FISHERY RESEARCH

SILVER CREEK FISHERIES EVALUATION

Final Report
Project No. F-71-R-12, Subproject III, Job 5

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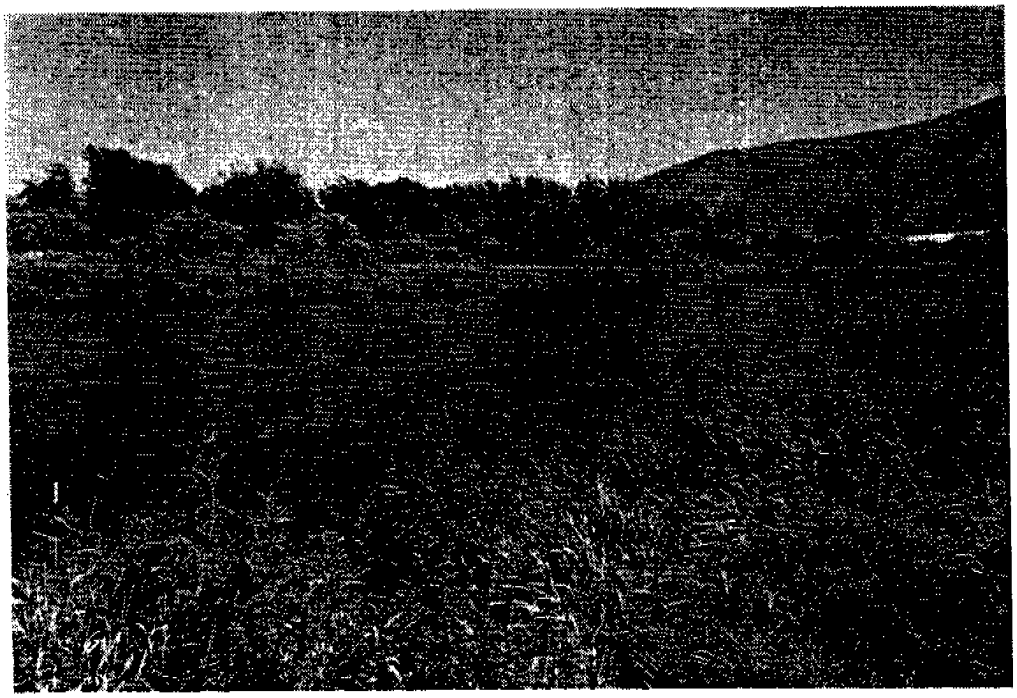

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JOB COMPLETION REPORT

State of: Idaho Title: Silver Creek Fisheries Evaluation

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ABSTRACT

The effect of ten years of catch-and-release regulations on rainbow trout and changes in trout populations in general regulation waters of Silver Creek were evaluated in relation to the IFDG study on Silver Creek by Thurow (1978). The fishery within the catch-and-release area of Silver Creek showed improvement over that of 1977 when the regulation was first instituted. The frequency of large (>400 mm) rainbow trout increased by 20% in the ten-year period, and the oldest rainbow trout collected in 1986-87 was age 5, as compared with age 4 in 1977. Annual mortality of age 3 and older rainbow trout decreased from 0.53 to 0.44. Catch increased from 1.13 fish/h to 1.81 fish/h over the ten-year period. Angler effort in Section 1 (1110 h/hectare in 1987) more than doubled since the institution of catch-and-release regulations, and 22% more anglers rated the fishing as "good" (the highest rating) in 1987, as compared with 1977. High angler density was not found to decrease feeding rates nor change microhabitat of feeding rainbow trout in the catch-and- release area. Hookscarring of rainbow trout was not significantly correlated to lowered body condition factors (K) of rainbow trout in the catch-and-release area.

The portion of Silver Creek below the catch-and-release section which was under general regulations experienced a decrease in angler effort over the ten years. In the middle portion of Silver Creek, which included the Martin Bridge and Point of Rocks areas, catch rates of wild rainbow trout increased from 0.24 to 1.38 fish/h, but the number of wild rainbow trout in the catch exceeding 300 mm declined by 29%. A portion of this change may be due to the elimination of hatchery rainbow trout released in this area (Section 3). In this section, the proportion of fly fishermen increased, and the proportion of bait anglers decreased, from 1977. Mortality of age 3 rainbow trout declined since 1977. Harvest of rainbow trout exceeding 300 mm in Section 3 was estimated to be 41% of the fish of that size present at the start of the angling season.

The rainbow trout population in the Priest area was characterized by 92% of the electrofishing catch being under 300 mm in length. Rainbow trout exceeding 400 mm were present in the spring estimate, but were not found in the subsequent summer and fall sampling. Catch rates decreased slightly in the ten years since 1977, and the number of rainbow trout less than 300 mm caught by anglers decreased by 22%. Harvest of rainbow trout greater than 300 mm was 10% of the total number of fish that size present at the beginning of the angling season.

Although brown trout were not present in Silver Creek above the town of Picabo in 1977, brown trout made up about 40% of the trout population and up to one half of the trout biomass of Section 3 in 1987. In the fall of 1986, 81% of the brown trout captured by electrofishing were 400 mm or greater in length, and 33% were 500 mm or greater. Brown trout comprised 6% of the trout population in the catch-and-release area and were also found in the tributaries. Harvest of older brown trout was low in Section 3 and Section 5.

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INTRODUCTION

Silver Creek has long been recognized as one of the most esteemed trout streams in North America. Its abundant surface-feeding rainbow trout and mayfly hatches have drawn anglers from all areas of the country. Throughout the past 40 years, the increasing popularity of Silver Creek has also brought with it concerns for the health of the fishery. In the 1940's, a decline in the size and number of rainbow trout was observed by anglers and biologists alike (Hauck 1947). Hatchery rainbow trout were released into the Silver Creek system in the years 1955 through 1977. Salvaged rainbow trout from the Richfield Canal, a canal that diverts water from the Big Wood River, were also released into Silver Creek from 1955 to 1970. In the 1960's and 1970's, increased agricultural activity, particularly grain farming, was indentified as having possible impacts on the habitat quality of the Silver Creek system (Thurow 1978).

In 1975, The Nature Conservancy (TNC) purchased 194 hectares (480 acres) of land surrounding 2.4 km of Silver Creek and portions of its tributaries. In 1977, catch-and-release regulations were initiated by the Idaho Department of Fish and Game (IDFG) within Silver Creek Preserve boundaries in cooperation with The Nature Conservancy. The IDFG conducted an investigation (Thurow 1978) in 1975 through 1977 to assess the condition of the fishery throughout Silver Creek and its tributaries.

The present study, conducted from 1986 through 1987, focuses on the evaluation of the effects of catch-and-release regulations over the ten years since its institution. Changes in the general regulations waters are assessed in relation to the 1975 through 1977 study as well. Angler use of the stream is evaluated in light of its increasing popularity. Specific objectives of the study were to:

1. evaluate the effects of the catch-and-release regulations on the size and growth of rainbow trout within the Silver Creek Preserve, in addition to the size and abundance of trout within the general regulation waters,

2. describe the distribution and population structure of brown trout in Silver Creek,

3. evaluate angler use and opinions of the Silver Creek fishery, and

4. assess the angler impact on the fish populations, both from the the direct effects of harvest and the indirect effects of hookscarring and disturbance of feeding fish.

DESCRIPTION OF STUDY SECTIONS

The Silver Creek drainage, located in south central Blaine County, Idaho, is almost exclusively a spring-fed system, with the source of the springs originating in the Big Wood River drainage (Brockway and Grover 1978). The confluence of Grove and Stalker creeks forms the headwaters of Silver Creek. From the confluence it flows east-southeasterly for 42 km until its junction with the Little Wood River (Figure 1). The majority of the valley is pastureland and farmland, and the lower valley is predominantly sagebrush steppe.

Peak flows in Silver Creek occur in late summer, due to decreased irrigation activities and influxes of groundwater recharge culminating during that period of the year (Figure 2). From 1975 to 1983, mean discharge ranged from a low of 120 ft^3/s in 1977 to a high of 217 ft^3/s in 1983. Specific conductance ranged from 275 to 434 umhos/cm. The pH varied from 7.9 to 8.7, and total alkalinity ($CaCo_3$) averaged 195 mg/l (USGS Water Supply Papers, 1975 to 1983). Summer water temperatures ranged from 10 to 22°C during the summer months. Winter temperatures exhibited less variation, with a range of 0.5 to 7.0°C.

Game fish present in Silver Creek include: rainbow trout Salmo gairdneri, mountain whitefish Prosopium williamsoni, brown trout Salmo trutta, and brook trout Salvelinus fontinalis. Nongame species include: bridgelip sucker Catostomus columbianus, redside shiner Richardsonius balteatus, longnose dace Rhinichthys cataractae, speckled dace R. osculus, and the Wood River sculpin Cottus leiopomus. Minshall and Manuel-Faler (unpublished 1982) found invertebrate densities within Section 1 in excess of 25,000 organisms/m^2 of stream bottom. Little is known about invertebrate densities in other portions of Silver Creek, although mayfly hatches similar to those which occur in Section 1 also occur in Sections 2 and 3.

Silver Creek was divided into five study sections during the 1976-1977 IDFG study (Thurow 1978). The five sections were used for creel census, and electrofishing sites were located within those sections. We used the original creel census sections for this study, and 1986-1987 electrofishing sites were located within the areas electrofished in 1976-1977 (Figure 1). In this report, the term "section" refers to a creel census section and "site" refers to an electrofishing site.

Section 1, which was located entirely within the boundaries of the Silver Creek Preserve, began at the confluence of Grove and Stalker creeks and extended downstream to Kilpatrick Bridge. Four electrofishing sites were located within the Preserve, two on Stalker Creek and two on Silver Creek (Table 1).

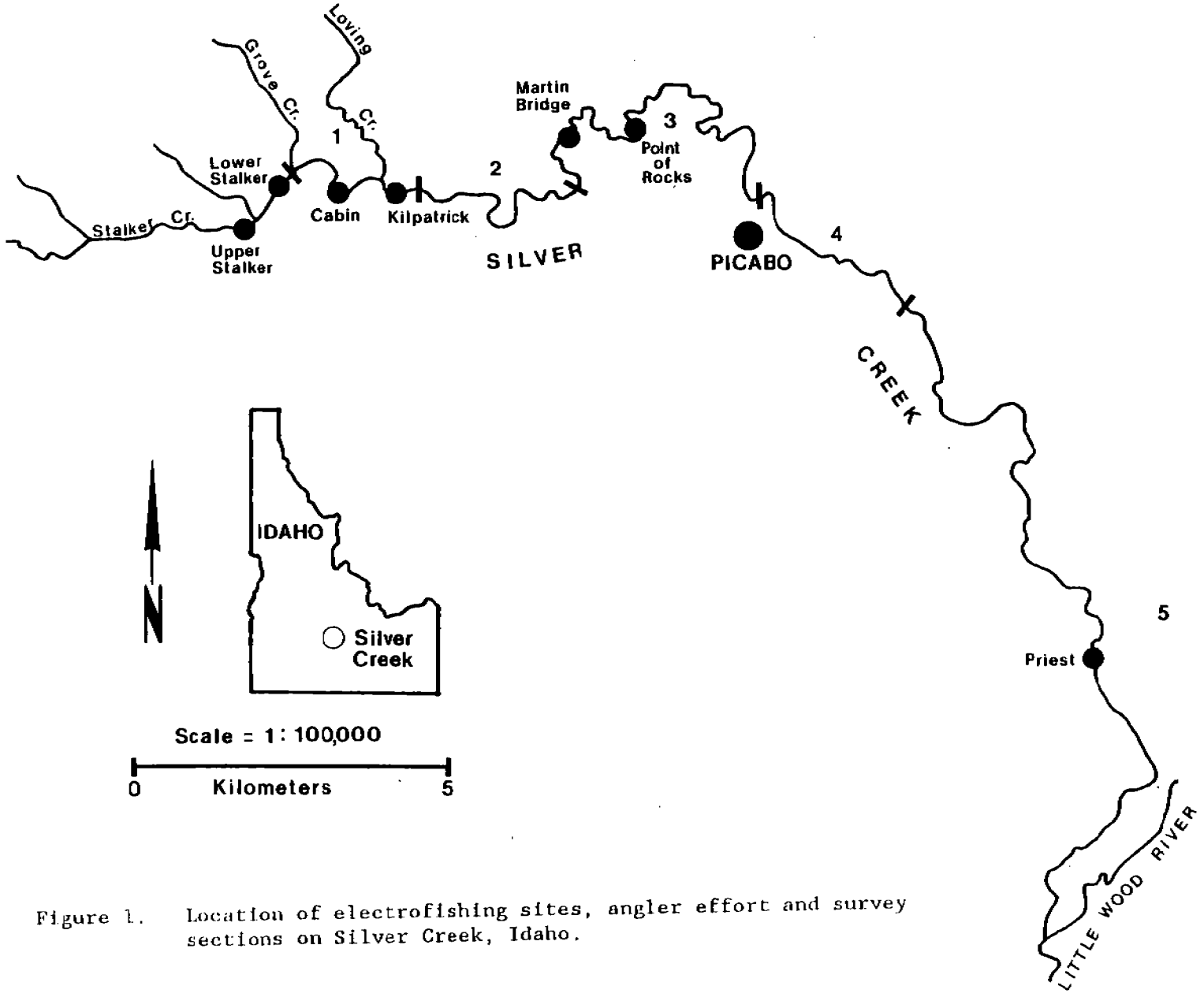

Figure 1. Location of electrofishing sites, angler effort and survey sections on Silver Creek, Idaho.

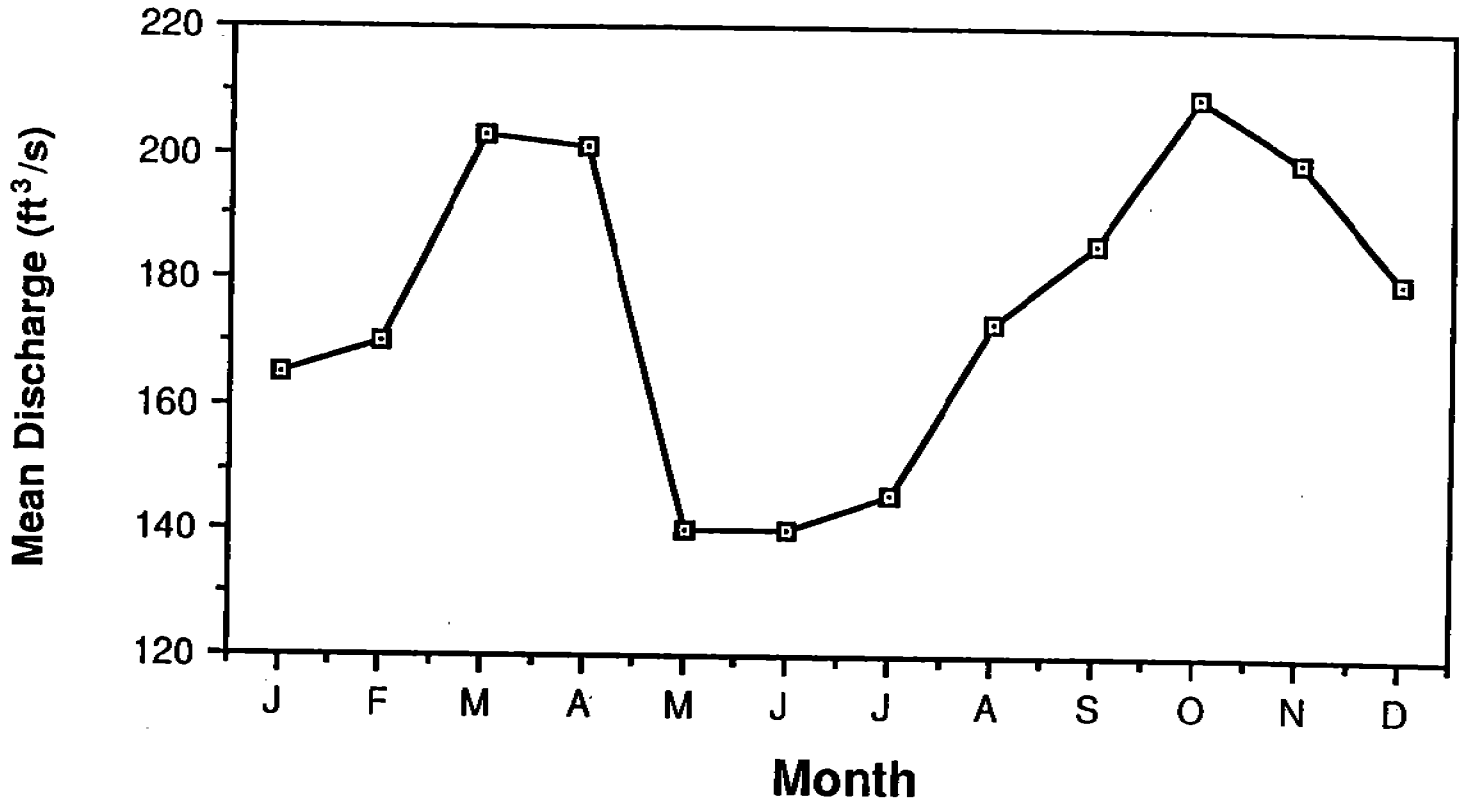

Figure 2. Monthly mean discharges (ft^3/s) for Silver Creek averaged from the calendar years 1975 to 1983 (Water Supply Papers).

Table 1. Surface areas of electrofishing sites on Stalker Creek and Silver Creek, during the 1986 and 1987 field seasons.

Electrofishing site	Length (m)	Surface Area (m^2)
Upper Stalker	805	7,242
Lower Stalker	950	8,835
Cabin	958	29,085
Kilpatrick Bridge	986	66,452
Martin Bridge	998	19,760
Point of Rocks	489	14,181
Priest	465	5,965

The upper Stalker Creek site began at the first powerline above the Stalker Creek Bridge and extended downstream 805 m to the Stalker Creek Bridge. Silt deposits ranging in depth from 30 to 125 cm characterized the majority of the substrate, but some exposed gravel and marl areas were present. The dominant macrophytes were Chara spp. and Potamogeton spp. and the riparian zone contained predominantly willow Salix spp., birches Betula spp., sedges Carex spp. and grasses Poa spp..

The lower Stalker Creek electrofishing site began at the metal fence post located in mid-channel, approximately 500 m downstream of the Stalker Creek Bridge. This site was 950 m in length and ended at the "No Shooting, Residential Zone" sign, which was located approximately 200 m upstream from the confluence of Grove and Stalker creeks. Mean stream width was 9 m, and substrate, macrophyte and riparian composition was similar to the upper Stalker site.

The Cabin electrofishing site began at the wooden bridge upstream from the Visitor's Center and extended downstream to the last island past the Visitor's Center. A marl substrate predominated in the upper stretch and silt covered the lower reach. Macrophytes present included: Chara, Veronica, Potamogeton, and Ranunculus spp. An open riparian zone was present, with considerably fewer shrubs and more grasses than in the Stalker sites.

Kilpatrick Bridge was the fourth electrofishing site located within the Preserve. This site started at the mouth of Loving Creek and extended downstream to Kilpatrick Bridge. The upper portion of this site had widths of 20 to 30 m with depths of 1 to 3 m in most areas. The remaining reach included the upper half of Kilpatrick Pond and was considerably wider and shallower, with widths exceeding 70 m and depths rarely exceeding 1.5 m. The substrate in the upper reach was predominantly marl, with some exposed gravels present, while the substrate in the lower portion was almost exclusively silt. The gradient of this site, as well as previous sites, averaged 0.8 m/km. Extensive growths of bulrush Scirpus spp. dominated the riparian vegetation in this site.

Angler survey Sections 2 through 5 are managed under general fishing regulations. Section 2 began at Kilpatrick Bridge and ended at the south side of the Highway 20 bridge west of Picabo. The irrigation diversion that forms Kilpatrick Pond was located approximately 300 m downstream from Kilpatrick Bridge. The portion of the Pond in Section 2 was much wider (80 to 120 m) than in Section 1. Stands of bulrush are again the primary riparian vegetation. The substrate within this area of the Pond was also silt, and abundant growths of Potamogeton spp. occurred from spring to late fall. The remainder of Section 2 below the diversion had an average stream width of approximately 30 m. Stands of bulrush and cattails Typha spp. were abundant in the lower end of this section. The substrate in this section was predominantly silt, although scattered areas of gravel were present. Section 2, though restricted in land trespass, receives a

substantial amount of use by anglers in float tubes who fish the pond or float through to the Highway 20 bridge.

Section 3 began on the north side of the Highway 20 bridge west of Picabo, continued downstream through both private and public property, and ended at the Picabo Bridge. The land between the Highway 20 bridge and Martin Bridge is privately owned but public access is permitted. The land bordering the portion of Silver Creek from Martin Bridge to the Bureau of Land Management Point of Rocks campground is owned by the Idaho Department of Fish and Game and is accessible to the general public. The stream between Point of Rocks campground and the Picabo Bridge flows through private property, but anglers were seen fishing up to 1 km upstream from the Picabo Bridge.

The Martin Bridge site was the first of two electrofishing sites in Section 3. This site began at Martin Bridge and ended at a metal fence post on the north side of the stream. This site had widths ranging from 10 to 15 m and contained number of deep pools, some up to 3 m in depth. The substrate was primarily gravel, with silt occurring in depositional areas. The banks supported dense growths of willows, birches, and wild roses Rosa spp., and Potamogeton spp. was the dominant macrophyte within the site.

The Point of Rocks site, also located within Section 3, began 490 m above the Point of Rocks campground and ended at the campground. This site had stream widths of 30 to 45 m, with depths ranging between 1 and 2 m. The substrate was comprised mainly of silt, with occasional pockets of gravel in the areas of swifter current. Potamogeton spp. were the most abundant macrophytes, and streambank vegetation consisted of grasses, sedges, and scattered clumps of willows.

Section 4 began at the east side of the Picabo Bridge and ended on the north side of the Highway 20 bridge east of Picabo. This section was located entirely within private property, and access was not permitted to the general public. We did not sample fish populations or estimate angler effort within this section.

Section 5 started immediately below the south side of the Highway 20 bridge east of Picabo and ended downstream at the Priest campground. Because the majority of the section is under private ownership, we limited the angler survey to 1 km above and 1 km below the upper camping area at the Bureau of Land Management Priest access point. The Priest electrofishing site began at the upper camping area and extended 465 m downstream to the diversion at the lower camping area. The average width of this site was 10 m, and depths ranged from less than 0.5 m in the upper reach to up to 1.5 m in the lower portion. The gradient of this site was 8 m/km, higher than all other electrofishing sites, and over half of the site is rapids. The substrate is predominantly igneous bedrock, with areas of gravel and silt also present. Potamogeton spp. were the dominant macrophytes, and the riparian zone consisted of grasses and a few isolated birches.

METHODS

Fish Populations

Electrofishing samples were used to obtain fish population densities, species composition, length frequencies, and to assess age, growth, and mortality of Silver Creek game fish. Mountain whitefish were included as game fish. Direct observation was used to assess possible effects of high angler densities on the surface-feeding behavior of adult rainbow trout.

Population Assessments

Sampling of game fish populations was conducted at night by electrofishing. A 4.3 m-long raft was equipped with a 3500 watt generator and a variable voltage pulsator (VVP). An electrofishing crew consisted of two netters and one oarsman. Typical output for the VVP was 200 to 230 volts pulsed D.C. and 4 to 6 amperes. Illumination was provided by two bow-mounted 150 watt floodlights. The electrical field was established using a single boom-mounted positive and six side-mounted negative electrodes. The electrodes were constructed of 9.5 mm-diameter stainless steel cable.

Electrofishing runs were started immediately after dusk and usually continued for three to five hours. Sampling was done at night due to the high angler densities during the day, particularly in the catch-and-release area. Night sampling was suspected to be more effective than daylight sampling. Captured fish were held in an aerated livewell before processing. Prior to handling, fish were anesthetized with a dilute solution of tricaine methanesulfonate (MS-222). Total lengths were recorded to the nearest millimeter and weights to the nearest gram. A scale sample was removed from the area just below and posterior to the dorsal fin from all fish collected. Fin clips were used to mark fish for population estimates. We assessed trout movements by tagging large (>350 mm) trout with a monel jaw tag during fall 1986 and spring 1987 electrofishing sample periods. Movements of individual fish were evaluated on the basis of angling recaptures during the 1987 angling season.

Population estimates were calculated using the Chapman modification of the Schnabel estimate. With this technique, multiple mark and recapture runs are made through a study site over a number of days. We utilized five to six runs for each population estimate when possible. Ninety-five percent confidence intervals were calculated for each estimate using Ricker (1975). The following equation was used to calculate the estimated population size:

$$N = \frac{C_t M_t}{R+1}$$

Where:

C_t = total sample taken on day t.
M_t = total marked fish at large at the start of the tth day (or any other interval), i.e. the number previously marked less any accidently killed at previous recaptures.
R = total recaptures during the experiment.
N = the estimate of the population present throughout the experiment.

Day versus Night Sampling

Since sampling in 1976 through 1977 was conducted during the day, larger fish are suspected to have been represented at a disproportionately lower frequency than in the night samples of 1986 and 1987. Differences in the size frequencies of fish between the 1976 through 1977 and the 1986 through 1987 samples may be partly due to the differences in sampling method. To address this topic, matched day and night electrofishing runs were made in the Cabin, Martin Bridge, and Priest sites in the spring of 1987. Comparisons of length frequency and numbers of fish captured were made for rainbow and brown trout.

Age, Growth and Condition

A total of 957 rainbow trout and 133 brown trout scale samples were read for age-growth analysis. Samples were dry mounted on glass microscope slides and a glass coverslip was taped in place over the scales. All scales were magnified 50.3 times and projected directly onto a Houston Hipad DT11A digitizing pad. Measurements were taken along the median anterior radius from the focus to each annulus. These data were directly entered into an Apple microcomputer and analyzed using the Disbcal program (Frie 1982).

Condition factors (K) were calculated to assess changes in condition over winter and between 1977 and 1987 samples. Condition factors were calculated using the following formula:

$$K = \frac{W}{L3} \times 10^5$$

Where:

K = condition factor
W = weight in grams
L = length in millimeters

We tested for significant differences in the condition factors of hookscarred and non-hookscarred rainbow trout of similar sizes, using two sample t-tests. Condition factors of electrofished rainbow and brown trout samples were tested for significant differences between sites and within seasons, between similar size classes using the Mann-Whitney test. Differences in the length-weight regression coefficients for electrofished rainbow and brown trout samples were tested for significance between sites by testing differences in regression coefficients (Zar 1974).

Mortality Estimates

Survival rates for rainbow and brown trout were calculated from the frequency of fish in age classes, as determined by scale analysis. The Heincke estimate was used to calculate survival (S). This method of calculating survival does not require as much strength in the age determinations of the older ages as does the catch curve (Ricker 1975). The instantaneous total mortality rate (Z) was calculated as the negative natural log of S. The annual total mortality rate (A) was calculated as 1-S. We used the Baranov catch equation to solve for the instantaneous rate of fishing mortality (F), using C and N from harvest and population estimates. The F estimate was subtracted from Z to arrive at the instantaneous rate of natural mortality (M). The equations used include the following:

$$S = \frac{N-N_o}{N}$$ eq. 2.4 Ricker (1975)

$$Z = -(\ln S)$$ eq. 1.5 Ricker (1975)

$$A = 1-S$$ eq. 1.4 Ricker (1975)

$$F = \frac{CZ}{NA}$$ eq. 1.17 Ricker (1975)

Where:

C = catch
N = population size

$$M = Z-F$$ eq. 1.3 Ricker (1975)

Redd Counts

Aerial counts of rainbow trout redds were conducted on 17 April 1987 to determine if substantial spawning occurred in the lower areas of Silver Creek. Sites were viewed from a helicopter at 30 to 40 m above the stream. Areas sampled included all of Section 3, one reach in Section 4, and two reaches in Section 5 (Figure 3). Counts were tallied for each reach, and redd densities were calculated.

Disturbance of Trout by Anglers

Possible effects of angler activity on the surface-feeding behavior of rainbow trout were studied in the Silver Creek Preserve during the summer of 1987. It was hypothesized that angling could disturb feeding trout and reduce or even terminate surface-feeding behavior. Reduced feeding might negatively impact growth and reduce long-term survival.

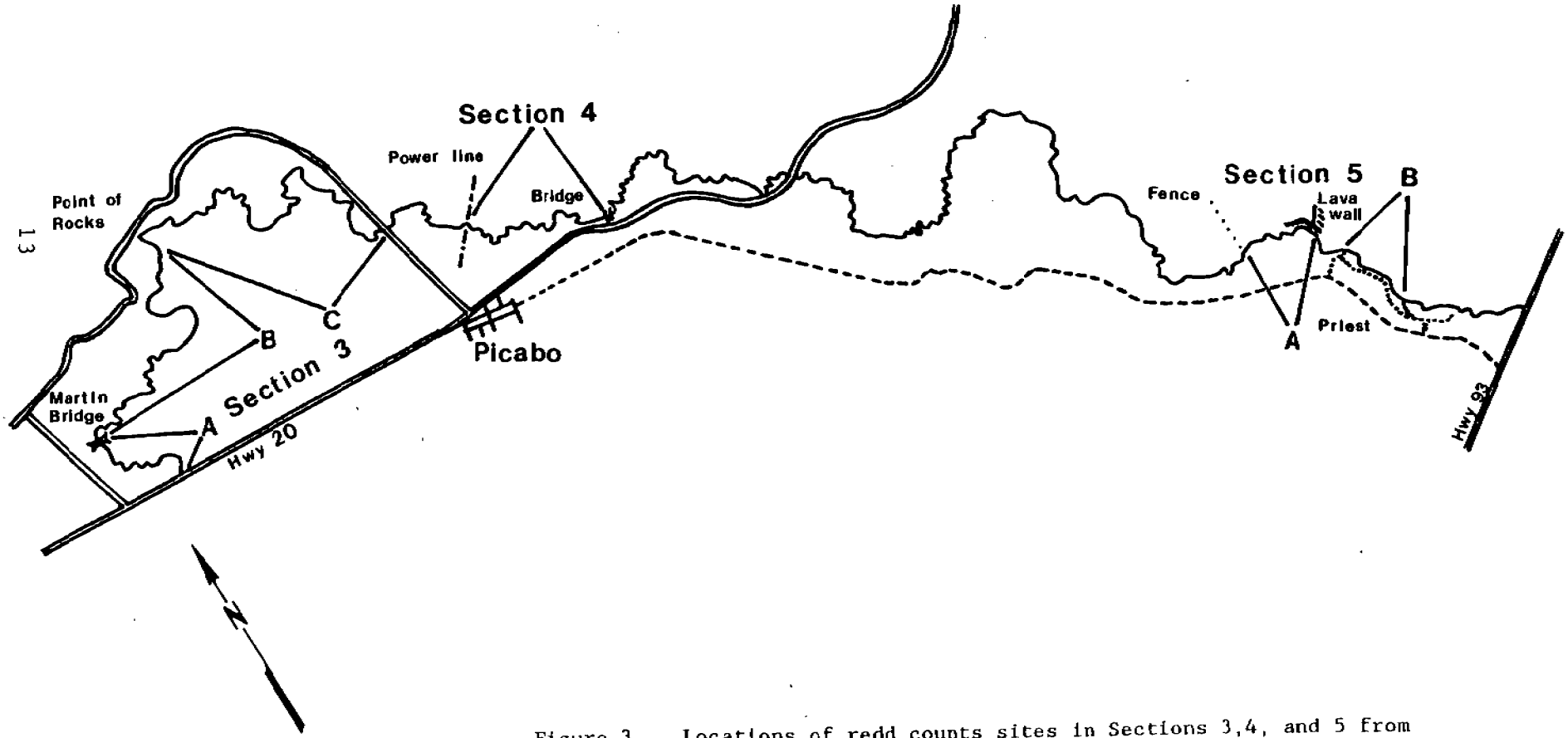

Figure 3. Locations of redd counts sites in Sections 3,4, and 5 from April 17, 1987.

The study site was located upstream of the Visitor's Center, above the wooden bridge. The lower end of the site was directly beneath the power line that crossed the stream. The upper boundary of the site was 100 m upstream from the powerline crossing. This location was utilized for several reasons: the site had high angler densities (2100 h/hectare/year) and an abundance of adult trout, and observational areas from which to record fish behavior were also present.

The duration of the study was divided into three periods: 7 days of observations with angling, 7 days of observations without angling, and a final 7 days of observations with angling resumed.

Observations and data collection were limited to the morning hours because evening light was insufficent to observe trout behavior. Surface drift nets with an opening 13 cm wide were set to assess food availability. The first drift net was set when adult mayflies were observed and juvenile trout had began to feed. Data were collected for the duration of the surface feeding activity, lasting from 45 minutes to two hours. Drift net samples were collected every 15 minutes and velocities were recorded at the beginning and end of each net set and used for volume calculations. Feeding rates (feeds/min) were characterized by the number of times that an individual fish's snout broke the waters surface. Binoculars and a stepladder were used to record the observations. Depths and feeding velocities were collected by tossing a brightly colored weight as close as possible to a feeding fish. These data were recorded after the feeding was completed for the morning. Counts of total fish present were made several times throughout the period of feeding.

Drift samples were enumerated and identified to genus. Large samples (>5000 individuals) were subsampled and the one-eighth subsample was counted by hand, with the resultant values multiplied by eight to estimate the total number in each genus. All measurements were averaged for each treatment to determine whether or not changes had occurred with regard to angler and non-angler treatments.

Angler Effort

Creel census was initiated on 23 May and completed on 29 November 1987. Counts were conducted by Idaho State University (ISU) researchers and TNC personnel. Counts and survey information were collected on the same sections surveyed in 1977.

Section 1 counts, conducted by TNC personnel, started on the bluff directly above the Visitor's Center. Anglers were counted in the area from the powerline crossing just upstream from the Visitor's Center, downstream through the Preserve to Kilpatrick Pond. Angler counts on Kilpatrick Pond itself were confirmed by driving to Kilpatrick Bridge, as all portions of the pond were not visible from the bluff. The Section 1 count was completed on foot from the Jack Kennedy property, located immediately north of the Preserve, for the portion of Section 1 upstream of the powerline crossing.

Sections 2 through 5 were censused by ISU researchers both from vehicles and on foot. Binoculars were used when necessary. Section 2 included anglers fishing from Kilpatrick Bridge downstream to the Highway 20 bridge west of Picabo. The portion within Section 2 that was inaccessible by road was completed from the Highway 20 bridge. Anglers on the south side of the Highway 20 bridge were counted in Section 2, and those on the north side of the bridge were counted in Section 3. The counts in Section 3, from Martin Bridge to the Point of Rocks campground, were completed on foot. Personnel also climbed the bluff opposite the Point of Rocks campground to census anglers. The portion of Section 3 from approximately 500 m downstream from the Point of Rocks campground to the Picabo Bridge was counted from the road. No creel or effort information was collected in Section 4. Section 5 counts were made on foot 1 km above and 1 km below the upper camping area at Priest.

We patterned our creel census after the one conducted by Thurow (1978). In our census we used the cluster method with three counts per day as opposed to the four that Thurow utilized. The days and count times were selected at random using a random number generator from a calculator. Counts were done on two weekdays and two weekend days in each 14-day interval. All holidays were counted, with the exception of Thanksgiving Day. The count schedule was reduced to 1 weekend day and 2 weekdays after Labor Day weekend for the duration of the angling season. A total of thirteen 14-day intervals and one 9-day interval were censused during the 1987 angling season.

Angler effort was estimated using the same method that Thurow (1978) used in 1977. The formula used to estimate angler effort for each interval is: $XWD(H) + X_1WE(H)$.

Where:

$X_1(X)$ = or the mean number of anglers calculated as:

$$X_1 = \frac{\text{total anglers counted on weekends}}{\text{total number of counts}}$$

$$X = \frac{\text{total anglers counted on weekdays}}{\text{total number of counts}}$$

WD = The total number of weekdays in the interval.

WE = The total number of weekend days in the interval.

H = The mean daylight hours per interval, taken from the sunrise and sunset timetable for Twin Falls, Idaho.

The same procedure was utilized for holiday counts.

Angler Catch and Harvest

Angler catch and harvest information was calculated for each interval from the interview data. Catch per hour and harvest per hour were estimated by dividing the total number of hours fished (from interviews) by the total number of fish captured or harvested for that interval. The resultant values were then multiplied by the total estimated hours of effort for that interval to calculate the estimated catch and harvest.

Angler Opinions

Angler interviews included four opinion questions that were designed by ISU researchers and subsequently approved by IDFG. Personnel from the Silver Creek Preserve conducted most of the interviews at the Visitor's Center as anglers left the Preserve. Researchers from ISU conducted interviews on the remaining angler census sections. Interviews were conducted throughout the summer.

RESULTS

Fish Populations

Species Composition

In the Cabin site, rainbow trout comprised 85% of the sample, the highest frequency of rainbow trout occurrence in any of the electrofishing sites (Table 2). Rainbow trout made up 75% of the upper Stalker sample. Rainbow trout comprised only 39% of the sample at Martin Bridge in the fall of 1986, but rose to 71% of the sample in the spring of 1987 (Table 2). In the Priest site (Section 5), the percentage of rainbow trout in the spring of 1987 was high (77% of the sample), but decreased in the fall to only 42% of the sample (Table 2). Brown trout made up the complement of the species composition in the Priest site.

Brown trout, which were not found above Picabo in 1977, increased to 21 and 61% of the population in the Martin Bridge area and to 6 and 12% in the Cabin site over the last ten years for spring and fall samples, respectively. The Martin Bridge site had a higher percent occurrence of brown trout, 21%, than did any of the electrofishing sites in Section 1 (Table 2). Brown trout comprised 61% of the sample in the fall of 1986 but dropped to 21% by spring of 1987, the reverse of rainbow trout in that site. The upper Stalker site had 17% brown trout in the spring of 1987, compared to the Cabin site of Silver Creek where brown trout comprised 6% of the sample (Table 2). The abundance of brown trout in the upper Stalker site was due to the presence of large numbers of yearling fish.

Brook trout comprised 6% or less of the sample in the upper Stalker and Cabin sites. Only 2% of the game fish sample at the Martin Bridge site was brook trout, while no brook trout were found during any sampling period in the Priest site (Table 2).

Whitefish were more numerous in the Cabin site than any other site, making up 6% of the game fish sampled in the fall of 1986. At the Martin Bridge site, whitefish comprised 1% of the spring 1987 sample, and no whitefish were found in the Priest site (Table 2).

Hatchery rainbow trout, which escaped from the Hayspur Fish Hatchery in the spring of 1987, made up 2% of the sample in the Cabin site and 5% of the sample in the Martin Bridge site. Hatchery rainbow trout were also found as far downstream as the Priest site (Table 2).

Trout Densities

Estimates of population size were made for all electrofishing sites sampled in the summer of 1986 (Tables 3 and 4). From these estimates, four representative sites (upper Stalker, Cabin, Martin Bridge and Priest), were selected, and sampling in those sites was continued in the fall of 1986 and spring of 1987. The Priest site was also sampled in the summer and fall of 1987.

Table 2. Species composition of gamefish abundance from electrofishing samples from the 1976 through 1977 and the 1986 through 1987 field seasons. Values shown are percentages of total game fish in the sample.

Study site and sample time	Wild trout			Hatchery rainbow trout	Mountain whitefish	Sample size
	Rainbow	Brown	Brook			
Upper Stalker						
Fall 1986	85	7	6	0	1	303
Spring 1987	75	17	4	0	4	138
Cabin (Section 1)						
1976-1977[a]	57	0	2	1	40	504
Fall 1986	76	12	6	0	6	230
Spring 1987	83	6	5	2	4	645
Martin Bridge (Section 3)						
1976-1977[a]	65	0	2	28	4	199
Fall 1986	39	61	0	0	0	183
Spring 1987	71	21	2	5	1	333
Priest (Section 5)						
1976-1977[a]	65	35	0	0	<1	
Spring 1987	77	21	0	0	2	338
Fall 1987	42	58	0	0	0	260

[a] Thurow, 1978.

Table 3. Population estimates (fish/site) using the Chapman modification of the Schnabel estimate for rainbow trout in Stalker Creek and Silver Creek study sites. Values in parentheses are 95% confidence limits.

Study Site	Summer 1986	Fall 1986	Spring 1987	Summer 1987	Fall 1987
Upper Stalker		927(610-1396)	235(153-358)		
Lower Stalker	1303(859-1965)				
Cabin	888(572-1363)	816(537-1230)	2337(1790-3047)		
Loving to Kilpatrick	1678(1070-2603)				
Martin Bridge	339(192-581)		638(464-875)		
Point of Rocks	332(157-639)				
Priest	187(108-314)		796(584-1083)	492(380-635)	385(232-627)

Table 4. Population estimates (fish/site) using the Chapman modification of the Schnabel estimate for brown trout in Stalker Creek and Silver Creek study sites. Values in parentheses are 95% confidence limits.

Study Site	Summer 1986	Fall 1986	Spring 1987	Summer 1987	Fall 1987
Lower Stalker	17(8-31)				
Cabin			129(57-255)		
Loving to Kilpatrick	27(15-47)				
Martin Bridge	59(38-92)	374(225-610)	86(65-113)		
Priest	39(23-65)		90(63-129)	165(124-218)	111(82-150)

The catch per unit effort (CPUE) of the summer sampling was highest in the lower Stalker site with 139 rainbow trout captured per hour, and lowest in the Martin Bridge site, with 16 rainbow trout/h (Table 5). The CPUE of the summer 1986 sampling was higher than that of 1976, when 87 rainbow trout/h were caught in Stalker Creek and 15 rainbow trout/h were caught in the Martin Bridge area (Thurow 1978).

Estimates of rainbow trout density ranged from the high of 1,476 fish/hectare in the lower Stalker site in the summer of 1986, to a low of 172 rainbow trout/hectare at the Martin Bridge site at the same time (Table 6). In the spring of 1987, rainbow trout densities increased greatly from the previous summer in the Cabin, Martin Bridge and Priest sites. In the upper Stalker site, the density of rainbow trout decreased from fall to spring, possibly a result of downstream movement of age 1 and 2 fish in late winter or early spring. Density of rainbow trout in the Priest site declined from spring through the fall of 1987 (Table 6).

Brown trout densities displayed similar seasonal fluctuations. More brown trout were found in the Martin Bridge and Priest sites in the spring than in the previous summer (Table 7). The Martin Bridge site also experienced a substantial increase in the concentration of brown trout in the fall of 1986, with densities increasing from 30 to 189 brown trout/hectare from the summer to the fall. In the lower Stalker site, brown trout densities were as high as 19 fish/hectare in the summer of 1986, which was nearly two- thirds of the density of brown trout in Martin Bridge during that same period (Table 7). Brown trout density in the Priest site in the summer of 1987 exceeded the spring and fall densities for the same year. The density of brown trout at that time, 277 fish/hectare, was the highest of all brown trout estimates in Silver Creek (Table 7).

In the Cabin site, 15 hatchery rainbow trout were caught by electrofishing in Section 1. They were so numerous in the Martin Bridge site that a density of 11 fish/hectare (95% C.I.= 6-20) was calculated using the modified Schnabel estimate. Hatchery rainbow trout were found in the Priest site as well, where 7 fish were captured by electrofishing.

Trout Biomass

The highest rainbow trout biomass, 239.1 kg/hectare, was estimated for the lower Stalker site in the summer of 1986. The Cabin site had the next highest biomass of rainbow trout (79.3 to 169.6 kg/hectare) and had a higher biomass of rainbow trout than Martin Bridge during all sample times. The Priest site had the lowest biomass, 21.3 kg/hectare, in the summer of 1986 but this increased to 92.2 kg/hectare the following spring (Table 8).

The mean weight of brown trout exceeded that of rainbow trout in every sample (Table 9). Therefore, brown trout biomass estimates in the Martin Bridge and Priest sites often were similar to or exceeded the biomass of rainbow trout, although rainbow trout densities nearly always exceeded that of brown trout (Tables 6 and 7). Biomass of brown trout was highest in the Martin Bridge site in the fall when an estimate of 205.4 kg/ha was

Table 5. Catch per unit effort (CPUE) for electrofishing runs during the summer 1986 field season on Stalker Creek and Silver Creek study sites.

Study site	Rainbow (trout/h)	Brown (trout/h)	Total (trout/h)
Lower Stalker	139	15	159
Cabin	71	6	80
Martin Bridge	16	11	28
Priest	22	14	36

Table 6. Density estimates (fish/hectare) for rainbow trout in Stalker Creek and Silver Creek study sites. Values in parentheses are 95% confidence limits.

Study Site	Summer 1986	Fall 1986	Spring 1987	Summer 1987	Fall 1987
Upper Stalker		1280(842-1928)	324(211-494)		
Lower Stalker	1476(647-2224)				
Cabin	305(197-469)	281(185-423)	804(615-1048)		
Loving to Kilpatrick	253(161-392)				
Martin Bridge	172(97-294)		323(235-443)		
Point of Rocks	234(111-451)				
Priest	313(181-526)		1336(979-1816)	825(637-1065)	645(389-1051)

Table 7. Density estimates (fish/hectare) for brown trout in Stalker Creek and Silver Creek study sites. Values in parentheses are 95% confidence limits.

Study Site	Summer 1986	Fall 1986	Spring 1987	Summer 1987	Fall 1987
Lower Stalker	19(9-35)				
Cabin			44(20-88)		
Loving to Kilpatrick	4(2-7)				
Martin Bridge	30(19-47)	189(114-309)	44(33-57)		
Priest	65(39-109)		151(106-216)	277(208-365)	186(137-251)

Table 8. Estimates of biomass (kg/hectare) based on densities for rainbow trout and brown trout in Stalker Creek and Silver Creek sites. Values in parentheses are 95% confidence limits.

Site	Summer 1986		Fall 1986		Spring 1987		Summer 1987		Fall 1987	
	Rainbow	Brown	Rainbow	Brown	Rainbow	Brown	Rainbow	Brown	Rainbow	Brown
Upper Stalker			226.6 (149.0-341.3)		108.2 (70.5-165.0)					
Lower Stalker	239.1 (104.8-360.3)	16.9 (8.0-31.1)								
Cabin	79.3 (51.2-121.9)		84.6 (55.7-127.3)		169.6 (129.8-221.1)	23.7 (10.8-47.4)				
Loving to Kilpatrick	105.8 (67.3-196.0)	3.8 (1.9-6.6)								
Martin Bridge	31.0 (17.5-52.9)	29.0 (18.4-43.6)	205.4 (123.9-335.9)		55.9 (40.7-76.6)	33.0 (24.7-42.7)				
Point of Rocks	40.5 (19.2-78.0)									
Priest	21.3 (12.3-35.8)	27.7 (16.6-46.4)			92.2 (67.8-125.3)	58.4 (41.0-83.6)	46.2 (35.7-59.6)	51.5 (38.7-67.9)	48.4 (29.2-78.8)	29.2 (21.5-39.4)

Table 9. Mean weights (g) of rainbow trout and brown trout captured by electrofishing in Stalker Creek and Silver Creek sites during the 1986 and 1987 field seasons.

Site	Rainbow		Brown	
	Mean weight	Number	Mean weight	Number
Upper Stalker				
Fall 1986	177	126	475	9
Spring 1987	334	93	208	16
Cabin				
Fall 1986	301	164	444	37
Spring 1987	211	502	539	38
Martin Bridge				
Fall 1986	329	70	1087	114
Spring 1987	173	182	749	58
Priest				
Spring 1987	69	193	387	62
Summer 1987	56	225	186	105
Fall 1987	75	110	157	93

obtained, an increase from the summer estimate of 29.0 kg/ha. Brown trout biomass in the Priest site declined steadily throughout the 1987 sampling period (Table 8).

Size Composition: Rainbow Trout

From the fall of 1986 to the spring of 1987 there was a shift in size composition of rainbow trout at the upper Stalker site from 80% under 300 mm in length to 52% exceeding 300 mm (Table 10, Figure 4). Rainbow trout greater than 500 mm in length were collected during both sampling periods. Although some of the largest rainbow trout that were collected during the study were found at the upper Stalker site, the greatest number of rainbow trout were found in the 200 to 299 mm size class.

The highest frequency of rainbow trout in the 400-499 mm size class occurred in the Cabin site of Section 1. In 1977 only 3% of the rainbow trout exceeded 400 mm, but by 1986, 23% of the electrofishing sample consisted of this size class. There was a consistently higher percentage of rainbow trout above 400 mm in length for each of the 1986 and 1987 Cabin site samples as compared to the 1977 Section 1 sample (Table 10, Figure 5). The Cabin site has two or more modes to the length distribution of any given season, and the rainbow trout year classes can be identified and followed, from season to season, through the series of length frequencies (Figure 5).

The Martin Bridge site had a lower percentage of rainbow trout longer than 400 mm than did the Cabin site (Table 10, Figure 6). The largest percentage above 400 mm in length, 14%, occurred during the fall of 1986. In fall 1977, only 4% of rainbow trout were over 400 mm in length.

At the Priest site, rainbow trout under 300 mm in length comprised at least 92% of the sample in all seasons (Table 10). Two rainbow trout exceeding 400 mm were collected in the spring of 1987. In the subsequent summer and fall sampling no fish exceeding 400 mm in length were collected (Figure 7).

Size Composition: Brown Trout

All of the brown trout samples for Martin Bridge were dominated by large fish (Figure 8). The summer 1986, fall 1986, and spring 1987 samples had 23, 33, and 25% of brown trout greater than 500 mm in length, respectively (Table 11). Congregation in the area for spawning apparently accounts for the increase in numbers of larger brown trout in the fall 1986 sample. Many fish were ripe, and fish were observed on redds in the site during the fall sampling.

The Priest site population samples, in contrast to the Martin Bridge samples, were dominated by smaller brown trout. The seasonal trend displayed in this site was towards smaller fish from spring to fall (Figure 9). In 1987, the percentages of brown trout smaller than 300 mm in length in the spring, summer, and fall were 53, 81 and 90%, respectively (Table 11).

Table 10. Length frequencies of rainbow trout from the Upper Stalker, Cabin, Martin Bridge and Priest study sites. Values shown are percentages of the total electrofishing sample.

Study site	Date	Length class in mm					N
		100-199	200-299	300-399	400-499	>500	
Upper Stalker	Fall 1986	30	50	13	6	1	244
Upper Stalker	Spr. 1987	17	31	36	15	1	118
Section 1	Fall 1977[a]	26	37	34	3	0	202
Cabin	Sum. 1986	37	28	19	16	0	234
Cabin	Fall 1986	40	20	17	23	0	180
Cabin	Spr. 1987	48	18	24	11	0	530
Section 3	Fall 1977[a]	22	50	24	4	0	105
Martin Bridge	Sum. 1986	66	10	20	4	0	90
Martin Bridge	Fall 1986	11	53	22	13	1	71
Martin Bridge	Spr. 1987	53	17	25	5	0	236
Priest	Sum. 1986	82	17	1	0	0	79
Priest	Spr. 1987	82	13	4	<1	0	267
Priest	Sum. 1987	86	12	2	0	0	225
Priest	Fall 1987	75	21	4	0	0	112

[a] Thurow, 1978.

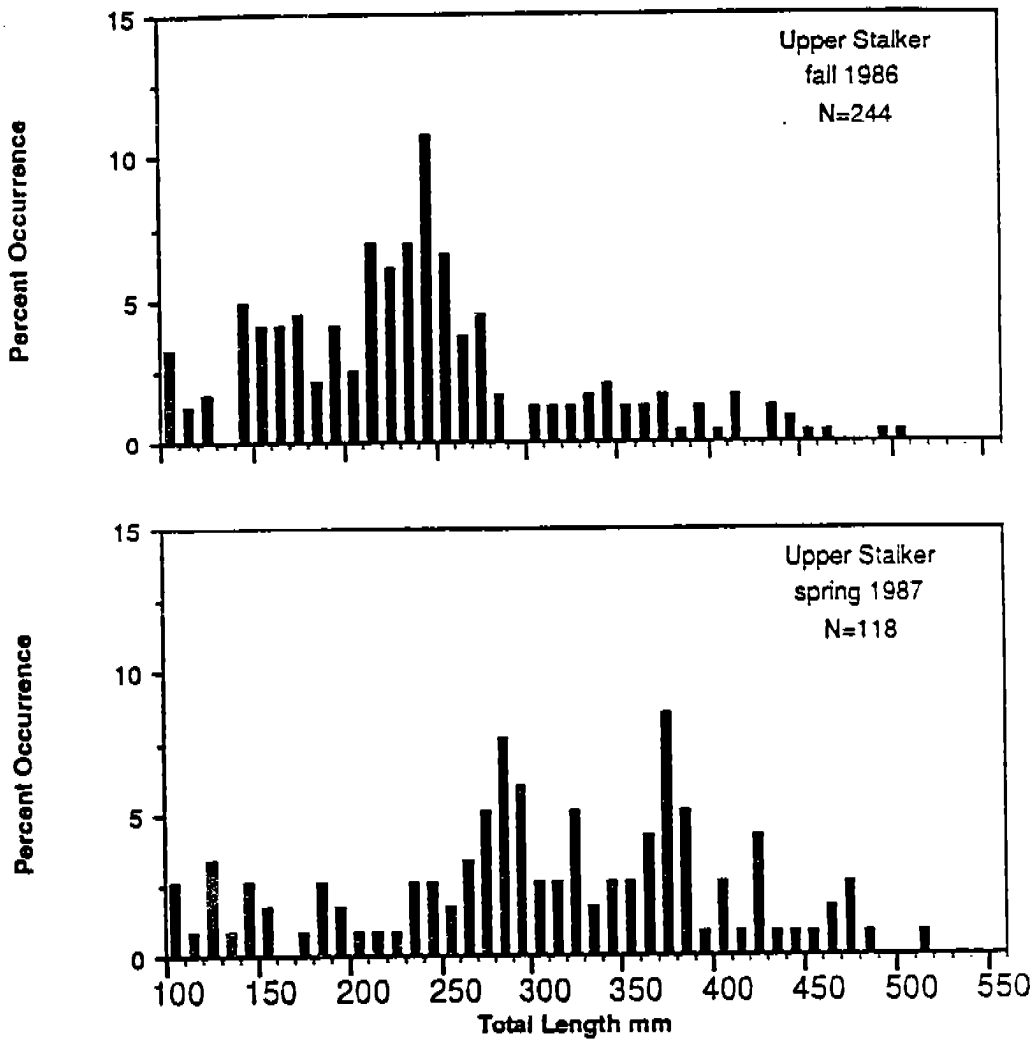

Figure 4. Length frequency histograms of rainbow trout electrofished in the Upper Stalker site, for the fall 1986 and spring 1987 samples.

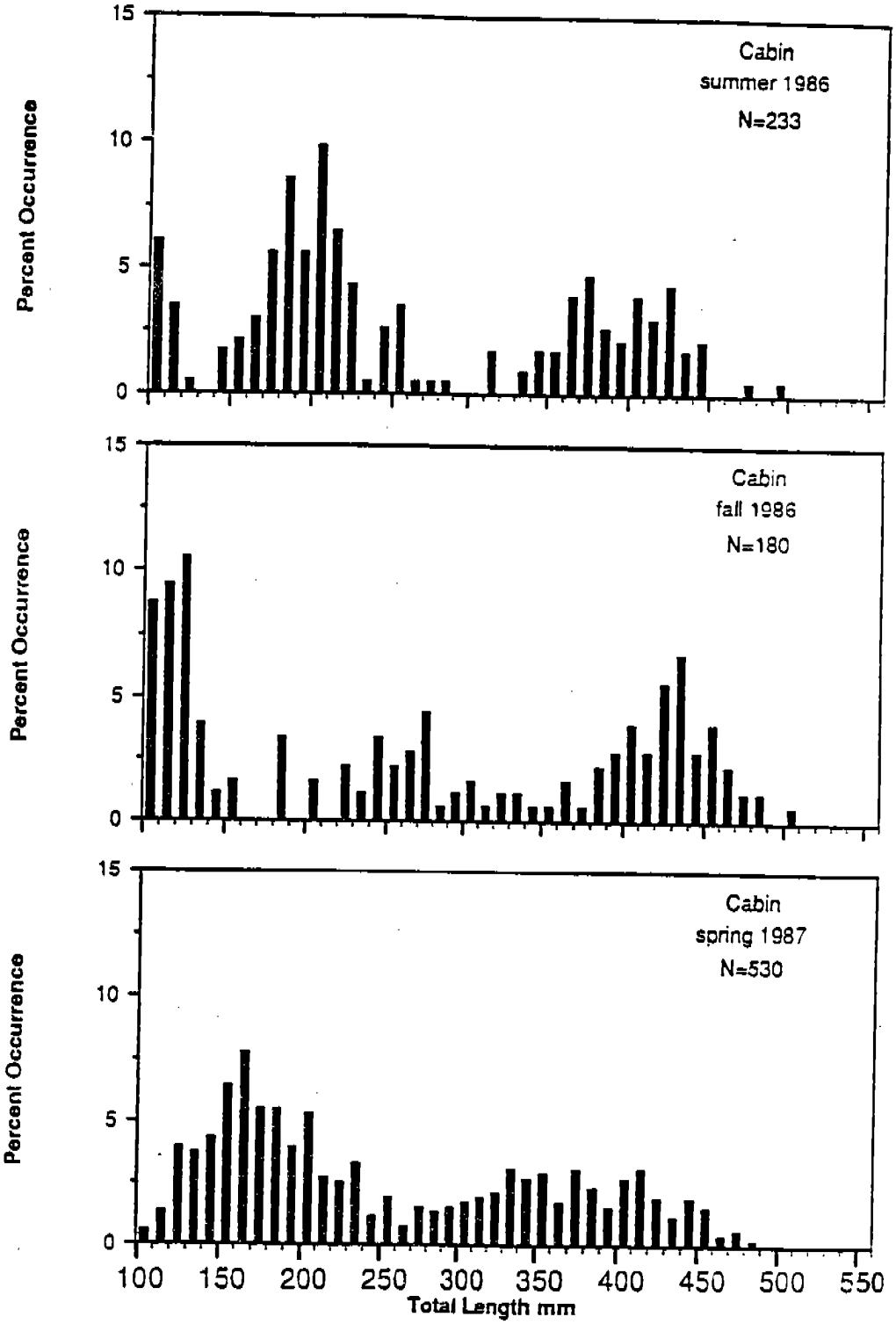

Figure 5. Length frequency histograms of rainbow trout electrofished in the Cabin site, for the summer 1986, fall 1986 and spring 1987 samples.

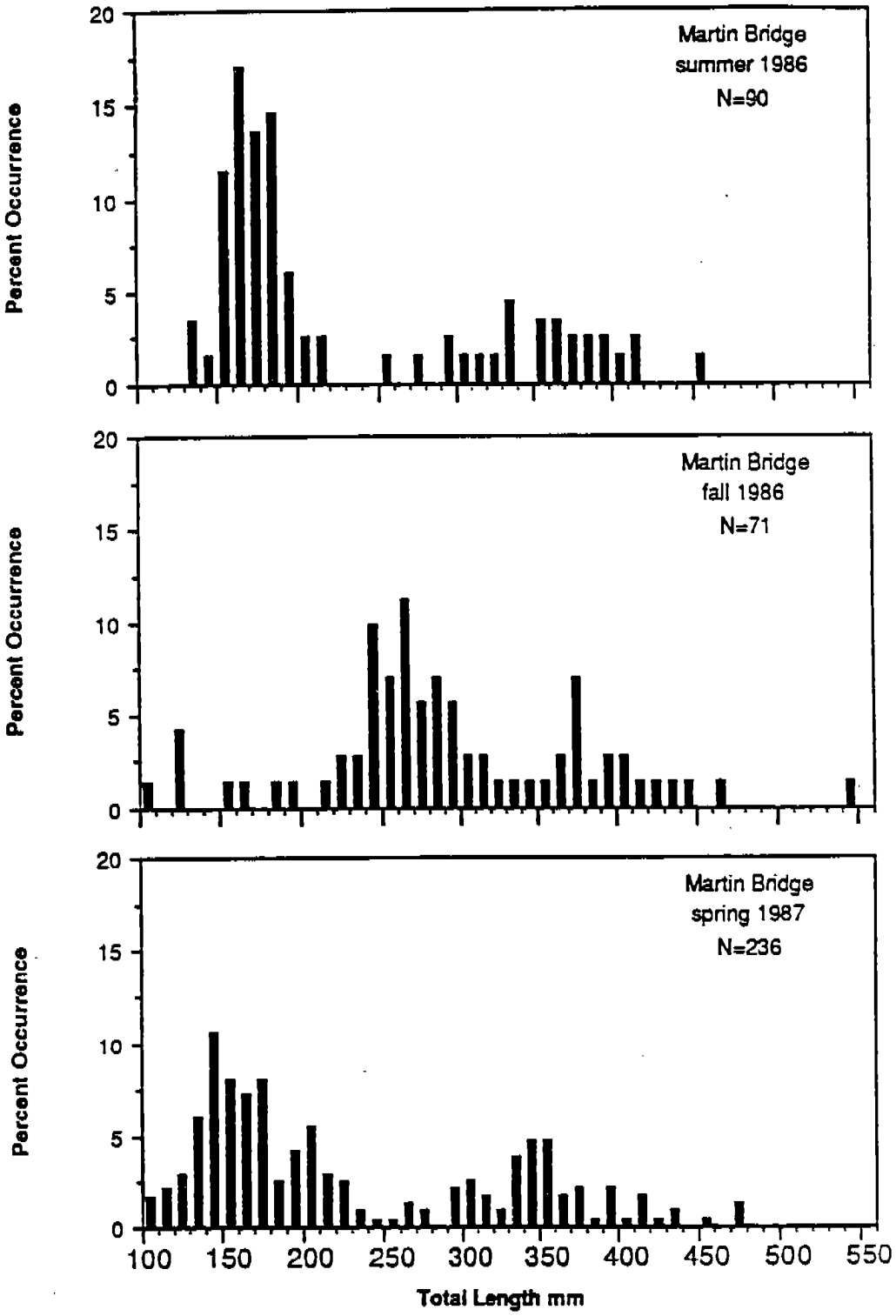

Figure 6. Length frequency histograms of rainbow trout electrofished in the Martin Bridge site, for the summer 1986, fall 1986 and spring 1987 samples.

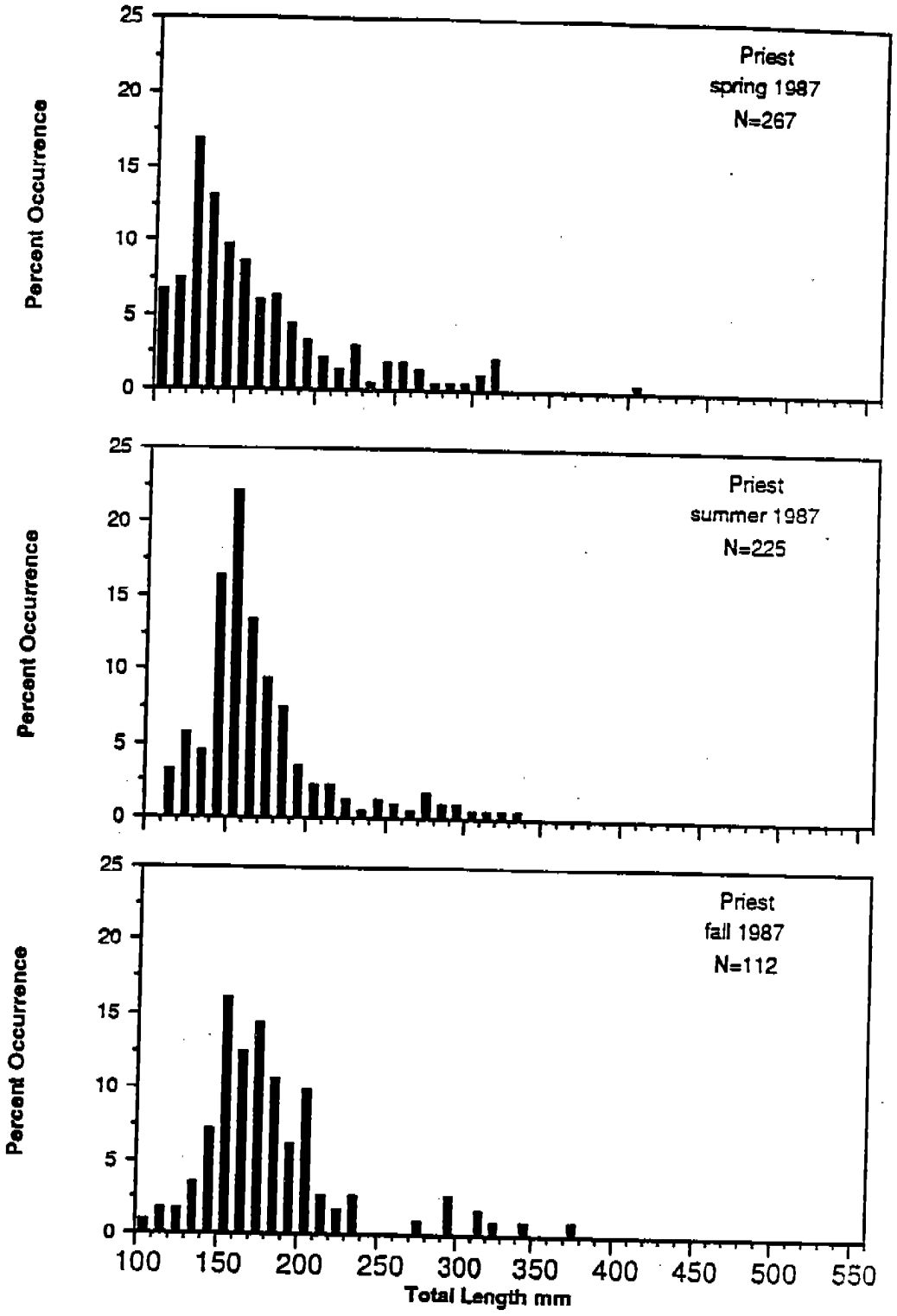

Figure 7. Length frequency histograms of rainbow trout electrofished in the Priest site, for the spring 1987, summer 1987 and fall 1987 samples.

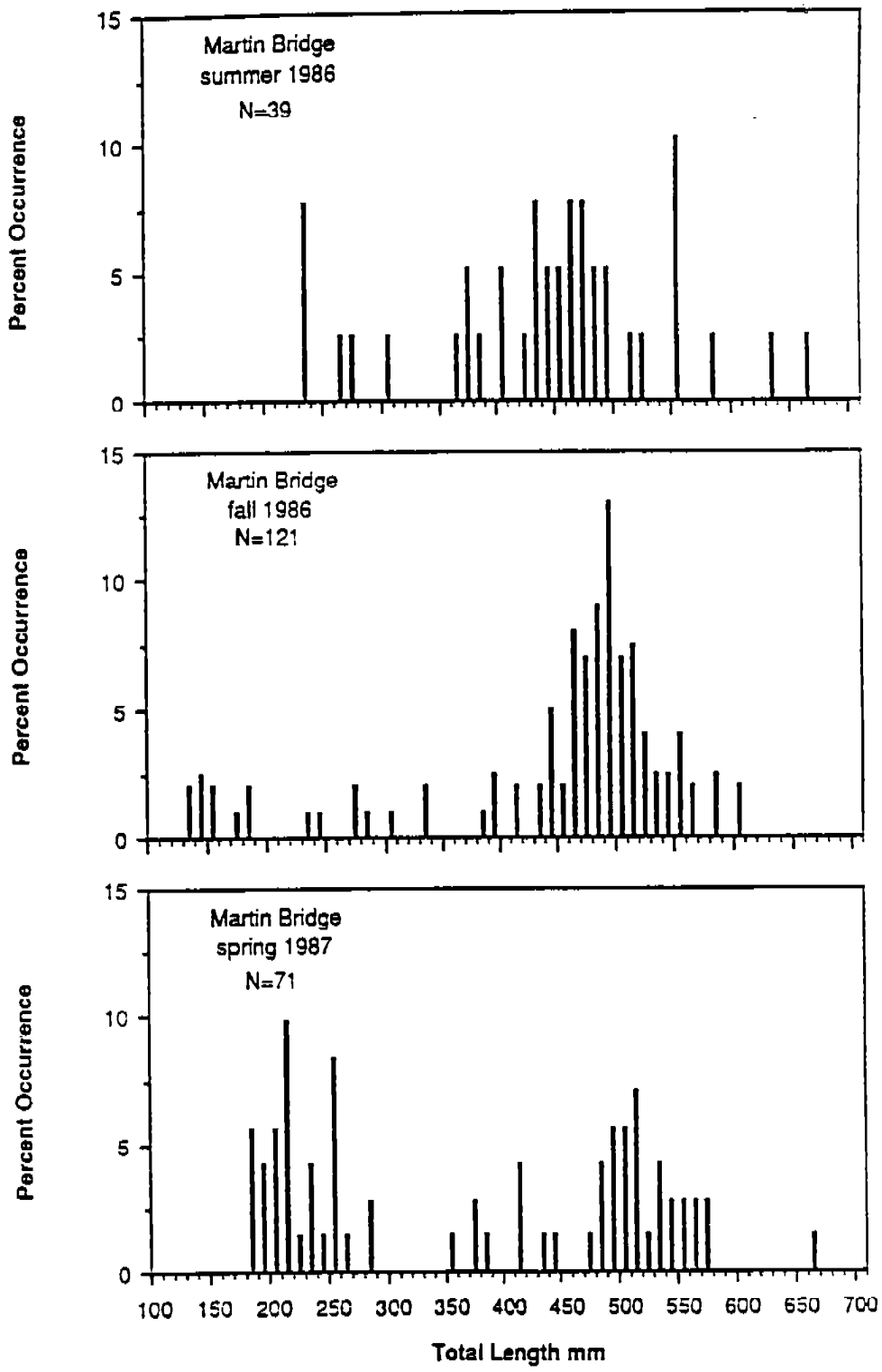

Figure 8. Length frequency histograms of brown trout electrofished in the Martin Bridge site, for the summer 1986, fall 1986 and spring 1987 samples.

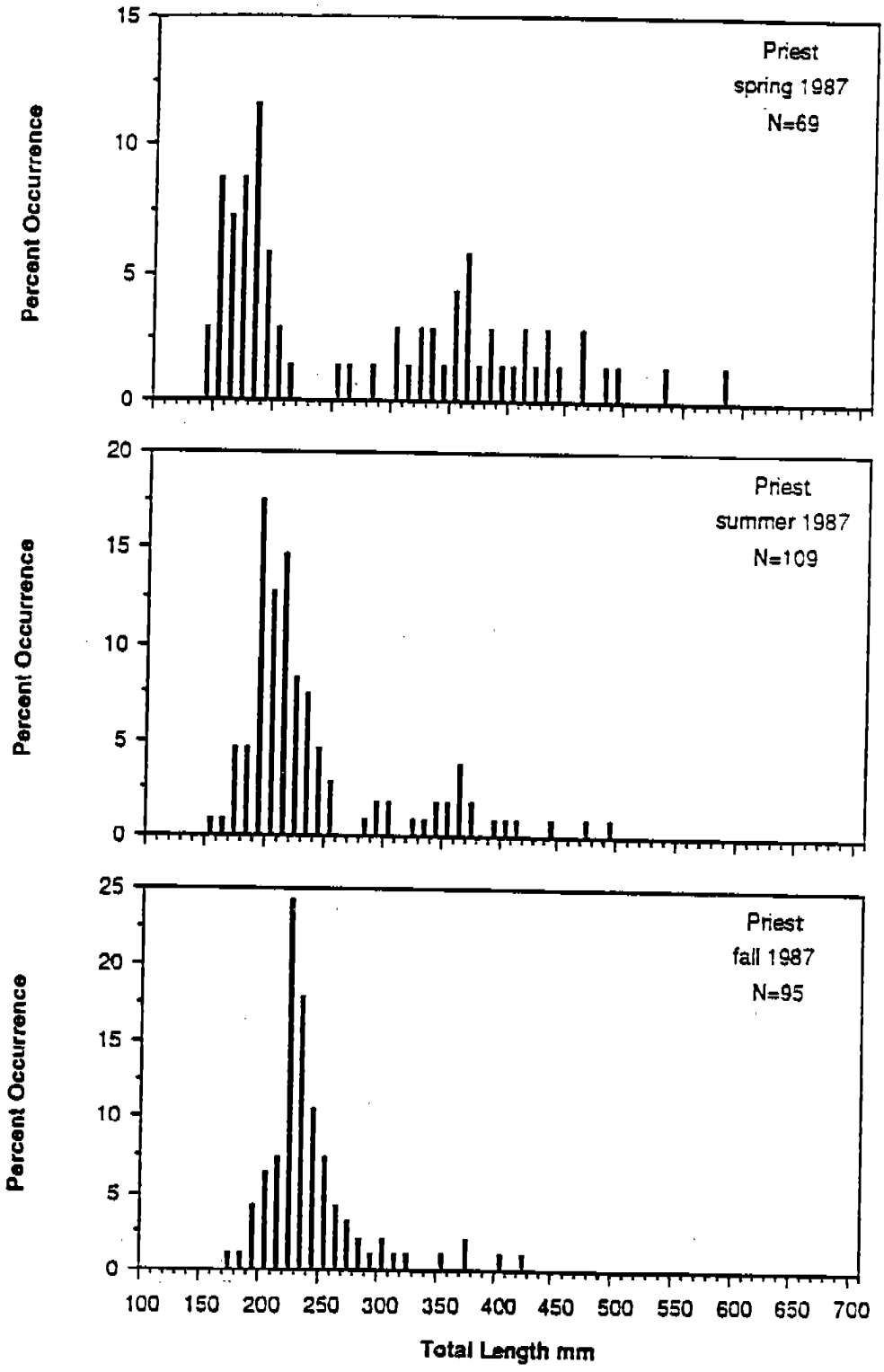

Figure 9. Length frequency histograms of brown trout electrofished in the Priest site, for the spring 1987, summer 1987 and fall 1987 samples.

Table 11. Length frequencies, expressed as percentages, of brown trout from electrofishing samples from the Upper Stalker, Cabin, Martin Bridge and Priest sites.

Study site	Date	Length class in mm						
		100-199	200-299	300-399	400-499	500-599	>600	N
Upper Stalker	Fall 1986	52	8	16	24	0	0	25
Upper Stalker	Spr. 1987	50	35	10	5	0	0	20
Cabin	Fall 1986	66	3	0	12	19	0	32
Cabin	Spr. 1987	13	66	0	8	8	5	38
Martin Bridge	Sum. 1986	0	13	13	51	18	5	39
Martin Bridge	Fall 1986	9	4	6	48	31	2	121
Martin Bridge	Spr. 1987	15	30	6	24	24	1	71
Priest	Sum. 1986	13	22	48	17	0	0	46
Priest	Spr. 1987	45	8	28	16	3	0	69
Priest	Sum. 1987	28	53	14	5	0	0	109
Priest	Fall 1987	6	84	8	2	0	0	95

Day versus Night Sampling

Night sampling was the more efficient method of electrofishing for rainbow trout and brown trout in slow water. More rainbow trout were captured during the night sampling in the Cabin and Martin Bridge sites (Table 12). In the fast water of Priest, however, more rainbow trout were caught during the day sampling than the night sampling. The rapids habitat of Priest is primarily day habitat (use at night tends to be in the margins and areas of low velocity) for the age 1 and 2 rainbow trout which comprised most of the electrofishing sample for both the day and the night. For all sites, more brown trout were caught in the night samples than in the day, although total numbers of brown trout were low for both times (Table 12).

Comparisons of length frequencies between matched day and night samples did not show any bias toward larger rainbow trout at night (Table 12). In the Cabin site, 16% more rainbow trout in the 300-399 mm class and 14% more in the 400-499 mm class were caught during the day. Rainbow trout held in pools during the day and were captured easily, although avoidance in the shallow areas was a problem during the day. Sample sizes in the Martin Bridge site were low, although no bias to smaller rainbow in the day samples was apparent. In the Priest site, the distribution of sizes of rainbow trout were similar for both the day and the night samples (Table 12).

Age and Growth

We found the largest increases in rainbow trout growth and longevity in the Cabin site. Less change occurred in the Martin Bridge and Priest sites. The mean length at age for the 1977 catch-and-release rainbow trout sample increased by 13 mm when compared with the 1987 sample of similar age fish (Table 13). Variation among the older age classes proved to be inconsistent for trend analysis. Longevity among rainbow trout in the 1976 and 1977 catch-and-release samples peaked at age 4 fish. Samples collected in 1986 and 1987 from the Cabin site showed an additional age class, with age 5 rainbow trout captured in both years.

The Martin Bridge sample showed a decrease in the mean length for age 1 rainbow trout when comparisons were made between the 1977 and fall 1986 samples (Table 13). As with the Cabin site, age 4 was the maximum age found in the electrofishing samples of 1977. Again, we found age 5 rainbow trout in our 1986 to 1987 evaluation. Age 5 fish were only found in the spring 1987 sample, and the proportion in the sample was approximately half of that found in the Cabin site (Table 13). Rainbow trout in the Priest site grew the slowest compared to our upstream study sites (Table 13). Age 4 was the maximum attained by rainbow trout in the 1986 and 1987 Priest site electrofishing samples.

Table 12. Day versus night electrofishing comparisons for rainbow trout and brown trout. Percentages of fish are shown in 100 mm increments.

Site and species		Number of fish caught	Size of fish (mm) <200	200-299	300-399	400-499	500-599	>600
Rainbow Trout								
Cabin								
21 May	Day	44	21	11	45	23	0	0
26 May	Night	137	45	17	29	9	0	0
Martin								
17 May	Day	10	30	0	70	0	0	0
18 May	Night	26	27	31	38	4	0	0
Priest								
16 May	Day	84	92	7	1	0	0	0
18 May	Night	43	84	14	0	2	0	0
Brown Trout								
Cabin								
21 May	Day	3	33	66	0	0	0	0
26 May	Night	9	0	78	0	0	11	11
Martin								
17 May	Day	3	0	33	0	33	33	0
18 May	Night	11	0	18	0	18	64	0
Priest								
16 May	Day	6	83	0	17	0	0	0
18 May	Night	14	22	14	43	14	7	0

Table 13. Back-calculated lengths (mm) for rainbow trout in Silver Creek from 1976 to 1987. Asterisk denotes a significant difference between age 1+ fish using a two sample t-test ($P < 0.05$).

Study site and source	Sample size	Estimated length at age 1	2	3	4	5
Cabin (Section 1)						
1976-77[a]	77	112	208	280	349	
Present Study, fall 1986 and spring 1987	505	126	213	294	358	389
Martin Bridge (Section 3)						
1976-77[a]	52	139	212	297	361	
Present Study, fall 1986 and spring 1987	256	122*	205	268	347	426
Priest (Section 5)						
Present Study, spring 1987	198	108	191	274	319	

[a] Thurow, 1978.

Table 14. Growth increments for Silver Creek rainbow trout and brown trout from the 1976-77 and 1986-87 field seasons.

Study Section	Sample Date	Sample Size	Mean Growth Increment at Age (mm)						
			1	2	3	4	5	6	7
Rainbow trout									
Section 1	1976	27	96	96	75	40	--	--	--
Section 1	1977	50	121	96	68	83	--	--	--
Cabin	Fall 1986	71	151	78	76	62	38	--	--
Cabin	Spring 1987	434	125	77	71	59	43	--	--
Section 2	1976	37	117	95	81	7	--	--	--
Section 2	1977	30	128	80	90	57	--	--	--
Section 3	1976	18	133	71	86	60	--	--	--
Section 3	1977	34	143	73	87	76	--	--	--
Martin Bridge	Fall 1986	42	167	69	77	83	--	--	--
Martin Bridge	Spring 1987	212	121	88	39	68	55	--	--
Priest	Spring 1987	198	112	74	66	71	--	--	--
Brown trout									
Martin Bridge	Spring 1987	70	157	74	84	72	65	48	48
Priest	Spring 1987	63	135	109	82	60	68	50	52

Brown trout mean length at age was substantially higher than that of rainbow trout in respective sections. In the Martin Bridge site, mean length at age 1 of brown trout was 157 mm compared to 117 mm for rainbow trout. Similar differences occurred in the Priest site sample (Table 14). For all ages, brown trout were generally larger than similarly-aged rainbow trout. Also, brown trout exhibited greater longevity than rainbow trout, attaining a maximum of 7 years of age as compared to a 5 year maximum for rainbow trout (Table 14).

Condition

In the Cabin and Martin Bridge sites, a significant decrease in mean condition factor was noted in rainbow trout from the fall of 1986 to the spring of 1987. In the Priest site, although the samples were not consecutive (fall and spring), a decrease in mean condition did occur. Changes in condition for sites other than Martin Bridge, however, were not significant at the $P < 0.05$ level using the Mann-Whitney test (Table 15). For brown trout at the Martin Bridge and Priest sites, seasonal decreases in condition factor were also not significant (Table 16). The differences in condition factors of rainbow trout between 1977 and 1987 samples were not significant (Table 17), using the Mann-Whitney test (Zar 1984).

Regression analysis was used to further test the relationship between length and weight. Changes in the length-weight relationships between seasons, within sites as determined by t-tests of the regression coefficients were not significant for all sites, confirming what the condition factor tests had shown. Differences between sites for each season were also found to be non-significant (Table 18).

Hookscarred Fish

Rainbow trout were generally hookscarred at a higher proportion than were brown trout. The highest extent of hookscarring for rainbow trout longer than 100 mm was 26% for the Cabin site during the summer of 1986 (Table 19). For rainbow trout exceeding 250 mm in length, hookscarring increased from 15% in 1977 to 24% for combined Cabin site samples in 1986. The lowest extent of hookscarring among rainbow trout was 1% of fish exceeding 100 mm in thespring 1987 sample from the Martin Bridge site (Table 19). The greatest hookscarring of brown trout occurred in the Cabin and Martin Bridge sites in the summer of 1986, when 20% of the fish exceeding 100 mm in length were scarred. Most of these brown trout were yearlings. This proportion exceeded that of scarred rainbow in those sections at that time. Brown trout showed little or no scarring in the upper Stalker and Martin Bridge sites in the spring of 1987 (Table 19).

To assess if differences existed in the condition of hookscarred and non-hookscarred fish, rainbow trout samples from the Cabin site were tested using a two sample t-test (Table 20). The 1986 summer sample was the only sample in which similar sample sizes occurred between hookscarred and non-hookscarred rainbow. For all size classes, no significant differences in condition were found.

Table 15. Condition factors (K) of rainbow trout in the Cabin, Martin Bridge, and Priest study sites for fall 1986 and spring 1987 sampling periods. Mean condition factors marked with asterisk if significantly different, within size classes, between seasons for each site (Mann-Whitney Test, $P < 0.05$).

Sampling period and size classes	Mean length (mm)	Mean condition factors	Number in sample
Cabin			
Fall 1986			
<200 mm	126	1.04	32
200-299 mm	243	1.01	33
300-380 mm	348	0.99	18
>380 mm	415	0.97	52
Spring 1987			
<200 mm	155	1.02	244
200-299 mm	241	1.01	96
300-380 mm	341	0.98	94
>380 mm	416	0.93	67
Martin Bridge			
Fall 1986			
<200 mm	148	1.10	8
200-299 mm	259	1.11	37
300-380 mm	344	1.05	14
>380 mm	427	1.04	11
Spring 1987			
<200 mm	154	0.91*	94
200-299 mm	229	0.98*	35
300-380 mm	340	0.96	43
>380 mm	427	1.03	10
Priest			
Spring 1987			
<200 mm	146	1.01	155
200-299 mm	239	1.00	28
300-380 mm	322	1.06	9
>380 mm	415	1.22	1
Fall 1987			
<200 mm	165	0.99	82
200-299 mm	226	0.95	23
300-380 mm	336	0.99	5
>380 mm			

Table 16. Condition factors (K) of brown trout in the Martin Bridge and Priest sites. No significant differences were found within similar size classes between seasons using the Mann-Whitney Test ($P < 0.05$).

Sampling period and size classes	Mean length	Mean condition factor	Number in sample
Martin Bridge			
Summer 1986			
<200 mm			
200-299 mm	251	1.00	6
300-399 mm	358	1.27	4
400-499 mm	454	1.16	21
>500 mm	541	1.06	6
Fall 1986			
<200 mm	157	1.02	10
200-299 mm	268	1.13	4
300-399 mm	365	1.07	4
400-499 mm	471	1.12	8
>500 mm	529	1.06	34
Spring 1987			
<200 mm	185	1.15	10
200-299 mm	233	1.04	17
300-399 mm	362	1.05	4
400-499 mm	455	1.04	10
>500 mm	540	0.98	16
Priest			
Spring 1987			
<200 mm	175	1.09	25
200-299 mm	239	1.11	6
300-380 mm	345	1.15	16
>380 mm	439	1.01	5
Summer 1987			
<200 mm	188	1.01	28
200-299 mm	224	1.05	58
300-380 mm	346	1.08	14
>380 mm	438	1.00	5
Fall 1987			
<200 mm	190	0.95	5
200-299 mm	236	0.97	78
300-380 mm	336	1.03	7
>380 mm	416	0.95	2

Table 17. Condition factors (K) of rainbow trout electrofished within Section 1 and Section 3 study sections during fall 1976 and spring 1977 sampling periods (Thurow 1978).

Sample Period and Size Classes	Mean length (mm)	Mean condition factor	Sample size
Section 1			
Fall 1976			
<200 mm	138	1.00	5
200-299 mm	251	0.99	15
300-380 mm	333	1.01	13
>380 mm	396	1.01	4
Spring 1977			
<200 mm	161	0.89	1
200-299 mm	268	1.03	4
300-380 mm	337	0.96	4
>380 mm	444	0.94	2
Section 3			
Fall 1976			
<200 mm	129	1.28	6
200-299 mm	240	1.06	6
300-380 mm	327	0.93	2
>380 mm	428	1.02	6
Spring 1977			
<200 mm	159	0.91	2
200-299 mm	264	0.97	13
300-380 mm	338	1.06	8
>380 mm	394	1.05	2

Table 18. Length-weight regressions for Silver Creek rainbow trout and brown trout in selected sites. Comparisons between sites within sample dates were found to not be significant with a regressions test ($P < 0.05$).

Study site and sample date	Constants	X-coefficients	R-squared values	Sample size
Rainbow trout				
Cabin				
Summer 1986	-4.62	2.8484	0.969	229
Fall 1986	-4.94	2.9717	0.994	165
Spring 1987	-4.84	2.9321	0.989	502
Martin Bridge				
Summer 1986	-4.99	2.9911	0.979	90
Fall 1986	-4.87	2.9589	0.987	70
Spring 1987	-4.77	2.9024	0.984	182
Priest				
Summer 1986	-5.43	3.1857	0.952	87
Spring 1987	-5.02	3.0083	0.958	193
Summer 1987	-4.85	2.9259	0.915	225
Fall 1987	-4.86	2.9347	0.961	110
Brown trout				
Cabin				
Fall 1986	-5.14	3.0702	0.982	29
Martin Bridge				
Fall 1986	-4.47	2.8142	0.959	114
Spring 1987	-4.73	2.9014	0.993	58
Priest				
Spring 1987	-4.69	2.8896	0.904	62
Summer 1987	-5.05	3.0309	0.989	105
Fall 1987	-5.23	3.0916	0.980	93

Table 19. Percentages of hookscarred rainbow trout and brown trout exceeding 100 mm, that were captured by electrofishing in Stalker Creek and Silver Creek.

Study site and sample time	Rainbow		Brown	
	Number captured	Percent scarred	Number captured	Percent scarred
Summer 1986				
Cabin	247	26	17	0
Martin Bridge	101	10	41	20
Priest	81	7	45	20
Fall 1986				
Upper Stalker	258	2	23	9
Cabin	174	12	29	3
Martin Bridge	72	8	111	4
Spring 1987				
Upper Stalker	107	5	23	0
Cabin	537	5	37	3
Martin Bridge	235	1	72	0
Priest	262	2	70	1
Summer 1987				
Priest	226	8	110	6
Fall 1987				
Priest	110	9	150	5

Table 20. Condition factors (K) of hookscarred and non-hookscarred rainbow trout from the Cabin electrofishing site, 1986 summer sample. Comparisons between like size classes were not found to be significantly different using a two sample t-test ($P < 0.05$).

	Hookscarred		Non-Hookscarred	
Size class (mm)	Mean condition factor	Number in sample	Mean condition factor	Number in sample
100-199	1.07	8	1.17	50
200-299	1.08	17	1.15	30
300-399	0.97	16	1.04	33
400-499	0.95	10	0.95	34

Mortality

In the Cabin site, annual mortality (A) for rainbow trout ranged from 0.44 to a high of 0.53 for age 3 and older fish. This represents a decrease from 0.67 in 1977. The estimate of natural mortality rate for the Cabin site (from 0.39 to 0.57, Table 21) includes hooking mortality because the site is in the catch-and-release area. The Martin Bridge site spring estimate of annual mortality for age 3 and older fish was 0.42, intermediate between the two Cabin site estimates. The spring mortality estimate was lower than the fall estimate for the Martin Bridge site, and may have been due to an influx of large spawning rainbow trout during the spring. Both 1986 and 1987 annual mortality estimates for the Martin Bridge site were less than the 0.72 value determined in 1977. The exploitation rate of age 3 and older rainbow trout was 0.38. The instantaneous total mortality (Z) rate was 1.01 and 0.54 in the fall of 1986 and spring of 1987, respectively, displaying the degree of fluctuation in the population of the site. In the Priest site, the instantaneous rate of total mortality (Z) was 1.48, the highest of all the rainbow trout estimates. Harvest was relatively low, and resulted in a low exploitaition rate of 0.12. Therefore, using this model results in a high natural mortality of 1.26. The absence of older fish is reflected in an annual mortality rate of 0.77.

Estimates of mortality were calculated for ages 4 and older for the brown trout of the Martin Bridge site because age 3 fish were not fully recruited into the sampling. For the older ages, annual mortality was quite low, A = 0.39 (Table 21). Exploitation (u) was low at 0.04 and suggests low vulnerability of the older brown trout to harvest. This estimate, however, may be an underestimate because the brown trout population density obtained for the Martin Bridge site was expanded to the entire Section 3. In areas outside of Martin Bridge, brown trout may not be nearly as abundant as in that site. When the open area of Point of Rocks was sampled in the summer of 1986, too few fish were captured to calculate a population estimate. Point of Rocks is the extreme opposite in habitat from Martin Bridge, however. From the frequency of capture estimates, we have shown that only 5% of the tagged brown trout in Section 3 were captured by angling (Table 22). The low catchability of brown trout greater than 350 mm in length suggests that exploitation of large fish is low in Martin Bridge site. Total annual mortality of brown trout in the Priest site (0.42 for age 3 and older fish) was higher than that of Martin Bridge. Fishing and natural mortality could not be calculated because of immigration into the site during the summer (Table 7). In both the Martin Bridge and Priest sites, annual mortality was lower for brown trout than rainbow trout.

Redd Counts

The count of rainbow trout redds in Section 3 was 240, giving a density of 28.9 redds/km (Table 23 and Figure 3). The majority of the redds in Section 3 were found in the upper portion, with the highest density occurring in the Martin Bridge area (45.9 redds/km). In Sections 4

Table 21. Estimates of mortality and survival for rainbow trout and brown trout calculated at time of sampling in Silver Creek study sites. Hooking mortality was included in the natural mortality estimates for the Cabin site.

	Rainbow					Brown	
	Cabin[b]		Martin[b]		Priest[a]	Martin[c]	Priest
	Fall 86	Spring 87	Fall 86	Spring 87	Spring 87	Spring 87	Spring 87
Survival rate (S)	0.47	0.56	0.33	0.58	0.23	0.61	0.58
Instantaneous rate of total mortality (Z)	0.75	0.57	1.10	0.54	1.48	0.49	0.54
Annual mortality (A)	0.53	0.44	0.67	0.42	0.77	0.39	0.42
Instantaneous rate of fishing mortality (F)				0.49	0.22	0.05	
Instantaneous rate of natural mortality (M)	0.39	0.57		0.05	1.26	0.47	
Rate of exploitation u(E)				0.38	0.12	0.04	
Expectation of natural death v(D)	0.33	0.44		0.04	0.66	0.372	

[a] Age 2 vs. 3 and older

[b] Age 3 vs. 4 and older

[c] Age 4 vs. 5 and older

Table 22. Movement (m) of jaw tagged rainbow trout and brown trout out of electrofishing sites as reported by anglers during the 1987 angling season.

	Rainbow trout				Brown trout			
	Upper Stalker	Cabin	Martin Bridge	Priest	Upper Stalker	Cabin	Martin Bridge	Priest
# Tagged	53	152	75	1	7	16	157	29
# Reported Caught	3	37	6	1	1	1	7	2
Percent Captured	6	24	8	100	14	6	5	7
# Caught in same Section	1	22	2	0	0	0	2	0
# Moved Upstream	0	3	0	0	0	0	2	1
# Moved Downstream	2	8	2	0	1	1	2	0
Movement Unknown	0	4	2	1	0	0	1	1
Movement Range in meters[a]	+250-3000	+750-850	+1750-28950		-4250	-500	+2750-12000	+17600

[a] Upstream movement (+) and downstream movement (-) are denoted by these respective symbols.

Table 23. Counts of rainbow trout redds in Silver Creek on April 17, 1987.

Section	Number of redds	Length of section (km)	Density (Redds/km)
Section 3	240	8.30	28.9
A - Hwy. 20 downstream to Martin Bridge	44	1.00	44.0
B - Martin Bridge downstream to Point of Rocks	123	2.68	45.9
C - Point of Rocks downstream to Picabo Bridge	73	4.63	15.8
Section 4	4	1.71	2.3
Section 5 Sites A & B	3	1.47	2.1

and 5 combined, only 7 redds were counted in 3.2 km of stream. Although densities may actually be lower than that of Section 3, poor visibility due to high water turbidity may have decreased the effectiveness of the counts in Sections 4 and 5. For this reason, only Section 3 data are considered reliable because of adequate visibility during the sampling. Based on Section 3 data alone, there appears to be substantial rainbow trout spawning occurring in the middle portion of Silver Creek.

Trout Movement

Movement of tagged fish out of the electrofishing sites was approximated from the angler description of the place the fish was caught. Only Section 1 had sufficient angler-reported catch information on rainbow trout to allow for analysis of movement (Table 22). From 152 rainbow trout tagged in the Cabin site in the fall of 1986 and spring 1987, 37 fish, or 25%, were reported to be captured by anglers during the 1987 fishing season. Those rainbow trout that were caught by anglers within the electrofishing site in which they were tagged represented 67% of those reported (Table 22). Downstream movement was displayed by 24%, and upstream movement by 9%, of the rainbow trout caught. No fish were found to have moved more than 850 m out of the Cabin site. Although most fish that moved did so in the downstream direction, movement was not substantial.

The only rainbow trout large enough to be tagged in the Priest site was caught by an angler in the 1987 angling season. Angler- reported capture was low in all other sites for both rainbow trout and brown trout, with a range of 6 to 14% reported. Therefore, trends in movement could not be determined by the data available. The longest distance moved was 29 km by a rainbow trout tagged in the Martin Bridge site. One brown trout and one brook trout did pass upstream and downstream through the diversion dam forming Kilpatrick Pond and through the diversion dam just below the Highway 20 bridge in Section 3. These dams do not appear to be complete barriers to fish movement.

Disturbance of Trout by Anglers

Rainbow trout exhibited little or no change in behavior in response to different levels of angling pressure (Table 24). Although trout did feed on a number of *Ephemeroptera* spp., only feeding rates on *Tricorythodes minutus* were analyzed because this species was fed on throughout the entire study. Feeding rates of 27, 26, and 27 *T. minutus*/min were observed for periods of angling, angler exclusion, and angling resumed, respectively (Table 24). Based on these data, high angling presure did not alter the surface-feeding frequency of rainbow trout.

The number of adult rainbow trout within the study site changed very little during the course of the study. The greatest abundance of adult trout (11 individuals) was observed during the period of angling exclusion (Table 24). This represents an increase of one fish from the period of angling to the period of angler exclusion, and may be the result of increased angler effort near the boundaries of the study site during the

Table 24. Mean values of feeding rates, trout numbers, feeding velocities and depths of surface feeding rainbow trout from the trout disturbance study on Silver Creek, summer 1987.

Phase of study	Feeding rates (feeds/min)	Number of trout feeding	Feeding velocities (cm/sec)	Feeding depths (cm)
With Angling	27	10	30.5	49
Range	8-35	4-20	23-41	20-66
Std. Dev.	8.0	7.0	0.27	11.4
N	10	91	88	75
Without Angling	26	11	30.5	40
Range	11-35	3-19	3-53	19-54
Std. Dev.	7.0	6.3	0.36	8.8
N	20	98	60	60
With Angling	27	9	30.5	40
Range	26-29	3-16	10-53	20-47
Std. Dev.	1.3	3.5	0.36	9.9
N	5	93	56	56

exclusion period. A decrease in the mean of two fish was noted after angling was resumed within the site. Anglers appeared to have moved fish to a limited extent from one area to another, although fish remained feeding and showed no signs of alarm (i.e. sulking, changes in color, flight behavior).

Mean water velocity at the point at which fish were feeding was 30.5 cm/s for all three treatment periods. The mean depth of water used by feeding fish did decrease, however, from 49 to 40 cm from the first angling period to the angler exclusion period. This decrease may have been a result of declining stream flows because the distribution of fish within the study area remained fairly consistent for the entire study.

Surface drift data showed that *Tricorythodes minutus* was the most abundant during the study, with more than 800 individual mayflies passing into the 13 cm wide opening of a net per minute. Because of this abundance of food, adult trout could conceivably ingest enough prey in 1-2 h to sustain their daily energy requirements for the next 16 to 20 h.

Angler Effort

Angling effort was heaviest during Intervals I, V, and VI, with total estimated effort of 5,641, 3,718, and 3,697 hours, respectively (Figure 10). Effort during these three intervals accounted for 44% of the total effort expended.

In Section 1, effort was estimated at 130 h/hectare during the first two weeks of the season. By Interval III (June 20-July 3), effort had declined substantially to 71 h/hectare (Figure 10). During the period between July 18 to July 31 (Interval V), Section 1 received the highest effort of the season for any section, estimated at 156 h/hectare. This peak in effort coincided with the most abundant yearly hatches of the mayfly *Tricorythodes minutus*. Effort declined throughout the remainder of the season (Figure 10).

Effort in Section 2 peaked during the first interval at 110 h/hectare. During Interval II (June 6 to June 19), effort declined to 61 h/hectare but rose with the increase in summer mayfly hatches as in Section 1. Effort remained fairly constant throughout the late summer and into October (Figure 10).

Section 3 received the greatest effort of any section during the first interval with a total of 2,277 hours expended. When expressed as density, however, only 102 h/hectare were expended in Section 3 during the first interval. The majority of this effort occurred on opening weekend of the angling season (Memorial Day weekend). Sections 1 and 2 received less total hours during Interval I (May 23 to June 5), but did have higher angler densities than Section 3. An increase in effort in Section 3 was again noted in the mid-summer and peaked during Interval VI (August 1 to August 14). Late summer and fall effort declined steadily from 38 h/hectare in Interval VI to approximately 2 h/hectare during Interval XIV (November 20 to November 29; Figure 10).

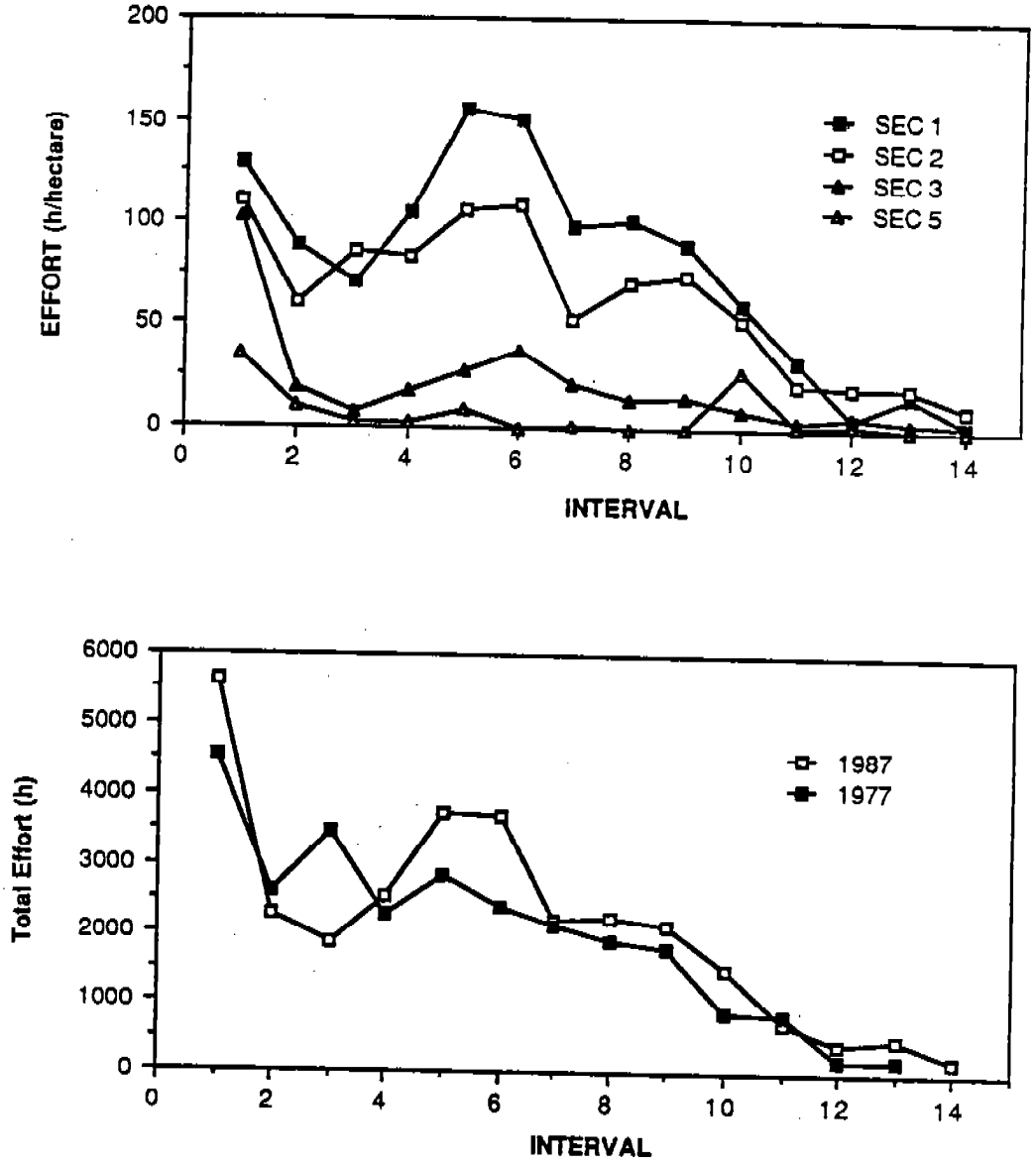

Figure 10. Estimated angler effort by section on Silver Creek for the 1987 season. Effort from all sections was pooled for the 1987 and 1977 comparison.

Section 5 received 589 h/hectare for the 1987 angling season, second in angler density only to Section 1. The highest amount of effort, 35 h/hectare, was expended during the first interval. Effort for the rest of the season was less than 10 h/hectare for all remaining intervals except Interval X (September 26 to October 9), which received 28 h/hectare. This may have been the result of the upland bird season opener, because a number of hunters were observed camping and fishing in the area.

In all sections, effort peaked during Intervals I, V and VI. The primary reason for the high effort in the first interval was the fishing season opening on Memorial Day weekend. Effort for opening day in 1987 was probably less than in 1986. Water conditions state-wide were high and unfishable in many streams in 1986, with the exception of those such as Silver Creek. In a 1986 preliminary survey, effort in Section 1 during Interval I was estimated at 173 h/hectare, 33% more than in 1987. Large increases in effort for Intervals V and VI were found in all sections except Section 5, where mid-summer insect hatches were probably not dense enough to attract large numbers of anglers. Effort was most similar between Sections 1 and 2 (Figure 10). Section 3 mirrored thesame fluctuations as the upper sections, but received less than one-fifth of the density of effort.

Total angling effort for Silver Creek for 1987 increased slightly over 1977. Effort for Sections 1,2,3, and 5 in 1987 totaled 29,562 hours, compared to 26,589 hours in 1977, representing an 11% increase (Table 25). Although total effort was similar, the distribution of effort among sections did change dramatically (Figure 11). Section 1 experienced the most substantial change in angling effort. In 1977, a total of 594 h/hectare were expended in contrast with 1110 h/hectare in 1987. Total estimated hours in the section increased from 7,772 in 1977 to 14,514 hours in 1987. Effort for Section 2 also increased from 343 h/hectare to 528 h/hectare. In the lower sections of Silver Creek, effort has declined just as dramatically. Section 3 effort decreased from 538 h/hectare to 289 h/hectare. Section 5 effort declined from 891 h/ha to 589 h/hectare from 1977 to 1987 (Figure 11). A small portion of Section 5 near the confluence with the Little Wood River was not counted in 1987. When Section 3 is divided into two reaches, the upper, from the Point of Rocks campground to Highway 20, and the lower, below Point of Rocks to Picabo, the recalculated estimates of effort display the difference in use within Section 3. Effort in the upper reach, including the Martin Bridge area, received 600 h/hectare, a level double that of the section as a whole (Table 25).

Angler Catch and Harvest

Section 1. Anglers captured an estimated 26,213 rainbow trout in Section 1 during the 1987 angling season (Table 26). Rainbow trout in the 100-199 mm size category represented 36% of the catch, followed by 32% for fish in the 300-399 mm catagory (Table 27). The length frequencies of angler-caught fish were similar to electrofishing samples (Table 10). Size data of fish caught in Section 1 are based on angler recall for both

Table 25. Total estimated effort on Silver Creek for the 1977 and 1987 angling seasons.

Study section	Total surface area (hectare)	Total estimated effort h		h/hectare	
		1977	1987	1977	1987
Section 1	13.1	7,772	14,514	594	1,110
Section 2	13.5	4,627	7,122	343	528
Section 3	22.2	11,963	6,417	538	289
Hwy. 20 to Pt. of Rocks	9.4		5,641		600
Pt. of Rocks to Picabo	12.8		777		61
Section 5	2.5	2,227[a]	1,509	891	589

[a] Includes a small portion of Silver Creek near its confluence with the Little Wood River was not censused in 1987.

Table 26. Estimated catch of rainbow trout in 1977 and all trout in the 1987 angling season, catch rates (fish/h) are in parentheses.

Study section	1977 Rainbow	1987 Rainbow	1987 Brown	1987 Brook
Section 1	8,803 (1.13)	26,213 (1.81)	1,221 (0.08)	688 (0.05)
Section 2	4,823 (1.04)	7,469 (1.05)	295 (0.04)	42 (0.006)
Section 3	2,846 (0.24)	8,886 (1.38)	1,356 (0.21)	141 (0.02)
Section 5	1,610 (0.72)	948 (0.63)	487 (0.32)	20 (0.01)
Total catch	18,082	43,516	3,359	891

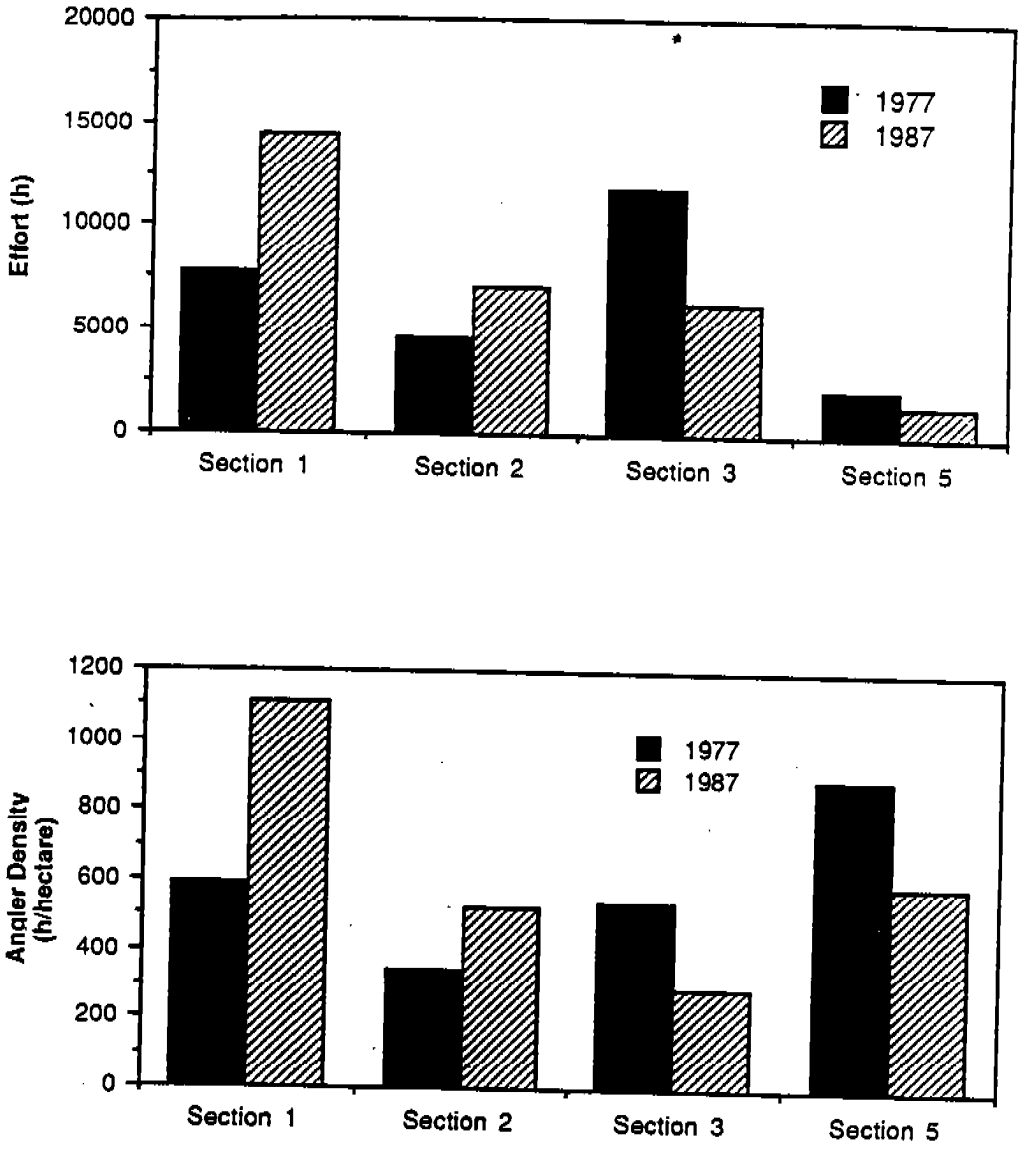

Figure 11. Estimated angler effort from the 1977 angling season compared with estimated effort from the 1987 season, for Sections 1, 2, 3, and 5. The area surveyed in 1977 was slightly larger than the area surveyed in 1987.

Table 27. Length frequencies (100 mm increments) of angler caught rainbow, brown, and brook trout in all study sections during the 1987 angling season, expressed as percentages. Values in parentheses are from the 1977 angling season.

Section and species	100-199	200-299	300-399	400-499	>500	Total fish caught (from interviews)
Section 1						
Rainbow	36	23	32	8	1	1,168
Brown	33	30	31	3	3	80
Brook	36	39	25	0	0	33
Section 2						
Rainbow	15	23	49	13	0	265
Brown	0	18	55	27	0	11
Section 3						
Rainbow	52	33	14	1	0	372
Brown	50	19	23	4	4	48
Brook	83	17	0	0	0	6
Section 5						
Rainbow	75	21	4	0	0	110
Brown	66	15	13	6	0	80
All Sections Combined						
Rainbow	39(12)	25(46)	29(32)	7(10)	<1(<1)	1915(1492)
Brown	48	22	24	6	0	219
Brook	43	37	20	0	0	39

1977 and 1987. Anglers did appear to be slightly more successful at catching large (>300 mm) rainbow trout, 41%, than was electrofishing, 35% (Table 28). Catch rates for rainbow trout increased from 1.13 fish/h in 1977 to 1.81 fish/h during the 1987 season (Figure 12). The increase in catch rates and effort resulted in a threefold increase in estimated number of rainbow trout caught, from 8,803 in 1977 to 26,213 in 1987. Overall mean size of rainbow trout caught decreased 30 mm from 1977, although the percentage of rainbow exceeding 300 mm and 400 mm increased slightly (Table 28).

Brown trout were the second most frequently captured fish in Section 1. Percentages of brown trout captured for the 100-199 mm, 200-299 mm, and 300-399 mm size classes were 33, 30, and 31%, respectively. Six percent of the browns caught exceeded 400 mm, and 3% exceeded 500 mm (Table 27). For brown trout in Section 1, electrofishing length frequencies were not similar to angler-caught length frequencies. Anglers caught proportionally more brown trout in the 100-199 mm size class than did electrofishing, 33 to 13%, while 31% of all fish caught by angling were between 300-399 mm in size and none were captured by electrofishing in this size class. This discrepancy was probably due to the overestimation of fish size by anglers, as all samples in the Cabin site showed the same lack of brown trout in the 300-399 mm size class (Table 11). Anglers, however, did capture proportions of brown trout greater than 399 mm in length that were similar to those captured in the electrofishing samples (Tables 27 and 11). The catch rate of brown trout in Section 1, 0.08 fish/h, was substantially less than that of rainbow trout. The estimated catch of brown trout was 1,221, approximately 5% of the catch of rainbow trout (Table 26).

Brook trout in Section 1 comprised a small portion of the total catch, 2.5%. All angler-caught brook trout were under 400 mm in length, and 75% were under 300 mm in length (Table 27). These percentages were similar to electrofishing samples, although a few brook trout exceeding 400 mm were captured in the electrofishing samples. Catch rates for brook trout were the lowest of the trout in Section 1, only 0.05 fish/h. Catch composition for brook trout between 1977 and 1987 was similar (Thurow 1978). An estimated 688 brook trout were captured by anglers in Section 1 during the 1987 season.

Section 2. In Section 2, 62% of the rainbow trout caught by anglers in 1987 exceeded 300 mm, the greatest percentage exceeding 300 mm in any of the sections. This percentage, however, is less than that of 1977 (Table 28). In 1987, no rainbow trout were caught in 1987 or 1977 that exceeded 500 mm. The mean length of rainbow trout caught in Section 2 declined from 336 mm in 1977 to 243 mm in 1987. Catch rates for rainbow trout were highest among bait fisherman in 1987 at 1.25 fish/h (Table 29). The overall catch rate for rainbow trout was essentially the same, 1.04 fish/h in 1977 to 1.05 fish/h in the 1987 census (Figure 12). The percentage of fish released increased from 71 to 85% over the last ten years. Harvest rates of rainbow trout in Section 2 in 1987 varied among method types (Table 30). Anglers using flies harvested 0.04 fish/h, while lure and bait

Table 28. Mean lengths (mm) of angler-caught wild rainbow trout and percentages of catch exceeding 300 mm and 400 mm for the 1977 and 1987 angling seasons. Section 1 data were collected from angler recall and data for sections 2 through 5 are from measurements of harvested fish. Parenthetical values are for all fish caught, whether they were released or harvested.

Stream section	1977				1987			
	Mean length	%>300	%>400	Sample size	Mean length	%>300	%>400	Sample size
Section 1	285	37	8	898	255	41	9	1168
Section 2	336	71	23	171	354(243)	80(62)	23(13)	30(265)
Section 3	280	44	8	146	286(213)	49(15)	6(1)	55(372)
Section 5	266	27	2	122	219(184)	12(5)	0(0)	17(110)

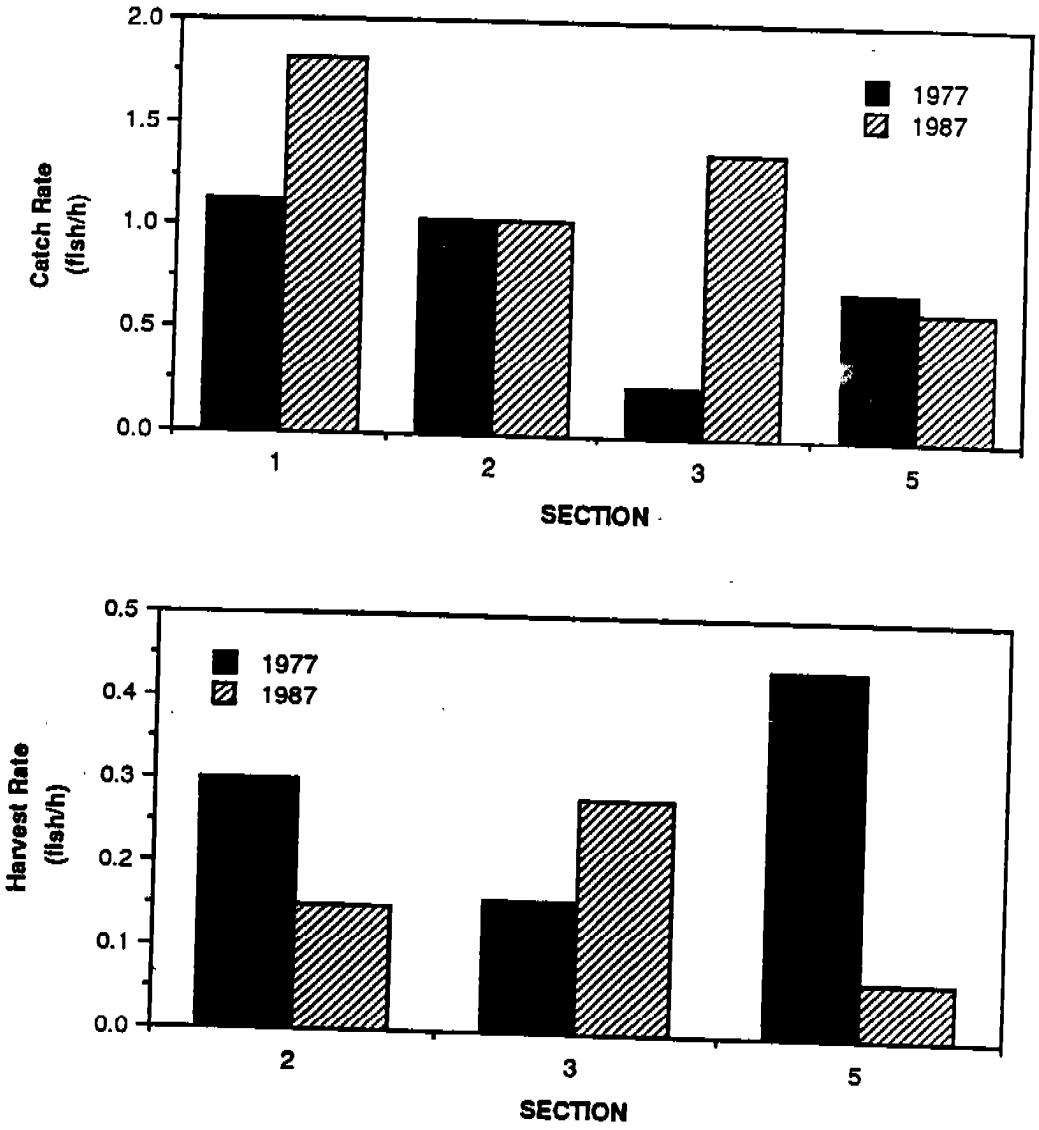

Figure 12. Catch rates and harvest rates for rainbow trout from the 1977 and 1987 angling seasons.

Table 29. Catch rates (fish/h) for Silver Creek, during the 1987 angling season.

	Fly				Bait				Lure				Total catch rate
	Rainbow	Brown	Brook	Total	Rainbow	Brown	Brook	Total	Rainbow	Brown	Brook	Total	
Sec 1	1.81	0.08	0.05	1.94									1.94
Sec 2	0.96	0.03	0.005	0.99	1.25	0.13	0.03	1.40	0.53			0.53	1.02
Sec 3	1.53	0.14	0.03	1.70	0.70	0.09	0.009	0.79	2.00	3.34	0.00	5.34	1.40
Sec 5	1.80	0.65	0.00	2.46	0.63	0.45	0.00	1.07	1.29	1.64	0.14	3.07	1.93
Total catch rates	1.58	0.12	0.03	1.73	0.78	0.21	0.009	0.99	1.09	1.22	0.09	2.39	1.64

anglers had substantially higher harvest rates at 0.33 and 0.50 fish/h. The number of rainbow trout harvested in 1987 declined from the 1977 value of 1,400 to 1,071 (Table 31).

Brown trout were not captured by anglers in Section 2 during 1977, but a few were caught in 1987. Like rainbow trout, the majority (82%) of the angler-caught brown trout exceeded 300 mm, while 27% exceeded 400 mm (Table 28). Catch rates for brown trout were low, ranging from 0.004 fish/h for fly anglers to 0.08 fish/h for bait anglers. Estimated harvest, 161 brown trout, was low in relation to the high effort expended in Section 2 (Table 31).

Brook trout were caught too infrequently to construct a length frequency. Catch rates ranged from 0.005 brook trout/h for fly anglers to 0.03 fish/h for bait anglers. An estimated 7 brook trout were harvested during the 1987 season in Section 2.

Section 3. Anglers caught primarily age 1 and 2 rainbow trout in Section 3. A total of 85% of all fish caught were under 300 mm in length, and 44% were between 100-199 mm (Table 27). The mean length of captured rainbow trout declined from 280 mm in 1977 to 213 mm in 1987. A 36% decline in the percentage of angler-captured rainbow trout exceeding 300 mm in length occurred during the ten years (Table 28). Electrofishing length frequencies were similar to the angler-captured length frequencies, except for rainbow trout in the 200-299 mm size class in which angler catch was almost double that of the electrofishing catch (33 to 17%). The total catch rate for rainbow trout in Section 3 increased over the last ten years from 0.24 fish/h in 1977 to 1.38 fish/h in 1987 (Table 26 and Figure 10). The increase in catch rate of rainbow trout may be correlated to the substantial increase in the proportion of rainbow trout in the 1987 catch as compared to 1977 (Table 32). Only 28% of fish caught in Section 3 in 1977 were wild rainbow trout, compared to 71% in 1987. Harvest rates of rainbow trout have almost doubled since 1977, from 0.16 to 0.28 fish/h (Figure 12). The number of fish harvested in 1987 decreased slightly from 1,805 compared to 1,924 fish in 1977, due to the reduction in effort from 1977 and an increase in the percentage of rainbow trout released from 32 to 80% (Table 32).

Over half of all brown trout caught by angling were under 200 mm in length, 27% exceeded 300 mm, and only 4% exceeded 400 mm (Table 27). Length frequencies of angler-caught brown trout were lower than comparative electrofished brown trout for all size classes over 200 mm in length (Table 11). The low vulnerability of large brown trout to angling was confirmed by the infrequent angling recaptures of tagged fish (Table 33).

Catch rates for brown trout in Section 3 were highly variable, although only a few anglers interviewed caught brown trout (Table 29). The lowest rate was 0.09 fish/h for bait users, and the highest was 3.34 fish/h

Table 30. Harvest rates (fish/h) for Silver Creek during the 1987 angling season.

	Fly				Bait				Lure				Total harvest rate
	Rainbow	Brown	Brook	Total	Rainbow	Brown	Brook	Total	Rainbow	Brown	Brook	Total	
Sec 2	0.04	0.004	0.00	0.05	0.50	0.08	0.03	0.06	0.33	0.00	0.00	0.33	0.14
Sec 3	0.04	0.00	0.00	0.04	0.43	0.03	0.009	0.53	0.33	0.00	0.00	0.33	0.23
Sec 5	0.08	0.05	0.00	0.14	0.26	0.26	0.00	0.52	0.04	0.25	0.00	0.29	0.36
Total harvest rate	0.05	0.007	0.00	0.05	0.39	0.14	0.009	0.54	0.15	0.15	0.00	0.30	0.22

Table 31. Estimated harvest of rainbow trout for the 1977 angling season and all trout for the 1987 season. Harvest rates (fish/h) are in parentheses.

Study section	Rainbow trout	Brown trout	Brook trout
1977			
Section 2	1,400 (0.30)		
Section 3	1,924 (0.16)		
Section 5	981 (0.44)		
1987			
Section 2	1,071 (0.15)	161 (0.02)	7 (0.001)
Section 3	1,805 (0.28)	487 (0.08)	4 (0.0006)
Section 5	106 (0.07)	121 (0.08)	0 (0.00)

Table 32. Estimated number of wild rainbow trout released in selected sections of Silver Creek for the 1977 and 1987 angling seasons.

Study section	1977		1987	
	Number released	Percent of catch	Number released	Percent of catch
Section 1	8,843	100	26,213	100
Section 2	3,423	71	6,398	85
Section 3	922	32	7,081	80
Section 5	629	39	842	92

Table 33. Capture by anglers of rainbow trout and brown trout tagged prior to the 1987 angling season.

Species and site	Number of fish tagged	Number reported caught	Percent reported as caught	Number of times captured			
				1	2	3	4
Rainbow trout							
Upper Stalker	53	3	6	3			
Cabin	152	38	25	32	4	1	1
Martin Bridge	75	6	4	5	1		
Priest	1	1	100	1			
Total	281	48					
Brown trout							
Upper Stalker	7	1	14	0	1		
Cabin	16	1	6	1			
Martin Bridge	157	7	5	6	1		
Priest	29	2	7	2			
Total	209	11					

for lure anglers. The total estimated catch in Section 3 during the 1987 season was 1,356 brown trout. Harvest was recorded only for bait anglers, who harvested brown trout at a rate of 0.08 fish/h (Table 31). An estimated 487 brown trout were harvested in Section 3 during the 1987 angling season.

All angler-caught brook trout were under 300 mm in length, and 83% of these were under 200 mm (Table 27). The size frequency of brook trout caught by anglers was similar to that for fish captured by electrofishing, although a few brook trout exceeding 300 mm in length were captured by electrofishing. Data on catch of brook trout were obtained only for fly and bait anglers. The catch rate for fly anglers was 0.03 fish/h and for bait anglers, 0.009 fish/h. Bait anglers were the only group recorded that harvested brook trout in Section 3, and total estimated harvest was 4 brook trout in 1987.

Section 5. The rainbow trout catch in Section 5 was dominated by small fish, with 75% being 100-199 mm in length (Table 27). Rainbow trout exceeding 400 mm were not captured in this section, unlike the other sections. Percentages of angler-caught rainbow trout were similar for all size intervals when compared to electrofishing results. The catch rate of rainbow trout decreased slightly from 0.72 fish/h in 1977 to 0.63 fish/h in 1987 (Table 26 and Figure 12). We estimated that a total of 948 rainbow trout were caught in 1987, a substantial decrease from the 1,610 caught in 1977. In addition to the decline in catch, the average length for rainbow trout caught declined from 266 mm to 184 mm. The harvest of rainbow trout has declined as well, from 981 fish in 1977 to 106 rainbow trout in 1987 (Table 31). This decline coincides with the increase in the proportion of rainbow trout released (39 to 92%) and the decline in effort since 1977 (Tables 32 and 25).

Two-thirds of the brown trout caught in Section 5 were under 200 mm in length. Unlike the rainbow trout catch, however, a few brown trout were caught in both the 300-399 mm and 400-499 mm size classes (Table 27). Anglers caught a higher percentage of brown trout 100-199 mm in length than were found in the electrofishing sample (Table 11). The overall catch rate was 0.32 fish/h, with the highest rate of 1.64 fish/h occurring for lure anglers (Table 29). Rates of catch for brown trout in 1977 were slightly less in 1977, with estimates of 0.27, 0.23, and 0.18 fish/h for anglers using flies, lures, and bait, respectively (Thurow 1978). Anglers caught an estimated 487 browns in 1987, and harvested 121 browns at a rate of 0.08 fish/h (Tables 25 and 31).

Frequency of Trout Capture by Anglers

A total of 281 rainbow trout and 209 brown trout over 350 mm in length were tagged before the 1987 fishing season. Anglers captured 48 of the rainbow trout and 11 of the brown trout that were tagged (Table 33). The highest percentage of tagged rainbow trout reported as caught by anglers, 25%, was reported in Section 1. Of those rainbow trout caught in Section

1, 84% were reported as caught only once. Eleven percent, however, were caught and released twice and one fish was caught four times during the fishing season. That particular fish held in a pool that received heavy angling pressure during the summer.

A total of 209 brown trout were tagged, and 11 were reported captured by anglers. Two of these 11 fish were caught twice during the season. Five percent of the tagged brown trout and 17% of the tagged rainbow trout were reported captured by anglers.

Angler Survey and Opinions

The majority (56%) of anglers interviewed in Section 1 were non-residents. Section 5 had the greatest percentage of resident anglers at 83%. We compared angler residence of 1987 with data from 1977 and found little change during the last ten years. The greatest shift was a 10% decrease in resident anglers in Section 3 (Table 34).

Based on angler interviews, we assessed the relative percentage of the different methods of angling for each section. Section 1 was restricted to fly fishing only. We noted a substantial decline progressively downstream in the percentage of fly fishing from 80% in Section 2, to 61% in Section 3, to 29% in Section 5. In Section 3, the proportion of fly fishermen had increased from 38% in 1977. The percentage of anglers using bait was 14, 38, and 49% for Sections 2, 3, and 5. We found 6, 1, and 22% of the anglers interviewed using lures in Section 2, 3, and 5, respectively.

In comparing the frequency of successful trips, as defined by at least one fish captured, to 1977 data, only Section 1 experienced an increase, from 80 to 85%. All other sections experienced declines in the number of successful trips (Table 35). The greatest decline, 12%, was found in Section 3. Section 5 experienced a decline of 7%. We asked anglers if they thought the quality of the fishing on Silver Creek was "good", "fair" or "poor". Anglers in Section 1 responded "good" 78% of the time, as compared to 56% in 1977. Those responding "good" in the sections under general regulations (Sections 2 through 5) ranged from 46 to 56%, overall slightly higher than in the 1977 season (Figure 13).

Question 2 inquired if anglers were satisfied with the present species composition. An overwhelming majority, 93 to 97%, were satisfied (Figure 13). The results from 1977 displayed a similar range, with from 85 to 100% replying that they were satisfied. In Question 3, anglers were asked if they had a preference for a particular fish species in Silver Creek. Anglers responded equally frequently to rainbow trout, 39%, as to having no preference at all. Brown trout were preferred by 15 to 28% of the anglers (Figure 13). In 1977, the species preference question did not include a no preference option, and rainbow trout were selected over 80% of the time (Thurow 1978). In the fourth question, anglers were asked if they were satisfied with the present general regulations, in maintaining the size and number of trout (Figure 13). General fishing regulations were defined as a

Table 34. The percentage of resident anglers versus non-resident anglers in 1987 compared with results from the 1977 season.

Section	1977 Angling Season Residents	Non-Residents	N	Section	1987 Angling Season Residents	Non-Residents	N
Section 1	40	60	466	Section 1	44	56	249
Section 2	74	26	258	Section 2	76	24	78
Section 3	77	23	622	Section 3	67	33	126
Section 4	64	36	87	Section 4[a]			
Section 5	89	11	132	Section 5	83	17	76
Totals	66	34	1565	Totals	60	40	529

[a] Section 4 was not surveyed during the 1987 season.

Table 35. Percentages of successful trips (at least one trout caught) on Silver Creek comparing the 1977 and 1987 angling seasons.

	1977		1987	
	Percent of trips successful	Number of trips	Percent of trips successful	Number of trips
Section 1	80	385	85	220
Section 2	81	206	74	91
Section 3	78	405	67	168
Section 5	79	81	72	71
Mean percentage and total trips from interviews	79	1077	76	550

Figure 13

ANGLER QUESTIONAIRE RESULTS

The results are in percentages of the total responses.

1. QUESTION: How would you rate the fishing on Silver Creek, good, fair, poor?

Response:	Good	Fair	Poor	N
Section 1	78	17	5	229
Section 2	46	27	27	75
Section 3	51	31	18	107
Section 5	46	16	38	50

2. QUESTION: Are you satisfied with the current species composition?

Response:	Yes	No	N
Section 1	93	3	223
Section 2	93	7	76
Section 3	94	6	99
Section 5	94	6	50

3. QUESTION: Which type of trout do you prefer to catch on Silver Creek?

Response:	Rainbow	Brown	Brook	No Preference	N
Section 1	42	15	3	40	231
Section 2	51	18	1	30	80
Section 3	35	28	1	36	111
Section 5	14	26	2	58	50

4a. QUESTION: Are you satisfied with the regulations below the Conservancy in maintaining the size and number of fish?

Response:	Yes	No	N
Section 1	15	85	217
Section 2	64	36	76
Section 3	77	23	104
Section 5	98	2	50

4b. QUESTION: If not, would you agree to more restrictive regulations on those areas?

Response:	Yes	No	N
Section 1	95	5	184
Section 2	100		27
Section 3	88	12	24
Section 5	100		1

six trout limit, only two of which may be over 406 mm (16 inches) in length. Satisfaction with the general regulations increased with anglers progressively downstream. Only 15% of Section 1 anglers were satisfied with the general regulations. In the general regulations areas, 64, 77, and 98% of the anglers in sections 2, 3, and 5 were satisfied with the general regulations (Figure 14). Ninety-five percent of dissatisfied anglers approved of more restrictive regulations. Anglers from Section 1 comprised 78% of these dissatisfied anglers. Both fly and bait users from Sections 2 through 5 were pooled and were found to have responded similarly; the majority of both angler types were satisfied with the regulations. Of those fly fisherman that were dissatisfied, 44 of 46 supported more restrictive regulations (Table 36).

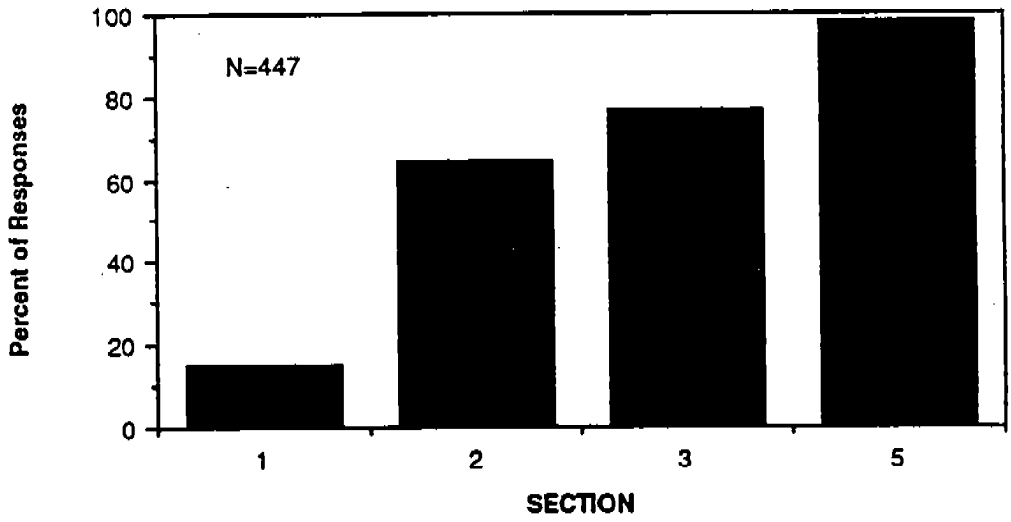

Figure 14. The percentage of anglers satisfied with the general regulations from 1987 angler questionaire.

Table 36. Responses to the survey question concerning satisfaction with general regulations from anglers below the catch and release section. All responses are pooled.

Question	Response			
	Fly		Bait	
	Y	N	Y	N
4a) Are you satisfied with fishing regulations downstream of the Nature Conservancy Preserve in maintaining the size and number of fish?	86	46	60	5
4b) If not, would you agree to more restrictive regulations?	44	0	1	2

DISCUSSION

Silver Creek's popularity stems from its ability to produce an abundance of large, wild trout. The combined biomass of rainbow trout and brown trout for the catch-and-release site was 193 kg/hectare at the time of our study. Lower Stalker Creek supports the highest trout biomass of the Silver Creek system, with a rainbow trout and brown trout combined biomass of 256 kg/hectare. Some streams do support a higher trout biomass, such as Summit Creek to the northeast, which supports 377 to 1189 kg/hectare of trout biomass in ungrazed sections (Keller and Burnham 1982). Estimates of biomass for game fish (excluding mountain whitefish) were 77 to 83 kg/hectare for the Pinehaven and Railroad Ranch sections of the Henrys Fork of the Snake River (Jeppson 1974; Angradi and Contor 1988). The Gibbon River in Yellowstone National Park, which is physically similar to Silver Creek, supported a biomass of 228 kg/hectare of brown trout and brook trout (Jones 1985).

Trout abundance in Silver Creek was compared to the Henrys Fork of the Snake River. The catch-and-release site of Silver Creek had densities of 281 to 804 rainbow trout/hectare, compared with 390 rainbow trout/hectare in the Railroad Ranch section of the Henrys Fork with similar gradient. At the time of the sampling this section of the Henrys Fork was under a slot limit of two fish under 300 mm and one fish over 508 mm. Although densities were similar between Silver Creek and the Railroad Ranch, the percentage of larger rainbow trout (>400 mm) in the Henrys Fork was double that of Silver Creek (Angradi and Contor 1988). Silver Creek has lower densities of rainbow trout when compared with a few other popular western streams. Estimates of rainbow trout densities in Montana's Armstrong Spring Creek ranged from 357 to 691 fish/hectare (Decker-Hess 1986). The physical and biological characteristics of this system are quite similar to those of Silver Creek. Anderson and Nehring (1984) found that densities of rainbow trout in the South Platte River catch-and-release section ranged from 818 to 958 fish/hectare. Although the South Platte River was not a spring creek, the high productivity of the system was claimed to aid in supporting the high densities of rainbow trout (Anderson and Nehring 1984).

During the 1920s to 1960s, numerous, large (>1.4 kg) rainbow trout were reportedly caught from Silver Creek's waters. In the 1976 and 1977 study, few fish were found exceeding 1.4 kg (Thurow 1978). The effect of the catch-and-release regulations instituted in 1977 to restore the abundance of large rainbow trout will be discussed in relation to the 1976 and 1977 study.

Effects of Catch-and-Release

In evaluating the effects of catch-and-release regulations on Silver Creek, factors that were considered key indicators of change were: frequency of large fish in the electrofishing sample, longevity, survivorship of older fish, angler catch rate, size of fish caught, angler

success, and angler satisfaction. All of these indicators have increased in the catch-and-release area of Silver Creek during the past ten years of special regulations.

An important point to be addressed in comparing the present study's data to that of the 1976 and 1977 is the difference in sampling methods. The data collected in 1976 and 1977 were gathered exclusively during the daylight hours. Our data for the 1986 and 1987 study were gathered at night, with the exception of the few comparative day runs. In the limited evaluation of the day versus night sampling comparisons that was conducted in 1987, no bias toward larger rainbow trout was found in the night sample. Therefore, the use of night electrofishing runs may not have prejudiced the comparisons between our data and those collected in the previous study. All of the size class comparisons were similar for both the day and night samples. We feel that the differences found in respective size classes between the two studies are representative of the rainbow trout populations sampled at the time. We may have underestimated the proportion of older rainbow trout (age 5+), because we did not sample all areas that were known to contain large trout (i.e. the confluence of Grove Creek and Stalker Creek).

The Cabin site within the catch-and-release area experienced an increase, from 3 to 23%, in the percentage of rainbow trout in the 400-499 mm length class since 1977. We attribute this increase to the protection of larger fish from harvest under the catch-and-release regulations.

In addition to an increase in the proportion of larger fish, we found a decrease in total annual mortality for rainbow trout of ages 3 and older. Along with the decrease in total annual mortality, we found that the rainbow trout population contained age 5+ fish. The decrease in mortality among older rainbow trout was also found by research on the Madison River in Montana (Vincent 1980). Increases in longevity among salmonids protected by catch-and-release regulations have been documented by several researchers (Johnson and Bjornn 1978; Vincent 1980; Jones 1985).

The growth of rainbow trout in the catch-and-release section of Silver Creek has increased from estimates made in 1977. The increase, although substantial, was not statistically significant. Increases in growth may have occurred from the protection afforded to fast growing individuals, assuming that these individuals would have otherwise been harvested (Thurow 1978). An alternate explanation is the elimination of competing hatchery catchable rainbow trout from the section. Vincent (1987) found an increase in growth of wild brown trout in O'Dell Creek in Montana after the elimination of hatchery catchable plantings. An ongoing program by The Nature Conservancy to reduce sediment input from the upper tributaries may have also increased the productivity of Silver Creek and increased trout growth.

Table 37. Catch rate (fish/h), for all gear types, of rainbow trout >300 mm in Silver Creek.

Section	1977	1987
1	0.42	0.74
2	0.74	0.65
3	0.11	0.21
5	0.19	0.03

One important question that this study cannot address is whether the number of large (>400 mm) rainbow trout has increased during the ten years of protection. Since no estimates of density using electrofishing were made in the 1976 and 1977 field seasons, only inferences based on catch rates are possible. This would require the assumption that angler ability has not changed in the 10-year period, and we are not comfortable with that assumption.

Anglers using the catch-and-release area have benefited from the improvement in the fishery. Catch rates have increased, and a slightly greater percentage of the rainbow trout caught in 1987 exceeded 300 mm in length. Catch rates of trout $\geq$ 300 mm in Section 1 increased from 0.42 fish/h in 1977 to 0.74 in 1987 (Table 37). A slightly higher proportion of the anglers caught at least one trout per trip and 22% more anglers rated the fishing "good" (the highest rating) than had ten years ago. Although angler effort on Silver Creek as a whole has remained quite similar since 1977, effort in Section 1 has more than doubled. This increase is not solely due to an increase in nonresident use, as little change in residence of anglers in Section 1 has occurred.

Indirect Angler Impacts on the Fishery

Due to the extent of angler effort on Silver Creek, primarily in Section 1, there is a possibility that anglers could impact fish populations in ways other than through direct harvest (Wydoski 1977). Although hookscarring of fish did increase in rainbow trout exceeding 250 mm in length since 1977, hookscarring was not found to significantly reduce rainbow trout condition (K). In Silver Creek, disturbance of feeding fish by anglers interrupting feeding or changing microhabitat use was found not to be a significant factor. There are, of course, other aspects of intense angler effort which may be harmful, but these were not addressed in this study. Roberts (1988) found significant mortality on pre-emergent rainbow trout fry as a result of trampling by wading anglers. However, at the present time this does not appear to be a problem in Silver Creek, based upon the high densities of juvenile rainbow trout (47 fish/100 m^2) estimated from snorkeling counts (Parker and Riehle 1987).

We assessed the extent of multiple captures of individual rainbow trout by utilizing numbered jaw tags and recording the number of captures per individual from angler reports. The estimates of capture of tagged fish reported in this study are certainly underestimates. We received 10 to 15 accounts of fish caught with unreadable tags due to algal and marl deposits. Also, we have no estimates of tag loss or the lack of compliance by anglers. Two tags were found on the stream bed, indicating that some tag loss did occur. An alternative method of assessing the degree of "recycling" of the catch-and-release fishery was computed by dividing the estimated number of fish caught by the estimated population present. For rainbow trout in Section 1, this method gives a value of 2.9, indicating

that about three times more fish were caught than were present in the area. This estimate merely displays the effort expended on a given population of fish. In actuality, only a portion of the population tends to be captured a number of times (Lewynsky and Bjornn 1987). Of the 38 tagged rainbow trout that were caught by anglers during our study, 84% were caught only once (Table 33).

Rainbow Trout in General Regulation Areas

In addition to the catch-and-release area, the rainbow trout population of the Martin Bridge area has also shown improvement over the last ten years. Total annual mortality of age 3 and older fish has fallen slightly, and as a result there has been a slight increase in the percentage of fish exceeding 399 mm in length. Also, just as we found in the Cabin site, age 5 rainbow trout were found in the Martin Bridge sample during the spring of 1987 and no age 5 fish were found there in 1977.

Possible reasons for these changes in the Martin Bridge rainbow trout population may be the 46% decrease in angler effort in Section 3 and also the substantial increase in the percentage of fish released. Harvest of rainbow trout was down by 37% from 1977. Another possibility for the changes may be related to the elimination of hatchery catchable rainbow trout plants within this section since 1977. During the 1976 and 1977 study years, approximately 12,000 catchable-sized rainbow trout were planted in Section 3. Some negative effects of hatchery catchable trout on wild trout populations have been documented (Mason et. al. 1967, Butler 1975, Bachman 1982, and Vincent 1987).

Angler effort for Section 3 in 1987 was the reverse of the situation that existed in 1977. The estimated angler effort in Section 3 in 1987 was approximately half that of 1977. In comparison, the estimated effort in Section 1 doubled in the ten years (Thurow 1978). Although the estimated effort in Section 3 declined, the catch rate of rainbow trout increased sharply from the 1977 catch rate. The estimated catch of wild rainbow trout increased by approximately 6,000 fish from the 1977 catch. In 1977, the catch was dominated by hatchery rainbow trout, with only 28% consisting of wild rainbow trout. This study documents an increase in the proportion of large rainbow trout caught (>300 mm) and a decrease in the mean length of all fish caught for the 1987 season. These values are in agreement with the indication that the proportion of rainbow trout greater than 300 mm captured by electrofishing increased 28% from the fall of 1977 to the fall of 1986.

Although the catch rate of rainbow trout has increased greatly since 1977 and the percentage of fish released has increased, anglers in Section 3 were still harvesting a substantial proportion of the larger rainbow trout. We found that in 1987, anglers harvested an estimated 41 and 28% of the rainbow trout present in the spring that exceeded 300 and 400 mm, respectively. Anglers appear to be harvesting a substantial proportion of the older rainbow trout, although the effort expended has decreased considerably.

We also found a similar decline in the mean length of rainbow trout captured in Section 5 (Priest electrofishing site). In 1977, approximately one-third of the angler catch exceeded 300 mm in length, and this declined to only 5% by the 1987 angling season. Unlike Section 3, the catch rate also declined during the past ten years from 0.72 fish/h in 1977 to 0.68 fish/h in 1987. This site was not regularly planted with catchable trout, although they were found in the catch for both studies (Thurow 1978). A drastic decline in harvest was noted over the ten years, from 981 rainbow trout in 1977 to 106 fish in 1987. We are unsure of the cause(s) that have lead to this decline in the number of fish harvested, although it is probably not related to the presence of hatchery fish. Since the proportion of fish greater than 300 mm in the catch has declined, the decrease in quality-sized trout may have led to an increase in voluntary catch-and-release. Of the total population of rainbow trout exceeding 300 mm present in the spring, 10% were harvested by anglers.

Brown Trout Dynamics

The brown trout population at the Priest site was the only established population sampled in 1976 and 1977. Although few data from 1977 are available, electrofishing samples did contain large (>500 mm) brown trout. In 1987, large brown trout were present in the spring but became less frequent in the summer and fall samples. Unlike Section 3, angler catch of brown trout in the Priest area mirrored the electrofishing samples of brown trout 400 mm or greater in length. With angler density in the Priest area second only to Section 1, anglers could conceivably harvest a substantial percentage of the larger fish in this site. The Priest site is relatively short in length, however, and large fish may immigrate into the site from fall to spring. The catch rate of brown trout in Section 5 was higher than that of Section 3. The probable explanation for this, in addition to the higher density of angler effort, is the difference in accessibility between the sites. Section 5 is much more open and easily waded than the deeper pools of Section 3. Deinstadt (1977) found similar variation in catch rates for two brown trout streams in central California, in which one had easy access and the other was limited by heavy riparian growth.

Considering that in 1977 brown trout were not found above the Picabo Bridge, the brown trout population has made strong advances in the ten years. Our snorkeling indicates that brown trout are now found well into Upper Stalker, Mud, and Grove Creeks (Riehle, unpublished data). Section 3 has the most mature population of the upper three sections, but densities

were not unusually high for western brown trout populations. The density in the Martin Bridge area was as high as 189 fish/hectare, much less than the Gibbon River in Yellowstone National Park, for example, which has an estimated density of 681 brown trout/hectare (Jones 1985). The Martin Bridge site does support a population of large brown trout, with 31% of the fall sample greater than 499 mm in length. Few anglers were successful in catching them and some of those anglers who were successful, fished at night. It is possible that night anglers were not interviewed in the same proportion as those who fished sunrise to sunset when most of the interviews were collected. This would represent few trips, however, and may not have a sustantial influence on the final harvest figures. From the interviews that were gathered, a harvest rate of 0.08 brown trout/h was calculated for Section 3 and only 4% of the catch was 400 mm or greater in length.

The annual mortality of age 4 and older brown trout was low as well (A = 0.39). From the tag return information, only 5% of the brown trout tagged (>350 mm) were reported caught by anglers in the 1987 season. These indications suggest that the large brown trout of Martin Bridge had a low vulnerability to angler capture. This mortality value is comparable to what other researchers have found on western streams such as the South Platte and the Madison rivers (Anderson and Nehring 1984; Vincent 1987).

Brown trout in the catch-and-release area have become more than a novelty. Although brown trout comprised only 6% of the catch in Section 1, a higher proportion of brown trout larger than 399 mm were caught there than were in Section 3. Although few brown trout were caught by anglers in Stalker Creek, the electrofishing sample from Lower Stalker revealed a relatively high density of brown trout that were predominantly yearlings. With undercut banks, brushy overhead cover, and deep pools, the habitat of Lower Stalker is well suited for brown trout and the population could grow to become similar to that of Martin Bridge.

Riparian Habitat

The portions of Silver Creek within the Silver Creek Preserve are excluded from grazing, and the limited agricultural use is buffered with wide (75 m) strips of undisturbed shrubs and grasses. Riparian habitat along Section 2 is predominantly grasses and bulrush. Grazing occurs throughout most of the year. The areas of bulrush are extensively disturbed in the winter months by cattle. Summer use is light. An electric fence has been erected along one section as a cooperative effort between the landowner and the group of sportsmen that are permitted land access to Silver Creek.

The section of Silver Creek in Section 3 immediately below the Highway 20 bridge to the boundary fence at the USGS flow gage has extensive eroding banks that are capable of directly delivering sediment into the stream. Heavy use by cattle along this reach of stream appears to be responsible for the damage. Downstream from this point, Idaho Department of Fish and Game property is not grazed by domestic livestock. The riparian zone downstream past the BLM Point of Rocks campground to a privately-owned arrea is in good to excellent condition. The area from the Point of Rocks campground to Picabo Bridge is private property, and was only inspected from the road. The riparian zone is predominantly grasses with scattered clumps of willows. The banks appear to be in good condition, although some bank sloughing has occurred near the Picabo Bridge.

The portion of Silver Creek referred to as Section 4 was not sampled or inspected closely to observe the riparian zone. Livestock grazing appears to occur along most of its length, and sloughing banks were observed in some areas close to roads.

Section 5 extended from below the Highway 20 bridge east of Picabo downstream to the Little Wood River. The riparian zone along both sides of our creel census section was heavily utilized by livestock from the spring until late in the fall (October) without rest. Bank trampling was the most severe of any of our study sites in the area between the upper and lower Priest camping areas, which is administered by the BLM.

Management Implications

In 1978, Thurow noted that after only one season of the catch-and-release regulation the trout fishery of Section 1 showed signs of change. The present study has documented that after ten years of the catch-and-release regulation the catch rate improved and the percentage of large (>400 mm) rainbow trout caught also increased. In addition, angler effort in Section 1 nearly doubled from the estimated effort of 1977.

Anglers in Sections 2, 3, and 5 also experienced a slight increase in the proportion of large (>300 mm) rainbow trout caught. The rainbow trout fishery of Section 3 has improved with respect to its ability to sustain a wild trout fishery without hatchery supplementation. The goal of the implementation of the catch-and-release regulation in Section 1 in 1977 was to restore the Silver Creek fishery to a historic level of producing many large trout. Our study indicates that increases in the quality of the Silver Creek rainbow trout fishery have been achieved through regulation management.

Options of harvest regulation for other portions of Silver Creek may be considered. The effects of restricting allowable harvest to two fish per angler in Section 3 would decrease total rainbow trout harvest by 19%. A further restriction that would exclude fish greater than 300 mm from harvest would reduce harvest by 75%, provided that harvest rates remained comparable to those of 1987. In Section 3, harvest of large rainbow trout (>400 mm) consisted of 6% of total rainbow trout harvested in the 1987 creel survey. Section 5 rainbow trout exceeding 300 mm in length comprised only 12% of the total rainbow trout harvest in 1987. Overall, fishing mortality accounted for little of the total mortality in Section 5. More than 60% of the anglers interviewed in the general regulations area stated they were "satisfied" with the present general regulations. However, only 15% of anglers interviewed in the catch-and-release area were satisfied with the present general regulations.

Brown trout mortality estimates for older age classes were low, and brown trout exceeding 350 mm in length were seldom captured by anglers. Therefore, it appears that the brown trout fishery in Silver Creek is affected little by angling mortality. No fishing mortality was calculated for the Priest site because of immigration into the site, but total annual mortality was low enough in the spring to suspect that fishing had a minor effect on the age 3 and older brown trout of that section. Because the density of brown trout increased from spring to summer, there seems to be substantial immigration into the site.

The following management recommendations are made:

1. The escape of hatchery trout from Hayspur Hatchery into Silver Creek should be prevented.

2. A plan for improvement of riparian habitat along Section 5 of the river, especially near the Priest camping areas, should be developed with the BLM and private landowners.

3. If angler effort in Section 3 increases and there is an indication of a decline in catch rate, a follow-up assessment of the trout population status and angler attitudes toward specific restrictive regulations should be initiated.

4. If the abundance of both brown trout and anglers appears to continue to increase in Section 1, follow-up fish population analysis and creel census should be conducted after 5 years and 10 years to assess changes in brown and rainbow trout size and abundance that may have occurred.

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Appendix 1. Mean calculated total lengths (mm) for rainbow trout sampled from the Cabin site in the fall of 1986 and the spring of 1987.

		Mean length at annulus				
Age	N	1	2	3	4	5
1	262	122				
2	69	127	194			
3	79	130	223	290		
4	81	133	220	299	360	
5	14	129	205	289	346	389
All fish in sample		126	213	294	358	389
Mean growth increment		126	82	74	60	43
N		505	243	174	95	14

Appendix 2. Mean calculated total lengths (mm) for rainbow trout sampled from the Martin Bridge site in the fall of 1986 and the spring of 1987.

		Mean length at annulus				
Age	N	1	2	3	4	5
1	133	120				
2	47	115	183			
3	36	131	241	263		
4	37	126	198	271	345	
5	3	126	204	294	371	426
All fish in sample		122	205	268	347	426
Mean growth increment		122	82	49	74	55
N		256	123	76	40	3

Appendix 3. Mean calculated total lengths (mm) for rainbow trout sampled in the Priest site in the spring of 1987.

		Mean length at annulus			
Age	N	1	2	3	4
1	159	110			
2	30	119	189		
3	8	125	214	279	
4	1	103	165	249	320
All fish in sample		112	194	275	320
Mean growth increment		112	74	66	71
N		198	39	9	1

Appendix 4. Mean calculated total lengths (mm) for brown trout sampled from the Martin Bridge site in the spring of 1987.

		Mean length at annulus						
Age	N	1	2	3	4	5	6	7
1	12	173						
2	17	128	179					
3	5	137	208	290				
4	14	165	269	353	417			
5	10	165	234	325	407	478		
6	11	172	250	330	401	461	508	
7	1	222	304	373	459	521	584	632
All fish in sample		157	228	333	411	472	514	632
Mean growth increment		157	74	84	72	65	48	48
N		70	58	41	36	22	12	1

Appendix 5. Mean calculated total lengths (mm) for brown trout sampled from the Priest site in the spring of 1987.

		Mean length at annulus						
Age	N	1	2	3	4	5	6	7
1	28	130						
2	11	143	256					
3	10	139	240	322				
4	10	139	261	345	396			
5	1	125	222	311	405	463		
6	2	135	225	294	358	428	472	
7	1	118	185	278	386	459	521	573
All fish in sample		135	248	327	390	444	488	573
Mean growth increment		135	109	82	60	68	50	52
N		63	35	24	14	4	3	1

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