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FISHERY RESEARCH

EFFECT OF STEELHEAD SMOLT SIZE ON RESIDUAUSM AND ADULTRETURN RATES

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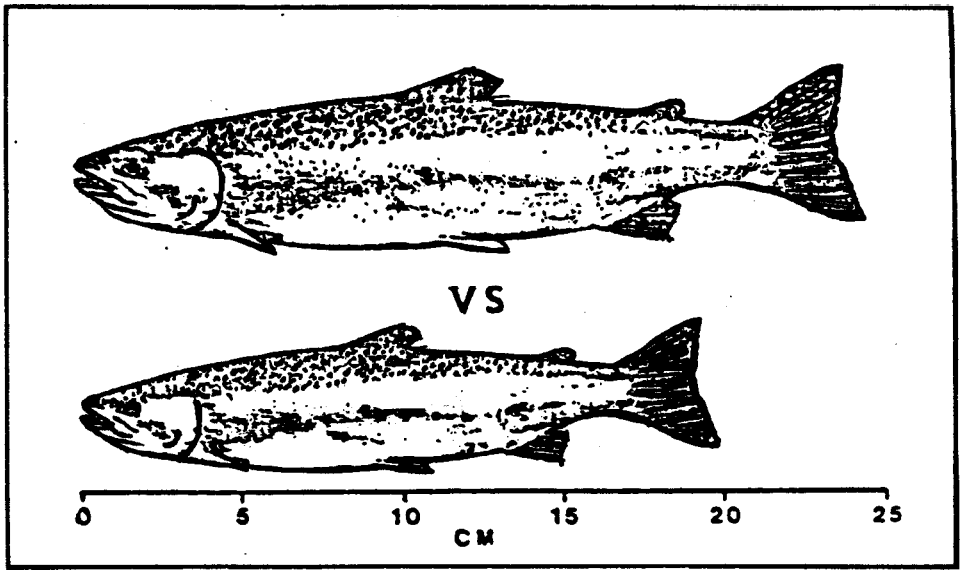

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Effect of Steelhead Smolt Size on ResIdualism and Adult Return Rate

ABSTRACT

The effects of size at release on steelhead (Salmo gairdneri) residualism were evaluated by conducting angler surveys, snorkeling, and electrofishing on the upper Saffron River in 1984. Equal numbers (40,000) of normal-size (FL=201.5 mm) and large-size (FL=264.6 mm) groups of steelhead smolts were marked and released along with 600,000 unmarked steelhead smolts during April and May. Angler surveys conducted during May 26 through September 15, 1984 estimated that 54,500 (8.0% of release) residualized steelhead were harvested from the upper Salmon River. Ninety-two percent of the marked steelhead harvested were from the large-size group with an estimated 13% of the large-size group being harvested as residualized steelhead. Only 1% of the normal-size group were found in the residualized harvest.

Residualized steelhead accounted for 78% of the total harvest in the upper Salmon River with 86% of the steelhead harvest occurring in the first two months of the fishing season. By mid-August, residualized steelhead were not being caught in the main portion of the study area. Fifty-seven percent of the residualized steelhead were harvested at the release site or within 5 km downstream.

The mean length of angler-caught residualized steelhead were significantly larger in each of the three marked and unmarked groups than at release with lengths at harvest being: normal-size - 238.0 mm, large-size - 297.2 mm, and unmarked - 280.3 mm. Mean length of residualized steelhead decreased significantly in each of the first three census intervals. The percent harvest of individual size classes of steelhead smolts remained low (0-3.1%) for fish under 250 mm, at which point the percent of harvest began to increase sharply until an estimated 74% of steelhead smolts released in the 330+ mm size class were harvested as residualized steelhead.

Hatchery catchable rainbow trout (Salmo gairdneri) which were released in mid-season accounted for 19% of the fish harvested. An estimated 59% of the hatchery catchables released were harvested.

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INTRODUCTION

The influence of the size of steelhead (Salmo gairdneri) released from Idaho hatcheries on parr-smolt transformation and adult survival has received considerable attention in recent years (Chrisp and Bjornn 1978; Bjornn et al 1979; Reingold 1979). Research has led to the conclusion that parr-smolt transformation in steelhead is primarily size and season dependent although other factors, such as age and water temperature, may be involved. If releases of truly smolted (or smolting) steelhead are made in tandem with acceptable downstream river conditions, a reasonable number of adults can be expected to return.

Because most fish cultural and economic conditions favor a one-year rearing period for steelhead, most of the Idaho research conducted to date has centered on the minimum size that must be achieved in one year in order to release smolted fish in the spring. Some work has been done to determine the size at which juvenile steelhead should be released (M. Reingold, IDFG, pers. comm.; Bjornn et al. 1979). In many anadromous stocks, adult survival increased (although at a decreasing rate) as the size of juveniles at release increased (Hallock et al. 1961; Wagner et al. 1963).

Chrisp and Bjornn (1978) concluded that steelhead parr must reach a minimum total length (TL) of 140-160 mm before they can become smolts and migrate to the sea. This was not viewed as a threshold size because not all of the parr reaching these lengths would smolt and migrate. However, researchers working with the lower Columbia River stocks believed that few steelhead less than 190 mm TL become emigrants and that 190 mm represented a minimum threshold size '(Buchanan and Wade 1982; Wade and Buchanan 1983). Using a variety of Idaho hatchery-reared groups of steelhead, Chrisp and Bjornn (1978) showed that the relationship between length at release and the percentage migrating was consistently linear up to 210 mm TL.

Research to date has led managers to conclude that steelhead releases averaging 190 to 210 mm are probably "best" for producing actively migrating downstream smolts. A stronger adult survival based on the "favorable" outmigration is assumed, and recent adult return rates support this assumption.

The importance of increased size, however, does not end at release. For a particular released group, the average size of that group Increases at each succeeding downriver sampling site. For example, a group of steelhead were released in the Lemhi River in April 1980 at an average size of about 182 mm. When sampled at Lower Granite Dam on the Snake River, the average length was 256 mm (T.C. Bjornn, pers. comm.). Even when interim growth was accounted for, it was still evident that the larger individuals of this lot were more successful in

their downstream migration than smaller fish. Similar relationships were shown in a variety of hatchery releases made earlier in the Lemhi River drainage and sampled at a- number of locations downstream as far as The Dalles Dam on the Columbia River (Chrisp and Bjornn 1978).

If large size is important to the parr-smolt transformation and successful downstream migration, then perhaps an objective of hatchery management should be to rear as large a smolt as possible within the limits of a one year production program. With the establishment of two Lower Snake River Compensation Plan (LSRCP) steelhead hatcheries In the Hagerman Valley of Idaho, rearing of steelhead smolts larger than the 190 to 210 mm "normal" size can be accomplished. The warm (15 C) Hagerman Valley spring water, introduction of demand (self) feeders, and other fish cultural advances have made it possible to rear steelhead smolts in excess of 250 mm in a one-year-program.

Although larger smolts may have higher adult return rates, they also have higher rates of precocialism and residual ism (Chrisp and Bjornn 1978, Partridge 1985). However, if the adult return rates for larger smolts Is sufficiently high, losses to precocialism and residualism will not harm the effectiveness of the rearing program. For example, if larger smolts return as adults at a theoretical rate of 2% instead of 1% for "normal" sized smolts, and the residual rates were figured at 11% for the "normal" group and 29% for the larger size groups (estimates extracted from Chrisp and Bjornn 1978), the projected rate of adult returns would still be 37% greater for the large size smolts.

Although larger smolts might return as adults more successfully, there are both biological and economic factors that argue against the need or desirability of rearing larger smolts:

1. Hatchery capacities are based on total pounds of fish that can be reared, and increased steelhead smolt size reduces the number of fish that can be reared at each facility.

2. Higher rates of precocialism and residualism in larger steelhead reduce the number of smolts that migrate to the ocean.

3. If large numbers of steelhead residualize in the Salmon River drainage, they could compete with wild steelhead or chinook salmon (Oncorhynchus tshawytscha) parr for food and space, thereby, negatively influencing wild stocks.

These questions tend to complicate the future operation and success of LSRCP programs making it necessary to evaluate the performance of the larger smolts from the Hagerman Valley hatcheries. This two-year study is designed to examine different residualism and adult return rates for "normal" and "large" size steelhead releases. Also, intra- and inter-species interactions between residualized steelhead and wild fish populations in the upper Salmon River will be evaluated.

OBJECTIVES

To determine the effect of accelerated hatchery growth of steelhead on outmigration, precocialism, residual ism, and adult survival.

To determine survival and harvest rates of residualized steelhead in release areas.

To evaluate potential antra- and inter-species interactions between residualized steelhead and wild steelhead and chinook salmon stocks.

RECOMMENDATIONS

Reduce steelhead smolt residualism by releasing smolts which are less than 250 mm In length.

Select steelhead smolt release sites which are as low in the river system as possible while still allowing for sufficient adults to return to collecting facilities to propagate runs or preventing the straying of adults.

Maintain fishing regulations at steelhead smolt release areas that will maximize angler harvest of residualized steelhead.

STUDY AREA

To produce steelhead for the Salmon River drainage under the LSRCP program, adult steelhead will be trapped in the upper Salmon River at the Sawtooth Hatchery (1,440 RKm to the ocean) and on the East Fork Salmon River near Big Boulder Creek (1,405 RKm). Eggs from these adults will be eyed at Sawtooth Hatchery then shipped to Magic Valley Steelhead and Hagerman National fish hatcheries to be reared to smolt size by the following April. The majority of these smolts will be released near the adult traps to maintain a returning run of spawners.

In 1984, marked steelhead groups were released into the upper Salmon River 11 km south of Stanley, Idaho, and 4 km upstream from the Sawtooth Hatchery. To monitor residualized steelhead, 60 km of the Salmon River above and below the release site and the lower 10 km of Valley Creek were selected for angler surveys (Fig. 1). This section of the river meanders through the lower portion *of* the Sawtooth Valley and has a mean gradient *of* 5.4 m/km with the elevation at the release site being 1,980 m. Mean river discharge at the USGS gauge station below the mouth of the Yankee Fork during the 1984 water year was 34.7 cms (59 year average, 28.7 cms) (Harper et al. 1985). River substrate consists mostly *of* gravel and rubble, and most *of* the river areas are prime spawning areas for chinook salmon and steelhead. The entire study area is used as rearing habitat by both these anadromous

species. Major resident fish population includes mountain whitefish (Prosopium williamsoni), bull trout (Salvelinus confluentus), brook trout (Salvelinus fontinalis), cutthroat trout (Salmo clarki), sculpins (Cottus sp), and suckers (Catostomus sp).

METHODS

Hatchery Rearing

To evaluate the effect of smolt size on adult returns, two test groups of 40,000 Group A steelhead were reared at Hagerman National Fish Hatchery (HNFH) from eggs received from Pahsimeroi Hatchery in May 1983. One test group was reared in four raceways on demand feeders and allowed to achieve a "large" size of approximately 250 mm. The second "normal" group was reared in three raceways and feeding was restricted by hand feeding a predetermined amount of feed so that the fish were approximately 200 mm at release. Each group was identified by coded wire tagging and clipping the adipose and left ventral fins on January 4-10, 1984 (Duke 1985). The adipose fin clip was a mark for all hatchery steelhead in Idaho, and the left ventral fin clip indicated the presence of a coded wire tag. Half of each group were freeze branded on February 28 and 29, 1984, to identify the downriver movement of the smolts. Both groups of marked steelhead were released simultaneously into the upper Salmon River above the Sawtooth Hatchery

on April 16 and 17, 1984 (Table 1). An additional 601,200 Group A steelhead smolts from HNFH and Magic Valley Steelhead Hatchery (MVSH) were released at the same point from April 2 to May 3, 1984. These fish were reared using standard hatchery methods and were fed from demand feeders at HNFH and hand fed at MVSH. All fish received an adipose clip prior to release. Total numbers released were based on pond counts and kilograms of fish hauled. Prior to release, samples of fish from each group were individually measured (fork length) and weighed. Fork lengths were used due to the variability in the amount of erosion on the caudal fins. Condition factors (K) were calculated using Fulton's condition formula, $K = W/L^3 \times 100{,}000$, where W = weight (g) and L = fork length (mm). Comparison of fork and total length values can be made by using total length (mm) = fork length (mm) x 1.05 (Ted Bjornn, ICFRU, pers. comm.).

In addition to the steelhead smolts, 22,300 hatchery catchable rainbow trout (Salmo gairdneri) were released throughout the study area from June 27 to August 29, 1984. The catchables ranged in size from 10.8 to 5.7 per kilogram.

Residualized Steelhead Sampling

Steelhead smolts remaining in the release area in excess of a month were considered residualized fish. These fish were sampled throughout the summer to determine the numbers of residualized fish, length of time they remained in the system, dispersal from the release site, and size ranges of the residualized steelhead. Sampling methods consisted of electrofishing and snorkeling during low flow periods and a stratified random angler survey.

The stratified angler survey which was used to estimate angler effort began with the opening of the fishing season on May 26 and continued through September 14, 1984. The survey was stratified by four-week intervals, by day type (weekday, weekend, and holiday), and by stream location. Weekends which occurred in conjunction with a holiday were considered as holidays. Within each interval, 50% of the weekends, 40% of the weekdays, and all holidays were selected as count days. Although initial count days were randomly selected, at least two days were counted together to offset travel costs. Each day was portioned into four equal count periods, and four counts were conducted over each two-day period. Count periods were selected so that each different period type (early morning, late morning, afternoon, evening) received one count during the two-day period. Counts were made by driving along the length of the study area and counting angler vehicles. Vehicles in campgrounds were not counted unless a party was

observed fishing. Calculations of effort and harvest for each interval was calculated using the method described by Rieman (1983) with a modification for vehicle counts (Rieman, IDFG, pers. comm.). Mean angler vehiclelday for each study section In each interval was calculated as:

$$\bar{Y}_i = \frac{1}{N} \sum_{i=1}^{L} N_i \bar{Y}_i$$

Where: N_i = the number of days per day type i.

$\bar{Y}_i$ = the mean number of angler vehicles per day type i.

N = the total days in the interval (28).

The variance was estimated as:

$$\hat{V}(\bar{Y}_i) = \frac{1}{N^2} \sum_{i=1}^{L} N_i^2 \frac{S_y^2}{n_i}$$

Where: n_i = the number of counts made for day type i.

S_y = the standard deviation for yi.

The total angler hours for each section in each interval were estimated as:

$$T_i = \bar{Y}_i \cdot \bar{A}_i \cdot D_i$$

with variance:

$$\hat{V}(T_i) = (D_i \cdot \bar{A}_i)^2 \hat{V}(\bar{Y}_i)$$

Where: $\bar{A}_i$ = the mean anglers per vehicle for the interval.

D_i = the total daylight hours in the interval.

The total effort for Interval and for the season was estimated as the sum of the study sections and the sum of the intervals.

Harvest rates and total harvest for residualized steelhead and other trout were estimated following the methods outlined by Rieman (1983).

Dispersal of residualized steelhead from the release site was monitored by dividing the angler survey into nine survey sections covering 60 km of the Salmon River above and below the release site and

on the lower portions of Valley and Alturas creeks (Table 2). Survey section boundaries were arbitrarily selected based on easily recognized features and fishing regulation boundaries.

Additional information on size and movement was collected by snorkeling and electrofishing in July and August. Five transects were selected in the main river and snorkeled by two observers on July 30 and 31, 1984. Each observer made two downstream passes through the transect, once along the shoreline and once in the middle of the river, with a ten minute interval between each pass. The highest counts for each species along the shore were averaged with the highest counts from the middle of the river to provide an overall count for each transect. Residualized steelhead and hatchery catchables were counted together as hatchery rainbow trout.

Two small tributary streams were sampled by electrofishing on August 13, 1984, to check for residualized steelhead. The streams were sampled using a Coffelt BP-3 backpack shocker. Sections of the main river were electrofished on August 14 and 15, 1984.

The river was sampled by placing a Coffelt VVP-2C shocker and a gas-powered generator in a drift boat and making one pass in a downstream direction. Only trout larger than 100 mm were collected and counted.

All residualized steelhead sampled were examined for marks, weighed, and measured. Stomachs were collected from a portion of the fish to determine feeding habits, and sex and maturity were recorded. Snouts were collected from those LV clipped fish which were not Identified with a freeze brand, and the coded wire tag was recovered to identify "large" and "normal" smolts.

Additional samples of residuaiized steelhead smolts were collected in the East Fork Salmon River on May 1, July 2 and 3, and September 17 18, and 19, 1984. The fish were sampled by fly fishing.

RESULTS

Size and Numbers Released

From April 2 to May 3, 1984, a total of 681,334 Group A steelhead smolts were released in the upper Salmon River above the Sawtooth Hatchery. The 40,322 "large" and 39,763 "normal" steelhead were released on April 16 and 17, 1984. The mean fork lengths of the four groups of steelhead released in the Salmon River were: "large" - 264.6 mm, "normal" - 201.5 mm, HNFH general - 242.5 mm, and MVSH general -

247.2 mm (Table 3, Fig. 2). The mean weight of the individually measured experimental fish were the same as the average pond count weights for the "large" - 216.9 g (4.6/kg) and "normal" groups - 85.7 g (11.7/kg). The general release pond counts at HNFH averaged slightly smaller at 5.6/kg compared to the 5.8/kg (172.3 g) observed In the measured sample. The general release pond count from MVSH were slightly higher at 5.7/kg compared to 5.5/kg (182.9 g) in the sample.

The mean lengths and weights for the general release from HNF and MVS hatcheries were not significantly different at the 95% level from each other, but there was a significant size difference in the "large" and "normal" groups of released steelhead. The mean condition factor of the four groups showed no significant difference between the HNFH general release (K=1.09) and the "large" release (K=1.10)(Table 3). The MVSH general release had a significantly higher condition factor (K=1.12) than the other groups due to hand feeding and less crowded raceways. The "normal" group had a significantly lower condition factor (K=1.00) due to the restrictive diet to retard their release size.

Residualized Steelhead

Angler Harvest

Anglers harvested an estimated 54,500 residualized steelhead (8.0% of smolt release) in the upper Salmon River during the May 26 to September 15, 1984 survey (Table 4, Appendix A-E). Most of the harvest occurred in the first eight weeks of the season with 54.4% of the fish being caught in the first four-week interval, 31.5% in the second, 13.1% in the third, and 1.0% in the fourth interval. No steelhead were observed in the catch in the main harvest area (sections U2-D4) after August 15, 1984. Steelhead were being caught in limited numbers in Valley Creek and in the Saffron River above Hell Roaring Creek (sections V and U3) in September when the census ended. These two stream sections had been closed to angling from July 7 through August 31, 1984.

Residualized steelhead accounted for 78% of the total number of fish harvested in the upper Salmon River followed by hatchery catchable rainbow trout (19%). Brook, bull, wild rainbow and cutthroat trout, and mountain whitefish combined accounted for 3% of the harvest. In the first interval, steelhead made up 98% of the harvest, with the percentage then decreasing to 87%, 50%, and 10% in the following three intervals, respectively. The mean overall catch rate for residualized

steelhead was 0.9 fish/hour. Catch rates declined in each of the successive census intervals as follows: 1.8, 0.9, 0.4, and 0.1 residualized steelhead/hour.

Residualized steelhead from the "large" and "normal" marked groups made up 9.7% of the residualized harvest compared to 11.8% of the release. Based on the percent of the catch which was marked, an estimated 5,700 LV clipped steelhead were harvested, which was 7.1% of the marked steelhead released. Freeze brands and coded wire tag recoveries showed that 92.1% of the marked fish in the angler harvest were from the "large" release group. An estimated 5,250 "large" steelhead, or 13.0% of the release, were harvested while only 450 "normal" steelhead (1.1% of release) were kept by anglers in the upper Salmon River.

Thirty-four percent of the residualized steelhead (RS) harvest occurred in section D1 immediately downstream from the release area with 23% of the harvest occurring at the release site; although, based on catch per kilometer of river, the 0.2 km release section (R) had a catch rate 16 times (62,515 RS/km) greater than section D1 (3,926 RS/km) (Table 5). The section with the third highest catch rate (1,598 RS/km) was U1, immediately upstream from the release site. Most of the fish harvested in section U1 were caught in the lower 1 km of the section which was adjacent to the release area. The harvest rate continued to decrease rapidly in the upstream direction with stream sections U2 and U3 having a harvest rate of 119 and 22 RS/km, respectively. Moving downstream from the release site and section D1,

the harvest rate decreased rapidly to 586 RS/km in section D2 then leveled off to 424 and 438 RS/km in sections D3 and D4, respectively. Valley Creek, with a harvest rate of 62 RS/km, had the second lowest harvest rate following section U3. Although these two sections U3 and V) were closed to fishing for July and August, which reduced the total steelhead harvest estimate, only a few fish were caught after September 3, 1984.

Snorkeling

During snorkeling, residualized steethead and hatchery catchable counts were combined due to their similar appearances. These counts showed an average of 2.8 hatchery rainbow trout per 100 m of river with the highest numbers occurring in the release area (7.4/100 m) and in section D1 (5.7/100 m) (Table 6). it was felt that most of these rainbow trout were hatchery catchables due to hatchery releases in the transect areas prior to snorkeling and the general appearance of the fish. Most hatchery rainbow trout and residualized steelhead were observed in the deeper portions of the pools. Who rainbow trout were mostly young-of-the-year or 1+ fish. The greatest concentration (18.1/100 m) of wild rainbow trout was in lower portions of the study area in the canyon habitat which consisted of large, deep pools; fast runs; and large boulders. These wild rainbow trout were mostly using the pocket water behind boulders along the shoreline. In the four upper snorkeling transects in the valley area, wild rainbow trout averaged 1.2 fish per 100 m.

Juvenile chinook salmon were the most numerous saimonid observed by snorkeling and averaged 26.7 fish per 100 m. They were most abundant in the uppermost transect where 48.3 chinook salmon per 100 m of river were observed. They were mostly seen in schools along the shoreline if there was vegetation such as willows (Salix sp) that provided cover, or in the low velocity portion of pools. When chinook salmon were observed in pools, they were generally higher in the water column than other species. Chinook salmon were observed in fair numbers in all transects except transect 4 in section D3. Very few fish were observed in this transect, which was in a long, shallow run with mostly a smooth rubble substrate. Except for a few mountain whitefish, all fish in this section were observed along the bank in the few places where there was some overhanging cover.

Eiectrofishing

Intermittent sampling with a drift boat electrofisher on the Salmon River on August 14 and 15, 1984, collected a total of 35 residualized steelhead, 39 hatchery catchable rainbow trout, and 26 wild rainbow trout. Sampling was conducted in the lower half of sections U2 and D3 and in sections U1, R, and D1 and was limited to shocking pools and portions of deeper runs. Only three residualized steelhead were collected above the release site with 31 steeihead being sampled between the release site and the lower end of section D1. One

steelhead was sampled in section D3. Four (11.4%) of the steelhead were from the large size release group, and one (2.9%) was from the normal size release group. Mean length of the residualized steelhead was 238.7 mm compared to 229.2 mm for the hatchery rainbow trout and 132.2 mm for the wild rainbow.

Electrofishing in two tributary streams on August 13, 1985, did not sample any residualized steelhead. On Decker Creek, a 400 m sample at the mouth of the stream collected 13 chinook salmon, 7 wild rainbow trout, and 18 brook trout. Several sculpin were also observed. Mean length of the chinook salmon was 74.3 mm, wild rainbow trout length was 102.4 mm, and brook trout length was 100.6 mm. In Fourth of July Creek, shocking a 400 m section of stream above the mouth resulted in 56 chinook salmon, 27 wild rainbow trout, 1 hatchery rainbow trout, 2 brook trout, 2 bull trout, 1 mountain whitefish, and numerous sculpin being collected. Mean lengths of the fish were as follows: chinook salmon - 79.5 mm, wild rainbow trout - 98.3 mm, hatchery rainbow trout - 196 mm, brook trout - 120.0 mm, bull trout - 226.5 mm, and mountain whitefish - 241 mm.

Size and Condition

The mean length of angler-caught residualized steelhead in the upper Salmon River in 1984 was 281.3 mm. Sizes of angler-caught steelhead In the normal, large, and unmarked groups were all significantly larger than at release with the mean length of the residualized smolt groups being 238.0, 297.2, and 280.3 mm, respectively (Table 7, Fig. 3). The percent of smolts in the 250+ mm size classes increased from 43.7% at release to 83.6% in the anglers' creel. There was some evidence that anglers were selecting larger fish either by fishing method (bait 73.8%, lure 18.5%, fly 7.7%) or by releasing smaller fish. The mean size of steelhead caught by project personnel. while fly fishing was 268.6 mm (error bound 9.5 mm, N=48). The mean length of residualized steelhead sampled by electrofishing in August was 238.7 mm (error bound 22.0, N=35).

Although the mean lengths of angler-caught steelhead were larger than when released, the size decreased significantly as the season progressed. The average length of residualized steelhead caught in interval 1 was 287.3 mm decreasing to 278.1 mm in interval 2 and 263.4 mm in interval 3 (Table 8). Residualized steelhead size increases in interval 4 (293.0 mm) were biased by small sample size (N=23) and the fish being caught in the two river sections which had been closed to angling from July 7 through August 31, 1984.

Residualized steelhead were larger than the average hatchery catchable rainbow trout caught in the upper Salmon River in 1984. Hatchery catchables averaged 227.7 mm, wild rainbow trout - 151.3 mm, brook trout - 202.4 mm, bull trout - 283.7 mm, juvenile chinook salmon - 93.5 mm, and mountain whitefish - 317.1 mm (Table 9).

The mean condition of residualized steelhead decreased from 1.10 at the time of release in April to 0.94 in July and increased slightly in August to 0.98 (Table 10). A decrease in condition is most evident when individual size classes are examined, such as the 325+ mm group in which condition decreased from 1.24 in April to 0.99 in July. The average condition by size class decreased 13.3% from April to June and 3.9% from June to July.

Harvest by Size Class

An evaluation of steelhead smolt residualism and the resulting harvest of residualized steelhead by anglers in the upper Salmon River was made by expanding the length frequencies of samples to the total release and estimated harvest (Table 11). Of the estimated harvest of 54,500, 83.7% were residualized steelhead in excess of 250 mm in length, while only 43.4% of the release were in this size group. The percent of released steelhead smolts in individual 20 mm size classes harvested by anglers remained relatively low (0-3.1%) until steelhead smolt size reached 250 mm, at which point, the percent of harvest began

to. increase sharply until an estimated 74% of fish in the 330+ size class were harvested (Fig. 4).

Food Habits

Residualized steelhead were actively feeding on available natural food items (Table 12). Tricoptera were the most common item and were found in 79% of the steelhead stomachs followed by Ephemoptera (35%), Plecoptera (22%), and Diptera (16%). Coleoptera, Hymenoptera, Annelida, and fish were found in less than 10% of the stomachs. Fish which were found in 4% of the stomachs consisted of Cottus sp, one salmonid, and pectoral fin rays from fish which had been cleaned by anglers and discarded in the river. Fish were eaten mostly by steelhead which were larger than 250 mm.

Sex and Maturity

Steeihead smolts which were caught in the upper. Salmon River in 1984 were predominantly male. Samples taken by fiyfishing on April 30, 1984, during the release period in the upper Salmon River found that 77.8% (28) of the steelhead caught were males with 50% (14) being

sexually mature. None of the females caught were mature. In the East Fork Salmon River on May 1, 1984, 100% (41) of the group B steelhead smolts sampled were males, with 12.2% being mature. Of the 211 angler-caught fish examined from the upper Salmon River during May 26 through September 15, 1984, 83.4% were male compared to 80.4% in 1983 (Partridge 1985). None of the females examined in the 1984 creel were mature, while 29.0% of the males were mature, which was similar to the 28.4% of mature males In 1983.

East Fork Salmon River

Additional sampling was conducted on the East Fork Salmon River where 412,300 group B steelhead smolts were released in March and April, 1984 (Table 1). Sampling consisted of angling in May, July, and September and snorkeling in September. Steelhead smolts caught in May, 1984, shortly after their release averaged 240.0 mm in length and had a condition factor (K) of 0.98 (Table 13). In July, 1984, residualized steelhead caught in the East Fork Salmon River averaged 250.7 mm with a K value of 0.99. The mean length and condition of residualized steelhead then decreased to 238.7 mm and 0.92, respectively, in September, 1984. Wild rainbow trout caught in September averaged 181.2 mm and had higher condition factors (K=1.06) than the residualized steelhead.

Angling pressure was light on the East Fork Salmon River, which resulted in numerous residualized steelhead remaining in the river near the release area Into September. -Department angling catch rates during September 17-19, 1984 averaged 7.8 residualized steelhead and 0.9 wild rainbow trout per hour. Snorkeling counts just below the release area observed 67.5 residualized steelhead, 5.0 Juvenile chinook salmon, 0.5 bull trout per 100 m of river. At the mouth of Herd Creek, 15 kilometers downstream from the release area, 6.0 residualized steelhead, 7.0 wild rainbow trout, 40.0 juvenile chinook salmon, 0.4 cutthroat trout, and 1.0 bull trout per 100 m were observed. In Herd Creek, 2 km above the mouth, 3.0 residualized steelhead, 5.0 wild rainbow trout, and 37.5 Juvenile chinook salmon per 100 m were observed by snorkeling.

DISCUSSION

The estimated harvest of 54,500 residualized steelhead in the upper Salmon River in 1984 would be considered as a minimum estimate of steeihead smolts which remained in the river. The actual estimate of the harvest may be low due to the method of estimating angler effort by counting vehicles from the highway. Counts in sections U2, U1, D2, and D3 were most likely lower than the actual effort due to difficulties in observing the river from the highway and in determining whether there

were anglers from the numerous camping areas. If the estimate in these areas are 10% low, then the estimated harvest would be increased by nearly 2,000 residualized steelhead.

Due to the heavy angling pressure (7.8 hr/km/d) and high catch rate (0.9/hr) for residualized steelhead on the upper Salmon River, it seems likely that most of the residualized steelhead were caught by anglers. Harvest estimates of hatchery catchable rainbow trout have been reported at 55 to 63% in the Portneuf River, Idaho (Helmer et al. 1985) and have ranged up to 77% in Mill Creek, Oregon (Moring 1982). During 1984, 59% of the hatcher catchable rainbow trout were harvested in the upper Salmon River with fish still being caught at the end of the census. Hatchery catchables were also distributed over a larger area than the steelhead. If 70% of the residualized steelhead were harvested by anglers, approximately 77,800 steelhead smolts (11.4% of release) remained in the upper Scrnon River.

If angling pressure is sufficient, most residualized steelhead are harvested within a few weeks of the opening of the fishing season. In the upper Salmon River, 86% ct the harvest occurred In two months time, significantly reducing the number of fish remaining in the river. In the East Fork Salmon River, where there is a combination of light angling pressure and closures during July and August, the numbers of residualized steelhead remained high into the fall.

Angler selection for larger fish during June and early July, when catch rates were high, would have caused an underestimate in the number of smaller (<250 mm) steelhead which residualized in the upper Salmon River. Due to the majority of the angling effort being by bait fishermen (74%), mortalities of fish which were caught and released could be expected to range from 20 to 50% (Mongillo 1984). This mortality would result in the loss of smaller fish during the early part of the season before anglers began to keep the small fish as the catch rates decreased as was evident by the decline in the mean size of residualized steelhead as the season progressed. Estimates of numbers of fish released by anglers were not made in 1984.

Although the number of smaller residualized steelhead including the normal-size group is underestimated, it is doubtful that the low estimate would significantly decrease the difference between the normal and large study groups. Even if the estimate of normal-sized smolts which were harvested was doubled, only 2% of the release would have residualized and been harvested compared to 13% for the large-size group. if the harvest estimate of normal-size residualized steelhead were doubled (900), the large to normal-size harvest ratio (5.8:1) would be similar to ratio (5.2:1) observed in 1983 when only marked groups (107,300 total) were released in the upper Salmon River, resulting in few fish being released by anglers (Partridge 1985). As

in 1983, the harvest of residualized smolts in the main portion of the study area had decreased to zero by mid-August indicating the near total removal of residualized steelhead from the system.

Most steelhead smolts which residualized in the upper Salmon River remained near the release area or moved downstream, which is also typical of hatchery catchable rainbow trout (Clady 1973). Upstream movement of more than a kilometer was limited to relatively few fish as was also the case for movement into major tributaries such as Valley Creek and Herd Creek on the East Fork Salmon River. Since most residualized steelhead do not move upstream, it would be beneficial to select smolt release areas which are as low in the river system as possible and yet still be high enough to prevent the wandering of returning adults and guaranteeing sufficient returning adults to the trap to sustain runs.

At normal stocking rates of hatchery catchable rainbow trout (which residualized steelhead would resemble), it cannot be ascertained through the literature if the competitive interactions between hatchery and wild stocks is detrimental to wild fish (Ciady 1973). However, at high stocking rates, hatchery catchables can reduce the survival of wild fish (Petrosky 1984). Due to the large numbers of steelhead smolts which are being released into the upper Salmon River, the potential for competition between residualized steelhead and wild fish is high. The estimated 77,800 smolts which remained in this portion of the upper river caused a population density of hatchery fish

considerably greater than would normally be found as the result of the stocking of hatchery catchables. Since these residuallzed steelhead are actively feeding, they have the potential of significantly reducing the available food for wild fish as well as displacing the smaller wild fish (Allen 1969; Petrosky 1984).

Factors which reduce the potential competition between residualized steelhead and wild fish include current low populations of wild fish, timing of releases, and spatial differences in habitat selection. The combination of record low numbers of adult chinook salmon returning to the Salmon River, and the collection of these adults at the Sawtooth Hatchery (Pollard 1985), have reduced numbers of juvenile chinook salmon in the Salmon River in Stanley basin. In the future, as chinook salmon runs are reestablished through hatchery production and improved migration conditions, the numbers of juvenile chinook salmon in the river will be Increased from current levels. Due to the spring releases of steelhead smolts, the potential interactions between residualized steelhead and chinook salmon will only occur as the chinook salmon fingerlings begin to move into pool habitat in the main river, since age 1 chinook salmon migrate out of the upper Salmon either in the fall or in the early spring as smolts. In areas with heavy fishing pressure, such as the upper Salmon River, most of the residuallzed steelhead are removed by mid-July, and the interactions are limited to a few weeks. In the East Fork Salmon River, where fishing pressure is light, interactions between residualized steelhead

and juvenile chinook salmon continue throughout the summer. Due to the spatial segregation between the species (Chapman and Bjornn 1969), with the chinook salmon preferring to be higher in the column in deep water than the steelhead, most of the competition would be for food in these low productivity streams.

Although steelhead residualism can be reduced by limiting the size of smolts and the potential interactions with wild fish reduced, the potential improved survival of large smolts may be more important in areas where interactions with wild fish can be minimized. Adult returns of the marked normal and large size smolt releases will be evaluated in the future as part of the Lower Snake River Compensation Plan Evaluation Project.

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Table 1. Number and size of steelhead smolts released into the upper Salmon and East Fork Salmon rivers in 1984. Numbers and size based on hatchery pond counts.

Hatcher	Steelhead stock	Release site	Date released	Number released	Number per kg	Number[a] marked	Mark
HNFH[b]	A	Salmon	4/16-17/84	40,322	4.6	40,322 (21,146)	CWT 15-10-29 FB LA-J-1
HNFH	A	Salmon	4/16-17/84	39,763	11.7	39,763 (22,238)	CWT #5-10-28 FB LA-J-3
HNFH	A	Salmon	4/2-5/3/84	397,079	5.6	0	--
MVSH[c]	A	Salmon	4/2-25/84	204170	5.7	0	--
TOTAL		Salmon		681,334			
HNFH	B	EFSR	3/27-4/13/84	393,452	9.7	0	--
MVSH	B	EFSR	4/25/84	18,860	9.0	0	--
TOTAL		EFSR		412,312			

[a]All hatchery steelhead were also marked with an adipose clip.
[b]Hagerman National Fish Hatchery.
[c]Maglc Valley Steelhead Hatchery.

Table 2. Location, length, and gradient of angler harvest survey study sections on the upper Salmon River.

Study section	Section boundaries	Length (km)	Gradient m/km
U3[a]	Pettit Lake Road on Alturas Creek and county line bridge to Hell Roaring Creek	6.1	3.5
U2	Heil Roaring Creek to Williams Creek	11.2	5.6
U1	Williams Creek to 100 m above release site	3.9	3.5
R	100 m above to 100 m below release area	0.2	4.0
O1	100 m below release area to steel bridge	4.7	4.0
D2	Steel bridge to Valley Creek	10.8	6.8
D3	Valley Creek to Basin Creek	12.6	3.6
D4	Basin Creek to Sunbeam Dam	8.1	5.6
V	Valley Creek from Stanley Lake Creek to the Salmon River	9.7	3.6

[a]Includes both lower Alturas Creek and a portion of the Salmon River.

Table 3. Size of group A steelhead smolts release into the upper Salmon River above the Sawtooth Hatchery, April 2 — May 3, 1984. Solid line indicates no significant difference between means.

Group	Number sampled	Mean	Error bound (95%)	Minimum	Maximum
Fork Length (mm)					
"Large"	408	264.6	3.37	152	358
"Normal"	402	201.5	2.19	143	268
General, HNFE[a]	418	1242.5	4.18	101	363
General, MVSH[b]	325	1247.2	4.07	115	332
Weight (g)					
"Large"	408	216.9	8.84	40	570
"Normal"	402	85.7	3.06	20	205
General, HNFH	418	1172.3	9.12	5	645
General, MOH	325	1182.9	9.20	15	500
Condition (k)					
"Large"	408	11.101	0.009	0.82	1.50
"Normal"	402	1.005	0.006	0.68	'1.20
General, HNFH	418	11.086	0.010	0.48	1.75
General, MVSH	325	1.126	0.009	0.71	1.39

[a]Hagerman National Fish Hatchery.
[b]Magic Valley Steelhead Hatchery.

Table 4. Estimated total angler hours, harvest and harvest rate for the upper Salmon River, May 26 through September 15, 1984. Error bounds (95%) are In parentheses.

Census Interval	Angler hours	Resldduallzed steelhead	Rainbow trout		Bull trout	Brook trout	Mountain whitefish	Cutthroat trout	Total	Harvest rate	
			Hatchery	Wild						RS/hr.	Fish/hr.
5/26-6/22	16,690 (2,201)	29,680 (7,055)	75 (101)	89 (162)	100 (151)	374 (412)	30 (59)	0	30,347 (7,086)	1.78	1.82
6/23-7/20	19,058 (2,312)	17,145 (3,577)	1,739 (1,280)	0	404 (405)	360 (480)	76 (230)	48 (136)	19,772 (4,022)	0.90	1.04
7/21-8/17	16,009 (2,353)	7,116 (2,675)	6,700 (2,937)	168 (297)	75 (308)	72 (81)	93 (188)	0	14,223 (3,840)	0.44	0.89
8/18-9/15	7,086 (1,406)	547 (491)	4,619 (2,920)	68 (123)	32 (62)	50 (67)	124 (237)	53 (226)	5,493 (3,171)	0.08	0.78
TOTAL	58,842 (4,207)	54,488 (8,364)	13,132 (4,336)	325 (360)	610 (534)	856 (641)	323 (384)	101 (264)	69,836 (9,549)	0.93	1.19

Table 5. Estimated harvest per kilometer of river for residualized steelhead in the Salmon River, 1984.

Stream section	Length (km)	Residualized steelhead harvested per kilometer of river 5/26-6/22	6/23-7/20	7/21-8/17	8/18-9/15	Total	Estimated harvest per section
U3	6.1	0	0	closed	22	22	135
U2	11.2	7	95	18	0	119	1,334
U1	3.9	709	567	322	0	1,598	6,233
R	0.2	47,740	12,770	2,005	0	62,515	12,502
D1	4.7	1,762	1,424	740	0	3,926	18,453
D2	10.8	285	194	108	'0	586	6,333
D3	12.6	258	150	17	0	424	5,346
D4	8.1	308	80	51	0	438	3,551
V	9.7	19	0	closed	42	62	600
TOTAL	67.3	441	255	138	8	810	54,488

Table 6. Mean number of fish per 100 m observed by snorkeling in the Salmon River, July 30-31, 1984.

Transect	Location	Chinook salmon	Rainbow trout		Mountain whitefish	Bull trout	Sucker	Sculpin
			Hatchery[a]	Wild				
1	112	48.3	0.2	1.0	27.7	0.2	P	P
2	R	27.5	7.4	1.7	5.3	0.2	P	P
3	D1	27.8	5.7	0.9	13.1 .	0	P	P
4	D3	3.3	0.2	1.1	2.8	0.6	A	A
5	D4	26.2	0.5	18.1	5.7	0	A	A
Average		26.7	2.8	4.6	10.9	0.2		

[a]includes both residuailzed steelhead and hatchery catchables.

Table 7. Size of residualized steelhead in the upper Salmon River in 1984.

	Size at release			Angler catch			t value
	Mean length (mm)	Error bound (95%)	Sample size	Mean length (mm)	Error bound (95%)	Sample size	
Normal	201.5	2.2	402	238.0	19.8	10	5.12[a]
Large	264.6	3.4	408	297.2	5.2	116	9.44[a]
Unmarked	244.5	3.0	743	280.3	2.0	1,428	12.05[a]

[a]Significant at the 95% level.

Table 8. Size of angler-caught residualized steelhead in the upper Salmon River in each census interval during 1984.

Interval	Date	Mean length (mm)	Error bound (95%)	Sample size
1	May 26–Jun 22	287.3	2.3	787
2	Jun 23–Jul 20	278.1	3.1	561
3	Jul 21-Aug 17	263.4	7.0	179
4	Aug 18-Sep 14	293.0	13.4	23[a]

Comparisons	Mean difference	q
4 vs. 3	29.6	5.264[b]
4 vs. 2	14.9	2.760
4 vs. 1	5.7	1.062
1 vs. 3	23.9	11.348[b]
1 vs. 2	9.2	6.562[13]
2 vs. 3	14.7	6.734[b]

[a]All fish were from river sections which had been closed from July 7 through August 31, 1985.
[b]Significant at the 95% level.

Table 9. Length frequencies of game species other than residualized steelhead in the upper Salmon River, 1984. Samples are combined from anglers' creel census and departmental sampling.

Size class (mm)	Rainbow trout		Brook trout	Bull trout	Chinook salmon	Mountain whitefish
	Hatchery	Wild				
50-59					1	
60-69		1			1	
70-79					5	
80-89					14	
-90-99					11	
100-109		1			2	
110-119		3			1	
120-129		6			1	
130-139	1	10			1	
140-149		9				
150-159		3	2			
160-169	4	5	1			
170-179	8	1	4		1	
180-189	13	1	2	1	1	
190-199	23	1	3		1	
200-209	25	2	3	1		
210-219	32	2		2		
220-229	53	2		1		
230-239	27	2				1
240-249	31		2			
250-259	29		2			1
260-269	15		1	1		
270-279	4			1		1
280-289	9		1	1		
290-299	6					1
300-309	3			2		2
310-319	2					2
320-329	1					1
330-339	1			1		2
340-349				2		1
350-359						
360-369						
370-379				1		
380-389						
390-399						
400-409						
410-419				1		1
420-429						1
430-439	1					
TOTAL	288	49	21	15	40	14
Mean length	227.7	151.3	202.4	283.7	93.5	317.1
95% error bound	4.0	10.4	16.5	35.7	9.0	28.7

Table 10. Condition"(K) of steelhead smolts at release and after residualizing in the upper Salmon River in 1984. Sample sizes are in parentheses.

Size class (mm)	April	June	July	August
<200	1.05 (84)	0.88 (3)	0.87 (11)	0.90 (2)
200-224	1.08 (124)	0.90 (18)	0.93 (16)	-- (0)
225-249	1.09 (200)	0.98 (35)	0.91 (25)	1.01 (2)
250-274	1.11 (173)	1.01 (77)	0.93 (39)	1.01 (8)
275-299	1.14 (98)	1.01 (153)	0.96 (44)	0.97 (10)
300-324	1.18 (53)	1.02 (134)	0.97 (22)	0.89 (3)
>324	1.24 (11)	1.04 (50)	0.99 (16)	1.02 (5)
Mean	1.10 (743)	1.01 (470)	0.94 (173)	0.98 (30)

Table 11. Estimated Numbers of group A steelhead smolts in individual size classes released into and harvested from the upper Salmon River in 1984. Percent is shown in parentheses.

Size classes (mm)	Steelhead smoits released		Residualized steel head harvested		Percent of release-harvested
<150	12,606	(1.8)	0	(0)	0
150-169	14,786	(2.5)	240	(0.4)	1.6
170-189	38,633	(5.7)	556	(1.0)	1.4
190-209	67,744	(9.9)	1,400	(2.6)	2.1
210-229	112,933	(16.6)	2,389	(4.4)	2.1
230-249	137,207	(20.1)	4,282	(7.9)	3.1
250-269	125,516	(18.4)	7,637	(14.0)	6.1
270-289	81,002	(11.9)	12,279	(22.5)	15.2
290-309	57,707	(8.5)	12,672	(23.2)	22.0
310-329	26,326	(3.9)	7,955	(14.6)	30.2
330-349	5,864	(0.9)	4,070	(7.5)	69.4
>349	1,010	(0.1)	1,008	(1.8)	99.8
Total[a]	681,334		54,488		8.0

[a]Totals are not exact due to rounding differences.

Table 12. Frequency of occurrence of food items in residuatized eteelheed stomachs from the upper Salmon River, 1984. Number of stomachs are in parenthssee.

	Pisces	Pleco.tern	Tricoptere	Ephemeroptere	Diptere	Coleoptere	H menoptere	Misc.[a]	Annelids	Empty
April (35)	0	0	91	23	8	0	0	8	0	8
June (79)	0	28	78	37	13	8	10	0	14	1
July (60)	5[b]	23	75	33	27	5	10	7	12	3
August (48)	12[a]	27	77	42	17	8	10	10	4	0
Total (222)	4	22	79	35	16	5	8	5	9	2
Size class (mm)										
<200(11)	0	9	91	27	38	0	18	9	18	9
200–224(29)	3	38	86	45	21	21	17	0	14	0
225–249(38)	0	18	79	37	0	5	10	5	6	3
250–274(44)	4	23	89	39	20	4	9	4	7	2
275–299(56)	4	23	78	34	27	2	7	9	5	4
>299 (44)	11	14	84	25	4	2	0	2	14	9

[a]Includes natural eggs, bait, terrestrial insects and vegetation.

[b]Cottid and eelmonid.

[c]Cottid and eelmonid bones (mostly pectoral rays from cleaned fish).

Table 13. Residualized group B steelhead sampled in the East Fork Salmon River by departmental angling in 1984. Error bounds (95%) are in parentheses.

	Residualized steelhead			Wild rainbow trout		
Date	Number	Mean length (mm)	k	Number	Mean length (mm)	k
May 1	41[a]	240.0 (9.3)	0.977 (0.030)	0	--	--
July 2-4	48	250.7 (8.9)	0.990 (0.026)	0	--	--
September 17-19	101	238.7 (7.0)	0.916 (0.022)	12	181.2 (14.8)	1.060 (0.063)

[a]Not classified as residualized since sampling was conducted just following release.

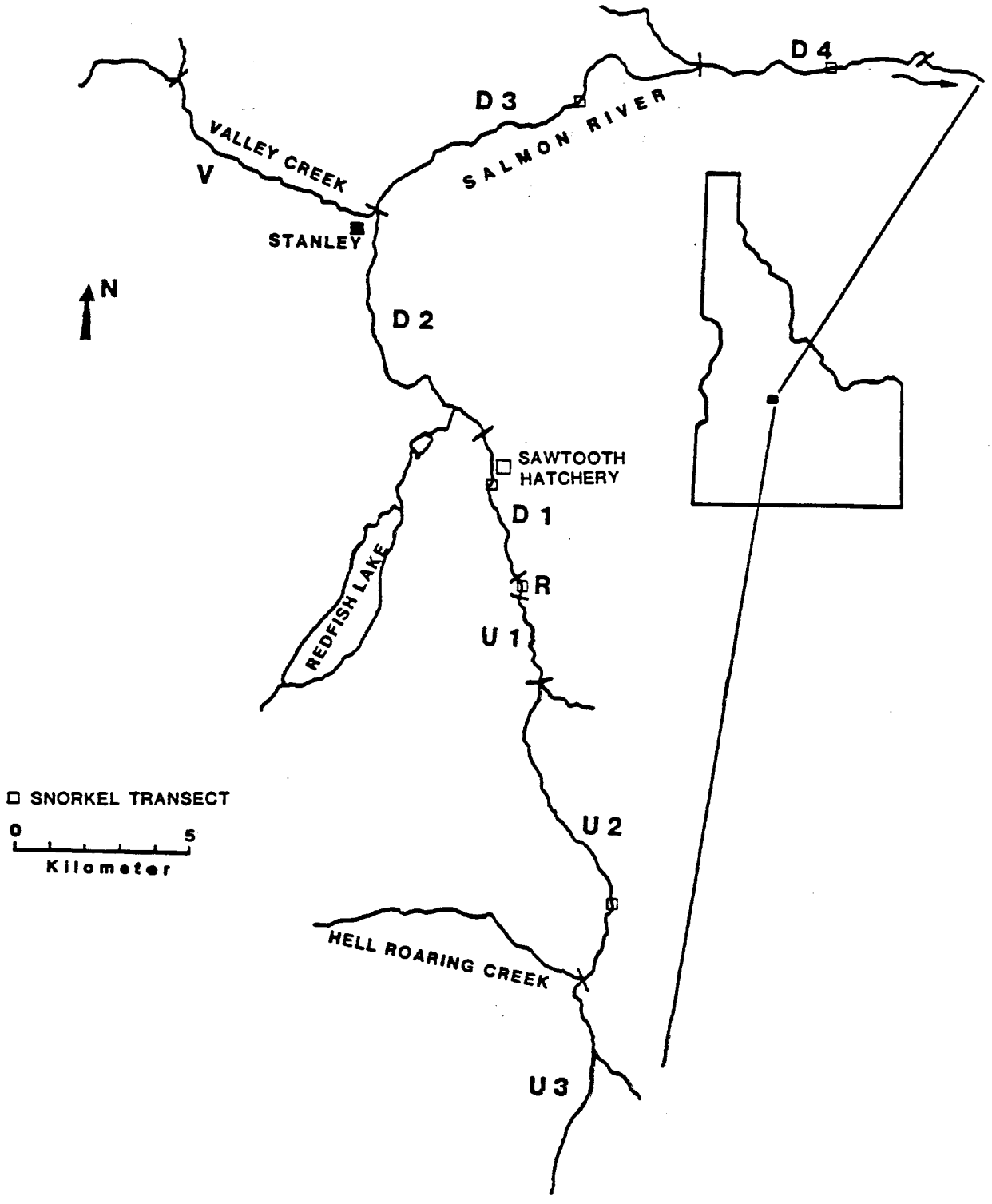

Figure 1. Angler survey study sections on the upper Salmon River.

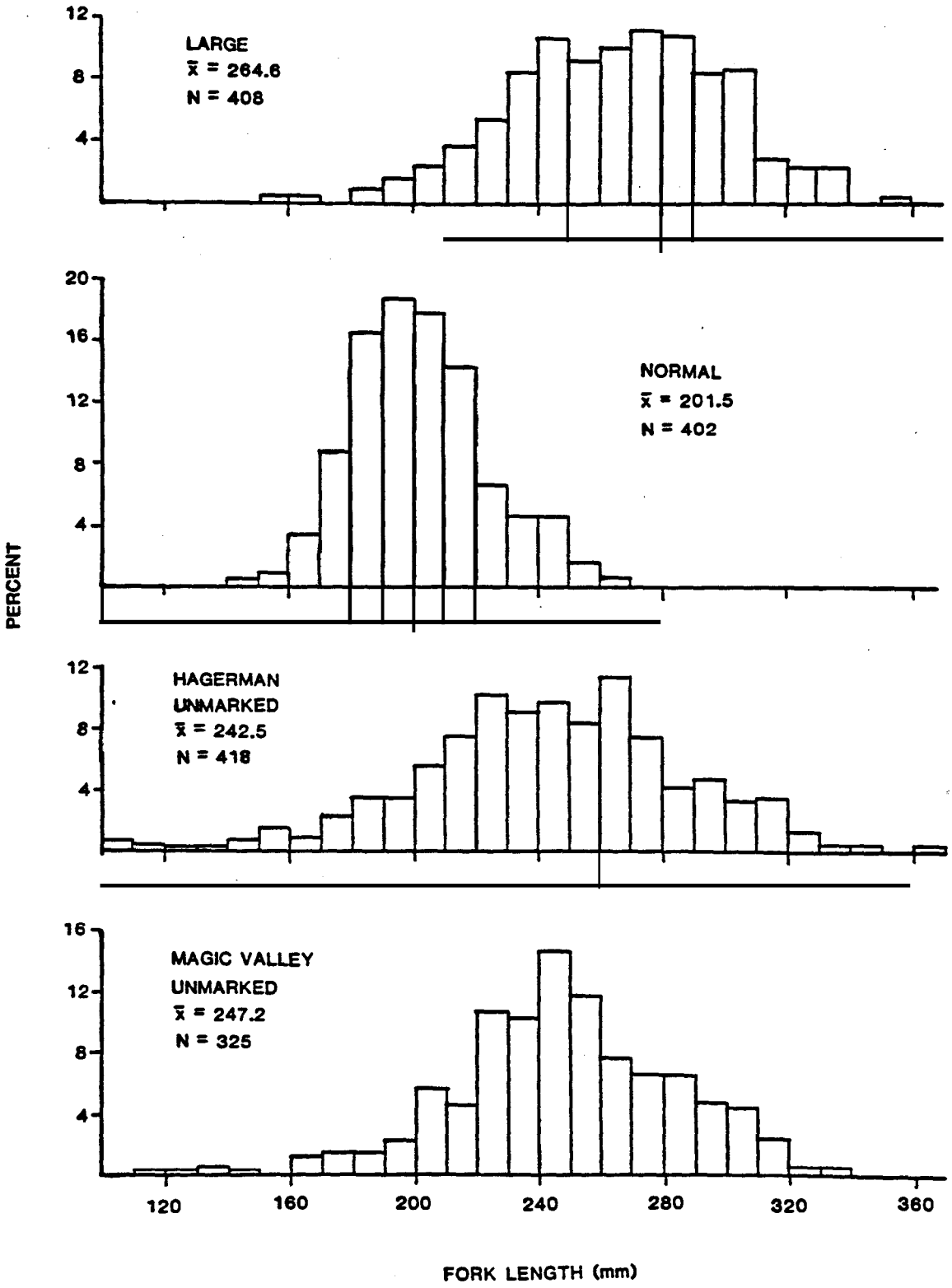

Figure 2. Length frequency of marked and unmarked steelhead smolts released into the upper Salmon River in 1984.

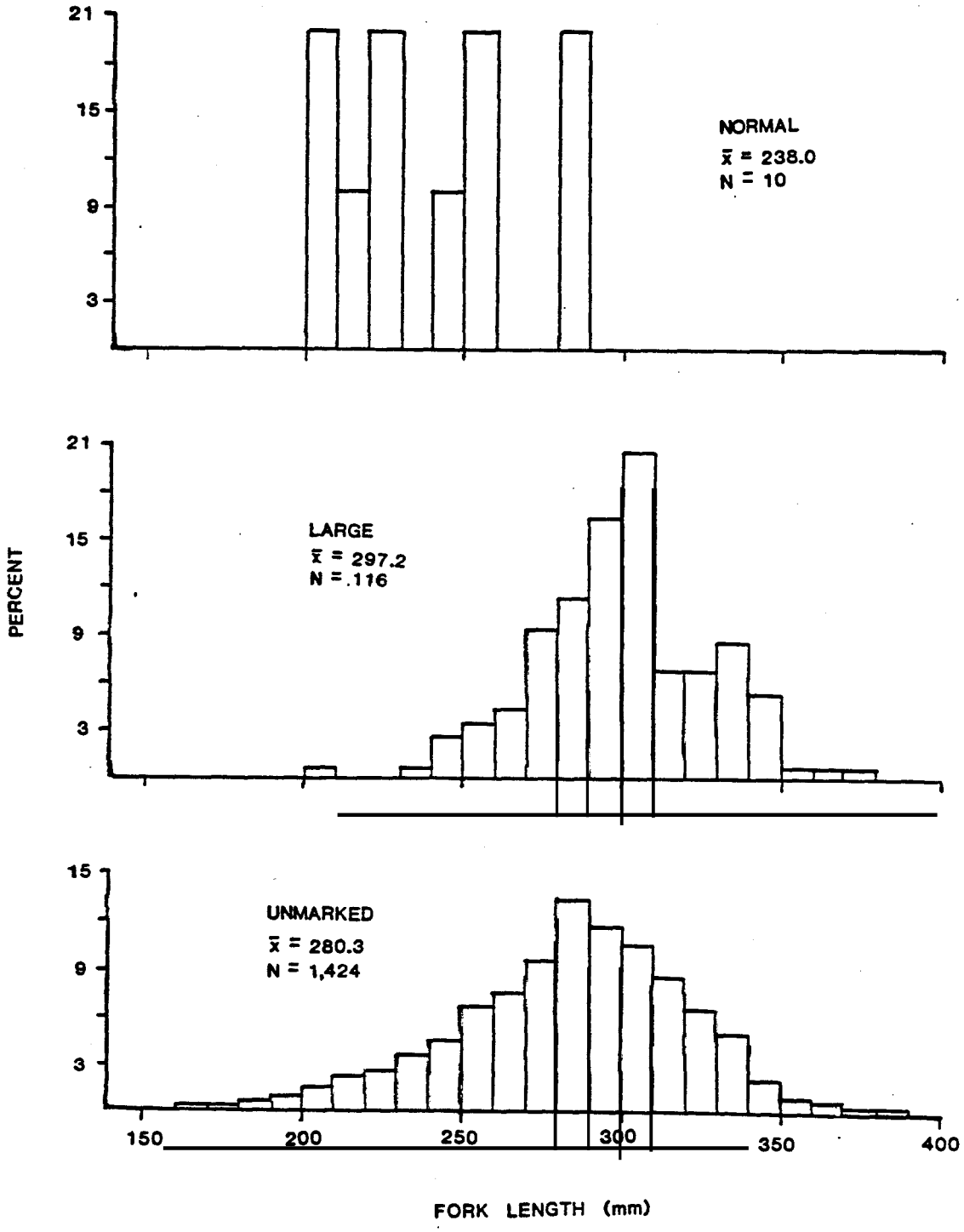

Figure 3. Length frequency of marked and umarked residualized steelhead caught by anglers in the upper Salmon River in 1984.

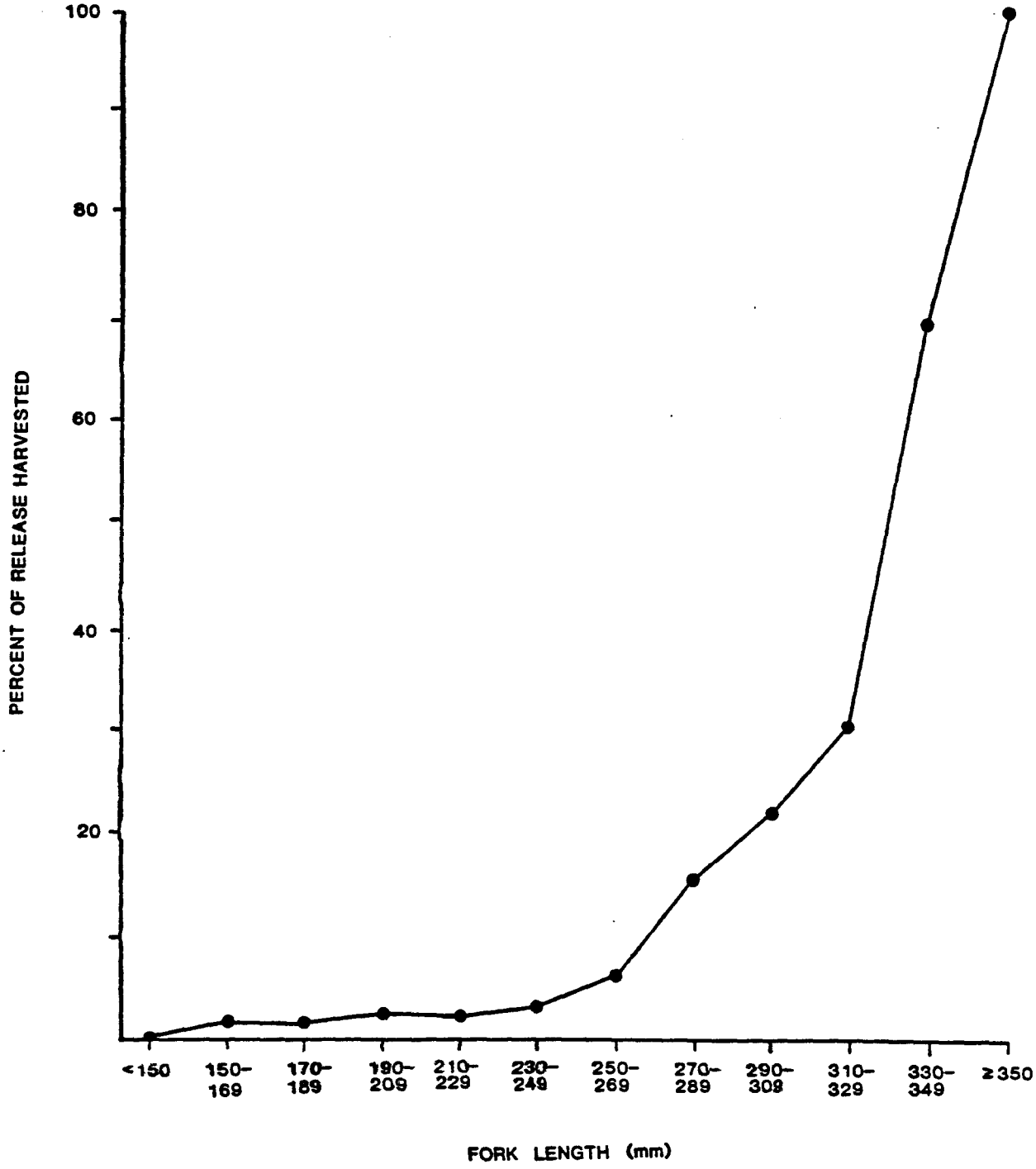

Figure 4. Percent of harvest of individual size classes of steelhead smolts released into the upper Salmon River in 1984.

APPENDICES

Appendix A. Estimated angler effort, harvest, and harvest rate by stream section In the Salmon River for May 26 through June 22, 1984. Error bounds (95%) are in parentheses.

River section	Angler hours	Resldualized steelhead	Rainbow trout		Bull trout	Brook trout	Mountain whitefish	Cutthroat trout	Total	Harvest rate	
			Hatchery	Wild						RS/hr	Fish/hr
U3	113 (131)	0	0	0	0	0	0	0	0	0	0
U2	770 (224)	77 (531)	0	0	0	0	0	0	77 (531)	0.10	0.10
U1	1,240 (459)	2,766 (1,924)	0	0	0	0	0	0	2,766 (1,924)	2.23	2.23
R	3,303 (871)	9,548 (5,076)	0	0	0	0	0	0	9,548 (5,076)	2.89	2.89
D1	4,616 (1,392)	8,281 (3,227)	0	89 (162)	0	0	30 (59)	0	8,400 (3,255)	1.79	1.82
D2	2,219 (721)	3,078 (1,349)	0	0	30 (89)	0	0		3,108 (1,366)	1.39	1.40
D3	2,427 (868)	3,247 (2,022)	0	0	70 (121)	0	0	0	3,317 (2,020)	1.34	1.37
D4	1,374 (573)	2,495 (1,873)	0	0	0	0	0	0	2,495 (1,873)	1.82	1.82
V	627 (518)	187 (435)	75 (101)	0	0	374 (412)	0	0	636 (641)	0.30	1.01
Total	16,690 (2,201)	29,680 (7,055)	75 (101)	89 (162)	100 (151)	374 (412)	30 (59)	0	30,347 (7,086)	1.78	1.82

Appendix B. Estimated angler effort, harvest, and harvest rate by stream section in the Salmon River for June 23 through July 20, 1984. Error bounds (95%) are In parentheses.

River section	Angler hours	Reslduallzed steelhead	Rainbow trout		Bull trout	Brook trout	Mountain whitefish	Cutthroat trout	Total	Harvest rate	
			Hatchery	Wild						RS/hr	Fish/hr
U3	269 (80)	0	0	0	0	231 (215)	0	0	231 (215)	0	0.86
U2	2,134 (723)	1,061 (892)	289 (884)	0	48 (136)	48 (277)	48 (226)	48 (136)	1,543 (1,457)	0.50	0.72
U1	1,529 (522)	2,212 (1,233)	0	0	32 (40)	0	0	0	2,244 (1,229)	1.45	1.47
R	2,137 (710)	2,554 (1,551)	374 (329)	0	0	0	0	0	2,928 (1,661)	1.20	1.37
01	6,745 (1,579)	6,693 (2,309)	885 (755)	0	0	0	0	0	7,578 (2,498)	0.99	1.12
D2	2,104 (633)	2,092 (1,026)	47 (112)	0	94 (129)	24 (30)	0	0	2,257 (1,108)	0.99	1.07
D3	3,133 (1,016)	1,888 (1,254)	114 (398)	0	229 (357)	57 (326)	0	0	2,289 (1,455)	0.60	0.73
D4	918 (327)	645 (344)	28 (85)	0	0	0	28 (38)	0	701 (382)	0.70	0.76
V	110 (57)	0	0	0	0	0	0	0	0	0	0
Total	19,058 (2,312)	17,145 (3,577)	1,739 (1,280)	0	404 (405)	360 (480)	76 (230)	48 (136)	19,772 (4,022)	0.90	1.04

Appendix C. Estimated angler effort, harvest, and harvest rate by stream section in the Salmon River for July 21 through August 17, 1984. Error bounds (95%) are in parentheses.

River section	Angler hours	Reslduallzed steelhead	Rainbow trout		Bull trout	Brook trout	Mountain whitefish	Cutthroat trout	Total	Harvest rate	
			Hatchery	Wlld						RS/hr	Flsh/hr
U3	Closed season										
U2	1,642 (692)	197 (294)	315 (476)	0	0	39 (52)	0	0	550 (532)	0.12	0.34
U1	1,405 (570)	1,255 (925)	0	0	0	0	60 (179)	0	1,315 (998)	0.89	0.94
R	1,363 (632)	401 (383)	187 (150)	0	0	0	0	0	588 **(476)**	0.29	0.43
D1	4,274 (1,328)	3,479 (2,176)	2,750 (2,037)	33 (141)	0	33 (61)	33 (55)	0	6,328 (2,963)	0.81	1.48
D2	2,827 (810)	1,162 (959)	1,341 (1,396)	45 (88)	0	0	0	0	2,548 (1,256)	0.41	0.90
D3	3,115 (929)	210 (272)	1,209 (1,282)	52 (225)	0	0	0	0	1,472 (1,374)	0.07	0.47
D4	2,488 (1,024)	412 (582)	898 (796)	37 (101)	75 (308)	0	0	0	1,422 (998)	0.16	0.57
V	Closed season										
Total	16,009 (2,353)	7,116 (2,675)	6,700 (2,937)	168 (297)	75 (308)	72 (81)	93 (188)	0	14,223 (3,840)	0.44	0.89

Appendix D. Estimated angler effort, harvest, and harvest rate by stream section In the Salmon River for August 18 through September 15, 1984. Error bounds (95%) are In parentheses.

River section	Angler hours	Resldual1zed steelhead	Rainbow trout		Bull trout	Brook trout	Mountain whitefish	Cutthroat trout	Total	Harvest rate	
			Hatchery	Wild						RS/hr	Fish/hr
U3	101 (81)	135 (181)	0	0	0	34 (61)	0	0	169 (174)	1.34	1.67
U2	353 (302)	0	0	0	0	0	0	0	0	0	0
U1	144 (189)	0	0	0	0	0	0	0	0	0	0
R	348 (253)	0	93 (234)	0	0	0	93 (234)	0	186 (468)	0	0.53
D1	1,170 (594)	0	312 (1,716)	0	0	0	0	0	312 (1,716)	0	0.27
D2	1,153 (528)	0	769 (1,377)	0	0	0	0	0	769 (1,377)	0	0.67
D3	1,368 (828)	0	1,578 (1,554)	0	0	0	0	53 (226)	1,631 (1,585)	0	1.19
D4	1,196 (517)	0	820 (774)	68 (123)	0	0	0	0	888 (1,228)	0	0.74
V	1,253 (441)	412 (456)	1,047 (783)	0	32 (62)	16 (28)	32 (36)	0	1,538 (972)	0.33	1.23
Total	7,086 (1,406)	547 (491)	4,619 (2,920)	68 (123)	32 (62)	50 (67)	124 (237)	53 (226)	5,493 (3,171)	0.08	0.78

Appendix E. Estimated angler effort, harvest, and harvest rate by stream section In the Salmon River for May 26 through September 15, 1984. Error bounds (95%) are In parentheses.

River section	Angler hours	Resldduallzed steelhead	Rainbow trout		Bull trout	Brook trout	Mountain whitefish	Cutthroat trout	Total	Harvest rate	
			Hatchery	Wild						RS/hr	Fish/hr
U3	484 (174)	135 (181)	0	0	0	264 (223)	0	0	399 (276)	0.28	0.82
U2	4,898 (1,070)	1,334 (1,079)	604 (1,004)	0	48 (136)	88 (282)	48 (226)	48 (136)	2,171 (1,640)	0.27	0.44
U1	4,318 (919)	6,233 (2,465)	0	0	32 (40)	0	60 (179)	0	6,325 (2,491)	1.44	1.46
R	7,150 (1,314)	12,502 (5,322)	654 (431)	0	0	0	93 (234)	0	13,250 (5,383)	1.75	1.85
D1	16,804 (2,559)	18,453 (4,525)	3,947 (2,769)	122 (215)	0	33 (61)	63 (81)	0	22,618 (5,344)	1.10	1.35
D2	8,303 (1,362)	6,333 (1,948)	2,157 (1,965)	45 (88)	124 (157)	24 (30)	0	0	8,682 (2,563)	0.76	1.04
D3	10,042 (1,826)	5,346 (2,395)	2,902' (2,054)	52 (225)	299 (377)	57 (326)	0	53 (226)	8,709 (3,256)	0.53	0.87
D4	5,977 (1,323)	3,551 (1,991)	1,746 (1,114)	106 (159)	75 (308)	0	28 (38)	0	5,506 (2,482)	0.59	0.92
V	1,991 (683)	600 (630)	1,122 (789)	0	32 (62)	390 (413)	32 (36)	0	2,175 (1,164)	0.30	1.09
Total	58,842 (4,207)	54,488 (8,364)	13,132 (4,336)	325 (360)	610 (534)	856 (641)	323 (384)	101 (264)	69,836 (9,549)	0.93	1.19

Appendix F. Residence of 1,355 anglers interviewed on the upper Salmon River in 1984.

Residence	Percent
Custer County	2.2
Treasure Valley	32.9
Magic Valley	25.6
Eastern Idaho	5.8
Northern Idaho	3.6
California	13.2
Utah	5.0
Arizona	1.8
Nevada	1.6
Oregon	1.3
Other states	6.7
Other countries	0.2