SC Fish Research

SILVER CREEK FISHERIES EVALUATION

by

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JOB COMPLETION REPORT

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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 rainbow trout (>400 mm) increased by 20% in the ten years and maximum age of rainbow trout increased from age 4+ to age 5+. Annual mortality of age 3+ and older rainbow decreased from 0.53 to 0.44. Angler catch increased from 1.13 fish/h to 1.81 fish/h over the ten year period. Angler effort in Section 1 more than doubled since the institution of the catch-and-release (1110 h/hectare in 1987) and 22% more anglers rated the fishing as "good" (the highest rating) in 1987, 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 related to lower body condition (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. Of the anglers interviewed in 1987 creel survey, a higher proportion of anglers were fly anglers. 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 percentage of wild rainbow exceeding 300 mm in the catch has declined by 29%. A portion of this change may be due to the elimination of hatchery rainbow trout released in this area (Section 3). 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 percentage 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. Browns were found to be 6% of the trout population of the catch-and-release area and were also found in the tributaries as well. 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 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 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.

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

2.4K

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 predominately sagebrush steppe. In the upper valley, 2.4 km of Silver Creek and portions of its tributaries are contained within the Silver Creek Preserve.

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 (umhos/cm) ranged from 275 mg/l to 434 mg/l. 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, however, 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 present 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).

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 characterize the majority of the substrate, but some exposed gravel and marl areas are present. The dominant macrophytes are *Chara* spp. and *Potamogeton* spp. and

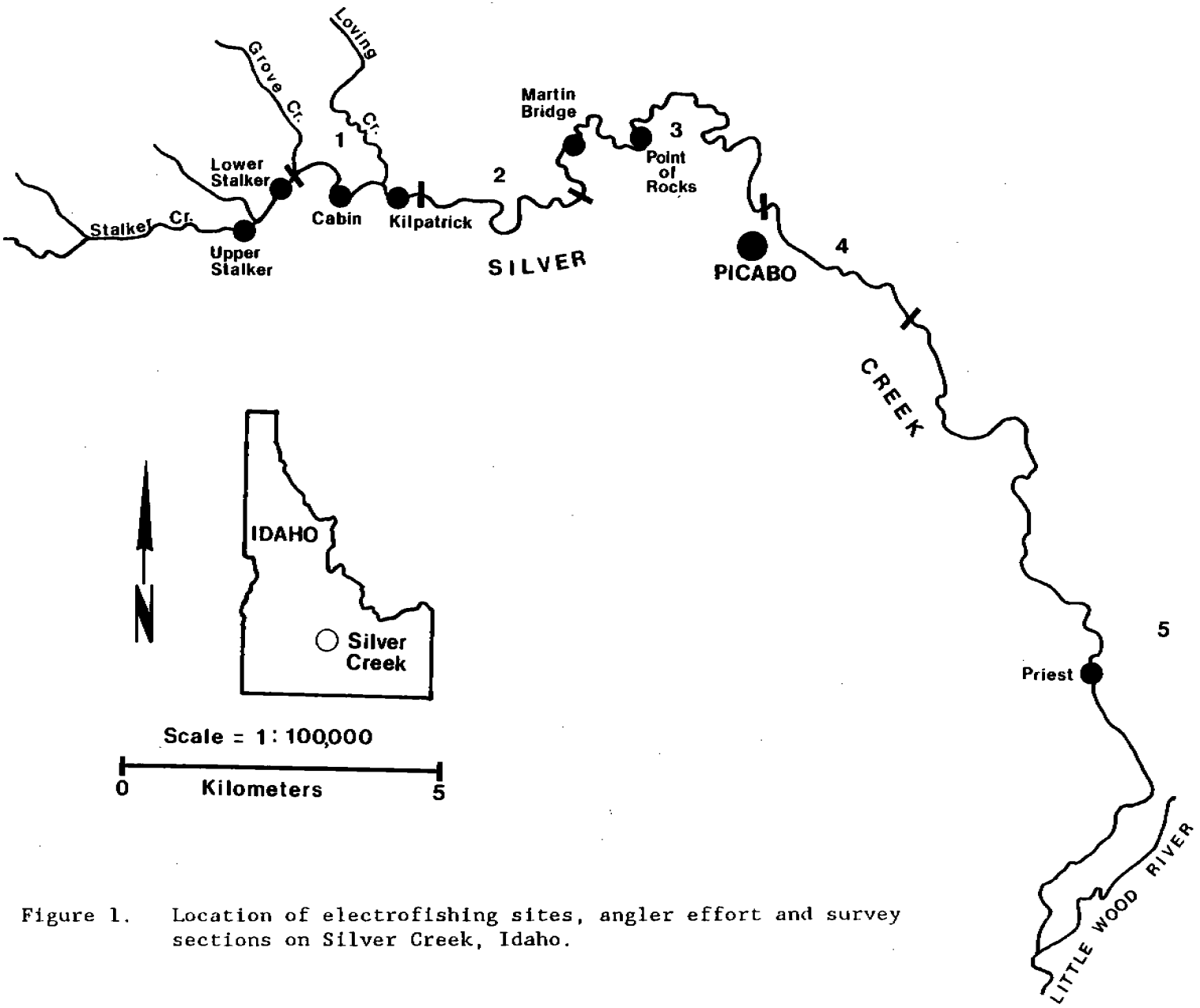


Figure 1. Location of electrofishing sites, angler effort and survey sections on Silver Creek, Idaho.

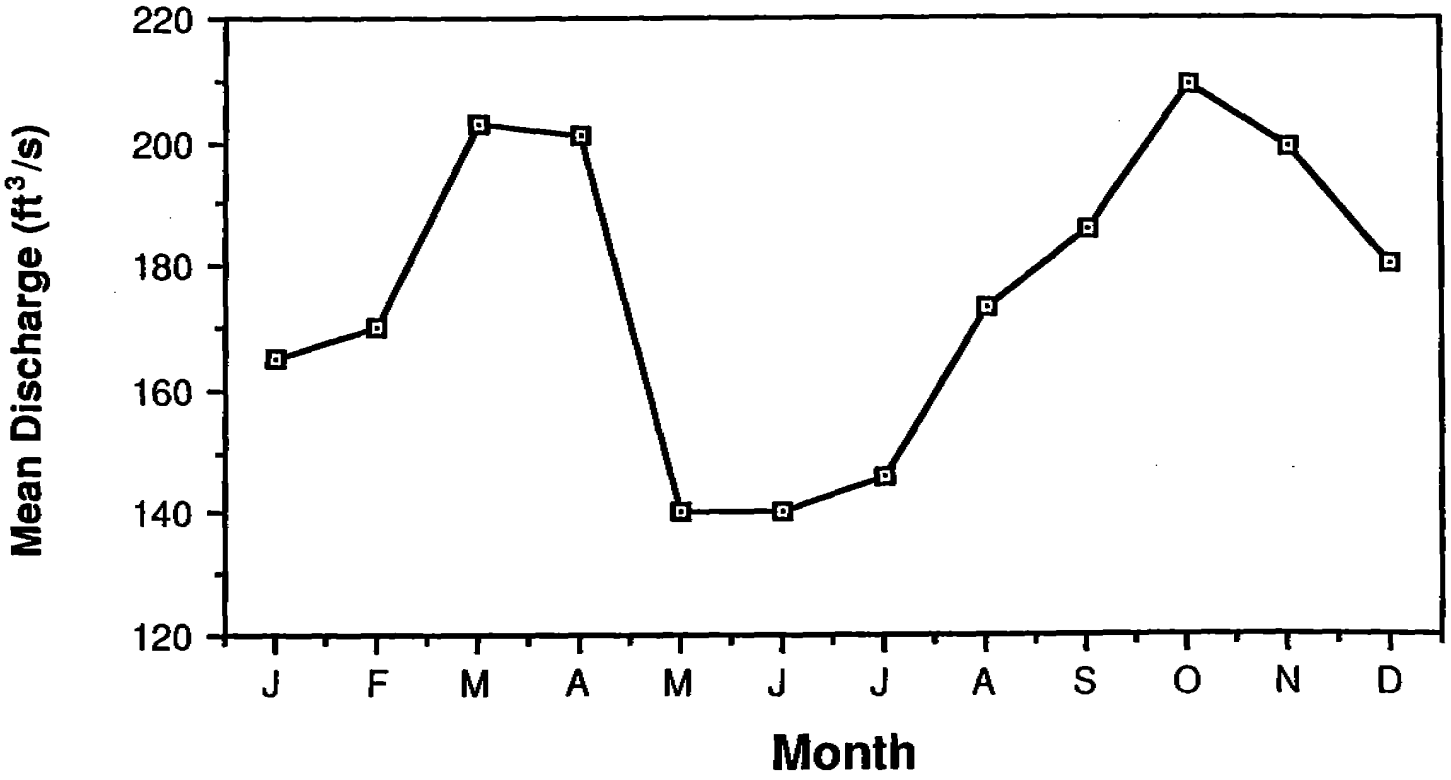


Figure 2. Monthly mean discharges (ft^3/s) for Silver Creek averaged from the calendar years 1975 to 1983 (Water Supply Papers).

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 riparian zone contains predominately 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, 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 predominates in the upper stretch and silty bottoms cover the lower reach. Macrophytes present include: *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 predominately 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 averages slightly under one meter of drop per kilometer (0.8m/km). Extensive growths of bulrush *Scirpus* spp. dominate the riparian vegetation in this site.

Angler survey Sections 2 through 5 are managed by 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. occur 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. are abundant in the lower end of this section. The substrate in this section was predominately silt, although scattered areas of gravel are present. Section 2, although restricted in land trespass, receives a substantial number of float tubers that 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 ending at a metal fence post on the north side of the stream. This site had widths ranging from 10 to 15 m and contains a number of deep pools, some up to 3 m in depth. The substrate was primarily gravel, with silt occurring in depositional areas. The banks support 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 489 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. *Potomogeton* spp. were the most abundant macrophyte 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 campgrounds. 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 campground at the Bureau of Land Management Priest access point. The Priest electrofishing site began at the upper campground and extended 465 m downstream to the diversion at the lower campground. 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 higher than all other electrofishing sites, 8m/km as compared to <1m/km and over half of the site is rapids. The substrate is predominately igneous bedrock, with areas of gravel and silt also present. *Potamogeton* spp. was the dominant macrophyte and the riparian zone consists 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. 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 whitewater raft was equipped with a 3500 watt generator and a 3500 watt variable voltage pulsator (VVP). An electrofishing crew consisted of two netters and one oarsman. Typical output for the VVP was 200 to 230 volts and 4 to 6 amps. 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 similar 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 ($\geq$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 Appendix 2 in Ricker (1975). The following equation was used to calculate the estimated population:

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

Definitions of symbols are:

C_t = total sample taken on day t.
M_t = total marked fish at large at the start of the tth day (or 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 sample method. To address this topic, matched day and night runs were electrofished in the Cabin, Martin Bridge, and Priest sites in the spring of 1987. Comparisons of length frequency and total 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 input 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:

$$K = \frac{[W]}{[L^3]} \times 10^5$$

Definitions for the symbols are:

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 using a differences in regression coefficients test (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:

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

$$Z = -(\ln S) \qquad \text{eq. 1.5 Ricker (1975)}$$

$$A = 1-S \qquad \text{eq. 1.4 Ricker (1975)}$$

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

$$M = Z-F \qquad \text{eq. 1.3 Ricker (1975)}$$

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 flown in 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 calculated.

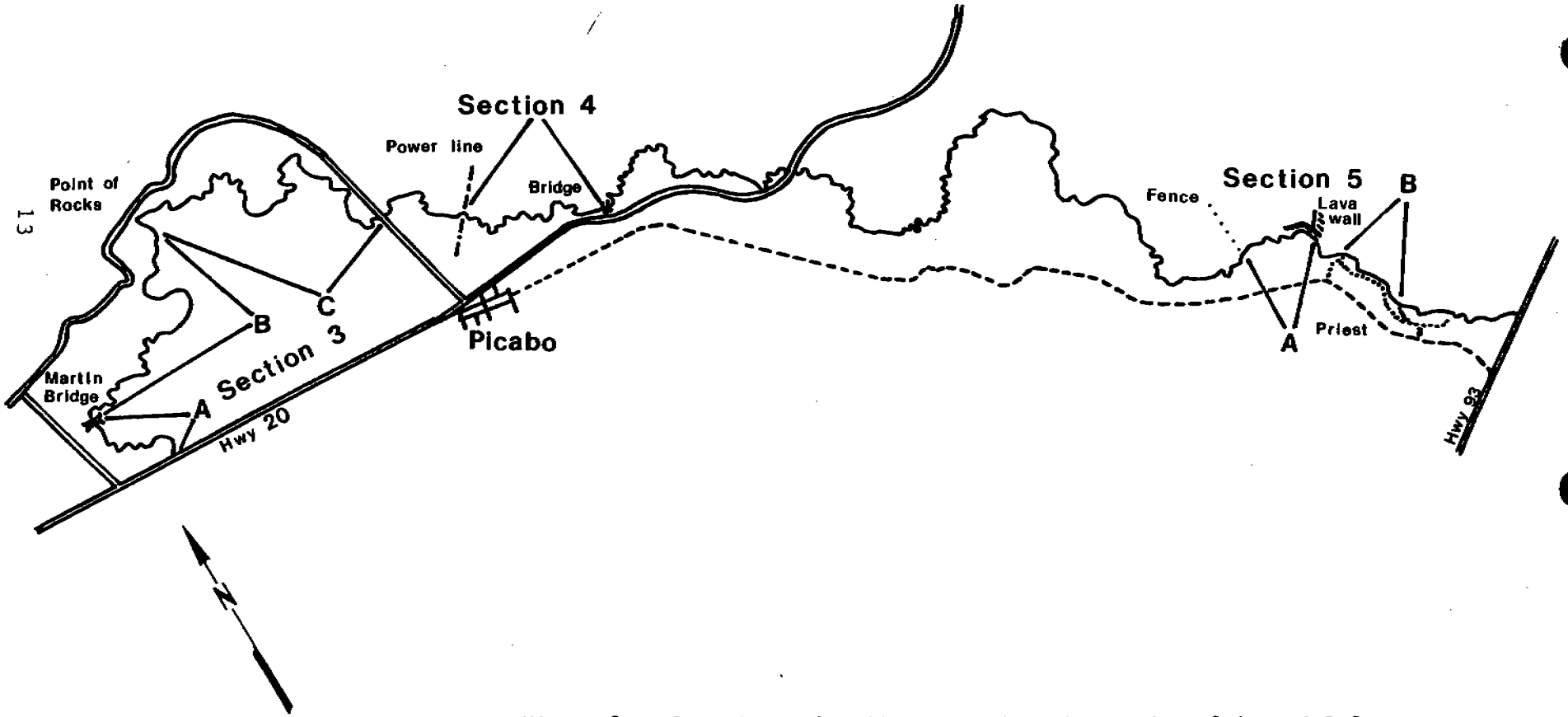


Figure 3. Locations of redd counts sites in Sections 3,4, and 5 from April 17, 1987.

Disturbance of Trout by Angling

Possible effects of high angler densities 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 could negatively impact growth and reduce long term survival.

The study site was located upstream of the Visitors 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), abundance of adult trout, 15 fish/100m^2 estimated by streambank counts, and observational areas to document fish behavior were also present.

The duration of the study was divided into three periods: 7 days of observations with angling, a 7 day period of observation 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. 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 net samples were enumerated and identified to genus. Large samples, (>5000 individuals), were subsampled and the one-eighth subsample was counted by hand and 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 nonangler treatments.

Angler Effort

Creel census was initiated on 23 May and completed 29 November, 1987. Counts were conducted by Idaho State University (ISU) researchers and TNC personnel. Counts and survey information was 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 are 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 campground at Priest.

We patterned our creel census after the one conducted by Thurow (1978). In our census we used the cluster method using 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 hand calculator. Counts were done on two weekdays and two weekend days per 14 day interval. All holidays were counted, with the exception of Thanksgiving Day. The count schedule was reduced by 50 percent after the 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 were taken from the sunrise and sunset timetable for Twin Falls, Idaho.

The same procedure was utilized for holiday counts.

Angler Catch, Harvest and Opinions

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 were largely responsible for the interviews conducted on the Preserve. Researchers from ISU conducted interviews for the remaining angler census sections and the collection of interviews was not restricted to any particular time.

RESULTS

Fish Populations

Species Composition

Electrofishing samples were used to evaluate the relative percentage of game fish in the population. Whitefish were included as game fish and were incorporated as part of the total percentage.

In the Cabin site, rainbow trout comprised 83% of the sample, the highest frequency of rainbow trout occurrence in any of the electrofishing sites (Table 2). Rainbow trout consisted of 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 sampling (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 of 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 upper Stalker was due to the large proportion of yearling fish.

Brook trout comprised 6% or less of the sample in the upper Stalker and the 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 the most numerous in the Cabin site, making up 6% of the sample in the fall of 1986. In Martin Bridge, 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).

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.

Trout Densities

Estimates of the population size were made for all electrofishing sites sampled in the summer of 1986 (Tables 3 and 4). From these estimates, four representative sites were singled out as areas of greatest concern and samplings in those sites were continued in the fall of 1986 and spring of 1987. These sites included: upper Stalker, Cabin, Martin Bridge and Priest. The Priest site was also sampled in the summer and fall of 1987.

The catch per unit effort (CPUE) of the summer sampling was highest in the lower Stalker site, 139 rainbow trout/h, and lowest in the Martin Bridge site, 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).

Rainbow trout estimates of density ranged from the high of 1476 fish/hectare in lower Stalker in the summer of 1986, to a low of 172 rainbow trout/hectare in Martin Bridge 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 1 and 2 year olds 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 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 lower Stalker, 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 (95% C.I.= 6-20) fish/hectare 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 estimate, 239.1 kg/hectare, was in lower Stalker 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. Priest had the lowest biomass, 21.3 kg/hectare, in the summer of 1986 but rose to 92.2 kg/hectare the following spring (Table 8).

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)

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.[illegible])

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 (Table 6 and 7). Biomass of brown trout was highest in the Martin Bridge site in the fall where 205.4 kg/ha was estimated, after it had increased from the summer estimate of 29.0 kg/ha. Brown trout biomass in Priest declined steadily throughout in 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 (Table 10).

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, however 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 samples as compared to the 1977 Section 1 sample (Table 10) (Figure 5). The Cabin site has 2 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 in length than the Cabin (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.

For all seasons, rainbow under 300 mm in length represented at least 92% of the Priest sample (Table 10). The only notable change between seasons was the presence of rainbow trout exceeding 400 mm (4%) in the spring of 1987. In the subsequent summer and fall sampling no fish exceeding 400 mm in length were collected (Figure 7).

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 500 mm in length, respectively (Table 11). A spawning run to the area in the fall accounts for the increase in numbers of larger browns in the fall 1986 sample. Many fish were ripe and fish were observed on redds in the site during the fall sampling.

Table 9. Mean weights 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

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.

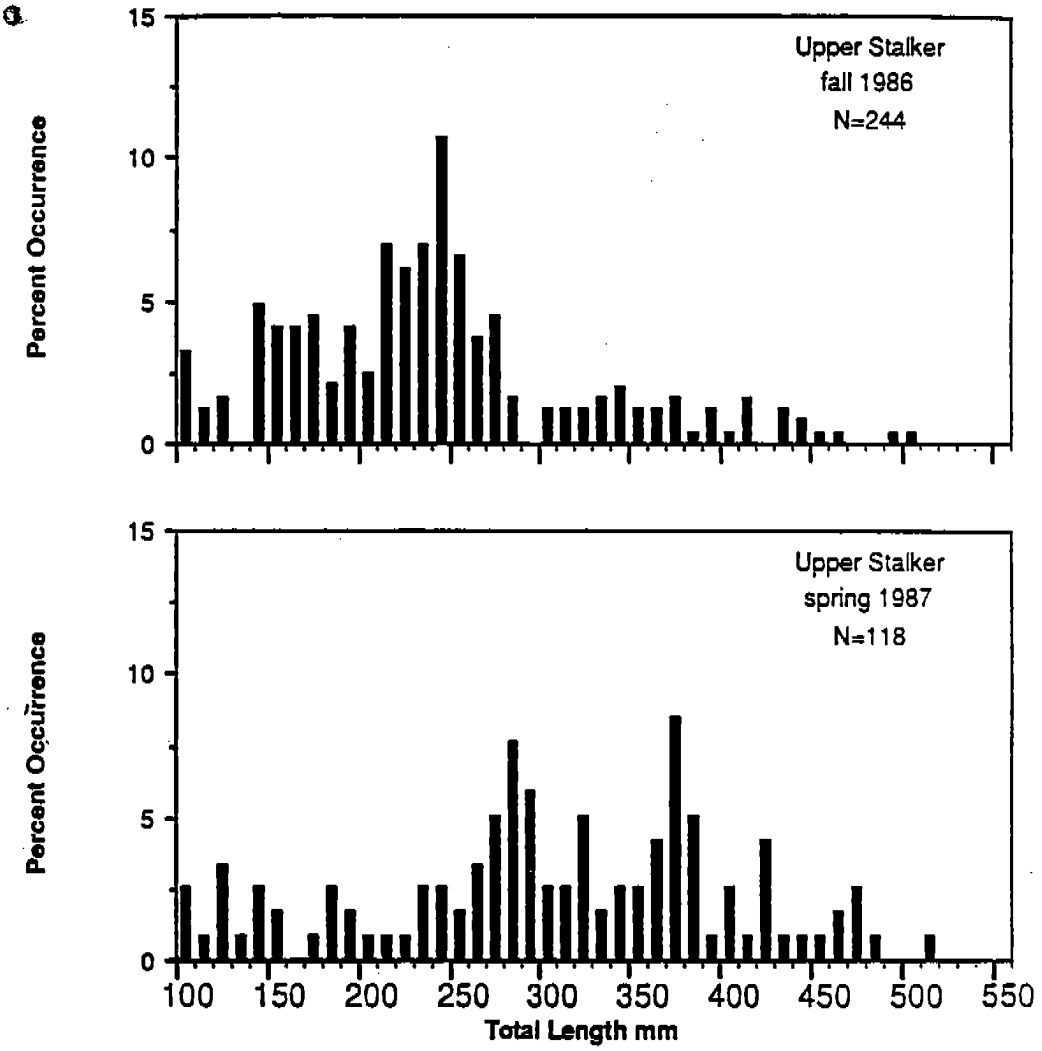


Figure 4. Length frequency histograms of rainbow trout electrofished in the Upper Stalker site, for the fall 1986 and spring 1987 samples.

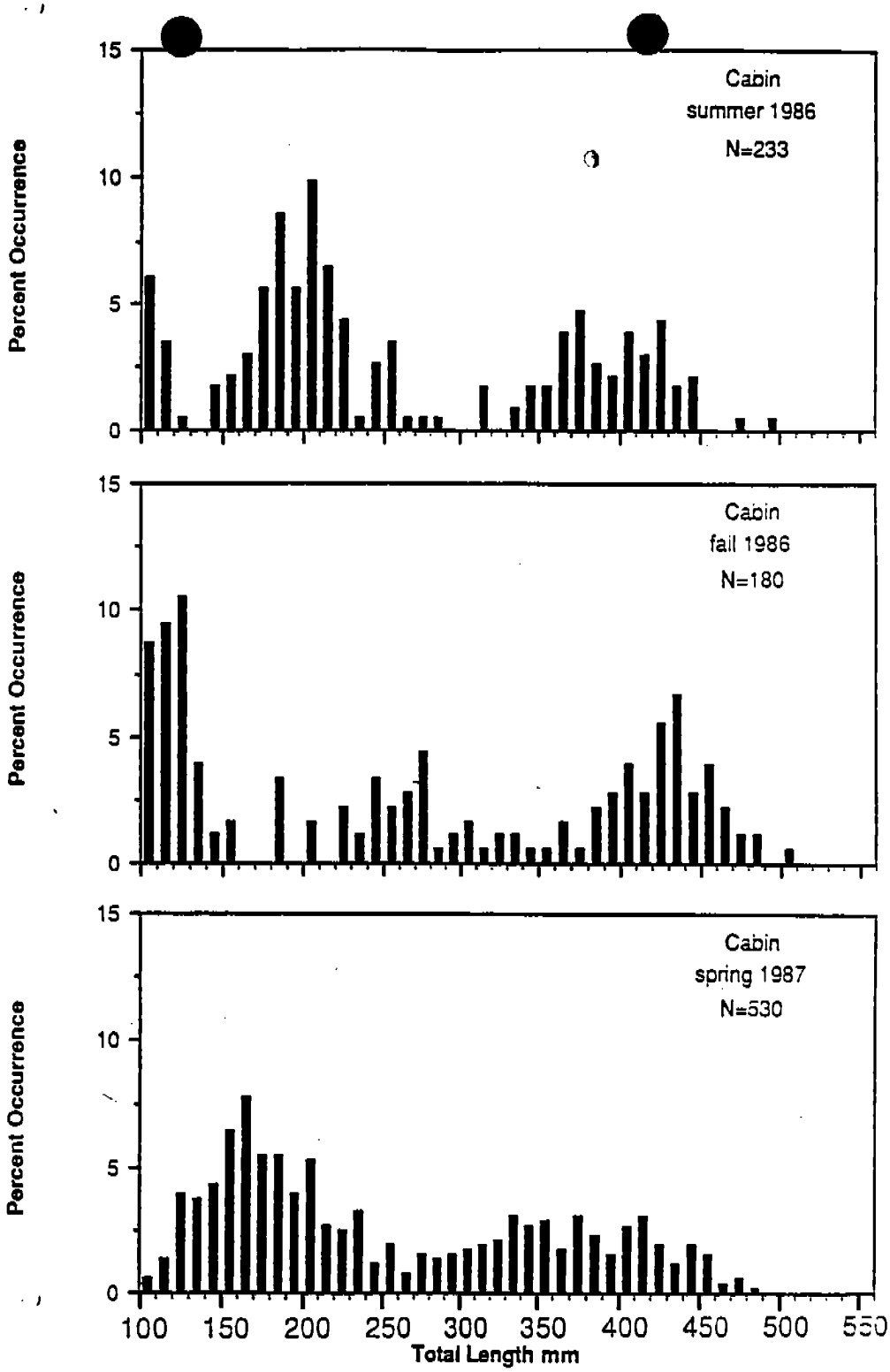


Figure 5. Length frequency histograms of rainbow trout electrofished in the Cabin site, for the summer 1986, fall 1986 and spring 1987 samples.

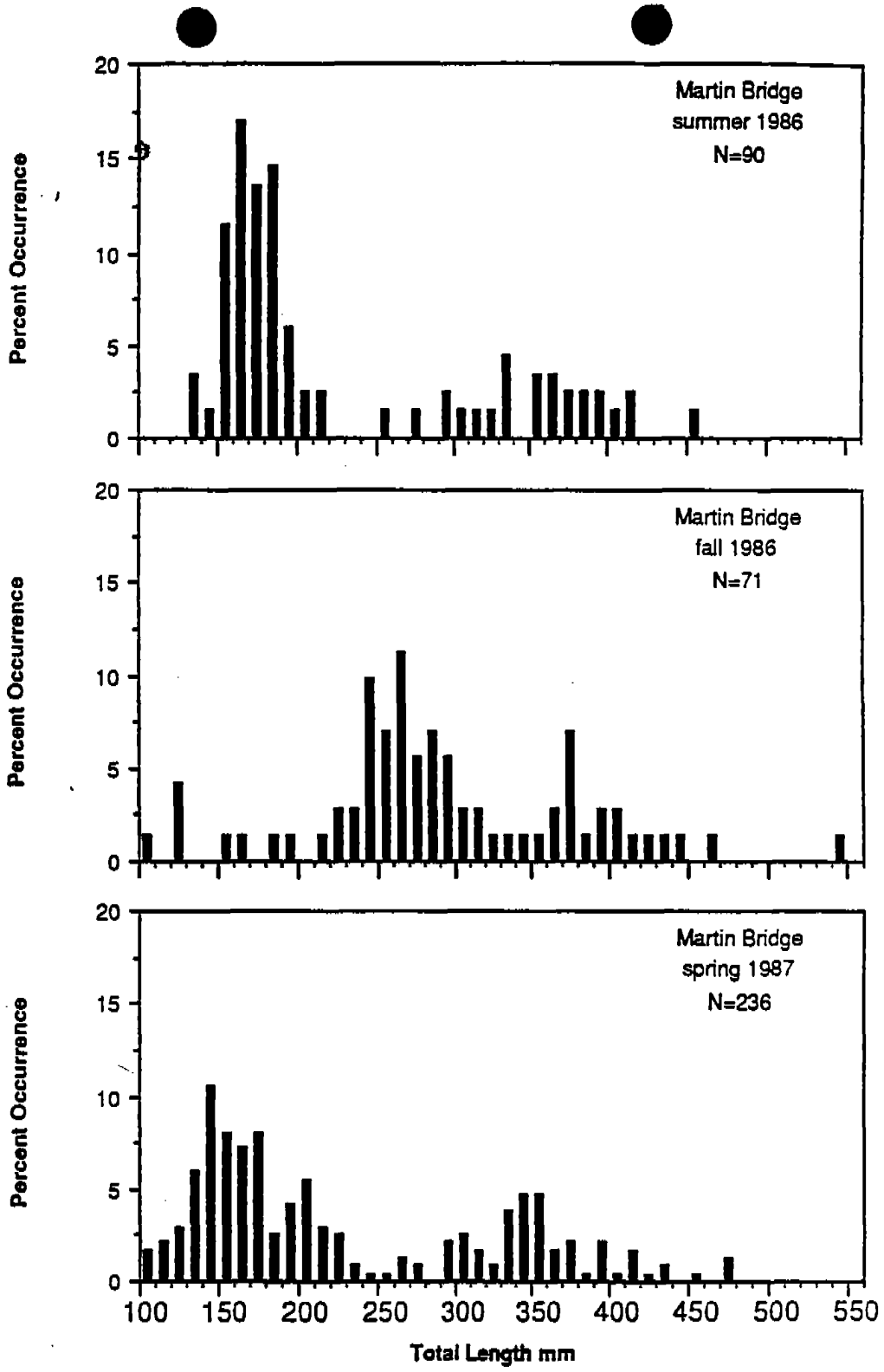


Figure 6. Length frequency histograms of rainbow trout electrofished in the Martin Bridge site, for the summer 1986, fall 1986 and spring 1987 samples.

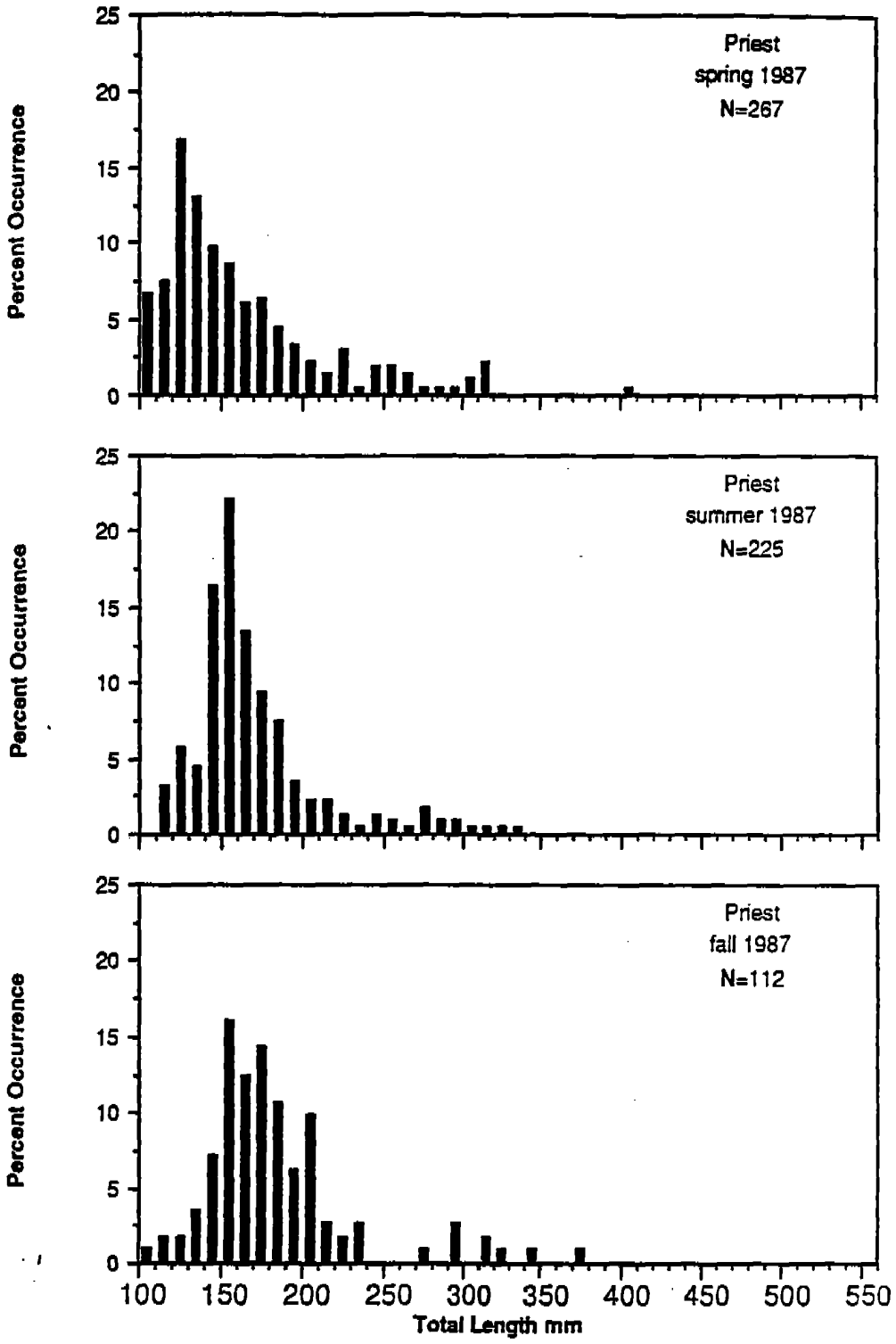


Figure 7. Length frequency histograms of rainbow trout electrofished in the Priest site, for the spring 1987, summer 1987 and fall 1987 samples.

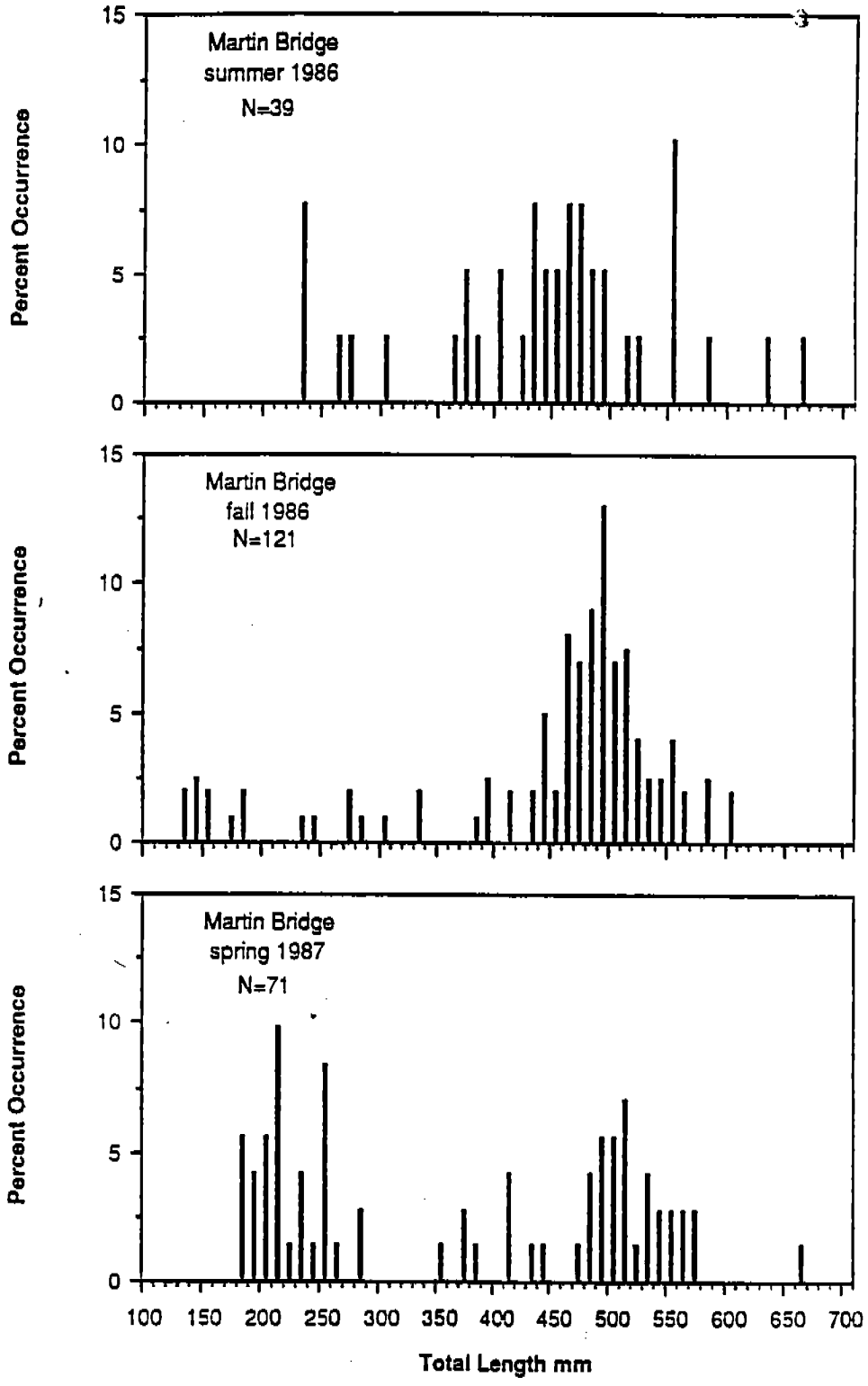


Figure 8. Length frequency histograms of brown trout electrofished in the Martin Bridge site, for the summer 1986, fall 1986 and spring 1987 samples.

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

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 percentage of brown trout below 300 mm in length in the spring, summer, and fall were 53, 81 and 90%, respectively (Table 11).

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 1 and 2 year old rainbow trout, which comprised most of the electrofishing sample for both the day and the night. Similar results were found by Campbell and Neuner (1985) for high gradient streams in the Cascades of western Washington state. 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 Martin Bridge 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 greatest increases in growth and longevity in the Cabin site. Less change occurred the Martin Bridge and Priest sites. The mean length at age for the 1977 catch-and-release rainbow trout sample increased 13 mm in length when compared with the 1987 sample of similar age fish (Table 13). Variation among the older age classes proved to be to 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 5+ rainbow trout captured 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+ rainbow trout 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 samples (Table 13). Rainbow trout in Priest grew the slowest compared to our upstream study sites (Table 13). Age 4+ was the maximum age obtained by rainbow trout in the 1986 and 1987 Priest electrofishing samples.

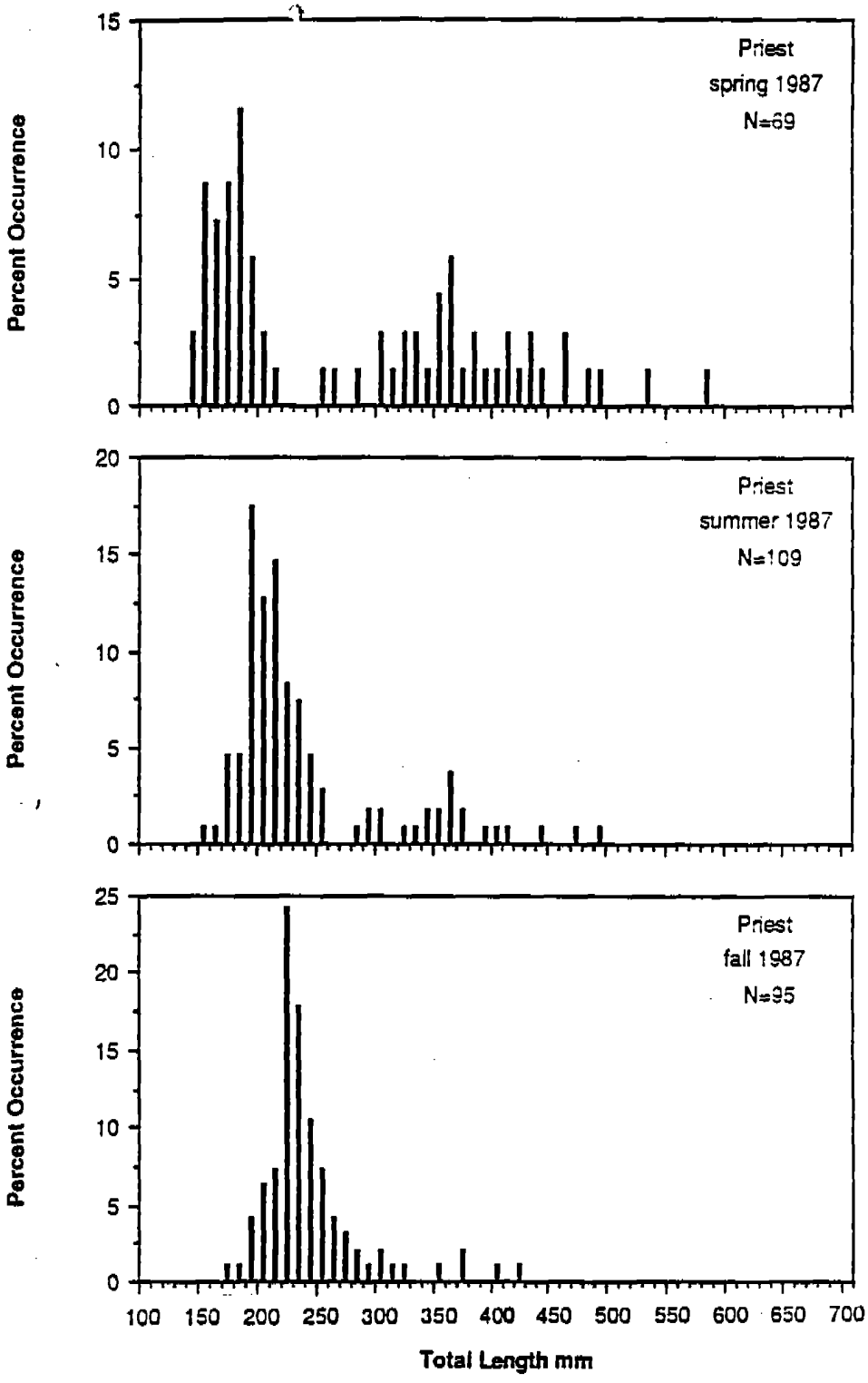


Figure 9. Length frequency histograms of brown trout electrofished in the Priest site, for the spring 1987, summer 1987 and fall 1987 samples.

Table 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.

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 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, in sites other than Martin Bridge however, were not found to be significant at the $P < 0.05$ level using the Mann Whitney test (Table 15). For brown trout of the Martin Bridge and Priest sites, seasonal decreases in condition factors were also found not to be significant (Table 16). The differences in condition factors of rainbow trout between 1977 and 1987 samples were found to be insignificant (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 hookscarred at a higher rate than the brown trout. The highest hookscarring rate for rainbow trout was 26% of fish exceeding 100 mm in length for the Cabin site during the summer of 1986 (Table 19). For rainbow trout exceeding 250 mm in length, the rate has increased from 15% in 1977 to 24% for combined Cabin samples in 1986. The lowest rate of hookscarring among rainbow trout was 1% of fish exceeding 100 mm in spring 1987 sample from Martin Bridge (Table 19). The highest rate of 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. Brown trout in sites of low angler effort had low rates of scarring, or no scarring at all, as 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 14. Mean back-calculated lengths (mm) of brown trout in selected sections of Silver Creek.

Section	Sample date	N	Estimated length at age						
			1	2	3	4	5	6	7[a]
Martin Bridge Section 3	Spring 1987	70	157	228	333	411	472	514	632
Priest Section 5	Spring 1987	63	135	248	327	390	444	484	573

[a] Only one fish per sample was found to 7 years of age.

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. Since the Cabin site is within the catch and release area and including hooking mortality, the natural mortality rate (M) would be from 0.39 to 0.57 (Table 21). The Martin Bridge spring estimate of annual mortality for age 3 and older fish was 0.42, intermediate to the two Cabin estimates. The spring mortality estimate was lower than the fall estimate in Martin Bridge and may have been due to an influx of large spawning rainbow into the site during the spring. Both 1986-87 annual mortality estimates for Martin Bridge were less than 1977, (A = 0.72). 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 in fluctuation in the population of the site. In the Priest site, the instanteous 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, u = 0.12. Therefore, using this model results in a high natural mortality of 1.26. The absence of older fish, also results in a high annual mortality rate of 0.77.

Estimates of mortality were calculated for ages 4 and older for the brown trout of Martin Bridge because 3 year old 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 of Martin Bridge 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 browns 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 was higher than that of Martin Bridge. The annual mortality of 0.42 was found for age 3 and older fish. 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 total count of rainbow trout redds in Section 3 was 240 at a density of 28.9 redds/km (Table 23) (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 the reach sampled in Section 4, only 4 redds were counted and only 3 redds were observed in the two reaches censused in Section 5. In Sections 4 and 5 together, 7 redds were counted in 3.2 km of stream. Although densities may actually be

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[b]
	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

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 is considered reliable because of adequate visibility in that section 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 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 the diversion dam just below the Highway 20 bridge in Section 3. These dams do not appear to be barriers to fish movement.

Disturbance of Trout by Angling

Rainbow trout exhibited little or no change in response to different levels of angling pressure (Table 24). Although trout did fed 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 was observed during the period of angling exclusion ($\bar{X}$ = 11)(Table 24). This represents an increase of one fish from the period of angling to the period of angler exclusion. The increase of fish maybe the result of increased angler effort near the boundaries of the study site during the exclusion period. A decrease of two fish in the mean was noted after angling was resumed within the site. Anglers appeared to have moved fish around from one area to another, although fish remained feeding and showed no signs of alarm (i.e. Sulking, changes in color, flight behavior).

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

Mean feeding velocities remained at 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 since the distribution of fish within the study area remained fairly consistent for the entire study.

Angler Use

Angler Effort

Angling effort was estimated during the 1987 angling season with a randomized, stratified schedule of counts. We found that angling effort was heaviest during Intervals I, V and VI, with total estimated efforts of 5641, 3718 and 3697 hours, respectively (Figure 10). Effort during these three intervals accounted for 44% of the total effort expended.

In Section 1, effort was estimated to be 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 2277 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, Interval VI, to approximately 2 h/hectare during Interval XIV (November 20 to November 29) (Figure 10).

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, and 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

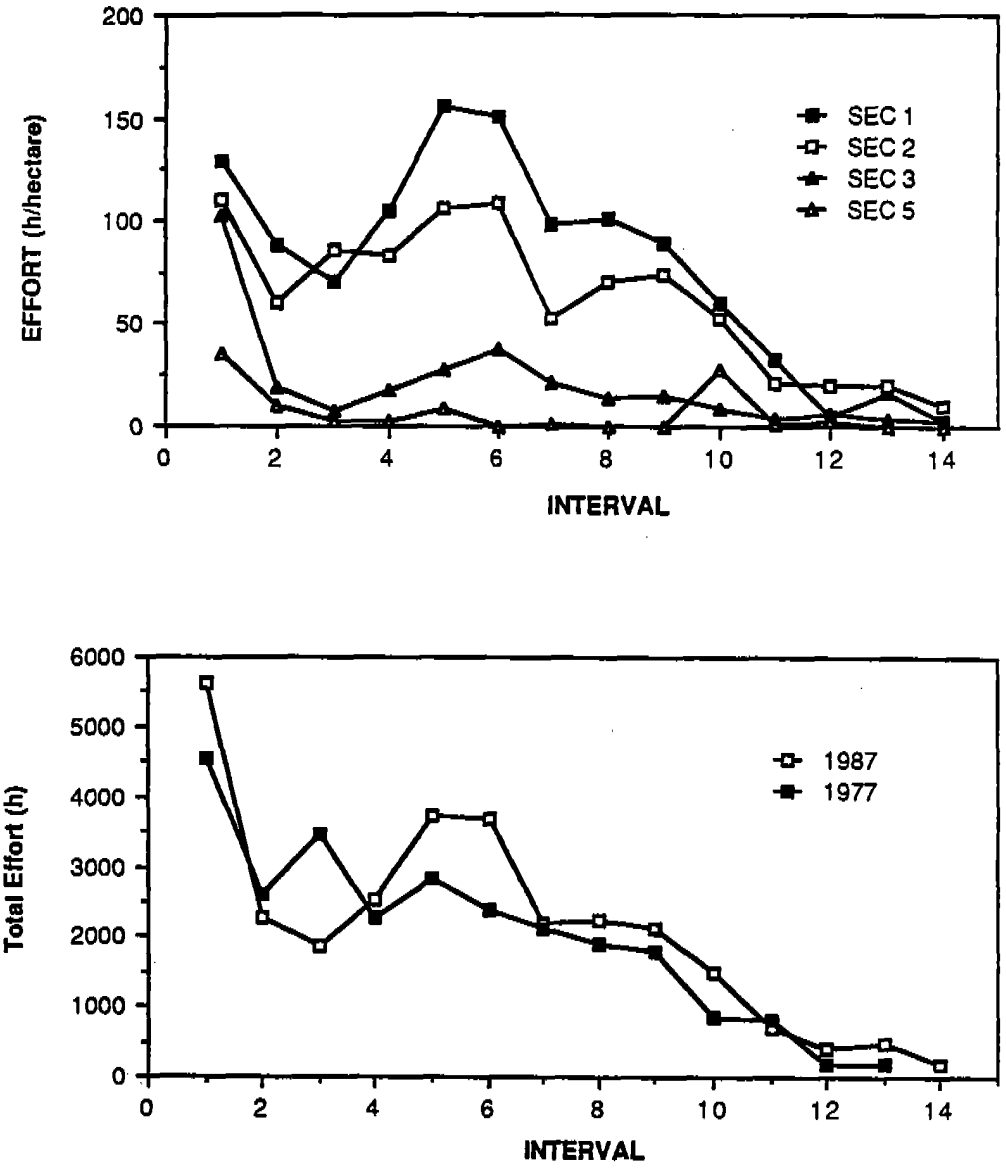


Figure 10. Estimated angler effort by section on Silver Creek for the 1987 season. Effort from all sections was pooled for the 1987 and 1977 comparison.

primary reason for the high effort in the first interval was due to the fishing season opener scheduled on Memorial Day weekend. Effort for opening day in 1987 was probably less than in 1986. Water conditions statewide were high and unfishable in many streams in 1986, with the exception of Silver Creek. In a 1986 preliminary effort survey, effort in Section 1 during Interval I in 1986 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 the same fluctuations as the upper sections but received less than one fifth of the density of effort as the upper sections.

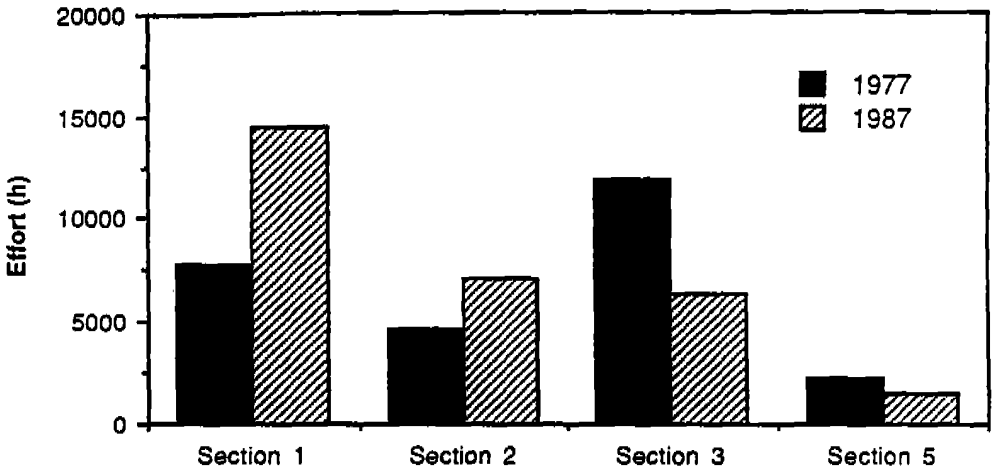
Total angling effort for Silver Creek for 1987 increased slightly over 1977. Effort for Sections 1,2,3 and 5 in 1987 totaled 29,562 hours, compared to 26,589 hours in 1977, representing an 11% increase (Thurow 1978) (Table 25). Although total effort was similar, the distribution of effort between sections 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 7772 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 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 density display the difference in use within Section 3. Effort in the upper reach, including the Martin Bridge area, received 600 h/hectare, two times that of the estimate of the entire Section 3 (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 the majority, 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). Anglers did appear to be slightly more successful at catching large (>300 mm) rainbow trout, 41%, than electrofishing, 35% (Table 28). Catch rates for rainbow increased from 1.13 fish/h in 1977 to 1.81 fish/h during the 1987 season (Figure 12). The rises in catch rates and effort resulted in a three fold increase in estimated number of rainbow trout caught, from 8803 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 in length and 3% also exceeded 500 mm



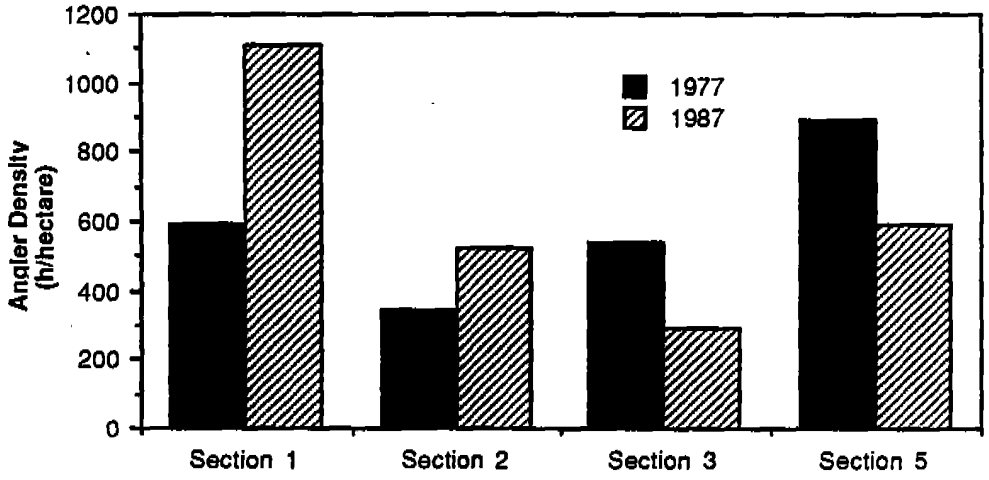


Figure 11. Estimated angler effort from the 1977 angling season compared with estimated effort from the 1987 season, for Sections 1, 2, 3, and 5. The area surveyed in 1977 was slightly larger than the area surveyed in 1987.

Table 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

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

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.

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	243	62	13	265
Section 3	280	44	8	146	213	15	1	372
Section 5	266	27	2	122	184	5	0	110

(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 in percentages 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 similar proportions of browns greater than 399 mm in length to those captured in the electrofishing samples (Table 27 and 11). The catch rate for brown trout in Section 1, 0.08 fish/h, was substantially less than that for rainbow trout. The estimated catch of browns was 1221, approximately 5% of the rainbow catch (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 300mm, 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 that exceeded 500 mm in length, in 1987 or 1977. 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 Section 2 rainbow trout in 1987 varied between method types (Table 30). Anglers using flies harvested 0.04 fish/h, while lure and bait anglers had substantially higher harvest rates at 0.33 and 0.50 fish/h. The number of rainbow trout harvested in 1987 declined from 1977 figure, 1400 to 1071 rainbow trout harvested, respectively (Table 31).

Brown trout were not captured by anglers in Section 2 during 1977 but small numbers of brown trout were caught in 1987. Like rainbow trout, the majority, 82%, of the angler caught brown trout exceeded 300 mm, while 27% exceeded 400 mm in length (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 was also low, 161 brown trout, in relation to the high effort expended in Section 2 (Table 31).

Brook trout were caught too infrequently to construct an angler catch 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.

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

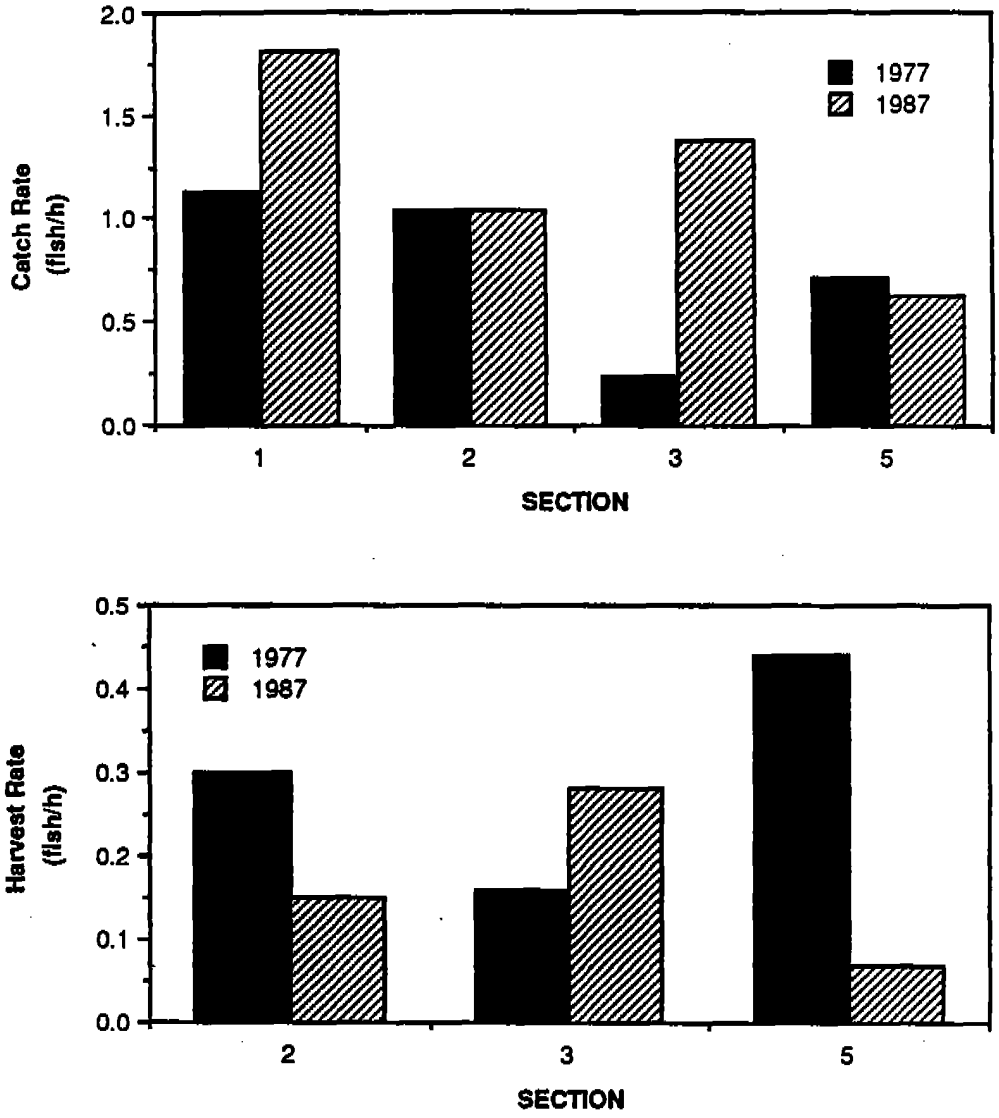


Figure 12. Catch rates and harvest rates for rainbow trout from the 1977 and 1987 angling seasons.

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)

Section 3

Anglers caught primarily age 1 and age 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 in length (Table 27). The mean length of captured rainbow trout declined substantially 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 electrofishing catch (33 to 17%). The total catch rate for rainbow trout in Section 3 increased dramatically over the last ten years, from 0.24 fish/h in 1977 to 1.38 fish/h in 1987 (Table 26) (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 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 11). The number of fish harvested in 1987 decreased slightly, 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% of brown trout exceeded 300 mm in length and only 4% of the catch exceeded 400 mm in length (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 the large brown trout to angling was confirmed by the low numbers of angling recaptures of tagged fish (Table 33).

Catch rates for Section 3 brown trout 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 among lure anglers. The total estimated catch in Section 3 was 1356 brown trout during the 1987 season. 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 those captured by electrofishing, although a few brook trout exceeding 300 mm in length were captured 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 it was 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) (Figure 12). We estimated a total of 948 rainbow trout were caught in 1987, a substantial decrease from the 1610 caught in 1977. In addition to the substantial 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).

The majority, 66%, of brown trout caught in Section 5 were under 200 mm in length. Unlike the rainbow 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.

Although 209 brown trout were tagged, only 11 were reported captured by anglers. Two of these 11 were caught twice during the season. Five percent of the brown trout tagged were reported captured while 17% of the rainbow trout tagged were captured by anglers. Brown trout, therefore, appear to be less vulnerable to capture by anglers than rainbow trout.

Angler Survey and Opinions

The majority of anglers interviewed in Section 1 were non-residents, 56%. 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. 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

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					

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

1977 Angling Season				1987 Angling Season			
Section	Residents	Non-Residents	N	Section	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.

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, from 85 to 100% replying that they were satisfied. In Question 3, anglers were asked if they had a preference for a particular species in Silver Creek. Anglers responded equally frequent 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 6 trout limit, only 2 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; as the majority of both angler types were satisfied with the regulations. Of those fly fisherman that were dissatisfied, 44 of 46 agreed to more restrictive regulations (Table 36).

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

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	2,177	85%	12,337	217	14,514
Section 2	64		36	2,564	76	
Section 3	77	4,941	23%	1,476	104	6,417
Section 5	98		2	50	50	
	34%	7,118		13,863	66%	20,931

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

Figure 13. Angler questionaire questions and replies for the 1987 angling season, answers from all sections are pooled.

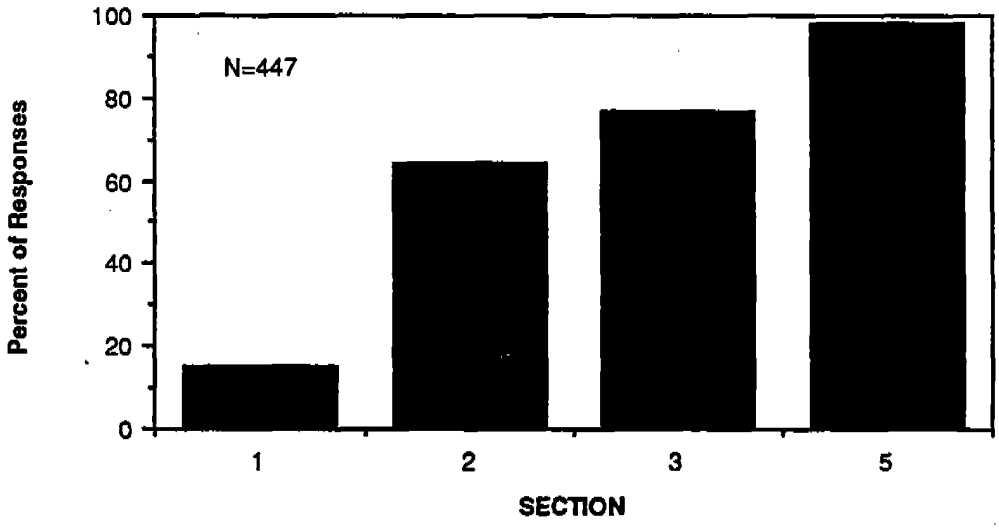


Figure 14. The percentage of anglers satisfied with the general regulations from 1987 angler questionaire.

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

Pool upstream statistics

DISCUSSION

Silver Creek's popularity stems from its ability to produce an abundance of large, wild trout. The biomass of the catch and release site for rainbow trout and brown trout combined was quite high, 193 kg/hectare, relative to most streams in the area. 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 Henry's 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 slightly higher biomass at 228 kg/hectare, consisting of brown trout and brook trout (Jones 1985). 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.

Trout abundance in Silver Creek was compared to the Henry's 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 similar low gradient Railroad Ranch section of the Henry's Fork. At the time of the sampling this section of the Henry's Fork was under a slot limit of only 2 fish under 300 mm and 1 fish over 508 mm in length. Although densities were similar between Silver Creek and the Railroad Ranch, the percentage of larger rainbow trout (>400 mm) in the Henry's 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 1920's to 1960's, 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, that were intended 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 indicators of change were: frequency of large fish in the electrofishing sample, longevity, survivorship of older fish, angler catch rate, size of fish in angler catch, angler success and angler satisfaction. All of these measures have increased in the catch-and-release area of Silver Creek during the past ten years of the special regulation.

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 was gathered exclusively during the daylight hours. Our data for the 1986 and 1987 study was gathered at night, with the exception of the few comparative day runs. In the limited evaluation of the day versus night sampling comparisons that were 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 that 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 ten years 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 experienced an increase, from 3 to 23%, in the percentage of rainbow trout in the 400-499 mm length class since 1977, an increase we contributed 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 the total annual mortality among rainbow trout 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 has been documented by several researchers including (Johnson and Bjornn 1978, Vincent 1980 and Jones 1985).

The growth of rainbow trout in the catch-and-release section of Silver Creek has increased from estimates in 1977. The increase, although substantial, was not significant when tested with a two-sample t-test. Increases in growth may have occurred from the protection afforded to fast growing individuals, assuming that these individuals would have other wise been harvested (Thurow 1978). An alternate hypothesis is the elimination of competing hatchery catchable rainbow trout from the section. Vincent (1987) found an increase in growth among 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.

Anglers of the catch-and-release area have benefited from the improvement in the fishery. Catch rates increased and a higher percentage of the rainbow trout caught exceeded 300 mm in length. A slightly higher proportion of the anglers caught at least one trout per outing and 22% more anglers rated the fishing "good" (the highest rating) than the previous ten years. We utilized the same rating system in 1987 that was used in the 1977 angler survey.

One important question that this study cannot address with certainty is whether the numbers of large rainbow trout (>400 mm) has increased during the

ten years of protection. Since no estimates of density using electrofishing were made in the 1976 and 1977 field seasons, we can only make inferences from the change of the success of anglers in catching large rainbow trout. We utilized CPUE data from 1977 and the ratio of CPUE from 1987 with our density estimates to estimate the density of rainbow trout present in 1977 (Table 37). We did find a substantial increase in the density of rainbow trout over the past ten years using this method.

In addition to the differential catchability of different sized fish, the technique and ability of the angler has changed substantially during the past decade confounding the 1977 population estimate because of the change in angler efficiency. Whether or not the angler has changed and the absolute number of large fish has increased, the catch of the large rainbow trout in the catch-and-release area has certainly increased since 1977. We can conclude based on the parameters assessed that the fishery has improved in quality within the catch-and-release boundries.

Although total angler effort on Silver Creek as a whole has remained quite similar compared to 1977, effort in Section 1 has more than doubled. This increase is not due only to non-residents as little change in residence of anglers in Section 1 has occurred. Even though we cannot identify the reasons for the increase in effort in the catch-and-release, we have documented that Silver Creek does receive some of the most intensive angling pressure for a stream found in the country, when expressed on a density basis.

Indirect Angler Impacts on the Fishery

Due to the phenomenal angler effort on Silver Creek, primarily in Section 1, there is a possibility that anglers could impact fish populations in ways other than 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 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 potential of multiple captures on individual rainbow trout 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 certain underestimates. We received 10 to 15 accounts of fish caught with unreadable tags due to algae 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 yielded an estimate of 2.9, or 2.9 times more fish were caught than were present in the area, displaying the degree

Table 37. Population estimates for 1977 calculated from the relationship of catch rates to population size (fish/hectare) of 1987. Only fly angler catch rates were used for calculations.

Species and site	1987		1977	
	C/f	N	C/f	N
Rainbow				
Cabin (Section 1)	1.81	804	1.14	512
Martin Bridge (Section 3)	1.53	323	0.42	89
Priest (Section 5)	1.80	1336	1.02	757
Brown				
Martin Bridge (Section 3)	0.14	44		
Priest (Section 5)	0.65	151	0.27	41

of recapture of individual fish by anglers. This estimate merely displays the effort expended on a given population of fish. In actuality, only a portion of the population was captured multiple times. Of the 38 tagged rainbow trout that were caught by anglers, 84% were caught only once (Table 33). Research by Lewynsky and Bjornn (1987) confirms our findings that unequal vulnerablility to capture exists within a given population of fish. They found that in seperate populations of wild and hatchery fish that some fish were never caught during the entire study, while others were caught several times a week. From our tag information, it can be shown that not all fish are caught at an equal rate; that is, some fish will be caught many times and some fish will not be caught at all (Table 33). Therefore, the intense pressure exerted by high angler densities may only be experienced by relatively few members of the population.

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 some improvements 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 maybe related to the elimination of hatchery catchable rainbow trout plants within this section since 1977.

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 of what it was in 1977. In comparison, the estimated effort in Section 1 was 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 angler catch was dominated by hatchery rainbow trout, with only 28% of the catch consisting of wild rainbow trout. This study documents a decrease 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 somewhat misleading because the proportion of rainbow trout greater than 300 mm captured by electrofishing increased 28% from the fall of 1977 to the fall of 1986. The reason for the contradiction maybe related to the elimination of hatchery rainbow trout plants within Section 3. We did sample hatchery rainbow trout in the spring of 1987, although these fish were not planted, rather they escaped from Hayspur Hatchery on Loving Creek. During the 1976 and 1977 study years, approximately 12,000 catchable-sized rainbow trout were planted in Section 3. The negative effects of hatchery catchable trout on wild trout populations has been documented by numerous researchers (Mason et. al. 1967, Butler 1975, Bachman 1982, and Vincent 1987).

Specifically, the plantings of hatchery catchable rainbow trout in Section 3 altered the species composition by reducing the number of wild rainbow trout available to the angler and accounted for the reduced catch rate of wild rainbow trout in 1977. The presence of hatchery fish has been shown to exclude similar-sized and smaller wild trout from a particular site (Bachman 1982). This aggressive behavior could explain the larger mean size of rainbow trout caught by anglers in 1977. The resulting decline in mean length of rainbow trout captured by anglers in 1987 would be from the increased number of smaller rainbow trout in 1987 due to the lack of competing hatchery fish. We also noted an increase in the number of fly fisherman from 1977 to 1987 and these fly fisherman consistently captured more, smaller fish than did bait fisherman. This also could explain the 1987 size reduction for angler caught rainbow trout.

Although the catch rate of rainbow trout has increased greatly since 1977 and the percentage of fish released has increased, anglers in Section 3 are 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 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 to occur 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 lead 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.

In all general regulation sections the percentage of large rainbow trout in the catch has declined since 1977. Only in the catch-and-release section did the percentage of large fish in the catch increase. However, the percentage of large fish in the electrofishing sample, in the Martin Bridge site at least, did not show a decline. The increase in the proportion of fly fisherman in all sections may have contributed to the increased overall efficiency of catching smaller fish. In fact, the percent of fly fisherman in Section 3 increased by 23% and fly anglers caught 33% less rainbow trout over 300 mm than did the bait anglers. Therefore, some of the decline in the fishery can be accounted for by effectiveness of flyfishing to catch smaller fish causing the percent of larger fish to decrease.

Brown Trout Dynamics

The brown trout population at the Priest site was the only established population sampled in 1976 and 1977. Although little data from 1977 is available in the Priest area, 1977 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 imigrate 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 would be 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 and now are found well into Upper Stalker, Mud Creek, and Grove Creeks (Riehle unpublished data). Section 3 has the most mature population of the upper three sections, but were not unusually high for western brown trout populations. The density in the Martin Bridge area was as high as 189 fish/ha, much less than the Gibbon River in Yellowstone National Park, for example, which has an estimated density of 681 brown trout/ha (Jones 1985). The Martin Bridge site does support a population of large brown trout with 31 percent 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 anglers at this time were not interviewed in the same proportion as the angler 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 comprized only 6% of the catch in Section 1, a higher proportion of brown trout that were caught there were greater than 399 mm in length than in Section 3. Although few brown trout were caught by anglers in Stalker Creek, the electrofishing sample of 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.

MANAGEMENT IMPLICATIONS

In 1978, Thurow noted that only after one season of the catch-and-release regulation the trout fishery of Section 1 showed signs of improvement. 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, the angler effort in Section 1 nearly doubled from the estimated effort of 1977.

On the other hand, anglers of Sections 2,3 and 5 experienced a decline in the proportion of large (> 300 mm) rainbow trout caught which may be a function of increased percentage of fly anglers in each section. The rainbow trout fishery of Section 3 has improved with respect to its ability to sustain a wild trout fishery without hatchery supplimentation. The goal of the implementation of the catch-and-release regulation in Section 1 in 1977 was to try to restore the Silver Creek fishery to a historic level of producing many large trout. It has been shown by this study that increases in the quality of the Silver Creek rainbow trout fishery can be achieved through regulation management. However, if the present goal is to manage Silver Creek as a large trout fishery, then Silver Creek has met its potential, particularly if the fishery indeed has declined from the 1940's to 1970's (Hauck 1947).

Options in harvest regulation alternatives should be considered. The effects of restricting allowable harvest to 2 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 result in a 75% reduction in harvest, 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 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. Only those dissatisfied anglers were asked if they would agree to more restrictive regulations. It is possible that the results may have been different if all anglers had been asked the latter question. Effort may be more evenly distributed throughout Silver Creek if more water was managed under more restrictive regulations.

Brown trout mortality estimates of older age classes were low and the low vulnerability of the brown trout exceeding 350 mm in length was demonstrated by the low capture of brown trout reported 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 (0.42) in the spring to suspect that fishing had a minor effect on the age 3+ and older brown trout of that section. Since the density of brown trout increased from spring to summer there seems to be substantial immigration into the site.

Harvest estimates of 1987 could possibly be underestimates since 1987 was a low water year and early season effort was distributed among other streams that would normally be unfishable due to high water. For this reason a brief 2 to 4 week effort and creel study could be conducted in a normal(high runoff) year to determine if harvest is substantially higher in normal years. Decisions can then be made whether or not harvest is normally higher and results in higher mortality of older age classes.

Management Recommendations

1. Monitor angler effort on general regulation water since 1987 data was from a low water year and early season effort was lower than normal years.

2. If angler effort increases and catch rate and percent of quality sized rainbow trout (> 300 mm) in the catch decreases, survey angler willingness for more restrictive regulations.

3. Follow up sampling (~1993) in Section 1 to evaluate possible changes in brown trout abundance and size composition.

4. Arrest incidental hatchery releases from the Hayspur Hatchery if Silver Creek is to be managed as a wild trout fishery.

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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