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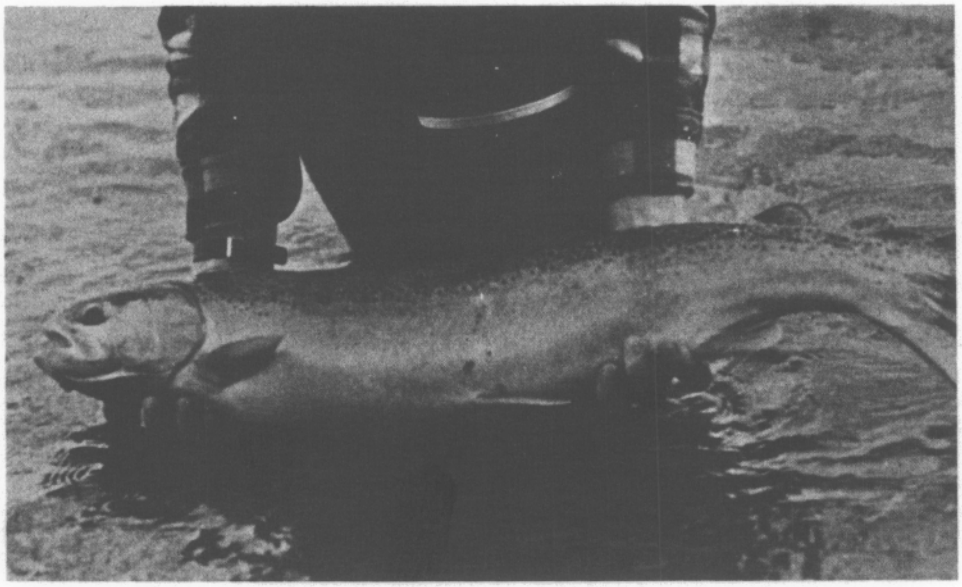
Job Performance Report, Project F-73-R-5
Subproject IV: River and Stream Investigations
Study X: Middle Fork Salmon River Fisheries Investigations



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November 1983

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JOB PERFORMANCE REPORT

State of: Idaho

Name: RIVER AND STREAM INVESTIGATIONS

Project: F-73-R-5

Title: Middle Fork Salmon River Fisheries Investigations

Subproject: IV

Study: X

Period Covered: 1 March 1982 - 28 February 1983

ABSTRACT

Fisheries investigations were continued in the Middle Fork Salmon River drainage in 1982 to evaluate the status of the wild steelhead population. Emphasis was directed on collecting biological data to assist future management of the steelhead resource.

Conditions were unfavorable for spring visual surveys of spawning areas as a result of a large snowpack. As in 1981, streams exhibited an abundance of suitable spawning substrate and most spawners and redds were observed between 1 and 15 May.

Numbers of juvenile steelhead in the Middle Fork transects were similar in 1981 and 1982. Densities remained small, averaging 0.25 fish per 100 m^2 surface area snorkled.

Densities of juvenile steelhead in tributaries ranged from 0.8 to 4.0 fish/100 m and were comparable to densities in underseeded streams. Bear Valley, Elk, and Marsh creeks support limited "pocket-water" habitat which steelhead apparently prefer. Indian Creek, Pistol Creek, and Rapid River support extensive juvenile steelhead rearing habitat.

As we observed in 1981, westslope cutthroat trout were uncommon in many sections of the tributaries. Upper sections of Indian and Pistol creeks supported the largest cutthroat populations. Bull trout populations were usually sympatric with cutthroat. Indian Creek supports a resident cutthroat population above a barrier falls.

Wild steelhead destined for the Middle Fork were observed in the lower 0.8 km of the Middle Fork by 30 August. Few steelhead ascended the Middle Fork in fall and the farthest upstream progress we observed was 14.5 km. Steelhead stage in the lower 400 m of the Middle Fork in large numbers during March and April and they are extremely vulnerable to angling.

Steelhead trout populations in Middle Fork Salmon River tributaries were electrophoretically examined. The Middle Fork stocks are similar to other inland steelhead trout populations sampled in the Snake and Middle Columbia rivers. The data also indicates that locally-isolated populations of summer steelhead trout exist within the Middle Fork Salmon River drainage.

Otolith nuclei were investigated as a means of distinguishing juvenile steelhead trout from juvenile rainbow trout. Populations analyzed from Big and Loon creeks exhibited otolith characteristics of juvenile steelhead trout.

Anglers harvested an estimated 885 Middle Fork stock steelhead in Salmon River, section 4 and 905 Middle Fork stock steelhead in Salmon River, sections 1, 2, and 3 during the fall 1981/spring 1982 fishery for an exploitation rate of 47%.

A differential harvest regulation based on a 57 nun (2.25 in) dorsal fin measurement was instituted during the fall 1982 fishery in section 4, which allowed anglers to harvest hatchery fish while releasing a majority of the wild fish. Section 4 anglers enjoyed improved catch rates and an estimated 540 Middle Fork stock steelhead were released, while 40 were creeled, during the fall fishery.

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INTRODUCTION

Fisheries investigations were continued in the Middle Fork Salmon River drainage in 1982 to evaluate the status of the wild steelhead populations. Emphasis was directed on collecting biological data to assist future management of the steelhead resource.

OBJECTIVES

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

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

To assess the abundance, distribution, and population structure of cutthroat trout and juvenile steelhead 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 steel head stocks.

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

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

RECOMMENDATIONS

1. Maintain differential harvest regulations on sections 1-4 of the Salmon River to increase escapements of wild steelhead into the Middle Fork.

2. Continue fish culture practices which result in recognizable fin deformities on returning hatchery steelhead until most hatchery smolts can be fin clipped.

3. Review the status of mass-marking techniques in order to develop a suitable methodology for marking juvenile steelhead of hatchery origin.

4. Collect additional creel census data in Salmon River sections 1 through 3.

5. Work with USDA-FS personnel on the Sawtooth National Forest to improve grazing management programs in the Marsh Creek drainage in order to restore aquatic habitat.

6. Removal of the barrier falls in Indian Creek is not presently warranted. The isolated westslope cutthroat population above the falls may warrant further investigation.

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 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).

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

Most of the Middle Fork drainage and its aquatic habitat lies in a pristine wilderness state. Within the 1982 study streams, human activity has significantly altered sections of Marsh and Bear Valley creeks. The Northwest Power Planning Council lists proposed habitat enhancement projects in Marsh, Bear Valley, and Elk creeks (NPPC, 1982).

Grazing of livestock in areas adjacent to Marsh Creek has taken place annually for many decades (May and Somes 1982). Within areas used by cattle, May and Somes reported a low degree of bank stability, disturbance of stream banks due to trampling by cattle, and reduction of overhanging grasses, sedges, and undercut banks (Fig. 2). Macro-invertebrate sampling indicated that disturbances had affected aquatic insect populations. The biologists also observed evidence of actual chinook salmon redd disturbance at livestock stream crossings. Aquatic habitat in some tributary streams entering Marsh Creek were found to be disturbed by road construction and irrigation.

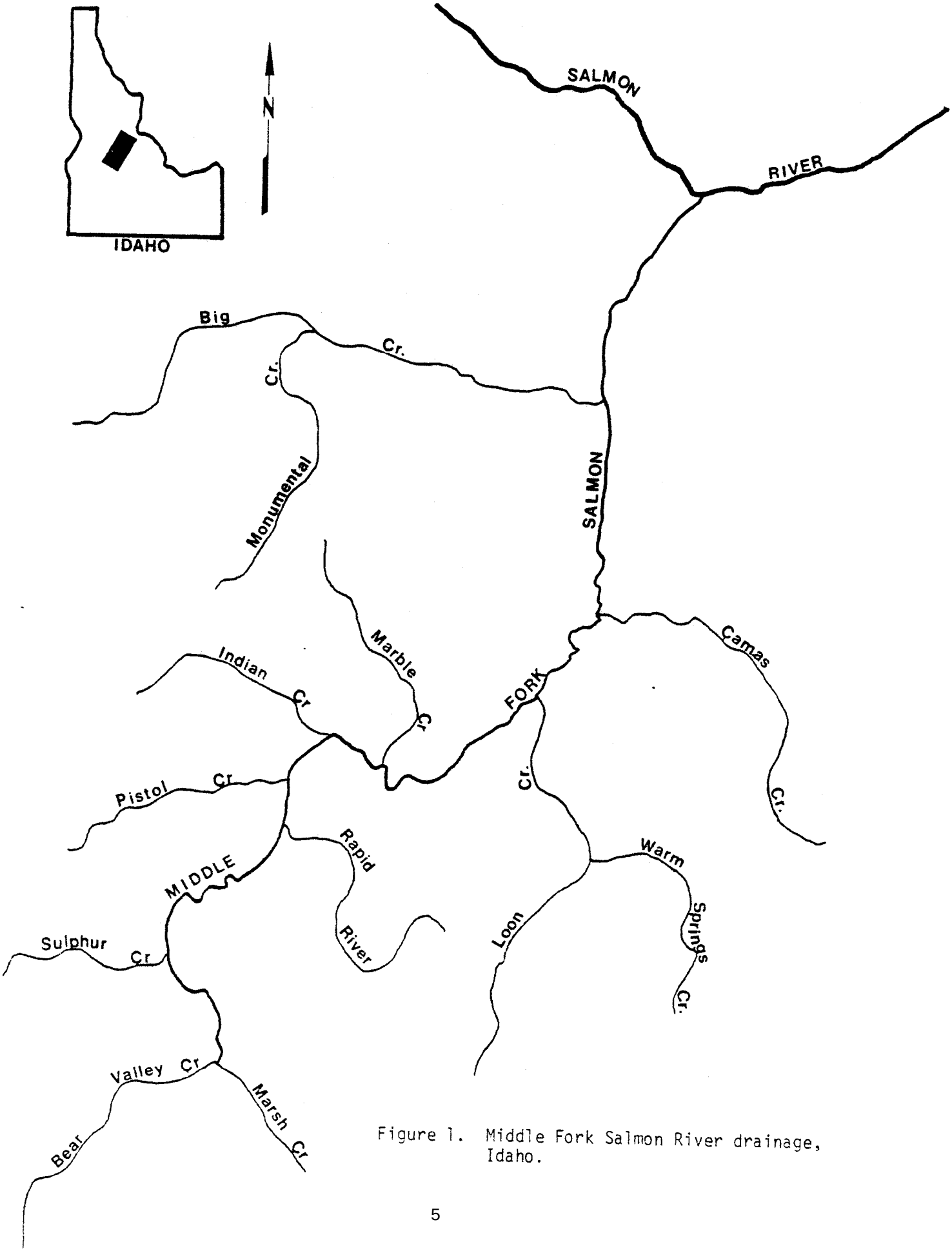

Figure 1. Middle Fork Salmon River drainage, Idaho.

Figure 3. Sand deposited in Bear Valley Creek near Sack Creek as a result of historical mining activities and livestock grazing, July 1982.

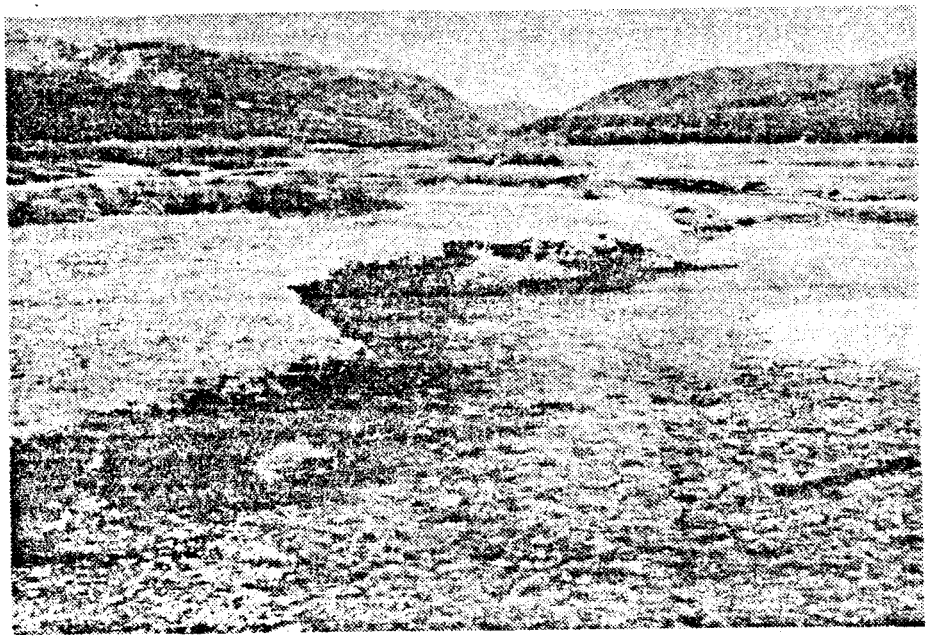

Figure 2. Aquatic habitat impacted by livestock use in upper Marsh Creek, Oct. 1979.

In 1950, mining exploration began in Bear Valley Creek and in 1954 a gold dredging operation was started in its headwaters (Gebhards 1959, Platts 1968). The operation resulted in sedimentation and destruction of habitat in Bear Valley Creek and the Middle Fork Salmon River. Platts estimated that 13 hectares of salmonid spawning area were destroyed. Although the dredging has terminated, Gebhards and Platts reported that poor settling pond management and breaching of the canal system has resulted in annual flows of sediment into Bear Valley Creek. Grazing by livestock has also degraded riparian habitat in Bear Valley and Elk creeks. Platts believed that livestock use could be the largest factor contributing to destruction of aquatic habitat in Bear Valley Creek. In August 1982, we observed extensive areas of Bear Valley Creek which were covered with fine sand and silt (Fig. 3).

TECHNIQUES USED

Spawning Area Surveys

We visually surveyed and fished sections of the Camas, Indian, Loon, Pistol, and Little Pistol Creek drainages between 27 April and 15 May. Surveys encompassed 106 km of stream and included six ground trips and one aerial trip. We mapped stream sections, counted spawners and redds, and recorded biological data on fish captured or observed.

Juvenile Distribution and Abundance

Abundance of juvenile steelhead was assessed using snorkeling counts of fish in established transects as described by Thurow (1982). Twenty transects were counted in the Middle Fork between Boundary Creek and the Salmon River. New transects were established and snorkeled in the Bear Valley, Indian, Marsh, and Pistol Creek drainages and in the Rapid River drainage. Juvenile steelhead were classified by length at Age I+ (70-130 mm), Age II+ (130-200 mm), and Age III+ (>200mm).

Size of Juveniles

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 in 1982.

Origin of Wild Steelhead

Angling gear was used to collect 60 juvenile steelhead from Big Creek and 100 juvenile steelhead from Marble Creek. We collected the Big Creek fish to supplement a small sample in 1981. Samples were frozen as soon as possible, packed in dry ice, and shipped to a research lab for analysis. Laboratory personnel extracted one eye, a piece of liver, and muscle tissue for electrophoretic analysis. Samples were screened for several genetic loci and 30 were consistently resolved (Appendix A).

Otolith nuclei were investigated as a means of distinguishing juvenile steelhead trout from juvenile rainbow using the techniques of Rybock et al. (1975) and McKern et al. (1974). We obtained otoliths from fish collected **in** Big and Loon creeks in 1981 (Thurow 1982) by splitting the cranium and extracting the otolith. Otoliths were stored dry in scale envelopes. Prior to examination, otoliths were placed in tap water to allow reabsorption of water and clearing. A binocular microscope was used to examine otoliths on a black background under reflected light. Improved readings were obtained by placing otoliths in HC1 in order to thin the otolith and allow clearer definition as Rybock observed. Otoliths were placed lateral surface up and the nucleus located. With the aide of an ocular micrometer, we measured the length of the opaque nucleus as Rybock describes.

Adult Steelhead Movements

During the spring of 1982, we captured adult steelhead in the Middle Fork and main Salmon rivers with angling gear and attached numbered tags to their mandibles. To obtain timing and movement data, we re-fished areas of the Middle Fork. Informational signs explaining the tag program were posted and all angler-creeled fish were checked for tags.

In the fall of 1982, we floated the Middle Fork from the Flying "B" downstream beginning on 28 September, 13 October, and 26 October. We used angling gear to assess the presence of adult steelhead and snorkeled "optimum" adult steelhead holding water.

Main Salmon River Sport Fi.s.hery

In the fall of 1982, we operated a check station on the Salmon River at the mouth of the Middle Fork to monitor the steelhead fishery in section 4. We operated the station as Thurow (1982) describes and interviewed anglers randomly between 18 September and 19 November. Total angler effort and catch were estimated for two 2-week intervals and compared to 1981 levels during the same time period.

A jet boat was used to monitor the steelhead fishery in the roadless area below Corn Creek. The jet boat fishery was monitored by :

1. interviewing anglers at the Middle Fork check station;
2. conducting field checks of anglers; and
3. gathering data compiled by cooperating outfitters.

FINDINGS

Spawner Characteristics and Densities

Due to variable water conditions; springtime visual surveys of spawning areas do not provide estimates of actual spawner abundance. They do provide information on timing and location of spawners in addition to biological data characterizing spawners.

In contrast to 1981 (Thurow 1982), larger-than-average snow-pack produced unfavorable survey conditions in 1982. We surveyed 76 km of Camas, Loon, Indian and Pistol creeks in replicates between 27 April and 15 May (Table 1). Visibility was unsatis-factory during most surveys as a result of turbid, rising water conditions.

We observed two steelhead and three redds for an average density of one spawner per 38 km surveyed (Table 1). Aerial surveys covered an additional 30 km and we observed four spawners and two redds. As we observed in 1981, streams exhibited an abundance of suitable spawning substrate and most spawning and redds were observed between 1 and 15 May.

Table 1. Data collected during steelhead spawning ground surveys on Middle Fork Salmon River tributaries, April-May, 1982.

Stream	Date surveyed	Stream reach surveyed location	kilometers	Observations spawners	spawners/km	redds	Location of suitable spawning areas
Camas Creek	14 May	Hammer Cr. to 2 km above Meyers Cv.	8.4	0	0	3	Entire section
	15 May	1 km above Meyers Cove to Castle Cr.	4.0	0	0	0	Scattered throughout
	14 May	Castle Cr. to 1 km above South Fork Camas	11.1	0	0	0	Scattered below Furnace Cr. Between Furnace and White Goat Or. Excellent between White Goat Cr. and So. Fk. Camas.
	14_May	South Fork Camas Creek	1.0	0	0	0	Scattered throughout ,
		Totals	24.5	0	0	3	
Indian Creek	77 April	Mouth to Cultus Creek	6.3	0	0	0	Scattered toO.5 km below Mowitch Cr. Between Mowitch Cr. and Middle Fork Indian Cr. limited, primarily juvenile rearing area to Cultus Cr.
		Totals	6.3	0	0	0	
Pistol Creek	29, 30 April	mouth to Popgun Creek	9.6	1	0	0	Scattered areas to 32 Cr. Improved, 32 to Little Pistol Cr. Limited, primarily juvenile rearing area to Beansnapper Cr. Improved, to Popgun Cr.
Little Pistol Cr.	30 April	mouth to Colt Creek	5.4	0	0	0	Scattered areas to Foresight Cr. Excellent within 1 km above Foresight Cr. Scattered to Colt Cr.
Pistol Cr.	5, 6 May	mouth to Popgun Cr.	9.6	0	0	0	(see above)
	5. 6 May	Popgun Cr. to Luger Cr.	8.4	0	0	0	Excellent Popgun to 22 Cr. Limited 22 to 44 Cr. Scattered 44 to Luger Cr.
	7 May	mouth to Little Pistol Creek	4.2	1		0	(see above)

Table 1 (continued).

Stream	Date surveyed	Stream reach surveyed location	kilometers	Observations spawners	spawners m	redds	Location of suitable spawning areas
Little Pistol Cr.	6 May	mouth to 1.5 km above Remington Cr.	8.1	0	0	0	Scattered, abundant juvenile rearing habitat
		iota s		-2-	.04	0	
		(wand Total	(76.11	2	.03	3	
			AERIAL SURVEYS				
Camas Creek	13 May	Hammer to J. Fell Creek	27.3	2	.07	1	
Loon (reek	13 May	Burn to Cabin Creek	2.8	2	.71	1	
		Totals	1 -jtij)	4	.13	2	

Bear Valley Creek

Bear Valley Creek enters the Middle Fork 170 km above the mouth and is 59 km in length. Average discharge at a point five km above the mouth is 8.0 m^3/sec (Gebhards 1959). Elk Creek, the largest tributary, is 35 km long, with an average discharge of 2.8 m^3 /sec.

Substantial numbers of chinook salmon formerly spawned in Bear Valley and Elk creeks. Although chinook salmon redd counts have been conducted since the 1950's, the steelhead resource has rarely been monitored. Pollard (1977) observed 16 redds in Bear Valley Creek and three redds in Elk Creek on 13 May 1977 (Fig. 4). He noted that flying conditions were poor. Most of the available spawning area exists between Fir and Elk creeks in Bear Valley Creek and in sections of Elk Creek.

Indian Creek

Indian Creek enters the Middle Fork 111 km above the mouth and is 35 km long, with an average discharge of 3.4 m^3/sec (Gebhards 1959). A pair of log jam falls create an effective barrier to anadromous fish 0.5 km above the mouth of Papoose Creek (Fig. 5).

Spring survey conditions were unfavorable in 1982 and we did not observe any adult steelhead or redds. Extensive spawning area is present below the Middle Fork of Indian Creek and suitable substrate is scattered between Cultus and Papoose creeks (Fig. 6).

Marsh Creek

Marsh Creek joins Bear Valley Creek to form the Middle Fork 170 km above the mouth and is 23 km long (Gebhards 1959). Average discharge is 6.5 m^3/sec at a point 2.4 km upstream.

The Marsh Creek drainage is a principal spawning and rearing area for adult chinook. The extent of the steelhead resource is relatively unknown. Corley (1964) observed 14 steelhead redds in Marsh Creek above Capehorn Creek on 15 May 1964 (Fig. 7). Most available spawning area exists in Marsh Creek above Capehorn Creek and near Potter Creek. Extensive spawning substrate is also present in Beaver Creek to Winnemucca Creek, Capehorn Creek to Banner Creek, and in Knapp Creek above Elk Lake (K. Ball, IFG, personal communication 1983).

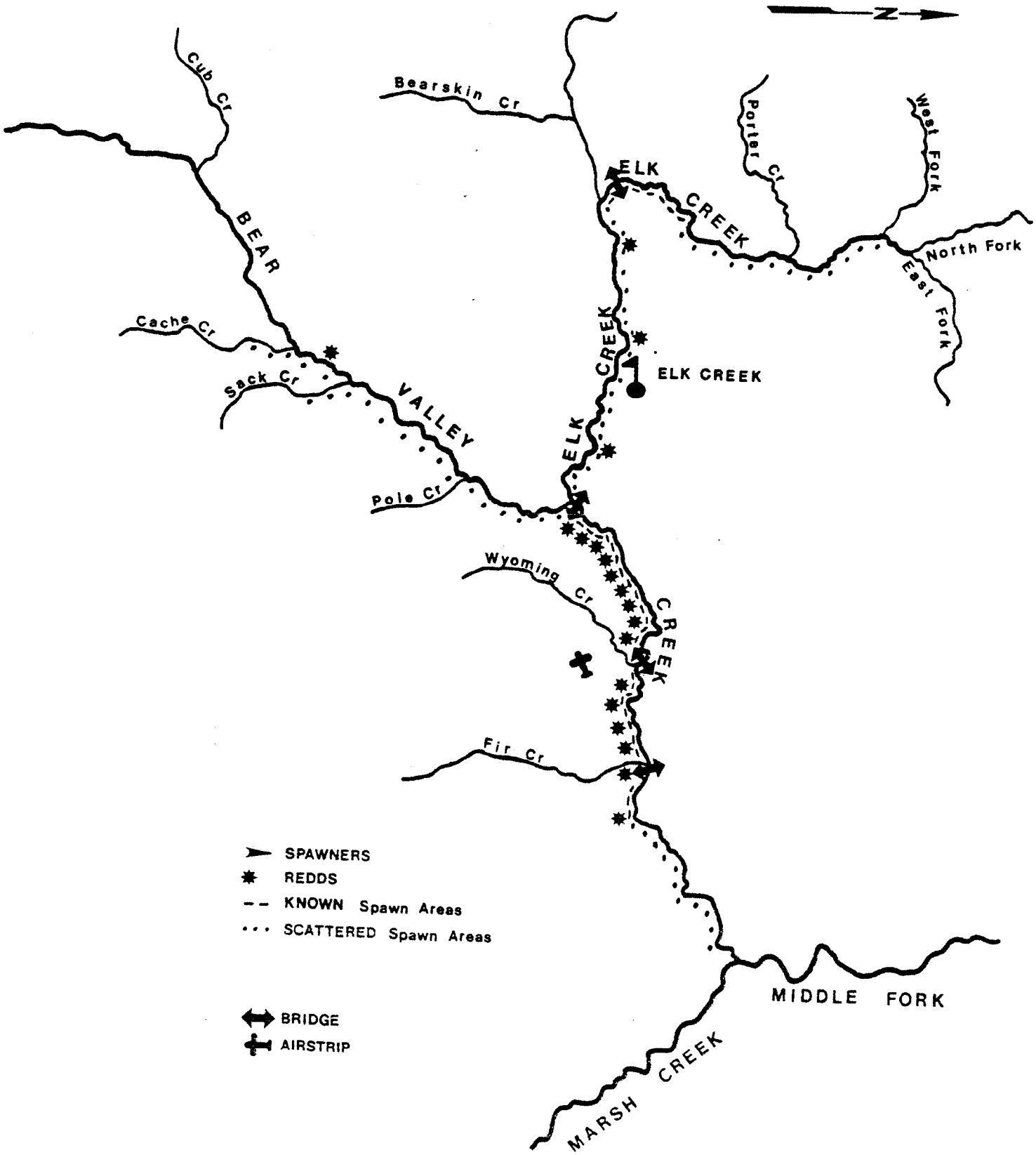

Figure 4. Spawning ground survey map of Bear Valley and Elk Creeks, 1982, steelhead redds observed by Pollard (1977).

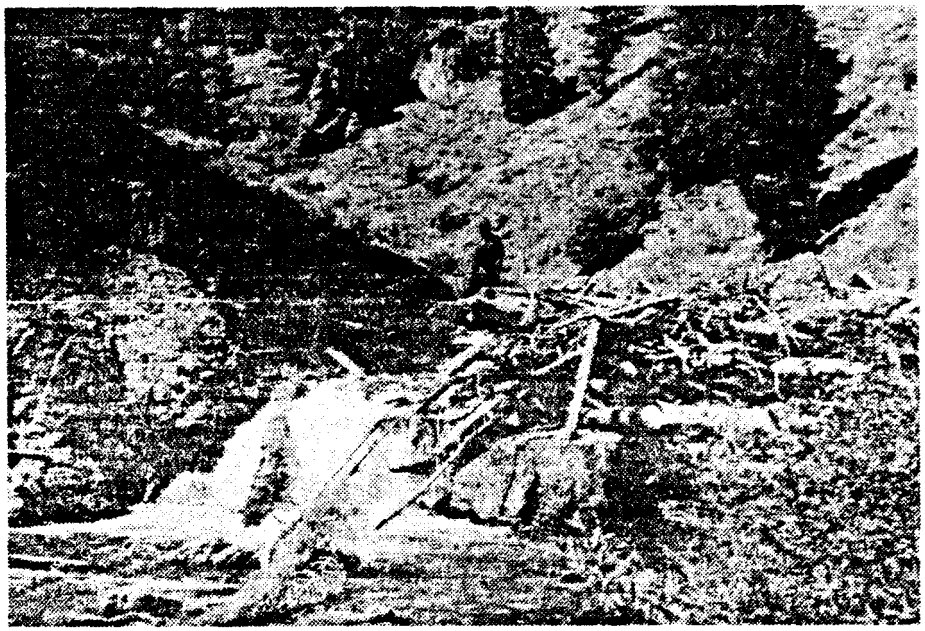

Figure 5. Barrier Falls in Indian Creek near Papoose Creek, August 1982.

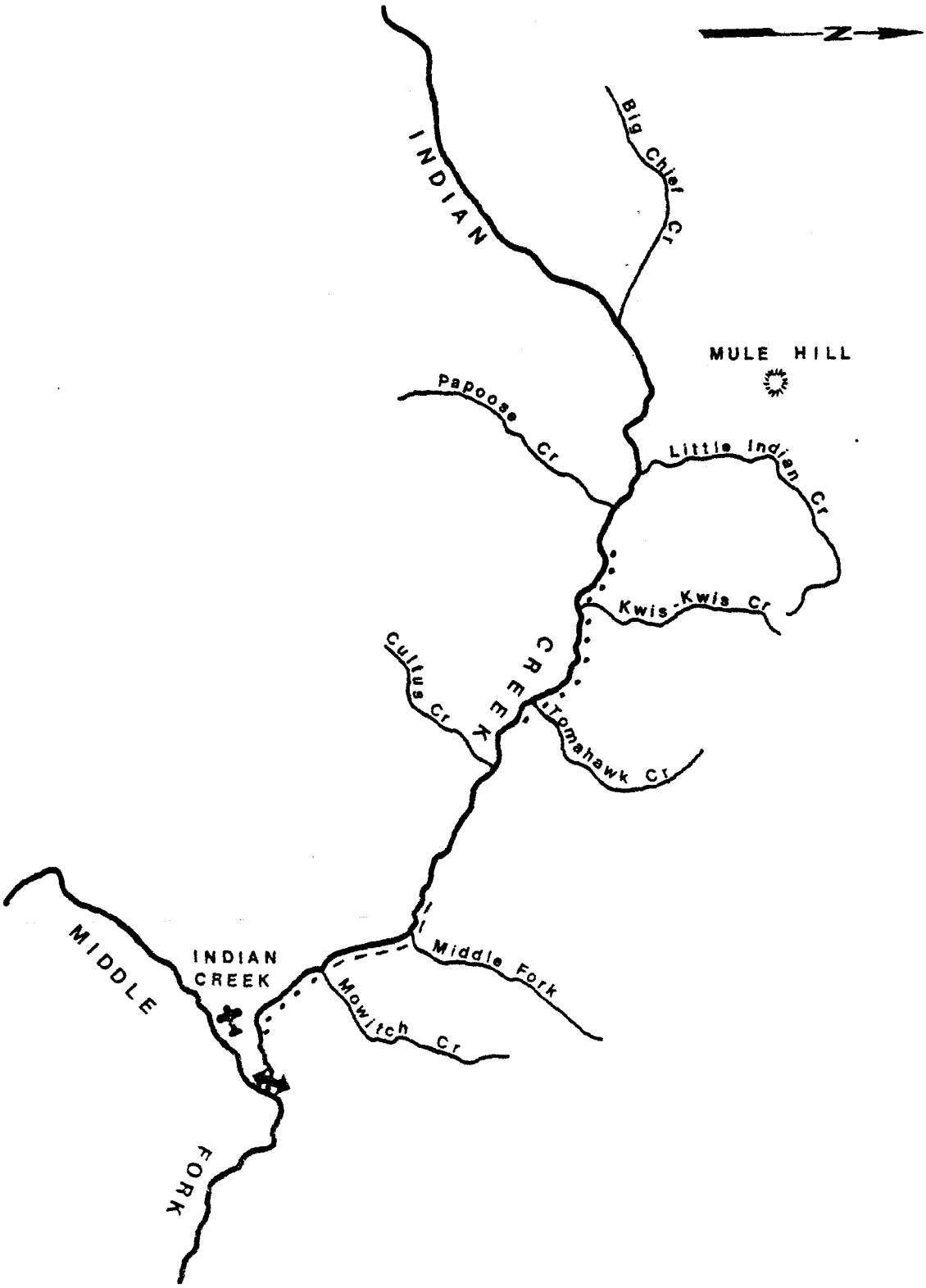

Figure 6. Spawning ground survey map of Indian Creek, 1982.

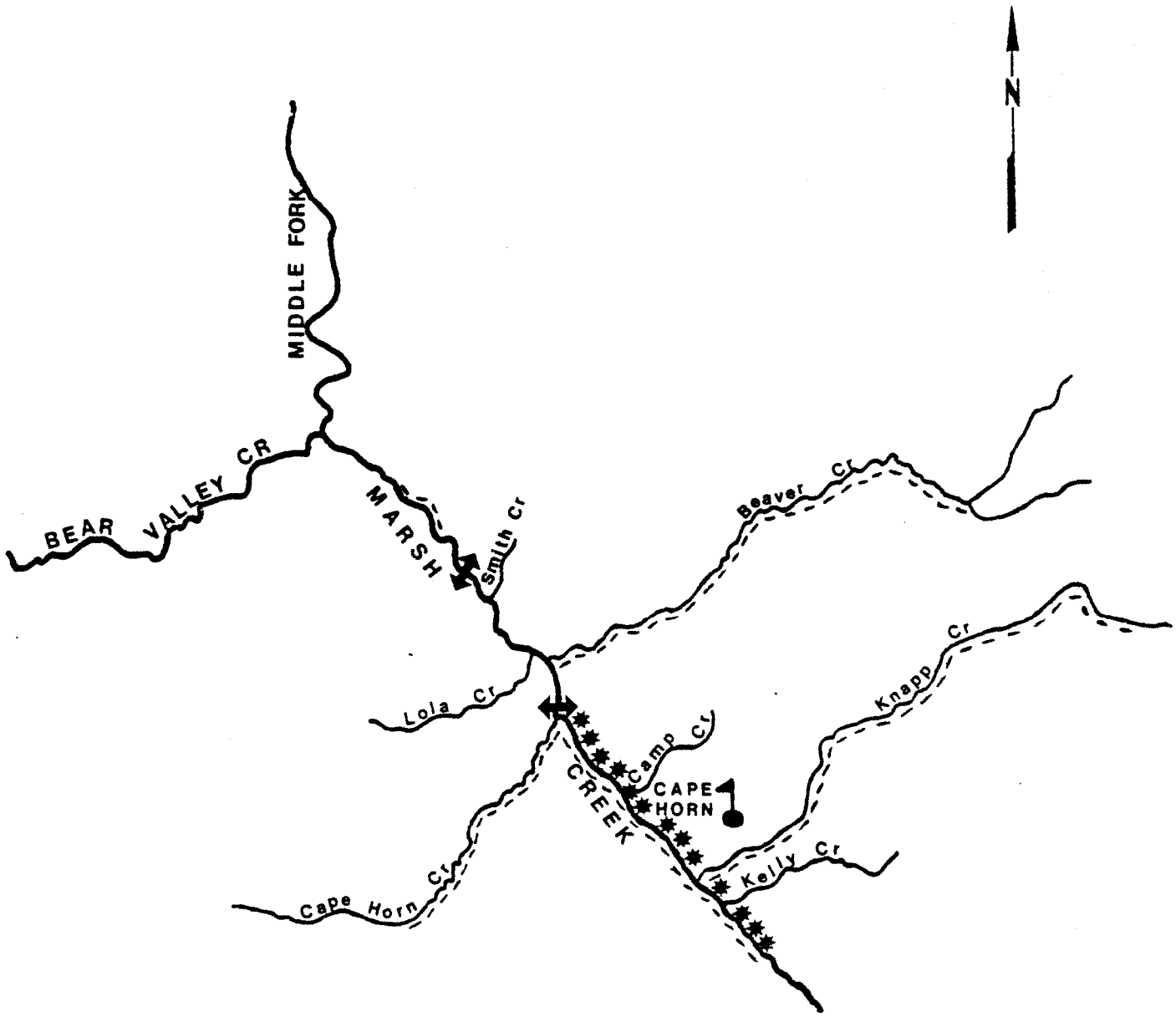

Figure 7. Spawning ground survey map of Marsh Creek, 1982, steelhead redds observed by Corley (1969).

Pistol Creek

Pistol Creek enters the Middle Fork 119 km above the mouth and is 29 km long, with an average discharge of 4.8 m^3/sec (Gebhards 1959). The largest tributary, Littl Pistol Creek, is 21 km long, with an average discharge of 121 m^3 /sec.

We substantiated the presence of steelhead in Pistol Creek during late April and May (Table 1). The most extensive spawning area exists in Pistol Creek between Popgun and Twenty-Two creeks and in Little Pistol Creek near Foresight and Savage creeks (Fig. 8).

Rapid River

Rapid River enters the Middle Fork 125 km above the mouth and is 32 km long, with an average discharge of 4.3 m /sec. The drainage is apparently susceptible to floods and erosion which alter portions of the stream (Gebhards 1959, Somes 1983).

During September 1982 surveys, we documented extensive spawning substrate between Hardscrabble and Cabin creeks and scattered areas to Sulphur Creek and near Fontez Creek (Fig. 9).

Juvenile Distribution and Abundance

Middle Fork

Numbers and densities of juvenile steelhead in the Middle Fork transects were similar in 1981 and 1982. We observed 215 juvenile steelhead in 1982,as compared to 200 in 1981 and 72 in 1980 (Table 2). Steelhead were present in all 20 transects. Densities of juvenile steelhead remained small, averaging 4.1 fish per 100 meters snorkled and ranging from 0.9 to 19.0 fish per 100 meters. We observed 0.25 fish per 00 m^2 surface area in 1982 as compared to 0.27 fish per 100 m' in 1981.

Transect lengths ranged from 70 to 235 meters, and water temperatures varied from 12-16 C above Indian Creek, 14-17 C from Indian to Camas Creek, and 15-17 C below Camas Creek (Appendix B). Visibility ranged from 7.8 to 9.0 meters. In 1982, water temperatures were cooler and visibility was improved as compared to 1981 (Thurow 1982).

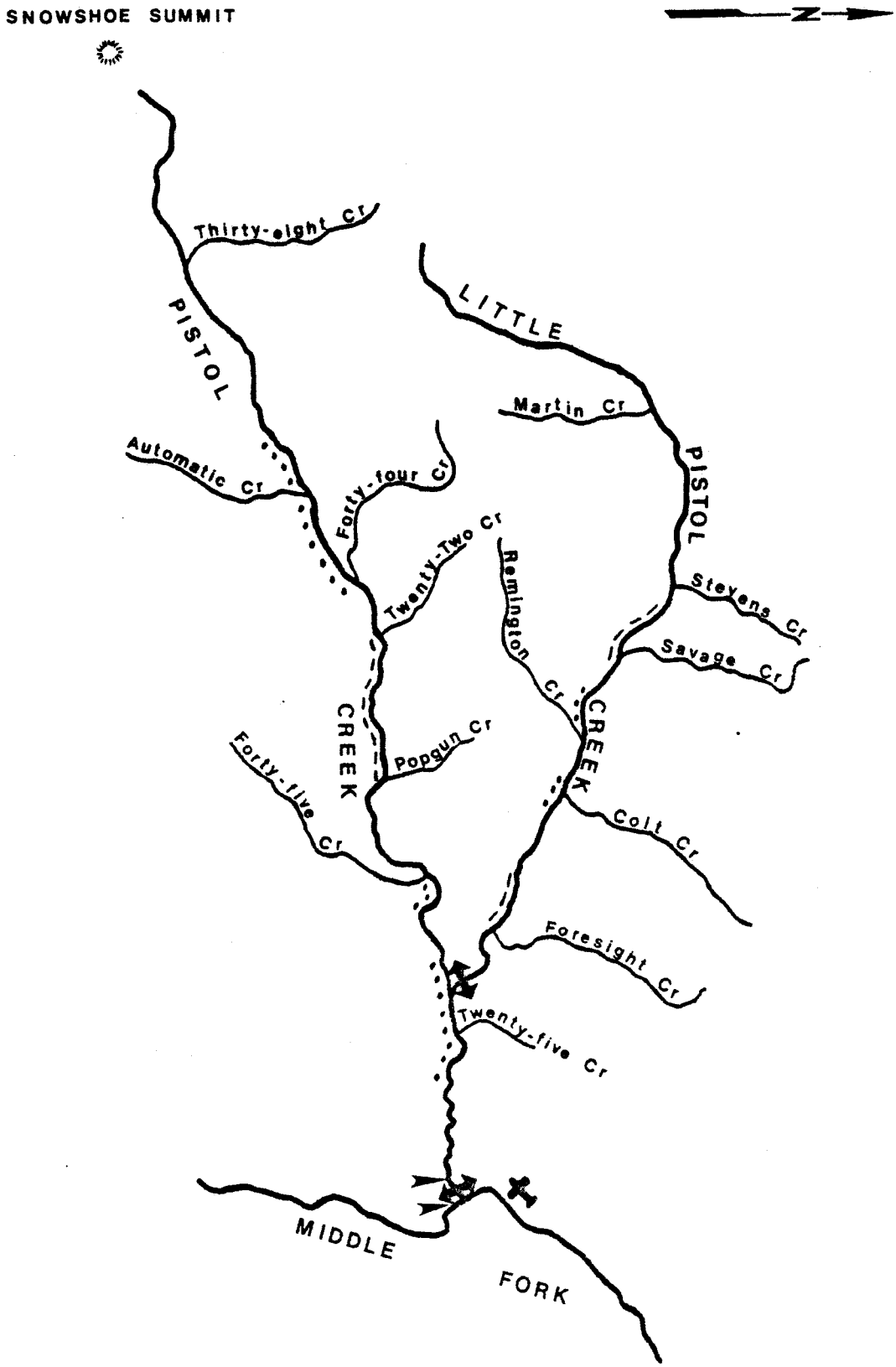

Figure 8. Spawning ground survey map of Pistol Creek, 1982.

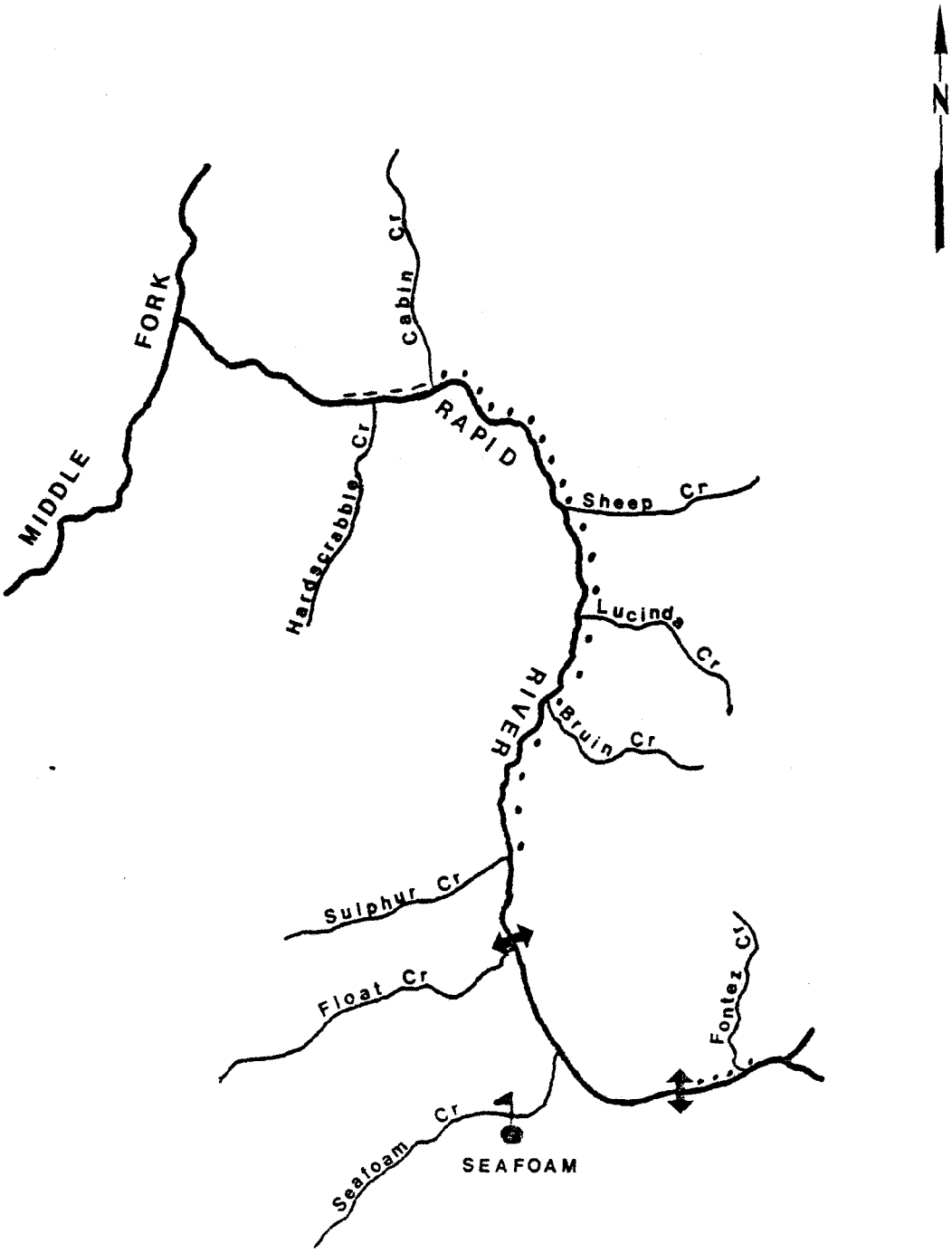

Figure 9. Spawning ground survey map of Rapid River, 1982.

Table 2. Numbers and densities of juvenile steelhead observed in Middle Fork Salmon River transects, 1980-1982.

	1982 count			Total steelhead			Steelhead per 100m			Steelhead per 100m^2	
Transect	Age 1+	Age II+	Age III+	1980	1981	198	1980	1981	1982	1981	1982
1	-	2	-	8	16	2	4.2	8.5	3.0	.57	.08
2	1	-	-	5	12	1	2.0	4.8	0.9	.32	.05
3	2	1	4	5	4	7	2.3	1.9	6.9	.14	.20
4	3	1	-	0	2	4	0.0	1.5	3.5	.11	.20
5	13	10	2	5	19	25	1.6	5.8	17.0	.44	.48
6	2	3	-	3	1	5	0.8	0.3	3.3	.02	.11
7	1	5	1	0	8	7	0.0	3.1	3.4	.22	.11
8	16	11	3	5	20	30	1.4	5.4	19.0	.38	.61
9	4	5	2	0	9	11	0.0	2.1	6.0	.15	.16
10	5	7	1	3	12	13	1.1	4.4	9.6	.31	.26
11	11	3	2	6	11	16	1.2	2.4	6.8	.19	.22
12	10	9	2	5	8	21	2.3	3.7	15.0	.29	.48
13	2	3	-	2	9	5	0.5	2.4	3.4	.19	.11
14	5	8	2	8	10	15	2.3	2.8	10.6	.26	.33
15	6	10	2	4	16	18	1.4	5.9	13.2	.54	.42
16	4	7	-	5	7	11	3.0	4.1	7.8	.38	.49
17	3	3	1	5	11	7	2.6	5.6	6.5	.47	.21
18	-	1	1	2	9	2	0.4	2.1	1.4	.17	.04
19	4	1	-	1	12	5	0.2	2.8	3.0	.24	.10
20	4	5	1	0	4	10	0.0	2.8	10.9	.24	.35
Totals	96	95	24	72	200	215	$\bar{x}$	$\bar{x}$	$\bar{x}$ =4.1	$\bar{x}$ =0.26	$\bar{x}$ =0.250

Concurrent with snorkeling, we captured fish with hook-and-line to collect length-frequency and species composition data. Three men fishing six-to-eight hours each day between 23 and 30 August caught-and-released 311 juvenile steelhead, 396 cutthroat, 7 rainbow x cutthroat hybrids, 4 bull trout, and 42 whitefish, for a total of 760 game fish. Flies were much more effective than lures.

The age-frequency of juvenile steelhead observed in the transects were nearly identical in 1981 and 1982 (Table 3). Length frequencies of hook-and-line caught steelhead were also similar in 1981 and 1982 (Fig. 10). A discrepancy in size composition between angling and snorkeling again resulted from angling gear which was selected for larger juvenile steelhead. We did not observe any consistent trend in the age structure of juvenile steelhead between Middle Fork sections (Appendix C).

We observed cutthroat in all 20 transects and an estimated 61% exceeded 300 mm (Table 4). Fifty percent of the cutthroat caught by hook-and-line exceeded 300 mm (Fig, 10). We observed 194 cutthroat in 1982 and 143 in 1981.

Juvenile chinook salmon were much more abundant in 1982 and we observed 161 as compared to 18 in 1981 (Table 4). We also saw one spent adult chinook and five bull trout. Whitefish were present in all 20 transects and squawfish and suckers were seen in the lowest transects.

Tributaries

We observed 584 juvenile steelhead in 61 transects (excluding Camas Creek) for an average of nearly ten steelhead per transect (Table 5). The streams we surveyed in 1982 supported smaller densities of juvenile steelhead than the 1981 study streams (Thurow 1982). In 1982, densities ranged from no steelhead observed in Elk Creek to 3.9 steelhead per $100m^2$ in Rapid River. The extremely small steelhead densities in areas of Bear Valley, Elk, and Marsh creeks may be a result of limited "pocket-water" type rearing habitat. Progeny of steelhead which spawn in those areas may migrate to downstream rearing areas soon after emergence. It is also possible that Dagger Falls creates a barrier to adult steelhead during certain years when low flows occur in the spring. Future spawning ground survey data may help resolve this question.

Table 3. Age frequency of juvenile steelhead observed in 20 Middle Fork transects, 1980-1982.

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

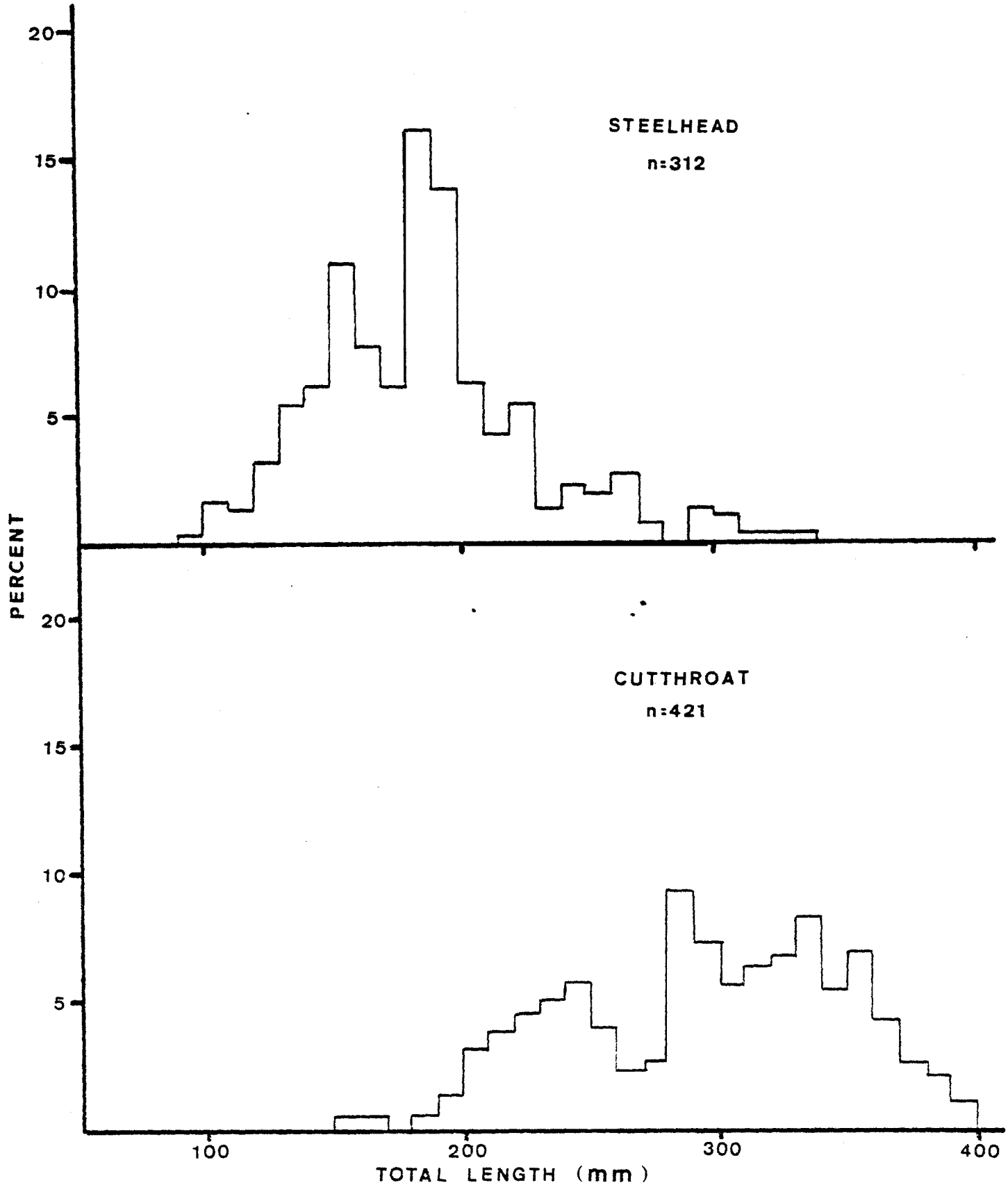

Figure 10. Length frequency of juvenile steelhead and cutthroat trout caught by anglers in the Middle Fork Salmon River, 1982.

Table 4. Fish species (non-steelhead) observed in Middle Fork Salmon River transects, August 1982.

Section	Transect	Cutthroat trout total	Cutthroat trout No. >300mm	Juvenile chinook	Bull trout	Nongame fish (+, -) whitefish	suckers	squawfish	redside shiner
	1	8	6	-	-	+	-	-	-
	2	9	8	13	-	+	-	-	-
I	3	6	4	1	1	+	-	-	-
-	4	2	2	1	-	+	-	-	-
	5	17	10	19	1	+	-	-	-
	6	13	8	3	-	+	-	-	-
	7	4	1	2	1	+	-	-	-
	8	13	7	4	1	+	-	-	-
	9	5	2	9	-	+	-	-	-
II	10	24	15	19	1	+	-	-	-
	11	14	7	21	-	+	-	+	-
	12	11	6	20	-	+	+	+	-
	13	7	6	3	-	+	+	+	-
	14	8	5	22	-	+	+	+	-
III	15	9	4	1	-	+	+	+	-
	16	19	13	13	-	+	+	+	+
	17	4	3	2	-	+	+	+	-
IV	18	6	4	4	-	+	+	+	-
	19	12	6	1	-	+	+	+	-
	20	3	1	3	-	+	+	+	-
Total numbers		194	118	161	5				
Number of transects present		20	20	19	5	20	9	10	1

Table 5. Fish population data collected by snorkeling in Middle Fork Salmon River tributaries, July-Sept. 1982.

Tributary	Section	Juvenile steelhead Age I+	Age II+	Age III+	Total	Cutthroat (mm) <100	100-200	200-300	>300	Total	Chinook juvenile	adult	Whitefish	Bull trout	Brook trout	Rainbow or steelhead	Steelhead per 100m^2
Bear Valley Cr.	Elk Cr.	-	-	-	-	-	-	-	-	-	8	-	+, YOY	-	-	-	-
	Cache Cr.[1]	7	1	-	8	-	-	-	-	-	1	-	-	-	5	-	4.0
	Sack Cr.[1]	1	-	-	1	-	-	-	-	-	-	-	-	1	6	-	0.7
		8	1	-	(9)	-	-	-	-	(-)	(1)	-	+, YOY	(1)	11	-	
Indian Cr.	Lower	58	30	2	90	-	3	3	1	7	44	-	+	4	-	-	4.0
	Middle	3	9	1	13	3	32	2	1	38	-	-	+	4	-	-	0.7
	Upper	-	-	-	-	2	31	14	-	47	-	-	-	12	-	-	no steelhead above falls
		61	39	3	(103)	5	66	19	2	(92)	(44)	-	+	(20)	-	-	$\bar{x}$=2.6
Marsh Cr.	Lower	27	8	2	37	-	-	-	2	2	39	1	+, YOY	-	-	YOY	0.9
	Upper	6	1	-	7	-	-	-	1	1	95	1	+	-	167	-	0.4
		33	9	2	(44)	-	-	-	3	(3)	(134)	2	+, YOY	(-)	167	YOY	$\bar{x}$=0.8
Pistol Cr.	Lower	40	45	4	89	-	9	16	6	31	71	1	+	6	-	YOY	2.3
	Middle	67	57	8	132	-	-	-	1	1	24	-	+	4	-	-	6.5
	Upper	-	3	1	4	3	10	5	-	18	-	-	-	16	-	-	0.2
		107	105	13	(225)	3	19	21	7	(50)	(95)	1	+	(26)	-	YOY	$\bar{x}$=3.0
	Little Pistol	13	26	2	(41)	1	18	3	-	(22)	(6)	-	+	3	-	YOY	2.4
Rapid River	Lower	56	31	7	94	-	1	2	2	5	3	-	+	5	-	YOY	4.0
	Upper	32	29	7	68	-	8	8	-	16	11	-	+	10	-	YOY	3.7
		88	60	14	(162)	-	9	10	2	(21)	(14)	-	+	(15)	-	YOY	$\bar{x}$=3.9
Grand Totals		310	240	34	(584)	9	112	53	14	(188)	(302)	3	+, YOY	(62)	178	YOY	

[1]One transect snorkeled
YOY = young-of-the-year

Age I+ steelhead were more prevalent in the 1982 transects as compared to 1981 transects. Fifty–three percent of the steelhead we observed were Age I+, 41% Age II+, and 6% Age III+, as compared to 36% Age I+, 59% Age II+, and 5% Age III+ in the 1981 transects (Table 5). As in 1981, angling gear selected for larger steelhead (Fig. 11).

Transects ranged from 30-to-50 meters long and varied considerably in width depending on the streams (Appendix D). Rubble was the predominant substrate, followed by gravel and boulders. Sand and silt comprised a small proportion of the substrate in most transects. Marsh and Elk creeks contained the largest percentage of sand. Riparian vegetation consisted of grasses, sedges, various brush, and shrubs.

As we observed in 1981, cutthroat were uncommon in many areas of the tributaries. Upper areas of Indian and Pistol creeks supported the largest cutthroat densities, while Bear Valley and Marsh creeks and Rapid River supported few cutthroat. Seventy-six percent of the cutthroat we observed in transects and 84% of the cutthroat we caught with hook-and-line were in the Indian and Pistol Creek drainages (Tables 5, 6).

Most cutthroat in Indian and Pistol creeks were juvenile-sized fish, 64% of the cutthroat we observed, and 58% of the cutthroat we caught in all tributaries were less than 200 mm (Table 5, Fig. 12). In tributaries surveyed in 1981, 81% of the cutthroat observed and 73% of the cutthroat caught exceeded 200 mm (Thurow 1982).

We observed 302 juvenile and three adult chinook in the transects (Table 5). Marsh and Pistol creeks supported the largest numbers of juvenile chinook. Whitefish were abundant in most stream sections.

Bull trout populations were usually sympatric with cutthroat populations and were most prevalent in Indian and Pistol creeks (Tables 5, 6). We observed 62 bull trout in 61 transects, compared to 11 bull trout in 55 transects in 1981 (Thurow 1982). Bull trout captured with hook-and-line ranged from 130 to 430 mm and 78% were less than 220 mm (Fig. 12). Brook trout were observed or captured only in tributaries to Bear Valley Creek and in Marsh Creek.

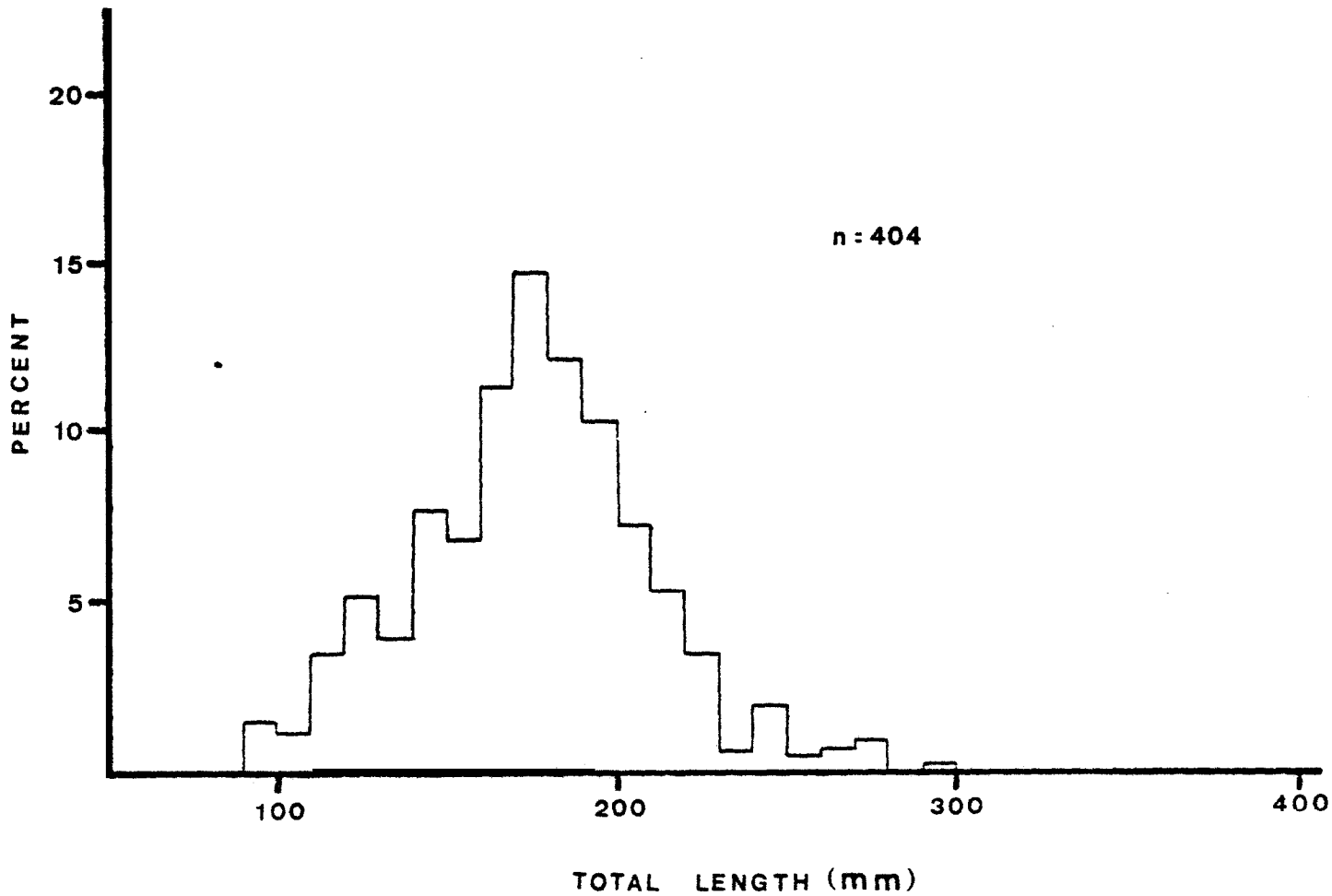

Figure 11. Length frequency of juvenile steelhead caught in Middle Fork tributaries, 1982.

Table 6. Species composition of hook-and-line catch in Middle Fork Salmon River tributaries, July-August 1982.

Date / Section	fish captured						
	steelhead	cutthroat	bull trout	hybrid	whitefish	other	game fish
Bear Valley Creek							
28 July Below Fir Creek	22	-	-	-	-	1 brook trout	23
Indian Creek							
4-5 August Above falls near Papoose Creek	-	71	13	-	-	-	84
6-7 August Below falls	39	44	1	-	9	-	93
Totals	39	115	14	-	9	-	177
Pistol Creek							
10-11 August Above Automatic Creek	-	15	1	-	-	-	16
11-12 August 22 to Automatic Creek	9	15	9	2	-	-	35
14-15 August Below 22 Creek	101	6	6	-	-	1 precocial chinook	114
Totals	110	36	16	2	-	1 chinook	165
Little Pistol Creek							
13 August Above Remington Creek	7	15	2	-	3	-	27
14 August Below Foresight Creek	10	2	-	-	-	-	12
Totals	17	17	2	-	3	-	39
Rapid River							
6 Sept. Fontez to Seafoam Creek	4	7	6	-	-	-	17
7 Sept. Below Cabin Creek	19	4	6	2	-	-	31
8,9 Sept. Cabin to Sheep Creek	10	8	-	-	1	-	19
Totals	33	19	12	2	1	-	67
Marsh Creek							
Below Capehorn Creek	22	1	-	-	-	1 brook trout	24
Marble Creek							
Below B. Mitchell Ranch	135	12	-	-	-	4 chinook	151
Camas Creek							
Below Hammer Creek	48	1	1	-	-	-	50
Totals	426	201	45	4	13	5 chinook 2 brook trout	696

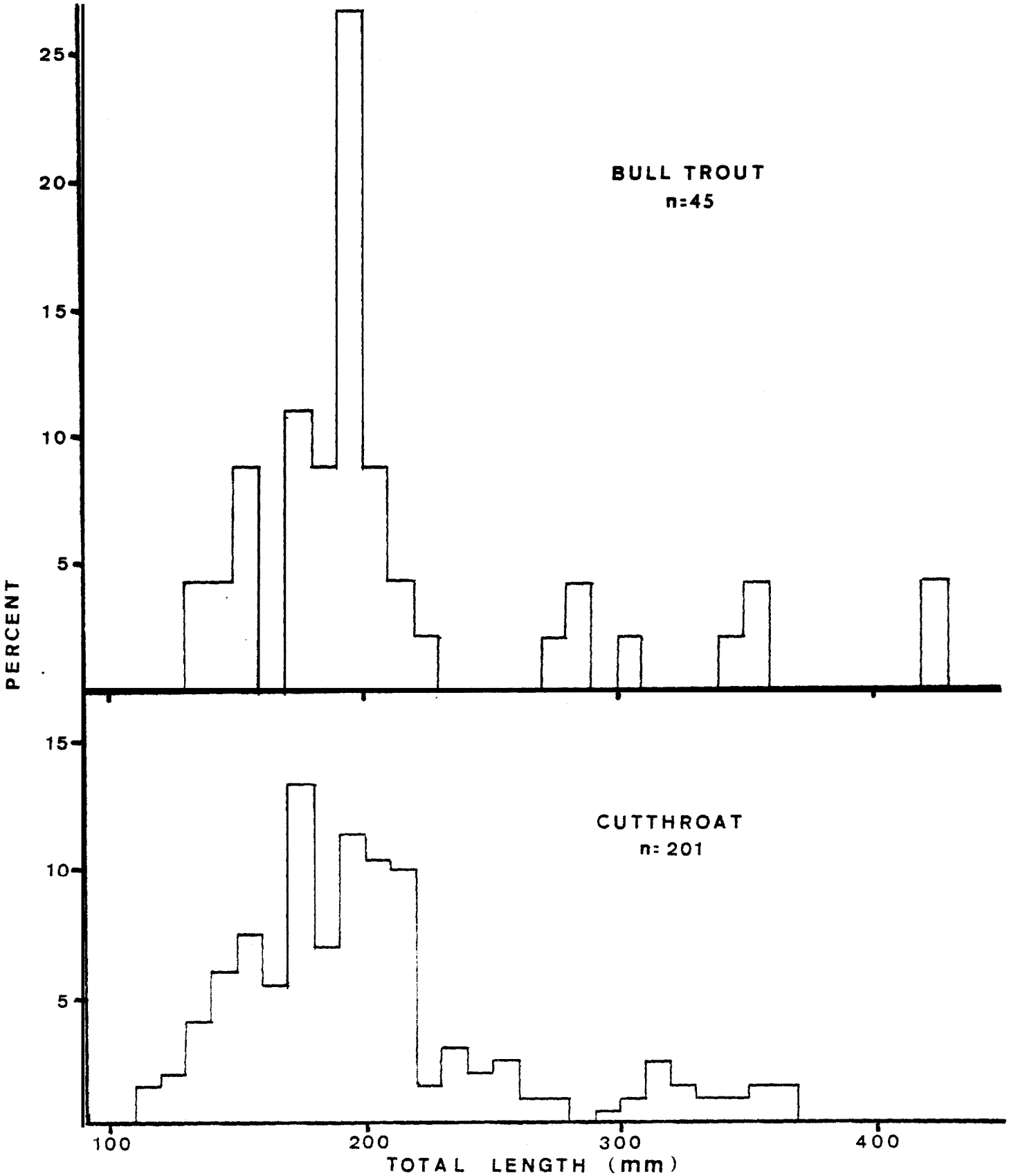

Figure 12. Length frequency of bull and cutthroat trout caught in Middle Fork tributaries, 1982.

Camas Creek

I recounted five transects in Camas Creek which we originally surveyed in 1981 (Thurow 1982). Although I observed 56% more steelhead in 1982 (233 versus 149 in 1981) densities were similar (9.5/100m2 in 1982 as compared to 7.3/100m4 in 1981) Appendix E). Juvenile chinook salmon were much more abundant in 1982 (99) as compared to 1981 (ten).

Bear Valley Creek

As a result of the extensive silt and sand substrate in Bear Valley Creek, the stream was too turbid to snorkle in July 1982. We selected transects in Elk, Cache, and Sack creeks (tributaries to Bear Valley Creek). Transects were selected in pools and runs since "pocket-water"-type habitat was rare.

Bear Valley Creek contains scattered pocket-water habitat between Fir Creek and the confluence with Marsh Creek. We used hook-and-line gear to catch 22 juvenile steelhead and one brook trout in that section on 28 July (Table 6). Juvenile steelhead ranged from 92 to 200 mm and most (73%) were Age II fish.

No juvenile steelhead were observed in Elk Creek and nine were present in the Cache and Sack Creek transects (Table 5). Juvenile chinook and whitefish were the only game fish observed in Elk Creek. Brook trout were present in Cache and Sack creeks.

Bjornn et al. (1974) snorkeled and reported Age I+ and older steel head densities ip Elk Creek of 3.1 fish per 100 m^2 in 1972 and 2.6 fish per 100m in 1973 in similar "pool" transects. Age 0 and Age I+ chinook were the most abundant game fish and densities equalled 36 fish per $100m^2$ in 1972 and 35 fish per $100m^2$ in 1973.

In 1975, Bjornn et al. (1977) snorkled 15 pool-riffle transects in Elk Creek and eight in Bearskin Creek (tributary to Elk Creek). Juvenile steelhead densities in Elk Creek ranged from 0.4 to 4.0 fish per $100m^2$ and steelhead were observed in only five transects. In Bearskin Creek, juvenile steelhead densities ranged from 3.0 to 6.0 fish/$100m^2$ and steelhead were present in four transects. Juvenile chinook were observed in all transects and densities ranged from four to 117 fish per 100 m^2. Lengths and weights of Age 0 chinook in lower Elk Creek were significantly larger than fish in upper Elk Creek.

Sekulich (1980) measured juvenile steelhead densities in Elk Creek in 1975 and observed 0.1 to 0.4 fish/100m^2 in pools and 0.1 to 0.03 fish/100m2 in riffles. Juvenile chinook densities equalled to l0-to-14 fish/100m2 in riffles.

Indian Creek

The upper section of Indian Creek supports abundant populations of cutthroat trout. As previously mentioned, two barrier falls above Papoose Creek provide an effective barrier to fish movements. Above the falls, only cutthroat and bull trout are present (Tables 5, 6). The cutthroat above the falls are apparently resident fish which rarely exceed 250 mm (Fig. 13). We captured two small, mature males (165, 198 mm) which are comparable in size to mature, resident westslope cutthroat trout populations in the St. Joe River drainage (Thurow 1978). Below the falls, larger cutthroat were more prevalent, 22% exceeded 250 mm and fish ranged to 370 mm. It is likely these cutthroat are of a migratory stock as Mallet (1963) observed. Bull trout ranged from 170 to 220 mm above the barrier.

Below the falls we observed cutthroat, bull trout, steelhead, chinook, and whitefish. Densities of juvenile steelhead were largest in the lower sections of Indian Creek where rubble-boulder habitat was most prevalent. Chinook salmon were also most abundant in the lower sections.

Rainbow/steelhead ranged from 90 to 230 mm and the length-frequency data suggests that Age I+ steelhead were less than 150 mm.

Marsh Creek

Juvenile steelhead were most prevalent in the pocket water habitat in Marsh Creek below Capehorn Creek (Tables 5, 6). Above Capehorn Creek, Marsh Creek flows through a broad, low-gradient meadow, with primarily pool-run habitat similar to Bear Valley Creek. We observed only seven steelhead in five transects in the meadow area.

Chinook salmon and brook trout were the most prevalent species above Capehorn Creek (Table 5). We observed 99 brook trout in one 45-meter-long transect near the mouth of Kelly Creek (Appendix E). Juvenile chinook, cutthroat, and whitefish were also present below Capehorn Creek.

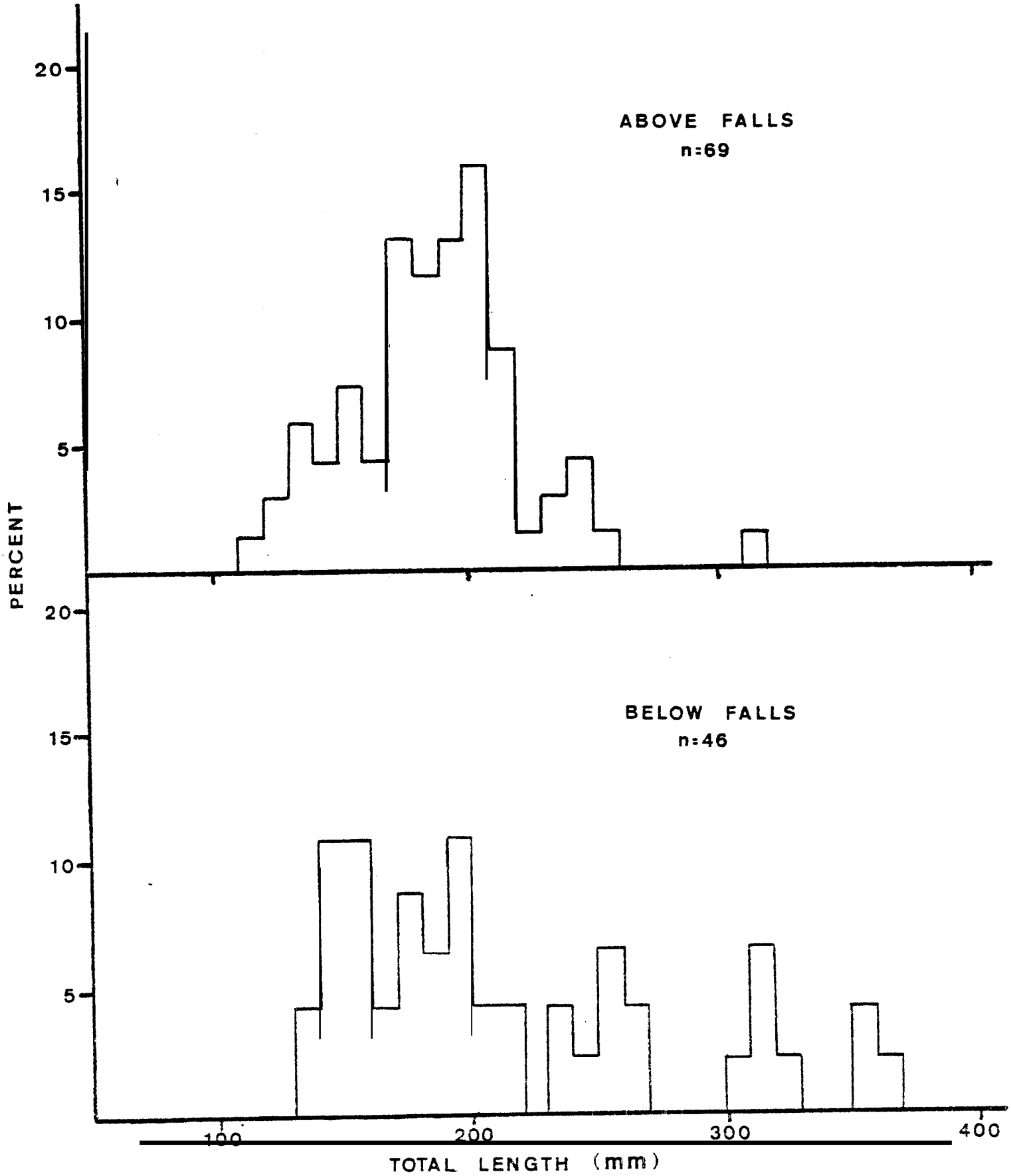

Figure 13. Length frequency of cutthroat trout caught in Indian Creek, above and below a barrier, August 1982.

Bjornn et al. (1974) reported Age I+ and older steelhead densities of 3.2 fish per 100m in pools in Marsh Creek. They also observed juvenile steelhead in Capehorn and Knapp creeks. Age 0 and Age I+ chinook salmon were the most abundant fish in pools and densities equalled 39 fish per $100m^2$.

Sekulich (1980) measured densities of juvenile steelhead and chinook in the Marsh Creek drainage in 1975 and 1976. Within Marsh Creek above Capehorn Creek, densitis of Age I+ and older steelhead ranged from 0.1 to 0.8 fish/$100m^4$ in riffles. In Knapp Creek, densities ranged from 2.5 to 3.4 fish/100m in pools and 0.4 to 1.2 fish/$100m^2$ in riffle g. Densities equalled 1.2 fish/$100m^2$ in pools and 0.7 fish/$100m^2$ in riffles in Beaver Creek. Densities of juvenile chinook equalled 47 and 48 fish/ $100m^2$ in Marsh Creek in 1975 and 1976. Brook trout were abundant in Marsh Creek above Knapp Creek, averaging 22-to-24 fish/$100m^2$.

Apparently, juvenile steelhead were not prevalent in upper Marsh Creek even prior to 1970. Reingold (1967) trapped Marsh Creek from 26 July to 9 November in 1966 near the mouth of Capehorn Creek. Although an estimated 40,519 juvenile chinook passed the trap, only an estimated 742 juvenile steelhead migrated downstream.

Pistol Creek

Although no barriers to fish movement exist, the upper areas of Pistol Creek (above Automatic Creek) contain fish populations similar to those in upper Indian Creek (Tables 5, 6). Apparently, the habitat type (abundant, low-gradient pools with sand and gravel substrate) is less desirable for juvenile steelhead. We observed only cutthroat and bull trout in uppermost areas above Automatic Creek.

Below Automatic Creek, the gradient increases and "pocket-water" is more prevalent, particulary above Little Pistol Creek. Densities of juvenile steelhead are also largest in this area (Tables 5, 6). The lowest section of Pistol Creek contained few steelhead and relatively large numbers of juvenile chinook and cutthroat. Many of the cutthroat are large fish (19% observed 300 mm), which probably ascended Pistol Creek from the Middle Fork to spawn.

Juvenile steelhead in Pistol and Little Pistol creeks ranged from 90 to 280 mm in length (Fig. 14). The data suggests that Age I+ steelhead were less than 150 mm.

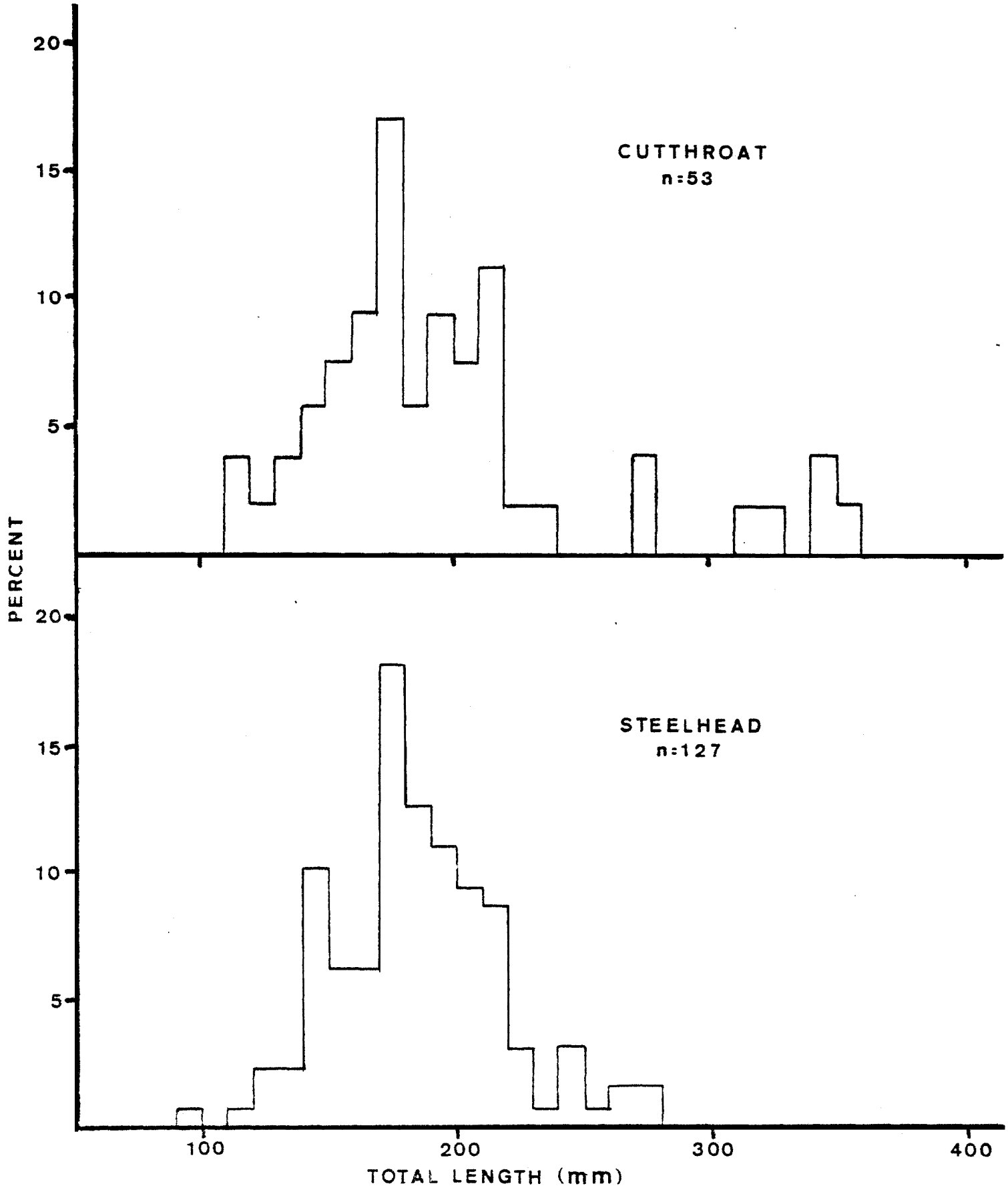

Figure 14. Length frequency of steelhead and cutthroat trout caught in Pistol and Little Pistol creeks, August 1982.

Cutthroat trout caught by hook-and-line in Pistol and Little Pistol creeks were predominately fish less than 250 mm (Fig. 14). Eighty-six percent of the cutthroat larger than 270 mm were caught below the confluence of Little Pistol and Pistol creeks. Bull trout ranged from 130 to 430 mm and a majority (75%) were less than 230 mm.

Angler effort on the lower section of Pistol Creek may be extensive. We saw 12 anglers in four parties on 15 August. The close proximity of the Pistol Creek cabins and airstrip provides ready access.

Rapid River

Juvenile steelhead were most prevalent below Hardscrabble Creek and in the scattered pocket water between Cabin and Float creeks (Tables 5, 6). Cutthroat and bull trout were present throughout the drainage, particularly above Float Creek. Juvenile chinook were most abundant in the upper section.

Juvenile steelhead ranged from 130 to 260 mm. Cutthroat ranged from 120 to 370 mm and 32% exceeded 250 mm. Bull trout ranged from 130 to 420 mm and 92% were less than 210 mm.

Adult Steel head Movements

1981-1982 Fish Run

As Thurow (1982) reported, project personnel tagged 25 steelhead in the Middle Fork in October-November 1981. Twenty-three other steelhead were tagged in the main Salmon River. Five steelhead tagged in the Middle Fork (19%) were recaptured in the Salmon River by 30 December and four (17%) steelhead tagged in the main Salmon were recaptured within four km of the original tag site.

Between 5 March and 20 April 1982, we captured and tagged 124 additional wild steelhead in the lower 400 meters of the Middle Fork and four steelhead in the main Salmon River. We also caught three hatchery-origin steelhead. I believe these hatchery fish were temporarily staging in the Middle Fork. All these were caught in the lower 200 meters of the stream and two were caught when the main Salmon was turbid while the Middle Fork was clear. We have not observed any hatchery steelhead farther up the Middle Fork.

Tagged steelhead ranged from 61 to 97 cm (24-38 in) and a majority (85%) exceeded 76 cm (30 in) (Fig. 15). Sex ratios averaged 2.3 females per male, for 53 fish in March and 4.5 females per male for 71 fish in April. Sex ratios in October-November 1981 averaged 5.2 females/male.

We recaptured four tagged steelhead in the lower 400 meters of the Middle Fork. One fish was originally tagged on 29 October 1981 in the same location; two fish were tagged on 23 March and recaptured on 25 March; and one fish was tagged and recaptured within two hours on 9 April.

Wild steelhead destined for the Middle Fork stage in the lower 400 meters of the Middle Fork in the spring. These fish are extremely vulnerable to angling and we captured up to 33 fish in one day, for a catch rate of one steelhead every 38 minutes. Water temperatures ranged from 6 to 15 C on peak catch days. Steel head were noticeably more active when water temperatures exceeded 6.5 C.

In order to monitor movements of the 149 steelhead tagged in the Middle Fork and the 29 steelhead tagged in the main Salmon, we also fished sections of the upper. Middle Fork drainage. Between 25 March and 23 April we made three trips into the Middle Fork between the Flying "B" and Camas Creek and two trips near the mouth of Big Creek. We captured steelhead on each trip, for a total of 18 fish. None of the fish had been previously tagged.

These 18 steelhead ranged from 56 to 92 cm and a majority (67%) exceeded 76 cm. Sex ratios averaged five females per male. We also caught 11 bull trout ranging from 350 to 530 mm and three cutthroat 380 to 400 mm long (Appendix F).

1982-1983 Fish Run

Some adult steelhead entered the Middle Fork by 30 August in 1982. We observed eight steelhead in the lower 0.8 km of the Middle Fork while snorkeling.

Between 28 September and 1 October, four project anglers fished 38 man-hours for adult steelhead between the Flying "B" (RM 3C) and the Salmon River. No adult steel head were caught or observed. The anglers caught ten cutthroat trout and water temperatures ranged from 6.5-10.5 C (Appendix F).

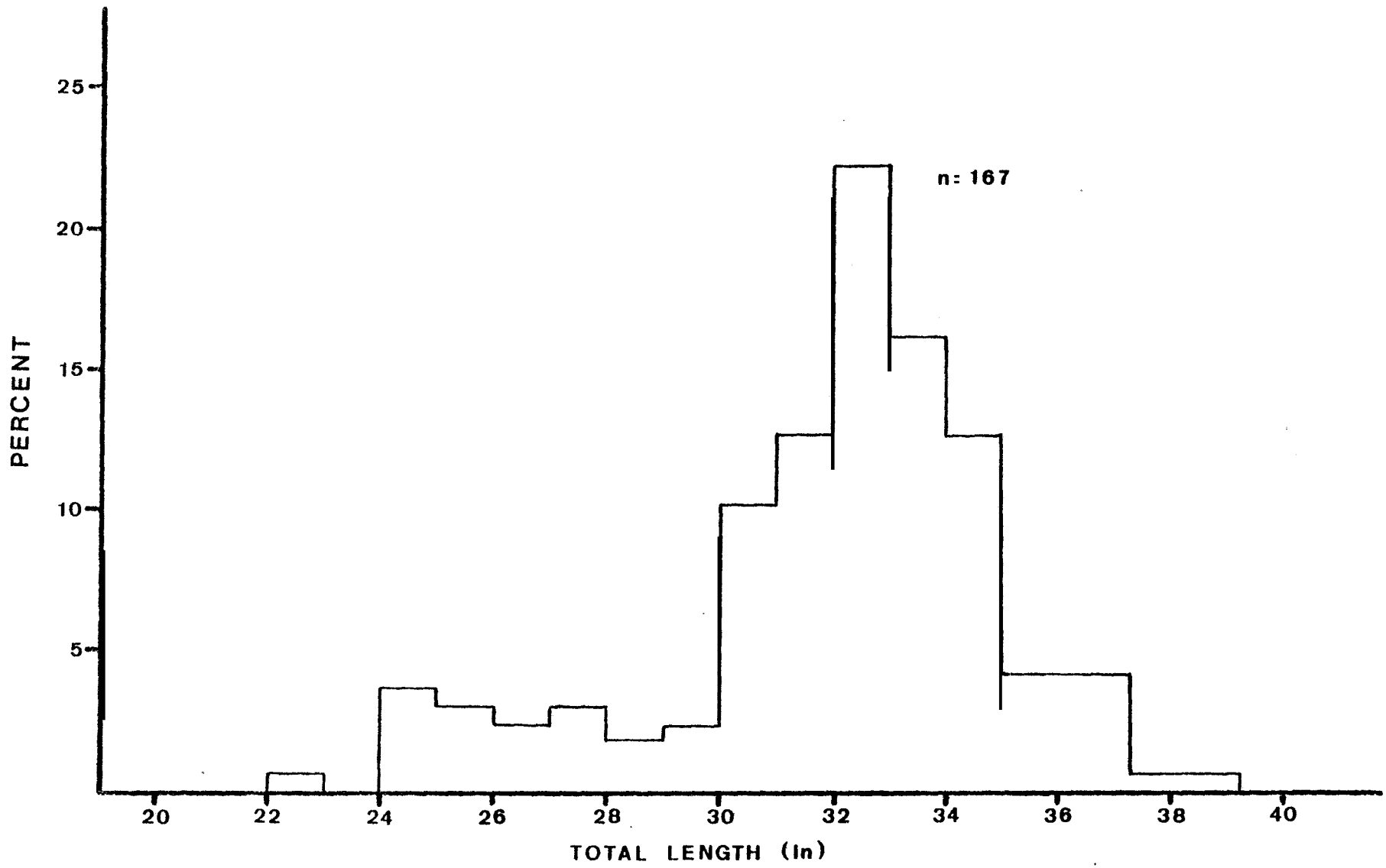

Figure 15. Length frequency of wild steelhead trout caught in the Middle Fork Salmon River, 1981-1982 fish run.

I snorkeled 20 transects in "optimal" adult steelhead holding water from the Flying "B" downstream between 13 and 16 October. No steelhead were observed until the lower 0.8 km of the Middle Fork, where I observed two adults. Four anglers fished 50 man-hours and no steelhead were caught. The anglers caught 19 cutthroat and nine bull trout and water temperatures ranged from 6.5-8.0 C (Appendix F).

Between 26 and 29 October, we floated from the Flying "B" downstream, but poor visibility limited me to snorkeling seven transects and I observed no adult steelhead. Anglers fished 41 man-hours and caught two wild steelhead {90 cm(♂), 81 cm ♀) approximately 14.5 km upstream from the main Salmon River. Water temperatures ranged from 4-6.5 C and 13 cutthroat and three bull trout also were caught (Appendix F).

Inclement weather conditions and the onset of "slush ice" prevented any later surveys in the fall. Our surveys suggest that few steelhead ascend the Middle Fork farther than the lower two-three km in the fall.

Origin of Middle Fork Steelhead

Results of the electrophoretic analysis of steelhead trout populations in Middle Fork Salmon River tributaries are presented in Appendix A.

Ninety-six otoliths were sufficiently distinct to permit measurement of nuclei length. A plot of the length-frequency distribution of otolith nuclei illustrates a group of fish exhibiting summer steelhead traits (Appendix G). Otolith nuclei measurements ranged from 0.21 to 0.42 mm and averaged 0.31 mm. Summer steelhead otolith nuclei as measured by McKern et al. (1974) and Rybock et al. (1975) averaged 0.348 mm and 0.354 mm, respectively.

No correlation existed between fish length and otolith nuclei measurement ($r^2 = 0.01$). Fish ranged from 120 to 230 mm. There was no difference between nuclei measurements of fish from Big Creek ($x = 0.30$) and Loon Creek ($\bar{x} = 0.31$).

Rainbow trout which Rybock et al. (1975) examined had otolith nuclei measurements averaging 0.245 mm. Based on this analysis, the fish sampled from Big and Loon creeks exhibited characteristics of juvenile steelhead rather than resident rainbow trout.

Main Salmon River Sport Fishery

In 1981-82, sport anglers continued to harvest wild steelhead destined for the Middle Fork in the main Salmon River below its confluence with the Middle Fork.

1981-1982 Annual Harvest Estimate

Total annual steelhead harvest estimates are drawn via a mail questionnaire survey from a random sample of steelhead permit-holders (Pollard 1983).

To supplement the sections 4 and 5 (Salmon River from South Fork to North Fork) estimates and obtain harvest composition data, an angler check station has been operated identically each year at the North Fork since the 1960's (Ball 1983). In the fall of 1981, we also operated a check station in section 4 (Thurow 1982). Data from these three sources were used in the following computations for estimating the harvest of wild steelhead.

Pollard (1983) estimated a fall 1981 harvest of 1,682 steelhead in section 4. This estimate increased by 63% (1,034 to 1,682) as compared to the fall 1980 harvest estimate. During the same period at the North Fork check station, angler effort increased 42% and the number of fish harvested increased by just 8% (Reingold 1982).

Thurow (1982) made a preliminary estimate for the fall 1981 harvest of 1,210 steelhead in section 4 by applying the fall North Fork check station observations to the percent of the total harvest seen since 1976. That estimate was based on limited data and I revised these calculations based on the data of Pollard (1983). Bank anglers within the 11.3 km roaded section exerted 52% of the section 4 effort (angler days), harvested 29% of the total catch, and creeled 35% of the total wild fish harvested. As Thurow (1982) observed, the disproportionate harvest of wild fish in the roaded section may be a result of wild fish staging there. The remainder of the effort and catch in section 4 occurred in the unroaded zone between Corn Creek and the South Fork Salmon River.

Wild steelhead comprised 50% of the fall 1981 harvest in section 4 (Thurow 1982), so an estimated 841 (1,682 x 0.5) wild fish were creeled. Since 84% of the 1981-1982 harvest occurred in fall (Ball 1983), the total fall and spring harvest equalled 2,002 (1,682 .084) and 320 steel head were caught in spring. Since wild fish comprised 64% (Ball 1983) of the spring harvest, an estimated 205 wild fish were creeled in the spring. An estimated 1,046 wild steelhead were harvested in section 4 during the fall 1981-spring 1982 season.

Anglers also caught steelhead in sections 1, 2, and 3 and Pollard(1983) estimated harvest of 1,226,800, and 1,524, respectively, in the fall of 1981. Wild steelhead comprised approximately 39%, 25%, and 8% of the harvest in sections 1, 2, and 3, respectively (Lindland and Bowler 1982). The proportion of wild fish was much lower in these areas in 1981 than in 1980, when nearly 50% of the catch was wild. The decrease in the percentage of wild fish in sections 2 and 3 is surprising, and it may be due to wild fish rapidly moving through those areas to stage in upstream areas. Since the 48 km stretch from Vinegar Creek to the South Fork was not censused, the percent of wild fish reported may not be representative of the entire section 3 harvest.

An estimated 478, 200, and 122 wild steelhead were creeled in sections 1, 2, and 3 in the fall 1981 fishery. I assumed that 84% of the fishery also occurred in the fall, so the combined section 1, 2, and 3 harvest totalled 4,226 (3,550÷0.84) and the spring harvest totalled 676. No creel data was collected in sections 1, 2, and 3 in the spring of 1982, so I applied the spring of 1981 percentage of wild fish (89%) (Thurow 1982) and estimated that 602 wild fish were creeled in the spring of 1982. A combined total estimate of 1,402 (800 + 602) wild fish were harvested in sections 1, 2, and 3 during the fall 1981-spring 1982 fishery.

Estimated Exploitation of Middle Fork Steelhead

The total estimated harvest of wild steelhead in sections 1, 2, 3, and 4 equalled 2,448 (1,046 + 1,402) in the fall 1981-spring 1982 fishery.

Using the ratio of wild steelhead above and below the Middle Fork (Reingold 1981), I calculated that 81% of the wild steelhead in section 4 in the fall of 1981 were destined for the Middle Fork. In the spring of 1982, 85% of the wild steelhead in section 4 were destined for the Middle Fork. As Thurow (1982) observed, some wild steelhead destined for the Middle Fork wander above the Middle Fork in the fall, so the 81% value underestimates.

Applying these values, 681 (841 x 0.81) Middle Fork-stock steelhead were harvested in section 4 in the fall of 1981 and 174 (205 x 0.85) were harvested in the spring of 1982, for a total section 4 harvest of 855 Middle Fork stock steelhead.

Since the percentage of wild steelhead decreased in sections 1 through 3 and increased again in section 4, I could not calculate the percentage of the wild run which was destined for the South Fork Salmon River. Reingold (1981) estimated that 22% of the wild run in section 3 was destined for the South Fork in the fall of 1980, and I applied that estimate. If 22% of the wild steelhead in sections 1, 2, and 3 were destined for the South Fork, 624 (800 x 0.78) were upriver wild fish and 505 (624 x 0.81) were destined for the Middle Fork. In spring, 470 (602 x 0.78) were upriver wild fish and 400 (470 x 0.85) were destined for the Middle Fork.

The total estimated harvest of Middle Fork-stock steelhead in sections 1, 2, 3, and 4 equalled 1,760 (855 + 905).

Fall 1982 Section 4 Fishery

A new regulation was instituted in section 4 in 1982 to reduce the harvest of wild steelhead. From Vinegar Creek boat ramp (35 km below the South Fork Salmon) to Long Tom Creek (400 m upstream from the Middle Fork), only steelhead with dorsal fins measuring 57 mm (2.25 in) or less in height or trophy steelhead 94 cm (37 in) or greater in total length could be reduced to possession. Steelhead less than 94 cm with dorsal fins exceeding 57 mm had to be immediately released unharmed. Barbless hooks were required.

The regulation was based on data which illustrates that 96-to-97% of the wild fish have a dorsal fin which exceeds 57 mm in height (Fig. 16, Thurow 1982), while 96% of the hatchery-reared steelhead have a dorsal fin less than 57 mm (Reingold 1982). Of 237 dorsal fins we measured on wild fish in 1981 and 1982, only nine did not exceed 57 mm.

The "trophy" steelhead regulations were based on measurements of 834 wild fish in the Salmon River, section 4, from the fall 1979 to the fall of 1982. The 834 fish were comprised of 199 wild steelhead measured on the Middle Fork and 633 measured on the main Salmon River. Nineteen fish exceeded 94 cm (2.3%) and 17 of those 19 (89%) were males (Fig. 17). If the "trophy" regulation had been set at 91 cm, 6% of the catch would have been harvested and 30% would have been females.

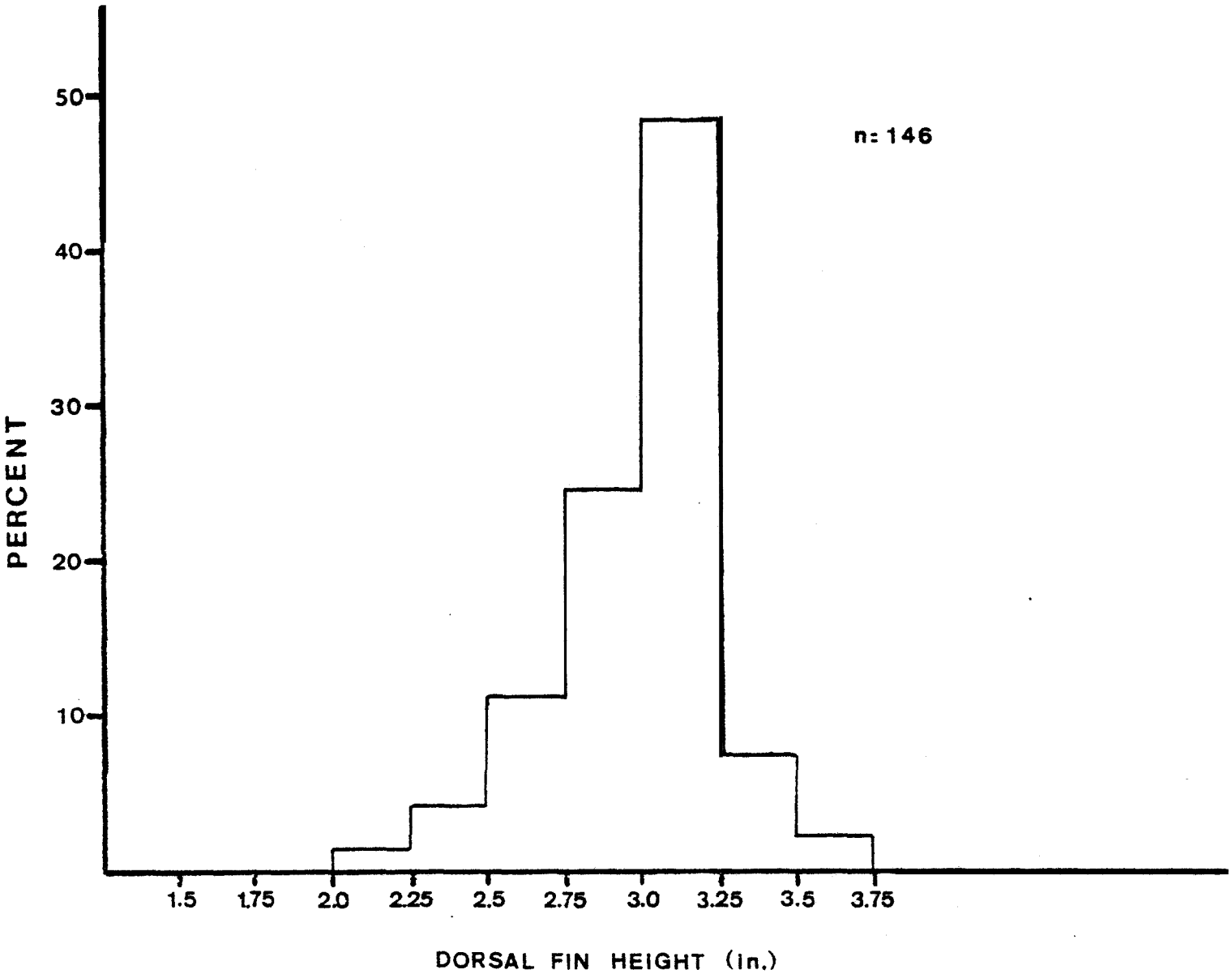

Figure 16. Maximum height of dorsal fins measured on wild steelhead caught by project personnel, spring 1982.

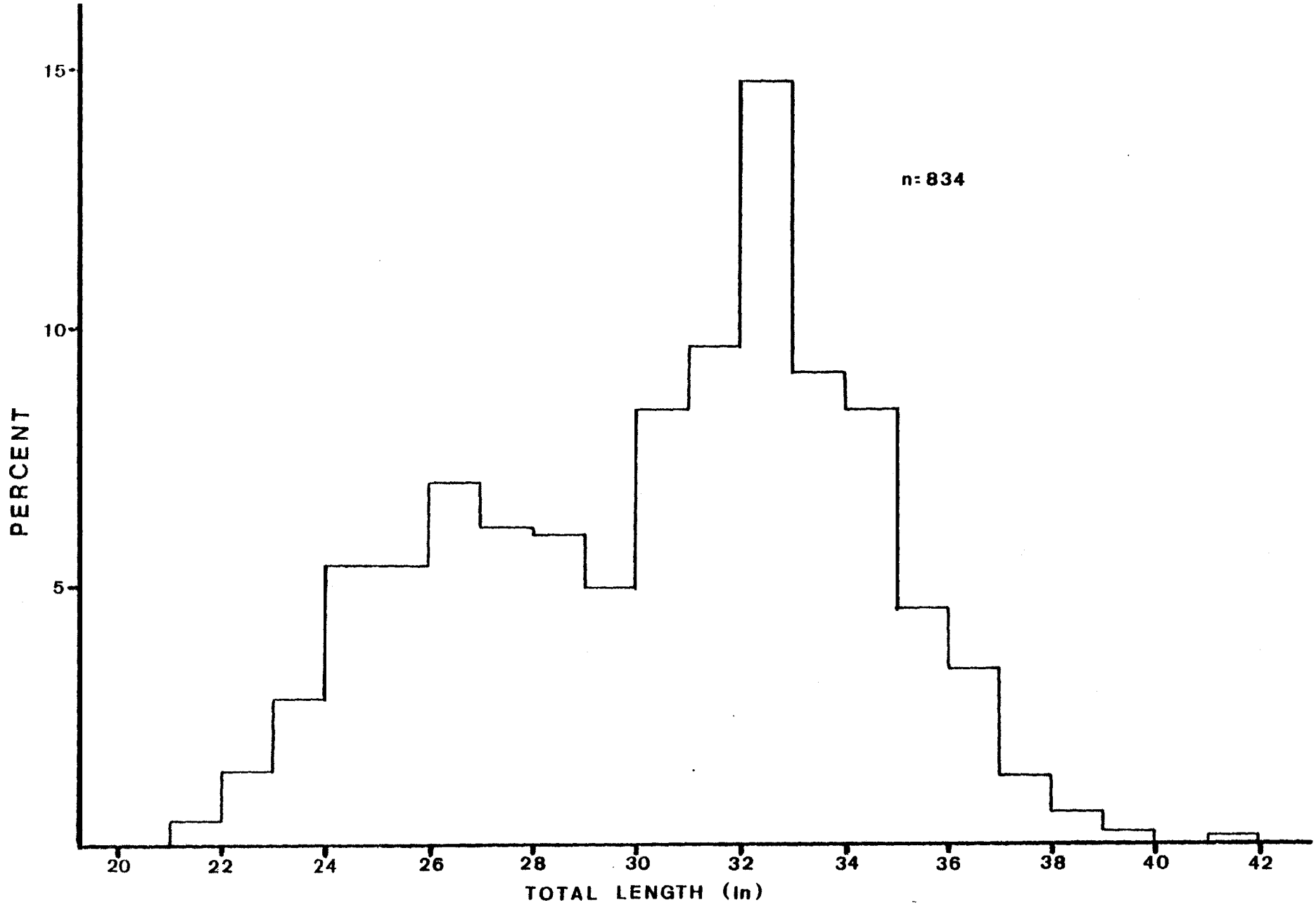

Figure 17. Length frequency of wild steelhead trout caught by project personnel and anglers, Salmon River, section 4, fall 1979-fall 1982.

As a result of the fall 1982 regulations, few wild steelhead were harvested in section 4. Of 362 creeled steelhead we checked, six fish (1.7%) were wild (three exceeded 94 cm, three were less than 63 cm) (Table 7). We estimated that 40 wild steelhead were harvested in section 4 in the fall of 1982.

Although the escapement of wild steelhead to the Salmon River decreased in the fall of 1982, a substantial number of wild fish were released. Preliminary estimates illustrate that about 660 wild steelhead were released in section 4. Calculations were based on an estimated fall 1982 section 4 harvest of 1,000 fish (North Fork count of 152 = 15% of the total fall estimate observed) and a total of 818 fish released (45% of total catch), of which 81% were wild.

An estimated 82% of the wild fish in section 4 were destined for the Middle Fork, so 541 (660 x 0.82) wild, Middle Fork steelhead escaped the fall 1982 fishery as a result of the special regulations.

Bank Anglers

We censused 508 bank anglers within the seven-mile roaded zone of section 4 who creeled 74 fish and released 129 between 18 September and 18 November 1982 (Table 7). Catch rates fluctuated from less than six hours/fish on 17 October, to more than 60 hours/fish on 28 Septmeber. The seasonal catch rate (creeled and released) averaged 13.9 hours/fish, as compared to 19.1 hours/fish in October-November 1981.

During the fall period, wild steelhead comprised 49% of the fish caught in 1982 and 74% of the fish released. In 1981, wild fish comprised 65% of the fish caught and 85% of the fish released.

I compared bank angler effort and catch in section 4 during two identical intervals in 1981 and 1982. Numbers of anglers decreased by 41% and effort decreased by 58% from 1981 to 1982 (Table 8). In 1982, creeled steelhead decreased by 53%, but 21% more fish were released and catch rates were 27% better {14.2 vs. 19.4 hours/fish).

In contrast, angler effort in section 5, as reflected by North Fork check station data, attained a record high, with a 49% increase in effort from 1981 to 1982 (Ball 1983). As a result, bank anglers in section 4 experienced good catch rates, but conditions were less crowded than in section 5.

Table 7. Summary of angler creel data for section 4, October-November 1982.

Source	Anglers	Fish creeled Total	Fish creeled wild	Fished released wild	Fished released hatchery	Total	Hours fished	Hours/fish caught	Census period
Bank angler census (Corn Creek to Middle Fork)									
check station	508	64	(0)	95	34	193	2677.5	13.9	18 Sept-18 "
Jet boat angler census (South Fork to Corn Creek)									
check station	120	61	(1)	26	2	89	1136.5	12.8	18 Sept-18 "
jet boat	205	44	(0)	- 30 -		75	1531.0	20.7	7 Oct-14 "
Outfitter volunteer data (South Fork to Corn Creek)									
outfitter 1	unk.	75	(0)	31	2	108	unk.	unk.	7 Oct-13 Nov
outfitter 2	unk.	49	(1)	21	9	79	unk.	unk.	7 Oct-13 "
outfitter 3	unk.	69	(4)	28	3	100	unk.	unk.	7 Oct-18
Grand Totals		362	(6)	201	50	644			

Table 8. Angler effort and catch in section 4 during similar intervals, 1981 and 1982.

Interval	Anglers	Estimated Effort	Creeled No,	Creeled %	Released No.	Released %	%	Hours/F
10-23 October 1981	1019	5505	189	66%	98	34%	69%	19.2
9-22 October 1982	587	2552	81	45%	100	55	43%	14.1
% Change	-42%	-54%	-57%		+2%			+27%
7-20 November 1981	576	2754	101	73%	37	27%	54%	19.9
6-19 November 1982	352	1702	56	47%	63	53%	23%	14.3
% Change	-39%	-38%	-45%		+70%			+24%

The fall escapement of wild fish in section 4 was diminished in 1982 as compared to 1981. In 1981, a mean of 74% of the fish caught during the two identical intervals were wild steelhead, while in 1982 35% of the fish caught were wild steelhead (Table 8). Although the escapement of hatchery fish increased from 1981 to 1982, fewer wild fish were present. Due to the catch-and-release regulations on wild fish in 1982, it is probable that some wild fish were caught-and-released more than once. This factor would artificially inflate the estimated percentage of wild fish in the catch.

The hatchery escapement into the Salmon River was estimated at 10,500 fish in 1981 and 16,000 fish in 1982 (Ball 1983). A combination of more hatchery steelhead and less wild steelhead resulted in smaller percentages of wild fish in the catch.

Wild steelhead destined for the Middle Fork apparently stage in section 4 above Corn Creek as Thurow (1982) observed. Although 49% of the fall 1982 catch from Corn Creek to the Middle Fork was comprised of wild steelhead, only 30% of the catch from the South Fork Salmon to Corn Creek was comprised of wild steelhead (Table 7).

Jet Boat Anglers

Outfitters recorded a catch of 287 fish, of which 28% were wild (Table 7). In contrast, in 1981, 44% of the fish caught by jet boat anglers in section 4 were wild (Thurow 1982). Wild fish were also less abundant in the canyon area (below Corn Creek) in 1982 as compared to 1981.

Catch rates for jet boat anglers were comparable in 1981 (16.3 hours/fish) and 1982 (16.4 hours/fish). Jet boat anglers released 34% of their catch, compared to bank anglers who released 67% of their catch. Jet boat anglers released just 6% of the hatchery fish caught, as compared to 35% of the hatchery steelhead released by bank anglers.

Hatchery-reared steelhead in section 4 ranged from 56 to 94 cm and most (60%) averaged from 68 to 79 cm (Fig. 18). Eight percent of the hatchery steelhead exceeded 81 cm and a majority of these (84%) were not harvested until after 1 November. Most hatchery steelhead larger than 81 cm were 'B" stock Clearwater River transplants. Ninety-eight percent of the known stock (coded-wire tag returns) Pahsimeroi Hatchery returnees larger than 81 cm were "8" stock fish (K. Ball, IFG, personal communications 1983).

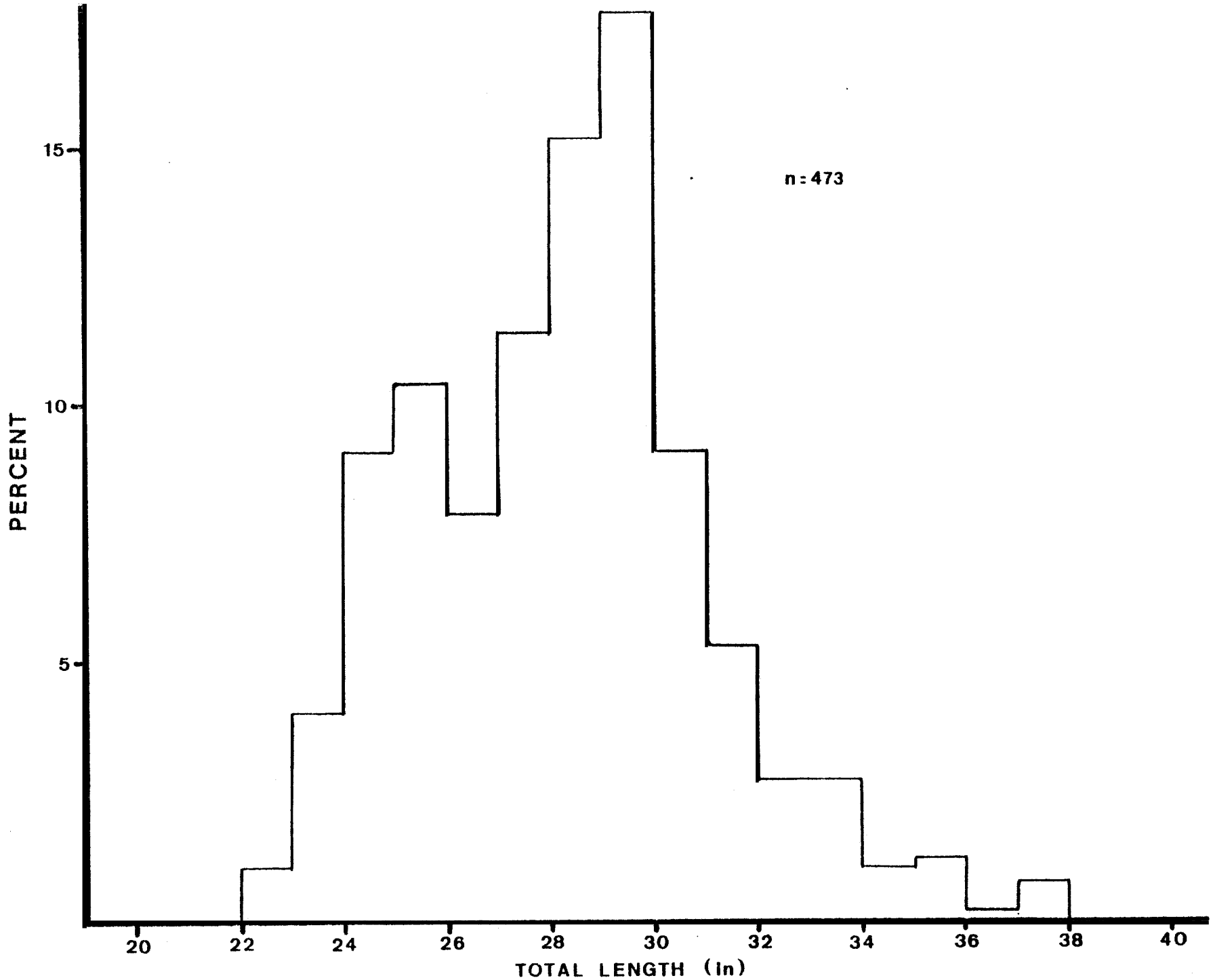

Figure 18. Length frequency of hatchery steelhead caught by anglers in Salmon River, section 4, September-November 1982.

DISCUSSION

Status of Wild Steelhead

Estimated annual spawning escapements to the Middle Fork declined steadily between 1970-71 and 1975-76, fluctuated between 1976-77 and 1979-80, and increased gradually from 1979-80 to the present (Appendix H). Current spawning escapements remain far below pre-1972 levels. The principal cause of the decline has been the excessive mortality on steelhead smolts migrating past the Snake and Columbia River dams. As Raymond (1979) observed, dams constructed on the Snake River since 1966 have adversely affected survival and delayed migration of juveniles. The extremely low escapements in 1975 and 1976 were caused by catastrophic losses during the spring 1973 outmigration, which resulted in a net survival of juveniles to Bonneville Dam of 4-5% (Raymond 1979). Escapements increased in 1977 and 1978, but decreased sharply during the next two years as a result of mortality rates approaching 99% during the spring 1977 outmigration (Raymond and Sims 1980).

The sport fishery has also had a significant effect on the spawning escapement to the Middle Fork. In 1980-81, anglers harvested an estimated 665 wild, Middle Fork steelhead in section 4 and an additional 1,236 in sections 1, 2, and 3 (Thurow 1982). This harvest equates to an exploitation rate of 50% (Appendix H). In 1981-82, an estimated 2,896 Middle Fork steelhead entered section 4, the largest run since 1974. However, anglers harvested 885 of the fish and slightly more than 2,000 escaped to spawn. An addtional 905 fish were harvested in sections 1, 2, and 3, resulting in an exploitation rate of 47%.

In 1982-83, regulations were designed to require anglers to release 97% of the wild steelhead caught between Vinegar Creek and the Middle Fork (48 km of section 3, all of section 4) in the fall. The regulation was extended to the mouth of the Salmon River in the spring. I estimated that anglers released 540 Middle Fork steelhead in section 4 during the fall. Data was not available to estimate the section 1-3 catch or the spring catch. Had anglers been allowed to kill wild fish, less than 1,500 adults would have escaped to spawn in the Middle Fork. The special regulations significantly increased the 1983 spawning escapement of wild Middle Fork stock steelhead.

Increased screening of turbine intakes and mass transportation of steelhead smolts was begun in 1975 (Park et al. 1983) and coupled with other improvements in dam passage, these appear to have improved steelhead smolt survival. As continued improvements are made, smolt-to-adult returns will continue to improve and result in larger adult escapements to the Middle Fork. Steelhead smolt survival from Lower Granite to John Day dams in 1982 was the highest since 1968 (C. Sims, NMFS 1983, personal communication).

Since Middle Fork-stock steelhead are principally two-ocean fish, the results of low adult escapements are manifested in correspondingly low escapements five years later. Also, the result of excessive juvenile mortality rates during the spring outmigration are manifested in low escapements three years later. Conversely, results of larger escapements will also be manifested in larger adult returns four and five years later.

The return of Middle Fork steelhead in 1984 can be expected to be similar to that of 1983. As a result of larger adult returns in 1980-81, the run could be expected to increase in 1985.

Juvenile steelhead rearing densities remained less than the carrying capacity in 1982. As we observed in 1981, the Middle Fork drainage supports abundant and high-quality spawning and rearing habitat for steelhead trout. The low adult escapements since 1972 have been the major factor limiting the use of this habitat. Given the vast amount of high-quality habitat, existing production is probably very efficient. It is imperative that abundant and quality habitat be maintained to insure optimal spawning-and-rearing conditions.

Implementation of Differential Harvest Regulations

The steelhead regulations adopted for the Salmon River in September 1982 allowed a liberal harvest of hatchery steelhead while aiding the rehabilitation of a diminished wild stock. The regulations were instrumental in meeting two statewide fishery management goals. First, by virtually eliminating the wild steelhead harvest in section 4, a larger number of wild steelhead (estimated 540 wild steelhead released) escaped to spawn. This increased escapement will help to restore native, wild steelhead to the Middle Fork Salmon River drainage. The regulations were especially timely since the escapement of wild steelhead was reduced in 1982. Since wild Middle Fork stocks also migrate through the lower Salmon River, additional creel data should be collected to determine the impact of the sport fishery in that area.

Secondly, the special regulations varied sport angling opportunities by providing anglers a choice of regulations and angling quality factors. In 1982, anglers could choose to fish in sections 5 or 6 where no gear restrictions were required and all fish (wild or hatchery) were legally harvestable. Due to these regulations and due to the available road access, large numbers of anglers selected this area to fish. Anglers could also fish in section 4 where barbless hooks were required and nearly all wild fish had to be released. Significantly more anglers chose to fish in section 5 and effort increased 49% from 1981 to 1982, while in section 4 effort decreased. As a result, bank anglers in section 4 enjoyed less crowded fishing conditions and improved catch rates.

Public acceptance of the special regulations appeared to be wide-spread, although we did not conduct an opinion survey. Anglers we interviewed in section 4 were generally knowledgeable about the new regulations and supportive of them. Anglers also continued to completely fill jet boat trips with outfitters in the unroaded area below Corn Creek and jet boat operators were supportive of the regulations (M. Reingold, personal communications).

A review of Idaho angler attitudes may help define why special regulations to protect wild steelhead were accepted. Most Idaho anglers fish for sport and. to enjoy the outdoors. Only 12% listed "getting fish for food" as their primary reason for fishing in response to a 1977 questionnaire (Mallet 1980). Mallet also found that most anglers (69%) placed more emphasis in the protection and enhancement of wild trout populations.

The special regulations can also be evaluated on economic factors. Meyer (1982) assessed the net monetary value of Columbia River steelhead trout based on the value of surplus fish harvested. Based on his model, each escaping steelhead spawner (to insure stock replacement) was worth $359. In comparison, each sport-caught fish was worth $214. From another approach, a steelhead which is caught-and-released maintains the same monetary value (the transfer costs to the angler would be the same) as a steelhead which is harvested, plus the additional value of the released fish as an escaping spawner. From a purely economic viewpoint, it could be argued that steelhead from a diminished stock become too valuable to harvest.

The current "trophy" steelhead regulation was initiated to allow anglers to harvest what may be the largest steelhead they have ever caught. It was surmised that such a regulation would assist public acceptance of the new "catch-and-release" regulations. Perhaps it is now timely to re-evaluate this trophy aspect. It is possible that wild fish near 94 cm in length are extensively handled and suffer more mortality than smaller wild fish which are immediately released. The small proportion of the very large (>94 cm) fish may also emphasize their importance as spawners and warrant their release.

Future differential harvest regulations will be dependent on angler acceptance and on the continued physical recognition of wild and hatchery stocks. The hatchery steelhead we observed in 1982 were readily recognized from wild fish by using the 57 mm (2.25 in) dorsal fin measurement. Most had dorsal fins which were less than 25 mm tall and many had completely "clubbed" fins. Consequently, experienced anglers were able to recognize wild or hatchery steelhead before the fish were landed and only a small proportion of the fish had to be measured.

Beginning in 1984, 100% of the hatchery-reared steel head in Idaho will receive a fin clip prior to release. This mark will enable managers to continue to apply differential harvest regulations to help restore wild steelhead stocks while harvesting surplus hatchery steelhead. Other states and provinces have recognized the value of these regulations. The Oregon Department of Fish and Wildlife clips fins on all hatchery steelhead smolts released in the Descutes River (Don Swartz, ODFW, Portland, personal communications 1983) and the Fish and Wildlife Branch clips fins on all of its hatchery steelhead smolts in British Columbia (A. Taudz, B. C. Fish and Wildlife Branch, Victoria, personal communications 1983).

An alternative mass-marking technique may be more feasible than handling and fin-clipping mass numbers of smolts. It is perhaps timely to instigate an updated review of mass-marking techniques. Significant technological advances may have occurred in the last decade, and it may be possible to locate or encourage development of a suitable technique. Obviously, such a technique would have widespread application in all states and provinces where mixed-stock fisheries occur.

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APPENDICES

Appendix A

A GENETIC ANALYSIS OF COLUMBIA RIVER STEELHEAD TROUT

Prepared for

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INTRODUCTION

Salmonid populations from upriver areas of the Columbia Basin are currently in a dynamic state. Many stocks are declining because of severe habitat degradation while others are increasing in response to mitigative and enhancement efforts. A multitude of factors including dam construction, poor farming and grazing practices, and overfishing have reduced populations to remnants of their former size. Many mitigative and cultural efforts have failed because of high mortality rates experienced by both adult and juvenile migrants passing dams. However, increased hatchery production and transportation of smolts around dams via trucks and barges are resulting in good adult steelhead returns to upriver areas.

Summer steelhead runs were at the lowest levels in history during 1974 and 1975. This can be correlated with estimates of 95% dam mortality for all downstream smolt migrants in 1973. The currently increasing Columbia steelhead runs can be directly attributable to the replacement of declining stocks with hatchery production. Sixty to eighty per cent of the Snake River returns are the result of releases from Dworshak and Pahsimeroi hatcheries (Raymond, 197S). Thus, the genetic assessment of the remaining wild stocks is timely in view of these facts.

The Middle Fork Salmon River is one of the few remaining rivers in the Columbia Basin which sustains unaltered wild summer

steelhead runs. As such the Middle Fork drainage is currently managed for the production and preservation of its wild, indigenous steelhead. In this paper we electrophoretically examine five collections of wild steelhead from the Middle Fork Salmon River and adjacent Chamberlain Creek. These results are used in conjunction with results from Allendorf (1975) and Milner et al. (1980) to identify the genetic structure and relationships of steelhead populations in the Columbia River Basin.

MATERIALS AND METHODS

Steelhead trout juveniles were collected by personnel of the Idaho Department of Fish and Game using hook and line. Approximately 380 specimens were collected during the falls of 1981 and 1982. They originated from four separate streams. Three of these streams (Big, Loon, and Marble Creeks) are within the Middle Fork drainage of the Salmon River. Chamberlain Creek is a tributary to the mainstem of the Salmon River below the confluence of the Middle Fork of the Salmon River (Appendix 1). Collections from Big and Loon Creeks were made during 1981. A second collection from Big Creek was made during 1982 along with collections from Chamberlain and Marble Creeks.

Fish were frozen upon collection and remained frozen through shipment and storage up to 4 months. Prior to the electrophoretic analysis, each fish was thawed, and one eye and a piece of liver and a piece of muscle tissue were extracted. Extractions were placed in culture tubes to which an equal volume water had been added, homogenized to free soluable proteins from the cells, and then centrifuged.

Electrophoresis followed procedures outlined in Utter et al. (1974) and May et al. (1979). Three buffer systems were used: (1) MF--a tris-boric acid-EDTA gel and tray buffer (pH 8.5) (Markert and Faulhaber, 1965); (2) RW--a Iris-citric acid gel buffer (pH 8.5), lithium hydroxide-boric acid tray buffer (pH

8.5) (Ridgway et al., 1970); and (3) AC--an amine citrate gel and tray buffer (pH 6.5) (Clayton and Tretiak:, 1972). Staining for enzyme activity followed methods outlined in Harris and Hopkinson (1976) and Allendorf et al., (1977). A list of the protein stains used, their abbreviations, and the numbers of loci expressed are given in Table 1. A system of nomenclature outlined in Allendorf and Utter (1979) was used so that the collected data would be comparable to the previously published data.

Nei's (Nei, 1978) genetic distance (D) measure was used to quantify the degree of differentiation between populations. A matrix of (D) values between all pairs of populations was generated and used to construct a phenogram using the unweighted average linkage method (UALM) (Sneath and Sokal, 1973).

A hierarchial gene diversity analysis following the computational methods of Wright (1978) and the procedures of Nei (1977) was performed. Total gene diversity was apportioned into three hierarchial levels (populations, river systems, and drainages) according to the model:

$$H_T = H_P + D_{PR} + D_{RD} + D_{DT}$$

where H_T = Total gene diversity

H_P = Gene diversity within populations

D_{PR} = Gene diversity among populations within rivers

D_{RD} = Gene diversity among rivers within drainages

D_{DT} = Gene diversity among drainages

Table 1. Designation of loci coding for the different enzymes and proteins. Abbreviations and Enzyme Commission numbers are also given.

Enzyme	Abbreviation	Locus designation (if multiple)	Enzyme Commission Number
Aconitase	ACO		
Adenosine deaminase	ADA		3.5.4.4
Alcohol dehydrogenase	ADH		1.1.1.1
Creatine kinase	CK	1 2	2.7.3.2
Glycerol-3-phosphate dehydrogenase	AGPD	1 2 4	1.1.1.8
Glucose phosphate isomerase	GPI	1 2 3	5.3.1.9
Isocitrate dehydrogenase	IDH	3 4	1.1.1.42
Lactate dehydrogenase	LDH	1 2 3 4 5	1.1.1.27
Malate dehydrogenase	MDH	1 3 4	1.1.1.37
Mannose phosphate isomerase	PMI		5.3.1.8
Peptidase 1/	GL	1	3.4.11
Peptidase 2/	LGG		3.4.11
Phosohoglucomutase	PGM		2.7.5.1

1/ Resolved using glycyl leucine
2/ Resolved using leucylglycylglycine

Table 1. continue.

Enzyme	Abbreviation	Locus designation (if multiple)	Enzyme Commission Number
Phosphogluconate dehydrogenase	6P6		1.1.1.43
Superoxide dismutase	SOD		1.15.1.1

The relative magnitude of gene differentiation can then be calculated at each level so that:

G_{Pr} = Proportion of gene diversity among populations within river systems

G_{RD} = Proportion of gene diversity among river systems within drainages

G_{DT} = Proportion of gene diversity among drainages

A set of values for each locus was obtained and then summed over all loci.

RESULTS

The objectives of this study were to survey the Middle Fork of the Salmon River including Chamberlain Creek and to compare the results with previous data from Columbia River steelhead trout. To this end a large number of loci were initially screened. A total of twenty four loci were consistently resolved in the 1981 samples. Six additional loci (ACO, ADA, AGP-3, AGP-4, IDH-33, IDH-4) for a total of thirty loci were resolved in the 1982 samples (Table 1). Of these thirty loci, thirteen--ACO, ADA, AGP-4. GL-1, IDH-3,4, PMI, LDH-4, LGG, MDH-3, SOD, GPI-1, and GPI-3--were polymorphic in at least one of the populations surveyed (Table 2). Variation at the ACO and ADA loci has not been previously reported. Mean heterozygosities calculated from Hardy-Weinberg expected values ranged from .031 to .037. These values are consistent with previous heterozygosity estimates for steelhead trout (Allendorf and Utter, 1979).

The 1981 and 1982 collections from Big Creek were compared by a chi-square contingency analysis to test for between year significant frequency differences. Only one significant value (chi square = 3.95, 1 df) was obtained at the MDH-3 locus. This low level of heterogeneity is consistent with what would be expected of a stable, random mating populations, and the two samples were pooled for the remaining analyses.

Significant allele frequency differences based on a chi

Table 2. Sample size and allele frequencies for each polymorphic locus in steelhead trout. Data are from this study and Milner et al (1980) and Allendorf (1975). Dashes (---) indicate that the resolution was too poor to accurately score or that the data was not taken on a particular locus.

Location	Brood Year	N	ACO 100	ACO 82	ACO 90	ADA 100	ADH 100	AGP1 100	AGP2 100	AGP4 100
CLEARWATER										
Dworshak	76,77	482	---	---	---	---	1.00	1.00	.97	---
Selway	77	178	---	---	---	---	1.00	1.00	1.00	---
MIDDLE FORK SALMON RIVER										
Bear Valley	77	178	---	---	---	---	1.00	1.00	1.00	---
Elk	77	56	---	---	---	---	---	---	---	---
Marsh	77	32	---	---	---	---	1.00	---	---	---
Loon	80	87	---	---	---	---	1.00	1.00	1.00	---
Marble	81	99	.77	.16	.07	.98	1.00	1.00	1.00	.79
Big	80	32	---	---	---	---	1.00	1.00	1.00	---
Big	81	59	.67	.21	.12	.95	1.00	1.00	1.00	.69
Big(pooled)	80,81	91	---	---	---	---	1.00	1.00	1.00	---
SOUTH FORK SALMON RIVER										
Buckthorn	77	78	---	---	---	---	1.00	1.00	1.00	---
Headwaters-1	77	168	---	---	---	---	.99	1.00	1.00	---
Headwaters-2	77	132	---	---	---	---	1.00	1.00	1.00	---
SALMON RIVER										
Pahsimeroi	70,71,77	80	---	---	---	---	1.00	.99	---	---
White Bird	77	136	---	---	---	---	1.00	1.00	1.00	---
Chamberlain	81	97	.69	.25	.06	.93	1.00	1.00	1.00	.69
LITTLE SALMON										
Mainstem	77	108	---	---	---	---	1.00	1.00	1.00	---
IMNAHA										
Gumboot	78	100	---	---	---	---	1.00	1.00	1.00	.74
NIAGRA SPRINGS	78	200	---	---	---	---	.99	.99	1.00	---
TUCANON	77	288	---	---	---	---	1.00	.80	1.00	.71
MIDDLE COLUMBIA										
Chelan	74,76	388	---	---	---	---	1.00	.97	1.00	---
Wells	74,76	178	---	---	---	---	1.00	.99	1.00	---
LOWER COLUMBIA										
Kalama	72-75	1742	---	---	---	---	1.00	.94	1.00	---
Cowlitz	78	200	---	---	---	---	1.00	.82	1.00	.80
Skamania	74,77-78	1990	---	---	---	---	.91	.86	1.00	.92
WILLAMETTE										
S. Santiam	78	200	---	---	---	---	1.00	.90	.86	.76

Table 2. Continue.

Location	Brood Year	N	LDH4			LGG	MDH1	MDH3			
			100	76	120	100	100	100	81	120	76
CLEARWATER											
Dworshak	76,77	482	.31	.69	.00	1.00	1.00	.99	.01	.00	.00
Selway	77	178	.28	.72	.00	1.00	1.00	.97	.03	.00	.00
MIDDLE FORK SALMON RIVER											
Bear Valley	77	178	.24	.76	.00	1.00	1.00	---	---	---	---
Elk	77	56	.21	.79	.00	1.00	1.00	1.00	.00	.00	.00
Marsh	77	32	.47	.53	.00	1.00	1.00	.98	.02	.00	.00
Loon	80	87	.32	.68	.00	1.00	1.00	.99	.01	.00	.00
Marble	81	99	.42	.57	.01	1.00	1.00	.98	.02	.00	.00
Big	80	32	.28	.72	.00	1.00	1.00	1.00	.00	.00	.00
Big	81	59	.22	.76	.02	.98	1.00	.94	.06	.00	.00
Big(pooled)	80,81	91	.24	.75	.01	.99	1.00	.96	.04	.00	.00
SOUTH FORK SALMON RIVER											
Buckthorn	77	78	.28	.72	.00	1.00	1.00	.99	.01	.00	.00
Headwaters-1	77	168	.26	.74	.00	1.00	1.00	1.00	.00	.00	.00
Headwaters-2	77	132	.39	.71	.00	1.00	1.00	.96	.04	.00	.00
SALMON RIVER											
Pahsimeroi	70,71,77	80	.39	.71	.00	---	.99	.99	.01	.00	.00
Hell Roaring	70,71,77	22	.15	.85	.00	.96	1.00	1.00	.00	.00	.00
White Bird	77	136	.27	.73	.00	.94	1.00	1.00	.00	.00	.00
Chamberlain	81	97	.24	.73	.03	1.00	1.00	.98	.00	.01	.01
LITTLE SALMON											
Mainstem	77	108	.18	.82	.00	1.00	1.00	1.00	.00	.00	.00
IMNAHA											
Gumboot	78	100	.34	.66	.00	1.00	1.00	1.00	.00	.00	.00
NIAGRA SPRINGS	78	200	.33	.67	.00	1.00	1.00	1.00	.00	.00	.00
TUCANON	77	288	.66	.20	.13	1.00	1.00	.96	.04	.00	.00
MIDDLE COLUMBIA											
Chelan	74,76	388	.38	.62	.00	1.00	1.00	.97	.01	.02	.00
Wells	74,76	178	.50	.50	.00	.98	1.00	.97	.03	.01	.00
LOWER COLUMBIA											
Kalama	72-75	1742	.81	.19	.00	---	1.00	.91	.08	.01	.00
Cowlitz	78	200	.80	.20	.00	1.00	1.00	.87	.12	.01	.01
Skamania	74,77-78	1990	.86	.14	.00	1.00	1.00	.91	.08	.00	.01
WILLAMETTE											
S. Santiam	78	200	.90	.10	.00	1.00	1.00	.78	.22	.00	.00

Table 2. Continue.

Location	Brood Year	N	GL1 100	GL1 111	GL1 94	IDH-3,4 100	IDH-3,4 38	IDH-3,4 67	IDH-3,4 171	PGM 100	PMI 100
CLEARWATER											
Dworshak	76,77	482	.47	.53	.00	1.00	.00	.00	.00	.99	1.00
Selway	77	178	.84	.16	.00	---	---	---	---	1.00	1.00
MIDDLE FORK SALMON RIVER											
Bear Valley	77	178	1.00	.00	.00	---	---	---	---	---	1.00
Elk	77	56	1.00	.00	.00	---	---	---	---	1.00	1.00
Marsh	77	32	1.00	.00	.00	---	---	---	---	1.00	1.00
Loon	80	87	.93	.07	.00	---	---	---	---	1.00	1.00
Marble	81	99	.98	.02	.00	.68	.15	.17	.00	1.00	1.00
Big	80	32	.92	.08	.00	---	---	---	---	1.00	1.00
Big	81	59	.97	.03	.00	.65	.16	.19	.00	1.00	1.00
Big(pooled)	80,81	91	.95	.05	.00	---	---	---	---	1.00	1.00
SOUTH FORK SALMON RIVER											
Buckthorn	77	78	.99	.01	.00	---	---	---	---	---	1.00
Headwaters-1	77	168	.83	.17	.00	---	---	---	---	1.00	1.00
Headwaters-2	77	132	.77	.23	.00	---	---	---	---	1.00	1.00
SALMON RIVER											
Pahsimeroi	70,71,77	80	---	---	---	.64	.14	.22	.00	1.00	---
White Bird	77	136	.97	.03	.00	---	---	---	---	1.00	.94
Chamberlain	81	97	.95	.04	.01	.67	.15	.18	.01	1.00	.98
LITTLE SALMON											
Mainstem	77	108	1.00	.00	.00	---	---	---	---	1.00	1.00
IMNAHA											
Gumboot	78	100	.90	.10	.00	.74	.15	.12	.00	1.00	.85
NIAGRA SPRINGS	78	200	.94	.06	.00	---	---	---	---	.98	1.00
TUCANON	77	288	.95	.05	.00	.72	.14	.11	.00	1.00	1.00
MIDDLE COLUMBIA											
Chelan	74,76	388	.91	.09	.00	.62	.24	.14	.00	1.00	1.00
Wells	74,76	178	.92	.08	.00	---	---	---	---	1.00	1.00
LOWER COLUMBIA											
Kalama	72-75	1742	.99	.01	.00	---	---	---	---	1.00	1.00
Cowlitz	78	200	.95	.02	.04	.68	.24	.14	.00	1.00	1.00
Skamania	74,77-78	1990	.98	.02	.00	.67	.15	.15	.00	1.00	1.00
WILLAMETTE											
S. Santiam	78	200	.99	.01	.00	.66	.18	.12	.02	1.00	1.00

Table 2. Continue.

Location	Brood Year	N	SOD 100	SOD 152	SOD 48	GPI1 147	GPI3 100
CLEARWATER							
Dworshak	76,77	482	1.00	.00	.00	---	1.00
Selway	77	178	.98	.01	.01	---	1.00
MIDDLE FORK SALMON RIVER							
Bear Valley	77	178	.89	.00	.11	---	1.00
Elk	77	56	---	---	---	---	1.00
Marsh	77	32	.94	.06	.00	---	1.00
Loon	80	87	.94	.01	.05	---	.99
Marble	81	99	.91	.01	.08	.00	1.00
Big	80	32	.88	.02	.10	---	.98
Big	81	59	.88	.00	.12	.09	1.00
Big(pooled)	80,81	91	.88	.01	.10	---	.99
SOUTH FORK SALMON RIVER							
Buckthorn	77	78	.89	.00	.11	---	1.00
Headwaters-1	77	168	.80	.01	.19	---	1.00
Headwaters-2	77	132	.97	.00	.03	---	1.00
SALMON RIVER							
Pahsimeroi	70,71,77	80	.94	.01	.05	---	---
White Bird	77	136	.94	.00	.08	---	1.00
Chamberlain	81	97	.96	.01	.03	.01	.99
LITTLE SALMON							
Mainstem	77	108	.97	.02	.01	---	1.00
IMNAHA							
Gumboot	78	100	.97	.02	.01	---	1.00
NIAGRA SPRINGS	78	200	.92	.04	.05	---	.99
TUCANON	77	288	.65	.35	.00	---	.88
MIDDLE COLUMBIA							
Chelan	74,76	388	.96	.06	.02	---	.97
Wells	74,76	178	.94	.05	.01	---	.97
LOWER COLUMBIA							
Kalama	72-75	1742	.69	.31	.00	---	.96
Cowlitz	78	200	.78	.22	.00	---	.96
Skamania	74,77-78	1990	.78	.22	.00	---	.96
WILLAMETTE							
S. Santiam	78	200	.71	.29	.00	---	.98

square contingency analysis exist among the four populations of the Snake River analyzed in this study (Table 3). Big Creek is set apart by its unique frequency for the $_{GpI1!147\}}$ allele, and Marble Creek has a significantly higher frequency of the LDH-4(100} allele than any of the other populations screened. Big Creek and Loon Creek showed no significance differences, although GPI-1 data was not available for Loon Creek. These heterogenous results indicate that locally isolated populations of summer steelhead trout exist within the confines of the Middle Fork Salmon drainage.

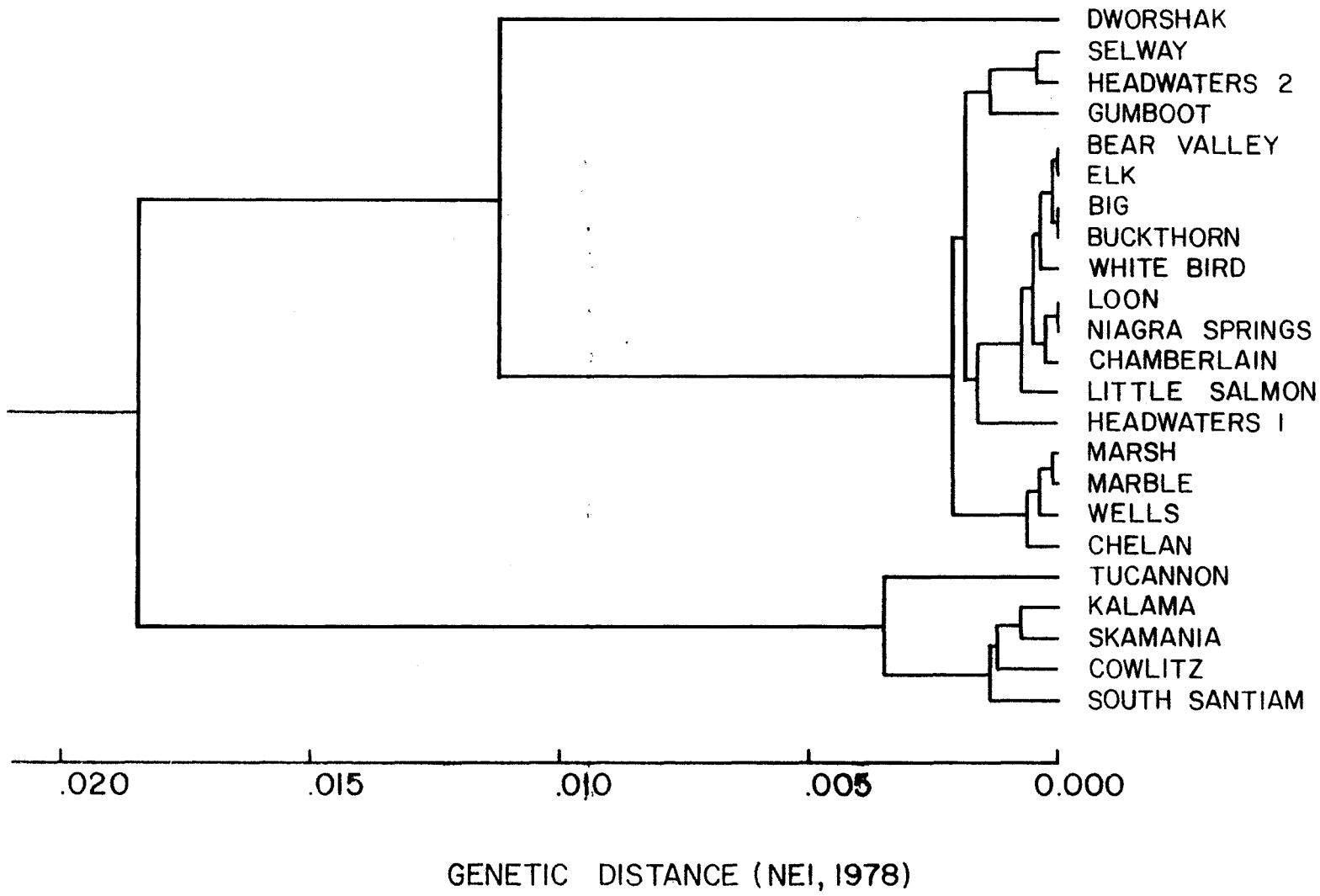
The results of this study were compared to other available data from steelhead trout of the Snake and Columbia Rivers. The low frequency of the LDH-4(100) allele and the high frequency of the common SOD allele observed in populations of this study are consistent with previous data from inland steelhead trout populations, and differ significantly from coastal steelhead of the Columbia River (Allendorf, 1975; Milner et al. 1980). Other shared characteristics of these populations with inland steelhead trout include a low frequency of the $_{MDH73}$ polymorphism and the relatively high frequency of the additional $_{SOD}$ alleles (152 and 48). The allele frequencies from other available data sets are also given in Table 2 and diagrammatically represented in Appendices 1 and 2.

These results can perhaps best be visualized by the phenogram (Figure 1) which clusters populations based on their

Table 3. Matrix giving loci at which significant gene frequency differences exist at or below the .05 level between all populations analyzed in this study. A (*) indicates that the significance level is less than .01, a (**) indicates that the significance level is less than .001.

	POPULATION			
	Big	Marble	Chamberlain	Loon
Big	-			
Marble	GPI-1* LDH-4	-		
Chamberlain	SOD* GPI-1**	LDH-4**, SOD ADA, AGP-4	-	
Loon	no differences	LDH-4 GL-1	LDH-4	-

Figure 1. Phenogram of Columbia River steelhead populations based upon 22 structural loci.


DWORSHAK
SELWAY
HEADWATERS 2
GUMBOOT
BEAR VALLEY
ELK
BIG
BUCKTHORN
WHITE BIRD
LOON
NIAGRA SPRINGS
CHAMBERLAIN
LITTLE SALMON
HEADWATERS 1
MARSH
MARBLE
WELLS
CHELAN
TUCANNON
KALAMA
SKAMANIA
COWLITZ
SOUTH SANTIAM
.020
.015
.010
.005
0.000
GENETIC DISTANCE (NEI, 1978)

overall genetic distance. Clearly the majority of the Snake River and Middle Columbia River populations are quite similar, clustering at approximately the .003 level. The two exceptions are the Dworshak and the Tucannon hatcheries. The Dworshak hatchery is significantly different from every other population at the GL-1 locus and shows significant differences from most other population at the PGM, AGP-2, and SOD loci. The Dworshak Hatchery represents a separate stock of Idaho steelhead trout. The Tucannon hatchery population shares characteristics with the Lower Columbia and Willamette populations at the AGP-4, LDH-4, and SOD loci.

The hierarchial analysis of the diversity provides a second method of data comparison. The results of this analysis are given in Tables 4 and 5. The total gene diversity is broken down into components at the population, river system, and drainage levels. As is the case in most natural populations the majority of the diversity exists within the populations (H_P = .897 or 84% for all loci combined). The second largest amount of diversity is among the drainages where approximately 9% of the variation resides (G_{ST} = .089). Approximately 5% of the variation is among river systems within drainages (G_{RS} = .045), while only about 2 % (G_{PR} = .024) of the variation is among populations within river systems. The results of the analysis also show that LDH=4, SOD, and GL=1 respectively contribute the greatest proportions to the total variation. These results

Table 4. Hierarchial levels used in the gene diversity analysis.

DRAINAGE	RIVER SYSTEM	POPULATION
Snake	Clearwater	Dworshak Hatchery
	Middle Fork Salmon	Selway
		Bear Valley
		Elk
		Marsh
		Loon
		Marble
	South Fork Salmon	Big
		Buckthorn
		Headwaters-1
	Salmon	Headwater-2
		White Bird
	Little Salmon	Chamberlain
		Mainstem
	Imnaha	Gumboot
	Niagra Springs	Niagra Springs
	Tucannon	Tucannon Hatchery
Mid Col.	Chelan	Chelan
	Wells	Wells
Lower Col.	Kalama	Kalama
	Cowlitz	Cowlitz
	Skamania	Skamania
Willamette	Willamette	S. Santiam

Table 5. Diversity analysis in Columbia River steelhead trout.

Locus	H_T	H_P	D_{PR}	D_{RD}	D_{DT}	G_{PR}	G_{RD}	G_{DT}
GPT-3	.030	.028	.000	.002	.000	.000	.066	.000
SOD	.219	.193	.004	.011	.011	.018	.050	.050
MDH-3	.069	.063	.001	.000	.005	.014	.000	.069
LGG	.008	.008	.000	.000	.000	.000	.000	.000
LDH-4	.496	.407	.000	.018	.071	.000	.036	.142
PMI	.020	.017	.000	.003	.000	.000	.150	.000
PGM-2	.002	.002	.000	.000	.008	.000	.000	.000
GL-1	.144	.115	.021	.008	.000	.145	.055	.000
AGP-2	.002	.002	.000	.0{)0	.000	.000	.000	.000
AGP-1	.061	.054	.000	.005	.002	.000	.081	.029
ADH	.009	.008	.000	.001	.000	.000	.111	.000
Combined Across Loci	1.060	.897	.026	.048	.089	.024	.045	.083

H_T = Total gene diversity

H_P = Gene diversity within populations.

D_{PR} = Gene diversity among populations within rivers

D_{RD} = Gene diversity among rivers within drainages

D_{DT} = Gene diversity among drainages

G_{PR} = Proportion of gene diversity among populations within river systems

G_{RD} = Proportion of gene diversity among river systems within drainages

G_{DT} = Proportion of gene diversity among drainages

reinforce the relationships defined in the phenogram, indicating that the majority of non-population diversity exists between major geographical areas.

DISCUSSION

The accumulation of genetic data has helped to clarify the relationships among populations of the Columbia River as a whole and the Snake River in particular. Within the Snake River localized isolated breeding demes likely exist although the overall similarity among the majority of the populations is quite high. The major exceptions are the Dworshak and Tucannon hatcheries which both are genetically distinct. Among the Columbia River drainages, the inland and coastal steelhead trout stocks represent two major divergent genetic groupings.

The genetic assessment of wild steelhead trout stocks in the Columbia River Basin is quite timely. Utter (1981) recognized that the need for genetic data was particularly acute in natural populations in which transplantations and hatcheries play a major role. Hatcheries have supplemented the runs since 1962 and now make up the majority of the Snake River outmigration. This proportion may increase even more in the future. Raymond (1978) when discussing the future of the summer steelhead on the Columbia River suggested that "Release of smolts throughout the watershed (in contrast to the present method of releasing at the hatchery) should ultimately provide a reasonable substitute for the original wild stocks."

Although hatchery propagation may be the only viable means

of maintaining steelhead runs, an area of concern with increased hatchery contributions has been the maintainance of the genetic characteristics and variability associated with wild salmonid stocks (Reisenbichler and McIntyre, 1977; Helle, 1981; Hynes et al. 1981). The electrophoretic data now available on wild summer steelhead populations can be used not only to identify closely related stocks, but also to detect in the future the instrusion of identifiable hatchery stocks as a result of strayings or plantings.

Additionally, mixed species and mixed stock fisheries pose complex problems for harvest management on the Columbia River (NMFS, 1978). Milner et al. (1980) have used biochemical differences to identify components in mixed stock chinook fisheries. The results of this study will be a useful addition to the existing steelhead trout data base should a comparable mixed stock analysis be undertaken.

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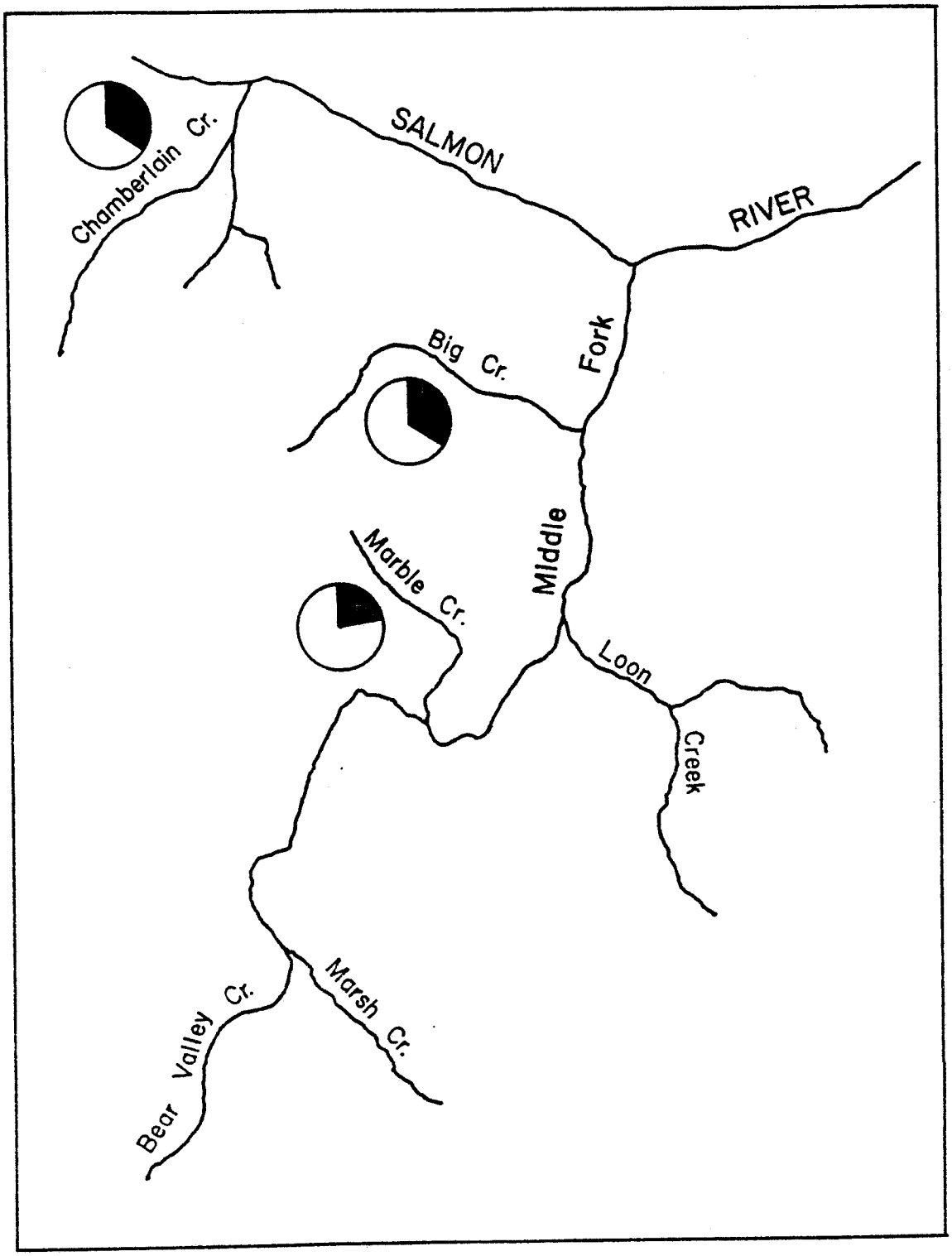
Appendix 1. Diagrammatic representations of allelic frequencies of wild steelhead populations within and near the Middle Fork of the Salmon River.

a. AGP-4

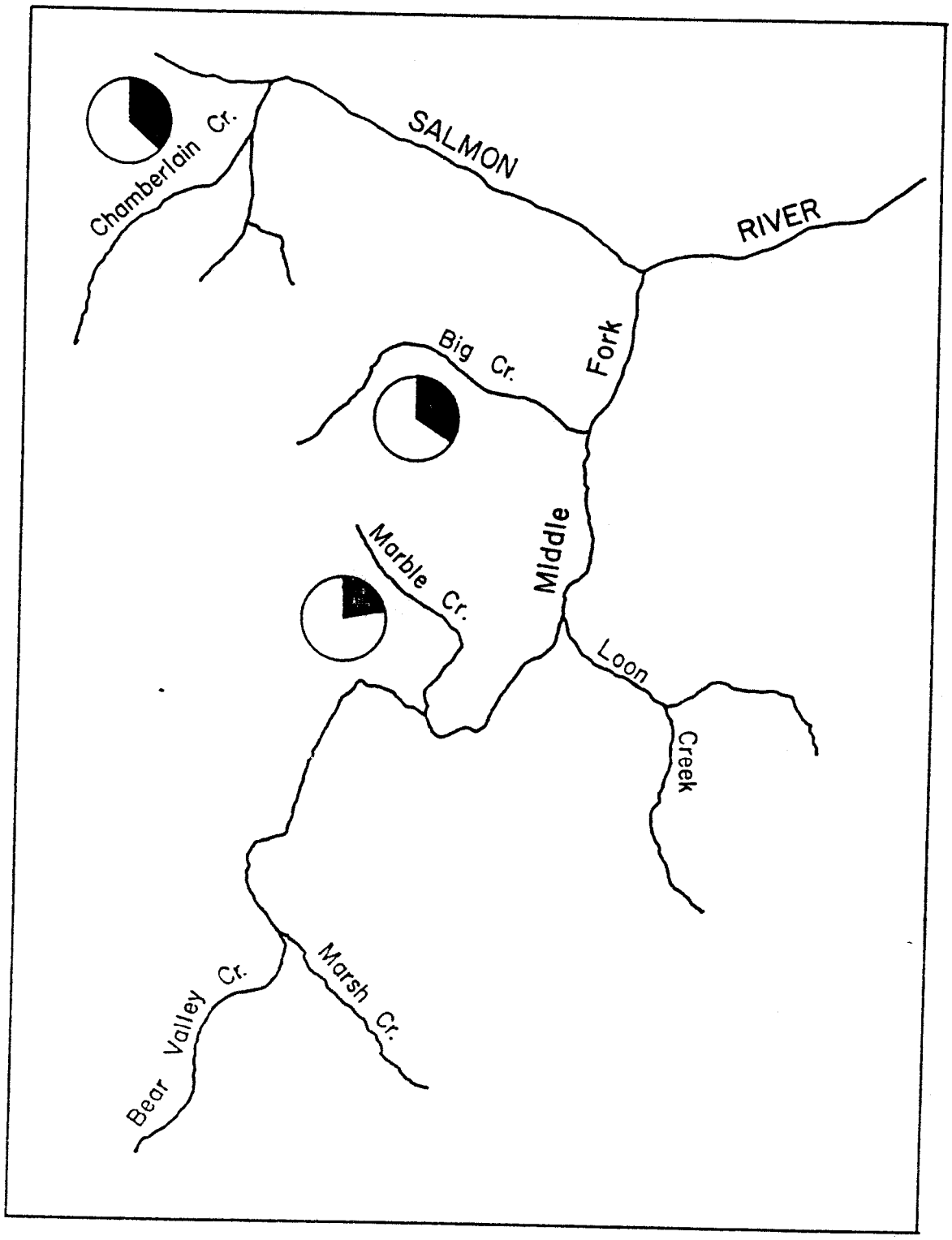
b. ACO

c. GPI-1

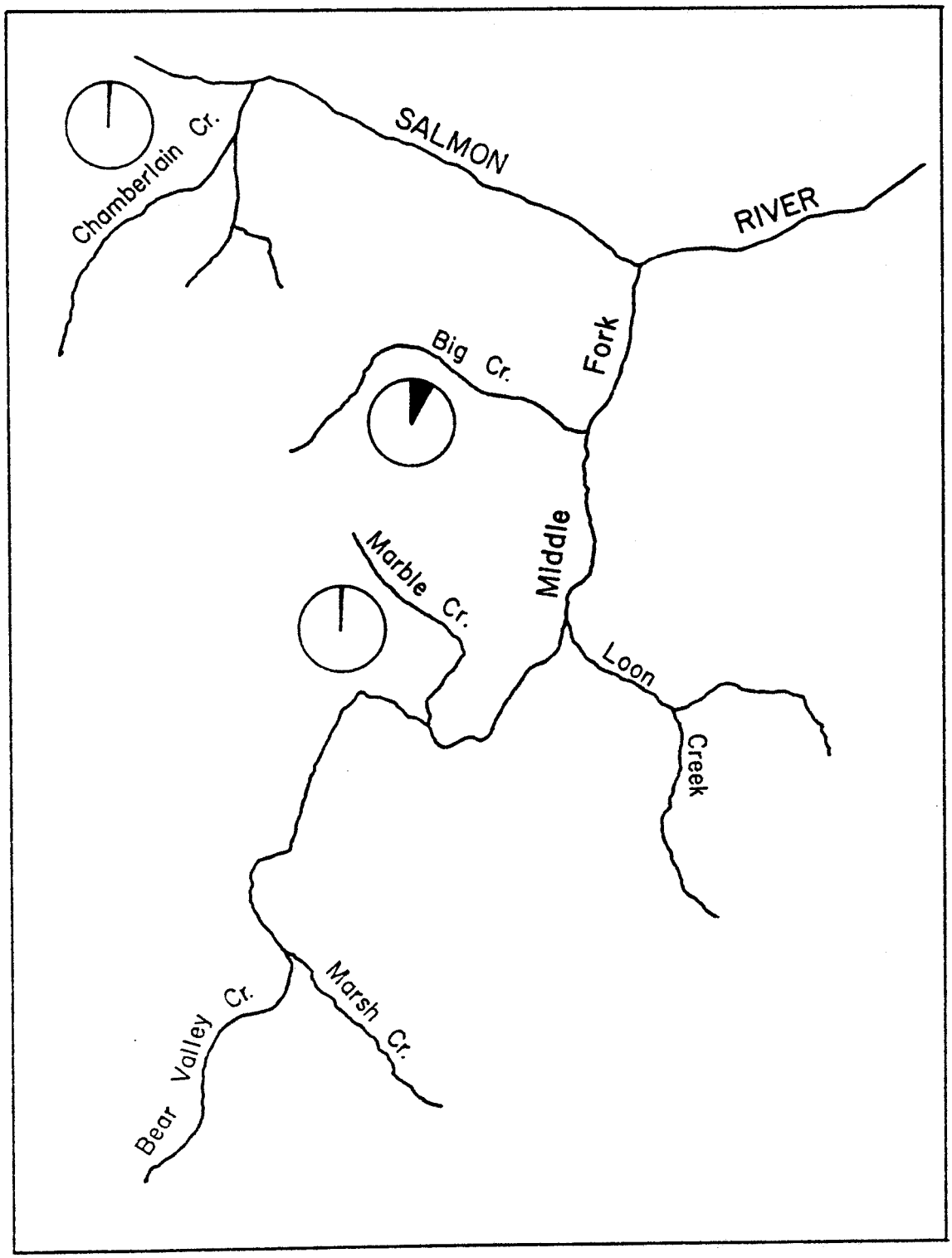
d. LDH-4


SALMON
RIVER
Chamberlain Cr.
Big Cr.
Fork
Middle
Marble Cr.
Loon
Creek
Marsh Cr.
Bear Valley Cr.

Appendix 1a.


Chamberlain Cr.
SALMON
RIVER
Big Cr.
Fork
Middle
Marble Cr.
Loon
Creek
Marsh Cr.
Bear Valley Cr.

Appendix 1b.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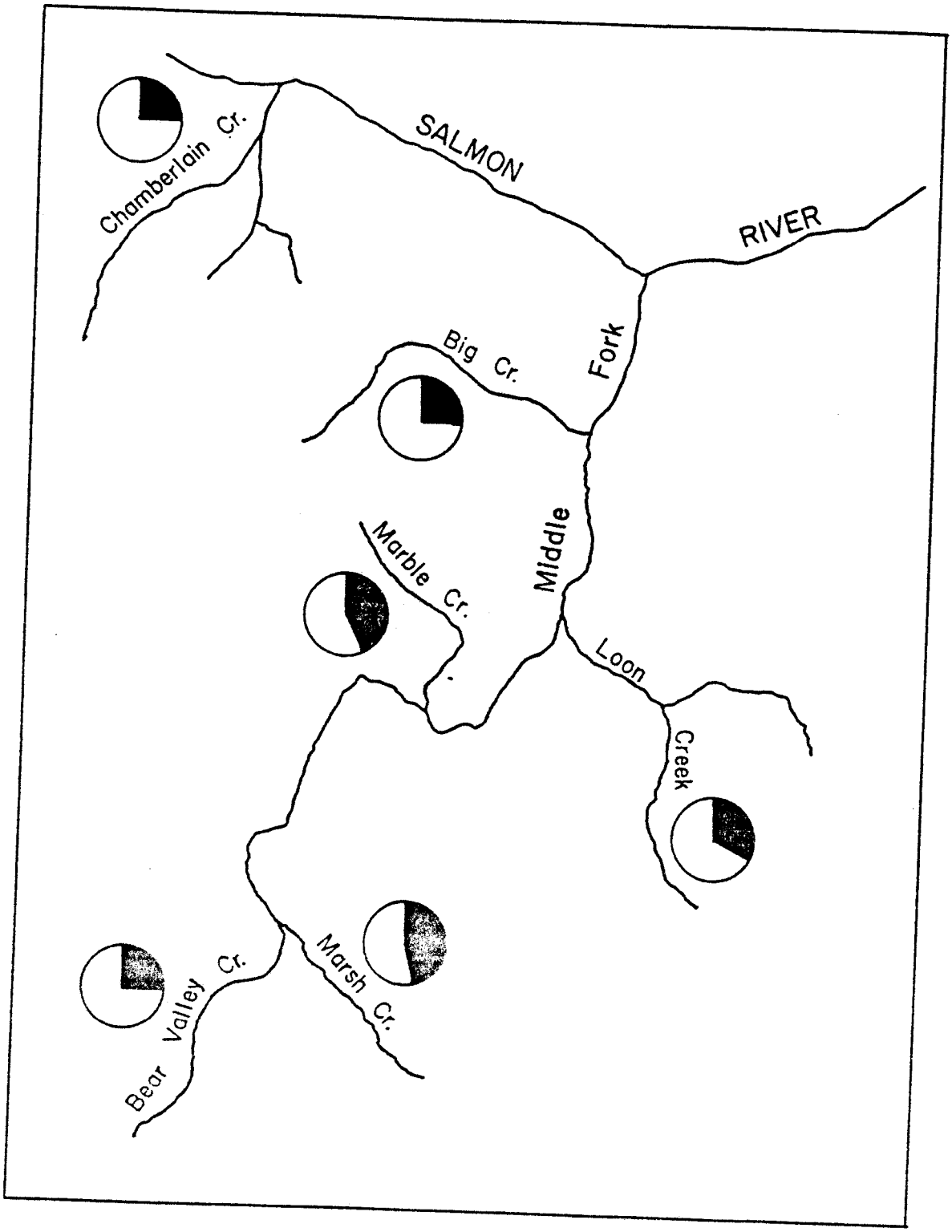
RIVER
Chamberlain Cr.
Big Cr.
Fork
Middle
Marble Cr.
Loon
Creek
Marsh Cr.
Bear Valley Cr.

Appendix 1c.


SALMON
RIVER
Chamberlain Cr.
Big Cr.
Fork
Middle
Marble Cr.
Loon
Creek
Marsh Cr.
Bear Valley Cr.

Appendix 1d.

Appendix 2. Diagrammatic representations of allelic frequencies of wild and hatchery steelhead populations in the Columbia River Basin.

a. SOD

b. AGP-1

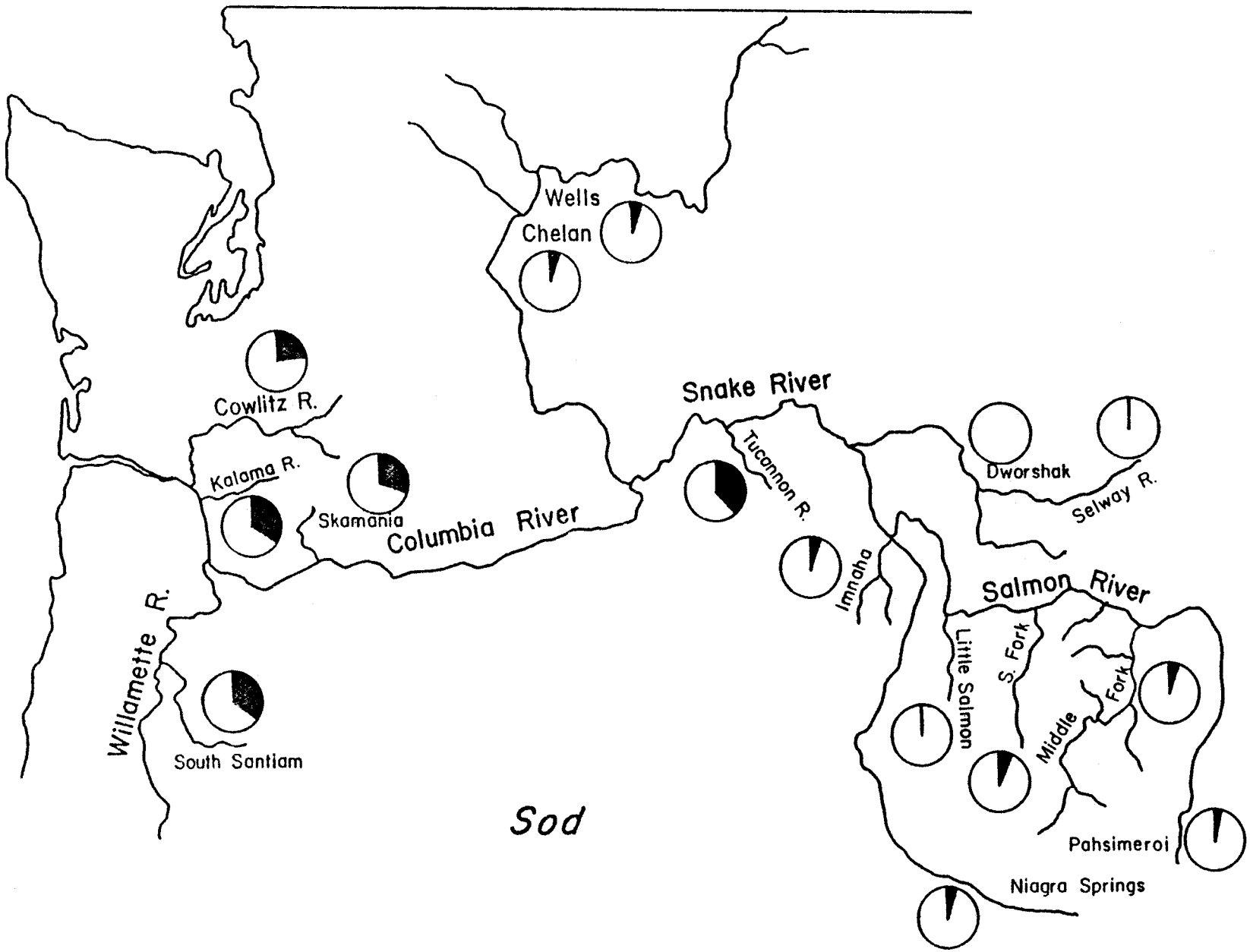
c. MDH-3

d. LDH-4

e. GL-1

f. GPI-3

Appendix 2a.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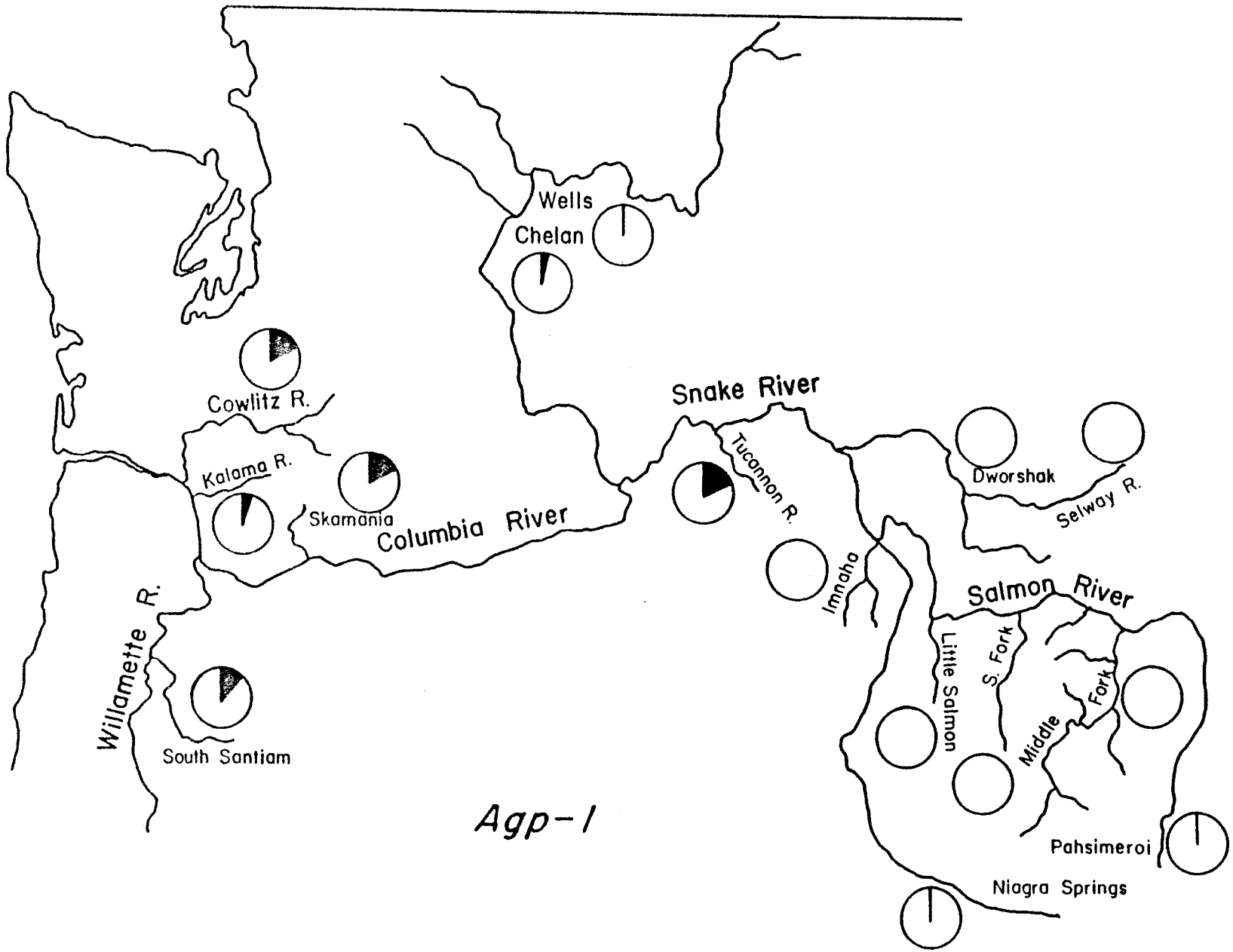
Kalama R.
Skamania
Columbia River
Snake River
Tucannon R.
Imnaha
Dworshak
Selway R.
Salmon River
Little Salmon
S. Fork
Middle
Fork
Pahsimeroi
Niagra Springs
Willamette R.
South Santiam
Sod

Appendix 2b.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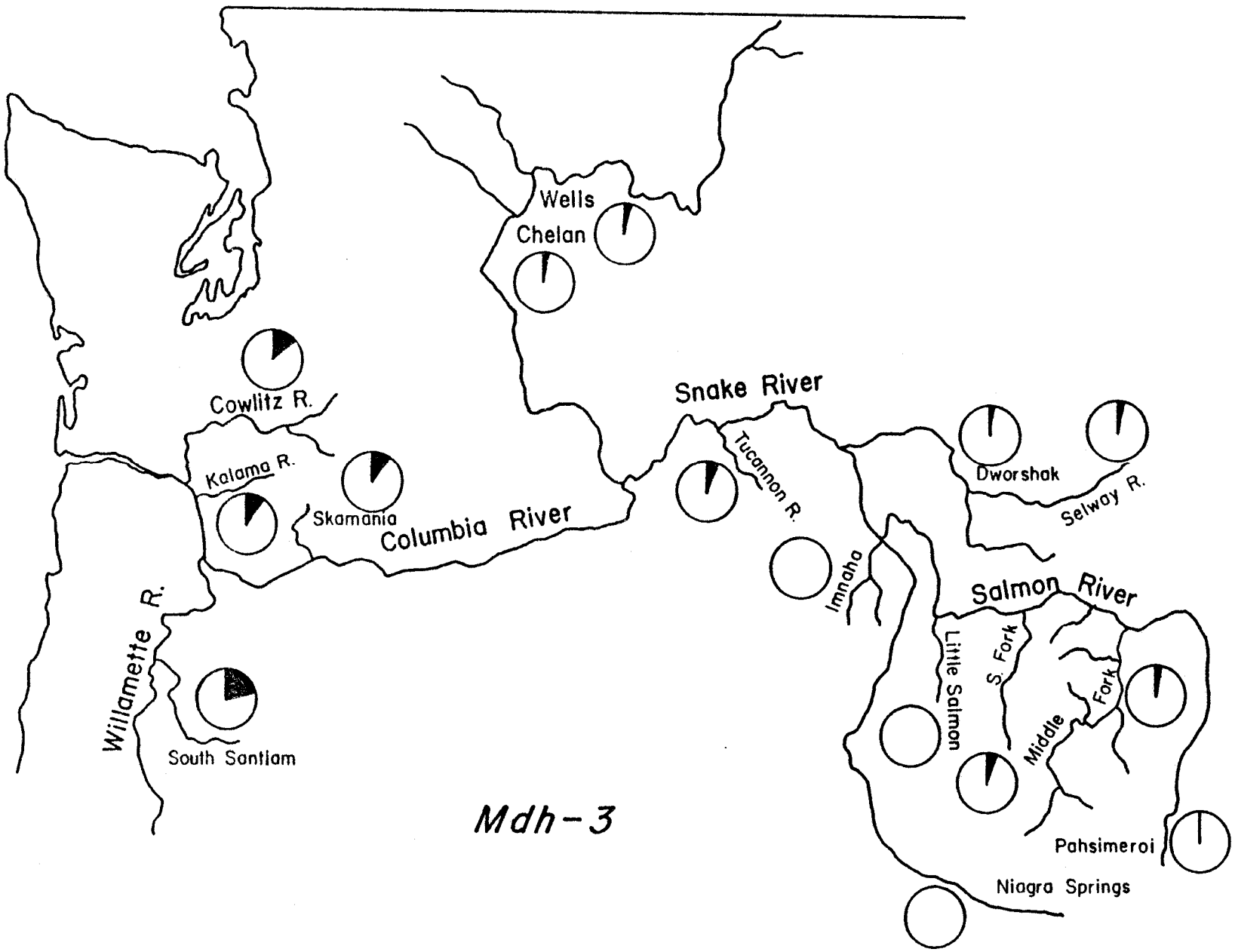
Cowlitz R.
Kalama R.
Skamania
Columbia River
Snake River
Tucannon R.
Imnaha
Dworshak
Selway R.
Salmon River
Little Salmon
S. Fork
Middle
Fork
Pahsimeroi
Niagra Springs
Willamette R.
South Santiam
Agp-1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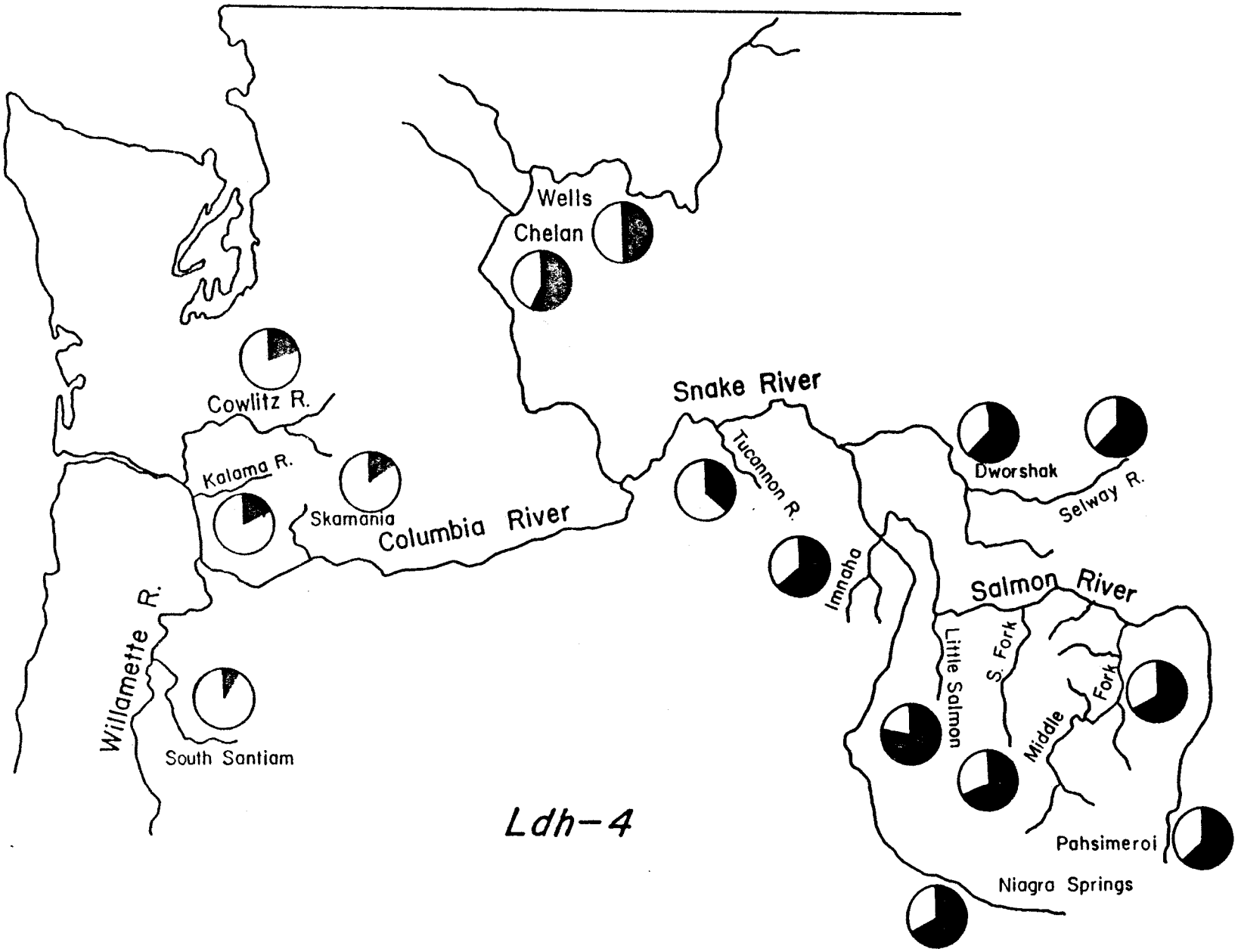
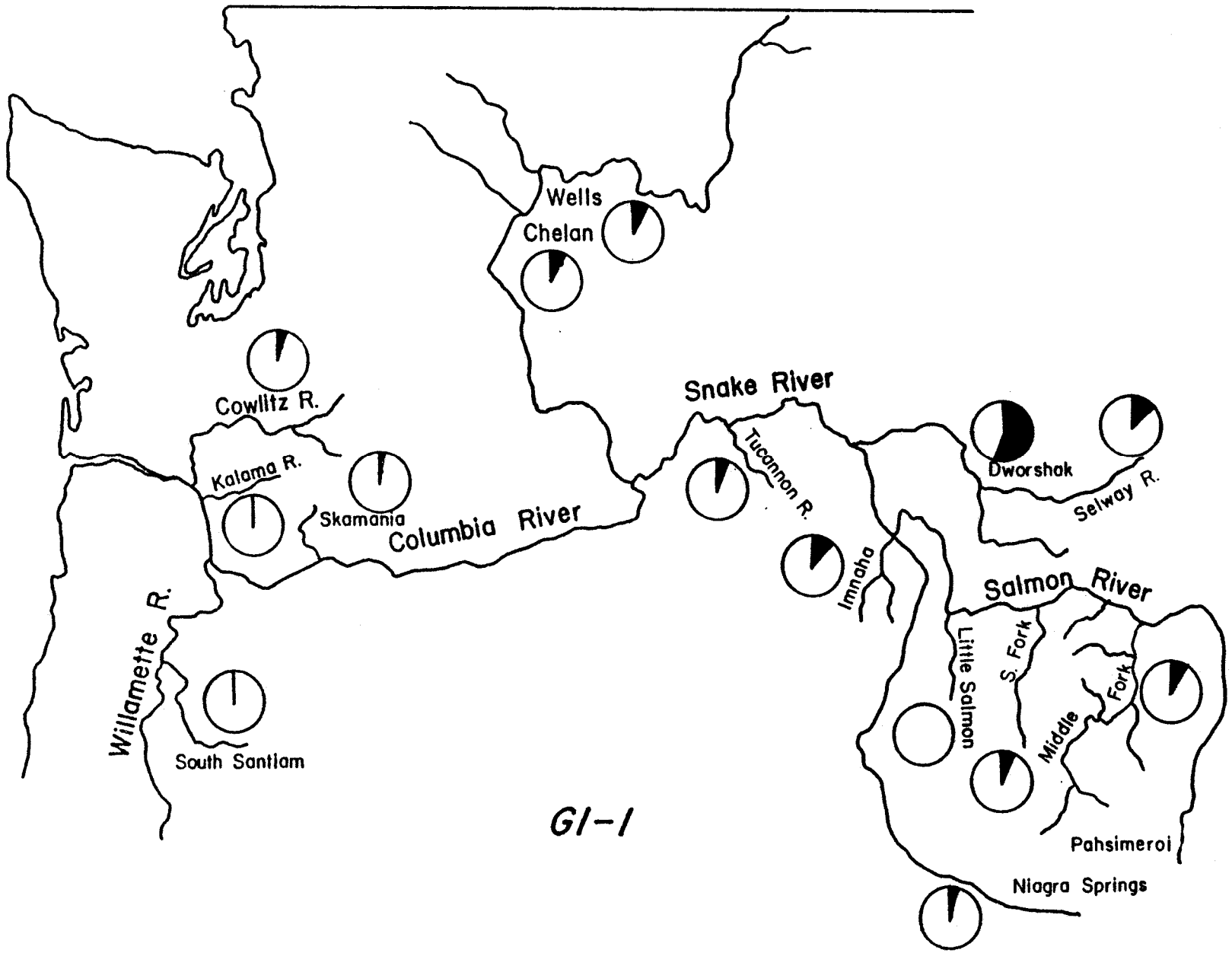
Cowlitz R.
Kalama R.
Skamania
Columbia River
Snake River
Tucannon R.
Imnaha
Dworshak
Selway R.
Salmon River
Little Salmon
S. Fork
Middle
Fork
Pahsimeroi
Niagra Springs
Willamette R.
South Santiam
Mdh-3

Appendix 2c.

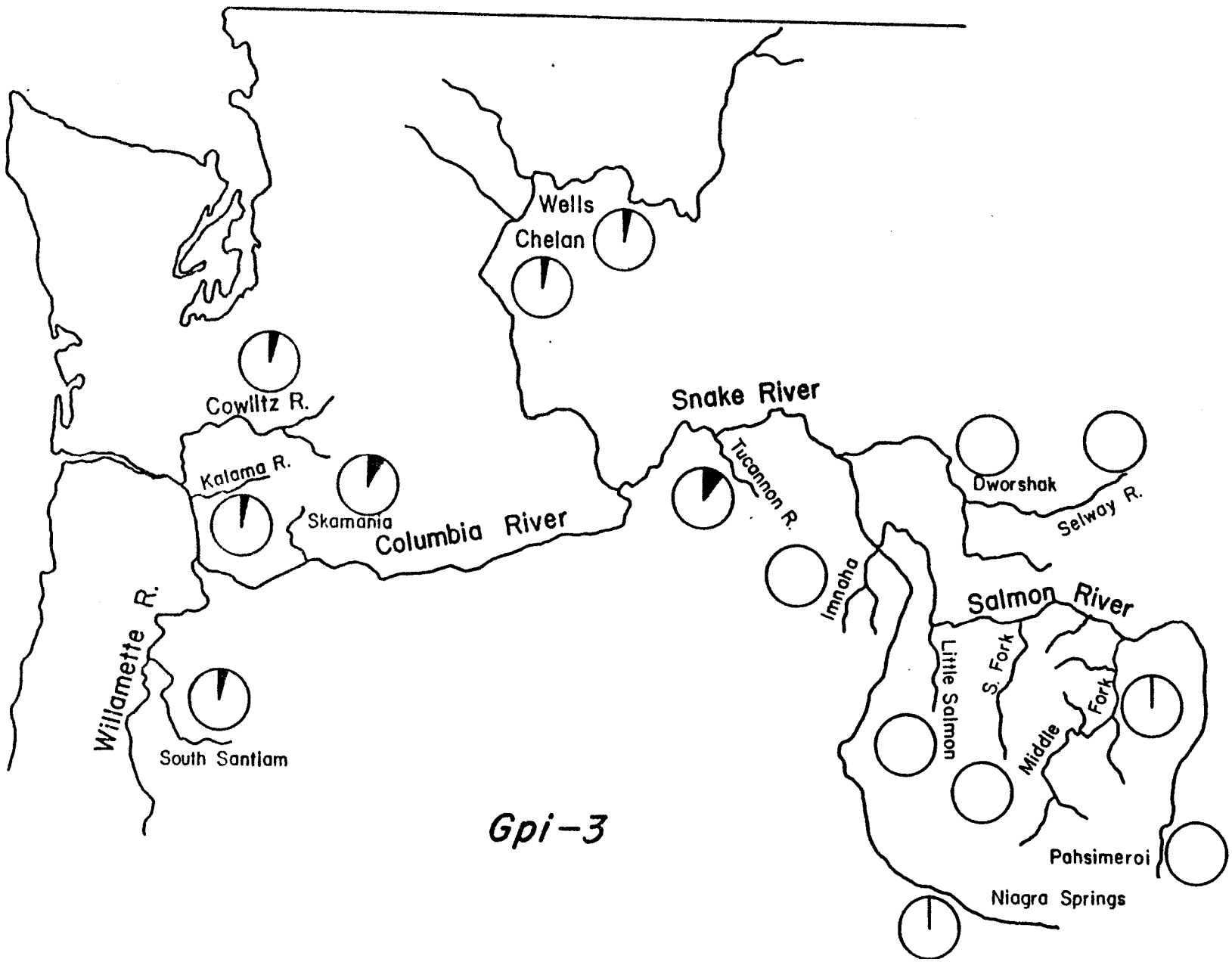

Wells
Chelan
Cowlitz R.
Kalama R.
Skamania
Columbia River
Snake River
Tucannon R.
Imnaha
Dworshak
Selway R.
Salmon River
Little Salmon
S. Fork
Middle
Fork
Pahsimeroi
Niagra Springs
Willamette R.
South Santiam
Ldh-4

Appendix 2d.

Appendix 2e.


Wells
Chelan
Cowlitz R.
Kalama R.
Skamania
Columbia River
Snake River
Tucannon R.
Imnaha
Dworshak
Selway R.
Salmon River
Little Salmon
S. Fork
Middle Fork
Pahsimeroi
Niagra Springs
Willamette R.
South Santiam
GI-1

Appendix 2f.


Wells
Chelan
Cowlitz R.
Kalama R.
Skamania
Columbia River
Snake River
Tucannon R.
Imnaha
Dworshak
Selway R.
Salmon River
Little Salmon
S. Fork
Middle
Fork
Pahsimeroi
Niagra Springs
Willamette R.
South Santiam
Gpi-3

Appendix B. Physical dimensions and characteristics of snorkeling transects in the Middle Fork Salmon River, 23-30 August 1982.

Transect	Location	Date surveyed	Length(m)	Visibility(m)	Surface area snorkeled(m^2)	(^oF) Temperature	(^oC) Temperature
1	Boundary Cr.	23 Aug.	66		2376	54	12
2	Ramshorn Cr.	23 Aug.	112	9.0	2016	58	14.5
3	Elkhorn	24 Aug.	102		3590	54	12
4	Sheepeater Hot Sp.	24 Aug.	115	8.8	2024	59	15
5	Rapid River	24 Aug.	147		5174	61	16
6	Indian Creek	25 Aug.	153		4774	54	12
7	Marble Cr.	25 Aug.	204	7.8	6364	57	14
8	Hood Ranch	25 Aug.	158		4930	59	15
9	Cougar Ranch	26 Aug.	185	9.2	6808	57	14
10	Whitey Cox	26 Aug.	136		5005	60	15.5
11	Hospital Bar	27 Aug.	235		7426	57	14
12	Tappan Falls	27 Aug.	140	7.9	4424	61	16
13	Camas Creek	27 Aug.	147		4645	63	17
14	Flying "B"	28 Aug.	142		4487	59	15
15	Driftwood	28 Aug.	136	7.9	4297	61	16
16	Survey	28 Aug.	142		2244	63	17
17	Elk Bar	29 Aug.	107		3384	59	15
18	Ship Island Creek	29 Aug.	147	7.8	4586	62	16.5
19	Little Ouzel	30 Aug.	169		5273	59	15
20	Goat Creek	30 Aug.	92	7.8	2870	61	16

Appendix C. Numbers, sizes and densities of juvenile steelhead observed by sections in Middle Fork transects 1980 to 1982.

			Snorkeling transects									
			Age I+		Age II+		Age III+		Total		Fish/	Fish/2
Location	Section	Year	o	%	no	%	no	%	no	%	100m	100 m
Above Marble Cr.	I	1980	9	(.35)	14	(.54)	3	(.11)	26	(.36)	1.8	---
		1981	25	(.46)	23	(.42)	6	(.12)	54	(.27)	3.7	0.27
		1982	21	(.48)	17	(.39)	6	(.13)	44	(.20)	3.8	0.22
Marble to Camas Cr.	II	1980	8	(.42)	10	(.53)	1	(.05)	19	(.26)	0.9	---
		1981	27	(.40)	27	(.40)	14	(.20)	68	(.34)	3.4	0.25
		1982	47	(.48)	40	(.41)	11	(.11)	98	(.46)	4.6	0.28
Camas to Big Creek	III	1980	7	(.37)	9	(.47)	3	(.16)	19	(.26)	1.6	---
		1981	20	(.48)	19	(.45)	3	(.07)	42	(.21)	3.6	0.31
		1982	17	(.35)	28	(.57)	4	(.08)	49	(.23)	4.9	0.31
Below Big Creek	IV	1980	2	(.25)	5	(.62)	1	(.13)	8	(.12)	0.7	---
		1981	17	(.47)	15	(.42)	4	(.11)	36	(.18)	3.0	0.25
		1982	11	(.46)	10	(.42)	3	(.12)	24	(.11)	2.3	0.14

Appendix D. Mean dimensions of snorkeling transects in Middle Fork tributary sections, 1982. Mean of five transects.

Stream	Section	Date	Mean[a] discharge (cfs)	Temperature range °C	Transect measurements (m)				Substrate				
					length	$\bar{x}$ width	Surface area	$\bar{x}$ thalweg depth	boulder	rubble	gravel	sand	silt
Bear Valley Cr.	Elk Cr.	29, 30 July	100	10-13.5	43.5	10.2	425.4	.94	---	10	50-60	30-50	5% veget.
	Cache Cr.	31 July	---	12	36.4	5.5	199.0	.58	---	50	40	10	---
	Sack Cr.	31 July	---	12	34.8	4.4	152.0	.57	---	15	50	25	5% veget.
Indian Cr.	Upper	4, 5 August	---	9-13.5	29.0	6.6	190.4	.67	5-10	25-50	25-50	15-20	< 5
	Middle	5, 6 August	120	13.5	41.7	8.4	354.0	.57	5-15	60-70	15-20	5-10	---
	Lower	7 August	---	12.5-17.0	42.8	10.6	454.4	.58	15-20	60-70	10-15	5	---
Marsh Cr.	Upper	20, 23 July	---	7-15.5	42.0	8.0	336.8	.79	---	15-20	40-60	15-25	< 5
	Lower	21, 22 July	231	---	40.7	19.3	793.2	1.08	15-20	30-60	25-40	5-20	---
Pistol Cr.	Upper	10,11 August	---	8.5-11.5	41.4	7.2	321.2	.58	20	50-70	15-50	5	< 5
	Middle	12 August	---	8.5-13.5	40.3	10.1	406.6	.67	15-20	50-65	5-25	5-10	---
	L. Pistol	13,14 August	75	9.5-13.5	43.2	8.6	335.0	.61	15-30	50-60	20-30	5	---
	Lower	14,15 August	170	11.	48.3	14.7	773.0	.85	10-20	50-75	10-15	5-10	---
Rapid River	Upper	9 Sept.	---	---	43.2	10.5	454.5	.60	15-25	45-60	10-20	5-10	< 5
	Lower	7,8 Sept.	150	---	43.1	11.1	472.4	.77	15-30	40-60	10-20	5-15	< 5

[a]Flow data cited by Gebhards (1959).

Appendix E. Fish observed by snorkeling in Middle Fork Salmon River tributaries, July-August 1982.

Stream	Transect	Fish observed: steelhead	cutthroat	bull trout	juvenile chinook	Surface area (m^2)	Steelhead per $100m^2$
Bear Valley Cr. (Elk Cr.)	U1	-	-	-	1	665	0
	U2	-	-	-	5	345	0
	U3	-	-	-	1	538	0
	U4	-	-	-	1	339	0
	U5	-	-	-	-	240	0
Totals		-	-	-	8	2127	$\bar{x}$ = 0
(Cache Cr.	L1	8	-	5 Bk	1	198.7	4.0
(Sack Cr.)	L1	1	-	1,6 Bk	-	152.4	0.7
Camas Creek (Hammer to Yellowjacket Creek)	M1	33	-	-	-	492	6.5
	M2	49	-	-	20	443	11.1
	M3	40	-	-	28	460	8.7
	M4	38	-	-	15	541	7.0
	M5	74	-	-	36	529	14.0
Totals		233	-	-	99	2465	$\bar{x}$ = 9.5
Indian Creek (below Middle Fork Indian Creek)	L1	24	-	-	7	448	5.4
	L2	11	2	1	6	400	2.8
	L3	16	1	1	14	505	3.2
	L4	17	-	1	14	526	3.2
	L5	22	4	1	3	393	5.6
Totals		90	7	4	44	2272	$\bar{x}$ = 4.0
(Quis Quis to Papoose Creek)	M1	5	8	1	-	477	1.0
	M2	2	14	1	-	405	0.5
	M3	5	9	-	-	324	1.5
	M4	1	5	2	-	282	0.4
	M5	-	2	-	-	282	0.0
Totals		13	38	4	-	1770	$\bar{x}$ = 0.7
(Above Papoose Creek Falls)	U1	-	4	1	-	187	No steelhead above barrier falls
	U2	-	3	1	-	176	
	U3	-	8	4	-	223	
	U4	-	16	5	-	189	
	U5	-	16	1	-	177	
Totals		-	47	12	-	952	-
Marsh Creek (below Capehorn Cr.	L1	3	2	-	1	662	0.4
	L2	8	-	-	-	697	1.2
	L3	2	-	-	26	1168	0.2
	L4	1	-	-	5	845	0.1
	L5	23	-	-	7	594	3.9
Totals		37	2	-	39	3966	$\bar{x}$ = 0.9

Appendix E. (continued) Fish observed by snorkeling in Middle Fork Salmon River tributaries, July-August 1982.

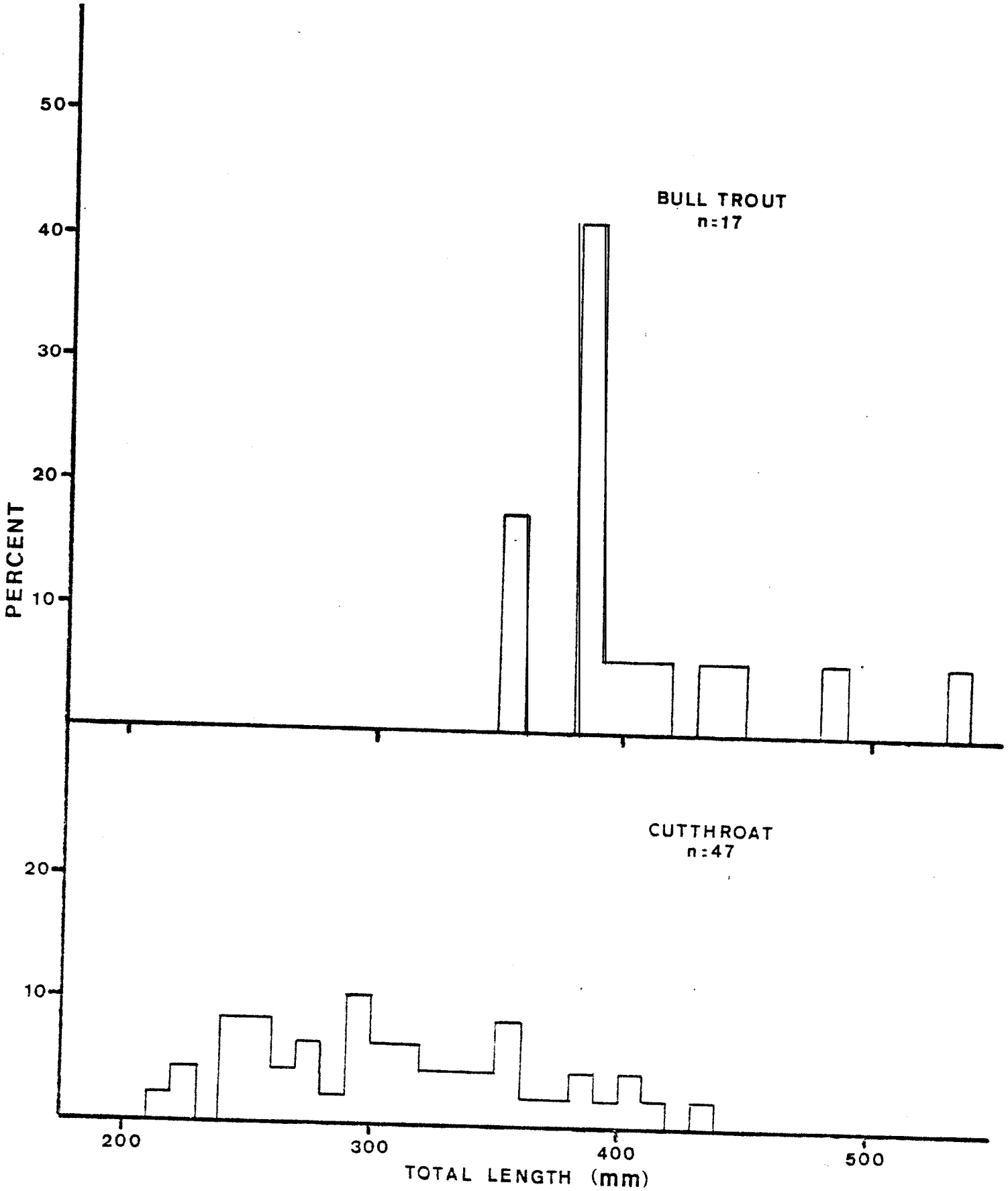
Stream	Transect	Fish observed: steelhead	cutthroat	bull trout	juvenile chinook	Surface area (m^2)	Steelhead per $100m^2$
Marsh Creek (above Camp Cr.)	U1	2	-	1 Bk	19	394	0.5
	U2	-	1	1 Bk	11	395	-
	U3	3	-	13 Bk	43	223	1.4
	U4	1	-	53 Bk	22	488	0.2
	U5	1	-	99 Bk	-	184	0.5
Totals		7	1	167 BK	95	1684	$\bar{x}$ = 0.4
Pistol Creek (below Little Pistol Creek)	L1	14	8	2	17	616	2.3
	L2	11	5	1	8	746	1.5
	L3	20	10	-	16	686	2.9
	L4	14	5	2	14	913	1.5
	L5	30	3	1	16	904	5.0
Totals		89	31	6	71	3865	$\bar{x}$ = 2.3
(Little Pistol to Popgun Creek)	M1	25	-	-	10	391	6.4
	M2	23	-	2	9	507	4.9
	M3	28	1	2	2	441	4.1
	M4	27	-	-	3	356	7.6
	M5	29	-	-	-	338	8.6
Totals		132	1	4	24	2033	$\bar{x}$ = 6.1
(Above 22 Creek)	U1	2	4	2	-	325	0.6
	U2	2	4	3	-	551	0.4
	U3	-	2	4	-	276	0.0
	U4	-	4	7	-	209	0.0
	U5	-	4	-	-	245	0.0
Totals		4	18	16	-	1606	$\bar{x}$ = 0.2
Little Pistol Cr. (mouth to Stevens Cr.)	LP1	12	3	-	6	368	3.3
	LP2	11	4	1	-	353	3.1
	LP3	7	4	-	-	345	2.0
	LP4	10	4	2	0	363	2.8
	LP5	1	7	-	-	246	0.2
Totals		41	22	3	6	1675	$\bar{x}$ = 2.4
Rapid River (below Cabin Creek)	RL1	12	1	2	-	467	2.6
	RL2	20	2	1	-	431	4.6
	RL3	22	-	-	-	484	4.6
	RL4	22	2	1	3	456	4.8
	RL5	18	-	1	-	524	3.4
Totals		94	5	5	3	2362	$\bar{x}$ = 4.0
(above Sheep Creek)	RU1	21	3	3	4	556	3.8
	RU2	18	4	1	2	509	3.5
	RU3	18	4	2	4	366	4.9
	RU4	11	5	4	1	387	2.8
Totals		68	16	10	11	1818	$\bar{x}$ = 3.7

Appendix E. Fish observed by snorkeling in Middle Fork Salmon River tributaries, July-August 1982.

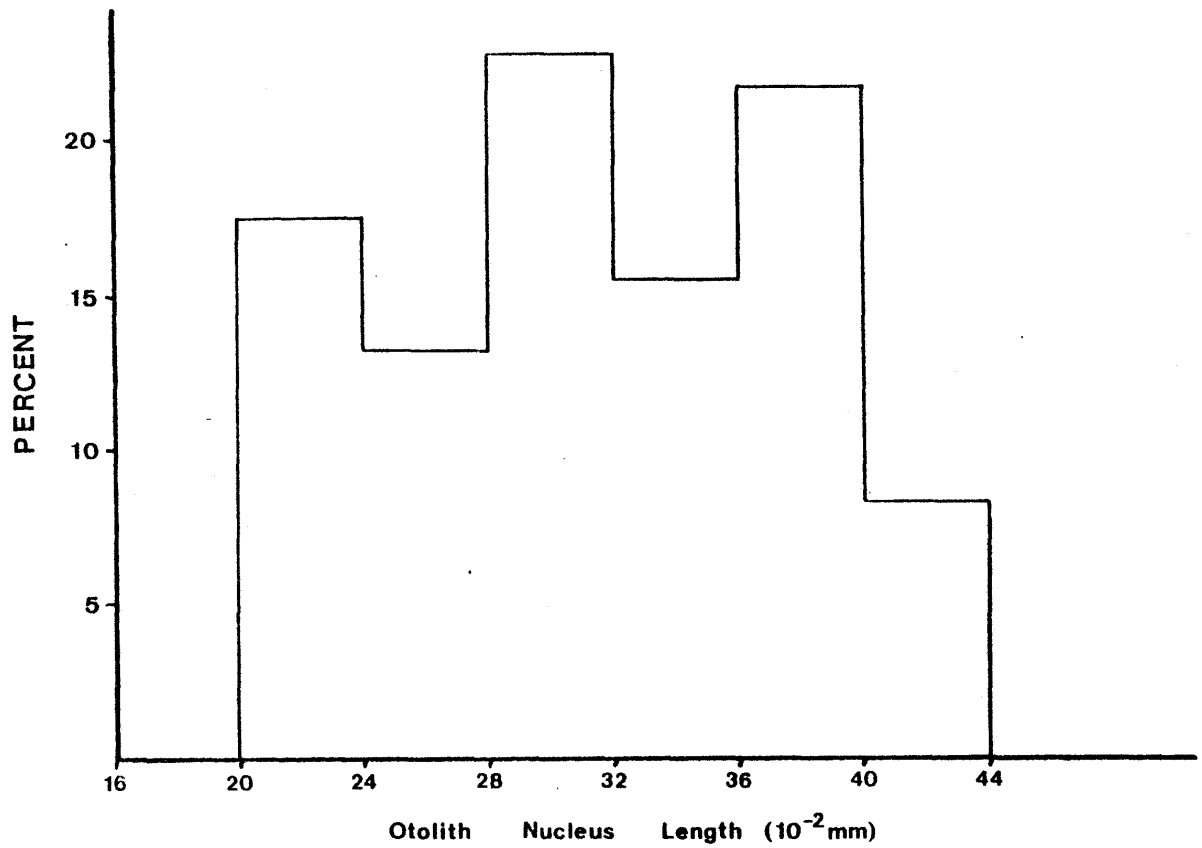
Stream	Transect	Fish observed: steelhead	cutthroat	bull trout	juvenile chinook	Surface area (m^2)	Steelhead per 100m^2
Bear Valley Cr	U1				1	665	0
(Elk Cr.)	U2	-		-	5	345	0
	U3				1	538	0
	U4		-		1	339	0
	U5	-				240	0
Totals				-	8	2127	x = 0
(Cache Cr.	L1	8		5 Bk	1	198.7	4.0
(Sack Cr.)	L1	1	-	1,6 Bk		152.4	0.7
Camas Creek	Ml	33				492	6.5
(Hammer to	M2	49		-	20	443	11.1
Yellowjacket	M3	40			28	460	8.7
Creek)	M4	38		-	15	541	7.0
	M5	74	-	-	36	529	14.0
Totals		233			99	2465	x = 9.5
Indian Creek	L1	24			7	448	5.4
(below Middle	L2	11	2	1	6	400	2.8
Fork Indian	L3	16	1	1	14	505	- 3.2
Creek)	L4	17	-	1	14	526	3.2
	L5	22	4	1	3	393	5.6
Totals		90	7	4	44	2272	X = 4.0
(Quis		5	8	1		477	1.0
to Papoose	M2	2	14	1	-	405	0.5
Creek)	M3	5	9	-		324	1.5
	M4	1	5	2		282	0.4
	M5	-	2	-		282	0.0
Totals		13	38	4	-	1770	x = 0.7
(Above	Ul	-	4	1	-	187	No
Papoose	U2		3	1		176	steelhead
Creek	U3	-	8	4	-	223	above
Falls)	U4		16	5	-	189	barrier
	U5	-	16	1	-	177	falls
Totals		-	47	12	-	952	-
Mar Creek	L1	3	2		1	662	0.4
(below		8			-	697	1.2
Capehorn Cr.	L3	2	-	-	26	1168	0.2
	L4	1			5	845	0.1
	L5	23	-	-	7	594	3.9
Totals		37	2		39	3966	x = 0.9

Appendix E. (continued) Fish observed by snorkeling in Middle Fork Salmon River tributaries, July-August 1982.

Stream	Transect	Fish observed: steelhead	cutthroat	bull trout	juvenile chinook	Surface area (m^2)	Steelhead per 100m^2
Marsh Creek (above Camp Cr.)	U1	2	-	1 Bk	19	394	0.5
	U2		1	1 Bk	111	395	-
	U3	3		13 Bk	43	223	1.4
	U4	1		53 Bk	22	488	0.2
	U5	1	-	99 Bk		184	0.5
Totals		7	1	167 BK	95	1684	x = 0.4
Pistol Creek (below Little Pistol Creek)	L1	14	8	2	17	616	2.3
	L2	11	5	1	8	746	1.5
	L3	20	10	-	16	686	2.9
	L4	14	5	2	14	913	1.5
	L5	30	3	1	16	904	5.0
Totals		89	31	6	71	3865	x = 2.3
(Little Pistol to Popgun Creek)	Ml	25	-		10	391	6.4
	M2	23	-	2	9	507	4.9
	M3	28	1	2	2	441	4.1
	M4	27			3	356	7.6
	M5	29				338	8.6
Totals		132	1	4	24	2033	x = 6.1
(Above 22 Creek)	U1	2	4	2		325	0.6
	U2	2	4	3		551	0.4
	U3		2	4	-	276	0.0
	U4	-	4	7	-	209	0.0
	U5	-	4			245	0.0
Totals		4	18	16	-	1606	x = 0.2
Little Pistol Cr. (mouth to Stevens Cr.)	LP1	12	3	-	6	368	3.3
	LP2	11	4	1	-	353	3.1
	LP3	7	4	-	-	345	2.0
	LP4	10	4	2	0	363	2.8
	LP5	1	7	-	-	246	0.2
Totals		41	22	3	6	1675	x = 2.4
Raid River below Cabin Creek)	RL1	12	1	2	-	467	2.6
	RL2	20	2	'1	-	431	4.6
	RL3	22	-	-	-	484	4.6
	RL4	22	2	1	3	456	4.8
	RL5	18	-	1		524	3.4
Totals		94	5	5	3	2362	x = 4.0
(above Sheep Creek)	RU1	21	3	3	4	556	3.8
	RU2	18	4	1	2	509	3.5
	RU3	18	4	2	4	366	4.9
	RU4	11	5	4	1	387	2.8
Totals		68	16	10	11	1818	x = 3.7



Appendix F. Length Frequency of bull and cutthroat trout caught by hook-and-line in the Middle Fork Salmon River, April-May and September-October 1982.



Appendix G. Length frequency of otolith nuclei of steelhead trout from Big and Loon creeks, Middle Fork Salmon River, 1981.

Appendix H. Estimated annual escapements of wild steelhead trout to the Middle Fork Salmon River (MFSR), 1970-1983.[a]

Fish year	MFSR steelhead entering sec.4	MFSR steelhead harvested sec.4	MFSR harvest	Exploitation rate Sec. 4	Exploitation rate Secs. 1-4	MFSR escapement
1970-71	6,053	784	156	0.16	-	5,123
1971-72	5,223	925	29	0.18	-	4,269
1972-73	2,778	523	27	0.20	-	2,228
1973-74	3,079	400	c.s.	0.13	-	2,659
1974-75	600	c.s.	"	-	-	600
1975-76	500	c.s.	"	-	-	500
1976-77	1,559	229	"	0.15	-	1,330
1977-78	2,428	653	"	0.27	-	1,775
1978-79	<1,000[b]	c.s.	"	-	-	<1,000
1979-80	<1,000[b]	98[c]	"	-	-	<1,000
1980-81[e]	2,566	665	"	0.26	0.50	1,900
1981-82[e]	2,896	885	"	0.31	0.47	2,011
1982-83[e]	2,100	40[d]	"	0.02	-	2,060

[a] The reader is cautioned that these estimates are not absolute, but are based on the best available data at this writing.

[b] No creel data available to calculate estimates.

[c] Closed season for steelhead larger than 28 inches, estimated catch includes SH <28" *583 catch x 0.21 W = 122 W x .080 = 98).

[d] Estimated 540 wild SH released.

[e] Projections based on limited data to be refined as more information is available.

c.s. = closed season.

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