timing, and approximated hydrograph at Pine Creek using the floating weir only (2003, top), hard picket weir only (2005, middle), and a combination Mitsubishi/hard picket weir (2007 bottom) South Fork Snake River, Idaho. Note bars are stacked and that the weir was not operated in 2006.

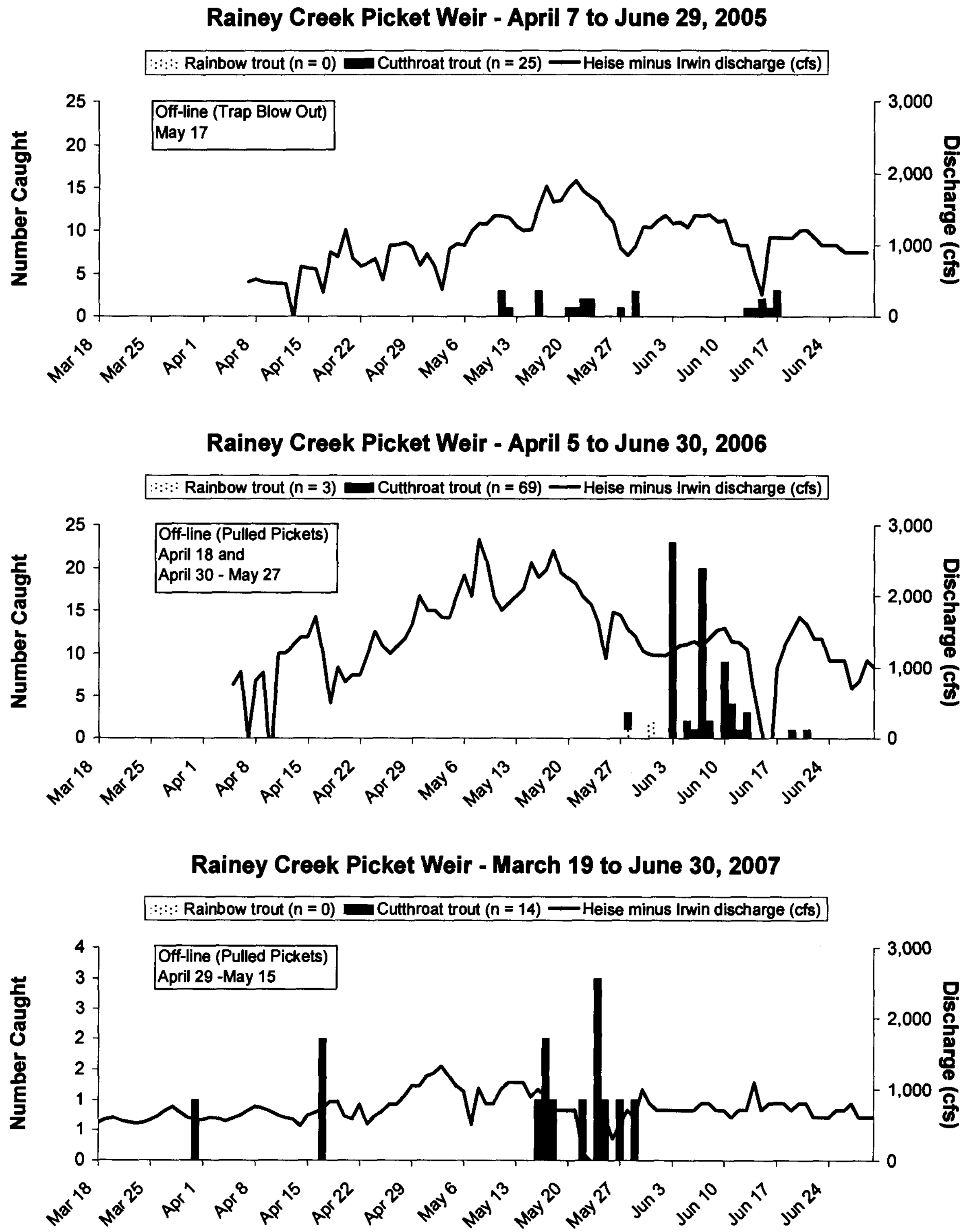


Figure 19. Number of fish caught, run timing, and approximated hydrograph at Rainey Creek using the hard picket weir (2005, top; 2006, middle; 2007, bottom), South Fork Snake River, Idaho. Note bars are stacked and that the weir was not operated in 2003 or 2004.

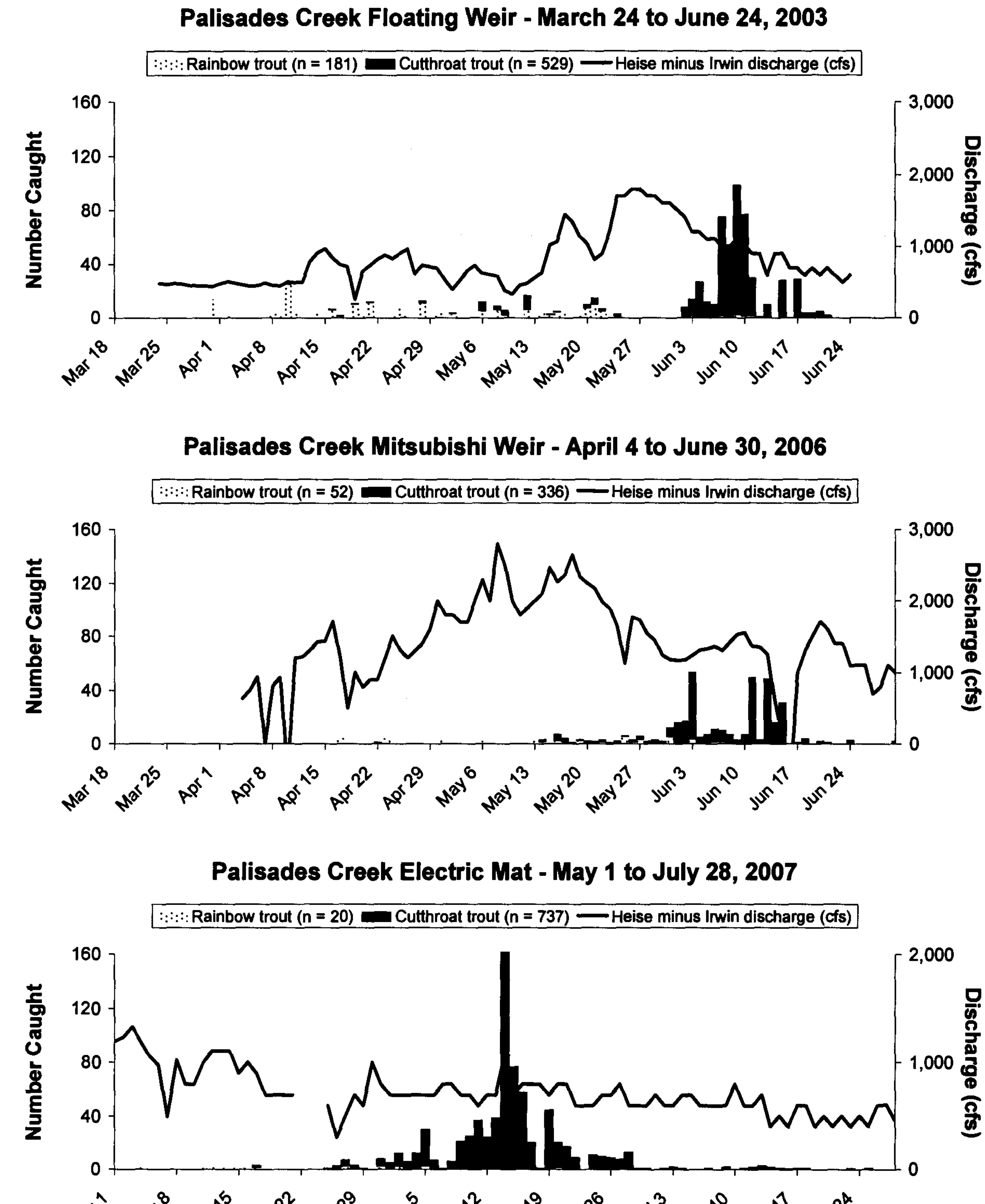


Figure 20. Number of fish caught, run timing, and approximated hydrograph at Palisades Creek using the floating weir (2003, top), Mitsubishi weir (2006, bottom), and electric mat (2007, bottom) South Fork Snake River, Idaho. Note bars are stacked and that the weir was not operated in 2004.

APPENDICES

Appendix A. Summary of South Fork Snake River, Idaho, fishing regulations 1970-2007.

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
2006-2008	Jan 1-Dec 31	Same	Same

Appendix B. Mark-recapture statistics for the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2007.

Appendix B-1. Sampling dates, flows, and catch rates at the Conant electrofishing section, South Fork Snake River, Idaho, 1986-2007. 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	90.7-128.0[e]	3,200-4,520[e]	105.7[e]	340
10/3,4,11,12 2006	88.4-89.0[e]	3,120-3,140[e]	88.6[e]	478
10/1,2,7,8 2007	86.4-163.7[e]	3,050-5,780[e]	166.2[e]	754

[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 B-2. Trout species composition and relative abundance (percent of catch) at the Conant electrofishing section, South Fork Snake River, Idaho, 1982 and 1986-2007. 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	ND[d]	0.9	ND	19.2	ND	0.9	0.0	100.0	ND
	(181)		(2)		(44)		(2)	(0)	(229)	
1986[c]	83.1	59.7	2.4	4.7	14.4	35.6	0.2	0.0	100.0	100.0
	(1,647)	(191)	(47)	(15)	(285)	(114)	(4)	(0)	(1,983)	(320)
1987[c,e,f]	85.9	87.6	1.7	2.1	12.4	10.3	0.0	0.0	100.0	100.0
	(299)	(85)	(6)	(2)	(43)	(10)	(0)	(0)	(348)	(97)
1988	87.8	54.2	3.2	9.0	8.9	36.8	0.1	0.0	100.0	100.0
	(1,570)	(115)	(58)	(19)	(159)	(78)	(1)	(0)	(1,788)	(212)
1989	89.2	66.5	4.0	14.9	6.8	18.5	0.0	0.0	100.0	100.0
	(2,291)	(165)	(103)	(37)	(175)	(46)	(0)	(0)	(2,569)	(248)
1990	84.3	71.7	6.1	12.2	9.5	16.0	0.1	0.0	100.0	100.0
	(2,978)	(849)	(216)	(145)	(335)	(190)	(4)	(0)	(3,533)	(1,184)
1991	80.1	51.2	7.3	18.4	12.6	30.4	0.0	0.0	100.0	100.0
	(1,646)	(290)	(150)	(104)	(259)	(172)	(0)	(0)	(2,055)	(566)
1992[e]	83.2	62.2	4.7	11.4	12.1	26.5	0.0	0.0	100.0	100.0
	(598)	(115)	(34)	(21)	(87)	(49)	(0)	(0)	(719)	(185)
1993	84.6	54.5	6.3	13.5	9.2	32.0	0.0	0.0	100.0	100.0
	(1,528)	(109)	(113)	(27)	(166)	(64)	(0)	(0)	(1,807)	(200)
1994[e]	78.5	70.4	9.1	12.4	12.3	17.2	0.0	0.1	100.0	100.0
	(867)	(357)	(100)	(63)	(136)	(87)	(0)	(1)	(1,104)	(507)
1995	68.6	31.4	15.7	36.5	15.8	32.1	0.0	0.0	100.0	100.0
	(1,121)	(150)	(256)	(174)	(258)	(153)	(0)	(0)	(1,635)	(477)
1996	66.4	49.9	15.3	23.5	18.1	26.6	0.1	0.1	100.0	100.0
	(1,190)	(371)	(274)	(175)	(325)	(198)	(1)	(1)	(1,791)	(744)
1997[g]	54.3	34.6	27.2	40.7	18.4	24.6	0.0	0.1	100.0	100.0
	(1,676)	(489)	(840)	(575)	(567)	(348)	(1)	(2)	(3,086)	(1,412)
1998	58.7	56.0	20.3	15.2	21.0	28.8	0.0	0.0	100.0	100.0
	(1,312)	(424)	(454)	(115)	(469)	(218)	(1)	(0)	(2,236)	(757)
1999	62.7	36.6	19.5	28.3	17.8	35.0	0.0	0.0	100.0	100.0
	(1,803)	(269)	(560)	(208)	(513)	(257)	(0)	(0)	(2,876)	(734)
2000[e]	66.4	42.8	22.5	38.1	11.1	19.1	0.0	0.0	100.0	100.0
	(800)	(110)	(271)	(98)	(134)	(49)	(0)	(0)	(1,205)	(257)
2001[e]	58.1	36.4	25.5	37.3	16.4	26.3	0.0	0.0	100.0	100.0
	(778)	(122)	(341)	(125)	(219)	(88)	(0)	(0)	(1,338)	(335)
2002	52.5	14.4	33.8	65.6	13.6	20.0	0.1	0.0	100.0	100.0
	(845)	(44)	(543)	(200)	(219)	(61)	(1)	(0)	(1,608)	(305)
2003	47.1	31.1	33.4	45.2	19.5	23.6	0.0	0.0	100.0	100.0
	(924)	(183)	(655)	(266)	(383)	(139)	(0)	(0)	(1,962)	(588)
2004	41.4	25.2	35.4	44.9	23.2	29.9	0.0	0.0	100.0	100.0
	(658)	(141)	(564)	(251)	(369)	(167)	(0)	(0)	(1,591)	(559)
2005	47.9	43.0	26.7	34.8	25.3	22.2	0.1	0.0	100.0	100.0
	(627)	(147)	(350)	(119)	(332)	(76)	(1)	(0)	(1,310)	(342)
2006	41.3	21.7	31.6	42.7	27.1	35.6	0.0	0.0	100.0	100.0
	(745)	(162)	(571)	(318)	(489)	(265)	(0)	(0)	(1,805)	(745)
2007	45.3	25.2	31.0	39.3	23.6	35.2	0.0	0.0	100.0	100.0
	(1,288)	(279)	(882)	(431)	(672)	(386)	(0)	(0)	(2,842)	(1,096)

[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 B-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, 1986-2007. 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
2006	745	329	17.6	571	274	15.4	489	266	17.4	1,805	295	16.8
2007	1,288	322	12.1	882	306	20.0	672	288	13.7	2,842	322	15.0

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

Appendix B-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, 1986-2007. Cases where $R \leq 3$ and unbiased density estimates are not possible (Ricker 1975) are in bold.

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
2006	423	365	54	14.8	289	251	23	9.2	215	223	31	13.9
2007	784	568	72	12.7	565	361	52	14.4	404	289	50	17.3

[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 B-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, 1986-2007. Confidence intervals at ±95% are in parentheses. Cases where *R*≤3 and unbiased estimates are not possible (Ricker 1975) are in bold.

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
2006	3,668 (512)	749 (104)	3,319 (871)	677 (178)	1,614 (343)	329 (70)	8,601	1,755
2007	6,762 (694)	1,380 (142)	4,041 (553)	825 (113)	2,595 (575)	530 (117)	13,398	2,734

[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 B-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, 1986-2007. Confidence intervals at ±95% are in parentheses. Cases where estimates are not possible are in bold.

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)	**NE**	**NE**	**NE**	2.4
1987[a,c,d]	**NE**	**NE**	**NE**	**NE**	322[e]	66[e]	**NE**	**NE**	**NE**	**NE**
1988	1,448 (412)	296 (84)	310[e]	63[e]	1,197 (1,441)	244 (294)	2,955[e]	603[e]	4.7[e]	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]	1,214[e]	248[e]	255[e]	52[e]	530[e]	108[e]	1,999[e]	408[e]	4.8[e]	2.3[e]
1993	1,680 (448)	343 (91)	198 (180)	40 (37)	214 (109)	44 (22)	2,092	427	8.5	7.9
1994[c]	2,311[e]	472[e]	1,096[e]	224[e]	1,680[e]	343[e]	5,087[e]	1,038[e]	2.1[e]	1.4[e]
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)	2,343[e]	478[e]	1,049 (325)	214 (66)	7,485[e]	1,528[e]	1.7[e]	3.9
1997[f]	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]	29[e]	6[e]	1,202[e]	245[e]	**NE**	**NE**	**NE**	**NE**	<0.1[e]	**NE**
2001[c]	43[e]	9[e]	2,796[e]	571[e]	322[e]	66[e]	3,161[e]	645[e]	<0.1[e]	0.1[e]
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[e]	347[e]	1,023[e]	209[e]	165[e]	34[e]	2,889[e]	590[e]	1.7[e]	10.3[e]
2006	1,607 (447)	328 (91)	2,013 (518)	411 (106)	1,072 (226)	219 (46)	4,692	958	0.8	1.5
2007	2,274 (513)	464 (105)	2,204 (442)	450 (90)	1,455 (246)	297 (50)	5,933	1,211	1.0	1.6

[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] Estimated using cohort analysis (Dr. Rob Van Kirk, Idaho State University, personal communication).
[f] Major habitat changes with spring, 1997, runoff.

Appendix C. Mark-recapture statistics for the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2007.

Appendix C-1. Sampling dates, flows, and catch rates at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2007. 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	67.7-87.0	2,390-3,070	78.0	310
9/19,21,27,28 2006	24.2-49.9[c]	855-1,760[c]	37.0[c]	601
9/17,18,24,25 2007	122.1-134.8[c]	4,310-4,760[c]	131.2[c]	362

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

Appendix C-2. Trout species composition and relative abundance (percent of catch) at the Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2007 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)
2006	7.7 (172)	4.1 (49)	0.9 (21)	0.7 (8)	91.4 (2,054)	95.2 (1,135)	0.0 (0)	0.0 (0)	100.0 (2,247)	100.0 (1,192)
2007	9.4 (129)	16.2 (45)	1.7 (23)	3.2 (9)	89.0 (1,226)	80.5 (223)	0.0 (0)	0.0 (0)	100.0 (1,378)	100.0 (277)

[a] Includes hatchery cutthroat trout.
[b] 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 Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2007 excluding years not sampled. Total individual fish captured during electrofishing equals *n*. QSD = (number ≥406 mm / number ≥203 mm) x 100.

	Cutthroat trout[a]			Rainbow trout			Brown trout			All trout[b]		
Year	*n*	Mean (mm)	QSD (%)	*n*	Mean (mm)	QSD (%)	*n*	Mean (mm)	QSD (%)	*n*	Mean (mm)	QSD (%)
1987	203	325	6.1	2	290	0.0	325	329	19.6	530	327	14.3
1988	210	332	9.9	6	311	0.0	363	309	22.0	579	317	17.2
1989	191	331	19.2	3	341	0.0	362	301	35.2	556	311	28.7
1990	288	297	9.9	2	512	100.0	471	257	23.2	761	273	17.4
1991	359	301	12.9	6	303	0.0	610	232	10.1	975	258	11.2
1993	342	325	5.3	15	294	15.4	572	261	13.1	929	285	9.9
1995	441	317	13.7	9	325	11.1	917	234	15.4	1,367	261	14.6
1999[c]	331	334	8.0	7	350	0.0	1,093	272	7.8	1,431	287	7.8
2002	232	316	2.3	6	340	16.7	1,026	321	14.4	1,264	321	12.1
2003	161	332	2.6	4	353	0.0	1,051	296	17.3	1,217	301	15.1
2005	81	333	10.7	7	294	0.0	1,080	285	18.1	1,168	288	17.3
2006	172	310	10.2	21	309	10.0	2,054	284	14.6	2,247	286	14.2
2007	129	300	12.7	23	296	0.0	1,226	317	15.5	1,355	316	15.3

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

Appendix 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 Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2007 excluding years not sampled. Cases where $R \leq 3$ and unbiased density estimates are not possible (Ricker 1975) are in bold.

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
2006	112	71	14	19.7	**10**	**12**	**1**	**8.3**	1,154	933	140	15.0
2007	**90**	**41**	**2**	**4.9**	**17**	**6**	**0**	**0.0**	764	446	67	15.0

[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 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 Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2007 excluding years not sampled. Confidence intervals at ±95% are in parentheses. Cases where *R*≤3 and unbiased estimates are not possible (Ricker 1975) are in bold.

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
2006	556 (122)	116 (25)	***NUE***	***NUE***	8,453 (708)	1,761 (148)	9,009	1,877
2007	***NUE***	***NUE***	***NUE***	***NUE***	5,401 (526)	1,125 (110)	5,401	1,125

[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 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 Lorenzo electrofishing section, South Fork Snake River, Idaho, 1987-2007 excluding years not sampled. Confidence intervals at ±95% are in parentheses. Cases where estimates are not possible are in bold.

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***
2006	179 (84)	37 (17)	***NE***	***NE***	5,716 (641)	1,191 (134)	5,895	1,228	***NE***	<0.1
2007	***NE***	***NE***	***NE***	***NE***	1,490 (280)	310 (58)	1,490	310	***NE***	***NE***

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

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