Fisheries and
Environment Canada

Dept. of Fisheries
and Oceans

A Review of the Kitimat River Watershed

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Internal Report

A REVIEW

of the

KITIMAT RIVER WATERSHED

compiled by

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May, 1983

ABSTRACT

The Kitimat River, which flows some 75km from the southwestern slope of Mount Davies (in the coastal mountains) to Kitimat Arm (of Gardener Canal), has been considered for the first stage of an integrated strategy to enhance Area 6 salmon stocks. Investigation to determine the feasibility of large scale enhancement operations in this watershed have been undertaken by SEP personnel through water quality testing, watershed reconnaissance, juvenile and adult salmon enumeration programs and pilot hatchery operations. The present review serves to desegregate the existing DFO data and combine it with background information obtained from additional sources.

Surface water in the watershed is characterized by extreme softness (and related problems) and elevated levels of non-filterable residues. In addition, aluminum, iron, and mercury concentrations are high, especially in the upper portions of the watershed. Phosphate levels are high in the lower section of the mainstem. River water will require aeration (and heating in the winter) before use in enhancement facilities.

Groundwater resources in the watershed are limited and largely of poor quality. Elevated levels of iron, zinc, copper, and manganese with low pH and total hardness are the major problems. The only known acceptable groundwater source in the watershed is at the proposed hatchery site. Water from this source will require aeration before use.

As groundwater resources are insufficient to support a major facility, it has become apparent that the balance of the flow requirements must be supplied from a surface source (Kitimat River). The river is subject to large variations in streamflow (46.3 m^3/sec in March to 274 m^3/sec in June during spring freshet), and correspondingly large variations in sediment loads. Surface water must, then, be filtered before use for incubation or early rearing.

The Kitimat River watershed supports all five species of east coast Pacific salmon, as well as anadromous trout species. Escapement takes place during July and August for chum (Oncorhychus keta), pink (O. gorbuscha) and sockeye (O. nerka). The chinook run (O. tshawytscha) begins in June continues through to mid August, while coho (O. kitsutch) escapement takes place from late August to mid Novemeber. Spawners (of one species or another) can be found utilizing the entire mainstem to just above Davies Creek, and nearly all accessible tributaries (the Anderson Creek watershed is not used). There has been a decline in abundance of almost all species of salmon returning to the Kitimat system, most noticeably chinook and coho stocks.

Emergence of chum, pink, and chinook fry occurs largely from April 1 to 20. Coho fry emerge somewhat later, usually throughout May and June. The Kitimat River and estuary are used extensively for rearing by juvenile salmonids.

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ACKNOWLEDGEMENTS

It would be impossible to acknowledge every person who had a degree of input into the preparation or content of the present report. However, we would like to take this opportunity to thank those persons whose assistance was invaluable. M. Waldron and P. Westlake at the Fisheries Regional Library in Vancouver, made library resources readily available and responded quickly to literature requests. Operators V. Mackulak, B. Sverre, S. Koltai, A. Lenser, and ranger I. Brown (B.C.F.S.) provided logging and forestry data. Water use data was provided by D. Tanner (Comptroller of Water Rights), while M. Cowey (Inland Waters Directorate) provided streamflow data. Water Quality data was graciously supplied by P. Whitefield, O. Nagy, and M. Lamb with Inland Waters; Dr. M.J.R. Clark and P. Wong with the Waste Management Branch; and J. Davidson at the Cypress Creek Laboratory (DFO). Thanks go to R.T. Hilland, M. Farwell, J.A. Macdonald, S. Willis, S. Barnetson, D. McNeil, C.N. MacKinnon, and DFO Scale Lab for biological data specific to Kitimat River salmonids. Dr. F.K. Sandercock, R.T. Hilland, D. Levy and D.D. MacKinlay reviewed preliminary drafts and made many suggestions helpful in the completion of the final draft of this report. Special thanks go to M.M. Miller for the final preparation of this report, and many useful reflections along the way.

INTRODUCTION

This is the third report in a continuing series, meant to summarize available data for the use of the New Projects Unit of the Enhancement Operations Division in preparation for the design of federal enhancement facilities, which are undertaken as part of the Salmonid Enhancement Program.

Previous reports dealt with the Quesnel and Nechako watersheds. The present report reviews the available information for the Kitimat watershed; as well, the existing data for the Kildala, Dala, and Bish tributaries of Kitimat Arm have been included, as the Northern Geographic Working Group (GWG) has identified these streams as important inclusions to a balanced enhancement program for the area.

This summary of aquatic environmental information is intended as a succinct review of readily available data for the Department of Fisheries and Oceans' internal reference only. All conclusions and recommendations are offered as guidance by the authors and do not necessarily reflect the opinion or policy of the Department of Fisheries and Oceans.

ENHANCEMENT RATIONALE

"Pacific salmon fisheries management is in crisis. Historic levels of salmon production were estimated to be in the order of 300 million pounds/year. At present this production has declined to approximately 140 million pounds/year, as a result of overharvesting by various fisheries and environmental degradation. This decline in abundance of natural salmon stocks is continuing at about 1-2%/year because present fisheries management and habitat protection approaches are inadequate to handle the situation" (Fraser River, Northern B.C. and Yukon Geographic Working Group, 1980 MS).

From the information reported in the DFO spawning files, escapement of chinook, coho, chum and even year pink salmon has declined at an average rate of 783 (15.8%), 992 (10.4%), 1235 (5.9%), 8418 (4.6%) spawners per year respectively over the last 15 years (1966-1980). Odd year pink salmon have exhibited a slight upward trend in spawning escapements (198 spawners/year) over the same period. There is, then, an urgent need to abate these declining trends, and restore chinook and chum stocks to economic levels.

Due to the seriousness of the situation, it was decided that the development of an integrated management and enhancement strategy would be the only suitable solution to the problems of today's fishery. Extensive bio-engineering reconnaissance surveys of the Kitimat River system revealed few favourable locations for enhancement facilities. The most amenable site, located adjacent to the Eurocan Pulpmill, has the only known suitable groundwater in the watershed. A tentative plan for enhancing Area 6 stocks was not developed until after the site choice had been made. The plan involved artificial enhancement techniques designed to increase production through greater spawning escapements and to take advantage of under-utilized spawning and rearing areas throughout Kitimat Arm.

The proposed hatchery has been designed as a central satellighting facility in order to fulfill the following production goals:

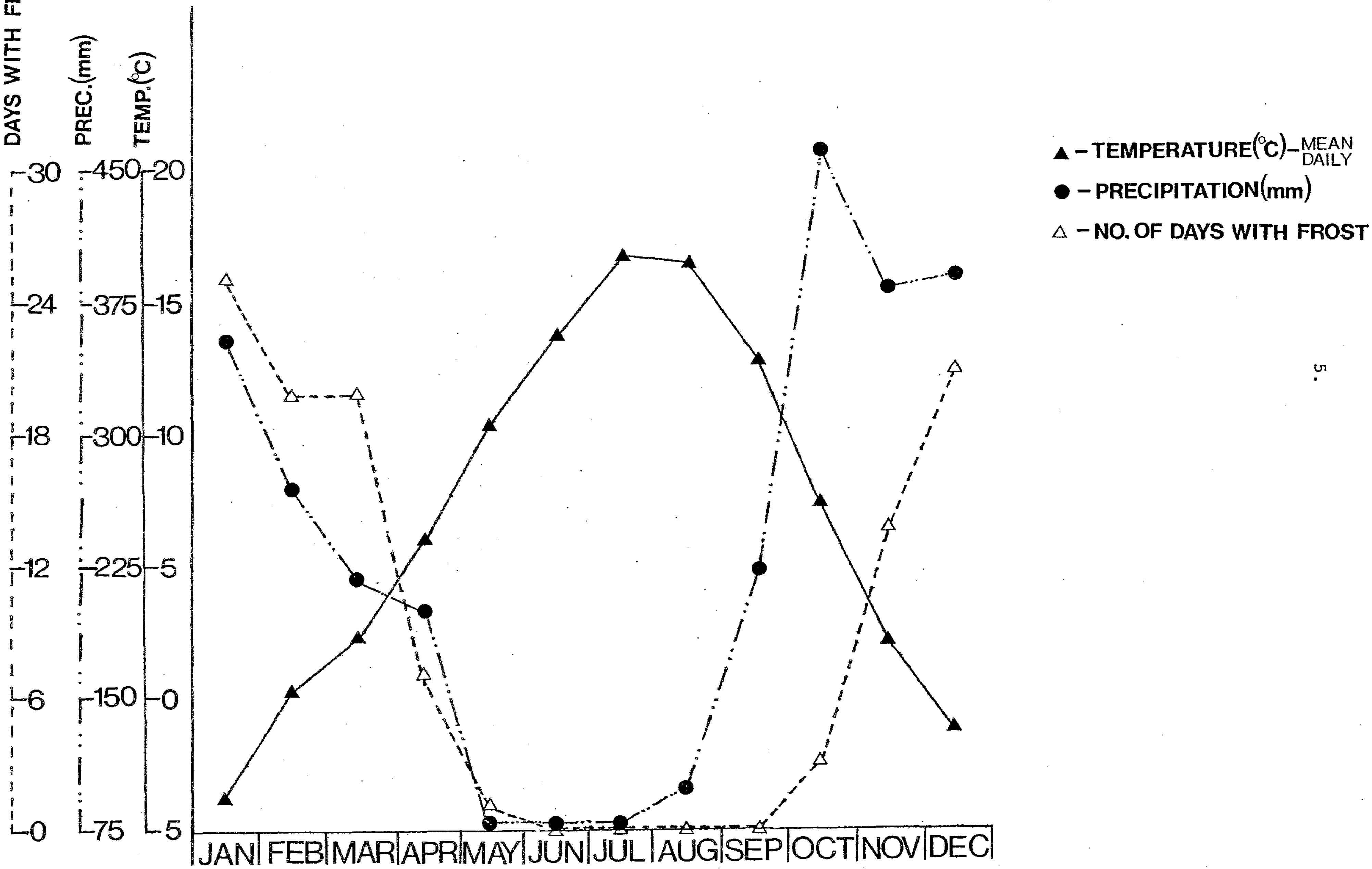
Species	no. of eggs	no. of adults prod.
Chum	$11.0x10^6$	158,400
Chinook	$3.0x10^6$	64,500
Coho	$0.6x10^6$	60,000
Steelhead	$55x10^3$	860
Pink	$0.5x10^6$	10,000
Sockeye	$0.5x10^6$	4,000

The facility is committed to developing stream-specific returns of chum and chinook. Surplus spawners resulting from hatchery operation will go toward augmenting natural production which will not be self-sustaining at the projected rates of exploitation.

CLIMATE

The Kitimat River watershed lies wholly in the "Head of Fjord" classification of the West Coast Climatic Region (Chapman et.al., 1956). The chief characteristic of this classification is very heavy annual precipitation as illustrated by meterorological data compiled by the Atmospheric Environmental Service at two sites in the Kitimat Municipal District. (One site is much closer to the Fjord Head than the other one, which is located at the actual Kitimat townsite). At these sites the average mean annual precipitation is 2377mm to 2826mm with the higher level reached (Fig. 1, Appendix 1) at the site closest to the Fjord Head (Douglas Channel). Of these totals 15%-23% falls as snow with the low percentage recorded at the site nearer Douglas Channel (due to moderating ocean influences and lower elevation). Seasonally for both sites autumn is wettest and spring driest; monthly, July is driest and October is wettest. Mean daily temperatures for both sites ranged from about -3.9 C^{o} in January to about 16.8^{o}C in July (although the inland site had, overall, slightly lower temperatures due to its higher elevation). In an average year, the site closest to Douglas Channel has a frost-free period of 254 days, while the townsite has a period of 236 days. At both sites there are four months (June, July, August, and September) in an average year that are completely frost-free (Dept. of Environment, Atmos. Env. Ser., 1971).

Figure 1. Weather for Kitimat (from Atmos. Env. Serv., 1971)
Daily Means of Air Temperature, Precipitation and Number of Days with Frost
(1941 to 1970)



GEOLOGY

The Kitimat-Kitsumkalum Valley lies within the Coast and Hazelton Mountain Ranges of west-central British Columbia. Fluvioglacial deposits of sand, clay, and alluvium formed during the Pleistocene period compose the bu871k of the Kitimat-Kitsumkalum Valley. Although the valley now contains two distinct drainages, the Kitimat and the Skeena, the relative continuity through the Lakelse region suggests that the Skeena historically flowed through the Kitimat Valley before some minor intrusion modified its course.

The lower peaks of the Coast Mountains have well-rounded tops with very steep sides and elevation levels of 1220m to 1525m. The higher peaks and ridges have sharp crests (often serrated), cirque glaciers and permanent snowfields. Streams in the area cut deeply into these ranges and occupy canyon-like gorges.

The Coast Mountains are composed mostly of undifferentiated coast intrusions of Upper Cretaceous or later material including grand-iorite, diorite, quartz diorite, quartz monzonite, adamellite, granite, and gabbro. Minor amounts of metamorphic sedimentary and volcanic rocks ranging in age from late Palaeozoic to early Cretaceous are also present. Patches of Mesozoic Jurrassic rock including andesite, breccia, tuff, greywacke, and argilite can be found west of Kitimat, southeast of Terrace, and around Iron and Kitsumkalum Mountians. There are also small sections of Triassic rock as well as Palaeozoic Carboniferous and Permian formations in the vicinity.

The Hazelton Mountains are composed mainly of Upper Jurassic and Lower Cretaceous rocks including greywacke, conglomerate, argillite, and minor tuff. The Seven Sisters Peaks, which have the highest elevation in the area (up to 2786m), are found within theses ranges. The lower peaks are rugged and usually sharp crested.

Gold, silver, lead, zinc, and copper are common in the region (Observations from uffell & Souther, 1964).

TOPOGRAPHY

The Kitimat River system (Fig. 2) drains an area of 1966km^2. It rises on the southwestern slopes of Mt. Davies (2089m), and flows in a northerly direction for about 24km, at which point it turns and flows in a westerly direction for another 19km towards the Kitimat Valley (Bell and Kallman, 1976). From the head of the valley (elevation 120m), the river flows 32km in roughly a southerly direction through a 1-8km wide valley to empty into Kitimat Arm (average gradient 0.35%). The sinuosity of this stretch of the river is 1.21, which classifies it as straight. The rivers overall sinuosity is 2.22, which represents an extremely non-linear drainage pattern.

The tributaries of the Kitimat River are fast moving streams, almost invariably flowing through deeply cut, canyonous courses. Illustrative of this characteristic is the occurence of impassable falls from 8-19km from the mouth of most of the major tributaries. There are 81 mapped tributaries to the Kitimat River (Fig. 3). The major tributaries (with lengths) are:

Anderson Creek	12km
Bolton Creek	12km
Chist Creek	31km
Cecil Creek	15km
Davies Creek	18km
Deception Creek	8km
Hirsch Creek	34km
Hoult Creek	14km
Humphreys Creek	11km
Little Wedeene River	25km
McKay Creek	15km
Nalbeelah Creek	16km
Wedeene River	37km

Access to the Kitimat River and its tributaries is variable (Fig. 4). Highway 25 from Terrace to Kitimat provides excellent access along the Kitimat River mainstem to the District of Kitimat, permitting the easy flow of materials in and out of the valley. In addition to this primary access, much of the lower watershed is made accessible via a myriad of secondary forest roads constructed over the last 25 years. In contrast, the Kitimat system upstream of Chist Creek is essentially inaccessible except by aircraft. Future logging operations will, undoubtedly, open up the upper portions of the watershed.

Figure 2. Kitimat River System Topography.

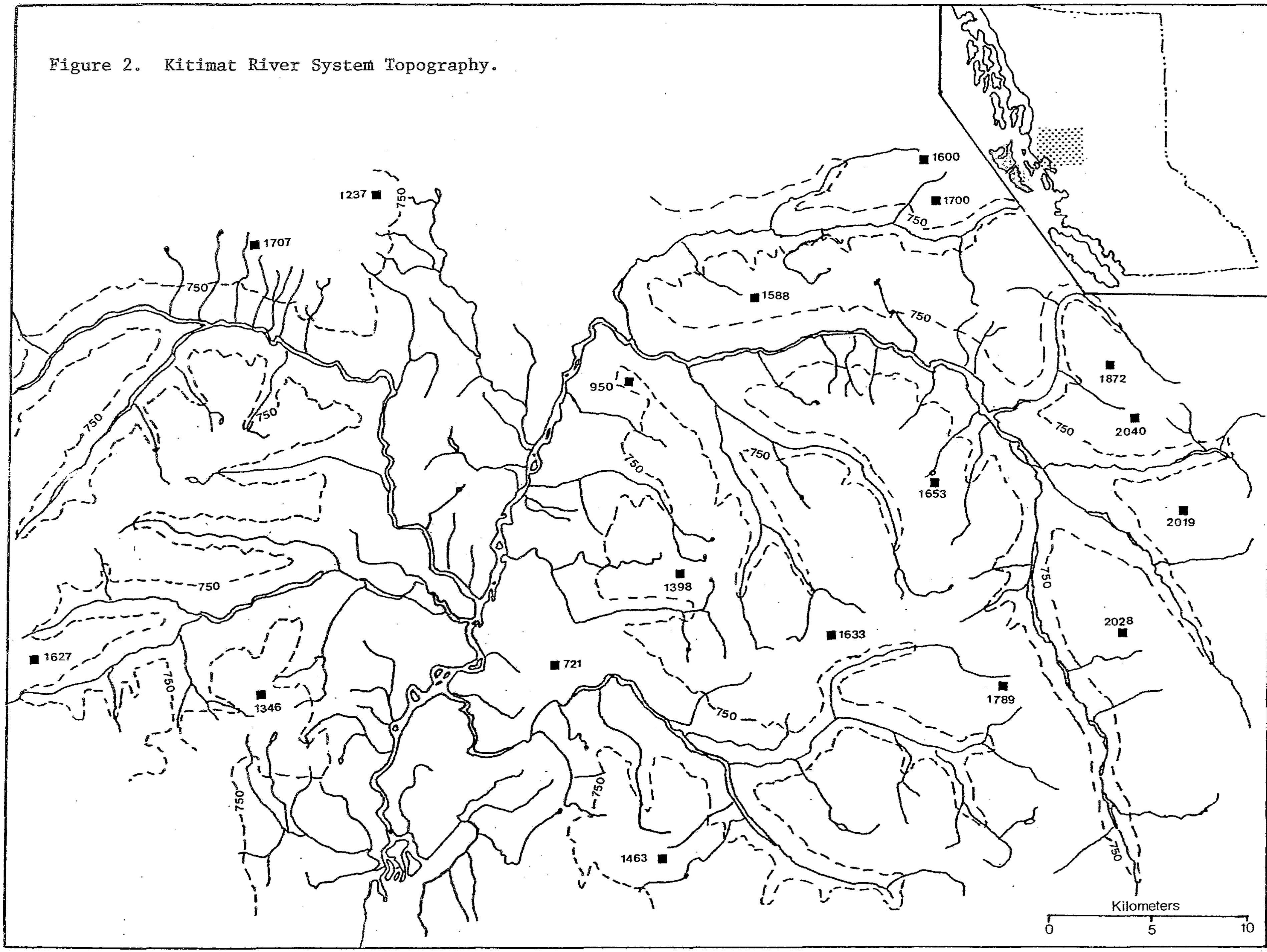
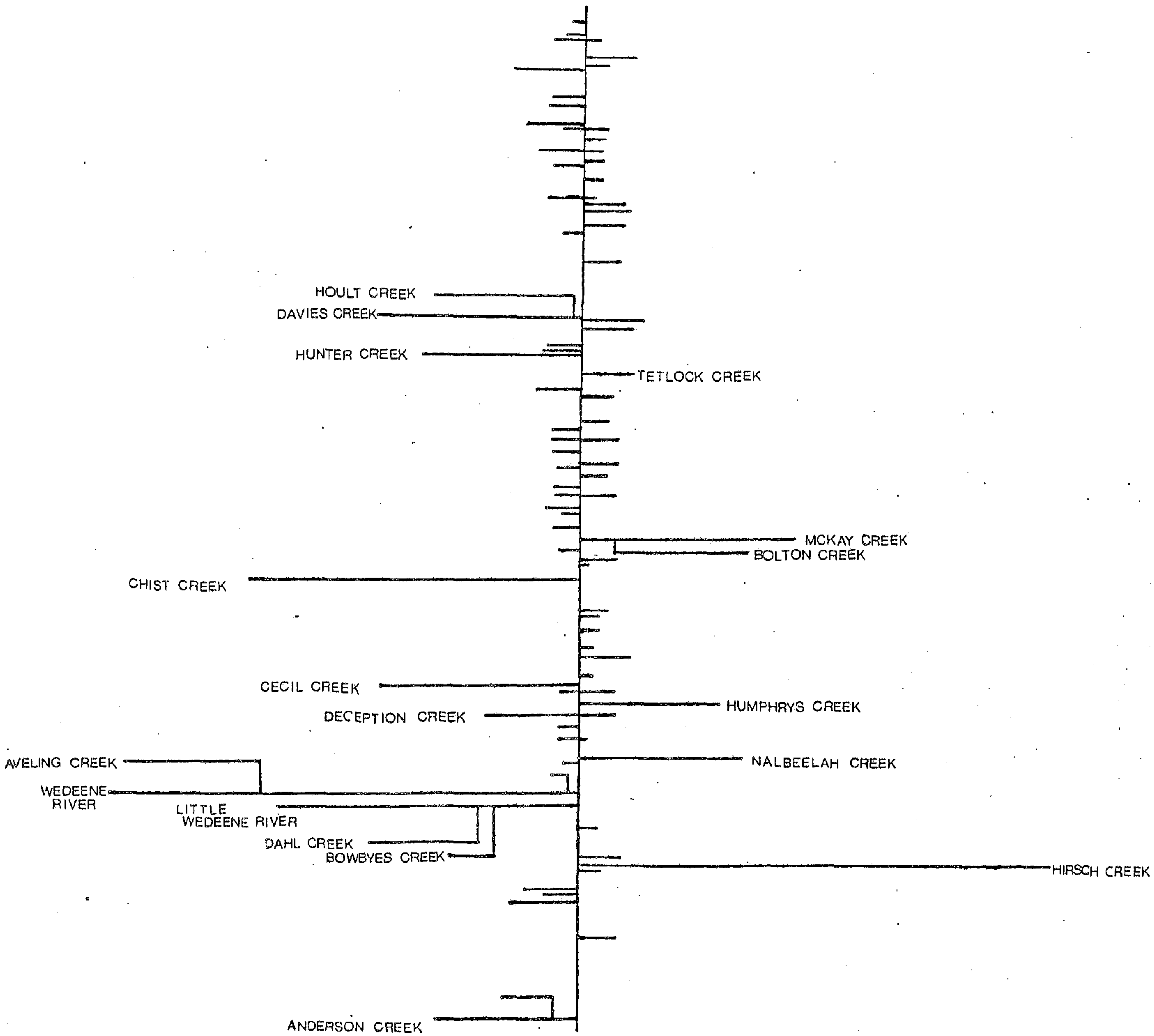


Figure 3. Kitimat River from its headwaters to Kitimat Arm.
Scale: 1cm = 4.5km
Total number of tributaries shown = 81.



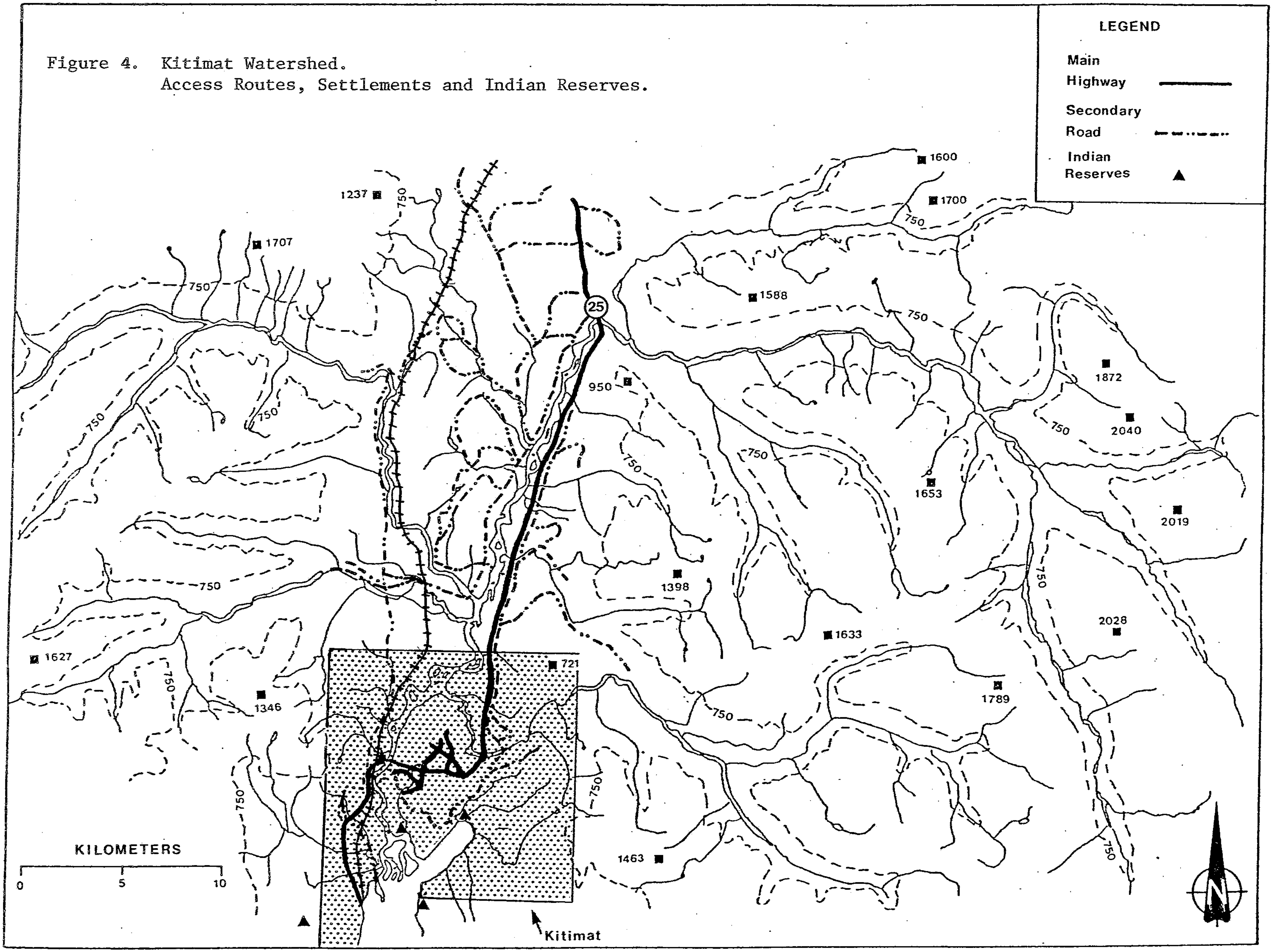


Figure 4. Kitimat Watershed.
Access Routes, Settlements and Indian Reserves.

WATERSHED UTILIZATION

History

The Kitimat Indians were the first inhabitants of this coastal area and established a village on the east shore of the Kitimat Arm of Douglas Channel in the Kitimat Valley.

In 1906, the first known development in the area occurred. A railway route was surveyed, a wharf and hotel were built, and a crude road to Terrace was cut. Through the next few decades, however, many of the settlers gradually departed.

At the end of the Second World War the government of British Columbia invited the Aluminum Company of Canada Ltd., to study the possibility of establishment in the province. In 1948, Alcan surveyors found the Kitimat-Kemano area suitable for a large aluminum smelter due to the abundant hydro-electric power potential, a deep natural ocean harbour and ample available space.

In 1951, work on the project began. The town of Kitimat was planned and built in conjunction with the aluminum smelter mill. The company felt that the workers would require an attractive town where they could establish permanent homes and raise their families. Much forethought and planning went into the development of Kitimat. There are many park areas, the residential and industrial areas are separated, with the industrial area generally located on the west side of the river. This development project is the largest ever ventured in Canadian history, with ALCAN'S capital investment of over $500 million being the largest financial undertaking in the country by a private enterprise.

The second major industry is Eurocan, the Finnish-Canadian pulp mill which was built in 1967 and completed in 1970.

Logging

The Kitimat River watershed is not managed on a Public Sustained Yield Unit (P.S.Y.U.) basis. Instead, Tree Farm and Timber Licences have been issued to direct cutting operations. Tree Farms are run on, more or less, a sustained yield basis while Timber Licences allow more exploitive harvesting. The occurrence of biological pests, such as the spruce bud worm and the saddle-backed looper, has made forest management more difficult in this region. The result being an essentially clear-cut valley.

In the past 10 years, intensive harvesting of the watersheds forest resources has taken place. According to the F381 spawning files, by 1967, "The lower portion of the river (had) deteriorated badly...Logging (had) almost stripped the watershed on the lower section of the mainstem. Stable conditions (will) not return until the stripped forest cover grows back". By 1971, "The river (had) lost much of its stability due to heavy logging in the drainage area".

Logging beyond that which represents sustained yield has served to contribute greatly to instability and flooding problems in this watershed, and can be at least partially blamed for the decline in salmon returns.

In the Kitimat Valley, the bulk of the central section was covered by Special Timber Licences issued to Crown Zellerbach and MacMillan Bloedel. MacMillan Bloedel will cut about 50,000 cunits in 1981 according to their timber licence, with only a small percentage of that total being in the Kitimat Valley. In addition, in 1982 they will log off approximately 10,000 cunits between Chist and Nalbeelah Creeks (B. Sverre, pers. comm.). Crown Zellerbach completed their logging activities in the watershed in June, 1980 (S. Koltai, pers. comm.).

Timber licences are held by Eurocan Pulp and Paper on both sides of the Lower Kitimat River. On the western side of the valley (Wedeene River area), enough timber remains to support heavy logging (60,000 cunits per year) for the next three to four years. Patch cutting will conclude operations in that area. In the eastern portion of the watershed, operations are concentrated on the north side of Chist Creek and on Hirsch Creek. Logging on Chist Creek began in 1971, and should be completed by 1987. Logging began in 1974 on Hirsch Creek, and should produce 30-40,000 cunits per year until 1984. By 1983 probably 70% of Eurocans total cut will be taken from the Upper Kitimat area, and as of 1984, the area should yield 130-140,000 cunits per year (V. MacKulak, pers. comm.).

The B.C. Forest Service (A. Lenser, pers. comm.) indicates that there are some private operators working in the Lower Kitimat Valley, however, the amount of wood taken is insignificant.

Mining

There are no mining operations nor exploration in progress in the Kitimat River drainage area (J. Arsenault, H.P.D., pers. comm.). However, there is some hard rock exploration for copper, silver, lead, and zinc being conducted in the area around Terrace. Similar rock formations in the Kitimat area would indicate a similar potential for these minerals, and probably for gold and molybdenum as well. Analysis of samples from streams in the upper portion of the watershed (Geological Survey of Canada, 1978) indicate a high content of iron in the water, and thus it is probable that substantial deposits of this mineral also exist in the area.

The discovery of the sizable Telkwa coalfield approximately 120km N.E. of Kitimat could, possibly, spark more intensive exploration for fossil fuel reserves in the region (B.C. Ministry of Mines and Petroleum Resources, 1977).

Population

The Kitimat River watershed is contained entirely within the Kitimat-Terrace Area of the Skenna-Stikine Region as catalogued by the British Columbia Regional Index (1976). This area had a total population of 30,183 persons in 1976, an increase of 3.4 percent from 1971. Major centres of population in 1976 include the District of Kitimat (11,956), the District of Terrace (10,251), which lies near the Skeena River, and the communities of Kemano (263), Kitimaat (614), and Lakelse Lake (213). Comparing these figures with 1971 populations, Kitimat and Terrace have shown 1.3 percent and 2.6 percent increases respectively.

Industry

The two major centres in the Kitimat River area, Kitimat and Terrace, have very different economic resources. Kitimat's economy is dominated by the Alcan aluminium smelter, with the Eurocan pulp and paper mill playing a secondary role. Timber obtained from additional logging activity is transported to southern mills.

The economy of Terrace is based primarily on the forest industries (logging, sawmilling and pole production), however, trade, services and administrative activity provide the largest proportion of employment positions. This statistic reflects the growing importance of the community as a regional service and distribution centre.

The Aluminium Company of Canada and Eurocan Pulp and Paper Co. Ltd., both located in Kitimat, are the two largest manufacturing firms in the area, followed by numerous sawmills mostly in Terrace. The area also supports bakeries, a dairy, a printing and publishing company, concrete producers, industrial gas suppliers and millworkers.

Logging is widespread throughout the area and has shown considerable growth despite the slump period from 1974 to 1975. Agriculture, which plays a minor role in the economy, is centered around Terrace, where there is good soil and relatively mild winters. The largest single source of farm revenues comes from poultry and egg production. There are also a few small dairy farms and beef cattle, hog, and sheep producers (B.C. Regional Index, 1978).

The mining industry consists of a small limestone quarry, operated by Terrace Calcium Products Ltd., near Terrace and several sand and gravel pits, producing material for construction purposes. The Hecate Gold property on Banks Island is currently undergoing a major exploration program.

The tourism trade has grown with the recent highway improvement projects completed in the area. The main attractions are the scenery, fishing, and hunting. Other attractions include the Lakelse Hotsprings, lava beds north of Terrace and conducted tours through the smelter and mill at Kitimat.

There is also a limited amount of non-salmonid commercial fishing done in the area.

Water Licences

There have been eight water licences issued in the Kitimat River watershed, with five of those being on the Kitimat River proper (Table 1). In addition, there have been three others issued on Anderson Creek. Industrial purposes are the most common usages (5 of 8), while waterworks licences constitute the remainder of usages on the system.

Priority of users is determined by the date of licence approval, not by licence classification. On the rare occasion that two licences are granted on the same date, then licence classification may dictate priority. From the year 1961, there has been a clause added to the water licences granted to large power companies that states: "priority is subsequent to any consumptive purposes" (D. Tanner, Water Management Branch, July 16, 1980, pers. comm.). This means that any private user (irrigation, waterworks, domestic, etc.), takes priority over a licence for power, regardless of the date on the licence.

Table 1. Water Licences on the Kitimat Watershed (from Water Resources Branch computer listing, 1980).

	Licence Holder	Priority	Water Resources Working Units	Standardized Units	Type (Usage)
	Kitimat River				
1.	Aluminum Co. of Canada	23/11/1953	50.00 CS	1.41 m^3/sec	Industrial (Sawmills)
2.	District of Kitimat	17/02/1959	1,000,000.00 GD	$5.26x10^{-2}$ m^3/sec	Waterworks (Municipal)
3.	Eurocan Pulp and Paper Co.	10/05/1967	70.00 CS	1.98 m^3 /sec	Industrial (Pulpmills)
4.	District of Kitimat	28/07/1969	3,000,000.00 GD	$1.58x10^{-1}$ m^3 /sec	Waterworks (Municipal)
5.	L.G. Scott & Sons Construction	30/03/1971	25,000.00 GD	$1.31x10^{-3}$ m^3/sec	Industrial (Unspecified)
	Anderson Creek				
1.	Aluminum Co. of Canada	23/11/1953	20.00 CS	5.7 $x10^{-1}$ m^3/sec	Industrial (Sawmills)
2.	Eurocan Pulp and Paper Co.	14/07/1970	0.26 CS	7.3 $x10^{-3}$ m^3/sec	Industrial (Unspecified)
3.	Eurocan Pulp and Paper Co.	14/07/1970	5,000.00 GD	$2.63x10^{-4}$ m^3/sec	Waterworks (Industrial)

CS - cubic feet per second

GD - gallons per day

KITIMAT RIVER CAPABILITY STUDY

Agriculture

Most of the land along the Kitimat River course is classified as either forage land or permanent pasture. Major limiting factors are stony soil and drought. Widely interspersed along the river are areas of reduced range of crops and low productivity. Limiting factors also include bank variability, periodic flooding, and undesirable soil sturcture. The lower stretches of the Little Wedeene and Wedeene Rivers have capabilities similar to those of the Kitimat. The areas upland from the rivers are very similar in classification while their course is within the valley. The mountainous sections of the rivers show low productivity due to steepness and large areas of exposed bedrock (B.C. Ministry of Environment, 1966).

Ungulates

The lower Kitimat, Wedeene, and Little Wedeene Rivers are rated as having moderately severe limitations upon their capability to support ungulate populations. Limiting factors include deep, demobilizing snows and adverse climatic conditions. In the lower valley, moose and deer are the predominant ungulates.

In the upland areas, severe conditions limit ungulate production. Lack of vegetation due to exposed bedrock becomes an additional limitation to ungulate populations. Some areas are incapable of supporting any animals at all. In the upland regions, moose and goats are the dominant species (B.C. Ministry of Environment, 1966).

Waterfowl

The mouth of the Kitimat River, Kitimat Arm, and Minette Bay are not important as waterfowl breeding areas, but are used as migratory or wintering areas. Upstream from the Kitimat townsite, waterfowl populations and their habitat are severely restricted. Limiting factors include extremes in flow, soil depth (which restricts plant growth), and lack of defined bank.

The Little Wedeene and Wedeene Rivers are canyonous and do not support any waterfowl populations.

Upland from all parts of the rivers there are generally such severe conditions that almost no waterfowl populations exist. Steep banks and valleys are the main limiting factors. Slightly less adverse conditions are found 4-5km from the river banks. These small areas are ranked as "severe" and opposed to "extremely severe" and lack of bank, lack of free flowing water, and reduced marsh edge are listed as limiting factors (B.C. Ministry of Environmnet, 1966).

Recreation

At the mouth of the Kitimat River a shoreland classification of moderate to moderately high recreational capability exists. Possible activities include wetland wildlife observation, hunting, angling, organized camping, viewing and using man-made features. Upstream, and for the majority of river's length, the river is classified as an upland area with moderate recreational capability. All of the previously mentioned activities, as well as canoeing are listed as potential pastimes. The same level of capabilities as well as the same number of activities exist along the Wedeene River and the Little Wedeene River. At their confluences with the Kitimat, their capability increases to a rating of moderately high.

Upland from the Kitimat, the recreational capability decreases to a low rating; only interesting topography and vegetation offer any attractions. Other areas also feature upland wildlife and small surface waters.

Around the townsite of Kitimat, there is a large area of moderate recreational capability. Potential activities include angling and viewing.

The upland area of the Wedeene and Little Wedeene Rivers include large tracts of low recreational capability. All previously mentioned activities are listed, as well as glacier travel (B.C. Ministry of Environment, 1966).

Forestry

Although no capability study has been done in the Kitimat River watershed (K. Gorse, pers. comm.), forestry capability ratings probably range from very poor (0-30 cf/acre/year) to excellent (111-130 cf/acre/year).

"Most of the lower Kitimat Valley has been logged at least once in its history. Enormous stumps and rotting logs strewn throughout the forests and tidal flats evidence this, as there are not mature forests within the Kitimat Study Area (ie, below 300m elevation) which remotely approach their dimensions. This early forest probably consisted primarily of western red cedar and western hemlock, with mature stands of Sitka spruce near the estuary" (Hay, 1976 MS).

Along the Kitimat mainstem, western hemlock (Pseudotsuga heterophylla) - western red cedar (Thuja plicata) and western hemlock-pacific silver fir (Abies amabilis) coniferous forests with Devils Club (Oplopanax horridum) lower slopes and blueberry (Vaccinium spp.) upper slopes predominate. Varying amounts of willows (Salix spp.) and northern black cottonwoods (Populus trichocarpa) occur near the water course in the lowland areas.

The upland areas are classified as Upland Coniferous Forest, with the dominant species being western hemlock and pacific silver fir. Understory species include Alaska blueberry (Vaccinium alaskaense) and salal (*Gaultheria shallon*). The higher elevation wooded areas probably exhibit the slowest growth rates.

In all probability, the best capability ratings in the watershed exist in the alluvial flood plain areas (especially at the mouth of the Kitimat River). Large stands of northern black cottonwood occupy the river banks, and represent the dominant species in the delta area. Red alder (*Alnus rubra*), willow, Sitka spruce (*Picea sitchensis*), western red cedar and western hemlock are also present in the area, along with rarely encountered specimens of trembling aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), vine maple (*Acer circinatum*) and Pacific crab-apple (*Pyrus fusca*). The understory tends to be very dense in these areas.

With the intensification of logging activities in the watershed, alder regeneration forest has become increasingly important in recent years. Characteristic of these areas are young stands of red alder, with shrub species such as goat's beard (*Aruncus sylvester*), thimbleberry (*Rubus parviflorus*), salmon berry (*Rubus spectabilis*), elderberry (*Sambucus spp.*) and blueberry abundant. With the onset of summer these cutovers take on a distinctive purple hue due to the prolific nature of the ubiquitous western fireweed (*Epiloobium augustifolium*).

STREAMFLOWS

The three stations monitored by Water Survey of Canada (1980), were utilized for streamflows for the Kitimat River watershed. The first was on the Little Wedeene River below Bowbyes Creek, the second was on Hirsch Creek near the mouth and the last was on the Kitimat River below Hirsch Creek.

The Little Wedeene River (Fig. 5, Appendix 2c & d) has a widely ranging flow regime in an average year. Low flows are observed from December to March inclusive with January having the lowest mean monthly discharge at $3.8m^3$/sec. Streamflow then rises quickly to a peak of $42.1m^3$/sec. (11 times the winter low). Maximum instantaneous discharges are usually observed in October (to $172.9m^3$/sec.), while extreme minimum daily discharges have been as low as $1m^3$/sec.

Hirsch Creek maintains a fairly stable mean monthly discharge profile over an average year. Peaks appear in June and October (as interpreted from mean monthly discharge). Monthly maximum discharge profiles, however, indicate much higher short term variability. Late autumn rains can bring huge changes in streamflows(as shown in Fig. 6, Appendix 2e & f).

The Kitimat River has a flow pattern very similar to that of Hirsch Creek, being subject to large variations in streamflow (augmented by deforestation). Acute run-off and little "buffering" capacity combine to make this river torrential at certain times of the year (Fig. 7). The river begins to rise early in April and continues a rapid rise (at a rate of $3m^3$/sec/day) through mid to late June (to $295m^3$/sec). Once past spring freshet, flows decrease ($2.3m^3$/sec/day) over the next 60 days, autumn precipitation again brings about an increase in streamflow in the system. Freezing at higher elevations then brings about the decreased low flow periods characteristic of the winter months (Appendix 2a & b).

Figure 5. Streamflow(m^3/sec) of the Little Wedeene River below Bowbyes Creek. Monthly Mean, Maximum and Minimum Discharge(Water Survey Canada, 1980).

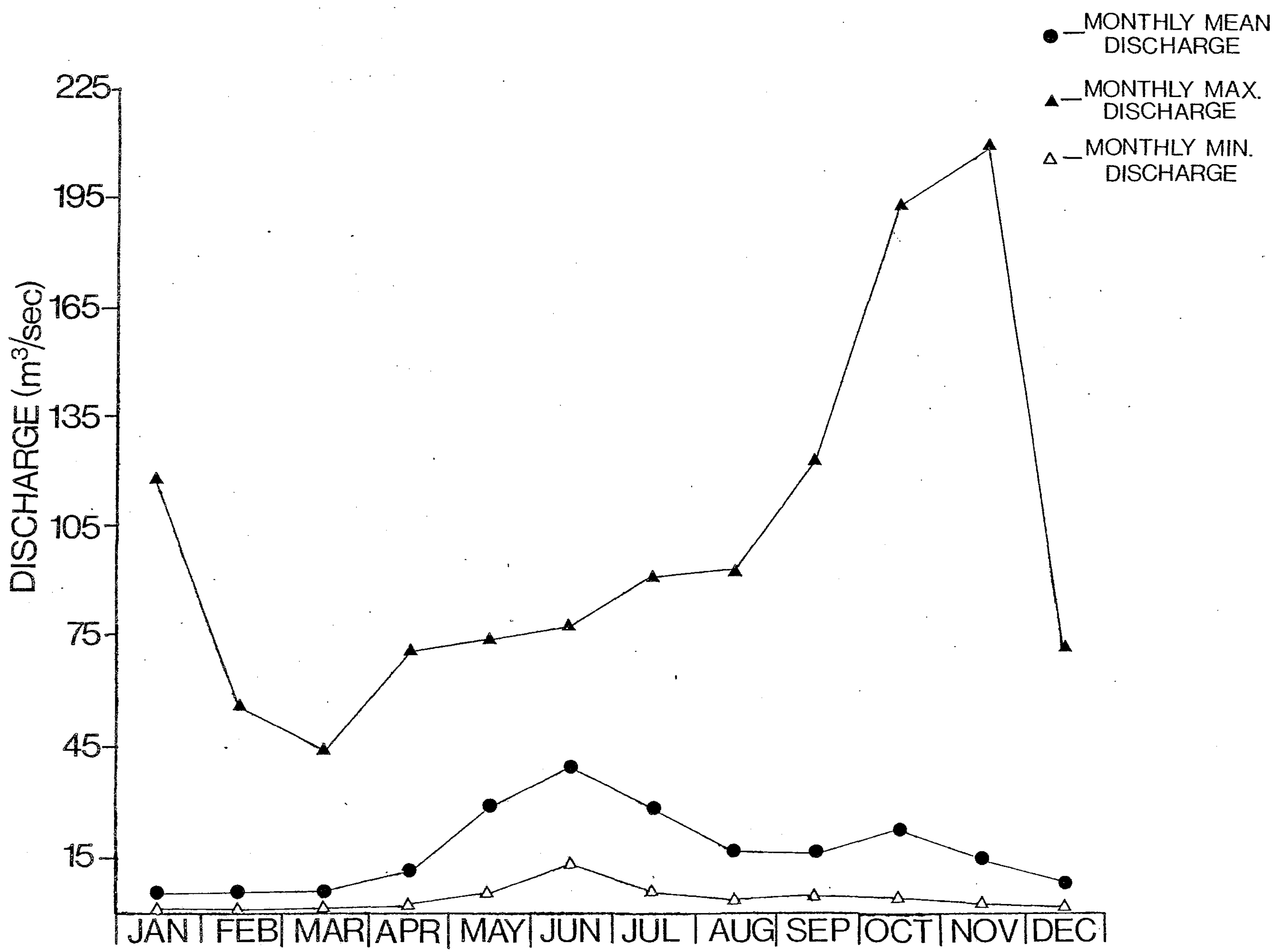


Figure 6. Streamflow(m^3/sec) of Hirsch Creek near the mouth. Monthly Mean, Maximum and Minimum Discharge (Water Survey Canada, 1980).

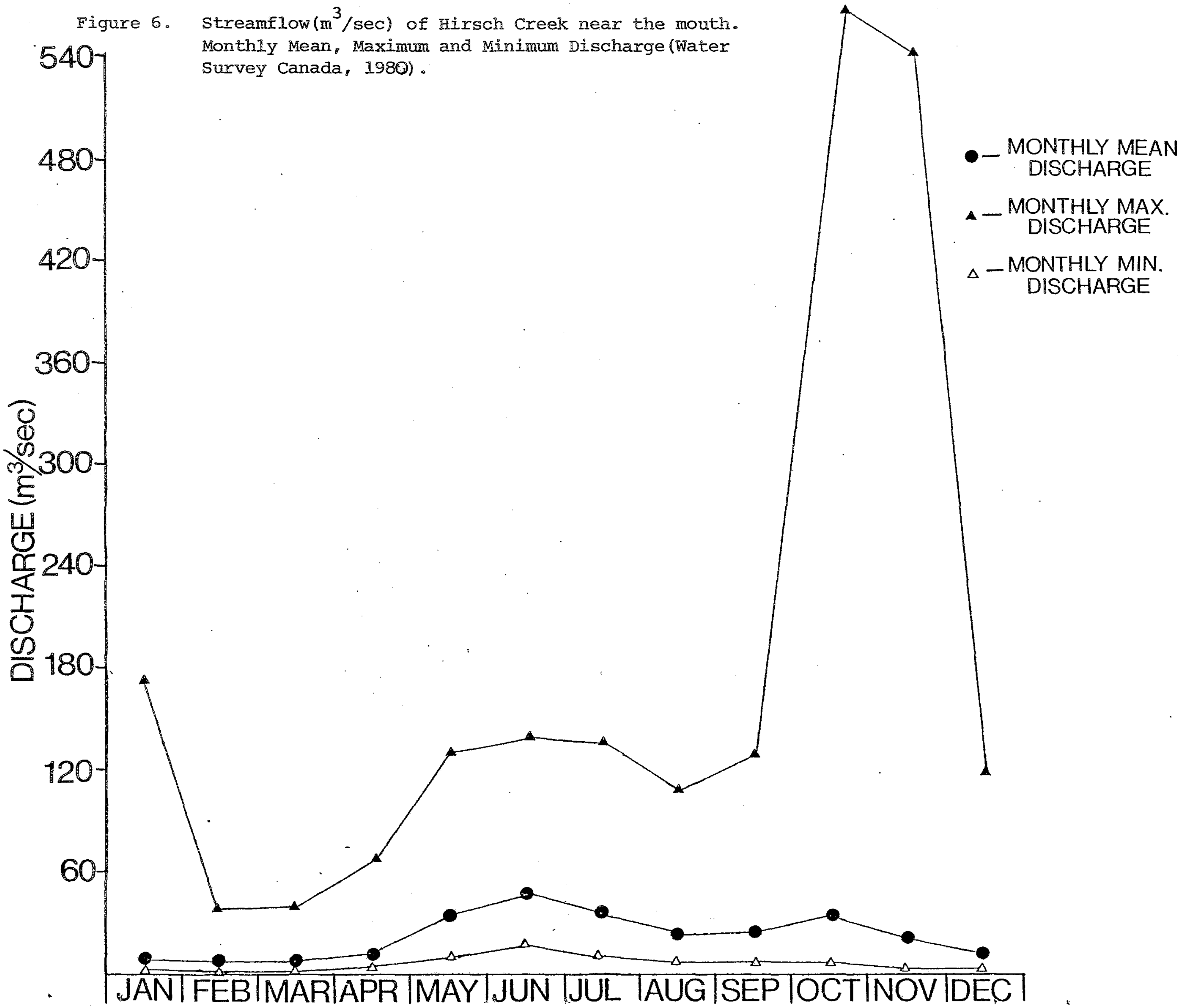
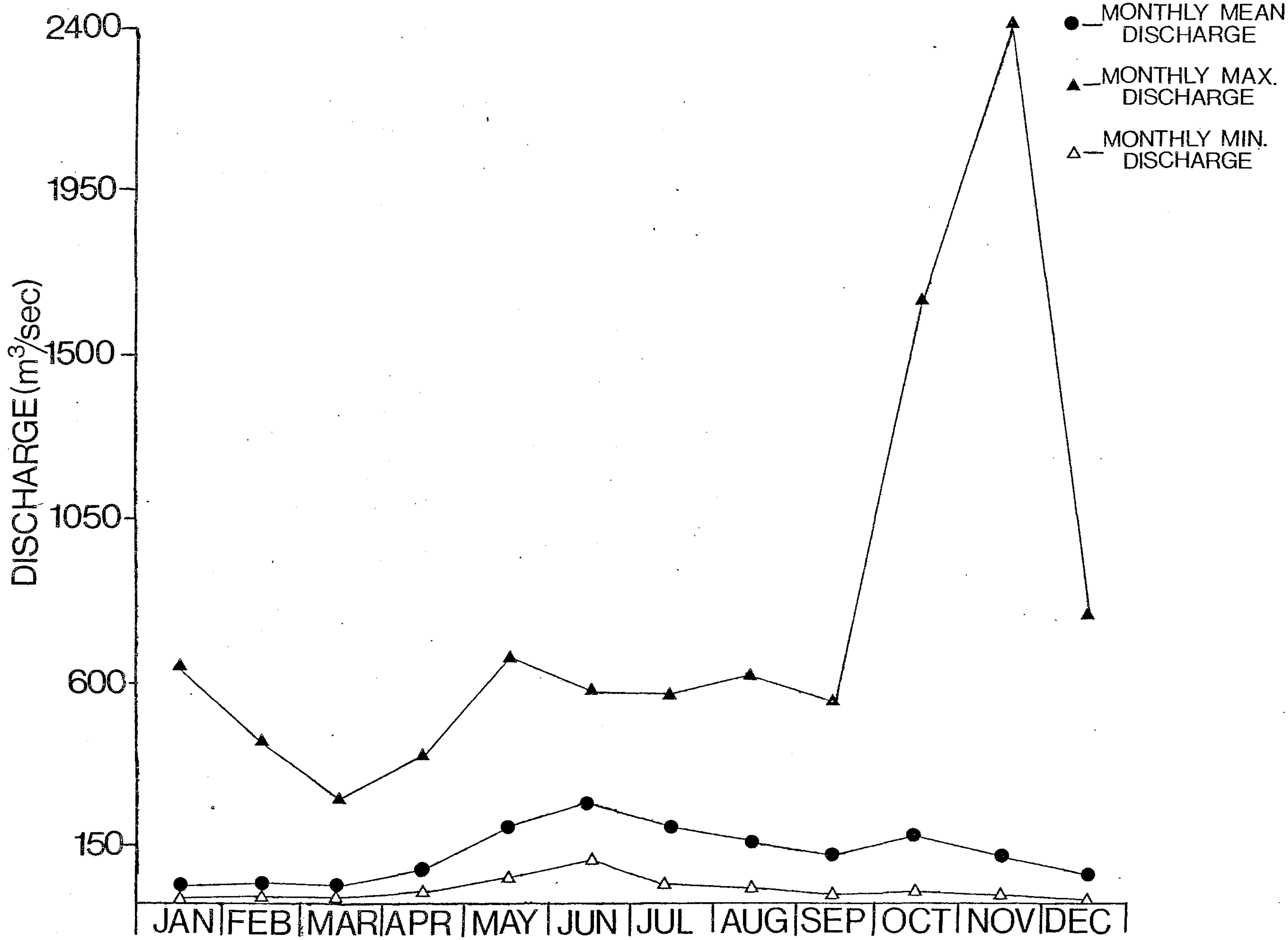


Figure 7. Streamflow(m^3/sec) of the Kitimat River below Hirsch Creek. Monthly Mean, Maximum and Minimum Discharge (Water Survey Canada, 1980).



WATER QUALITY

Surface Water

On the Kitimat River system, many sites could be deemed appropriate for salmonid enhancement on the bias of strictly physical parameters (ie, absence of impassable barriers, good access, etc.). Use of water quality criteria further limits the areas suited for enhancement (see Table 2 and Fig. 8 for sample site definitions and locations).

Starting at the headwaters of the Kitimat system and working downstream (Table 3), the Chist Creek area is the first sampled region to be encountered. On the basis of one sample, all water quality parameters tested lie within the Recommended Fish Culture Limits (R.F.C.L.-Appendix 8) with the exception of mercury, which is almost 8 times the threshold toxic level (Fedorenko, 1979). This could have been sample contamination, as salmon stocks successfully spawn in Chist Creek.

The Kitimat mainstem at 'Seventeen Mile Bridge' is characterized, from 11 samples, by extreme softness and low ionic content, as evidenced by low values for filterable residue, specific conductance, total alkalinity and hardness (Laboratory Services (EPS-FMS) Chemistry, 1980). In addition, non-filterable residue (N.F.R.) concentrations are elevated (to 140 mg/l) and water colour ranges well above R.F.C.L. (Naquadat, 1979). Iron levels range as high as 2.3 mg/l, however, the concentration appears to be dependant on flow, indicating that a substantial portion of the metal is present in sediments rather than dissolved in the water.

Two samples of water from Cecil Creek indicate it to be soft (18.1 mg/l CaCO) and to have high levels of mercury (10 times toxic threshold), however, again this could represent sample containimination. In addition, aluminum and iron concentrations exceed R.F.C.L.

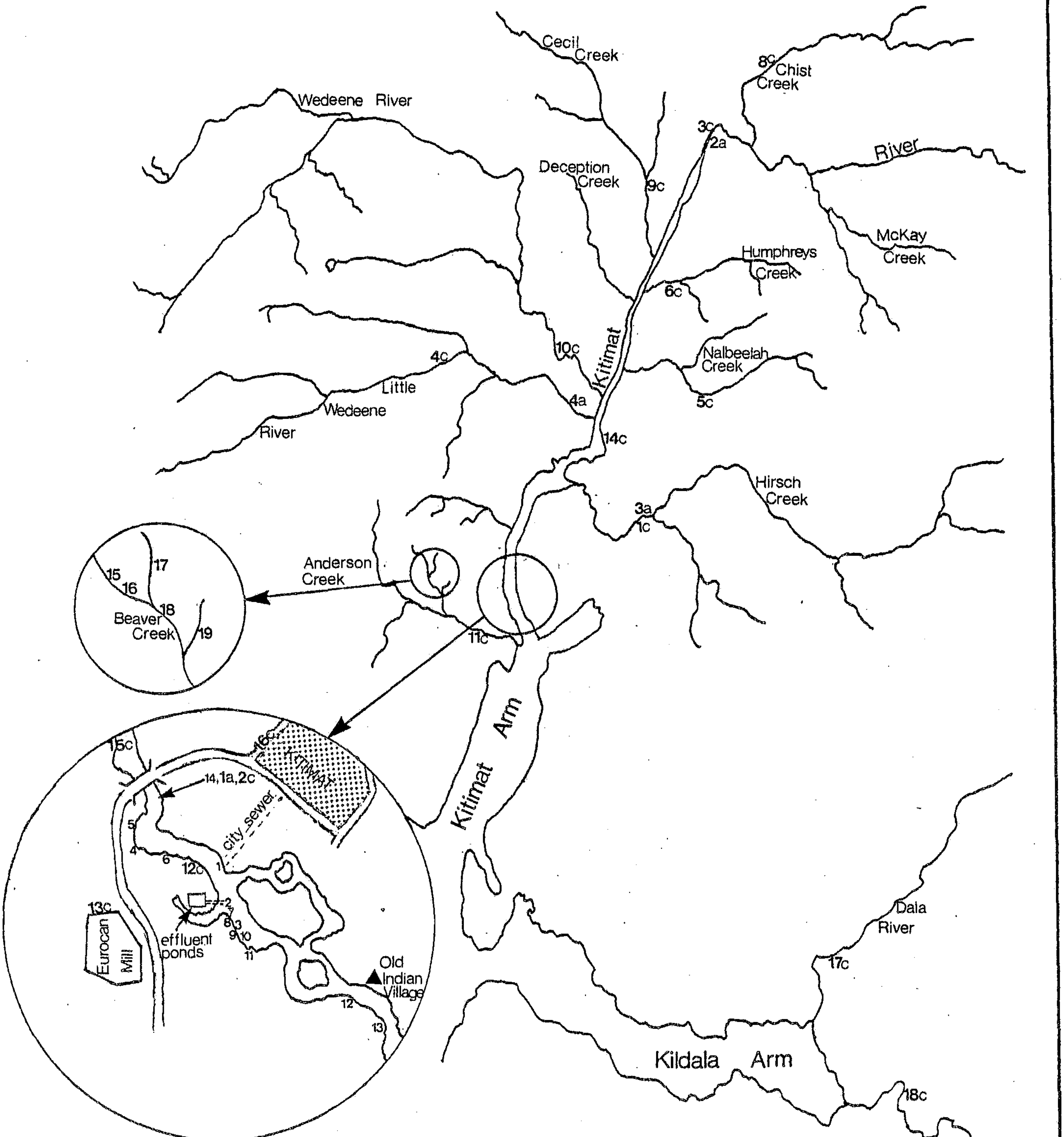
Table 2. Water Quality Sample Sites (B.C. Ministry of Environment 1979; Naquadat, 1979).

Pollution Control Branch Sample Sites		
1.	Kitimat District site	- outfall
2.	Eurocan Pulp, Kitimat	- outfall
3.	Kitimat R. D/S of Eurocan (FOM)	- stream
4.	Kitimat R. D/S of L.G. Scott (FOM)	- stream
5.	Kitimat R. D/S of L.G. Scott (35m)	- stream
6.	Kitimat R. Station #1	- stream
7.	Kitimat R. Station #2	- stream
8.	Kitimat R. Station #26	- stream
9.	Kitimat R. Station #3	- stream
10.	Kitimat R. Station #4	- stream
11.	Kitimat R. Station #5	- stream
12.	Kitimat R. Station #6	- stream
13.	Kitimat R. Station #7	- stream
14.	Kitimat R. Station #8	- stream
15.	Beaver Cr. sample Point 1	- stream
16.	Beaver Cr. sample Point 2	- stream
17.	Beaver Cr. sample Point 3	- stream
18.	Beaver Cr. sample Point 4	- stream
19.	Beaver Cr. sample Point 5	- stream
Naquadat Sample Sites		
1a.	Kitimat River @ Haisla bridge	- stream
2a.	Kitimat River @ 17 mile bridge	- stream
3a.	Hirsch Creek adj. H.C. Park	- stream
4a.	Little Wedeene R. @ confluence	- stream
Geological Survey of Canada Sample Sites (App. 3)		
1b.	Kitimat River Tributaries (18 tributaries sampled)	- stream and sediment

Table 2. (cont'd).

2b.	Wedeene River Tributaries (18 tributaries sampled)	- stream and sediment
D.F.O. Sample Sites		
1c.	Hirsch Creek near C.Z. bridge	- stream
2c.	Kitimat River @ Haisla bridge	- stream
3c.	Kitimat River @ 17 Mile bridge	- stream
4c.	Little Wedeene River	- stream
5c.	Nalbeelah River	- stream
6c.	Humphreys Creek	- stream
7c.	Upper Kitimat River	- stream
8c.	Chist Creek	- stream
9c.	Cecil Creek	- stream
10c.	Wedeene River	- stream
11c.	Anderson Creek	- stream
12c.	Kitimat River @ Hatchery site	- stream
13c.	Kitimat River @ Eurocan (potable)	- stream
16c.	Municipal hydrant (Kitimat)	- stream
17c.	Dala River	- stream
18c.	Kildala River	- stream

Figure 8. Kitimat River watershed showing Pollution Control Branch, NAQUADAT and DFO Sampling Sites.*



* See Table 2 for site description

Table 3. Kitimat River Water Quality Sample Sites. Listed in order of occurence from headwaters to Kitimat Arm (B.C. Ministry of Environment,1979; NAQUADAT, 1979; Laboratory Services(EPS-FMS) Chemistry, 1980).

WATER QUALITY PARAMETER (mg/l)* / SAMPLE SITE	8c	3c	2a	9c	6c	5c	10c	4c	4a	14c	3a	1c	15c	14	1a	2c	16c	5	4
pH		7.4	6.8	7.0			7.0		6.3	7.2	7.4	7.3		7.3	7.1	7.0	6.8	6.8	7.0
F.Residue		27.2	22	36.5			14		13	26	12	25.0	18		16	27.2	21		
N.F.Residue		27.6	22.8	76			10.9		10.4	39.3	16	17.3	<4		44.4	73.1	5	3	6
S. Cond. (microhm/cm)		29.8	33	32.7			17.0		18.3	30.7	31.7	29.7		29.9	28.3	32.9		24	24
D. Oxy.		10.4					11.0			10.9				11.4					
Chl. Res.		.98		.95			<.5			<.5		.52				.93			
Colour(TCU)			33						6.6		7				8.7	5			15
Turb.(JTU)		45	2.8	20.4			5.4		2.6	26		4.6		7.6	7.7	16.3		2	3.3
Hardness	33.4	15.6	13.5	15.8	17.8	18.4	13.7		7.2	15.5	14.7	13.6			12.2	13.6	12	10.2	9.8
T. Alk		15.9	12.4	13.2			9.1		5.7	17.0	12.6	12.7			10.2	11.5		10.5	10.3
NH_3		.002		<.001			.002			.001		<.001				<.001			
T.Nitrogen		.163+	.057+				<.001+		.086+	<.001+	.024+		.12+		.058+		.062+		.07
T.Phosphate		<.01	.02	.06			.002		.016	.001	.014	.017	.01	1.57	.04	.07	<.01		.02
Sulphate		2.7	2.4	3.3			.2		1.57	.4	1.6	2.5	2.3		2.0	3.38	2.1		5
O. Carbon																			3
T. Al	<.09		.01	.34	<.09	.49	.20	<.09	<.01			.02				.45			
T. Ca	11.8	5.6	5.0	5.3	5.8	5.5	4.6	3.7	2.3	4.8	4.8	4.5	4.1		4.0	4.9	3.8	2.9	3.1
T. Cu	<.001	<.01	.001	<.01	<.001	.002	<.001	<.001	.001	.004	.001	.006	.01		.002	.008	<.01		
T. Fe	<.02	.54	.12	.37	.08	.77	.30	.07	.27	1.29	.15	.13	.10		.25	.45	.55		
T. Hg($x10^{-3}$)	1.55	<.2	.05	10	1.8	1.3	1.0	1.5	.05	<.2	.05	<.2			.05	<.2			
T. Mn	<.004	.039	.01	.03	<.004	.033	.018	<.004	.01	.04	.01	.006	<.03		.01	.02	<.03		
T. Pb	<.001	<.02	.001	<.08	<.001	<.001	<.001	<.001	.001		.001	<.001	<.02		.002	<.001	<.02		
T. Si	2.48	1.92		1.21	2.4	4.2	2.9	2.1				1.07	1.7			1.36	1.9		
T. Zn	<.001	<.01		<.02	<.001	<.001	<.001	<.001	.001	.009	.001	.004	<.01		.003	.015	<.01		

* except where otherwise defined
—— mean value exceeds RFCL
— — range extremity(ies) exceed RFCL
\+ represents NO_3 conc.

Table 3. Kitimat River Water Quality Sample Sites(cont.).

WATER QUALITY PARAMETER (mg/l)*	SAMPLE SITE																	
	6	12c	1	2	13c	7	8	3	9	10	11	12	13	15	16	17	18	19
pH	7.2	7.1	6.9	7.6	7.2	7.3	7.4	6.9	7.3	7.2	7.3	7.2	7.2	6.7	6.8	6.8	6.9	6.9
F. Residue		21	146	857	99									2.9	10.5	45.8	17.6	46.4
N.F.Residue		54.6	12.9	99	15.7			17										
S. Cond. (microhms/cm)	35.6	24.0	257	769	29.8	35.4	37.7	25	46.6	42	41.8	42.4	46.8	365	146	392	174	
D. Oxy.	11.7	10.9	3.5	5.4	10.9	11.7	10.4		11.5	11.6	11.5	11.5	11.5	11.8	10.9	5.3	9.6	5.6
Chl. Res.		<.5	0		<.5													
Colour	20			606		20		15										
Turb.	6.9	18	8.7	26	22	6.0	19.1	6.5	9.3	9.6	10.0	9.6	11.5	1.2	11.9	87.2	35.6	87.7
Hardness		12.6			15.8													
T. Alk.		13.0		120	15.3			10										
NH_3		<.001	.029		.002									.006				
T. Nitrogen		<.001+	10.3	1.0	<.001+			.14							.32	.54	.35	
T. Phosphate	.86	.002	1.73	1.08	.007	1.0	1.26	.03	.95	.68	1.02	.68	1.3					
Sulphate		.2		251	8.7			5										
O. Carbon								2										
T. Al																		
T. Ca	3.8				36.6			3.3										
T. Cu	.003				<.01													
T. Fe	1.22				<.03													
T. Hg($x10^{-3}$)	<.2				<.2			50										
T. Mn	.05																	
T. Pb					<.02													
T. Si					4.9													
T. Zn	.005				<.01													

* except where otherwise defined
—— mean value exceeds RFCL
— — range extremity(ies) exceed RFCL
\+ represents NO_3 conc.

Humphreys Creek has water quality similar to Cecil Creek (1 sample). That is, the water is quite soft, and contains substantial levels of mercury. No problem with any other heavy metals is expected, as all surveyed lie safely within R.F.C.L.

The Weedene River is characterized from 3 samples, as unfavourable for intensive fish culture due to high aluminum, iron and mercury concentrations and extremely soft water. However, salmonids do successfully utilize this stream, at the low natural loading densities encountered.

One sample from Nalbeelah Creek indicates the same water quality problems as the majority of Kitimat River tributaries; high aluminum, iron, and mercury concentrations and extremely soft water. It is probable that N.F.R. levels are also elevated at many times throughout the year.

The Little Wedeene River has been sampled for water quality at two sites (Fig. 8). A collective total of 4 samples indicate low pH, specific conductance, total alkalinity and hardness, and high mercury (0.00145 mg/l) and iron (ranging to 0.41 mg/l) levels. These characteristics represent fish culture problems.

Hirsch Creek has been sampled fairly extensively for water quality (19 samples). The water from this area is extremely soft, and tends to be quite corrosive. N.F.R. average 25 mg/l, ranging from 16-34 mg/l over the dates surveyed. Low specific conductance and total alkalinity indicate the buffering problems of the source. Copper and zinc range to .028 and .0135 mg/l respectively). Little is known about the potential for toxicity through synergism between these metals in the soft water, as the proportion of dissolved to sedimented metal is not known.

Below Hirsch Creek, the Kitimat River can be functionally separated into two regions, divided at the hatchery site.

The water quality of the stretch of the Kitimat River from the confluence with Hirsch Creek to the proposed hatchery site is marked by N.F.R. concentrations ranging from 5 to 300 mg/l. Turbidity, aluminum, and iron follow the same basic pattern as do the non-filterable residues and mean daily discharge (Water Survey Canada, 1980) (Fig. 9). This indicates that although aluminum and iron concentrations often exceed R.F.C.L. by sizeable margins, toxicity, should not be a problem as they are largely suspended, not dissolved, and thus will be partly eliminated during the filtration process. All other water quality parameters measured lie safely within R.F.C.L. with the exception of manganese, which ranges above the upper limit during periods of excessive stream flows, and hardness, which averages 16 mg/l.

Downstream of the proposed hatchery site to Kitimat Arm, the Kitimat River receives a number of industrial effluents and private outfalls (Table 4). Low ionic content is indicated by low values of specific conductance and hardness. In addition, elevated levels of N.F.R., total phosphate, colour, nitrate and nitrite combine to produce conditions unfavourable for salmonid culture. Temperatures may be elevated in the future as a result of effluent from a plant now being constructed. There is potential for the development of algal and bacterial blooms, as a result of these effluents, that would further degrade water quality in the lower portion of the Kitimat River.

Low pH and dissolved oxygen, and high N.F.R. and turbidity characterize the water (in 9 samples) from Beaver Creek, a tributary of Anderson Creek. Samples from Anderson Creek suggest high aluminum and mercury levels in soft water with very low calcium content, indicating this area to be unsuitable for fish culture (B.C. Ministry of Environment, 1979).

From one sample taken from the Kildala River, flowing into Kildala Arm of Douglas Channel, water quality is typical of this coastal area. The water is very soft with low ionic content. Below

Figure 9. Metal concentrations in the Kitimat River relative to discharge and suspended solids (at Haisla bridge, 1980) (Laboratory Services (EPS-FMS) Chemistry, 1980, Water Survey Canada, 1980).

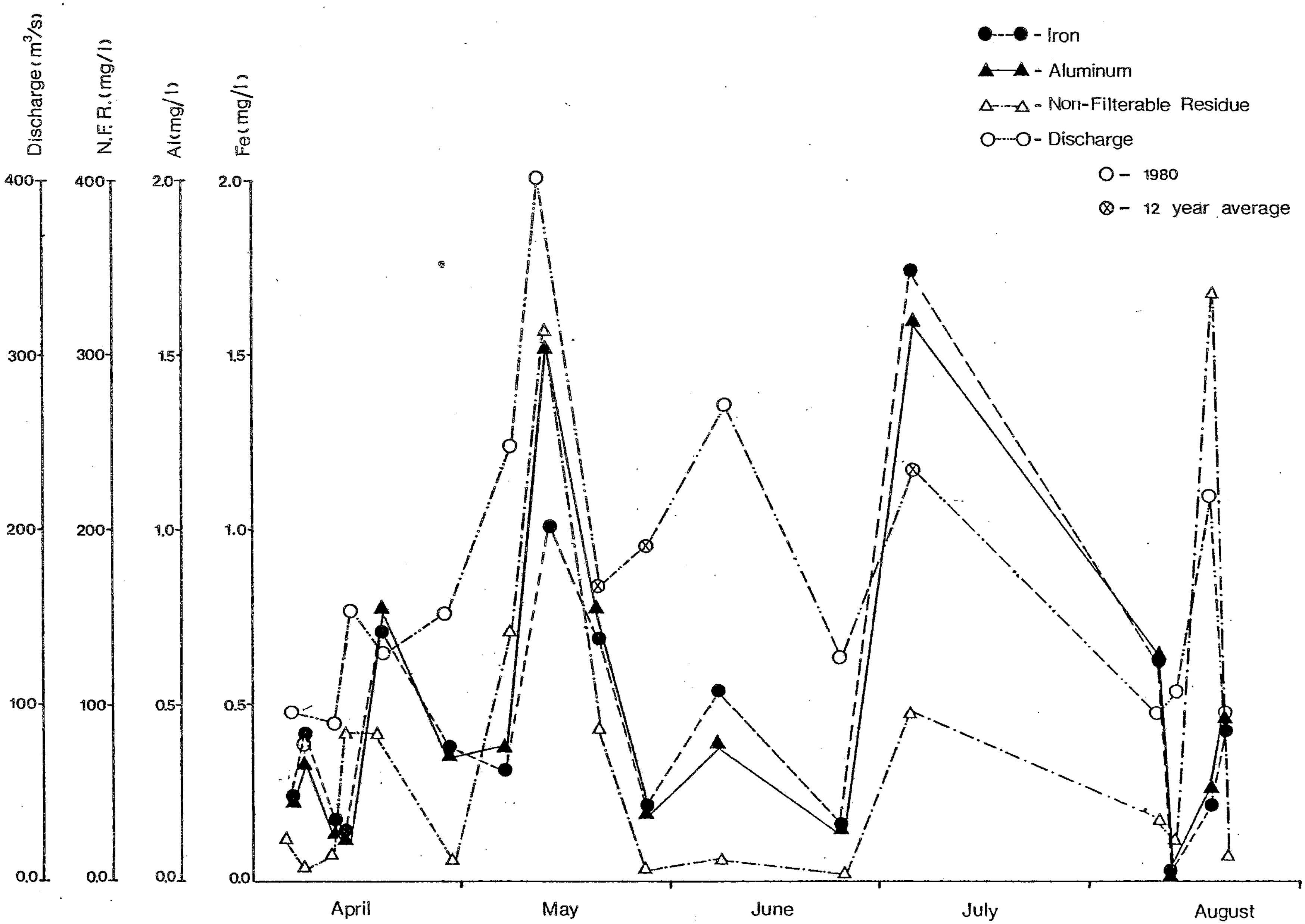


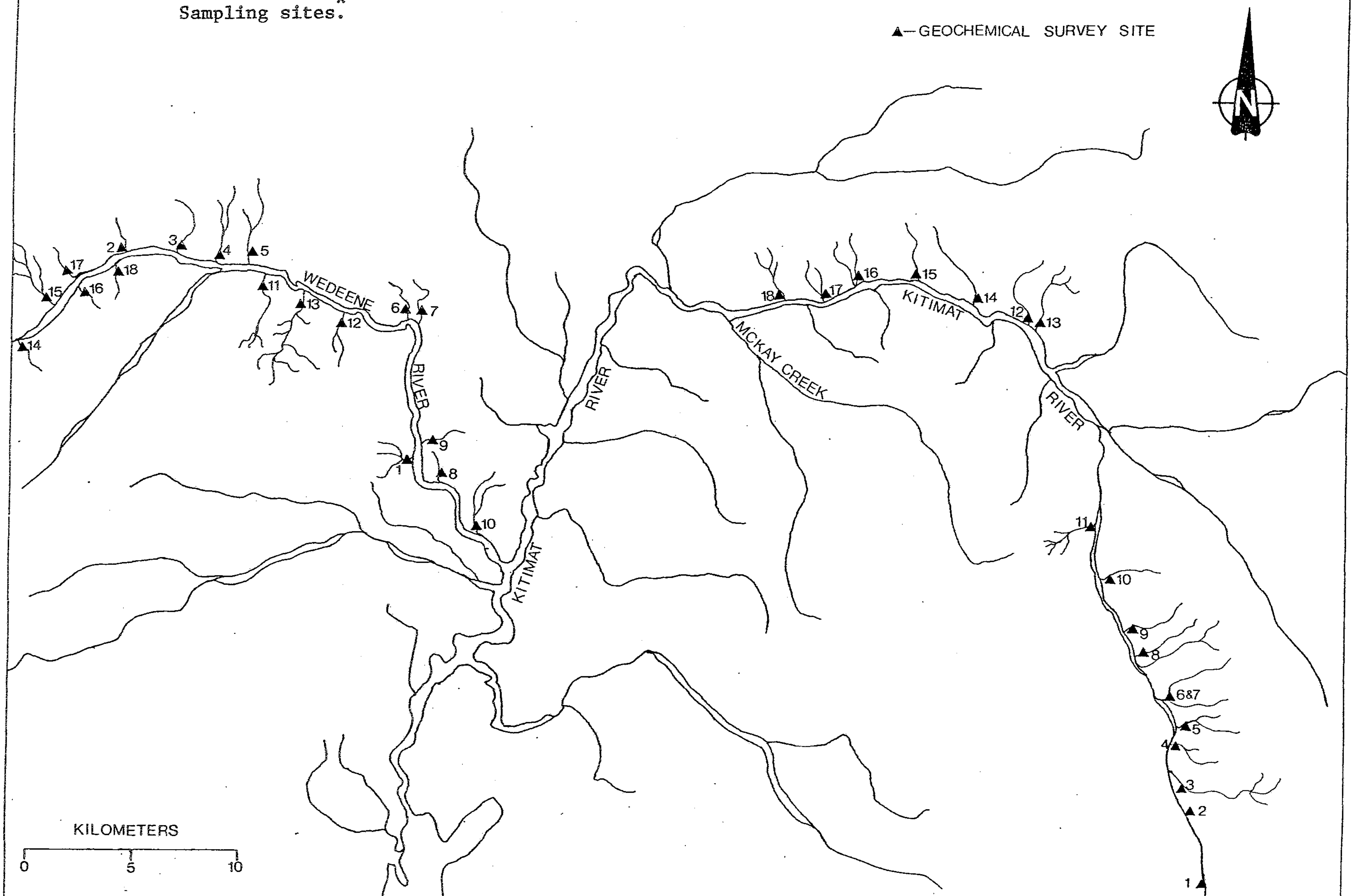
Table 4. Domestic and Industrial Effluent Sources on the Kitimat River System (B.C. Ministry of Environment, 1979).

	Location	Name	Map Location No.	Effluent
1.	Kitimat	District of Kitimat	2	Sewer Outfall
2.	Kitimat	Eurocan Pulp and Paper	1	Sewer Outfall
3.	Kitimat	Eurocan Pulp and Paper	15,16,17,18,19	Pond Leachate
4.	Kitimat	Ocelot Methanol	N/A	Unknown
5.	Kitimat	L.G. Scott	N/A	Sewer Outfall

neutral pH and low levels of calcium and total alkalinity combine to make the water very corrosive (I_S = 13.9). Aluminum, iron, and mercury levels exceed the R.F.C.L. In addition, N.F.R. concentrations probably range well above the upper limit for fish culture during periods of high flow. One water sample was taken from the Dala River on the same date as from the Kildala. Water quality was very similar to the Kildala, save that the water was slightly harder, and had lower levels of aluminum, iron, and N.F.R. (Laboratory Services (EPS-FMS) Chemistry, 1980).

Geological Survey of Canada (1978) surveys watercourses to characterize stream type and analyze stream sediment composition. Figure 10 illustrates G.S.C. sample sites, while appendix 3 summarizes the available data on the Kitimat drainage from this source.

Figure 10. Kitimat River watershed showing Geological Survey Canada Sampling sites.*



* See Appendix 3 A, B, and C for details

Groundwater

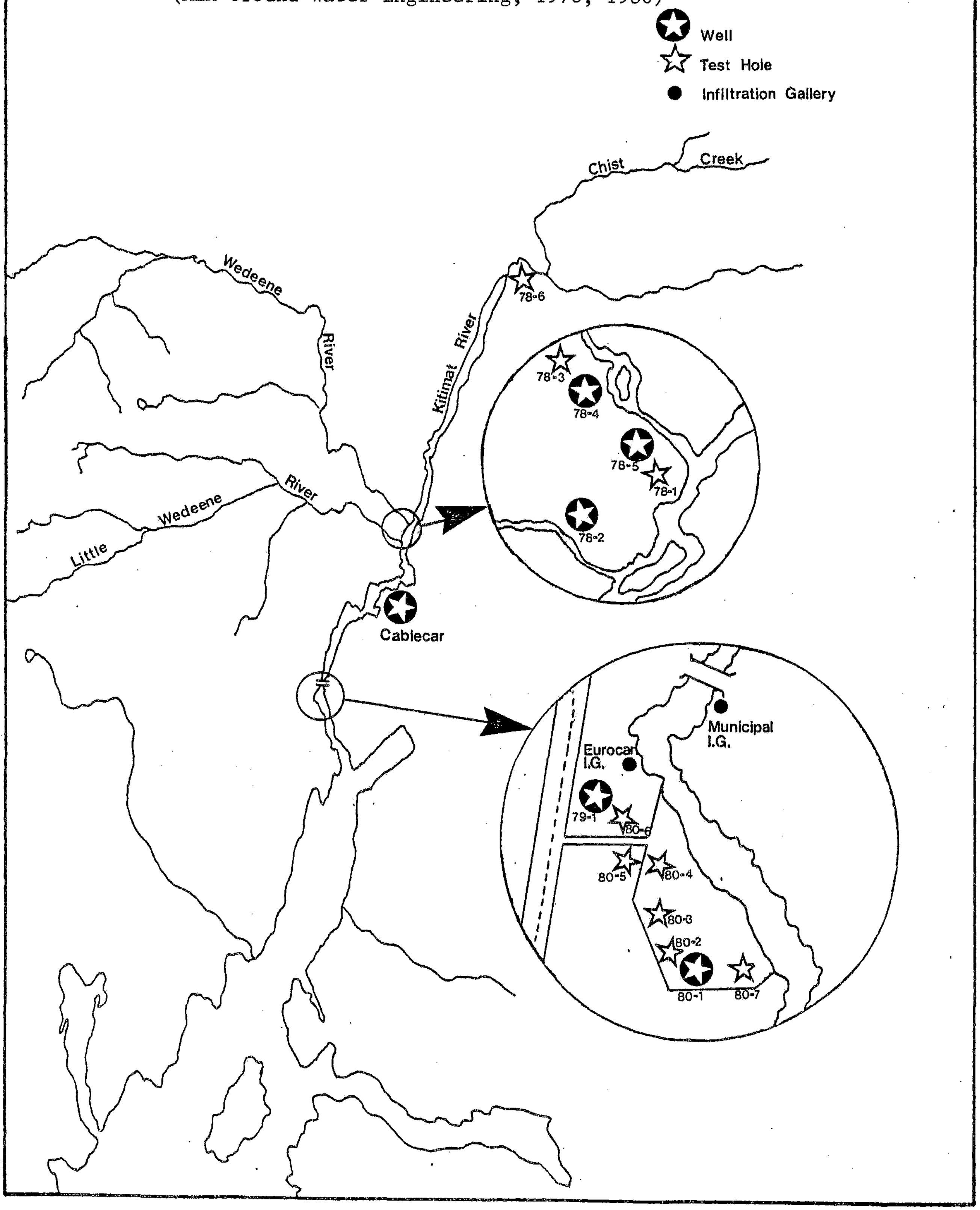
Groundwater is one of the earth's most widely distributed and most important resources. Groundwater exists wherever water penetrates beneath the surface the rocks beneath the surface are permiable enough to transmit this water and the rate of infiltration is sufficient that the rocks are saturated to an appreciable thickness (Walton, 1970). In the Kitimat River watershed extensive groundwater sampling has been done through testhole drilling and well development (Fig 11).

At Seventeen Mile Bridge, testhole 78-6 was drilled to examine groundwater potential in that area. The estimated maximum yield of this well was in the order of 26 gpm. Due to this low yield exploration was terminated in this locale. Little is known about the quality of water from this well but it is suspected to be high in iron content due to the staining of gravels on site (MLM Ground-Water Engineering, 1978).

Near the confluence of the Wedeene and Kitimat Rivers five testholes have been drilled, three of which were developed and assayed for water quality. The remaining testholes were completed for aquifer definition. The wells in this area yielded very soft water with high iron content (1.49-17.5 mg/l) and low pH (6.1-6.25). Marginally high ammonia (un-ionized) was present in wells 78-2 and 78-5. In addition, copper and zinc were at toxic levels in well 78-4 at the time of testing. Dissolved oxygen was extremely low in all three wells (0.5-1.1 mg/l).

In the Kitimat area, several attempts have been made to intercept groundwater through the construction of shallow wells and infiltration galleries. Analysis of this method of groundwater catchment was expedited through sampling of the Cablecar well, and the Eurocan and Municipal galleries.

Figure 11. Groundwater well location map for the Kitimat River hatchery site. (MLM Ground-Water Engineering, 1978, 1980)



The Cablecar well yields water unfit for fish culture. Soft water combined with low levels of pH, specific conductance, alkalinity and dissolved oxygen, and high levels of iron, total phosphate, manganese, copper, zinc, and non-filterable residues, contribute to the poor water quality. A trench was excavated from the river to within 10m of the well. The effect of the ditch was to increase yield and reduce the concentration of iron to levels generally below 0.3 mg/l (Sigma Resource Consultants Ltd., 1978).

The Municipal gallery, in which groundwater accounts for about one quarter of the total output during normal flow periods, has water of very similar quality to that from the Cablecar well (Table 5). The major difference is that iron and manganese levels are within R.F.C.L. in water from this source. The water from this gallery like water from the Cablecar well is highly corrosive.

Water obtained from the Eurocan gallery used for domestic consumption and for the pilot hatchery, generally, is of very good quality. The water is well buffered and is less corrosive than water from other sources. The only problems include slightly high total phosphate levels and low dissolved oxygen with high levels of nitrogen and argon.

On the proposed hatchery site, eight testholes have been drilled, two of which were completed as production wells (79-1 and 80-1). The remaining holes, valuable in aquifer definition, were either dry or abandoned due to low yield.

Production well 80-1 has water very similar in quality to Kitimat River water, which is its probable primary recharge source. The water is very soft, and has low pH and specific conductance. In addition, elevated levels of N.F.R., aluminum, iron and zinc contribute to water quality problems. Nothing is known about dissolved gasses in this water, but it is presumed that D.O. is low while N_2 + Ar is high. 80-1 should be capable of producing at a rate of 1510 lpm on

Table 5. Water Quality for Groundwater of the Kitimat River Watershed

Water Quality Parameter (mg/l)*	78-2+	78-4+	78-5+	Cablecar Well+	Municipal Gallery+	Eurocan Gallery+	KE-1 (79-1)++	80-1++
pH	6.4	6.3	6.3	5.85	6.55	7.40	8.0	6.4
F. Residue	76.0	42.3	36.0	28.0	25.0	141.0	103.1	34.5
N.F. Residue	25.7	4.4	≤10	1.3	1.3	0.7	≤5	27.0
S. Cond(microhms/cm.)	100.0	47.1	51.5	41.6	32.7	194	159.4	43.0
D. Oxygen				4.7	4.4	4.5	5.8	
D. Gases(N_2+Ar)(% sat.)							118.5	
Chloride	7.5	3.3	4.8	2.93	0.93	1.96	3.66	1.53
Turbidity				0.72	0.94	0.15	2.0	12.0
Hardness	22.1	15.5	12.9	9.48	12.3	85.7	70.7	17.5
Colour							< 5	
$NH_3 (\times 10^{-3})$	< 1.0	<1.0	<1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
$NO_2 + NO_3$				<.002	<.002	<.002		
T. Phosphate								<.005
Sulphate	5.1	4.25	2.09	0.2	0.2	2.3	15.6	4.27
Silica							4.78	3.31
Aluminum							< 0.9	0.23
Calcium	6.9	5.6	4.1	2.84	4.15	31.3	25.4	5.93
Copper	0.004	0.016	0.001	0.007	0.022	0.005	0.015	.002
Iron	16.1	1.11	2.70	0.36	0.10	< .03	0.18	.35
Manganese	0.31	0.30	0.20	< .001	0.006	.006	<.003	.024
Lead				.015	<.001	<.001	<.001	<.001
Zinc	0.054	0.012	0.004	.060	0.006	0.005	0.006	.009
Temperature Range (°C)	5.8-7.0	5.6-8.0	5.4-6.5	12	12	9	6.0-6.5	

* except where otherwise defined
___ mean value exceeds R.F.C.L.
_ _ range extremity(ies) exceed R.F.C.L.

a continual basis (MLM Ground-Water Engineering, 1980).

Produciton well 79-1, better known as Well KE-1, produces water of very good quality. The river is not the primary recharge source of the aquifer tapped by KE-1, but rather a harder, better buffered source, as indicated by specific conductance, hardness, filterable residue and total alkalinity data (MacKinlay, 1980). The only problems include N.F.R. and specific conductance ranging outside R.F.C.L., and dissolved gasses (O_2 = 47.3% of saturation) at levels typical of groundwater exposed to reducing conditions. Thus, aeration is a necessity before this water can be used for incubation or rearing (Laboratory Services (EPS-FMS) Chemistry, 1980). It appears as if this well could produce only at a rate of 2270 lpm over the long term, while maximum groundwater requirements would be at least 10,870 lpm (Morris, 1980), if 15.6×10^6 eggs were the final production goal (the reamining 8600 lpm will be supplied as filtered river water). Over the sampling period, the water temperature of this well has remained relatively constnat at 6.0-6.5 ^{o}C. It is not known what the effect of constant pumping at capacity will be on the present temeprature regime or the buffering capacity of water from this source.

Estuarine Water

The following highlights are taken from a detailed summary of oceanographic data available for the Kitimat River estuary. (Bell and Kallman, 1976).

The major source of adverse effects on water quality appears to be the use of Minette Bay for log storage facilities (Paish, 1974). Probable effects include low dissolved oxygen, increased B.O.D. and elevated levels of leached chemicals, such as tannins.

Other sources of water contaminants include the Alcan outfalls, the Alcan docking facilities, and the Kitimat River. Of these, the Kitimat River probably has the most pronounced effect on the estuary ecosystem. This is due to the heavy sediment loads carried by the river during periods of high precipitation. These suspended solids increase turbidity to the extent that photosynthesis is retarded in some areas of the estuary.

Owing to the possibility of Kitimat becoming an oil port, there is a substantial risk of oil spills in the area. Such spills would have catastrophic effects on salmon populations, as crude oil is toxic to juvenile salmonids (McKay, 1978). The effects of a spill would be very much dependent on location, weather, time of year, and current and tidal patterns.

An exhaustive study by Dobrocky Seatech Ltd. (Webster, 1980), has attempted to elucidate the physical oceanography of the Kitimat area. Included are studies on estuarine circulation, the response of Douglas Channel to meteorological forces and temporal variations of the barocline tide in Douglas Channel. In addition, a tidal circulation model is presented.

POLLUTION POTENTIAL

Four major sources of pollution are known in the Kitimat area. These include Alcan Smelters and Chemicals, Eurocan Pulp and Paper, the District of Kitimat and the Ocelot Methanol plant. Of these, the first three have been monitored, and their effluents assayed for water quality. The fourth, Ocelot Methanol, is in the process of construction and could create new and interesting problems in the Kitimat River.

The standard method for the industrial production of methanol involves the reduction of carbon monoxide (CO) under conditions of high temperature (350-400^{o}C) and pressure (200-270 atm). In this process, Cr_3 and ZnO are used as catalysts (Morrison and Boyd, 1965). Thus, thermal pollution is probably the most pressing problem, as river water is used as a coolant.

This problem of thermal pollution is greatest during periods of low flow (Jan-Mar) (owing to decreased dilution rate) and during periods of elevated river temperatures with only moderate late summer flows. Associated problems could include low dissolved oxygen levels, blooms of filamentous blue-green and green algae, elevated B.O.D. (due to bacterial metabolism), increased toxicity of pollutants and promotion of fungal growth. Continued monitoring of the lower Kitimat River should reveal the extent of the environment impact of continued industrialization in this region.

WATERSHED TEMPERATURES

Kitimat River

Water temperatures were recorded by Water Survey of Canada (1977) on the Kitimat River at a site just below Hirsch Creek (Figure 12). Using data collected from spot observations from 1964 to 1976, this site has a range of temperature of 0.5-12^{o}C over an average year (App. 4a). The upper temperature peak usually occurs in early July, while the months of December, January and February usually have temperatures in the 0-1^{o}C range. The average monthly temperature is within the recommended limits for fish culture (2-18^{o}C) from April to October. Extremes during these months range from 3^{o}C (April) to 12^{o}C (July).

Hirsch Creek

On Hirsch Creek, water temperatures were recorded by Water Survey of Canada near its confluence with the Kitimat River. Temperatures range from 0-21^{o}C over an average year (Table 6, App. 4b). The summer peak is usually reached in late July, while during the winter months (December-March) the river has water temperatures ranging from 0.0-0.5^{o}C. The average monthly temperature is probably within R.F.C.L. from April to October, with extremes during this period ranging from a low of 2^{o}C in April to a high of 21^{o}C in July. However, the latter figure is probably not very representative as only one reading has ever been made for the month of July. Extrapolations from the available data would indicate that an average July water temperature would be in the order of 7-13^{o}C, well within R.F.C.L.

Little Wedeene River

A site just below Bowbyes Creek was selected by Water

Figure 12. Kitimat River Water Temperature Sites.
(Water Survey Canada, 1977)

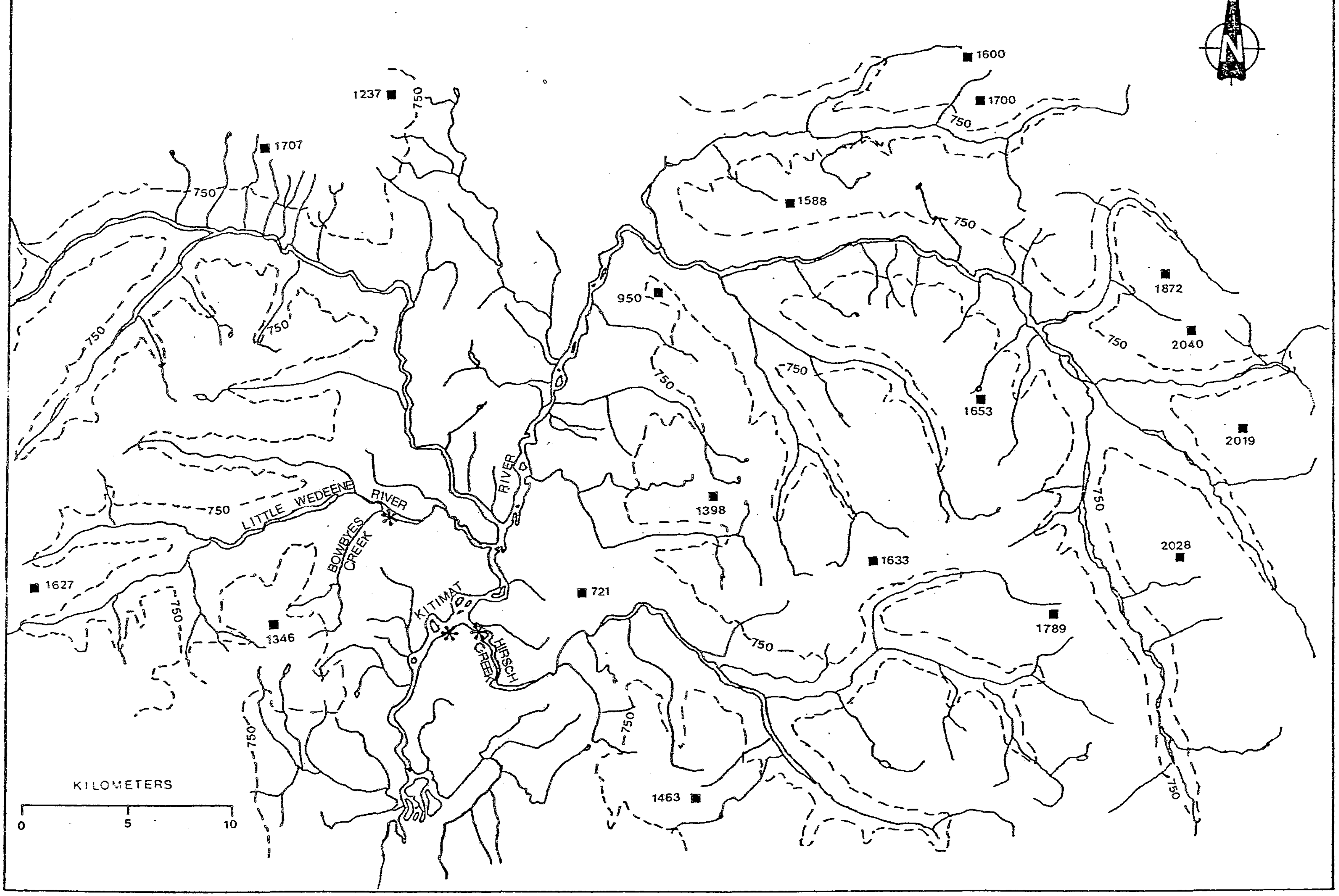


Table 6. Average Monthly Water Temperatures (^{o}C)

Month	Kitimat River (below Hirsch Cr.)	Hirsch Creek (near the mouth)	Little Wedeene R. (below Bowbyes Cr.)
Jan	0.5	0.5	0.6
Feb	1.7	1.1	2.2
Mar	1.5	1.1	1.2
Apr	3.7	3.2	5.7
May	5.3	6.4	6.1
Jun	6.3	6.1	5.9
Jul	10.3	21.0	10.7
Aug	10.0	9.5	9.0
Sep	9.7	9.2	8.1
Oct	6.6	5.7	6.6
Nov	1.5	1.8	2.4
Dec	1.8	0.3	2.3

Survey of Canada to record water temperatures for the Little Wedeene River. The temperature range over an average year at this site is 0-18.5 $^{\circ}$C (App. 4c). The months of November, December and January often record water temperatures hovering around the 0 $^{\circ}$C mark, while the warmest temperatures have been recorded in mid-late July. The recommended limits for fish culturing are satisfied (using monthly mean temperatures) from April to December, with extremes in these months ranging from 0 $^{\circ}$C (mid-December) to 18.5 $^{\circ}$C (late July). Again, this upper extreme has been recorded only once, and extrapolations from available data would suggest that readings of 5-13 $^{\circ}$C would be more probable in an average year.

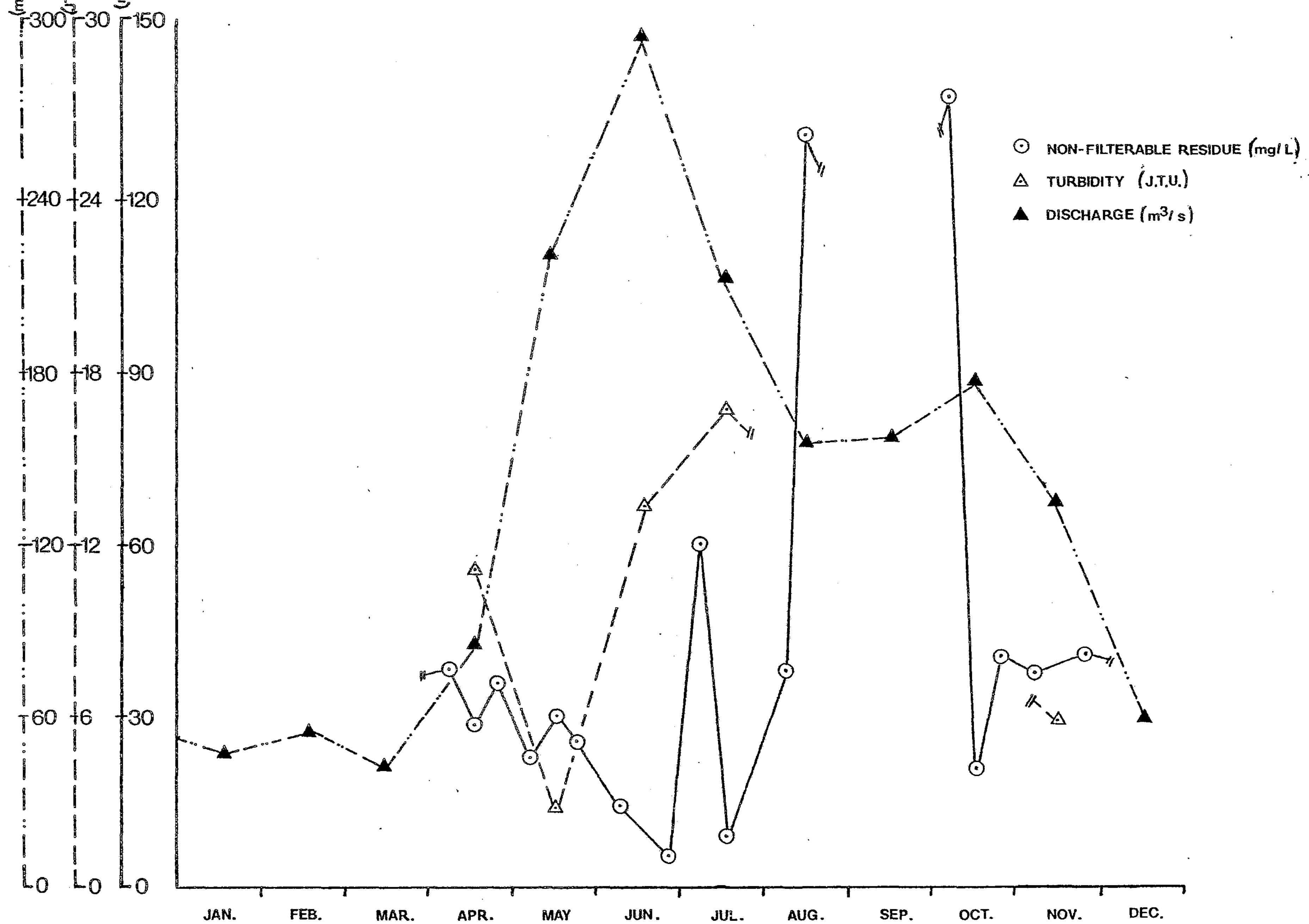
SEDIMENT LOADS

Using N.F.R. (Laboratory Services (EPS-FMS) Chemistry, 1980) as a relative index for sediment loads in the Kitimat River, there is some basis for concern with respect to fish culture. Changes in discharge cause fluctuations both in the amount of sediment entering the flow (due to erosion) and in the amount of sediment suspended in the flow (due to increased water velocity). This problem has been magnified in recent years due to extensive deforestation in the watershed. The problem should subside as stream banks begin to stabilize with new growth.

Peaks in N.F.R. occur in mid-May and mid-August up to 350 mg/l (Figure 13). Heavy rains in the autumn months produce similarly high sediment loads.

Some analysis of particle size has been done on suspended sediment, and a summary of this data can be found in a recent technical report by Hilland, et al, 1981.

Figure 13). Water Quality parameters of the Kitimat River at Haisla Bridge (Water Survey Canada, 1974., Laboratory Services (EPS-FMS) Chemistry, 1979-80)



PAST BIOPHYSICAL STUDIES

The biophysical aspects of the River watershed and estuary have been studied rather extensively. Data from the following sources have been summarized (where applicable) in the appropriate sections of this report.

Baseline biological data collection has been good in the watershed and estuary, Kussat (1668) conducted an intertidal survey in the promimity of the present Eurocan effluent outfall. This study provided comparative data for later studies on the environmental impact of the Eurocan mill (Derksen, MS 1980). Similar biobaseline studies by Beak (1974) on the Kitimat River, and Paish (MS 1974), Hay (MS 1976), and Levings (1976) on the Kitimat estuary, provide a data base for assessment of the environmental implications of development in the region, as well as being useful is assessing fisheries potential in the area.

Birch, et al (MS 1981) investigated downstream migrations and rearing distributions of juvenile salmonids. Additional information on salmon biology has been contributed by Hilland, et al (1981) in their summary of chinook salmon studies in the Kitimat valley (included are results of the pilot hatchery operations).

An overview of environment knowledge to 1976 has been presented by Bell and Kallman (1976). The report addresses such concerns as land and water use, pollution and water quality, physical characteristics and floral and faunal resources.

Planning studies for additional development of the Kitimat area have been prepared by the Corportation of Kitimat (1976), for neighbourhood planning and by Swan Wooster Engineering Ltd., (1977) for development of major port faiclities. McKay (1978) examined the potential impact of oil spills if Kitimat was utilized as a major oil port.

SPECIES COMPOSITION AND PREDATORS

According to F381 biological observations (App. 7b) the predators on Kitimat salmon include bear, wolves, eagles, seals, dogs, and humans. Other predators include small mammals (such as mink, otter, and marten, etc.) and wildfowl, which probably utilize other salmonid and non-salmonid species as well as juvenile salmon. The following is a list of the species of fish reported to be in the Kitimat watershed.

Table 7. Species composition of fishes in the Kitimat Watershed. Adapted from Bell and Kallman, 1976.

SCIENTIFIC NAME	COMMON NAME
Oncorhynchus gorbuscha (Walbaum)	pink salmon
O. keta (Walbaum)	chum salmon
O. nerka (Walbaum)	sockeye salmon
O. tshawytscha (Walbaum)	chinook salmon
O. kisutch (Walbaum)	coho salmon
Salmo clarki clarki (Richardson)	coastal cutthroat trout
S. gairdneri (Richardson)	steelhead and coastal rainbow trout
Salvelinus malma (Walbaum)	Dolly Varden char
Cottus asper (Richardson)	prickly sculpin
Cottus aleuticus (Gilbert)	Aleutian sculpin
Gasterosteus stenolepis (c.f. aculeatus) (Linnaeus)	threespine-stickleback
Lampetra sp.	lamprey

GENERAL WATERSHED RECONNAISSANCE

Overview reconnaissance of the Kitimat River watershed was undertaken by R.M.J. Ginetz and O. Rapp (1980). The area surveyed in this region can be seen in Figure 12.

In order to identify particular river systems and specific sites for salmonid enhancement opportunities, aerial (August, September, 1980) and ground bio-engineering reconnaissance surveys were conducted at key times of the year.

General surveys were conducted to obtain information on stream locations and to evaluate their potential for enhancement. Topographical features of the watershed, vegetation types, drainage and areas, and stream characteristics have been studied. Other criteria established to evaluate enhancement potential were water quality and quantity, road access, power availability and gravity supply potential that could be developed on site. Some of these criteria are discussed in greater detail in their appropriate sections of this report.

In 1977, a potential hatchery site was located on the Kitimat mainstem between the mouths of the Wedeene and Little Wedeene Rivers. The site was physically sound, as access is good, there is good potential for development of a surface water supply, and the topography is such that a site could be cleared and developed with relative ease. In addition, it is located far enough upstream to allow the sport fishery access to migrating salmonids. Test drilling, however, indicated that groundwater in the area was unacceptable due to high iron levels (Laboratory Services (EPS-FMS) Chemistry, 1980), and therefore, the site was abandoned.

The area located near Seventeen Mile Bridge has good access and hydro availability. There is, however, no good site utilizable

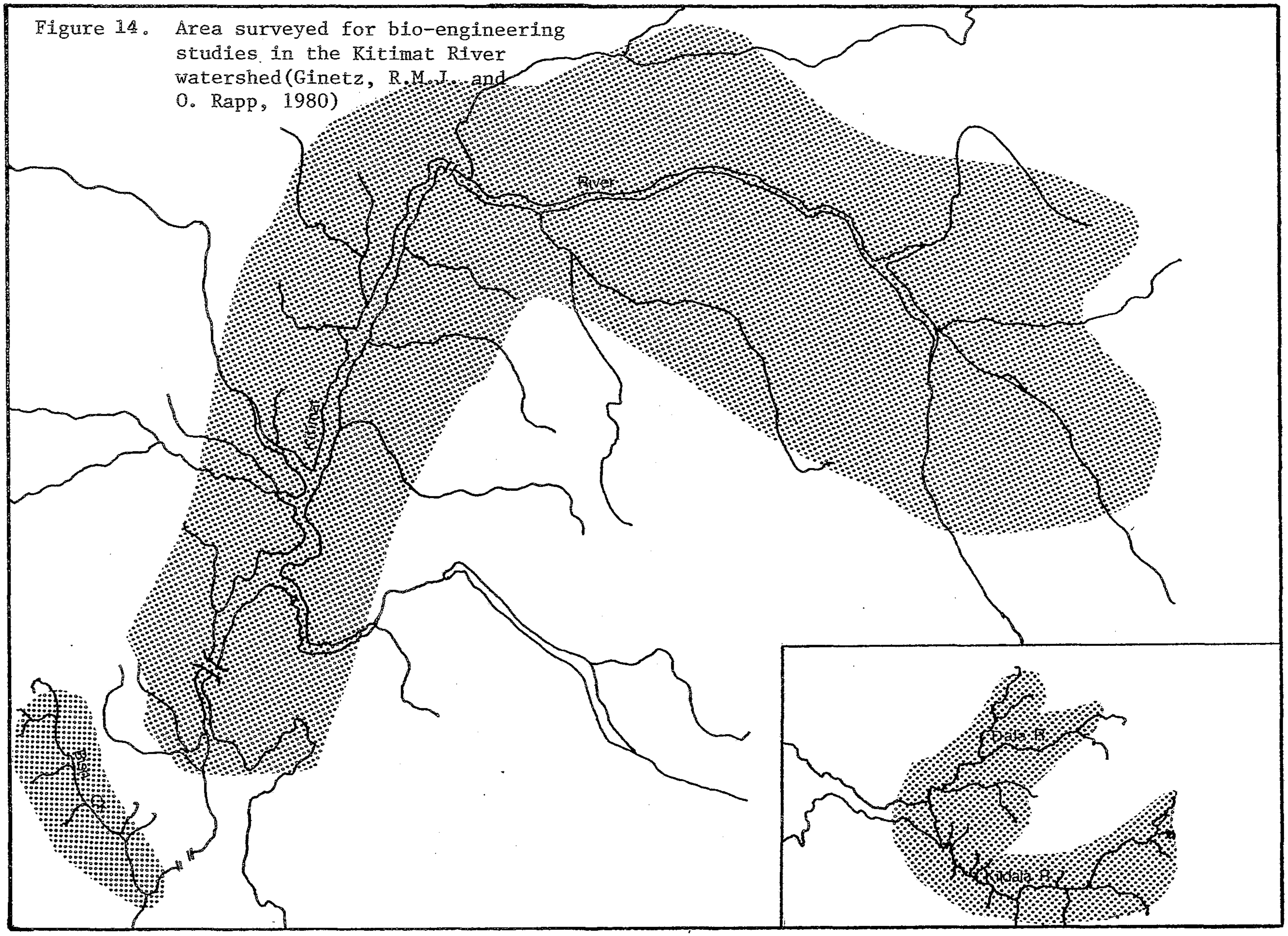


Figure 14. Area surveyed for bio-engineering studies in the Kitimat River watershed (Ginetz, R.M.J. and O. Rapp, 1980)

for construction (due to substrate instability) or a surface water gravity supply. In addition, aquifer testing indicated extremely limited sub-surface water resources.

Due to the logistical attractiveness and the acceptable water quality of the Eurocan potable supply (infiltration gallery) it was decided to locate a pilot chinook salmon hatchery on that site in 1977 (R. Hilland, pers. comm.). Test drilling on the Eurocan site located two distinct aquifers, one of which produced water of good quality. The temperature of water from this well was reported to be 6.0 to 6.6°C. Pump-testing has revealed that the aquifer should yield water at a rate of 2270 lpm. The surface water supply at the Eurocan site is adequate, but will require filtration before use in enhancement facilities. In addition to the thermal advantage realized through the use of groundwater, surface water could be heated using waste heat from the nearby Ocelot Methanol plant or the Eurocan pulp mill. A major disadvantage of the Eurocan site is that it is located near the mouth of the Kitimat River, which may interfer with the imprinting and homing responses of the upstream donor stocks.

SALMON RESOURCE

Escapement and Spawning

Timing

The Kitimat watershed supports all five species of salmon native to the eastern Pacific coast. Of these, chinook salmon are the first to enter the river. Escapement usually begins in May, and potential spawners remain in holding areas until they are ripe enough to commence spawning activities. The period of peak spawning usually occurs between August 5 and 25 (Table 8).

The early arrivals of the chum, pink and sockeye salmon runs have historically appeared at the end of June. Spawning begins in mid to late July for chums and pinks, and the peak spawning date for both species is around August 9. Sockeye salmon start spawning about August 12, with peak spawning activity usually observed two weeks later.

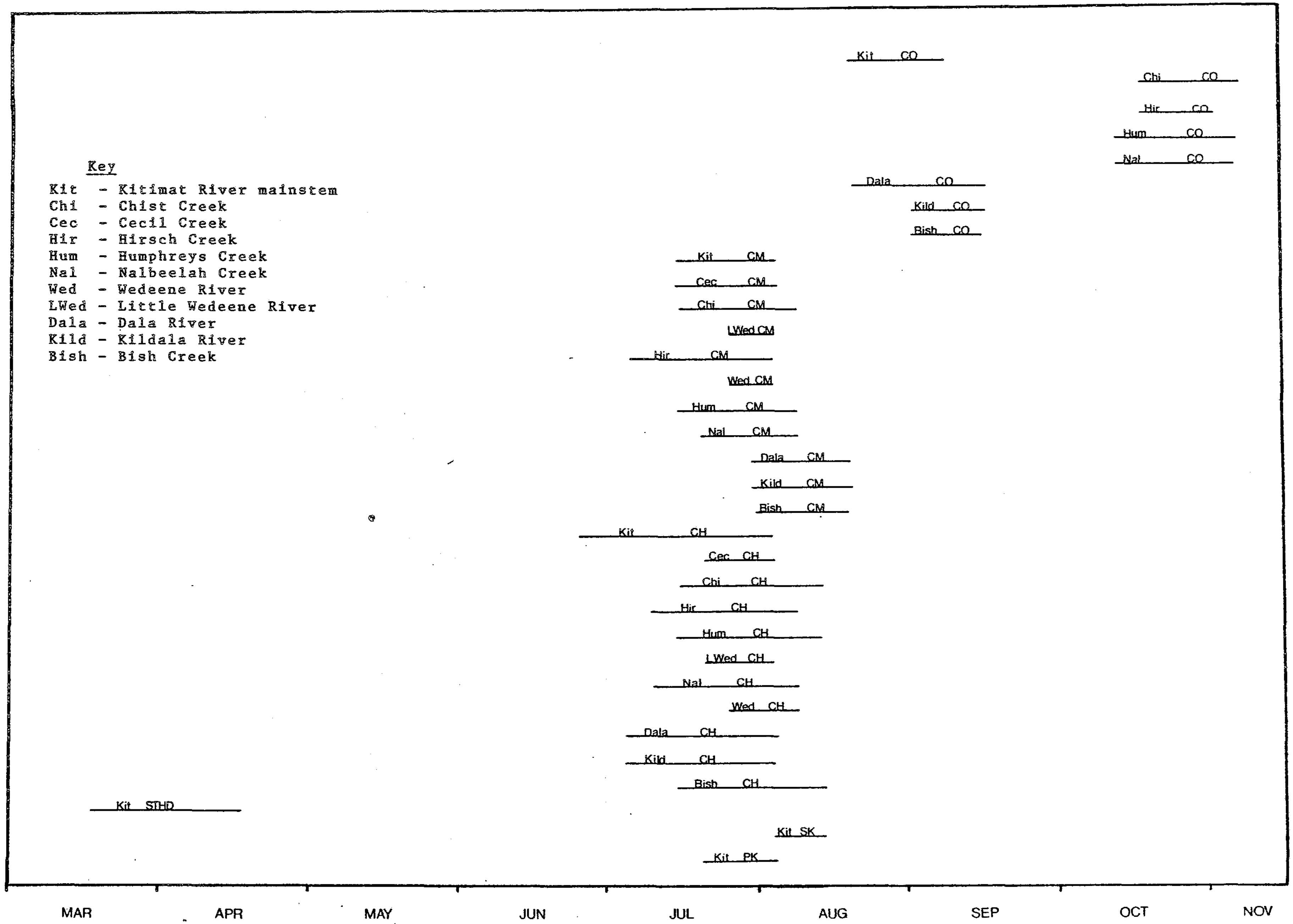
Coho is the last species of salmon to enter the Kitimat system (mean arrival date of September 1). Spawning does not begin until late September, however, it may continue throughout the fall to December 15 in some years. Figure 15 represents the relative timings (arrival date to start of spawning) for Kitimat and Kildala Arm salmon stocks.

The escapement and spawning timings for salmon returning to the Kitimat tributaries, Bish Creek and the Dala and Kildala Rivers are summarized in (App. 6a, b, and c). The similarity of the Kitimat River and Kitimat Arm tributary migration timings has necessitated the inclusion of Kitimat Arm stocks in the tentative Kitimat enhancement strategy. This should guarantee stock integrity when commercial fishing pressure is directed on the enhanced runs.

Table 8. Summary of F381 Information on Timing of Kitimat River Spawners (1953 - 1980).

SPECIES	PERIOD	START		PEAK	END	
		earliest	latest	average	average	latest
CHINOOK	1953-1980	Jun 15	Aug 15	Aug 15	Sep 5	Sep 15
COHO	1965-1980	Aug 25	Oct 25	Nov 5	Nov 30	Dec 15
SOCKEYE	1965-1980	Aug 5	Aug 20	Aug 25	Sep 15	Sep 30
PINK	1967-1980	Jul 15	Aug 15	Aug 8	Sep 3	Sep 15
CHUM	1967-1980	Jul 15	Aug 15	Aug 9	Sep 18	Oct 15
STEELHEAD	1967-1972	Mar 15	May 1	Apr 15	May 10	May 30

Figure 15. Arrival date to start of spawning for Kitimat and Kildala Arm stocks(1958-1980)
(From F381 Spawning Files).



Distribution

Salmon spawning in the Kitimat River watershed extends from the mouth of the mainstem to approximately 53km upstream, and encompasses most of the tributaries to the mainstem. The F381 spawning files suggest a range for each species (Fig. 16-25), and it is assumed that the considerable variation occurs yearly as a result of changes in water temperatures, streamflows, etc.

Kitimat River chinooks utilize areas from Hirsch Creek to the 50km mark of the river. Most annual reports indicate spawners above the Highway 25 bridge, and in 1968 it was reported that 70% of them used areas above Humphrey's Creek for egg deposition. Chinooks also utilize all tributary streams for which spawning files are prepared. Although spawners are found in the Dala and Kildala Rivers, Bish Creek no longer holds chinooks (Appendicies 6a, b & c).

Kitimat River coho spawning has been observed from 5 to 53km from the mouth of the river. The majority of mainstem spawners are found above the Highway 25 bridge. Although the mainstem is used by many coho, most utilize upper portions of tributary streams for spawning activities. Coho spawners use the mid-upper sections of Bish Creek, and the Dala and the Kildala Rivers for egg deposition.

Chum salmon in the Kitimat mainstem spawn from the mouth to the 40km mark of the river. The lower 14km is heavily utilized, as are the first 4-5km downstream of the Highway 25 bridge. Mainstem spawners prefer side channels and heavy gravel. Chum also use the mid-lower sections of tributary streams for egg deposition. Spawning chums can be found in the mid-lower sections of the Kildala and Dala Rivers and Bish Creek.

Kitimat pinks have historically utilized areas from the confluence with Humphreys Creek to the tidal areas of the mainstem for spawning activities. The largest concentration of spawners exists below Haisla bridge. In addition, the first 4-5km of the lower tributaries are utilized for egg deposition. Pink salmon can also be found spawning in the lower portions of Bish Creek and the Dala and Kildala Rivers.

The only location that sockeye salmon have been observed spawning in the Kitimat mainstem is just below its confluence with Hunter Creek. In 1969, 25 sockeye were observed spawning in the Little Wedeene River. Hirsch, Humphreys and Chist Creeks reportedly had a few sockeye spawners in 1980.

Figure 16. Distribution of spawners in the Kitimat River mainstem(F381 Spawning Files).

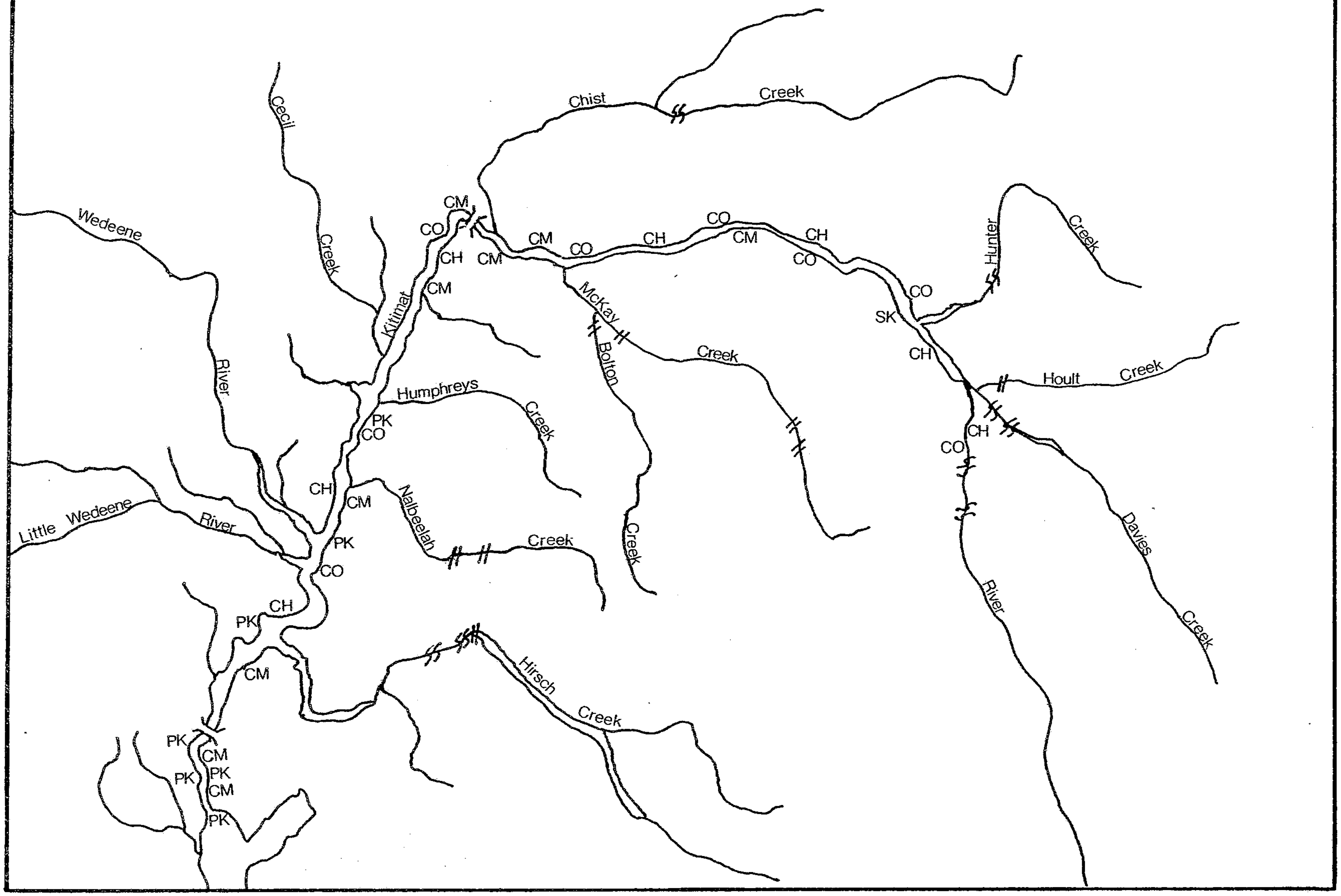


Figure : 17. Distribution of spawners in Hirsch Creek(F381 Spawning Files).

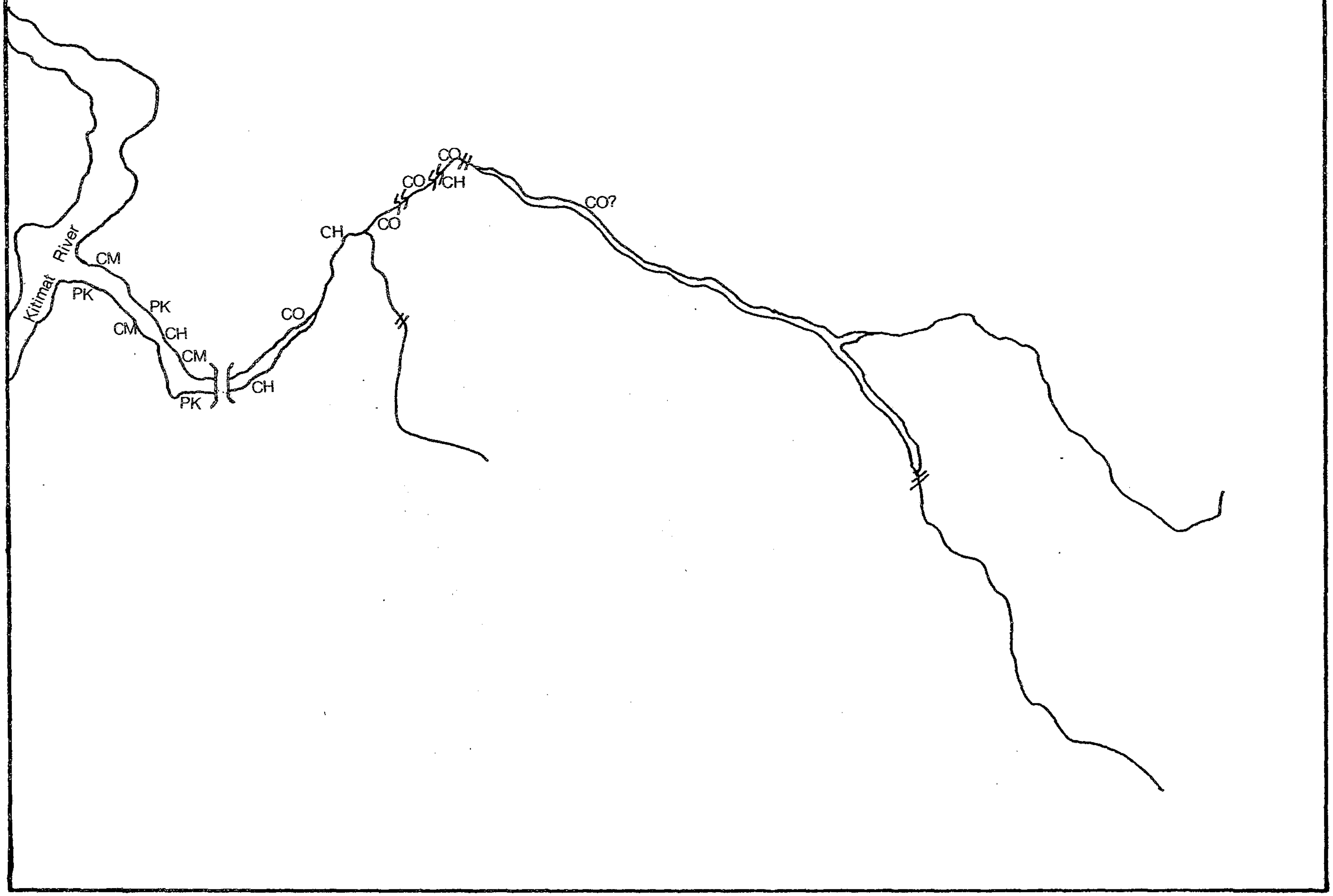


Figure 18. Distribution of spawners in the Wedeene River (F381 Spawning Files).

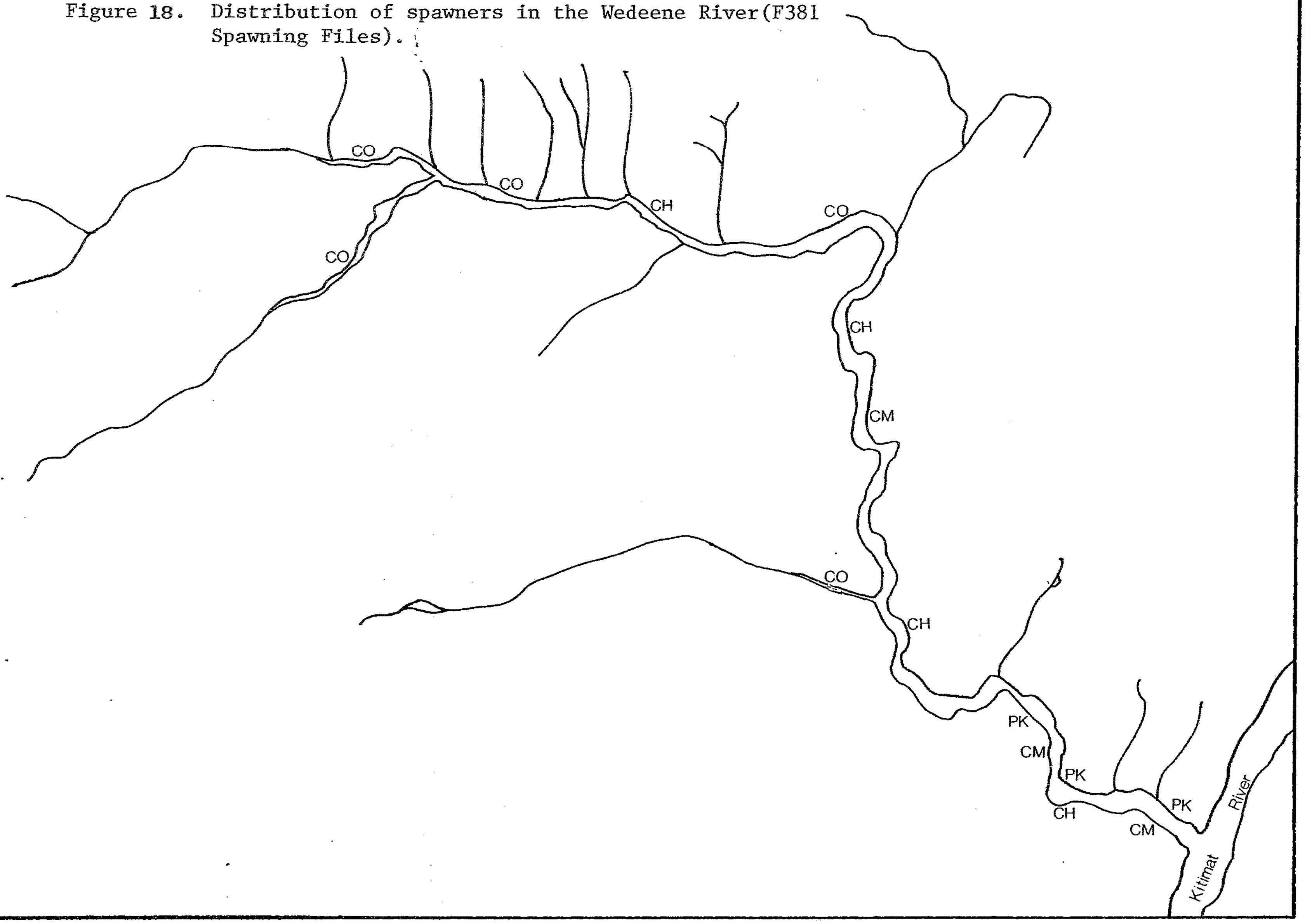


Figure 19. Distribution of spawners in the Little Wedeene River (F381 Spawning Files).

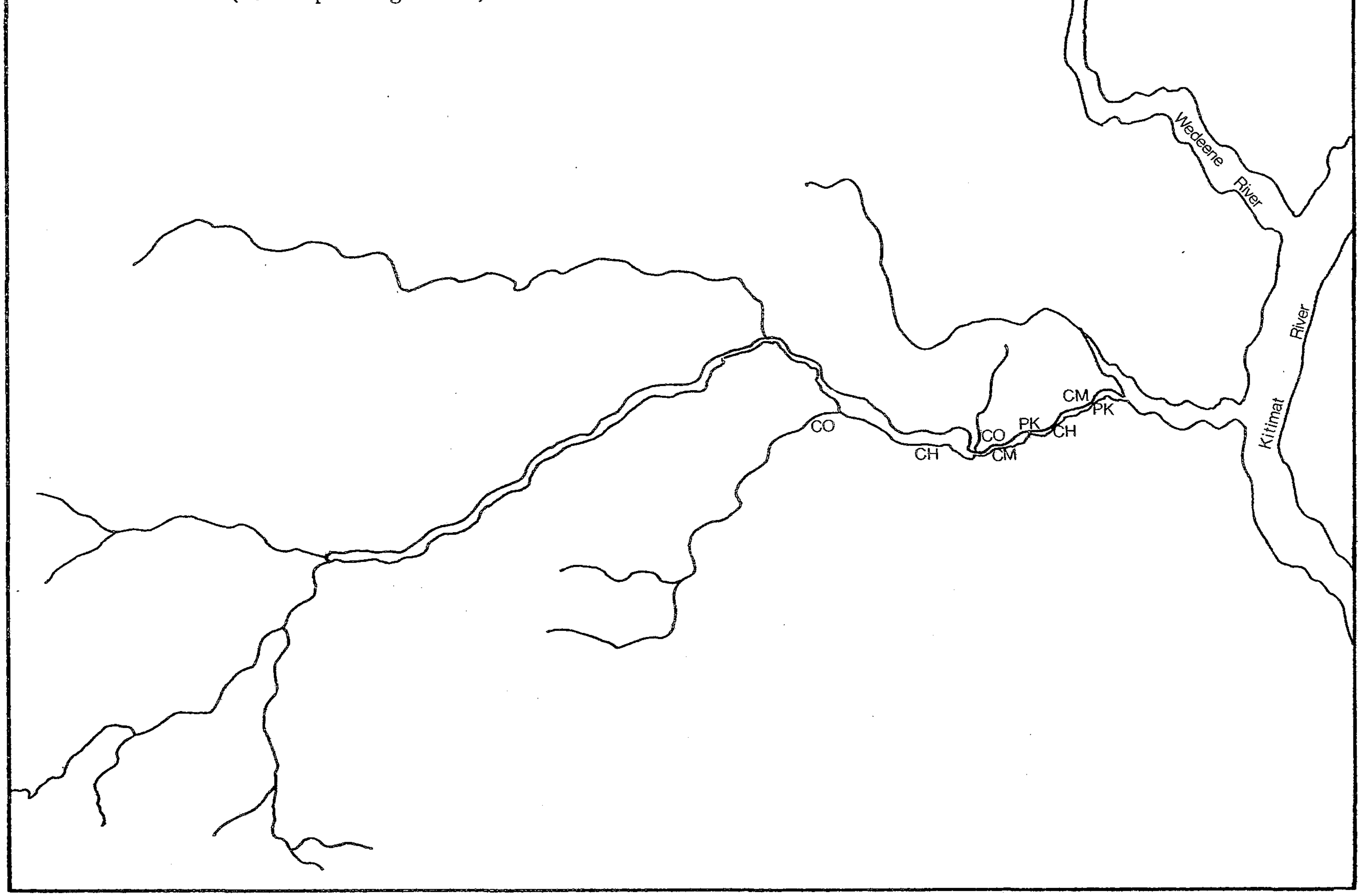


Figure 20. Distribution of spawners in Nalbeelah Creek(F381 Spawning Files).

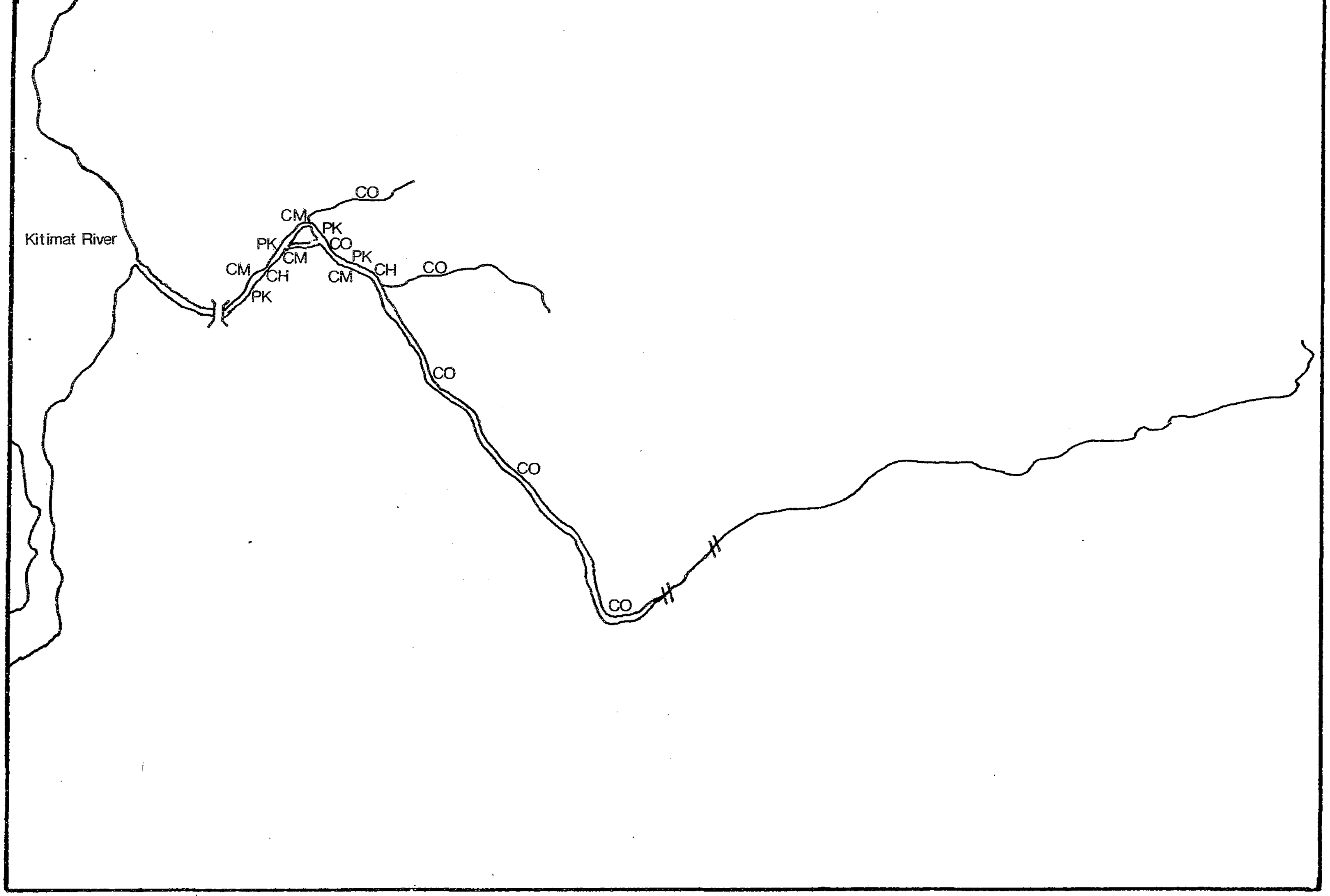


Figure 21. Distribution of spawners in Humphreys Creek(F381 Spawning Files).

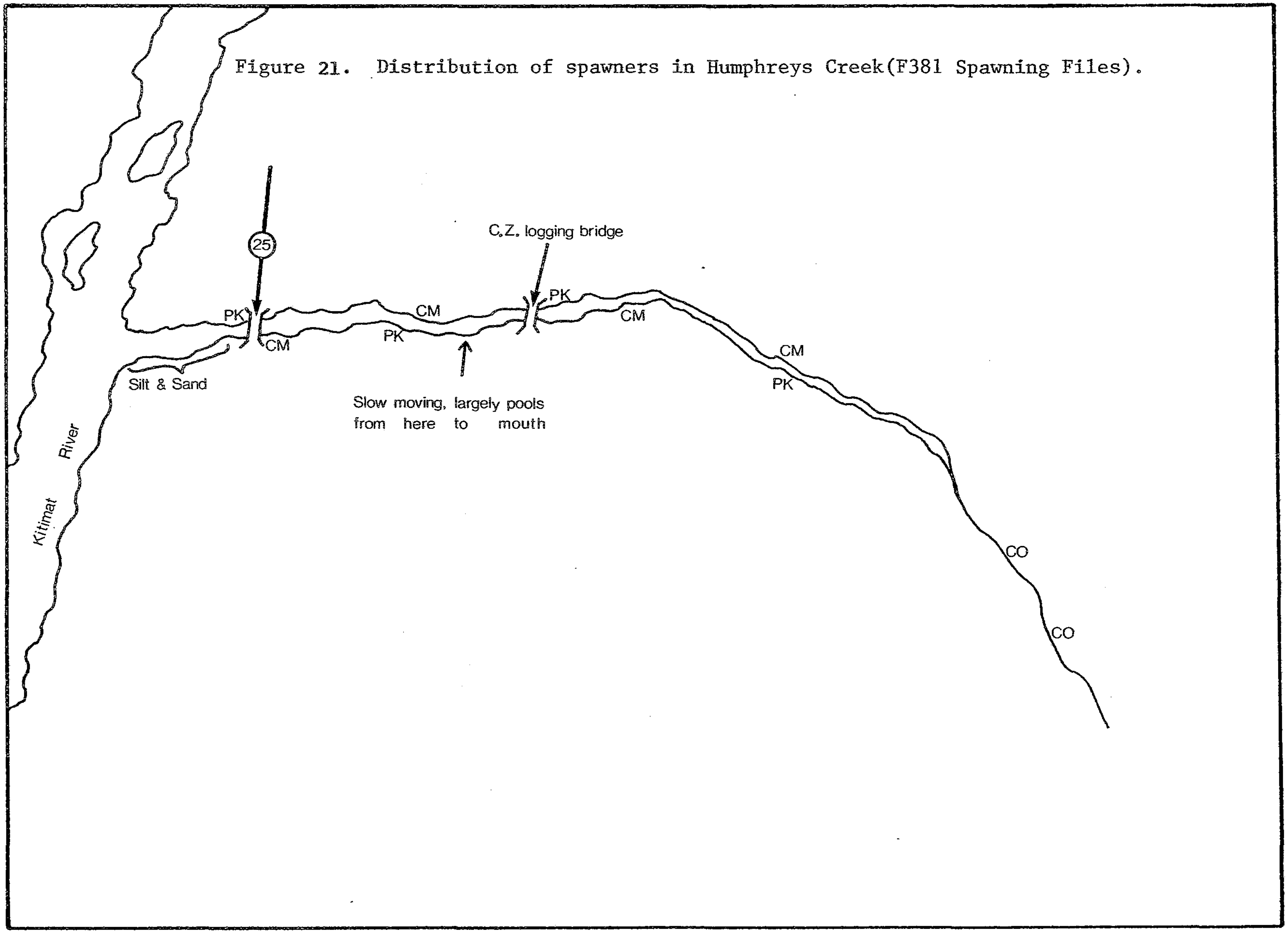


Figure 22. Distribution of spawners in Chist Creek(F381 Spawning Files).

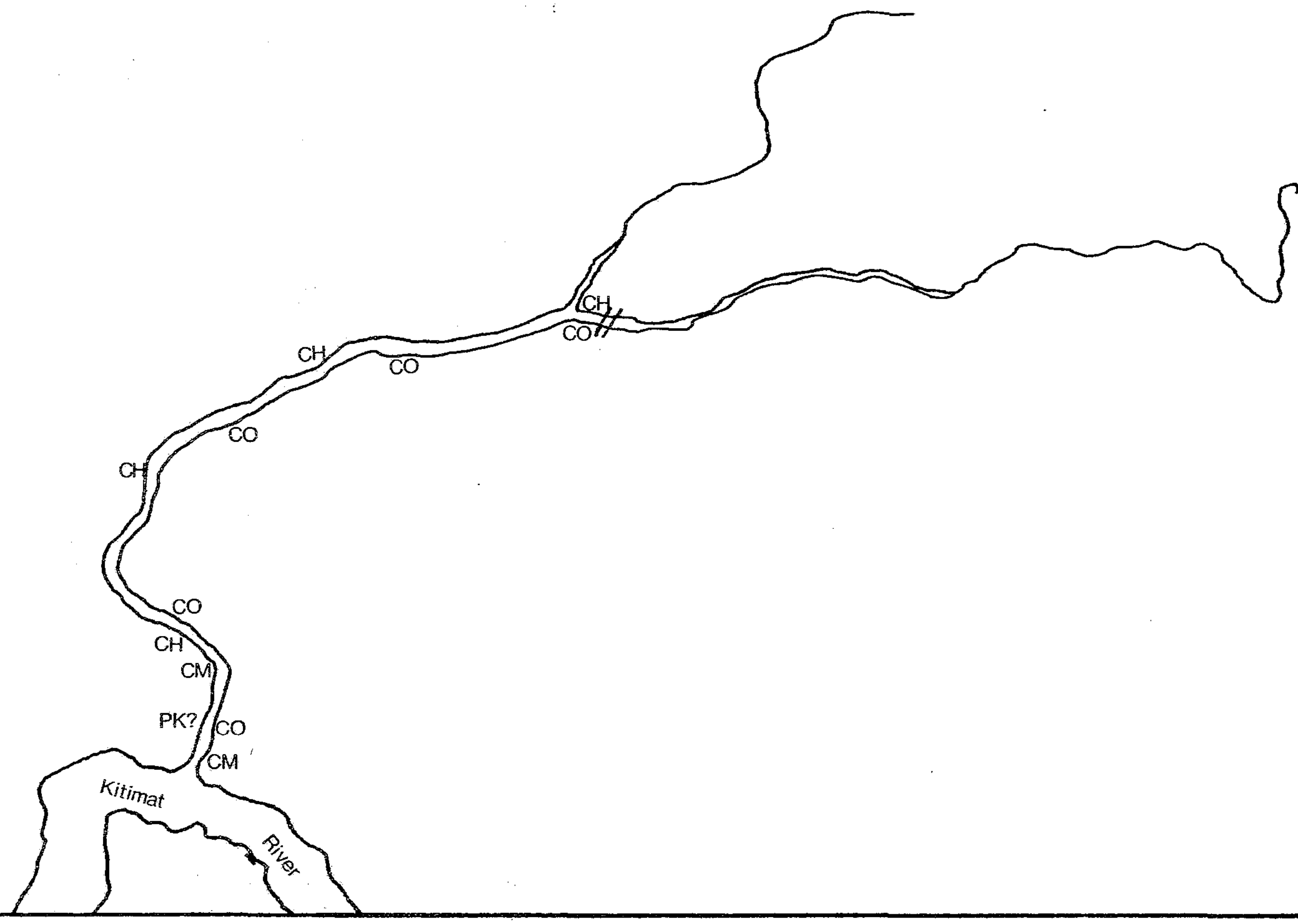


Figure 23. Distribution of spawners in Bish Creek(F381 Spawning Files; S. Barnetson, pers. comm.).

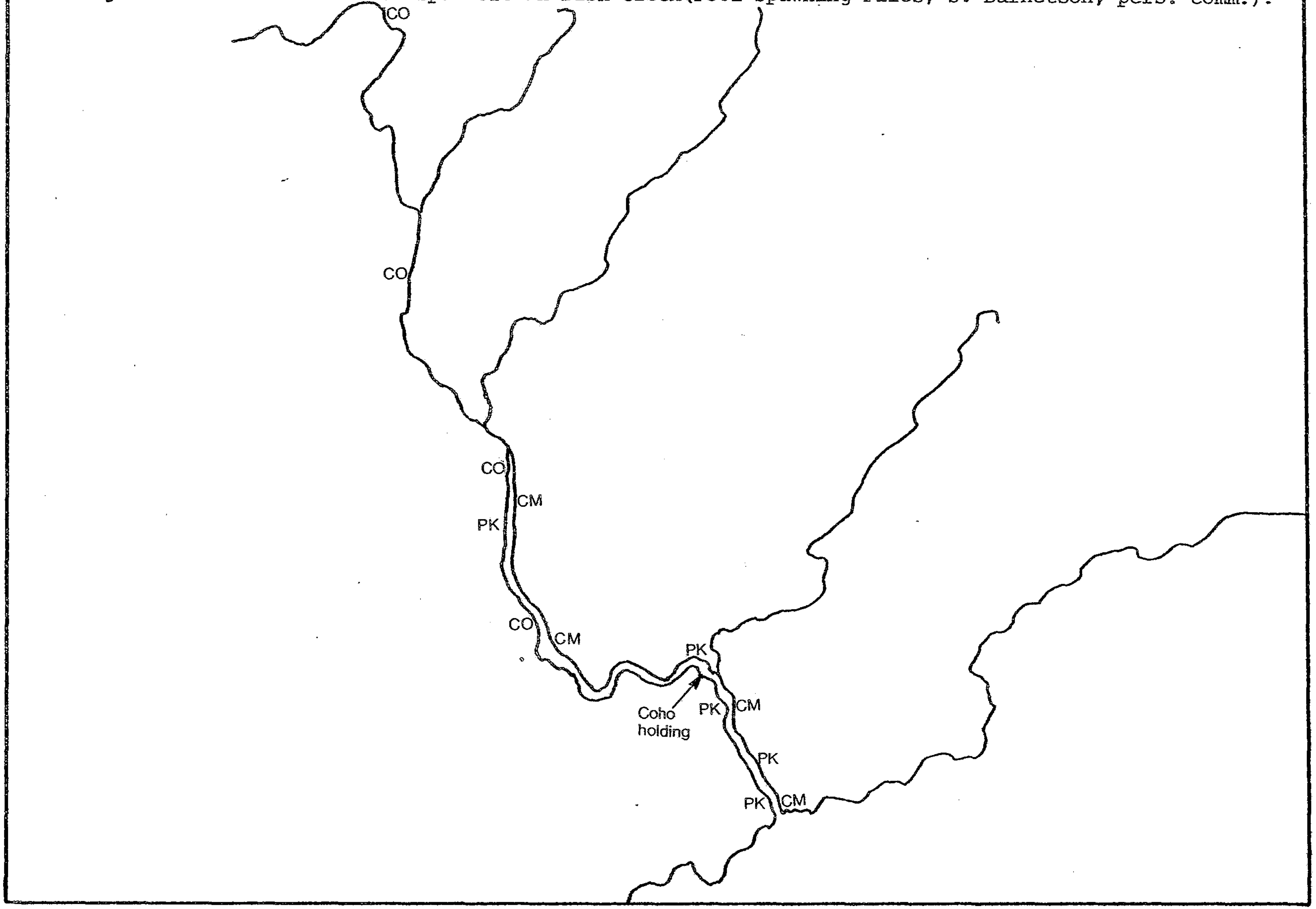


Figure 24. Distribution of spawners in the Dala River(F381 Spawning Files: S. Barnetson, pers. comm.).

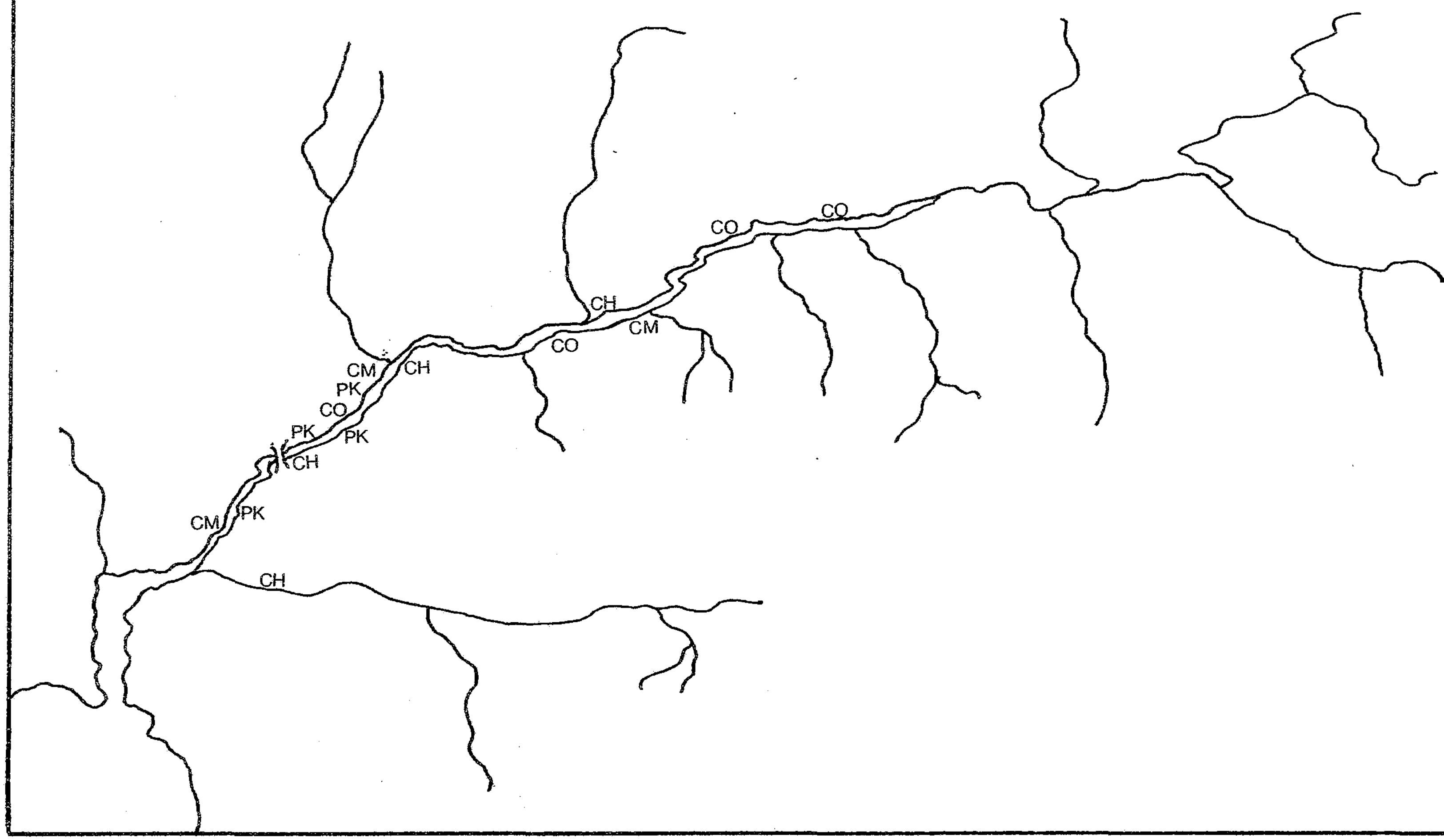
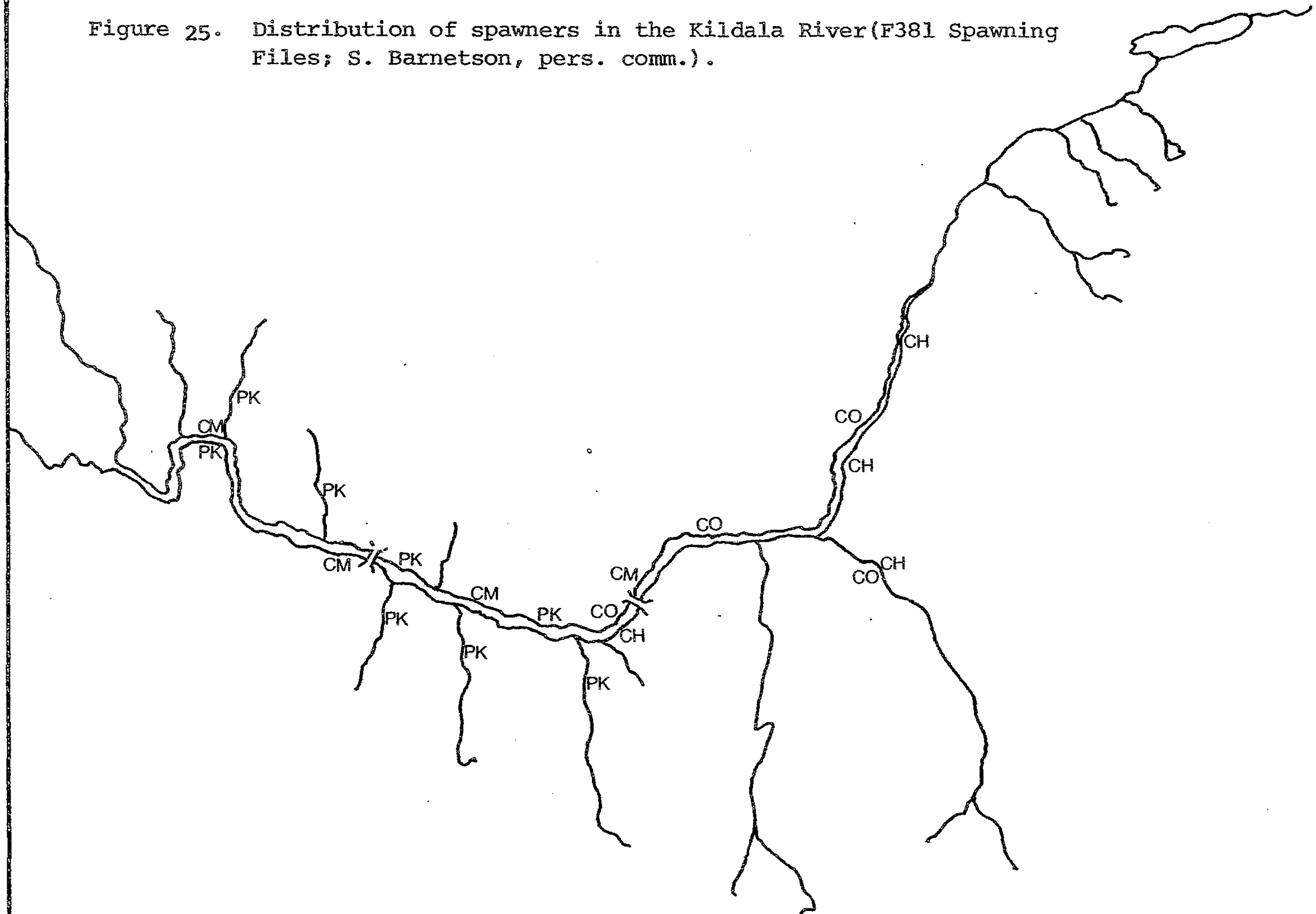


Figure 25. Distribution of spawners in the Kildala River(F381 Spawning Files; S. Barnetson, pers. comm.).



Abundance

The total annual chinook escapement to the Kitimat River mainstem and tributaries has ranged from 1,225 to 75,000 with the average being about 6,600 from 1934 to 1980 (Fig. 26). The mainstem accommodates, on an average, 67% of chinook spawners (1958-1980), and there appears to be little correlation between total escapement and percent utilization of the mainstem. These data suggest that optimum escapement is not being achieved. The total escapement of chinook to the Kitimat watershed has declined drastically in the period 1967-1980 (Fig. 27).

Coho salmon escapements have varied considerably over the last 47 years (1934-1980) in the Kitimat River watershed (Fig. 28). The estimated number of spawners has ranged from 100,000 in 1934 to 1,500 in 1950. The average annual escapement for the period on record has been 16,000 fish. In recent years, there has been a substantial decrease in coho salmon returns. Over the past 15 years (1966-1980) total escapement has declined by an average of 850 fish per year (Fig. 29).

Both odd and even year pink salmon stocks exist in the Kitimat system, with even year pinks predominating. Over the past 47 years, escapements of the even year stock has ranged from 35,00 to 355,000 pieces, with the average being approximately 120,000 (Fig. 30). In contrast, odd year pink runs have ranged from 1,500 to more than 100,000 (Table 9) with a mean annual escapement of 32,600 over the same period (1934-1980) (Fig. 31). However, the average escapement of 6,100 from 1953-1979 is more indicative of the size of recent runs.

The escapement of chum salmon to the Kitimat watershed has averaged 19,800 spawners from 1934 to 1980 (Fig. 32). The estimated number of spawners has ranged from 1,500 to more than 100,000 over that period. Since the time that Kitimat tributaries became identified separately in the spawning records (1958), an average of 59% of chum spawners have utilized the mainstem for egg deposition. Escapements to Kitimat tributaries are reported in Table 10 (Appendix 4).

Escapements of sockeye salmon to the Kitimat River have varied considerably over the period on record (1934-1980). Fluctuations in sockeye escapements, from the F381 spawning files, are represented in Figure 33.

Figure 26. Kitimat River, Area 6(1934-1980)
Estimated Escapement of Chinook Salmon(from F381)

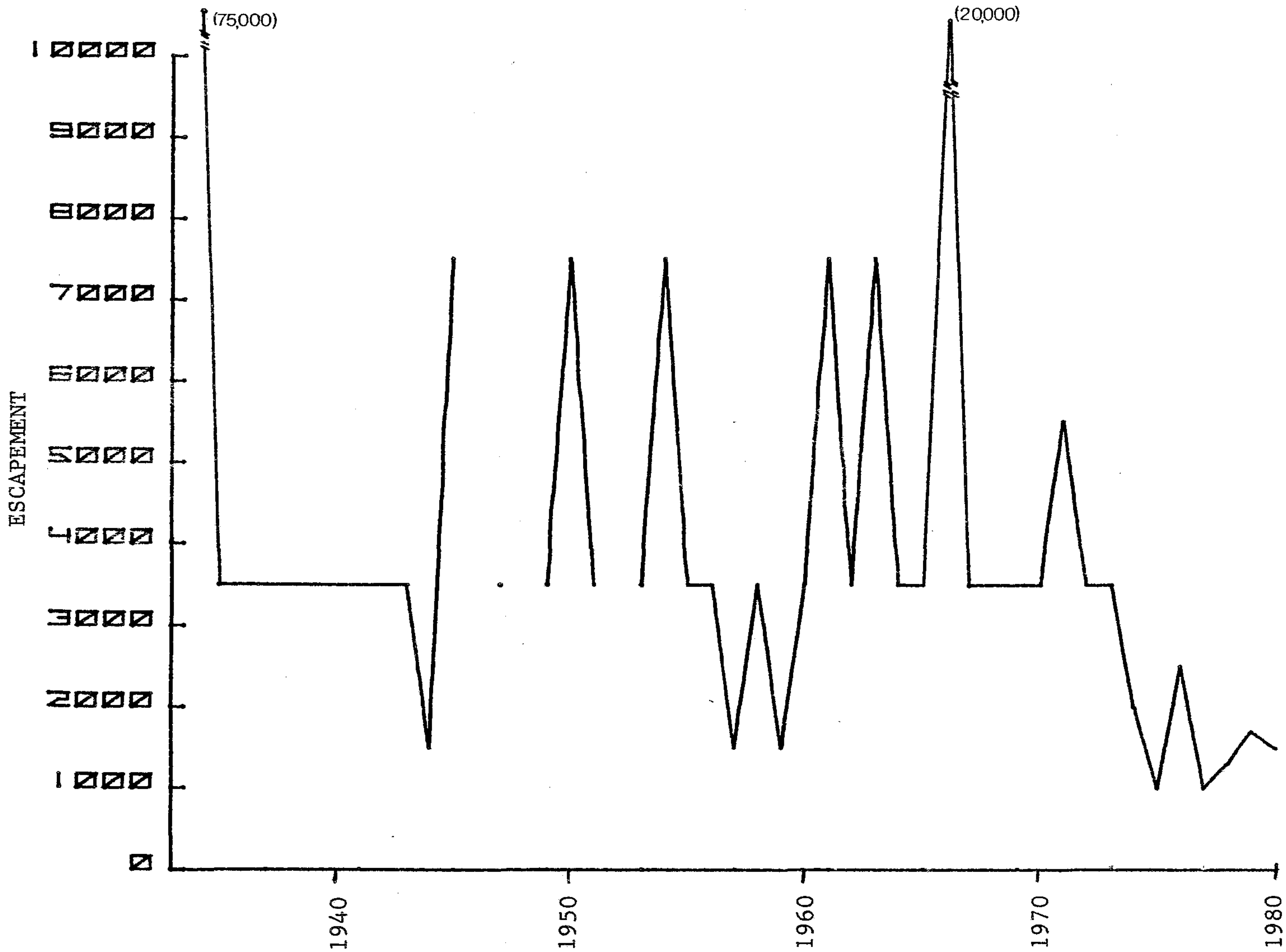


Figure 27. Regression showing the declining trend in total chinook salmon escapements to the Kitimat River watershed($m=-483.7$, $R=-0.764$, $T=-4.1$, and $p \leq 0.05$). (1966-1980)

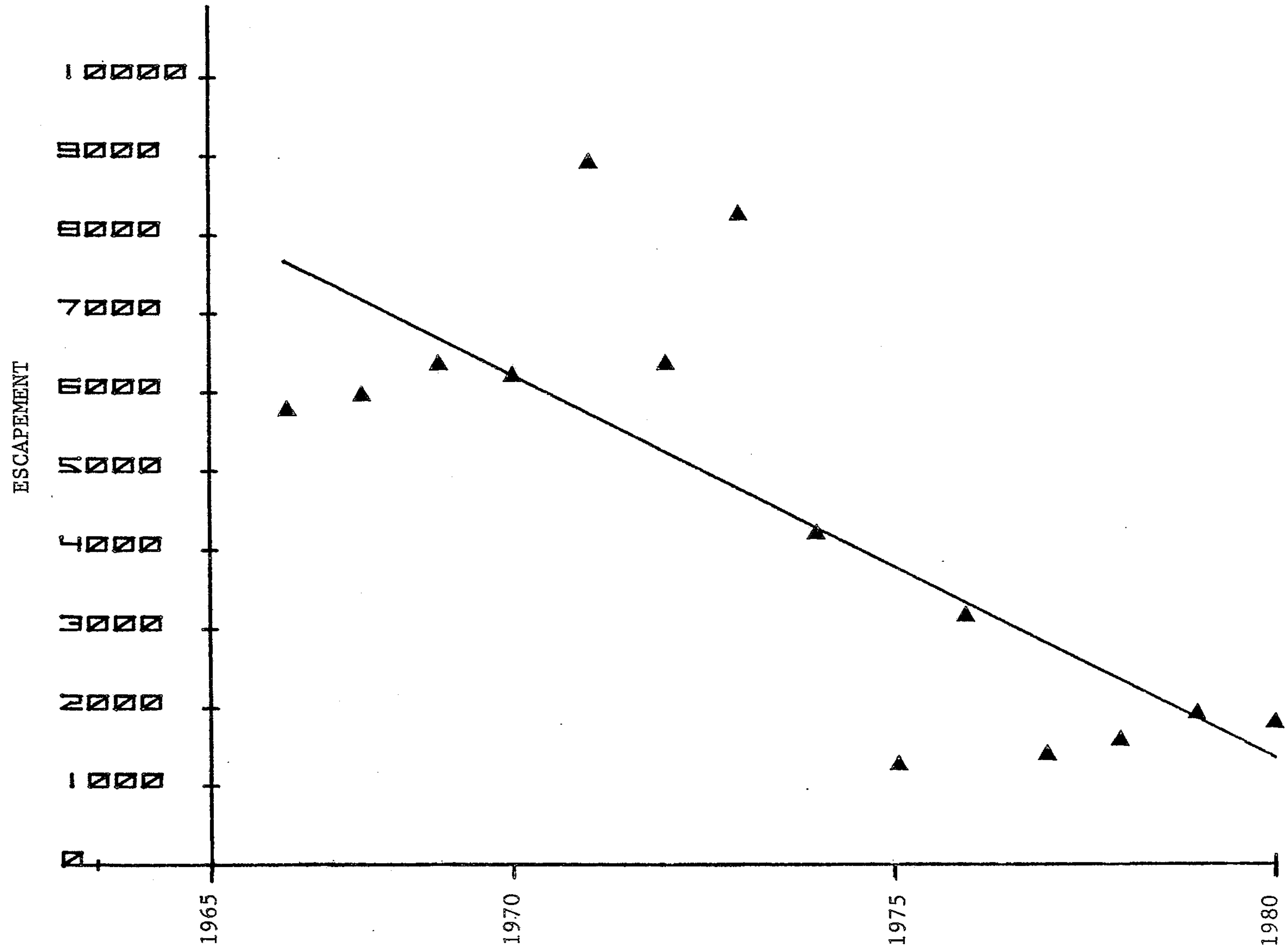


Figure 28. Kitimat River, Area 6(1934-1980)
Estimated Escapement of Coho Salmon(from F381)

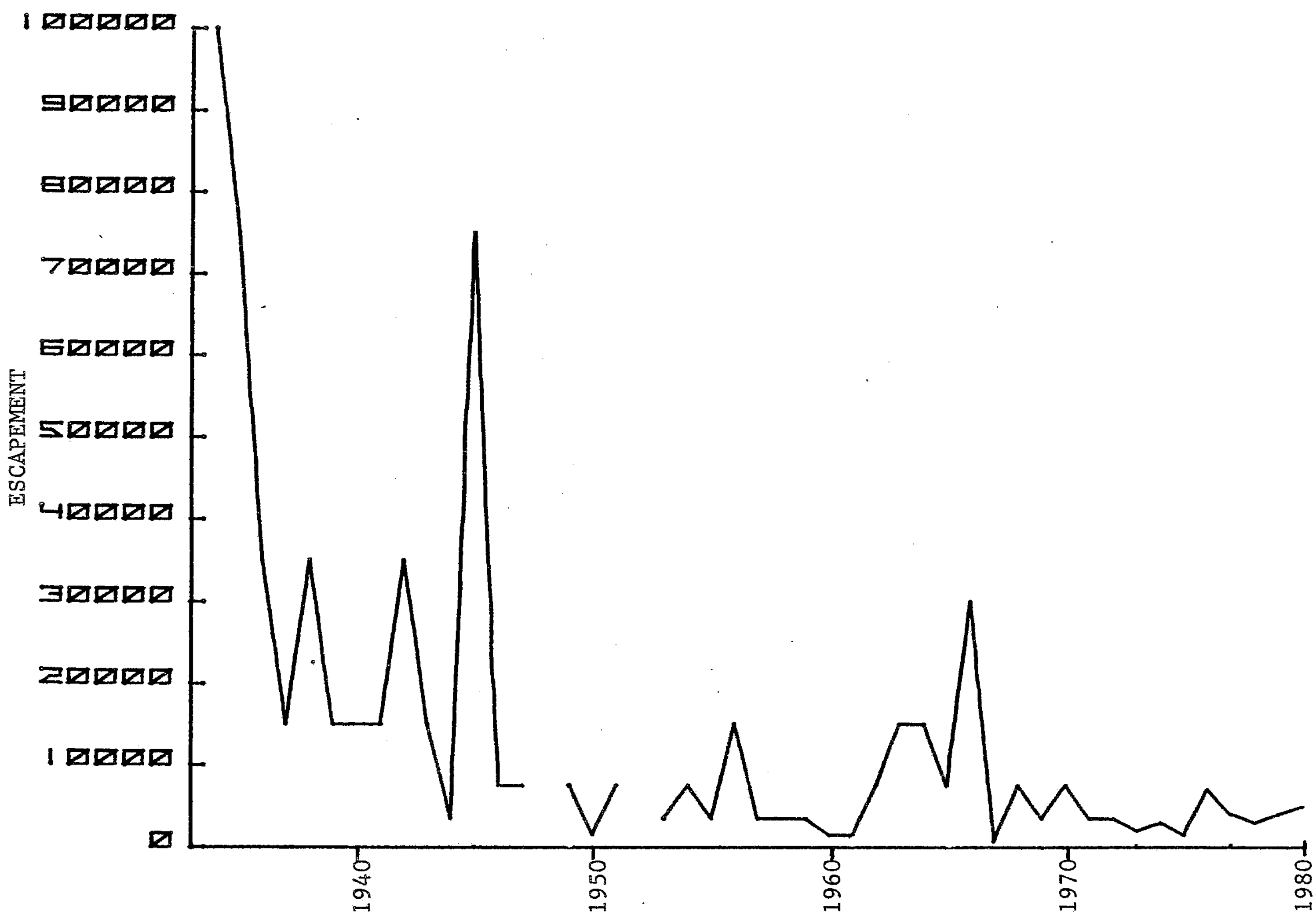


Figure 29. Regression showing the trend toward declining coho salmon escapements to the Kitimat River watershed($m=-865.1$, $R=-0.520$, $T=-2.19$, and $p \leq 0.05$). (1966-1980).

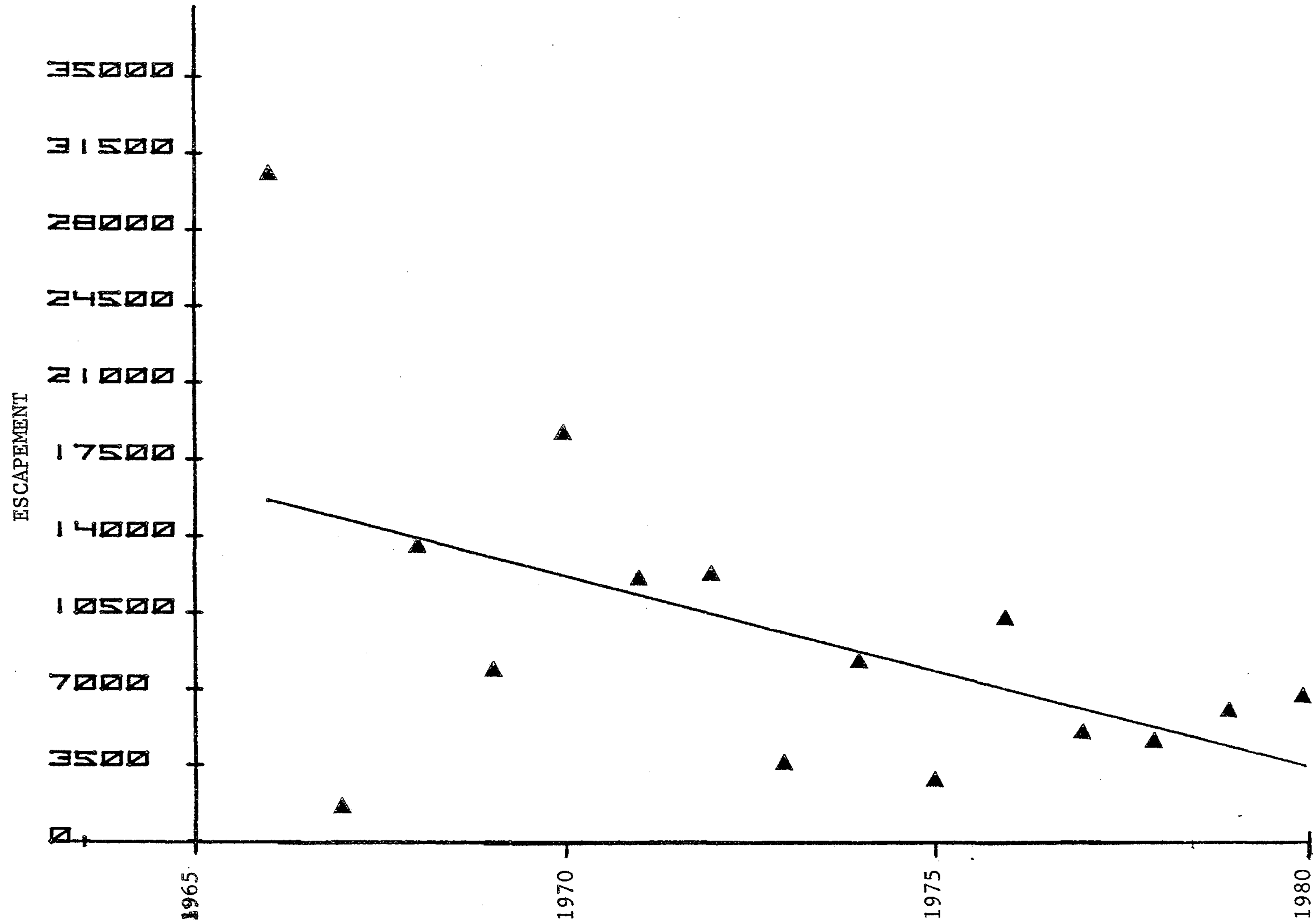


Figure 30. Kitimat River, Area 6(1934-1980)
Estimated Escapement of Even Year Pink Salmon(from F381)

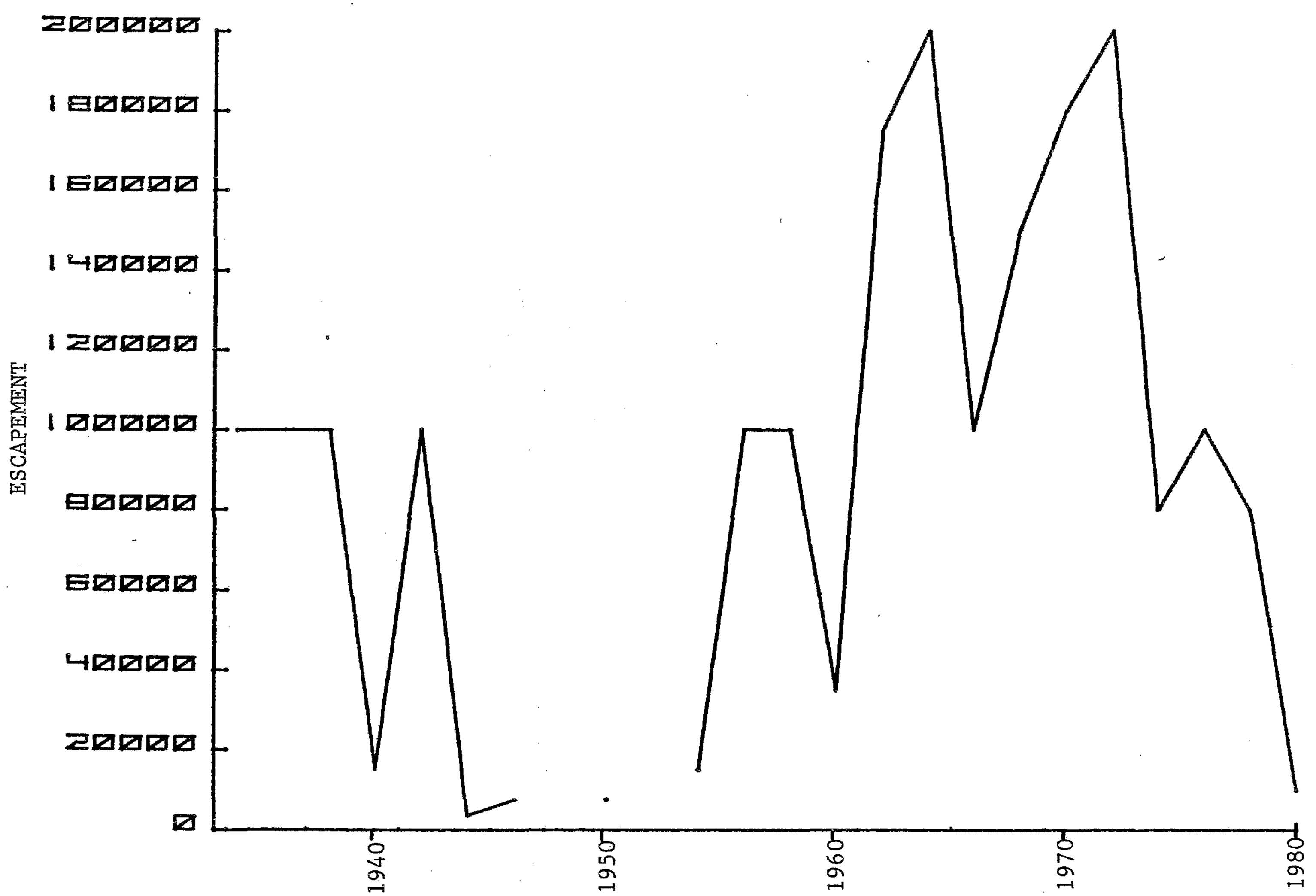


Table 9. Kitimat River. Area 6. F381 Salmon Stream and Spawning Ground Enumeration Data.

	SPECIES					
YEAR	SOCKEYE	SPRING	COHO	PINK	CHUM	STEELHEAD
1934	15,000	75,000	100,000	100,000	3,500	3,500
1935	15,000	3,500	75,000	100,000	100,000	15,000
1936	15,000	3,500	35,000	100,000	100,000	3,500
1937	7,500	3,500	15,000	35,000	15,000	3,500
1938	15,000	3,500	35,000	100,000	15,000	UNK
1939	7,500	3,500	15,000	75,000	7,500	UNK
1940	7,500	3,500	15,000	15,000	3,500	UNK
1941	3,500	3,500	15,000	100,000	15,000	UNK
1942	3,500	3,500	35,000	100,000	7,500	UNK
1943	7,500	3,500	15,000	100,000	7,500	UNK
1944	UNK	1,500	3,500	3,500	7,500	UNK
1945	7,500	7,500	75,000	100,000	15,000	-
1946	3,500	UNK	7,500	7,500	7,500	-
1947	7,500	3,500	7,500	35,000	35,000	UNK
1948	-	-	-	-	-	-
1949	7,500	3,500	7,500	75,000	7,500	750
1950	3,500	7,500	1,500	7,500	7,500	-
1951	3,500	3,500	7,500	45,000	17,500	750
1952	-	-	-	-	-	-
1953	1,500	3,500	3,500	3,500	3,500	-
1954	3,500	7,500	7,500	15,000	3,500	UNK
1955	750	3,500	3,500	7,500	1,500	UNK
1956	-	3,500	15,000	100,000	3,500	UNK
1957	-	1,500	3,500	1,500	35,000	400
* 1958	-	3,500	3,500	100,000	15,000	75
1959	-	1,500	3,500	3,500	1,500	-
1960	-	3,500	1,500	35,000	15,000	-
1961	-	7,500	1,500	750	3,500	-
1962	-	3,500	7,500	175,000	35,000	-
1963	-	7,500	15,000	7,500	7,500	-
1964	-	3,500	15,000	200,000	15,000	-
1965	-	3,500	7,500	15,000	1,500	-
1966	1,000	20,000	30,000	100,000	20,000	-
1967	-	3,500	750	7,500	7,500	-
1968	-	3,500	7,500	150,000	15,000	-
1969	200	3,500	3,500	3,500	15,000	750
1970	-	3,500	7,500	180,000	15,000	1,500
1971	400	5,500	3,500	750	25,000	3,500
1972	750	3,500	3,500	200,000	60,000	3,500
1973	75	3,500	2,000	1,000	25,000	-
1974	-	2,000	3,000	80,000	40,000	-
1975	75	1,000	1,500	2,000	1,000	-

Table 9. (cont'd.)

YEAR	SOCKEYE	SPRING	COHO	PINK	CHUM	STEELHEAD
			SPECIES			
1976	1,000	2,500	7,000	100,000	10,000	-
1977	500	1,000	4,000	2,000	8,000	-
1978	200	1,300	3,000	80,000	15,000	-
1979	400	1,700	4,000	3,000	3,000	-
1980	2,500	1,500	5,000	10,000	3,000	-

* Includes mainstem spawners only from 1958-1980.
UNK - number of spawners unknown.

Figure 31. Kitimat River, Area 6(1934-1980)
Estimated Escapement of Odd Year Pink Salmon(from F381)

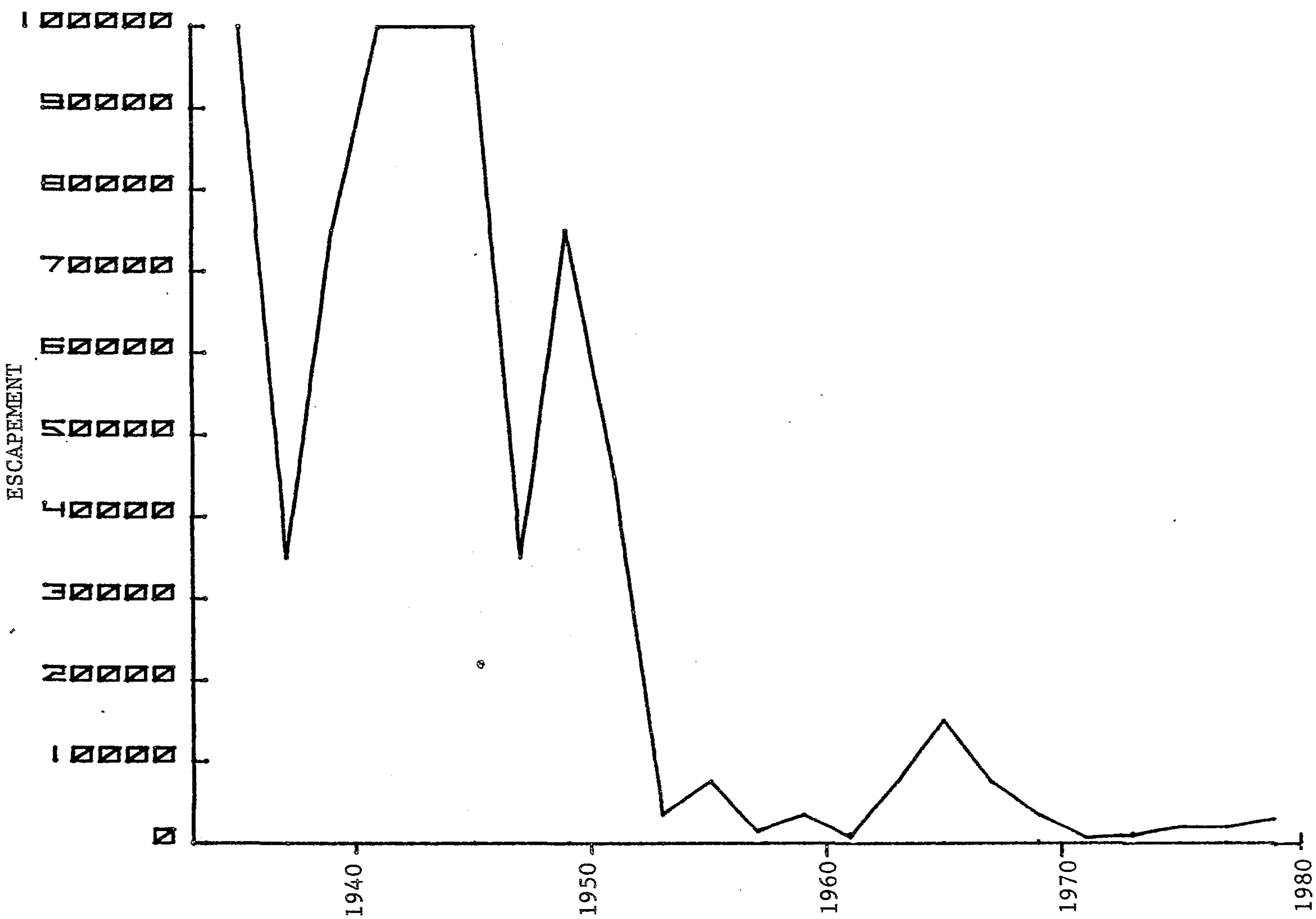


Figure 32. Kitimat River, Area 6(1934-1980)
Estimated Escapement of Chum Salmon(from F381)

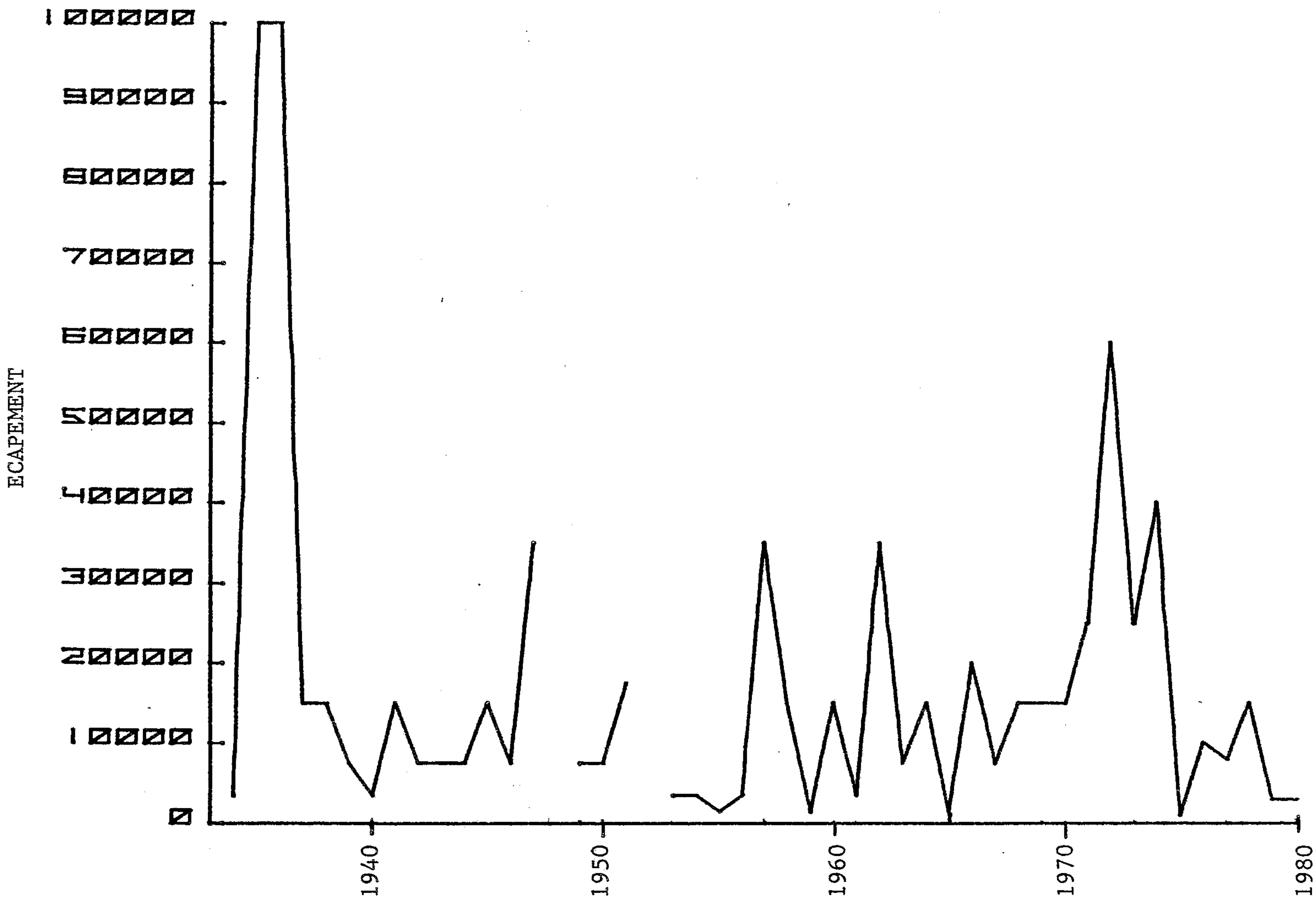


Figure 33. Kitimat River, Area 6(1934-1980)
Estimated Escapement of Sockeye Salmon(from F381).

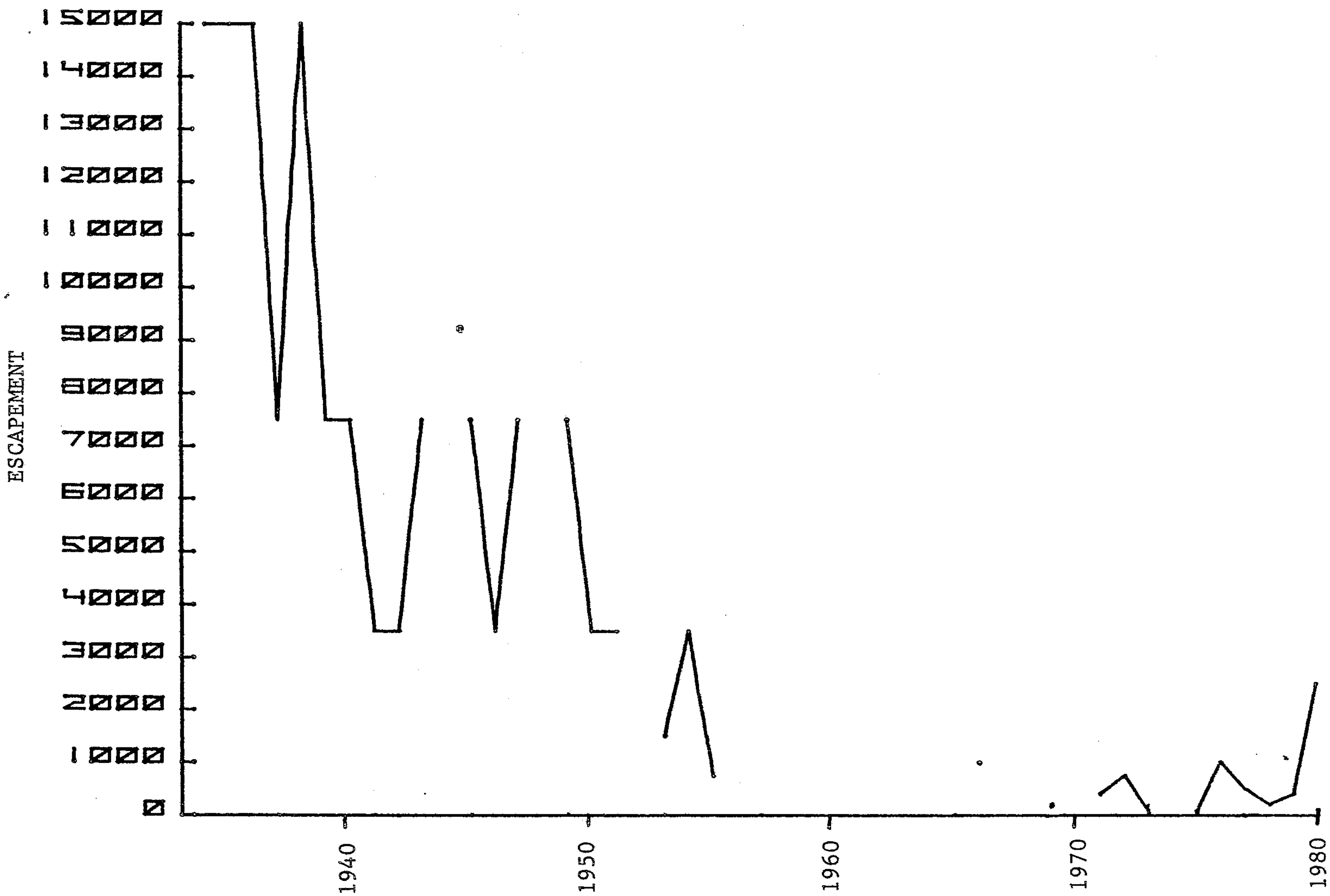


Table 10. Kitimat River Tributaries. Area 6. F381 Salmon Stream and Spawning Ground Enumeration Data.

			SPECIES		
YEAR	SOCKEYE	SPRING	COHO	PINK	CHUM
1958		1,500	740	40,500	56,000
1959		150	4,700	4,075	4,900
1960		425	1,150	118,000	5,475
1961		125	4,675	3,850	1,025
1962		11,000	4,700	115,000	87,500
1963		975	1,950	9,600	5,600
1964		1,650	7,425	135,000	12,150
1965		NO	2,650	3,500	NO
1966		3,500	500	35,000	3,500
1967		2,275	725	150	2,525
1968		2,450	5,150	48,500	3,250
1969	25	2,850	4,200	1,250	3,875
1970		2,700	9,850	56,000	7,300
1971		3,400	8,750	800	3,950
1972		2,850	8,750	67,250	9,500
1973		4,750	1,575	850	17,200
1974		2,200	5,100	25,750	14,200
1975		225	1,125	375	1,000
1976		639	3,300	11,070	2,250
1977		473	1,520	925	4,640
1978		300	1,425	13,000	3,700
1979		255	2,225	740	1,130
1980*	16	350	1,750	3,400	1,100

In 1958 tributary rivers in the Kitimat System began to have their spawning enumerations kept separately from the Kitimat mainstream records.

NO - None observed

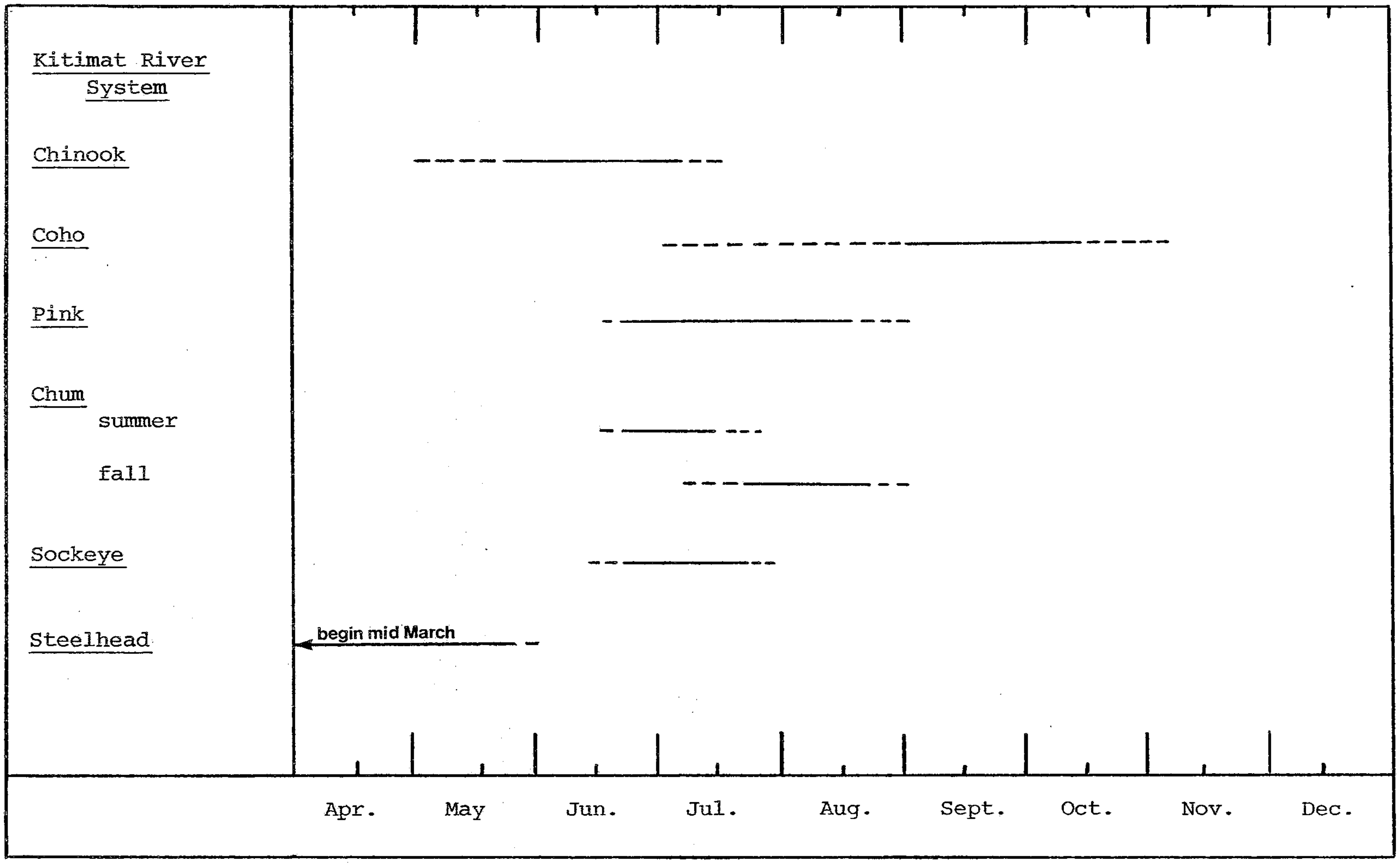
*Does not include 1980 escapement to Little Wedeene River.

Migration Timing of Salmonids

The relationship of migration timing of Kitimat River produced salmonids is summarized in Fig. 34. Of the five salmon species, chinook are the first through the fishery, commencing May 1 and continuing to mid-late July. During the period from June 10 to July 15, sockeye salmon can be found passing through the fishery. Pinks and chums exhibit a great deal of overlap in timing, with the migration through the Area 6 fishery taking place from mid June to September 1.

The summer chum run is through by August 1, while the fall run chums start appearing about July 10. Coho are present in the fishery longer than any other salmon, exhibiting a migration period of July 1 to October 31 (M. Farwell, pers. comm.,1981).

Figure 34. Approximate migration timing through the Area 6 commercial fishery (M. Farwell, pers. comm. 1981; GWG, 1980).



ANNUAL CATCH

Sport Catch

The Kitimat River supports a large anadromous fish population (average annual escapement - 200,000) that is heavily exploited by commercial, recreational and Indian food fisheries (Bell and Kallman, 1976). In the Kitimat River and its' tributaries, a substantial sport fishery expends great effort (73,425 angler days in 1974) to catch, on an average 300 chinook and 700 coho salmon annually (Sinclair, 1975). This effort (at $5.35/day) represents, approximately an expenditure of $400,000 annually (in 1974 dollars).

In addition to the freshwater sport fishery, Kitimat fish support an extensive recreational fishery in Douglas Channel. In 1978, it was estimated that the total sport catch of Kitimat chinook and coho salmon were 3000 and 1350 pieces respectively in tidal waters. Approximately 10,000 angler days are spent annually in pursuit of these fish (Masse, 1978b). Sport caught chinook salmon averaged 4.18 lb. (indicating a large proportion of immature fish) while coho salmon caught in the same waters (Douglas Channel) averaged 6.98 lb., in 1978 (Masse, 1978a).

Indian Food Catch

The Indian food fishery on Kitimat River stocks is composed of tidal and non-tidal fisheries, with the former being by far the more important of the two. The freshwater fishery is conducted on several streams in the area, while the tidal fishery is conducted from Kitimat Village to Kitsaway Anchorage. Over the period 1972-1980, catches of sockeye, coho, pink, chum and chinook slamon have averaged 993, 658, 408, 1021 and 571 pieces respectively (Friedlaender and Reif, 1979; J.A. Macdonald, pers. comm.). Refer to Table 11 for tidal water catch summary.

Table 11. Indian Catch of Salmon for the Kitimat Band 1972 - 1980 (J.A. Macdonald pers. comm. 1981; Freidlaender and Reif, 1979).

		Total Native Catch			
Year	Sockeye	Coho	Pink	Chum	Chinook
1972	150	600	1,000	2,000	300
1973	200	400	100	1,500	200
1974	400	420	50	1,400	800
1975	3,000	500	400	1,200	1,300
1976	1,500	600	500	800	1,000
1977	640	1,200		535	535
1978	1,500	1,200	575	530	350
1979	645	600	150	425	350
1980	900	400	900	800	250

Commercial Catch

Douglas Channel is closed to the commercial fleet from Gill Island to the head of the fjord. Kitimat bound fish that are commercially caught in the Area 6 fishery, are represented in the Area 6 annual catch (Table 12). It is difficult to determine the percentage of the Area 6 catch that is composed of Kitimat fish. Using catch:escapement ratios of 5:1 for chinook and 2:1 for coho, it has been estimated that on an average 11,900 chinook and 10,000 coho produced by the Kitimat River are commercially caught annually (Masse, 1978b MS).

Coded wire tagging (CWT) data (D. Bailey, pers. comm. 1981) indicate that Kitimat coho and chinook salmon are not unique to the Area 6 fishery. Tags have been recovered from coho caught in the northern troll and net fisheries (NTR and NN; Areas 1-5), northwest Vancouver Island troll fishery (NWTR; Areas 25-27), southwest Vancouver Island troll and net fisheries (SWTR and SWVN; Areas 21, 23, 24 and subareas 12, 13) as well as the Central troll and net fisheries (CTR and CN; Areas 6-12, 30).

Chinook salmon from the Kitimat River have been caught in the NN, NTR, SWVN, NVTR fisheries as well as the CN fishery. As of yet, no chinook have turned up in the CTR fishery. CWT data from sport caught chinook indicate, however, that a substantial number of Kitimat fish remain in Douglas Channel.

Table 12. Annual Commercial Catch for Area 6 (Area 6 - Net Fishery Records, Dept. of Fisheries and Oceans, 1977, 1978, 1979 and 1980).

YEAR OF FISHERY	SPECIES SOCKEYE	COHO	PINK	CHUM	CHINOOK
1969					
Net	34,026	26,496	34,305	58,440	7,403
Troll	30	16,041	1,130	27	18,138
Total	34,056	42,510	35,435	58,467	25,541
1970					
Net	90,987	144,351	2,787,170	270,170	11,486
Troll	846	47,540	445,841	4,603	15,803
Total	91,833	191,891	3,232,952	174,773	27,289
1971					
Net	32,440	31,701	214,986	66,559	18,084
Troll	35	21,170	1,956	182	16,649
Total	32,475	52,871	216,942	66,741	34,733
1972					
Net	101,200	161,032	5,069,300	470,252	18,781
Troll	452	71,920	523,474	1,826	31,036
Total	101,652	232,952	5,592,774	472,078	49,817
1973					
Net	65,246	39,824	400,569	162,385	3,044
Troll	309	53,775	16,850	472	20,248
Total	65,555	93,599	417,419	162,857	23,292
1974					
Net	56,965	66,020	525,749	166,492	13,688
Troll	304	39,775	47,284	139	25,790
Total	57,269	105,795	573,033	166,631	39,478
1975					
Net	22,721	12,856	39,840	15,424	9,420
Troll	156	9,140	1,236	123	22,645
Total	22,877	21,996	41,076	15,547	32,065
1976					
Net	14,532	34,142	487,084	13,306	4,477
Troll	130	27,371	11,352	626	14,715
Total	14,662	61,513	498,436	13,932	19,192

Table 12 (cont'd.)

YEAR OF FISHERY	SPECIES SOCKEYE	COHO	PINK	CHUM	CHINOOK
1977					
Net	33,122	11,906	404,138	55,332	3,484
Troll	198	19,382	8,228	436	11,823
Total	33,320	31,288	412,366	55,768	15,307
1978					
Net	55,829	73,606	2,733,839	224,155	9,516
Troll	1,212	30,869	18,778	1,180	17,888
Total	57,041	104,475	2,752,617	225,335	27,404
1979					
Net	86,592	36,296	724,255	88,605	16,682
Troll	92	16,473	5,855	109	14,044
Total	86,684	52,769	730,110	88,714	30,726

BIOLOGICAL SURVEYS

Juvenile Summary

Juvenile chum, chinook and coho salmon utilize the Kitimat watershed for rearing. Chum remain in fresh water for only a few weeks, while many chinooks and most coho overwinter in the system. After rearing in the mainstem and tributaries for a period of time, salmon migrate to the estuary to rear before moving on to more open waters. All four species of salmon (CM, CH, CO and PK) studied displayed strong preferences toward noctural migration. Migration timings through the Kitimat River below Haisla Bridge are as follows (Birch, et. al., 1981 MS).

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	May 23	April 22	June 15	July 9	-
Coho	smolt	-	April 12	April 27	June 22	-

Chinook Salmon

Fry Emergence and Growth

Exact hatching times have not been recorded for any of the salmon species in the Kitimat system. Using August 15 as the peak spawning time, however, it is possible to estimate the mean hatching time for chinook salmon to be October 5 (based on developmental estimates by R. Hilland). Using the same method, peak emergence would occur in late April, but Birch, et. al. (1981) reported an outmigration peak of newly emergent fry in early April in 1980.

Kitimat River chinook fry had mean fork lengths of 47.1 ± 5.3mm in the first week of June, and 81.5 ± 0.7mm in mid August. This represents an in-stream growth rate (expressed as % length increase/ day) of 0.79. Over the same period (70 days), mean weight increased from 1.36 ± 0.82g to 6.27 ± 0.25g, representing a 2.21% weight increase/ day (Birch, et. al., MS 1981).

The Kitimat River estuary is extremely important to Kitimat chinooks. After four months of estuarine growth the 0^+ fish were larger than the 1^+ fish had been after a year of freshwater rearing.

Post-Emergent Fry Distribution and Abundance; Juvenile Migration and Age Determinations

The chinook juvenile reconnaissance conducted from April 1 to August 20, 1980, executed by F.F. Slaney and Company, indicated that post-emergent fry are present in Kitimat and Big Wedeene Rivers, and Humphrey's Hirsch, Chist, McKay and Davie-Hoult Creeks in the vicinity of the spawning grounds. Subsequent changes in population concentrations in these areas reflect changes in habitat preference with increased size.

The outmigration of emergent chinook salmon is apparently unimodal, and takes place from April to late May. The peak catch, using 2x3 Incline Plane Traps (IPT's), in the Kitimat mainstem was observed on April 10 (104 fry). Emergent fry then decreased in abundance to minimal numbers by June. The fingerling migration occurred from June 4 to July 18 primarily, but late migrants were observed as late as August 12. These '90 day' fish exhibited two small outmigration peaks (June 10 and July 5-7), and low numbers were attributed to the poor trapping efficiency of the 2x3 IPT.

Overwintering chinooks displayed an overall migration period of April 8-May 31. The peak migration was observed on April 23 when 13 chinook smolts were caught. Population estimates were not made for chinook juveniles.

The Slaney report (1981) indicated that the majority of emigrant chinook are newly emergent fry (89%), while '90 day' fish make up a much smaller proportion of the run (8.5%). Overwintering fish made up the balance of the run (2.4%). These numbers are probably skewed as trapping efficiency decreases as fish size increases. Commercial net and sport fishery data (Hilland, et. al., 1981) indicates that sub 2 (overwintering) fish make up an average of 18.3% of returning adults.

Coho Salmon

Fry Emergence and Growth

Using November 10 as the peak spawning time for Kitimat River coho salmon, the estimated peak hatching period should be May 25 to June 15 in an average year, and peak emergence of coho fry would occur in late June to early July. Birch et. al. (1981) report the onset of emergence in May, continuing to late June in 1980.

Although an attempt was made to estimate coho in-stream growth rates, meaningful numbers were unobtainable due to constant emergence of fry from May to July.

Post-Emergent Fry Distribution and Abundance;
Juvenile Migration and Age Determination

Surveys indicate that juvenile coho salmon are distributed throughout the Kitimat system (either fry or smolt) in all areas accessible to returning adults. Changes in relative population concentrations of coho probably reflect changes in habitat preference with increased size.

The outmigration of coho fry apparently occurs from early April to mid August. The period of heaviest migration activity began on May 16 and continued on to the end of June. Peak migrations were observed on June 10 and July 5, however, many of these were trout misidentified as coho.

Due to low recapture rates, an estimation of the Kitimat mainstem coho population was not possible. Estimates of Hirsch and Cecil Creek coho salmon fry populations were 189,000 ± 65.6% and 177,000 ± 37.5% respectively.

The outmigration of coho smolts consisted of both one and two year old juveniles. Both age classes were sampled on the first day of trapping (April 8), however, two year olds were represented in catches only to May 5, while the outmigration of one year old fish continued through to August 13. Ninety percent of the 1^+ outmigration was complete by June 6.

Kitimat bound coho (n = 294) caught by beach seine (1977) were comprised of 62.2% sub-2, 37.1% sub-3, and 0.7% sub-4 fish.

This indicates that fish that do not spend their first winter in freshwater utilize the estuary for rearing. It also appears that a good number of coho salmon continue to rear in the estuarine environment for a substantial period of time following their migration from the river.

Chum Salmon

Fry Emergence

Using August 9 as the average peak spawning time for Kitimat mainstem chum, the estimated peak hatching time would be October 10, and peak emergence would occur from April 10 to 20 in an average year. Birch, et. al. (MS 1981) report the peak outmigration of chum fry in 1980 probably occurred before April 8. Emigration continued to June 4, however, 90% of the run was through by April 19. Chum fry in tributaries migrated slightly later than mainstem produced fish.

Although no attempt was made to compute the in-stream growth rate of chum fry, it was reported that the mean fork length and weight of fry increased over the survey period. Statistically valid interpretation of these trends is difficult as the number of fish sampled decreased dramatically from April 8 to May 18.

Post-Emergent Fry Distribution and Abundance; Juvenile Migration and Age Determinations

Little is known about the chum salmon in-stream rearing distribution, but it is assumed that fry rear in the vicinity of the spawning grounds. Using mark-recapture data, Birch, *et. al.* (MS 1981) estimated the total chum outmigration to be 459,200 ± 40.7% for the Kitimat mainstem, and 43,600 ± 43.3% fry for Hirsch Creek in 1980. Using SEP bio-standards, 1979 chum escapements and chum sex ratios, 756,000 and 97,900 outmigrant fry would have been predicted for mainstem and Hirsch Creek fish. Thus, peak outmigration of chum fry probably occurred before trapping operations had begun (April 8).

Pink Salmon

Fry Emergence

Mainstem pink salmon have an average peak spawning time of August 4, thus the peak hatching time for eggs deposited by these fish can be estimated to be October 13, and the date of peak emergence can be estimated to be April 4, 1980. It was reported that the peak outmigration probably occurred before April 8 (Birch, et. al. 1981).

Post-Emergent Fry Distribution and Abundance

Juvenile Migration and Age Determinations

Upon emergence from the gravel, pink fry begin their seaward migration almost immediately. Slaney and Company, Ltd., attempted to enumerate these pink salmon during their 1980 downstream program. Although trapping efficiency was too low to get meaningful population estimates for mainstem produced fish, it was reported that Hirsch Creek produced about 38,000 ± 63.1% fry.

In the mainstem, outmigration probably began well before the start of trapping (April 8), and it would not be unreasonable to assume that the peak of the migration had also occurred before that date. Ninety percent of the mainstem run was complete by April 23, according to the Slaney report. Tributary outmigration took place slightly later than in the mainstem, with the peak occuring at least two weeks later (April 23) for Hirsch Creek produced fish. No in-stream rearing of pinks was observed.

SPAWNER CHARACTERISTICS

Sex Ratio

Little is known about the sex ratios of salmon returning to the Kitimat River. Data which can be reported has been obtained, largely, from sporadic entries in the F381 Spawning Files. Three entries each for chum and coho salmon have indicated sex ratios for these species to be even. The average sex ratio for pink salmon has been 38% males, however, the ratios have reportedly ranged from 25 to 60% males. No data is available on the relative percentages of each sex for sockeye salmon.

Significantly more data is available on Kitimat River chinooks than any other anadromous salmonid. The F381 records reveal that about 40% of all returning chinooks are male (excluding jacks). Data from sport, gillnet and seine catches (Hilland, et. al, 1981), suggest that males (excluding jacks) represent approximately 48% of returning adults, while 33% of the fish sampled (1975-1979) were female.

Age Composition

Analysis of scales from Kitimat River chum salmon sampled from three sites in 1978 indicated that three, four and five year olds made up 4.9%, 86.9% and 1.6% of the total respectively. These numbers compare favourably with otolith, beach seine and dead pitch data collected in 1977 and 1980 (Table 13).

Limited data is available on the age composition of sockeye salmon returning to the Kitimat River. Of 18 fish sampled (1977), 4_1's and 5_2's were the most prevalent (comprising 27.8 and 33.3% respectively) age classes. One-third of the scales taken were too resorbed to accurately determine age.

Beach seine and sport catch data (1977) indicated that roughly two-thirds of Kitimat coho return as 3_2's and one-third return as 4_3's. These data suggest that these fish spend a substantial period of time rearing in freshwater and the rivers estuary (1-3 years) before moving to more open waters. These coho are, then, available to Kitimat area sport fishermen throughout the bulk of their life cycle.

Table 13 demonstrates that a wide variety of age classes are represented in the Kitimat River chinook population. Three and four year olds predominate, with sub 1 's comprising the majority of the escapement. Analysis of scales also indicates that five and six year olds, at times, may make up as much as 40% of the total escapement (Hilland et al 1981), but on an average these fish represent 21% and 3% of the total respectively.

Table 13. Age Composition of Kitimat River Salmon Species (Hilland, et. al., 1981); DFO Scale Bank, 1981).

SOCKEYE			4_1	4_2	5_1	5_2				unk	n
	1977	Beach Seine (B.S.)	27.8%	5.6%	0.0%	33.3%				33.3%	18
CHINOOK			2_1	3_1	4_1	5_1	4_2	5_2	6_2		
	1975	Sport Catch	9.7%	18.4%	25.8%	16.1%	3.2%	12.9%	12.9%	0%	31
	1976	Sport Catch	0%	23%	62%	6%	1%	0%	6%	0%	16
	1977	Sport Catch	0%	45%	22%	15%	13%	5%	0%	0%	55
	1977	B.S./Gillnet	0%	48%	20%	17%	13%	2%	0%	0%	46
		TOTAL	2.0%	38.5%	26.4%	14.9%	9.4%	6.1%	2.7%	0%	148
COHO			3_2	4_2	4_3	5_4					
	1977	B.S./Sport	63.0%	0.3%	36.0%	0.7%				0%	295
CHUM			3	4	5						
	1977	Otolith	12.8%	82.1%	5.1%					0%	39
	1978	B.S.	4.9%	86.9%	1.6%					6.4%	61
	1980	B.S.	7.1%	85.7%	0%					7.2%	20
	1980	Dead Pitch	0%	100%	0%					0%	28
		Total	6.8%	87.2%	2.0%					4.0%	148

*

sub 1 = rearing part of first year in estuary

sub 2 = a) rearing entire first year in freshwater
b) rearing entire first year in estuary

Lengths

Sex specific postorbital-hypural (POHL) lengths for chum and chinook salmon, and non-specific fork lengths (FL) for chum and sockeye salmon from the Kitimat River are summarized in Table 14. Chinook females averaged slightly larger than males (Hilland, et. al. 1981), however, the largest fish sampled were males (demonstrating the relatively large proportion of jacks in the run). POHL ranged from 530-900mm for females, and from 430-970mm for males). Significantly less data is available for the other salmon species. Male chums average about 30mm larger than female chums, while the largest fish sampled were males. Very little can be conclusively stated regarding sockeye salmon, however, it is interesting to note that fish in the 4_1 and 5_2 age classes averaged approximately the same size. This would suggest that freshwater rearing results in little growth for overwintering fry.

Table 14. Fork and Postorbital-Hypural Lengths (FL and POHL) of Kitimat River Salmon (Hilland, et. al., 1981; DFO Scale Bank, 1981).

Species	Sex	Age	POHL (mm) av.	POHL (mm) range	FL (mm) av.	FL (mm) range	n
CHINOOK	M	uns	587	430 - 970			473
	F	uns	733	530 - 900			229
CHUM	M	3	579	540 - 618			2
	F	3	623				1
	M	4	635	573 - 702			29
	F	4	606	503 - 676			24
	M	5	672				1
	F	5					0
	uns	3			710	640 - 780	2
	uns	4			805	700 - 940	19
SOCKEYE	uns	4_1			672	510 - 720	5
	uns	4_2			510		1
	uns	5_2			670	610 - 720	4
	–						

*

uns = unspecified

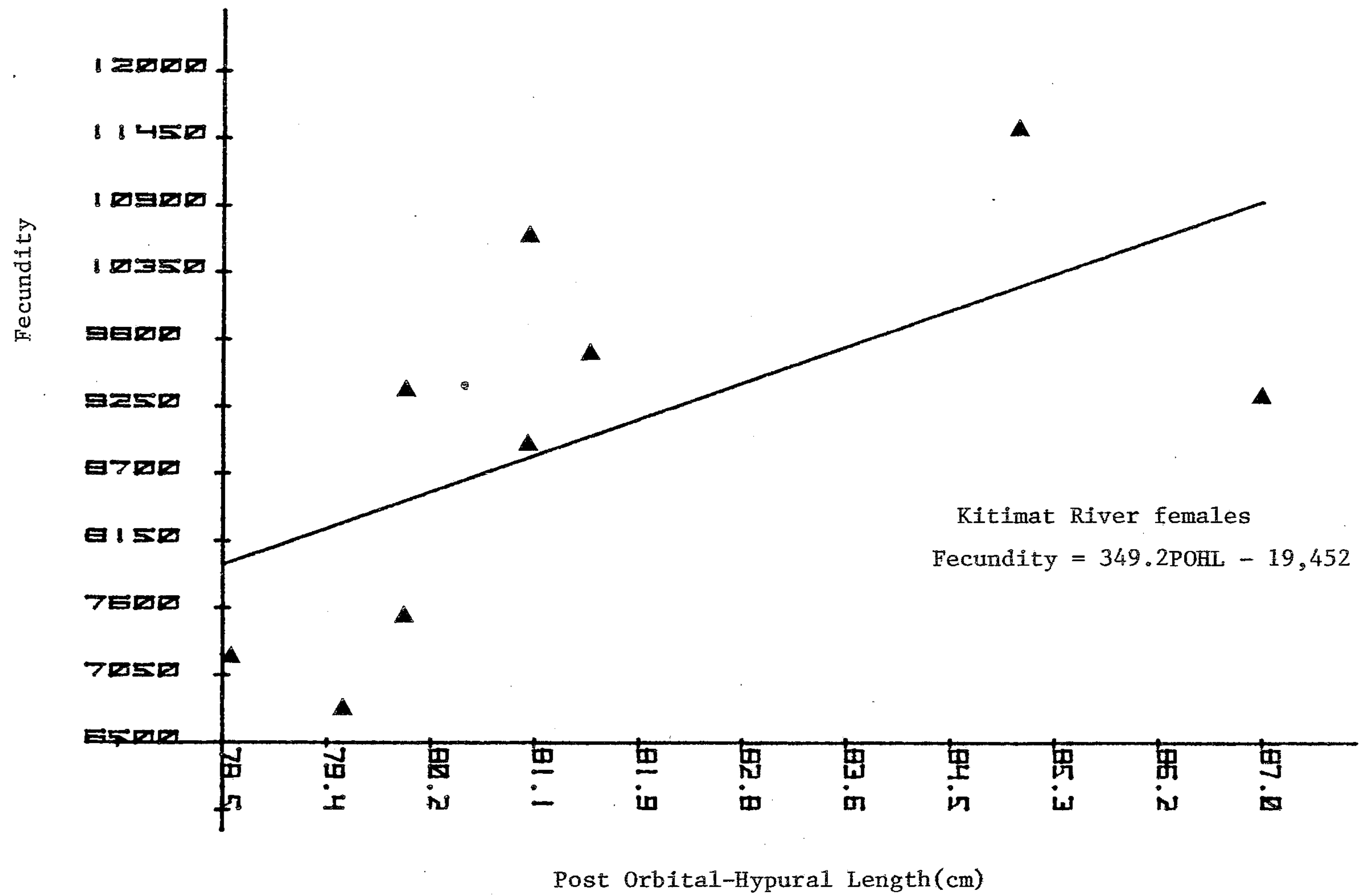
Fecundity

The average fecundity for chinook salmon for the years 1977, 1978, and 1979 was 8,500 (n = 9), 4,573 (n = 18), and 7,928 (n = 10) respectively. Nine unspawned females (pre-spawn mortalities) held for the pilot hatchery egg-takes in 1980 carried, on an average, 9007 eggs/female. Thus, the mean fecundity from 1977-1980 was 8112 eggs/female Hilland, 1981). The fecundity for 1980 females was positively correlated to post orbitalhypural lengths (POHL) (R = .604) as illustrated in (Fig. 33). (No attempt was made to correlate fecundities and lengths prior to 1980). This relationship was expressed by the regression equation:

$$\text{Fecundity} = 349.2 \ \text{POHL} - 19{,}452.$$

Using this equation, the calculated average fecundity was predicted using a mean hypural length of 73.3cm. Thus, the adjusted average fecundity for Kitimat River chinook females is 6143 eggs/female. No fecundity data is available on the other species of salmon native to the Kitimat River.

Figure 35. Relationship between post orbital-hypural length(POHL) and fecundity, Kitimat River chinook females(1980)(Adapted from Hilland, 1981).



Egg Retention and Pre-spawning Mortality

No data is available on egg retention for any species of Pacific salmon endigenous to the Kitimat system.

Pre-spawning mortalities of chinook salmon have varied considerably among adults held for donor stock for Kitimat pilot hatchery operations (1977-1980). In 1977, 62% (8 of 13) chinook females died before they were ripe enough to have their eggs stripped. The following year, however, only 2 of 33 females died prior to being spawned. Overall, pre-spawning mortalities have averaged about 20% for both sexes of chinook (Table 15). The spawning success of chinooks and other salmonid species under natural conditions in this system remains unknown.

Table 15. Chinook Salmon Pre-spawning Mortality (R. Hilland, et. al., 1981 MS; Hilland, 1981 MS).

Year	Females		Male		pen size
	# held	pre-spawning mortality (%)	# held	pre-spawning mortality (%)	
1977	13	8(62%)	14	unknown	3mx3mx2.5m
1978	*33	2(6%)	29	8(28%)	3mx3mx2.5m
1979	18	3(17%)	15	7(47%)	3mx3mx2.5m
1980[a]	18	5(27.8%)	26	1(3.9%)	8'x8'x8'
1980[b]	29	5(17.2%)	25	5(20%)	4'x8'x4'
TOTAL	111	23(20.7%)	109	21(19.3%)[c]	

*

a - held near hatchery site
b - held at site of capture
c - excluding 1977 results

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Appendix 1a

TEMPERATURE AND PRECIPITATION 1941 - 1970
BRITISH COLUMBIA

TYPE OF NORMAL CODE

1. 30 years between 1941 and 1970
2. 25 to 29 years between 1941 and 1970
3. 20 to 24 years between 1941 and 1970
4. 15 to 19 years between 1941 and 1970
5. 10 to 14 years between 1941 and 1970
6. less than 10 years
7. combined data from 2 or more stations
8. adjusted
9. estimated

Appendix 1 b. Means of Temperature and Precipitation for Kitimat
Latitude 54 00 N, Longitude 128 42 W, Elevation 55 FT ASL
(from Atmospheric Environment Service 1941-1970)

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	YEAR	NORMAL
Mean Daily Temperature (DEG. F.)	24.9	32.1	36.0	42.9	50.6	56.7	62.2	61.5	55.2	45.5	35.7	29.7	44.4	4
Mean Daily Maximum Temperature	29.5	37.0	42.4	51.0	59.8	64.9	70.9	69.1	62.4	50.0	39.4	33.3	50.8	4
Mean Daily Minimum Temperature	20.2	27.2	29.7	34.7	41.2	48.5	53.4	53.9	48.0	40.7	32.0	26.0	38.0	4
Extreme Maximum Temperature	62	55	62	80	93	103	106	93	88	74	60	55	106	3
No. of Years of Record	19	19	18	18	19	21	21	20	20	19	20	20		
Extreme Minimum Temperature	-9	-8	-2	19	29	33	38	40	34	27	2	-10	-10	4
No. of Years of Record	19	19	18	18	19	21	21	20	19	19	20	19		
No. of Days with Frost	25	20	20	7	1	0	0	0	0	3	14	21	111	5
Mean Rainfall (inches)	8.33	8.22	6.91	7.44	3.09	3.02	3.05	3.78	8.88	17.85	12.61	11.28	94.46	8
Mean Snowfall	56.4	24.2	17.1	0.0	0.0	0.0	0.0	0.0	0.0	2.5	24.0	39.6	167.8	8
Mean Total Precipitation	13.97	10.64	8.62	7.84	3.09	3.02	3.05	3.78	8.88	18.10	15.01	15.24	111.24	8
Greatest Rainfall in 24 Hours	4.90	4.59	7.29	3.05	3.08	1.71	1.45	3.30	3.43	4.52	5.70	5.80	7.29	1
No. of Years of Record	29	30	31	31	32	31	31	29	31	34	34	33		
Greatest Snowfall in 24 Hours	29.0	26.0	20.0	6.0	0.0	0.0	0.0	0.0	0.0	13.0	20.0	27.0	29.0	1
No. of Years of Record	30	32	33	31	32	32	31	30	31	34	33	33		
Greatest Precipitation in 24 Hours	4.90	4.59	7.29	3.05	3.08	1.71	1.45	3.30	3.43	4.52	5.70	5.80	7.29	1
No. of Years of Record	29	30	31	31	32	31	31	29	31	34	33	33		
No. of Days with Measurable Rain	10	12	15	15	12	13	11	12	14	23	17	14	168	3
No. of Days with Measurable Snow	11	6	4	1	0	0	0	0	0	1	6	10	39	3
No. of Days with M. Precipitation	19	16	17	15	12	13	11	12	14	23	21	22	195	3

Appendix 1c. Means of Temperature and Precipitation for Kitimat Townsite
Latitude 54 03 N, Longitude 128 38 W, Elevation 420 FT ASL
(from Atmospheric Environment Service 1941-1970)

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	YEAR	NORMAL
Mean Daily Temperature (DEG. F.)	24.4	32.0	36.2	42.5	50.5	57.2	61.2	60.6	54.6	44.3	34.8	28.6	43.9	4
Mean Daily Maximum Temperature	28.9	37.3	43.3	51.1	60.6	66.3	70.0	68.8	62.2	49.4	38.8	32.3	50.8	4
Mean Daily Minimum Temperature	19.9	26.7	29.1	33.9	40.3	48.1	52.4	52.6	47.0	39.2	30.7	24.8	37.1	4
Extreme Maximum Temperature	54	54	62	76	91	96	97	96	84	68	56	50	97	4
No. of Years of Record	16	17	17	15	16	17	16	17	17	17	17	16		
Extreme Minimum Temperature	-11	-9	-3	14	28	34	40	40	30	25	-1	-13	-13	4
No. of Years of Record	15	17	17	16	16	16	16	16	17	17	16	16		
No. of Days with Frost	27	21	22	11	2	0	0	0	*	4	16	26	129	4
Mean Rainfall (inches)	6.19	6.60	5.70	5.05	2.94	2.29	2.08	3.20	7.67	13.59	9.56	7.56	72.43	8
Mean Snowfall	70.4	39.6	17.7	5.0	0.0	0.0	0.0	0.0	0.0	2.9	23.2	52.6	211.4	4
Mean Total Precipitation	13.23	10.56	7.47	5.55	2.94	2.29	2.08	3.20	7.67	13.88	11.88	12.82	93.57	8
Greatest Rainfall in 24 Hours	3.44	3.41	4.25	2.12	1.77	1.12	1.64	2.10	2.79	4.70	3.80	4.18	4.70	4
No. of Years of Record	14	16	16	15	15	15	16	15	16	14	14	14		
Greatest Snowfall in 24 Hours	29.0	23.0	18.5	8.5	T	0.0	0.0	0.0	0.0	13.0	23.0	22.5	29.0	4
No. of Years of Record	14	17	17	16	16	17	17	16	16	16	17	16		
Greatest Precipitation in 24 Hours	3.44	3.41	4.25	2.27	1.77	1.12	1.64	2.10	2.79	4.70	3/80	4.18	4.70	4
No. of Years of Record	14	16	16	15	15	15	16	15	16	14	14	14		
No. of Days with Measurable Rain	10	12	13	14	12	10	12	15	15	22	17	13	165	4
No. of Days with Measurable Snow	13	8	7	2	0	0	0	0	0	1	6	11	48	4
No. of Days with M. Precipitation	20	17	16	14	12	10	12	15	15	22	20	22	195	4

* Less than one day in an average year
T Trace

Appendix 2a. Kitimat River below Hirsch Creek - Station No. 08FF001
Monthly and Annual Mean Discharge in Cubic Meters Per Second for the Period of Record

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1964	---	---	---	---	---	---	---	---	165	250	108	78.7	---
1965	61.0	80.7	60.9	87.6	168	215	195	106	42.8	---	---	---	---
1966	---	---	---	---	---	322	252	201	191	212	115	95.0	---
1967	50.9	109	24.8	50.1	252	385	202	159	272	238	123	54.0	160
1968	122	38.7	72.1	95.9	264	228	216	99.7	194	209	168	44.9	146
1969	22.2	17.1	17.5	96.4	209	319	113	207	138	87.3	329	132	141
1970	30.2	65.4	55.3	66.5	150	278	210	145	122	105	53.0	16.0	108
1971	24.1	55.6	32.6	102	187	285	196	184	145	158	121	35.8	127
1972	16.7	13.7	20.2	73.2	304	358	303	152	89.9	169	137	44.7	140
1973	41.1	47.0	50.8	104	213	258	207	130	200	152	45.9	20.4	123
1974	19.9	27.8	31.6	135	182	253	223	152	133	338	73.3	138	143
1975	46.9	20.6	26.1	78.0	191	273	249	138	81.5	110	106	95.2	119
1976	111	49.7	44.8	88.0	207	296	319	234	183	210	148	89.1	165
1977	85.3	112	57.4	127	139	220	168	132	56.6	203	108	37.5	120
1978	22.8	49.8	69.8	94.5	130	210	119	150	110	202	250	53.3	122
1979	20.6	23.6	83.6	122	214	215	170	105	92.3	144	89.5	148	120
Mean	48.2	50.8	46.3	94.3	201	274	209	153	139	186	132	72.2	133

Location - Lat 54 03 34 N   Drainage Area, 1,990 km^2

Long 128 40 29 W   Natural Flow

Appendix 2b. Kitimat below Hirsch Creek - Station No. 08FF001
Annual Extremes of Discharge and Annual Total Discharge for the Period of Record

Year	Maximum Instantaneous Discharge (m^3/s)	Maximum Daily Discharge (m^3/s)	Minimum Daily Discharge (m^3/s)	Total Discharge (dam^3)*
1964	1,140 at 08:45 PST on Oct 12	892 on Oct 12	---	---
1965	1,680 A on Oct 12	1,100 A on Oct 22	22.7 on Sep 17	---
1966	1,680 A at 08:10 PST on Oct 24	1,120 A on Oct 24	---	---
1967	957 at 09:30 PST on Oct 10	886 on Sep 23	16.4 E on Mar 29	5,040,000
1968	1,080 at 11:40 PST on Jan 23	881 on Jan 23	9.34B on Jan 13	4,630,000
1969	1,540 at 15:40 PST on Nov 30	1,300 on Nov 30	14.7 B on Mar 20	4,440,000
1970	648 at 01:04 PST on Jun 3	566 on Jun 3	13.5 B on Dec 31	3,410,000
1971	1,010 at 13:30 PST on Nov 19	739 on Nov 19	13.3 B on Jan 5	4,020,000
1972	1,020 at 19:56 PST on Oct 24	665 on May 13	10.2 B on Feb 6	4,440,000
1973	674 at 23:20 PST on Sep 6	538 on May 15	9.20B on Dec 22	3,870,000
1974	2,020 E at 15:53 PST on Oct 15	1,650 E on Oct 15	13.0 B on Jan 20	4,510,000
1975	722 at 01:25 PST on Jul 27	564 on Jul 26	16.9 B on Feb 15	3,740,000
1976	1,870 at 10:20 PST on Oct 27	1,390 on Oct 27	25.1 on Mar 15	5,230,000
1977	1,770 at 14:07 PST on Oct 22	1,240 on Oct 22	21.8 B on Dec 31	3,800,000
1978	3,000 at 20:56 PST on Nov 1	2,410 on Nov 1	12.5 B on Jan 19	3,840,000
1979	1,230 at 05:10 PST on Dec 27	794 on Dec 27	16.6 B on Jan 19	3,770,000

A - Manual Gauge (See Reference Index)
B - Ice Conditions
E - Estimated
* - Extreme Recorded for the Period of Record 4,210,000

* dam^3 = $decameters^3$

Appendix 2c. Little Wedeene River below Bowbyes Creek - Station No. 08FF003
Monthly and Annual Mean Discharges in Cubic Metres Per Second for the Period of Record

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1966	---	---	---	---	---	45.0	35.9	20.1	22.5	20.0	9.81	5.41	---
1967	3.94	6.21	2.76	4.65	34.4	49.2	25.1	13.0	34.3	35.3	13.1	4.84	18.9
1968	7.99	4.98	15.2	11.9	36.6	34.0	25.7	11.0	21.8	32.4	23.0	4.87	19.2
1969	1.80	1.34	1.48	11.9	30.1	45.1	17.8	25.6	14.6	12.2	35.5	8.94	17.2
1970	3.35	7.96	8.24	9.83	27.6	41.6	31.9	17.3	18.2	15.0	9.45	2.84	16.1
1971	3.29	5.79	3.56	13.8	27.9	39.2	27.4	27.5	21.3	19.2	13.6	3.56	17.2
1972	1.88	1.67	3.22	8.10	37.3	46.6	39.2	17.8	11.7	16.6	16.9	4.59	17.2
1973	4.36	5.49	3.98	10.7	28.2	37.3	29.0	14.6	19.9	18.7	3.83	2.84	15.0
1974	1.89	2.19	2.73	14.2	27.0	37.1	29.1	18.1	12.6	33.4	8.59	12.8	16.8
1975	5.09	2.93	2.86	7.18	28.9	42.0	36.6	16.1	8.87	18.0	10.1	8.53	15.7
1976	15.0	5.26	4.80	10.8	32.3	44.9	44.1	28.9	22.08	25.2	20.3	11.4	22.2
1977	11.4	17.9	6.18	27.7	27.7	48.2	15.8	9.98	6.58	24.3	15.5	3.91	17.9
1978	2.20	3.58	6.73	14.1	24.3	26.8	10.4	11.5	16.4	27.4	---	---	---
1979	---	---	---	---	---	30.5	16.3	8.10	11.5	14.9	18.5	16.3	---
Mean	5.18	5.44	5.15	12.1	30.2	40.5	27.5	17.1	17.4	22.3	15.2	6.99	17.6

Location - Lat 54 08 11 N
Long 128 41 24 W Natural Flow

Appendix 2d. Little Wedeene River below Bowbyes Creek - Station No. 08FF003
Annual Extremes of Discharge and Annaul Total Discharge for the period of Record.

Year	Maximum Instantaneous Discharge (m^3/s)	Maximum Daily Discharge (m^3/s)	Minimum Daily Discharge (m^3/s)	Total Discharge (dam^3)
1966	173 at 03:15 PST on Oct 24	86.4 on Oct 24	---	
1967	172 at 02:50 PST on Oct 10	123 on Sep 23	1.53 on Mar 31	598,000
1968	141 at 08:30 PST on Sep 24	107 on Nov 19	0.963 B on Jan 12	606,000
1969	152 at 09:00 PST on Nov 30	97.1 on Nov 29	1.22 B on Mar 18	543,000
1970	114 at 18:24 PST on Jul 3	87.2 on Jun 2	1.95 B on Mar 31	509,000
1971	126 at 02:31 PST on Oct 6	98.0 on Sep 12	1.81 B on Jan 6	543,000
1972	117 at 14:55 PST on Oct 24	78.7 on Oct 24	1.26 B on Feb 8	543,000
1973	82.7 at 00:04 PST on Oct 27	70.5 on Jun 6	1.60 B on Dec 31	472,000
1974	214 at 09:42 PST on Oct 15	131 on Oct 15	1.34 B on Jan 21	528,000
1975	114 at 22:56 PST on Jul 25	92.0 on Jul 26	2.39 B on Feb 15	495,000
1976	300 E at 20:19 PST on Nov 3	210 E on Nov 3	2.63 B on Mar 14	702,000
1977	---	119 E on Jan 17	2.04 B on Dec 31	563,000
1978	382 at 10:40 PST on Nov 1	274 on Nov 1	1.33 B on Jan 21	---
1979	334 at 20:15 PST on Nov 21	156 on Nov 21	---	---

B - Ice Conditions

* - Extreme Recorded for the Period of Record 555,000

E - Estimated

* dam^3 = decameters*

Appendix 2e. Hirsch Creek near the Mouth - Station No. 08FF002
Monthly and Annual Mean Discharges in Cubic Metres Per Second for the Period of Record

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1966	---	---	---	---	34.4	53.9	46.5	27.2	25.9	18.6	21.1	8.89	---
1967	7.46	9.10	5.27	7.69	40.4	66.4	32.4	20.0	42.1	33.7	14.6	6.51	23.8
1968	13.8	6.13	13.1	12.8	46.3	41.7	37.0	14.5	33.7	36.2	25.8	7.55	24.1
1969	2.50	1.68	1.90	14.8	25.5	47.7	17.0	36.2	19.8	15.7	59.2	21.3	22.8
1970	4.21	6.71	8.40	9.97	28.6	50.0	35.0	25.5	21.2	18.6	7.97	1.80	18.2
1971	2.63	6.35	3.72	3.72	34.5	51.2	30.1	25.1	22.5	25.3	20.5	3.82	19.9
1972	1.89	1.19	3.00	8.41	52.8	65.9	50.3	21.4	13.2	31.1	20.9	7.25	23.2
1973	5.41	7.74	6.58	13.9	38.3	45.8	40.8	20.7	41.8	27.4	4.72	1.85	21.3
1974	1.41	2.02	2.74	15.7	29.8	47.2	42.1	23.4	18.3	68.4	10.7	19.6	23.6
1975	5.94	2.77	3.29	10.1	33.6	52.4	44.1	24.1	14.5	19.3	17.0	14.9	20.3
1976	15.7	6.65	5.32	12.7	35.2	55.0	57.8	39.1	28.9	37.9	30.3	20.7	28.9
1977	17.2	15.8	6.94	21.7	24.7	40.6	31.3	20.0	9.84	37.5	15.5	4.57	20.5
1978	1.93	3.34	6.17	14.7	24.0	38.4	18.3	24.2	16.8	37.4	51.6	9.86	20.6
1979	2.82	3.48	10.5	19.5	36.6	41.3	28.4	13.9	12.8	26.6	11.5	19.5	19.0
Mean	6.38	5.61	5.92	13.4	35.3	49.8	36.5	24.0	23.0	32.4	22.2	10.7	22.0

Location - Lat 54 03 48 N Drainage Area, 347 km^2

Long 128 36 00 W Natural Flow

Appendix 2f. Hirsch Creek near the Mouth - Station No. 08FF02
Annual Extremes of Discharge and Annual Total Discharge for the Period of Record

Year	Maximum Instantaneous Discharge (m^3/s)	Maximum Daily Discharge (m^3/s)	Minimum Daily Discharge (m^3/s)	Total Discharge (dam^3)*
1966	382 at 12:30 PST on Oct 24	187 on Oct 24	---	---
1967	136 at 14:00 PST on Oct 8	128 on Sep 23	3.11 B on Dec 25	751,000
1968	155 at 00:30 PST on Oct 17	106 on Oct 23	1.43 B on Jan 13	762,000
1969	402 at 11:00 PST on Nov 30	282 on Nov 30	1.55 B on Mar 19	719,000
1970	123 at 20:27 PST on Jun 2	101 on Jun 2	1.48 B on Dec 31	575,000
1971	251 at 09:58 PST on Nov 19	163 on Nov 19	1.44 B on Jan 4	627,000
1972	245 at 15:00 PST on Oct 8	141 on Oct 8	0.776B on Mar 11	733,000
1973	262 at 19:45 PST on Sep 8	126 on Sep 2	0.657B on Dec 21*	672,000
1974	807E at 11:12 PST on Oct 15*	566E on Oct 15*	0.929B on Jan 20	745,000
1975	2.20 at 04:22 PST on Nov 3	138 on Jul 16	2.27 B on Feb 15	639,000
1976	3.57 at 08:50 PST on Oct 27	221 on Oct 27	2.55 on Mar 14	913,000
1977	388 at 08:15 PST on Oct 22	265 on Oct 22	1.93 B on Dec 31	646,000
1978	691 at 11:45 PST on Nov 1	541 on Nov 1	1.06 B on Jan 19	650,000
1979	187 at 21:45 PST on Dec 26	110 on Dec 27	2.21 B on Jan 20	599,000

B - Ice Conditions
E - Estimated
* dam^3 = $decameters^3$

* - Extreme Recorded for the Period of Record 695,000

Appendix 3a. Geological Survey Canada (1979) Accelerated Streamflow Data.

Data List Legend

Sample Type :	SW/S	Simultaneous Stream Water and Sediment
	SB/S	Stream Bed Sediment
Sample Composition:	0	Absent
	1	Minor 33%
	2	Medium 33 - 67%
	3	Major 67%
Stream Type:	PER	Permanent, Continous
	INT	Intermittent, Seasonal
Stream Class:	PEM	Primary
	SEC	Secondary
	TER	Tertiary
Water Source:	GW	Groundwater
	SM	Snow Melt or Spring Run-off
	IC	Ice-cap or Glacier Melt Water
	UNK	Unknown
Flow :	NA	Not Available
	SLW	Slow
	MOD	Moderate
	FST	Fast
	TOR	Torrential
Drainage Pattern:	PDF	Poorly Defined
	DEN	Dendritic
	HBN	Herring Bone
Water Colour:	CLR	Clear
	WHC	White, Cloudy
Bank Type:	ALL	Alluvial
	COL	Colluvial (Residual) and Mountain Soils
	GTT	Glacial Till, Tillite

APPENDIX 3b - GEOLOGICAL SURVEY CANADA (1979) ACCELERATED STREAMFLOW DATA

KITIMAT RIVER TRIBUTARY DATA

Sample Site No. (from Figure 8)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SAMPLE TYPE	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SB/S	SW/S	SB/S
Sediment Composition																		
(a) Sands	1	0	1	1	2	2	2	2	2	2	1	3	1	1	2	2	0	3
(b) Fines	2	3	3	2	2	1	1	2	1	1	3	1	2	2	1	1	3	1
(c) Organics	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stream Type	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	INT	PER	INT
Stream Class	PRM	PRM	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC
Water Source	IC	IC	IC	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
Flow	FST	FST	MOD	FST	FST	FST	FST	FST	FST	MOD	FST	MOD	FST	MOD	FST	N/A	SLW	N/A
Drainage Pattern	DEN	DEN	DEN	HBN	HBN	HBN	HBN	HBN	HBN	HBN	DEN	HBN	HBN	HBN	HBN	HBN	HBN	HBN
Water Colour	WHC	WHC	WHC	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	N/A	CLR	N/A
Bank Type	COL	COL	ALL	ALL	COL	ALL	ALL	GTT	GTT	ALL	COL	ALL	ALL	ALL	ALL	ALL	ALL	ALL
Metals (mgl)																		
T. Cu	32	16	20	26	24	22	22	8	16	26	220	36	54	68	48	84	28	72
T. Hg	20	10	10	40	20	20	20	20	20	40	30	20	10	40	40	90	20	60
T. Mn	380	230	200	635	400	330	330	155	285	555	805	530	685	840	900	1200	345	625
T. Pb	1	1	1	1	1	1	1	1	1	1	1	1	1	11	26	46	3	10

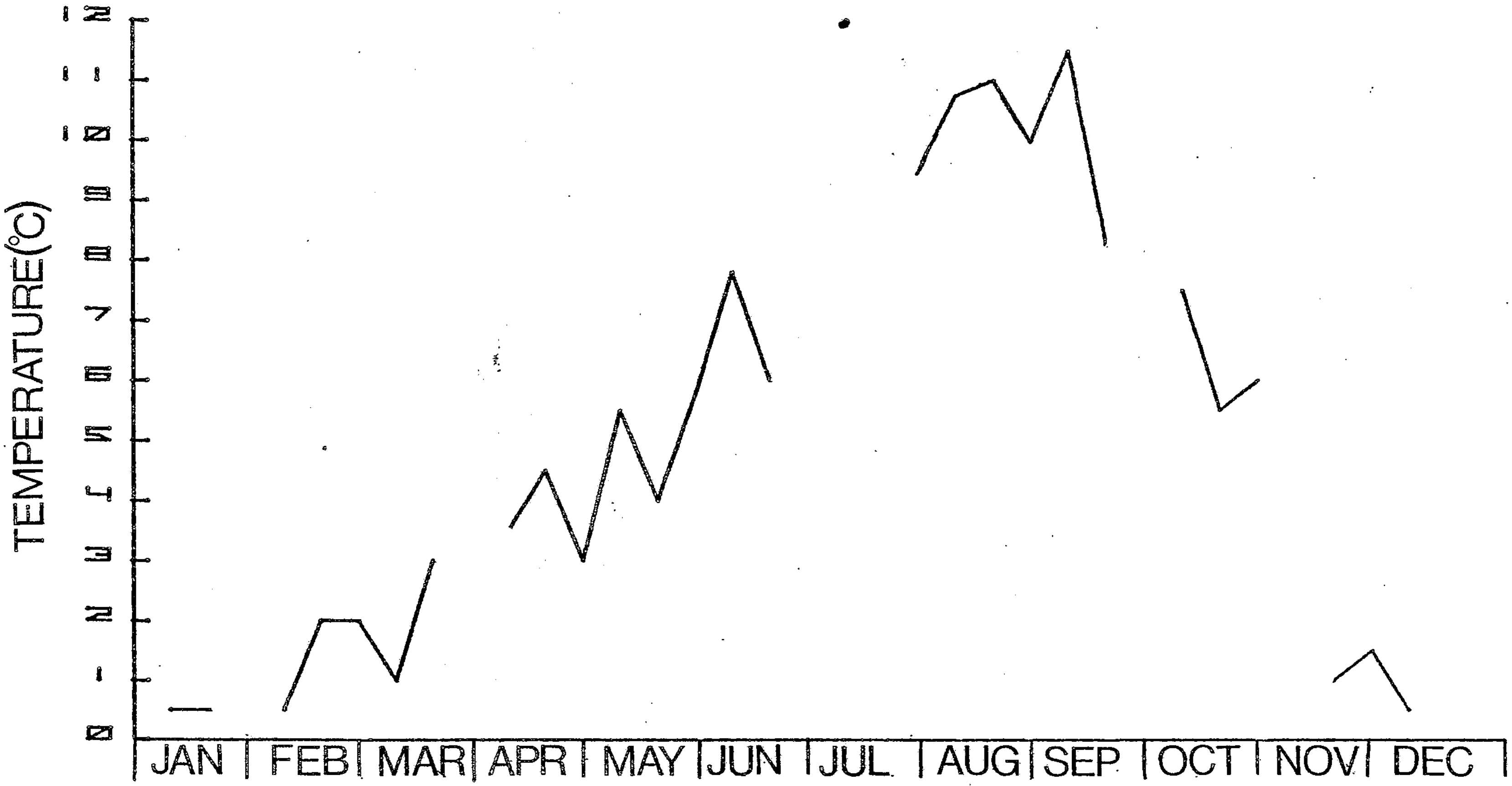
APPENDIX 3c – GEOLOGICAL SURVEY CANADA (1979) ACCELERATED STREAMFLOW DATA

WEDEENE RIVER TRIBUTARY DATA

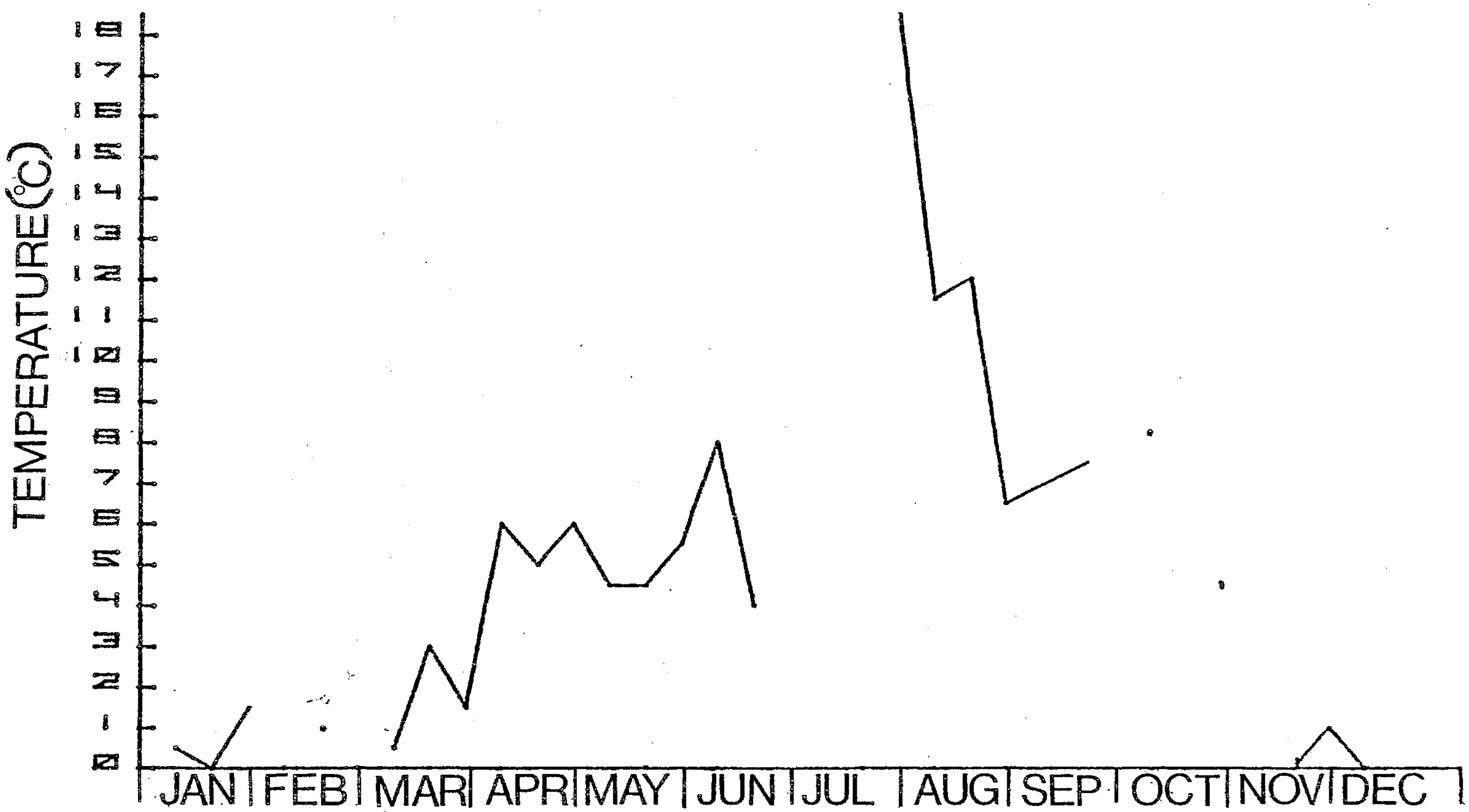
Sample Site No. (from Figure 8)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SAMPLE TYPE	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S	SW/S
Sediment Composition																		
(a) Sands	2	1	1	2	2	0	1	1	1	1	1	2	1	1	1	1	1	1
(b) Fines	2	2	2	2	2	2	2	2	2	2	2	1	2	1	2	3	3	3
(c) Organics	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Stream Type	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER	PER
Stream Class	TER	TER	TER	TER	TER	TER	TER	TER	TER	TER	TER	TER	TER	SEC	SEC	SEC	TER	TER
Water Source	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	GW	GW	GW	IC	GW	GW	SM	GW
Flow	MOD	FST	TOR	TOR	FST	MOD	SLW	MOD	SLW	MOD	MOD	MOD	FST	TOR	TOR	TOR	MOD	MOD
Drainage Pattern	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	PDF	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN
Water Colour	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR
Bank Type	COL	COL	COL	COL	COL	COL	COL	COL	COL	COL	GTT	ALL	ALL	COL	ALL	COL	COL	GTT
Metals (mgl)																		
T. Cu	12	22	12	38	48	16	24	32	34	26	2	46	14	50	50	22	78	8
T. Hg	20	5	10	5	5	90	20	90	40	30	20	20	10	10	10	10	10	20
T. Mn	410	440	475	620	460	290	500	345	610	630	500	790	400	320	180	395	460	375
T. Pb	1	1	3	1	1	4	4	1	1	5	1	4	2	1	1	4	1	4
T. Zn	42	46	36	54	42	32	52	36	54	70	18	80	48	30	22	42	42	36

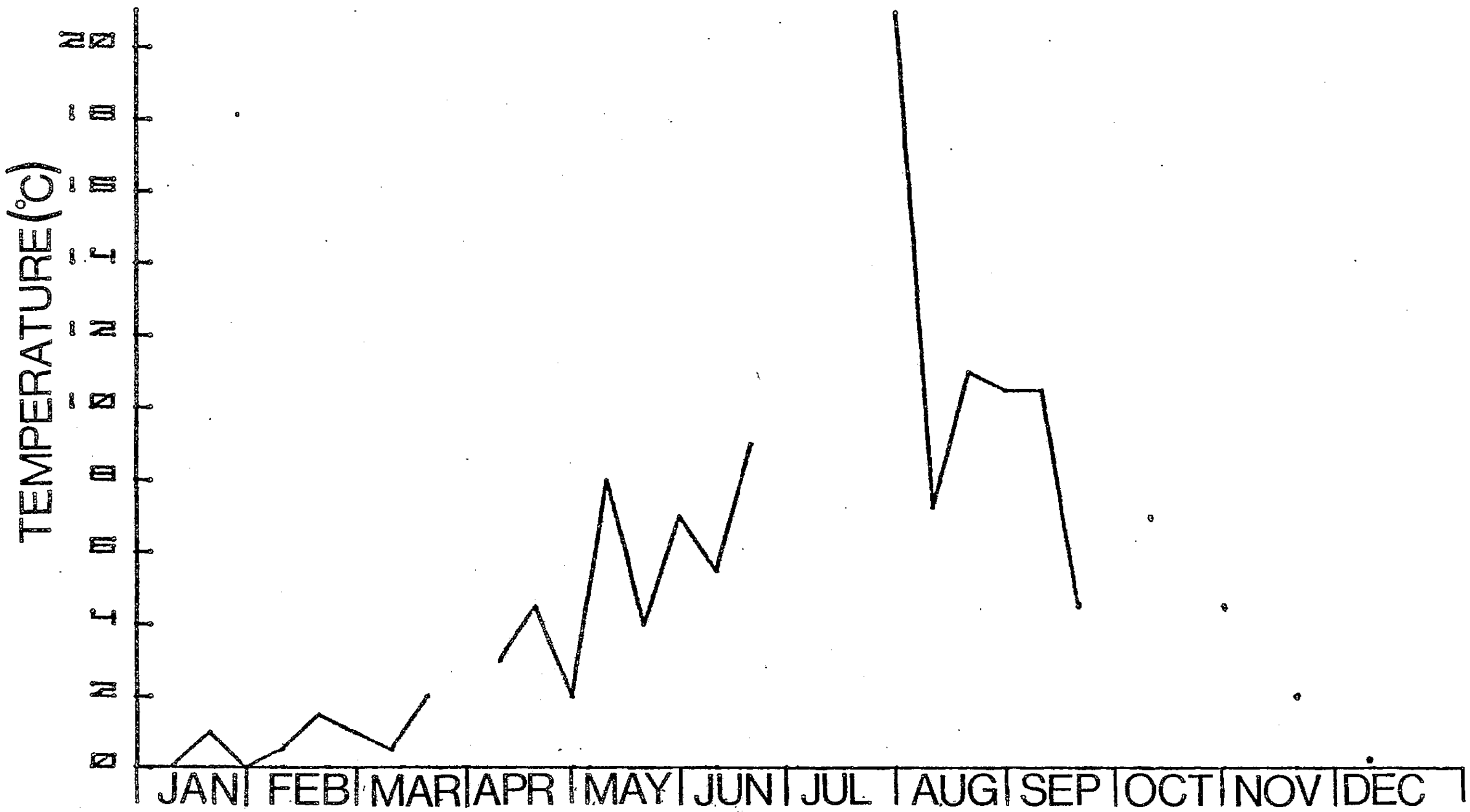
Appendix 4a. Kitimat River below Hirsch Creek. Monthly average water temperature (W.S.C., 1977)



Appendix 4b. Little Wedeene River below Bowbyes Creek. Monthly average water temperatures (W.S.C., 1977)



Appendix 4c. Hirsch Creek near the mouth. Monthly average water temperatures(W.S.C., 1977)



Appendix 5a. Dala River. Area 6. Escapement and Spawner Timing in the Dala River from F381.

1. Chum Salmon

A. Timing

(i) Arrival

Chum spawners have historically entered the Dala River on approximately August 1st, with the ranges of mid-July to August 20th.

(ii) Spawning

	Mean Date	Range
Start	August 10	early August-September
Peak	August 25	August 10-September
End	mid-September	early-September-late September

B. Distribution

Chum spawners are present throughout the first 8 miles of the Dala River. While some fish spawn in areas of the stream under tidal influence, upstream spawners concentrate their activities near the old bridge, 1.5 miles from mouth and 3.5 miles from the mouth. Recent returning spawners (1980) have concentrated their efforts in the first 2 km of the river, below the first set of rapids.

C. Abundance

1949	-	7,500	1965	-	1,500
1950	-	3,500	1966	-	50,000
1951	-	25,000	1967	-	3,500
1952	-	NR	1968	-	15,000
1953	-	7,500	1969	-	2,500
1954	-	3,500	1970	-	3,500
1955	-	750	1971	-	2,000
1956	-	750	1972	-	9,000
1957	-	750	1973	-	10,000
1958	-	7,500	1974	-	15,000
1959	-	750	1975	-	3,000
1960	-	400	1976	-	500
1961	-	200	1977	-	4,000
1962	-	15,000	1978	-	5,000
1963	-	3,500	1979	-	16,000
1964	-	3,500	1980	-	4,500

NR - No Report NO - None Observed

2. Pink Salmon

A. Timing

(i) Arrival

Mean Date	Range
August 5	July 20-late August

(ii) Spawning

	Mean Date	Range
Start	August 15	early August-September
Peak	August 30	mid-August-September
End	September 15	late August-early October

B. Distribution

Pink spawners are found throughout the first 6 km of the river. The majority of pinks are concentrated between the 1.9 and 3.0 mile marks of the river.

C. Abundance

Odd Year		Even Year	
1949	15,000	1950	1,500
1951	15,000	1952	NR
1953	3,500	1954	1,500
1955	1,500	1956	750
1957	400	1958	15,000
1959	400	1960	750
1961	NO	1962	35,000
1963	1,500	1964	15,000
1965	1,500	1966	80,000
1967	15,000	1968	15,000
1969	500	1970	15,000
1971	2,500	1972	24,000
1973	500	1974	20,000
1975	500	1976	4,000
1977	500	1978	20,000
1979	2,000	1980	6,000

3. Coho Salmon

A. Timing

(i) Arrival

Mean Date	Range
August 15	August 1 - September

(ii) Spawning

	Mean Date	Range
Start	late August	August - September
Peak	September 15	August - October
End	early October	September - December

B. Distribution

Coho seem to be found mainly in the upper reaches of the river. However, a number of spawners seem to utilize an area just upstream of the old bridge.

C. Abundance

1949 -	3,500	1965 -	3,500
1950 -	1,500	1966 -	3,000
1951 -	2,500	1967 -	7,500
1952 -	NR	1968 -	3,500
1953 -	1,500	1969 -	2,500
1954 -	3,500	1970 -	3,500
1955 -	1,500	1971 -	3,500
1956 -	1,500	1972 -	2,500
1957 -	NO	1973 -	3,000
1958 -	1,500	1974 -	3,500
1959 -	3,500	1975 -	3,500
1960 -	NO	1976 -	2,500
1961 -	NO	1977 -	2,500
1962 -	3,500	1978 -	3,000
1963 -	200	1979 -	5,000
1964 -	7,500	1980 -	3,000

4. Chinook Salmon

A. Timing

(i) Arrival

Mean Date	Range
June 15	May - July 15

(ii) Spawning

	Mean Date	Range
Start	July 15	June - August
Peak	August 15	late July - September
End	September 15	July - October

B. Distribution

Chinook spawners can be found throughout the Dala River. A concentration of spawners appears to exist at the 3.9 mile mark of the river. There is probably some utilization of Dahlaks Creek, and, in the mainstream chinook are usually found between the 2 and 7 mile mark.

C. Abundance

1949 -	750	1965 -	750
1950 -	750	1966 -	2,500
1951 -	750	1967 -	3,500
1952 -	NR	1968 -	750
1953 -	750	1969 -	400
1954 -	750	1970 -	750
1955 -	750	1971 -	3,500
1956 -	400	1972 -	1,500
1957 -	25	1973 -	1,500
1958 -	3,500	1974 -	1,500
1959 -	750	1975 -	1,000
1960 -	25	1976 -	600
1961 -	NO	1977 -	300
1962 -	3,500	1978 -	500
1963 -	7,500	1979 -	600
1964 -	3,500	1980 -	500

5. Sockeye Salmon and Steelhead Trout

Particulars on steelhead and sockeye spawning timing and distribution are not available for the Dala system.

Appendix 5b . Kildala River. Area 6. Escapement and Spawner Timing in the Kildala River from F381.

1. Chum Salmon

A. Timing

(i) Arrival

Mean Date	Range
August 5	July - August 15

(ii) Spawning

	Mean Date	Range
Start	August 15	early August - September
Peak	August 30	mid-August - September
End	September 15	early September - October

B. Distribution

Little is reported on spawning distribution of returning Kildala chum. It seems, however, that chums are found more or less scattered evenly throughout the first 11 km of the rivers length. Chums utilize side channels wherever possible. There is no spawning by any species within the first 2 km of the river's length.

C. Abundance

1949 -	7,500	1965 -	UNK
1950 -	1,500	1966 -	5,000
1951 -	16,500	1967 -	15,000
1952 -	NR	1968 -	7,500
1953 -	7,500	1969 -	300
1954 -	1,500	1970 -	3,500
1955 -	1,500	1971 -	1,500
1956 -	750	1972 -	8,000
1957 -	1,500	1973 -	10,000
1958 -	15,000	1974 -	20,000
1959 -	400	1975 -	4,000
1960 -	200	1976 -	2,000
1961 -	75	1977 -	5,000
1962 -	1,500	1978 -	5,000
1963 -	400	1979 -	9,000
1964 -	15,000	1980 -	5,000

2. Pink Salmon

A. Timing

(i) Arrival

Mean Date	Range
August 7	July 20 - late August

(ii) Spawning

	Mean Date	Range
Start	August 15	early August - early September
Peak	August 30	mid-August - mid-September
End	September 15	late August - late September

B. Distribution

Pink salmon spawners seem to be distributed evenly throughout the first 8 miles of the river's length. In this region, the spawners seem to concentrate in the river's tributaries.

C. Abundance

Odd Year	Even Year
1949 - 15,000	1950 - 1,500
1951 - 20,000	1952 NR
1953 - 1,500	1954 - 3,500
1955 - 1,500	1956 - 1,500
1957 - 750	1958 - 7,500
1959 - 750	1960 - 3,500
1961 - 25	1962 - 75,000
1963 - 400	1964 - 3,500
1965 - UNK	1966 - 50,000
1967 - 1,500	1968 - 15,000
1969 - 200	1970 - 15,000
1971 - 750	1972 - 18,000
1973 - 500	1974 - 15,000
1975 - 1,500	1976 - 3,000
1977 - 800	1978 - 20,000
1979 - 1,000	1980 - 3,000

3. Coho Salmon

A. Timing

(i) Arrival

	Mean Date	Range
	August 10	July - September 15

(ii) Spawning

	Mean Date	Range
Start	September 5	August - September
Peak	September 15	September - October
End	October 1	September - December

B. Distribution

Coho spawners in this system are reported above the 8 km mark of the river.

C. Abundance

1949	750	1965	UNK
1950	750	1966	3,000
1951	1,500	1967	3,500
1952	NR	1968	1,500
1953	750	1969	500
1954	1,500	1970	3,500
1955	750	1971	750
1956	750	1972	1,500
1957	NO	1973	2,500
1958	750	1974	2,000
1959	750	1975	2,000
1960	0	1976	4,000
1961	0	1977	2,000
1962	750	1978	2,000
1963	NO	1979	6,000
1964	3,500	1980	3,000

4. Chinook Salmon

A. Timing

(i) Arrival

	Mean Date	Range
	late June	May - August

(ii) Spawning

	Mean Date	Range
Start	July 10	June - September
Peak	August 1	July - September
End	August 25	July - September

B. Distribution

Returning adult chinook salmon have been reported spawning above the 8 km mark of the river. The first two miles of the major tributary entering at the 18 km mark is also utilized.

C. Abundance

1949	750	1965	UNK
1950	750	1966	500
1951	750	1967	750
1952	NR	1968	750
1953	750	1969	300
1954	750	1970	1,500
1955	750	1971	750
1956	400	1972	750
1957	26	1973	1,500
1958	750	1974	500
1959	75	1975	600
1960	75	1976	500
1961	75	1977	300
1962	1,500	1978	500
1963	NO	1979	500
1964	200	1980	500

5. Sockeye Salmon and Steelhead Trout

No sockeye salmon have ever been recorded in the Kildala River. Nothing has been reported regarding steelhead spawning time, however, migrating steelhead may have entered the river in June according to a solitary report in the F381 records.

Appendix 5c. Bish Creek. Area 6.- Escapement and Spawner Timing in Bish Creek from F381.

1. Chum

A. Timing

(i) Arrival

Mean Date	Range
August 7	early July - early September

(ii) Spawning

	Mean Date	Range
Start	August 15	July - September
Peak	August 25	August - October
End	September 15	August - October

B. Distribution

Chum salmon in the Bish system seem to concentrate their spawning activity within 5 km of the creeks mouth. In addition, up to 10% of the returning fish spawn in the intertidal area of the stream's mouth.

C. Abundance

1949 -	7,500	1965 -	750
1950 -	1,500	1966 -	NO
1951 -	13,500	1967 -	750
1952 -	NR	1968 -	7,500
1953 -	3,500	1969 -	1,500
1954 -	1,500	1970 -	1,500
1955 -	1,500	1971 -	400
1956 -	1,500	1972 -	2,700
1957 -	75	1973 -	3,000
1958 -	400	1974 -	6,000
1959 -	200	1975 -	100
1960 -	750	1976 -	50
1961 -	75	1977 -	400
1962 -	200	1978 -	2,000
1963 -	400	1979 -	600
1964 -	750	1980 -	1,500

2. Pink Salmon

A. Timing

(i) Arrival

Mean Date	Range
August 1	mid-July - August 10

(ii) Spawning

	Mean Date	Range
Start	August 15	July - September
Peak	August 30	August - September
End	September 15	August - late September

B. Distribution

Pink spawners in the Bish system are found largely below the 5 km mark of the river, with a majority concentrated in the first 2 km of its length. The intertidal zone is utilized for spawning by up to 10% of the returning adults. Early and late run pinks have been recorded in this system.

C. Abundance

Odd Year	Even Year
1949 - 100,000	1950 - 7,500
1951 - 90,000	1952 - NR
1953 - 3,500	1954 - 7,500
1955 - 1,500	1956 - 7,500
1957 - 400	1958 - 750
1959 - 200	1960 - 1,500
1961 - 15,000	1962 - 35,000
1963 - 7,500	1964 - 35,000
1965 - 7,500	1966 - 10,000
1967 - 1,500	1968 - 7,500
1969 - 500	1970 - 15,000
1971 - 25	1972 - 20,000
1973 - 2,000	1974 - 8,000
1975 - 1,000	1976 - 5,000
1977 - 1,200	1978 - 10,000
1979 - 3,000	1980 - 15,000

3. Coho Salmon

A. Timing

(i) Arrival

	Mean Date	Range
	August 15	August 1 - September 15

(ii) Spawning

	Mean Date	Range
Start	August 30	August - mid-September
Peak	September 15	September - October
End	October 10	September - November

B. Distribution

Coho spawners primarily utilize the upper reaches of the system (i.e., to 10 km) but can spawn anywhere above the 3 km mark. A coho holding pool is located about 6 km from the stream's mouth.

C. Abundance

1949 -	1,500	1965 -	1,500
1950 -	400	1966 -	NO
1951 -	6,000	1967 -	750
1952 -	NR	1968 -	750
1953 -	400	1969 -	300
1954 -	1,500	1970 -	750
1955 -	1,500	1971 -	750
1956 -	1,500	1972 -	400
1957 -	NO	1973 -	500
1958 -	400	1974 -	500
1959 -	400	1975 -	400
1960 -	0	1976 -	300
1961 -	200	1977 -	300
1962 -	400	1978 -	400
1963 -	23	1979 -	400
1964 -	15,000	1980 -	750

4. Chinook Salmon

A. Timing

(i) Arrival

	Mean Date	Range
	July	N/A

(ii) Spawning

	Mean Date	Range
Start	August	August - September 1
Peak	mid-September	August - September
End	September 15 - 17	early September - late September

B. Distribution

Chinook spawners have been, at best, intermittent in the Bish system. In the five years that have had reported chinook spawners, the preference seems to have been for beds above the 6.5 km mark of the river.

C. Abundance

1949 -	0	1965 -	0
1950 -	0	1966 -	0
1951 -	0	1967 -	0
1952 -	NR	1968 -	0
1953 -	0	1969 -	0
1954 -	0	1970 -	0
1955 -	0	1971 -	75
1956 -	0	1972 -	0
1957 -	0	1973 -	0
1958 -	0	1974 -	0
1959 -	200	1975 -	0
1960 -	0	1976 -	0
1961 -	0	1977 -	0
1962 -	200	1978 -	0
1963 -	400	1979 -	0
1964 -	25	1980 -	0

5. Sockeye Salmon and Steelhead Trout

There has never been a record of steelhead or sockeye returning to this system.

Appendix 5d . Hirsch Creek , Area 6 Escapement and Spawner Timing in Hirsch Creek from F381.

1. Chinook Salmon

A. Timing

(i) Arrival

Mean Date	Range
June 18	May 15 - August 5

(ii) Spawning

	Mean Date	Range
Start	August 1	July 15 - August 15
Peak	August 8	July 15 - August 25
End	September 4	August 15 - September 15

B. Abundance

1967 - 25	1974 - 300
1968 - 200	1975 - 100
1969 - 200	1976 - 15
1970 - 400	1977 - 140
1971 - 400	1978 - 50
1972 - 200	1979 - 100
1973 - 300	1980 - 60

2. Coho Salmon

A. Timing

(i) Arrival

Mean Date	Range
September 24	August 15 - October 15

(ii) Spawning

	Mean Date	Range
Start	October 11	August 15 - November 5
Peak	October 29	September 15 - November 15
End	November 23	October 15 - December 15

B. Abundance

1967 - 75	1974 - 500
1968 - 3,500	1975 - 200
1969 - 400	1976 - 200
1970 - 750	1977 - 200
1971 - 1,500	1978 - 200
1972 - 750	1979 - 150
1973 - 300	1980 - 300

3. Pink Salmon

A. Timing

(i) Arrival

Mean Date	Range
July 21	July 15 - August 10

(ii) Spawning

	Mean Date	Range
Start	August 4	July 15 - August 15
Peak	August 13	August 1 - August 25
End	August 29	August 15 - September 15

B. Abundance

Odd Year	Even Year
1967 - NO	1968 - 15,000
1969 - 200	1970 - 15,000
1971 - 200	1972 - 15,000
1973 - 200	1974 - 2,500
1975 - 50	1976 - 800
1977 - 50	1978 - 1,000
1979 - 40	1980 - 1,400

4. Chum Salmon

A. Timing

(i) Arrival

Mean Date	Range
July 18	July 5 - August 15

(ii) Spawning

	Mean Date	Range
Start	July 25	July 5 - August 15
Peak	August 9	July 25 - September 5
End	September 19	September 5 - October 5

B. Abundance

1967 - 200	1974 - 4,000
1968 - 200	1975 - 200
1969 - 750	1976 - 100
1970 - 750	1977 - 500
1971 - 750	1978 - 200
1972 - 1,500	1979 - 500
1973 - 3,000	1980 - 500

Appendix 5e . Little Wedeene River . Area 6 Escapement and Spawning Timing in the Little Wedeene River from F381.

1. Chinook Salmon

A. Timing

(i) Arrival

	Mean Date	Range
	June 6	May 15 - August 15

(ii) Spawning

	Mean Date	Range
Start	August 2	July 15 - August 15
Peak	August 16	August 15 - August 25
End	September 2	August 20 - September 15

B. Abundance

1967 - 750	1974 - 600
1968 - 750	1975 - 25
1969 - 750	1976 - 200
1970 - 400	1977 - 150
1971 - 750	1978 - 50
1972 - 400	1979 - 40
1973 - 200	

2. Coho Salmon

A. Timing

(i) Arrival

	Mean Date	Range
	September 2	July 25 - October 5

(ii) Spawning

	Mean Date	Range
Start	October 4	August 25 - October 25
Peak	October 25	September 20 - November 15
End	November 26	October 15 - December 15

B. Abundance

1967 - 200	1974 - 1,000
1968 - 750	1975 - 100
1969 - 750	1976 - 400
1970 - 3,500	1977 - 150
1971 - 750	1978 - 200
1972 - 1,500	1979 - 50
1973 - 400	

3. Pink Salmon

A. Timing

(i) Arrival

Mean Date	Range
July 17	July 15 - August 5

(ii) Spawning

	Mean Date	Range
Start	August 1	July 15 - August 15
Peak	August 14	July 25 - September 15
End	September 1	August 15 - September 20

B. Abundance

Odd Year	Even Year
1967 - 75	1968 - 15,000
1969 - 750	1970 - 15,000
1971 - 200	1972 - 7,500
1973 - 200	1974 - 6,000
1975 - 200	1976 - 3,000
1977 - 600	1978 - 2,000
1979 - 100	

4. Chum Salmon

A. Timing

(i) Arrival

Mean Date	Range
July 17	July 5 - August 10

(ii) Spawning

	Mean Date	Range
Start	July 30	July 10 - August 15
Peak	August 14	July 25 - September 15
End	September 15	August 20 - October 10

B. Abundance

1967 - 750	1974 - 3,500
1968 - 400	1975 - 100
1969 - 750	1976 - 400
1970 - 1,500	1977 - 500
1971 - 750	1978 - 400
1972 - 1,500	1979 - 30
1973 - 5,000	

Appendix 5f . Wedeene River. Area 6. Escapement and Spawner Timing in the Wedeene River from F381

1. Chinook Salmon

A. Timing

(i) Arrival

Mean Date	Range
June 17	May 20 - July 10

(ii) Spawning

	Mean Date	Range
Start	July 25	June 20 - August 15
Peak	August 10	July 15 - August 25
End	September 10	August 15 - September 25

B. Abundance

1967 - 1,500	1974 - 1,000
1968 - 1,500	1975 - 50
1969 - 1,500	1976 - 350
1970 - 1,500	1977 - 100
1971 - 1,500	1978 - 100
1972 - 1,500	1979 - 50
1973 - 3,500	1980 - 170

2. Coho Salmon

A. Timing

(i) Arrival

Mean Date	Range
September 3	July 25 - September 15

(ii) Spawning

	Mean Date	Range
Start	October 7	August 20 - October 25
Peak	November 1	September 15 - November 17
End	December 6	October 15 - December 25

B. Abundance

1967 - 400	1974 - 1,500 (?)
1968 - 750	1975 - 400
1969 - 1,500	1976 - 2,000
1970 - 3,500	1977 - 400
1971 - 3,500	1978 - 400 (?)
1972 - 1,500	1979 - 1,500
1973 - 400 (?)	1980 - 800

3. Pink Salmon

A. Timing

(i) Arrival

Mean Date	Range
July 22	July 5 - August 5

(ii) Spawning

	Mean Date	Range
Start	August 1	July 15 - August 15
Peak	August 18	July 25 - September 10
End	September 6	August 15 - September 15

B. Abundance

Odd Year	Even Year
1967 - 75	1968 - 7,500
1969 - 200	1970 - 15,000
1971 - NO	1972 - 35,000
1973 - 300	1974 - 8,000
1975 - 100	1976 - 3,000
1977 - 100	1978 - 3,000
1979 - 10	1980 - 500

4. Chum Salmon

A. Timing

(i) Arrival

	Mean Date	Range
	July 21	July 5 - August 10

(ii) Spawning

	Mean Date	Range
Start	July 27	July 5 - August 15
Peak	August 18	July 15 - September 10
End	September 23	September 10 - October 15

B. Abundance

1967 - 1,500	1974 - 4,000
1968 - 750	1975 - 150
1969 - 1,500	1976 - 750
1970 - 3,500	1977 - 100
1971 - 750	1978 - 1,000
1972 - 3,500	1979 - 150
1973 - 6,000	1980 - 600

Appendix 5g. Nalbeelah Creek, Area 6 Escapement and Spawner Timing in Nalbeelah Creek from F381.

1. Coho Salmon

A. Timing

(i) Arrival

Mean Date	Range
October 1	August - October 31

(ii) Spawning

	Mean Date	Range
Start	October 10	August - October 31
Peak	November 5	October 15 - November 15
End	December 4	November 15 - December 15

B. Abundance

1967 - NO	1974 - 4,000
1968 - 7,500	1975 - NO
1969 - 25	1976 - 520
1970 - 3,500	1977 - NO
1971 - 200	1978 - 1,500
1972 - 7,500	1979 - NO
1973 - 50	1980 - 800

2. Pink Salmon

A. Timing

(i) Arrival

Mean Date	Range
July 26	July 15 - August 15

(ii) Spawning

	Mean Date	Range
Start	August 9	July 15 - August 15
Peak	August 17	August 5 - August 25
End	September 3	August 15 - September 15

B. Abundance

Odd Year	Even Year
1967 - NO	1968 - 7,500
1969 - 25	1970 - 3,500
1971 - 200	1972 - 7,500
1973 - 50	1974 - 4,000
1975 - NO	1976 - 520
1977 - NO	1978 - 1,500
1979 - NO	1980 - 800

3. Chum Salmon

A. Timing

(i) Arrival

Mean Date	Range
July 23	July 15 - August 15

(ii) Spawning

	Mean Date	Range
Start	August 4	July 15 - August 15
Peak	August 18	July 25 - September 15
End	September 9	August 15 - September 15

B. Abundance

1967 - NO	1974 - 1,000
1968 - 400	1975 - 100
1969 - 75	1976 - 50
1970 - 400	1977 - 20
1971 - 200	1978 - 300
1972 - 750	1979 - NO
1973 - 700	1980 - NO

Appendix 5h . Humphreys Creek , Area 6 Escapement and Spawner Timing in Humphreys Creek from F381.

1. Chinook Salmon

A. Timing

(i) Arrival

	Mean Date	Range
	July 15	June - July 25

(ii) Spawning

	Mean Date	Range
Start	July 25	July 15 - August 5
Peak	August 5	July 15 - August 15
End	August 30	August 25 - September 5

B. Abundance

1967 - NO	1974 - NO
1968 - NO	1975 - NO
1969 - NO	1976 - 19
1970 - NO	1977 - 3
1971 - NO	1978 - NO
1972 - NO	1979 - 5
1973 - NO	1980 - 20

2. Coho Salmon

A. Timing

(i) Arrival

	Mean Date	Range
	October 4	late August - October 31

(ii) Spawning

	Mean Date	Range
Start	October 12	September 15 - October 31
Peak	November 4	October 15 - November 15
End	November 28	November 15 - December 15

B. Abundance

1967 - 25	1974 - 800
1968 - 75	1975 - 75
1969 - 400	1976 - 100
1970 - 400	1977 - 20
1971 - 750	1978 - 75
1972 - 750	1979 - 27
1973 - NO	1980 - 50

3. Pink Salmon

A. Timing

(i) Arrival

Mean Date	Range
July 24	July 15 - August 15

(ii) Spawning

	Mean Date	Range
Start	August 4	July 15 - August 15
Peak	August 13	August 1 - August 25
End	August 28	August 15 - September 25

B. Abundance

Odd Year	Even Year
1967 - NO	1968 - 3,500
1969 - 400	1970 - 7,500
1971 - 200	1972 - 7,500
1973 - 100	1974 - 5,000
1975 - 25	1976 - 3,000
1977 - 50	1978 - 4,000
1979 - 450	1980 - 1,000

4. Chum Salmon

A. Timing

(i) Arrival

Mean Date	Range
July 23	July 5 - September 5

(ii) Spawning

	Mean Date	Range
Start	July 29	July 5 - September 15
Peak	August 16	July 25 - September 25
End	September 5	August 5 - October 5

B. Abundance

1967 - 75	1974 - 1,500
1968 - 1,500	1975 - 400
1969 - 400	1976 - 750
1970 - 750	1977 - 400
1971 - 750	1978 - 1,500
1972 - 1,500	1979 - 200
1973 - 1,500	1980 - 250

Appendix 5i . Chist Creek , Area 6 Escapement and Spawner Timing in Hirsch Creek from F381

1. Chinook Salmon

A. Timing

(i) Arrival

Mean Date	Range
June 27	June 15 - August 5

(ii) Spawning

	Mean Date	Range
Start	July 29	July 15 - August 15
Peak	August 16	August 15 - August 25
End	August 29	August 15 - September 15

B. Abundance

1967 - NR	1974 - 300
1968 - NR	1975 - 50
1969 - 400	1976 - 50
1970 - 400	1977 - 20
1971 - 750	1978 - 100
1972 - 750	1979 - 60
1973 - 750	1980 - 100

2. Coho Salmon

A. Timing

(i) Arrival

Mean Date	Range
October 2	September 15 - October 25

(ii) Spawning

	Mean Date	Range
Start	October 23	October 15 - November 15
Peak	November 12	October 20 - November 25
End	December 10	October 25 - December 25

B. Abundance

1967 - NR	1974 - 1,000
1968 - NR	1975 - 200
1969 - 750	1976 - 200
1970 - 1,500	1977 - 100
1971 - 1,500	1978 - 400 (?)
1972 - 3,500	1979 - 350
1973 - 400	1980 - 350

3. Pink Salmon

A. Timing

(i) Arrival

Mean Date	Range
July 15	July 10 - July 20

(ii) Spawning

	Mean Date	Range
Start	July 27	July 15 - August 15
Peak	August 9	July 25 - August 15
End	August 19	August 15 - August 25

B. Abundance

Odd Year	Even Year
1967 - NR	1968 - NR
1969 - NO	1970 - 400
1971 - NO	1972 - 1,500
1973 - NO	1974 - 250
1975 - NO	1976 - 750
1977 - 150	1978 - 1,000
1979 - 50	1980 - 100

4. Chum Salmon

A. Timing

(i) Arrival

	Mean Date	Range
	July 22	July 15 - August 20

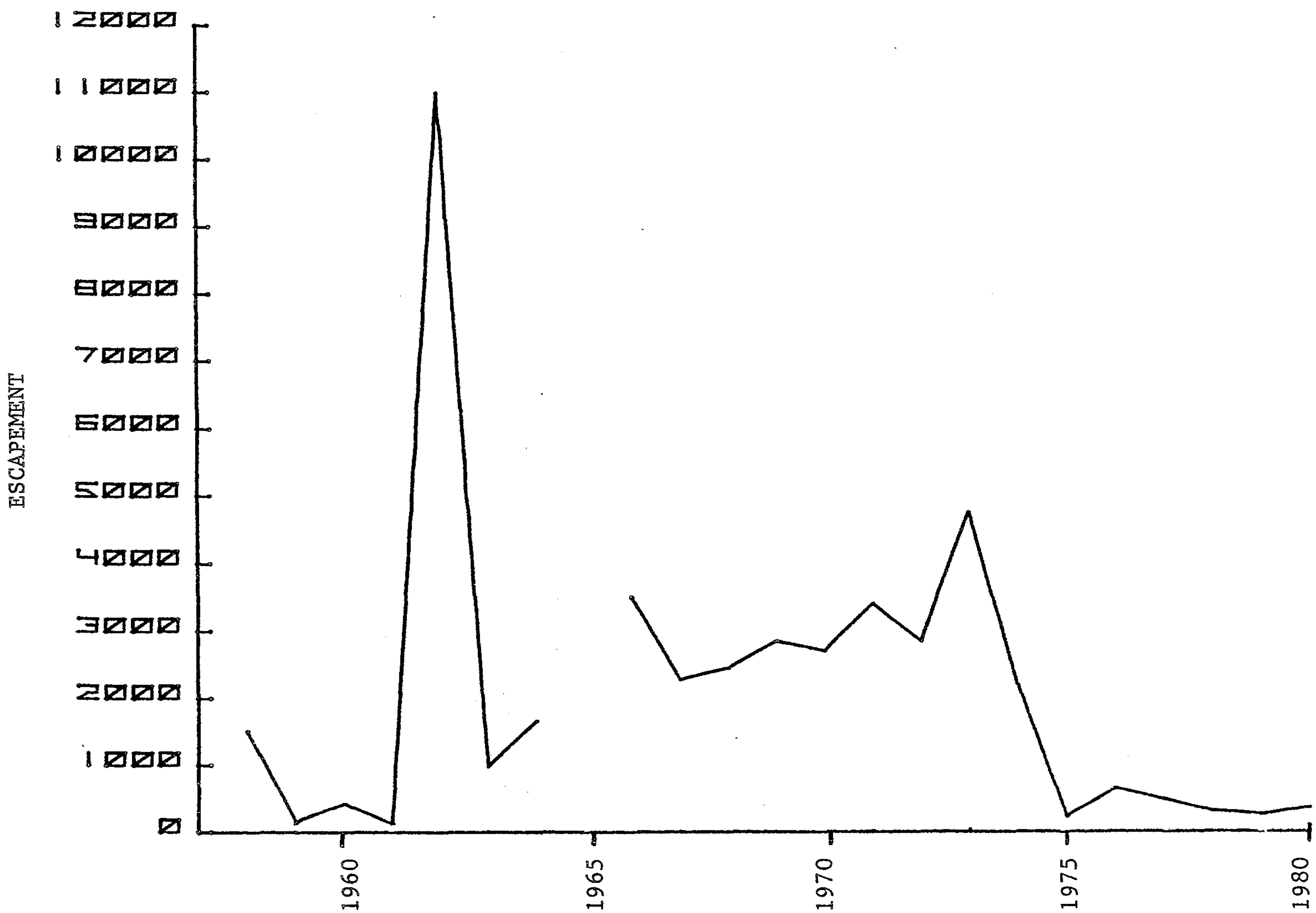
(ii) Spawning

	Mean Date	Range
Start	August 3	July 15 - August 25
Peak	August 13	August 5 - September 5
End	August 31	August 15 - September 15

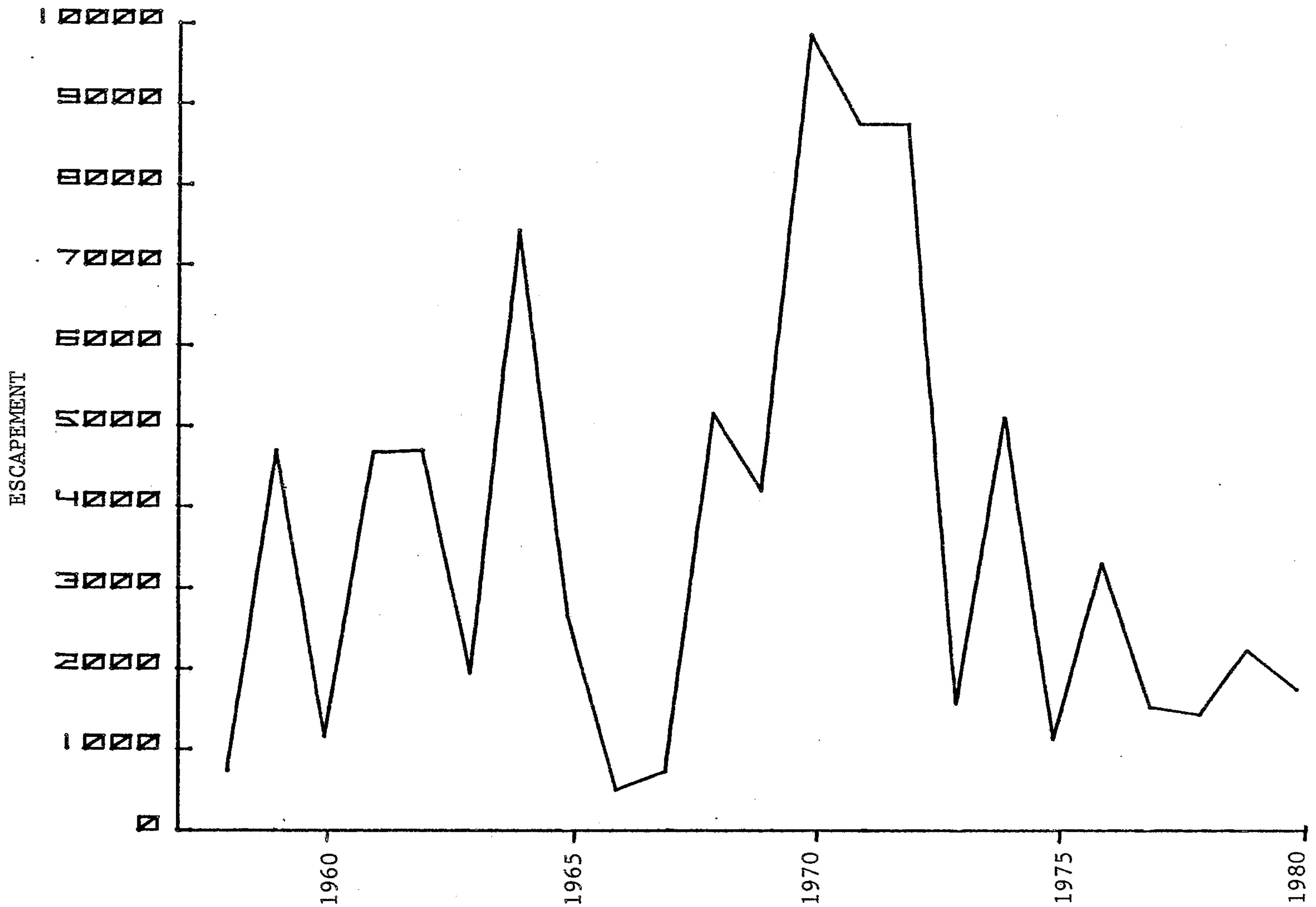
B. Abundance

1967 - NR	1974 - 200
1968 - NR	1975 - 50
1969 - 400	1976 - 200
1970 - 400	1977 - 120
1971 - 750	1978 - 300
1972 - 750	1979 - 250
1973 - 1,000	1980 - 200

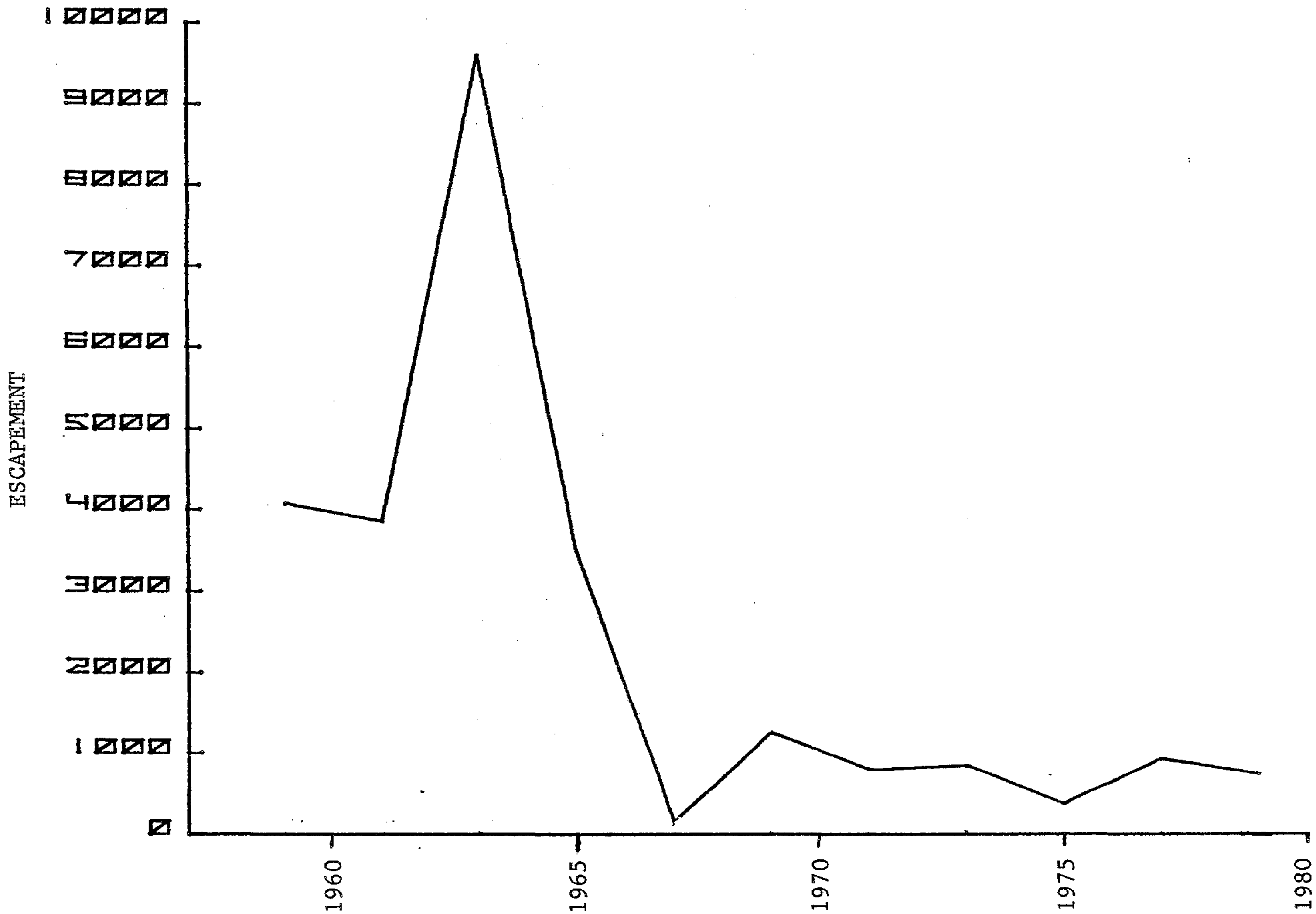
Appendix 6a. Kitimat River tributaries, Area 6(1958-1980)
Estimated Escapement of Chinook Salmon(from F381).



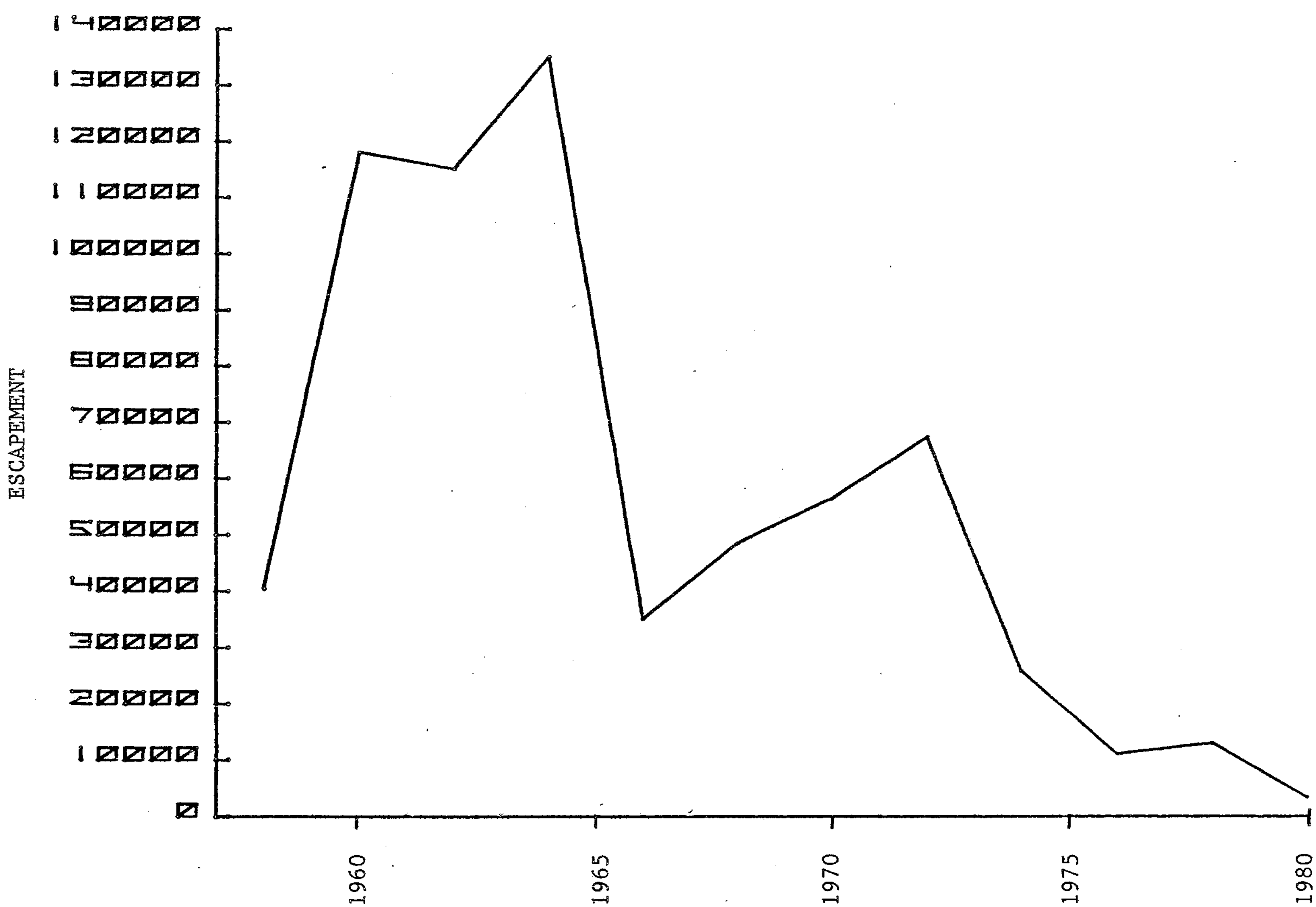
Appendix 6b. Kitimat River tributaries, Area 6(1958-1980)
Estimated Escapement of Coho Salmon(from F381).



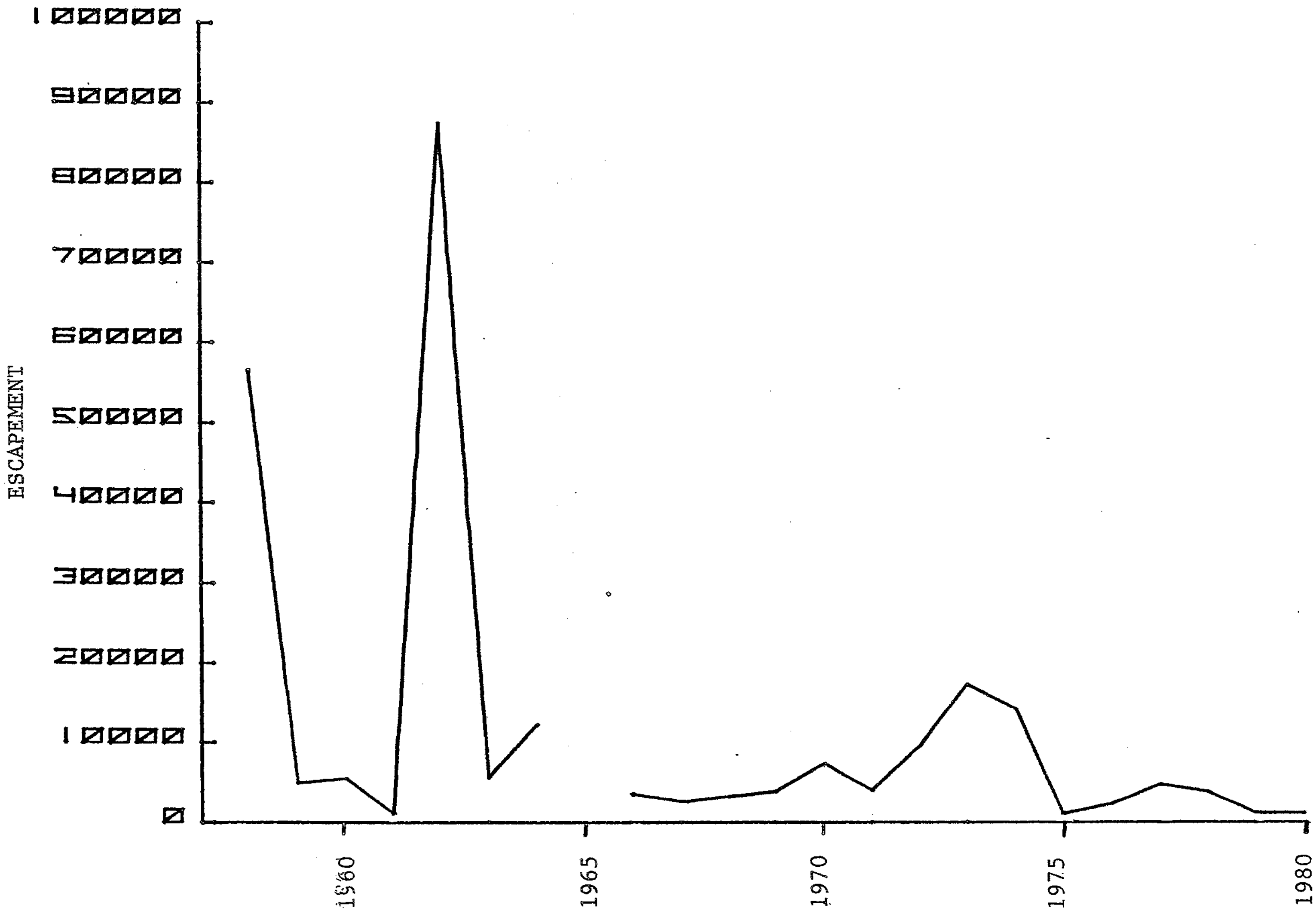
Appendix 6c. Kitimat River tributaries, Area 6(1958-1980)
Estimated Escapement of Odd Year Pink Salmon(from F381)



Appendix 6d. Kitimat River tributaries, Area 6(1958-1980)
Estimated Escapement of Even Year Pink Salmon(from F381)



Appendix 6e. Kitimat River tributaries, Area 6(1958-1980)
Estimated Escapement of Chum Salmon(from F381).



Appendix 7a. Kitimat River. Miscellaneous F381 Observations: Conditions affecting the Stream.

YEAR	OBSERVATIONS
1950	"Opaqueness of water in main river makes inspection difficult."
1956	"Large gravel removal operations from the bars in the lower portion of the river will create some scouring of the river bed during high water."
1957	"Evidence of erosion and silting within the (last) 2 miles (of river) to the estuary (ie, under tidal influence)...Changes in bars and some levelling off noticeable after gravel removal operations near main Kitimat townsite bridge."
1958	"Alcan suggesting diversion of lower river."
1959	"Raw sewage still discharging into river."
1960	"Water levels normal except in October when flood conditions prevailed."
1961	"Water levels high in fall."
1964	"Up to 10% of stream bed could be influenced by erosion and silting."
1965	"A slide 60 yards x 10 yards x 10 feet which occurred at mile 12 on September 17 caused more silt than usual to be deposited on spawning grounds downstream."
1966	"On October 24 a serious flooding condtion existed in the Kitimat River. The river flooded 3 feet higher than previously recorded. Some changes in the course of the river and some serious scouring at different locations were the result, how serious - yet to be determined."
1967	"The lower portion of this river has deteriorated badly during the past number of years....Logging has almost stripped the watershed on the lower section of the main stem and almost all tributaries on the complete system. Stable conditions that existed will not return until the stripped forest cover grows back - in 15 years?"
1968	"Logging in the Kitimat River valley is expanding at a rapid rate and is watched by area officers (as well as time permits)."
1969	"Pulp and Paper mill should be in operation by 1970."

Appendix 7a. Kitimat River. Miscellaneous F381 Observations: (cont'd)
Conditions affecting the Stream.

YEAR	OBSERVATIONS:
1970	"Severe loss of spawn during fall and winter due to low water levels and severe frost."
1971	"This river has lost much of its stability because of heavy logging in the drainage area. Several channels which were spawned during the summer dried up during the fall."
1972	"Numerous channel changes and log james caused by logging and construction of roads etc., over the past years."
1974	"Many changes in river course, bars throughout changed by October flood."
1976	"Some silt in river during periods of hat weather or during flood conditions."
1977	"Silty conditions due to hot weather conditions, ie, glacial melt."
1980	"Some erosion contributes to silting by sluffing banks near 15 miles. Heavy rains and glacial melt in the last half of December caused very high water levels, displacing gravel, uprooting some trees and moving log jams with some losses of spawn and spawning beds likely."

Appendix 7b. Kitimat River F381 Biological Conditions Summary.

YEAR	OBSERVATIONS
1951	"Spawning mostly in tributary streams. Pink and chums in some riffles in mainstem."
1952	"Trout and char are predators on young salmon."
1953	"Sockeye, coho and springs in upper reaches and tributaries."
1954	"Upper reaches and upper tributaries not inspected, estimates from main river observations, sport fishermen, locals and Indian fishery."
1956	"Seals are predators in lower portions of river."
1957	"Expect heavy loss of chum as side channels extremely low and stagnant when heaviest spawning occured in early September."
1958	"Prolific trout populations exploited by local anglers."
1959	"Normal bear and wildfowl predation on salmon."
1961	"Heavy sport fishing taking place above tidal waters and mostly in the area above 12 miles."
1962	"Unexpected good run of eulachon this year."
1963	"Sport fishing continues to be heavy and good catches of spring and coho are reported from time to time."
1964	"This year springs were more or less protected by high water conditions at the time they were entering."
1965	"Due to extremely low water condition during the months of August and September, pinks and chum salmon which normally spawn in Humphrey and Nelbeelah Creeks (Tribs. of Kitimat) were unable to enter these creeks and subsequently spawned in the mainstem of the Kitimat."
1966	"On October 24th, a serious flooding condition existed in the Kitimat. The river flooded 3 feet higher than previously recorded. Some change in the course of the river and some serious scouring at different locations were the result."

Appendix 7b. Kitimat River F381 Biological Conditions Summary (cont'd).

YEAR	OBSERVATIONS
1967	"Logging has almost stripped the watershed on the lower section of the mainstem and almost all tributaries on the entire system, stable conditions that existed previously will not return until the stripped cover grows back - in 15 years?"
1968	"A conservative estimate would place approximately 35% of the returning Spring salmon to the anglers catch. Springs are fished from May to late September on an 18 hour/day, 7 days/week basis by at least 250 ardent anglers."
1969	"Sockeye observed spawning below the confluence of Hunter Creek and the Kitimat River on September 9. This is believed to be the first time that sockeye have actually been observed spawning in this system."
1970	"Severe losses of spawn during fall and winter due to low water levels and severe frost."
1971	"Anglers travel from all parts of Canada and the United States to participate in the chinook fishery."
1973	"...a considerable amount of damage has occured in the Kitimat River to deposited salmon eggs and alevins. This damage occured...when large snow falls combined with excessive rains and mild temperatures resulted in flood conditions...This huge downstream movement of ice caused severe scouring of salmon spawning areas, resulting in the alevins being brought out of the protecting gravel and washed out of the river...Most of the damage took place in the bottom 16 or 17 miles of the river...."
1974	"Due to the great amount of erosion, scouring, channel changes, etc., in the October flood, it must be assumed that losses of spawn will make effective spawning equivalent to light or very light for all species except possibly coho."
1975	"Sports fishermen took an estimated 40% of chinook and a somewhat smaller proportion of the coho run."
1977	"Predators include birds, bears, and humans."
1980	"SEP hatchery project ook 160,000 chinook eggs, 3 times the number taken the previous year. Largest sockeye escapement on record."

Appendix 8a. Recommended Fish Culture Limits (R.F.C.L.)

Water Quality Parameter[+]	Recommended	Toxic	Source
Alkalinity, total	20-300	not lethal to pH 9.0	11
Ammonia (as NH_3)	<.002 inc. <.005 rear.	>.08	3,5,10,11
Chloride (Cl^-)	< 170		5
Chlorine Residue	<.002	>.006	10,11
Colour (TCU)	< 15		3,5,10
Conductivity (microhms/cm)	150-2000		3,5
Dissolved Gases, Total	< 103%	110%	8
N_2 + Ar	< 100%	110%	8
O_2	95-100%	< 4.0	4,5
Hardness (as $CaCO_3$)	20-400		8
pH (in pH units)	6.5-8.5	< 5;> 9	8,9,10
Phosphate, total	<.05	.01-.05 allows plankton blooms	10
Residue, filterable	70-400	2000	3
non-filterable	< 3.0 inc. < 25 rear.	1000	2,6,10
Sulphate	< 90	5000-7000	5
Temperature (°C)	> 2-3,<18-25	25.1	1,2
Turbidity (JTU)	1-60	1000	2
Metals, Al	<.1	5	4
Ca	4-150	300	5,9
Cu*	<.006 soft H_2O <.03 hard H_2O		5
Fe	<.3	1-2@ pH 5.0-6.7	3,4,9,10
Hg	<.00005	.0002	10
Mn	<.05	> 15	10
Pb	<.01	.1	4,7
Si	10-60	diatom growth inhibited below 0.5	3
Zn*	<.005 soft H_2O < 2 hard H_2O	.01-4 kills salmonids	3

* Zinc and copper should not exceed .01 and .001 respectively when they appear together. Cu at .005 mg/l may suppress gill ATPase and compromise smoltification in anadromous salmonids.[4]

\+ in mg/l except where otherwise specified

Appendix 8b. Sources of Recommended Fish Culture Limits.

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1. Brett, J.R., 1952.
2. Cleugh, T., 1978 MS.
3. Environment Canada, 1976.
4. Kramer Chin and Mayo, Inc., 1976.
5. McKee, J.E. and W.H. Wolf, 1971.
6. McLean, W.E., 1979 MS.
7. Newton, L., 1944.
8. Perry, E.A. and W.E. McLean, 1978 MS.
9. Robbins, G.B., 1976.
10. Sigma Resource Consultants, Ltd., 1976.
11. Wedemeyer, G., et al., 1976.