A Review
of the
Quesnel River Watershed

compiled by

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ABSTRACT

The Quesnel River flows from the Cariboo Mountains across the Quesnel Highlands, the Fraser Plateau and the Fraser Basin and then joins the Fraser River. The geology of the river contains rock of the Triaasic-Jurassic period including argillates, cherts, lavas, tuffs and limestone.

The river drains an area of 11,400km^2 and drops from headwaters as high as 2,000m to its confluence with the Fraser at 485m ASL.

The economy is dominated by forestry and related industries with agriculture, mining and tourism completing the economic basis. The total population of the areas that contain the watershed is 51,616. The largest settlements are Likely and Quesnel. Both towns are easily accessible via the Cariboo Highway.

The Quesnel River supports pink, sockeye and chinook salmon. Artificially enhancing the Quesnel-bound middle-timing chinook may strengthen the overall stock. No further enhancement of Fraser River sockeye and pink is recommended until an international agreement is reached.

Escapement takes place from early September to late October for all species. Pink spawners concentrate near the confluence of the river, chinook spawners in the vicinity of Likely and sockeye spawners tend to utilize the Horsefly system. There is no evidence of upward or declining trends in the abundance of chinook escapement. Sex ratios for chinooks average 45% female, with 16% of the males being jacks and 48% female for pinks. The dominant chinook age class in the escapement was four year olds. Chinook length averaged 911mm and 904mm for adult males and females respectively. The adjusted average fecundity was 5750 eggs/female.

The chinook fry emergence is completed by late June, and the fry exhibit an average growth rate of .315% length increase/day. Many of the fry rear in the foreshore areas of Quesnel Lake or migrate downstream toward the Fraser River.

Water quality in several sample sites exhibited toxic levels for many parameters measured. Two areas showed favourable levels: the Crooked Lake area on the Horsefly River and the Quesnel River just downstream from Likely.

The water temperatures of the Quesnel River are within Fish Culture Limits from mid-April to December. Throughout an average year, the water temperature extremes are zero and twenty degrees celsius.

The area has between 130 and 160 frost free days per year and a temperature range of -13 to 24 degrees C. Precipitation ranges from 300-500mm of rain with 2000 to 4000mm of snow.

At its confluence with the Fraser, the Quesnel River has flow ranges from $70m^3/s$ during the winter low to $735m^3/s$ during the freshet. The flows at the river outflow from Quesnel Lake are roughly one half those of the confluence. High water comes in early June, after a month long rapid rise in water levels.

General biophysical parameters have been examined for the area near Likely Bridge. The Quesnel River has a meander length of between .5km and 2km. It has an average gradient of .136 degrees.

ENHANCEMENT RATIONALE

The early plans regarding the enhancement of salmonids were primarily concerned with a priority for the Upper Fraser River Chinook. R.M.J. Ginetz and G.O. Nielsen conducted several bio-engineering reconnaisance surveys during different times of the year to determine suitable sites on river systems in the Upper Fraser Watershed for potential chinook enhancement opportunities. Observations consisted of both aerial and ground surveys. The results of these surveys identified the Quesnel River, particularly in the vicinity of Likely, B.C. as a suitable site for a hatchery facility.

The Fraser River, Northern B.C. and Yukon Geographical Working Group (GWG) then developed a tentative plan for the enhancement and management of Fraser River chinook. 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 (R. Harrison, memorandum, Feb. 1980). The GWG Management/Enhancement Strategy Group then characterized the Quesnel Sub-District escapement as a middle-timing chinook stock that is not included in the early-timing stock. From the information reported in the DFO Spawning Files, the Quesnel River 'middle-timing' chinook stock had an average annual escapement of 1300 spawners from 1969 to 1979. This escapement has remained relatively constant over the last 10 years showing no evidence of significant upward or declining trends. The GWG has suggested that since the migration timing partially coincides with the sockeye migration, a substantial number of chinook are caught during the commercial harvesting of sockeye and pink while passing through Area 29, during the International Pacific Salmon Fisheries Commission (IPSFC) Management period. Since the IPSFC manage the Fraser River for sockeye and pink salmon from the beginning of July through to the end of September, it has also been recommended by the GWG (May 1980) that no further enhancement of these two Fraser River species is undertaken until an international salmon agreement is reached.

The facility design for the Quesnel Hatchery (B.G. Shepherd, April 1980) is for a central satellite hatchery with adult donors taken from

the slim, Blackwater, Bowron, Willow, Cottonwood and all sub-stocks of the Quesnel River system. These sub-stocks have been identified in the Horsefly River, the Quesnel River mainstem and the Cariboo River (R.M.J. Ginetz and G.O. Nielsen, June 1980). Incubation and rearing on full groundwater only, to produce 2 to 5g fry which will then be transported to their donor streams. Sub-2 rearing of some Quesnel stock only, which will be transferred to the Quesnel River Water and held for one year in order to duplicate the natural system, has also been recommended (B.G. Shepherd).

CLIMATE

The Quesnel River Watershed lies across the boundary of the South West and South East Interior regions (Chapman et. al., 1956). The river flows from the mountainous regions of the South East into the northern plateau of the South West region.

The South East Interior region can be described as having diverse climatic characteristics, as it forms the western slope of the Rocky Mountains. The most obvious of these is a higher precipitation than the lowlands of the South West Interior. Chapman et. al. predict that between 1020mm and 1270mm of precipitation will fall annually, 900mm to 1000mm of which will fall during the winter. Of the total precipitation, 50% to 70% will fall as snow. Mean monthly temperatures should range from -12°C to -9°C in January, and from 13°C to 16°C in July.

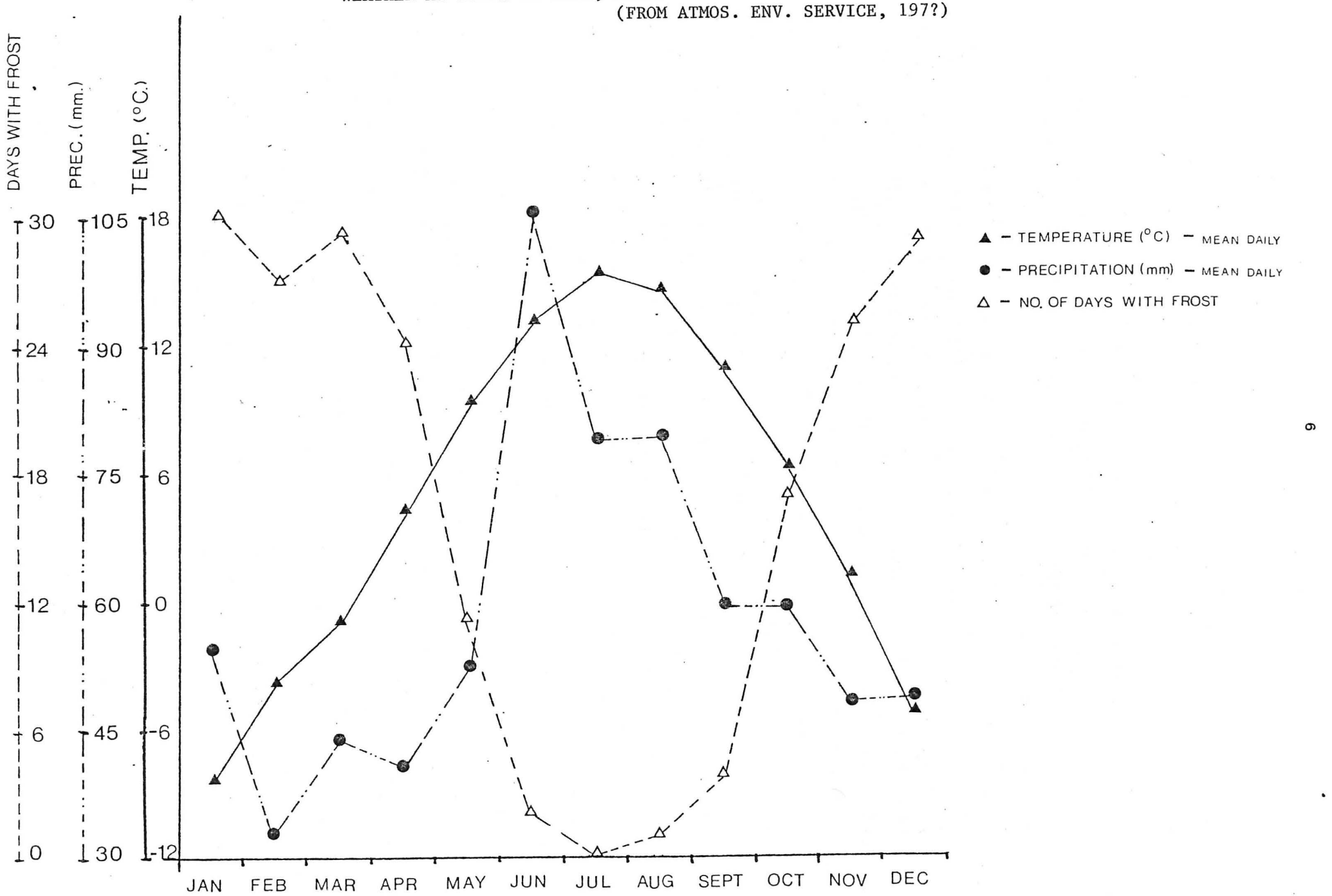
The semi-arid South West Interior region enfolds the hottest and driest areas of the province. It is subdivided by topographical influences into "valley" and "plateau" regions. The Quesnel flows through the latter. Chapman et. al. predict that between 380mm and 600mm of precipitation will fall, 30-50% of which will be received as snow. Mean monthly temperatures should range from -12° C to -6°C in January and from 13°C to 16°C in July.

As both regions are away from the moderating influence of the ocean, these wide ranges in average temperature are expected. (Chapman et. al.)

The weather station at Horsefly showed a yearly temperature range of -13.94°C in January to 23.44°C in July). Annual precipitation averaged 733mm, with June being the wettest month and February the driest. Only July is completely free of frost in an average year (figure 1).

Figure 1.

WEATHER AT HORSEFLY LAKE; DAILY MEANS OF TEMPERATURE AND PRECIPITATION
(FROM ATMOS. ENV. SERVICE, 197?)



GEOLOGY

For the most part the Quesnel River geology contains rock of the Triassic-Jurassic period including argillates, cherts, lavas, tuffs and limestones. The same types of rocks are found in the area about the city of Quesnel but date from the Permian period. The area east of Likely, in the Cariboo River watershed, in contrast, is lower Cambrian with a large proportion of older quartzite, argellites, conglomerates and schists.

The Quesnel River flows from the Cariboo Mountains, across the Quesnel Highlands, the Fraser Plateau, and the Fraser Basin, and finally joins the Fraser River.

The Cariboo Mountains are the most northerly part of the Columbia Mountain Range. They are composed of sedimentary and metamorphosed sedimentary rock, mainly quartzite.

These mountains were heavily glaciated during the Pleistocene age but peaks over 8000 feet (2,450 meters) projected through the ice sheet. These peaks were subjected to intense frost action and cirque attack. There are some rounded peaks below 7,000 to 7,500 feet (2,150 to 2,300 meters), but late cirque glaciation left many peaks with sharp northern or northeastern slopes and gentler southern or southwestern slopes. Debris left in strongly glaciated valleys has caused lakes such as Quesnel, Isaac and Lanezi Lakes to form.

The Quesnel Highland consists of the remains of a highly dissected plateau rising from 5,000 feet (1,500 meters) in the west to over 6,500 feet (2,000 meters) in the east. It is generally underlain by schistose rocks of Proterozoic and Lower Cambrian age, containing infolds of volcanic and sedintary rocks of Carboniferous and Permian age. Limestone and quartzite usually form the high peaks.

The Fraser Plateau has only a small portion lying west of the Fraser River, and this is deeply incised by the Fraser Basin along the Quesnel River. The division between the plateau and the Quesnel Highland is arbitrarily set along the 1,525m contour, as the two merge with

no distinct division. Most of the plateau is covered by glacial alluvia to the point that only about 5 percent of bedrock is exposed.

The Fraser Basin lies in a narrow strip along the Fraser River north from the Chilcotin River. It has a flat, or gently rolling surface, and lies mostly under 3,000 feet (900 meters). A narrow extension reaches into the Quesnel River Valley. The shape and slope of the basin indicates that it was eroded by a northward flowing river which flowed through the McLeod Lake gap and into the Peace River. The reversal of flow probably occurred in the late Pleistocene.

TOPOGRAPHY

The total drainage area of the Quesnel River watershed is 11,400km^2 from the confluence of the Quesnel and Fraser Rivers upstream. This area includes the Horsefly River system, which is not covered in detail here. Below Likely, which is located at the outflow of Quesnel Lake, the system drains a total of 5,650km^2.

The Quesnel River proper drains Quesnel Lake (which has an area of 275km^2 and an elevation of 723m) and drops in a generally northwestern direction to the Fraser River, entering at 485m ASL. The total drop in elevation is 238m over a distance of about 100km which has an average gradient of approximately .238%. The river flows through a fairly narrow valley with few major rapids along its course. Lying in the bottom of the valley, the river has approximately two wide sweeping turns every kilometer. Its sinuosity is 1.28 which classifies the river as straight. The valley width ranges from three-quarters to one and one-half kilometers and is characterized by steep walls. Many of the smaller tributaries fall steeply to the valley floor from their sources, lakes on the plateau above the river. Most of these smaller tributaries are from three to nine kilometers in length. The Cariboo River, the largest tributary of the Quesnel, flows into the latter from a branch of the valley.

Most of the smaller tributaries are accessible for only the first one-half to one kilometer from their confluence with the river.

The two largest settlements in the area are: Likely, at the outflow of the Quesnel River from Quesnel Lake, and Quesnel, at the confluence with the Fraser River. The latter is easily accessible via Hwy. 97. Likely is easily accessible from 150 Mile House or McLeese Lake, which are both on Hwy. 97. The only Indian Reserve along the Quesnel River is Quesnel Indian Reserve #3, on Dragon Creek near Quesnel.

Quesnel and Likely are connected by a series of roads which provide good access to the river for some of its course, however, road conditions in other than dry weather is questionable.

Figure 2. Quesnel River System Topography.

The Watershed Boundaries identify the Quesnel, Cariboo and Horsefly Rivers.

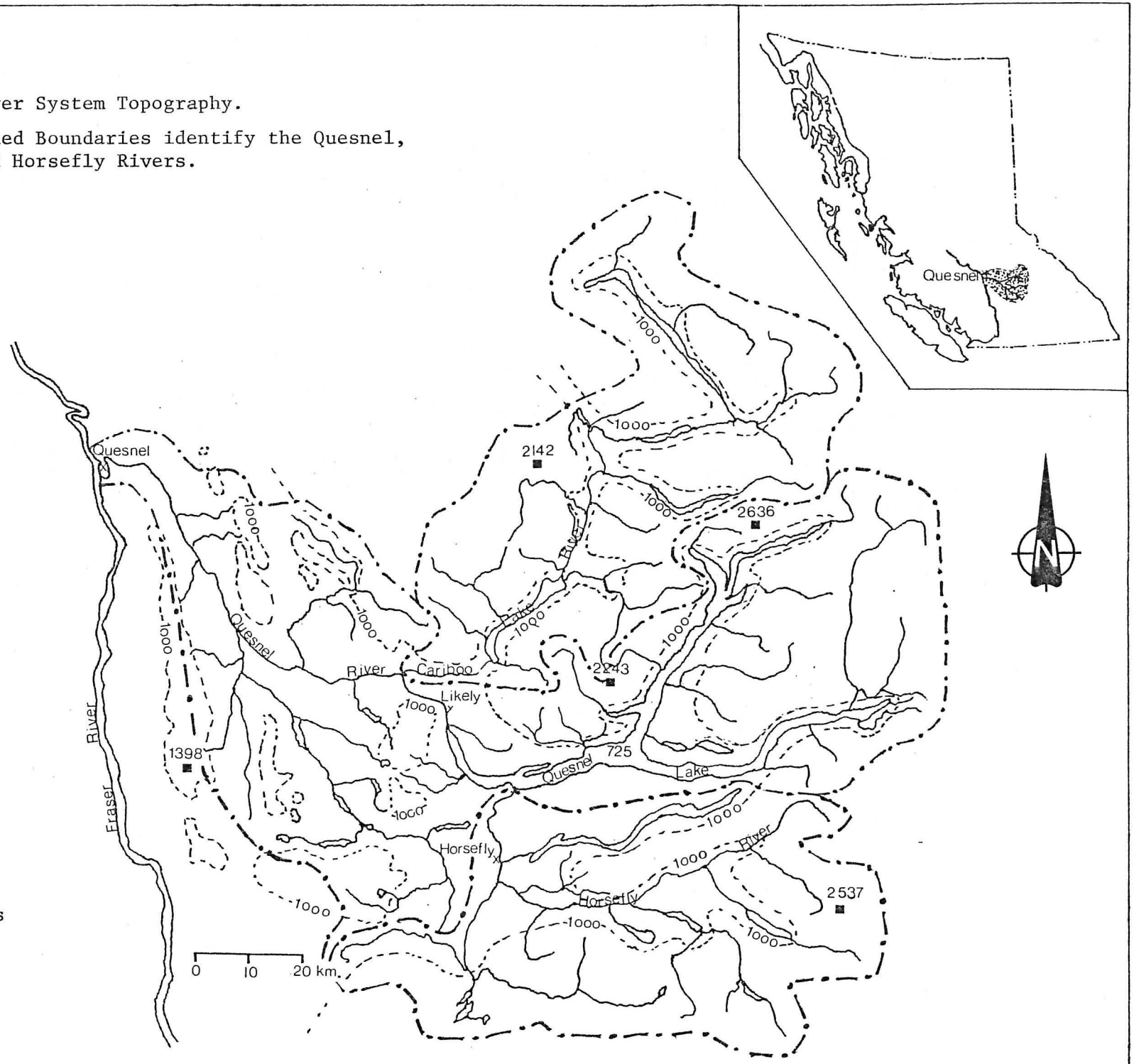


Figure 3 (a). Quesnel Watershed. Access routes, settlements and Indian Reserves.

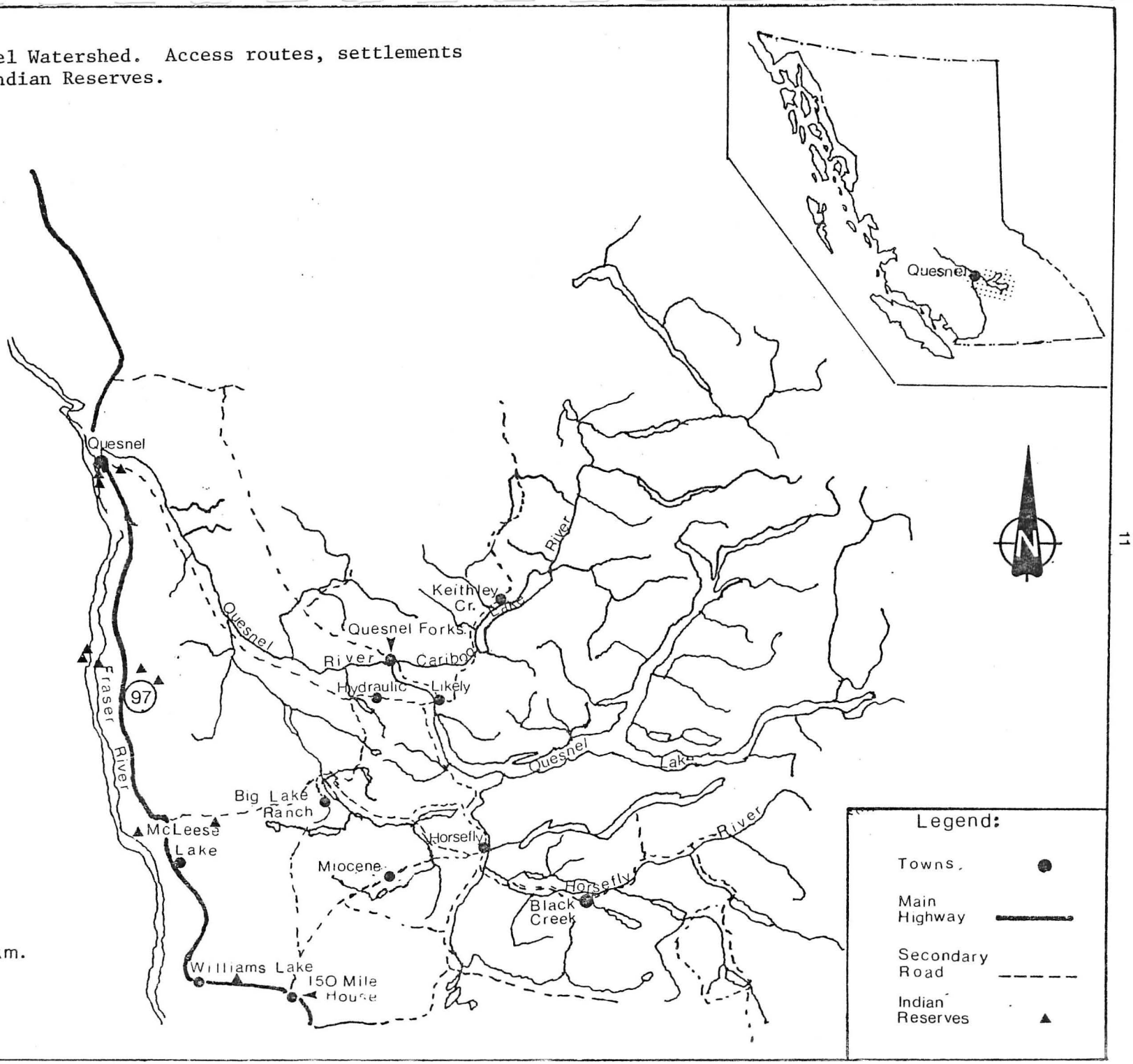


Figure 3 (b). Area near Likely Bridge showing the proposed hatchery site. (E.V.S., 1980. Chinook Enhancement Facilities - Quesnel River).

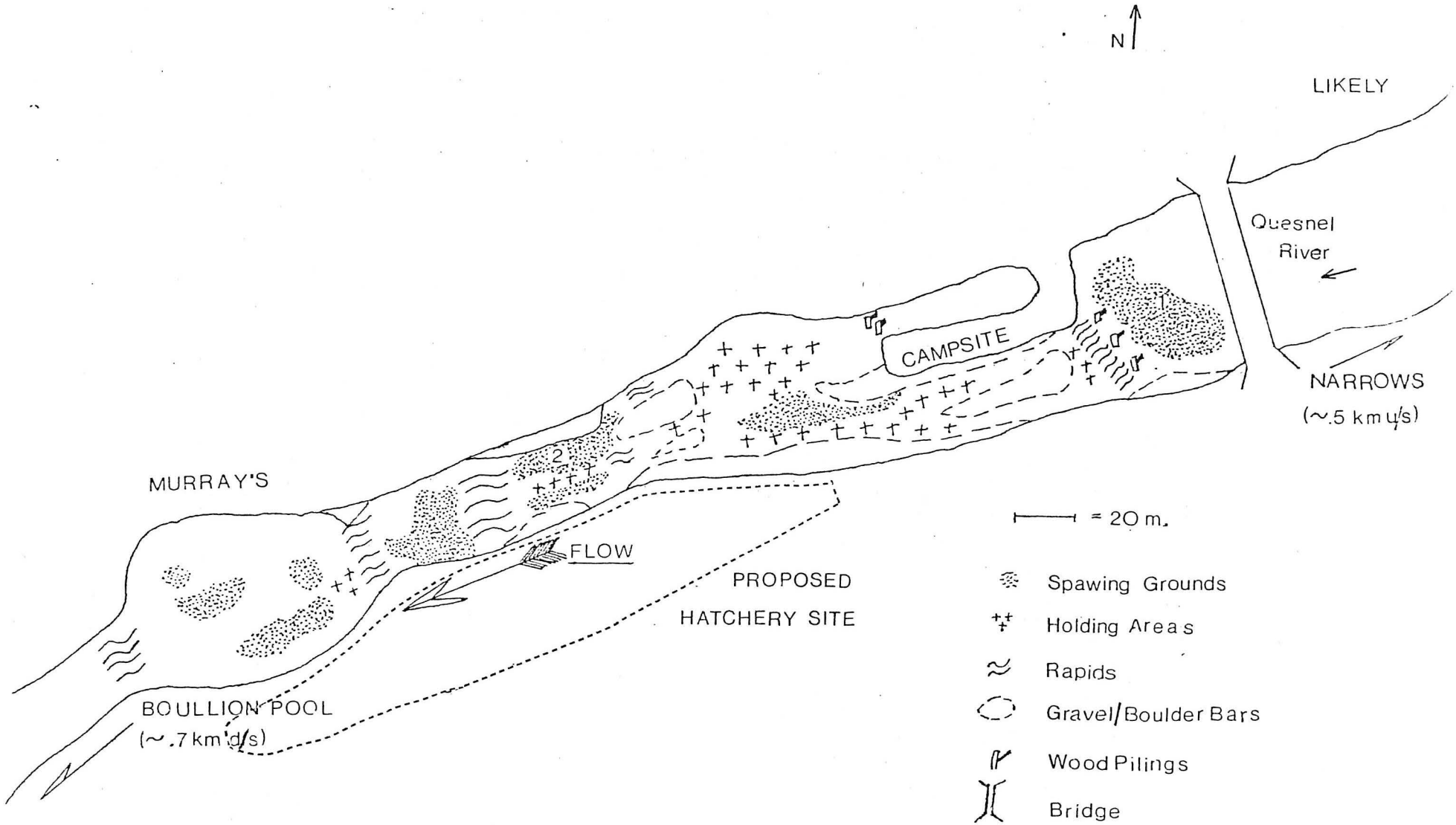
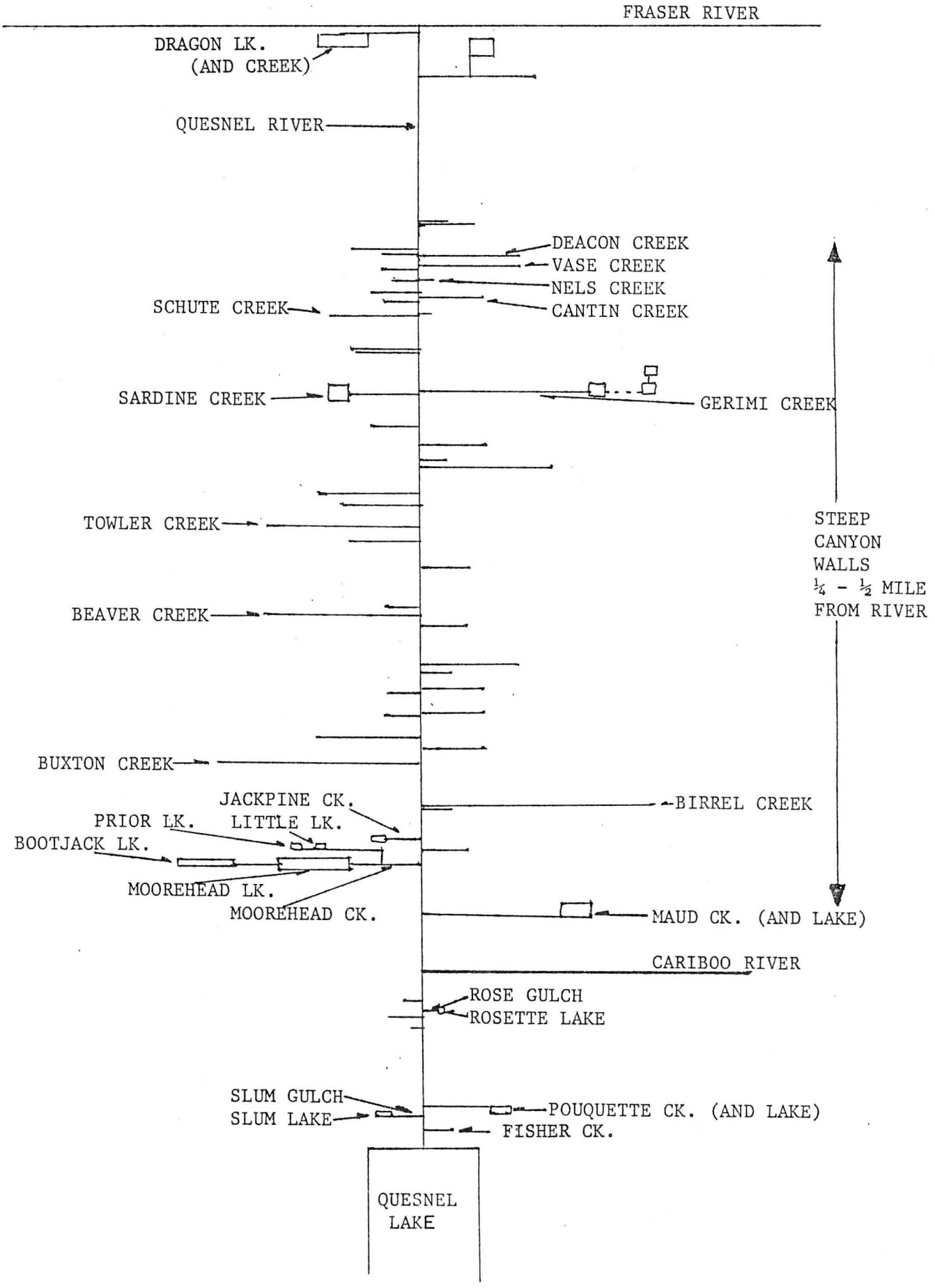


Figure 4. QUESNEL RIVER TO QUESNEL LAKE

SCALE: ¼ in.=2 miles
TRIBUTARIES: 56



QUESNEL RIVER WATERSHED UTILIZATION

The History of Quesnel

The Quesnel River was named after Simon Fraser's lieutenant, Maurice Quesnel in 1808. Quesnel Forks was the earliest locality to develop into a permanent camp and was located on a flat area at the foot of the mountains separating the two branches of the Quesnel River. By 1860, twenty or more houses, 10 - 12 stores, boarding houses, whiskey shops and tents were cramped onto a 10-acre site.

The junction of the Quesnel and Fraser Rivers was a favourite fishing ground and ferrying point for the nation of Carrier Indians who congregated there for the August run of salmon. The site of Quesnel, or Quesnellemouth as it was known for many years, remained in obscurity until the great gold rush reached the mouth of the Quesnel River in May 1859. Farming had existed in the area as far back as 1837.

The village of Quesnel was built on what was once the Quesnel River bed. The first buildings went up in 1861. As a consequence of the great influx of miners to the area, Quesnel eventually assumed a position of importance as a transhipment point and a distributing center. The Hudson's Bay Post at Fort Alexandria was closed and a store and warehouse opened at Quesnel. The town became the supply depot for Barkerville to the east, Fort George to the north, and to the Blackwater country to the west. Farms sprang up and a flour mill and saw mill followed. By the early 1900's, Barkerville had faded and for a time it looked as if Quesnel might follow. Then a mining company decided to dredge the bottom of the Fraser River for gold. This proved impractical but did create a temporary boom to the area. The rail boom of 1906-1914 was a significant event in the history of the Quesnel area. During this period the GTP (now the CNR) was extended across northern B.C. to Prince Rupert, and Quesnel played host to many survey parties, handled much of the construction material and sold supplies to dozens of new settlers. In 1921, the PGE Railroad was completed to Quesnel. This became the

northern terminus because a suitable crossing site on the Cottonwood River could not be found. A revival in the mining industry in the 1940's saw an increase in Quesnel's population. The main reasons for this expansion were the development of road transport to haul supplies to the growing town of Well's and an increased utilization of the region's timber resources to meet the needs of the mining industry. From this small start the thriving lumber industry dominates the activity in the region today. 1948 saw the completion of the PGE Railway from Quesnel to Prince George.

Logging

The Quesnel River watershed drains the Quesnel Lake Public Sustained Yield Unit (P.S.Y.U.) and the western half of the Bowron P.S.Y.U. Total forest land of the Quesnel Lake P.S.Y.U. is 1,536,854 acres out of 2,073,296 acres total land. Approximately one-quarter of the forest land is classified as having "good" timber values. One-half of the forests are classified as "medium" value land and the final one-quarter as "poor" (Forest Inventory Statistics Report, 1975). The rotation age for Quesnel is 90 years with a calculated annual cut of 418,120 cunits.

The Bowron P.S.Y.U. has similar characteristics to the Quesnel P.S.Y.U., with 150,686 acres forest land out of 168,773 acres total. The land is approximately one-quarter "good" forest, one-half "medium", and one-quarter "poor". The rotation age is 87 years with a calculated annual cut of 51,000 cunits, (Forest Inventory Statistics Report, 1975).

The forests of the Quesnel River proper have a high proportion of immature and deciduous trees. This is, in part, due to a history of high fire activity. Consequently, there are no major logging operations in the lower watershed. This area is the area from Quesnel Lake down to the river's confluence with the Fraser River. The only land clearing taking place is for private agricultural land or placer mining. Generally the rate of harvest and levels of logging activity are low.

The major logging operations in the Quesnel Watershed are on the upper reaches of the Cariboo River, its tributary the Little River, between the North and East Arms of Quesnel Lake and in the Mitchell Creek drainage (p. comm, Ministry of Forestry, District Manager, Quesnel). The following companies have licences to cut timber in the previously mentioned areas:

Jacobson Bros. Ltd. (Williams Lake)

p. comm: D. Micadae, July 10, 1980

Cutting operations on Keithley Creek, south of the west shore of Cariboo Lake.

Lignum Ltd. (Williams Lake)

p. comm: Ellen Whittle, July 10, 1980

No cutting operations within the watershed.

Starline Cedar Ltd.

p. comm: D. Bonley, July 10, 1980

Cutting operations on Winkley Lake, near Likely; on Cameron Creek, North Arm of Quesnel Lake, on Gavin Lake on the Quesnel River and on Hazeltine Creek, Quesnel Lake.

Weldwood Ltd.

a. Williams Lake

p. comm: Ken Robertson

Cutting operation at junction of Matthew Creek and Cariboo River.

b. Quesnel, B.C.

p. comm: Allan MacDonald, July 10, 1980.

Cutting operations for the coming year are:

July - Sept: Above and south of the outflow at Cariboo Lake.

Oct. - Jan: At the confluence of the Cariboo and Little Rivers.

Jan. - March: South of the confluence of the Cariboo River and Frank's Creek near Cariboo Lake.

Expected total cut: approximately 40,000 cunits.

There is a potential operation for the Maude and Labordey Lake area in the winter with an expected cut of 30,000 cunits.

The timber cut by Weldwood operations in the watershed is transported to the mill near Quesnel by floating the logs down the river. The Habitat Protection Unit, Department of Fisheries and Oceans (DFO) is attempting to have the log drive phased out via negotiations with the logging companies

involved.

The drive begins in mid-May if water levels are above arbitrary flow to minimize scouring. This date has been set by the DFO in consultation with the International Pacific Salmon Fisheries Commission (IPSFC) to allow the completion of downstream migration of sockeye smolts from the system. Logs which have been stored at the eight landings from winter operations are watered by log carriers. The watering of logs ends by mid-July, while clearing of log jams and hung up logs (rearing) begins shortly after the first watering and continues until the drive ends, at the beginning of August. This ensures that the log drive has minimal effect upon sockeye escapement.

The major effects of the log drive upon the river are a significant increase in both organic (bark etc.) and inorganic sediments. The watering of the logs, and handling of them below the high water line results in large amounts of debris being introduced into the river. The debris also increases the concentrations of phenols and tannins in the river. Movement by bulldozers and log carriers at the landings and along the banks releases sediment into the river which combines with that released by log/bank interaction to increase the inorganic sediment levels. Some of the rearing is done with the use of jet boats which at times causes the beneficial effect of scarifying the gravel on the river bottom.

Although the log drive is instinctively detrimental to the river ecosystem, concrete evidence of damage to its biological elements has not been obvious. The effects on the river would be linked to the increased sediment loads and erosion at the banks. The former could affect resident and juvenile salmonids as well as lower levels of the system's food chains. The debris introduced into the river could also affect the downstream systems of the Fraser River.

The log drive was to be phased out by 1978, but changes in the industry have allowed it to continue. The potential to switch to truck transportation exists as low-water levels have forced operators to truck logs to other landings and to the mill. The proponents of the drive cite high changeover and road construction costs as reasons for continuing the drive.

The actual cost of the drive is about the same as trucking due to the rearing operations needed to ensure the logs' passage to the mill. The mill, downstream from Quesnel on the Fraser River, is geared towards water delivery of the logs.

The entire operation is closely monitored by fisheries officers in the area (p. comm, with Mike Flynn, HPU, Elvidge and Wickerson, 1974).

Mining

Much exploratory work has been done in the Quesnel River Watershed. To this date, copper, gold, silver, lead, zinc and tungsten have been discovered. There are no major mining developments in the actual watershed, however, there is diatomite mining on a moderate scale around the city of Quesnel, and many placer operations on the Quesnel and its tributaries. Many of the latter claims date back to the Cariboo Gold Rush.

In the Quesnel Watershed, HPU is involved with regulating placer mining operations in the system. As this type of mining involves flushing large volumes of sediment with water in order to yield a significant amount of gold, HPU's main responsibility is to ensure that the many placer operations neither release tailings into the system nor exceed their licenced capabilities. Unfortunately, HPU and Fisheries officers cannot continuously monitor all operations, therefore some illegal polluting does take place.

The Quesnel Watershed is one of the designated areas within the province in which a placer operation may be opened. It is designated as such because of the area's historical and geological background which shows it to be potentially productive. The operator must follow provisions which ensure the least environmental impact upon the stream. If these provisions are strictly adhered to (Simpson and Mitchell, 1978), the operation should not affect the water quality of the system. According to the level of fish utilization, the streams are coded:

No code: - no fish utilization
- does not flow into utilized stream for 80km

Green code: - no fish utilization
- flows into utilized stream

Yellow code: - stream used by migrating and rearing fish

Red code: - stream used by migrating, rearing and actively spawning fish.

(Appendix II(b)).

The fish which are protected by these provisions include all salmonids, white fish, and grayling. (per comm. J. Arsenault, HPU. July 18, 1980)

Sluice Dam

In the late 1800's, a sluice dam was built just below the Likely Bridge (near the present proposed hatchery site). Its condition has decayed to the point that all that remains is a timber sill, and several pilings which extend across the river. HPU reports that the sill is silted up, and there is a riffle just downstream which is presumably caused by the obstruction. (p. comm. Mike Flynn. July 10, 1980)

Population

The Quesnel watershed encompasses two areas within the Cariboo Region as catalogued by the British Columbia Regional Index. The Quesnel Area, which includes the mouth of the Quesnel River, had a population of 20,751 persons in 1976, an increase of 23.6 percent from 1971. The major population centre, the Town of Quesnel, had a total of 7,637 persons in 1976. The Williams Lake Area represents the more upstream portion of the Quesnel River and Quesnel Lake. In 1976, the Williams Lake Area had a population of 30,865 persons, an increase of 36.8 percent from 1971, making this the fastest growing area of the Cariboo-Fort George Region. In 1976, the Town of Williams Lake had 6,199 persons and the Village of 100 Mile House had 1,584 persons. These two towns represent the major population centres. The communities of Likely and Horsefly had 358 and 140 persons respectively in 1976. The rest of the population consists of the many small communities that make up the Quesnel and Williams Lake Areas which encompass the Quesnel River Watershed.

Industry

Forest industries constitute the dominating factor in the economy of the area. Logging is widespread throughout the district while processing is concentrated at Quesnel, Williams Lake and 100 Mile House. Although manufacturing is dominated by the forest industry, printing and publishing, ready-mix concrete, furniture, pre-fabricated housing, bakeries, saw mill machinery, upholstering and abattoirs can also be found.

Agriculture, mining and tourism round out the resource base. Mixed farming with emphasis on livestock is the chief form of agriculture in the lower Quesnel River area and around the city of Quesnel, with only a small amount of cattle ranching being done. In contrast, the area around Williams Lake is primarily beef cattle country. Grazing land, at higher elevations, is almost all crown land, although some is held by individual ranchers under grazing leases. Hay, potatoes, hardy vegetables and nursery items are grown in selected locations in both districts.

The areas are not particularly well-endowed with mineral potential because of the very thick glacial mantle overlying much of the surface. The major mines in the areas are as follows: The Boss Mountain Underground Mine of Noranda Mines Ltd., 57 miles east of 100 Mile House, went into production in 1965 and closed down in 1971 because of a weak market--the mine was re-opened in 1973. Gibraltar Mines Ltd., which is the largest development, is an open pit mine near McLeese Lake, 30 miles north of Williams Lake. This mine went into production in 1972, mining molybdenum and copper. Placer gold mining, which was the basic support of the historical town of Barkerville, is still carried on to a limited extent. The Aurum Lode Gold Mine at Wells closed in 1967 because of fixed gold prices. Renewed interest in old gold camps is occurring since the price of gold has been allowed to seek its own level. Diatomite mining near Quesnel is developed enough to warrant a processing plant being built there in 1969 by Crownite Industrial Minerals Ltd.

A new era of tourist trade has come into the area with the paving of the Cariboo Highway (No. 97). The annual Williams Lake Stampede, the "living museum" at Barkerville, and the Bowron Lake Provincial Park all provide attractions to the public. Fishing, riding, hunting and canoeing provide an additional interest to the area.

Water Licences

In the Quesnel River Watershed there have been sixty-seven water licences granted, with only six of those being on the Quesnel River proper. By far, the most common usages on the system are for irrigation and domestic purposes (59 of 67). A variety of industrial, municipal, mining, storage, land improvement and conservation licences constitute the remainder of the holders of water licences in the area (Table 1(a)).

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" (p. comm. D. Tanner, Water Management Branch, July 16, 1980). This means that any private user (irrigation, waterworks, domestic, etc.) takes priority over a licence for power, regardless of the date on the licence.

Water licence type (usage) is always determined by the water licence class, as illustrated in Table 1(a).

Table 1(a): Water Licences on the Quesnel System

	Licence Holder	Priority	W.R. Working Units	Standardized Units	Class	Type (Usage)
	Quesnel River					
1.	Town of Quesnel	21/09/1929	200,000.0 GD	908 m^3/day	00A	Waterworks (Municipal)
2.	Gardner, Leslie H.A.	18/07/1952	37.5 AF	$46x10^6$ m^3/yr	03B	Irrigation (Private)
3.	Cariboo Pulp and Paper	20/07/1966	150.0 CS	4.24 m^3/sec	02A	Industrial (Pulp mill)
4.	Town of Quesnel	04/08/1966	1,528,000.0 GD	6,937 m^3/day	00A	Waterworks (Municipal)
5.	Cameron, K. D/G G.	20/02/1967	50.0 AF	$62x10^3$ m^3/yr	03B	Irrigation (Private)
6.	Karl Contracting Ltd.	21/05/1977	100.0 AF	$123x10^3$ m^3/yr	03B	Irrigation (Commercial)
	Dragon Creek					
1.	Word, Dr. F.E.	12/06/1941	73.2 AF	$90x10^3$ m^3/yr	03B	Irrigation (Private)
2.	Word, Dr. F.E.	29/05/1942	85.0 AF	$105x10^3$ m^3/yr	08B	Storage
3.	Hong, W.M.	19/08/1953	3.0 CS	.085 m^3/sec	05A	Mining (Hydraulic)
4.	Fish and Wildlife Br.	18/07/1960	0.0	0.0 m^3/sec	11C	Conservation
5.	Gravelle Ferry Road	03/10/1967	2,000.0 GD	9.08 m^3/day	01A	Domestic
6.	Cleave, I.B.	25/04/1975	1.0 AF	1,231 m^3/yr	03B	Irrigation
7.	Non-Commercial Developments		550.0 GD	2.49 m^3/day	01A	Domestic
	Dragon Lake					
1.	Dragon Lake, Improvement District	22/01/1958	0.0	0.0	04A	Land Improvement
2.	Zschiedrich, C.E.	08/02/1960	90.0 AF	$111x10^3$ m^3/yr	03B	Irrigation (Private)
3.	Word, Dr. F.E. + B.J.	02/07/1963	50.0 AF	$62x10^3$ m^3/yr	03B	Irrigation (Private)

Table 1(a): Water Licences on the Quesnel System (cont'd.)

	Licence Holder	Priority	W.R. Working Units	Standardized Units	Class	Type (Usage)
	Dragon Lake (cont'd.)					
4.	Word, Dr. F.E. + B.J.	02/07/1963	100.0 AF	123×10^3 m^3/yr	03B	Irrigation (Private)
5.	Royal Canadian Legion Cariboo Branch	30/04/1976	1,500.0 GD	6.81 m^3/day	02D	Industrial (Hotel)
6.	Non-Commercial Developments		20,000.0 GD	90.80 m^3/day	01A	Domestic
	Sardine Creek					
1.	Cameron, K. D/G G.	08/02/1960	90.0 AF	111×10^3 m^3/yr	03B	Irrigation (Private)

QUESNEL RIVER CAPABILITY STUDY

Agriculture

In general, agricultural ratings are poor along the Quesnel River, with the majority of areas along the river's length rated as permanent pasture or natural grazing land. Moisture deficiency, stoniness and steep slopes combine to make cultivation difficult. The best agricultural areas appear to be north of Gravelle, close to the river, with irrigation being of fundamental importance to crop success. Largely, only the area from Little Canyon and downstream 10-15km is subject to flooding, which makes this area rather marshy along the river.

Forestry

In general, forest resources in the Quesnel River area can be considered fair. From Quesnel Lake to Quesnel along the river course, production ranges from 1.5-2.5 cubic meters per acre per year. In this region, the major restrictive factors include dense soil restricting root depth and moisture deficiency. Species composition reflects these limitations with Douglas Fir (Pseudotsuga menziesii) and Lodgepole Pine (Pinus contorta) being the dominant species. South of Gravelle 10-20km there is a significant growth of White Spruce as well as the other two dominants.

Along Quesnel Lake, production is rated on par with the areas along the river, however, Balsam Poplar (Populus balsamifera) occurs as well as Douglas Fir, Lodgepole Pine and White Spruce (Picea engelmannii).

Recreation

The Quesnel River area ranges from moderately high to low capability for outdoor recreation. Along Quesnel Lake the average rating is

moderately high with angling, beach related activities, canoeing, camping, lodging, and cottaging being the major attractions.

Along the Quesnel River proper, from Gravelle to the lake, the rating is almost uniformly moderate with angling being the most important activity. Other activities include camping, viewing, lodging and cottaging. Further downstream, upland recreation becomes more important than shoreland recreation. Upland Wildlife hunting is very important, with canoeing, angling and rock formation related activities rounding out the recreational interests.

Waterfowl

Generally, waterfowl production in the Quesnel River area is limited. The entire length of the river is largely classified as having no waterfowl production, with small pockets interspersed along its length that have only moderately severe limitations on production. The major problems are the lack of marshy edge, and excessively deep or shallow waters.

There are areas in the watershed, however, such as the Beaver Creek area, Cariboo River beyond Cariboo Lake and at the mouth of the Quesnel River which are important wintering areas and have only slight limitations on the production of waterfowl.

Ungulates

The entire length of the Quesnel River is listed as an important wintering range, with only moderate limits on the production of ungulates. Generally, it is the snow depth which limits production but soil depth restricting the plant growth also has its effects. Moose and deer are the dominant ungulates in the area.

STREAMFLOWS

Two stations were utilized to obtain the streamflow data for the Quesnel River. One was situated at the outflow of the river from Quesnel Lake near the town of Likely (elevation 723m), and the other at the river's confluence with the Fraser River, at Quesnel (elevation 485m). Between the two stations, the river doubles its flow, largely due to the influence of the Cariboo River, which enters the Quesnel about 40km above the latter's mouth.

The Quesnel begins to rise in early May, and high water comes about a month after the first increase in flow. The rate of increase of flow is quite rapid. The river reaches a flow of $660m^3/s$ at Quesnel and $396m^3/s$ at Likely. These mean flow values are reached in mid-June.

Once past its freshet, the Quesnel drops at a relatively constant rate until levelling off in December at the winter low. This rate of flow is almost constant until May. The mean flow levels during the winter months are $71m^3/s$ at Quesnel and $28m^3/s$ at Likely.

Figure 5. Streamflow (m^3/sec) of the Quesnel River at Quesnel. Daily Maximum, Minimum and Mean.

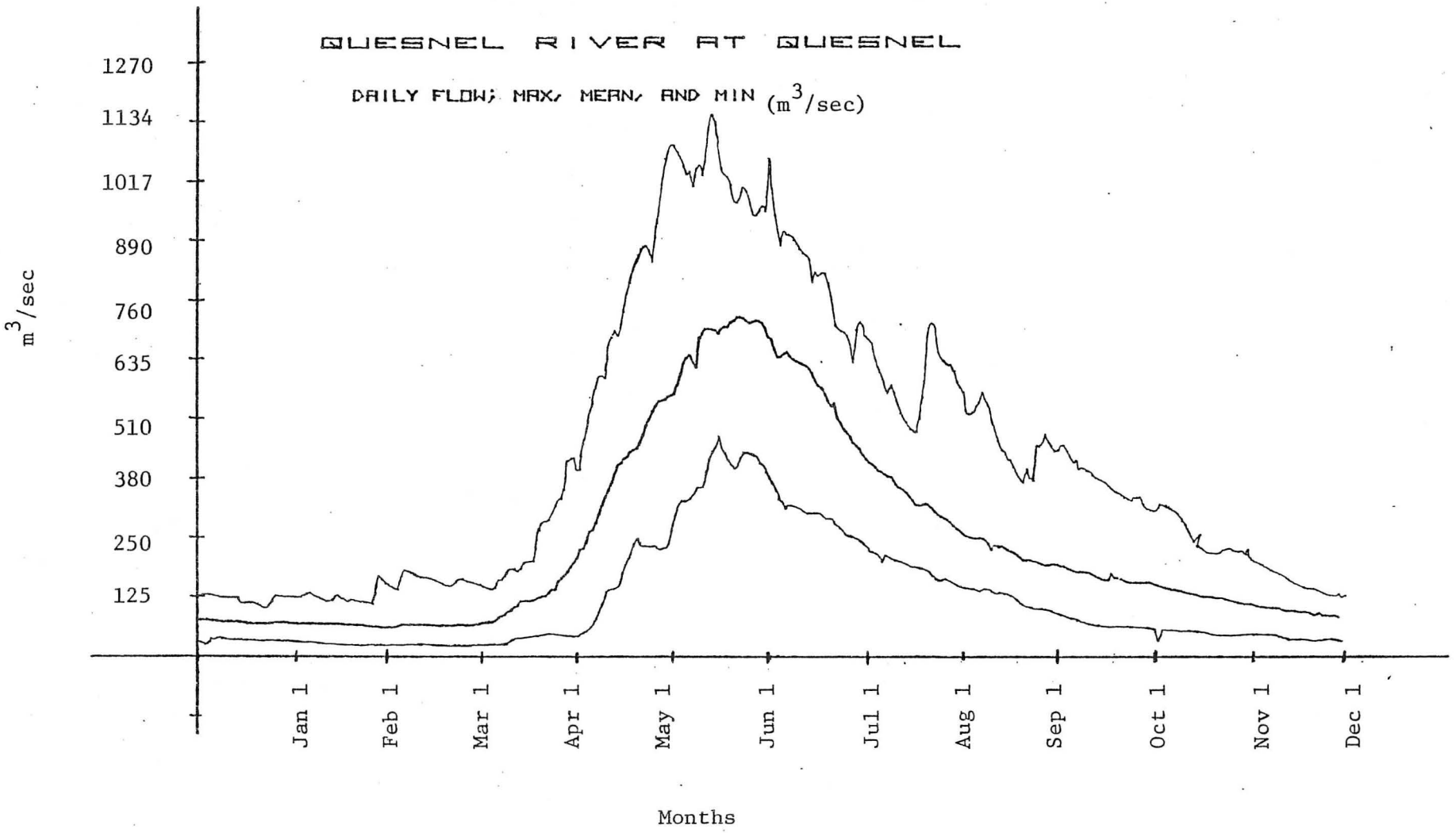
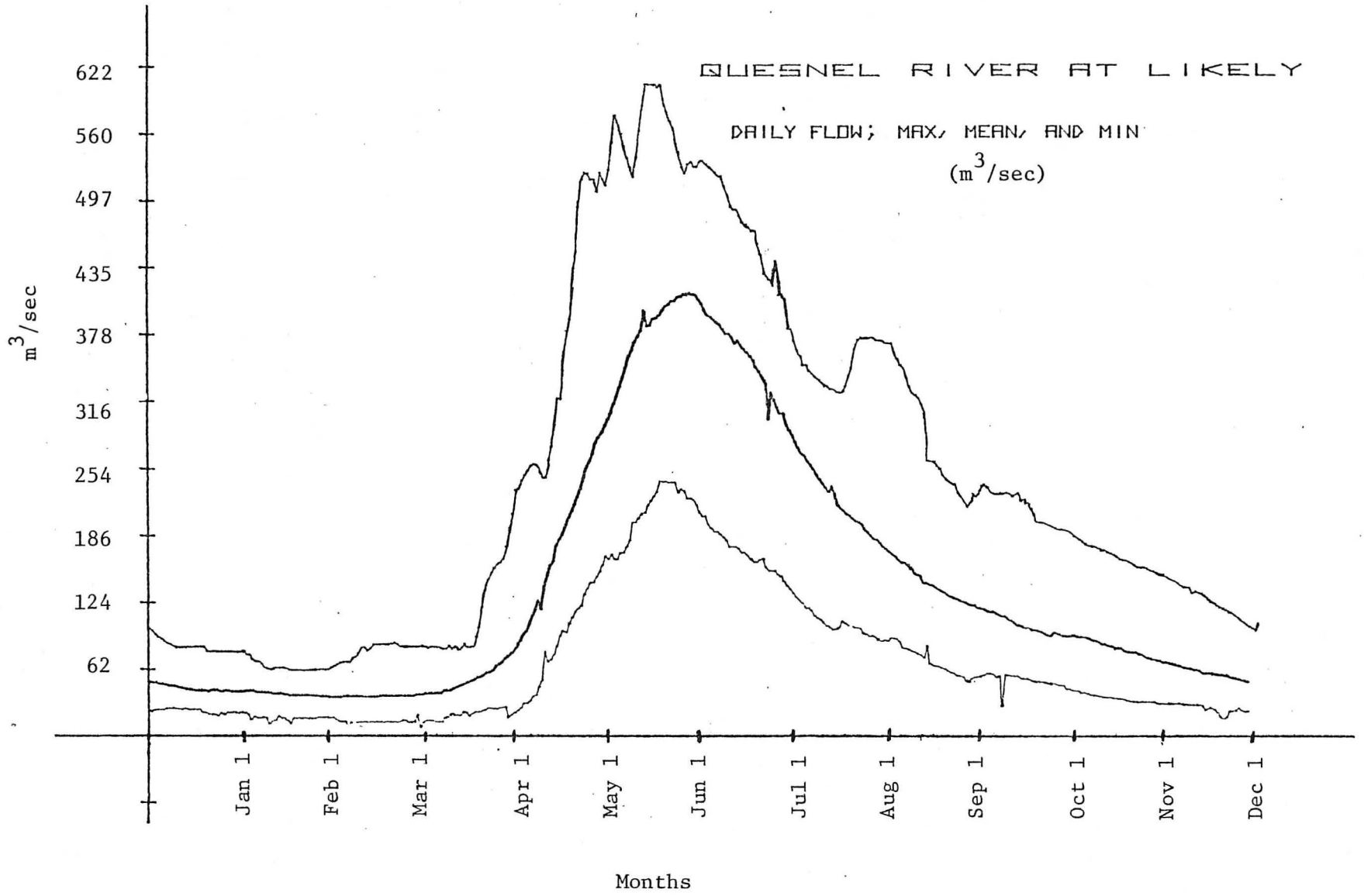


Figure 6. Streamflow (m^3/sec) of the Quesnel River at Likely. Daily Maximum, Minimum and Mean.



WATER QUALITY

The Quesnel River System is composed of many areas possibly suitable for fish culture. Many of these could be deemed suitable for salmonid enhancement on the basis of strictly physical parameters (i.e. suitable spawning sites, absence of impassable obstacles, etc.), however, using water quality criteria it is possible to determine the areas best suited to undergo enhancement.

Starting at the mouth of the river and working upstream, the Quesnel area is marked by sub-standard water quality. The river water in this area is characterized by high nitrogen levels as ammonia, nitrite and nitrate, primarily due to Quesnel's sewer discharge into the river. In addition, phosphate, non-filterable residue, chlorine, magnesium, copper, iron, and lead levels (P.C.B., 1979) far exceed allowable fish culture limits (Einvironment Canada, et al, 1979).

The Lfill Creek area, as a whole, tends toward a low pH, probably due to organic acids as is suggested by the water colour data. The area also has high levels of chlorine and non-filterable residues (3 to 4 times the recommended fish culture limits). Ionized ammonia (NH_4^+) concentrations are high, however moderate temperatures and low pHs combine to shift the $H^+ + NH_3 \rightleftharpoons NH_4^+$ equilibrium to the right, away from the toxic unionized (NH_3) form. Thus, ammonia values do fall within R.F.C.L. Although the data is scarce, it is probable that heavy metal concentrations would be high enough to cause rearing and/or incubation problems.

The Beaver Creek area is prone to elevated pHs , presumably due to high $CaCO_3$ concentrations. Aside from high magnesium, sulphide and iron levels, elevated ammonia levels and a set of impassable falls are the major restrictive factors to enhancement of this area.

At Likely, two test wells have been drilled and tested for water quality, and the Quesnel River and a spring near to well #2 have been assayed for the same parameters. Preliminary studies show that water quality is not an obstacle to the enhancement of this area. The well

water is high in dissolved gases (Nitrogen and Argon - up to 105% saturation) while the dissolved oxygen levels are fairly low (in the order of 48% saturation (Sigma R.C., 1979)) - a situation easily rectified by a gravity fed aeration system. All other water quality parameters lie safely within the recommended fish culture ranges except for specific conductance and turbidity, which are both slightly low (Sigma R.C., 1979) (with specific conductance @ 142 microhms/cm - R.L. 150-2000 and turbidity @ 1 J.T.U. - R.L. 1-60), but insignificantly so. One possible problem is the development of a water supply that insures availability of constant temperature water. Continuing studies of ground and surface water sources will be required before this question can be fully elucidated.

Subsequent monitoring of the groundwater at Likely has revealed that the well cannot supply a constant temperature water supply. Piteau and Associates (1980) have estimated that the well water temperatures vary between $8^{o}C$ in late May and $12^{o}C$ in late October. In actuality, the temperatures vary from about $11.5^{o}C$ in early December (Sigma R.C., 1978) to $4.5^{o}C$ in mid-June (A. Rowland, p. comm.). These data indicate a six month aquifer recharge time, which is not ideal for fish culture. This is due to the temperature related feeding suppression at a time when, ideally, there should be a burst growth period to produce super smolts.

Table 1(b). Water Quality Sample Sites

	Pollution Control Board Sample Sites	Abr.
1.	Quesnel Sewer System	Qsl.Sewer
2.	Cariboo Pulp, Quesnel - effluent on river	Crbo.Plp.Eff.
3.	Quesnel River at Gravelle Stream	Qsl.R. @Grvl.
4.	Quesnel River at the Mouth	Qsl.R. @mouth
5.	Quesnel River at Likely	Qsl.R. @Likely
6.	Quesnel STP-Main Central (Pre-Discharge)	Qsl. STP.main
7.	Quesnel STP-React. Central (Pre-Discharge)	Qsl. STP.Rct.
8.	Quesnel River at HWY. 97 Bridge	Qsl.R. @97 br.
9.	Beaver Creek near Mouth	Bv.Cr. n.mouth
10.	Beaver Creek at Likely Road	Bv.Cr. @Ly.Rd.
11.	Beaver Creek above Gravel Creek	Bv.Cr. a.Gr.Cr.
12.	Horsefly River at Horsefly	Hf.R. @Hf.
13.	Horsefly River near McKuskey Creek	Hf.R. n.Mc.Cr.
15.	McKinley Lake - average of 14,15,16	Mc.Lk. $\bar{X}$
17.	McKinley Creek below McKinley Lake	Mc.Cr. b.Lk.
18.	McKinley Creek below Molybdenite Creek	Mc.Cr. b.Mo.Cr.
20.	Crooked Lake - average of 19,20,21	Ch.Lk. $\bar{X}$
22.	Cariboo River near Likely	Crbo.R.
23.	Barlow Creek at HWY 26	Brl.Cr. @26 Hwy.
24.	Molybdenite Creek near mine	Mo.Cr. n.mine
25.	450 meters below Lake Outlet	450m. b.out
26.	Lake Outlet at C.P. Landfill	Lk.out str.
27.	Lake Inlet at C.P. Landfill	Lk.In. @Lfl.
28.	Lfill Creek near mouth	Lfl. Cr.n.mouth
29.	Lfill Creek below confluence	Lfl. Cr. b.conf.
30.	Donut Creek below Donut Lake	Do.Cr. b.Do.Lk.
	Naquadat Sample Sites	
1a.	Quesnel River at HWY. 97 Bridge	NQDT. @97br.
	Dept. of Fisheries and Oceans Sample Sites	
2b.	Quesnel River at Quesnel	QUES.R. @Q.
2c.	Quesnel River at Likely	QUES.R.
2d.	Well #1 on Proposed Hatchery Site	Well #1
2e.	Well #2 on Proposed Hatchery Site	Well #2
2f.	Spring near Proposed Hatchery Site	Spring

Table 1(c). Domestic and Industrial Effluent Sources on the Quesnel River System.

Location	Name	Map Location No.	Effluent
Quesnel	Quesnel Sewer System	1	Sewer Outfall
Quesnel	Cariboo Pulp	2	Industrial Effluent
Quesnel	Quesnel STP	6,7	Pre-Discharge
Lfill Creek	Cariboo Pulp	26,27	Leachate Discharge
Molybdenite Creek	Noranda Mine Area	24	Industrial Trailings

TABLE 2: QUESNEL RIVER WATER QUALITY SAMPLE SITES

Listed in order of occurence from headwaters to confluece with the Fraser River

WATER QUALITY PARAMETER (mg./L.)△	SAMPLE SITE																												
	20 Ck.Lk. X	13 Hf.R. n.M^C.Cr.	12 Hf.R @ Hf.	15 M^C.Lk. X	17 M^C.Cr. b.Lk	24 Mo.Cr. n.mine	18 M^C.Cr. b.Mo.Cr.	5 Qsl.R @Likely	22 Crbo. R.	11 Bv.Cr. a.Gr.Cr.	10 Bv.Cr. @Ly.Rd.	9 Bv.Cr. n.mouth	3 Qsl.R. @Grvl.	27 Lk.In. @Idfl.	25 450m b.out.	26 Lk.out str.	30 Do.Cr. b.Do.Lk	29 Lfl.Cr b.conf.	28 Lfl.Cr n.mouth	2 Crbo. Plp.Eff	8 Qsl.R. @97 br.	23 Brl.Cr @26Hwy.	1 Qsl. Sewer	4 Qsl.R. @mouth	7 Qsl. STP.Rel	6 Qsl. STP.main		1a NQDT. @97 br.	Rec. Limits
pH	7.3	7.5	7.3	7.8	7.7	7.0	7.4	7.4	7.4	8.0	8.0	8.3	7.6	4.7	6.7	6.4	7.2	6.9	8.0	7.3		8.3	7.3	7.7	7.2	7.4		7.3	6.5-8.5
Residue			66.4		75	43	60	63	68	218	213	218	78	925	240	302	140	210	192	11492		292	321	177	323	388		321	70-400
N.F.Res.			4.25		1		2.3	1.5	4	3.25	3	5	165						9.5	7090				97.1	126	122			L.T. 3
S.Cond. (microhm/cm)	35.3	49	101	92.4	100	51.3	90.6	117	134	350	333	356	177	629	167	237	170	168	309	184		492	558	168	506	604			150-2000
D.Oxy.	8.55		9.65	8.03	9.45	10.1	9.7	10.0	9.87	10.6	10.3	10.6	10.6	4.63	7.55	5.15	8.3	10.	9.97	10.1	10.2	7.7	6.6	10.3	4.51	3.27		6.61	G.T. 6
Chl.Res.																			2.7	.529			.171	1.08	1.34	.209		.171	L.T. .002
Colour (TCU)	7.4	7.5	12.9	18.4	14.4	18.5	23.2	2.86	3.85	15.9	12.9	12.1	2.0	705	111	113	45	104	50.1	2.67			40.7	5.83	29.3	46.2		40.7	L.T. 15
Turb.(JTU)			3.97		.6	.75	2.52	.59	3.04	2.2	1.58	1.5	25.4	13	11.3	25	4.1	11.1	36	204		34.9	74.3	30.9	35.7	26		.04	1-60
T.Alk.	12.5	9.9	44.2	42.8	46.6	16.1	35.8	47.0	52.7	189	174	180	58.9	99.3	68.1	100	85.6	72.3	133	58.8		229	191		120	217		191	20-300
Hardness	13.9	21.1	45.7	45.5	47.8	18.7	36.9	49.8	57.1	154	164	165	61.8	156	77.4	108	90.2	88.3	55.5	69.6		258	30.5	61.6	133	142		123	20-400
NH_3 ($x10^{-3}$)			.36	.38	.89	.11	.49	1.6	1.9	2.9	2.4	3.5	2.2		.26	.08	.58	.44	1.8	.20			160	.30	73	305		160	L.T. 2
T.Nit.			.221		.228	.135	.212	.179	.168	.389	.472	.339	.210	1.28	1.04	1.27	.708	.932	.488	1.00		.59	29.4	.267	22.5	23.3			
T.Phos.	.004	.007	.016	.006	.032	.013	.009	.005	.001	.026	.011	.009	.051	.924	.105	.149	.022	.075	.037	1.43		.225	4.54	.064	5.12	3.14		4.53	L.T. .05
Sulphate	5	5	5.73	5.1			.5	6.1	6.5				7.44		5	5	5	5	5	18.3		19.8		7.12					L.T. 90
O.Carbon	3.05	3.5	.45	6.9						4.25	5.5	5.7	2.5	608	55	124	18	65	19.6	27.9			74.7	2.1	31.2	46			
Al																				84.9				.024					L.T. .1
Ca	4.7	6.95	13.7	15.0	15.5	5.4	11.9	16.8	18.4	39.2	39.5	41.8	19.5	35.9	17.4	25	33.2	22	14	22.1		60.6	30.5	19.5	35.7	39.2			L.T. 150
Cu	.002		.005	15.8	.008	.003	.004	.002	.005			.004	.006						.004			.002	.05	.006				.005	L.T. .006
Fe	.1		.3	13.4	.15	.30	.34	.133	.5			.001	.1					.4				.1	.4	.1				.63	L.T. .3
Mg	.65	.91	2.84	2.13	2.05	1.25	1.83	1.81	2.52	13.7	15.9	14	3.05	16.1	8	11.1		8.05	5	3.5		20.9	9.9	3.05	8.6	10.8		.04	L.T. 10
Mn	.02		.024	.02	.02	.02	.022	.013	.02			.05	.033					.17				.14	.04	.033				.01	L.T. .05
Pb	.001		.016	4.26	.001	.003	.006	.017	.002			.003	.049					.001				.055	.011	.049				.003	L.T. .01
Zn	.008		.007	23.5	.006	.010	.006	.008	.005			.008	.024					.005	.113			.05		.211				.005	L.T. .005

mean value exceeds Recommended Limits for Fish Culture

range extremities exceed Recommended Limits for Fish Culture

△ except where otherwise defined

Figure 7. Quesnel Watershed showing P.C.B., NAQUADAT,and D.F.O. Sampling Sites.

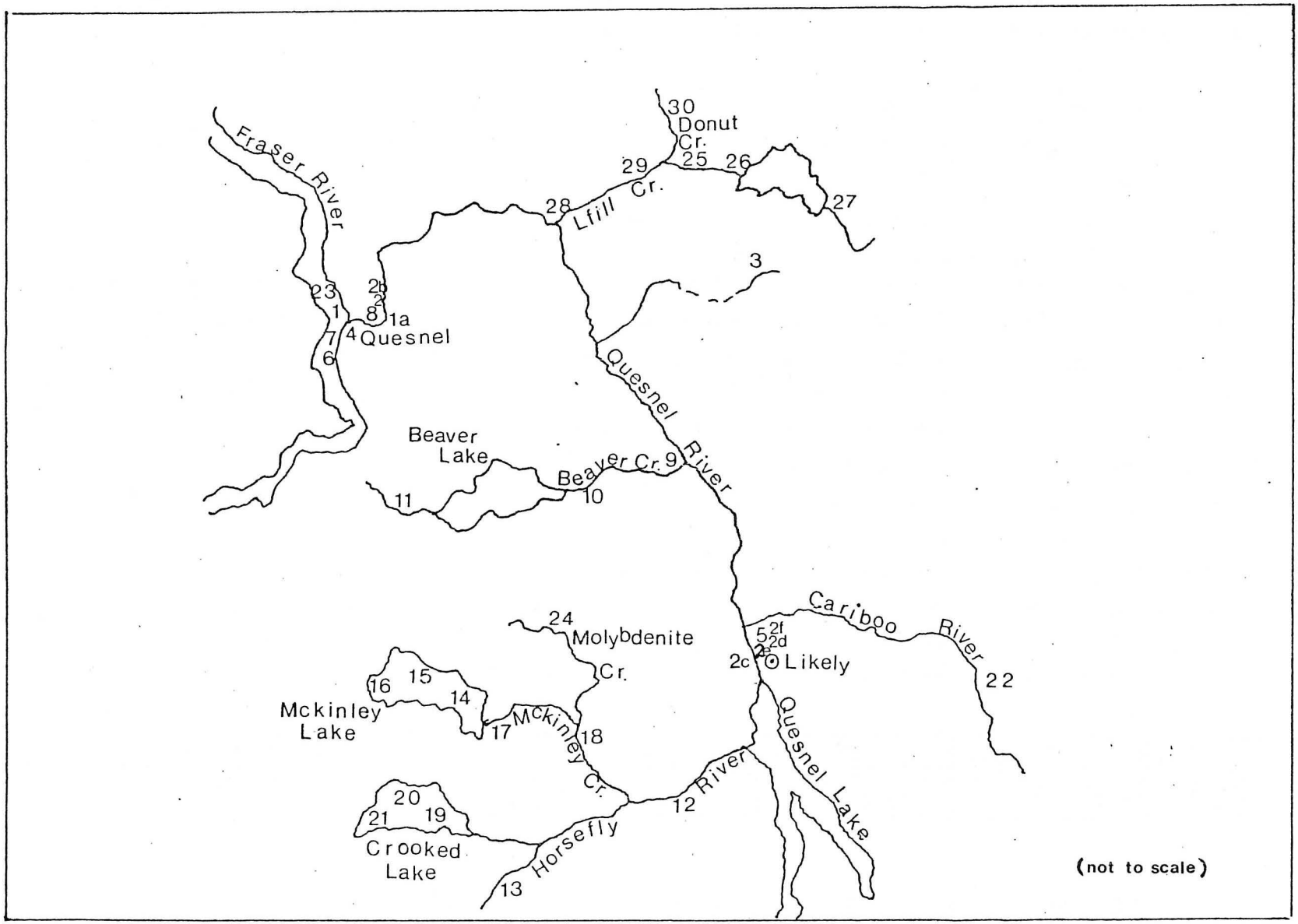


Table 3 : WATER QUALITY FOR THE PROPOSED HATCHERY SITE NEAR LIKELY

PARAMETER	WELL #1(APR.)†	WELL #2(DEC.)*	WELL #2(APR.)†	QUES. R.(DEC.)*	QUES. R.(APR.)†	SPRING(APR.)†
pH	7.8	7.5	8.0	7.8	7.85	7.8
Residue	96.5	93	91	84.2	76	88
N.F.Residue	L.T. 5	L.T. 5	L.T. 5	L.T. 5	L.T. 5	L.T. 5
S. Cond.	149	152	153	131.6	114	138
D. Oxy.		4.8		11.0		
D.Gases($Ar+N_2$)		104%		99.5%		
Chloride	.71	.50	.68	.63	.34	.75
Turbidity	L.T. 1	L.T. 1	L.T. 1	L.T. 1	L.T. 1	L.T. 1
T.Alkalinity	66.7	69.2	66.9	58.1	50.1	61.3
Hardness	78.7	74.4	76.0	65.6	59.0	66.0
Ammonia	L.T. .005	L.T. .005	L.T. .005	.0042	L.T. .005	.0193
Nitrite	.0056	L.T. .005	L.T. .005	L.T. .005	L.T. .005	L.T. .005
Nitrate	.145	.195	.167	.191	.119	.211
T.Phosphate	L.T. .005	L.T. .005	L.T. .005	L.T. .005	L.T. .005	L.T. .005
Sulphate	9.52	6.90	7.10	7.95	7.75	
Silica	2.15	2.55	2.12	1.91	1.72	1.95
Aluminium	L.T. .09	L.T. .09	L.T. .09	L.T. .09	L.T. .09	L.T. .09
Calcium	26.65	24.7	26.0	22.9	20.0	24.0
Copper	L.T. .01	L.T. .001	L.T. .01	L.T. .01	L.T. .01	L.T. .01
Iron	L.T. .01	L.T. .01	L.T. .01	L.T. .01	L.T. .01	L.T. .01
Manganese	L.T. .003	L.T. .003	L.T. .003	L.T. .003	L.T. .003	L.T. .003
Lead	L.T. .08	L.T. .001	L.T. .08	L.T. .08	L.T. .08	L.T. .08
Zinc	L.T. .02	L.T. .0075	L.T. .02	L.T. .02	L.T. .02	L.T. .02

* Sigma Resource Consultants Ltd.
\+ Laboratory Services(EPS-FMS) Chemistry

WATERSHED TEMPERATURES

Quesnel River

Water temperatures were recorded at two stations on the Quesnel River: Quesnel and Likely. Likely showed the greater range of temperature over an average year (0-25°C), while at Quesnel the highest value recorded was 20°C. Both stations reached their peak in mid-late August. During January, February and March both stations recorded temperatures of 0°C. The average monthly temperature is within the recommended limits for fish culture (2°C F.C.L. 18°C) from April to January at Likely and from April to December at Quesnel. Extremes during these months at Likely range from 1.5°C (Jan.) to 20°C (at the end of Aug.). At Quesnel, the lowest temperatures recorded during the April to December period were 1.5°C (in mid-April), and 1°C (in mid-November). The temperature surpassed 18°C on one occasion only, reaching 20°C at the end of August.

Quesnel Lake

Quesnel Lake temperatures range from 0-20°C throughout the year. Stratification occurs through the top 30m; below this depth, the temperature is relatively constant at 4°C. Spring turnover occurs as early as March, as shown by the cold constant depth profile. The lake warms up to about 5°C by late May, and stratification is highly pronounced by July, and is maintained through August. Surface temperatures reach 18-20°C by late August. The thermocline lies between the 10 and 25 meter marks, with about a 1°C per meter gradient in July (figure 9). Complete fall turnover occurs by October, and causes the hypolimnion to warm slightly. With the onset of winter, the lake surface begins to cool to close to freezing levels.

The data from Water Survey of Canada used for this section showed that epilimnion and thermocline temperatures are within fish culture

limits from March to November, the entire scope of the data. As the data did not cover the winter months (Dec. to Feb.), very little can be reported. However, it is feasible that this lake, with a deep water (100m) intake system, could produce a constant temperature (approximately 2-4^{o}C) water source during the winter months.

Figure 8.: QUESNEL RIVER WATER TEMPERATURE

SAMPLE SITES (+) (Water Survey Canada, 1977)

RIVER SITES UNDERLINED

LAKE SITES: 1.HAZELTINE PT. IN OUTLET ARM.
2.PLATO ISLAND.
3.NORTH ARM NEAR ROARING RIVER.
4.EAST ARM.
5.HORSEFLY BAY.

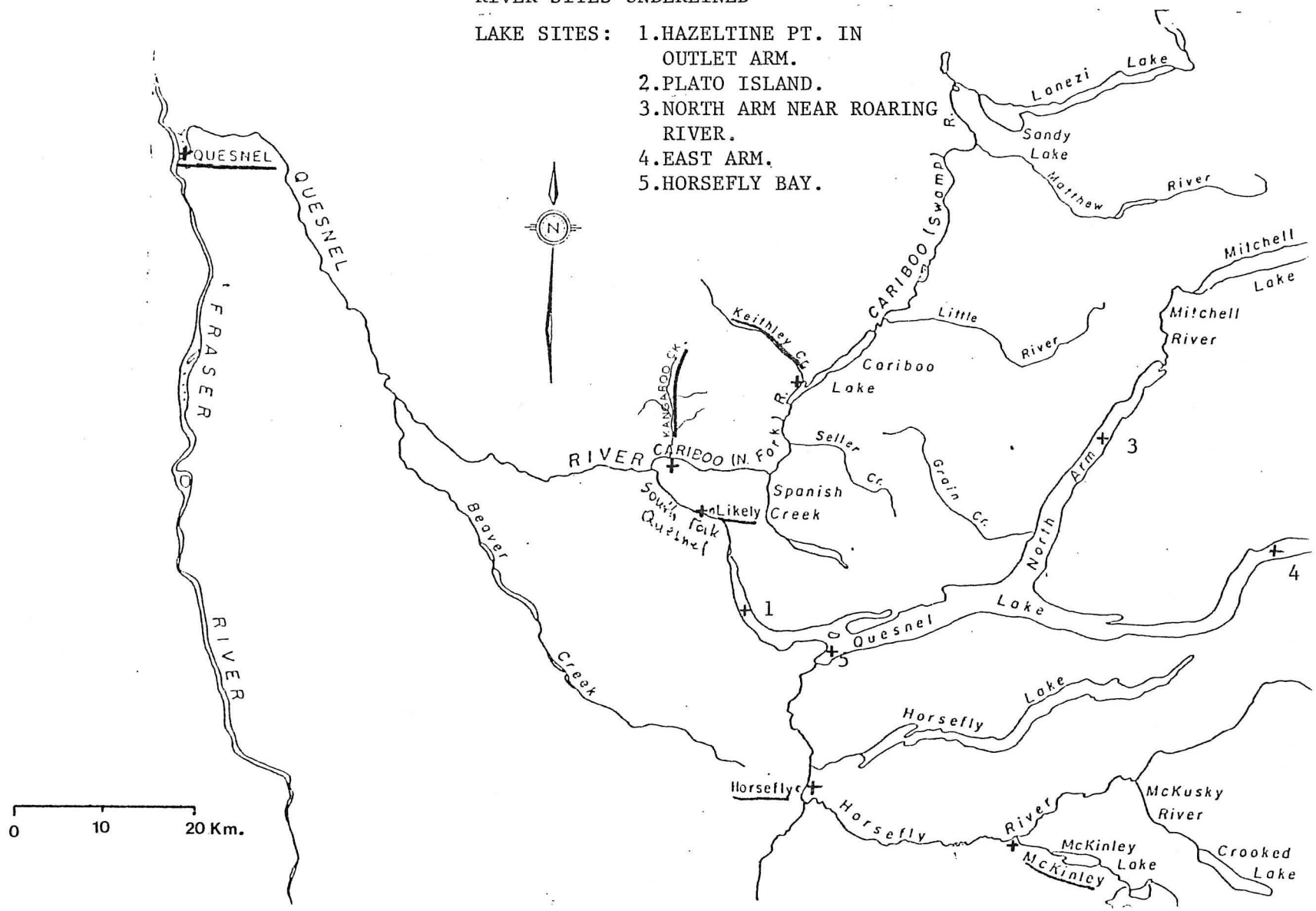


Figure 9. TEMPERATURE/DEPTH PROFILE: QUESNEL LAKE MEAN MONTHLY TEMPERATURES FROM WSC AND BATHYTHERMOGRAPH DATA -IPSFC (to 1978).

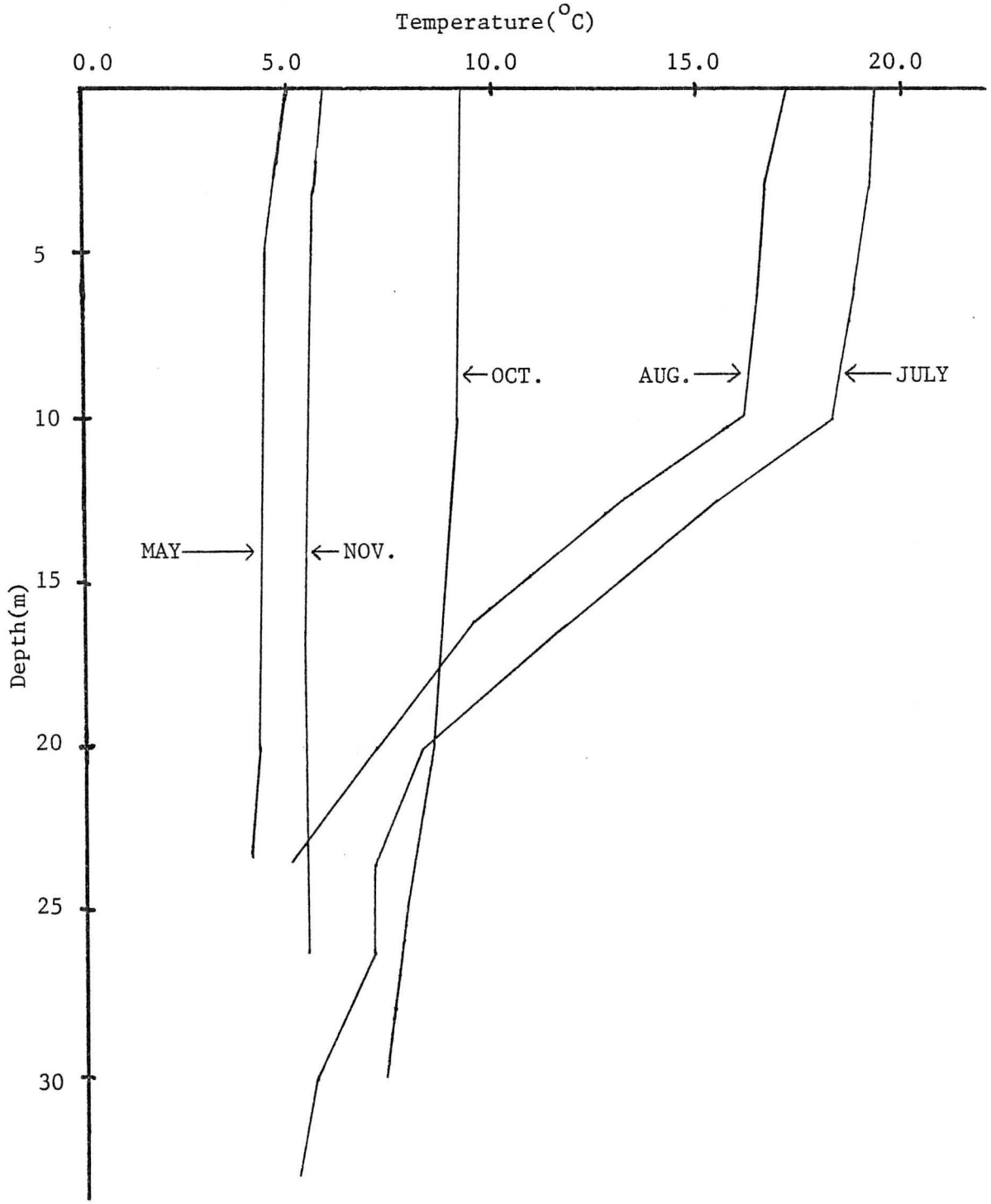


Table 4(a). Average Monthly Water Temperatures (^{o}C)

Month	STATION			
	Likely (Quesnel R.)	Quesnel (Quesnel R.)	Keithly Cr. (Cariboo R.)	Kangaroo Cr. (Cariboo R.)
JAN.	2.0	0.8	0.9	0.2
FEB.	0.6	1.3	0.5	0.3
MAR.	1.9	2.1	0.7	0.5
APR.	4.3	4.9	4.8	3.0
MAY	7.1	7.5	5.0	6.0
JUNE	8.6	9.5	10.3	10.4
JULY	8.8	14.9	---	10.0
AUG.	16.0	16.0	---	13.6
SEPT.	11.2	12.1	12.6	12.4
OCT.	8.6	7.8	10.5	8.0
NOV.	5.1	3.2	5.3	4.8
DEC.	3.1	1.5	0.0	2.0

Taken from Water Survey of Canada, 1977.

SEDIMENT LOADS

Along the length of the Quesnel River, from Quesnel Forks to the mouth, fifteen sample sites were utilized to determine sediment loads and composition. The maximum load occurs about 15km downstream of Little Canyon (653ppm) while the minimum load occurs at Quesnel Forks (approximately 2ppm). Although the maximum value does exceed the recommended fish culture limits (70 - 400ppm) the bulk of the load settles out within the next 3km (i.e. 18km downstream of Little Canyon the value was 91.7ppm). Thus, the placer mining near the outlet of the lake that feeds the Quesnel River appears as if it would have little detrimental effect on fish in culture. (R.E. Elvidge and G.S. Wickerson, 1973)

Table 4(b). Distribution of Sediment Loads along Quesnel River.

LEVELS AND COMPOSITION OF RIVER LOADS (Adapted from R.E. Elvidge and G.S. Wickerson, 1973)

DISTANCE FROM RIVERS MOUTH (km)	DATE	TOTAL(ppm)	% INORGANICS	% ORGANICS
93.6	June 13	1.65	27.0	73.0
84.2	June 19	54.93	88.5	11.5
36.3	June 4 - 5	77.08	84.0	16.0
31.2	June 20	104.00	67.3	32.7
22.9	June 20	91.40	82.1	17.9
19.7	June 20	92.90	93.7	6.3
17.6	June 20	91.00	85.6	4.4
16.0	June 20	100.30	86.7	13.3
15.4	June 20	653.00	85.9	14.1
12.0	June 21	91.70	85.1	14.9
10.2	June 21	91.70	84.0	16.0
5.6	June 21	89.60	89.3	10.7
1.8	June 21	97.40	86.2	13.8
0.3	June 16 - 27	141.35	89.4	10.6
0.0	June 21	84.00	90.5	9.5

BIOPHYSICAL PARAMETERS OF THE AREA NEAR LIKELY BRIDGE

The Quesnel River below Likely Bridge has a meander length of between 0.5km and 2.0km, and an average gradient of .238%. The river lies on the floor of a steep sided valley. The floor is three-quarters to one and one-half km wide, and quite flat. The river's path meanders through this valley, which could be considered as potential flood plain.

In the 500m stretch below the bridge (near the proposed hatchery site) the river ranges from 40 to 80m wide. There are five small riffles, four of which extend across the river: below and above Murray's Pool, just below the campsite, and below the bridge (as seen in figure 3(b)).

Spawning grounds constitute approximately 16% of the river area in this stretch; holding areas constitute about 9%; rapids, 7.5%, and gravel or boulder bars make up about 20% of the total area. Area of the river which can be considered as pool is about 30% of the total.

The only unnatural obstacles to escaping salmon are pilings, which may cause a build-up of debris upstream, and erosion downstream.

GENERAL WATERSHED RECONNAISSANCE

The general Quesnel River Watershed reconnaissance is based on information obtained from the bio-engineering surveys which were primarily conducted by R.M.J. Ginetz and G.O. Nielsen. The area surveyed in the Quesnel River System is shown in figure 10.

In order to locate suitable sites and river systems for salmonid enhancement opportunities, R.M.J. Ginetz and G.O. Nielsen conducted several aerial and ground bio-engineering reconnaissance surveys during different times of the year - autumn spawning, winter and flood surveys.

General surveys were conducted to obtain information on stream locations, the size of drainage area, topographical features of the watershed and vegetation cover. Additional information regarding stream characteristics, resource activities in the watershed, gravity, supply potential to service a facility, access routes and power availabilities have also been obtained. These are discussed in greater detail under the appropriate sections in this report.

The site identified for a hatchery facility is located on the left bank of the Quesnel River on a ground elevation that ranges from about 723m to 740m above sea level, the river elevation being 720m (Piteau and Associates, 1980). This location is approximately 78km southeast of Quesnel, B.C. and 1km west of the village of Likely, B.C. Access to the site is excellent via well maintained roads from Quesnel and hydro power is available.

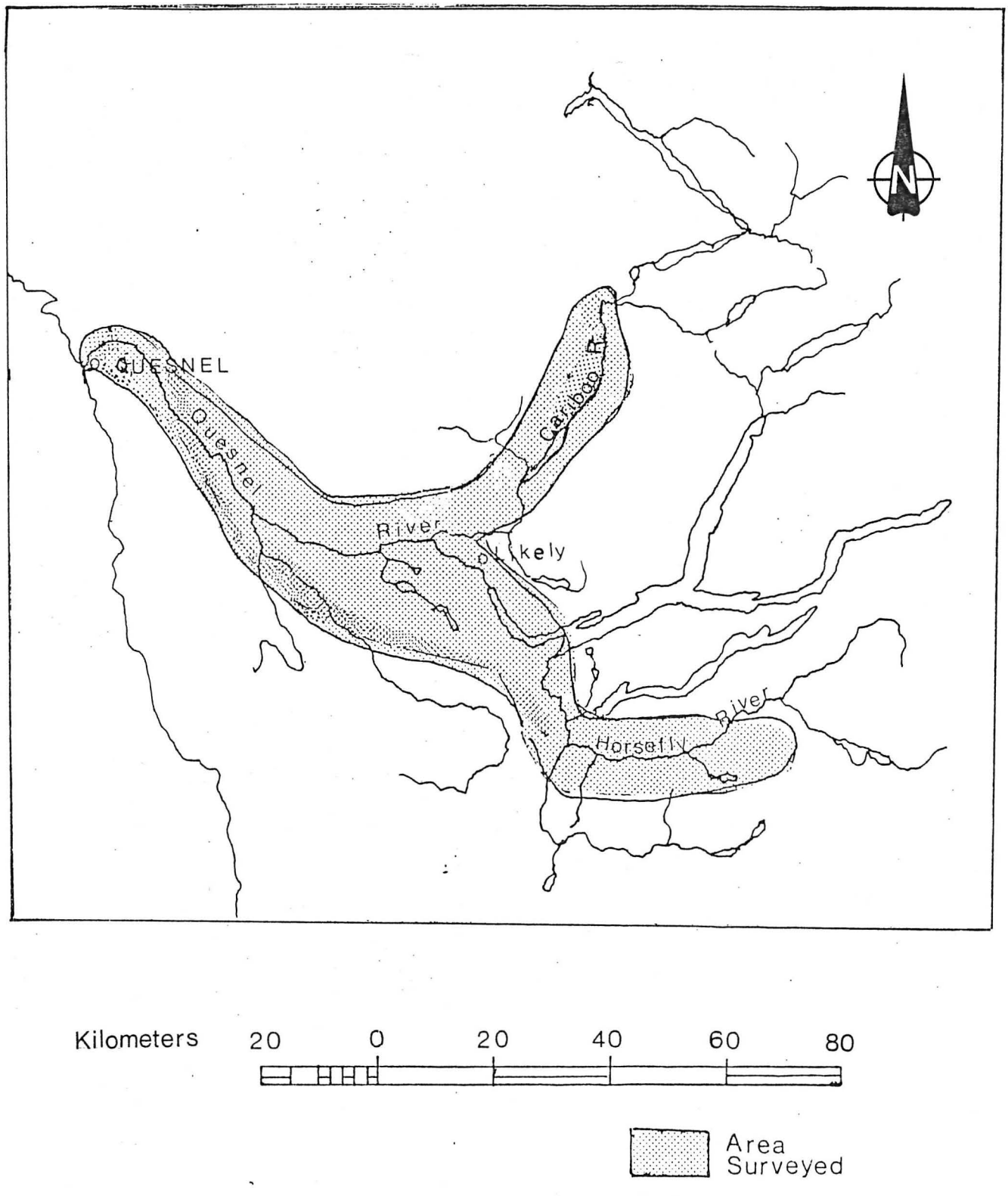
According to R.M.J. Ginetz and G.O. Nielsen, bio-engineering feasibility studies including groundwater exploration and testing program, has confirmed the potential for a relatively large-scale development at this location. They also suggested that a gravity fed surface plus a pumped groundwater supply could be developed between Likely and the lake outlet. Also, a sub-surface water supply could possibly be developed in Quesnel Lake in order to obtain optimal water temperatures. Various studies concerning water quality have confirmed that temperture, pH, dissolved oxygen, metals and nutrients were well within the safety range for fish culture at this site.

The hatchery site location is also adjacent to the main spawning area. Spawning surveys were conducted during the period of peak spawning in order to ascertain the spawning distribution and abundance, location data on spawning and rearing areas, adult capture methods and potential fence sites. Adult collection is possible by seining on the spawning grounds. (R.M.J. Ginetz and G.O. Nielsen, 1978). A few biological surveys and summary of bio-baseline studies and spawning files has been covered elsewhere. Additional bio-baseline work will be continued throughout the 1980/1981 fiscal year which will provide a constant influx of biological information.

Results of other surveys conducted at potential enhancement sites, also contributed information regarding site location preferences. Among these were winter, flood and ground surveys. Winter surveys as well as information gathered from other agencies have put forward data pertaining to quantity and temperature of ground water outflows, low winter flows and degree of freezing. Flood surveys, undertaken during the time of peak run off, identified the amount of scouring and erosion, extent of flooding and water turbidity. Ground surveys as well as compilation of available hydrological and topographical data also provided specific information to ensure that the sites are suitable for the construction of the enhancement facility.

In their "Review of Enhancement Potential for Chinook and Coho Salmon Stocks in the Fraser River Watershed", R.M.J. Ginetz and G.O. Nielsen reported that the facility is presently being designed and construction to date (June 1980) has included the drilling and testing of test wells, drilling of production wells, clearing of the site and construction of access roads to the site.

Figure 10. Area surveyed for bio-engineering studies in the Quesnel River Watershed.



SALMON RESOURCE

QUESNEL RIVER ESCAPEMENT AND SPAWNING

Timing

The Quesnel watershed supports sockeye, pink, and chinook salmon. The sockeye run migrates through the Quesnel River to the Horsefly, McKinley and Mitchell systems where the average period of peak spawning has been early to mid-September. Pink salmon escapements to the Quesnel River have occurred on an odd year cycle from 1971 to 1979, with the exception of 1973, for which nothing was recorded. The average timing of pink spawners ranges from the fourth week in September through to mid-October, peaking in the first week of October. Chinook salmon have an average spawner timing that ranges from early/mid-September to the third week in October, with a period of peak spawning in the first week of October. The summary of chinook and pink spawner timing can be seen in Table 5.

Distribution

Pink salmon spawning distribution on the Quesnel River extends from the confluence with the Fraser River to about fifteen miles upstream (Fig. 13). The most heavily utilized spawning area has been opposite the town of Quesnel.

The distribution of chinook spawners in the Quesnel River (as seen in Fig. 12) extends from the "Narrows" near the outflow of Quesnel Lake to Quesnel Forks. The "Narrows" are located approximately 0.5km upstream from the bridge and support about 20% of the spawners. The rest of the spawner distribution averages about 30% at Likely Bridge, 40% downstream from the bridge (about 0.8km) and 10% scattered spawning in the remaining reach to Quesnel Forks. (Biological observations; DFO Spawning Files; EVS Consultants Ltd. 1980b)

Abundance

Annual sockeye escapements to the Fraser River spawning area for

cycles 1976 to 1980 has been summarized from IPSFC Annual Reports, 1974 to 1978. The estimated number of sockeye to the Horsefly/McKinley Creek and Mitchell systems was 2,200; 515,000; 8,500 and 500 for the 1976, 1977, 1978 and 1979 cycles respectively. These figures are a good example of the cyclical patterns of sockeye escapement seen in the Quesnel system. The pink salmon escapements to the Quesnel system average 1000 based on an odd-year cycle from 1971 to 1979 with the exception of 1973. In this cycle year, the pink salmon which were expected to appear, were not observed. Quesnel River chinook escapements have averaged 1,300 spawners from 1969 to 1979. This escapement has remained relatively constant over the last ten years showing no significant upward or declining trends.

TABLE 5. SUMMARY OF F381 INFORMATION ON TIMING OF QUESNEL RIVER SPAWNERS (DFO SPAWNING RECORDS, 1948-1979) (Appendix XIV)

SPECIES	PERIOD	START		PEAK	END	
		earliest	average	average	average	latest
CHINOOK	1948-1979	4th wk Aug	early-mid Sept	1st wk Oct	3rd wk Oct	4th wk Oct
PINK	1971,75,77,79 (4 years only)	4th wk Sept	4th wk Sept	1st wk Oct	mid Oct	4th wk Oct

TABLE 6. APPROXIMATE TIMING OF CHINOOK SPAWNING AND DIE-OFF, QUESNEL RIVER (EVS, 1980b)

SPECIES	PERIOD	START	PEAK	END
CHINOOK (SPAWNING)	1979	Sept. 20	Sept. 28	Oct. 10
CHINOOK (DIE-OFF)	1979	Sept. 11?	Oct. 10	Nov. 1?

Figure 11. QUESNEL RIVER, AREA CA (1936-1978) ESTIMATED ESCAPEMENT OF CHINOOK SALMON
(DFO Spawning Files)

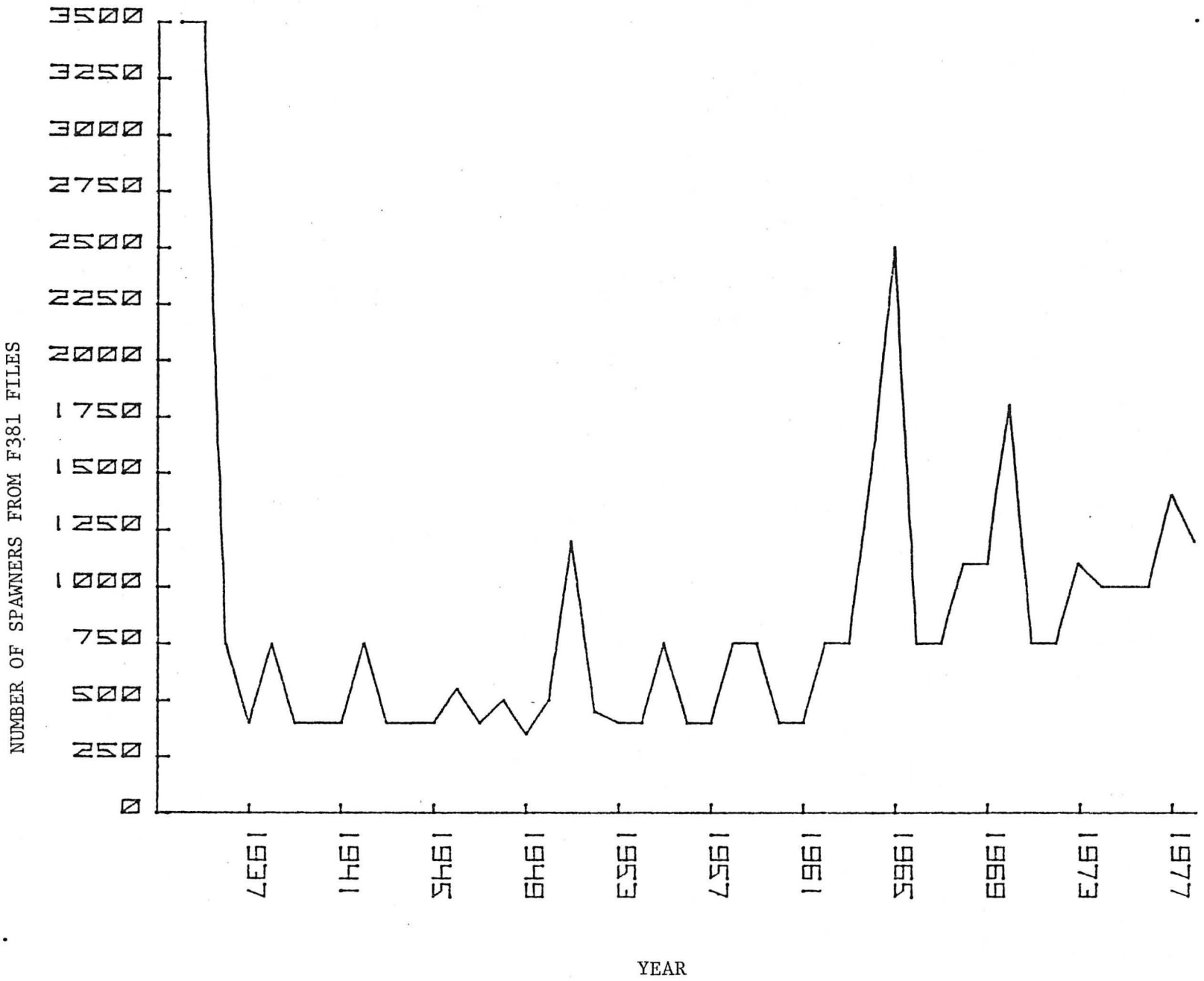


Figure 12. Distribution of spawning chinook salmon, Quesnel River, fall 1979 (adapted from E.V.S. 1980 b)

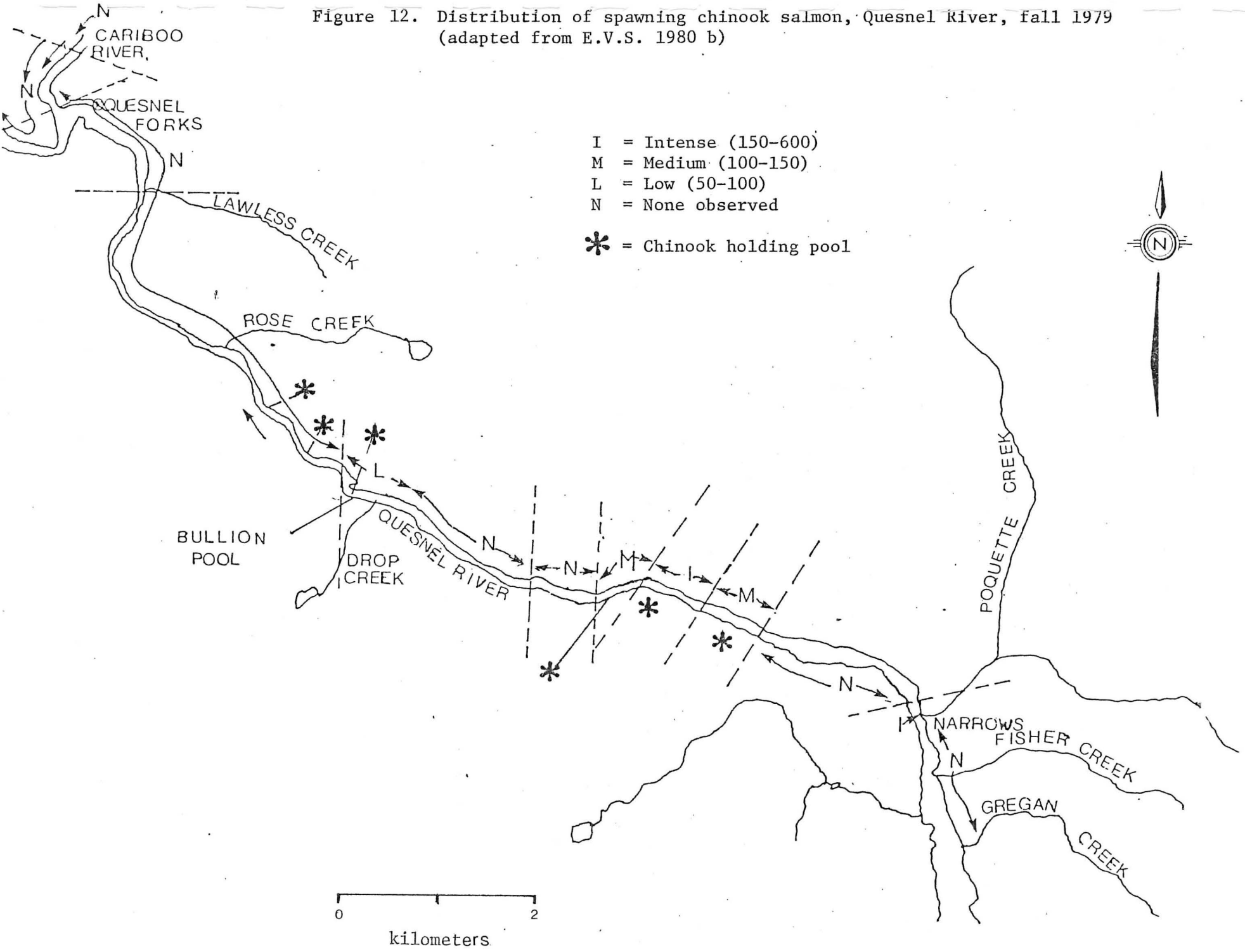
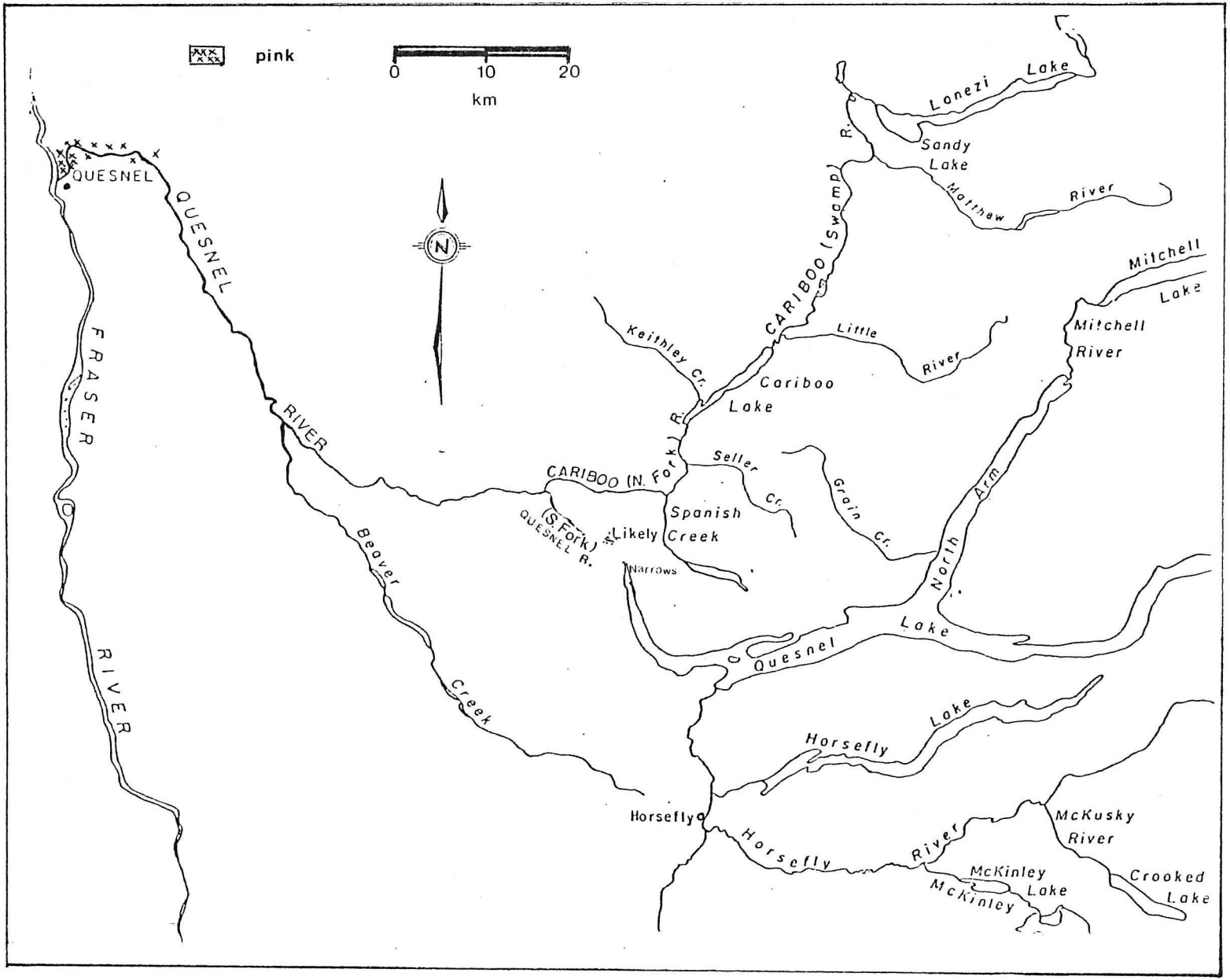


Figure 13: Distribution of spawning pink salmon, Quesnel River.
(DFO Spawning Files, Fraser River Baseline Reports compiled by Simpson, K. and B. Mitchell, 1976)



MIGRATION TIMING OF SALMONIDS

The relationship of migration timing of Quesnel River salmon species through the lower Fraser River fishery is summarized in figure 14. The Quesnel River chinook escapement are a middle-timing stock that migrate through the Fraser River fishery (Area 29) from April 30 to August 21. Sockeye and pink migration through Area 29 is from July 20 to August 15 and from August 27 to October 24 respectively. It is significant to note that the International Pacific Salmon Fisheries Commission (IPSFC) manage the river for sockeye and pinks from about July 1 to September 30.

ANNUAL CATCH

Sport Catch

The Quesnel River is closed to sport fishing for salmon.

Indian Food Catch

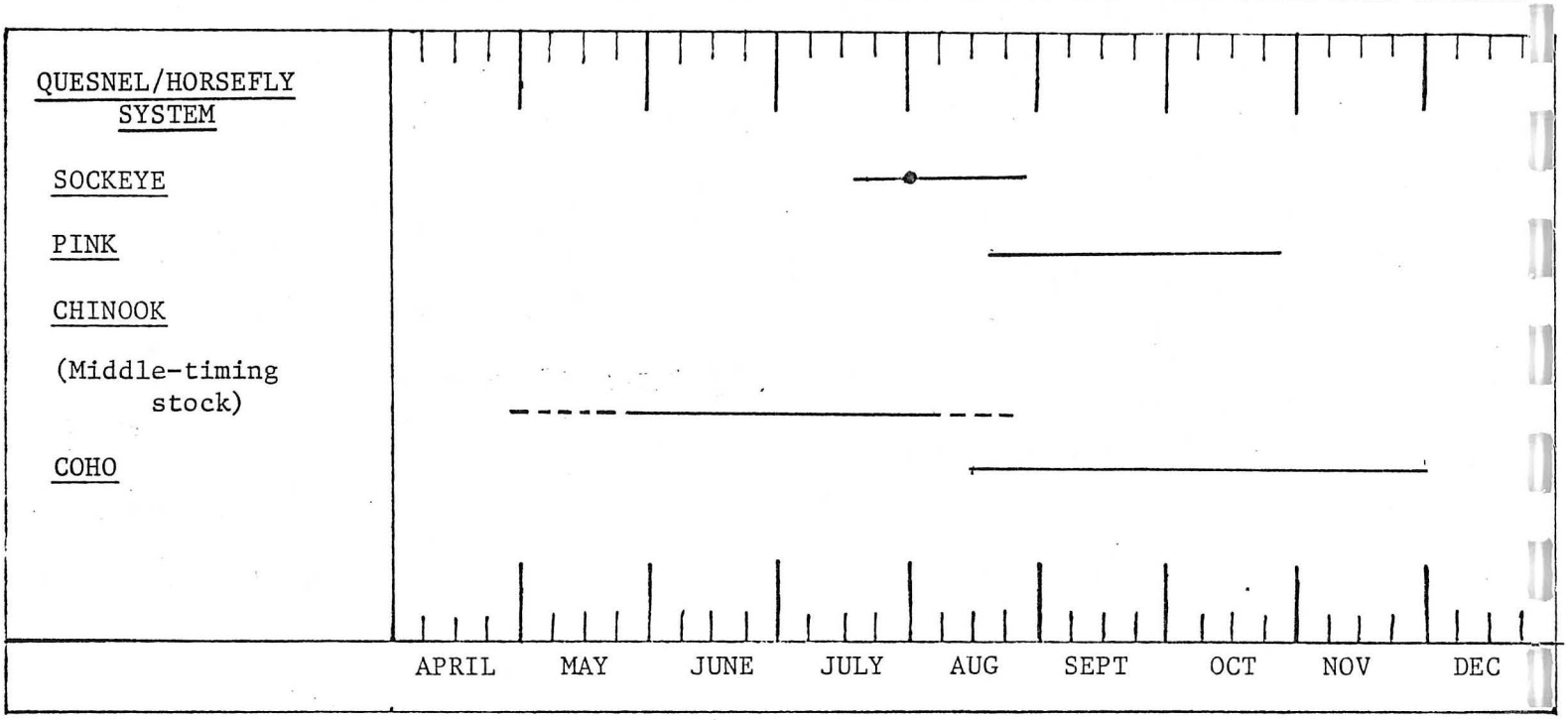
The Indian food fishery is non-existent on the Quesnel River. It has been noted, however, that the sockeye salmon are heavily fished while migrating through the several native fisheries in the Fraser mainstem prior to actually reaching the Quesnel River (table 7).

Commercial Catch

The Quesnel River does not support a commercial fishery. Quesnel-bound salmon that are commercially caught prior to reaching the River are represented in the Fraser River annual catch (table 7).

Figure 14.

APPROXIMATE MIGRATION TIMING OF SALMONIDS THROUGH THE LOWER FRASER RIVER COMMERCIAL FISHERY



(p. comm R. Harrison, DFO, Geographical Working Group, May 1980)

TABLE: 7 . ANNUAL CATCH (GWG, 1980 and DFO District Office Quesnel)

FRASER RIVER	SOCKEYE				CHINOOK
	1977 CYCLE	1978 CYCLE	1979 CYCLE	1980 CYCLE	
Current:					
Catch area 29	955,000	603,000	803,000	615,000	100,000
Catch (all areas)	3,866,000	4,388,000	4,023,000	2,399,000	700,000
Escapement	1,082,000,	1,954,000	1,131,000	670,000	66,000
Opt. Escapement	?	?	?	?	155,000
Difference	-	-	-	-	89,000
Total run	5,107,000	6,610,000	5,307,000	3,243,000	766,000
Stock Trend:	UPWARD	UPWARD	UPWARD	UPWARD	DECLINE
Sport catch in river only:					10,000
Indian Food Catch:	250,000	250,000	250,000	250,000	20,000
QUESNEL RIVER	Closed to sport fishing. No Indian Food Fishery.				

BIOLOGICAL SURVEYS

INTRODUCTION

The summary of existing biological data was primarily based on the biobaseline studies of 1979 by E.V.S. Consultants Ltd. Information regarding fry emergence timing, growth, post-emergent fry distribution and abundance as well as other data on chinook juveniles has been compiled from the Chinook Salmon (Oncorhynchus tshawytsha) Fry and Smolt Enumeration/Marking Project, Nechako and Quesnel/Horsefly Rivers, B.C., preliminary draft. Information regarding adult spawner characteristics, fecundity and egg retention has been compiled from the 1979 Investigations of Fall Spawning Chinook Salmon (Oncorhynchus tshawytsha) Nechako and Quesnel/Horsefly Rivers, B.C., preliminary draft. Other biological surveys that contributed information were those conducted by International Pacific Salmon Fisheries Commission primarily concerned with pink and sockeye salmon and unpublished data from A.L. Kahl concerning Quesnel River age composition of chinook salmon. The Quesnel River System, Review of Fisheries Related Information by B. Mitchell and K. Simpson was also very informative regarding the compilation of biological surveys.

JUVENILE

Fry Emergence Timing and Growth

The peak timing for chinook fry emergence for 1980, was on the 16th and 17th of April.[1] In the 1979 survey (E.V.S. Consultants Ltd.) the emergence was completed by June 25. The average length of these emergent fry was 38.5mm. In June, July and August, the average lengths of the Quesnel fry were 41.2, 47.7, and 53.7mm respectively. These underyearlings were relatively consistant in size and exhibited a growth rate (expressed as % length increase/day) of 0.315 during a growth period extending from May 5 to July 15, 1979.

Post-Emergent Fry Distribution and Abundance

The post-emergent fry showed significant recruitment of the foreshore areas of upper Quesnel River and lower Quesnel Lake for rearing purposes from May until late July at which time they began to move out. Daily trap catches showed that a few fry were still present in the lake on August 17, 1979 (E.V.S., 1980a). Some utilization of the area around Quesnel Forks for summer rearing was also reported. Also of interest, in the present observations of spring 1980, a large number of chinook fry were reported migrating directly downstream to the Fraser rather than taking up summer rearing sites in the Quesnel.

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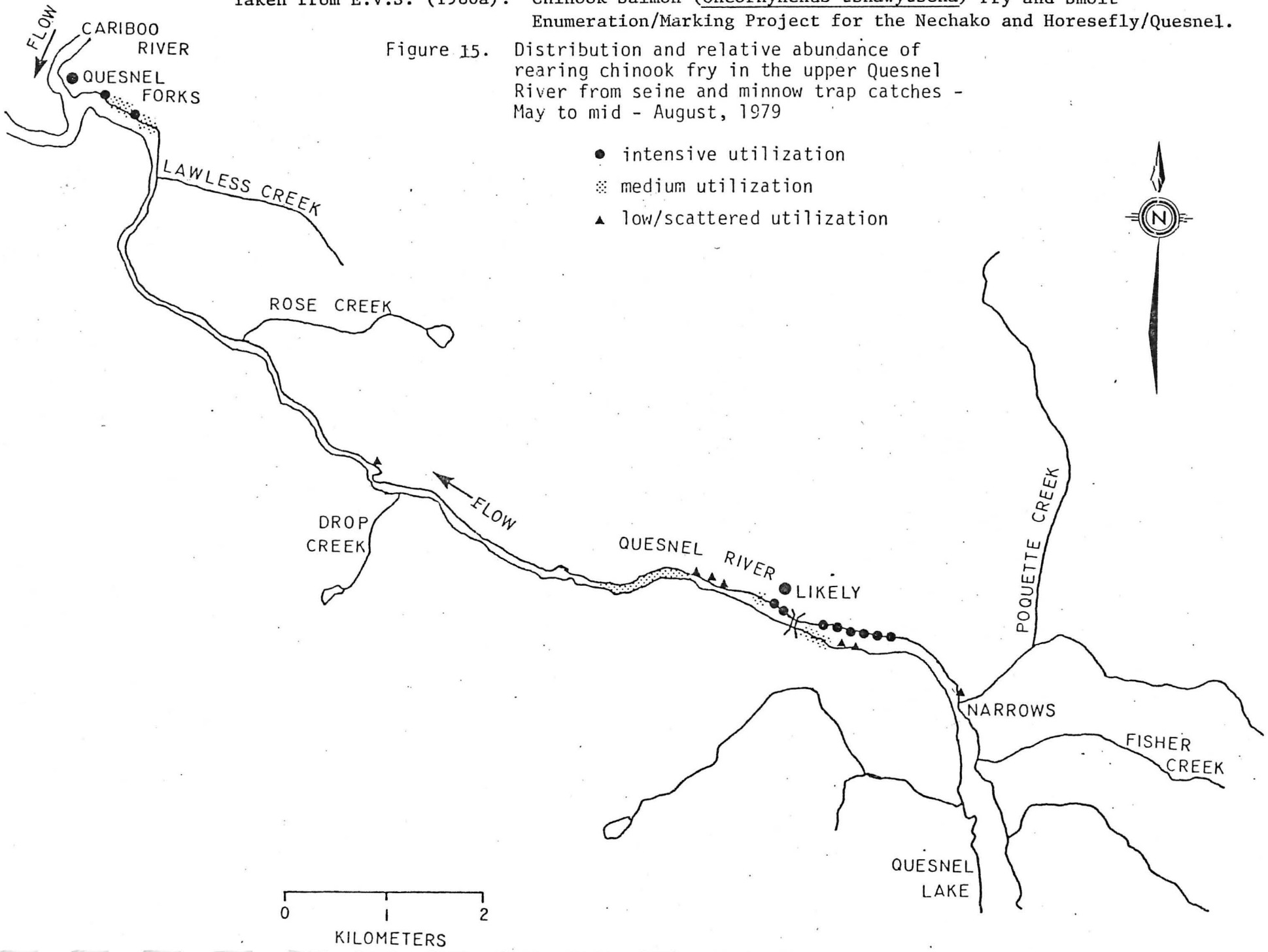
[1] p. comm: Ric Olmsted; Thurs. June 12, 1980.

p. comm: P. Starr, Fri. June 13, 1980. "These dates seem a bit early when compared with other fry emergence timing for interior river systems in the general."

Taken from E.V.S. (1980a): Chinook Salmon (Oncorhynchus tshawytscha) Fry and Smolt Enumeration/Marking Project for the Nechako and Horsefly/Quesnel.

Figure 15. Distribution and relative abundance of rearing chinook fry in the upper Quesnel River from seine and minnow trap catches - May to mid - August, 1979



SPAWNER CHARACTERISTICS

Sex Ratios

A tabulation of percent sex ratios of chinook and pink salmon on the spawning grounds as per DFO spawning files are shown in appendix XV. The average chinook sex ratios for the past 32 years was 45% female, with 16% of the males being jacks. A recent survey (E.V.S. Consultants Ltd., 1980) has shown 39% of the males to be jacks. The jacks were defined on the basis of size (≤500mm FL) as opposed to age analysis. The average pink salmon sex ratios for the 1975, 1977 and 1979 cycles was 48% female and 52% male.

Age Composition

The age composition summary (table 8) shows that with respect to both sexes, the four year old fish were numerically more abundant in 1976 and 1979, with five year olds being more abundant in 1977. The overall age composition shows that four year old fish were dominant in the escapements (60%) and five year old fish present as the sub-dominant age class (23%). Fish with ages three and six years were also represented in the return as 15% and 2% respectively. The majority of fish sampled had emigrated to the Fraser River estuary in their first year of life, with only 22% overall overwintering as fry in freshwater and going to sea in their second year. E.V.S. Consultants Ltd. (1980) observed 10% of the fry to remain in fresh water for the winter. With respect to female age composition only, the percentage of three, four, and five year old returns in 1979 was 6%, 80% and 14% respectively (E.V.S. Consultants Ltd., 1980).

Lengths

The sex specific fork and postorbital-hypural lengths for chinook salmon, as determined by E.V.S. Consultants Ltd. (1980) from both angling

and carcass recovery, has been summarized in table 9. If the jacks are considered separately, the overall male chinook size was slightly larger than the female size having fork lengths ranging from 505-1170mm and 780-1005mm respectively, the average difference being 28mm. The jacks (defined here as males having a fork length measuring $\leq$ 500mm) ranged from 365-490mm. The average postorbital-hypural length for the chinook females was 675mm, ranging from 580-752mm.

Figure 16. Taken from E.V.S. 1980. Investigations of Fall Spawning Chinook Salmon (Oncorhynchus tshawytscha), Nechako, Quesnel/Horsefly Rivers, BC. Preliminary Draft.

Relationship between postorbital-hypural length (POHL) and fecundity, Quesnel River chinook females.

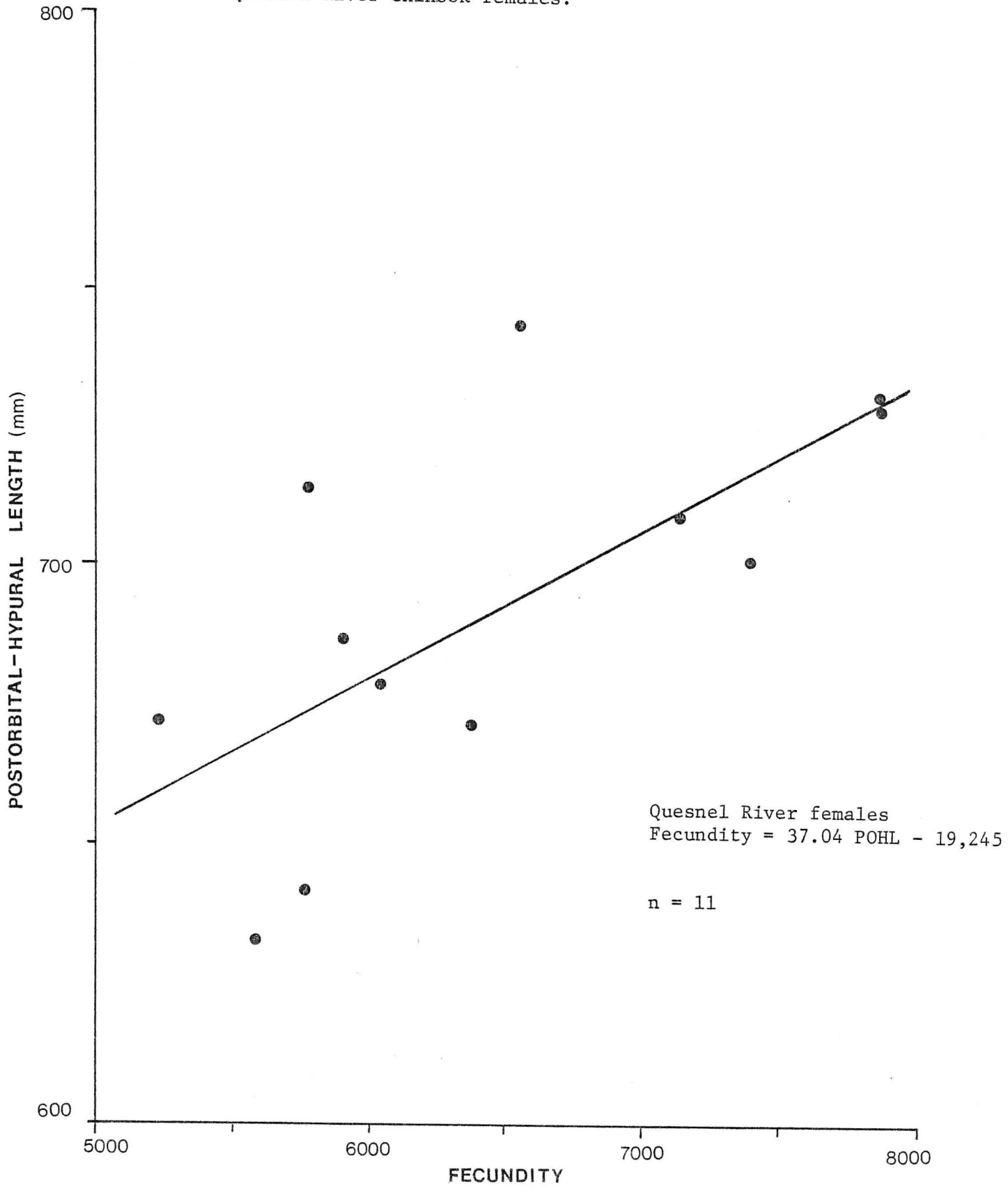


TABLE 8. QUESNEL RIVER; AGE COMPOSITION OF CHINOOK SALMON DURING THE MIDDLE-UPPER FRASER AND THOMPSON RECONNAISSANCE (L. Kahl, unpublished, 1976, 1977) and (E.V.S., 1980b)

DATE	AGE	NUMBER	PERCENT
October 5,6, 1976 (Both sexes)	3_1	6	32
	4_1	10	53
	4_2	1	5
	5_1	2	10
October 12, 1977 (Both Sexes)	3_1	2	9
	4_1	5	23
	4_2	2	9
	5_2	11	50
	6_2	2	9
September 11, 1979 to October 9, 1979			
Males	3_1	4	15
	4_1	17	63
	4_2	1	4
	5_1	5	18
Females	3_1	2	6
	4_1	27	75
	4_2	2	6
	5_1	2	6
	5_2	3	8

Table 9. Hypural and Fork Lengths (mm) of Chinook Salmon Sample by Angling and Carcass Recovery in the Quesnel River (E.V.S. Consultants Ltd., 1980. 1979 Investigations of Fall-Spawning Chinook Salmon (Oncorhynchus tshawytscha), Nechako and Quesnel/Horsefly Rivers, B.C.).

		Fork Length (mm)		Hypural Length (mm)		HL:FL
Sex	n	Ave.	Range	Ave.	Range	Regression
jacks	28	430	365-490	--	--	--
males	44	932	505-1170	--	--	--
females	59	904	780-1005	674.8	580-752	HL=.766HL-17.8

N.B. Regression calculation based on seven female chinook only. Post-orbital-hypural length of remaining 52 Quesnel River females predicted using this equation.

Fecundity

The fecundity of Quesnel River chinook was determined by E.V.S. Consultants Ltd. (1980) from an egg count of eleven unspawned females collected by angling and carcass recovery. The average fecundity from this subsample was 6,342 eggs/female, with a range of 5,257 to 7,884 eggs. Fecundity was positively correlated with female hypural length. This relationship was expressed by the regression equation: Fecundity = 37.04HL-19,245. Using this equation, the calculated average fecundity can be predicted from the mean female hypural length of 675mm. Hence, the adjusted average fecundity for the Quesnel River chinook females is 5750 eggs.

Egg Retention and Pre-spawning Mortality

The average egg retention for the Quesnel River chinook females was reported by E.V.S. (1980b) to be approximately 1.0% of the mean fecundity and occurred in 9.3% of the spawned females examined. The pre-spawning mortality of 12.5% was determined from a sample size of 32.

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APPENDICES

Appendix I. Means of Temperature and precipitation for Quesnel (197?) (from Atmospheric Environment Service 1941-1970)

LATITUDE 52 59 N LONGITUDE 122 29 W ELEVATION 1600 FT ASL

Quesnel	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Mean Daily Temperature (DEG F)	14.2	24.3	32.5	42.7	52.2	58.3	62.5	60.6	53.1	42.9	30.0	21.0
Mean Daily Maximum Temperature	22.2	34.7	44.1	55.6	66.4	71.2	75.6	72.9	64.9	52.7	37.1	27.9
Mean Daily Minimum Temperature	6.1	13.9	20.8	29.7	37.9	45.4	49.4	48.1	41.2	33.1	22.8	13.9
Extreme Maximum Temperature	61.0	66.0	74.0	88.0	96.0	98.0	105.0	101.0	94.0	83.0	76.0	65.0
No. of Years of Record	71	72	72	72	72	73	72	72	73	72	73	72
Extreme Minimum Temperature	-51	-50	-30	-7.0	12	18	30	29	12	-4	-31	-52
No. of Years of Record	72	71	72	71	72	69	70	72	73	71	76	72
No. of Days with Frost	30	27	28	20	7	*	0	*	3	15	26	30
Mean Rainfall (inches)	0.16	0.23	0.38	0.78	1.36	2.24	2.25	2.55	1.70	1.61	0.70	0.28
Mean Snowfall	19.0	9.4	4.7	1.3	0.2	0.0	0.0	0.0	T	1.8	8.7	14.7
Mean Total Precipitation	2.07	1.17	0.86	0.91	1.38	2.24	2.25	2.55	1.70	1.79	1.57	1.75
Greatest Rainfall in 24 Hrs	0.50	0.80	0.88	1.04	1.46	2.84	1.50	1.54	1.35	1.44	1.02	0.80
No. of Years of Record	76	71	69	70	74	72	73	71	73	71	75	73
Greatest Snowfall in 24 Hrs	17.0	14.0	8.0	4.0	4.5	T	0.0	0.0	0.8	8.0	13.0	11.0
No.of Years of Record	76	71	69	70	75	75	74	75	74	74	75	69
Greatest Precip. in 24 Hrs	1.70	1.40	0.88	1.04	1.46	2.84	1.50	1.54	1.35	1.44	1.30	1.10
No. of Years of Record	76	71	69	70	75	74	73	71	74	72	76	71
No. of Days with Measurable Rain	2	2	4	6	9	11	11	12	11	10	5	2
No. of Days with Measurable Snow	9	6	3	1	*	0	0	0	*	1	5	8
No. of Days with M. Precipitation	11	7	7	7	9	11	11	12	11	11	9	10

Appendix I. Means of Temperature and precipitation for Quesnel (197?) (from Atmospheric Environment Service 1941-1970) (cont'

LATITUDE 53 02 N LONGITUDE 122 31 W ELEVATION 1787 FT ASL

Quesnel A	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Mean Daily Temperature (DEG F)	11.6	22.8	31.1	41.1	51.2	57.6	61.5	59.8	52.5	42.2	28.7	19.5
Mean Daily Maximum Temperature	20.1	33.1	42.1	53.3	65.3	71.0	75.2	73.0	65.0	51.9	35.9	26.7
Mean Daily Minimum Temperature	3.0	12,4	20.0	28.9	36.9	44.2	47.7	46.6	39.9	32.4	21.3	12.2
Extreme Maximum Temperature	57	59	67	80	90	96	98	96	86	78	63	54
No. of Years of Record	24	24	25	25	25	25	25	25	25	25	25	25
Extreme Minimum Temperature	-52	-44	-38	-4	14	26	33	29	16	-6	-36	-42
No. of Years of Record	24	24	25	25	25	25	25	25	25	25	25	25
No. of Days with Frost	30	27	28	21	9	1	0	*	5	16	26	30
Mean Rainfall (inches)	0.14	0.22	0.36	0.78	1.40	2.23	2.13	2.80	1.63	1.61	0.7-	0.22
Mean Snowfall	23.4	12.5	6.7	1.9	0.1	0.0	0.0	0.0	0.1	2.6	11.2	17.4
Mean Total Precipitation	2.22	1.42	1.02	0.96	1.41	2.23	2.13	2.80	1.64	1.86	1.79	1.83
Greatest Rainfall in 24 Hrs.	0.40	1.00	0.53	1.34	1.11	2.17	1.20	1.90	0.77	1.22	0.68	0.37
No. of Years of Record	24	24	25	25	25	25	25	25	25	25	25	25
Greatest Snowfall in 24 Hrs.	15.8	14.5	9.6	8.5	0.5	0.0	0.0	0.0	1.5	7.4	8.8	14.4
No. of Years of Record	24	24	25	25	25	25	25	25	25	25	25	25
Greatest Precipitation in 24 Hrs	1.58	1.45	0.96	1.34	1.11	2.17	1.20	1.90	0.77	1.38	0.92	0.79
No. of Years of Record	24	24	25	25	25	25	25	25	25	25	25	25
No.of Days with Measurable Rain	1	2	4	7	10	12	11	13	11	11	6	2
No. of Days with Measurable Snow	13	9	6	2	*	0	0	0	*	2	9	12
No. of Days with M. Precipitation	14	11	9	8	10	12	11	13	11	12	13	14

Appendix I:

Means of temperature and precipitation for Horsefly Lake (from Atmos. Env. Serv., 197?)

LATITUDE 52 23 N LONGITUDE 121 17 W ELEVATION 2585 FT ASL

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Mean Daily Temperature (DEG. C.)	-8.67	-4.17	-1.06	4.33	9.5	12.89	15.28	14.83	11.00	6.17	-1.00	-5.33
Mean Daily Maximum Temperature	-3.44	1.72	5.83	11.11	17.17	20.28	23.44	22.78	18.06	11.94	3.11	-0.78
Mean Daily Minimum Temperature	-13.94	-10.06	-7.94	-2.44	1.78	5.50	7.06	6.89	3.89	-0.39	-5.17	-9.94
Extreme Maximum Temperature	12.22	12.22	-18.33	23.33	29.44	33.33	33.33	33.33	28.89	23.33	16.11	15.56
No. of Years of Record	10	11	11	11	10	10	9	10	8	10	10	11
Extreme Minimum Temperature	-42.22	-44.44	-40.56	-18.33	-7.22	-1.66	0.0	-1.11	-6.11	-12.78	-32.22	-41.11
No. of Years of Record	10	11	11	11	10	9	8	9	8	10	10	11
No. of Days with Frost	30	27	29	24	11	2	*	1	4	17	25	29
Mean Rainfall (mm)	1.02	3.81	10.67	35.31	50.80	106	79.00	80.26	59.69	56.13	20.32	7.11
Mean Snowfall	533	287	328	38.10	17.78	0.0	0.0	0.0	0.0	35.56	274	414
Mean Total Precipitation	54.36	32.51	43.43	39.12	52.58	106	78.99	80.26	59.69	59.69	47.75	48.51
Greatest Rainfall in 24 Hours	6.35	13.21	18.80	40.13	38.61	51.82	41.40	35.56	30.48	24.64	18.80	19.30
No. of Years of Record	10	10	11	11	10	10	10	9	9	10	10	11
Greatest Snowfall in 24 Hours	216	267	343	102	165	0.0	0.0	0.0	0.0	102	229	292
No. of Years of Record	10	11	10	11	10	10	10	9	9	10	10	11
Greatest Precipitation in 24 Hours	21.59	26.67	34.29	40.13	38.61	51.82	41.40	35.56	30.48	24.64	22.86	29.21
No. of Years of Record	10	11	11	11	10	10	10	9	9	10	10	11
No. of Days with Measurable Rain	*	1	2	5	7	13	9	12	10	9	4	1
No. of Days with Measurable Snow	11	8	8	1	*	0	0	0	0	1	5	8
No. of Days with M. Precipitation	11	9	10	6	7	13	9	12	10	10	9	9

APPENDIX II(a). QUESNEL WATERSHED FORESTRY TABLES; ACREAGE, SITE CLASSIFICATION; ALIENATED LANDS ROTATION AGES

CARIBOO FOREST DISTRICT

FOREST AND NON-FOREST AREA IN ACRES FOR

- LANDS ON WHICH THE FOREST SERVICE CAN DISPOSE OF TIMBER VALUES

NAME	FOREST LAND						NON-FOREST	TOTAL
APPROVED SUSTAINED-YIELD UNITS	MATURE	IMMATURE	RESIDUAL	N.S.R.	N.C.	TOTAL	LAND	AREA
BOWRON P.S.Y.U.	93,993	49,179	4,526	2,534	454	150,686	18,087	168,773
QUESNEL LAKE P.S.Y.U.	898,012	542,380	1,115	84,027	11,329	1,536,854	536,442	2,073,296

CARIBOO FOREST DISTRICT

FOREST AREA IN ACRES BY SITE CLASS FOR:

- LANDS ON WHICH THE FOREST SERVICE CAN DISPOSE OF TIMBER VALUES

NAME	SITE CLASSIFICATION				TOTAL FOREST
APPROVED SUSTAINED-YIELD UNITS	GOOD	MEDIUM	POOR	LOW	AREA
BOWRON P.S.Y.U.	37,375	67,065	40,088	5,558	150,686
QUESNEL LAKE P.S.Y.U.	348,593	696,845	489,983	2,318	1,536,854

Appendix II(a). CARIBOO FOREST DISTRICT

FOREST AND NON-FOREST AREAS IN ACRES FOR:

- LANDS ALIENATED[1] AND NON-ALIENATED[2] ON WHICH THE FOREST SERVICE DOES NOT DISPOSE OF TIMBER VALUES

STATUS	FOREST LAND						NON FOREST LAND	TOTAL AREA
	MATURE	IMMATURE	RESIDUAL	N.S.R.	N.C.	TOTAL		
MAJOR PROVINCIAL PARKS	421,832	168,681		281	229,023	819,817	732,712	1,552,529
NON FOREST RESERVES & MINOR PARKS	34,193	31,178	974	3,079	139	70,103	14,728	84,831
TREE FARM LICENCES INCLUDING TEMPORARY TENURES BUT EXCLUDING CROWN GRANTS IN SCHEDULE "A"	31,580	49,063	-	-	654	81,297	2,931	84,228
TEMPORARY TENURES (LEASES, LICENCES, ETC.) OTHER THAN THOSE IN SCHEDULE "A"	2,675	346	-	5	-	3,026	313	3,399
TOTAL NON- ALIENATED[2]	490,280	249,808	974	3,365	229,816	974,243	750,684	1,724,927
CROWN GRANTS INCLUDING THOSE IN T.F.L. SCHEDULE "A"	139,453	280,663	36,343	25,448	4,887	486,794	460,875	947,669
FEDERAL PARKS	-	-	-	-	-	-	-	-
OTHER FEDERAL LANDS	82,020	49,397	4,197	1,235	1,672	138,521	52,989	191,510
TOTAL ALIENATED[1]	221,473	330,060	40,540	26,683	6,559	625,315	513,864	1,139,179
TOTAL[1 and 2]	711,753	579,868	41,514	30,048	236,375	1,599,588	1,264,548	2,864,106
DISTRICT TOTAL	7,797,775	7,305,919	200,143	423,226	290,635	16,017,698	5,227,247	21,244,945

Appendix II(a). CARIBOO FOREST DISTRICT

ROTATION AGE & CALCULATED ALLOWABLE ANNUAL CUT (7.1"+ D.B.H. CLOSE UTILIZATION LESS DECAY

-IF ALL LANDS ON WHICH THE FOREST SERVICE CAN DISPOSE OF TIMBER VALUES WERE UNDER SUSTAINED-YIELD

NAME	ROTATION AGE (YEARS)	CALCULATED ANNUAL CUT 6" TOP D.I.B. (C.C.F.)
APPROVED SUSTAINED-YIELD UNITS -		
BOWRON P.S.Y.U.	87	51,000
QUESNEL LAKE P.S.Y.U.	90	418,120

Appendix II(b). Schedule "B" Provisions for Green, Yellow and Red Coded Streams. (1 of 3)

PLACER MINING

SCHEDULE "B" PROVISIONS

FOR

GREEN CODED STREAMS

The following shall be adhered to unless amended by written permission of the Chief Inspector of Mines:

1. Forest cover, topsoil and debris shall be disposed of in such a manner as to prevent their entry into any watercourse.

2. Sediment-contaminated water caused by any operation shall be contained and/or treated prior to discharging into any watercourse and the suspended solids content of the effluent shall conform with Level A of the Pollution Control Objectives for the Mining, Mine-milling and Smelting Industries of British Columbia.

3. All mined or otherwise disturbed ground surfaces, including cut banks, fill slopes and tailing piles, shall be stabilized to prevent surface run-off from carrying sediment into adjacent watercourses.

Appendix II(b). Schedule "B" Provisions for Green, Yellow and Red Coded Streams. (2 of 3)

PLACER MINING

SCHEDULE "B" PROVISIONS

FOR

YELLOW CODED STREAMS

The following shall be adhered to unless amended by written permission of the Chief Inspector of Mines:

1. Forest cover and vegetation adjacent to any watercourse shall not be disturbed or removed.

2. Forest cover, topsoil and debris shall be disposed of in such a manner as to prevent their entry into any watercourse.

3. Gravel or other material in any stream or lake shall not be removed or displaced.

4. Machinery and equipment shall not be operated in any stream or lake.

5. Tailings shall not be placed into any stream or lake.

6. Water intakes and diversions shall be screened in accordance with the screening specification.

7. Sediment-contaminated water caused by any operation shall be contained and/or treated prior to discharging into any watercourse and the suspended solids content of the effluent shall conform with Level A of the Pollution Control Objectives for the Mining, Mine-milling and Smelting Industries of British Columbia.

8. All mined or otherwise disturbed ground surface, including cut banks, fill slopes and tailings piles, shall be stabilized to prevent surface run-off from carrying sediment into adjacent watercourses.

9. All mined or otherwise disturbed areas below the normal high water level of any watercourse shall be graded prior to inundation so as not to create new channels or pools at high water levels.

Appendix II(b). Schedule "B" Provisions for Green, Yellow and Red Coded Streams. (3 of 3)

PLACER MINING

SCHEDULE "B" PROVISIONS

FOR

RED CODED STREAMS

The following shall be adhered to unless amended by written permission of the Chief Inspector of Mines:

1. Forest cover and vegetation adjacent to any watercourse shall not be disturbed or removed.

2. Forest cover, topsoil and debris shall be disposed of in such a manner as to prevent their entry into any watercourse.

3. Gravel or other material below the normal high water level of any watercourse shall not be removed or displaced..

4. Machinery and equipment shall not be operated in any stream or lake.

5. Tailings shall not be placed below the normal high water level of any watercourse.

6. Water intakes and diversions shall be screened in accordance with the screening specifications.

7. All wash water shall be recirculated in a closed system so that there will be no discharge of sediment-contaminated water into any watercourse. Settling ponds shall be located above the normal high water level of any watercourse.

8. All mined or otherwise disturbed ground surfaces, including cut banks, fill slopes and tailings, shall be stabilized to prevent surface run-off from carrying sediment into adjacent watercourses.

Appendix III QUESNEL RIVER NEAR QUESNEL - STATION NO. 08KH006

(a) MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC FEET PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1939	---	---	---	---	---	19100	17100	10800	7590	7660	7240	---	---	1939
1940	---	---	---	6120	12700	17000	15500	12400	8870	5870	3970	2850	---	1940
1941	---	---	---	5740	9760	14300	13000	8330	9020	12400	7730	4600	---	1941
1942	2430	1790	1520	2760	10000	18300	14900	9220	6280	5140	3640	2880	6600	1942
1943	---	---	---	5630	9790	19900	21000	13700	6640	4280	2140	1450	---	1943
1944	---	---	---	4360	12100	18900	13000	12300	10700	8460	4870	---	---	1944
1945	---	---	---	2110	10100	18300	12100	7230	5130	3530	2690	1980	---	1945
1946	1800	1720	1670	2290	15500	21600	15600	9140	4710	2540	1870	1650	6710	1946
1947	1420	1260	1510	4600	14400	22300	16700	9000	5800	5640	4060	2790	7480	1947
1948	2280	1920	1750	2300	17400	31000	15900	14600	11800	8130	5790	4250	9770	1948
1949	2690	1880	2090	6200	17500	17900	13700	12100	7050	4930	4850	4100	7960	1949
1950	2840	1920	1640	2890	10100	23100	18400	9830	6340	5470	5620	3930	7690	1950
1951	2620	2050	1850	3890	15900	16400	13300	7350	4740	4120	3730	3080	6620	1951
1952	2210	1490	1410	4730	16000	20600	17000	9370	6080	4720	3120	2020	7410	1952
1953	1620	1370	1470	2190	14500	19100	14300	9040	8010	6010	6730	4270	7410	1953
1954	3190	2440	1870	1680	9510	22000	20400	13400	9840	7920	7250	5410	8780	1954
1955	3530	2550	2060	2730	8090	24900	28400	16200	7630	4910	3300	2540	8940	1955
1956	1560	1100	1020	3590	14500	24600	16700	9750	6150	5200	4130	3160	7630	1956
1957	2270	---	---	3380	23700	20200	15700	11400	8690	5290	4660	4200	---	1957
1958	3140	2830	2840	5590	15800	21300	12200	7020	5830	7880	4110	2670	7630	1958
1959	2130	1650	1350	2380	10900	20300	16600	10000	12800	10900	8790	5310	8620	1959
1960	3230	2570	2390	5250	10500	20400	24200	13500	10900	9850	6920	3810	9480	1960
1961	2830	2290	2450	5310	14100	21600	11100	7140	5790	6900	4910	3230	7330	1961
1962	2700	3100	2550	6970	13000	22400	21100	16700	9170	7680	7640	4850	9860	1962
1963	3920	3570	4350	5970	11700	20400	17600	12300	9290	6220	4350	3330	8610	1963
1964	2430	2150	1900	2930	8130	28900	21500	14900	11000	12400	6490	3350	9680	1964

QUESNEL RIVER (con't)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	MEAN	YEAR
1965	2490	2460	2370	5540	14700	24500	15800	11800	7870	6760	5990	3690	8690	1965
1966	2960	2140	1800	5760	14300	22000	18800	12200	7110	5790	4280	3380	8420	1966
1967	2880	2330	2070	2770	12400	31100	21800	11500	7130	5380	5890	4460	9170	1967
1968	3670	3910	5410	5280	14000	24500	23500	12500	10100	6560	4450	2930	9750	1968
1969	1830	1730	1520	5180	13800	17900	12600	11800	10800	10000	6400	4370	8190	1969
1970	2810	2150	1800	2940	9660	22500	14800	8620	5850	5200	3280	2330	6850	1970
1971	2250	2360	2120	3950	17400	23500	17000	10800	7450	5540	4370	3550	8390	1971
1972	3380	3920	4270	5390	18100	34200	23100	11000	5580	4790	4210	3070	10100	1972
1973	2280	1930	1720	3160	13500	21800	17700	9600	5080	5400	4950	2860	7520	1973
1974	2000	2110	1780	4960	13500	24300	25000	13100	7140	5450	3560	2470	8870	1974
1975	2000	1730	1670	2320	10300	22800	22100	12400	7690	6020	5790	3740	8250	1975
1976	2880	2390	2100	5510	19900	21200	25500	20100	14600	7030	4300	3800	10800	1976
mean	2570	2220	2140	4190	13400	22000	17800	11400	7950	6530	4950	3400	8360	mean

LOCATION - LAT 52 51 13 N
LONG 122 14 07 W

DRAINAGE AREA 4450 SQ MILES
NATURAL FLOW

Appendix III. QUESNEL RIVER NEAR QUESNEL - STATION NO. 08KH006

(b) ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YEAR
1939	---	22400 CFS ON MAY 19	---	---	1939
1940	---	18900 CFS ON JUN 16	---	---	1940
1941	---	16500 CFS ON JUL 3	---	---	1941
1942	---	21400 CFS ON JUN 9	1410 CFS ON MAR 24	4780000 AC-FT	1942
1943	---	26400 CFS ON JUN 23	1180 CFS ON DEC 31	---	1943
1944	---	21200 CFS ON JUN 3	---	---	1944
1945	---	20600 CFS ON JUN 10	---	---	1945
1946	---	26000 CFS ON MAY 29	1550 CFS ON DEC 16	4860000 AC-FT	1946
1947	---	24400 CFS ON JUN 11	1160 CFS ON FEB 26	5420000 AC-FT	1947
1948	---	38500 CFS ON MAY 31	1600 CFS ON MAR 25	7090000 AC-FT	1948
1949	---	22300 CFS ON JUN 8	1480 CFS ON MAR 11	5760000 AC-FT	1949
1950	---	31900 CFS ON JUN 22	1570 CFS ON MAR 25	5570000 AC-FT	1950
1951	---	21600 CFS ON MAY 25	1610 CFS ON MAR 8	4790000 AC-FT	1951
1952	---	24400 CFS ON MAY 29	1400 CFS ON FEB s1	5380000 AC-FT	1952
1953	---	21700 CFS ON JUN 10	1330 CFS ON FEB 18	5370000 AC-FT	1953
1954	---	25600 CFS ON JUN 15	1580 CFS ON APR 12	6360000 AC-FT	1954
1955	---	40400 CFS ON JUN 29	1780 CFS ON MAR 31	6470000 AC-FT	1955
1956	---	28300 CFS ON JUN 12	980 CFS ON MAR 20*	5540000 AC-FT	1956
1957	---	30900 CFS ON MAY 22	---	---	1957
1958	---	26700 CFS ON MAY 31	2310 CFS ON DEC 30	5530000 AC-FT	1958
1959	---	22300 CFS ON JUN 23	1260 CFS ON MAR 29	6250000 AC-FT	1959
1960	---	30900 CFS ON JUL 2	1850 CFS ON MAR 17	6880000 AC-FT	1960
1961	---	28900 CFS ON JUN 8	1910 CFS ON MAR 12	5310000 AC-FT	1961
1962	---	27100 CFS ON JUN 28	2310 CFS ON MAR 28	7140000 AC-FT	1962
1963	---	23200 CFS ON JUN 20	2700 CFS ON DEC 28	6240000 AC-FT	1963
1964	---	34500 CFS ON JUN 19	1720 CFS ON MAR 24	7030000 AC-FT	1964

QUESNEL RIVER (con't)

1965	---	28800 CFS ON JUN 12	2150 CFS ON APR 1	6290000 AC-FT	1965
1966	---	25400 CFS ON JUN 20	1570 CFS ON MAR 20	6090000 AC-FT	1966
1967	---	35300 CFS ON JUN 23	1870 CFS ON APR 3	6640000 AC-FT	1967
1968	---	28000 CFS ON JUN 13	2080 CFS ON DEC 31	7080000 AC-FT	1968
1969	---	19800 CFS ON JUN 13	1350 CFS ON MAR 26	5930000 AC-FT	1969
1970	---	27200 CFS ON JUN 7	1640 CFS ON MAR 17	4960000 AC-FT	1970
1971	---	27800 CFS ON JUN 10	1840 CFS ON APR 2	6080000 AC-FT	1971
1972	---	40800 CFS ON JUN 13*	2260 CFS ON DEC 23	7330000 AC-FT	1972
1973	---	28700 CFS ON JUN 27	1620 CFS ON MAR 6	5450000 AC-FT	1973
1974	---	32400 CFS ON JUN 24	1620 CFS ON MAR 25	6420000 AC-FT	1974
1975	---	26600 CFS ON JUN 24	1480 CFS ON APR 9	5980000 AC-FT	1975
1976	---	30700 CFS ON JUL 2	1970 CFS ON MAR 4	7840000 AC-FT	1976

mean 60600

*Extreme recorded for the period of record

Appendix IV . QUESNEL RIVER AT LIKELY - STATION NO. 08KH001

(a) MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC FEET PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	MEAN	YEAR
1924	---	---	---	---	---	---	---	---	4780	3740	2510	---	---	1924
1925	---	---	---	2420	11100	14800	8900	4220	3240	2160	1530	2090	---	1925
1926	2060	1460	1300	3370	8730	8190	7600	3910	2550	2260	1980	1460	3750	1926
1927	1220	1080	942	1100	3820	11600	10900	5830	3970	4240	3940	2390	4270	1927
1928	1720	---	---	---	---	14500	9960	5110	2650	---	---	---	---	1928
1929	---	---	786	858	4040	12000	8760	5740	3200	2000	1430	1270	---	1929
1930	878	798	838	1740	5320	10000	9480	5410	3470	2910	2230	1420	3730	1930
1931	950	876	878	1460	6000	10400	10400	5380	3310	3870	2820	1710	4020	1931
1932	---	---	1040	1730	5510	12600	12500	9520	6010	---	3220	---	---	1932
1933	---	---	---	---	---	14400	16400	9020	4760	2970	2760	---	---	1933
1934	---	---	1360	2850	7740	10600	7760	5780	4170	3450	3070	2510	---	1934
1935	1860	2170	1940	1630	3740	8250	8770	6310	3760	3010	2790	2290	3890	1935
1936	---	---	---	---	9820	16700	9950	4900	3390	---	4380	---	---	1936
1937	2940	1640	916	1400	4640	9700	---	---	---	---	---	---	---	1937
1938	---	---	956	1440	3810	8260	7280	3960	2940	2600	2150	1820	---	1938
1939	1760	1400	1160	2320	9810	13300	12200	7570	4110	3200	3380	3300	5310	1939
1940	2030	1300	1160	2400	6750	11900	10700	7780	4460	2990	2170	1500	4600	1940
1941	1140	1040	962	2610	5090	7770	6880	4330	4230	5590	4550	3090	3950	1941
1942	1760	1250	1030	1340	3740	8420	7610	5270	3690	3030	2310	1810	3450	1942
1943	1260	861	519	1400	3710	7630	9700	6300	3800	2510	1750	1310	3410	1943
1944	942	693	595	1840	4770	8040	6210	5190	4910	4300	3010	2030	3550	1944
1945	1460	1130	895	864	3790	9190	7420	4170	3180	2070	1450	940	3060	1945
1946	898	829	873	982	6020	11100	8950	5970	3290	1930	1260	1010	3610	1946
1947	---	---	---	2220	7280	12400	9200	5510	3320	2900	2610	2100	---	1947
1948	1750	1070	1000	1110	5890	16000	9320	7360	6900	4830	3620	2350	5100	1948
1949	1430	1060	876	1700	8020	11500	7950	7310	4450	2570	2220	1750	4260	1949
1950	1500	1040	810	895	3430	11500	11700	6050	3490	2930	2250	2050	3990	1950
1951	1670	1290	1050	1430	6430	9010	6970	3070	2400	2050	1400	1040	3160	1951
1952	859	825	679	1190	6340	11500	10200	5590	3150	2380	1750	1130	3810	1952
1953	881	847	955	1100	6040	10700	8170	5110	4130	3460	3640	2620	3990	1953
1954	1710	1210	1020	910	3730	11700	12600	7840	6070	4440	4030	3470	4910	1954

QUESNEL RIVER (con't)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	MEAN	YEAR
1955	2130	1610	1230	1250	3380	11600	16200	8850	3900	2450	1810	1270	4670	1955
1956	910	735	1697	1140	5490	13300	10400	5820	3480	2940	2440	1870	4110	1956
1957	1460	1090	841	1240	10800	12800	9660	7080	5170	3360	2660	2400	4910	1957
1958	1910	1550	1690	2800	7070	13100	8190	4380	3310	3200	2610	1950	4330	1958
1959	1290	1030	805	1070	4580	11100	11000	6800	6580	7210	6020	4530	5190	1959
1960	2330	1530	1150	2500	5050	10400	15400	8910	6680	6270	5140	2920	5710	1960
1961	2030	1690	1560	2130	5950	12900	7740	4700	3540	3700	3280	2080	4290	1961
1962	1690	2180	1800	2680	6660	12900	13000	10000	6030	4340	4690	3250	5790	1962
1963	2450	1990	2300	2900	5920	11000	10900	7780	6150	4090	2920	2090	5060	1963
1964	1590	1350	1090	1460	3760	15100	14900	9640	6340	7360	4260	2370	5780	1964
1965	1640	1680	1450	1960	6970	13900	10300	7100	5440	3820	3860	2620	5080	1965
1966	1690	1350	1150	2430	6780	12400	11900	8310	4860	3510	2790	2320	4980	1966
1967	1990	1630	1350	1410	5190	16200	14100	7340	4220	3370	3790	3020	5320	1967
1968	2210	2120	2810	2950	5930	13300	14300	8550	6060	4570	3150	2270	5700	1968
1969	1380	1160	981	2180	7010	10900	8460	6540	5820	6350	4410	3060	4880	1969
1970	1860	1410	1160	1420	3810	11300	9170	5230	3460	2900	1980	1320	3770	1970
1971	1230	1640	1390	1480	8450	13700	10600	7000	5010	3640	2500	1960	4910	1971
1972	1490	1240	1510	2550	7560	19200	14500	7330	3820	2610	2220	1720	5480	1972
1973	1330	984	956	1260	5650	11600	11400	6460	3600	3200	3390	2040	4340	1973
1974	1330	1390	1190	2070	7060	12900	14900	9210	4460	2780	2040	1380	5050	1974
1974	1180	1050	984	920	3920	11800	13200	7700	4850	3440	3320	2240	4570	1975
1976	1630	1370	1250	2030	9200	11700	14300	12200	9750	4450	2910	2130	6100	1976
mean	1580	1290	1150	1760	6710	11900	10600	6600	4430	3350	2910	2110	4520	mean

LOCATION - LAT 52 36 54 N
LONG 121 34 15 W

DRAINAGE AREA 2330 sq. miles
NATURAL FLOW

Appendix IV. QUESNEL RIVER AT LIKELY - STATION NO. 08KH001

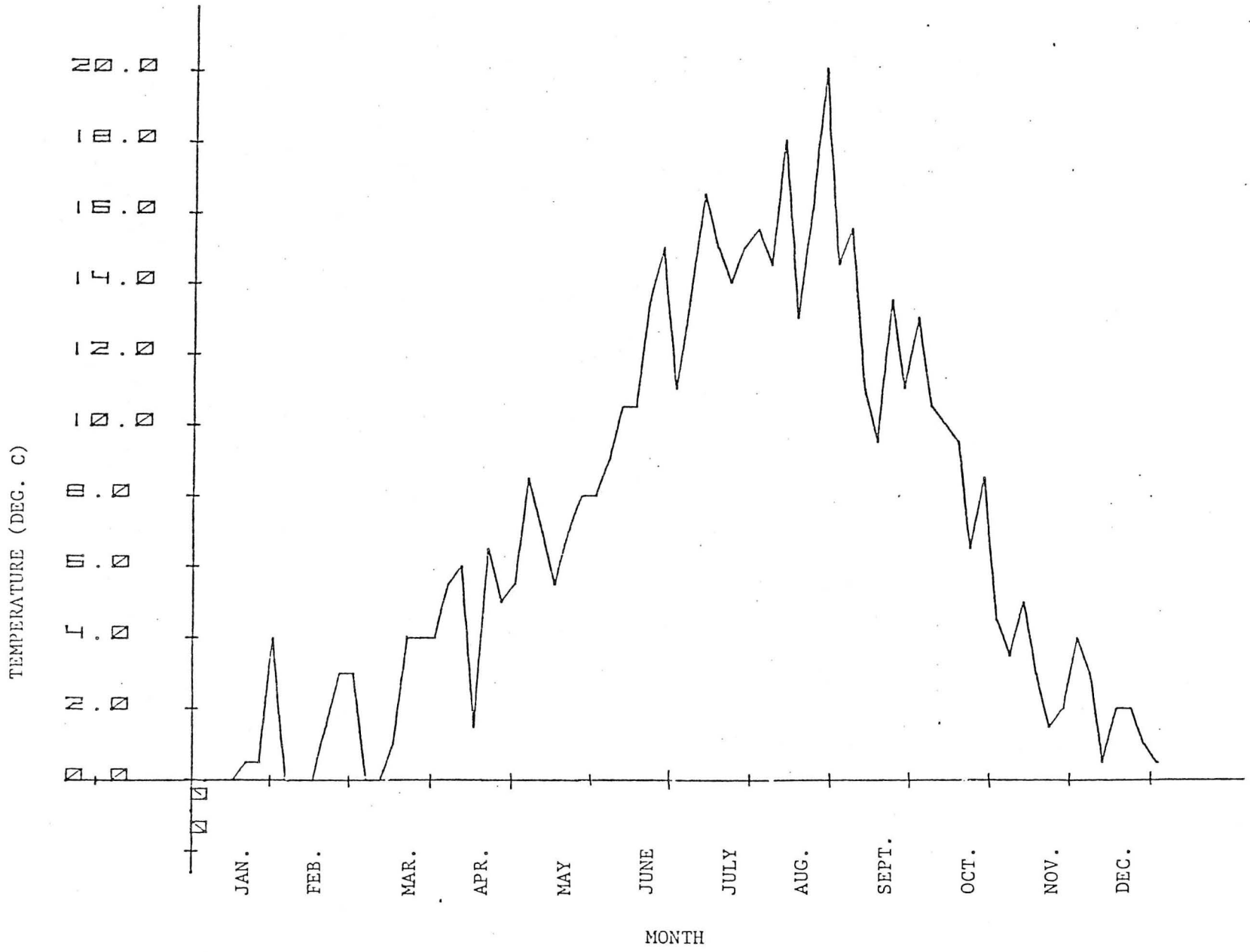
(b) ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YEAR
1924	---	---	---	---	1924
1925	---	18500 CFS ON MAY 24	---	---	1925
1926	---	9560 CFS ON MAY 21	1090 CFS ON MAR 8	2720000 AC-FT	1926
1927	---	14200 CFS ON JUN 22	910 CFS ON MAR 12	3090000 AC-FT	1929
1928	---	17500 CFS ON MAY 29	---	---	1928
1929	---	14400 CFS ON JUN 16	320 CFS ON FEB 11	---	1929
1930	---	11700 CFS ON JUN 22	625 CFS ON JAN 23	2700000 AC-FT	1930
1931	---	12200 CFS ON JUN 21	746 CFS ON JAN 26	2910000 AC-FT	1931
1932	---	16700 CFS ON JUL 3	---	---	1932
1933	---	18900 CFS ON JUL 1	---	---	1933
1934	---	11400 CFS ON JUN 16	1170 CFS ON MAR 4	---	1934
1935	---	9660 CFS ON JUL 13	1530 CFS ON APR 15	2810000 AC-FT	1935
1936	---	20400 CFS ON JUN 3	---	---	1936
1937	---	11500 CFS ON JUN 19	838 CFS ON MAR 8	---	1937
1938	---	9400 CFS ON JUN 26	877 CFS ON MAR 1	---	1938
1939	---	14700 CFS ON MAY 30	840 CFS ON MAR 23	3850000 AC-FT	1939
1940	---	12400 CFS ON JUN 15	886 CFS ON FEB 26	3340000 AC-FT	1940
1941	---	8750 CFS ON JUN 28	830 CFS ON MAR 4	2860000 AC-FT	1941
1942	---	9520 CFS ON JUN 16	786 CFS ON APR 5	2500000 AC-FT	1942
1943	---	10800 CFS ON JUL 3	290 CFS ON APR 2*	2470000 AC-FT	1943
1944	---	8390 CFS ON JUN 14	290 CFS ON MAR 9	2580000 AC-FT	1944
1945	---	9620 CFS ON JUN 11	510 CFS ON DEC 23	2210000 AC-FT	1945
1946	---	11900 CFS ON JUN 7	720 CFS ON FEB 21	2610000 AC-FT	1946
1947	---	13600 CFS ON JUN 16	---	---	1947
1948	---	17 500 CFS ON JUN 9	790 CFS ON FEB 14	3700000 AC-FT	1948
1949	---	13200 CFS ON JUN 10	805 CFS ON MAR 18	3080000 AC-FT	1949
1950	---	16200 CFS ON JUN 23	740 CFS ON MAR 28	2890000 AC-FT	1950
1951	---	9730 CFS ON MAY 31	'87 CFS ON DEC 31	2290000 AC-FT	1951

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YEAR
1952	---	12300 CFS ON JUL 5	586 CFS ON MAR 21	2770000 AC-FT	1952
1953	---	12000 CFS ON JUN 13	787 CFS ON JAN 23	2890000 AC-FT	1953
1954	---	14700 CFS ON JUL 10	852CFS ON MAR 18	3560000 AC=FT	1954
1955	---	18300 CFS ON JUL 1	1040 CFS ON APR 7	3380000 AC-FT	1955
1956	---	14100 CFS ON JUN 12	660 CFS ON MAR 26	2980000 AC-FT	1956
1957	---	15600 CFS ON MAY 24	760 CFS ON MAR 27	3550000 AC-FT	1957
1958	---	14400 CFS ON JUN 12	1510 CFS ON FEB 13	3130000 AC-FT	1958
1959	---	12200 CFS ON JUL 3	775 CFS ON MAR 27	3760000 AC-FT	1959
1960	---	17500 CFS ON JUL 7	979 CFS ON MAR 20	4150000 AC-FT	1960
1961	---	14800 CFS ON JUN 9	1450 CFS ON MAR 22	3100000 AC-FT	1961
1962	---	15000 CFS ON JUN 28	1470 CFS ON JAN 20	4190000 AC-FT	1962
1963	---	12400 CFS ON JUN 26	1490 CFS ON DEC 6	3660000 AC-FT	1963
1964	---	18700 CFS ON JUN 20	932 CFS ON MAR 29	4200000 AC-FT	1964
1965	---	15500 CFS ON JUN 17	1330 CFS ON MAR 28	3680000 AC-FT	1965
1966	---	13800 CFS ON JUN 19	914 CFS ON MAR 28	3600000 AC-FT	1966
1967	---	18900 CFS ON JUN 28	1150 CFS ON APR 7	3850000 AC-FT	1967
1968	---	16100 CFS ON JUL 13	1630 CFS ON DEC 30	4140000 AC-FT	1968
1969	---	11700 CFS ON JUN 13	920 CFS ON MAR 28	3530000 AC-FT	1969
1970	---	12600 CFS ON JUN 28	1080 CFS ON MAR 15	2720000 AC-FT	1970
1971	---	15100 CFS ON JUN 12	974 CFS ON JAN 16	3550000 AC-FT	1971
1972	---	21400 CFS ON JUN 13*	1020 CFS ON FEB 16	3980000 AC-FT	1972
1973	---	143 CFS ON JUN 29	826 CFS ON FEB 26	3140000 AC-FT	1973
1974	---	17000 CFS ON JUN 26	1100 CFS ON MAR 24	3680000 AC-FT	1974
1975	---	14200 CFS ON JUL 16	750 CFS ON APR 9	3310000 AC-FT	1975
1976	---	15200 CFS ON JUL 11	1090 CFS ON MAR 8	4430000 AC-FT	1976

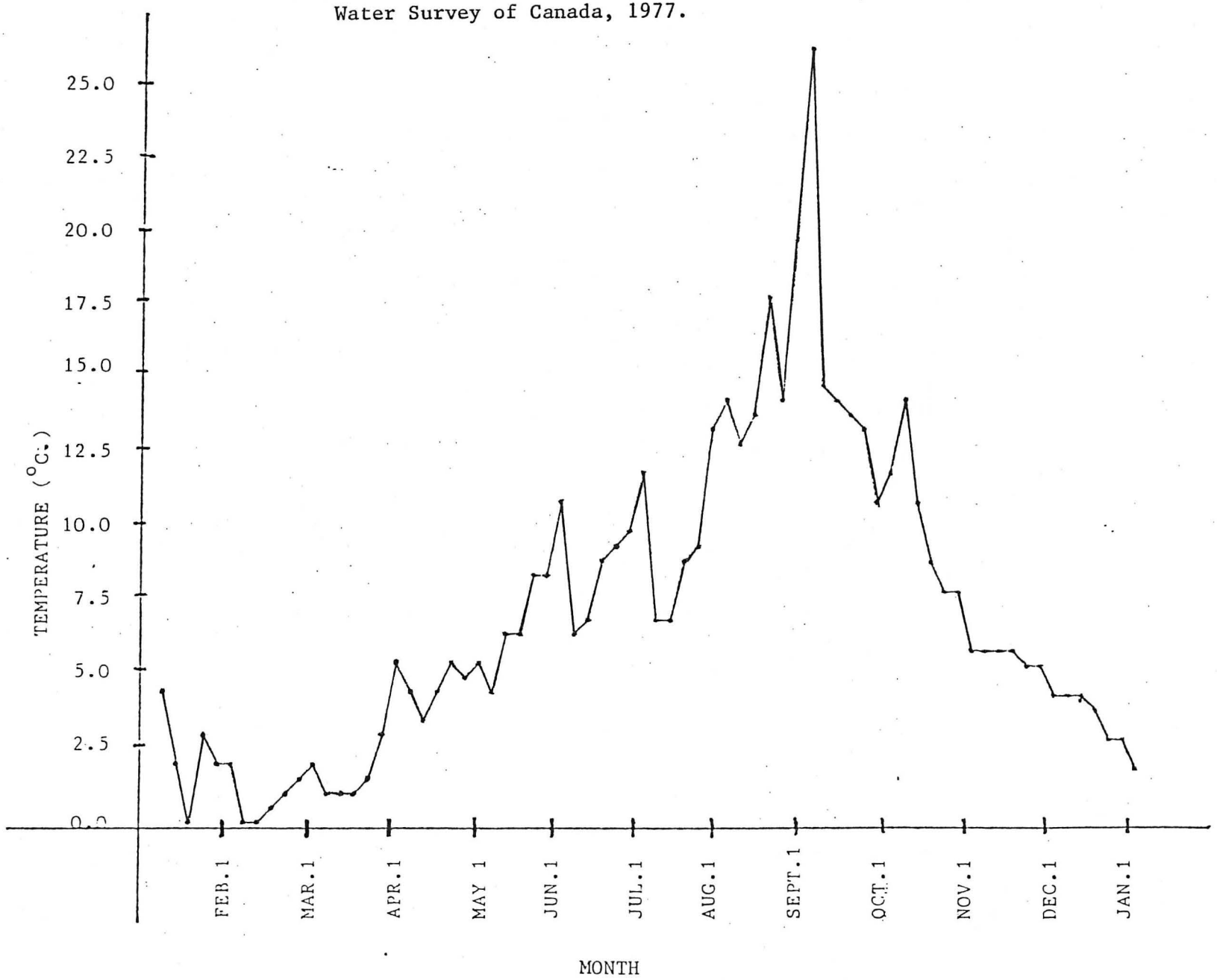
* Extreme recorded for the period of record

Appendix V : Quesnel River at Quesnel.
Water temperatures from spot observations.
Water Survey of Canada, 1977.



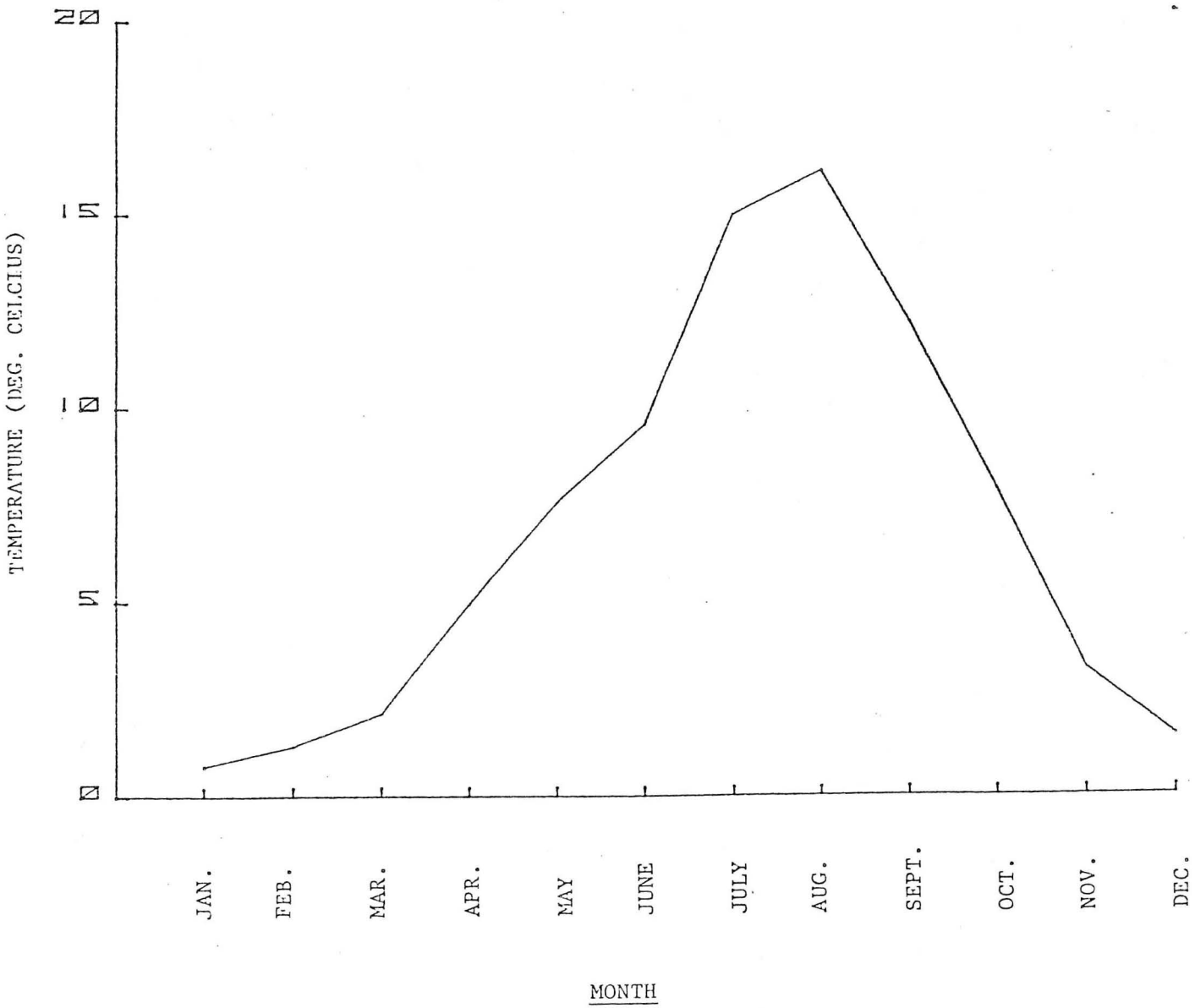
Appendix VI. : Quesnel River at Likely.
Water Temperatures from spot observations.

Water Survey of Canada, 1977.

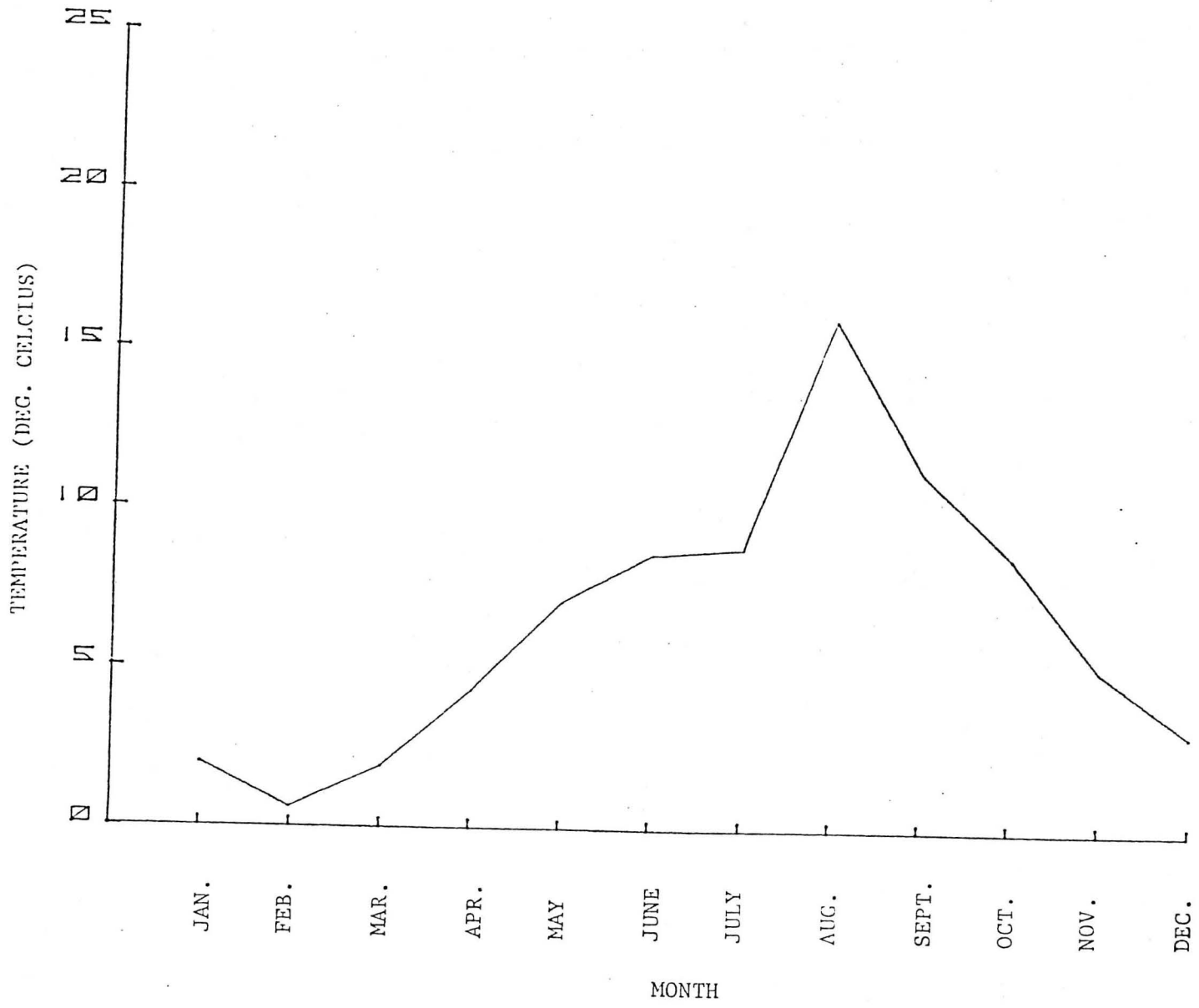


Appendix VII.

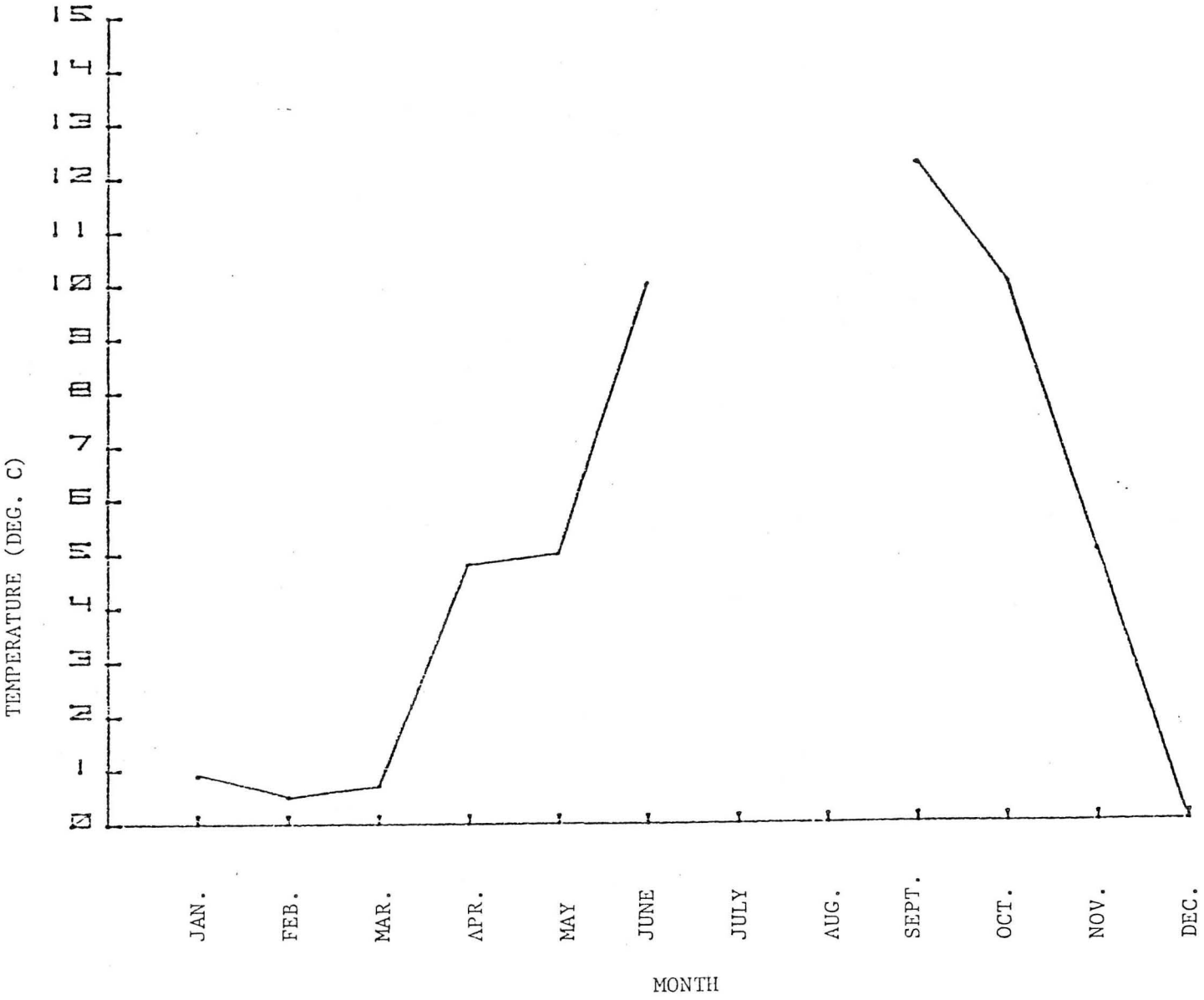
QUESNEL RIVER AT QUESNEL : MONTHLY AVERAGE WATER TEMPERATURE



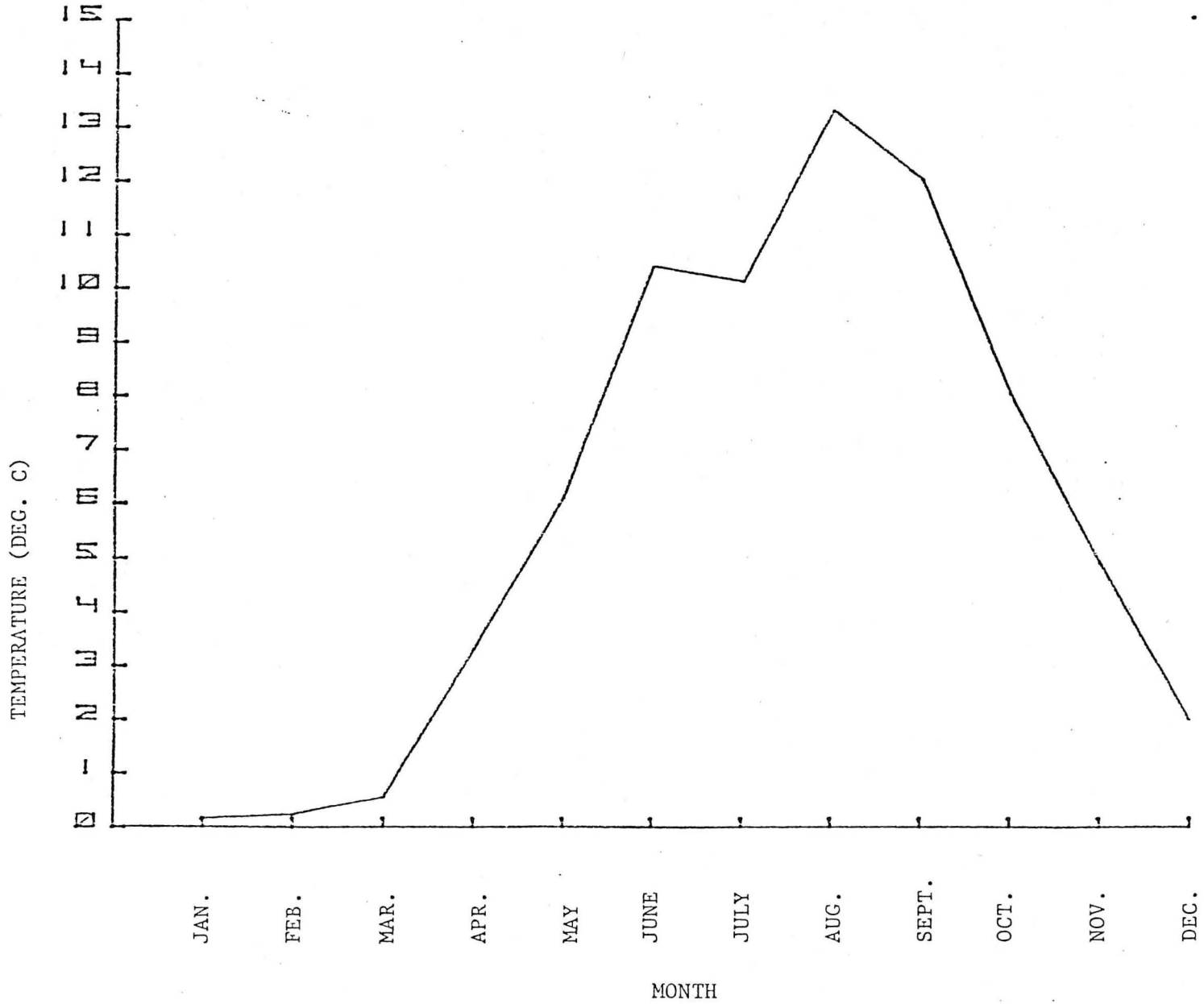
Appendix VIII. QUESNEL RIVER AT LIKELY : MONTHLY AVERAGE WATER TEMPERATURE



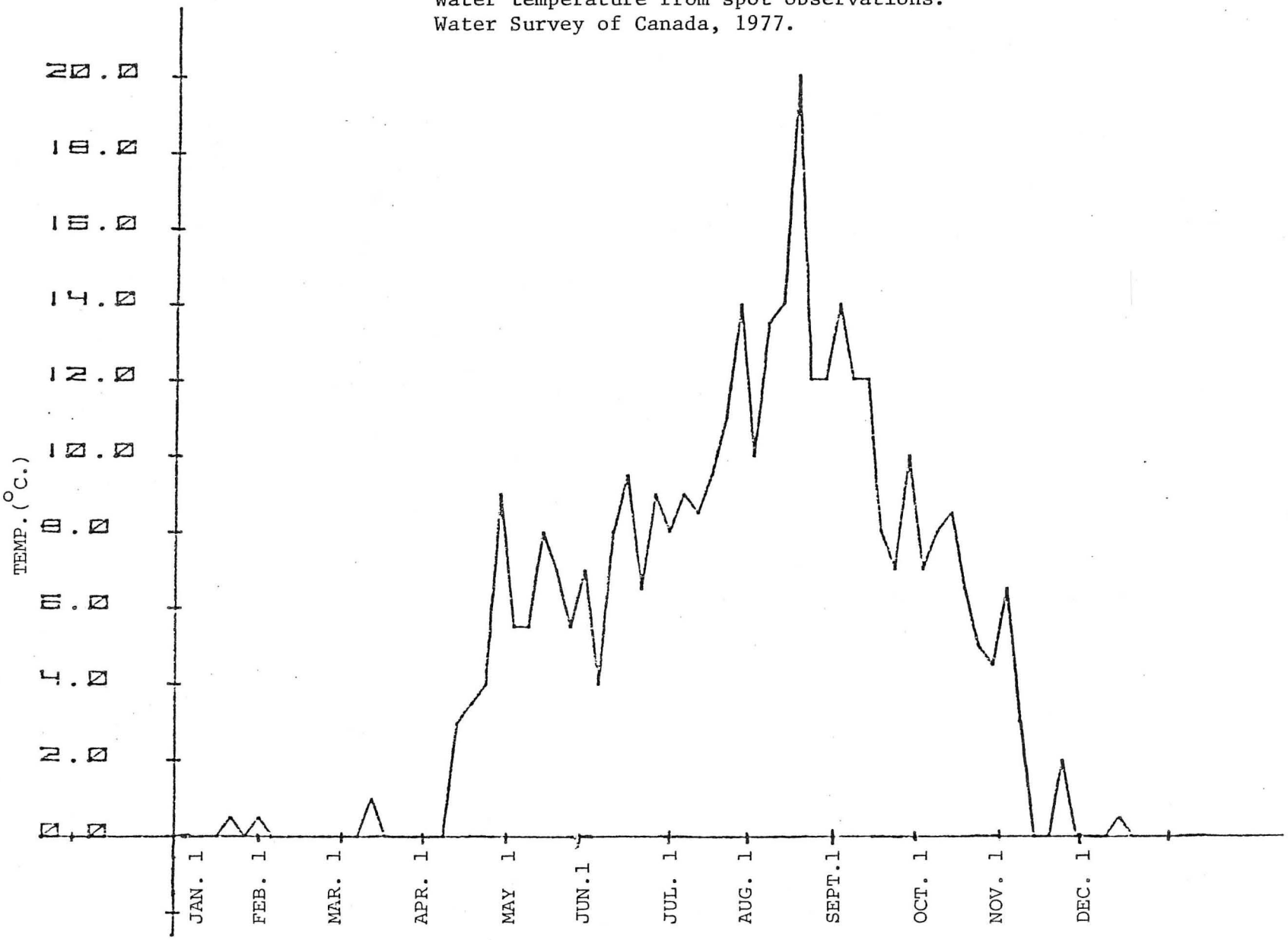
Appendix IX : Caribou River at Keithley Creek: Monthly average water temperatures (Water Survey of Canada, 1977).



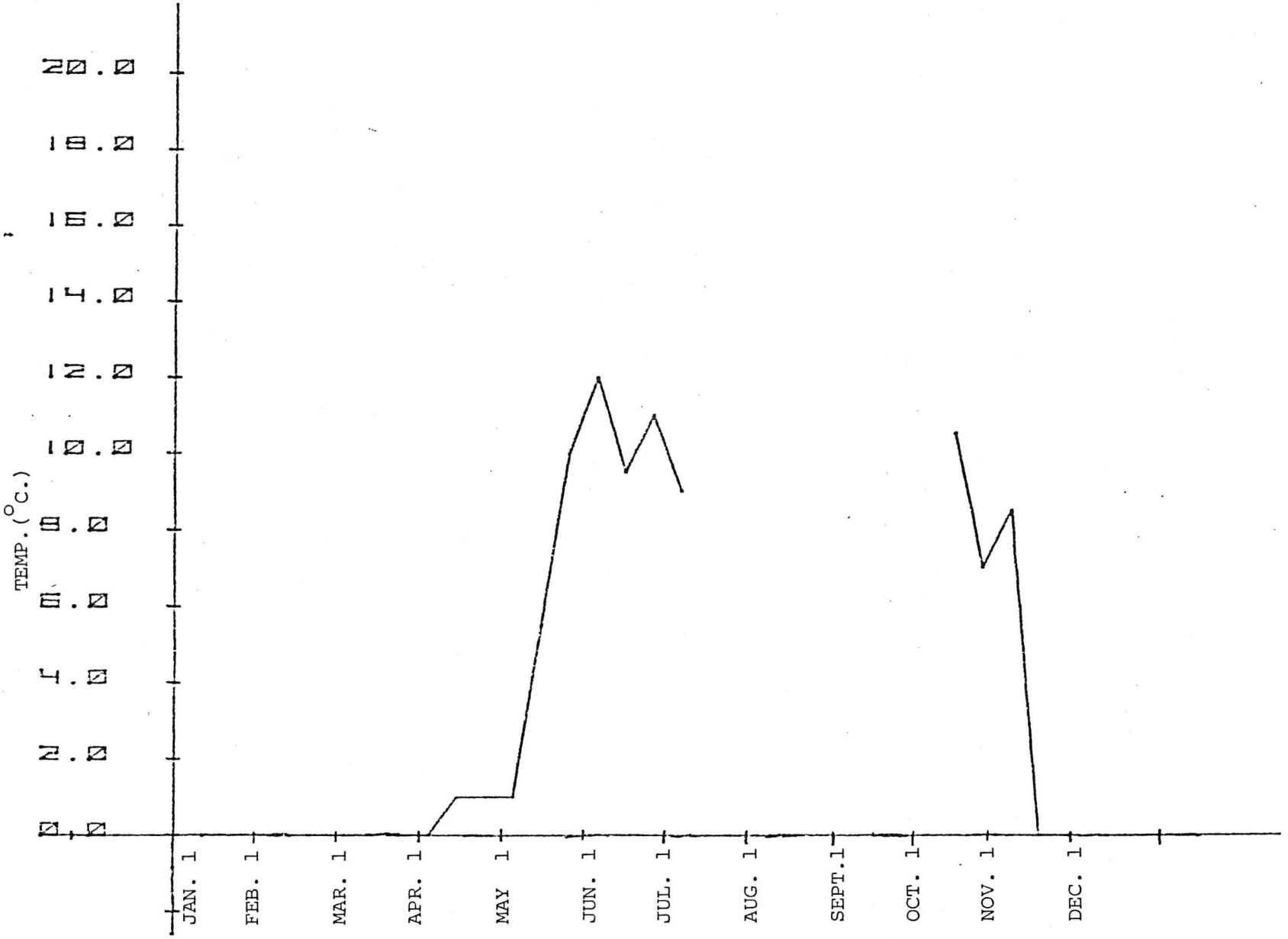
Appendix X : CARIBOO RIVER NEAR KANGAROO CREEK : MONTHLY AVERAGE WATER TEMPERATURE



Appendix XI : McKinley Creek (Horsefly River)
Water temperature from spot observations.
Water Survey of Canada, 1977.



Appendix XII. Horsefly River at Horsefly
Water temperature from spot observations.
Water Survey of Canada, 1977.



Appendix XIII. Quesnel Lake Depth Profile, to 1978.
Water Temperatures are monthly means in ^{o}C.

DEPTH	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
0.0m	---	---	2.4	3.1	4.9	---	19.4	17.3	---	9.3	5.9	---
3.3m	---	---	2.2	2.9	4.5	---	19.2	16.8	---	9.2	5.7	---
6.7m	---	---	2.2	2.9	4.4	---	18.9	16.7	---	9.2	5.6	---
10.0m	---	---	2.2	2.8	4.3	---	18.3	16.4	---	9.1	5.6	---
13.3m	---	---	2.2	2.9	4.2	---	15.5	13.2	---	8.9	5.6	---
16.7m	---	---	2.2	2.9	4.1	---	11.8	9.6	---	8.7	5.4	---
20.0m	---	---	2.2	2.9	4.1	---	9.3	7.2	---	8.6	5.4	---
23.3m	---	---	2.2	2.9	4.0	---	7.1	5.7	---	8.3	5.4	---
26.7m	---	---	---	---	---	---	7.1	---	---	7.7	5.4	---
30.0m	---	---	---	---	---	---	5.8	---	---	7.3	---	---
33.3m	---	---	---	---	---	---	5.3	---	---	---	---	---

Appendix XIV.

QUESNEL RIVER; Area CA

CHINOOK SPAWNER TIMING IN THE QUESNEL RIVER FROM F381 DFO SPAWNING FILES

YEAR	ARRIVAL	START	PEAK	END
1934	Sept. 4			
1935	Aug. 28			
1936	Sept. 1			
1937	Aug. 25			
1938	Sept. 29			
1939	Aug. 24			
1940	Sept. 1			
1941	Aug. 28			
1942	Aug. 29			
1943	Sept. 8			
1944	Sept. 1			
1945	Aug. 20			
1946	Aug. 20			
1947	Sept. 15			
1948		Aug. 30	Sept. 25	Oct. 20
1949		Aug. 25	Sept. 25	Oct. 25
1950		Sept. 1	Oct. 1	Oct. 10
1951		Sept. 1	Sept. 20	Oct. 15
1952		Sept. 1	Sept. 25	Oct. 15
1953		Sept. 5	Sept. 30	Sept. 30
1954		Sept. 5	Sept. 30	Oct. 15
1955		Sept. 15	Sept. 30	Oct. 15
1956	Aug. 25	Aug. 25	Sept. 15	Oct. 1
1957		Sept. 5	Sept. 15	Oct. 30
1958		Sept. 5	Sept. 30	Oct. 10
1959		Sept. 15	Oct. 5	Oct. 20
1960		Sept. 15	Sept. 20	Oct. 15
1961		Sept. 1	Sept. 30	Oct. 15
1962		Sept. 7	Sept. 30	Oct. 25
1963		Sept. 15	Oct. 10	Oct. 20
1964		Sept. 7	Oct. 1	Oct. 15
1965		Sept. 1	Sept. 16	Oct. 13
1966		Sept. 7	Sept. 15	Oct. 15
1967	Sept. 5	Sept. 26	Oct. 6	Oct. 15
1968	Sept. 8	Sept. 22	Oct. 2	Oct. 16
1969	Sept. 9	Sept. 16	Oct. 1	Oct. 10
1970	Sept. 7	Sept. 18	Sept. 28	Oct. 13
1971	Sept. 2	Sept. 16	Oct. 3	Oct. 13
1972	Sept. 1	Sept. 15	Oct. 6	Oct. 18
1973	Sept. 1	Sept. 13	Oct. 1	Oct. 16
1974	Sept. (early)	Sept. 18	Oct. 1	Oct. 15
1975	Sept. 1	Sept. 20	Oct. 2	Oct. 16
1976	Sept. 3	Sept. 20	Oct. 1	Oct. 18
1977	Sept. 1	Sept. 15	Oct. 1	Oct. 16
1978	Sept. 1	Sept. 20	Oct. 1	Oct. 16
1979	Aug. 18	Sept. 10	Sept. 29	Oct. 14

Appendix XV.
QUESNEL RIVER; Area CA

F381 SALMON STREAM AND SPAWNING GROUND NUMERATION DATA (1934 - 1979)

ESTIMATED ESCAPEMENT; DFO SPAWNING FILES

YEAR	SPECIES			SEX RATIO IN %		
	SOCKEYE	CHINOOK	PINK	MALE	FEMALE	JACKS
1934	200	3,500				
1935	---	3,500				
1936	75	750				
1937	25	400				
1938	25	750				
1939	---	400				
1940	---	400				
1941	10	400				
1942	---	750				
1943	---	400				
1944	---	400				
1945	---	400				
1946	---	550				
1947	---	400				
1948	---	500		45	50	5
1949	---	350		60	40	0
1950	---	500		45	45	10
1951	---	1,200		45	45	10
1952	---	450		45	45	10
1953	---	400		45	40	15
1954	---	400		45	40	15
1955	---	750		45	45	10
1956	---	400		40	40	20
1957	---	400		45	45	10
1958	---	750		45	45	10
1959	---	750		45	45	10
1960	---	400		45	45	10
1961	---	400		45	50	5
1962	---	750		40	40	20
1963	---	750		45	45	10
1964	---	1,500		45	45	10
1965	---	2,500		45	50	5
1966	---	750		40	40	20
1967	---	750		45	40	15
1968	---	1,100		45	45	10
1969	---	1,100		45	50	5
1970	---	1,800		45	50	5
1971	---	750	3,500	45	50	5
1972	---	750		45	50	5
1973	---	1,100		45	50	5
1974	---	1,000		50	45	5
1975	---	1,000	600	50(40)	45(60)	5(0)
1976	---	1,000		50	45	5
1977	---	1,400	1,500	50(55)	45(45)	5(0)
1978	---	1,200		48	50	2
1979	---	900	500	50(50)	50(50)*	

* Brackets indicate sex ratio percentage for pink salmon.

Appendix XVI. Miscellaneous F381 Observations; Quesnel River

YEAR	OBSERVATION
1941	"On the upper spring salmon beds (Narrows)...a heavy out-wash took place during excessive highwater in October. Between 30 and 40 feet of tailings, 5 or 6 feet deep pushed out from the mouth of Poquette Cr. onto the salmon spawning beds."
1942	"Males appear to predominate slightly...." "All hydraulic placer mining operations have now closed in the whole area." "A great many predatory fish were in evidence as usual."
1944	"Sex ratio on average, appeared to be 60% male to 40% female (springs)."
1948	"These spawning grounds tend to show very consistent returns from year to year."
1949	"No mining activity this year. Drilling carried on at various points during season by B.C. Power Comm'n. with view towards storage dam on Quesnel Lake and power head dams near Little and Big Canyons."
1950	"More fish observed on Narrows area this season than for a number of years. Although a few springs spawned in North Fork, this stream has not any importance as a seeding area."
1952	"Streambed below old Bullion mine dump is now widened out, causing an easier passage for ascending salmon. No silt in the mainstem of river."
1953	"Unusually high percentage of immature (jack) springs - 15%."
1954	"Water level in lake remained well above normal throughout the season."
1957	"Many 'jacks' of very small size about 1½lbs." "Spawning conditions very good at all times."
1958	"As old bridge has been removed, there is poor observation on likely spawning grounds."
1960	"Water levels remained higher than normal throughout spawning period. Water temperatures generally low."

Appendix XVI. Miscellaneous F381 Observations; Quesnel River (cont'd.)

1964 "Water levels in S. Fork remained above normal stage but clear up to late fall."

1967 "Pink salmon were observed....4 Mile Creek returns were about ¼ of 1965."

1968 "Use of aircraft...."

1973 "Pink salmon, which were to appear in the Quesnel River this cycle year, did not materialize."

1974 "Higher than usual fall water levels...."

1976 "A massive earth slide occured on the Quesnel River at Moorehead Cr. on May 4th. The river was completely blocked for a short period of time. The river has now washed out the channel and the existing blockage offers no obstruction to fish passage. The slide occured downstream from the spring salmon spawning grounds at Likely, 30-35 miles upstream from the pink salmon spawning area near the town of Quesnel."

1977 "Several spring salmon were observed spawning in the Quesnel River, 1 mile below Quesnel Forks, perhaps an indication of good escapement to this system."

1978 "The number of spring salmon spawning in the Quesnel River below Quesnel Forks increased to approximately 50 this year. Approximately 50 spring salmon spawned in the Cariboo River."

Appendix XVII. Chinook Juvenile Tagging Summary for 1979. (E.V.S. Consultants Ltd., (Oncorhynchus tshawytscha) Fry and Smolt Enumeration / Marking Project, Nechako and Quesnel/Horsefly Rivers, B.C.

1) Number held: 31,000 chinook fry

2) Location: Floating net pens in the Quesnel Lake.

3) Food source: OMP

4) Growth rate: .786 - 1.288 in pens, expressed as percent daily change in length. Stream-reared (natural fry) had a growth rate of .715 for the same period. The pen-reared fry grew from 1.1 to 1.8 times faster than the natural reared fry.

5) Mortality factors: none significant

6) Tag loss: 0 to 4% per night

7) Releasals: 29,146 fry marked with binary-coded wire nose tags were released on July 23-26, 1979 to the Quesnel River at Likely.

8) Calculation of recapture data showing the mean daily population estimates of chinook fry.

   (a) Quesnel Forks side channel (July 4 to July 9) range = 1,454 to 8,799

   (b) Likely, B.C. (July 24 to July 27) range = 7,037 to 15,734

9) Total Emigration downstream past the Likely bridge was 38,190 fry, 29,146 of which were pen-reared and tagged.

Appendix XVIII. Persons Contacted and Information Sources.
Quesnel River Watershed.

ENHANCEMENT RATIONALE

B.G. Shepherd
A/New Projects Head 6th floor
Biological Criteria for Quesnel Hatchery.
Current plans for facilities design and history of planning for the enhancement facility.

J. Barnetson
Planning Biologist 11th floor
GWG Management/Enhancement Strategy Report (Prelim. Draft)
Discussions/direction

WEATHER

Environment Canada

Atmospheric Environment Service
Temperature and Precipitation 1941-1970, British Columbia (overall monthly means for period)

Pacific Region (Atmos. Env. Serv.)
Norm Penny
Sinclair information regarding temp. and precip.

WATERSHED GEOLOGY

British Columbia,
Ministry of Mines and Petroleum Resources
Dr. Nick Carter
Publications
more information/studies - Regional Stream Sediment and Water Accelerated Geochemical Survey, B.C. (no more on Quesnel watershed)

British Columbia,
Ministry of Mines and Petroleum Resources, 1977.
(a) Exploration in British Columbia in 1976.

British Columbia,
Ministry of Mines and Petroleum Resources, 1977.
(b) Geology in British Columbia, 1975.

Appendix XVIII. Persons Contacted and Information Sources.
Quesnel River Watershed.
(Cont'd.)

Energy, Mines and Resources Canada
Geological Survey of Canada, 1979.
Index to Reports, British Columbia

British Columbia,
Ministry of Energy, Mines and Petroleum Resources 1979.
Publications and Maps
Mineral Resources Branch

- Geochemical Reconnaissance Map Series

WATERSHED TOPOGRAPHY

Topography Maps obtained from:

Dominion Map Ltd.
571 Howe Street,
Vancouver, B.C.

NTS (National Topographic System) Maps of Canada, Index 2.

B.C. Ministry of Recreation and Conservation
B.C. Recreational Atlas.

WATERSHED UTILIZATION

1. <u>History</u>	B.C. Ministry of Economic Development B.C. Regional Index
2. <u>Logging</u>	A.C. Schutz List of Rangers and map showing Boundary of their Districts District Manager, Quesnel Region HPU Forest Harvesting and Urban Development

Appendix XVIII. Persons Contacted and Information Sources.
Quesnel River Watershed.
(Cont'd.)

1. HPU, Mike Flynn

2. Ministry of Forestry
   p. comm. D. MacDonald, District Manager for Quesnel

   (In Williams Lake)

3. B.C. Forestry Planning Division
   p. comm. Hal Giles

   (In Williams Lake)

4. Jacobson Bros. Ltd.
   p. comm. Don Micadae

5. Lignum Ltd.
   p. comm. Ellen Whittle

6. Starline Cedar Ltd.
   p. comm. Mr. D. Bonley

7. Weldwood (Williams Lake)
   p. comm. Ken Robertson

8. Weldwood (Quesnel)
   p. comm: Allan MacDonald

3.	Mining	J. Arsenault, HPD. Information on Placer Mining
4.	Population and Industry	British Columbia Regional Atlas Some sources unknown

Appendix XVIII. Persons Contacted and Information Sources.
Quesnel River Watershed.
(Cont'd.)

5. Water Licences

Bill Tuthill contacted.
Water Investigations Branch, referred to
Comptroller.
H.D. Debeck
Letter sent to Comptroller of Water Rights
Parliament Buildings, Victoria V8V 1X4
- reply received from David Tanner
- water licence holders, purposes, length of time requested, % of available flows spoken for, location, priorities, codes for computer printout.

6. Capability Ratings

Karen L. Gorse
Librarian, Ministry of Environment
Resource Analysis Branch
Parliament Buildings, Victoria
Capability Maps
Keys for Interpretation of Capability
Manuscript Maps, B.C.

F. Hedgi
Forestry Information

STREAMFLOWS

Marion Courie
- contacted
- no additional recent flow data

Historical Streamflow Summary, B.C. to 1973
Summary of monthly means, maximums and minimums
- very helpful
- used extensively

SEDIMENT LOADS

Carl Halstead
Geohydrologist for Inland Waters
- contacted
- no more available information

Appendix XVIII. Persons Contacted and Information Sources.
Quesnel River Watershed.
(Cont'd.)

Resource Analysis Branch
Regional Stream Sediment and Water Accelerated Geochemical Survey, B.C.
1978. Computer printout - no information compiled for Quesnel.

Resource Analysis Branch
Request for any information - point sampling taken during inventory.

WATER QUALITY/TEMPERATURES

Dr. Erlebach general information - no additional
Jim Taylor general Information - no additional
Water Quality Branch
4th floor - 1001 West Pender St.
Vancouver, B.C.

Paul H. Whitefield
Project Scientist
Water Quality Branch
Inland Waters Directorate
Pacific and Yukon Region
Room 402 - 1001 West Pender St.
Vancouver, B.C.

- provided information on site locations

Oliver Nagy
Water Quality Branch
Inland Waters Directorate
Pacific and Yukon Region
1001 West Pender St.
Vancouver, B.C.

- sent volumes 1-4
  Water Temperatures, British Columbia and Yukon Territory
  Environment Canada
  Inland Waters Directorate, 1977

Maureen Lamb
Senior Programmer,
Water Quality Branch
Inland Waters Directorate
Ottawa, Ontario

- sent NAQUADAT Station List
- User's Manual for NAQUADAT System

Appendix XVIII. Persons Contacted and Information Sources.
Quesnel River Watershed.
(Cont'd.)

NAQUADAT (Computer File for Canadian Water Quality Data)

Peter Wong
Pollution Control Branch Laboratory
NH_3 Information

M.J.R. Clark
Branch Environmental Chemist
Services Unit, Resource Services Unit

- data for Environmental Site, Quesnel River

Fish Culture Limit Table - recommended values compiled from:
- Pollution Sampling Handbook 1976 (PEI)
- Tom Cleugh (memo)
- Bruce Shepherd (MSc)
- Ted Perry and Bill McLean (memo) DFO
- Bill McLean (term paper)
- Kramer, Chin and Mayo, Inc. (memo)
- Quality Criteria for water. 1978
- Diseases of Fishes, Book 5: Environmental Stress and Fish Diseases, 1976. Wedemeyer, G.A., F.P. Meyer and L. Smith
- Summary of Water Quality Criteria for Salmonid Hatcheries, 1979. Sigma Resource Consultants Ltd. for Dept. of Fisheries and Oceans

General Personnel
Laboratory Services
4195 Marine Drive
West Vancouver, B.C.

- Pollution Control Handbook
- Water Quality Analysis Manual

Resource Analysis Branch
Map Library - maps regarding water quality flow sites

B.C. Fish and Wildlife Branch
Fisheries Biologists at Regional Head Quarters

1. 350 Barlow Avenue
   Quesnel, B.C. V2J 2C1

   - Quesnel/Horsefly/Cariboo Rivers

Appendix XVIII. Persons Contacted and Information Sources.
Quesnel River Watershed.
(Cont'd.)

2. 1777 West 3rd Avenue
Prince George, B.C. V2L 3G7

- Nechako/Stuart Rivers

- request for point samplings for WQ, temperatures, vertical T/O_2 series for lakes, available temperature data

Pollution Control Branch

1. Dr. Malcolm Clark
Services Section

- sent information regarding effluent sources for Quesnel River

2. Mr. Lance McLeod
Environment Protection Services
Capilano 100
West Vancouver, B.C. V7T 1A2

- sending information regarding effluent sources, WQ data, etc.

Private Industry and Miscellaneous

John Stockner
West Vancouver Laboratory

- sending data with respect to specific lakes on the Upper Fraser system

Groundwater Well Information

Ministry of Environment
Inventory and Engineering Branch
Groundwater Group, Hydrology section
Victoria, B.C.

Ernie Tradewell
sent computer printout - chemistry
sending index map

Mr. Quaker
no information on groundwater on index map
has files, specific site

Appendix XVIII. Persons Contacted and Information Sources.
Quesnel River Watershed.
(Cont'd.)

Reports

Sigma Resource Consultants, File: 2650
801-1155 W. Georgia St.
Vancouver, B.C.

Water Quality at Quesnel Well #2 and Quesnel River, 1979
Alice Federenko
DFO memo. File: 5830-13-16

Department of Fisheries and Oceans,
Laboratory Services (EPS-FMS) Chemistry,
Piteau and Associates, April, 1980.

GENERAL WATERSHED RECONNAISSANCE

B.G. Shepherd
A/New Projects Coordinator
History of Watershed Reconnaissance, bio-engineering studies and parameters studied in the identification of the hatchery site.

R.M.J. Ginetz
Head, Small Projects Division,
G.O. Nielsen
Senior Project Engineer

DFO file: 5830-13-13, -13-14. Review of Enhancement Potential for Chinook and Coho Salmon Stocks in the Fraser River Watershed

ESCAPEMENT DATA

DFO F381 Spawning Files

1. Particulars of Spawning and Spawning Conditions

Species (primarily chinook recorded)
Arrival in stream timing
Dates of duration of spawning
Approximate total number of spawning grounds
Sex ratios

Appendix XVIII. Persons Contacted and Information Sources.
Quesnel River Watershed
(Cont'd.)

2. Physical Conditions of Spawning Grounds

Evidence of erosion and silting
Particulars of scowing and spawning beds or change in course of stream
Water Levels (low, normal, high, abnormal)

3. Biological Conditions

Particulars of distribution of Spawning salmon over the stream bed
Comments re. predators
Evidence of digging up of eggs by later spawning fish.

4. Obstructions

Passable or Impassable. If nil, indication from mouth to furthest point of access.
Nature of obstruction
Distance from mouth to stream

E.V.S. Consultants Ltd., 1980 (b). Olmsted W.R., M. Whelen and G.A. Vigers, prepared for DFO. 1979 Investigations of Fall Spawning Chinook Salmon (Oncorhynchus tshawytscha). Nechako and Quesnel/ Horsefly Rivers, B.C. Preliminary Draft.

1979 Spawner timing (period of peak spawning and die-off) distribution and abundance.

International Pacific Salmon Fisheries Commission, New Westminster, B.C.

1. Annual Reports 1974-1978
Sockeye and Pink Escapement Data

2. Jim Woody
Current information and unpublished data
Escapement data

ADULT/JUVENILE DATA

C.R. Harrison
Fraser River, NBC and Yukon Section
Quesnel Stock timing through the lower Fraser River fishery (Area 29)
Annual Fraser River Catch (native, sport and commercial)

Appendix XVIII. Persons Contacted and Information Sources.
Quesnel River Watershed.
(Cont'd.)

GWG, Feb. 1980. File: 5830-13-1, R. Harrison. Proposed Enhancement Targets for Fraser River, Chinook, Coho, Chum Salmon and Steelhead trout.

J. Barnetson
SEP Planning
GWG, May 1980. Management/Enhancement Strategy, Preliminary draft. Discussions regarding current management problems as well as options for management and enhancement.

A.L. Kahl
1976, 1977. Quesnel River Age Composition of Chinook Salmon during the Middle-upper Fraser Reconnaissance. Unpublished data.

P. Starr
Discussions regarding Chinook spawner timing, age-sex rations of adults, fry emergence and smolt migration timing in the Upper Fraser system.

W.R. Olmsted
E.V.S. Consultants Ltd.
1980 fry emergence timing in the Quesnel River

DFO
Quesnel District Office
Information concerned with commercial, native and sport catch on the Quesnel River.

International Pacific Salmon Fisheries Commission

1. Annual Reports (1974-1978)
Annual Commercial and Native Catch Information in Area 29.

2. Jim Woody
Information on commercial and Native catch statistics.

E.V.S. Consultants Ltd., 1980 (a) Olmsted, W.R., P.W. Delaney, T.L. Slaney and G.A. Vigers, prepared for DFO. Chinook Salmon (Oncorhynchus tshawytscha), Fry and Smolt Enumeration/Marking Project, Nechako and Quesnel/Horsefly Rivers, B.C. Preliminary Draft.

1. Studies and information regarding chinook fry emergence timing, growth, post-emergent fry distribution and abundance.

2. Juvenile Tagging Summary.

Appendix XVIII. Persons Contacted and Information Sources. Quesnel River Watershed. (Cont'd.)

E.V.S. Consultants Ltd., 1980 (b). Olmsted, W.R., M. Whelen and G.A. Vigers, prepared for DFO. 1979 Investigations of Fall Spawning Chinook Salmon (Oncorhynchus tshawytscha), Nechako and Quesnel/ Horsefly Rivers, B.C. Preliminary Draft.

1. Chinook Sex rations, fork lengths and postorbital-hypural length regressions.

2. Chinook ages

3. Fecundity

4. Calculated egg deposition

5. Chinook egg survival and spawning capacity

Mitchell, B. and K. Simpson, 1976. Quesnel River System. Review of Fisheries Related Information.

- compilation of bio-baseline reports and human influence within the watershed.