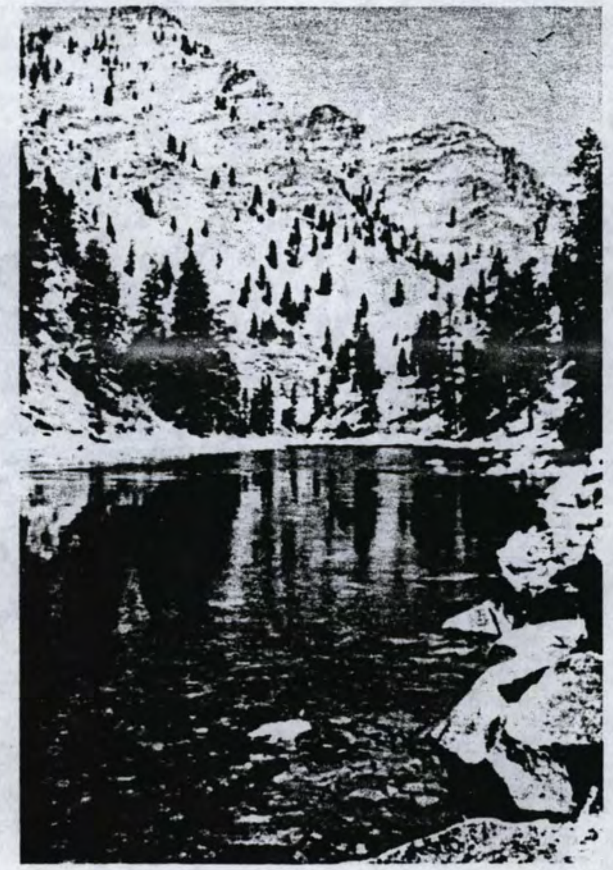
FISHERY RESEARCH

FEDERAL AID IN FISH RESTORATION

Job Completion Report, Project F-73-R-6
Subproject II: River and Stream Investigations
Study VI: Middle Fork Salmon River Fisheries Investigations



Russ Thurow
Senior Fishery Research Biologist
January, 1985

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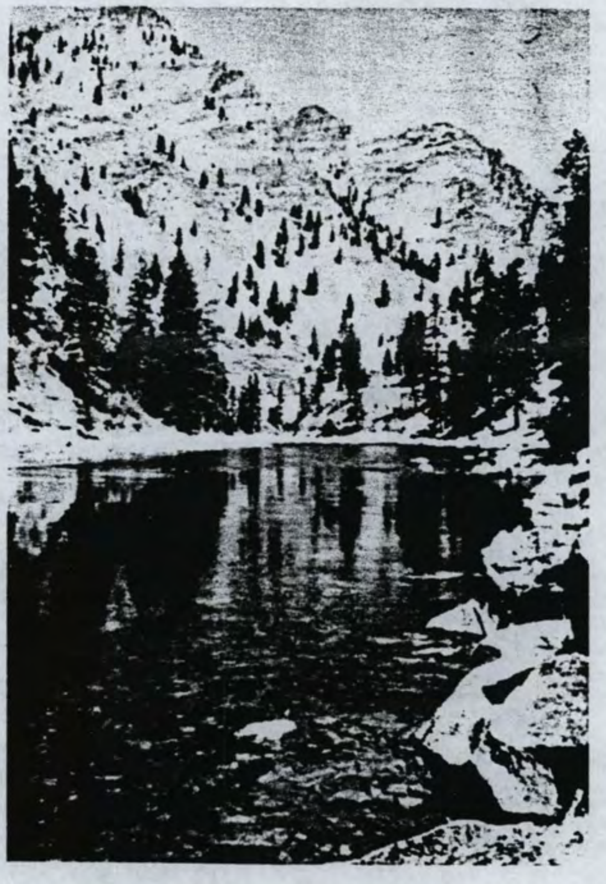

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JOB COMPLETION REPORT

State of: Idaho

Name: RIVER AND STREAM INVESTIGATIONS

Project: F-73-R-6

Title: Middle Fork Salmon River Fisheries Investigations

Subproject: II

Study: VI

Period Covered: 1 March 1983 - 29 February 1984

ABSTRACT

Status of wild steelhead trout (Salmo gairdneri) was evaluated in 14 tributaries to the Middle Fork Salmon River from 1981 to 1983. Emphasis was directed at collecting biological data to assist future management of the drainage.

Most of the drainage is in a pristine wilderness. Exceptions occur in several tributaries where man-caused activities (livestock grazing, placer gold and other precious metal mining) have degraded habitat. The proposed acceleration of mining within several drainages has the potential to degrade additional habitat.

Electrophorectic analysis suggests that Middle Fork Salmon River steelhead trout are similar to other "B" stock summer steelhead populations sampled in the Snake River basin. The data also illustrate that separate sub-populations exist within the Middle Fork Salmon River drainage.

Adult escapements in the study period were not sufficient to seed the available spawning habitat. Spawning commenced in early April and was completed prior to peak runoff in early June. We estimated that 640 km of tributaries were accessible to steelhead trout.

Tributaries provide the principal rearing habitats for steelhead trout in the Middle Fork drainage. Densities of steelhead trout ranged from 0.2 to 10.0 fish per 100 m^2 and averaged 4.0 fish per 100 m^2. Tributary rearing areas were underseeded from 1981 to 1983.

A small number of tributaries produce a majority of the westslope cutthroat trout (Salmo clarki) in the Middle Fork Salmon River. Bull trout (Salvelinus confluentus) were usually sympatric with cutthroat trout. Cutthroat trout populations were observed above migration barriers in three streams.

Few adult steelhead trout ascended the Middle Fork in the fall. Middle Fork Salmon River steelhead trout which stage in the mainstem Salmon River were formerly susceptible to an intensive sport fishery. A differential harvest regulation based on a 57 mm dorsal fin height measurement was instituted in the fall 1982. This regulation has allowed anglers to harvest a maximum number of hatchery-reared steelhead trout while releasing wild Middle Fork fish.

Future management considerations for the Middle Fork Salmon River steelhead trout population are discussed.

Author:

Russ Thurow
Senior Fishery Research Biologist

INTRODUCTION

Historically large runs of wild steelhead trout (Salmo gairdneri) returned annually to Idaho's abundant rivers and streams. The construction of dams has eliminated nearly 50% of the steelhead trout's original habitat by totally blocking runs in the Boise, North Fork Clearwater, Payette, Upper Snake and Weiser rivers.

The Middle Fork Salmon River is one of three major Idaho rivers which sustain wild steelhead trout (steelhead) runs unaltered by hatchery propagation. Historically, the Middle Fork supported substantial runs of steelhead which probably exceeded an annual spawner escapement of 10,000 fish. During the last decade, hydroelectric dams on the Columbia and Snake rivers have severely reduced survival of migrating steelhead, and Middle Fork spawning escapements have diminished from approximately 5,000 in 1970-71 to 500 (or less) in 1975-76 (Jeppson and Ball 1979). Consequently, the Middle Fork has been closed to steelhead fishing since 1974 in an attempt to sustain the wild steelhead stock.

Although several biologists have evaluated the cutthroat trout (Salmo clarki) resources of the Middle Fork drainage (Mallet 1963, Ortmann 1971, Ball and Jeppson 1980), very little data has been collected on its steelhead resources. Preliminary work on steelhead was conducted in 1980 (Reingold 1981). In 1981, the Idaho Department of Fish and Game initiated an intensive 3-year fishery investigation. This project was designed to evaluate the current status of wild steelhead and to provide information to assist future management of the steelhead resource of the Middle Fork. Data on cutthroat trout (cutthroat) and other species was also collected.

Results of the 1981 and 1982 field work have been reported in job performance reports (Thurow 1982a, 1983). This report includes 1983 field data and a synopsis of the research program from 1981 to 1983.

Since 1981, significant changes in steelhead fishing regulations have been enacted on the Salmon River. The major objective has been to differentially harvest hatchery stocks, while increasing escapements of wild stocks.

During the fall 1980-spring 1981 fishery, no special limits or gear restrictions were set, although anglers were encouraged to voluntarily release wild steelhead. In the fall 1981, the possession limit was increased from two to four fish above the Middle Fork, and in the spring 1982, the bag, possession and season limits were set at one, one, three, respectively, below the Middle Fork and two, four, six, respectively, above the Middle Fork. Barbless hooks were also required below the Middle Fork. In the fall 1982, a regulation was initiated in Section 4 (South Fork to Middle Fork) and a portion of Section 3 (Vinegar Creek to South Fork) which required anglers to use barbless hooks and release most wild steelhead based on a dorsal fin measurement (Thurow 1983). Steelhead larger than 94 cm were exempted to allow anglers to keep a "trophy" fish. In the spring 1983 these regulations were extended to include Sections 1 through 4. Most recently, regulations for the fall 1983-spring 1984 fishery were set to require release of wild fish, based on a dorsal fin height measurement, regardless of total length.

An ultimate goal of this program is to restore angling opportunities for wild steelhead within the Middle Fork drainage. The baseline studies have provided management alternatives and a means of monitoring the status of the population. Descriptions of fish populations in Middle Fork tributaries also provide management biologists with data for technical assistance.

DESCRIPTION OF STUDY AREA

The Middle Fork of the Salmon River flows through a remote area of central Idaho and for most of its length, lies within the Frank Church River of No Return Wilderness Area. From its origin at the confluence of Bear Valley and Marsh creeks, the Middle Fork flows north-northeast for 171 km through the Salmon River mountains and joins the Salmon River 92 km below Salmon, Idaho (Fig. 1).

The earliest known human inhabitants of the Middle Fork were likely Paleo Indians 10,000 years ago (Knudson et al. 1982). White men initially described the drainage in 1824 when Alexander Ross traveled along Marsh Creek. Carrey and Conley (1980) and Knudson provide detailed discussion of the prehistory and human history of the Middle Fork drainage.

Mallet (1963), Minshall et al. (1981) and Thurow (1982a) provide detailed descriptions of study area's topography, climate, vegetation, stream discharge, water quality and recreational use.

Peak stream discharges occur during a two- to six-week period in May and June as a result of snowmelt. Spring runoff extends over four months, with a base flow over the remaining eight months. Flows decrease throughout summer and increase with the onset of winter precipitation.

Mean annual discharge equals 43.2 m^3/sec (1973-1980). Flows during the past five years varied considerably between years, ranging from a 1977 mean annual flow of 16.1 m^3/sec, and a maximum discharge of 52.7 m^3/sec, to a mean flow of 43.9 m^3/sec, and a maximum discharge of 255.1 m^3/sec in 1980 (USGS 1977-1980). The gauge at Middle Fork Lodge was discontinued in 1981.

Road access exists to Dagger Falls and at the Middle Fork's confluence with the Salmon River. Although headwaters of a few tributaries are accessible via unimproved roads, the lower 156 km of the Middle Fork is accessible by air, float craft, or trail only. Ortmann (1969) observed that the Middle Fork has attained national prominence as a recreational stream since it offers outdoor enthusiasts opportunities in whitewater boating, angling, hunting, or passive enjoyment of rugged scenery. In 1983, 7,943 people floated the Middle Fork (Challis National Forest 1984), compared to 625 in 1962 (Ortmann 1969).

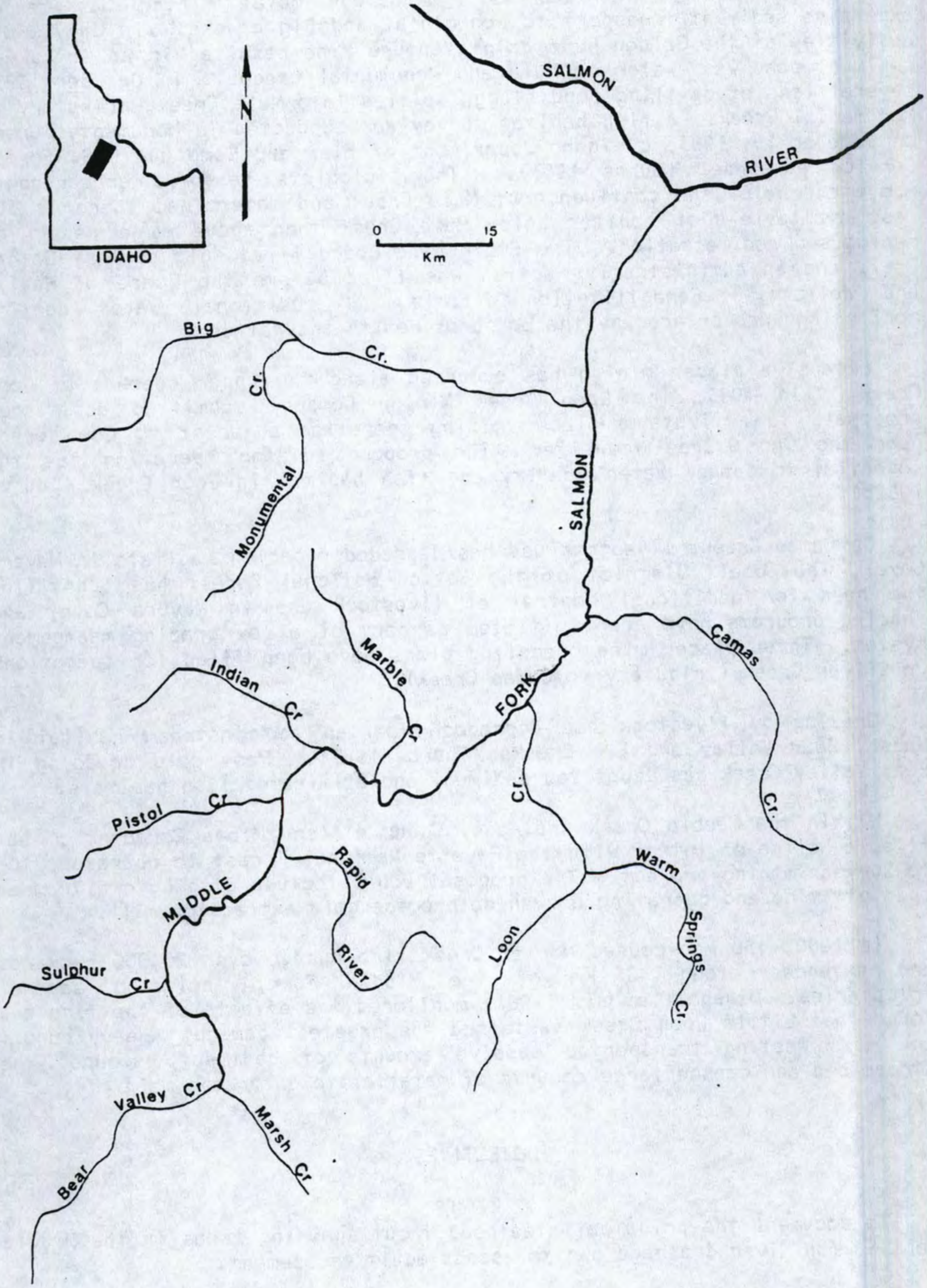

Figure 1. Middle Fork Salmon River drainage, Idaho.

Although most of the Middle Fork drainage and its aquatic habitat lies in a pristine wilderness, human activity has significantly altered sections of several tributaries. Precious metal mining has caused extensive sediment transport to Monumental and Big creeks. In July 1981, activities at the Golden Reef Joint Venture Mine resulted in an influx of sediment pond wastewater to Mule and Monumental creeks. In October 1983, several tons of settling pond sludge spilled into Mule Creek, tributary to Monumental Creek. A fish habitat survey was conducted in Monumental Creek on October 19, 1983, by Idaho Department of Fish and Game and U.S. Forest Service personnel (Burns 1983). The biologists measured embeddedness above and below the confluence of Mule Creek and determined there is 50% less available fish habitat below Mule Creek than above as a result of man-caused sedimentation. The State Land Board filed suit against Golden Reef, and an administrative action was filed before the Board of Health and Welfare. Rehabilitation efforts and additional water quality monitoring were ordered by the Board of Health and Welfare.

Extensive placer mining has occurred along the upper reaches of Loon Creek. In 1983, the Loon Creek Mining Company submitted additional proposals to activate a placer mining operation adjacent to Loon Creek near the Oro Grande townsite. The proposed mining operation has the potential to damage water quality and fish habitat in Loon Creek (Thurow 1982b).

On Camas Creek, livestock use has degraded riparian habitats in Meyers Cove. The Cobalt District of the Salmon National Forest has identified the need for additional control of livestock use in Meyers Cove, and fencing programs have been initiated as part of a new grazing management system. Three placer mine operating plans have been filed for operations on Silver Creek (tributary to Camas Creek).

Grazing by livestock has degraded riparian and instream habitat in Marsh, Bear Valley and Elk creeks (Thurow 1983). Past gold dredging in Bear Valley Creek has deposited sediment and eliminated fish habitats.

Within the Marble Creek drainage, Coeur d'Alene Mines Corporation has filed a Notice of Intent with the Payette National Forest to operate a 10- to 20-year mining project. The proposal would include digging ore from an open pit mine and operating a cyanide process gold extraction mill.

In 1980, the man-caused Mortar Creek fire burned over 26,000 hectares and extended along 40 km of the Middle Fork, including several tributaries. Minshall et al. (1981) monitored the effects of the fire and found that Little Loon Creek sustained the greatest damage. Heavy runoff and mass wasting transported massive amounts of sediment, scoured the stream bed and caused large amounts of material to enter the main river.

OBJECTIVES

To document the principal steelhead trout spawning areas in the Middle Fork Salmon River drainage and to assess adult escapement.

To collect biological data characterizing the size, sex ratio and origin (wild or hatchery) of steelhead trout spawners.

To assess the abundance, distribution and population structure of cutthroat trout and juvenile steelhead trout in the Middle Fork Salmon River and tributaries.

To genetically characterize fish from Middle Fork Salmon River tributaries in order to compare them to each other and to other Idaho steehead stocks.

To evaluate the timing and movement of wild steelhead trout in the main Salmon River and in the Middle Fork Salmon River and tributaries.

To assess the contribution of wild Middle Fork Salmon River steelhead trout to the main Salmon River sport fishery downstream from the Middle Fork.

RECOMMENDATIONS

1. Wild steelhead trout stocks are unique in Idaho. The Middle Fork Salmon River is one of three drainages which sustain steelhead trout unaltered by hatchery-reared stocks. Continued management for the production and preservation of the indigenous stock is the recommended alternative for restoration of steelhead trout sport fishing opportunities to the Middle Fork Salmon River.

2. Differential harvest regulations initiated in 1982 have been successful in increasing escapements of wild steelhead trout. Maintenance of these regulations on the Salmon and Snake rivers will aid restoration of the Middle Fork Salmon River steelhead trout population.

3. Optimal escapement of wild steelhead trout, defined as the number of spawners required to fully seed the available habitat with parr, is recommended for the Middle Fork Salmon River. Calculations based on the application of steelhead production data to available habitat suggest a spawning escapement goal of approximately 8,000, with a range from 6,000 to 11,500 depending on spawning success.

4. Escapement estimates for wild steelhead trout are critical for future management decisions. The angler creel census initiated on the Salmon and Snake rivers in 1984 will quantify escapements of wild steelhead trout to the Middle Fork Salmon River using wild fish: hatchery fish ratios and hatchery escapements. Estimates can be compared to escapement goals to monitor the population status. Corraborative field data can be collected with a small expenditure of effort. Snorkeling counts of selected tributary transects and redd counts of index areas should be conducted annually. Selection of tributary transects can be coordinated with research personnel. Recommended procedures for and location of redd index surveys are in Appendix A.

5. Maintenance of fisheries habitats in a pristine condition will assist the restoration of wild steelhead trout. An aggressive stance for habitat protection is warranted when reviewing proposals which have the potential to degrade aquatic habitats. Fish populations will benefit if corrective measures are applied to restore aquatic habitats which have been degraded. Impacted areas listed in the Description of Study Area require restoration efforts.

6. Section 9(a) of the Central Idaho Wilderness Act addresses a ban on dredge and placer mining. The wording and intent of the Act are subject to interpretation. A legal opinion is needed to resolve the intent of the Act.

7. Accessible sections of Indian, Loon and Pistol creeks appear to receive considerable angling effort. A periodic creel census would define the angler effort and harvest.

8. With the exception of Big Creek, anglers can harvest fish of any size in tributaries. Steelhead trout parr apparently comprise a majority of the fish caught in tributaries. A 200 mm minimum size limit would restrict the harvest of most steelhead trout parr. The regulation would also enable anglers to harvest residualized steelhead trout, resident rainbow trout and larger cutthroat and bull trout.

METHODS

Spawning Area Surveys

Commencing in March and extending to the third week in May, we visually surveyed and fished sections of tributaries to the Middle Fork during 1981, 1982 and 1983. We surveyed 262 km of stream in 1981, 106 km in 1982 and 337 km in 1983. Thirteen streams were surveyed by both ground and aerial methods. We mapped stream sections, counted steelhead spawners and redds, observed spawning behavior and recorded biological data on fish captured or observed. Since most steelhead apparently remain on redds from one to three days and migrate from spawning areas soon after spawning (T. Johnson, Washington Department of Game, pers. comm.; Reingold 1964), it is unlikely we counted any fish more than once.

Springtime visual surveys of spawning areas do not provide a reliable estimate of actual spawner abundance. Water conditions are subject to change, and even during excellent conditions, only a portion of the spawners in a stream reach are visible. However, surveys do provide important information on the timing and location of steelhead spawning in addition to biological data characterizing spawners.

Survey conditions were excellent in 1981 and 1983 and poor in 1982.

Juvenile Distribution and Abundance

We used snorkeling counts of fish in previously established transects to assess the abundance of juvenile steelhead. Counts were made on cloudless days between 0930 and 1630 when visibility was maximum. Several researchers (Northcote and Wilkie 1963, Goldstein 1978, Griffith 1980) have concluded that reliable estimates of fish abundance can be obtained by underwater counts. We completed our counts in July and August because juvenile steelhead maintain specific daytime stations and home ranges in summer (Edmundson et al. 1968). Underwater census techniques were ideal for surveying the streams in the Middle Fork drainage. Everest (1969) quantitatively described habitat selected by juvenile steelhead. We reviewed his descriptions and selected transects exhibiting abundant rubble-boulder substrates, moderate or faster velocities and run-slick qualities (Thurow 1982a). Pools, riffles and shallow runs were not selected because they are not preferred habitats. Most transects contained abundant rubble-boulder pocket water habitat.

Juvenile steelhead were classified by length at Age I (70-130 mm), Age II (130-200 mm) and Age III (>200 mm) using a classification similar to Everest (1969). I did not attempt to count young-of-the-year salmonids (<70 mm) since they were indistinquishable by species and timing of complete emergence was unknown. It is likely that most fish larger than 250 mm were residualized steelhead or resident rainbow trout. Idaho Cooperative Fishery Unit personnel measured lengths of 1,592 wild steelhead smolts at Lower Granite Dam in 1977 (unpublished). Smolts ranged from 120 to 290 mm and most (89% to 96% for two groups) ranged from 170 to 250 mm. One to six percent exceeded 250 mm and only 1% of the total 1,592 exceeded 270 mm. Since we sampled Middle Fork fish in August, they would have continued to grow until late October, with additional growth in spring prior to smoltification. Everest (1969) estimated a length increase of 9 mm per month in the third summer of a steelhead's freshwater rearing state. Consequently, a juvenile steelhead 250 mm long in mid-August would exceed 270 mm prior to the following spring, and it is unlikely a fish of that size would undergo smoltification and migrate. Within this report, I assumed that below barriers all rainbow trout or steelhead parr less than 250 mm were juvenile steelhead trout. It was further assumed that all rainbow trout or steelhead parr larger than 250 mm were non-smolting residualized steelhead or resident rainbow trout. Rainbow trout observed above barriers were classified as resident rainbow trout. A resident rainbow trout population often remains when steelhead are blocked from an area (Simpson and Wallace 1982).

Total numbers of other game fish were counted by species. Within the Middle Fork, the number of cutthroat larger than 300 mm was recorded. Within tributaries, cutthroat were recorded in 100 mm size groups. The presence of mountain whitefish (Prosopium williamsoni) and nongame species was noted.

To assess length frequency distributions of steelhead and other game fish, we used barbless flies and lures to capture fish in the Middle Fork and tributaries. Species, total length, date and location of capture were recorded for all fish caught.

Middle Fork Salmon River

Twenty longitudinal transects had been established in 1980 at sites we considered good steelhead habitat (rubble-boulder pocket water) between Boundary Creek and the Salmon River (Reingold 1981). Chapman and Bjornn (1969) used the term "rubbly-glide" to describe such habitat. Using a wetsuit and snorkel, I floated two separate glides (visible corridors) down each transect and enumerated all fish by species (Thurow 1982a). One glide was made close to the shoreline and the second near midstream. A second diver made consecutive passes down each glide approximately five minutes later and the maximum count was used. Following the counts, we measured the total length of each transect and recorded water temperatures. Visibility was determined by measuring the distance a diver was able to see a brass scale underwater. The area snorkeled was calculated by the formula:

$$\text{Surface area} = (2V)\ (L)\ (G)$$

Where: V = Visibility
L = Total transect length
G = Number of glides snorkeled.

Each transect was photographed and physical descriptions and channel characteristics recorded.

Tributaries

We established and surveyed transects in 12 tributaries. Streams were separated into upper, middle and lower sections. Within each section, we established five transects of similar length at sites we considered good steelhead habitat. Using a wetsuit and snorkel, I proceeded upstream through each transect and counted all fish by species (Thurow 1982a).

After completing the counts, we measured the physical dimensions of each transect including total length and depth and width at 10 m intervals. We photographed each transect and recorded water temperatures, substrate, channel characteristics and riparian vegetation.

Origin of Middle Fork Steelhead

We used angling and electrofishing gear to collect juvenile steelhead in Big, Loon and Marble creeks in 1981 and 1982. Samples were packed in dry ice and frozen prior to analysis. Laboratory personnel extracted a piece of skeletal muscle, the liver and eye fluid for electrophoretic analysis. Samples were screened for several genetic loci (Thurow 1982a) and 24 to 30 were consistently resolved.

Otolith nuclei were investigated as a means of distinquishing juvenile steelhead from juvenile rainbow trout in Big and Loon creeks using techniques described by Thurow (1982a).

Adult Steelhead Movements

During the spring and fall, we captured and tagged adult steelhead in the Middle Fork and main Salmon rivers. We used barbless lures, flies and bait to capture fish, then attached numbered metal tags to their mandibles. Total length, dorsal fin height, sex, tag number and date and location of capture were recorded before releasing the fish.

To obtain timing and movement data, we refished areas of the Middle Fork and Salmon rivers. We also checked for tags on all angler-creeled fish we encountered on the main Salmon River. Informational signs explaining the tag program were posted along the main Salmon River, and tag deposit boxes were placed locally. A brief history of the tagged fish was sent to each angler who returned tag recovery information.

We made several float trips in the fall to document the location of adult steelhead downstream from the Flying "B" Ranch. Angling and snorkeling gear were used to locate fish.

Main Salmon River Sport Fishery

We annually operated a check station on the Salmon River at the mouth of the Middle Fork to monitor the steelhead fishery below that point. Part of the season was divided into three two-week intervals as follows: (1) October 10-23, (2) October 24 to November 6, and (3) November 7-20. Within each interval, we randomly selected three weekdays and two weekend days. Holidays were also censused.

On each census day, a clerk interviewed all anglers leaving by the single access road from 1000 hours to darkness. The clerk recorded numbers of anglers, stream section fished and numbers of fish creeled and released. Total length, dorsal fin height, sex and origin (wild or hatchery) were recorded.

We estimated the total harvest of steelhead per interval as follows:

$$\text{Catch} = \bar{x}\ WD + \bar{x}_2\ WE + \bar{x}_3\ H$$

$\bar{x}$ = mean catch per weekday
$\bar{x}_2$ = mean catch per weekend day
$\bar{x}_3$ = mean catch per holiday
WD = number of weekdays per interval
WE = number of weekend days per interval
H = number of holidays per interval

A jet boat was used to monitor the steelhead fishery in the roadless area below Corn creek (11 km below the Middle Fork). The roadless area fishery also was monitored by interviewing anglers at the check station, conducting field checks of anglers and gathering data compiled by cooperating outfitters.

RESULTS

Biological Characteristics

Both anadromous (steelhead) and nonmigratory (resident) rainbow trout (*Salmo gairdneri*) are indigenous to the Middle Fork Salmon River. These rainbow trout may be analogous to the redband trout (*Salmo sp.*) described by Behnke (1979).

The fish fauna of the Middle Fork is represented by five families (Catostomidae, Cottidae, Cyprinidae, Petromyzontidae and Salmonidae), 10 genera and 16 species (Table 1). Only one species (brook trout, *Salvelinus fontinalis*) is nonindigenous and it is found only in isolated areas.

Macroinvertebrates are abundant in the Middle Fork and tributaries and are represented by five principal orders consisting of 81 taxa (Minshall et al. 1981). Generally, tributary streams supported 40+ and the mainstream 25+ taxa on a seasonal basis. The orders Ephemeroptera, Diptera and Trichoptera were the most prevalent organisms collected in both the mainstem and tributaries. Plecoptera were also prevalent in tributaries.

Spawner Characteristics and Densities

Seventy-eight steelhead spawners and 80 redds were observed for an average of one spawner or redd per 5 km surveyed (Appendix B). Spawning activity varied by stream and timing of surveys. Peak densities of spawners and redds were observed in Big, Camas and Loon creeks.

Table 1. Fishes present in the Middle Fork Salmon River drainage.

Common name	Scientific name	Status by location	
		Middle Fork	Tributaries
Rainbow-steelhead trout	Salmo gairdneri	abundant	abundant
Westslope cutthroat trout	Salmo clarki lewisi	abundant	common
Chinook salmon	Oncorhynchus tshawytscha	currently depressed	currently depressed
Bull trout	Salvelinus confluentus	common	common
Mountain whitefish	Prosopium williamsoni	abundant	common
Northern squawfish	Ptychocheilus oregonensis	common in lower 32 km	uncommon
Redside shiner	Richardsonius balteatus	common in lower 32 km	uncommon
Bridgelip sucker	Catostomus columbianus	unknown	unknown
Largescale sucker	Catostomus macrocheilus	unknown	uncommon
Longnose dace	Rhinichthys cataractae	common	common
Speckled dace	Rhinichthys osculus	unknown	unknown
Shorthead sculpin	Cottus confusus	unknown	unknown
Mottled sculpin	Cottus bairdi	unknown	unknown
Torrent sculpin	Cottus rhotheus	unknown	unknown
Pacific lamprey	Entosphenus tridentatus	unknown	unknown
Brook trout (introduced)	Salvelinus fontinalis	absent	headwaters of Marsh & Big creeks

Spawning activity commenced in early April, and peak activity occurred in May (Fig. 2). Conditions were too turbid for surveys after late May. We observed most of the spawners and redds in Monumental and Big creeks between May 17-20, 1983.

Steelhead spawners ranged from 61-91 cm, and sex ratios averaged 1:1.

Individual tributaries surveyed in 1983 are listed in the following section. Tributaries surveyed in previous years are discussed in Thurow (1982a, 1983). Additional data for previously surveyed streams are presented in Appendix B.

Brush Creek

Brush Creek enters the Middle Fork 47 km above the mouth and is 9.7 km long to the confluence of its north and south forks (Fig. 3). A hydropower diversion for the Flying "B" Ranch creates a barrier to fish passage approximately 1.6 km above the mouth. A natural barrier exists approximately 0.8 km above the diversion dam. Suitable spawning substrate exists both below and above the diversion dam and barrier. No spawning activity was observed.

Marble Creek

Marble Creek enters the Middle Fork 101 km above the mouth and is 39 km long (Gebhards 1959). Average discharge is approximately 3.5 m^3/sec. Survey conditions were unfavorable in 1983, and we observed one spawner and redd (Fig. 4). Extensive spawning area is present throughout the drainage, including several smaller tributaries.

Monumental Creek

Monumental Creek enters Big Creek approximately 50 km above the mouth and is Big Creek's largest tributary. Lower sections of Monumental Creek were surveyed in 1981 (Thurow 1982a). In 1983, we surveyed the entire drainage from Roosevelt Lake to Big Creek and observed large densities of spawners and redds (Fig. 5). Monumental Creek supported the largest numbers of steelhead spawners we observed in the Big Creek drainage. Densities of spawners and redds were the largest we observed in any Middle Fork tributary from 1981 to 1983 (one spawner or redd each 1.2 km surveyed).

Sheep Creek

Sheep Creek enters the Middle Fork 49 km above the mouth and is 8.1 km long to the confluence with its south fork (Fig. 3). A steep gradient

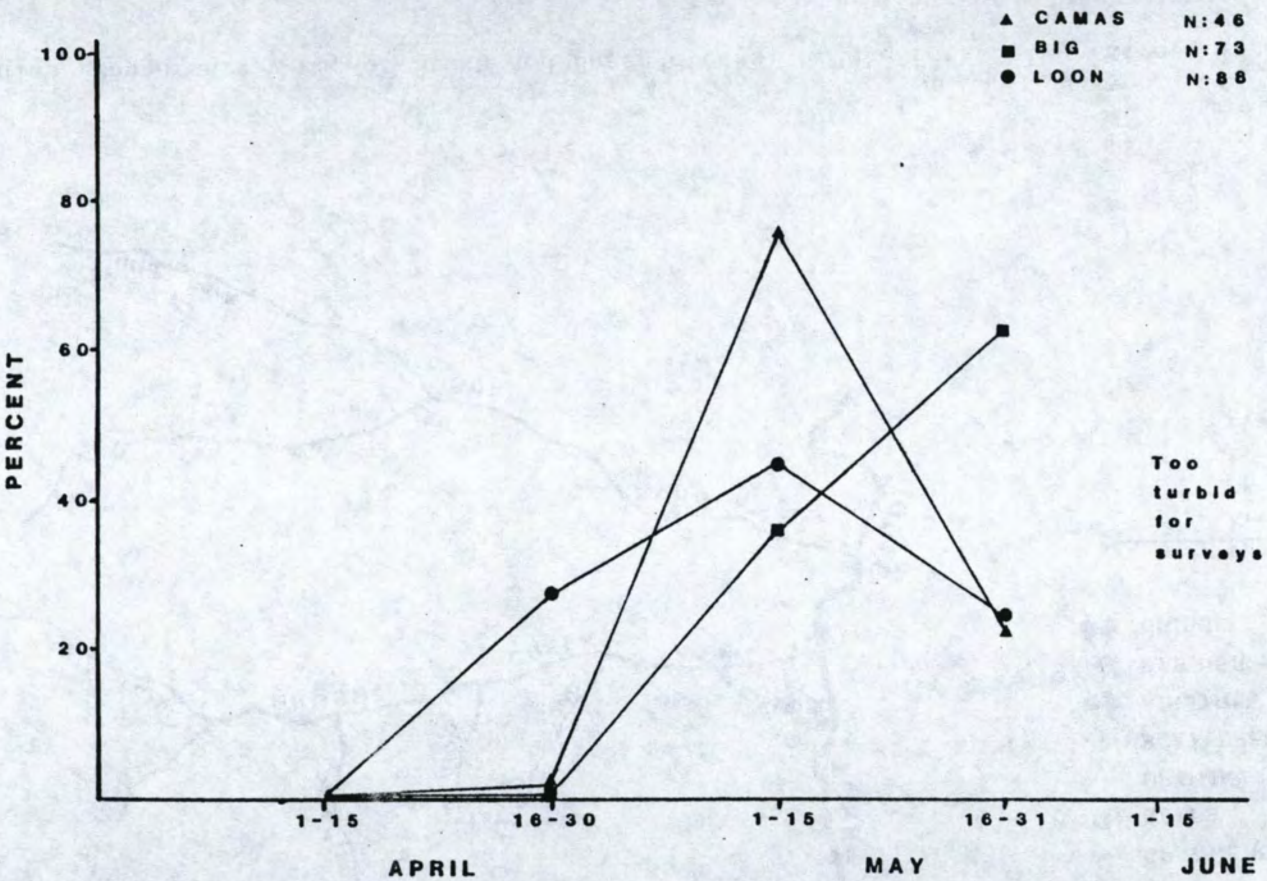

Figure 2. Percent of steelhead spawners and redds (combined) observed in Big, Camas and Loon creeks during specified periods, 1968-1983.

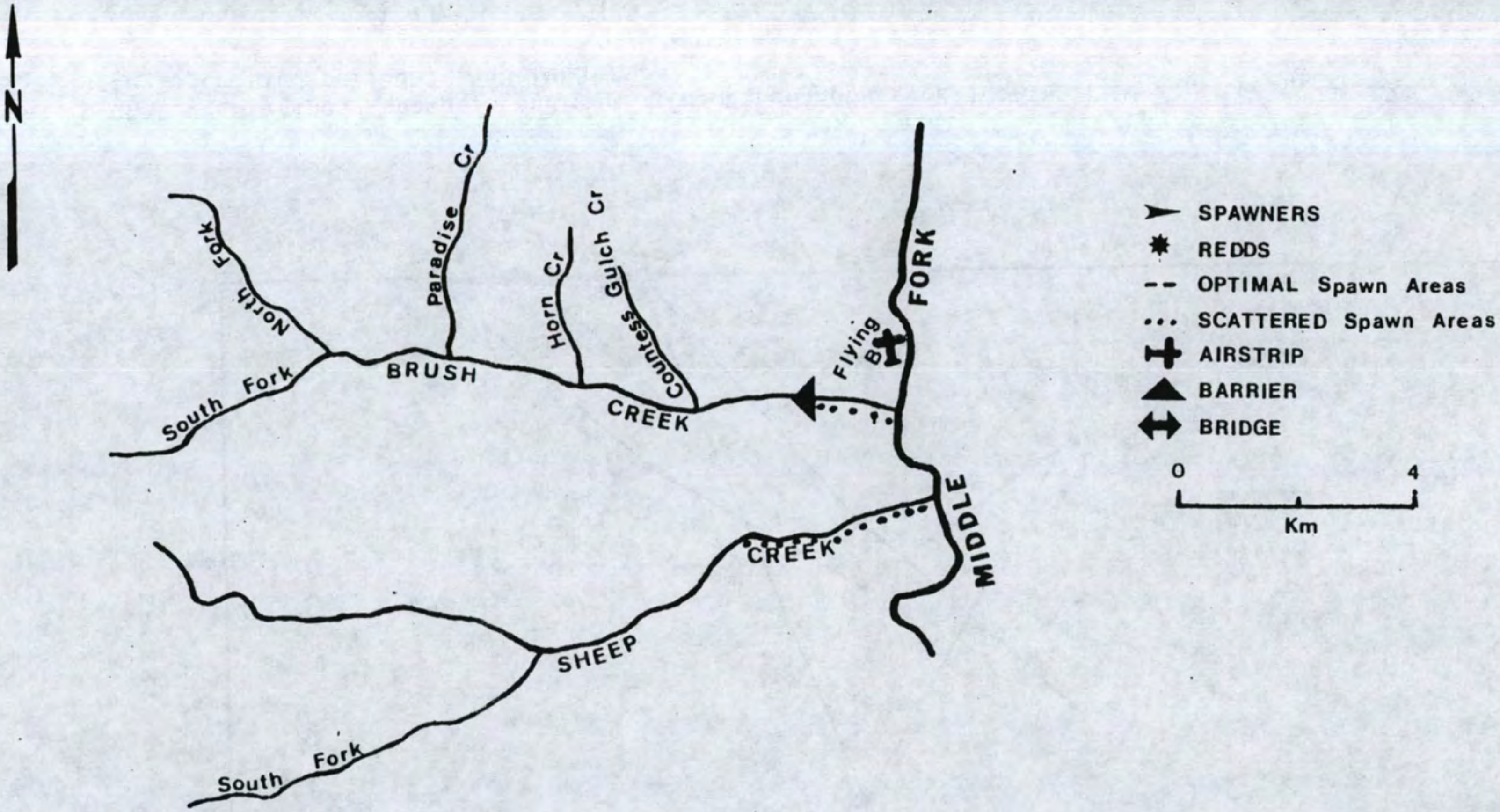

Figure 3. Spawning ground survey map of Brush and Sheep creeks, Middle Fork Salmon River, Idaho, 1983.

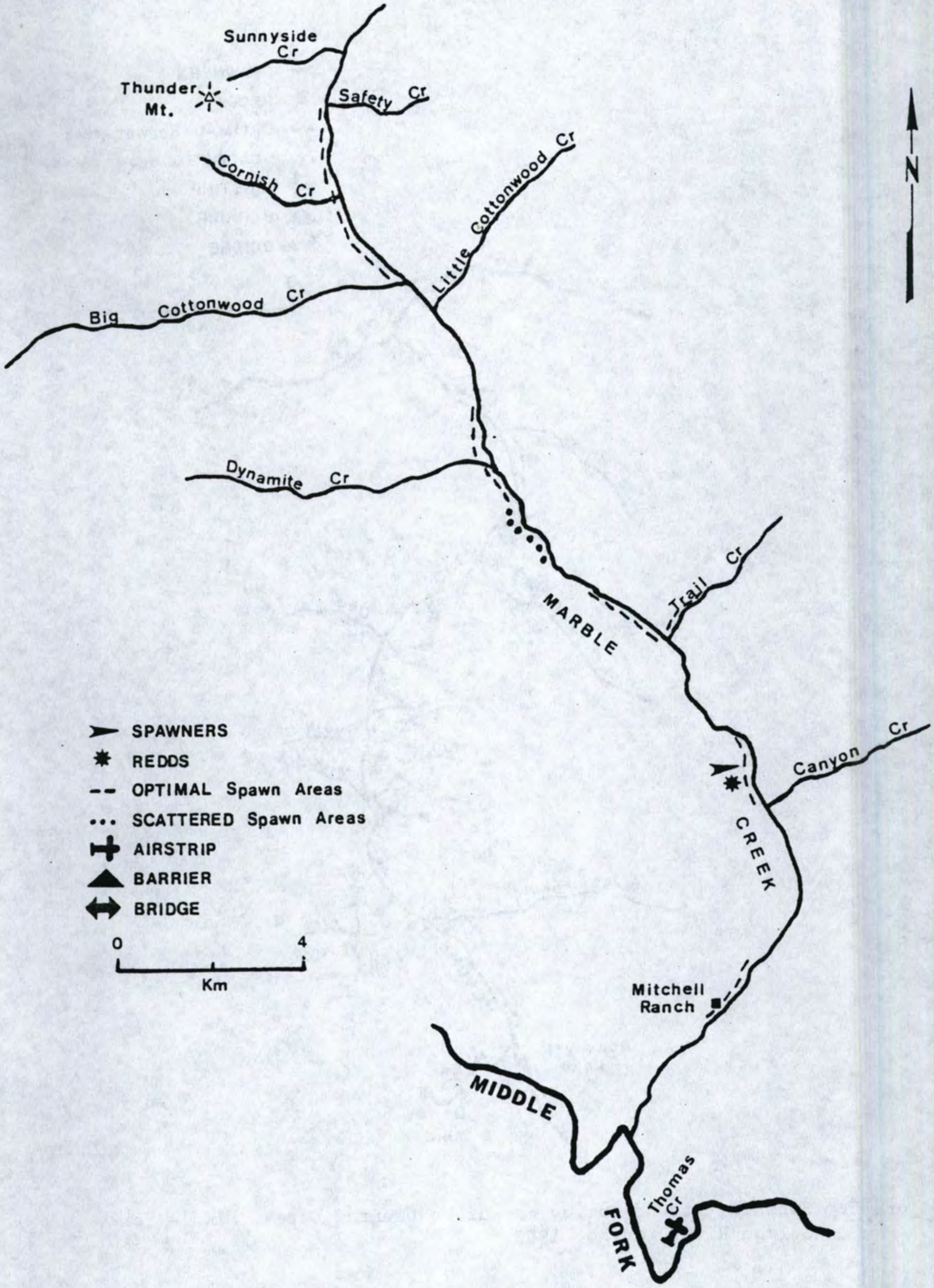

Figure 4. Spawning ground survey map of Marble Creek, Middle Fork Salmon River, Idaho, 1983.

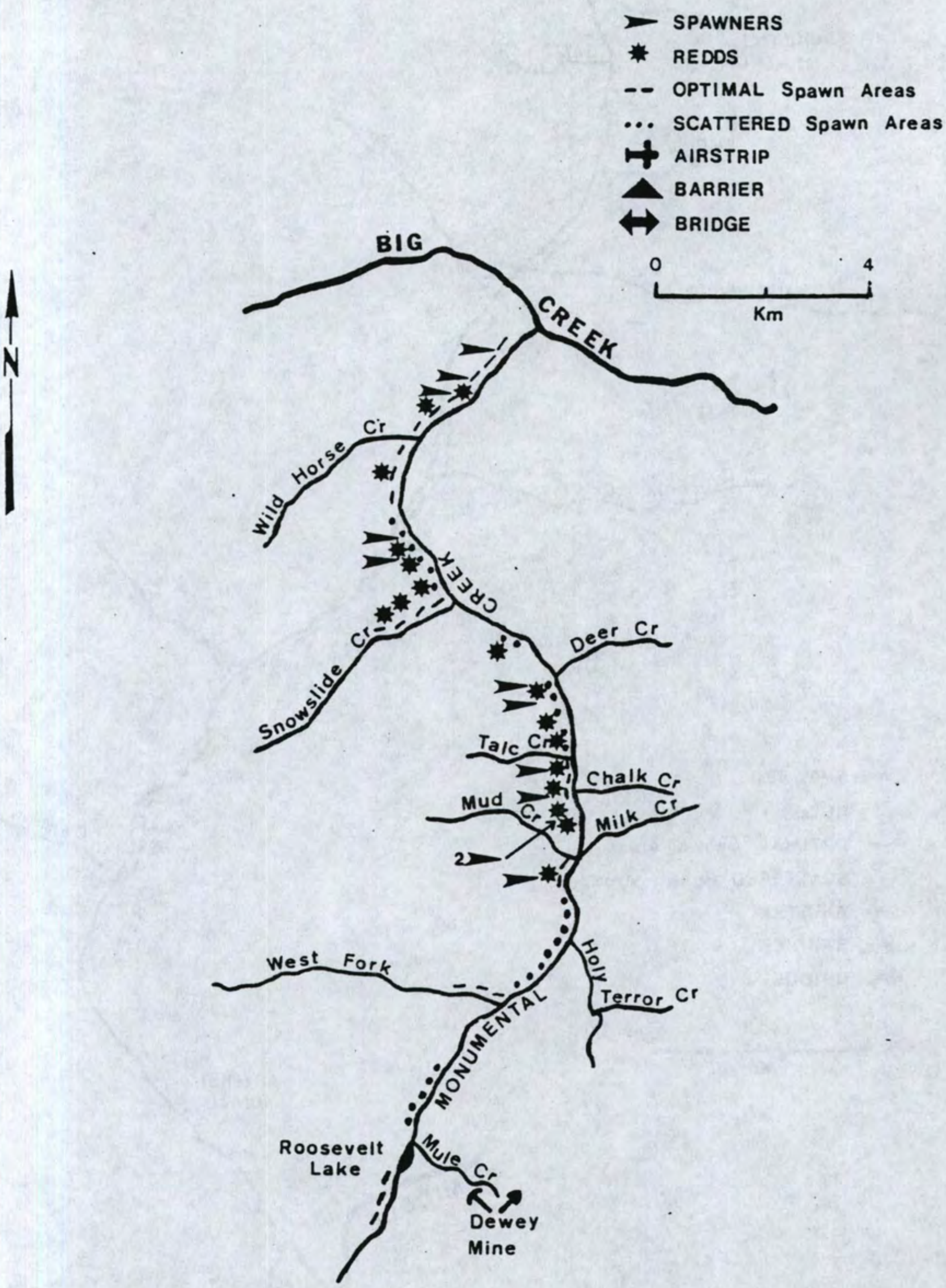

Figure 5. Spawning ground survey map of Monumental Creek, Middle Fork Salmon River, Idaho, 1983.

section, approximately 6 km above the mouth, may create an impassible barrier to steelhead. Suitable spawning area is prevalent in the lower 3 km and scattered above that point. No spawning activity was observed.

Sulphur Creek

Sulphur Creek enters the Middle Fork 152 km above the mouth and is 31 km long (Gebhards 1959). Average discharge is approximately 1.7 m^3/sec. Sulphur Creek is a principal spawning and rearing area for chinook. Suitable steelhead trout spawning substrate is also present (Fig. 6). A barrier to fish migration exists 17.7 km above the mouth. No spawning activity was observed.

Wilson Creek

Wilson Creek enters the Middle Fork 37 km above the mouth and is 22.5 km long (Gebhards 1959). Flow is approximately 1.8 m^3/sec. A large rock slide and "blow out" occurred in the 1950's above Alpine Creek. The event created a barrier to fish movement 6 km above the mouth. Suitable spawning area is present throughout the drainage and some excellent substrate exists in upper reaches of the stream (Fig. 7). No spawning activity was observed.

Yellowjacket Creek

Yellowjacket Creek enters Camas Creek 8 km above the mouth and is 40 km long (Gebhards 1959). Average discharge is approximately 1.7 m^3/sec. The stream contains suitable spawning substrate above the Yellowjacket Mine for several miles (Fig. 8). A constricted area of the channel, 2.4 km above Camas Creek, was believed to be a passage barrier, and in 1976, the USDA-FS removed a barrier at the site. No spawning activity was observed.

Juvenile Distribution and Abundance

Middle Fork

Numbers and lineal densities (fish/100 m) of juvenile steelhead in the Middle Fork transects increased nearly three-fold from 1980 to 1981 and were similar from 1981 to 1983 (Table 2, Fig. 9). In contrast, densities of juvenile steelhead per unit surface area (fish/100 m^2) were similar in 1981 and 1982 and nearly doubled in 1983. A two-factor analysis of variance was used to test for differences in densities between years. For lineal densities (fish/100 m) significantly ($p<0.05$) more steelhead were

Table 2. Numbers and densities of juvenile steelhead observed in Middle Fork Salmon River transects, 1983.

Transect	1983 count Age I+	Age II+	Age III+	Total 1983	Steelhead per 100 m 1983	Steelhead per 100 m^2 1983
1	4	3	1	8	6.2	.49
2	3	3	1	7	6.7	.53
3	3	7	2	12	6.6	.47
4	1	0	1	2	2.2	.16
5	9	13	4	26	10.5	.75
6	3	8	1	12	5.2	.66
7	3	5	3	11	3.0	.39
8	3	19	2	24	11.4	1.47
9	5	11	3	19	7.0	.86
10	2	5	0	7	6.7	1.19
11	4	11	2	17	5.3	.80
12	2	3	0	5	2.0	.31
13	2	1	1	4	1.6	.28
14	1	10	3	14	6.1	.66
15	3	3	5	11	5.2	.57
16	1	3	1	5	2.2	.24
17	1	6	3	10	5.0	.54
18	2	3	1	6	1.8	.22
19	3	5	4	12	3.7	.38
20	--	2	2	4	2.4	.25
Totals	55	121	40	216	$\bar{x}$ = 4.9	$\bar{x}$ = .540

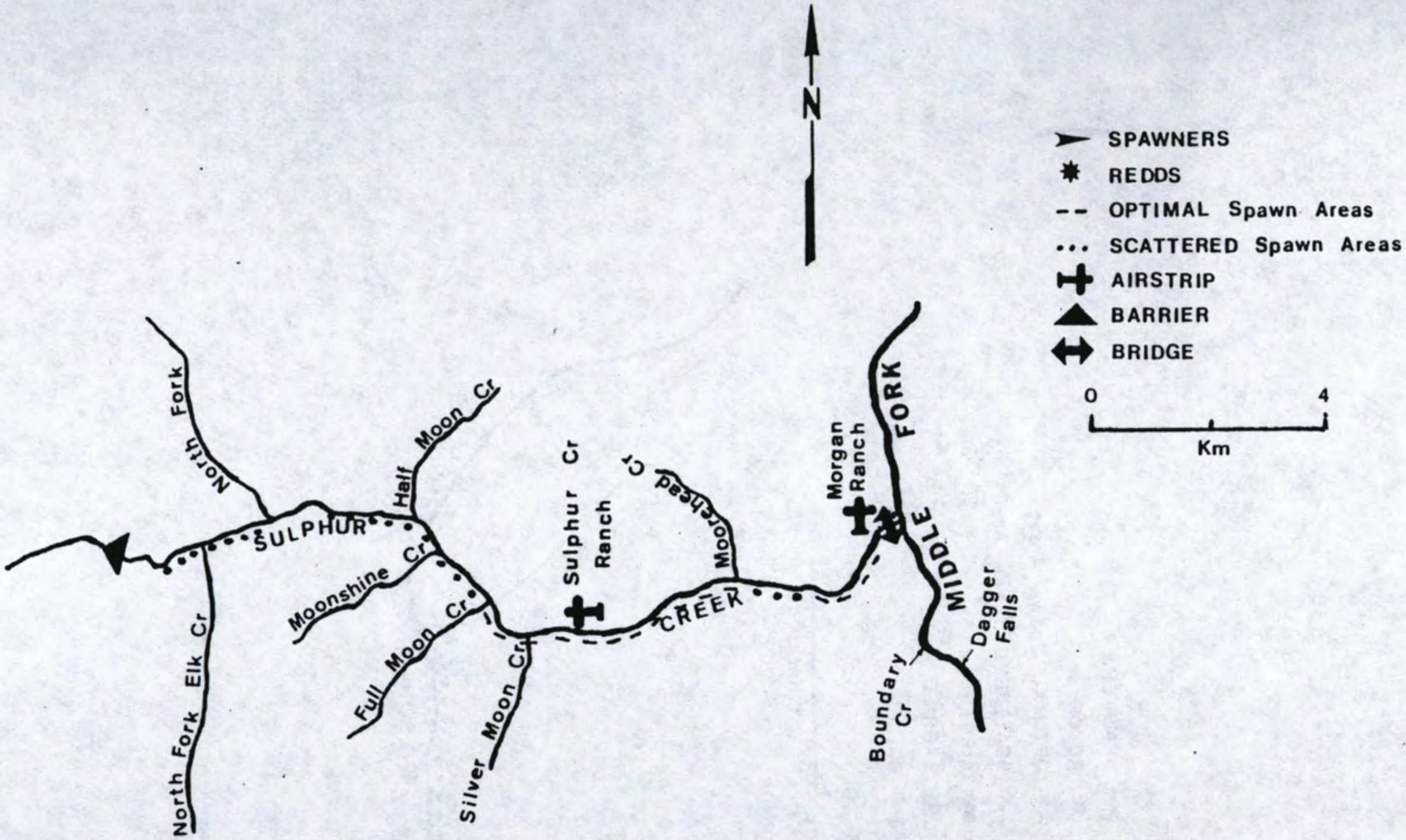

Figure 6. Spawning ground survey map of Sulphur Creek, Middle Fork Salmon River, Idaho, 1983.

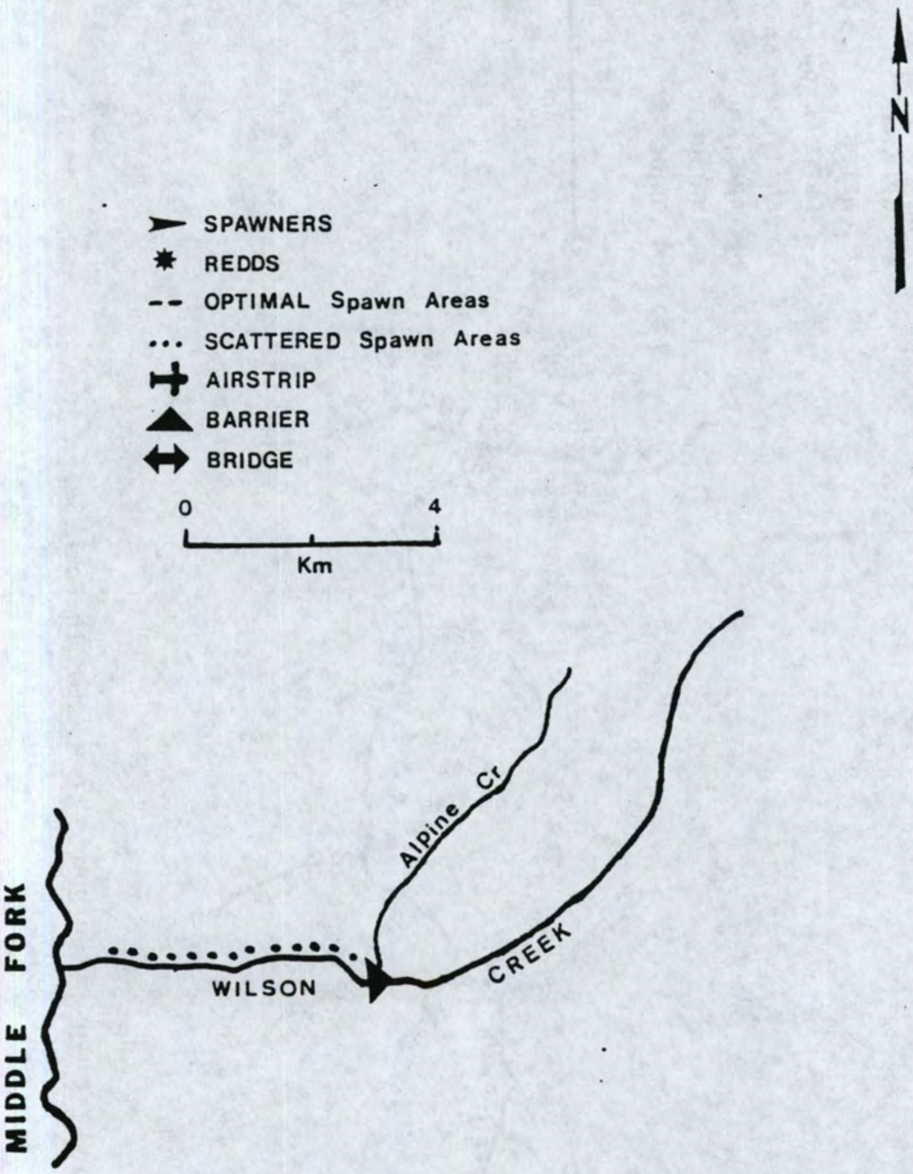

Figure 7. Spawning ground survey map of Wilson Creek, Middle Fork Salmon River, Idaho, 1983.

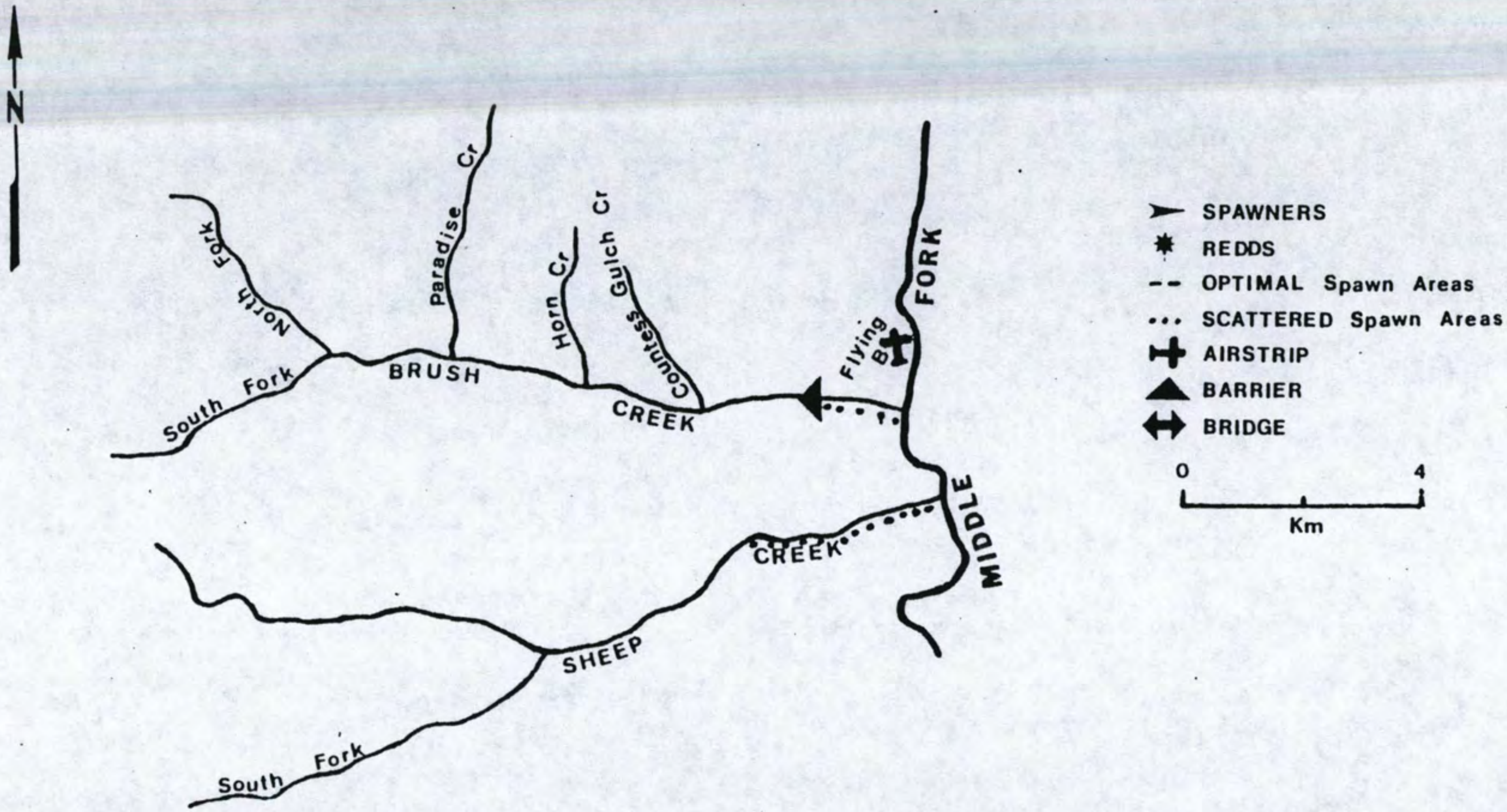

Figure 3. Spawning ground survey map of Brush and Sheep creeks, Middle Fork Salmon River, Idaho, 1983.

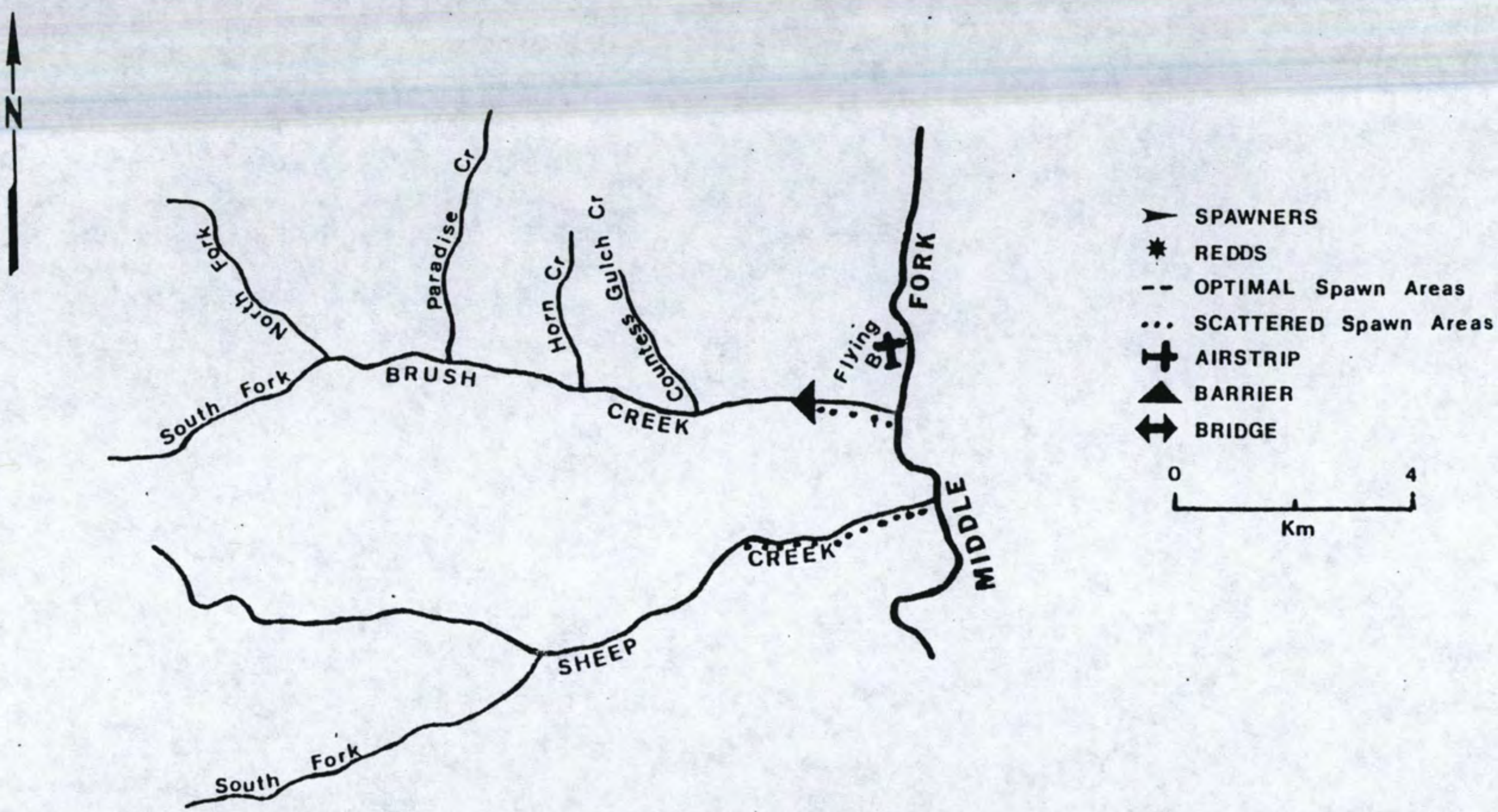

Figure 3. Spawning ground survey map of Brush and Sheep creeks, Middle Fork Salmon River, Idaho, 1983.

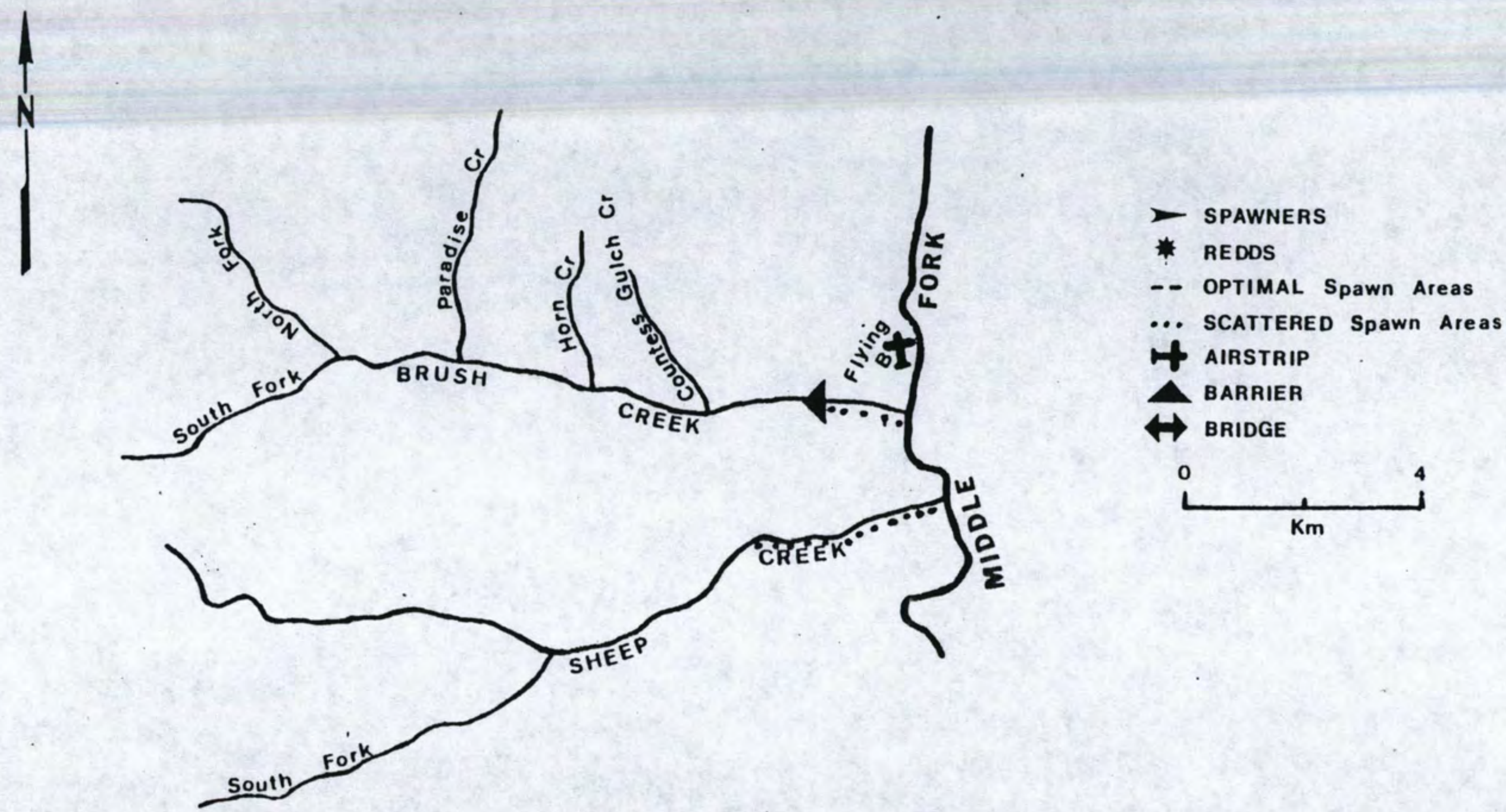

Figure 3. Spawning ground survey map of Brush and Sheep creeks, Middle Fork Salmon River, Idaho, 1983.

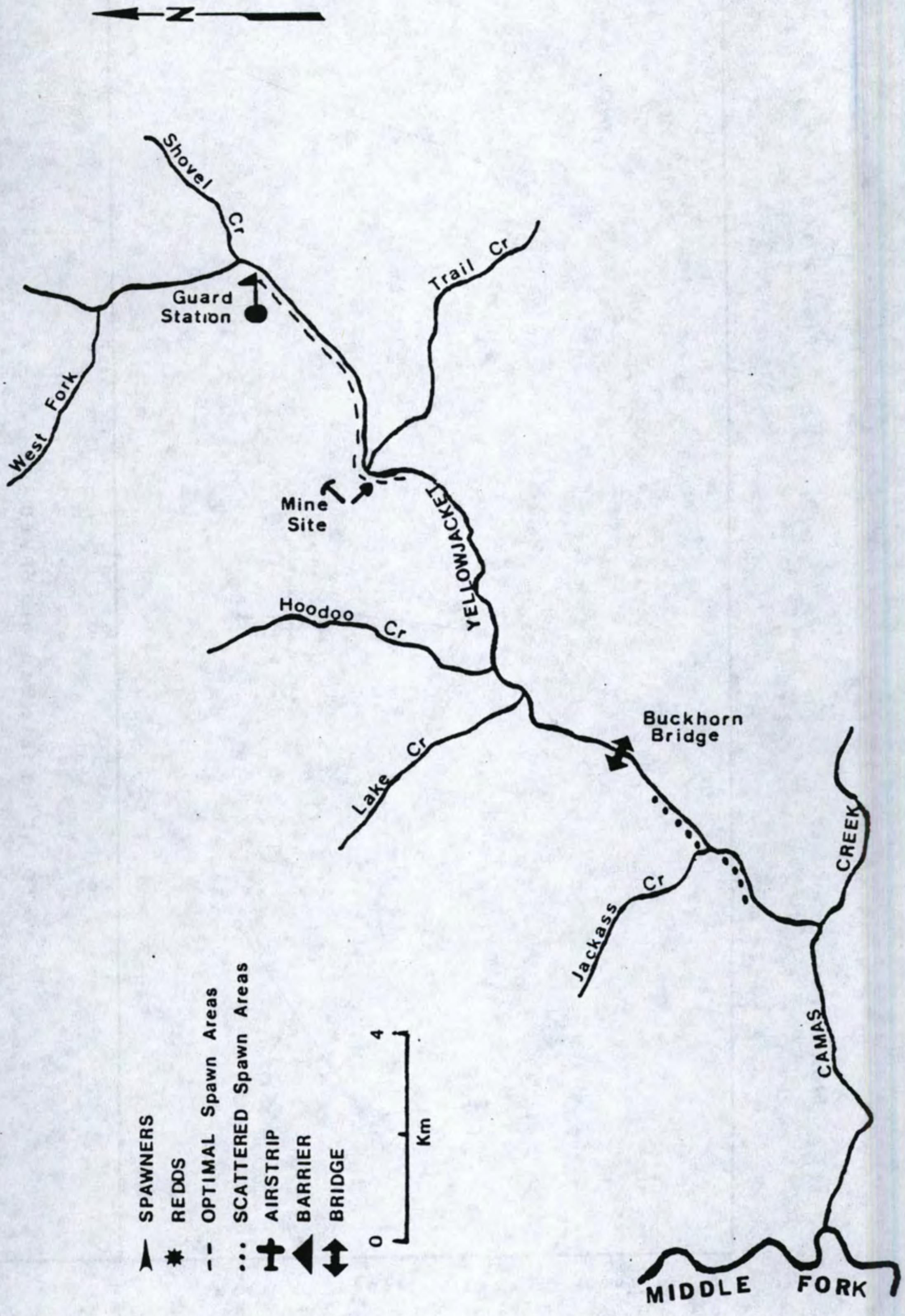

Figure 8. Spawning ground survey map of Yellowjacket Creek, Middle Fork Salmon River, Idaho, 1983.

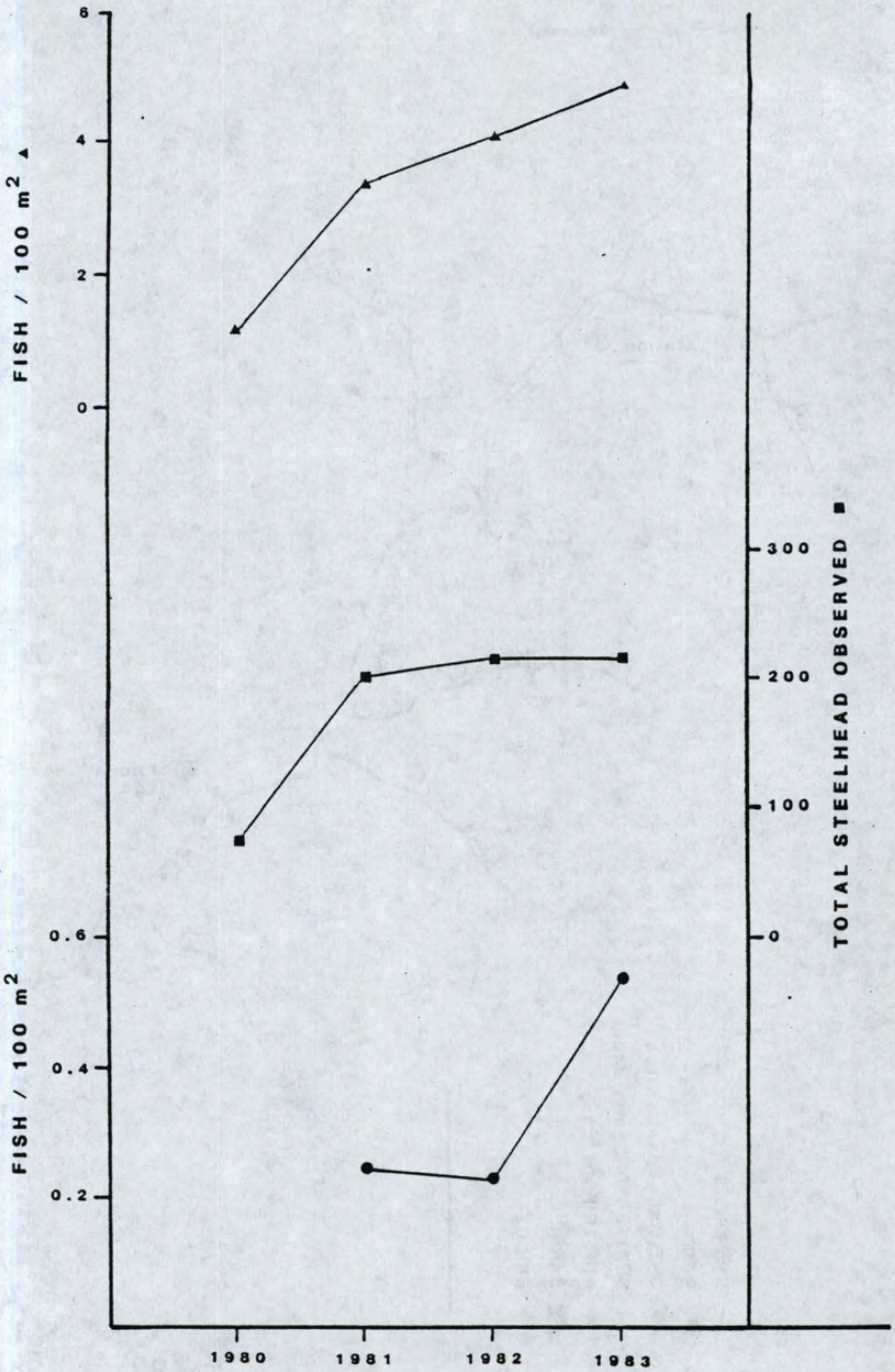

Figure 9. Number and density of juvenile steelhead observed in Middle Fork Salmon River transects, 1980-1983.

observed from 1980 to 1983. Densities per unit surface area (fish/100 m^2) were similarly tested and no significant (P<0.05) differences occurrred in Age I+ steelhead densities from 1981 to 1983 although signficant (P<0.05) differences occurred in Age II+ and total steelhead densities during the same period.

Although lengths of individual transects remained similar from 1980-1983, visibility varied significantly (Appendix C). Transects ranged from 65 to 252 m and visibility ranged from 5.4 to 7.5 m in 1981 and 7.8 to 9 m in 1982. In August 1983, severe rains created turbid water conditions in several tributaries (particularly Little Loon and Marble creeks), and visibility decreased to 2.8 to 4.8 m below Indian Creek. Water temperature from Boundary Creek to the mouth varied from 12 to 19 C in 1981, 12 to 17 C in 1982 and 13 to 19.5 C in 1983.

Angling proved to be an effective technique for collecting fish species composition and length frequency data. We caught and released 1,942 game fish in the Middle Fork during July and August 1980-1983 (Table 3). In 1982, 760 game fish were caught in 24 man days of fishing. Artificial flies were consistently the most effective terminal tackle.

In 1983, juvenile steelhead comprised 45% of the catch, cutthroat 51% and rainbow x cutthroat trout hybrids, bull trout (Salvelinus confluentus) and chinook salmon (Oncorhynchus tshawytscha) less than 1% (Table 3). In comparison, juvenile steelhead comprised 44% of the fish observed by snorkeling, cutthroat 33%, chinook salmon 21% and bull trout 2%. Transects were selected in optimal steelhead habitat while hook-and-line sampling covered all habitats. The small size of juvenile chinook salmon and the sedentary behavior of whitefish resulted in both species not being caught in proportion to their abundance.

The age-frequency of juvenile steelhead observed by snorkeling varied among years (Table 4). Age II+ and I+ fish predominated with smaller percentages of Age III+ fish. Hook-and-line gear was ineffective in sampling steelhead less than 130 mm (Age I+), but was effective in sampling larger fish. Length frequencies of steelhead caught by angling were similar from 1980 to 1983 (Appendix D). We measured 893 steelhead which ranged from 90 to 370 mm (Fig. 10).

We observed cutthroat trout in 57 of 60 transects sampled. Cutthroat were most abundant in transects between Rapid River and Tappan Falls and least abundant below Big Creek. Numbers of cutthroat were similar from 1981 to 1983 and averaged 159 per 20 transects (Table 5). Densities of cutthroat ranged from 2.4 to 3.7 fish/100 m and averaged 3.1 fish/100 m. Cutthroat per unit surface area increased from 0.19 to 0.35 fish/100 m^2 from 1981 to 1983. Cutthroat abundance is affected by seasonal movements as Mallet (1963) observed.

Length frequencies of hook-and-line caught cutthroat were similar from 1980 to 1983 (Appendix D). We measured 1,009 cutthroat which ranged from 130 to 430 mm (Fig. 10). Forty-eight percent of the fish exceeded 300 mm and 0.2% exceeded 400 mm. We observed a decline in the abundance of cutthroat larger than 300 mm from 1980 to 1983 in our hook-and-line samples. The percentage of large cutthroat (>300 mm) also declined in our snorkeling surveys from 62% in 1980 to 53% in 1983 (Table 5).

Table 3. Number of fish sampled by hook-and-line and snorkeling in the Middle Fork Salmon River, July-August 1980-1983.

Year	Steelhead	Cutthroat	Hybrid (rainbow x cutthroat)	Bull trout	Chinook salmon	Mountain whitefish	Sub-totals
				Hook-and-Line			
1980	167	190	8	6	1	3	375
1981	126	133	6	0	1	2	268
1982	311	396	7	4	0	42	760
1983	266	265	5	1	1	1	539
Total	870	984	26	11	3	48	1,942
Percent	45	51	1	<1	<1	2	
				Snorkeling			
1981	200	143	a	10	18	b	371
1982	215	194	a	5	161	b	575
1983	216	139	a	11	115	b	481
Total	631	476	a	26	294	b	1,427
Percent	44	33	--	2	21	--	

a - Not identified.
b - Not enumerated.

Table 4. Age frequency of juvenile steelhead observed in twenty Middle Fork Salmon River transects, 1980-1983.

Year	Percent of juvenile steelhead observed		
	Age I+	Age II+	Age III+
1980	36	53	11
1981	45	42	13
1982	45	43	12
1983	25	56	19

Table 5. Numbers of fish (non-steelhead) observed in Middle Fork Salmon River transects, August 1983.

		Cutthroat		Juvenile			Nongame fish (+,-)		
Section	Transect	Total	No. >300 mm	chinook salmon	Bull trout	Mountain whitefish	Suckers	Northern squawfish	Redside shiner
I	1	6	6	0	0	+	-	-	-
	2	6	4	13	0	+	-	-	-
	3	8	4	2	0	+	-	-	-
	4	2	2	2	2	+	-	-	-
	5	28	14	12	4	+	-	-	-
	6	14	9	3	0	+	-	-	-
II	7	7	4	12	0	+	-	-	-
	8	12	8	1	1	+	-	-	-
	9	9	2	1	1	+	-	+	-
	10	0	0	1	0	+	-	-	-
	11	4	2	11	0	+	-	-	-
	12	3	2	7	0	+	+	-	-
III	13	0	0	11	0	+	+	-	-
	14	10	5	9	0	+	+	-	-
	15	4	1	2	0	+	+	+	-
	16	8	3	0	0	+	+	+	+
IV	17	0	0	18	0	+	+	+	-
	18	2	1	8	1	+	+	+	-
	19	7	2	2	0	+	+	+	-
	20	9	4	0	2	+	+	+	-
Total numbers		139	73	115	11				
Number of transects where species present:		17	17	17	6	20	9	7	1

In addition to steelhead and cutthroat, we also observed and captured other game fish and nongame species. Although we did not record their abundance, mountain whitefish were the most abundant game fish as Corley (1972) and Jeppson and Ball (1979) also observed. Mountain whitefish were present in all 80 snorkeled transects from 1980 to 1983. We captured 48 mountain whitefish with angling gear and 94% exceeded 280 mm.

Bull trout were often difficult to observe, and snorkeling did not provide a reliable estimate of their abundance. We counted 26 bull trout in 60 transects (Thurow 1982a, 1983) (Table 5). Corley (1972) and Jeppson and Ball (1979) observed only 14 and 1 bull trout, respectively, in the 21 transects they snorkeled in 1971 and 1978. We also caught few bull trout with artificial flies, comprising less than 1% of the 1,942 fish caught (Table 3). In 1959 and 1960, the percentage of bull trout in the catch ranged from 4 to 14% (Mallet 1963). The fish we caught in summer ranged from 150 to 360 mm. We also captured bull trout during spring and fall surveys ranging up to 560 mm. As Jeppson and Ball (1979) observed, most bull trout in the Middle Fork are caught during the spring and fall months. Mallet (1963) reported that bull trout migrate into the Middle Fork from the mainstem Salmon River during the fall and winter.

Juvenile chinook salmon were in low abundance and we observed 294 in 60 transects (Table 5). Captured chinook salmon ranged from 75 to 115 mm.

We could not differentiate rainbow x cutthroat trout hybrids while snorkeling. We captured 28 with hook-and-line, ranging from 180 to 410 mm. Forty-three percent exceeded 300 mm and 11% exceeded 350 mm.

Northern squawfish (Ptychocheilus oregonensis) and suckers (Catostomus sp.) were most abundant in river sections below Tappan Falls (Table 5). We observed northern squawfish in only 4 of 33 transects snorkeled above the falls. Redside shiners (Richardsonius balteatus) were observed in one transect each of the three years.

Tributaries

Juvenile steelhead were much more abundant in tributaries than in the Middle Fork. Tributaries provide the principal rearing habitat for steelhead in the drainage. We snorkeled 153 transects in twelve major tributaries and observed 2,263 juvenile steelhead for an average of nearly 15 per transect (Table 6).

Most transects ranged from 30 to 50 m long and varied considerably in width depending on the streams (Appendix E). Rubble was the predominant substrate, followed by gravel and boulders. Sand and silt comprised a small proportion of the substrate in most stream sections. Bear Valley Creek, upper Marsh Creek and Elk Creek contained the largest percentage of sand substrate. Riparian vegetation consisted of grasses, sedges, various brush and shrubs. Forest canopies of pine and fir were generally sparse. Water temperatures ranged from 9 to 17 C in individual tributary sections.

Table 6. Numbers and sizes of fish observed by snorkeling in Middle Fork Salmon River tributaries, July-September, 1983.

Stream	Juvenile Steelhead Age I+	Age II+	Age III+	Total	Cutthroat (mm) 100	100-200	200-300	>300	Total	Juvenile chinook salmon	Mountain whitefish	Bull trout	Age 0 salmonids	Steelhead per 100 m^2
Marble Creek														
Upper	2	7	3	12	25	54	25	0	104	0	–	0	+	1.7
Sunnyside	0	0	0	0	1	2	2	0	5	0	–	0	+	0
Cornish	0	0	0	0	1	2	5	0	8	0	–	0	–	0
Totals	2	7	3	12	27	58	32	0	117	0	–	0	+	
Sheep Creek														
Lower	34	43	13	90	0	10	7	0	17	0	–	9	–	10.5
Sulphur Creek														
Lower	24	20	6	50	0	3	1	0	4	17	+	0	+	2.2
Upper	0	0	0	0	3	10	8	0	21	0	–	0	+	0
Totals	24	20	6	50	3	13	9	0	25	17	+	0	+	
Wilson Creek														
Lower	44	61	9	114	0	0	0	0	0	0	+	0	–	7.8
Upper	78	80	19	177	0	0	0	0	0	0	–	2	–	13.6
Totals	122	141	28	291	0	0	0	0	0	0	+	2	–	
Yellowjacket Creek														
Lower	65	76	16	157	0	0	0	0	0	0	–	0	–	9.9
GRAND TOTALS	247	287	66	600	30	81	48	0	159	17	+	11	+	

–Absent
+Present

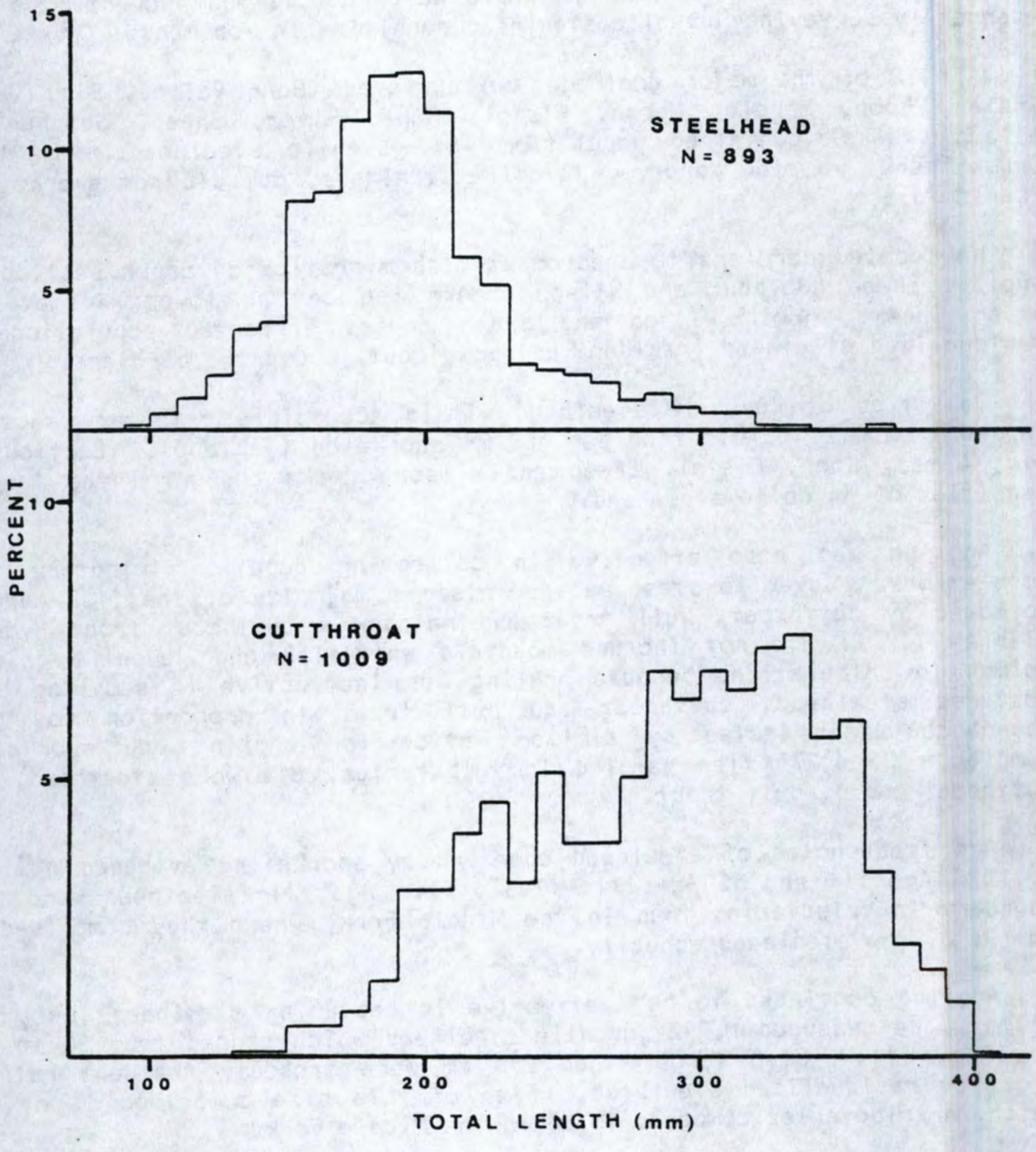

Figure 10. Length frequency of juvenile steelhead and cutthroat trout caught by angling in the Middle Fork Salmon River, 1980-1983.

Sections of Big, Camas, Loon and Wilson creeks supported the largest numbers of juvenile steelhead per transect. Based on angling surveys, lower sections of Marble Creek contain similar, large numbers of juvenile steelhead, but turbid water conditions prevented a snorkeling survey of the stream in 1983. Similarly, turbid water conditions prevented us from adequately surveying juvenile steelhead densities in Monumental Creek.

All 12 of the major drainages we surveyed (Bear Valley, Big, Camas, Indian, Loon, Marble, Marsh, Pistol, Rapid River, Sheep, Sulphur and Wilson creeks) contained populations of juvenile steelhead. In lower Brush Creek, we also observed juvenile steelhead, but did not snorkel any transects.

We located barriers to anadromous fish migration on upper sections of Indian, Sheep, Sulphur and Wilson creeks and on the lower kilometer of Brush Creek. Both Wilson and Brush creeks supported populations of residualized steelhead (resident rainbow trout) above the barriers.

Densities of juvenile steelhead within accessible tributary sections ranged from 0.2 to 10.5 fish per 100 m^2 snorkeled (Table 6). Sections of Big, Camas, Loon, Pistol, Sheep and Wilson creeks supported the largest densities of juvenile steelhead.

Angling was also effective in collecting data on tributary fish populations. Juvenile steelhead comprised a majority of the fish caught, followed by cutthroat, bull trout and rainbow x cutthroat trout hybrids (Table 7). I did not include mountain whitefish and juvenile chinook salmon in calculations because angling was ineffective in sampling. We captured steelhead, cutthroat and bull trout in proportion to their abundance as reflected by similar ratios for angling and snorkeling samples. Of 4,275 fish sampled in tributaries, 81% were steelhead, 16% cutthroat and 3% bull trout.

Age frequencies of steelhead observed by snorkeling averaged 42% Age I+, 52% Age II+ and 6% Age III+ (Table 6). Age III+ steelhead were less abundant in tributaries than in the Middle Fork, where they comprised 11 to 19% of the steelhead annually.

Angling continued to be ineffective in capturing steelhead less than 130 mm. We measured 1,992 juvenile steelhead which ranged from 80 to 370 mm (Fig. 11). Fish larger than 250 mm were probably resident rainbow trout or residualized steelhead. Fish of this size comprised 3% of the catch in tributaries compared to 9% in the Middle Fork.

Cutthroat were uncommon in most areas of the tributaries. We observed 415 cutthroat in 153 transects snorkeled for a mean of 2.7 per transect (Table 6). Fifty-six percent of the areas we snorkeled contained less than one cutthroat per transect, and 32% of the areas did not support any cutthroat. The upper section of Marble Creek supported the largest density of cutthroat trout (20.8/transect), followed by Indian (7.6/transect) and Pistol creeks (6.2/transect) (Table 8). Sixty-eight percent of the cutthroat we observed were sampled in the Indian, Marble

Table 7. Number of fish sampled by hook-and-line and snorkeling in Middle Fork Salmon River tributaries, July-August 1981-1983.

Year	Steelhead	Cutthroat	Bull trout	Hybrid (rainbow x cutthroat)	Chinook salmon	Mountain whitefish	Totals
				Hook-and-Line			
1981	841	132	19	3	12	2	1,009
1982	426	130	45	4	13	5	623
1983	745	180	16	5	8	7	961
Total	2,012	442	80	12	14	33	2,593
Percent[a]	79	17	3	<1	0	0	
				Snorkeling			
1981	1,079	68	11	b	92	c	1,250
1982	584	188	62	b	302	c	1,136
1983	600	159	11	b	17	c	787
Total	2,263	415	84	b	411	c	3,173
Percent[a]	82	15	3	--	--	--	
Grand Totals	4,275	857	164				
Percent[a]	81	16	3				

a - Chinook salmon and mountain whitefish were not included in calculations.
b - Not identified.
c - Not enumerated.

Table 8. Fish observed by snorkeling in Middle Fork Salmon River tributaries, July-August 1983.

Stream	Transect	Fish observed: Steelhead	Cutthroat	Bull trout	Juvenile chinook salmon	Surface area (m^2)	Steelhead per 100 m^2
Camas Creek	M1	53	0	0	25	434	12.2
	M2	18	0	1	4	502	3.6
	M3	18	2	0	12	394	4.6
	M4	27	0	0	2	373	7.3
	M5	39	0	0	22	372	10.5
Totals		155	2	1	65	2,075	$\bar{x}$=7.5
Yellowjacket Creek (tributary to Camas Creek)	L1	23	0	0	0	257	9.0
	L2	23	0	0	0	349	6.6
	L3	26	0	0	0	268	9.7
	L4	34	0	0	0	351	9.7
	L5	51	0	0	0	358	14.3
Totals		157	0	0	0	1,583	$\bar{x}$=9.9
Marble Creek	U1	0	36	0	0	109	0
	U2	0	20	0	0	112	0
	U3	3	19	0	0	225	1.3
	U4	3	17	0	0	134	2.2
	U5	6	12	0	0	130	4.6
Totals		12	104	0	0	710	$\bar{x}$=1.7
Sunnyside Cr.		0	5	0	0	22	0
Cornish Cr.		0	8	0	0	44	0
Sheep Creek	L1	25	1	3	0	128	19.5
	L2	23	1	4	0	206	11.2
	L3	25	5	1	0	181	13.8
	L4	6	5	0	0	167	3.6
	L5	11	5	1	0	173	6.4
Totals		90	17	9	0	855	$\bar{x}$=10.5

Table 8. Continued.

Stream	Transect	Fish observed: Steelhead	Cutthroat	Bull trout	Juvenile chinook salmon	Surface area (m^2)	Steelhead per 100 m^2
Sulphur Creek	L1	22	4	0	1	463	4.8
	L2	23	0	0	7	470	4.9
	L3	1	0	0	7	449	0.2
	L4	4	0	0	0	404	1.0
	L5	0	0	0	2	482	0.0
Totals		50	4	0	17	2,268	$\bar{x}$=2.2
	U1	0	3	0	0	288	0
	U2	0	5	0	0	204	0
	U3	0	4	0	0	126	0
	U4	0	6	0	0	212	0
	U5	0	3	0	0	118	0
Totals		0	21	0	0	948	$\bar{x}$=0
Wilson Creek	L1	27	0	0	0	270	10.0
	L2	21	0	0	0	209	10.1
	L3	26	0	0	0	344	7.6
	L4	21	0	0	0	328	6.4
	L5	19	0	0	0	301	6.3
Totals		114	0	0	0	1,452	$\bar{x}$=7.8
	U1	38	0	0	0	249	15.3
	U2	29	0	2	0	330	8.8
	U3	37	0	0	0	274	13.5
	U4	42	0	0	0	251	16.7
	U5	31	0	0	0	194	16.0
Totals		177	0	2	0	1,298	$\bar{x}$=13.6

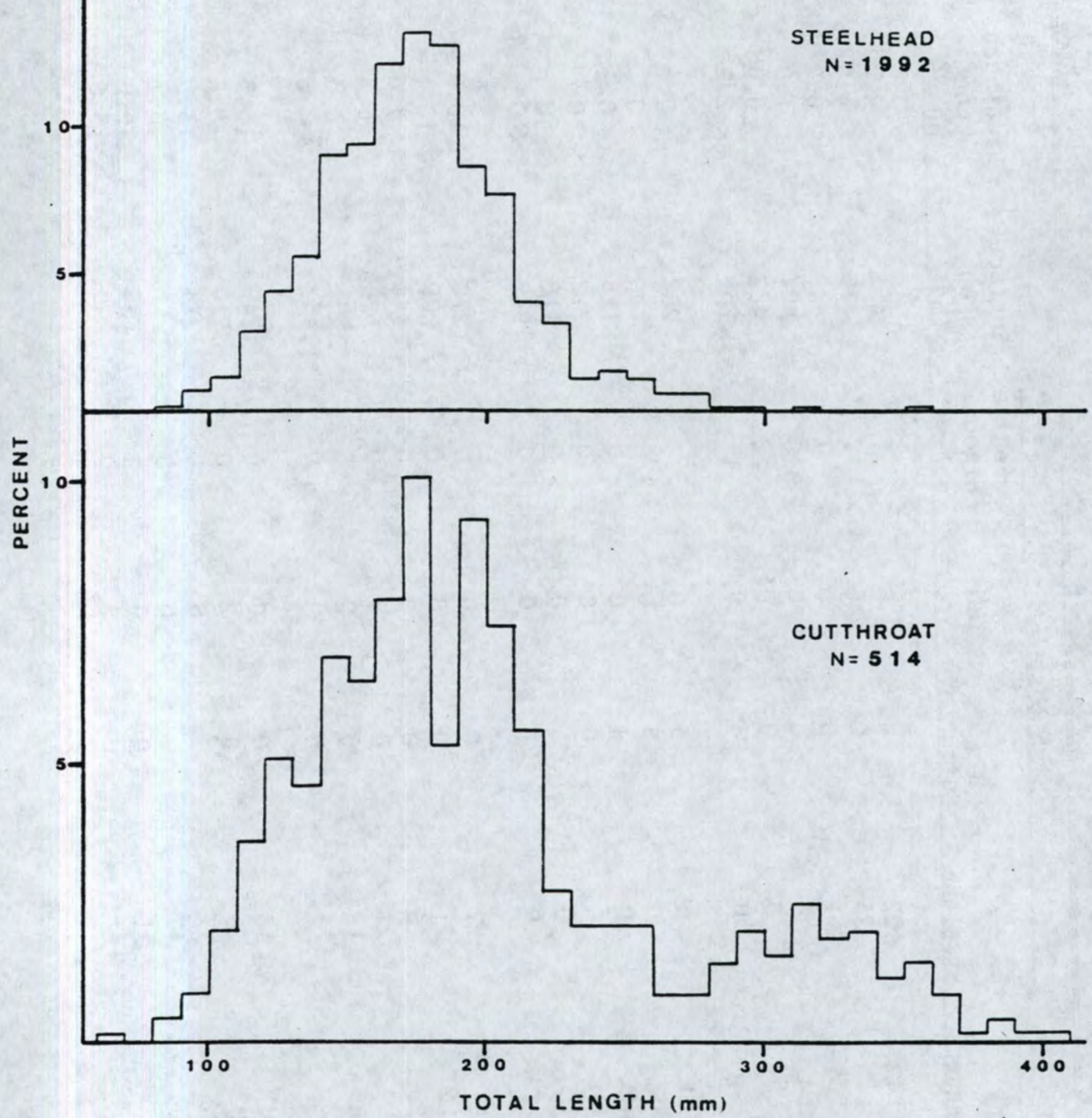

Figure 11. Length frequency of juvenile steelhead and cutthroat trout caught by angling in Middle Fork Salmon River tributaries, 1981-1983.

and Pistol creek drainages. Areas of Big, Sheep and Sulphur creeks also contained abundant cutthroat trout populations. Headwater sections of Brush, Indian and Sulphur creeks support resident populations of cutthroat above barrier falls.

Densities of cutthroat within tributary sections ranged from 0.05 to 14.7 fish per 100 m^2 snorkeled (Table 8). Upper Marble Creek supported the largest cutthroat densities followed by sections of Indian, Pistol, Sheep and Sulphur creeks, which contained 1.3 to 2.2 fish per 100 m^2.

Length frequencies of cutthroat observed by snorkeling in tributaries averaged 10% for fish less than 100 mm, 47% 100 to 200 mm, 34% 200 to 300 mm and 9% larger than 300 mm (Table 6). Sections of Marble, Indian, Pistol and Sulphur creeks contained the largest number of fish less than 200 mm. Sections of Big, Loon and Pistol creeks contained the largest number of cutthroat which exceeded 300 mm. In comparison, resident cutthroat in upper Indian Creek averaged 4% less than 100 mm, 66% 100 to 200 mm, 30% 200 to 300 mm, and no cutthroat exceeded 300 mm.

Cutthroat captured with angling gear ranged from 60 to 410 mm and a majority (59%) ranged from 100 to 200 mm (Fig. 11). In comparison, resident cutthroat in upper Indian Creek rarely exceeded 250 mm (Thurow 1983). Mature, resident cutthroat less than 200 mm were also captured in that section.

Bull trout were usually sympatric with cutthroat and were most prevalent in Indian, Loon, Pistol and Sheep creeks (Table 6). Bull trout were uncommon in most other tributary sections. We observed 84 in 153 transects. Fifty percent of the areas we snorkeled did not support any bull trout. We observed bull trout above barrier falls in Indian and Wilson creeks.

Eighty bull trout, ranging from 130 to 425 mm, were captured in tributaries (Fig. 12). A majority (80%) were less than 250 mm.

Mountain whitefish were present in all tributaries except Sheep Creek, and 68% of the areas we snorkeled contained mountain whitefish. Mountain whitefish were most prevalent in the deepest stream sections, where they exhibited schooling behavior. Young-of-the-year mountain whitefish were observed in Bear Valley and Marsh creeks. We captured 33 mountain whitefish ranging from 270 to 420 mm in the tributaries. Mountain whitefish were not captured in proportion to their abundance.

Juvenile chinook salmon were not common and we observed 411 in 153 transects (Table 6). Sixty-two percent of the areas contained juvenile chinook salmon. We observed juvenile chinook salmon in all tributaries except Sheep and Wilson creeks. We captured 14 juvenile chinook salmon with angling gear ranging from 80 to 140 mm. One precocial male captured in August measured 165 mm.

The only non-indigenous species we observed were brook trout (Salvelinus fontinalis), which had been introduced in Bear Valley, Big and Marsh creeks in the early 1900's. We observed 13 brook trout within five

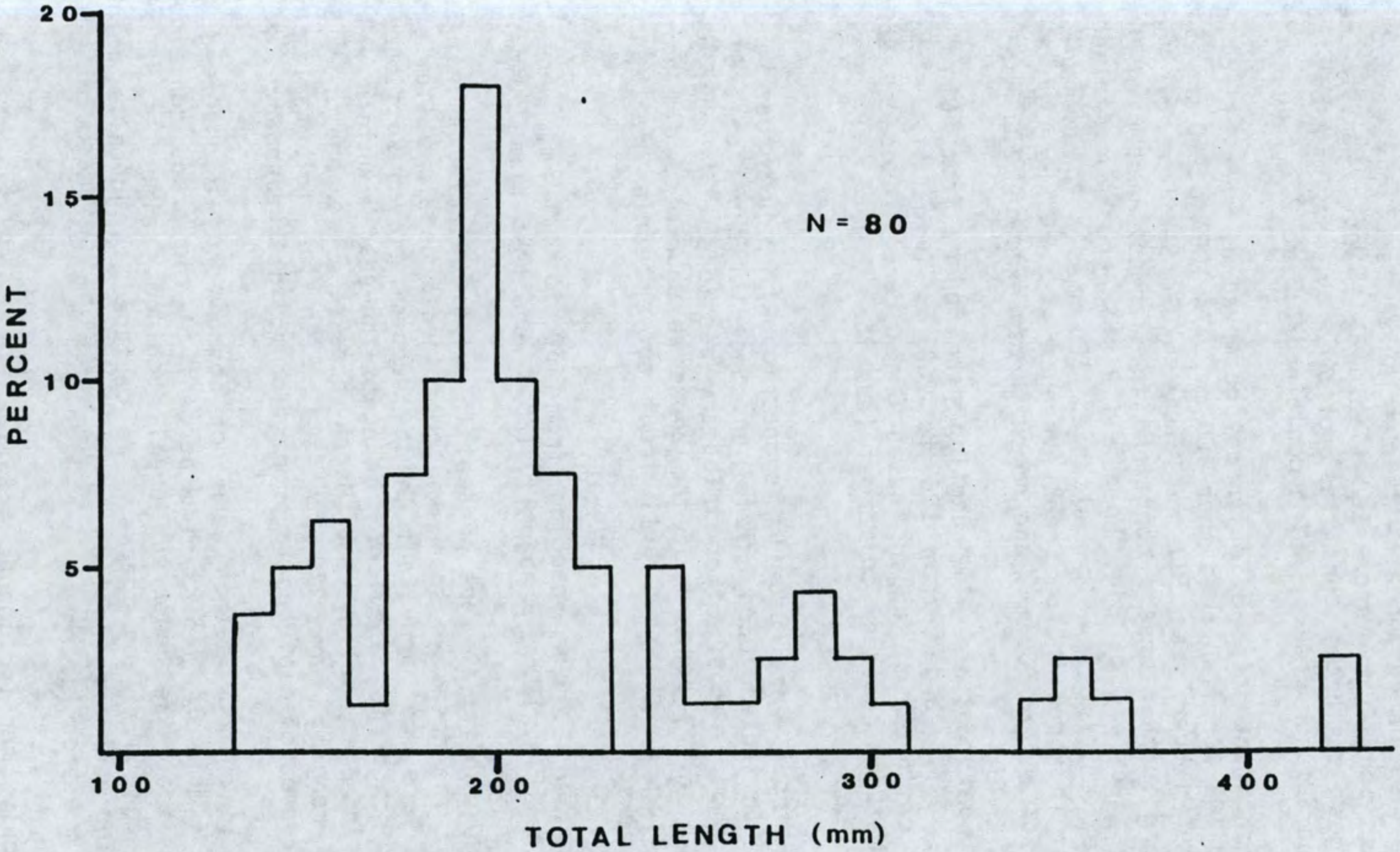

Figure 12. Length frequency of bull trout caught by angling in Middle Fork Salmon River tributaries, 1981-1983.

transects in upper Big Creek, 5 brook trout, respectively, in single transects in Sack and Cache creeks (tributaries to Bear Valley Creek) and 167 brook trout in five transects in Marsh Creek above Capehorn Creek. A single, 45-meter-long transect in Marsh Creek near Kelly Creek contained 99 brook trout.

Other species, including dace (Rhinichthys sp.), sculpins (Cottus sp.) and suckers, were observed in tributaries while snorkeling, but we did not record their abundance.

Detailed descriptions of tributaries sampled in 1983 are provided in the next section. Data collected in tributaries sampled in 1981 and 1982 are provided in Thurow (1982a, 1983)

Bear Valley Creek

Newberry and Corley (1984) electrofished 13 tributaries to Bear Valley Creek and two sites within Bear Valley Creek in August 1982. Sampling sites were located in streams between Fir and Cassner creeks. Of the 15 sites surveyed, steelhead were collected in nine sites, bull trout in eight, brook trout in seven and chinook salmon in three. Three adult chinook salmon were sighted near the dredge mining area on August 16. Mountain whitefish were collected in six sites.

Steelhead were most abundant in Cache and Wyoming creeks and in an unnamed stream between Cold and Wyoming creeks. Only 51 steelhead were collected in 22 sites which were electrofished.

Big Creek Tributaries

We attempted to snorkel additional transects in Monumental Creek in August 1983, but turbid water conditions prevented our surveys. Our August 1981 surveys observed densities of 216 steelhead per 100 m^2 in the lower 3 km of Monumental Creek. We also observed cutthroat, juvenile chinook salmon and mountain whitefish in that section. It is possible that large sediment influx to Mule and Monumental creeks in July 1981 caused some rearing fish to emigrate from the section.

We observed rearing habitat in Monumental Creek from the West Fork Monumental Creek to Big Creek during 1983 spring surveys. The previously described sediment influxes to Mule and Monumental creeks have probably affected the rearing capabilities of Monumental Creek. Embeddedness sampling by Burns (1983) illustrates the extensive sedimentation of the substrate. Invertebrate habitat utilized immediately below Mule Creek was limited to the swiftest portions of the stream (James M. Montgomery, Consulting Engineers 1983). Slower moving areas were completely covered with sediment.

Personnel from Montgomery Engineers conducted electrofishing surveys of eight 60 m transects in Monumental Creek on October 5-6, 1983, between Buck and Mule creeks (James M. Montgomery, Consulting Engineers 1983). A total of 29 juvenile steelhead were captured, which ranged from young-of-the-year (35 to 70 mm) to 215 mm (fork length). Steelhead were present throughout the transects below Century Creek and were most abundant below Mule Creek. Bull trout, juvenile chinook salmon, mountain whitefish and cutthroat were also captured. Surveys in July and August would provide more reliable estimates of maximum rearing densities, since emigration may have begun in October.

Brush Creek

Brush Creek contains scattered rearing areas throughout the area surveyed (mouth to 0.8 km above Horn Creek). A hydropower diversion for the Flying "B" Ranch creates a barrier to migration approximately 1.6 km above the mouth. We captured juvenile steelhead, cutthroat and bull trout below the diversion (Table 9). A small, unscreened irrigation ditch approximately 0.4 km below the diversion may impact migrating fish, in which case, some form of screening would be beneficial (May 1983).

A natural rock barrier exists approximately 0.8 km above the diversion, and we captured rainbow, cutthroat and rainbow x cutthroat trout hybrids between the two barriers (Table 9). Above the barrier we also captured rainbow, cutthroat and hybrids. Cutthroat comprised 20% of the catch above the barrier and 10% below.

Camas Creek

To monitor the annual trend in juvenile steelhead densities within tributaries, we recounted five transects in Camas Creek from 1981 to 1983 (Table 8). Densities of juvenile steelhead remained very similar from 1981 to 1983, ranging from 7.3 to 9.5 fish/100 m^2. Using a Kruskal-Wallis test, densities of Age I+ steelhead and total steelhead (all age groups) were not significantly different from 1981 to 1983 ($P<0.05$).

Juvenile chinook salmon were uncommon in 1981 and abundance increased nearly ten and six times in 1982 and 1983, respectively. Juvenile steelhead comprised 99% of the fish caught in Camas Creek in 1983 (Table 9).

Yellowjacket Creek, the largest tributary to Camas Creek, supports an abundant population of steelhead between the Yellowjacket Mine and Camas Creek. We observed 157 in 5 transects for a density of 9.9 fish per 100 m^2 (Table 8). Steelhead comprised 99% of the fish captured, followed by cutthroat, bull trout and rainbow x cutthroat trout hybrids (Table 9). Steelhead ranged from 90 to 260 mm (Fig. 13).

Table 9. Numbers of fish sampled by hook-and-line in Middle Fork Salmon River tributaries, July-August, 1983.

Date	Section	Steelhead	Cutthroat	Bull trout	Hybrid (rainbow x cutthroat)	Mountain whitefish	Chinook salmon	Total game fish
Brush Creek								
28 July	Above diversion	31	8	0	2	0	0	41
28 July	Below diversion	18	2	0	1	0	0	21
	Totals	49	10	0	3	0	0	62
Camas Creek								
20 July	Dry Gulch to Hammer Cr.	63	1	0	0	0	0	64
21 July	West Fork	5	0	0	0	0	1	6
1 Sept.	Dry Gulch to Hammer Cr.	51	0	0	0	0	0	51
	Totals	119	1	0	0	0	1	121
Yellowjacket Creek								
14 July	Mine to trailhead	108	0	1	1	0	0	110
19 July	Mouth to trailhead	101	1	0	0	0	0	102
	Totals	209	1	1	1	0	0	212
Loon Creek								
7 July	Diamond "D" upstream	3	1	2	0	0	0	6
6-7 July	East Fork Mayfield Cr.	34	0	8	0	2	0	44
	Totals	37	1	10	0	2	0	50
Marble Creek								
22 Aug.	Sunnyside-Safety Cr.	0	20		0	0	0	20

Table 9. Continued

Date	Section	Steelhead	Cutthroat	Bull trout	Hybrid (rainbow x cutthroat)	Mountain whitefish	Chinook salmon	Total game fish
	Marble Creek (cont'd)							
23 Aug.	Safety-Cornish Creek	0	35	0	0	0	0	35
23 Aug.	Cornish-1 km downstream	7	13	1	0	0	0	21
23 Aug.	1 km below Cornish-Cottonwood Creek	4	23	1	0	0	0	28
5-6 Sept.	Mouth-Mitchell Ranch	66	15	0	0	3	2	86
6 Sept.	Canyon-Birch Creek	9	2	0	0	0	0	11
6 Sept.	Above Birch Creek	44	16	0	1	3	1	65
	Totals	130	124	2	1	6	3	266
	Sheep Creek							
29 July	Lower 3.2 km	16	1	0	0	0	0	17
	Sulphur Creek							
29 Aug.	Mouth to North Fork	15	0	0	0	0	3	18
30 Aug.	In North Fork	0	19	2	0	0	0	21
31 Aug.	In South Fork	0	23	0	0	0	0	23
	Totals	15	42	2	0	0	3	62
	Wilson Creek							
25-26 July	Above barrier	119	0	0	0	0	0	119
27-28 July	Below barrier	51	0	0	0	0	0	51
	Totals	170	0	0	0	0	0	170
	GRAND TOTALS	745	180	15	5	8	7	960

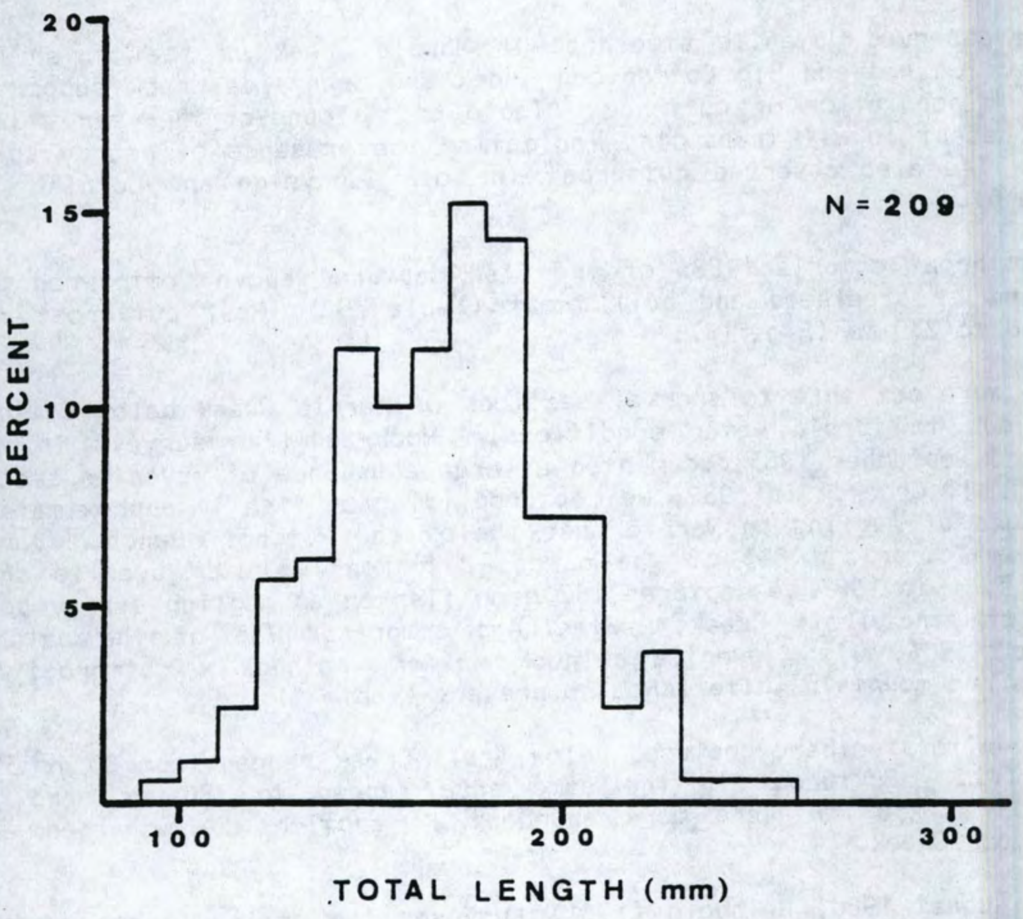

Figure 13. Length frequency of juvenile steelhead caught in Yellowjacket Creek, July 1983.

We captured juvenile steelhead and chinook salmon in the West Fork Camas Creek up to Pole Creek.

Loon Creek

Transects were surveyed in Loon and Warm Springs creeks in 1981. We surveyed Loon Creek above Mayfield Creek and the East Fork Mayfield Creek in 1983. Both sections contain suitable rearing habitats and we captured steelhead, cutthroat, bull trout and mountain whitefish (Table 9).

Marble Creek

We observed juvenile steelhead in Marble Creek up to Cornish Creek. The section between Big Cottonwood Creek and Sunnyside Creek supported an abundant population of cutthroat (Table 8). Young-of-the-year salmonids were present in all transects, indicating the presence of nearby spawning areas. We also observed cutthroat in both Sunnyside and Cornish creeks (Table 6).

Cutthroat comprised 88% of the fish captured above Cottonwood Creek, followed by steelhead and bull trout (Table 9). Most cutthroat ranged from 60 to 230 mm (Fig. 14).

We were not able to snorkel sections of Marble Creek below Cottonwood Creek due to turbid water conditions. Hook-and-line surveys in August 1982 and September 1983 documented a large abundance of juvenile steelhead below Trail Creek. In 1982, we captured 151 game fish in approximately 20 man hours of angling on Marble Creek below the Mitchell Ranch. Juvenile steelhead comprised 89% of the catch, cutthroat 8% and juvenile chinook salmon 3%. In 1983 we captured 162 game fish on an angling survey between the mouth and Trail Creek. Steelhead comprised 73% of the catch and cutthroat 20%, with juvenile chinook salmon, rainbow x cutthroat trout hybrids and mountain whitefish also present (Table 9).

Juvenile steelhead captured below Trail Creek ranged from 80 to 300 mm (Fig. 14). Cutthroat in the same area ranged to 380 mm, and large cutthroat (>250 mm) were more abundant in sections below, than above, Cottonwood Creek.

In August 1980, Reingold (1981) surveyed the entire length of Marble Creek with hook-and-line gear and also observed cutthroat to be most abundant in upper sections and steelhead in lower areas. He observed juvenile chinook salmon in most pools between Dynamite and Canyon creeks. Six adult chinook salmon and four redds were observed in the same area. Numerous fry and Age I fish were observed in the lower 0.4 km of Trail Creek. Idaho Department of Fish and Game biologists have photographs of chinook salmon spawning near the mouth of Sunnyside Creek in 1978.

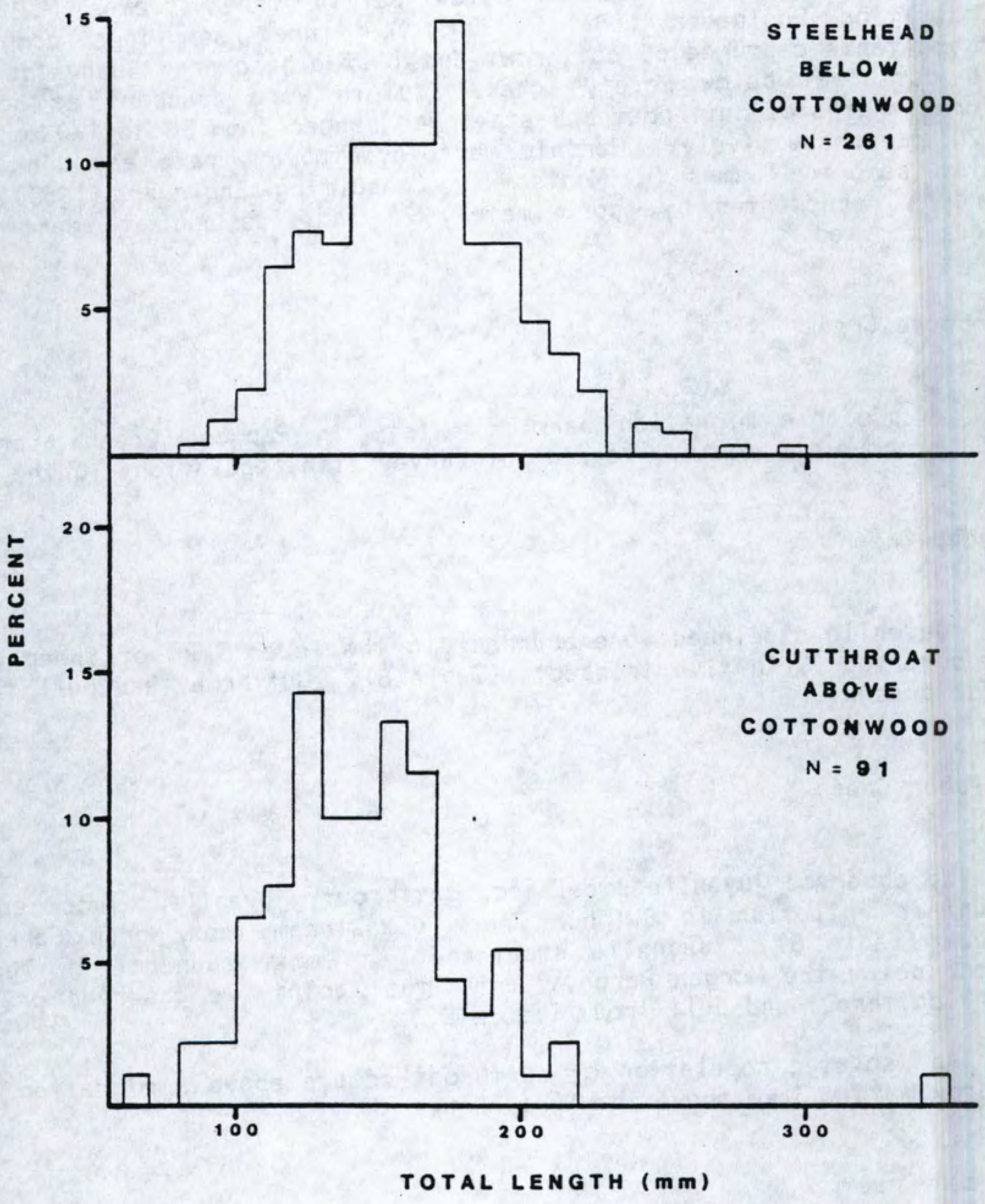

Figure 14. Length frequency of juvenile steelhead and cutthroat trout caught in Marble Creek, 1982-1983.

Personnel from Montgomery Engineers surveyed sections of Marble Creek on September 16, 1981, September 23, 1982 and October 5, 1983 near Sunnyside Creek and 0.8 km below Safety Creek (James M. Montgomery Consulting Engineers 1983). For the three samplings combined, the consultants captured 66 cutthroat and 1 steelhead near Sunnyside Creek and 70 cutthroat below Safety Creek. Sculpin were abundant at both sites. Fork lengths of cutthroat and steelhead ranged from 30 to 170 mm and 60 to 120 mm, respectively. Benthic macroinvertebrate taxa and densities were also sampled (James M. Montgomery Consulting Engineers 1983). Eleven orders represented by approximately 25 families and at least 40 genera were sampled.

Papoose Creek

A probable migration barrier exists in Papoose Creek approximately 200 m above the mouth. We did not survey fish populations in the stream.

Sheep Creek

Juvenile steelhead were abundant in the lower 3 km of Sheep Creek and we observed 90 in five transects (Table 8). Cutthroat and bull trout were also present.

Sulphur Creek

We observed juvenile steelhead, cutthroat, juvenile chinook salmon and mountain whitefish in Sulphur Creek downstream from North Fork Sulphur Creek (Table 6). Juvenile steelhead were most abundant in the pocket water below the Morgan Ranch. Above that point, we observed or captured only cutthroat and bull trout (Table 9).

An isolated population of cutthroat occurs above a migration barrier, approximately 3 km above the North Fork.

Wilson Creek

A migration barrier occurs in Wilson Creek approximately 0.4 km below the confluence of Alpine Creek. Above the barrier, we observed an abundant population of residualized steelhead or resident rainbow trout and bull trout (Table 6). Below the barrier, we observed steelhead and mountain whitefish. Fish below the barrier had a length frequency distribution similar to those above the barrier (Fig. 15).

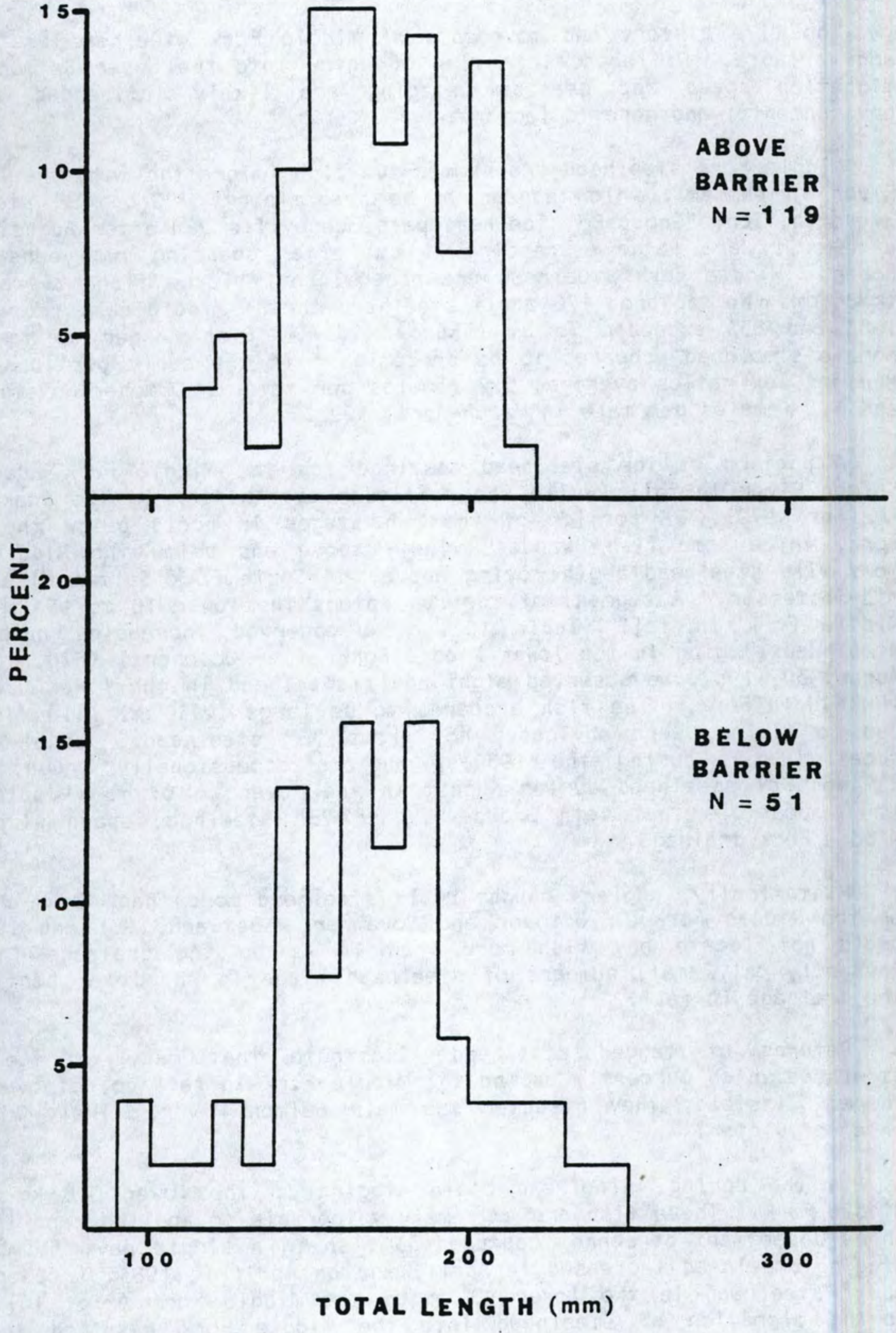

Figure 15. Length frequency of juvenile steelhead-rainbow caught in Wilson Creek, above and below a barrier, July 1983.

Life History and Movements

The life history and movements of Middle Fork steelhead are complex and variable. Differences in time of entry into the upper Salmon River, migration speed and seasonal staging are likely influenced by both environmental and genetic factors.

Middle Fork steelhead are summer-run fish (migrating into the Columbia River in summer), which appear to be predominantly "Group B" steelhead. By definition, "Group B" steelhead pass Bonneville Dam after August 25 and a majority are large (exceeding 71 cm) after spending two years in the ocean. Middle Fork steelhead are predominantly large fish, averaging 81 to 86 cm. We captured 170 adult steelhead in the Middle Fork from 1981 to 1983 and 85% exceeded 76 cm (Thurow 1983). Fish ranged up to 99 cm. Female steelhead appeared to be predominant in the early portions of the run, as sex ratios averaged 5.2 females per male in October-November 1981 and 3.3 females per male in March-April 1982.

A portion of the steelhead destined for the Middle Fork ascend the Salmon River in fall, while the remainder over-winter in the Snake River (Mallet 1970). A portion of the run stages in pools below the Middle Fork, while some fish "wander" widely above and below the Middle Fork. Most wild steelhead begin moving above the South Fork Salmon River after mid-September. A segment of the run enters the lower 10 to 15 km of the Middle Fork in fall (Table 10). We observed increasing numbers of steelhead staging in the lower Middle Fork after October 1 (Fig. 16). On August 30, 1982, we observed eight adult steelhead in the lower 0.8 km of the Middle Fork. The fish appeared to be large (>71 cm) wild fish, but due to timing, were obviously not group "B" steelhead. Local anglers recalled that during the 1950's, anglers occassionally caught "large numbers" of steelhead during August in the lower km of the Middle Fork. It is possible that both Group "A" and "B" steelhead spawn within the Middle Fork drainage.

Historically, anglers caught adult steelhead more than 48 km upstream on the Middle Fork in October and November. Between 1981 and 1983, we could not locate any fish more than 14 km up the drainage in fall. Presently only small numbers of steelhead stage in the lower portions of the drainage in fall.

Returns of tagged steelhead illustrate that many of the adult steelhead which currently ascend the Middle Fork in fall do not overwinter there. Instead, they re-enter the main Salmon River, likely with the onset of winter.

In the spring, steelhead begin staging in the lower 0.8 km of the Middle Fork. These fish are extremely vulnerable to angling, and in 1982, three Department personnel captured 33 fish in a single day. Numbers of staging steelhead increased in April, and on April 1, 1983, I observed 72 adult steelhead in the lower 400 m of the Middle Fork (Fig. 16). The spring migration of steelhead into the Middle Fork resulted in large catches near the mouth that were documented during March and April, 1958 to 1962 (Idaho Department of Fish and Game files, Boise).

Table 10. Results of spring and fall surveys for adult steelhead in the Middle Fork Salmon River drainage, 1983.

Date	Location	River km	Number steelhead caught or observed
15-17 March	Flying "B" Ranch to Camas Creek	48-57	3 adults, river km 51
4-7 October	Flying "B" Ranch to main Salmon River	0-48	4 adults, river km 1
2-4 November	Big Creek vicinity	26-31	No adults
15-18 November	Flying "B" Ranch to main Salmon River	0-48	2 adults, river km 1

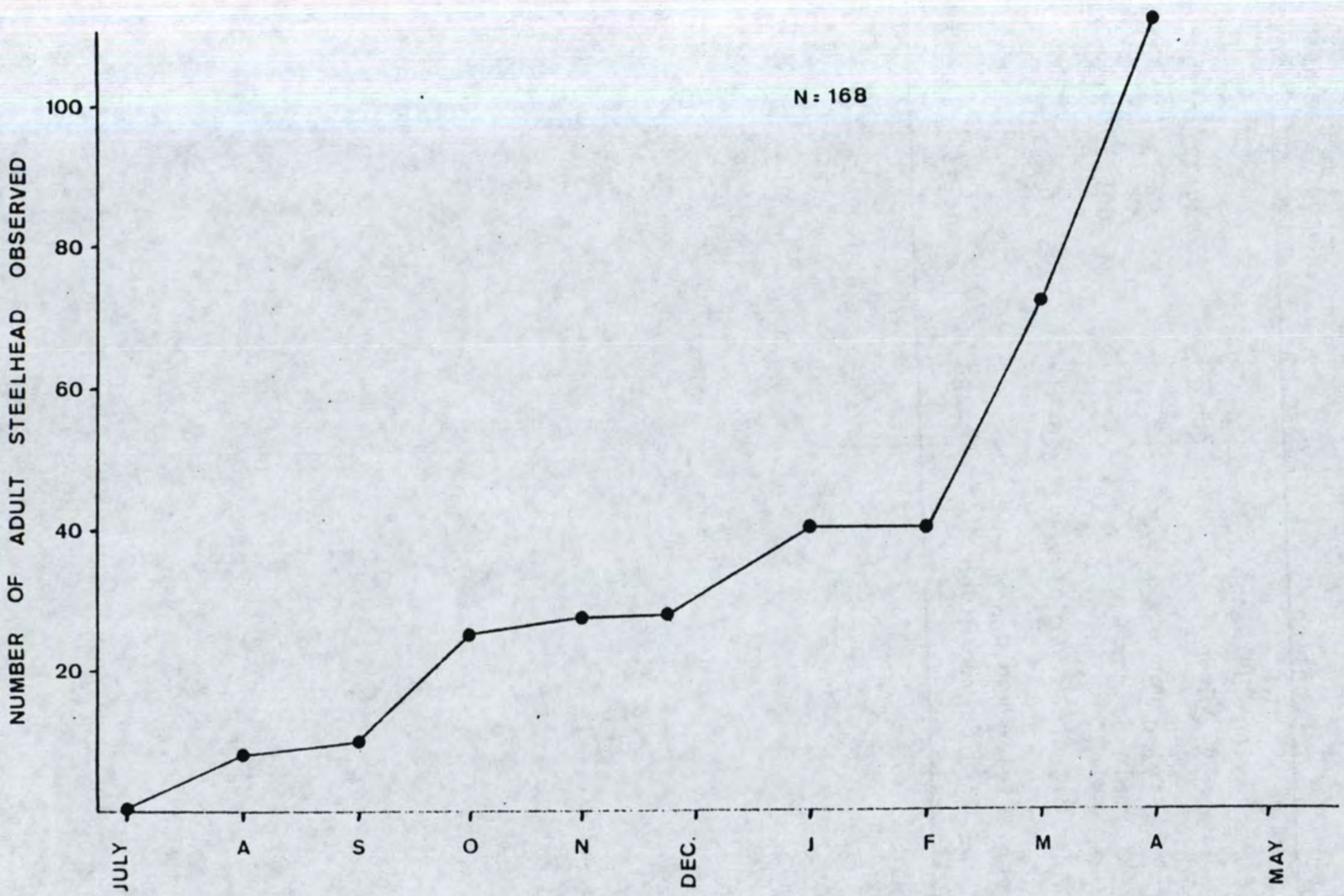

Figure 16. Numbers of adult steelhead observed in the lower 800 m of the Middle Fork Salmon River, 1981-1983.

Adult steelhead rapidly ascend the Middle Fork in spring and proceed to spawning streams. Our surveys located adult steelhead upstream as far as Aparejo Rapids (river km 51) by March 15, 1983. Personal recall and fishing records of longtime residents at the Middle Fork Lodge (river km 102) suggest that steelhead arrived there by approximately April 15. In 1975, three Idaho Department of Fish and Game personnel observed an adult steelhead at Dagger Falls (river km 156) on April 23. Results of spawning ground surveys indicate that many steelhead are in tributaries and spawning by April 15 (Fig. 2).

Origin of Middle Fork Steelhead

Our observations suggest that the Middle Fork sustains a wild, unaltered stock of steelhead trout. We found no evidence of dilution by non-indigenous stocks at spawning areas. Three hatchery steelhead (identified by eroded fins) were observed in the lower 200 m of the Middle Fork in 1982. I believe the fish were temporarily staging there because the mainstem Salmon River was turbid when two of the fish were captured. We did not observe any hatchery steelhead above that point or in tributaries throughout this study.

Results of the electrophorectic analysis for samples collected in Big, Loon and Marble creeks showed heterogeneity among the populations (Wishard and Seeb 1983). That is, isolated populations exist within the Middle Fork drainage.

Results were compared to other available data from steelhead of the Snake and Columbia rivers. Middle Fork steelhead stocks shared characteristics of other Snake River stocks, but differed from coastal steelhead and lower Columbia River populations.

We assumed that most steelhead-rainbow less than 250 mm were juvenile steelhead. Otolith nuclei measurements of 96 fish, from 120 to 230 mm, supported that hypothesis (Thurow 1983). The fish collected from Big and Loon creeks exhibited otolith nuclei measurements which were more characteristic of juvenile steelhead than resident rainbow trout.

Main Salmon River Sport Fishery

Estimated Exploitation of Middle Fork Stocks

As a result of angling regulation changes, a significant reduction in the harvest of wild stocks has occurred since the 1980-1981 season.

Although anglers were encouraged to voluntarily release wild fish in 1980-81, nearly 80% of those who caught wild fish did not release them. An estimated 1,901 wild steelhead destined for the Middle Fork were harvested in the Salmon River, Sections 1 through 4 during the fall 1980-spring 1981 season.

Anglers continued to harvest wild fish in 1981-82, and an estimated 1,760 wild steelhead destined for the Middle Fork were harvested in Salmon River Sections 1 through 4.

Anglers harvested lesser numbers of wild steelhead during the fall 1982 and spring 1983 season. Partridge and Pollard (1983) estimated a fall 1982 harvest of 1,112 steelhead in Salmon River Section 4. Within Section 4, 1.7% of the harvest was comprised of wild steelhead in the fall 1982. Consequently, an estimated 20 wild steelhead were harvested in the fall. The spring 1983 harvest estimate totaled 538 steelhead in Section 4, and no "trophy-sized" steelhead were observed in creel checks.

Anglers continued to harvest wild steelhead in Sections 1, 2 and 3 (mouth to Vinegar Creek) in the fall of 1982. Partridge and Pollard (1983) estimated fall harvest of 1,470, 780 and 825 in Sections 1, 2 and 3, respectively. Assuming that roughly 50% of the Section 3 (Little Salmon River to South Fork) harvest may occur from the Little Salmon to Vinegar Creek, the harvest in that area was estimated at 413. Limited census work was done in the area in 1982, and the combined proportion of wild fish in Section 2 and 3 equaled 40% in the fall of 1982. No data were available for Section 1, so I assumed 40% of the creeled fish were wild in that section, also. Using the 40% value, an estimated 588, 313 and 165 wild steelhead were creeled in Sections 1, 2 and 3, respectively, in the fall 1982 fishery. In the spring 1983, an estimated 105, 169 and 169 steelhead were harvested in Sections 1, 2 and 3, respectively. As a result of the special regulations, few wild fish were harvested in Sections 1, 2 and 3 in the spring 1983.

Using the ratio of wild steelhead above and below the Middle Fork, as recorded at the North Fork check station, 80% and 86%, respectively, of the fall 1982 and spring 1983 wild fish caught in Salmon River Section 4 were destined for the Middle Fork. Consequently, an estimated 16 (20 x 0.80) Middle Fork stock steelhead were harvested in the fall 1982 in Section 4.

Since limited creel data were available in Sections 1, 2 and 3, I applied the most recent estimate (22%) of wild stocks destined for the South Fork (Reingold 1981). If 22% of the wild steelhead in Sections 1, 2 and 3 were destined for the South Fork, the remainder were largely upriver wild fish. In the fall 1982, 1,066 wild fish were creeled in Sections 1, 2 and 3 and 831 were upriver fish. Eighty percent or 665 were destined for the Middle Fork. The total estimated harvest of wild steelhead destined for the Middle Fork equaled 847 fish for Sections 1 through 4 in fall 1982 and spring 1983.

Fall 1983 Section 4 Fishery

The mandatory release regulation was expanded to Salmon River Sections 1 through 4 in the fall 1983, and few wild steelhead were harvested. Only 3% of the fish we observed at the Salmon River Section 4 check station appeared to be wild fish (dorsal fins less than 57 mm). Similarly, 2% of the fish creeled by jet boat anglers in Section 4 appeared to be wild.

Bank anglers. On the 11.3 km roaded zone of Section 4 we interviewed 402 bank anglers who creeled 46 fish and released 95 between October 10 and November 20, 1983 (Table 11). The seasonal catch rate averaged 13.0 hours/fish as compared to 13.9 in 1982 and 19.1 in 1981.

Wild steelhead comprised 57% of the fish caught and 82% of the fish released (Table 11). In 1981 and 1982, wild fish comprised 65% and 49% of the fish caught, respectively.

I compared bank angler effort and catch in Salmon River Section 4 during identical intervals from 1981 to 1983 (Table 12). Numbers of anglers, effort and creeled fish declined with the onset of special regulations in 1982, but the decline continued at a lesser rate from 1982 to 1983. Steelhead fishing effort and harvest on the Salmon River is exhibiting a trend toward smaller proportions in Sections 1 through 4 and significant increases in Sections 5 and 6, as large hatchery runs return to upriver areas.

The fall escapement of wild steelhead in Salmon River Section 4 was diminished in 1982 and 1983 as compared to 1981 (Table 12). Seventy-four percent of the fish caught during the two intervals were wild in 1981 as compared to 35% in 1982 and 49% in 1983. Due to the catch-and-release regulations on wild fish in 1982 and 1983, some wild fish were likely caught and released multiple times. This factor would artificially inflate the estimated wild fish ratios.

Jet boat anglers. We interviewed 731 jet boat anglers in Salmon River Section 4 and obtained additional data from cooperating outfitters (Table 11). Catch rates were similar in 1983 (16.2 hours/fish), 1982 (16.3 hours/fish) and 1981 (16.4 hours/fish).

Wild steelhead comprised 46% of the catch as compared to 28% in 1982 and 44% in 1981 (Table 11). As in previous years, jet boat anglers released a smaller proportion of their catch (46%) as compared to bank anglers (67%). In 1983, jet boat anglers released just 2% of the hatchery fish caught as compared to bank anglers who released 28%.

DISCUSSION

Spawning Behavior

The Middle Fork and its tributaries contain extensive areas of high quality spawning habitat. We surveyed 540 accessible kilometers in 13 tributaries. Within most of the streams, spawning escapements appeared to be insufficient to occupy the available spawning habitat. The mainstem Middle Fork contained isolated sites of suitable spawning substrate which also may be utilized by adult steelhead.

Table 11. Summary of steelhead angler creel data for Salmon River Section 4, October-November 1983.

Source	Anglers	Fish creeled Total	Fish creeled (wild)	Fish released wild	Fish released hatchery	Total catch	Hours fished	Hours/fish caught	Census period
Bank angler census (Corn Creek to Middle Fork)									
Check station	402	46	(2)	78	17	141	1,834	13.0	10 Oct-20 Nov
Jet boat angler census (South Fork to Corn Creek)									
Check station	168	40	(1)	61	2	103	1,388	13.5	10 Oct-20 Nov
Jet boat[a]	563	111	(3)	105	3	219	3,836	17.5	1 Sept-20 Nov
Outfitter volunteer data[a] (South Fork to Corn Creek)									
	--	306	(7)	216	4	526	--	--	1 Sept-20 Nov

[a]M. Reingold, Idaho Department of Fish and Game, pers. communication, 1984, for jet boat anglers.

Table 12. Steelhead angler effort and catch in Salmon River Section 4 during similar intervals, 1981-1983.

Interval	No. of anglers	Estimated effort (hrs)	Steelhead Creeled No.(%)	Steelhead Released No.(%)	% wild	Hours/fish
10-23 Oct 1981	1,019	5,505	189(66)	98(34)	69	19.2
9-22 Oct 1982	587	2,552	81(45)	100(55)	43	14.1
10-20 Oct 1983	574	2,256	22(45)	27(55)	49	18.1
7-20 Nov 1981	576	2,754	101(73)	37(27)	54	19.9
6-19 Nov 1982	352	1,702	56(47)	63(53)	23	14.3
7-20 Nov 1983	234	939	12(39)	19(61)	48	11.4

We observed steelhead spawning in a wide range of locations within Middle Fork tributaries. Many of the spawners we observed constructed redds in small, 5 to 10 m^2 graveled areas isolated within sections of unsuitable substrate. Other steelhead spawned within large expanses of gravel. Redd selection in tributaries may be dependent on the presence of escape cover (Jones 1976) and substrate parameters.

Orcutt et al. (1968) studied spawning behavior of steelhead in the Salmon and Clearwater rivers. Spawning peaked April 20 through May 10 at water temperatures of 2.5 to 8.5 C. Size of redds averaged 5.2 m^2, and most redds were constructed at depths of 0.2 to 1.5 m in 1.3 to 10.2 cm diameter gravel. Water velocities averaged 0.7 to 8.0 m/sec. at a point 12.7 cm above the stream bed.

Female steelhead commonly construct multiple redds. In Washington, biologists reported a range of 1.1 to 1.4 redds per female and a mean of 1.3 redds per female from six years of data on winter-run steelhead (T. Johnson, Washington Department of Game, pers. comm.).

Precocial male steelhead trout 170 to 230 mm were observed on redds with adult steelhead in Middle Fork tributaries. In several cases, we observed several precocial males attempting to spawn with a single adult female. We observed adult males attempting to drive precocial males from the redds. As Gebhards (1960) observed for precocial chinook salmon, these fish produce viable sperm and may perform the same function as adult males in fertilizing the eggs. Dalley et al. (1983) also reported that precocial Atlantic salmon (Salmo salar) are fertile. It could be hypothesized that precocial male steelhead serve an important function in insuring the fertilization of eggs, particularly in a depressed run. Montgomery (1983) observed that the incidence of precocity increased when overall Atlantic salmon parr densities were low. Spawning of precocial males also insures mixing of year classes, which may be important in maintaining healthy population genetics.

Establishment of Escapement Goals

Future management of the Middle Fork steelhead population will require establishment of adequate escapement goals and accurate annual run size predictions. There are two methods to establish escapement objectives: (1) development of stock recruitment (S/R) curves based on measured escapement and adult recruitment, and (2) application of juvenile production data to available rearing habitat (Washington Department of Game 1983). Insufficient data is available to develop S/R curves for the Middle Fork drainage so juvenile production data collected since 1981 will be applied to habitat measurements.

This methodology consists of calculating potential smolt production and back calculating the number of adults required to produce that number of smolts as follows (Washington Department of Game 1983):

I. Measurement of total steelhead rearing habitat at mid-summer flows

Total accessible habitat surveyed from 1981 to 1983 was measured from aerial photos for 14 streams. Surface areas at mid-summer flows were calculated by applying mean widths of surveyed sections to lineal distances of similar habitat. Rearing habitat was expressed in 100 m^2 units.

Tributaries:

Total accessible km = 644.4 km
Surface area = 6,541,950 m^2
100 m^2 units = 65,419.5

Mainstem:

Total accessible km = 170.6 km
Surface area = 6,824,000 m^2
100 m^2 units = 68,240

Mallet (1974) also estimated total areas of accessible anadromous fish habitat in the Middle Fork drainage. He reported 671 km of tributaries and 170 km of mainstem area.

II. Conversion of total accessible habitat to a refined estimate of usable habitat

Where available, Instream Flow Incremental Measurement (IFIM) weighted usable area data may be applied to total rearing habitat. As Chapman (1981) observed, weighted usable area models compensate for the fact that much surface area of mainstem reaches is little used by rearing steelhead. Unfortunately, no IFIM data are available for the mainstem Middle Fork or its tributaries. Such data are required to refine future calculations.

III. Application of steelhead production data to available habitat

Perhaps the best technique for assessing juvenile steelhead production is to quantitatively classify habitat into representative types and randomly sample abundance within each habitat. Slaney (1981) used six habitat classifications to estimate juvenile steelhead production in the Keogh River, British Columbia. Shepard (1983) classified habitats into six types in the Clearwater River Drainage, Idaho. Within the Middle Fork, we selected sampling sites only within optimal "pocket-water" habitats. This sampling scheme was initiated for two reasons: (1) preliminary surveys indicated very small densities of steelhead, even within "optimal" habitat, and (2) the project duration (3 years) and magnitude of the drainage, required a relatively rapid survey of individual streams. As Shepard (1983) observed, a major drawback associated with sampling all habitat units is the time required to sample an entire stream.

Densities of juvenile steelhead within Middle Fork tributaries ranged from 0.2 to 10.0 fish per 100 m^2 and averaged 4.0 fish per 100 m^2.

Middle Fork tributaries can support much larger densities of juvenile steelhead with large adult escapements. Seeding rate (defined as the number of eggs deposited by returning adults) may be the most important variable in determining year-class abundance of juvenile steelhead (Graham 1977). Mabbott (1982) observed a correlation between Age I juvenile steelhead densities and adult escapements in the Lochsa River and tributaries.

Data from other, under-seeded Idaho streams exhibit densities similar to those we observed in the Middle Fork. A comparison with data from fully-seeded streams suggests that current rearing densities in the Middle Fork may be a fraction of the potential carrying capacity (rearing densities of up to 20 fish per 100 m^2) (Table 13). Similarly, densities of 20 to 50 juvenile steelhead per 100 m^2 have been observed in some Clearwater River tributaries by Clearwater National Forest personnel. Densities of Age I and older steelhead averaged 19 fish per 100 m^2 and 15 fish per 100 m^2 in Beaver and Skull creeks (tributaries to the North Fork Clearwater), respectively, in 1968 and 1969 (Cannon 1970).

Since we were not able to capture outmigrating smolts, potential smolt production must be estimated using data from other streams. Unfortunately, there is currently no detailed smolt yield data available for wild steelhead populations in Idaho. Most available information has been collected on coastal British Columbia and Washington streams. Smolt trapping studies on five streams illustrated production of 0.6 to 2.2 smolts per 100 m^2 (Marshall et al. 1980). Within Snow Creek, Washington, biologists recorded production levels of 3.1 smolts per 100 m^2 (T. Johnson, Washington Department of Game, pers. comm.). Data collected on interior streams suggest larger production rates. Bjornn (1978) observed production of 15.1 smolts per 100 ^{2} in the Lemhi River, Idaho. Estimates of smolt production (based on density data rather than actual trapping) ranged from 6.2 to 11.6 smolts per 100 m^2 for three interior British Columbia streams (Marshall et al. 1980).

A relationship apparently exists between stream productivity, as expressed by total dissolved solids (TDS) and potential smolt production. The TDS of the mainstem Middle Fork is approximately 60 mg/l. Data plotted for nine coastal and interior streams suggest smolt production of 3.0 to 4.0 smolts per 100 m^2 for streams with TDS of 60 to 80 mg/l (Marshall et al. 1980).

Another method of estimating smolt production is to evaluate the relationship between rearing juveniles and outmigrant smolts. Slaney (1981) estimated a smolt yield to summer parr density relationship of 0.4. Shepard (1983) estimated that 40% of the 51 to 150 mm juvenile steelhead migrated out as smolts. Thirty-six percent of the parr which migrated from Gobar Creek to the Kalama River out-migrated as smolts the following year (Chilcote 1984). If 30 to 40% of the summer parr in the Middle Fork out-migrate as smolts, and potential rearing densities equal 10 to 20 parr per 100 m^2, potential smolt production may range from three to eight smolts per 100 m^2.

I believe four smolts per 100 m^2 may be a reasonable potential production level for Middle Fork tributaries. Smolt production potential from the mainstem Middle Fork may be somewhat less since observed rearing densities in the mainstem currently average 9% of those in tributaries (Tables 2 & 6). If mainstem rearing is density dependent, existing adult

Table 13. Juvenile steelhead densities observed in underseeded and fully seeded Idaho streams.

Stream	Density of age I+ and older steelhead (fish per 100 m^2) Range	Mean	Author
Underseeded streams			
Middle Fork Salmon River tributaries	0.2 - 10.5	4.0	Thurow (1982, 1983)
Mainstem Salmon River tributaries	9.8 - 14.5	--	Reingold (1981)
Selway River tributaries	5.7 - 17.2	--	Graham (1977)
Lochsa River tributaries (upper sections)	8.5 - 10.0	--	Graham (1977)
Fully seeded streams			
Crooked Fork, tributary to Clearwater River	80 - 100	--	Everest (1969)
Tributaries to South Fork Salmon River	--	40	Everest (1969)
Lochsa River tributaries (upper sections)	32 - 77	51	Edmundson (1967)

steelhead escapement levels would not be sufficient to adequately seed the mainstem Middle Fork. Even with full seeding of tributaries, it is unlikely the mainstem would produce as many smolts per unit area as tributaries because there is less usable habitat for steelhead in the mainstem. Production of one smolt per 100 m^2 (25% of tributary production) may be a reasonable level for the mainstem Middle Fork. Chapman (1981) similarly reported smolt production from mainstem Skagit River areas at 22% the level of tributary areas.

Potential smolt yield was calculated as follows:

Smolts from tributary areas

(4 smolts/100 m^2 x 65,419.5 units): = 261,678 smolts

Smolts from mainstem areas

(1 smolt/100 m^2 x 68,240 units): = 68,240 smolts

329,918 smolts

These calculations result in an estimated annual production of approximately 350,000 smolts. Bjornn (1981) estimated an annual production of 700,000 smolts in the Clearwater River drainage, Idaho. These data are comparable since the Middle Fork drainage area is 40% that of the Clearwater River drainage.

Steelhead egg-to-smolt survival rates range from 0.5% to 2.5% for wild populations. Data from seven river systems in Idaho, Washington and British Columbia suggest that most egg-to-smolt survival rates are between 1 and 2% (Bjornn 1978, Phillips et al. 1981, Washington Department of Game 1983). I assumed a survival rate of 1% under poor spawning conditions (poor quality spawning habitat, abnormal flows, abnormal temperature regimes, redd superimposition, etc.), 1.5% under average conditions and 2% under optimal conditions in the Middle Fork.

Adult steelhead returning to Idaho exhibit a larger proportion of females than males. Sixty-five percent of the wild steelhead trapped at the Lewiston Dam (N=2,364) from 1951 to 1957 were females (Keating and Murphy 1958). Wild steelhead trapped in the Lemhi River between 1969 and 1972 ranged from 63 to 81% females. Hatchery-reared steelhead returning to Dworshak National Fish Hatchery averaged 62% females from 1980 to 1984 (Fisheries Assistance Office, USFWS, pers. comm.). Between 1980 and 1983, 59% of the hatchery steelhead returning to the Pahsimeroi Hatchery were females (Moore 1981 to 1984). I assumed a 60% female, 40% male proportion for the Middle Fork wild steelhead population.

I applied egg-to-smolt survival rates of 1 to 2%, assumed a fecundity of 5,000 eggs per female and a sex ratio of 1.5 females per male in calculating escapement needs (Table 14). Depending on the spawning success, I estimated that a spawning escapement ranging from 6,000 to 11,500, with a mid-range of 8,000 fish would produce 350,000 smolts.

Table 14. Required escapement to produce 350,000 smolts in the Middle Fork Salmon River drainage with varying egg-to-smolt survival rates.

Egg-to-smolt survival rate (%)	Required egg deposition (millions)	Required No. of females	Total escapement
1.0	35.0	7,000	11,500
1.5	23.4	4,700	8,000
2.0	17.5	3,500	6,000

The corresponding adult return rate from 350,000 smolts can be used to estimate when replacement will occur. At smolt-to-adult survival rates of 1%, replacement would not occur and the population would continue to decline. At a survival rate exceeding 2.3%, replacement of 8,000 adult steelhead would occur. At survival rates approaching historical levels (4-5% in Raymond 1979), a surplus of several thousand steelhead would return to the Middle Fork drainage. These calculations illustrate that restoration of the Middle Fork steelhead population will be dependent on measures to increase adult escapements in order to attain full smolt production potential.

Smolt production might also be enhanced by eliminating the harvest of steelhead parr. Current angling regulations require the release of all juvenile steelhead in the mainstem, but anglers are allowed to harvest juvenile steelhead in tributaries (with the exception of Big Creek). Since 80% of the salmonids we observed or captured in tributaries were juvenile steelhead, they probably comprise the bulk of the tributary harvest. Angler effort and harvest in Middle Fork tributaries is unrecorded; however, our observations suggest that substantial effort may occur in accessible tributary sections. Collection of creel data in selected Middle Fork tributaries should be accomplished in the future.

Pollard (1969) reported that a large proportion of the juvenile steelhead trout can be removed with a moderate amount of angling. Restricting harvest of juvenile steelhead within the Middle Fork drainage would be consistent with statewide programs to protect wild stocks. In order to prevent the future harvest of juvenile steelhead in tributaries, managers could utilize either a size limit or a species limit. Within western Washington, a 200 mm minimum size limit is widely used to protect juvenile steelhead (Washington Department of Game 1984). A size limit would allow anglers to harvest resident rainbow trout, cutthroat trout and bull trout while releasing juvenile steelhead and small resident trout. A 200 mm minimum size limit would protect 80% of the juvenile steelhead in tributaries and a 250 mm limit would protect 97% (Fig. 11). The size limit may be more appropriate than a species restriction which would require anglers to differentiate juvenile steelhead trout from other trout.

Restoration of Steelhead Sport Fishing Opportunities

An ultimate goal of fishery managers is to restore sport fishing opportunities for steelhead trout in the Middle Fork. The drainage currently supports a viable, though depressed, stock of indigneous steelhead. The Anadromous Fish Management Plan (IFG 1984) recommends that the drainage continue to be managed for the production and preservation of wild, indigenous steelhead.

Management for indigenous stocks may be the best alternative for restoration of sport fishing opportunities. As Horrall (1981) observed, remnant stocks of a species should be protected and encouraged as they offer the most rapid means of rehabilitation. The concepts of genetic adaptation to a specific environment as reviewed by Ricker (1972) and the

Stock Concept International Symposium (1981) illustrate that such adaptation results in maximum survival in a specific environment. Electrophoresis data collected from Middle Fork populations suggest that individual drainages may support discrete stocks (Wishard and Seeb 1983). Consequently, the most practical and ecologically safe way to preserve genetic diversity is to maintain wild stocks (Wagner 1979). Research suggests that mixing of wild and hatchery stocks results in negative consequences for the fitness of wild stocks (Chilcote et al. 1982, Helle 1981, Reisenbichler and McIntyre 1977).

In addition to their importance to restoring Middle Fork populations, maintenance of wild gene pools also offers a means of increasing the viability of future hatchery stocks for use in other drainages (Stock Concept International Symposium 1981).

Although management for indigenous stocks is judged to be the most suitable goal for the Middle Fork drainage, as Loftus (1981) states, attainment of the goal is likely to be a slow, deliberate and unspectacular process. Current spawning escapements to the Middle Fork remain far below historical escapement levels. Estimated escapements declined steadily between 1970-71 and 1975-76, fluctuated between 1976-77 and 1979-80, and have shown a gradual increase since 1979-80 (Fig. 17).

Historical escapement levels probably exceeded 10,000 fish. An escapement of 8,000 fish may currently be required to fully utilize the productive capabilities of available habitat. Consequently, a goal of 8,000 fish requires a tripling of current escapements to fully seed rearing areas. Full seeding of rearing areas and maximum smolt production may be a necessary goal to maintain wild stocks until downriver smolt passage problems are resolved (Bjornn 1981).

Options for increasing escapements of the wild stock include reducing harvests, use of short-term hatchery rearing, improvements in downstream passage and habitat restoration and maintenance.

The differential harvest regulations adopted for the Salmon River have significantly increased adult steelhead escapements to the Middle Fork. Beginning in 1984, 100% of the hatchery-reared steelhead in Idaho are receiving an adipose fin clip prior to release. This mark will enable managers to apply differential harvest regulations to restore wild steelhead while harvesting surplus hatchery steelhead.

A second alternative to be considered for the restoration of wild steelhead is to enhance survival and smolt production via short-term artificial rearing. Research on egg-to-fry survival suggests survival rates of 20 to 60% in the wild. In contrast, artificial fertilization and incubation often results in egg-to-fry survival of 80 to 90%. Although rearing to swim-up fry would not alter the wild appearance of the fish, the selective nature of this short-term hatchery rearing is unknown. There is evidence that survival of hatchery-reared Atlantic salmon of wild parentage is much lower than naturally-produced fish (Dickson and MacCrimmon 1982). The authors found behavioral modifications in juvenile Atlantic salmon when hatched and reared to alevin stage to be of "particular ecological significance" when the fish were released into streams. The possibility that the genetic integrity of the wild steelhead stock may be altered makes short-term artificial rearing an unappealing alternative.

Other researchers have tested the viability of fry releases to supplement salmon and steelhead populations. Graham (1977) released fry at a seeding rate of 9.0 fry/m^2 which resulted in stable densities of 1.0 fry/m^2 in Lochsa River tributaries. He found fry survival of 6-8% in release sections. Bjornn (1978) increased the production of smolts in Big Springs Creek and the Lemhi River by fry releases and estimated 80-90% density independent mortality on stocked fry. Wentworth and LaBar (1984) believed stocking of steelhead fry was a feasible alternative, provided there was sufficient rearing habitat. The authors recommended seeding rates of one fry per m^2 for their streams as compared to seeding rates of four to five fry per m^2 suggested by Bjornn (1978) and Graham (1977).

Logistical factors may limit the feasibility of fry plants in the Middle Fork drainage. Donor streams must sustain a reasonable return of adults, be feasible to trap during the adult migration and have reasonable access to allow transportation of eggs to an incubation facility. Few streams meet these criteria due to the low run sizes and limited access.

Further, if discrete stocks occur among tributaries, they may also exist within tributaries. Consequently, fry produced from eggs collected at the lower end of a stream may differ from those which would be naturally spawned in headwater areas or side tributaries. Artificial mixing of discrete stocks would alter the genetic characteristics of the wild population. As a final concern, by trapping a portion of a depressed spawning run, managers may actually decrease the genetic variability of the naturally spawning population by reducing the number of naturally spawning pairs. The biological expression of a decrease in genetic variability is a loss in reproductive performance (Hershberger and Iwamoto 1981). Stocking of hatchery-reared steelhead fry of wild parentage is not a viable alternative for the Middle Fork drainage at this time.

Habitat management is another critical factor in restoring wild steelhead. It is imperative that the high quality habitat within the Middle Fork and tributaries be maintained. The acceleration of mining activities in several drainages has the potential to adversely affect additional fisheries habitats. Constraints can be applied by those agencies with jurisdiction to protect aquatic habitat and fisheries resources. Measures should also be applied to restore degraded habitats. The Northwest Power Planning Council's Fish and Wildlife Program lists proposed habitat restoration projects in Marsh, Bear Valley and Elk creeks (NPPC 1982). Additional restoration projects may be warranted within Monumental Creek as a result of existing mining operations. Although we identified barriers to steelhead movements on four streams (Brush, Indian, Sheep and Wilson creeks), removal of the barriers is not recommended at this time. Since several of the areas support isolated indigenous cutthroat populations above the barrier, each site should be closely evaluated before any action is taken.

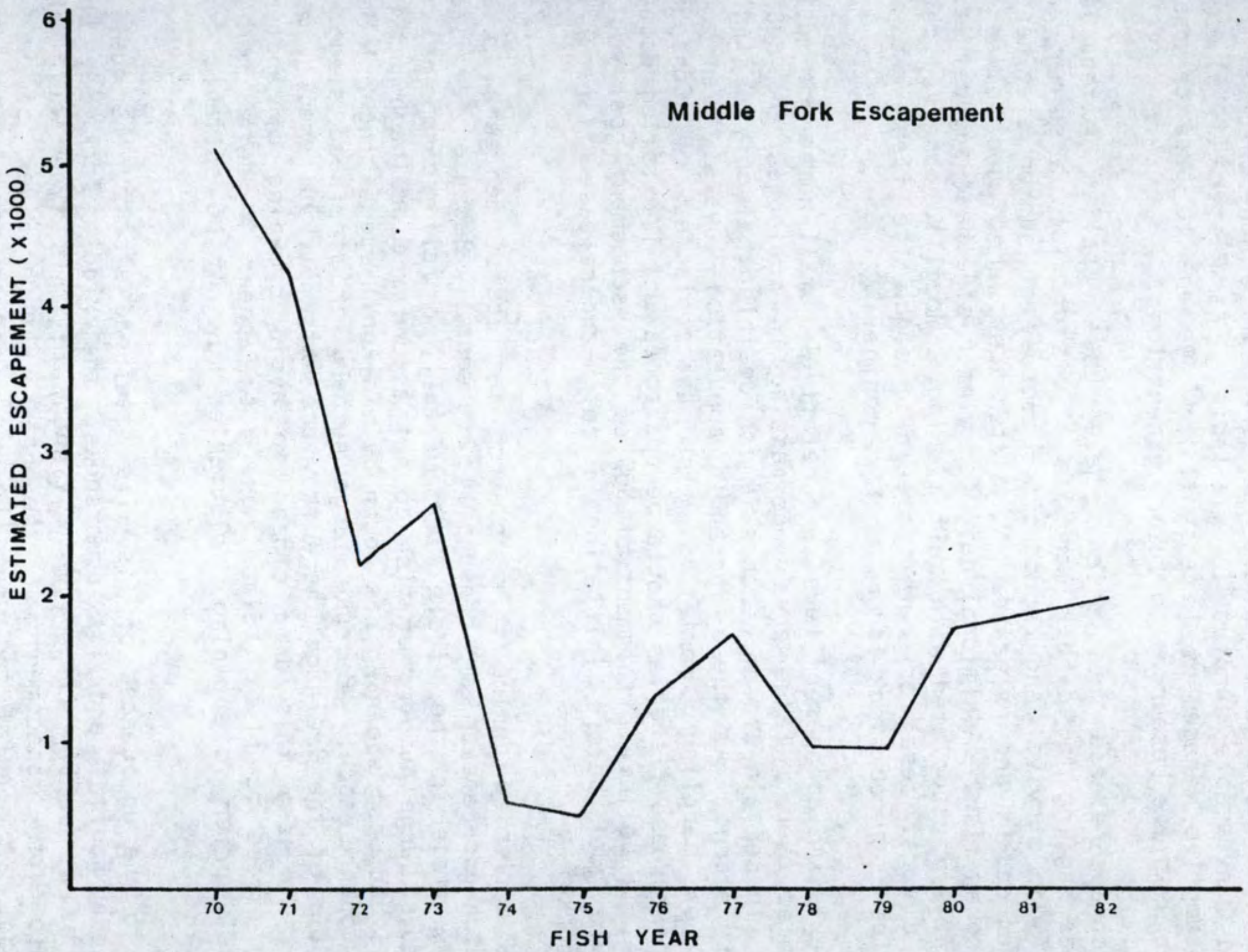

Figure 17. Estimated annual escapements of wild steelhead trout to the Middle Fork Salmon River, 1970-1983.

Considerations for Future Sport Fishing

As recommended in the Idaho Department of Fish and Game's Anadromous Fish Management Plan (1984), proposed natural escapement goals are based on an escapement which makes full utilization of all natural spawning and rearing habitats. Harvest of Middle Fork stocks would be restricted until this escapement goal is met.

One alternative is to manage the stream as a non-consumptive fishery until a harvestable surplus is available. As Pister (1976) observed, non-consumptive management is essential if we are to pass on meaningful fish and wildlife resources to future generations.

Catch-and-release regulations have been applied extensively to steelhead angling in Idaho. Mongillo (1984) provides a summary of data dealing with survival and reproductive success of summer steelhead which have been caught and released. No differences were found between hooked and unhooked fish. Additional data for winter steelhead suggest less than 10% mortality associated with bait fishing. Mongillo observed that this may be a worst case for winter steelhead since the fish were held in hatcheries as brood stock for up to five months.

At existing escapement levels, a relatively small number of adults are distributed over a large area encompassing 14 drainages and 640 km of stream. In certain stream reaches it is feasible that only a single pair of fish return. At these threshold population levels, even a slight degree of angling mortality is unacceptable. Consequently, catch-and-release fisheries should be postponed until existing escapements increase. I believe attainment of 50% of the escapement goal would be a reasonable goal before initiating a catch-and-release fishery in the Middle Fork.

Data collected during this research can assist managers in setting both catch-and-release or consumptive seasons. Because few steelhead currently stage in the Middle Fork in fall, a fall season may not be warranted. Large numbers of fish do not ascend the drainage until March and April and most spawning has begun by mid-April suggesting a 1 March to 1 April open season. Because large numbers of steelhead stage in the lower 400 m of the drainage where they are extremely vulnerable, managers may want to keep this area closed to avoid crowding of anglers and handling stress to fish. Since most fish appear to enter tributaries immediately prior to spawning, tributaries may not be suitable for open seasons.

Due to the uniqueness of its wild steelhead stocks, the quality and picturesque habitat and its remoteness, the Middle Fork may best be managed as a quality fishery. A fishery of this type would also be compatible with management of the Frank Church River of No Return Wilderness. A special tag could be used (either random draw or first come) to maintain low numbers of anglers. In order to monitor the fishery, anglers could be required to submit completed forms (catch rates, locations, etc.) at the termination of their angling trips. Enforcement problems may also be lessened by mandatory angler check-ins. The Middle Fork is one of the few wild rivers outside of Alaska which lends itself to a remote and quality angling experience for large wild steelhead.

Status of Indigenous Chinook Salmon

Historically, the Middle Fork drainage produced a substantial number of spring chinook and lesser numbers of summer chinook salmon. The Middle Fork and tributaries formerly supported 26.7% of Idaho's annual chinook harvest (Mallet 1970). Between 1967 and 1969, chinook salmon harvest in th Middle Fork ranged from 1,994 to 3,396 fish annually. Mallet also observed that an average of 31.9% of the annual, statewide chinook salmon redd counts were observed in the Middle Fork drainage. Between 1955 and 1958, Gebhards (1959) reported a maximum annual count of 3,851 redds.

As early as 1941, Parkhurst stated that the run of salmon in the Middle Fork was poor and it has been progressively declining for years (Gebhards 1959). During the last decade, in particular, wild chinook salmon runs have been severely depleted and no angling season has been approved in Idaho since 1978.

The severe decline in chinook salmon is illustrated by comparison of redd counts. Between 1960 and 1969, an annual mean of 1,221 redds were observed in Bear Valley, Big, Marsh and Sulpher creeks combined (Pollard 1983). Since 1980, an annual mean of 90 redds were observed in the same locations to document a 93% reduction in redds. Existing chinook salmon escapements to the Middle Fork may total less than 1,000 fish.

Juvenile chinook salmon are also in extremely low abundance. We observed 294 within 60 transects in the mainstem Middle Fork from 1981 to 1983 (Table 5). A decline in rearing chinook salmon has occurred since Corley (1972) observed 700 and Jeppson and Ball (1979) observed 311 in 21 transects. Juvenile chinook salmon were also uncommon in tributaries as we observed just 411 in 153 transects from 1981 to 1983 (Table 6).

Although the runs are in extremely low abundance, viable populations of chinook salmon remain in the following tributaries: Big, Bear Valley, Camas, Indian, Loon, Marble, Pistol, Rapid River and Sulphur creeks. Chinook salmon in Big, Bear Valley, Marsh and Sulphur creeks are classified as spring chinook, those in Loon Creek as summers and the remainder of the tributary runs are unclassified (Pollard 1983).

In the future, the Middle Fork will continue to be managed for the production of indigenous stocks (IFG 1984). As hatchery runs of chinook salmon increase in the Salmon River drainage, a mixed stock fishery may develop to the detriment of wild stocks. Managers may find it desirable to apply harvest management techniques, analogous to those currently in effect for steelhead, to accommodate harvest of hatchery chinook stocks, while attempting to increase escapements of wild chinook stocks.

Status of Westslope Cutthroat Trout

Westslope cutthroat trout were historically very abundant in the Middle Fork and certain tributaries. Carrey and Conley (1980) observed that the first settlers of the area described the fishing as "remarkable" and note that as late as 1955 it was possible to catch "more than a hundred fish a day ranging in size up to 16 inches." It seems likely that most of the fish were cutthroat.

In 1959, the Idaho Department of Fish and Game initiated a research project designed to gather information on the status of resident trout populations in the Middle Fork (Mallet 1963). At the time of this research, anglers were allowed to keep 15 fish per day. Mallet documented the slow growth, relatively late age at initial spawning and unique seasonal movement patterns of the Middle Fork cutthroat. Mallet found that most sexually mature cutthroat exceeded 295 mm and were of age class V and VI. He also recorded a substantial amount of fishing pressure in the Middle Fork and a year-round fishery on cutthroat as a result of their migration into the Salmon River. In 1962, a special bag and possession limit of three cutthroat was initiated for the mainstem Middle Fork.

In 1968, a follow-up study was initiated to further assess the status of the Middle Fork cutthroat population (Ortmann 1969). Ortmann documented an increase from 625 floaters in 1962 to 1,600 floaters in 1969 on the Middle Fork (Ortmann 1971). He estimated that 43% of the floaters in 1969 were anglers and expressed concern over the increasing fishing pressure. Ortmann observed little change in the age composition of cutthroat from 1959 to 1969. In 1972, a special "catch-and-release" season was initiated for the mainstem Middle Fork. In 1973, a section of the mainstem Salmon River was closed to trout fishing in the fall through spring to protect overwintering cutthroat.

Corley (1972) established snorkel trend counts on the mainstem Middle Fork in 1971, and periodic counts have been made in recent years (Jeppson and Ball 1979). In 1978, Ball documented a 162% increase in cutthroat abundance and more than five times as many cutthroat larger than 305 mm as compared to Corley's counts in 1971.

Cutthroat in the mainstem Middle Fork exhibited a relatively rapid response to catch-and-release regulations reflected in increased population abundance and larger numbers of older-age trout. This response was documented in the snorkel trend counts and in the percentage of cutthroat larger than 300 mm (Fig. 18). Between 1960 and 1980, the percentage of cutthroat larger than 300 mm more than doubled. Other biologists have observed a rapid response of cutthroat to restrictive angling regulations in other waters (Chapman et al. 1973, Johnson and Bjornn 1978 and Radford 1975a, 1975b).

However, since 1981 we have observed a significant decline ($P \leq .05$) in the percent of cutthroat larger than 300 mm in the catch (Fig. 18). Since large cutthroat are not caught on hook and line in relation to their abundance (Jeppson and Ball 1979), we also compared snorkel data. The

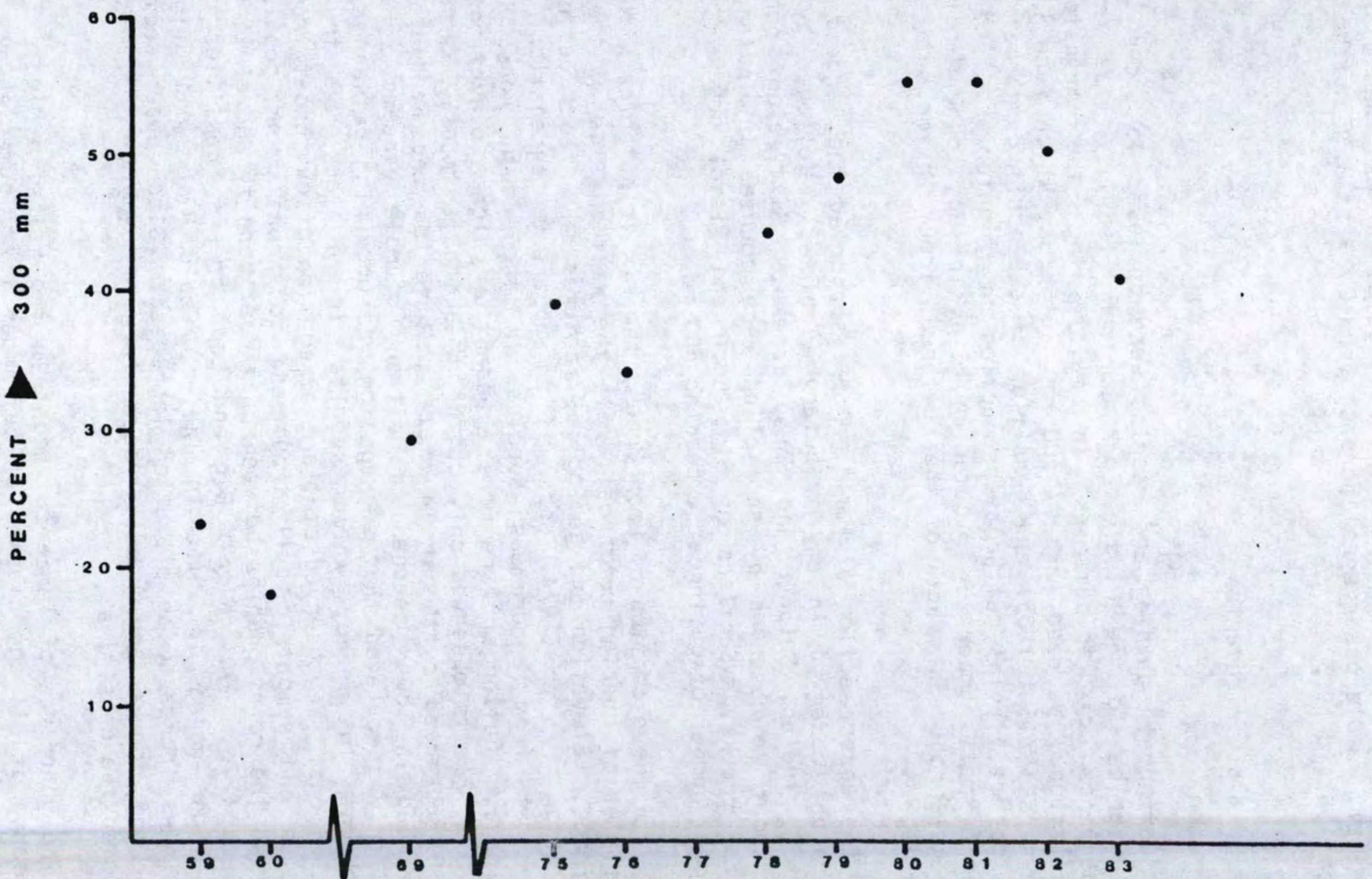

Figure 18. The percentage of cutthroat trout exceeding 300 mm from hook-and-line samples from the Middle Fork Salmon River, 1959-1983.

percentage of cutthroat larger than 300 mm also declined in the snorkel transects from 62% in 1980 to 53% in 1983 (Table 5).

One explanation for the decline in large cutthroat in the catch may be a continued increase in the younger age classes of the population. Although our snorkel transects were located in less than optimal cutthroat habitat, we did observe an increase from 0.19 to 0.35 cutthroat per 100 m^2 from 1981 to 1983.

The Role of Tributaries

Cutthroat spawning and rearing were believed to occur in most major tributaries to the Middle Fork (Ortmann 1969). This emphasized the importance of tributaries in maintaining the mainstem cutthroat population. We used large (>300 mm) cutthroat which were likely fluvial spawners (Mallet 1963) and densities of sub-adult cutthroat (<200 mm) as indices of fluvial cutthroat production in tributaries. The data suggest that a small number of tributaries (Big, Indian, Loon, Marble and Pistol creeks) produce the bulk of the cutthroat trout in the entire Middle Fork drainage.

The upper section of Marble Creek supported the largest densities of cutthroat observed in any tributary (Table 8), followed by sections of Pistol, Indian, Sulphur and Sheep creeks. Sixty-eight percent of the cutthroat we observed by snorkeling were counted in Indian, Marble and Pistol creeks. Sections of Big, Loon and Pistol creeks contained the largest number of cutthroat exceeding 300 mm.

With the exception of Loon Creek, the six tributaries with the largest densities of rearing cutthroat drain the western side of the Middle Fork drainage. Elevation and geological features may affect cutthroat rearing habitat. Platts (1974) observed an apparent segregation of westslope cutthroat from anadromous species in the South Fork Salmon River drainage. Cutthroat were more abundant at higher elevations, and above 2,070 m, Platts observed only cutthroat and bull trout. Hartman and Gill (1968) observed cutthroat in small tributaries and headwater areas and steelhead in lower reaches in British Columbia streams. Hanson (1977) similarly speculated that segregation was occurring between steelhead and cutthroat in Idaho, which results in a lack of true sympatric populations. We observed similar segregation of cutthroat from anadromous species and sympatric bull trout and cutthroat trout populations. We plotted the relationships between cutthroat density and elevation for five streams (Fig. 19). Within Big and Loon creeks, densities decreased as elevation increased; while in Indian, Rapid River and Sulphur creeks, densities increased as elevation increased. Since upper sections of Big and Loon creeks are readily accessible to anglers, harvest may have affected the densities.

The abundance of large cutthroat in the mainstem Middle Fork and the abundance of all age classes of cutthroat in tributaries may be affected by angler harvest of cutthroat in tributaries. With the exception of Big

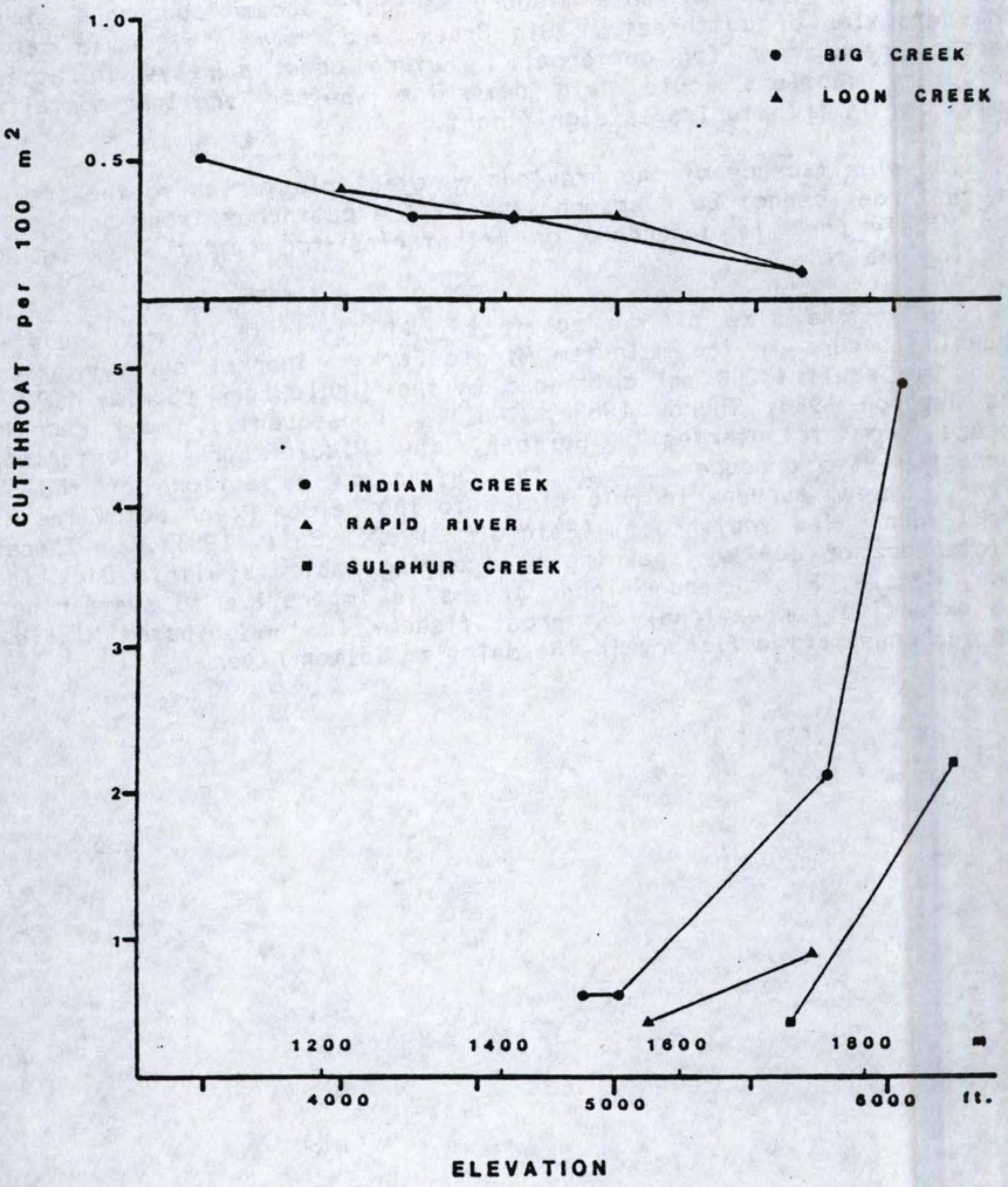

Figure 19. Cutthroat trout densities at various elevations in Middle Fork Salmon River tributaries, 1982-1983.

and Camas creeks, general angling regulations (six fish daily bag limit) are in effect on tributaries. Accessible tributaries in close proximity to private residences (Big, Loon, Pistol creeks) may receive extensive angler effort. Although we did not conduct angler surveys, we observed evidence of substantial angler effort in some tributaries. In 1982, Idaho Department of Fish and Game fishery managers became concerned about the low densities of cutthroat in Big Creek, and they initiated a catch and release regulation for cutthroat. Future creel surveys in accessible tributary sections would help determine whether angling mortality on cutthroat in tributaries is significant.

The significance of the previously noted tributaries to the production of cutthroat cannot be overemphasized. The cutthroat trout population in the Middle Fork is dependent on tributaries for cutthroat spawning and rearing habitats.

Due to the size of the substrate, it is unlikely that substantial spawning occurs in the mainstem Middle Fork. Snorkel surveys have also found few small (<200 mm) cutthroat in the Middle Fork (Corley 1972, Ball and Jeppson 1980, Thurow 1982a, 1983). Consequently, most recruitment occurs from tributaries. Further, the Middle Fork tributaries may currently also produce most of the cutthroat in sections of the Salmon River. Stream surveys in tributaries to the Salmon River below the Middle Fork found few cutthroat (Reingold 1982, Ball 1983). Therefore, maintenance of quality spawning and rearing habitats within Big, Indian, Loon, Marble, Pistol and Sulphur creeks is imperative to sustaining both the extensive recreational cutthroat fishery in the mainstem Middle Fork and the consumptive fishery in the mainstem Salmon River.

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APPENDICES

Appendix A

MANUAL FOR STEELHEAD
SPAWNING GROUND
SURVEYS

in

Tributaries to the
Middle Fork Salmon River

ABSTRACT

From 1981 to 1983 research personnel surveyed tributaries of the Middle Fork Salmon River to locate major steelhead spawning areas. Personnel categorized habitats, recorded timing of observations, counted numbers of redds and spawners, and obtained biological information on the spawners.

Spawning activities occurred between 15 April and 30 May with most spawners and redds observed between 1 and 20 May. Both ground and aerial surveys were effective in identifying spawners and redds when observation conditions were good.

Proposed steelhead spawning index areas are presented in a series of maps.

RECOMMENDATIONS

Annual surveys of index areas should be conducted, under the supervision of regional fishery managers.

Surveys should be conducted between 1 and 20 May with fixed-wing aircraft, helicopter, or on foot. Where possible, replicate surveys should be conducted which are separated by 10 to 15 days.

Where practical, ground counts should be used to monitor the size, sex ratio, and origin of spawners.

OBJECTIVES

To obtain trends in steelhead trout spawning escapements to the Middle Fork Salmon River drainage.

METHODS

Redd and spawner counts are made from low flying, fixed-wing aircraft, helicopter, or on foot; depending on access and time constraints. Individual redds and spawners are counted and their locations marked on detailed maps of index areas.

When ground surveys are used, observers can collect biological data on spawners including: size, sex ratio, and origin (wild or hatchery).

RESULTS

Counts of steelhead spawners and redds were conducted in 13 major Middle Fork Salmon River tributaries from 1981 to 1983. Spawning activities occurred between 15 April and 30 May with most spawners and redds observed between 1 and 20 May. When observation conditions were good, both ground and aerial surveys were effective.

Index areas were identified in eleven drainages (Fig. 1-11). With prior planning, aerial surveys of several index areas may be completed in a single day.

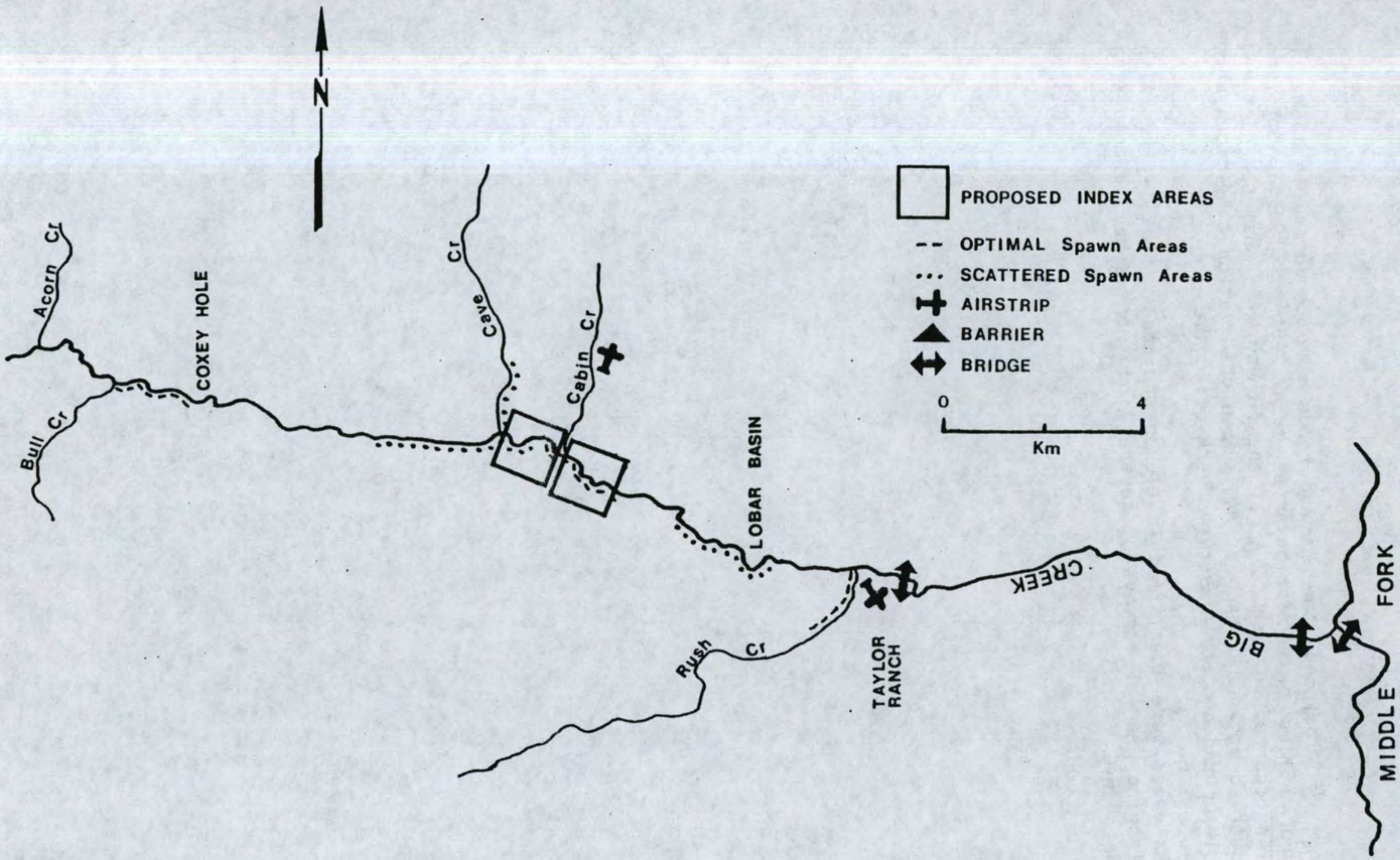

Figure 1. Spawning ground survey map of lower Big Creek, Middle Fork Salmon River, Idaho.

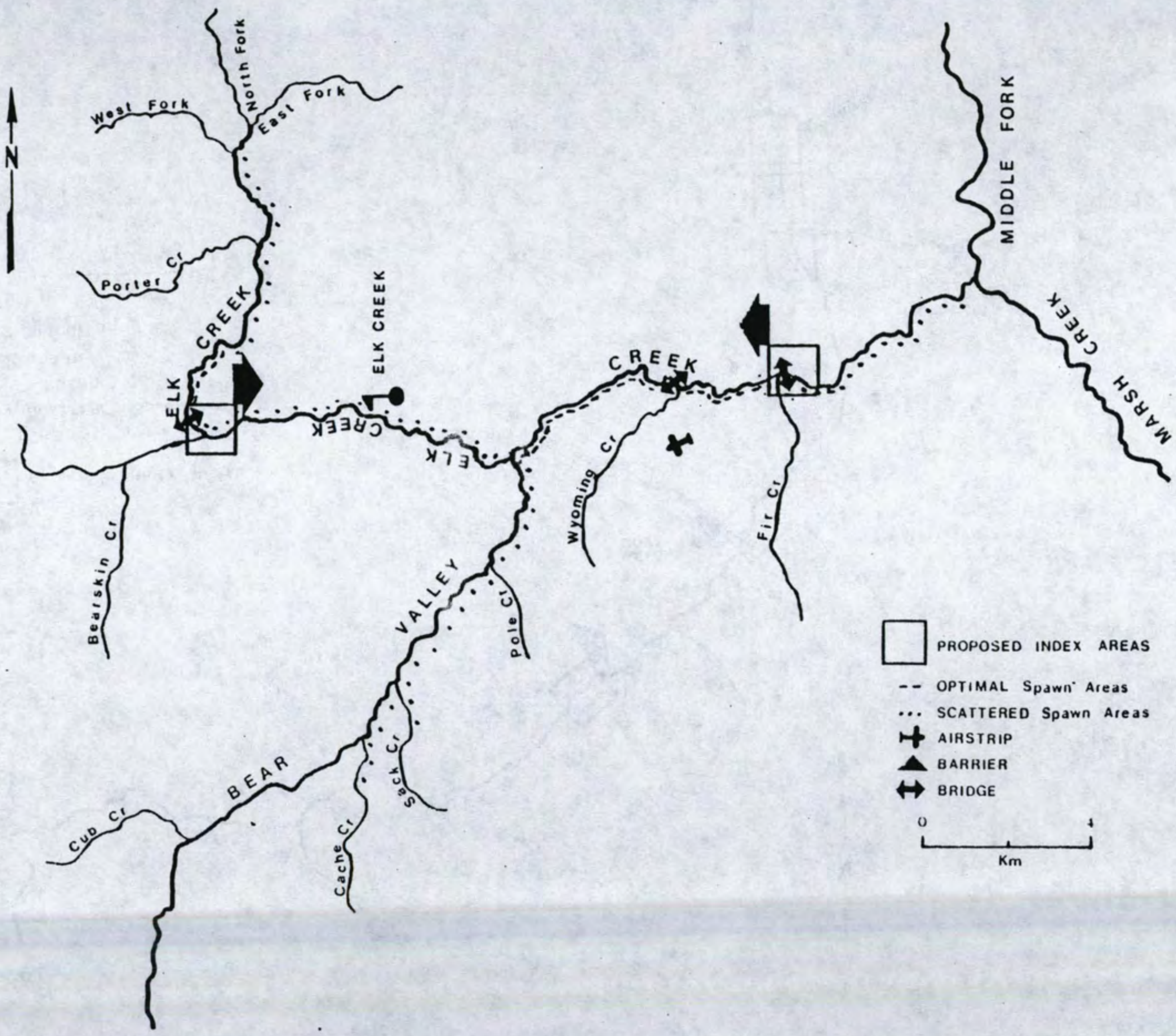

Figure 2. Spawning ground survey map of Bear Valley and Elk creeks, Middle Fork Salmon River, Idaho.

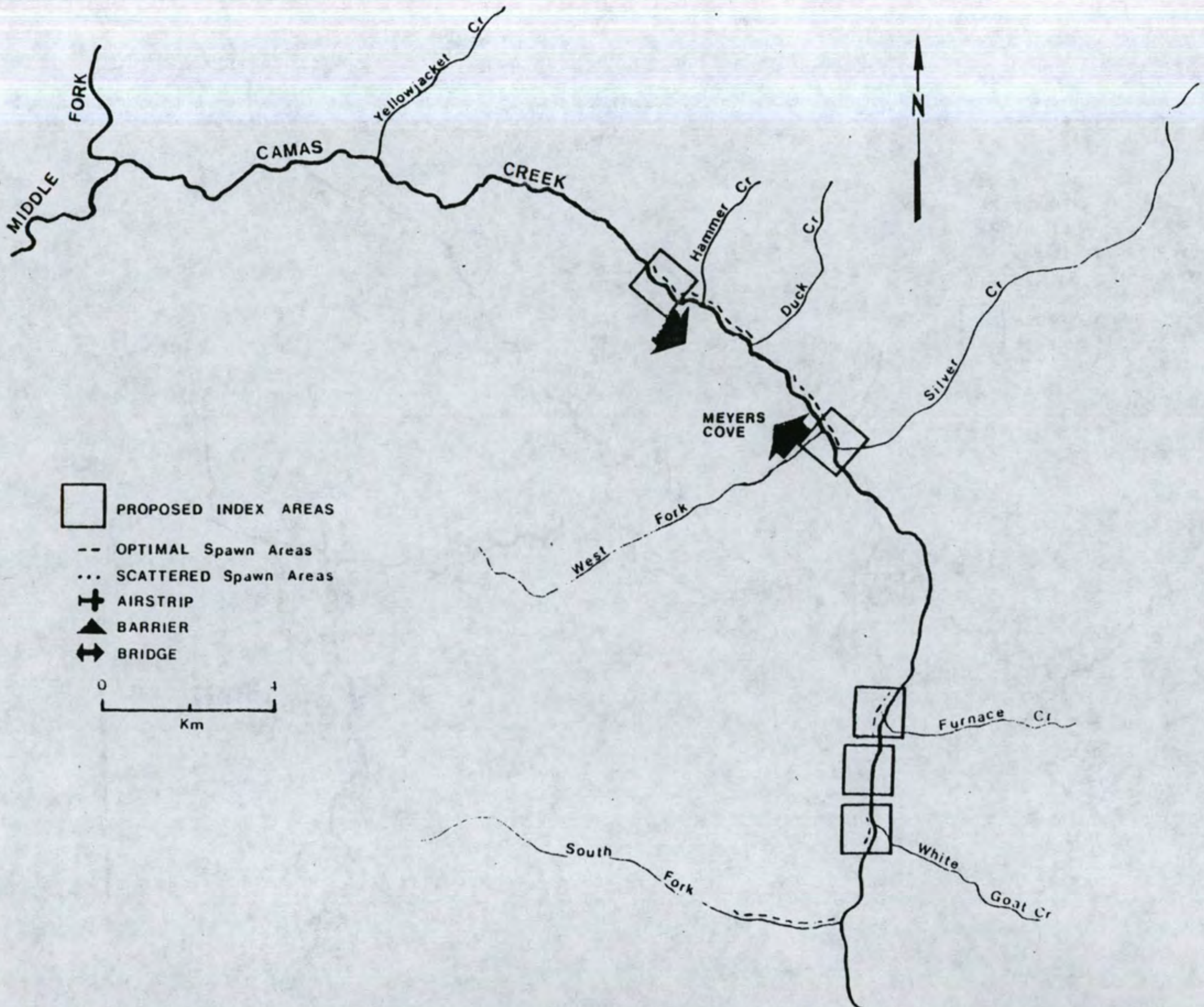

Figure 3. Spawning ground survey map of Camas Creek, Middle Fork Salmon River, Idaho.

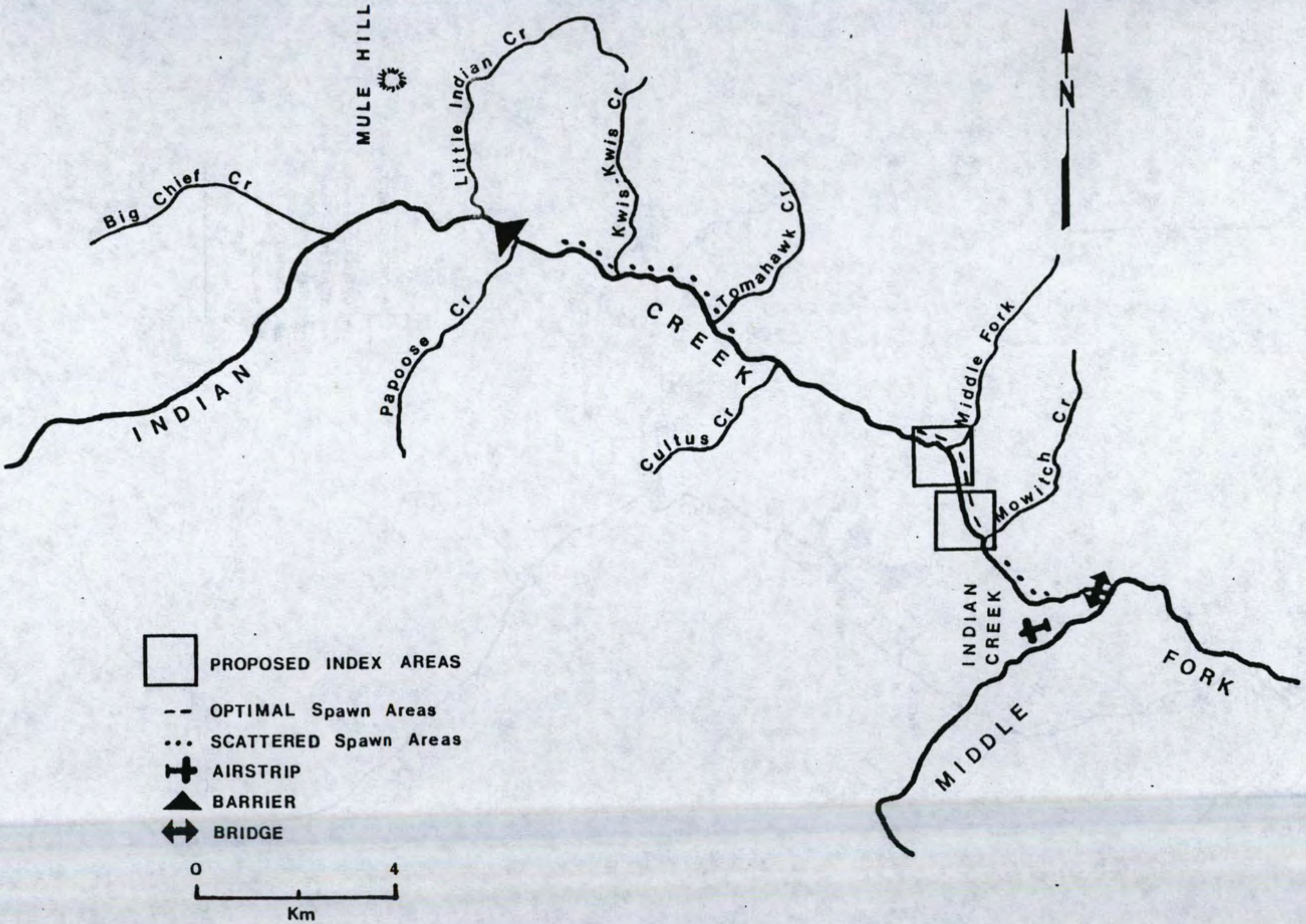

Figure 4. Spawning ground survey map of Indian Creek, Middle Fork Salmon River, Idaho.

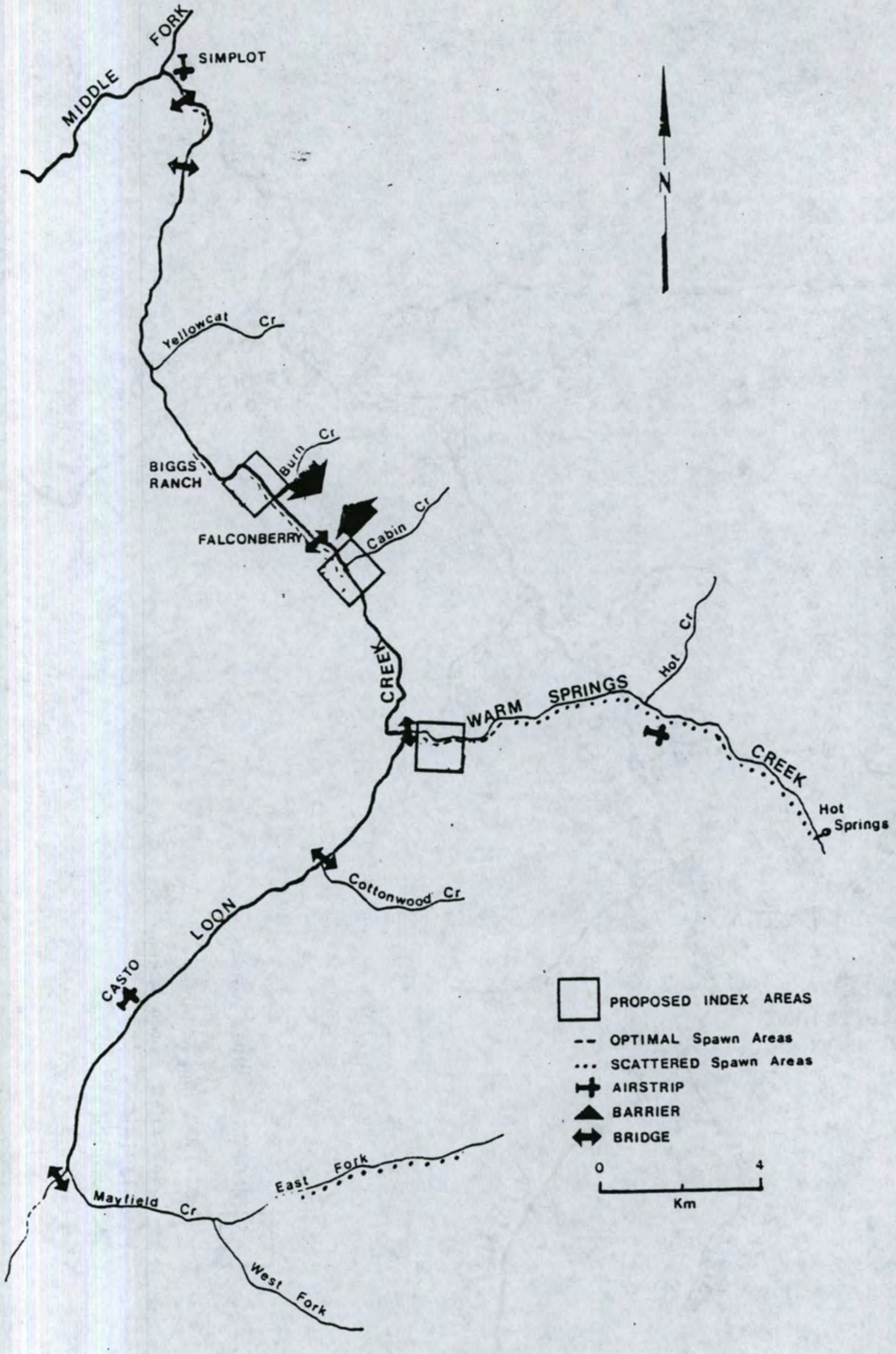

Figure 5. Spawning ground survey map of Loon Creek, Middle Fork Salmon River, Idaho.

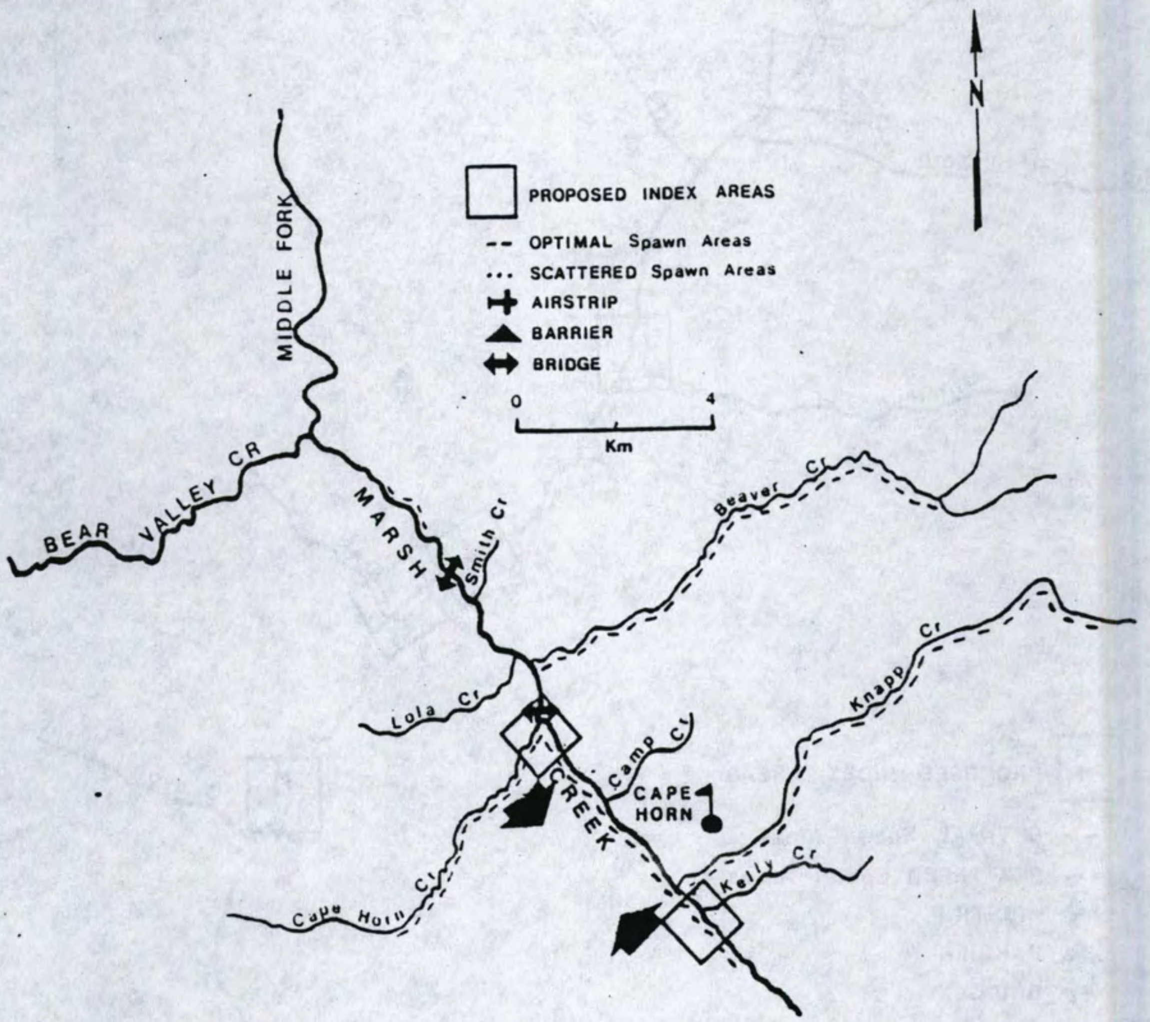

Figure 6. Spawning ground survey map of Marble Creek, Middle Fork Salmon River, Idaho.

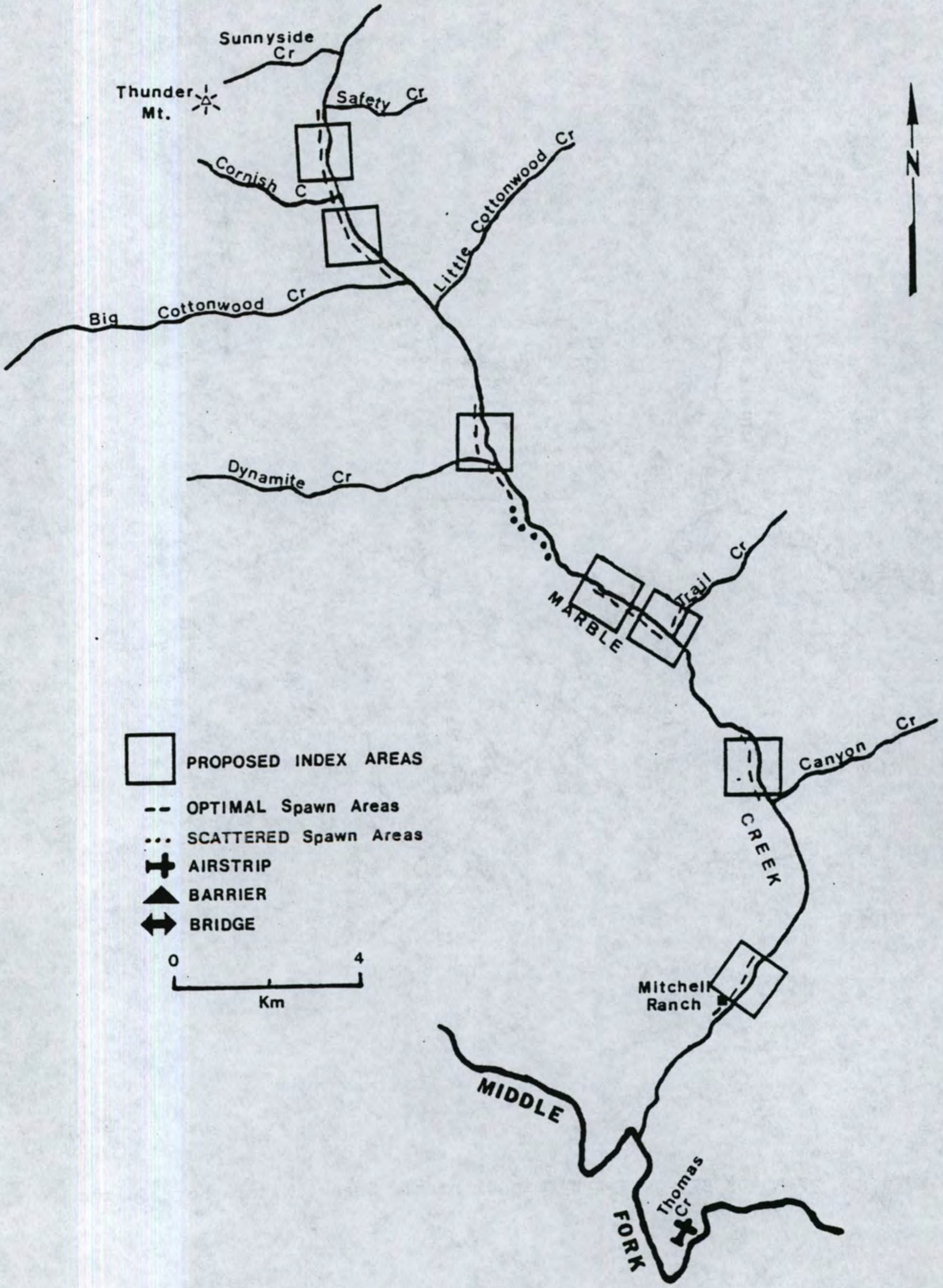

Figure 7. Spawning ground survey map of Marsh Creek, Middle Fork Salmon River, Idaho.

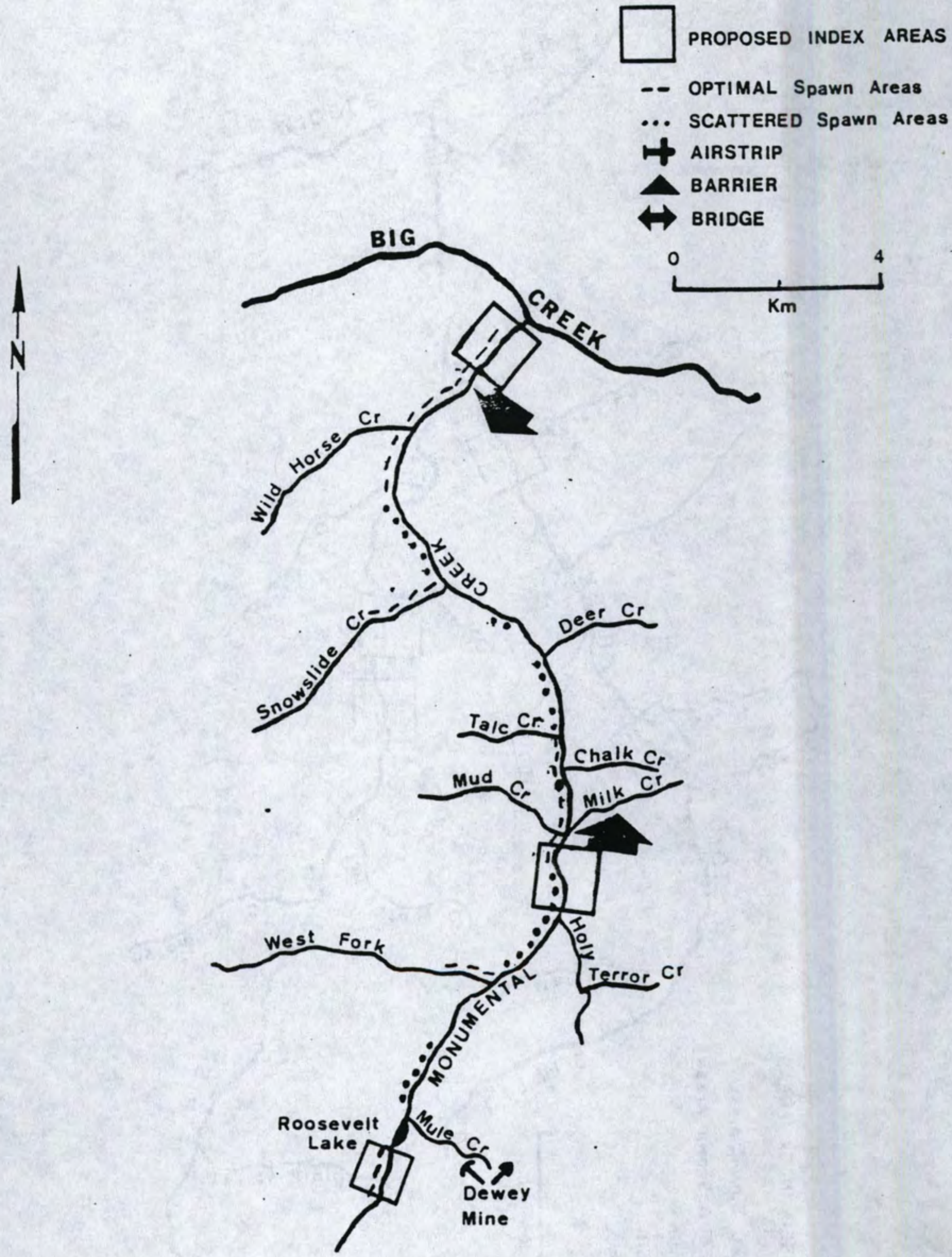

Figure 8. Spawning ground survey map of Monumental Creek, Middle Fork Salmon River, Idaho.

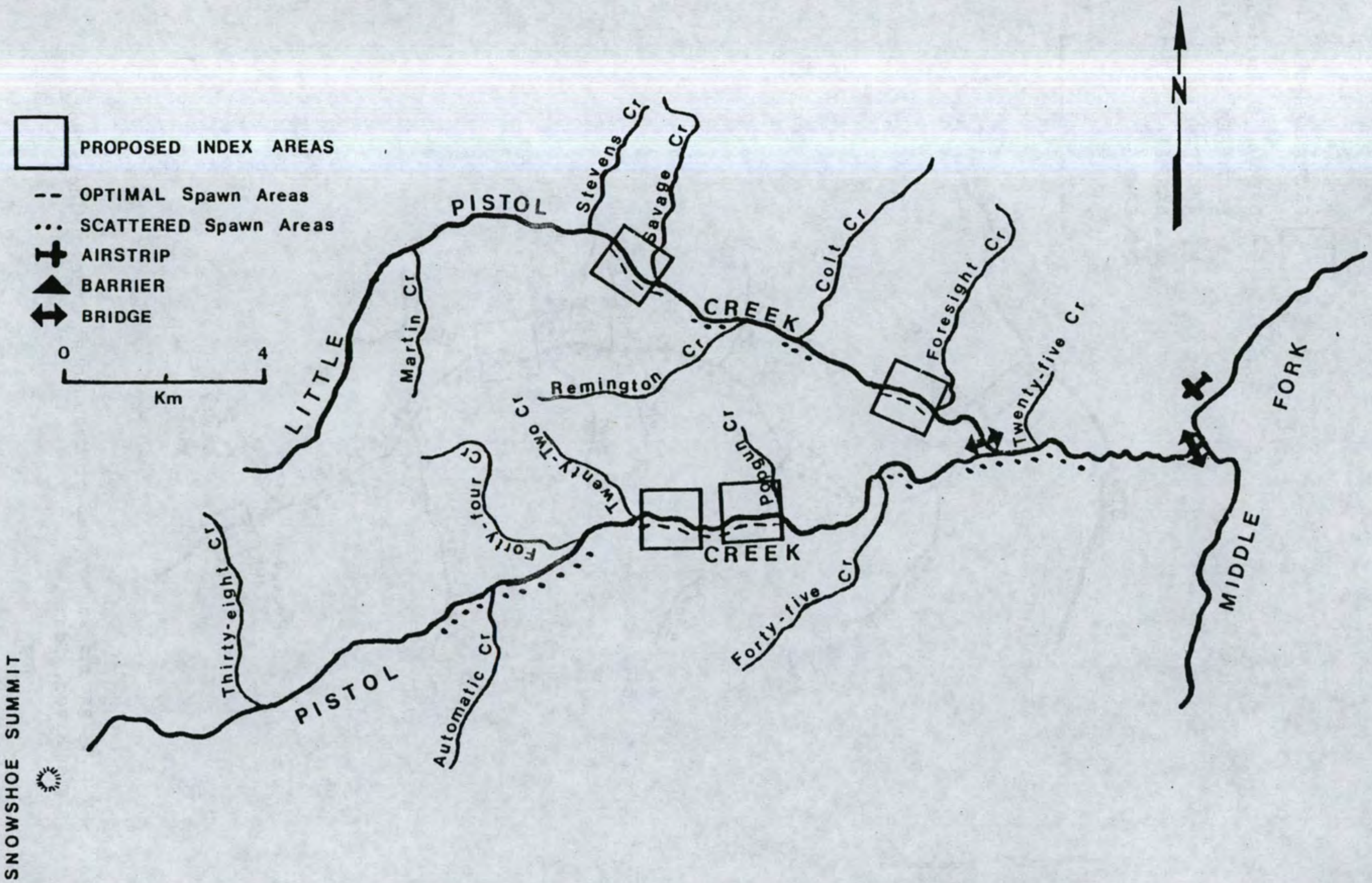

Figure 9. Spawning ground survey map of Pistol Creek, Middle Fork Salmon River, Idaho.

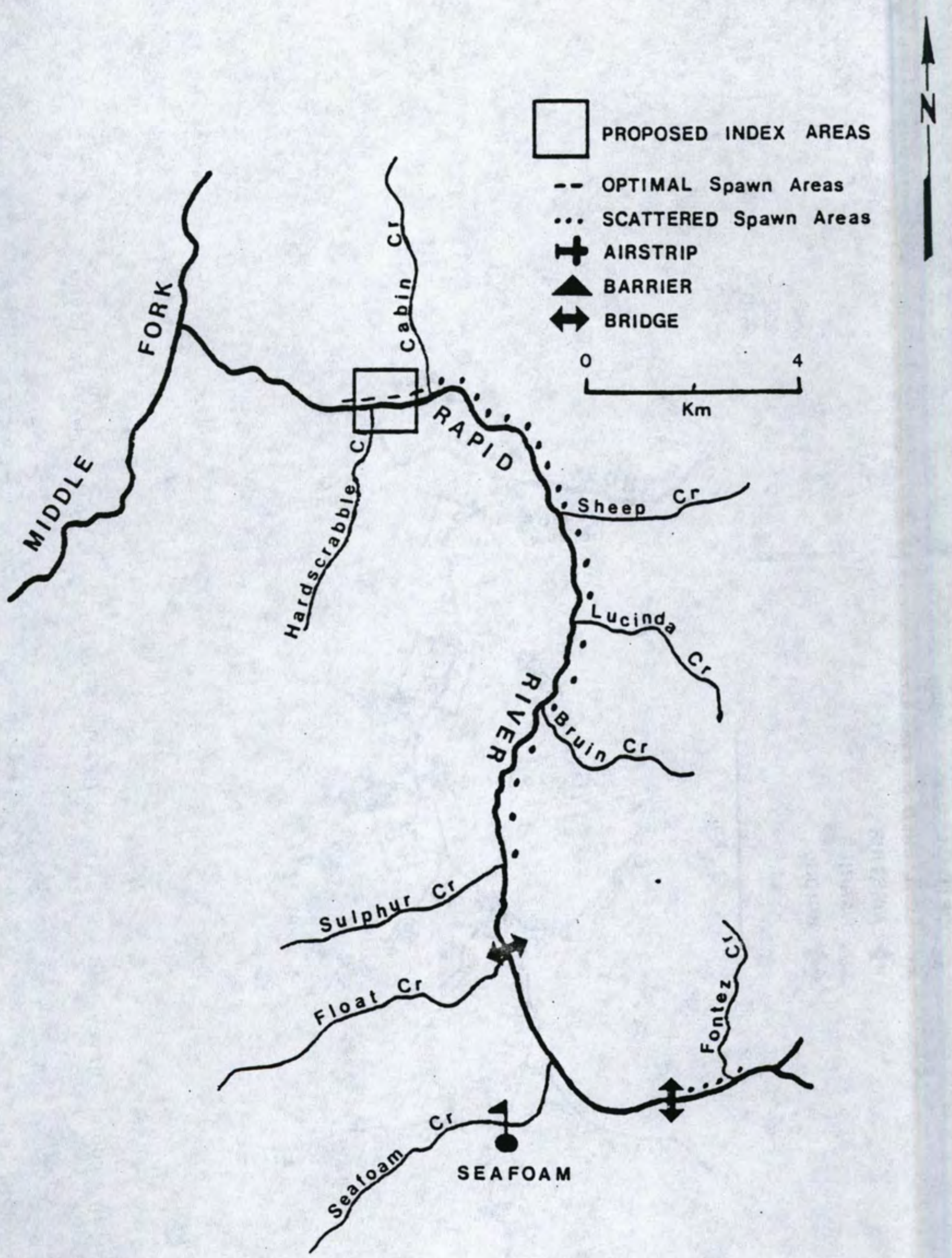

Figure 10. Spawning ground survey map of Rapid River, Middle Fork Salmon River, Idaho.

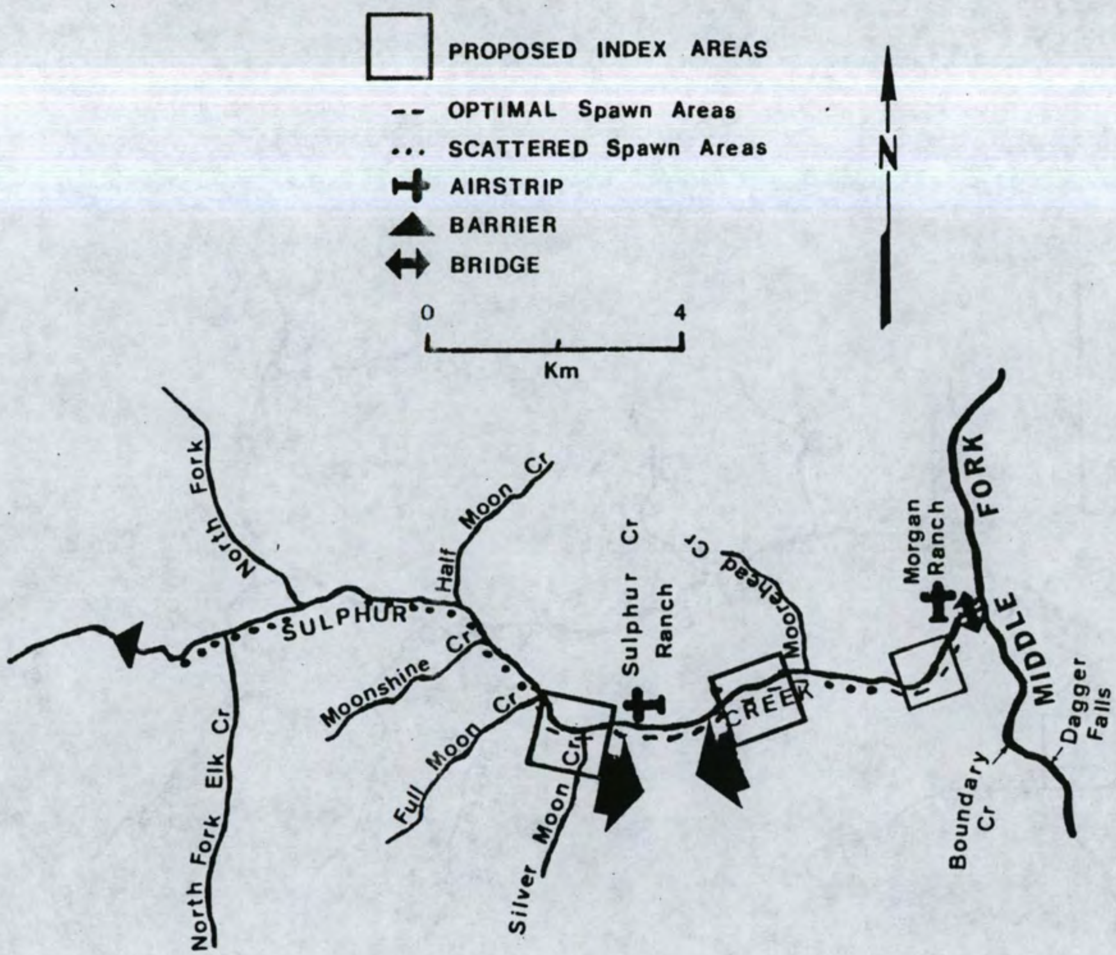

Figure 11. Spawning ground survey map of Sulphur Creek, Middle Fork Salmon River, Idaho.

Appendix B. Data collected during steelhead spawner surveys (ground and aerial) on Middle Fork Salmon River tributaries, April-May 1983.

	Ground	Stream reach surveyed		Observations	
Stream	surveys	location	kilometers	spawners	redds
Camas Cr.	30 April	West Fork (mouth to Pole Creek)	8.9	0	0
	30 April	1 km above Meyers Cove to Hammer Creek.	7.4	0	0
	1 May	Hammer to Yellowjacket Creek	10.4	4(2P)	3
	1 May	Yellowjacket Creek (mouth to upstream)	1.6	0	0
Brush Cr.	20 April	Mouth to 0.8 km above Horn Creek	6.9	0	0
Sheep Creek	21 April	Mouth upstream to spike camp	6.6	0	0
Wilson Creek	22-23 April	Mouth upstream to boulder slide	4.2	0	0
Marble Creek	3 May	Mouth to Canyon Creek	9.4	0	0
	4 May	Canyon Creek to 0.5 km below Buck Creek	14.4	1	1
	5 May	Trail Creek	2.0	0	0
	6 May	Canyon Creek to mouth	9.4	0	0
Monumental Creek	17 May	Talc Creek to 1 km above Roosevelt Lake	14.7	5(3P)	5
	18 May	Talc to Cold Springs Creek	10.2	4	6
	18 May	Snowslide Creek (mouth upstream)	3.5	0	3
	19 May	Cold Spring Creek to mouth	6.3	3	3
Crooked Creek	19 May	Mouth upstream	2.4	0	0
Big Creek	19 May	Monumental bridge to Coxey Hole	16.2	5(1P)	7
	20 May	Coxey Hole to Cabin Creek	8.0	0	1
	20 May	Cave Creek (mouth upstream)	1.6	0	0
Yellowjacket Creek	25 May	0.5 km below Camp Creek to guard station	18.7	0	0
GRAND TOTALS			162.8	22	29

P=precocial male (170 to 230 mm)

Appendix B. Continued.

Stream	Aerial surveys	Stream reach surveyed: location	Stream reach surveyed: kilometers	Observations: spawners	Observations: redds
Camas Creek	3 May	South Fork (mouth upstream)	2.4	0	0
	3 May	South Fork to 2 km below Hammer Creek	23.5	4	5
	19 May	South Fork (mouth upstream)	2.4	0	0
	19 May	South Fork to 2 km below Hammer Creek	23.5	0	10
Yellowjacket Creek	3 May	Guard station to mine	2.5	0	0
	19 May	Guard station to mine	2.5	0	0
Loon Creek	3 May	Cabin Creek to Burn Creek	3.0	0	1
	19 May	Cabin Creek to Burn Creek	3.0	0	3
East Fork Mayfield	19 May	Mouth upstream	4.8	0	0
Big Creek	14 May	Monumental Creek to Taylor Ranch	35.4	1	5
	14 May	Rush Creek	1.6	0	0
Monumental Creek	14 May	Mouth to Roosevelt Lake	31.2	0	0
Marble Creek	12 May	Safety Creek to Cottonwood Creek		0	0
	12 May	Buck Creek to Placer Creek	31.1	0	0
	12 May	Mink Creek to Trail Creek		0	0
	12 May	Trail Creek to Canyon Creek		0	0
Indian Creek	12 May	0.8 km above Middle Fork Indian Creek to Mowitch Creek	4.0	0	0
Rapid River	12 May	0.8 km above Cabin Creek to Hardscrabble Creek	3.2	0	0
GRAND TOTALS			174.1	5	24

Appendix C. Physical dimensions and characteristics of snorkeling transects in the Middle Fork Salmon River, 2-9 August 1983.

Transect	Location	Date surveyed	Length (m)	Visibility (m)	Surface area snorkeled (m^2)	°C temperature
1	Boundary Creek	2 Aug	65	6.3	1638	13.0
2	Ramshorn	2 Aug	105	6.3	1323	14.5
3	Elkhorn	3 Aug	91	7.0	2548	13.0
4	Sheepeater Hot Springs	3 Aug	90	7.0	1260	14.5
5	Rapid River	3 Aug	124	7.0	3472	16.0
6	Indian Creek	4 Aug	116	3.9	1810	13.0
7	Marble Creek	4 Aug	181	3.9	2824	14.0
8	Hood Ranch	4 Aug	105	3.9	1638	14.0
9	Cougar Ranch	5 Aug	135	4.1	2214	16.5
10	Whitey Cox	5 Aug	105	2.8	588	18.5
11	Hospital Bar	6 Aug	161	3.3	2125	15.5
12	Tappan Falls	6 Aug	124	3.3	1637	18.0
13	Camas Creek	6 Aug	124	2.9	1438	19.0
14	Flying "B"	7 Aug	115	4.6	2116	17.0
15	Driftwood	7 Aug	105	4.6	1932	18.5
16	Survey	7 Aug	114	4.6	2098	19.5
17	Elk Bar	8 Aug	101	4.6	1858	18.5
18	Ship Island Creek	8 Aug	163	4.2	2738	19.0
19	Little Ouzel	9 Aug	164	4.8	3148	19.0
20	Goat Creek	9 Aug	82	4.8	1574	19.5

Appendix D. Length frequency of juvenile steelhead and cutthroat trout caught by angling in the Middle Fork Salmon River and tributaries, 1983.

Length range (millimeters)	Number of Fish: Middle Fork Steelhead	Middle Fork Cutthroat	Tributaries Steelhead	Tributaries Cutthroat
80-89	--	--	1	3
90-99	1	--	9	4
100-109	--	--	10	10
110-119	4	--	21	16
120-129	5	--	35	22
130-139	5	--	64	16
140-149	6	1	93	22
150-159	20	4	89	17
160-169	30	2	98	21
170-179	37	3	94	16
180-189	35	7	81	8
190-199	40	14	47	14
200-209	30	8	50	2
210-219	20	12	20	1
220-229	12	18	16	3
230-239	5	6	5	--
240-249	6	18	6	1
250-259	1	14	7	--
260-269	--	13	--	--
270-279	1	8	1	--
280-289	5	16	--	--
290-299	1	12	--	--
300-309	1	15	--	--
310-319	1	18	--	--
320-329	--	18	--	1
330-339	--	17	--	--
340-349	--	13	--	1
350-359	--	9	--	--
360-369	--	7	--	1
370-379	--	5	--	1
380-389	--	4	--	1
390-399	--	2	--	--
400-409	--	1	--	--
410-419	--	--	--	--
420-429	--	--	--	--
Totals	266	265	747	181

Appendix E. Mean dimensions of snorkeling transects (mean of 5) in Middle Fork Salmon River tributary sections, 1983.

Stream	Section	Date	Temperature range °C	Transect measurements (m) Length	$\bar{x}$ width	Surface area	$\bar{x}$ thalweg depth	Boulder	Rubble	Gravel	Sand
Yellowjacket Creek	Lower	19-20 July	10.5-12.0	35.9	8.8	317	0.79	10-15	60-70	15-25	5
Marble Creek	Upper	22-24 July	11-14	44.3	3.2	142	0.24	5	50-60	30-50	5-10
	Sunnyside Cr.	22 August	12	18.1	1.2	22	0.10	5	60	30	5
	Cornish	23 August	10	20.0	2.2	44	0.20	0	15	75	10
Sheep Creek	Lower	29 July	12-13	39.6	4.3	171	0.32	5-10	60-70	15-30	5
Sulphur Creek	Lower	29 August	13.5-14.5	42.4	10.7	454	0.61	15-20	55-75	15-30	5
	Upper	31 August	10-13	33.7	5.5	190	0.45	10-30	40-50	30-50	5-10
Wilson Creek	Lower	27 July	12-13	37.8	7.6	290	0.58	10-20	60-65	10-20	5
	Upper	25-26 July	12-13	37.5	6.9	260	0.63	15-25	65-70	5-10	5

Submitted by:

Russ Thurow
Senior Fishery Research Biologist

Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

Jerry M. Conley, Director

Monte R. Richards, Chief
Bureau of Fisheries

David W. Ortmann
Fishery Research Supervisor