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STEELHEAD SUPPLEMENTATION IN IDAHO RIVERS

Project Progress Report

2003 Annual Report

By

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ABSTRACT

The Steelhead Supplementation Studies (SSS) has two broad objectives: 1) investigate the feasibility of supplementing depressed wild and natural steelhead *Oncorhynchus mykiss* populations using hatchery populations, and 2) monitor and collect life history information and genetic characteristics from wild and natural steelhead populations in the Salmon and Clearwater Basins.

Idaho Department of Fish and Game personnel have stocked adult steelhead from Sawtooth Fish Hatchery into Frenchman and Beaver creeks and estimated the number of age-1 parr produced from the outplants since 1993. On May 6, 2003, both Beaver and Frenchman creeks were stocked with hatchery adult steelhead. A SSS crew snorkeled the creeks in August 2003 to estimate the abundance of age-1 parr from brood year 2002. I estimated that the yield of age-1 parr per female stocked in 2002 was 30.5 and 2.1 in Beaver and Frenchman creeks, respectively.

An adult weir has been operated annually since 1992 in Fish Creek, a tributary of the Lochsa River. The weir remained intact throughout the 2003 spawning season. Trap tenders captured 340 adult steelhead, the most fish captured in the 12 years of monitoring escapements. A screw trap has been operated annually in Fish Creek since 1994 to estimate the number of emigrating parr and smolts. I estimated that 45,288 juvenile steelhead emigrated from Fish Creek in 2003, the highest estimate made to date.

SSS crews snorkeled three streams in the Selway River drainage and 12 streams in the Lochsa River drainage to estimate juvenile steelhead densities. The densities of age-1 steelhead parr increased in nearly all streams compared to the densities observed in 2002 and nearly doubled in West Fork Gedney, Boulder, Canyon, and Deadman creeks.

The SSS crews and other cooperators tagged more than 14,500 juvenile steelhead with passive integrated transponder tags (PIT) in 2003.

In 2003, technicians aged 356 adult steelhead from Fish Creek, 44 adult steelhead from Rapid River, and 1,922 juvenile steelhead collected from Colt Killed Creek, Crooked Fork Creek, Fish Creek, Marsh Creek, Pahsimeroi River, and the Salmon River.

Dr. Jennifer Nielsen at the U.S. Geological Survey Alaska Biological Science Center, Anchorage continued the microsatellite analysis of the steelhead tissue samples that were collected from Idaho streams in 2000. An interim report based on 31 wild populations and five hatchery stocks was completed in December 2003. Significant regional spatial structuring of populations was apparent among 10 different river drainages. Many *O. mykiss* populations were most closely related genetically to other *O. mykiss* from streams within the same drainage. Significant allelic frequency differences were found in 98.5% of all pairwise comparisons for the 36 *O. mykiss* populations. These data suggest that significant genetic population structure remains for steelhead populations within the Snake River.

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INTRODUCTION

The Steelhead Supplementation Study (SSS) was designed to assess the effects of supplementation and to gather life history and genetic data from wild steelhead *Oncorhynchus mykiss* populations. A detailed experimental design for this project was submitted to Bonneville Power Administration in 1992, and fieldwork began in 1993 (Byrne 1994). This report documents the work conducted from January 1, 2003 to December 31, 2003. Previous reports have summarized the work performed before January 1, 2003 (Byrne 1996; Byrne 1997; Byrne 1999; Byrne 2001a; Byrne 2001b; Byrne 2002; Byrne 2003). From January 1, 2003 to December 31, 2003, our effort focused on three objectives:

Objective 1: Assess the performance of hatchery and wild brood sources to reestablish steelhead *Oncorhynchus mykiss* in streams where extirpated.

The original plan was to assess the performance of hatchery stock and a wild stock with a paired watershed study in tributaries of the upper Salmon River (Byrne 1994). However, this approach was abandoned when wild steelhead abundance declined and Idaho Department of Fish and Game (IDFG) decided that "mining" a wild stock for this experiment was no longer appropriate. Wild steelhead were subsequently listed under the Endangered Species Act (ESA) in 1997. Since 1993, IDFG personnel have stocked adult hatchery steelhead in Beaver and Frenchman creeks and estimated the yield of age-1 parr from the outplants (Figure 1). In 2003, Sawtooth Fish Hatchery personnel stocked hatchery adult steelhead that returned to the Sawtooth Fish Hatchery in Beaver and Frenchman creeks. A SSS crew snorkeled the streams in August 2003 to estimate the juvenile production of the brood year 2002 adults.

Objective 2: Evaluate the ability of returning adults from hatchery smolt and fingerling releases to produce progeny in streams.

This objective was designed to assess which life stage of release (fish stocked as fingerlings or those stocked as smolts) would be best for supplementation by comparing the number of age-1 parr produced by the two groups of adults when they returned to spawn naturally. This experiment was implemented in the Red River drainage, a tributary of the South Fork (SF) Clearwater River, with the Dworshak hatchery stock (Figure 2). Fingerlings were stocked yearly in the SF Red River from 1993 to 1996, and smolts were stocked in Red River in the spring from 1996 to 1999 (Byrne 2001a). The last sizeable smolt migration resulting from these stockings likely occurred in 1999. Since most adults spend two years in the ocean, adult returns from the juvenile stockings were largely completed in 2002. IDFG has conducted yearly snorkel surveys to monitor the densities of juveniles produced by naturally spawning adults from the fingerling and smolt stocking programs. A SSS crew assessed the juvenile density with a snorkel survey of the streams in July 2003. The final evaluation of age-1 parr production from the adult returns will be done in 2004.

Objective 3: Assess the abundance, habitat, genetic, and life history characteristics of existing wild and natural steelhead populations in the Clearwater and Salmon River drainages.

SSS crews conducted snorkel surveys during the summer to assess juvenile steelhead abundance in tributaries of the Selway and Lochsa rivers, tagged wild steelhead throughout the Salmon and Clearwater river drainages with passive integrated transponder (PIT) tags, and recorded stream temperatures. SSS personnel operated a screw trap in Fish Creek and coordinated the PIT tagging of wild steelhead at other trapping sites throughout Idaho. The Fish Creek adult weir was operated from March 18 until September 6, 2003 to determine the escapement of wild steelhead and Chinook salmon *Oncorhynchus tshawytscha*.

Dr. Jennifer Nielsen at the Alaska Biological Science Center in Anchorage continued the genetic analysis of the wild and hatchery steelhead populations IDFG collected in 2000. An interim report based on the microsatellite analysis of five hatchery stocks and 31 wild populations was completed in December 2003.

METHODS

Objective 1

Collect and Outplant Adult Steelhead

Sawtooth Fish Hatchery personnel installed a temporary weir at the upstream and downstream boundary of a 1 km stream segment in Beaver and Frenchman creeks and stocked adults in these sections (Figure 1). The stocking location in both streams was the same stream segment used for this experiment since 1993. The outplanted hatchery adults were randomly sorted from fish that returned to the Sawtooth Fish Hatchery. I assumed that all females remained in the outplant section and spawned successfully. I used the mean eggs per female, calculated by dividing the total green egg take by the number of females spawned at Sawtooth Fish Hatchery, to estimate the number of eggs deposited in Beaver and Frenchman creeks.

Evaluation of Spawner Success

I used the mean age-1 juvenile steelhead density (fish/100 m^2) in Frenchman Creek and Beaver Creek as an index of reproductive success. I assumed that all age-1 steelhead in Beaver and Frenchman creeks were the progeny of the previous year's hatchery adult outplant. I estimated the age-1 population in each stream and the number of age-1 parr produced per female.

Systematic snorkel surveys were conducted to estimate the density of fish by species and size category in each study stream. Each snorkel site consisted of a single distinct habitat type (pool, pocket water, riffle, or run) and was chosen randomly throughout the stream. Crews snorkeled at least seven sites per kilometer of stream. The number of snorkel sites of each habitat type was allocated proportional to the type's abundance in the stream strata. One to five snorkelers counted fish in each site, depending on the stream size. Each snorkel site was separated by at least one distinct habitat type change from a prior site. Snorkelers estimated the size of all fish to the nearest inch except Chinook salmon *Oncorhynchus tshawytscha* parr, dace *Rhinichthys sp.*, and sculpin *Cottus sp*. After the crew snorkeled each site, they measured its length and three to six widths to calculate the surface area.

Chinook salmon parr were counted and classified as age-0 (<100 mm) or age-1 (≥100 mm). Steelhead parr were classified as age-1, length 3 in to 5 in (76 mm to 127 mm) and age-2+, length >5 in (127 mm). Because steelhead fry (age-0, <75 mm) are indistinguishable from westslope cutthroat trout *O. clarki* fry, snorkelers classified both as trout fry. I did not partition westslope cutthroat trout, bull trout *Salvelinus confluentus*, brook trout *S. fontinalis*, or mountain whitefish *Prosopium williamsoni* into age classes. Mean densities (fish/100 m^2) by habitat type in each stream strata were calculated for trout fry, the two age classes of steelhead and Chinook salmon, resident trout, and mountain whitefish.

I calculated the mean stream density (m_t) for each species as:

$$m_t = \sum p_i \overline{d_{it}}$$

where p_i = proportion of habitat i in the stream,
$\overline{d_{it}}$ = mean age t parr density (fish/100 m^2) in habitat i,
t = fish species (and age class, if steelhead or Chinook), and
i = pool, riffle, run, pocket water.

I estimated the age-1 steelhead population (N) and confidence intervals in Beaver and Frenchman creeks using the stratified sampling estimates of Scheaffer et al. (1986):

$$N = \sum A_i \overline{d_{i1}}$$

where N = population total,
A_i = total surface area (m^2) of habitat i,
$\overline{d_{i1}}$ = mean age-1 parr density (fish/m^2) of habitat i, and
i = pool, riffle, run, pocket water.

An approximate 95% confidence interval (CI) on the age-1 steelhead population estimate was calculated as:

$$CI = 2\sqrt{\sum A_i^2 \left(\frac{A_i - a_i}{A_i}\right)\left(\frac{s_i^2}{x_i}\right)}$$

where A_i = total surface area of habitat i,
s_i^2 = the sample variance of the mean age-1 parr density (fish/m^2) in habitat i,
a_i = total surface area that was snorkeled in habitat i,
x_i = number of habitat i sites snorkeled, and
i = pool, run, pocket water, or riffle habitat.

I treated A_i and a_i as constants when calculating the confidence interval and assumed that the variance was due to differences of densities in each snorkel site, not area measurements. This assumption implies that all area measurements were obtained without error. The total surface area (A_i) of each habitat type in the stream was calculated as:

$$A_i = l p_i w_i$$

where l = length of the study section (m) in each stream,
p_i = proportion of habitat i in the study section, and
w_i = mean width of habitat i.

Objective 2

Fingerling and Smolt Stocking Prior to 2003

Personnel from IDFG stocked Dworshak Hatchery fingerlings in the SF Red River yearly from 1993 to 1996 and Dworshak Hatchery smolts in Red River yearly from 1996 to 1999 (Figure 2). Fingerlings were marked with a coded-wire tag (CWT, 90% of total) or a PIT tag (10% of total). Half of the 1996 smolt release was marked with a PIT tag and the other half was marked with a CWT. All smolts that were released from 1997 to 1999 were PIT tagged (Byrne 2001a).

Estimate Adult Returns from Hatchery Stockings

In 2003 it was likely that any adults returning to Red River or the SF Red River would be from the 1999 smolt stocking returning as 3-ocean fish and possibly the 1996 fingerling stocking. Any returning adults from our stocking programs would be marked with a PIT tag or a CWT. There were no adult PIT tag detections at the Columbia River and Snake River dams from the 1999 smolt stocking. Since 1994, only one PIT-tagged adult was detected from the fingerling stockings at the dams, and none were captured at the Red River. Because no adult returns were expected from the smolt stocking and the chance of an adult returning from a fingerling stocking was low, IDFG did not operate the Red River weir during the spring 2003.

Estimate Juvenile Production from Naturally Spawning Adult Returns

Crews snorkeled the SF Red River from its mouth upstream to the West Fork (WF) SF Red River in 2003 to assess juvenile steelhead densities, using the procedures outlined in the Methods section for Objective 1. Juvenile steelhead densities in Red River upstream of the SF Red River to Shissler Creek were obtained from six stream transects snorkeled yearly by IDFG Clearwater Region crews. There may be several habitat types within each Red River snorkel transect. The Red River juvenile steelhead densities were calculated as the average density of the snorkel transects. The stream sections the crews snorkeled were the same sections where the fingerlings and smolts were stocked (Figure 2).

Objective 3

Estimate Steelhead Escapement in Fish Creek

A SSS crew worked from March 8 to 12 to install a temporary weir in Fish Creek. Operations to enumerate and sample adult steelhead and pass them upstream of the weir began on March 18, 2002 (Figure 3). Adult steelhead trapped at the weir entered a holding box that was checked throughout the day. When adults were present, the trap tender removed them with a net and placed them in a 100-gallon plastic water trough. The trap tender determined the sex of each adult fish based on external characteristics, measured fork length to the nearest cm, scanned for the presence of a PIT tag, collected scales, snipped a small portion of the anal fin for future DNA analysis, and used a paper punch to mark the right opercule before releasing the fish upstream of the weir. Steelhead kelts were collected at the weir and checked for a right opercule punch, sexed, scanned for PIT tag, and measured for length. If the kelt was alive, the trap tender punched the left opercule and passed it downstream of the weir. I estimated the adult steelhead escapement using two methods: (1) summing the number of adults trapped in the upstream live box and the number of unmarked kelts recovered, and (2) a maximum likelihood estimate using the number of marked adults passed upstream of the weir, the total number of kelts recovered, and the number of marked kelts recovered (Steinhorst et al., in press).

PIT-tagged Adult Steelhead Returns

I queried the PTAGIS database on March 1, 2003 and May 30, 2003 to obtain the date adult steelhead that were PIT tagged in Fish Creek as juveniles were detected at Bonneville, McNary, and Lower Granite dams. I restricted the query to adults that were detected at the three dams between July 1, 2002 and May 30, 2003. These fish were expected to return to Fish Creek and spawn during spring 2003.

Estimate Chinook Salmon Escapement in Fish Creek

The weir used to trap adult steelhead was left in the stream until September 6, 2003 to capture adult Chinook salmon that returned to Fish Creek. Hatchery origin Chinook salmon were not passed upstream of the weir. The Chinook salmon escapement was made by counting the number of naturally produced adults that were trapped and passed upstream of the weir. The trap tender determined the sex of each naturally produced Chinook salmon based on external characteristics, measured fork length to the nearest cm, scanned for the presence of a PIT tag, collected scales, snipped a small portion of the anal fin for future DNA analysis, and used a paper punch to mark the right opercule before releasing the fish upstream of the weir. The trap tenders walked Hungery Creek from Doubt Creek to its mouth and Fish Creek downstream of Hungery Creek several times from September 20, 2003 to October 6, 2003 to locate and count Chinook salmon redds (Figure 3).

Estimate Wild Juvenile Steelhead Densities

The SSS crews use the same snorkel methods described for Objective 1 to estimate juvenile fish densities in wild production streams. During the summer of 2003, SSS crews snorkeled Basin Creek in the Salmon River drainage; Gedney, WF Gedney, and O'Hara creeks in the Selway River drainage; and Canyon, Crooked Fork, Deadman, Fish, Hungery, Bald Mountain, Boulder, Stanley, Holly, Weir, Post Office, and Lake creeks in the Lochsa River drainage (Figure 4). The boundaries of the stream sections SSS crews snorkeled are provided in Appendix 1.

PIT Tag Juvenile Steelhead from Wild Populations

This project operated a screw trap in Fish Creek and coordinated steelhead tagging at screw traps used in the Idaho Supplementation Study (ISS). In addition to Fish Creek, steelhead were tagged at eight screw traps operated by IDFG in Crooked Fork Creek, Colt Killed Creek, Red River, South Fork Salmon River at Knox Bridge, Pahsimeroi River, Lemhi River 0.2 km downstream of Hayden Creek, Marsh Creek, and the Salmon River at Sawtooth Fish Hatchery; three traps operated by the Nez Perce Tribe in the South Fork Salmon River drainage in Lake

Creek, Secesh River, and Johnson Creek; and one trap operated by the U.S. Fish and Wildlife Service in Clear Creek (Figure 5). The screw trap in Clear Creek was fished from March 10 to June 11, 2003. At most other sites, the screw traps were fished continuously from early March until ice-up in November, river conditions permitting (Appendix 2). The traps were checked daily, and the number of steelhead captured and tagged was recorded. Each fish was scanned before tagging to verify that it had not been tagged previously. All steelhead >80 mm were PIT tagged, measured (fork length) to the nearest mm, and weighed to the nearest 0.1 g.

In addition to the screw traps, SSS crews PIT tagged wild steelhead that were collected flyfishing in Fish Creek on June 27, July 13, and July 14; Gedney Creek on July 28; Lick Creek from August 12 to August 21, and Boulder Creek on August 31 and September 1. I combined all fishing occasions in each stream for the data analysis. Crews from NOAA Fisheries, Pasco, Washington (supervised by Steve Achord) tagged juvenile steelhead they collected during their summer sampling of Chinook salmon parr in Big Creek, Camas Creek, Chamberlain Creek, Herd Creek, Loon Creek, Marsh Creek, Rush Creek, and Valley Creek from July 31 to August 22, 2003 (Figure 5).

I calculated the mean length, weight, and condition factor of steelhead at each screw trap site for the spring (start of trapping to May 31), summer (June 1 to August 31), and fall (September 1 to end of trapping) periods. I also calculated the mean length, weight, and condition factor of steelhead collected in streams by flyfishing and electrofishing. At all sites, the PIT-tagged fish were grouped into 5 mm interval length classes (class 70 = fish 70-74 mm, class 75 = fish 75-79 mm, etc.). I plotted the length frequency for all screw trap sites that had >100 steelhead tagged and all fly-fishing sites. I determined the date that 10%, 25%, 50%, 75%, and 90% of the fish were tagged at all screw trap sites except Red River.

Estimate the Number of Juvenile Steelhead Out-migrating from Fish Creek

The trap tender released PIT-tagged steelhead about 600 m upstream of the Fish Creek screw trap and recorded the number of recaptures at the trap daily to estimate trap efficiency. All recaptures were released downstream of the trap. When more than 50 steelhead were tagged in a day, only 50 fish were released upstream of the trap and the remainder downstream of the trap. When less than 50 steelhead were tagged in a day, all the newly tagged fish were released upstream of the trap.

I split the trapping season into periods based on flow and time of year and determined the number of steelhead trapped, fish released upstream (marks), and recaptured fish in each period. This data was used as input for a maximum likelihood estimator (Steinhorst et al., in press) to estimate the number of migrants and a 95% CI that left the stream during each period, during the entire year, and from August 15 to October 31. In Fish Creek, most of the juvenile steelhead during the season are trapped after August 15 (>90% of the total in all years since 1996).

Estimate Juvenile Steelhead Growth Rates in Wild Populations

The growth rate of individual juvenile steelhead was calculated from previously PIT-tagged fish that were recaptured in 2003. I put the recaptured fish into two groups: (1) fish tagged and recaptured in 2003, and (2) fish tagged in 2002 that were recaptured in 2003. I omitted the fish from the analysis if it was recaptured ≤30 days after tagging. I calculated the daily growth rate (DGR) of a fish as:

$$DGR = \frac{L_2 - L_1}{D_2 - D_1}$$

where L_1 = length at first capture,
L_2 = length at second capture,
D_1 = date the fish was tagged and,
D_2 = date the fish was recaptured.

I also calculated the instantaneous growth rate (IGR) as:

$$IGR = 100\left[\frac{\ln(L_2) - \ln(L_1)}{(D_2 - D_1)}\right]$$

I calculated the mean DGR and IGR and the 95% CI in each stream that had >10 steelhead recaptured in 2003. I calculated the mean DGR and IGR of steelhead that were captured in the Fish Creek screw trap, captured in Fish Creek flyfishing, and by combining all steelhead captured in Fish Creek.

Estimate Smolt Detection Rates and Travel Times for PIT-tagged Steelhead Smolts

I queried the PTAGIS database on October 22, 2003 and obtained the date and dam of detection, date of tagging, and the length and weight at tagging of all wild steelhead smolts tagged at SSS release sites and subsequently detected at Lower Granite (LGR), Little Goose (LGO), Lower Monumental (LMN), McNary (MCN), John Day (JDA), and Bonneville (BON) dams during 2003 (Figure 6). For each release site, I calculated the number of smolt detections from steelhead that were tagged from March 1, 2003 to May 31, 2003 (Period 1), August 15, 2002 to December 15, 2002 (Period 2), June 1, 2002 to August 14, 2002 (Period 3), fish tagged March 1, 2002 to May 31, 2002 (Period 4), and fish tagged before March 1, 2002 (Period 5). For each tag period, I determined the number of steelhead juveniles that were tagged and the number of tagged fish that were detected as smolts in 2003. I calculated the percentage of steelhead that were >125 mm when tagged that were detected as smolts in 2003 from each period.

I calculated the mean smolt length using the length of the fish when they were PIT tagged or recaptured between August 15, 2002 and May 31, 2003. Steelhead PIT tagged or recaptured between August 15, 2002 and May 31, 2003 and detected as smolts were grouped into 5 mm interval length classes (class 130 = fish 130-134 mm, class 135 = fish 135-139 mm, etc.), and the length frequency was plotted.

I determined the date that 10%, 25%, 50%, 75%, and 90% of the total number of smolt detections at LGR was attained from each stream. I included all smolt detections from each stream regardless of the tagging date. I determined the median travel time (and 90% CI) from release site to LGR of fish that were tagged in 2003 and detected as smolts at LGR. I only included sites with >15 detections at LGR in the travel time analysis. Travel time was calculated as kilometers traveled per day from the release site to LGR.

Estimate Age Composition of Adult and Juvenile Steelhead Populations

Trap tenders collected scales from adult steelhead trapped at the Fish Creek and Rapid River weirs (Figure 7). Personnel from IDFG collected scales from juvenile steelhead caught in screw traps in Crooked Fork Creek, Colt Killed Creek, Fish Creek, Marsh Creek, SF Salmon River, and the Salmon River at Sawtooth Fish Hatchery. The collectors measured the fork length of each fish and obtained scales from the preferred area (MacLellan 1987). This area is located just above the lateral line, posterior of a vertical line drawn from the posterior end of the dorsal fin.

Adult and juvenile scales were mounted between two glass microscope slides. The scales were observed on a computer video monitor using a Leica DME microscope and a Leica DC300 digital camera. A technician chose the best scale(s) for aging the fish and saved the scale as a digitized image. Most juvenile scale images were obtained using 100x magnification and most adult images were obtained using 25x magnification. The saltwater age of adults and the freshwater age of juvenile steelhead were determined by counting the number of overwinter annuli. At least three technicians aged each scale independently using the same digitized scale image without knowledge of the length of the fish. If there was no age consensus among the readers, then the readers collectively examined the image to resolve their differences before a final age was assigned to the fish. If a consensus could not be attained, the scale was not included in our analysis. In 2003, a final age was attained for Fish Creek adults from 1998 to 2002, Rapid River adults from 1998 to 2001, Colt Killed juveniles from 1999 to 2001, Crooked Fork juveniles from 1999 to 2001, Fish Creek juveniles from 2002, Marsh Creek juveniles from 2001, Pahsimeroi River juveniles from 1999 to 2001, and Salmon River juveniles collected at the Sawtooth Fish Hatchery site in 2001 and 2002.

Once an age consensus was reached for a stream, I put the juvenile fish in two groups to calculate the age proportions and the mean length of each age class. I put juvenile fish sampled between March 1 and June 15 of each year in the spring period and all fish sampled on or after August 15 of each year in the fall period. I determined the proportion of each age class and the mean length of the age class for each year and collection period.

I calculated the mean length of each age class from each stream for the spring and fall periods by combining all data collected from 1999 to 2002 except Fish Creek. Previously aged Fish Creek juvenile steelhead (Byrne 2002) from 1998 to 2001 were included with the 2002 data in the combined data set to calculate the mean length of each age class. I calculated mean lengths of spring migrants in Colt Killed Creek, Crooked Fork Creek (one year only), and the Salmon River. I calculated the mean length of fall migrants in Colt Killed Creek (one year only), Crooked Fork Creek, Marsh Creek (one year only), Pahsimeroi River, and Fish Creek.

Characterize Genetic Structure and Introgression Rates of Steelhead Populations

This project collected and is presently analyzing tissue samples from steelhead populations that span the range of geographic, temporal, and phenotypic variability observed in the Salmon and Clearwater basins. IDFG collected tissue samples from juvenile steelhead in 2000 from five hatchery stocks and 74 wild populations. Microsatellite allelic diversity was visualized and analyzed at the U.S. Geological Survey Alaska Science Center’s Conservation Genetics Laboratory (Byrne 2001b).

Chinook Salmon Parr, Resident Trout, and Dace Trapped at Fish Creek Screw Trap

Trap tenders collected data from cutthroat trout, bull trout, longnose dace, speckled dace, and Chinook salmon parr that were caught in the Fish Creek screw trap. The number of dace, Chinook salmon parr, cutthroat trout, and bull trout trapped daily was recorded. The trap tenders PIT tagged all bull trout and Chinook salmon parr and up to 20 cutthroat trout each day. All Chinook salmon parr, cutthroat trout, and bull trout were measured to the nearest mm and weighed to the nearest 0.1 g. All dace were counted, and a subsample was measured and weighed daily. Each day the trap tender recorded the stream conductivity, TDS, pH, and the river level at the U.S. Forest Service (USFS) gauge located near the mouth of Fish Creek.

Document Water Temperature in Steelhead Streams

I recorded water temperatures in tributaries throughout the Clearwater and Salmon river drainages with HOBO™ temperature recorders to obtain yearly temperature profiles from streams with wild steelhead populations. The streams span a range of elevation, geomorphic, and vegetative cover found in Idaho’s steelhead streams. The water temperatures were recorded every 0.5 h to 1.6 h from early spring until late October. Winter water temperatures were recorded every 0.5 h to 2.5 h, depending on location and access. The daily mean, maximum, and minimum water temperatures were calculated for each stream.

RESULTS

<u>Objective 1</u>

Collect and Outplant Adult Steelhead

Personnel from Sawtooth Fish Hatchery stocked 10 pair of hatchery adult steelhead in Beaver Creek and 10 pair in Frenchman Creek on May 6, 2003. The mean length of female steelhead that were stocked in Beaver and Frenchman creeks were 61 cm (±4 cm) and 61 cm (±5 cm), respectively. Male steelhead were not measured before they were stocked. There were 508 female steelhead spawned at Sawtooth Fish Hatchery yielding 2,807,840 eggs. The pooled mean fecundity per female spawner was 5,527. Using this fecundity, I estimated that 55,270 eggs were deposited in both Beaver Creek and Frenchman in 2003 (Table 1).

Evaluation of Spawner Success

A SSS crew snorkeled Beaver and Frenchman creeks on August 19 and August 20, 2003 to evaluate the success of the 2002 hatchery outplant. The age-1 steelhead densities in Beaver and Frenchman creeks were 3.89 and 0.34 fish/100 m^2, respectively (Figure 8). The estimated age-1 steelhead populations in Beaver and Frenchman creeks were 458 and 33 fish, respectively. The estimated number of age-1 parr produced per female spawner was 30.5 in Beaver Creek and 2.1 in Frenchman Creek (Table 1).

Objective 2

Fingerling and Smolt Stocking Prior to 2003

The fingerling stocking in the SF Red River from 1993 to 1996 and smolt stocking in Red River from 1996 to 1999 results were summarized in a previous report (Byrne 2001a, see Tables 4 and 5).

Estimate Adult Returns from Juvenile Stocking

No adult steelhead were detected as adults at Lower Granite Dam during fall 2002; therefore, the Red River weir was not operated to enumerate adult steelhead in the spring 2003.

Estimate Juvenile Production from Naturally Spawning Adult Returns

A SSS crew snorkeled the SF Red River from its mouth upstream to the WF SF Red River on June 28 and June 29, 2003. The mean age-1 and age-2+ steelhead densities (fish/100 m^2) were 1.12 and 1.30, respectively (Figure 9). The IDFG Clearwater Region crew snorkeled Red River upstream of the SF Red River to Shissler Creek on June 29, 2003. The mean age-1 and age-2+ steelhead densities (fish/100 m^2) were 0.23 and 0.09, respectively (Figure 9).

Objective 3

Estimate Steelhead Escapement in Fish Creek

The weir was closed during the morning of March 18, 2003. The trap tenders never had to open the weir (or live box) after closing it, and the river never flowed over the top of the weir. The trap tenders found some small openings in the weir during the first week it was operated and repaired them. They are confident that most of the adult steelhead spawners were trapped in the live box and that kelts were not able to pass the weir undetected. Some adult spawners may have entered Fish Creek before we installed the weir or swam through the weir before the trap tenders closed it. The adults entered Fish Creek earlier than in past years. Twenty-nine spawners (8.8% of the 330 trapped at the weir) were caught before April 1, 2003 (Figure 10). The only other years that >8.8% of the adults had been trapped by April 1 was 1992 (24%) and 1995 (9%). However, 1992 was the first year the weir was operated and more unmarked kelts were caught than spawners in the live box. This was likely due to many undiscovered openings in the weir. In 1995, the weir was opened on May 2; hence, the percentage of the total escapement that entered the stream by April 1 was likely much lower than 9%. Spawners have been trapped during March in five of the 11 previous years the weir has been operated. In most years, the first adult was trapped between April 1 and April 7.

The 2003 escapement was the largest that has been recorded since monitoring of the steelhead escapement in Fish Creek began in 1992 (Figure 11). Trap tenders captured 233 females in the trap box and another six as unmarked kelts. They captured 97 males in the trap box and another four as unmarked kelts. I made a maximum likelihood (ML) estimate of the escapement because a few fish were able to get upstream of the weir without being trapped. I estimated the escapement was 343 fish (95% lower CI = 315 and 95% upper CI = 371). Trap tenders physically handled 340 unique adult steelhead, so the actual escapement was at least 340 adults (Table 2).

The first male and female adults were trapped on March 19 and March 21, 2003, respectively. The median date of arrival was April 30, 2003 for females and males. We continued to trap adults until June 16, 2003 (Figure 10). The mean length of adults caught in the trap box was 80 cm for both females and males. Based on their length frequency, most of the adults were 2-ocean fish. A higher proportion of the males appear to be 1-ocean fish compared to females based on length frequency (Figure 12).

Of the 330 adults sampled during the upstream migration past the Fish Creek weir, 254 (77%) were subsequently recovered by trap tenders as kelts during their downstream migration. One hundred sixty-six of the 254 kelts were alive (63%) when captured. A higher proportion of females were recaptured as kelts (82% compared to 65% for males), and a higher proportion of the female kelts were alive (66% compared to 54% of males) compared to the males. The first kelt was captured on April 16, 2003, and the last kelt was caught on June 28, 2003 (Figure 13). The median date of capture was May 31 and May 29, 2003 for females and males, respectively.

PIT-tagged Adult Steelhead Returns

Seventy-four PIT-tagged adults were detected at Bonneville Dam and two were detected at McNary Dam (that passed Bonneville Dam undetected) that had been tagged as juveniles in Fish Creek (64) or elsewhere (12) but were trapped at the Fish Creek weir. At Bonneville Dam, the first adult was detected on August 6, 2002, and the last adult was detected on October 2, 2002. The median date of passage of the 74 adults at Bonneville Dam was September 6, 2002. On August 26, the date historically used to separate A-run and B-run steelhead, 23 percent of the adults tagged in Fish Creek as juveniles had passed Bonneville Dam in 2002 (Figure 14).

Sixty-four adult steelhead that were detected at Bonneville or McNary dams between August 12, 2002 and October 2, 2002 were PIT tagged in Fish Creek as juveniles. These fish were expected to return to Fish Creek and spawn during spring 2003. Of these 64 adults, 63 were detected at Bonneville Dam, 54 were detected at McNary Dam, 52 detected at Lower Granite Dam, and 48 were detected at the Fish Creek weir between April 7, 2003 and May 29, 2003 (Figure 15). Trap tenders also captured 12 PIT-tagged adults at the Fish Creek weir that were not tagged in Fish Creek. Ten adults were PIT tagged as smolts at LGR, one adult was PIT tagged at Bonneville Dam as an adult, and one adult was PIT tagged as a juvenile in the Lochsa River (Table 3).

Sixty PIT-tagged adults were trapped at the Fish Creek weir and passed upstream to spawn in 2003. Twenty-five of these adults were recovered as kelts. The median time spent in the stream from upstream passage to kelt capture for females and males were 36 and 34 days, respectively. The minimum time spent in the stream was five days for males and 19 days for females. The maximum time spent in the stream was 52 days for females and 56 days for males. There was a significant relationship between the date of upstream passage and time spent in the stream for males (Pearson's $r = -0.692$, $p = 0.027$) but not for females (Pearson's $r = -0.376$, $p = 0.167$). However, the correlation for males was significant because of two late arriving fish that spent 11 and five days in the stream (Figure 16). If these two males were omitted, then there was no significant correlation between date of upstream passage and time spent in the stream (Pearson's $r = -0.298$, $p = 0.473$).

Estimate Chinook Salmon Escapement in Fish Creek

Trap tenders caught six male and five female naturally produced Chinook salmon and passed them upstream of the weir in 2003. They also trapped six hatchery origin Chinook salmon (three males and three females) that were released downstream of the weir. The first naturally produced Chinook was trapped on June 8, 2003 and the last on July 16, 2003. The first hatchery origin salmon was trapped on July 13, 2003 and the last on August 3, 2003 (Figure 17).

After the weir was removed on September 7, 2003, Chinook salmon entered and were observed spawning in Fish Creek. Personnel from IDFG walked Fish Creek from Pagoda Creek to the weir site on September 20, 2003 and Hungery and Fish creeks from Doubt Creek to Pagoda Creek on October 4, 2003 (Figure 3). IDFG personnel also surveyed Fish Creek from the Lochsa River upstream to the release site used for screw trap efficient estimates (about 1 km upstream of the weir) on four occasions from September 21 to October 6, 2003. During these surveys they counted four redds. One redd was upstream of the weir site and the other three were located downstream of the weir site. No redds were counted upstream of the trap efficiency release site. Five carcasses were recovered, but the origin could only be determined from two fish (one natural and one hatchery).

Estimate Wild Juvenile Steelhead Densities

Crews began the snorkel surveys in the SF Red River on June 28, 2003 and completed the final Lochsa River tributaries on August 29, 2003. Crews were unable to snorkel any stream in the Lochsa River drainage upstream of Fish Creek from August 12 to August 22, 2003 because of a forest closure due to fires. Snorkel conditions were excellent in all streams during the summer surveys. The mean age-1 steelhead densities increased from those observed in 2002 in all streams that were snorkeled except Frenchman Creek, SF Red River, Lake Creek, and Weir Creek (Tables 4, 5, and 6). Age-1 densities were nearly double the densities observed in 2002 in WF Gedney, Boulder, Canyon, and Deadman creeks. The largest increase of age-1 density was from 1.24 fish/100 m^2 in 2002 to 8.48 fish/100 m^2 in Pete King Creek (Table 6).

The mean density of all steelhead parr (except fry) increased from the density observed in 2002 and ranged from 7.00 to 15.76 fish/100 m^2 in the four Lochsa River tributaries (Canyon, Deadman, Post Office, and Weir) that have been monitored since 1996 (Figure 18). Steelhead densities were: 11.94 fish/100 m^2 in strata 1 of Gedney Creek, 21.29 fish/100 m^2 in the WF Gedney Creek, and 13.22 fish/100 m^2 in Fish Creek. The steelhead density in the Gedney drainage and Fish Creek were at their highest level since 1994 and 1995, respectively (Figure 19).

PIT Tag Juvenile Steelhead from Wild Populations

Trap tenders tagged 8,696 juvenile steelhead at the five screw trap sites in the Clearwater River drainage. Eighty-six percent (7,465 fish) were tagged in Fish Creek. The mean length of tagged steelhead (excluding Red River because of low sample size) ranged from 135 mm (±1 mm) in Fish Creek to 167 mm (±5 mm) in Colt Killed Creek (Table 7 and Figure 20).

Trap tenders tagged 5,880 juvenile steelhead at the eight screw trap sites in the Salmon River drainage. Thirty-eight percent (2,246 fish) of all steelhead tagged in the Salmon River drainage were from the Pahsimeroi River. The mean length of tagged fish ranged from 125 mm (±2 mm) in Marsh Creek to 157 mm (±2 mm) in the Salmon River (Table 8 and Figure 21).

Summer field crews using flyfishing gear collected and PIT tagged 1,308 juvenile steelhead in Fish, Hungery, Gedney, Boulder, and Lick creeks. The mean length ranged from 131 mm (±2 mm) in Lick Creek to 142 mm (±2 mm) in Fish Creek (Table 9 and Figure 22).

The NOAA Fisheries crew used electrofishing gear to collect and PIT tag 634 juvenile steelhead from seven streams for this study. In five of the seven streams, they collected and tagged fewer than 100 steelhead. The mean length of the steelhead ranged from 99 mm (±4 mm) in Camas Creek to 134 mm (±5 mm) in Chamberlain Creek (Table 9).

The median tag date at the screw traps ranged from May 6 in Salmon River to September 16 in Fish Creek. The date the 90% quantile was attained ranged from September 3 in the Secesh River to October 29 in Colt Killed and Crooked Fork creeks. The duration from the date the 10% quantile was attained to the 90% quantile date (excluding Red River and Clear Creek) ranged from 83 days at Secesh River to 210 days at the Pahsimeroi River (Figure 23).

Estimate the Number of Juvenile Steelhead Out-migrating from Fish Creek

I split the trapping season into 12 periods. The first period, from March 10 to June 2, was the longest duration. During the first period, the river level was usually between 3.7 and 4.2 feet. In this first period 36 steelhead were tagged, and only one was recaptured. After June 2, the trap periods were usually 14 days long (Table 10). The trap was fished in the thalweg once the river level was less than 3.0 feet. The river level dropped below 3.0 feet on June 17 and never exceeded 3.0 feet for the remainder of the trapping season (Figure 24).

I estimated that 45,288 juvenile steelhead (lower CI = 42,087, upper CI = 48,073) left Fish Creek from March 10 to November 1. The number of steelhead that left Fish Creek from August 15 to October 31 was 36,307 (lower CI = 34,214, upper CI = 38,687). The 2003 yearly and fall migration estimates were the largest since 1994 (Figure 25).

Estimate Juvenile Steelhead Growth Rates in Wild Populations

I calculated DGR and IGR in Fish Creek and Hungery Creek for steelhead that were tagged and recaptured in 2003. The mean DGR ranged from 0.0904 mm/day for steelhead caught in the Fish Creek screw trap to 0.1375 mm/day in Hungery Creek (Figure 26). The median total growth was 8 mm in Hungery Creek and 7 mm for Fish Creek when fish captured flyfishing and in the screw trap were combined.

I calculated DGR and IGR in Fish, Gedney, and Chamberlain creeks for steelhead that were tagged in 2002 and recaptured in 2003. The DGR was 0.112 mm/day in Gedney Creek, 0.1203 mm/day in Fish Creek (combined), and 0.1228 in Chamberlain Creek (Figure 26). The median total growth of fish in these streams was 39 mm in Gedney Creek, 47 mm in Fish Creek, and 48 mm in Chamberlain Creek.

Estimate Smolt Detection Rates and Travel Times for PIT-tagged Steelhead Smolts

During 2003 the juvenile collection facilities at LGR, LGO, LMN, MCN, JDA, and BON made 2,245 unique steelhead smolt detections from the Clearwater River drainage and 799 unique steelhead smolt detections from the Salmon River drainage that were PIT tagged by SSS crews. In the Clearwater River drainage, 62% of all steelhead ≥125 mm that were tagged during Period 1 and 37% of all steelhead ≥125 mm tagged during Period 2 were detected as smolts. In the Salmon River drainage, 25% steelhead ≥125 mm that were tagged during Period 1 and 14% of all steelhead ≥125 mm tagged during Period 2 were detected as smolts (Table 11). The detection rates of streams in the Salmon drainage exceeded 30% only from the Secesh River and Johnson Creek during Period 1. All detection rates from the Salmon drainage from Period 2 were <25%. The Clearwater drainage detection rates exceeded 40% from all streams in Period 1 and were >30% in all streams from Period 2.

The mean smolt length in the Clearwater drainage ranged from 154 mm (±1 mm) in Fish Creek to 180 mm (±3 mm) in Colt Killed Creek. The mean smolt length in the Salmon drainage ranged from 158 mm (±6 mm) in the SF Salmon River to 189 mm (±18 mm) in the Lemhi River (Table 12 and Figures 27 and 28).

A total of 1,699 steelhead smolts were detected at LGR from SSS tagging sites. Over half of all detections were from Fish Creek. The only other streams that had >100 smolt detections at LGR were Crooked Fork Creek and Clear Creek. The first smolt from SSS sites was detected at LGR on March 28, 2003 and the last smolt was detected on June 22, 2003. The median smolt detection date at LGR ranged from April 20, 2003 from Boulder Creek to May 25, 2003 from the Salmon River. The median detection date was usually later and length of time smolts were detected was usually longer from streams in the Salmon drainage compared to streams in the Clearwater drainage (Figure 29).

I calculated travel time statistics for six streams. The median travel time ranged from 29.1 km/day from Johnson Creek to 62.18 km/day from the Pahsimeroi River (Table 13). The regression of smolt travel time (km/day) and distance to LGR was not significant ($p = 0.31$) in 2003 (Figure 30).

Estimate Age Composition of Adult and Juvenile Steelhead Populations

In 2003, IDFG personnel collected scales from 340 adult steelhead from Fish Creek, 88 adult steelhead from Rapid River, 1,034 juvenile steelhead from six streams from the Clearwater drainage, and 791 juvenile steelhead from six streams from the Salmon drainage (Table 14). They also aged scales collected in previous years and, for those samples, there was consensus about the age determination of 356 adult steelhead from Fish Creek, 44 adult steelhead from Rapid River, and 1,922 juvenile steelhead collected from Colt Killed Creek, Crooked Fork Creek, Fish Creek, Marsh Creek, Pahsimeroi River, and the Salmon River.

Adults

Adult steelhead that spent two years in the ocean made up >82% of the fish returning to Fish Creek each year from 1998 to 2001. In 2002, 52% of the returning adults to Fish Creek spent one year in the ocean. During the years 1998 to 2002, only one adult that returned to Fish

Creek was aged as a 3-ocean fish. The adult escapement in Rapid River was lower than Fish Creek, and in 1999 and 2000, less than five readable scales were obtained from each return year. In 1998 and 2001, 2-ocean adults made up 83% and 60% of the total escapement in Rapid River. No 3-ocean adults were collected in Rapid River from 1998 to 2001 (Table 15).

The mean length of 1-ocean adults in Fish Creek ranged from 63 cm in 1998 to 67 cm in 2002. The mean length of two-ocean adults from Fish Creek ranged from 78 cm to 80 cm (Table 16). In Rapid River, only two 1-ocean adults were aged from the 1998 return. The mean length of Rapid River 1-ocean adults in 2001 was 62 cm, and the mean length of the 2-ocean adults in 1998 and 2001 was 76 cm (Table 16).

When the length at age data was combined for all years, adults from Fish Creek were significantly different than adults of the same ocean age from Rapid River (Figure 31). The mean length of 1-ocean adults was 67 cm in Fish Creek and 63 cm in Rapid River (*t*-test, $t = 3.798$, $df = 116$, $p = 0.0002$). The mean length of 2-ocean adults in Fish Creek was 79 cm and 76 cm in Rapid River (*t*-test, $t = 3.928$, $df = 280$, $p = 0.0001$).

Juveniles

During the spring collection period steelhead fry have not emerged; hence, no age-0 fish were sampled. Steelhead juveniles that emigrate from tributary streams in the fall will spend at least one more winter in freshwater before smolting and will be at least one year older. Fish of a similar age that were collected in the fall had an additional growing season compared to fish collected in the spring; hence, the mean length of similar aged fish collected in the fall will be larger than fish collected in the spring from the same stream and the same year.

The youngest migrants were from the fall period in the Pahsimeroi River. Age-0 steelhead made up 61% to 75% of the migrants, and age-1 migrants made up 24% to 37% of the migrants each year (Table 17). Mean length of the age-0 parr ranged from 104 mm to 114 mm, and the mean length of age-1 parr ranged from 171 mm to 187 mm, respectively (Table 18).

The oldest migrants were collected in Colt Killed Creek. In spring 1999, 54% of the fish were age-4 and 8% age-5. In spring 2000, 22% and 10% of the migrants were age-4 or age-5, respectively. Colt Killed Creek was the only stream where age-5 fish were observed (Table 17). The mean length of spring collected fish ranged from 165 mm at age-2 to 199 mm at age-5 (Table 18).

The majority of fall migrants from Fish Creek and Crooked Fork Creek were age-1 or age-2. These two age classes made up 95% of the migrants from Fish Creek and >80% of the migrants from Crooked Fork Creek. Age-3 fish were present in both streams and ranged from 5% to 13% of the migrants in Crooked Fork Creek for years 1999 to 2001 and 5% of the migrants in Fish Creek in 2002. Age-4 fish made up <1% of the migrants in Crooked Fork Creek in the fall 1999. The mean length of age-1 and age-2 migrants from Fish Creek was 120 mm and 160 mm, respectively. The mean length in Crooked Fork Creek ranged from 127 mm to 155 mm for age-1 fish, 173 mm to 177 mm for age-2 fish, and 182 mm to 193 mm for age-3 fish (Table 18).

Age-0 and age-1 fish made up 89% and 77% of the fall migrants from the Salmon River and Marsh Creek. The mean length from the Salmon River was 81 mm for age-0 fish, 148 mm for age-1, and 162 for age-2. The mean length from Marsh Creek was 65 mm for age-0, 125 mm for age-1, and 140 mm for age-2. Only one year of data was analyzed from these streams, and the sample size for the Salmon River was 42 fish. Additional years of data from these streams remain to be analyzed.

When the spring data was combined for all years, the mean length of age-1, -2, and -3 steelhead from Colt Killed and Crooked Fork creeks were within 2 mm of each other. Average length of the age-1 parr from both Colt Killed and Crooked Fork creeks were 78 mm, and the age-2 parr were more than twice as large, averaging 165 mm in Crooked Fork and 166 mm in Colt Killed. The Salmon River age-1 steelhead were larger than Colt and Crooked Fork creeks; however, the age-2 and age-3 Salmon River steelhead were 10 to 16 mm smaller. Colt Killed Creek age-4 and age-5 fish averaged 193 mm and 197 mm in length, respectively (Figure 32).

When the fall data was combined for all years, age-0 parr ranged from 65 mm in Marsh Creek to 108 mm in the Pahsimeroi River. The mean length of age-1 parr from the Pahsimeroi River was 179 mm, 40 mm larger than the other streams. Mean length of age-1 parr ranged from 125 mm to 139 mm in Marsh, Crooked Fork, and Fish creeks. The age-2 parr from Colt Killed, Fish, and Crooked Fork creeks ranged from 164 mm to 175 mm, whereas Marsh Creek age-2 parr were the smallest, averaging 140 mm length. Fish Creek age-3 parr were the largest, averaging 197 mm length, and Colt Killed Creek had the smallest age-3 parr, averaging 180 mm length (Figure 33).

Characterize Genetic Structure of Steelhead Populations

An interim report based on 31 wild populations and five hatchery stocks was completed in December 2003 and is provided in Appendix 3. Work is continuing on the remaining wild populations.

Chinook Salmon Parr, Resident Trout, and Dace Trapped at Fish Creek Screw Trap

In addition to juvenile steelhead, 55 Chinook salmon parr, 52 Chinook salmon fry, seven bull trout, 379 westslope cutthroat trout, 2,916 longnose dace *Rhinichthus cataractae*, 744 speckled dace *Rhinichthus osculus*, and 363 dace that were not identified to species were trapped in the Fish Creek screw trap. Trap tenders PIT tagged 27 Chinook salmon parr, seven bull trout, and 282 westslope cutthroat trout (Table 19).

Document Water Temperature in Steelhead Streams

The water temperature was recorded at 12 locations in the Salmon River drainage and 25 locations in the Clearwater River drainage (Table 20). All data were entered into a stream temperature database maintained at the Nampa Research Office. The daily mean, maximum, and minimum temperature from Fish Creek is shown in Figure 34.

Table 1. The number of hatchery adult steelhead that were stocked in Beaver and Frenchman creeks in 2002 and 2003 and the estimated yield of age-1 parr from the 2002 adult stocking. The smolt yield was estimated assuming an overwinter mortality rate of 50% (age-1 parr will spend two additional winters in the stream before smolting).

Year Stocked	Date Stocked	Females Stocked	Eggs Deposited	Age-1 parr Population	Age-1 parr 95% CI	Age-1 parr Per Female	Egg to Age-1 Survival	Age-3 Smolt[a] Total Yield	Age-3 Smolt[a] Per Female
Beaver Creek									
2002	5/2	15	79,110	458	±222	30.5	0.58%	115	8
2003[b]	5/6	10	55,270						
Frenchman Creek									
2002	5/2	16	84,384	33	±47	2.1	0.04%	8	1
2003[b]	5/6	10	55,270						

[a] Values were rounded to the nearest integer.
[b] IDFG crews will estimate the age-1 parr population from the 2003 adult stocking during the summer of 2004.

Table 2. The number of adult steelhead that were captured at the Fish Creek weir and passed upstream to spawn and the number of kelts that were recovered in 2003

Sex	Adults Trapped	Unmarked kelts recovered	Total handled	Mean length (cm)	95% CI	Maximum length	Minimum length	Marked kelts recovered	Percent of adults recovered
Female	233	6	239	80	1	91	63	191	82%
Male	97	4	101	80	2	98	62	63	65%
All	**330**	**10**	**340**					**254**	**77%**

Table 3. Summary of the detection history of adult steelhead that were PIT tagged as juveniles in Fish Creek and those adults trapped at the Fish Creek weir in 2003 that were PIT tagged at other locations. BON = Bonneville Dam; MCN = McNary Dam; LGR = Lower Granite Dam.

PIT tag site	Number of adults detected at dams: BON	MCN	LGR	Adults at Fish Creek	Kelts recovered at Fish Creek
Fish Creek	63	54[a]	52	48	21
Lower Granite Dam	9	10[a]	10	10	2
Lochsa River	1	1	1	1	1
Bonneville Dam[b]	1	1	1	1	1
Totals	**74**	**66**	**64**	**60**	**25**

[a] The McNary Dam count includes one adult that was not detected at Bonneville Dam.
[b] This fish was PIT tagged as an adult.

Table 4. Mean fish densities (fish/100 m^2) by habitat type in streams of the Clearwater River drainage that were snorkeled during summer 2003. Area = total area snorkeled (m^2); N = number of sites snorkeled; Trout fry = all trout (except brook trout) ≤75 mm; Age-1 steelhead = juvenile steelhead 76 mm to 127 mm; Age-2+ steelhead = all juvenile steelhead >127 mm; Brook fry = all brook trout <75 mm; Brook parr = all brook trout ≥75 mm; PW = pocket water.

Stream	Date	Habitat type	Strata	N	Area	Trout fry	Steelhead parr		Chinook parr		Cutthroat	Bull	Brook fry	Brook parr	Whitefish	Total salmonid
							Age-1	Age-2+	Age-0	Age-1						
Bald Mountain Creek	8/10	Pool	1	4	133	9.04	16.70	17.20	0.00	0.00	8.03	0.00	0.00	0.00	0.00	50.96
Bald Mountain Creek		PW	1	16	1,720	1.82	8.69	4.36	0.00	0.00	3.54	0.05	0.00	0.00	0.00	18.45
Bald Mountain Creek		Riffle	1	2	92	0.00	16.93	3.30	0.00	0.00	1.58	0.00	0.00	0.00	0.00	21.83
Bald Mountain Creek		Run	1	3	158	1.75	12.57	9.32	0.00	0.00	5.14	0.00	0.00	0.00	0.00	28.78
Boulder Creek	8/8	Pool	1	6	489	1.37	20.71	19.23	5.06	0.00	7.17	0.00	0.00	0.00	0.00	53.54
Boulder Creek		PW	1	30	5,506	3.15	7.69	7.86	0.72	0.02	0.58	0.00	0.00	0.00	0.00	20.01
Boulder Creek		Riffle	1	4	527	4.44	8.47	2.53	3.25	0.00	1.20	0.00	0.00	0.00	0.00	19.88
Boulder Creek		Run	1	6	931	8.72	10.24	9.68	11.14	0.24	2.76	0.00	0.00	0.00	0.00	42.78
Canyon Creek	8/7	Pool	1	5	184	2.01	16.06	5.12	0.00	0.00	5.38	0.00	0.00	0.00	0.00	28.57
Canyon Creek		PW	1	14	1,212	3.78	12.06	2.48	0.00	0.00	0.49	0.00	0.00	0.00	0.00	18.80
Canyon Creek		Riffle	1	4	339	19.30	11.45	2.24	0.00	0.00	0.39	0.00	0.00	0.00	0.00	33.36
Canyon Creek		Run	1	5	341	0.99	14.01	3.44	0.00	0.00	0.93	0.00	0.00	0.00	0.00	19.37
Deadman Creek	8/7	Pool	1	3	79	35.67	21.59	8.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65.64
Deadman Creek		PW	1	15	1,425	26.48	6.33	1.41	0.15	0.00	0.07	0.00	0.00	0.00	0.00	34.44
Deadman Creek		Riffle	1	5	426	19.82	16.83	2.34	0.00	0.00	0.18	0.00	0.00	0.00	0.00	39.18
Deadman Creek		Run	1	5	327	20.82	25.72	2.36	0.78	0.00	0.40	0.00	0.00	0.00	0.00	50.08
Fish Creek	7/10	Pool	1	8	1,246	5.33	11.37	11.26	0.04	0.04	2.32	0.19	0.00	0.00	0.00	30.55
Fish Creek	to	PW	1	25	11,687	5.50	8.32	4.70	0.05	0.00	1.13	0.00	0.00	0.00	0.01	19.71
Fish Creek	7/16	Riffle	1	8	3,191	8.30	6.72	3.64	0.00	0.00	1.55	0.00	0.00	0.00	0.00	20.20
Fish Creek		Run	1	20	6,364	6.62	8.88	5.08	0.02	0.00	1.90	0.00	0.00	0.00	0.01	22.50
Fish Creek	7/14	Pool	2	3	288	11.66	7.74	2.76	0.00	0.00	1.38	0.00	0.00	0.00	0.00	23.54
Fish Creek		PW	2	4	754	5.44	7.92	4.04	0.00	0.88	0.92	0.00	0.00	0.00	0.00	19.19
Fish Creek		Riffle	2	1	78	0.00	10.22	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.50
Fish Creek		Run	2	4	556	15.40	6.72	2.72	0.00	0.00	0.53	0.00	0.00	0.00	0.00	25.38
Hungery Creek	7/14	Pool	1	3	140	4.36	14.27	10.85	0.98	0.00	1.81	0.00	0.00	0.00	0.00	32.27
Hungery Creek		PW	1	3	857	7.02	7.35	2.90	0.00	0.00	0.46	0.00	0.00	0.00	0.00	17.74
Hungery Creek		Run	1	4	681	7.68	10.99	6.54	0.00	0.00	1.24	0.00	0.00	0.00	0.00	26.46
Gedney Creek	7/24	Pool	1	6	719	18.01	15.28	10.21	14.07	0.52	2.76	0.31	0.00	0.00	1.29	62.46
Gedney Creek	to	PW	1	22	7,120	10.22	6.98	3.53	2.59	0.05	0.26	0.01	0.00	0.00	0.25	23.91
Gedney Creek	7/29	Riffle	1	6	1,638	13.97	7.65	3.40	10.14	0.05	0.52	0.00	0.00	0.00	0.19	35.91
Gedney Creek		Run	1	13	3,078	15.03	7.85	3.89	6.04	0.12	0.84	0.02	0.00	0.00	0.62	34.42

Table 4. Continued.

Stream	Date	Habitat type	Strata	N	Area	Trout fry	Steelhead parr Age-1	Steelhead parr Age-2+	Chinook parr Age-0	Chinook parr Age-1	Cutthroat	Bull	Brook fry	Brook parr	Whitefish	Total salmonid
Gedney Creek	7/26	Pool	2	4	210	1.16	12.26	6.17	0.31	0.00	0.00	0.00	0.00	0.00	0.00	19.89
Gedney Creek		PW	2	8	947	6.20	8.02	1.87	0.00	0.00	0.11	0.00	0.00	0.00	0.00	16.20
Gedney Creek		Riffle	2	4	357	10.72	11.69	4.05	0.31	0.00	0.00	0.00	0.00	0.00	0.00	26.77
Gedney Creek		Run	2	3	288	4.61	11.35	6.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.30
WF Gedney Creek	7/26	Pool	1	4	358	5.25	24.38	14.49	3.27	0.21	0.21	0.00	0.00	0.00	0.00	47.83
WF Gedney Creek		PW	1	8	1,748	5.84	12.14	3.57	3.53	0.00	0.04	0.00	0.00	0.00	0.04	25.17
WF Gedney Creek		Riffle	1	3	571	14.85	14.83	6.72	1.35	0.00	0.49	0.00	0.00	0.00	0.71	38.94
WF Gedney Creek		Run	1	4	672	17.14	12.26	6.00	9.35	0.00	0.24	0.00	0.00	0.00	0.14	45.12
Holly Creek	8/23	Pool	1	4	164	0.37	9.74	15.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.45
Holly Creek		PW	1	9	565	0.43	5.35	5.65	0.00	0.00	0.37	0.00	0.00	0.00	0.00	11.80
Holly Creek		Riffle	1	2	108	2.69	2.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.15
Lake Creek	8/11	Pool	1	4	498	4.56	3.90	3.69	0.21	0.00	1.38	0.00	0.00	0.00	0.00	13.73
Lake Creek		PW	1	15	2,979	2.84	1.00	0.80	0.00	0.00	0.45	0.07	0.00	0.00	0.00	5.16
Lake Creek		Riffle	1	3	498	2.24	0.21	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.87
Lake Creek		Run	1	5	800	3.26	1.76	1.54	0.00	0.00	0.75	0.10	0.00	0.00	0.00	7.40
O'Hara Creek	8/9	Pool	1	8	504	2.54	11.08	4.03	42.93	0.68	0.00	0.00	0.00	0.00	0.00	61.26
O'Hara Creek		PW	1	23	3,561	3.74	8.16	2.64	10.15	0.28	0.13	0.06	0.00	0.00	0.06	25.22
O'Hara Creek		Riffle	1	7	1,173	6.45	6.93	1.67	11.37	0.34	0.06	0.00	0.00	0.00	0.00	26.83
O'Hara Creek		Run	1	10	1450	4.42	5.85	3.86	22.91	1.52	0.11	0.00	0.00	0.00	0.00	38.67
Hanby Fork	8/9	Pool	1	2	44	11.34	18.27	3.86	49.45	0.00	0.00	0.00	0.00	0.00	0.00	82.93
Hanby Fork		PW	1	3	303	10.87	4.25	1.25	15.07	0.00	0.00	0.00	0.00	0.00	0.00	31.44
Hanby Fork		Run	1	1	52	27.20	3.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.09
Pete King Creek	8/20	Pool	1	3	123	34.28	15.45	5.71	67.81	7.28	1.18	0.00	0.00	0.00	0.00	131.72
Pete King Creek	and	PW	1	8	726	3.74	9.46	1.15	23.53	0.44	0.00	0.00	0.00	0.00	0.00	38.32
Pete King Creek	8/21	Riffle	1	16	1336	8.01	7.25	0.26	1.88	0.00	0.00	0.00	0.00	0.00	0.07	17.47
Pete King Creek		Run	1	8	552	12.68	8.97	0.58	11.13	0.76	0.16	0.00	0.00	0.00	0.00	34.28
Post Office Creek	8/11	Pool	1	5	216	16.81	17.86	4.26	0.00	0.00	2.73	0.00	0.00	0.00	0.00	41.67
Post Office Creek		PW	1	7	885	19.77	11.27	1.53	0.08	0.00	0.65	0.00	0.00	0.00	0.00	33.30
Post Office Creek		Riffle	1	10	956	19.77	14.02	0.21	0.00	0.00	0.28	0.00	0.00	0.00	0.00	34.27
Post Office Creek		Run	1	6	469	26.11	11.45	1.47	0.19	0.00	2.65	0.00	0.00	0.00	0.00	41.87
SF Red River	6/28	Pool	1	3	166	0.00	5.81	3.78	0.00	0.00	3.07	0.00	0.00	1.53	0.00	14.20
SF Red River		PW	1	4	517	1.23	2.12	1.92	0.00	0.00	0.36	0.00	0.00	0.00	0.19	5.81
SF Red River		Riffle	1	5	774	0.58	1.27	1.54	0.00	0.00	0.13	0.00	0.00	0.00	0.00	3.52
SF Red River		Run	1	8	1,494	4.20	2.07	3.76	0.00	0.00	0.93	0.00	0.00	0.00	0.05	11.01
SF Red River	6/28	Pool	2	5	257	0.00	0.66	0.00	0.00	0.00	9.17	0.00	0.00	0.26	0.00	10.09
SF Red River	and	PW	2	4	637	0.00	1.05	0.35	0.00	0.00	0.45	0.00	0.00	0.00	0.00	1.85
SF Red River	6/29	Riffle	2	8	1,168	0.00	0.43	0.31	0.00	0.00	0.99	0.00	0.00	0.06	0.13	1.92
SF Red River		Run	2	14	1,840	0.00	0.34	0.57	0.00	0.00	3.90	0.00	0.00	0.35	0.00	5.16

Table 4. Continued.

Stream	Date	Habitat type	Strata	N	Area	Trout fry	Steelhead parr		Chinook parr		Cutthroat	Bull	Brook fry	Brook parr	Whitefish	Total salmonid
							Age-1	Age-2+	Age-0	Age-1						
Trapper Creek	6/29	Pool	1	1	19	0.00	0.00	0.00	0.00	0.00	41.18	0.00	0.00	0.00	0.00	41.18
Trapper Creek		PW	1	2	142	0.00	0.00	0.00	0.00	0.00	4.29	0.00	0.00	0.00	0.00	4.29
Trapper Creek		Riffle	1	2	132	0.00	0.00	0.00	0.00	0.00	7.71	0.00	0.00	0.00	0.00	7.71
Trapper Creek		Run	1	2	128	0.00	0.00	0.00	0.00	0.00	4.81	0.00	0.00	0.00	0.00	4.81
WF SF Red River	6/29	Pool	1	1	52	0.00	0.00	0.00	0.00	0.00	13.60	0.00	0.00	0.00	0.00	13.60
WF SF Red River		PW	1	2	90	0.00	0.00	0.00	0.00	0.00	8.43	0.00	0.00	0.00	0.00	8.43
WF SF Red River		Riffle	1	2	127	0.00	0.00	0.00	0.00	0.00	9.18	0.00	0.00	0.00	0.00	9.18
WF SF Red River		Run	1	2	179	0.58	0.00	0.54	0.00	0.00	3.84	0.00	0.00	0.00	0.00	4.96
Stanley Creek	8/29	Pool	1	5	386	5.07	2.23	3.82	0.00	0.00	3.53	0.65	0.00	0.28	0.00	15.58
Stanley Creek		PW	1	12	1,207	4.38	5.39	3.04	0.00	0.00	1.69	0.00	0.00	0.09	0.00	14.59
Stanley Creek		Run	1	2	238	3.14	5.96	3.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.16
Weir Creek	8/10	Pool	1	5	174	7.16	6.64	1.97	0.00	0.00	5.49	0.00	0.00	0.00	0.00	21.24
Weir Creek		PW	1	8	853	13.76	6.36	0.64	0.00	0.00	1.35	0.00	0.00	0.00	0.00	22.11
Weir Creek		Riffle	1	8	701	16.75	4.29	1.29	0.00	0.00	2.92	0.00	0.00	0.00	0.00	25.25
Weir Creek		Run	1	5	396	28.42	7.67	2.62	0.00	0.00	2.05	0.00	0.00	0.00	0.00	40.77

Table 5. Mean fish densities (fish/100 m^2) by habitat type in streams of the Salmon River drainage that were snorkeled during summer 2003. Area = total area snorkeled (m^2); N = number of sites snorkeled; Trout fry = all trout (except brook trout) ≤75 mm; Age-1 steelhead = juvenile steelhead 76 mm to 127 mm; Age-2+ steelhead = all juvenile steelhead >127 mm; Brook fry = all brook trout <75 mm; Brook parr = all brook trout ≥75 mm; PW = pocket water.

		Habitat				Trout	Steelhead parr		Chinook parr				Brook			Total
Stream	**Date**	**type**	**Strata**	**N**	**Area**	**fry**	**Age-1**	**Age-2+**	**Age-0**	**Age-1**	**Cutthroat**	**Bull**	**fry**	**parr**	**Whitefish**	**salmonid**
Basin Creek	8/21	Pool	1	2	139	0.65	4.21	0.65	1.29	0.65	0.00	0.00	0.00	0.00	1.46	8.89
Basin Creek		PW	1	1	206	1.46	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.91
Basin Creek		Riffle	1	13	2,407	3.50	0.78	0.32	0.36	0.05	0.00	0.00	0.00	0.00	0.00	5.00
Basin Creek		Run	1	6	955	5.31	1.76	1.05	4.37	0.53	0.00	0.00	0.00	0.00	0.24	13.26
Beaver Creek	8/20	Pool	2	6	150	8.38	5.79	6.73	6.10	1.26	0.00	0.00	0.00	10.19	0.00	38.45
Beaver Creek		PW	2	3	210	11.24	4.93	4.65	2.96	0.00	0.00	0.00	0.49	1.37	0.00	25.62
Beaver Creek		Riffle	2	11	606	8.05	2.94	1.13	0.97	0.00	0.00	0.00	0.12	2.83	0.00	16.04
Beaver Creek		Run	2	16	981	2.20	3.99	4.32	3.29	0.00	0.00	0.00	0.41	5.88	0.00	20.08
Frenchman Creek	8/19	Pool	1	6	102	25.82	2.84	6.43	0.00	0.00	0.00	0.00	1.74	13.42	0.00	50.26
Frenchman Creek		PW	1	4	194	21.79	0.60	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.69
Frenchman Creek		Riffle	1	8	351	13.33	0.00	0.23	0.00	0.00	0.00	0.00	1.16	1.08	0.00	15.80
Frenchman Creek		Run	1	20	1,027	8.92	0.16	0.08	0.00	0.00	0.00	0.00	0.28	3.44	0.00	12.88

Table 6. The mean stream density (fish/100m^2) of juvenile steelhead, Chinook salmon parr, cutthroat trout, bull trout, brook trout, and mountain whitefish in streams that were snorkeled in 2003. The age-1 change column is the percent change of the age-1 steelhead parr density from 2002. nc = no change.

			Steelhead parr		Chinook parr							Total	Age-1
Stream	Strata	Trout fry	Age-1	Age-2+	Age-0	Age-1	Cutthroat	Bull	Brook fry	Brook parr	Whitefish	salmonid	change
Fish Creek	1	5.98	8.35	4.87	0.04	0.00	1.34	0.01	0.00	0.00	0.01	20.60	52%
Gedney Creek	1	12.26	7.86	4.08	5.19	0.10	0.59	0.03	0.00	0.00	0.39	30.51	83%
	2	5.67	8.79	2.83	0.03	0.00	0.08	0.00	0.00	0.00	0.00	17.40	14%
	1 & 2	10.46	8.24	3.80	3.47	0.07	0.42	0.02	0.00	0.00	0.28	26.75	57%
WF Gedney Creek	1	8.38	14.83	6.46	4.46	0.04	0.14	0.00	0.00	0.00	0.09	34.41	92%
SF Red River	1	2.12	1.94	2.59	0.00	0.00	0.61	0.00	0.00	0.06	0.06	7.38	-39%
	2	0.00	0.50	0.40	0.00	0.00	3.05	0.00	0.00	0.20	0.04	4.19	-33%
	1 & 2	0.83	1.12	1.30	0.00	0.00	2.02	0.00	0.00	0.16	0.05	5.48	-36%
Bald Mountain Creek	1	2.10	9.17	4.98	0.00	0.00	3.74	0.05	0.00	0.00	0.00	20.03	85%
Boulder Creek	1	3.86	9.00	8.90	2.59	0.05	1.37	0.00	0.00	0.00	0.00	25.76	93%
Canyon Creek	1	3.45	12.75	2.88	0.00	0.00	1.05	0.00	0.00	0.00	0.00	20.12	93%
Deadman Creek	1	24.46	11.97	1.89	0.23	0.00	0.15	0.00	0.00	0.00	0.00	38.71	99%
Lake Creek	1	2.89	1.12	0.95	0.01	0.00	0.48	0.07	0.00	0.00	0.00	5.52	-66%
O'Hara Creek	1	4.44	7.74	2.49	11.61	0.38	0.11	0.04	0.00	0.00	0.04	26.85	173%
Pete King Creek	1	9.18	8.48	0.76	11.62	0.57	0.09	0.00	0.00	0.00	0.04	30.73	583%
Post Office Creek	1	20.96	12.99	0.95	0.06	0.00	0.95	0.00	0.00	0.00	0.00	35.90	179%
Weir Creek	1	17.05	5.73	1.27	0.00	0.00	2.26	0.00	0.00	0.00	0.00	26.30	-5%
Basin Creek	1	3.92	1.15	0.53	1.55	0.20	0.00	0.00	0.00	0.00	0.10	7.44	nc
Beaver Creek	2	4.97	3.89	3.60	2.83	0.11	0.00	0.00	0.29	5.11	0.00	20.79	220%
Frenchman Creek	1	11.08	0.34	0.58	0.00	0.00	0.00	0.00	0.51	3.71	0.00	16.22	-76%

Table 7. Length and weight statistics of wild steelhead juveniles PIT tagged at trap sites in the Clearwater River drainage in 2003.

	Fork length (mm)				Weight (g)			Condition factor	
Release site	**Number**	**Mean**	**95% CI**	**Median**	**Number**	**Mean**	**95% CI**	**Mean**	**95% CI**
Spring period (start of trapping to 5/31)									
Crooked Fork Creek	96	173	4	174	96	50.2	2.7	0.9385	0.0104
Clear Creek[a]	603	155	1	153	585	37.9	0.9	1.0044	0.0078
Colt Killed Creek	92	180	2	180	92	51.8	2.0	0.8763	0.0104
Fish Creek	36	148	11	155	36	35.2	6.4	0.9640	0.0226
Red River	1	81		81	1	3.4		0.6398	
Summer period (6/1 to 8/31)									
Crooked Fork Creek	195	136	5	129	195	31.7	3.2	1.0912	0.0130
Colt Killed Creek	28	117	5	116	28	17.8	2.5	1.0811	0.0495
Fish Creek	2,004	132	1	132	1,705	25.1	0.7	1.0456	0.0045
Red River	14	106	22	91	11	12.6	7.5	0.9887	0.1910
Fall period (9/1 to end of trapping)									
Crooked Fork Creek	184	168	3	167	184	48.0	2.2	0.9871	0.0089
Colt Killed Creek	18	174	5	174	18	51.6	4.5	0.9702	0.0277
Fish Creek	5,425	136	1	134	5,288	26.3	0.4	0.9633	0.0018
Year total									
Crooked Fork Creek	475	156	3	163	475	41.8	1.8	1.0200	0.0087
Clear Creek	603	155	1	153	585	37.9	0.9	1.0044	0.0078
Colt Killed Creek	138	167	5	176	138	44.9	2.8	0.9301	0.0185
Fish Creek	7,465	135	1	134	7,029	26.0	0.3	0.9832	0.0019
Red River	15	104	21	87	12	11.9		0.9596	

[a] Includes six fish captured and tagged between June 1 and June 11, 2003.

Table 8. Length and weight statistics of wild steelhead juveniles PIT tagged at trap sites in the Salmon River drainage in 2003.

	Fork length (mm)				Weight (g)			Condition factor	
Release site	**Number**	**Mean**	**95% CI**	**Median**	**Number**	**Mean**	**95% CI**	**Mean**	**95% CI**
Spring period (start of trapping to 5/31)									
Johnson Creek	80	149	7	161	80	35.3	4.0	0.9384	0.0170
Lake Creek	23	110	7	112	23	14.1	2.8	0.9915	0.0346
Lemhi River	168	131	6	114	167	29.3	4.4	1.0441	0.0275
Marsh Creek	40	119	10	113	39	21.4	6.3	1.0137	0.0195
Pahsimeroi River	1,366	133	1	125	1,366	26.9	0.9	1.0350	0.0048
Salmon River	390	157	2	159	390	38.8	1.5	0.9588	0.0084
Secesh River	17	114	11	109	16	16.8	6.2	0.9966	0.3640
SF Salmon River	168	115	3	110	167	16.1	1.2	1.0161	0.0159
Summer period (6/1 to 8/31)									
Johnson Creek	257	128	4	127	257	26.1	2.2	1.0526	0.0116
Lake Creek	219	140	3	139.0	212	33.5	2.7	1.1367	0.0166
Lemhi River	359	121	2	117	359	21.4	1.3	1.1287	0.0120
Marsh Creek	310	117	3	112	304	21.4	2.0	1.0923	0.0103
Pahsimeroi River	86	121	3	117	86	20.9	2.0	1.1143	0.0279
Salmon River	63	153	7	162	63	40.5	5.3	1.0229	0.0217
Secesh River	147	137	4	132	147	33.6	3.4	1.1707	0.0188
SF Salmon River	317	129	3	123	314	28.6	1.9	1.2176	0.0144
Fall period (9/1 to end of trapping)									
Johnson Creek	113	151	4	151	113	35.1	2.5	0.9751	0.0100
Lake Creek	44	153	9	151	44	42.2	8.7	1.0296	0.0259
Lemhi River	459	179	3	183	335	74.0	4.0	1.1060	0.0088
Marsh Creek	225	138	3	139	224	28.3	1.9	0.9884	0.0090
Pahsimeroi River	794	135	2	126	794	28.3	1.5	1.0020	0.0070
Salmon River	75	160	7	161	75	45.7	6.2	1.0294	0.0420
Secesh River	22	147	12	151	19	32.6	7.4	1.0490	0.0420
SF Salmon River	138	134	4	131	138	28.7	2.8	1.0697	0.0179
Year total									
Johnson Creek	450	138	3	144	450	30.0	1.6	1.0129	0.0088
Lake Creek	286	139	3	137	279	33.3	2.6	1.1078	0.0148
Lemhi River	986	150	3	140	861	43.4	2.5	1.1035	0.0083
Marsh Creek	575	125	2	122	567	24.1	1.4	1.0458	0.0078
Pahsimeroi River	2,246	133	1	125	2,246	27.1	0.8	1.0264	0.0041
Salmon River	528	157	2	159	528	39.9	1.5	0.9765	0.0093
Secesh River	186	136	4	132	182	32.0	2.9	1.1427	0.0181
SF Salmon River	623	126	2	119	619	25.3	1.3	1.1303	0.0118

Table 9. Length and weight statistics of PIT-tagged wild steelhead juveniles that were collected flyfishing, electroshocking, and in a minnow trap in 2003.

	Fork length (mm)				Weight (g)			Condition factor	
Release site	**Number**	**Mean**	**95% CI**	**Median**	**Number**	**Mean**	**95% CI**	**Mean**	**95% CI**
Flyfishing									
Boulder Creek	205	138	2	132	205	29.4	2.5	1.0035	0.0115
Fish Creek	257	142	2	146	227	27.9	1.9	0.9101	0.0265
Gedney Creek	138	136	5	139	138	30.7	2.2	1.0650	0.0159
Lick Creek	593	131	2	128	343	25.1	1.5	1.0366	0.0074
Hungery Creek	115	140	5	145	115	34.5	3.6	1.1219	0.0123
Electroshock									
Big Creek	196	106	3	103	173	15.1	1.7	1.1217	0.0215
Camas Creek	70	99	4	96.5	29	11.7	2.0	1.1508	0.0441
Chamberlain Creek	30	134	12	140	13	20.5	8.7	1.1016	0.0553
Herd Creek	149	119	3	115	9	18.5	6.4	1.1426	0.1350
Loon Creek	34	106	6	102.5	0				
Valley Creek	88	106	4	103.5	52	14.8	2.7	1.2202	0.0424
Rush Creek	67	100	4	94	0				
Minnow trap									
Fish Creek	22	117	13	114	22	15.2	2.2	0.9336	0.0343
Beach seine									
WF Chamberlain Creek	56	99	6	92	0				

Table 10. The number of wild steelhead juveniles that were captured in the Fish Creek screw trap, number of marked fish released upstream of the trap, number of recaptures, trap efficiency (p), migration estimate (Migrants), and 95% CI of the migration estimate for each trap period in 2003. Steelhead fry that emerged in 2003 (fish <80 mm) were excluded from this analysis.

Trap period	**Start date**	**End date**	**Catch**	**Marks**	**Recaps**	**p**	**Migrants**	**95% CI Lower**	**95% CI Upper**
1	3/10	6/2	36	35	1	0.03	648	120	486
2	6/3	6/16	19	12	1	0.08	124	32	234
3	6/17	6/30	272	212	31	0.15	1,811	916	3,516
4	7/1	7/14	561	465	67	0.14	3,845	1,872	8,856
5	7/15	7/28	123	132	7	0.05	2,045	612	2,106
6	7/29	8/14	93	81	14	0.17	508	258	1,068
7	8/15	8/28	1,066	251	49	0.20	5,373	2,991	10,089
8	8/29	9/11	1,177	296	74	0.25	4,661	2,765	8,388
9	9/12	9/25	4,872	2,127	635	0.30	16,301	10,355	28,728
10	9/26	10/9	884	590	171	0.29	3,038	1,908	5,292
11	10/10	10/28	2,564	708	355	0.50	5,106	3,801	7,206
12	10/29	11/1	293	155	24	0.15	1,828	903	3,540
Fall period, 8/15 to 10/31							**36,307**	**34,214**	**38,687**
Entire year							**45,288**	**42,087**	**48,073**

Table 11. The number of wild steelhead that were detected as smolts in 2003, the number of steelhead PIT tagged, and the percent of all PIT-tagged fish that were ≥125 mm from each period that were detected in 2003. Tagging periods were: Period 1 = March 1, 2003 to May 31, 2003; Period 2 = August 15, 2002 to December 31, 2002; Period 3 = June 1, 2002 to August 14, 2002; Period 4 = March 1, 2002 to May 31, 2002; Period 5 = March 1, 2001 to December 31, 2001. na = not applicable; no fish were tagged during the period.

	Number of smolts detected that were tagged in Period						Number of fish tagged in Period					Percent of fish ≥125 mm detected from Period				
Release site	**All**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Clearwater River drainage																
Boulder Creek	16	0	0	2	0	14	0	3	11	0	476	na	0%	22%	na	2.1%
Crooked Fork Creek	225	61	93	12	3	56	97	242	101	171	1,605	65%	39%	23%	1%	2.3%
Clear Creek	377	369	0	2	6	0	597	0	219	466	110	62%	na	0%	0%	0.0%
Colt Killed Creek	75	62	10	2	0	1	92	25	20	253	220	67%	42%	29%	0%	0.5%
Fish Creek	70	0	0	47	10	13	22	0	303	134	651	0%	na	21%	10%	0.8%
Fish Creek screw trap	1,433	11	1,116	89	1	216	36	4,275	457	29	6,875	44%	36%	35%	0%	1.7%
Gedney Creek	42	0	0	19	0	23	0	0	309	0	781	na	na	10%	na	1.4%
Red River	7	0	0	4	2	1	1	1	77	78	75	na	0%	17%	2%	0.0%
Total	**2,245**	**503**	**1,219**	**177**	**22**	**324**	**845**	**4,546**	**1,497**	**1,131**	**10,793**	**62%**	**37%**	**22%**	**1%**	**1.7%**
Salmon River drainage																
Bear Valley Creek	19	0	0	2	0	17	0	0	129	0	536	na	na	6%	na	1.4%
Elk Creek	7	0	0	1	0	6	0	0	68	0	127	na	na	9%	na	0.0%
Herd Creek	9	0	0	9	0	0	0	0	308	0	139	na	na	4%	na	0.0%
Johnson Creek	108	34	21	17	3	33	80	171	1,231	769	1,699	55%	21%	13%	1%	1.4%
Lake Creek	14	0	2	8	0	4	23	40	186	29	224	0%	6%	10%	0%	1.4%
Lemhi River	20	15	2	1	2	0	169	35	42	71	0	22%	6%	0%	2%	na
Lick Creek	65	0	8	28	0	29	0	145	448	0	640	na	9%	9%	na	3.6%
Lower SF Salmon River	45	0	17	12	0	16	0	94	89	38	304	na	24%	24%	0%	2.8%
Marsh Creek	81	2	34	21	2	22	40	310	452	69	352	15%	15%	13%	3%	3.6%
Pahsimeroi River	164	150	9	1	2	2	1,370	348	119	734	925	21%	4%	1%	0%	0.0%
Salmon River	123	106	8	1	3	5	390	113	48	197	689	29%	8%	0%	0%	0.0%
Secesh River	79	1	8	24	1	45	17	58	262	24	446	50%	17%	17%	17%	3.8%
SF Salmon River	65	8	27	7	14	9	168	359	177	79	324	27%	19%	8%	22%	0.7%
Total	**799**	**316**	**136**	**132**	**27**	**188**	**2,257**	**1,673**	**3,559**	**2,010**	**6,405**	**25%**	**14%**	**10%**	**1%**	**1.5%**

Table 12. Fork length (mm) at the time of tagging or recapture of wild steelhead smolts that were detected in 2003. All fish were tagged or recaptured between August 15, 2002 and May 31, 2003.

Release site	Number	Mean length	95% CI (± mm)	Median length	Minimum length	Maximum length
Clearwater River drainage						
Crooked Fork Creek	154	174	2	173	144	201
Clear Creek	369	155	1	153	122	198
Colt Killed Creek	72	180	3	178.5	157	207
Fish Creek	1,161	154	1	154	114	213
Salmon River drainage						
Big Creek	67	169	4	166	124	212
Camas Creek	116	178	3	180	126	238
Johnson Creek	55	168	4	172	137	204
Lemhi River	17	189	18	196	121	241
Lick Creek	10	161	9	161	142	181
Loon Creek	67	174	6	174	131	241
Lower SF Salmon River	17	160	11	154	131	198
Marsh Creek	38	162	5	161	125	191
Pahsimeroi River	158	159	3	158	100	216
Salmon River	114	162	3	162	124	209
SF Salmon River	36	158	6	159	132	198

Table 13. Travel time (days and km/day) of wild steelhead smolts tagged in the spring 2003 from screw trap to Lower Granite Dam (LGR). N = number of smolts detected at Lower Granite Dam.

		Distance	Travel time (days)			Travel time (km/day)		
Stream	**N**	**to LGR (km)**	**Median**	**Lower**	**Upper**	**Median**	**Lower**	**Upper**
Clearwater River drainage								
Crooked Fork Creek	34	324	6	6	8	54.0	54.0	40.5
Clear Creek	223	176	6	6	6	29.3	29.3	29.3
Colt Killed Creek	34	322	7	6	8	46.0	53.7	40.3
Salmon River drainage								
Johnson Creek	15	407	14	9	43	29.1	45.2	9.5
Pahsimeroi River	66	621	10	9	11	62.1	69.0	56.5
Salmon River, Sawtooth	51	747	16	12	19	46.7	62.3	39.3

Table 14. The number of scales that were collected from adult and juvenile steelhead during 2003.

Stream	Number of scales collected from	
	Adults	Juveniles
Clearwater drainage		
Colt Killed Creek		92
Crooked Fork Creek		201
Fish Creek	340	654
Gedney Creek		17
North Fork Moose Creek		40
Red River		30
Salmon drainage		
Horse Creek		38
Lemhi River		133
Marsh Creek		180
Rapid River	88	0
Salmon River at Sawtooth Hatchery		249
SF Salmon River at Knox bridge		191

Table 15. The ocean age proportions of adult steelhead trapped at Fish Creek from 1998 to 2002 and Rapid River from 1998 to 2001.

Stream	Year	Number	Proportion of fish aged		
			1	2	3
Fish Creek	1998	62	0.177	0.823	0
	1999	62	0.016	0.984	0
	2000	21	0.143	0.857	0
	2001	56	0.107	0.893	0
	2002	156	0.519	0.474	0.006
Rapid River	1998	12	0.167	0.833	0
	1999	3	0	1.0	0
	2000	4	1.0	0	0
	2001	25	0.4	0.6	0

Table 16. The mean length (cm) and 95% CI (in parenthesis) of adult steelhead that spent one or two years in the ocean.

		Ocean age-1		Ocean age- 2	
Stream	**Year**	**Number**	**Mean length**	**Number**	**Mean length**
Fish Creek	1998	11	63 (3)	51	78 (1)
	1999	1	65	61	79 (1)
	2000	3	64 (8)	18	80 (3)
	2001	6	66 (3)	50	79 (1)
	2002[a]	81	67 (1)	74	80 (1)
Rapid River	1998	2	68 (13)	10	76 (3)
	1999	0		3	75 (10)
	2000	4	65 (10)	0	
	2001	10	62 (4)	15	76 (4)

[a] One 89 cm adult was aged 3-ocean.

Table 17. The proportion of juvenile steelhead age classes from 1999 to 2002 based on scale analysis. The spring period includes scales collected between March 1 and June 15 of each year, and the fall scales were collected after August 14 of each year.

				Proportion of fish aged					
Stream	**Year**	**Period**	**Number**	**0**	**1**	**2**	**3**	**4**	**5**
Colt Killed Creek	1999	Spring	101	0	0.020	0.030	0.337	0.535	0.079
	2000	Spring	58	0	0.241	0.241	0.190	0.224	0.103
	2001	Fall	64	0	0.016	0.422	0.563	0	0
Crooked Fork Creek	1999	Fall	86	0	0.442	0.372	0.128	0.058	0
	2000	Spring	69	0	0.232	0.420	0.290	0.058	0
	2000	Fall	132	0	0.273	0.682	0.045	0	0
	2001	Fall	194	0.124	0.423	0.376	0.077	0	0
Fish Creek	2002	Fall	360	0	0.603	0.350	0.047	0	0
Marsh Creek	2001	Fall	113	0.310	0.460	0.186	0.044	0	0
Pahsimeroi River	1999	Fall	88	0.614	0.330	0.057	0	0	0
	2000	Fall	155	0.619	0.368	0.013	0	0	0
	2001	Fall	122	0.754	0.238	0.008	0	0	0
Salmon River[a]	2001	Spring	221	0	0.656	0.231	0.109	0.005	0
	2001	Fall	42	0.739	0.152	0.087	0.022	0	0
	2002	Spring	117	0	0.248	0.590	0.137	0.026	0

[a] Salmon River fish were collected in a screw trap at the Sawtooth Fish Hatchery site.

Table 18. The mean length (mm) and 95% CI (in parenthesis) of juvenile steelhead aged in 2003. Numbers in italics indicate that the sample size for that age class was <10 fish and that the 95% CI was not reported. The spring period includes scales collected between March 1 and June 15 of each year, and the fall collection period was after August 14 of each year.

			Mean length (mm) of age class					
Stream	**Period**	**Year**	**0**	**1**	**2**	**3**	**4**	**5**
Colt Killed Creek	spring	1999		*82*	*165*	185 (6)	193 (4)	*199*
	spring	2000		76 (5)	167 (10)	176 (11)	189 (6)	*195*
	fall	2001			164 (5)	180 (4)		
Crooked Fork Creek	fall	1999		155 (3)	173 (5)	182 (9)	*192*	
	spring	2000		78 (5)	166 (5)	185 (7)	*191*	
	fall	2000		146 (4)	174 (4)	*192*		
	fall	2001	87 (3)	127 (4)	177 (5)	193 (8)		
Fish Creek	fall	2002		120 (2)	160 (3)	190 (10)		
Marsh Creek	fall	2001	65 (3)	125 (4)	140 (11)	*183*		
Pahsimeroi River	fall	1999	114 (6)	187 (9)	*189*			
	fall	2000	110 (5)	180 (8)	*201*			
	fall	2001	104 (4)	171 (9)				
Salmon River	spring	2001		92 (2)	156 (7)	170 (6)		
	fall	2001	81 (5)	*148*	*162*			
	spring	2002		107 (3)	154 (4)	166 (14)	*199*	

Table 19. Length (mm) and weight (g) statistics of Chinook salmon, resident trout and dace that were caught in the Fish Creek screw trap in 2003. nm = not measured.

	Number	Fork length (mm)				Weight (g)			Condition factor	
Species	**trapped**	**Number**	**Mean**	**95% CI**	**Median**	**Number**	**Mean**	**95% CI**	**Mean**	**95% CI**
Chinook salmon	107[a]	27	90	5	87	27	8.2	2.0	1.0900	0.0636
Bull trout	7	7	302	34	310	7	306.2	116.8	1.0611	0.0452
Cutthroat trout	379	282	209	6	191.5	275	100.3	10.3	0.9625	0.0110
Longnose dace	2,916	554	103	1	101	551	13.6	0.7		
Speckled dace	744	195	88	2	89	195	9.8	0.4		
Dace spp.										

[a] Of the 107 Chinook salmon that were trapped, 52 were newly emerged fry that were not measured for length or weight.

Table 20. Streams that were sampled for water temperatures in 2003 and the associated winter and summer temperature recording intervals. The water temperature was measured within 1 km of the mouth of each stream unless noted. The winter recording interval in the Salmon River drainage was used from January 1 to April 24 and from October 29 to December 31. The winter recording interval in the Clearwater River drainage was used from January 1 to March 27 and from November 2 to December 31. The Fish Creek air temperature, relative humidity, and barometric pressure were measured at the trailhead. NR = not recorded.

	Recording Interval (Hours)	
Stream	**Winter**	**Other**
Salmon River drainage		
Basin Creek, 500 m upstream of hot springs	2.5	1.5
Beaver Creek, 2 km upstream of irrigation diversion	1.0	1.0
East Fork Salmon River, upstream of Bowery Hot Springs	2.5	1.5
East Fork Salmon River	2.5	1.5
Frenchman Creek, first meadow upstream of mouth	1.0	1.0
Germania Creek	2.5	1.5
Marsh Creek, 100 m downstream of screw trap site	2.5	1.5
Pole Creek, 2 km upstream of irrigation diversion	1.0	1.0
Redfish Lake Creek at weir	2.5	1.5
Salmon River at Sawtooth Fish Hatchery	1.0	0.5
Valley Creek, 200 m upstream of Meadow Creek	2.5	1.5
West Pass Creek, at irrigation diversion	2.5	1.5
Clearwater River drainage		
Bald Mountain Creek	2.0	1.0
Bimerick Creek	2.0	1.0
Boulder Creek	1.0	0.5
Brushy Fork Creek	1.0	1.0
Canyon Creek	1.0	0.5
Crooked Fork Creek, 50 m upstream of Brushy Fork Creek	1.0	1.0
Deadman Creek	2.0	1.0
Fish Creek #1, at screw trap site	0.5	0.5
Fish Creek #2, 100 m upstream of screw trap site	1.0	0.5
Fish Creek #3, 2 km upstream of Hungery Creek	1.0	1.0
Fish Creek, air temperature	2.0	1.0
Fish Creek, barometric pressure	NR	1.0
Fish Creek, relative humidity	NR	1.0
Gedney Creek #1	1.0	0.5
Gedney Creek #2, upstream of mouth about 2 km	1.0	1.0
Hungery Creek	1.0	1.0
Lost Creek	2.0	1.0
O'Hara Creek, 2 km downstream of Hanby Fork	1.0	1.0
Post Office Creek	1.0	0.5
Red River, 1 km upstream of SF Red River	1.0	1.0
SF Red River, 50 m downstream of Schooner Creek	1.0	1.0
Squaw Creek	2.0	1.0
Trapper Creek	1.0	1.0
Weir Creek	1.0	0.5
Wendover Creek	2.0	1.0
WF Gedney Creek	1.2	1.2
Willow Creek (tributary of Fish Creek)	1.0	1.0

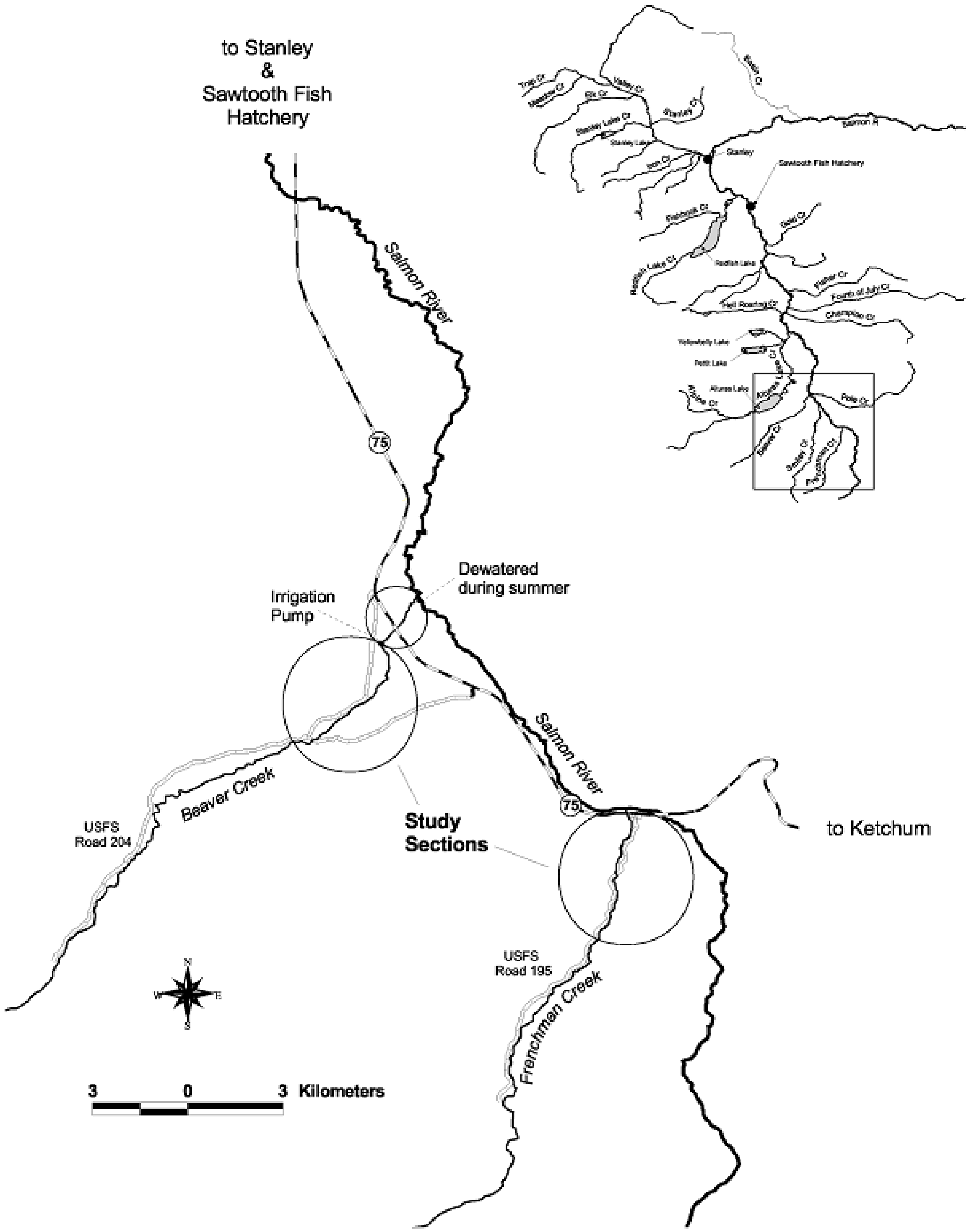


Figure 1. Location of the study section in Beaver and Frenchman creeks. The study sections were stocked with hatchery adult steelhead in May 2003 and were snorkeled in August 2003.

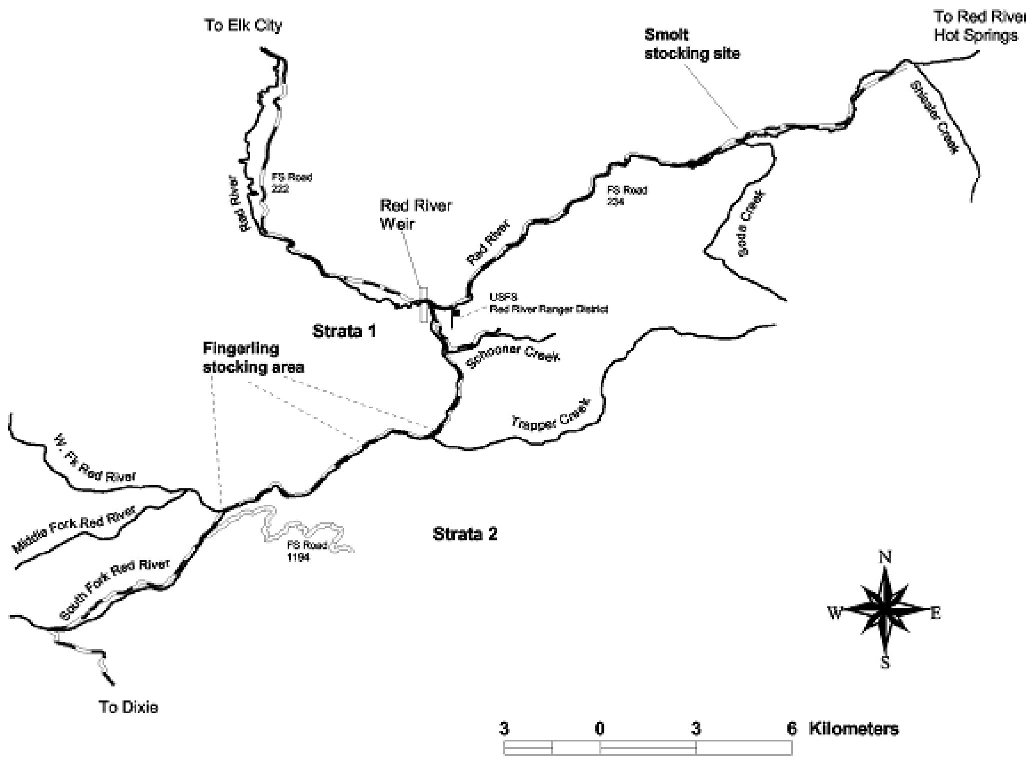


Figure 2. The sites where hatchery steelhead fingerlings were stocked from 1993 through 1996 in the SF Red River and the site in the Red River where hatchery steelhead smolts were stocked from 1996 through 1999. A snorkel survey was done in the SF Red River from its mouth to the WF SF Red River and in Red River from the SF Red River to Shissler Creek in 2003. The Red River weir is located just downstream of the confluence of the SF Red River and Red River.

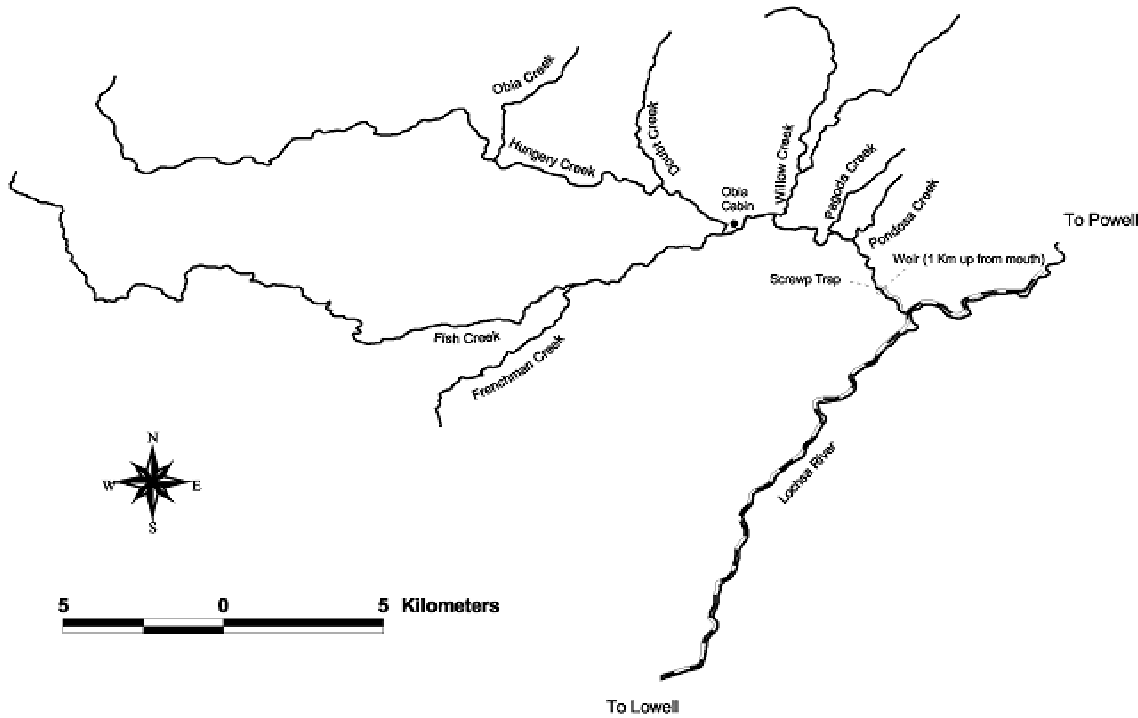


Figure 3. The Fish Creek drainage showing the location of the Fish Creek screw trap and adult weir. Chinook redds were counted in Hungery Creek downstream of Doubt Creek and in Fish Creek from Hungery Creek to the Lochsa River. Water temperature was recorded at the screw trap location.

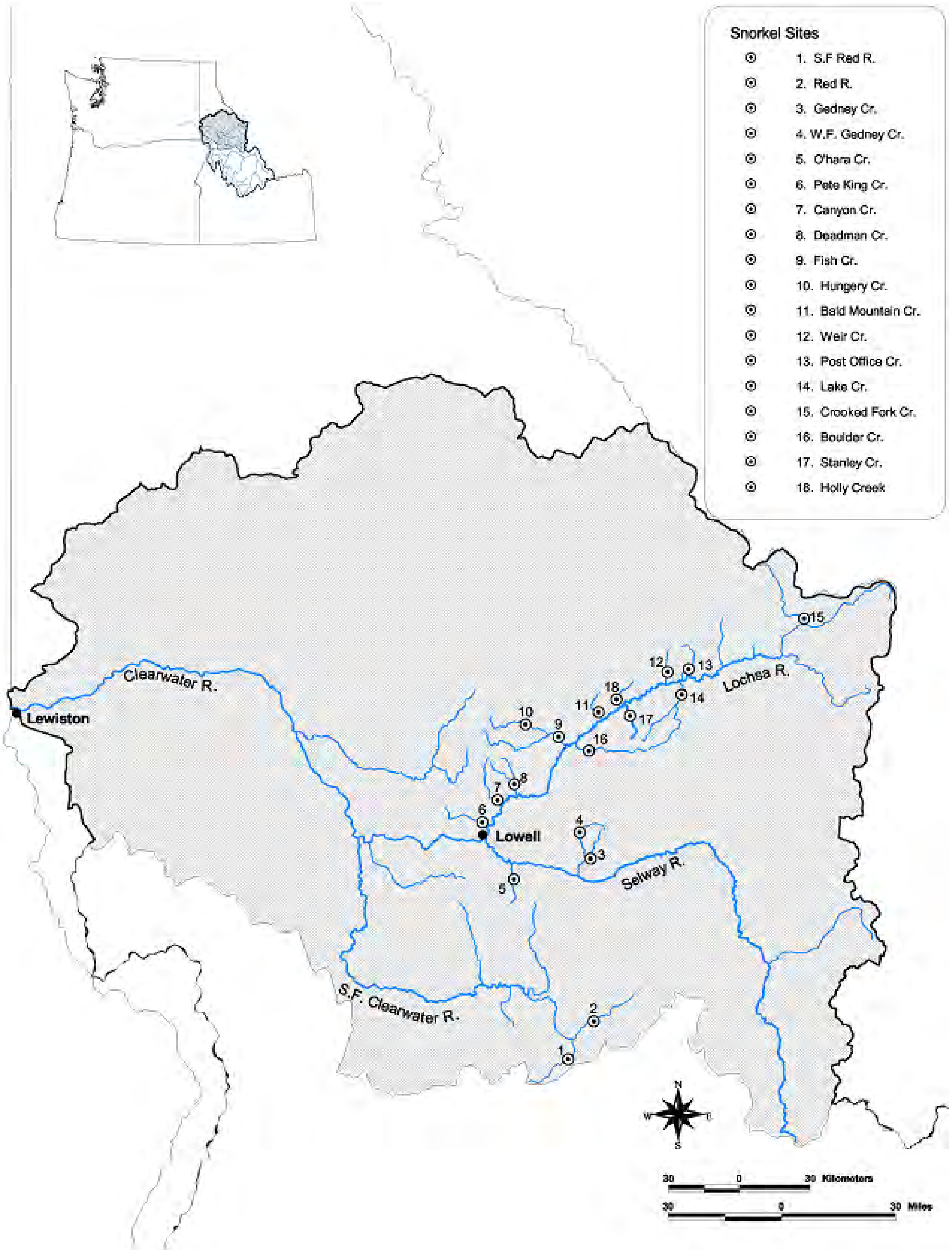


Figure 4. Map of the Clearwater River drainage showing streams that were snorkeled in 2003.

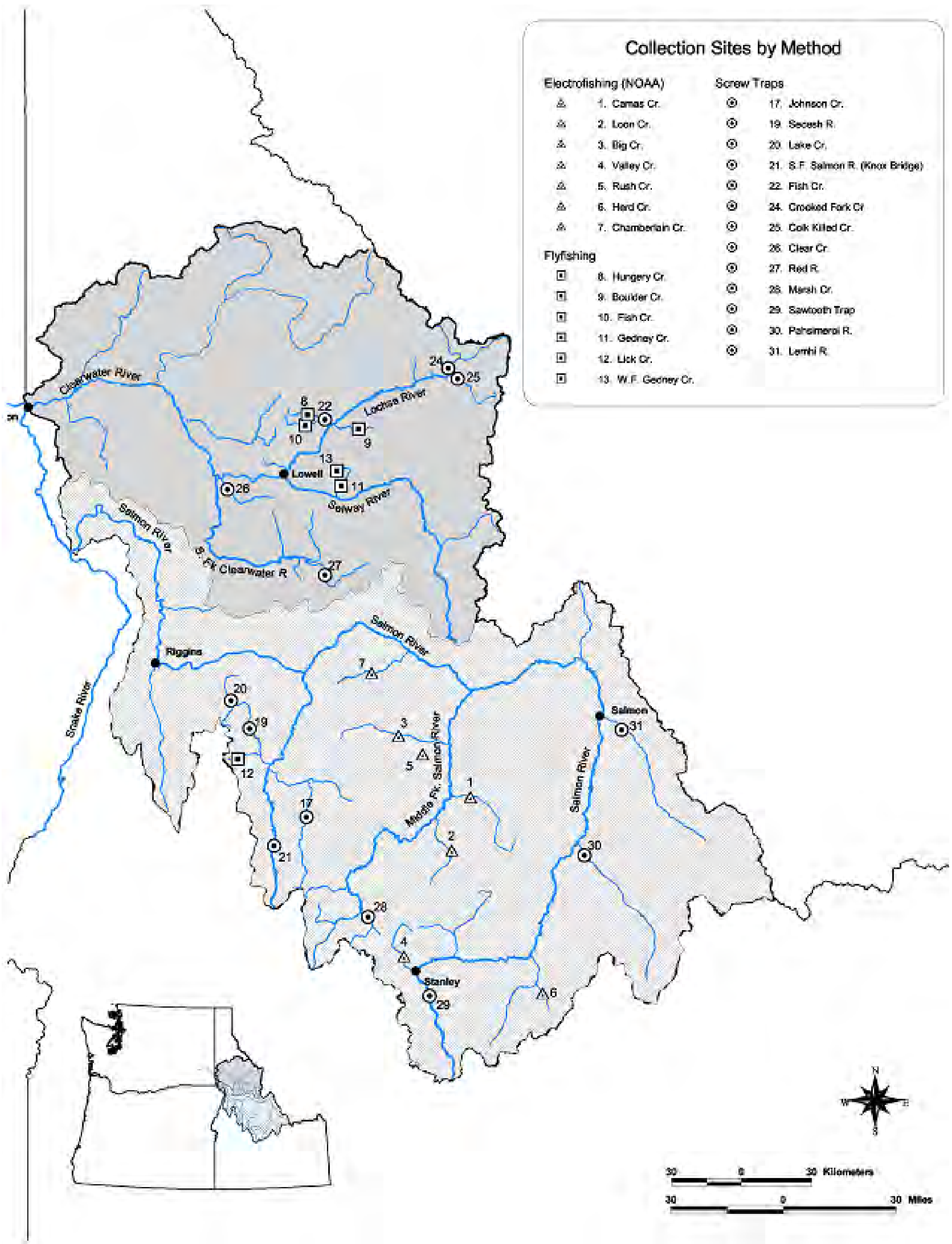


Figure 5. Map of the Salmon and Clearwater drainages showing the sites of the screw traps and the stream where crews captured and PIT tagged juvenile steelhead in 2003.

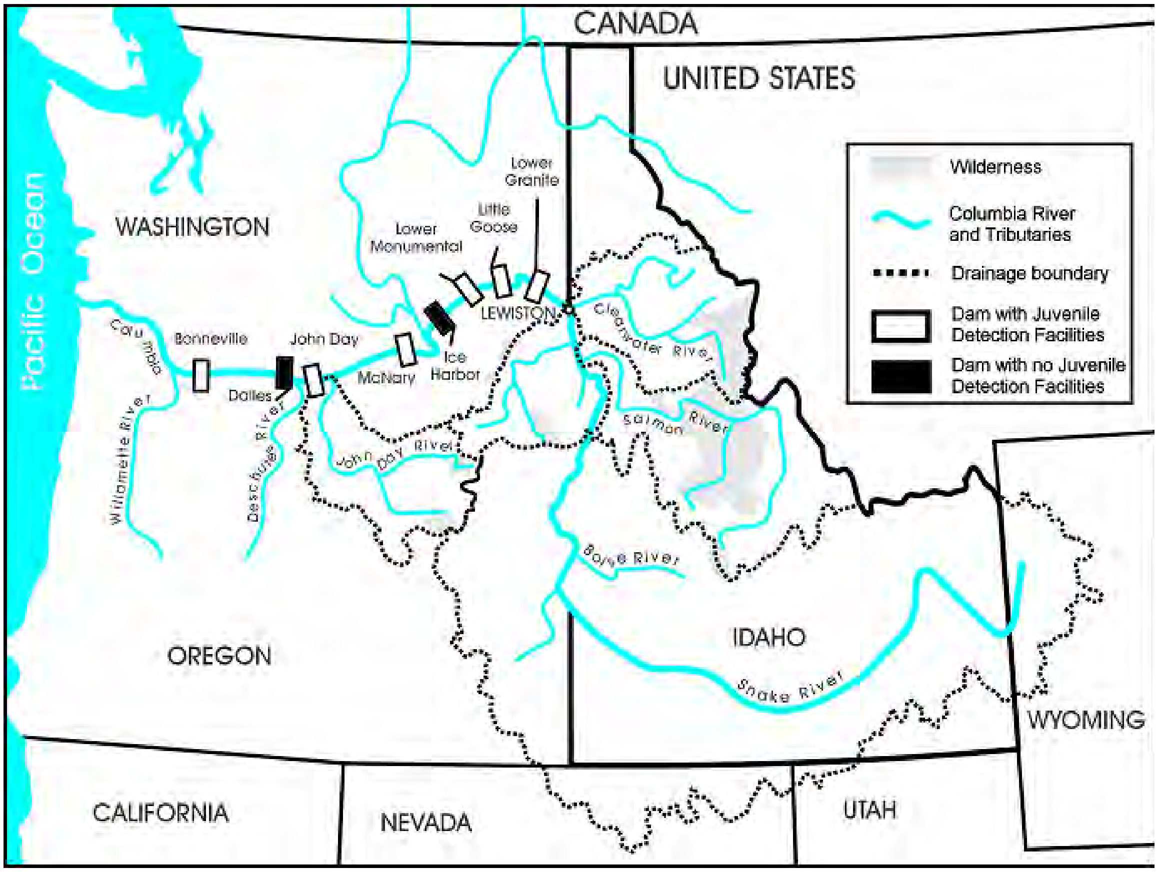


Figure 6. The location of dams on the Snake and Columbia Rivers where PIT tags were detected during the juvenile smolt out-migration in 2003.

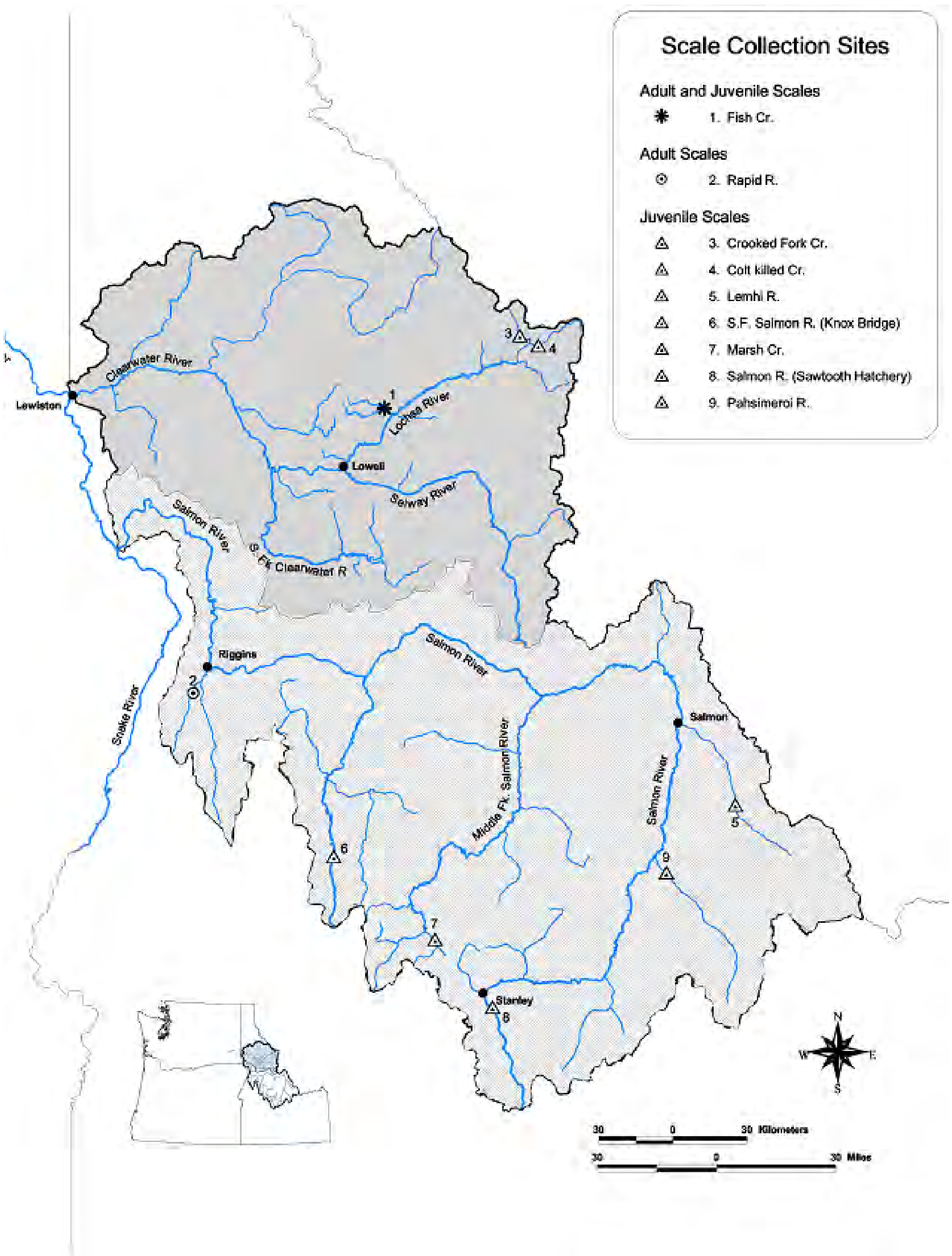


Figure 7. Map showing sites where scales were collected from adult and juvenile steelhead in 2003.

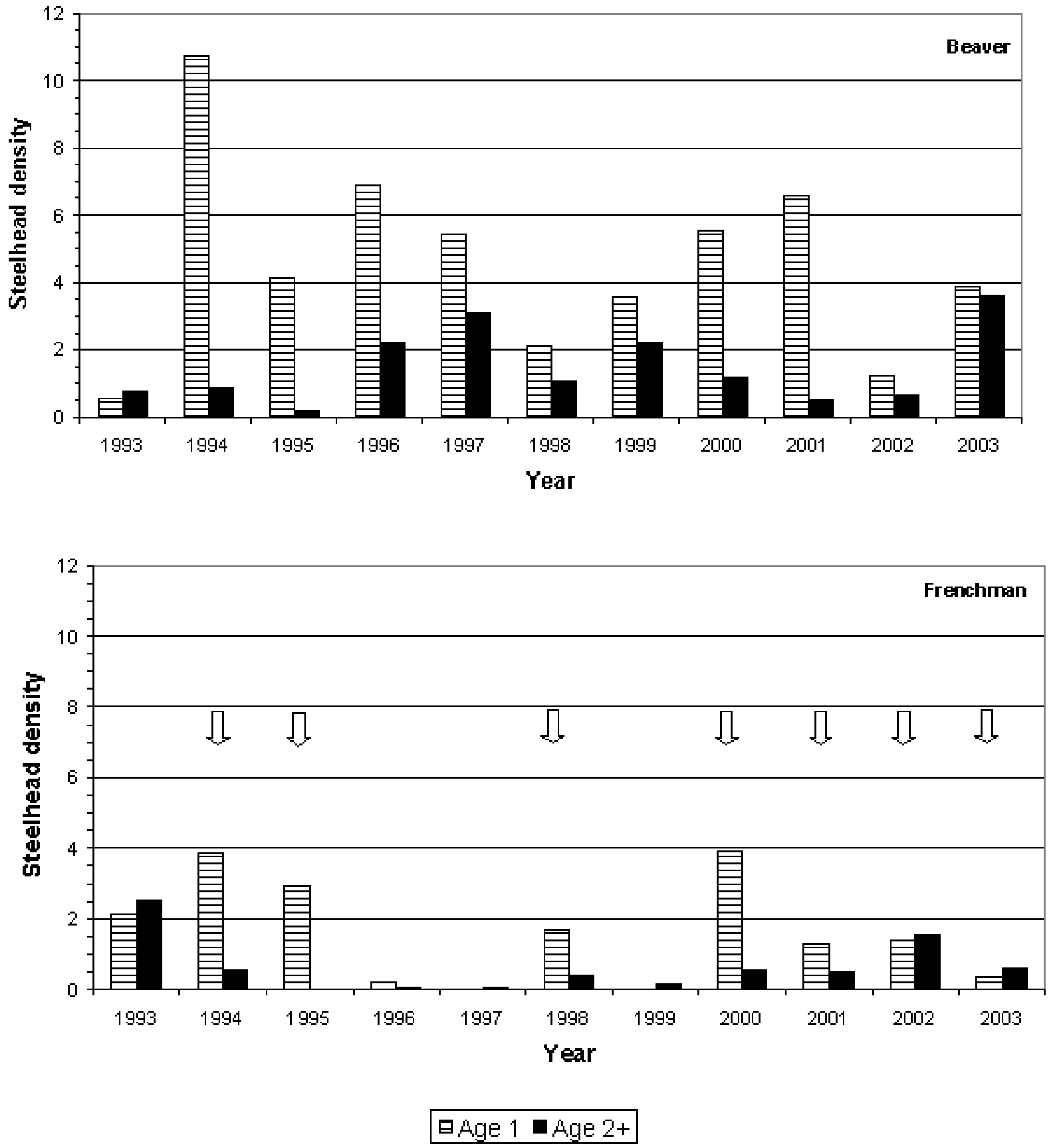


Figure 8. The mean density (fish/100m^2) of age-1 and age-2+ steelhead in Beaver (top) and Frenchman (bottom) creeks from 1993 to 2003. Adult steelhead were stocked in Beaver Creek annually from 1993 through 2003. The years marked with an arrow in the Frenchman Creek graph indicate that adult steelhead were stocked the previous year.

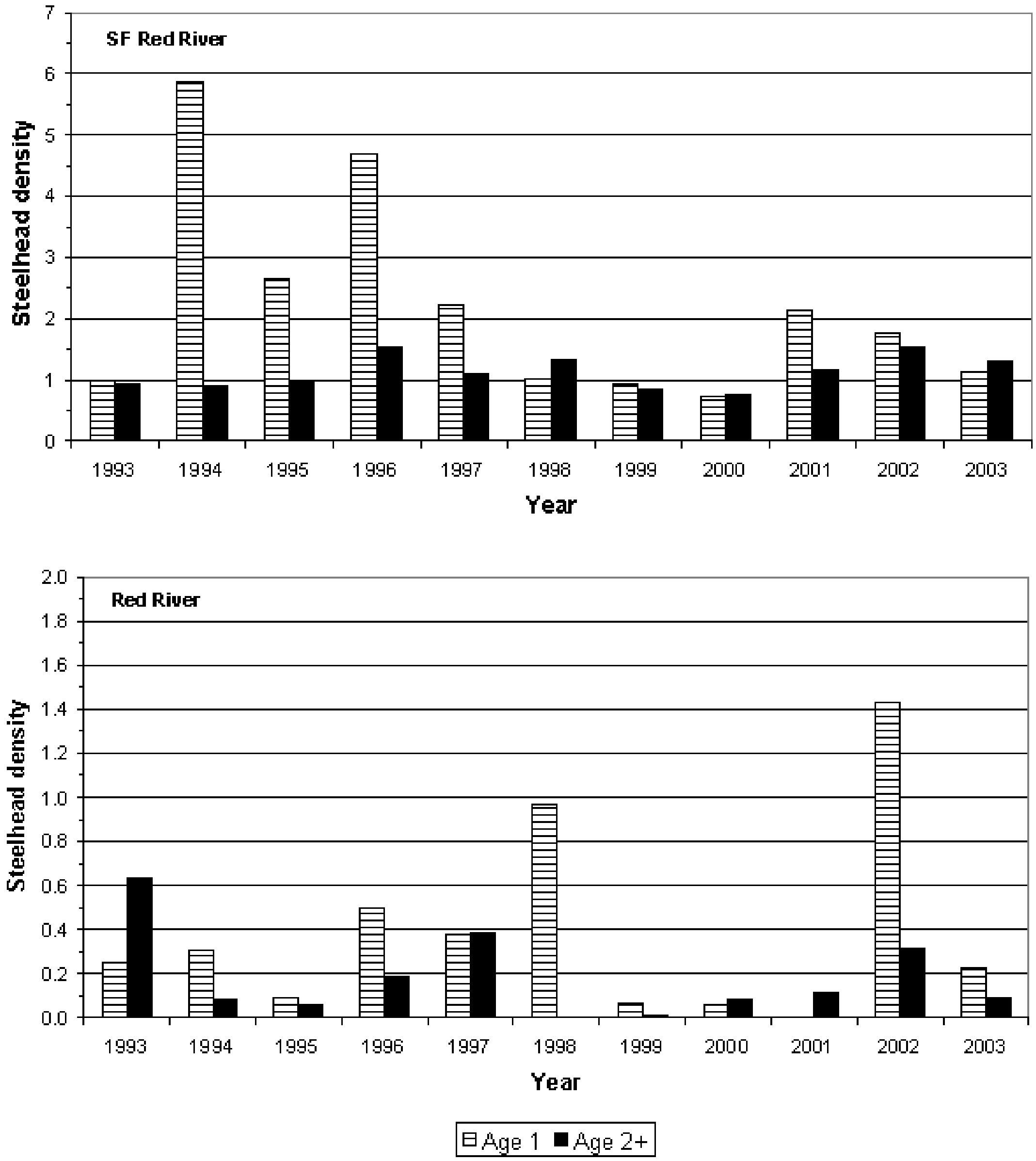


Figure 9. The mean stream density (fish/100 m^2) of age-1 and age-2+ steelhead from 1993 to 2003 in the South Fork (SF) Red River (top) and Red River (bottom) upstream of the SF Red River.

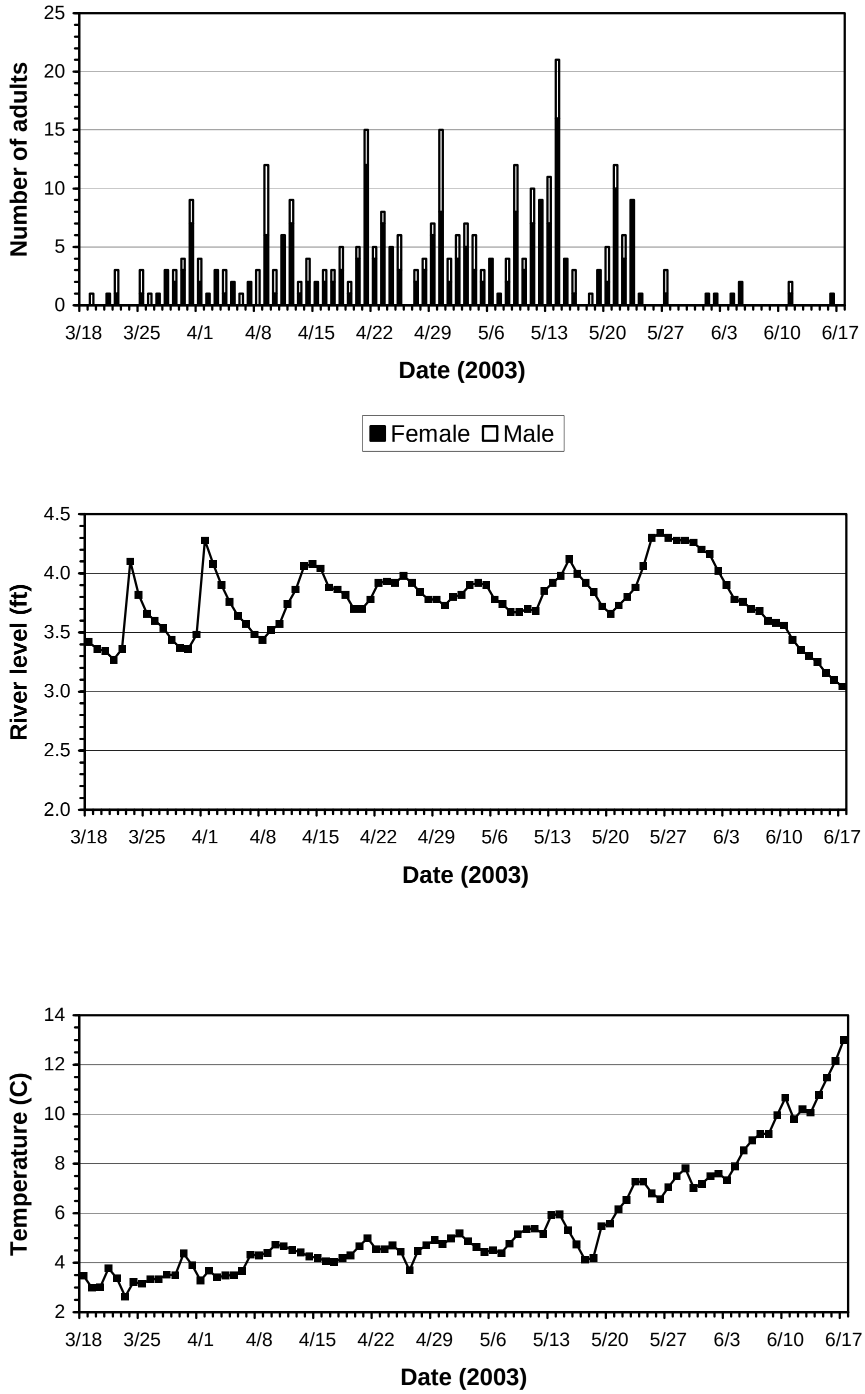


Figure 10. The daily number of adult steelhead trapped at the Fish Creek weir (top), daily Fish Creek river level measured in feet at the USFS gauge (middle), and the daily mean water temperature (°C) in Fish Creek (bottom) from March 18, 2003 to June 17, 2003.

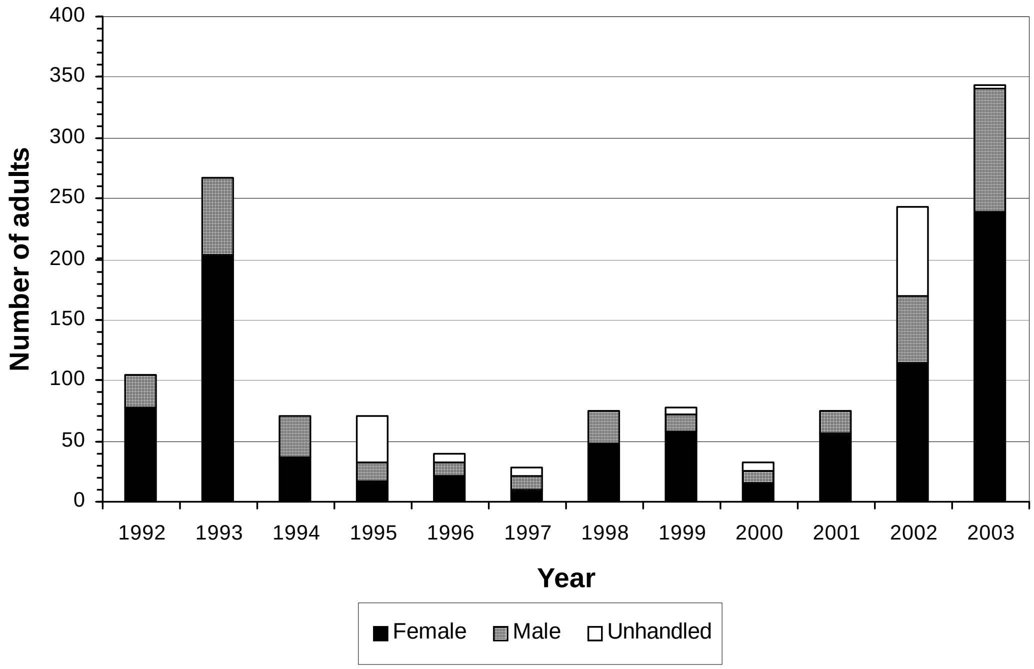


Figure 11. The steelhead escapement in Fish Creek from 1992 to 2003. The open bar is the estimate of unhandled adults that entered Fish Creek in the years the weir was breached or damaged. The solid and cross-hatched bars are the number of fish that were trapped at the weir and passed upstream and the number of unmarked kelts that were recovered.

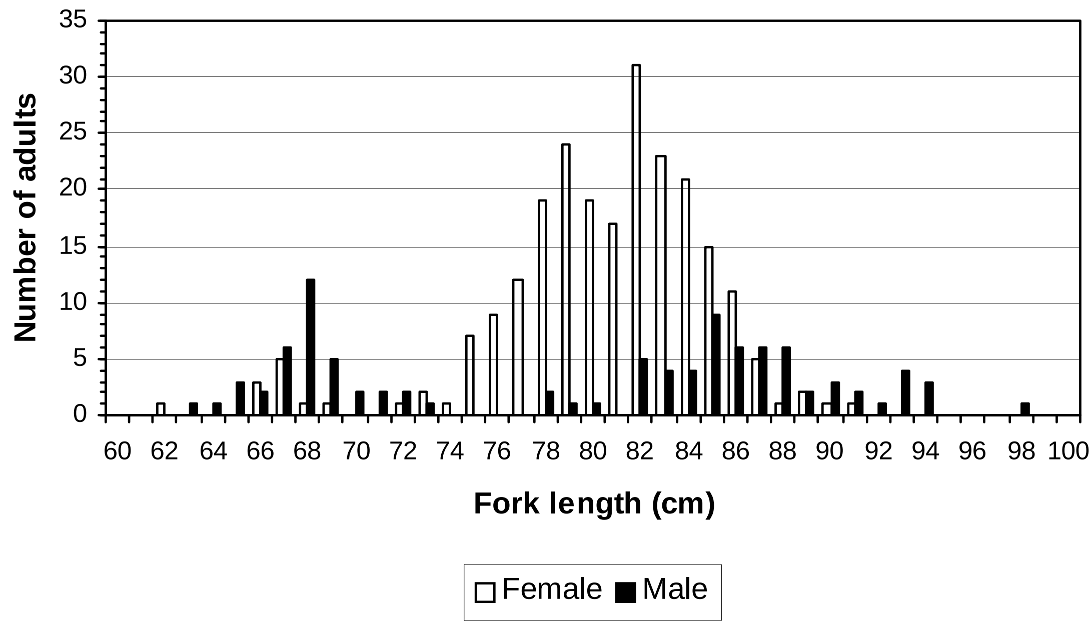


Figure 12. Length frequency of male and female adult steelhead that were trapped at the Fish Creek weir and passed upstream to spawn in 2003.

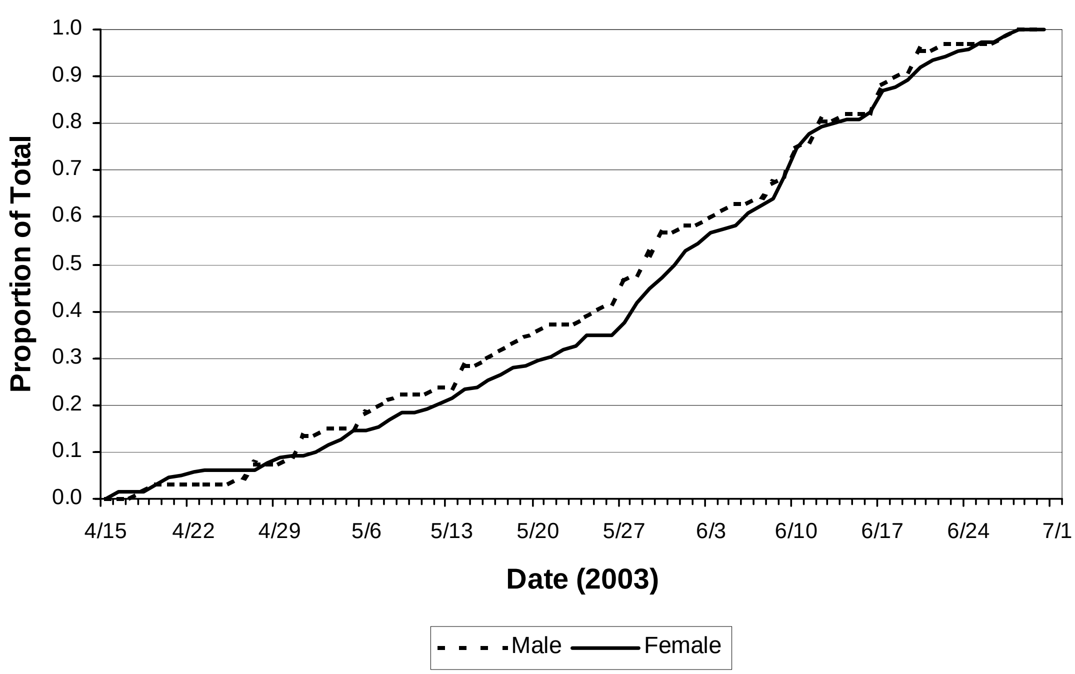


Figure 13. The cumulative proportion of kelts captured at the Fish Creek weir in 2003.

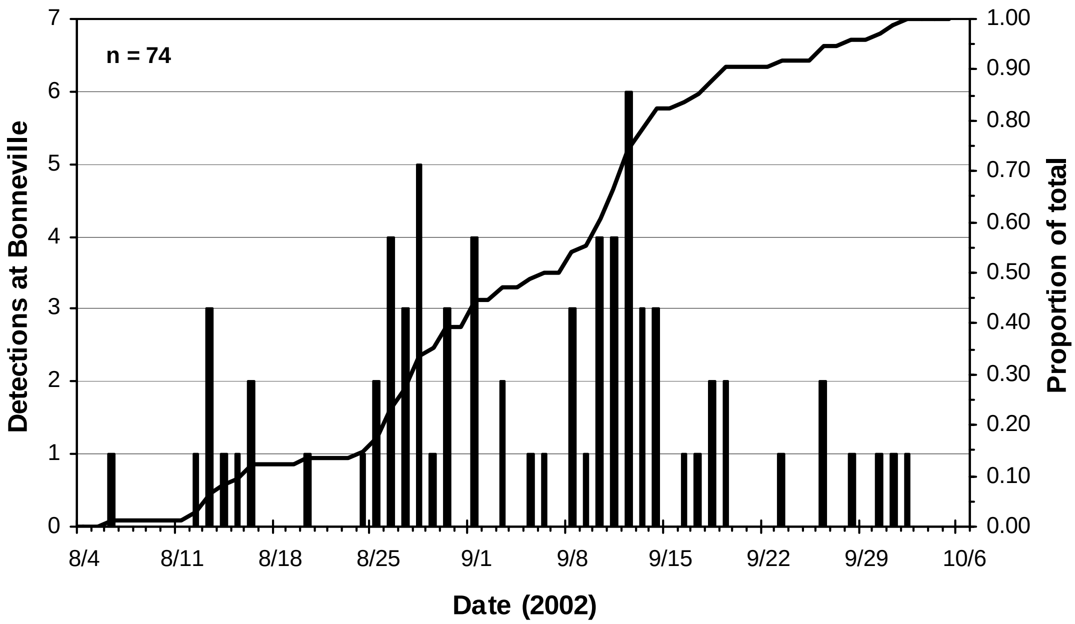


Figure 14. The number of adult detections at Bonneville Dam and the proportion of the total number of detections observed between August 4, 2002 and October 6, 2002. All adults were either PIT tagged as juveniles in Fish Creek or were tagged elsewhere and captured at the Fish Creek weir in 2003.

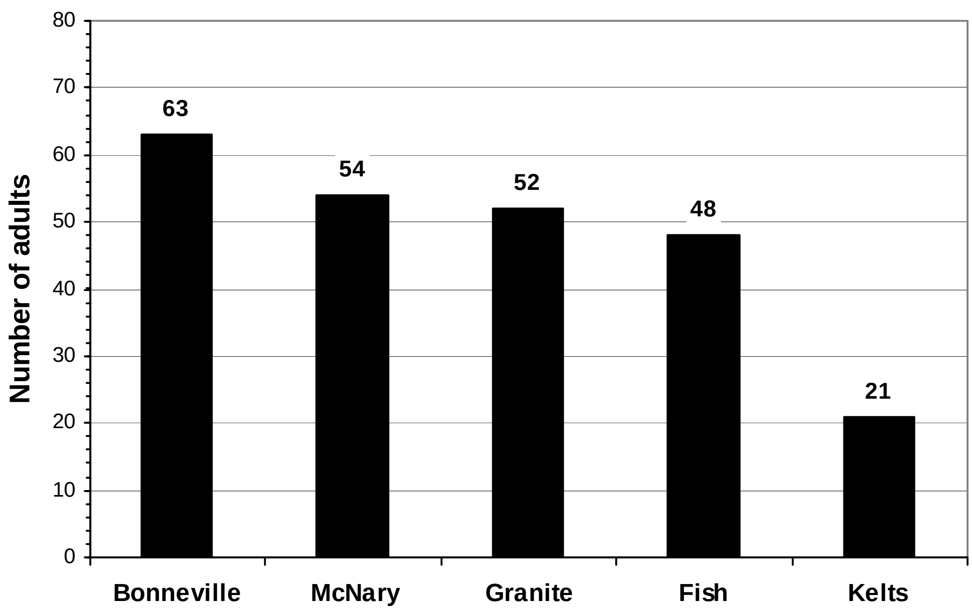


Figure 15. The number of adult steelhead that were PIT tagged in Fish Creek as juveniles that were observed at Bonneville, McNary, and Lower Granite dams between August 12, 2002 and April 7, 2003 and the number of adults (Fish) and kelts that were trapped at the Fish Creek weir during 2003. One adult was detected at McNary Dam that was not detected at Bonneville Dam.

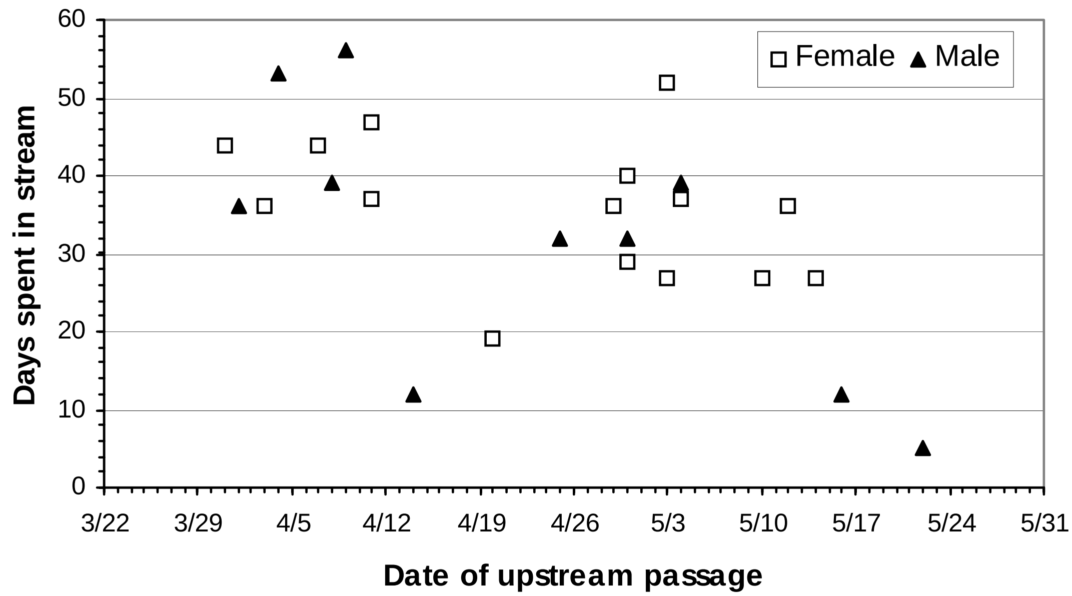


Figure 16. The number of days adult steelhead spent in Fish Creek in 2003 from upstream passage at the weir to recovery as a kelt at the weir.

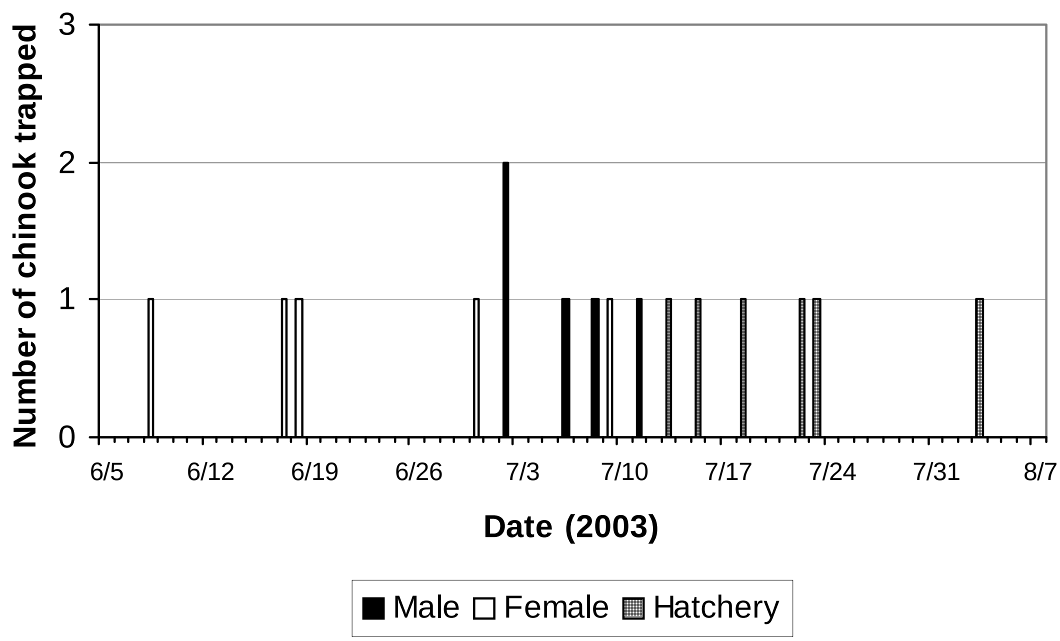


Figure 17. The daily number of adult Chinook salmon that were trapped at the Fish Creek weir between June 5, 2003 and August 7, 2003.

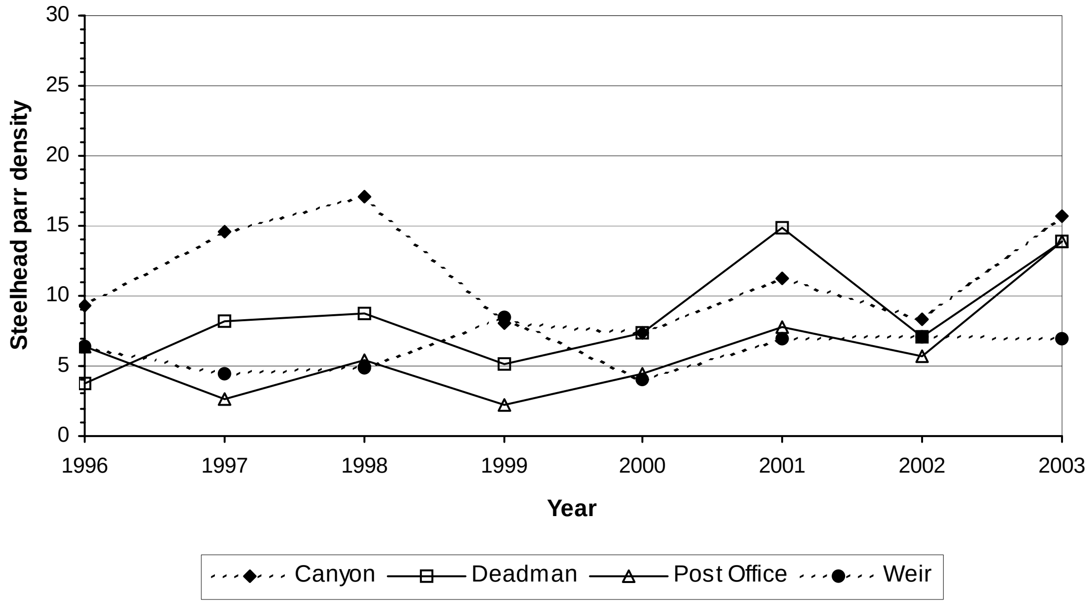


Figure 18. The mean stream density (fish/100 m^2) from 1996 to 2002 of all juvenile steelhead (except fry) in the Lochsa River tributaries Canyon, Deadman, Post Office, and Weir creeks.

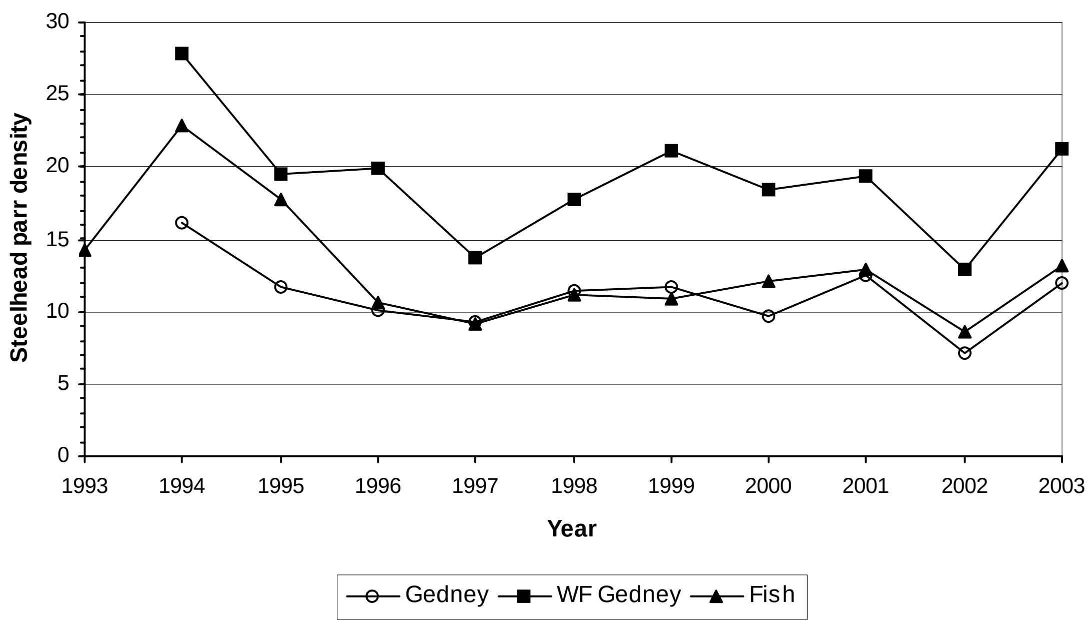


Figure 19. The mean stream density (fish/100 m^2) from 1993 to 2003 of all juvenile steelhead (except fry) in Fish Creek, Gedney Creek strata 1, and West Fork Gedney Creek.

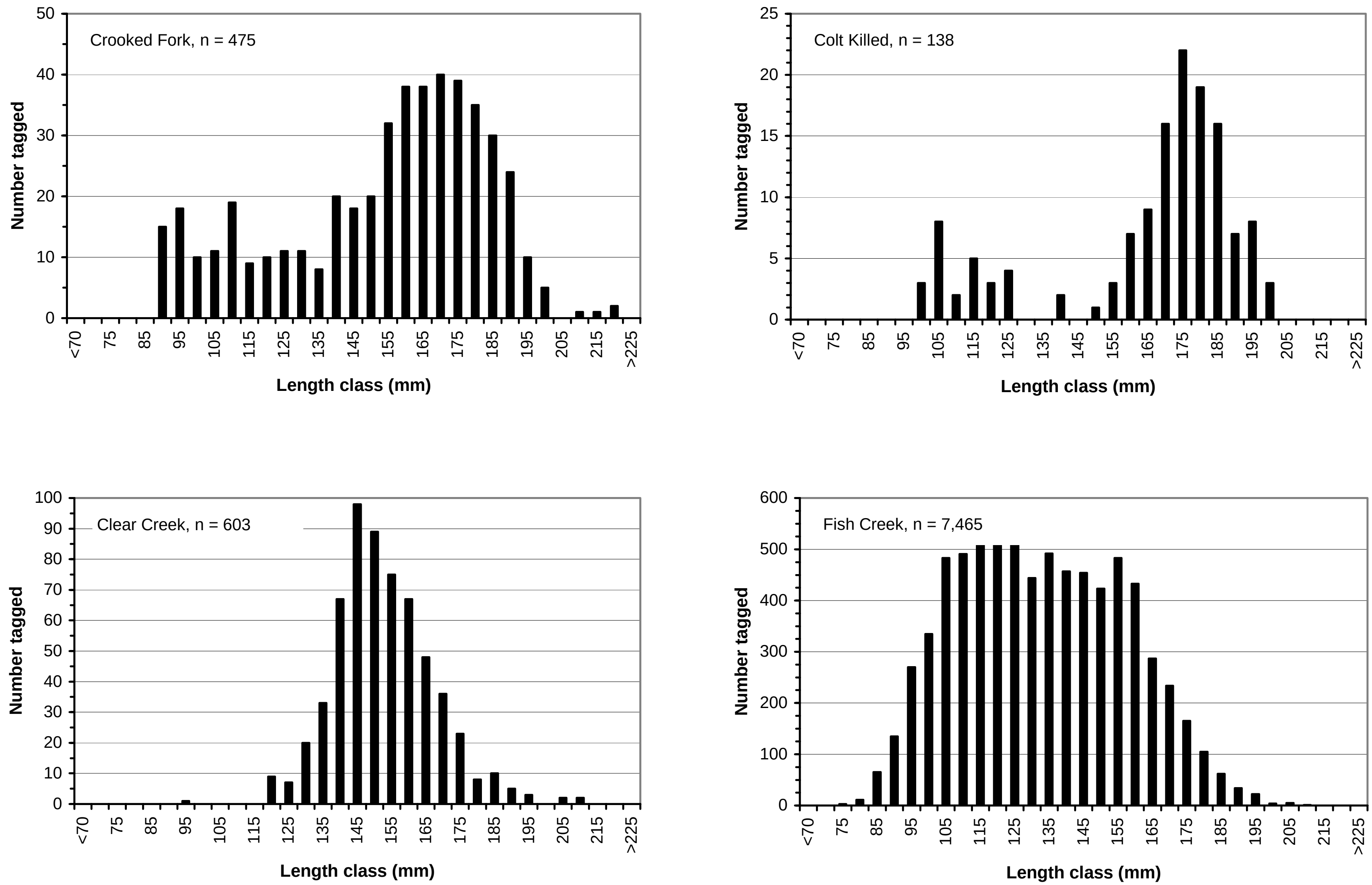


Figure 20. Length frequency of PIT-tagged wild steelhead juveniles captured in screw traps located in tributaries of the Clearwater River drainage during 2003.

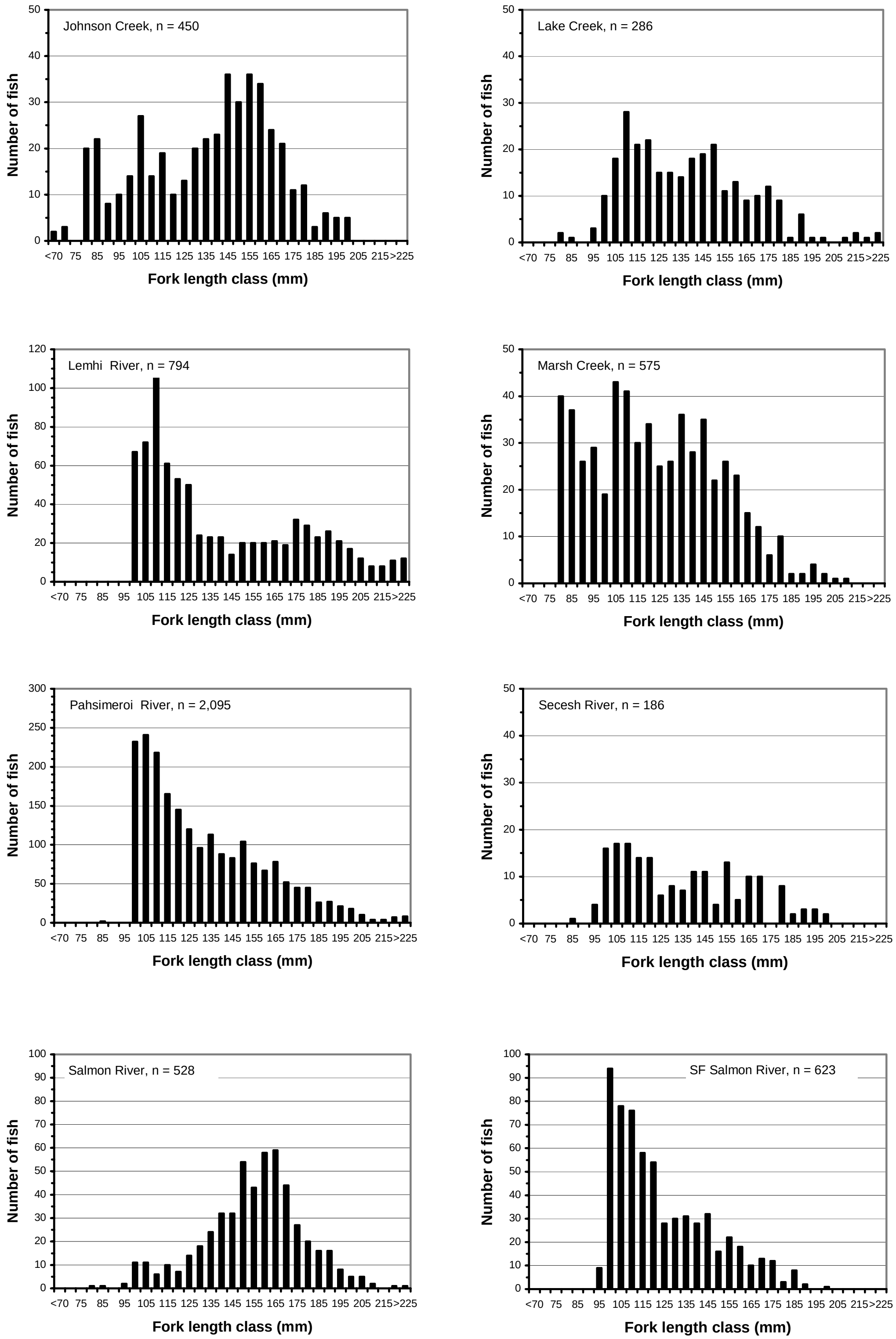


Figure 21. Length frequency of PIT-tagged wild steelhead juveniles captured in screw traps located in tributaries of the Salmon River drainage during 2003.

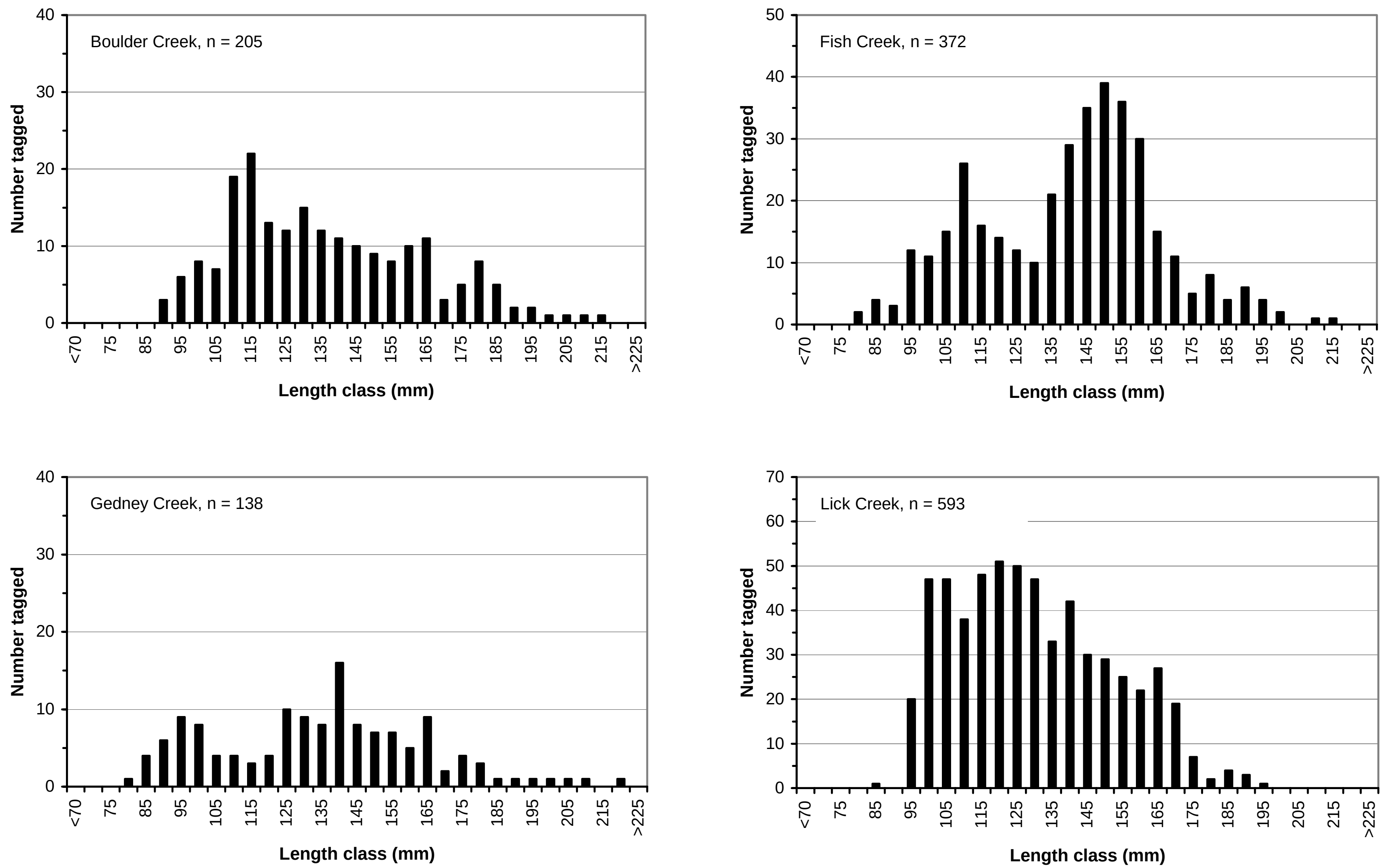


Figure 22. Length frequency of PIT-tagged wild steelhead juveniles captured flyfishing during the summer 2003 in Lick, Gedney, and Fish creeks. The Gedney Creek graph includes fish caught in the WF Gedney Creek.

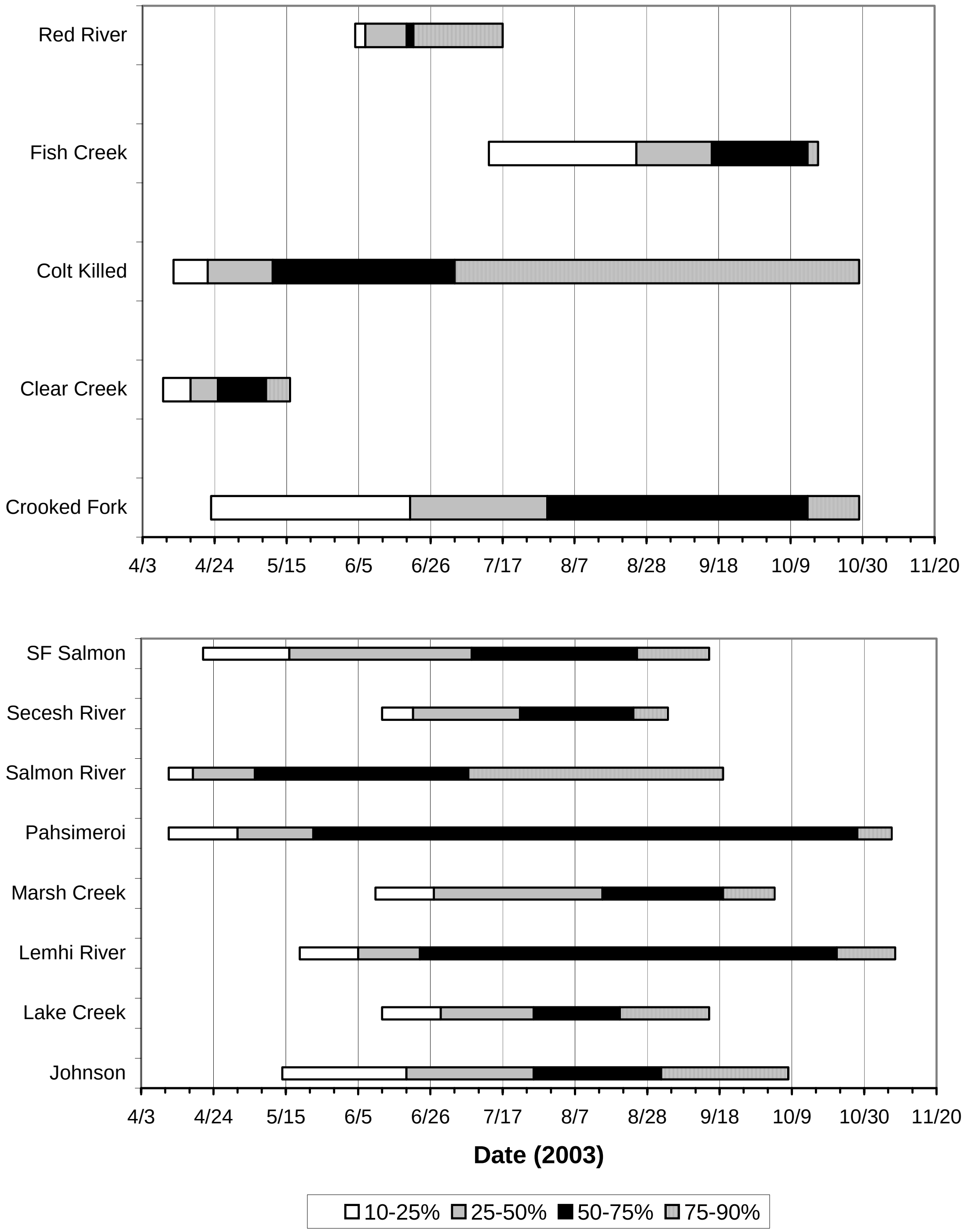


Figure 23. The date that 10%, 25%, 50%, 75%, and 90% of the total number of steelhead tagged at screw traps fished in the Clearwater River drainage (top) and Salmon River drainage (bottom) in 2003 was attained. The left edge of each block is the date that the lower quantile of the block was reached. The Clear Creek trap was only fished until June 11, 2003. The Red River trap did not fish during most of September and October due to low flows.

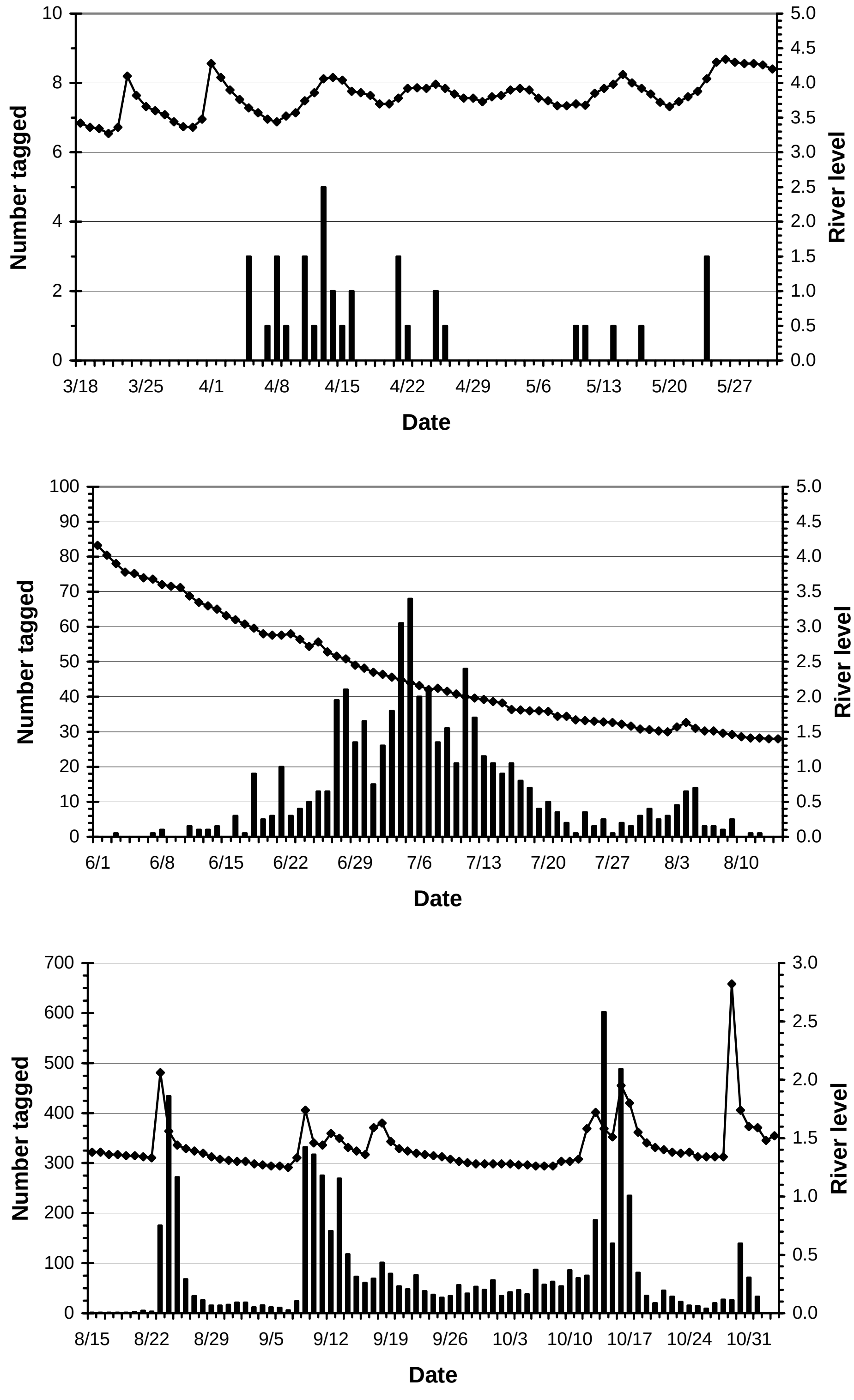
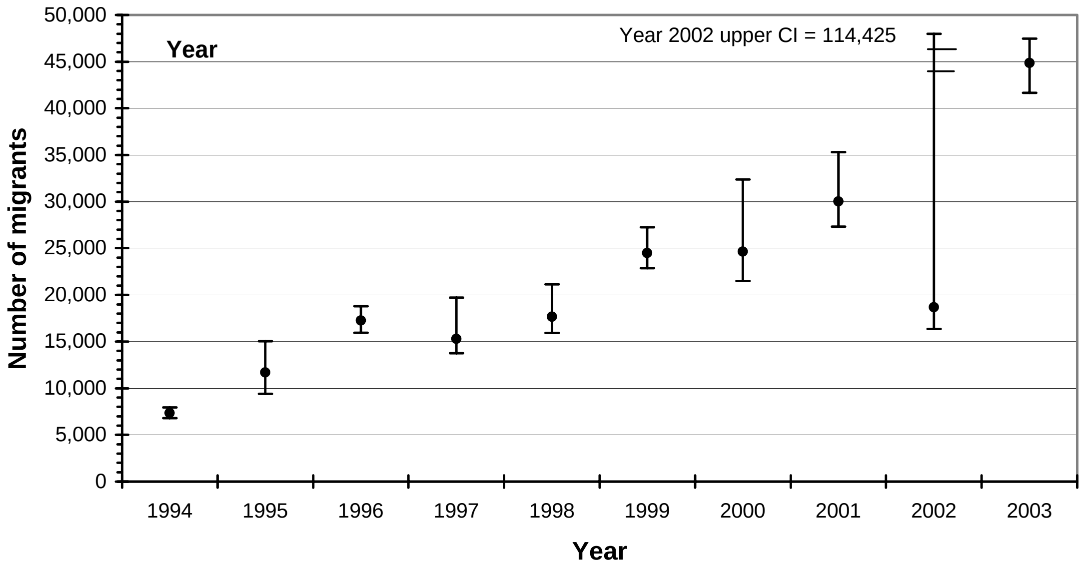


Figure 24. The daily river level and the number of wild steelhead juveniles that were trapped (excluding fish recaptured for trap efficiency estimate) in the Fish Creek screw trap from March 18, 2003 to November 3, 2003.



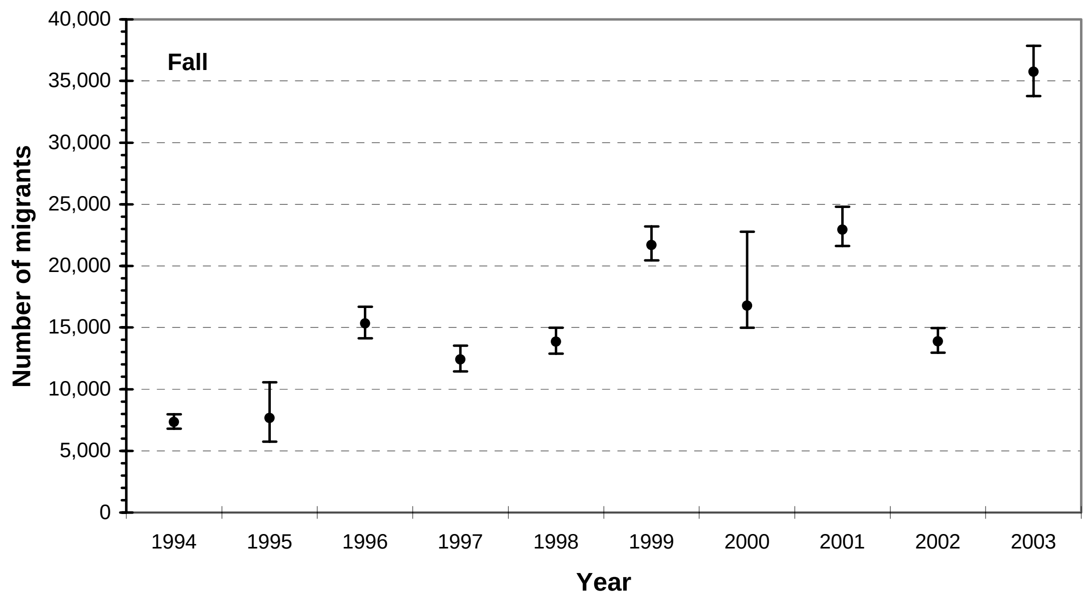


Figure 25. The number of juvenile steelhead (and 95% CI) that migrated past the screw trap in Fish Creek during the entire trapping season (Year, top graph) and from August 15 to the end of trapping in November (Fall, bottom graph) from 1994 to 2003. The large upper CI of yearly migration estimate for 2002 was a result of getting only one recapture during the spring high flow. In 1994, the trap was fished from September 22 to November 2. In 1995, the trap was fished from March 16 to June 14 and from August 18 to November 2. Beginning in 1996, IDFG crews have fished the trap (conditions permitting) continuously from mid-March until the creek freezes in the fall.

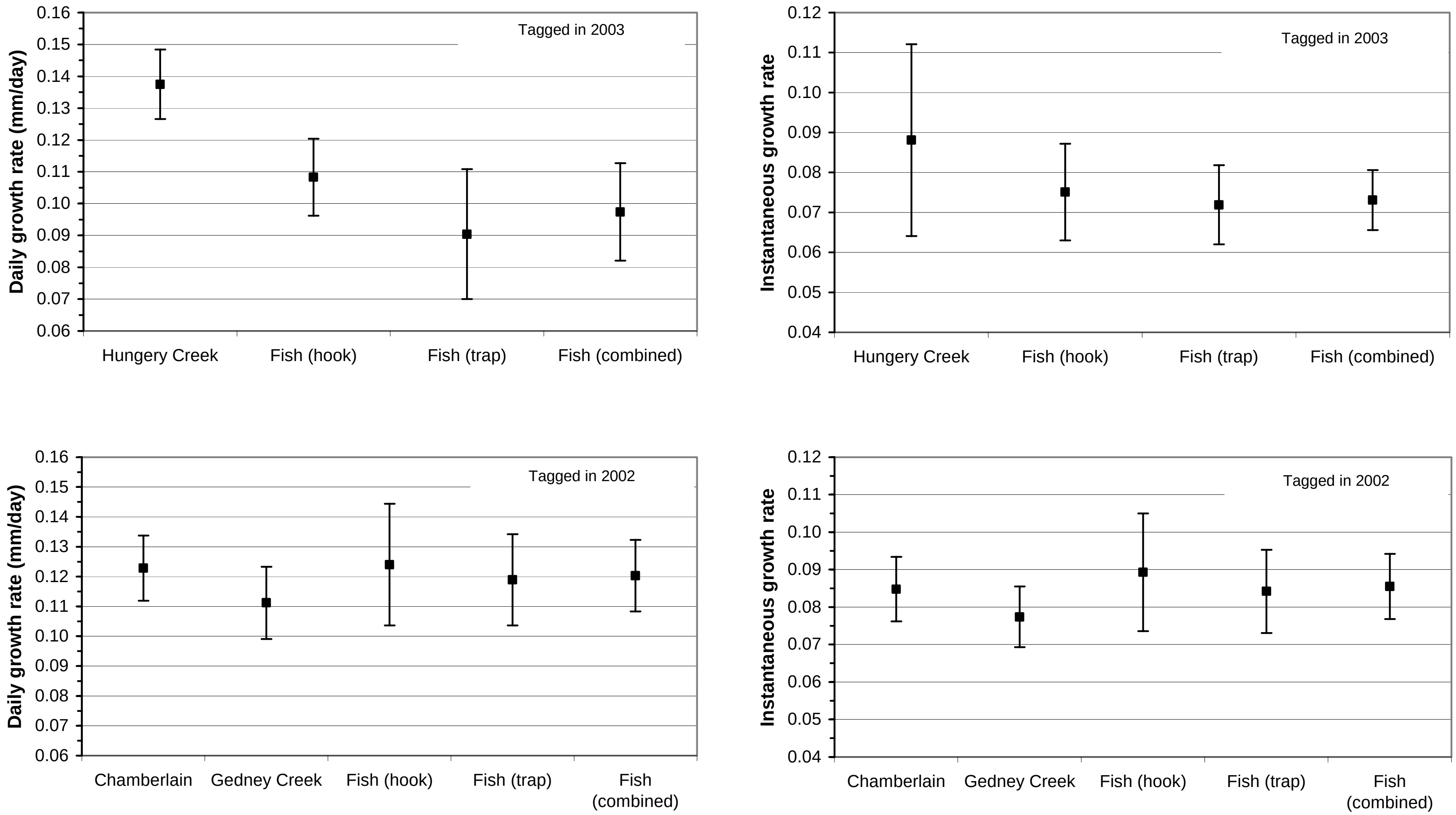


Figure 26. The daily growth rate (mm/day) and instantaneous growth rate of wild steelhead PIT tagged and recaptured in 2003 (upper graphs) and those tagged in 2002 and recaptured in 2003 (lower graphs). Vertical lines show the upper and lower 95% confidence interval.

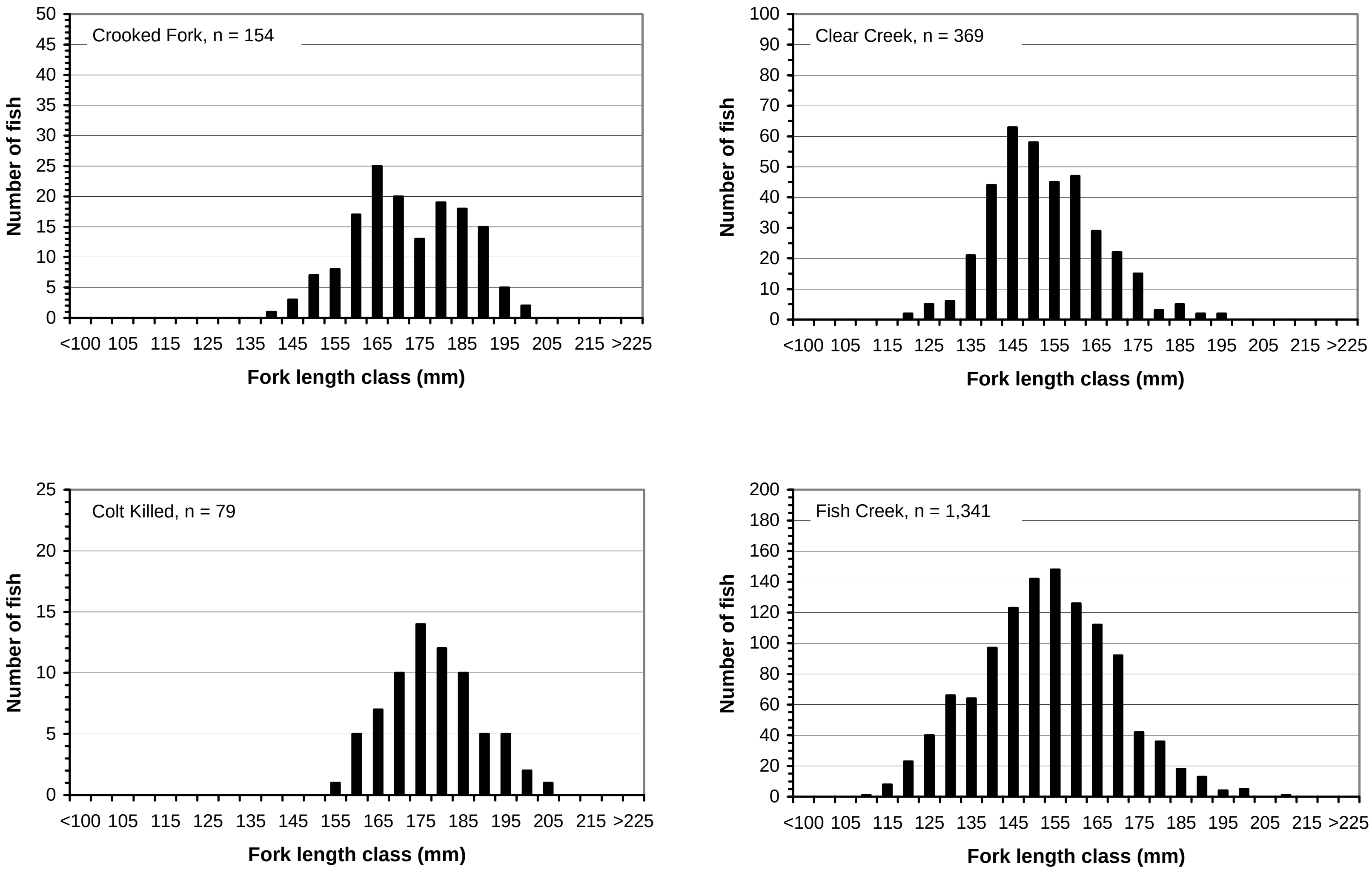


Figure 27. The length frequency of wild steelhead that were PIT tagged or recaptured in Clearwater River tributaries from August 15, 2002 to May 31, 2003 and detected as smolts during 2003 at the lower Snake River, McNary, John Day, and Bonneville dams.

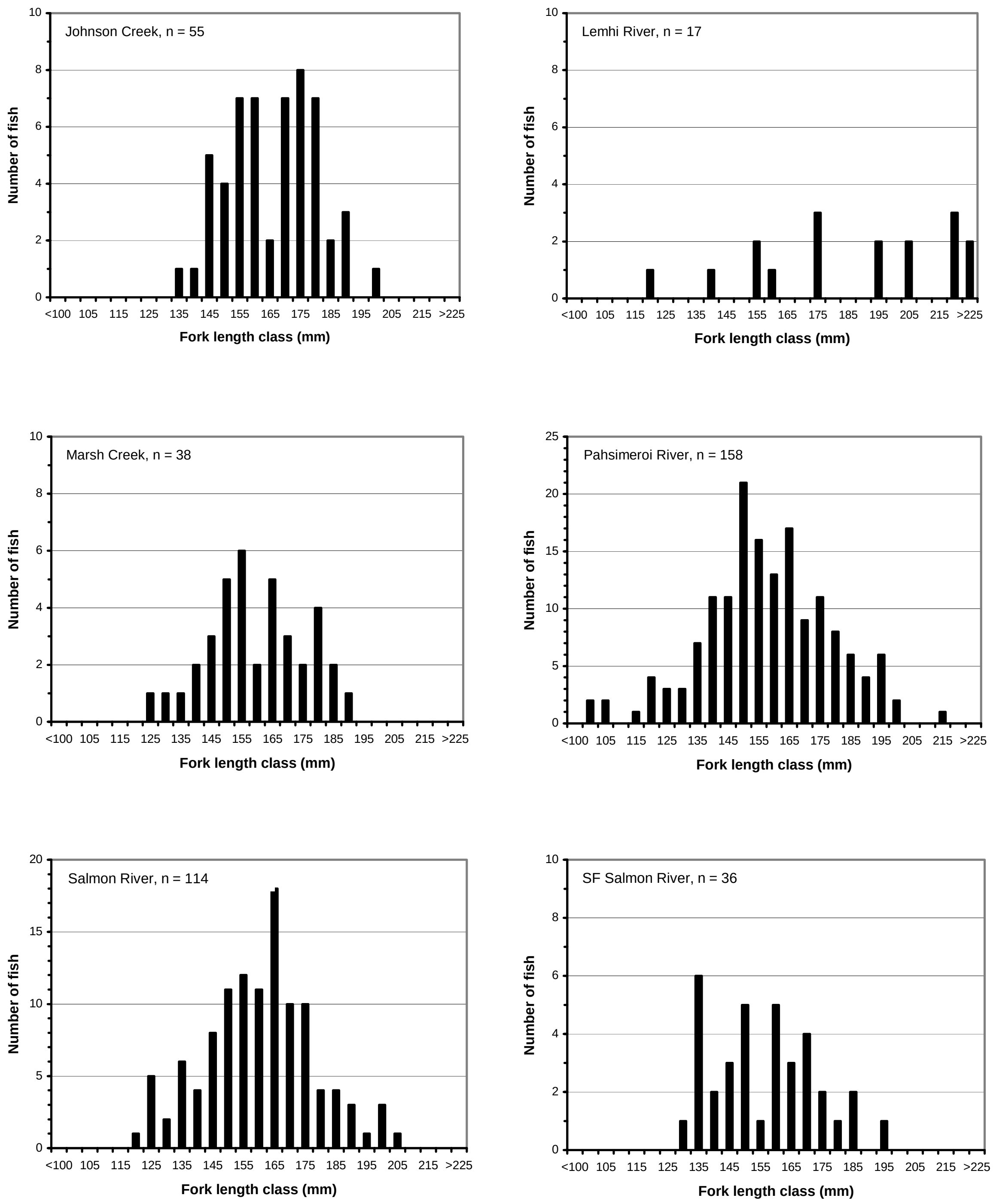


Figure 28. The length frequency of wild steelhead that were PIT tagged or recaptured in Salmon River tributaries from August 15, 2002 to May 31, 2003 and detected as smolts during 2003 at the lower Snake River, McNary, John Day, and Bonneville dams.

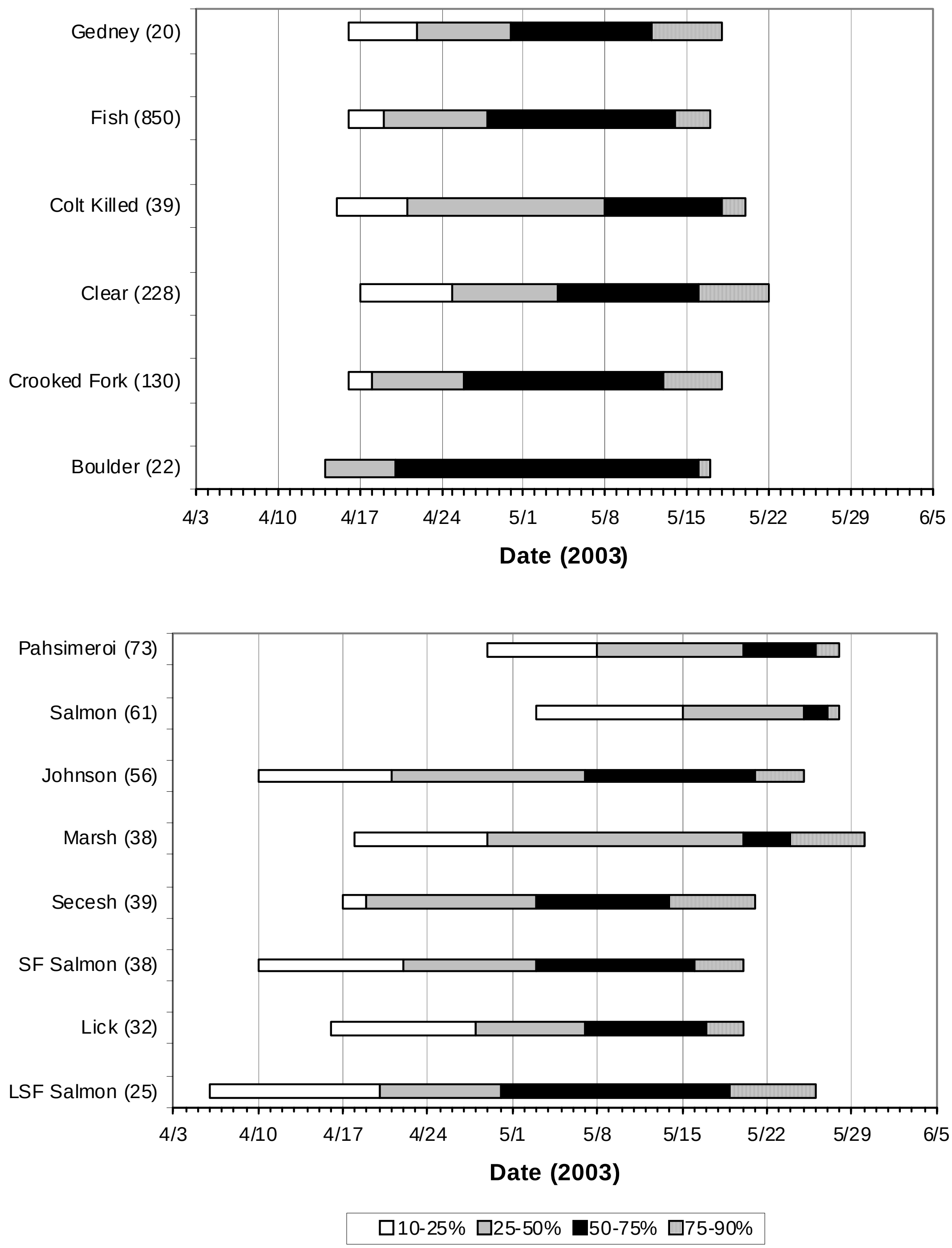


Figure 29. The date that 10%, 25%, 50%, 75%, and 90% of the total number of steelhead smolt detections at Lower Granite Dam in 2003 was attained from tributaries of the Clearwater River (top graph) and Salmon River (bottom graph). The left edge of each block is the date that the lower quantile of the block was reached. The number of detections from each site is in parenthesis.

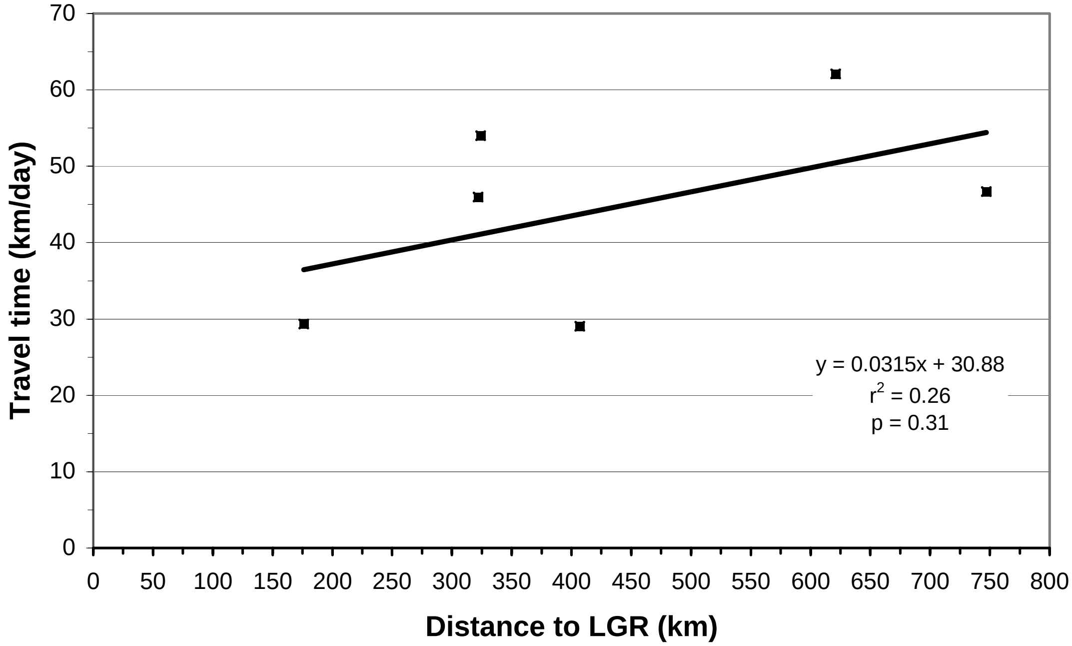


Figure 30. The relationship between median smolt travel time from tag site to Lower Granite Dam (LGR) and the distance to LGR in 2003.

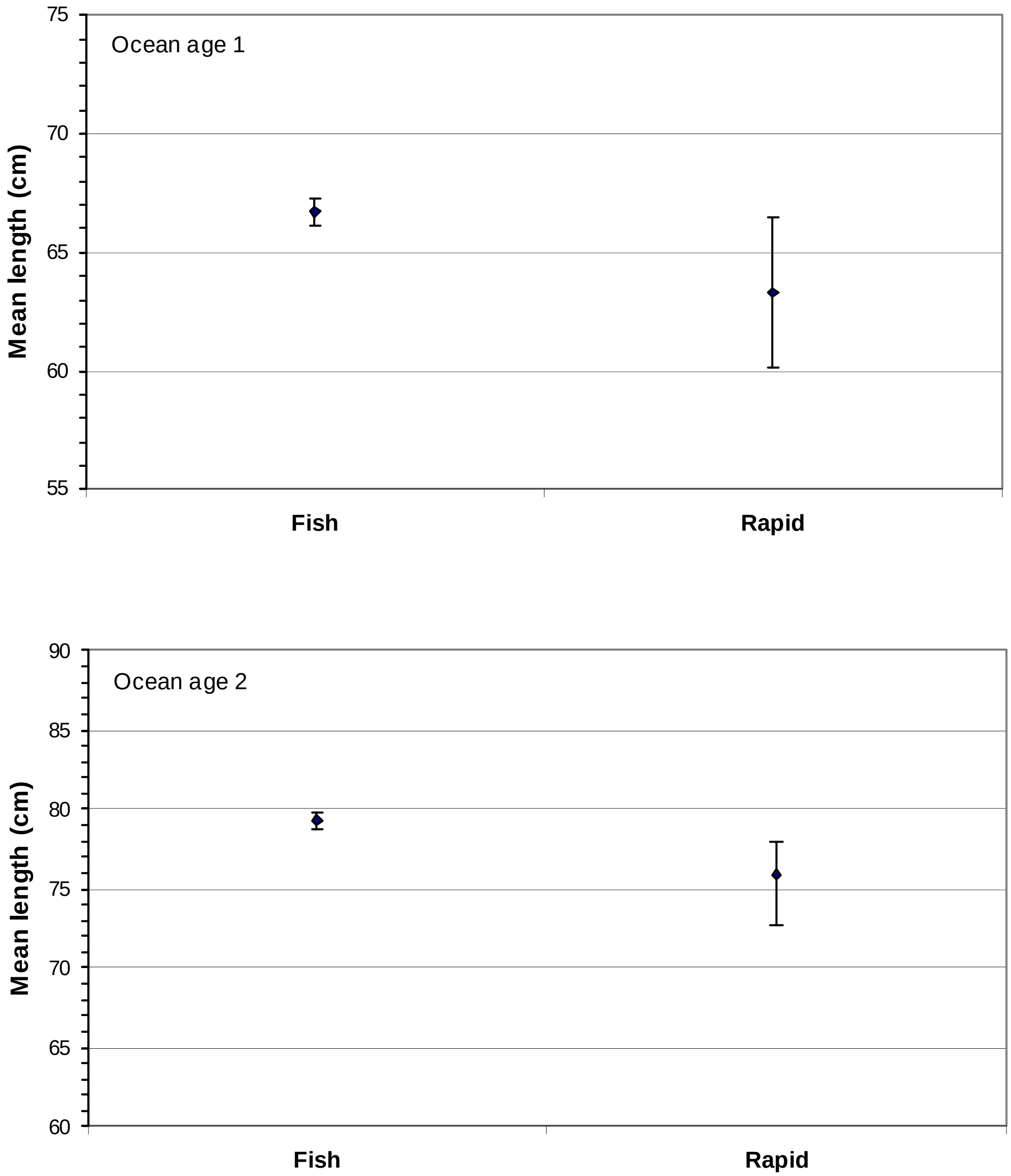


Figure 31. The mean fork length (mm) and 95% CI of adult steelhead trapped at Fish Creek and Rapid River after spending one year in the ocean (upper) or two years in the ocean (lower). All lengths from each stream from 1998 to 2002 were combined for this analysis.

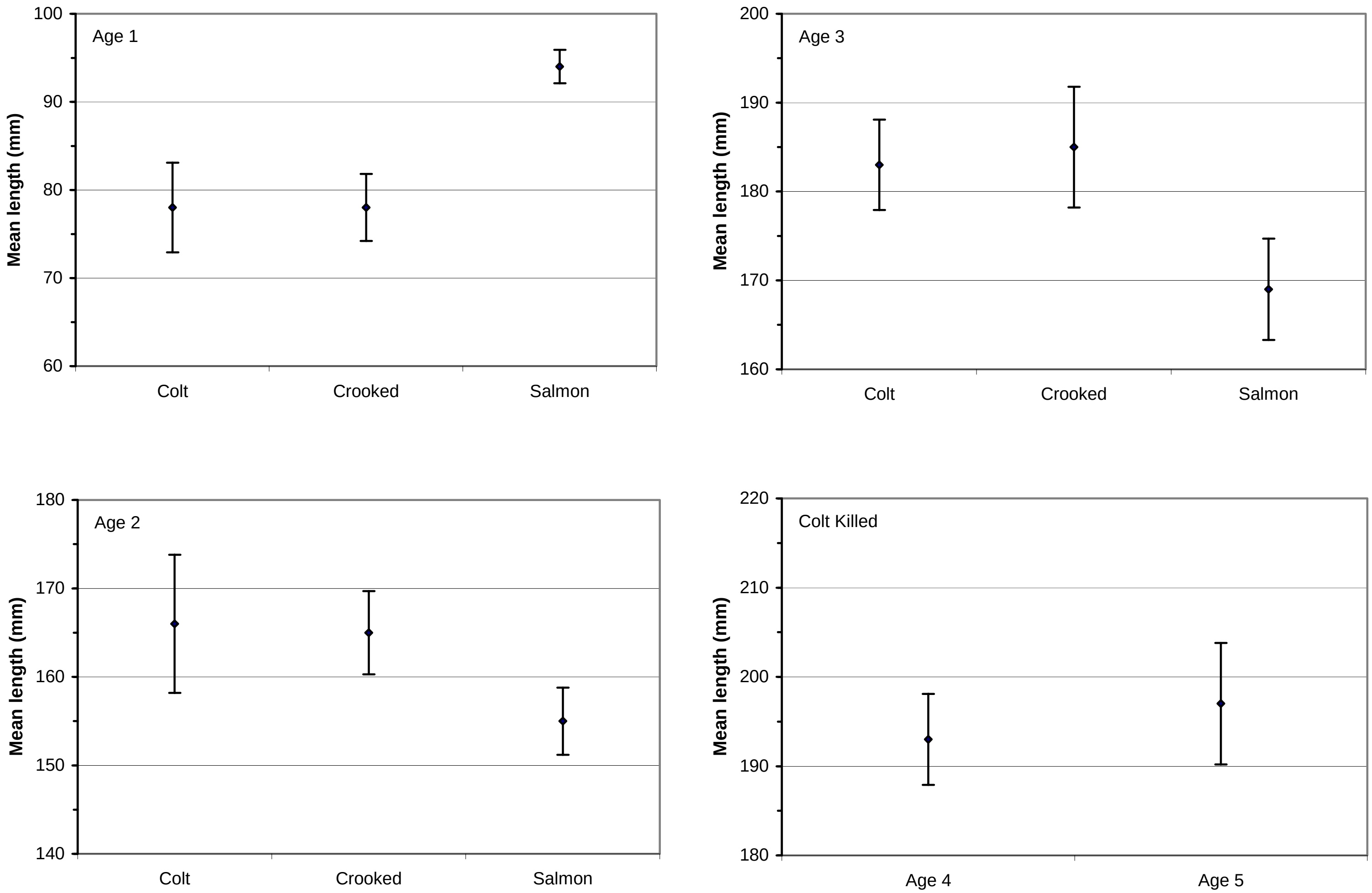


Figure 32. The mean length (mm) and 95% CI of juvenile steelhead age-1 to age-3 from Colt Killed Creek, Crooked Fork Creek, and the Salmon River. Age-4 and age-5 fish from Colt Killed Creek are shown in the lower right graph. Colt Killed Creek was the only stream that had >10 fish aged four or older. Within each stream, all available data from 1998 to 2002 was combined. All fish were sampled between March 1 and June 15 of each year.

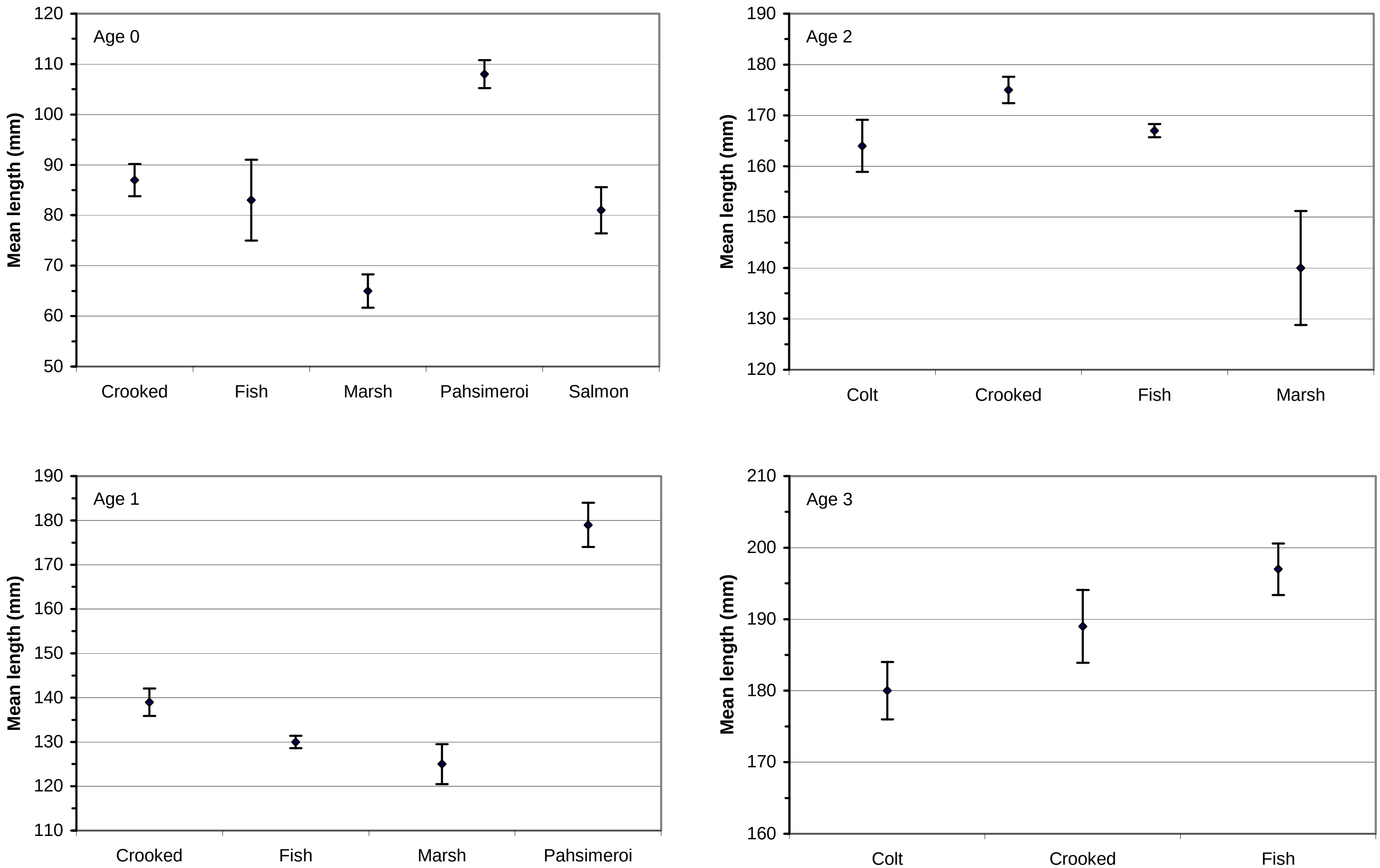


Figure 33. The mean length and 95% CI of juvenile steelhead age-0 to age-3. Within each stream, all available data from 1998 to 2002 was combined. All fish were sampled after August 14 of each year.

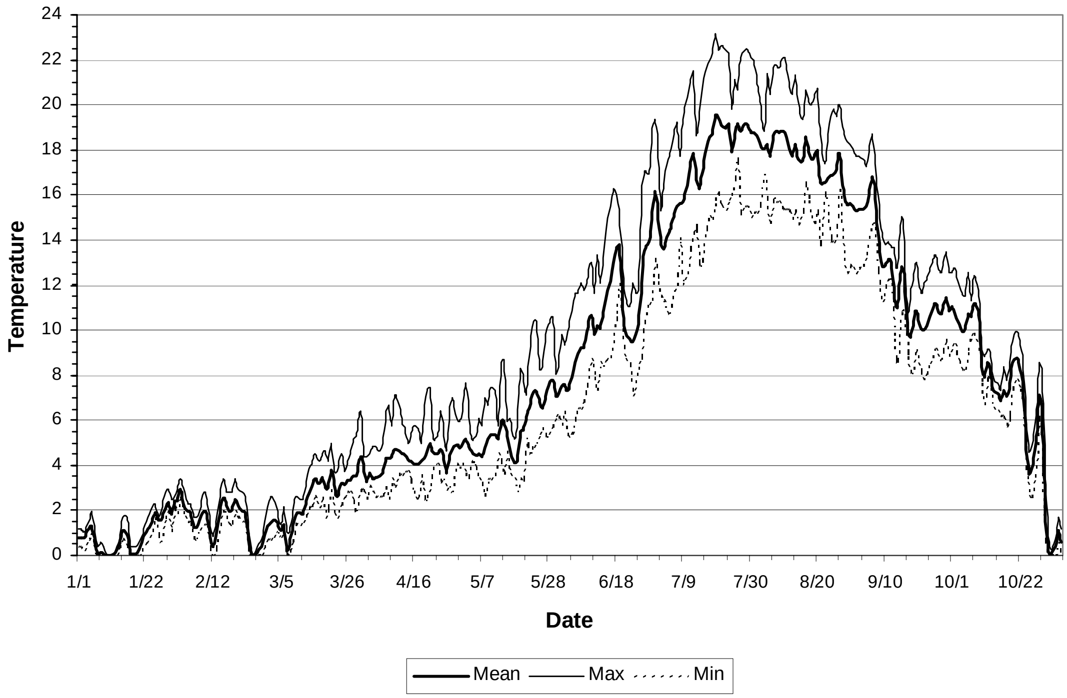


Figure 34. The daily mean, maximum, and minimum water temperature in Fish Creek from January 1, 2003 to November 4, 2003.

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APPENDICES

Appendix 1. Streams that were snorkeled by steelhead supplementation crews in 2003. In streams with more than one strata, the downstream boundary of strata 2 and strata 3 begins at the upstream boundary of the previous strata.

		Strata boundary	
Stream	**Strata**	**Downstream**	**Upstream**
Clearwater River drainage			
Fish Creek	1	mouth	Hungery Creek
	2	—	Frenchman Creek
Hungery Creek	1	mouth	Doubt Creek
Gedney Creek	1	mouth	West Fork Gedney Creek
	2	—	Canteen Creek
West Fork Gedney Creek	1	mouth	Waterfall about 2 km upstream
South Fork Red River	1	mouth	Trapper Creek
	2	—	West Fork South Fork Red River
Canyon Creek	1	mouth	Upstream about 4 km
Crooked Fork Creek	1	mouth	Brushy Fork Creek
Deadman Creek	1	mouth	WF Deadman Creek
Weir Creek	1	mouth	Upstream about 3 km
Post Office Creek	1	mouth	about 2 km upstream of West Fork Post Office Creek
Lake Creek	1	mouth	Upstream about 4 km
Boulder Creek	1	mouth	Huckleberry Creek
Bald Mountain Creek	1	mouth	Upstream about 4 km
Pete King Creek	1	mouth	Placer Creek bridge
O'Hara Creek	1	Stillman Creek	Saddle Creek
Stanley Creek	1	mouth	Gold Meadow Creek
Holly Creek	1	mouth	upstream about 3 km
Salmon River drainage			
Basin Creek	1	mouth	East Fork Basin Creek
	2	—	about 2-3 km upstream of East Fork Basin Creek
Beaver Creek[a]	2	irrigation pump	Jeep trail crossing about 3 km upstream of irrigation pump
Frenchman Creek	1	mouth	start of the second meadow about 4 km upstream

[a] Strata 1 (mouth to the irrigation pump) was dewatered when the stream was snorkeled.

Appendix 2. Dates the IDFG, U.S. Fish and Wildlife Service (USFWS), and Nez Perce Tribe (NPT) screw traps were installed, removed, and unable to fish during 2003.

Trap site	Date	Comments
Crooked Fork Creek	3/20	Trap installed
	5/17 and 5/24 to 6/5	not operated due to high flow
	10/31	Trap removed
Colt Killed Creek	3/20	Trap installed
	5/16-5/17 and 5/24-6/5	not operated due to high flow
	11/3	Trap removed
Fish Creek	3/18	Trap installed
	4/1-4/3 and 5/25 to 6/1	not operated due to high flow
	11/1	trap removed
Marsh Creek	3/18	Trap installed
	11/5-11/9	not operated due to ice
	11/11	trap removed
Pahsimeroi River	3/4	Trap installed
	12/6	Trap removed
Salmon River at Sawtooth	3/19	Trap installed
	5/25 to 6/2	not operated due to high flow
	11/11	Trap removed
SF Salmon River	3/6	Trap installed
	3/30-4/5	not operated—hatchery Chinook release
	5/17-5/27; 5/29-6/17	not operated due to high flow
	6/21, 6/22, and 7/7	not operated
	10/31	Trap removed
Lemhi River	3/7	Trap installed
	3/14; 5/28; 7/4; 7/9; 8/5	not operated
	9/9; 9/26; 9/27; 10/8-10/10	not operated
	10/12; 10/13; 10/26; 10/29	not operated
	10/31; 11/2	not operated
	12/11	Trap removed
Red River	3/26	Trap installed
	4/3; 4/18-4/20; 4/22-4/24	not operated-hatchery Chinook release
	4/28; 5/20; 5/25-5/31; 6/2	not operated due to high flow
	7/12; 8/10-8/13; 9/4-9/9	trap not operated –low flow
	9/11-9/17; 9/19-9/24;9/26	trap not operated –low flow
	9/27; 10/1-10/8; 10/11-10/12	trap not operated –low flow
	10/14; 10/19	trap not operated –low flow
	10/30	Trap removed
Clear Creek (USFWS)	3/10	Trap installed
	3/26-4/3; 4/8; 5/8; 6/7	not fished
	6/11	Trap removed
Johnson Creek (NPT)	3/5 to 10/28	Dates of operation. No data for down time.
Lake Creek (NPT)	4/1 to 11/3	Dates of operation. Not fished 5/25 to 6/6.
Secesh River (NPT)	4/16 to 11/3	Dates of operation. Not fished 5/25 to 6/11

Appendix 3. Genetic Population Structure of Snake River Basin Steelhead in Idaho

Genetic Population Structure of Snake River Basin Steelhead in Idaho

by

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Idaho Department of Fish and Game, Boise, ID

ABSTRACT

Idaho Department of Fish and Game (IDFG) collected tissue samples from 74 wild juvenile steelhead *O. mykiss* populations throughout the state and five hatchery stocks in 2000. These samples were used to determine the genetic population structure of Idaho's steelhead assemblage. In this interim progress report we present results based on 31 wild populations and 5 hatchery stocks. The final analysis will include all 74 wild populations and the 5 hatchery stocks. Genetic variation found at 11 microsatellite loci was used to describe population structure for steelhead (*Oncorhynchus mykiss*) from 36 populations in the Snake River basin, Idaho. DNA was amplified and analyzed for 1905 fish samples. Significant regional spatial structuring of populations was apparent among 10 different river drainages. Many *O. mykiss* populations were most closely related genetically to other *O. mykiss* from streams within the same drainage. Significant allelic frequency differences were found in 98.5% of all pairwise comparisons for the 36 *O. mykiss* populations. AMOVA analyses showed that 2.8% of the molecular variance could be attributed to differences among 10 major river drainages (Clearwater, Middle Fork Clearwater, South Fork Clearwater, Salmon, Middle Fork Salmon, South Fork Salmon, Little Salmon, Lochsa, Selway and Snake rivers). All Idaho steelhead hatchery populations were shown to contain genetic diversity that was similar to that found in geographically proximate wild *O. mykiss*, with the exception of the East Fork Salmon "B-run" hatchery population that contained allelic structure most closely related to Ten Mile Creek *O. mykiss* in the Clearwater River drainage. Two Salmon River *O. mykiss* populations, Lemhi River and Pahsimeroi River, separated from the rest of the populations in the Snake River basin with 96% bootstrap values in an unrooted Neighbor-Joining tree based on chord genetic distance. Overall classification accuracy of single individuals to their stream of origin using these 11 microsatellite loci was 66%. Garza and Williamson's (2001) *M* over all populations of *O. mykiss* was M = 0.635, below the published threshold ($M \leq$ 0.68), supporting recent population reductions for steelhead within the Snake River drainage. Average estimated effective population size (*Ne* based on SMM) for Snake River steelhead populations, however, was relatively high (*Ne* =5098). These data suggest that significant genetic population structure remains for steelhead populations within the Snake River, and careful consideration of this genetic diversity should be part of future conservation and restoration efforts.

INTRODUCTION

There are two recognized lineages of *O. mykiss* in North America – coastal (*O. m. irideus*) and inland (*O. m. gairdneri*; Behnke 1992). Historically, anadromous steelhead (*Oncorhynchus mykiss*) were broadly distributed throughout most Columbia River drainages (Busby et al. 1996). The Cascade crest is thought to separate the two *O. mykiss* lineages within the Columbia River drainage, making all up-river steelhead found in Idaho part of the inland group. The construction of dams on the Columbia River drainage has markedly changed the temperature and flow regime compared to historical patterns available to steelhead (Robards and Quinn 2002). There have been substantial declines in these populations over the last 150 years, due primarily to lost spawning and rearing habitats, changes in water quality, and within-basin dams and diversions (Busby et al. 1996). Steelhead that spawn in Idaho are summer-run fish. Steelhead in Idaho, i.e. populations in the Snake, Salmon and Clearwater rivers migrate further from the ocean (up to 1,500 km) than all other Columbia River populations and spawn at high elevations (up to 2,000 m). Anadromous steelhead in the Snake River basin found in streams of southeast Washington, northeast Oregon and Idaho, were listed under the Federal

Endangered Species Act (ESA) as a threatened Evolutionarily Significant Unit (ESU) in 1997 (Federal Register Vol. 62 No. 159: 43937 - 43954).

Wild steelhead abundance in the Snake River basin declined relative to their historical abundance after the construction of the four Lower Snake River dams. Declines of wild B-run steelhead1 have generated particular concern over the potential loss of life history diversity for this species. *O. mykiss* expresses a range of variations in life history strategies, from strongly migratory to non-migratory, throughout the species' range. Individual runs or stocks of *O. mykiss* found within the same drainage cannot be separated taxonomically based on migration timing or the distribution of anadromony (Behnke 1992; Allendorf and Utter 1979). Highly flexible life history strategies in *O. mykiss* (Shapovalov and Taft 1954), otolith microchemistry (Rybock et al. 1975; Zimmerman and Reeves 2000), and genetic studies (Gall et al. 1990; Nielsen et al. 1997) suggest that freshwater habitats may contain relic, non-anadromous components of the *O. mykiss* gene pool found in geographically proximate anadromous populations.

In recent years, over 80% of the adult steelhead passing Lower Granite Dam derived from hatchery origins (Busby et al. 1996). Large-scale artificial propagation of steelhead in the Snake and Salmon drainage began in the 1960's with the construction of Oxbow Hatchery, Niagara Springs Hatchery, and Pahsimeroi Hatchery. In the Clearwater drainage, large-scale hatchery releases began in 1970 after Dworshak National Fish Hatchery was built. The Dworshak summer steelhead stock was developed from native B-run North Fork Clearwater River steelhead in 1969 (Howell et al. 1985). Oxbow, Niagara Springs, and Pahsimeroi hatcheries were all part of Idaho Power Company's program to relocate steelhead stocks after the construction of dams in Hells Canyon. The brood source for these facilities was obtained from native steelhead trapped at the base of Hells Canyon Dam. Pahsimeroi Hatchery also incorporated some Dworshak hatchery adults into their brood source during the late 1970's (Ball 1985). Dworshak National Fish Hatchery released between 1.9 and 2.4 million smolts each year since 1997 into the Clearwater River Basin (Fish Passage Center 2004). Hatchery steelhead releases in the Salmon and Snake drainages from other Idaho hatcheries has ranged from 4 to 6 million yearly since 1997 (IDFG hatchery release database).

The impact of hatchery *O. mykiss* on wild stocks in streams and reservoirs throughout North America over the last 200 years has been the subject of many studies (see reviews in Reisenbichler and McIntyre 1977, Waples and Do 1994, Campton 1995, and Nielsen 1999). Straying and introgression by hatchery fish presents a high risk to the genetic integrity of some wild steelhead populations according to some authorities (Busby et al. 1997). Early findings of Gall et al. (1990) suggested that anadromous steelhead populations have residualized as freshwater fish behind man-made structures and dams throughout their natural range. Within Idaho there are numerous populations of non-anadromous rainbow trout upstream of both natural long-standing and artificial barriers (see Figure 1). Many of these populations have had an opportunity to interbreed with hatchery fish. The genetic integrity of locally adapted stocks of *O. mykiss* is of critical importance to issues of restoration and recovery.

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1 Snake River steelhead runs are commonly referred to as "A-run" or "B-run" stocks based on designations developed from the bimodal migration of adult steelhead at Bonneville Dam. Adult A-run fish migrate upstream earlier (June to August) than B-run fish (August to October); B-run fish are primarily defined as 2-ocean adults having spent two years at sea (as opposed to 1-ocean A-run fish) and are on average 75-100 mm larger than A-run fish of the same age.

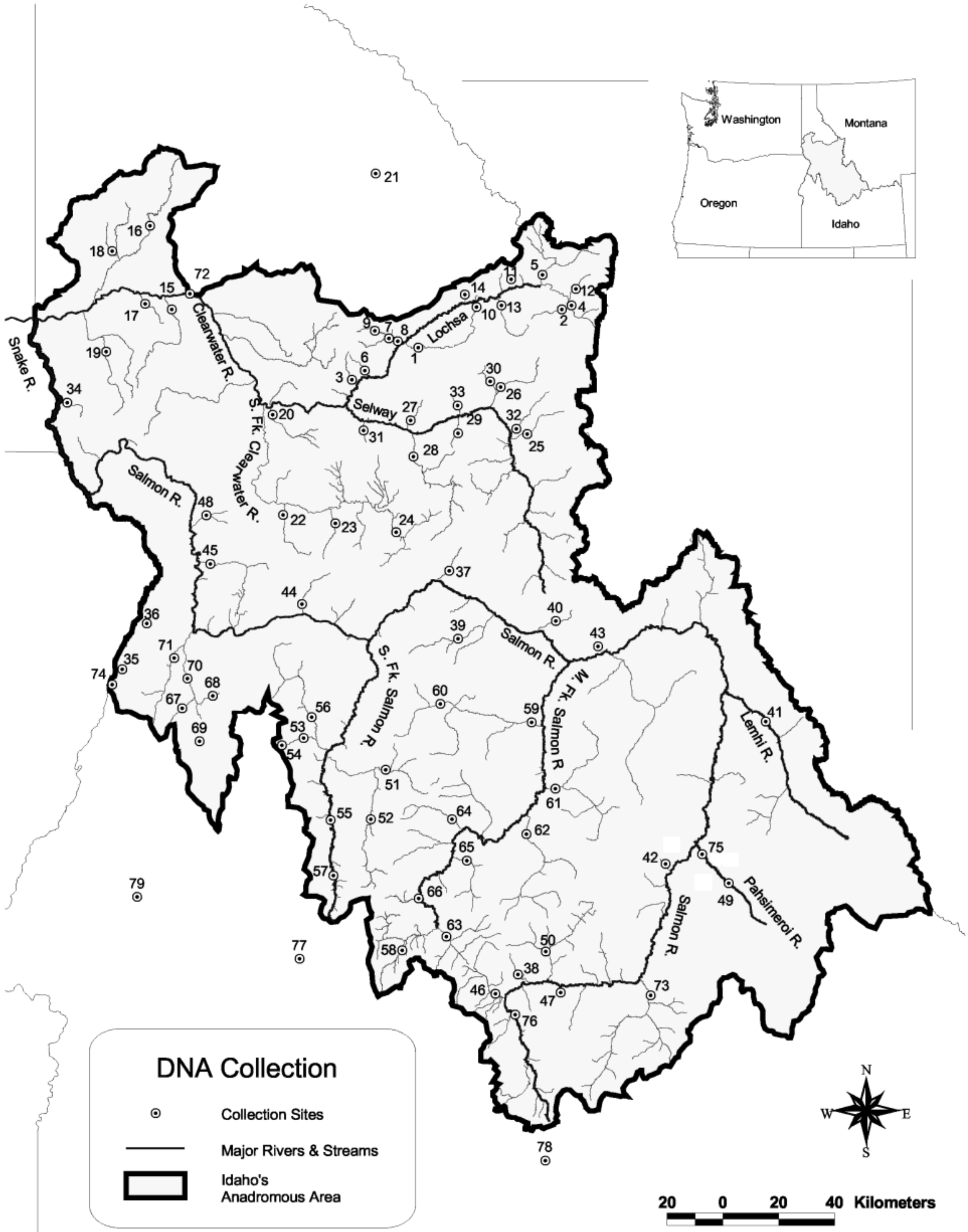

Figure 1. *O. mykiss* populations sampled for Idaho's baseline genetic database in 2000. Collection site location numbers are listed in Table 1 (this report) and Appendix I.

Table 1. Idaho drainages, populations, site locations and total number of samples (N), unbiased and observed Hz collected by the Idaho Department of Fish & Game in 2000.

Drainage	Population	Site Location on Map	N	Unbiased Hz*	Observed Hz	Stream Code
Clearwater River	Big Canyon Creek	15	60	0.6601	0.6758	BCAN
	EF Potlatch River	16	51	0.6407	0.6645	EPOT
	Mission Creek	19	49	0.6317	0.6218	MISS
Middle Fork Clearwater River	Clear Creek	20	53	0.5945	0.5987	CLRC
South Fork Clearwater River	John's Creek	22	49	0.6117	0.5732	JOHN
	Red River	24	60	0.6357	0.6246	REDR
	Ten Mile Creek	23	49	0.6014	0.6168	MILE
Salmon River	Basin Creek	38	54	0.7099	0.6636	BASC
	Chamberlain Creek	39	46	0.6441	0.6148	HAM1
	Lemhi River	41	49	0.7274	0.6682	LEMR
	Pahsimeroi River	49	49	0.7019	0.6689	PAHR
	Whitebird Creek	48	56	0.6527	0.6485	WHBC
Middle Fork Salmon River	Big Creek (lower)	59	49	0.6082	0.5983	BIG1
	Camas Creek	61	53	0.6262	0.5688	CAM1
	Loon Creek	62	54	0.5617	0.5595	LON1
	Marsh Creek	63	59	0.5836	0.5881	MARC
South Fork Salmon River	East Fork SF Salmon River	51	52	0.6304	0.6151	EFSF
	Johnson Creek	52	56	0.6350	0.6379	JSON
	Poverty Flat Area	55	55	0.6142	0.6038	POVF
	Secesh River	56	56	0.6285	0.5559	SECR
Little Salmon River	Little Salmon, Pinehurst area	70	51	0.6705	0.6285	LSR2
	Rapid River	71	51	0.6363	0.6260	RAPR
Lochsa River	Brushy Fork Creek	2	55	0.5492	0.5457	BRUS
	Canyon Creek	3	53	0.5941	0.5879	CANY
	Colt Creek	4	54	0.5866	0.5544	COLT
	Fish Creek	7	56	0.6152	0.5944	FISH
Selway River	Bear Creek	25	42	0.5931	0.5860	BEAR
	East Fork Moose Creek	26	55	0.6247	0.6252	EMOS
	Gedney Creek	27	56	0.6063	0.6025	GEDC
	Three Links Creek	33	55	0.5993	0.5960	3LNK
Snake River	Granite Creek	35	49	0.6806	0.6771	GRAN
Hatchery	Dworshak Hatchery	72	52	0.5823	0.6006	DWOR
	EF Salmon "B-run"	73	55	0.5974	0.5783	EFRB
	Oxbow Hatchery	74	53	0.6758	0.6295	OXBW
	Pahsimeroi Hatchery	75	53	0.6916	0.6535	SIMH
	Sawtooth Hatchery	76	56	0.6886	0.6733	SAWT
TOTAL			**1905**			

* Based on Nei's unbiased gene diversity (1987)

This study represents genetic analyses of a diversity of samples of *O. mykiss*, i.e. fish collected above and below dams, putative natural spawning anadromous populations and hatchery steelhead from Idaho. The Idaho Department of Fish and Game (IDFG) collected juvenile *O. mykiss* samples during the summer of 2000. Microsatellite allelic diversity was visualized and analyzed at the USGS Alaska Science Center's Conservation Genetics Laboratory. *O. mykiss* genetic diversity was analyzed within and among samples and groups of samples at several spatial scales: 1) allelic diversity among and between large river drainages; 2) pairwise comparisons of genetic diversity between 36 unique *O. mykiss* populations; 3) within population genetic diversity was used for comparisons across broad spatial scales. We compared genotype and allelic frequencies for *O. mykiss* populations to data for known hatchery steelhead strains with a history of stocking in Idaho, looking at relationships among and between all *O. mykiss* populations, and between hatchery and wild populations within the sampling area.

METHODS

Sample Collections

O. mykiss fin tissue was collected and analyzed for DNA from 1905 fish in this study (Table 1). IDFG collected tissues from fish throughout the Snake River basin, Idaho, in 2000 (Figure 1; see also Appendix I). These samples are part of a larger collection of steelhead populations taken for a broad scale analysis of genetic population structure within Idaho that have or will contribute to future technical reports and other publications (see Nielsen et al. 2003a).

Microsatellite Amplification Protocols

Microsatellite loci taken from the published literature were selected for analysis based on documented variability in *O. mykiss*, ease of amplification in polymerase chain reaction (PCR), and allele scoring rigor. Table 2 gives the total number of alleles found for each locus across all populations.

G. K. Sage (Alaska Science Center, Conservation Genetics Laboratory) developed multiplex systems using 13 loci grouped together for amplification of steelhead allelic size structure. G. K. Sage redesigned several primers in order to establish the three multiplex protocol used in this study, one containing 5 loci and two containing 4 loci (Table 3). *Oneμ10-(F)*, *Ogo4-(F)*, *Ogo4-(R)* and *Ogo3-(R)* were redesigned as follows: *Oneμ10-(F)* was renamed *Oneμ10.2-(F)* (5'-TGTTGGCACCATTGTAACAG-3'); *Ogo4-(F)* was renamed *Ogo4.2-(F)* (5'-CAGAATGAGTAACGAACG C-3'); *Ogo4-(R)* was renamed *Ogo4.2-(R)* (5'-GAGGATAGAAGA GTTTGGC-3'); and *Ogo3-(R)* was renamed *Ogo3.2-(R)* (5'-CACAATGGAAGACCAT-3'). *Ogo1a*, *Ogo4.2*, *Oneμ10.2* and *Ots3* forward primers were modified by the addition of M13R tails, and *Oneμ8* and *Oneμ11* forward primers were modified by the addition of M13F tails. All M13 tails were added to the primers at the 5' end. These tails allowed for allele fragment visualization by annealing to labeled complementary M13 tails added to the PCR mix. The remaining loci were visualized by adding directly labeled forward primer. Allele sizes (from adapted primers) were standardized to single locus products by running known standards for allelic size for each locus on all multiplex gels.

In general, PCR reactions were conducted in 10µl volumes using approximately 50ng of genomic DNA, 0.1-0.2 U of DNA polymerase (Perkin Elmer), 10mM Tris-HCl (pH 8.3), 1.5mM $MgCl_2$, 50mM KCl, 0.01% gelatin, 0.01% NP-40, 0.01% Triton X-100, and 200µM each dNTP.

To visualize loci with directly labeled primers, the total of forward (F) and reverse (R) primers per locus per reaction equaled 4 pmoles, with the F primer concentration being a combination of labeled and unlabeled primer. Tailed F and R primer concentrations for the multiplex systems were as follows: *Oneµ10* (10 pmoles), *Ogo1a*, *Ogo4*, *Oneµ11*, *Ots3* (5 pmoles) and *Oneµ8* (1 pmole).

The following amounts of labeled primers were added in each of the three multiplex systems. Multiplex A had between 0.06-0.20 pmoles per reaction (*Omy325*, 0.06; *Ots1*, 0.20; *Oneµ14*, 0.40; *Ots4*, 0.06). Multiplex B was between 0.1-1.5 pmoles (Omy77, 0.2; M13F, 0.3; M13R, 1.5), and multiplex C had between 0.1-1.5 pmoles (M13F, 1.5; M13R, 1.5; Omy27, 0.1; Omy207, 0.2). Gel electrophoresis and visualization of microsatellite alleles was performed using LI-COR Model 4200 and IR2 automated fluorescent DNA Sequencers and sizing was performed using V3.00 Gene ImagIR (LI-COR, Lincoln, NE, USA). Microsatellite allele sizes (including the amplified primer) were determined in relation to the M13 ladder or to the GeneScan-350 internal size standard (P-E Biosystems, Foster City, CA, USA), and *O. mykiss* DNA samples of known size that were rerun on each gel. Approximately 10% of all samples were run on a second gel and scored independently to verify allelic size.

Table 2. List of microsatellite loci used in this study. Mean Hz = mean observed heterozygosity per locus across 36 Idaho steelhead populations.

Locus	**Source**	**Number Alleles**	**Allelic Size Range (bp)**	**Mean Hz**
Ogo 1a	Olsen et al. 1998	14	123-168	0.58
Ogo 4.2	Olsen et al. 1998	25	118-179	0.80
Omy 27	Heath et al. 2001	10	99-117	0.52
Omy 325	O'Connell et al. 1997	32	87-149	0.88
Onem8	Scribner et al. 1996	25	144-222	0.84
Onem10.2	Scribner et al. 1996	9	113-131	0.20
Onem11	Scribner et al. 1996	3	145-149	0.44
Onem14	Scribner et al. 1996	14	143-179	0.54
Ots 1	Banks et al. 1999	32	157-279	0.81
Ots 3	Banks et al. 1999	9	77-93	0.63
Ots 4	Banks et al. 1999	8	108-130	0.68

Table 3. Multiplex systems used to amplify 13 microsatellite loci from DNA from Snake River drainage steelhead on the LI-COR automatic sequencer. Additional primer modifications made to enhance these multiplexes are given in the text. The columns “700” and “800” represent different dyes used on the LI-COR platform.

Multiplex	Anneal Temp(°C)/Cycles	30 min. extension	Loci 700	Loci 800
A	52/40	NO	Omy 325 Ots 1	Ots 4 Oneμ14
B	52/40	YES	Omy 77 Oneμ8	Ogo 1a Ogo 4.2 Ots 3
C	52/40	YES	Omy 207 Oneμ10.2	Omy 27 Oneμ11

Table 4. Hardy-Weinberg equilibrium (HWE) results for 11 loci showing populations within HWE "-" and out of HWE "+" based on exact tests performed by ARLEQUIN 1.1.

		LOCUS										
POPULATION	N	Ogo1a	Ogo4	Omy27	Omy325	Onem8	Onem10	Onem11	Onem14	Ots1	Ots3	Ots4
1. Big Canyon Creek	60	-	-	-	-	-	-	-	-	-	-	-
2. Clear Creek	53	-	-	-	-	-	-	-	-	-	-	-
3. EF Potlatch River	51	-	-	-	-	-	-	-	-	-	-	-
4. Johns Creek	49	+	-	-	-	-	+	-	-	-	+	-
5. Fish Creek	56	-	+	+	-	+	+	-	+	-	-	-
6. EF SF Salmon River	52	-	+	-	-	-	-	-	-	-	-	-
7. Dworshack Hatchery	52	-	-	-	-	-	-	-	+	-	-	-
8. EF Salmon "B-run" Hatchery	55	-	+	-	+	+	-	-	+	-	+	+
9. Rapid River	51	-	-	-	-	-	-	-	-	-	+	-
10. Oxbow Hatchery	53	-	-	-	-	-	-	-	-	-	-	-
11. Whitebird Creek	56	-	-	-	+	-	-	-	-	-	+	-
12. Johnson Creek	56	-	-	-	-	-	-	-	+	-	+	-
13. Pahsimeroi Hatchery	53	-	-	-	-	-	-	-	-	+	-	-
14. Brushy Fork Creek	55	-	-	-	-	-	+	-	-	-	-	-
15. Sawtooth Hatchery	56	-	-	-	-	-	-	-	-	+	-	-
16. Colt Creek	54	-	+	-	+	-	-	-	-	-	-	-
17. Poverty Flat	55	-	+	-	-	-	-	-	+	+	-	-
18. Secesh River	56	-	+	-	-	-	+	+	-	+	-	-
19. Canyon Creek	53	-	-	-	-	-	-	-	+	-	-	-
20. Camas Creek	53	-	-	-	-	-	+	-	+	+	-	-
21. Big Creek (lower)	49	-	-	-	-	-	-	-	-	+	+	-
22. Basin Creek	54	-	-	+	-	-	+	-	+	+	-	-
23. Chamberlain Creek	46	+	-	-	-	-	-	-	-	+	-	-
24. Bear Creek	42	-	+	+	+	-	+	-	-	-	-	-
25. EF Moose Creek	55	-	-	-	-	-	-	-	-	-	-	-
26. Loon Creek	54	-	-	-	-	+	-	-	-	+	-	-
27. Gedney Creek	56	-	-	-	-	-	-	-	+	-	-	-
28. Marsh Creek	59	-	-	-	-	+	-	-	-	-	-	-
29. Three Links Creek	55	+	-	+	-	-	-	-	-	-	-	+
30. Lemhi River	49	-	-	-	+	-	-	-	+	+	-	+
31. Granite Creek	49	-	-	-	-	-	-	-	-	-	-	-
32. Ten Mile Creek	49	-	-	-	-	+	-	-	-	+	-	-
33. Red River	60	-	-	-	-	+	-	-	+	-	-	-
34. Mission Creek	49	-	-	-	-	-	-	-	-	-	+	-
35. Pahsimeroi River	49	-	-	-	-	-	-	-	+	-	-	-
36. Little Salmon (Pinehurst)	51	-	-	-	-	-	-	-	+	-	-	-
Total within HWE		33	29	32	31	30	29	35	23	25	29	33

Genetic Analyses

Genetic data were analyzed using a variety of software from different statistical packages including ARLEQUIN version 1.1 (Schneider et al. 2000), BOTTLENECK (Piry et al. 1999), NEIGHBOR from PHYLIP (Felsenstein 1993), and GENEPOP version 3.3 (Raymond and Rousset 1997). Heterozygosity and simulated Fisher's exact tests using randomizations for Hardy-Weinberg equilibrium (HWE) were performed using GENEPOP and ARLEQUIN.

Tests of HWE were performed to look at the performance of different loci among these *O. mykiss* populations to gain inference on population structure. It is well known that two populations that are in HWE independently may not be so when they are combined (Hartl 1988). There are several assumption built into HWE that cannot be supported without additional knowledge of the demographics of these populations, i.e. non-overlapping populations (i.e. the samples included juveniles of different ages), random mating, negligible migration (natural and artificial movement above and below dams can be undocumented or inconclusive), etc. Most importantly, the assumptions that mutation can be ignored and that natural selection does not affect alleles under consideration for HWE are hard to support in studies involving microsatellite loci where we know so little about the mutation processes involved.

ARLEQUIN F_{st} pairwise comparisons were used to test for differences in allele frequencies between and among populations. Statistical significance levels for allelic frequency comparisons were set using sequential Bonferroni tests (Rice 1989). Partitioning of microsatellite allelic variation based on analysis of molecular variance (AMOVA) was performed using ARLEQUIN. Detection of recent reductions in population size using microsatellite data were performed on 36 Idaho *O. mykiss* populations using Garza and Williamson's *M* (2001). Effective population size (*Ne*) estimates based on microsatellite data were made under the assumption of mutation-drift equilibrium using the Single-Step Mutation Model (SSM) and the Infinite Allele Model (IAM) with a mutation rate of $2.05E^{-4}$ (Garza and Williamson 2001 based on methods from Lehmann et al. 1998 and Rooney et al. 1999).

Genetic distance values reflecting the proportion of shared alleles between individuals and groups of individuals can be used to graphically depict genetic relationships and population structure. A Cavalli-Sforza and Edward's chord genetic distance (1967) matrix was generated using Treemaker version 1.0 (Cornuet et al. 1999). An unrooted Neighbor-Joining tree (NJ) was generated using the NEIGHBOR application of PHYLIP and visualized with TreeView version 1.6.6 (Page 1996). To assess the reproducibility of branching patterns on the consensus tree, bootstrapping over loci (n = 2000; Felsenstein 1985) was performed using NJBPOP (Cornuet et al. 1999). The program WHICHLOCI was used to rank the microsatellite loci used in this study based on their relative allelic differential derived from Idaho *O. mykiss* populations (Banks and Eichert 2000).

RESULTS

Microsatellite Loci and HWE

GENEPOP's analyses of expectation of HWE gave mixed results among the microsatellite loci and *O. mykiss* populations in this study (Table 4). Deviations from HWE were primarily due to heterozygote (*Hz*) excess under the assumptions of the single-step mutation-drift model (SMM). Two loci (Omy77 and Omy207) were found to be out of HWE in a large portion of the Idaho sample populations and were dropped from any further analyses. Locus

Omy77 (40% of the populations out of HWE) suffered from *Hz* deficiency in 13 steelhead populations. This locus has been shown to carry "null" alleles in other populations of *O. mykiss* (Ardren et al. 1999). Locus Omy207 had *Hz* excess in 18 steelhead populations. We know of no studies explaining the behavior of this locus in steelhead or *O. mykiss* populations outside of this study. This locus was dropped from further analyses because 53% of the Idaho populations did not meet HWE. All other loci conformed to HWE in over 70% of the study populations.

Fourteen sample populations fell significantly out of HWE for the remaining 11 loci combined: Camas Creek (Chi^2 = 58.9; df = 22; p < 0.001; Lower Big Creek (Chi^2 = 41.7; df = 22; p = 0.007); Johns Creek (Chi^2 = 40.3; df = 22; p = 0.01); Basin Creek (Chi^2 = Infinity; df = 22; p < 0.001); Fish Creek (Chi^2 = 56.7; df = 22; p < 0.001); Bear Creek (Chi^2 = 46.4; df = 22; p = 0.002); East Fork Salmon "B-run" (Chi^2 = Infinity; df = 22; p < 0.001); Whitebird Creek (Chi^2 = 51.2; df = 22; p < 0.001); Three Links Creek (Chi^2 = 46.2; df = 22; p < 0.002); Lemhi River (Chi^2 = 61.6; df = 22; p < 0.001); Pahsimeroi Hatchery (Chi^2 = Infinity; df = 22; p < 0.001); Pahsimeroi River (Chi^2 = Infinity; df = 22; p < 0.001); Red River (Chi^2 = 48.7; df = 22; p < 0.001); Secesh River (Chi^2 = 60.8; df = 22; p < 0.001). Sample sizes for all of these populations exceeded N = 42. We judged the allelic diversity found within these populations to be informative despite non-conformity to HWE and retained these populations in our analyses.

Optimal locus combinations provided population assignments among *O. mykiss* populations in the Snake River basin. Following the "leave-one-out" approach for reassignment, WHICHLOCI indicated that all 11 loci were needed for 66% reassignment accuracy. However, caution is advised in consideration of this value since the assignment accuracy of individuals back to their population of origin may be inflated due to the lack of alternative baseline data outside of those generated by this study. Loci were ranked according to their relative contribution to the analyses of allelic frequency differences among populations (Table 5).

Snake River Basin Genetic Population Structure

<u>Clearwater River</u>

We visualized allelic diversity at 11 microsatellite loci for 160 *O. mykiss* from the Clearwater River, 53 fish from the Middle Fork Clearwater drainage, and 158 fish from the South Fork Clearwater drainage (Table 1). The average number of alleles per locus found throughout Clearwater River *O. mykiss* was 7.45. Average observed heterozygosity (*Hz*) for Clearwater River *O. mykiss* populations was *Hz* = 0.63. Clearwater River basin *Fst* = 0.029. Clearwater River drainage *Fst* = 0.019. South Fork Clearwater drainage *Fst* = 0.034.

ARLEQUIN's population pairwise comparison found significant differences in allelic frequencies for all Clearwater River drainage *O. mykiss* populations. Mean *M* for the Clearwater drainage was *M* = 0.57. Effective population size (*Ne*) for the

Clearwater River drainage calculated by Garza and Williamson's (2001) program for *M* based on the SMM ranged from *Ne* = 2996 (Clear Creek) to *Ne* = 4498 (Big Canyon Creek), mean drainage *Ne* = 3629. AMOVA distribution of the allelic variation found within the Clearwater River drainage showed that 2.94% of the variation was found among populations and 97.06% was found within populations.

Table 5. Microsatellite loci rank using allele frequency differential method from WHICHLOCI (Banks and Eichert 2000).

Rank	Locus	Score	% Relative Score
1	Omy325	0.1932	16.896
2	Oneμ8	0.1869	16.345
3	Ots1	0.1270	11.111
4	Ots3	0.1186	10.377
5	Ogo4	0.1008	8.815
6	Oneμ14	0.1008	8.815
7	Ots4	0.0740	6.474
8	Omy27	0.0730	6.382
9	Ogo1a	0.0667	5.831
10	Oneμ10	0.0614	5.372
11	Oneμ11	0.0409	3.581

Salmon River

We visualized allelic diversity at 11 microsatellite loci for 254 *O. mykiss* from the Salmon River, 215 fish from the Middle Fork Salmon River drainage, 219 fish from the South Fork Salmon River, and 102 fish from the Little Salmon River (Table 1). The average number of alleles per locus found throughout the Salmon River *O. mykiss* was 7.1. Average observed heterozygosity (*Hz*) for Salmon River *O. mykiss* populations was *Hz* = 0.61. Salmon River basin *Fst* = 0.054. Salmon River drainage *Fst* = 0.065. South Fork Salmon drainage *Fst* = 0.015 and Middle Fork Salmon drainage *Fst* = 0.018. Little Salmon River *Fst* = 0.025.

ARLEQUIN's population pairwise comparison found significant differences in allelic frequencies for all but 2% of the Salmon River pairwise population comparisons (Table 6). Mean *M* for the Salmon River drainage was *M* = 0.58. Effective population size (*Ne*) for the Salmon River drainage calculated by Garza and Williamson's (2001) program for *M* based on the SMM ranged from *Ne* = 2490 (Loon Creek) to *Ne* = 7129 (Lemhi River), mean drainage *Ne* = 4261. AMOVA distribution of the allelic variation found within the Salmon River drainage showed that 5.38% of the variation was found among populations and 94.62% was found within populations.

Lochsa River

We visualized allelic diversity at 11 microsatellite loci for 218 *O. mykiss* from the Lochsa River (Table 1). The average number of alleles per locus found throughout the Lochsa River steelhead populations was 6.45. Average observed heterozygosity (*Hz*) for Lochsa River *O. mykiss* populations was *Hz* = 0.57. Lochsa River basin *Fst* = 0.019. ARLEQUIN's population pairwise comparison found significant differences in allelic frequencies for all of the Lochsa River pairwise population comparisons. Bear Creek (Selway River) shared similar allelic structure for all 11 loci combined with three streams in the Lochsa River basin (Canyon, Colt and Fish creeks; Table 6). Mean *M* for the Lochsa River drainage was *M* = 0.57. Effective population size (*Ne*) for the Lochsa River drainage calculated by Garza and Williamson's (2001) program based on the SMM ranged from *Ne* = 2315 (Brushy Fork Creek) to *Ne* = 2986 (Fish and Canyon creeks), mean drainage *Ne* = 2787. AMOVA distribution of the allelic variation found within the Lochsa River drainage showed that 1.85% of the variation was found among populations and 98.15% was found within populations.

Selway River

We visualized allelic diversity at 11 microsatellite loci for 208 *O. mykiss* from the Selway River (Table 1). The average number of alleles per locus found throughout the Selway River steelhead populations was 6.41. Average observed heterozygosity (*Hz*) for Selway River *O. mykiss* populations was *Hz* = 0.6. Selway River basin *Fst* = -0.01. ARLEQUIN's population pairwise comparison found no significant differences in allelic frequencies for four pairwise population comparisons (Table 6). Within-basin pairwise comparisons showed that Selway's Bear Creek shared similar allelic structure for all 11 loci combined with three streams (East Fork Moose, Gedney, and Three Links creeks; Table 6). East Fork Moose and Gedney creeks also carried similar allelic diversity for all 11 microsatellite loci combined (*Fst* = -0.001). Mean *M* for the Selway River drainage was *M* = 0.56. Effective population size (*Ne*) for the Selway River drainage calculated by Garza and Williamson's (2001) program for *M* based on the SMM ranged from *Ne* = 2906 (Bear Creek) to *Ne* = 3579 (East Fork Moose Creek), mean drainage *Ne* = 3196.

Table 6. Pairwise *Fst* comparisons between 36 Idaho steelhead populations. Pairwise *Fst* values are given below the diagonal and the matrix of significant *Fst* P values (“+”= significant pairwise difference) is given above the diagonal. Population codes are listed in Table 1.

	BASC	BCAN	BEAR	BIG1	BRUS	CAM1	CANY	CLRC	COLT	DWOR	EFRB	EFSF	EMOS	EPOT	FISH	GEDC	GRAN	HAM1	JOHN	JSON	LEMR	LON1	LSR2	MARC	MILE	MISS	OXBW	PAHR	POVF	RAPR	REDR	SAWT	SECR	SIMH	WHBC	3LNK
BASC		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
BCAN	0.026		-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
BEAR	0.044	-0.009		+	+	+	-	-	-	+	+	+	-	+	-	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-
BIG1	0.056	0.042	0.029		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
BRUS	0.081	0.040	0.013	0.100		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
CAM1	0.044	0.037	0.028	0.013	0.082		+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
CANY	0.060	0.017	-0.001	0.076	0.015	0.061		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
CLRC	0.050	0.017	-0.012	0.049	0.039	0.026	0.028		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
COLT	0.063	0.037	0.002	0.088	0.024	0.064	0.031	0.030		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
DWOR	0.060	0.023	0.007	0.071	0.066	0.048	0.047	0.015	0.056		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
EFRB	0.050	0.038	0.043	0.076	0.058	0.078	0.045	0.045	0.047	0.076		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
EFSF	0.058	0.045	0.029	0.026	0.094	0.035	0.073	0.048	0.074	0.075	0.074		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
EMOS	0.052	0.017	-0.040	0.049	0.033	0.030	0.030	0.016	0.011	0.031	0.039	0.034		+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
EPOT	0.050	0.024	0.013	0.055	0.068	0.051	0.051	0.033	0.049	0.049	0.044	0.050	0.019		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
FISH	0.051	0.028	-0.007	0.066	0.011	0.045	0.020	0.021	0.011	0.031	0.045	0.063	0.006	0.040		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
GEDC	0.063	0.027	-0.024	0.065	0.031	0.056	0.029	0.025	0.013	0.044	0.035	0.055	-0.001	0.029	0.016		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
GRAN	0.015	0.017	0.029	0.033	0.074	0.025	0.053	0.038	0.050	0.048	0.061	0.030	0.025	0.027	0.038	0.047		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
HAM1	0.021	0.000	0.007	0.012	0.054	0.001	0.028	0.010	0.051	0.022	0.041	0.012	0.017	0.017	0.018	0.031	0.011		+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+
JOHN	0.050	0.010	-0.009	0.065	0.026	0.048	0.010	0.019	0.046	0.023	0.059	0.065	0.020	0.042	0.021	0.032	0.042	0.010		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
JSON	0.039	0.015	0.020	0.021	0.052	0.022	0.030	0.024	0.050	0.042	0.057	0.011	0.014	0.032	0.035	0.036	0.024	-0.004	0.023		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
LEMR	0.058	0.074	0.087	0.112	0.137	0.107	0.118	0.107	0.112	0.123	0.115	0.100	0.107	0.079	0.106	0.113	0.059	0.084	0.105	0.090		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
LON1	0.069	0.049	0.043	0.015	0.093	0.010	0.072	0.039	0.084	0.057	0.098	0.042	0.043	0.071	0.056	0.072	0.046	0.018	0.063	0.030	0.140		+	+	+	+	+	+	+	+	+	+	+	+	+	+
LSR2	0.013	0.025	0.041	0.048	0.094	0.035	0.062	0.036	0.076	0.046	0.052	0.048	0.049	0.041	0.061	0.069	0.019	0.016	0.050	0.036	0.074	0.059		+	+	+	+	+	+	+	+	+	+	+	+	+
MARC	0.061	0.052	0.056	0.025	0.097	0.013	0.077	0.036	0.073	0.062	0.079	0.037	0.047	0.057	0.051	0.064	0.038	0.021	0.068	0.035	0.123	0.028	0.056		+	+	+	+	+	+	+	+	+	+	+	+
MILE	0.055	0.023	0.042	0.089	0.064	0.067	0.041	0.032	0.041	0.040	0.061	0.076	0.037	0.057	0.040	0.044	0.055	0.044	0.038	0.053	0.110	0.091	0.061	0.079		+	+	+	+	+	+	+	+	+	+	+
MISS	0.041	0.017	0.011	0.044	0.063	0.046	0.051	0.036	0.045	0.054	0.034	0.035	0.024	0.013	0.039	0.021	0.021	0.027	0.045	0.025	0.075	0.064	0.039	0.048	0.062		+	+	+	+	+	+	+	+	+	+
OXBW	0.014	0.013	0.033	0.040	0.074	0.043	0.052	0.038	0.056	0.042	0.058	0.044	0.036	0.031	0.046	0.050	0.010	0.010	0.038	0.033	0.046	0.061	0.021	0.059	0.049	0.024		+	+	+	+	-	+	-	+	+
PAHR	0.078	0.108	0.153	0.166	0.178	0.163	0.151	0.154	0.155	0.169	0.148	0.157	0.159	0.130	0.154	0.164	0.104	0.135	0.139	0.143	0.024	0.203	0.101	0.183	0.144	0.130	0.081		+	+	+	+	+	+	+	+
POVF	0.053	0.027	0.033	0.027	0.079	0.026	0.055	0.034	0.069	0.046	0.082	0.020	0.031	0.039	0.049	0.051	0.025	0.009	0.038	0.011	0.088	0.032	0.044	0.033	0.075	0.029	0.039	0.150		+	+	+	+	+	+	+
RAPR	0.046	0.034	0.044	0.026	0.099	0.028	0.063	0.039	0.078	0.059	0.067	0.020	0.039	0.030	0.058	0.056	0.022	0.012	0.054	0.027	0.095	0.044	0.025	0.034	0.087	0.024	0.038	0.156	0.018		+	+	+	+	+	+
REDR	0.050	0.014	0.020	0.062	0.065	0.042	0.039	0.019	0.056	0.011	0.071	0.061	0.030	0.031	0.030	0.043	0.033	0.023	0.018	0.035	0.084	0.061	0.029	0.064	0.048	0.042	0.031	0.134	0.035	0.042		+	+	+	+	+
SAWT	0.012	0.019	0.014	0.052	0.059	0.047	0.047	0.041	0.044	0.054	0.037	0.039	0.033	0.027	0.035	0.039	0.013	0.016	0.038	0.024	0.053	0.069	0.028	0.055	0.045	0.024	0.002	0.084	0.039	0.037	0.036		+	-	+	+
SECR	0.046	0.033	0.030	0.031	0.077	0.028	0.056	0.033	0.061	0.051	0.059	0.021	0.032	0.034	0.050	0.044	0.024	0.013	0.050	0.013	0.095	0.037	0.040	0.037	0.071	0.027	0.038	0.160	0.013	0.017	0.041	0.033		+	+	+
SIMH	0.013	0.007	0.011	0.044	0.060	0.039	0.038	0.033	0.040	0.050	0.040	0.036	0.028	0.023	0.035	0.038	0.005	0.001	0.031	0.021	0.044	0.061	0.023	0.051	0.036	0.021	0.002	0.075	0.035	0.031	0.034	-0.003	0.028		+	+
WHBC	0.027	0.014	0.004	0.038	0.041	0.032	0.027	0.031	0.036	0.043	0.052	0.037	0.015	0.042	0.023	0.032	0.013	-0.002	0.028	0.020	0.079	0.035	0.036	0.044	0.043	0.026	0.019	0.129	0.030	0.031	0.034	0.018	0.032	0.013		+
3LNK	0.070	0.031	-0.026	0.071	0.031	0.059	0.027	0.031	0.017	0.058	0.043	0.058	0.006	0.047	0.030	0.007	0.049	0.036	0.034	0.036	0.118	0.076	0.071	0.076	0.040	0.036	0.058	0.160	0.059	0.063	0.050	0.049	0.053	0.041	0.034	

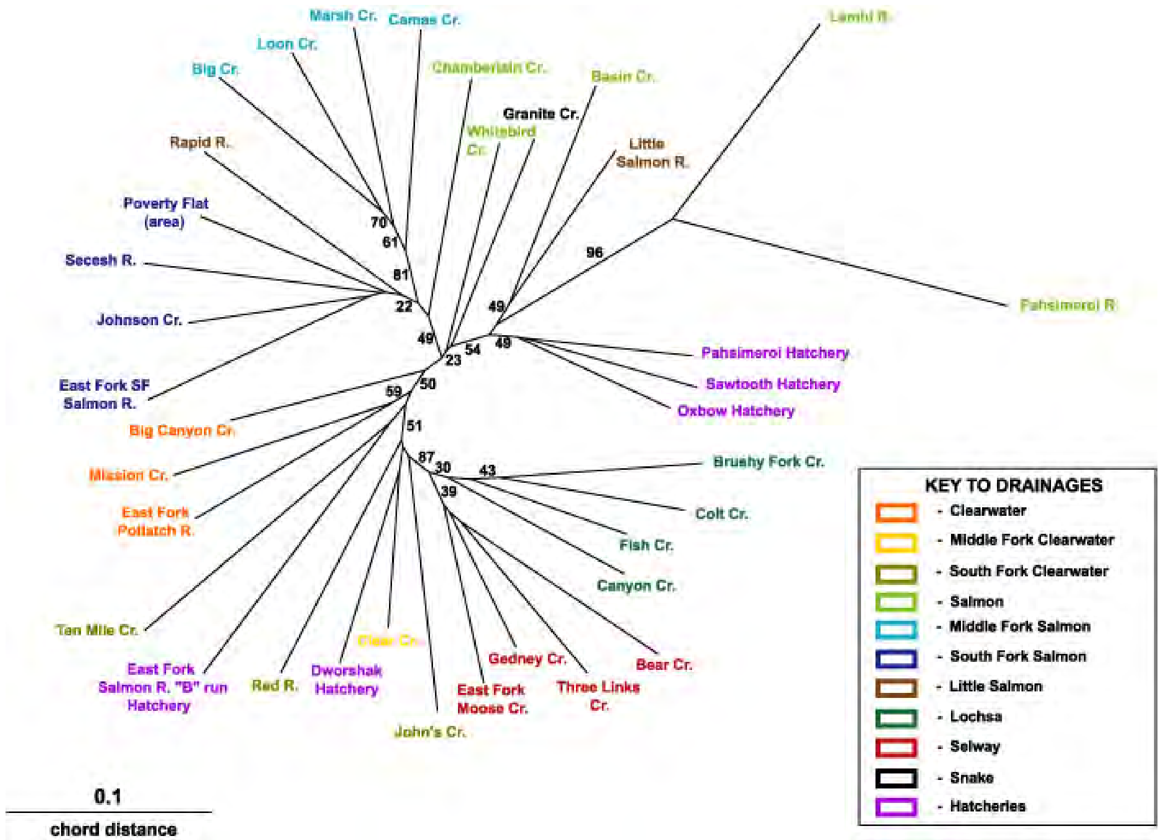

Figure 2. Unrooted Neighbor-Joining tree based on Cavalli-Sforza and Edwards (1968) chord distance for steelhead populations sampled in the Snake River drainage, Idaho. Bootstrap values (% 2000 replicate trees) are given for major branches.

Table 7. Estimations of recent reductions in population size (Garza and Williamson's *M*) and effective population size (Ne) based on the Infinite Allele (IAM) and Single Mutation (SMM) models .

DRAINAGE	POPULATION	Garza & Williamson's *M*	*N*e IAM	*N*e SMM
Clearwater River	Big Canyon Creek	0.597	2310	4498
	EF Potlatch River	0.607	2114	3947
	Mission Creek	0.570	2030	3721
MF Clearwater River	Clear Creek	0.496	1746	2996
SF Clearwater River	John's Creek	0.482	1871	3305
	Red River	0.580	2074	3837
	Ten Mile Creek	0.577	1789	3101
Salmon River	Basin Creek	0.589	2883	6290
	Chamberlain Creek	0.604	2129	3988
	Lemhi River	0.633	3125	7129
	Pahsimeroi River	0.622	2766	5903
	Whitebird Creek	0.630	2232	4274
SF Salmon	EF SF Salmon River	0.538	2026	3709
	Johnson Creek	0.577	2067	3819
	Poverty Flat Area	0.555	1894	3364
	Secesh River	0.532	2012	3672
MF Salmon River	Big Creek (lower)	0.575	1828	3198
	Camas Creek	0.577	1990	3614
	Loon Creek	0.577	1530	2490
	Marsh Creek	0.588	1673	2821
Little Salmon River	Little Salmon, Pinehurst area	0.660	2404	4774
	Rapid River	0.533	2072	3833
Lochsa River	Brushy Fork Creek	0.578	1451	2315
	Canyon Creek	0.586	1742	2986
	Colt Creek	0.565	1691	2862
	Fish Creek	0.573	1904	3391
Selway River	Bear Creek	0.553	1709	2906
	EF Moose Creek	0.549	1977	3579
	Gedney Creek	0.617	1834	3214
	Three Links Creek	0.522	1782	3085
Snake River	Granite Creek	0.635	2512	5098
Hatcheries	Dworshak Hatchery	0.610	1660	2790
	EF Salmon "B-run"	0.522	1767	3048
	Oxbow Hatchery	0.599	2465	4956
	Pahsimeroi Hatchery	0.627	2646	5518
	Sawtooth Hatchery	0.609	2617	5425

Snake River

One population of steelhead from Granite Creek on the Snake River was analyzed in this study (N = 49 fish). Observed HZ for Granite Creek was 0.68. The mean number of alleles for all 11 loci in this sample was 7.91. Population *M* = 0.64 and Garza and Williamson's (2001) SMM *Ne* = 5098 fish.

Total Basin AMOVA

AMOVA for all Snake River drainages combined gave the following Fixation Indices: *Fsc* = 0.025; *Fst* = 0.052; *Fct* = 0.028. Allelic variation was partitioned across the Snake River drainage as 2.79% among river basins, 2.44% among populations within river basins, and 94.77% within populations.

Idaho Steelhead Hatchery Populations

Population pairwise comparisons showed no significant differences in allelic frequencies for Oxbow, Sawtooth, and Pahsimeroi hatcheries. Pahsimeroi Hatchery was the only hatchery population in this study with allelic frequencies that were not significantly different from wild *O. mykiss* populations. Pahsimeroi Hatchery steelhead and fish from Chamberlain Creek in the Salmon River drainage were not significantly different in allelic frequencies for the 11 microsatellite loci combined (*Fst* = 0.001; P = 0.265; Table 6). The average observed *Hz* within the hatchery populations was *Hz* = 0.63 and the average number of alleles per locus was 7.22. Hatchery *M* ranged from *M* = 0.522 (East Fork Salmon "B-run") to *M* = 0.627 (Pahsimeroi Hatchery), mean *M* = 0.59. Dworshak Hatchery *Ne* = 2790; East Fork Salmon "B-run" *Ne* = 3048; Oxbow Hatchery *Ne* = 4956; Pahsimeroi Hatchery *Ne* = 5518; Sawtooth Hatchery *Ne* = 5425.

Table 8. BOTTLENECK's mutation drift equilibrium probabilities under the heterozygote deficient (HZD), heterozygote excess (HZE), and two-tailed deficiency and excess (TTM) models for Idaho steelhead populations based on all 11 microsatellite loci combined under SMM and IAM mutation-drift equilibrium assumptions using Wilcoxon tests.

Population	SMM Model HZD	SMM Model HZE	SMM Model TTM	IAM Model HZD	IAM Model HZE	IAM Model TTM
Big Canyon Creek	0.01	0.99	0.02	0.97	0.03	0.07
East Fork Potlatch River	0.16	0.86	0.32	0.99	0.01	0.02
Mission Creek	0.03	0.99	0.05	0.99	0.01	0.02
Clear Creek	0.01	0.99	0.02	0.88	0.14	0.28
John’s Creek	0.01	0.99	0.01	0.88	0.14	0.28
Red River	0.00	1.00	0.01	0.91	0.10	0.21
Ten Mile River	0.21	0.82	0.41	0.99	0.01	0.02
Basin Creek	0.03	0.99	0.05	0.99	0.00	0.00
Chamberlain Creek	0.05	0.96	0.10	0.97	0.04	0.08
Lemhi River	0.52	0.52	1.00	1.00	0.00	0.01
Pahsimeroi River	0.01	0.99	0.02	0.99	0.01	0.02
Whitebird Creek	0.02	0.99	0.05	1.00	0.00	0.01
East Fork South Fork Salmon River	0.09	0.93	0.18	0.99	0.01	0.02
Johnson Creek	0.14	0.88	0.27	1.00	0.00	0.01
Poverty Flat area	0.01	0.99	0.02	1.00	0.00	0.01
Secesh River	0.01	0.99	0.02	0.99	0.01	0.02
Big Creek (lower)	0.10	0.91	0.21	0.97	0.04	0.08
Camas Creek	0.00	1.00	0.01	0.91	0.10	0.21
Loon Creek	0.03	0.97	0.07	0.97	0.03	0.07
Marsh Creek	0.42	0.62	0.83	0.94	0.07	0.15
Little Salmon River Pinehurst area	0.03	0.99	0.05	0.99	0.01	0.02
Rapid River	0.23	0.79	0.47	1.00	0.00	0.01
Brushy Fork Creek	0.10	0.91	0.21	0.97	0.04	0.08
Canyon Creek	0.23	0.79	0.47	0.99	0.01	0.02
Colt Creek	0.16	0.86	0.32	0.99	0.01	0.01
Fish Creek	0.01	0.99	0.01	0.91	0.10	0.21
Bear Creek	0.32	0.71	0.64	0.99	0.03	0.05
East Fork Moose Creek	0.04	0.97	0.08	0.97	0.04	0.08
Gedney Creek	0.14	0.88	0.28	0.97	0.04	0.08
Three Links Creek	0.38	0.65	0.77	0.99	0.01	0.02
Granite Creek	0.03	0.97	0.07	0.99	0.01	0.02
Dworshak Hatchery	0.09	0.93	0.18	0.99	0.01	0.02
East Fork Salmon “B-run”	0.32	0.71	0.64	0.96	0.05	0.10
Oxbow Hatchery	0.35	0.68	0.70	1.00	0.00	0.00
Pahsimeroi Hatchery	0.35	0.68	0.70	1.00	0.00	0.01
Sawtooth Hatchery	0.10	0.91	0.21	1.00	0.00	0.00

Snake River Ne and Bottleneck Analyses

Garza and Williamson's (2001) *M* demonstrates a recent reduction in population, i.e. a population bottleneck, when $M \leq 0.68$. In tests of Snake River steelhead populations mean *M* across all 11 microsatellite loci was less than 0.68 in all populations. Garza and Williamson's (2001) *M* estimates of effective population size assuming mutation-drift equilibrium and a mutation rate of $2.05E^{-4}$ for both SMM and IAM are given for steelhead populations in the Snake River drainage in Table 7. Probabilities calculated under the assumption that all loci meet expectations for mutation-drift equilibrium using three models (heterozygote (*Hz*) deficiency (one tailed); *Hz* excess (one tailed); two tails *Hz* excess and deficiency) using the program BOTTLENECK are given for the Snake River steelhead populations in Table 8.

Snake River Genetic Distance

A consensus Neighbor-Joining tree based on Cavalli-Sforza and Edwards chord distance for the entire set of samples analyzed in this report from the Snake River system is presented in Figure 2. Branch bootstrap values (% of 2000 replicate trees) are given for major branches. NJ analyses demonstrated inferential clustering of populations within drainages, especially the Middle Fork Salmon, South Fork Salmon, Lochsa, and Selway rivers. Ninety-six percent bootstraps supported unique allelic population structure in the Pahsimeroi and Lemhi populations. Microsatellite distance analyses of the Dworshak Hatchery population, although distinct to some degree from many other *O. mykiss* populations, does not show significantly different allelic variation as would have been predicted from previous allozyme analyses.

DISCUSSION

This study focused on genetic population structure in 36 Snake River *O. mykiss* populations as part of a larger ongoing study of 79 Idaho *O. mykiss* populations. Completion of the second phase of this project is expected late 2004 or early 2005. Final publication of these results will be submitted at that time. Relationships among populations shown in this report may change after the completed data set is analyzed, therefore, the results in this report should be considered preliminary. A previous analysis of four steelhead populations from the Clearwater River basin was made in relationship to the Dworshak Hatchery fish (Nielsen et al. 2003a). A total of seven steelhead populations from the Clearwater River basin were included in this report, adding fish from Mission Creek, Red River and Ten Mile Creek. Big Canyon Creek carried the highest observed heterozygosity (*Hz* = 0.68) and the largest estimate of effective population size (SMM *Ne* = 4498). Clear Creek from the Middle Fork Clearwater drainage had the lowest estimated effective population size (SMM *Ne* = 2996). John's Creek from South Fork Clearwater River carried the lowest observed *Hz* = 0.57 in this drainage.

Populations in the lower Clearwater drainage from Big Canyon Creek, Mission Creek, and EF Potlatch River are considered A-run fish and are downstream of Dworshak NFH. Dworshak stock smolts are released annually in Clear Creek (Middle Fork Clearwater) and the South Fork Clearwater River to provide for angler harvest. Dworshak NFH adults and smolts have been stocked in many South Fork Clearwater tributaries for state and Nez Perce Tribe supplementation efforts. Our microsatellite analyses showed mixed results in genetic associations for this group. Two *O. mykiss* samples collected from streams in the Clearwater River drainage, Mission Creek and East Fork Potlatch River, separated from the rest of the Clearwater River group containing the Dworshak hatchery stock with 59% bootstrap replication in 2000 NJ trees (Mission/Dworshak F_{st} = 0.054; EF Potlatch/Dworshak F_{st} = 0.049). The Big Canyon Creek *O. mykiss* population was marginally distinct from Dworshak hatchery stocks based on allelic frequencies for these 11 microsatellite loci (pairwise F_{st} = 0.023). Ten Mile Creek in the South Fork Clearwater was weakly associated with the East Fork Salmon B-run hatchery stock in our NJ tree, with very low bootstrap replication (25%; pairwise F_{st} = 0.061). Clear Creek, John's Creek and the Red River (SF Clearwater R.) *O. mykiss* populations were more difficult to differentiate from Dworshak hatchery fish (pairwise F_{st} = 0.015; 0.023; 0.011; respectively). Weak bootstraps (38%) supported the NJ branch containing Dworshak Hatchery and Clear Creek.

The steelhead population from Dworshak Hatchery was the most divergent single population of inland steelhead based on genetic traits determined by protein electrophoresis (Busby et al. 1996). However, this conclusion was based on very limited sampling of Idaho steelhead populations. In this microsatellite study, Dworshak Hatchery fish were significantly different in allelic frequencies from all other Snake River basin populations, but only 1.4% of all basin-wide population pairwise comparisons were non-significant, indicating significant genetic structure throughout this system. Using microsatellite analyses Dworshak Hatchery had the lowest estimated effective population size of the five hatcheries populations we analyzed (SMM *Ne* = 2790). Only wild *O. mykiss* populations from Loon Creek from the Middle Fork Salmon River (*Ne* = 2490) and Brushy Fork Creek on the Lochsa River (*Ne* = 2315) had lower effective population size estimates.

We found little support from the genetic distance analyses to separate the East Fork Salmon B-run hatchery stock from the Dworshak Hatchery (also considered B-run fish) and several other Clearwater River drainage *O. mykiss* populations (see Figure 2). These two hatchery populations shared their most common alleles for all but three loci (Ogo4, Omy325, and Ots3). A 50% bootstrap value supported the NJ branch pattern grouping the East Fork Salmon B-run hatchery stock with *O. mykiss* from Ten Mile Creek, East Fork Potlatch River and Mission Creek in the Clearwater River drainage in our NJ analysis (pairwise F_{st} range = 0.034 – 0.061). The EF Salmon B-hatchery stock was expected to cluster closely with Dworshak Hatchery fish, but instead we found a closer genetic association with *O. mykiss* from Ten Mile Creek. This suggests that differential reproductive success may have biased the resulting genetic population structure away from the Dworshak hatchery contribution. However, only 25% to 51% of the NJ bootstrap trees separate the branch containing the Dworshak hatchery population from the EF Salmon B-hatchery population.

Significant genetic separation of the Lochsa and Selway River *O. mykiss* from Clearwater River drainage fish was shown in these microsatellite analyses. The differentiation was greater between Clearwater/Lochsa than between Clearwater/Selway (Clearwater/Lochsa mean pairwise F_{st} = 0.061; Clearwater/Selway mean pairwise F_{st} = 0.037). Genetic pairing of the Lochsa and Selway River *O. mykiss* populations was supported with a bootstrap value of 87% suggesting fine-scale population genetic structure across both drainages. Genetic substructure among streams within each of the Lochsa and Selway rivers was less significant (all bootstraps < 43%), but additional sampling within both drainages may reveal fine-scale genetic substructure. Bear Creek in the Selway River drainage was unusually common in F_{st} pairwise comparisons with no significant differences in allelic frequency relative to nine other populations (Table 6). This resulted from the fact that the Bear Creek *O. mykiss* population contained a high proportion of the most common alleles for all 11 loci and carried limited genetic diversity outside of these common alleles, making this population difficult to differentiate from many other groups of *O. mykiss* where common alleles predominated.

Salmon River drainage wild steelhead showed significant biogeographic structuring in this study (see Figure 2). Support for genetic population structure was greatest for the Middle Fork Salmon River where 81% bootstraps supported clustering within this drainage. Significant bootstrap values (61-70%) also supported genetic substructure among tributaries sampled in the Middle Fork Salmon River suggesting fine-scale population differentiation within this drainage. Middle Fork Salmon River within-drainage pairwise F_{st} values were all significant. Genetic diversity within the Middle Fork Salmon River was not as large as that found within the Clearwater River drainage (mean MF Salmon River F_{st} = 0.017; Clearwater River F_{st} = 0.021). Genetic samples from Big and Loon creeks were more closely allied than either was to samples from Marsh Creek (Big/Loon F_{st} = 0.015; Big/Marsh F_{st} = 0.025; Loon/Marsh F_{st} = 0.028). *O. mykiss* sampled in Camas Creek, downstream from Loon Creek were also genetically distinct from other tributaries sampled in the Middle Fork Salmon River (within-drainage comparisons mean F_{st} = 0.012) and were more closely allied with Loon Creek *O. mykiss* (F_{st} = 0.010). Similar genetic relationships are depicted in our NJ tree (Figure 2). Additional samples taken from sites above Loon Creek in the Middle Fork Salmon River remain to be analyzed and may add resolution to the within-drainage separation found in this system.

O. mykiss collected from the South Fork Salmon River, considered B-run fish, also clustered together in our NJ tree, but with less statistical support based on replicate trees. Rapid River (tributary of the Little Salmon River) *O. mykiss* fell within this group in these microsatellite analyses. A velocity barrier weir separates fish from upper Rapid River and downstream locations in the Little Salmon River where there are large hatchery releases yearly to provide angler harvest. Samples collected in Rapid River were taken upstream of the weir. Bootstrap values supporting branching patterns within this cluster were not high, ranging from 6-28%. *O. mykiss* samples collected from Secesh River were not as isolated genetically from other South Fork Salmon River populations in this study as previously reported in ICBTRT (2003). However, within-SF Salmon River drainage pairwise F_{st} values using Secesh River samples were all significant: Secesh/EF South Fork F_{st} = 0.021; Secesh/Poverty Flat F_{st} = 0.013; Secesh/Johnson Creek F_{st} = 0.013.

Oxbow hatchery fish were only weakly separated from four geographically proximate sample locations (Oxbow/Little Salmon F_{st} = 0.021; Oxbow/Granite F_{st} = 0.010; Oxbow/Whitebird F_{st} = 0.019; Oxbow/Chamberlain F_{st} = 0.010). The Little Salmon River *O. mykiss* weakly grouped with fish from Basin Creek from the upper Salmon River in our NJ tree (49% bootstrap). Whitebird Creek, a tributary just downstream of the mouth of the Little Salmon River was part of the larger grouping of *O. mykiss* including fish from the mainstem Snake River in Granite Creek. F_{st} analyses showed no significant differences in allelic frequency for microsatellite loci between Whitebird Creek and Chamberlain Creek, a putative A-run population.

Three steelhead hatchery populations, Oxbow, Sawtooth and Pahsimeroi hatcheries, were statistically similar in allelic frequency for all 11 microsatellite loci and grouped together in our NJ analysis of chord genetic distance (see Figure 2 and Table 6). All of these hatchery populations were primarily derived from wild steelhead collected at the base of Hells Canyon Dam and would be expected to have similar genetic signatures. Only one wild population in the Salmon River drainage carried allelic frequencies that were not significantly different from hatchery steelhead (Chamberlain Creek and the Pahsimeroi Hatchery pairwise F_{st} = 0.001, p = 0.265). Our NJ analysis weakly placed Chamberlain Creek *O. mykiss* within the group containing South Fork Salmon River and Middle Fork Salmon river B-run populations with 49% bootstraps.

The Snake River steelhead ESU includes both resident and anadromous *O. mykiss* (ICBTRT 2003). Differentiation of freshwater and anadromous life history components for *O. mykiss* has been controversial since the renaming of steelhead and rainbow trout to the *Oncorhynchus* genus by Smith and Stearley (1989). Early genetic studies of *O. mykiss* above and below waterfalls suggested unique evolutionary lineages for these two life history types (Currens et al. 1990). Recent studies of coastal *O. mykiss* populations have been unable to genetically differentiate anadromous and freshwater-resident types sampled from the same river drainages suggesting parallel evolution of divergent life histories within each river (Beacham et al. 1999; Nielsen 1999; Nielsen et al. 1999; McCusker et al. 2000; Docker and Heath 2003). However, studies of population structure and otolith microchemistry have been shown to support reproductive separation between anadromous and resident components of *O. mykiss* within the same river drainage (Zimmerman and Reeves 2000 and 2002).

Pascual et al. (2001) have documented the development of anadromous runs of steelhead derived from introduced rainbow trout in Patagonia, Argentina. Previous genetic studies have suggested a resident contribution to the anadromous component of the Snake River steelhead population (Moran unpublished data; Figure IV-2 page 60 ICBTRT 2003). The source of the anadromous component of Snake River *O. mykiss* and the interplay between anadromous and resident life histories are important questions for restoration and de-listing criteria.

Two Salmon River *O. mykiss* populations in this study were found to have uniquely distinct allelic frequencies and genetic structure – Lemhi River and Pahsimeroi River. These two *O. mykiss* populations separated from the rest of our sample locations with 96% bootstraps on the NJ tree. Allele frequencies comparisons between both populations were statistically significant (pairwise F_{st} = 0.024, $p < 0.001$). Both populations shared a similar level of observed heterozygosity (Hz = 0.67) and average number of alleles per locus (8). The Pahsimeroi River population had a lower estimated effective population size (Pahsimeroi SMM Ne = 5903; Lemhi SMM Ne = 7129) and Garza and Williamson's M was lower in the Lemhi River *O. mykiss* (M = 0.46 versus Pahsimeroi M = 0.55), probably reflecting different characteristics of recent population declines.

These *O. mykiss* populations were collected from high mountain valley, spring-fed streams with highly productive populations. These streams, unlike other systems in the Snake River basin contain a relatively steady flow regime with groundwater-mitigated stream temperatures that are warmer than average in the winter and cooler than average in the summer. These environmental conditions may have led to unique life history structure in these populations where large components of the population remain in fresh water throughout their life, not migrating to the Pacific Ocean.

Anadromous steelhead currently found in these rivers are presumably primarily derived from several hatchery stocking efforts (ICBTRT 2003). Consistent reproductive isolation between freshwater and anadromous *O. mykiss* based on a pattern of freshwater maturation in wild resident fish could lead to separation of resident strains despite hatchery stocking of steelhead. It is significant that these unique sample locations can be rigorously separated from the other study sites, including local hatcheries, suggesting a unique evolutionary status for these populations. Additional sampling in putative "resident" stocks in the Snake River basin may help support genetic structure for unique evolutionary life histories for *O. mykiss* in this area.

Snake River steelhead have been genetically differentiated from other interior Columbia River steelhead populations (Busby et al. 1996) and listed under the Endangered Species Act by the Federal government. In this study, significant biogeographic population genetic structure was documented within the Snake River basin in Idaho. Wild steelhead abundance in the Snake River has declined precipitously over the last 50 years, with many stocks currently in decline (Busby et al 1996 and 1997). Habitat alterations due to water diversions, increased water demands, changes in water management strategies, dams and barriers, bank protection, dredging, sediment disposal, gravel mining, contaminant exposure, climate change and shifts in ocean conditions have clearly impacted the size and distribution of steelhead runs throughout the Columbia River (Robards and Quinn 2002). The loss of access to upriver spawning habitats, declines in once viable tributary populations, and limited productivity in large river populations have also had potentially significant effects on Snake River steelhead with important implications for genetic diversity and restoration (ICBTRT 2003).

Estimates of effective population size (*Ne*) incorporate relative parameters related to demographic information. In small populations, *Ne* is important because it is inversely related to the rate of loss of genetic diversity. Estimates of *Ne*, however, are based on several assumptions (identity-by-descent, random mating, temporal stability in finite populations) that are generally difficult to support for *O. mykiss* and can often overestimate population size (Heath et al. 2002, Palm et al. 2003; Ardren and Kapuscinski 2003). The relationship between effective population size (i.e. the estimated number of individuals contributing genes to the next generation) and actual demographic population size is important in understanding the effects of artificial husbandry on the genetic composition of hatchery stocks (Waples and Do 1994). Comparisons of these two characteristics deserve attention in all hatchery populations considered for supplementation of wild stocks. Temporal changes in genetic structure and effective population size can be used to monitor intermittent gene flow and address concerns about population stability (Frankham 1995) and size in populations of concern (Heath et al. 2002). We recommend additional temporal sampling in Snake River steelhead hatchery populations to gain inference on these issues (see Hansen et al. 2002 and Guinard et al. 2002).

Implications of intra-specific hatchery production on wild steelhead stocks within genetically distinct river drainages are also a critical concern for steelhead restoration. The degree of straying and interbreeding with hatchery fish, especially non-native derived populations, is important to our understanding of the status of remaining wild stocks and the position hatcheries can play in the restoration of steelhead in the ESU. Local gene flow to or from hatchery fish may link hatchery stocks with geographically adjacent wild populations, for example: (1) Oxbow, Sawtooth, and Pahsimeroi hatcheries with the Little Salmon River (Pinehurst), Granite Creek, Whitebird Creek and Basin Creek; (2) Dworshak Hatchery with Clear Creek, John’s Creek, Red River, and Ten Mile Creek. Directionality of this gene flow is difficult to interpret from these data since hatchery stocks were, for the most part, developed from local adult steelhead populations at specific times and from different migration patterns. This relationship will also depend on the management history of the hatchery broodstock, the amount and extent of hatchery stocking into wild river systems, and the reproductive success of straying hatchery fish in the wild. To address this question genetically, a broader coverage of both spatial and temporal samples is required.

Analysis of mitochondrial DNA (mtDNA) sequence from both hatchery and wild populations may add resolution to this question. Maternally inherited mtDNA has been used to discriminate between hatchery and wild stocks based on sexually dimorphic selection or admixture from divergent gene pools that occurred in either population’s recent history (Nielsen et al. 1994). However, when the hatchery stock is derived from local wild sources within the same ESU, the resolution found in mtDNA analyses is minimal unless significant artificial selection for females has occurred within the hatchery broodstock development (Nielsen et al. 2003b).

Genetic analyses of 36 *O. mykiss* populations throughout the Snake River basin provide a better understanding of population structure in this complex system. The dynamic genetic structure of *O. mykiss* in this basin will be better understood when additional populations within individual drainages are analyzed. We also suggest testing year-to-year variation at unique sample sites within individual drainages where hatchery stocks have been stocked and in drainages with no hatchery stocking. Additional sampling of adult fish to compare hatchery and wild fish interactions will also add significant rigor to these analyses. The hint of genetic separation between different life histories, i.e. resident and anadromous fish from the Salmon River, is very intriguing and should be followed with more sample locations where separation of these life history types is suspected. The significance of the microsatellite separation found in the Lemhi and Pahsimeroi river *O. mykiss* populations make them a good candidate for molecular systematic studies using other rigorous genetic tools where time since divergence can be confidently estimated. Our analysis of the Idaho steelhead leaves us with as many new questions as it provides answers. It is clear that the addition of data from the remaining sample collections currently in analysis at ASC will add new insight and complexity to these analyses.

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Appendix 1. Wild steelhead populations that were sampled in 2000 that will be analyzed and included in the final report.

Drainage	Population	Site Location on Map
Clearwater River	Jacks Creek	17
	Little Bear Creek	18
Salmon River	Bargamin Creek	37
	Horse Creek	40
	Morgan Creek	42
	Owl Creek	43
	Sheep Creek	44
	Slate Creek	45
	Valley Creek	46
	Warm Springs Creek	47
	WF Yankee Fork	50
Middle Fork Salmon River	Bear Valley Creek	58
	Big Creek (upper)	60
	Pistol Creek	64
	Rapid River	65
	Sulphur Creek	66
South Fork Salmon River	Lick Creek (downstream of barrier)	53
	Lick Creek (upstream of barrier)	54
	Stolle Meadow	57
Little Salmon River	Boulder Creek	67
	Hazard Creek	68
	Little Salmon River, upstream of falls	69
Lochsa River	Boulder Creek	1
	Crooked Fork Creek	5
	Deadman Creek	6
	Fish Creek (fall migrants)	8
	Hungery Creek	9
	Lake Creek	10
	Papoose Creek	11
	Storm Creek	12
	Warm Springs Creek	13
	Weir Creek	14
Selway River	Meadow Creek	28
	Mink Creek	29
	NF Moose Creek	30
	O'Hara Creek	31
	Pettibone Creek	32
Snake River	Captain John Creek	34
	Sheep Creek	36
Boise River	Big Smoky Creek	78
North Fork Clearwater River	Collins Creek	21
Payette River	MF Payette River	77
Weiser River	Little Weiser River	79

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