FISHERY RESEARCH

IDAHO STEELHEAD MONITORING AND EVALUATION STUDIES

ANNUAL PROGRESS REPORT
January 1, 2007—December 31, 2007

Photo: Ron Roberts

Prepared by:

Timothy Copeland
Senior Fishery Research Biologist

and

Scott Putnam
Senior Fishery Technician

IDFG Report Number 08-05
April 2008

Idaho Steelhead Monitoring and Evaluation Studies

Project Progress Report

2007 Annual Report

By

Timothy Copeland
Scott Putnam

Idaho Department of Fish and Game
600 South Walnut Street
P.O. Box 25
Boise, ID 83707

To

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR 97283-3621

Project Number 1990-055-00
Contract Number 31601

IDFG Report Number 08-05
April 2008

TABLE OF CONTENTS

Page

ABSTRACT 1
INTRODUCTION 2
OBJECTIVES 2
METHODS 3
- Adult Escapement 3
  - Numbers and Sex Ratio 3
  - Age Composition 4
  - Run Timing 4
- Parr Density 4
- Juvenile Emigrant Abundance 6
- Juvenile Emigrant Age Composition 6
- Smolt Survival 7
- Genetic Diversity 7
- Water Temperature Monitoring 8

RESULTS 8
- Adult Escapement 8
  - Fish Creek 8
  - Rapid River 9
- Parr Density 9
- Juvenile Emigrant Abundance 10
- Juvenile Emigrant Age Composition 11
- Smolt Survival 12
- Genetic Diversity 12
- Water Temperature Monitoring 12

DISCUSSION 13
ACKNOWLEDGEMENTS 15
LITERATURE CITED 16
APPENDIX 37

LIST OF TABLES

Page

Table 1. The number of adult steelhead captured at Fish Creek and Rapid River and the number of kelts recovered in 2007. Fork length 95% CI is in parentheses. 18

Table 2. Capture dates of adult steelhead at the Fish Creek and Rapid River weirs in 2007 by life stage (pre- versus post-spawn). N = number of fish. 18

Table 3. Individual adult steelhead that were PIT-tagged in Fish Creek as juveniles and later detected during the 2006-2007 spawning run at Bonneville (BON), McNary (MCN), and Lower Granite (LGR) dams. 19

Table 4. Age composition, by sex, of adult steelhead captured at the Fish Creek and Rapid River weirs during 2007. Mean fork length at age 95% CI is in parentheses..... 19

Table 5. Densities (fish/100 m^2) of salmonids observed at new basinwide and historic GPM sites snorkeled in the Fish Creek drainage during 2007. Trout fry = all trout <50 mm. Sites are arranged in upstream to downstream order..... 20

Table 6. Densities (fish/100 m^2) of salmonids observed at new basinwide and historic GPM sites snorkeled in the Rapid River drainage during 2007. Trout fry = all trout <50 mm. Sites are arranged in upstream to downstream order..... 21

Table 7. Densities (fish/100 m^2) of salmonids observed at new basinwide sites snorkeled in the Boulder Creek drainage during 2007. Trout fry = all trout <50 mm. Sites are arranged in upstream to downstream order. 22

Table 8. The number of scale samples, by season, collected from juvenile steelhead during 2007 by ISMES personnel and cooperators. Seasons are defined in the text..... 23

Table 9. Mean fork length at age of juvenile steelhead captured at screw traps in three streams during 2007 by season. Number of fish aged is in parentheses..... 23

Table 10. Number of PIT-tagged steelhead smolts that were detected at least once moving downstream during 2007 by population and year tagged. See text for list of interrogation sites..... 24

Table 11. Percentile dates of arrival at Lower Granite Dam for PIT-tagged steelhead smolts detected in spring 2007..... 24

Table 12. Number of genetic samples collected from juvenile and adult steelhead during 2007. 24

Table 13. Streams sampled for water temperatures in 2007. Measurements were taken within 1 km of the mouth of each stream unless noted. 25

LIST OF FIGURES

Page

Figure 1. Map of the Clearwater River and Salmon River drainages showing the locations of the Fish Creek, Rapid River, Secesh River, and Big Creek screw trap sites in 2007. 26

Figure 2. Length frequency of steelhead observed in three watersheds while snorkeling during 2007. Fish Creek (top, n=1,015). Rapid River (middle, n = 1,145). Boulder Creek (bottom, n = 701). 27

Figure 3. Daily number of steelhead juveniles captured in the Fish Creek screw trap and river level (ft) during 2007. Spring (3/8–5/31, n = 61) is top panel; summer (6/1–8/14, n = 356) is middle panel; and fall (8/15–11/7, n = 8,039) is bottom panel. Note difference in scale in bottom panel. 28

Figure 4. Length frequency of steelhead juveniles captured in the Fish Creek screw trap during 2007. Spring (3/8–5/31, n = 61) is top panel; summer (6/1–8/14, n = 356) is middle panel; and fall (8/15–11/7, n = 8,039) is bottom panel. 29

Figure 5. Daily number of steelhead juveniles captured in the Rapid River screw trap and river level (ft) during 2007. Spring (4/9–5/31, n = 305) is top panel; summer (6/1–8/14, n = 75) is middle panel; and fall (8/15–11/10, n = 411) is bottom panel. 30

Figure 6. Length frequency of steelhead juveniles captured in the Rapid River screw trap during 2007. Spring (4/9–5/31, n = 305) is top panel; summer (6/1–8/14, n = 75) is middle panel; and fall (8/15–11/10, n = 411) is bottom panel. 31

Figure 7. Daily number of steelhead juveniles captured in the Big Creek screw trap and sill depth (cm) during 2007. Spring (5/21–5/31, n = 100) is top panel; summer (6/1–8/14, n = 960) is middle panel; and fall (8/15–11/12, n = 2,263) is bottom panel. 32

Figure 8. Length frequency of steelhead juveniles captured in the Big Creek screw trap during 2007. Spring (5/21–5/31, n = 100) is top panel; summer (6/1–8/14, n = 960) is middle panel; and fall (8/15–11/12, n = 2,263) is bottom panel. 33

Figure 9. Daily number of steelhead juveniles captured in the Secesh River screw trap and sill depth (cm) during 2007. Spring (3/23–5/31, n = 85) is top panel; summer (6/1–8/14, n = 403) is middle panel; and fall (8/15–10/19, n = 225) is bottom panel. 34

Figure 10. Length frequency of steelhead juveniles captured in the Secesh River screw trap during 2007. Spring (3/23–5/31, n = 85) is top panel; summer (6/1–8/14, n = 403) is middle panel; and fall (8/15–10/19, n = 225) is bottom panel. 35

Figure 11. Daily mean, maximum, and minimum water temperatures (C) recorded in Fish Creek (top), Rapid River (middle), and Big Creek (bottom) during 2007. 36

LIST OF APPENDICES

Appendix A. Genotyping Results 38

ABSTRACT

The goal of Idaho Steelhead Monitoring and Evaluation Studies is to collect monitoring data to evaluate wild and natural steelhead populations in the Clearwater and Salmon river drainages. During 2007, intensive population data were collected in Fish Creek (Lochsa River tributary) and Rapid River (Little Salmon River tributary); extensive data were collected in other selected spawning tributaries. Weirs were operated in Fish Creek and Rapid River to estimate adult escapement and to collect samples for age determination and genetic analysis. Snorkel surveys were conducted in Fish Creek, Rapid River, and Boulder Creek (Little Salmon River tributary) to estimate parr density. Screw traps were operated in Fish Creek, Rapid River, Secesh River, and Big Creek to estimate juvenile emigrant abundance, to tag fish for survival estimation, and to collect samples for age determination and genetic analysis. The estimated wild adult steelhead escapement in Fish Creek was 81 fish and in Rapid River was 32 fish. We estimate that juvenile emigration was 24,127 fish from Fish Creek; 5,632 fish from Rapid River; and 43,674 fish from Big Creek. The Secesh trap was pulled for an extended period due to wildfires, so we did not estimate emigrant abundance for that location. In cooperation with Idaho Supplementation Studies, trap tenders PIT tagged 25,618 steelhead juveniles at 18 screw trap sites in the Clearwater and Salmon river drainages. To estimate age composition, 143 adult steelhead and 5,082 juvenile steelhead scale samples were collected. At the time of this report, 114 adult and 1,642 juvenile samples have been aged. Project personnel collected genetic samples from 122 adults and 839 juveniles. We sent 678 genetic samples to the IDFG Eagle Fish Genetics Laboratory for analysis. Water temperature was recorded at 37 locations in the Clearwater and Salmon river drainages.

Authors:

Timothy Copeland
Senior Fishery Research Biologist

Scott Putnam
Senior Fishery Technician

INTRODUCTION

Populations of steelhead trout *Oncorhynchus mykiss* in the Snake River basin declined precipitously following the construction of hydroelectric dams in the Snake and Columbia rivers. Raymond (1988) documented a decrease in survival of emigrating steelhead trout and Chinook salmon *O. tshawytscha* from the Snake River following the construction of dams on the lower Snake River during the late 1960s and early 1970s. There was a period of recovery in the early 1980s, but then escapements over Lower Granite Dam into the Snake River basin declined again. While hatchery returns increased, the returns of naturally produced steelhead trout remained critically low, especially for stocks with later run timing (B-run populations; Busby et al. 1996). As a result, Snake River steelhead trout (hereafter steelhead) were classified as threatened under the Endangered Species Act (ESA) in 1997. Within the Snake River steelhead evolutionarily significant unit, there are six major population groups, of which three are located in Idaho (Clearwater River, Salmon River, and Hells Canyon; ICBTRT 2003).

Federal management agencies in the basin are required to mitigate for hydroelectric impacts and recover all ESA-listed salmonid populations, including steelhead. In addition, the Idaho Department of Fish and Game (IDFG) has the long-term goal of preserving naturally-reproducing steelhead populations and recovering them to levels that will provide a sustainable harvest (IDFG 2007). Management to achieve these goals requires an understanding of how salmonid populations function (McElhany et al. 2000) as well as regular status assessments. However, specific data on Idaho steelhead populations are lacking, particularly key parameters such as population density, age composition, genetic diversity, recruits per spawner, and survival rates (ICBTRT 2003). These data are fundamental to status assessments and to guide mitigation and recovery.

The goal of Idaho Steelhead Monitoring and Evaluation Studies (ISMES) is to collect data to guide restoration of wild and natural steelhead populations in Idaho. Data are collected not only by intensive studies in Fish Creek (Lochsa River tributary) and Rapid River (Little Salmon River tributary), but also by extensive efforts in other selected spawning tributaries in the Clearwater and Salmon river basins. This report summarizes the work conducted from January 1, 2007 to December 31, 2007.

OBJECTIVES

1. Estimate adult steelhead escapement, sex ratio, age composition, and run timing at Fish Creek and Rapid River.

2. Estimate steelhead parr density in selected streams in the Clearwater and Salmon river drainages.

3. Estimate abundance of juvenile steelhead emigrants from selected streams in the Clearwater and Salmon river drainages.

4. Assess age and growth of steelhead emigrating from selected streams in the Clearwater and Salmon river drainages.

5. Estimate smolt survival and arrival timing from natal stream to Lower Granite Dam, through the hydrosystem, and to adult return.

6. Describe temporal and spatial patterns in the genetic diversity of steelhead populations in Idaho.

7. Monitor water temperatures in selected streams in the Clearwater and Salmon drainages.

METHODS

Adult Escapement

Numbers and Sex Ratio

The aggregate escapement of most Snake River steelhead is measured at Lower Granite Dam. Some of these fish are headed to Washington or Oregon, but the vast majority is destined for Idaho. In Idaho, population escapement can be measured at some IDFG hatcheries, such as the Rapid River Hatchery, and at the ISMES weir in Fish Creek. The Fish Creek weir is the only weir in Idaho operated solely for wild B-run steelhead. Fish Creek is a tributary to the Lochsa River in the upper Clearwater River drainage (Figure 1).

We operated a temporary picket weir to estimate escapement in Fish Creek beginning March 8, 2007. The weir was dismantled on September 8. Adult fish moving upstream entered a holding box that was checked daily. The trap tender removed the trapped fish with a net and placed them in a large plastic water trough for processing. Gender was determined based on external secondary sex characteristics, e.g., a developed kype for males. Fork length (FL) was measured to the nearest centimeter. Each fish was scanned for the presence of a passive integrated transponder (PIT) tag. Scales were collected and a small portion of the anal fin was removed for future genetic analysis. All fish were released upstream of the weir after being marked on the right operculum with a paper punch. All hatchery fish, as determined by lack of an adipose fin or excessive fin erosion, were transported to the Lochsa River and released without processing. Kelts (post-spawn adults) were collected at the weir, checked for a right operculum punch, sexed, scanned for a PIT tag, and measured for length. If the kelt was alive, the trap tender punched the left operculum and passed it downstream. We used two methods to estimate steelhead escapement: 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 fish passed upstream of the weir, the total number of kelts recovered, and the number of marked kelts recovered (Steinhorst et al. 2004).

We assisted hatchery staff to collect and process adult steelhead at the Rapid River Hatchery fish trap beginning on April 2, 2007. Rapid River is a tributary of the Little Salmon River in the lower Salmon River drainage (Figure 1). The fish trap is a velocity barrier with the trap located in the fish ladder. Fish cannot pass upstream of the trap without passing through the ladder. Fish were processed as in Fish Creek but, because the trap is a velocity barrier without a downstream trap, kelts were not marked nor collected. Adult steelhead escapement was enumerated by summing the number of adults trapped in the upstream live-box.

Age Composition

Age composition was estimated from scale patterns. Six to eight scales from both sides of the fish were collected from the area just above the lateral line and posterior from a vertical line drawn from the posterior end of the dorsal fin (MacLellan 1987). Scales were stored in coin envelopes until transport to the laboratory.

Technicians processed the scales in the laboratory. Scales were examined for regeneration. Eight non-regenerated scales were cleaned and mounted between two glass microscope slides. If non-regenerated scales were not available, the sample was not processed. The scales were examined on a computer video monitor using a Leica DM4000B microscope and a Leica DC500 digital camera. A technician chose the best scales for aging the fish and saved them as a digitized image. Most images of scales from adults were obtained using the 25x magnification. The saltwater age of adults was determined by counting the number of overwinter annuli. The criterion for a saltwater annulus was the crowding of circuli outside of the check for ocean entry. Two technicians independently viewed each image to assign ages. If there was no age consensus among the readers, a third reader viewed the image and all readers collectively examined the image to resolve their differences before a final age was assigned to the fish. If a consensus was not attained, the scale sample was excluded from further analysis. For each collection site, the numbers assigned to each saltwater-age category were summed and a percentage computed.

Run Timing

Fish Creek run timing was based on passage through the hydrosystem of fish that had been PIT tagged as juveniles by ISMES. The PTAGIS database (http://www.psmfc.org) was queried to obtain the date of detection and PIT tag code of adult steelhead that were detected at Bonneville, McNary, and Lower Granite dams. The query was restricted to include only those fish that were originally PIT tagged in Fish Creek as juveniles and later detected as returning adults at the three dams between July 1, 2006 and May 30, 2007. These fish were expected to return to Fish Creek and spawn during the spring of 2007. Of the Fish Creek adults detected at Bonneville Dam, we calculated the proportion that was later detected at McNary Dam, Lower Granite Dam, and the Fish Creek weir. The number of days the spawners spent in Fish Creek was also calculated for all PIT-tagged adults that were recaptured as kelts.

Parr Density

Snorkel surveys were used to estimate density and relative size structure of steelhead parr. The ISMES site selection protocol used in the last 15 years was changed in 2007 to be consistent with other IDFG snorkel surveys. Site selection was based on a generalized random-tessellation stratification design, i.e. a spatially-balanced probabilistic selection from all potential sites (Stevens and Olsen 2004). A list of all potential sites in the Clearwater and Salmon basins was obtained from personnel in the US-EPA office in Corvallis, Oregon. These sites were plotted on a 1:100,000 stream layer and their order randomized by EPA. We selected three basins of interest: Fish Creek, Rapid River, and Secesh River. Because of wildfires, we omitted the Secesh drainage for 2007 and substituted the Boulder Creek watershed. Boulder Creek is tributary to the Little Salmon River immediately to the north of Rapid River. We used the anadromous stream data layer from StreamNet (www.streamnet.org) to determine which sites in each watershed were within the anadromous production zone. The potential sites that fell within

100 m of an anadromous stream were retained. A list of approximately twice the desired number of sites was drawn for the three watersheds.

This list was narrowed down to a logistically feasible plan before crews began field operations. Some new sites were inspected, documented, and photographed before the field crew arrived. This helped in the planning process. The site selection procedure was dependent on the order of the list of sites. Each potential site had a design number that was used as the unique site identifier for data entry forms and the IDFG Standard Stream Survey database. Site priority started with the lowest design number (high priority) and proceeded to the highest number (low priority). High priority sites were included or rejected before lower-priority sites could be considered in survey plans. Criteria for rejection were: 1) the site could not be safely surveyed or site boundaries adjusted to make it safe (see next paragraph); 2) the location was above barriers to spring movement of adult steelhead; 3) there was no water at the time of survey; 4) a private owner denied access to the site; or 5) the site was too wide or complex to be surveyed efficiently by the full crew. Survey dates were arranged as logistics dictated and did not always follow the priority order. In the Fish Creek and Rapid River watersheds, sites that have been historically sampled in the past for General Parr Monitoring (GPM) were repeated, as time and logistics allowed. The purpose was to provide a link between the new site selection protocol and previous statewide monitoring.

Field surveys were done after preliminary site evaluations. Site locations and lengths were adjusted by the crew leader based on actual stream conditions. The desired average site length was 100 m. Actual site bounds were adjusted to fit within hydraulic controls. If necessary, a site was moved up to 500 m from the designated point. The percentage of each habitat type (pool, pocket water, riffle, or run) within the site was visually estimated and recorded. One to five snorkelers counted fish in each site, depending on the stream size and visibility. All salmonids were counted and individual size was estimated to the nearest inch while moving slowly upstream. Chinook salmon parr were assigned an age based on length. Non-salmonids were noted if present. After the crew snorkeled each site, they measured site length and up to ten widths to calculate surface area. Gross habitat characteristics were also evaluated. This included habitat types, mean and maximum depth, substrate composition, large woody debris (LWD) amount, and cover components. Data were entered into the IDFG Standard Stream Survey database.

We completed watershed-level surveys in Fish Creek, Rapid River, and Boulder Creek during July and August. Fish Creek was surveyed on July 11-18. This is approximately the same time that Fish Creek had been snorkeled in previous years and water conditions were favorable. The goal was to survey a minimum of 11 sites. Crews were able to sample 19 sites. In addition, two historic GPM sites were surveyed for comparison. Rapid River was surveyed on July 25 to August 1, approximately two weeks earlier than it had been snorkeled in previous years. This was possible because of low flows. The goal was to survey a minimum of 10 sites. Crews were able to sample 14 sites. In addition, six historic GPM sites were surveyed for comparison. Boulder Creek was surveyed on August 8-15. Only the main stem was sampled. Crews were able to sample 23 sites. No historic GPM sites were surveyed.

Beginning in 2007, we evaluated the efficiency of the snorkel crew at detecting juvenile steelhead. We conducted mark-resight studies at four locations, two on Fish Creek and two on Rapid River. A protocol modified from Thurow et al. (2004) was designed to allow us to estimate efficiency through re-observation of marked individuals. Juvenile steelhead were caught, measured, marked (caudal notch), and released within the selected site. The next day, snorkeling began approximately 50 m downstream of the main transect and the marked fish

were recorded. Boundary lengths were adjusted to begin and end at hydraulic controls. Then, the main 100 m section was snorkeled and all salmonids were counted, measured, and recorded. Finally, a section approximately 50 m in length upstream of the main section was snorkeled and the marked fish were recorded. Snorkel crews recorded a larger suite of habitat characteristics than used during standard surveys. The intent is to use these data in the future to validate the use of the Thurow et al. (2004) model relating habitat conditions to daytime snorkel survey efficiency for *O. mykiss*.

Juvenile Emigrant Abundance

Emigrant abundance was estimated from data collected at rotary drum screw traps located near the mouths of natal streams. This project operates screw traps in Fish Creek, Rapid River, Big Creek, and the Secesh River. The Fish Creek screw trap operated continuously from March 7 to November 9. The Rapid River trap operated from April 7 to November 11 except for three days. This was the first year a trap was operated below the hatchery on Rapid River. Between April 7 and April 30, the Rapid River trap was operated less than 24 hours per day because of the release of Chinook parr from Rapid River Hatchery. The Big Creek trap operated from May 21 to November 13, except for four days due to debris in the stream. This was the first year a trap was operated on Big Creek. The Secesh River screw trap operated from March 16 to October 19. However, the trap was pulled for 13 days in May due to high water, and was not fishing or accessible for 52 days from July through September due to wildfires and road closures.

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 previously tagged. All steelhead >80 mm were PIT tagged, measured (fork length) to the nearest mm, and weighed to the nearest 0.1 g. The tag files were uploaded to the PTAGIS database. Flow conditions were recorded, either as flow at nearby stream gauges or as depth below the sill of the trap.

Trap tenders released PIT-tagged steelhead at least 500 m upstream of the screw traps and recorded the number of recaptures at the traps to estimate efficiency. All recaptures were released downstream of the traps. When >50 steelhead were tagged in a day, only 50 fish were released upstream of the trap and the remainder were released downstream of the trap. When ≤50 steelhead were trapped in a day, all of the newly tagged fish were released upstream of the trap.

Data from each trap are summarized by season in this report. The seasonal designations we used are arbitrary but are consistent with past ISMES reports. Spring was from trap installation until May 31. Summer was from June 1 to August 14. Fall was from August 15 until trap removal. Using software developed by Steinhorst et al. (2004), we estimated emigrant abundance by season with Bailey's modification of the Lincoln-Peterson estimator. The 95% confidence intervals were computed with the bootstrap option.

Juvenile Emigrant Age Composition

We estimated emigrant age composition using scale samples collected at screw traps. Screw trap tenders from ISMES collected scale samples from juvenile steelhead caught in Fish Creek, Rapid River, Big Creek, and Secesh River. Other IDFG personnel collected scale samples at screw traps in Crooked Fork Creek, Colt Killed Creek, American River, Red River, Crooked River, Salmon River at Sawtooth Fish Hatchery, Pahsimeroi River, Lemhi River (two

traps), Marsh Creek, Rush Creek, and SF Salmon River at Knox Bridge. Personnel from U.S. Fish and Wildlife Service (USFWS) collected scale samples at the Clear Creek screw trap.

Scales were generally collected and processed as described above for adults. Laboratory technicians examined scales using the 100x magnification. Age was determined by counting the number of overwinter annuli, defined by pinching or cutting over of circuli. Two 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, the readers examined the image collectively with a third reader to resolve differences before a final age was assigned to the fish. If a consensus was not attained, the scale was excluded from the analysis.

Once all samples from a particular location were processed, data were grouped by season before calculation of age proportions and mean lengths at age. The seasonal designations we used are arbitrary but are consistent with past ISMES reports. Juvenile fish sampled between March 1 and June 14 were placed in the spring period, fish sampled between June 15 and August 14 were placed in the summer period, and fish sampled after August 15 were placed in the fall period. Although these three classes are somewhat arbitrary, the intent was to account for differences in growth among sampling periods. Note that seasons used for age composition are different than those used for abundance estimates.

Smolt Survival

Smolt survival is usually estimated using PIT tags implanted in juvenile steelhead as they leave their natal streams. This project PIT tagged fish at screw traps in Fish Creek, Rapid River, Big Creek, and Secesh River. We also coordinated PIT tagging at screw traps used in the Idaho Supplementation Study (ISS). These included ten ISS screw traps operated by IDFG (project 1989-098-00; Crooked Fork Creek, Colt Killed Creek, American River, Red River, Crooked River, Salmon River at Sawtooth Fish Hatchery, Pahsimeroi River, Lemhi River, Marsh Creek, and SF Salmon River at Knox Bridge); two ISS traps operated by the Nez Perce Tribe (project 1989-098-02; Lake Creek and Johnson Creek); and one ISS trap operated by the USFWS (project 1989-098-01; Clear Creek). Additional tagging was done at a trap in the lower Lemhi River by the Lemhi Conservation Plan. At most sites, the screw traps were fished continuously from early March until ice-up in November, river conditions permitting. For this report, we only present data from ISMES traps.

We ascertained smolt detection rates and emigration timing during the 2007 emigration using PIT-tagged fish detections downstream of the four ISMES traps. The PTAGIS database (www.ptagis.org) was queried to obtain detection date and location, tagging date and location, and the length and weight at tagging of all wild steelhead smolts tagged by ISMES. Potential interrogation sites were Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville dams; the Clearwater River smolt trap; and the upper estuary tow array. Passage date at LGR was calculated for three percentiles (10%, 50%, and 90%) for each trap location.

Genetic Diversity

Since 2000, ISMES has collected tissue samples from populations that span the range of geographic, temporal, and phenotypic variability observed in the Salmon and Clearwater basins. In 2007, we analyzed a set of previously collected genetic samples (n = 678). The

analyses were conducted by the IDFG Eagle Fish Genetics Laboratory. The full text of the report is in the Appendix. Results are summarized in the text.

Additional samples for future genetic analysis were collected in 2007. Samples were collected from all adult steelhead handled. We also sampled all juveniles collected in Rapid River. Finally, we identified a gap in the genetic sample collection in the upper Selway River and began collecting samples there. All samples were stored for future analysis.

Water Temperature Monitoring

Water temperatures were monitored in tributaries throughout the Clearwater and Salmon river drainages with HOBO™ temperature recorders. Our objective was 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. Water temperature was recorded every 0.25 h to 0.33 h from early spring until late October. Winter water temperatures were recorded every 0.25 h to 1.0 h, depending on recorder data storage capacity, site location, and access. The daily mean, maximum, and minimum water temperatures were calculated for each stream. Air temperature, barometric pressure, and relative humidity were recorded at Fish Creek.

RESULTS

Adult Escapement

Fish Creek

The 2007 spawning run lasted from March 23 to June 9 in Fish Creek. Low flows allowed the weir to operate without any downtime. Trap tenders passed 79 fish, 48 females and 31 males, above the weir (Table 1). The sex ratio was 61% females. The mean FL of females and males was 78 cm (95% CI, ±2) and 78 cm (95% CI, ±4), respectively. Females ranged in length from 62 to 93 cm, and males ranged from 62 to 95 cm. Trap tenders captured 59 marked kelts (36 females and 23 males) and two unmarked kelts (two females and no males). Estimated total escapement was 81 fish with an upper 95% confidence bound of 96 fish. The lower 95% CI value (67 fish) was less than the actual number marked (79 fish).

Timing of arrival to, and post-spawn exit from, Fish Creek differed between sexes (Table 2). The first female spawner arrived on March 23 and the last on May 24. The first male spawner arrived on March 30 and the last on June 9. The median date of arrival of the female and male spawners was May 6 and April 24, respectively. The first kelt (a female) was captured on April 17 and the last kelt (a male) was captured on June 29. The median date of kelt capture was June 3 for females and May 28 for males.

Twelve PIT-tagged adults were trapped at the Fish Creek weir during spring 2007 (Table 3). All were tagged as juveniles in Fish Creek. Ten were first detected at Bonneville Dam, one was first detected at McNary Dam, and one was not detected at any dam on the Snake or Columbia rivers. The first PIT-tagged adult to arrive at Fish Creek (April 26, 2007) was first detected at McNary Dam on September 9, 2006. The last PIT-tagged adult (May 12, 2007) was first detected at Bonneville Dam on September 7, 2006. The median date of passage at Bonneville Dam was September 6, 2006. Not all PIT-tagged fish detected in the hydrosystem

made it to Fish Creek. The conversion rate from Bonneville Dam (n = 12) to McNary Dam was 92%; from Bonneville Dam to Lower Granite Dam was 83%; from Bonneville Dam to Fish Creek weir was 50%; and from Lower Granite Dam (n = 10) to Fish Creek weir was 60%.

The trap tenders recovered four PIT-tagged kelts at the weir. One of these adults was not detected when it was passed upstream of the weir to spawn. However, it had unique markings which allowed us to determine the date it was handled at the weir. The four adults captured before and after spawning spent 14, 18, 31, and 32 days in Fish Creek.

Individuals returning to Fish Creek in 2007 had spent 1-3 years in the ocean (Table 4). The overall age composition was 20% 1-ocean, 79% 2-ocean, and 1% 3-ocean (n = 82). Of the 51 females, 10% were 1-ocean, 88% were 2-ocean, and 2% were 3-ocean. Of the 31 males, 35% were 1-ocean and 65% were 2-ocean.

Rapid River

The 2007 spawning run lasted from April 2 to June 4 in Rapid River. Escapement was 32 fish, 21 females and 11 males, above the weir (Table 1). The sex ratio was 66% females. The mean FL of females and males was 70 cm (95% CI, ±4) and 63 cm (95% CI, ±3), respectively (Table 1). Females ranged in length from 57 to 85 cm, and males ranged from 59 to 78 cm.

Timing of arrival to Rapid River did not differ much between the sexes (Table 2). The first female spawner arrived on April 10 and the last on June 2. The first male spawner arrived on April 2 and the last on June 4. The median date of arrival for both female and male spawners was May 10.

Run timing through the hydrosystem was not monitored because few PIT-tagged adults returned in 2007.

Individuals returning to Rapid River in 2007 had spent 1-2 years in the ocean (Table 4). The overall age composition was 61% 1-ocean and 9% 2-ocean adults (n = 31). Of the 21 females, 43% were 1-ocean and 57% were 2-ocean. All 10 males aged were 1-ocean.

Parr Density

Steelhead were the most common salmonid observed in Fish Creek (Table 5). Five salmonid taxa were identified: trout fry *Oncorhynchus sp*., juvenile steelhead, Chinook salmon *O. tshawytscha* parr, cutthroat trout *O. clarkii*, and mountain whitefish *Prosopium williamsoni*. The mean steelhead density was 5.60 fish/100 m^2 (SD = 2.85, n = 19) for the new sites and 11.43 fish/100 m^2 (SD = 4.88, n = 2) for the GPM sites. The historic GPM sites were located among the three downstream-most sites selected for the basinwide assessment, and average density based on these sites was twice the basin average. Steelhead parr were most abundant in downstream sites but were present throughout the basin. Trout fry were patchily distributed with several contiguous sites of high density separated by areas of low density. Cutthroat trout were present in much of the watershed but most abundant in the extreme headwaters. Chinook salmon and mountain whitefish were found only in the lower parts of the watershed.

Steelhead were also the most common salmonid observed in Rapid River (Table 6). Six salmonid taxa were identified: trout fry, juvenile steelhead, wild Chinook salmon parr, hatchery

Chinook salmon parr, cutthroat trout, and bull trout *Salvelinus confluentus*. The mean steelhead density was 5.38 fish/100 m^2 (SD = 3.91). Historic GPM sites were distributed throughout the stream and average density based on these sites (5.06 fish/100 m^2, SD = 3.31) was similar to the basinwide mean. Steelhead were not observed in the extreme headwaters. Bull trout were most abundant in the headwaters but were distributed throughout the drainage. Chinook parr were found in the lower quarter of Rapid River.

In Boulder Creek, trout fry were the most common salmonid taxa observed (Table 7). Besides the six taxa that were observed in Rapid River, brook trout *Salvelinus fontinalis* were also present in Boulder Creek. Brook trout had not been observed in the other two watersheds during 2007. The mean steelhead density was 4.38 fish/100 m^2 (SD = 5.21). Fish densities across all species were lowest in the middle reaches of Boulder Creek. Steelhead were distributed throughout the stream but densities were greatest in the downstream canyon reach. Chinook parr were found only in the downstream reach, including a hatchery stray. A few bull trout were observed in the downstream reach, presumably immigrants from elsewhere in the Little Salmon drainage because none were seen in the headwaters. Brook trout were most abundant in the headwaters.

Juvenile steelhead length distribution was unimodal in Fish Creek but bimodal in Rapid River and Boulder Creek (Figure 2).

Snorkel crew efficiency in 2007 was highly variable. Efficiencies ranged from 37% to 104% (median = 64%). We suspect the 104% value was caused by double counting. In general, efficiencies were higher in the simple channel of Rapid River compared to the wider and more complex Fish Creek.

Juvenile Emigrant Abundance

We estimated 24,127 juvenile steelhead (95% CI 22,008-24,492) emigrated from Fish Creek from March 7 to November 9, 2007. Based on trapping results, most juvenile steelhead emigrants leave Fish Creek during the fall (Figure 3). We trapped 61 fish during spring, 356 fish during summer, and 8,039 fish during fall. Spring stream level ranged from 2.49 to 4.09 ft without an obvious peak. Summer stream level declined from 3.26 to 1.31 ft. Fall stream level ranged from 1.14 to 1.94 ft. Daily catch did not appear to be related to flow in either spring or summer. Daily catch was <200 fish through most of the fall except for four occasions with peaks from 214 to 1,877 fish. These peaks corresponded to slight increases in the hydrograph following rainfall. A total of 3,163 fish were marked out of 8,456 trapped throughout the trapping season for trap efficiency analyses. A total of 1,157 were recaptured.

Length frequencies of Fish Creek steelhead emigrants differed among seasons (Figure 4). During the spring, there were two modes in the length distribution at 100 mm and 170 mm. During the summer, the length distribution was unimodal with an upper tail and mean length 130 mm. During the fall, the length distribution was very bell-shaped with mean length 139 mm.

We estimated 5,632 juvenile steelhead (95% CI 4,108-7,091) emigrated from Rapid River from May 2 to November 11, 2007. Each season had relatively large pulses of emigrants collected at the trap (Figure 5). We trapped 305 fish during spring, 75 fish during summer, and 411 fish during fall. Spring river level ranged from 1.00 to 2.08 ft. Few steelhead were trapped before April 30 because the trap only operated a few hours a day. On the first day the trap operated for 24 hours continuously, 79 fish were trapped. The next day, 47 were trapped. Daily

catch was <20 for the remainder of the spring. Summer river level declined from 1.80 to 0.90 ft. The daily trap catch was <4 except for July 13. Steelhead caught on that day were newly emerged steelhead 27-29 mm. Fall river level ranged from 0.78 to 1.02 ft. The daily trap catch was <20 except October 20-22. This spike may have been prompted by a slight increase in river flow. We do not know if river level influenced trap catch before or after this time. Fish were not marked for trap efficiency before May 2. A total of 435 fish were marked out of 661 trapped throughout the trapping season for trap efficiency analyses. A total of 50 were recaptured.

Length frequencies of Rapid River steelhead emigrants differed among seasons (Figure 6). The length frequency distribution of fish collected in the spring had two modes at 80 mm and 180 mm. The summer length distribution was very even except for the spike caused by emerging fry. The fall length distribution had two modes, <70 mm and 170 mm.

We estimated 43,674 juvenile steelhead (95% CI 35,356 – 54,470) emigrated from Big Creek from May 21 to November 13, 2007. Based on trapping results, most emigrants leave Big Creek during the fall (Figure 7). We trapped 100 fish during spring, 960 fish during summer, and 2,263 fish during fall. Spring sill depth increased from 460 to 506 cm and daily catch peaked on May 27. As river level increased, daily catch tended to increase. Summer sill depth increased from 495 to 576 cm and as the river level increased the daily catch increased. Fall sill depth remained fairly steady from 539 to 581 cm. The fall daily trap catch was <100 except for two spikes.

The length frequency distribution of Big Creek steelhead collected in the spring was unimodal with a mean of 96 mm FL and an extended upper tail (Figure 8). The summer length distribution was trimodal with modes at <70 mm, 95 mm, and 185 mm. The fall sample exhibited a bimodal length distribution with modes at <70 mm and 170 mm.

We did not estimate abundance of juvenile steelhead emigrating from the Secesh River in 2007. Summer and fall samples were incomplete because the trap was pulled for extended periods (Figure 9). We trapped 85 fish during spring, 403 fish during summer, and 225 fish during fall. Spring sill depth ranged from 490 to 535 cm. Summer sill depth increased from 509 to 583 cm. Fall sill depth ranged from 546 to 596 cm.

The length frequency distribution of Secesh River fish was bimodal each season, although the modes changed (Figure 10). In the spring, modes were at <70 mm and 170 mm. In the summer, modes were at <70 mm and 120 mm. In the fall, modes were at 72.5 mm and 165 mm.

Juvenile Emigrant Age Composition

In 2007, ISMES personnel and cooperators collected 5,083 scale samples from juvenile steelhead (Table 8). In the Clearwater River drainage, we collected scales from 1,362 fish in seven streams. In the Salmon River drainage, we collected 3,721 samples in nine streams. As of this writing, final ages have been assigned to samples from all streams except South Fork Salmon River (Knox Bridge), Secesh River, Crooked Fork Creek, and Pahsimeroi River. However, for this report, we will only present results from scales taken at ISMES screw traps.

Comparison of emigrants in number and length at age showed two generalities among populations (Table 9). Mean length at age within each stream increased through the year, while mean age at emigration decreased. On average, the largest spring emigrants came from Rapid River, which also had the largest percentage of its emigrants at ages 3 and 4. Otherwise, the

largest emigrants at a particular age were from Big Creek, which also had largest percentage of age-1 emigrants.

Smolt Survival

During spring 2007, there were 2,977 unique detections of juvenile steelhead tagged in ISMES study streams (Table 10). Most of the detections, 2,620 or 88%, were from fish tagged in Fish Creek, where most tagging was done. Of the Fish Creek detections, the vast majority of fish had left the stream from 2004 to 2006 and resided downstream before migrating to the ocean as smolts. In contrast, all 235 detections from Rapid River were from fish tagged in 2007; however, no fish were tagged prior to 2007. Only eleven detections were from Big Creek. A total of 111 detections were from the Secesh River. In general, over all streams, the majority of fish detected in 2007 had left their natal streams during fall 2006.

Arrival times at Lower Granite Dam were consistent among populations (Table 11). For Fish Creek smolts, the median arrival date at Lower Granite Dam was May 3 (range March 27—June 11). Timing for Secesh River smolts was very similar with a median of May 3 (range March 27—May 18). Rapid River smolts had the latest median arrival date on May 9 (range May 3—May 26); however, no fish were tagged prior to 2007. For Big Creek smolts, median arrival date was May 8 (range April 23—May 11).

Genetic Diversity

Two efforts were made towards this objective in 2007: collection of new genetics samples and analysis of archived samples. Project personnel collected new samples from 839 juvenile steelhead and 122 adult steelhead (Table 12). Adult samples were collected from fish handled at the Fish Creek and Rapid River weirs. In addition, two technicians angled for adult steelhead in lower Big Creek over four days in late April; six adults were caught and sampled. Juvenile samples were primarily from Rapid River because this population had not been previously sampled. Similarly, we identified a lack of samples from the upper Selway River and collected them in five tributaries.

Genotypes were determined for 678 steelhead samples from 15 locations (Appendix A). Most, but not all, samples were collected from juvenile fish. Cutthroat trout alleles were detected in several populations. Genetic diversity, in terms of expected heterozygosity and number of alleles, was similar across sample locations. However, there was significant genetic differentiation among populations. The 2007 results were concordant with analyses done on other samples in 2006. The results of both years were combined to show geographic structure in genetic diversity for Idaho steelhead.

Water Temperature Monitoring

Water temperatures were recorded at 37 locations in the Clearwater River and Salmon River drainages (Table 13). Besides water temperature, we recorded air temperature, barometric pressure, and humidity at Fish Creek. Stream temperatures for Fish Creek, Rapid River, and Big Creek have similar seasonal patterns (Figure 11). Peak summer temperatures were lowest in Rapid River and highest in Fish Creek.

DISCUSSION

The status of Idaho's wild steelhead populations has increased in importance relative to hydropower mitigation requirements and ESA recovery plans. The draft Federal Columbia River Power System Biological Opinion (NMFS 2007) specifically addresses gaps in wild B-run steelhead monitoring information. Regional planning efforts have been hampered by the lack of productivity estimates for steelhead in Idaho (e.g., the USFWS Columbia River hatchery review process). Although this is the only project funded by Bonneville Power Administration specifically to collect demographic or genetic data on wild steelhead in Idaho, the project has been limited in its geographic scope. The recent Memorandum of Agreement between the State of Idaho and the action agencies in the Federal Columbia River Power System mandated that this scope be expanded to provide additional B-run steelhead population status information. To meet this objective, we plan to monitor more populations, explicitly focusing on Viable Salmonid Population (VSP) criteria (abundance, productivity, diversity, spatial structure; McElhany et al. 2000). The emphasis will be monitoring abundance and productivity for the majority of B-run populations in Idaho.

Adaptive management is founded on reliable and timely data, but it is difficult to track wild steelhead and efforts to monitor them have fallen primarily to ISMES for many years. The Fish Creek data set, which includes all the VSP criteria, spans 13 years and is the most complete demographic data on a wild B-run population. Likewise, the Rapid River data set may be the most complete demographic data on a wild A-run population in Idaho. While the importance of these long-term data sets is clear, it is equally important to collect data from other locations to provide a more complete perspective. In the future, we will seek to identify opportunities to cooperate with other projects and to make ISMES more efficient at producing and transmitting this information.

The chief purpose of this report is to provide a summary of work conducted in 2007. Necessarily, the report is brief. In the following, we discuss some of the changes we anticipate in 2008 by objective.

Data on adult escapement by population are limited, as noted above. Some opportunities, such as the development of new field sites, depend on future funding. However, some data can be generated with little effort beyond coordination. Examples of such opportunities include taking scales from wild adult steelhead at hatchery weirs on the Pahsimeroi and Crooked rivers, or expanding adult return information by searching PTAGIS for adults from other sites. Additional adult information can be generated for Big Creek by angling, which was limited in 2007 and is still in the feasibility stage.

Our primary method to evaluate steelhead status and trends has been estimating juvenile abundance via parr monitoring and snorkel surveys. In 2007, we began to change our methodology to allow ISMES data to be more comparable and statistically rigorous (Byrne and Copeland 2007). This will continue in close cooperation with Idaho Natural Production Monitoring and Evaluation project (1991-073-00). Our intention is to use intensive, probabilistic sampling in basins with emigrant traps to calibrate snorkel data such that we can estimate juvenile abundance in basins where we use extensive, probabilistic sampling. In 2008, we will sample the Fish Creek and Rapid River sites that we surveyed in 2007. However, Boulder Creek will not be surveyed during 2008 if the Secesh River is accessible. Based on analysis of the data, we estimate a minimum of 10 sites in Fish Creek and 14 sites in Rapid River will be required. The target for the Secesh drainage will be 20 sites.

A large portion of data generated by ISMES is collected using screw traps. We anticipate severe operational challenges in 2008 at these traps. All traps will begin operation in March, and high river flows during late spring may necessitate reductions in trapping. Debris from the 2007 fires may be troublesome in the Secesh River. Project personnel will experiment with various ways to keep the Rapid River trap in the water during hatchery Chinook salmon releases. Spring emigration appears to be important in Rapid River and data need to be collected in ways that allow for quantification of abundance. Additionally, more PIT tags should be used to track survival from emigration to adulthood.

A major contribution to regional data needs by ISMES has been the description of genetic diversity (Byrne 2006). A manuscript on this topic has been developed in cooperation with Jennifer Nielsen (USGS, Alaska Science Center) and submitted for publication. Samples collected by ISMES have been part of a coastwide effort to standardize genetic analyses for steelhead among laboratories and to create a baseline for genetic stock identification. Project personnel will continue to gather samples to address gaps in the baseline (e.g., upper Selway River populations) as well as to address other questions. Potential research topics include parentage analysis and relationship of resident *O. mykiss* to anadromous populations. While answering these questions depends on future funding, samples generated by ISMES can be used to address them.

Water temperature monitoring has been a long-time component of ISMES. We will pursue changes to increase the cost-effectiveness of this effort. During 2008, we will convert from Stowaway temperature recorders to Hobo U-10 recorders. Our goal is to check the units only twice per year (after high water and before winter), for which the U-10 has adequate data storage and battery capacity. We will continue to record temperatures in streams that have fish traps or weirs and are significant steelhead production streams. However, we will streamline our monitoring by discontinuing sites that are providing duplicate information. We will expand our scope. We have up to 14 years of data on several streams in the Clearwater and Salmon river drainages. However, we have no information from the upper Selway River and the Middle Fork Salmon River. We will transfer temperature recorders to begin recording temperatures in five new sites. Making these changes will require no additional equipment or personnel. By transferring U-10s from discontinued sites, we can make this conversion at no additional cost. Additionally, we will identify other suitable water temperature data that can be obtained by other projects or entities. Finally, we will incorporate all temperature data into project databases.

This project has generated a substantial amount of data relevant to evaluation of steelhead status and trends during the last decade. A major focus in 2008 will be collating and summarizing these data so they may be disseminated. Several manuscripts for peer-reviewed publication are in preparation. We are gradually moving project data into standardized databases so they can be archived and made available to co-managers. Analysis will help economize data collection (e.g., if age structure is stable, then annual assessments are unnecessary). Assembling stream temperature data, fish ages, abundance estimates, and PIT-tag detections will enable status assessments and construction of productivity indices. In the future, project focus will shift towards addressing abundance, productivity, diversity, and spatial structure for steelhead populations with more complete geographic coverage than previously used. This knowledge will help managers conserve and recover Idaho steelhead.

ACKNOWLEDGEMENTS

Ron Roberts helped coordinate project activities and was invaluable in the field. Nick Duthler, Brandon Font, Levi Frasier, Matt Hangsleben, James Harter, Ben Marshall, and Travis Parrill assisted in the field. Scales were aged by Melanie Dohner and Rebecca Schooner. Genetic analyses were provided by Matt Campbell, Eric Tretter, and Christine Kozfkay. Cheryl Leben helped format and edit the document. This report benefited from reviews by Matt Campbell, Bill Schrader, and Carl Stiefel.

LITERATURE CITED

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Wauneta, and I. V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-27.

Byrne, A. 2005. Steelhead supplementation studies in Idaho rivers. 2004 Annual Report to the U.S. Department of Energy, Bonneville Power Administration. Contract No. DE-B179-89BP01466, Project No. 199005500. Idaho Department of Fish and Game, Boise, Idaho. 79 pp.

Byrne, A. 2006. Idaho steelhead monitoring and evaluation studies. 2005 Annual Report to the U.S. Department of Energy, Bonneville Power Administration. Contract No. DE-B179-89BP01466, Project No. 199005500. Idaho Department of Fish and Game, Boise, Idaho. 121 pp.

Byrne, A., and T. Copeland. 2007. Idaho steelhead monitoring and evaluation studies. 2006 Annual Report to the U.S. Department of Energy, Bonneville Power Administration. Contract No. DE-B179-89BP01466, Project No. 199005500. Idaho Department of Fish and Game, Boise, Idaho. 48 pp.

ICBTRT (Interior Columbia Basin Technical Recovery Team). 2003. Independent populations of Chinook, steelhead, and sockeye for listed evolutionarily significant units within the interior Columbia River domain, July 2003 working draft. Available http://www.nwfsc.noaa.gov/trt/ (May 2004).

IDFG (Idaho Department of Fish and Game). 2007. Fisheries management plan 2007-2012. Boise, Idaho.

MacLellan, S. E. 1987. Guide for sampling structures used in age determination of Pacific salmon. Department of Fisheries and Oceans, Fisheries Research Branch, Pacific Biological Station. Nanaimo, British Columbia, Canada. 27 pp.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonids populations and the recovery of evolutionarily significant units. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-NWFSC-42.

NMFS (National Marine Fisheries Service). 2007. Endangered Species Act Section 7 consultation, biological opinion remand draft. Consultation on remand for operation of the Federal Columbia River Power System, 11 Bureau of Reclamation projects in the Columbia basin and ESA 10(a)(1)(A) permit for juvenile transportation program. National Marine Fisheries Service, Seattle, Washington.

Raymond, H. L. 1988. Effects of hydroelectric development nd fisheries enhancement on spring and summer Chinook salmon and steelhead in the Columba River basin. North American Journal of Fisheries Management 8:1-24.

Steinhorst, K, Y. Wu, B. Dennis, and P. Kline. 2004. Confidence intervals for fish out-migration estimates using stratified trap efficiency methods. Journal of Agricultural, Biological, and Environmental Statistics 9:284-299.

Stevens, D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99:262-278.

Thurow, R. F., J. T. Peterson, and John W. Guzevich. 2004. Utility and validation of day and night snorkel counts for estimating bull trout abundance in first- to third-order streams. North American Journal of Fisheries Management 26:217-232.

Table 1. The number of adult steelhead captured at Fish Creek and Rapid River and the number of kelts recovered in 2007. Fork length 95% CI is in parentheses.

Sex	Adults trapped	Unmarked kelts recovered	Marked kelts recovered	Fork length (cm)		
				Mean	Maximum	Minimum
Fish Creek						
Female	48	2	36	78 (2)	93	62
Male	31	0	23	78 (4)	95	62
All	79	2	59	78 (2)	95	62
Rapid River						
Female	21	—	—	70 (4)	85	57
Male	11	—	—	63 (3)	78	59
All	32	—	—	67 (3)	85	57

Table 2. Capture dates of adult steelhead at the Fish Creek and Rapid River weirs in 2007 by life stage (pre- versus post-spawn). N = number of fish.

Life stage	Sex	N	Date percentile attained						
			First	10%	25%	50%	75%	90%	Last
Fish Creek									
Spawner	Female	48	3/23	4/14	4/26	5/7	5/10	5/13	5/24
Spawner	Male	31	3/30	4/8	4/19	4/26	5/8	5/18	6/9
Spawner	All	79	3/23	4/8	4/20	5/2	5/10	5/13	6/9
Kelt	Female	38	4/17	5/14	5/21	6/4	6/12	6/17	6/24
Kelt	Male	23	4/20	5/8	5/23	5/28	6/10	6/24	6/29
Kelt	All	61	4/17	5/9	5/21	6/2	6/12	6/22	6/29
Rapid River									
Spawner	Female	21	4/10	5/1	5/7	5/14	5/16	5/21	6/2
Spawner	Male	11	4/2	5/2	5/7	5/14	6/2	6/4	6/4
Spawner	All	32	4/2	5/1	5/2	5/14	5/16	5/2	6/4

Table 3. Individual adult steelhead that were PIT-tagged in Fish Creek as juveniles and later detected during the 2006-2007 spawning run at Bonneville (BON), McNary (MCN), and Lower Granite (LGR) dams.

		Detection at:			Date at Fish Creek	
PIT tag number	**Tag date**	**BON**	**MCN**	**LGR**	**Passed upstream**	**Kelt recovered**
3D9.1BF1CBD2F6	8/24/04		9/9/06	9/17/06	4/26/07	
3D9.1BF1398965	10/14/03	9/4/06	11/28/06		5/2/07	6/2/07
3D9.1BF16A176D	10/14/03	9/7/06			5/7/07	5/25/07
3D9.1BF16BFFA0	8/24/03	9/6/06	12/18/06		5/8/07	5/22/07
3D9.1BF179AA7A	10/29/02				5/9/07	6/10/07
3D9.1BF16BD46C	9/11/03	9/7/06	10/8/06		5/12/07	
3D9.1BF17990D9	10/27/02	8/31/06	11/5/06	11/15/06		
3D9.1BF169EA18	9/11/03	8/31/06				
3D9.1BF169A6CE	9/2/03	9/4/06	9/28/06			
3D9.1BF169F71B	10/12/03	9/14/06	9/22/06	10/3/06		
3D9.1BF13954FF	10/16/03	9/18/06	10/2/06	10/12/06		
3D9.1BF1396865	10/16/03	9/23/06	11/14/06	11/26/06		

Table 4. Age composition, by sex, of adult steelhead captured at the Fish Creek and Rapid River weirs during 2007. Mean fork length at age 95% CI is in parentheses.

		Ocean age 1		Ocean age 2		Ocean age 3	
Stream	**Sex**	**N**	**Length (cm)**	**N**	**Length (cm)**	**N**	**Length (cm)**
Fish Creek	F	5	64 (2)	45	80 (1)	1	90
	M	11	65 (2)	20	85 (2)	0	—
Rapid River	F	9	61 (2)	12	76 (3)	0	—
	M	10	61 (1)	0	—	0	—

Table 5. Densities (fish/100 m^2) of salmonids observed at new basinwide and historic GPM sites snorkeled in the Fish Creek drainage during 2007. Trout fry = all trout <50 mm. Sites are arranged in upstream to downstream order.

Site number	Stream	Trout Fry	Steelhead	Wild Chinook Salmon	Cutthroat Trout	Whitefish
Basinwide						
57378	Fish Creek	5.94	8.49	0.00	0.00	0.00
69666	Fish Creek	0.82	1.91	0.00	14.76	0.00
24610	Hungery Creek	0.00	2.71	0.00	9.02	0.00
33698	Hungery Creek	0.00	4.17	0.00	0.00	0.00
164770	Hungery Creek	0.00	5.43	0.00	0.00	0.00
17314	Hungery Creek	0.00	5.78	0.00	2.10	0.00
97698	Hungery Creek	0.00	0.00	0.00	0.15	0.00
96194	Fish Creek	5.87	0.93	0.00	0.00	0.00
167874	Fish Creek	14.43	5.46	0.00	1.12	0.00
151490	Fish Creek	3.09	6.76	0.00	0.58	0.00
20418	Fish Creek	0.00	4.81	0.00	0.92	0.00
102338	Fish Creek	0.92	5.17	0.00	1.66	0.00
58050	Hungery Creek	0.00	4.93	0.00	0.79	0.00
221890	Willow Creek	0.00	5.46	0.00	0.00	0.00
156354	Willow Creek	5.91	9.26	0.00	0.00	0.00
172738	Fish Creek	4.25	8.61	0.00	0.40	0.00
74434	Fish Creek	1.44	9.87	3.72	0.00	0.00
41666	Fish Creek	11.06	9.35	0.00	0.77	0.06
12994	Fish Creek	1.69	7.31	0.90	0.11	0.22
	Mean	2.92	5.60	0.24	1.71	0.01
	SD	4.13	2.85	0.87	3.76	0.05
Historic						
GPM2	Fish Creek	4.52	7.98	0.00	1.33	0.00
GPM1	Fish Creek	0.00	14.88	1.01	0.23	0.00
	Mean	2.26	11.43	0.51	0.78	0.00
	SD	3.20	4.88	0.72	0.78	0.00

Table 6. Densities (fish/100 m^2) of salmonids observed at new basinwide and historic GPM sites snorkeled in the Rapid River drainage during 2007. Trout fry = all trout <50 mm. Sites are arranged in upstream to downstream order.

Site	Stream	Trout Fry	Steelhead	Hatchery Chinook Salmon	Wild Chinook Salmon	Cutthroat Trout	Bull Trout
Basinwide							
24658	Rapid River	0.00	0.00	0.00	0.00	0.00	4.17
90194	Rapid River	0.00	0.00	0.00	0.00	0.00	7.54
155730	Rapid River	0.00	0.00	0.00	0.00	0.00	5.76
192402	Rapid River	0.23	0.70	0.00	0.00	0.00	1.41
126866	Rapid River	0.31	5.90	0.00	0.00	0.47	2.64
17298	Rapid River	0.12	8.54	0.00	0.00	0.00	1.38
122258	Hall Creek	0.56	6.50	0.00	0.00	0.00	0.19
15762	Rapid River	0.63	8.07	0.00	0.50	0.00	0.00
163218	West Fork Rapid River	1.94	6.53	0.00	0.00	0.00	0.53
193426	Rapid River	0.82	5.77	0.00	0.07	0.00	0.30
127890	Thorn Gulch, mouth	4.28	5.50	0.00	0.46	0.08	0.31
62354	Rapid River	7.05	9.34	0.00	0.26	0.00	0.62
19346	Rapid River	3.40	12.74	0.00	2.69	0.00	0.24
215954	Rapid River	12.45	5.70	10.63	2.35	0.00	0.29
	Mean	2.27	5.38	0.76	0.45	0.04	1.81
	SD	3.59	3.91	2.84	0.90	0.12	2.37
Historic							
Paradise Bridge	Rapid River	0.26	4.24	0.00	0.00	0.00	2.83
Copper Creek	Rapid River	0.81	3.93	0.00	0.00	0.00	0.54
Castle Creek	Rapid River	0.00	10.01	0.00	0.00	0.00	0.30
Cora Cliff	Rapid River	1.27	5.45	0.00	0.18	0.00	1.09
Cliff	Rapid River	0.00	0.00	0.00	0.62	0.00	0.00
04	Rapid River	0.55	6.70	0.00	0.55	0.00	0.14
	Mean	0.48	5.06	0.00	0.23	0.00	0.82
	SD	0.50	3.31	0.00	0.29	0.00	1.06

Table 7. Densities (fish/100 m^2) of salmonids observed at new basinwide sites snorkeled in the Boulder Creek drainage during 2007. Trout fry = all trout <50 mm. Sites are arranged in upstream to downstream order.

Site	Trout Fry	Steelhead	Hatchery Chinook Salmon	Wild Chinook Salmon	Cutthroat Trout	Brook Trout	Bull Trout
163922	0.00	0.00	0.00	0.00	0.00	7.55	0.00
98386	3.36	5.59	0.00	0.00	0.00	0.00	0.00
278610	3.01	0.25	0.00	0.00	0.00	7.28	0.00
331666	17.06	0.32	0.00	0.00	0.00	2.53	0.00
200594	25.45	1.93	0.00	0.00	0.00	14.82	0.00
266130	4.10	1.49	0.00	0.00	0.00	2.24	0.00
188498	5.46	2.34	0.00	0.00	0.00	2.08	0.00
4178	2.66	0.30	0.00	0.00	0.00	1.18	0.00
385106	5.54	0.40	0.00	0.00	0.00	2.18	0.00
400274	5.26	0.53	0.00	0.00	0.00	1.58	0.00
203666	0.00	0.00	0.00	0.00	0.00	0.00	0.00
334738	0.00	0.00	0.00	0.00	0.00	0.16	0.00
465810	0.00	0.00	0.00	0.00	0.00	0.00	0.00
117650	0.33	0.22	0.00	0.00	0.00	0.00	0.00
425874	0.49	2.58	0.00	0.00	0.00	0.00	0.00
98194	0.00	3.86	0.00	0.00	0.00	0.00	0.00
32658	1.37	6.65	0.00	0.00	0.00	0.00	0.00
162706	3.03	13.29	0.00	1.05	0.13	0.00	0.00
327570	13.19	12.81	0.13	7.91	0.00	0.00	0.25
97170	17.96	9.78	0.00	12.10	0.00	0.00	0.37
214930	17.55	12.73	0.00	9.29	0.00	0.00	0.00
477074	20.29	12.52	0.00	7.95	0.00	0.00	0.51
182162	20.16	13.24	0.00	10.74	0.00	0.00	0.00
Mean	7.23	4.38	0.01	2.13	0.01	1.81	0.05
SD	8.27	5.21	0.03	4.10	0.03	3.56	0.13

Table 8. The number of scale samples, by season, collected from juvenile steelhead during 2007 by ISMES personnel and cooperators. Seasons are defined in the text.

Trap	Spring	Summer	Fall	Total
Clearwater Drainage				
American River	20	5	5	30
Clear Creek	84	0	0	84
Colt Killed Creek	2	16	10	28
Crooked Fork Creek	73	348	188	609
Crooked River	136	13	0	149
Fish Creek	76	27	343	446
Red River	11	4	0	15
Salmon River Drainage				
Big Creek	190	236	261	687
Lemhi River	201	0	209	410
Marsh Creek	0	108	111	219
Pahsimeroi River	623	53	301	977
Rapid River	247	26	236	509
Rush Creek	0	55	0	55
Sawtooth	62	14	51	127
Secesh	107	56	143	306
SF Salmon (Knox Bridge)	361	48	22	431

Table 9. Mean fork length at age of juvenile steelhead captured at screw traps in three streams during 2007 by season. Number of fish aged is in parentheses.

		Fork length (mm) at:			
Season/stream	**Age 0**	**Age 1**	**Age 2**	**Age 3**	**Age 4**
Spring					
Fish Creek	—	91 (13)	113 (46)	148 (12)	176 (5)
Rapid River	—	84 (61)	152 (39)	180 (137)	196 (10)
Big Creek	—	94 (155)	125 (31)	164 (4)	—
Summer					
Fish Creek	—	99 (3)	113 (15)	136 (9)	--
Rapid River	—	99 (11)	150 (9)	244 (3)	216 (3)
Big Creek	85 (1)	106 (164)	171 (61)	198 (9)	247 (1)
Fall					
Fish Creek	85 (1)	122 (153)	160 (169)	186 (21)	—
Rapid River	78 (11)	146 (49)	167 (144)	187 (32)	—
Big Creek	85 (10)	123 (67)	168 (148)	199 (36)	—

Table 10. Number of PIT-tagged steelhead smolts that were detected at least once moving downstream during 2007 by population and year tagged. See text for list of interrogation sites.

	Year tagged			
Stream tagged	**2004**	**2005**	**2006**	**2007**
Fish Creek	7	614	1986	13
Rapid River	—	—	—	235
Big Creek	—	1[a]	9[a]	1
Secesh River	—	9	84	18

[a] Tagged by BPA project 1991-028-00

Table 11. Percentile dates of arrival at Lower Granite Dam for PIT-tagged steelhead smolts detected in spring 2007.

	Percentile		
Stream	**10%**	**50%**	**90%**
Fish Creek	April 29	May 3	May 13
Rapid River	May 4	May 9	May 19
Big Creek	April 23	May 8	May 11
Secesh River	April 17	May 3	May 13

Table 12. Number of genetic samples collected from juvenile and adult steelhead during 2007.

Stream	**Juvenile**	**Adult**
Fish Creek	—	83
Deep Creek	48	—
Indian Creek	55	—
Little Clearwater River	6	—
Running Creek	43	—
White Cap Creek	5	—
Big Creek	269	6
Rapid River	413	33

Table 13. Streams sampled for water temperatures in 2007. Measurements were taken within 1 km of the mouth of each stream unless noted.

Salmon River drainage
Basin Creek, 500 m upstream of hot springs
Beaver Creek, 2 km upstream of irrigation diversion
East Fork Salmon River, upstream of Bowery Hot Springs
East Fork Salmon River
Germania Creek
Marsh Creek, 100 m downstream of screw trap site
Pahsimeroi River at weir
Pole Creek, 2 km upstream of irrigation diversion
Redfish Lake Creek at weir
Rapid River at Rapid River Fish Hatchery
Salmon River at Sawtooth Fish Hatchery
Valley Creek, 200 m upstream of Meadow Creek
West Pass Creek at irrigation diversion
Clearwater River drainage
Bald Mountain Creek
Bimerick Creek
Boulder Creek
Brushy Fork Creek
Canyon Creek
Crooked Fork Creek, 50 m upstream of Brushy Fork Creek
Deadman Creek
Fish Creek #1 at screw trap site
Fish Creek #2, 100 m upstream of screw trap site
Fish Creek #3, 2 km upstream of Hungery Creek
Gedney Creek #1
Gedney Creek #2 upstream of mouth about 2 km
Hungery Creek
Lost Creek
O'Hara Creek, 2 km downstream of Hanby Fork
Post Office Creek
Red River, 1 km upstream of SF Red River
SF Red River, 50 m downstream of Schooner Creek
Squaw Creek
Trapper Creek
Weir Creek
Wendover Creek
WF Gedney Creek
Willow Creek (tributary of Fish Creek)

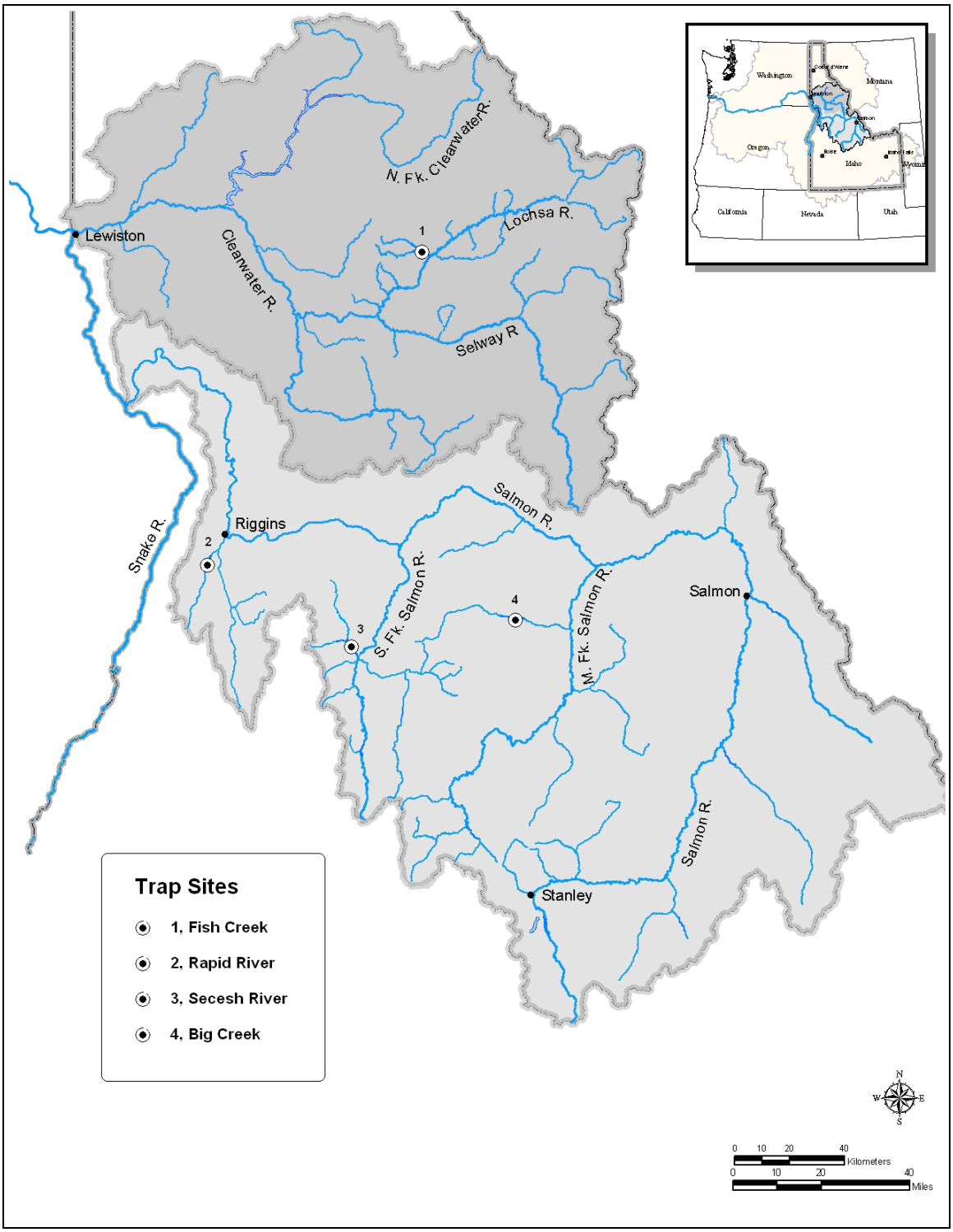


Figure 1. Map of the Clearwater River and Salmon River drainages showing the locations of the Fish Creek, Rapid River, Secesh River, and Big Creek screw trap sites in 2007.

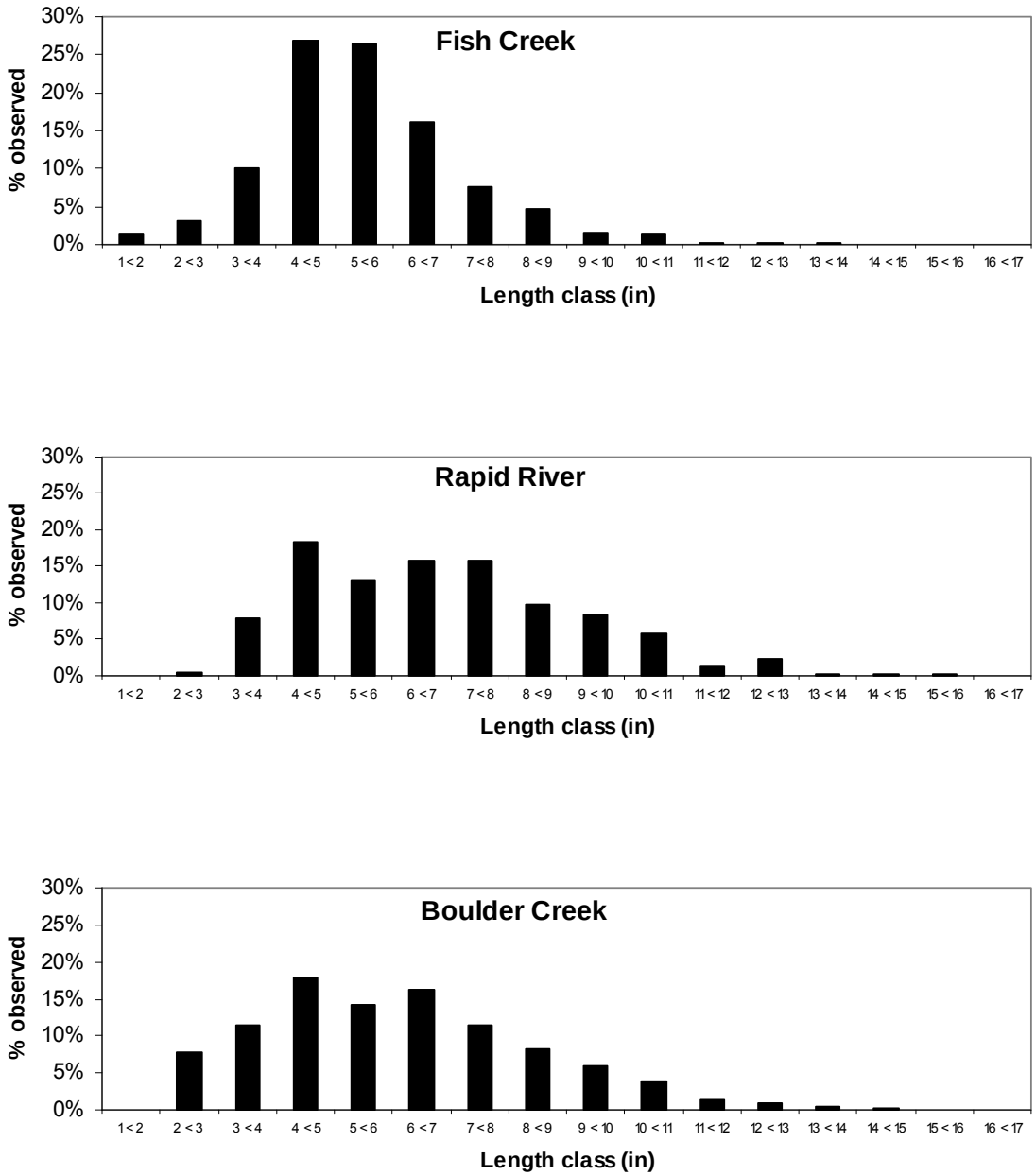


Figure 2. Length frequency of steelhead observed in three watersheds while snorkeling during 2007. Fish Creek (top, n=1,015). Rapid River (middle, n = 1,145). Boulder Creek (bottom, n = 701).

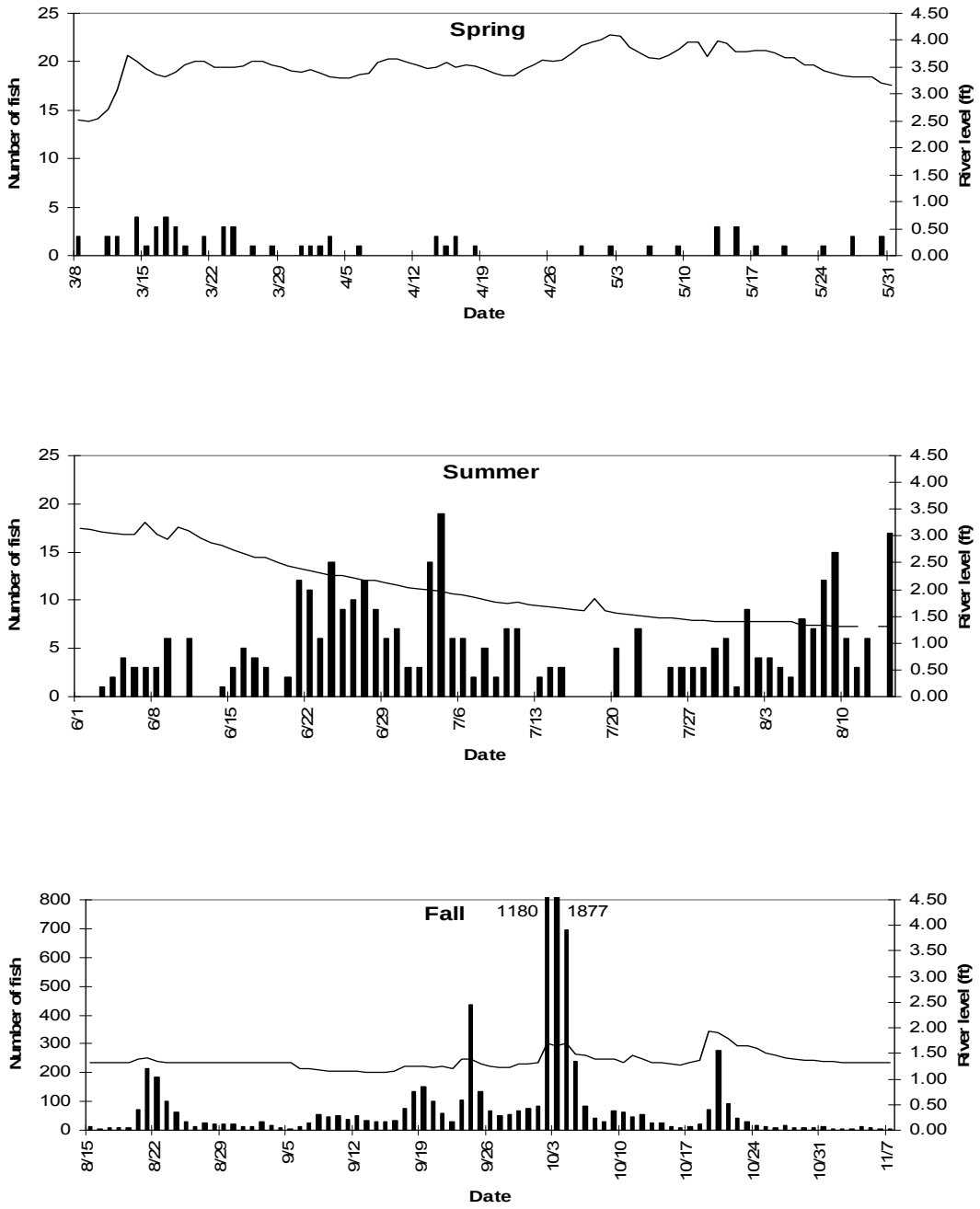


Figure 3. Daily number of steelhead juveniles captured in the Fish Creek screw trap and river level (ft) during 2007. Spring (3/8–5/31, n = 61) is top panel; summer (6/1–8/14, n = 356) is middle panel; and fall (8/15–11/7, n = 8,039) is bottom panel. Note difference in scale in bottom panel.

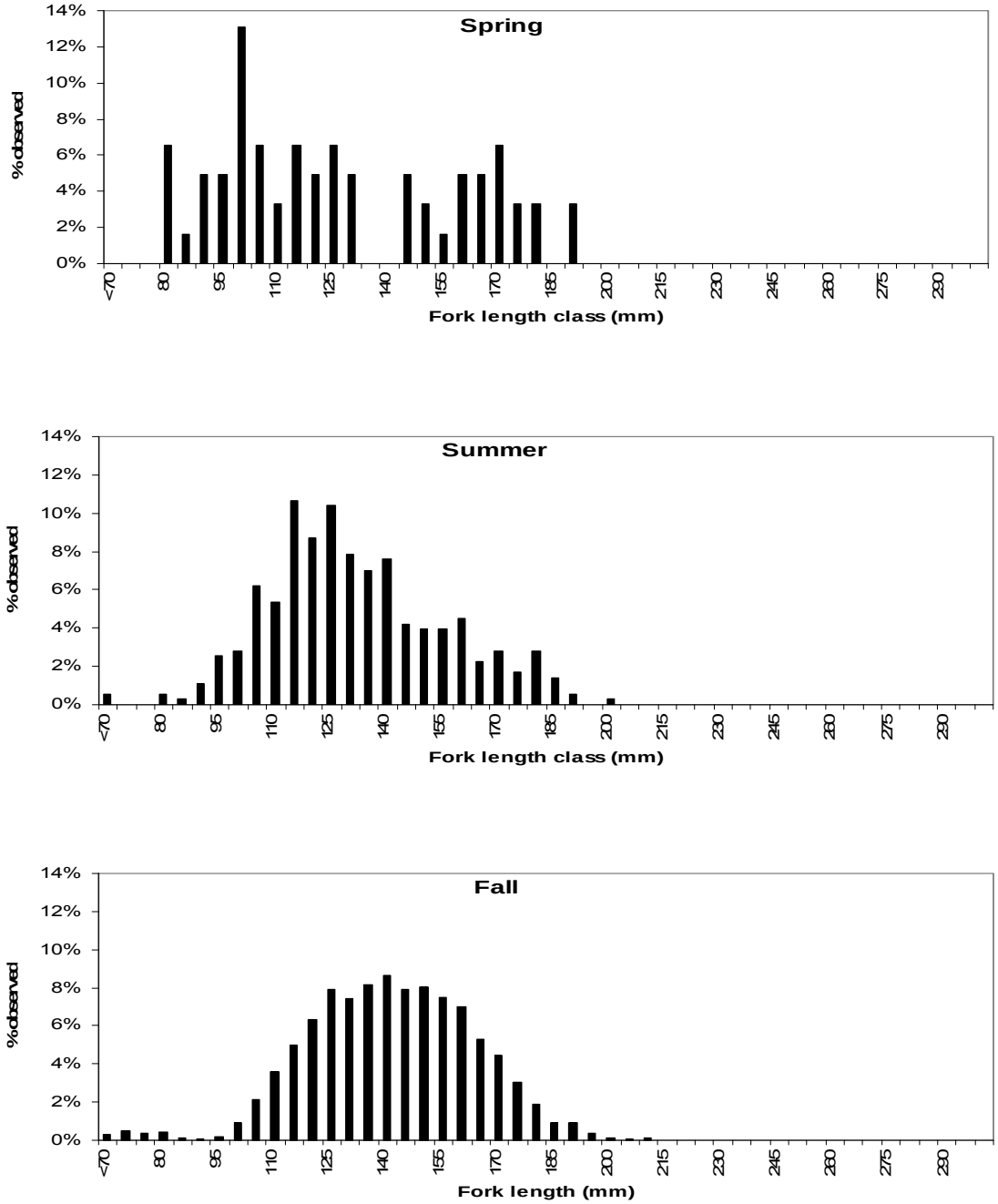


Figure 4. Length frequency of steelhead juveniles captured in the Fish Creek screw trap during 2007. Spring (3/8–5/31, n = 61) is top panel; summer (6/1–8/14, n = 356) is middle panel; and fall (8/15–11/7, n = 8,039) is bottom panel.

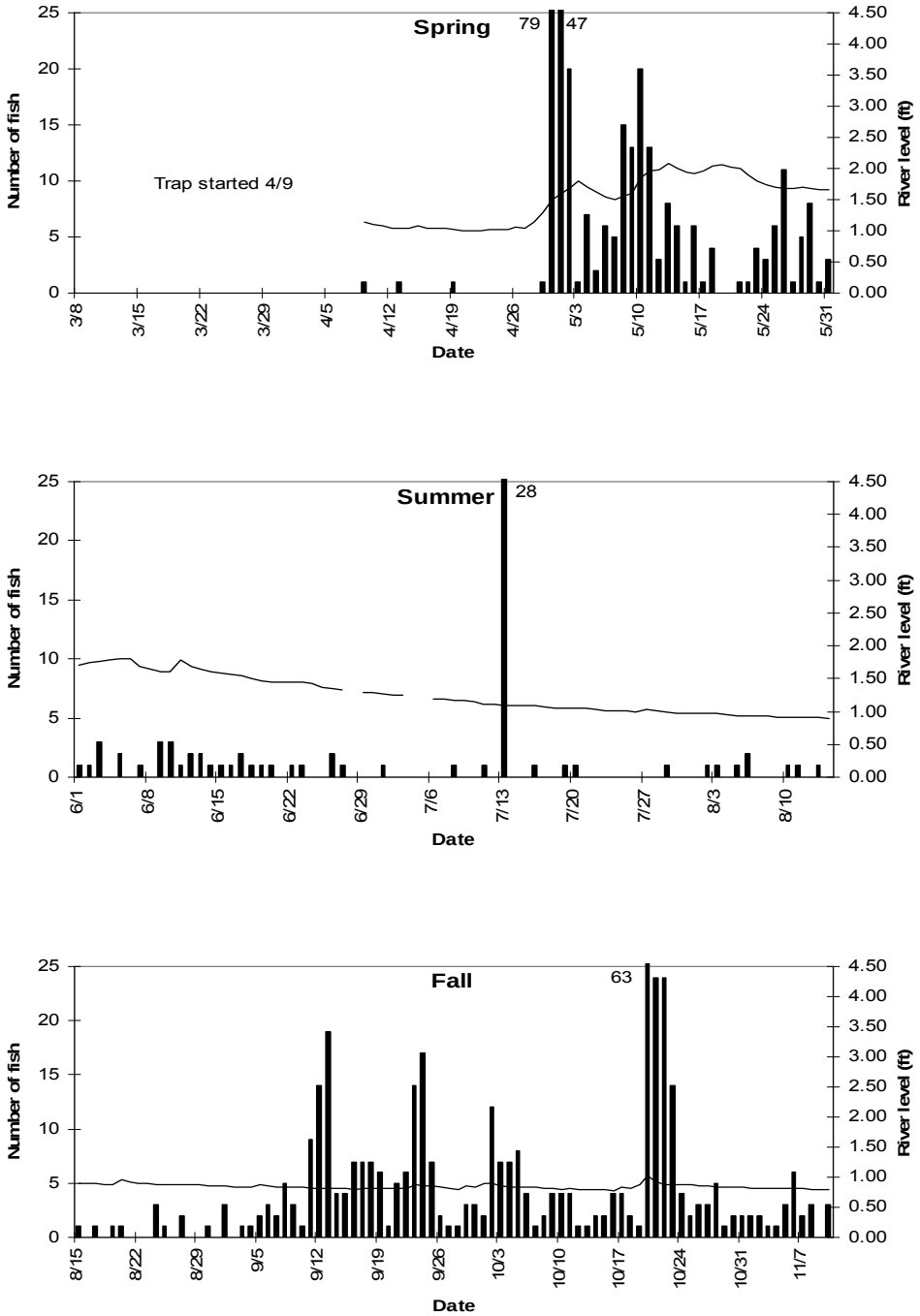


Figure 5. Daily number of steelhead juveniles captured in the Rapid River screw trap and river level (ft) during 2007. Spring (4/9–5/31, n = 305) is top panel; summer (6/1–8/14, n = 75) is middle panel; and fall (8/15–11/10, n = 411) is bottom panel.

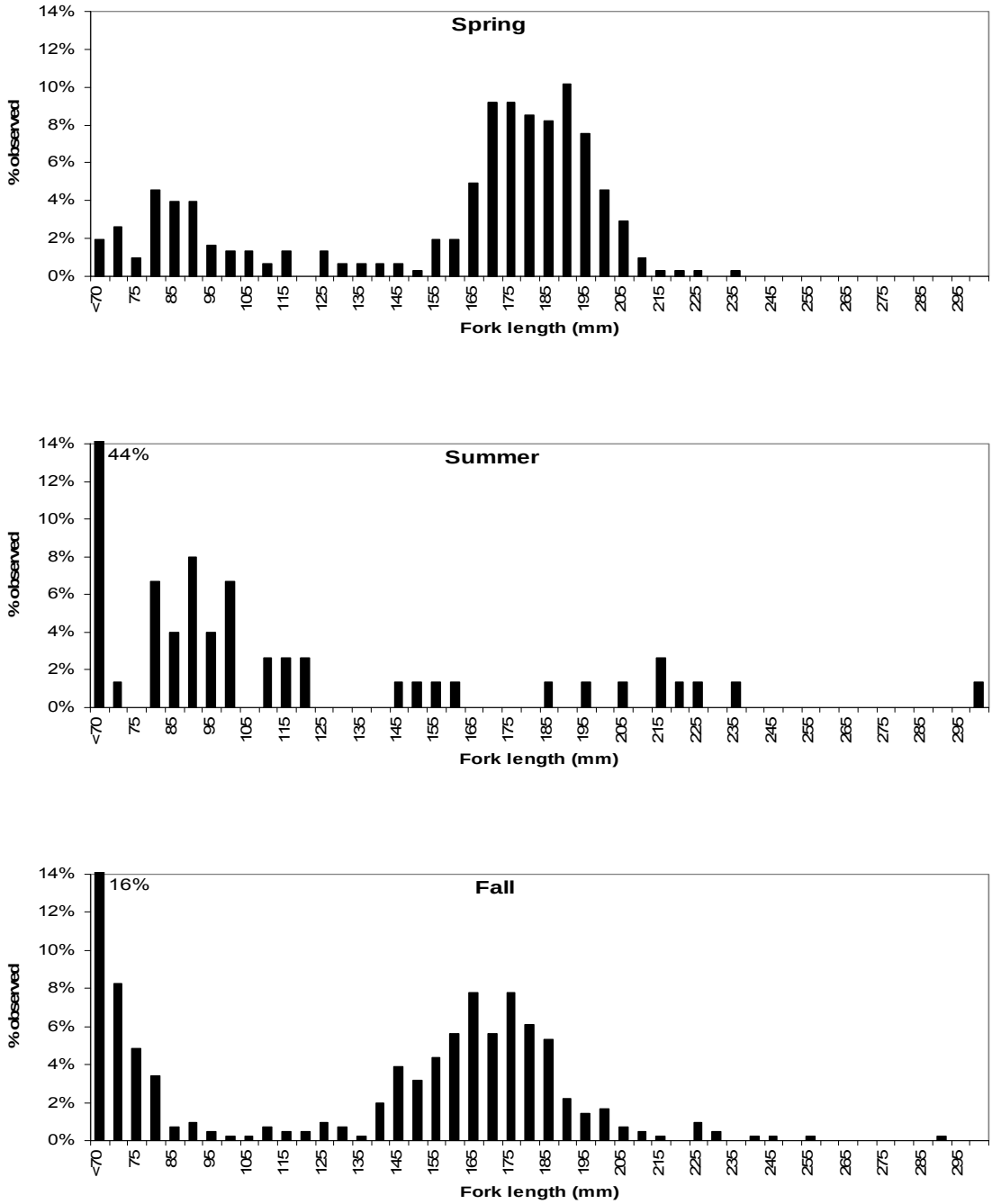


Figure 6. Length frequency of steelhead juveniles captured in the Rapid River screw trap during 2007. Spring (4/9–5/31, n = 305) is top panel; summer (6/1–8/14, n = 75) is middle panel; and fall (8/15–11/10, n = 411) is bottom panel.

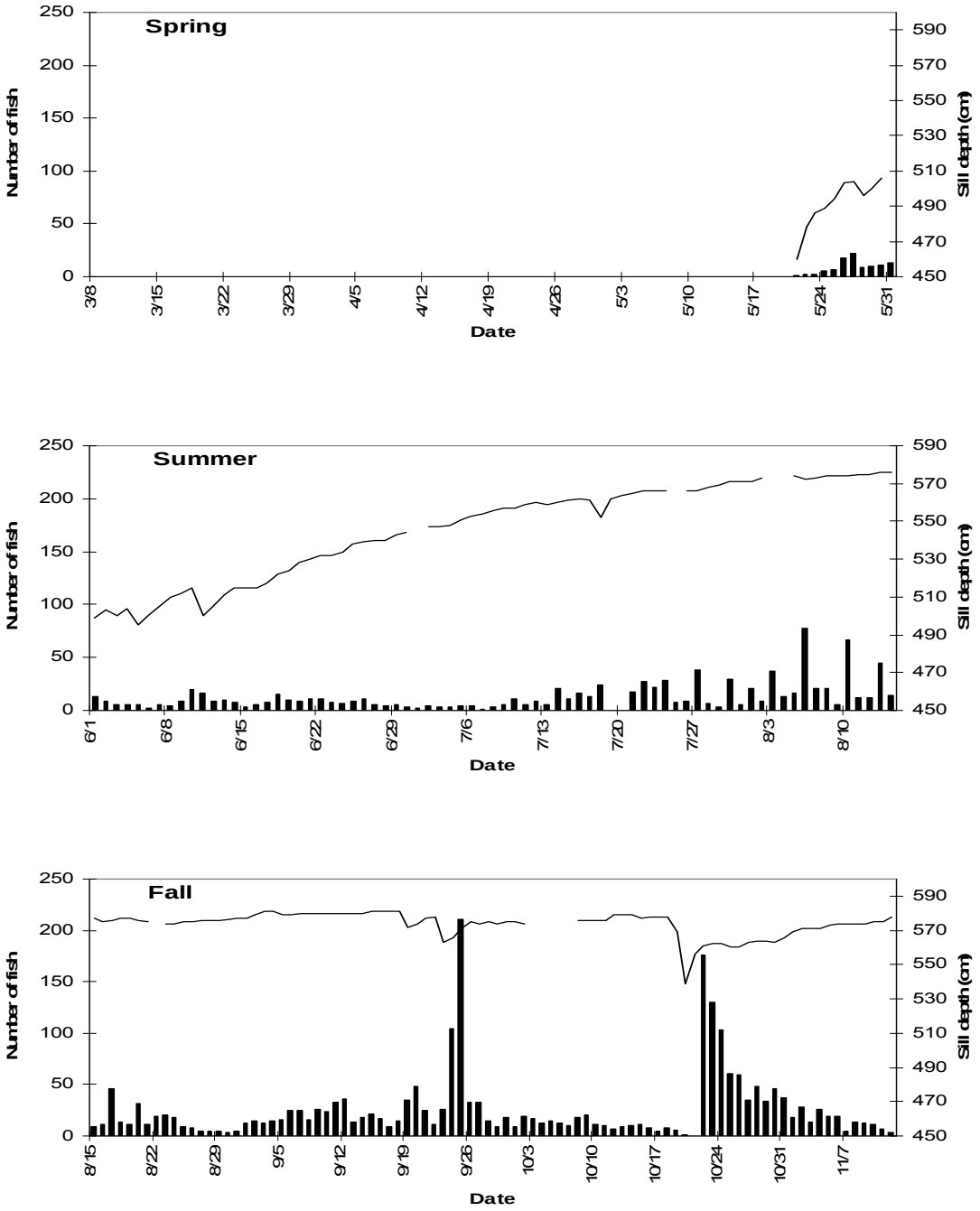


Figure 7. Daily number of steelhead juveniles captured in the Big Creek screw trap and sill depth (cm) during 2007. Spring (5/21–5/31, n = 100) is top panel; summer (6/1–8/14, n = 960) is middle panel; and fall (8/15–11/12, n = 2,263) is bottom panel.

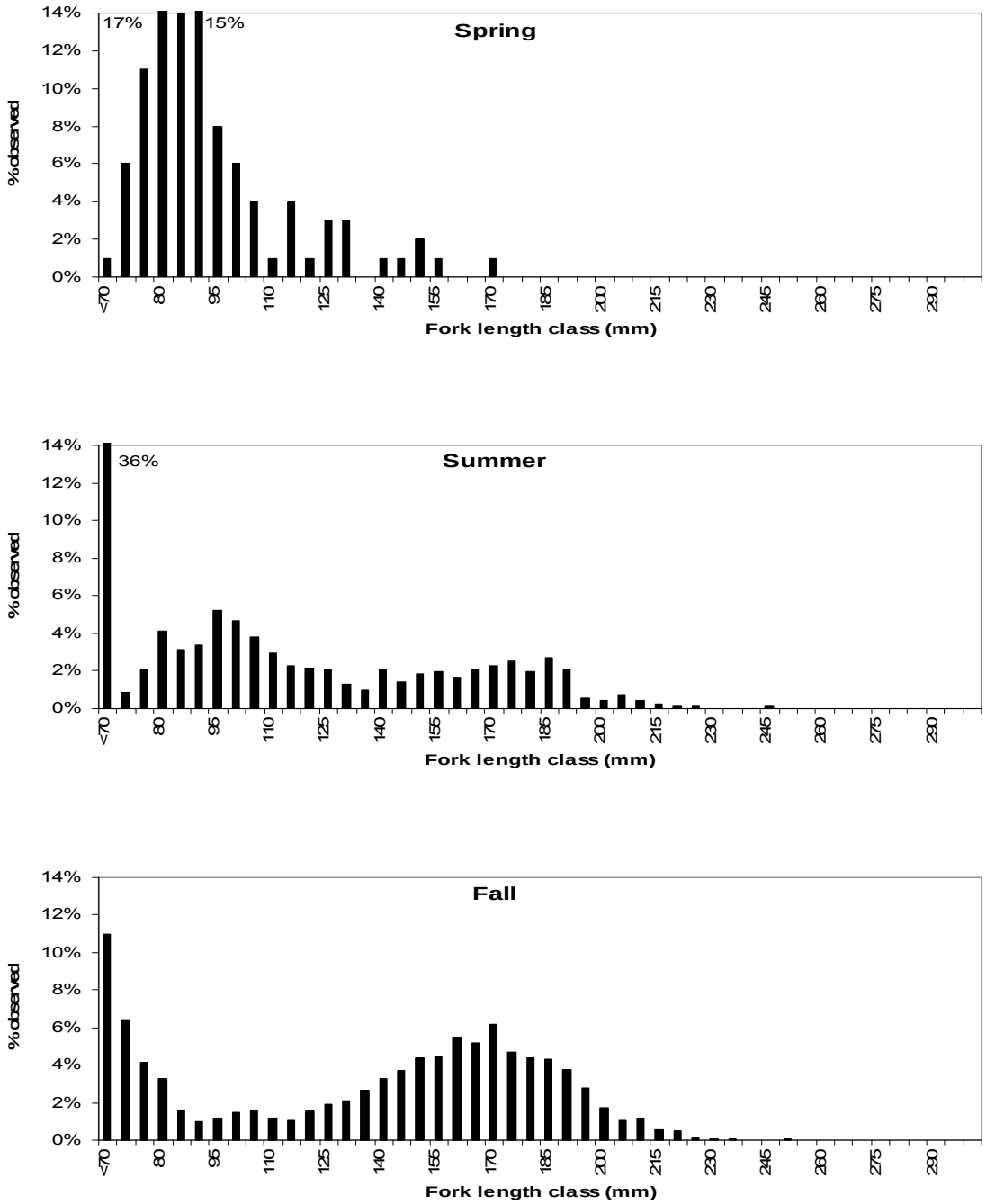


Figure 8. Length frequency of steelhead juveniles captured in the Big Creek screw trap during 2007. Spring (5/21–5/31, n = 100) is top panel; summer (6/1–8/14, n = 960) is middle panel; and fall (8/15–11/12, n = 2,263) is bottom panel.

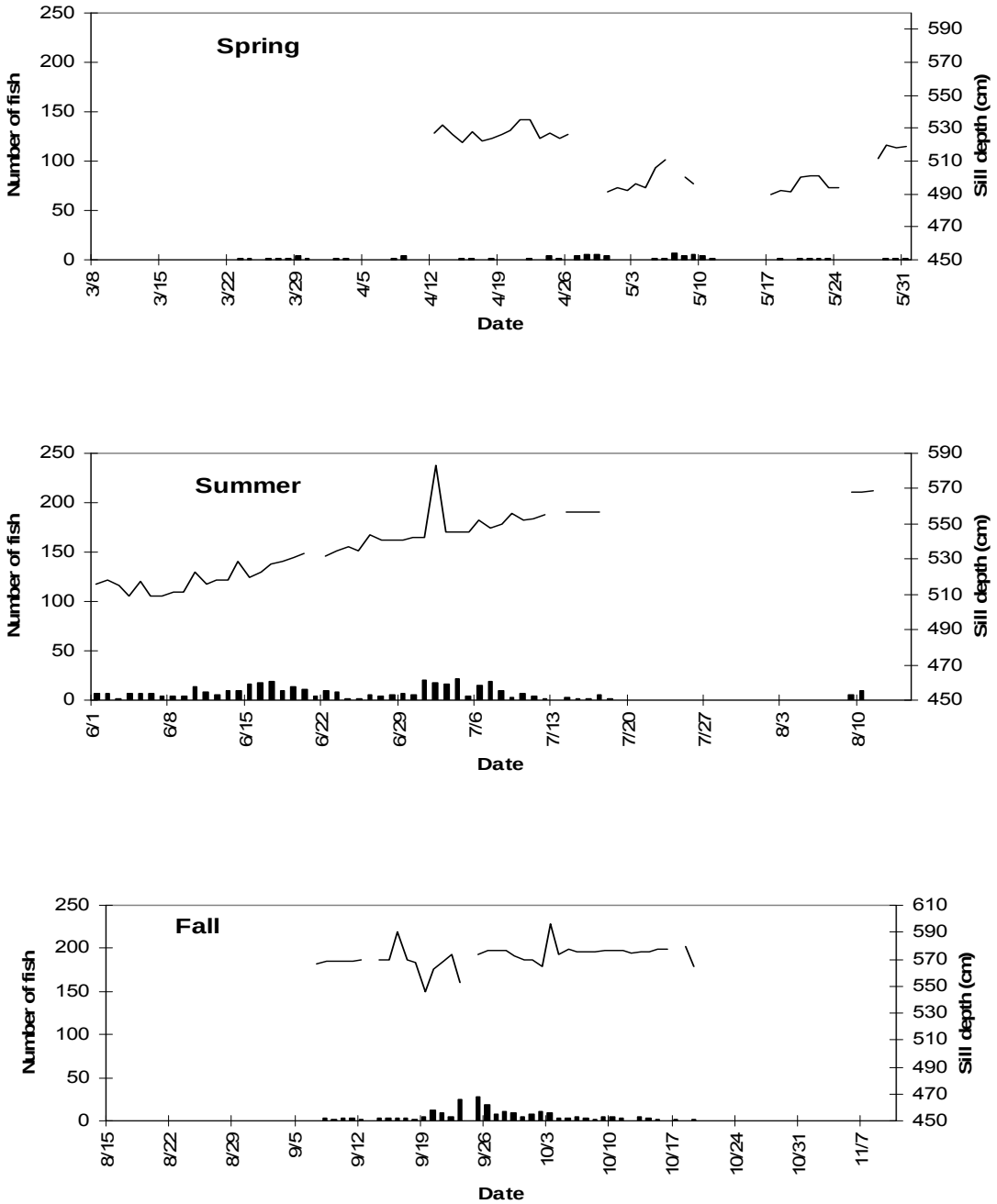


Figure 9. Daily number of steelhead juveniles captured in the Secesh River screw trap and sill depth (cm) during 2007. Spring (3/23–5/31, n = 85) is top panel; summer (6/1–8/14, n = 403) is middle panel; and fall (8/15–10/19, n = 225) is bottom panel.

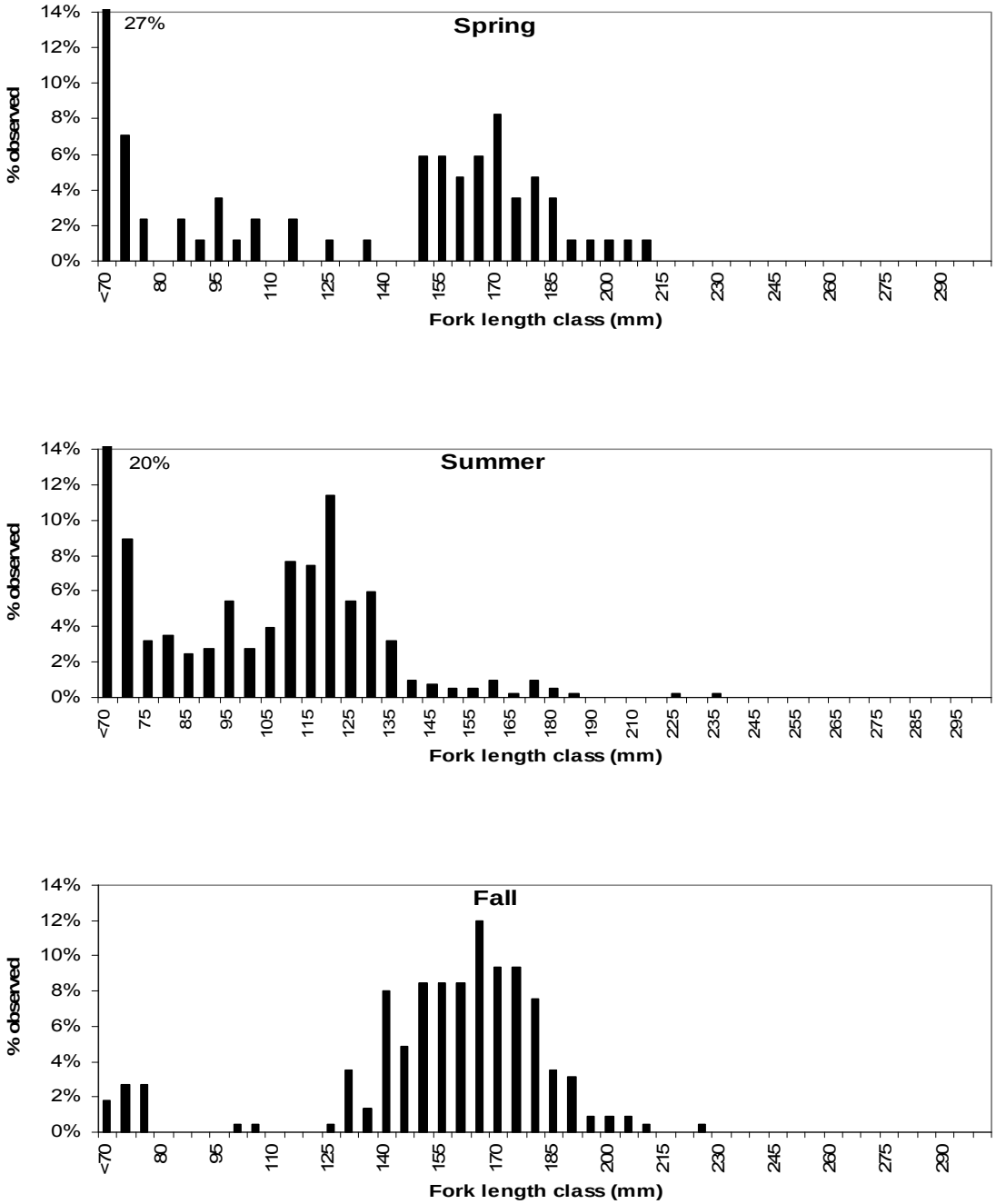


Figure 10. Length frequency of steelhead juveniles captured in the Secesh River screw trap during 2007. Spring (3/23–5/31, n = 85) is top panel; summer (6/1–8/14, n = 403) is middle panel; and fall (8/15–10/19, n = 225) is bottom panel.

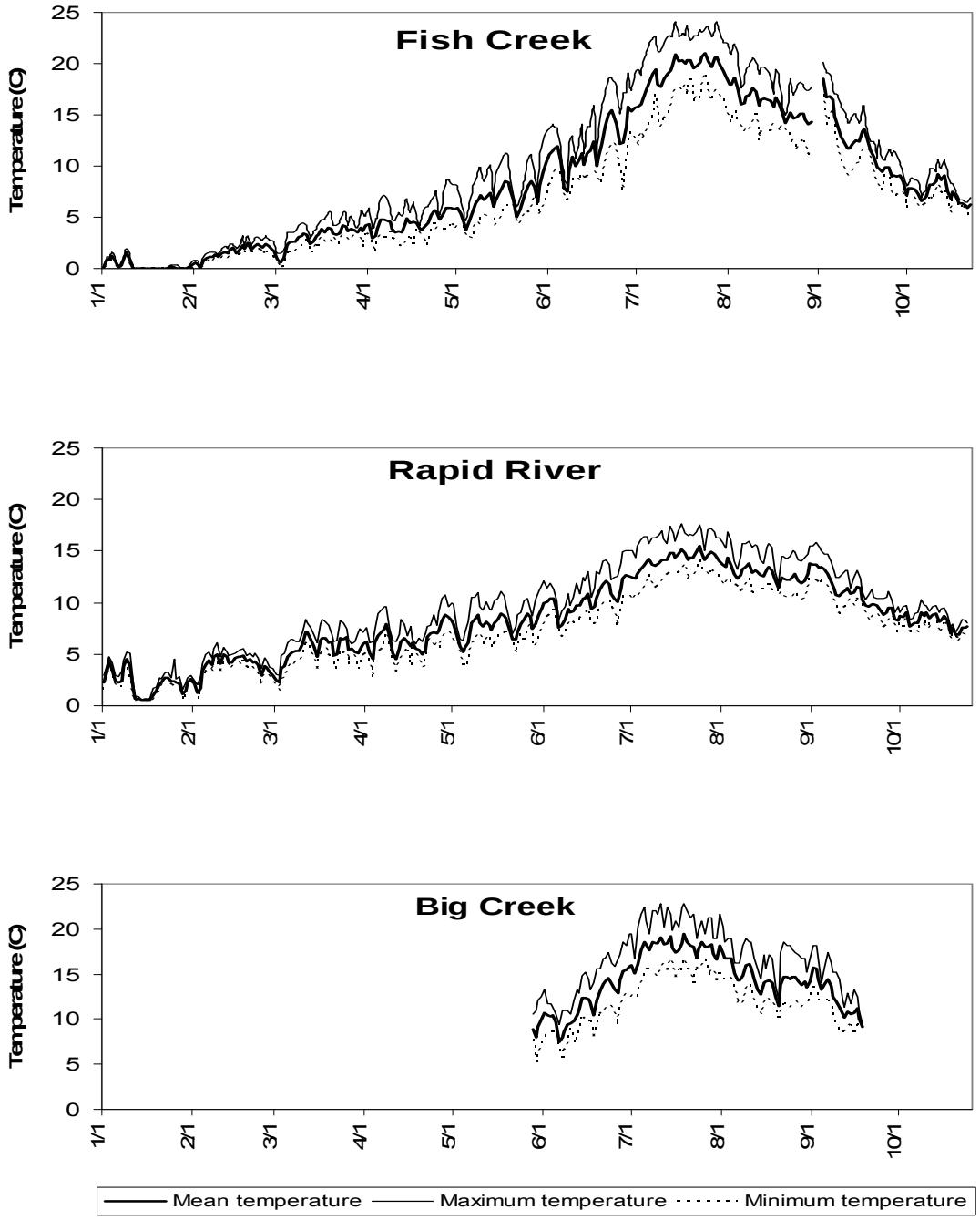


Figure 11. Daily mean, maximum, and minimum water temperatures (C) recorded in Fish Creek (top), Rapid River (middle), and Big Creek (bottom) during 2007.

APPENDIX

IDAHO DEPARTMENT OF FISH AND GAME
EAGLE FISH GENETICS LAB
1800 Trout Road
Eagle, Idaho 83616

C.L. "Butch" Otter/ Governor
Cal Groen / Director

December 7, 2007

M E M O R A N D U M

To: Tim Copeland, Bill Schrader
Cc: Sam Sharr, Brian Leth, Alan Byrne, Dan Schill, Shawn Narum
From: Matthew Campbell, Eric Tretter, Christine Kozfkay, Eagle Fish Genetics Lab
Subject: Steelhead results

Tim and Bill,

We have completed genotyping 678 steelhead samples with the 12 SPAN microsatellite loci. While all of these genotypes will be sent to the WDFW (Sewall Young/Denise Hawkins/Ken Warheit) for inclusion into a comprehensive coastwide steelhead genetic baseline and subsequent GSI analyses, I wanted to provide you a brief summary of results for BPA/COTR reporting purposes. The 678 samples were chosen from 15 populations to fill-in existing gaps in the baseline or to increase sample sizes and provide temporal replication at specific sites (Table 1, Figure 1). Last year's screening included 878 samples from 10 sample locations/populations, and these are also included in Figure 1.

The 12 SPAN loci are a set of microsatellite loci standardized by five Northwest genetics labs (NWFSC, CRITFC, USFWS, WDFW, and IDFG) specifically to address genetic issues associated with Columbia River steelhead. We also screened these samples with an additional 5 loci that were previously used by USGS-Jennifer Nielsen/IDFG-Alan Byrne to examine genetic population structure of steelhead in Idaho. By running these additional loci we can potentially compare these samples to samples that the USGS has previously run, as well as to resident *O. mykiss* samples that we are currently genotyping as part of another BPA project managed by

Kevin Meyer. Of the 17 microsatellite loci, 15 (Ots100SPAN, Omy1001SPAN, Ogo4SPAN/USGS, Omy07SPAN, Oke4SPAN, Oki23SPAN, Omy1011SPAN, Ots3MUSGS, Ssa407SPAN, Ssa408SPAN, Ogo1aUSGS, Omy27USGS, Oneu14SPAN/USGS, Oneu8USGS, and Ots4SPAN/USGS) were amplified in three multiplex PCRs (3 runs on the ABI 3100 fragment analyzer). The remaining two loci (Omy325USGS and Ssa289SPAN), were amplified in single PCR reactions and were each run alone on the fragment analyzer.

Statistical analyses-

Each population was tested for Hardy–Weinberg equilibrium and linkage disequilibrium with GENEPOP on the Web (Raymond and Rousset 1995). A sequential Bonferroni correction was used to adjust significance for multiple comparisons (Rice 1989). Genetic diversity was measured by the number of alleles per locus (A), observed heterozygosity (Ho), and expected heterozygosity (He) using the Microsatellite Toolkit for Microsoft excel ™ (Park 2001). GENEPOP on the Web was used to perform exact tests to assess the significance of allelic differentiation between pairs of populations and to estimate pairwise population differentiation (F_{ST}; Weir and Cockerham, 1984). The significance of F_{ST} values was assessed with allelic permutations generated by FSTAT ver 3.0 (GOUDET 1997).

In order to examine genetic relationships among populations, genetic distances (Cavalli-Sforza and Edwards 1967) between all populations were estimated in GENDIST in PHYLIP v. 3.5 (Felsenstein 1993). A neighbor-joining dendogram was generated from these genetic chord distances with the program FITCH in PHYLIP. Bootstrap replicates of 1000 iterations were attained with SEQBOOT and a consensus tree was formed with CONSENSE in PHYLIP. We included the additional group of samples/populations completed in 2006 in these analyses for comparison purposes.

Results-

While screening samples, we identified putative cutthroat alleles (either outside known allele size ranges for *O. mykiss* or exhibited unusual peak morphology) in several populations. Samples from John's Creek and Hazard Creek were screened with a panel of seven nDNA markers diagnostic between rainbow trout and cutthroat trout (Ostberg and Rodriguez 2002, 2004) and hybrids were confirmed in those two populations (John's Creek 2 F_1, 12 >F_1; Hazard Creek 2 F_1). These samples were removed from the dataset. The remaining populations were not screened with the nDNA hybrid panel, but hybrids identified with the microsatellite screen were also removed from analysis (Bargamin Creek, N = 1; Moose Creek, N = 2; Morgan Creek, N =2; Rapid Creek, N = 2; Bear Creek, N = 1, and Secesh River, N =1).

Tests for Hardy-Weinberg equilibrium revealed that genotypes were in expected proportions for 252 of the 255 tests performed (Bonferroni corrected α = 0.05 / 17 tests per population = 0.0029). Of the 3 significant tests (Table 1), 2 were observed for Big Creek (OMY325- heterozygote excess; Oki23-heterozygote deficit), and 1 was observed for Hazard Creek (Ots3M - heterozygote deficit.) Prior to the Bonferroni correction, Big Creek and Bear Creek exhibited the highest number of loci out of HWE (each with 6, Table 1).

A total of 2,040 tests for linkage disequilibrium were performed of which 67 were rejected (Bonferroni corrected α = 0.05 / 136 tests per population = 0.000368). Of the 67 significant tests, 4 locus pairs had significant results for more than two populations: Ssa408/Oneu8, 5 populations; Omy325/Omy1001, 4 populations; Oki23/Oneu8, 3 populations, and Ots100/Oneu8, 3 populations. On a per population basis, Bear Creek exhibited the highest level of linkage disequilibrium (11/136 significant pairs following correction, 68 before correction).

The several anomalies observed within the Hardy-Weinberg equilibrium and linkage disequilibrium tests, especially those observed in Big Creek and Bear Creek, could be due to a variety of factors affecting the populations from which these samples were drawn, as well as the sample group itself (genetic drift, non-random mating, inter- and intraspecific hybridization, sampling family groups, sampling multiple populations, etc.). Despite these issues, there was no overwhelming pattern that suggested that any populations or loci should be removed from this dataset prior to analysis.

Because of necessity, many of the steelhead populations sampled for the baseline consist of juvenile collections. It has been asserted that it may be more difficult to obtain a representative sample from juvenile collections and easier to sample multiple populations (resident/anadromous or rearing migrants) when sampling juveniles (Hansen et al.1997; Parkinson et al. 1984). Additionally, limited hybridization has been documented in several drainages across the species' range in the Columbia basin (Howell and Spruell 2003; kozfkay et al. 2007). Obviously, these issues will continue to be carefully scrutinized during analysis and testing of the baseline.

Genetic diversity (expected heterozygosity and number of alleles observed) was generally uniform across sites (Table 1). Expected heterozygosity ranged from 0.7012 (Rapid River (M.F. Salmon R.)) to 0.7923 (Morgan Creek) with an average of 0.7470 observed. The number of alleles observed per locus ranged from 6.94 (Big Creek) to 11.47 (Hazard Creek) with an average of 9.27 observed. The number of alleles per locus was not corrected for sample

size due to the similarity in the sample sizes of the groups. Similar to what we have reported previously, the genetic diversity observed in these populations was comparable to what has been observed in steelhead throughout the Columbia River basin (Beacham et al. 2004, Narum In Press, Winans et al. 2004).

Pairwise F_{ST} estimates of the fifteen populations indicated significant genetic differentiation between 103 of 105 pairwise comparisons. The two non-significant tests were among Boulder Creek versus Hazard Creek, and Bear Creek versus Gedney Creek. Generally, F_{ST} values were higher among sample locations between drainages, than among samples within drainages. The largest F_{ST} (0.087) was observed between Ten Mile Creek (Clearwater drainage) and Rapid Creek (M.F. Salmon drainage). These results were concordant with our previous analyses in 2006, and the resulting neighbor-joining dendogram (Figure 2), with both datasets combined (2006 and present), supports genetic population structuring at the drainage level, with some limited exceptions. All sample locations from the Clearwater River drainage cluster together with 100% bootstrap support. Within drainage structuring is also observed within the Clearwater with the four Selway River sample locations (tributaries) clustering with 74.9% bootstrap support. As expected, all of the temporal samples of adult steelhead released above the Rapid River weir cluster together (98.1%). Boulder Creek, just upstream of Rapid River clusters with these temporal samples, although only with moderate support (63.2%). Sample sites within the M.F. Salmon River, and within the S.F. Salmon River, cluster by drainage (97.0% and 99.4% respectively). Bargamin Creek's intermediate placement between the M.F. Salmon River group and the S.F. Salmon River group, is reasonable given its geographic position between the two drainages (tributary to the main salmon). All of the upper Salmon River sample locations cluster together (82.4%). Samples from the Oxbow hatchery also cluster within this group. This is not surprising given that Oxbow (Hells Canyon stock) was historically a brood source for the Pahsimeroi and Sawtooth hatcheries. Samples from the East Fork Salmon River do not cluster with the Upper Salmon River Group, although this is also not surprising given that the East Fork Salmon River had received supplementation (both directly from hatchery releases and indirectly from straying) from two divergent groups: A-run (presumably both indigenous and Hells Canyon origin) and B-run (Dworshak origin). Finally, although samples from Hazard Creek and Slate Creek did cluster with any of the groups in the tree, their placement still makes sense given their geographic locations. Hazard Creek is a tributary to the little Salmon River, and Slate Creek is a tributary to the lower mainstem Salmon

River. The BRR 2002 samples are from an unknown location (originally thought to be Rapid River) and will be removed from future analyses/baselines.

As another way to examine genetic population structure, we also performed assignment tests using the Bayesian method (Rannala and Mountain 1997) in the software program ONCOR http://www.montana.edu/kalinowski/ONCOR.htm. Reporting units were derived from the population groupings observed in the neighbor-joining dendrogram. Reporting units included the Upper Salmon River Group, Rapid River temporal Group, M.F. Salmon River Group, S.F. Salmon River Group, and Clearwater Group. Sample locations that did not cluster within these groups were input as individual reporting units.

Results indicated that overall assignment accuracy was fairly high (82.0%) (Table 3), with the highest accuracy observed for the Clearwater Group (95.5%), followed by the M.F. Salmon River Group (89.0%), and the Upper Salmon Group (88.7%). While all of these results have to be scrutinized in the context of the limited baseline they represent, overall findings from this combined dataset appears to be concordant with previous studies (Beacham et al. 2004; Narum In Press; Winans et al. 2004) that have demonstrated that steelhead are significantly structured at the drainage level, and suggests that mixed stock analyses are likely possible for Snake River steelhead returning to Idaho.

At the SPAN meeting back on November 26th/27th, Paul Moran (NWFSC), Shawn Narum (CRITFC), and Christian Smith (USFWS) agreed to provide us with all Snake River Idaho/Oregon steelhead genotypes by January 31st, 2008 in order to run some preliminary power analyses on the completed baseline. I hope to have those analyses completed by early February with the idea that some of those results could be discussed at the Anadromous meeting. Apparently, the USFWS will receive funding to genotype adult steelhead collected at Lower Granite Dam in 2006 and 2007/2008 and it is possible that some preliminary mixture analyses could be completed on those samples early next year. Please call me if you have any questions/comments.

Sincerely,

Matt

References-

Beacham, T. D., K. D. Le, and J. R. Candy. 2004. Population structure and stock identification of steelhead trout (Oncorhynchus mykiss) in British Columbia and the Columbia River based on microsatellite variation. Environmental Biology of Fishes 69:95–109.

Cavalli-Sforza, L. L., and A. W. F. Edwards. 1967. Phylogenetic analysis: models and estimation procedures. Evolution 21:550-570.

Felsenstein J. 1993 phylip (Phylogeny Inference Package) version 3.5c. Distributed by the author. Department of Genetics, University of Washington, Seattle, Washington, USA

Goudet, J., 1997. FSTAT [a program for IBM PC compatibles to calculate WEIR and COCKERHAM's (1984) estimators of F-statistics], version 1.2. Available from the author. Institut de Zoologie et d'Ecologie Animale, Bâtiment de Biologie, Université de Lausanne, CH-1015 Dorigny, Switzerland.

Hansen, M.M., E.E. Nielsen and K.L.D. Mensberg. 1997. The problem of sampling families rather than populations: Relatedness among individuals in samples of juvenile brown trout Salmo trutta L. Molecular Ecology 6: 469–474.

Howell, P., and P. Spruell. 2003. Information regarding the origin and genetic characteristics of westslope cutthroat trout in Oregon and Central Washington. Preliminary report. Oregon Department of Fish and Wildlife, Portland.

Kozfkay, C. C., M. R. Campbell, S. P. Yundt, M. P. Peterson, and M. S. Powell. 2007. Incidence of hybridization between naturally sympatric westslope cutthroat trout and rainbow trout in the Middle Fork Salmon River drainage, Idaho. Transactions of the American Fisheries Society 136:624-638.

Narum, S.R. In Press. Iteroparous salmonids in complex mating systems. Journal of Fish Biology.

Ostberg, C. O., and R. J. Rodriguez. 2002. Novel microsatellite markers differentiate Oncorhynchus mykiss (rainbow trout and steelhead) and the O. clarki (cutthroat trout) subspecies. Molecular Ecology Notes 2:197–202.

Ostberg, C. O., and R. J. Rodriguez. 2004. Bi-parentally inherited species-specific markers identify hybridization between rainbow trout and cutthroat trout subspecies. Molecular Ecology Notes 4:26–29.

Park S.D.E. 2001. Trypanotolerance in West African cattle and the population genetic effects of selection. PhD Thesis. University of Dublin.

Parkinson, E.A. 1984. Genetic variation in populations of steelhead trout (Salmo gairdneri) in British Columbia. Canadian Journal of Fisheries Aquatic Sciences 41: 1412–1420.

Rannala, B. and Mountain, J. L. 1997. Detecting immigration by using multilocus genotypes. Proceedings of the National Academy of Sciences of the United States of America. 94:9197-9201.

Raymond M. F. and F. Rousset . 1995. GENEPOP (version 1.2): population genetics software for exact tests and ecumenicism. Journal of Heredity, 86, 248-249.

Rice, W. R. 1989. Analyzing tables of statistical tests. Evolution 43: 223–225.

Winans, G. A., M. M. Paquin, D. M. Van Doornik, B. M. Baker, P. J. Thornton, D. Rawding, A. R. Marshall, P. Moran, S. T. Kalinowski. 2004. Genetic stock identification of steelhead in the Columbia River basin: an evaluation of different molecular markers. North American Journal of Fisheries Management, 24:672-685.

Table 1. Genetic diversity statistics for 15 sample sets of steelhead in the Snake River. H_E = unbiased heterozygosity, H_O = observed heterozygosity, NA = number of alleles observed, # of loci out of HWE (before Bonferroni correction/after correction). Notes include whether samples were run to provide temporal replicate (year and lab listed that genotyped earlier samples) or to provide samples from locations that had not been previously genotyped with SPAN loci. ✓ indicates total rather than average. All samples were taken in the year 2000 from wild juvenile fish.

Population	n	H_E	H_O	NA	# of loci out of HWE	Notes
Bargamin Creek	46	0.7691	0.7559	9.41	1/0	Temporal Replicate to 1999 NWFSC
Morgan Creek	45	0.7923	0.7918	11.12	3/0	Temporal Replicate to 1997 NWFSC
Tenmile Creek	47	0.7299	0.7697	8.53	1/0	Not previously genotyped with SPAN
O'Hara Creek	47	0.7535	0.7447	9.76	1/0	Not previously genotyped with SPAN
Rapid River (M. F. Salmon R.)	45	0.7012	0.6850	8.24	3/0	Not previously genotyped with SPAN
East Fork S. F. Salmon R.	46	0.7484	0.7544	8.53	0/0	Not previously genotyped with SPAN
Big Creek	47	0.7176	0.7272	6.94	6/2	Not previously genotyped with SPAN
Boulder Creek	47	0.7597	0.7491	10.24	1/0	Temporal Replicate to 1994 & 1997 NWFSC
Hazard Creek	44	0.7679	0.7620	11.47	2/1	Temporal Replicate to 1997 NWFSC
Crooked Fork Creek	47	0.7328	0.7222	8.53	2/0	Not previously genotyped with SPAN
Slate Creek	47	0.7770	0.7497	10.82	1/0	Not previously genotyped with SPAN
Secesh River	45	0.7221	0.6936	8.12	1/0	Temporal Replicate to 1999 NWFSC
John's Creek	33	0.7382	0.7357	9.47	1/0	Temporal Replicate to 1997 NWFSC
Gedney Creek	46	0.7449	0.7265	9.12	2/0	Temporal Replicate to 1990, 1991, & 1992 NWFSC

Bear Creek	46	0.7507	0.7762	8.71	6/0	Not previously genotyped with SPAN
Average	678 ✓	0.7470	0.7429	9.27	N/A	

Table 2. Pairwise F_{ST} estimates (below diagonal). Grayed boxes contain F_{ST} estimates indicating "moderate differentiation" (0.05-0.15). Clear boxes contain F_{ST} estimates indicating "little differentiation" (0-0.05). Pairwise estimates noted with * indicate that F_{ST} estimate was not significantly different than zero. Values above diagonal indicate number of alleles out of 17 that showed significant differentiation (Fisher exact test) following Bonferroni correction.

	Bargamin	Morgan	TenMile	Ohara	Rapid	E.F.S.F	Big	Boulder	Hazard	Crk. Fork	Slate	Secesh	John's	Gedney	Bear
Bargamin		8	14	15	10	6	13	7	8	16	9	9	11	13	14
Morgan	0.022		14	11	14	12	14	7	3	15	7	12	12	12	13
TenMile	0.054	0.044		13	15	15	15	14	14	13	12	14	11	9	15
Ohara	0.041	0.030	0.027		15	12	14	13	10	6	9	14	0	1	4
Rapid	0.038	0.049	0.087	0.057		12	12	12	10	17	11	13	15	14	16
E.F.S.F.	0.023	0.039	0.063	0.051	0.047		13	8	8	14	11	7	12	13	14
Big	0.037	0.054	0.080	0.065	0.043	0.042		14	12	16	14	12	13	14	14
Boulder	0.018	0.018	0.049	0.032	0.031	0.022	0.038		0	15	2	8	11	15	15
Hazard	0.014	0.017	0.043	0.027	0.031	0.022	0.040	0.006*		14	3	8	8	11	14
Crk. Fork	0.057	0.039	0.043	0.017	0.078	0.066	0.077	0.042	0.042		14	13	3	8	8
Slate	0.022	0.017	0.037	0.025	0.037	0.026	0.041	0.010	0.011	0.034		9	9	8	11
Secesh	0.038	0.036	0.071	0.054	0.055	0.025	0.057	0.030	0.033	0.072	0.035		14	11	13
John's	0.048	0.035	0.036	0.007	0.065	0.059	0.070	0.035	0.029	0.015	0.029	0.063		3	7
Gedney	0.046	0.028	0.031	0.010	0.069	0.050	0.075	0.042	0.032	0.023	0.027	0.055	0.025		1
Bear	0.045	0.032	0.038	0.013	0.065	0.051	0.076	0.042	0.038	0.023	0.029	0.057	0.027	0.009*	

Table 3. Self-assignment test results produced using the program ONCOR. The 36 populations (both datasets combined) are listed with their designated Reporting Group (as determined from the NJ tree), sample size (N), and percent of samples that assigned correctly back to Reporting Group. Also listed is the Reporting Group(s) in which the largest misidentification occurred.

Population	Reporting Group	N	% Correct	Largest Misidentification	
Sawtooth Hatchery	Upper Salmon	46	89.1%	Clearwater	4.3%
Sawtooth Wild	Upper Salmon	25	84.0%	Rapid R.	8.0%
Squaw Creek Hat.	Upper Salmon	33	84.8%	Clearwater, Hazard	6.0%
Squaw Creek Wild	Upper Salmon	11	90.9%	Rapid R.	9.0%
Pahsimeroi '05 Hat.	Upper Salmon	44	93.2%	Hazard	4.5%
Pahsimeroi '05 Wild	Upper Salmon	40	97.5%	Clearwater	2.5%
Pahsimeroi '06 Hat.	Upper Salmon	39	89.7%	Hazard	7.6%
Pahsimeroi '06 Wild	Upper Salmon	43	90.7%	(4 groups)	2.3%
Oxbow Hatchery	Upper Salmon	42	76.2%	Hazard	14.2%
Morgan Creek	Upper Salmon	44	88.6%	Rapid R.	4.5%
W. F. Yankee Fork	Upper Salmon	42	90.5%	Clearwater, Hazard	4.7%
Rapid River 1997	Rapid R.	18	77.8%	(4 groups)	5.5%
Rapid River 1998	Rapid R.	21	71.4%	(6 groups)	4.7%
Rapid River 1999	Rapid R.	10	80.0%	Boulder, Hazard	10.0%
Rapid River 2000	Rapid R.	17	76.5%	Boulder	11.7%
Rapid River 2001	Rapid R.	29	79.3%	Upper Salmon	10.3%
Rapid River 2002	Rapid R.	75	85.3%	Upper Salmon	6.6%
Rapid River 2003	Rapid R.	84	79.8%	Upper Salmon	5.9%
Rapid Creek	M. F. Salmon R.	45	80.0%	Rapid R.	8.8%
Big Creek	M. F. Salmon R.	47	97.9%	Rapid R.	2.1%
E.F.S.F. Salmon R.	S. F. Salmon R.	43	72.1%	Hazard	9.3%
Secesh River	S. F. Salmon R.	44	84.1%	Rapid R.	13.6%
Crooked F. Ck.	Clearwater	47	100.0%	-	
Tenmile Creek	Clearwater	47	97.9%	Rapid R.	2.1%
O'Hara Creek	Clearwater	47	93.6%	Slate	6.3%
John's Creek	Clearwater	31	93.5%	Upper Salmon, Hazard	3.2%
Gedney Creek	Clearwater	41	90.2%	Upper Salmon, Rapid R.	4.8%
Bear Creek	Clearwater	46	100.0%	-	
Canyon Creek	Clearwater	43	90.7%	Upper Salmon	6.9%
Dworshak Hatchery	Clearwater	44	95.5%	Upper Salmon, Boulder	2.2%
N. F. Moose Creek	Clearwater	47	97.9%	Upper Salmon	2.1%
E. F. Salmon River	E. F. Salmon R.	38	65.8%	Upper Salmon	18.4%
Bargamin Creek	Bargamin C.	44	65.9%	Upper Salmon	15.9%
Boulder Creek	Boulder C.	46	43.5%	Rapid R.	15.2%
Hazard Creek	Hazard C.	44	15.9%	Rapid R.	29.5%
Slate Creek	Slate C.	47	42.6%	Upper Salmon	17.0%

Figure 1. Map of the Snake River basin showing locations of fifteen sample locations as part of the current analysis group (2007), as well as sample locations of nine additional sites as part of the 2006 analysis group. Two sites from the 2006 analysis group are not shown: Oxbow Hatchery and BRR02UNK (unknown location). This map was adapted from:http://www.nwfsc.noaa.gov/trt/maps/map_stlhsrb.pdf

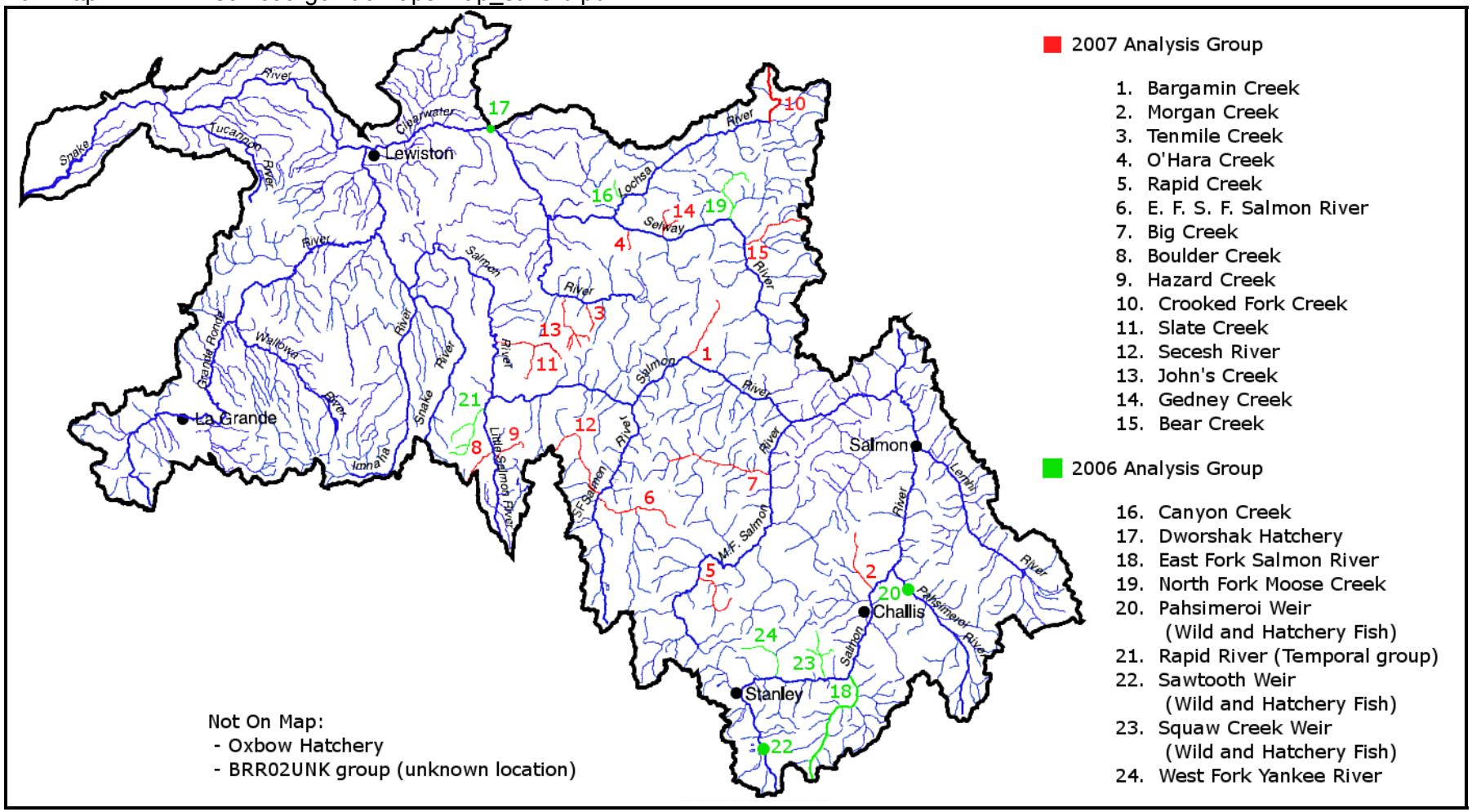
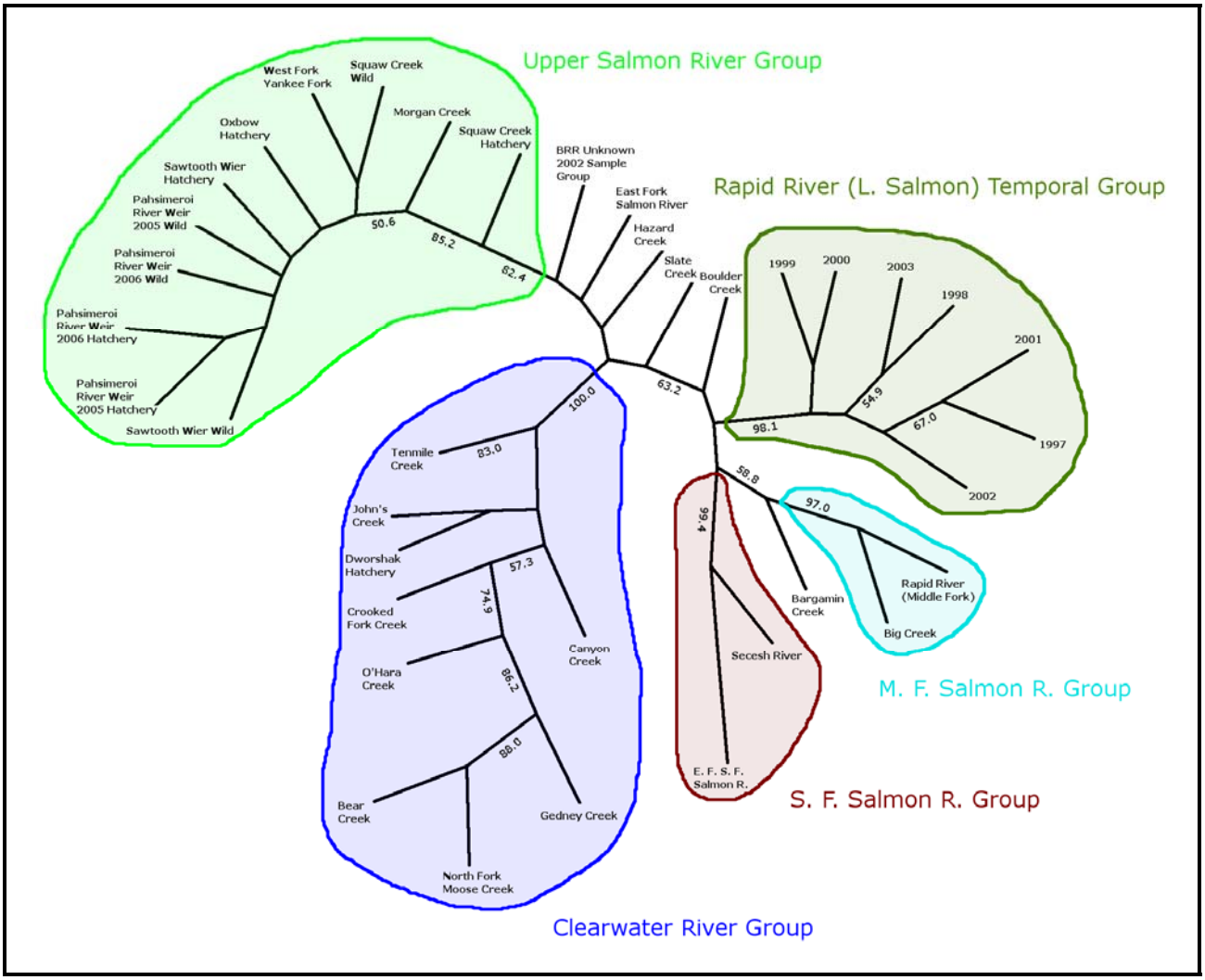


Figure 2. Neighbor-joining dendogram produced from Cavalli-Sforza and Edwards (1967) genetic chord distances using a combined data set containing the 2007 and 2006 sample/analysis groups. Colored shapes enclose tree branches that correspond with geographical areas. Bootstrap values are reported as percentages of the total and were listed only if they exceeded 50%.



Prepared by:	**Approved by:**
	IDAHO DEPARTMENT OF FISH AND GAME
Timothy Copeland Senior Fishery Research Biologist	Edward B. Schriever, Chief Bureau of Fisheries
Scott Putnam Senior Fishery Technician	Daniel J. Schill Fisheries Research Manager