Biological Reconnaissance of Kitimat Chinook and Results of Pilot Hatchery Operations to May, 1980

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ABSTRACT

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The results of Chinook salmon studies conducted in the Kitimat Valley to May, 1980 are presented, along with relevant background data. Water quality parameters were determined for a number of potential hatchery supplies in the study area. Migrant wild chinook fry and smolts were trapped and enumerated to determine the timing of their respective migrations. The timing, abundance and distribution of chinook spawners were investigated through mark-recapture, temporary fences, seining, gillnetting and walking surveys. Spawner characteristics were determined from both live and dead samples, age composition: 2.1% age 2_1, 41.3% age 3_1, 21% age 4_1, 15.9% age 5_1, 10.1% age 4_2, 6.5% age 5_2, 2.9% age 6_2; sex-ratio: 2.07 males per female (1.48 males per female, excluding "jacks"); fecundity: 8,000 eggs per female; mean length: males 58.7 cm, females 73.3 cm; mean weight: males 5.9 kg, females 8.6 kg . Differences in morphology and timing were not demonstrable in fish from the various tributaries.

Since 1977, approximately 314,775 eggs have been incubated at a pilot hatchery 3 km from the mouth of the Kitimat River, 265,793 fry have been reared of which 185,294 were coded-wire tagged prior to release.

Key words:

Chinook salmon, Kitimat Valley, water quality parameters, fry and smolt studies, spawner characteristics, pilot hatchery, incubation, rearing, coded-wire tagging.

Les résultats d'études sur le saumon quinnat, menées dans la vallée de la Kitimat jusqu'en mai 1980 sont présentés, ainsi que les données de base pertinentes. Des paramètres de qualité d'eau ont été déterminés dans la région à l'étude pour un certain nombre de points éventuels d'approvisionnement de piscifactures. Des alevins et des saumoneaux quinnats sauvages ont été capturés au cours de la migration et dénombrés de façon à déterminer le moment de la migration pour chacun des deux groupes. Le moment de la migration, l'abondance et la répartition des quinnats reproducteurs ont été recherchés au moyen de la récupération du dispositif de marquage, de l'érection de barrières temporaires, de la pêche à la seine et au filet maillant et d'observations effectuées tout au long de la rivière. Les caractéristiques des reproducteurs ont été déterminées à partir d'échantillons vivants et morts, dont voici la composition par âge: 2_1 ans, 2,1%, 3_1 ans, 41,3%, 4_1 ans, 21%; 5_1 ans, 15,9%; 4_2 ans, 10,1%; 5_2 ans, 6,5%; 6_2 ans, 2,9%; rapport des sexes: 2,07 mâles par femelle (1,48 mâle par femelle, si l'on excepte les jeunes saumons mâles), fécondité: 8,000 oeufs par femelle; longueur moyenne: mâles, 58,7 cm, femelles 73,3 cm; poids moyen: mâles 5,9 kg, femelles 8,6 kg. On n'a pu démontrer de différences d'un tributaire de la rivière à l'autre en ce qui concerne la morphologie et le moment de la migration.

Dupuis 1977, près de 314,775 oeufs ont été incubés dans une piscifacture pilote à 3 km de l'embouchure de la rivière Kitimat et 265,793 alevins y ont été élevés sur lesquels 185,294 ont été marqués à l'aide de fils de fer codés avant d'être relâchés.

Mots clés:

Saumon quinnat, vallée de la Kitimat, paramètres de qualité d'eau, études sur l'alevin et le saumoneau, caractéristiques des reproducteurs, piscifacture pilote, incubation, élevage, marquage à l'aide de fils de fer codés.

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INTRODUCTION

The chinook population of the Kitimat River is in a depressed state. The average escapement from 1975-1978 was only 1,750 fish, as compared to an average escapement of approximately 6,250 fish in the preceding 25 years (1950-1974). Environmental degradation following clear-cut logging of the Kitimat Valley and increasing harvest levels of chinook in both salt and freshwater have been major factors in the decline.

A complete closure to commercial fishing in the inside channels for some 72 km from the Kitimat River and a delayed opening of the gillnet and seine fisheries in the remainder of Fisheries Management Area 6 have been enforced to protect this run. No further net restrictions are feasible without affecting the harvest of other species in the area.

Because of the wide geographical range of occurrence during the ocean rearing and the large number of chinook stocks mixing in the north coast waters, specific restrictions on the troll fishery to conserve Kitimat chinook are not practical. Indian food fishing in the Kitimat River has been prohibited since 1968 and food fishing in Kitimat Arm has been curtailed significantly.

Closure of the freshwater recreational fishery, presently averaging 300 chinooks a year, and restriction of the marine recreational fishery, which accounts for 2500 adults and grilse annually, remain as options for increasing the Kitimat River chinook escapement. Construction of a hatchery to rehabilitate and subsequently enhance the run is another alternative.

In order to gather more information regarding the status of the Kitimat chinook run and evaluate possible enhancement opportunities, bio-reconnaissance programs were conducted in 1975 and 1976. In 1977, 1978 and 1979, eggs were collected and incubated at a pilot hatchery located on Eurocan Pulp and Paper Company property, approximately 3 km upstream from the mouth of the Kitimat River. Resultant fry were reared and coded-wire tagged prior to release, to study stock distribution, fishery contribution and reared smolt-to-adult survival rates.

DESCRIPTION OF THE AREA

The Kitimat River originates on the slopes of Mount Davies in the Coastal Range and flows northwest for about 43 km, at which point it enters the Kitimat Valley (Fig. 1). It then continues with a southerly flow for 32 km before discharging into Kitimat Arm at the head of Douglas Channel.

The Kitimat River and its tributaries drain an approximate area of 200,000 hectares. The major portion of the drainage basin lies to the east of the Kitimat Valley and is drained by the Kitimat River, Chist Creek, Hirsch Creek, Davies Creek and McKay Creek. The west side of the valley is drained principally by the Wedeene and Little Wedeene Rivers, Cecil Creek, Goose Creek, Anderson Creek and Moore Creek.

The mean annual discharge for the Kitimat River from 1964 to 1973 was 134 CMS, measured at Station 08FF001 at the Kitimat town site. The maximum mean annual flow for this period was 160 CMS and the minimum was 108 CMS. The maximum instantaneous discharge for the Kitimat River was 2,020 CMS, recorded on October 15, 1974. Other flow data measured at Station 08FF001 are presented in Table 1.

Table 1 - Kitimat River flow data (Can. Dept. Env., 1976, unpublished surface water data)

	CMS	DATE
Maximum daily flow	1,647	Oct. 15 1947
Minimum daily flow	9	Dec. 22 1973
Largest mean annual flow	160	1967
Smallest mean annual flow	108	1970
Maximum mean monthly flow	385	Jun. 1967
Minimum mean monthly flow	14	Feb. 1972

Peak river flows generally occur during October and November and during May and June, following the snowmelt and subsequent spring runoff. High river flows have also been recorded during January and February, during periods of abnormal weather conditions.

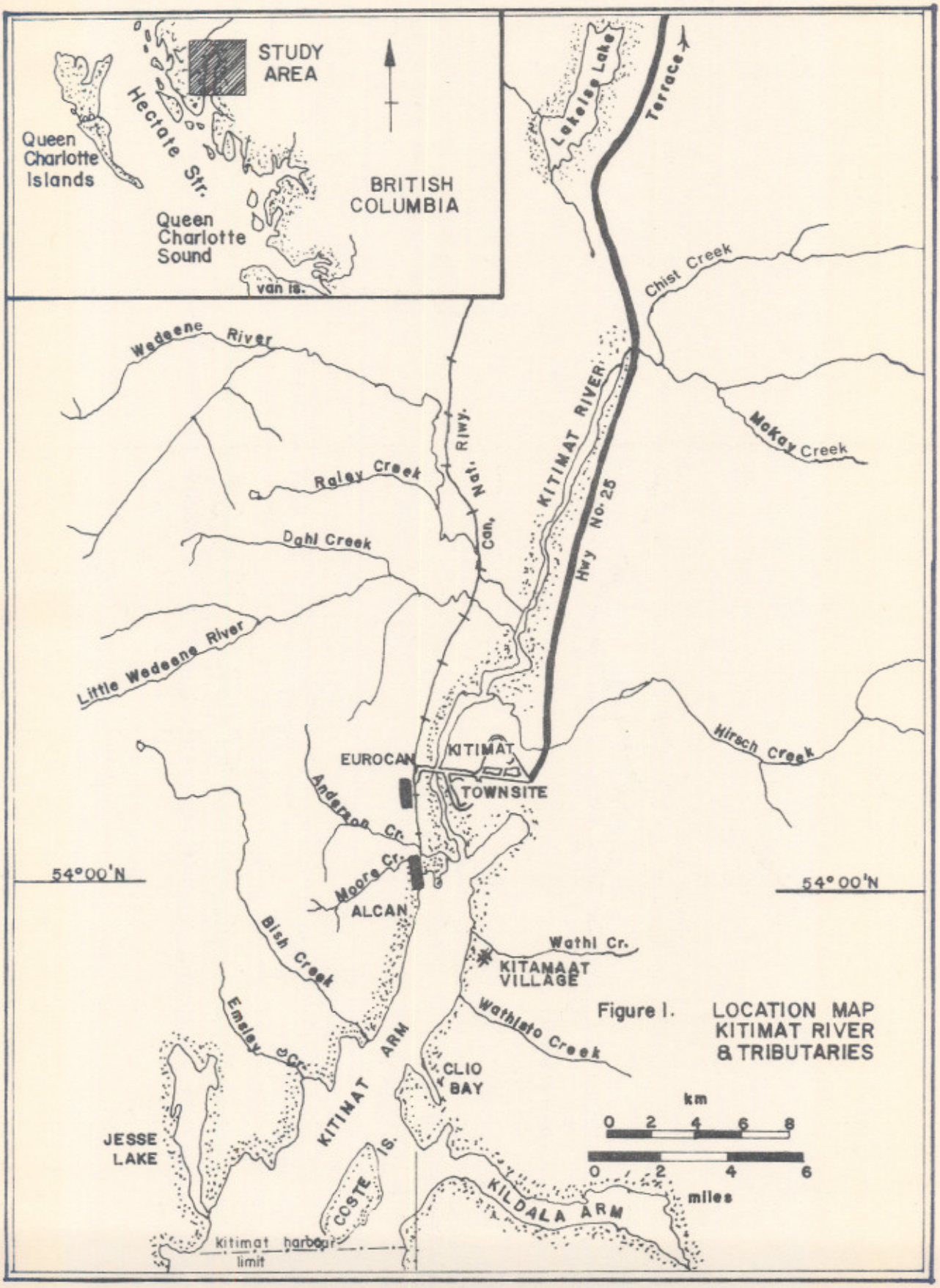


Figure 1. LOCATION MAP KITIMAT RIVER & TRIBUTARIES

CLIMATE

The climate of the Kitimat Valley is influenced, during most seasons, by low pressure systems that have moved eastward across the Pacific Ocean (Bell and Kallman, 1976). These are most intense in the fall, producing an October peak in precipitation. An outflow of cold Arctic air from the interior plateau often occurs during the winter. Temperature and precipitation records from Kitimat town site (Table II) indicate that the climate of the Kitimat Valley can be classified as West Coast - Head of Fiord (Chapman et al., 1956).

Table II - Observed temperatures and precipitation, Kitimat Townsite, 1941 - 1970 (Can. D.O.E., Atmospheric Environment Service, 1975).

Temperature		Precipitation	
Mean annual	6.6°C	Mean annual (total ppt.)	- 2377 mm
Mean January	- 4.2°C		
Mean July	16.2°C		
Extreme Max.	36.1°C	Mean annual rainfall	- 1840 mm
Extreme Min.	-25.0°C	Mean Annual snowfall	- 537 mm

HISTORIC CHINOOK ESCAPEMENTS, CATCHES

Chinook escapements to the Kitimat system over the past 30 years are summarized in Appendix I. The most important chinook spawning areas are: Kitimat River mainstem (maximum escapement 20,000, 1966), Wedeene River (maximum escapement 7,500, 1962), Little Wedeene River (maximum escapement 3,500, 1962), Hirsch Creek (maximum escapement 750, 1964), Humphrys Creek (maximum escapement 75, 1964), Nalbeelah Creek (maximum escapement 25, several years) and Chist Creek (approximate escapement 50 - 150/year).

Although the Area 6 commercial chinook catch normally ranges from 25 - 40,000, most of these fish are thought to belong to transient stocks. The contribution of Kitimat stocks to the total catch remains unknown. Since 1968, the Kitimat River Indian food fishery has been closed. The annual Kitimat River sports catch is estimated to be 250 - 300 chinook. An average of 2500 adults and grilse

are taken each year by sports fishermen in Kitimat Arm and Douglas Channel. The timing of the adult catch indicates that a significant proportion of these fish are bound for the Kitimat River. In recent years, both fresh and saltwater fishing effort has increased dramatically.

METHODS

(1) 1975 - 1979 BIOLOGICAL PROGRAMS

(a) Adult Studies

A beach seine survey was conducted from July 31 - August 31, 1975 to investigate the stock strength, timing of migration and spawning distribution of Kitimat River chinooks. A 61 m long, 4.6 m deep, 6.3 cm mesh net was used in broad, deep pools. In shallower, faster pools, a 46 m long, 3.7 m deep, 5 cm mesh net was used. Both nets were set off the bow of a 5.6 m long steel river boat. All fish captured were examined and enumerated prior to release.

In 1976, seining commenced on June 11. Individual chinooks were captured as they entered the Kitimat River, and tagged with a 22 mm diameter Petersen disc tag, just below the dorsal fin. A time varied combination of coloured baffles was used, so that migration could be monitored visually. To facilitate the enumeration and observation of tagged fish and provide a means of capturing additional fish, a broomstick fence was constructed across the east channel of the Kitimat River approximately 500 m below Humphrys Creek. Unfortunately the fence washed out on June 8, before it could be of any real use.

The spawning grounds were surveyed by boat and on foot from September 8 - 27. A record was kept of all marked and unmarked chinooks observed. The survey was terminated on September 27 due to high water levels and poor visibility.

The 1977 chinook tagging program commenced on June 6. Gillnets were used to supplement the seine-net catch. To facilitate observation and recovery of tagged fish and provide more accurate spawning counts, broomstick fences were operated on Nalbeelah Creek, Humphrys Creek, Goose Creek and the Little Wedeene River. The major spawning grounds were surveyed by boat, foot and aircraft.

The tagging program ended on August 7, the spawning ground survey on October 16.

Adult chinook were not tagged in 1978 and 1979. Gillnetting and seining were primarilly geared to provide donor stock for the pilot hatchery.

Since 1975, representative samples from the sport fishery and various biological programs have been sexed, weighed, measured and scale-sampled. In addition, the fecundity of fish used as hatchery donor stock has been monitored by direct counts and extrapolated volume/counts (Hilland, 1977).

On August 23, 1977, seventy spawned-out fish were examined by the Diagnostic Service of the Pacific Biological Stations' Fish Health Laboratory.

(b) Fry and Smolt Studies.

In the spring of 1978, a downstream trapping program was initiated to establish the timing and population size of emigrant Kitimat chinooks. Four types of traps were fished from March 31 to mid-June:

1. A 4 x 4 inclined plane trap was fished in the main Kitimat River at Cable Car (Fig. 2). This trap was fished nightly from March 31 - April 27, intermittently thereafter.

2. From March 31 - April 27, 2 x 3 inclined plane traps were fished nightly at the mouth of the Little Wedeene River (this trap was later moved to Hirsch Creek), in the Kitimat River above Cable Car and in Hirsch Creek. After April 27, these traps were fished infrequently, due to rising water levels.

3. Two types of modified Wolf traps (Armstrong and Argue, 1977) were used:

   (a) Wire flume traps were fished at Humphrys Creek, Goose Creek, Deception Creek, in a side channel of the Kitimat River at Cable Car and in Nalbeelah Creek. The Nalbeelah Creek traps employed a series of logs and gates to direct fish from the main channel of the creek into the trap.

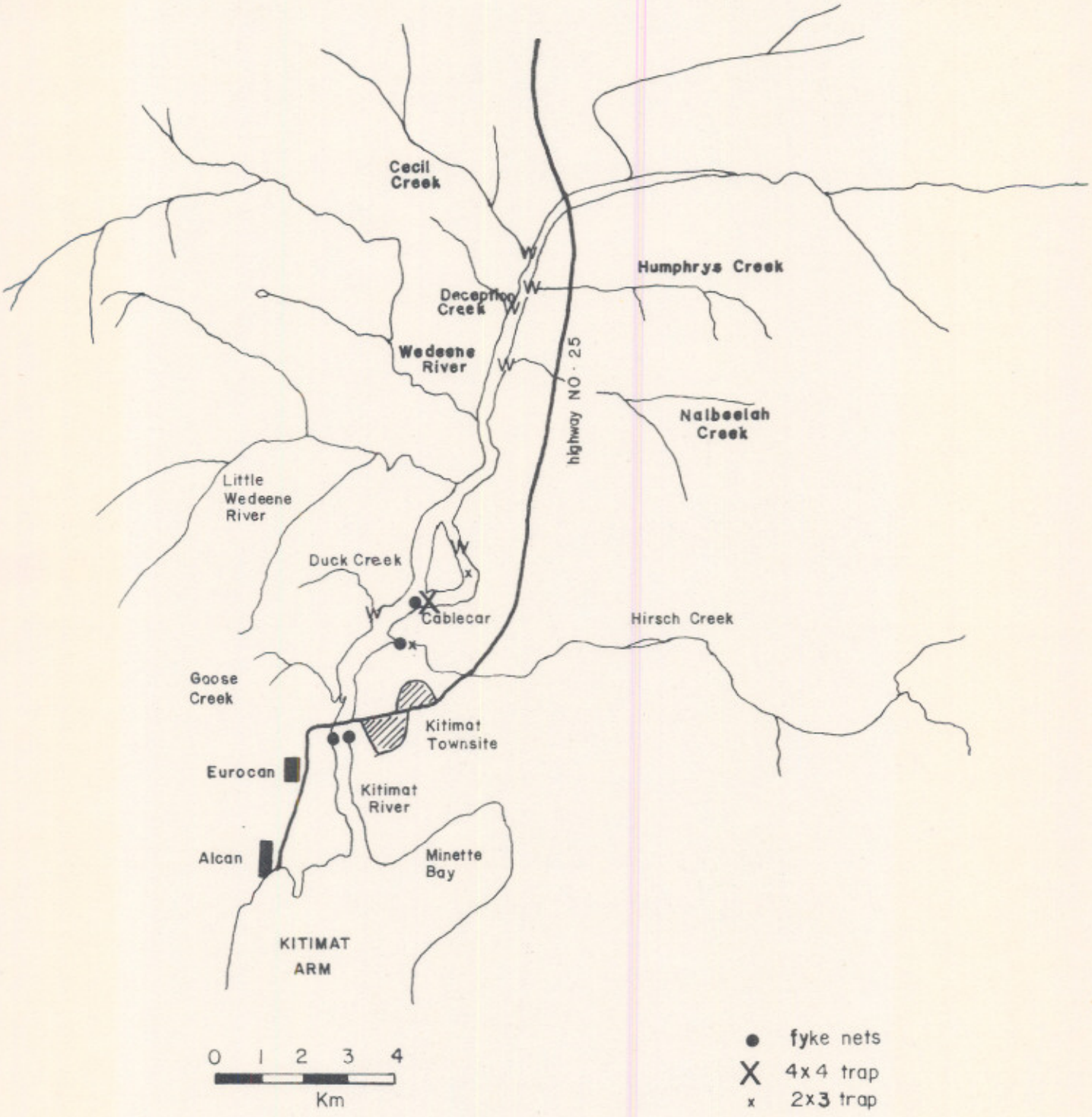


Figure 2. Location of fry traps, 1978.

(b) Traps with a solid flume were used at Cecil Creek and Duck Creek, primarily to offset the effect of low flow.

4. Fyke nets with an approximate 1 m x 1 m opening were fished in the Kitimat River at Cable Car, Hirsch Creek, Radly Park and below the Haisla Bridge. These traps were normally fished from dusk until dawn, but on nights when water levels were high and debris abundant, efficiency was reduced.

The chinook fry and smolt catch at each location was recorded. A number (1578) of 1976 brood chinook smolts were coded-wire tagged (code used 2/20/50) and adipose clipped prior to release.

2. WATER QUALITY SAMPLING

(a) Surface Water Analysis

Although several water quality studies have been conducted along the Kitimat River, prior to 1977 the majority were designed to assess the potential impact of effluent from the Eurocan pulp mill. For example, from July 1969 to October 1971, the Eurocan Pulp and Paper Company commissioned T.W. Beak and Associates to survey the physical, chemical and bio-chemical qualities of the water at three locations:

1. Upstream of all known outfalls.
2. Between the City of Kitimat sewage outfall and proposed pulp mill outfall.
3. Downstream from the proposed pulp mill outfall.

Sampling and analytical techniques are summarized in Beak (1971; 1972).

More extensive surveys commenced in 1977:

(i) During the May to November bio-reconnaissance program, intermittent "grab" samples were collected at the "17 mile" bridge, Haisla bridge and from the Eurocan potable supply. The samples were frozen and shipped immediately to the Pacific Environmental Institute laboratory, where a number of water quality parameters were measured. Duplicate samples were shipped to the Can-Test Ltd. Laboratory in Vancouver for

sediment character analysis (for description of methods for particle-size analysis, see Appendix II).

(ii) During September and October, the Environmental Protection Service sampled six stations (fig. 3) between the Haisla Bridge and mouth of the Kitimat River for water quality, benthic invertebrates, periphyton and salmonids. In addition, bacteriological samples were collected at each of the water quality sampling sites.

Studies designed to investigate the suitability of the Kitimat River and its tributaries for fish culture, and locate a groundwater supply for use in a hatchery, commenced in the summer of 1978. In August, samples were taken from the Wedeene River and Kitimat River at Eurocan, 500 m downstream from Eurocan, Haisla Bridge, Cable Car and "17 mile" (Fig. 4). The following water quality parameters were quantified, in accordance with procedures set out in "Standard Methods for the Examination of Water and Wastewater" (14th Ed.) (Rand et al, 1975).

Physical Tests

pH, Conductance (umhos/cm), Color (C.U.), Turbidity (J.T.U.), Total Dissolved Solids (mg/L), suspended solids (mg/L) and Temperature.

Dissolved Anions (mg/L)

Alkalinity (HCO_3 and CO_3), Cl, SO_4, Nitrate (N), Nitrite (N), PO_4, F, Si, Cn.

Dissolved Cations (mg/L)

Total Hardness ($CaCO_3$), Ca, Mg, Na, K, Fe, Mn, Cd, Cu, Pb, Zn.

Others (mg/L)

Ammonia (N), Total Phosphate (PO_4), Total Mercury (Hg), Dissolved Oxygen.

On January 24, 1979, Anderson Creek, Little Wedeene River, Wedeene River, Cecil Creek, Chist Creek, Humphrys Creek, Nalbeelah Creek, Hirsch Creek and the upper Kitimat River were sampled for metals. Duplicate samples were collected at each site, fixed with HNO_3 and immediately flown to the Pacific Environmental Institute Laboratory in sealed ice chests. As in 1978, analysis was done in accordance with APHA (1975) guidelines.

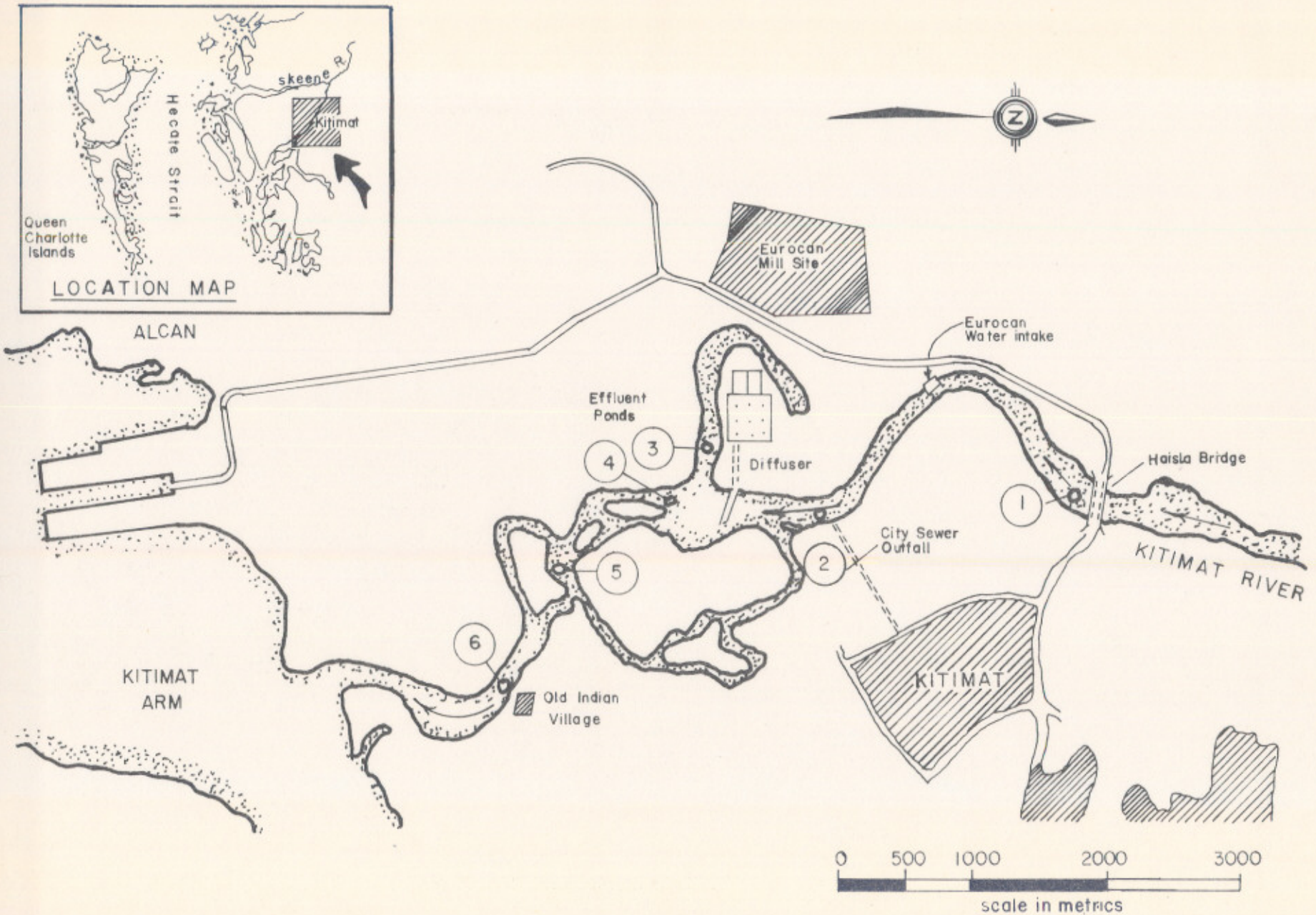
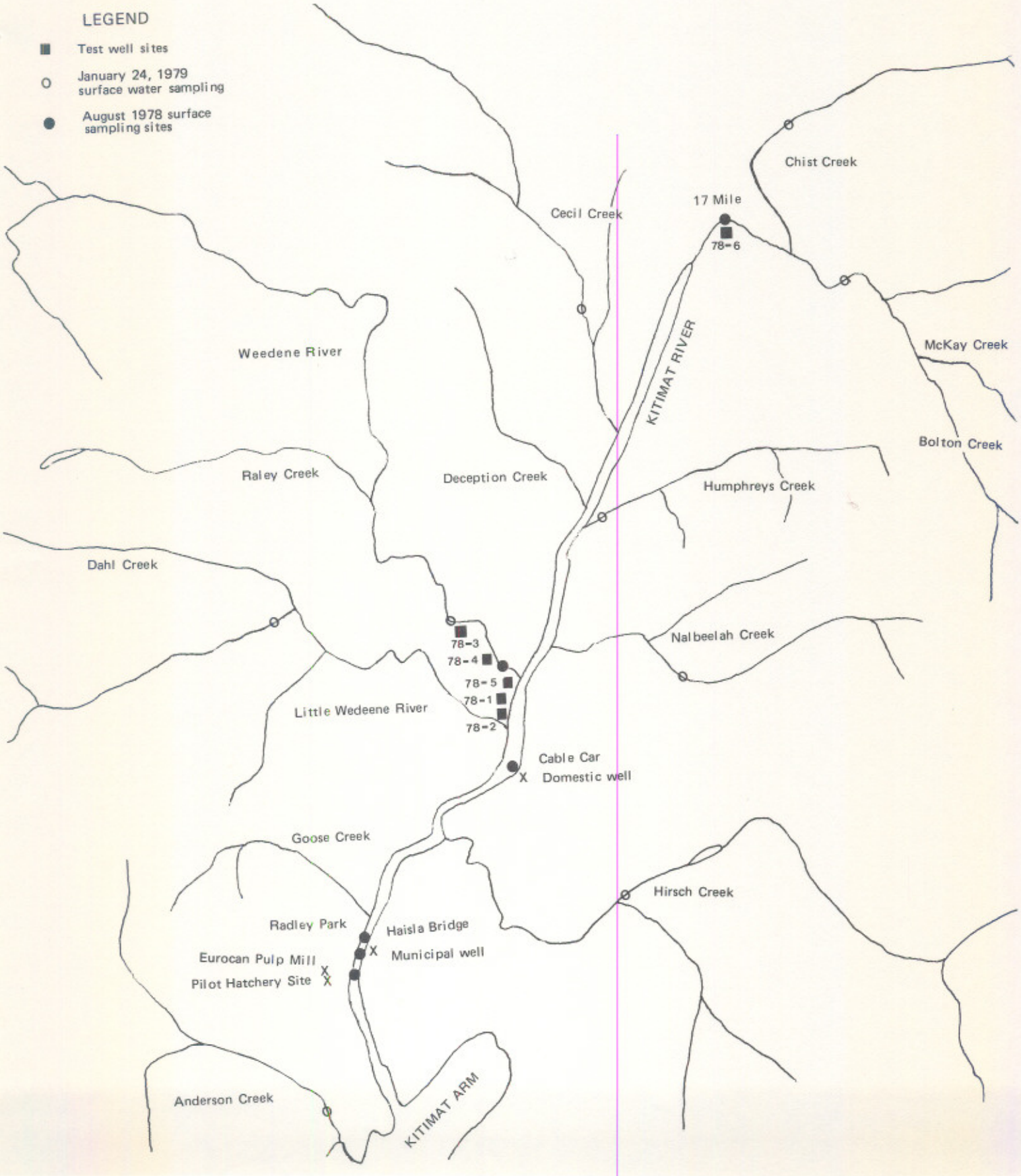


Figure 3 KITIMAT RIVER SURVEY -- September - October, 1977

Figure 4 1978/79 Surface and Well Sampling Sites



(b). Well Water Analysis

In May, 1978, five test wells were drilled on the flood plain between the Wedeene and Little Wedeene Rivers (MLM Groundwater Engineering, 1978a). Water samples were shipped to Western Industrial Laboratories in Edmonton. Analysis complied with guidelines established by the National Department of Health and Welfare (1969).

On July 18, 1978, samples were taken from test well 78-5 (Fig. 4). For comparison, surface water samples were taken from the Wedeene River and Kitimat River above the mouth of the Wedeene. The Dissolved Oxygen content of the groundwater was measured with a YSI oxygen meter. The D.O. of the surface water was measured with a Hach DR-El Kit, using the azide modification of the Winkler method (Taras et al., 1971). pH was measured in the field with a Hach Kit. Samples to be analyzed for carbon dioxide and nitrogen content were chilled and shipped to the Capilano hatchery. Samples to be tested for metals, nutrients, residues and pH were similarly shipped to the Cypress Creek lab.

All samples were analyzed in compliance with APHA (Rand et al, 1975) guidelines.

An additional test well was drilled in August, 1978, on the south side of the Kitimat River, 500 m downstream from Chist Creek (MLM Groundwater Engineering, 1978b). Pump tests indicated that very little groundwater was available, thus water samples were not taken.

On August 15, additional samples were taken from test wells 78-2, 78-4 and 78-5. Samples for comparison were taken from the Kitimat municipal well and a domestic well at Cable Car. These samples were fixed, transported and analyzed in the same manner as the previously discussed August, 1978 surface water samples.

3. 1977 - 1980 PILOT HATCHERY OPERATIONS

(a) 1977 - 1978

In July and August, 1977, thirteen male and eleven female chinook were seined and held near the mouth of Goose Creek in 3m x 3m x 2.5m deep floating pens lined with 6.3 cm mesh vinyl coated chain-link fence (Fig. 5).

Figure 5. Adult holding pens, 1977

The fish were segregated by sex and sorted regularly for ripeness. Occasional treatment with malachite (Wood, 1974) was required to combat a fungal infection (Saprolegnia, spp.).

When ripe, the females were killed by a sharp blow to the head, hung head downwards to bleed and wiped dry with paper towels. Eggs were collected by hanging each female tail downwards over a dry plastic bucket and making a ventral incision from the ovipositor to the forward end of the body cavity.

Sperm from the ripe males was expressed into zip-loc bags and transferred on crushed ice to the hatchery site, where it was gently stirred into the eggs. Water was then added to effect fertilization.

After fertilization, the eggs were placed in a stack of 16 Heath trays located in a small building adjacent to the hatchery trailer. Each tray received the eggs from one female. Water from Eurocan potable supply was directed through

the trays at a rate of 11.5 ℓ/min. from initial planting to hatch. The flows were gradually increased to 16 ℓ/min. after hatch. The eggs were treated with Malachite twice weekly until eyed, using the "California flush" method (Wood, 1974). On October 15, the eggs were shocked by pouring them from one tray to another, volume-counted and picked.

The eggs began to hatch in mid-December; the alevins were ponded from January 1 - 8. Two 6.7 m x 9 m x 6 m deep fiberglass troughs were placed side by side in the hatchery trailer (Fig. 6) to receive the alevins. Flows through the troughs were maintained at 160 - 180 ℓpm, with partial recirculation. A Polano water heater was used to raise water temperatures in the rearing troughs on January 18. Its use was discontinued on January 19, when fish began to die for no apparent reason.

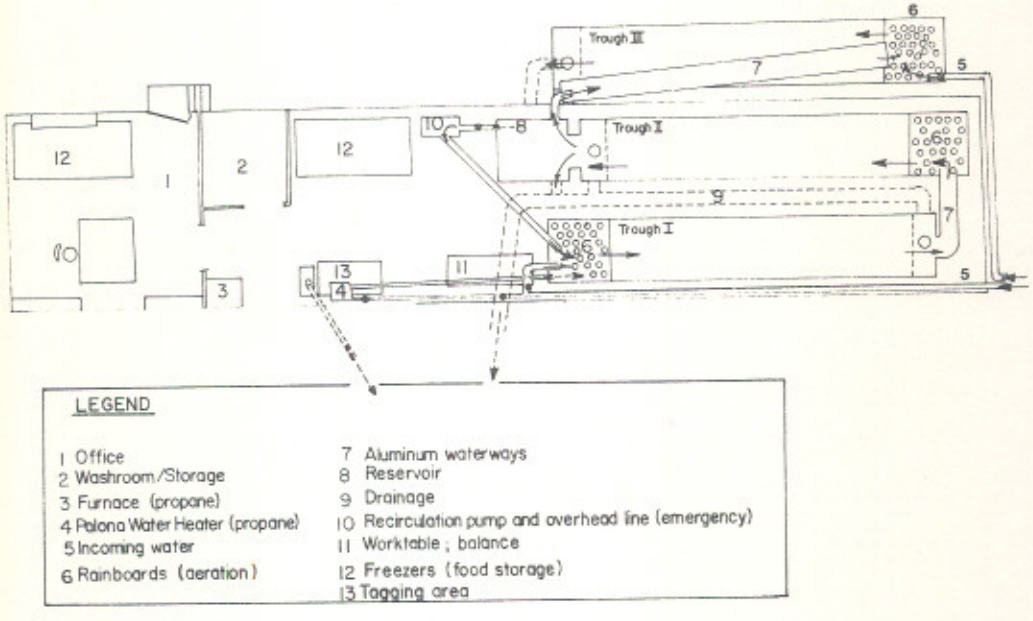


Figure 6 - Diagram of Kitimat Pilot Hatchery Rearing Troughs and Water Supply

Commencing on January 7, the fry were fed 1/32" O.M.P. at a standard hatchery rate (Appendix III). As some fry showed symptoms of "cold-water" disease (Cytophaga psychrophila), 2 mg of sufamethazine was added to each of the 6 daily feedings. Treatment continued until January 25. In early April, when the fry were able to ingest 3/64" feed, the frequency of feeding was reduced to 4/day.

As the fry grew larger, the troughs became crowded. Subsequently, on April 25, 17,808 fry were transferred to 1.5 m x 1.8 m x 1.2 m deep ABS frame, marquisette-lined pens in the Kitimat River across from the Eurocan intake (Fig. 7).

Figure 7. Fry rearing pens, 1977

On May 15, when the average fry weight approximated 5 gms, coded-wire tagging began. Small groups of fry were anaesthetized with MS-222, adipose-clipped and tagged (codes used 2/20/48 and 2/20/34). Marked fry were trucked to the 17 mile bridge in a 1,300 ℓ fibreglass tank and released at dusk.

A number of sets with a 1 cm mesh seine net were made from June 12 - 16 to monitor the distribution and abundance of tagged fish in Kitimat Arm.

(b) 1978 - 1979

In 1978, 12 cm mesh "tangle" gillnets were used to supplement the seine catch. A total of 33 females and 29 males were collected from July 31 - September 3, sexually segregated and held in floating 3 m x 3 m x 2.5 m deep pens, lined with 1 cm mesh knot-less nylon netting, across from the Eurocan intake. To discourage predators, a 6.3 cm mesh vinyl coated chain-link barrier was constructed around the pens.

The fish were regularly sorted and those judged ripe spawned in the same manner as in 1977. The eggs were incubated, shocked and picked as in 1977, however, malachite treatments were only administered once a week.

Four groups of alevins were ponded from December 18 to January 10, and segregated in the troughs with marquissette screens until their feeding behavior stabilized. Feeding rates are summarized in Appendix III. As the fry grew and the troughs became crowded, approximately 75,636 were transferred to 1.5 m x 1.8 m x 1.2 m deep, marquissette-lined ABS frame pens in the Kitimat River across from the Eurocan intake, and reared for a short-time prior to release.

Coded-wire tagging commenced on May 5, when the average fry weight approximated 5.3 gms.

Fry handling, marking and release procedures duplicated those of 1977.

(c) 1979 - 1980

In 1979, 18 females and 15 males were captured with 12 cm mesh "tangle nets" and held in a single floating pen, similar to the type used in 1978, located across from the Eurocan water intake. When the fish ripened, they were spawned in the same manner as in 1977 and 1978. Immediately following fertilization, the eggs were disinfected with 100 ppm active iodine. Otherwise, incubation, shocking and picking proceeded as in previous years.

Alevins were ponded from December 10 - January 4. Coded wire tagging commenced on April 14, when the average fry weight approximated 5.0 gms. Marked fry were transferred to marquissette pens across from the Eurocan pumphouse and released at dusk. The first group of fish were released on May 7, the final group on May 10.

RESULTS

(1) 1975 - 1979 BIOLOGICAL PROGRAMS

(a) Adult Studies

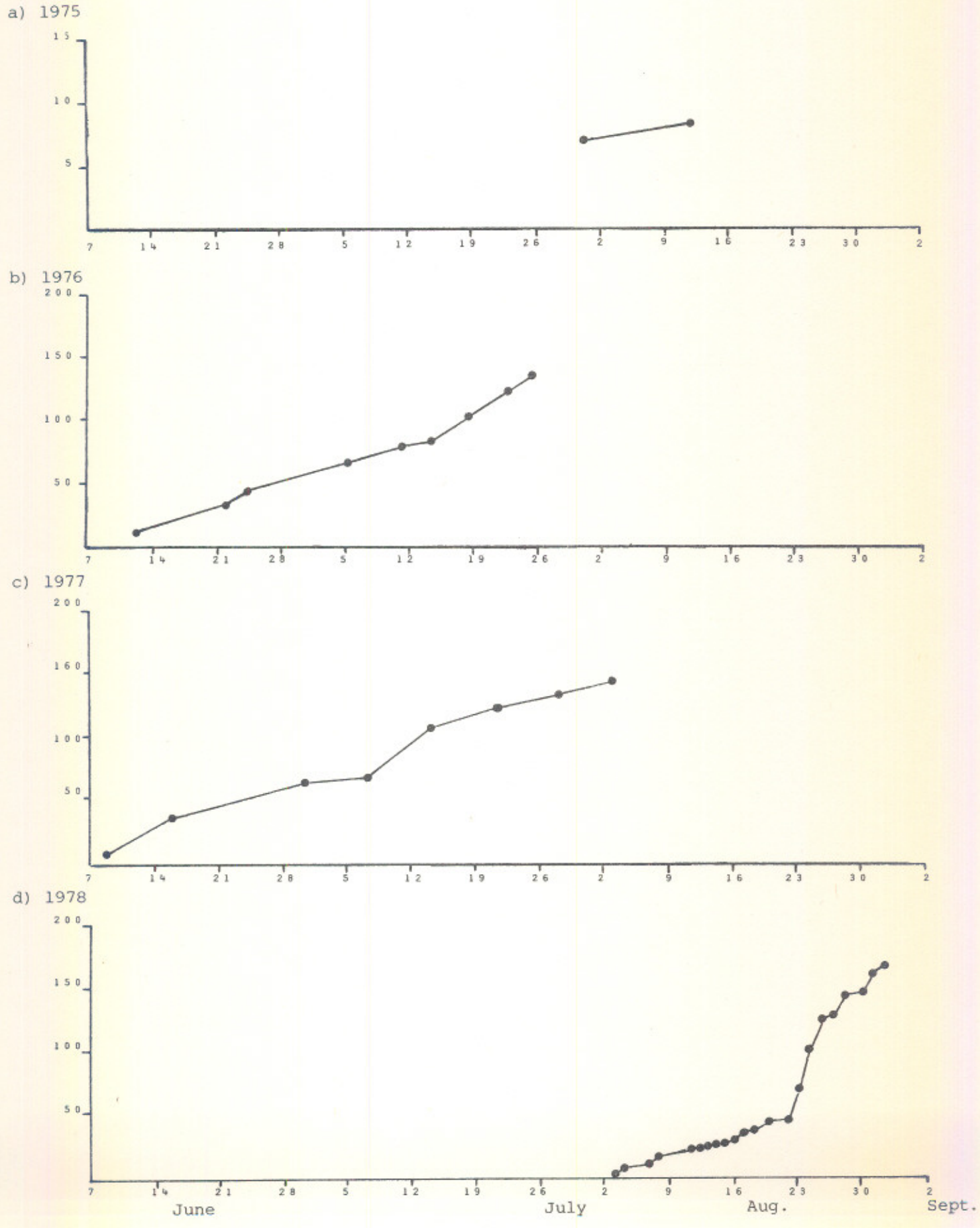
In 1975, only 8 chinooks were captured. In 1976, 184 were captured: 121 were tagged and released (Table III), the remaining 63 (34.2%) were jacks, and were released untagged. In 1977, 198 chinook were taken: 45 jacks (23%) were released untagged, 129 of the remaining 153 were tagged prior to release. In 1978, 157 fish were captured, 63 (30 males and 33 females) were retained for the egg-take, the remaining 94 were released untagged. In 1979, 156 fish were captured, 33 (18 females and 15 males) were retained for the egg-take.

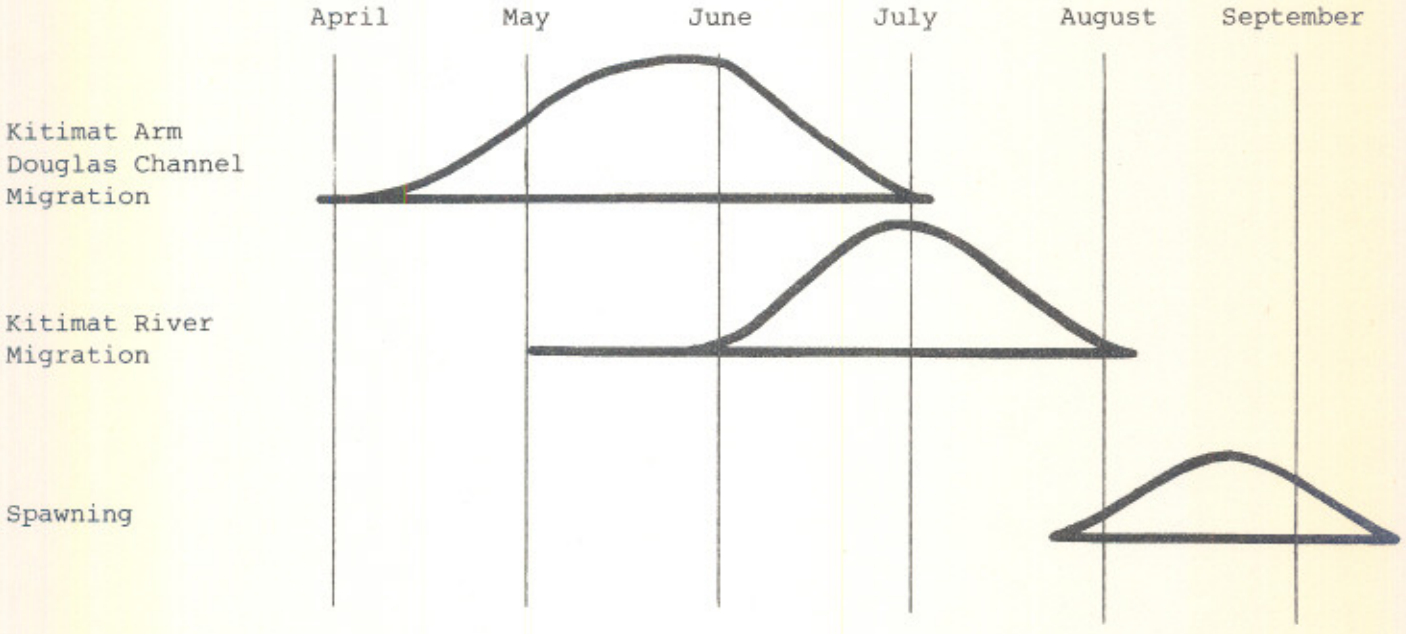
Table III - Summary of 1976 Distribution Study

Date	Colour Combination (Tag/Baffle)	Number Tagged	Recoveries: Date, Location
June 11-17	Blue/white	13	July 14, Coho Flats
June 21-24	Blue/red	18	June 25, Coho Flats
June 24-25	White/red	12	July 5, above Rod and Gun Club
July 2- 7	Green, white/red	23	
July 9-13	Yellow, green/clear	11	July 13, Coho Flats
July 14	Yellow, green/green	6	
July 16-19	Red/green	17	Sept.18, Coho Flats
July 20-22	Red/red	13	Sept.18, Location unknown
July 23-27	White/green	8	
	TOTAL	121	

Sports fisherman begin catching chinooks in the Kitimat River in late May. Seine net/gill-net records (Fig. 8) and visual observations on the spawning grounds suggest that the migration and spawning of Kitimat chinook proceeds as follows:

FIGURE 8. Daily Record of Chinook Captured, 1975-1978





The primary holding and spawning areas of these chinook are shown in Figure 9.

Biological Characteristics of Kitimat River Chinooks

Age Composition

The existing age data is heavily dependent upon sports caught chinook sampled prior to 1977. The overall aging analysis is shown in Table IV.

Table IV - Age Composition of Kitimat Chinooks

Year	Source of Scales	No. at Age (%)						
		2_1	3_1	4_1	5_1	4_2	5_2	6_2
1975	Sport Fishery	3(9.7%)	6(18.4%)	8(25.8%)	5(16.1%)	1(3.2%)	4(12.9%)	4(12.9%)
1976	Sport Fishery	0	4(23%)	10(62%)	1(6%)	0	1(6%)	0
1977	Sport Fishery	0	25(45%)	12(22%)	8(15%)	7(13%)	3(5%)	0
1977	Seine/Gillnet	0	22(48%)	9(20%)	8(17%)	6(13%)	1(2%)	0
1975-1977	TOTALS	3(2%)	57(38.5%)	39(26.4%)	22(14.9%)	14(9.5%)	9(6.1%)	4(2.7%)

Total "Sub 1" fresh-water age 121 (81.8%)

Total "Sub 2" fresh-water age 27 (18.2%)

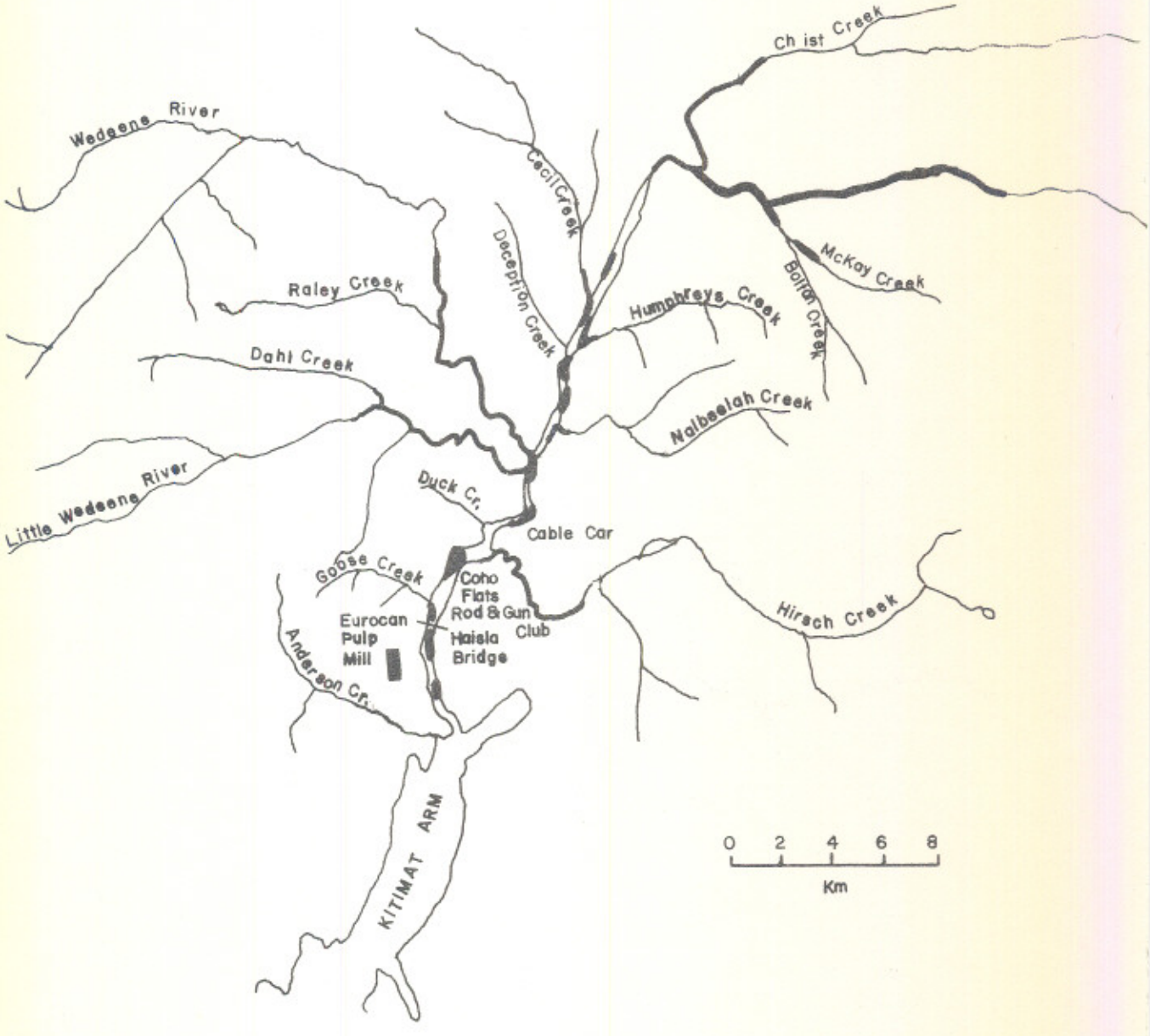


Figure 9. Chinook spawning and holding areas, Kitimat River and tributaries

Sex Ratio

The sex composition of the run is variable, but on the average males comprise 66% of the run (Table V) and 28.1% of the males are "jacks".

Table V - Male to female ratio of Kitimat Chinooks

Year (Source)	Number of Males "Jacks"	Large	Number of Females	Male: Female Ratio	Male: Female Ratio (excluding "jacks")
1975 (sports catch)	3	25	21	1.33:1	1.19:1
1976 (seine)	63	73	48	2.83:1	1.52:1
1977 (seine/Gillnet)	45	88	65	2.05:1	1.35:1
1978 (seine/Gillnet)	5	63	47	1.45:1	1.34:1
1979 (seine/Gillnet)	17	91	48	2.25:1	1.90:1
TOTALS	133	340	229	2.07:1	1.48:1

Size

The sampled chinooks showed a larger average size for females. However, the largest fish sampled were males (Table VI).

Table VI - Size of Kitimat Chinooks

*Males: mean orbital-hypural length 58.7 $\pm$ 1.5 cm ($t_{.05,111}$)
range : 43 - 97 cm
mean weight: 5.9 $\pm$ 1.0 kg ($t_{.05,197}$)
range : 1 - 30 kg

*"jacks" included.

Females: mean orbital-hypural length 73.3 $\pm$ 2.5 cm ($t_{.05,53}$)

range : 53 - 90 cm

mean weight: 8.6 $\pm$ 1.0 kg ($t_{.05,59}$)

range : 2.5 - 25 kg

Fecundity

The average fecundity of Kitimat chinook approximates 8000 eggs:

Year	Eggs per Female	
1977	8,500	(n= 9)
1978	7,573	(n=18)
1979	7,928	(n=10)
mean	8,000	(n=37)

In 1977 and 1978, Kitimat River chinooks were examined by the Diagnostic Service of the Pacific Biological Station's Fish Health Laboratory. Results to date have shown an absence of potentially serious disease causing organisms (Appendix IV).

(b) Fry and Smolt Studies

Due to differences in design and extremely unstable water levels, the efficiency of the various traps fluctuated each night and from one night to the next. Thus it was impossible to derive an estimate of the size of the migrant chinook fry and smolt populations. However, a rough idea of the timing of these migrations was obtained by pooling the nightly trap catches (Figs. 10 and 11). The fry migration commenced prior to March 31 (the first day of trapping) and terminated on May 5. Peak catches occurred on May 1.

The only chinook yearlings were captured in early April, with an apparent peak on April 9.

Figure 10- Pooled nightly Kitimat River chinook fry catch, 1978.

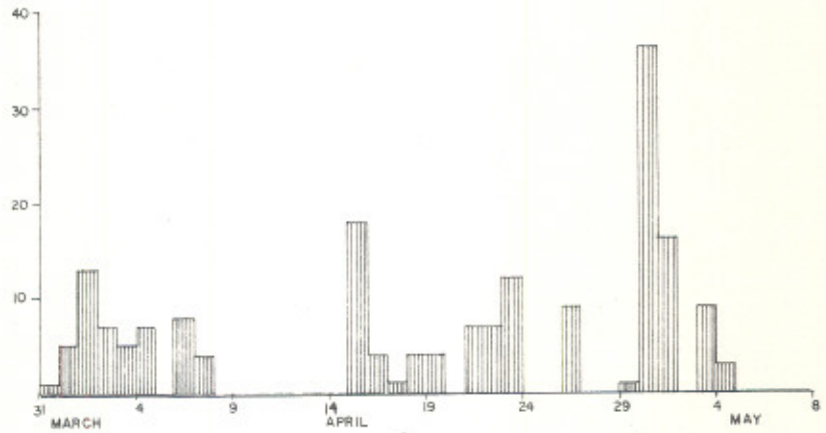
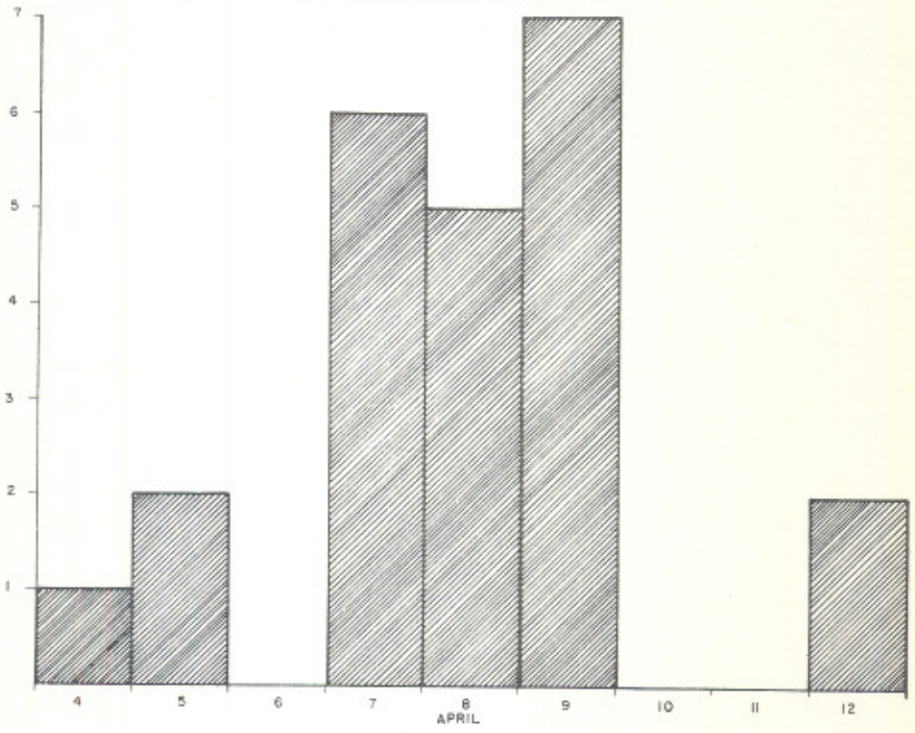


Figure 11- Pooled nightly Kitimat River chinook smolt catch, 1978.



2. WATER QUALITY SAMPLING RESULTS

(a) Surface Water Analysis

(i) Pre 1977 Studies:

The 1972 Beak report concluded that "Kitimat River water was very soft and low in dissolved solids. Suspended solids were also generally low except during high run off periods. Water temperatures were generally low (average 7.0°C; range 2 - 12°C); dissolved oxygen was near saturation; and colour was very slight, increasing during run-off periods. Biochemically the river was low in organic matter, with small increase in biochemical oxygen demand (BOD_5) due to the discharge of the city of Kitimat municipal waste and the Eurocan pulp mill waste".

(ii) 1977 - 1979 Studies:

Tables VII - X summarize the results of surface water sampling programs conducted since 1977. In 1977 the mainstem samples did not indicate any parameters other than water hardness and sediment load which were above levels recommended for fish culture (Tables VII and VIII). However, the August 1978 samples identified unacceptable levels of iron in the Kitimat mainstem and in the Wedeene River tributary (Table IX). Further samples collected in January 1979 confirmed that the iron content of several Kitimat River tributaries exceeds critical levels (Table X).

(b) Well Water Analysis

Table XI summarizes the physical and chemical characteristics of groundwater samples collected in 1978. Two surface water samples taken coincidentally with the July 18 well water samples are included for comparison.

Table VII: Results of Resource Services Branch, Kitimat River Water Quality and Suspended Solids Sampling, 1977.

Parameter Measured	"17 Mile" Bridge					Haisla Bridge				Eurocan Potable Supply			
	May 30	Apr. 23	July 5	Sept. 28	Nov. 22	May 30	July 5	Sept. 28	Nov. 22	Jun 16	July 12[1]	Sept. 28	Nov. 22
TPO_4 (mg/ℓ)	< .010	< .010	-	-	-	<0.01	-	-	-	-	-	-	-
NO_3 "	0.12	0.35	-	-	-	0.12	-	-	-	-	-	-	-
NO_2 "	<0.005	<0.005	-	-	-	<0.005	-	-	-	-	-	-	-
SiO_2 "	2.0	1.4	-	-	-	1.7	-	-	-		2.1	-	-
SO_4 "	2.7	3.0	1.6	3.6	5.1	2.3	2.0	3.3	5.0	12	-	11.7	11.0
F- "	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.060	0.09	0.07	0.089	0.077
FR "	19	31	21	25	40	18	21	33	40	120	21	120	130
NFR "	<4	5*	<5	<5	<5	<4	<5	<5	<5	<4	<5	<5	<5
Cu "	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fe "	0.03	-	0.05	0.04	0.05	0.10	0.13	0.16	0.28	0.03	0.55*	0.03	0.05
Mn "	<0.03	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Pb "	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Zn "	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ca "	5.4	5.8	4.1	6.3	7.6	4.6	3.6	5.7	6.2	32	3.8	34	39
Mg "	0.53	.59	.43	.57	.76	0.44	0.43	0.59	0.72	2.1	0.50	1.9	2.2
K "	0.35	0.39	0.33	0.47	0.48	0.35	0.36	0.51	0.97	1.2	0.47	1.3	1.4
Na "	0.63	0.93	0.57	0.71	0.85	0.77	0.74	1.3	1.7	3.0	1.1	2.4	2.8
pH "	-	-	7.4	-	-	-	7.2	-	-	-	6.8	-	-
PO_4 (mg/ℓ)	-	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite (NO_2) "	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05
Nitrate (NO_3) "	-	-	0.027	0.036	0.096	-	0.028	0.036	0.12	0.17	0.062	0.20	0.22
Si "	-	-	1.3	1.8	2.9	-	1.4	1.9	3.1	4.6	1.9	4.6	5.5
Hardness ($Mg/ℓCaCO_3$)	-	-	12*	18*	-	-	11*	17*	-	-	12*	93	-
Particle Size >14μ													
Total (mg/ℓ)	-	-	0.8	2.6	2.0	-	1.4	2.2	9.1*	2.4	3.2	2.2	4.0*
Fixed "	-	-	0.4	0.8	0.8	-	1.0	0.8	2.3	1.1	1.5	1.6	0.2
Volatile "	-	-	0.4	1.8	1.2	-	0.4	1.4	6.8	1.3	1.7	0.6	3.8
>5μ													
Total (mg/ℓ)	-	-	0.2	0.8	0.8	-	1.6	0.6	1.4	0.8	1.4	0.8	0.7
Fixed "	-	-	-	0.3	0.4	-	1.0	0.2	0.6	-	0.8	0.5	0.3
Volatile "	-	-	-	0.5	0.4	-	0.6	0.4	0.8	-	0.6	0.3	0.4
>.45μ													
Total (mg/ℓ)	-	-	0.2	0.6	0.4	-	0.2	0.2	1.1	2.2	0.2	0.4	0.2
Fixed "	-	-	-	0.2	0.2	-	-	-	0.2	1.5	-	0.3	0.1
Volatile "	-	-	-	0.4	0.2	-	-	-	0.9	0.7	-	0.1	0.1

1 From Municipal hydrant at Eurocan

* Concentration exceeds level recommended for fish culture (Sigma Resource Consultants, 1979)

TABLE VIII - Results of Kitimat River Survey Conducted by Environmental Protection Service, September - October, 1977.

Parameter Measured*	(Station) Sampling Location 1		2		3		4		5		6	
	Sept.	Oct.	Sept.	Oct.	Sept.	Oct.	Sept.	Oct.	Sept.	Oct.	Sept.	Oct.
D. O. (mg/ℓ)	10.5	11.5	10.0	11.5	10.5	11.4	-	9.8	11.0	11.3	10.5	11.3
T. Organic C (mg ℓ)	1.0	3.0	2.0	4.0	8.0	6.0	9.0	5.0	5.0	4.0	4.0	4.0
T. Inorganic C "	3.0	3.0	3.0	3.0	6.0	4.0	29.0	5.0	4.0	3.0	4.0	3.0
T. R. "	32	75	33	87	59	100	181	71	44	96	55	95
N.F.R. "	<5	43**	<5	53**	7**	60**	39**	27**	<5	53**	<5	55**
Na "	1.2	.92	1.2	-	4.8	-	26	-	5.1	-	8.3	-
TPO_4 "	0.095	0.080	<0.010	0.068	0.090	0.100	0.030	0.041	0.016	0.094	0.013	0.099
Nitrate (NO_3) "	0.021	0.19	0.096	0.24	0.021	1.1	<0.010	0.11	<0.010	0.20	<0.010	0.56
Nitrate (NO_2) "	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ammonia (NH_3) "	0.005	0.017	0.027	0.044	0.027	0.032	0.62	0.049	0.008	0.027	<0.005	0.017
pH	6.9-7.0	6.6-6.9	6.9	6.7-7.0	6.9-7.1	6.7-6.9	6.7	6.7	7.0-7.1	6.9-7.0	7.0-7.1	6.9-7.0
Conductance (umhos/cm)	35-38	32-22	37.5-38	32	112-113	39-42.5	245	46-55	117-118	35-44	124	35-38
Colour	4-10	40-42	4-5	43-44	5-38	40-52	196	48-59	19-48	45-49	19-21	45-53
Turbidity (FTU)	2	13-14	1.8-20	15-19	1.8-4.0	16-19	80	14-17	2.6-3.0	15-18	2.3-3.0	14-21

* Value shown is highest of three consecutive samples, except for colour, conductance, turbidity and pH, where the range of recorded values is given.

** Concentration exceeds level recommended for fish culture (Sigma Resource Consultants, 1979).

Table IX - Results of Analysis of Surface Water Samples Collected From Kitimat and Wedeene Rivers, August, 1978.

Parameter Measured	Kitimat River at: "17 Mile"	Cable Car	Haisla Bridge	Eurocan	Below Eurocan	Wedeene River
a. Physical Tests						
pH	7.30	7.15	6.55	7.20	7.10	6.95
Conductivity (umhos/cm)	30.1	30.7	32.7	29.8	24.0	17.1
Colour	-	-	-	-	-	-
Turbidity (JTU)	32	21	0.94	22	18	5.4
Dissolved Solids (mg/ℓ)	27	26	25	24	21	14
Total Suspended Solids (mg/ℓ)	54.6*	39.3*	1.3	48.9*	54.6*	10.9
b. Dissolved Anions						
Alkalinity (HCO_3) mg/ℓ	15.3	17.0	15.3	15.3	13.0	9.1
Cl "	<0.5	<0.5	0.98	<0.5	<0.5	<0.5
SO_4 "	0.2	0.4	0.2	0.2	0.2	0.2
Nitrate (NO_3) "	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrite (NO_2) "	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PO_4 "	-	-	-	-	-	-
F "	-	-	-	-	-	-
Si "	-	-	-	-	-	-
Cn "	-	-	-	-	-	-
c. Dissolved Cations						
Hardness ($caCO_3$) (mg/ℓ)	15.6	15.5	12.3	15.8	12.6	3.60
Ca "	4.82	4.83	4.15	4.91	3.84	2.29
Mg "	0.86	0.84	0.47	0.86	0.72	0.32
Na "	0.88	0.76	1.28	0.99	0.85	0.66
K "	-	-	-	-	-	-
Fe "	1.29*	1.29*	0.10	1.24*	1.22*	0.43*
Mn "	0.045	0.039	0.006	0.060	0.046	0.012
Cd "	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu "	0.003	0.004	0.022	0.003	0.003	0.001
Pb "	-	-	-	-	-	-
Zn "	0.006	0.009	0.006	0.005	0.005	0.001
d. Others						
Ammonia (NH_3) (mg/ℓ)	0.21	0.12	0.06	0.17	0.13	0.17
T.PO_4 "	0.61	0.34	0.39	0.49	0.43	0.12
Hg "	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Dissolved Oxygen "	10.9	10.9	4.4	10.9	10.9	11.0
Temperature (^oC)	12	12	12	12	12	11.5

* Concentration exceeds levels recommended for fish culture (Sigma Resource Consultants, 1979)

Table X - Results of January, 1979 survey to test the metal content of surface water in the upper KITIMAT RIVER and selected tributaries.

Parameter Tested*	Hirsch Creek	Nalbeelah Creek	Humphrys Creek	Upper Kitimat R.	Chist Creek	Cecil Creek	Big Wedeene R.	Little Wedeene R.	Anderson Creek
Cu (mg/ℓ)	<0.001	0.0018	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Fe	<0.02	** .786	.075	.087	<0.02	** .797	** .302	.066	.046
Pb	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cd	<0.015	<0.015	<0.001	<0.001	<0.015	<0.001	<0.001	<0.001	<0.001
Hg	.00259	.00142	.002	.00142	.00168	.00311	.00213	.00148	.00317
Ca	8.95	5.50	5.79	9.66	11.8	5.55	4.59	3.74	3.8
Si	2.03	4.2	2.37	2.73	2.48	4.84	2.98	2.09	1.77
Mn	<0.004	.0333	<0.004	<0.004	<0.004	0.0421	.0183	<0.004	<0.004
Mg	1.25	1.15	.801	1.45	.951	1.03	.576	.409	.474

* Value shown is highest of two consecutive (duplicate) samples.

** Concentration exceeds level recommended for fish culture (Sigma Resource Consultants, 1979).

Table XI - Physical and chemical characteristics of groundwater from Wedeene/Little Wedeene test wells, Kitimat municipal well and domestic well at Cablecar, May - August, 1978.

* Concentration less than or greater than level recommended for fish culture (Sigma Resource Consultants, 1979)

Parameter Measured	Well 78-2 May 25/78	Well 78-2 Aug.15/78	Well 78-4 May 25/78	Well 78-4 Aug.15/78	Well 78-4 Aug.15/78	Well 78-5 May 25/78	Well 78-5 Jul.18/78	Well 78-5 Jul.18/78	Well 78-5 Aug.15/78	Municipal Well Aug.15/78	Cable Car Well Aug.15/78	Kitimat R. Jul.18/78	Wedeene R Jul.18/78
T. Dissolved Solids(mg/ℓ)	61	91	42	43	42	51	>29	>30	34	27	28	>19	>12
T. Suspended Solids(mg/ℓ)	--	25.7*	--	*5.0	3.7	--	<10	<10	8.3*	54.6*	1.3	<10	<10
Dissolved Anions(mg/ℓ)													
Bicarbonate (HCO_3)	26	44.2	20	20.2	20.2	26	--	--	16.4	15.3	12.5	--	--
Carbonate (CO_3)	Nil	Nil	Nil	Nil	Nil	Nil	--	--	Nil	Nil	Nil	--	--
Chloride (Cl)	13	1.96	5	2.93	1.96	9	3.63	3.75	<2.93	0.5	2.93	<0.5	<0.5
Sulfate (SO_4)	--	5.1	--	4.3	4.2	--	1.55	1.62	3.1	0.2	0.2	1.65	1.24
Nitrate (N)	--	<0.001	--	<0.001	<0.001	--	<0.005	<0.005	<0.001	<0.001	<0.001	<0.005	<0.005
Nitrate (N)	<0.2	<0.001	<0.2	0.001	<0.001	<0.2	0.010	0.012	<0.001	<0.001	<0.001	0.015	0.036
Dissolved Cations(mg/ℓ)													
Hardness (C_2O_3)	19*	25.1	15*	15.5*	15.9*	19	11.2*	11.6*	9.78*	15.6*	9.48*	11.3*	5.8*
Calcium (C_2)	6	7.75	6	5.37	5.48	6	3.55	3.65	3.14	4.82	2.84	3.83	1.93
Magnesium (Mg)	1	1.39	1	0.51	0.53	1	0.56	0.60	0.47	0.86	0.58	0.41	0.25
Iron (Fe)	14.6*	17.5*	0.20	1.49*	1.63*	3.93*	2.56*	2.45*	1.85*	1.29*	0.36*	0.208	0.247
Maganese (Mn)	--	0.31*	--	0.029	0.031	--	0.216*	0.223*	0.16*	0.045	0.053	0.0103	0.0075
Cadmium (Cd)	--	<0.001	--	<0.001	<0.001	--	<0.01	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
Copper (Cu)	<0.1	0.004	<0.1	0.022	0.009	<0.1	<0.02	<0.02	0.001	0.003	0.007	<0.02	<0.02
Zinc (Zn)	0.1	0.008	<0.1	0.018	0.006	<0.1	<0.02	<0.02	0.004	0.006	0.060	<0.02	<0.02
Others													
O_2CO_2 (mg/ℓ)	--	0.5/-	--	1.1/-	-/-	--	.6/54.2*	.7/47.5*	.5/-*	10.9/-	4.7/-	-/-	12.2/-
Ammonia (NH_3)(mg/ℓ)	--	0.29*	--	0.05*	0.13*	--	0.0246	0.0239	0.31*	0.21*	0.14*	<0.005	<0.005
Conductivity (umhos/cm)	81	120	44	49.1	48.1	63	51.5	51.0	40.6	30.1	41.6	27.9	13.8
pH	6.52	6.25*	6.56	6.10*	6.15*	6.50	6.3*	6.3*	6.15*	7.20	5.85*	7.2	6.8
Temp. (°C)	5.8	7	5.6-5.8	8	--	5.4-5.5	6.1	6.1	6.5	12	12	11.2	8.0

3. Pilot Hatchery Results

Since 1977, aproximately 314,775 eggs have been taken for the pilot hatchery, in spite of a continued scarcity of donor stock and a relatively high pre-spawning mortality rate (Table XII).

Table XII - Number of chinooks held and spawned, pre-spawning mortality and total eggs taken, Kitimat Pilot Hatchery, 1977-1979

Year	Female holding and spawning # held/# spawned	Female holding and spawning pre-spawning mortality (%)	Male holding and spawning[a] # held/# spawned	Male holding and spawning[a] pre-spawning mortality (%)	Total Eggs Taken
1977	13/5	8 (62%)	14/unknown	-	94,287
1978	33[b]/24[c]	2 (6%)	29[d]/19[e]	8 (28%)	168,043
1979	18[f]/10[g]	3 (17%)	15[h]/9	7 (47%)	52,445
Total	64/39	25 (39%)	44/28	15 (36%)	314,775

[a] Each year, most of the males were stripped several times.

[b] 6 escaped from pens, 1 was released.

[c] 3 partially spent females were included in the egg-take.

[d] 6 males escaped in 1978.

[e] 3 of the males used in the egg-take were "jacks".

[f] 10 females escaped from the pen in 1979.

Overall survival to the "eyed" stage of development has ranged from 81.1 - 96.6%, to ponding from 80.2 - 92.8%, and to release 79.4 - 90.1%:

Table XIII - Survival rates to the eyed stage, to ponding and to release, 1977-1979

Brood Year	Eggs Taken	Survival to Eyed Stage (%)	Survival to Ponding (%)	Survival to Release (%)
1977	94,287	85,805 (91%)	81,594 (86.5%)	74,823 (79.4%)
1978	168,043	162,324 (96.6%)	155,911 (92.8%)	151,771 (90.3%)
1979	52,445	42,518 (81.1%)	42,050 (80.2%)	39,199 (74.7%)

Water temperatures during incubation normally range from 6.9 - 8.2°C. The overall mean temperature during incubation approximates 7.2°C, with daily mean temperatures ranging from 6.5 - 7.9°C (Fig. 12). The daily mean temperature during rearing varies from 6.7 - 7.3°C, averaging 6.9°C.

The eggs are eyed after 300 - 350 ATU, hatch at 510 - 560 ATU and are ready for ponding at 910 - 935 ATU. Oxygen levels remain constant at 9 ppm from planting to hatch, drop to 6 - 8 ppm during hatching, and fluctuate from 7 - 9 ppm throughout rearing (prior to the installation of aeration equipment, oxygen levels occasionally fell to 5 ppm during rearing).

Initial fry loading rate varied from 0.09 kg/ℓpm (Trough II, 1977) to 0.28 kg/ℓpm (Trough II, 1978), and initial ponding density from 6.27kg/m^3 (Trough II, 1977) to 16.23 kg/m^3 (Trough I, 1978):

Year	Number Ponded	Mean Size at Ponding	Density (kg/m^3)	Flow (ℓpm)	Initial Loading Rate (kg/ℓpm)
1977					
TROUGH I	47,467	.42 gms	8.73	160	.12
TROUGH II	34,127	.42 gms	6.27	160	.09
1978					
TROUGH I	88,183	.42 gms	16.23	130	.28
TROUGH II	67,728	.46 gms	13.64	130	.24

The maximum loading rate was .79 kg/ℓpm (Trough I, April 1977), the maximum density 66.4 kg/m^3 (Trough II, April 1978):

Year	Number in Pond	Mean Weight (gms)	Density (kg/m^3)	Flow (ℓpm)	Maximum Loading Rate (kg/ℓpm)
1977					
TROUGH I	45,803	3.09 gms	62.0	180	.79
TROUGH II	37,882	3.27 gms	54.3	180	.69
1978					
TROUGH I	86,097	1.45 gms	54.7	225	.55
TROUGH II	64,482	2.35 gms	66.4	225	.67

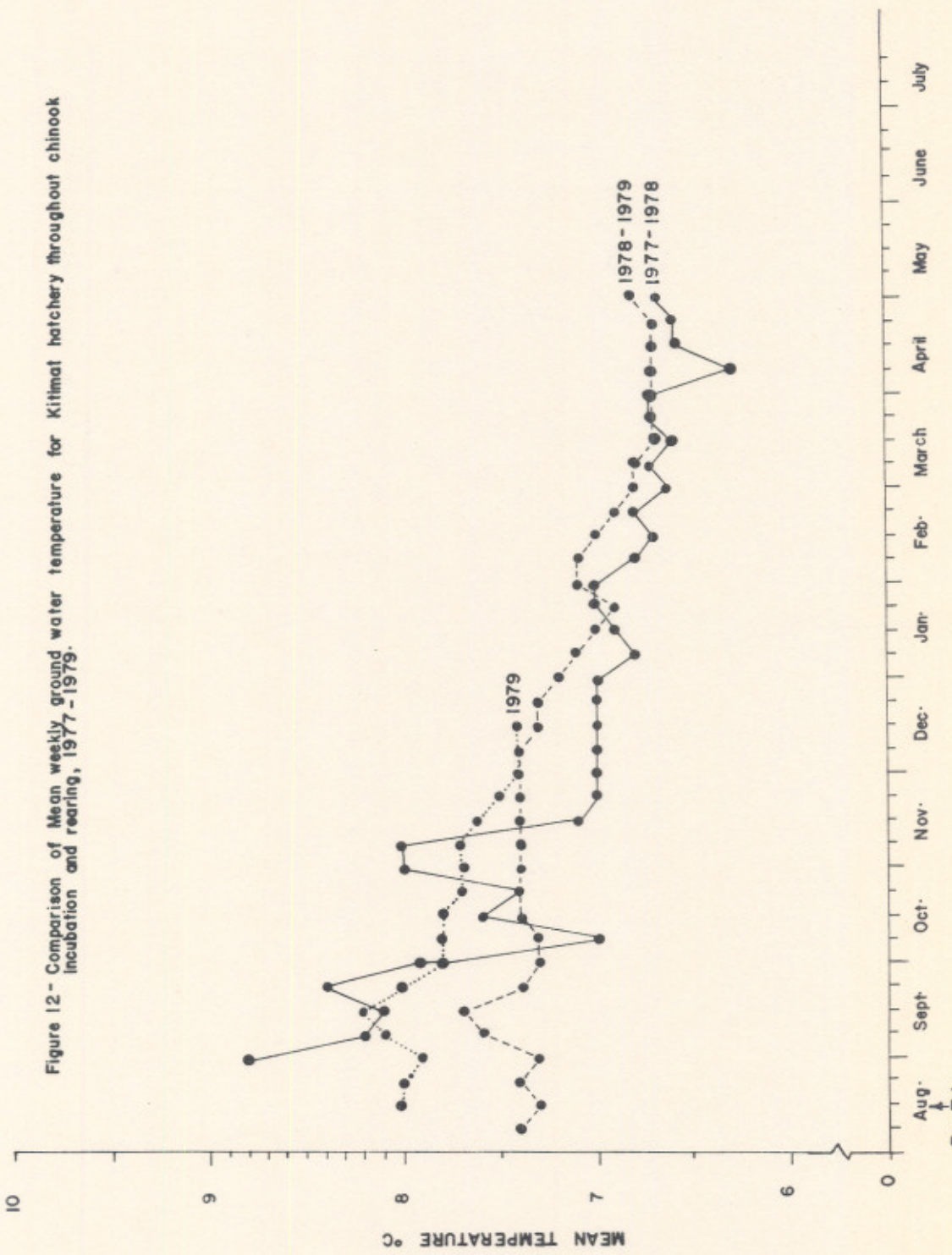


Figure 12- Comparison of Mean weekly ground water temperature for Kitimat hatchery throughout chinook incubation and rearing, 1977-1979.

As the fish increased in size, loading rates and densities were periodically reduced by moving fish from a crowded trough to a less crowded trough. If there was insufficient trough space available, they were transferred to marquisette pens in the river.

Growth, as indicated by increase in weight over time, is summarized in Fig. 13. Percent food utilization (Burrows, 1972) varied from 4% to over 90% (Fig. 14). Overall rearing mortality was 6771 (8.3%) in 1977/78, 4140 (2.7%) in 1978/79, and 2851 (5.4%) in 1979/80.

4. Coded Wire Tagging

To date, approximately 185,294 hatchery "90 day" smolts and 1578 wild yearling smolts have been coded-wire tagged and released into the Kitimat River (Table XIV).

Table XIV - A summary of coded-wire tag releases to the KITIMAT RIVER system since 1976.

Brood Year	Date Tagged	Size at Release	Total Release	Released Untagged	Released Tagged	Code Used	% Tag Retention	Tagging Mortality (%)	Release Site
1976[1]	April - June/78	6-8 gms	1,578	--	1,578	2/20/50	97%	15 (.95%)	see footnote 1
1977	May 5 - June 23/78	4.5-7.1 gms	75,496	500	68,838 6,158	2/20/48 2/20/34	97% 97%	51 (.08%)[2]	17 mile bridge
1978	May 10 - 27/79	4.6-5.2 gms	151,771	78,335	73,436	2/16/14	97.3%	98 (.13%)[3]	17 mile bridge
1979	May 7-9/80	4.6-5.4 gms	39,199	2,337	36,862	2/02/01	94.3%	50 (.12%)[3]	Across River from Eurocan Pumphouse

[1] Wild yearling smolts released at site of capture/tagging.
[2] Combined mortality.
[3] Includes a number of fish sacrificed to check tag placement.

From June 12 - 16, 1978, 8 coded-wire tagged chinook smolts were captured in the Kitimat estuary, along with 12 unmarked (presumably wild) smolts.

Table XV summarizes recoveries of coded wire-tagged Kitimat chinooks to May, 1980.

Figure 13- Kitimat hatchery chinook rearing: Weight increase over time (growth), 1977, 1978 broods.

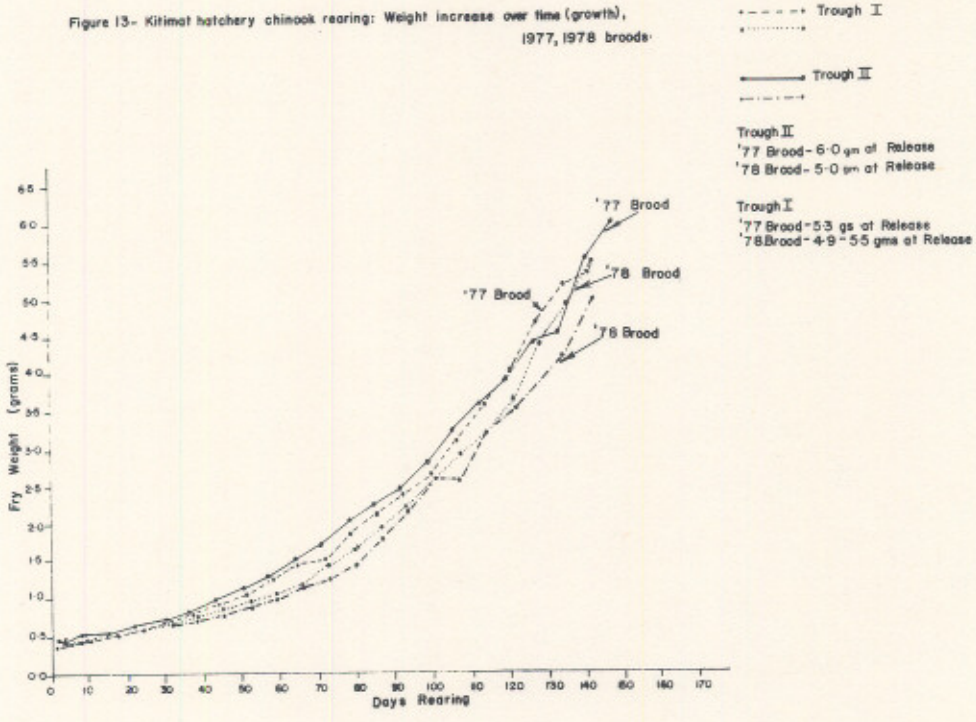


Figure 14- Kitimat hatchery chinook rearing: % food utilization, 1977, 1978 broods.

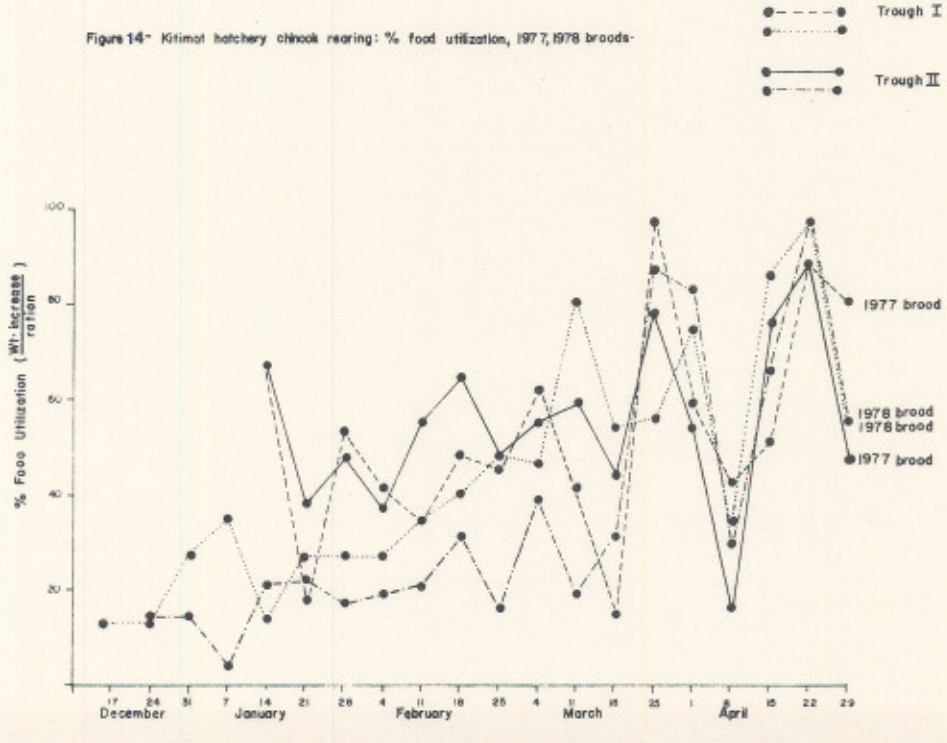


Table XV - Recoveries of coded-wire tagged Kitimat chinooks to May, 1980

Tag Code	Brood Year (source)	Recovery Date	Recovery Area	No. Recovered
2/20/34	1977 (wild)	May 1980	Area 6	3
2/20/48	1977 (hatchery)	Jul. 1979	Area 3x	2
		Jul. 1979	Area 4	2
		Jul. 1979	Area 6	1
		Aug. 1979	Northern Net*	6
		May 1980	Area 6	17
2/16/14	1978 (hatchery)	May 1980	Area 6	10
	TOTAL			41

*Data courtesy of R. Kadawaki

DISCUSSION

Current Status of Kitimat Chinook Stock

The search for pilot hatchery donor stock has resulted in a thorough survey of the spawning grounds, and confirmed that the Kitimat chinook population has declined at an alarming rate. Thus conservation measures taken to date appear to have been inadequate.

For instance, the Kitimat River sports catch has not declined, in spite of a ban on the use of treble hooks and roe. The estuary sports catch seems to be increasing. The total sports catch, based on creel census data, is probably being underestimated. When comparing sports catch estimates independently derived from coded-wire tag recoveries and creel census, Argue et al (1977) found that the creel census technique underestimated total catch by as much as 120%.

Restrictions imposed on the Area 6 commercial fishery have also failed to arrest the decline of Kitimat chinooks. Chinook are known to have a tremendous feeding range (Argue, 1976), especially stocks such as the Kitimat, which have a low proportion of yearling smolts (Argue and Marshall, 1976). Thus, Kitimat chinooks are probably being exploited in Fisheries Management areas other than Area 6. As marked fish from the pilot hatchery are recovered, new opportunities to protect Kitimat chinooks may be identified.

Biological Characteristics of Kitimat Chinooks

In comparison to other northern stocks, Kitimat chinook return and spawn at about the same time as Atnarko chinook, but somewhat earlier than Skeena, Nass, Docee and Wannock River chinooks. They are slightly smaller than Wannock River chinook (Schutz, 1975), but of comparable size to Skeena and Nass stocks (Godfrey, MS, 1968). With the exception of some Nass River stocks, no other northern chinook population has as high a proportion of "jacks" as the Kitimat stock. Most Kitimat chinook smolt and migrate seaward as "sub 1's",

as is the case with Atknarko and Wannock River chinooks. The Skeena and Nass stocks contain a higher proportion of "sub-2's" (overwintering, juvenile fish). This difference may be related to the distance of the spawning grounds from the estuary (Tutty and Yole, MS, 1978).

As in other northern chinook populations, such as the Skeena, Nass and Atnarko stocks, the sex composition of Kitimat chinooks is skewed towards male dominance. Average fecundities of the major northern red fleshed chinook stocks are listed below, in decreasing order:

		n
Wannock River	9489 (Schutz, 1975)	60
Kitimat River	8000	37
Skeena River	6490 (Godfrey, MS, 1968)	155
Nass River	6343 (Godfrey, MS, 1968)	37
Atnarko River	6050 (Hilland, unpublished data)	20

Trap records indicated that most chinook fry migrate from the Kitimat River between the first week of April and the first week of May. The migration appears to be unimodal, indicating that the timing of emergence does not vary significantly between tributaries, and subsequently, that the timing of spawning is relatively uniform throughout the system.

Suitability of Kitimat Surface and Ground-Water for Fish Culture

The Kitimat River's sediment load exceeds the level recommended for the incubation of salmon eggs through much of the year, and at times, is too high for the rearing of fry and juveniles. Surface water from the Wedeene River, Cecil Creek and Nalbeelah Creek is contaminated with iron, hence is unsuitable for fish culture. Hirsch, Chist, Humphrys and Anderson Creeks appear to have relatively pure water, and therefore may have some potential as future hatchery sites or for satellite rearing.

With the exception of the Eurocan "Potable" supply, all of the wells tested had either chemically unsuitable water (excessive iron, Nitrogen, ammonia,

carbon dioxide, hardness, etc.) or provided too little water for use in a major hatchery. Thus several additional wells were drilled beside the Eurocan intake in October, 1979. Pump tests and water quality sampling subsequently confirmed the existence of an adequate supply of water suitable for hatchery use (Shepherd, unpublished data).

Pilot Hatchery Results

To date, the prespawning mortality of fish held for the pilot hatchery has been somewhat excessive. Holding success may be improved by providing a more stable holding environment (i.e. silt-free water supply with flow control) and perhaps, more space for each of the males (Harding, pers. comm.).

The success of fertilization has, for the most part, been excellent. Survival to ponding normally exceeds 80%. It has been noticed that delayed fertilization consistently results in higher survivals to ponding than immediate fertilization and water hardening. The rate of development of Kitimat chinook eggs, as indicated by the number of accumulated thermal units to the eyed stage, hatch, and ponding, roughly conforms to that of other Northern chinook, such as the Atnarko (Hilland, MS, 1979) and Babine (Banford, unpublished data) stocks. This suggests that incubation in a water supply with a relatively constant temperature does not significantly alter the rate of development from that observed when eggs are incubated in water whose temperature fluctuates (eg. surface water or shallow groundwater).

To date, Kitimat hatchery fry have not grown as quickly as Atnarko hatchery fry. This may be a function of density related stress (Wedemeyer et al, 1976). The Atnarko loading density rarely exceeded the 10 kg/m^3 limit recommended by McNeil and Bailey (1975), whereas the Kitimat loading density was consistently higher. Logan (Pers. comm.) suggests that a loading density of 45 kg/m^3 may be maintained for short periods without adversely affecting chinook fry; however, the Kitimat loading density often exceeded even this maximum level. As an result of crowding, oxygen levels in the

rearing troughs at Kitimat occasionally fell below 6 ppm. Prolonged oxygen shortages are known to inhibit the growth of chinook fingerlings (Elliott, 1969). A first step in increasing growth would therefore seem to be reducing loading rate. However, any rearing strategy which results in accelerated growth must be approached with caution, until the relationship between time and size of release and subsequent survival and growth is more thoroughly understood.

RECOMMENDATIONS

(1) Thorough studies to investigate the timing and size at migration of wild Kitimat River chinook fry and smolts must be initiated prior to hatchery expansion.

(2) If the number of eggs taken is to be increased, the mainstem seining and gillnetting programs should be combined with a weir construction /trapping program on some of the major tributaries, such as Chist Creek, Little Wedeene River and the slough at the mouth of Cecil Creek.

(3) Donor stock holding facilities will have to be improved to reduce pre-spawn mortality.

(4) The only spawning technique used in future operations should be delayed fertilization.

(5) To improve juvenile growth, hatchery loading densities should be held between 10 and 20 kg/m^3 at all times.

(6) Until further information on the relationship between size and time of release and subsequent growth and survival is available, releases from the hatchery should conform, as closely as possibly, to wild fish patterns.

(7) An aggressive coded-wire tag recovery program must be pursued in 1980, as marked 1976 and 1977 brood chinook will be returning to the Kitimat system to spawn.

(8) The existing pilot hatchery/tagging program should be extended until more is known about the oceanic distribution and fishery contributions of the Kitimat chinook stock.

ACKNOWLEDGEMENTS

Brian Allen co-ordinated and supervised much of the initial field work upon which the report is based. Don Lawseth supervised the 1978 field program. Thanks are also extended to the Eurocan Pulp and Paper Company, the Aluminum Company of Canada and the Kitimat Rod and Gun Club, for their support and assistance. Vital background information and technical support provided by E.R. Christiansen and his staff were appreciated, as was technical advice contributed by G. Logan and D. McNeil. Sylvia Willis was the fish culturist during the first three years of the Pilot Hatchery Operation. D. Meerburg, E.A. Perry and Dr. F.K. Sandercock critically reviewed the manuscript prior to publication.

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APPENDICES

1. Chinook escapements to the Kitimat River, 1949-1978.
2. Particle-size analysis method used by Cantest Ltd.
3. Oregon Pellet feeding chart.
4. Survey of pathogens in Kitimat River chinook salmon to September 28, 1979.

APPENDIX I

Chinook escapements to the Kitimat River, 1949 - 1978 (from file F381)

Year	Kitimat River						Total
1950	7500						7500
1951	3500						3500
1952	3500						3500
1953	3500						3500
1954	7500	Prior to 1958, escapements were not broken down to stream of origin					7500
1955	3500						3500
1956	3500						3500
1957	1500						1500
		Little Wedeene R.	Wedeene River	Nalbeelah Creek	Humphrys Creek	Hirsch Creek	
1958	3500	1500	-	-	-	-	5000
1959	1500	75	-	25	25	25	1650
1960	3500	200	-	25	25	200	3950
1961	7500	75	-	25	-	25	7625
1962	3500	3500	7500	-	-	-	14500
1963	7500	750	200	25	-	-	8475
1964	3500	75	750	-	75	750	5150
1965	3500	-	-	-	-	-	3500
1966	20000	-	3500	-	-	-	23500
1967	3500	750	1500	-	-	25	5775
1968	3500	750	1500	-	-	200	5975
1969	3500	750	1500	-	-	200	5975
1970	3500	400	1500	-	-	400	5800
1971	5500	750	1500	-	-	400	8150
1972	3500	400	1500	-	-	200	5600
1973	3500	200	3500	-	-	300	7500
1974	2000	600	1000	-	-	300	3900
1975	1000	25	50	-	-	100	1175
1976	2500	200	350	5	19	15	3089
1977	1000	150	100	-	-	-	1250
1978	1300	50	100	-	-	50	1500

APPENDIX II

Particle-size Analysis Method Used By Cantest Ltd.

The samples were filtered successively through pre-weighed 14-micron, 5-micron and .45 micron membranes. The membranes were air-dried and weighed to give the weight of the material retained, and then ashed to give the volatile content. All weights thus obtained were subsequently converted to mg/ℓ.

An additional aliquot was filtered through 14-micron membranes, and the membranes were observed under a microscope. The particles retained were measured and counted with the aid of a calibrated measuring eyepiece.

R. V. Moore Company, Inc.

Box M
LaConner, Washington 98257
Phone 466-4161

OREGON PELLET FEEDING CHART

(Includes recommended feeding level and feeding frequency)

Feeding level (L) expressed as percentage of lot weight to be fed per feeding day.
Feeding frequency (F) expressed as number of days to feed per week and number of feedings per day.
Example: 7/4 means feed 7 days per week, 4 times per day; E/1 means feed every other day, one feeding per day.

Ave. H2O Temp. (F)	*FISH SIZE (number per pound)*															
	800-300		300-200		200-135		135-90		90-60		60-40		40-25		25-Larger	
	L	F	L	F	L	F	L	F	L	F	L	F	L	F	L	F
35	2.7	7/5	2.3	7/4	1.8	7/2	1.6	6/1	1.3	5/1	1.4	E/1				
6	2.8	7/5	2.4	7/4	1.9	7/2	1.8	6/1	1.4	5/1	1.4	E/1				
7	2.9	7/5	2.5	7/4	2.0	7/2	1.9	6/1	1.5	5/1	1.6	E/1				
8	3.0	7/5	2.6	7/4	2.1	7/2	2.0	6/1	1.7	5/1	1.8	E/1				
9	3.2	7/5	2.7	7/4	2.2	7/2	2.1	6/1	1.8	5/1	1.8	E/1				
40	3.4	7/5	2.8	7/4	2.3	7/2	1.9	7/1	1.6	6/1	1.3	5/1				
1	3.6	7/5	2.9	7/4	2.4	7/2	2.0	7/1	1.8	6/1	1.3	5/1	1.4	E/1	1.0	E/1
2	3.8	7/5	3.0	7/4	2.5	7/2	2.1	7/1	1.9	6/1	1.4	5/1	1.4	E/1	1.0	E/1
3	4.0	7/5	3.1	7/4	2.6	7/2	2.2	7/1	2.0	6/1	1.5	5/1	1.6	E/1	1.2	E/1
4	4.2	7/5	3.3	7/4	2.7	7/2	2.3	7/1	2.1	6/1	1.7	5/1	1.8	E/1	1.2	E/1
45	4.4	7/5	3.5	7/4	2.8	7/2	2.4	7/1	2.2	6/1	1.8	5/1	1.8	E/1	1.4	E/1
6	4.6	7/5	3.7	7/4	2.9	7/2	2.5	7/1	2.3	6/1	2.0	5/1	2.0	E/1	1.4	E/1
7	4.8	7/5	3.9	7/4	3.0	7/2	2.6	7/1	2.5	6/1	2.1	5/1	2.2	E/1	1.6	E/1
8	5.0	7/5	4.1	7/4	3.2	7/2	2.7	7/1	2.6	6/1	2.2	5/1	2.4	E/1	1.6	E/1
9	5.3	7/5	4.3	7/4	3.4	7/2	2.8	7/1	2.7	6/1	2.4	5/1	2.4	E/1	1.8	E/1
50	5.6	7/5	4.5	7/4	3.6	7/2	2.9	7/1	2.8	6/1	2.1	6/1	1.8	5/1	1.8	E/1
1	5.9	7/5	4.7	7/4	3.8	7/2	3.0	7/1	2.9	6/1	2.2	6/1	2.0	5/1	2.0	E/1
2	6.2	7/5	4.9	7/4	4.0	7/2	3.2	7/1	3.0	6/1	2.3	6/1	2.1	5/1	2.2	E/1
3	6.5	7/5	5.1	7/4	4.2	7/2	3.4	7/1	3.2	6/1	2.5	6/1	2.2	5/1	2.4	E/1
4	6.8	7/5	5.4	7/4	4.4	7/2	3.6	7/1	3.3	6/1	2.6	6/1	2.4	5/1	2.6	E/1
55	7.1	7/5	5.7	7/4	4.6	7/2	3.8	7/1	3.5	6/1	2.7	6/1	2.5	5/1	2.8	E/1
6	7.5	7/5	6.0	7/4	4.8	7/2	4.0	7/1	3.7	6/1	2.8	6/1	2.7	5/1	3.0	E/1
7	7.9	7/5	6.3	7/4	5.0	7/2	4.2	7/1	4.0	6/1	2.9	6/1	2.8	5/1	3.2	E/1
8	8.3	7/5	6.6	7/4	5.3	7/2	4.4	7/1	4.2	6/1	3.0	6/1	2.9	5/1	3.4	E/1
9	8.7	7/5	6.9	7/4	5.6	7/2	4.6	7/1	4.4	6/1	3.2	6/1	3.1	5/1	3.6	E/1
60	9.1	7/5	7.2	7/4	5.9	7/2	4.8	7/1	4.7	6/1	3.3	6/1	3.2	5/1	3.8	E/1

RECOMMENDED PELLET SIZE

Fish Size (Number Per Pound)	*Pellet Size (inches)*
800 - 500	1/32
500 - 250	3/64
250 - 150	1/16
150 - 50	3/32
50 - larger	1/8

APPENDIX IV

Survey of pathogens in Kitimat R. chinook salmon to Sept. 28, 1979

Diagnosis	Species	Age/Stage	Date
Acanthocephala	Pink Salmon	spawned	09/19/1977
Anisakis	Chum Salmon	spawned	09/19/1977
Anisakis	Pink Salmon	spawned	09/19/1977
Brachyphalus	Pink Salmon	spawned	09/19/1977
Chloromyxum	Chinook Salmon	ripe adult	08/23/1978
Chloromyxum	Pink Salmon	ripe adult	08/23/1978
Chloromyxum	Pink Salmon	spawned	09/19/1977
Diphyllobothrium	Pink Salmon	ripe adult	08/23/1978
Eubothrium	Chum Salmon	spawned	09/19/1977
Eubothrium	Pink Salmon	spawned	09/19/1977
fusiform gill	Chum Salmon	spawned	09/19/1977
Haplosporidian	Chum Salmon	spawned	09/19/1977
Lecithaster	Chum Salmon	spawned	09/19/1977
Lecithaster	Pink Salmon	spawned	09/19/1977
metal poison	Chinook Salmon	yolk fry	01/26/1978
Myxidium	Pink Salmon	spawned	09/19/1977
Myxidium	Pink Salmon	ripe adult	08/23/1978
Myxobolus sp.	Dolly Varden	ripe adult	09/19/1977
M. squamalis	Coho Salmon	ripe adult	08/23/1978
Nematodes	Pink Salmon	spawned	09/19/1977
Neural Tumour	Rainbow Trout	ripe adult	04/24/1974
no infection	Chinook Salmon	spawned	09/19/1977
no infection	Coho Salmon	ripe adult	09/19/1977
no infection	Cutthroat Trout	imm. adult	08/23/1978
*PEN	Chum Salmon	ripe adult	08/23/1978
PEN	Pink Salmon	ripe adult	08/23/1978
Phyllobothrium	Chum Salmon	spawned	09/19/1977
Phyllobothrium	Pink Salmon	spawned	09/19/1977
Salvelinema	Dolly Varden	ripe adult	09/19/1977
Saprolegnia	Pink Salmon	spawned	09/19/1977
Scolex	Chum Salmon	spawned	09/19/1977

Number of Samples:

Pink Salmon	82
Chum Salmon	123
Chinook Salmon	120
Dolly Varden Char	6
Rainbow Trout	1
Cutthroat Trout	7
Coho Salmon	85
Total	424

*Piscine Erythrocytic Necrosis