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ENVIRONMENTAL STUDIES ASSOCIATED WITH THE PROPOSED KEMANO COMPLETION HYDROELECTRIC DEVELOPMENT

VOLUME 4

FISH RESOURCES OF THE MORICE RIVER SYSTEM BASELINE INFORMATION

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PREFACE

This volume is one of 13 presenting the results of baseline inventory studies of resources potentially affected by the Aluminum Company of Canada's (Alcan's) proposed Kemano Completion Hydroelectric Development. It describes the fish resources of the Morice River and its tributaries, Morice Lake, and the Bulkley River above Driftwood Creek.

Section A of this volume is revised version of the initial baseline studies issued for public and agency comment in November 1981. It is based on field studies of adult and juvenile salmonids in the Morice River system during 1979.

Supplementary field studies (Sections B through K) were conducted on the Morice River system from 1980 to 1982 to provide specific data on (1) the distribution, abundance, habitat preferences and densities of juvenile salmonids rearing in the Morice River system (Sections B, D, F, G, and J); (2) the importance of winter habitat availability to juvenile salmonids (Section C); (3) the timing of steelhead trout spawning and fry emergence (Section E); (4) the distribution, abundance and physical characteristics of preferred pink salmon spawning habitat (Section H); and (5) the spawning areas used by Morice Lake rainbow trout (Section I). The fish resources of Atna Lake were also investigated (Section K).

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1.0 INTRODUCTION

This section was Volume 4 of the thirteen volume series of initial baseline environmental studies originally issued in draft form in November 1981. It addresses the fish resources of the Morice River system, Morice Lake, and the Bulkley River above Driftwood Creek based on 1979 field studies. This section was revised in response to comments on the draft released in 1981, to reflect some of the results of concurrent studies conducted by the Department of Fisheries and Oceans and the B.C. Fish and Wildlife Branch, and to incorporate results from supplementary studies. Results of the supplementary studies, conducted from 1980 through 1982, are presented in detail in Sections B to K.

1.1 Study Objectives

Fish distribution and relative abundance in the Morice River and its tributaries, Morice Lake and the Bulkley River were primary focuses of this study. The relationship between available fish habitat at changing discharges was also investigated to provide the basis for an impact assessment of reduced discharge effects on these downstream areas (Volumes 15 and 19).

Fish resource studies focused on steelhead and resident fish since information on salmon was available from previous studies conducted by the Department of Fisheries and Oceans. In addition, these earlier data on salmon were supplemented with spawning and rearing information collected during the present study, and the two are presented together in this section.

1.2 Study Area Description

The study area consisted of the mainstem (including the main channel and side channels) Morice and Bulkley Rivers downstream to the confluence of Driftwood Creek, and the Bulkley River and Morice River tributaries, and Morice Lake and its tributary streams, excluding the Nanika River. Fish resources of the Nanika River are considered in Volume 3 of this report.

<u>Morice River</u>

The Morice River watershed is located in the southwest portion of the Bulkley River drainage basin (Figure 1.1) and is comprised of tributaries draining both the Interior Plateau and the heavily glaciated Coast Mountains. The Morice River originates from the northern end of Morice Lake at an elevation of approximately 785 m, and flows northeast for 80 kilometers (km) to join the Bulkley River near Houston (Plate 1). It then becomes the Bulkley River and flows northwest for 150 km to join the Skeena River at Hazelton. A more detailed description of the Morice and Bulkley Rivers is presented in Appendix A1, Table A1.1.

The Morice River below Morice Lake has several large tributaries draining mountainous areas to the north, including the Thautil River, and Gosnell and Houston Tommy Creeks. Two lake-headed tributaries, Lamprey and Owen Creeks, drain southern plateau areas. Many small tributary streams flow into the main river throughout its length. Descriptions of most tributaries can be found in Morris and Eccles (1975) and Carswell (1979a and 1979b).

Peak flows in the Morice River generally result from snowmelt and occur from late May to July (Figure 1.2). A combination of glacier melt, lake storage, and autumn rains maintain high streamflows in the mainstem Morice River until freeze-up in late October or early November, and extreme low summer flows do not occur in the main river. Streamflows decrease to a minimum in mid-April. Water temperatures in the mainstem Morice River are above 5 degrees Centigrade (^{o}C) from approximately the middle of May until early November, with maximum water temperatures approaching 15^{o}C during August (Figure 1.2).

Larger tributaries such as the Thautil River, and Gosnell, Lamprey and Owen Creeks have more extreme discharge fluctuations and peak earlier in the season than the Morice River (Appendix A1, Figure A1.1). Water temperatures in both Owen and Lamprey Creeks reach a maximum of 19^{o}C during the late summer.

Morice Lake

Morice Lake lies between two ranges of glaciated mountains (Plate 2). It is approximately 42 km long, 4.5 km wide and has maximum and mean depths of 236 and 100 m, respectively (Godfrey 1955). Most Morice Lake tributaries, with the exception of Nanika River and McBride Creek, have a steep gradient and are turbid for much of the summer. Morice Lake and its tributaries provide almost all of the lake storage in the Morice and Bulkley River system (Robertson et al. 1979).

An investigation of the limnology of Morice Lake by Cleugh and Lawley (1979) indicated that the lake is relatively cool (maximum summer temperature of 13^{o}C) and unproductive, with the highest nutrient levels occurring at the lake's north end.

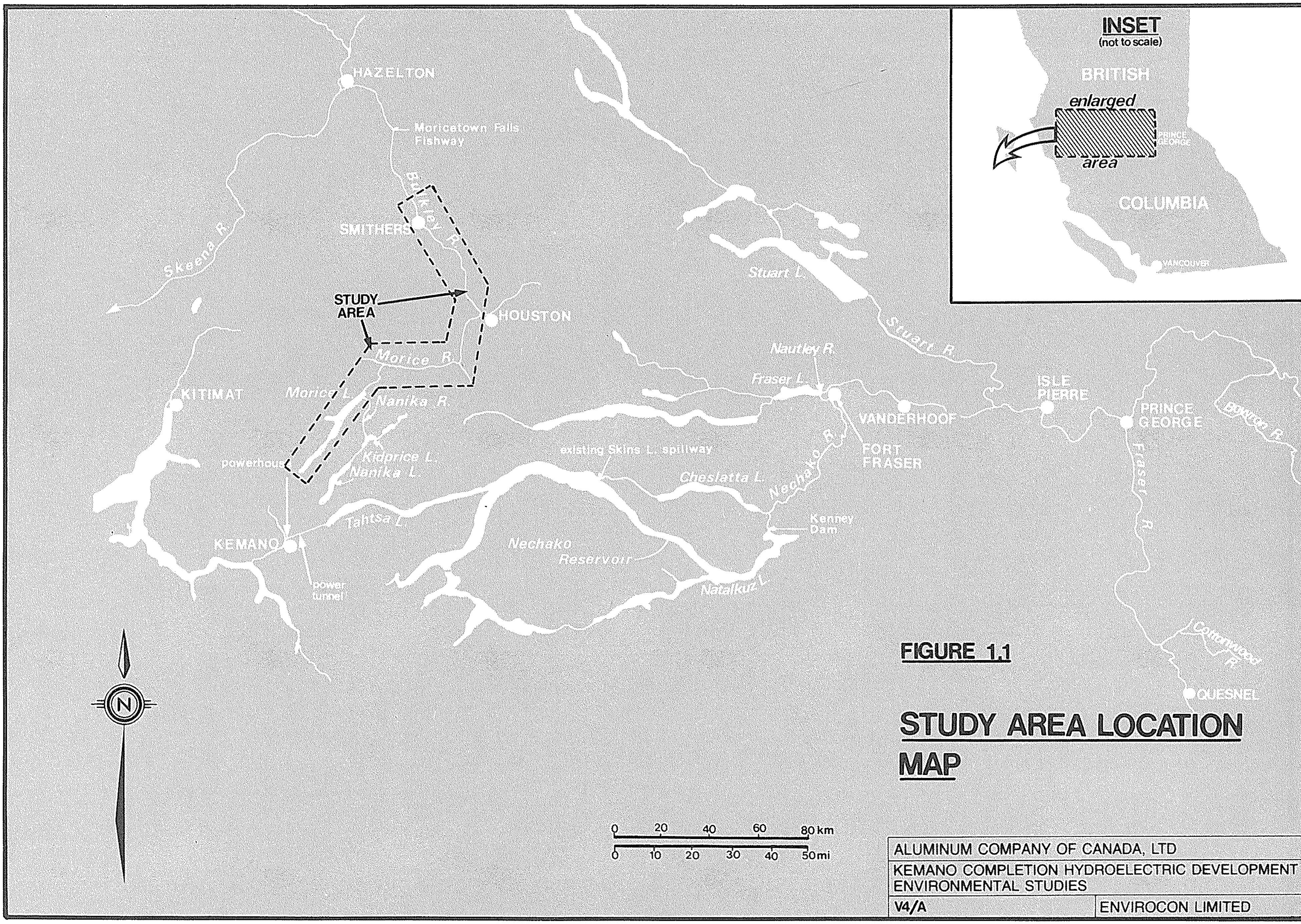


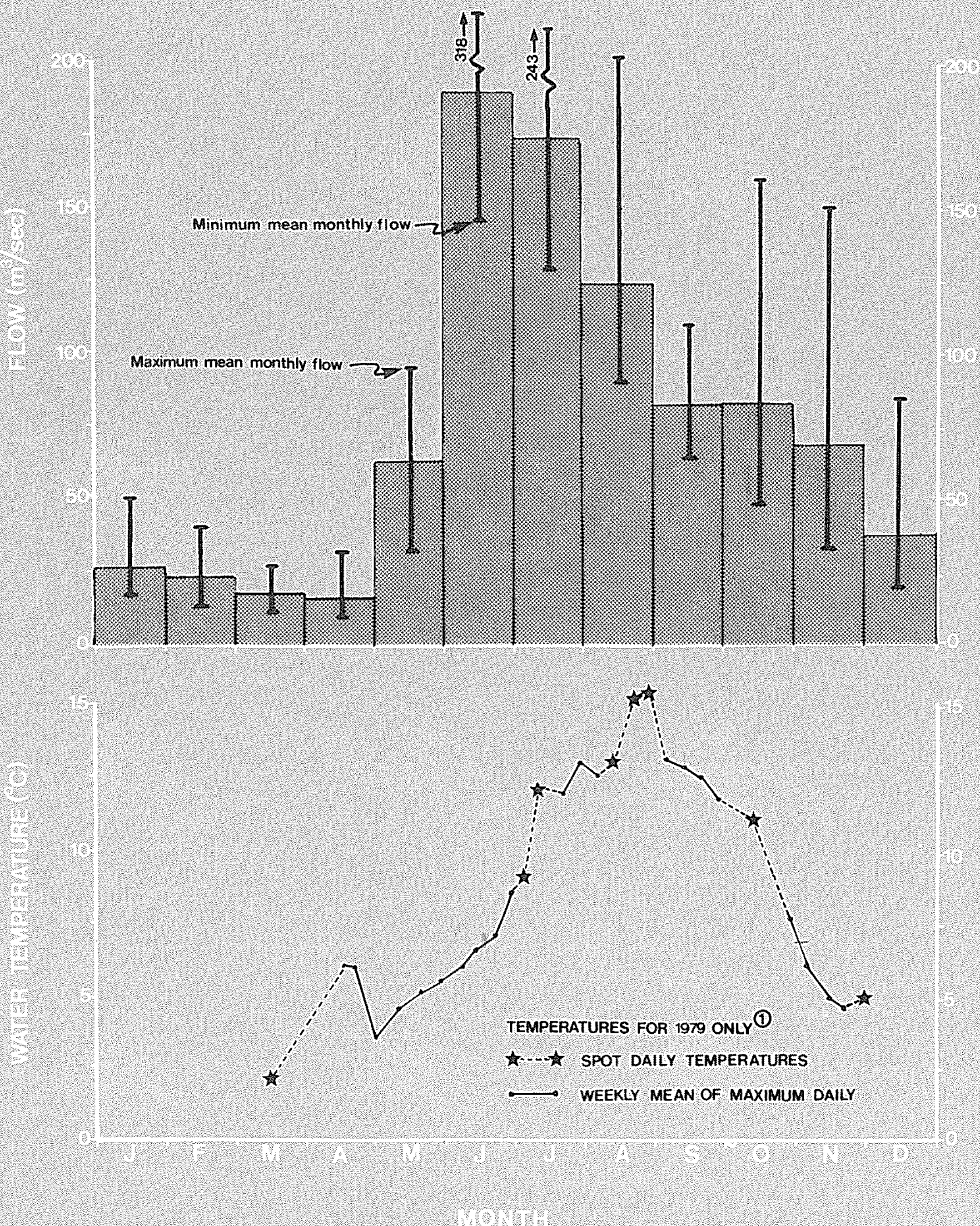
FIGURE 1.1

STUDY AREA LOCATION MAP

Plate 1: Upper Morice River, illustrating side channels used by spawning steelhead trout, and coho, chinook and pink salmon.

Plate 2: Morice Lake.

FIGURE 1.2: MEAN MONTHLY FLOWS (1961–1982) AND MEAN MAXIMUM WEEKLY TEMPERATURES OF THE MORICE RIVER BELOW MORICE LAKE



① additional temperature data for 1982-83 is given in Volume 2, Table E5.7

Stockner and Shortreed (1979) suggested that primary and secondary production in Morice Lake are limited by low nutrient availability.

2.0 METHODS

2.1 Study Duration and Logistics

Field studies on the Morice and Bulkley Rivers and Morice Lake (Figure 2.1) were conducted by a crew of four between March and late November 1979. Supplementary fish tagging studies were conducted on Morice Lake and the Morice River by a crew of two during May and June 1980. Supplementary juvenile distribution and abundance studies, juvenile overwinter survival studies and adult spawner studies were conducted by crews varying from two to five during 1981 and 1982 (Sections B through K). Access to the Morice River from May through October was mainly with a 6-m river boat. A 4-m inflatable jet boat and helicopter provided access during periods of lower flows in April and November. Access to tributaries was by truck, riverboat, helicopter or on foot, depending on location.

2.2 Flow and Water Temperature Measurements

Morice River discharge data were obtained from the Water Survey of Canada gauging station located 1 km downstream of the Morice Lake outlet (Station No. 08ED002).

Staff gauges were installed on both Gosnell Creek and Thautil River just upstream of the Morice River, and on Lamprey and Owen Creeks. Flow was metered at four to six different levels to establish a stage-flow relationship. Staff gauges were usually read at least once a week during 1979, although readings at the Gosnell Creek site were less frequent due to difficult access. A Marsh-McBirney Model 201 current meter was used to measure water velocities. Average velocity readings were obtained at 40% of the water depth from the bottom (Arseneault 1976). Additional water level readings were recorded in main and side channels of Reach 2 in early May 1982 (Volume 15, Section G).

Water temperatures in the Morice River were recorded from April through November 1979 using a Kahl thermograph installed just upstream of the Gosnell Creek confluence. Water temperatures were also regularly recorded at all fish sampling and transect sites using hand-held thermometers. Maximum-minimum thermometers were installed at the three tributary staff gauge sites during 1979. Additional water temperatures using Kahl thermographs were recorded from June 1982 through November 1983 (Volume 2, Section E).

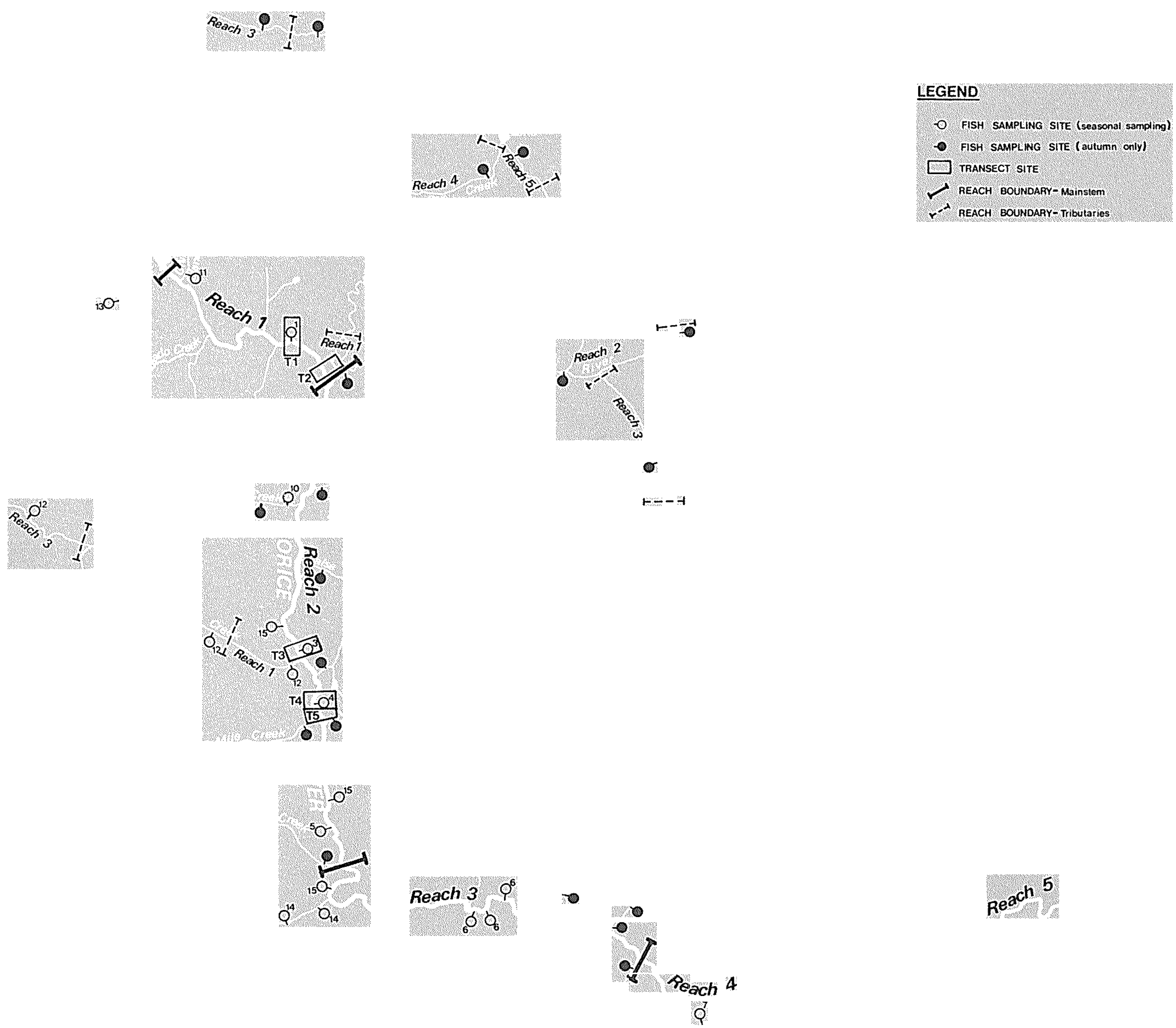


FIGURE 2.1

FISH SAMPLING AND TRANSECT SITES IN THE MORICE RIVER SYSTEM, 1979

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2.3 Fish Capture, Observation and Examination

a) Aerial Observations

Surveys to determine the distribution and abundance of adult pink and coho salmon were conducted from helicopters in early September and late November 1979, respectively. Aerial surveys were continued from 1980 to 1982. Pink salmon surveys were conducted in the Bulkley and Morice Rivers above Smithers, while coho salmon surveys were conducted upstream of Houston Tommy Creek. During surveys, the helicopter flew approximately 30 to 50 m above the river channel. Where channel braiding occurred, an effort was made to examine all channels large enough to be used by spawning adults. Helicopter surveys were conducted for each species during their peak spawning period.

b) Snorkel Observations

Fourteen snorkel surveys were conducted in the upper 15 km of the Morice River between March 21 and November 16, 1979 to determine fish distribution and abundance. This section of the Morice was the only reach sufficiently clear to permit snorkel observations throughout the study. Swimmers in dry suits examined the margins of the river, since these areas offered the greatest amount of cover and tended to be used more by fish. The number and species of fish observed and their location were reported to a recorder in an accompanying boat. The same areas were observed during each survey until reduced water levels in the late summer and fall restricted observations in side channels. Additional adult steelhead trout observations were made in May and June 1982 (Section E).

A supplementary snorkel and SCUBA study was undertaken during September 1982 to determine juvenile salmonid habitat preferences and densities in the Morice River. Observations of juvenile chinook and coho salmon and steelhead trout fry and parr were made at random and selected sites from approximately 1 km upstream of Gosnell Creek to Lamprey Creek (Section G).

c) Radio Telemetry

Since 1978, the B.C. Fish and Wildlife Branch has been conducting a radio telemetry tagging program on Skeena River adult steelhead trout. Envirocon contributed to this project during 1979 by providing tags which permitted the number of radio-tagged steelhead in the Morice River to be increased from 14 to 24 fish, and by assisting with surveillance of tagged fish from February to June 1979.

A detailed description of the tagging and tracking procedures and equipment used during the study is provided by Lough (1980). The frequency of surveillance varied from several times a month early in the study to several times a week during the spawning period. The date, method and extent of surveillance are summarized in Appendix A2, Table A2.1.

Tracking data were summarized on maps indicating the location of each fish by date. These data, in conjunction with field observations, were used to determine movement patterns and eventual spawning locations of steelhead trout.

d) Adult Tagging

During 1979 a limited fish tagging study was conducted by Envirocon in the Morice River and Morice Lake. Supplementary tagging studies were conducted in May and June 1980. Rainbow, steelhead and lake trout, as well as Dolly Varden char and mountain whitefish were tagged using a Dennison tagging gun which inserted a numbered Floy T-bar tag (FT-68) into the flesh immediately below the dorsal fin. Fish were captured by angling and, in Morice Lake, with gill nets (1.3 to 3.8 cm stretched mesh). Tagging location, date and fork length were recorded and scales were removed from rainbow and steelhead for aging and to ensure that larger rainbow and steelhead had been correctly identified. A reward was offered for tags returned by lake and river sport fishermen.

e) Electrofishing

Juvenile fish were collected along the margins of the mainstem Morice River and its tributaries between April and November 1979 using a backpack Coffelt electrofishing unit powered by a sealed 12-volt battery. The following standard procedure was utilized during sampling. A two-man crew moved upstream in the sampling area making a 2-m wide sweeping motion with the electrofisher anode. Fish collected were anaethetized with MS 222, measured, and released. The length of margin sampled was measured, and the area sampled was calculated. A description of available habitat types from which fish were obtained was recorded. Electrofishing results were used to compare juvenile fish abundance throughout the river system. Supplementary electrofishing studies were conducted during the fall of 1981 and 1982 (Sections B, C, F and J). These additional studies used stop-nets and mark-recapture or removal methods for estimating fish abundance. A boat-mounted electrofisher was also used to sample sites in the mainstem Morice and Bulkley Rivers.

f) Minnow Trapping

Gee minnow traps were set from May through November 1979 in the vicinity of the electrofishing sample sites to provide supplementary data on juvenile fish distribution, abundance, and habitat preference. Minnow traps permitted sampling in the deeper waters not effectively sampled by electrofishing, although they did not catch fry less than 45 mm in fork length, and did not fish in areas less than 10 cm deep. Minnow trap effectiveness was also limited at lower water temperatures. Most minnow trap sampling was conducted during July to September when fish activity was greatest and trapping effectiveness high. Traps were baited with approximately 30 grams of salmon roe and were set for 24 hours.

Average water velocity, depth, and available cover within 2 m of each trap were recorded. Depth was recorded to the nearest centimeter (cm) using a graduated metal rod marked at 2-cm intervals. The following were designated as areas of potential cover:

Cobble (i.e., greater than 20 cm diameter with accessible interstitial spaces)
Overhanging bank
Log jam
Vegetation
Debris (i.e., small temporary accumulations of branches and snags)
Rootwad (i.e., upturned tree roots).

Traps set more than 2 m from cover were assigned to a "no cover" category.

In addition, macrohabitat characteristics at trapping sites were categorized as follows:

Pool (deep and slow)
Riffle (shallow and fast, with broken water surface)
Run (deep and fast)
Flat (shallow and slow)
Back eddy (upstream current)
Side pool (cul-de-sac or bay)
Log jam (constitutes a mixture of all types)
Ponds (separate from main river; usually in old river channels).

All catch data and physical descriptions of trap sites were initially recorded on sample cards, then transferred to a computer for storage and analysis. Catch data were separated by species, age categories and sampling periods for different reaches of the main river and tributaries. Mainstem catches were also analyzed by species and age categories for a variety of velocity and depth increments, cover types and macrohabitat characteristics.

g) Creel Census

A creel census was conducted at Morice Lake from 13 May to 31 October 1979 to provide an estimate of the sport catch and to collect biological data on anglers' catches. The program involved sampling anglers' catches on one randomly selected weekday and weekend day each week. Information collected included number of anglers, fishing effort and catch. Lengths and weights of uncleaned fish were measured and scales were removed from a position slightly anterior to the dorsal fin for aging.

2.4 Habitat Studies

2.4.1 Sample Design

To facilitate representative sampling, the Morice River and larger tributaries were separated into reaches based on differences of physical parameters such as gradient and channel form as determined from air photos and aerial reconnaissance. Small tributaries were treated as single reaches.

Areas representative of the various habitat types found within a reach were selected for fish sampling. Where appropriate, this included main and side channel habitats. At each sampling site an area of 100 to 500 m^2 along the margin was sampled. In some of the smaller tributaries a smaller area provided a representative sample. The locations of all sample sites are shown in Figure 2.1.

During 1979, all Morice River sites were sampled at two-month intervals beginning in early May. Due to high, muddy water in the Bulkley River downstream of Houston during May, sampling in this river did not begin until July. Owen, Lamprey, McBride and Chinook Island Creeks were sampled on several occasions while the 13 remaining tributaries were sampled only during the fall.

Plate 3: Morice River steelhead.

Plate 4:
Chinook Island Creek in late May. This small tributary of the Morice River was used by spawning and rearing steelhead in the spring but was dry by late September.

TABLE 3.1
Comparison of the Freshwater and Ocean Residence Periods of Steelhead Trout from the Morice, Babine, Kispiox and Dean Rivers[1]

	Morice R[2] (1976-77)		Babine R[3] (1967-68)		Kispiox R[4] (1975)		Dean R[5] (1973-75)	
	number	%	number	%	number	%	number	%
Freshwater Age								
2	1	0.2	2	2.0	3	1.5	43	15.2
3	122	23.5	82	82.0	78	40.0	233	82.3
4	362	69.9	15	15.0	109	55.0	7	2.5
5	33	6.4	1	1.0	5	2.6	-	-
Total	518		100		195		283	
Ocean Age								
1	286	59.1	12	10.2	9	5.7	23	7.7
2	192	39.7	82	69.5	93	58.5	223	74.8
3	6	1.2	24	20.3	51	32.1	52	17.4
4	-	-	-	-	5	3.1	-	-
5	-	-	-	-	1	0.6	-	-
Total	484		117		159		581	

1 Repeat spawners not included

2 Whately et al. (1978)

3 Narver (1969)

4 Whately (1977)

5 Leggett and Narver (1976)

The weight and length of returning steelhead depend on the number of years spent in the ocean environment. The high percentage of steelhead returning after one year of ocean life accounts for the predominance of small steelhead caught in the Morice River (Table 3.2) compared with the Kispiox River, which has a reputation as a "trophy" fishery. Over 32% of the Kispiox River steelhead return after three years of ocean life (Whately 1977) compared to 1% in the Morice River.

Upstream Migration and Fall Distribution of Adult Steelhead

Summer steelhead stocks move into the lower Skeena River in June, July and August, with a peak in landings per unit effort in the Tyee test fishery on the lower Skeena in early July (Andrews and McSheffrey 1976). Steelhead are first caught in the Hagwilget Canyon near Hazelton in late July, and appear shortly afterwards at Moricetown Falls (from data on file, B.C. Fish and Wildlife Branch, Smithers). Steelhead continue to move through the Moricetown fishway until at least the end of September (Taylor 1968).

The first steelhead appear in the Morice River in mid-August (Whately et al. 1978) and continue to move into the river throughout the autumn. In 1979, steelhead first arrived in the upper Morice River below Morice Lake between August 8 and August 22. During September, steelhead trout were commonly observed holding immediately downstream from spawning chinook salmon. Taylor and Seredick (1968a) reported that steelhead fed on chinook eggs during this period. Angler catch data indicate that steelhead are distributed throughout the Morice and Bulkley Rivers during the fall (Whately et al. 1978).

Overwintering of Adult Steelhead

Adult steelhead overwinter throughout the Morice, from the lowest point of tagging, near the Bulkley River confluence, to the upper end of the river (Appendix A4, Figures A4.1 to A4.4). More recent radio-tagging information collected by the B.C. Fish and Wildlife Branch indicates steelhead overwinter through much of the Bulkley River as well (pers. comm., M. Lough). No large concentration of fish was observed in any one section the river during winter. Steelhead apparently do not overwinter in any Morice tributaries. With the exception of Gosnell Creek, Morice River tributaries do not have sufficient discharge for overwintering steelhead.

Relatively few steelhead overwinter in the upper 15 km of the Morice River. Only 18 steelhead were observed there during a snorkel survey in March, 1979 (Appendix A3,

TABLE 3.2
Weights and Fork Lengths of Steelhead Trout with Different Periods of Ocean Residence[1]

Sex	Ocean Age	Mean Weight (kg)	Range (kg)	n	Mean Length (cm)	Range (cm)	n
Male							
	1	1.8	0.9-4.0	101	57.1	50.0-72.5	148
	2	4.5	2.2-7.5	45	77.1	62.0-96.5	65
	3	7.9	7.2-9.5	5	91.0	88.9-95.0	5
Female							
	1	1.6	0.7-4.5	97	56.0	49.5-66.0	140
	2	3.7	2.7-5.5	93	72.9	62.0-90.5	135
	3	-	-	0	-	-	-

1 Data from Morice River anglers' catches in the fall of 1976 and 1977 (Whately et al. 1978). Repeat spawners not included

Table A3.3). Calculations based on the proportion of tagged fish observed (3) to tagged fish known to be present (13), suggest that approximately 80 steelhead were in this section of the river during the survey. Surface ice below Gosnell Creek prevented comparable observations for downstream sections of the Morice River.

Past aerial observations during the late winter suggest scattered steelhead wintering in the Morice River to approximately 3 km upstream of Gosnell Creek (Appendix A4, Table A4.1). Few steelhead have been observed wintering above that point. This aerial count information should be interpreted cautiously, keeping in mind that steelhead are usually very difficult to observe in aerial counts, and that several other fish species were present during counts.

There is evidence that steelhead also overwinter in Morice Lake. On May 2, 1979 and on April 25, 1983 groups of at least 20 steelhead were observed at the outlet of the lake. Late October and November snorkel surveys indicate a decline in the abundance of those steelhead which had arrived in the upper Morice in August and September (Appendix A3, Table A3.3). This suggests that following chinook salmon spawning, some steelhead from the upper Morice move into Morice Lake to overwinter. A single ripe steelhead was recovered by gill net in late May 1980 in Morice Lake near the mouth of the Nanika River (on file, B.C. Fish and Wildlife Branch, Smithers). Steelhead also overwinter in lakes in other Skeena systems (pers. comm., Mike Lough, B.C. Fish and Wildlife Branch).

Distances travelled by steelhead wintering in the Morice River were quite variable, ranging from less than 10 km (Fish 8, 10, 11, 16) up to 70 km (Fish 17) (Appendix A4, Figures A4.1 to A4.4). Steelhead moved both upstream and downstream from fall tagging sites, with no obvious pattern to the timing or magnitude of these movements.

Nearly all steelhead observed during the March 1979 snorkel survey were holding at the tail end of runs, usually in 1 to 2 m of water over gravel or cobble-sized substrate. Wintering fish were in areas with velocities up to 1 m/s.

Timing of Steelhead Spawning and Post-Spawning Movements

During late April and early May 1979 most tagged steelhead began moving upstream to spawning sites. Only two of the tagged fish that were tracked moved downstream to spawning grounds.

Increased fish movement coincided with increased flows in the Morice River resulting from snowmelt in the lower elevation tributaries. It was also a period of rapid temperature increase in the tributaries as indicated by Lamprey Creek temperatures which rose from 0°C on April 24 to 9°C on May 25 (Appendix A1, Figure A1.1). Steelhead moved into Owen, Lamprey and Gosnell Creeks during the period of high spring discharge, enabling them to pass areas which might be barriers at lower flows.

In 1979 and 1982, peak spawning occurred from the last week of May to the first week of June inclusive, although the spawning period probably extended from May 15 to at least June 15 in some tributaries (Appendix A4, Table A4.2; Section E). The timing of main river spawning may be slightly later than tributary spawning, possibly a result of cooler water temperatures. During 1979, the last tagged fish were recorded on June 18 in the mainstem Morice River downstream of Gosnell Creek.

Steelhead angling and visual observations in the upper Morice River suggested that in 1980 steelhead spawning occurred earlier than in 1979 and 1982, and was virtually finished by the end of May. Twelve steelhead spawning downstream of Chinook Island Creek on May 26 were the last observed in 1980. The catch per unit effort (CPUE) of steelhead spawners sampled by angling was highest during the first three weeks of May as shown below:

Date	Number of Steelhead Angled	Angling Hours	CPUE (Fish/Hour)
May 1-10	14	44	0.32
May 11-20	9	24	0.38
May 21-30	7	42	0.17
May 31-June 9	2 (1 Kelt)	18	0.11

Mainstem steelhead spawning during 1979 and 1982 occurred on the increasing freshet at water temperatures of 5 to 7°C in 1979 and 3 to 6°C in 1982. Water temperatures in Owen, Lamprey and Chinook Island Creeks during the 1979 spawning period were 8 to 12°C. A review of other steelhead trout systems suggests that increasing discharge associated with the spring freshet may be more important in determining spawning timing than water temperature (Section E). Water clarity in spawning areas varied from clear to heavily silted.

Limited radio-tagging information is available describing steelhead movements following spawning. Some steelhead remained in the vicinity of the spawning area for several days after spawning. On June 7, 1979 an Owen Creek spawner (Fish 4) was found holding in a pool several hundred meters below its spawning area. Three days later, this fish was located approximately 3 km downstream, and on June 15 was located 120 km downstream in the Bulkley River. This fish had moved an average of 25 km/day for the previous five days. Nearly all steelhead kelts (spawned steelhead) probably leave the Bulkley and Morice Rivers by the last week of June, since test fishing at Tyee on the Skeena River indicates that the kelt outmigration is almost completed by the first week in July (Andrews and McSheffrey 1976). However, a steelhead tagged on May 26, 1980, just downstream of Morice Lake, was recaptured by an angler in Atna Bay of Morice Lake on June 29, 1980, suggesting that some kelts may remain in the area for a longer period.

Distribution of Steelhead Spawning

Steelhead spawning sites were located in the mainstem Morice River upstream of Houston Tommy Creek and in a number of tributary streams (Figure 3.1). Both radio tracking and snorkelling were used during 1979 to locate spawning sites. That the greatest number of spawning sites were identified in the upper Morice River does not necessarily reflect a higher proportion of spawners in this section, since snorkelling was restricted to the clear section of river above Gosnell Creek, while radio tracking could be used throughout the river.

Of the 16 tagged steelhead which were followed to their eventual spawning sites in 1979, nine spawned in the mainstem Morice and seven spawned in Morice River tributaries. Of the tributary spawners, four were found in Owen Creek, two in Cox Creek and one in Lamprey Creek.

Two of the seven tagged steelhead whose spawning locations were not identified (Fish 17 and 19) were located near the upper Bulkley River in late April and early May, and may have spawned in the Bulkley River above the Morice confluence. One of the 24 fish tagged was angled and killed one week after tagging. Two additional spawning sites were observed in a small tributary, Chinook Island Creek (Plate 4), while snorkelling its lower section during late May 1979.

Between May 4 and June 5, 1980, 27 steelhead spawners were angled in the 2 km section of the Morice River downstream of Morice Lake. Four of these 27 fish (which had been marked and released) were recaptured during the angling surveys, suggesting that up to several hundred steelhead may have been present in this section of river during this period.

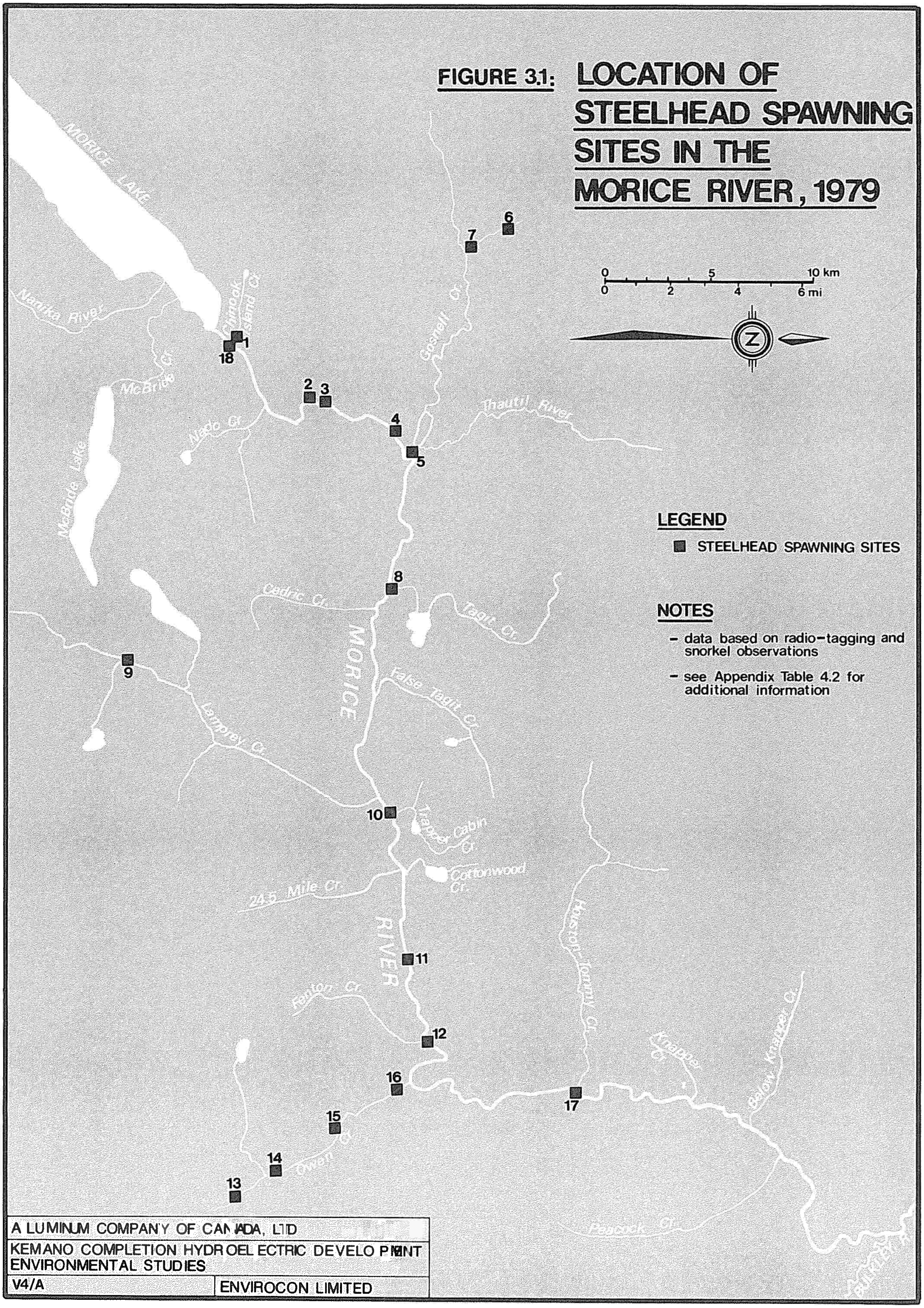

FIGURE 3.1: LOCATION OF STEELHEAD SPAWNING SITES IN THE MORICE RIVER, 1979

Pinsent and Chudyk (1973) suggested that up to 90% of steelhead spawning in the Morice and Bulkley Rivers occurred near the outlet of Morice Lake. Another survey (Morris and Eccles 1975) suggested a more widespread distribution of steelhead spawning in both the mainstem Morice River and its tributaries. The latter study agrees with the results of the 1979 spawning studies. The 1980 studies suggest that the Morice Lake outlet area provides valuable spawning habitat for steelhead. In 1982, steelhead trout were observed in six spawning locations similar to those observed during the 1979 studies (Section E). Although these recent observations suggest that steelhead trout may be quite specific in their choice of spawning sites, radio telemetry studies conducted by Spence (1981) in the Chilko River suggest that steelhead trout spawning distributions can vary considerably from year to year in that system.

Characteristics of Steelhead Spawning Areas

Based on the 1979 studies, mainstem Morice River steelhead spawners used both main and side channel sites as follows:

	Main Channel	Side Channel
Radio-tagging	4	4
Snorkel observation	1	6

Steelhead redds were identified in the Morice River above Gosnell Creek and in Chinook Island Creek. The number of redds identified was small due to poor visibility, high flows, the evasive nature of steelhead, and their wide-spread distribution.

Detailed physical measurements were made at a number of steelhead spawning sites in 1979 (Appendix A4, Table A4.3). Redds were usually in low velocity runs or at the tail end of a pool just upstream of a riffle. Substrate size was 1 to 15 cm in diameter, and was not compacted. Nose velocities ranged from 50 to 85 cm/s at main river sites and depths were 55 to 104 cm. Most spawning areas were close to cover such as logs, overhanging banks, or vegetation.

Physical characteristics of suspected steelhead redds measured in June 1982 had comparable results (Section E). Although nose velocities recorded during spawning are similar to those reported in other rivers (Smith 1973; Bovee 1978), the upper depths are greater. This may be a reflection of larger river size in this study and suggests that upper depth limits are less critical than velocity in determining spawning locations.

Interception and Escapement of Adult Steelhead

In this section, interception and spawning escapement data were used to estimate numbers of adult steelhead of Morice and Bulkley River origin. Sport, commercial and Indian food fishery interceptions, as well as spawning escapements, are subject to considerable annual variation. Some of the estimates provided are rather crude, but are included to provide some scale to the total population of adult steelhead in the system.

Anglers in the Morice and Bulkley Rivers kill an estimated 1,500 steelhead annually. An additional 200 steelhead of Morice and Bulkley origin are taken in the lower Skeena River sport fishery (Appendix A4, Table A4.4). The Morice and Bulkley Rivers account for 40 to 50% of the total Skeena River steelhead sport fishery and 10% of the total steelhead killed and released in British Columbia (Table 3.3). The numbers of steelhead taken from the Morice and Bulkley Rivers between 1976 and 1978 were the highest reported for any river system in B.C. (Anon. 1976, 1977 and 1978).

Morice and Bulkley River-bound summer steelhead are taken as incidental catches in net fisheries for sockeye and pink salmon in the lower Skeena River. The commercial fishery interception of Morice and Bulkley steelhead may be in the order of 2,000 to 4,000 fish annually (Appendix A4) excluding U.S. interceptions. This is based on an estimated 5,000 to 10,000 Skeena River steelhead taken annually in the commercial fisheries (Oguss and Andrews 1977; Oguss and Evans 1978).

Steelhead bound for the Morice and Bulkley Rivers are subject to a variety of Indian food fisheries along the Skeena and Bulkley Rivers, including set nets near Terrace, Cedarvale, Kitwanga, Kitseguecla, Hazelton and Moricetown, as well as a gaff fishery at Moricetown. Based on a five-year average of estimates by Fishery Officers, Friedlaender and Reif (1979) have estimated an annual catch of 1,050 steelhead by the Indian food fishery on the Skeena River. They consider that to be an underestimate of the real catch. In this analysis it was assumed that 450 steelhead, 43% of the total Indian food fishery catch, were of Morice and Bulkley origin, although more recent information being gathered by B.C. Fish and Wildlife staff suggests that Indian food fish catches of Morice and Bulkley steelhead may be substantially higher (Lough 1981).

Enumeration of steelhead trout is difficult due to poor visibility, high flows, the evasive nature of steelhead, and their wide distribution. An estimated spawning population (Volume 15, Section I) of 2,000-3,000 steelhead trout in the entire Morice and Bulkley River system is crude, but reasonable based on the present knowledge of

TABLE 3.3
Morice and Bulkley Steelhead Angler Catch as a Percentage of Total Skeena and Total B.C. Angler Catch of Steelhead[1]

Year	Percentage of Skeena Catch[2]		Percentage of B.C. Catch[3]	
	Kill	Release	Kill	Release
1972-73	46.6	42.8	8.5	8.9
1973-74	42.1	40.0	6.9	7.5
1974-75	45.2	30.1	6.6	4.9
1975-76	48.9	37.5	6.7	7.0
1976-77	46.9	35.0	8.0	6.5
1977-78	47.1	30.5	7.9	6.1
1978-79	58.4	42.3	10.9	10.6
1979-80	69.5	62.4	16.2	14.0
1980-81	73.8	54.4	21.3	12.4
1981-82	51.3	35.5	10.0	6.4
	53.0	**41.0**	**10.3**	**8.4**

1 Based on estimates from Steelhead Harvest Analyses (Anon. 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979a, 1980, 1981 and 1982)

2 Refers to all steelhead catches in Skeena River tributaries. If only summer steelhead were included in this calculation, for the purpose of this analysis, catches from the Kitsumkalum and Lakelse Rivers could be reduced by 50% (pers. comm., M. Whately) and the revised 10-year mean would be 57.3% of the total Skeena angler catch

3 The Morice and Bulkley catch does not include estimates of mainstem Skeena steelhead bound for the Morice and Bulkley Rivers

steelhead in the system. As described in Volume 15, Section I, this estimate represents the number of adult steelhead which require spawning habitat, and should not be confused with production or catch values or with estimated escapement numbers. Since there has been no census program to estimate the number of steelhead spawning in the Morice and Bulkley Rivers, these estimates are based on comparisons with several river systems where population estimates have been made.

Hemus (1973) conducted a tagging and recapture study on the Dean River and estimated a steelhead spawning escapement of approximately 6,500. Babine River escapements were estimated to be 2,000 and 2,100 by Pinsent (1971) and Whately and Chudyk (1979), respectively. The Morice and Bulkley River escapements are thought to be greater than those in the Babine River and less than in the Dean River (pers. comm., M. Whately, B.C. Fish and Wildlife Branch).

The total production of adult steelhead of Morice and Bulkley River origin may be in the order of 6,000 to 9,000 fish based on the following estimates:

Sport fishery catches	1,700
Commercial fishery	2,000-4,000
Indian fishery	450
Spawning population	2,000-3,000

However, the data are limited and in some areas quite crude. The extent of non-Canadian commercial fishing interceptions is unknown, the Indian food fishery estimate is probably low, and the actual spawning population could easily vary by 2,000 fish in either direction in any given year.

3.1.1.2 Juvenile Steelhead Trout:

The following section discusses age and growth of juvenile steelhead trout, the distribution and abundance of juvenile steelhead in the Morice River and its tributaries, and juvenile steelhead habitat preferences within the main river system.

For present purposes all fish less than 250 mm (maximum steelhead smolt size) are referred to as juvenile steelhead as there is no method of visually separating juvenile steelhead from rainbow trout. Since steelhead are more common than resident rainbow in the Morice River (based on angler surveys), it is assumed that steelhead juveniles predominate.

Age and Growth of Juvenile Steelhead

In this study, juvenile steelhead were separated into two age categories based on fork length. Fish in their first growing season are referred to as fry (age 0^+) and fish in their second to fifth growing season are referred to as parr.

Studies conducted in the mainstem Morice River during 1982 indicated that steelhead fry emergence occurred throughout August with a peak during the period August 9-13 (Section E). Observations suggest that in some tributaries, emergence may occur in late July (Appendix A4, Table A4.5), probably a result of earlier spawning dates and higher incubation temperatures. In 1982, newly-emerged fry were typically 27-32 mm in fork length. Fry entering their first winter averaged 50 mm fork length or less. Most parr captured in the years 1979-1982 by electrofishing with a backpack electrofisher were less than 150 mm fork length and comprised age 1^+ and age 2^+ fish (Appendix A4, Figure A4.5 and Tables A4.6 to A4.8; Section J). Electrofishing samples collected from a boat in September, 1982 included age 3+ and 4+ parr although age 2+ fish were most abundant (Section F). That sampling indicated there was little difference in the mean lengths of age 2^+ and 3^+ parr (142 mm and 154 mm, respectively), while age 4^+ parr averaged 204 mm and age 1^+ parr, 90 mm (based on sample sizes of only 7 and 9 fish, respectively; Section F). Additional length and weight information for Morice and Bulkley River steelhead parr is given in Section F.

Scale analyses indicate that most adult Morice steelhead had remained in freshwater for three (24%) or four (70%) winters prior to smolting (a life stage of juvenile salmonids in which physiological preparation for the transition from freshwater to the marine environment occurs). Steelhead which leave fresh water after four winters have spent approximately 45 months in the river, 19 of these months in an active growing period from mid-May until the end of October (summer period), and 26 months in a relatively inactive period from the beginning of November until mid-May (winter period). Morice steelhead have a longer freshwater residency time than three other summer steelhead systems in northwestern B.C., suggesting a less productive rearing environment for juveniles (Table 3.1). This is supported by the finding that Morice River smolts were consistently smaller than Kispiox and Babine smolts of the same age class (Whately et al. 1978). Scale analyses from adults captured in the Bulkley and lower Morice River in 1982 indicated a higher proportion of steelhead returning after 3 years freshwater rearing than do earlier studies (pers. comm., M. Lough, B.C. Fish and Wildlife Branch).

During the 1979 sampling, only 12 steelhead smolts were captured. This was due to ineffective sampling techniques for smolts. Studies conducted elsewhere (summarized in Schmidt et al. 1979) suggest that Morice River steelhead smolts probably migrate seaward between May and July, the period of greatest discharge.

Distribution and Abundance of Juvenile Steelhead

Juvenile steelhead were found in 16 tributaries of the Morice River and throughout the mainstem Morice and Bulkley Rivers (Figure 3.2). More detailed information of fry and parr catches during four sample periods in the mainstem and tributaries is presented in Appendix A4, Tables A4.9 and A4.10, and in Sections B, F, and J.

Steelhead Fry:

Steelhead fry were relatively abundant in the upper three reaches of the Morice River with the CPUE declining considerably in downriver sites (Table 3.4). If catch estimates are corrected for total channel length per reach, an estimated 76% of the main river steelhead fry rearing occurred in the upper three reaches of the Morice and approximately 24% occurred in the lower three reaches (i.e., from Driftwood Creek to Peacock Creek). On this basis, the 34 km of river between Fenton Creek and Gosnell Creek (Reach 2) accounted for 50% of the main river steelhead fry rearing. Reach 2 side channel habitat was important for steelhead fry during the three years of study. However, in 1981 and 1982 more steelhead fry were found in the lower three reaches, particularly Reach 5, than in 1979 (Section J).

Based on electrofishing data collected during 1980, 1981 and 1982, mean densities of steelhead fry from mainstem and side channel habitats combined were estimated to range from a low of 0.06 fry/m^2 in 1982 (Section J) to a high of 0.29 fry/m^2 in 1981 (Tredger 1983). The 1980 fry density (0.14/m^3) fell between these two values (Tredger 1981).

Approximately 85% of the total steelhead fry rearing in tributaries during 1979 occurred in four systems: Lamprey Creek (25%), Thautil River (22%), Owen Creek (19%) and Gosnell Creek (19%) (Table 3.5). Eleven other tributaries accounted for the remaining tributary rearing of steelhead fry (approximately 15% of the total). Although the CPUE was high in some of these smaller tributaries, the stream length accessible to fish was usually quite short and their contribution to total fry rearing correspondingly low. Some of the smaller tributaries had intermittent flow in the fall of 1979. This probably resulted in increased electrofishing efficiency in tributaries,

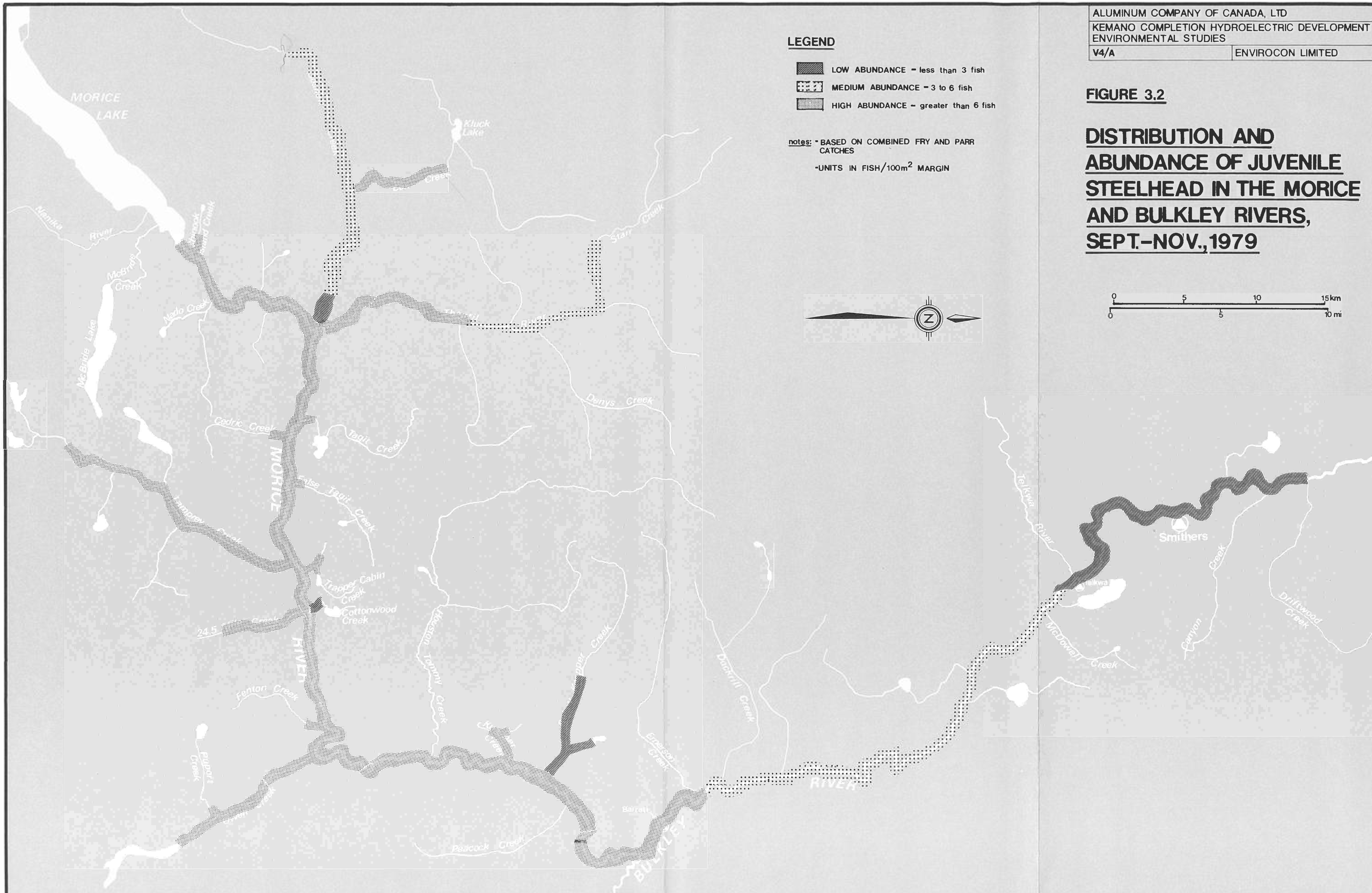

FIGURE 3.2

DISTRIBUTION AND ABUNDANCE OF JUVENILE STEELHEAD IN THE MORICE AND BULKLEY RIVERS, SEPT.-NOV., 1979

TABLE 3.4
Summary of Steelhead Trout Fry and Parr Electrofishing Catches by Reach in the Morice and Bulkley Rivers in September and November 1979[1], and a Comparison of Main River and Tributary Abundance Estimates

STEELHEAD FRY

Reach	Area of Margin Electrofished (m²)	Channel[2] Length (km)	Fish/100 m² of Margin	Channel Length x Catch	Weighted Distribution (%)
1	1,160	25.6	6.7	171.5	9.8
2	6,863	159.5	5.5	877.2	49.9
3	1,632	33.1	8.7	288.0	16.4
4	1,128	36.7	3.9	143.1	8.1
5	1,134	47.2	3.7	174.6	9.9
6	1,043	57.1	1.8	102.8	5.9
Total catch estimate for Reaches 1 to 6				1,757.2	52.3
Total tributary catch estimate (Appendix A4, Table A4.11)				1,604.3	47.7

STEELHEAD PARR

Reach	Area of Margin Electrofished (m²)	Channel[2] Length (km)	Fish/100 m² of Margin	Channel Length x Catch	Weighted Distribution (%)
1	1,160	25.6	1.6	41.0	9.0
2	6,863	159.5	1.0	159.5	35.0
3	1,632	33.1	0.3	9.9	2.2
4	1,128	36.7	2.4	88.1	19.4
5	1,134	47.2	2.1	99.1	21.8
6	1,043	57.1	1.0	57.1	12.6
Total catch estimate for Reaches 1 to 6				454.7	56.3
Total tributary catch estimate (Appendix A4, Table A4.12)				352.9	43.7

1 Refer to Section J, Table 3.4 for a summary comparison of juvenile steelhead distribution, 1979-82

2 Combined length of main and side channels

TABLE 3.5
Summary of Calculated Steelhead Fry and Parr Abundance in Morice River Tributaries[1]

Rating	Tributary	% OF OVERALL TRIBUTARY ABUNDANCE	
		Fry	Parr
1	Owen Creek	19.3	36.2
2	Gosnell Creek	18.6	26.2
3	Thautil River	21.9	11.2
4	Lamprey Creek	24.7	6.6
5	Knapper Creek	4.2	4.4
6	Tagit Creek	2.3	2.9
7	24.5 Mile Creek	1.0	3.9
8	Chinook Island Creek	1.4	2.2
9	Below Knapper Creek	1.2	1.9
10	False Tagit Creek	1.4	1.2
11	Fenton Creek	0.7	1.7
12	Cedric Creek	2.3	-
13	Trapper Cabin Creek	0.8	0.9
14	Cottonwood Creek	0.2	0.2
15	Peacock Creek	-	0.3
16	Puport Creek	0.1	-
17	Houston Tommy Creek[2]	-	-

1 Based on sampling during September and October 1979. Does not include the Nanika River. See Appendix A4, Tables A4.11 and A4.12, for detailed calculations

2 Juvenile steelhead have been reported in lower Houston Tommy Creek (Shepard and Algard 1977)

thus causing an overestimate of the tributary catch. B.C. Fish and Wildlife estimates of steelhead fry mean densities in three tributaries studied during 1980 and 1981 (Gosnell, Lamprey and Owen Creeks) ranged from a low of 0.02 fry/m^2 for Gosnell Creek in 1981 to a high of 1.53 fry/m^2 for Owen Creek in 1981 (Tredger 1983).

There appeared to be nearly equal proportions of rearing steelhead fry in the main river from Driftwood Creek to Morice Lake (52%) and in the 15 tributaries of the Morice River (48%) which had rearing fry during 1979 (Table 3.4). This is based on a comparison of total catches corrected for channel length in the mainstem compared to tributary catches corrected for the length of the tributary accessible to fish. The increased catchability of fry in some of the smaller tributaries would overestimate tributary catches.

Results of 1981-82 overwinter survival studies indicated that steelhead fry did not leave side channel areas as flows declined during the late fall and winter period. The overwinter survival of steelhead fry in the four study side channels was approximately 30%. Mortalities occurred due to a variety of factors associated with low winter flows and ice conditions (Section C).

Steelhead Parr:

Electrofishing catches in 1979 indicated that steelhead parr were distributed throughout the six reaches of the Morice and Bulkley Rivers, with the highest catch per unit effort in Reach 4 and the lowest catch per unit effort in Reach 3 (Table 3.4). A higher percentage of steelhead parr (54%) than fry (24%) were rearing in the lower three reaches of the main river. Fry distribution more closely reflected the location of steelhead spawning. Reach 2, with its complex of channels, accounted for 35% of the total steelhead parr rearing. However, less confidence should be placed in the parr data collected in 1979 (n = 150) than in the fry distribution information (n = 700) because of the difference in sample sizes. September minnow trap data supplement the electrofishing results and indicate a relatively even distribution of parr throughout the system during the fall (Appendix A4, Table A4.10).

Electrofishing surveys conducted with a boat electrofisher in September 1982 indicated that steelhead parr abundance progressively increased in the lower reaches, with the greatest weighted distribution in Reach 7 (Section F). In contrast, backpack electrofishing results in 1981 and 1982 indicated parr were more abundant in the upper reaches (Sections B and J). However, the larger sample size of parr caught by boat electrofishing and the greater success of this technique in catching older parr (age 3+

and 4+) compared to backpack electrofishing suggest that more confidence should be placed in boat electrofishing data and that steelhead trout parr are likely more abundant in the lower reaches. Limitations of both sampling techniques (i.e. in fast runs and log jam areas), especially in Reach 2 which provides the greatest amount of instream cover in the system, may have resulted in underestimates of steelhead parr abundance in all years. Electrofishing data collected by B.C. Fish and Wildlife during 1980 and 1981 (Tredger 1983) and by Envirocon in 1982 (Section J) indicated that steelhead parr mean density, from mainstem and side channel habitats combined, was consistently low at 0.02 parr/m^2 or less.

Nearly 75% of the total parr rearing in the tributaries occurred in three tributary systems: Owen Creek (36%), Gosnell Creek (26%) and the Thautil River (11%) (Table 3.5). An additional 11 tributaries accounted for approximately 25% of the total estimated tributary rearing of parr. Shepard and Algard (1977) concluded that the highest population of steelhead parr in Morice River tributaries was in Owen Creek followed by Lamprey Creek, with limited use of a number of smaller tributaries. During their study only the lower sections of Gosnell Creek and the Thautil River were examined. The 1979 catch data indicate that Gosnell Creek, and its tributary Cox Creek, are important steelhead producers. This conclusion is supported by the observation that two of the 23 radio-tagged steelheod spawned in Cox Creek in 1980. B.C. Fish and Wildlife estimates of steelhead parr (1^+) densities in three tributaries studied during 1980 and 1981 (Gosnell including Cox Creek, Lamprey and Owen Creeks) ranged from a mean of 0.40 parr/m^2 in Gosnell Creek for both years to 0.21 parr/m^2 in Owen Creek in 1981 (Tredger 1983).

Total catches corrected for channel length in the main river and tributaries suggest that a slightly greater proportion of steelhead parr rear in the Morice and Bulkley Rivers (56%) than in the 14 tributaries known to be used (44%) (Table 3.4). As with steelhead fry, the increased catchability of parr in smaller tributaries probably overestimates tributary catches and underestimates mainstem catches.

Preliminary evidence indicates that some steelhead parr move out of the mainstem Morice River to rear in warmer tributary streams during high spring flows, and move back into the Morice River as flows recede in late summer and fall. Electrofishing CPUE in 1979 in the main river was two to three times greater in May, September and November than in July (Figure 3.3). In addition, there was a six-fold increase in steelhead parr CPUE in minnow traps in the main river during the fall, and greater numbers of parr were observed during September than in the July snorkel surveys (Figure 3.3). Parr movements into the tributaries could account for the decreased July catches in the Morice River.

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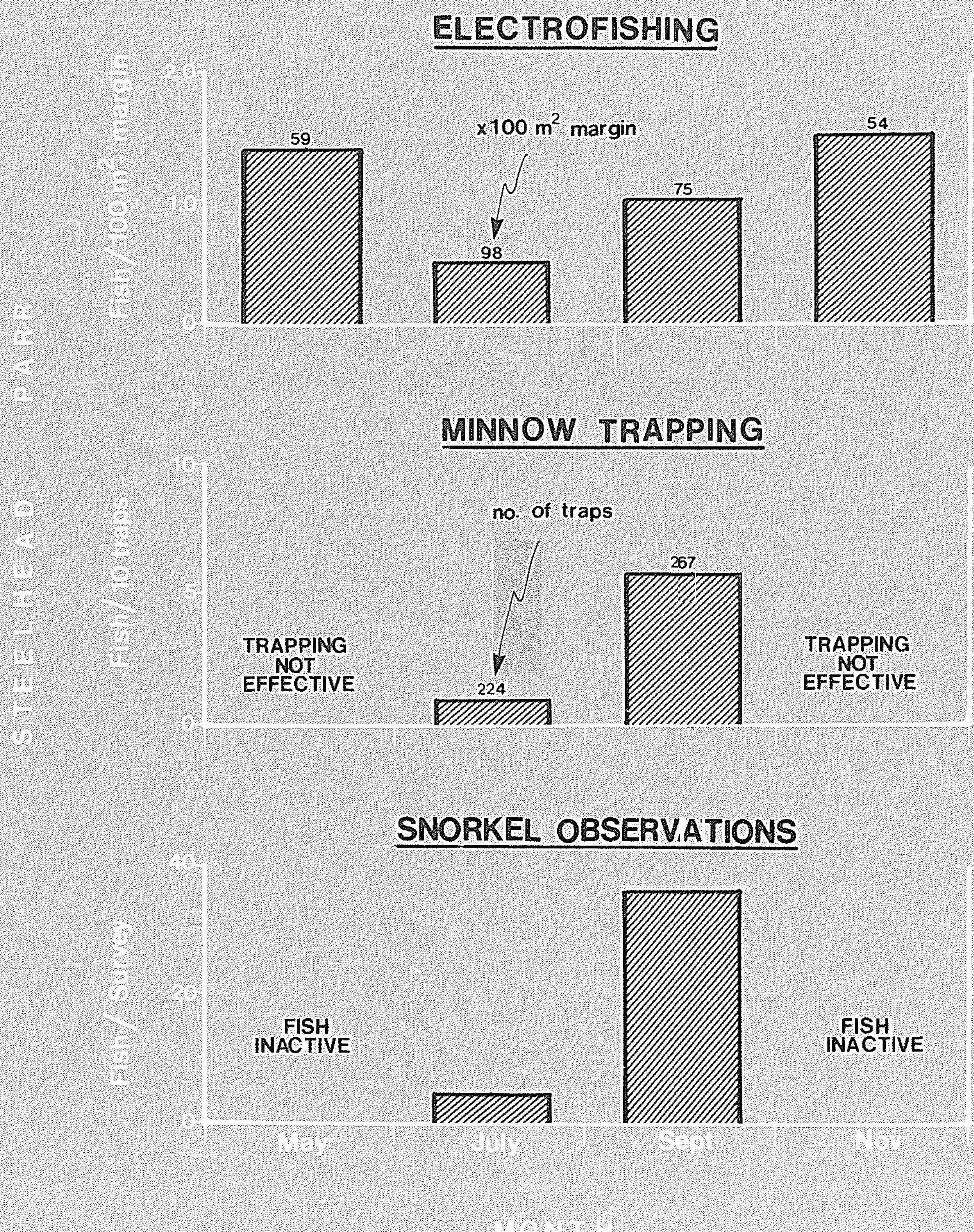
FIGURE 3.3: MAINSTEM STEELHEAD PARR ABUNDANCE DURING FOUR SAMPLE PERIODS, MORICE RIVER, 1979



Movement into tributaries during the spring and back into the mainstem in the fall and winter could be of considerable advantage to rearing steelhead. For example, Chinook Island Creek (Plate 4) provided excellent rearing habitat for steelhead parr during the spring. Water temperatures during May were 11°C and snorkel observations indicated numerous steelhead parr which were actively feeding. During the same period, mainstem temperatures were 5 to 7°C and no parr activity was observed. Flow in Chinook Island Creek became intermittent in early August and the creek offered poor habitat for juvenile steelhead after this time. By late October, this creek was virtually frozen solid while the mainstem Morice was 8 to 10°C. Larger tributaries such as Owen and Gosnell Creeks may have sufficient winter flows to accommodate juveniles, and seasonal movements into these creeks may not offer the same advantages as the small tributaries.

Seasonal movements of juvenile steelhead between tributaries and mainstem rivers have been reported elsewhere. Starr (1979) reported a substantial outmigration of yearling steelhead from the Deadman River into the Thompson River during the late summer and fall period. Everest (1973) demonstrated that juvenile steelhead in the Rogue River in Oregon moved out of small tributaries during the summer to avoid low flows and high water temperatures, and that many juveniles returned to tributaries in the fall prior to winter freshets in the mainstem. Chapman and Bjornn (1969) reported a fall-winter exodus of juvenile steelhead from most small streams in Idaho into larger rivers. This movement coincided with decreasing water temperatures and is related to a lack of suitable overwintering areas in the small tributaries.

Overwintering studies conducted in 1981-82 indicated that little movement in or out of side channels by steelhead parr occurred during late fall - early winter. An average 23% survival rate for steelhead parr in side channels was the lowest survival rate of all Morice River juvenile salmonids sampled in that study (Section C).

Habitat Preferences of Juvenile Steelhead

This section describes habitat preferences of steelhead fry and parr in the Morice River. These data were derived from observations and measurements made at electrofishing and minnow trapping sites in the mainstem only.

Steelhead Fry:

A comparison of 1979 CPUE (expressed as a percentage of total CPUE) in main and side channels suggested that fry were distributed fairly evenly throughout the various river channels during September and November (Figure 3.4). During their active period (prior to November), steelhead fry favoured shallow margin areas typically less than 85 cm in depth (Figure 3.5). The CPUE was greatest in areas with water velocities less than 35 cm/s. Marginal flats, side pools and shallow riffles were generally occupied. Riffles were not sampled effectively with minnow traps, but electrofishing indicated that these areas received considerable use. Steelhead fry were commonly associated with some type of cover such as debris, roots, vegetation and cobble, but catches were low in log jams. During SCUBA and snorkel observations in September 1982, fry were strongly associated with cover (81% of the observations). Fry were most often observed in shallow pools within one meter of overhanging rootwads, vegetation or log jams. Steelhead trout fry showed depth preferences of 10 to 80 cm and velocity preferences of 2 to 32 cm/s (Section G).

During the 1979-80 overwinter period, nearly 80% of the steelhead fry captured were in cobble greater than 20 cm in diameter in areas similar to that shown in Plate 5. These cobble areas were in deep, fast water from May to September. As water levels dropped during October and November, cobble areas became the channel margins, and a combination of shallow, low velocity water and good cover made these areas most suitable for overwintering fry. The other 20% of the fry were recovered in various areas offering debris and vegetation cover. Most fry were found in water less than 30 cm deep with water velocities generally not exceeding 15 cm/s. Shelf ice offered good cover in shallow cobble areas, as indicated by high November catches in such sites.

Steelhead Parr:

The 1979 CPUE data for steelhead parr indicated similar use of main and side channels, suggesting a wide distribution of parr throughout the various river channels during the year (Figure 3.5). Steelhead parr favoured areas with depths greater than 15 cm and water velocities ranging from 5 to 60 cm/s. Steelhead parr utilized a variety of habitats but were found most frequently in log jams (Plate 6) and did not use side pools or swamps. Parr were generally associated with some form of cover such as log jams, debris or cobble. Traps more than 2 m from some form of cover tended to have low catches.

Ages 3^+ and 4^+ steelhead in the Morice River probably occupy faster and deeper water than that reported above. Observations during 1982 boat electrofishing studies indicated that parr utilized stream habitat along the edge of fast current areas. They were commonly observed in the Bulkley River in edge areas with cobble and boulder substrate, back eddy areas and, to some degree, in log debris. Boat electrofishing was

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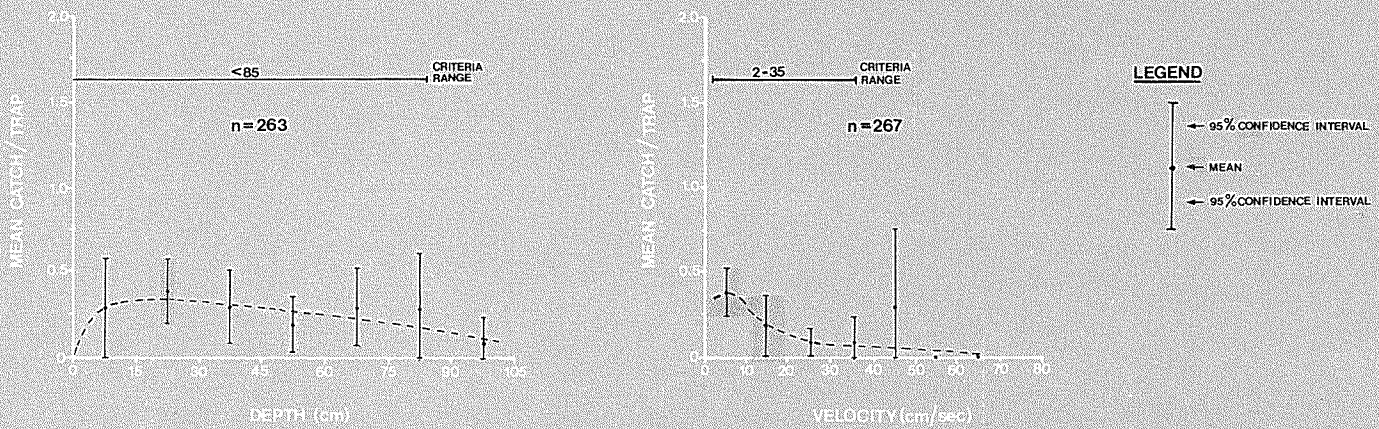
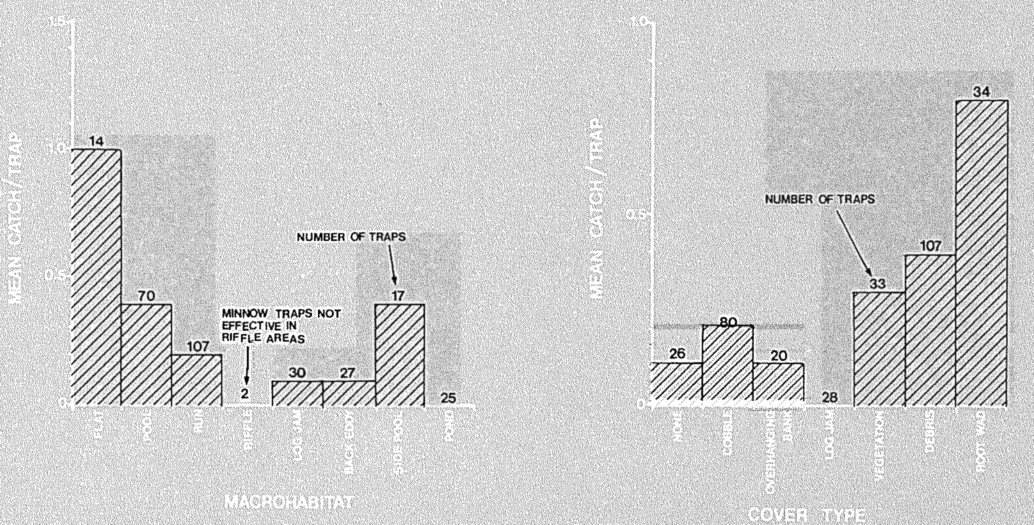
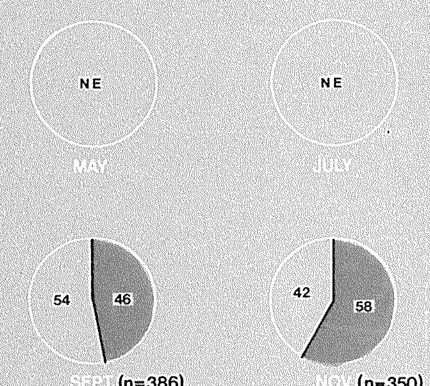
FIGURE 3.4

HABITAT PREFERENCES OF STEELHEAD FRY IN THE MORICE RIVER, SEPT., 1979





RELATIVE COMPARISON OF C.P.U.E. IN SIDE AND MAIN CHANNEL HABITATS FOR REACHES 1-6, MORICE RIVER



(note: expressed as a percentage of total C.P.U.E.)

LEGEND
- SIDE AND INTERMITTENT CHANNELS
- MAIN CHANNEL
- NE NOT EMERGED

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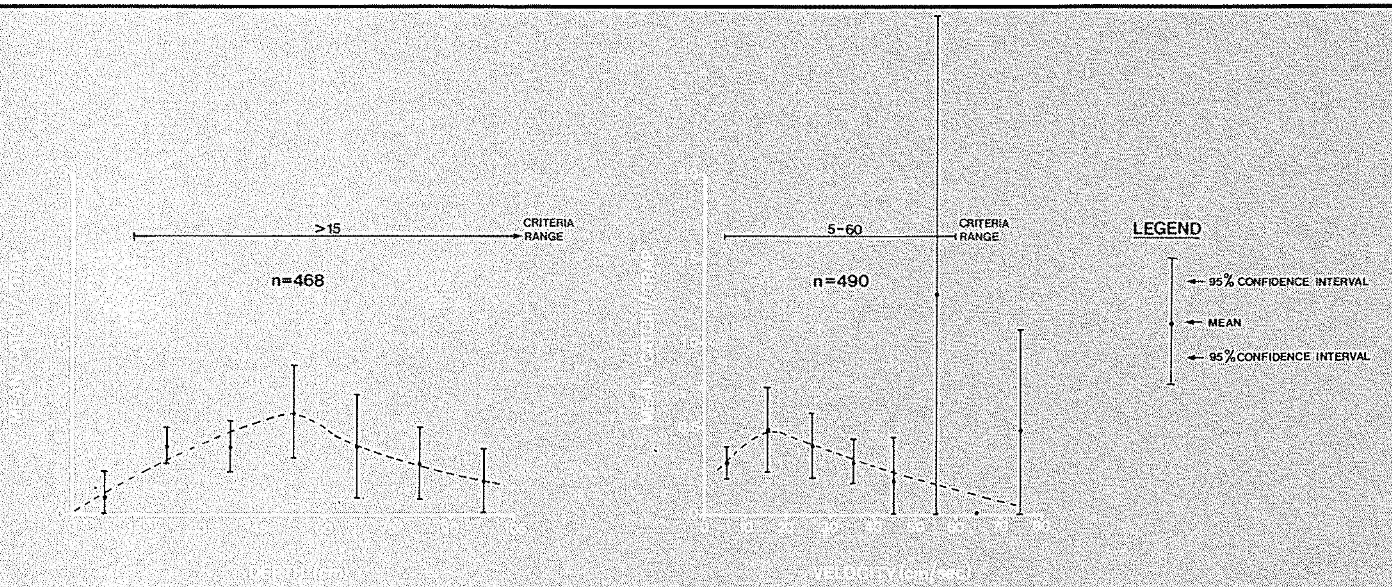
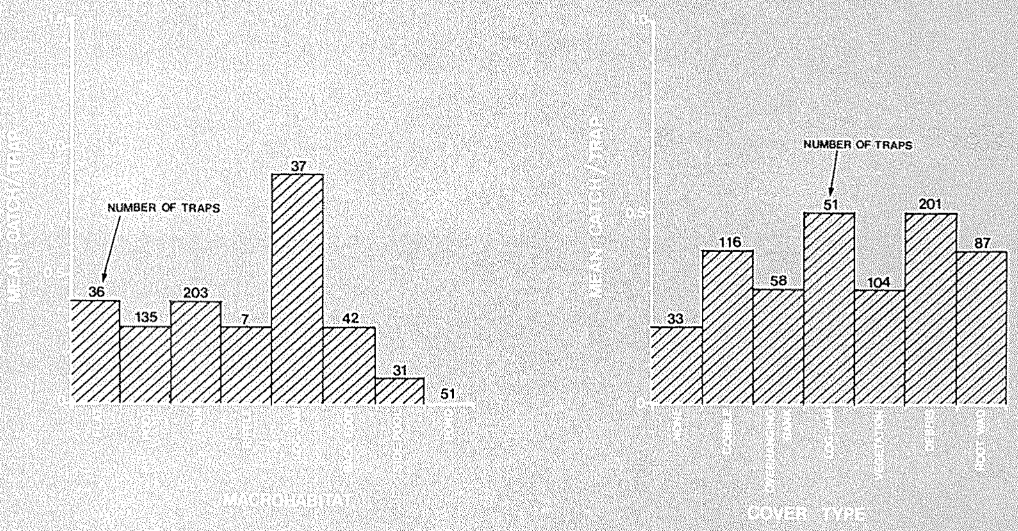
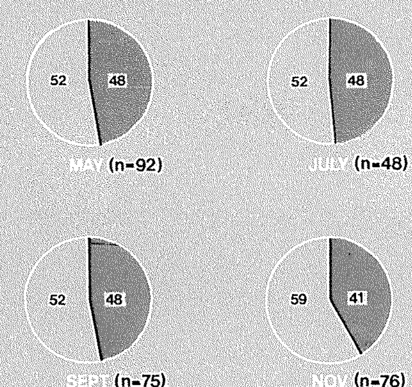
FIGURE 3.5

HABITAT PREFERENCES OF STEELHEAD PARR IN THE MORICE RIVER, JULY–SEPT., 1979





RELATIVE COMPARISON OF C.P.U.E. IN SIDE AND MAIN CHANNEL HABITATS FOR REACHES 1-6, MORICE RIVER



(note: expressed as a percentage of total C.P.U.E.)

LEGEND
- SIDE AND INTERMITTENT CHANNELS
- MAIN CHANNEL

Plate 5: Mainstem Morice River illustrating marginal cobble areas. As water levels drop during the fall, these sites provide good overwintering areas for steelhead and chinook fry.

Plate 6: Log jam in Reach 2 of Morice River. This type of area provides excellent rearing habitat for juvenile steelhead and salmon.

probably not as effective in complex log jam sites (Section F). Shepard and Algard (1977) reported that steelhead parr were found almost exclusively in log jams in the mainstem Morice during August. Their sampling technique (angling) tended to favour capture of older parr. Large log jams located in Reach 2 of the Morice River were sampled using SCUBA techniques in September 1982, when a number of parr were observed in the deeper, swifter areas of these habitats (Section G). Everest and Chapman (1972) have shown that, as juvenile steelhead grow, they move into faster and deeper water.

During the 1979-80 overwinter period, steelhead parr were found in areas with depths up to 50 cm, although some parr were caught in marginal areas less than 10 cm deep. Water velocities in these areas were generally less than 15 cm/s. Most parr (75%) were found in areas offering debris and log cover, with the remainder (25%) using cobble substrate. The substrate used tended to be larger than that used by steelhead fry, usually exceeding 40 cm in diameter.

The large numbers of log jams in the Morice River, and their reported importance to overwintering steelhead parr in other areas (Hartman 1965; Bustard and Narver 1975), suggests that they are important overwintering areas for larger steelhead parr in the Morice River. Higher gradient boulder areas on the lower Bulkley River may also serve as overwintering areas for steelhead parr, although this was not verified.

<u>Juvenile Steelhead Trout Summary</u>

Steelhead fry typically emerge in August and spend three to five years in the Morice and Bulkley system before migrating to the ocean as smolts. Rearing occurs throughout the mainstem of these rivers and in 15 of the Morice River tributaries examined. The 1979 surveys suggest that approximately 50% of steelhead fry rearing occurs in tributaries, with the remainder in the mainstem, particularly from Peacock Creek to Morice Lake. Steelhead parr catches were more widely distributed throughout the mainstem including downstream sites in the Bulkley River. Four Morice River tributaries - Owen Creek, Gosnell Creek, Thautil River, and Lamprey Creek -accounted for most of the tributary steelhead fry (85%) and parr (75%) catches.

In 1979, steelhead fry and parr CPUE were similar in side and main channel locations, suggesting a widespread distribution in the various channel types throughout the year. During the active feeding period, fry preferred shallower and lower velocity habitats than parr, and were commonly associated with instream cover such as root wads and debris accumulations in marginal shallows of the river. In 1979, parr were typically associated with log jams, debris, root wads and cobble cover. Observations during 1982 studies suggest that parr are primarily found along the river margin, and tend to favor the interface between slow and fast currents. During winter, steelhead fry were most commonly captured in shallow cobble areas along the river margin, while parr were typically found in areas with debris and log cover. The many log jams between Fenton and Gosnell Creeks may provide the most suitable wintering habitat for Morice River steelhead parr.

3.1.2 Coho Salmon

3.1.2.1 Adult Coho Salmon:

Adult coho first arrive at Moricetown Falls in late July, with peak migration occurring in the latter half of August (Palmer 1966). Coho salmon move into the Morice River between the middle of August and the end of September, with peak migration occurring from the end of August to early September (Shepherd 1979).

During the 1979 studies, the first coho arrived in the upper Morice River between August 8 and August 22. Low numbers were observed until the end of October (Appendix A3, Table A3.3). An increase in the number of coho observed in November suggests that coho either dropped back down out of Morice Lake or moved upstream from holding downriver.

Snorkel and aerial observations in 1979 indicated that coho spawning occurred predominantly in mid- to late November, and probably continued through December. Shepherd (1979) suggested that coho spawning peaks in mid-October, but noted that late spawning had been observed through to mid-December. Coho spawning has been observed in December beneath the ice in the Morice River near Owen Creek (pers. comm., R. Estabrooks, Alcan Smelters and Chemicals, Ltd (AS & C).

Water temperatures in the upper Morice River ranged from 4 to 7°C between November 1 to 20, 1979. These temperatures were similar to those recorded during November 1982. During the coho spawning period, the moderating influence of Morice Lake maintains these higher water temperature in the upper river. On November 26, 1979 the water temperature just below Morice Lake was 5 to 6°C, while the water temperature 30 km downstream was 2°C.

The long term average coho spawning escapement in the Morice River and tributaries is approximately 2,500 to 5,000 spawners (Tables 3.6 and 3.7). There is considerable discrepancy in the annual escapement estimates reported by the Department of Fisheries and Oceans and counts of adult coho migrants moving past the Alcon counting tower just below Owen Creek. The coho abundance estimates from both sources are crude due to the long duration of spawning, the widespread distribution of coho throughout the main river and tributaries, and limited visibility typical of the fall spawning period. An estimated spawning population of 4,000 coho salmon (Volume 15 Section I) spawns in the upper Morice River and its tributaries. This estimate is based on doubling the recent (1971-81) counts of mainstem coho spawners (2,000 fish) due to the difficulty of conducting accurate counts. DFO escapement records indicate that approximately 8% of the total coho escapement to the Skeena system spawn in the mainstem Morice River and its tributaries.

The 1979 run of coho was the lowest ever recorded at the Alcon counting tower, and was the second lowest count reported by the Department of Fisheries and Oceans. A total of 261 adult coho were counted in the Morice River during flights on November 26 and 27 (Figure 3.6). The low, clear water conditions provided excellent visibility for the survey. Most spawners (85%) were observed above Gosnell Creek, particularly in the 2 km of river immediately below Morice Lake. This was the same area utilized by large numbers of spawning chinook salmon during September. The remaining 15% were scattered, usually in side channels, between Fenton and Gosnell Creeks. This section of river was not identified as a coho spawning area by Shepherd (1979). At a discharge of 27 m3/s in late November 1979, few side channels offered suitable spawning flows, and 80% of all coho observed during the survey were spawning in the main channel.

Additional distribution information outlining specific coho salmon spawning locations based on subsequent surveys is presented in Appendix AS, Figure A5.2. Subsequent surveys of adult coho spawners were conducted from 1980 to 1983 (Appendix A5, Table A5.7). Although these surveys do not accurately reflect total numbers, they offer additional timing and distribution information and provide an index of relative abundance in the upper Morice River. These observations confirm the 1979 observations that peak coho salmon spawning probably occurs in late November, although it can extend from mid-October to late December depending on river location. Up to 500 coho salmon spawners were observed in the upper 4 km of the Morice River. Some side channels in Reach 2, with apparent groundwater influence, were identified as coho spawning sites.

TABLE 3.6
Estimate of the Numbers of Coho Salmon Spawners in the Morice River from 1956 to 1982

Year	Fisheries [1] and Oceans	Alcan [2]	Year	Fisheries and Oceans	Alcan
1956	10,000-20,000	2,000	1970	2,500	1,700
1957	2,000-5,000	900	1971	3,000	3,500
1958	2,000-5,000	5,100	1972	3,500	1,200
1959	2,000-5,000	3,500	1973	4,000	3,200
1960	5,000-10,000	700	1974	3,000	1,600
1961	1,000-2,000	1,100	1975	30	2,800
1962	1,000-2,000	2,800	1976	NR [4]	500
1963	1,000	4,300	1977	4,000	1,600
1964	1,000	1,300	1978	3,000	900
1965	1,500	6,000	1979	300	200
1966	1,500	2,700	1980	1,600 [5]	2,500
1967	2,500	5,900	1981	500 [5]	800
1968	2,500	4,200	1982	NR [4]	1,850
1969	3,000	3,700			
Mean [3] (1956-1970)	3,433	3,060			
Mean (1971-1981)	2,293	1,609			
Mean (1956-1981)	2,977	2,415			

1 Hancock et al. 1983

2 Farina 1983. These estimates are based on tower counts near Owen Creek

3 When range is given, the mean of the range was used in calculating means

4 Not reported

5 Department of Fisheries and Oceans, Smithers, B.C.

TABLE 3.7
Estimates of the Numbers of Coho Salmon Spawners in Three Morice River Tributaries Between 1956 and 1970[1]

Year	Gosnell Creek	Thautil River	Owen Creek
1956	4,000	NR	400
1957	1,500	NR	200
1958	3,500	NR	200
1959	3,500	NR	400
1960	1,500	NR	200
1961	1,500	NR	NR
1962	NR[2]	NR	300
1963	1,000	NR	400
1964	500	NR	200
1965	1,000	NR	200
1966	1,000	300	50
1967	1,200	200	NR
1968	1,500	300	200
1969	1,000	300	60
1970	1,000	300	100
Mean	**1,690**	**280**	**225**

Mean tributary spawning for those years reported = 2,030

1 Hancock et al. 1983. Escapement estimates for these tributaries have not been reported since 1970 except in 1980 with an estimate of 1,600 spawners

2 N0t reported

In 1979, adult coho were observed in Gosnell and Houston Tommy Creeks during September and October. These two tributaries and the Thautil River were the only Morice tributaries with sufficient discharge for coho salmon migration. McBride Creek, normally considered a major coho producer (Shepherd 1979), was inaccessible due to low flows. In a low flow year such as 1979, all coho spawning probably occurred in the mainstem Morice River, Gosnell and Houston Tommy Creeks and the Thautil River. Based on many years of salmon observations in the Morice River, R. Estabrooks (pers. comm., AS & C) suggests that during years when fall freshets provide adequate flows for access, most coho spawn in tributaries. When autumn flows are low, mainstem spawning predominates.

3.1.2.2 Juvenile Coho Salmon:

Data on age and growth of juvenile coho salmon, the distribution and abundance of juveniles in the Morice River and its tributaries, and juvenile habitat preferences within the main river system are presented in this section.

Age and Growth of Juvenile Coho Salmon

Juvenile coho are separated into two age categories in the following discussion based on fork length (Appendix AS, Figure AS.1). The smallest fish, which were in their first summer, are referred to as fry (age 0^+), and those in their second season are referred to as yearlings (age 1^+). Some coho captured in the spring of their third growing season prior to smolting are included with yearlings.

Coho fry emergence begins in mid-May, peaks in June, and continues into early July. The extended period of emergence reflects the lengthy duration of adult spawning. Analyses of scales from returning adults indicate that Morice River coho remain in freshwater for one (75%) or two (25%) winters prior to smolting (Shepherd 1979). In 1979, the mean length of a sample of coho fry entering their first winter was 61 mm, while yearlings which entering their second winter in the Morice averaged 87 mm (Appendix A5, Table A5.2). Fork lengths of 41 coho smolts captured during May 1979 in Owen Creek and Mile 18 pond ranged from 70 to 96 mm (Section D). Coho smolts from side channels of Reach 2 collected on May 15 and 16, 1982, had mean fork lengths of 84 mm for age 1^+ smolts and 94 mm for age 2^+ smolts (N = 86 and 3, respectively). Mile 18 Pond was sampled for coho smolts from May 28 - June 8, 1982, and fork lengths were 118 mm for age 1^+ smolts and 127 mm for age 2^+ smolts (N = 50 and 14 respectively) (Section D). Morice coho smolts migrate seaward between late April and July (Shepherd 1979). In 1979, the peak coho smolt movement out of

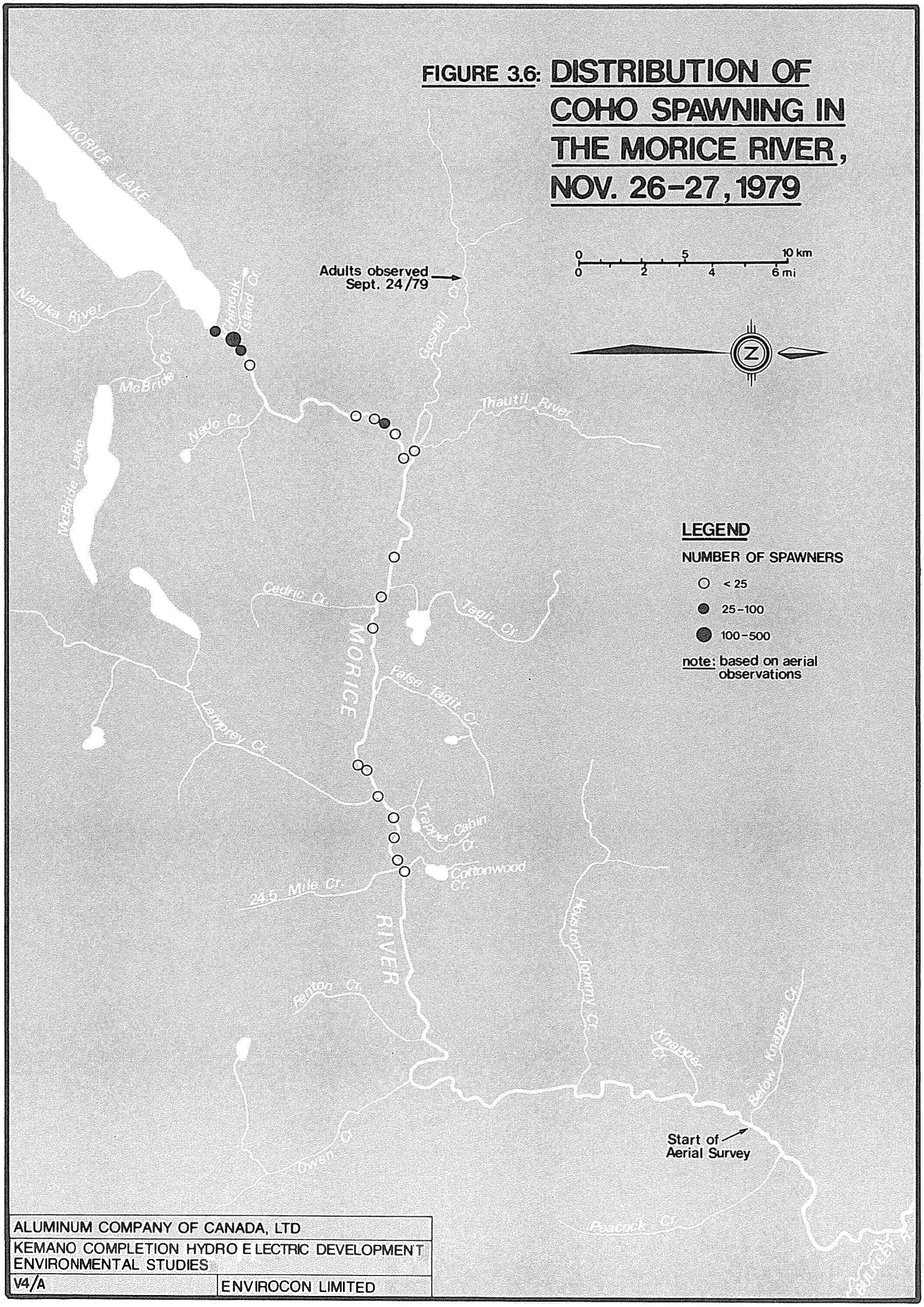


FIGURE 3.6: DISTRIBUTION OF COHO SPAWNING IN THE MORICE RIVER, NOV. 26-27, 1979
0 5 10 km
0 2 4 6 mi
Adults observed Sept. 24/79
MORICE LAKE
Nanika River
Chinook Cr.
Island Cr.
McBride Cr.
McBride Lake
Nado Cr.
Gosnell Cr.
Thautil River
LEGEND
NUMBER OF SPAWNERS
< 25
25-100
100-500
note: based on aerial observations
Cedric Cr.
Tagit Cr.
MORICE
False Tagit Cr.
Lamprey Cr.
Trapper Cabin Cr.
Cottonwood Cr.
24.5 Mile Cr.
RIVER
Houston Tommy Cr.
Fenton Cr.
Knapper Cr.
Below Knapper Cr.
Start of Aerial Survey
Owen Cr.
Peacock Cr.
BULKLEY R.
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McBride Creek occurred from late May to mid-June (Smith and Berezay 1983). Additional information on size, weight and downstream migration timing for coho salmon in the Morice River and several tributaries is presented in Smith and Berezay (1983).

Distribution and Abundance of Juvenile Coho Salmon

Juvenile coho were found in 15 tributaries of the Morice River and throughout the mainstem Morice and Bulkley Rivers (Figure 3.7). Juvenile coho also rear in McBride and Morice Lakes (Shepherd 1979). More detailed information describing fry and yearling catches during four sample periods in the mainstem and tributary sites is presented below; in Appendix A5, Tables A5.3 and A5.4; and in Sections Band J.

Coho Fry:

The 1979 electrofishing CPUE of coho fry was greatest in the upper two reaches of the Morice River and in Reach 6 in the vicinity of Telkwa (Table 3.8). The highest catches were in reaches with abundant channels, instream cover, and side pool areas. If catch estimates are corrected for total channel length (side and main channels) per reach, an estimated 68% of the main river coho fry rearing occurs in the upper two reaches of the river. The braided channel section between Fenton and Gosnell Creeks (Reach 2) accounts for more than half (57%) of the main river coho fry rearing. Reach 2 probably accounts for more of the rearing than indicated since ponds adjacent to the main river channel in this reach are productive coho areas, but pond and stream CPUE could not be compared due to different sampling techniques. Overall, the relative distribution by reach of rearing coho fry in 1981 and 1982 was very similor to that determined in 1979 (Sections B and J).

Based on electrofishing data collected during 1980, 1981 and 1982, mean densities of coho fry from mainstem and side channel habitats combined were estimated to range from a low of 0.06 fry/m^2 in 1982 (Section J) to a high of 0.16 fry/m^2 in 1981 (Tredger 1983). The mean density of coho fry (0.10 fry/m^2) captured in side channels alone during 1982 compares more favourably to the B.C. Fish and Wildlife estimates (Tredger 1983) for all habitat types combined.

Approximately 86% of the total estimated coho fry rearing in tributaries in 1979 occurred in three tributaries: Gosnell Creek (49%), Houston Tommy Creek (20%) and McBride Creek (17%) (Table 3.9). Houston Tommy Creek rearing estimates may be high as only one reach was sampled and extrapolated to a lower canyon reach which has poorer potential coho habitat than the area sampled. Coho fry rearing in McBride Lake (Shepherd 1979) were not incorporated into the McBride Creek estimates, thus production for this tributary was probably underestimated. Relatively high minnow trapping and electrofishing catches during the spring and summer suggest that Owen Creek may be a more important producer of coho fry than indicated by the low fall catches which were used in the comparisons (Table 3.9 and Appendix A5, Tables A5.3 and A5.4). B.C. Fish and Wildlife estimates of coho fry densities in three tributaries studied during 1980 and 1981 (Gosnell, Lamprey and Owen Creeks) ranged from a mean of 0.11 fry/m^2 for Gosnell Creek in 1980 to 0.49 fry/m^2 in Owen Creek for both years (Tredger 1983).

The catch results corrected for channel length suggest that in 1979 approximately 67% of the coho fry rearing occurred in tributaries and 33% in the mainstem river from Driftwood Creek to Morice Lake. The low flows in the autumn of 1979 may have increased electrofishing efficiencies in tributaries, resulting in an overestimate of the proportion of tributary coho rearing. Further, comparisons of main river and tributary rearing catches do not incorporate coho catches in ponds in either tributaries or main river areas. These two factors could affect estimates of the percentage of fry rearing in the main river and tributaries. Mundie (1969) suggested that coho fry most commonly occupy small streams since these streams possess a higher proportion of marginal slack-water suitable for coho feeding than larger river systems.

Yearling Coho Salmon:

In 1979, the highest catches of yearling coho were in Reaches 2 and 6, which offered abundant side channels, instream cover and side pool habitat. This is based on September minnow trapping (Appendix A5, Table A5.4) since electrofishing was not an effective method of sampling coho yearlings. Because minnow traps were not set in most tributaries, and the electrofishing sample size is small, mainstem and tributary catches have not been compared. Coho yearling tributary catch data are given in Appendix A5, Table A5.6.

<u>Ponds</u>

Ponds and slough-like areas adjacent to the main river channel provide rearing habitat for significant numbers of coho juveniles. The catches of coho yearlings in two ponds sampled in 1979 were an order of magnitude greater than in the main river or tributaries (Figure 3.8). These results are based on minnow trap catches in two pond areas designated Mile 18 pond (Plate 7) and Mile 28 Pond. These ponds are

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FIGURE 3.7

DISTRIBUTION AND ABUNDANCE OF JUVENILE COHO IN THE MORICE AND BULKLEY RIVERS, SEPT.-NOV.,1979

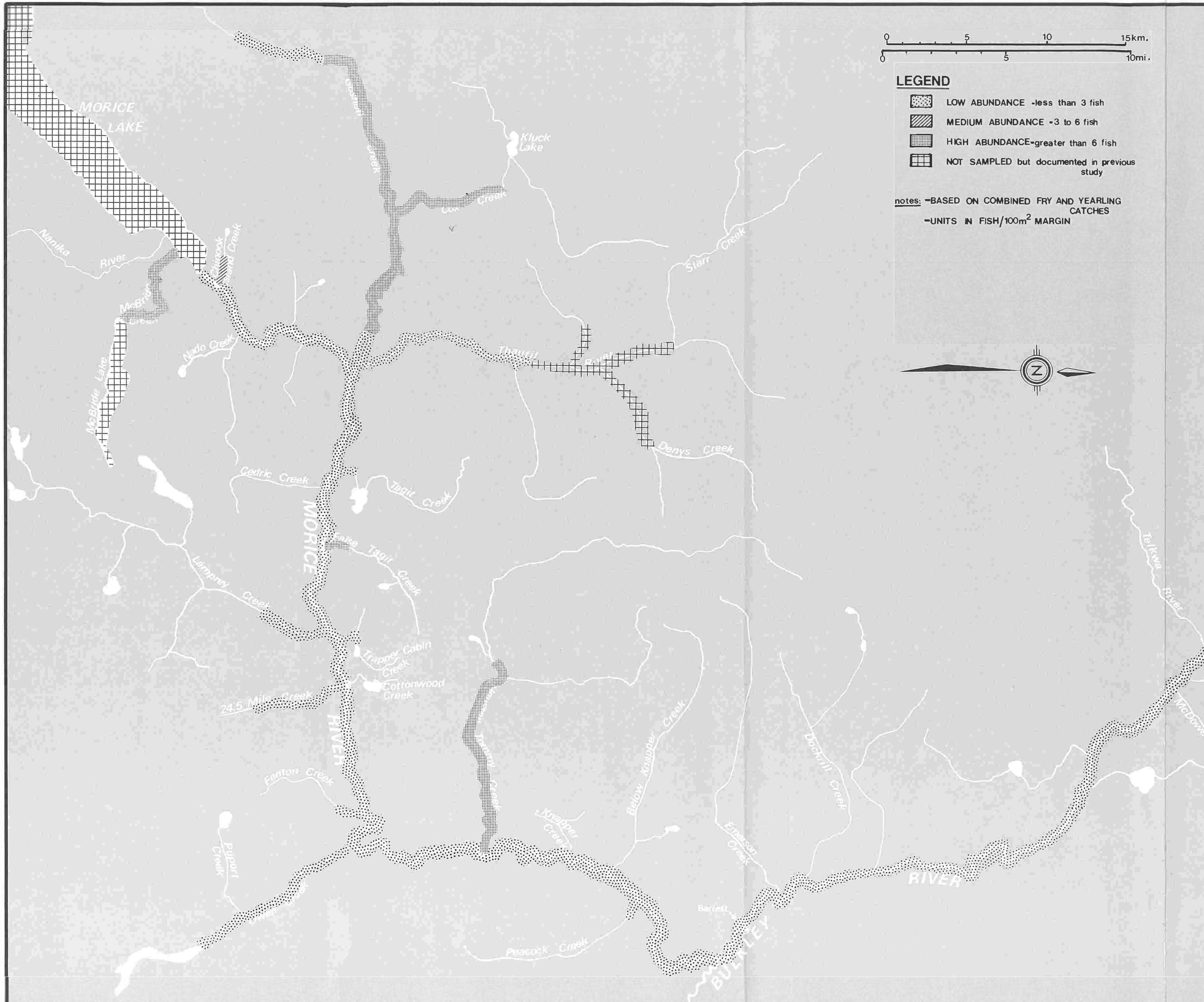

TABLE 3.8
Summary of Coho Fry Electrofishing Catches by Reach in the Morice and Bulkley Rivers in September and November 1979,[1] and a Comparison of Main River and Tributary Abundance Estimates

Reach	Area of Margin Electrofished (m^2)	Channel[2] Length (km)	Fish/100 m^2 of Margin	Channel Length x Catch	Weighted Distribution (%)
1	1,160	25.6	1.3	33.3	10.9
2	6,863	159.5	1.1	175.4	57.3
3	1,632	33.1	0.1	3.3	1.1
4	1,128	36.7	0.6	22.0	7.2
5	1,134	47.2	0.2	9.4	3.1
6	1,043	57.1	1.1	62.8	20.5
Total catch estimate for Reaches 1 to 6				306.2	32.9
Total tributary catch estimate (Appendix A5, Table A5.5)				625.8	67.1

1 Refer to Section J, Table 4.1 for a summary comparison of coho fry distribution, 1979-82

2 Combined length of main and side channels

TABLE 3.9
Summary of Calculated Coho Fry Abundance in Morice River Tributaries[1], 1979

Tributary	% OF OVERALL TRIBUTARY ABUNDANCE Fry
Gosnell Creek	49.1
Houston Tommy Creek	20.0
McBride Creek	17.0
Thautil Creek	6.3
False Tagit Creek	3.4
Lamprey Creek	2.1
Owen Creek	0.7
Cottonwood	0.6
24.5 Mile Creek	0.6
Tagit Creek	0.1
Chinook Island Creek[2]	0
Peacock Creek	0
Trapper Cabin Creek	0
Fenton Creek	0
Atna Creek[3]	-

1 Based on sampling during September and October 1979, and does not include the Nanika River (See Appendix A5, Table A5.5 for detailed calculations)

2 Only yearlings captured

3 Fry present but in low abundance

FIGURE 3.8: SUMMARY OF MINNOW TRAP CATCHES OF JUVENILE COHO IN PONDS, TRIBUTARIES AND MAINSTEM OF THE MORICE AND BULKLEY RIVERS, 1979

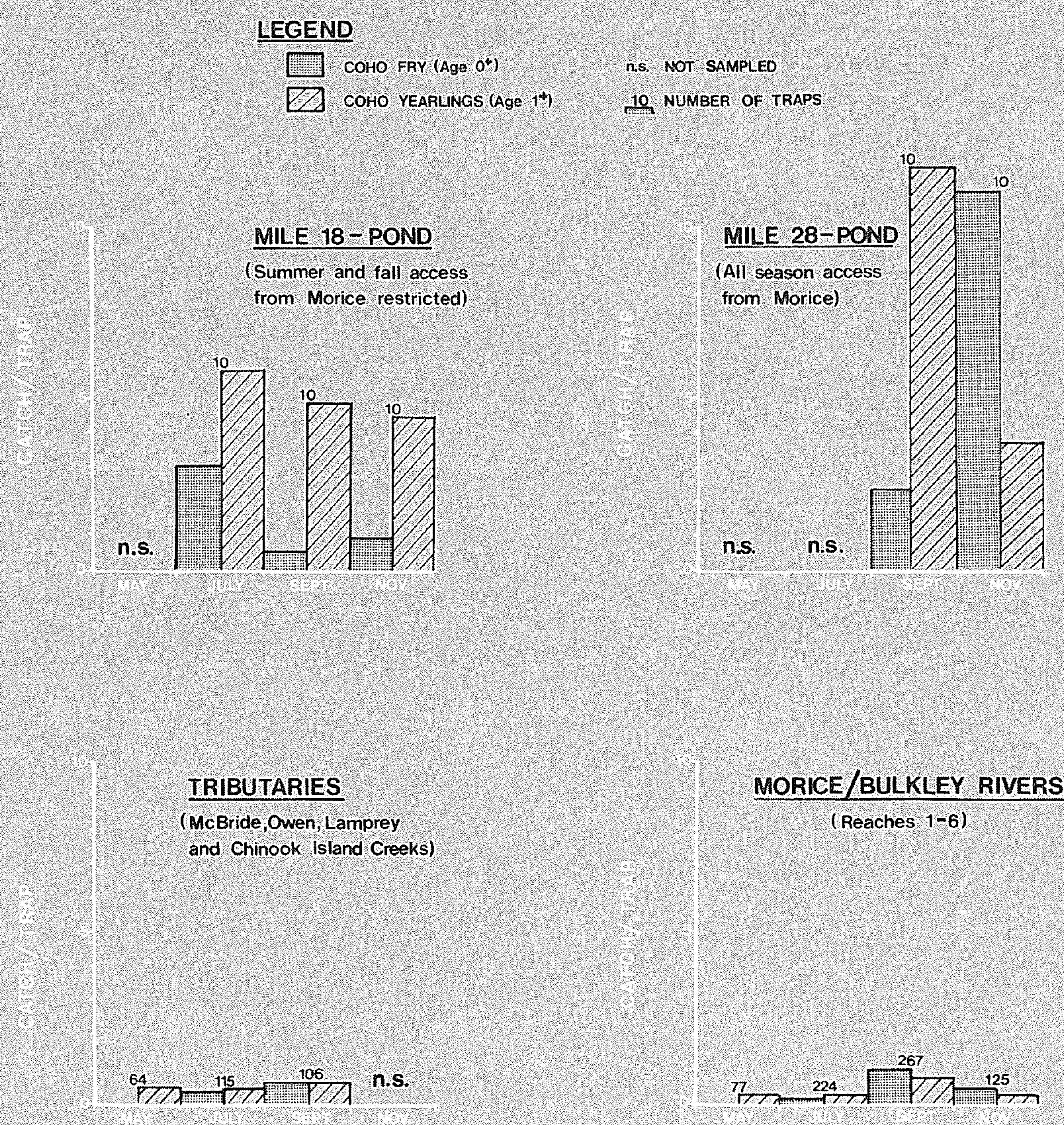

Plate 7: Mile 18 Pond offers important juvenile coho rearing habitat adjacent to the Morice River.

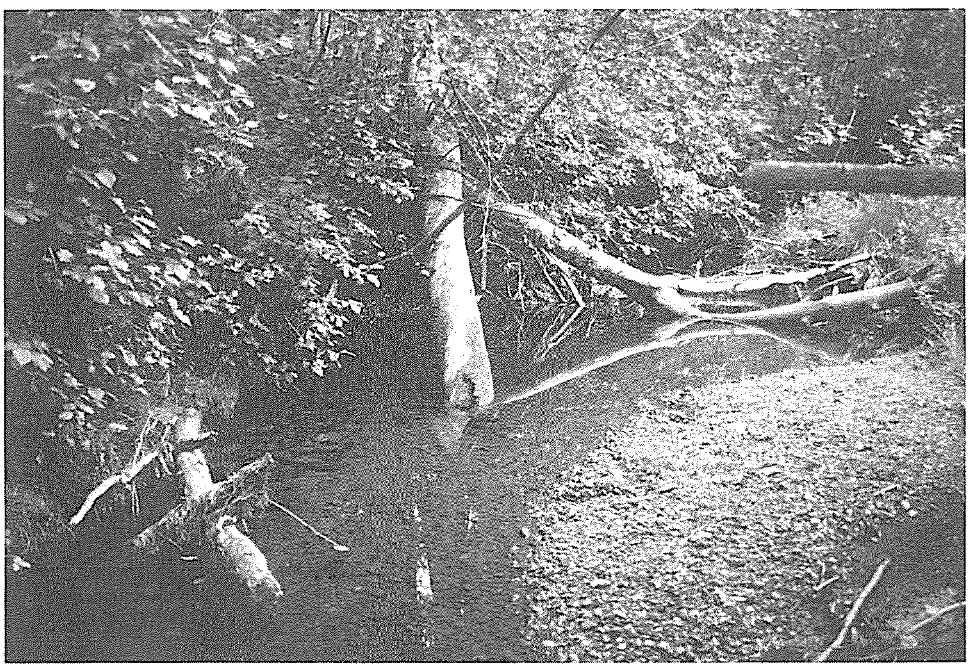

Plate 8: A side channel of the Bulkley River which offers good summer rearing habitat but dewaters in September stranding coho salmon, steelhead trout and Dolly Varden char juveniles.

representative of extensive similar areas occurring throughout Reach 2 and the Gosnell and McBride Creek drainages. In Reach 2, more than 20 ponds in old river channels may be accessible to fish from the main river.

The ponds and their outlet streams provide a favorable feeding environment earlier in the spring than in the main river. Water temperatures in a small creek draining Mile 18 Pond were 11 to 12°C in early May, while main river temperatures were 3 to 4°C. Sixty yearling coho (including 30 smolts), and newly-emerged coho fry were electrofished in a 40-m section of this small creek, indicating high use during this period.

Smolt emigration and juvenile coho immigration into Mile 18 Pond was observed in 1982, using a fence trap in the small outlet stream (Section D). Major movements were restricted to a short period in May and June, shortly after ice break-up on the pond, when water temperatures were greater than 5°C. The immigration of more than 650 juvenile coho into Mile 18 Pond (0.5 hectare in area) coincided with rapidly rising flows in the Morice River, suggesting that these juveniles were avoiding freshet conditions in the mainstem river (Section D). In coastal pond and slough systems, immigration typically occurs from September to January, coinciding with freshets resulting from winter rains (Cedarholm and Scarlett 1981; Tschaplinski and Hartman 1983).

An increase in fry catches in Mile 28 Pond and a decrease in the main river electrofishing catches between September and November 1979 suggests that some coho move into these pond areas as winter approaches (Figure 3.8). Similar behaviour has been noted in Carnation Creek (Bustard and Narver 1975) and in Washington streams (Peterson 1980) where marked yearlings moved as much as 33 km downstream into spring-fed pond areas. Both studies reported higher overwinter survival rates in ponds. A large number of coho can overwinter in a relatively small area as indicated by the overwintering of 3,000 coho smolts in a pond 1 hectare in area in the Washington study.

Habitat Preferences of Juvenile Coho Salmon

This section describes habitat preferences of coho fry and yearlings in the Morice River based on observations and measurements made at electrofishing and minnow trapping sites in the mainstem river.

Coho Fry:

The 1979 electrofishing CPUE (expressed as a percentage of total CPUE) of coho fry indicated higher use of side channel areas (81 to 88%) than main channel sites (12 to 19%) during July and September, suggesting that side channel areas (Plate 8) are highly important to coho fry rearing (Figure 3.9). The November sample size is too small for a reliable comparison of channel use. Electrofishing results from October 1981 and 1982 indicated 77 to 89% of the Reach 2 coho population reared in side channels as opposed to mainstem habitat (Sections B and J).

During their active period, coho fry were most commonly captured in low velocity areas (0 to 15cm/s) with depths greater than 15 cm. Areas such as side pools, ponds, pool habitat in side channels, flats along the channel margin and log jams were commonly used. Coho fry were usually associated with some form of cover, particularly debris, root wads and vegetation. Traps set in areas with cobble cover produced low catches. During snorkel observations in September 1982, virtually all coho salmon fry (99.6%) were associated with cover within 2m. Most coho fry observed occupied back eddies and pools in side channels with depths ranging from 10 to 120 cm and low velocities of 2 to 28 cm/s (Section G).

Overwintering studies in selected Reach 2 side channels in 1981-82 indicated an average 52% survival rate of juvenile coho (Section C). Juvenile coho salmon overwinter survival was higher than that reported for steelhead trout, probably a result of the tendency of coho salmon to occupy deep pool habitat with debris cover. These areas are less subject to dewatering during the low-flow winter period than the shallower sites typically used by juvenile steelhead.

Coho Yearlings:

The 1979 CPUE of yearlings during July and September indicated a greater use of side channel (66 to 71%) than main channel sites (29 to 34%), suggesting that side channels are important to yearling coho (Figure 3.10). May and November sample sizes were too small to permit a reliable comparison of side and main channel use.

During the active period, coho yearlings tended to occupy low velocity (0 to 15 cm/s) areas greater than 30 cm in depth. Ponds, log jams and side pools were preferred rearing areas. Yearlings made more use of log jams and less use of shallow flat areas than fry. Areas offering cover such as roots, log jams and debris accumulations were favored, with few fish found in cobble cover areas.

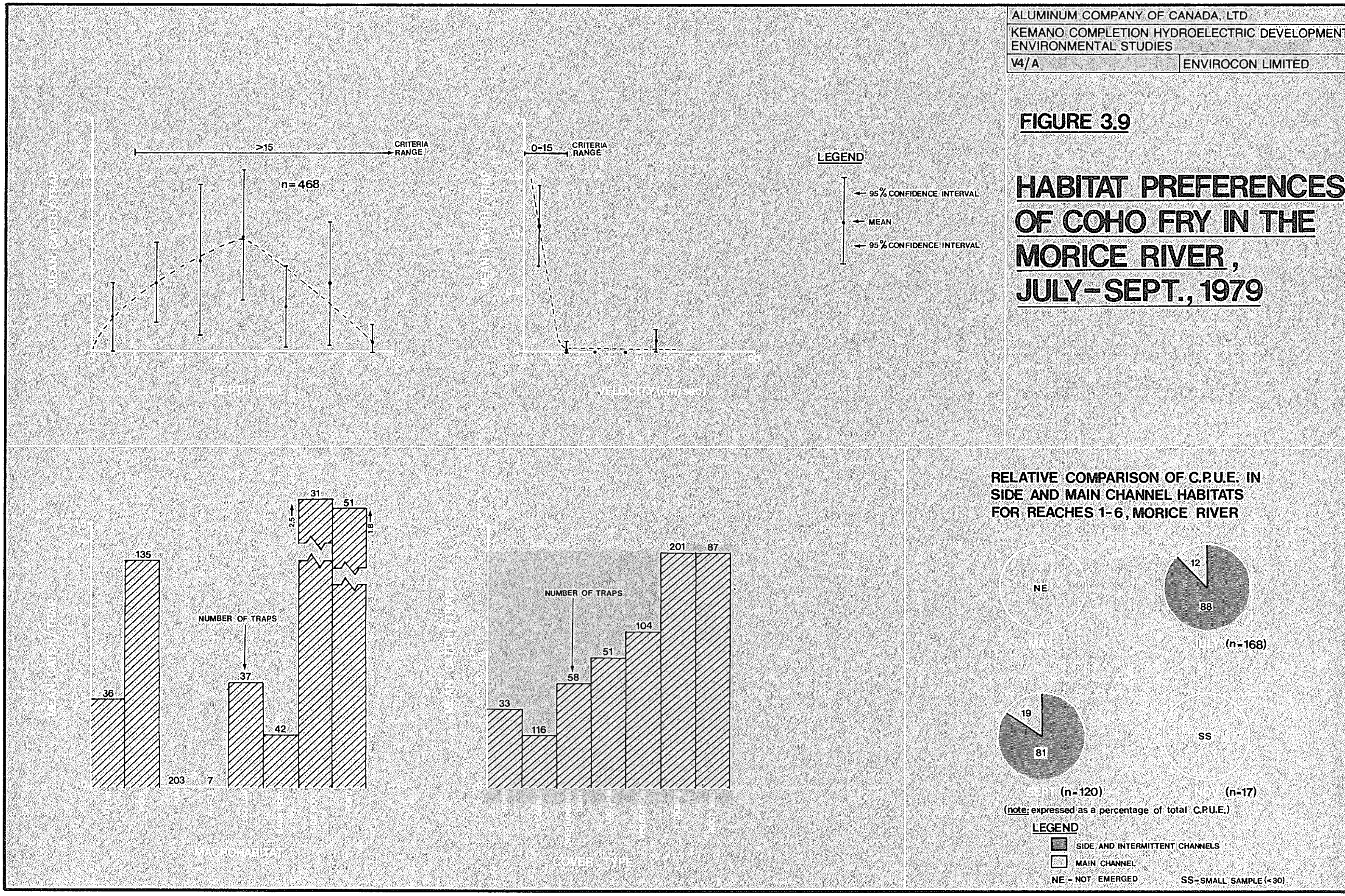

FIGURE 3.9

HABITAT PREFERENCES OF COHO FRY IN THE MORICE RIVER, JULY-SEPT., 1979

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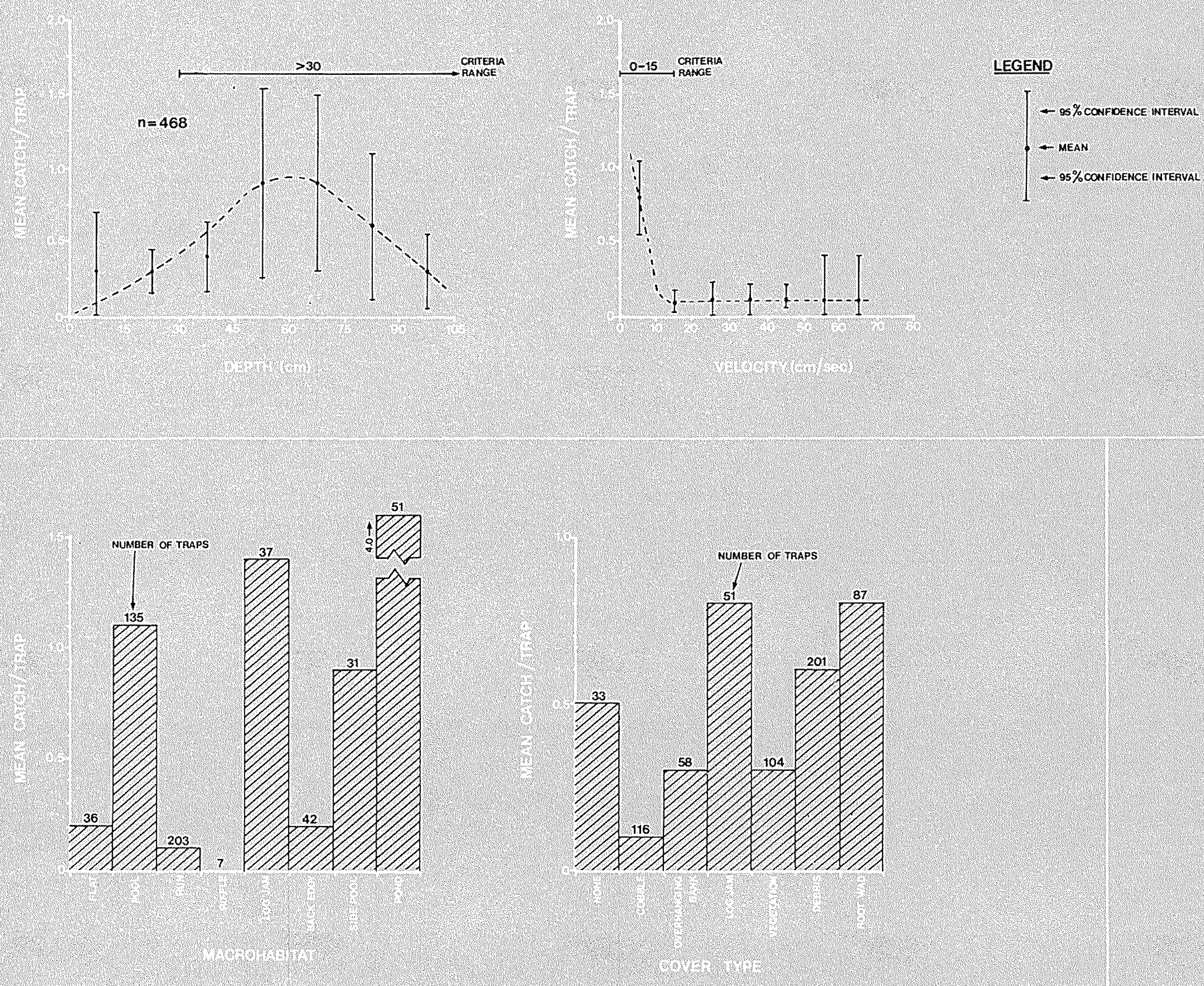
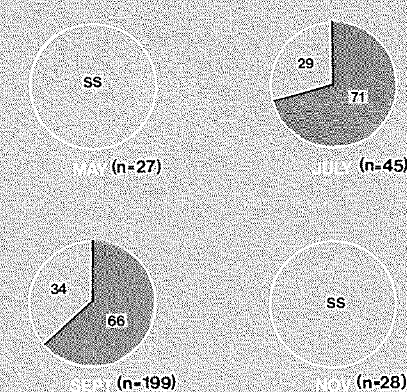
FIGURE 3.10

HABITAT PREFERENCES OF COHO YEARLINGS IN THE MORICE RIVER, JULY-SEPT., 1979



RELATIVE COMPARISON OF C.P.U.E. IN SIDE AND MAIN CHANNEL HABITATS FOR REACHES 1-6, MORICE RIVER



(note: expressed as a percentage of total C.P.U.E.)

LEGEND

- SIDE AND INTERMITTENT CHANNELS
- MAIN CHANNEL
- SS - SMALL SAMPLE (<30)

The many log jams present in the Morice River probably offer important overwintering habitat for yearling coho. Hartman (1965) found large concentrations of coho using log jam cover in the Chilliwack River during the winter.

Juvenile Coho Salmon Summary

Coho fry emerge from mid-May through early July. Most coho reside in the Morice and Bulkley River systems for one year prior to smolting, although a small proportion remains for two years.

The 1979 studies suggested a more widespread distribution of juvenile coho rearing in tributary streams than reported by Shepherd (1979). Approximately 67% of coho fry rearing occurred in tributaries and 33% in the mainstem river, particularly from Fenton Creek to Morice Lake. Three tributaries - Gosnell, Houston Tommy and McBride Creeks - accounted for most of the tributary coho fry catches (86%). The distribution of coho is probably largely influenced by the accessibility of tributary streams to adult spawners during the fall since low autumn tributary flows can apparently limit tributary spawning. Pond areas in old river channels offer important rearing areas in the Morice River and several tributaries.

A comparison of CPUE suggests that juvenile coho salmon have a strong year-round preference for side channels offering low velocities and instream cover such as debris and vegetation. Yearling coho were found in deeper water areas and were more commonly associated with log jams than were fry.

3.1.3 Chinook Salmon

3.1.3.1 Adult Chinook Salmon:

This section summarizes information from Shepherd (1979) and Neilson and Geen (1981) describing the timing of chinook salmon migration and spawning as well as spawner abundance and distribution data.

Chinook salmon migrate into the Morice River from July through late September. The peak of migration past the Alcan counting tower near Owen Creek occurs in the first two weeks of August (Shepherd, 1979). In 1979, adults first reached the upper Morice River between July 19 and August 8 (Appendix A3, Table A3.3).

Maturing adults hold in deep pools in the Morice River and in Morice Lake prior to spawning. Several hundred chinook were observed holding in Morice Lake near the river outlet from September 5 to 20, 1979. Adult chinook were angled in Morice Lake from late July through September, usually near the lake outlet. However, a number of fish were angled in Atna Bay and at the south end of Morice Lake.

Spawning extends from the first week of September to the first week of October, with a peak occurring between September 10 and 20. Water temperatures during the peak spawning period in 1979 ranged from 12 to 14°C.

The 1961 to 1982 average chinook spawning escapement in the Morice River is approximately 5,700 spawners (Table 3.10). Escapement estimates are based on aerial counts conducted by the Department of Fisheries and Oceans, and on counts conducted by Alcan. Alcan estimates prior to 1961 were based only on tower counts, which were consistently lower than aerial counts on the spawning grounds (Neilson and Geen 1981). Thus, only data from 1961 onward (i.e., the period of aerial counts) are presented. Aerial counts are a more reasonable index of abundance of chinook salmon spawners than discussed above for coho salmon since chinook spawning is concentrated in space and time, spawners are larger and more visible, and water conditions are clearer during spawning.

The estimated 5,700 annual mean spawning escapement (Alcan Tower Counts 1961-82) for chinook salmon probably underestimates the actual escapement. This conclusion is based on a spawning study conducted during September 1979 (Neilson and Geen 1981). Several "waves" of chinooks used the same spawning areas, with residence time on the spawning grounds decreasing as the spawning period progressed. Although the maximum aerial count of adult spawners was 2,330, the estimate of the total population was 4,269, nearly 1.83 times the maximum aerial count. A similar residence time study was conducted in 1982 with a spawning escapement estimate of 1.67 times the maximum helicopter count (Farina 1983). The existing chinook spawning population was estimated at 8,000 fish. This was derived by multiplying the 1971-82 mean escapement (4,575) by a mean residence time factor (1.75) resulting in a revised estimate of approximately 8,000 chinook. Based on DFO escapement records, Morice River chinook salmon represent approximately 25% of the total escapement of chinook salmon to the Skeena system.

Nearly all chinook spawning occurs in the main channel of the Morice River between Lamprey Creek and Morice Lake, with the greatest concentration of spawners in the upper section of the Morice River just downstream of Morice Lake (Plate 9)

TABLE 3.10
Estimate of the Number of Chinook Salmon Spawners in the Morice River from 1961 to 1982

Year	Fisheries and Oceans[1]	Alcan[2]	Year	Fisheries and Oceans	Alcan
1961	3,500	5,500	1971	4,200	3,500
1962	4,000	2,880	1972	8,400	4,200
1963	7,500	8,700	1973	12,000	6,300
1964	5,000	6,300	1974	9,000	9,500
1965	5,000	11,000	1975	2,500	5,300
1966	6,000	6,500	1976	1,700	1,600
1967	12,000	11,000	1977	4,500	5,800
1968	7,000	7,000	1978	6,000	4,500
1969	5,000	7,500	1979	4,030	3,400
1970	4,600	4,600	1980	4,500	5,400
			1981	3,000	3,350
			1982	3,000	2,053

Summary of Spawner Estimates

	Fisheries & Oceans	Alcan
Mean[3] (1961-1970)	5,960	7,098
Mean (1971-1982)	5,236	4,575
Mean (1961-1982)	5,565	5,721

1 Hancock et al. (1983)

2 These estimates are based on the single highest helicopter count without a residence time factor applied (Farina 1983)

(Figure 3.11). At the peak of spawning, 63% of chinook salmon spawners were observed in the upper 4 km of the Morice River. Another 23% were located between Gosnell Creek and a point 4 km downstream of Morice Lake, and an estimated 14% were spawning between Lamprey and Gosnell Creeks. A detailed breakdown of chinook salmon spawner distribution based on 1982 observations is presented in Figure 3.11.

3.1.3.2 Juvenile Chinook Salmon:

This section describes the age and growth of juvenile chinook salmon, their distribution and abundance in the Morice River, and their habitat preferences.

Age and Growth of Juvenile Chinook

Chinook salmon fry emergence occurs in early April, peaks about the third week and is 90% complete by late April. This information, based on two years of downstream trapping studies (Smith and Berezay 1983), indicates that most chinook emergence occurs up to a month earlier than reported by Shepherd (1979). Newly-emerged chinook fry were observed in the vicinity of redds in the upper Morice as early as March 20.

Smith and Berezay (1983) estimated populations of 1.5 million and 3.4 million downstream migrant chinook fry in 1979 and 1980, respectively. Calculated egg to fry survival rates were 12.5% and 23.7% in 1979 and 1980, respectively. These high survival rates were attributed to the spawning gravel quality and the moderating effect of Morice Lake on water temperature and discharge rates.

Some chinook salmon leave the Morice as smolts during September and October of their first summer, while others remain in the Morice and Bulkley Rivers during the winter and smolt the following spring. Shepherd (1979) reports that 35% of Morice River chinook adults had smolted in their first season (age 0^+) and 65% had smolted as yearlings (age 1^+). Approximately 30% of the September 1979 juvenile chinook sample appeared to be smolts and ranged from 75 to 95 mm in length (Figure 3.12). The remaining 70% presumably spend the winter in freshwater since these smaller fish must add some growth prior to smolting. Subsequent age analysis of adult Morice River chinook scales based on an additional three years of data indicates that returning adults were predominantly from juveniles which had one year freshwater rearing (Smith and Berezay 1983). However, the 1978 escapement was predominantly from fish which had smolted in their first season.

Plate 9: The major chinook salmon spawning area in the Morice River illustrating salmon redds during September.

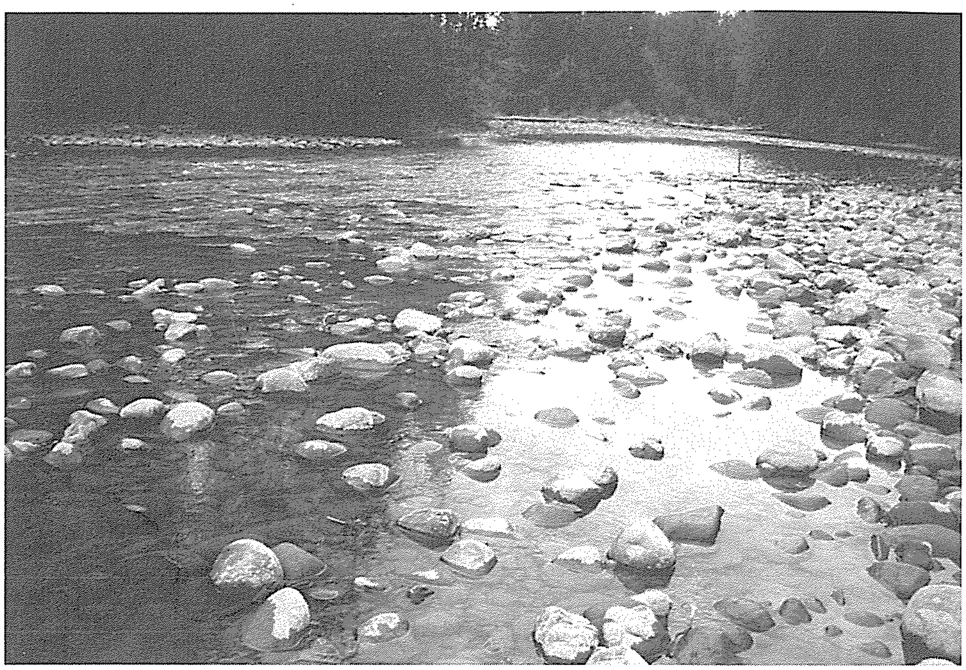


Plate 10: Morice River side channel offering excellent rearing for chinook and steelhead fry during the summer but is often dry by the late winter.

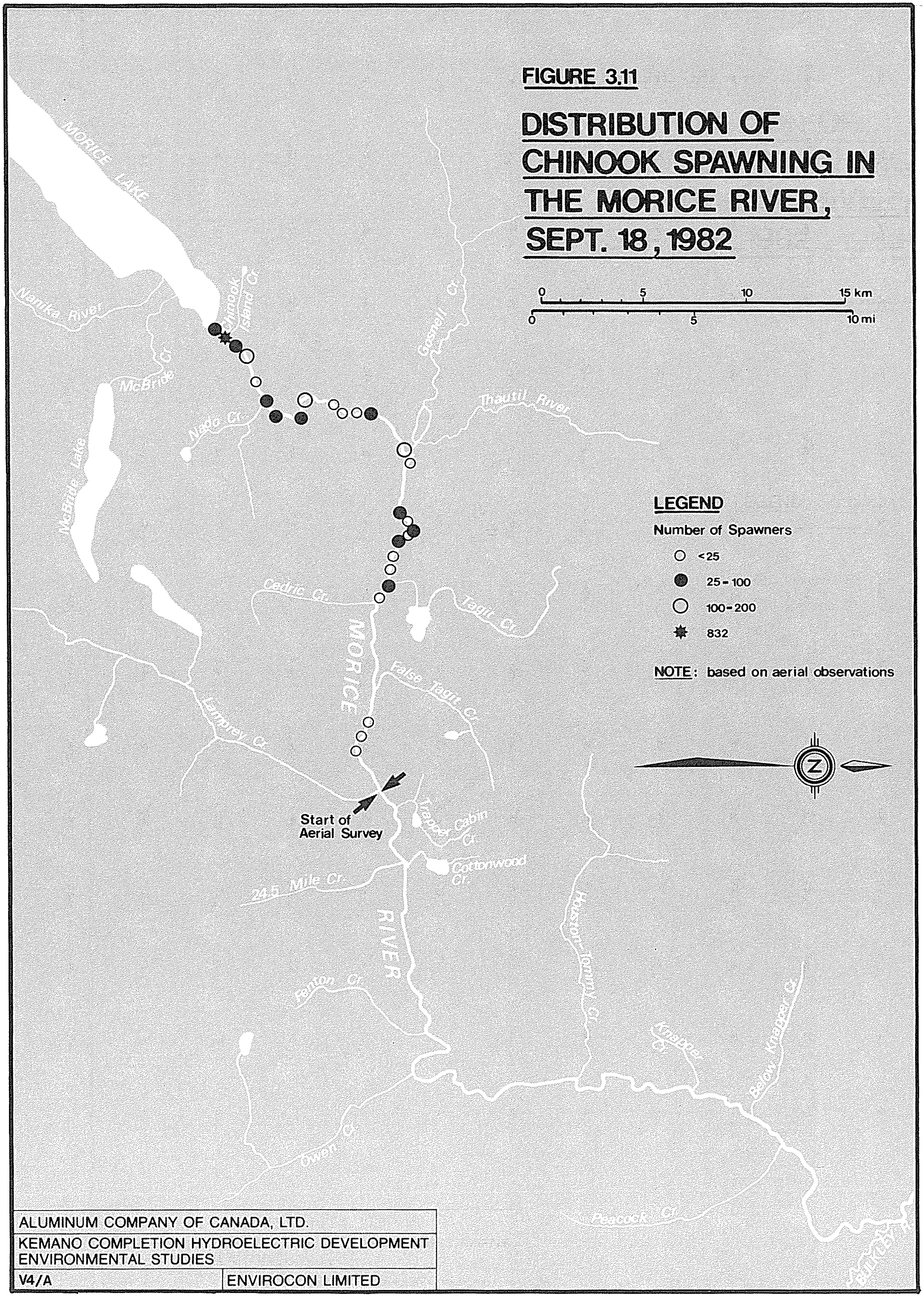


FIGURE 3.11

DISTRIBUTION OF CHINOOK SPAWNING IN THE MORICE RIVER, SEPT. 18, 1982

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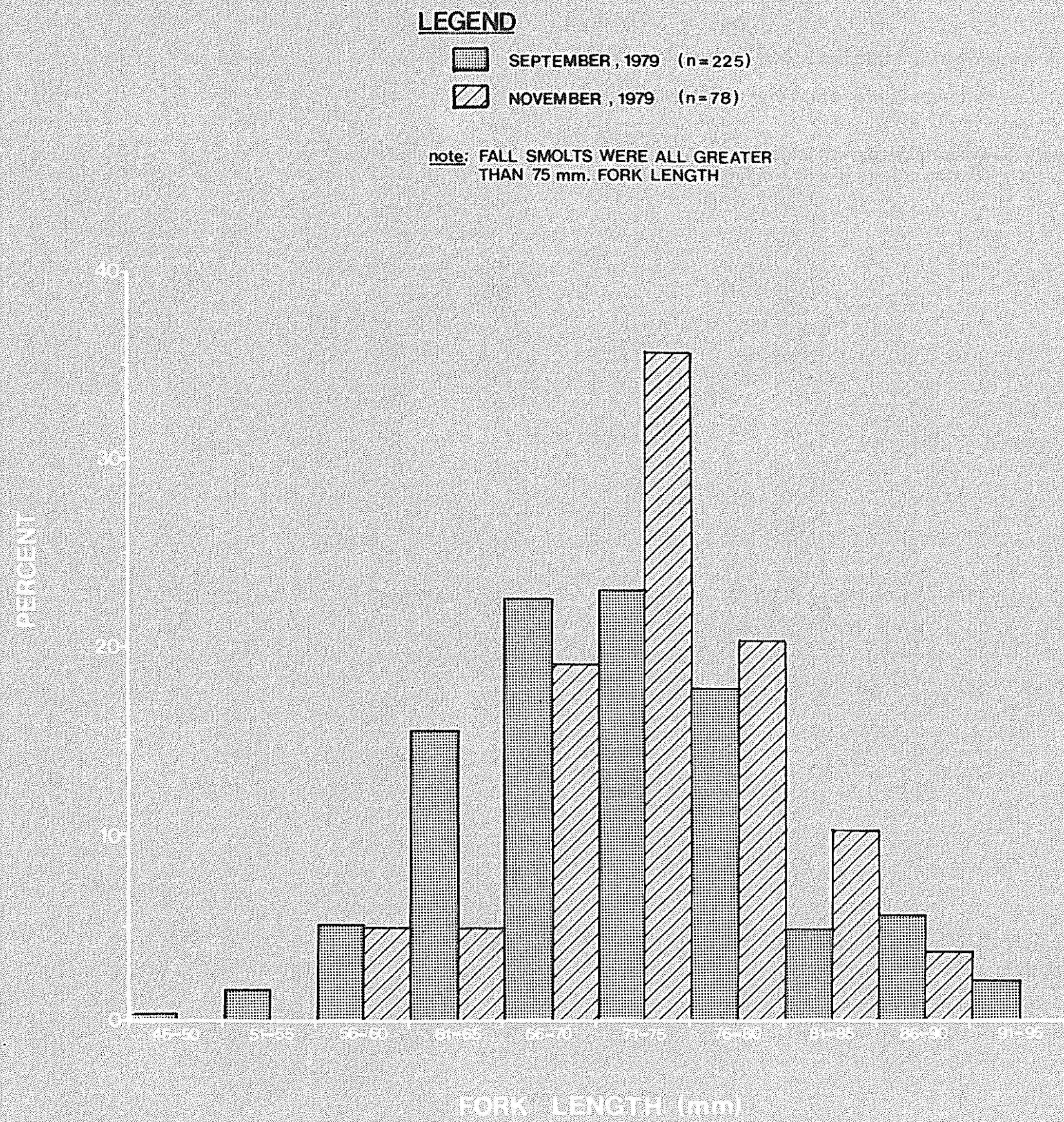
FIGURE 3.12: PERCENT OCCURRENCE vs FORK LENGTH FOR CHINOOK FRY IN THE MORICE AND BULKLEY RIVERS, 1979



Based on three years of age-length data, the average fork-length of chinook fry entering their first winter ranged from 68-74 mm (Section J). Ewing et al. (1979) suggested that juvenile chinook in the Rogue River must attain a minimum size of 80 mm before smolting occurs during October of their first year. The fork lengths of chinook fry during four sampling periods in 1979 are shown in Appendix A6, Table A6.2 and a comparison between three study years is given in Section J, Appendix J6. Additional age and growth data for Morice River chinook salmon juveniles are presented in Smith and Berezay (1983).

Distribution and Abundance of Chinook Fry

Chinook fry were distributed throughout the six reaches of the Morice and Bulkley Rivers in similar proportions in 1979, 1981 and 1982. The highest 1979 CPUE during the fall occurred in Reaches 1, 3 and 5 (Figure 3.13). If catches are corrected for total useable channel length, slightly more than half of the chinook fry rearing occurs in the upper three reaches of the Morice (Table 3.11; Section J). During each year of study, Reaches 2 and 5 together accounted for 65-72% of the total chinook rearing population (Section J). By fall, chinook fry are probably distributed throughout the lower Bulkley and down into the Skeena River. A more detailed summary of 1979 electrofishing and minnow trapping catches of chinook salmon is presented in Appendix A6, Tables A6.3 and A6.4. Based on electrofishing data collected during 1980, 1981 and 1982, mean densities of chinook from mainstem and side channels combined were estimated to range from 0.03 fry/m^2 in 1980 and 1981 (Tredger 1983) to 0.06 fry/m^2 in 1982 (Section J). Side channel and mainstem densities estimated from 1982 samples were similar.

Chinook fry were found almost exclusively in the Morice and Bulkley Rivers in 1979, with less than 1% of the population rearing in the lower ends of several tributaries (Lamprey, Trapper Cabin and False Tagit Creeks). Those fry apparently move into these creeks after emergence in the main river. Shepherd (1979) reported that chinook fry rear in lower Gosnell and Owen Creeks, although they were not found in these systems during 1979.

Chinook fry CPUE dropped steadily from May through November (Figure 3.13). This may have been the result of competition for territories. As the large number of fry initially present grew in size, competition for larger territories probably resulted in an outmigration of those fry unable to find suitable territories.

Habitat Selection by Chinook Fry

The CPUE of chinook fry caught by electrofishing in May 1979 indicated higher use of the main channel (74%) than side channels (26%) (Figure 3.14). With increasing flows during the spring snowmelt, fry moved into side channels. This is reflected in a relatively low CPUE (27%) in the main channel in July. During September and November 1979, chinook fry were distributed equally throughout the main and side channels. Chinook fry abundance was higher in the main channel than side channels in 1981 and 1982 (Section J).

During the active period, chinook fry favoured low velocity (2 to 25 cm/s) areas deeper than 15 cm (Figure 3.14, Plate 10). Fry were commonly found in a variety of habitat types such as flats, pools, log jams, side pools and back eddy areas. Low catches were typical in runs and no chinook were captured in ponds. Although fry were often associated with cover, catches were high in areas which did not offer cover within 2 m. This suggests that cover is not as important for chinook fry rearing as for other species, or that chinook fry are more mobile and forage farther from cover. However, during SCUBA and snorkel observations in September 1982, 92% of chinook salmon observed were associated with some form of cover, usually root wads (Section G). These underwater observations also indicated chinook salmon juveniles utilized deeper and faster water than coho or steelhead fry. Eighty percent of the chinook fry observations were at sites with average velocities ranging from 4-47 cm/s and depths from 90-310 cm.

During November 1979, chinook fry were usually captured in shallow, low velocity areas along the river margin. Most fry wintered in clean cobble generally greater than 30 cm in diameter. Areas offering cover of debris, roots and logs were used to a lesser extent. Log jams were not sampled, although they probably provide good overwintering areas for chinook fry. The steep gradient boulder areas on the lower Bulkley River probably also serve as good wintering habitat for chinook fry although this has not been verified.

Overwintering studies in selected Reach 2 side channels conducted in 1981-82 indicated that some chinook salmon juveniles tended to migrate out of side channel habitat during late fall. However, for the chinook salmon juveniles remaining in side channels over winter, survival averaged 61%, the highest of all species. As with coho salmon juveniles, the high survival was likely a result of the tendency of chinook salmon juveniles to occupy deep pool habitat with debris cover, which is less subject to dewatering and freezing during the low flow winter period than areas utilized by juvenile steelhead trout.

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FIGURE 3.13: ELECTROFISHING CATCH PER UNIT EFFORT FOR CHINOOK FRY IN THE MORICE AND BULKLEY RIVERS, MAY–NOV., 1979

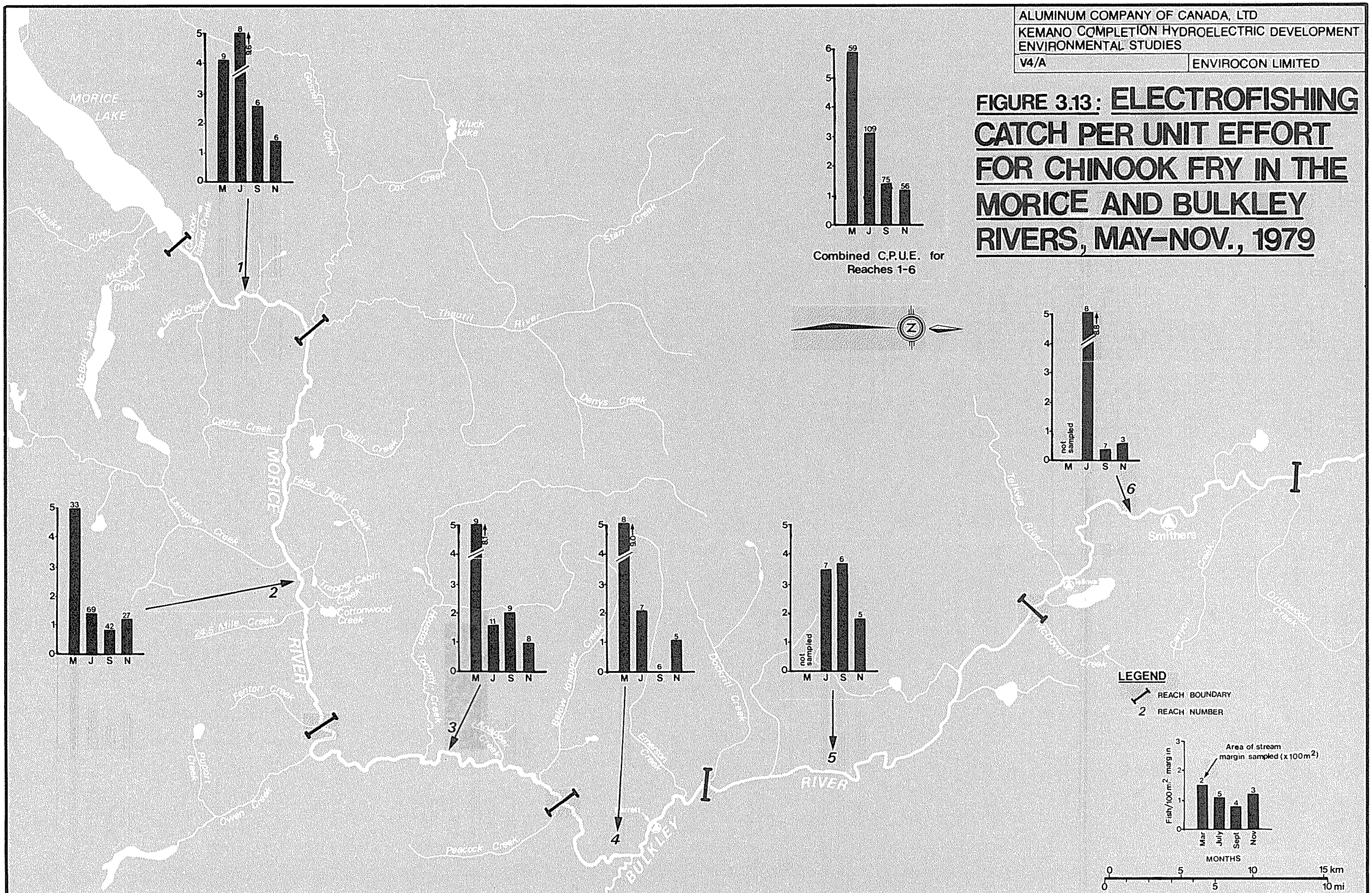

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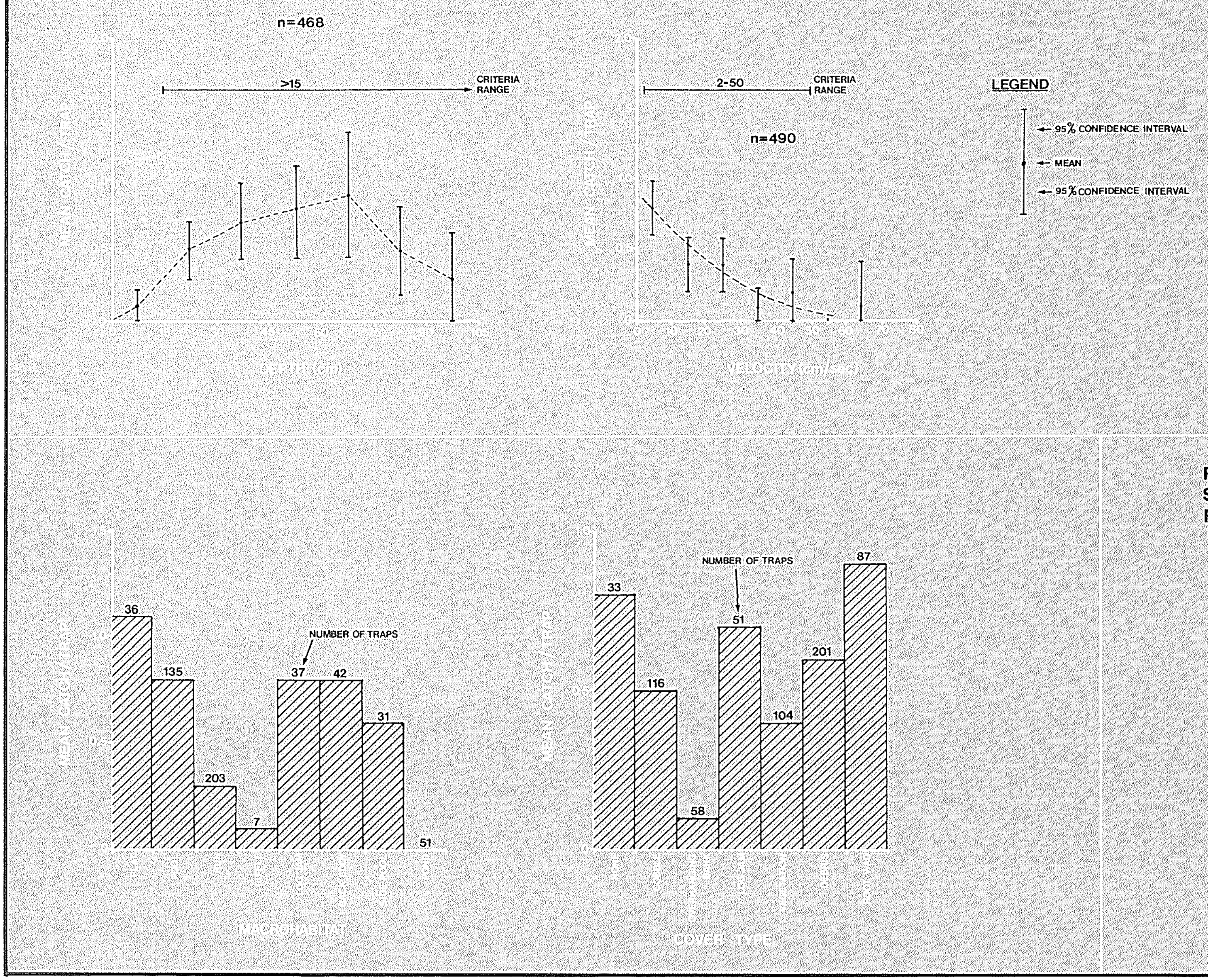
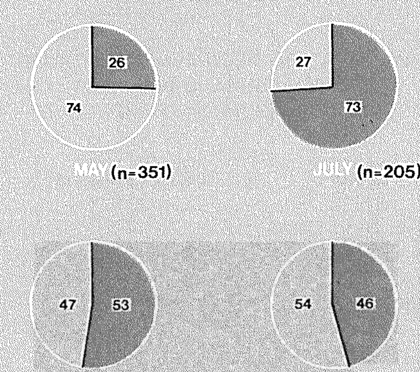
FIGURE 3.14

HABITAT PREFERENCES OF CHINOOK FRY IN THE MORICE RIVER, JULY-SEPT., 1979



RELATIVE COMPARISON OF C.P.U.E. IN SIDE AND MAIN CHANNEL HABITATS FOR REACHES 1-6, MORICE RIVER



(note: expressed as a percentage of total C.P.U.E.)

LEGEND

- SIDE AND INTERMITTENT CHANNELS
- MAIN CHANNEL

TABLE 3.11
Summary of Chinook Fry Electrofishing Catches by Reach in the Morice and Bulkley Rivers in September and November 1979[1], and a Comparison of Main River and Tributary Abundance Estimates

Reach	Area of Margin Electro-fished (m^2)	Channel Length[2] (km)	Fish/100 m^2 Of Margin	Channel Length x Catch	Weighted Distribution (%)
1	1,160	25.6	2.0	51.2	12.1
2	6,863	159.5	0.9	143.6	33.9
3	1,632	33.1	1.5	49.6	11.7
4	1,128	36.7	0.5	18.4	4.3
5	1,134	47.2	2.8	132.2	31.2
6	1,043	57.1	0.5	28.6	6.8
Total Catch Estimate for Reaches 1 to 6				423.6	99.8
Total Catch Estimate for Tributaries				1.1	0.2

1 Refer to Section J, Table 4.1 for a summary comparison of juvenile chinook distribution, 1979-82

2 Combined length of main and side channels

Juvenile Chinook Salmon Summary

Peak chinook fry emergence occurred in April although some emergence continued through June. Most chinook juveniles appearred to overwinter in the Morice and Bulkley Rivers prior to smolting the following spring, although some of the larger juveniles left in September and October of their first season.

Chinook fry were found almost exclusively in the mainstem of the Morice and Bulkley Rivers, and by the fall sample period they were found dispersed throughout the six reaches examined. A comparison of CPUE's suggested that chinook fry occupied marginal areas of the mainstem shortly after emergence, shifted to predominantly side channels during high flows, and were distributed throughout main and side channel habitats by the fall and early winter. During the summer period, juvenile chinook salmon preferred low velocity habitats and did not typically display a close association with cover. Most fry wintered in clean cobble areas along the river margin.

3.1.4 Pink Salmon

In 1979, peak pink salmon migration into the Morice River occurred from the middle to the end of August. Peak spawning occurred in early September, and was finished by September 19 (Appendix A3, Table A3.3). In 1981, peak spawning occurred from September 7 to 12 (Section H), similar to the timing reported by Shepherd (1979).

Pink salmon in the upper Morice River spawn later than those in downstream areas. On September 4, 1979, over 40% of the pink salmon observed below Fenton Creek had died, compared to 6% above Fenton Creek (Table 3.12). Observations made on September 5 and 6, 1981, are comparable to these results (Section H). A helicopter flight in Gosnell Creek nine days after the 1979 Morice survey indicated that few fish had completed spawning and only a single carcass was observed, suggesting that spawning in this tributary occurred later than in the Morice and Bulkley Rivers.

Morice River pink salmon are predominantly odd-year fish, with escapement estimates averaging approximately 18,000 fish during the past decade (Table 3.13). The average estimate of even-year pink runs since 1970 is approximately 2,000 fish. The pink salmon run in the Morice River has increased substantially in numbers and extent of spawning during the past 20 years. The expansion upstream is related to the installation of the fishways at Moricetown, and the removal of an obstruction at Hagwilget in the 1950's (Shepherd 1979). Morice River pink salmon have an estimated spawning population size of 20,000-25,000 in odd years and 10,000 in even years

TABLE 3.12
Aerial Count of Pink Salmon Spawners in the Morice and Bulkley Rivers on September 4, 1979

Location		Live Spawners		Carcasses	Total	% of Total Spawners
		Side Channel	Main Channel			
Reach 1 -	Gosnell to Morice Lake	135	100	0	235	3.9
Reach 2a -	Lamprey to Gosnell	2,675	771	60	3,506	59.0
Reach 2b -	Fenton to Lamprey	1,229	115	289	1,633	27.4
Reach 3 -	Peacock to Fenton	0	12	46	58	1.0
Reach 4 -	Dockrill to Peacock	118	41	95	254	4.3
Reach 5 -	McDowell to Dockrill	18	48	36	102	1.7
Reach 6 -	Driftwood to McDowell	0	0	37	37	0.6
Main River Total		4,175	1,087	563	5,825	
Gosnell Creek			124	1	125	2.1
Thautil River					0	
Overall Total					**5,950**	**100.0**

TABLE 3.13
Pink Salmon Escapement Estimates for the Morice River and its Tributaries from 1961 to 1982

Year	Fisheries and Oceans[1]	Alcan[2]	Year	Fisheries and Oceans	Alcan
1961	1,500	520	1971	4,500	6,800
1962	0	20	1972	1,000	200
1963	1,000	120	1973	14,000	15,500
1964	0	0	1974	1,000[3]	500
1965	500	0	1975	50,000	42,000
1966	500	0	1976	100	50
1967	400	200	1977	25,000	23,000
1968	1,000[3]	0	1978	200	300
1969	2,500	2,500	1979	6,000[4]	6,700
1970	NR[5]	250	1980	100	4,680
			1981	12,500	12,500
			1982	9,000[4]	8,400
Even-year means (1962-70)[5]	300	54	(1972-82)	1,900	2,355
Odd-year means (1961-69)	1,180	668	(1971-81)	18,666	17,683

1 Hancock et al. (1983)
2 Estabrooks (1978)
3 Shepherd (1979)
4 Department of Fisheries and Oceans, Smithers, B.C.
5 Not reported

(Volume 15, Section I). The odd year pink spawning population size estimate was based on the past 12 years escapements revised upwards to allow for underestimates due to low visibility and residence time. The even year pink spawning population size was based on a peak escapement year in 1982 of 9,000 fish. Based on DFO escapement records, the Morice River pink salmon represent less than 1% of both the odd year and even year escapements to the Skeena system.

The distribution and relative abundance of pink salmon spawners in the Morice and Bulkley Rivers in early September 1979 is shown in Figure 3.15. Of the nearly 6,000 spawners observed in 1979, 86% spawned in Reach 2 between Fenton Creek and Gosnell Creek, with 59% of spawning occurring between Lamprey and Gosnell Creeks. The limited use of Reach 1 of the Morice River (4%) was verified by snorkel observations during September 1979. The only tributary used by spawning pink salmon was Gosnell Creek. Scattered spawning for at least 13 km up Gosnell Creek accounted for approximately 2% of the total 1979 pink salmon run. In 1981, 12,500 pink salmon were counted and most (96%) spawning occurred in Reach 2, with 70% of the total occurring betweeen Lamprey and Gosnell Creeks (Section H).

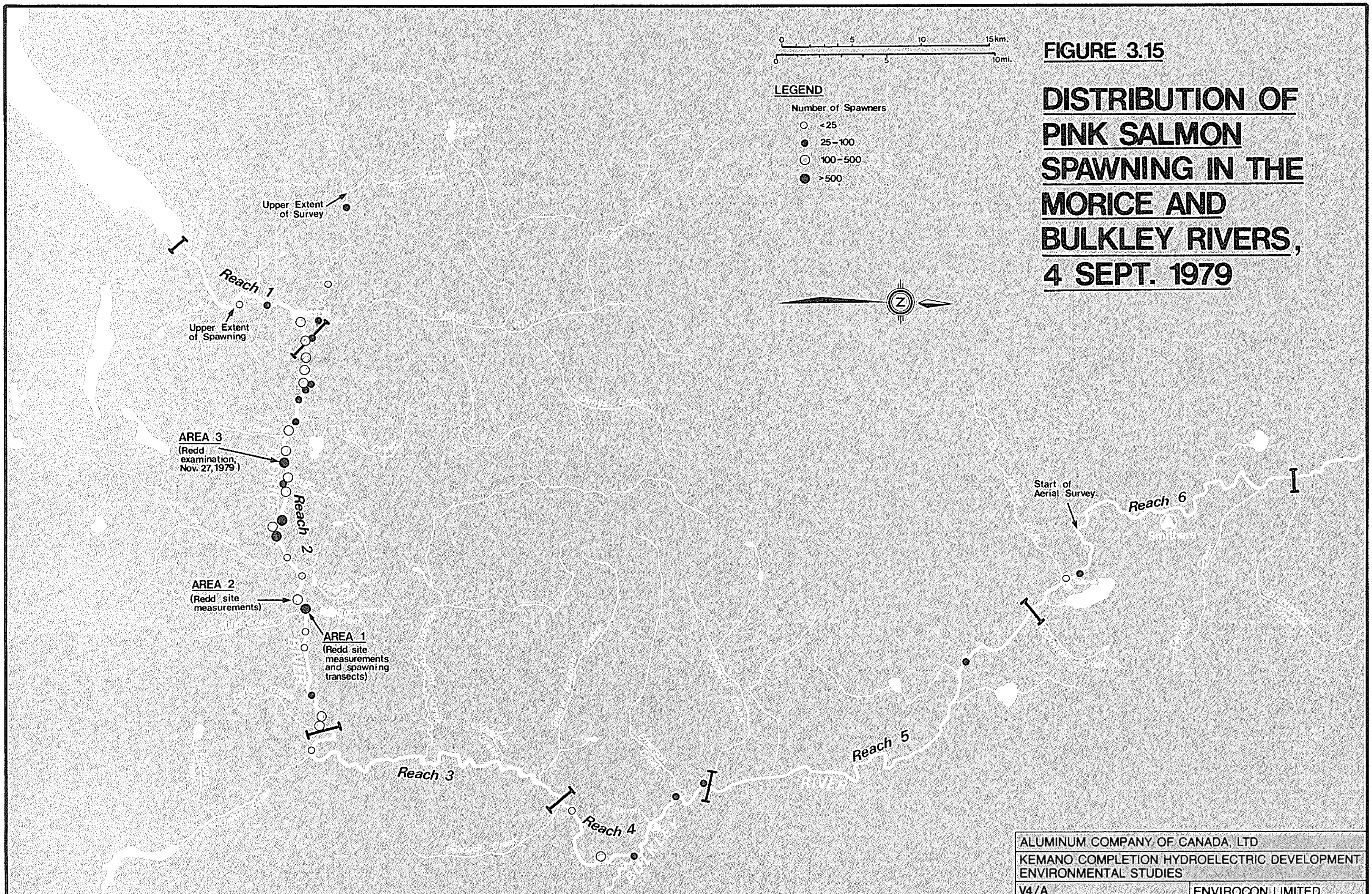
Approximately 80% of all pink salmon observed in 1979 were spawning in side channels, with the remaining 20% spawning in main channel areas (Table 3.12). A similar pattern was observed during the 1981 studies (Section H). Most (80%) of the pink salmon spawning sites were in slow runs with nose velocities ranging from 29 to 60 cm/s and water depths ranging from 74 to 129 cm (Appendix A7, Table A7.2). Measurements made in 1981-1982 on 120 redds indicated that 80% of the spawning sites fell within velocity and depth ranges of 30-79 cm/s and 39-110 cm, respectively. The spawning substrate in 1979 was comprised predominantly of gravel less than 15 cm diameter, but included some fines and occasionally cobble up to 30 cm diameter, similar to substrate used in 1981 (Section H).

Pink fry emergence in 1982 was estimated to occur mainly from May 1 to 15, based on observations in the vicinity of redd sites during that period (Section H). It is assumed that pink salmon fry move downstream to the Skeena River estuary immediately after emergence. The emergence period in 1982 was probably slightly later than usual due to cold temperatures and a delayed rise in spring runoff.

Results of water temperature, dissolved oxygen and gravel quality measurements at pink salmon redd sites are reported in Section H. Dissolved oxygen and water temperature measurements taken in side channels during the winter of 1981-82, as well as the presence of open water areas during late winter, suggest that some sites selected by pink salmon spawners are directly influenced by groundwater (Section H). The detrimental effects of low dissolved oxygen levels to developing eggs and alevins in some side channel areas may be offset by the tempering effect of groundwater inputs on redd desiccation and freezing.

FIGURE 3.15

DISTRIBUTION OF PINK SALMON SPAWNING IN THE MORICE AND BULKLEY RIVERS, 4 SEPT. 1979



3.2 Morice Lake Fish Resources

Fourteen fish species have been identified in Morice Lake including sockeye, coho and chinook salmon; rainbow (Plate 11), cutthroat and lake trout; Dolly Varden char; mountain, pygmy and lake whitefish, longnose and largescale suckers; prickly sculpins and longnose dace (Godfrey 1955; Anon. 1979b; Shepherd 1979; B.C. Fish and Wildlife Branch, Smithers unpublished data). Kokanee salmon were identified during the present study. Burbot may also occur in Morice Lake since they are present in McBride and Owen Lakes (B.C. Fish and Wildlife Branch, Smithers unpublished data).

This section presents information on sport species collected during a creel census program conducted on Morice Lake from May 13 to October 30, 1979 and from tagging studies conducted primarily in May and June 1980 (Section I). The final portion summarizes sockeye salmon use of Morice Lake based on Shepherd (1979). Fish resources of Atna Lake are discussed in Section K.

3.2.1 Morice Lake Sport Fish

Anglers spent an estimated 1,183 days catching 1,032 fish in Morice Lake in 1979. The peak fishery occurred from June to September, with the greatest numbers of anglers visiting the lake in August (Table 3.14). The predominant species angled in Morice Lake was rainbow trout (57.7%) followed by lake trout (19.8%) and Dolly Varden char (8.5%). An estimated 54 chinook salmon and seven coho salmon were captured in Morice Lake from July through September. A small number of cutthroat trout, kokanee salmon and mountain whitefish were also angled.

The catch estimates do not take into account anglers who camped in areas away from the B.C. Forest Service campsite and launching facilities at the north end of the lake, or who left early in the day prior to the arrival of the census person. In addition, the small amount of fishing which takes place between November and mid-May has not been recorded. The figures presented in this report probably underestimate lake use and fish catches by approximately 20%.

Chinook salmon are also fished in the upper 15 km of the Morice River during the first two weeks of August. Anglers gain access to the upper river by boat from Morice Lake, and many of them are either based at the lake or camp on the river during this period. During 1979, this fishery accounted for an estimated 700 angler days which are not included in Table 3.14. Numerous rainbow trout and Dolly Varden char, probably originating from Morice Lake, are taken in the Morice River in addition to chinook salmon, but are not included in the Morice Lake catch figures. In 1981, new regulations resulted in closure of the upper Morice River to angling until the end of September, thus the pattern of angler use has changed since the 1979 studies.

Rainbow Trout

An estimated 596 rainbow trout were angled in Morice Lake in 1979. Fork lengths of a sample of 110 Morice Lake rainbow trout ranged from 24 to 61 cm with a mean fork length of 36 cm (Table 3.15; Appendix A8, Figure A8.1). The heaviest rainbow from a sample of 36 was 1.4kg (Appendix A8, Table A8.1).

Length and age data for samples of Morice Lake rainbow trout obtained in 1979 and 1980 suggest that growth rates are relatively slow compared to length and age data for Babine Lake and Babine River rainbow trout (Appendix A8, Table A8.2). However, Morice Lake rainbow attain a larger size (61 cm) than rainbow trout from Nanika and Kidprice Lakes (48 cm) (Anon. 1979b).

To date, the Nanika River is the only identified spawning area for Morice Lake rainbow trout. Tag returns during 1979 and 1980 indicate a movement of rainbow trout between the Nanika River, Morice Lake and the upper Morice River at various times of the year. Morice Lake rainbow trout probably move into the Nanika River in late May and early June, spawn, and return to the lake by late June. Some rainbow trout move down into the Morice River in August and September, coinciding with chinook salmon spawning.

A total of 21 rainbow trout was tagged during the 1979 study, 12 in the upper Nanika River spawning areas during late May and June and nine at sites in the upper Morice River and in Morice Lake (Appendix A8, Table A8.3). Three of the fish tagged in the Nanika River were subsequently captured in the Morice River immediately downstream of Morice Lake between August 8 and October 2. An additional tagged rainbow was reported angled and released near Pyramid Creek on July 8. This fish was a kelt and was probably tagged in the Nanika River, as only one non-spawning rainbow had been tagged in Morice Lake at that time.

A total of 148 rainbow trout was tagged and released during the 1980 study. Of 45 spawners tagged in the Nanika River, four were subsequently captured by anglers in Morice Lake, further evidence that fish spawning in the Nanika River are from the same population of rainbow trout that are angled in Morice Lake. Detailed tagging and recapture information for 1980 is presented in Section I.

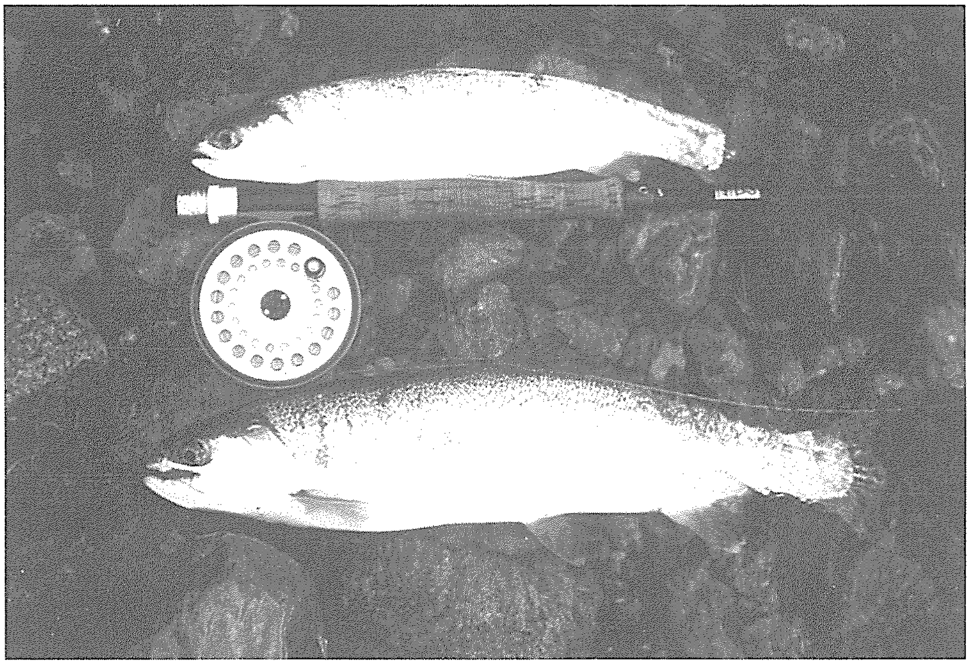


Plate 11: Morice Lake rainbow trout.

Plate 12: Pyramid Creek, a typical unproductive glacial tributary of Morice Lake.

TABLE 3.14
Estimated Number of Angler Days and Catch by Species in Morice Lake, May to October 1979[1]

	May	June	July	Aug.	Sept.	Oct.	Total	Percentage of Total
Angler Days	14	199	164	561	177	68	1,183	
				CATCH				
Rainbow Trout	2	76	120	207	117	74	596	57.7
Lake Trout	-	76	76	34	2	16	204	19.8
Dolly Varden Char	-	18	12	18	18	22	88	8.5
Mountain Whitefish	-	5	-	44	4	15	68	6.6
Chinook Salmon	-	-	4	37	13	-	54	5.2
Kokanee Salmon	-	-	2	10	-	-	12	1.2
Coho Salmon	-	-	-	5	2	-	7	0.7
Cutthroat Trout	-	-	1	2	-	-	3	0.3
Total	**2**	**175**	**215**	**357**	**156**	**127**	**1,032**	**100**

1 Catch estimates are for Morice Lake only and do not include catches from the upper Morice River

TABLE 3.15
Size Range of Morice Lake Fish, 1979 and 1980

1979[1]

Species	Sample Size	Size Range (cm)	Mean Size (cm)	Standard Deviation
Rainbow Trout	110	24 - 61	36.7	8.7
Lake Trout	39	35 - 89	45.2	8.8
Dolly Varden Char	22	30 - 61	37.3	7.8
Mountain Whitefish	3	24 - 30	27.0	3.0
Kokanee Salmon	2	24 - 25	24.5	0.7
Cutthroat Trout	4	28 - 30	29.0	1.4

1980[2]

Species	Sample Size	Size Range (cm)	Mean Size (cm)	Standard Deviation
Rainbow Trout	67	25 - 50	37.6	6.4
Lake Trout	8	35 - 52	42.1	5.4
Dolly Varden Char	17	34 - 49	41.9	4.1
Mountain Whitefish	23	22 - 42	29.1	6.0
Cutthroat Trout	1	-	29.5	-

1 Based on angler catch data

2 Based on a combination of angling and gill netting data collected during tagging studies

The movement of rainbow trout between Morice Lake and the Morice River is substantiated by snorkel observations in 1979, which indicated an increase in resident rainbow trout downstream of the lake during August and September (Appendix A3, Table A3.3). As well, three rainbow trout tagged and recaptured during 1980 demonstrated movement between Morice Lake and the Morice River (Section I).

A reconnaissance of Morice Lake tributaries during early June 1979 indicated three areas in addition to the Nanika River with suitable water temperatures and physical characteristics for potential spawning of rainbow trout from Morice Lake. These were:

1) portions of the upper Morice River downstream from Morice Lake;
2) McBride Creek; and
3) two small tributaries in Atna Bay (Figure 3.16).

No spawners were observed in the upper Morice River during snorkel surveys in early June 1979, although several rainbow 25 to 50 cm in length were observed holding with steelhead in Chinook Island Creek and at a site lower in the river. No spawning rainbow were captured by limited angling during 1979.

Low catches of juvenile trout in McBride Creek indicate that use of this system by rainbow trout is minimal. Only two juveniles were captured in McBride Creek during sampling from May to November 1979 during which time over 700 m^2 of margin were electrofished and 65 minnow traps set.

No spawning adults or rainbow trout juveniles were observed in the two Atna Bay tributaries, suggesting a low importance to rainbow trout. The remaining tributaries of Morice Lake are unsuitable for rainbow trout spawning since many are steep and inaccessible (Plate 12) or cold and turbid, with water temperatures less than 4°C during the spawning period (Appendix A8, Table A8.4). Information presented by Bovee (1978) suggests that rainbow trout do not spawn at water temperatures less than 5.5°C and usually spawn when temperatures exceed 6.5°C. Water temperatures in the Nanika River during rainbow trout spawning ranged from 5° to 9°C during 1979 and 1980.

Additional surveys of Morice Lake tributaries during 1980 provided little information to suggest that Morice Lake rainbow trout spawn elsewhere than the Nanika River (Section I). Of 63 rainbow trout captured in Morice Lake during late May and June, only a single fish was in spawning condition. Electrofishing in Cabin Creek and the two Atna Bay tributaries did not indicate that juvenile rainbow trout were present. As well, ripe rainbow trout were not captured in the upper Morice River despite 128 hours of angling during May and early June.

Lake Trout

An estimated 204 lake trout were angled in Morice Lake in 1979. Fork lengths ranged from 35 to 89 cm with a mean of 45 cm (Table 3.15; Appendix A8, Figure A8.1). A 92 cm lake trout weighing 11 kg was captured in Morice Lake in late May 1980 (Appendix A8, Table A8.1). Large lake trout are not commonly captured in Morice Lake, and most fish are less than 55 cm in length, weighing from 0.5 to 1.5kg.

No information about lake trout spawning was obtained during this study. Scott and Crossman (1973) report that lake trout generally spawn from September through November (usually October) in lake shore areas from 0.3 to 12 m deep. Areas with large boulder or rubble bottom are usually selected, and young hatch the following spring.

Dolly Varden Char

An estimated 88 Dolly Varden char were angled in Morice Lake in 1979. Fork lengths ranged from 30 to 61 cm with a mean of 37 cm (Table 3.15; Appendix A8, Figure A8.1).

Dolly Varden probably move between Morice Lake and the Morice River at various stages in their life history. Limited Dolly Varden spawning may occur in the upper Morice River, although most spawning probably occurs in streams tributary to the Morice River. Spawning Dolly Varden angled in the Nanika River during late October may have been of Morice Lake origin.

Three of 93 Dolly Varden tagged during 1979 and 1980 in the Morice River and Morice Lake were recaptured by anglers. One fish tagged in the upper Morice River was captured in Morice Lake at the mouth of the Nanika River. The other two fish did not demonstrate significant movements.

Other Species

Mountain whitefish, kokanee salmon and cutthroat trout comprised a small proportion of the sport fish catch in Morice Lake during 1979. Size ranges based on few measurements are given in Table 3.15. Although whitefish represented a small

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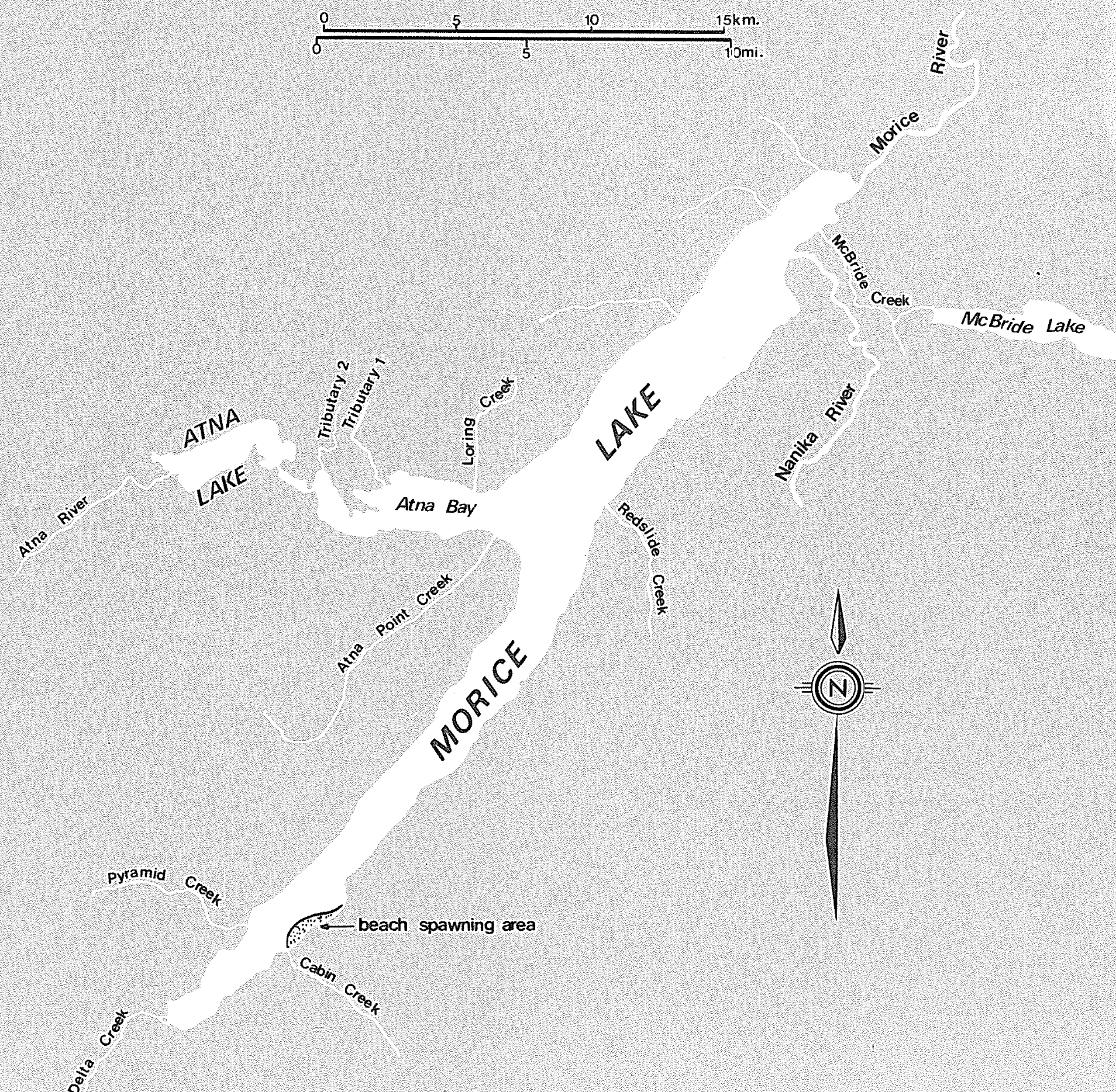
FIGURE 3.16: LOCATION OF MORICE LAKE TRIBUTARIES AND SOCKEYE SALMON BEACH SPAWNING AREA*



* from Shepherd, 1979

proportion of the angler catch in Morice Lake (7%), they probably comprise a substantial proportion of total fish present in the lake. For example, 34% of the 113 fish captured in gill nets by the B.C. Fish and Wildlife Branch in late May, 1980, were whitefish (On file, B.C. Fish and Wildlife Branch, Smithers). One of 30 whitefish tagged during 1980 was recaptured within 1 km of its original point of capture in Morice Lake.

3.2.2 Morice Lake Sockeye Salmon

An estimated 300 to 500 adult sockeye salmon beach spawn in the vicinity of Cabin Creek near the south end of Morice Lake at depths of up to 10m (Shepherd 1979; Figure 3.16).

Morice Lake serves as the freshwater rearing area for sockeye spawned in the Nanika River and in Morice and possibly Atna Lakes (see Section K for additional information on Atna Lake sockeye). The highest beach seine catch of juvenile salmon in 1974 was at the north end of Morice Lake (Shepherd 1979). Scale analysis of returning adults indicated that most (86%) spent two years in Morice Lake prior to smolting, whereas the majority of the Skeena River sockeye (91%) rear for one year in lake systems prior to smolting (Shepherd 1979). This suggests that Morice Lake provides a relatively unproductive rearing environment for juvenile sockeye salmon. However, scales taken from a small number of sockeye smolts during downstream trapping in 1979 and 1980 indicated that most (80%) were age 1+ (Smith and Berezay 1983). The peak out-migration of sockeye smolts from Morice Lake occurs in mid-May (Shepherd 1979). This was confirmed by 1979 and 1980 studies which indicated that the smolt migration was essentially completed by early June (Smith and Berezay 1983).

3.3 Relationship Between River Flows and Available Fish Habitat

This section presents the results of initial transect studies conducted in 1979 to relate the availability of steelhead and salmon spawning, incubation and rearing habitat to changing river flows in the Morice River. Subsequent studies to examine the availability of spawning, incubation and rearing habitat were undertaken in 1981 and 1982. Physical characteristics of pink salmon spawning habitat, its availability with flow, and conditions in the resulting incubation environment were examined at selected sites from spawning in 1981 to emergence in 1982 (Section H). Additional studies on habitat criteria for rearing juveniles were based on underwater observations (Section G). Habitat simulation in supplementary studies was based on a series of surveys in 1982 conducted at one flow and extrapolated to other flows using a hydraulic simulation model (Volume 15, Section D). The sensitivity of modelled habitat to changes in criteria was also examined (Volume 15, Section D). The results presented below are from the 1979 studies. These were used in conjunction with the more recent habitat vs. flow information to form a component of the input to the flow derivations presented in Volume 15, Section D and the impact assessment presented in Volume 19, Section A.

A number of significant assumptions were made in developing the relationships between flow and available fish habitat determined in 1979. Habitat-flow relationships developed at a small number of selected transect sites in Reaches 1 and 2 were assumed to be representative of the remainder of the river. While considerable error may be involved in such extrapolations, the transect approach was judged the most satisfactory technique available for assessing habitat changes with flow.

The transect approach required that specific quantitative criteria be developed to describe those physical characteristics of fish habitat which govern its suitability for fish. In the 1979 habitat determinations, spawning and rearing criteria were developed from information available in the literature and data collected in the Morice River in 1979. Factors such as changes in food production with flow were not incorporated into the analysis since they could not be described in adequate quantitative terms. While these considerations are important to note, the transect approach provided a valuable tool for assessing habitat-flow relationships.

3.3.1 Spawning Habitat - Flow Assessment

The relationships between steelhead trout and pink salmon spawning habitats and river flow were derived during 1979 field studies, while that for chinook salmon spawning habitat was based on studies conducted by the Department of Fisheries and Oceans (Robertson et al. 1979). No habitat-flow studies were conducted in 1979 for coho salmon due to low escapement and late, scattered spawning.

3.3.1.1 Steelhead Trout:

The relationship between steelhead trout spawning habitat and flow in the upper Morice River (immediately upstream of Gosnell Creek) is illustrated in Figure 3.17. Greatest amounts of main channel spawning habitat were indicated at flows between 60 and 100 m^3/s with suitable spawning area reduced at higher and lower flows. The maximum amount of suitable spawning habitat in side channels occurred at the highest flow measured (144 m3/s). Suitable spawning habitat would be reduced at greater

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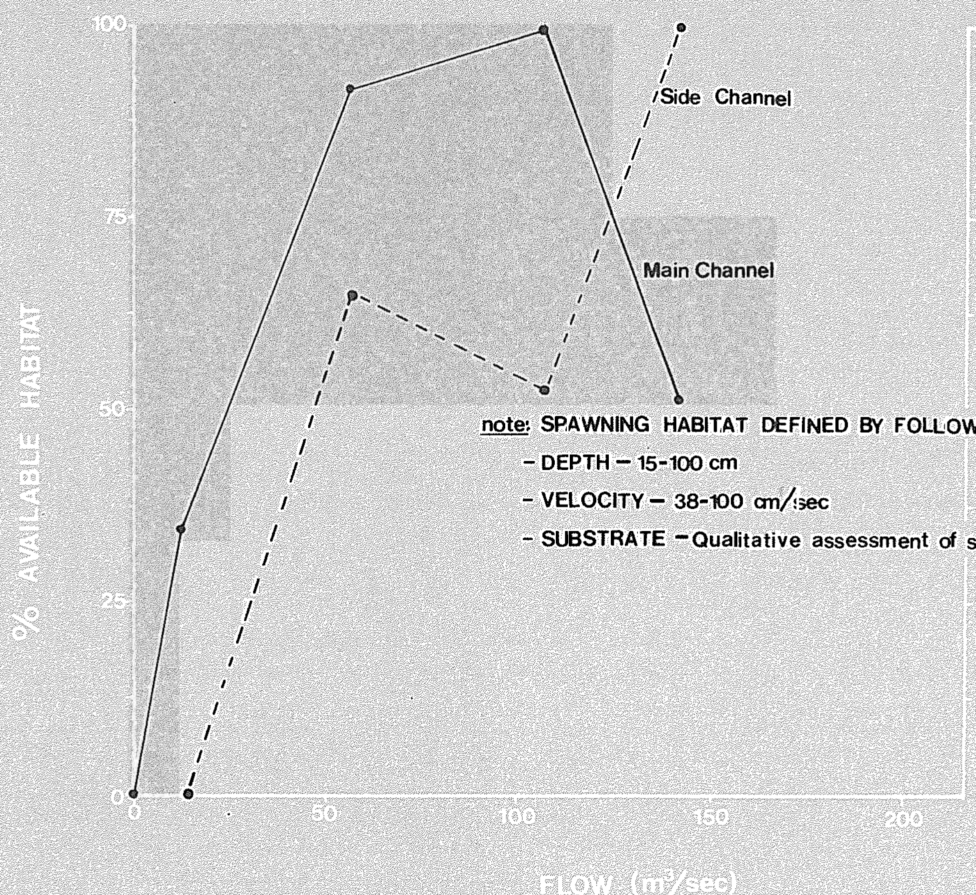
FIGURE 3.17: ESTIMATED CHANGES IN STEELHEAD SPAWNING HABITAT WITH CHANGING FLOW IN THE UPPER MORICE RIVER



note: SPAWNING HABITAT DEFINED BY FOLLOWING LIMITS:

- DEPTH – 15-100 cm
- VELOCITY – 38-100 cm/sec
- SUBSTRATE – Qualitative assessment of suitability

flows as nose velocities would exceed upper limits of the criteria used in this assessment (Appendix A10, Figures A10.1 to A10.3). In both side and main channels, suitable spawning habitat was reduced substantially at habitat flows of less than 60 m^3/s. At 14 m^3/s no side channel spawning would be available, and less than 50% of the main channel spawning habitat would remain.

Nose velocity and depth information used in the development of steelheod spawning criteria were derived from Bovee (1978), Smith (1973) and from measurements made on a small number of steelhead redds in the upper Morice River during the 1979 field studies. Bovee (1978) indicated that steelhead most frequently spawn at velocities between 38 and 100 cm/s, and depths of 15 to 69 cm. Smith (1973) reported that 80% of the steelheod sites examined by him occurred in velocities ranging from 40 to 91 cm/s, and were in water depths greater than 24 cm. The few measurements made at steelhead redds in the Morice River indicate that spawning occurred at depths of up to 100 cm (Appendix A4, Table A4.3). Based on these three sources, the following spawning criteria were established for steelheod trout: a) water depth between 15 and 100 cm; b) nose velocity between 38 and 100 cm/s; and c) substrate 1 to 15 cm diameter and uncompacted.

A summary of the total length of steelhead spawning habitat along 10 transects at four flows is presented in Table 3.16. Three main channel transect lines (at site T2) are presented to illustrate how water depth and nose velocity change with flow (Appendix A10, Figures A10.1 to A10.3). It was assumed for all transects that suitable spawning distance along the transect lines provides on index of spawning area availability in the vicinity of the transects, and that changes in the length of transects satisfying spawning criteria reflect changes in suitability of the river for spawners.

3.3.1.2 Chinook Salmon:

Virtually all chinook salmon spawning areas are useable at a flow of 80 m^3/s, and suitable areas available for spawning decrease with flows below 80 m^3/s as shown in Figure 3.18 (adapted from Robertson et al. 1979). At flows of 50 m^3/s, suitable spawning areas ore reduced to less than half of the maximum available at 80 m3/s (based on Robertson et al. (1979)).

Suitable spawning areas had a minimum depth of 30 cm, minimum nose velocity of 30 cm/s, and clean gravel substrate. Robertson et al. (1979) assumed that their study area was representative of other chinook spawning areas in the Morice River, particularly in the 4 km below Morice Lake where the majority of chinook salmon spawning occurs.

TABLE 3.16
Length of Steelhead Spawning Habitat Along Main and Side Channel Transects at Four Flows in the Morice River

Transect Number		FLOW (m^3/s)			
		14.2	58.9	107.8	143.6
		Length of Available Spawning Habitat(m)			
Main Channel					
Site T2	1	29.0	44.5	47.5	19.0
	2	0	41.0	35.5	0
	3	0	10.0	2.5	0
Site T1	1	6.0	7.0	13.0	19.0
	2	8.0	12.0	26.0	26.5
Total		**43.0**	**114.5**	**124.5**	**64.5**
% of Maximum Available[1]		34.5	92.0	100.0	51.8
Side Channel					
Site T1					
	4	0	12.5	9.0	24.0
	5	0	13.0	5.0	20.0
	7	0	2.5	2.5	1.0
	21	0	2.0	7.0	3.0
	22	0	5.5	5.0	6.0
Total		**0**	**35.5**	**28.5**	**54.0**
% of Maximum Available[1]		0	65.7	52.8	100.0

1 Total length of spawning habitat at each flow is expressed as a percentage of the maximum length available at the flow with the greatest amount of spawning habitat

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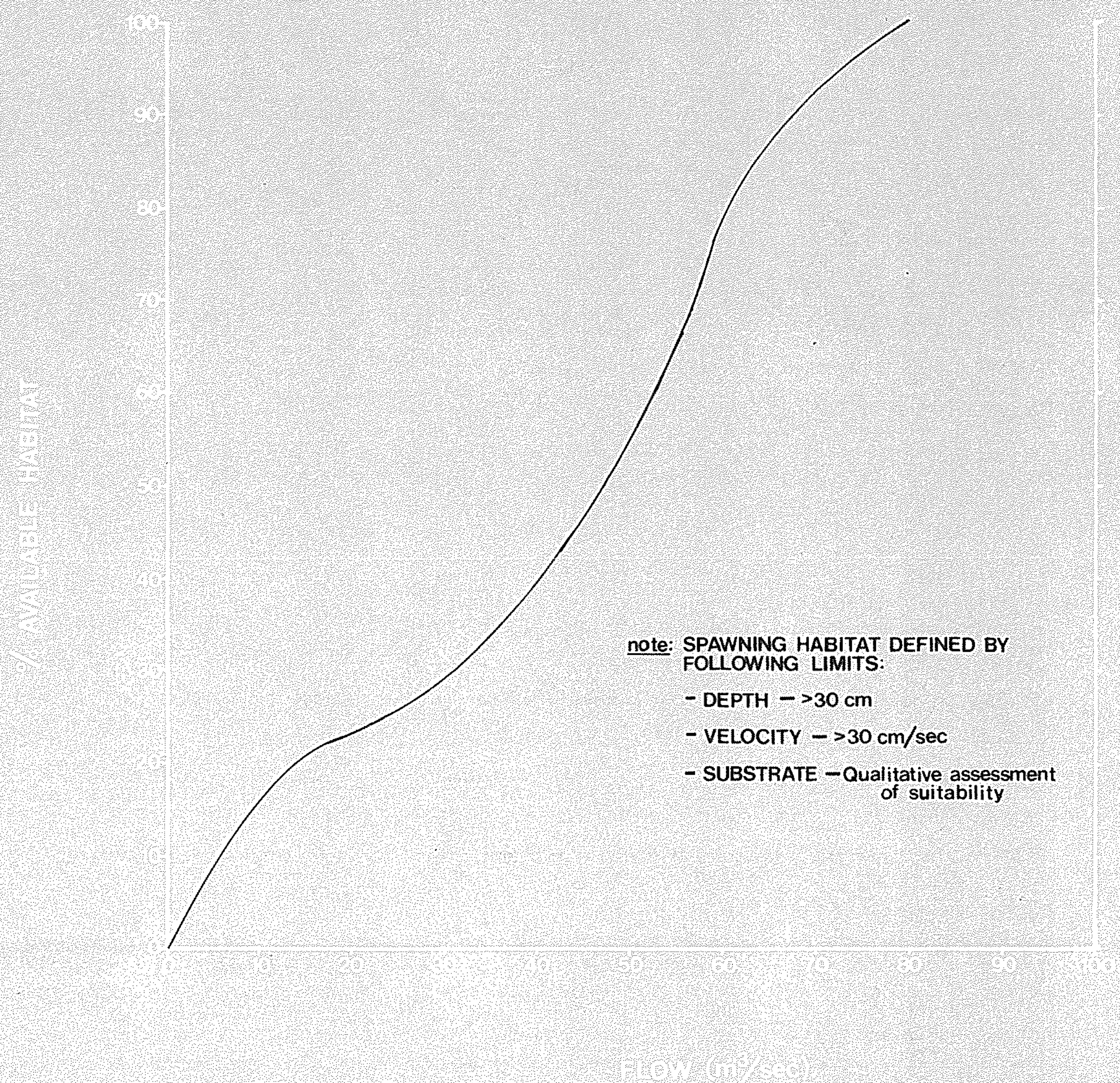
FIGURE 3.18: ESTIMATED CHANGES IN CHINOOK SPAWNING HABITAT WITH CHANGING FLOW IN THE UPPER MORICE RIVER*



* from: Robertson et al, 1979

Robertson et al. (1979) also assumed that all suitable spawning gravel would be fully utilized by the maximum recorded escapement of 12,000 adults. Since there is no evidence that the spawning capacity of the river is either under or over-utilized at the 12,000 escapement level, the changes in suitable chinook spawning habitat with reduced flows have been expressed in Figure 3.18 as a percentage of the maximum spawning habitat available (i.e., at 80 m^3/s) rather than as a percentage of the maximum chinook escapement which could be accommodated at reduced flows as presented in Robertson et al. (1979).

3.3.1.3 Pink Salmon:

On average, the amount of suitable pink salmon spawning habitat is reduced by approximately 40% when flows drop from 120 to 88 m^3/s (Table 3.17). Since measurements token in 1979 were mode at only two flows, a graphical relationship of available spawning habitat and discharge could not be presented.

The side channel chosen as a transect site was used by 300 pink salmon spawners in 1979. The majority (80%) of pinks spawned in side channels, and on estimated 86% of the total Morice River pink run spawned in the same reach as the transect site location.

Pink salmon spawning criteria are based on measurements at redd sites in 1979. Those results indicated that 80% of the pink salmon spawning in the Morice occurred at locations with nose velocities from 29 to 60 cm/s, depths from 74 to 129 cm, and clean substrate predominantly less than 15 cm diameter (Appendix A7, Table A7.1). Measurements made at 120 additional pink spawning redds in 1981-82, indicated that the majority of spawning occurred at depths ranging from 39 to 110 cm and nose velocities ranging from 30 to 79 cm/s (Section H).

The results of depth and nose velocity measurements in 1979, and a qualitative assessment of substrate suitability for the four transect lines located in a side channel in T5 ore shown in Appendix A10, Figures A10.4 and A10.5. The total distance along the four transects suitable for pink spawning was reduced from 86.5 m at the higher flow to 50.5 m at the lower flow (42% reduction). Most of this reductian results fram nose velocities dropping below the minimum level of 29 cm/s. As shown (Appendix A10, Figures A10.4 and A10.5), those areas still satisfying the velocity criterian are near the minimum, and small additional velocity reductions would result in further spawning area reduction.

TABLE 3.17
Length of Pink Salmon Spawning Habitat in Side Channel Transects at Two Flows[1] in the Morice River, 1979

Transect	Length of Available Spawning Habitat (m)[2] Flow $120\ m^3/sec$	$88\ m^3/sec$	Difference	% Reduction
1	27.0	20.0	7.0	25.9
2	26.0	9.0	17.0	65.4
3	18.0	17.5	0.5	2.8
4	15.5	4.0	11.5	74.2
Total (m)	86.5	50.5	36.0	41.6

1 Discharge estimates are for Reach 2 (i.e., including input from Gosnell Creek and Thautil River). The $120\ m^3/sec$ flow is approximately 5% higher than the mean flow for the pink spawning period based on discharges from 1962 to 1979

2 See Appendix A10, Figures A10.4 and A10.5

Based on the additional spawning criteria collected at a larger and more representative series of spawning areas in 1981, a relationship was developed between discharge and available spawning habitat. It was found that side channel and main channel sites responded differently to reductions in discharge below the level measured during the spawning period (93-97 m^3/s). Approximately 20% of those side channel areas sampled would be useable at 60 m3/s and none would be useable at 40 m^3/s. The availability of suitable spawning areas in the main channel increased as discharge dropped to a level between 35 and 50 m^3/s (Section H).

3.3.2 Incubation - Flow Assessment

Flows required for egg incubation are determined by a complex set of interactions between surface flows (sufficient to cover redds and influence gravel temperature) and the intragravel environment (dissolved oxygen and water movement). The incubation-flow assessment discussed in this section is based on subjective field observations made during the early and late winter periods. In-depth quantitative evaluations of incubation conditions were not conducted.

As a rule, the flow required for successful incubation depends on the spawning flow, with a lower spawning flow requiring a lower incubation flow. Based on extensive field observations on Oregon streams, Thompson (1972) recommended that incubation flows be maintained at two-thirds of the minimum spawning flows to provide adequate intragravel flows for successful incubation and fry emergence and to ensure that redds on the periphery of the spawning area do not dry up. However, this recommended ratio of spawning to incubation flow (1.5:1) is far less than the existing spawning to incubation flow ratio for chinook and pink salmon in the Morice River, which is characteristically 6:1 (based on a 10-year period of record: 1966-1975), and thus may not be applicable to this system.

The incubation period in the Morice River was separated into two phases as outlined in Robertson et al. (1979):

(1) The egg stage when embryonic salmon are immobile; and

(2) the post-hatching alevin stage, when young salmon in the gravel are capable of some movement.

It was assumed that flow requirements during the alevin stage were less than those of the egg stage because of the ability of alevins to move downward or laterally.

3.3.2.1 Chinook Salmon:

Chinook salmon losses due to declining flows during incubation probably occur naturally when the Morice River flow falls below 28 m^3/s prior to December 31 (egg stage), and below 14 m^3/s prior to April 30 (alevin stage). Since egg abundance at various depths within the substrate was not known, it was not possible to determine the extent of losses with reduced flow below these levels.

The main chinook spawning area below Morice Lake was examined at a flow of 27 m3/s on November 26, 1979. At 27 m3/s most redd sites were wetted or slightly exposed. However, the tops of some marginal redds where chinook were observed spawning in September were up to 30 cm above the water surface. Since chinook eggs had not hatched and were therefore immobile, it was judged that inadequate flows resulting in some egg losses would occur at lower flows. Flows in the upper Morice in December 1979 dropped to 20 m^3/s, probably exposing some redds sufficiently to cause egg dewatering. However, this was not verified by field examination. Robertson et al. (1979) indicated a flow of 28 m^3/s is required to maintain chinook redd sites sufficiently wetted during the egg incubation phase. Field observations agree with this estimate for existing spawning flows. However, since incubation flow requirements are dependent on spawning flows, if spawning occurred at flows of less than 80 m^3/s it is probable that flows of less than 28 m3/s could be tolerated without unduly high egg losses.

An examination of six chinook redd sites in the upper Morice River on April 20, 1979 suggests that a flow of 13 m3/s is marginal for the survival of chinook alevins and fry within the gravel. Alevins and "buttoned-up" fry were found in dense groups just at water level within the gravel, and in some instances fry were in gravel that was barely moist (Plates 13 and 14). The gravel deeper in the redds was judged by the field crew to be closely packed with fines, and continued downward or lateral alevin movement would likely be increasingly difficult.

Dill (1969) indicated that salmon alevins space themselves within the gravel, probably as a result of competition for well-oxygenated water, or pre-emergent feeding. The dense fry accumulations shown in Plate 14 suggest that at 13 m^3/s there is insufficient flow in the redds for intragravel spacing of fry. Dense grouping of pre-emerged fry could result in some retardation of development or mortalities. Robertson et al. (1979) indicated that a flow of 14 m3/s is required to maintain chinook redds sufficiently wetted during the alevin stage. Field observations during this study suggest that this estimate may be low in relation to existing spawning flows.

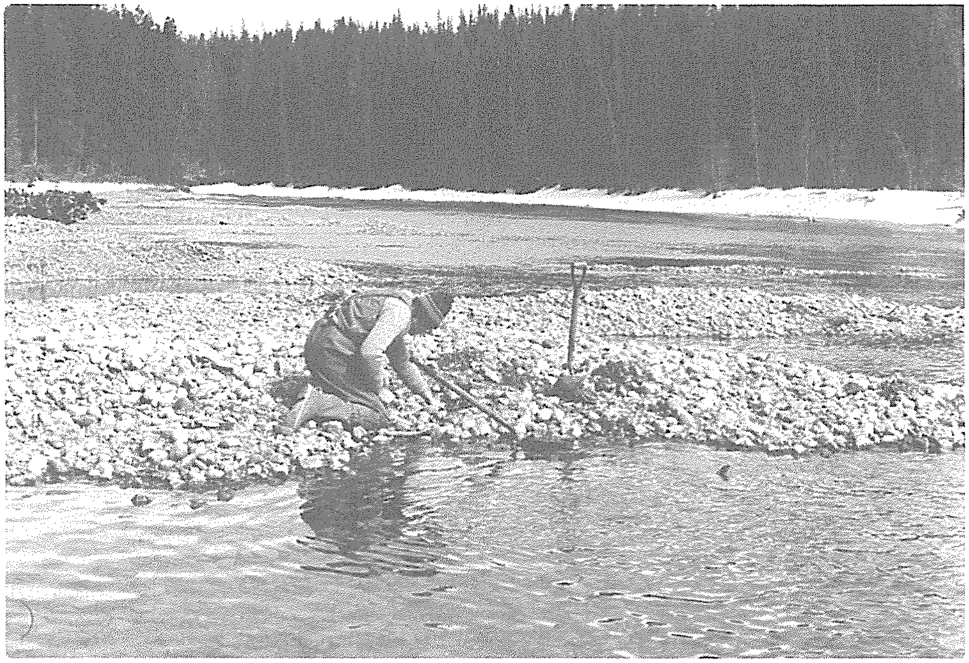


Plate 13: Exposed chinook redds in the upper Morice River on 20 April 1979 at a flow of 13 m^3/s.

Plate 14: Chinook fry in moist gravel prior to emergence in the upper Morice River, 20 April 1979.

3.3.2.2 Pink Salmon:

The flow at which pink salmon egg and alevin losses might occur as a result of inadequate intragravel flows in the Morice is not known. However, such losses probably occur at higher flows than for chinook salmon since pink salmon spawn earlier (two to three weeks) than chinooks, and typically at higher flows (20% higher on the average, based on a comparison of September 1 and 15 flows for 10 years).

Most pink spawning occurs in side channels in Reach 2. These channels are subject to more streamflow fluctuations, including dewatering during periods of reduced flow, than the more stable main channel chinook salmon spawning areas immediately downstream of Morice Lake. The pronounced "dune" formations which presumably enhance subgravel water percolation in chinook salmon spawning areas are not evident in pink salmon spawning areas, suggesting that greater flows might be necessary to obtain required intragravel flow.

A study of side channel flows in relation to river stage in May, 1982 determined that, at a mainstem flow of 70 m^3/s, 65% of 27 side channels studied had surface flow. A flow of 95 m^3/s resulted in 80% of the side channels having flow (Section H).

A side channel used by over 600 spawners during early September was examined on November 26, 1979 when river flow was 27 m^3/s. The tops of many redds were up to 25 cm above the water surface (Plate 15). Losses of eggs and newly hatched alevins were probably occurring at these flows and would continue to occur as flows dropped during the period prior to emergence in April.

Sheridan (1962) demonstrated that the dissolved oxygen content of intragravel water remained high as long as water flowed over a gravel bed. Dissolved oxygen levels dropped when flows were insufficient to cover the gravel. High pink salmon egg mortalities due to low flows and insufficient dissolved oxygen levels have been reported by McNeil (1969).

Dissolved oxygen and water temperatures were measured during March and April 1982 at two Morice River side channels which remained ice-free throughout the winter (Section H). Surface waters in the side channels had consistently higher dissolved oxygen levels than the intragravel environment, and water temperatures in the redds were between 1-2°C in one side channel and 2-5°C in the other. In comparison, the mainstem river had temperatures near 0°C under thick ice cover. Higher water temperatures and lower dissolved oxygen levels (5 ppm) in the warmer side channel were likely influenced by groundwater inflow. Dissolved oxygen levels at some areas within these side channels decrease to levels which probably limit the metabolic activity of developing eggs and alevins, resulting in reduced fry size and in some cases direct mortality. However, the disadvantage of dissolved oxygen depression may be offset by the tempering effect of groundwater in preventing redd desiccation and freezing of eggs and alevins - a major concern in rivers such as the Morice River with long cold winters and low winter flows (Section H).

During November, newly hatched alevins were found in the gravel 2 to 3 cm below the water line at two sites examined, indicating that at least some pink eggs were hatched by this time. This early hatching of pink salmon suggests that they may be less vulnerable to low December flows than chinook salmon since pink salmon alevins could move downward to some degree and avoid dewatering.

3.3.3 Juvenile Rearing Habitat - Flow Assessment

The availablility of rearing habitat for juvenile salmonids influences the capability of stream systems to produce smolts (Chapman 1966). For this assessment, the rearing phase of steelhead trout, and chinook and coho salmon was separated into two periods - the active summer period and the inactive winter period. The active period extends from approximately May 15 to the end of October when water temperatures are generally above 5°C and juvenile salmonids are actively maintaining feeding territories. The inactive period extends from early November to May 15 when maintenance of feeding territories is probably not critical.

The initial study design placed most emphasis on changes in summer rearing areas since that has been the focus in previous studies of this nature (e.g., Neuman and Newcombe 1977). However, the 1979 Morice River work indicated that winter low flows are also an important consideration in an assessment of juvenile rearing capacity. Supplementary studies conducted during the winters of 1981 and 82 to determine the overwinter survival of juvenile salmonids in side channels of Reach 2 (Section C), indicated that the late March-early April period of lowest flow is a period when significant mortality of juvenile salmonids overwintering in side channel habitats occurs.

3.3.3.1 Summer Rearing Phase:

Rearing habitat for all species generally increased with increased flow to at least 176 m3/s, the highest flow for which measurements were made (Figure 3.19). The

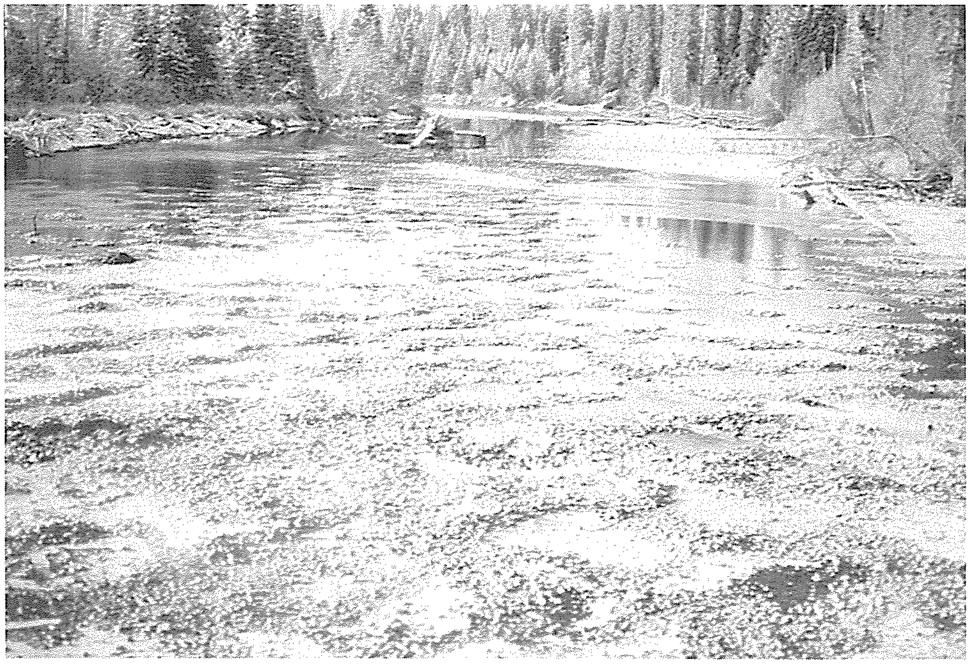


Plate 15: A side channel of the Morice River used by 600 pink salmon spawners illustrating conditions on 26 November 1979 at a flow of $27 m^3/s$.

Plate 16: Isolated pools such as this one had high concentrations of overwintering salmonids during April, 1979.

increased rearing habitat at higher flows results from flooding of additional channels which frequently offer low velocity water and suitable cover. Although depths and velocities may be most suitable in the main channel at lower flows, rearing of juvenile salmonids is often restricted to marginal areas because of limited cover in mid-channel sections. Coho rearing habitat was reduced more rapidly as flow dropped than was the case for steelhead and chinook rearing (Figure 3.19). This is partially a result of coho making little use of cobble cover, which becomes more available at low flows.

Three parameters were used to establish availability of suitable habitat along transect lines: average water velocity, water depth, and the availability of cover within 2 m. After a thorough review of salmonid streamflow requirements, Giger (1973) indicated that these are major parameters determining fish species distributions and territorial behavior.

Water depth and velocity criteria were developed from the minnow trap data discussed in Section 3.1 and from information derived from the probability-of-use curves developed by Bovee (1978). Probability-of-use curves provide a quantitative description of the frequency of occurrence of juveniles at various water depths and velocities. For the purpose of this study, a 0.2 probability of occurrence was used to derive the upper and lower criterion limits, as this covers most of the estimated range of use by juveniles.

The criteria used in the analysis of the availability of suitable rearing habitat along transect lines are presented in Table 3.18. In addition to points falling within the depth and velocity criteria, some form of cover must be present within 2 m to provide acceptable rearing. For steelhead and chinook, any cover category was acceptable. However, cobble cover was judged as not acceptable for coho since field studies indicated low use of cobble areas.

It was assumed that changes in length of suitable rearing habitat along the transect lines reflected changes in the overall availability of rearing habitat in the two reaches examined.

As discussed in the introduction to Section 3.3, extensive additional work was undertaken to examine the availability of rearing habitat with changing discharge in the Morice River. This work incorporated additional criteria based on underwater observations of fish habitat (Section G), and tested the sensitivity of these relationships to changes in the criteria used. This supplementary work is based on a series of surveys conducted at one flow and extrapolated to other flow levels using computer modelling (Volume 15, Section D).

3.3.3.2 Winter Rearing Phase:

Severe ice conditions and the availability of side channels which do not dewater during winter influence the quality of juvenile salmonid overwinter habitat in the Morice River. Both are influenced by flow.

Lowest flows in the Morice River occur in late winter. Flows characteristically decrease from a monthly mean of 70 m^3/s in November to less than 20 m^3/s in April (Figure 1.2). The number of wetted side channels decreases substantially between early and late winter (Figure 3.20), and could account for the loss of juveniles stranded in isolated channels in the late winter (Plate 10). Approximately 70% of the side channels examined in this study during November were dewatered by April.

The number of wetted side channels decreases most rapidly at low flow levels which occur during the winter. Although Figure 3.20 suggests wetted side channels would be eliminated only at zero flow, this would in fact occur at some flow below 20 m^3/s when all of the Morice River flow would be restricted to the main channel.

From early November through mid-May, juvenile salmonids are inactive and exhibit a characteristic hiding behaviour, either in the substrate, in log jams or in other cover in both side and main channel areas. As flows drop during the winter, side channels become intermittent or completely dry, and fish must move out or into more confined areas. By mid-April, high concentrations of fish may occur in the pools left in some channels (Plate 16). If no pools exist, fish perish, as was observed in April 1979 when dead juveniles were found in dried channels. During years when river flows drop the lowest, losses would likely be the greatest. Some sections of the Morice River such as Reach 2 are comprised of extensive side channels. Juvenile salmonid rearing in these sections would be most affected by the loss of side channels.

Electrofishing in two isolated pools in a side channel in Reach 2 in late April 1979 resulted in the capture of 54 and 120 juvenile salmonids, respectively. This indicates a high concentration of fish in the few pool areas left in the channel. As snow and shelf ice melted, and water temperatures in the side pools increased to a range of 6 to 14°C (compared to 3 to 4°C in the main river), fish in the isolated pools were readily observed foraging.

Fish remaining in exposed pools in intermittent channels during April are vulnerable to predation from a sizeable population of mergansers (100+) on the Morice River. Under suitable conditions, mergansers can take a heavy toll of juvenile salmonids (Elson

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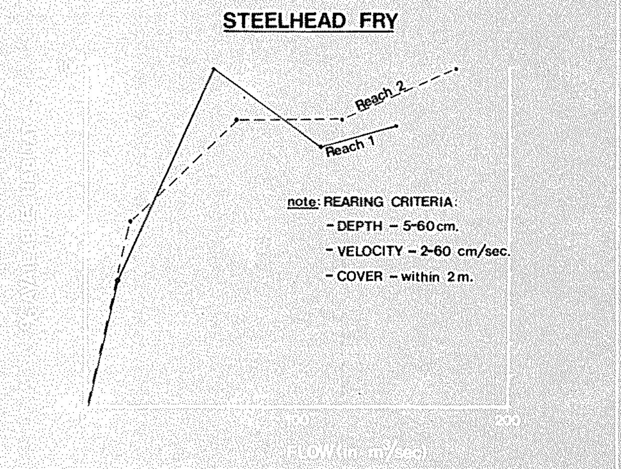
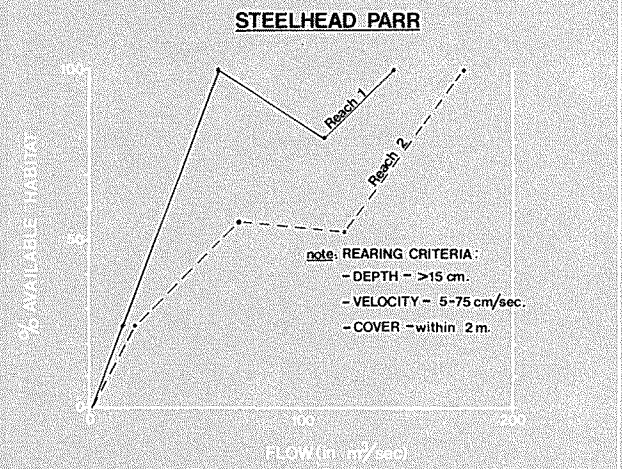
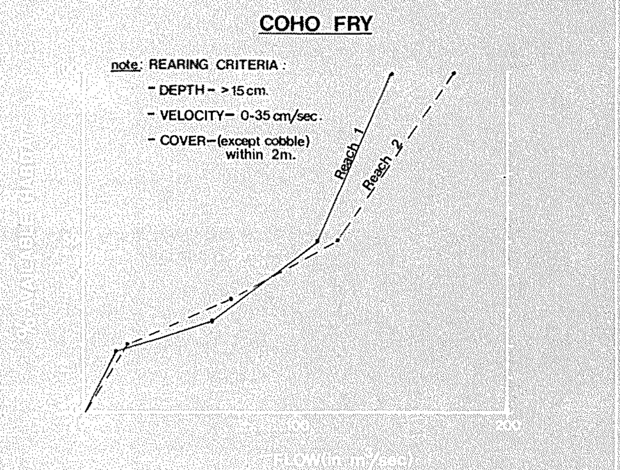
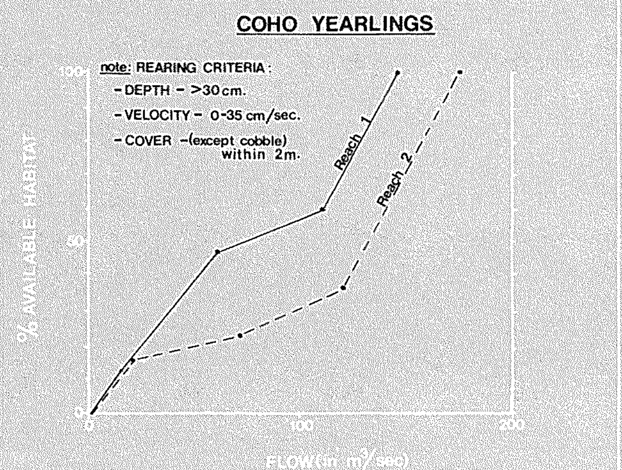
FIGURE 3.19

ESTIMATED CHANGES IN JUVENILE SALMONID HABITAT WITH CHANGING FLOW IN THE MORICE RIVER









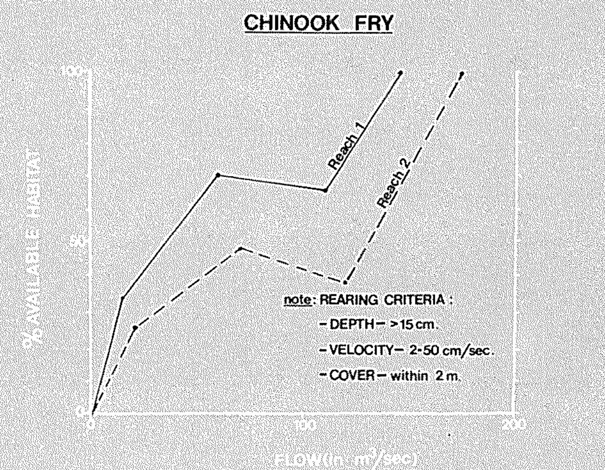


FIGURE 3.20: ESTIMATED CHANGES IN WETTED SIDE CHANNEL ABUNDANCE WITH CHANGING FLOW IN THE MORICE RIVER

notes: - PERCENTAGE WETTED SIDE CHANNEL EXPRESSED AS A PERCENTAGE OF THE MAXIMUM NUMBER MEASURED DURING SURVEYS.
- DATA BASED ON REARING TRANSECTS IN REACHES 1 AND 2.

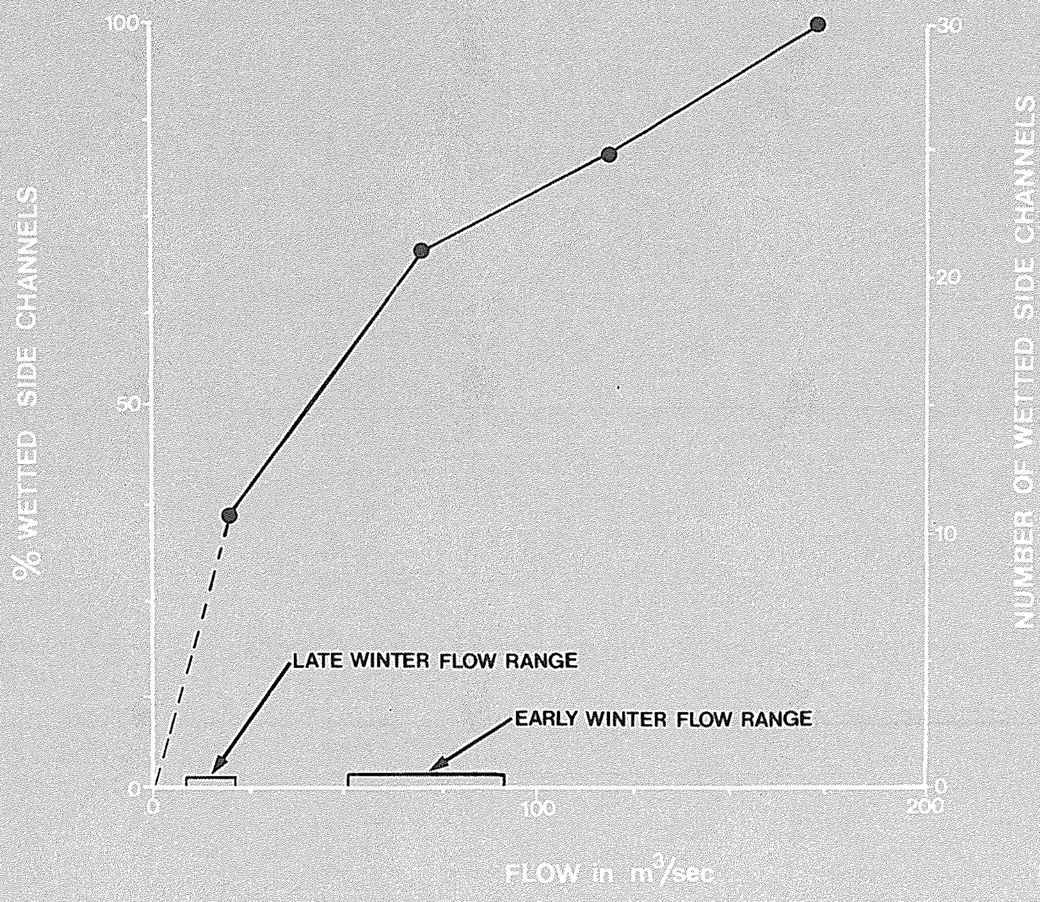


TABLE 3.18
Rearing Criteria for Juvenile Salmonids During the Late Summer and Fall Period in the Morice River

	DEPTH (cm)			VELOCITY (cm/s)		
Species and Age	Bovee[1]	1979 Morice Study[2]	Adopted Criteria[3]	Bovee	1979 Morice Study	Adopted Criteria
Steelhead fry	5-56	<85	5-60	5-64	2-35[4]	2-60
Steelhead parr	8-112	>15	>15	6-75	5-60	5-75
Coho fry	27-126	>15	>15	3-38	0-15	0-35
Coho yearling	NC[5]	>30	>30	NC[5]	0-15	0-35[6]
Chinook fry	>19	>15	>15	5-51	2-50	2-50

1 From Bovee (1978). Based on 0.2 probability-of-use

2 See Section 3.1.1

3 Adopted criteria were used for the rearing habitat transect analysis. These criteria are the best estimates of depth and velocity use by juveniles after considering collection techniques and applicability to the mainstem Morice River. Bovee's velocity data are more reliable due to the site specific method of collection. However, some of his depth criteria may be less applicable since some of the smaller creeks he sampled may not have had deeper water areas, thus underestimating useable depth.

4 The Morice study indicated use of the 0-5 cm/s category. However, field observation indicated fish were using areas with slight current and 2 cm/s was estimated as the lower limit

5 No criteria presented

6 Coho yearling criteria not available from Bovee (1978); however velocity criteria assumed to be similar to coho fry velocity criteria

Note: Results of supplementary studies conducted during 1982 (Section G) to determine habitat preferences of juvenile salmonids were used to develop new rearing criteria for habitat modelling (Volume 15, Section D).

1962). During 1979, exposed side pools were isolated for approximately two weeks from the time the ice cover was gone until rising river levels flooded the side channels and enabled the juveniles in the pools to disperse.

Unusually low winter flows may also influence overwintering juvenile salmonids though the development of severe ice conditions which may lead to fish mortalities. Severe ice conditions were observed during November 1979 when a combination of unseasonably low flow (30 to 40 m3/s), lack of snow cover and freezing air temperatures resulted in the development of thick surface ice on many of the side channels and small tributaries of the Morice River. Some side channels in Reach 2 were completely frozen. Juvenile fish in these channels were frozen or suffocated (Plates 17 and 18). Dead coho salmon, steelhead trout, mountain whitefish, largescale suckers, lamprey and aquatic insects were identified through the ice. Intermittent tributaries such as Chinook Island and Cedric Creeks were also frozen, and high juvenile mortalities probably occurred.

A study of juvenile salmonid overwinter survival during 1981-82 found that only 43% of the juvenile fish overwintering in isolated side channels of Reach 2 survived to the following spring, when flows through the side channels resumed (Section C). The study also indicated that the channels with groundwater inflows and consequently smaller reductions in wetted area (from October to April), had the greatest overwinter survival rate. Steelhead trout parr and fry had a lower overall survival rate (23% and 30%, respectively) than coho and chinook salmon (52% and 61%, respectively). These higher overwinter survival rates may result from the tendency of chinook and coho salmon fry to occupy deep pool habitats with log debris cover, rather than the shallow riffle areas with less cover occupied by steelhead fry (Section C). The low survival of steelhead parr is not explained by these data as parr tend to occupy habitats similar to those of chinook salmon during the autumn.

During November 1979, subsurface ice (anchor ice) formed in Reaches 5 and 6. The ice covered marginal substrate areas generally occupied by chinook and steelhead fry. Water temperatures in the upper four reaches of the Morice River remained above freezing, and no anchor ice was observed. Little research has been conducted into the effects of anchor ice on fish and aquatic insects, although work in the Sierra Nevadas has indicated that subsurface ice formation could have severe implications to fish overwintering in streams, due to ice scouring and channel dewatering (Maciolek and Needham 1952; Needham and Jones 1959). Butler (1979) indicated that streams exposed to frequent anchor ice formation may be poor fish producers despite other desirable features such as high fertility, good cover and adequate flows.

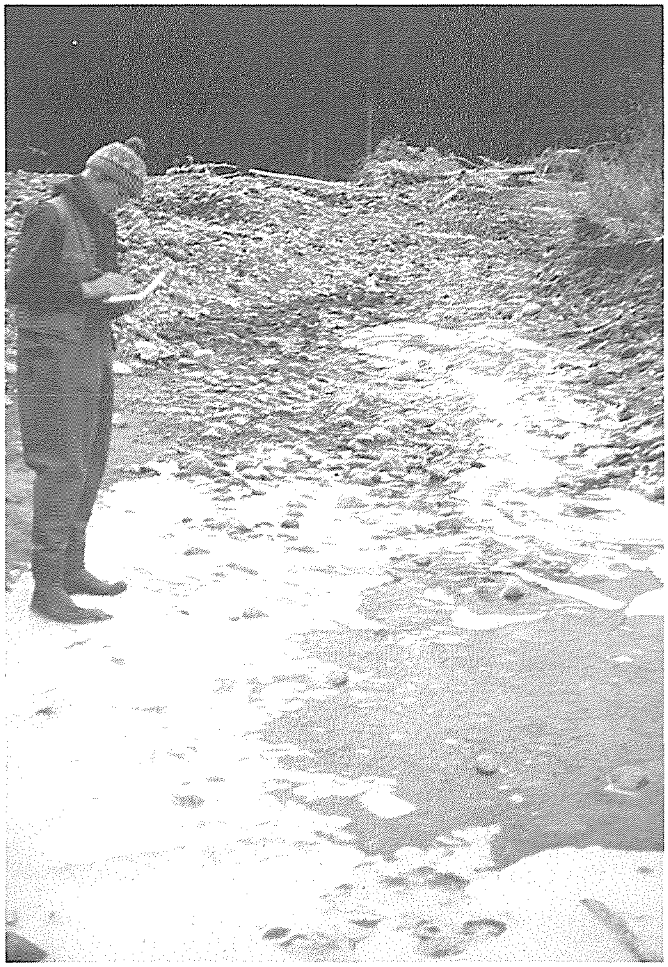


Plate 17:
Side channels such as this site used by rearing juvenile salmonids were frozen solid during a cold dry period in early November, 1979.

Plate 18: Dead juvenile fish such as these were commonly observed through the ice in side channels in the Morice during November, 1979.

4.0 SUMMARY

4.1 Morice River Fish Resources

The Morice River system supports substantial populations of chinook, coho and pink salmon; steelhead, rainbow and cutthroat trout; Dolly Varden char, mountain whitefish as well as largescale suckers, longnose dace, prickly sculpins and Pacific lamprey. The Morice River is well known for its run of summer steelhead trout. This section summarizes information on the fish resources of Morice River, its tributaries and Morice Lake based on the initial baseline studies conducted during 1979 and supplementary studies conducted during 1980 to 82.

Adult summer steelhead trout first appear in the Morice River in mid-August, overwinter in the mainstem river and in Morice Lake, and spawn in mainstem and tributary locations during May and early June the following year. Most spawning occurs upstream of Houston Tommy Creek in both main and side channel locations of the Morice River. As well, adult spawners utilize Owen, Cox, Lamprey and Chinook Island Creeks and a number of Bulkley River tributaries. An estimated spawning population of 2,000-3,000 summer run steelhead utilize the Morice and Bulkley River system, usually returning after one year of ocean life. The Morice and Bulkley Rivers account for approximately 40-50% of the total Skeena River steelhead sport fishery (based on B.C. Fish and Wildlife Branch estimates), and have had the highest reported harvest for any river system in B.C. since 1976.

Steelhead fry typically emerge in mid-August and spend three to five years in the Morice system prior to migrating to the ocean as smolts. Juvenile steelhead rearing occurs throughout the mainstem river and in 16 tributaries of the Morice River, particularly Owen, Gosnell and Lamprey Creeks, and the Thautil River. Tributaries account for approximately 50% of steelhead fry rearing, while the mainstem Morice accounts for a higher proportion of the parr rearing in the system. Juveniles move seasonally between tributaries and the mainstem river.

The first adult coho salmon arrive in the Morice River in mid-August. An estimated spawning population of 4,000 coho salmon spawn in the Morice River from late October to mid-December, with an apparent peak in activity in mid- to late November. Based on DFO escapement records, approximately 8% of the total coho escapement to the Skeena River system spawn throughout the mainstem Morice River and its tributaries. Most mainstem spawning occurs upstream of Owen Creek, with the heaviest use in the 2 km of river immediately below Morice Lake. Tributaries are utilized by Morice coho salmon during those years when fall freshets provide adequate flows for access. During extreme low flow years, coho spawning is concentrated in the mainstem and side channels of the Morice River and in Gosnell Creek, Houston Tommy Creek and Thautil River. During most years fall freshets provide adequate access to other tributaries and coho spawning is partitioned evenly between tributaries and the mainstem.

Coho fry typically emerge from mid-May through early July and spend one or two years in the Morice system prior to ocean migration. Approximately two-thirds of the coho fry rearing occurs in tributary streams to the Morice River, particularly in Gosnell, Houston Tommy and McBride Creeks. Rearing distribution may vary considerably from year to year depending upon spawner access to tributaries. As well, ponds in old river channels offer important rearing areas in the Morice River and several tributaries.

Chinook salmon adults migrate into the Morice River from July to late September, and hold in the upper river and Morice Lake until spawning during September and early October. Chinook salmon spawning populations are estimated to number 8,000 fish in the main channel of the upper Morice River. Nearly all chinook spawning occurs between Lamprey Creek and Morice Lake, with the greatest concentration of spawners occurring in the 4 km immediately downstream of Morice Lake. Based on DFO escapement records, Morice River chinook salmon represent 25% of the total escapement of chinook salmon to the Skeena system.

Chinook fry typically emerge from April through June, with most juveniles spending one winter in the river prior to ocean migration. Chinook fry were found almost exclusively in the mainstem Morice and Bulkley Rivers, and were dispersed throughout the length of river examined.

Pink salmon migrate into the Morice River during late August with peak spawning occurring in early September. Pink fry presumably migrate downstream to the Skeena River estuary immediately after spawning. Most spawning occurs in side channels of the Morice River between Fenton and Gosnell Creeks, with tributary spawning accounting for only 2% of the total pink run. Morice River pink salmon are predominantly an odd-year stock, with an estimated spawning population size of 20,000-25,000 in odd years and 10,000 in even years. Based on DFO escapement records, Morice River pink salmon represent less than 1% of both the odd-year and even-year escapements to the Skeena system.

Resident fish in the upper Morice River consist primarily of mountain whitefish (85%), largescale suckers (6%), Dolly Varden char (6%), and rainbow trout (3%).

4.2 Morice Lake Fish Resources

Data on the fish resources of Morice Lake were collected during a creel census program in 1979 and tagging studies conducted in 1980. Based on creel census data, anglers spent an estimated 1,183 days catching 1,032 fish in Morice Lake in 1979. The predominant species angled in the lake is rainbow trout (58%), followed by lake trout (20%), and Dolly Varden char (8%). Chinook, coho and kokanee salmon, cutthroat trout and mountain whitefish are also taken by anglers. The Nanika River is the only identified spawning area for Morice Lake rainbow trout.

An estimated 300 to 500 sockeye salmon beach spawn in the vicinity of Cabin Creek near the south end of Morice Lake. Morice Lake serves as the juvenile rearing area for sockeye spawned in the Nanika River and Morice Lake and possibly Atna Lake.

4.3 Relationship Between River Flow and Available Fish Habitat

Studies conducted in 1979 relate the availability of steelhead and salmon spawning, incubation, and rearing habitat to flow in the Morice River. The results of more detailed studies conducted in 1982 are reported in Volume 15. Results of the 1979 studies suggest that suitable steelhead trout spawning habitat is most abundant in the main channel at flows between 60 and 100 m^3/s and in side channels at flows up to 144 m^3/s. Steelhead trout spawning habitat is reduced substantially at flows less than 60 m^3/s. All chinook salmon spawning areas are useable at a flow of 80 m^3/s. Available chinook salmon spawning areas decrease at flows less than 80 m^3/s, and less than half of the spawning areas available at higher flows are useable at 50 m^3/s. Suitable pink salmon spawning habitat is reduced by approximately 40% when flows drop from 120 to 88 m^3/s, which is within the range of natural spawning flows.

Chinook salmon egg and alevin losses due to inadequate incubation flows likely occur when the Morice River flow falls below 20 m^3/s prior to December 31 (egg stage) and below 14 m3/s prior to April 30 (alevin stage). Pink salmon egg and alevin mortalities likely occur at higher flows than these since pink salmon spawn at higher flows than chinook salmon in sections of the river which dewater more readily. Since steelhead incubation flows are generally at least as great as spawning flows, during incubation, losses due to insufficient flows likely do not occur in the mainstem Morice River.

Juvenile summer rearing habitat for all species increases with increased flows to at least 176 m3/s, the highest flow at which measurements were conducted. The increased rearing habitat at higher flows results from flooding of additional channels which typically offer low velocity water and suitable cover. Although depths and velocities may be most suitable in the main channel at lower flows, rearing is often restricted to the river margins due to limited cover in mid-sections of the channel.

Winter low flows have an important influence on juvenile rearing in the Morice River. Flows characteristically decrease from a monthly mean of 70 m^3/s in November to less than 20 m3/sin April. The number of wetted side channels decreases substantially between early and late winter and accounts for a heavy loss of juveniles stranded in isolated channels in the late winter. Approximately 70% of the side channels examined during November were dewatered by April. Severe ice conditions early in the winter result in mortalities to juvenile fish, particularly those rearing in side channel locations. Additional studies examining the relationship between discharge and suitable fish habitat are discussed in Volume 15, Section D.

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APPENDIX A1

Study Area Description

TABLE AI.1
Some Physical Characteristics of the Morice and Bulkley Rivers

Reach	Location	Length (km)	Gradient (m/km)	Channel Complexity[1]	Instream Cover[2]	Substrate	Miscellaneous Comments
1	Morice Lake to Gosnell Creek	15.4	3.2	1.7	Moderate abundance of log jam and debris in lower section	Mainly cobble with some gravels	The upper 4 km is lower gradient than the remaining 11 km with excellent spawning gravels. Some deep pools, rock outcrops and steep banks
2	Gosnell Creek to Fenton Creek	33.8	1.9	4.7	High abundance of log jams and debris	Mainly gravel with cobble in main channel	Most braided reach with greatest fish habitat diversity. A large number of ponds associated with old river channels and beaver activity
3	Fenton Creek to Peacock Creek	27.8	2.7	1.2	Low abundance	Variable. Silt to boulder and bedrock	Low fish habitat diversity
4	Peacock Creek to Dockrill Creek	18.1	1.3	2.0	Moderate abundance of log jams and debris	Gravel and cobble	Some areas of good spawning gravels. Numerous pools and some extensive gravel bar development
5	Dockrill Creek to McDowell Creek	35.0	1.7	1.4	Low abundance	Silt to cobble	Low fish habitat diversity
6	McDowell Creek to Driftwood Ck.	31.2	2.2	1.8	Moderate abundance of log jams and debris in upper section	Silt to cobble and boulder	Extensive side channel and gravel bar development in the vicinity of Telkwa. Moderate fish habitat diversity
	Driftwood Ck. to Skeena River	73.4	2.8		Boulder habitat	Abundance of cobble and boulder	Many rapids and deep pools, confining canyons and rock outcrops. Not examined for fish abundance in this study

1 Refers to proportion of total channel length to main channel length during the late summer.
2 Abundant = 20 to 40 log jams/km; Moderate = 5 to 20 log jams/km; Low = less than 5 log jams/km.

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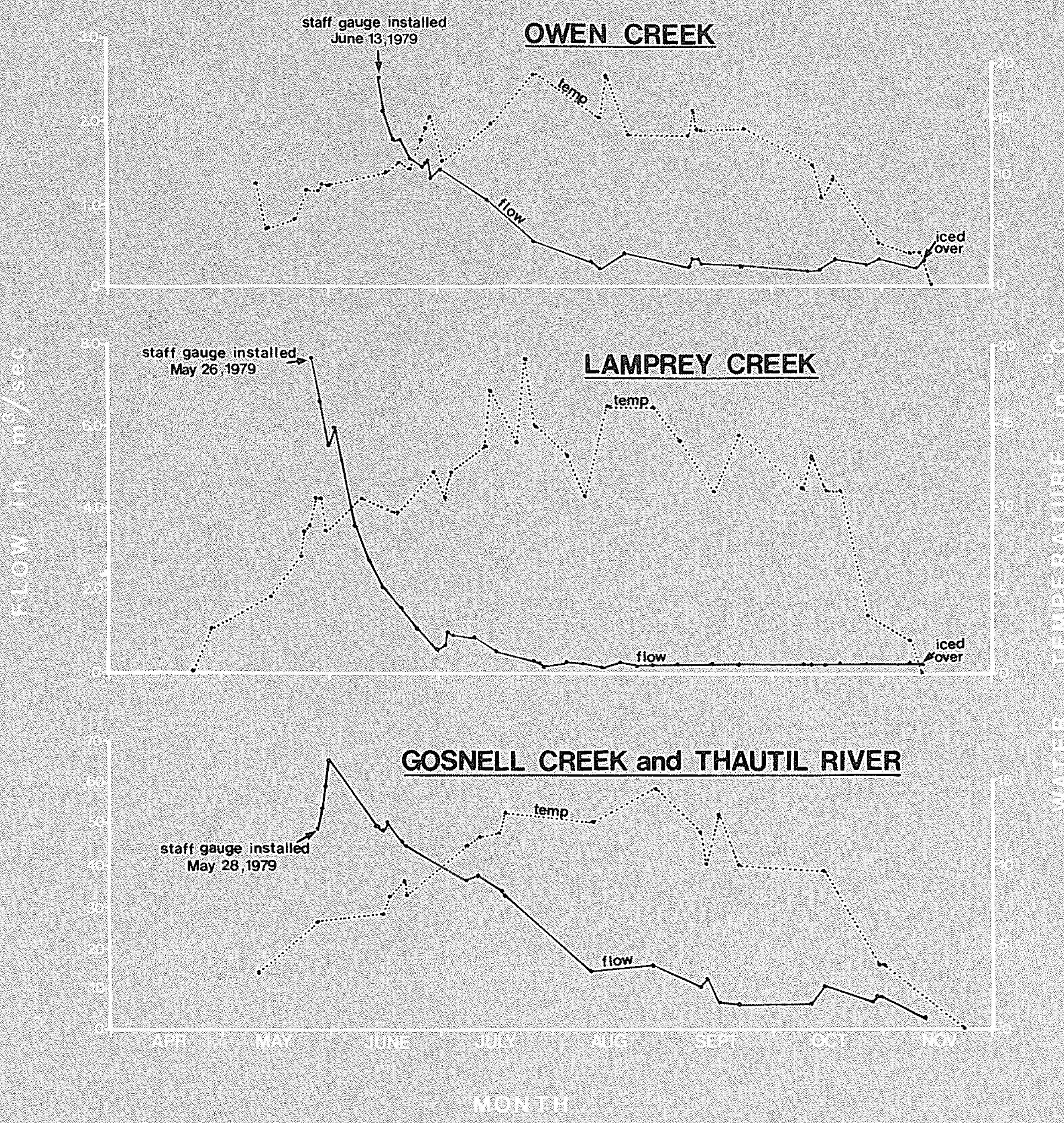
FIGURE A1.1: FLOW AND WATER TEMPERATURE MEASUREMENTS IN THREE MORICE RIVER TRIBUTARIES, MAY-NOV., 1979



APPENDIX A2

Methods

TABLE A2.1
Dates, Methods, and Extent of Radio-Tagging Surveillance

Date	Method[1]	Extent
Oct 11-26	RB, Ground	Tagged fish from Bulkley confluence to above Gosnell.
Oct 19	Ground	Lower Morice
Oct 26	Ground	Lower Morice
Nov 7-10	RB	Bulkley confluence to Morice Lk.
Nov 21		
Nov 26		
Dec 6		
Jan 14		
Jan 31		
Feb 15	FW	Bulkley/Morice from Smithers to Morice Lake.
Feb 21	Ground	Tagged fish upper Morice above Gosnell.
Feb 27	Ground	Upper Morice.
March 5	FW	Bulkley/Morice from Smithers to Morice Lake.
March 24	FW	Bulkley/Morice from Smithers to Morice Lake. Nanika River.
April 11	Ground	Morice below Owen Creek.
April 13-14	Ground	Tagged fish from Owen Creek to Peacock Creek.
April 23	FW	Bulkley/Morice from Smithers to Morice Lake. Nanika. Lower ends of Lamprey and Owen Creeks.
April 26	Ground	Morice to above Lamprey.
April 30	FW	Bulkely/Morice from Smithers to Morice Lake. Nanika.
May 3-7	Ground	Morice below Lamprey Creek.
May 11	FW	Bulkley/Morice from Smithers to Morice Lake. Nanika, Gosnell, Lamprey, Owen, Houston Tommy
May 12	RB	From Mile 11 to Gosnell confluence.
May 13	RB	Nanika River mouth to Owen Creek.
May 18	RB	Owen Creek to Gosnell.
May 19	FW	Morice/Bulkley, Nanika and Morice tributaries.
May 21	Ground, RB	Lower Lamprey, Owen Creek to Lamprey.
May 23	RB	Mile 16 to Owen Creek.
May 23	Hel	Morice tributaries only.
May 24	RB	Owen Creek to Lamprey Creek.
May 26	FW	Bulkley, Buck, Owen, Lamprey, Cedric.
May 27	FW	Gosnell, Atna, Nanika, Houston Tommy.
May 28	RB	Below Bulkley confluence to Morice Lake.
May 30	FW	Bulkley/Morice and tributaries.
June 1	Hel, RB	Lamprey, Gosnell, Morice Lake to Owen Creek.
June 7	RB, Ground	Owen Creek to Lamprey, upper Owen Creek.
June 10	FW	Morice/Bulkley and tributaries.
June 10	RB	Owen Creek to 5 km above Gosnell.
June 12	Hel	Morice from Owen to Morice Lake, Gosnell, Lamprey, Owen and Nanika.
June 15	Hel	Morice Lake tributaries including Nanika.
June 18	RB	Owen Creek to Morice Lake.

1 Surveillance Method:

RB - Riverboat
Ground - Truck, snowshoes, etc.
FW - Fixed wing aircraft
Hel - Helicopter

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FIGURE 3.7

DISTRIBUTION AND ABUNDANCE OF JUVENILE COHO IN THE MORICE AND BULKLEY RIVERS, SEPT.-NOV., 1979

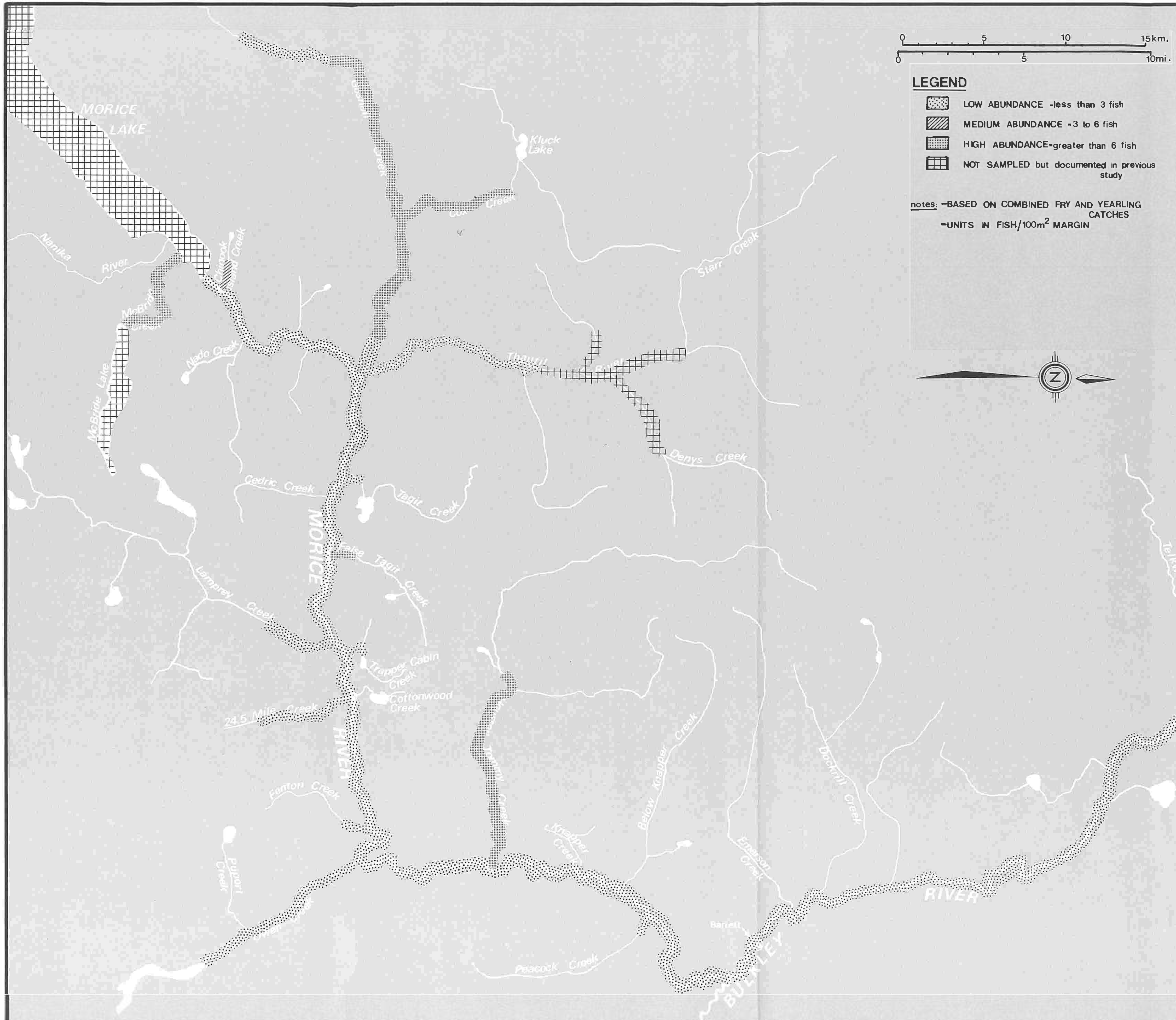

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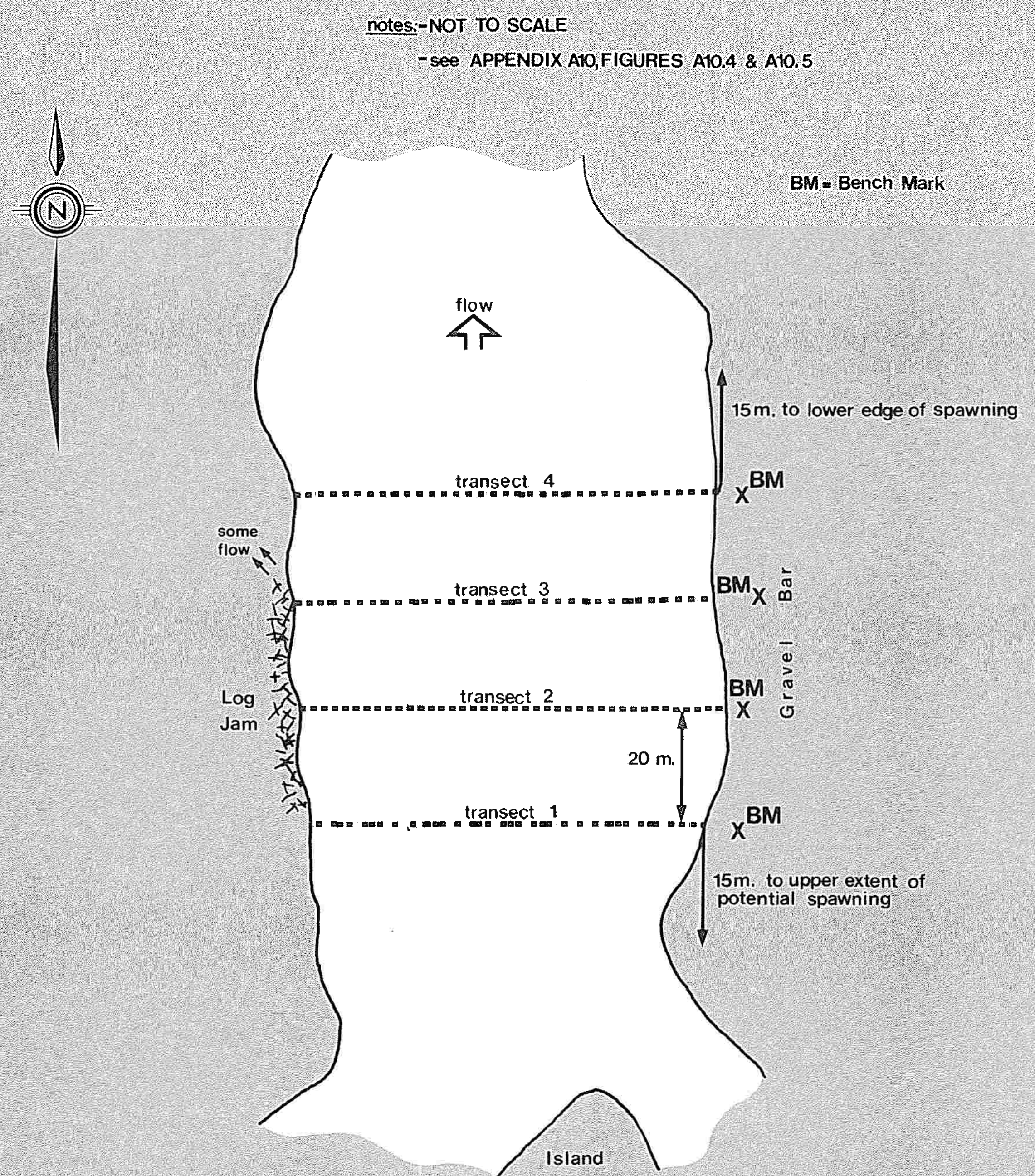
FIGURE A2.2: MORICE RIVER PINK SALMON SPAWNING TRANSECTS (Site T5)*



* see Figure 2.1 for location

APPENDIX A3
Summary of Fish Sampling in the Morice River

TABLE A3.1
Common and Scientific Names of Fish Species Found in the Morice River System

Family	Common Name	Scientific Name
Salmonidae	Steelhead trout	Salmo gairdneri Richardson
	Rainbow trout	Salmo gairdneri Richardson
	Cutthroat trout	Salmo clarki Richardson
	Lake trout	Salvelinus namaycush (Walbaum)
	Dolly Varden char	Salvelinus malma (Walbaum)
	Chinook salmon	Oncorhynchus tshawytscha (Walbaum)
	Coho salmon	Oncorhynchus kisutch (Walbaum)
	Pink salmon	Oncorhynchus gorbuscha (Walbaum)
	Sockeye salmon	Oncorhynchus nerka (Walbaum)
	Kokanee	Oncorhynchus nerka (Walbaum)
	Mountain whitefish	Prosopium williamsoni (Girard)
	Lake whitefish	Coregonus clupeaformis (Mitchill)
	Pygmy whitefish	Prosopium coulteri (Eigenmann and Eigenmann)
Catostomidae	Largescale suckers	Catostomus macrocheilus Girard
	Longnose suckers	Catostomus catostomus (Forster)
Cyprinidae	Redside shiner	Richardsonius balteatus (Richardson)
	Longnose dace	Rhinichthys cataractae (Valenciennes)
Cottidae	Prickly sculpin	Cottus asper Richardson
Gadidae	Burbot	Lota lota (Linnaeus)
Petromyzontidae	Pacific lamprey	Lampetra tridentata (Gairdner)

TABLE A3.2
Numbers of Fish Captured by Electrofishing from May to November 1979 in the Morice and Bulkley Rivers

	May[1]	July	Sept	Nov	Total	%
Steelhead Trout	96	48	461	426	1,031	(39.0)
Chinook Salmon	354	304	109	65	832	(31.4)
Coho Salmon	27	200	139	20	386	(14.6)
Longnose Dace	9	106	124	8	247	(9.3)
Mountain Whitefish	36	8	4	29	77	(2.9)
Dolly Varden Char	3	6	4	11	24	(0.9)
Prickly Sculpin	0	8	15	8	31	(1.2)
Largescale Sucker	3	3	6	4	16	(0.6)
Cutthroat	1	0	0	1	2	(0.0)
	529	**683**	**862**	**572**	**2,646**	

1 Includes a sample collected on April 28, 1979

TABLE A3.3
Adult Fish and Parr (Steelhead Only) Observed in the Morice River Between Morice Lake and Gosnell Creek During Snorkel Surveys from 21 March to 16 November 1979, and Temperature, Visibility and Discharge Data at the Time of Observations

Date	Steelhead	Steelhead Parr[1]	Chinook	Coho	Pink	Resident Rainbow	Dolly Varden	Mountain Whitefish	Largescale Sucker	Pacific Lamprey	Temperature (°C)	Visibility (m)	Discharge (m^3/s)
March 21-22	18	0	0	0	0	0	3	0	0	0	2.0	5	14
May 13	4	0	0	0	0	0	0	67	30+	0	4.0	3-4	72
May 30-31	7	1	0	0	0	2	3	34	few	0	5.5-7.0	3	123
June 5[2]	9	0	0	0	0	1	0	0	0	0	6.0	2	173
June 14[3]	0	0	0	0	0	0	0	0	0	5	6.5	poor	148
July 10	0	5	0	0	0	3	3	104	0	7	10.0	3	138
July 19	0	4	0	0	0	3	8	106	0	20	12.5-14.5	2	146
Aug 8-9	0	35	187	0	0	26	10	435	13	2	13.5	2-3	115
Aug 22	3	26	643	4	66	12	13	723	46	0	15.0-16.0	2-3	104
Sept 5	15	62	285	13	122	49	43	741	36	0	13.5-14.5	2	95
Sept 18-19	28	12	675	13	86	13	42	840	16	0	12.0-13.0	2	83
Oct 10	25	12	2	18	0	8	71	435	55	0	11.0	4	68
Oct 25	10	0	0	6	0	2	25	272	18	0	8.0	2-3	59
Nov 16[4]	3	1	0	74	0	4	21	98	71	0	5.5	4	31

1 Trout visually estimated to be less than 25 cm in fork length. Total could include some resident rainbow and cutthroat
2 Spot survey of specific channels which appeared to offer suitable spawning for steelhead
3 Survey was conducted by one swimmer in the upper 4 km of the Morice river
4 Survey ended 2 km upstream of Gosnell Creek

APPENDIX A4

Steelhead Trout - Commerical Catch,
Spawner Observations, and Juvenile Catch Data

1.0 CALCULATION OF COMMERCIAL FISHERY CATCH OF MORICE AND BULKLEY RIVER STEELHEAD TROUT

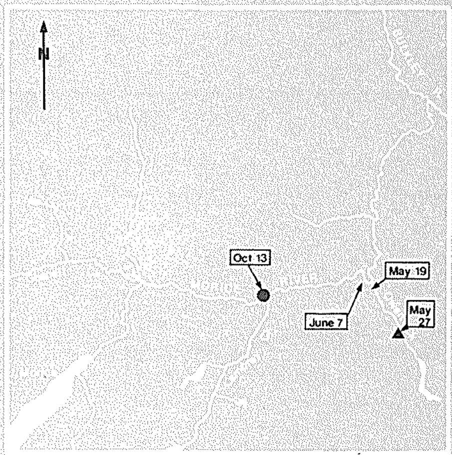
The Marine Resources Branch of the B.C. Fish and Wildlife Branch conducted studies on the steelhead trout catch in the B.C. commercial fisheries in 1976 and 1977, and concluded that approximately 5,000 Skeena steelhead were taken in 1976 and 10,000 in 1977 (Oguss and Andrews 1977; Oguss and Evans 1978). The 1976 season was short with few openings for the Skeena commercial fishery. The resulting steelhead catch was considered atypical and the 1977 catch more representative. These studies did not examine the U.S. interceptions of Skeena steelhead, although such interceptions may be significant (Oguss and Evans 1978).

It was assumed that the proportion of steelhead trout of Morice and Bulkley River origin taken in the Skeena commercial fishery is the same as the proportion of Skeena steelhead taken by anglers in the Morice and Bulkley Rivers (i.e., approximately 43%). The commercial fishery interception of Morice and Bulkley steelhead may thus be estimated as 2,000 to 4,000 fish annually.

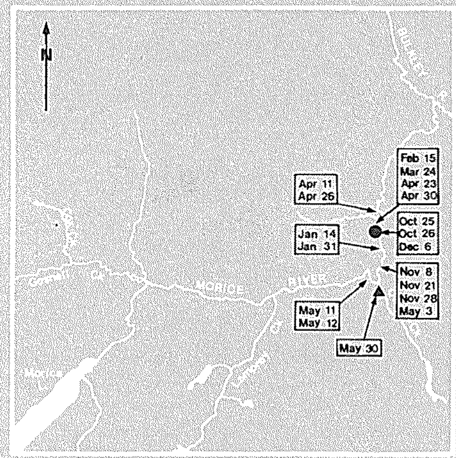
For this analysis, it was assumed that the various runs of steelhead are subjected to equal commercial fishing pressure. However, some runs migrating to certain streams are probably subjected to heavier fishing pressure than others, and would thus comprise a greater proportion of the commercial catch. Information from lower Skeena radio-tagging in 1979 indicates that many of the Morice and Bulkley River fish pass through the lower Skeena during the main part of the commercial fishery (pers. comm., M. Lough, B.C. Fish and Wildlife Branch). It was also assumed that there is equal angling pressure on the major stocks of steelhead destined for various parts of the Skeena system, a situation which likely does not exist.

FIGURE A4.1

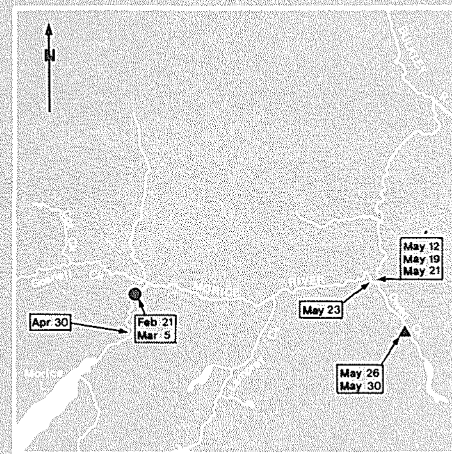
STEELHEAD RADIO-TAGGING AND TRACKING DATA FROM THE MORICE RIVER SYSTEM, OCT. 1978–JUNE 1979



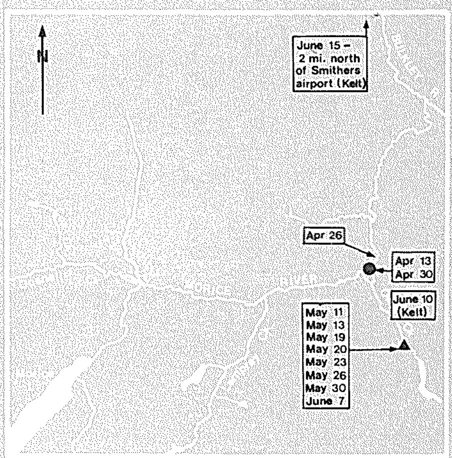
Fish 1 - 4.1 kg. female



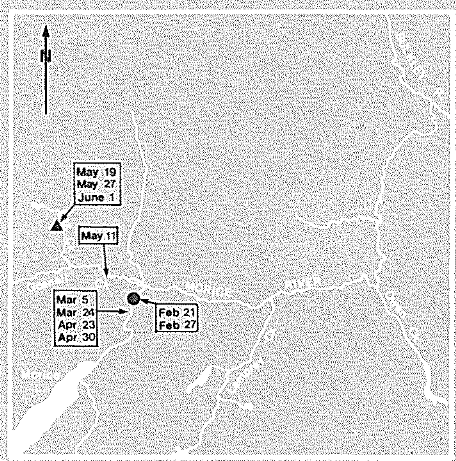
Fish 2 - 4.1 kg. female



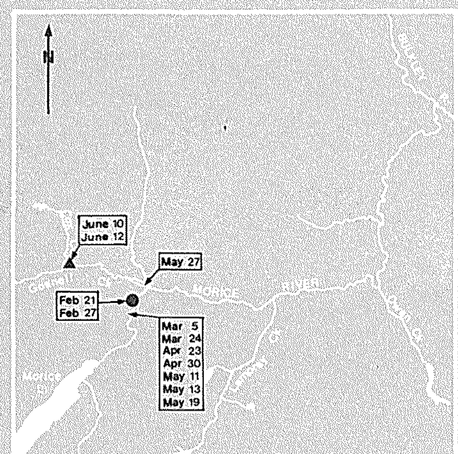
Fish 3 - 5.5 kg. male



Fish 4 - 7.3 kg. female



Fish 5 - 3.0 kg. female



Fish 6 - 3.6 kg. female

0 4 8 12 16 20 24 28 32 km.
0 5 10 15 20 mi.

LEGEND

- ● RADIO-TAGGING SITE
- ▲ SPAWNING LOCATION

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FIGURE A4.2

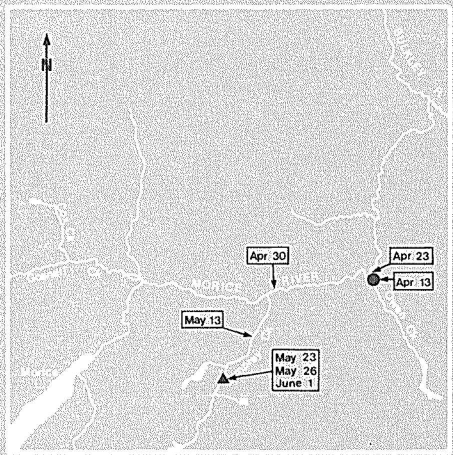
STEELHEAD RADIO-TAGGING AND TRACKING DATA FROM THE MORICE RIVER SYSTEM, OCT. 1978–JUNE 1979

0 4 8 12 16 20 24 28 32 km.
0 5 10 15 20 mi.

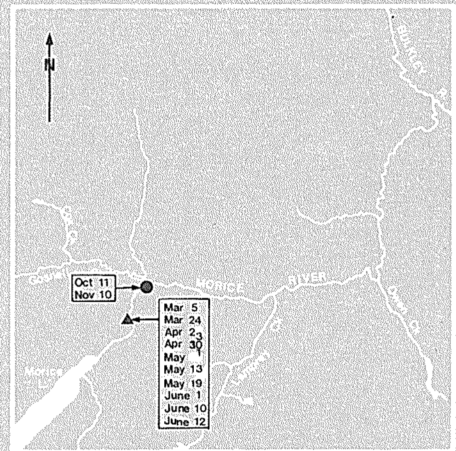
LEGEND

● RADIO-TAGGING SITE

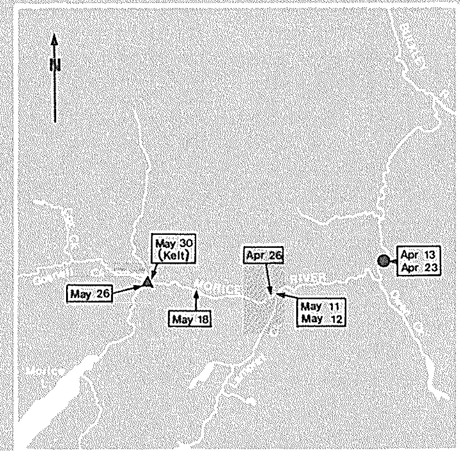
▲ SPAWNING LOCATION



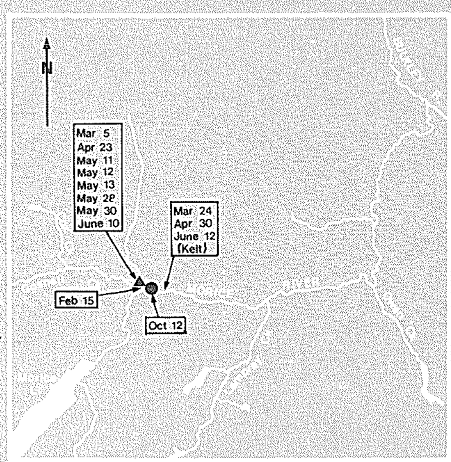
Fish 7 – 5.0 kg. female



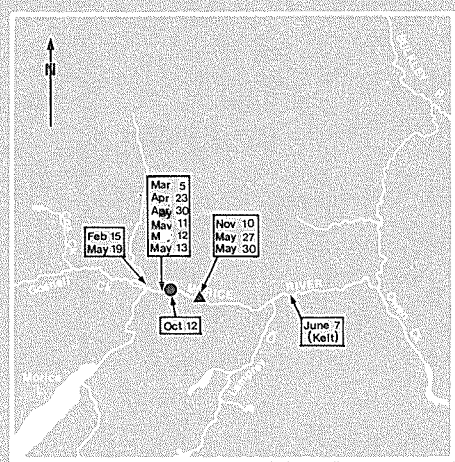
Fish 8 – 5.9 kg. male



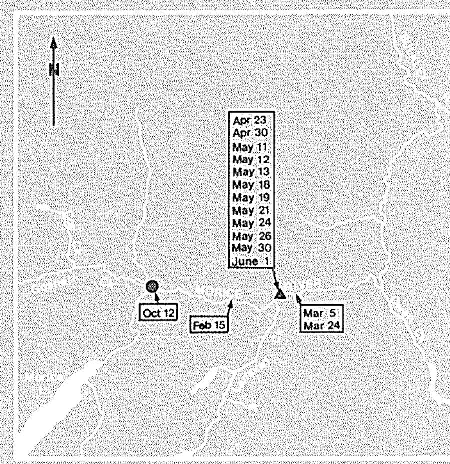
Fish 9 – 5.5 kg. male



Fish 10 – 4.1 kg. female



Fish 11 – 5.5 kg. male



Fish 12 – 5.5 kg. male

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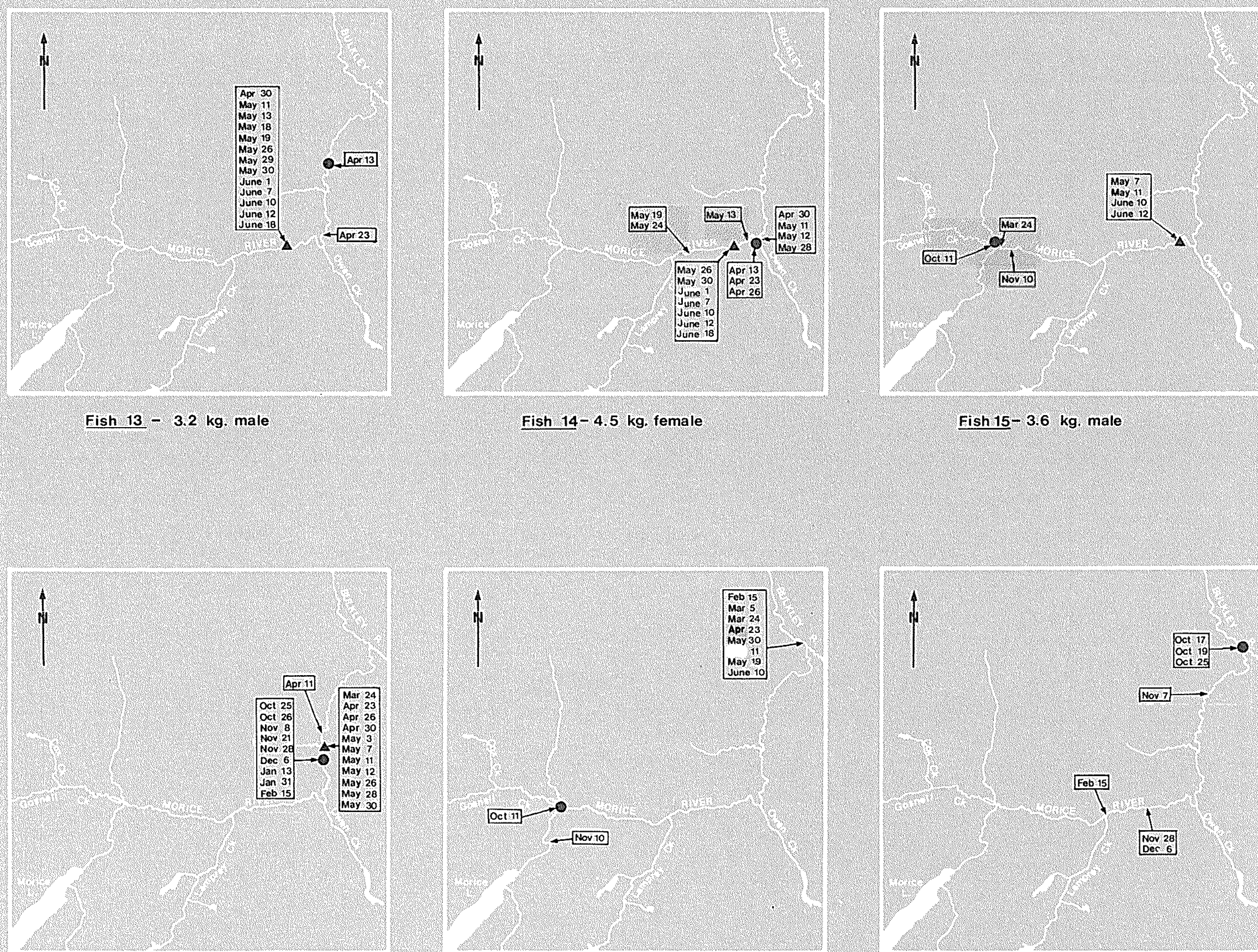
FIGURE A4.3

STEELHEAD RADIO-TAGGING AND TRACKING DATA FROM THE MORICE RIVER SYSTEM, OCT. 1978 – JUNE 1979

0 4 8 12 16 20 24 28 32 km.
0 5 10 15 20 mi.

LEGEND
- ● RADIO–TAGGING SITE
- ▲ SPAWNING LOCATION



Fish 13 – 3.2 kg. male

Fish 14 – 4.5 kg. female

Fish 15 – 3.6 kg. male

Fish 16 – 3.6 kg. female

Fish 17 – 4.5 kg. male

Fish 18 – 4.1 kg. female

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FIGURE A4.4

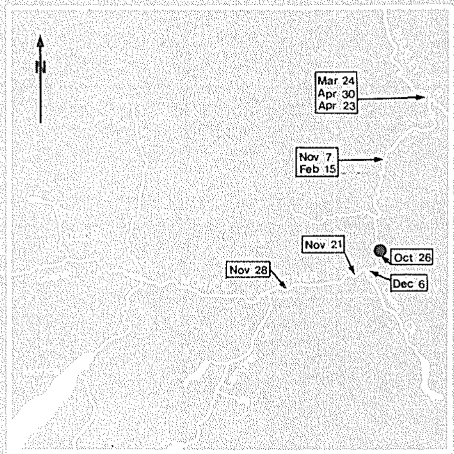
STEELHEAD RADIO-TAGGING AND TRACKING DATA FROM THE MORICE RIVER SYSTEM, OCT. 1978 - JUNE 1979

0 4 8 12 16 20 24 28 32 km.
0 5 10 15 20 mi.

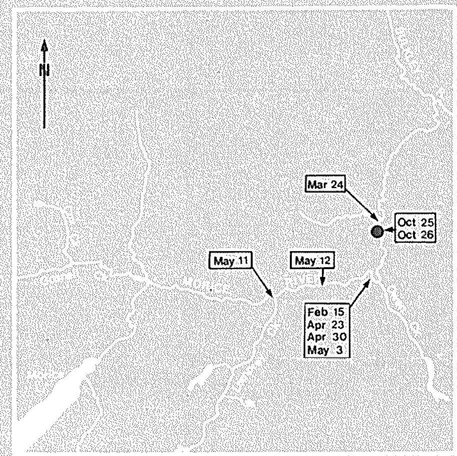
LEGEND

● RADIO-TAGGING SITE

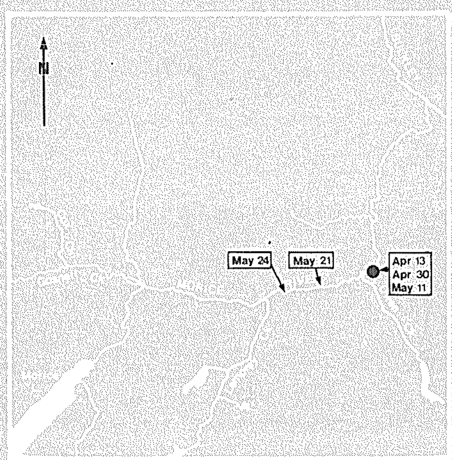
▲ SPAWNING LOCATION



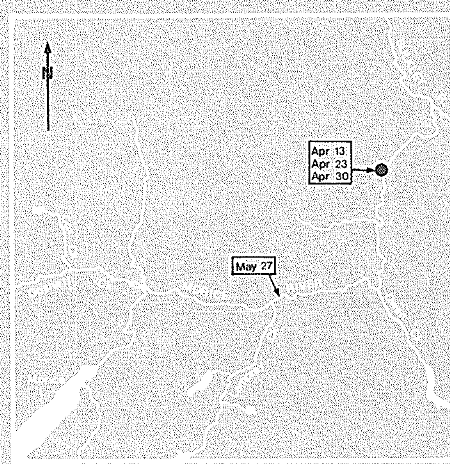
Fish 19 - 5.0 kg. female



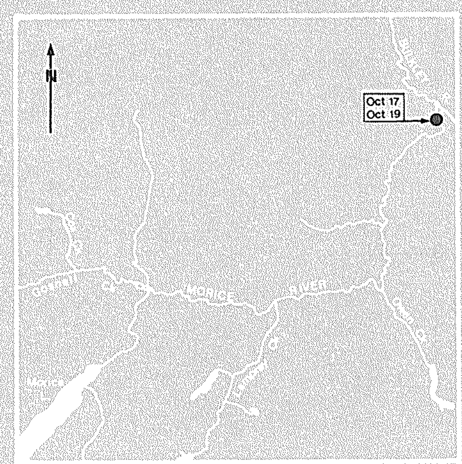
Fish 20 - 5.5 kg. male



Fish 21 - 5.9 kg. male



Fish 22 - 5.9 kg. male



Fish 23 - 4.1 kg. female

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TABLE A4.1
Helicopter Observations of Steelhead Trout in the Morice River[1]

Date	Extent of Survey	Number of Observations and Location	Total	Comments
April 1964	Morice Lk to Lamprey		1,500	As reported in April 14/65 survey
April 14, 1965	Morice Lk to Lamprey	Not specific	102	Difficulty with shadows
April 1, 1968	Morice Lk to Bulkley	Morice Lk to Gosnell - 2 Gosnell to Owen Ck - 52 Owen to Bulkley - 5	59	Important holding water between Lamprey and Gosnell. Some wind problem.
May 7, 1969	Morice Lk to Lamprey	Not specific	7	
April 1, 1970	Morice Lk to Owen	2 miles above Gosnell to Gosnell - 510 Gosnell to Lamprey - 257 Lamprey to Owen - 100	867	Visibility excellent Some question re large schools of fish - suckers?
May 27, 1970	Morice Lk to Gosnell	No fish	0	Good visibility
March 26, 1971	Morice Lk to Gosnell	4 miles below Morice Lk - 2	2	Good visibility
April 21, 1971	Morice Lk to Owen	Morice Lk to Gosnell - 0 Gosnell to Lamprey - 51 Lamprey to Owen - 11	62	
May 27, 1976	Morice Lk to Gosnell	0.5 miles below Morice Lk - 4	4	Poor visibility
June 4, 1976	Morice Lk to Gosnell	0.5 miles below Morice Lk - 8	8	Good visibility
March 17, 1977	Morice Lk to Barrett	Morice Lk to Gosnell - 30		Just above Gosnell in transect area
		Gosnell to Lamprey - 12		Just below Gosnell junction
		Lamprey to Owen - 20	62	250 suckers observed between Mile 3 & 5. Excellent visibility.
Nov 26-27, 1979	Morice Lk to Houston Tommy Creek	Morice Lk to Gosnell - 25 Gosnell to Lamprey - 69 Lamprey to Owen - 74 Owen to Houston Tommy - 0	168	50% of area in shadows. Over 700 suckers observed in large schools. Confirmed by snorkelling.

1 Aerial observations of steelhead are very unreliable estimates of steelhead escapements in the Morice. Steelhead are extremely difficult to see under the best of light conditions, and many tend to hold under logs, banks and in heavily shadowed areas. As well, Dolly Varden and largescale suckers are present in the river and may cause some confusion. The usefulness of this information is mostly for its description of distribution. 1964-1977 data based on flight reports, B.C. Fish and Wildlife Branch, Smithers. 1979 data based on a helicopter flight Nov. 26-27/79. Flow was extremely low (27 m^3/s) and clear, allowing unusual visibility for this time of year.

TABLE A4.2
Morice River Steelhead Spawner Observations

Map Location[1]	Fish No.[2]	Observation Dates in Spawning Area	Channel Type[3]	Method of Observation[4]	Comments
1979 Observations					
1	-	May 30	Trib	S	Five steelhead in two locations. One steelhead observed holding at mouth of Chinook Island Creek on May 16.
2	8	Mar 5-June 12	Side	R, S	Pair observed June 5.
3	-	June 5-14	Side	S, V	At least five steelhead in two sites. One fish observed on June 14.
4	-	May 31-June 5	Side	S	Five steelhead observed at four different locations. This is transect study area (T1).
5	10	Mar 5-June 10	Main	R, V	Single fish observed on redd June 10. On June 12, this fish was approx 1 km downstream. This is transect study area (T2).
	9	May 26	Main	R	
	-	May 31	Main	S	Pair of steelhead on redd. One fish had single spaghetti tag.
6	5	May 19-June 1	Trib	R	
7	6	June 10-June 12	Trib	R	No surveys conducted after June 12, 1979.
8	11	May 27-30	?	R	
9	7	May 23-June 1	Trib	R	
10	12	Apr 23-June 1	Main	R	
11	14	May 26-June 18	Side	R	Subsequent examinations indicate very little good spawning gravel in this channel.
	13	Apr 30-June 18	Side	R	
12	15	May 7-June 12	Side	R	

(Continued)

Table A4.2 (Continued)

Map Location[1]	Fish No.[2]	Observation Dates in Spawning Area	Channel Type[3]	Method of Observation[4]	Comments
13	4	May 11-June 7	Trib	R	Steelhead moving downstream by June 10.
14	3	May 26-30	Trib	R	
15	1	May 27	Trib	R	
16	2	May 30	Trib	R	
17	16	Mar 24-May 30	Main	R	
Miscellaneous Observations from Other Years[5]					
18	-	June 4/76	Main	H	Five steelhead in chinook redds.
			Side	H	Three steelhead at mouth of Chinook Island Creek (On file, B.C. Fish and Wildlife Branch, Smithers, 1976).
18	-	May 4-June 5/80	-	-	27 Steelhead spawners angled from immediate lake outlet to 2 km downstream.
	-	May 24-26/80			12 steelhead observed spawning in area just below Chinook Island Creek.

1 Refers to Figure 3.1

2 Refers to Appendix A4, Figures A4.1-A4.4

3 Channel Types

Trib Tributary
Main Main channel Morice River
Side Side channel Morice River

4 Method of Observation

S Snorkel observation
R Radio-telemetry
V Visual, either from a riverboat or from shore
H Helicopter observation

5 Although numerous helicopter spawning surveys have been conducted over the past 10 years, only the 1976 flight was conducted during the actual spawning period for Morice steelhead (May 15 - June 15)

TABLE A4.3
Measurements of Physical Characteristics of Steelhead Spawning Sites in the Morice River and a Small Tributary

Map Location[1]	Date (1979)	Substrate (cm)	Nose Velocity (cm/sec)	Water Depth (cm)	Water Temp (°C)	Comments
3	June 5	1-10	52-72	75	6	Slow velocity run
3	June 5	1-10	52	71	6	Redd located immediately below a submerged log. Slow run
4	May 31	2-15	NM[2]	104	5.5-7.0	Slow velocity run
4	May 31	1-15	70	74	5.5-7.0	Downstream end of run
5	June 10	1-10	84	55	7	Run at lower end of pool
1	May 30	1-15	33	40	11	Downstream end of pool. Good log cover within 2 m. Poor gravel, i.e., spotty

1 Refer to Figure 3.1

2 Measurements not made due to velocity meter problems

TABLE A4.4
Estimated Numbers of Steelhead Killed and Released in the Morice and Bulkley Rivers from 1968-1982[1]

	Morice		Bulkley		Morice and Bulkley Combined[2]	
Year	Kill	Release	Kill	Release	Kill	Release
1968-69	962	NR[3]	1,275	NR	2,237	NR
1969-70	1,464	NR	1,244	NR	2,708	NR
1970-71	1,164	843	1,725	897	2,889	1,740
1971-72	1,279	1,256	1,375	1,327	2,654	2,583
1972-73	1,402	1,061	1,653	1,211	3,055	2,272
1973-74	930	961	1,298	1,000	2,228	1,961
1974-75	697	511	1,129	646	1,826	1,157
1975-76	1,027	1,152	1,094	701	2,121	1,853
1976-77	553	595	1,068	741	1,621	1,336
1977-78	630	952	803	696	1,433	1,648
1978-79	643	1,314	959	1,299	1,602	2,613
1979-80	786	2,112	1,260	1,660	2,046	3,780
1980-81	704	1,700	1,621	3,242	2,325	4,942
1981-82	331	1,446	661	1,595	992	3,041
Mean	898	1,159	1,226	1,252	2,124	2,411
Revised Mean[4]	605	781	827	844	1,432	1,625

1 Based on estimates from Steelhead Harvest Analyses 1968-1978, B.C. Fish and Wildlife Branch

2 Angler catches in the Morice and Bulkley Rivers are combined, since the major flow in the Bulkley River below Houston is from the Morice River. Many steelhead which are angled in the Bulkley River are fish which eventually spawn in the Morice River and its tributaries

3 Not Reported

4 Results of creel census studies of major steelhead rivers in B.C. indicate that estimate from the Steelhead Harvest Analyses should be revised downward by 32.6% (B.C. Fish and Wildlife Branch 1978)

5 A proportion of the steelhead angled in the lower Skeena River is of Morice and Bulkley Rivers origin. Radio telemetry studies indicated that steelhead tagged on the lower Skeena River during the main angling period were subsequently tracked to the Bulkley and Morice Rivers during the fall of 1979 (Lough 1981). It is assumed that the proportion of Morice and Bulkley fish angled in the lower Skeena River is the same proportion that Morice and Bulkley River steelhead comprise of the total Skeena sport catch (43%). The 10 year mean of the lower Skeena River catch is 651 steelhead. A 32.6% reduction based on (4) above yields an estimate of 439 steelhead taken annually in the lower Skeena River with 189 (43%) being Morice and Bulkley River-bound steelhead. This raises the total estimated average sport fishing catch of Morice and Bulkley River fish to approximately 1,700 steelhead annually

TABLE A4.5
Observations of Recently Emerged Steelhead Fry in the Morice River and Tributaries from 1968 to 1982

Date	Location	Method	Observation
Aug 22/68	Upper Thautil R.	Rotenone, seine	Recently emerged steelhead fry (Taylor and Seredick 1968)
July 29/69	Owen Creek	Rotenone	40 mm trout fry (Pinsent 1969)
Aug 13/75	Lamprey Creek	Electrofishing	Numerous suspected steelhead fry (Morris and Eccles 1975)
Aug 15/75	Owen Creek	Electrofishing	No steelhead fry (Morris and Eccles 1975)
July 28/77	Cox Creek	Visual	Numerous recently emerged trout fry in this tributary known to be used by steelhead
Aug 8/79	Upper Morice	Snorkel Survey	No Age O^+ steelhead observed
Aug 22/79	Upper Morice	Snorkel Survey	Several O^+ steelhead near previously identified steelhead spawning site
Sept 12-15/79	Morice and tributaries	Electrofishing	Numerous O^+ steelhead including some just 'buttoned up'
Aug 9-14/82 (peak) Aug 4-20/82 (range)	Upper Morice	Incline Plane Traps	Traps were located in the vicinity of two steelhead spawning areas (Section E)

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FIGURE A4.5: LENGTH-FREQUENCY OF JUVENILE STEELHEAD IN THE MORICE RIVER, 1979

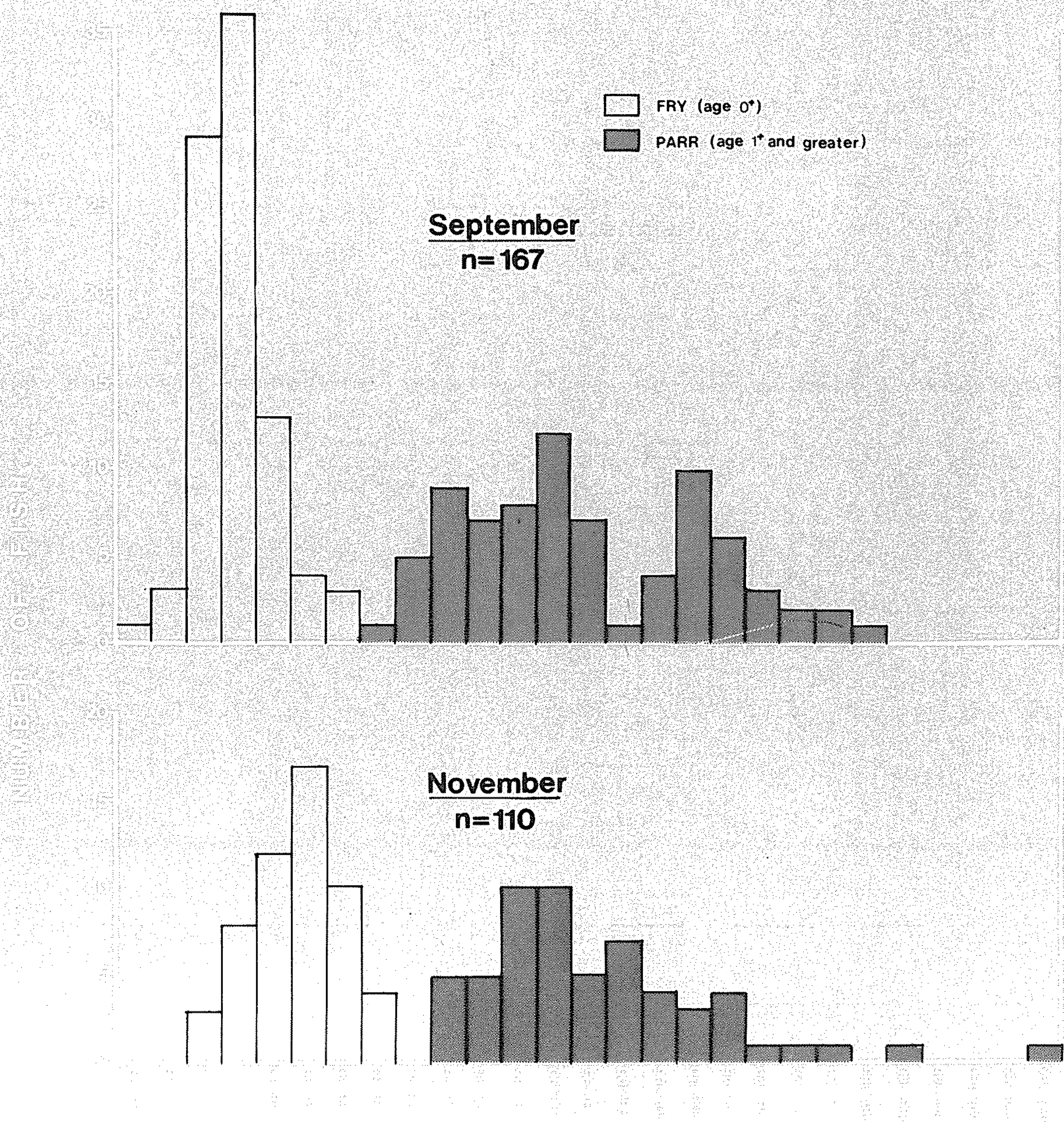

TABLE A4.6
Mean Fork Lengths of Juvenile Steelhead Captured from May Through November 1979 in the Morice River and Tributaries

Age	Sample Location	Sample Period	Sample Size	Mean Fork Length (mm)	S.D.	95% C.L. of Mean[1]	Size Range (mm) Min	Max
Fry	Reach 2	Sept 7-12	87	42.3	4.9	1.0	33	57
	Owen Ck	Sept 6	162	51.3	6.5	1.0	36	64
	Lamprey Ck	Sept 12	53	48.4	5.5	1.5	37	59
	Gosnell Ck	Sept 24	50	45.5	5.0	1.4	34	56
	Thautil R.	Sept 24	37	43.9	5.6	1.8	31	52
	Reach 2	Nov 9	52	50.0	8.9	2.4	37	65
	Owen Ck	Nov 5	222	54.5	6.8	4.5	38	68
Parr[2]	Reach 2	May 1-18	62	66.8			37	165
	Owen Ck	May 20	16	58.9			41	74
	Reach 1-2	July 5-20	50	79.1			49	125
	Owen Ck	June 29-July 3	40	69.8			48	135
	Reach 1-2	Sept 6-Oct 1	80	92.0			60	131
	Owen Ck	Sept 16	41	96.1			73	165
	Reach 1-2	Nov 6-17	58	95.2			74	158
	Owen Ck	Nov 5	41	101.1			73	178

1 C.L. = Confidence Limits

2 Represents 2,003 age classes

TABLE A4.7
Age and Size (fork length in mm) of a Sample of Juvenile Steelhead Trout from the Morice River in August of 1976 and 1977 Combined[1]

Age	Mean (mm)	Range (mm)	Total Sample Size
0+	55[2]		1
1+	97	87-146	8
2+	138	101-191	47
3+	170	150-213	37
4+	222	175-230	6
5+	265		1

1 From Whately et al. (1978)

2 The mean fork length of 87 steelhead fry in September 1979 was 42 mm and ranged from 33 to 57 mm (Table A4.6)

TABLE A4.8
Means and Ranges of Estimated Fork Lengths at Time of Formation of Freshwater Annulus for Morice River Steelhead Sampled from Anglers' Catches in 1977 According to Age Group[1]

Age[2]	Mean Length at Smolting (mm)	Range (mm)	Total Sample Size
3.1^+	142	128-194	35
3.2^+	150	128-180	24
4.1^+	173	142-209	110
4.2^+	182	151-238	72
4.3^+	180	174-186	4
5.1^+	203	157-257	21
5.2^+	193	171-209	3

1 from Whately et al. (1978)

2 Age 3.1^+ designates 3 winters in freshwater and one winter in the ocean

TABLE A4.9
Summary of Electrofishing Catches of Juvenile Steelhead in Reaches 1 to 6 of the Morice and Bulkley Rivers and Four Tributaries from May to November 1979

Reach	Channel Type[1]	MAY Margin Area Sampled (m^2)	MAY Fish/100 m^2 of Margin Fry	MAY Fish/100 m^2 of Margin Parr	JULY Margin Area Sampled (m^2)	JULY Fish/100 m^2 of Margin Fry	JULY Fish/100 m^2 of Margin Parr	SEPTEMBER Margin Area Sampled (m^2)	SEPTEMBER Fish/100 m^2 of Margin Fry	SEPTEMBER Fish/100 m^2 of Margin Parr	NOVEMBER Margin Area Sampled (m^2)	NOVEMBER Fish/100 m^2 of Margin Fry	NOVEMBER Fish/100 m^2 of Margin Parr
1	M	406		0.5	274			202	5.0		220	1.8	0.4
	S	458		2.0	550		0.2	378	9.3	2.6	360	8.1	2.2
	T	864		.3	824		0.1	580	7.8	1.7	580	5.7	1.6
2	M	846		1.0	3,730		0.2	1,476	4.1	0.7	976	7.5	2.2
	S	2,457		1.4	2,448		0.4	1,916	4.6	0.6	1,434	6.9	0.8
	I				666		0.4	791	2.8	1.1	270	12.2	1.1
	T	3,303		1.3	6,884		0.3	4,183	4.1	0.7	2,680	7.6	1.3
3	M	948		3.3	1,100		1.1	852	8.4	0.6	780	9.0	
4	M	246		0.8	238		0.4	202	2.5		548	6.4	4.0
	I	578		0.9	416		0.2	378	1.1	1.3			
	T	824		0.8	654		0.3	580	1.6	0.9			
5	M	NS[2]			664		0.9	622	6.3	3.4	512	0.6	0.6
6	M				426		0.5	242	6.2	0.4	320	1.2	1.9
	I	NS[2]			415		1.2	481		0.6			
	T				841		0.8	723	2.1	0.6			
Total Reaches 1 - 6	M	2,446		1.8	5,376		0.5	3,596	5.6	1.0	3,356	5.6	1.6
	S	2,915		1.5	2,998		0.4	2,294	6.9	0.9	1,794	7.1	1.1
	I	578		0.9	1,453		0.6	1,650	1.6	1.0	270	12.2	1.1
	T	5,939		1.4	9,827		0.5	7,540	5.2	1.0	5,420	6.5	1.4
Chinook Is Ck	M	NS[2]			122		10.7	218	19.7	6.9	NS[2]		
Lamprey Ck	M	660		1.1	852		1.2	670	8.2	0.4	380	4.7	
McBride Ck	M	NS[2]			284			164		0.6	312		
Owen Ck	M	730		2.2	854		4.7	794	18.0	7.4	794	27.6	5.0
Total Tribs	M	1,390		1.6	2,112		3.0	1,912	14.3	4.4	1,552	16.8	2.6

1 M = Main Channel; S - Side Channel; I - Intermittent Channel; T = Total of all channels

2 NS = Not Sampled

TABLE A4.10
Summary of Minnow Trap Catches of Juvenile Steelhead in the Morice and Bulkley Rivers and Four Tributaries from May to November 1979

Reach	Channel Type[1]	MAY Number of Traps	MAY Catch/Trap Fry	MAY Catch/Trap Parr	JULY Number of Traps	JULY Catch/Trap Fry	JULY Catch/Trap Parr	SEPTEMBER Number of Traps	SEPTEMBER Catch/Trap Fry	SEPTEMBER Catch/Trap Parr	NOVEMBER Number of Traps	NOVEMBER Catch/Trap Fry	NOVEMBER Catch/Trap Parr
1	S				15		0.1	20	*	1.5	20	0	0.3
	M	NS[2]			5		-	9	-	0.3	10	0.1	0.1
	I				-		-	1	1.0	-	-	-	-
	T				20		*	30	0.1	1.1	30	0.1	0.2
2	S	28		-	30		*	40	0.4	0.5	25	0.2	0
	M	39		*[3]	42		0.3	55	0.2	0.7	40	0.3	0.4
	I	10		-	20		*	2	0.5	0.2	-	-	-
	T	77		*	92		0.1	120	0.3	0.5	65	0.3	0.2
3	M	NS			28		0.1	29	0.5	0.5	30	-	0.1
4	M	NS			15		-	13	-	1.2	NS		
	I				10		0.1	15	-	0.3			
	T				25		*	28	-	0.7			
5	M	NS			29		0.1	30	0.6	0.5	NS		
6	M	NS			10		0.1	15	0.1	0.5	NS		
	I				20		0.4	15	-	0.5			
	T				30		0.3	30	*	0.5			
Total Reaches 1-6	S	28		-	45		*	60	0.3	0.9	45	0.2	0.1
	M	39		*	129		0.1	151	0.3	0.6	80	0.2	0.2
	I	10		-	50		0.2	56	0.3	0.3	-	-	-
	T	77		*	224		0.1	267	0.3	0.6	125	0.2	0.2
Chinook Island Ck.	T	NS		-	20		0.8	10	0.7	1.2	NS		
Lamprey Creek	T	20		0.6	30		0.6	30	0.5	1.1	NS		
McBride Creek	T	20		*	25		-	20	-	-	NS		
Owen Ck.	T	24		0.3	30		0.3	30	1.4	0.8	NS		

1 M = Main Channel; S = Side Channel; I = Intermittent Channel; T = Total of all channels
2 NS = Not Sampled
3 * = The catch/trap is greater than 0 but less than 0.05

TABLE A4.11
Summary of Steelhead Fry Catches by Reach in Morice River Tributaries Based on Electrofishing Data from September and October 1979

Tributary	Reach	Area of Margin Electrofished (m^2)	Channel Length (km)	Fish/100 m^2 of Margin	Channel Length x Catch	Weighted Distribution (%)
Lamprey	1	224	13.6	7.6	103.4	
	2	336	26.0	11.3	293.8	
	3	110	6.0			
Total		770	45.6		397.2	24.7
Thautil	1	655	37.1	8.6	317.2	
	2	233	9.9	3.4	34.0	
	3	230	32.5			
Total		1,118	79.5		351.2	21.9
Owen	1	794	17.2	18.0	309.6	19.3
Gosnell	1	222	8.1	0.4	3.6	
	2	846	42.5	4.0	170.0	
	3	284	12.7			
Cox	4	204	10.2	12.2	124.9	
Total		1,556	73.5		298.5	18.6
Knapper	1	222	3.5	19.4	67.1	4.2
Tagit	1	200	1.3	28.5	36.5	2.3
Cedric	1	66	1.0	36.4	36.4	2.3
Chinook Is	1	218	1.2	19.7	22.7	1.4
False Tagit	1	188	1.0	21.8	21.8	1.4
Below Knapper	1	514	8.8	2.1	18.8	1.2
24.5 Mile	1	220	4.4	3.6	15.8	1.0
Trapper Cabin	1	174	1.9	6.9	13.2	0.8
Fenton	1	112	0.5	20.5	10.4	0.7
Cottonwood	1	182	1.6	2.2	3.5	0.2
Puport	1	150	0.8	2.7	2.1	0.1
Total					**1,604.8**	

TABLE A4.12
Summary of Steelhead Parr Catches by Reach in Morice River Tributaries Based on Electrofishing Data from September and October 1979

Tributary	Reach	Area of Margin Electrofished (m^2)	Channel Length (km)	Fish/100 m^2 of Margin	Channel Length x Catch	Weighted Distribution (%)
Owen	1	794	17.2	7.4	127.8	36.2
Gosnell	1	222	8.1	0.9	7.3	
	2	846	42.5	1.1	45.0	
	3	284	12.7			
Cox	4	204	10.2	3.9	40.1	
Total		1,556	73.5		92.4	26.2
Thautil	1	655	37.1	1.1	39.7	
	2	233	9.9			
	3	230	32.5			
Total		1,118	79.5		39.7	11.3
Lamprey	1	224	13.6			
	2	336	26.0	0.9	23.1	
	3	110	6.0			
Total		770	45.6		23.1	6.6
Knapper	1	222	3.5	4.5	15.6	4.4
24.5 Mile	1	220	4.4	3.2	13.9	3.9
Tagit	1	200	1.3	8.0	10.2	2.9
Chinook Is	1	218	1.2	6.9	7.9	2.2
Below Knapper	1	514	8.8	0.8	6.9	2.0
Fenton	1	112	0.5	11.6	5.9	1.7
False Tagit	1	188	1.0	4.2	4.2	1.2
Trapper Cabin	1	174	1.9	1.7	3.3	0.9
Peacock	1	114	1.3	0.9	1.1	0.3
Cottonwood	1	182	1.6	0.6	0.9	0.2
Houston Tommy	1	372	15.0			
Total					**352.9**	

APPENDIX A5

Coho Salmon - Escapement Estimates and Catch Data

TABLE A5.1
Skeena River Escapement Estimates For Coho Salmon[1]

Year	Escapement Estimate
1956	102,890
1957	74,195
1958	197,150
1959	30,250
1960	67,507
1961	58,308
1962	44,997
1963	58,030
1964	67,557
1965	114,330
1966	96,175
1967	52,435
1968	112,150
1969	63,664
1970	76,675
1971	67,245
1972	52,266
1973	37,875
1974	28,352
1975	19,970
1976	31,527
1977	38,445
1978	51,947
1979	22,770

Mean Escapements

Skeena River	65,280
Morice River[2]	5,175
Morice as % of Skeena	7.9%

1 Based on Fisheries Stream Reports, Department of Fisheries and Oceans, Vancouver. These estimates are crude, with no reports for some streams during many years. When a range was reported the midpoint of the range was used in calculating estimates.

2 Morice River coho average is based on a combination of mainstem and tributary estimates (Tables A5.6 and A5.7)

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FIGURE A5.1: LENGTH-FREQUENCY OF JUVENILE COHO IN THE MORICE RIVER, 1979

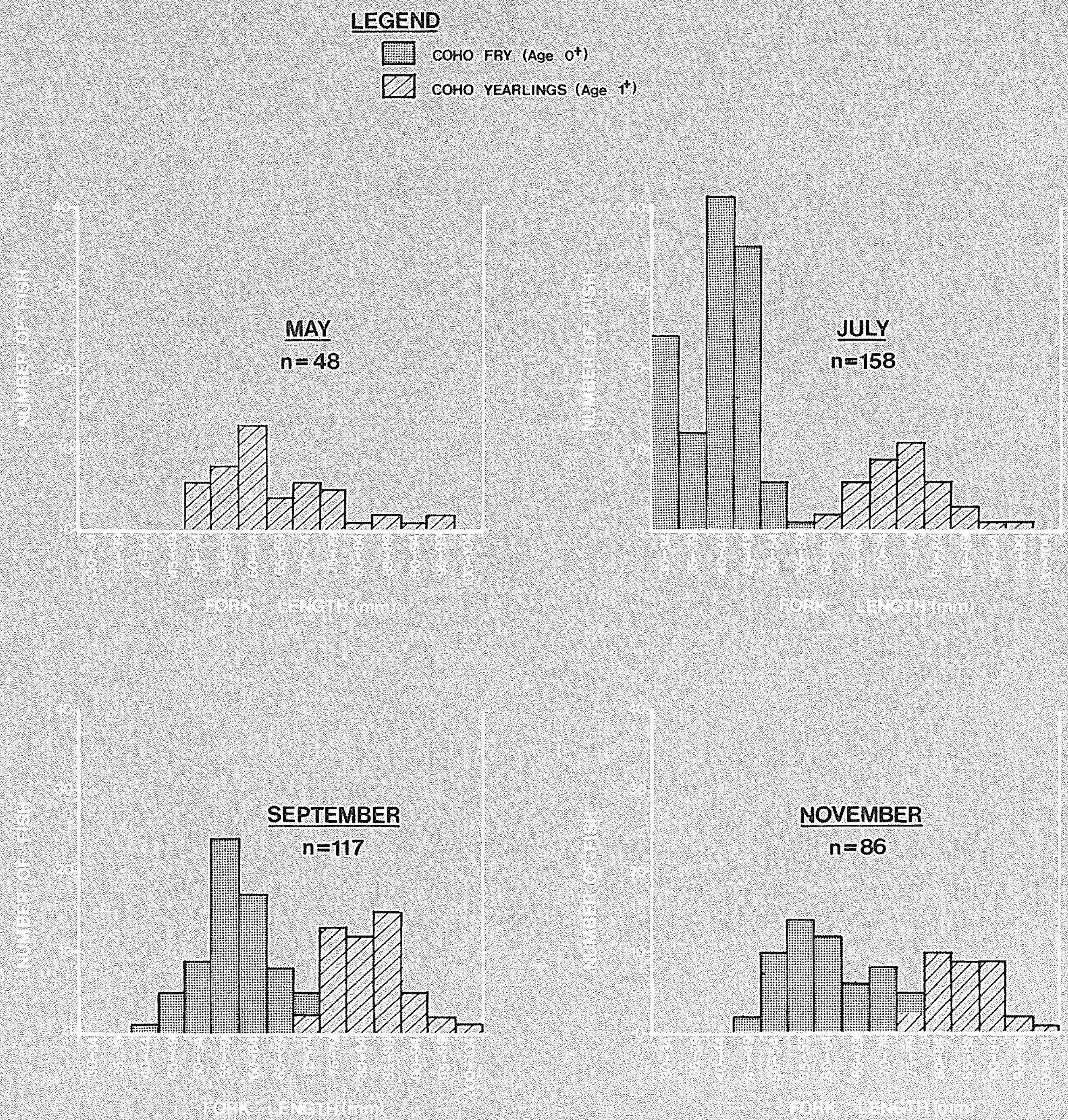

TABLE A5.2
Mean Fork Lengths of Juvenile Coho Captured from May through November 1979 in the Morice River and Tributaries

Age	Sample Location	Sample Period	Sample Size	Mean Fork Length (mm)	S.D.	95% C.L.[1] of Mean
Fry	Reach 2	July 10-13	119	41.6	5.8	1.0
	Owen Ck	June 29-July 3	28	34.3	3.0	1.1
	McBride Ck	July 17	58	45.9	4.6	1.2
	Reach 2	Sept 7-20	64	57.5	5.9	1.4
	Owen Ck	Sept 3-4	28	61.6	4.7	1.8
	McBride Ck	Sept 21-22	62	59.6	6.3	1.6
	Reach 1-4	Nov 6-9	55	60.9	8.5	2.3
	McBride Ck	Nov 8	78	58.5	7.7	1.7
Yearlings	Reach 1-4	May 5-27	48	66.6	11.6	3.3
	Owen Ck	May 20-29	20	83.3	13.3	2.9
	McBride Ck	May 31-June 1	22	79.2	12.9	5.4
	Reach 1-4	July 5-20	39	75.8	7.3	2.3
	Reach 1-4	Sept 6-Oct 1	53	82.9	6.8	1.8
	Owen Ck	Sept 3-6	17	85.0	9.4	4.5
	McBride Ck	Sept 21-22	16	83.1	12.8	6.3
	Reach 1-4	Nov 6-14	31	87.3	5.6	2.0

1 C.L. = Confidence Limits

TABLE A5.3
Summary of Electrofishing Catches of Juvenile Coho in Reaches 1 to 6 of the Morice and Bulkley Rivers and Four Coho Tributaries from May to November 1979

Reach	Channel Type[1]	MAY Margin Area Sampled (m^2)	MAY Fish/100 m^2 of Margin Fry	MAY Fish/100 m^2 of Margin Yearlings	JULY Margin Area Sampled (m^2)	JULY Fish/100 m^2 of Margin Fry	JULY Fish/100 m^2 of Margin Yearlings	SEPTEMBER Margin Area Sampled (m^2)	SEPTEMBER Fish/100 m^2 of Margin Fry	SEPTEMBER Fish/100 m^2 of Margin Yearlings	NOVEMBER Margin Area Sampled (m^2)	NOVEMBER Fish/100 m^2 of Margin Fry	NOVEMBER Fish/100 m^2 of Margin Yearlings
1	M	406			274			202			220		
	S	458		1.1	550	3.1		378	2.1	0.3	360	2.2	0.6
	T	864		0.6	824	2.1		580	1.4	0.2	580	1.4	0.3
2	M	846		0.1	3,730	0.1		1,476	1.2	0.2	976	0.4	0.1
	S	2,457		0.3	2,448	2.2		1,916	1.7	0.2	1,434	0.4	
	I				666	9.6	0.3	791	1.9	0.4	270		
	T	3,303		0.2	6,884	1.8		4,183	1.6	0.2	2,680	0.3	
3	M	948	0.1	0.2	1,100	0.7		852	0.2		780		
4	M	246	0.8	1.6	238	0.4		202			548		
	I	578			416	3.4		378	1.9	0.3			
	T	824	0.2	0.5	654	2.3		580	1.2	0.2	548		
5	M	NS[2]			664	2.3		622	0.3	0.3	512		
6	M				426			242			320		
	I	NS			415	4.3	0.5	481	2.3	1.0			
	T				841	2.1	0.2	723	1.5	0.7	320		
Total Reaches 1 - 6	M	2,446	0.1	0.3	5,376	0.5		3,596	0.6	0.1	3,356	0.1	
	S	2,915		0.4	2,998	2.4		2,294	2.9	0.2	1,794	0.7	0.1
	I	578			1,453	6.6	0.3	1,650	2.0	0.6	270		
	T	5,939	0.1	0.3	9,827	2.0	0.1	7,540	1.6	0.3	5,420	0.3	
Chinook Is Ck	M	NS			122		6.6	218		3.2	NS		
Lamprey Ck	M	660			852	0.1		670	2.2	0.3	380	1.0	
McBride Ck	M	NS			284	18.7	0.3	164	13.4	2.4	312	34.6	1.3
Owen Ck	M	730		2.0	854	3.3	0.5	794		0.3	794	0.3	
Total Tribs	M	1,390		1.1	2,112	3.9	0.6	1,912	1.9	0.8	1,552	7.3	0.3

1 M = Main Channel; S = Side Channel; I = Intermittent Channel; T = Total of all channels

2 NS = Not Sampled

TABLE A5.4
Summary of Minnow Trapping Catches of Juvenile Coho in the Morice and Bulkley Rivers and Four Tributaries from May to November 1979

Reach	Channel Type[1]	MAY Number of Traps	MAY Catch/Trap Fry	MAY Catch/Trap Yearlings	JULY Number of Traps	JULY Catch/Trap Fry	JULY Catch/Trap Yearlings	SEPTEMBER Number of Traps	SEPTEMBER Catch/Trap Fry	SEPTEMBER Catch/Trap Yearlings	NOVEMBER Number of Traps	NOVEMBER Catch/Trap Fry	NOVEMBER Catch/Trap Yearlings
1	S				15		0.1	20	0.7	0.3	20	0.7	0.5
	M	NS[2]			5	0.2	0.2	9	0.1	0.4	10	0.2	0.3
	I				-	-	-	1	-	-	-	-	
	T				20	*[3]	0.1	30	0.5	0.3	30	0.5	0.4
2	S	28		0.1	30	0.5	0.3	40	1.5	0.6	25	0.7	-
	M	39		0.5	42	0.1	0.2	55	1.3	1.2	40	0.6	0.4
	I	10		-	20	*	0.6	25	3.2	1.5	-	-	-
	T	77		0.2	92	0.2	0.3	120	1.8	1.1	65	0.6	0.2
3	M	NS			28	-	0.1	29	0.2	0.1	30	*	-
4	M	NS			15	-	-	13	-	0.3	NS		
	I				10	-	0.2	15	1.7	0.8			
	T				25	-	0.1	28	0.9	0.6			
5	M	NS			29	-	-	30	0.1	-	NS		
6	M	NS			10	-	-	15	0.1	0.1	NS		
	I				20	0.4	0.6	15	1.1	2.6			
	T				30	0.2	0.4	30	0.6	1.3			
Total Reaches 1-6	S	28		0.1	45	0.3	0.2	60	1.2	0.5	45	0.7	0.2
	M	39		0.5	129	0.1	0.1	151	0.5	0.5	80	0.3	0.2
	I	10		-	50	0.2	0.5	56	2.2	1.6	-	-	-
	T	77		0.2	224	0.1	0.7	267	1.0	0.7	125	0.5	0.2
Chinook Is. Creek	T	NS			20	0.2	1.2	10	-	1.3	NS		
Lamprey Creek	T	20			30	*	0.2	30	0.6	0.7	NS		
McBride Creek	T	20	-	1.1	25	0.9	0.2	20	2.1	0.5			
Owen Ck.	T	24	-	0.3	30	-	0.1	30	0.9	0.5	NS		

1 M = Main Channel; S = Side Channel; I = Intermittent Channel; T = Total of all channels

2 NS = Not Sampled

3 * = The catch/trap is greater than 0 but less than 0.05

TABLE A5.5
Summary of Coho Fry Electrofishing Catches by Reach in Morice River Tributaries in September and October 1979

Tributary	Reach	Area of Margin Electrofished (m^2)	Channel Length (km)	Fish/100 m^2 of Margin	Channel Length x Catch	Weighted Distribution (%)
Gosnell	1	222	8.1	3.6	29.0	
	2	846	42.5	3.9	165.7	
	3	284	12.7	1.8	22.3	
	4	204	10.2	8.8	90.3	
	Total	1,556	73.5		307.3	49.1
Houston Tommy	1	372	15.0	8.3	125.0	20.0
McBride	1	164	8.0	13.4	106.7	17.0
Thautil	1	655	37.1	1.1	39.7	
	2	233	9.9			
	3	230	32.5			
	Total	1,118	79.5		39.7	6.3
False Tagit	1	188	1.0	21.3	21.3	3.4
Lamprey	1	224	6.0	2.2	13.4	2.1
Cottonwood	1	182	1.6	2.2	3.5	0.6
Owen	1	794	17.2	0.2	4.3	0.7
Chinook Island	1	218	1.2	0		
24.5 Mile	1	220	4.4	0.9	4.0	0.6
Peacock	1	114	1.3	0		
Tagit	1	200	1.3	0.5	0.6	0.1
Trapper Cabin	1	174	1.9	0		
Fenton	1	112	0.5	0		
Atna	1	426	NE[1]	0.4		

1 Not examined

TABLE A5.6
Summary of Coho Yearling Electrofishing Catches by Reach in Morice River Tributaries in September and October 1979

Tributary	Reach	Area of Margin Electro-Fished (m^2)	Channel Length (km)	Fish/100 m^2 of Margin
Gosnell	1	222	8.1	0.9
	2	846	42.5	3.6
	3	284	12.7	0.4
	4	204	10.2	0
	Total	1,556	73.5	
Houston Tommy	1	372	15.0	1.1
McBride	1	164	8.0	2.4
Thautil	1	655	37.1	0.2
	2	233	9.9	-
	3	230	32.5	-
	Total	1,118	79.5	
False Tagit	1	188	1.0	6.4
Lamprey	1	224	6.0	0.6
Cottonwood	1	182	1.6	2.2
Owen	1	794	17.2	0
Chinook Island	1	218	1.2	3.2
24.5 Mile	1	220	4.4	0
Peacock	1	114	1.3	1.8
Tagit	1	200	1.3	0.5
Trapper Cabin	1	174	1.9	0.6
Fenton	1	112	0.5	1.8
Atna	1	426	NE[1]	0

1 Not examined

TABLE A5.7
Miscellaneous Helicopter Observations of Coho Salmon Spawners in the Morice River, 1979-1983

Date	Extent of Survey	Number of Observations and Location	Total[1]	Comments
Nov. 26 & 27/79	Houston Tommy to Morice Lake	Gosnell to Morice Lake (85%) Owen to Gosnell (15%)	261	Very low water conditions Thorough survey and good visibility
Nov. 25/80	Upper 1 km of Morice River	Vicinity of Chinook Island	45	Good visibility
Nov. 15/81	Lamprey Ck. to M. 34 Gosnell to Morice Lake	19 coho in side and 2 in main channels 95 incl. 53 near Chinook Island	116	Cursory examination Nine specific areas mapped
Dec. 20/81	Upper 4 km of Morice River	No coho observed	0	
Aug. 26/82	Gosnell Ck. area	200 coho observed at mouth of Gosnell	200	Miscellaneous observations
Sept. 15/82	Gosnell Ck. area	39 coho observed at mouth of Gosnell	39	During chinook surveys
Oct. 20/82	Complete survey from Owen Ck. Lowest 6 km Lowest 3 km	Owen to Lamprey - 21 Lamprey to Gosnell - 172 Thautil R. - 7 Gosnell Ck. - 12	212	78% of fish in main channel but many were in holding water. Nineteen specific sites mapped.
Nov. 1/82	Upper 4 km of Morice River	Chinook Island area	170	40 of 170 fish on redds
Nov. 27/82[2]	Lamprey Ck. to Morice Lake	Lamprey to Gosnell - 72 Gosnell to Morice Lake - 372	444	Side channels below Gosnell are partially iced over. Fish still spawning in these areas. Some fish still holding at upper sites.
Dec. 25/82	Upper 4 km of Morice River	Chinook Island Area - 18 30-50 m below Morice Lake - 20	38	Spawning near completion.
Nov. 15/83	Upper 4 km of Morice River	Chinook Island area - 100 Holding downstream - 300 to 400	400-500	Approx. 25% of fish were on spawning redds.

1 Aerial observations of adult coho are unreliable in assessing total numbers. However repeated surveys over specific sites do provide a useful index of timing of spawning and relative abundance between years

2 As reported by John Wall (Alcan)

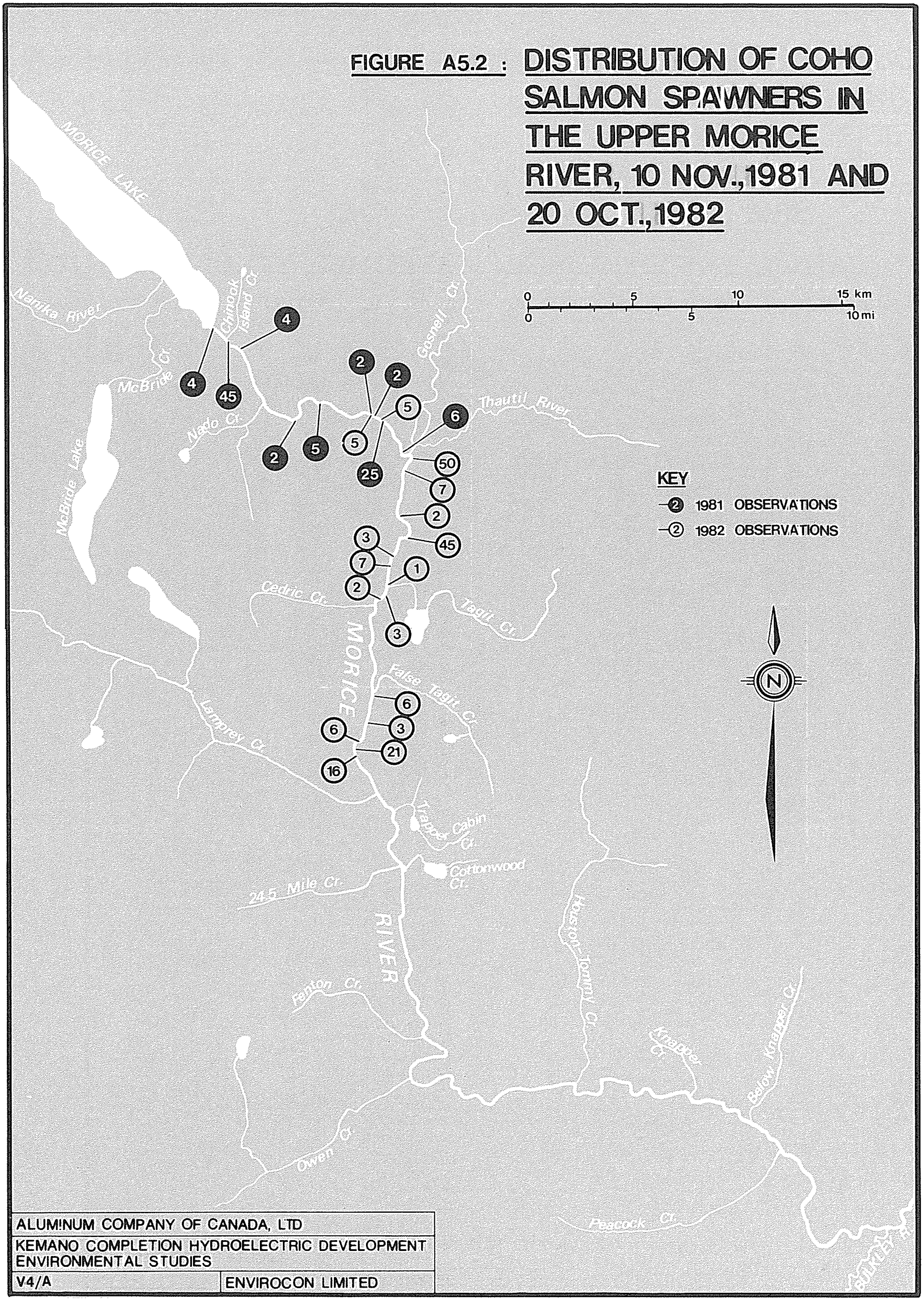
FIGURE A5.2 : DISTRIBUTION OF COHO SALMON SPAWNERS IN THE UPPER MORICE RIVER, 10 NOV.,1981 AND 20 OCT.,1982
MORICE LAKE
Nanika River
Chinook Cr.
Island Cr.
McBride Cr.
Nado Cr.
McBride Lake
Gosnell Cr.
Thautil River
Cedric Cr.
Tagit Cr.
MORICE
False Tagit Cr.
Lamprey Cr.
Trapper Cabin Cr.
Cottonwood Cr.
24.5 Mile Cr.
RIVER
Houston Tommy Cr.
Fenton Cr.
Knapper Cr.
Below Knapper Cr.
Owen Cr.
Peacock Cr.
BULKLEY R.
0 5 10 15 km
0 5 10 mi
KEY
1981 OBSERVATIONS
1982 OBSERVATIONS
N
4
4
45
2
2
5
6
2
5
5
25
50
7
2
45
3
7
1
2
3
6
6
3
21
16
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TABLE A6.1
Skeena River Escapement Estimates of Chinook Salmon[1]

Year	Escapement Estimate
1961	18,875
1962	25,725
1963	26,430
1964	24,300
1965	19,025
1966	18,875
1967	25,275
1968	25,250
1969	29,850
1970	21,975
1971	21,450
1972	20,960
1973	40,795
1974	32,276
1975	17,590
1976	13,356
1977	31,504
1978	23,324
1979	19,047

Mean Escapements

Skeena River	23,994
Morice River[2]	5,865
Morice as % of Skeena	24.4%

1 Based on Fisheries Stream Reports, Department of Fisheries and Oceans, Vancouver. Estimates are crude, with no reports for some streams during many years. When a range was reported, the mean of the range was used in calculating estimates

2 See Table 3.10

APPENDIX A6

Chinook Salmon - Escapement Estimates and Catch Data

TABLE A6.2
Mean Fork Lengths of Chinook Fry Captured from May thraugh November 1979 in the Morice (Reaches 1-4) and Bulkley (Reaches 5-6) Rivers

Sample Location	Sample Period	Sample Size	Mean Fork Length (mm)	S.D.	95% C.L.[1] of Mean
Reach 1	May 5	52	40.0	2.2	0.6
Reach 2	July 10-12	82	47.5	5.4	1.2
Reaches 5-6	July 24-26	96	52.8	7.3	1.5
Reaches 1-3	Sept 6-Oct 1	63	69.9	8.5	2.1
Reaches 5-6	Sept 27-29	51	74.2	6.9	1.9
Reaches 1-4	Nov 6-13	54	73.8	7.6	2.0
Reaches 5-6	Nov 12-13	11	77.0	6.2	3.7

1 C.L.- Confidence Limits

TABLE A6.3
Summary of Electrofishing Catches of Juvenile Chinook in Reaches 1 to 6 of the Morice and Bulkley Rivers from May to November 1979

		MAY		JULY		SEPTEMBER		NOVEMBER	
Reach	Channel Type[1]	Margin Area Sampled (m^2)	Fish/100 m^2 of Margin	Margin Area Sampled (m^2)	Fish/100 m^2 of Margin	Margin Area Sampled (m^2)	Fish/100[2] of Margin	Marginal Area Sampled (m^2)	Fish/100 m^2 of Margin
1	M	406	2.2	274	1.1	202	-	220	0.5
	S	458	5.7	550	13.8	378	4.0	360	1.9
	T	864	4.1	824	9.6	580	2.6	580	1.4
2	M	846	8.7	3,730	0.3	1,476	0.5	976	1.7
	S	2,457	3.7	2,448	1.5	1,916	1.0	1,434	0.9
	I			666	7.4	791	0.8	270	0.7
	T	3,303	5.0	6,884	1.4	4,183	0.8	2,680	1.1
3	M	948	8.1	1,100	1.6	852	2.0	780	1.0
4	M	246	30.1	238	2.1	202	-	548	1.1
	I	578	-	416	1.9	378	-	-	-
	T	824	9.0	654	2.1	580	-	548	1.1
5	M	NS[2]	-	664	3.5	622	3.7	512	1.8
6	M		-	426	7.5	242	0.9	320	0.6
	I	NS	-	415	10.1	481	0.2	-	-
	T			841	8.8	723	0.4	320	0.6
Total Reaches 1-6	M	2,446	9.6	5,376	1.7	3,596	1.4	3,356	1.3
	S	2,915	4.0	2,998	3.7	2,294	2.3	1,794	1.1
	I	578	-	1,453	6.8	1,650	0.4	270	0.7
	T	5,939	5.9	9,827	3.1	7,540	1.4	5,420	1.2

1 M = Main Channel; S = Side Channel; I = Intermittent Channel; T = Total of all Channels

2 NS = Not Sampled

TABLE A6.4
Summary of Minnow Trap Catches of Juvenile Chinook in the Morice and Bulkley Rivers from May to November 1979

Reach	Channel Type[1]	MAY Number of Traps	MAY Catch/Trap	JULY Number of Traps	JULY Catch/Trap	SEPTEMBER Number of Traps	SEPTEMBER Catch/Trap	NOVEMBER Number of Traps	NOVEMBER Catch/Trap
1	S			15	0.3	20	*[3]	20	0.4
	M	NS[2]		5	-	9	-	10	0.3
	I			-	-	1	-	-	-
	T			20	0.2	30	*	30	0.4
2	S	28	0.1	30	0.3	40	0.8	25	0.4
	M	39	*[3]	42	0.1	55	0.4	40	0.4
	I	10	0.1	20	1.6	25	0.6	-	-
	T	77	0.1	92	0.5	120	0.6	65	0.4
3	M	NS		28	0.4	29	0.8	30	*
4	M	NS		15	0.3	13	0.5	NS	
	I			10	0.6	15	1.5		
	T			25	0.4	28	1.1		
5	M	NS		29	0.4	30	0.8	NS	
6	M	NS		10	0.2	15	1.5	NS	
	I			20	0.9	15	0.6		
	T			30	0.7	30	1.1		
Total Reaches 1-6	S	28	0.1	45	0.3	60	0.5	45	0.4
	M	39	*	129	0.3	151	0.7	80	0.2
	I	10	0.1	50	1.1	56	0.8	-	-
	T	77	0.1	224	0.5	267	0.7	125	0.3

1 M = Main Channel; S = Side Channel; I = Intermittent Channel; T = Total of Channels

2 NS = Nat Sampled

3 * = The catch/trap is greater than 0 but less than 0.05

TABLE A7.1
Skeena River Escapement Estimates of Pink Salmon[1]

Year	Escapement Estimate
1971	1,073,875
1972	1,664,063
1973	1,247,475
1974	312,075
1975	1,819,690
1976	583,775
1977	9,511,135
1978	727,773
1979	508,160

Mean Escapements[2]

Skeena River	1,939,669
Morice River[3]	11,311
Morice as % of Skeena	0.6%

1 Based on Fisheries Stream Reports, Department of Fisheries and Oceans, Vancouver. Estimates are crude, with no reports for some streams during many years. When a range was reported, the mean of the range was used in calculating estimates

2 Based on a combination of even and odd year escapements

3 See Table 3.13

APPENDIX A7

Pink Salmon - Escapement Est imates and Redd Measurements

TABLE A7.2
Measurements of Physical Characteristics of 29 Pink Salmon Spawning Sites in the Morice River, 30 August 1979

SIDE CHANNEL - AREA 1[1]

	Substrate[2] Size (cm)	Water Depth (cm)	Nose Velocity (cm/sec)
1	1-20	91	37
2	1-20	109	40
3	1-20	110	42
4	1-15	76	34
5	1-15	77	31
6	1-20	82	38
7	1-20	71	41
8	1-20	78	42
9	1-20	67	41
10	1-15	98	78
11	1-15	122	55
12	1-10	132	41
13	Sand-15	116	35
14	Sand-15	119	32
15	1-20	118	43
16	1-25	120	54
17	1-20	120	41
18	1-30	120	38
19	1-20	120	51
20	1-25	66	78

MAIN CHANNEL - AREA 2

	Substrate Size (cm)	Water Depth (cm)	Nose Velocity (cm/sec)
1	1-15	75	52
2	1-20	86	52
3	1-20	100	45
4	1-25	110	45
5	1-20	130	55
6	1-20	116	40
7	1-20	130	42
8	1-20	96	38
9	1-20	90	26

TOTALS[3]: AREA 1 & AREA 2

	Water Depth	Nose Velocity
Mean	101.6	44.4
Standard Deviation	21.0	11.8
Confidence Limits (80%)	27.6	15.5
Spawning Criteria	74-129	29-60

1 Refer to Figure 3.14 for location of Areas 1 and 2

2 Upper limit refers to maximum size substrate in vicinity of digging

3 A t-test comparing mean water depths and mean nose velocities of side and main channels indicated no significant difference (p = 0.05) between the two sites

APPENDIX A8

Fish Resources and Fish Habitat in Morice Lake and Tributaries

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FIGURE A8.1: LENGTH-FREQUENCY OF MORICE LAKE RAINBOW TROUT, LAKE TROUT AND DOLLY VARDEN, 1979

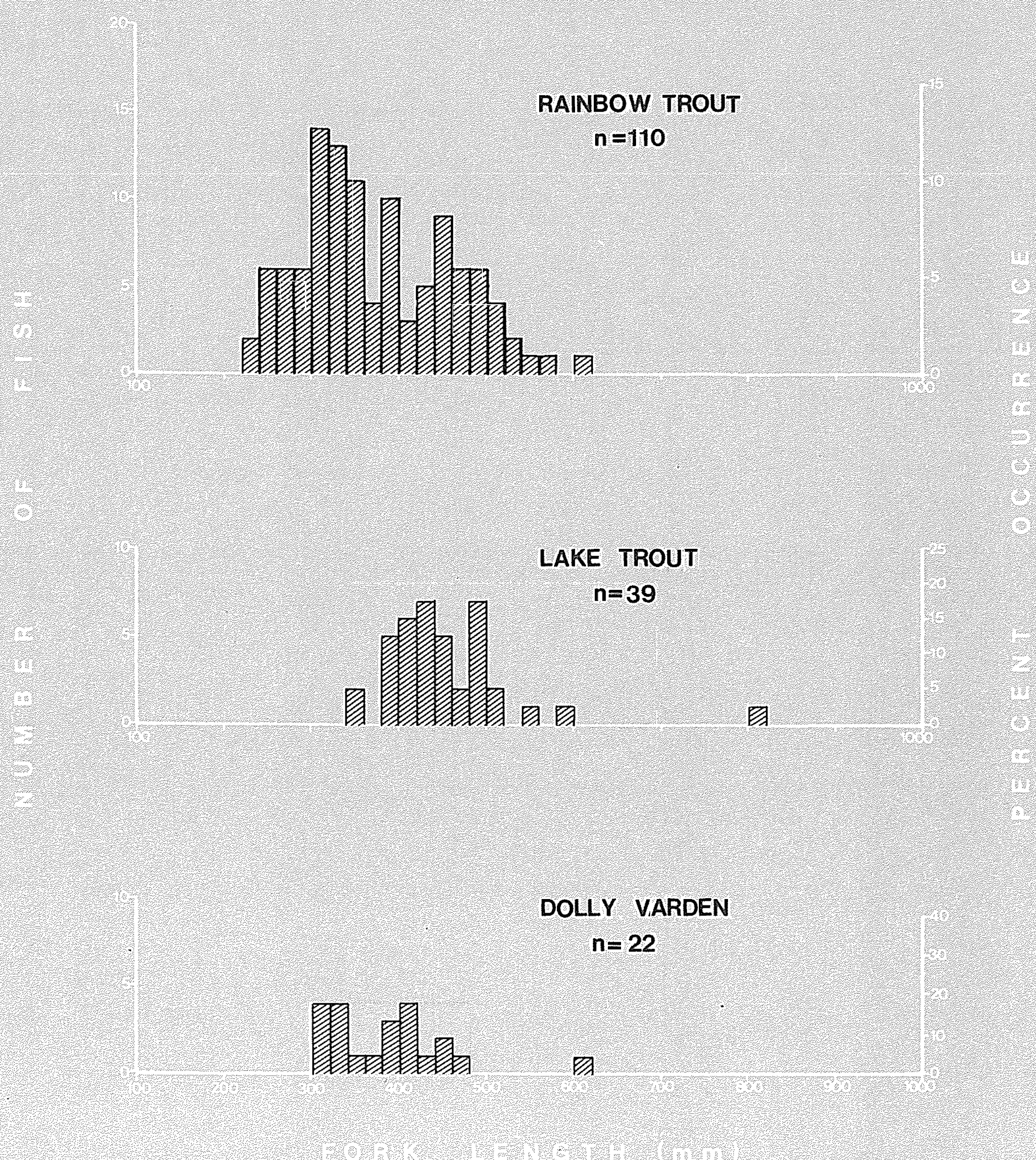

TABLE A8.1
Length and Weight Measurements for a Sample of Rainbow and Lake Trout from Morice Lake, 1979 and 1980

Species	Length (mm)	Weight (g)
Rainbow[2] (1979)	260	150
	270	230
	280	270
	288	275
	290	270
	300	300
	300	200
	300	400
	300	300
	300	290
	302	320
	310	300
	310	350
	320	400
	320	400
	320	400
	330	420
	340	350
	350	530
	350	450
	376	580
	380	800
	380	600
	390	600
	402	680
	420	800
	430	900
	435	1,000
	440	1,000
(kelt)	450	630
	450	1,100
	450	1,100
	455	955
	480	1,100
	490	1,380
	510	1,300
Mean	**363**	**587**
Lake Trout (1979)[1]	350	580
	350	600
	380	700
	400	700
	400	710
	430	1,000
	440	1,000
	450	925
	490	700
	560	1,500
	890	8,200
Mean	**467**	**1,510**

Species	Length (mm)	Weight (g)
Lake Trout[3] (1980)	204	65
	242	130
	367	350
	371	430
	375	290
	395	640
	395	625
	402	550
	426	675
	407	560
	407	540
	420	750
	421	680
	430	790
	432	800
	433	775
	440	825
	440	800
	445	900
	450	720
	450	830
	450	820
	451	860
	452	860
	452	860
	455	925
	458	900
	460	1,125
	462	850
	465	910
	470	1,000
	481	1,040
	481	1,175
	482	1,025
	488	1,080
	498	1,100
	500	1,150
	510	1,375
	529	1,720
	555	1,675
	925	11,000
Mean	**448**	**1,077**

1 Only includes fish for which weights were obtained. Table 3.15 gives mean and range of lengths for all fish sampled from Morice Lake

2 Angler catch data, 1979

3 From gill net sets May 27-30, 1980. B.C. Fish and Wildlife Branch, Smithers, B.C.

TABLE A8.2
Summary of Length and Age Data for Rainbow Trout from Morice Lake and Morice River During 1979 and 1980, and from Babine Lake and Babine River in 1969

Age	Sample Size	Composition (%)	Mean Size (cm)	Standard Deviation
	Morice Lake - 1979[1]			
4+	8	20.0	27.9	2.3
5+	13	32.5	32.3	2.4
6+	9	22.5	39.1	3.4
7+	5	12.5	43.9	4.7
8+	1	2.5	49.0	-
9+	4	10.0	47.6	3.9
Mean	40		36.3	
	MoriceLake-MoriceRiver, 1980[2]			
3+	1	1.1	17.7	-
4+	5	5.4	25.8	4.3
5+	25	26.9	32.5	3.4
6+	18	19.4	36.9	4.4
7+	23	24.7	41.1	3.9
8+	16	17.2	44.9	3.7
9+	5	5.4	46.7	3.2
Mean	93		37.8	
	Babine River-Babine Lake, 1969[3]			
2+	4	2.3	28.3	2.1
3+	49	28.6	30.8	3.4
4+	56	32.7	37.9	5.2
5+	35	20.5	42.5	4.7
6+	18	10.5	53.1	6.9
7+	6	3.5	55.4	3.4
8+	3	1.7	58.7	4.4
Mean	171		38.8	

1 From anglers' catch
2 From angling and gill net catches
3 From anglers' catch (Narver 1975)

TABLE A8.4

Summary of a Reconnaissance of Morice Lake Tributaries (excepting McBride Creek and Nanika River) on June 15 and September 14, 1979

Tributary[1]	Date	Water Temperature (°C)	Discharge Estimate (m^3/sec)	Turbidity	Comments
Delta Creek	June 15/79	3.5-4.0	3.0	glacial	Gravel substrate heavily compacted with glacial fines. The lower 3 km of creek is extensively braided. Spawning potential is low to nil
	Sept 14/79	4.5	1.5	glacial	Poor visibility. No salmon observed
	Aug/75	3.3	28.0	glacial	Surveyed on foot for 0.5 km. No fish observed. Rearing and spawning potential poor (Shepherd 1979)
Pyramid Creek	June 15/79	2.5	No estimate	glacial	Gravel substrate heavily compacted with fines. The lower section of the creek is braided. No spawning potential at this time of year (Plate 12)
	Sept 14/79	4.5	1.5	glacial	Poor visibility and no spawning potential
	Aug/75	7.2	23.0	glacial	Surveyed on foot for 0.6 km where there is a 5 m falls. Spawning and rearing potential poor (Shepherd 1979)
Cabin Creek	June 15/79	3.5	No estimate	clear	Lower 1 km has gravel and lots of instream debris. From this point upstream the substrate is large, with pockets of good gravel for spawning, and some potential trout rearing areas with holding pools. The channel upstream of 3 km is steep gradient and narrow
Atna Point Creek	June 15/79	Not measured	>3.0	glacial	Large boulder substrate with pockets of potential spawning gravel. Spawning and rearing potential is poor
	Sept 14/79	5.5	No estimate	glacial	
Atna River (upstream of Atna Lake)	Sept 14/79	3.0	No estimate	glacial	Gravel bars heavily compacted with fines. No visibility
	Sept 24/79	7.0	No estimate	glacial	Two coho fry and two Dolly Varden electrofished
Atna River (between Atna & Morice Lakes)	Aug/75	9.4	57	glacial	No fish species observed (Shepherd 1979)
Atna Bay Tributary 1	June 15/79	10.0	<0.3	clear	No spawning fish observed. 10% of substrate may be suited for spawning; the rest is large cobble and bedrock. Lake headed with good instream cover with some juvenile coho observed near creek mouth. May be accessible for 1.4 km
Atna Bay Tributary 2	June 15/79	10.0	<0.3	clear	No spawning fish observed. Estimated 20% of the substrate may be suited for spawning. Good instream cover and accessible for estimated 0.4 km. Some juvenile coho observed in a side pool

1 Refer to Figure 3.15 for map location of tributaries

TABLE A8.3
Summary of Rainbow Trout Tagging in the Nanika River, Morice Lake and the Morice River in 1979[1]

Fish No.	Tag No.	Length (cm)	Date Tagged	Location Tagged	Return Information[2]
1	9	47	May 27	Nanika - spawning grounds	
2	13	45	May 31	Nanika - spawning grounds	
3	14	53	June 16	Nanika - spawning grounds	Angler Aug 8/79 - Upper Morice River[3]
4	18	52	June 16	Nanika - spawning grounds	
5	19	49	June 16	Nanika - spawning grounds	
6	11	49	June 16	Nanika - spawning grounds	
7	21	49	June 16	Nanika - spawning grounds	Angler Sept 1/79 - Upper Morice River
8	23	49	June 16	Nanika - spawning grounds	
9	24	54	June 16	Nanika - spawning grounds	Angler Oct 2/79 - Upper Morice River
10	25	51	June 16	Nanika - spawning grounds	
11	27	52	June 16	Nanika - spawning grounds	
12	25	49	June 17	Nanika - spawning grounds	
13	255	45	June 15	Morice Lk - Atna Bay	
14	264	46	July 30	Morice Lk - Atna Bay	
15	265	43	July 30	Morice Lk - Atna Bay	Angler Sept 23/79 - Morice Lake at mouth of Nanika River
16	269	40	July 30	Morice Lk - Atna Bay	
17	271	36	July 31	Morice Lk - Atna Bay	
18	273	30	July 31	Morice Lk - Atna Bay	
19	280	31	Aug 22	Upper Morice River	Angler Sept 19/79 - Upper Morice River
20	281	30	Aug 22	Upper Morice River	
21	282	27	Aug 22	Upper Morice River	

1 For 1980 tagging summary see Section I
2 A tagged rainbow kelt was angled and released on July 8/79 at the south end of Morice Lake
3 All fish angled within 4 km of Morice Lake

APPENDIX A9

Resident Fish and Pacific Lamprey in the Morice River

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1.0 RESIDENT RAINBOW TROUT

Resident rainbow trout occur in low numbers throughout the Morice River. A sample of 19 resident rainbow trout angled in the Morice River during May and June 1980 ranged in fork length from 26 to 52 cm, with a mean of 40 cm. Resident rainbow smaller than 25 cm could not be distinguished from steelhead (Section 3.1.1). Snorkel surveys from 22 March to 16 November 1979 in the upper Morice River indicated greatest abundance of rainbow trout was during August and September, when they were commonly observed holding just downstream of spawning chinook (Appendix A3, Table A3.3). No resident rainbow were observed prior to late May in the upper Morice River. Of the total number of rainbow observed during all of the surveys, 54% were above Nado Creek and 46% were from Nado to Gosnell Creek.

In the period from September 4 to November 20, 1976, 101 resident rainbow were reported angled in the Morice between Barrett and Morice Lake (on file, B.C. Fish and Wildlife Branch, Smithers). Approximately 50% of these fish were angled in the Morice River below the Owen Creek confluence, indicating a widespread distribution in the river.

Life history and spawning information for resident rainbow trout are discussed in Section 3.2.1.

2.0 RESIDENT CUTTHROAT TROUT

Although resident cutthroat trout are found in the Morice River and at least 10 tributary streams, they are not common in most of the system. During the fall of 1976, only 13 cutthroat were reported angled in the Morice River, between Morice Lake and Peacock Creek (on file, B.C. Fish and Wildlife Branch, Smithers). No cutthroat were identified during snorkel surveys, although some trout listed as resident rainbow may have been cutthroat. Taylor and Seredick (1968) report that 3 cutthroat angled in the upper Morice were between 28-34 cm in length, similar to the 28-30 cm length for four cutthroat caught in Morice Lake (Section 3.2.1). Only two juvenile cutthroat (less than 20 cm fork length) were captured in the mainstem Morice River during the entire sampling program and none were captured in the Bulkley River.

A summary of juvenile cutthroat catches in 10 tributaries of the Morice River is presented in Table A9.1. The upper reach of Lamprey Creek had the greatest abundance of cutthroat juveniles, and many newly emerged fry were sampled in this reach in September. Trapper Cabin Creek and upper Cox Creek had a moderate abundance of juvenile cutthroat.

TABLE A9.1
Summary of Juvenile Cutthroat Trout Catches in Morice River Tributaries Based on Electrofishing During September and October 1979

Tributary	Reach	Area of Margin Electrofished (m^2)	Fish/100m^2 Margin
Lamprey	1	224	0.0
	2	336	6.8
	3	110	66.4
Trapper Cabin		174	7.5
Cox	4	204	0.0
	5	242	3.7
Peacock		114	2.6
McBride		164	1.8
24.5 Mile		220	1.4
Cottonwood		182	0.5
Knapper		222	0.4
Below Knapper		514	0.2
Cedric[1]		66	0.0

1 Cutthroat trout are known to be present in Cedric Creek in low numbers (November sample)

Lake surveys (on file, B.C. Fish and Wildlife Branch, Smithers) report cutthroat populations in Collins and Kluck Lakes and they are known to occur in several lake systems associated with Lamprey Creek. Most juvenile cutthroat captured in this study probably originated from lake populations.

3.0 DOLLY VARDEN CHAR

The following section discusses the distribution and abundance of Dolly Varden char in the Morice River and tributaries. For the purpose of this study, Dolly Varden less than 20 cm in length are referred to as juveniles, although some smaller Dolly Varden become sexually mature.

3.1 Adult Dolly Varden Char

Adult Dolly Varden char are common throughout the mainstem Morice River and in Morice and Owen Lakes. A sample of 44 Dolly Varden char angled in the Morice River during May and June 1980 ranged in fork length from 27 to 63 cm, with a mean of 44 cm. Taylor and Seredick (1968) report that 51 Dolly Varden from the Morice River ranged in fork length from 27 to 49 cm, with a mean fork length of 38 cm. Although ages were not determined, these fish are probably age 4^+ and greater based on growth rates for Dolly Varden reported by Scott and Crossman (1973) and by McLeod et al. (1978) for the McGregor and Parsnip Rivers.

Dolly Varden char comprised 6% of the total resident fish observed during snorkel surveys (Appendix A3, Table A3.3), with the greatest numbers generally occurring between Nado Creek and Morice Lake. The snorkel survey counts represent an unknown percentage of the total number of Dolly Varden present, and can only be used as an index of seasonal abundance. No snorkel surveys were conducted below Gosnell Creek. However, angling indicates Dolly Varden are found throughout the mainstem of the Morice River. Between September and early December 1976, 295 Dolly Varden were reported angled between Barrett and Morice Lake (on file, B.C. Fish and Wildlife Branch, Smithers).

The number of adult Dolly Varden in the upper Morice River remained low throughout the summer but increased in early September, coinciding with the arrival of chinook salmon spawners in the upper river. Throughout September, Dolly Varden were commonly observed holding immediately downstream of spawning chinook salmon, sometimes in groups of up to 10 fish. Taylor and Seredick (1968) reported that all Dolly Varden examined in the upper Morice during September had been feeding on eggs, suggesting that salmon eggs are an important food source for Dolly Varden at that time of year.

Although visibility improved during November, the numbers of adults observed decreased, suggesting that some adults move into Morice Lake or the lower sections of the Morice River to overwinter. Lakes have been shown to be important for overwintering Dolly Varden char in Alaska (Armstrong 1965) with fish making substantial migrations to overwinter in lake systems. Some Dolly Varden adults do overwinter in the mainstem Morice River. Three were observed during a snorkel survey in March and 30 were observed during a spot snorkel examination of a run just below Gosnell Creek on November 27.

Little information is available on Dolly Varden spawners in the Morice River. Taylor and Seredick (1968) report that all fish angled in the upper Morice in the fall were non-spawners. During the October 25 and November 16, 1979 snorkel surveys, four pairs of Dolly Varden were observed in the upper river. These fish were more brightly coloured and larger than any Dolly Varden previously observed in the river (estimated 2 to 3 kg), and were holding adjacent to suitable spawning gravel areas, suggesting that some spawning occurs in this section of the river. Water temperatures were 5.5 to 8^{o}C, which is near the optimum for Dolly Varden spawning (Scott and Crossman 1973). Dolly Varden spawning in the Nanika River was observed on October 20, 1979 at 8.5^{o}C.

In both the Morice and Nanika Rivers, spawners were larger individuals than normally observed in the systems or caught by anglers in Morice Lake. Four out of the eight Dolly Varden spawners captured in the Nanika River ranged from 65 to 80 cm, while the largest Dolly Varden captured in Morice Lake was 61 cm and most ranged from 30 to 50 cm. In both cases, the sample size was small.

Sexually mature Dolly Varden from 12 to 20 cm in length were captured in a number of Morice River tributaries in late October, suggesting the presence of dwarf populations in these tributaries, or alternatively, the early maturation of some individuals prior to moving into a lake system. Scott and Crossman (1973) report some males may become sexually mature after three years.

No adult Dolly Varden were captured in tributary creeks during the fall. However, it is expected that potential spawners would be found in deeper water not effectively sampled by electrofishing. A 50 cm Dolly Varden was captured in Denys Creek, a tributary of the Thautil River, in July of 1978 (Carswell 1979a). Many tributaries were not accessible to Dolly Varden spawners during October 1979 due to the low streamflows. Unless fish migration had occurred during higher flows in the late summer, access to headwater areas would be hindered. Dolly Varden spawning migrations of over 150 km in the Flathead River were reported by Hanzel (1965), so movements of 10 to 50 km into the upper ends of Morice River tributaries by adult Dolly Varden are quite feasible.

3.2 Juvenile Dolly Varden Char

Dolly Varden char fry emerge from June through August, with later emergence probably occurring in colder headwater tributaries such as Denys Creek in the upper Thautil River. Dolly Varden fry only 30 to 40 mm in length were captured in Denys Creek in late September. Recently emerged fry were sampled in upper Gosnell, Owen, Lamprey and Houston Tommy Creeks and the Thautil River.

Fork lengths of juveniles ranged from 30 to 170 mm (Figure A9.1). Based on size and growth estimates from Scott and Crossman (1973), these fish were probably juveniles up to 4 years of age. Dolly Varden char young generally spend from several months to 3 to 4 years in streams prior to moving into a lake (Scott and Crossman 1973). Movements out of tributaries and into lakes may be quite extensive. McLeod et al. (1978) reported a tagged juvenile moving 145 km between the Parsnip River and Williston Lake.

Juvenile Dolly Varden were captured throughout the mainstem Morice and in 15 tributary streams (Figure A9.2). The distribution of Dolly Varden in tributaries is probably more extensive than illustrated, since many headwater areas were not sampled in the 1979 studies.

Dolly Varden char catches in the mainstem Morice River were low, with only 36 juveniles caught by electrofishing and minnow trapping during four sample periods in 1979. Catches of Dolly Varden never exceeded 2% of the total catch of juvenile salmonids during any sample period in the mainstem electrofishing catches (Appendix A3, Table A3.2). Dolly Varden char juveniles comprised <1% of the electrofishing samples in 1981 and 1982 (Section J). All of the fish captured were greater than 70 mm in length. The absence of fry in the mainstem, and their presence in a number of tributaries, suggest that most Dolly Varden spawning occurs in tributaries. McLeod et al. (1978) found very little evidence of the use of either the mainstem McGregor or Parsnip Rivers by Dolly Varden fry, which were found predominantly in tributary streams.

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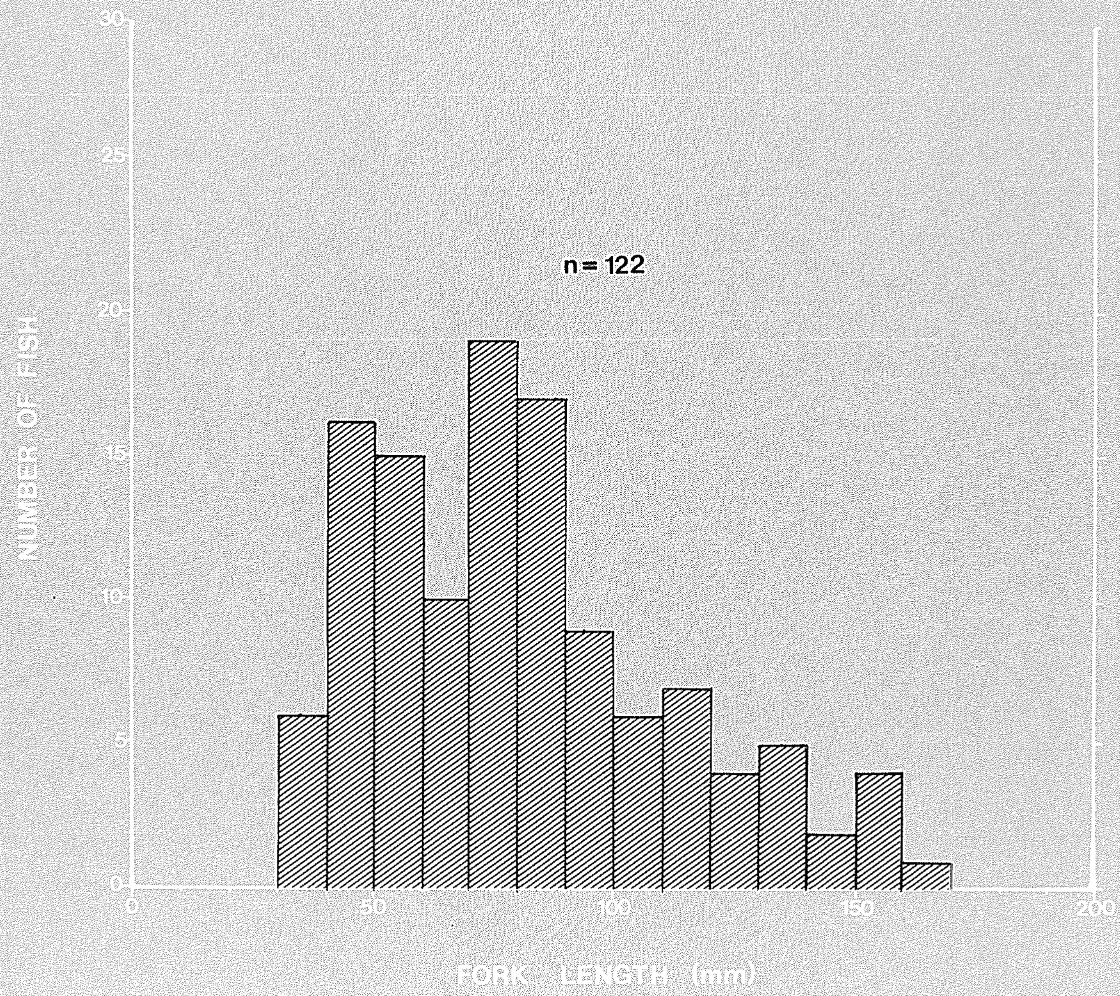
FIGURE A9.1: LENGTH-FREQUENCY OF JUVENILE DOLLY VARDEN IN THE MORICE RIVER SYSTEM, 1979



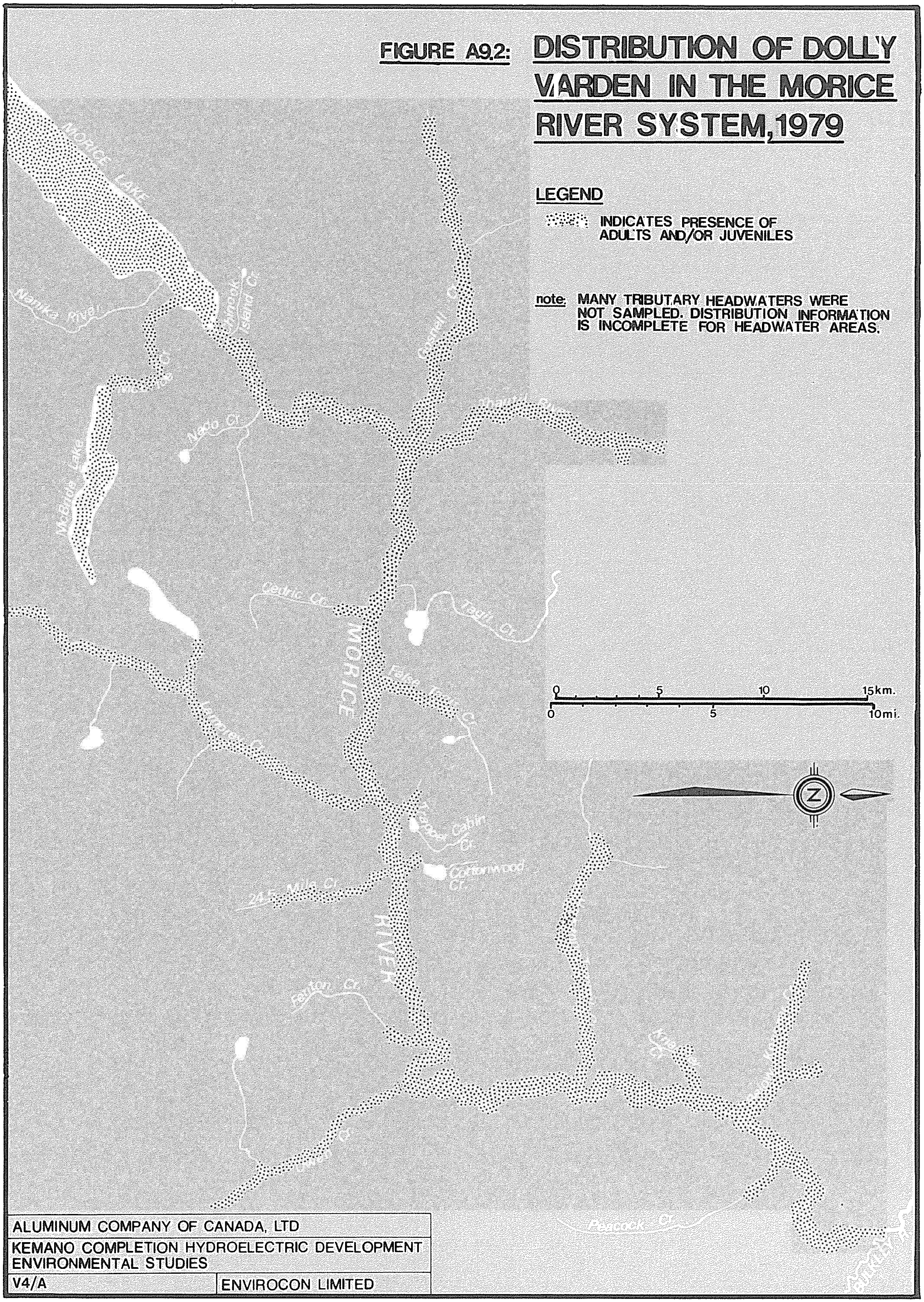


FIGURE A9.2: DISTRIBUTION OF DOLLY VARDEN IN THE MORICE RIVER SYSTEM, 1979

Juvenile Dolly Varden catches suggest extensive tributary rearing, particularly in the upper Gosnell, Owen, Lamprey and Houston Tommy Creeks and the Thautil River (Table A9.2). Catches of Dolly Varden char tended to be highest in the upper sections of tributaries, which are the areas least utilized by juvenile salmon and steelhead trout. Additional data on tributary Dolly Varden char populations is presented in Tredger (1982 and 1983).

In summary, Dolly Varden char is common in the Morice system. Adults appear to use the mainstem river extensively for feeding, with a limited amount of adult spawning and juvenile rearing occurring in the main river. Although no spawners were captured in tributaries, catches of newly emerged fry and the higher abundance of juveniles in 15 tributaries suggest that most spawning and early rearing of Dolly Varden occurs in tributary streams, particularly in their upper ends, with a movement into the Morice River and possibly Morice Lake occurring as juveniles reach 3 to 4 years of age. Detailed trapping, marking and aging studies of adults and juveniles would be necessary to verify these movement patterns.

4.0 MOUNTAIN WHITEFISH

Available data on the distribution and abundance of mountain whitefish are presented in the following section. For the purpose of this study, those mountain whitefish less than 200 mm in fork length are referred to as juveniles.

4.1 Adult Mountain Whitefish

Adult mountain whitefish are common throughout the mainstem Morice River and in McBride, Morice, Owen and Kluck (headwaters of Cox Creek) Lakes (on file, B.C. Fish and Wildlife Branch, Smithers).

A sample of 113 mountain whitefish angled in the upper Morice River ranged in length from 19-39 cm with a mean fork length of 30 cm (Taylor and Seredick 1968). Growth rates reported in Scott and Crossman (1973) suggest that most of these fish were age 2^+ and greater.

Mountain whitefish comprised 85% of the total resident fish observed during snorkel surveys in the upper Morice River from May through October 1979 (Appendix A3, Table A3.3). No whitefish were observed during the March surveys, suggesting that adults may overwinter in Morice Lake. Numbers of adult whitefish gradually increased through the summer with a peak during the September surveys coinciding with the

TABLE A9.2
Summary of Juvenile[1] Dolly Varden Char Catches by Reach in the Marice River Tributaries Based on Electrofishing Data from September and October 1979

Tributary	Reach	Area of Margin Electrofished (m^2)	Fish/100 m^2 Margin
Gosnell	1	222	0
	2	846	1.6
	3	284	7.0
Cox	4	204	0.5
	5	242	1.6
Thautil	1	655	0.2
	2	233	1.3
	3	230	3.9
Lamprey	1	224	
	2	336	
	3	110	20.0
Owen		794	2.5
Puport		150	2.7
Peacock		114	5.3
Houston Tommy		372	4.0
Fenton		112	3.6
False Tagit		188	3.2
Cedric		66	1.5
24.5 Mile		220	1.4
Cottonwood		182	1.1
Below Knapper		514	0.6
Trapper Cabin		174	0.6
Knapper		222	0.4
McBride[2]		164	0

1 All fish were less than 200 mm in fork length

2 Dolly Varden char are known to be present in McBride Creek in low numbers (November sample)

peak of chinook spawning. Many whitefish were observed immediately downstream of spawning chinook, apparently feeding on eggs and insects dislodged by the digging activity. Whitefish were also observed holding in the vicinity of steelhead redds in early June and pink salmon redds in early September. The numbers of mountain whitefish in the upper Morice declined through October. By November 16, virtually all whitefish observed were within 3 km of Morice Lake, usually in schools, a further indication that they overwinter in the lake.

Little information is available on adult mountain whitefish use of the river below Gosnell Creek other than occasional observations or captures of individuals in downstream areas. A reported 92 mountain whitefish were angled between Barrett and Morice Lake during the autumn of 1976 (on file, B.C. Fish and Wildlife Branch, Smithers). Subsequent observations during boat electrofishing studies (Section F) have confirmed that whitefish are abundant throughout the Bulkley River.

Mountain whitefish occupied a greater range of fast water habitats in the mainstem Morice River than other species observed. They were frequently observed in deep, fast water areas holding close to the substrate. Cover and depth did not appear to be important in determining areas preferred by mountain whitefish, and they were often observed in midstream areas, many meters from the stream margin or from cover.

Little information was gathered on mountain whitefish spawning in the Morice River during the study. Whitefish usually spawn between October and November when water temperatures are 8°C or less (Scott and Crossman 1973). Thompson and Davies (1976) report that mountain whitefish spawn in small groups of 2 to 20 fish in substrate ranging from 5 to 80 cm diameter. Average water velocities on spawning sites ranged from 60 to 150 cm/sand water depths ranged from 30 to 65 cm. Taylor and Seredick (1968) found that most whitefish captured on October 15, 1979 in the upper Morice were in spawning condition. Based on snorkel observations in late October 1979, whitefish were abundant in the upper 10 km of the Morice River, suggesting that this may be an important area for mountain whitefish spawning.

4.2 Juvenile Mountain Whitefish

Few juvenile mountain whitefish were captured during the river sampling program, despite the abundance of adult whitefish in the Morice River. A total of 71 juveniles was captured in the main river by electrofishing during four sample periods in 1979, with the majority captured in early May or late November. Juvenile whitefish never comprised more than 5% of the total 1979 catch of salmonids during any sample period. No whitefish were captured in the 860 minnow traps set throughout the main river and tributaries. Subsequent studies (Sections B and J) indicate that juvenile whitefish are more common than do the 1979 surveys. Juvenile whitefish comprised approximately 9% of the juvenile catches in 1981 and 1982.

Six newly emerged whitefish fry ranging from 20 - 37 mm in length were captured in early July along the mainstem river margin suggesting that whitefish fry probably first appear from May through early July. Whitefish fry move away from the margins when they reach lengths of between 30-40 mm (Scott and Crossman 1973). This may account for the low numbers of juveniles captured.

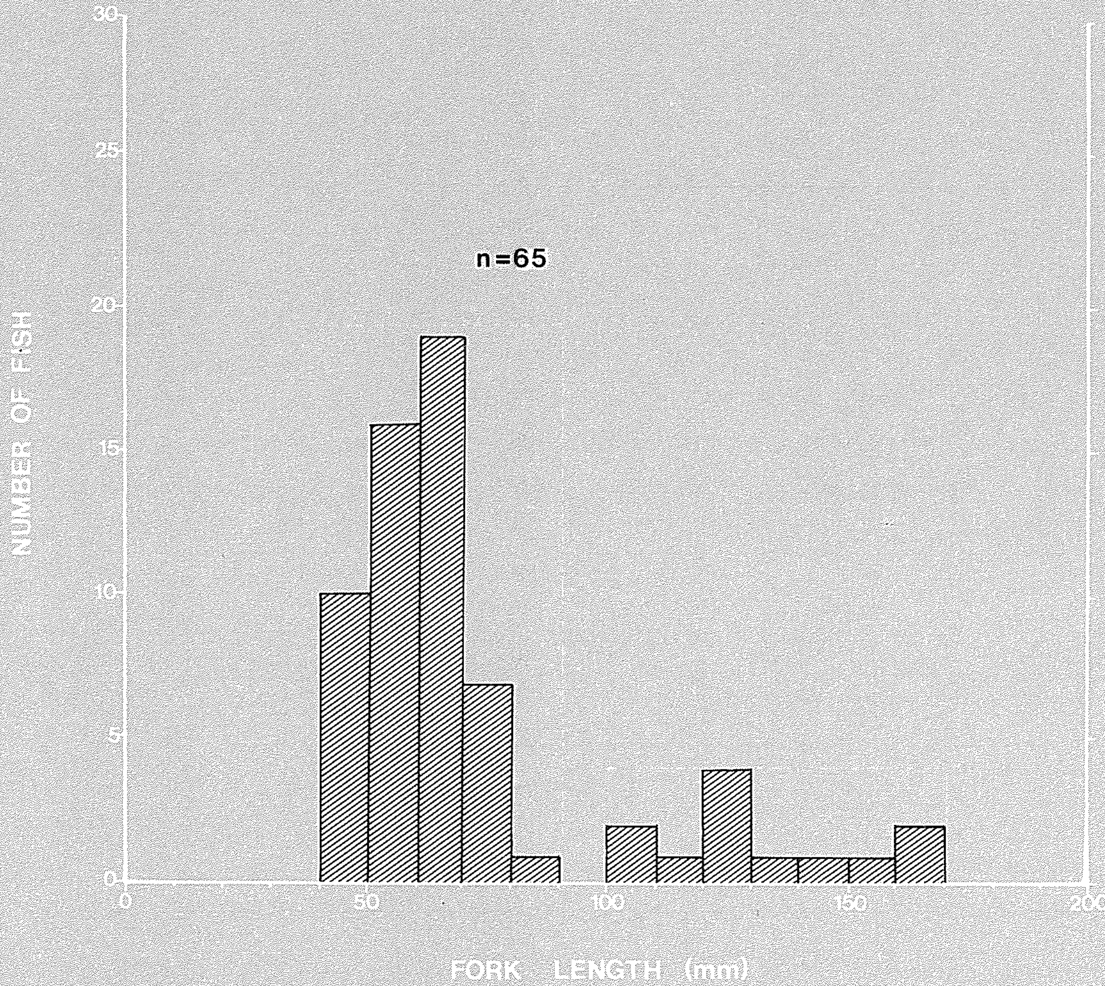
Fry at the end of their first growing season (November) and prior to their second (early May) ranged in fork length from 44 to 77 mm (Figure A9.3). Yearlings were greater than 100 mm in fork length.

Only seven juveniles were captured in the tributaries during the 1979 season, suggesting a low use of tributaries by mountain whitefish. Juveniles were captured in McBride, Gosnell and Owen Creeks, while juvenile whitefish (including fry) have been reported in the Thautil River (Taylor and Seredick 1968; Carswell 1979a) and in Peacock and lower Lamprey Creeks (Shepard and Algard 1977).

The low catches of juvenile whitefish in the Morice River, despite a high adult population, suggests that some spawning and juvenile rearing may occur in Morice Lake. Most studies report that mountain whitefish spawn in tributary streams (Scott and Crossman 1973). However, Hagen (1970) reports that all mountain whitefish in Phelps Lake, Wyoming were lake spawners. Another possible explanation for low juvenile catches is that heavy egg and fry losses may have occurred during severe floods in the early winter of 1978, reducing the 1979 juvenile recruitment to low levels. The latter explanation seems more reasonable in light of recent surveys outlined in Sections Band J.

In summary, mountain whitefish are the most common resident fish species found in the Morice River. Adults were abundant in the mainstem river from May through late October and probably overwinter in Morice Lake. Spawning areas were not identified. Newly emerged fry captures were uncommon in tributaries and the mainstem river, and few juveniles were captured during the studies, possibly a result of the mid-river habitat apparently preferred by whitefish.

FIGURE A9.3: LENGTH-FREQUENCY OF JUVENILE WHITEFISH IN THE MORICE RIVER SYSTEM, SEPT./OCT., 1979



5.0 LARGESCALE SUCKER

Adult largescale suckers were observed in the mainstem Morice River from Owen Creek to Morice Lake. They probably occur downstream of this section although their presence was not verified in 1979. Surveys conducted by the B.C. Fish and Wildlife Branch indicate that largescale suckers also occur in McBride, Morice and Owen Lakes (on file, B.C. Fish and Wildlife Branch, Smithers). Boat electrofishing surveys in 1982 indicate that largescale suckers are common throughout the system including the Bulkley River (Section F).

Adult largescale suckers comprised 6% of the total number of resident fish observed in the Morice River during 1979 snorkel surveys from May through November (Appendix A3, Table A3.3). Largescale suckers were mainly observed from early August onward, usually in small groups occupying silt-bottomed side pool areas. The numbers increased in the fall, probably a result of dewatering or freezing of backwater areas resulting in a greater concentration of fish in the mainstem. During the snorkel survey on November 16, the only suckers observed were a school of 70 near the outlet of Morice Lake, suggesting a movement of fish from the upper Morice River into the lake in the late fall.

Large numbers of largescale suckers overwinter in the mainstem Morice River between Owen Creek and Gosnell Creek. An estimated 760 largescale suckers were observed in schools of from 40 - 300 fish in pool areas during an aerial survey on November 26-27. These observations were verified by spot snorkel checks of the larger schools. This section of the Morice River (Reach 2) probably has the greatest abundance of largescale suckers because of the numerous backwater and slough-like areas which apparently provide suitable habitats.

Only 34 largescale sucker juveniles were captured by electrofishing and minnow trapping in the mainstem Morice and Bulkley Rivers. Newly emerged fry were first captured in July and ranged in length from 33 to 58 mm by September. Juveniles were generally found in slow current, silt-bottomed side pools, ponds or sloughs. Twenty-five largescale sucker fry were found frozen in an isolated side pool in Reach 2 during November. No largescale sucker juveniles were captured in tributaries.

6.0 LONGNOSE SUCKER

No longnose sucker adults or juveniles were observed or recovered in the mainstem Morice River. A total of 20 juveniles ranging from 55 to 132 mm in length were recovered in McBride, Owen and Lamprey Creeks during the course of this study, indicating a low abundance of this species in those areas that were examined. Longnose suckers are reported in McBride, Morice, Owen, and Kluck Lakes (on file, B.C. Fish and Wildlife Branch, Smithers).

7.0 REDSIDE SHINER

Redside shiners were found in two Morice River tributaries, Owen Creek and McBride Creek. Eight individuals ranging from 25-70 mm in length were captured between May and July. Redside shiners have been reported in Owen Lake (On file, B.C. Fish and Wildlife Branch, Smithers).

8.0 LONGNOSE DACE

Longnose dace were abundant throughout the mainstem Morice and Bulkley Rivers and in Lamprey and McBride Creeks. This species was not present in any of the other tributaries sampled. Over 9% of the electrofishing sample from May to November in the mainstem river consisted of longnose dace (Appendix A3, Table A3.2). Samples during subsequent years were considerably less than this, ranging from 1-2% (Section J).

Catches were greatest during the July and September sample periods, particularly in the lower Morice and Bulkley Rivers during July (Table A9.3). Based on the catch data, longnose dace were most abundant in Lamprey Creek, particularly in the middle and lower reaches.

The longnose dace captured in this study ranged in fork length from 21 to 105 mm and were commonly in the 30 to 60 mm range during all seasons. Young ranging in length from 21 to 40 mm, were often captured in shallow marginal areas of low water velocity from May through September in both tributaries and the mainstem Morice River. Larger individuals were generally caught in runs and riffles.

Longnose dace spawn from May to August and the young spend approximately four months in a pelagic stage occupying quiet water areas prior to taking up a bottom-dwelling existence typical of the adult (Scott and Crossman 1973).

TABLE A9.3
Summary of Longnose Dace Electrofishing Catches by Reach in the Morice and Bulkley Rivers and in Two Tributaries from May to November 1979

	Number of fish/100 m^2 margin[1]			
Reach	May	July	September	November
1	0.0	0	0.3	0.0
2	0.2	0.2	2.0	0.1
3	0.0	0.4	2.0	0.0
4	0.1	5.4	1.9	1.3
5	NS[2]	3.8	1.1	0.0
6	NS	3.3	0.7	0.0
Lamprey	0.9	8.8	6.4	0
McBride	NS	2.5	7.3	0.3

1 For sampling effort see Appendix A4, Table A4.9

2 Not sampled

9.0 PRICKLY SCULPIN

Prickly sculpins were found in the Morice and Bulkley Rivers and in McBride, Owen, Chinook Island, and lower Gosnell Creeks during the 1979 study. None was recovered in any of the other creeks sampled, although they have been reported in lower Lamprey Creek (Morris and Eccles 1975). Sculpins were the most frequent species captured during a netting program in Morice Lake in 1974 (Shepherd 1979), and have been reported in Owen Lake (on file, B.C. Fish and Wildlife Branch, Smithers).

Only 1% of the 1979 electrofishing sample from May through November in the mainstem Morice was comprised of prickly sculpins (Appendix A3, Table A3.2). Sculpins comprised a similar proportion of catches in 1981 and 1982. Most Morice River catches were in the top reach with low catches below Gosnell Creek (Table A9.4). The greatest concentration of prickly sculpins in tributaries occurred in McBride Creek. This was confirmed by minnow traps set in July and September, when 207 sculpins were captured in 45 traps.

Spawning apparently occurs in June based on the capture of a number of larger spawned-out individuals in a downstream trap in McBride Creek. Large numbers of sculpin fry were electrofished in lower McBride Creek in November.

Sculpins were frequently found hiding under rocks in the upper Morice River during March snorkel surveys, indicating that cobble substrate is used by overwintering fish.

10.0 PACIFIC LAMPREY

Pacific Lampreys up to approximately 70 cm are abundant and widely distributed in the Morice drainage. Figure A9.4 illustrates the distribution of lampreys based on a combination of adult observations and ammocoete (larvae) recovery during the electrofishing program.

Adult upstream migration past Moricetown Falls occurs in late July (pers. comm., L. Cox, B.C. Fish and Wildlife Branch). Adult lamprey spend an entire year in the river prior to spawning the following summer. Four adult lamprey were electrofished in large loose cobble in the upper Morice on September 14. It would appear that lamprey remain in the substrate until the following spring since none were observed in snorkel surveys from August until early June.

TABLE A9.4
Summary of Prickly Sculpin Electrofishing Catches by Reach in the Morice and Bulkley Rivers and in Three Tributaries from May to November 1979

Reach	Number of fish/100m² of margin[1]			
	May	July	September	November
1	0.0	0.4	2.2	0.9
2	0.0	0.1	0.1	0.1
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.2
5	0.0	0.0	0.0	0.0
6	0.0	0.1	0.0	0.0
Chinook Island	NS[2]	3.3	0.5	NS
McBride	NS	2.8	1.2	11.2
Owen	0.2	0.0	0.0	0.0

1 For sampling effort see Appendix A4, Table A4.9

2 Not sampled

Lamprey spawning takes place in June and July, with a few individuals remaining on their redds until early August. Large numbers of lamprey were observed spawning at the top end of riffles throughout Owen and Lamprey Creeks. Morris and Eccles (1975) report 195 suspected lamprey redds in the mid-section of Lamprey Creek during their 1975 surveys. Pairs of adult spawners were observed in Cottonwood and False Tagit Creeks in mid-June, and up to 20 lamprey were observed spawning in the Reach 1 of the Morice River during surveys in June and July (Appendix A3, Table A3.3). The largest number of lamprey were observed in the upper Morice in late July and spawning appeared to take place later than in warmer tributaries. Spawning was observed throughout the side channels in Reach 2. An estimated 50 dead lamprey were observed during helicopter surveys just downstream of the Bulkley River confluence in early September, suggesting spawning occurs through much of the mainstem river. Tributary temperatures were 10^{o} to $15^{o}C$ while the mainstem Morice temperatures ranged from 5^{o} to $13^{o}C$ during the spawning period.

Lamprey ammocoetes remain buried in the mud for up to six years prior to transforming from a blind, suckerless form to an eyed, parasitic form which leaves freshwater to begin a parasitic life in the ocean (Scott and Crossman 1973). Ammocoetes captured throughout the mainstem Morice and Lamprey and Owen Creeks, were nearly always in areas of slow water and silt bottom. Reach 2 and Reach 4 are particularly suited for ammocoete development as they have numerous backwater channels. Numerous dead lamprey ammocoetes were observed frozen in side pool areas during a low flow cold period in November. Four transformed young lamprey between 130-180 mm in length were captured in Lamprey Creek in mid-September prior to their seaward migration. Numerous transformed lamprey were captured in traps and on fences in side channels of the Morice River during November and early December.

Historically, adult lampreys have been used by British Columbia Indians who smoked, sun-dried or salted them. In the past, some lamprey have been taken for food at Moricetown Falls if salmon were in short supply (pers. comm., L. Cox, B.C. Fish and Wildlife Branch).

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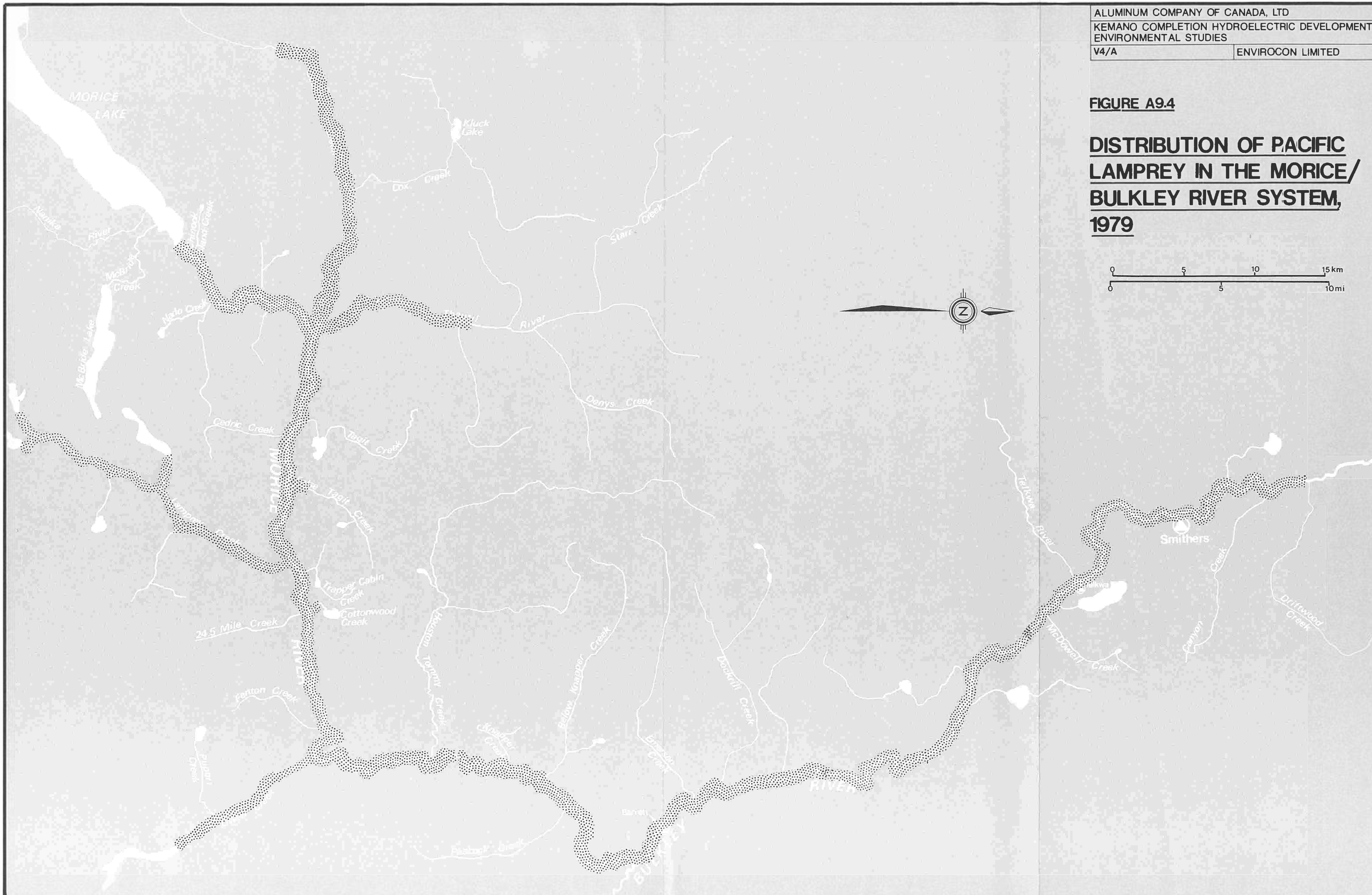
FIGURE A9.4

DISTRIBUTION OF PACIFIC LAMPREY IN THE MORICE/ BULKLEY RIVER SYSTEM, 1979



APPENDIX A10

Habitat - Flow Relationships

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FIGURE A10.1

STEELHEAD SPAWNING, TRANSECT 1, SITE T2

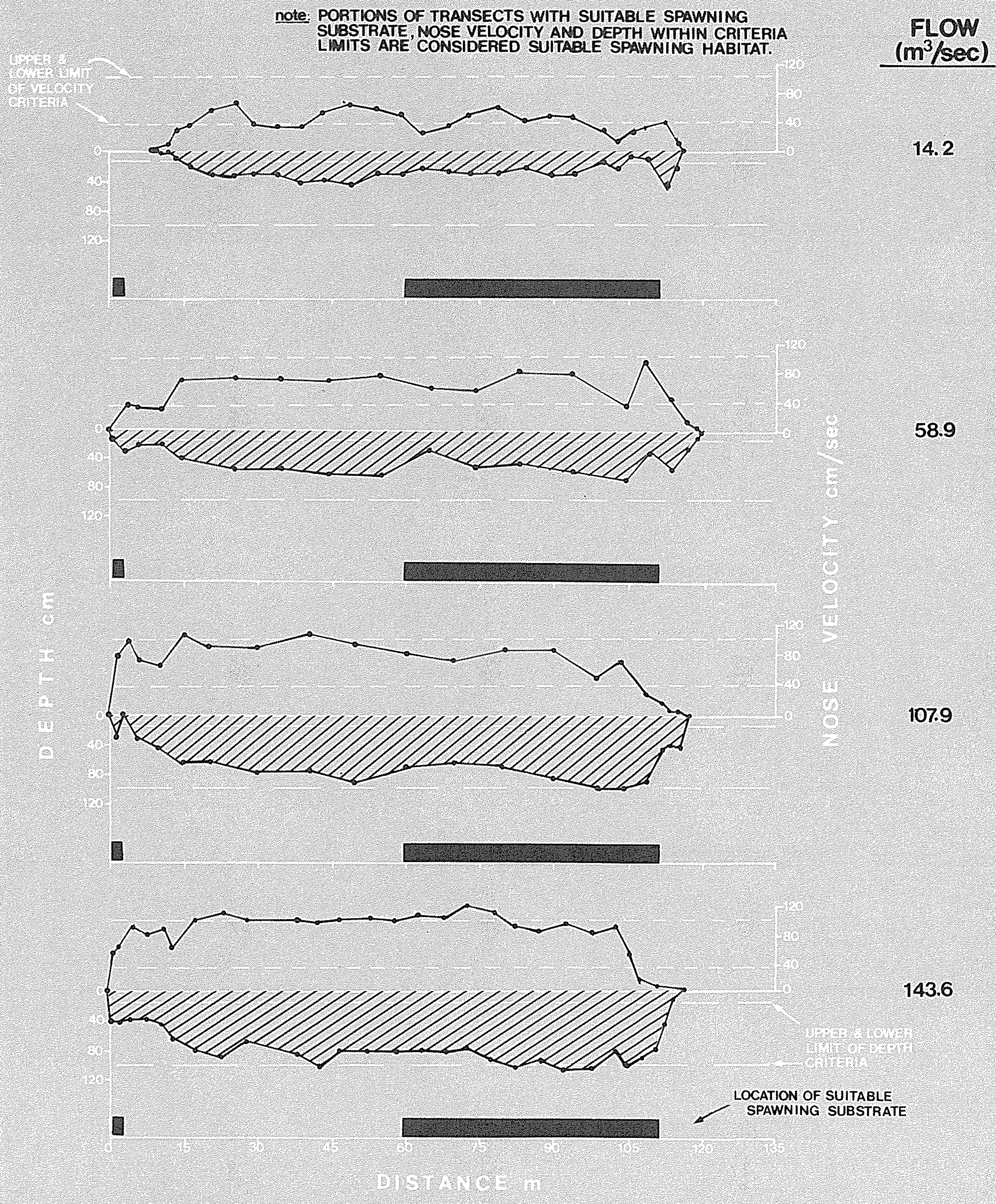

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FIGURE A10.2

STEELHEAD SPAWNING; TRANSECT 2, SITE T2

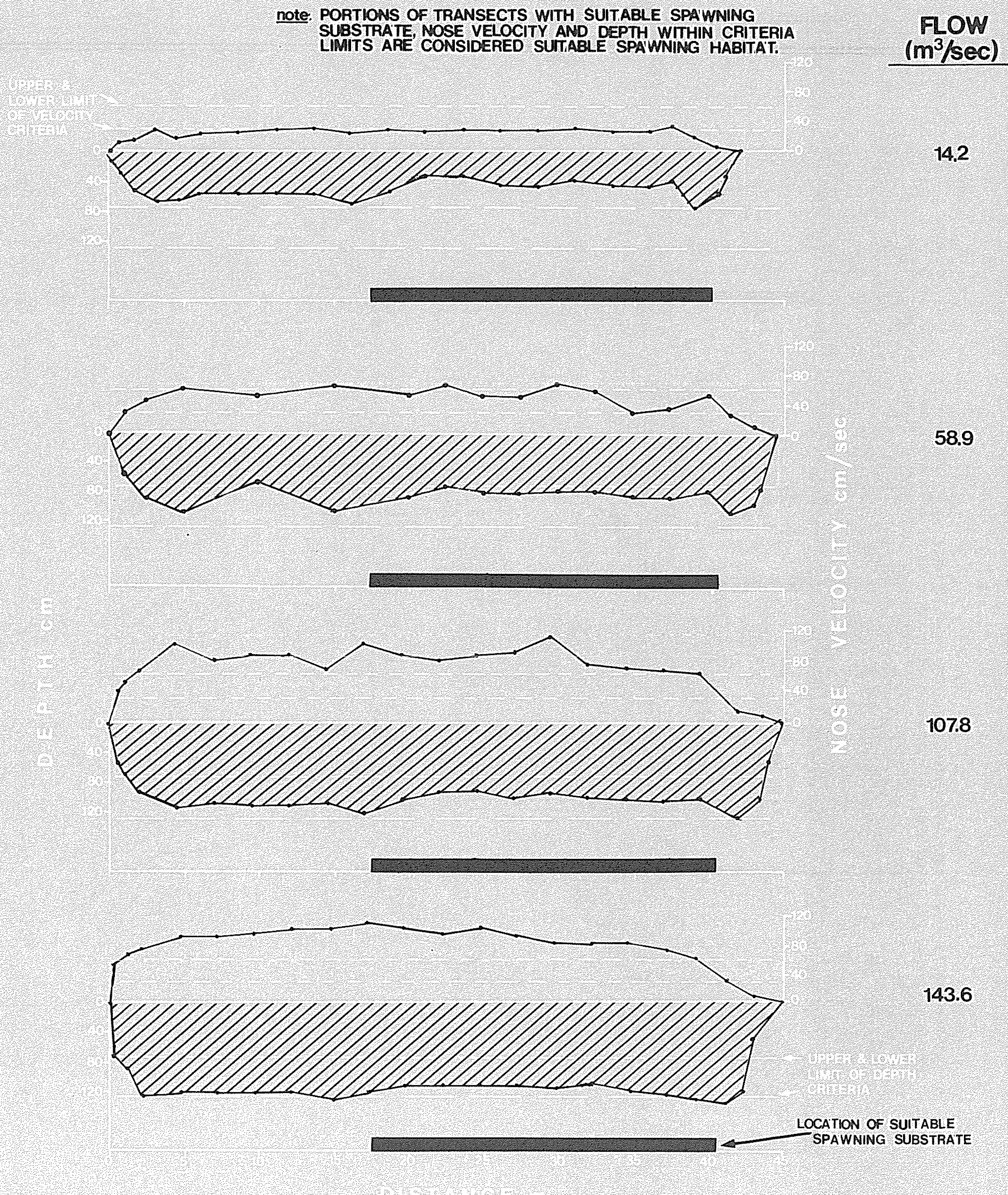

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FIGURE A10.3

STEELHEAD SPAWNING, TRANSECT 3, SITE T2

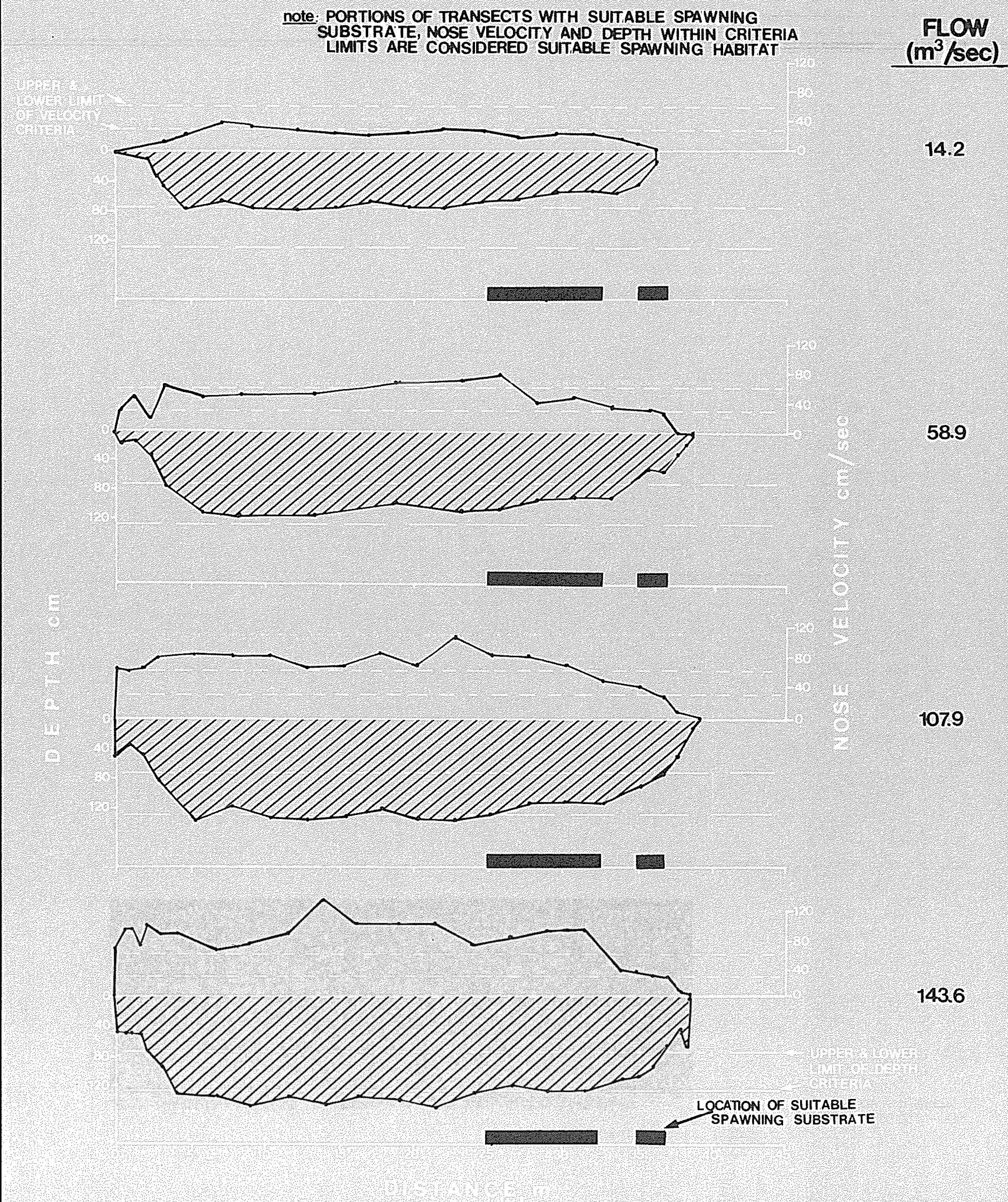

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FIGURE A10.4

PINK SALMON SPAWNING TRANSECTS; SITE T5
(Flow of 88 m^3/s)

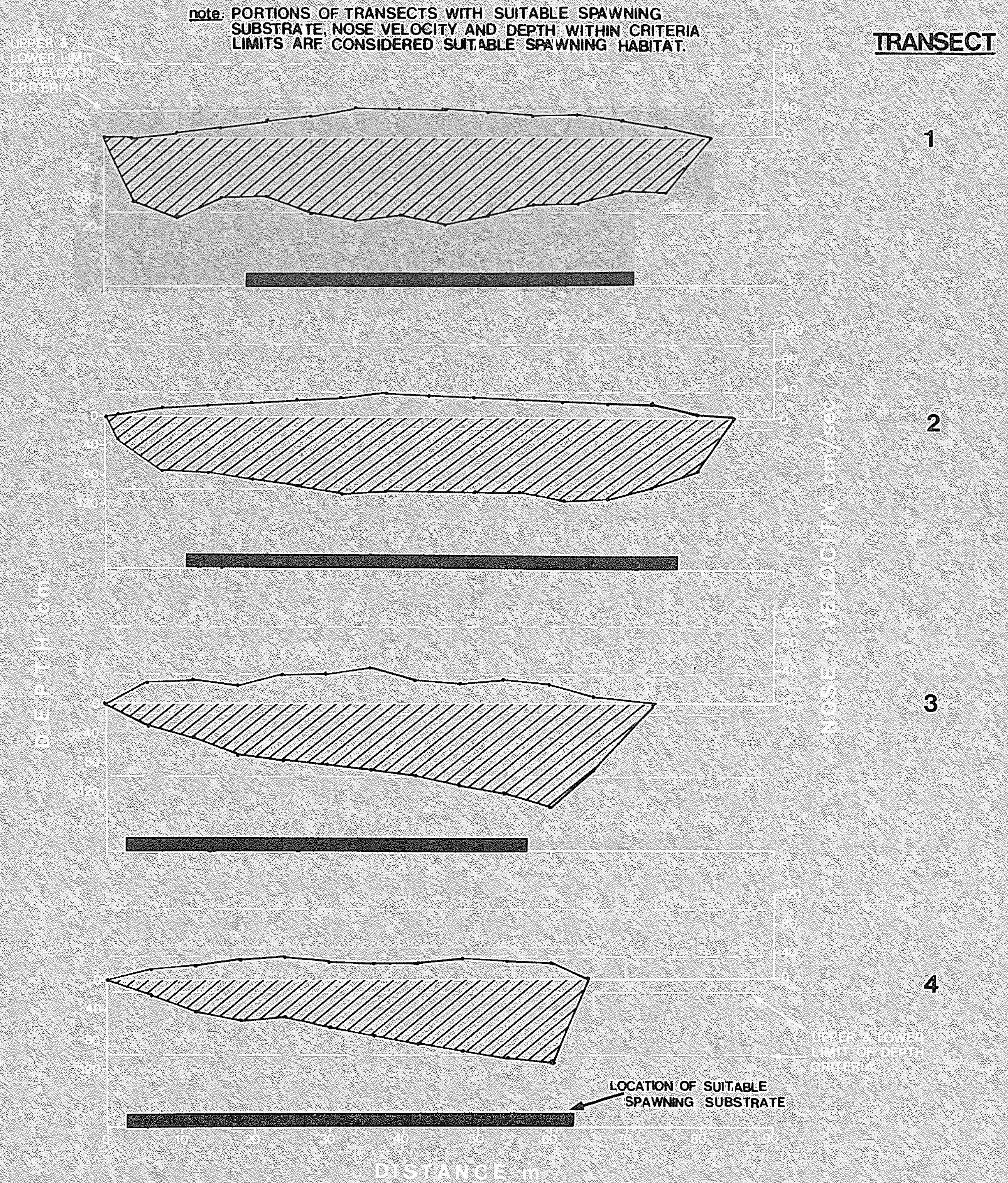

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FIGURE A10.5

PINK SALMON SPAWNING TRANSECTS; SITE T5
(Flow of 120 m^3/s)

note: PORTIONS OF TRANSECTS WITH SUITABLE SPAWNING SUBSTRATE, NOSE VELOCITY AND DEPTH WITHIN CRITERIA LIMITS ARE CONSIDERED SUITABLE SPAWNING HABITAT.

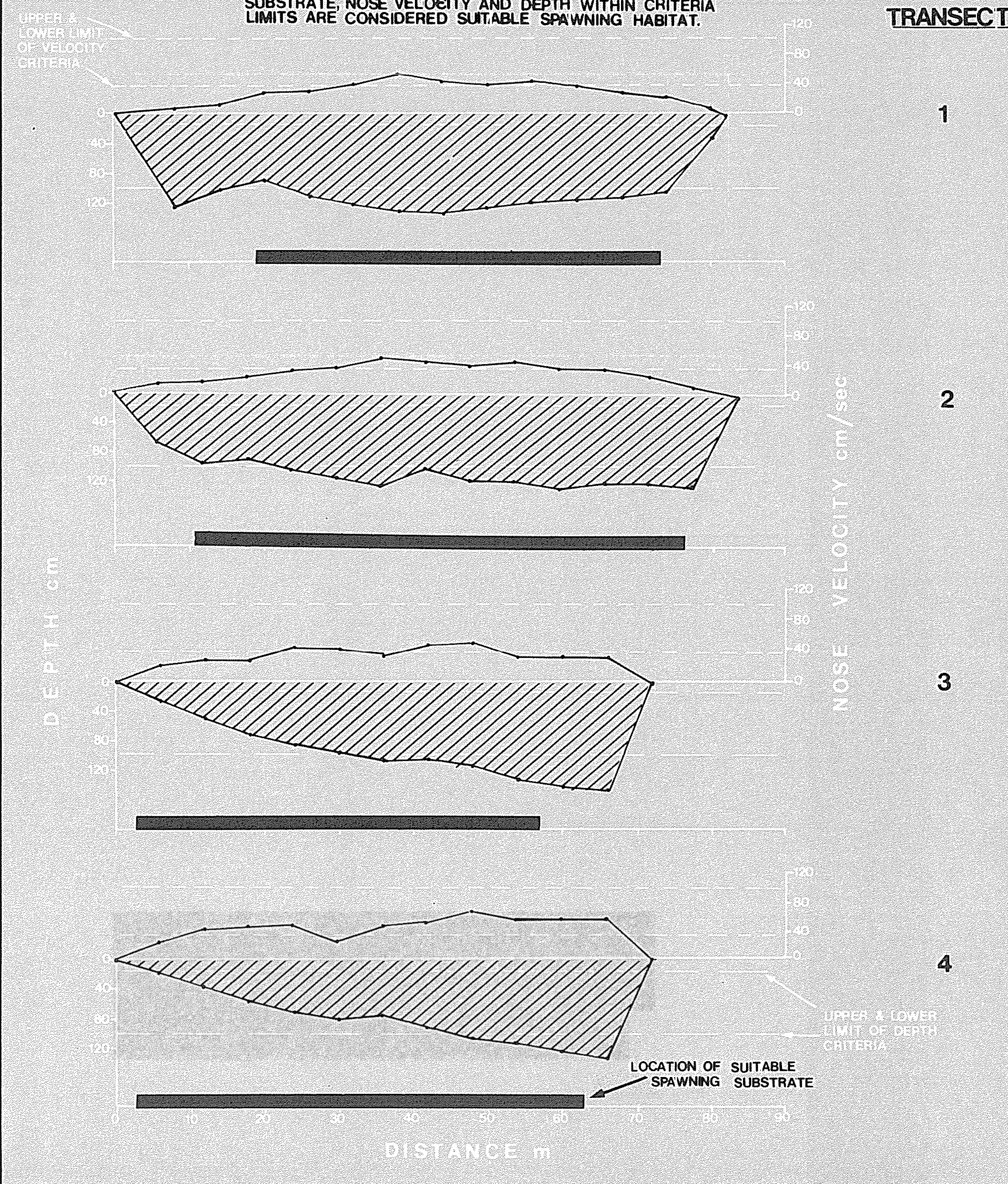

TABLE A10.1
Calculated Available Juvenile Salmonid Rearing Habitat from Transect Measurements at Four Flows in Reaches 1 and 2 of the Morice River, 1979

	Reach 1[1]			Reach 2[2]		
Species	Flow (m^3/sec)	Rearing Habitat[3] (m)	% of Maximum Available	Flow (m^3/sec)	Rearing Habitat[3] (m)	% of Maximum Available
Steelhead Fry	14.8	28.2	38.4	19.3	40.2	55.9
	60.6	73.4	100.0	69.4	61.2	85.1
	109.9	46.8	76.6	119.0	62.2	86.5
	143.3	61.1	83.2	176.4	71.9	100.0
Steelhead Parr	14.8	17.4	25.0	19.3	26.7	25.9
	60.6	68.8	98.8	69.4	57.5	55.7
	109.9	56.3	80.9	119.0	53.7	52.0
	143.3	69.6	100.0	176.4	103.2	100.0
Coho Fry	14.8	9.0	17.7	19.3	20.6	20.8
	60.6	14.3	28.1	69.4	36.0	36.4
	109.9	26.0	51.2	119.0	49.4	50.0
	143.3	50.8	100.0	176.0	98.8	100.0
Coho Yearling	14.8	2.8	12.6	19.3	11.4	IS.1
	60.6	10.6	47.5	69.4	17.1	22.6
	109.9	13.1	58.7	119.0	31.8	42.0
	143.3	22.3	100.0	176.0	75.7	100.0
Chinook Fry	14.8	19.9	33.8	19.3	26.5	26.7
	60.6	41.5	70.6	69.4	47.0	47.4
	109.9	38.6	65.6	119.0	37.5	37.8
	143.3	58.8	100.0	176.0	99.2	100.0

1 Based on calculated rearing habitat for Transect Site T1
2 Based on calculated rearing habitat for Transect Sites T3 and T4 combined
3 See Table 3.18 for rearing criteria used to calculate length of suitable rearing habitat along transects