1980 INVESTIGATIONS OF DOWNSTREAM MIGRATIONS AND REARING DISTRIBUTIONS IN JUVENILE SALMONIDS OF THE KITIMAT RIVER, B.C.

BY

G.J. BIRCH, T.L. SLANEY AND M. MILKO

PREPARED FOR

DEPARTMENT OF FISHERIES AND OCEANS

FISHERIES OPERATIONS

PREPARED BY

F.F. SLANEY & COMPANY LIMITED

VANCOUVER, B.C.

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LIST OF APPENDICES

NOTE: Appendices are under separate cover and can be obtained from B. Shepherd, New Projects Unit, Enhancement Services Branch, Department of Fisheries and Oceans.

SUMMARY

1. A juvenile salmonid downstream migration and rearing study was conducted on the Kitimat River between April 1 and August 20, 1980. The general objectives of the study were: i) to determine the size and timing of seaward migrations by juvenile salmonids; ii) to determine the extent and duration of juvenile rearing in the Kitimat watershed and on the estuary; and iii) to provide measures of precipitation and ambient air temperature as well as water levels, temperatures and quality over the study period.

2. The Kitimat River and its tributaries are characterized by rapid response to rainfall and snowmelt and have large discharge variations. The water is generally very soft and carries high levels of non filterable residues. When the streams are in freshet iron, manganese, nitrates and in some instances, aluminum approach or exceed the levels recommended for fish culture.

3. A 2 x 3 inclined plane trap was fished on the Kitimat River below the Haisla Bridge. Migration timings were:

Species	Age Class	Start	10%	50%	90%	End
Pink	fry	--	April 8	April 11	April 23	May 25
Chum	fry	--	April 8	April 12	April 19	June 4
Chinook	fry	--	April 8	April 16	June 5	--
Chinook	smolt	--	April 13	April 26	May 12	--
Coho	fry	April 22	May 23	June 15	July 9	--
Coho	smolt	--	April 12	April 27	June 22	--

Fyke net catches in Cecil and Hirsch Creeks showed similar timings.

SUMMARY

4. Rearing populations of chum, coho and chinook juveniles were observed in the Kitimat watershed. The chum remained in the system for only a few weeks in April and were found in the lower portions of Hirsch, Nalbeelah and Humphreys Creeks; the lower mainstem Kitimat; and in the mouths of the lower tributaries. Chinook juveniles reared in all of the tributaries except Goose, Duck, Lone Wolf and Deception Creeks. They were also found in the Kitimat River up to its headwaters with concentrations above Davies Rapids and below the Highway 25 Bridge. Coho fry and smolts were found throughout the system. Rainbow and cutthroat trout were found in most streams below Davies Rapids and Dolly Varden char were found throughout the watershed and into all of the headwaters.

5. The Kitimat estuary and Minette Bay were used extensively by juvenile chum, chinook and coho. The chum were found in all parts of the estuary in April and May, and were by far the most numerous salmonids. They moved seaward in late May, however larger individuals returned in July and remained until August. Juvenile chinook were present throughout the study. Chinook fry were present in April, peaked in May and most had left the estuary by July. Chinook smolt numbers peaked May 5 to 15 and declined through July. Chinook were not collected from the western estuary but were distributed throughout the remainder of the estuary. Coho juveniles were concentrated in the central estuary. The coho fry numbers peaked in June and were still present in August while smolts peaked in May and moved offshore in July.

ACKNOWLEDGEMENTS

We would like to express our appreciation to a number of people who assisted us with the study. M. Drewes and D. Archibald provided technical assistance, particularly Mr. Drewes whose knowledge of the watershed and salmonid distribution proved very helpful. S. Willis of the Kitimat Hatchery located chum and chinook background data and assisted in raising the ginpole. J. MacDonald and the staff of the Department of Fisheries Kitimat office provided information and advice. Finally, we would like to thank those residents of Kitimat whose friendship helped complete the project.

Assistance was also provided during data analysis and report preparation. Y. Yole of the D.F.O. Scale laboratory read scales and provided insight into chinook life history types. J. Pel of Environment Canada Laboratory Services oversaw the analysis of water samples. M. Peters, S.E.P. Planning Biologist, helped find necessary unpublished information. Finally, J. Lawrence, F.F. Slaney & Company Limited, provided invaluable assistance without which the production of the final report would not have been possible.

The report was reviewed by W.Griffioen, R.Hilland and B.Shepherd all of whom provided helpful suggestions.

PART I

INTRODUCTION

1.0 INTRODUCTION

This project was commissioned by the Department of Fisheries and Oceans (D.F.O.), to provide baseline information on juvenile salmon stocks of the Kitimat River. The information collected is to be used to supplement existing data and thereby contribute to the design and operational strategy of a hatchery which is being built at Kitimat, B.C. as part of the federal/provincial Salmonid Enhancement Program.

The major emphasis of the 1980 study was placed upon an assessment of the rearing distributions of juvenile chum, chinook and coho. Physical and chemical data were required to determine possible problem areas and limits to production. Biological, migration and distribution data was needed for hatchery production scheduling, for evaluation of results and for predictions of stock interactions and year of return.

1.1 OBJECTIVES

The specifications of the request for proposal stated the project objectives as follows:

1. To determine the number of chinook, coho and chum juveniles migrating from and/or rearing in the Kitimat river and estuary, the timing of emergence and migration, the duration and distribution of rearing, and size and age distributions.

2. To record daily river and estuary water temperatures and levels, and to determine water quality in order to assess potential limitations to salmonids.

3. To determine estuary morphometry, and to inventory estuary habitat in relation to utilization by chum fry.

1.2 DESCRIPTION OF THE STUDY AREA

The location of the study area is shown in Figure 1.0-1. The Kitimat River drains an area of approximately 200,000 ha. and flows a distance of 75 km from Mount Davies to the head of Kitimat Arm (Figure 1.0-2). It is a typical coastal stream with fall freshets due to precipitation and spring freshets due to snowmelt and precipitation. The annual mean discharge is 134 cms. The valley is steep walled, flat bottomed and of glacial origin. It is overlain with glacial drift and till, marine silts and clays. The river delta is extensive and slopes gently into Kitimat Arm where it drops rapidly (Figure 1.0-3).

The escapements to the Kitimat system in 1979 were estimated at 2,795 chinook, 3,880 chum, 5,875 coho and 3,675 pink salmon (M. Peters, pers. comm.). Despite the lack of lakes in the system, sockeye were once abundant in the Kitimat River. At present, though, the annual returns are about 400. These numbers all represent substantial declines from the return of former years. The principal reasons for these declines include extensive logging in the watershed and heavy exploitation by commercial, recreational and native food fisheries (Bell and Kallman, 1976).

Logging and clearing in the Kitimat Valley began before the turn of the century, however, it was not until 1950 that major logging operations began. Much of the land on the floor of the valley was held under tenures which did not include allowable cut or logging plan restrictions and has been totally deforested. There have been numerous instances of stream siltation from road building and logging (MacDonald, 1976). Log dumping and storage on the poorly flushed waters of Minette Bay has also resulted in some environmental degradation (Beak, 1971).

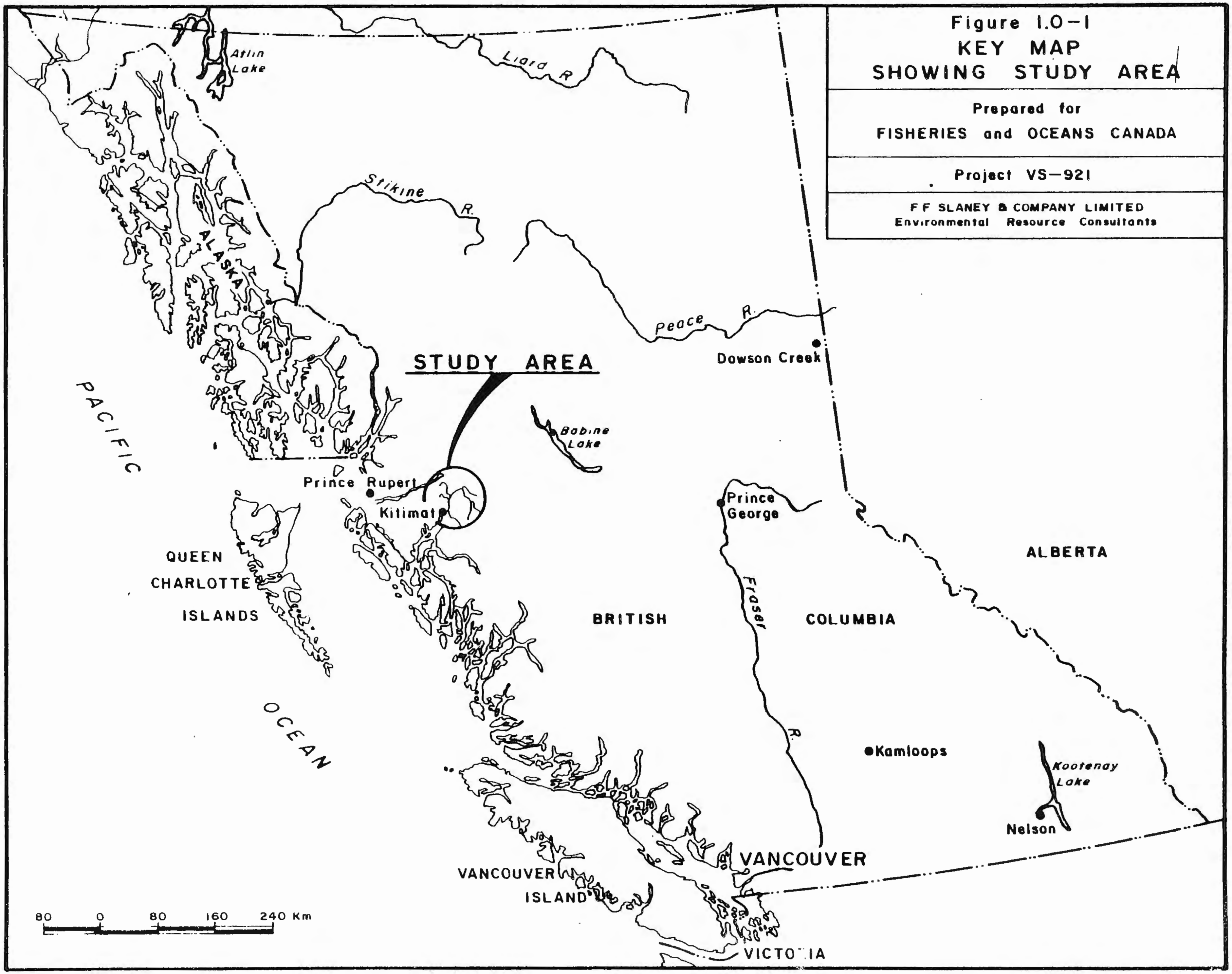

Figure 1.0-1
KEY MAP
SHOWING STUDY AREA
Prepared for
FISHERIES and OCEANS CANADA
Project VS-921
F F SLANEY & COMPANY LIMITED
Environmental Resource Consultants
Atlin Lake
Liard R.
Stikine R.
Peace R.
ALASKA
STUDY AREA
Babine Lake
Dowson Creek
PACIFIC
OCEAN
Prince Rupert
Kitimat
Prince George
QUEEN CHARLOTTE ISLANDS
Fraser R.
BRITISH
COLUMBIA
ALBERTA
Kamloops
Kootenay Lake
Nelson
VANCOUVER
VANCOUVER ISLAND
VICTORIA
80 0 80 160 240 Km

In 1951 construction began on an aluminum reduction plant. The plant went into operation in 1954 and discharges effluents from its settling lagoons into the western estuary and from other sources to Moore Creek and Hospital Beach. The settling lagoon effluents have a high fluoride content and elevated fluoride levels have been found throughout Douglas Channel and Kitimat Arm (Harbo et al 1974). The mill also emits a large plume of gaseous fluoride and some sulphur compounds. The construction of the mill necessitated clearing of a large area and construction of the town of Kitimat. The town discharged raw sewage into the Kitimat River until 1970 when a primary treatment plant was completed.

An integrated pulp, paper and sawmill opened in Kitimat in 1970. The mill discharges treated effluents into the Kitimat River which have resulted in alterations to the benthic community of the river below the outlet. However the alterations probably do not extend to the delta (Beak, 1974). The operation has also resulted in deposition of some sulphur compounds in the vicinity of the millsite. The mill operation has had two major impacts upon the Kitimat estuary. A dock was constructed which alienates the western portion of the delta from river flow and log storage on the estuary began. The pulpmill operation initially resulted in an increased logging rate and the removal of trees from steeper slopes and higher elevations, although the rate of logging has recently decreased (MacDonald, 1978).

The available environmental information on the Kitimat River was summarized by Bell and Kallman (1976). Recent investigations in the Kitimat River have included a preliminary survey of juvenile salmonid rearing habitat (Morris and Eccles, 1976, 1977) and a series of chinook salmon surveys associated with the operation of a pilot hatchery (Hilland, in prep.).

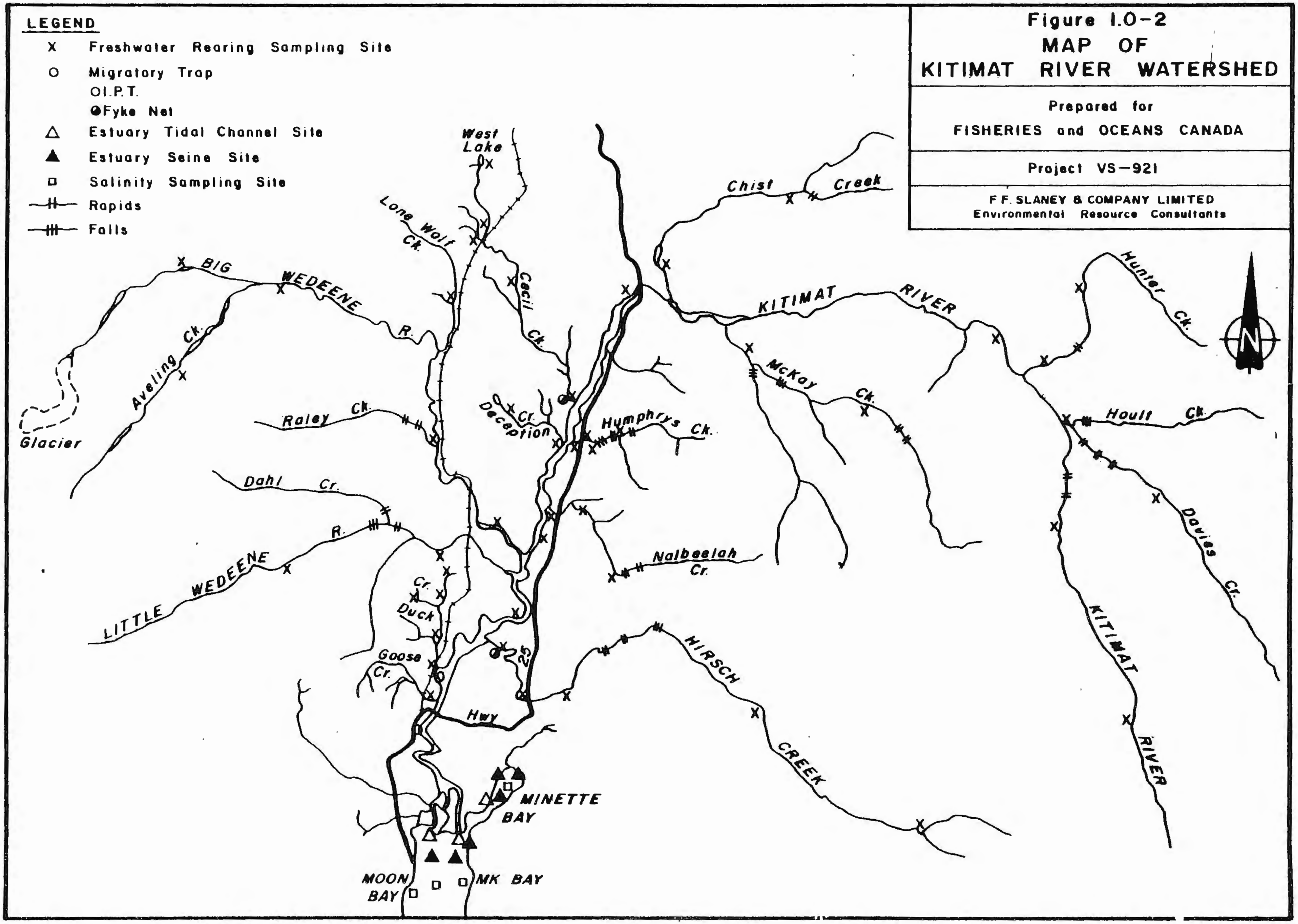

Figure 1.0-2
MAP OF
KITIMAT RIVER WATERSHED

Prepared for
FISHERIES and OCEANS CANADA

Project VS-921

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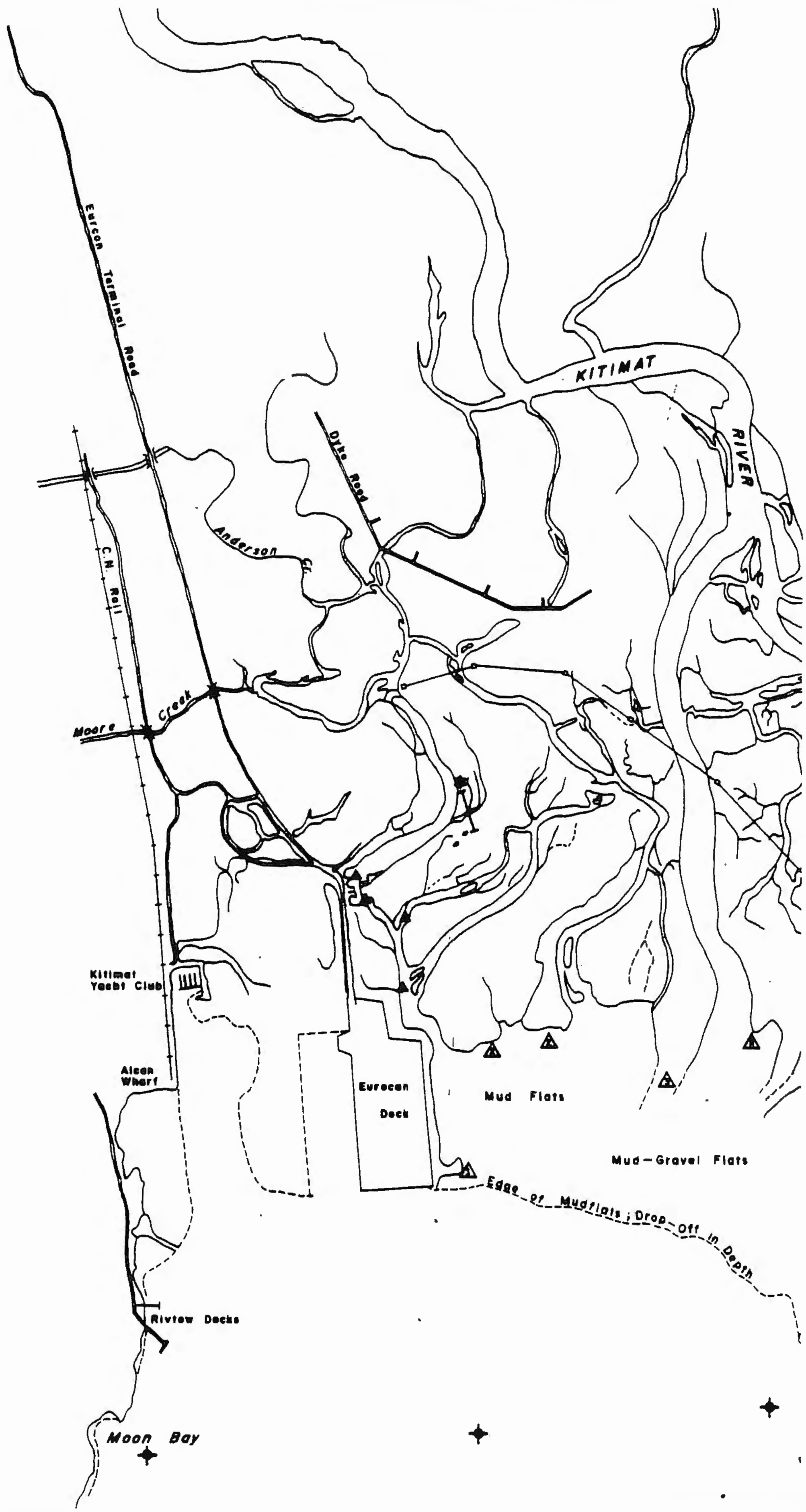
Environmental Resource Consultants



Eurcon Terminal Road
KITIMAT
RIVER
Dyke Road
Anderson Cr.
C.N. Rail
Moore Creek
Kitimat Yacht Club
Alcan Wharf
Eurocan Dock
Mud Flats
Mud-Gravel Flats
Edge of Mudflats; Drop-Off in Depth
Rivtow Docks
Moon Bay

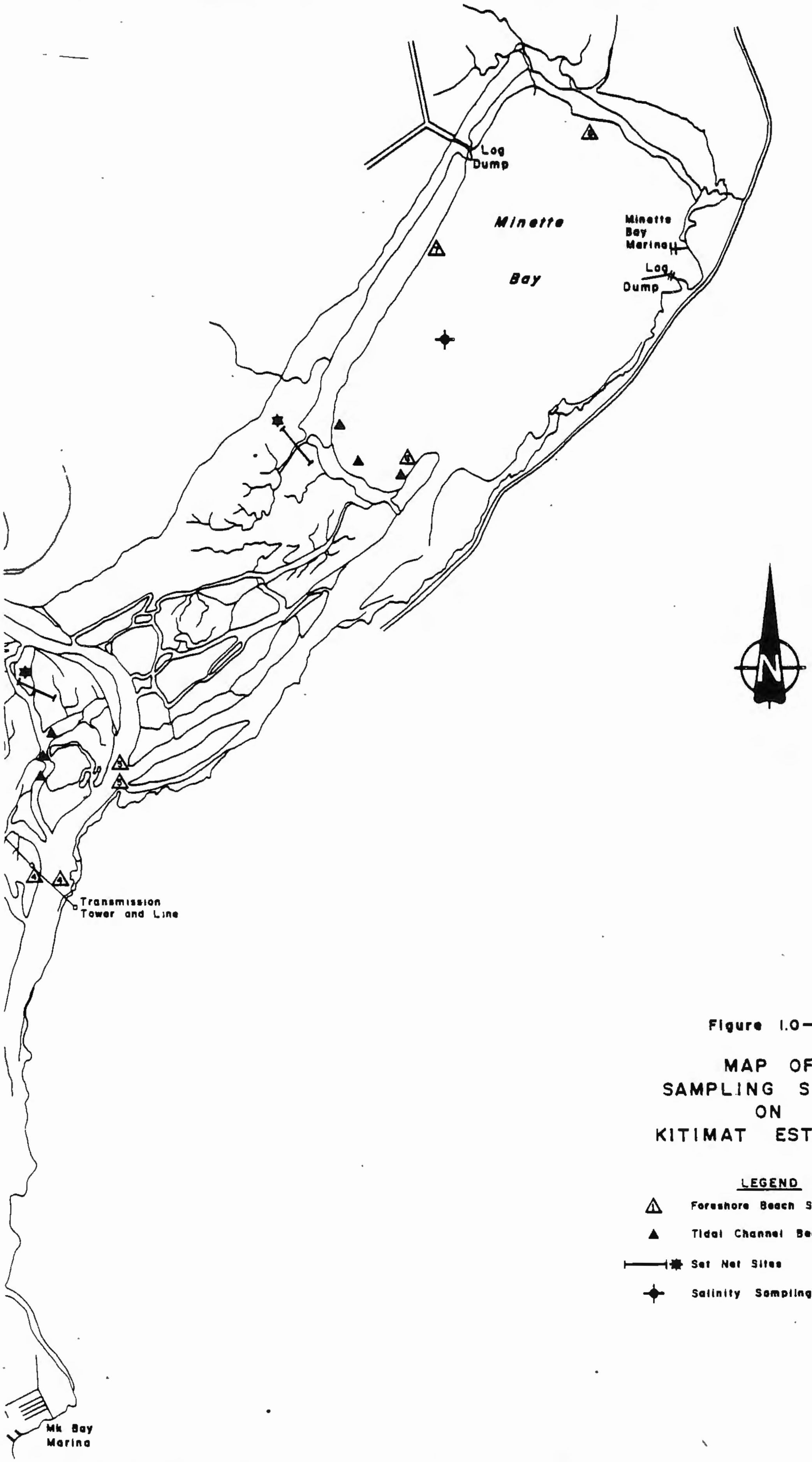


Figure 1.0-3

MAP OF
SAMPLING SITES
ON
KITIMAT ESTUARY

LEGEND

Foreshore Beach Seine Sites

Tidal Channel Beach Seine Sites

Set Net Sites

Salinity Sampling Sites

PART II

METHODS

2.1 PHYSICAL AND CHEMICAL OBSERVATIONS

2.1.1 Weather

Precipitation, sunshine and ambient temperature data were taken from the Atmospheric Environment Service records for Kitimat townsite.

2.1.2 Stream Conditions

Discharge data for the Kitimat River and Hirsch Creek were taken from the Water Survey of Canada records. On Cecil Creek the discharge was measured daily using a Kahlisco Pygmy Price current meter and velocity-area method.

Maximum/minimum thermometers were installed at each migration index trap site (Fig. 1.0-2) and were read and calibrated daily. A Ryan Model G recording thermometer was placed in the Kitimat River near the inclined plane trap and served to verify thermometer recordings. Incidental water temperature measurements were taken throughout the watershed in conjunction with the rearing survey.

Water samples were taken every month from the Kitimat River and Hirsch Creek. They were packed in ice and within 48 hours were delivered to the D.F.O. Cypress Creek laboratory for analysis. Additional samples were taken when the streams were high or dirty. These samples were frozen and delivered to the lab at the end of the field program.

2.1.3 Estuary Conditions

Salinity and temperature were recorded weekly at four stations across the estuary (Fig. 1.0-3). Readings were taken at the surface, 1 m and 5 m, with a YSI Model 33 meter and later, with a Hydrolab conductivity/temperature meter.

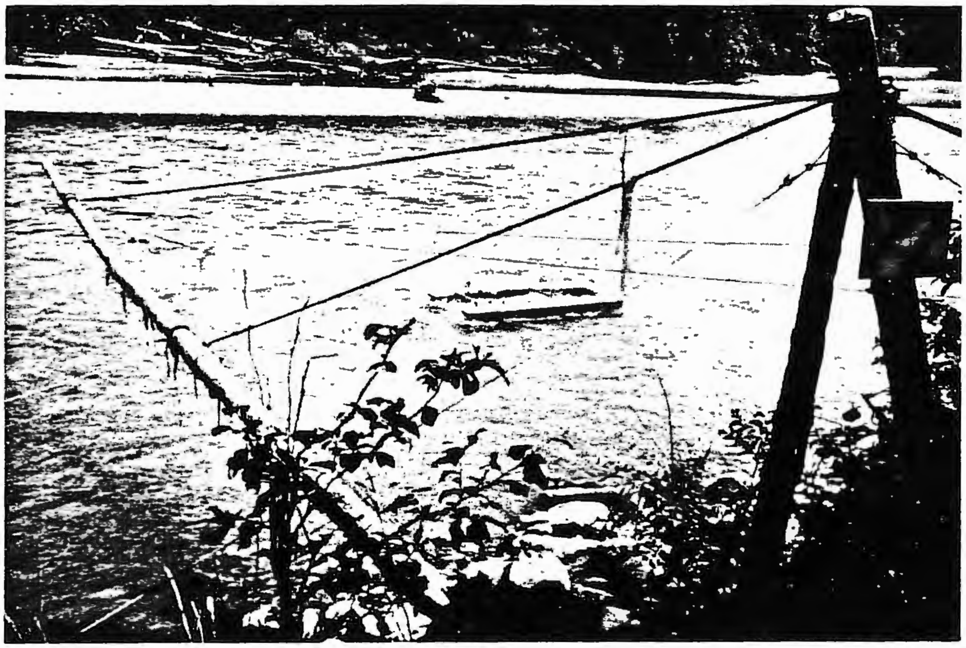


PHOTO 2-1: INCLINE PLANE TRAP SET FROM A 15 METRE GINPOLE ON THE KITIMAT RIVER AT RADLEY PARK

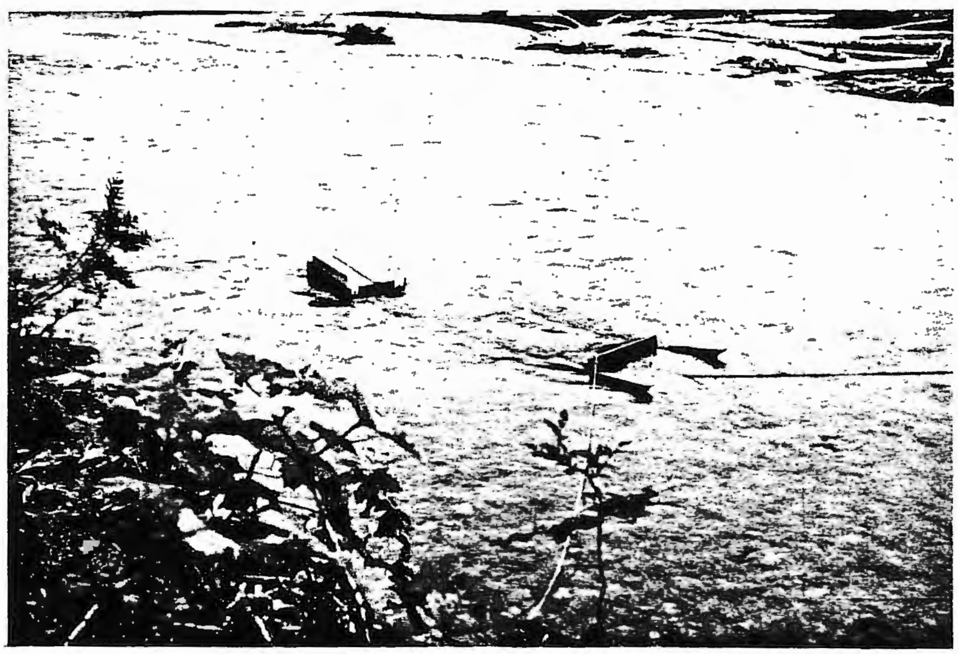


PHOTO 2-2: FLOATING FYKE NET SET IN HIRSCH CREEK FROM A FALLEN LOG

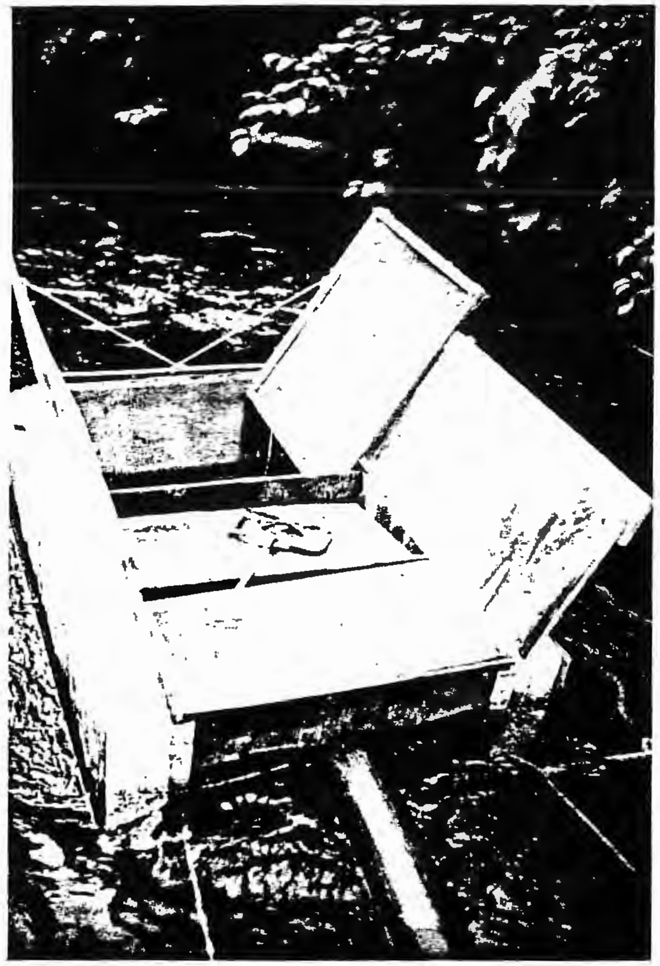
2.2 OUTMIGRATION

Migration index traps were used on the Kitimat River and on Hirsch and Cecil Creeks. On the Kitimat, a 2 x 3 inclined plane trap (IPT) of the International Pacific Salmon Commission style was deployed from a 5 m ginpole on April 7 (Photo 2-1). The Radley Park location (Fig. 1.0-2) was chosen over that used by Allen in 1978 (Hilland in prep) because the trap required faster water velocities than the 4 x 4 which had been used previously. The trap was fished from dusk to dawn three nights per week on alternate nights. When the migrations exceeded 1% of the expected outmigration of any species, the trap was fished nightly. The expected outmigration was calculated from the 1979 escapements and Lill et al (1979) percent survival estimates. Catches were sorted to species, size and class and then counted. The catches were never large enough to require volumetric estimates.

At four day intervals a subsample of 50 fish or as many as were available of each species, was retained for analysis. The fish were anaesthetized in 2-phenoxy ethanol (0.3 mg/L), patted dry, individually measured to ± 0.5 mm fork length and weighed to ± 0.01 g on an Ohaus Dial-o-gram Model 310 Scale. Mean fork length and weight ± 1 standard deviation were calculated for each sample by species and stage. Mean length and weight, and range were graphed over time to illustrate changes on outmigrant size. Where sample size was small several day's samples were grouped for a more accurate mean. Scale samples were taken from chinook and coho smolts and interpreted by the DFO scale analysis laboratory in Vancouver.

Fyke nets with live boxes (Photo 2-3) were installed on Cecil and Hirsch Creeks (Fig. 1.0-2). The traps had mouths of 90 x 120 cm and were constructed of 6 mm stretch mesh. They were fished in a manner similar to the IPT. The Cecil Creek trap was installed below a

PHOTO 2-3
LIVE BOX ARRANGEMENT USED WITH FYKE NETS, BACK AND BOTTOM SCREENS ALLOW FOR FLOW, IN CASE OF CLOGGING OF THESE SCREENS WITH DEBRIS THE TOP SCREEN PREVENTS FRY LOSS



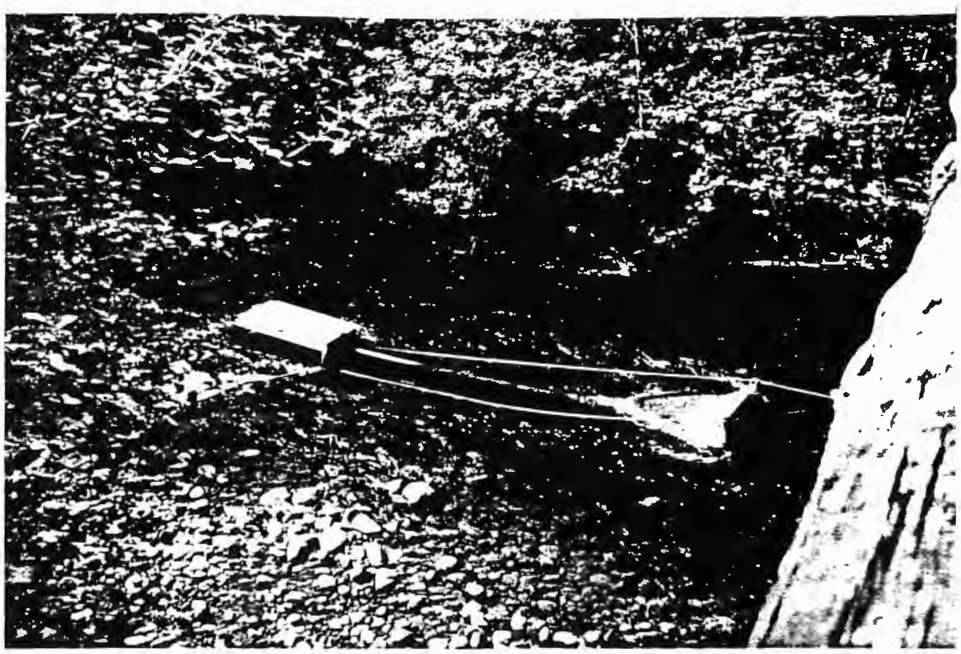


PHOTO 2-4
FYKE NET TRAP SET BELOW THE BRIDGE ON CECIL CREEK FROM A CROSS-STREAM CABLE (HIDDEN)

logging bridge (Photo 2-4) on a cross stream table. The lateral position was occasionally adjusted to compensate for variations in stream discharge.

In Hirsch Creek the fyke net was initially supported by reinforcing bar driven into the substrate and by an upstream cable. This system proved incapable of dealing with the rapid fluctuations typical of Hirsch Creek. On May 22, floats were placed on the fyke net. With this arrangement (Photo 2-2) the trap fished efficiently with the top about 10 cm out of the water under most conditions.

Mark and recapture methods were attempted weekly to assess the trap efficiencies. Fish to be marked were dyed in a well aerated solution of 0.8 g Bismark brown 'Y' dye per 45 litres of water for approximately two hours, rinsed in fresh water for at least an hour and then released at dusk upstream of the trap at either side of the river by the Haisla Bridge on the Kitimat (a distance of about 1 kilometer) and two riffles upstream of the traps on Hirsch and Cecil Creeks.

Low recapture rates resulted in migrant population estimates during the summer which are of dubious validity. The problem stems from the inability of the test method to satisfy the necessary conditions for limiting the effect of recruitment (Ricker, 1975). Statistically, the infrequency of gear efficiency tests and the subsequent inability to account for temporal variations as well as variations resulting from changing discharge levels make any population estimates suspect. Still, an attempt was made to arrive at a total migratory population estimate for each species in each stream to allow comment on fry migration timing and the accuracy of escapement estimates. Estimates should not be viewed as very accurate. Available data was analyzed by the following methods.

Despite variations between tests in the time period over which fish were recaptured, an adjusted Petersen equation (Ricker, 1975; Chapman, 1951) was used to estimate population size.

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

where Ni = estimated migration in period i

M = number of marks released

C = total catch (marked and unmarked) in period i

R = number of marks recaptured in period i.

It was recognized that other multiple census techniques (Ricker, 1975) were applicable in that they account for removal of recaptures, and provide more conservative estimates, however it was felt that for reasons of consistency, given small recapture sample sizes and the progressive loss of marks from the system that the above equation was sufficient.

For a Poisson distribution, it was recognized that for the probability that the lower confidence limit of R (and therefore N) to be greater than zero, the observed R must be greater than or equal to 4. For this reason, tests where $R < 4$ were not used in the data and instances where $R = 4$ were treated with skepticism.

For estimates of variance and confidence limits ($P < 0.5$) the following formula given by Chapman (1951) for the adjusted Petersen estimate was used.

$$V(N_i) = \frac{N_i^2\ (C_i - R_i)}{(C_i + 1)\ (R_i + 2)}$$

where N_i = estimate of migration over period i

C_i = total catch over period i

R = number of marks recaptured over period i

$V(N_i)$ = estimated variance of the population estimate

Confidence limits were then calculated as:

$$N_i \pm 1.96 \sqrt{V(N_i)} \quad (p \leq 0.05)$$

To determine nightly estimates of migration numbers an efficiency multiplication factor (N/C) was calculated from the total captures (C) and the best estimate (N) for the relative test period. As mark-recapture tests were usually conducted over a specific peak in migration the resulting efficiency factor was deemed applicable over the period of that peak. Estimates for periods before and after peaks in migration are determined by a mean efficiency factor calculated as the average of factors for each peak period. In cases where only one mark-recapture was successful the single efficiency factor was applied throughout the sampling period. For nights when no sampling occurred, estimated catch per night was extrapolated from the graph of catch vs. time.

Minimal sampling occurred during daylight hours. For migration occurring during these hours, a factor was determined based on the proportion of summed day catch to 24 hour catch for days sampled during each period of migration for which a different gear efficiency factor was applied. The resulting factor was applied to the summed nightly catch for the same period to determine the resulting diurnal estimate of catch. The diurnal and nocturnal estimates were summed to give the total migration estimate for each period.

Confidence limits for each relative period were then determined proportionately based on calculated confidence limits for each test. Finally the sum of total 24 hour estimates and their confidence limits were taken as an estimate of the total species migration for the spring and summer months sampled.

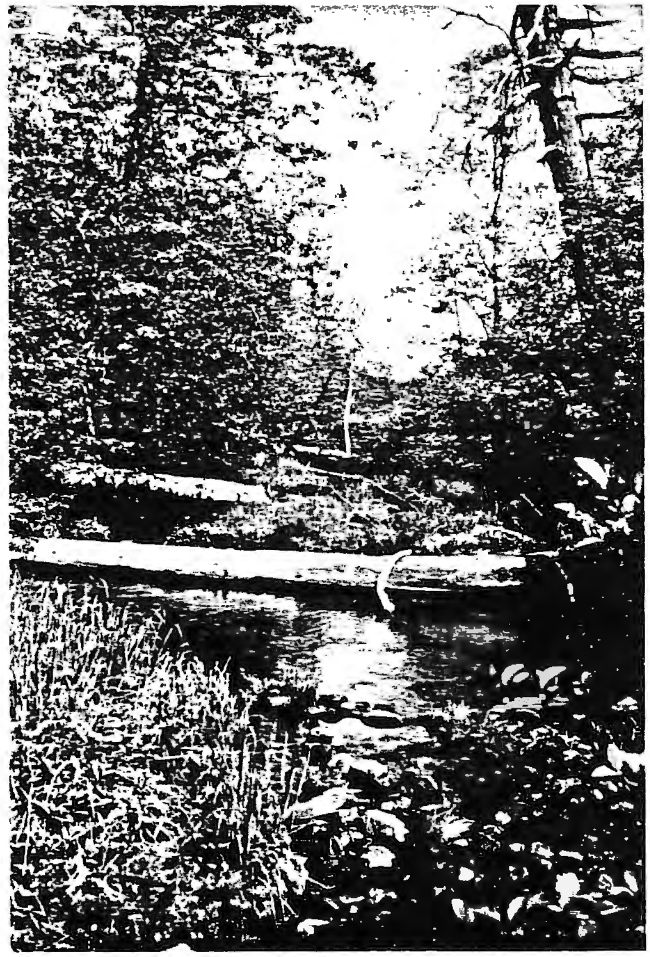
2.3 REARING SURVEYS

2.3.1 Stream Rearing

A freshwater rearing habitat survey was conducted at three levels of intensity throughout the spring and summer. The first level of effort included sampling the stream or stream sections once during the study with access either by helicopter or truck. The upper limits of the mainstem Kitimat River and tributaries inaccessible by road were sampled the first week in June (June 4-5) using seine nets and a portable electroshocker, a Smith Root Mark VII (Photo 2-6). The objective of this survey was to delineate the rearing areas of *Oncorhynchus* species within the system, and thus to suggest extensions of known spawning areas and possibly increases in estimates of escapment numbers. The upper reaches of several tributaries are known to support isolated populations of Dolly Varden char or rainbow trout (Morris and Eccles, 1976). Sites on these stream sections were sampled once or twice during the summer intensively with minnow traps and seine net or electroshocker to verify the isolated and single species nature of these populations.

The second level of effort included sampling at least three times during the study at approximately monthly intervals to provide patterns of change in species composition of the population as well as an inference of mean size and therefore growth of salmonid juveniles at each site and within each stream. Standard sets of 5 or 10 minnow ('Gee') traps baited with roe were set overnight, and where catches warranted it population estimates were made by mark

PHOTO 2-5
COHO REARING HABITAT IN CECIL CREEK (#1) MINNOW TRAPPING AT THIS SITE PRODUCED LARGE NUMBERS OF COHO AND DOLLY VARDEN



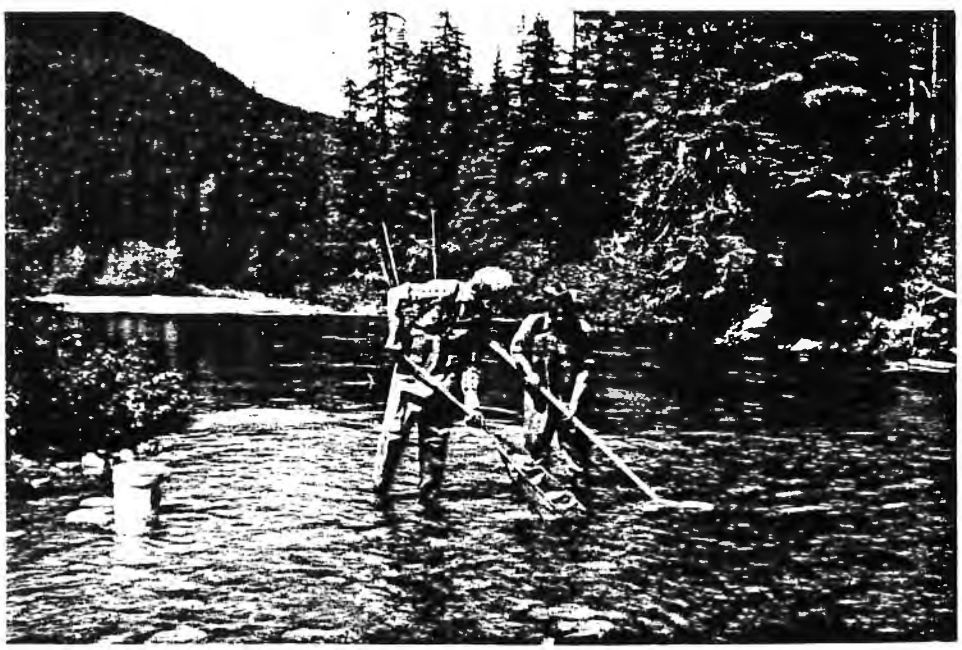


PHOTO 2-6
ELECTROFISHING AT THE MOUTH OF DAVIES-HOULT CREEKS

and recapture. Catches were identified, counted and fork length measurements were taken. When catches were large (>20) a subsample was measured. For population estimates fish were marked in the same manner as for the migration traps and released in the vicinity of the minnow traps. Population estimates were made by the adjusted Peterson method (Ricker, 1975) described earlier. In addition, samples were augmented by beach seining and after June 1, by electroshocking over a standard area. Sites on all tributaries below 32 km on the Kitimat River and the mainstem itself received this attention.

Finally, a third level of effort which required sampling by minnow traps and seine or electroshocker at fixed sites every 2 weeks was implemented in Hirsch and Cecil Creeks with the intention of indicating trends in species composition and mean growth rates per species.

2.3.2 Estuarine Rearing

The Kitimat Estuary and Minette Bay were sampled at biweekly intervals using a combination of beach seine and set net techniques. For sampling purposes the estuary was divided into three areas: Minette Bay, the central estuary between the mouths of the two main river channels and the western estuary adjacent to the Eurocan dock. In each area a set net station (Photos 2-7, 3-8 and 3-9) and a series of regular beach seine stations (Photo 3-6) were established (Figure 1.0-3).

A 15 x 3 m set net with a 6 mm stretch mesh bunt was fished in a manner similar to that described by Levy et al (1979). At each sampling location, stakes to support the net were driven on both sides of the tide channel. When sampling, the net was pulled across the channel and fastened to the stakes just after the tide began to fall (Photo 2-7). As the water dropped (Photo 2-8), fish in the

PHOTO 2-7: SET NET AT HIGH TIDE IN THE EUROCAN TIDAL CHANNEL

PHOTO 2-8: SET NET IN THE ERUOCAN TIDAL CHANNEL DURING FALLING TIDE

channel were trapped behind the net. When only a small amount of water remained in the channel the fish were "herded" down to the net (Photo 3-8). The net was then pursed and the captured fish were transferred to a 125 litre bucket. The catch was identified, counted fork lengths were measured and scale samples were taken from any smolts captured. Beach seine catches were treated in a similar manner.

PART III

RESULTS AND DISCUSSION

3.1 PHYSICAL AND CHEMICAL OBSERVATIONS

3.1.1 Weather

The air temperature, precipitation and sunshine during the study period were recorded by the Atmospheric Environment Service at the Kitimat townsite and the results are shown in Figure 3.1-1 and in Appendix I. The monthly climatic means are compared to the thirty year normals in Table 3.1-1.

Table 3.1-1

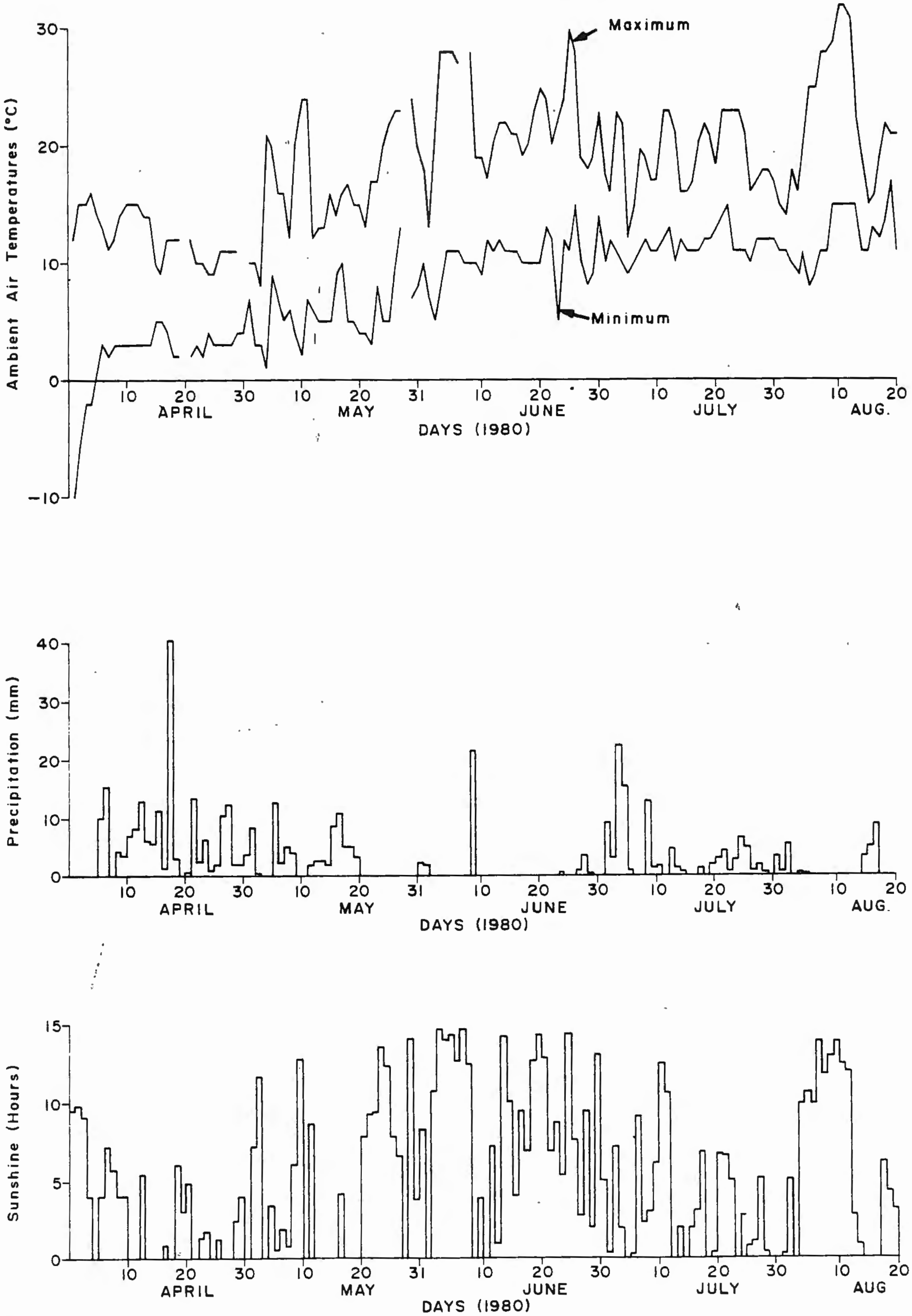
Comparison of 1980 Monthly Climatic Means with 30 year (1941-1970) normals recorded at Kitimat Townsite

	TEMPERATURE (°C)						PRECIPITATION (mm)		SUNSHINE (HOURS)	
	MAXIMUM		MINIMUM		MEAN					
	1980	30 yr	1980	30 yr	1980	30 yr	1980	30 yr	1980	30 yr
APRIL	12.3	10.6	2.0	1.1	7.2	5.8	172	141.0	105	157
MAY	16.4	15.9	5.2	4.6	11.0	10.3	77	74.7	186	211
JUNE	22.3	19.1	10.3	8.9	16.3	14.0	28	58.2	265	201
JULY	19.0	21.1	11.5	11.3	15.3	16.2	109	52.8	100	217
AUGUST	21.0	20.4	10.8	11.4	15.4	15.9	61	81.3	141	173

SOURCE: DOE, Atmospheric Environment, File Data.

The monthly of April was warmer and wetter than normal and the amount of sunshine was below average. In May sunshine was still below average although the rainfall and temperatures were near the normals. There was very little rainfall during June and the sunshine was well above average. The rainfall in July and August was double the seasonal normals and the amount of sunshine was quite low. However the temperatures in both months were close to normal.

Figure 3.1-1 WEATHER RECORD AT KITIMAT TOWNSITE 1980. SOURCE: D.O.E. ATMOSPHERIC ENVIRONMENT SERVICE.



3.1.2 Stream Conditions

Kitimat River

On April 1 at the start of the study period, the maximum and minimum stream temperatures were 8 and 4°C respectively. They rose steadily to 15 and 10°C in June and remained more or less stable until the conclusion of the project August 20 (Figure 3.1-2).

Although the Water Survey of Canada discharge calculations are preliminary and incomplete at the time of writing, they do illustrate the general trend of the Kitimat River discharge (Figure 3.1-3). The warm damp weather of April and May resulted in an earlier and slightly larger freshet than normal (Table 3.1-2). The discharge rose from 40.6 m^3/sec on April 1 to 358 m^3/sec on May 12. Although the sunshine and temperature were above average in June, the discharge began to fall after the middle of the month indicating that the majority of the snowpack was gone. Thereafter the river continued to fall until it reached 59.9 m^3/sec on August 20.

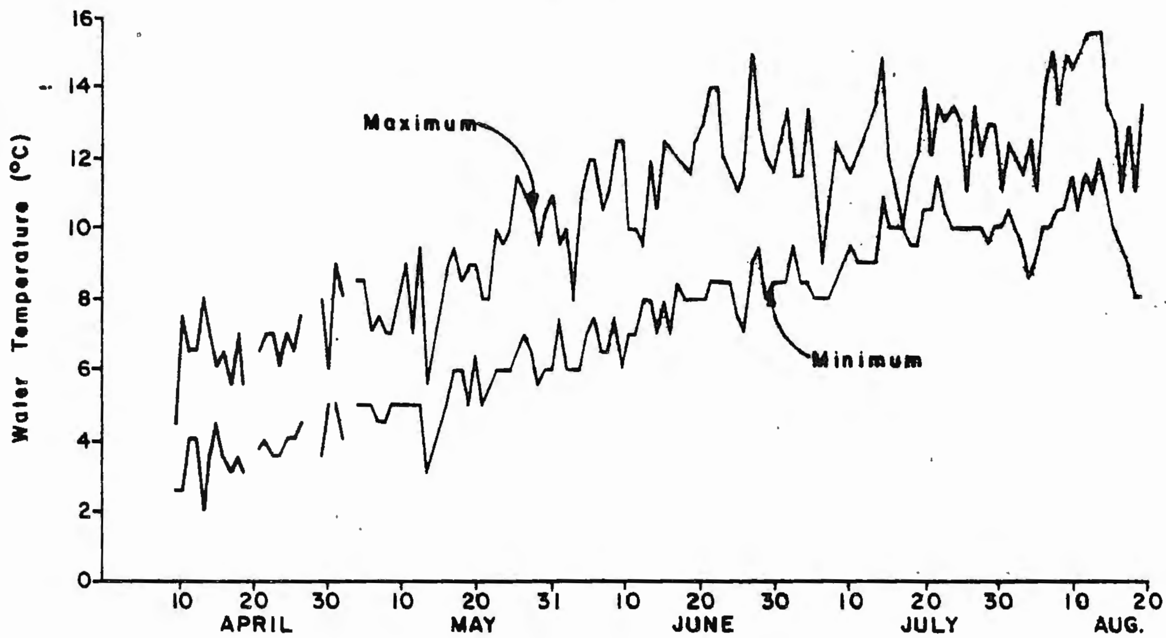
Table 3.1-2

Summary of 1980 Kitimat River Streamflow and Temperature Data

	April	May	June	July	August
Discharge (m^3/sec)*					
mean	100	209	176	122	91.0
maximum	207	358	293	242	173
minimum	40.6	169	96.8	74.5	59.9
14 yr. mean (1967-80)	94.3	200	273	208	153
Temperature (°C)					
mean	4.9	8.1	9.5	11.0	11.7
maximum	8.0	11.5	15.0	15.0	15.5
minimum	2.5	3.0	8.0	8.0	8.0

*DOE, Water Survey of Canada.

Figure 3.1-2 DAILY MAXIMUM AND MINIMUM TEMPERATURES OF THE KITIMAT RIVER NEAR THE INCLINED PLANE TRAP SITE 1980.



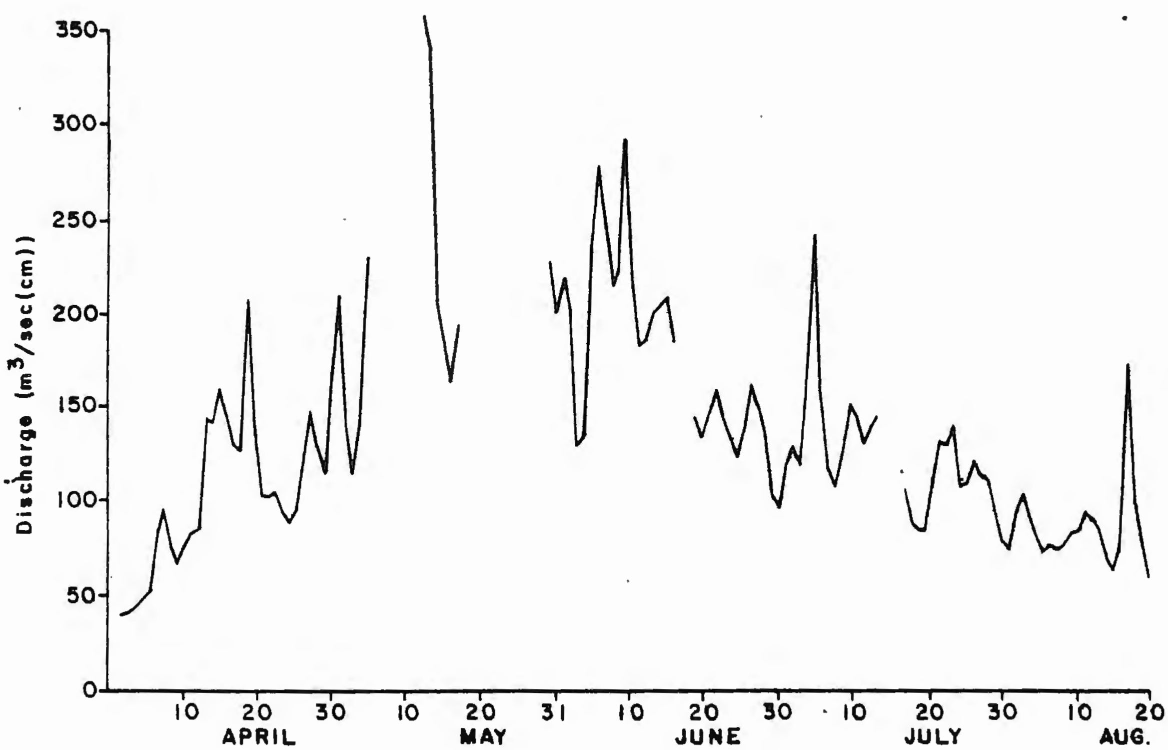


Figure 3.1-3 KITIMAT RIVER DISCHARGE RECORDED BELOW HIRSCH CREEK 1980
SOURCE : D.O.E. WATER SURVEY OF CANADA

Sharp peaks on the discharge record were caused by rain and snowmelt in April and May and by rain alone in June and July. The discharge peak on April 19 which followed heavy rain on April 17 and the maximum discharge of 358 m^3/sec which followed sunshine on May 8, 9 and 11 are typical of the spring condition. Later in the year the spikes on the discharge curve, such as that on July 5, follow periods of rain with a lag time of about twelve hours. Rapid runoff and flash floods are characteristic of the Kitimat system. Extensive areas of clear cut logging in the valley and shallow soils underlain by impermeable clay speed the runoff (Bell and Kallman, 1976).

The results of the water quality analysis and the recommended criteria for salmonid culture are shown in Table 3.1-3. The results are similar to those of the Resource Services Branch (1977) and Hilland (in prep). The mainstem Kitimat River at the Haisla Bridge is generally very soft and although aluminum exceeded the recommended limits and non-filterable residues were above the limits for incubation, most of the parameters were within the recommended limits for fish culture (Shepherd, in prep; Sigma, 1979). In freshet, the water quality decreased. In the samples taken at high water levels, the alkalinity levels were higher while the iron and manganese content approached recommended limits. Nitrates exceeded the limits while the river was up and suspended solids exceeded the recommended limits for rearing.

Hirsch Creek

The daily water temperatures in Hirsch Creek are shown in Figure 3.1-4. On April 6 when the creek was first sampled the maximum and minimum temperatures were 6 and 2°C respectively. They rose steadily to 11.5 and 8.5°C at the end of June. Thereafter they remained more or less constant with the conclusion of the project.

Table 3.1-3

SUMMARY OF WATER QUALITY DATA

Parameter Analysed	Kitimat River		Hirsch Creek		Cecil Creek	
	normal	freshet	normal	freshet	normal	freshet
pH	0	0	0	0		0
Total Alkalinity($CaCO_3$)	0	0	0	0		0
Sulphate (SO_4)	0	0	0	0		0
Cl	0	0	0	0		0
Total PO_4	0	0	0	0		0
Nitrite	0	0	0	0		0
Nitrate	0	0	0	0		0
Total Ammonia	0	0	0	0		0
Silica	0	0	0	0		0
Turbidity	0	0	0	0		0
Conductivity	0	0	0	0		0
Hardness ($CaCO_3$)	X	X	X	X		X
Dissolved As	0	0	0	0		0
Dissolved Ba	0	0	0	0		0
Dissolved Cd	0	0	0	0		0
Dissolved Co	0	0	0	0		0
Dissolved Cr	0	0	0	0		0
Dissolved Cu	0	0	0	0		0
Dissolved Hg	0	0	0	0		0
Dissolved Mn	0	0	0	0		0
Dissolved Mo	0	0	0	0		0
Dissolved Ni	0	0	0	0		0
Dissolved P	0	0	0	0		0
Dissolved Pb	0	0	0	0		0
Dissolved Sb	0	0	0	0		0
Dissolved Se	0	0	0	0		0
Dissolved Sn	0	0	0	0		0
Dissolved Sr	0	0	0	0		0
Dissolved Ti	0	0	0	0		0
Dissolved V	0	0	0	0		0
Dissolved Zn	0	0	0	0		0
Dissolved Al	X	X	X	X		X
Dissolved Fe	0	X	0	0		0
Dissolved Si	0	0	0	0		0
Dissolved Ca	0	0	0	0		0
Dissolved Mg	0	0	0	0		0
Dissolved Na	0	0	0	0		0
Dissolved K	0	0	0	0		0
Filterable residues	0	0	0	0		0
Non filterable residues	X	X	0	X		X

0 - All sample concentrations were within recommended limits (Shepherd, in prep: Sigma , 1979).
X - One or more samples exceeded recommended limits.

The Hirsch Creek stream flow summary in Table 3.1-4 shows a pattern similar to that of the Kitimat River with above average flow in April and May followed by discharges in June through August which were well below seasonal normals.

Table 3.1-4

Summary of Hirsch Creek 1980 Streamflow and Temperature Data

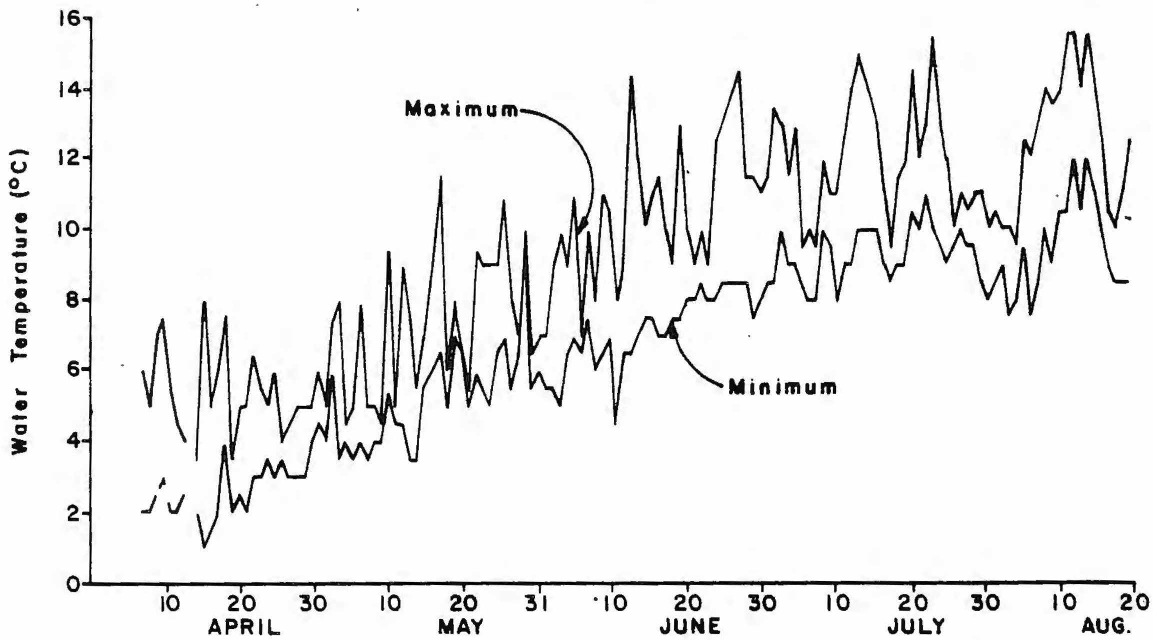
	April	May	June	July	August
Discharge (m^3/sec)*					
Mean	16.7	46.3	31.9	24.2	17.5
Maximum	29.3	71.2	60.5	51.0	46.1
Minimum	5.3	15.6	15.8	15.1	10.8
14 yr Mean (1967-80)	13.4	35.2	49.7	36.5	24.0
Temperature (°C)					
Mean	4.4	6.3	8.7	10.5	11.0
Maximum	7.5	11.5	14.5	15.5	15.5
Minimum	1.0	3.5	4.5	8.0	7.5

*DOE, Water Survey of Canada.

The general trend was a rise from 5.29 m^3/sec in early April to a mean of 40 m^3/sec in early June and a slow decline thereafter. The highly variable nature of Hirsch Creek streamflow is shown in Figure 3.1-5. Daily variations in discharge of up to 100% were not uncommon during the study period. Most of the spikes in the discharge record occur on the same days as those in the Kitimat River and can be ascribed to similar causes although their proportionate effect on Hirsch Creek was much greater.

Like the Kitimat River, the water of Hirsch Creek was softer than recommended for rearing salmonids. However, the results of analyses summarized in Table 3.1-3 show that all of the other parameters were within the recommended limits except during freshets. At high water aluminum and suspended solids exceeded the limits.

Figure 3.1—4 DAILY MAXIMUM AND MINIMUM TEMPERATURES RECORDED IN HIRSCH CREEK CREEK NEAR THE FYKE TRAP SITE 1980.



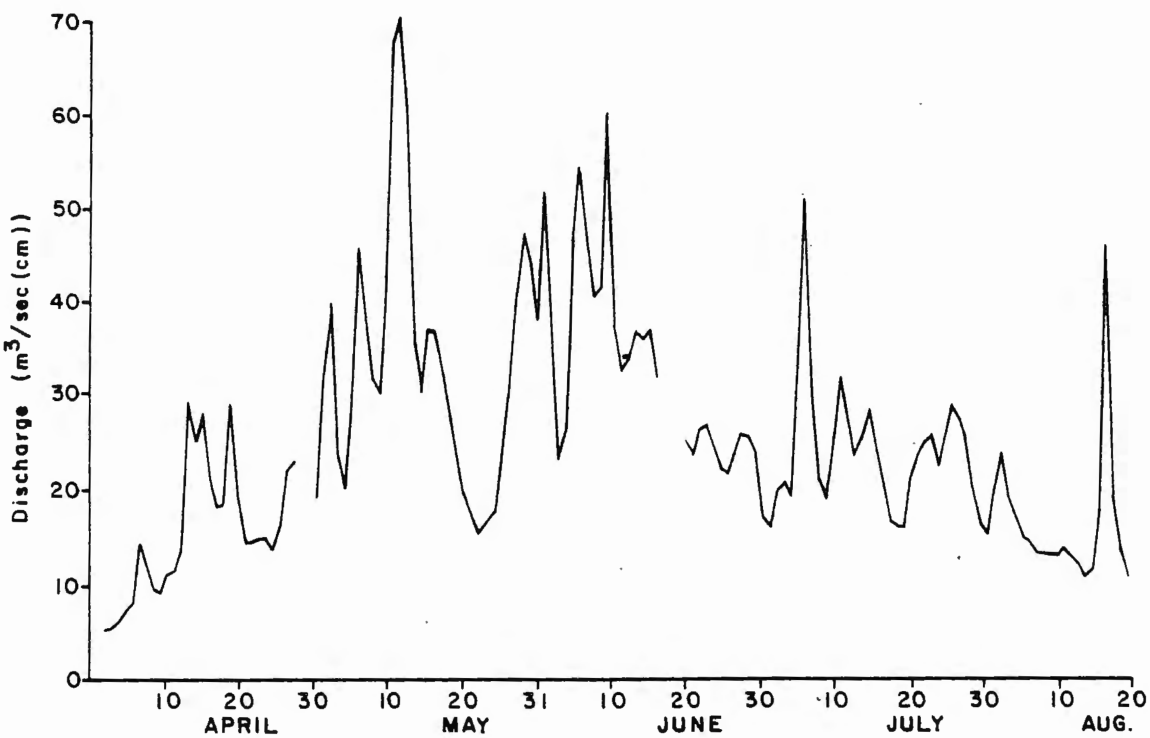


Figure 3.1—5 DAILY DISCHARGE RECORDED NEAR THE MOUTH OF HIRSCH CREEK 1980. SOURCE : D.O.E. WATER SURVEY OF CANADA

Cecil Creek

The flow regime of Cecil Creek is much more stable than those of the Kitimat River or Hirsch Creek. Both the temperatures shown in Figure 3.1-6 and the discharge (Figure 3.1-7) exhibit far less daily variation than the other streams. Cecil Creek drains a water shed of fairly low elevation and the effects of snowmelt are thus quite brief. In addition the creek flows through some swampy ponds and deep braided areas which have a stabilizing effect.

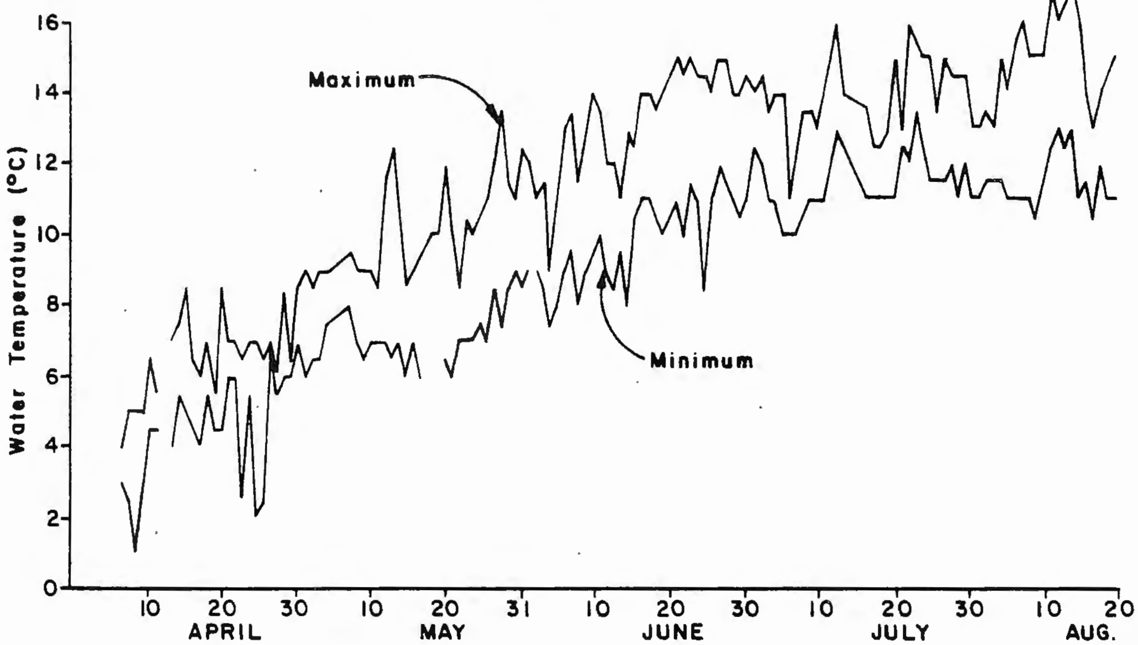
At the start of the study on April 6 the daily maximum and minimum temperatures in Cecil Creek were 4 and 1°C respectively. They rose steadily until the end of June at which time the average maximum was about 15°C and the minimum 10°C. The temperatures tended to remain relatively constant throughout July and August. The monthly mean temperatures and ranges in Cecil Creek are shown in Table 3.1-5.

Table 3.1-5
Summary of Cecil Creek 1980 Streamflow and Temperature Data

	April	May	June	July	August
Discharge (m^3/sec)					
Mean	4.3	3.1	1.7	1.3	0.8
Maximum	8.4	4.6	2.5	2.6	1.2
Minimum	2.5	1.7	1.2	0.9	0.6
Temperature (°C)					
Mean	5.4	8.7	11.6	12.2	13.2
Maximum	8.5	13.5	15.0	16.0	17.0
Minimum	1.0	6.0	7.5	10.0	10.5

The discharge of Cecil Creek was 3.9 m^3/sec when first measured on April 6. There was a sharp peak of 8.47 m^3 on April 19 similar to that observed on the Kitimat River and Hirsch Creek, and a second peak of 6.61 m^3/sec on April 28 after heavy rain on the 27th and

Figure 3.1-6 DAILY MAXIMUM AND MINIMUM TEMPERATURES RECORDED IN CECIL CREEK AT THE FYKE TRAP SITE 1980.



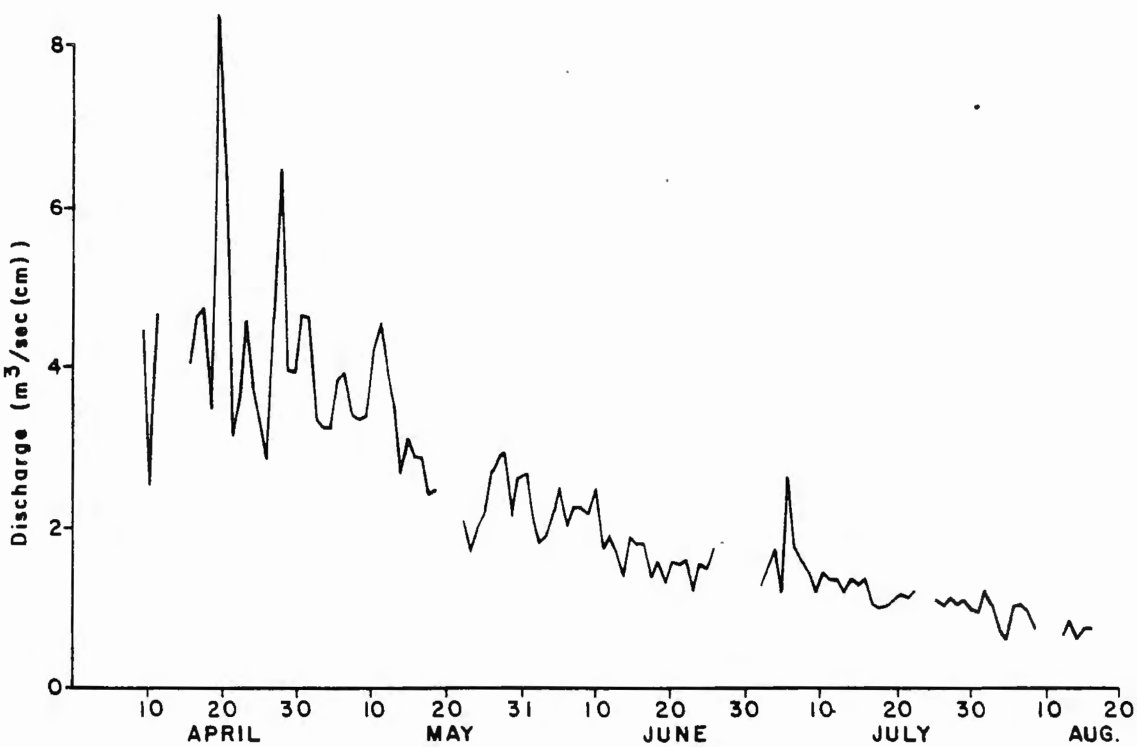


FIGURE 3.1-7 CECIL CREEK DISCHARGE RECORDED NEAR THE FYKE NET SITE 1980.

28th of the month. With these exceptions the discharge was relatively consistent and declined slowly to 0.94 m^3/sec when last sampled on August 19.

Cecil Creek water samples were taken only during the spring freshet. On those occasions the water hardness was below the recommended levels while aluminum and suspended solids exceeded the limits. The total phosphates exceeded the limits in the April 7 sample. Later in the year, as discharge decreased, it was observed that the stream had a deep brown stain which was probably due to the swamps it drains.

3.1.3 Temperatures and Salinity in Kitimat Arm

As described in Section 2.1.3, salinity measurements were taken at weekly intervals at surface, 2 m and 5 m depths at 4 sites; Moon Bay just south of the Rivtow docks, mid-channel off the Eurocan dock, 50 m off the MK Bay boom buoys, and in the centre of Minette Bay. Persistent calibration problems with both salinity meters used have, however, rendered the resulting data (Appendix IV) of limited usefulness. The following general comments are therefore made with reference to unpublished data by Higgins and Schmidt (1976) collected in 1974-75 and unrelated to tidal cycles. Considering the lack of data these comments are as yet unsubstantiated and are offered here only in the context of discussing possible net pen sites. Further measurements will be required.

Minette Bay is a short inlet off the estuary separated from the open arm by tidal flats and drained by a narrow channel which probably limits flooding of the system. The bay is characterized by fairly low salinities at shallow depths (<5 m). Our measurements frequently suggest <5 ‰ salinity in the central bay down to 5 m. Higgins and Schmidt reported 8.4 ‰ salinity at 0 m, 12.7 ‰ at 2 m and 15 ‰ at 5 m in Minette Bay on August 30, 1974

While fairly high in comparison to our data, these measurements are significantly lower than salinities taken the same day by Higgins and Schmidt in the open arm.

MK Bay on the east side of the Kitimat Arm is frequently exposed to the south winds. The river flow veers away from the side of the channel towards the west and as such salinity measurements at MK Bay tends to be slightly higher than those at the other sites sampled. Higgins and Schmidt frequently found such a relationship as indicated below:

Salinity Measurements taken July 26, 1975

Depth (m)	Moon Bay	Salinity (‰) Center Channel	MK Bay
0	0.79	0.94	0.51
2	0.79	0.94	2.34
5	3.28	9.39	9.05

Webster (1980) also suggested a similar cross channel salinity profile.

Moon Bay on the west side of the arm is a shallow dish-shaped bay that is somewhat protected from the prevalent winds and fairly deep (18 m). As previously mentioned, the Kitimat River flow tends to be deflected towards the west shore of the arm and as such Moon Bay consistently appears to have slightly lower salinities than MK Bay.

Temperatures regimes throughout the area sampled seem quite consistent despite the low flushing rate in Minette Bay and river flow pattern suggested above. Minette Bay was at times slightly warmer than the other sites and MK Bay slightly cooler. In general, the entire area appears to reflect the water temperatures of the Kitimat River. Temporally, temperatures rose from the 6-10°C range in April, to 8-11°C in May, 12-15°C in June and July, and 14-15°C in August.

3.2 OUTMIGRATION

Fry outmigration was monitored by an inclined plane trap set on the Kitimat River and fyke nets set at the lower limits of both Hirsch and Cecil Creek. Outmigration composition and timing was highly reflective of the extent of spawning stock utilization and timing in the drainage. Data analysis has indicated that project initiation should have occurred in March if all species migration peaks were to have been documented. Population estimates were derived to aid in discussing the accuracy of escapement figures and survival standards. Mark and recapture tests used in calculating these estimates are listed in Table 3.2-1. Spawning stock utilization and subsequent data omissions are discussed briefly below.

A major proportion of the pink adult stock spawn in the mainstem Kitimat River and Hirsch Creek. Odd year mainstem spawners are found as far upstream as the Little Wedeene River although fish have been noted in Cecil Creek and Humphreys Creek (Walker et al, 1972; update by Cousens et al, 1979) (Hilland, in prep). Previous outmigration studies in the system have been designed for other species and have concentrated on migration after April (Hilland, in prep). Documentation of fry migration early in March has been noted in

Table 3.2-1

Successful Mark and Recapture Tests conducted on Migratory populations in the Kitimat drainage in 1980

Stream	Species	Dates Sampled*	Total Marks Released (M)	Total Captures (C)	Total Marks Recaptured (R)	Estimate (N)
Kitimat R.	Chum fry	April 8-11	1074	2437	24	104834±40090
		April 14-15	818	143	12	9072±4533
	Coho fry	July 7-9	505	14	5	1265±726
Hirsch Creek	Pink fry	April 21-22	170	118	7	2544±1605
	Chum fry	April 21-23	265	715	18	10024±4335
	Coho fry	May 31-June 2	196	303	6	8555±5860
		June 25-26	400	201	6	11572±7879
		July 5-7	355	251	17	4984±2160
Cecil Creek	Chinook fry	May 13-14	15	9	4	32±18
	Coho fry	May 8-11	123	177	7	2759±1762
		May 13-14	240	172	32	1263±382
		May 21-23	237	263	13	4488±2210
		May 29-31	181	75	8	1537±894
		June 3-4	836	272	40	5573±1554
		June 7-8	998	242	36	6461±1891

*Note: The initial data refers to the day of release, the latter refers to the last day recaptures were taken.

other north coast rivers (eg. Atnarko River; Hilland, 1977). Unfortunately, the 1980 study was also initiated in April with the result that at least an estimated 75-80% of the outmigration of pink fry in the mainstem may not have been monitored.

Chum salmon spawners in the Kitimat River system have historically numbered as high as 20,000 to 35,000 adults, and spawn as far upstream as Chist Creek, occasionally migrating as far as the mouth of Davies-Hoult Creeks (Walker et al, 1972). The 1979 escapement, though, was low (3,880) as a result of the 1975 escapement of 1,000 fish. Consequently, the fry outmigrant estimates and the timing of fry migration may not entirely reflect the historical average for the species. In addition, chum migration also probably began in March and thus the early run was not monitored in this study. Again, outmigration studies in the Bella Coola documented chum fry migration in March (R. Hilland, pers. comm.).

Chinook escapements to the Kitimat River system were estimated at 2,795 in 1979 (M. Peters, pers. comm.). Adult spawning runs disperse throughout the system with the main concentration of spawning located from Chist Creek downstream (Walker et al, 1972). However, the rearing survey which was concurrent with these migratory studies located concentrations of rearing chinook above Davies Rapids and small numbers were found as far upstream as the headwaters of the Kitimat River (see Section 3.3.3), thus suggesting that escapement estimates may be low. Chinook fry migrations in March was also missed in this study.

Coho spawn throughout most of the Kitimat River and its tributaries (Walker et al, 1972). In 1979, a total of 5,875 adults were estimated to have spawned in the system with 150 of these in Hirsch Creek (M. Peters, J.A. MacDonald, pers. comm.). Cecil Creek, for which escapements were not enumerated separately until 1980, is estimated to provide spawning area for roughly 10% of the total coho escapements in any one year (J.A. MacDonald, pers. comm.). Data analysis of fry outmigrant abundance suggests that estimated escapements of coho are low, a not unusual possibility considering adult migration continues into October and even late December (M. Drewes, pers. comm.). Coho outmigration occurs in summer just prior to a trout fry migration with the result that some confusion in identification of the two species makes data for that period just prior to July 17 suspect.

3.2.1 Pink Salmon

Of the portion of the pink fry run that was monitored in the Kitimat River, 50% of the fry outmigrated within 4 days of the initiation of trapping on April 7, and the run was 90% complete on April 23 (Figure 3.2-1). Juvenile pink outmigrations are often characterized by single large peaks in migration (Walker, 1970; MacDonald, 1960) which would result in similar seasonal patterns. A peak catch of 164 fry occurred April 8, and a second smaller peak of 26 fry occurred April 23. The pattern of pink fry outmigration from Hirsch Creek was fully monitored over the peak period of migration from April 20 to 30 (Figure 3.2-3). The peak catch of 406 fry was taken on April 23, concurrent with the Kitimat Creek secondary peak.

Hirsch Creek was characterized by cold water temperatures early in the field study (Figure 3.1-4) and was observed to be edged by ice shelves well into April. Colder water and intragravel temperatures are often instrumental in slowing development rates, thus delaying emergence (Murray, 1980) and probably resulting in delayed outmigration. In Hirsch Creek, 10% of the downstream migration of pink fry occurred by April 21, 50% by April 23, and 90% by April 26 (Table 3.2-2).

Table 3.2-2

Percent Timing in Pink and Chum Fry Outmigrations in the Kitimat River and Hirsch Creek, 1980

Stream	Species	10%	50%	90%
Kitimat River	Pink	April 8	April 11	April 23
	Chum	April 8	April 12	April 19
Hirsch Creek	Pink	April 21	April 23	April 26
	Chum	April 7	April 21	April 25

In Cecil Creek only one pink fry was collected (on April 9). Because Cecil Creek is warmer than Hirsch Creek, it is likely that the migration occurred prior to the start of the study.

Diel variation in migration in the Kitimat River mainstem approximates that found by Walker (1970) in the Yakoun River. In the Kitimat River, an average of 80% of the daily catch occurred at night. However, during peak migration from April 8 to 11 diurnal catches increased to 25% of the total catch. MacDonald (1960) notes that pink salmon fry continue downstream movement into and throughout daylight hours when faced with a lengthy migratory route. In contrast, minimal day time movement (<1.0%) of fry was monitored in Hirsch Creek (Table 3.2-3).

Table 3.2-3

Diel Periodicity in Pink Fry Migrations in the Kitimat System in 1980

	Proportionate Migration	
Stream	Diurnal	Nocturnal
Kitimat River	0.209	0.79
Hirsch Creek	0.002	0.998

Figure 3.2-1 KITIMAT RIVER: NIGHTLY AND DAILY INCLINE PLANE MIGRATORY CATCHES OF PINK FRY FOR APRIL 8 - MAY 31, 1980.
•—NIGHTLY CATCH
■—DAILY CATCH

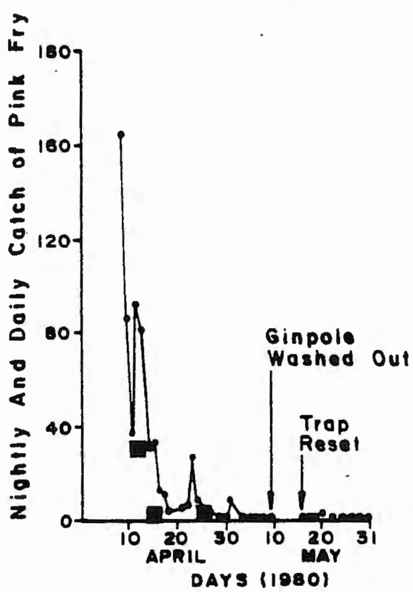


Figure 3.2-3 HIRSCH CREEK: NIGHTLY AND DAILY FYKE NET MIGRATORY CATCH OF PINK FRY APRIL TO MAY 1980.
•—NIGHTLY CATCH
■—DAILY CATCH

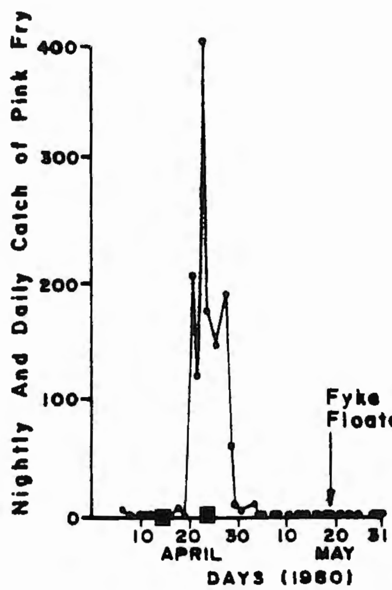


Figure 3.2-2 MEAN FORK LENGTH (mm) AND WEIGHT (g) FOR MIGRATING PINK FRY SAMPLED FROM KITIMAT RIVER I.P.T. CATCHES APRIL - MAY 1980.

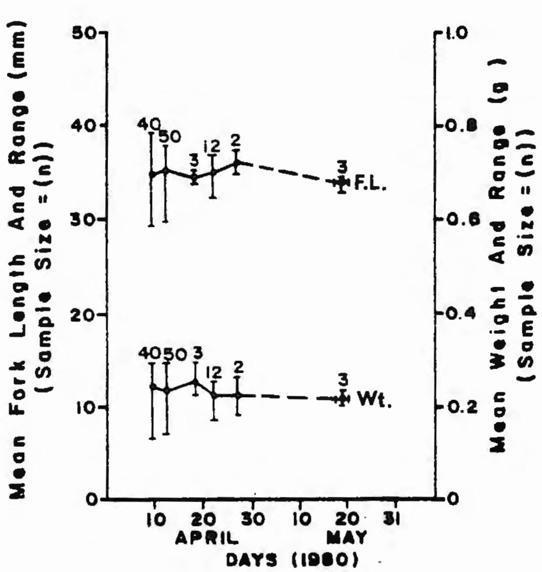
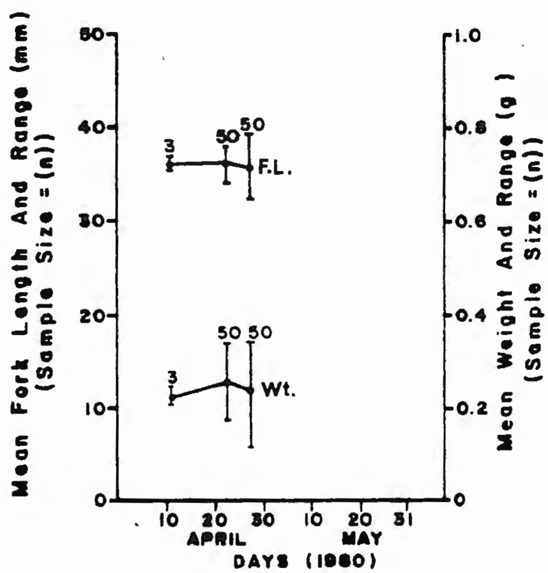


Figure 3.2-4 MEAN FORK LENGTH (mm) AND WEIGHT (g) AND RANGES FOR MIGRATING PINK FRY SAMPLED FROM THE HIRSCH FYKE NET APRIL - MAY 1980.



The potential 1980 pink salmon fry production of the Kitimat River was calculated from the 1979 escapement estimates and the S.E.P. standards (Lill et al, 1979). The results are shown in Table 3.2-4. Unfortunately the inclined plane trap efficiency tests were insufficient to provide an estimate of the actual population for comparison.

The total fry population migrating from Hirsch Creek above the fyke net was estimated to be 38,800 ± 24,500. As indicated in Table 3.2-5, even the lower confidence limit of such an estimate (14,300) does not closely approximate the total potential fry production of the 1979 pink escapement, which was estimated to be 40 adults. Based on the above fry estimate, and assuming S.E.P. survival standards (Lill et al, 1979) and a 1:1 sex ratio, an estimated 400 pink should have spawned in Hirsch Creek in 1979, with a lower confidence limit of 160. It therefore appears that the escapement estimates for pink salmon in Hirsch Creek are somewhat low.

Length and weight data are tabulated in Appendix V and summarized in Figure 3.2-2. In the Kitimat River, mean fry length varied from 33.5 ± 0.9 mm to 35.8 ± 1.8 mm during the run (range from 29.0 mm to 37.5 mm). Mean fry weight varied slightly from 0.21 ± 0.02 g to 0.25 ± 0.04 g (range 0.13 to 0.29 grams). Similar trends for mean fork length and weight were observed in the Hirsch Creek samples (31.5 ± 1.6 mm to 35.7 ± 1.1 mm; 0.22 ± 0.02 g to 0.25 ± 0.04 g).

No significant increment in size was evident in the pink fry migrating from the system. Increased variability in early Kitimat mainstem fry is probably accounted for by larger sample sizes. Development indices were calculated from the relationship

TABLE 3.2-4

Potential fry production for the Kitimat River for 1979 escapements, and comparable estimated fry migration based on mark recapture tests

Species	[1] Adult Escapement (1979)	[2] Sex Ratio ♂/♀	[3] Fecundity	Potential Egg Deposition	[4] Net Egg Deposition	[5] S.E.P. Egg-Fry Survival	Potential Fry Production	Estimated Fry Migration
Sockeye	400	1/1	3,000	600,000	594,000	.15	89,100	N.P.
Pink	3675	1/1	1,500	2,756,250	2,714,900	.12	325,788	N.P.
Chum	3880	1/1.3	2,500	5,482,610	5,400,370	.14	756,052	459,200± 187,700
Chinook	2795	2/1	8,000	7,378,800	7,305,012	.15	1,095,752	N.P.
Coho	5875	1/1	2,500	7,343,750	7,343,750	.15	1,090,547	N.P.

1 source: M. Peters, S.E.P. Planning
2 source: Chum - S. Willis, Kitimat Hatchery; Chinook - R. Hilland, in prep.; others - assumed 1/1
3 source: Chinook - R. Hilland, in prep.; others - Lill et al, 1979
4 egg retention source: Chum - Bakkala, 1970 for Hooknose Ck.; Pink - Hooknose Ck.; Hunter, 1959; others - assumed limited retention ie 1%
5 source: Lill et al, 1979
N.P. - Not Possible, Mark-Recapture tests unsuccessful

TABLE 3.2-5

Potential fry production for Hirsch Creek for 1979 escapements, and comparable estimated fry migration based on mark-recapture tests.

Species	[1] Adult Escapement (1979)	[2] Sex Ratio ♂/♀	[3] Fecundity	Potential Egg Deposition	[4] Net Egg Deposition	[5] S.E.P. Egg-Fry Survival	Potential Fry Production	Estimated Fry Migration
Pink	40	1/1	1500	30,000	29,550	.12	3,560	38,800 ± 24,500
Chum	500	1/1.3	2500	706,520	699,455	.14	97,920	43,600 ± 18,800
Chinook	100	2/1	8000	266,700	264,030	.15	39,600	N.P.
Coho	150	1/1	2500	187,500	185,625	.15	27,840	189,800 ± 12,400

1 source: J.A, MacDonald, D.F.O. Kitimat
2 source: as for Table 3.2-1
3 source: "
4 source: "
5 source: "
N.P. - Not Possible, Mark-Recapture tests unsuccessful

$$K_D = \frac{10\sqrt[3]{\text{weight (mg)}}}{\text{length (mm)}}$$

and tended to support this conclusion (Table 3.2-6). While some variation is present in Kitimat River samples (1.686 to 1.887), no trend of change is evident. In the Hirsch Creek fry, the development index remained fairly constant (range 1.701 to 1.765). Bams (1970) suggests K_D values of less than 1.88 indicate "late" migrant pink fry.

Table 3.2-6

Mean Developmental Indices (K_D) of Pink Salmon collected in 1980

Kitimat River			Hirsch Creek		
Date	Sample Size	K_D	Date	Sample Size	K_D
April 09	40	1.810	April 11	3	1.701
April 12	50	1.751	April 23	50	1.765
April 18	3	1.842	April 28	50	1.746
April 22	12	1.887			
April 27	2	1.686			
May 18-21	3	1.774			

3.2.2 Chum Salmon

Chum fry are known to emerge from the gravel at about the same time as pink fry, given similar temperature conditions and spawning times (Hunter, 1959). It is not unusual, therefore, for outmigration timing to closely parallel that of pink fry (Figure 3.2-1 and 3.2-3 and Table 3.2-2). While migration immediately after emergence is the general rule (Bakkala, 1970; Neave, 1966), incidents of chum fry actively rearing for a short time in freshwater prior to migration have been documented (Bams, 1970). Some indication of in-stream growth, then, may be expected in the pattern of change in fork length and weight of fry during the period of migration (Figure 3.2-6).

Chum fry migration in the Kitimat River mainstem continued from trap installation on April 8 until June 4. The majority of the migration occurred prior to April 30. The largest catch of 1,821 chum fry coincided with trap installation on the night of April 8 but the trend suggests the peak migration may have occurred earlier. Secondary peaks occurred during the month as the magnitude of migration decreased. (Figure 3.2-5), which may reflect migrations from tributary spawning grounds. A final peak April 23 (213 fry) coincided with peak migration in Hirsch Creek (Figure 3.2-7). As further evidence, two marked chum fry caught in the incline plane trap on April 22 could only have come from Hirsch Creek where a mark-recapture experiment had been initiated April 21. In general, at least 50% of the observed Kitimat River outmigration occurred by April 12 with 90% of the fry outmigrating by April 19 (Table 3.2-2).

The chum fry migration from Hirsch Creek occurred somewhat later from April 20 to 29 than in the Kitimat mainstem (Figure 3.2-7). As with pink fry, colder water temperatures probably resulted in delayed outmigration. The fyke net trap was installed April 6; 10% of the chum fry outmigration in the creek occurred by April 7, 50% by April 21, 90% by April 25 and by April 29 was complete (Table 3.2-2). A peak catch of 363 chum fry occurred April 22 in Hirsch Creek.

In Cecil Creek, only one chum fry was sampled in the fyke net. It was collected on April 9; trap installation had occurred April 7. Warmer water temperatures and higher relative discharge may have resulted in earlier fry migration, but observations in 1979 and 1980 noted that major spawning of chum salmon occurred downstream of the fyke net site (Hilland, pers. comm.). The study may have missed the main chum migration by placing the migratory trap 1/2 mile upstream of the creek mouth, and just upstream of the main chum spawning area in the stream.

Figure 3.2-5 KITIMAT RIVER: NIGHTLY AND DAILY I.P.T. MIGRATORY CATCHES OF CHUM FRY FOR APRIL TO MAY 1980.
• — NIGHTLY CATCH
■ — DAILY CATCH

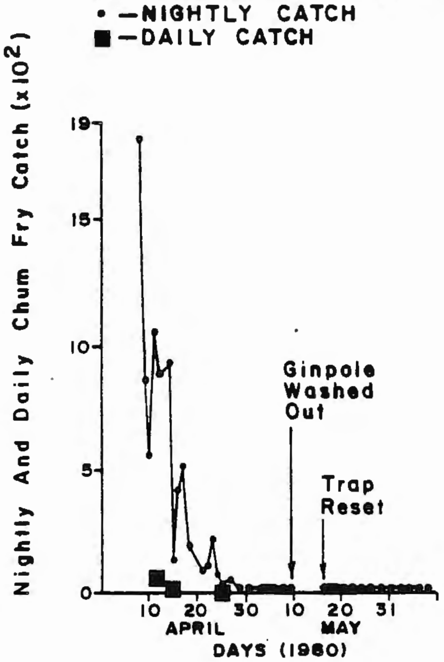


Figure 3.2-7 HIRSCH CREEK: NIGHTLY AND DAILY FYKE NET MIGRATORY TRAP CATCHES OF CHUM FRY FOR APRIL TO MAY 1980
• — NIGHTLY CATCH
■ — DAILY CATCH

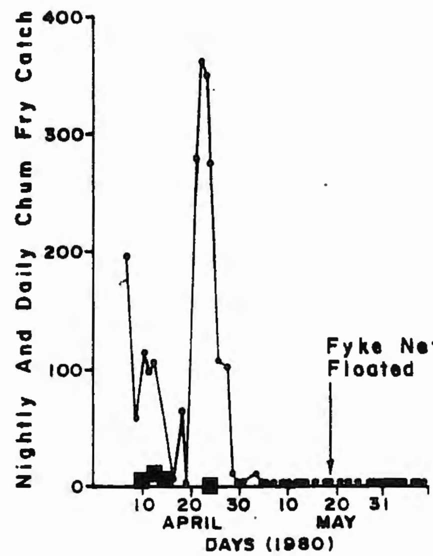


Figure 3.2-6
MEAN FORK LENGTH (mm) AND WEIGHT (g) FOR MIGRATING CHUM FRY SAMPLED FROM THE KITIMAT I.P.T. CATCHES APRIL TO MAY 1980.

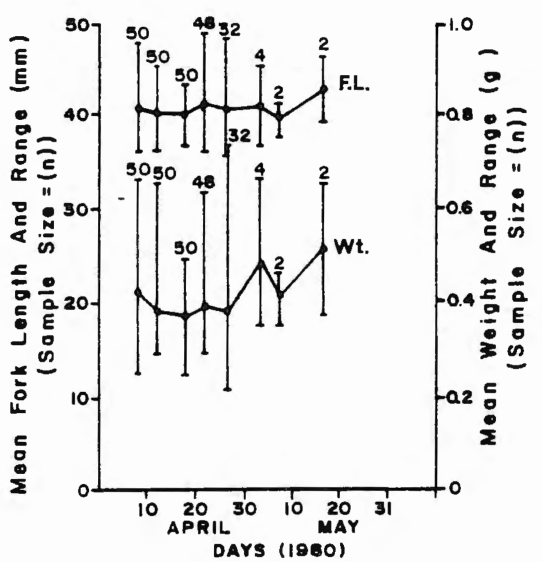
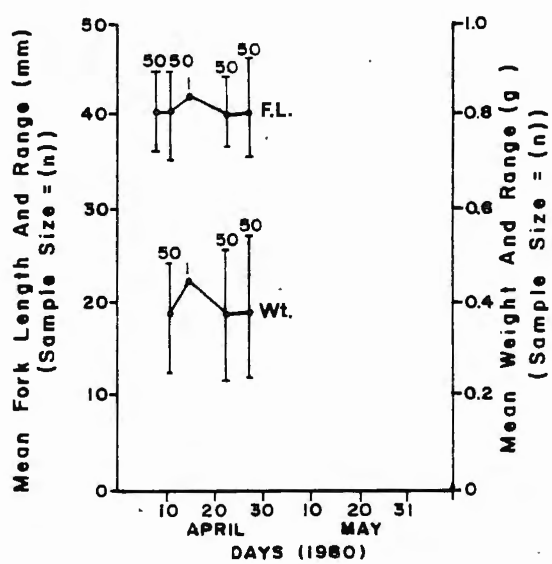


Figure 3.2-8
MEAN FORK LENGTH (mm) AND WEIGHT (g) AND RANGES FOR MIGRATING CHUM FRY SAMPLED FROM THE HIRSCH CREEK FYKE NET. (APRIL — MAY 1980)



Chum primarily migrate at night as shown in Table 3.2-7. The slightly larger value for diurnal movement in the Kitimat River, while not significant, may reflect the more lengthy migratory route being negotiated.

Table 3.2-7

Diel Periodicity in Chum Fry Migrations
in the Kitimat River and Hirsch Creek, 1980

	Proportionate Migration	
Stream	Diurnal	Nocturnal
Kitimat River	0.058	0.942
Hirsch Creek	0.019	0.981

Trap efficiency tests were conducted in both the Kitimat River mainstem, and Hirsch Creek. In the Kitimat River, the total estimated chum outmigration for the study period was 459,200 ± 187,000 fry. Based on chum escapements for 1979, S.E.P. survival factors (Lill et al, 1979), and known chum sex ratios for the system, about 756,000 outmigrant fry would have been expected this year assuming 14% egg to fry survival (Table 3.2-4). If the numbers of adults and fry are assumed to be accurate, then the estimated chum fry outmigration for the study period suggests that either 40% of the migration in the Kitimat occurred before April 8 or the egg to fry survivals were lower than the standard.

The total chum fry population outmigrating from Hirsch Creek was estimated at 43,600 ± 18,800 fry. Considering chum escapements for 1979 of 500 adults (Table 3.2-5), the expected outmigration would total approximately 97,900 fry at 14% egg to fry survival. Therefore, either the peak shown in Figure 3.2-7 was secondary and 50-60% of the migration from Hirsch Creek occurred prior to April 6 or the egg to fry survival was about 6%.

In the Kitimat River the mean length of migrating chum fry varied from 39.3 ± 2.8 mm to 42.5 ± 4.9 mm (range 35.5 to 48.5 mm). Similarly mean weight spanned from 0.37 ± 0.06 g to 0.51 ± 0.02 g (range of 0.21 to 0.74 g). Trends in both length and weight were noted (Figure 3.2-6). Mean size and variability were relatively large on the first sampling date and fell slightly until April 20 when the migration was almost complete. Mean length and weight then rose, reaching a maximum on May 18, the last date sampled. Similarly, an increase in the standard deviation of the means was observed. The increase in size and standard deviation suggest rearing fry mixed with and ultimately replaced the migrating emergent cohort. Mean development indices (Appendix VI) follow a similar pattern (Table 3.2-8)

Table 3.2-8

Mean Development Indices (K_D) of Chum Salmon Collected in 1980

Kitimat River			Hirsch Creek		
Date	Sample Size	$\bar{K_D}$	Date	Sample Size	$\bar{K_D}$
April 08	50	1.849	April 11	50	1.786
April 12	50	1.820	April 15	1	1.825
April 18	50	1.799	April 23	50	1.808
April 22	48	1.782	April 28	50	1.806
April 27	32	1.797			
May 04	4	1.914			
May 08	2	1.890			
May 17-18	2	1.880			

In comparison, the delayed migration (in Hirsch Creek) was characterized by rather more consistent mean lengths and weights (Figure 3.2-8). Mean fork length varied from 39.7 ± 1.8 mm to

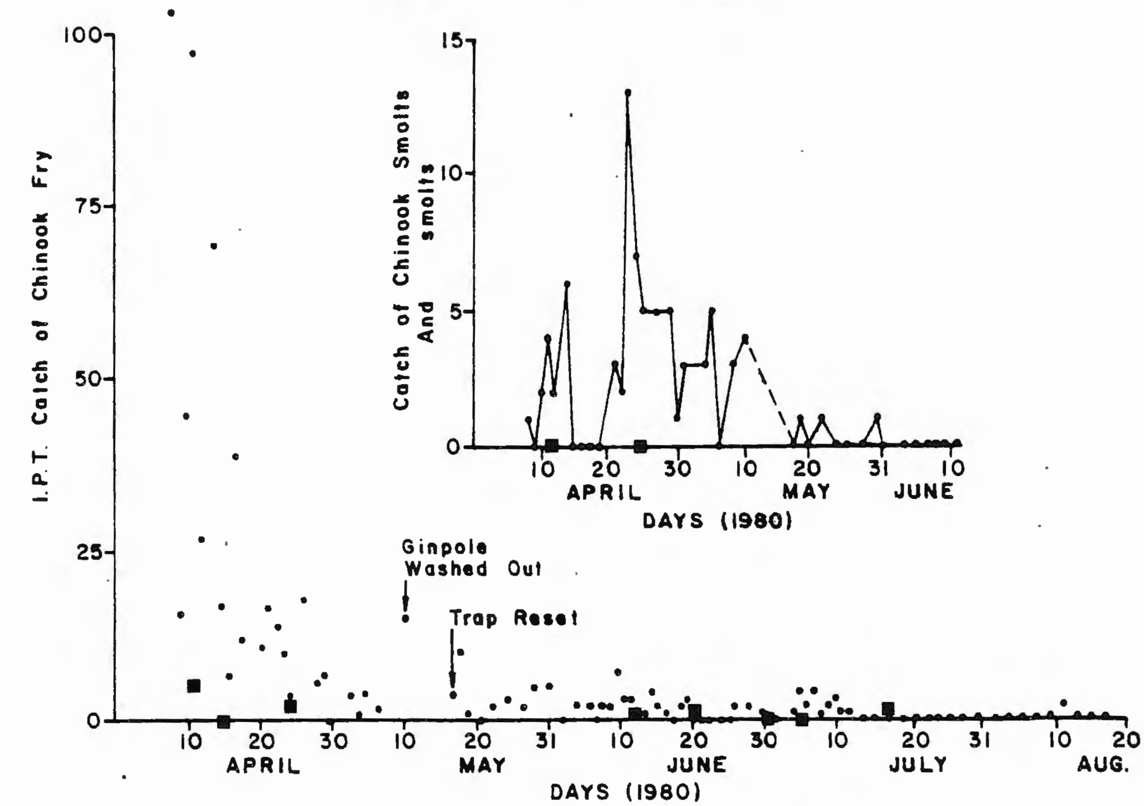
40.2 ± 2.4 mm, if one eliminates the April 15 sample due to low sample size (n=1). Mean weight varied from 0.37 ± 0.06 g to 0.38 ± 0.07 g, and mean developmental indices ranged from 1.786 to 1.808. Such consistency in migration size indicates continuous recruitment of recent emergents and suggests less rearing time for chum fry collected in Hirsch Creek than in the Kitimat mainstem. Such differences can be explained on the basis of migratory distance.

3.2.3 Chinook Fry

Chinook fry emerge from the gravel between the months of March and June (Schmidt et al, 1979) and several rearing and migration patterns have been observed. Outmigration of the juveniles has been monitored in several British Columbia south coast streams including the Cowichan River (Lister et al, 1971) and the Nanaimo River (Healey, 1980). In most cases, the majority of chinook migrate as fry to the estuary soon after emergence. The remainder take up residence in their natal streams. A second outmigration of juveniles occurs after 60 to 90 days of stream rearing. It is this second life history type that contributes dominantly to adult returns in many southern rivers (Reimers, 1973). Finally, many chinook fry remain to overwinter in freshwater, migrating downstream in April and May of the following spring. Northern streams have been shown to have a considerable incidence of these sub-2 (or 1+) life history types (Meehan and Siniff, 1962; Hilland, in prep). Previous studies though, have suggested that most Kitimat chinook migrate downstream within the first several months following emergence (Hilland, in prep.).

In the present study, outmigration of chinook juveniles from the Kitimat River was apparently unimodal (Figure 3.2-9) and occurred from early April to late May in agreement with Hilland (in prep). A peak fry catch of 104 fry occurred April 10. Emergent fry migration

Figure 3.2—9 KITIMAT RIVER INCLINE PLANE TRAP NIGHTLY CHINOOK CATCHES FOR APRIL TO AUG. 1980



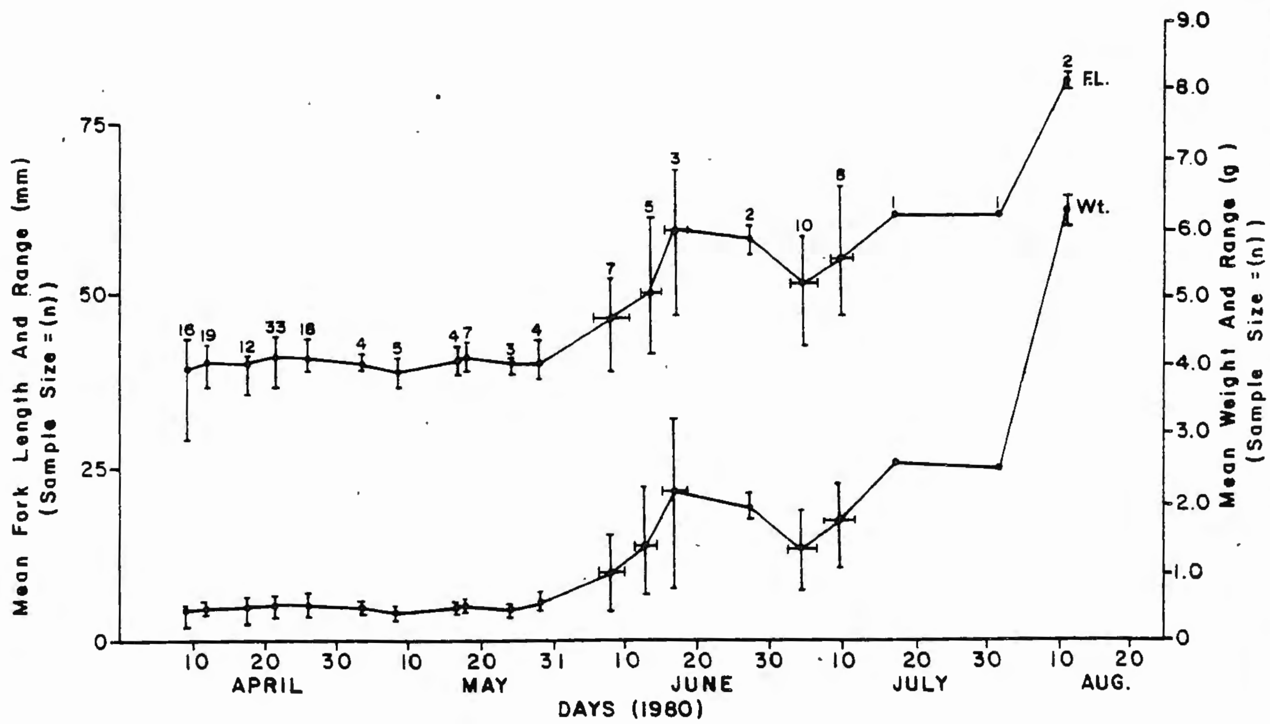


Figure 3.2—10 MEAN FORK LENGTH AND WEIGHT FOR MIGRATING JUVENILE CHINOOK CAPTURED IN KITIMAT RIVER INCLINE PLANE TRAP APRIL TO AUG. 1980.

decreased thereafter to minimal numbers by June. Subsequently, "90-day" juveniles (fingerlings) were present in the migration, initially mixing with the final few emergent fry as indicated by mean length and weight analyses (Figure 3.2-10). The fingerling migration occurred primarily from June 4 to July 18 with the odd fingerling taken as late as August 12. Migration was limited to two small peaks; June 10 with 7 juveniles and July 5 to 7 with 4 fingerlings sampled. The low numbers may in part be due to the greater ability of the "90-day" fish to avoid the 2x3 IPT. The second peak roughly corresponded to an early July peak discharge of 242 m^3/sec. Cramer and Lichatowich (1978) have suggested the rate of downstream movement of chinook juveniles is highly affected by mid-summer freshets. On the basis of numbers caught "90-day" migrants appear to make up about 8.5% of the observed juvenile migration. The majority of the run was composed of fry (89%) with smolts the minority (2.4%).

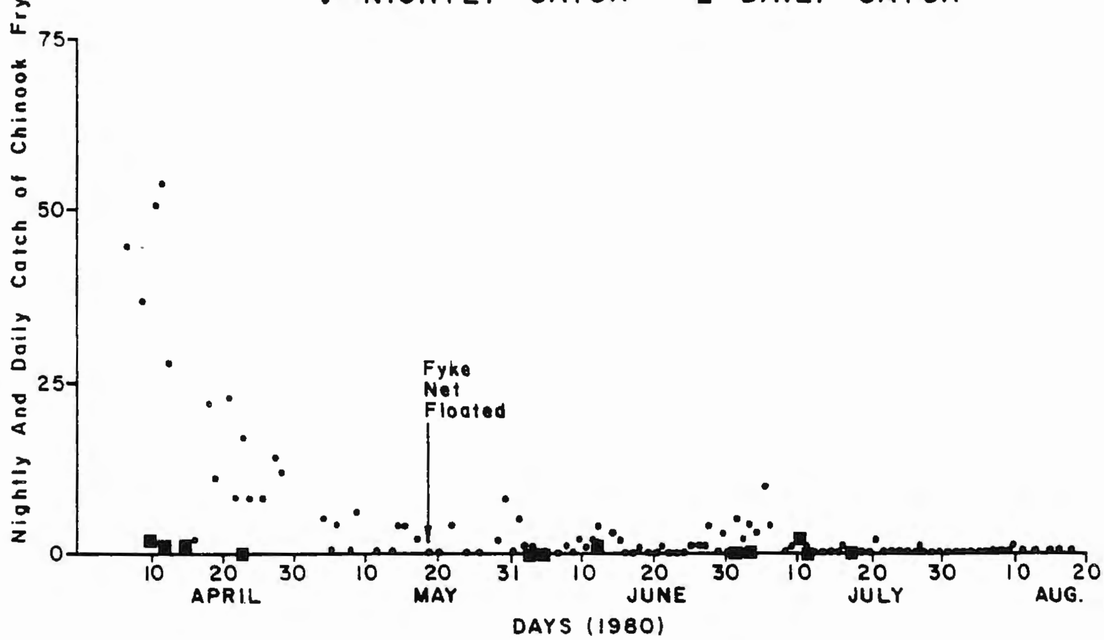
The apparent timing of juvenile chinook migrations in the watercourses studied is listed in Table 3.2-9. Repeated efficiency tests were unsuccessful in all streams and population estimates of migrating juveniles were therefore not possible (Appendix V, VI and VII).

Table 3.2-9

Percent Timing of Chinook Fry and Smolt Migrations in the Kitimat River, and Hirsch and Cecil Creeks, 1980

Development Stage	Stream	10%	50%	90%
Chinook fry	Kitimat River	April 8	April 16	June 5
	Hirsch Creek	April 7	April 13	June 9
	Cecil Creek	May 7	May 12	May 14
Chinook smolts	Kitimat River	April 13	April 26	May 12

Figure 3.2-11 HIRSCH CREEK: NIGHTLY AND DAILY CATCH OF CHINOOK FRY TAKEN IN A MIGRATORY FYKE NET TRAP APRIL — AUG. 1980.
•—NIGHTLY CATCH ■—DAILY CATCH



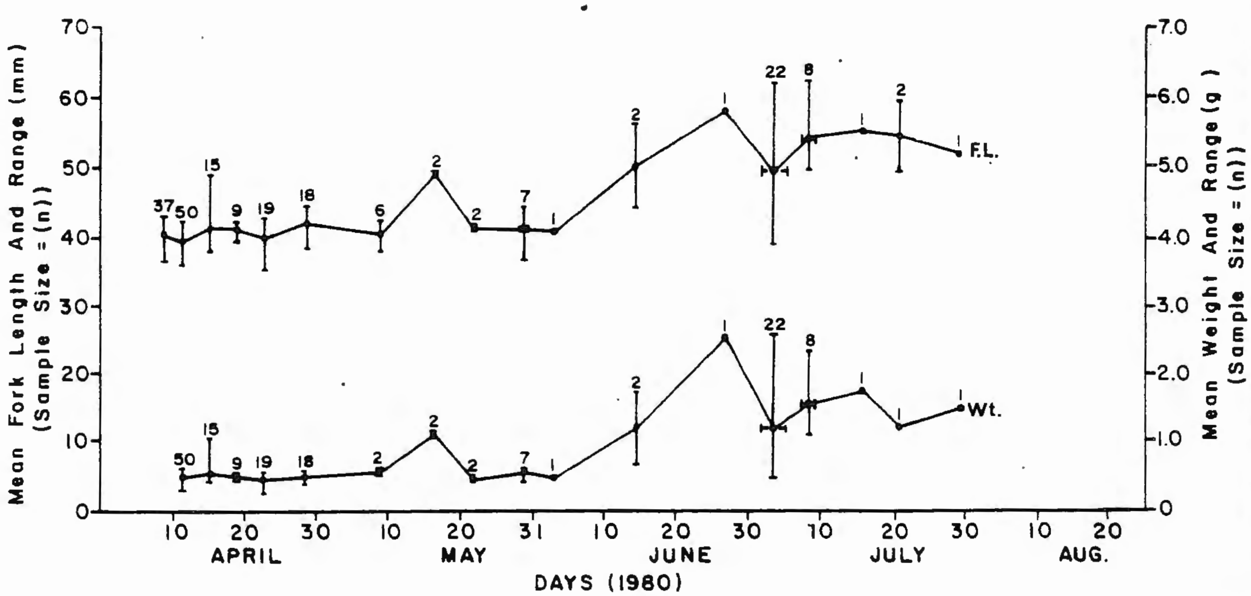


Figure 3.2-12 MEAN FORK LENGTH (mm) AND MEAN WEIGHT (g) FOR MIGRATING CHINOOK FRY SAMPLED FROM HIRSCH CREEK FYKE NET CATCHES APRIL — AUG. 1980.

In Hirsch Creek the juvenile migratory pattern closely replicated that found in the Kitimat mainstem population (Figure 3.2-11). Fry migration occurred from the time of trap installation on April 6 until June 5. A peak of 54 fry was collected April 11. A progressive decrease in numbers caught occurred during the remainder of fry outmigration. Fingerlings appeared in length and weight analyses June 15 (Figure 3.2-12). The "90-day" juvenile migration lasted from about June 10 to July 11 and contained two small peaks; June 13 when 4 fingerlings were caught and July 6 when 10 fingerlings were collected. The latter peak corresponded to a mid summer freshet of 51 m^3/sec on July 5. As noted earlier the 90 day fish appear better able to avoid the traps; however, based on numbers caught, the "90-day" juvenile migration contributed only 13% to the total juvenile outmigration.

Chinook escapements into Cecil Creek have not been observed historically (J.A. MacDonald, pers. comm.) alhtough Hilland (pers. comm.) observed one spawner in 1979. In 1980 a few adult chinook were observed spawning just below the fyke net trap site on Cecil Creek during August and a short outmigration of chinook fry was noted from May 7 to 15. A single trap efficiency test on May 13 resulted in 4 recaptures. While recaptures are minimal and the resulting estimate should be viewed with skepticism, the total population would be 220 ± 120 chinook fry, probably the result of a single spawning pair. Rearing fry were also sampled in lower Cecil Creek (see Section 3.3.2).

In contrast with pink and chum fry migrations, chinook fry migration during daylight hours was minimal. During fry migrations, approximately 6% of the fry in the Kitimat River and 2% in Hirsch Creek migrated during the daytime. During "90-day" juvenile migrations approximately 25% of the Hirsch Creek catch migrated proportionately during daylight hours and up to 33% of the Kitimat River catch occurred during the daytime (Table 3.2-10).

Table 3.2-10

Diel Periodicity in Chinook Juvenile Migrations in the Kitimat River and Hirsch Creek, 1980

Development Stage	Stream	Proportionate Migration Diurnal	Nocturnal
Chinook fry	Kitimat River	0.06	0.94
	Hirsch Creek	0.02	0.98
	Cecil Creek	0.00	1.00
Chinook "90-day" juveniles	Kitimat River	0.33	0.67
	Hirsch Creek	0.25	0.75
Chinook Smolts	Kitimat River	0.00	1.00

Mean length and weight of recently emerged migrant fry were consistent at all three trap sites. From April 9 to May 20 in the Kitimat River, mean length varied from 39.2 ± 1.8 mm to 41.6 ± 1.7 mm and mean weight varied from 0.44 ± 0.07 g to 0.58 ± 0.12 g. Mean length in Hirsch Creek samples during the same period ranged from 39.4 ± 2.0 mm to 42.2 ± 1 except for May 16 when a sample (n=2) with a mean of 49.5 ± 0.7 mm was taken. The latter sample occurred at the upper limit of the emergent fry fork length range for Hirsch Creek (range: 36.5 - 50.0 mm). Mean weight in Hirsch Creek ranged from 0.40 g to 1.11 g during the emergent fry migration (roughly April 9 to May 30). In Cecil Creek samples taken during the short migration had a mean length of 41.6 ± 0.63 mm, and a mean weight of 0.51 ± 0.02 g to 0.53 ± 0.02 g.

The "90-day" juvenile migration in both the Kitimat River and Hirsch Creek coincided with an increasing trend in mean fork length and mean weight (Figures 3.2-10 and 3.2-11) during June. This trend appeared to be the result of growth increments on the part of "90-day" juveniles and progressive loss of emergent fry. In the Kitimat River, mean length increased from 47.1 ± 5.34 mm in the first week of June to 81.5 ± 0.7 mm in mid August (range from 39.0 to 82.0 mm). In Hirsch Creek, mean length increased from 50.5 ± 9.2 mm to 68.0 mm (range from 39.0 to 68.0 mm). The mean weight of "90-day" juveniles in the Kitimat River increased from 1.36 ± 0.82 g to 6.27 ± 0.25 g during the period while in Hirsch Creek weight increased from 1.23 ± 0.76 g to 2.82 g.

The mean developmental indices of the chinook fry collected also increased during the study period (Table 3.2-11). In the Kitimat River the index rose from 1.91 on April 9 to 2.26 on August 12. The values in Hirsch Creek were somewhat lower and rose from 1.88 on April 11 to 2.19 on July 30. The mean K_D's of the chinook fry collected from Cecil Creek May 8 and 12 were 1.95 and 1.92 respectively.

Chinook Smolts

Chinook smolts were captured migrating from the system in April and May in both the Kitimat River (Figure 3.2-9) and Hirsch Creek (Figure 3.2-11) (Appendix V and VI). Scale analyses of smolts indicated that all had spent one winter in the freshwater habitat. In the Kitimat River the migration consisted of several peaks with an overall migration period of April 8 to May 31. A peak migration occurred the night of April 23 when 13 chinook smolts were sampled. Timing as a percent of total numbers captured during the study is indicated in Table 3.2-9. In Hirsch Creek, a single smolt was sampled April 19. Population estimates were not made for either stream, and daytime migration of smolts was not observed (Table 3.2-10) although this may be a result of avoidance.

Table 3.2-11

Mean Developmental Indices (K_D) of Chinook Salmon Fry Collected in 1980

Kitimat River

Date	Sample Size	K_D
April 9	16	1.91
April 12	19	1.92
April 18	12	1.94
April 22	33	1.89
April 27	18	1.90
May 4	4	1.94
May 8	5	1.94
May 17	4	1.94
May 18	7	1.95
May 25	3	1.90
May 29	4	2.05
June 6-10	7	2.11
June 13-14	5	2.18
June 16-18	3	2.16
June 28	2	2.15
July 4-7	10	2.12
July 8-12	8	2.15
July 18	1	2.21
August 2	1	2.19
August 12	2	2.26

Hirsch Creek

Date	Sample Size	K_D
April 11	50	1.88
April 15	15	1.99
April 19	9	1.93
April 23	19	1.92
April 28	18	1.88
May 9	6	2.02
May 16	2	2.08
May 22	3	1.97
May 29-30	7	1.97
June 3	1	1.92
June 15	2	2.06
June 27	1	2.34
July 2-6	22	2.09
July 7, 9-11	8	2.10
July 16	1	2.17
July 21	1	2.12
July 30	1	2.19

Cecil Creek

Date	Sample Size	K_D
May 8	20	1.95
May 12	17	1.92

In the Kitimat River smolts sampled, mean length varied from 75.6 ± 5.9 mm to 87.3 ± 13.4 mm (range of 62.5 to 111.0 mm). Mean weight varied from 4.21 ± 1.08 g to 6.46 ± 3.37 g (range of 3.30 g to 11.80 g), (Table 3.2-12). Fork length of the single Hirsch Creek smolt was 68.0 mm, with a weight of 2.82 g.

Table 3.2-12

Fork Length and Weight of Chinook Smolts
Collected in the Kitimat River, 1980

Date	Scale Age	Sample Size	Fork Length (mm)		Weight (g)	
			Mean (x ± SD)	Range	Mean (x ± SD)	Range
April						
8-12	1+	2	83.0 ± 17.0	71.0 - 95.0	6.46 ± 3.37	4.07 - 8.84
18-21	1+	3	80.8 ± 10.8	68.5 - 88.5	5.26 ± 1.47	3.67 - 6.58
26	1+	5	86.0 ± 7.4	78.0 - 94.5	6.30 ± 1.97	4.26 - 8.77
27	1+	5	84.3 ± 10.5	76.5 - 102.0	6.02 ± 2.35	4.15 - 9.90
May						
5	1+	5	72.9 ± 6.6	62.5 - 8.05	4.68 ± 1.08	3.47 - 6.27
8	1+	3	83.8 ± 3.5	80.0 - 87.0	6.27 ± 0.30	5.95 - 6.54
10	1+	4	75.6 ± 5.9	68.0 - 81.0	4.21 ± 1.08	2.92 - 5.21
18-21	1+	2	82.8 ± 0.4	82.5 - 83.0	5.86 ± 0.63	5.41 - 6.30
29-31	1+	3	76.0 ± 10.0	64.5 - 82.5	4.55 ± 1.61	2.70 - 5.66

3.2.4 Coho Fry

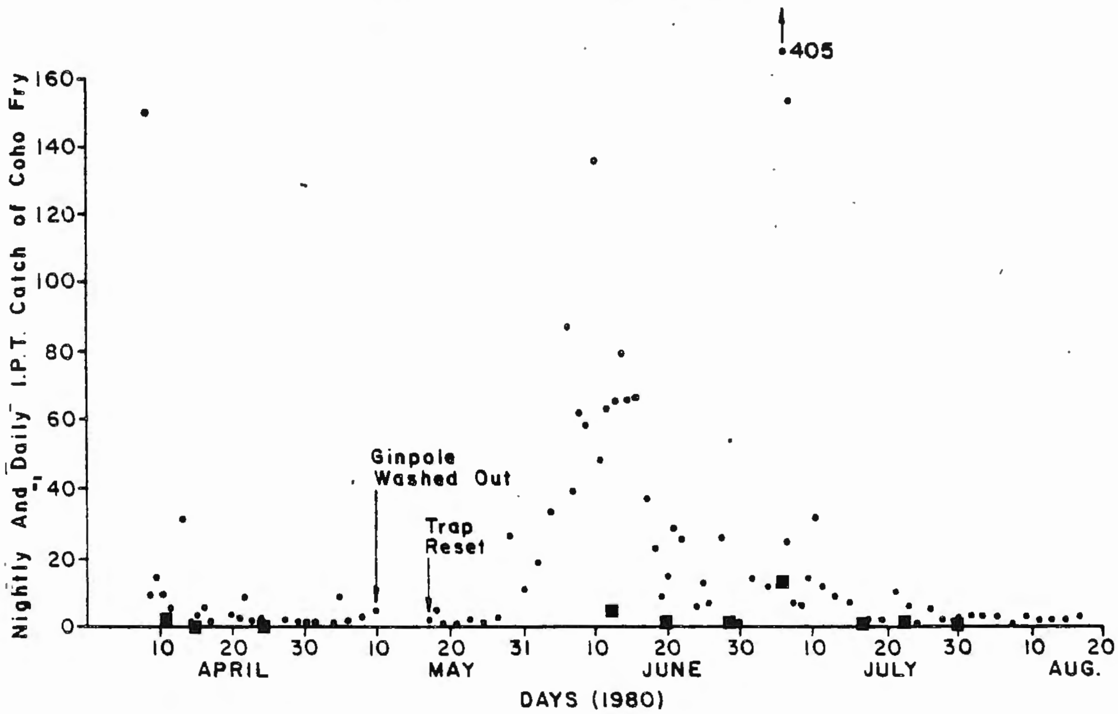
Coho fry generally emerge somewhat later in the spring than chinook as a function of later spawning, and are smaller than any sympatric chinook fry (Lister and Genoe, 1970). Coho fry outmigrations generally follow emergence in mid-March to mid-June. Most fry take up stream residence and may remain in freshwater for a year or more, particularly in northern rivers. Coho juveniles finally outmigrate as smolts in their second or third spring (Meehan and Siniff, 1962). Dispersal within a system usually takes place during freshwater rearing with upstream fall movement into smaller tributaries (Skeesick, 1970), and winter movement into deep pools (Bustard and Narver, 1975).

While coho outmigration has received attention in numerous southern streams (Mason, 1974), comparable attention has not been directed towards northern stocks. Higgins and Schouwenburg (1975) observed juvenile outmigration in the Skeena River as being composed of numerous peaks extending throughout the summer. The 1980 Kitimat results were very similar with migration extending throughout June and much of July in the mainstem (Figure 3.2-13) and Hirsch Creek (Figure 3.2-17). In Cecil Creek the coho outmigration was earlier, starting in early May and continuing until June 20 (Figure 3.2-19).

Fry outmigration in the Kitimat River system was characterized by a non-volitional migration in April that constituted about 10% of the run (up to April 22). The main migration began May 16, peaked June 10 with 117 fry caught and thereafter decreased in numbers caught per night until June 30. In general, 50% of the outmigration occurred by June 15. A second peak in migration occurred the night of July 5 when 405 fry were caught in the trap. Unfortunately, a problem with misidentification of trout fry as coho during this period (and until July 16) made the magnitude of this peak questionable. Certainly, a second peak was found at this time in both Hirsch and Cecil Creeks, indicating coho fry outmigration did continue into late July. Ninety percent of the outmigration had occurred by July 7.

Outmigration in Hirsch Creek followed a pattern similar to that found in the mainstem river. Non-volitional downstream movement in April was not of the same magnitude as that found in the Kitimat River but did exhibit the same timing and terminated towards the end of April (Figure 3.2-17). The mean migration began May 21, continued until June 22, and was characterized by a series of migration peaks, the largest being 242 fry caught the night of May 31. The second largest peak occurred June 28 when 227 fry were caught in the fyke net. It should be pointed out that from about June 25 until

Figure 3.2-13 NIGHTLY AND DAILY CATCH OF COHO FRY CAUGHT IN THE KITIMAT RIVER INCLINE. PLANE TRAP (I.P.T.) FROM APRIL TO AUG. 1980
•—NIGHTLY CATCH ■—DAILY CATCH



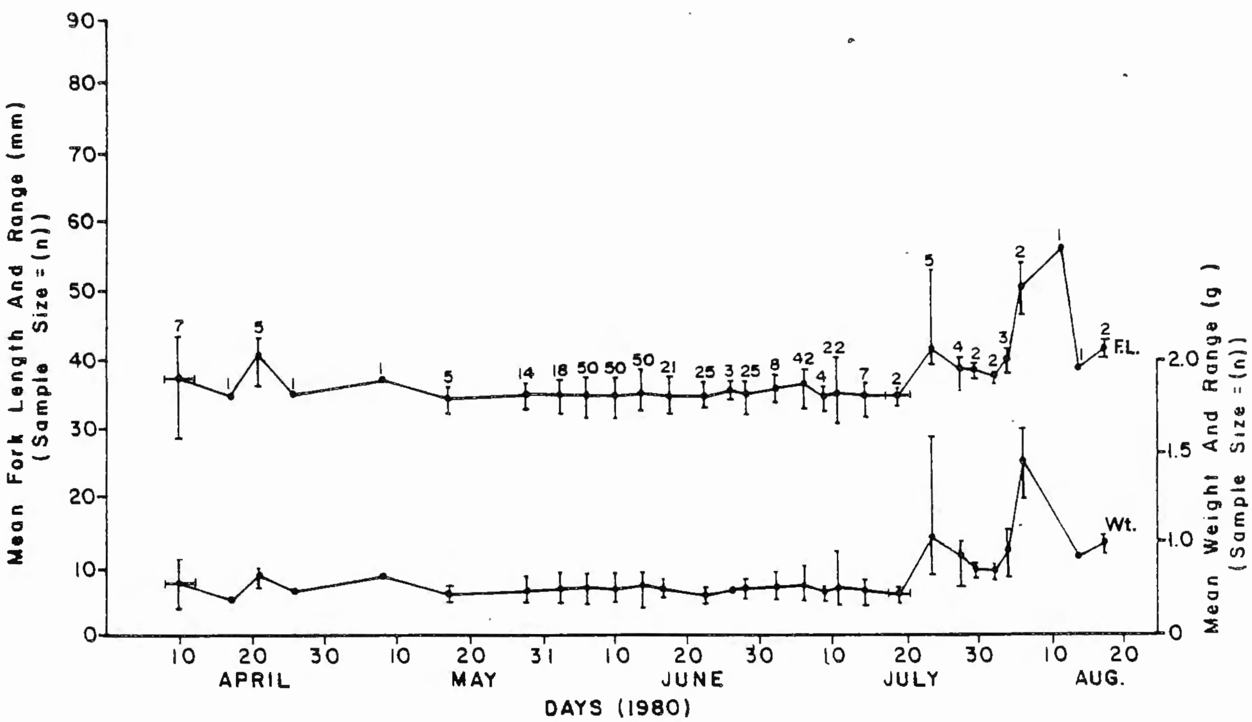


Figure 3.2-14 MEAN FORK LENGTH AND WEIGHT FOR MIGRATING COHO FRY CAPTURED IN THE KITIMAT RIVER INCLINE. PLANE TRAP DURING APRIL TO AUG. 1980

July 15 the same problem with misidentification of trout fry as coho existed. Fork length/weight and analyses based on frequent samples allowed the catch over that period to be divided proportionately between species. The resulting graph may be somewhat inaccurate in numbers caught but should display a realistic pattern of migration. Timing in percent migration is listed in Table 3.2-13.

Table 3.2-13

Percent Timing of Coho Fry and Smolt Migrations in the Kitimat River, and Hirsch and Cecil Creeks, 1980

Development Stage	Stream	10%	50%	90%
Coho fry	Kitimat River	April 22	June 15	July 9
	Hirsch Creek	June 1	June 20	June 29
	Cecil Creek	May 20	June 5	July 6
Coho smolts	Kitimat River	April 12	April 27	June 22
	Cecil Creek	April 12	April 18	May 9

The fry migration in Cecil Creek did not follow the characteristic timing of Hirsch Creek or the mainstem river, but was similarly composed of a series of peaks (Figure 3.2-19). Non-volitional early spring movement was not observed in Cecil Creek, and the main migration there began early (April 30) and was essentially complete by June 20. The final peak in outmigration on July 6 (648 fry) could have resulted from problems with species identification. However, when lengths and weights of all the fry sampled were plotted the coho and trout were easily separated such that the presence of this peak was warranted. Peak migration overall occurred the night of June 6 when 2,754 fry were caught in the fyke net trap.

Diel periodicity in migration varied throughout the system. While limited daytime movement was noted during April in the tributary streams studied, 14% of the non-volitional movement in the Kitimat

Figure 3.2-15 NIGHTLY AND DAILY CATCH OF COHO SMOLTS IN THE KITIMAT RIVER SAMPLED MIGRATING DOWNSTREAM BY INCLINE PLANE TRAP. •—NIGHTLY CATCH ■—DAILY CATCH

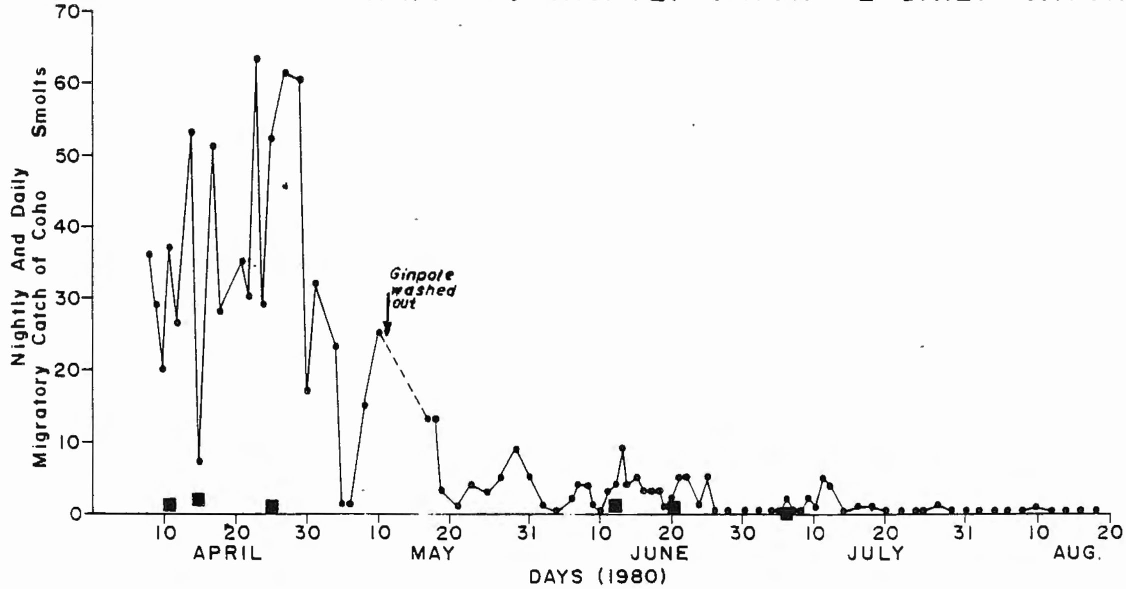
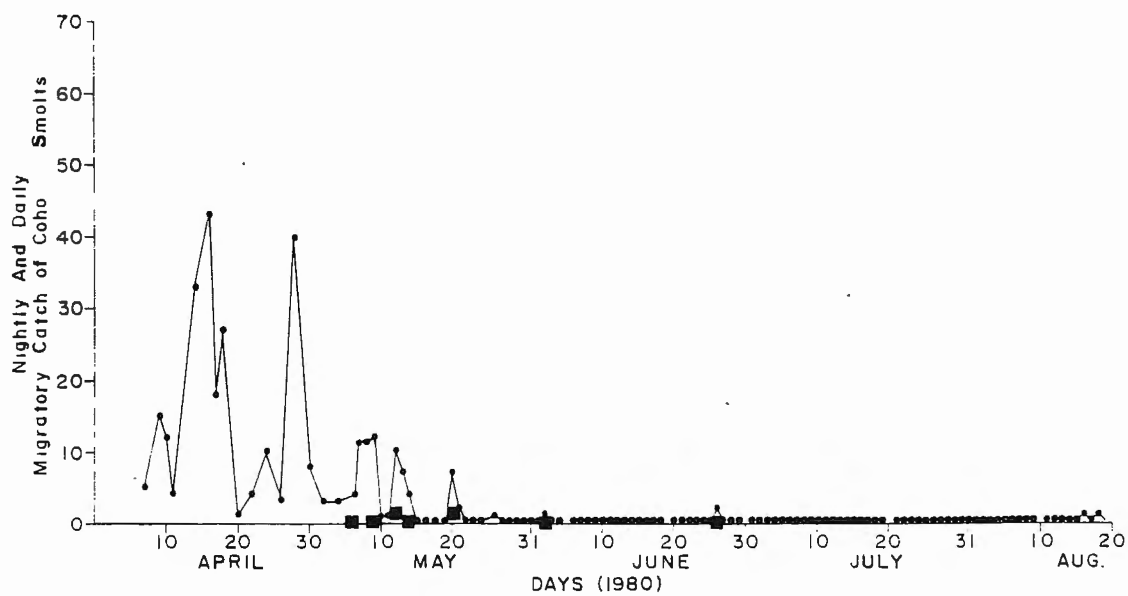


Figure 3.2-16 NIGHTLY AND DAILY CATCH OF MIGRATORY COHO SMOLTS SAMPLED IN CECIL CREEK APRIL TO AUG. 1980.



River mainstem occurred during the day. The proportions of diel movement during the main and late peak migrations are shown in Table 3.2-14.

Table 3.2-14

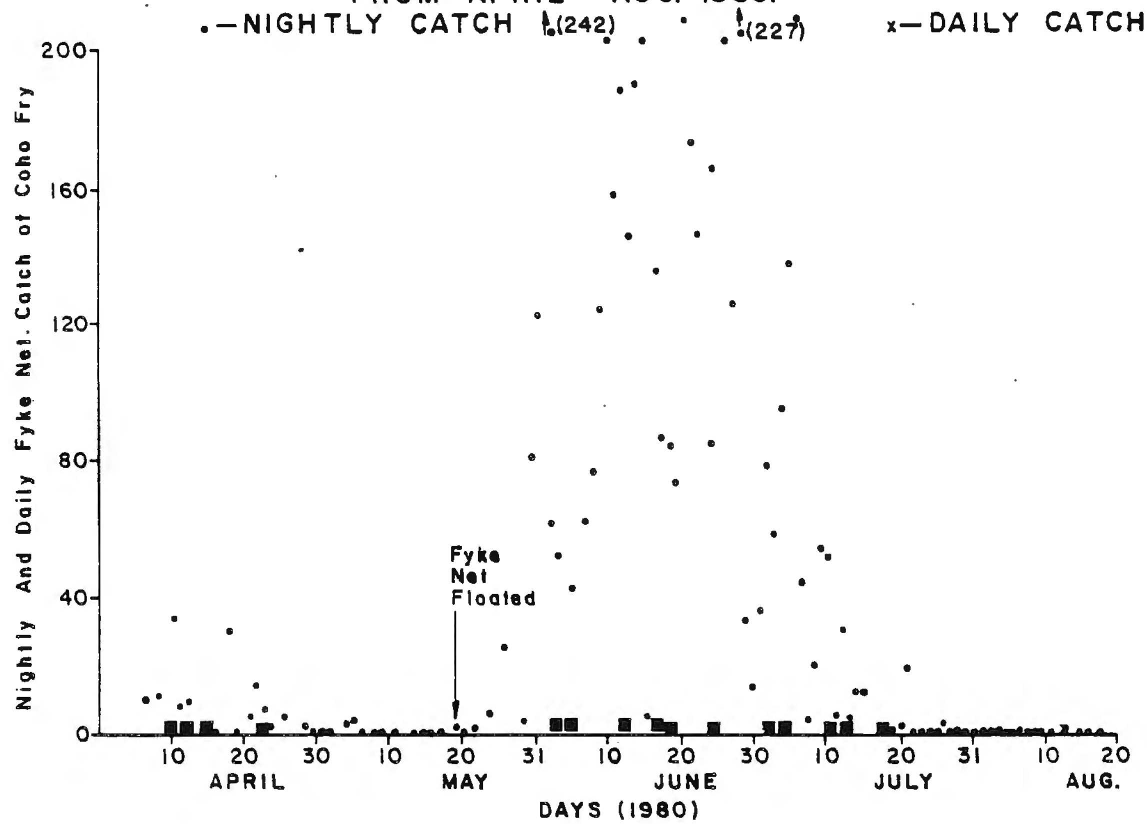
Diel Periodicity in Coho Juvenile Migrations in the Kitimat River, Hirsch and Cecil Creeks, 1980

Development Stage	Stream	Proportionate Migration	
		Diurnal	Nocturnal
Coho fry	Kitimat River	.06	.94
	Hirsch Creek	.019	.98
	Cecil Creek	.05	.95
Coho smolts	Kitimat River	.09	.91
	Cecil Creek	.04	.96

Population estimates of coho fry migrations were not possible in the Kitimat River mainstem because recapture rates were very low. Estimates were calculated for Hirsch and Cecil Creeks. In Hirsch Creek an estimated 189,800 ± 124,000 fry outmigrated through the summer. While one might expect moderate numbers of coho to spawn below the trap site, even considering the exclusion of such numbers, it appears the coho escapement for the stream for 1979 was underestimated. Back calculations showed an estimated 1,000 coho adults in Hirsch Creek with a lower confidence limit of 350, or at least twice the escapement number recorded.

In Cecil Creek an estimated 177,000 ± 66,300 fry outmigrated during the study period. Back calculation from this figure suggested a spawning run of approximately 900 coho, with a lower limit of 600 adults. While this figure accounts for about 10% of the total escapement for the system (5,875 coho) the consideration of rearing

Figure 3.2-17 NIGHTLY AND DAILY CATCH OF COHO FRY CAUGHT IN THE HIRSCH CREEK FYKE NET TRAP FROM APRIL - AUG. 1980.



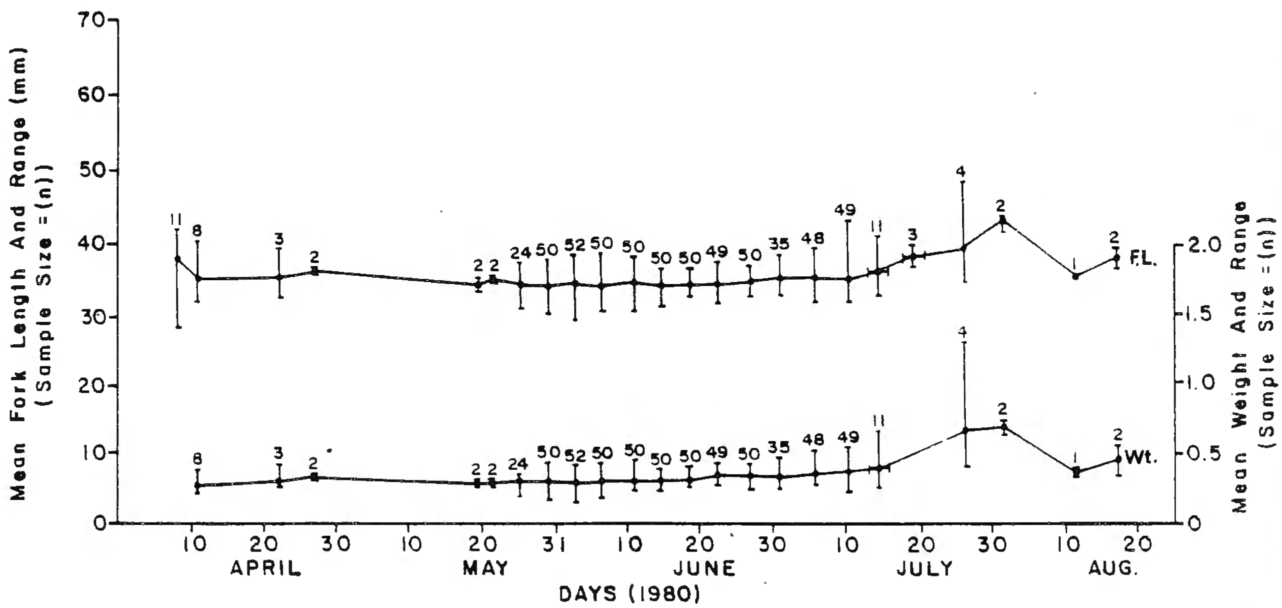


Figure 3.2-18 MEAN FORK LENGTH AND WEIGHT FOR COHO FRY SAMPLED FROM THE HIRSCH CREEK FYKE NET TRAP DURING APRIL - AUG. 1980.

juvenile would suggest higher escapement numbers. The estimates indicate that escapement figures for the system were somewhat under estimated; not an unusual suggestion considering the spawning migration occurs well into the late fall and winter months when location of spawning adults is difficult.

Length and weight trends over time (Figure 3.2-14, 3.2-18 and 3.2-20) suggest the juvenile outmigration is composed of emergent fry from April through to mid July. Mean length ranged during this period from 34.3 ± 1.77 mm to 36.3 ± 1.6 mm in the Kitimat River from 34.3 ± 3.65 ± 29 mm in Hirsch Creek and from 34.4 ± 1.94 mm to 37.4 ± 3.11 mm in Cecil Creek. Mean weight of emergent fry also exhibited close similarity between streams. In the Kitimat mainstem mean weight varied from 0.27 ± .03 g to 0.37 ± 0.16 g. In Hirsch Creek mean weight ranged from 0.29 ± 0.01 g to 0.45 ± 0.11 g while in Cecil Creek mean weight ranged from 0.28 ± 0.05 g to 0.46 ± 0.16 g.

Emigration after about July 15 was limited at all trap sites and appeared to be composed of coho juveniles that had undergone some rearing. Mean fork lengths and weights increased in all three water courses and exhibited a high standard deviation as a result of variable individual growth movements and the continuing emergence of fry. Maximum mean fork lengths reached in each stream were 50.3 ± 5.3 mm in the Kitimat River, 42.8 ± 1.06 mm in Hirsch Creek, and 43.1 ± 2.75 mm in Cecil Creek. Proportionately, weight changes were much higher. Mean weight in the Kitimat reached 1.25 ± 0.36 g; in Hirsch Creek 0.69 ± 0.03 g; and in Cecil Creek 0.74 ± 0.16 g.

At all three of the migration index traps the developmental indices (K_D) of the coho fry collected tended to increase during the study period. In the Kitimat River it rose from 1.92 April 9-12 to 2.10 on August 18. The indices of fry sampled in Hirsch Creek were somewhat lower and rose from 1.86 on April 8 to 1.99 on August 18. The indices of Cecil Creek fry rose from 1.99 to 2.11 (Table 3.2-15).

Table 3.2-15

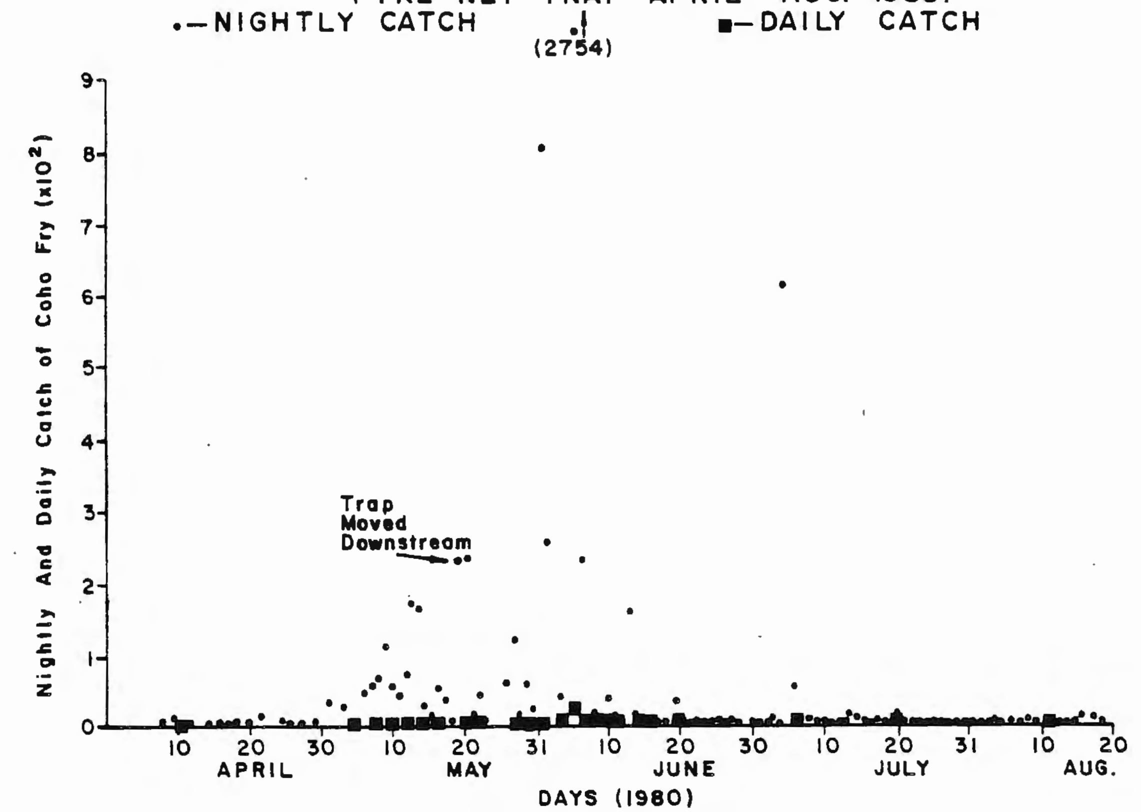
Mean Developmental Indices (K_D) of Coho Salmon Fry Collected in 1980

Kitimat River			Cecil Creek			Hirsch Creek		
Date	Sample Size	K_D	Date	Sample Size	K_D	Date	Sample Size	K_D
Apr. 9-12	7	1.92	Apr. 9	10	1.99	Apr. 11	8	1.86
18	1	1.83	18	2	2.02	23	3	1.90
22	5	1.85	20	5	2.12	28	2	1.86
27	1	1.93	22	15	1.93	May 20	2	1.92
May 8	1	2.04	26	5	1.91	22	2	1.84
17-18	5	1.92	30	3	1.94	26	24	1.93
29	14	1.96	May 4	28	1.98	30	50	1.97
June 2	18	1.99	8	51	1.96	June 3	52	1.92
6	50	2.00	12	50	1.97	7	50	1.98
10	50	1.99	17	20	1.90	11	50	1.95
14	50	2.01	20	50	1.95	15	50	1.99
18	21	1.98	27	50	1.98	19	50	1.97
22	25	1.87	31	22	1.99	23	49	2.04
26	3	1.94	June 4	42	1.97	27	50	2.00
28	25	1.99	9	7	1.93	July 1	35	1.97
July 2	8	1.96	13	50	1.95	6	48	2.01
6	42	1.96	17	1	2.13	7	5	2.08
9	4	1.96	21	4	2.07	10	49	1.99
11	22	1.99	26	6	1.94	14-15	11	2.04
14	7	1.97	July 1	5	2.06	26-28	4	2.13
18-20	2	1.93	6	37	1.95	Aug. 1-2	2	2.06
24	5	2.13	10	1	2.06	18	2	1.99
27	4	2.15	15	2	1.99			
29-31	2	2.02	21	6	2.02			
Aug. 1	2	2.06	27	1	2.15			
4	3	2.10	Aug. 3	1	2.12			
6	2	2.14	6	2	2.12			
14	1	2.13	13	5	2.10			
18	1	2.10	16	11	2.13			
			18-19	10	2.11			

Coho Smolts

The size and timing of coho smolt migration varied considerably between tributaries and the mainstem river. Outmigration patterns for the Kitimat River and Cecil Creek are depicted in Figures 3.2-15 and 3.2-16. Smolt catches in Hirsch Creek were too low to warrant graphic display.

Figure 3.2—19 CECIL CREEK: NIGHTLY AND DAILY CATCH OF MIGRATORY COHO FRY TAKEN IN A FIXED FYKE NET TRAP APRIL—AUG. 1980.



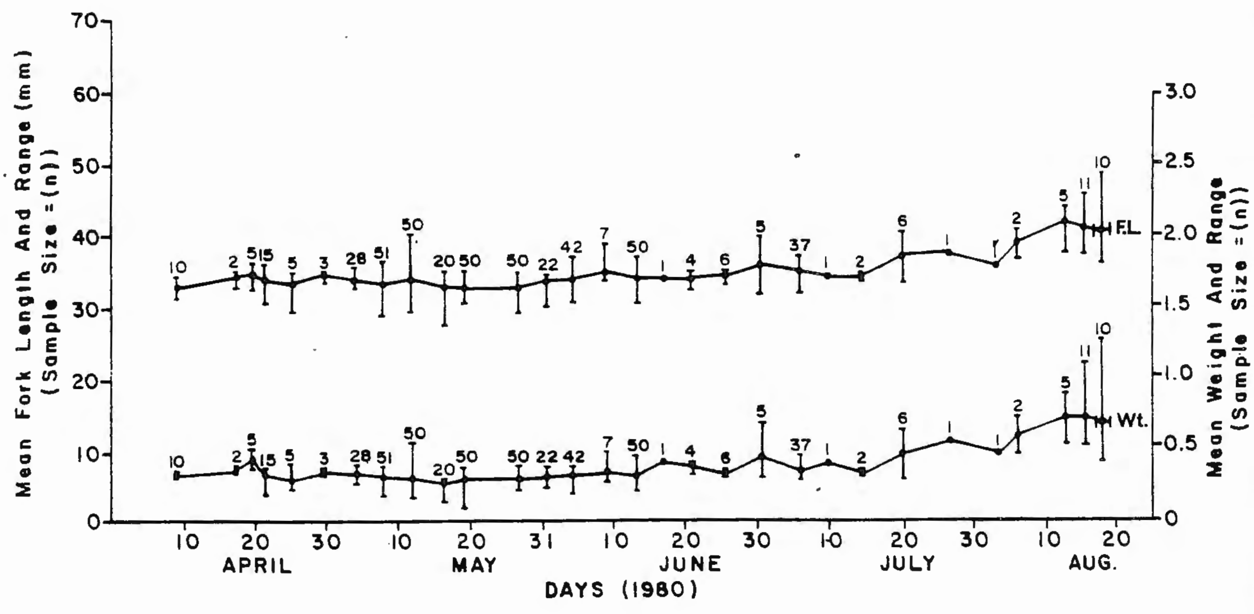


Figure 3.2—20 MEAN FORK LENGTH (mm) AND MEAN WEIGHT (g) WITH RANGE FOR MIGRATORY COHO FRY SAMPLED FROM CECIL CREEK FYKE NET TRAP APRIL—AUG. 1980.

Smolt outmigration was underway in the Kitimat mainstem when the inclined plane trap was installed. The main outmigration consisted of a series of peaks continuing through until June 26. A smaller subsequent peak occurred on July 9-12. Overall peak daily migration occurred April 23 when 63 smolts were captured.

In Cecil Creek, the outmigration of smolts was similar in pattern but shorter in period (Table 3.2-13). Main emigration was underway when the fyke net was installed and continued until May 15. The overall peak in daily migration occurred April 16 with 43 smolts sampled. A subsequent smaller peak followed on May 20-21.

Coho smolt downstream movement in Hirsch Creek was infrequent and erratic and was not considered an outmigration.

Numbers caught per night are noted in Appendix VI. Estimates of migratory smolt populations were not possible in any of the streams studied.

With regard to diel periodicity in smolt outmigration, 9.3% of downstream migration in the Kitimat River and 4% of the catch in Hirsch Creek occurred during daylight hours (Table 3.2-14).

The migration in both Kitimat River and Cecil Creek was comprised of both one and two year old juveniles. Interestingly, all smolts sampled migrating from Hirsch Creek had spent one winter in fresh water (i.e. 1 + year class). Migration of two year old smolts (2+) appeared to start and definitely ended earlier than 1+ smolts. In the Kitimat River 1+ and 2+ fish were caught from April 8 until May 5. Both year classes were caught in Cecil Creek from April 10 to April 17. In both streams subsequent smolt migration was made up totally of one year old juveniles. During the period of comigration, approximately 20% of the migrant smolts in both the Kitimat River and Cecil Creek had inhabited freshwater for two winters.

Table 3.2-16

Seasonal changes in Development (K_D) and Mean Size at Year Class of Coho Smolts collected in 1980

Stream	Sampling Date	1+ Sample Size	1+ K_D	1+ Mean F.L. (mm)	2+ Sample Size	2+ K_D	2+ Mean F.L. (mm)
Kitimat River	8/4	28	2.16	79.6 ± 9.43	8	2.21	98.1 ± 16.81
	12/4	20	2.15	81.0 ± 9.53	6	2.10	89.6 ± 7.53
	18/4	23	2.14	80.5 ±11.45	4	2.18	94.8 ± 13.15
	22/4	28	2.13	84.4 ±11.18	6	2.14	86.8 ± 7.59
	27/4	18	2.14	84.2 ±12.45	2	2.26	83.75± 7.42
	5/5	4	2.15	83.1 ±12.59	4	2.07	110.0± 18.0
	17/5-23/5	32	2.18	72.1 ±10.73			
	25/5-29/5	10	2.19	72.6 ± 9.1			
	2/6-6/6	3	2.18	68.3 ±10.68			
	14/6-22/6	7	2.18	75.2 ± 8.26			
	6/7-12/7	12	2.20	71.7 ± 7.20			
	27/7-13/8	3	2.31	73.0 ±18.38			
Cecil Creek	10/4	11	2.16	70.0 ± 6.23	1	2.06	89.5
	14/4	27	2.14	72.3 ±14.24	6	2.10	92.1 ± 3.93
	17/4	12	2.13	79.7 ± 8.14	4	2.08	97.8 ± 16.26
	18/4-22/4	6	2.13	61.3 ±15.0			
	26/4-30/4	11	2.10	63.1 ±10.7			
	4/5-8/5	25	2.17	63.9 ±11.6			
	12/5-20/5	17	2.14	62.9 ± 6.92			
	26/6	2	2.17	72.0 ± 4.24			
	16/8	1	2.19	62.0			
Hirsch Creek	28/4	2	2.21	73.8 ± 0.35			
	26/5	2	2.22	61.8 ± 3.90			
	30+31/5	2	2.19	54.8 ± 1.10			
	6/7	2	2.24	59.8 ± 2.40			
	15/7	1	2.19	66.0			

This percent figure is based on the catches subsampled for length and weight (Table 3.2-16). On the same basis 9% and 14% of the smolts sampled migrating throughout the season in Cecil Creek and the Kitimat River respectively were 2+ fish.

As might be expected of a cohort that has reared in a variety of stream habitats, there was a broad range in size of both 1+ and 2+ smolts (Table 3.2-16). In addition, there was a large degree of overlap of size ranges between year classes. In Cecil Creek during the period of comigration 2+ smolts varied in fork length from 82.5 mm to 113.5 mm while 1+ smolts ranged from 61.0 mm to 95.0 mm. Overlap in size in the Kitimat River was even larger; 2+ smolts ranged from 78 to 130 mm in length and 1+ smolts were found in the 60.5 mm to 112 mm range. Following comigration the size of migrating 1+ smolts tended to decrease through the season. After the period of comigration, the length range of coho smolts (1+) in the Kitimat River was from 48.0 mm to 91.5 mm, while in Cecil Creek comparable smolts ranged from 49.5 mm to 90.5 mm in size. All this suggests that smaller, less efficient or successful fish remain in the stream for several weeks, months or another winter.

3.2.5 Other Species Observed

Additional species monitored during migratory studies included sockeye, rainbow and cutthroat trout, Dolly Varden char, coast-range and prickly sculpins, sticklebacks, lamprey (ammocoetes and metamorphosed juveniles) and eulachon. Catches of each species are listed in Appendices V, VI and VII.

Six sockeye presmolts were sampled from the Kitimat River between July 4 and 22. These juveniles were still parred and were approximately 50 mm in length. Both sockeye and kokanee have been reported in the system (M. Peters, pers. comm.; Morris and Eccles, 1976) but in limited numbers.

Movements of identifiable rainbow juveniles were infrequent and did not follow a pattern. On the other hand, a migration of unidentified trout fry observed from late June through August in all streams could correspond to spring spawning rainbow or steelhead stocks. Cutthroat trout fry migrations were also generally erratic except for a small outmigration noted in the Kitimat River from April 11 to early June; peak migration occurred April 14. The fry have been identified as cutthroat and probably are the progeny of the anadromous fall to winter adult run. A limited migration of Dolly Varden fry was observed in the Kitimat from April, through early June.

The outmigrations of non-salmonid species were often erratic and probably a function of high discharge and silty water conditions. Adult stickleback movement in the Kitimat River occurred throughout April to May, and into early June. Peak migration was documented May 4 with 43 sticklebacks caught. A later migration in late July and August was composed of stickleback juveniles. Lamprey ammocoetes and, later in the summer, metamorphosed juveniles were caught migrating in large numbers in Cecil Creek and less abundantly in the Kitimat River. The pattern of migration appeared to be a series of peaks closely related to peaks in discharge.

3.3 FRESHWATER REARING

A freshwater rearing habitat survey was conducted at three levels of intensity throughout the spring and summer as described in Section 2.3.1. Due to the large number of sample sites and the usually infrequent sampling at any one site, data analysis was kept to a minimum.

Catch records indicating effort, numbers and mean fork length are tabulated in Appendix VIII. Table 3.3-1 indicates species utilization at each site sampled. Sample sites are shown on Figure 1.0-2. Rearing data for chum, chinook, and coho juveniles is discussed in the sections following. Pink fry observe obligatory migration

TABLE 3.3-1

Species present at sites sampled in the Kitimat Watershed during the juvenile Salmonid rearing survey, 1980. Streams and sites are listed and numbered in sequences going upstream. (*) denotes isolated populations.

		Chum	Chinook Fry	Chinook Smolt	Coho Fry	Coho Smolt	Rainbow Trout	Cutthroat Trout	Dolly Varden	Stickle-back	Coast Range Sculpin	Lamprey
Kitimat River	1		X		X	X	X	X	X	X	X	X
	2		X		X	X			X		X	
	3		X		X	X	X	X	X		X	X
	4		X		X	X		X	X			
	5		X		X	X			X			
	6		X			X			X			
Goose Creek	1				X	X			X	X	X	
Duck Creek	1				X	X	X	X	X	X	X	X
	2				X	X		X	X		X	X
	3				X	X		X	X			
	4				X	X		X	X			
	5				X	X		X	X			
Hirsch Creek (Site #1 denotes isolated side-channel, site #2 is the mainstream at same site)	1		X	X	X	X	X	X	X		X	
	2	X	X	X	X	X	X	X	X		X	X
	3	X	X		X	X	X	X	X		X	
	4		X		X	X	X	X	X		X	X
	*5								X			
	*6								X			
Little Wedeene River	1		X	X	X	X	X		X		X	
	*2								X			
Big Wedeene River	1	X	X	X	X	X	X		X		X	
	2		X	X	X	X	X	X	X		X	
	3		X		X	X			X			
	4				X				X			
Lone Wolf Creek	1				X	X		X	X			
Aveling Creek	1		X			X			X			
Nalbeelah Creek	1	X	X		X	X	X	X	X	X	X	
	2		X		X	X	X	X	X		X	
	3				X	X	X					
Humphreys Creek	1	X	X		X	X	X		X		X	
	2				X	X	X	X	X			
	3				X	X	X	X	X			
	*4								X			
Deception Creek	1				X	X	X	X	X		X	X
	*2						X					
Cecil Creek	1		X		X	X	X	X	X	X	X	X
	2				X	X	X	X	X		X	X
	3				X	X	X	X	X			
	4				X	X	X	X	X			
West Lake	1									X		
Chist Creek	1		X		X	X	X		X			
	2		X		X	X	X		X			
	*3								X			
McKay Creek	1		X			X	X		X			
	*2								X			
Hunter Creek	1		X		X	X						
	2		X						X			
Davies-Hoult Creek	1		X		X		X		X			
Davies Creek	*2		NO FISH SAMPLED									

seaward immediately after emergence (Neave, 1966) and are therefore not discussed in this portion of the report. Observations of salmonid species other than *Oncorhynchus* are discussed in Section 3.3.4.

3.3.1 Chum Fry

As observed by Bams (1970) and Disler (1953; cited in Bakkala, 1970), chum fry often exhibit limited rearing prior to outmigration from freshwater habitat. Emergent chum fry average 30 to 32 mm in length (Bakkala, 1970) and appear to range from approximately 35.5 mm to 36.5 mm in length on initiation of migration (Section 3.2-2). Limited increases in size during the late stages of migration were previously discussed and probably reflect the presence of chum fry which have reared following emergence.

Sampling for the rearing survey was limited during April when priority was given to migratory trap installation; consistent effort began in May. Since the majority of chum fry had migrated out of the system by mid May, catches of rearing chum were limited. Chum fry were captured in the lower reaches of Hirsch, Nalbeelah and Humphreys Creeks as well as the Big Wedeene River. Other tributaries, as well as the Kitimat River, were not sampled before the end of the fry migration, but probably also support rearing chum fry. Fry sampled in Hirsch Creek in late April (April 20-21) were 39.2 ± 2.0 mm in length, just slightly larger than emergent size. Fry taken in the Big Wedeene River were slightly larger with a mean of 41.0 ± 2.2 mm on April 18. Two weeks later on May 5 fry sampled in Humphreys Creek were 45.9 ± 4.9 mm in length with the largest fry caught being 53.0 mm. Two fry caught in Nalbeelah Creek on May 7 were 41.0 mm and 42.0 mm long and were the last rearing chum fry taken in the watershed.

3.3.2 Chinook Fry

Freshwater rearing of chinook fry both for 60 to 90 days and over one winter has received attention in the literature. Reimers (1973) suggested the importance of abundant food resources and habitat such as backeddies where spatial shifting is minimized for rearing fall chinook. Both Chapman and Bjorn (1969), and Lister and Genoe (1970) noted that young chinook typically occupy faster water as they grow larger. Chapman and Bjorn (1969) further observed downstream fall movement in Idaho streams to larger streams or at least greater depths in response to limiting of the food resource and the requirement for winter substrate cover.

The 1980 study found chinook fry in concentrations and localities that were surprising given our preconceptions of major spawning localities (Hilland, in prep; J.A. MacDonald, pers. comm.). Chinook fry were found in most of the lower drainage including: the mainstem Kitimat; the lower reaches of Hirsch, Humphreys, Cecil, Chist and Nalbeelah Creeks, and the Big and Little Wedeene Rivers. Concentrations were particularly noteworthy in Hirsch Creek, Chist Creek and the Wedeene Rivers. Headwater extensions of rearing area (and subsequently suggested spawning areas) included the upper Big Wedeene River below the confluence of Aveling Creek, McKay Creek, Hunter Creek (above and below the rapids), the mouth of Davies-Hoult Creeks, and the headwaters of the Kitimat River. Chinook fry were taken at sites 5 and 6 (Photo 3-3) in the Kitimat (see Figure 1.0-2) with particular concentrations just above Davies Rapids. At the latter site, 55 fry were caught June 4 with minimal effort. The highest catch of chinook fry occurred during the week of May 21 to 27 during a mark-recapture test on lower Hirsch Creek; 493 fry were caught over 3 days of sample captures and 3 days of mark recapture effort using 20 minnow traps per day and beach seining. Sampling efforts were not strictly consistent, however, the changes in abundance are large enough and consistent enough that they probably reflect fry movement within streams and between water courses. The concentrations of fry observed in April, May and early June in the Kitimat and Big Wedeene Rivers, and Humphreys, Hirsch, Chist, MacKay and Davies-Hoult Creeks were probably post-emergent fry in the vicinity of spawning grounds. Certainly the size ranges found in these areas with lower limits of 36.0 mm to 37.0 mm in length would support this contention. Subsequent drops in numbers at most concentration sites and sudden appearances at other sites suggest shifts in habitat preference with increased size as noted by Chapman and Bjorn (1969). Specifically, appearances at site 3 in Hirsch Creek on July 7, and site 1 in Cecil Creek on July 14 may represent changes in habitat preferences. Both sites are examples of deep pool habitat associated with current and abundant substrate or overhanging cover. Sudden decreases in catch in Hirsch Creek in late August (i.e. n=33 on August 8, n=2 on August 19 at site 1) may reflect fall migration into overwintering habitat in the Kitimat River.

An inability to successfully use mark recapture techniques to estimate chinook fry population sizes may be a further indication of fry movement in Hirsch Creek. Indeed, during a mark-recapture test July 7 to 12, marked juveniles were caught in the migratory trap downstream of the study site. Shifts in abundance at this time period may correlate with "90-day" juvenile outmigration.

Increases in length over time suggest that most sections of the watershed which support chinook fry produce growth rates similar to those calculated for lower Hirsch Creek. The apparent growth rates in both isolated side channel habitat (site 2) and braided mainstream habitat (site 1) were also comparable in Hirsch Creek (Photos 3-1, 3-2). Based on bimonthly sampling, mean growth increment in length was 0.25 ± 0.17 mm per day (see Figure 3.3-2). The exceptions to this estimate included site 4 on Hirsch Creek (just below the canyon) and site 1 on Cecil Creek (see

Figure 3.3-1). While sample sizes were small and mean length over time variable, higher mean length and range at a given time suggest higher growth rates at these two sites. On July 23, fry at site 1 in Hirsch Creek were 57.3 ± 7.9 mm in length (n=10) with a range of 48.0 to 71.5 mm. In comparison, fry at site 4 in Hirsch Creek were 79.0 ± 5.7 mm in length (n=2) with a range of 75.0 to 83.0 mm, and fry at site 1 in Cecil Creek on July 18 were 70.5 ± 13.3 mm in length (n=6) with a range of 58.5 to 91.0 mm.

The primary goal of the rearing survey was to identify the extent of utilization of the drainage by each species and to attempt to identify some measure of habitat quality through comparative rearing densities and size ranges of the samples. As a subsequent outcome of sampling, subjective comments on the suitability of streams for hatchery outplanting of chinook fry can be made. Stream areas of diverse, good quality rearing habitat which sampling suggested as underutilized are of main importance. Several such areas were observed.

The Kitimat mainstem is presently utilized throughout the drainage for rearing. Two sections though deserve consideration for outplanting. Above MacKay Creek, the stream habitat is excellent for rearing purposes, but the area below Hoult-Davies Creek should receive further attention. Here the river braids extensively and produces a number of slough-like side channels. Habitat diversification is extensive and, while further study of the site is warranted to determine present rearing densities, additional potential utilization is probable.

A second stretch of the river below the Eurocan bridge at Nalbeelah Creek also should be considered. Again braiding provides diverse habitat with plenty of cover and while the area is presently utilized by chinook the potential for additional fry planting probably exists.

PHOTO 3-1: ISOLATED SIDE CHANNEL REARING AREA IN HIRSCH CREEK (SITE #1)

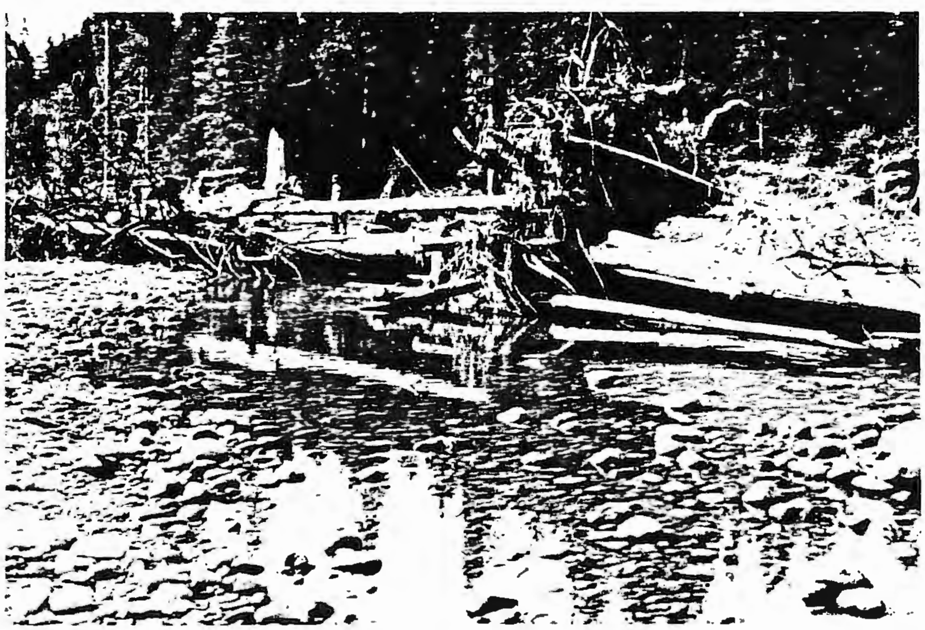


PHOTO 3-2: POOL USED AS REARING HABITAT IN BRAIDED MAIN CHANNEL OF HIRSCH CREEK (SITE #2)

The tributaries of the river above Chist Creek are presently utilized only in their lower reaches, but poor habitat quality would appear to be a continuing restraint. Chist Creek itself is presently utilized by rearing chinook. The lower reaches though could potentially be used for outplanting. Below Chist Creek several potential sites exist. Cecil Creek and Nalbeelah Creek are presently underutilized by chinook fry probably as a result of spawning restrictions. In Cecil Creek only a few adults can successfully penetrate the stream but the highly variable habitat in the lower reaches would be excellent for rearing purposes.

Nalbeelah Creek is underutilized by chinook probably as a result of heavy freshet siltation and poor gravel substrates. The area upstream of the highway and particularly above and below the upper logging bridge displays pools and current sections with abundant bank and instream cover. The stream could be considered for short term rearing purposes.

Two other tributaries are underutilized, probably as a result of limited habitat variability. With some habitat alteration the potential exists for additional utilization of these sites. The Big Wedeene River is probably underutilized as a result of limited braided sections exhibiting good pool structure particularly below Aveling Creek and in the area about Radley Creek. Secondly Hirsch Creek just below the canyon appears to provide excellent habitat perhaps lacking only in instream cover. Only limited utilization by chinook fry was indicated in this study.

3.3.3 Coho Juveniles

As previously discussed, large numbers of coho juveniles in northern streams rear in stream habitat for one or two winters prior to outmigration from April to mid June (Meehan and Siniff, 1962). Several workers have investigated rearing behaviour and habitat preference of juvenile coho as it pertains to cohabitation with chinook and trout juveniles. In both cases, spatial competition is reduced by habitat preference based on size and species. As indicated in the migratory data (Section 3.2), chinook fry emerge much earlier than coho. Juveniles of both species occupy habitat of progressively higher velocity as body size increases and thus spatial segregation of the two species results from size differences dependent on emergent time (Lister and Genoe, 1970). Hartman (1965) demonstrated habitat specific segregation in summer and winter between coho and steelhead.

A discussion of coho rearing data is difficult due to the large variability (Appendix VIII) in size and numbers within and between streams, and the time limits on data analyses. Such variations are not unusual as coho are found in all areas of the watershed accessible to migrating adults (Table 3.3-1). The long time span of adult immigration and spawning further complicates the picture as timing of emergence appears to extend from April to late June. This results in a disproportionate skewing of mean length towards emergent size making calculation of growth increments difficult. Some analyses of coho data have been conducted but are preliminary in nature; further analyses may be warranted. Data is presented in Appendix VIII, Tables 3.3-1 and 3.3-2, and Figures 3.3-1 and 3.3-2.

Coho fry and smolts were found in almost all areas of the watershed with the exception of certain habitats isolated by various falls and rapids (Table 3.3-1). Coho fry were present in larger but variable numbers at most sites sampled, usually in shallow side channels on in pools. Little in the way of trends in abundance between streams is evident. Within streams the predominant pattern is an increase in numbers with the onset of emergence in May. The increase reaches a maximum in June-July and is followed by a continuing abundance of fry for the rest of the summer. A slight decrease in numbers is often notable in late August, possibly as a result of changing habitat preference. Changes in coho smolt numbers do not appear to follow a discernible pattern, at least not ones unattributable to changes in sampling methodology and effort. Coho smolts were often found in slower current than chinooks, such as back channels and isolated pools and always in association with overhanging or in-stream cover (photo 2-5).

Rearing population estimates were carried out with variable success in both Hirsch and Cecil Creeks. As both minnow traps (standard sets of 20) and electroshocking were used to sample and recapture juveniles it is not possible to establish juvenile density per unit effort. It is possible, though, to estimate juvenile populations per stream section as an approximate 100 meter section of stream bounded by riffles at both ends was used as a test unit in each case. Results for each species and developmental stage successfully estimated are listed in Table 3.3-2.

Table 3.3-2

Species population estimates for 100 meter stream sections in Cecil and Hirsch Creeks, 1980

Stream	Site	Date	Temperature (°C)	Salmonid Species	Stage	Estimate
Hirsch Ck.	1	July 7-12	11.0°-14.5°	Coho	smolts	1600±852
Cecil Ck.	1	May 19-24	6.0°-9.0°	D.V.		64±45
	1	July 14-18	12.5°-13.5°	Coho	fry	3447±1198
				Coho	smolts	551±193
				D.V.		59±32
Cecil Ck.	2	August 12-17	9.0°-10.0°	Coho	fry	692±525
				Coho	smolts	421±139
				D.V.		447±189

Figure 3.3-1 FORK LENGTH OF JUVENILE SALMON REARING IN THE VICINITY OF STATION 1 HIRSCH CREEK 1980.

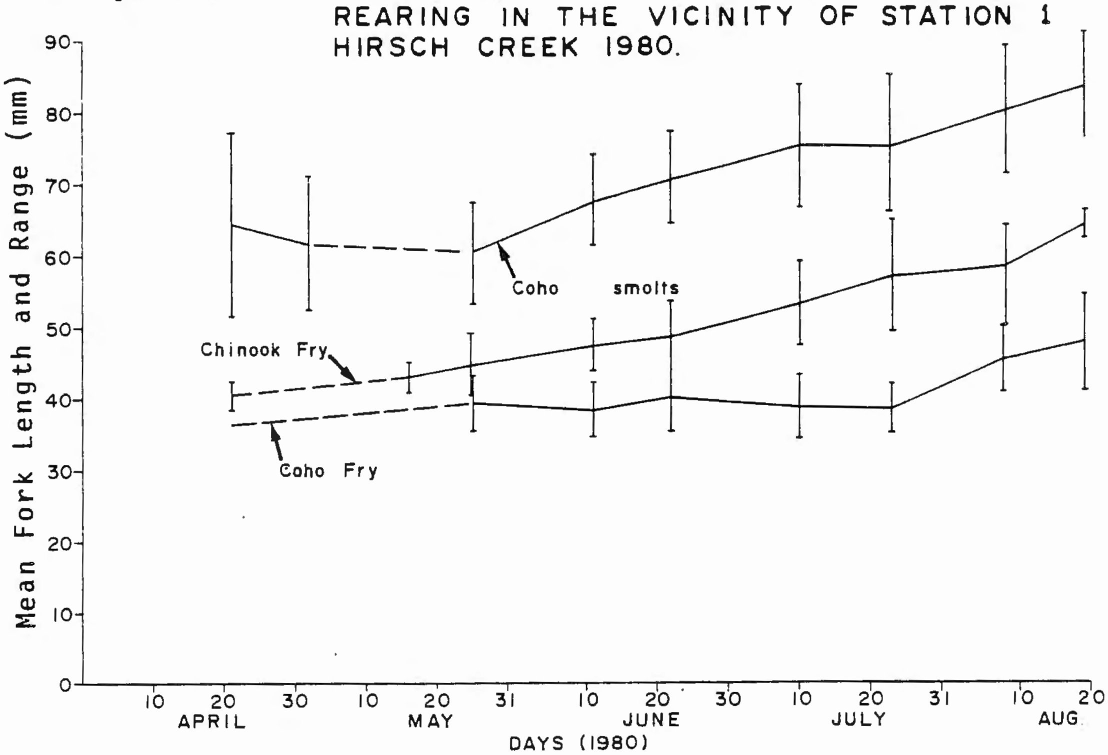
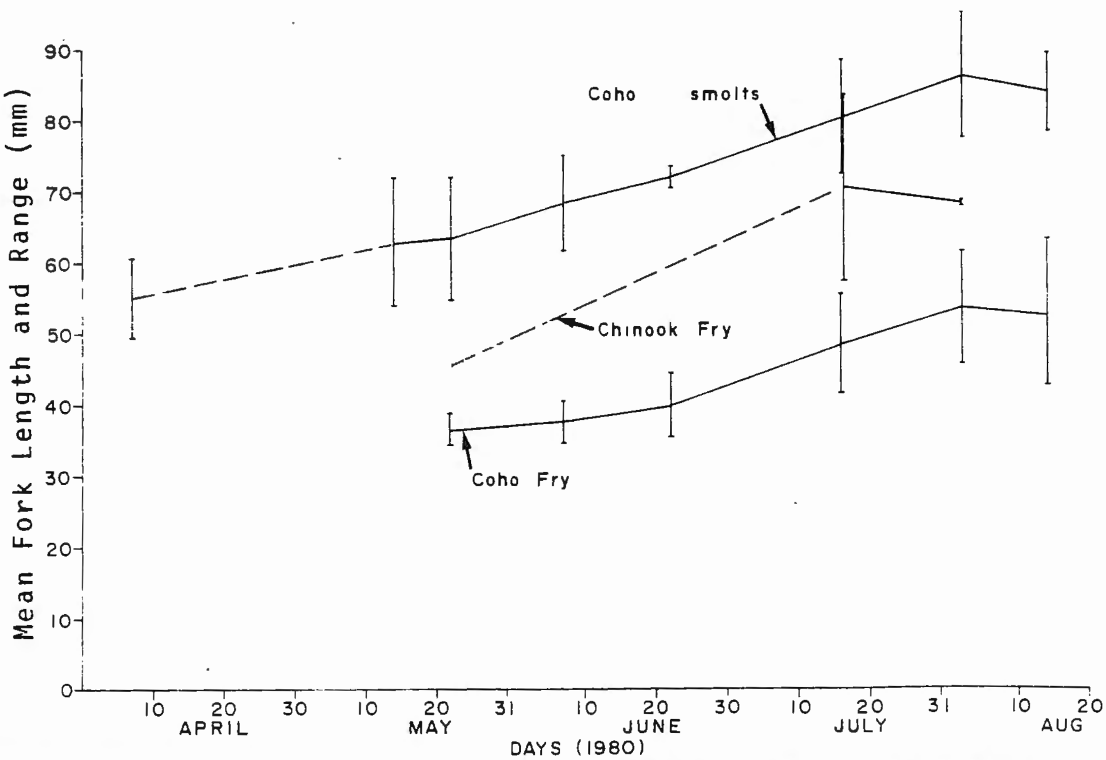


Figure 3.3-2 FORK LENGTHS OF JUVENILE SALMON REARING IN THE VICINITY OF STATION 1 IN CECIL CREEK 1980.



A coho fry estimate for Hirsch Creek was not possible since marked fry were caught leaving the study area and recaptures were too few. Smolt numbers in Hirsch Creek were significantly larger than those in Cecil Creek but the cross sectional area of the Hirsch Creek mainstream is far greater (by at least three times). Fry estimations in Cecil Creek suggest twice as large a population as in the lower stream reaches. It should be pointed out that during the mark-recapture test at Cecil Creek site 1, the migratory fyke net was fished continually and no marked juveniles were sampled leaving the study area. Coho smolt numbers between site 1 and 2 are consistent.

As mentioned previously, variations in juvenile size, the effects of emergent fry on mean length and the impact of juvenile dispersal, make conclusions of variations in growth rate between streams difficult at this time. A mean growth rate of approximately 0.20 ± 0.15 mm per day for coho fry at Cecil Creek site 1 (Figure 3.3-1) was calculated and while it is expected that this rate is slightly higher than comparable rates in Hirsch Creek (Figure 3.3-2) the effects of emergent fry well into June and July made it impossible to test this assertion. Comparable growth rates of 0.29 ± 0.16 mm for smolts from Cecil Creek site 1 and 0.31 ± 0.17 mm for Hirsch Creek site 1 smolts were calculated. Further analyses of the significance of variation in fry and pre-smolt length per time is suggested.

3.3.4 Other Salmonids Observed in Rearing Survey

The Kitimat River steelhead and rainbow stocks have received particular attention from the Provincial Fish and Wildlife Branch by virtue of the importance of the species to the freshwater sports fishery (Morris and Eccles, 1976; Morris and Eccles, 1977; Eccles et al, 1977; Chudyk et al, 1977). The steelhead run in the spring of each year (Eccles et al, 1977), presently numbers about 1,500 adults, and serves to complement resident populations found throughout the drainage. Rainbow were caught in minimal numbers at a number of locations as indicated in Table 3.3-1. The species were somewhat more abundant in tributaries of the lower valley, but this result may be a product of increased effort. Certainly though, Hirsch, Cecil, Nalbeelah, Humphreys, Deception and Chist Creeks all support limited but consistently present populations of fry and smolts. Concentrations of unidentified trout fry that might be the progeny of spring spawning rainbows were found from late June until the end of the study in each of the above tributaries. An isolated population of lake rainbow was found above the barrier falls on Deception Creek as described by Morris and Eccles (1976).

Anadromous cutthroat trout are another important constituent of the Kitimat River sports fishery and are taken in fall and spring runs. Many of the tributaries though are populated by a more colourful and easily identifiable resident stock. Cutthroat trout smolts and occasional adults were caught in larger numbers than rainbow, possibly as a function of habitat preference (Morris and Eccles, 1976). Slow pools and underbank areas are prime cutthroat habitat and received special attention with minnow traps and electroshocking. Concentrations were found in Humphreys, Duck and Hirsch Creeks. Cecil Creek was particularly productive where consistent fry samples easily discernible from rainbow juveniles were taken.

Dolly Varden char are found throughout the Kitimat River drainage (Table 3.3-1) as well as in the estuary (Section 3.4) and were often in great abundance. As Morris and Eccles (1976) observed, Dolly Varden are often the main or only species present in glacial fed streams and above the migratory limits of anadromous salmon. In the 1980 study isolated populations of Dolly Varden were found above barrier falls in Hirsch, Humphreys, MacKay and Chist Creeks as well as the Little Wedeene River. The only sites sampled where Dolly Varden were not captured were upper Deception Creek with its allo-

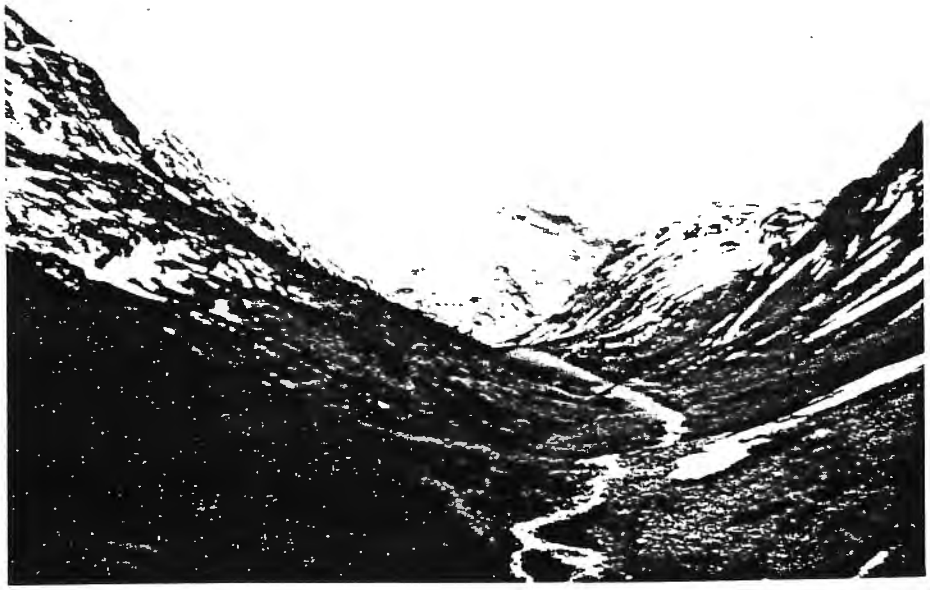


PHOTO 3-3: KITIMAT RIVER HEADWATERS; CHINOOK FRY WERE SAMPLED JUST DOWNSTREAM OF THIS AREA (SITE #6)

PHOTO 3-4: KITIMAT RIVER NEAR HAISLA BRIDGE; SLOW SIDE CHANNELS, BACKEDDIES AND POOLS PROVIDE EXCELLENT REARING HABITAT (BELOW SITE #1)

patric rainbow population, and Davies Creek above the barrier rapids and falls where no fish were found. The largest number of Dolly Varden captured was 151 taken in Cecil Creek, site #2, during a mark-recapture study from August 12 to 17. An estimated 447 ± 189 char were resident in roughly 100 m of stream, a decided increase over the 59 ± 32 estimated to be resident in a comparable section of the lower reaches of Cecil Creek on July 14 to 18 (Table 3.3-2). Increased numbers of Dolly Varden caught late in the summer were not uncommon. Infrequent sampling of gut contents in late July and August indicates salmon eggs were a popular food resource and may have accounted for concentrations of Dolly Varden in and below salmon spawning areas.

Threespine sticklebacks were predominant in the slow, well-covered areas of Goose, Duck, Nalbeelah and Cecil Creeks as well as the mainstem Kitimat River. The coast range sculpin was present through most of the lower river and the lower sections of tributaries. Lamprey were found in large numbers wherever slow water and silty substrate conditions existed.

3.4 ESTUARY REARING

The Kitimat estuary and Minette Bay were utilized extensively by chum fry and by juvenile chinook and coho. The principal vegetation types of this area are shown in Figure 3.4-1 and the plant communities have been described by Bell and Kallman (1976) and Hubbard (1976).

The land above the high tide mark is flooded only under storm surge conditions. Much of this area is covered by red and sitka alders with dense undergrowths of various berries. The ground surface is dominated by grasses including bent grass, reed grass, little hair grass, red fescue and alkali grass. Beach rye is found at some higher levels. There are also some mature groves of conifer forest in the central estuary which are completely surrounded by salt marsh.

Arrowgrass marshes occur over most of the delta where the river channels merge with the salt water. In this area, which is inundated at high tide, clumps of glass wart and dodder are dominant. In addition, there are tufts of arrowgrass, sea blite and sand splurry. Lower down the marsh is dominated by sedges and bullrushes (Photos 3-8 and 3-9).

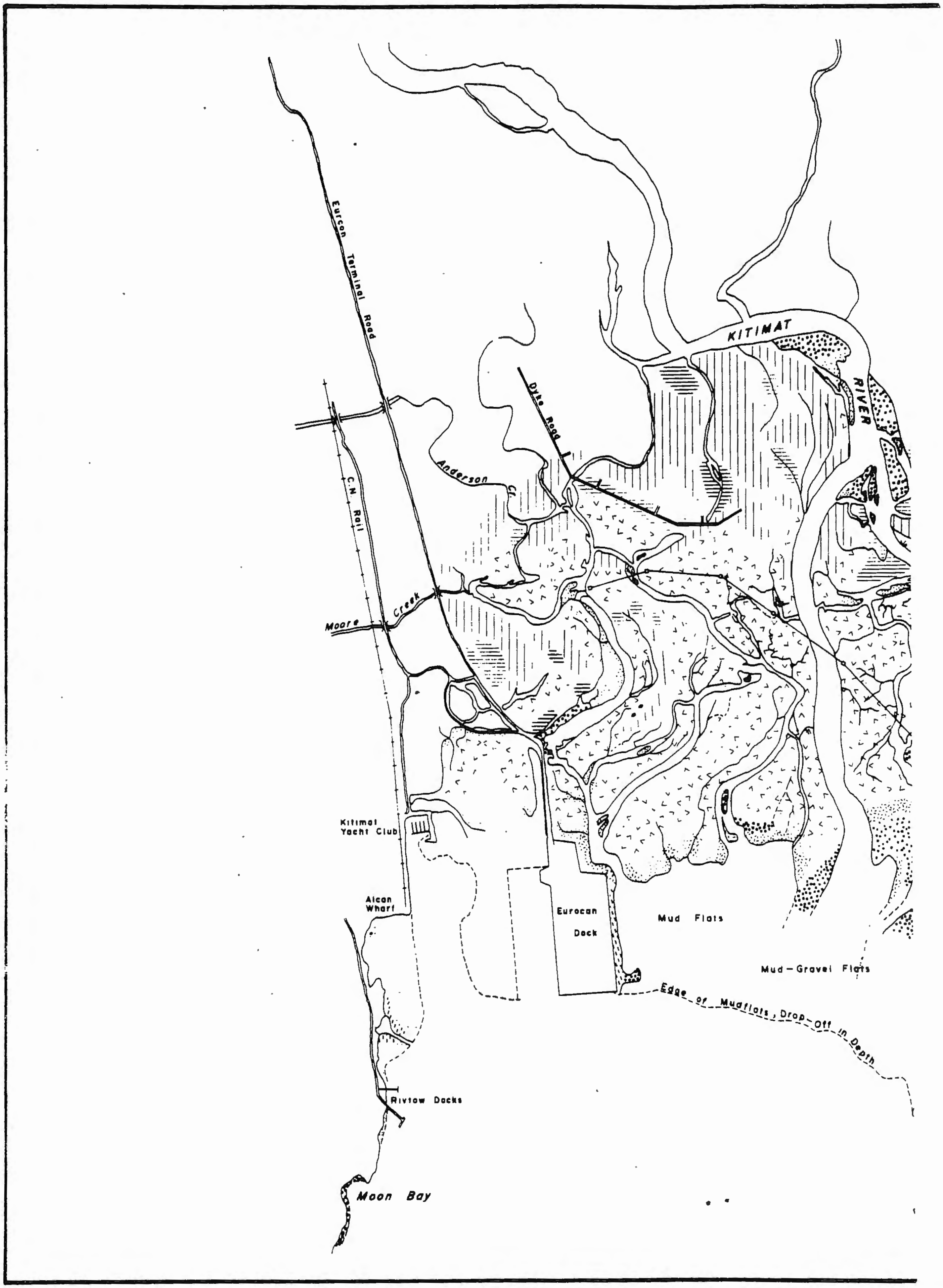
The lowest parts of the estuary are mainly bare gravel or mud (Photos 3-5, 3-6 and 3-7) and are exposed only at low tide. Where vegetation occurs in this zone it is dominated by eelgrass or rockweed. Paish (1974) reported rockweed scattered on rock, gravel and wood debris over much of the area near the mouth of the river. This was also observed in the foreshore areas sampled in 1980.

3.4.1 Pink Salmon

Pink salmon fry did not make extensive use of the Kitimat estuary. Although the sampling program began after the peak outmigration (Section 3.2.1) there were still large numbers of pink fry moving out of the river when the first round of estuary set netting was conducted. The set nets and beach seines which were fished April 15, 16 and 17 captured only 3 pink fry.

By the second round of estuary sampling (May 2-4) the outmigration from the river appeared to be over. Nonetheless, 13 pinks were collected in the Minette Bay set net and 8 were caught in the central estuary net. One more pink was collected in Minette Bay on May 15.

The small number of pink fry collected and their relatively small size (32.0 - 39.0 mm) suggest that their use of the estuary is at most a matter of hours.


KITIMAT
RIVER
Eurcon Terminal Road
Dyke Road
Anderson Cr.
C.N. Rail
Moore Creek
Kitimat Yacht Club
Alcan Wharf
Eurocan Dock
Mud Flats
Mud-Gravel Flats
Edge of Mudflats, Drop-Off in Depth
Rivtow Docks
Moon Bay

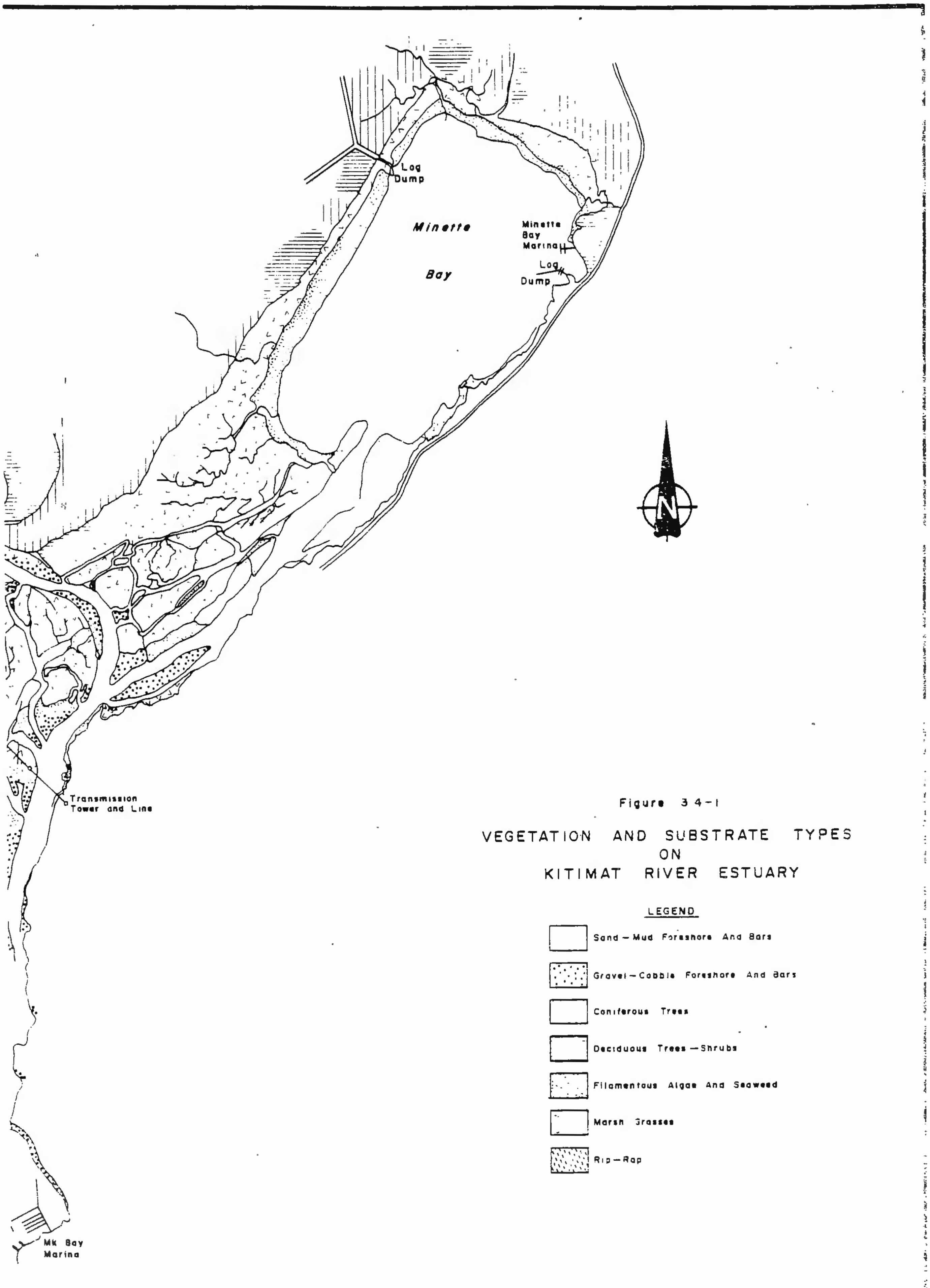
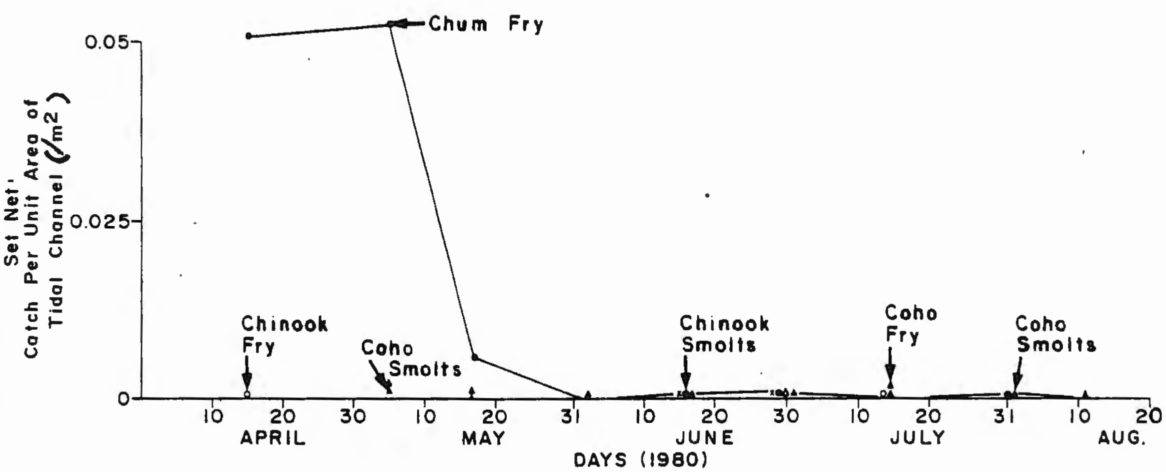
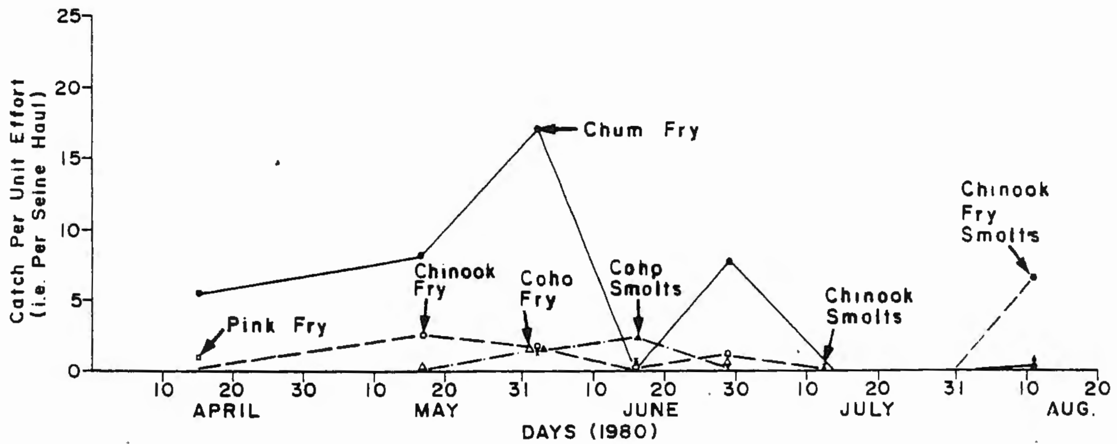


Figure 3 4-1

VEGETATION AND SUBSTRATE TYPES ON KITIMAT RIVER ESTUARY

Figure 3.4-2 UTILIZATION OF EUROCAN TIDAL CHANNEL BY JUVENILE SALMONDS DURING APRIL TO AUG. 1980.





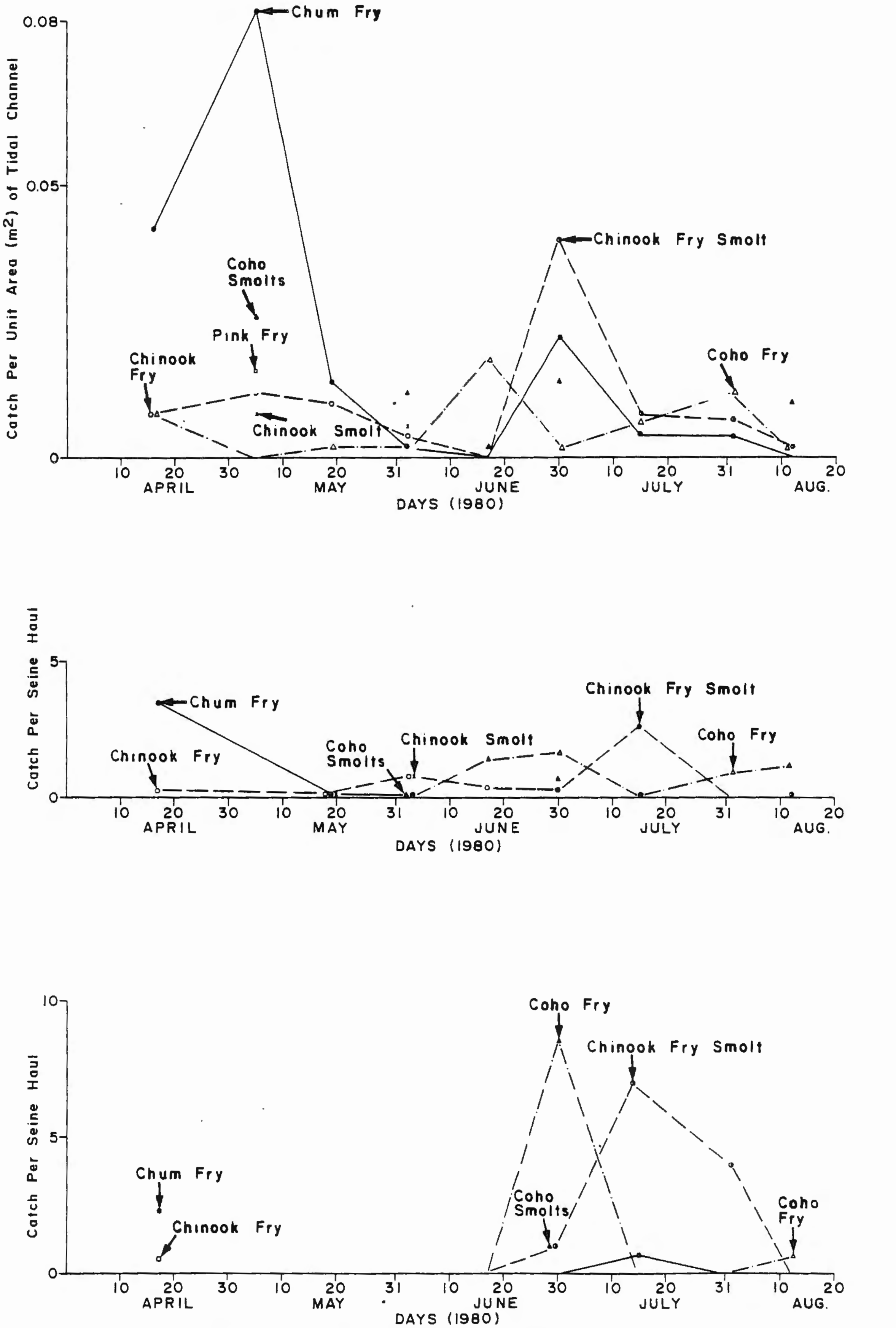
3.4.2 Chum Salmon

Chum salmon fry appear to make extensive use of the entire Kitimat River estuary. During April and May they were the most abundant species collected and were found at all stations (Figures 3.4-2, 3.4-3 and 3.4-4). The peak river outmigration occurred some time prior to April 7 (Section 3.2.2) and was essentially complete by the end of April. Peak numbers on the estuary occurred some time around the May 3 to 5 sampling, and estuarine rearing continued until the end of May. The fish ranged in size from 38 to 77 mm (Figures 3.4-6, 3.4-7 and 3.4-8) fork length which includes the smallest fish collected in the river and some much larger fry. Together this evidence suggests a residence time not unlike the "days or weeks" estimated by Levy et al (1980) on the Fraser River estuary or the "2-19 days" calculated by Healey (1979) for the Nanaimo estuary.

Interestingly, there was a second peak of chum fry on the estuary in late June and the first week of July. The increase was noted in all of the sampling areas but did not coincide with any movement of fish from the Kitimat River (Figure 3.2-5). The fish were relatively large (48-77 mm) and appear to have spent time rearing elsewhere before moving on to the estuary. Higgins (1976) also reported large chum fry returning to the estuary in July and remaining until late September.

Catch per unit area of tide channel was calculated from the set net catches and the measured areas of the tidal channels. During peak periods in April the catch was 0.03 fish per square meter in the Eurocan tidal channel, 0.03 to 0.04 in the central estuary and 0.08 in Minette Bay. Unfortunately, the available resources did not permit an assessment of set net efficiency. However, if the efficiencies are assumed to be similar to those of Levy et al (1979) who used set nets in a similar environment (mean efficiency$\sim$48%), then the peak densities of chum fry in the channels would be within an order of magnitude of the peak densities observed on the Fraser estuary (0.12 - 0.19 fish/m^2).

Figure 3.4-3 CENTRAL ESTUARY TIDAL CHANNEL JUVENILE UTILIZATION DURING APRIL TO AUG. 1980.



Low water beach seines were made in the larger tidal channels adjacent to the set net sites and produced catches which were generally like those of the set nets. In the central estuary, beach seine sets were made at the seaward end of the major tidal channels. No chum were collected in this area until July.

On the open flats of the lower estuary, chum were collected until mid to late June. The greatest diversities in this habitat appeared to occur in the area between the mouth of the Kitimat River main channel and the mouth of Minette Bay (Figure 3.4-5).

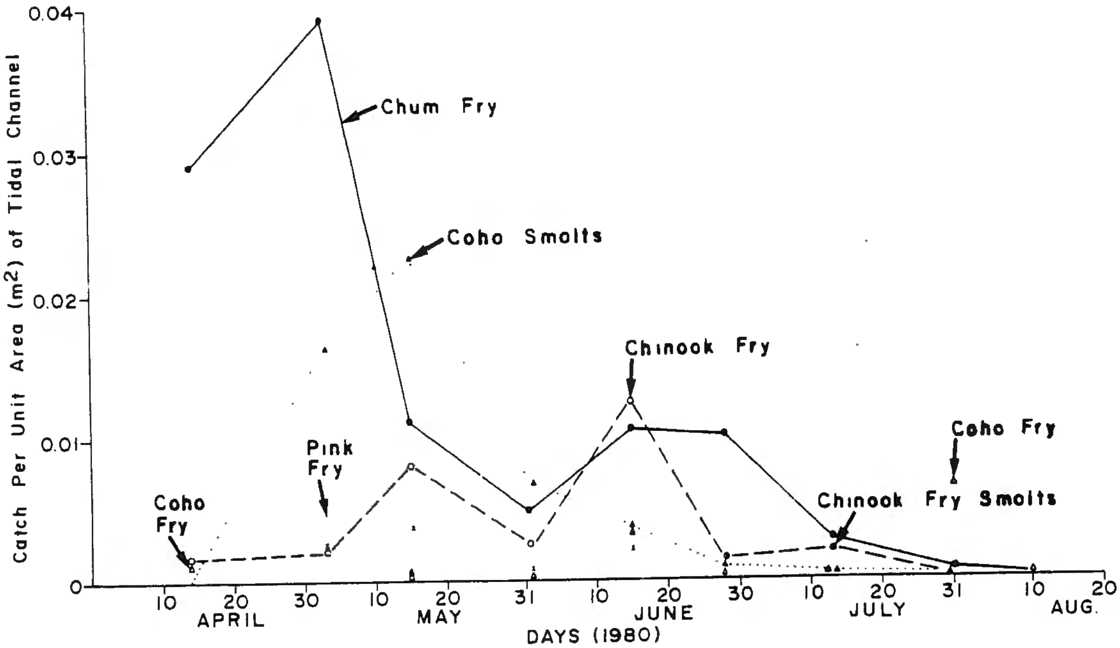
Potential Chum Netpen Sites in the Kitimat Estuary

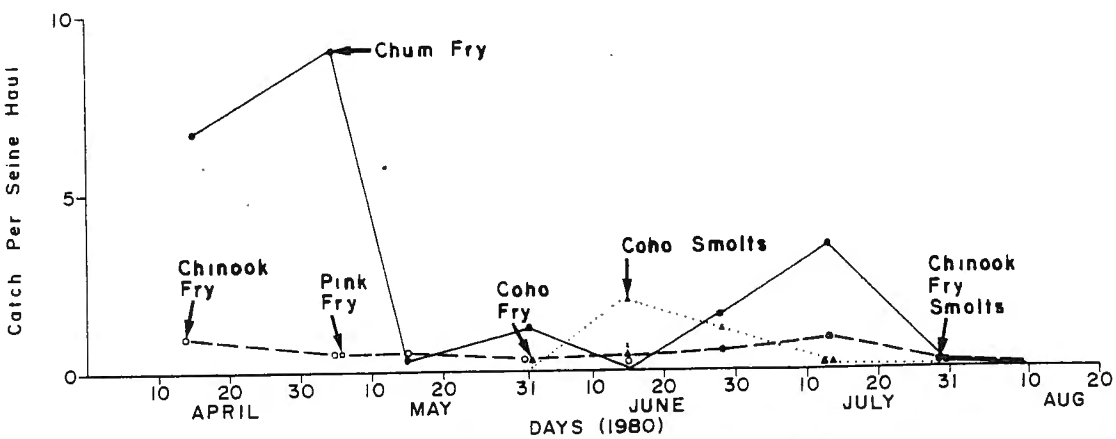
The following discussion is based on known estuary morphometry (Figure 3.4-1), suggested salinity variations (Section 3.1.2), and timing of chum utilization on the estuary during 1980 (Section 3.4.2).

Raising of chum fry in netpens has shown promise in some Japanese hatchery operations. In Canada, rearing of chums in seapens has received considerable attention in an effort to determine the suitability of chum for sea farming (Brett et al, 1978). Shelbourn (1980) reviewed the early growth efficiencies of chum fry in laboratory fresh and saltwater. His results indicate that seawater is not growth inhibiting, and that seasonal effects and food limitations may be responsible for growth limitations. In his discussion Shelbourn refers to several instances where chum fry have been successfully raised in estuarine (Shepherd, in prep) or nearshore sites (Vanstone _et al_, 1970).

According to Shepherd (pers. comm.) salinities of 10-30 and approximately 10°C are optimal for estuary netpens. These conditions can be used as criteria for suggesting netpen sites,

Figure 3.4-4 MINETTE BAY ESTUARY AND TIDAL CHANNEL JUVENILE UTILIZATION DURING APRIL TO AUG. 1980.





along with good flushing action; a sheltered locality and the absence of planktonic blooms. Brett et al, (1978) noted mortality amongst pen raised chum from gill damage attributable to diatomaceous spines. The planktonic species *Chactoceros convolutus* has been documented as responsible for severe pen reared salmon mortalities (Kennedy et al, 1976).

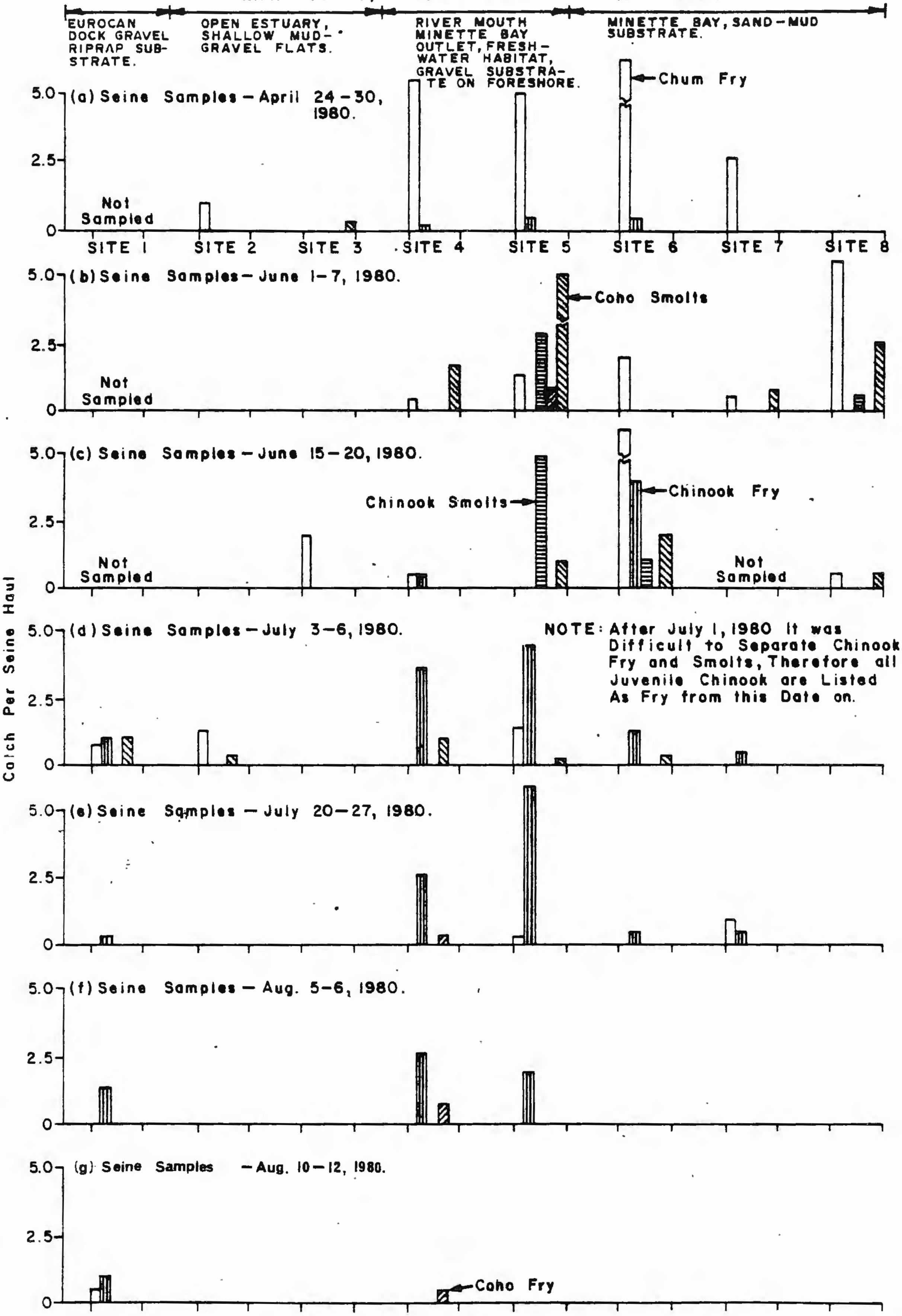
Three sites are available in the Kitimat estuary for chum netpens; Minette Bay, MK Bay, and Moon Bay. All three sites have adequate access, but each has habitat advantages and disadvantages. Due to the limited available salinity data, only the contrasting aspects of each site are discussed here, recommendations must await further studies.

Minette Bay provides a sheltered potential netpen site but may suffer from poor flushing rates. While this problem may be alleviated by positioning the pens near the outlet channel, the factors of relatively high summer water temperatures (14-15°C) and low flushing rates could result in planktonic blooms. In addition, salinities tend to be low. Natural chum fry utilization of the bay and its tidal channels appears to be quite high in comparison to the open estuary.

Moon Bay is relatively sheltered, and on average has slightly higher salinities than Minette Bay at comparable temperatures. It is unknown if the site is actively utilized by chum fry, but the bay is only a short distance (1 km) from estuary flats which extend to Hospital Beach near the Rivtow Dock. The salinity data suggests the site is characterized by a lower than optimal salinity range but further study of the site is warranted.

MK Bay is fairly open on the east shore of the Arm. The site is presently utilized for both log booming and marina operations. MK

Figure 3.4-5 JUVENILE SALMONID CATCH PER SEINE HAUL AT 8 SITES ACROSS THE ESTUARY FORESHORE (SEE MAP 1.0-4) FROM APRIL TO AUG. 1980.



Bay, though, is suggested as the most acceptable of the sites studied according to salinity and temperature data collected in 1980 and by previous workers (Higgins and Schmidt, unpublished data). Salinities are still low (<9.0‰) early in the season in the upper 2 m of the water column.

In conclusion, it is suggested that further salinity/temperature studies and chum utilization surveys be undertaken to include the above sites prior to final decisions on optimal chum netpen sites in the estuary.

3.4.3 Chinook Salmon

Chinook fry and smolts were collected on the Kitimat River estuary from April until August 1980. Both age classes moved out of the river in April and May (Section 3.2.3). At that time the fry were typically 40 mm fork length and 0.5 g damp weight. The smolts averaged 80 mm and 6 g (Figure 3.2-10). The importance of estuarine growth can be seen in Figure 3.4-6 where after four months estuarine growth the 0+ fish were larger than the 1+ fish had been after a year of stream residence.

Very few chinook fry were collected in the set net by the Eurocan dock. Catches never exceeded 0.005 fish/m^2 of channel although beach seines in the adjacent tidal channels collected fry throughout May and June. Fry were also collected in the August seines (Figure 3.4-2). In this area chinook exhibited steady growth and approached 100 mm fork length by August (Figure 3.4-6).

In the central estuary the set net catch peaked at 0.13 fish/m^3 of channel on May 5 and declined until late June when a second peak of 0.04 fish/m^2 occurred. This second peak occurred at about the time "90-day" fingerlings were observed leaving the river (Section 3.2.3).

A similar although less pronounced sequence occurred in Minette Bay (Figure 3.4-3). These later arrivals appear to be similar in size to those already on the estuary and there are no sudden changes in the growth curves (Figures 3.4-6 and 3.4-7).

The movement of chinook fry out of the small tidal channels and out to the seaward face of the estuary in July can be seen in Figure 3.4-5. By July the catch densities in all of the set nets had decreased and the 0+ chinook appear to have moved out to the seaward face of the estuary. Large numbers were collected in the area between the mouths of Minette Bay and the main channel. Very few chinook fry remained on the estuary by August.

Chinook smolts appeared on the estuary somewhat later than the outmigration record would suggest. Although the downstream migrants in the river peaked in April, few were collected in set nets before May and no obvious 2+ were observed. The 1+ chinooks were collected in all of the set nets in May and remained in the western estuary and Minette Bay until the end of June. In the set net by the Eurocan dock (Figure 3.4-6) the smolts were somewhat smaller than those found in the river and a growth trend was not evident. In the central estuary, chinook smolts were collected only in May and were similar in size to those migrants collected in the river. The chinook smolts collected in Minette Bay were somewhat larger than the others and a definite growth trend was observed (Figure 3.4-7).

Beach seines in the larger tidal channels adjacent to the set nets collected chinook smolts only during June. Seine nets at the mouth of the main channel did not include chinook smolts at any time. On the open flats of the outer estuary (Figure 3.4-5) chinook smolts were collected only in the area at the mouth of the main channel and the mouth of Minette Bay in the June 15-20 round of sampling. These fish were about 85 mm average fork length and appeared to be moving out of the estuary.

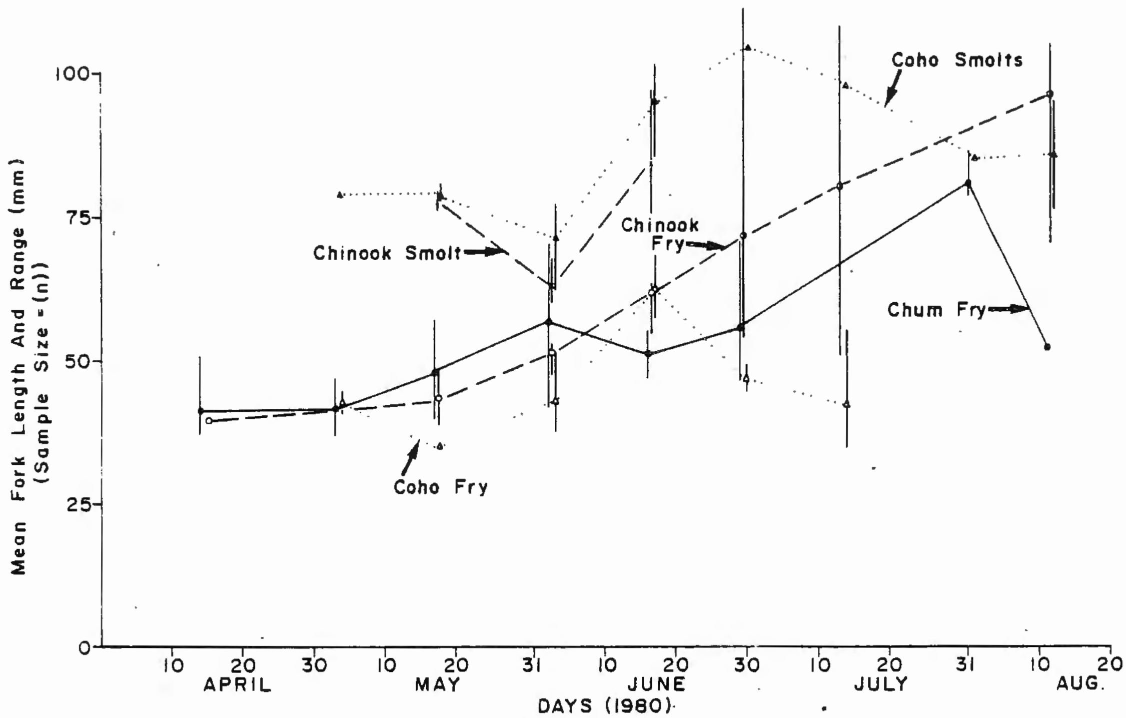
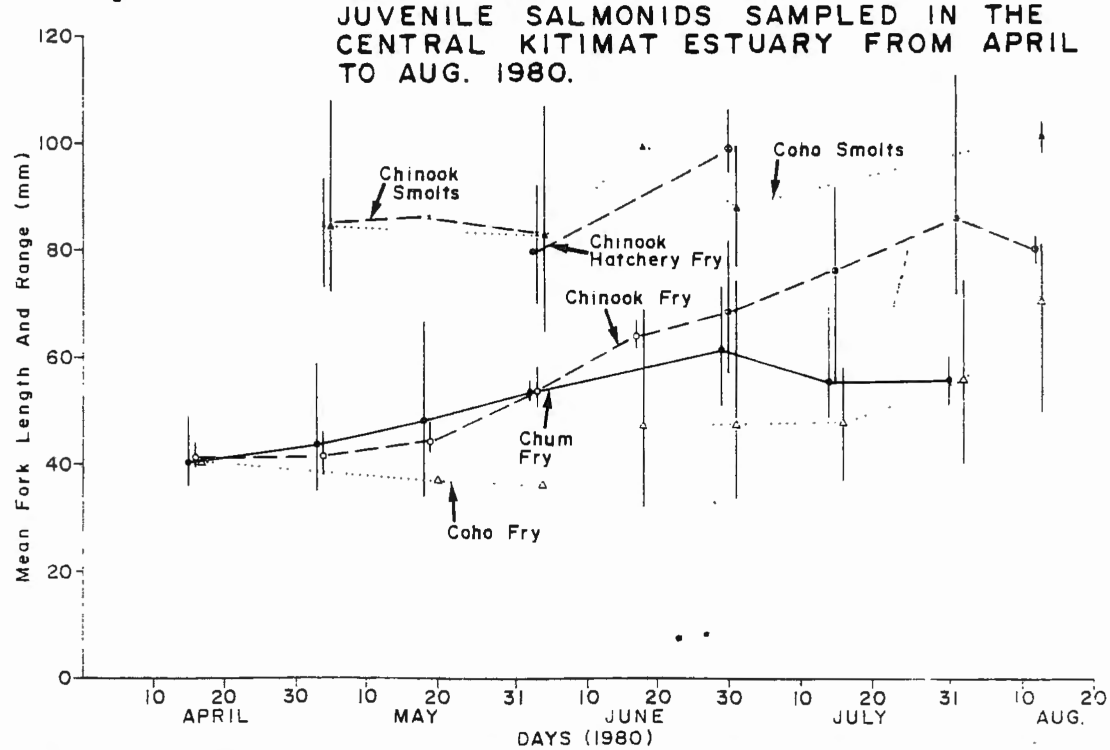


Figure 3.4-6 MEAN FORK LENGTH (mm) AND RANGE FOR JUVENILE SALMONDS SAMPLED BY SET NET AND BEACH SEINE IN THE KITIMAT RIVER ESTUARY NEAR EUROCAN DOCK.
NOTE: LOW SAMPLE SIZE AND OVER LAP OF FORK LENGTH RANGES NECESSITATED POOLING OF CHINOOK FRY AND SMOLT LENGTHS AFTER JUNE 30, 1980.

Figure 3.4-7 MEAN FORK LENGTH AND RANGE FOR JUVENILE SALMONIDS SAMPLED IN THE CENTRAL KITIMAT ESTUARY FROM APRIL TO AUG. 1980.



The D.F.O. pilot hatchery released chinook fry into the Kitimat River May 7-9. These adipose-clipped fry were recaptured in set nets on the central estuary and in Minette Bay during May and June. In size the hatchery fish were only slightly smaller than the 1+ "river type" smolts and their movements appeared to be similar. Although the sample sizes were very small they did indicate positive growth in both areas (Figures 3.4-6 and 3.4-7).

3.4.4 Coho Salmon

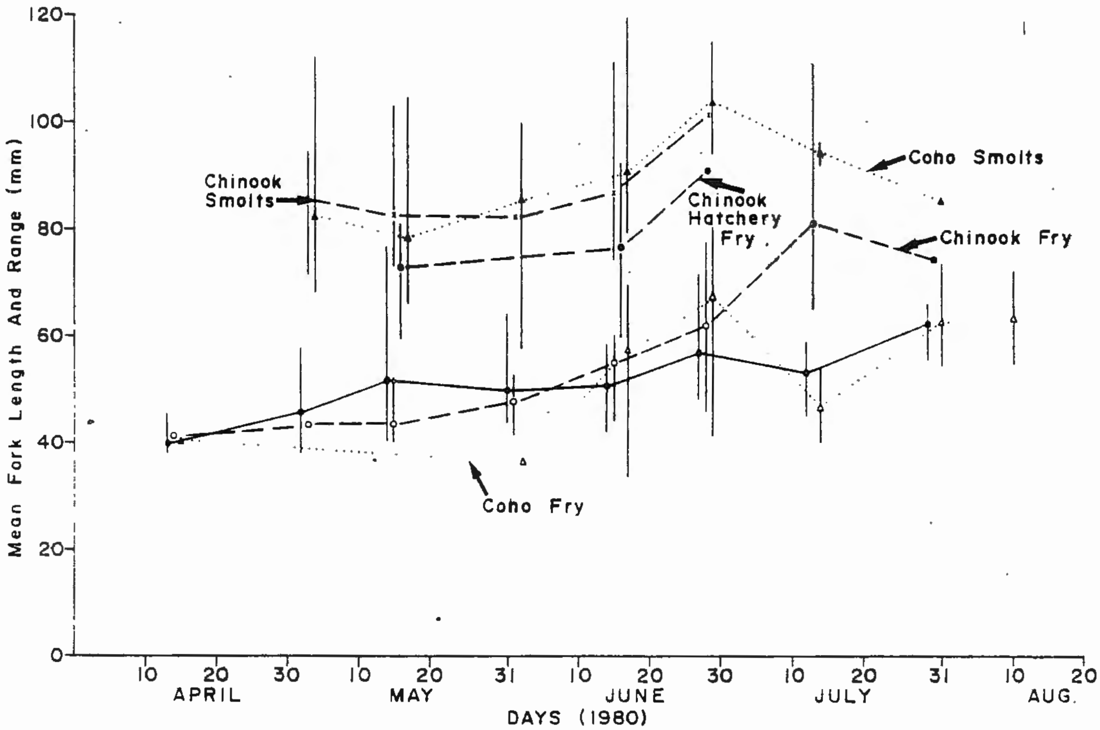
Juvenile coho salmon were collected in all areas of the estuary sampled with the densest aggregations occurring in the central estuary and Minette Bay. Fry were present throughout the study period while smolts peaked in May and decreased through July. These observations suggest a much longer period of residence than reported by Higgins (1976) and one similar to those of Paish (1974) who reported fry were still present at the end of July.

Downstream migrating coho fry were collected in the inclined plane trap throughout the study period (Figure 3.2-13) however the major outmigration occurred in June and early July. Small numbers of fry were collected throughout the estuary but the only dense aggregations were found in the central estuary (Figure 3.4-3). In that set net, the catch densities were low (0.01 fish/m^2) until after the peak outmigration in late June when they rose to 0.02 fish/m^2. The fry in this area increased in average fork length from 41 mm on April 7 to 70 mm on August 12. A similar late June peak of coho fry abundance was found in the large tidal channel adjacent to the set net site and at the lower end of the channel. This suggests that many of the fry move right through the estuary.

Coho fry were collected at the seaward edge of the estuary only in July and August and then only at station 4 near the mouth of the river.

Figure 3.4–8 MEAN FORK LENGTH AND RANGE FOR JUVENILE SALMON SAMPLED FROM A MINETTE BAY TIDAL CHANNEL AND THE ASSOCIATED MUD FLATS FROM APRIL TO AUG. 1980.

NOTE COMMENT FIGURE 3.4-6



The majority of the downstream migrant coho smolts left the river in April and early May. They were found on the estuary from May 5 to the end of the study in August. In the central estuary set net the peak catch density of 0.025 fish/m^2 occurred May 5 and the population decreased through July. The mean size increased from 83 mm fork length to 101 mm during the period. Very few coho smolts were collected in the adjacent larger channel or at the mouth of the main channel. In Minette Bay the set net catch followed a similar trend with a May 15 peak of 0.025 fish/m^2. Coho smolts do not appear to make extensive use of the area by the Eurocan dock as very few were collected there.

On the seaward face of the estuary the peak number of coho smolts was collected in June 1-7 beach seines in the central estuary near the mouth of Minette Bay and in the Bay itself. Smaller numbers of smolts were found at these sites until July (Figure 3.4-4).

3.4.5 Other Fish observed on the estuary

In addition to the pink, chum, chinook and coho juveniles whose use of the estuary was outlined in the preceding sections, the estuary habitat was utilized by several resident and anadromous species. In April through July, cutthroat fry were observed in most areas and later, in July and August, cutthroat adults were collected on the seaward edge of the estuary. Adult Dolly Varden char appeared to be resident in the tidal channels throughout the study period. Large numbers of sticklebacks, starry flounders and staghorn sculpins were collected in the beach seines and set nets. On occasion herring, eulachon, eelpouts and pricklebacks were also seen.

PHOTO 3-5
MINETTE BY MUDFLATS AT LOW TIDE NEAR THE MOUTH OF THE TIDAL CHANNEL SAMPLED BY SET NET

PHOTO 3-6
BEACH SEINING OFF THE EUROCAN DOCK AT FORESHORE SEINE SITE #1

PHOTO 3-7
GRAVEL/MUD HABITAT ON THE OPEN ESTUARY AT FORESHORE SEINE SITE #3

PHOTO 3-8: MINETTE BAY TIDAL CHANNEL WITH SET NET AT LOW TIDE

PHOTO 3-9: CENTRAL ESTUARY TIDAL CHANNEL AT LOW TIDE

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