SECTION H

MORICE RIVER PINK SALMON SPAWNING STUDIES, 1981-1982

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Pink salmon populations have expanded upstream in the Bulkley River and into the Morice River since the installation of the Moricetown fishway in 1951 and removal of the Hagwilget obstruction in 1958. Pink salmon were first seen in the Morice River just above the confluence with the Bulkley in 1953 (Shepherd 1979).

In 1979, the distribution and abundance of pink salmon spawners was described from a helicopter survey and detailed physical measurements of spawning sites were subsequently collected in a single side channel (Section A).

The present study was designed to obtain additional information on the timing of pink salmon upstream migration and spawning, the abundance and distribution of spawners, physical characteristics of the spawning habitat, and the availability of suitable spawning habitat at different discharges.

2.0 METHODS

2.1 Timing, Distribution and Abundance Observations

Adult pink spawners in the Morice and Bulkley Rivers were counted from a helicopter on September 5 and 6, 1981. The survey examined those side channels large enough to support pink salmon spawning, the mainstem river from Smithers to Morice Lake and Gosnell Creek (Figure 2.1). The helicopter flew approximately 30 to 50 m above the river channel at a speed of 50 to 60 km/hr. Spawning locations were marked on 20-chain air photographs and later recorded on 1:50,000 maps.

Although detailed studies of pink fry emergence were not conducted during the spring of 1982, observations of emergence at the redd sites were made during the gravel sampling operations in March and April and during staff gauge readings at spawning sites in May.

2.2 Spawning Transect Measurements

Five study areas in the Morice River between Gosnell and Owen Creeks were selected to examine the relationship between discharge and available spawning habitat. Based on the helicopter surveys, these areas were considered representative of the range of conditions utilized by pink salmon spawners in main channel and side channel locations.

Transect lines were established across four side channel sites designated SC 1, SC 2, SC 3A and SC 3B and one main channel site designated MC 4 where pink salmon were observed spawning (Figure 2.2). The number of transect lines at each site varied from 3 to 9 depending on the length of channel under study (Appendix H2, Figures H2.1 to H2.5).

At each site, transect lines were established at right angles to the channel and marked by permanent hubs on both banks. A rope marked in 1 m intervals was strung across the river channel between the hubs and measurements of water depth, average velocity and nosepoint velocity (12 cm above substrate) were made at 2 or 3 m intervals along each transect depending on channel width. All velocity measurements during this study were made using a Marsh-McBirney Model 201 current meter. Depths greater than 1 m and velocities greater than 1 m/s were measured from the front of a river boat. Lower velocities and depths were measured by wading. A qualitative assessment of substrate quality was made, based in part on the presence of spawning fish.

The first set of transect measurements was conducted between September 3 and 9, 1981 during the spawning period, at an average flow of 95 m^3/s (range: 93 to 97 m^3/s). Subsequent depth and velocity measurements were made at each site at three lower discharges (Table 2.1).

2.3 Redd Measurements

2.3.1 Depth, Nose Velocity and Redd Area

In addition to the transect measurements, depth, nose velocity and redd area measurements were made at 120 pink salmon redd sites. Sites were initially identified by observing paired fish digging. The redd location, in relation to the transect line, was recorded and the redd site was marked with a white rock. To determine redd area, measurements were made of length (measured from the upstream to downstream edge at the center of the excavation) and width (measured from the left to right edge at the center of the excavation). Measurements of nose velocity and water depth were taken on both sides slightly upstream of the excavated area to avoid sampling hydraulic conditions altered by redd construction. Intervals for pink salmon depth and velocity criteria were calculated by combining data for all sites and determining the 10th and 90th percentile values within which the fish were observed spawning.

2.3.2 Relationship Between Discharge and Available Spawning Habitat

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). Estimated flows from the Gosnell-Thautil systems based on staff gauge readings were added to the upper river flows to more closely approximate the true discharge in the section of river studied.

A computer program was designed to sum the useable area of each transect which satisfied the spawning criteria (Volume 15, Section C). The suitable spawning area of all transects was then combined for the study area at each discharge, and used to derive a relationship between suitable spawning habitat and discharge for pink salmon (Bovee and Cochnauer 1977; Anon. 1979; Linsley and Franzini 1979; Milhous et al. 1981; Bovee 1982).

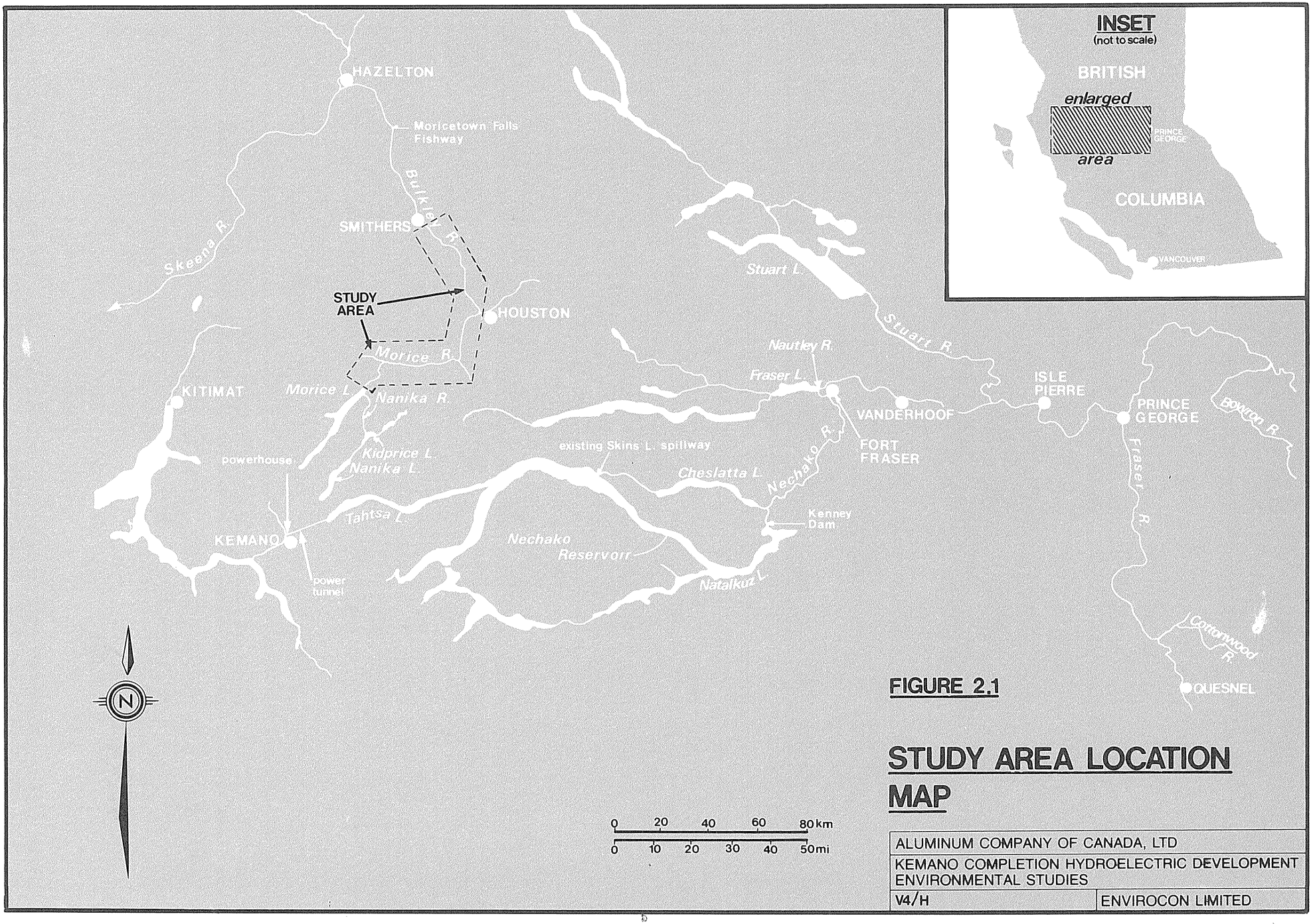

FIGURE 2.1

STUDY AREA LOCATION MAP

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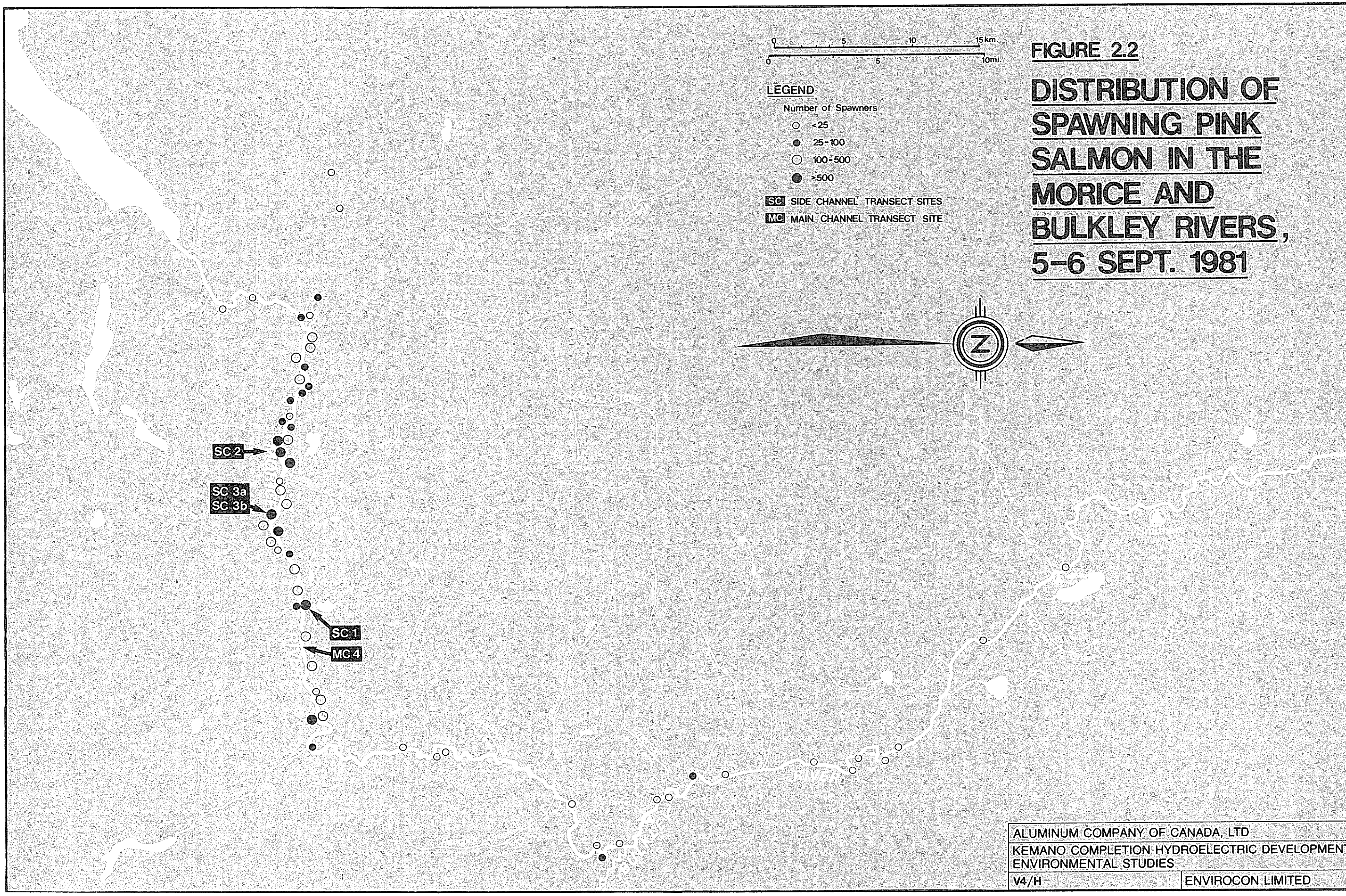

FIGURE 2.2

DISTRIBUTION OF SPAWNING PINK SALMON IN THE MORICE AND BULKLEY RIVERS, 5-6 SEPT. 1981

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TABLE 2.1
Discharges in the Morice River During Transect Measurements, 1981-1982

Date	Study Area	Flow (m^3/s) Morice Lake Outlet[1]	Gosnell/ Thautil[2]	Above Owen Creek	Total[5]
1981					
September 3	S.C. 1	89.5	6.9	-	94.2
September 6	S.C. 2	88.4	6.7	-	93.1
September 7	S.C. 3A	89.2	5.5	-	93.7
September 8	S.C. 3B	90.0	6.6	-	94.7
September 9	MC. 4	92.0	7.2	-	96.7
October 28	S.C. 3A	50.0	12.6	-	60.9
October 29	S.C. 2	49.0	11.7	-	59.9
October 30	S.C. 1 MC. 4	48.5	13.2	-	59.4
December 15	S.C. 3A & S.C. 3B	34.7	3.1	39.0[3]	39.0
1982					
March 16	S.C. 1	13.5	-	20.0[3]	20.0
March 17	S.C. 3A	13.3	-	18.5[3]	18.5
March 30	S.C. 3A	10.6	-	16.0[3]	16.0
April 2	S.C. 1	10.0	-	15.0[3]	15.0
April 19	MC. 4	8.2	-	14.0[3]	14.0
April 28	S.C. 3B	8.1	-	18.0[4]	18.0

1 Data from Water Survey of Canada, 1981-1982

2 Gauge height readings taken for September 4 and October 14, 1981

3 Calculated from drainage area ratios by Envirocon

4 Staff gauge installed upstream of Owen Creek by Envirocon on April 26, 1982

5 Total estimated flow at Owen Creek

2.3.3 Dissolved Oxygen and Water Temperatures

Dissolved oxygen concentrations were measured in surface and subsurface waters at 13 locations in SC 1 and SC 3A during late March and early April 1982. At each site, a metal standpipe was driven into an area previously identified as a pink salmon redd such that the upper perforations on the standpipe were 30 cm below the gravel surface. The internal plug was removed and the standpipe was left for 30-60 minutes. Dissolved oxygen measurements were taken 30 cm below the gravel surface and in the surface water using a YSI Model 54A Oxygen Meter. Water temperatures were measured at the same locations. Ice and streamflow conditions at the study sites were observed periodically from February through to early May when pink salmon fry emerge.

2.3.4 Spawning Gravel Composition

A total of 68 gravel samples was collected from randomly selected redds in the five study areas during late March and April. Gravel was removed from the streambed using a modified McNeil sampler as described by Cederholm and Salo (1979). This sampler removes a circular core of gravel 15 cm in diameter and 20-25 cm deep.

Gravel samples were dried and separated into seven size classes by shaking them through six standard Tyler sieves with the following mesh sizes; 77, 25.4, 6.30, 3.35, 0.850, and 0.106 mm. Sediment retained by each sieve and the silt passing through the finest screen were weighed and expressed as a percentage, by weight, of the total sample.

In this study, sand is defined as particles smaller than 3.35 mm in diameter and fines are particles less than 0.850 mm in diameter. These size classes were selected so that the egg survival rate versus gravel composition relationship found in this study could be compared with results reported elsewhere.

3.0 RESULTS AND DISCUSSION

3.1 Timing, Distribution and Abundance of Adult Pink Spawners

A total of 12,533 pink salmon was counted during the helicopter surveys on September 5 and 6 (Table 3.1), indicating an approximate escapement estimate of 12,500 fish. Approximately 96% of the spawners were in Reach 2 of the Morice River (between Fenton and Gosnell Creeks), with 70% of this total occurring between Lamprey and Gosnell Creeks. The Morice and Bulkley Rivers downstream of Fenton Creek (Reaches 3 to 6) accounted for slightly more than 3% of the total pink salmon escapement. Less than 1% of the pink salmon spawned in the Morice River upstream of Gosnell Creek or approximately 10 km upstream in Gosnell Creek. No spawners were observed in the lower Thautil River. Detailed breakdowns of spawner distribution and abundance are shown in Figure 2.2 and Appendix H1.

The 1981 escapement estimate (12,500) is lower than the average (18,000 to 19,000) estimated for odd years during the past decade (Table 3.2). The pattern of spawner distribution in 1981 was similar to the 1979 distribution (Section A), although a higher percentage of the run (70%) utilized the section of river between Lamprey and Gosnell Creeks in 1981 than in 1979 (59%). The run size in 1981 was nearly double the run of 6,700 pink spawners in 1979.

Of the 12,100 live spawners observed in the Morice and Bulkley Rivers during 1981, approximately 79% spawned in side channels and 21% spawned in main channel sites. This distribution is very similar to that noted during the 1979 surveys (i.e. 80% side channel spawners and 20% main channel spawners). During the 1981 survey many salmon used spawning sites in the same channels used in 1979, despite differences in average spawning discharge (95 m^3/s in 1981 and 120 m^3/s in 1979). The mean discharge based on 19 previous years of record (1961-1980) is 93 m^3/s.

The 1981 surveys were conducted during the early part of the spawning period (September 5 to 6). Peak spawning was estimated to occur between September 7 to 12. Most fish were observed holding on spawning sites, although a small proportion were still grouped in pools near the spawning areas. As in 1979, pink salmon in the upper Morice River spawned later than those in downstream areas. Approximately 42% of the pink salmon observed below Fenton Creek had spawned and died by September 5 and 6 compared to less than 2% above Fenton Creek (Table 3.1).

TABLE 3.1
Aerial Count of Pink Salmon Spawners in the Morice and Bulkley Rivers, September 5 and 6, 1981

Location		Live Spawners: Side Channel	Live Spawners: Main Channel	Carcasses	Total	Total % of Spawners
Reach 1 -	Morice Lake to Gosnell	45	0	0	45	0.4
Reach 2a -	Gosnell to Lamprey	7,323	1,397	68	8,788	70.1
Reach 2b -	Lamprey to Fenton	2,050	1,044	127	3,221	25.7
Reach 3 -	Fenton to Peacock	23	37	40	100	0.8
Reach 4 -	Peacock to Dockrill	102	24	70	196	1.6
Reach 5 -	Dockrill to McDowell	7	43	41	91	0.7
Reach 6 -	McDowell to Driftwood	0	5	22	27	0.2
Main River Total		9,550	2,550	368	12,468	
Gosnell Creek			65	0		
Thautil River			0	0	65	0.5
Overall Total					**12,533**	**100.0**

TABLE 3.2
Pink Salmon Escapement Estimates for the Morice River and 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[3]	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[3]	200	1977	25,000	23,000
1968	1,000[3]	0	1978	200[4]	300
1969	2,500[3]	2,500	1979	6,000[4]	6,700
1970	N/R[5]	250	1980	100	4,680
			1981	12,500[4]	12,500
			1982	9,000[4]	8,400
Even-year means (1962-70)[3]	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 Farina (1983)

3 Shepherd (1979)

4 Department of Fisheries and Oceans, Smithers, B.C. (data on file)

5 Not reported

The numbers of spawners in each of the study channels examined were 322 (SC 1), 1,350 (SC 2), 1,165 (SC 3A), 347 (SC 3B) and 67 (MC 4) (Appendix H1).

3.2 Timing of Pink Salmon Fry Emergence

Although detailed studies of emergence timing were not conducted during the spring of 1982, observations made in the vicinity of redd sites while conducting gravel sampling and staff gauge readings suggest that most fry emerged from May 1 to May 15 (Appendix H6, Table H6.1).

Gravel sampling in early April indicated that pink fry were generally at least 15 cm below the gravel surface. By the end of April, they were commonly found just below the gravel surface indicating that emergence had probably started. During the last week of April, the river discharge started to rise slightly, and increased more rapidly in early May. Large numbers of fry were observed along channel margins, sometimes stranded in isolated pools until rising flows permitted access to downstream areas. Large numbers of birds (greater yellowlegs and mergansers) were observed feeding on pink fry at this time. No pink fry were observed after the third week of May, but this may have been because visibility had decreased considerably.

3.3 Redd Measurements

3.3.1 Spawning Criteria Development

Depth, velocity and redd area measurements at 120 redd sites are summarized in Table 3.3. Detailed measurements are presented in Appendix H3, Tables H3.1 to H3.5. Data from all of these sites were combined to develop spawning criteria. These criteria, the 10th and 90th percentile values for depth and velocity within which spawning occurred are:

Depth - 0.39 m to 1.10 m
Nose Velocity - 0.30 m/s to 0.79 m/s.

Data from several other studies conducted on pink salmon spawning indicate that the above velocity criteria are within the ranges observed elsewhere (Table 3.4). However, Morice River pink salmon appear to utilize spawning areas which are deeper than those reported in the literature for other streams (Anon. 1981; Swift 1979; Collings 1974). Since these studies examined smaller streams, deeper locations, such as those reported here, may not have been available to spawners.

TABLE 3.3
Summary of Redd Measurements in Pink Salmon Study Areas, Morice River, September 1981

Study Area	n	Mean Depth (Range) (m)	S.D.[1]	Mean Nose Velocity (Range) (m/s)	S.D.[1]	Mean Redd Area (Range) (m^2)	S.D.[1]
SC 1	30	0.94 (0.53-1.27)	0.20	0.37 (0.29-0.50)	0.06	1.4 (0.7-2.8)	0.5
SC 2	30	0.50 (0.21-0.89)	0.16	0.61 (0.25-0.94)	0.21	1.6 (0.7-3.6)	0.6
SC 3A	15	0.55 (0.32-0.89)	0.17	0.42 (0.18-0.80)	0.16	2.2 (1.0-4.0)	0.8
SC 3B	15	0.50 (0.21-0.83)	0.16	0.61 (0.28-1.00)	0.21	1.6 (1.0-3.0)	0.6
MC 4	30	0.92 (0.59-1.25)	0.15	0.51 (0.26-0.78)	0.09	1.0 (0.7-1.8)	0.3
Total	120						
Mean		0.70	0.29	0.48	0.16	1.4	0.7
Range (Min.-Max.)		0.21-1.27		0.18-1.00		0.70-4.0	
10th and 90th percentile Range		0.39-1.10		0.30-0.79			

1 Standard Deviation

TABLE 3.4
Comparison of Depths and Velocities Preferred by Spawning Pink Salmon

Depth (m)	Nose Velocity (m/s)	Source
0.31-0.76	0.31-0.61	Anon. (1981)
0.15 (minimum)	0.23-0.99	Swift (1979)
0.15-0.53	0.21-1.00	Collings (1974)
0.39-1.10	0.30-0.79	This study

3.3.2 Relationship Between Discharge and Available Spawning Habitat

Figure 3.1 shows the relationship between discharge and usable spawning area (based on depth and velocity criteria) at the five study sites. The side channel locations respond differently than the mainstem site to changing discharge, particularly SC 1 which is deeper and slower than the others. However, in all cases, available spawning area decreases with decreasing discharge from the levels measured during the period of spawning (93 to 97 m^3/s). Approximately 20% of the total side channel spawning areas would be usable at 60 m^3/s and none would be usable at 40 m^3/s. At the main channel site the availability of suitable spawning areas increased as discharge dropped to between 35 and 50 m^3/s, and then decreased as discharge declined further.

At a discharge of 95 m^3/s, there was an estimated 1,900 m^2 of usable spawning gravel in SC 1 and SC 2. This would provide approximately 2.3 m^2 of spawning gravel per pair of spawners at the two sites (1,672 spawners in total). Data from SC 3A and 3B were not included in these calculations since the spawner estimates presented in Section 3.1 were for the entire side channel and not just for the area of transect measurements. At the mainstem site (MC 4), 67 fish were observed in an area calculated to offer approximately 2,500 m^2 of usable area. This results in an estimated 75 m^2 of usable spawning gravel per pair. This 30-fold difference between mainstem and side channel spawner densities suggests that pinks strongly prefer side channel locations despite what appear to be suitable depth, velocity and substrate conditions in the mainstem river.

3.3.3 Dissolved Oxygen and Water Temperatures

The dissolved oxygen content and water temperature data for surface and subsurface waters collected at a total of 14 redds in SC 1 and SC 3A are presented in Appendix H4, Table H4.1. Measurements were made during March and April 1982 at these two side channels which remained ice-free throughout the winter. All eight redds examined in SC 1 had dissolved oxygen levels greater than 5 ppm 30 cm below the redd surface while 4 of 6 redds in SC 3A had levels less than 5 ppm. Surface waters in the side channels had consistently higher dissolved oxygen levels than the sub-surface environment.

The lowest dissolved oxygen concentrations were recorded at a redd site with no surface flows (Appendix H4, Table H4.1). Sheridan (1962) found that dissolved oxygen levels within the gravel remained high as long as surface water flowed over the gravel permitting exchange to occur. Schreier et al. (1980) suggested that dissolved oxygen

depression is a widespread phenomenon in northern rivers during the late winter low flow period when poorly oxygenated groundwater inputs comprise a large proportion of the total discharge. They observed depressed oxygen levels (< 5ppm) under a variety of ice conditions and suggested that ice cover reduces the reaeration rate.

Davis (1975) reviewed the effects of low dissolved oxygen levels on incubating salmonid eggs and alevins. He suggested that oxygen requirements of both eggs and alevins increase markedly with age. Alderdice et al. (1958) reported that during early incubation, the oxygen requirements of eggs were low, but based on calculated oxygen diffusion rates in the incubating eggs, they estimated that this requirement increased to 7 ppm as eggs neared hatching. Shumway et al. (1964) demonstrated from laboratory experiments that incubation at dissolved oxygen levels less than 6.6 ppm resulted in a reduced fry size at hatching and an increased incubation period. Brannon (1965) monitored sockeye salmon embryos in situ in Cultus Lake, and found that while alevins were relatively small at hatching in redds with 3.0 ppm of oxygen, these alevins survived and emerged at almost the same weight as fry incubated in water at or near saturation. Servizi et al. (1971) have suggested that oxygen concentrations of 5 ppm in intragravel waters may permit a satisfactory rate of development.

Water temperatures in the redds during late March and early April 1982 were between 1-2°C in SC 1 and 2-5°C in SC 3A. The main channel Morice River adjacent to these side channels was covered in thick ice with water temperatures near 0°C. Temperatures in SC 3A, a smaller channel receiving relatively little input from the main channel, are probably influenced more by groundwater inflow than temperatures in SC 1.

Measurements of dissolved oxygen and water temperature in side channels, as well as the presence of open water areas during the late winter, suggest that at least some sites selected by pink salmon spawners are directly influenced by groundwater. Dissolved oxygen levels at some areas within these channels decrease to levels which probably limit the metabolic activity of developing eggs and alevins, and in some cases may result in direct mortality. However, the disadvantages of low dissolved oxygen levels may be offset by the effect of groundwater which can reduce redd dessication and freezing of eggs and alevins -a major concern in areas such as the Morice River with long cold winters and low winter flows. Other studies have identified the importance of groundwater inflow to other species of spawning salmonids. Its importance in determining spawning locations of brook trout and sockeye salmon has been reviewed by Sheridan (1962). Groundwater has been recognized as important in determining chum salmon spawning locations and extensive developments of

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Notes

Depth: 0.39 - 1.10 m.

Velocity: 0.30 - 0.79 m/sec.

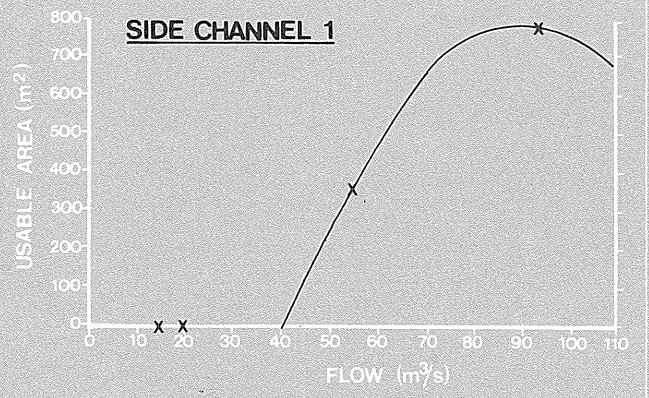
(These criteria represent the 80% range about the median)

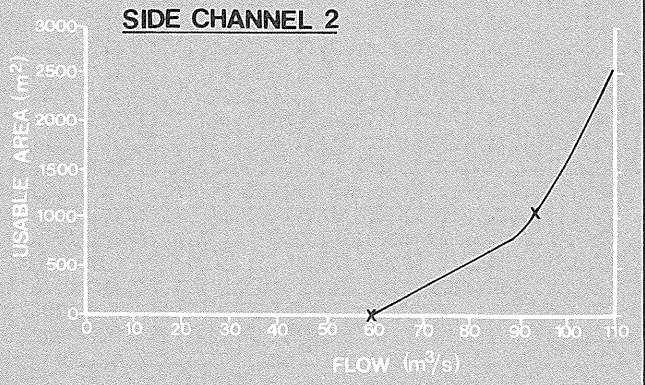
KEY

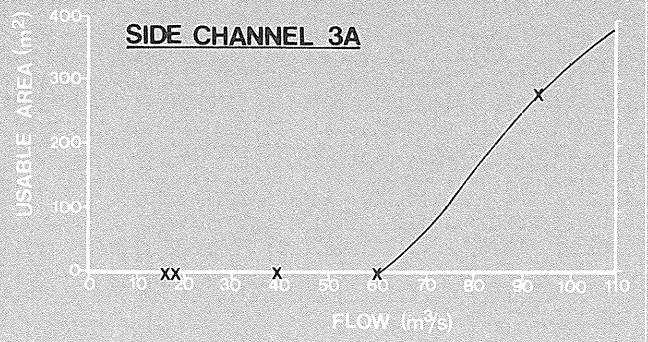
x - data points for which transect measurements were made

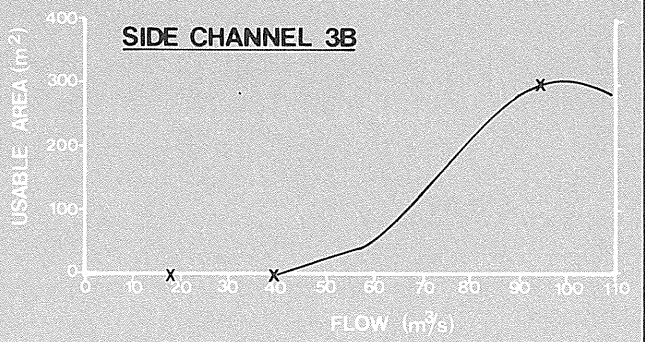
FIGURE 3.1

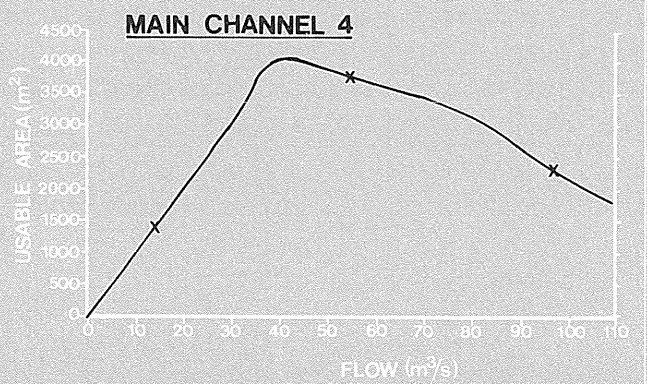
RELATIONSHIP BETWEEN DISCHARGE AND USEABLE PINK SPAWNING AREA IN THE MORICE RIVER

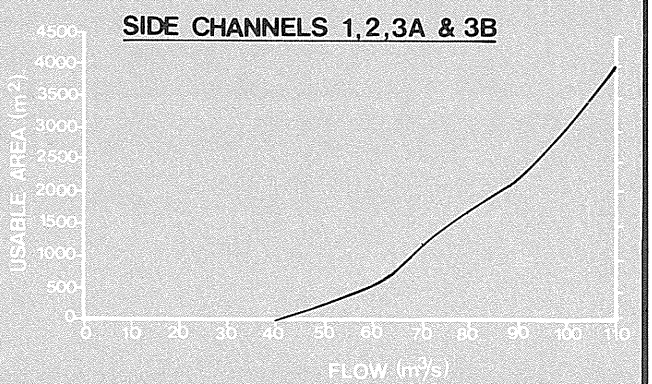












groundwater-fed side channels have been undertaken to improve chum spawning areas in southwestern British Columbia (Lister et al. 1980).

3.3.4 Spawning Gravel Composition

Analyses of 68 gravel samples taken from redd sites during the low flow period in April and early May are presented in Table 3.5. The percentage by weight of fines (<0.85 mm) in the spawning areas ranged from a low of 7.2% in SC 3B to a high of 10.9% in MC 4. The percentage by weight of sand-sized particles including fines (<3.35 mm) ranged from a low of 15.9% in SC 3B to a high of 22.6% in MC 4.

Extensive research on the effects of spawning bed sedimentation on the pre-emergent life of salmonids has shown that during intragravel life, high percentages of fines and sands can limit survival by reducing gravel permeability and by physically blocking fry emergence. According to Wickett (1958), the survival of pink and chum salmon eggs is directly related to substrate permeability. McNeil and Ahnell (1964) found that the permeability of spawning gravels was low when the percentage of fines (<0.833) increased above 15%. Other researchers (Becker et al. 1982; Reiser and White 1981) have shown that fine sediment can be beneficial to embryos in redds which are dewatered for long periods of time, because sediment retards desiccation and provides an insulating layer to buffer temperature fluctuations.

The results of two studies (Koski 1975; Cederholm and Salo 1979) on the effects of sediments on intragravel survival of salmonids are presented in Figure 3.2. Although the studies were for chum and coho salmon, these were the best data presently available relating percentages of sands and fines to survival of eggs to emergence. Results of experiments conducted by Koski (1975) on the effects of increased sand on the survival of chum salmon eggs indicated that survival to emergence decreased 1.26% for each 1.0% increment in sand (Figure 3.2). Results of the present study plotted on this graph indicate 55% to 65% survival to emergence for pink fry.

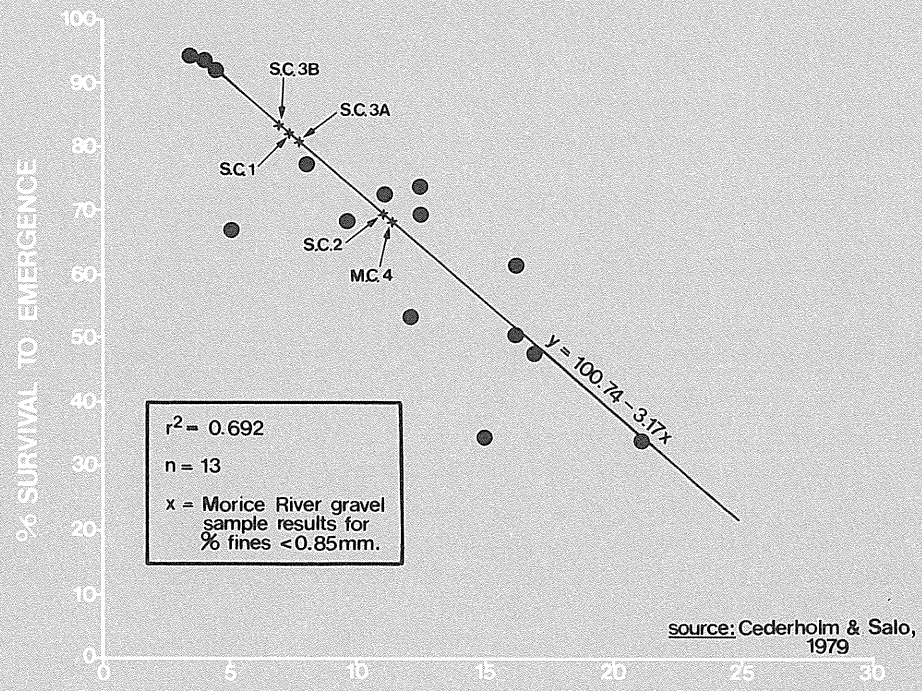
Studies reviewed by Cederholm and Salo (1979) on the effect of fine sands on survival of salmonid eggs to emergence suggest that survival is low when the sand composition of gravels is above 20%. The relationship between percent survival to emergence of coho salmon and percent fines (<0.850 mm) determined by Cederholm and Salo (1979) is presented in Figure 3.2. Results from the present study plotted on this graph would indicate 70% to 85% survival to emergence for pink fry in the Morice River and side channels.

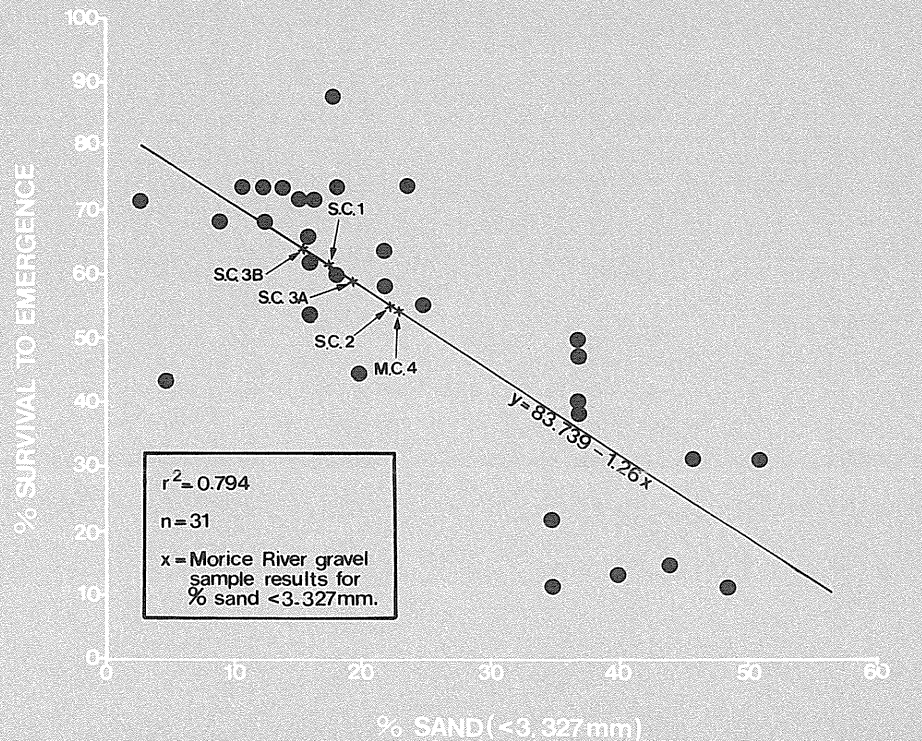
TABLE 3.5
Percent Composition of Sand and Fines by Weight
in Selected Pink Salmon Redds, Morice River, 1982

	% Sand[1] (< 3.35 mm)	% Fines (< 0.85 mm)
SC 1 (n=20)	18.6	7.8
SC 2 (n=16)	22.5	10.2
SC 3A (n=10)	20.0	7.4
SC 3B (n=9)	15.9	7.2
MC 4 (n=13)	22.6	10.9
Mean (n=68)	19.9	8.7

1 Includes fines

FIGURE 3.2: SURVIVAL TO EMERGENCE OF SALMONID EGGS IN DIFFERENT GRAVEL COMPOSITIONS





These comparisons suggest that the present condition of spawning gravels in side channel and main channel sites used by pink salmon in the Morice River should provide high survival. Other factors such as fluctuations in river discharge, freezing and dewatering of redds and low oxygen levels probably play a more important role in egg and alevin survivals at most sites.

4.0 SUMMARY

A total of 12,533 pink salmon spawners was counted in the Morice River during 1981 and escapement was estimated at 12,500. The majority of spawning (96%) occurred in Reach 2. Approximately 79% of all spawning occurred in side channels and the remaining 21% in main channel sites. Peak spawning was estimated to occur from September 7 to 12.

Although detailed studies of emergence timing were not conducted during the spring of 1982, observations in the vicinity of the redd sites during that period suggested that most fry emerged from May 1 to 15.

Measurements at the redd sites indicated that the majority of spawning (10th and 90th percentiles) occurred at a depth range from 0.39 to 1.10 m and a nose velocity range from 0.30 to 0.79 m/s. Based on these spawning criteria, a relationship between discharge and available spawning habitat was developed. Side channel and main channel sites responded differently to reductions in discharge below the level measured during the spawning period (93 to 97 m^3/s). Approximately 20% of the side channel areas would be usable at 60 m^3/s and none would be usable 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, then decreased as discharges dropped further.

The results of dissolved oxygen and water temperature measurements taken in side channels during the winter, 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. The detrimental effects of low dissolved oxygen levels to developing eggs and alevins in some side channel areas may be offset by the effect of groundwater inputs in preventing redd desiccation and freezing.

The spawning gravel in sites used by pink salmon has low percentages of fines and sand and therefore appears suitable for high egg-to-fry survival.

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APPENDIX HI

Distribution of Spawning Pink Salmon in the Upper Morice River, September 5 and 6, 1981

TABLE HI.1
Distribution of Pink Spawners, Morice and Bulkley Rivers, September 5 and 6, 1981

Location	Live Spawners: Side Channel	Live Spawners: Main Channel	Carcasses	Comments
1		20	3	20 coho off Owen
2-3	2	8	8	
				Reach Break
3	342		20	
4	12			
5	362		1	
6	60			
7		55	4	
8	137			
8	27			
9	4		1	Start of Sept. 6 count
10		10		
11		160	1	
12		67	27	Main channel (MC) 4
13	10	10	3	
14		42	4	
14		8	4	
15		51	5	
16				14 geese
17		11	5	
18	85		1	
19		6	11	
20		5		
21	320		2	Side channel (MC) 1
22	128		4	
23	124		4	
24	418			
25		21	2	
26		25	4	
27		10	1	
28		195	2	
29		120		
29		150	2	

(Continued)

TABLE HI.1 (Continued)

Location	Live Spawners: Side Channel	Live Spawners: Main Channel	Carcasses	Comments
30	4		2	
31		4	2	
32		4		
33	16		3	
34	1		2	
35		89	5	
				Reach Break
36		39		
37	2		5	
38	4		1	
39	380		5	
40		1	5	
41		116	2	
42			1	
43	47	15		
44	31			
44		4		
45			3	
46	1156		9	Side Channel (SC) 3A
47	345		2	Side Channel (SC) 3B
46&47	110			
48	865		11	
49	530			
50	30		1	
51	115		4	
52	2	16	2	
53	324		4	
54		30	1	
35	265			
56&57		5	1	
58	12			
59	10			
60	320			
61	435		2	

(Continued)

TABLE HI.1 (Continued)

Location	Live Spawners: Side Channel	Live Spawners: Main Channel	Carcasses	Comments
62	115			
63	1350			Side Channel (SC) 2
64		55	2	
65	190			
66		600		
67	17			
66	16		1	
68	32			
66	32		1	
69	70	2	1	
70	3			
71	4			
72	no fish			
73		35		
74		83	1	
75	6			
76	No fish - flows too low			
77		35	2	
78		3	1	
79	110			
80	5			
81	70			
82	15			
83		200		
84	15			
85		135		
86	no fish			
87		1		
88a	185	20		
87a	10			200 coho off Gosnell Creek
				Reach Break

(Continued)

TABLE HI.1 (Continued)

Location	Live Spawners: Side Channel	Live Spawners: Main Channel	Carcasses	Comments
88	31			
89	8			
90	4			
91	2			
Gosnell Creek - Flows very low (2.9 m^3/s)				
Braided section	92	23		
1.5km upstream	93	25		
Area B		12		
Area C		5		
Total:		65		

APPENDIX H2

Summary of Water Depths, Water Velocities and Substrates at Transects Across Pink Salmon Spawning Areas in the Morice River, 1981 - 1982

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FIGURE H2.1

MORICE RIVER PINK SALMON SPAWNING TRANSECTS, 1981-82 : SIDE CHANNEL 1

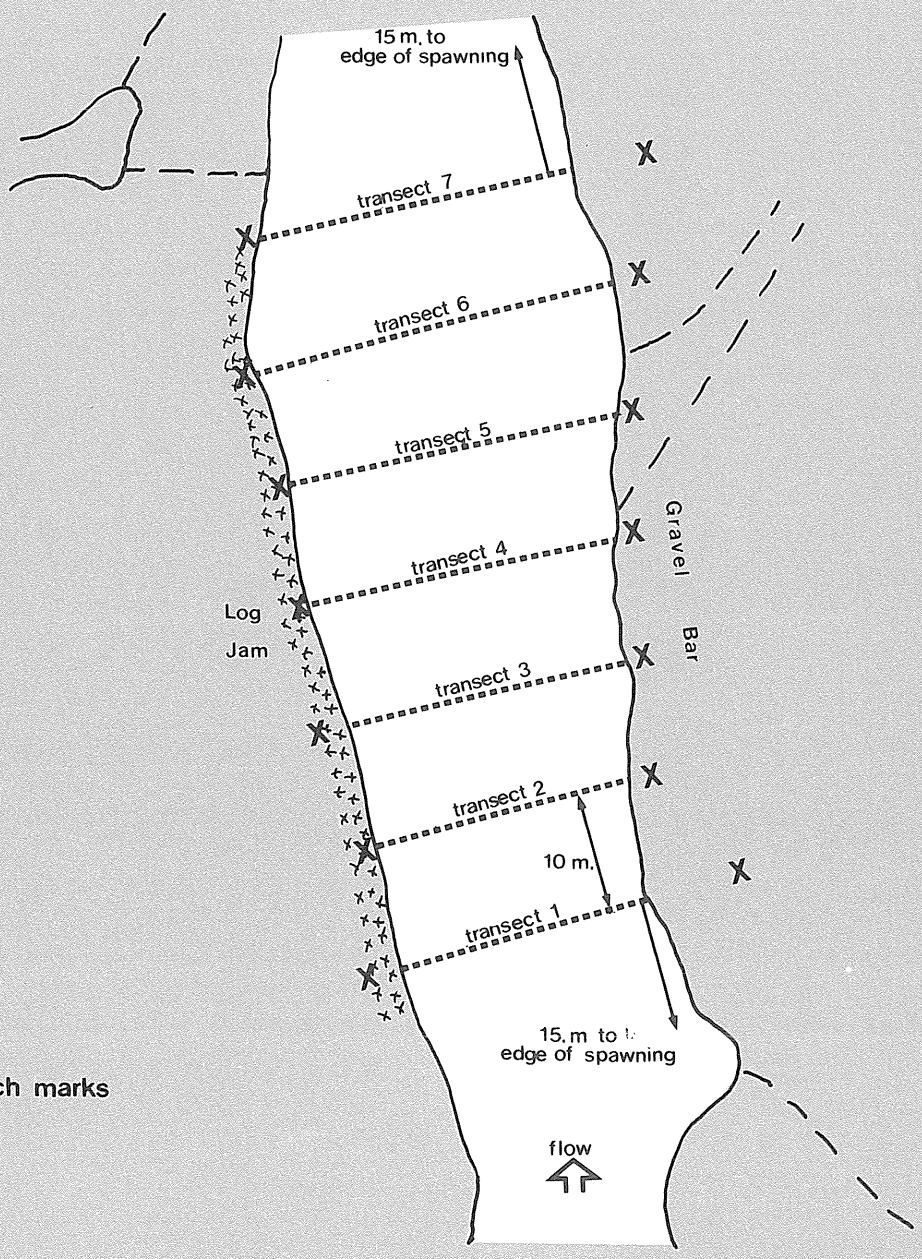

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FIGURE H2.2

MORICE RIVER PINK SALMON SPAWNING TRANSECTS, 1981-82 : SIDE CHANNEL 2

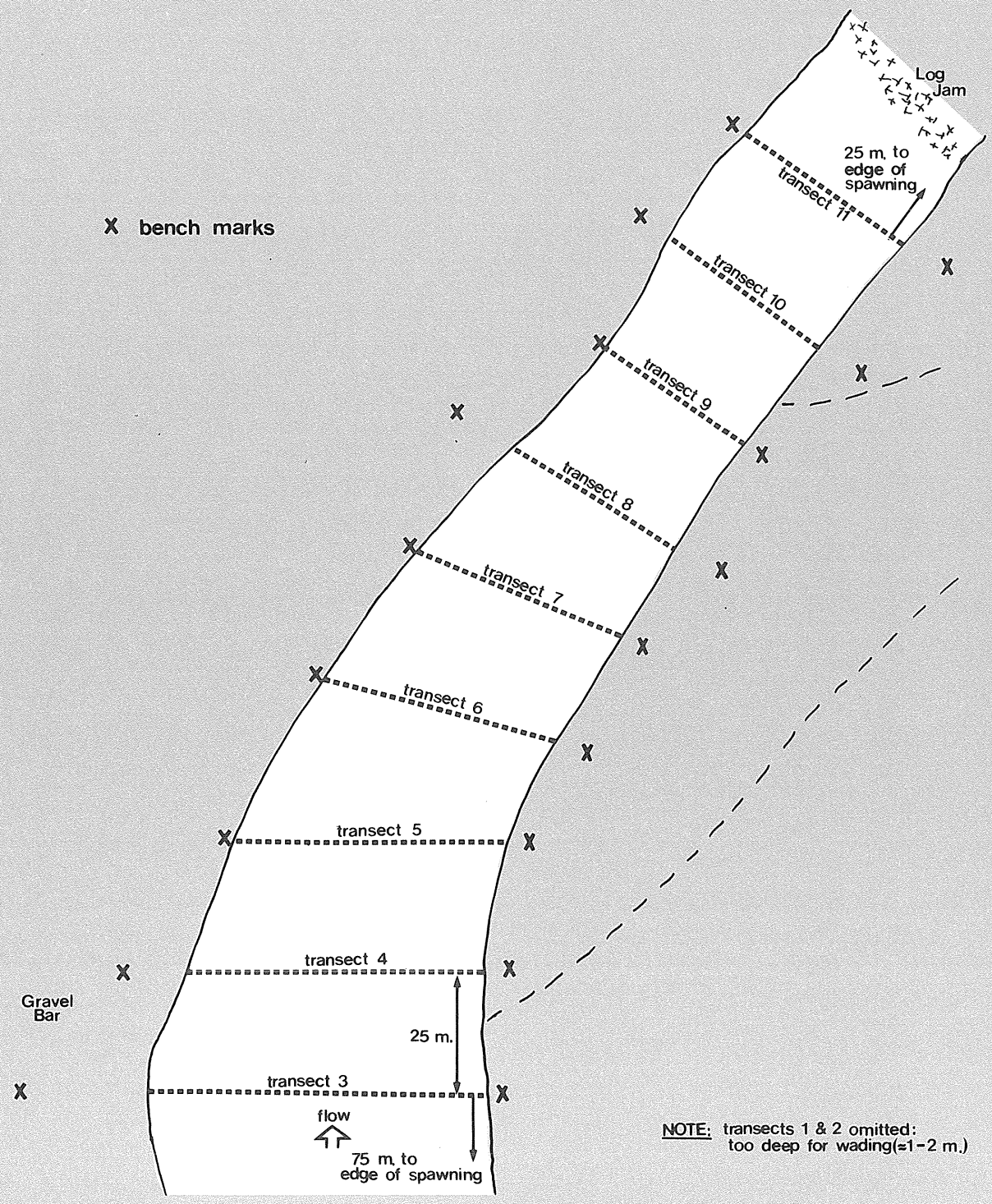

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FIGURE H2.3

MORICE RIVER PINK SALMON SPAWNING TRANSECTS, 1981-82 : SIDE CHANNEL 3A

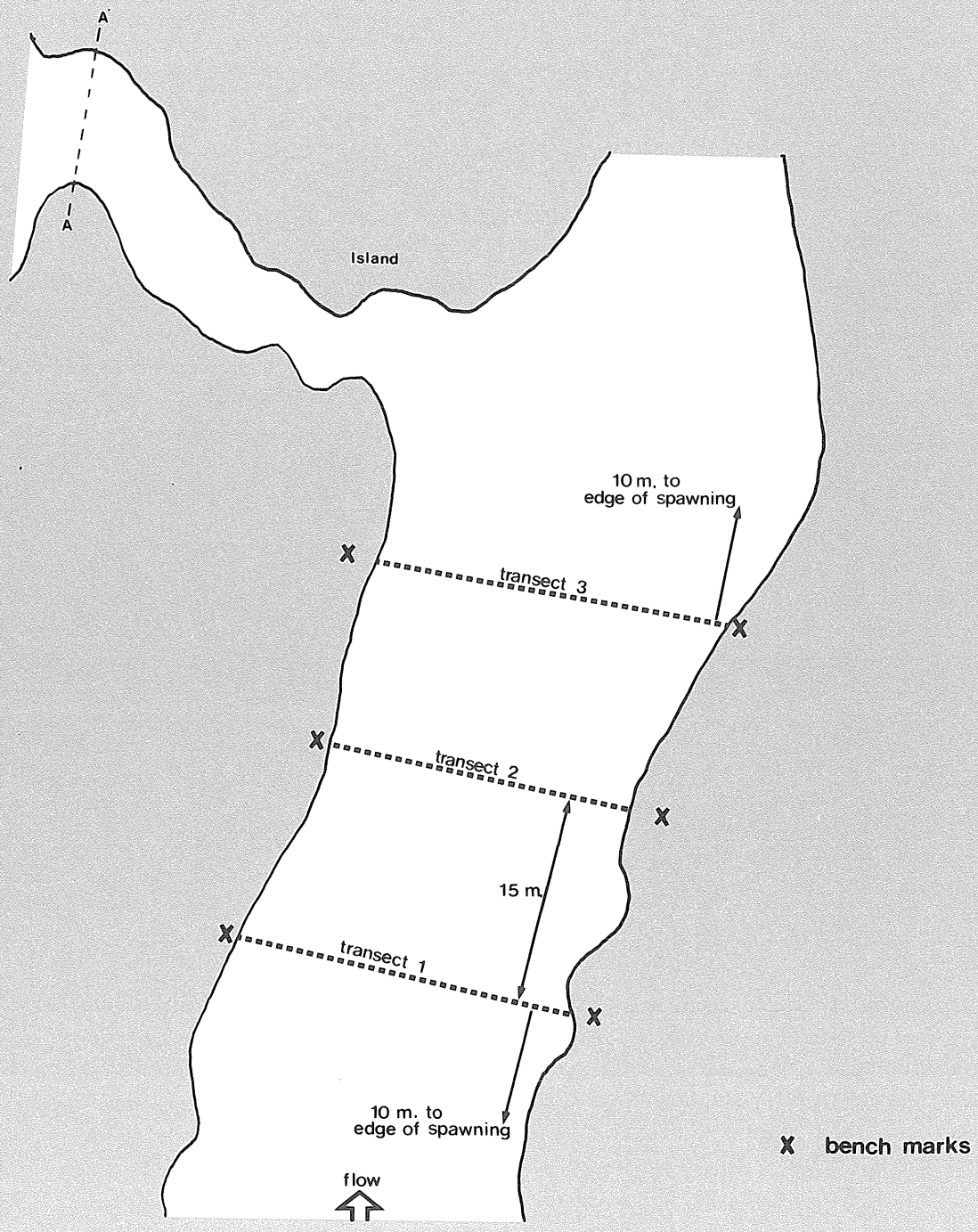

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FIGURE H2.4

MORICE RIVER PINK SALMON SPAWNING TRANSECTS, 1981-82 : SIDE CHANNEL 3B

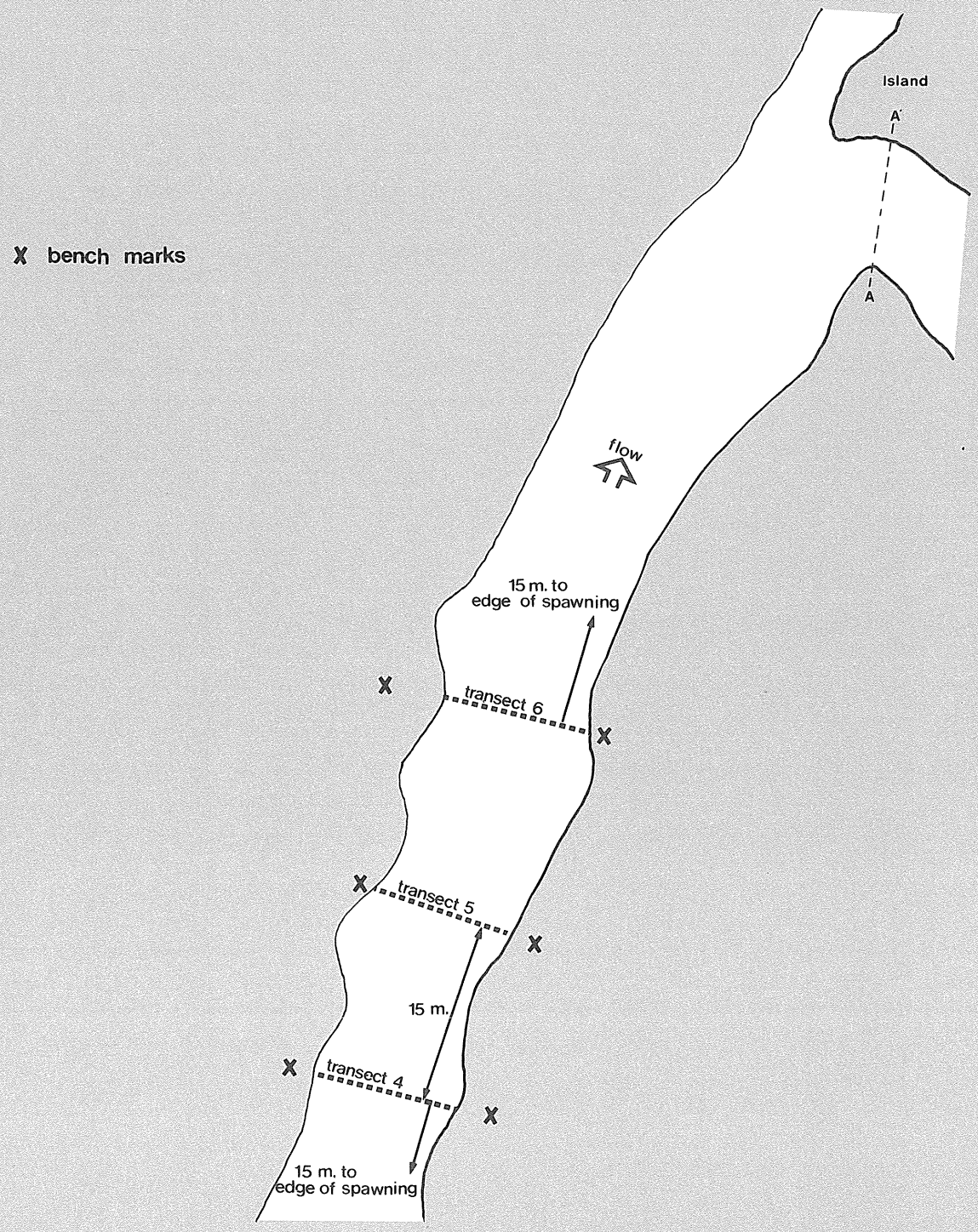

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FIGURE H2.5

MORICE RIVER PINK SALMON SPAWNING TRANSECTS, 1981-82 : MAIN CHANNEL 4

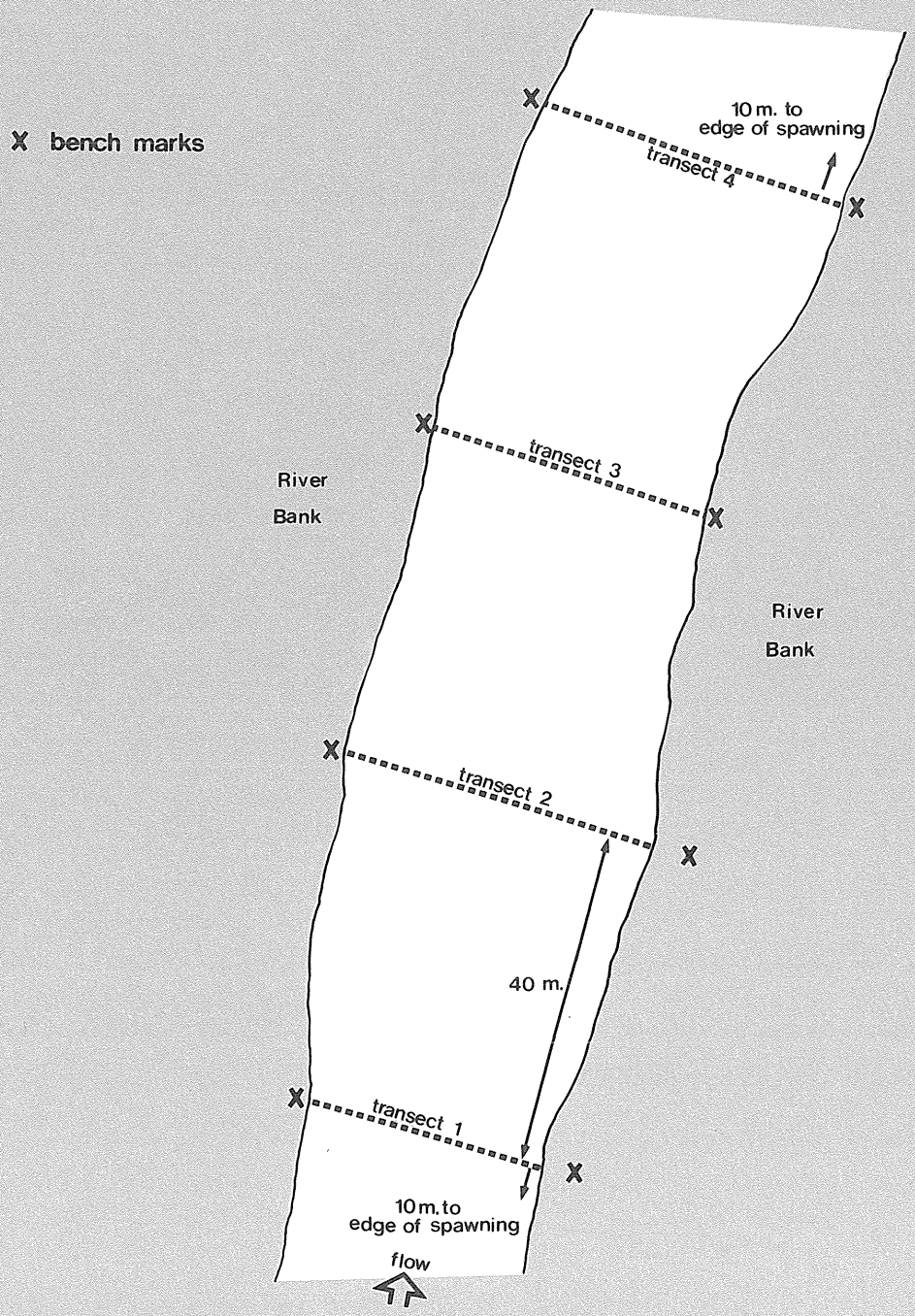

TABLE H2.1
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 1
Set #1
September 3, 1981

Water Temp. = 15.0°C @ 1900 Hrs.
Q = 94.2 m^3/s

Transect 1					Transect 2					Transect 3				
Distance from Hub 1 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential
11.0	to wet edge				4.0	wet edge				7.5	wet edge			
13.0	0	Not	1.08	0	6.0	0	Not	1.71	0	9.0	0.04	0.05	0.36	0
15.0	0	Measured	1.08	0	8.0	0.10	Measured	1.65	1	11.0	0.16	0.13	0.62	0
17.0	0.16		0.91	1	10.0	0.11		1.21	1	13.0	0.18	0.18	0.78	1
19.0	0.18		0.83	1	12.0	0.22		1.02	1	15.0	0.15	0.20	0.78	1
21.0	0.17		0.91	1	14.0	0.19		1.07	1	17.0	0.18	0.26	0.80	1
23.0	0.30		1.04	1	16.0	0.25		1.06	1	19.0	0.23	0.40	0.90	1
25.0	0.31		1.13	1	18.0	0.26		1.09	1	21.0	0.24	0.35	1.02	1
27.0	0.52		1.13	1	20.0	0.42		1.08	1	23.0	0.25	0.32	1.06	1
29.0	0.47		1.17	1	22.0	0.45		1.11	1	25.0	0.31	0.62	1.09	1
31.0	0.40		1.20	1	24.0	0.48		1.07	1	27.0	0.28	0.40	1.12	1
33.0	0.35		1.19	1	26.0	0.36		1.06	1	29.0	0.45	0.50	1.12	1
35.0	0.38		1.13	1	28.0	0.24		1.07	1	31.0	0.43	0.47	1.11	1
37.0	0.24		1.12	1	30.0	0.30		1.10	1	33.0	0.32	0.46	1.04	1
39.0	0.17		1.13	1	32.0	0.23		1.10	1	35.0	0.28	0.40	1.08	1
41.0	0.22		1.02	1	34.0	0.29		1.13	1	37.0	0.25	0.37	1.11	1
43.0	0.18		1.03	1	36.0	0.26		1.14	1	39.0	0.25	0.45	1.6	1
45.0	0.14		0.95	1	38.0	0.19		1.01	1	41.0	0.22	0.40	1.20	1
47.0	0.13		0.89	1	40.0	0.05		0.89	0	43.0	0.21	0.24	1.09	1
49.0	0.18		0.56	0	43.0	0.02		0.60	0	45.0	0.12	0.16	1.06	0
50.0	wet edge				44.0	0				47.0	0.05	0.08	0.65	0
55.3	Hub 1 (L.B.)				46.0	wet edge				49.0	0	0	0.24	0
					51.0	Hub 2 (L.B.)				50.0	wet edge			
										57.5	Hub 3 (L.B.)			

(Continued)

TABLE H2.1 (Continued)

Water Temp. = 15.0°C @ 1900 Hrs.
Q = 94.2 m^3/s

Transect 4					Transect 5					Transect 6				
Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 5 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 6 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential
6.5	wet edge				8.0	wet edge				11.0	wet edge			
8.0	0.27	-	0.20	0	10.0	0.23	Not	0.18	1	13.0	0.21	Not	0.18	1
10.0	0.25	0.30	0.40	1	12.0	0.33	Measured	0.32	1	15.0	0.32	Measured	0.29	1
12.0	0.26	0.33	0.60	1	14.0	0.33		0.45	1	17.0	0.40		0.44	1
14.0	0.32	0.34	0.68	1	16.0	0.29		0.57	1	19.0	0.39		0.54	1
16.0	0.25	0.31	0.82	1	18.0	0.38		0.69	1	21.0	0.33		0.66	1
18.0	0.34	0.34	0.92	1	20.0	0.27		0.81	1	23.0	0.33		0.69	1
20.0	0.32	0.41	0.97	1	22.0	0.40		0.80	1	25.0	0.34		0.77	1
22.0	0.26	0.49	1.01	1	24.0	0.32		0.91	1	27.0	0.35		0.81	1
24.0	0.40	0.51	1.07	1	26.0	0.46		0.91	1	29.0	0.42		0.82	1
26.0	0.40	0.58	1.03	1	28.0	0.41		0.94	1	31.0	0.38		0.89	1
28.0	0.33	0.61	1.00	1	30.0	0.43		0.94	1	33.0	0.53		0.99	1
30.0	0.38	0.50	0.99	1	32.0	0.50		1.07	1	35.0	0.48		1.11	1
32.0	0.19	0.46	0.97	1	34.0	0.38		1.18	1	37.0	0.36		1.15	1
34.0	0.28	0.45	1.14	1	36.0	0.37		1.17	1	39.0	0.46		1.15	1
36.0	0.24	0.32	1.09	1	38.0	0.29		1.32	1	41.0	0.29		1.25	1
38.0	0.20	0.41	1.09	1	40.0	0.25		1.12	0	43.0	0.13		1.11	0
40.0	0.18	0.30	1.01	0	42.0	0.27		0.59	0	45.0	log jam			
42.0	0.17	0.23	0.57	0	44.0	0.04		0.39	0	47.5	Hub 6 (L.B.)			
44.0	0.14	-	0.25	0	46.0	log jam								
45.0	to wet edge				48.0	log jam								
49.0	Hub 4 (L.B.)				49.0	Hub 5 (L.B.)								

(Continued)

TABLE H2.1 (Continued)

Water Temp. = 15.0°C @ 1900 Hrs.
Q = 94.2 m^3/s

Transect 7				
Distance from Hub 7 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential
15.0	to wet edge			
17.0	0.24	Not	0.16	1
19.0	0.28	Measured	0.28	1
21.0	0.42		0.37	1
23.0	0.39		0.46	1
25.0	0.26		0.53	1
27.0	0.39		0.61	1
29.0	0.36		0.72	1
31.0	0.43		0.73	1
33.0	0.47		0.73	1
35.0	0.52		0.80	1
37.0	0.54		0.87	1
39.0	0.37		1.02	1
41.0	0.35		1.11	1
43.0	0.43		1.15	1
45.0	0.45		1.23	1
47.0	0.11		1.40	0
47.5	log jam			
49.0	Hub 7 (L.B.)			

1 1 = Suitable spawning gravel
0 = Not Suitable spawning gravel

TABLE H2.2
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 1
Set #2
October 30, 1981

Water Temp. = 6.0°C
Q = 59.4 m^3/s

Transect 1				Transect 2				Transect 3			
Distance from Hub 1 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
10.5 wet edge				4.0 wet edge				8.0 wet edge			
12.1	0.03	Not	0.64	6.0	0	Not	1.40	10.0	0.07	0.09	0.24
14.0	0.01	Measured	0.84	8.0	0.02	Measured	1.30	12.0	0.10	0.07	0.46
16.0	0.03		0.66	10.0	0.09		0.90	14.0	0.08	0.13	0.55
18.0	0.12		0.59	12.0	0.12		0.70	16.0	0.15	0.16	0.54
20.0	0.17		0.48	14.0	0.21		0.76	18.0	0.15	0.18	0.64
22.0	0.18		0.68	16.0	0.23		0.80	20.0	0.22	0.23	0.61
24.0	0.20		0.79	18.0	0.26		0.79	22.0	0.23	0.25	0.75
26.0	0.23		0.86	20.0	0.20		0.83	24.0	0.24	0.29	0.81
28.0	0.27		0.90	22.0	0.23		0.75	26.0	0.19	0.37	0.77
30.0	0.26		0.90	24.0	0.22		0.84	28.0	0.25	0.30	0.80
32.0	0.32		0.90	26.0	0.32		0.83	30.0	0.17	0.30	0.86
34.0	0.26		0.89	28.0	0.24		0.79	32.0	0.19	0.31	0.82
36.0	0.22		0.81	30.0	0.22		0.80	34.0	0.28	0.28	0.80
38.0	0.21		0.81	32.0	0.21		0.86	36.0	0.22	0.29	0.83
40.0	0.22		0.70	34.0	0.16		0.83	38.0	0.23	0.31	0.86
42.0	0.20		0.78	36.0	0.17		0.81	40.0	0.22	0.20	0.84
44.0	0.18		0.66	38.0	0.15		0.74	42.0	0.20	0.22	0.70
46.0	0.16		0.67	40.0	0.10		0.53	44.0	0.19	0.22	0.82
48.0	0.11		0.52	42.0	0	(In debris)	0.32	46.0	0.06	0.04	0.49
50.0	-		0.12	43.0 wet edge				48.0	-	0.02	0.10
50.2 wet edge				51.0 Hub 2 (L.B.)				49.0 wet edge			
57.0 Hub 1 (L.B.)								58.0 Hub 3 (L.B.)			

(Continued)

TABLE H2.2 (Continued)

Water Temp. = 6.0°C

Q = 59.4 m^3/s

Transect 7

Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
18.0	wet edge		
20.0	-	Not	0.11
22.0	0.24	Measured	0.24
24.0	0.31		0.24
26.0	0.36		0.34
28.0	0.33		0.40
30.0	0.42		0.42
32.0	0.39		0.50
34.0	0.25		0.62
36.0	0.39		0.65
38.0	0.46		0.72
40.0	0.47		0.74
42.0	0.40		0.88
44.0	0.37		1.04
46.0	0.16		1.09
48.0	log jam		
48.5	Hub 7 (L.B.)		

TABLE H2.2 (Continued)

Water Temp. = 6.0°C
Q = 59.4 m^3/s

Transect 4				Transect 5				Transect 6			
Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 5 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 6 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
8.5 wet edge				10.5 wet edge				14.5 wet edge			
10.0	0.21	0.13	0.14	12.0	-	Not	0.09	16.0	-	Not	0.11
12.0	0.20	0.20	0.35	14.0	0.24	Measured	0.24	18.0	0.31	Measured	0.21
14.0	0.22	0.25	0.44	16.0	0.25		0.40	20.0	0.29		0.38
16.0	0.24	0.23	0.55	18.0	0.21		0.51	22.0	0.29		0.44
18.0	0.25	0.28	0.65	20.0	0.29		0.57	24.0	0.28		0.50
20.0	0.23	0.31	0.70	22.0	0.21		0.64	26.0	0.31		0.52
22.0	0.26	0.27	0.72	24.0	0.26		0.63	28.0	0.33		0.57
24.0	0.21	0.35	0.76	26.0	0.37		0.58	30.0	0.32		0.64
26.0	0.23	0.37	0.78	28.0	0.29		0.69	32.0	0.36		0.77
28.0	0.26	0.36	0.72	30.0	0.34		0.72	34.0	0.39		0.80
30.0	0.37	0.39	0.70	32.0	0.30		0.80	36.0	0.34		0.87
32.0	0.30	0.37	0.84	34.0	0.26		0.98	38.0	0.32		0.83
34.0	0.25	0.29	0.87	36.0	0.29		1.10	40.0	0.24		1.07
36.0	0.24	0.28	0.80	38.0	0.25		1.08	42.0	0.12	(in debris)	0.92
38.0	0.28	0.31	0.78	40.0	0.09		0.91	44.0	0.02	(in debris)	0.57
40.0	0.21	0.26	0.75	42.0	0.05	(in debris)	0.44	45.0 log jam			
42.0	0.20	0.20	0.32	44.0	-		0.10	47.0 Hub 6 (L.B.)			
43.5 wet edge				45.0 wet edge/log jam							
48.0 Hub 4 (L.B.)				48.5 Hub 5 (L.B.)							

(Continued)

TABLE H2.3
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 1
Set #3
March 16, 1982

Water Temp. (Not recorded)
Q = 20.0 m^3/s

Transect 1				Transect 2				Transect 3			
Distance from Hub 1 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
12 to 17m wet edge (ice too thick)				10.0m to wet edge (ice too thick)				12.5 wet edge (est. due to thick ice)			
17.0	0	Not	0.40	10.0	0		0.26	13.0	0.01	Not	0.24
21.0	0.03	Measured	0.47	13.0	0.02		0.48	15.0	0.01	Measured	0.24
23.0	0.04		0.54	15.0	0.02		0.52	17.0	0		0.26
25.0	0.04		0.64	17.0	0.03		0.58	19.0	0.02		0.36
27.0	0.06		0.64	19.0	0.05		0.58	21.0	0.05		0.38
29.0	0.04		0.67	21.0	0.03		0.58	23.0	0.04		0.50
31.0	0.05		0.64	23.0	0.04		0.59	25.0	0.04		0.52
33.0	0.04		0.66	25.0	0.05		0.56	27.0	0.06		0.52
35.0	0.05		0.55	27.0	0.05		0.54	29.0	0.06		0.56
37.0	0.05		0.55	29.0	0.05		0.49	31.0	0.04		0.58
39.0	0.04		0.52	31.0	0.03		0.55	33.0	0.05		0.53
41.0	0.04		0.53	33.0	0.04		0.53	35.0	0.05		0.54
43.0	0.02		0.48	35.0	0.04		0.65	37.0	0.02		0.58
45.0	0.03		0.47	37.0	0.03		0.57	39.0	0.05		0.60
47.0	0.01		0.32	39.0	0.03		0.50	41.0	0.03		0.62
48.0	wet edge			41.0	0		0.20	43.0	0.05		0.46
56.5	Hub 1 (L.B.)			42.0	wet edge (Thick ice)			45.0	0.03		0.52
				52.0	Hub 2 (L.B.)			47.0	wet edge (thick ice)		
								60.0	Hub 3 (L.B.)		

Transects done when considerable amount of ice present. Had to chop holes in ice at point of measurement at marginal sites.

(Continued)

TABLE H2.3 (Continued)

Water Temp. (Not recorded)

Q = 20.0 m^3/s

Transect 4			Transect 5			Transect 6				Transect 7[1]		
Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Depth (m)	Distance from Hub 5 (m)	Nose Point Vel. (m/s)	Depth (m)	Distance from Hub 6 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 7 (m)	Nose Point Vel. (m/s)	Depth (m)
11.5 wet edge			15.0 wet edge			19.0 wet edge				23.5 wet edge		
13.0	0	0.8	17.0	0	0.16	21.0	0	0	0.14	25.0	0	0.08
15.0	0	0.14	19.0	0.01	0.26	23.0	0.03	0.02	0.24	27.0	0	0.07
17.0	0.04	0.30	21.0	0.05	0.35	25.0	0.04	0.05	0.27	29.0	0.03	0.17
19.0	0.04	0.45	23.0	0.05	0.39	27.0	0.06	0.06	0.30	31.0	0.07	0.18
21.0	0.05	0.46	25.0	0.04	0.39	29.0	0.07	0.07	0.31	33.0	0.09	0.27
23.0	0.06	0.43	27.0	0.07	0.30	31.0	0.06	0.06	0.25	35.0	0.09	0.32
25.0	0.04	0.49	29.0	0.05	0.46	33.0	0.09	0.09	0.34	37.0	0.11	0.39
27.0	0.06	0.59	31.0	0.07	0.49	35.0	0.09	0.09	0.57	39.0	0.11	0.50
29.0	0.08	0.43	33.0	0.07	0.56	37.0	0.07	0.09	0.63	41.0	0.12	0.49
31.0	0.08	0.41	35.0	0.06	0.68	39.0	0.08	0.10	0.60	43.0	0.12	0.65
33.0	0.05	0.57	37.0	0.05	0.86	41.0	0.04	0.11	0.81	45.0	0.07	0.80
35.0	0.05	0.58	39.0	0.03	0.88	43.0	0.03	0.05	0.60	47.0	0.04	0.86
37.0	0.07	0.55	41.0	0.01	0.47	45.0 wet edge (log jam)				48.5 wet edge (log jam)		
39.0	0.05	0.52	43.0 wet edge/(log jam)		48.0	Hub 6 (L.B.)				49.5 Hub 7 (L.B.)		
41.0	0.05	0.50	50.0 Hub 5 (L.B.)									
43.0 wet edge												
49.5 Hub 4 (L.B.)												

1 Transect #7 is the old Transect #4 from 1979 studies.

TABLE H2.4
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 1
Set #4
April 2, 1982

Water Temp. = 2.0°C
Q = 15.0 m^3/s

Transect 1				Transect 2				Transect 3			
Distance from Hub 1 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
18.0 wet edge				9.0 wet edge				11.0 wet edge (Est. due to ice)			
19.0	0.01	0	0.10	10.0*	0	0	0.20	13.0	0.02	0	0.12
21.0	0.02	0.01	0.14	12.0	0.01	0.01	0.32	15.0	0	0	0.18
23.0	0.04	0.04	0.32	14.0	0.02	0.02	0.30	17.0	0.02	0.01	0.16
25.0	0.04	0.05	0.37	16.0	0.04	0.04	0.39	19.0	0.02	0.03	0.25
27.0	0.04	0.06	0.47	18.0	0.06	0.06	0.37	21.0	0.04	0.04	0.30
29.0	0.06	0.06	0.48	20.0	0.05	0.04	0.40	23.0	0.04	0.05	0.38
31.0	0.07	0.07	0.47	22.0	0.04	0.06	0.40	25.0	0.06	0.06	0.44
33.0	0.05	0.08	0.51	24.0	0.06	0.07	0.40	27.0	0.08	0.08	0.39
35.0	0.05	0.07	0.43	26.0	0.06	0.04	0.41	29.0	0.05	0.06	0.45
37.0	0.05	0.06	0.41	28.0	0.04	0.06	0.39	31.0	0.05	0.06	0.49
39.0	0.05	0.04	0.38	30.0	0.05	0.06	0.32	33.0	0.06	0.06	0.43
41.0	0.05	0.06	0.33	32.0	0.02	0.04	0.40	35.0	0.06	0.17	0.37
43.0	0.04	0.03	0.32	34.0	0.04	0.04	0.46	37.0	0.06	0.06	0.44
45.0	0.02	0.02	0.30	36.0	0.04	0.04	0.45	39.0	0.06	0.06	0.47
47.0	0.02	0.02	0.25	38.0	0.02	0.02	0.39	41.0	0.05	0.04	0.50
49.0	0	0	0.10	40.0	0.03	0.03	0.32	43.0	0.04	0.06	0.49
50.0 wet edge				42.0 wet edge				45.0	0.02	0.03	0.45
57.5 Hub 1 (L.B.)				50.0 Hub 2 (L.B.)				47.0	0.02	0.02	0.40
								48.0 wet edge			
								60.0 Hub 3 (L.B.)			

* Estimate; under ice

(Continued)

TABLE H2.4 (Continued)

Water Temp. = 2.0°C
Q = 15.0 m^3/s

Transect 4				Transect 5				Transect 6			
Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 6 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
13.5 wet edge				16.0 wet edge				21.0 wet edge			
14.0	-	0	0.04	18.0	-	0	0.08	23.0	-	0	0.6
16.0	0.02	0.02	0.17	20.0	0.01	0.01	0.18	25.0	-	0	0.11
18.0	0.04	0.04	0.26	22.0	0.04	0.04	0.25	27.0	0.01	0	0.13
20.0	0.04	0.04	0.36	24.0	0.06	0.04	0.28	29.0	0.04	0.03	0.18
22.0	0.06	0.06	0.34	26.0	0.09	0.08	0.27	31.0	0.07	0.07	0.21
24.0	0.06	0.08	0.38	28.0	0.09	0.09	0.29	33.0	0.09	0.09	0.23
26.0	0.06	0.07	0.42	30.0	0.09	0.08	0.33	35.0	0.08	0.09	0.40
28.0	0.08	0.06	0.35	32.0	0.10	0.09	0.37	37.0	0.10	0.10	0.48
30.0	0.08	0.08	0.33	34.0	0.07	0.08	0.50	39.0	0.11	0.11	0.46
32.0	0.10	0.10	0.30	36.0	0.06	0.08	0.59	41.0	0.07	0.10	0.58
34.0	0.06	0.08	0.45	38.0	0.06	0.07	0.70	43.0	0.08	0.09	0.70
36.0	0.04	0.06	0.52	40.0	0.05	0.07	0.80	45.0	0	0	0.34
38.0	0.04	0.08	0.46	42.0	0.01	0.01	0.35	45.5 wet edge			
40.0	0.08	0.08	0.44	43.0 wet edge				49.0 Hub 6 (L.B.)			
42.0	0	0	0.39	49.0 Hub 5 (L.B.)							
43.0 wet edge											
50.0 Hub 4											

(Continued)

TABLE H2.4 (Continued)

Water Temp. = 2.0°C

Q = 15.0 m^3/s

Transect 7

Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
29.0	wet edge		
31.0	-	0.02	0.5
33.0	-	0.01	0.6
35.0	0.03	0.03	0.18
37.0	0.09	0.08	0.24
39.0	0.10	0.12	0.25
41.0	0.13	0.14	0.34
43.0	0.13	0.14	0.40
45.0	0.09	0.12	0.56
47.0	0.07	0.11	0.70
49.0	0.03	0.05	0.80
50.0	wet edge and Hub 7 (log jam)		

TABLE H2.5
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 2
Set #1
September 6, 1981

Water Temp. = 15.7°C
Q = 93.1 m^3/s

Transect 3					Transect 4					Transect 5				
Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 5 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential
1.5 wet edge					3.0 wet edge					3.0 wet edge				
3.0	0.06	0.07	0.47	0	5.0	0.09	0.14	0.60	0	5.0	0.10	0.12	0.36	0
5.0	0.05	0.11	0.62	0	7.0	0.03	0.11	0.70	1	7.0	0.33	0.33	0.42	1
7.0	0.24	0.26	0.85	1	9.0	0.30	0.41	0.68	1	9.0	0.42	0.49	0.40	1
9.0	0.20	0.27	0.90	1	11.0	0.25	0.41	0.58	1	11.0	0.57	0.57	0.32	1
11.0	0.27	0.33	0.84	1	13.0	0.35	0.45	0.60	1	13.0	0.40	0.47	0.49	1
13.0	0.26	0.34	0.90	1	15.0	0.23	0.36	0.68	1	15.0	0.44	0.48	0.46	1
15.0	0.26	0.35	0.78	1	17.0	0.27	0.44	0.60	1	17.0	0.38	0.47	0.53	1
17.0	0.28	0.33	0.77	1	19.0	0.22	0.32	0.60	1	19.0	0.42	0.43	0.52	1
19.0	0.20	0.28	0.75	1	21.0	0.26	0.40	0.54	1	21.0	0.41	0.46	0.41	1
21.0	0.22	0.28	0.68	1	23.0	0.30	0.43	0.48	1	23.0	0.39	0.36	0.32	1
23.0	0.23	0.24	0.60	1	25.0	0.26	0.32	0.44	1	25.0	0.28	-	0.31	1
25.0	0.24	0.28	0.54	1	27.0	0.21	0.25	0.48	1	27.0	0.33	-	0.31	1
27.0	0.23	0.23	0.43	1	29.0	0.37	0.37	0.30	1	29.0	0.33	-	0.25	1
29.0	0.21	0.22	0.32	1	31.0	0.34	-	0.28	1	31.0	0.43	-	0.25	1
31.0	0.22	-	0.18	1	33.0	0.30	-	0.20	0	33.0	0.55	-	0.19	1
33.0	-	-	0.10	0	35.0	0.30	-	0.16	0	35.0	0.48	-	0.15	1
35.0 wet edge		-	-	0	37.0	-	-	0.12	0	37.0	-	-	0.13	1
36.0 sandbar		-	-	0	39.0	-	-	0.12	0	39.0	-	-	0.12	0
37.0	-	-	0.06	0	41.0	-	-	0.12	0	41.0	0.82	-	0.15	1
39.0	-	-	0.04	0	43.0	-	-	0.11	0	43.0	-	-	0.13	1
41.0	-	-	0.04	0	45.0	-	-	0.02	0	45.0	-	-	0.14	1
42.0 wet edge					47.0	-	-	0.01	0	47.0	0.15	-	0.15	1
72.0 Hub 3 (L.B.)					48.0 wet edge					49.0	0.27	0.27	0.33	0
					64.0 Hub 4 (L.B.)					51.0	0.16	0.16	0.42	0
										53.0	0.15	0.16	0.51	0
										54.0 log jam				
										59.0 wet edge				
										61.0 Hub 5 (L.B.)				

(Continued)

TABLE H2.5 (Continued)

Water Temp. = 15.7°C
Q = 93.1 m^3/s

Transect 6					Transect 7					Transect 8				
Distance from Hub 6 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 7 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 8 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential
5.3	wet edge				4.3	wet edge				7.0	wet edge			
7.0	0.34	Not	0.36	0	6.0	0.29	Not	0.54	1	9.0	0.12	Not	0.16	0
9.0	0.22	Measured	0.46	1	8.0	0.26	Measured	0.64	1	11.0	0.13	Measured	-	0
11.0	0.26		0.42	1	10.0	0.57		0.50	1	13.0	-		0.20	0
13.0	0.36		0.34	1	12.0	0.57		0.45	1	15.0	0.36		0.40	0
15.0	0.46		0.41	1	14.0	0.56		0.20	1	17.0	0.07		0.31	1
17.0	0.35		0.32	1	16.0	0.56		0.23	1	19.0	0.65		0.41	1
19.0	0.51		0.40	1	18.0	0.47		0.27	1	21.0	1.04		0.39	1
21.0	0.46		0.38	1	20.0	0.64		0.25	1	23.0	0.69		0.25	1
23.0	0.59		0.24	1	22.0	0.61		0.22	1	25.0	0.89		0.29	1
25.0	0.26		0.36	1	24.0	0.67		0.22	1	27.0	0.63		0.27	1
27.0	0.29		0.36	1	26.0	0.48		0.17	1	29.0	0.53		0.22	1
29.0	0.39		0.20	1	28.0	-		0.06	1	31.0	0.55		0.33	1
31.0	0.38		0.16	1	30.0	-		0.03	1	33.0	0.50		0.27	1
33.0	-		0.12	0	32.0	-		0.01	0	35.0	0.51		0.30	1
35.0	-		0.06	0	34.0	-		0.04	0	37.0	0.53		0.33	1
37.0	-		0.04	1	36.0	0.10		0.17	1	39.0	0.56		0.40	1
39.0	-		0.04	0	38.0	0.20		0.36	1	41.0	0.47		0.42	1
41.0	-		0.06	0	40.0	0.26		0.63	0	43.0	0.45		0.47	1
43.0	0.15		0.16	0	42.0	0.30		0.86	0	45.0	0.54		0.31	1
45.0	0		0.30	0	44.0	0.22		0.95	1	47.0	0.57		0.31	1
47.0	0.18		0.60	0	16.0	0.19		0.76	1	49.0	0.36		0.33	1
49.0	0.18		1.00	0	47.5	log jam and sand bar			0	51.0	-		0.10	1
51.0	0.20		1.08	1	54.0	-		0.20	0	52.0	wet edge			
53.0	0.28	-	0.85	0	55.0	wet edge				64.5	Hub 8 (L.B.)			
55.0	wet edge				56.0	Hub 7 (L.B.)								
56.0	Hub 6 (L.B.)													

(Continued)

TABLE H2.5 (Continued)

Water Temp. = 15.7°C

Q = 93.1 m^3/s

Transect 9					Transect 10					Transect 11				
Distance from Hub 9 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning Potential[1]	Distance from Hub 10 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning Potential[1]	Distance from Hub 11 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning Potential[1]
4.5	wet edge				11.5	wet edge								
6.0	0.10	Not	0.54	0	13	-	Not	0.12	1	11	wet edge	Not		
8.0	0.26	Measured	1.06	0	15	0.75	Measured	0.28	1	13	-	Measured	0.08	0
10.0	0.15		0.62	0	17	0.62		0.42	1	15	0.33		0.16	0
12.0	0.03		0.56	0	19	0.64		0.34	0	17	0.54		0.16	0
14.0	0		0.36	0	21	0.55		0.28	0	19	0.80		0.22	0
16.0	0.52		0.20	0	23	0.58		0.44	0	21	0.82		0.34	0
18.0	0.53		0.26	0	25	0.55		0.46	1	23	0.83		0.44	1
20.0	0.56		0.36	1	27	0.66		0.50	1	25	0.92		0.44	1
22.0	0.52		0.38	1	29	0.10		0.46	1	27	0.84		0.50	1
24.0	0.75		0.26	1	31	0.68		0.30	1	29	0.26		0.50	1
26.0	0.45		0.30	1	33	0.55		0.32	1	31	0.35		0.42	1
28.0	0.69		0.32	1	35	0.34		0.34	1	33	0.60		0.20	1
30.0	0.63		0.28	1	37	0.45		0.20	1	35	0.36		0.22	1
32.0	0.55		0.36	1	39	-		0.12	1	37	0.29		0.18	1
34.0	0.55		0.36	1	41	-		0.06	0	39	-		0.12	0
36.0	0.49		0.36	1	43	wet edge				41	-		0.12	1
38.0	0.39		0.38	1	51	Hub (L.B.)				43	-		0.06	0
40.0	0.60		0.24	1						44	wet edge			
42.0	0.53		0.22	1						48	Hub (L.B.)			
44.0	0.55		0.28	1										
46.0	0.03		0.64	0										
48.0	0.03		1.04	0										
50.0	wet edge													
51.0	Hub (L.B.)													

[1] 1 = Suitable spawning gravel
0 = Not suitable spawning gravel

TABLE H2.6
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 2
Set #2
October 29, 1981

Water Temp. = 6.5°C @ 1600 hrs

Q = 59.9 m^3/s

Transect 3				Transect 4				Transect 5			
Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 5 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
4.0	wet edge			3.5	wet edge			4.0	wet edge		
6.0	0.03	0.07	0.65	5.0	0.07	0.08	0.50	6.0	0.18	0.19	0.22
8.0	0.08	0.10	0.65	7.0	0	0.03	0.52	8.0	0.21	0.24	0.23
10.0	0.10	0.11	0.66	9.0	0.15	0.15	0.47	10.0	0.12	0.08	0.38
12.0	0.08	0.15	0.72	11.0	0.17	0.17	0.41	12.0	0.28	0.29	0.28
14.0	0.10	0.10	0.66	13.0	0.11	0.14	0.46	14.0	0.22	0.23	0.38
16.0	0.11	0.12	0.61	14.0	0.10	0.09	0.52	16.0	0.24	0.27	0.35
18.0	0.08	0.10	0.50	17.0	0.14	0.16	0.46	18.0	0.24	0.26	0.40
20.0	0.08	0.12	0.50	19.0	0.10	0.14	0.46	20.0	0.25	0.26	0.30
22.0	0.08	0.09	0.42	21.0	0.15	0.14	0.30	22.0	0.13	0.14	0.20
24.0	0.09	0.07	0.43	23.0	0.11	0.10	0.32	24.0	-	0.06	0.07
26.0	0.08	0.08	0.31	25.0	0.10	0.10	0.28	26.0	0.13	0.13	0.18
28.0	0.06	0.08	0.22	27.0	0.12	0.11	0.29	28.0	-	0.15	0.09
30.0	-	0	0.06	29.0	0.08	0.06	0.18	30.0	0.14	0.10	0.16
32.0	wet edge			31.0	-	0.02	0.08	32.0	-	0.03	0.06
72.0	Hub (L.B.)			33.0	-	0.03	0.06	34.0	wet edge of gravel bar		0.02
				35.0	-	-	0.01	36.0	-	-	0.01
				36.0	wet edge			38.0	-	-	0.01
				64.0	Hub (L.B.)			40.0	-	-	0.01
								42.0	-	-	0.01
								44.0	-	-	0.01
								46.0	-	-	0.01
								48.0	wet edge of gravel bar		0.02
								50.0	0.01	0.03	0.16
								52.0	0.03	0.01	0.16
								54.0	log		
								61.0	Hub 5 (L.B.)		

(Continued)

TABLE H2.6 (Continued)

Water Temp. = 6.5°C @ 1600 hrs
Q = 59.9 m^3/s

Transect 6			
Distance from Hub 6 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
6.0	wet edge		
8.0	0.28	0.27	0.20
10.0	0.13	0.19	0.34
12.0	0.20	0.19	0.32
14.0	0.36	0.40	0.30
16.0	0.43	0.45	0.24
18.0	0.40	0.40	0.28
20.0	0.36	0.35	0.30
22.0	0.37	0.35	0.24
24.0	0.37	0.30	0.18
26.0	-	0.14	0.06
28.0	-	-	0.04
30.0	-	0.08	0.05
32.0	-	-	0.02
33.0	wet edge of gravel bar		
34.0			
36.0			
38.0			
40.0			
42.0			
43.5	wet edge of gravel bar		
44.0	-	0.02	0.06
46.0	0.01	0.01	0.26
48.0	0	0.01	0.68
50.0	0	0.01	0.87
52.0	0	0	0.80
54.0	0	0	0.34
54.5	wet edge		
56.0	Hub 6 (L.B.)		

Transect 7			
Distance from Hub 7 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
4.5	wet edge		
6.0	0.18	0.24	0.40
8.0	0.24	0.29	0.50
10.0	0.24	0.27	0.40
12.0	0.48	0.49	0.24
14.0	0.27	0.34	0.16
16.0	0.04	0.03	0.18
18.0	-	0	0.08
20.0	0.08	0.06	0.19
22.0	-	0.25	0.05
24.0	-	0.17	0.10
26.0	-	0.20	0.06
27.5	wet edge of gravel bar		
36.5	wet edge of gravel bar		
38.0	0.01	0.01	0.20
40.0	0.02	0.02	0.50
42.0	0	0	0.60
44.0	0	0	0.62
46.0	0	0	0.54
47.5	log jam		
56.0	Hub 7 (L.B.)		

Transect 8			
Distance from Hub 8 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
7.0	wet edge		
9.0	log jam		
11.0	-	0	0.05
13.0	log jam		
15.0	log jam		
17.0	0.03	0.12	0.16
19.0	0.70	0.82	0.30
21.0	0.70	0.68	0.25
23.0	0.52	0.42	0.18
25.0	0.48	0.42	0.22
27.0	0.60	0.50	0.14
29.0	-	0.27	-.08
31.0	0.49	0.47	0.16
33.0	0	0	0.18
35.0	-	0.20	0.08
37.0	0.45	0.27	0.14
39.0	0	0	0.16
41.0	0.16	0.18	0.35
43.0	0.15	0.14	0.27
45.0	-	0.17	0.11
47.0	-	0.08	0.07
49.0	-	0	0.07
49.5	wet edge		
64.0	Hub 8 (L.B.)		

(Continued)

TABLE H2.6 (Continued)

Water Temp. = 6.5°C @ 1600 hrs
Q = 59.9 m^3/s

Transect 9				Transect 10				Transect 11			
Distance from Hub 9 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 10 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 11 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
6.0	wet edge			13.5	wet edge			19.5	wet edge		
8.0	0.03	0.07	0.86	15.0	0.13	0.10	0.18	21.0	-	0.44	0.08
10.0	0.17	0.17	0.46	17.0	0.32	0.29	0.28	23.0	0.52	0.59	0.33
12.0	0.18	0.18	0.22	19.0	0.34	0.32	0.28	25.0	0.90	0.81	0.18
14.0	0.12	0.11	0.12	21.0	0.15	0.14	0.22	27.0	0.66	0.75	0.30
16.0	-	0.03	0.05	23.0	0.05	0.05	0.32	29.0	0.12	0.05	0.24
18.0	-	0.07	0.08	25.0	0.52	0.51	0.32	31.0	0.20	0.15	0.16
20.0	0.29	0.11	0.12	27.0	0.20	0.20	0.30	33.0		gravel	
22.0	0.26	0.19	0.22	29.0	0.15	0.15	0.24	35.0		wet edge	
24.0	0.02	0.01	0.20	31.0	0.30	0.30	0.14	48.0		Hub 11 (L.B.)	
26.0	-	0.22	0.10	33.0	-	0.03	0.05				
28.0	0.12	0.11	0.14	35.0	0.02	0.02	0.14				
30.0	-	0.31	0.05	37.0	wet edge (sand bar and log jam)						
32.0	0.25	0.16	0.18	51.0	Hub 10 (L.B.)						
34.0	-	0.28	0.12	60.0	wet edge						
36.0	0.33	0.27	0.16	61.0	0	0	0.16				
38.0	-	0.15	0.10	62.0	0.05	0.05	0.26				
40.0	0.13	0.09	0.22	63.0	0.20	0.23	0.38				
42.0	0.08	0.07	0.21	64.0	0	0	0.62				
44.0	-	0.17	0.06	65.0	wet edge						
46.0	0	0	0.28								
48.0	0.01	0	0.78								
50.5	wet edge										
52.0	Hub 9 (L.B.)										

TABLE H2.7
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 3A
Set #1
September 7, 1981

Water Temp. = 13.4°C @ 0730 hrs.

Water Temp. = 15.6°C @ 2000 hrs.

Q = 93.7 m^3/s

Transect 1					Transect 2					Transect 3				
Distance from Hub 1 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential
3.5 wet edge					4.0 wet edge					1.0 wet edge				
5.0	0.09	0.29	0.62	0	6.0	0.30	0.30	0.32	0	3.0	0.20	0.33	0.88	0
7.0	0.14	0.32	0.63	0	8.0	0.23	0.38	0.55	0	5.0	0.65	0.79	0.62	0
9.0	0.17	0.34	0.60	0	10.0	0.51	0.57	0.36	1	7.0	0.64	0.72	0.51	1
11.0	0.23	0.38	0.70	0	12.0	0.55	0.54	0.38	1	9.0	0.43	0.47	0.50	1
13.0	0.20	0.33	0.81	1	14.0	0.51	0.57	0.41	1	11.0	0.55	0.58	0.41	1
15.0	0.22	0.35	0.91	1	16.0	0.43	0.44	0.50	1	13.0	0.67	0.69	0.45	1
17.0	0.20	0.33	0.86	1	18.0	0.48	0.53	0.51	1	15.0	0.52	0.55	0.49	1
19.0	0.25	0.38	0.90	1	20.0	0.40	0.48	0.52	1	17.0	0.73	0.75	0.33	1
21.0	0.23	0.36	0.86	1	22.0	0.34	0.41	0.54	1	19.0	0.51	0.47	0.18	1
23.0	0.19	0.32	0.80	1	24.0	0.36	0.54	0.44	1	21.0	0.20	0.20	0.14	1
25.0	0.24	0.37	0.78	1	26.0	0.40	0.40	0.29	1	23.0	0	0.02	0.05	1
27.0	0.18	0.34	0.59	1	28.0	0.42	0.42	0.30	1	25.0	0	0.02	0.02	1
29.0	0	0.25	0.59	0	30.0	0.15	0.23	0.38	1	27.0	0	0.02	0.02	1
30.0 wet edge					32.0	0.13	0.13	0.30	0	28.0 wet edge				
32.0 Hub 1 (L.B.)					34.0	0.23	0.18	0.24	0	33.5 Hub 3 (L.B.)				
					36.0	0	0	0.12	0					
					37.0 wet edge									
					39.0 Hub 2 (L.B.)									

(Continued)

TABLE H2.7 (Continued)

Water Temp. = 1.5°C @ 1200 hrs
Q = 39.0 m^3/s

Transect 1				Transect 2				Transect 3			
Distance from Hub 1 (m)	Nose Point Vel.[2] (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
4.0 wet edge				6.0 wet edge				2.5 wet edge			
5.0	0	0.06	0.27	7.0	0.26	0.25	0.06	3.0	0.07	0.13	0.38
7.0	0.02	0.08	0.30	9.0	0.26	0.25	0.13	5.0	0.24	0.23	0.16
9.0	0.02	0.08	0.27	10.0 wet edge Island R		-	-	7.0	0.80	0.73	0.15
11.0	0.02	0.08	0.35	11.0 wet edge Island L		-	-	9.0	0.78	0.71	0.13
13.0	0.04	0.10	0.46	12.0	0.18	0.18	0.06	11.0	0.29	0.28	0.16
15.0	0.05	0.27	0.54	14.0	0.29	0.28	0.10	13.0	0.03	0.05	0.16
17.0	0.06	0.28	0.53	16.0	0.18	0.24	0.24	15.0	0.09	0.10	0.9
19.0	0.03	0.26	0.57	18.0	0.20	0.28	0.20	17.0	0.09	0.10	0.12
21.0	0.03	0.26	0.54	20.0	0.18	0.24	0.24	18.5 wet edge			
23.0	0.02	0.08	0.50	22.0	0.12	0.13	0.21	32.5 Hub 3 (L.B.)[3]			
25.0	0.03	0.09	0.48	24.0	0.02	0.04	0.13				
27.0	0.01	0.07	0.35	25.5 wet edge Island R							
29.0	0.02	0.08	0.33	30.0 wet edge Island L							
30.0 wet edge				31.0	0	0.02	0.02				
32.0 Hub 1 (L.B.)				32.0 wet edge							
				39.0 Hub 2 (L.B.)							

1 1 = Suitable spawning gravel
0 = Not suitable spawning gravel

2 If depth less than 15 cm, velocity is average velocity
Some surface ice forming along edge of Transect 1

3 Hub missing

TABLE H2.8
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 3A
Set #3
March 17, 1982

Water Temp. (Not recorded)

Q = 18.5 m^3/s

Transect 1

Distance from Hub 1 (m)	Nose Point Vel. (m/s)	Depth (m)
4.0 wet edge		
5.0	0	0.30
7.0	0	0.29
9.0	0.02	0.27
11.0	0.03	0.35
13.0	0.04	0.44
15.0	0.04	0.51
17.0	0.03	0.53
19.0	0.03	0.56
21.0	0.03	0.53
23.0	0.03	0.49
25.0	0.02	0.39
27.0	0	0.36
29.0	0.09	0.31
30.5[1] wet edge		
32.5 Hub 1 (L.B.)		

Transect 2

Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
6.0 wet edge			
7.0	0.07	0.07	0.30
9.0	0.25	0.25	0.12
9.5 wet edge gravel bar			
11.5 wet edge gravel bar			
13.0	-	0.02	0.05
15.0	0.23	0.34	0.14
17.0	0.13	0.13	0.27
19.0	0.19	0.19	0.20
21.0	0.17	0.16	0.14
23.0	0.11	0.11	0.20
25.0	-	0.05	0.06
26.0[1] wet edge gravel bar			
30.0[1] wet edge gravel bar			
31.0	0	0	0.02
32.0 wet edge			
39.5 Hub 2 (L.B.)			

Transect 3

Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Depth (m)
2.5 wet edge		
3.0	0.04	0.30
5.0	0.23	0.17
7.0	0.62	0.15
9.0	0.62	0.13
11.0	0.34	0.16
13.0	0.05	0.18
15.0	0.12	0.11
17.0	0.01	0.13
18.5[1] wet edge		

Left Hub missing

1 Approximate due to ice

Observations: Shelf ice on left side of channel; more open than during February visit; Dippers, stellars jays in the vicinity; signs of moose and wolf.

TABLE H2.9
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 3A
Set #4
March 30, 1982

Water Temp. = 2.6°C @ 1530 hrs
Q = 16.0 m^3/s

Transect 1				Transect 2				Transect 3			
Distance from Hub 1 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
4.0 wet edge				7.0 wet edge				2.5 wet edge			
5.0	0	0	0.13	9.0	-	0.12	0.06	3.0	0.05	0.05	0.25
7.0	0.01	0.01	0.20	9.3 wet edge gravel bar				5.0	-	-	0.01
9.0	0.01	0.01	0.20	13.5 wet edge gravel bar				7.0	0.48	0.48	0.07
11.0	0.01	0.01	0.27	15.0	-	0.07	0.06	9.0	-	0.44	0.07
13.0	0.01	0.02	0.40	17.0	0.06	0.05	0.18	11.0	-	0.21	0.08
15.0	0.01	0.02	0.45	19.0	0.06	0.05	0.12	13.0	-	0.01	0.08
17.0	0.01	0.02	0.48	21.0	-	0.03	0.09	15.0	-	-	0.01
19.0	0.01	0.01	0.49	23.0	-	0.01	0.08	17.0	-	-	0.01
21.0	0.01	0.01	0.45	24.5 wet edge				17.5 wet edge			
23.0	0	0	0.42								
25.0	0	0.01	0.40	Hub[1] 2 (L.B.)				Hub[1] 3 (L.B.)			
27.0	0	0	0.30								
29.0	0	0	0.23								
29.5 wet edge											
Hub[1] 1 (L.B.)											

1 Measurements were only conducted to wetted edge
Flows have dropped since March 17, 1982

TABLE H2.10
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at
Pink Salmon Spawning Sites on the Morice River
Side Channel Area 3B
Set #1
September 8, 1981

Water Temp. = 13.5°C @ 0730 hrs
Water Temp. = 14.9°C @ 1930 hrs
Q = 94.7 m^3/s

Transect 4					Transect 5					Transect 6				
Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 5 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential	Distance from Hub 6 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential
5.5	wet edge				2.5	wet edge				2.0	wet edge			
7.0	0.56	0.56	0.32	1	4.0	0.20	0.23	0.40	1	4.0	0.42	0.46	0.38	1
9.0	0.82	0.84	0.34	1	6.0	0.50	0.70	0.74	1	6.0	0.59	0.62	0.42	1
11.0	0.67	0.78	0.66	1	8.0	0.45	0.58	0.60	1	8.0	0.71	0.73	0.38	1
13.0	0.45	0.70	0.64	1	10.0	0.49	0.52	0.60	1	10.0	0.80	0.82	0.43	1
15.0	0.28	0.42	0.46	1	12.0	0.43	0.49	0.44	1	12.0	0.70	0.72	0.38	1
17.0	0.45	0.45	0.24	1	14.0	0.30	0.31	0.38	0	14.0	0.53	0.49	0.15	1
20.0	wet edge				16.0	0	0.06	0.06	1	16.0	0	0.02	0.04	1
25.5	Hub 4 (L.B.)				18.0	0	0	0.04	1	18.0	0.41	0.38	0.22	1
					20.0	0	0	0.09	0	20.0	0.56	0.59	0.26	1
					21.5	wet edge				22.0	0.45	0.42	0.14	1
					24.5	Hub 5 (L.B.)				23.0	wet edge			
										36.0	Hub 6 (L.B.)			

[1] 1 = Suitable spawning gravel
0 = Not suitable spawning gravel

TABLE H2.11
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 3B
Set #2
December 15, 1981

Water Temp. = 1.5°C @ 1200 hrs
Q = 39.0 m^3/s

Transect 4				Transect 5				Transect 6			
Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 5 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 6 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
6.5	wet edge			3.5	wet edge			2.5	wet edge		
7.0	0.06	0.07	0.11	4.0	0.07	0.19	0.24	3.0	0.49	0.45	0.17
9.0	0.29	0.28	0.19	6.0	0.17	0.34	0.62	5.0	0.35	0.33	0.16
11.0	0.25	0.28	0.45	8.0	0.21	0.36	0.59	7.0	0.32	0.30	0.15
13.0	0.26	0.29	0.43	10.0	0.18	0.23	0.38	9.0	0.45	0.45	0.22
15.0	0.19	0.25	0.22	12.0	0.09	0.15	0.33	11.0	0.39	0.43	0.27
17.0	0	0.02	0.01	14.0	0.03	0.05	0.15	13.0	0.16	0.16	0.10
18.0	wet edge			16.0	wet edge			14.0	wet edge gravel bar		
26.0	Hub 4 (L.B.)			25.0	Hub 5 (L.B.)			17.5	wet edge gravel bar		
								19.0	0.17	0.17	0.8
								21.0	0.12	0.12	0.11
								22.0	wet edge		
								36.0	Hub 6 (L.B.)		

TABLE H2.12
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Side Channel Area 3B
Set #3
April 28, 1982

Water Temp. = 3.0°C
Q = 18.0 m^3/s

Transect 4			
Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
8.5 wet edge			
11	0.05	0.04	0.28
13	0.06	0.06	0.25
15	-	0.04	0.10
16.3 Ice Shelf 30 cm thick			
16.7 wet edge			
25.5 Hub 4 (L.B.)			

Transect 5			
Distance from Hub 5 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
4.5 wet edge			
6.0	1	0.01	0.42
8.0	2	0.02	0.49
10.0	3	0.03	0.30
12.0	3	0.03	0.23
14.0	-	0	0.13
14.6 Ice shelf 25 cm thick			
15.0 wet edge (Approx.)			
24.5 Hub 5 (L.B.)			

Transect 6			
Distance from Hub 6 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
4.5 wet edge			
5.3 to 5.5 Gravel ridge			
6.0	-	-	0.04
8.0	-	0.07	0.06
10.0	-	0.10	0.11
12.0	-	0.11	0.12
14.0 wet edge of ice ridge			
36.0 Hub 6 (L.B.)			

1 Flow is not at right angle to transect

TABLE H2.13
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Main Channel Area 4
Set #1
September 9, 1981

Water Temp. = 13.8°C @ 0700 hrs
Water Temp. = 14.3°C @ 2030 hrs
Q = 96.7 m^3/s

Transect 1					Transect 2					Transect 3				
Distance from Hub 1 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning Potential	Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning Potential	Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning Potential
4.0 wet edge					3.5 wet edge					1.5 wet edge				
7.0	0.13	0.56	1.32	0	6.0	0.25	0.30	0.22	1	3.0	0.42	0.45	0.56	1
10.0	0.55	0.63	0.99	1	9.0	0.43	0.27	0.77	1	6.0	0.58	0.67	1.13	1
13.0	0.70	0.80	0.98	1	12.0	0.25	0.77	0.97	1	9.0	0.36	0.63	1.33	1
16.0	0.65	0.84	1.12	1	15.0	0.40	0.50	0.87	1	12.0	0.40	0.55	1.08	1
19.0	0.70	0.95	1.27	1	18.0	0.58	0.66	0.76	1	15.0	0.57	0.75	0.81	1
22.0	0.78	0.98	1.23	1	21.0	0.73	0.83	0.77	1	18.0	0.60	0.62	0.85	1
25.0	0.50	0.71	1.25	1	29.0	0.70	0.80	0.92	1	21.0	0.72	1.00	0.86	1
28.0	0.65	1.00	1.55	1	27.0	0.85	1.07	1.07	1	24.0	0.85	0.78	0.90	1
31.0	0.75	1.11	1.61	1	30.0	0.68	0.88	1.22	1	27.0	0.78	1.00	1.02	1
34.0	0.75	1.11	1.70	1	33.0	0.54	0.74	1.23	1	30.0	0.80	1.10	1.10	1
37.0	0.70	1.06	1.62	1	36.0	0.80	1.05	1.40	1	33.0	0.80	1.20	1.11	1
40.0	0.62	0.97	1.57	1	39.0	0.75	1.21	1.46	1	36.0	0.78	1.10	1.27	1
43.0	0.65	1.00	1.52	1	42.0	0.82	1.19	1.55	1	39.0	1.05	1.20	1.35	1
46.0	0.55	0.83	1.45	1	45.0	0.70	1.06	1.61	1	42.0	0.85	1.20	1.41	1
49.0	0.50	0.79	1.48	1	48.0	0.85	1.23	1.66	1	45.0	0.80	1.25	1.50	1
52.0	0.50	0.79	1.45	1	51.0	0.62	0.97	1.67	1	48.0	0.70	1.20	1.50	1
55.0	0.50	0.79	1.39	1	54.0	0.45	0.82	1.69	1	51.0	0.85	1.10	1.52	1
58.0	0.58	0.85	1.32	1	57.0	0.62	0.97	1.56	1	54.0	0.72	0.82	1.41	1
61.0	0.60	0.87	1.45	1	60.0	0.65	0.91	1.47	1	57.0	0.62	0.92	1.43	1
64.0	0.45	0.82	1.54	1	63.0	0.58	0.93	1.70	1	60.0	0.70	0.88	1.49	1
67.0	0.40	0.63	1.19	1	66.0	0.55	0.91	1.82	1	63.0	0.70	1.02	1.51	1
70.0	0.13	0.26	0.51	0	69.0	0.45	0.82	1.61	1	66.0	0.55	0.85	1.50	1
71.0 wet edge					72.0	0.20	0.37	0.92	1	69.0	0.53	0.70	1.25	1
73.0 Hub 1 (L.B.)					74.5 wet edge					72.0	0.26	0.30	0.43	1
					76.0 Hub 2 (L.B.)					73.0 wet edge				
										75.5 Hub 3 (L.B.)				

(Continued)

TABLE H2.13 (Continued)

Water Temp. = 13.8°C @ 0700 hrs
Water Temp. = 14.3°C @ 2030 hrs
Q = 96.7 m^3/s

Transect 4				
Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Spawning[1] Potential
1.5	wet edge			
3.0	0.40	0.51	0.77	1
6.0	0.32	0.45	1.00	1
9.0	0.60	0.80	1.07	1
12.0	0.55	0.53	0.98	1
15.0	0.62	0.74	0.83	1
18.0	0.60	0.68	0.80	1
21.0	0.70	0.80	0.81	1
24.0	0.60	0.68	0.85	1
27.0	0.70	0.80	0.89	1
30.0	0.95	1.16	0.90	1
33.0	0.75	0.86	1.02	0
36.0	0.80	1.01	1.05	0
39.0	0.82	1.03	1.10	0
42.0	0.90	1.13	1.16	0
45.0	1.05	1.36	1.25	1
48.0	0.80	1.04	1.35	1
51.0	0.84	1.09	1.36	1
54.0	0.70	0.95	1.38	1
57.0	0.86	1.11	1.31	1
60.0	0.75	1.00	1.31	1
63.0	0.65	0.91	1.37	1
66.0	0.70	1.06	1.55	1
69.0	0.68	1.04	1.50	1
72.0	0.72	0.82	0.98	0
75.0	0.62	0.68	0.70	1
77.0	wet edge			
79.0	Hub 4 (L.B.)			

[1] 1=Suitable spawning gravel
0=Not suitable spawning gravel

TABLE H2.14
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Main Channel Area 4
Set #2
October 30, 1981

Water Temp. = 6.0 °C @ 1400 hrs
Q = 59.4 m^3/s

Transect 1				Transect 2				Transect 3			
Distance from Hub 1 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)	Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
4.0 wet edge				6.5 wet edge				2.5 wet edge			
7.0	0.09	0.09	1.00	9.0	0.33	0.41	0.37	5.0	0.34	0.50	0.78
10.0	0.25	0.48	0.80	12.0	0.52	0.49	0.60	8.0	0.35	0.45	0.94
13.0	0.43	0.60	0.67	15.0	0.18	0.40	0.56	11.0	0.20	0.30	1.00
16.0	0.55	0.68	0.86	18.0	0.42	0.42	0.45	14.0	0.20	0.30	0.70
19.0	0.65	0.66	0.90	21.0	0.55	0.59	0.45	17.0	0.38	0.54	0.50
22.0	0.50	0.85	1.00	24.0	0.58	0.60	0.61	20.0	0.58	0.62	0.54
25.0	0.55	0.80/1.10	1.12	27.0	0.42	0.64	0.74	23.0	0.58	0.70	0.56
28.0	0.45	0.88/1.25	1.24	30.0	0.55	0.90	0.89	26.0	0.55	0.62	0.66
31.0	0.75	0.85/1.20	1.38	33.0	0.55	1.00	1.00	29.0	0.55	0.74	0.76
34.0	0.75	0.65/1.15	1.30	36.0	0.46	0.70/1.05	1.10	32.0	0.65	0.90	0.84
37.0	0.65	0.85/1.10	1.28	39.0	0.62	0.84/0.90	1.22	35.0	0.82	0.82	0.90
40.0	0.80	0.80/1.00	1.26	42.0	0.60	0.94/1.10	1.24	38.0	0.85	0.25/1.05	1.10
43.0	0.40	0.65/0.75	1.10	45.0	0.58	0.90/1.22	1.31	41.0	0.50	0.85/0.90	1.10
46.0	0.40	0.45/0.62	1.14	48.0	0.60	0.95/1.05	1.45	44.0	0.70	0.95/1.10	1.21
49.0	0.35	0.45/0.60	1.16	51.0	0.70	0.60/0.95	1.40	47.0	0.85	0.90/1.05	1.23
52.0	0.40	0.38/0.45	1.08	54.0	0.62	0.50/0.80	1.40	50.0	0.50	0.86/1.02	1.26
55.0	0.30	0.30/0.38	1.10	57.0	0.65	0.65/0.75	1.28	53.0	0.55	0.62/0.94	1.20
58.0	0.28	0.32	0.80	60.0	0.40	0.56/0.65	1.22	56.0	0.65	0.68/0.98	1.13
61.0	0.35	0.48	1.16	63.0	0.35	0.40/0.55	1.25	59.0	0.40	0.60/0.85	1.20
64.0	0.38	0.52	1.20	66.0	0.30	0.42/0.65	1.50	62.0	0.50	0.48/0.86	1.26
67.0	0.20	0.44	0.80	69.0	0.42	0.30/0.74	1.45	65.0	0.36	0.55/0.90	1.31
70.0 wet edge				72.0	0.37	0.38	0.80	68.0	0.60	0.54/0.85	1.17
72.5 Hub 1 (L.B.)				74.0 wet edge				71.0	0.47	0.40	0.66
				77.0 Hub 2 (L.B.)				73.0 wet edge			
								76.0 Hub 3 (L.B.)			

(Continued)

TABLE H2.14 (Continued)

Water Temp. = 6.0 °C @ 1400 hrs
Q = 59.4 m^3/s

Transect 4

Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
2.0	wet edge		
5.0	0.58	0.62	0.60
8.0	0.42	0.52	0.76
11.0	0.46	0.49	0.75
14.0	0.50	0.53	0.54
17.0	0.52	0.47	0.48
20.0	0.54	0.49	0.50
23.0	0.56	0.51	0.52
26.0	0.64	0.58	0.52
20.0	0.60	0.65	0.55
32.0	0.62	0.68	0.68
35.0	0.64	0.71	0.75
38.0	0.66	0.75	0.85
41.0	0.70	0.80	0.86
44.0	0.75	0.86	1.00
47.0	0.75	0.95	1.03
50.0	0.64	0.83	1.06
53.0	0.75	0.95	1.20
56.0	0.52	0.72	1.08
59.0	0.80	1.01	1.03
62.0	0.64	0.83	1.09
65.0	0.75	0.95	1.16
68.0	0.64	0.83	1.24
71.0	0.28	0.55	1.18
74.0	0.38	0.41	0.58
75.5	wet edge		
79.0	Hub 4 (L.B.)		

TABLE H2.15
Summary of Transect Measurements of Water Depth, Water Velocity and Substrate at Pink Salmon Spawning Sites on the Morice River
Main Channel Area 4
Set #3
April 19, 1982

Water Temp. (Not Recorded)

Q = 14.0 m^3/s

Transect 1			
Distance from Hub 1 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
4.5	wet edge		
7.0	0.01	0.01	0.52
10.0	0.05	0.05	0.18
13.0	0.21	0.16	0.16
16.0	0.17	0.17	0.30
19.0	0.20	0.28	0.36
22.0	0.26	0.35	0.50
25.0	0.25	0.34	0.61
28.0	0.28	0.34	0.70
31.0	0.40	0.40	0.75
34.0	0.40	0.50	0.81
37.0	0.28	0.48	0.80
40.0	0.34	0.32	0.74
43.0	0.30	0.35	0.68
46.0	0.23	0.33	0.64
49.0	0.16	0.28	0.64
52.0	0.21	0.20	0.60
55.0	0.16	0.20	0.56
58.0	0.14	0.12	0.46
61.0	0.10	0.10	0.60
64.0	0.06	0.07	0.66
67.0	0.06	0.06	0.38
69.0	wet edge		
73.0	Hub 1 (L.B.)		

Transect 2			
Distance from Hub 2 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
11.0	approx wet edge to ice		
15.0	see notes below[1]		
22.5	wet edge		
24.0	-	0.05	0.11
27.0	0.15	0.10	0.22
30.0	0.09	0.19	0.36
33.0	0.17	0.22	0.42
36.0	0.22	0.22	0.54
39.0	0.20	0.24	0.63
42.0	0.25	0.30	0.71
45.0	0.30	0.33	0.79
48.0	0.27	0.40	0.86
51.0	0.30	0.32	0.86
54.0	0.30	0.35	0.81
57.0	0.25	0.34	0.75
60.0	0.24	0.25	0.62
63.0	0.15	0.28	0.74
66.0	0.18	0.22	1.02
69.0	0.18	0.22	0.82
72.0	0.16	0.16	0.30
73.0	wet edge		
76.5	Hub 2 (L.B.)		

Transect 3			
Distance from Hub 3 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
7.0	wet edge (thick ice)		
10.0[2]		0	0.25
13.0	wet edge gravel bar		
17.5	wet edge gravel bar		
18.0	Under edge of ice		
21.0	-	-	0.03
24.0	-	0.14	0.08
27.0	0.24	0.22	0.15
30.0	0.30	0.30	0.27
33.0	0.34	0.34	0.30
36.0	0.27	0.33	0.44
39.0	0.34	0.34	0.54
42.0	0.29	0.36	0.60
45.0	0.35	0.43	0.65
48.0	0.31	0.45	0.70
51.0	0.35	0.46	0.65
54.0	0.37	0.43	0.60
57.0	0.33	0.42	0.58
60.0	0.36	0.37	0.66
63.0	0.27	0.41	0.74
66.0	0.30	0.36	0.74
69.0	0.32	0.35	0.46
71.5	wet edge		
75.5	Hub 3 (L.B.)		

(Continued)

TABLE H2.15 (Continued)

Water Temp. (Not Recorded)
Q = 14.0 m^3/s

Transect 4			
Distance from Hub 4 (m)	Nose Point Vel. (m/s)	Avg. Vel. (m/s)	Depth (m)
3.0	wet edge (thick ice)		
5.2	Edge of ice		
6.0	-	0.04	0.11
9.0	0.05	0.04	0.26
12.0	0	0	0.25
14.5	wet edge gravel bar 30 - 40 cm of ice on bar		
23.0	wet edge of gravel bar		
24.0	Iced over to 25 m		
27.0	-	0	0.08
30.0	-	0.14	0.80
33.0	0.28	0.27	0.20
36.0	0.37	0.33	0.28
39.0	0.39	0.40	0.32
42.0	0.46	0.45	0.36
45.0	0.38	0.46	0.48
48.0	0.35	0.44	0.54
51.0	0.45	0.52	0.56
54.0	0.46	0.51	0.60
57.0	0.39	0.57	0.58
60.0	0.43	0.54	0.55
63.0	0.50	0.57	0.58
66.0	0.28	0.54	0.80
69.0	0.33	0.48	0.75
72.0	0.19	0.20	0.40
75.0	wet edge		
79.0	Hub 4 (L.B.)		

1 Area from 11 m to 15 m under 20 cm of ice
Est. (from holes). Water vel. = 0
x Depth = 0.15 m

2 Area from 7 m to 13 m under thick ice
Est. (from holes)

APPENDIX H3

Summary of Pink Salmon Redd Measurements in the Morice River, 1981

TABLE H3.1
Measurements of Physical Characteristics of Pink Salmon
Spawning Sites in the Morice River, September 3 to September 9, 1981

Side Channel Area 1 - Sept. 3, 1981

Transect No.	Redd No.	Distance from Transect Line (m)	Distance from Hub at Right Bank (m)	Width (m)	Length (m)	Redd Area (m^2)	Nose Point Velocity 12 cm above substrate (m/s)			Depth (m)		
							Left	Right	Mean	Left	Right	Mean
3	1	1 u/s	40	1.5	1.5	2.3	0.25	0.32	0.29	1.08	1.10	1.09
	2	3 d/s	40.5	1.5	1.8	2.8	0.29	0.40	0.34	1.14	0.98	1.06
	3	on line	34	1.25	1.3	1.6	0.27	0.40	0.34	1.10	1.01	1.06
	4	on line	29.5	1.0	1.0	1.0	0.41	0.43	0.42	1.12	1.07	1.10
	5	0.5 u/s	23	1.3	1.3	1.7	0.30	0.40	0.35	1.04	1.00	1.02
	6	0.5 d/s	20	0.9	1.0	0.9	0.32	0.27	0.30	0.96	0.93	0.95
4	7	1 d/s	38	1.0	1.0	1.0	0.37	0.31	0.39	1.07	1.07	1.07
	8	1.5 u/s	30	1.4	1.4	2.0	0.31	0.35	0.33	1.06	1.03	1.05
	9	0.5 u/s	28	1.4	1.4	2.0	0.39	0.40	0.40	0.97	1.04	1.01
	10	1 d/s	23	1.1	1.5	1.7	0.37	0.35	0.36	1.0	0.99	1.0
	11	0.5 u/s	18	1.5	1.5	2.3	0.32	0.36	0.34	0.95	0.90	0.93
	12	2 u/s	14	1.0	1.5	1.5	0.30	0.28	0.29	0.74	0.72	0.73
5	13	on line	36.5	1.2	1.4	1.7	0.22	0.36	0.29	1.33	1.21	1.27
	14	1 d/s	34	1.15	1.2	1.4	0.37	0.31	0.34	1.17	1.12	1.15
	15	2.5 u/s	30	1.15	1.5	1.7	0.38	0.47	0.43	1.00	0.97	0.99
	16	1 d/s	24	1.10	1.10	1.2	0.40	0.44	0.42	0.82	0.82	0.82
	17	on line	19	1.3	1.0	1.3	0.35	0.32	0.34	0.77	0.69	0.73
	18	on line	27	1.0	1.0	1.0	0.37	0.51	0.44	0.91	0.90	0.91
6	19	1 d/s	35.5	1.10	1.10	1.2	0.45	0.34	0.40	1.13	1.13	1.13
	20	on line	39	1.10	1.10	1.2	0.36	0.37	0.37	1.23	1.16	1.20
	21	1.5 d/s	31.5	1.10	1.10	1.2	0.39	0.48	0.44	0.93	0.90	0.92
	22	3.5 d/s	30.5	1.25	1.25	1.6	0.41	0.40	0.41	0.84	0.81	0.83
	23	2 u/s	18	0.8	1.0	0.8	0.28	0.33	0.31	0.54	0.52	0.53
	24	0.5 d/s	24	0.9	0.9	0.8	0.37	0.35	0.36	0.75	0.73	0.74
7	25	0.5 d/s	42.5	0.9	1.10	1.0	0.27	0.43	0.35	1.23	1.28	1.26
	26	on line	39.5	0.9	0.9	0.8	0.35	0.45	0.40	1.06	1.00	1.03
	27	on line	33.5	0.9	0.8	0.7	0.52	0.47	0.50	0.79	0.69	0.74
	28	0.5 d/s	28.5	1.0	1.0	1.0	0.51	0.49	0.50	0.69	0.61	0.65
	29	2.5 d/s	28.5	1.0	1.20	1.2	0.42	0.42	0.42	0.67	0.61	0.64
	30	1.5 u/s	25	1.10	1.10	1.2	0.42	0.36	0.39	0.60	0.63	0.62
Mean						1.4			0.37			0.94
Standard Deviation						0.5			0.06			0.20

TABLE H3.2
Measurements of Physical Characteristics of Pink Salmon Spawning Sites in the Morice River, September 3 to September 9, 1981

Side Channel Area 2 - September 5 - 6, 1981

Transect No.	Redd No.	Distance from Transect Line (m)	Distance from Hub at Right Bank (m)	Width (m)	Length (m)	Redd Area (m^2)	Nose Point Velocity 12 cm above substrate (m/s)			Depth (m)		
							Left	Right	Mean	Left	Right	Mean
3	1	on line	19.5	1.1	1.3	1.4	0.25	0.25	0.25	0.72	0.70	0.71
	2	1.5 u/s	15.5	1.1	1.2	1.3	0.25	0.29	0.27	0.85	0.79	0.89
	3	on line	11.5	1.0	1.0	1.0	0.36	0.37		0.85	0.84	0.85
4	4	on line	10.0	1.5	1.6	2.4	0.35	0.33	0.34	0.56	0.56	0.56
	5	0.5 u/s	15.0	1.0	2.0	2.0	0.35	0.38	0.37	0.56	0.56	0.56
	6	on line	19.0	1.3	1.5	2.0	0.48	0.39	0.40	0.48	0.58	0.53
	7	on line	27.0	1.0	1.5	1.5	0.35	0.30	0.33	0.36	0.40	0.38
5	8	1.5 d/s	10.0	1.1	1.2	1.3	0.52	0.47	0.50	0.40	0.45	0.43
	9	0.5 d/s	14.5	1.0	1.0	1.0	0.46	0.47	0.47	0.47	0.49	0.48
	10	2 u/s	20.0	1.1	1.1	1.2	0.52	0.38	0.45	0.39	0.48	0.44
	11	2 u/s	24.0	1.0	1.2	1.2	0.48	0.47	0.48	0.23	0.28	0.26
6	12	2.5 u/s	10.0	1.8	2.0	3.6	0.47	0.48	0.48	0.38	0.34	0.36
	13	1.5 u/s	15.5	1.2	1.7	2.0	0.48	0.47	0.48	0.44	0.40	0.42
	14	0.5 u/s	21.5	1.0	1.0	1.0	0.56	0.59	0.58	0.30	0.36	0.33
	15	0.5 u/s	26.5	1.0	1.3	1.3	0.51	0.49	0.50	0.24	0.28	0.26
7	16	0.5 u/s	18.0	1.0	1.1	1.1	0.53	0.68	0.61	0.23	0.23	0.23
	17	2.5 u/s	16.5	1.0	1.1	1.1	0.69	0.75	0.72	0.25	0.20	0.23
	18	0.5 u/s	18.0	0.8	1.1	0.9	0.53	0.68	0.61	0.23	0.23	0.23
8	19	2 u/s	25.5	1.5	1.5	2.3	0.80	1.00	0.90	0.23	0.25	0.24
	20	1.5 u/s	26.5	1.4	1.4	2.0	0.34	0.46	0.40	0.26	0.16	0.21
	21	2 u/s	37	1.2	1.2	1.4	0.24	0.25	0.25	0.31	0.30	0.31
9	22	1.5 u/s	17.5	0.7	1.0	0.7	0.44	0.38	0.41	0.30	0.22	0.26
	23	on line	30.5	0.7	1.0	0.7	0.60	0.70	0.65	0.26	0.26	0.26
	24	1.2 u/s	36	1.0	1.0	1.0	0.68	0.60	0.64	0.30	0.34	0.32
10	25	0.5 u/s	36.5	0.7	1.0	0.7	0.40	0.45	0.43	0.24	0.24	0.24
	26	1 u/s	31.0	1.2	1.2	1.4	0.57	0.56	0.57	0.34	0.40	0.38
	27	3 u/s	17.0	1.3	1.5	2.0	0.67	0.65	0.66	0.50	0.38	0.44
11	28	2 u/s	24.0	0.8	1.0	0.8	0.98	0.90	0.94	0.38	0.40	0.39
	29	on line	28.0	1.0	1.2	1.2	0.82	0.78	0.80	0.44	0.46	0.45
	30	on line	31	1.0	1.5	1.5	0.57	0.41	0.46	0.36	0.48	0.42
Mean						1.4			0.51			0.40
Standard Deviation						0.6			0.18			0.20

TABLE H3.3
Measurements of Physical Characteristics of Pink Salmon Spawning Sites in the Morice River, September 3 to September 9, 1981

Side Channel Area 3A - September 7, 1981

Transect No.	Redd No.	Distance from Transect Line (m)	Distance from Hub at Right Bank (m)	Width (m)	Length (m)	Redd Area (m^2)	Nose Point Velocity 12 cm above substrate (cm/s)			Depth (m)		
							Left	Right	Mean	Left	Right	Mean
1A	1	2 d/s	13.5	1.25	1.25	1.7	19	20	19.5	0.81	0.81	0.83
	2	2 d/s	16	1.0	1.0	1.0	21	15	18	0.88	0.90	0.89
	3	5 d/s	40	2.0	1.5	3.0	35	22	28.5	0.74	0.74	0.74
2A	4	6 d/s	14	1.0	1.5	1.5	52	48	50	0.50	0.51	0.51
	5	6 d/s	17.5	1.5	2.0	3.0	67	32	49.5	0.46	0.48	0.47
	6	1 d/s	17.0	1.5	2.0	3.0	62	58	60	0.51	0.53	0.52
	7	1.5 d/s	18	1.5	2.0	2.3	46	32	39	0.62	0.64	0.63
	8	4 d/s	20	1.0	1.5	1.5	61	44	52.5	0.52	0.56	0.54
	9	3 u/s	21.5	2.0	1.0	2.0	40	38	39	0.57	0.63	0.60
	10	1 d/s	25	1.25	1.5	1.9	33	32	32.5	0.31	0.32	0.32
	11	1.5 u/s	29.5	1.5	1.0	1.5	25	31	28	0.36	0.44	0.40
3A	12	2.5 u/s	11	2.0	1.5	3.0	54	33	43.5	0.51	0.54	0.53
	13	4 d/s	10.5	2.0	2.0	4.0	38	72	80	0.38	0.41	0.40
	14	2 u/s	20	1.5	1.5	2.3	65	40	52.5	0.46	0.50	0.48
	15	3 u/s	23	1.0	1.25	1.3	40	43	41.5	0.30	0.38	0.34
Mean						2.2			42.3			0.55
Standard Deviation						0.8			16.2			0.17

(Continued)

TABLE H3.3 (Continued)

Side Channel Area 3B - September 8, 1981

Transect No.	Redd No.	Distance from Transect Line (m)	Distance from Hub at Right Bank (m)	Width (m)	Length (m)	Redd Area (m^2)	Nose Point Velocity 12 cm above substrate (cm/s)			Depth (m)		
							Left	Right	Mean	Left	Right	Mean
4B	16	1.5 u/s	10.5	1.25	1.5	1.9	75	80	77.5	0.70	0.64	0.67
	17	on line	10.5	1.0	1.0	1.0	62	80	71	0.66	0.60	0.63
	18	1.5 u/s	14	1.0	1.5	1.5	60	75	67.5	0.46	0.54	0.50
	19	on line	12.5	1.7	1.5	2.6	80	62	71	0.58	0.66	0.62
	20	2.5 d/s	16	1.0	1.25	1.3	52	51	51.5	0.36	0.40	0.38
5B	21	6.5 u/s	6	1.0	1.5	1.5	49	52	50.5	0.52	0.48	0.50
	22	6.5 u/s	5	1.0	1.3	1.3	63	35	49	0.52	0.62	0.57
	23	4 u/s	4.5	1.0	1.2	1.2	41	10	25.5	0.82	0.84	0.83
	24	1 d/s	10	1.3	1.4	1.8	17	38	27.5	0.58	0.63	0.61
	25	5.5 d/s	7	1.0	1.5	1.5	48	45	46.5	0.60	0.44	0.52
6B	26	4 d/s	20	0.8	1.5	1.2	82	75	78.5	0.20	0.22	0.21
	27	2 u/s	19	1.5	1.5	2.3	38	48	43	0.36	0.26	0.31
	28	1 u/s	11.5	1.5	2.0	3.0	76	30	78	0.45	0.50	0.48
	29	4.5 u/s	6	1.0	1.0	1.0	73	68	70.5	0.38	0.35	0.37
	30	4 d/s	7	1.0	1.0	1.0	100	100	100	0.32	0.30	0.31
Mean						1.6			60.5			0.50
Standard Deviation						0.6			20.7			0.16

TABLE H3.4
Measurements of Physical Characteristics of Pink Salmon Spawning Sites in the Morice River, September 3 to September 9, 1981

Mainstem Area 4 - September 9, 1981

Transect No.	Redd No.	Distance from Transect Line (m)	Distance from Hub at Right Bank (m)	Width (m)	Length (m)	Redd Area (m^2)	Nose Point Velocity 12 cm above substrate (cm/s)			Depth (m)		
							Left	Right	Mean	Left	Right	Mean
1	1	12 d/s	5	1.0	1.0	1.0	30	22	26	0.79	0.75	0.77
	2	8 d/s	10.5	1.1	1.1	1.2	50	42	46	0.88	0.94	0.91
	3	6 d/s	8.5	1.4	1.3	1.8	55	42	48.5	1.03	1.05	1.04
	4	0.5 u/s	19	1.0	1.0	1.0	95	60	77.5	1.25	1.25	1.25
	5	2.5 d/s	15	0.9	1.0	0.9	52	65	58.5	1.02	0.95	0.99
	6	on line	12	0.8	0.9	0.7	45	50	47.5	1.0	1.02	1.01
2	7	2 d/s	8.0	1.0	1.0	1.0	37	39	38	0.81	0.77	0.79
	8	3 u/s	8.5	1.0	1.0	1.0	50	48	49	0.69	0.49	0.59
	9	35 u/s	10.5	1.2	1.0	1.2	54	63	58.5	0.90	0.77	0.84
	10	0.5 d/s	15.0	1.0	1.0	1.0	45	38	41.5	0.86	0.90	0.88
	11	2 d/s	16.5	1.1	1.1	1.2	67	57	62	0.77	0.73	0.75
	12	1.5 d/s	19	0.9	1.1	1.0	70	48	59	0.73	0.74	0.74
	13	3 u/s	19	1.0	1.1	1.1	48	53	50.5	0.79	0.64	0.72
	14	5 d/s	21	0.85	0.90	0.8	46	48	47	0.87	0.93	0.90
	15	5 d/s	19	0.9	1.0	0.9	42	40	41	0.81	0.89	0.85
3	16	2.5 d/s	5	0.9	0.9	0.8	42	35	38.5	1.19	1.09	1.14
	17	6 d/s	7	1.5	1.2	1.8	54	53	53.5	1.23	1.13	1.18
	18	4 d/s	12	1.2	1.1	1.3	49	53	51	1.06	1.0	1.03
	19	2.5 u/s	5.5	0.9	0.9	0.8	52	53	52.5	1.18	1.04	1.11
	20	9 u/s	11	1.0	1.1	1.1	55	59	57	0.89	0.95	0.92
	21	8 u/s	15	0.85	0.85	0.7	61	51	56	0.80	0.79	0.80
	22	2 u/s	65	0.9	0.9	0.8	51	42	46.5	1.0	1.12	1.06
	23	2.5 u/s	13.5	0.9	0.9	0.8	46	45	45.5	0.93	1.0	0.97
	24	3.5 u/s	16.5	1.0	0.9	0.9	55	65	60	0.85	0.83	0.84
4	25	4 d/s	4	0.9	1.0	0.9	60	32	46	0.96	0.85	0.91
	26	on line	7	0.9	1.0	0.9	55	42	48.5	1.02	0.96	0.99
	27	4 u/s	11	1.3	1.0	1.3	57	52	54.5	0.92	1.00	0.96
	28	1.5 d/s	14	0.8	0.9	0.7	60	59	59.5	0.80	0.97	0.89
	29	1 u/s	16	1.1	1.2	1.3	60	45	52.5	0.79	0.77	0.78
	30	8 u/s	12	1.0	1.0	1.0	60	45	52.5	0.78	1.03	0.91
Mean						1.0			50.8			0.92
Standard Deviation						0.3			9.3			0.15

APPENDIX H4

Summary of Water Temperatures and Dissolved Oxygen Levels Measured at Pink Salmon Redd Sites in the Morice River, 1982

TABLE H4.1
Dissolved Oxygen and Temperature Measurements at Pink Salmon Redd Sites
Morice River, 1982

SC 3A

Redd#	Date	Subgravel (30 cm) D.O. (ppm)	Subgravel (30 cm) Temp (°C)	Surface D.O (ppm)	Surface Temp (°C)	Remarks
1	March 30	3.8	4.0	-	-	Good surface flow
2	March 30	6.8	3.5	-	3.0	Good surface flow
5	March 30	4.5	3.8	9.3	1.5	Surface D.O. taken 50 m downstream (below riffle)
10	March 30	0.5	4.5	7.6	3.0	No surface water, ice or snow
13	March 30	7.7	5.0			Very little surface flow.
Site	March 30	4.7	2.0			Located 2m upstream of Transect #3. Area dry.
Mean		4.7	3.8			

SC 1

Redd#	Date*	Subgravel (30 cm) D.O. (ppm)	Subgravel (30 cm) Temp (°C)	Surface D.O (ppm)	Surface Temp (°C)	Remarks
6	April 1/82	8.6	1.0	12.8	1.5	Located in 25-30 cm of surface water
12	April 1/82	7.2	2.0	10.4	1.5	Located at wetted edge
17	April 1/82	7.7	2.0	12.4	1.0	15 cm surface water
18	April 1/82	7.4	1.0	13.6	2.0	
21	April 1/82	6.5	1.0	10.4	1.5	Good surface flow
26	April 1/82	5.5	1.5	10.6	1.5	
29	April 1/82	6.0	2.0			Marginal surface flow
30	April 1/82	5.5	2.0		1.5	Surface dry and covered in ice
Mean		6.3	1.6			

(Continued)

TABLE H4.1 (Continued)

Misc. Comments re D.O. and Temps

Redd #17: Pink fry and dead eggs were found 15-25 cm down at this redd site.

Measurements: In all cases, a metal standpipe with perforations in the lower 10 cm was driven into areas previously identified as pink redds. Upper perforations were 30 cm into the substrate. Standpipes left 30-60 minutes.

O_2 Meter-YSI Mosel 54 A.

APPENDIX H5

Summary of Gravel Sampling in Pink Salmon Redds in the Morice River, 1982

TABLE H5.1
Summary of Sieve Analysis for Gravel Samples
of Pink Salmon Redds in the Morice River, 1982

SC 1 N=20

	Percentage Sediment Retrieved by Each Sieve Size						
	77 mm	25.4 mm	6.30 mm	3.35 mm	0.850 mm	0.106 mm	<0.106 mm
Mean	14.5	33.9	26.2	6.8	10.8	7.6	0.20
Var.	187.1	92.2	32.5	1.7	4.8	6.3	0.01
St. Dev.	13.7	9.6	5.7	1.3	2.2	2.5	0.10
S.E. Mean	3.1	2.2	1.3	0.3	0.5	0.6	0.02
95% C.L.	6.6	4.6	2.7	0.6	1.1	1.2	0.05

SC 2 N=16

	Percentage Sediment Retrieved by Each Sieve Size						
	77 mm	25.4 mm	6.30 mm	3.35 mm	0.850 mm	0.106 mm	<0.106 mm
Mean	6.2	35.7	28.2	7.3	12.3	9.9	0.3
Var.	43.0	64.8	13.3	1.0	7.2	6.7	0.1
St. Dev.	6.6	8.1	3.6	1.0	2.7	2.6	0.2
S.E. Mean	1.6	2.0	0.9	0.3	0.7	0.7	0.1
95% C. L.	3.5	4.3	1.9	0.5	1.4	1.4	0.1

SC 3A N=10

	Percentage Sediment Retrieved by Each Sieve Size						
	77 mm	25.4 mm	6.30 mm	3.35 mm	0.850 mm	0.106 mm	<0.106 mm
Mean	14.8	27.0	29.3	8.2	12.6	7.0	0.4
Var	366.1	109.8	60.9	2.7	14.5	4.5	0.1
St. Dev.	19.1	10.5	7.8	1.7	3.8	2.1	0.3
S.E. Mean	16.1	3.3	2.5	0.5	1.2	0.7	0.1
95% C. L.	13.3	7.3	5.4	1.2	2.7	1.5	0.2

TABLE H5.1 (Continued)

SC 3B N=9

	Percentage Sediment Retrieved by Each Sieve Size						
	77 mm	25.4 mm	6.30 mm	3.35 mm	0.850 mm	0.106 mm	<0.106 mm
Mean	17.0	30.3	30.4	6.5	8.7	6.4	0.8
Var.	254.5	90.2	158.9	4.1	11.3	9.0	0.2
St. Dev.	16.0	9.5	12.6	2.0	3.4	3.0	0.5
S.E. Mean	5.3	3.2	4.2	0.7	1.1	1.0	0.2
95% C. L.	12.3	7.3	9.7	1.6	2.6	2.3	0.4

MC 4 N=13

	Percentage Sediment Retrieved by Each Sieve Size						
	77 mm	25.4 mm	6.30 mm	3.35 mm	0.850 mm	0.106 mm	<0.106 mm
Mean	2.2	39.1	29.1	7.1	11.7	10.0	0.9
Var.	38.1	171.1	60.1	2.7	7.0	12.2	1.7
St. Dev.	6.2	13.1	7.8	1.6	2.7	3.5	1.3
S.E. Mean	0.1	3.6	2.2	0.5	0.7	1.0	0.4
95% C. L.	3.7	8.0	4.7	1.0	1.6	2.1	0.8

APPENDIX H6

Summary of Observations of Pink Salmon Fry Emergence in the Morice River, 1982

TABLE H6.1
Miscellaneous Observations of Pink Fry, 1982

April 1	Pink fry found 15 cm below gravel surface at SC 1 while conducting DO readings.
April 9 & 10	Pink fry found at 5 redd sites during gravel sampling at SC First encountered at approx. 15 cm depth.
April 20 - 28	Pink fry disturbed at 4 redd sites while gravel sampling in SC 3B.
April 28	Pink fry disturbed at surface of redds while gravel sampling at mainstem study site.
April 30	Pink fry obs. in shallows SC 3A
May 1	Pink fry obs. in shallows GS 3
May 1	Large schools of pink fry GS 11
May 2	Pink fry obs. in shallows GS 1
May 3	Large schools of pink fry GS 11
May 4	No large schools of fry at GS 11
May 4	5,000 to 10,000 fry in area downstream of GS 5
May 4	Pink fry obs. at GS 6
May 4	Pink fry obs. in gravel sample pockets at GS 1
May 5	Very few pink fry obs. at GS 11. Schools of pink fry in mainstem side pool areas.
May 5	Some pink fry still present in channel
May 7	Pink fry present in 3 redds in GS 33
May 7	Pink fry obs. in GS 6
May 10	Pink fry obs. in GS 2 and moving downstream in side channel at GS 3
May 10-17	Few pink fry caught on side channel fences and in traps. Most pink redds covered by May 10 to 14.
May 21	No live pink fry observed while gravel sampling SC 2.

Suspect most emergence in 1982 occurred between May 1-15th on the rising water.

GS = Staff Gauge Sites

APPENDIX H7

Relationship Between Discharge and Suitable Pink Salmon Spawning Area in the Morice River, 1981-1982

TABLE H7.1
Relationship Between Flow and Useable Pink Spawning Area at 80% and 100% Range for Depth and Velocity, Morice River, 1981

100% range:	Depth:	0.21 - 1.27 m
100% range:	Velocity:	0.18 - 1.00 m/s
80% range:	Depth:	0.39 - 1.10 m
80% range:	Velocity:	0.30 - 0.79 m/s

SC 1	100% Range		80% Range		
Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area	Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area
0	0	0.0	0	0	0.0
10	0	0.0	10	0	0.0
20	0	0.0	20	0	0.0
30	220	9.1	30	0	0.0
40	441	17.5	40	0	0.0
50	1,159	44.5	50	229	8.8
60	1,811	67.6	60	457	17.0
70	1,863	68.7	70	666	24.6
80	1,914	69.4	80	779	28.2
90	1,964	69.7	90	796	28.3
100	2,030	70.7	100	759	26.4
110	2,106	72.0	110	685	23.4

SC 2	100% Range		80% Range		
Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area	Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area
0	0	0.0	0	0	0.0
10	0	0.0	10	0	0.0
20	0	0.0	20	0	0.0
30	131	2.7	30	0	0.0
40	262	4.5	40	0	0.0
50	744	10.6	50	1	0.0
60	1,227	14.9	60	3	0.0
70	2,605	29.7	70	305	3.4
80	3,830	40.5	80	595	6.3
90	4,903	47.9	90	873	8.5
100	5,554	52.0	100	1,628	15.2
110	6,024	54.7	110	2,589	23.5

TABLE H7.1 (Continued)

SC 3A	100% Range		80% Range		
Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area	Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area
0	0	0.0	0	0	0.0
10	0	0.0	10	0	0.0
20	1	0.1	20	0	0.0
30	15	1.8	30	0	0.0
40	38	4.4	40	0	0.0
50	138	15.1	50	0	0.0
60	238	24.7	60	0	0.0
70	324	31.8	70	69	6.8
80	421	39.1	80	157	14.6
90	532	46.7	90	256	22.4
100	597	49.4	100	326	27.0
110	632	49.2	110	378	29.4

SC 3B	100% Range		80% Range		
Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area	Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area
0	0	0.0	0	0	0.0
10	0	0.0	10	0	0.0
20	17	4.0	20	0	0.0
30	106	19.8	30	0	0.0
40	197	31.5	40	2	0.3
50	304	47.0	50	25	3.9
60	411	61.3	60	48	7.1
70	438	59.6	70	130	17.7
80	464	59.7	80	208	26.8
90	488	61.5	90	281	35.4
100	510	62.9	100	305	37.7
110	529	63.9	110	281	34.0

TABLE H7.1 (Continued)

MC 4

	100% Range		80% Range		
Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area	Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area
0	0	0.0	0	0	0.0
10	2,472	57.7	10	1,024	23.9
20	4,945	57.7	20	2,048	23.9
30	6,334	72.9	30	3,098	35.6
40	7,723	87.7	40	4,148	47.1
50	7,315	82.3	50	3,931	44.2
60	6,832	76.1	60	3,717	41.4
70	5,676	62.8	70	3,544	39.2
80	4,824	53.0	80	3,194	35.1
90	4,277	46.6	90	2,666	29.0
100	3,823	41.3	100	2,199	23.7
110	3,586	38.4	110	1,874	20.0

SC 1, 2, 3A and 3B

	100% Range		80% Range		
Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area	Flow (m^3/s)	Useable Area (m^2)	Percent Useable Area
0	0	0.0	0	0	0.0
10	0	0.0	10	0	0.0
20	19	0.2	20	0	0.0
30	474	5.4	30	0	0.0
40	939	9.5	40	2	0.0
50	2,347	21.0	50	256	2.2
60	3,688	29.5	60	509	4.0
70	5,232	39.5	70	1,172	8.8
80	6,631	47.2	80	1,741	12.3
90	7,889	52.7	90	2,207	14.7
100	8,693	55.8	100	3,020	19.4
110	9,293	57.9	110	3,934	24.5

SECTION I

MORICE LAKE RAINBOW TROUT SPAWNING STUDIES, 1980

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Morice Lake, located in the southwest portion of the Bulkley River drainage (Figure 1.1), supports a locally significant sport fishery. Rainbow trout are the most important sport fish in this lake. A creel census survey conducted from May to October, 1979 indicated that approximately 700 rainbow trout, representing 58% of the total angler catch in Morice Lake, were taken annually (Section A).

Preliminary information collected during 1979 (Section A) suggested that rainbow trout moved between the Nanika River, Morice Lake and the upper Morice River. The Nanika River was the only tributary of Morice Lake which was identified as a spawning location for rainbow trout.

This study was undertaken with the following objectives:

a) To document, through a mark/recapture program, the movement of rainbow trout between spawning areas in the Nanika River and Morice Lake and River; and

b) To examine potential spawning areas not examined in 1979 in the upper Morice River and tributaries of Morice Lake to determine whether rainbow trout spawn in locations other than the Nanika River.

2.0 METHODS

From May 3 to May 19, 1980, a crew of two captured and tagged rainbow trout in Morice Lake at the mouth of the Nanika River and in the upper sections of the Morice River. From May 24 to June 22, rainbow trout were tagged in the Nanika River between Glacier Creek and Nanika Falls, an area previously identified as a rainbow trout spawning area (Section A). Potential spawning sites in other Morice Lake tributaries and the upper Morice River were examined between May 24 and June 19 to determine whether rainbow trout spawn elsewhere in the system.

Rainbow trout were separated visually into spawners and nonspawners, as described in Russell (1974). Spawners included fish in prespawning condition (mature and ripe) and in postspawning condition (kelts), identified by external sexual characteristics such as spawning coloration and changes in body shape. The stage of maturity was distinguished on the basis of these characteristics. Nonspawners comprised immature rainbow which did not display external sexual characteristics. It was assumed that these fish would not spawn in 1980.

Fish were captured both by angling and with 1.3-3.8 cm stretched mesh gillnets (Morice Lake only) which were checked at least hourly. Rainbow trout greater than 25 cm fork length were tagged with a numbered Floy T-bar tag (FT-68) inserted into the flesh immediately below the dorsal fin. Tagging location, date and fork length were recorded and scales were removed for aging and to ensure correct identification of larger rainbow and steelhead trout.

Rainbow trout scales were mounted on microscope slides and age interpretations made using a microfiche viewer. Ages of approximately 25% of the total sample were verified by staff of the B.C. Fish and Wildlife Branch, Smithers.

A reward was offered for tags returned by lake and river sport fishermen. Angling in the Nanika River during the rainbow trout spawning period served as a recapture method for rainbow trout tagged in Morice Lake, thus indicating movements of trout within the systems.

Three Morice Lake tributaries not previously examined for rainbow trout spawning were assessed for the presence of adult spawners. Three other tributaries previously identified as having some potential rainbow spawning habitat (Section A) were examined for adult presence. These latter three tributaries were also electrofished to

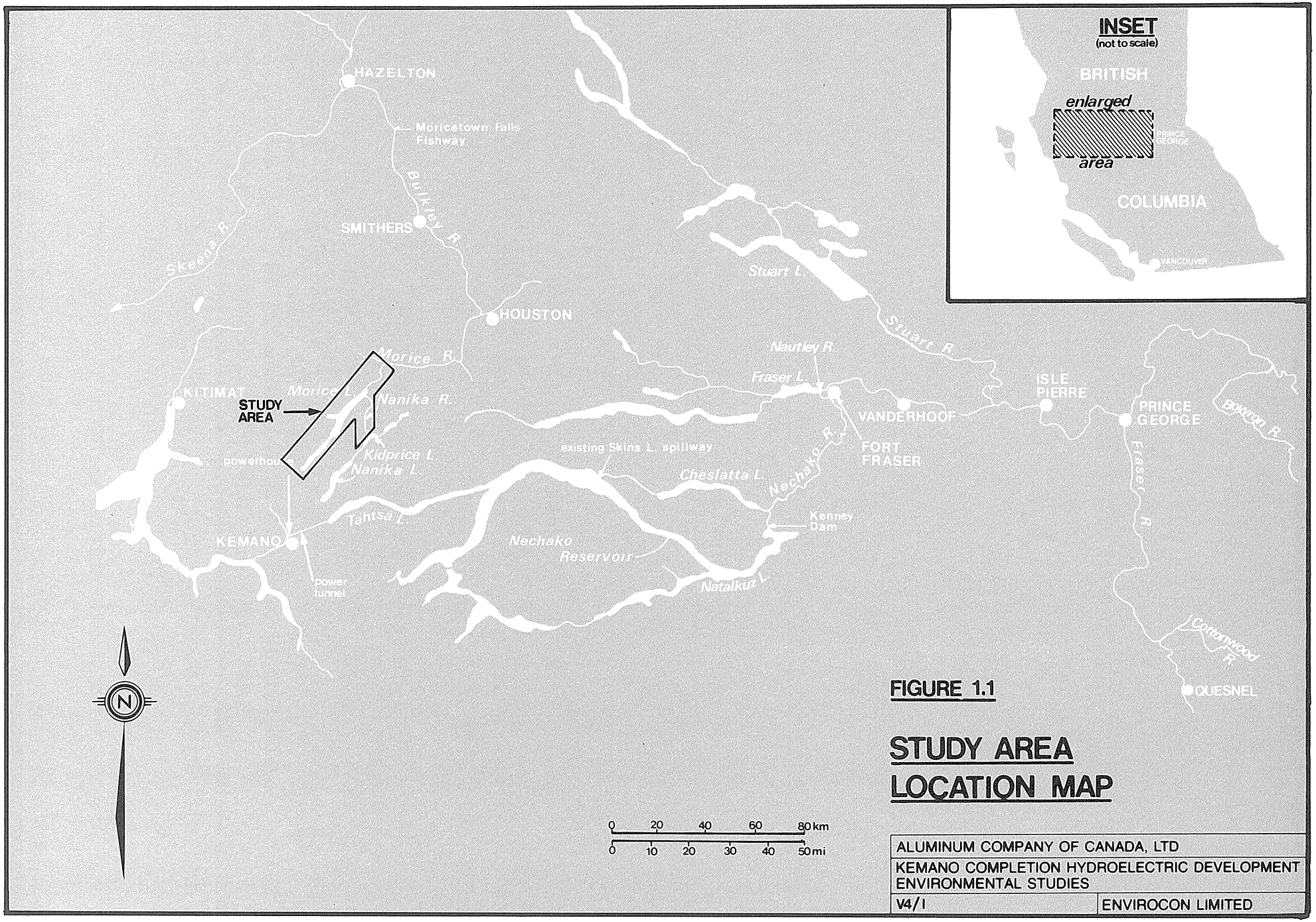

FIGURE 1.1

STUDY AREA LOCATION MAP

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determine whether juvenile rainbow trout were present. Since most Morice Lake tributaries are turbid and have steep gradients, additional efforts to identify rainbow trout spawning areas focused on netting and angling in the vicinity of creek mouths to determine whether ripe fish or kelts were present.

3.0 RESULTS

A total of 148 rainbow trout was tagged and released during the study (Table 3.1). Ten rainbow trout injured during capture were not released, so tagging and captured numbers of fish are not always the same in the following results. Seventeen tags from fish angled in Morice Lake, the upper Morice River and the Nanika River were returned by sport fishermen and four tagged fish were recaptured by tagging crews more than one week after their initial tagging (Table 3.2). The locations of tagging and recapture sites in the study area are shown in Figure 3.1.

3.1 Nanika River Rainbow Trout

From May 24 to June 22, 58 rainbow trout were tagged in the Nanika River upstream of Glacier Creek. Two additional rainbow trout were captured and tagged in the Nanika River prior to May 24. Of the total fish tagged in the Nanika River, 75% (45) were spawners (including six kelts) and 25% (15) were non-spawners (Table 3.1). Four of the spawners, all ripe at the time of tagging, were subsequently captured by anglers in Morice Lake from three weeks to four months later (Table 3.2). These tag returns demonstrate that fish spawning in the Nanika River are from Morice Lake.

Field observations of spawning activity, in addition to the capture of ripe individuals, indicated Sites N7 and N5 (Figure 3.1) were the main rainbow trout spawning locations in the lower Nanika River. These two sites are referred to as Areas A and B in Section A. Of the 38 ripe fish captured in the Nanika River, 15 were angled at Site N7 and 16 were angled at Site N5. Small areas of potential spawning gravels exist at Sites N8 and N3, but no spawning activity was observed. Visibility was restricted by high discharges from snowmelt during May and June, so it was not possible to estimate numbers of spawners.

Based on a small number of observations and the capture of ripe fish and kelts, in 1980 most rainbow trout spawned from mid-May to the end of the third week of June. This is similar to the estimated timing for 1979 spawners (Volume 3 of this report series). However, if it is assumed that the catchability of spawners did not change with maturity, and that the catch per unit effort (CPUE) of spawners was indicative of spawner abundance, then, based on angling catches, the peak spawner abundance occurred approximately 3 weeks earlier in 1980 than in 1979 as shown below:

TABLE 3.1
Summary of Rainbow Trout Tagged and Released in the Nanika River and Morice Lake and River, 1980

Location	Tagging Period	Rainbow Trout		
		Spawners	Non-Spawners	Total
Morice Lake	May 2-19	2[1]	14	16
Morice Lake	May 24-June 19	2[2]	51	53
Nanika River	May 24-June 22	45[3]	15	60
Morice River	May 2-19	4[4]	5	9
Morice River	May 24-June 19	-	10	10
		53	95	148

1 These two fish were captured at the mouth of the Nanika River

2 Includes one kelt captured at the mouth of the Nanika River and one ripe fish captured near Redslide Creek in Morice Lake

3 Includes six kelts as well as two ripe fish captured prior to May 24 in the Nanika River

4 These four fish were captured in the Morice Lake outlet. They were slightly coloured but not ripe

TABLE 3.2
Summary of Tagging and Recapture of Rainbow Trout from Morice Lake, Morice River and the Nanika River, 1980[1]

Morice Lake

Tagging Site		Recapture Site		Tag Number
Date[2]	Location[3]	Date	Location	
06/15/79	M16	05/15	M16	255
05/12	M15	06	Morice Lake	952
05/16	M17	06/14	M23	608
05/16	M17	07/18	Morice Lake	609
05/29	M17	07/3	M17	653
05/30	M18	06/16[4]	M17	677
06/4	M17	Early July	M17	708
06/4	M17	06/12	M17	709
06/4	M17	07/27	M1	724
06/9	M17	06/14	M17	738
06/12	M15	Early June	M23	755

Morice River

Tagging Site		Recapture Site		Tag Number
Date	Location	Date	Location	
05/6	M1	Late July	M15	521
05/19	M1	07/27	M1	968
05/31	M3	08/6	M20	680
06/18	M4	07/28	M4	748

Nanika River

Tagging Site		Recapture Site		Tag Number
Date	Location	Date	Location	
05/24	N7	06/17[4]	N7	977
05/24	N5	06/18[4]	N7	985
05/24	N5	06/29	M16	986
05/28	N7	06/22	M16	1479
06/6	N5	Late Sept.	M20	1494
06/15	N7	10/17	Morice Lake	1444

1 Includes 1 fish tagged in 1979. Fish recaptured within one week by tagging crew are excluded. In some instances, recapture dates and locations are not specific depending on sport angler return information

2 Unless otherwise stated all dates are for 1980

3 Refer to Figure 3.1

4 Recaptured by tagging crew at least one week after initial tagging

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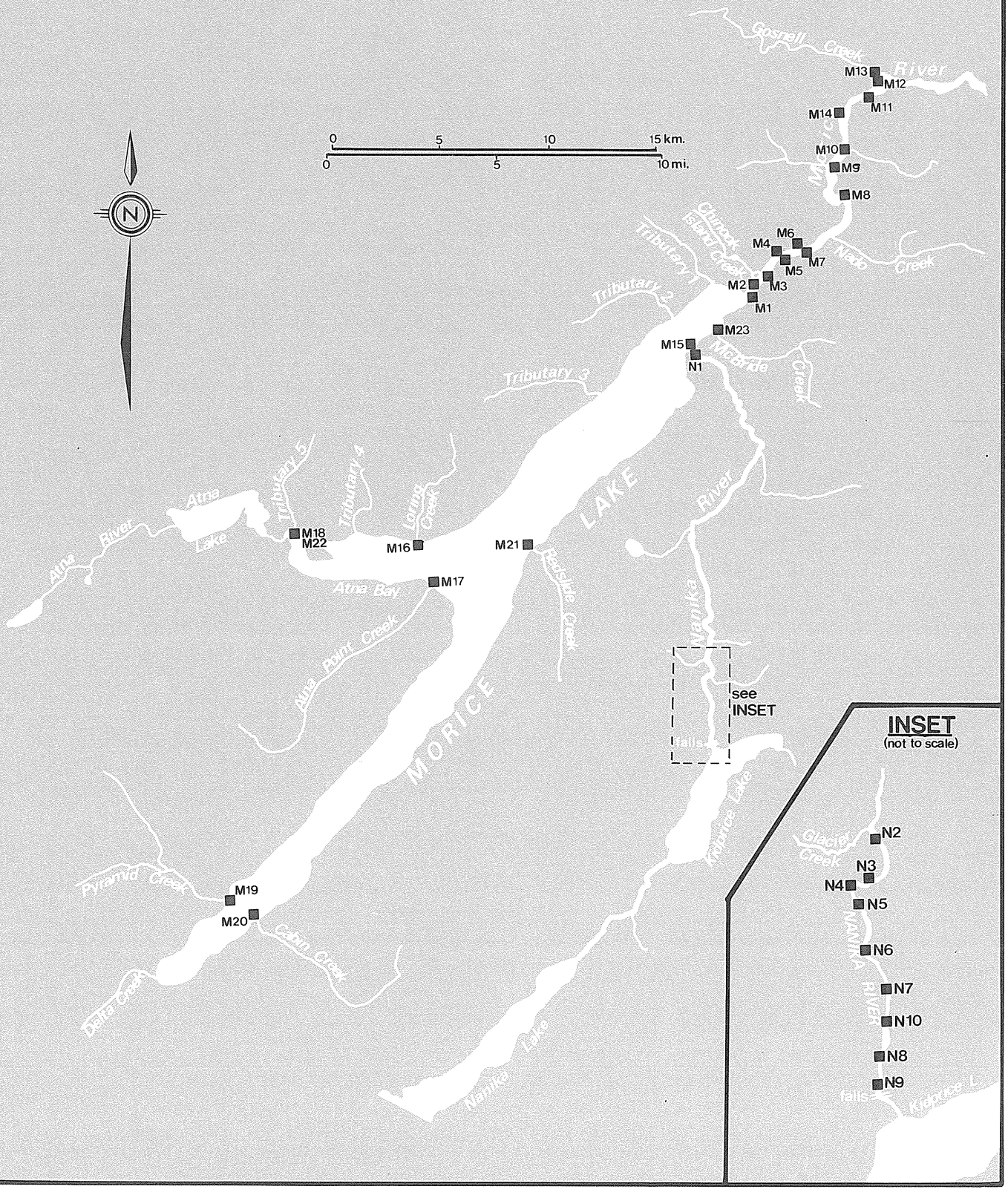
FIGURE 3.1 : LOCATION OF TAGGING SITES IN MORICE RIVER, MORICE LAKE AND NANIKA RIVER, 1980



CPUE (Fish/Angler-day) of Rainbow Trout Spawners in the Nanika River

	May 24-27	May 28-31	June 1-6	June 7-11	June 12-15	June 16-19	June 20-22
1979	0.5	0.5	NS[1]	NS[1]	2-3	5.5	NS[1]
1980	3.0	2.0	1.8	1.5	1.8	0.5	0.3

1 Not Sampled

During 1980, some rainbow kelts were captured from May 26 to June 2, although most were captured after the first week of June. Several kelts were captured at the mouth of the Nanika River in late May and early June, indicating that some spawners had returned to Morice Lake by this time.

Water temperatures in the Nanika River during the spawning period varied from 5.0°C on May 24 to 9.5°C on June 20. Discharges during this period were average compared to other years and ranged from 55 to 100m^3/sec, peaking in mid-June.

Length and age data for rainbow trout angled in the Nanika River are summarized in Table 3.3. The non-spawners were generally smaller than spawners and ranged from 30 to 40 cm fork length ($\bar{x}$ = 34.1 cm). Fish in spawning condition or kelts ranged from 36 to 57 cm fork length ($\bar{x}$ = 46.7 cm) and were from 6 to 11 years in age. Many of the rainbow trout scales showed a characteristic pattern of narrow spacing of circuli up to three or four years followed by more rapid annual growth. Narver (1975) observed a similar pattern for Babine Lake rainbow and suggests that the initial slow growth occurs while the fish are stream residents. Lake residence is characterized by more rapid growth.

3.2 Morice Lake Rainbow Trout

From May 3 to May 19, 25 rainbow trout were captured for tagging in Morice Lake and the upper Morice River. Six of these fish were in pre-spawning condition (i.e., they were beginning to develop spawning colouration but were not ripe). Since these rainbow trout were not ripe and were captured prior to the main spawning period, the locations of capture was not necessarily indicative of spawning locations.

TABLE 3.3
Summary of Length and Age Data for Rainbow Trout Angled and Gill Netted in the Nanika River and Morice Lake and River, 1980

Nanika River

Age	Sample Size	Percent of Total (%)	Mean Length (cm)	Standard Deviation
5	4	7.1	32.5	1.7
6	15	26.8	38.1	5.3
7	13	23.2	43.4	3.5
8	14	25.0	46.0	6.2
9	7	12.5	51.4	3.5
10	2	3.6	50.5	0
11	1	1.8	54.0	-
	56		43.3	

Morice Lake and River

Age	Sample Size	Percent of Total (%)	Mean Length (cm)	Standard Deviation
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
	93		37.8	

Of the 25 tagged fish released during this period, five were recaptured by anglers (Table 3.2). One fish (#521) tagged in the upper Morice River was recaptured in Morice Lake at the mouth of the Nanika River, further demonstrating a movement between the upper Morice River and Morice Lake. None of the 25 tagged rainbows were recaptured in the Nanika River, so a movement of rainbow trout from Morice Lake into the Nanika River spawning area was not demonstrated by these fish.

During the period May 24 to June 19, 63 rainbow trout were tagged in Morice Lake and the upper Morice River (Table 3.1). Sixty-one of these fish were nonspawners. One ripe spawner was captured near Redslide Creek in Morice Lake on June 16 and a single kelt was captured at the mouth of the Nanika River on the same date.

Eight of the 63 tagged rainbow trout were subsequently recaptured by anglers in Morice Lake, and one was recaptured by the tagging crew (Table 3.2). Most recaptured fish were caught near their tagging sites. However, one fish (#724) tagged in Atna Bay was captured in the upper Morice River, and a second fish (#680) tagged in the upper Morice River was recaptured in the south end of Morice Lake, demonstrating that rainbow trout move between the upper Morice River and Morice Lake and make substantial movements within Morice Lake. A rainbow trout tagged on June 15, 1979 was recaptured at the same location in Atna Bay on May 16, 1980.

Length and age data for rainbow trout angled in Morice Lake and the upper Morice River are summarized in Table 3.3. Rainbow trout ranged from 18 to 50 cm fork length ($\bar{x}$ = 37.8 cm). Approximately 30% of the rainbow angled during the study exceeded 40 cm fork length, the minimum size of most (95%) spawners in the Nanika River.

3.3 Morice Lake Tributary Surveys

The tributaries of Atna Bay and Cabin Creek (Figure 3.1), previously recognized as possible rainbow trout spawning systems (Section A), were re-examined in 1980. No spawners were observed and no juvenile rainbow trout were captured by electrofishing in any of the systems (Table 3.4). Examination of three tributaries on the northwest side of Morice Lake (Figure 3.2), not examined during June, 1979, indicated that low water temperatures (3 to 4°C), steep gradients with predominantly boulder substrate, and barriers just upstream from Morice Lake would limit the use of these tributaries by rainbow trout.

TABLE 3.4
Summary of Data on Morice Lake Tributaries on June 2 and 3, 1980[1]

Tributary	Date	Water Temperature (°C)	Discharge Estimate (m^3/sec)	Turbidity	Comments
Tributary 1	June 2	4	0.1	moderate	A flashy high gradient stream with no spawning potential and barrier 100 m upstream of Morice Lake
Tributary 2	June 2	3.5	0.1	clear	A flashy high gradient stream predominantly boulder substrate with no spawning potential
Tributary 3	June 2	3.5	0.1	clear	High gradient system with no spawning potential.
Tributary 4 (Atna Bay)	June 2	8.5	0.1	slightly tannic	Stable stream with some spawning gravel. Electrofishing 115 m^2 resulted in capture of 8 juvenile coho and 1 prickly sculpin.
Tributary 5 (Atna Bay)	June 2	10.0	0.1	slightly tannic	Electrofishing 150 m^2 resulted in capture of 1 juvenile coho and 7 prickly sculpin.
Cabin Creek	June 3	6.0	0.4	clear	Electrofishing 70 m^2 resulted in the capture of 1 juvenile Dolly Varden

1 For additional information describing Morice Lake tributaries, see Section A

4.0 DISCUSSION

Rainbow trout tagged while on spawning grounds in the Nanika River were recaptured in Morice Lake, further documenting the movement of rainbow trout between the two systems. This information, in addition to the documented movement of tagged rainbow trout between the upper Morice River and Morice Lake, suggests that rainbow trout in the Nanika River, Morice Lake and Morice River constitute a single spawning stock.

During 1979, three rainbow trout tagged in the Nanika River were subsequently recaptured by anglers in the Morice River. New regulations introduced in 1980 restricting angling in the upper Morice River after August 1 probably account for the low number of tag returns from the Morice River in 1980.

Most (75%) rainbow trout angled in the Nanika River between Glacier Creek and Nanika Falls were either spawners or kelts. Despite angling and gillnetting efforts in Morice Lake and the upper Morice River, only a single ripe fish was captured. Additional gill net surveys conducted by the B.C. Fish and Wildlife Branch from May 27 to 30, 1980 (on file, B.C. Fish and Wildlife Branch, Smithers) indicated that, of 17 rainbow trout captured in Morice Lake, 15 were nonspawners, and two were spawners including a kelt captured at the mouth of the Nanika River. The results of these two studies suggest that few spawners were present in Morice Lake from late May to mid-June.

Studies of rainbow trout in Loon Lake, British Columbia indicated that outlet spawning populations of rainbow trout entered the outlet stream three to five weeks earlier and at lower water temperatures than inlet spawning populations (Hartman et al. 1962). If rainbow trout were spawning in the Morice Lake outlet (Morice River), then one would expect that ripe rainbow trout and possibly kelts would have been captured during the early May surveys. The capture of 27 steelhead spawners, but no ripe rainbow trout during 128 hours of angling between May 4 and June 5, 1980, suggests that the sampling effort was sufficient to capture some rainbow spawners if significant numbers had been present in the upper Morice River at this time.

Few tributaries of Morice Lake provide suitable physical conditions for rainbow trout spawning since they tend to be steep gradient, turbid and cold for much of the summer (Section A). No juvenile rainbow trout were found during 1980 electrofishing surveys in three tributaries with potentially suitable spawning conditions. Although much of

the netting and angling effort in Morice Lake was at the mouth of tributaries, other than at the Nanika River inlet to Morice Lake, only one ripe fish and no kelts were captured. This suggests that the gravel fans at tributary mouths were not used to any extent by rainbow spawners, and provides further evidence of the relative unimportance of tributaries other than the Nanika River for rainbow trout spawning. Studies in the Atna River and Atna Lake during 1980 indicate rainbow trout are absent from this system (Section K).

The low numbers of rainbow trout captured during this study suggest that rainbow trout are not abundant in Morice Lake. Tagging operations in the Nanika River were hampered by spring run-off which created poor angling conditions during much of the tagging period and this may partially account for the low number of fish tagged. The 0.5 fish/day catch reported for rainbow trout in Morice Lake (Section A) is only 10% of the angler CPUE reported for Loon Lake, British Columbia (Tautz and Peterson 1977), suggesting that Morice Lake is not a productive rainbow trout lake on a provincial scale.

Morice Lake anglers recaptured 16 of 128 tagged rainbow trout for a tag return of 12.5%, excluding immature fish tagged in the upper Morice River and the Nanika River since they may remain in the river system for the season. Assuming the 1980 angler catch was similar to the 1979 catch of approximately 700 rainbow trout (Section A), a crude estimate of the Morice Lake rainbow trout population greater than 25 cm fork length would be 5,600 fish. For harvests of 500 and 900 rainbow trout, the Morice Lake population would be estimated at 4,000 and 7,200 fish, respectively. These estimates assume no mortality of tagged fish during the season. Since rainbow trout spawning mortalities may be significant (Hartman et al. 1962), this assumption tends to overestimate the population.

These estimates are quite crude due to non-random sampling in terms of location, lack of harvest data for 1980, the low number of marked fish and assumption that all tags were returned from captured fish, in addition to assuming no mortality as discussed previously. Despite these limitations, the estimates are useful in that they provide at least a rough scale of the overall rainbow trout population in Morice Lake.

5.0 SUMMARY

Results from the recapture of marked rainbow trout during 1980 concur with the preliminary results of 1979 tagging, and suggest that there is a movement of rainbow trout between the upper Morice River, Morice Lake and the Nanika River. Although no rainbow trout marked in Morice Lake were recaptured in the Nanika River, rainbow trout spawners tagged in the Nanika River were recaptured by anglers in Morice Lake, suggesting that the Nanika River is the principal spawning area for Morice Lake rainbow trout. There was little evidence of rainbow trout spawning elsewhere in the system.

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SECTION J

DISTRIBUTION AND ABUNDANCE OF JUVENILE SALMONIDS IN THE MORICE/BULKLEY RIVER SYSTEM DURING OCTOBER 1982

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Previous distribution and abundance studies on the Morice/Bulkley River system demonstrated differences in the habitat preferences of juvenile salmonids (Sections A and B). Side channels in Reach 2 of the upper system were important for overwintering juvenile coho salmon and steelhead trout fry, while mainstem areas of Reaches 2 and 5 were important for overwintering steelhead fry and parr and juvenile chinook salmon.

This study was conducted during October of 1982 to supplement data collected in the fall/early winter of 1979 and 1981, and to provide some index of the year-to-year variability in the distribution and abundance of juvenile salmonids in the Morice/Bulkley River system.

2.0 METHODS

The 1982 sampling was conducted in October at 28 main channel and 4 side channel sites in Reaches 1-6 of the Morice/Bulkley Rivers from Morice Lake to Smithers (Figure 2.1). An effort was made to locate all sample sites in the same areas used in the 1981 study (Section B), but higher discharge levels and some channel changes during 1982 resulted in some differences in sample site location. Additional mainstem areas were included in this study to increase both its representation and the total area sampled. Many deep, complex sites along the mainstem such as fast runs and log jam habitat could not be sampled effectively.

Reach 2 was sampled at more sites than other reaches since it contains the greatest range of habitat types and is an important rearing area. Three of four representative side channels selected in 1981 (A, C and D) were re-sampled in this study. Access to Side Channel B was precluded by high flows in 1982 and Side Channel E was selected as a replacement.

Both mainstem and side channel areas were sampled by electrofishing (Figure 2.1; Appendix J1). Stop nets were used to minimize the movement of fish out of the area during sampling. Mainstem sites, extending to the estimated edge of useable juvenile habitat, were enclosed with a 30 m seine held in place by reinforcing bar positioned two hours prior to sampling. The multiple-pass removal method (Delury 1951) with a minimum of three passes was used to estimate mainstem populations, and the Peterson mark and recapture method (Ricker 1975) was used to estimate side channel populations (Appendix J2). Juvenile salmonids initially captured in side channels were marked with a caudal-lobe fin clip and released within the sample area. A second sample was taken after a minimum two-hour period with an effort to obtain a similar sample size. Channel length and width measurements were made at each site. Mainstem catches were expressed as fish/m^2 of habitat and as fish per length of margin. As side channel sampling was conducted only in Reach 2, population estimates in side channels of the other reaches were extrapolated based on abundance studies during September 1979 (Section A). For example, in 1979 the ratio of steelhead trout fry estimates in Reach 1 side channels to estimates in Reach 2 side channels was 2.51:1. This ratio was then applied to the 1982 population estimate for Reach 2 side channels (2.51 x 467 fish/km) to account for fry distribution in Reach 1 side channels.

Each mainstem and side channel site was sampled once. All fish collected were anaesthetized with 2-phenoxyethanol, and fork lengths to the nearest millimeter were measured. Scales for aging were removed from a sample of 37 steelhead parr (greater

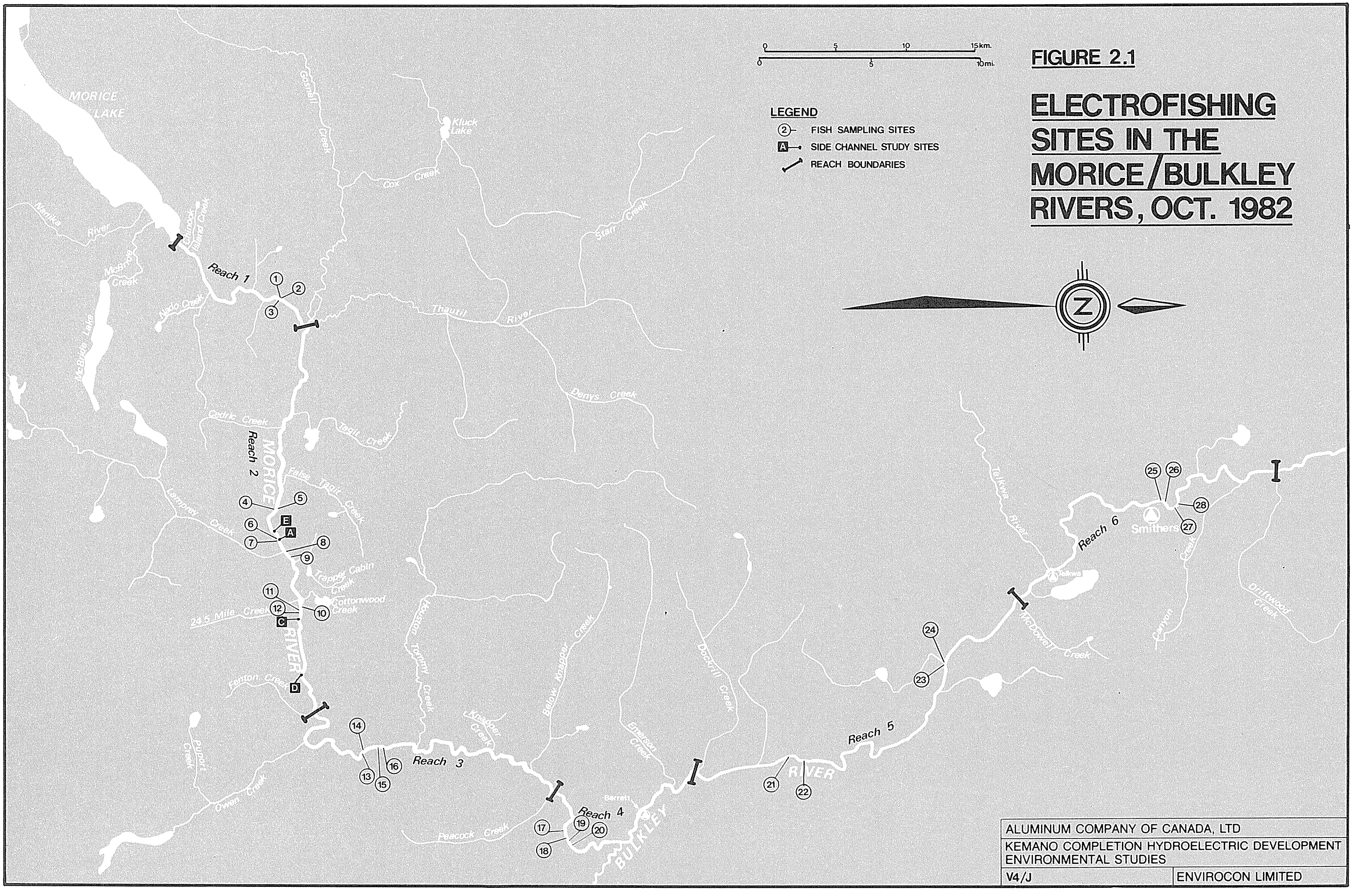
FIGURE 2.1
ELECTROFISHING SITES IN THE MORICE/BULKLEY RIVERS, OCT. 1982
LEGEND
FISH SAMPLING SITES
SIDE CHANNEL STUDY SITES
REACH BOUNDARIES
0 5 10 15km.
0 5 10mi.
MORICE LAKE
MORICE
RIVER
BULKLEY
RIVER
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Nanika River
McBride Lake
Gosnell Creek
Kluck Lake
Cox Creek
Starr Creek
Thautil River
Denys Creek
Cedric Creek
Tagit Creek
False Tagit Creek
Lamprey Creek
Trapper Cabin Creek
Cottonwood Creek
24.5 Mile Creek
Fenton Creek
Puport Creek
Owen Creek
Houston Tommy Creek
Below Knapper Creek
Knapper Creek
Peacock Creek
Barrett
Emerson Creek
Dockrill Creek
McDowell Creek
Telkwa River
Telkwa
Smithers
Canyon Creek
Driftwood Creek
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522

than 50 mm F.L.) collected in side channels (Appendix J5). Habitat characteristics recorded at each site included the type of hydraulic unit (run, glide, riffle or pool), substrate composition, cover type and abundance, and water temperature (monitored daily with recording thermographs).

3.0 RESULTS

Of the 1,454 fish captured in the Morice/Bulkley River system during October 1982, steelhead trout fry and parr comprised 22% and 11% of the sample, respectively, while juvenile coho and chinook salmon comprised 29% and 24% respectively. Incidental catches constituted the remaining 14% (Table 3.1). The raw catch data by reach and site are presented in Appendix J3. A comparison of fork lengths by species and between side channels and mainstem is given in Appendix J6.

3.1 Steelhead Trout

Steelhead trout fry were most abundant in the mainstem margins of Reach 5 and in side channels and mainstem margins of Reach 2. When catches were corrected for the length of habitat sampled and weighted for total channel length, 82% of the fry population was estimated to occur in these two reaches (Figure 3.1; Appendix J4). Reach 2 was characterized by abundant side channel habitat with diverse riffle-pool combinations, gravel substrate, and abundant log debris cover. Preferred habitat in all mainstem areas was characterized by low velocities (in runs or pools), gravel to boulder substrate, and cover in the form of cobble or log debris.

Steelhead trout parr were most abundant in mainstem areas of Reaches 2 and 3 in the upper system and Reach 5 in the lower system. A comparison of the catch estimates, corrected for the total length of main and side channels combined, indicated that 43% of the parr were rearing in Reach 2 (Figure 3.1; Appendix J4). An abundance of suitable habitat characterized by glide-pool combinations and abundant log debris cover probably accounts for this distribution. In Reach 2 mainstem areas, parr were associated with log jams, moderate velocities and sand/gravel substrate, while in Reach 3, mainstem parr habitat was characterized by slow backwater/pool areas, boulder/cobble substrate, and cover consisting of logs and overhanging vegetation. Parr captured in the lower system mainstem were found along the edges of runs with cobble and log debris cover.

Analysis of length-age data indicated that parr comprised 37% of the 277 juvenile steelhead trout captured in Reach 2 side channels (Appendix J6). An estimated 68% of these were age 1+ and 32% were age 2+.

Catch estimates for Reach 2, the area most extensively sampled, suggest that steelhead fry numbers were similar in main channel and side channel sections (Appendix J4). Steelhead parr, on the other hand, were more numerous along sections

TABLE 3.1
Summary of Electrofishing Catches in Reaches 1-6 of the Morice/Bulkley River System during October 1982, October/November 1981, and late September/November 1979

	Number of Fish Captured/Percent Abundance by Species					
	1982		1981		1979	
Species[1]	#	%	#	%	#	%
Steelhead trout fry	317	21.8	319	23.6	738	51.5
Steelhead trout parr	159	10.9	75	5.5	149	10.4
Coho Salmon[2]	417	28.7	539	40.0	159	11.1
Chinook Salmon	352	24.2	154	11.3	174	12.1
Dolly Varden char	11	0.8	1	0.1	15	1.0
Cutthroat trout	0	0.0	0	0.0	1	0.1
Mountain Whitefish	131	9.0	108	8.0	33	2.3
Longnose Dace	29	2.0	13	1.0	132	9.2
Largescale Sucker	19	1.3	0	0.0	10	0.7
Prickly Sculpin	16	1.1	3	0.2	23	1.6
Longnose Sucker	3	0.2	0	0.0	0	0.0
	1,454	100	1,212	100	1,434	100

1 In addition, 4 adult Pacific Lamprey and numerous lamprey ammocoetes were captured during October 1982

2 An estimated 25% of the total number of juvenile coho salmon captured during October 1982 were yearlings

of the main channel with estimates of fish/km approximately 1.5 times higher than in side channel sections.

3.2 Coho Salmon

All coho salmon were collected in Reach 2. Abundance was high in side channel habitats where juvenile coho utilized pool areas with low water velocities and abundant cover (overhanging vegetation, leaf litter, and log debris). Based on catch estimates weighted for channel length, 60% of coho rearing is estimated to occur in Reach 2, with almost 90% of that population in side channels (Figure 3.1; Appendix J4). In the mainstem, coho were found along margins in pool areas with silt/sand substrate and log debris cover.

Juvenile coho salmon was the most abundant species in side channel habitats (42% of the total population) (Appendix J5). Catch estimates per kilometer of side channel section in Reach 2 were approximately twice those per length of mainstem margin. Reach 2 offers the greatest fish habitat diversity in the Morice/Bulkley system, including an abundance of instream cover (especially log jams) and ponds associated with old river channels and/or beaver activity. Very little of the main channel margin in sections other than Reach 2 provides suitable coho habitat.

3.3 Chinook Salmon

Chinook salmon fry were most abundant in Reaches 2 and 5. Comparison of the catch estimates, corrected for the total length of main and side channels combined, indicates that these reaches accounted for 68% of the chinook fry population, with similar proportions in Reach 5 mainstem and Reach 2 side channels (Figure 3.1; Appendix J4). Chinook salmon fry inhabited pools and shallow runs with sand to cobble substrate and log debris or boulder cover.

Juvenile chinook salmon were the dominant salmonids in the mainstem (35% of the total population). Catch estimates per length of channel margin in the mainstem of Reach 2 were approximately 1.5 times higher than in side channel sections (Appendix J4).

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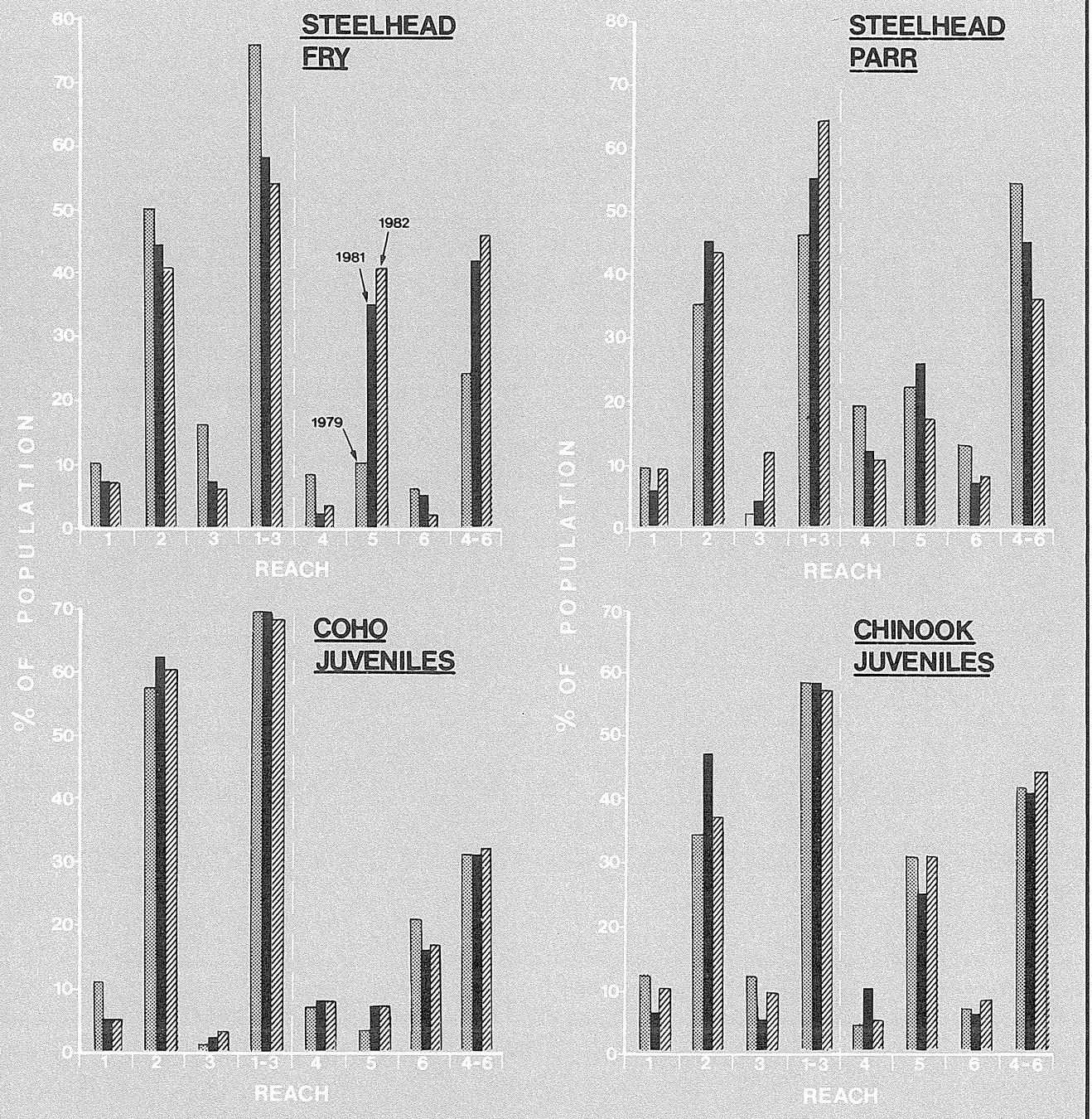
FIGURE 3.1: COMPARISON OF JUVENILE SALMONID DISTRIBUTION IN THE MORICE RIVER SYSTEM, LATE SEPT./NOV. 1979 AND OCT. 1981/82



NOTES: - sidechannels sampled: 1979 – reaches 1,2 & 6 / 1981 – reaches 2 & 6 / 1982 – reach 2
- sidechannels not sampled in 1981 & 1982 were extrapolated and included in reach totals
- estimates for: -1979 based on single pass along river margin with no stop nets (fish/100 m^2)
-1981/82 based on shoreline length (fish/1000 m.)

4.0 DISCUSSION

4.1 Annual Variability in Juvenile Salmonid Distribution and Abundance

Distribution and abundance studies conducted in the Morice River system during the fall of 1979, 1981 and 1982 (Sections A and B) indicate some year-to-year variability in juvenile salmonid distribution within the Morice and Bulkley Rivers.

Steelhead trout fry utilized side channel habitats in the upper reaches of the system more heavily in 1979, while in 1981 and 1982 the distribution shifted somewhat to the lower three reaches (Figure 3.1). Reach 2 side channel habitat was important for steelhead fry during all three years. The apparent shift in distribution from the upper to the lower reaches of the river may, in part, reflect the higher efficiency of mainstem sampling techniques used in 1981 and 1982. In those years, nets minimized the movement of fish and the multiple-pass method of electrofishing provided a more accurate estimate of fish populations.

Steelhead trout parr, while more abundant in the Morice River than the Bulkley River during this study, were more evenly distributed during 1979 and 1981 (Figure 3.1). Reach 2 side channels account for 31% of the total steelhead parr catch in this study. Limitations to sampling fast runs and log jam areas, especially in Reach 2, may have resulted in underestimates of the abundance of steelhead parr in all years. Despite the sampling limitations, Reach 2 accounted for the greatest proportion (approximately 40%) of the estimated population in all study years. The data indicate Reach 5 is also an important parr area as it accounts for approximately 20% of the steelhead parr population in all years (Figure 3.1). However, a survey conducted during September 1982 (one month prior to this study) using a boat electrofisher indicated that steelhead parr abundance progressively increased from low numbers in the upper river to high numbers in the lower reaches, with the greatest weighted distribution in Reach 7 (Section F).

While the multiple-pass removal method used in October 1982 (this study) is useful in providing an index of the relative distribution of steelhead parr in side channel and main channel sites, boat electrofishing proved to be a more efficient method of capturing steelhead parr in main channel sites. The results of the September 1982 study are likely more representative of parr distribution throughout the main channel of the Morice and Bulkley River. See Section F for these results.

In October 1982, juvenile coho salmon were caught only in Reach 2. However, using the extrapolation procedures outlined in Section 2.0, the upper reaches were estimated to account for 68% of the population (Figure 3.1). During 1979 and 1981, an estimated 69% of coho rearing occurred in the upper system (Figure 3.1). The main channel abundance was low each year (Appendix J7) and coho were found only where suitable pool and/or log jam habitat was available. In all years, coho fry and yearlings were most abundant in side channels between Gosnell Creek and Fenton Creek (Reach 2). This section of the river has the greatest habitat diversity and a high abundance of log jam and log debris cover.

Chinook salmon fry were evenly distributed between upper and lower reaches during all years (Figure 3.1). Reach 2 consistently had the highest abundance of fry in side channels, while the highest fry abundance in main channels was in Reach 5 in 1982 and in Reach 2 in 1981. In all years, Reaches 2 and 5 together accounted for 65-72% of the total chinook population.

A comparison of mainstem abundance (fish/km) between 1981 and 1982 indicated that salmonid fry populations were lower in 1982 (Appendix J7). Chinook salmon fry estimates declined approximately 22%, steelhead trout fry 58%, and coho salmon fry 54%.

In general, steelhead fry and parr and chinook salmon fry densities in Reach 2 were quite similar between main and side channel locations (Table 4.1). Coho salmon juvenile densities were much higher in side channel sites than in the main channel.

4.2 Side Channel Rearing in Reach 2

Extensive side channel sampling in 1981 and 1982 at three identical locations (Side Channels A, C and D) indicated some differences between years in the population sizes and the relative abundance of juvenile salmonids (Table 4.2). Steelhead trout fry and parr numbers and relative abundance were higher in 1982. Population estimates, adjusted for the area sampled (Appendix J5), indicated that fry density in 1982 was highest in Side Channel D which was characterized by riffle-pool combinations and boulder and log debris cover.

Overall, juvenile coho salmon abundance and density were lower in 1982 than 1981. The large decline in Side Channel C may be partly explained by poorer recruitment of fry prior to this channel becoming isolated in 1982. Escapement estimates for adult coho salmon were approximately 3 times greater during 1980 then during 1981 (Farina

TABLE 4.1
Summary of Juvenile Salmonid Densities in the Morice/Bulkley River System Based on Electrofishing Catches during October 1982

Location	Reach	Channel Type[1]	Fish/m^2 Steelhead Trout Fry	Steelhead Trout Parr	Coho Salmon	Chinook Salmon	Total
Morice/Bulkley	1-6	M	.053	.021	.011	.065	.150
Morice	2	M	.047	.028	.038	.058	.171
Morice	2	S	.064	.025	.103	.054	.246

[1] M = Mainstem

S = Side channels

TABLE 4.2
Population Estimates, Density, and Relative Abundance of Juvenile Salmonids in Reach 2 Side Channels of the Morice River System Based on Electrofishing Catches during October 1981 and 1982

Location and Year	Approx. Area Sampled (m^2)	Population Estimates (# of fish)				
		Steelhead Trout Fry	Steelhead Trout Parr	Coho Salmon	Chinook Salmon	All Species
Side Channel A						
1982	2,600	135	25	74	130	364
1981	815	46	7	74	10	137
Side Channel B						
1982	N/A	N/A	N/A	N/A	N/A	N/A
1981	1,100	63	22	34	34	153
Side Channel C						
1982	1,200	4	15	316	14	349
1981	1,200	17	3	914	1	935
Side Channel D						
1982	2,600	282	108	261	170	821
1981	600	72	18	64	14	168
Side Channel E						
1982	400	11	23	42	49	125
1981	N/A	N/A	N/A	N/A	N/A	N/A

(Continued)

TABLE 4.2 (Continued)

Location and Year	Approx. Area Sampled (m^2)	Population Estimates (# of fish) Steelhead Trout Fry	Steelhead Trout Parr	Coho Salmon	Chinook Salmon	All Species
Side Channels A,C,D						
1982	6,300	421	148	651	308	1,534
relative abundance		28%	10%	42%	20%	
1981	2,615	135	28	1,052	25	1,240
relative abundance		11%	2%	85%	2%	
Side Channel Total						
1982	6,700	432	171	693	363	1,659
density (# of fish/m^2)		(.064)	(.025)	(.103)	(.054)	(.246)
1981	3,715	198	50	1,086	59	1,393
density (# of fish/m^2)		(.053)	(.013)	(.292)	(.016)	(.375)

1983), suggesting that fry recruitment may have been considerably higher for the 1981 sample period. Of the total number of salmonids captured in Side Channel C, coho comprised over 90% in both years (Table 4.2).

Chinook salmon fry abundance estimates in 1982 were higher than 1981 estimates in all three study side channels (Table 4.2). The greatest change occurred in Side Channel A where chinook fry comprised 36% of the salmonid population in 1982, and only 7% in 1981. Increased flows through Side Channel A in 1982 may have provided more suitable habitat for the production of chinook fry.

The extensive use of side channel habitat in Reach 2 by juvenile coho salmon, and to a lesser extent by steelhead trout fry and chinook salmon fry, emphasizes the importance of wetted side channels to fish production in the Morice River system. This highly braided section of river contains 126 km of side channels, amounting to 64% of the total side channel length and 35% of the total length of main channel and side channels combined in Reaches 1-6. Reach 2 provides excellent summer rearing habitat for juvenile salmonids, although high winter mortalities occur in Reach 2 side channels (Section C). Based on 1981 and 1982 population estimates, Reach 2 side channels account for approximately 36% of juvenile salmonid rearing in the Morice and Bulkley Rivers. This does not, however, reflect the higher abundances of steelhead parr found further downstream during boat electrofishing (Section F).

5.0 SUMMARY

Studies conducted in the Morice/Bulkley River system during October 1982 demonstrated some differences in the distribution and abundance of juvenile salmonids rearing in mainstem and side channel habitats. Steelhead trout fry and chinook salmon fry were generally most abundant in the lower reaches of the mainstem; however, their abundance was also high in Reach 2 side channels. The majority of steelhead trout parr was found in Reach 2 side channels and in the mainstem of Reaches 2 and 5. Juvenile coho salmon were found only in Reach 2, primarily in side channels. Approximately 36% of total mainstem juvenile salmonid rearing occurred in Reach 2 side channels.

Of a total 1,454 fish captured, steelhead trout fry and parr comprised 32.7%, coho salmon fry and yearlings 28.7%, chinook salmon fry 24.2%, and other species 14.4%. Coho fry and yearlings were the most abundant salmonids in side channel habitats (42%), while chinook fry were the most abundant salmonid in the mainstem (35%).

High densities of steelhead fry were found in side channel habitat and along mainstem margins of Reach 5. Steelhead parr and chinook fry densities were similar in both mainstem and side channel habitat in Reaches 2 and 5. Juvenile coho salmon utilized side channel areas in Reach 2.

The results of the 1982 study were compared to those of other studies conducted in early winter 1979 and 1981. All salmonid species were abundant in Reach 2 side channels during all three years. Yearly variations in distribution were apparent for steelhead trout and coho salmon. Steelhead fry distribution shifted from the upper system in 1979 to lower reaches in 1981 and 1982. In contrast, steelhead parr, which were more abundant in upper reaches during 1982, were evenly distributed in 1979 and 1981. Boat electrofishing results from September 1982 (Section F), which are more representative of steelhead trout parr distribution (on which boat electrofishing was focused), indicated a greater proportion of parr rearing occurring in the lower reaches, particularly Reach 5. The majority of juvenile coho was found in the upper system during 1981 and 1982, while in 1979 over 30% reared in the lower system. Chinook fry were nearly equally distributed during each year. Differences in sampling procedures may account for some of this annual variability.

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APPENDIX J1

Habitat Characteristics of Mainstem Sampling Sites in the Morice/Bulkley River System (Reaches 1-6) in October 1982

TABLE J1.1
Habitat Characteristics of Mainstem Sampling Sites in the Morice/Bulkley River System (Reaches 1-6) in October 1982

Reach	Site 1982	Site 1981	Hydraulic Unit	Substrate	Cover[1]	Depth
1	1		edge of run	large gravel	none	15 cm ave.
	2		quiet backwater	cobble/boulder	u/c bank, log debris	-
	3		edge of run (slow)	boulder/cobble	-	-
2	4		slow run	sandy	log debris	-
	5		edge of run	gravel/cobble	u/c bank	-
	6	5	shallow riffle	sand/gravel	none	30 cm max.
	7		edge of run (fast)	angular cobble	cobble	-
	8	6	pool	silt	log debris	-
	9		(point bar)	large gravel/cobble	none	-
	10		edge of run (fast)	gravel/cobble	u/c bank, rootwad	-
	11		(log jam)	sand/large gravel	logs	100 cm max.
	12	10	edge of run (slow)	gravel/cobble	none	10 cm ave.
3	13		edge of run	cobble/boulder	cobble, boulders	-
	14		slow water	silt & boulders	debris, o/s vegetation	-
	15	11	pool	sand	log debris	-
	16	12	slow run & backwater	boulder/cobble	logs, o/s vegetation	-
4	17		moderate flow	cobble	poor	-
	18		-	cobble	loose cobble spaces	-
	19	13	slow shallow	sand	logs, debris	-
	20	14	run	cobble	cobble	35-40 cm
5	21		shallow run	cobble	cobble	30 cm max.
	22		pool & backwater	sand/silt/cobble	debris	-
	23	15	edge of run (slow)	sand/cobble	debris	-
	24	16	run	-	-	-
6	25		shallow riffle	large gravel	none	20 cm
	26	17	edge of run (slow)	cobble	-	40 cm ave.
	27	18	glide (fast)	cobble	cobble	-
	28	19	edge of glide (slow)	cobble/boulder	none	-

1 u/c bank = undercut bank
o/s vegetation = overstream vegetation

APPENDIX J2

Methods of Estimating Juvenile Salmonid Populations

1.0 MULTIPLE-PASS POPULATION ESTIMATION

For mainstem sites, the juvenile salmonid populations were estimated using Braaten's (1969; cited in Ricker 1975) modification of Delury's (1951) method for the multiple-pass removal sampling technique. Delury's method relates fishing success to effort and assumes that the catchability of the fish remains constant during each pass. The population estimate is taken as the intercept of the regression line with the x-axis, and the confidence limits of this estimate are the roots of a quadratic equation. However, if the assumption of constant catchability is not met, the fit of the regression line to the data will be poor. To overcome this problem, Braaten's technique uses the x-axis intercepts of the confidence limits of the regression slope to give the confidence limits of the population estimate. It should be noted that due to the effective removal of all fish within a sample area, there was little variance between multiple-pass population estimates and the actual numbers of fish collected.

2.0 MARK-RECAPTURE POPULATION ESTIMATION

For side channel sites, Chapman's (1951) modification of the Peterson estimate was used, giving an unbiased estimate of the fish population with the equation:

$$N_o = \frac{(M+1)(C+1)}{R+1} - 1$$

where N_o = Population estimate
M = Number of fish marked (captured in first pass)
C = Number of marked and unmarked fish (captured in second pass)
R = Number of marked fish recaptured

Ninety-five percent confidence limits for each population estimate were calculated using the standard error of the estimate from Robson and Reiger (1971; cited in Ricker 1975):

$$S.E.(N_o) = N_o \sqrt{\frac{(N_o-M)(N_o-C)}{MC(N_o-1)}}$$

where $S.E.(N_o)$ = Standard error of N_o.

The following assumptions are made (Ricker 1975) prior to application of the formula:

1) Marked fish do not lose their mark;
2) Marked fish become randomly mixed with unmarked fish;
3) Marked fish suffer the same natural mortality as unmarked fish;
4) Marked fish have not learned an avoidance to capture by electrofishing;
5) Marked fish are easily recognized and recorded on capture; and
6) There is only a negligible amount of recruitment to the catchable population during the time recoveries are being made.

APPENDIX J3

Multiple-Pass Electrofishing Data and Population Estimates for the Mainstem Morice/Bulkley River System (Reaches 1-6) During October 1982

TABLE J3.1
Multiple-Pass Electrofishing Data and Population Estimates for the Mainstem Morice River System (Reaches 1-6) During October 1982

Date	Reach	Site	Length of Margin Sampled (m)	Area Sampled (m^2)	Pass Number	Number Captured: Steelhead Trout Fry	Steelhead Trout Parr	Coho Salmon	Chinook Salmon	All Species
Oct. 25	1	1	14.8	91.8	1	1	0	0	0	1
					2	0	0	0	0	0
	1	2	23.5	72.8	1	0	1	0	0	1
					2	0	0	0	0	0
					3	0	0	0	0	0
	1	3	19.2	85.1	1	1	0	0	0	1
					2	0	0	0	1	1
					3	0	0	0	0	0
	Totals:		57.5 m	249.7 m^2		2	1	0	1	4
			Population Estimate			2	1	-	1	4
			95% Confidence Intervals			2-2	1-1	-	SIE*	SIE*
	Fish/km					70	35	0	35	140
	Fish/m^2					.008	.004	0	.004	.016

(Continued)

TABLE J3.1 (Continued)

Date	Reach	Site	Length of Margin Sampled (m)	Area Sampled (m^2)	Pass Number	Number Captured: Steelhead Trout Fry	Steelhead Trout Parr	Coho Salmon	Chinook Salmon	All Species
Oct. 22	2	4	17.0	99.6	1	1	1	0	7	9
					2	1	0	0	3	4
					3	0	0	0	2	2
					4	0	0	0	1	1
	2	5	23.6	56.6	1	0	0	0	0	0
					2	0	0	0	0	0
					3	0	0	0	0	0
	2	6	10.4	92.2	1	0	0	0	0	0
					2	0	0	0	0	0
	2	7	17.7	115.1	1	3	1	0	4	8
					2	3	1	0	1	5
					3	0	0	0	1	1
					4	1	0	0	0	1
	2	8	17.8	85.4	1	2	2	7	4	15
					2	3	0	5	5	13
					3	1	0	1	1	3
					4	1	0	0	0	1
	2	9	18.5	87.0	1	2	0	0	2	4
					2	3	0	0	0	3
					3	0	0	0	0	0
					4	1	0	0	0	1
					5	1	0	0	0	1

(Continued)

TABLE J3.1 (Continued)

Date	Reach	Site	Length of Margin Sampled (m)	Area Sampled (m^2)	Pass Number	Number Captured: Steelhead Trout Fry	Steelhead Trout Parr	Coho Salmon	Chinook Salmon	All Species
Oct. 23	2	10	18.5	50.0	1	0	3	1	0	4
					2	2	1	0	0	3
					3	0	0	0	0	0
					4	0	0	0	0	0
	2	11	22.1	90.6	1	5	9	10	7	31
					2	0	3	2	3	8
					3	1	1	1	1	4
					4	0	0	2	1	3
	2	12	15.3	96.4	1	4	0	0	2	6
					2	0	0	0	0	0
					3	0	0	0	0	0
					4	1	0	0	0	1
	Totals:		160.9 m	772.9 m^2		36	22	29	45	132
	Population Estimate					36	22	29	47	135
	95% Confidence Intervals					SIE*	22-24	29-24	46-48	132-153
	Fish/km					447	273	360	584	1,664
	Fish/m^2					.047	.028	.038	.061	.174

(Continued)

TABLE J3.1 (Continued)

Date	Reach	Site	Length of Margin Sampled (m)	Area Sampled (m^2)	Pass Number	Number Captured: Steelhead Trout Fry	Steelhead Trout Parr	Coho Salmon	Chinook Salmon	All Species
Oct. 27	3	13	21.5	94.6	1	4	1	0	7	12
					2	1	0	0	4	5
					3	0	0	0	1	1
					4	1	0	0	2	3
					5	0	0	0	0	0
	3	14	27.4	112.3	1	3	0	0	4	7
					2	0	0	0	2	2
					3	0	0	0	1	1
	3	15	21.4	175.5	1	1	0	0	0	1
					2	0	0	0	0	0
	3	16	22.9	105.3	1	4	8	0	0	12
					2	1	2	0	4	7
					3	0	1	0	1	2
					4	0	1	0	0	1
	Totals:		93.2 m	487.7 m^2		15	13	0	26	54
			Population Estimate			15	13	-	26	54
			95% Confidence Intervals			15-15	13-17	-	SIE*	54-63
	Fish/km					322	279	0	558	1,160
	Fish/m^2					.031	.027	0	.053	.111

(Continued)

TABLE J3.1 (Continued)

Date	Reach	Site	Margin Sampled (m)	Area Sampled (m^2)	Pass Number	Number Captured: Steelhead Trout Fry	Steelhed Trout Parr	Coho Salmon	Chinook Salmon	All Species
Oct. 28	4	17	25.8	77.4	1	0	0	0	0	0
					2	0	0	0	0	0
	4	18	24.5	58.8	1	3	1	0	4	8
					2	2	1	0	0	3
					3	0	0	0	0	0
					4	0	0	0	0	0
	4	19	19.0	81.7	1	2	1	0	8	11
					2	0	0	0	2	2
					3	0	0	0	2	2
					4	2	2	0	0	4
	4	20	19.7	86.4	1	1	2	0	6	9
					2	0	0	0	0	0
					3	0	0	0	0	0
	Totals:		89.0 m	304.3 m^2		10	7	0	22	39
			Population Estimate			10	7	-	22	39
			95% Confidence Intervals			SIE*	SIE*	-	22-25	39-63
	Fish/km					225	157	0	494	876
	Fish/m^2					.033	.023	0	.072	.128

(Continued)

TABLE J3.1 (Continued)

Date	Reach	Site	Margin Sampled (m)	Area Sampled (m^2)	Pass Number	Number Captured: Steelhead Trout Fry	Steelhed Trout Parr	Coho Salmon	Chinook Salmon	All Species
Oct. 29	5	21	15.9	160.6	1	15	1	0	11	27
					2	5	0	0	0	5
					3	3	0	0	0	3
					4	1	0	0	0	1
	5	22	19.4	122.2	1	7	1	0	15	23
					2	8	1	0	4	13
					3	1	0	0	0	1
					4	1	0	0	3	4
	5	23	20.5	114.8	1	8	1	0	11	20
					2	1	1	0	0	2
					3	2	1	0	2	5
					4	0	0	0	0	0
	5	24	18.1	130.3	1	19	4	0	9	32
					2	3	0	0	6	9
					3	2	0	0	0	2
					4	0	0	0	0	0
	Totals:		73.9 m	527.9 m^2		76	10	0	61	147
			Population Estimate			77	10	-	61	147
			95% Confidence Intervals			76-81	10-11	-	61-64	147-154
	Fish/km					2,084	271	0	1,651	4,006
	Fish/m^2					.146	.019	0	.116	.281

(Continued)

TABLE J3.1 (Continued)

Date	Reach	Site	Margin Sampled (m)	Area Sampled (m^2)	Pass Number	Number Captured: Steelhead Trout Fry	Steelhed Trout Parr	Coho Salmon	Chinook Salmon	All Species
Oct. 17	6	25	22.1	112.7	1	2	0	0	2	4
					2	0	0	0	0	0
					3	0	0	0	0	0
	6	26	24.5	98.0	1	2	3	0	7	12
					2	0	0	0	3	3
					3	0	0	0	0	0
					4	0	0	0	0	0
	6	27	16.6	61.4	1	0	0	0	0	0
					2	0	0	0	0	0
					3	0	0	0	0	0
	6	28	18.1	61.5	1	0	0	0	1	1
					2	0	0	0	2	2
					3	0	0	0	1	1
					4	0	0	0	0	0
	Totals:		81.3 m	333.6 m^2		4	3	0	16	23
			Population Estimate			4	3	-	17	23
			95% Confidence Intervals			4-4	3-3	-	16-23	23-24
	Fish/km					98	74	0	418	590
	Fish/m^2					.012	.009	0	.051	.072

* Statistically Invalid Estimate

APPENDIX J4

Summary of Multiple-Pass Electrofishing Catches of Juvenile Salmonids in the Morice/Bulkley River System During October 1982

TABLE J4.1
Summary of Multiple-Pass Electrofishing Catches of Juvenile Steelhead Trout In Reaches 1-6 of the Morice/Bulkley River System during October 1982

Species	Reach	Habitat[1] Type	Length of Margin Sampled (m)	Fish per km[2] of margin	X Channel length (km)	= Population Estimate[3] for Reach	Weighted Distribution by Reach (%)
Steelhead fry	1	M	58	70	15.4	1,078	7
		S	-	**1,172**	**10.2**	**11,954**	
	2	M	161	447	33.8	15,109	41
		S	**926**	**467**	**125.7**	**58,702**	
	3	M	93	322	27.8	8,952	6
		S	-	**304**	**5.3**	**1,611**	
	4	M	89	225	18.1	4,072	3
		S	-	**140**	**18.6**	**2,604**	
	5	M	74	2,084	35.0	72,940	41
		S	-	**75**	**12.2**	**915**	
	6	M	81	98	31.2	3,058	2
		S	-	**0**	**25.9**	**0**	
	Total	M			161.3	105,209	58
		S			**197.9**	**75,786**	**42**
					359.2	180,995	
Steelhead parr	1	M	58	35	15.4	539	9
		S	-	**601**	**10.2**	**6,130**	
	2	M	161	273	33.8	9,227	43
		S	**926**	**185**	**125.7**	**23,254**	
	3	M	93	279	27.8	7,756	12
		S	-	**231**	**5.3**	**1,224**	
	4	M	89	157	18.1	2,842	11
		S	-	**300**	**18.6**	**5,580**	
	5	M	74	271	35.0	9,485	17
		S	-	**231**	**12.2**	**2,818**	
	6	M	81	74	31.2	2,309	8
		S	-	**139**	**25.9**	**3,600**	
	Total	M			161.3	32,158	43
		S			**197.9**	**42,606**	**57**
					359.2	74,764	

1 M= Mainstem, S= Side channels

2 Actual numbers of fish captured in mainstem habitats were doubled to account for both sides of the river; side channel estimates of fish/km are calculated by multiplying the number of fish/km for Reach 2 times the ratio for other side channels vs. Reach 2 side channels derived from 1979 estimates

3 Population estimates are not accurate to the nearest fish

TABLE J4.2
Summary of Multiple-Pass Electrofishing Catches of Juvenile Coho and Chinook Salmon In Reaches 1-6 of the Morice/Bulkley River System during October 1982

Species	Reach	Habitat[1] Type	Length of Margin Sampled (m)	Fish per km^2[2] of margin	X Channel length (km)	= Population Estimate[3] for Reach	Weighted Distribution by Reach (%)
Coho juveniles	1	M	58	0	15.4	0	5
		S	**-**	**853**	**10.2**	**8,701**	
	2	M	161	360	33.8	12,168	60
		S	**926**	**748**	**125.7**	**94,024**	
	3	M	93	0	27.8	0	2
		S	**-**	**785**	**5.3**	**4,160**	
	4	M	89	0	18.1	0	9
		S	**-**	**785**	**18.6**	**14,601**	
	5	M	74	0	35.0	0	7
		S	**-**	**995**	**12.2**	**12,139**	
	6	M	81	0	31.2	0	17
		S	**-**	**1,174**	**25.9**	**30,407**	
	Total	M			161.3	12,168	7
		S			**197.9**	**164,032**	93
					359.2	176,200	
Chinook juveniles	1	M	58	35	15.4	539	10
		S	**-**	**1,740**	**10.2**	**17,748**	
	2	M	161	584	33.8	19,739	37
		S	**926**	**392**	**125.7**	**49,274**	
	3	M	93	558	27.8	15,512	9
		S	**-**	**172**	**5.3**	**911**	
	4	M	89	494	18.1	8,941	5
		S	**-**	**0**	**18.6**	**0**	
	5	M	74	1,651	35.0	57,785	31
		S	**-**	**43**	**12.2**	**525**	
	6	M	81	418	31.2	13,042	8
		S	**-**	**86**	**25.9**	**2,227**	
	Total	M			161.3	115,558	62
		S			**197.9**	**70,685**	**38**
					359.2	186,243	

1 M = Mainstem, S = Side channels

2 Actual numbers of fish captured in mainstem habitats were doubled to account for both sides of the river; side channel estimates of fish/km are calculated by multiplying the total number of fish/km for Reach 2 times the ratio for other side channels vs. Reach 2 side channels derived from 1979 estimates

3 Population estimates are not accurate to the nearest fish

APPENDIX J5

Mark-Recapture Electrofishing Data and Population Estimates in Reach 2 Side Channels of the Morice River During October 1982

TABLE J5.1
Mark-Recapture Electrofishing Data and Population Estimates in Reach 2 Side Channels of the Morice River During October 1982

Date	Side Channel	Length Sampled (m)	Area Sampled (m^2)	Species	Pass Number	n	Recap.	Population Estimate[1]	Density (fish/m^2)	Standard Error	95% Confidence Intervals
Oct. 20	A	185.0	2553.0	Steelhead fry	1	40					
					2	44	13	135	.053	24.7	85-185
				Steelhead parr	1	13					
					2	10	5	25	.010	6.0	13-37
				Coho salmon	1	29					
					2	19	7	74	.029	18.4	37-111
				Chinook salmon	1	39					
					2	36	11	130	.051	25.8	77-183
				All species	1	124					
					2	109	36	374	.146	42.9	288-460
Oct. 21	C	404	1233.7	Steelhead fry	1	0					
					2	4	0	4	.003	-	-
				Steelhead parr	1	3					
					2	3	0	15	.012	16.0	3-47
				Coho salmon	1	117					
					2	114	42	316	.256	30.9	254-378
				Chinook salmon	1	6					
					2	12	6	14	.011	1.8	12-18
				All species	1	126					
					2	133	48	349	.283	31.7	286-412

(Continued)

TABLE J5.1 (Continued)

Date	Side Channel	Length Sampled (m)	Area Sampled (m^2)	Species	Pass Number	n	Recap.	Population Estimate[1]	Density (fish/m^2)	Standard Error	95% Confidence Intervals
Oct. 19	D	275	2552	Steelhead fry	1	42					
					2	51	7	282	.111	85.6	111-453
				Steelhead parr	1	39					
					2	40	14	108	.042	18.1	72-144
				Coho salmon	1	65					
					2	74	18	261	.102	44.7	172-350
				Chinook salmon	1	35					
					2	37	7	170	.067	48.7	73-267
				All species	1	181					
					2	202	46	790	.310	87.9	614-966
Oct. 26	E	62.0	384.4	Steelhead fry	1	6					
					2	4	2	11	.029	4.2	6-19
				Steelhead parr	1	11					
					2	5	2	23	.060	9.7	11-42
				Coho salmon	1	26					
					2	23	14	42	.109	4.7	33-51
				Chinook salmon	1	28					
					2	22	13	49	.127	6.4	35-61
				All species	1	72					
					2	54	31	125	.325	11.0	103-147

1 Corrected for mortalities

2553 1293.7 2552 384 6723

Coho 74 316 261 42 693

APPENDIX J6

Mean Fork Lengths of Fish Captured in the Morice/Bulkley River System (Reaches 1-6) During November 1979 and October 1981 and 1982

TABLE J6.1
Mean Fork Lengths of Fish Captured in the Morice/Bulkley River System (Reaches 1-6) during November 1979 and October 1981 and 1982

Species	Habitat[1] Type	1982 Sample Size	1982 Mean	Mean Fork Length (mm) by Year 1982	1981	1979
Steelhead fry	M	143	49.9	48.5	44.5	50.0
	S	174	47.4			
Steelhead parr	M	56	83.0	86.8	86.3	95.2
	S	103	88.8			
Coho Salmon	M	29	64.3	64.9	62.8	70.4
	S	388	64.9			
Chinook Salmon	M	169	67.5	68.1	68.9	74.3
	S	183	68.6			
Dolly Varden Char	M	6	156.3	141.6	-	70-170
	S	5	124.0			
Mountain Whitefish	M	56	97.8	73.3	76.8	-
	S	75	55.0			
Longnose Dace	M	22	39.8	37.6	-	30-60
	S	7	30.6			
Prickly Sculpin	M	11	82.4	89.1	-	-
	S	5	103.8			
Longnose Sucker[2]	M	2	104,112	116.3	-	-
	S	1	133			
Largescale Sucker	M	19	47.3		-	-

1 M = Mainstem, S = Side channels
2 Only 3 fish captured; individual lengths given

Length-Age Data for Juvenile Steelhead Sampled in Morice River Side Channels (Reach 2) during October 1982

Age	0+	1+	2+
Sample Size	5	21	10
Mean fork Length (mm)	55.6	79.0	110.6
Standard Deviation	4.8	7.2	10.7
Range (mm)	52-65	68-96	90-132

APPENDIX J7

Population Estimates of Juvenile Salmonids in Reaches 1-6 of the Morice/Bulkley River System Based on Multiple-Pass Electrofishing During October 1981 and 1982

TABLE J7.1
Population Estimates of Juvenile Steelhead Trout Fry in Reaches 1-6 of the Morice/Bulkley River System Based on Multiple-Pass Electrofishing during October 1981 and 1982

Species	Zone	Channel[1] type	Channel length (km)	Fish/km of margin[2] 1981	Fish/km of margin[2] 1982	Channel length x Fish/km 1981	Channel length x Fish/km 1982	Weighted distribution (%) for all channels 1981		Weighted distribution (%) for all channels 1982	
Steelhead Fry	1	M	15.4	187	70	2,880	1,078	0.8	6.7	0.6	7.2
		S	10.2	2,314	1,172	23,603	11,954	6.6		6.6	
	2	M	33.8	1,219	447	41,202	15,109	11.5	39.6	8.3	40.7
		S	125.7	922	467	115,895	58,702	32.2		32.4	
	3	M	27.8	833	322	23,157	8,952	6.4	6.6	4.9	5.8
		S	5.3	599	304	3,175	1,611	0.9		0.9	
	4	M	18.1	2,148	225	38,879	4,072	9.8	11.1	2.2	3.6
		S	18.6	277	140	5,152	2,604	1.3		1.4	
	5	M	35.0	3,481	2,084	121,835	72,940	33.9	31.2	40.3	40.8
		S	12.2	148	75	1,806	915	0.5		0.5	
	6	M	31.2	600	98	18,720	3,058	5.2	4.7	1.7	1.7
		S	25.9	0	0	0	0	0.0		0.0	
						396,304	180,995				

1 M = Main Channel
S = Side Channels

2 Side channel estimates of fish/km are extrapolated from Reach 2 side channel abundance by applying the ratios for other side channels vs. Reach 2 side channels derived from 1979 estimates:
Reach 1 = 2.51/1, Reach 3 = .65/1, Reach 4 = .30/1, Reach 5 = .16/1, Reach 6 = 0/1.

TABLE J7.2
Population Estimates of Juvenile Steelhead Trout Parr in Reaches 1-6 of the Morice/Bulkley River System Based on Multiple-Pass Electrofishing during October 1981 and 1982

Species	Zone	Channel[1] type	Channel length (km)	Fish/km of margin[2] 1981	Fish/km of margin[2] 1982	Channel length x Fish/km 1981	Channel length x Fish/km 1982	Weighted distribution (%) for all channels 1981		Weighted distribution (%) for all channels 1982	
Steelhead Parr	1	M	15.4	0	35	0	539	0.0	6.1	0.7	8.9
		S	10.2	523	601	5,335	6,130	6.1		8.2	
	2	M	33.8	562	273	18,996	9,227	21.7	44.8	12.3	43.4
		S	125.7	161	185	20,238	23,254	23.1		31.1	
	3	M	27.8	83	279	2,307	7,756	2.6	3.8	10.4	12.0
		S	5.3	201	231	1,065	1,224	1.2		1.6	
	4	M	18.1	296	157	5,358	2,842	6.1	11.6	3.8	11.3
		S	18.6	261	300	4,855	5,580	5.5		7.5	
	5	M	35.0	593	271	20,755	9,485	23.7	26.5	12.7	16.5
		S	12.2	201	231	2,452	2,818	2.8		3.8	
	6	M	31.2	100	74	3,120	2,309	3.6	7.2	3.1	7.9
		S	25.9	176	139	3,134	3,600	3.6		4.8	
						87,615	74,764				

1 M = Main Channel
S = Side Channels

2 Side channel estimates of fish/km are extrapolated from Reach 2 side channel abundance by applying the ratios for other side channels vs. Reach 2 side channels derived from 1979 estimates:
Reach 1 = 3.25/1, Reach 3 = 1.25/1, Reach 4 = 1.62/1, Reach 5 = 1.25/1, Reach 6 = .75/1.

TABLE J7.3
Population Estimates of Juvenile Coho Salmon in Reaches 1-6 of the Morice/Bulkley River System Based on Multiple-Pass Electrofishing during October 1981 and 1982

Species	Zone	Channel[1] type	Channel length (km)	Fish/km of margin[2] 1981	Fish/km of margin[2] 1982	Channel length x Fish/km 1981	Channel length x Fish/km 1982	Weighted distribution (%) for all channels 1981		Weighted distribution (%) for all channels 1982	
Coho Salmon	1	M	15.4	187	0	2,880	0	0.8	5.2	0.0	4.9
		S	10.2	1,643	853	16,759	8,701	4.4		4.9	
	2	M	33.8	1,594	360	53,877	12,168	14.3	62.2	6.9	60.3
		S	125.7	1,441	748	181,134	94,024	47.9		53.4	
	3	M	27.8	0	0	0	0	0.0	2.1	0.0	2.4
		S	5.3	1,513	785	8,019	4,160	2.1		2.4	
	4	M	18.1	148	0	2,679	0	0.7	8.1	0.0	8.3
		S	18.6	1,513	785	28,142	14,601	7.4		8.3	
	5	M	35.0	74	0	2,590	0	0.7	6.9	0.0	6.9
		S	12.2	1,917	995	23,387	12,139	6.2		6.9	
	6	M	31.2	0	0	0	0	0.0	15.5	0.0	17.3
		S	25.9	2,262	1,174	58,586	30,407	15.5		17.3	
						378,053	176,200				

1 M = Main Channel
S = Side Channels

2 Side channel estimates of fish/km are extrapolated from Reach 2 side channel abundance by applying the ratios for other side channels vs. Reach 2 side channels derived from 1979 estimates:
Reach 1 = 1.14/1, Reach 3 = 1.05/1, Reach 4 = 1.05/1, Reach 5 = 1.33/1, Reach 6 = 1.57/1.

TABLE J7.4
Population Estimates of Juvenile Chinook Salmon in Reaches 1-6 of the Morice/Bulkley River System Based on Multiple-Pass Electrofishing during October 1981 and 1982

Species	Zone	Channel[1] type	Channel length (km)	Fish/km of margin[2] 1981	Fish/km of margin[2] 1982	Channel length x Fish/km 1981	Channel length x Fish/km 1982	Weighted distribution (%) for all channels 1981		Weighted distribution (%) for all channels 1982	
Chinook Salmon	1	M	15.4	0	35	0	539	0.0	6.1	0.3	9.8
		S	10.2	1,412	1,740	14,402	17,748	6.1		9.5	
	2	M	33.8	2,125	584	71,825	19,739	30.3	47.2	10.6	37.1
		S	125.7	318	392	40,035	49,274	16.9		26.5	
	3	M	27.8	417	558	11,593	15,512	4.9	5.2	8.3	8.8
		S	5.3	140	172	742	911	0.3		0.5	
	4	M	18.1	1,333	494	24,127	8,941	10.2	10.2	4.8	4.8
		S	18.6	0	0	0	0	0.0		0.0	
	5	M	35.0	1,704	1,651	59,640	57,785	25.2	25.4	31.0	31.3
		S	12.2	35	43	427	525	0.2		0.3	
	6	M	31.2	400	418	12,480	13,042	5.3	6.1	7.0	8.2
		S	25.9	70	86	1,813	2,227	0.8		1.2	
						237,084	186,243				

1 M = Main Channel
S = Side Channels

2 Side channel estimates of fish/km are extrapolated from Reach 2 side channel abundance by applying the ratios for other side channels vs. Reach 2 side channels derived from 1979 estimates:
Reach 1 = 4.44/1, Reach 3 = .44/1, Reach 4 = 0/1, Reach 5 = .11/1, Reach 6 = .22/1.