INTERCEPTION OF FALL-RUN STEELHEAD TROUT (Salmo gairdneri) BY SPORT, COMMERCIAL AND INDIAN FOOD FISHERIES OF THE FRASER RIVER, 1985

Prepared For:

Department of Fisheries and Oceans
1090 West Pender Street
Vancouver, B.C.
V6E 2P1

Ministry of Environment
2204 Main Mall, UBC Campus
Vancouver, B.C.
V6T 1W5

Prepared By:

V.A. Lewynsky[1], W.R. Olmsted[2], R.J. Stewart[3] and K.J. Scott[4]

W.R. Olmsted & Associates, Inc.
1491 Edgewater Lane
North Vancouver, B.C.
V7H 1T3

Project 005-7

DSS Contract No. 09SB.FP501-5-5445

July, 1987

[1]Western Renewable Resources, 100 Mile House, B.C.
[2]W.R. Olmsted & Associates, Inc., North Vancouver, B.C.
[3]Central Interior Tribal Councils, Kamloops, B.C.
[4]Scott Resource Services, Vancouver, B.C.

ABSTRACT

Through the auspices of the Salmonid Enhancement Program, the Department of Fisheries and Oceans (DFO) and Ministry of Environment contracted W.R. Olmsted & Associates, Inc. to estimate numbers of steelhead trout (Salmo gairdneri) harvested by commercial, Indian food and sport fisheries during their autumn spawning immigration through the Fraser River. Each fishery was sampled by survey from September 01 to November 15, 1985. The 1985 commercial fishery was sampled during two 12-hour openings (October 09 and November 21). Steelhead catch by the Indian food fishery downstream of Deas Island were estimated solely from DFO records. The Indian catch between Deas Island and North Bend was estimated from a combination of data obtained from DFO and field surveys; the catch between North Bend and Lytton was estimated by survey sampling. Steelhead catch by the Fraser River sport (bar) fishery between the confluences of the Vedder River and Ruby Creek was calculated by a roving creel survey. Steelhead catch records were also obtained from the Pacific salmon (Oncorhynchus spp.) test fisheries conducted by DFO and International Pacific Salmon Fisheries Commission in the lower Fraser River mainstem at Albion and Cottonwood, respectively.

Of the estimated 3,895 steelhead trout harvested, 1,441 (37.0%) were captured in the two 12-hour commercial fisheries, 279 (7.2%) in the test fisheries, 1,712 (44.0%) in the Indian food fisheries and 463 (11.8%) in the sport fishery. Commercial harvest estimates were compared to preliminary estimates generated from records of steelhead sold to fish processors (DFO Salmon Services); our survey estimates were 2.8 times higher for the October 09 opening and 7.6 times higher for the November 21 opening. The disparity was partially related to differences in sampling methods, but more likely the result of unrecorded sales (i.e., personal use or sold privately).

Although the estimated catch by the 1985 Indian food fishery was slightly greater than DFO records during the past decade, the high abundance of pink salmon (O. gorbuscha) and unseasonally inclement weather probably reduced potential harvest.

Estimated steelhead catch by the mainstem Fraser River sport fishery in 1985 was substantially lower than the previous year; 1984 was the largest recorded escapement of fall-run steelhead to tributaries of the Fraser River. Atypically inclement weather and fluctuations in flows during the 1985 steelhead season likely caused angler use to decline.

Data obtained from DFO test fishery (at Albion) provided the best available index of steelhead abundance and movement through the lower Fraser River during the study period. Based on this index, the October 09 commercial fishery occurred at the approximate peak of fall steelhead immigration in 1985.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF APPENDICES[1]

1. Field net-effort and catch data, Albion salmon test fishery.
2. Field biological sampling data for steelhead intercepted at Albion salmon test fishery.
3. Field net-effort and catch data, Cottonwood salmon test fishery.
4. Field biological sampling data for steelhead intercepted at Cottonwood salmon test fishery.
5. Computer analyses of catch and effort data, Albion and Cottonwood salmon test fisheries[2].
6. Field net-effort and catch data, Fraser River commercial salmon fisheries.
7. Field biological sampling data for steelhead intercepted in Fraser River commercial salmon fisheries.
8. Computer analyses of catch and effort data, Fraser River commercial salmon fisheries[2].
9. Field net-effort and catch data, Indian food fisheries.
10. Field biological sampling data for steelhead intercepted in Indian food fisheries.
11. Computer analyses of catch and effort data, Indian food fisheries[b].
12. Field angler effort data, Fraser River sport fishery.
13. Field angler catch data, Fraser River sport fishery.
14. Computer analyses of catch and effort data, Fraser River sport fishery[2].

[1]Appendices are available for inspection from:
I. McGregor
Ministry of Environment
Salmonid Enhancement Program
1259 Dalhousie Drive
Kamloops, B.C.
V2C 5Z5
(604) 374 9717

[2]Computer data may be requested from:
V. Lewynsky
Western Renewable Resources
P.O. Box 2
100 Mile House, B.C.
V0K 2E0
(604) 791 6449

ACKNOWLEDGEMENTS

Field studies were designed and comducted by the authors with the support of P. Cockfield, B. Kearns (W.R. Olmsted & Associates, Inc.), M. Whelen (M.A. Whelen & Associates Ltd.), A. Point, R. Charlie, P. Matthew and K. Malloway (CITC). Drafting was completed by R. Fink.

W.R. Olmsted & Associates, Inc. gratefully acknowledge the following individuals for their contribution to the project: I. McGregor, Fishery Biologist, Ministry of Environment (MOE), Kamloops, and Dr. A. Tautz, Head, Research Division, MOE, Vancouver for technical support and direction throughout the project; S. Steele, S. Brownlee and D. Barrett, Department of Fisheries and Oceans (DFO), Vancouver for administrative and technical assistance as Scientific Authorities; P. Caverhill, MOE, Surrey for assistance in data collection from the commercial fishery; N. Schubert, M. Farwell and K. Wilson, DFO, New Westminster for provision of data related to commercial and Indian food fisheries; W. Saito and J. Gable, International Pacific Salmon Fisheries Commission, for assistance in collecting biological data from Cottonwood test fishery and historic Commission commercial data; M. Birch (Salmon Services) and J. Thomas (J.E. Sager & Associates Limited) for data related to commercial landings; A. Baker, K. Buxton, M. Forest, G. Bennett, B. Bennett, R. Forest, T. Sakurai and S. McIndoe for assistance in collection of biological data during test and commercial fisheries; and, commercial, Indian and sport fishermen for their cooperation with project personnel.

I. McGregor reviewed the manuscript and provided many technical suggestions.

The investigation was funded through the Salmonid Enhancement Program, Department of Supply and Services Contract No. 09SB.FP501-5-5445.

CITATION

Lewynsky, V.A., W.R. Olmsted, R.J. Stewart and K.J. Scott. 1987. Interception of fall-run steelhead trout (Salmo gairdneri) by sport, commercial and Indian food fisheries of the Fraser River, 1985. Prepared for the Department of Fisheries and Oceans, Vancouver and the Ministry of Environment, Vancouver and Kamloops, by W.R. Olmsted & Associates, Inc. vii + 68 p. + appendix.

1.0 INTRODUCTION

Select Fraser River tributaries (Thompson, Chilcotin, Bridge Nahatlatch, Stein, Seton rivers, and Cayhoosh Creek; Fig. 1) support production of unique fall-run races of steelhead trout (Salmo gairdneri) characterized by unusually large average size. These steelhead stocks are highly valued by anglers and support an intense recreational fishery in the Fraser River mainstem and Thompson River. In contrast to their summer-run counterparts which enter natal watercourses in late spring and summer, fall steelhead are believed to migrate through the Fraser River from late August through December. This period of migration parallels that of many stocks of Pacific salmon (Oncorhynchus spp.) which are the target of the mainstem commercial gillnet fishery. As a result, fall-run steelhead are caught with Pacific salmon in the commercial and Indian food fisheries. Fall-run steelhead are also the focal species of the lower Fraser River sport fishery.

The Department of Fisheries and Oceans (DFO) and Ministry of Environment (MOE) are charged with restoration of Pacific salmon and anadromous trout to historic levels through the mandate of the Salmonid Enhancement Program (SEP). Federal and Provincial fishery managers recognize that fall steelhead are harvested by commercial and Indian food fisheries of the Fraser River, in addition to sport fisheries in the Fraser River mainstem and tributaries. However, reliable harvest data in the Fraser River mainstem are limited, and the collective impact of these fisheries on steelhead stocks is not fully known. In order to maintain and/or increase production of fall steelhead in enhanced mixed-stock salmon fisheries of the Fraser River, accurate estimates of steelhead harvested in each consumptive fishery are required. Temporal/spatial characteristics of these fisheries, and variables that influence the magnitude of the annual catch, must also be determined to effectively manage fall-run steelhead stocks.

DFO and MOE contracted W.R. Olmsted & Associates, Inc. to design and conduct surveys to estimate numbers of fall-run steelhead harvested by the commercial, Indian food and sport fisheries. This report describes the results of the survey programs conducted from September 01 to November 21, 1985 during the suspected period of fall-run steelhead trout immigration through the Fraser River.

1.1 Objectives

The objectives of the 1985 steelhead interception program on the Fraser River were to:

1. Determine the locations, timings and magnitudes of steelhead catches by commercial, subsistence and sport fisheries;

2. Determine the contribution of hatchery-produced steelhead to the incidental and sport catch;

3. Obtain data and, where possible, tissue samples of steelhead from all fisheries (for stock identification) throughout the period of

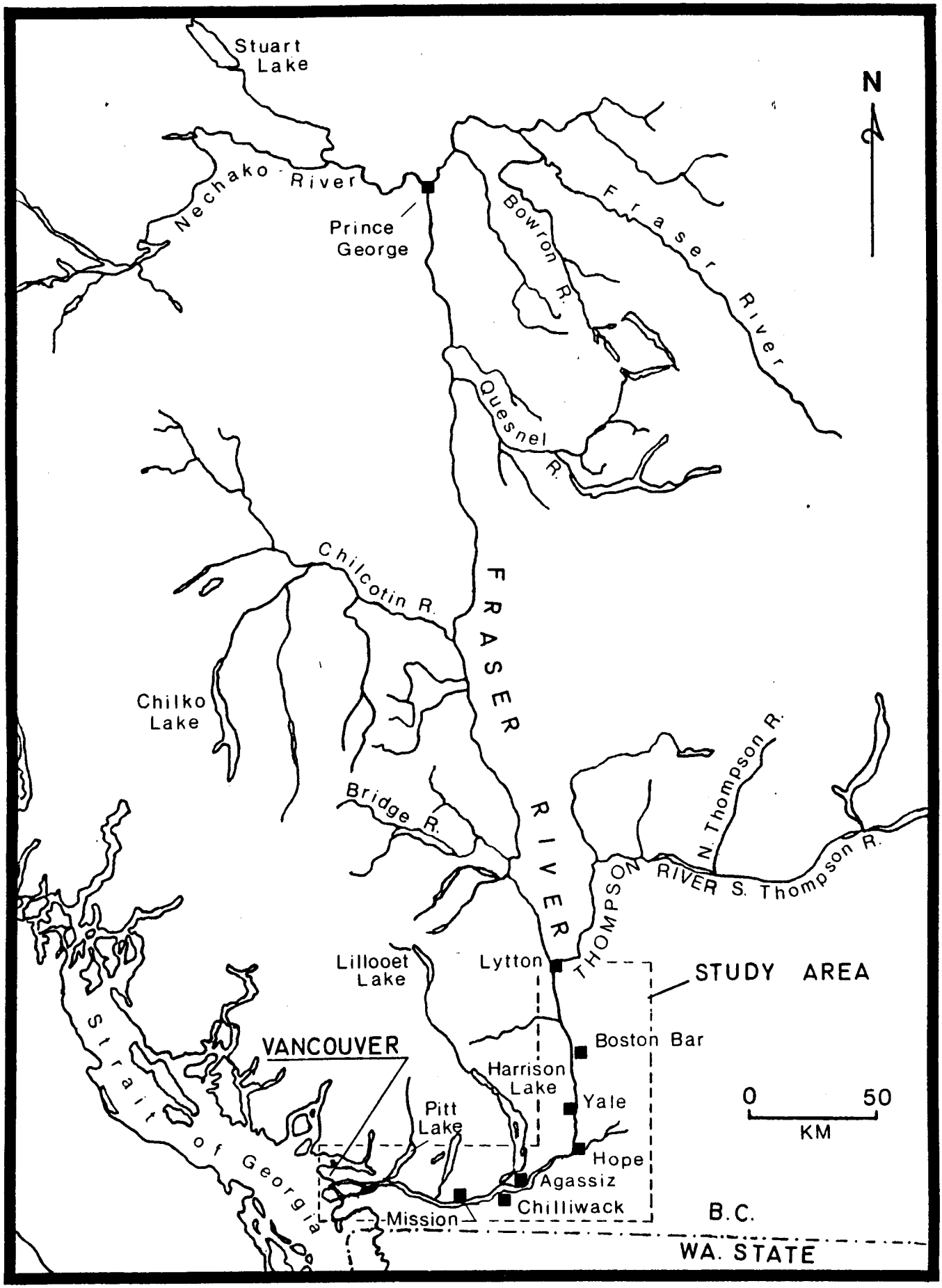


Figure 1. Key map of the study area in the mainstem Fraser River.

immigration;

4. Obtain historical test fishing data and other related information for steelhead interceptions from regulatory agencies;

5. Prepare a comprehensive report describing the methods, results and a discussion of results.

1.2 Previous Studies

1.2.1 Commercial Fisheries

Through the auspices of SEP, the Marine Resources Branch of MOE compiled preliminary estimates of the commercial harvest of various steelhead stocks in British Columbia (Andrews and McSheffrey 1976). Such estimates were required to identify the magnitude of interceptions, address the overall paucity of information, and provide a preliminary direction of field studies to develop a resource management base for anadromous trout during the inception of SEP. Using various sources of commercial catch statistics, MOE collated and analysed available data by region, and provided annual estimates of steelhead interceptions from 1963 to 1974 in commercial salmon fisheries of British Columbia. Results showed that significant interception of steelhead occurred in commercial gill net fisheries in Statistical Area 29; the majority of these interceptions occurred from mid-August through mid-November, coincident with the suspected timing of fall-run steelhead immigration through the lower Fraser River.

MOE subsequently initiated studies to estimate the steelhead catch from commercial salmon fisheries in Juan de Fuca Strait, and the Skeena and Fraser rivers during 1976 (Oguss and Andrews 1977). Catch and effort data were acquired directly on collector boats through interviews with commercial fishermen during deliveries and/or at boat docking facilities. Information on gillnet dimensions, target salmon species and anecdotal observations were recorded concurrently, and biological samples for age determination and stock identification were collected. The proportion of steelhead not sold as a salmon species, also referred to as "take-homes" (i.e., for personal consumption or sold later), was also estimated. During 1977, a field investigation of similar design addressed interception of steelhead in commercial salmon fisheries of Barkley Sound, Johnstone Strait and the Fraser and Skeena rivers (Oguss and Evans 1978). A final study was conducted by MOE in 1978 to quantify incidental catches of steelhead in commercial salmon fisheries of Barkley Sound and Johnstone Strait, and to provide baseline interception data in Dean and Burke Channels for Dean and Bella Coola river stocks (Evans 1979).

1.2.2 Indian Food Fisheries

The present investigation represents the first study designed to estimate numbers of fall-run steelhead intercepted in the Fraser River Indian food fishery which target on Pacific salmon. Weekly estimates of catch and effort have been summarized by DFO, and are presented by year from 1951 to 1985 (Schubert 1983, 1984, 1985, 1986). Net-effort

was estimated by ground, river and/or aerial surveys, and catch rates were determined from net inspections by fishery officers (Schubert 1985). Sampling procedures varied annually, both between and within areas, in response to hydrologic conditions, DFO budgetary allocations (Schubert 1985) and enforcement priorities. As a result of these constraints, catch and effort estimated by fishery officers have not been verified, and reliability is unknown.

1.2.3 Sport Fisheries

During 1984, SEP funded two independent angler surveys of the lower Fraser River bar fishery. A contracted survey focused on the sport harvest of anadromous trout, while a concurrent DFO study targeted on angler catches of Pacific salmon. Angler use and catch was was estimated using a roving creel survey. Results of these surveys were reported by Scott (1985) and Schubert et al. (in prep.). In 1985, DFO restructured the design, and implemented a combination aerial and an access point survey which monitored a larger area and time frame than the survey of the Fraser River described herein.

2.0 COMMERCIAL FISHERIES

2.1 Introduction

This section of the report describes the methods and results of the program conducted to estimate steelhead catch by commercial salmon fisheries in the Fraser River mainstem (Fig. 2) during October and November, 1985.

The commercial gill-net fishery in the Fraser River mainstem (DFO Statistical Area 29) targets on specific stocks of Pacific salmon and is regulated by two agencies. International Pacific Salmon Fisheries Commission (IPSFC) has jurisdiction over sockeye (O. nerka) and pink (O. gorbuscha) salmon, and DFO manages chum (O. keta), chinook (O. tshawytscha) and coho (O. kisutch) salmon. The timing, location and duration of a commercial fishery (opening) in Statistical Area 29 is based on the predicted strength of species and stock-specific returns to the Fraser River drainage.

In order to predict the timing and estimate the magnitude of salmon returning to the Fraser River, regulatory agencies conduct test fisheries at strategic times and locations. Test fisheries are conducted in the lower Fraser River by IPSFC at Cottonwood and by DFO at Albion (Fig. 2) throughout the period of salmon immigration. Catch information generated by these test fisheries provide an index of the strength of salmon returns and timing of their movements through the lower Fraser River. Regulatory agencies use test fishery results to estimate whether or not returns of specific stocks of salmon will be sufficient to sustain production in the Fraser River drainage, and to identify an harvestable surplus to regulate commercial fisheries in Statistical Area 29.

Regulatory agencies stipulate the dates, duration and locations of commercial openings when a salmon surplus is predicted. Openings for the gill net fleet which fish in Statistical Area 29 are spatially termed "full river" (i.e., Fraser River to Mission Bridge and Georgia Strait) and "outside" (i.e., Georgia Strait, bounded by the mouth of the Fraser River). In general, few steelhead are intercepted in outside gillnet openings [redacted] pers. comm.); however, previous studies showed that inside openings during September, October and November resulted in significant catches of fall steelhead (Andrews and McSheffrey 1976, Oguss and Andrews 1977, Oguss and Evans 1978).

2.2 Methods

2.2.1 On-boat Surveys

In 1985, four commercial openings occurred in Statistical Area 29 during the expected period of fall steelhead immigration. Two 24-hour outside (Georgia Strait) openings occurred on September 09 and September 16, and two 12-hour inside (mainstem) river openings occurred on October 09 and November 21. The outside fisheries were not directly monitored by our investigation; rather, anecdotal information regarding steelhead interceptions was acquired from commercial fishermen. Quantitative data, derived from commercial sales records

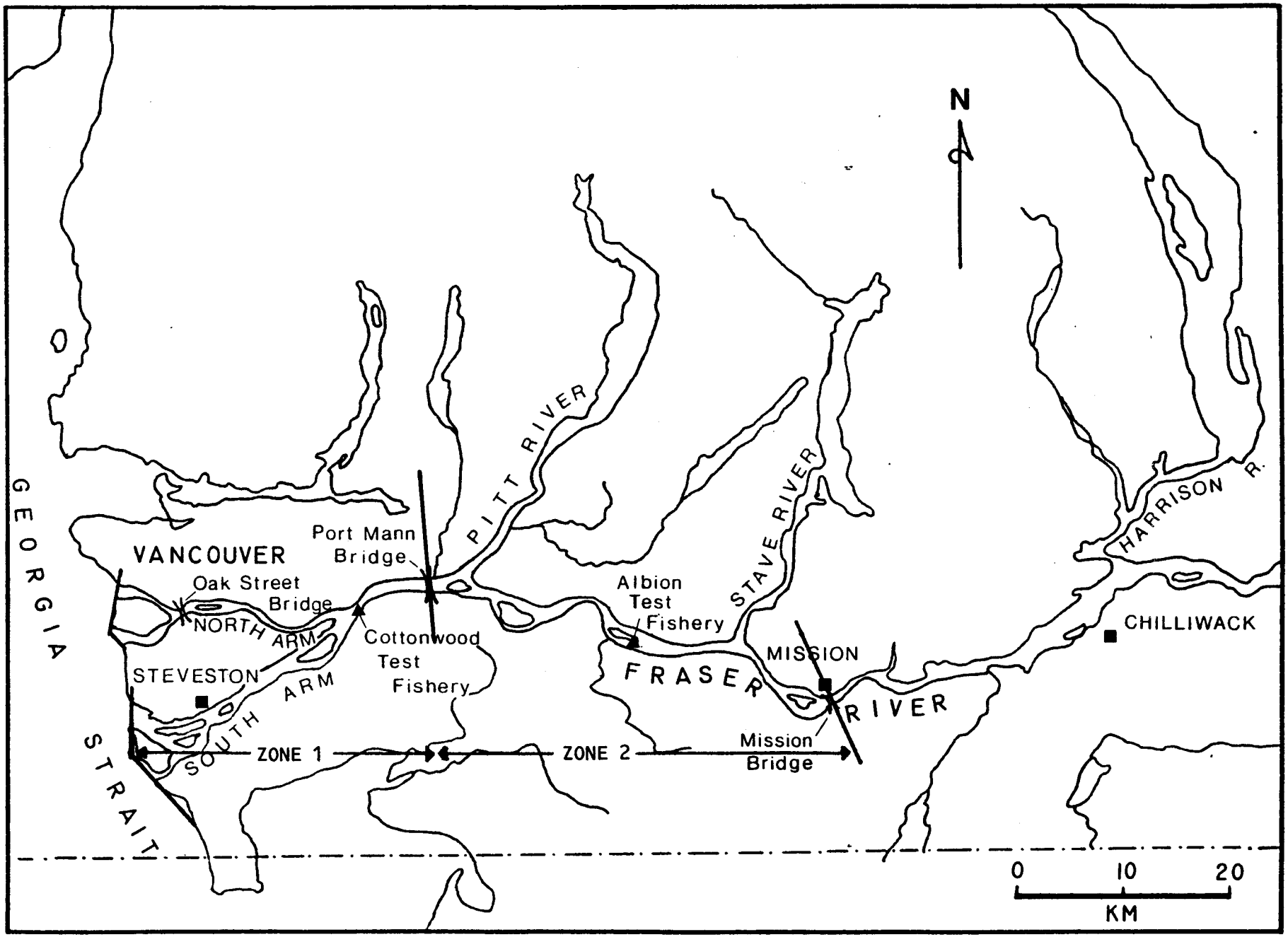


Figure 2. Locations of Cottonwood and Albion salmon test fisheries and the two zones in the Fraser River mainstem used during on-boat surveys of commercial salmon fisheries in 1985.

for the month of September, were obtained from DFO Salmon Services.

For the two inside river openings, commercial catch of steelhead trout was estimated by multiplying the total number of commercial boats by the mean catch per boat during the 12-hour opening. Catch per boat was recorded by direct sampling. With special permission, our personnel accompanied a boat owner for the duration of the 12-hour opening, and recorded relevant biological and catch data. Numbers and distribution of commercial boats per opening were obtained from DFO; commercial boats were enumerated in the Fraser River by DFO Field Services Branch from a fixed-wing aircraft.

Additional catch and biological data were acquired during the fishery from unaccompanied commercial fishermen. When appropriate, adjacent boats were contacted by radio or hailed; with permission of the skipper, catches of steelhead were recorded and sampled. During the October opening, commercial fishermen were also interviewed during deliveries at a collector/buyer boat to acquire anecdotal catch data, sample steelhead landed, and estimate steelhead takehome (i.e., steelhead retained for personal use or sold later). However, only catches based on a completed fishing day were used to calculate catch per boat-day for each commercial opening.

All steelhead landed by a sampled boat and all other steelhead sampled during the commercial opening were checked for hatchery marks. Chinook and coho salmon were also examined for hatchery clips at the request of DFO, and these data supplied under separate cover. Hatchery marks and enumerative data were recorded from all fisheries sampled, and provided to the Scientific Authority in a separately bound appendix.

The Fraser River mainstem was broadly divided into two areas (Fig. 2): Zone 1 (entrances of North, Middle and South arms to Port Mann Bridge), and Zone 2 (Port Mann Bridge to Mission Bridge). Total catch of wild and hatchery steelhead in each zone during an inside river opening was estimated as follows:

$$\text{Total catch} = N\bar{y} = \frac{N \sum_{i=1}^{n} y_i}{n},$$

$$\text{Variance of } N\bar{y} = V(N\bar{y}) = N^2(1 - n/N)S^2/n,$$

where N = total number of boats enumerated by DFO overflights,

n = number of boats sampled,

y_i = steelhead catch per boat-day (12-hour opening) for boat i,

$\bar{y}$ = mean number of steelhead trout captured per boat during a 12-hour opening, and

S^2 = sample variance of steelhead per boat-day.

This analysis assumed that the boats sampled were representative of the commercial fleet at large.

2.2.2 Commercial Sales Records

Catch estimates for steelhead and salmon landed during 1985 commercial fisheries in Statistical Area 29 were provided by DFO Salmon Services. Estimates were derived by J.E. Sager & Associates Limited from salmon and steelhead commercial catches sampled at all major landing and processing sites.

2.2.3 Test Fisheries

Salmon test fisheries conducted annually in the lower Fraser River at Cottonwood and Albion occur during the period of fall steelhead immigration. Because fall steelhead are captured in these salmon test fisheries, IPSFC and DFO consented to record steelhead catch data for the present study. Test fishery personnel used log books to record information on effort and catches of salmon and steelhead during each fishing day. Log books and biological samples were obtained upon completion of each test fishery. The IPSFC test fishery at Cottonwood provided daily information until termination on October 14. One set/day was conducted on flood tides with 5.5 inch (14.0 cm) mesh gill nets to target on pink and sockeye salmon. The DFO test fishery at Albion provided steelhead catch data three days/week to September 30, and daily to November 20 when floe ice and inclement conditions forced suspension. Two sets were usually made each fishing day on flood tides; occasionally only one set was made if large numbers of salmon were caught. Gill net mesh diameter was varied in relation to the target species. During September, 8 inch (20.3 cm) mesh targeted on chinook salmon, while 6.75 inch (17.2 cm) mesh was used in October and November, primarily for chum and coho salmon.

Data related to catches of Pacific salmon were recorded, but not analysed, and supplied to the Scientific Authority in a separate bound appendix.

2.3 Results

2.3.1 On-boat Surveys

2.3.1.1 October 09 Commercial Opening

The commercial fishery on October 09 targeted on pink salmon and occurred during favourable weather. At 0800, DFO enumerated 422 boats fishing the Fraser River mainstem. At this time 276 boats (65.4% of the fleet) were fishing in Zone 1 and 146 boats (34.6%) were distributed throughout Zone 2 (Table 1). Catch per boat in Zone 1 ranged from 0 - 5 and averaged 2.7 steelhead per boat. In Zone 2, the catch ranged from 1 - 10 and averaged 4.0 steelhead per boat. An estimated total of 736 and 584 steelhead were captured in Zone 1 and 2, respectively. In total, an estimated 1,320 steelhead were harvested during the October commercial opening from the on-boat survey.

Table 1. Steelhead catch by the commercial gill net fishery during the October 9 and November 21, 1985 Fraser River (Statistical Area 29) openings as estimated by the on-boat survey.

Date	Zone[a]	Boats Fishing	Number of Boats Sampled	Catch per Boat Mean	Catch per Boat Range	Total Catch (SE)[b]
October 9	1	276	3	2.7	0-5	736 2.6
	2	146	11	4.0	1-10	584 4.0
Opening Total						1320 (419.4)
November 21	1	106	8	0.5	0-2	53
	2	79	7	0.9	0-2	68
Opening Total						121 (37.4)
Area 29 Total						1441 (421.1)

[a]1 = mouth of Fraser River to Port Mann Bridge (Zone 1)

2 = upstream of Port Mann Bridge (Zone 2)

[b]SE = standard error of the estimated total catch

Table 3. Comparison of Fraser River commercial catch estimates for the October 9 and November 21, 1985 openings.

Commercial Opening	DFO Sales Slip Count[a]	Salmon Services(SS) Estimate[a]	On-boat Survey Estimate	SS/Survey (x 100)
October 9	220	470	1320	35.6
November 21	11	16	121	13.2

[a]data from J.E. Sager & Associates Limited and are preliminary and subject to revision (J. Thomas, pers. comm.)

Table 2. Numbers and average weights of steelhead reported captured during commercial openings in Statistical Area 29 (Fraser River) based on 1985 DFO sales slips and revised capture estimates[a].

Week Ending	Reported Catch from DFO Sales Slips		Steelhead Sampled[b]		Correction Factor[c]	Estimated Number of Steelhead Captured
	Number	Average Weight (kg)	Number	Average Weight (kg)		
Jul 27	4	3.750	4	3.500	0.367	11
Aug 3	6	3.500	6	2.000	0.733	8
10	6	5.166	2	6.400	0.104	19
17	2	5.000	8	3.000	0.564	14
24	12	5.250	7	3.200	0.195	36
31	20	5.600	9	6.000	0.466	19
Sep 7	10	5.100	8	4.600	0.517	15
14	14	7.000	0			14
21	2	6.500	0			2
28[d]	2	5.500	0			2
Oct 5[d]	10	6.500	3	11.300	0.270	11
12	220	6.750	166	6.400	0.353	470
19	No Commercial Fishery					
26	No Commercial Fishery					
Nov 2	No Commercial Fishery					
09	No Commercial Fishery					
16	No Commercial Fishery					
23	11	6.636	12	6.400	0.733	16

[a] all data and estimates are preliminary and subject to revision

[b] mark Recovery Program sampling for DFO Salmon Services conducted by J.E. Sager & Associates Limited

[c] based on coho sample rates (i.e., % of coho as reported in catch divided by % in sample); based on the assumption that all species have equal probability of being sampled

[d] no commercial fishery; data dervived from steelhead captured by test fishery

2.3.1.2 November 21 Commercial Opening

The commercial fishery on November 21 was directed at Weaver Creek chum salmon. Weather conditions this day (sub-zero air temperatures, winds to 70 kmh), and a rapid decline in chum stocks (based on Albion test fishery) resulted in a significant reduction in commercial effort. Thus, behaviour of the November commercial fishery was considered atypical (M. Farwell, pers. comm.). At 0800, DFO counted 185 boats in the Fraser River mainstem. Of these, 106 boats (57.2%) were located in Zone 1 and 79 (42.8%) in Zone 2 (Table 1). By 1200 approximately 130 boats were fishing (M. Farwell, pers. comm.). At 1600, only 20 boats remained; four were fishing Zone 1 and 16 were located in Zone 2. A total of 15 boats with complete catch data were sampled (8.1% of the fleet). Catch per sample boat ranged from 0 - 2 and averaged 0.7 steelhead per boat (Table 1). A total catch of 121 steelhead was estimated for the November 21 commercial opening from the on-boat survey.

2.3.2 DFO Commercial Sales Records

DFO Salmon Services estimated that 530 steelhead captured in Statistical Area 29 were sold through commercial markets between September 01 and November 23 (Table 2). A preliminary estimate of 470 and 16 steelhead resulted from commercial openings on October 09 and November 21, respectively (J. Thomas, pers. comm.; Table 3). DFO Salmon Services total estimated steelhead catch for the October 09 commercial opening was approximately 36% of that estimated by the on-boat survey; for the November 21 opening, commercial sales were approximately 13% of the steelhead catch estimated by the on-boat survey (Table 3).

2.3.3 Test Fisheries

Seventeen steelhead were captured by the Cottonwood test fishery between September 01 and fishery termination on October 15 (Table 4). The Albion test fishery captured 262 steelhead between September 04 and November 20 (test fishing was suspended during unusually cold weather). The large differences in catch can be partially explained by significantly higher effort expended at Albion, but it should also be noted that mesh size differed; Cottonwood fishery used 5.5 inch (14.0 cm) mesh exclusively, while Albion fishery used 6.75 inch (17.2 cm) and 8 inch (20.3 cm) mesh (Table 4).

2.4 Discussion and Conclusions

There is little doubt that all steelhead captured in the October and November commercial openings were not recorded on DFO sales slips; alternatively (but unlikely), our on-boat survey may have over-estimated total catch. Survey estimates were based on the assumption of simple random samples of all commercial boats. However, boats sampled were only those where permission was granted (primarily in the New Westminster-Port Mann Bridge area), and therefore were not a true simple random sample of the fleet. These boats may have had higher success rates than those at or near the mouth, and if this was the case, catch estimates may be slightly inflated.

Table 4. Wild steelhead trout catch and catch per unit effort by the Albion (DFO) and Cottonwood (IPSFC) test fisheries on the Fraser River, September to November, 1985[a].

Date	Albion			Cottonwood		
	Mesh (cm)	Mean Catch per 1 h Set	Total Catch	Mesh (cm)	Mean Catch per 1 h Set	Total Catch
August	20.3	0.00	0	14.0	0.00	0
Sep 4	20.3	0.50	1			
9	20.3	1.00	2			
11	20.3	1.50	3			
13	20.3	1.00	2	14.0	0.00	0
14				14.0	0.00	0
15				14.0	0.00	0
16				14.0	0.00	0
17				14.0	0.00	0
18	20.3	0.00	0	14.0	0.00	0
19				14.0	0.00	0
20	20.3	0.50	1	14.0	0.00	0
21				14.0	0.00	0
22				14.0	1.00	1
23	20.3	4.00	8	14.0	0.00	0
24				14.0	0.00	0
25	20.3	2.00	4	14.0	0.00	0
26				14.0	0.00	0
27	20.3	2.00	4	14.0	0.00	0
28				14.0	1.00	1
29				14.0	1.00	1
30	20.3	2.00	4	14.0	2.00	2
September		1.45	29		0.28	5
Oct 1	20.3	17.00	17	14.0	2.00	2
2	20.3	7.00	14	14.0	4.00	4
3	17.2	5.50	11	14.0	0.00	0
4	20.3	3.00	6	14.0	0.00	0
5	17.2	2.00	4	14.0	1.00	1
6	17.2	11.00	11	14.0	1.00	1
7	20.3	5.50	11	14.0	1.00	1
8	17.2	3.00	6	14.0	3.00	3
9						
10	17.2	0.50	1	14.0	0.00	0
11	17.2	1.50	3	14.0	0.00	0
12	17.2	3.50	7	14.0	0.00	0
13	17.2	7.00	7	14.0	0.00	0
14	17.2	2.50	5	14.0	0.00	0
15	17.2	2.00	4			

Table 4. (page 2)

Date	Albion Mesh (cm)	Albion Mean Catch per 1 h Set	Albion Total Catch	Cottonwood Mesh (cm)	Cottonwood Mean Catch per 1 h Set	Cottonwood Total Catch
Oct 16	17.2	3.00	6			
17	17.2	5.00	10			
18	17.2	4.50	9			
19	17.2	0.00	0			
20	17.2	3.00	6			
21	17.2	7.00	7			
22	17.2	7.00	14			
23	17.2	5.00	10			
24	17.2	3.00	3			
25	17.2	1.00	2			
26	17.2	2.00	2			
27	17.2	1.00	2			
28	17.2	0.00	0			
29	17.2	0.50	1			
30	17.2	1.00	2			
31	17.2	2.00	4			
October		3.43	185		0.92	12
Nov 1	17.2	3.00	6			
2	17.2	1.00	2			
3	17.2	1.00	1			
4	17.2	1.50	3			
5	17.2	1.50	3			
6	17.2	5.00	5			
7	17.2	2.50	5			
8	17.2	1.00	2			
9	17.2	2.00	4			
10						
11	17.2	0.00	0			
12	17.2	2.00	2			
13	17.2	1.00	1			
14	17.2	0.00	0			
15	17.2	1.00	1			
16	17.2	2.00	2			
17	17.2	1.00	1			
18	17.2	4.00	4			
19	17.2	2.00	2			
20	17.2	2.00	4			
November		1.78	48			
Season		2.59	262		0.55	17

[a] no marked (hatchery) steelhead captured

Although the on-boat survey estimates are subject to sampling error, we conclude that the number of steelhead sold through regular markets was substantially lower than the actual total catch. However, because only a single season can be compared, it is unknown whether or not the magnitude of the differences between sales record estimates and the on-boat survey estimates for the two commercial openings in 1985 is representative of previous years.

Based on the standardized catch rates by the test fisheries, it appears that the October 09 commercial opening occurred during peak immigration of fall steelhead, whereas apparent steelhead abundance was low by the November 21 opening (see Section 5.0).

3.0 INDIAN FOOD FISHERIES

3.1 Introduction

This section of the report describes the results of the program conducted to estimate steelhead catch by the Fraser River Indian food fishery between Steveston and Lytton (Fig. 3) from September 01 to November 17, 1985.

The Indian food fishery is the most complex of the three Fraser River fisheries that harvest fall-run steelhead, and despite its long history, is the least understood. The annual harvest rate of fall steelhead by they Indian community, factors which affect the rate of harvest and the species relative importance is also not well known. In recognition of these deficiencies, the study design used in 1985 was, of necessity, exploratory in nature; it was also the first investigation structured to obtain reliable steelhead catch statistics and describe the Indian food fishery on the Fraser River during the period of fall steelhead immigration.

The survey was initially designed to be completely independent of DFO fishery officer data collection activities. However, following pre-contract discussion with the Scientific Authority, DFO/MOE management and enforcement personnel, we decided (due to logistical and budget constraints) to obtain net-effort data from DFO fishery officers for the regions downstream of North Bend (Petch Creek). The region between North Bend and Lytton, which historically has received the least sampling effort by DFO and MOE, would remain the responsibility of the Contractor, and all fishery statistics for the Steveston to Mission region would be obtained from DFO Field Services Branch, New Westminster.

For the region between Mission and North Bend, DFO management staff requested that the Contractor conduct a "log book" program to assess the efficacy of the method to estimate catch and catch per unit of effort (CPUE) data, and general fishery information. However, despite the use of local Indian technicians familiar with local fisherman, the log book program failed. Under the supervision of the Central Interior Tribal Councils (CITC) senior fishery biologist, Native technicians were able to recruit a large number of Indian fisherman, but were unable to persuade these fisherman to consistently record each day's data. In short, fisherman found the log book an inconvenient burden during their fishing activities. The log book program was therefore abandoned by mid-September, and promptly replaced by on-site surveys to obtain CPUE data by interview and direct observation.

Data related to catches of Pacific salmon were recorded, but not analysed, and supplied to the Scientific Authority in a separate bound appendix.

3.2 Methods

3.2.1 Steveston Area to Mission (Regions 1 & 2)

Estimates of net-effort and steelhead catch for the Steveston-Deas

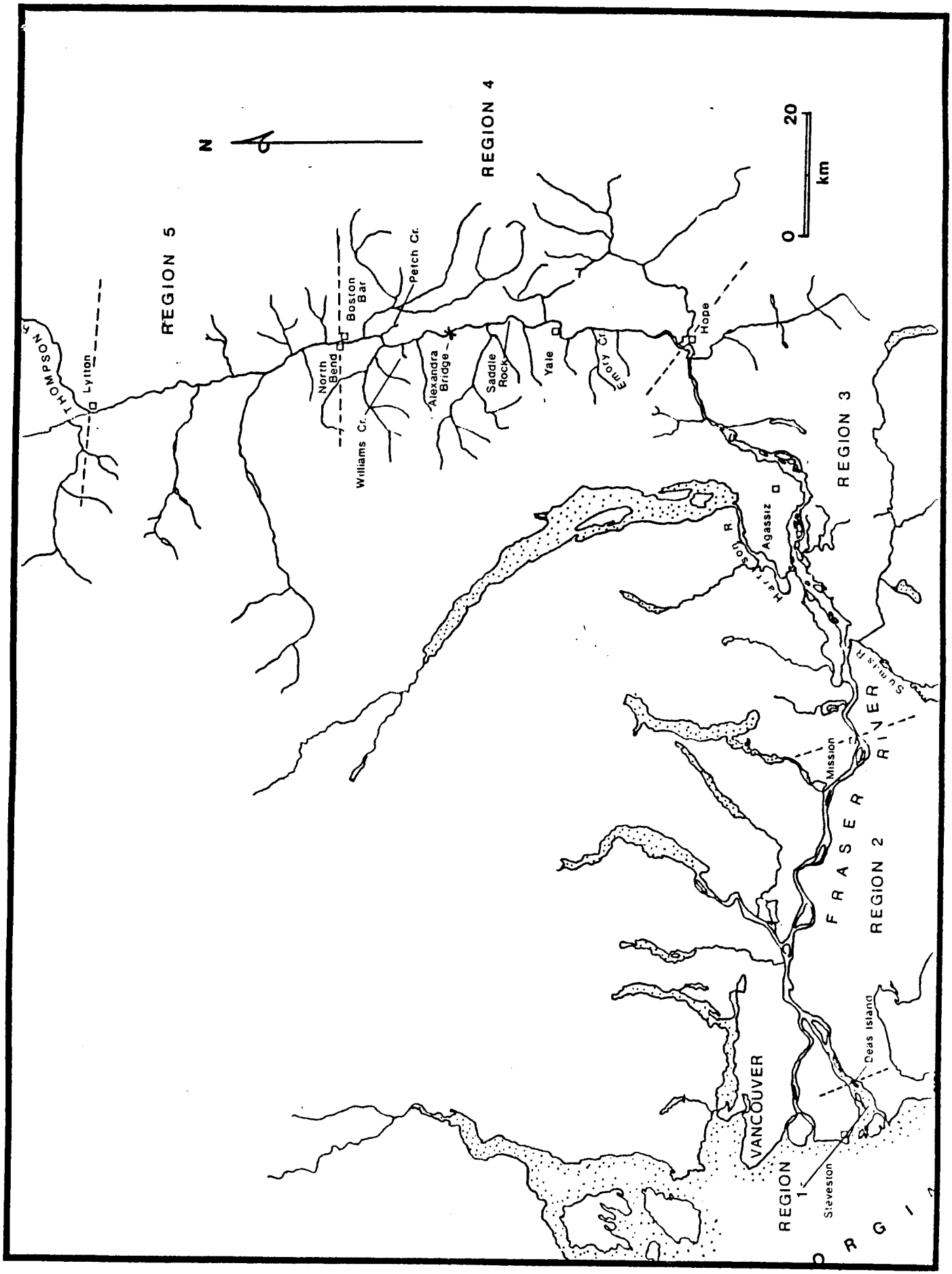


Figure 3. The study area encompassed by the Indian food fisheries of the Fraser River mainstem from Steveston to Lytton showing the five geographic regions used by the 1985 investigation.

Island and Deas Island-Mission were obtained from DFO Field Services Branch. Data acquisition and compilation procedures have been described by Schubert (1983, 1984, 1985, 1986). The region downstream of Deas Island was open to fishing 1200 Friday to 2400 Saturday each week; the Deas Island-Mission region was open to fishing three days per week from 1200 Thursday to 1200 Sunday.

3.2.2 Mission to North Bend (Region 3)

Estimates of steelhead catch for the Mission-Hope and Hope-North Bend (Petch Creek) regions were calculated from net counts obtained by DFO fishery officers and catch per net-day estimates from the on-site surveys. Total weekly net-days were calculated by multiplying the maximum number of nets enumerated by the fishery officer by three (the number of days the fishery was open). Nets were enumerated one to three times per weekly opening but only the maximum count obtained via river boat was used because lower counts usually reflected missing data (i.e., some counts were conducted from vehicles). Thus, a mean net count and variance could not be calculated. Because the maximum count was used, estimates of net-days (and resulting catch) may be slightly inflated.

Mean weekly catch per net-day was estimated by multiplying the mean number of pickings per day by the mean steelhead catch per net pick as follows:

$$\text{Mean weekly catch/net-day} = (C_w) = P_w F_w,$$

where P_w = mean number of pickings per net-day for week w,

F_w = mean number of steelhead per picking for week w.

Number of pickings per day was obtained by direct observation and interview reports. Steelhead catch per net pick was primarily obtained by direct observation at the time of picking or subsequent to net picking by intercepting net owners upon return from a just-completed pick (e.g., at commonly used boat launches). Approximately 80% of the catch per pick was obtained by direct observation.

Mean steelhead catch for each week (stratum) was estimated as follows:

$$\text{Total catch for week w} = D_w C_w,$$

where D_w = total net-days for week w,

C_w = mean catch per net-day for week w.

Variances (and standard errors) of total weekly catch were not calculated because variances could not be generated from the DFO net

effort survey.

All above estimates refer only to set and gin-pole gill net fishing, as no dip netting was observed during the survey period. Both regions were open to fishing three days per week, 1200 Thursday to 1200 Sunday. In the Mission-Hope region, catch data (date, time, net type, number of pickings per 24 h, catch of each species per net picking) were obtained by a single survey worker using a power-boat. Sampling was concentrated between the Sumas River and Seabird Island and coincided with the time fishermen checked their nets, typically in the mornings between 0500 and 0800, and evenings between 1700 and 2000.

In the Hope-North Bend region, sampling was concentrated between Emory Creek and Saddle Rock upstream of Yale (Fig. 3). Several fishermen (nets) were located at Alexandera in early September, but terminated fishing by mid-September. The Chapman Bar-Komo area was consistently checked weekly until early October, but no active fishing was observed at various fishing sites used earlier in the season. The majority of Indian fishermen in the Emory Creek-Saddle Rock area (typically Chilliwack area residents) obtained access to their net sites by boat. A few sites on the west bank were accessed from Highway #1, but were only used sporadically in early September. Consistent shore searches were conducted from Saddle Rock upstream to Spuzzum to locate nets, but none was found after the first week in September. Limited access may have mitigated against net effort in this area. Similar to the Mission-Hope region, catch data were obtained by a single technician by power-boat, and sampling coincided with the time fishermen checked their nets (mornings and evenings). However, the launch site also provided the opportunity interview fishermen returning from their just-completed net pickings. The area between Hope and Emory Creek (typically utilized by local residents) was not surveyed because of time (efficiency) constraints. Boat surveys of the areas downstream of Emory Creek were surveyed by boat at times when we were likely to intercept Indian fishermen at their nets (sparsely scatterd to Hope) would have been at the expense of data acquisition from the more concentrated and consistent fishery around Yale. The former area could only be effectively surveyed by boat, as shore access is limited and foot surveys in September failed to locate net effort.

3.2.3 North Bend to Lytton (Region 4)

Net-effort, mean catch per net-day and steelhead catch for the North Bend-Lytton region were estimated using a stratified random survey. The 1985 survey period from September 01 to November 17 was stratified into periods corresponding to weekly openings. The region was open to fishing four days per week, 0001 Tuesday to 2400 Friday. The entire region was surveyed on two randomly selected days each week by one technician.

During the first week of September, the region between Petch Creek and Lytton was throughly examined to identify all net (sites) by exact location, net type and owner. This was accommplished by ground census and by personal contact with the local Indian community. (All active nets encountered during the period surveyed belonged to local residents.) The location of each net did not change during the study,

as net sites are traditionally occupied by family members for virtually their lifetime. The ground census of all active nets was verifed using a boat between Lytton and North Bend in early and late October (planned aerial flights with DFO did not occur due to budget restraints). A large number of inactive net sites were observed, but surveyors located only two nets that were not accounted by ground surveys. This effort was subsequently incorporated into the sampling schedule.

On each of two ramdomly selected days per week, the survey worker visited net sites primarily in the mornings and evenings to correspond with the most common times of net pickings. As noted in the lower regions, net pickings during the fall season occurred shortly after dawn and just prior to dusk. When the owner was absent upon arrival, or where isolated nets (e.g., on the west side of the river, etc.) could not be efficiently accessed, net owners were interviewed at their residence. In many cases, fishermen had just returned with their catch or were in the process of dressing their catch when the survey worker arrived. Where the catch was not directly observed, catch information was obtained by interview report. Thus, catch data (date, time, net type, net owner, number of pickings per 24 h, steelhead catch per net picking) and the number of active nets were recorded from direct observations (on-site and at the fisherman's residence) and by interview reports. Samples sizes within each week stratum were insufficient to test the null hypothesis that mean catch per picking differed among the three data collection procedures. However, we believe that the catches observed at the fishermens' residences were complete, and reported catch information obtained by interview was accurate (honest); the use of an Indian technician under the supervision of CITC's fishery biologist and CITC's excellent public relations was well received by the local Native community.

All recorded net effort consisted of gin-pole gill nets. Dip-net fishing was common in the North Bend-Lytton region in early September, but was only infrequently observed during the fall survey period. The survey technician located the occasional dip-net fisherman but in all cases the fisherman's effort was short and sporadic, and no catches were observed throughout the survey period.

Based on the above sampling approach, we assumed probability samples which justified the use of inferential statistics.

Total net-days for each week were estimated as follows:

$$\text{Total net-days}(D_w) = Nd_w = \frac{N \sum_{i=1}^{n} d_i}{n},$$

$$\text{Variance of } Nd_w = V(Nd_w) = N^2(1 - n/N)S_w^2/n,$$

where N = total number of possible net-days per week (4),

n = number of days sampled per week,

d_i = number of active nets on day i,

d_w = mean number of active nets per day for week w,

S_w^2 = sample variance of the number of active nets.

Mean weekly catch per net-day was estimated by multiplying the mean number of pickings per day by the mean steelhead catch per net pick as follows:

$$\text{Mean weekly catch/net-day} = (C_w) = P_w F_w),$$

$$\text{Variance of } C_w = V(P_w F_w) = P_w^2 V(F_w) + F_w^2 V(P_w) + 2P_w F_w \text{Cov}(P_w, F_w) + V(P_w)V(F_w) + \text{Cov}^2(P_w, F_w),$$

where P_w = mean number of pickings per net-day in week w,

F_w = mean steelhead catch per picking in week w,

V = variance,

Cov = covariance;

and

$$\text{Mean weekly net picks per day} = P_w = \frac{\sum_{i=1}^{n} P_i}{n},$$

$$\text{Variance of } P_w = V(P_w) = (1 - n/N)S_w^2/n$$

where N = total number of active nets in week w,

n = number of nets (fisherman) surveyed in week w,

p_i = number of picks per day for net i,

P_w = mean number picks per day for week w,

S_w^2 = sample variance of the number of net picks per day in week w;

and

$$\text{Mean weekly catch per pick} = F_w = \frac{\sum_{i=1}^{n} f_i}{n},$$

$$\text{Variance of } F_w = V(F_w) = S_w^2/n \quad \text{(n.b. this is an approximation)}$$

where n = number of net picking samples in week w,

f_i = number of steelhead for pick i,

F_w = mean number steelhead per pick for week w,

S_w^2 = sample variance of the number of steelhead per pick for week w.

Total weekly catch and variance of total steelhead catch were estimated as follows:

$$\text{Total weekly catch} = D_w C_w,$$

$$\text{Variance of total catch} = D_w^2 V(C_w) + C_w^2 V(D_w) + 2D_w C_w \text{Cov}(D_w, C_w) + V(D_w)V(C_w) + \text{Cov}^2(D_w, C_w),$$

where D_w = total net-days,

C_w = mean catch per net-day,

V = variance,

Cov = covariance.

3.3 Results

3.3.1 Effort and Catch Estimates

From September 03 to November 17, 1985 the Fraser River Indian food fishery between Steveston and Lytton captured an estimated 1,712 steelhead trout; regional catches were estimated as: 139 in the Steveston-Mission region; 569 in the Mission-Hope region; 868 in the Hope-North Bend region; and 136 in the North Bend-Lytton region (Tables 5 to 8). On average, catch was highest in October with the exception of the North Bend region where maximum catch occurred in early November (Fig. 4). For all three regions upstream of Mission, catch per net-day was low until late September, increased until the second week of November and then declined abruptly in the final week (November 17) of the survey (Fig. 5). Differences between weekly trends in catch and catch rates can be explained by the general decline in weekly fishing effort (cf., Tables 5 to 8).

With the exception of the high estimated catch and catch rates for the Hope-North Bend region in early November, the 1985 catch and catch

Table 5. Estimated net effort and steelhead catch by the Fraser River Indian food fishery in the Steveston to Mission region, September through mid-November, 1985[a].

Week Ending	Steveston Area		Deas to Island Mission	
	Net Count	Total Catch	Net Count	Total Catch
Sep 8	24	0	15	2
15	22	5	15	0
22	21	14	17	0
29	28	13	22	12
Oct 6	27	44	16	1
13	19	8	13	0
20	19	9	22	0
27	19	10	15	8
Nov 3	7	3	6	0
10			6	0
17	4	0	7	10
Season Total		106		33

[a]estimates obtained from DFO Field Services Branch

Table 6. Estimated net effort and steelhead catch by the Fraser River Indian food fishery food fishery between Mission and Hope, September through mid-November, 1985.

Week Ending	Net Effort		Catch per Effort				Total Catch
	Net[a] Count	Total Net Days	Number of Nets Sampled	Mean Catch per Net Pick	Mean Net Picks per Day	Mean Catch/Day	
Sep 8	100	300	6	0.17	2.00	0.33	100
15	89	267	36	0.08	1.92	0.16	43
22	75	225	6	0.00	2.00	0.00	0
29	41	123	48	0.31	1.85	0.58	71
Oct 6	27	81	10	0.70	1.90	1.33	108
13	17	51	1	2.00	1.00	2.00	102
20	18	54	12	0.58	2.00	1.17	63
27	13	39	17	0.59	1.47	0.87	34
Nov 3	5	15	18	0.39	1.44	0.56	8
10	6	18	6	1.67	1.33	2.22	40
17	0	0	0				0
Season Total		1173					569

[a]estimates obtained from DFO Field Services Branch (New Westminster)

Table 7. Estimated net effort and steelhead catch by the Fraser River Indian food fishery between Hope and North Bend (Williams Creek), September to mid-November, 1985.

Week Ending	Net Effort		Catch per Effort				
	Net[a] Count	Total Net Days	Number of Nets Sampled	Mean Catch per Net Pick	Mean Net Picks per Day	Mean Catch/Day	Total Catch
Sep 8	82	246	0	-	-	-	-
15	71	213	24	0.125	2.125	0.266	57
22	55	165	29	0.172	1.448	0.250	41
29	29	87	4	0.750	1.000	0.750	65
Oct 6	30	90	1	1.000	1.000	1.000	90
13	16	48	3	0.667	1.000	0.667	32
20	18	54	7	1.143	1.286	1.469	79
27	10	30	6	1.333	1.000	1.333	40
Nov 3	15[b]	45	17	5.176	1.118	5.785	260
10	8[b]	24	4	5.000	1.500	7.500	180
17	8[b]	24	4	1.000	1.000	1.000	24
Season Total		1026					868

[a] estimates obtained from DFO Field Services Branch (New Westminster)

[b] net count approximated (no DFO counts conducted)

Table 8. Estimated net effort and steelhead catch by the Fraser River Indian food fishery between North Bend (Petch Creek) and Lytton, September to mid-November, 1985.

Week Ending	Net Effort		Catch per Effort[a]				
	Mean Daily Net Count	Total[a] Net-Days	Number of Nets Sampled	Mean Catch per Net Pick	Mean Net Picks per Day	Mean Catch per Net-Day	Total[a] Catch
Sep 8	5.5	22 (1.4)	5	0.00	2.00 (0.00)	0.00	0
15	4.5	18 (1.4)	8	0.13 (0.09)	2.00 (0.00)	0.25 (0.19)	5 (3.4)
22	6.5	26 (7.1)	11	0.46 (0.21)	1.73 (0.10)	0.79 (0.37)	20 (11.5)
29	4.5	18 (4.2)	8	0.38 (0.28)	1.88 (0.09)	0.70 (0.53)	13 (10.2)
Oct 6	1.5	6 (1.4)	2	1.00 (0.82)	1.50 (0.41)	1.50 (1.33)	9 (8.5)
13	1.5	6 (1.4)	3	0.33 (0.24)	1.67 (0.24)	0.56 (0.40)	3 (2.6)
20	6.0	24 (0.0)	13	1.46 (0.53)	1.77 (0.08)	2.59 (0.94)	62 (22.7)
27	4.5	18 (1.4)	6	0.50 (0.28)	1.17 (0.14)	0.58 (0.33)	10 (6.1)
Nov 3	2.0	8 (2.8)	3	1.00 (0.48)	1.67 (0.28)	1.67 (0.86)	13 (8.7)
10	1.0	4 (0.0)					
17	2.0	8 (0.0)	2	0.00	1.00 (0.00)	0.00	0
Season Total		158 (9.3)					136 (30.9)

[a]standard error of the estimate given in brackets

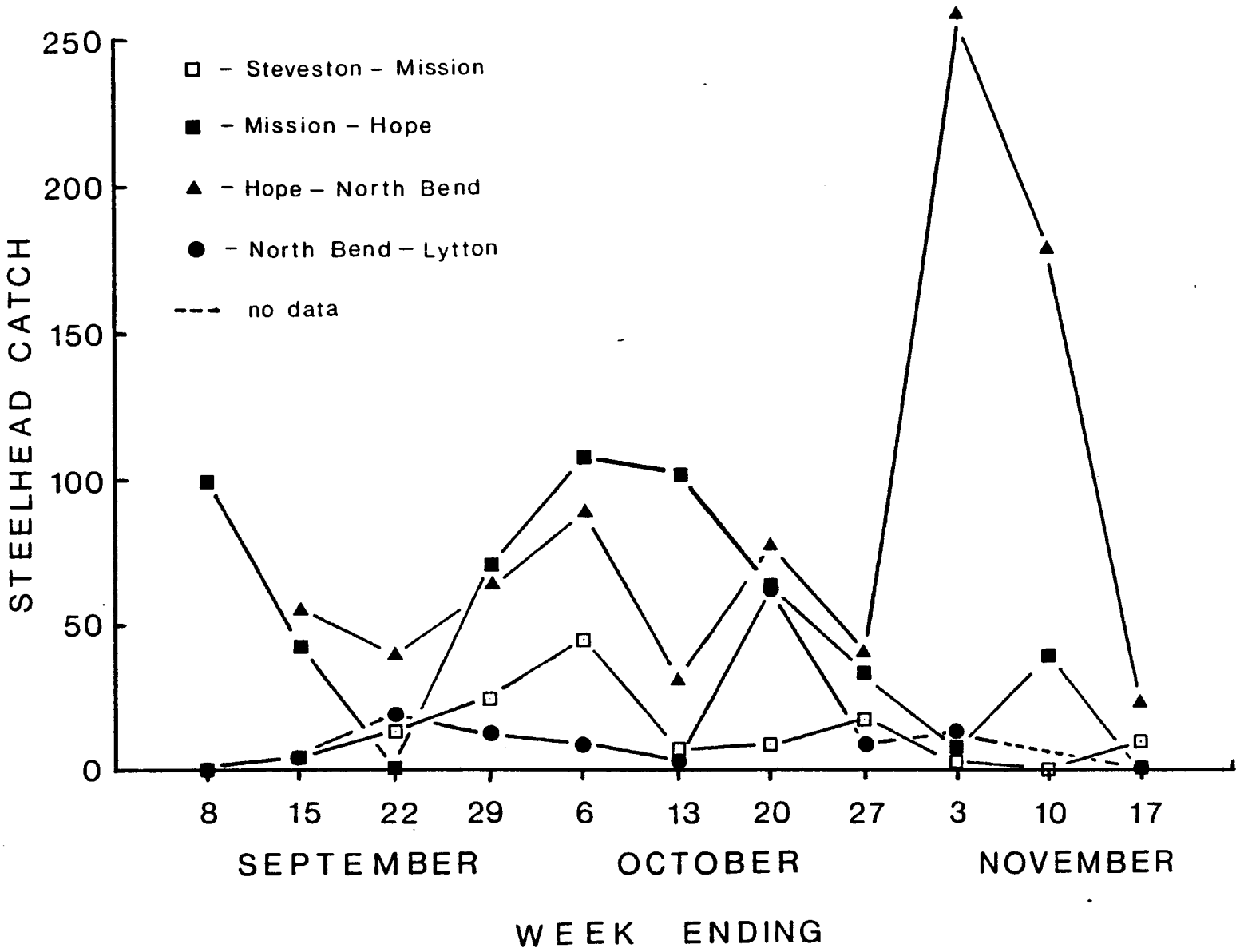


Figure 4. Weekly regional estimates of steelhead catch by the Fraser River Indian food fisheries, September through mid-November, 1985.

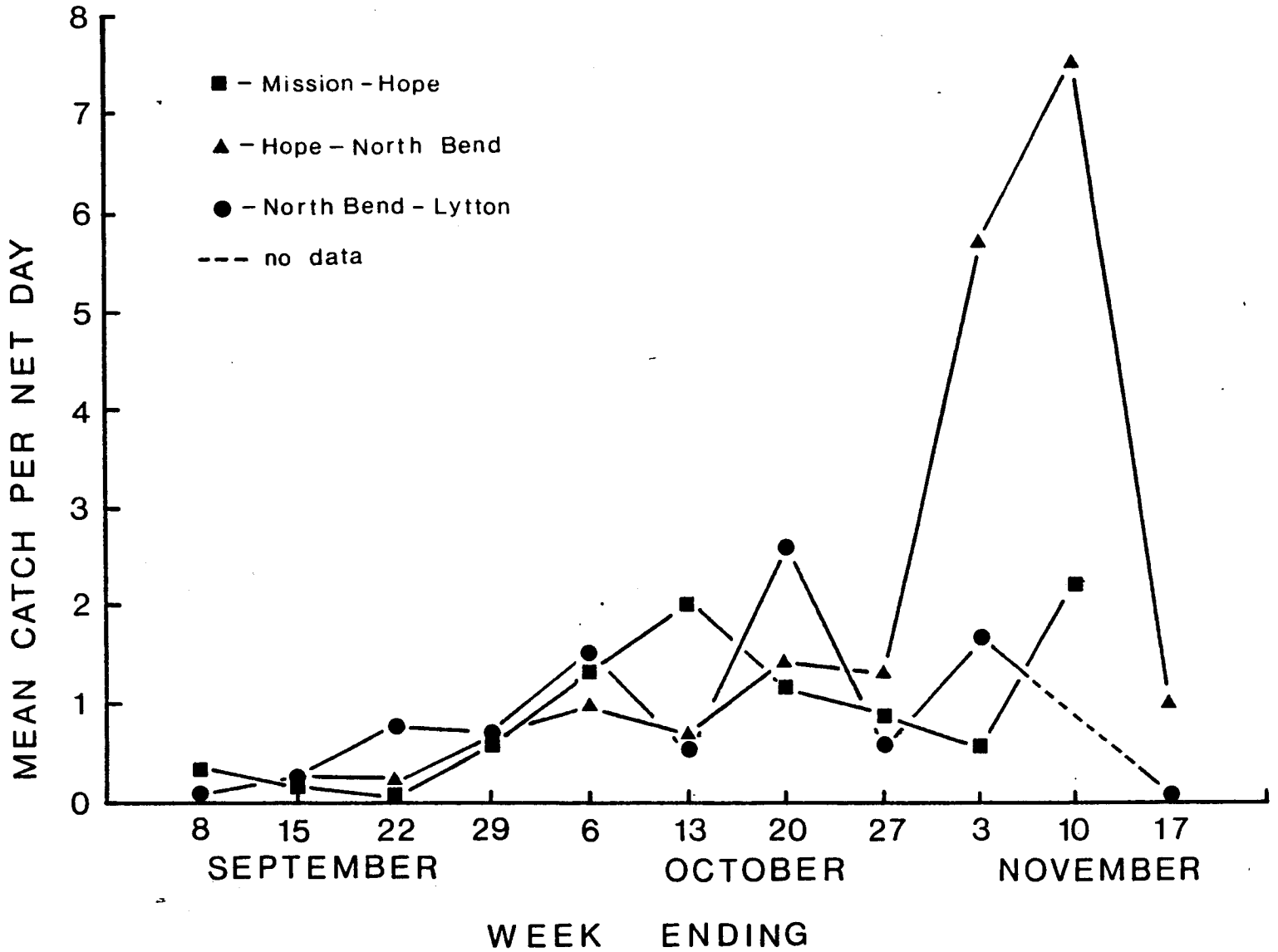


Figure 5. Weekly regional estimates of steelhead catch per net-day by the Fraser River Indian food fisheries, September through mid-November, 1985.

rate patterns were in general agreement with average historical (1974-1985) weekly pattern (Figs. 6 and 7). The observed differences could have resulted from annual variability in run timing and fishing effort, or differences in sampling procedures. Inconsistent historical data prevented comparisons of the other regions.

The estimated catch of 1,712 steelhead in 1985 is approximately twice the DFO estimate of 816 steelhead (Schubert 1986) during the period surveyed, (September through November 17). The lower DFO estimate was due to the absence of a catch estimate for the North Bend-Lytton region, and significantly lower estimated catch for the Mission-Hope and Hope-North Bend regions (Fig. 8). With the exception of 1984, the 1985 DFO catch estimate was similar to historic estimates for September through late November, while the survey study estimate is substantially higher than the DFO annual average (Fig. 9).

3.3.2 General Fishery Characteristics

The following sections describe characteristics of Indian food fisheries in the area directly surveyed by the 1985 investigation (i.e., Mission-Lytton).

3.3.2.1 Mission to Hope (Region 3)

Fishermen surveyed in the Mission-Hope region during the month of September typically set their nets shortly after the 1200 Thursday opening. The first picking usually occurred Friday morning followed by evening and morning pickings until net removal on Sunday morning.

In late September through mid-November, fishing activity became less predictable. Although timing and frequency of pickings remained about the same, nets were often not set until Friday (usually late afternoon). If the catch of desirable species was low and the pink salmon catch was high, nets were removed for the remainder of the weekly opening. Once the pink salmon migration and carcass drift subsided, fishing activity became more consistent to target on chum or coho salmon. However, total effort did not increase as unusually cold weather occurred in late October and again in mid-November (Table 6).

Most nets in the region surveyed were floating gill nets anchored in back eddies, slough mouths or flow reversals. In flow reversals and eddies, one end of the net was usually attached by a length of line to a shore anchor. The nets would lie with a slight belly upstream with the outer end attached to an anchored buoy. Nets in slough mouths or slack areas behind bars or islands were typically not attached to the shore, but buoy-anchored at each end.

Virtually all nets were the maximum legal length (10 fathoms or approximately 18 m) and occasionally two nets were attached end-to-end (20 fathoms), provided that each net had a permit number. Mesh size to 5.5 inches (14. 0 cm) throughout the survey period even though there was no mesh size restriction after September 22. Common net depth was 30 meshes (approximately 3.4 m).

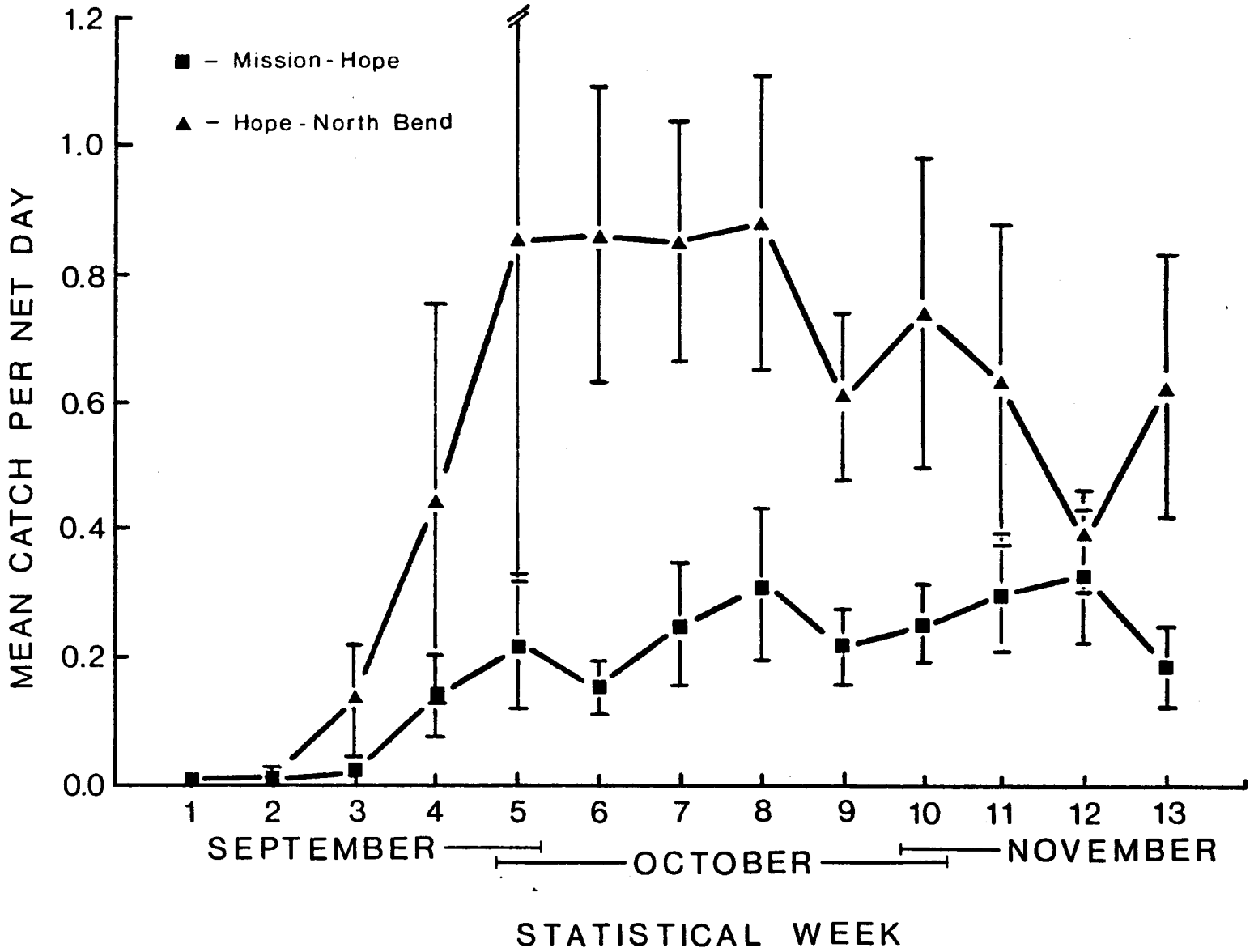


Figure 7. Historical mean weekly estimates (SE) of steelhead catches per net-day from 1974-1985 (from Schubert 1983, 1984, 1985, 1986) between early September and late November by the Fraser River Indian food fisheries, Mission-North Bend.

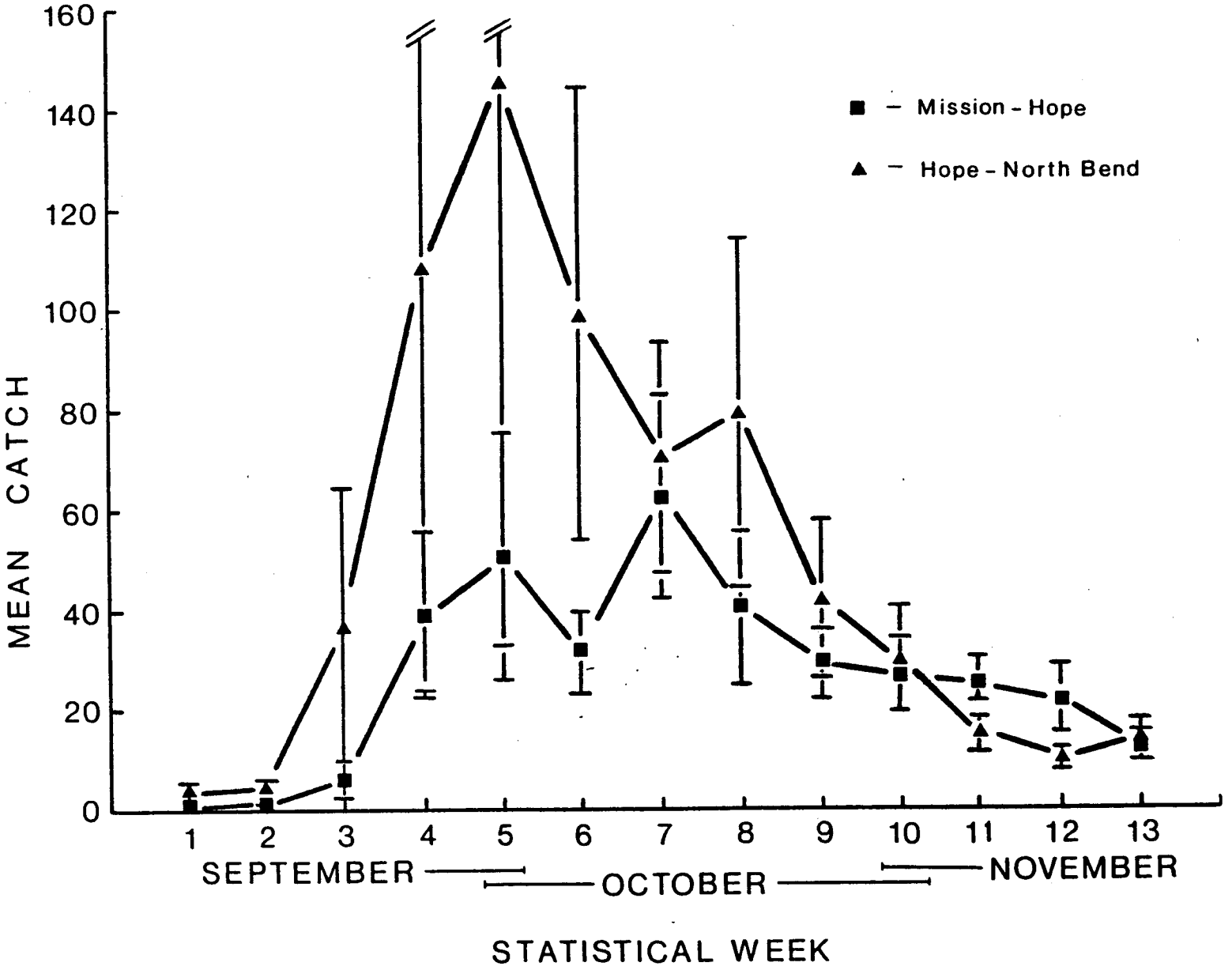


Figure 6. Historical mean weekly estimates (SE) of steelhead catches from 1974-1985 (from Schubert 1983, 1984, 1985, 1986) between early September and late November by the Fraser River Indian food fisheries, Mission-North Bend.

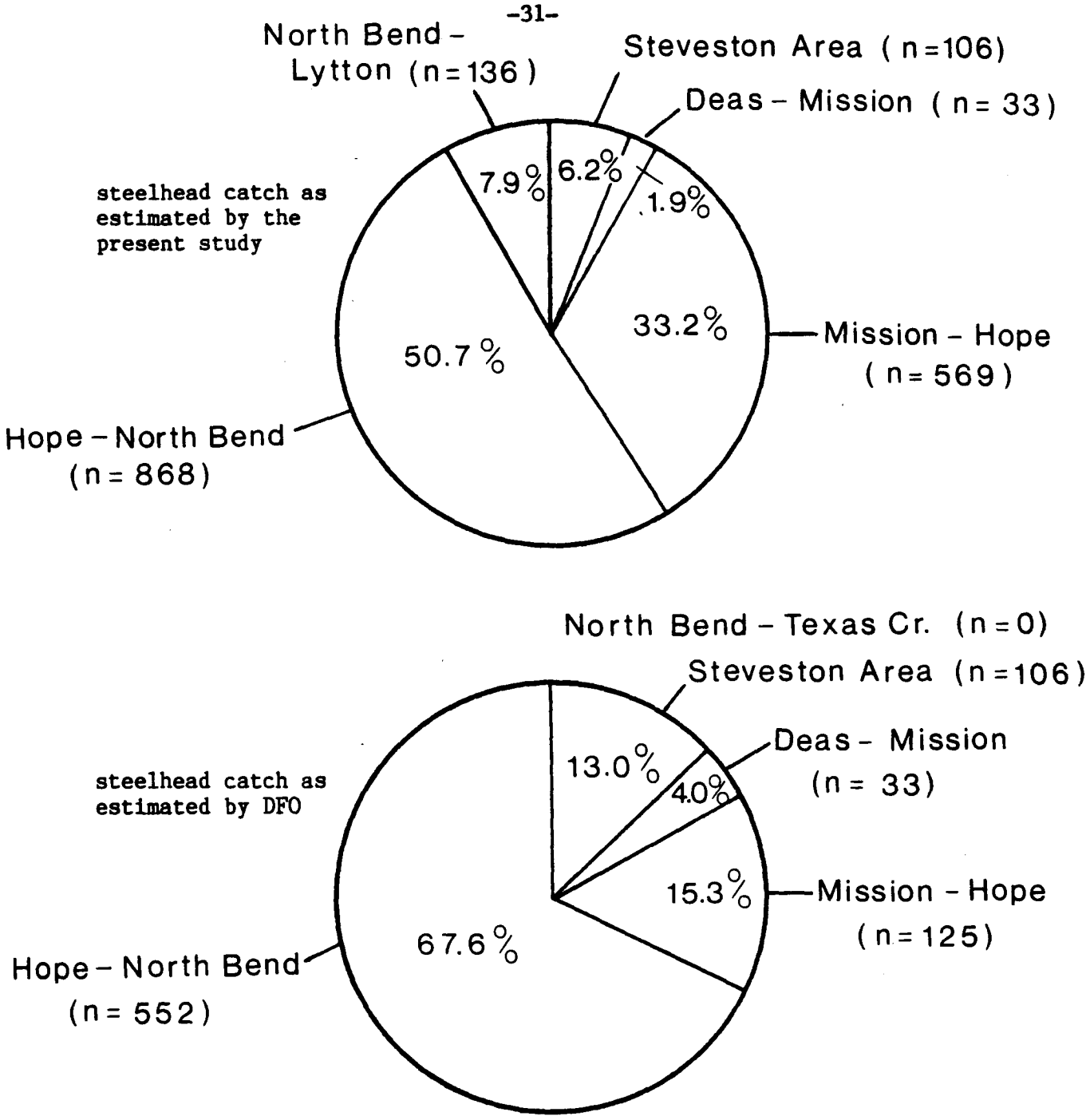


Figure 8. Geographic distribution of the steelhead catch by the Fraser River Indian food fishery as estimated by DFO (Schubert 1985) and the present survey, September to mid-November, 1985.

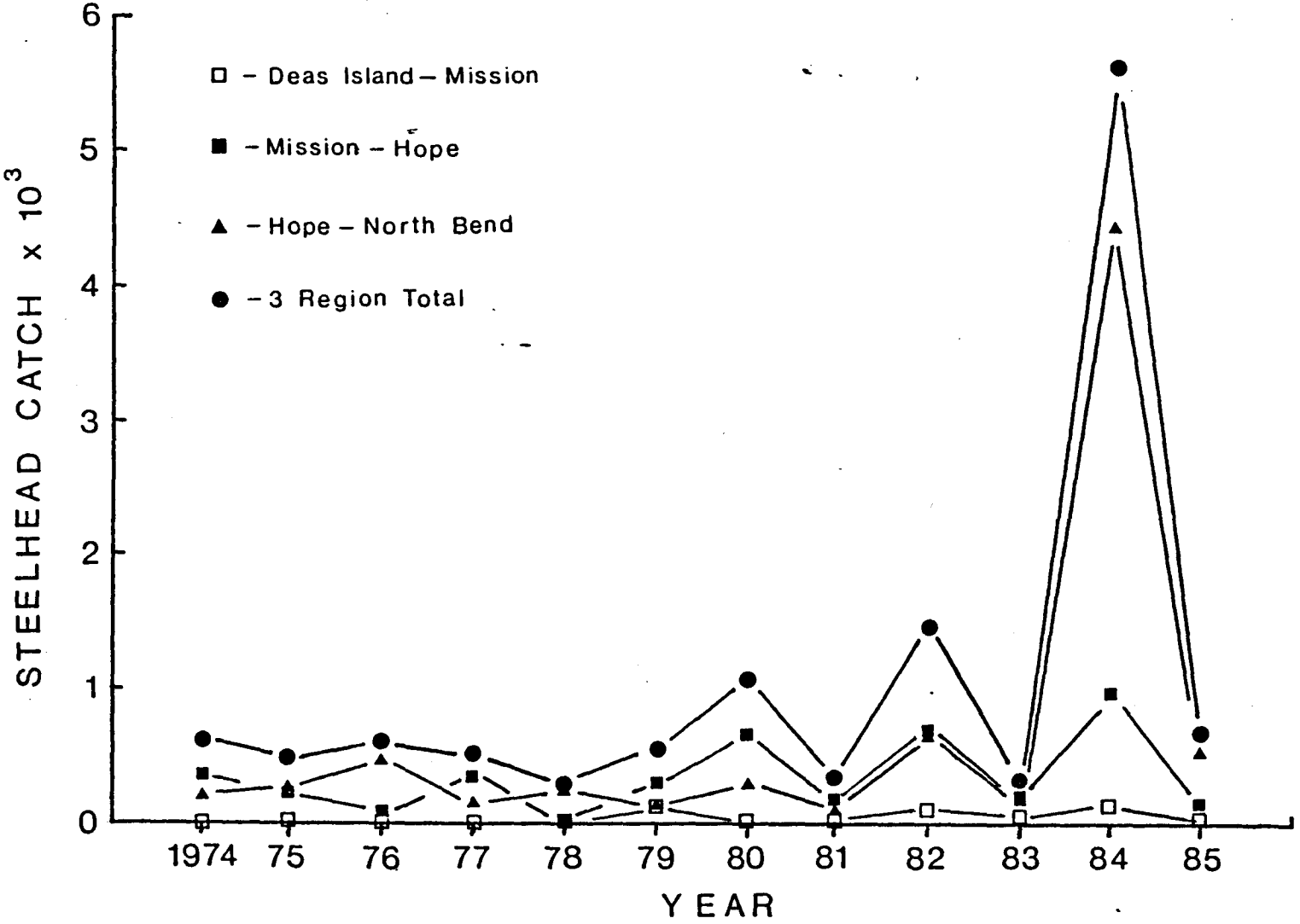


Figure 9. Historic estimates of steelhead catch between early September and late November by the Fraser River Indian food fishery between Deas Island and North Bend, 1974–1985 (Schubert 1983, 1984, 1985, 1986).

3.3.2.2 Hope to North Bend (Region 4)

Fishermen in the Yale area showed similar use patterns as those in the Mission-Hope region. Fishing activity was high from survey commencement to mid-September in response to end of the sockeye salmon run (including chinook and early coho salmon). Nets were typically set Thursday evening, picked twice Friday and Saturday, and once Sunday morning at the time of net removal. Fishing activity decreased as pink salmon abundance increased, and fishing patterns became less consistent. In late September and October, many fishermen did not set their nets until late Friday and removed them on Saturday if the pink salmon catch was high and catch success of the other species was low. At one point in early October, pink salmon abundance was so high (due to migration difficulty in the canyon above Yale) that regional fishing effort virtually ceased. As the pink salmon run declined, fishing effort increased slightly, mainly to target on coho and chum salmon, but declined again partly due to unusually cold weather. While steelhead trout were a desirable catch, there was no indication that any fishermen were directly targeting on the species.

In the Alexandra area and other areas accessed from the highway above Yale (Fig. 3), nets were only observed from survey commencement until the peak of the pink salmon migration (end of September).

As in the lower region, most fishermen used anchored gill nets in flow reversals and occasionally at the upstream end of backeddies. The majority of nets were attached to the shore with the streamward end buoy-anchored. Nets were usually the 10 fathom (approximately 18 m) legal length. Mesh size ranged from 4.5 (11.4 cm) to 5.5 inches (14.0 cm) and depth was generally 30 meshes (approximately 3.4 m). Gin-pole anchored nets were not observed during the survey, but are relatively common during the summer months.

3.3.2.3 North Bend to Lytton (Region 5)

Most nets were set (late) Monday night and picked each morning and evening until removal Friday night (or occassionally early Saturday morning). In summer, when fish abundance was high, nets were monitored (picked) continuously, but during the 1985 survey period (September 01 to November 17) most fishermen visited and picked their nets consistently each morning and evening. Like in the lower two regions, fishing activity temporarily declined as the pink salmon run peaked. Those who continued to fish during this period fished a few hours each morning (approximately 0500 to 0800) and evening (1630 to 2000) to avoid excessive catches of pink salmon.

Two types of nets were observed during the survey: gin-pole anchored nets, and drift nets (Table 9). Gin-pole nets, which were the predominant gear, were composed of a floating gill net supported by a long pole held immediately above and parallel to the water by guy ropes. These nets were set in flow reversals created by rock outcrops and bends in the river.

Drift nets were shorter floating gill nets usually set in the upper extremity of a back eddy. Nets were anchored to a suitable location,

Table 9. Description of Fraser River Indian food fishery nets (net-sites) sampled in the Petch Creek (Boston Bar) to Lytton region, 1985.

Net Code	Net[a] Type	Length (m)	Depth (m)	Mesh (cm)	Location (Owner)
E-1	Gp	-	-	-	west bank at Lytton RR Bridge (Earl)
NK-1	Gp	8.0	2.6	11.4	west bank at Nikaia Creek
SM-1	Gp	6.0	3.3	11.4	east bank at Lytton sawmill (Nathan)
SM-2	Gp	5.0	3.0	10.8	east bank at Lytton sawmill (Doug)
SM-3	Gp	5.0	3.5	11.4	east bank at Lytton sawmill (Sam)
SM-4	Gp	-	-	-	east bank at Lytton sawmill
W-1	Dr	3.0	-	-	east bank at white house
S-1	Gp	5.0	3.5	11.4	east bank at Siska Flat IR3
S-2	Gp	4.0	3.0	11.4	east bank at Siska Flat IR3
S-3	Gp	5.0	3.5	11.4	east bank at Siska Flat IR3
K-1	Gp	4.0	3.0	11.4	east bank at Kanaka Bar
EK-1	Gp	-	-	-	east bank at Kwoiek Creek
WK-1	Gp	-	-	-	west bank at Kwoiek Creek
FA-1	Gp	6.0	3.0	17.8	east bank at Falls Creek
J-1	Gp	-	-	-	east bank at Jack Ass Mountain
J-2	Gp	-	-	-	east bank at Jack Ass Mountain
IN-1	Gp	-	-	-	east bank at Inkahtsaph IR6
B-1	Gp	-	-	-	east bank at Nahatlatch River
B-2	Gp	6.0	3.5	11.4	east bank at Boothroyd IR5b
B-3	Gp	6.5	3.0	10.8	east bank at Boothroyd IR5b
B-4	Gp	5.0	3.5	12.7	east bank at Tsintahkl IR2
NB-1	Gp	-	-	-	east bank north of N. Bend Bridge
NB-2	Gp	5.0	3.0	11.4	east bank at North Bend Bridge
NB-3	Gp	4.0	3.5	11.4	west bank near Boston Bar log dump
NB-4	Dr	3.5	2.5	11.4	west bank at Komo IR1
NB-5	Gp	5.0	3.5	15.2	west bank 1 km below Boston Bar
NB-6	Gp	-	-	-	west bank at Komo IR1
4M-1	An	5.0	3.0	-	east bank above Petch Creek

[a]Gp = gin pole gill net

Dr = drift net

An = anchored gill net

usually a protruding rock, without the support of a pole. In larger eddies, a floating polypropylene line (anchored at an ideal location below the eddy shoreline) provided the required tension to the streamward end of the net by capturing outward flows on the eddy surface. The streamward end of the net was equipped with a float which rode the shear zone between the main current and eddy flow. Drift nets were portable and usually limited to 3.5 m in length.

Description of individual nets are given in Table 9.

3.4 Discussion and Conclusions

Although the estimated steelhead catch from September through November, 1985 was similar to historical averages (relative to DFO estimates considering increased sampling effort by the 1985 survey), catch and particularly fishing effort was affected by the odd-year pink salmon run. Unlike the commercial fishery, high pink abundance reduces Indian fishing effort, and thus a survey conducted on an even-year may produce substantially different results. Most Indian fisherman ceased fishing as pink salmon abundance increased and nets had to be picked continuously to release the undesirable catch. Possible effects of the increasing abundance of Fraser River pink salmon in recent years are apparent in historical catches; steelhead catch has been consistently lower on odd-years than even years since 1980 (Fig. 9).

While pink salmon are disliked by the Indian community, sockeye salmon are highly prized. Thus, steelhead interception may be considerably higher on even years, particularly during the dominant years for major sockeye salmon returns (i.e., Adams, Chilko, Stuart and Horsefly river stocks). Sockeye salmon returning to these systems in dominant ans sub-dominant years are abundant in the Fraser River downstream of the Thompson River in September and October which coincides with the first half of the fall steelhead immigration. The high abundance of sockeye may cause increased steelhead interception if fishing effort is exceptionally high. Alternatively, if sockeye saturate the gear and/or sufficient catches are realized early in the fall (and thereby reducing the length of fishing season), steelhead interception may be low. During even-years, when pink salmon are absent and sockeye abundance is low, there may be a tendency to target for coho and steelhead, particularly if abundance is high enough to yield sufficient catch success. 1984 was such a year and steelhead catch was the highest on record (Fig. 9). Dip-net fishing also increases when sockeye abundance is high; however, catch rates for steelhead by dip-netting is still unkown and may warrant future investigation.

In sum, the abundance of desired and avoided salmon species may greatly affect the magnitude of steelhead catch and thus further study is required.

According to some fishermen interviewed, steelhead and chinook salmon catches could be increased simply by using a larger mesh size of 7 inches (17.8 cm). Significantly increased catch rates of steelhead by the larger mesh size was also clearly evident between the Cottonwood

and Albion test fisheries (Section 2.0). Although gill net mesh size was legally restricted to 5.5 inches (14.0 cm) until the week ending September 22, 1985 (Schubert 1986), most fishermen continued to use nets between 4.5 and 5.5 inches. In many cases, changes to larger mesh size was not made simply because fishermen only owned one net. In fact, the only fishermen using a 7 inch mesh net in the North Bend-Lytton region had significantly higher catch rates for steelhead than any other fishermen. Thus, the extension of the 5.5 inch (14.0 cm) mesh size restriction through early winter would likely reduce interception of fall steelhead.

This study likely produced more accurate estimates of the fall steelhead catch than the DFO surveys simply because of greater coverage of the North Bend-Lytton region. However, the single exploratory survey of the lower two regions is insufficient to assess relative accuracy, particulary since only catch per net-day sampling differed between the two surveys. To improve the reliability of estimates and assess their accuracy, additional years of survey will be required using an improved survey design and sampling effort.

Given the large and diverse areas covered by the two survey workers in the Mission to North Bend region, in concert with the difficulty in intercepting net owners at the time of picking, all locations within each area were not evenly surveyed. For most weeks, net catch statistics were only obtained from relatively small sub-areas; of necessity, however, data (i.e., to estimate catch per unit of effort and catch) were considered representative of the entire area. These logistical constraints should be addressed in future surveys.

4.0 SPORT FISHERY

4.1 Introduction

This section of the report describes the results of the survey conducted to estimate the steelhead catch by the Fraser River sport fishery between the confluence of Vedder and Fraser rivers and Ruby Creek (Fig. 10) from September 01 to November 15, 1985.

Results of the 1984 angler survey commissioned by DFO/MOE (Scott 1985) showed that steelhead interception was largely confined to bars upstream of the Vedder River confluence during September and October and generally corresponded to the probable timing of immigration of fall steelhead. No steelhead were captured by surveyed anglers downstream of Pitt River, and only 7% (80 fish) of the total estimated steelhead catch occurred downstream of the Vedder River confluence. In 1984, bars from the Vedder River confluence to Agassiz Bridge produced 95% and 93% of the total surveyed steelhead catch in September and October, respectively. In view of 1984 results, the 1985 Fraser River sport fishery was restricted to the area between the Vedder River and Ruby Creek confluences.

The present study was designed with the (budget) constraint of using a single technician working 17 days per month to survey the entire study area from September 01 to November 15, 1985. This dictated the use of the roving creel survey procedure to estimate angler effort and catch rates.

In 1985, MOE included the Fraser River mainstem as "steelhead designated" which required an angler to cease fishing after killing a single steelhead. The effect of the change in regulation on the survey sampling procedure, however, did not become apparent until early October when fall steelhead immigration began (see Section 5.0). The design of the roving creel survey required interviews of anglers while actively fishing (in contrast, anglers are interviewed at the completion of a fishing trip using the access point survey). Therefore, once an angler killed one steelhead, fishing was terminated. This requirement significantly reduced the probability of the survey technician intercepting an angler who killed a steelhead. However, because Fraser River bar anglers are typically gregarious, the survey technician was able to obtain the number of anglers who had left prior to his arrival from a concensus of interviewed anglers. Using this procedure, we therefore assumed that: a) the angler would still have been actively fishing and therefore would have been interviewed if the steelhead designation regulation had not required fishing cessation; and b) interviewed angler reports were accurate.

It will not be known if the two assumptions were met until results become available from the access point survey conducted by DFO (New Westminster; Shubert in prep).

4.2 Methods

Angler effort and steelhead catch by the Fraser River bar fishery between the confluences of the Vedder River and Ruby Creek (Fig. 10)

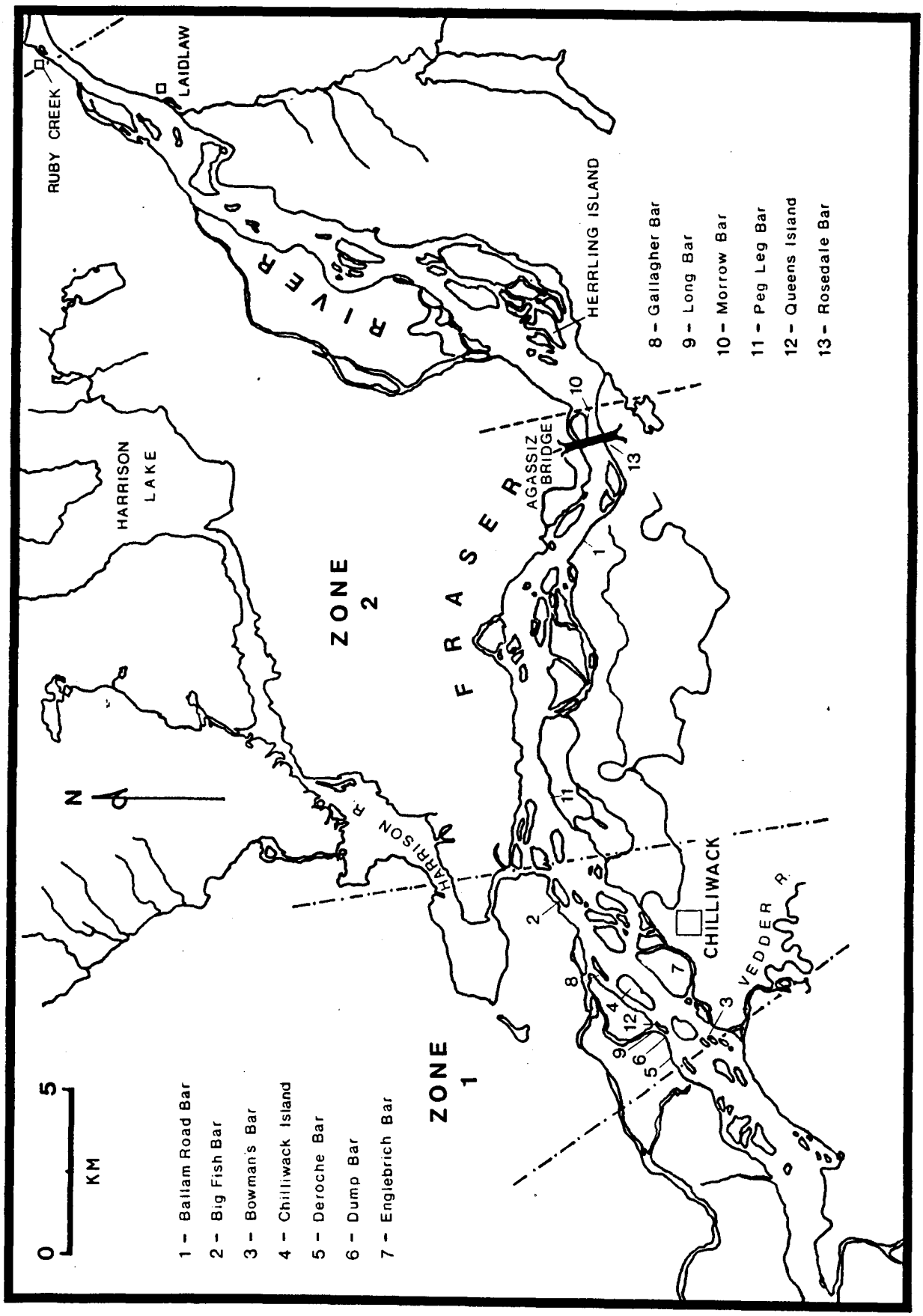


Figure 10. The survey area encompassed by the 1985 survey of the Fraser River sport fishery showing the zones and major access points (bars).

was estimated using a roving creel survey. The survey was a two-way stratification design in time and space. The sampling period from September 1 to November 15 was divided into monthly time blocks, and days within each month were partitioned into weekday and weekend day strata (holidays were condsidered weekend days). Sampling occurred on two of five weekdays and both weekend days (plus Labour Day and Thanksgiving Day). A weekday and the hour of sampling was initially drawn at random independently for each stratum (using a random number table) and then systematically sampled in each stratum to ensure that all mid-week days and hours of the day were sampled. The number of possible sampling hours within each day decreased with the number of daylight hours.

The mainstem Fraser River study area between the Vedder River confluence and Ruby Creek was divided into two zones: Zone 1 extended from Bowman's Bar to the confluence of the Harrison River and Zone 2 included the area from Harrison River to Ruby Creek (Fig. 10). Partitioning the area into two zones allowed complete enumeration of anglers in approximately 1 h (per zone), and ground counts were therefore considered instantaneous (Neuhold and Lu 1957). Thus, the sampling unit to estimate total angler effort (to enable estimation of total catch) was defined as 1 h, and all daylight (fishing) hours between September 01 and November 15 was the sampling frame. To randomize river zone sampling, launch sites and direction of travel were alternated each sample day. The region between Morrow Bar and Ruby Creek was sampled in the first half of October only because bars commonly used by anglers in this area were submerged in September and again by mid-October. No angler effort was observed upstream of Herrling Island.

Angler use was specifically recorded for nine bars in Zone 1 and four bars in Zone 2 (Fig. 10). These included:

Zone 1 —— Big Fish Bar (BIG)
Bowmans Bar (BOW)
Chilliwack Island (CHI)
Deroche Bar (DER)
Dump (DUM)
Englebrich Bar (ENG)
Gallagher Bar (GAL)
Long Bar (LON)
Queens Island (QUE)

Zone 2 —— Ballum Bar (BAL)
Morrow Bar (MOR)
Peg Leg Bar (PEG)
Rosedale Bar (ROS)

All other bars used by anglers were collectively termed miscellaneous (MISC).

An outboard-powered inflatable raft was used to access bars to enumerate and interview anglers. Angler interviews occurred either immediately preceding or following enumeration. All anglers encountered were interviewed unless the number of anglers exceeded the

capacity of the survey technician. Under this circumstance, a "one-in-k" systematic sample of anglers was made to prevent the possibility of (unconscious) angler selection bias by the survey technician. For example, the value of "k" was proportional to angler abundance (e.g., k=3, k=6, k=10, etc.).

The survey technician recorded the river location (zone and bar), date and time, and asked anglers what time they began fishing that day, the number and location of wild and hatchery (by mark) steelhead creeled and released, terminal gear (tackle) used, if steelhead was their primary target, and if they posessed a valid steelhead licence (if so, their licence number was recorded). Therefore, the sampling unit to estimate mean angler catch rates (and other attributes) was the streamside angler. Physical characteristics which affected angler success (i.e., winds, water height, temperature) were anecdotically recorded.

Steelhead observed outside the surveyor's subsample were biologically sampled with permission of the angler. Data related to catches of Pacific salmon, anadromous cutthroat (S. clarkii) or Dolly Varden char (Salvelinus malma) were recorded, but not analysed, and supplied to the Scientific Authority (in a separately bound appendix).

Total angler use per month was estimated as follows:

$$\text{Total angler hours} = N\bar{y}_{st} = \sum_{i=1}^{L} N_i \bar{y}_i ,$$

$$\text{Variance of } Ny_{st} = V(N\bar{y}_{st}) = \sum_{i=1}^{L} N^2(N_i - n_i/N_i)S_i^2/n_i ,$$

where N_i = total number of sampling units (hours) in stratum i,

n_i = sample size for stratum i,

y_i = mean angler count for stratum i,

y_{st} = mean angler count over all strata,

S_i^2 = sample variance for stratum i,

L = number of strata.

The steelhead sample catch rate was calculated by dividing the number of fish creeled and reported released by the number of hours fished by each angler at the time of interview. Mean catch per hour for a particular bar and month was estimated as follows:

$$\text{Estimated mean catch per hour} = \bar{y}_{st} = \frac{1}{N} \sum_{i=1}^{L} N_i \bar{y}_i ,$$

$$\text{Estimated mean catch per hour} = \bar{Y}_{st} = \frac{1}{N} \sum_{i=1}^{L} N_i \bar{Y}_i ,$$

$$\text{Variance of } Y_{st} = V(y_{st}) = \frac{1}{N^2} \sum_{i=1}^{L} N^2(N_i - n_1/N_i)S_i^2/n_1 ,$$

where N_i = total number of sampling units (anglers) in stratum i,

n_i = sample size (number of anglers interviewed) for stratum i,

$\bar{Y}_i$ = weighted mean catch rate for stratum i,

$\bar{y}_{st}$ = mean catch rate for overall strata,

S_i^2 = weighted sample variance for stratum i,

L = number of strata,

with

$$\text{weighted mean catch per hour } (\bar{y}_i) = \frac{\sum_{j=1}^{n} h_j y_j}{\sum_{j=1}^{n} h_j},$$

$$\text{weighted sample variance } (S_i^2) = \frac{\sum_{j=1}^{n} h_j (y_j - \bar{y}_i)^2}{\sum_{j=1}^{n} h_j},$$

where h_j = number of hours fished by angler j,

y_j = catch per hour by angler j.

Total catch and variance of total steelhead catch were estimated as follows (Goodman 1960):

Total catch = $E(xy) = E(x)E(y)$

Variance of total catch = $V(xy) = E^2(x)V(y) + E^2(y)V(x) + V(x)V(y)$,

where x = total angler use/km,

y = mean angler catch rate (trout/hour),

E = expected value.

4.3 Results

4.3.1 Angler Effort

From September 01 to November 15, 1985 anglers fished an estimated 122,860 h on the Fraser River bars between the Vedder River and Ruby Creek confluences (Table 10). Angler use increased through September and peaked in early October (Fig. 11). Almost half (45%) of the estimated total effort occurred in the first half of October during the apparent peak of fall steelhead immigration in 1985 (see Section 5.0). Angler effort declined markedly in the later half of October and early Novermber, probably due to inclement weather and poor fishing success. Approximately 90% of the estimated angler use occurred between the confluences of the Vedder and Harrison rivers (Zone 1), and 77% of the estimated angler effort was expended on Bowmans, Englebrich and Deroche bars. Englebrich Bar supported the highest angler use (29,290 h), followed by Deroche (26,460 h) and Bowmans (20,880 h) bars. Gallagher Bar, Long Bar and Queens Island received moderate use; all other bars received low effort (Fig. 12).

Angler use was consistently higher on a weekend day than during a mid-week day, but total use per day-of-week strata was about equal during the extent of the survey (Table 10).

4.3.2 Angler Catch and Success

Anglers harvested an estimated 463 steelhead and released an estimated 96 steelhead during the 1985 survey (Table 11). About 4% of the catch consisted of hatchery fish (Section 5.0), compared to 1% in 1984 (Scott 1985). The majority of the estimated steelhead catch occurred at Bowmans and Englebrich bars during the first two weeks of October, during the apparent peak period of fall steelhead immigration (see Section 5.0). Angler catch rates for steelhead trout was exceptionally low (Table 11), with the large majority of anglers unsuccessful in catching steelhead. Highest angler success was estimated for Bowmans and Englebrich bars (Table 11). Some success occurred at Queens Island, Deroche Bar and Gallagher Bar, but no catch was recorded from any of the other bars.

4.3.3 Angler Characteristics

Fifty-two percent of the anglers interviewed used artificial lures (e.g., spin-and-glows) and 47% used a combination of bait (usually roe) and artificial lure. Only 1% percent were observed using bait only. Approximately, 8% of the anglers interviewed targeted on steelhead, although the percentage varied through the season (Fig. 13). However, 31% (62% in total) reported that they were fishing for "salmon or steelhead" and an equal 31% were hoping to catch

Table 10. Estimated angler effort for steelhead and salmon on Fraser River bars between the Vedder River confluence and Agassiz Bridge, September 1 to November 15, 1985.

Month	River Zone	Bar	Daytype	Available Sampling Units[a]	Units Sampled (N)	Total Angler Hours[b]	
September	1	Big	Weekday	240	8	60	
			Weekend	120	9	267	
			Total			327	(109.1)
		Bowmans	Weekday	240	9	4427	
			Weekend	120	9	5907	
			Total			10333	(1916.4)
		Chilliwack	Weekday	240	9	773	
			Weekend	120	9	2093	
			Total			2866	(440.3)
		Deroche	Weekday	240	8	8340	
			Weekend	120	9	6280	
			Total			14620	(1803.9)
		Dump	Weekday	240	6	240	
			Weekend	120	7	463	
			Total			703	(212.9)
		Englebrich	Weekday	240	9	7973	
			Weekend	120	9	6400	
			Total			14373	(1462.3)
		Gallagher	Weekday	240	9	2107	
			Weekend	120	9	1693	
			Total			3800	(825.5)
		Long	Weekday	240	9	1333	
			Weekend	120	9	2067	
			Total			3400	(590.1)
		Queens	Weekday	240	9	1013	
			Weekend	120	9	1653	
			Total			2667	(571.2)
		Misc.	Weekday	240	7	789	
			Weekend	120	7	720	
			Total			1509	(482.5)
	Zone 1 Total					54598	(3302.3)

Table 10. (page 2, continued)

Month	River Zone	Bar	Daytype	Available Sampling Units[a]	Units Sampled (N)	Total Angler Hours[b]	
September	2	Ballam	Weekday	240	9	507	
			Weekend	120	9	613	
			Total			1120	(309.6)
		Carey Pt.	Weekday	240	5	96	
			Weekend	120	4	60	
			Total			156	(111.8)
		Morrow	Weekday	240	9	453	
			Weekend	120	9	613	
			Total			1067	(315.6)
		Peg Leg	Weekday	240	8	240	
			Weekend	120	9	456	
			Total			696	(165.4)
		Rosedale	Weekday	240	9	2133	
			Weekend	120	8	1455	
			Total			3588	(604.2)
		Misc.	Weekday	240	6	160	
			Weekend	120	8	795	
			Total			955	(220.1)
	Zone 2 Total					7582	(805.5)
September Total						62180	(3399.1)

Table 10. (page 3, continued)

Month	River Zone	Bar	Daytype	Available Sampling Units[a]	Units Sampled (N)	Total Angler Hours[b]
October	1	Big	Weekday	220	8	220
			Weekend	90	9	470
			Total			690 (216.8)
		Bowmans	Weekday	220	9	5524
			Weekend	90	9	5020
			Total			10544 (2416.6)
		Chilliwack	Weekday	220	9	1418
			Weekend	90	9	810
			Total			2228 (784.8)
		Deroche	Weekday	220	9	5916
			Weekend	90	9	4220
			Total			10136 (1365.5)
		Dump	Weekday	220	9	171
			Weekend	90	8	405
			Total			576 (202.0)
		Englebrick	Weekday	220	9	8824
			Weekend	90	9	4960
			Total			13784 (2996.4)
		Gallagher	Weekday	220	9	3031
			Weekend	90	9	1640
			Total			4671 (1151.3)
		Long	Weekday	220	9	1516
			Weekend	90	9	1580
			Total			3096 (604.0)
		Queens	Weekday	220	9	1662
			Weekend	90	8	2273
			Total			3935 (927.2)
		Misc.	Weekday	220	8	495
			Weekend	90	9	1290
			Total			1785 (466.1)
	Zone 1 Total					51445 (4489.3)

Table 10. (page 4, continued)

Month	River Zone	Bar	Daytype	Available Sampling Units[a]	Units Sampled (N)	Total Angler Hours[b]	
October	2	Ballam	Weekday	220	9	391	
			Weekend	90	9	180	
			Total			571	(152.0)
		Carey Pt.	Weekday	220	9	0	
			Weekend	90	9	50	
			Total			50	(25.1)
		Morrow	Weekday	220	9	416	
			Weekend	90	9	180	
			Total			596	(234.8)
		Peg Leg	Weekday	220	9	122	
			Weekend	90	9	170	
			Total			292	(115.4)
		Rosedale	Weekday	220	9	1149	
			Weekend	90	9	640	
			Total			1789	(316.7)
		Misc.	Weekday	220	8	165	
			Weekend	90	8	641	
			Total			806	(251.4)
	Zone 2 Total					4104	(505.7)
October Total						55549	(4517.7)

Table 10. (page 5, continued)

Month	River Zone	Bar	Daytype	Available Sampling Units[a]	Units Sampled (N)	Total Angler Hours[b]	
November (1-15)	1	Big	Weekday	80	2	0	
			Weekend	40	4	0	
			Total			0	
		Bowmans	Weekday	80	2	0	
			Weekend	40	4	0	
			Total			0	
		Chilliwack	Weekday	80	2	0	
			Weekend	40	4	50	
			Total			50	(47.4)
		Deroche	Weekday	80	2	1120	
			Weekend	40	4	580	
			Total			1700	(131.0)
		Dump	Weekday	80	2	0	
			Weekend	40	4	0	
			Total			0	
		Englebrich	Weekday	80	2	960	
			Weekend	40	4	170	
			Total			1130	(401.7)
		Gallagher	Weekday	80	2	40	
			Weekend	40	4	20	
			Total			60	(41.0)
		Long	Weekday	80	2	160	
			Weekend	40	4	120	
			Total			280	(96.7)
		Queens	Weekday	80	2	240	
			Weekend	40	4	80	
			Total			320	(243.0)
		Misc.	Weekday	80	2	0	
			Weekend	40	3	0	
			Total			0	
	Zone 1 Total					3540	(500.9)

Table 10. (page 6, concluded)

Month	River Zone	Bar	Daytype	Available Sampling Units[a]	Units Sampled (N)	Total Angler Hours[b]	
November (1-15)	2	Ballam	Weekday	80	2	40	
			Weekend	40	4	20	
			Total			60	(43.8)
		Carey Pt.	Weekday	80	2	0	
			Weekend	40	4	0	
			Total			0	
		Morrow	Weekday	80	2	0	
			Weekend	40	4	0	
			Total			0	
		Peg Leg	Weekday	80	2	80	
			Weekend	40	4	20	
			Total			100	(81.2)
		Rosedale	Weekday	80	2	200	
			Weekend	40	4	90	
			Total			290	(55.6)
		Misc.	Weekday	80	2	80	
			Weekend	40	4	60	
			Total			140	(81.2)
	Zone 2 Total					590	(134.9)
November 1-15 Total						4130	(518.7)
SEASON TOTAL						121859	(5677.4)

[a] sample unit = 1 h

[b] standard error of total angler effort in brackets

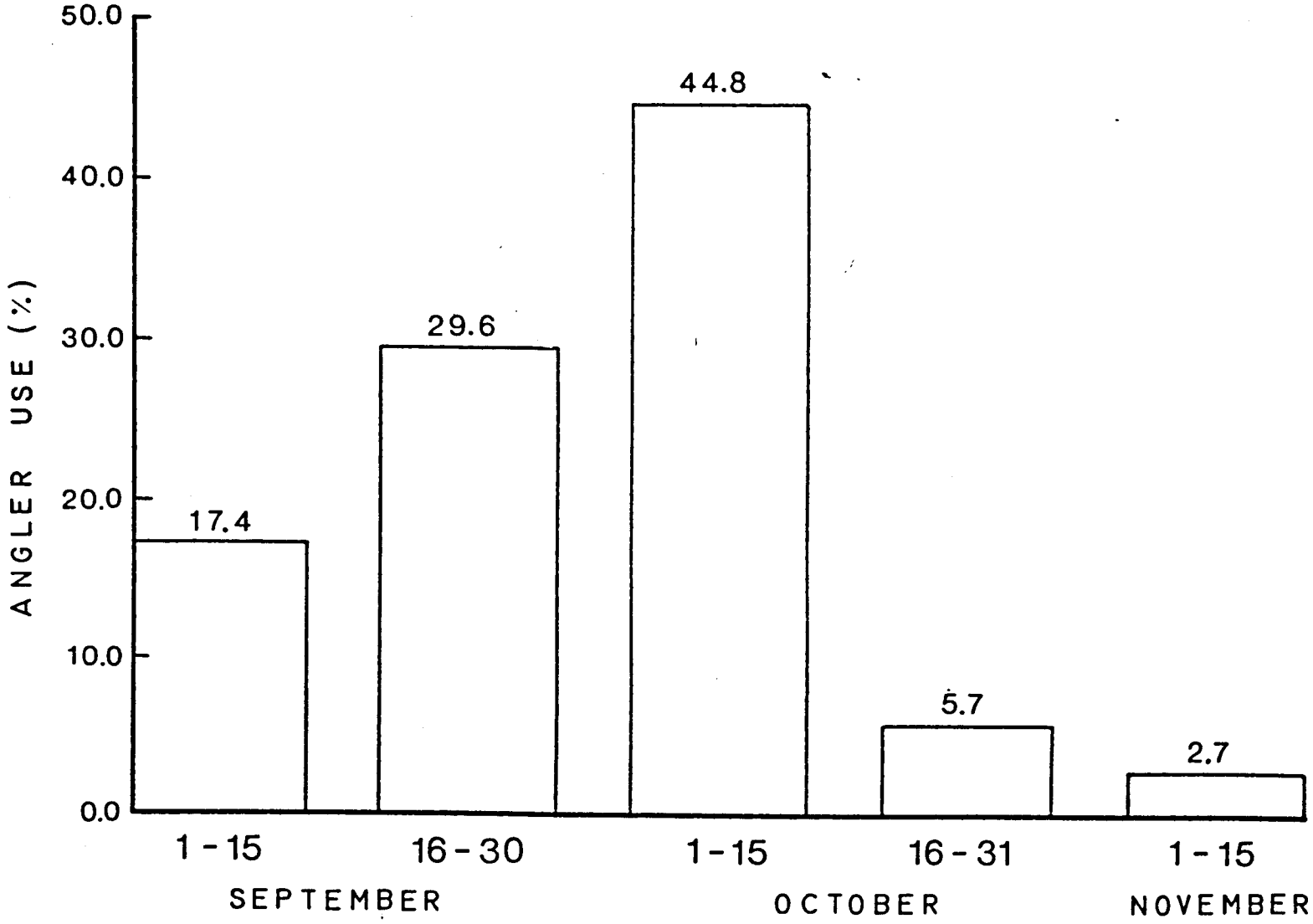


Figure 11. Biweekly distribution of angler effort on Fraser River bars, September 1 to November 15, 1985.

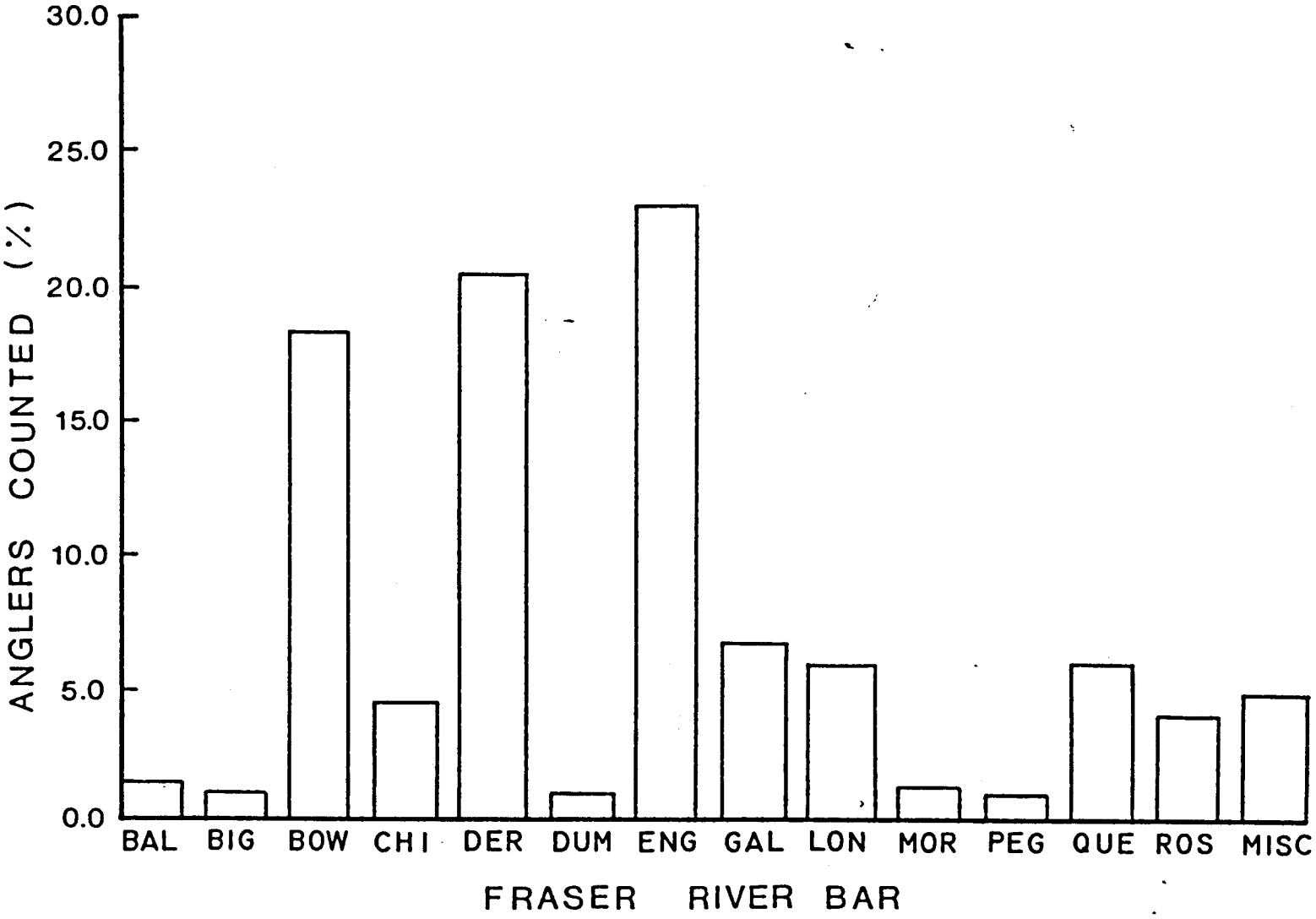


Figure 12. Relative angler use on major Fraser River bars between September 1 and November 15, 1985.

Table 11. Estimated angler catch per hour and total catch of steelhead on Fraser River bars between the Vedder River confluence and Agassiz Bridge, September 01 to November 15, 1985.

Month	River Zone	Bar	Daytype	Number of Anglers Interviewed	Mean Catch per Hour			Total Steelhead Catch					
					Creeled		Released	Creeled					Released
					Wild	Unknown	Wild	Wild	(SE)	Unknown	(SE)	Total (SE)	Wild (SE)
September	1	Bowmans	Weekday	60	0	0.007	0	0		29		29	0
			Weekend	77	0.002	0	0.002	13		0		13	13
			Total					13	(28.3)	29	(52.7)	42 (59.8)	13 (27.1)
		Chilliwack	Weekday	19	0	0	0	0		0		0	0
			Weekend	43	0	0	0	0		0		0	0
			Total					0		0		0	0
		Deroche	Weekday	77	0	0	0	0		0		0	0
			Weekend	71	0	0	0	0		0		0	0
			Total					0		0		0	0
		Englebrich	Weekday	115	0	0	0	0		0		0	0
			Weekend	88	0	0	0	0		0		0	0
			Total					0		0		0	0
		Gallagher	Weekday	25	0	0	0	0		0		0	0
			Weekend	24	0.009	0	0	16		0		16	0
			Total					16	(61.1)	0		16 (61.1)	0
		Long	Weekday	19	0	0	0	0		0		0	0
			Weekend	40	0	0	0	0		0		0	0
			Total					0		0		0	0
		Queens	Weekday	13	0	0	0	0		0		0	0
			Weekend	28	0	0	0	0		0		0	0
			Total					0		0		0	0
		Misc.	Weekday	2	0	0	0	0		0		0	0
			Weekend	19	0	0	0	0		0		0	0
			Total					0		0		0	0
	Zone 1 Total							28	(67.3)	29	(52.7)	58 (85.5)	13 (27.1)

Table 11. (page 2)

Month	River Zone	Bar	Daytype	Number of Anglers Interviewed	Mean Catch per Hour: Creeled Wild	Mean Catch per Hour: Creeled Unknown	Mean Catch per Hour: Released Wild	Total Steelhead Catch: Creeled Wild	(SE)	Creeled Unknown	(SE)	Creeled Total	(SE)	Released Wild	(SE)
September	2	Rosedale	Weekday	31	0	0	0	0		0		0		0	
			Weekend	21	0	0	0	0		0		0		0	
			Total					0		0		0		0	
		Misc.	Weekday	20	0	0	0	0		0		0		0	
			Weekend	32	0	0	0	0		0		0		0	
			Total					0		0		0		0	
	Zone 2	Total						0		0		0		0	
September	Total							28	(67.3)	29	(52.7)	58	(85.5)	13	(27.1)

Table 11. (page 3)

Month	River Zone	Bar	Daytype	Number of Anglers Interviewed	Mean Catch per Hour: Creeled Wild	Mean Catch per Hour: Creeled Unknown	Mean Catch per Hour: Released Wild	Total Steelhead Catch: Creeled Wild	(SE)	Creeled Unknown	(SE)	Creeled Total	(SE)	Released Wild	(SE)
October	1	Bowmans	Weekday	55	0	0.036	0.004	0		201		201		22	
			Weekend	69	0	0.009	0.009	0		43		43		43	
			Total					0		244	(195.0)	244	(195.0)	66	(72.1)
		Chilliwack	Weekday	4	0	0	0	0		0		0		0	
			Weekend	13	0	0	0	0		0		0		0	
			Total					0		0		0		0	
		Deroche	Weekday	84	0	0.003	0	0		19		19		0	
			Weekend	76	0	0	0	0		0		0		0	
			Total					0		19	(41.6)	19	(41.6)	0	
		Englebrich	Weekday	97	0	0.011	0	0		101		101		0	
			Weekend	70	0	0	0.003	0		0		0		15	
			Total					0		101	(99.4)	101	(99.4)	15	(30.5)
		Gallagher	Weekday	35	0	0.007	0	0		22		22		0	
			Weekend	23	0	0	0	0		0		0		0	
			Total					0		22	(65.4)	22	(65.4)	0	
		Long	Weekday	25	0	0	0	0		0		0		0	
			Weekend	17	0	0	0	0		0		0		0	
			Total					0		0		0		0	
		Queen's	Weekday	18	0	0	0	0		0		0		0	
			Weekend	27	0	0.006	0	0		13		13		0	
			Total					0		13	(51.9)	13	(51.9)	0	
		Misc.	Weekday	6	0	0	0	0		0		0		0	
			Weekend	14	0	0	0	0		0		0		0	
			Total					0		0		0		0	
	Zone 1 Total							0		399	(237.9)	399	(237.9)	80	(78.3)

Table 11. (page 4)

Month	River Zone	Bar	Daytype	Number of Anglers Interviewed	Mean Catch per Hour: Creeled Wild	Mean Catch per Hour: Creeled Unknown	Mean Catch per Hour: Released Wild	Total Steelhead Catch: Creeled Wild	(SE)	Creeled Unknown	(SE)	Creeled Total	(SE)	Released Wild	(SE)
October	2	Rosdale	Weekday	10	0	0	0	0		0		0		0	
			Weekend	16	0	0	0	0		0		0		0	
			Total					0		0		0		0	
		Misc.	Weekday	4	0	0	0	0		0		0		0	
			Weekend	22	0	0	0	0		0		0		0	
			Total					0		0		0		0	
	Zone 2 Total							0		0		0		0	
October Total								0		399	(237.9)	399	(237.9)	80	(78.3)
November (1-15)	1	All bars	Weekday	54	0	0.021	0.011	0		5		5		3	
			Weekend	96	0.006	0.003	0	1		0		1		0	
			Total					1	(0.6)	5	(5.1)	6	(5.1)	3	(3.7)
	2	All bars	Weekday	8	0	0	0	0		0		0		0	
			Weekend	14	0	0	0	0		0		0		0	
			Total					0		0		0		0	
November Total (1-15)								1	(0.6)	5	(5.1)	6	(5.1)	3	(3.7)
Season Total								29	(67.3)	434	(243.7)	463	(252.8)	96	(82.9)

"anything". Collectively this equated to approximately 70% (85,300 h) of effort directed toward steelhead trout during the period surveyed. Approximately 30% of the anglers reported that they were fishing for salmon.

Most anglers interviewed (72%) possessed a steelhead licence and corresponded to the reported cumulative effort directed toward steelhead (70%). The proportion of licence holders increased as catch success increased during the season (Fig. 14). In early October when angler use was highest, nearly 80% of interviewed anglers had steelhead licences.

4.3.4 Fishing Conditions

Approximately 51%, 41% and 8% of the observed angler effort occurred under what we considered to be pleasant, fair and poor weather conditions, respectively. Fraser River flows were favourable during the first half of September, the first half of October and early November. High flows (from rainfall) and exceptionally cold weather by the second week in November created poor fishing conditions during the remaining periods of the survey.

4.4 Discussion and Conclusions

Angler effort estimated by the 1985 survey was slightly lower than in 1984. Scott (1985) estimated that 164,000 h (26,462 days) were fished during the same time period and region of the Fraser River in 1984. Both estimates are lower than recent Steelhead Harvest Analysis (SHA) estimates for the entire Fraser River (Billings 1984, 1985). However, it should be recognized that the SHA estimates are based on the time fished as reported by a target population of licence holders only, while the 1984 and 1985 on-site survey estimates are based on all anglers capable of catching steelhead, licenced or not.

Steelhead catch estimates were also substantially lower in 1985 than in 1984. This was not unexpected because the 1984 Thompson River steelhead run was among the highest on record (Moore and Olmsted 1985a). However, as previously discussed, differences may have also resulted from the change in the regulation that required cessation of fishing for the remainder of the day once a steelhead was killed. The change in regulation may have reduced the actual harvest rate, but more likely decreased the probability of the survey technician intercepting an angler who killed a steelhead.

If the geographical distribution of steelhead catch is similar to 1984, then the estimate of 559 steelhead represents approximately 93% of the total catch in the lower Fraser River between Steveston and Ruby Creek.

Catch trends in 1984 and 1985 were only similar at Bowmans and Englebrich bars. Thus, these two bars may provide suitable index sites in future to monitor sport catch of fall steelhead, and obtain biological samples.

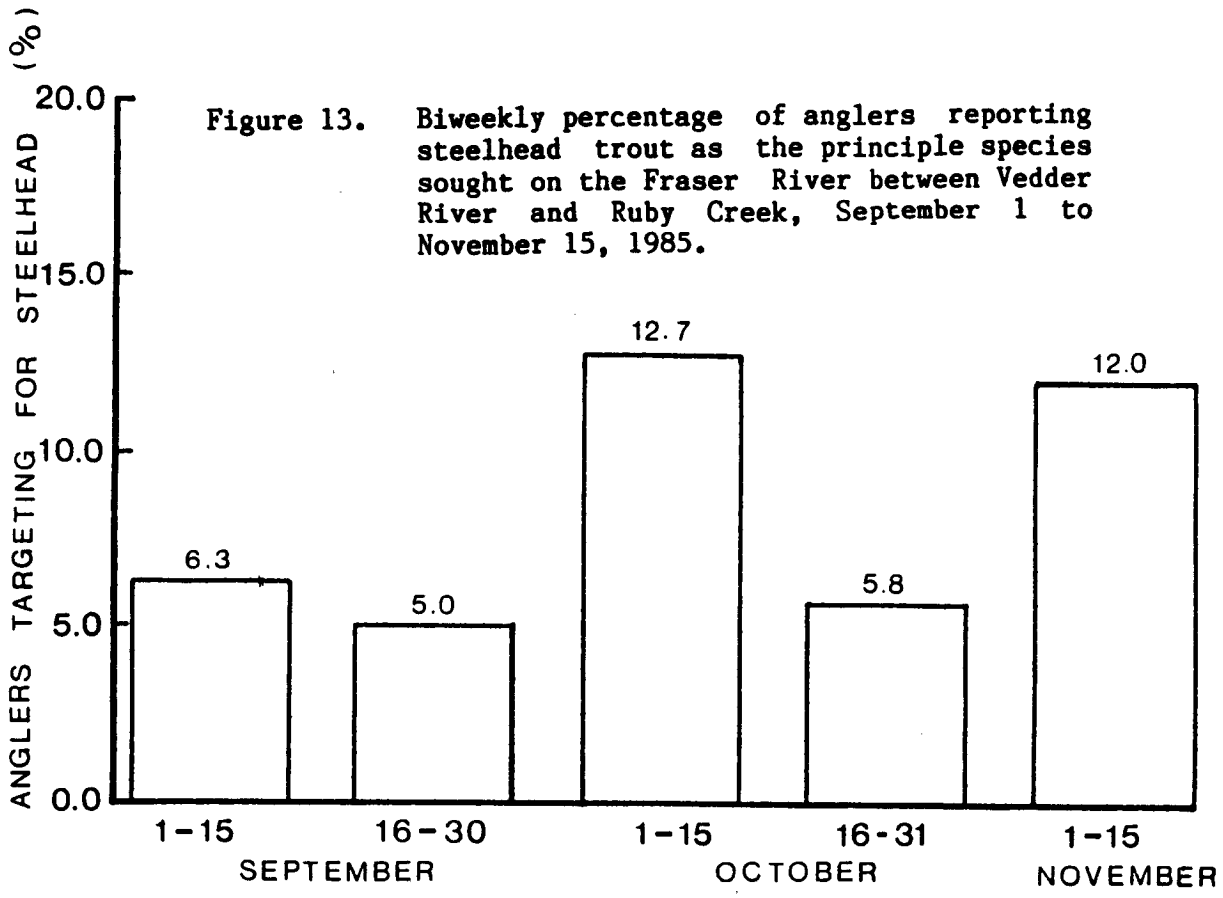


Figure 13. Biweekly percentage of anglers reporting steelhead trout as the principle species sought on the Fraser River between Vedder River and Ruby Creek, September 1 to November 15, 1985.

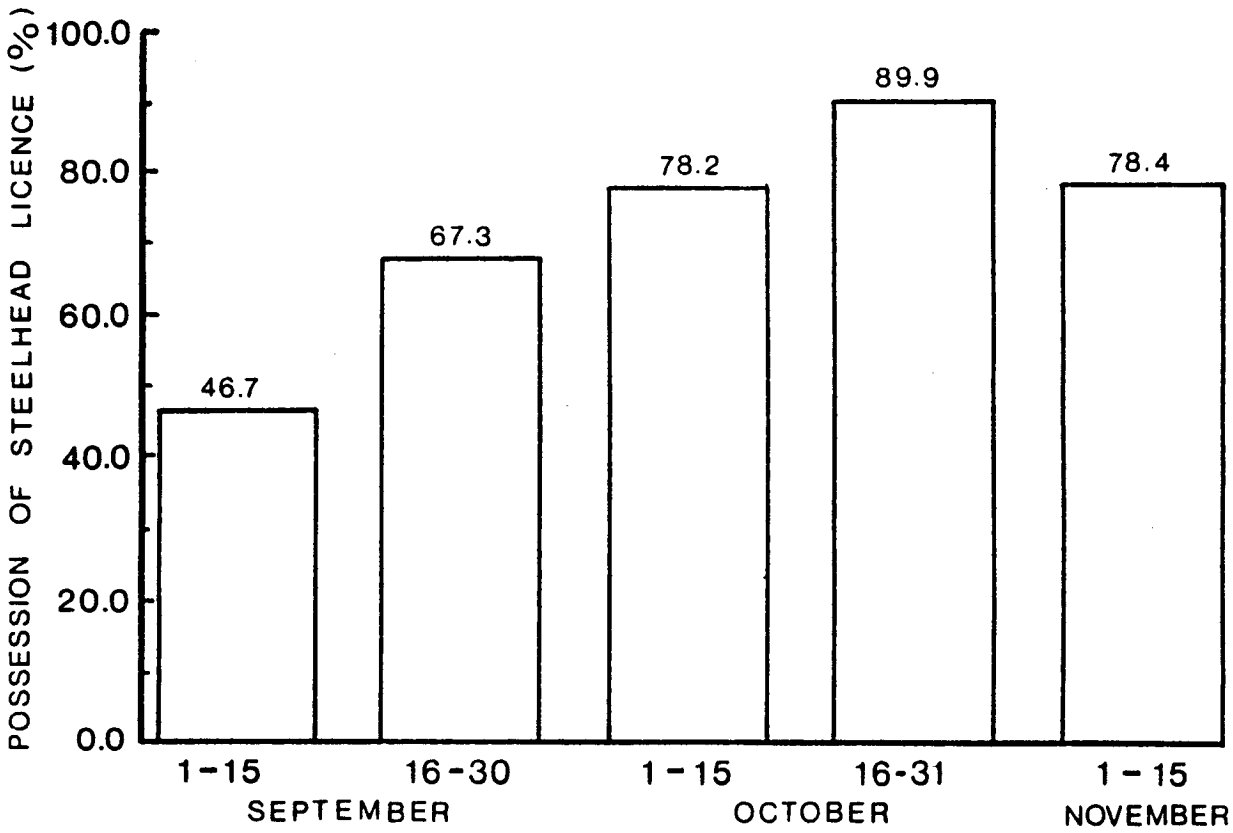


Figure 14. Biweekly percentage of anglers in possession of a steelhead licence on the Fraser River between Vedder River and Ruby Creek, September 1 to November 15, 1985.

5.0 RUN TIMING, INCIDENCE OF HATCHERY MARKS AND BIOLOGICAL CHARACTERISTICS OF FRASER RIVER FALL-RUN STEELHEAD

5.1 Run Timing

The standardized fishing procedures used by Pacific salmon test fisheries at Albion and Cottonwood provided the most suitable (consistent) index of relative abundance of fall steelhead during their believed period of August-December immigration (Andrews and McSheffrey 1976). The Albion test fishery was characterized by constant effort of 1-h sets, net length (300 m), net depth (15 m) and mesh diameter (19.2 cm to October 04, and 17.2 cm to November 20). The IPSFC test fishery at Cottonwood was conducted under similar conditions but was terminated on October 14, and used a smaller mesh diameter (14.0 cm) throughout the fishery. Both test fisheries were conducted under consistent tidal conditions (i.e., peak flood) at fixed locations in the Fraser River mainstem. The reader is referred to Section 2.0 for additional descriptions of these test fisheries.

Although the test fisheries were active through August, steelhead were first captured at Albion and Cottonwood during the first and last weeks of September, respectively (Table 4; Fig. 15). By the first week of October, steelhead catch rates increased markedly at both sites, and peaked at both fisheries during the first week of October. Catch rates at Cottonwood declined consistently until termination of fishing activity during the week ending October 19. Catch rates remained high at Albion until through October and into the first week of November. Moderate rates of catch continued through project termination, the week ending November 23. Because of the uniform and consistent fishing effort, the catch rates likely reflected actual temporal patterns of movements by fall-migrating Fraser River steelhead.

Two marked (hatchery) steelhead captured in commercial fisheries in Statistical Area 29 (Fraser River downstream of Mission including inner Georgia Strait) prior to September were identified by CWT as Coquihalla River origin (Table 12). In addition, average weight of steelhead captured during July and August was relatively small compared to fish sampled by the four fisheries monitored after September by the present investigation (c.f., Table 2 and Table 13). Prior to September, sport (Table 11) and Indian (Fig. 7) catches of steelhead were also negligible. Thus, these data indicate that steelhead captured prior to September were most likely late summer-run steelhead of lower Fraser River tributary origin.

Steelhead migrating through the lower Fraser River in October and early November were likely of Thompson River, Chilcotin River, or other mid-Fraser River tributary stocks; steelhead catch patterns further upstream in the sport fishery and in the Indian food fishery from Steveston through Lytton were generally similar to the catch rate patterns of the test fisheries. The large average size of steelhead captured in the test, commercial, sport and Indian food fisheries in October also corresponded well with the known unique large-sized steelhead of the Thompson River (e.g., Moore and Olmsted 1985a, 1985b). The single identified hatchery (CWT) steelhead captured by the commercial inside Fraser River opening on October 09 (during the

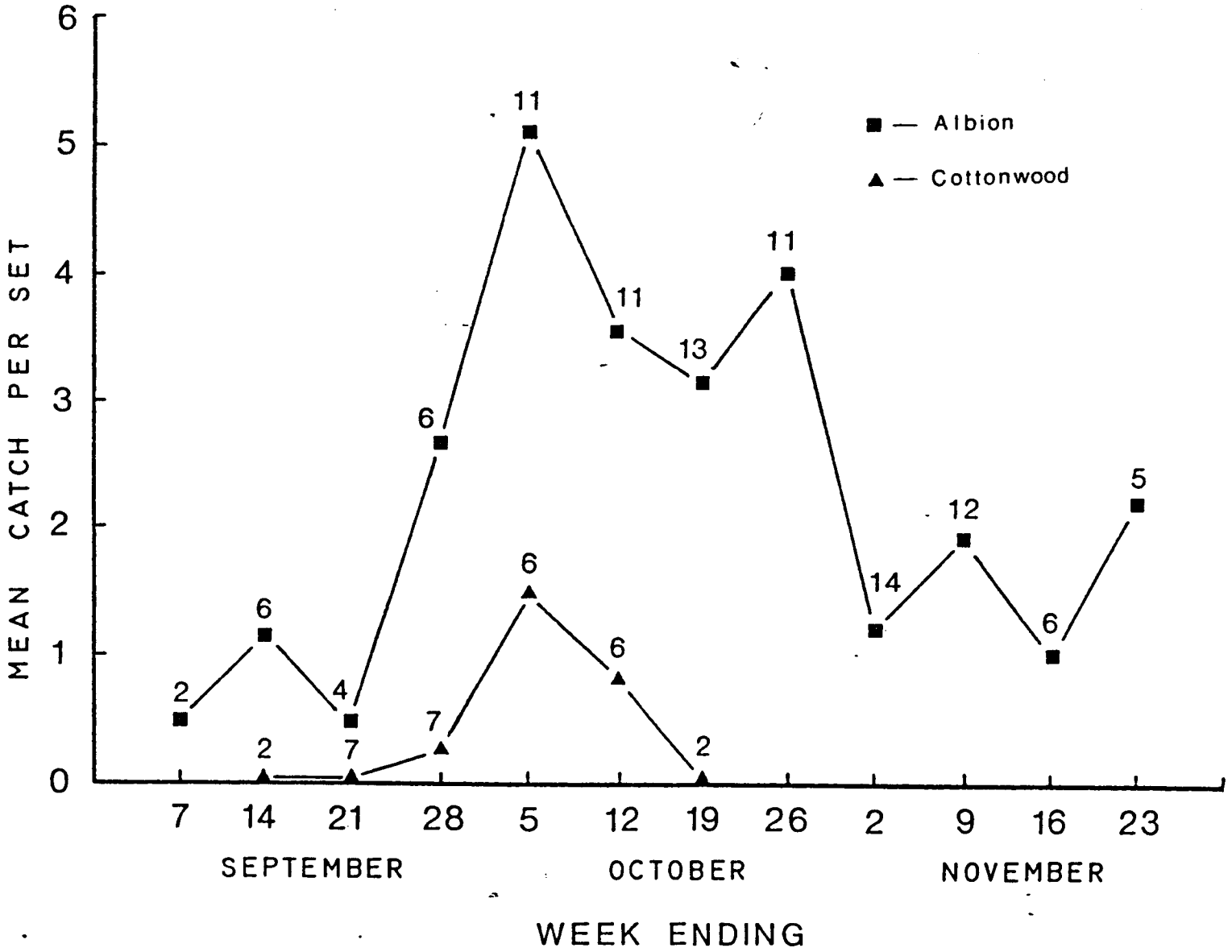


Figure 15. Mean steelhead catch per 1 h net-set by the Albion (mesh diameter 17.2 - 20.3 cm) and Cottonwood (mesh diameter 14.0 cm) salmon test fisheries in the Fraser River mainstem, September through November, 1985.

Table 12. Steelhead tag recoveries by DFO Salmon Services from the 1985 Fraser River commercial fisheries.

Week Ending	Number of Steelhead Sampled	Number of Steelhead with Clipped Adipose	Tag Origin	Brood Year
Jul 27	4	1	Coquihalla River	1980
Aug 3	6	1	Coquihalla River	1982
10	2	0		
24	8	1	No Tag	
31	9	0		
Sep 7	8	0		
14	0	0		
21	0	0		
28	0	0		
Oct 5	3	0		
12	166	1	Bonaparte River	1982
19	0	0		
Nov 2	0	0		
16	0	0		
23	12	1	No Tag	

Table 14. Numbers of marked steelhead sampled in Fraser River native, sport, commercial and test fisheries, September through mid-November, 1985.

Fishery	Fraser River Mainstem Region	Mark - Clip		
		Adipose	Left Maxillary	Right Maxillary
Native	Deas Island to Lytton	0	2	2
Sport	Mission to Hope	2	0	4
Commercial[a]	Estuary to Mission	2	0	0
Test[b]	Albion & Cottonwood	0	0	0
Total		4	2	6

[a] on-boat survey only

[b] DFO and IPSFC test fisheries

Table 13. Lengths and weights of steelhead trout captured by the Fraser River native, sport, commercial and test fisheries, 1985.

	Length (cm)									Weight (kg)								
	September			October			November			September			October			November		
Fishery[a]	N	Mean	Range	N	Mean	Range	N	Mean	Range	N	Mean	Range	N	Mean	Range	N	Mean	Range
Native Food	2	82.5	82.0-83.0	15	77.3	66.0-87.0	6	83.1	67.0-94.0				7	5.3	3.2-7.3	3	7.9	6.4-9.5
Sport	12	82.0	66.0-92.0	50	84.8	66.5-101.0	2	89.0	89.0-89.0	10	5.8	2.3-7.0	44	7.1	4.1-11.3	2	6.8	6.7-6.9
Commercial				22	81.9	63.0-96.0	7	89.3	65.0-94.0							6	6.0	3.0-9.1
Test - Albion	23	86.7	81.5-93.5	69	80.7	45.0-94.0	25	84.6	66.5-94.0	23	7.9	6.4-10.0	69	7.0	3.6-13.2	25	6.9	4.5-9.5
Test - Cottonwood	4	81.0	73.0-92.0	12	79.8	67.5-86.0				3	5.5	5.0-6.4	12	6.0	3.2-8.2			
All Fisheries	41	84.6	66.0-93.5	68	81.7	45.0-101.5	40	84.0	65.0-94.0	36	7.1	2.3-10.0	132	6.9	3.2-13.2	36	6.8	3.0-9.5

[a]Average net mesh sizes: Native food - 11.4cm; commercial - 14.6cm; Albion test - 18.5cm; Cottonwood test - 13.3cm.

apparent peak migration) originated from the Thompson River drainage (Table 12).

Average length and weight of steelhead captured by the Albion test showed a slight decline in mid-November (Fig. 16). This indicated that early winter steelhead of perhaps Chehalis and/or Vedder River origin were being intercepted. However, there is also some indication that average size of steelhead captured in the Thompson River sport fishery declined in December (S. Maricle, pers. comm.), or the relative abundance of "medium-sized" Bridge or Chilcotin river stocks increased.

5.2 Recovery of Marked Steelhead

Marked steelhead recoveries recorded by DFO Salmon Services in commercial fisheries of Statistical Area 29 are presented in Table 12. Of 218 steelhead examined from July 27 to November 23, five (2.3%) lacked adipose fins and three contained CWTs. It must be emphasized, however, that only steelhead lacking the adipose fin were recorded by Salmon Services, and maxillary clips may have been present but unrecorded in the commercial sample. An additional 203 steelhead were examined from the sport, commercial and test fisheries, and seven (3.5%) had distinct hatchery marks. One steelhead sampled during the November 21 commercial opening was adipose clipped but did not contained a CWT (Table 12). However, examination of the degree of development of the ovaries and the fecundity in relation to size indicated that it was an early winter steelhead (see Section 5.3).

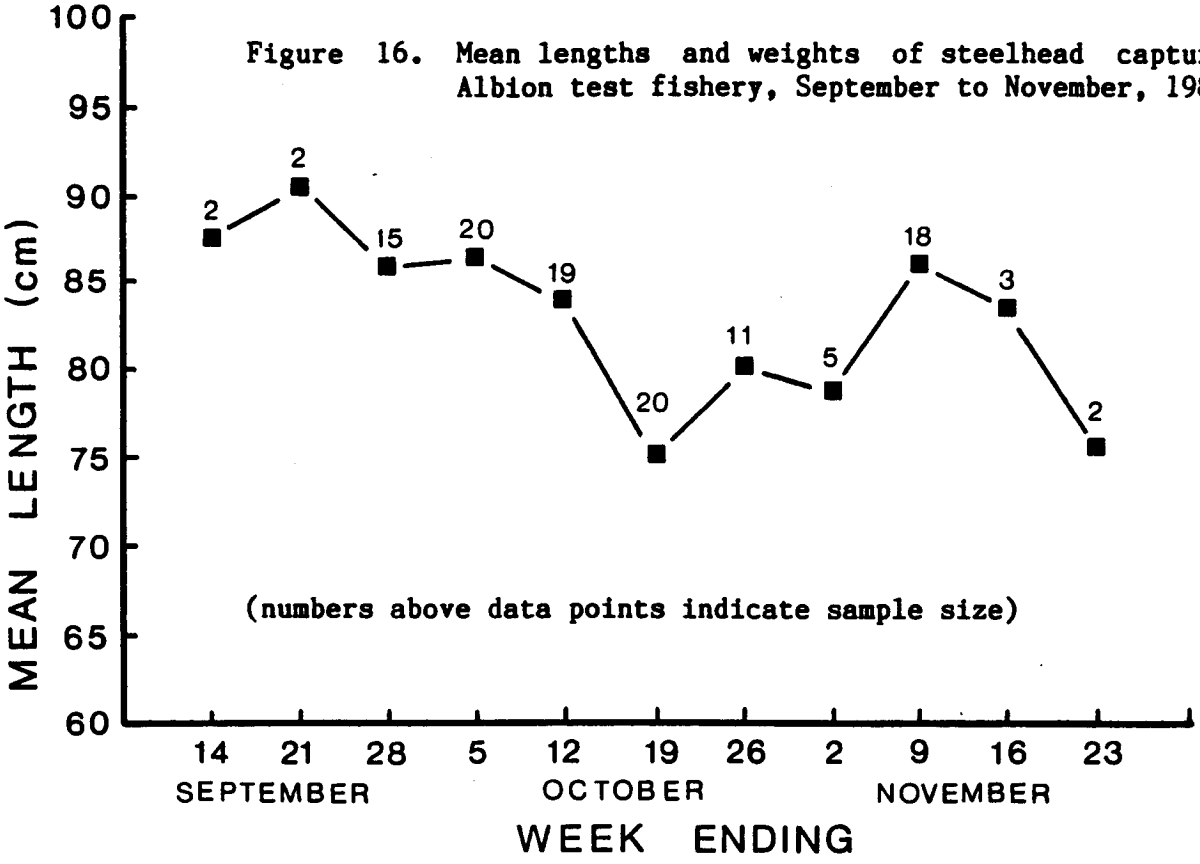
Of 65 steelhead sampled from the Fraser River sport fishery, six (9.2%) were distinctly of hatchery origin (Table 14). Two (1.0%) had adipose clips and four (2.0%) had right maxillary clips (Deadman River) that indicated Thompson River origin. Four of 65 (6.2%) steelhead examined from the Native food fishery lacked a maxillary: two right maxillary and two left maxillary (Bonaparte River release).

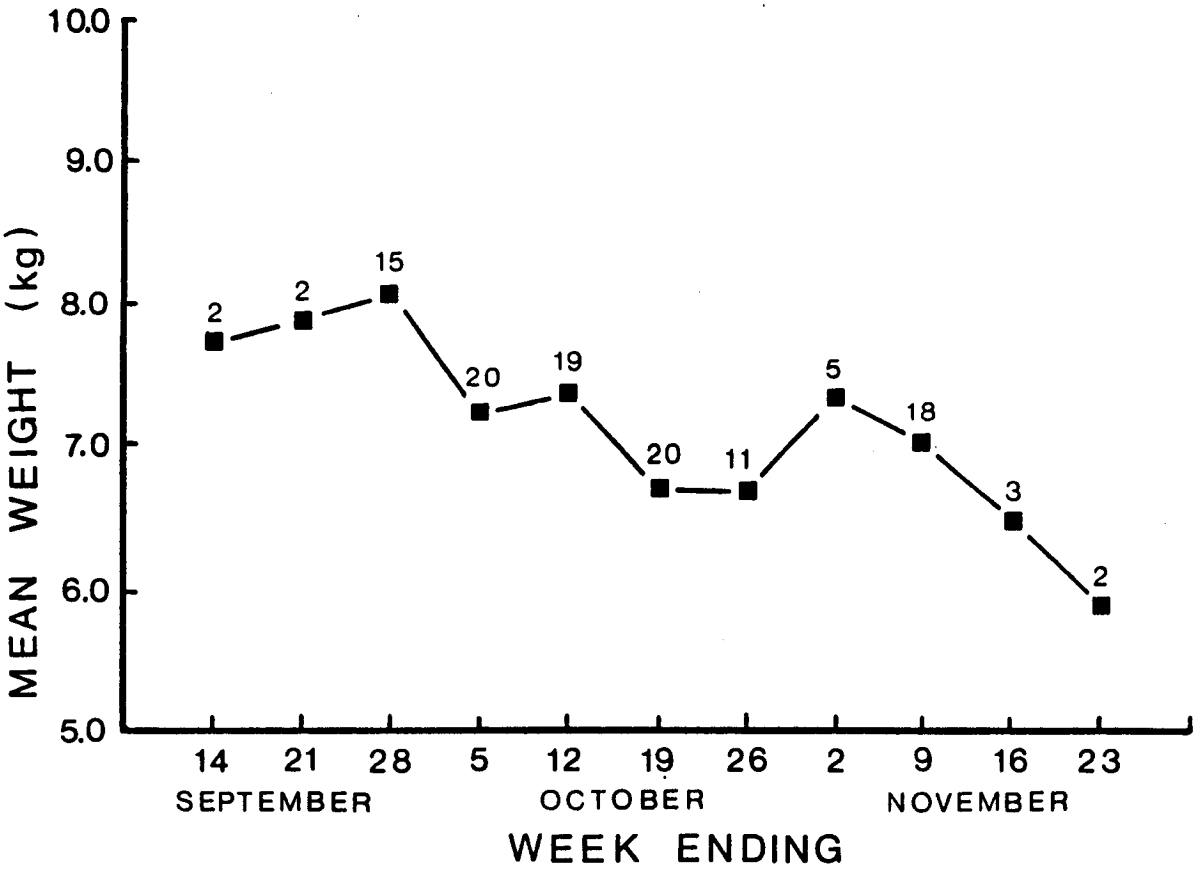
5.3 Biological Characteristics

5.3.1 Sampling Procedure

Steelhead intercepted in commercial, subsistence and sport fisheries were sampled with permission of the fisherman. All steelhead captured by Fraser River test fishing were sampled. Sex was determined by external inspection of morphometric features (i.e., contour of the snout) and/or by internal examination of gonads. Nose to caudal fork length was measured to the nearest millimeter. Weight of non-gutted steelhead was measured by a pre-calibrated hand-held spring balance accurate to 0.1 kg. Five scales per side were removed from the mid-dorsal area, one or two rows above the lateral line, and stored dry in gummed MOE scale envelopes. Areas of obvious scars were avoided. Scale samples were submitted to MOE for age interpretation. Steelhead were examined for hatchery marks (maxillary clip or adipose excision); heads from steelhead lacking adipose fins were labelled

Figure 16. Mean lengths and weights of steelhead captured by the Albion test fishery, September to November, 1985.





with wire tags through the lower jaw and forwarded to the nearest head recovery depot. Whenever possible, tissue samples were collected for subsequent determination of stock origin using electrophoretic analyses by MOE (e.g., Parkinson 1984). Eyes, approximately 2 cc of throat tissue and/or liver were removed by scalpel, placed in a sterile Whirlpak bag and stored frozen. Age and electrophoretic analyses were the responsibility of MOE.

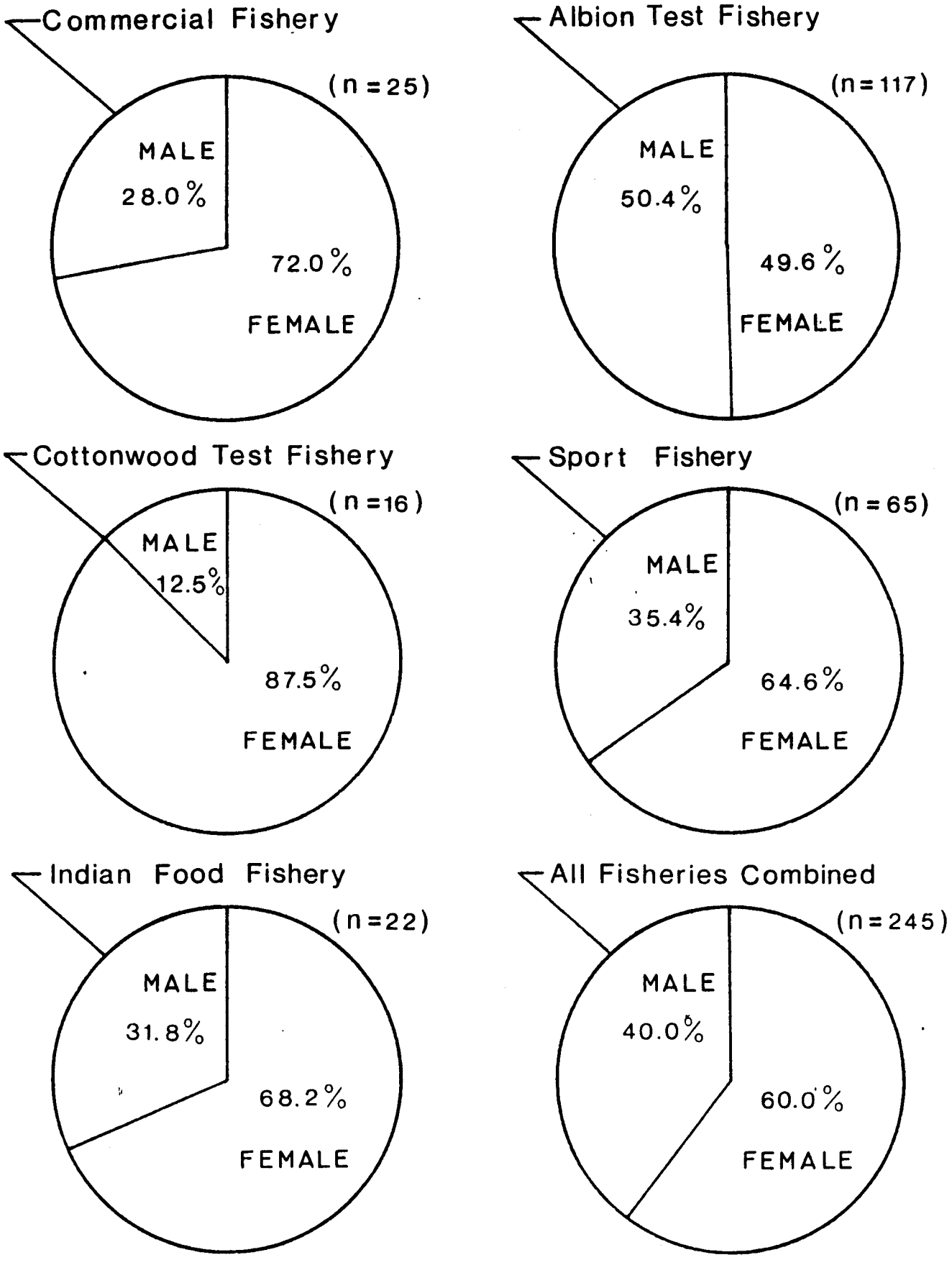
In an effort to distinguish fall steelhead from early winter stocks, we examined gonad size and development whenever possible. Subjective criteria used for females were egg diameter and fecundity: fall-run steelhead are two to three times more fecund than winter fish (Moore and Olmsted 1985b; C. Spence, pers. comm.), and their eggs are comparatively smaller during November and December. Similarly, we surmized that the testes of fall-run males would be much smaller and less mature than early winter steelhead.

5.3.2 Findings

Lengths and weights of steelhead sampled are presented by month and fishery in Table 13. Average weights and lengths did not differ markedly among the four fisheries, irrespective of month.

The composition of females in the four fisheries ranged from 49.6% at Albion to 87.5% at Cottonwood (Fig. 17). Sixty percent (N=245) of all steelhead sampled were female.

Figure 17. Sex compositions of steelhead captured by the Indian, sport, commercial and test fisheries in the Fraser River mainstem, September through November, 1985.



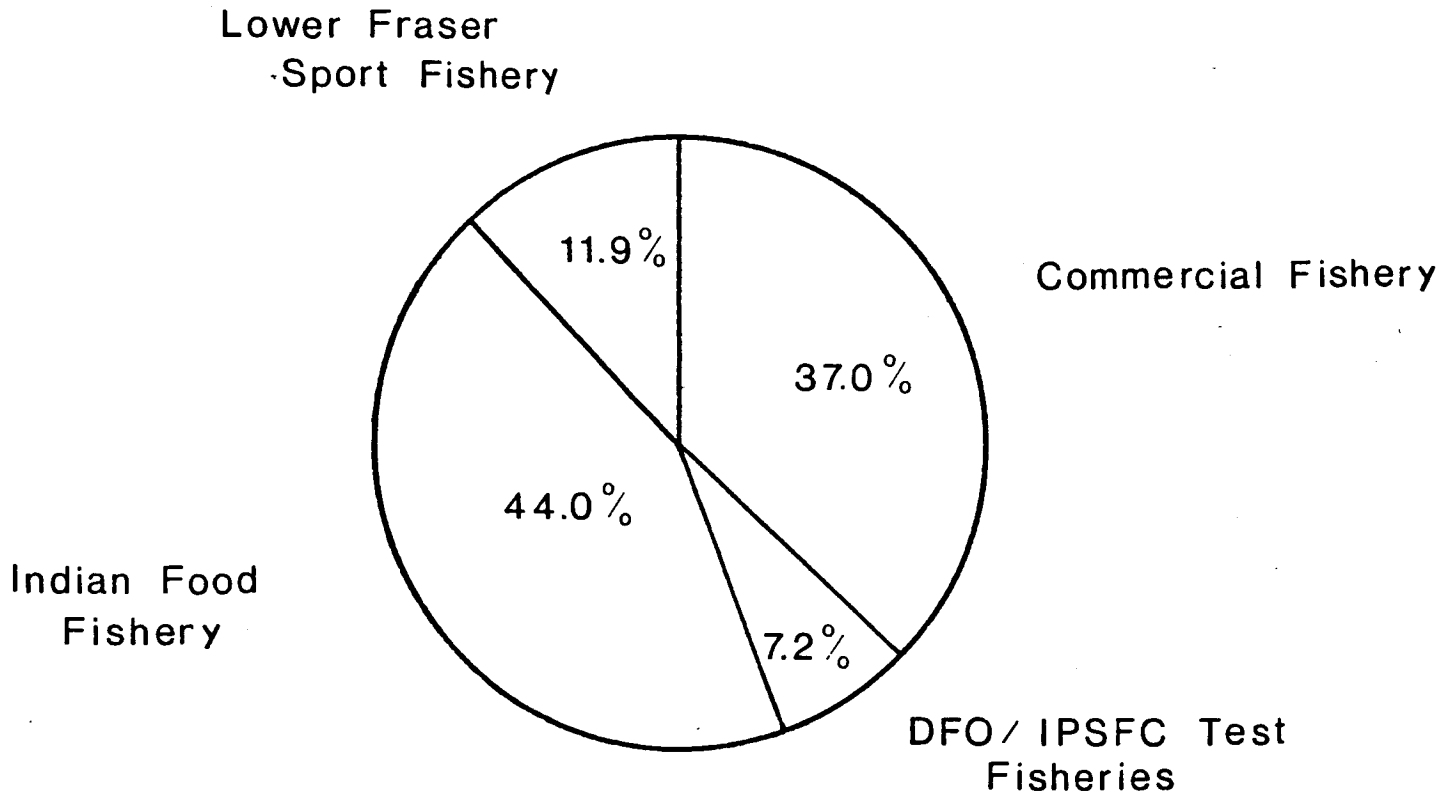
6.0 COMPARATIVE TOTAL HARVEST OF FALL-RUN STEELHEAD AMONG FISHERIES SURVEYED

Of the estimated 3,895 steelhead trout harvested from September 01 to November 21, 1985, 37.0% were captured in the two 12-hour commercial fisheries, 7.2% in the test fisheries, 44.0% in the Indian food fisheries and 11.8% in the sport fishery (mouth of Vedder River to Ruby Creek; Fig. 18).

Based on our observations, it appeared that steelhead catchability was a function of mesh size in all net fisheries. Catchability of steelhead tended to be high among nets with mesh larger than 6.0 inches (15.2 cm). Most of the commercial fishermen used mesh diameters less than 6.0 inches, but a significant number used nets as large as 7.25 inches. Two Native fishermen using mesh diameters greater than 6.0 inches upstream of Hope were more successful in catching steelhead than the average Indian fishermen who used meshes between 4.5 and 5.5 inches.

For conservation of steelhead in net fisheries or reallocation to the sport fishermen, we recommend extension of the 5.5 inch (14.0 cm) mesh restriction through December in the Indian food fishery and a similar size restriction for mainstem commercial salmon fisheries of the Fraser River.

Figure 18. Distribution of the estimated steelhead catch among the commercial, test, sport and Indian food fisheries of the Fraser River mainstem, September 1 to November 21, 1985.



7.0 LITERATURE CITED

Andrews, T.F. and H. McSheffrey. 1976. Commercial interceptions of steelhead trout in British Columbia. Marine Resources Branch, Mininstry of Environment, Victoria B.C. Fisheries Management Bulletin 1: 31 p.

Billings, S.J. 1983. Steelhead Harvest Analysis, 1982-83. Ministry of Environment, Victoria, B.C. Fisheries Technical Circular 59.

Billings, S.J. 1984. Steelhead Harvest Analysis, 1983-84. Ministry of Environment, Victoria, B.C. Fisheries Technical Circular 64.

Billings, S.J. 1985. Steelhead Harvest Analysis, 1984-85. Ministry of Environment, Victoria, B.C. Fisheries Technical Circular 68.

Cochran, W.G. 1977. Sampling techniques. John Wiley & Sons, Toronto, Canada, 428p.

Evans, L.K. 1979. Incidental catches of steelhead trout in the commercial salmon fisheries of Barkley Sound, Johnstone Strait and the Dean and Bella Coola Rivers area. Ministry of Environment Fisheries Technical Circular 39: 30 p.

Goodman. L.A. 1960. On the exact variance of products. American Statistical Association Journal 55: 708-713.

Moore, D.C. and W.R. Olmsted. 1985a. Thompson River steelhead angler survey, 1984. Prepared for B.C. Ministry of Environment and Department of Fisheries and Oceans by H. Paish & Associates, Ltd., Coquitlam, B.C.

Moore, D.C. and W.R. Olmsted. 1985b. An ecological study of steelhead trout (Salmo gairdneri) reproduction in Deadman River, B.C., 1984. Prepared for Department of Fisheries and Oceans and B.C. Ministry of Environment, Vancouver, by W.R. Olmsted & Associates, Inc. 43 pp. + appendix.

Neuhold, J.M. and K.H. Lu. 1957. Creel census method. Utah State Department of Fish and Game Publication Number 8: 36p.

Oguss, E. and T.R. Andrews. 1977. Incidental catches of steelhead trout in the commercial salmon fisheries of the Fraser River, Skeena River and Juan de Fuca Strait. Marine Resources Branch, Ministry of Environment, Victoria, B.C. Fisheries Management Bulletin 7: 50 p.

Oguss, E. and L.K. Evans. 1978. Incidental catches of steelhead trout in the commercial salmon fisheries of Barkley Sound, Johnstone Strait, and the Skeena and Fraser Rivers. Marine Resources Branch, Ministry of Environment, Victoria, B.C. Fisheries Management Bulletin 14: 64 p.

Parkinson, E.A. 1984. Genetic variation in populations of steelhead trout (Salmo gairdneri) in British Columbia. Candian Journal of Fisheries and Aquatic Sciences 41: 1412-1420.

Schubert, N.D. 1983. The Indian food fishery of the Fraser River: catch summary, 1951 to 1982. Canadian Data Report of Fisheries and Aquatic Sciences 412: v + 357p.

Schubert, N.D. 1984. The Indian food fishery of the Fraser River: 1983 summary. Canadian Data Report of Fisheries and Aquatic Sciences 479: v + 67p.

Schubert, N.D. 1985. The Indian food fishery of the Fraser River: 1984 summary. Canadian Data Report of Fisheries and Aquatic Sciences 512: v + 64p.

Schubert, N.D. 1986. The Indian food fishery of the Fraser River: 1985 summary. Canadian Data Report of Fisheries and Aquatic Sciences 560: v + 80p.

Scott, K.J. 1985. Angler use and catch survey of anadromous trout fisheries in the lower Fraser River, 1984. Prepared for Department of Fisheries and Oceans and Ministry of Environment, Vancouver, by H. Paish & Associates Ltd.