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Dept. of Fisheries
and Oceans

A Review of the Nechako River Watershed

compiled by

R. Helm, D. MacDonald, B. Sinclair,
D. Chan, T. Herrington, A. Chalmers
and B.G. Shepherd

Internal Report,
November, 1980

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ABSTRACT

The Nechako River flows from high in the Coast Mountains, across the Nechako Plateau until it joins with the Fraser. In geological terms, the watershed contains rock from the Permian to Recent periods, including sedentary volcanic, basalts, granite, andesite, desite, agglomerate, and granodiorite.

The river drains an area of 51,900km^2 and drops from an elevation of 853m at Kenney Dam to 564m ASL at its confluence with the Fraser. This represents an average gradient of .098%, and a meader length of .55km.

The economy is dominated by forest and related industries, with agriculture, mining, manufacturing and tourism completing the economic basis. The total population of the areas that contain the watershed is 89,821 persons. Highway 16 and some secondary roads provide access to the major townsites: Prince George, Vanderhoof and Ft. Fraser.

The Nechako River supports sockeye and chinook salmon. A plan involving the artifical enhancement of Nechako springs has been developed to increase the production of these early-timing chinook. No further enhancement of the Fraser River sockeye is advised until an international agreement is reached.

Escapement takes place from March to mid-July for chinook, and from mid-July to the end of August for sockeye. The distribution of chinook spawners in the mainstem extends from Vanderhoof to Cheslatta Falls, while sockeye utilize the Nadina, Stellako and Stuart Rivers. Ther has been a slight upward trend in chinook escapements after the dramatic fall due to the construction of the Kenney Dam in 1953. Sex ratios for chinooks averaged 51.6% female, 42.6% male and 5.8% jacks. The dominant chinook age class in the escapement was four year olds. Chinook length for males averaged 61mm longer than that of the females. The adjusted average fecundity was 6005 eggs/female.

Chinook fry emergence is completed by the end of May, and the fry exhibit an average growth rate of .633% length increase/day. These fry appear to exhibit a 90 day rearing behavior.

Water quality in most sites sampled exhibited toxic levels of several

parameters measured. The Nechako above Greer Creek, however, had water of very good quality. Groundwater in the area has the potential to be acceptable with some treatment.

The water temperatures of the Nechako River are within fish culture limits from mid-April to mid-December. The temperature extremes are $0^{\circ}C$ in the winter and $22^{\circ}C$ in the summer.

The area has, on an average, 170 frost free days per year, and a temperature range of -17 to $23^{\circ}C$. Precipitation ranges from 260-400mm of rain with 1760-2340mm of snow.

At Isle-Pierre, the Nechako River has flow ranges from $120mm^3$/ sec during the winter low to $480m^3$/ sec during the spring freshet. Flows over the Ootsa-Skins Lake Spillway are controlled by the Aluminium Company of Canada(Alcan).

ENHANCEMENT RATIONALE

The preliminary plans involving priority salmonid ennancement opportunities were concentrated on the Upper Fraser River chinook. Several bio-engineering reconnaissance surveys (aerial and ground) were conducted at different times of the year by R.M.J. Ginetz and G.O. Nielsen. These surveys resulted in the identification of suitable sites on river systems in the Upper Fraser River watershed for chinook enhancement potentials. Based on these surveys, the Nechako River was selected as a very favourable system on which to develop a salmon hatchery. A specific site located in the former Nechako River bed immediately above Cheslatta Falls was chosen based on criteria such as inexpensive water supply (excellent ground water source of good quality and quantity), road access, hydro-power availability, land availability and site location in relation to adult collection.

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, 1980 MS). The GWG Management/Enhancement Strategy Group then characterized the Nechako-bound chinook as an early-timing stock. The GWG define early-timing as having a main migratory period through the lower Fraser prior to July 1.

From the information reported in the DFO Spawning Files, the Nechako 'early-timing' chinook stock had an average annual escapement of 1000 spawners from 1949 to 1979. This escapement exhibited a significant decline in 1953 following the construction of Kenny Dam and resultant diversion of the Nechako stream flow. Since that time, with the release of storage water from Skins Lake Dam, the chinook escapement has shown a gradual upward trend. The GWG reports that this 'early-timing' chinook migration precedes that of pink and sockeye passing through Area 29, prior to International Pacific Salmon Fisheries Commission (IPSFC) management period. Therefore, enhancement facilities concerned with the development of the 'early-timing' chinook population would be favoured because their migration timing through Area 29 does not overlap with that of other salmonid species and hence could be independently harvested. Since the International Pacific Salmon Fisheries Commission (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 (1980 MS) that no further enhancement of these two Fraser River species be undertaken until an international salmon agreement is reached.

Although the Nechako River provides excellent potential for the construction of a salmonid enhancement facility, the Department of Fisheries and Oceans and the Aluminum Company of Canada (Alcan) are in disagreement over the amount of flow releases. The water licence issued to Alcan in 1950 has given them the authority to divert all waters in the Nechako Watershed upstream of Cheslatta River with no conditions concerning minimum flow releases necessary for salmonid transportation, spawning, and rearing, despite recommendations by the Department of Fisheries and the International Pacific Salmon Fisheries Commission. The plans regarding the Nechako salmon hatchery have been suspended until an agreement is reached concerning adequate quantities of discharge to the Nechako River to ensure the protection of the salmon population (B.G. Shepherd, pers. comm.)

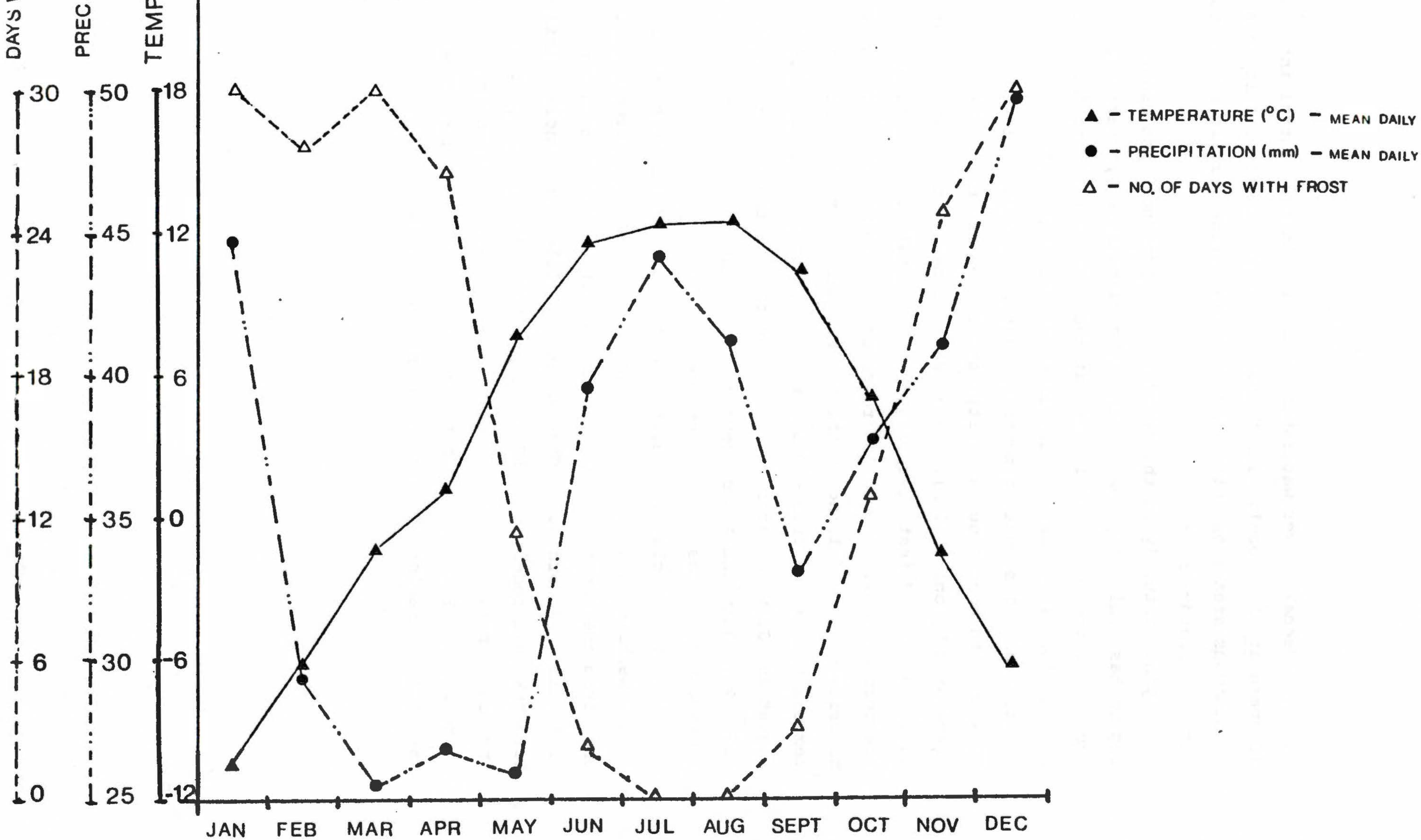
CLIMATE

The Nechako River watershed is located in the central interior region (Chapman et al., 1956). The Nechako River itself flows through a low mountainous area from Ootsa Lake to plateau-like terrain at its confluence with the Fraser River.

Lying virtually in the centre of the province, the central interior region has dominantly continental-like climatic characteristics. A site typical of the region is located at the Ootsa Lake-Skins Lake spillway. At this location, the mean annual precipitation is 438mm (Fig 1, Appendix 1 a,b,c, & d). The wettest month is January closely followed by July (due to summer thunder-cloud activity) and the driest months are March and May (separated by only 0.5mm). On a seasonal basis, the wettest season is autumn and the driest is spring. Of the total precipitation, 40% falls in the form of snow. Snowfalls are recorded from September to May with the majority of snow falling in the October-March period. The mean daily temperatures range from -10.5°C in January to 13.72°C and 13.67°C for August and July respectively. The duration of the frost-free period is 167 days. July and August represent the only frost-free months in an average year (Atmos. Envir. Service, 1971).

Two minor enclaves of differing climatic characteristics also exist in the Nechako River watershed. These enclaves' most significant difference from the continental-like characteristics is the mean annual precipitation. According to Chapman et al. (1956), one enclave influencing Tetachuk Lake receives 33-50% more precipitation (because of high surrounding mountains). The other enclave, forming a strip along the Nechako from approximately Fort Fraser to the confluence of the Stuart River, receives 25-33% less precipitation than the rest of the watershed.

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



GEOLOGY

The Nechako River area from Ootsa Lake to Vanderhoof is underlain by Permian to late Tertiary sedimentary and volcanic rock and by Jurassic to Cretaceous granite. The bedrock is obscured by a thick mantle of glacial drift, which may be the main reason why no important mineral deposits have been found (B.C. Ministry of Mines & Petroleum Res., 1977)

Construction of Kenney Dam on the Nechako River resulted in flooding of the area in this drainage system that is below 853m; the rest of this area is drained by streams flowing to the Pacific Ocean. Fortunately, the geology of this area was mapped before the dam was completed (Armstrong, 1949) Elevations range between about 762 and 1920m, but the local relief rarely exceeds 762m.

There is a strong relationship between the topography and the underlying rocks of the area. The northwest trend of the Fawnie and Nechako Ranges reflect that of the folded Jurassic rocks, while the rounded hills of the area below the river reflect the absence of pronounced trends in either the early Tertiary volcanic rocks or the Topley granitic rocks of the Nulki Hills. The flat, swampy areas are usually underlain by flat-lying late Tertiary basalts.

Just north of Fraser Lake there are rocks of Tertiary Oligocene or later, consisting mainly of basalt, andesite and dasite as well as flow braccia and agglomerate. There are also some Palaeozoic Pennsylvania and Permian origin rocks to the east. To the south, west and northwest of Fraser Lake there is granite and granodiorite from the Post-Middle Permian - Pre-Upper Jurassic period. The area alongside the river between Fort Fraser and Vanderhoof is covered heavily by glacial drift (Tipper, 1963).

The only important lake deposits are those laid down in the Vanderhoof Lake basin (1152km^2 in area and generally 79m to 122m deep). Silt and clay are the most common deposits. Distortion of the upper beds in most sections, which presumably represent a poorly developed till sheet with an older till below the lake beds, and the presence of pebbles suggest that these deposits were overridden by ice. The period of recession during which the lake deposits were formed may have been very brief. The lacustine deposits around Lily Lake do not seem to have been overridden by ice, suggesting that either these are later deposits or, more likely, the ice did not re-advance to this sector.

The area around Nechako River east of Vanderhoof to Prince George is composed of Cenozoic Quarternary of Pleistocene and Recent periods, consisting of till, gravel, sand, clay and silt. Bedrock everywhere is poorly exposed, but well distributed outcrops permit a reasonable interpretation of the major geological features. Bedrock is best exposed along major creeks and rivers. A thin covering of glacial deposits, 1.5 to 6.1m deep, can be found over much of the area. Proglacial lake deposits are widespread around Prince George, along Nechako River, and north of West Road (Blackwater) River (Armstrong, 1949).

TOPOGRAPHY

The Nechako River drains 51,900km^2 of west central B.C. Its headwaters are high in the Coast Mountains within the Tahtsa and Quanchus Ranges. The watershed boundaries, Whitesail Lake and Ootsa Lake form the northern boundary of Tweedsmuir Park. The Nechako River proper actually begins as the river flows out of the Coast Ranges and enters the Nechako Plateau, escaping the myriad of lakes and dam developments within the mountains.

The river falls from an elevation of 853m above the Kenney Dam to 564m at Prince George over a distance of 290km. Excluding the Stuart River Watershed, which will be dealt with separately, the Nechako drains an area of 32,000km^2. Its source is the 230km long reservoir behind the dam, with the primary source coming from the Skins Lake Spillway via Cheslatta Lake. No water comes over the Kenney Dam, therefore, above the Cheslatta confluence, the Nechako's flow is residual.

The 900km^2 reservoir drains west into the Kemano River via Alcan's Kemano Diversion, an underwater aquaduct to the power house at Kemano on the coast. Runoff via the Skins Lake Spillway is controlled to maintain flow levels which allow fish life in the Nechako River.

The river flows north-east for the first 70km of its length, then turns almost due east at Ft. Fraser. It enters the Fraser River at Prince George. Its major tributaries are the Nautley River (from Fraser and Francois Lakes), the Chilako River, the Nadina and the Stuart River. The Nechako has 102 mapped tributaries along its length (see figure 4). There are six major lakes (excluding the reservoir) within the watershed. They are:

Cheslatta Lake	47km^2
Francois Lake	220km^2
Fraser Lake	52km^2
Nulki Lake	16km^2
Stuart Lake	370km^2
Tachik Lake	22km^2

Access to the Nechako is inconsistent. Highway 16 and some secondary roads provide some access to the river, especially in the locales of the major townsites: Prince George, Vanderhoof, and Ft. Fraser. Most of the roads which provide access to the area have loose or stabilized surfaces and many of the all weather roads are not even two lanes wide. Others are dry weather only roads. The car rail line right of way provides limited access to the river in some stretches, and it is often the only route in these parts of the river. Access to the river east of Ft. Fraser is very limited until the Kenney Dam road meets it. The proposed hatchery site is reached via this road and the Kenney Dam.

Figure 2. Nechako River System Topography.

The Watershed Boundaries identify the Stuart and Nechako Rivers.

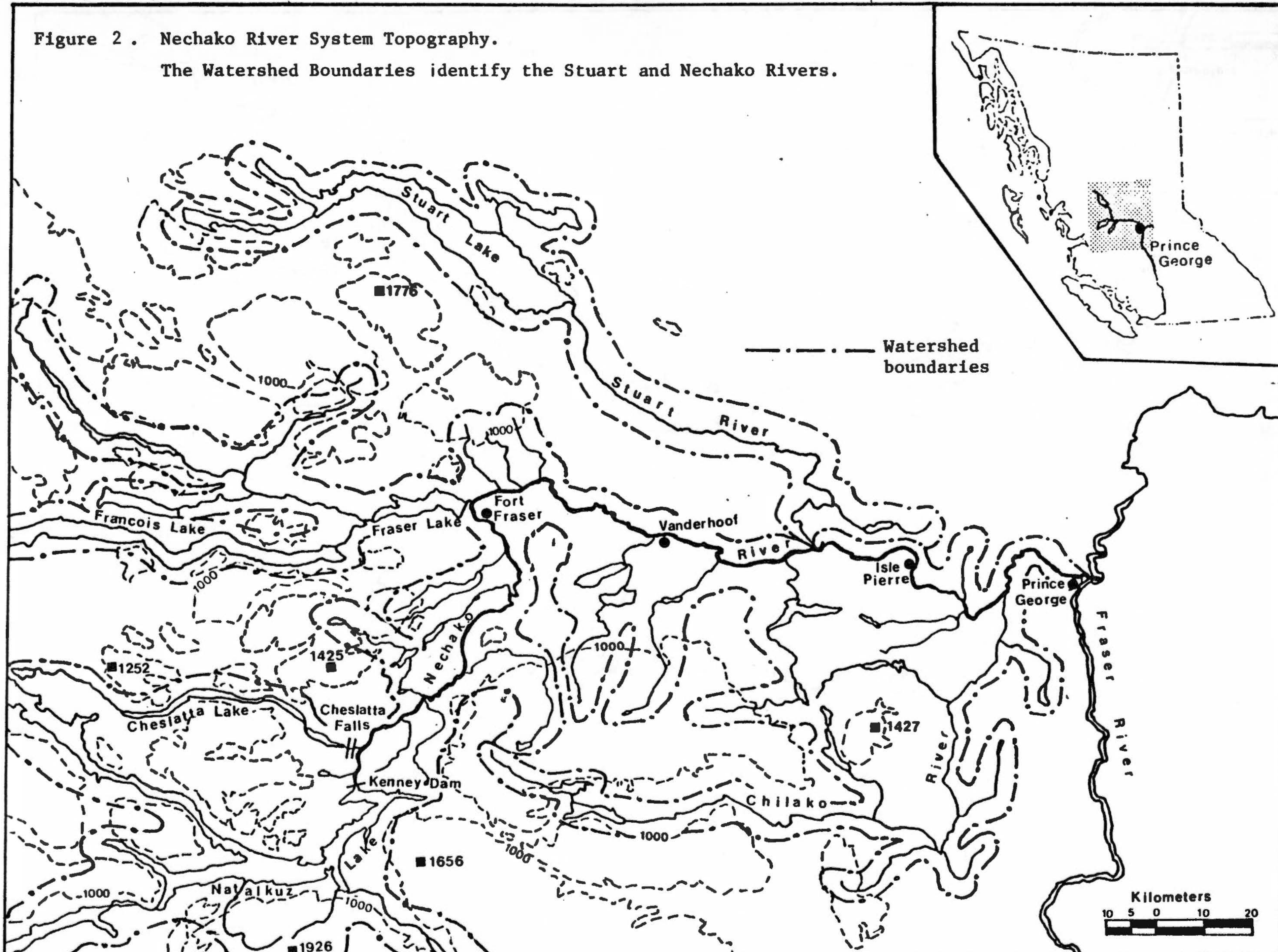


Figure 3 . Nechako Watershed.
Access Routes, Settlements and Indian Reserves.

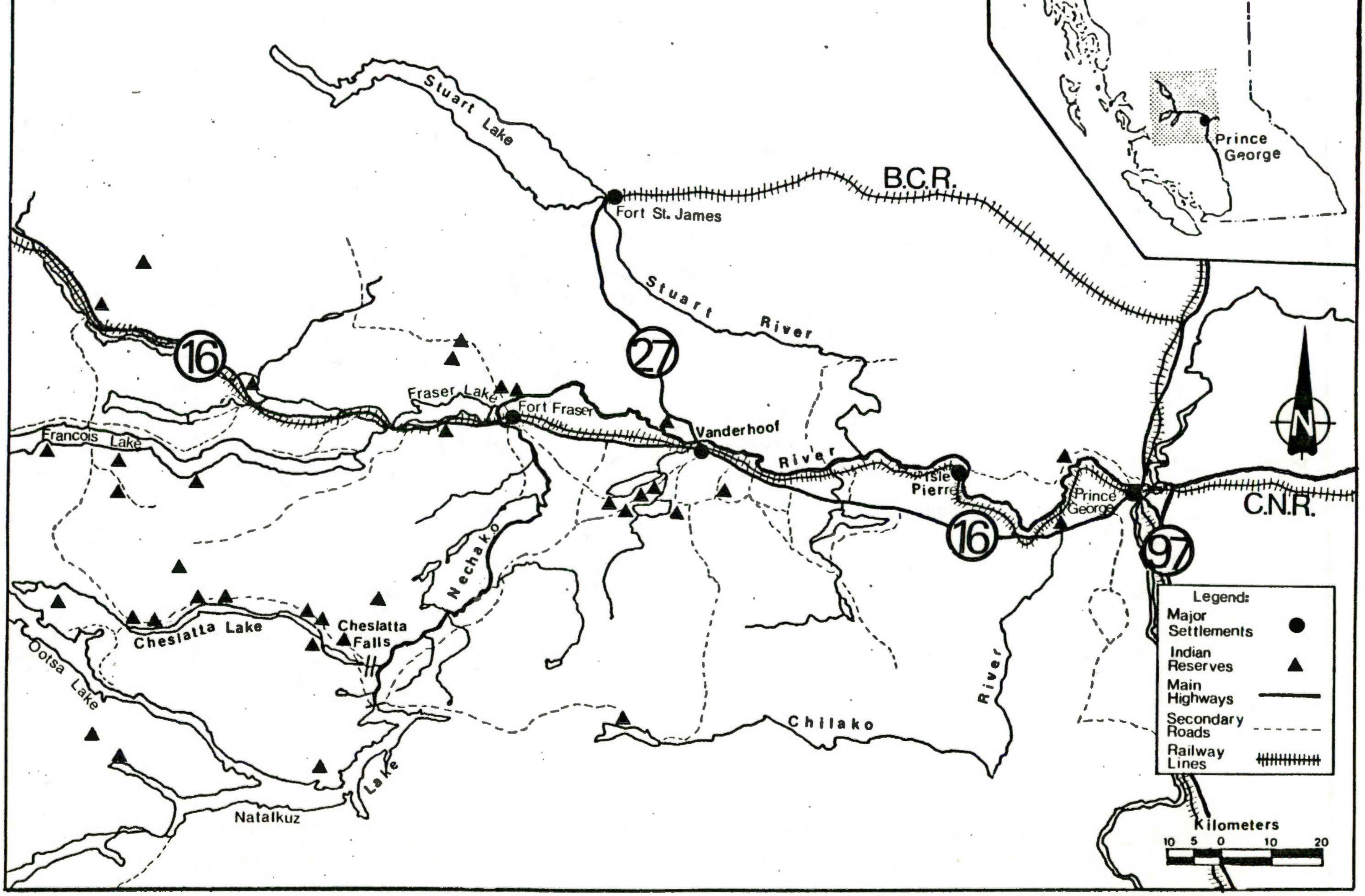


Figure 4 . Nechako River from its confluence with the Fraser River to Kenney Dam.
Scale: 1cm = 5km
Total number of tributaries shown = 110.

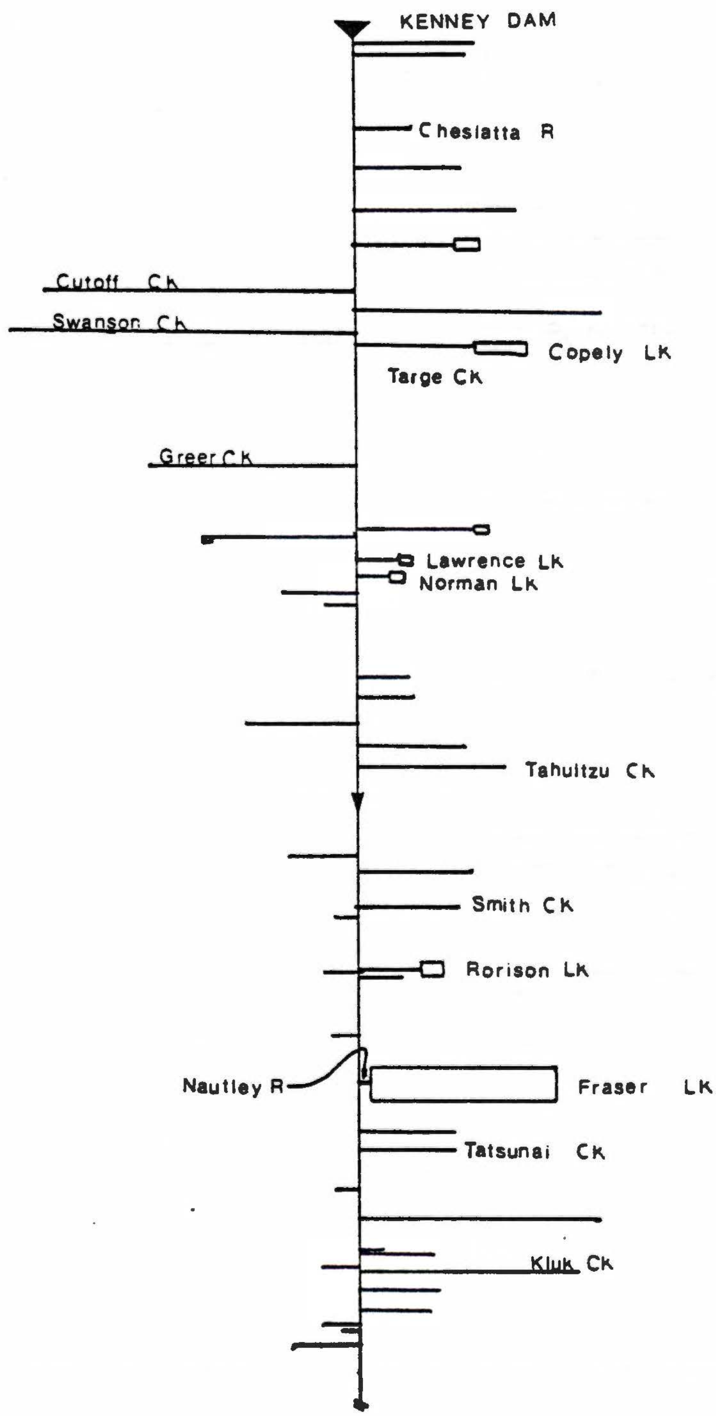
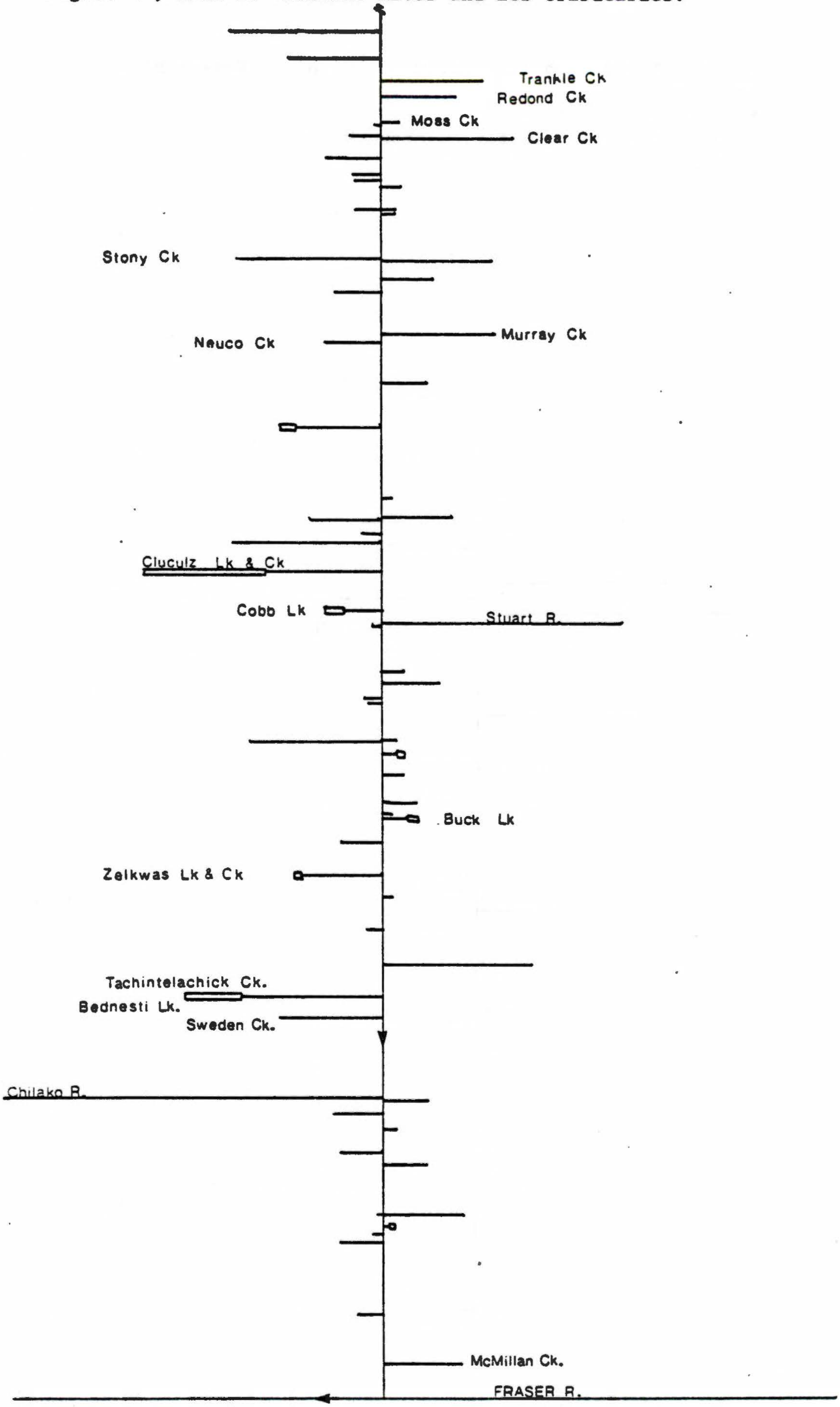


Figure 4 , cont'd. Nechako River and its tributaries.



WATERSHED UTILIZATION

History of Vanderhoof

The first people in the Vanderhoof area were the Indians. The earliest pioneers to settle in Vanderhoof were the fur traders, telegraph men, miners, packers and surveyors. In 1806, Simon Fraser, the first fur trader, with John Stuart, established Ft. St. James and Ft. Fraser.

Around 1906, Vanderhoof consisted of wilderness with only a survey line marking the location of the railway. On April 7, 1914, the completion of railway construction brought great surges of settlers to the Nechako Valley. They were also lured by real estate promoters' promises of unlimited rich farmland, homes and businesses. A townsite had to be established.

Herbert Vanderhoof, an American who was backed by the Grand Trunk Pacific Development Company, selected a townsite on his land south of the railroad, where First Street is today. He began to plan the streets and building lots without any consideration of the natural landscape and named the town after himself (Hancock, 1979).

Vanderhoof is the Dutch name meaning "of the farm". It is an appropriate name for an area where farming has always been an important livelihood.

Within days, the town began to expand. It was nicknamed "The Town That Wouldn't Wait" due to the rapid rate at which the buildings were constructed. The first building to be completed was the MacMillan Building on Fraser and Third, which also included offices of the MacMillan Real Estate Company. According to a pamphlet published by the Board of Trade in December, 1946, 46 buildings were either completed or under construction.

Spring floods, however, made the south side of the tracks a poor townsite. Only buildings on the higher ground were safe. Even sidewalks were built four or five feet above the ground. Businesses began to move to the north side of the tracks where the land was higher and drier. By the time the floods of 1919 came, the entire town had moved to the north side, and not until the mid 40's did construction resume on the original townsite.

In the early 1950's, the Aluminum Company of Canada built Kenney Dam which is situated 60 miles southeast of Vanderhoof. This helped boost Vanderhoof's economy because it was the nearest supply centre to the dam.

At the peak of the construction period, the project employed 1500 men. Since then, Vanderhoof and the surrounding area has grown steadily.

Logging

The Nechako watershed covers three B.C. Ministry of Forest Districts: the Ootsa P.S.Y.U. (Prince Rupert Region), the Nechako P.S.Y.U. (Prince George Region), and the West Prince George District (Prince George Region). Logging operations are currently under way in all three.

The Ootsa P.S.Y.U. is composed of 5,154km^2 of mature forest, 2,708km^2 of immature, and 2,946km^2 of non-productive land. The total area of the district is 10,807km^2. The volume of mature trees is 45,780,314 cunits, 632,780 of which is the allowable cut. Of the allowable cut, 358,591 cunits (40%) is committed to the mills by the various operators within the area (Appendix 2a to d).

There are six Timber Sale Harvesting Licenses within the Ootsa district. These are for "clear-cut" logging, and are held by:

Houston F.P. Ltd. (Houston)
pers. comm: Roger Crosby (July 23, 1980)
Cutting operations in the Nechako and Francois Lake areas with 250,000 cunits per year being cut. Lumber is milled in Houston and shipped to Kitimat. HFP are associated with Eurocan Ltd. in Kitimat.

Babine F.P. Ltd. (Burns Lake)
pers. comm: Dennis Bell (July 23, 1980)
Babine F.P. is cutting 26,000 cunits per year in the Ootsa and Uncha Lake area. In the Endako Valley, across the Skeena/Fraser divide, a cut of 40,000 cunits over the next five years is taking place. Some private purchase wood is being cut in the Nechako River valley.

Bond Bros. Ltd. (Vanderhoof)
pers. comm: Ray Abersek (July 23, 1980)
Bond Brothers is involved with the underwater logging of the Alcan Reservoir in Ootsa and Netalkut Lakes. Upland logging at Tim Smith Point is also taking place, with an annual cut of 30,000 cunits per year over the next three years. Logs are transported via booms to the Kenney Dam, then trucked to Vanderhoof. All operations by Bond Bros. Ltd. in this region are summer only workings.

L + M Lumber Ltd. (Vanderhoof)
pers. comm: Lloyd Larson (July 23, 1980)
Winter cutting at Tim Smith Point on Knewstubb Lake. About 30,000 cunits per year are cut and transported across the ice of the reservoir to the Kenney Dam and then by road to Vanderhoof.

Fraser Lake Sawmills Ltd. (Fraser Lake)
pers. comm: George Hicks (July 23, 1980)
Currently cutting about 6,000 cunits at the west end of Francois Lake about 350m south of the shore. Near Stern Lake (north of Endako) 24,000 cunits per year are being cut for the next three years. 12,000 cunits will be cut at Ansis Lake at the end of the Nithi River. This cut will be increased to 25,000 cunits next year.

Source of operator list: pers. comm, Al Gorley, BCFS, July 23, 1980.

In the Nechako P.S.Y.U. , which has a total area of 9,344km^2, there are 4,872km^2 of mature forest; 3,110km^2 of immature forest, and 996km^2 of non-forest land. Of the mature volume of 37,046,020 cunits, 500,000 cunits are allocated and committed for cutting. Of the total forest area, 1,513km^2 is classified as "good" land, 5,696km^2 as "medium", and 1,243km^2 as "poor".

There are many smaller operations within the Nechako P.S.Y.U. For example, private operations on alienated land, or the River Ranch's liquidation of its assets. Also, many of the large operations listed in the Ootsa P.S.Y.U. overlap into the Nechako district. In the Hallet Lake area, Fraser Lake Sawmills is preparing for a long term operation; building roads and clearing landings etc. (pers. comm: Wayne Selewski, District Manager, Vanderhoof. July 23, 1980).

In the Prince George West district, there are no large cutting operations taking place. There is no logging at all on the river, but there is some private clearing and some private timber sales. There is some small scale logging up the Chilako River Valley. Most of the logging is for farms adjacent to the Nechako and the Chilako in the region of the confluence of these rivers (pers. comm: G. Meets, BCFS, July 23, 1980)

Although the Habitat Protection unit of DFO is deeply involved with studies regarding the effects of the Kemano II project on the Nechako, they are not monitoring the logging operations beyond the standard jurisdictions of Fisheries officers (pers. comm: Mike Flynn, HPD, July 23, 1980).

Mining

There is one major mining operation within the drainage of the Nechako River. The Endako molybdenum mine is situated on the Endako River, west of Fraser Lake. There are also more than fifteen sites being explored in the area. Many show copper and molybdenum deposits, and zinc, lead, silver, and perlite have all been found. Within the drainage basin, outcrops of bedrock are very rare, and the soil covering may vary from 15 to 22 meters. (B.C. Ministry of Mines & Petroleum Res., 1977).

The Habitat Protection Division, Department of Fisheries and Oceans is not involved with monitoring any major operations in the Nechako watershed because no placer mining is permitted in the area. Also, prospectors are not allowed to stake claims within the watershed. There is, however, some hard-rock prospecting taking place in the area (pers. comm: J. Arsenault, HPD. July 23, 1980).

Population

The Nechako River watershed is encompassed within parts of three areas in the Cariboo - Fort George Region as catalogued by the British Columbia Regional Index. These parts are: the lower portion of the Burns Lake Area, the Vanderhoof Area and the southwest portion of the Prince George Area. The Burns Lake Area, which includes various communities around Cheslatta Lake, had a population of 5,573 in 1976, an increase of 11.6 per cent from 1971. The Vanderhoof Area had a total population of 14,049 in 1976 which was a 25.4 per cent increase from 1971. In 1976 major centres of population in this area included Fraser Lake Village (1430), Vanderhoof Village (1990) as well as the communities of Fort Fraser (443) and Endako (228). Fraser Lake and Vanderhoof have shown an increase of 11 per cent and 20 per cent respectively from 1971 to 1976. The city of Prince George, which is situated near the confluence of the Nechako River with the Fraser River, is the major population centre in the Prince George Area with a population of 59,929 persons in 1976 compared to that of 33,101 in 1971, showing an increase of 81 per cent. (B.C. Ministry of Economic Development, 1978).

Industry

The economy of the region surrounding the Nechako River is primarily based on the forest industries. Manufacturing, agriculture, mining and tourism are other major sources of income. Prince George, which lies at the confluence of the Nechako and Fraser Rivers, is the commercial centre of the northern Interior of B.C., with transportation, distribution, trade, service and manufacturing all concentrated in the area.

The forest industries (pulp, paper, lumber and plywood) are the major manufacturers, with sawmills located at Vanderhoof, Prince George, Engen and Fort Fraser. Other industries include printing and publishing, machine shops, millworking and abattoirs. Prince George, being the largest centre in the region, also has a variety of smaller enterprises including bakeries, dairies, a brewery, carbonated beverage plants, steel fabricators, upholstering, cabinet making, chemicals, an oil refinery, concerete products, dental labs and more. There is also a satellite explosives plant at Endako.

In the area west of the Nechako River, agriculture is mostly concentrated on beef cattle and the associated production of forage. In the Vanderhoof area, agriculture continues to expand as new land is brought into production. The large acreage of almost flat land surrounding Vanderhoof is known to be among the most favourable for farming in the northern interior. This land is mostly used to produce hay, grain and other fodder crops for beef and dairy cattle, which provide the bulk of agricultural income. Milk is trucked to Prince George dairies for processing and packaging. There is also sheep, swine and poultry production in the Vanderhoof area. In the Prince George area forage and cattle production are the most important sources of farm revenue. Only a small percentage of the arable land here has been cleared due to low returns and indications that trees may be a more profitable crop than farm produce.

Mining in the region includes the Endako molybdenum mine (which opened in 1965 and has been steadily expanding since then) and limestone (used for bleaching purposes in the manufacture of pulp), which is quarried near Prince George.

Tourism has expanded with the development of Alaska and Vancouver

Island-Prince Rupert ferry systems and with Provincial highway improvement projects. The travel industry has especially expanded in Prince George, which is located at the junction of the two major highway routes in north-central B.C. Of additional interests are big and small game hunting, fishing and camping in all of the areas in the vicinity of the Nechako River. Other attractions are the huge Endako Open-pit molybdenum mine (which provides regular tours) and the Kenney Dam (taken from B.C. Ministry of Economic Development, 1978).

Water Licences

In the Nechako River Watershed there have been forty water licences issued, with twenty-six of them being on the Nechako River proper and ten of them on Fraser Lake. The most common usages on the system are for irrigation and waterworks (15 and 12 of 40 respectively), followed by domestic use (7 of 40). The remainder of the water licences are held for industrial, land improvement, power and storage purposes (Table 1).

The major water user on the Nechako River is the Aluminum Company of Canada. With its storage and power licences, it controls over 99% of the licenced flow. The remaining users consume less than 1% of the licenced flow, with the city of Prince George using one third of that amount.

Priority of users is determined by the date of licence approval rather than licence classification. When two licences are granted on the same date, priority is then determined by licence classification. However, as of 1961, there has been a clause added to the water licences granted to large power companies stating: "priority is subsequent to any consuptive purposes" (pers. comm. D. Tanner, Water Management Branch, July 16, 1980), meaning that any private user has priority over a licence for power, regardless of the date issued.

Water licence type (usage) is always determined by the water licence classification.

Table 1 . Water Licences on the Nechako Watershed. (from B.C. Ministry of Environment, 1980)

	Licence Holder	Priority	W.R. Working Units [a]	Standardization Units	Class [b]	Type (Usage)
	Cutoff Creek					
1.	River Ranch Co.Ltd.	10/06/1957	0.00	0.0	04A	Land Improvement
	Swanson Creek					
1.	River Ranch Co.Ltd.	10/06/1957	1,000.00 GD	4.540 m^3/day	01A	Domestic
2.	River Ranch Co.Ltd.	10/06/1957	250.00 AF	$308x10^3$ m^3/yr	03B	Irrigation (Commercial)
	Tatsutnai Creek					
1.	Raymond, S.+D.	23/06/1969	1,000.00 GD	4.540 m^3/day	01A	Domestic
	Fraser Lake					
1.	Powney, C.S.	15/07/1957	8.25 AF	$10x10^3$ m^3/yr	03B	Irrigation (Private)
2.	Powney, C.S.	15/07/1957	21.75 AF	$27x10^3$ m^3/yr	03B	Irrigation (Private)
3.	Evans, W.E.	23/10/1962	2,000.00 GD	9.08 m^3/day	01A	Domestic
4.	Parker, R.G.	25/06/1963	100.00 AF	$123x10^3$ m^3/yr	03B	Irrigation (Private)
5.	Village of Fraser Lake	18/09/1964	50,000.00 GD	227 m^3/day	00A	Waterworks (Municipal)
6.	Carpenter, K.R.	09/04/1965	500.00 GD	2.27 m^3/day	01A	Domestic
7.	Stellaquo Band - Indian Agency	24/01/1966	20,000.00 GD	90.8 m^3/day	00B	Waterworks (Indian band)
8.	Parks Branch	28/07/1966	10,000.00 GD	45.4 m^3/day	00B	Waterworks (Parks branch)
9.	Ponsford, H. W/L B.	23/01/1967	500.00 GD	2.27 m^3/day	01A	Domestic

Table 1 . Water Licences on the Nechako Watershed (cont'd.)

	Licence Holder	Priority	W.R. Working Units [a]	Standardized Units	Class [b]	Type (Usage)
	Fraser Lake (cont'd.)					
10.	Fraser Lake Band - Indian Agency	21/07/1967	20,000.00 GD	90.8 m^3/day	00B	Waterworks (Indian band)
	Nechako River					
1.	City of Prince George	08/05/1916	270,000.00 GD	1225.8 m^3/day	00A	Waterworks (Municipal)
2.	Aluminum Co. of Canada	03/08/1949	35,000,000.00 AF	43.1×10^9 m^3/yr	08A	Storage
3.	Aluminum Co. of Canada	03/08/1949	9,500.00 CS	268.4 m^3/sec	07A	Power
4.	City of Prince George	27/04/1953	2,230,000.00 GD	10×10^3 m^3/day	00A	Waterworks (Municipal)
5.	Tritt, J. W/H M.	02/02/1954	75.00 AF	92×10^3 m^3/yr	03B	Irrigation (Private)
6.	Ft. Fraser Waterworks District	07/01/1963	100,000.00 GD	454 m^3/day	00A	Waterworks (Municipal)
7.	Prince George Pulp and Paper Ltd.	25/06/1963	100.00 CS	2.83 m^3/sec	02A	Industrial (Pulpmills)
8.	City of Prince George	31/12/1963	7,000,000.00 GD	32×10^3 m^3/day	00A	Waterworks (Municipal)
9.	Dunn, J.F.	20/01/1964	70.00 AF	86×10^3 m^3/yr	03B	Irrigation (Private)
10.	City of Prince George	24/06/1965	450,000.00 GD	2043 m^3/day	00A	Waterworks (Municipal)
11.	Intercontinental Pulp Co.	30/08/1966	100.00 CS	2.83 m^3/sec	02A	Industrial (Pulpmills)
12.	Reinke, D.K.	19/06/1967	15.00 AF	18×10^3 m^3/yr	03B	Irrigation (Private)
13.	McNolty, L.	15/11/1967	1,000.00 GD	4.54 m^3/day	01A	Domestic
14.	McNolty, L.	15/11/1967	105.00 AF	129×10^3 m^3/yr	03B	Irrigation (Private)

Table 1 . Water Licences on the Nechako Watershed (cont'd.)

	Licence Holder	Priority	W.R. Working Units [a]	Standardized Unites	Class [b]	Type (Usage)
	Nechako River (cont'd.)					
15.	River Ranch Co.Ltd.	23/06/1969	2,500.00 AF	$3.1x10^6$ m^3/yr	03B	Irrigation (Commercial)
16.	Omineca Hospital Society	31/10/1969	50,000.00 GD	227 m^3/day	02G	Industrial (Unspecified)
17.	Hoek, J. L/W J.	30/01/1970	240.00 AF	$295x10^3$ m^3/yr	03B	Irrigation (Private)
18.	Reeder, M.+H.	05/01/1971	240.00 AF	$295x10^3$ m^3/yr	03B	Irrigation (Private)
19.	Bublitz, R.A.	29/01/1971	220.00 AF	$271x10^3$ m^3/yr	03B	Irrigation (Private)
20.	Norhelm, B.	02/11/1971	115.00 AF	$142x10^3$ m^3/yr	03B	Irrigation (Private)
21.	City of Prince George	13/03/1972	1,250,000.00 GD	5675.1 m^3/day	00A	Waterworks (Municipal)
22.	City of Prince George	20/03/1972	10,300,000.00 GD	$47x10^3$ m^3/day	00A	Waterworks (Municipal)
23.	City of Prince George	25/01/1973	30,000,000.00 GD	$136x10^3$ m^3/day	00A	Waterworks (Municipal)
24.	Merz, L.+D.L.	09/04/1973	200.00 AF	$246x10^3$ m^3/yr	03B	Irrigation (Private)
25.	Barclay, F.E.+R.S.	01/06/1973	100.00 AF	$123x10^3$ m^3/yr	03B	Irrigation (Private)
26.	Silver, K.M.	12/07/1974	500.00 GD	2.27 m^3/day	01A	Domestic

(a)
AF acre-feet
CS cubic-feet per second
GD gallons per day
A. acres
M. miles
TF total flow of stream.

(b)
01A domestic
02A industrial (pulpmills)
02G industrial (other)
03B irrigation (by other)
04A land improvement
07A power
08A storage
00A waterworks (Municipalities)
00B waterworks (other)

NECHAKO RIVER CAPABILITY RATINGS

Agriculture

On a whole, agricultural capability rating in the Nechako River watershed can be considered poor. The most prevalent ratings, by far, are permanent pasture or forage, natural grazing, and no production.

West of Vanderhoof, the most common rating is permanent pasture or forage. In the area, adverse climate, a combination of soil factors, poor slope and moisture deficiency all limit agricultural production. There are also large areas in this region that have no agricultural capability.

Around the city of Vanderhoof itself, production includes a reduced range of crops as well as permanent pasture or forage.

From Vanderhoof to the confluence with the Stuart is an area dominated by ratings of permanent pasture or forage and unproductive land. In the area poor slope is the major limiting factor, combining with poor soil structure to make agricultural endeavors difficult.

East of the Stuart River confluence to Prince George there are large stretches of unproductive land and permanent pasture or forage land. In some areas of this region excess soil moisture is an additional limiting factor to agricultural production. (B.C. Ministry of Environment, 1966).

Forestry

In the Nechako River watershed, the capability for forest production ranges from very poor (0-30 cf/acre/yr) to excellent (111-130 cf/acre/yr). On the whole, however, timber production potential can be considered fair (51-90 cf/acre/yr).

Along the river itself, fair production predominates. Production along most of its length is limited by soil moisture deficiency and by rooting depth restrictions. The dominant species include white spruce (Picea engelmannii) and lodgeple pine (Pinus contorta), with the former being the most abundant. The only major exceptions to this classification are: the area near the confluence with the Stuart River, where the production is poor (31-50 cf/acre/yr) with lodgepole pine being dominant, and the area near the confluence with the Fraser, which has excellent production and black cottonwood (Populus trichocarpa) predominates.

The upland areas within the watershed have, largely, forestry capability ratings of fair. However, isolated pockets of very poor production exist in the Hulatt region. The major limiting factor being an excess of soil moisture, which is characteristic of swampland. There are also large regions of good production in the Bednesti area, where white spruce is the dominant species. (B.C. Ministry of Environment, 1966)

Recreation

The Nechako River, as a whole can be classified as shore land with a moderately low capability rating for recreation. Outdoor enthusiasts are offered, largely, only angling and canoeing along the river's length, with some organized camping featured near the confluence with the Stuart River.

The upland areas in the watershed are almost uniformly rated as having low capability for recreational activities. The primary attraction to the area appears to be significant vegeation, with some hunting activities probably offered to the heartier outdoor types. Only around the upland lakes does the classification vary, and in those areas the rating is moderately high with angling, family boating, lodging and cottaging being the principle attractions.

In the Prince George area ski hill developments are recent recreational additions. (B.C. Ministry of Environment, 1966)

Ungulates

From the Kenney Dam to that area just north of Tachick Lake ungulate production along the Nechako is, generally, quite good. Along the Kenney Dam stretch there is, for about 35km downstream, a region on both sides of the river where only slight limitations to the production of ungulates exist. Moose and deer are the two main species in this area, where demobilizing periods of deep snow is the only factor that limits production. Most significant is the area's status as a very important winter range for moose. Down the river, approximately 35km from Kenney Dam, there is an important winter range for moose and deer. Poor climate and snow depth combine to limit production in this range. Further downstream, to just north of Tachick Lake and inclusive of virtually all upland areas from Kenney Dam, is an area classified as having only moderate limitations, primarily due to snow depth. Moose are the dominant species and have a very important winter range around Tachick Lake and Nulki Lake.

The Vanderhoof to Stuart River confluence strip of river is an important winter range, primarily for moose but also for deer. Upland there are moderate limitations on ungulate production due to snow depth, but these areas are still very important winter ranges for moose.

Downstream, ungulate classifications remain virtually unchanged (i.e. moderate limitations) to the confluence with the Fraser. The only major exception is an area about 30km upstream from Prince George. This area stretches upland about 12km from the river and is ranked as an extremely important winter range for moose (B.C. Ministry of Environment,1966).

STREAMFLOWS

Three stations were utilized to obtain stream flows on the Nechako River. The first was the Ootsa-Skins Lake Spillway (elevation 853m) at the head of the Nechako system. The second was Ft. Fraser (elevation 667m), where the river veers eastward from its northeast course, and the third was at Isle Pierre (elevation 650m) approximately 25km downstream of the confluence with the Stuart River (Water Survey Canada, 1974).

The Nechako River at Isle Pierre (1979) (Fig. 9) had a yearly flow pattern similar to other rivers of its size. Winter flows hovered around $120m^3$/sec from December to March. By early April, the spring freshet had begun and flows rose at a rate of about $10m^3$/sec/day until the beginning of May. Flows then remained relatively constant at 400 - $480m^3$/sec until the end of July, at which time the discharge rate tended to drop slowly towards winter levels (Water Survey Canada, 1980).

Prior to the construction of the Kenney Dam in 1952, flow patterns on the Nechako River near Ootsa Lake (Fig.6) and at Ft. Fraser (Fig.8) were very similar. Flows began to rise very quickly in early May to about 8x their winter levels ($60m^3$/sec and $80m^3$/ sec respectively) by mid-June. There was then a slow decrease in flow rates (3-$4m^3$/sec/day) over the next four months to mid-October. Heavy winter rains in the area caused increased flows in November and December, probably tapering off by mid-January.

Shortly after the completion of the dam, flows in the upper reaches of the Nechako changed dramatically (Fig. 7, Appendix 4e). In 1953, there was no disernible flow pattern for the river at Ft. Fraser. The greatest flow occured in late September and even then it only reached $18m^3$/sec. The low escapement of chinook in 1957, 1958, and 1959 is undoubtedly, a reflection of the reduced, erratic flows during the reservoir filling period.

Presently, the flows of the Nechako are controlled by the Aluminium Company of Canada (Alcan). Prior to 1979, the rate of discharge over the spillway had rarely dipped below $30m^3$/sec (1061 cfs), however, in December of 1979 (Envirocon,1980 a & b MS, Alcan, 1980), flows were cut to about $14m^3$/sec (500 cfs) (Fig. 5). Department of Fisheries and Oceans officials have questioned the wisdom of reducing flows to this extent as it is thought to render upstream movement of migrating salmonids very difficult, and perhaps have adverse effects on incubating eggs and rearing fry. Alcan has since agreed to increase the flow to $17m^3$/sec (600 cfs) for the spawning migration in 1980, and a recent injunction has ordered the release of $226m^3$/sec (8000cfs) until the question is resolved. Perhaps a cooperative planning program would assure enough water for both industrial man and native salmonids in this system, thus ensuring the survival of each.

Figure 5 . Discharge over Ootsa-Skins Lake Spillway, 1979-1980

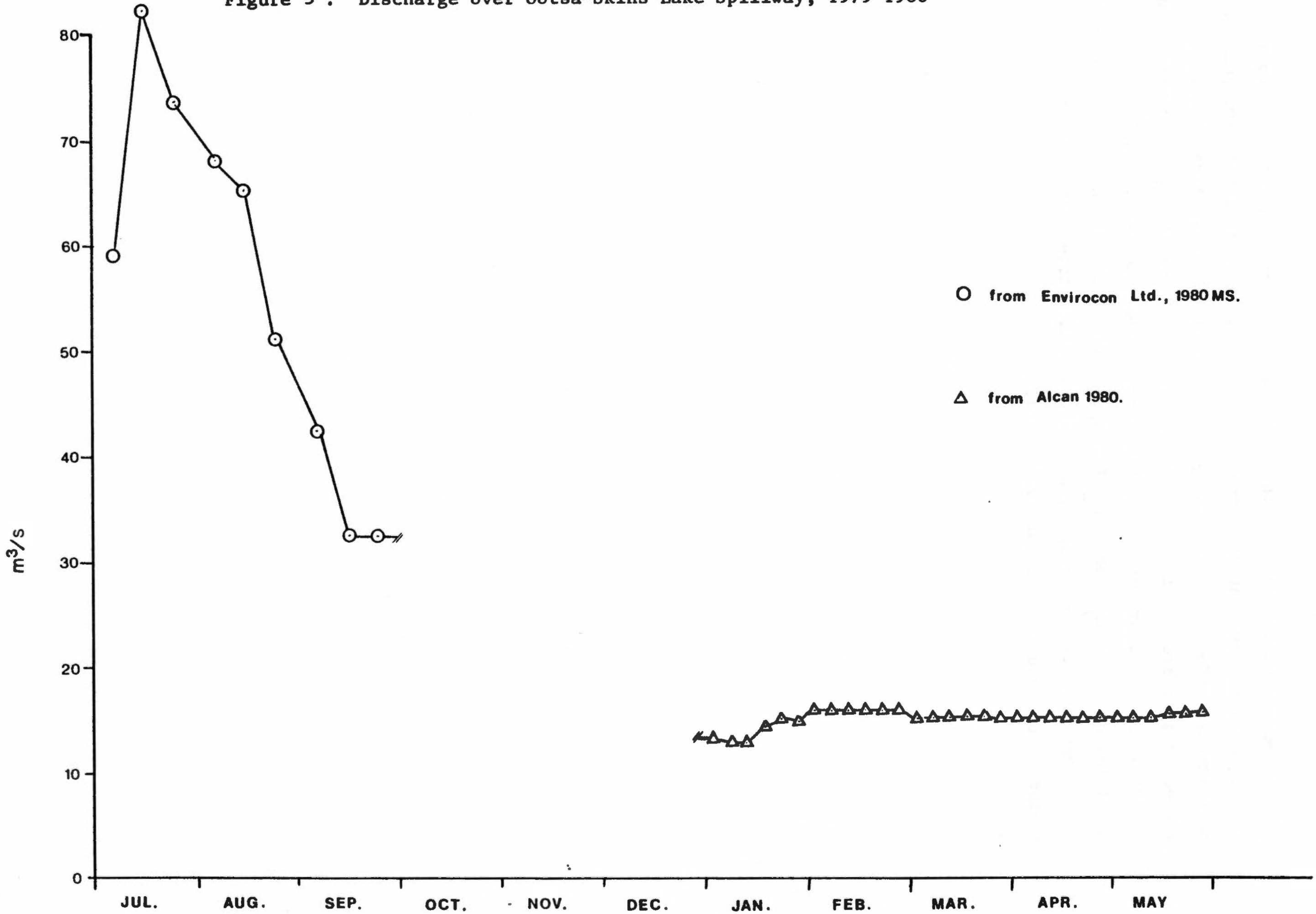


Figure 6 . Streamflow (m^3/s) of the Nechako River near Ootsa Lake. Tri-monthly Maximum, Minimum and Mean (averaged from 1949 and 1950 data) (Water Survey Canada, 1980)

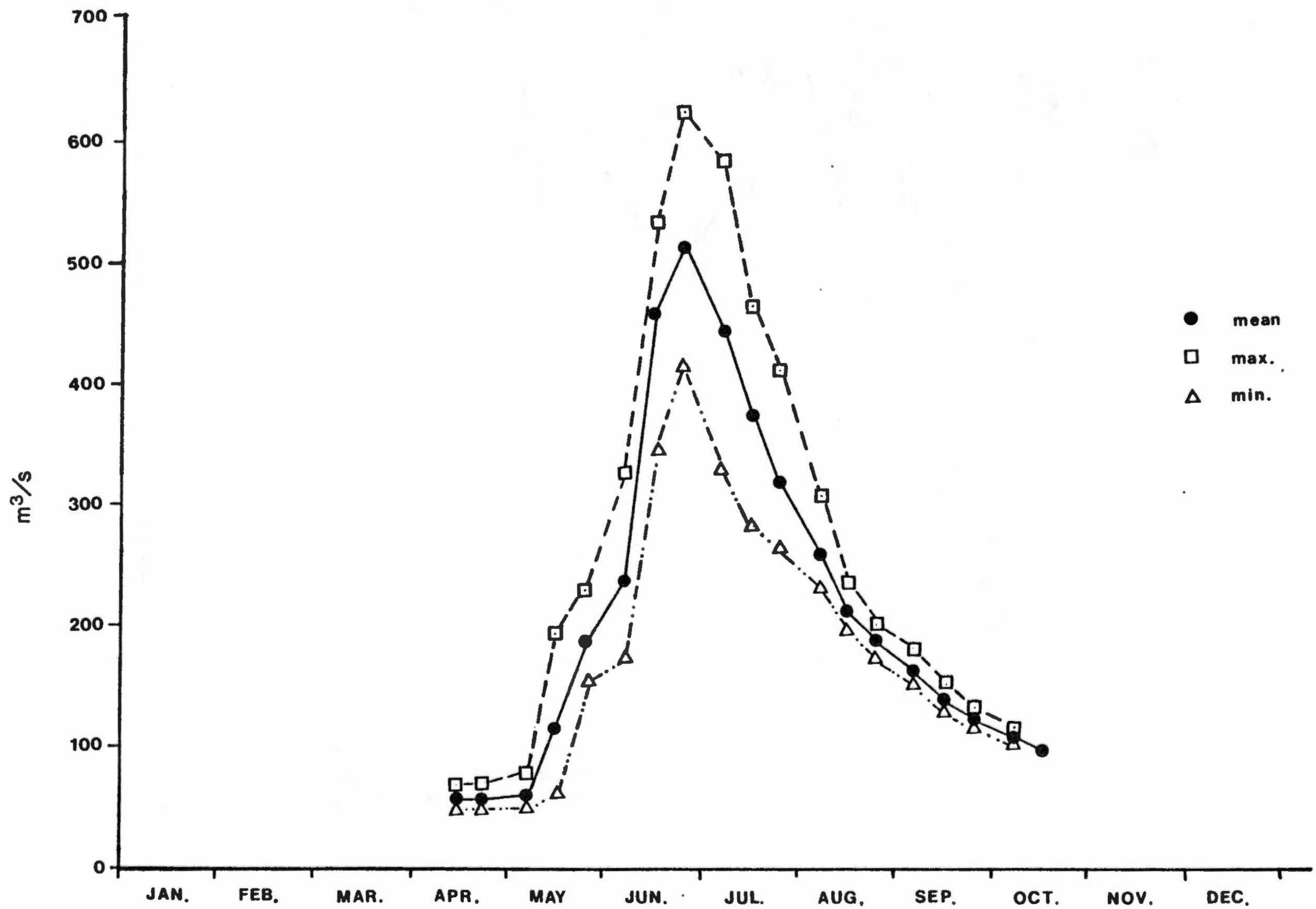


Figure 7. Streamflow (m^3/s) of the Nechako River at Fort Fraser. Tri-monthly Maximum, Minimum and Mean (for 1953). (Water Survey Canada, 1980)

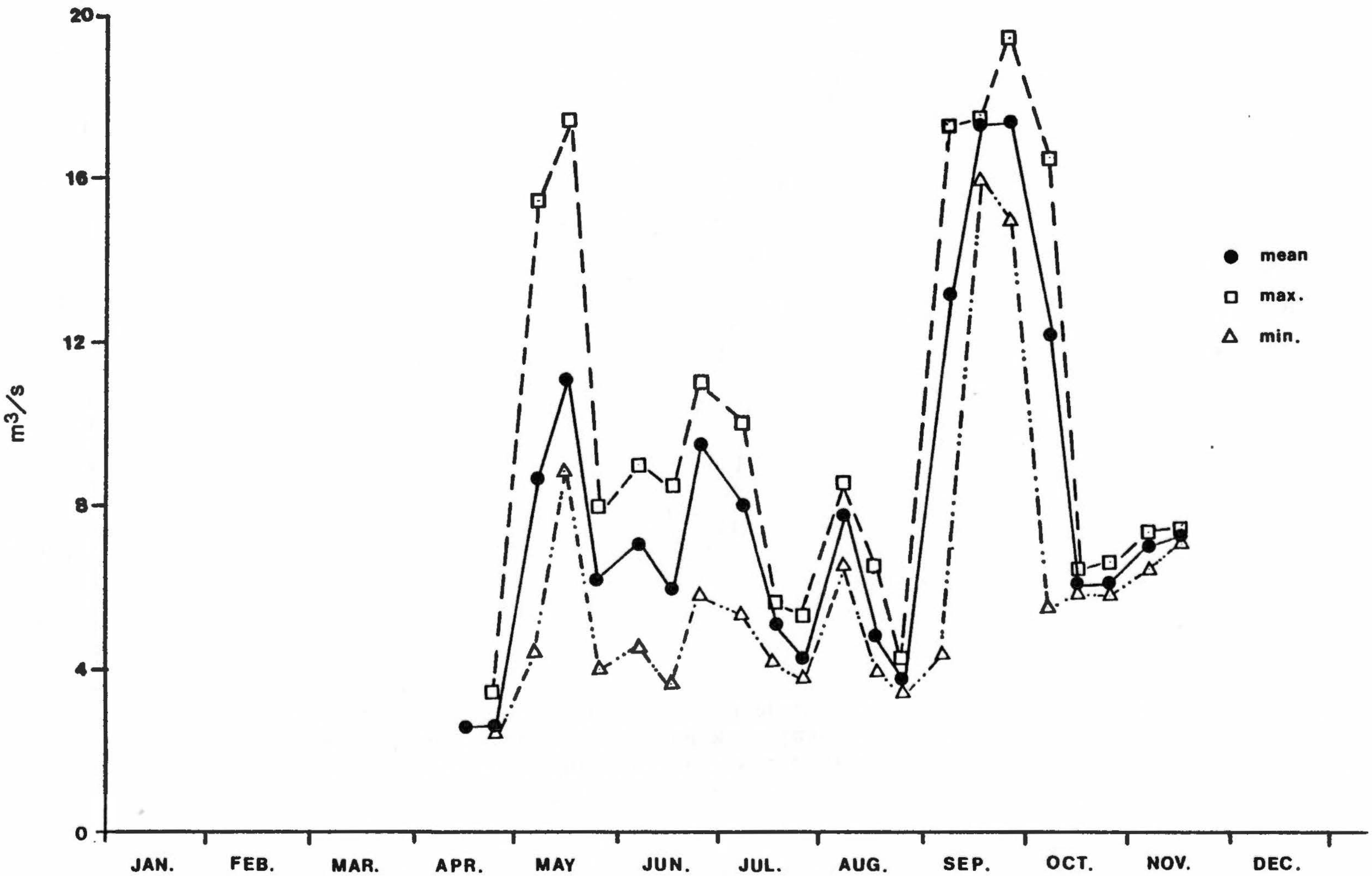


Figure 8 . Streamflow (m^3/s) of the Nechako River at Fort Fraser. Tri-monthly Maximum, Minimum and Mean averaged for 1947-1951. (Water Survey Canada, 1980)

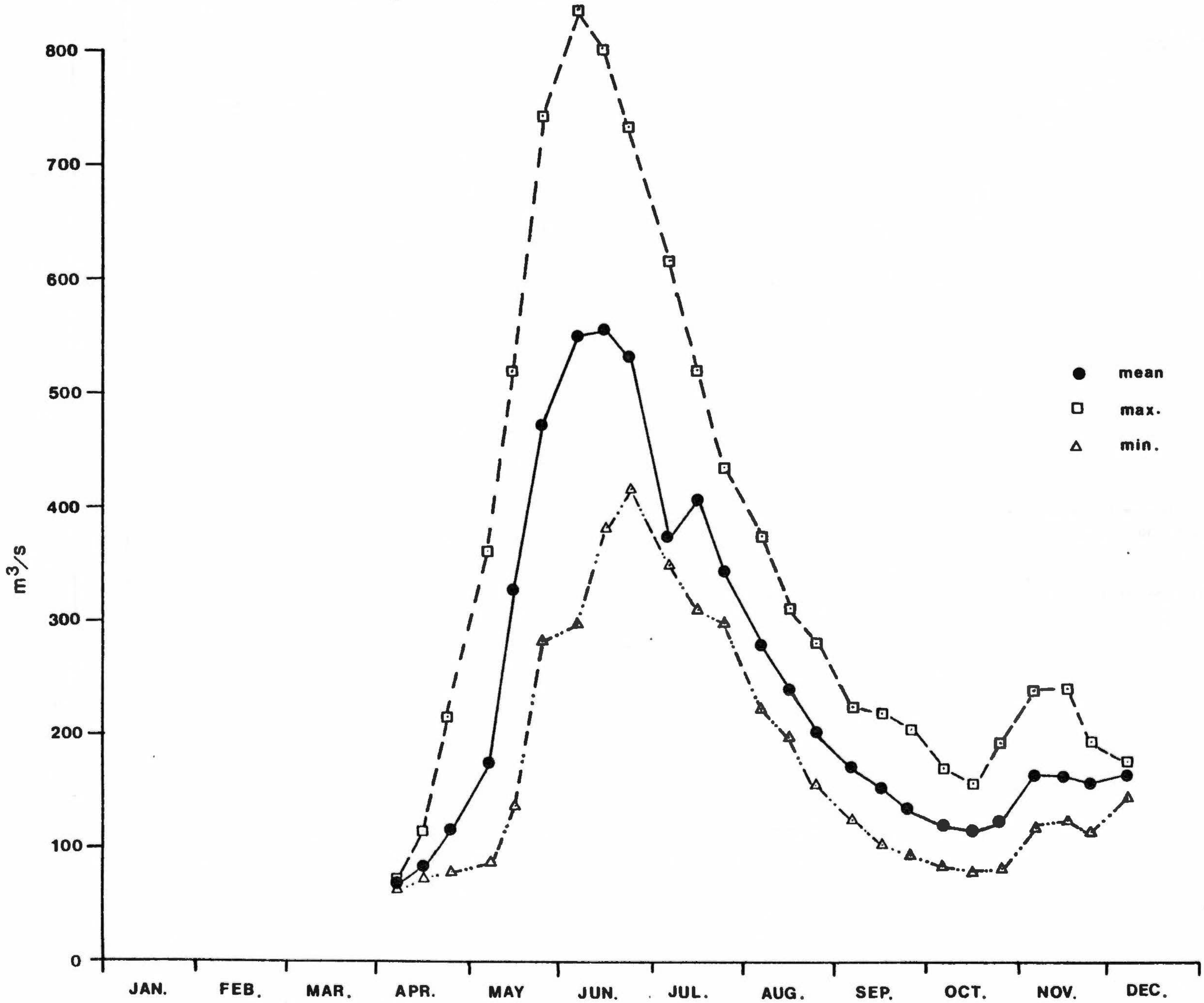
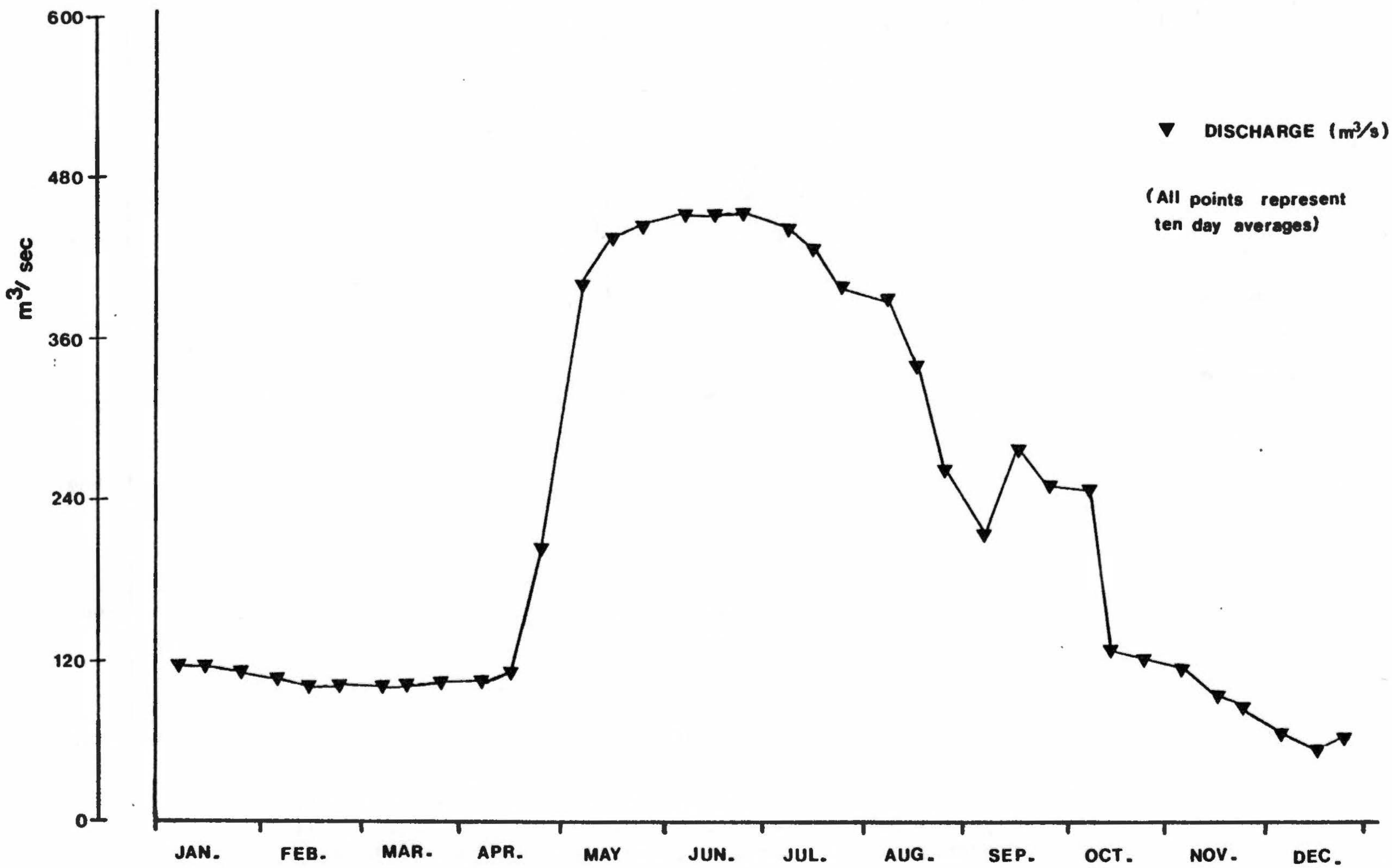


Figure 9 . Streamflow (m^3/s) of the Nechako River at Isle Pierre.
Tri-monthly Maximum, Minimum and Mean. (Water Survey Canada, 1974)



WATER QUALITY

Surface Water

The Nechako 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 obstructions, etc.), however, using water quality criteria it is possible to determine the areas best suited to undergo enhancement (Table 2,3,4, Fig. 11).

Starting at the mouth of the river, and working upstream, the Prince George area is the first to be encountered. Although the data is sparse, there appears to be some problems with the water in the area. Non-Filterable Reside (N.F.R.) levels are very high, up to 10x incubation limits (L.T.3mg/l) in the river proper, and up to 25x R.F.C.L. (Recommended Fish Culture Limits, Appendix 7), in some of the outfalls,(B.C. Ministry of Environment 1979). Elevated values of pH,chlorine residues, total alkalinity and ammonia, along with low specific conductance combine to characterize the water in the region. In addition, probable high metal concentrations also contribute to make the water quality poor for fish culture.

Upstream approximately 85km, the Isle Pierre (Fig.10) area tends toward low specific conductance and filterable residue, while non-filterable residue levels exceed R.F.C.L. The toxicity of the high concentrations of copper, iron, mananese and lead increases, due to decreased complexing as a result of the soft waters (hardness - 12.3-40mg/l). Total phosphate and ammonia (as NH_3) levels are also high in the area, contributing to the water quality problems.

In the Vanderhoof area, very little water quality data is available. All that can be conclusively stated is that non-filterable residues are prevalent, and specific conductance is low. In all probability the water is quite soft, and it is also probable that high iron and manganese concentrations exist.

Further upstream, where the Nechako bends eastward from its northeasterly course, the river water at Ft. Fraser is fairly good. The only problems are slightly high N.F.R. and iron concentrations, and decreased specific conductance. Water colour exceeds the R.F.C.L. in this area as well.

Near Greer Creek, the Nechako River's water quality is excellent. Only the turbidity, which ranges below the lower recommended limit, varies from the recommended fish culture requirements (Laboratory Services(EPS-FMS) Chemistry, 1979).

An excellent surface water supply is available from the Cheslatta River. The available gross head is in the order of 43m. In addition, the water is of good quality and discharges out of Murray and Cheslatta Lakes, thus eliminating the necessity of constructing settling basins (Ginetz, and Nielsen, 1979).

Groundwater

On the Nechako Floodplain, five testholes and four wells have been drilled and some tested for water quality. Testhole No. 1 and wells No. 6, No. 7, and No. 8 were assayed while the remaining testholes were completed for aquifer definition (Fig. 12).

The well water (Table 5) is high in dissolved gases (Nitrogen and Argon 136% saturation in well No. 7), while dissolved oxygen (D.O.) was non-existent. This is a situation which may be rectified by aeration. All other water quality parameters fall safely within R.F.C.L. with the exception of un-ionized ammonia (NH_3), which is just slightly above the limit in wells No. 7 and No. 8 (2.3 and 3.0μg/l respectively), manganese (elevated levels in all wells), and iron (high in testhole No. 1). In the moderately hard water (95.2mg $CaCO_3$/l), manganese levels under 0.5mg/l probably would have no adverse effects (McKee and Wolf, 1971).

From all indications, a well on the floodplain could produce water at a rate of at least 3400 LPM, and probably at a rate of 5675-6500 LPM (G.O. Nielsen, pers. comm.), while maximum groundwater requirements would be 8500 LPM (B.G. Shepherd, pers. comm.), if 2.4M eggs was the production goal. However, additional well construction, test drilling and pump-testing will be required to determine the maximum capacity of the aquifer (G.O. Nielsen, pers. comm.).

Very little is known about the temperature regimes of the groundwater at the floodplain site. However, during the ninety-two hour pumptest on well No. 7, the water temperature dropped from 9.5 to 8.5°C. Continued monitoring of groundwater in the area will be required to fully comprehend the capacity of the aquifer.

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

Pollution Control Branch Sample Sites			Abbr.
1.	Ft. Fraser Waterworks	- outfall	Ft. F.W.
2.	Vanderhoof - Village Site	- outfall	V.V.S.
3.	Uncle Ben's. Prince George	- outfall	U.B. #1
4.	Uncle Ben's. Prince George	- outfall	U.B. #2
6.	Nechako R. nr. Isle Pierre	- stream	N.R. @ I.P.1
7.	Nechako R. @ McMill Cr. #1	- stream	N.R. @ M.C. #1
8.	Nechako R. @ McMill Cr. #3	- stream	N.R. @ M.C. #3
9.	Nechako R. @ McMill Cr. #4	- stream	N.R. @ M.C. #4
10.	Vanderhoof Control	- stream	V.C.
11.	Vanderhoof IDZ	- stream	V. IDZ
12.	Vanderhoof Downstream	- stream	V. D/S
13.	Uncle Ben's Control	- stream	U.B.C.
14.	Uncle Ben's IDZ	- stream	U.B. IDZ
15.	Uncle Ben's Downstream #2	- stream	U.B. D/S #2
16.	Uncle Ben's Downstream #1	- stream	U.B. D/S #1
17.	Ft. Fraser Upstream	- stream	F.F. U/S
18.	Ft. Fraser IDZ	- stream	F.F. IDZ
19.	Ft. Fraser Downstream	- stream	F.F. D/S
20.	Nechako River below Mud R.	- stream	N.R. b. M.R.
21.	Nechako River @ Prince George	- stream	N.R. @ P.G.1
22.	Nechako River @ Prince George	- stream	N.R. @ P.G.2
23.	Nechako River @ Kenney Dam	- stream	N.R. @ K.D.
24.	Nechako River @ Ft. Fraser	- stream	N.R. @ F.F.
25.	Nechako River @ Vanderhoof	- stream	N.R. @ V.
26.	Nechako River @ Hulatt Road	- stream	N.R. @ H.R.
27.	Nechako River @ Isle Pierre	- stream	N.R. @ I.P.2

Naquadat Sample Sites

1a.	Nechako River @ Isle Pierre	- stream	NAQUADAT

D.F.O. Sample Sites

1b.	Nechako River @ Greer Creek	- stream	N.R. @ G.C.
2b.	Well #6 on Nechako Flood Plain	- ground	Well #6
3b.	Well #7 on Nechako Flood Plain	- ground	Well #7
4b.	Well #8 on Nechako Flood Plain	- ground	Well #8

Table 3. Domestic and Industrial Effluent Sources on the Nechako River System (B.C. Ministry of Environment, 1979)

Location	Name	Map Location No.	Effluent
1. Prince George	Uncle Ben's	3,4	Sewer Outfall
2. Vanderhoof	Vanderhoof Sewer System	2	Sewer Outfall
3. Ft. Fraser	Ft. Fraser Waterworks	1	Sewer Outfall

Table 4: Nechako River Water Quality Sample Sites. Listed in order of occurence from headwaters to the confluence with the Fraser River. (B.C. Ministry of Environment, 1979, NAQUADAT, 1979)

SAMPLE SITE

WATER QUALITY PARAMETER (mg/l.)*	23 N.R. @ K.D.	1b N.R. @ G.C.	17 F.F. U/S	18 F.F. IDZ	19 F.F. D/S	24 N.R. @ F.F.	1 F.F. W.	25 N.R. @ V.	2 V. V.S.	10 V.C.	11 V. IDZ	12 V. D/S	26 N.R. @ V.	20 N.R.b. M.R.	27 N.R. @ I.P. 2	1a NAQUADAT	6 N.R. @ I.P. 1	3 U.B. #1	4 U.B. #2	22 N.R. @ P.G. 2	8 N.R. @ M.C. #3	13 U.B. C.	14 U.B. IDZ	15 U.B. D/S #2	16 U.B. D/S #3	Rec. Limits
pH		7.5	7.7	7.6	7.6		7.7		8.1						7.5	7.5	7.7	7.5	7.6			7.7	9.1	7.9	8.2	6.5-8.5
Residue		1	85	87	83		412		668						48	30	69	752	246			76	916	86	109	70-400
N.F. Res.		49	4.8	1.6	3.3		82.3		50.6	8	8	6			20	11	10	62.7	1.92			22	89.5	30	10.7	L.T. 3
S.Cond. (micromho/cm)		62	98	102	95		516	75	966	80	80	110			90	95	102	601	400		100	109	955	112	139	150-2000
D.Oxy	12.1		9.2	9.1	9.4	8.2	6.55	10.1	4.7				11.4	10.2	11.3	11	10.4	8.5	4.8	11.2	9.6	8.9	9.0	10.7	9.4	G.T. 6
Chl. Res.																		.54			0	0	.12	.025		L.T. .002
Colour (T.C.U.)				22.6	27.7		43.5		29.5				80		15.3	13.8	12									L.T. 15
Turb. (J.T.U.)		1.0	2.1	.92	1.7			1.7	10.5						5.3	1.6	4.2	27.3								1-60
T.Alk.		28	49	51	47		174		287						41	38	40	429	196			52	508	53		20-300
Hardness		31	49	50	48		131		225						42	12.3	40									20-400
NH_3 ($x10^{-3}$)		.2	.4	.3	.3		70.2		228						1.9		.3	62.8			.6					L.T. 2
T.Nit.			.34	.35	.34		16.0		11.5						.34	.02	.31	17.0			.17					
T.Phos.		.005	.015	.012	.015		3.37		2.46						.010	.015	.019	2.9			.018					L.T. .05
Sulphate		3.3													3.9	.05	5									L.T. 90
O.Carbon			9	8.2	9.7		79.6		42.5						8.2	8.8	5.7	394								
Al		.09														.04										L.T. .1
Ca		9.6	13.4	13.6	13				52						12.5		10.9									4-150
Cu		.001	.002	.002	.002										.012	.01	.001	.02								L.T. .006
Fe		.026	.275	.16	.3										.276	.02	.15									L.T. .3
Hg		.0002	.05	.05	.05										.05		.05									L.T. $5x10^{-5}$
Mn		.0066	.023	.02	.02										1.33	.02	.02									L.T. .05
Pb ($x10^{-3}$)		1.0	1.3	1.4	3.0										6.0	10	1.0									L.T. 10

* except where otherwise defined

——— mean value exceeds RLFC

– – – – range extremities exceed RLFC

Figure 10. Water Quality Parameters of the Nechako River at Isle Pierre (NAQUADAT, 1979)

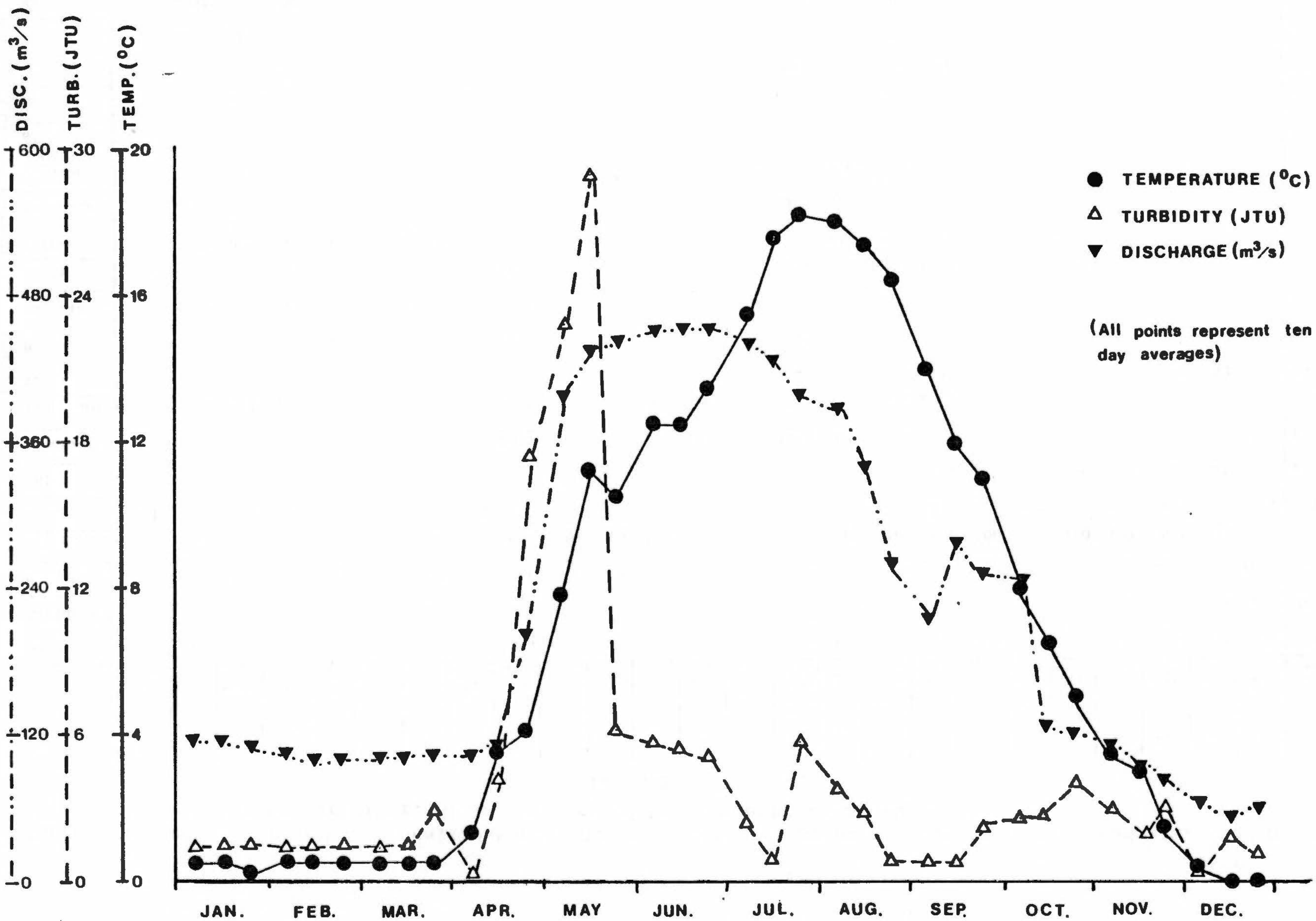
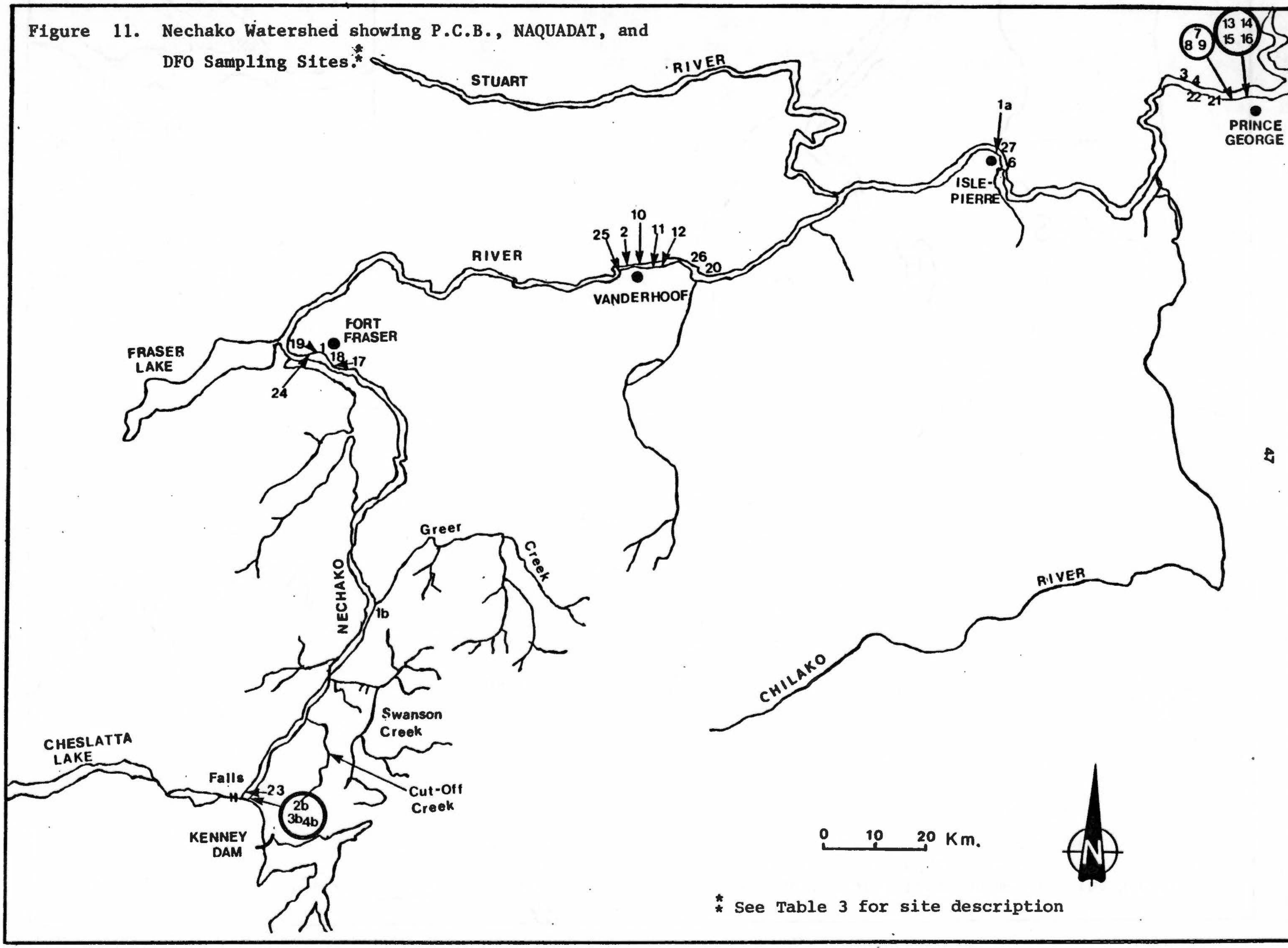


Figure 11. Nechako Watershed showing P.C.B., NAQUADAT, and DFO Sampling Sites.*



* See Table 3 for site description

Figure 12 . Groundwater well location map for the Nechako River proposed hatchery site. (Pacific Hydrology Consultants, 1979)

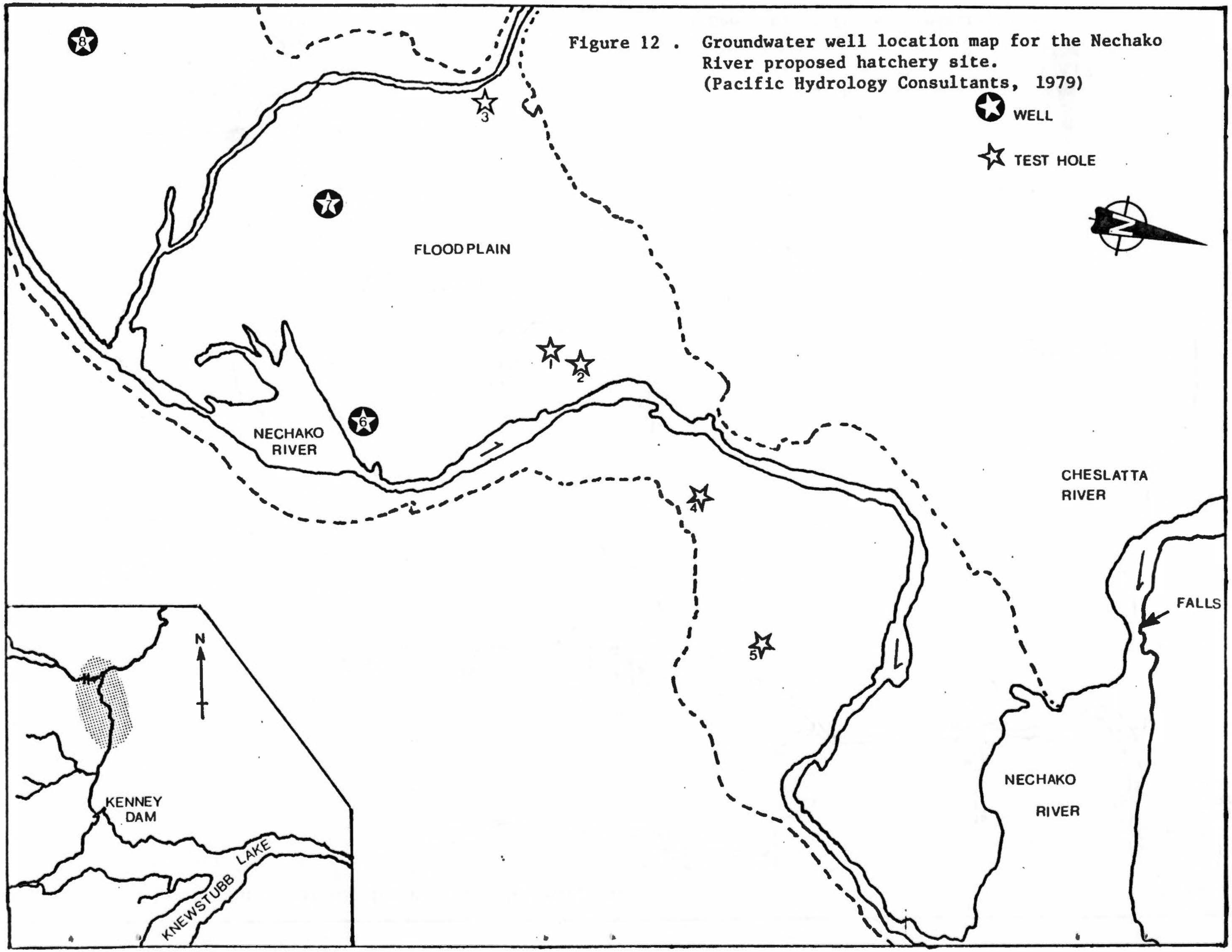


Table 5. Water Quality for the Proposed Hatchery Site on Nechako Flood Plain.

WATER QUALITY PARAMETER(mg/1)*	WELL #1 (DEC)+	WELL #6 (MAR)++	WELL #7 (MAR)++	WELL #8 (MAR)++
pH	7.6	7.8	8.0	7.9
Residue	225	230	169	188
N.F.Residue	39.2	3	1	0
S.Cond. (microhms/cm.)	265	364	251	284
D.Oxygen		0	0	0
D.Gases(N_2+Ar) (% saturation)		116	136	125
Chloride	4.9			
Turbidity	15			
T.Alkalinity	156	174	112	136
Hardness		152	95	112
Colour	15	clear	clear	clear
Nitrite + Nitrate	0.002	0.01	0.01	0.01
NH_3(μg/1)		0.44	2.3	3.0
T.Phosphate	0.17	0.016	0.067	0.062
Sulphate	4.90	17.4	15.5	12.3
Silica		11.5	13.3	13.2
Aluminium		0.09	0.09	0.09
Calcium	23.0	43.3	26.2	32.2
Copper	0.002	0.001	0.001	0.001
Iron	0.89	0.113	0.025	0.059
Manganese	0.19	0.15	0.19	0.34
Lead	0.001	0.001	0.001	0.001
Zinc	0.017			
Temperature			8.5-9.5	

* unless otherwise defined
——— mean value exceeds R.F.C.L.
– – – range extremities exceed R.F.C.L.
\+ Pacific Hydrology Consultants Ltd., 1979.
++ Laboratory Services (EPS-FMS) Chemistry, 1979.

WATERSHED TEMPERATURES

Nechako River

Water temperatures were recorded at three stations on the Nechako River: Ft. Fraser, Vanderhoof, and Isle Pierre (Fig. 13, Appendix 3a,b,c). All three sites showed a great range of temperatures (0-22°C)(Table 6), with the warmest temperatures occuring in the month of July. Winter temperatures tend to hover around 0°C from late December to early April, with Isle Pierre averaging the warmest at about 0.5°C, (Water Survey Canada (W.S.C.) 1977). By December 18 (1979), the upstream areas of the Nechako (ie. upstream of Cutoff Creek and near Burt Irvine's Lodge) were almost entirely frozen, with only small patches of open water apparent. In all areas surveyed at that time, the substrate was always covered by flowing water. It is probable that these areas freeze and thaw a number of times throughout the winter (K. Johansen, 1980). The effect that this freezing has had on incubating eggs is, as of yet, undetermined. The average monthly temperature is within R.F.C.L. (2-18°C) from mid-April to mid-December.

Nautley River

The Nautley River has the same general temperature regime as the Nechako proper at the Ft. Fraser site (Appendix 3d). This river takes slighty longer to warm up and, therefore, reaches its peak maximum temperature of about 22°C in late August. Winter temperatures range between 0-1.5°C, and, in all probability, the river freezes intermittently in those months. Water temperatures fall within the R.F.C.L. from early April to late November (W.S.C., 1977).

Chilako River

The Chilako River feeds the Nechako near Prince George, and although the data is sparse (Appendix 3c), it appears as if the temperature range is from 0°C in the winter to about 20°C in late July. From November to March, water temperatures probably hover between 0-0.5°C, with parts of the river freezing during the coldest periods. Temperatures fall within R.F.C.L. from mid-April to late October (W.S.C., 1977).

Figure 13 . Nechako River Water Temperature Sites (X). (Water Survey Canada, 1977).

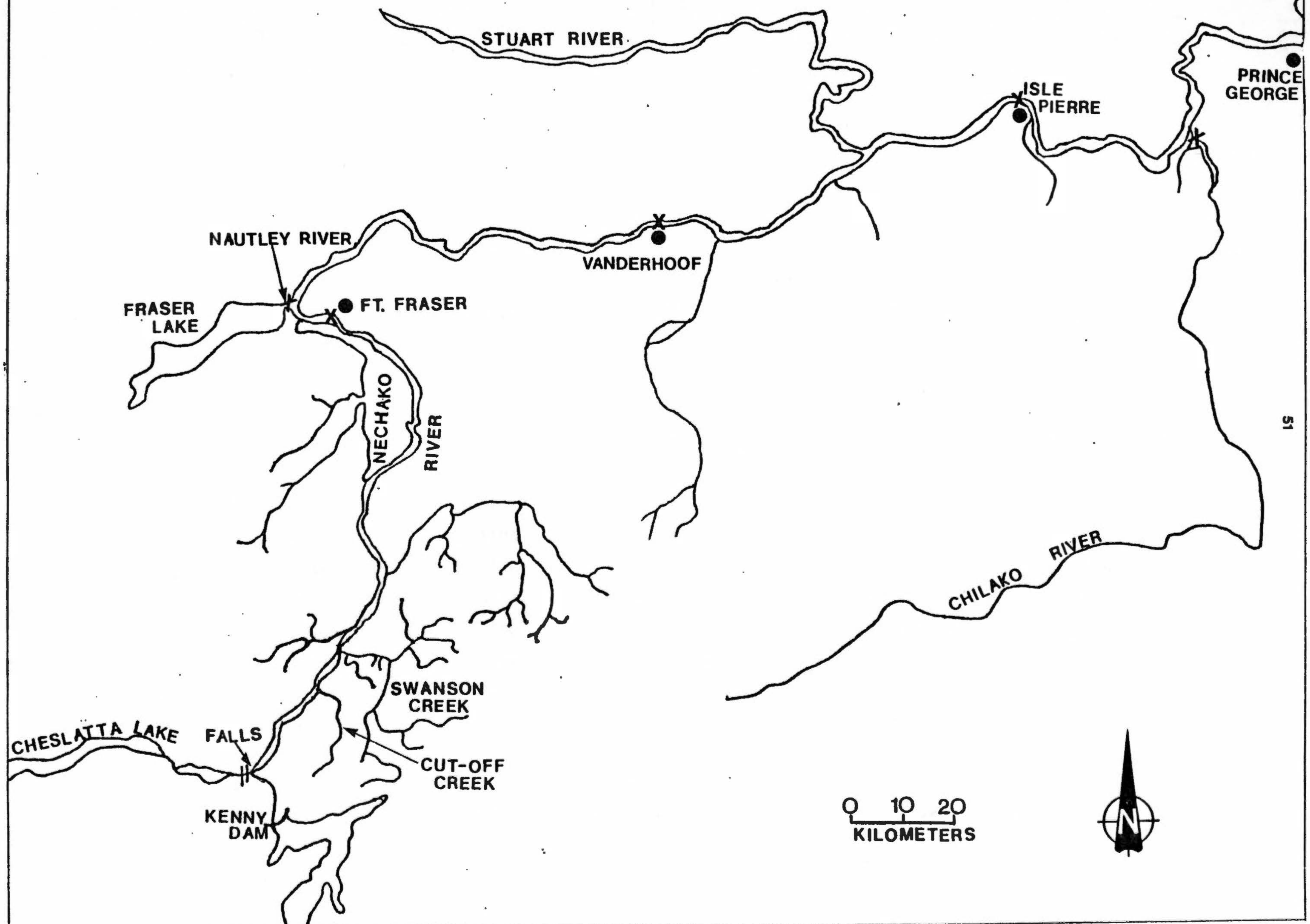


Table 6 . Average Monthly Water Temperatures(°C) (Taken from Water Survey Canada, 1977)

Month	STATION Ft. Fraser (Nechako R.)	Vanderhoof (Nechako R.)	Isle-Pierre (Nechako R.)	Nautley River (into Nechako)	Chilako River (into Nechako)
JAN.	0.75	0.18	0.35	0.70	0.00
FEB.	0.00	0.20	0.47	0.55	0.13
MAR.	0.00	0.17	0.36	1.00	0.00
APR.	2.75	2.79	3.75	4.36	4.38
MAY	8.75	7.67	9.03	9.11	6.19
JUN.	14.50	13.92	12.56	13.29	12.50
JUL.	18.41	17.35	18.55	17.00	15.50
AUG.	16.63	16.56	16.89	15.64	17.50
SEP.	11.88	13.13	13.17	11.75	8.56
OCT.		8.44	6.67	7.59	4.33
NOV.	3.75	2.42	2.57	2.67	0.33
DEC.	1.50	0.19	0.10	0.70	0.00

SEDIMENT LOADS

There is no sediment load data, as such, available for the Nechako River system. However, colour and turbidity may provide a relative index for sediment loads and show how they change through the year.

Colour is a variable index for two reasons. Firstly, it follows the turbidity profile for much of the data. Secondly, it is not due to organic acids as the fluctuations in pH, and consequently, acid content of the river water, are small and correspond to changes in total alkalinity (NAQUADAT, 1979).

Annual profiles for turbidity and colour approximate the yearly changes in streamflow in the Nechako. One might then assume that the changes in these two parameters, at least from January to August, may be the result of changes in flow. These changes cause fluctuations both in the amount of sediment entering the flow(due to erosion) and in the amount of sediment suspended in the flow(due to increased water velocity). The same peaks in turbidity and colour, however, might also be attributed to algal blooms in the lakes during the late spring. The causative factors cannot be easily deduced as the fractions of organic and inorganic sediments are not known.

Peaks in turbidity and colour from October to December may or may not reflect changes in sediment load, as they may be a result of a combination of many other factors.

Both colour and turbidity peak in the month of May and then again in late November(NAQUADAT, 1979).

PAST BIOPHYSICAL STUDIES

Report: Salmon Studies Associated with the Potential Kemano II Hydo-electric Development (1979). Fisheries and Marine Service and International Pacific Salmon Fisheries Commission.

The Habitat Protection Division of DFO is currently involved in extensive studies of the potential effects of the Kemano II Power Project on the Nechako, Morice, and Dean Rivers. The report covers the flow and water quality requirements for the preservation of these rivers' salmon stocks. It also examines downstream effects and socio-economic impacts.

With regards to the Nechako watershed, the report concludes:

1) Transportation Requirements: Minimum of $28.3 m^3/s$
2) Spawning Requirements (spawning area $\propto$ flow): $25.4 - 42.0 m^3/s$ from September 1 to October 15.
3) Incubation Requirements: At least as high as flows during spawning until spring break-up.
4) Rearing Requirements: never less than $28.3 m^3/s$ (additional interaction/ecosystem studies required).
5) Flushing Requirements: flows high enough to ensure flushing of gravel prior to spawning are needed.
6) Temperature Control Requirements: A volume of water (released at about $7.3^\circ C$) sufficient to maintain river water temperatures below $20^\circ C$ is imperative, provided that the discharge does not exceed the maximum limit of $127 m^3/s$.
7) Supersaturation: With $127 m^3/s$ flow of $7.2^\circ C$ water, problems with oxygen and nitrogen concentrations could be encountered. The approximately 115% of saturation of O_2 and N_2 concentrations encountered with this flow may not cause rapid mortality, but would be sufficiently high to produce stress and/or impairment of some physiological processes, or lead to increased susceptibility to disease. Resident fish (as well as migrating salmon) would be affected. Further studies are needed.
8) It is estimated that the Kemano I and II effects on smolt survival would reduce the commercial sockeye catch by approximately 9.6%.

SPECIES COMPOSITION AND PREDATORS

During their investigations in 1979, E.V.S. Consultants Ltd. characterized the upper Nechako, from Kenney Dam to Greer Creek, as a broad, slow moving water course flowing over a sand/gravel/cobble substrate. Of the several different species determined in the study's sampling, four were salmonids, and the nine others were fish typical of this type of water course. The species composition is summarized in table 7.

According to the F381 Biological observations (Appendix 4f) the main predators of the Nechako salmon are eagles and bears. Other predators include small mammals (such as otter, mink, and marten etc.) which may prey upon other species of fish encountered in the study.

Table 7. Species Composition of Fishes in the Nechako Watershed. Adapted from E.V.S. Consultants Ltd., 1980(a).

COMMON NAME	SCIENTIFIC NAME
mountain whitefish	*Prosopium williamsoni* (Girard)
chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)
sockeye salmon	*Oncorhynchus nerka* (Walbaum)
rainbow trout	*Salmo gairdneri* (Richardson)
Dolly Varden char	*Salvelinus malma* (Walbaum)
leopard dace	*Rhinichthys falcatus* (Eigenmann and Eigenmann)
peamouth	*Mylocheilus caurinus* (Richardson)
redside shiner	*Richardsonius balteatus* (Richardson)
brassy minnow	*Hybognathus hankinsoni* (hubbs)
northern squawfish	*Ptychocheilus oregonensis* (Richardson)
longnose sucker	*Catostomus catostomus* (Forster)
white sucker	*Catostomus commersoni* (Lacépède)
slimy sculpin	*Cottus cognatus* (Richardson)

GENERAL WATERSHED RECONNAISSANCE

The general Nechako River Watershed reconnaissance is primarily based on bio-engineering surveys conducted by R.M.J. Ginetz and G.O. Nielsen. The area surveyed in the Nechako River system can be seen in figure 14.

In order to identify particular river systems and specific sites for salmonid enhancement opportunities. They conducted several aerial and ground bio-engineering reconnaissance surveys during different times of the years. Observations were recorded during autumn spawning, winter and floods, so that seasonal conditions could be accurately assessed.

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

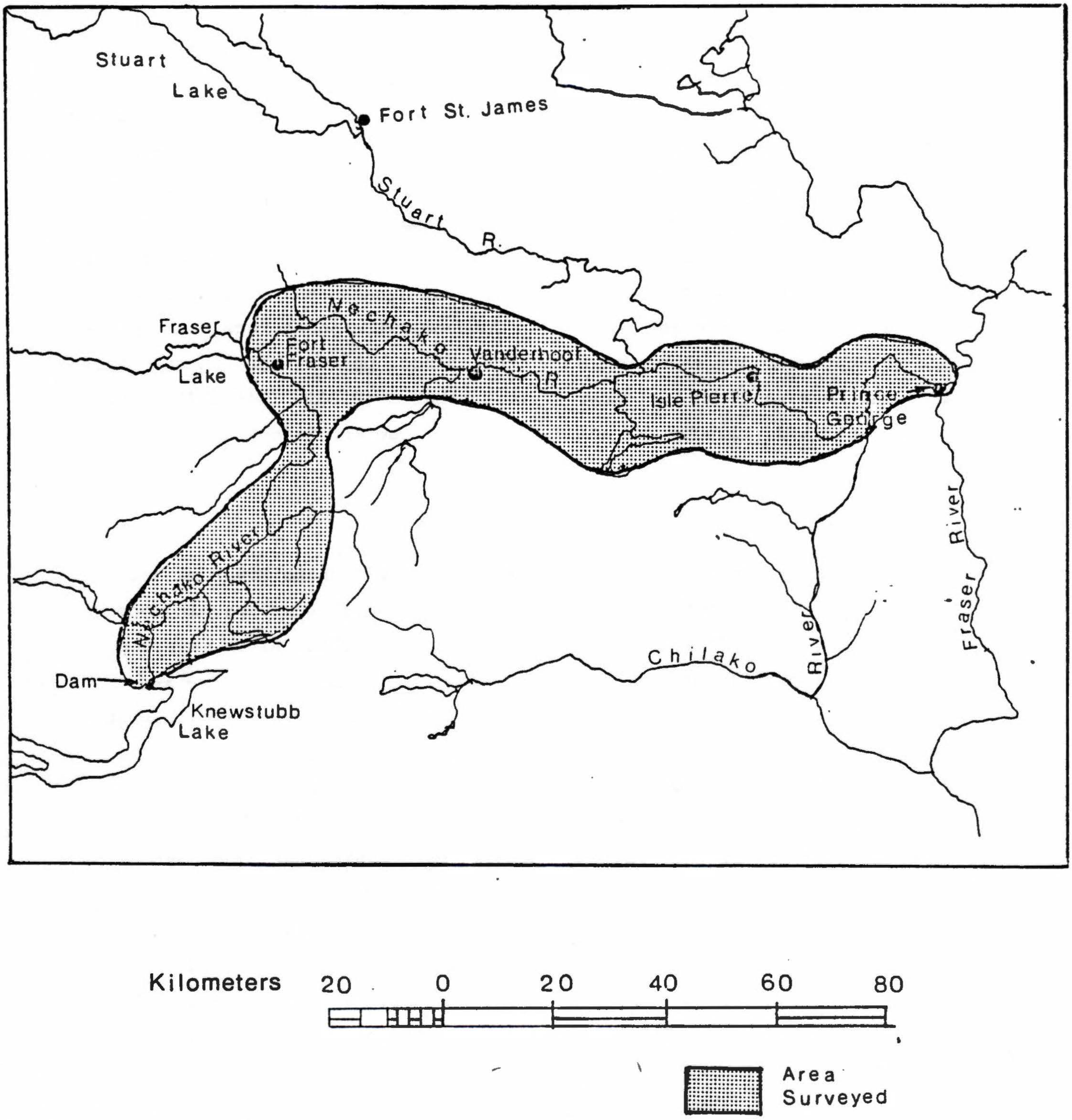
Ginetz and Nielsen (1979b, 1980) located a potential chinook salmon hatchery site in the former bed of the Nechako River immediately upstream of Cheslatta Falls and approximately 6.4km downstream of Kenney Dam. Several reasons deemed this site to be excellent for the construction of a salmon hatchery. To begin with, the deposition of sand and gravel resulting from the diversion of the Cheslatta River would provide good foundation conditions for the proposed structures. A recent groundwater exploration program has confirmed that an excellent groundwater source of good quality is available at the site. The groundwater temperature was reported to be between 8.5^{o}C and 9.5^{o}C. Pump-testing revealed that recharge to the aquifer is good and should yield 1500-1700 USgpm.

Ginetz and Nielsen (1979) also report an excellent surface water supply from the Cheslatta River. Because the available gross head is approximately 43m, a power generating facility could be installed at the site, thereby reducing operational costs of the proposed facility. They also presume that, because the water discharges out of Murray and Cheslatta Lakes, the water would be of good quality and the need for settling basins could be eliminated.

All of the spawning occurs several miles downstream from the production site of the proposed facility. Although this may prove to be inconvenient with respect to adult collection, ideal water supplies, land availability and access were the most important considerations in site selection. On the basis of their surveys, Ginetz and Nielsen suggested that the most appropriate method of obtaining eggs would be to capture the adults, strip them on the spawning grounds and then transport the eggs and sperm to the hatchery site. The availability of donor chinook stocks has also been addressed in the same memo. Details on the various bio-baseline studies can be referred to in the appropriate sections of this review.

Although the site selection was primarily based on the above criteria, it is significant to note that Alcan's water licence, with their authority to completely control streamflows would be an unfavourable situation if they decided to maintain the flow at a level below spawning and rearing requirements.

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



SALMON RESOURCE

NECHAKO RIVER ESCAPEMENT AND SPAWNING

Timing

The Nechako watershed supports sockeye and chinook salmon. The sockeye salmon escapement timing to the Nechako River tributaries is summarized in(Appendix 4c). The early and late Nadina River sockeye approximate peak spawning period has been from August 21 to September 7 and from September 10 to September 28 respectively, (Appendix 4d). The Stellako River run has had a period of peak spawning from September 23 to October 5. The average timing of chinook spawners in the Nechako mainstream ranges from mid-August to the second week in October, with an average peak spawning on September 20, (Appendix 4a). The chinook peak die-off in the years 1978 and 1979 was from September 24 to October 3 (F 381. 1948-1979; E.V.S. Consultants Ltd., 1980b, FMS and IPSFC, 1979; Fee and Sheng, 1978)

Distribution

The distribution of chinook spawners in the Nechako River mainstem extends from Vanderhoof to Cheslatta Falls. Although some spawning occurs in the Nautley and Stuart tributary systems, the Nechako River mainstem has the most heavily utilized spawning areas. The major spawning and holding areas are in the upper reaches of the Nechako River as illustrated in figures 17 and 18. A small percentage of the spawning occurs in the lower portion of the river between Fort Fraser and Vanderhoof as seen in figure 19. From the helicopter surveys in 1978, Fee and Sheng (1978) reported that 81% of the spawning occurred in a 5.8km area from just below Bert Irvine's Lodge. In 1979, the Nechako spawners were also enumerated by helicopter by Envirocon Ltd. (1980a) who estimated that 86% of the spawning occurred upstream of Greer Creek with 56% of these found in the principal spawning area near Bert Irvine's Lodge. The spawning distibution, as reported by E.V.S. Consultants Ltd. (1980b) who monitored the river during the summer and fall of 1979, was said to be consistent with previous studies. They reported that the area of intense spawning activity

(50% of the total reproduction) was in the 7-8km stretch in the vicinity of Irvine's Lodge. Redd superimposition was also evident in this heavily utilized area of the Nechako River. The pre-spawning chinook were holding in deep pools located from 2-15km upstream and downstream of the spawning sites.

Abundance

The total annual sockeye escapement to the Nechako River tributaries, the Nadina and the Stellako Rivers, ranges from 2,600 to 193,000 with average of 25,200 from 1938 to 1978. The Stellako River is the most heavily utilized system (Volume 1. FMS and IPSFC, 1979 and IPSFC 1976-1978). The Stellako run as well as the early and late Nadina runs are listed on a yearly basis in (Appendix 4c). The Stuart River, also a tributary to the Nechako River, produces a significant number of sockeye as well. However, the Stuart River watershed will be dealt with on an individual basis elsewhere.

The estimated annual average of chinook spawners (Appendix 4b) in the Nechako mainstem has been 1000 adults from 1949 to 1979 (F 381). These escapement values were determined by visual surveys only. Prior to the construction of Kenney Dam and resultant diversion of the Nechako stream flow, the annual average escapements from 1948 to 1952 was 3000. The number of chinook spawners have averaged about 700 adults per year from 1953 to 1979. The most significant decline in escapement was seen in the fall of 1953 (Appendix 4f). Since that time, with the release of storage water from Skins Lake Dam, the chinook escapement has shown a gradual upward trend. In 1978 and 1979, the annual escapements to the Nechako River have been 2600 and 1800 spawners respectively (F 381). Other enumeration studies by helicopter reported 1,767 spawners in 1979 (Envirocon Ltd., 1980a) and 1350 spawners on September 20, 1979 (E.V.S.. 1980b). The enumerative data collected by helicopter on September 12 and 20, 1978 (Fee and Sheng, 1978) shows a mean escapement of 1,834 spawners for that time period. From these recent enumeration surveys for 1978 and 1979, the overall average chinook escapement was 2200 and 1600 respectively.

The distribution and abundance of spawning chinook and sockeye salmon can be seen in figures 18 and 19.

Table 8. Summary of F381 Information on Timing of Nechako River Spawners (1948 - 1979)

SPECIES	PERIOD	START		PEAK	END	
		earliest	latest	average	average	latest
CHINOOK	1948-1979	mid-Aug	4th wk Aug	Sept	1st wk Oct	2nd wk Oct
SOCKEYE	1954	1st wk Sept	1st wk Sept	3rd wk Sept	4th wk Sept	4th wk Sept

Table 9. Approximate Timing of Chinook Spawning and Die-off, Nechako River (E.V.S. Consultants Ltd, 1980)

SPECIES	PERIOD	START	PEAK	END
CHINOOK (SPAWNING)	1979	September 12	September 20	October 1
CHINOOK (DIE-OFF)	1979	September 5 ?	October 4	October 15

Table 10. Timing of Adult Sockeye Migrations (FMS and IPSFC, 1979)

NECHAKO RIVER LOCATION	NADINA RUN				STELLAKO RUN	
	EARLY RUN		LATE RUN			
	Earliest Date	Latest Date	Earliest Date	Latest Date	Earliest Date	Latest Date
PRINCE GEORGE	July 18	Aug. 14	July 25	Aug. 21	Aug. 12	Sept. 29
STUART	July 20	Aug. 16	July 27	Aug. 23	Aug. 15	Oct. 2
NAUTLEY	July 22	Aug. 18	July 29	Aug. 25	Aug. 18	Oct. 5

Figure 15. Approximate timing of spawning and die-off for the Nechako River and Tributaries (Compiled from F381; E.V.S. Consultants, 1980b; and FMS and IPSFC, 1979)

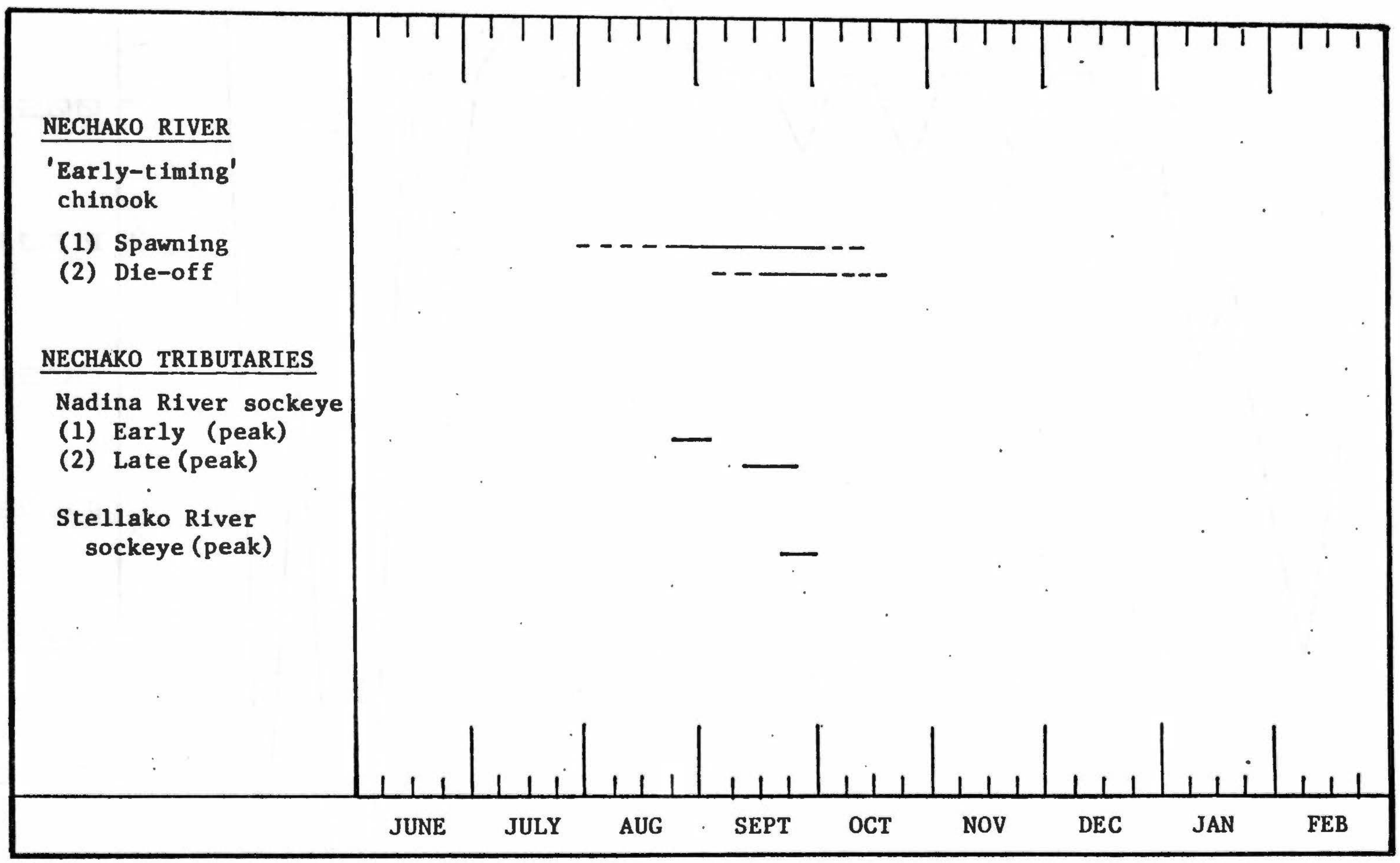


Figure 16. NECHAKO RIVER, AREA PG (1948-1979) ESTIMATED ESCAPEMENT OF CHINOOK SALMON (F381, 1948 to 1979).

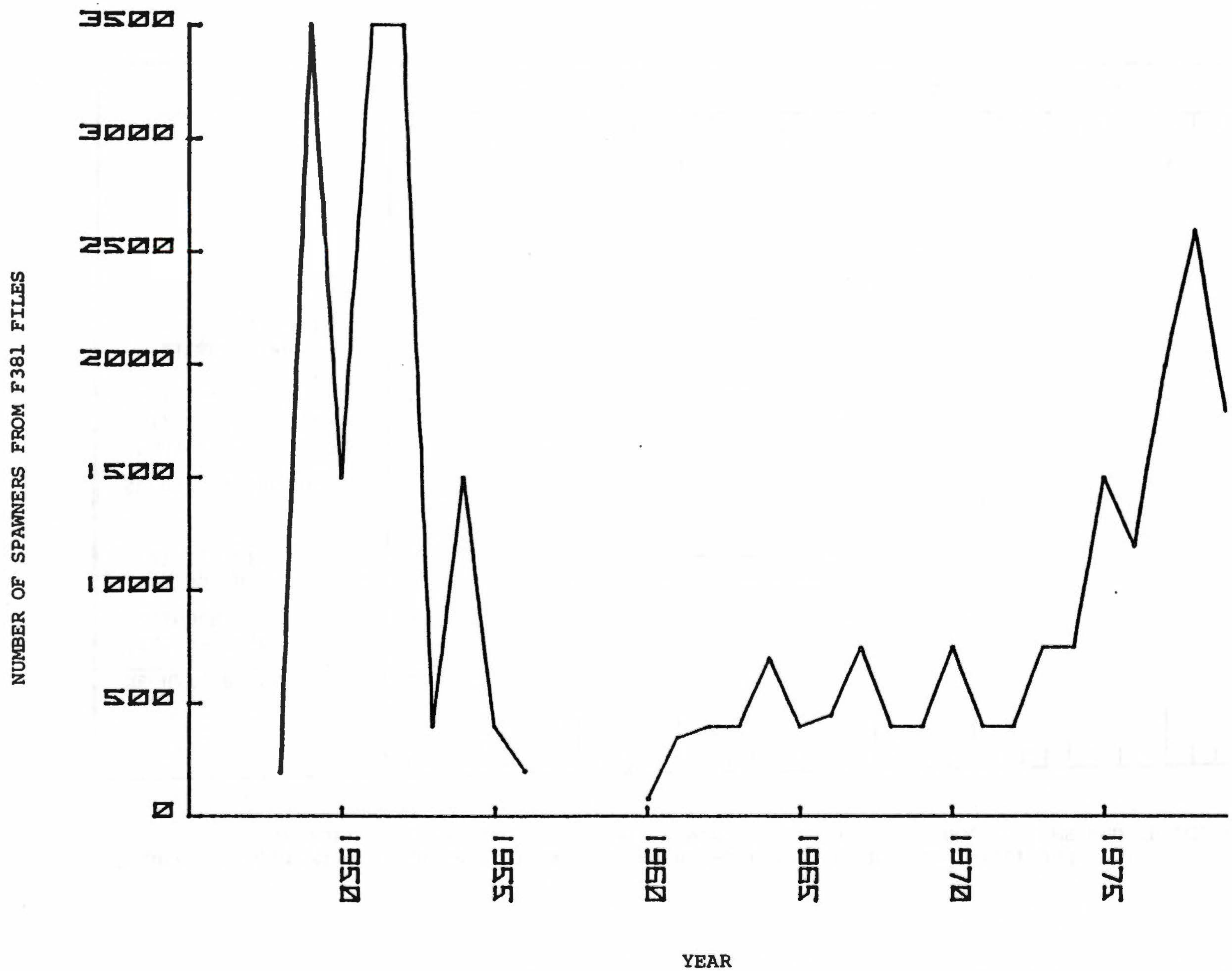


Figure 17. Distribution of Chinook Spawning Sites (as per F381; Fee and Sheng, 1978; and E.V.S. Consultants Ltd., 1980b)

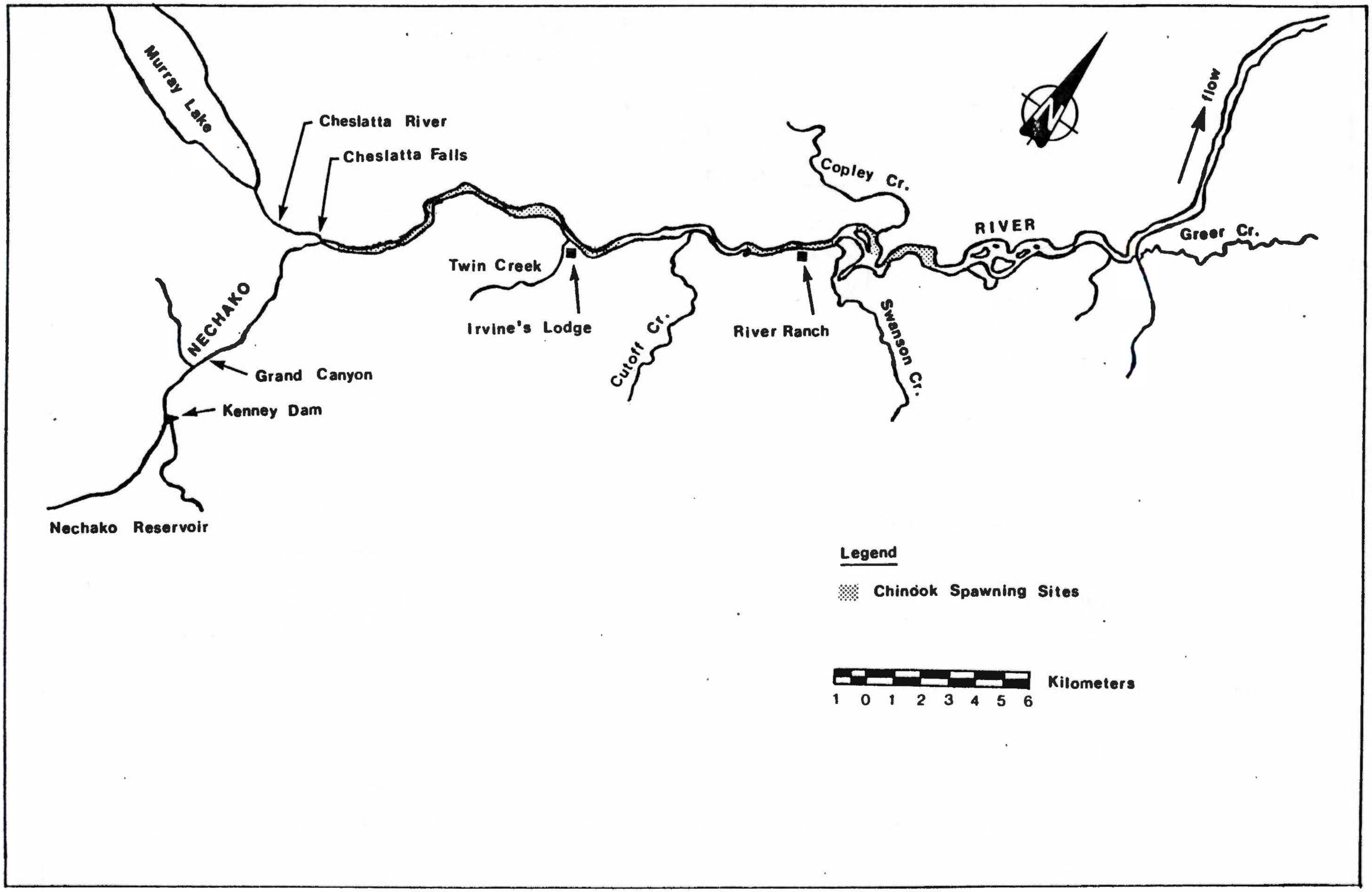


Figure 18. Distribution of spawning chinook and sockeye salmon, Nechako River, Fall 1979. (E.V.S. Consultants Ltd., 1980b)

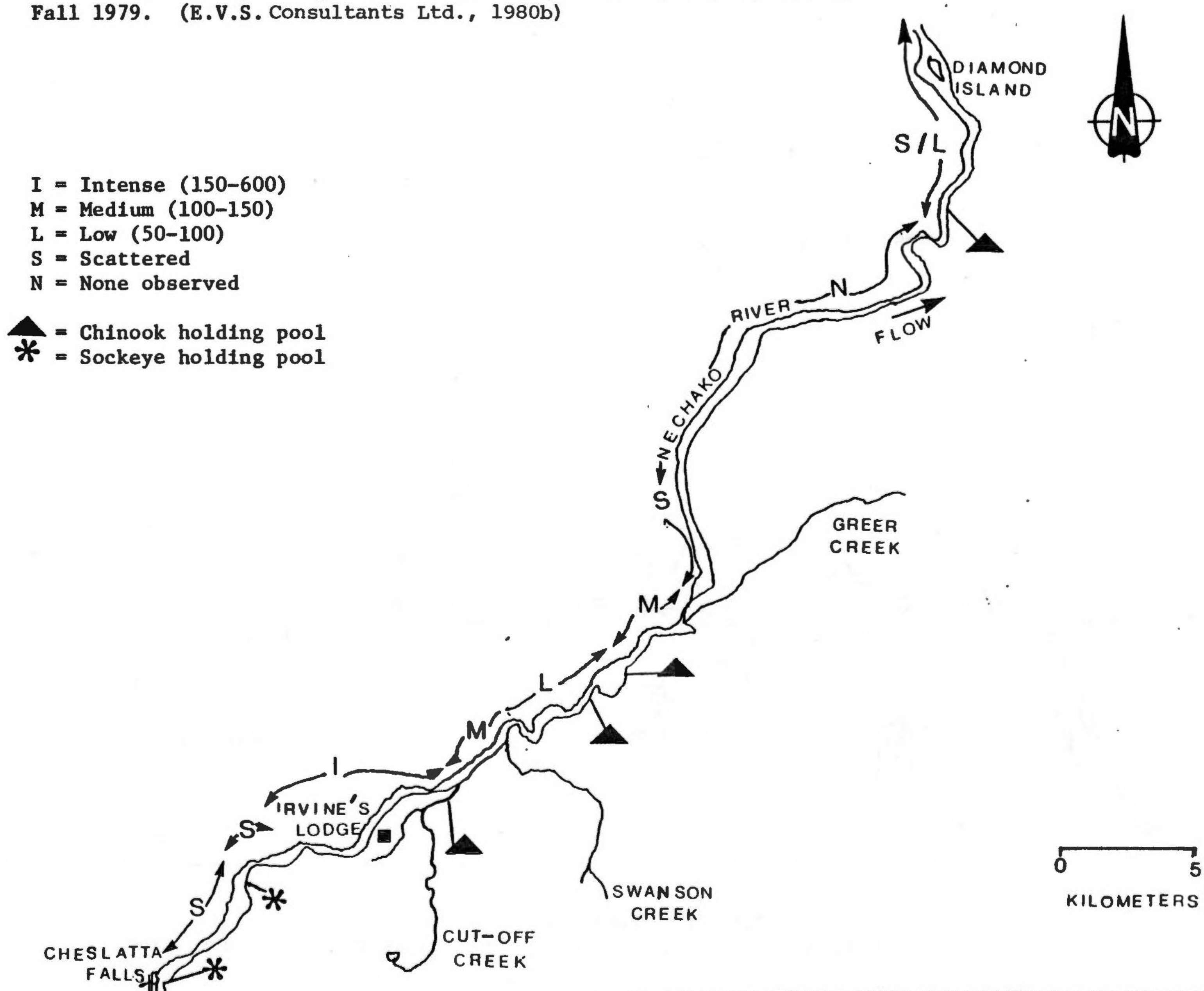
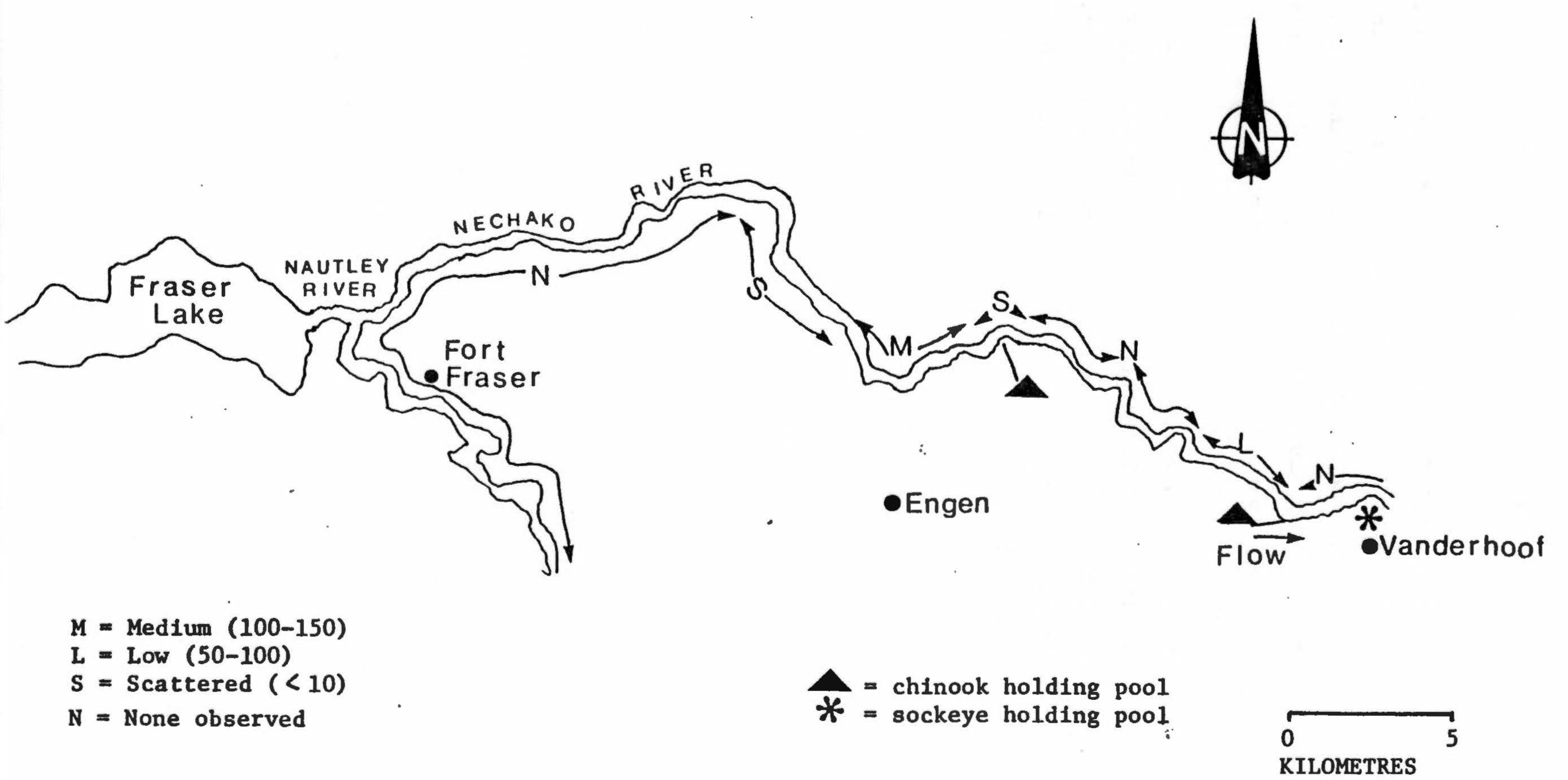


Figure 19. Distribution of spawning chinook and sockeye salmon, Nechako River, fall 1979. (E.V.S. Consultants Ltd., 1980b)

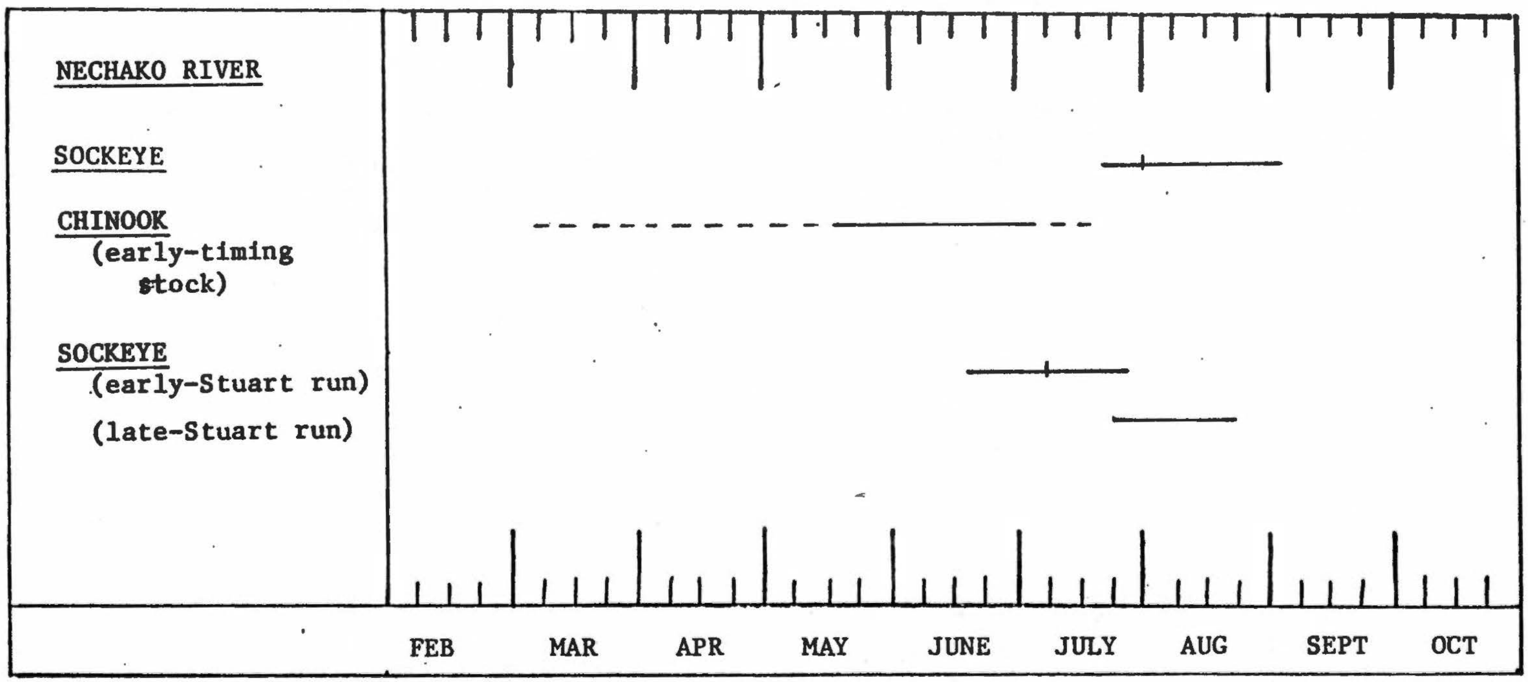


MIGRATION TIMING OF SALMONIDS

The relationship of migration timing of Nechako River salmon species through the Lower Fraser River fishery is summarized in figure 20. The Nechako River chinook escapements are an early timing stock that migrate through the Lower Fraser River fishery (Area 29), from early March through to the middle of July (pers. comm. R. Harrison).

The Nechako-bound sockeye have an approximate migration timing through Area 29 from July 18 through to the first week in September. The tributary stocks, the Early and Late Stuart runs of sockeye, are present in the Lower Fraser fishery from about June 15 to July 26 and July 21 to August 20 respectively.

Figure 20. Approximate Migration Timing of Salmonids Through the Lower Fraser River Commercial Fishery. (from R. Harrison, 1980)



ANNUAL CATCH

Sport Catch

The Nechako River is closed to sport fishing for salmon. Those salmon produced by the Nechako River are caught by sport fishermen in the Fraser River and Georgia Strait.

Indian Food Catch

The Indian food fishery for all of the Nechako River reserves is represented by an average annual catch of 6700 sockeye and 10 chinook for the period 1970-1979 (Table 11). The majority of the Nechako stocks are heavily fished while migrating through the native fisheries in the Fraser mainstem upstream from Mission. The Indian food fishery catch of sockeye produced from the Nechako River tributaries can be seen in (Appendix 5a). The average annual native sockeye catch in the Fraser River from Nechako stocks, has been 36,000(FMS and IPSFC, 1979).

Commercial Catch

The Nechako River does not have a commercial fishery. The Nechako bound salmon that are commercially caught in the Fraser fishery, are included in the Fraser River annual catch (Table 11). Annual commercial catch of sockeye produced from the Nechako tributaries have had an annual average of 800,000 in the period from 1952 to 1972 (Table 12, Appendix 5b) The estimated average annual commercial catch of Nechako-bound chinooks for the years 1965 to 1974 has been 4,300 adults (FMS and IPSFC).

Table 11. Annual Catch for Fraser River (GWG, 1980 MS)

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

NECHAKO RIVER There is no sport fishing or commercial harvest of salmon on the Nechako River.

Table 12. Indian Catch of Sockeye and Chinook for the Nechako and Stuart River Reserves (pers, comm. L. Ottman, DFO, 1974-1978)

Year	Nechako Reserves Total Native Catch		Stuart Reserves Total Native Catch	
	Sockeye	Chinook	Sockeye	Chinook
1970	4,123	5	2,952	29
1971	6,696	10	6,336	15
1972	4,142	6	1,175	10
1973	4,880	8	15,122	9
1974	4,328	6	3,908	10
1975	6,303	15	6,471	15
1976	5,702	17	2,231	6
1977	5,698	7	10,284	5
1978	6,248	11	7,012	13
1979	19,294	19	16,102	11

BIOLOGOICAL SURVEYS

INTRODUCTION

The summary of existing biological data was compiled from studies conducted by E.V.S. Consultants Ltd., 1980a,b; Envirocon Ltd., 1980a,b. Department of Fisheries and Marine Service, 1979; International Pacific Salmon Fisheries Commission 1979; FMS and IPSFC, 1979; Fee and Sheng, 1978; and Tutty and Yole, 1978.

JUVENILE

Fry Energence Timing and Growth

Although the exact hatching times for chinook salmon have not been recorded for the Nechako River, the eggs have probably hatched by the end of January (Volume 3, Fisheries and Marine Service, 1979). In 1979, the peak chinook emergence timing was observed to be from May 17 to 22 and completed by the end of May (E.V.S. Consultants Ltd., 1980a). The mean fork length of these chinook fry during the period of emergence in May was 37.9mm and 68.2mm in August, 1979. The mean weight of the same sample in May, June and July, 1979 was .84g, .70g and 1.81g respectively; no value was obtained for August (E.V.S. Consultants Ltd., 1980a). The Nechako fry in-stream growth rate (expressed as % length increase/day) determined for the 107-day period from May 5 to August 19, 1979 was .633 (E.V.S. Consultants Ltd., 1980a).

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

The chinook fry reconnaissance from May to mid-August, 1979, conducted by E.V.S. Consultants Ltd., showed the emergent fry to be found throughout the Upper Nechako mainstem, primarily in the 9km reach from Bert Irvine's Lodge to Greek Creek as well as certain backwaters and tributaries located along the watercourse in May, 1979. The distribution are relative abundance of rearing chinook fry as reported by E.V.S. (1980a, Appendix 6) can be seen in Figure 22. The number of fry in these rearing areas declined in June and July and with total absence of fry in August. This 90-day rearing behavior observed by E.V.S. Consultants Ltd., was similar to that reported by Envirocon Ltd. (1980a). After June 1, 1979, the chinook fry were reported to have either moved downstream or ascended to selected rearing tributaries (primarily the Swanson, Camp and Twin Creeks) as evidenced from seine and MT effort (E.V.S. Consultants Ltd., 1980a). In addition, it is significant to note that scale interpretations from the Nechako escapements indicate a major portion of the adult returns had spent their first year in fresh water and then smolted in their second spring(Tutty and Yole, 1978).

In May 1977, smolting chinook juveniles were captured in the Upper Nechako River. Tutty and Yole(1978) demonstrated that 16 smolts trapped during May 12 to 14, 1977 had overwintered in the headwater stream, as evidenced by a distinct freshwater annulus as well as a mean fork length of 102mm. During this fyke net capture, they also report that 234 fry-of-the-year caught from May 12 to June 10, 1977 exhibited a mean fork length of 34.2mm. During their survey in 1979, E.V.S. Consultants Ltd., sampled chinook smolts from the Nechako River mainstem between May 29 and June 7, and found the mean length to be 86mm. Since no other +1 chinook were caught during their investigation, it was suggested that emigration of yearling chinook from the Upper Nechako River took place during this period(E.V.S. Consultants Ltd., 1980a). The scales were shown to have a freshwater annulus, and hence these smolts had spent the winter of 1978 in fresh water (E.V.S. Consultants Ltd., 1980a and DFO Scale Bank, Vancouver, B.C.).

Figure 21 . Post-Emergent Fry Rearing Distribution and Study Areas (Fisheries and Marine Service, 1979).

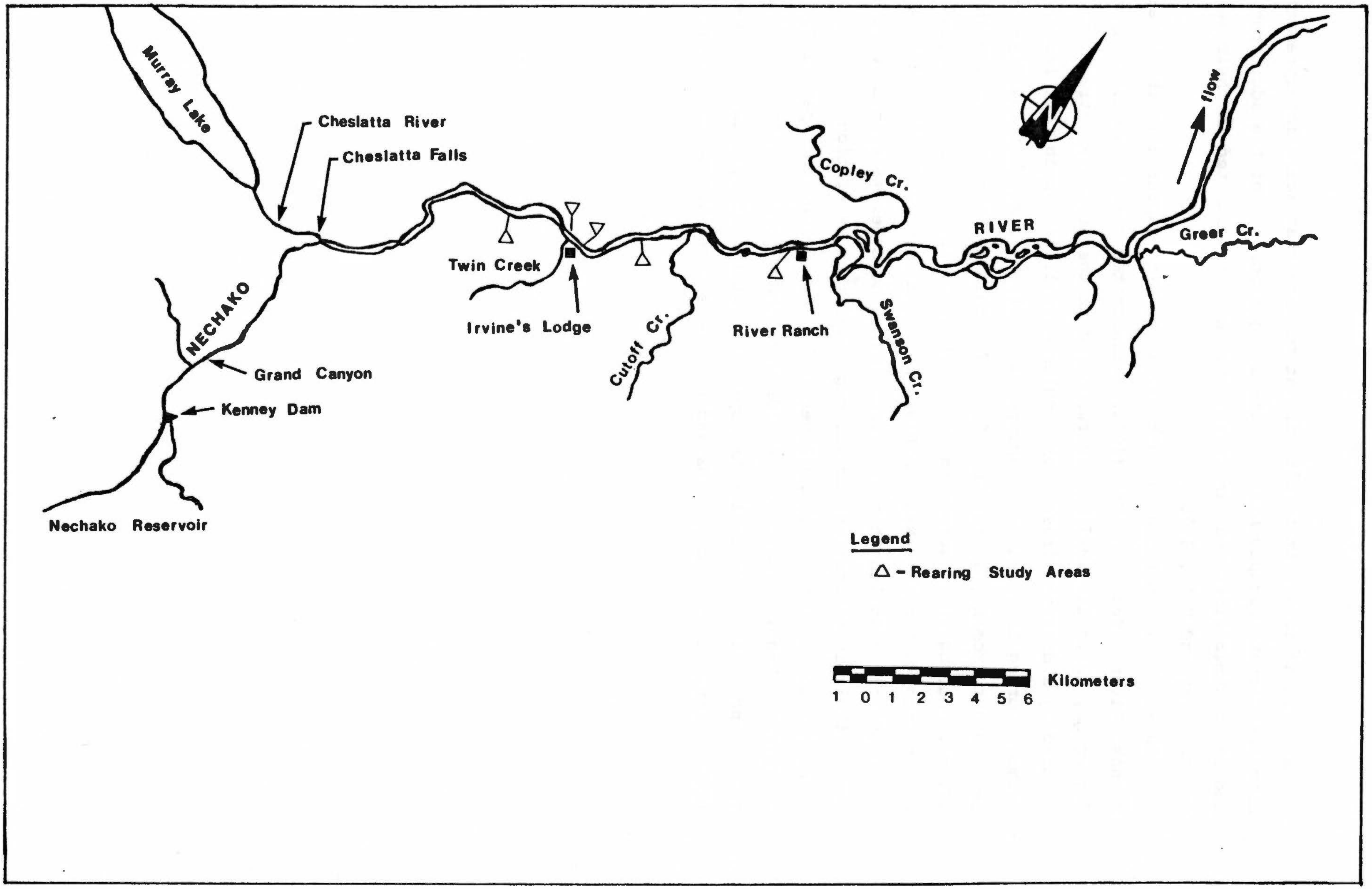
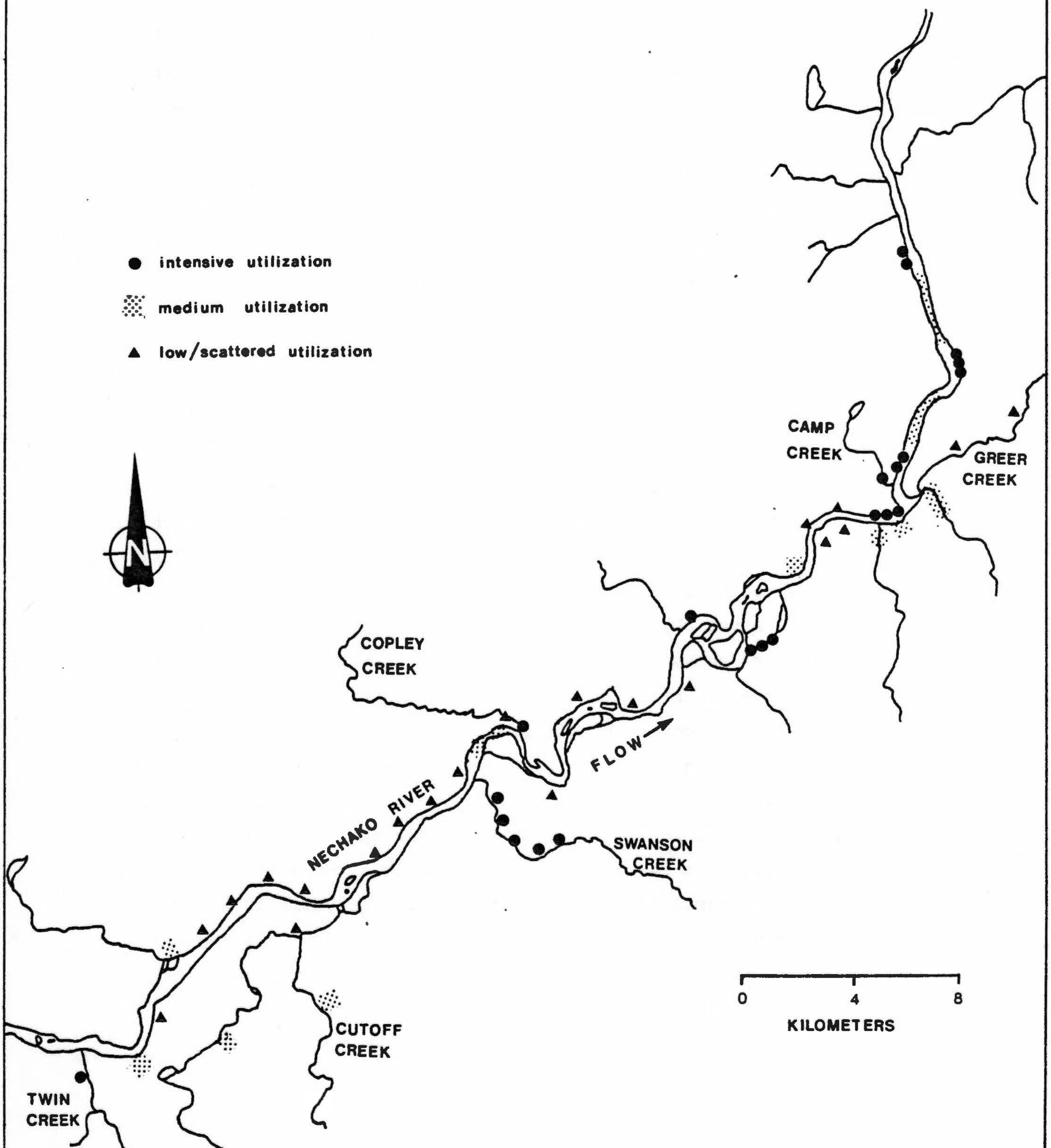


Figure 22. Distribution and Relative Abundance of Rearing Chinook Fry in the Upper Nechako River from Seine and Minnow Trap Catches from May to mid-August, 1979.

(taken from E.V.S. Consultants Ltd., 1980a).



SPAWNER CHARACTERISTICS

Sex Ratio

A summary of percent sex ratios of chinook salmon as per the F381 Spawning Files can be seen in Appendix 4b. From these data, the average sex ratio from 1953 to 1979 was 52% female, with 12% of the males being jacks. A recent survey (E.V.S. Consultants Ltd., 1980a), also reported the same percentage of females, however no jacks were observed in their 1979 investigations of the fall-spawning chinook. The average sockeye salmon sex ratio for the 1966/1970/1974/1978 cycle was 55% female with 6% of the males being jacks (IPSFC Annual Report, 1978).

Age Composition

From the scale data analysis for the years 1974 to 1979, it is apparent that the Nechako River escapements were dominated by four and five year olds, which constituted 51% and 25% of the sample respectively. Three year old fish were also well represented in the escapements (23%). A summary of age composition and freshwater classification of scales from the Nechako River chinook escapements can be seen in (Table 14). The scale data also shows that 67% of the adult fish analyzed were representative of the juveniles that overwintered in the stream, having gone to sea in their second year of life. The remaining 33% had no freshwater annulus and hence had migrated to sea as fry-of-the-year. In 1979, the percentage of three, four and five year olds sampled (Table 13) in the adult female return was 17%, 50% and 22% respectively (E.V.S. Consultants, 1980a). It is significant to note that the age composition of the fish sampled varied from year to year. In the years 1974, 1977, 1978 and 1979, overwintering chinook represented 92%, 72%, 52% and 22% of the population sampled respectively (DFO Sale Bank; Tutty and Yole, 1978; E.V.S. Consultants Ltd., 1980a)

Lengths

The sex specific fork and postorbital-hypural lengths for the chinook salmon in the 1979 escapement as determined by E.V.S. Consultants Ltd., (1980) from both angling and carcass recovery has been summarized in Table 15. No jacks were sampled and overall male chinook were found to be slightly larger than female, having fork lengths ranging from 665-1110mm and 730-935mm respectively. The average fork length of the males was reported to be 61mm larger than that of the females.

Table 13. Age and Sex Composition of Chinook taken by Angling and Carcass Recovery from Sept. 5 to Sept. 25, 1979. (E.V.S. Consultants Ltd., 1979)

AGE	MALES		FEMALES	
	No.	Percent	No.	Percent
3_1	2	22	3	17
4_1	4	44	9	50
4_2	1	11	4	22
5_1	2	22	1	6
5_2	0	0	1	6

Table 14. **Summary of Age Composition and Freshwater Classification of Scales from Nechako River Chinook Escapements.**

(From Fisheries and Marine Service, 1979; DFO Scale Bank, Vancouver, B.C.; and E.V.S. Consultants Ltd., 1980b)

AGE COMPOSITION

YEAR	2_1	2_2	3_1	3_2	4_1	4_2	5_1	5_2	6_1	6_2
1974	--	--	3	24	3	50	--	35	--	--
1975	--	--	--	--	--	--	--	--	--	--
1976	--	--	--	--	--	--	--	1	--	--
1977	--	--	2	2	3	5	--	6	--	--
1978	1	--	32	3	37	42	1	31	--	1
1979	--	--	5	--	13	5	3	1	--	--
TOTALS	1	--	42	29	56	102	4	74	--	1
PERCENT	.3	--	13.7	9.4	18.1	33	1.3	23.9	--	.3

sub-1: **(fry-of-the-year)**
fish of all ages having gone to sea in their first year of life.

sub-2: **(juveniles that overwintered in the stream)**
fish of all ages having gone to sea in their second year of life.

Table 15. Hypural and Fork Lengths (mm) of Chinook Salmon Sampled by Angling and Carcass Recovery in the Nechako River (E.V.S. Consultants Ltd., 1980b).

		Fork Length (mm)		Hypural Length (mm)		HL:FL
Sex	n	Avg.	Range	Avg.	Range	Regression(a)
JACKS	0	--	--	--	--	--
MALES	20	907	665-1110	--	--	--
FEMALES	24	846	730-935	643	563-703	HL=.684FL + 63.9

(a) Regression calculation based on eleven female chinook only. Postorbital-hypural length of remaining 12 Nechako River females predicted using this equation.

Fecundity

The average fecundity for chinook females, based on two unspawned females in good condition, was 5778 in the fall of 1978 (Fee and Sheng, 1978).

The fecundity of the Nechako River chinook, as determined by E.V.S. Consultants Ltd., (1980a) during their bio-reconnaissance survey, was based on three unspawned females collected during their carcass recovery in the fall of 1979. The average fecundity from this subsample was 5,932 eggs/female with a range of 5,284 to 7,200 eggs. The fecundity was positively correlated with the female hypural lengths as shown in figure 23. This relationship was expressed by the regression equation: Fecundity = 20.83HL-7389. Using this equation, the calculated average fecundity was predicted from the mean female hypural length of 643mm. Hence, the adjusted average fecundity for the Nechako River chinook females is 6005 eggs (E.V.S. Consultants Ltd., 1980a).

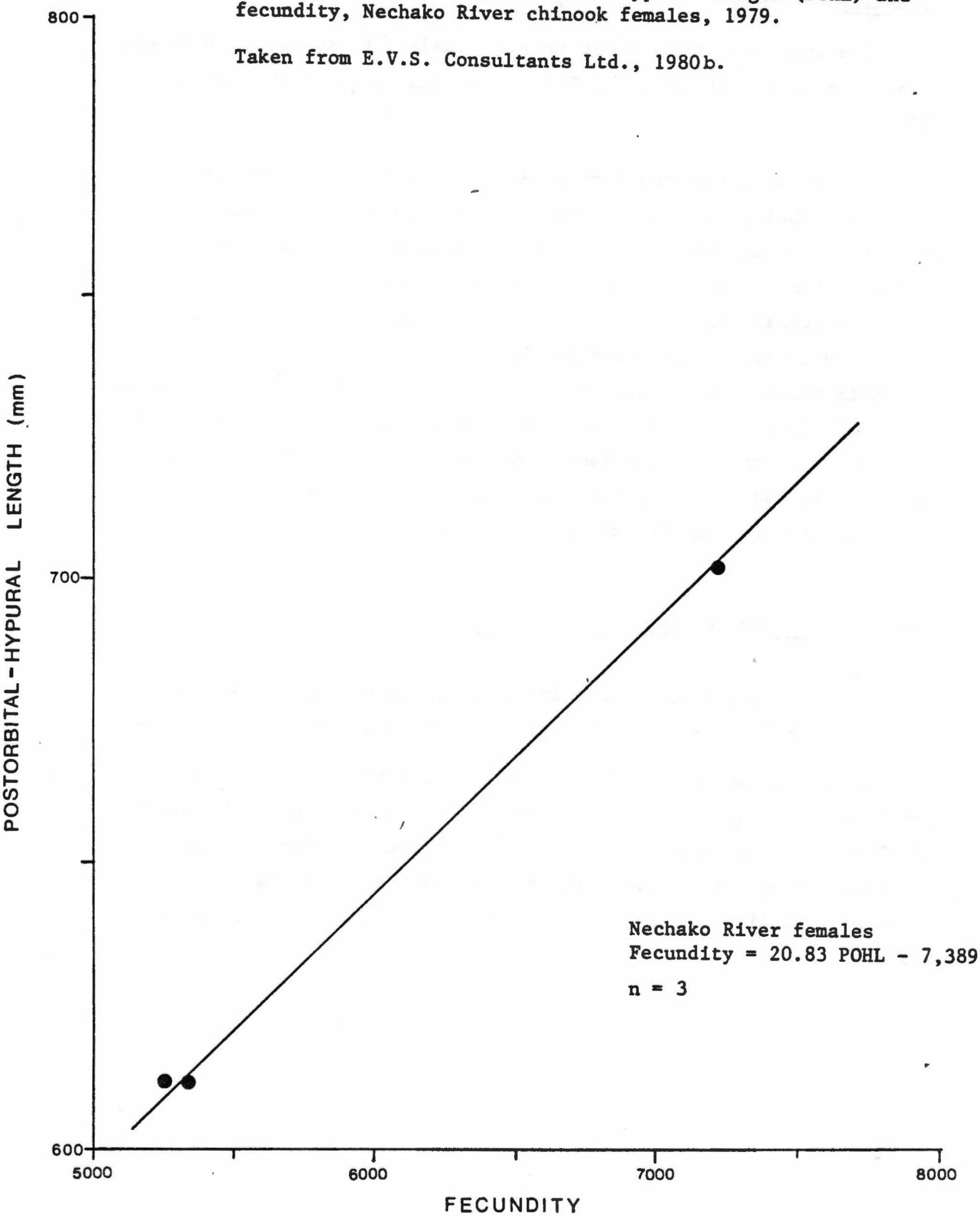
Egg Retention and Pre-spawning Mortality

The spawning success of chinook salmon as reported by Fee and Sheng (1978) was 95.2% (n=83) and 97.1%(n=307) for 1974 and 1978 respectively.

E.V.S. Consultants Ltd., (1980a) found retained eggs in only one female during their bio-reconnaissance of the Nechako River in the fall of 1979. This represented 7.1% of the post-spawning females that they examined for egg retention. From a small sample of 14 fish, the pre-spawning mortality was determined to be 21% (E.V.S. Consultants Ltd., 1980a).

Figure 23. Relationship between postorbital-hypural length (POHL) and fecundity, Nechako River chinook females, 1979.

Taken from E.V.S. Consultants Ltd., 1980b.



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Appendix 1a
TEMPERATURE AND PRECIPITATION 1941 - 1970
BRITISH COLUMBIA

TYPE OF NORMAL CODE

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

Appendix 1b . Means of Temperature and Precipitation for Ootsa Lake Skins Lake Spillway
Latitude 53 46 N, Longitude 125 58 W, Elevation 2825 FT ASL
(from Atmospheric Environment Service 1941-1970)

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	YEAR	NORMAL
Mean Daily Temperature (DEG. F.)	13.5	20.9	26.8	35.8	45.6	52.3	56.6	56.7	50.8	41.3	29.1	20.5	37.5	8
Mean Daily Maximum Temperature	21.9	31.4	37.3	45.5	56.5	62.5	67.3	67.3	61.2	49.3	35.3	27.3	46.9	8
Mean Daily Minimum Temperature	5.0	10.3	16.3	26.1	34.6	42.0	45.8	46.0	40.4	33.3	22.9	13.7	28.0	8
Extreme Maximum Temperature	54	54	59	65	82	88	88	92	82	70	57	52	92	5
No. of Years of Record	14	14	14	14	14	14	14	14	14	14	14	15		
Extreme Minimum Temperature	-42	-30	-30	- 8	21	29	31	33	23	8	-15	-40	-42	5
No. of Years of Record	14	14	14	14	13	14	14	14	14	14	14	15		
No. of Days with Frost	30	28	30	26	11	2	*	0	3	13	25	30	198	5
Mean Rainfall (Inches)	0.22	0.26	0.26	0.70	0.94	1.56	1.73	1.62	1.26	1.00	0.36	0.39	10.30	8
Mean Snowfall	15.5	9.0	7.4	3.5	0.8	0.0	0.0	0.0	0.3	4.8	12.5	15.7	69.5	8
Mean Total Precipitation	1.77	1.16	1.00	1.05	1.02	1.56	1.73	1.62	1.29	1.48	1.61	1.96	17.25	8
Greatest Rainfall in 24 Hours	1.50	0.60	0.50	1.17	0.55	1.16	1.35	1.21	0.80	1.23	0.48	1.61	1.61	5
No. of Years of Record	14	14	13	13	14	14	14	14	14	13	13	14		
Greatest Snowfall in 24 Hours	6.9	11.4	4.6	7.2	3.4	0.0	0.0	0.0	2.7	5.8	9.2	9.0	11.4	5
No. of Years of Record	14	14	13	13	14	14	14	14	14	14	14	14		
Greatest Precipitation in 24 Hrs.	1.50	1.14	0.54	1.17	0.85	1.16	1.35	1.21	0.80	1.23	0.92	2.11	2.11	5
No. of Years of Record	14	14	13	13	14	14	14	14	14	13	13	14		
No. of Days with Measurable Rain	*	1	2	3	7	8	8	10	9	8	3	2	61	5
No. of Days with Measurable Snow	11	6	6	2	1	0	0	0	*	1	7	10	44	5
No. of Days with M. Precipitation	11	7	7	5	7	8	8	10	9	9	9	11	101	5

* Less than one day in an average year

Appendix 1c . Means of Temperature and Precipitation for Vanderhoof
Latitude 54 03 N, Longitude 124 00 W, Elevation 2093 FT ASL
(from Atmospheric Environment Service 1941-1970)

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	YEAR	NORMAL
Mean Daily Temperature (DEG. F.)	10.6	19.9	27.2	38.9	48.2	54.0	58.5	56.2	48.7	40.0	25.6	14.6	36.9	4
Mean Daily Maximum Temperature	19.8	31.0	38.9	51.0	62.9	67.6	73.0	70.8	62.0	50.1	33.7	23.0	48.7	4
Mean Daily Minimum Temperature	1.3	8.7	15.5	26.8	33.8	40.4	43.8	41.5	35.5	29.9	17.9	6.8	25.2	4
Extreme Maximum Temperature	54	62	68	78	92	93	104	92	88	80	62	52	104	1
No. of Years of Record	37	37	36	35	36	35	37	36	36	37	36	38		
Extreme Minimum Temperature	-61	-60	-45	-21	15	20	28	23	2	-15	-44	-59	-61	1
No. of Years of Record	38	38	38	37	37	37	37	36	37	37	35	37		
No. of Days with Frost	31	27	30	25	15	4	1	2	11	20	28	30	224	4
Mean Rainfall (Inches)	0.04	0.16	0.19	0.53	1.07	1.74	1.74	1.64	1.53	1.27	0.51	0.33	10.75	8
Mean Snowfall	17.9	11.6	7.3	2.4	0.4	0.0	0.0	0.0	0.3	2.8	11.7	17.8	72.2	8
Mean Total Precipitation	1.83	1.32	0.92	0.77	1.11	1.74	1.74	1.64	1.56	1.55	1.68	2.11	17.97	8
Greatest Rainfall in 24 Hours	0.75	0.60	0.75	1.10	0.81	1.25	1.24	0.88	1.60	0.89	0.70	1.21	1.60	1
No. of Years of Record	37	37	34	34	35	35	36	34	36	35	36	38		
Greatest Snowfall in 24 Hours	11.1	11.0	8.0	4.0	2.3	0.0	0.0	0.0	3.5	8.0	15.0	12.0	15.0	1
No. of Years of Record	32	37	31	34	36	37	37	36	37	37	36	35		
Greatest Precipitation in 24 Hrs.	1.11	1.10	0.80	1.40	0.81	1.25	1.24	0.88	1.60	0.89	1.50	1.21	1.60	1
No. of Years of Record	32	37	31	33	35	35	36	34	36	35	36	35		
No. of Days with Measurable Rain	1	1	2	4	7	10	8	9	10	8	3	1	64	4
No. of Days with Measurable Snow	10	7	4	2	*	0	0	0	*	2	6	9	40	4
No. of Days with M. Precipitation	11	7	6	6	7	10	9	9	10	10	10	10	105	5

* Less than one day in an average year

Appendix 1d. Means of Temperature and Precipitation for Prince George
Latitude 53 53 N, Longitude 122 40 W, Elevation 2218 FT ASL
(from Atmospheric Environment Service 1941-1970)

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	YEAR	NORMAL
Mean Daily Temperature (DEG. F.)	10.7	20.8	28.3	39.1	49.0	55.4	58.9	56.7	49.7	40.4	26.9	18.3	37.9	2
Mean Daily Maximum Temperature	19.0	30.5	38.3	49.6	61.6	67.8	71.8	69.4	61.5	49.3	33.8	25.4	48.2	2
Mean Daily Minimum Temperature	2.4	11.2	18.2	28.6	36.3	43.0	45.9	44.0	37.8	31.5	20.0	11.1	27.5	2
Extreme Maximum Temperature	55	55	64	74	86	93	94	92	84	77	61	53	94	2
No. of Years of Record	28	28	28	28	28	28	29	29	29	29	29	29		
Extreme Minimum Temperature	-58	-49	-36	-14	17	27	29	25	10	-14	-43	-50	-58	2
No. of Years of Record	28	28	28	28	28	28	29	29	29	29	29	29		
No. of Days with Frost	30	27	29	22	10	2	*	1	8	18	26	30	203	2
Mean Rainfall (Inches)	0.18	0.24	0.28	0.76	1.58	2.29	2.28	2.89	2.16	2.00	0.75	0.33	15.74	2
Mean Snowfall	23.4	14.7	9.8	4.0	0.8	T	0.0	0.0	0.4	4.0	15.5	19.3	91.9	2
Mean Total Precipitation	2.33	1.69	1.24	1.16	1.66	2.29	2.28	2.89	2.20	2.40	2.16	2.13	24.43	2
Greatest Rainfall in 24 Hours	0.49	0.70	0.71	0.73	0.84	1.53	1.10	1.97	1.31	1.53	0.70	0.51	1.97	2
No. of Years of Record	28	28	28	28	28	28	29	29	29	29	29	29		
Greatest Snowfall in 24 Hours	11.4	9.0	7.8	8.6	3.7	0.1	T	T	3.6	4.6	10.6	11.4	11.4	2
No. of Years of Record	28	28	28	28	28	28	29	29	29	29	29	29		
Greatest Precipitation in 24 Hrs.	1.14	0.90	0.78	0.86	0.95	1.53	1.10	1.97	1.31	1.53	0.87	1.14	1.97	2
No. of Years of Record	28	28	28	28	28	28	29	29	29	29	29	29		
No. of Days with Measurable Rain	2	2	3	7	11	13	13	13	12	13	6	3	98	2
No. of Days with Measurable Snow	17	12	10	5	1	*	0	0	*	3	11	15	74	2
No. of Days with M. Precipitation	17	13	12	10	11	13	13	13	12	15	16	17	162	2

* Less than one day in an average year
T Trace

Appendix 2a Nechako Watershed, Prince George 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 LAND	TOTAL AREA
	MATURE	IMMATURE	RESID.	N.S.R.	N.C.	TOTAL		
NECHAKO P.S.Y.U.	866,293	1,261,404	979	34,856	1,476	2,165,008	246,317	2,411,325
PRINCE GEORGE S.S.A.* (Partial)	265,056	340,372	95	66,206	25,557	697,286	87,702	784,988
TOTAL (FOR DISTRICT)	17,790,143	19,666,710	47,659	1,934,398	3,022,672	42,461,582	26,250,759	68,712,341

* All Prince George District tables contain only the portion of the Big Valley P.S.Y.U. and the Prince George S.S.A. inside the Prince George Forest District Boundary.

Appendix 2b Nechako Watershed, Prince George 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
	GOOD	MEDIUM	POOR	LOW	FOREST AREA
APPROVED SUSTAINED-YIELD UNITS -					
NECHAKO P.S.Y.U.	373,932	1,474,494	307,143	9,439	2,165,008
PRINCE GEORGE S.S.A. (Partial)	263,443	416,519	17,291	33	697,286
TOTAL	3,849,527	15,016,274	21,339,211	2,256,570	42,461,582

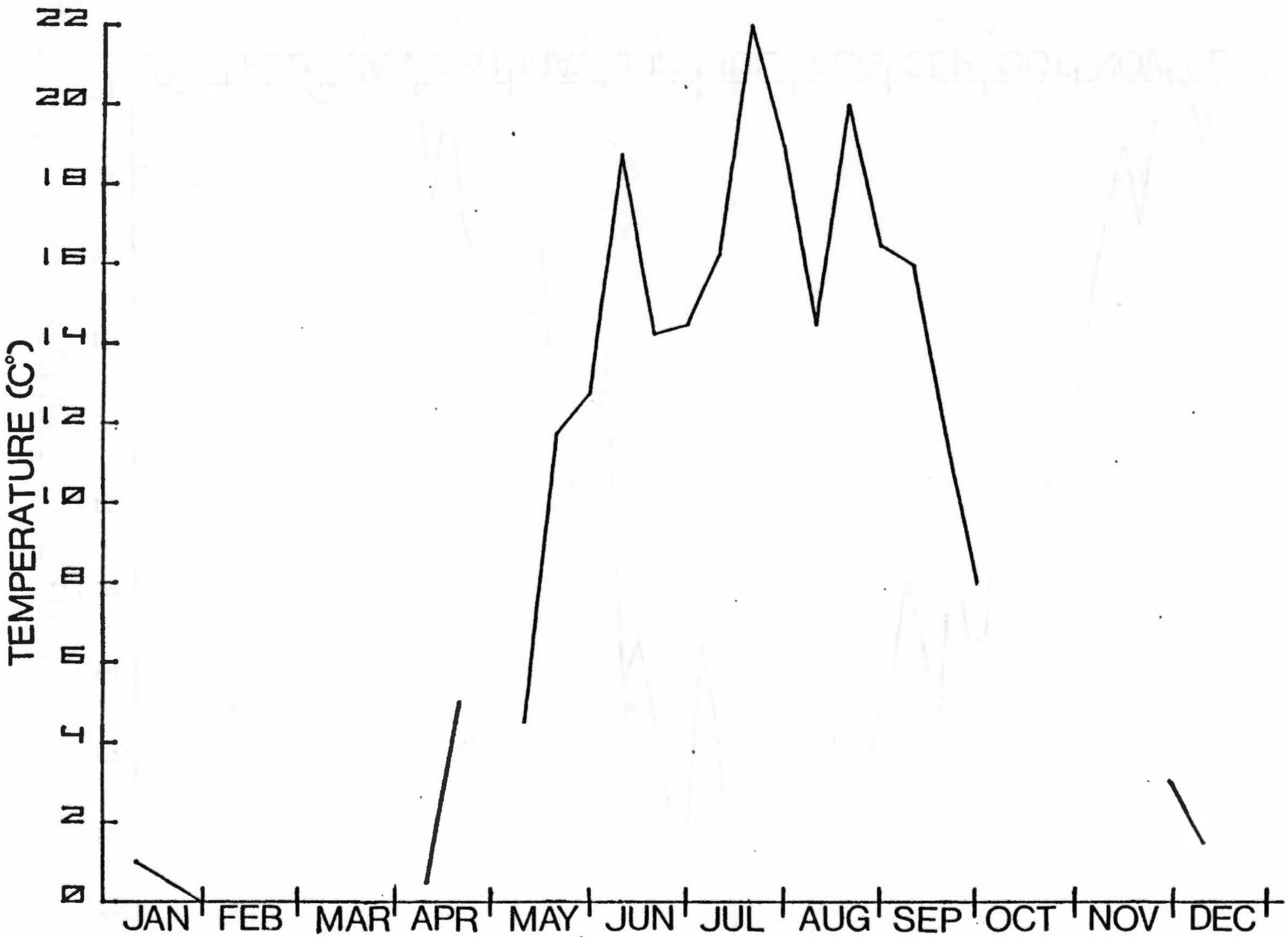
Appendix 2c. Nechako Watershed, Prince George Forest District. Forest and non-forest area in acres for lands alienated[1] and non-alienated[2] on which the Forest Service does not dispose of timber values.

STATUS	FOREST LAND						NON-FOREST LAND	TOTAL AREA
	MATURE	IMMATURE	RESID.	N.S.R.	N.C.	TOTAL		
MAJOR PROVINCIAL PARKS	207,134	113,250	---	6,873	20,771	348,028	1,060,842	1,408,870
NON-FOREST RESERVES AND MINOR PARKS	47,037	62,034	655	3,864	6,333	119,923	28,775	148,698
TREE FARM LICENCES INCLUDING TEMPORARY TENURES BUT EXCLUDING CROWN GRANTS IN SCHEDULE "A"	302,342	30,831	9,980	27,831	19,949	390,933	55,185	446,118
TEMPORARY TENURES (LEASES, LICENCES, ETC.) OTHER THAN THOSE IN SCHEDULE "A"	25,880	2,474	1,000	4,510	619	34,483	1,709	36,192
TOTAL NON-ALIENATED[2]	582,393	208,589	11,635	43,078	47,672	893,367	1,146,511	2,039,878
CROWN GRANTS INCLUDING THOSE IN T.F.L. SCHEDULE "A"	198,155	945,004	2,017	68,831	276,686	1,490,693	1,257,324	2,748,017
FEDERAL PARKS	---	---	---	---	---	---	---	---
OTHER FEDERAL LANDS	25,022	46,163	98	2,186	8,186	81,655	43,059	124,714
TOTAL ALIENTATED[1]	223,177	991,167	2,115	71,017	284,872	1,572,348	1,300,383	2,872,731
TOTAL 1 and 2	805,570	1,199,756	13,750	114,095	332,544	2,465,715	2,446,894	4,912,609
DISTRICT TOTAL	18,595,713	20,866,466	61,409	2,048,493	3,355,216	44,927,297	28,697,653	73,624,950

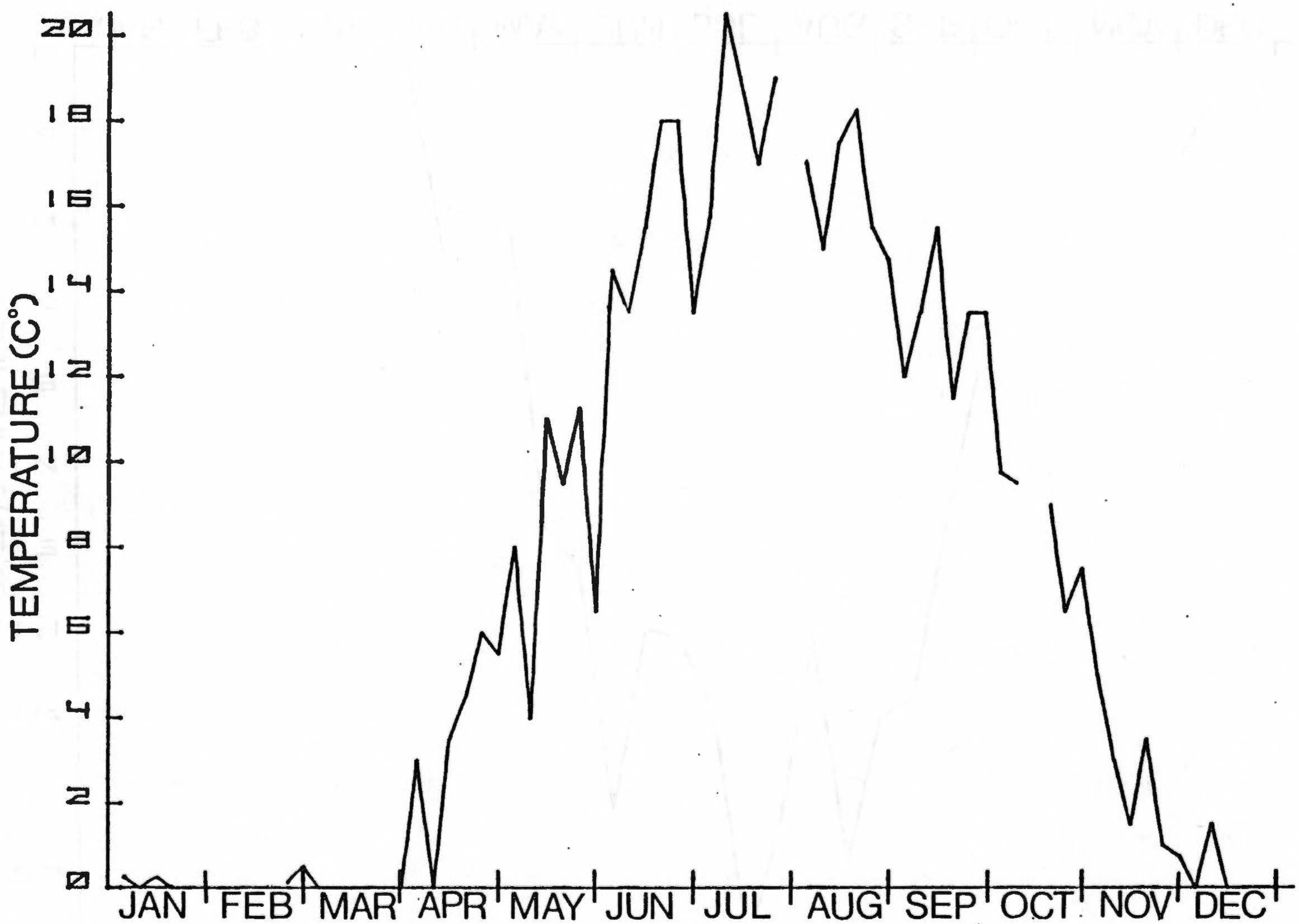
Appendix 2d. Nechako Watershed, Prince George Forest District. Rotation age and calculated allowable annual cut (7.1"+D.B.H. close utilization less decay), if all lands on which the Forest Service can dispose of timber values were under sustained-yield.

NAME	ROTATION AGE (YEARS)	CALCULATED ANNUAL CUT 6" TOP D.I.B. (C.C.F.)
NECHAKO P.S.Y.U.	91	540,000
PRINCE GEORGE S.S.A. (Partial)	93	160,550
TOTAL	--	8,156,180
AVERAGE	97	--

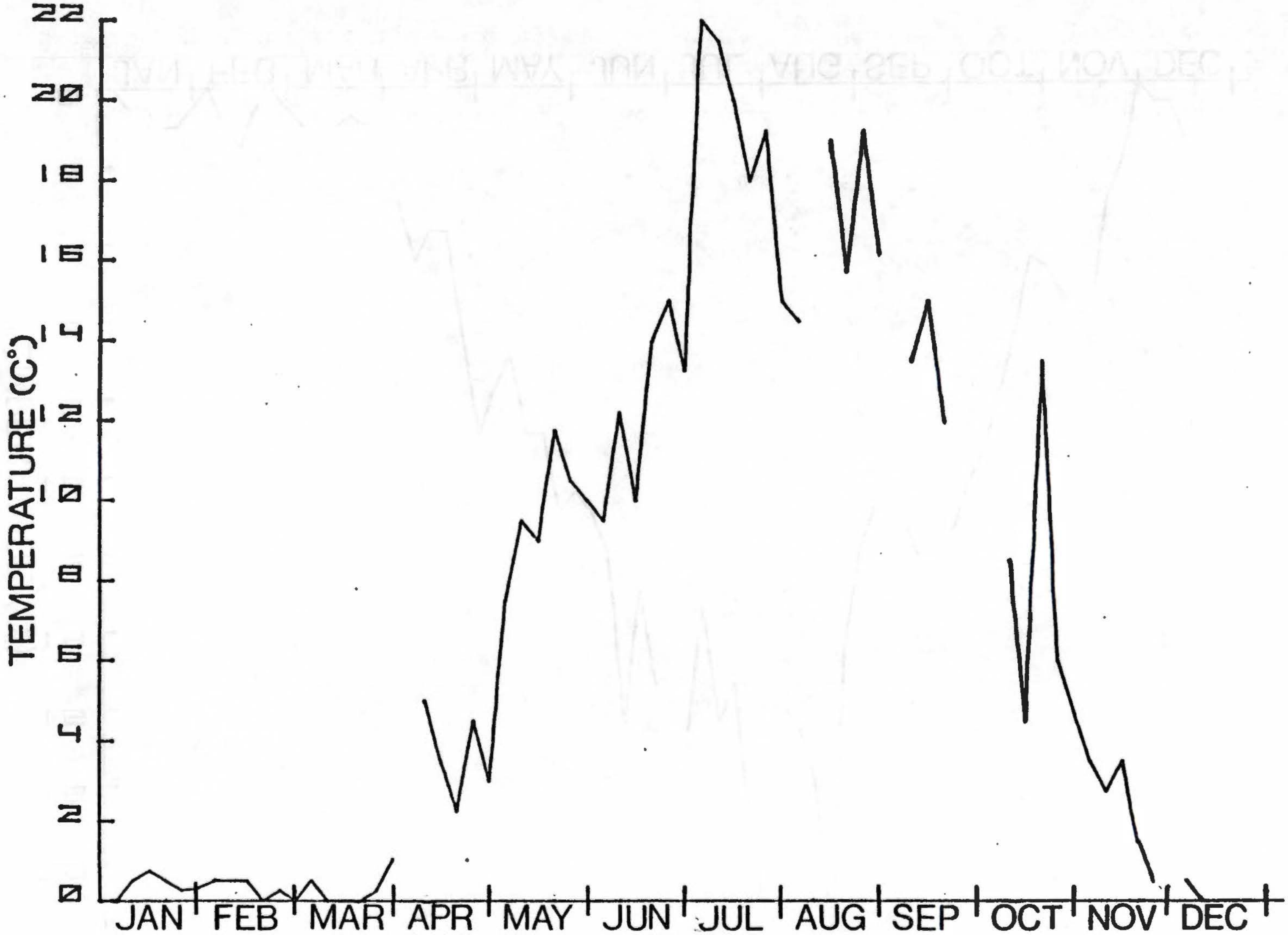
Appendix 3a: Nechako River at Ft. Fraser: Monthly average water temperatures (W.S.C., 1977).



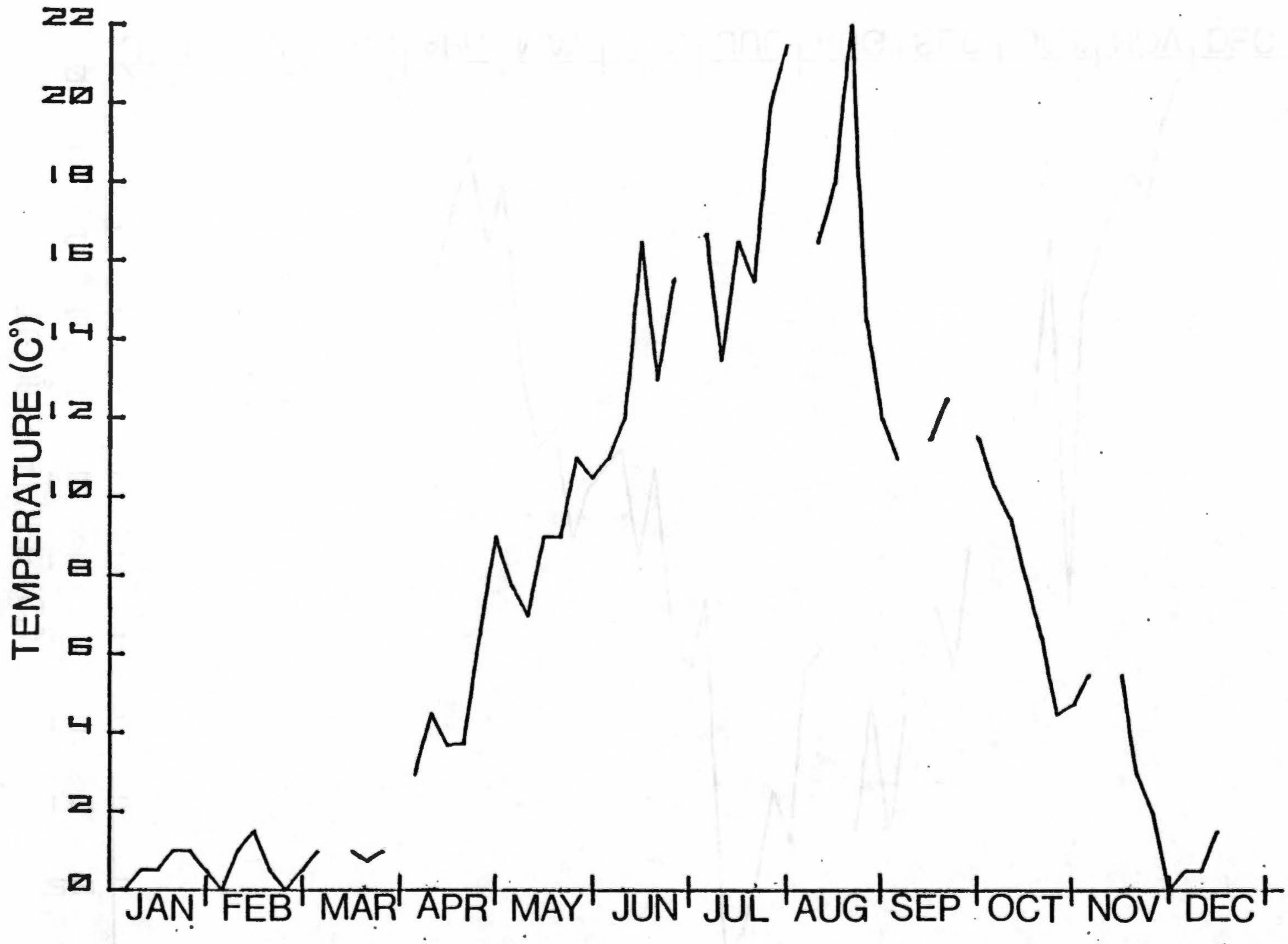
Appendix 3b. Nechako River at Vanderhoof: Monthly average water temperatures (W.S.C., 1977).



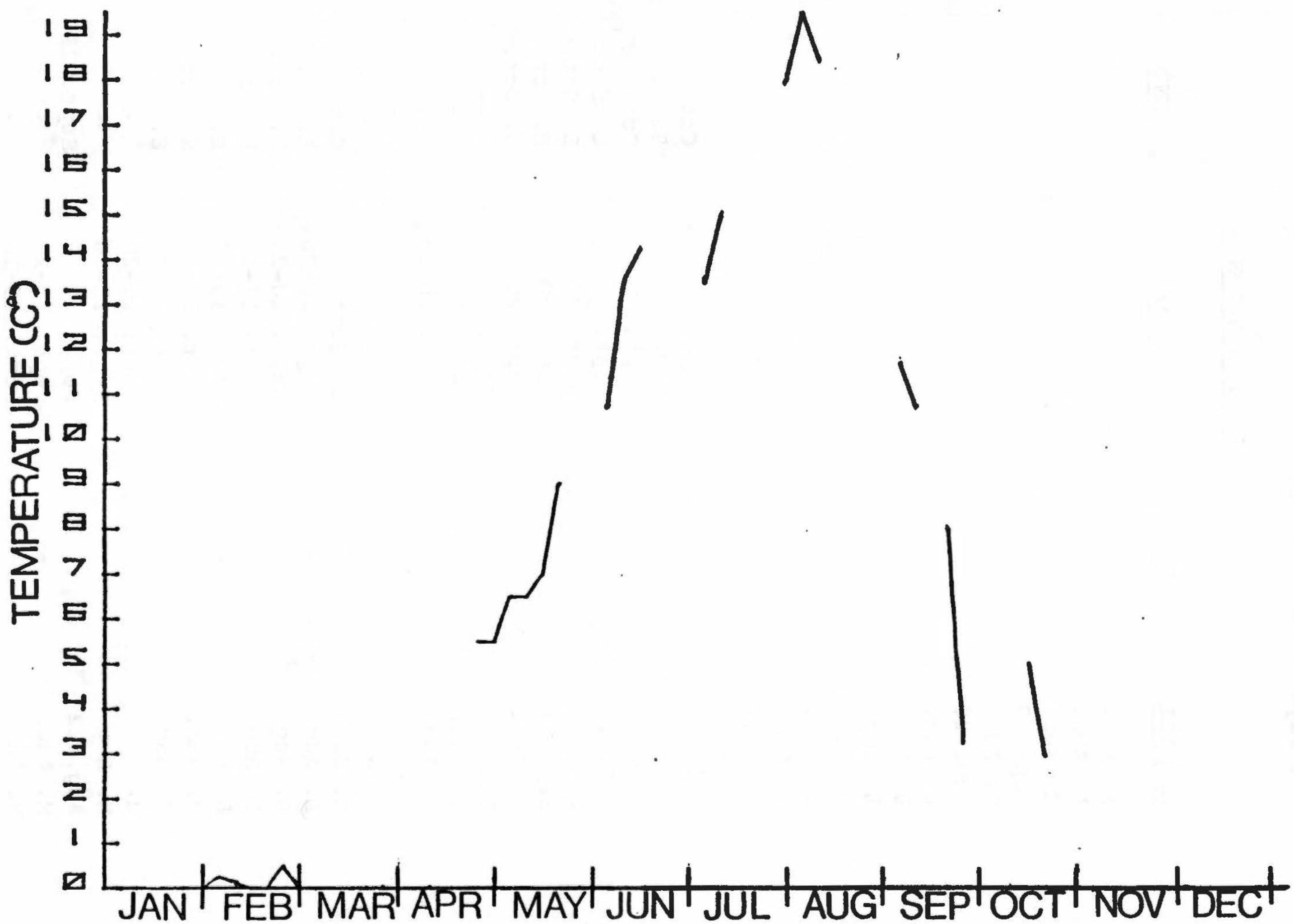
Appendix 3c. Nechako River @ Isle Pierre: Monthly average water temperatures (W.S.C., 1977).



Appendix 3d Nautley River near Ft. Fraser: Monthly average water temperatures (W.S.C., 1977).



Appendix 3e Chilako River near Prince George: Monthly average water temperatures (W.S.C., 1977).



Appendix 4a. Nechako River Area PG; Chinook Spawner Timing in the Nechako River. From F381.
(E=early, M=mid, L=late)

		SPAWNING		
YEAR	ARRIVAL	START	PEAK	END
1934	E. Aug.			
1935	L. Aug.			
1936	E. Sept.			
1937	Sept. 7			
1938	E. Aug.			
1939	Aug. 20			
1940	L. Aug.			
1941	L. Aug.			
1942	L. Aug.			
1943	L. Aug.			
1944	L. Aug.			
1945	L. Aug.			
1946	L. Aug.			
1947	--			
1948	Aug.		Sept.	Oct.
1949	--	--	Sept.	Sept.
1950	--	--	Sept.	Oct. 10
1951	Aug.	--	SEpt.	L. Sept.
1952	L. Aug.	--	Sept. 20	E. Oct.
1953	Sept. 1	--	Sept. 20	E. Oct.
1954	E. Sept.	--	Sept. 20	E. Oct.
1955	L. Aug.	--	Sept. 20	--
1956	L. Aug.	--	Sept. 20	--
1957	L. Aug.	--	Sept. 20-25	Oct.
1958	--	--	--	--
1959	--	--	--	--
1960	E. Sept.	--	L. Sept.	Oct.
1961	L. Aug.	--	Sept. 20-30	E. Oct.
1962	L. Aug.	--	Sept. 20-30	E. Oct.
1963	L. Aug.	--	Sept. 15-20	E. Oct.
1964	L. Aug.	--	Sept. 16-22	E. Oct.
1965	M. Aug.	--	Sept. 16-22	E. Oct.
1966	M. Aug.	--	Sept. 20-30	E. Oct.
1967	M. Aug.	--	Sept. 15-20	--
1968	M. Aug.	--	Sept. 15-20	--
1969	Aug. 22	Sept. 15	Sept. 17	Sept. 23
1970	M. Aug.	--	Sept. 17-20	--
1971	M. Aug.	--	Sept. 15-20	--
1972	L. Aug.	--	Sept. 20-25	--
1973	L. Aug.	--	Sept. 17-21	--
1974	M. Aug.	--	Sept. 17-21	--
1975	L. Aug.	--	Sept. 15-22	--
1976	L. Aug.	--	Sept. 15-24	--
1977	L. Aug.	--	Sept. 12-20	--
1978	M. Aug.	--	Sept. 8-15	--

Appendix 4b. Nechako River Area PG; F381 Salmon Stream Ground Numeration Data (Estimated Escapement and % Sex Ratios)

Date (Year)	Species Chinook	Sex Ratio in % % Males	% Females	% Jacks
1948	UNK			
1949	3500			
1950	1500			
1951	3500			
1952	3500			
1953	400	50	50	
1954	1500	50	50	
1955	400	50	50	
1956	200	50	50	
1957	UNK	50	50	
1958	N/O	-	-	
1959	N/O	-	-	
1960	75	40	60	
1961	350	45	55	
1962	400	-	-	-
1963	400	45	50	5
1964	700	40	58	2
1965	400	40	50	10
1966	450	40	50	10
1967	750	45	50	5
1968	400	45	50	5
1969	400	45	54	1
1970	750	50	50	-
1971	400	46	50	4
1972	400	48	50	2
1973	750	45	55	5
1974	750	-	-	-
1975	1500	45	50	5
1976	1200	45	52	3
1977	2000	45	50	5
1978	2600	-	-	-
1979	1800	-	-	-

Appendix 4c. Sockeye Salmon Escapements to Nechako River Tributaries (Vol. 1 FMS and IPSFC 1979 and IPSFC Annual Reports 1976-1978)

ESTIMATED NUMBER OF SOCKEYE

Year	Nadina River Early	Nadina River Late	Stellako River
1938	272	N/O	6,943
1939	23	P	2,585
1940	70	N/O	3,276
1941	525	45	8,566
1942	686	N/O	91,840
1943	83	N/O	14,897
1944	29	N/O	5,768
1945	1,405	205	20,826
1946	1,401	N/O	245,172
1947	589	N/O	59,904
1948	291	N/O	16,213
1949	25,168	N/O	104,835
1950	4,325	774	145,108
1951	1,005	175	96,208
1952	2,829	38	40,466
1953	27,114	14,438	43,688
1954	2,032	770	141,882
1955	798	108	51,746
1956	1,613	83	38,459
1957	31,744	29,146	38,921
1958	854	718	112,273
1959	2,106	1,013	79,355
1960	1,755	157	38,884
1961	18,578	17,544	47,241
1962	758	1,683	124,495
1963	4,363	7,304	138,805
1964	1,597	232	31,047
1965	3,920	11,293	39,418
1966	83	1,784	101,684
1967	4,232	7,790	91,525
1968	1,021	1,496	30,420
1969	8,681	27,898	49,341
1970	78	3,939	45,876
1971	3,302	14,525	39,726
1972	996	2,702	36,771
1973	2,759	16,737	30,755
1974	0	3,825	41,473
1975	1,817	15,319	176,079
1976	171	1,673	150,741
1977	1,603	16,896	23,452
1978	0	2,782	60,421

p= some spawners present, number unknown. N/O = no observations made. Uncha, Nithi, Ormonde and Endako Rivers are included in the early Nadina run. Tagetochlain included in the late Nadina run.

Appendix 4d. Summary of the Sockeye Escapement to the Nechako River District Spawning Areas (IPSFC Annual Reports 1975-1978)

Year	PERIOD OF PEAK SPAWNING		
	Nadina River		Stellako River
	Early	Late	
1971	Sept. 1- 3	Sept. 15-18	Sept. 25-27
1972	Aug. 21-24	Sept. 10-13	Sept. 26-29
1973	Aug. 21-28	Sept. 12-18	Sept. 23-28
1974	-	Sept. 12-15	Sept. 30-Oct. 4
1975	Aug. 28-Sept. 1	Sept. 18-20	Sept. 29-Oct. 5
1976	Aug. 27	Sept. 25-28	Sept. 29-Oct. 3
1977	Sept. 7	Sept. 16-19	Sept. 23-29
1978	-	Sept. 20-23	Sept. 24-30

Appendix 4e. Miscellaneous F381 Observations. Conditions affecting the stream.

Year	Observations:
1952	"On October 8, the waters of the Nechako River were cut off by Kenny Dam which is in the Grand Canyon about 60 miles upstream from Ft. Fraser. The stream bed below the dam is now practically dry and it is possible, due to severe winter conditions, that practically all the spring salmon eggs will perish."
1953	"The release of Cheslatta storage water into the Nechako River enabled a greatly reduced run of spring salmon to spawn successfully. An examination of a few redds during November showed that the eggs were well "eyed" and would be soon passing into the alevin stage."
1954	"Winter water cover for spring salmon eggs will be maintained at 150-200 cfs from Cheslatta reservoir."
1956	"On October 8, 1952 the Kenny Dam was closed and as a result most of the spring salmon spawning redds were exposed to the elements. The officer at this time estimated that 95% of the spring salmon eggs deposited would be destroyed. From the return of springs this year, this prediction was accurate."
1957	"Spill discharges from the Skins Lake Dam were high and as a result of channel cutting above Cheslatta Lake, much silt etc. was suspended in the water which made visual observations impossible."
1958	"The spill from the Skins Lake Dam was maintained at approximately 10,000 cfs for the season. As a result, the water was high and very silty."
1959	"The spill from the Skins Lake Dam was maintained at 10,000 to 14,000 cfs all summer and fall. The water in the residual river was quite high and very brown and silty."
1960	"The channel being cut from Skins Lake to Cheslatta Lake (re: Alcan Spill from reservoir) is evidently stabilizing at the low end but much of the channel banks below Skins Lake is still mostly mud and dirt. When discharges are less than 5,000 cfs, the water in the Nechako tends to clear somewhat."
1961	"A large percentage of the silt load in the water in this river is not present now and as a result the spring salmon are returning to their original spawning areas. A more careful control on the water discharges from the Skins Lake Dam would help to rebuild this important run."

Year	Observations (continued):
1962	"Discharge of water down Nechako from Skins Lake Dam was not to great this year. Flow at spawning time was approximately 8,000 cfs and cut back to 1500 cfs on December 1st. Water is becoming 'clearer' and the springs are spawning in areas noted in 1949-1952."
1963	"Flow through Skins Lake Dam was about 6800 cfs during September. Water is becoming quite clear. Water was cut back to about 1500 cfs on November 22nd."
1964	"Flow from Skins Lake Dam was approximately 700 cfs while springs were spawning in river."
1965	"The water in the residual Nechako is clearing each year. This is the first year since 1957 (start of heavy spills from Skins Lake Dam) that a spawning count was done during the peak of spawning. Visibility was about 3 feet into the water. Spill flow during spawning was about 5000 cfs. Since September 25, flow has been about 3100 cfs.
1966	"The flow of the Nechako River is controlled by Skins Lake Dam. During the summer and fall, the flow was above normal.... At the time of spawning the flow was some 8000 cfs. Some redds will become exposed.
1967	".... This year the flow was low enough that the springs stayed in the 'bottom' of the river to spawn."
1968	".... The Company brought their reservoir to full height (2800 feet) in July ... above normal discharges have been made since that date ie. 8500 cfs in September."
1969	"The water level was much better this year ... most of the redds are near the bottom of the river."
1970	"The spill from Skins Lake Dam was maintained at some 4000 cfs during the spawning time. This was reduced to 2200 cfs in November."
1971	"The spill... was 60% cfs at spawning-time ... and about one-half this amount in early November."
1972	"The spill ... was 8000 cfs during September and October ... to 2500 cfs on October 28th. As a result 10% of the redds will likely by affected by frost this winter."
1973	"Due to a saddle dam being built on the lower portion of the Cheslatta River, flows from Skins Lake Dam were reduced to 1000 cfs in September.

Year	Observations (continued):
1974	"Due to low water conditions, water temperatures were some 2 to 4 degrees above normal and this may have caused some stress to some fish."
1975	"Due to fishermen's strike, many more springs came through the Lower Fraser River "unmolested". Water levels and temperatures were very good this year. Winter cover water ... 3000 cfs from Skins Lake Dam.
1976	"Due to an above average snowfall ... over-abundance of water ... flooding at Vanderhoof ..."
1977	"Water flow ... 3000 cfs during spawning in September reduced flow to 1500 cfs ... On November 15 and 16 some 42 redds had tops showing with another 59 redds with 1-4 inches of water covering..."
1978	"Water flows were reduced at Skins Lake Dam in August to 950 cfs with this flow to be maintained for the winter months ... Salmonid Enhancement Program conducted biological and engineering studies towards a hatchery-rearing pond complex. A drilling rig situated upstream from Cheslatta Falls, is presently (November) drilling for groundwater.

Appendix 4f F381 Biological Conditions Summary

Year	Observations
1937	"Springs were of red and white variety. A greater increase than in brood year. Springs spawning on all bars between Prince George and Big Canyon 60 miles upstream from Fort Fraser."
1938	"This report is based on spring salmon that were spawning in the upper part of the river above Nautley River at Fort Fraser... Red and white variety."
1939	"Red and white variety ... large number of springs were observed spawning this year one mile of stream from Vanderhoof on CNR - this was unusual."
1940	"Springs ... both red and white variety. Estimate 3000, brood year 1000. Springs arrived in good physical condition, very few external bruises observed. Percentage of sex in stream unknown. Duration of spawning period approximately 8 weeks. Areas seeded from five to forty-five miles upstream from Fort Fraser on CNR and from one to six miles upstream from Vanderhoof on CNR."
1941	"Main spawning grounds 60 miles upstream from Fort Fraser not visited. No springs seen on bars below Fort Fraser."
1944	"The run of spring salmon to this spawning ground was light ... All spawning grounds were not visited during the season ... A few spring salmon also spawned this year in area 1-6 miles above Vanderhoof ...."
1945	"Nechako River (above Fort Fraser) spring salmon number on spawning grounds estimated at up to 1000 ... spawning conditions good and fish arrived in fine condition and of good average size. All of the spawning grounds were not visited during the season ... 200 to 300 spring salmon also spawned in the Nechako River 1 to 6 miles above Vanderhoof on the CNR. Some also spawned here in 1940 but none were observed in 1941."
1946	"Nechako River spring salmon ... spawning conditions excellent and fish arrived in splendid condition. Some fine large individuals noted in run. All this spawning ground was not visited during the spawning season ... A few spring salmon also spawned in the Nechako River 1 to 6 miles above Vanderhoof.
1948	"Several good spawning areas along the Nechako - all well populated this year. Spawning takes place on gravel bars in mid-stream."

Year	Observations (continued):
1949-51	"Distribution of spawning salmon over the stream-bed was described as spotty. Main predators were bears and eagles."
1952	"Spawning salmon distribution occurred mostly near upper end of river. Predation by bears, eagles, etc."
1953	"An inspection trip down the residual Nechako River from Cheslatta to Fort Fraser ... spring salmon have commenced to spawn ... Better than 400 spring salmon have been counted ... Spawning was spotty."
1954	"Spawning salmon distribution was spotty, with visual predation by bears, etc. This year about one dozen sockeye salmon were observed to be spawning in the Nechako River where the Cheslatta River enters the Nechako."
1955-56	"Spawning salmon distribution was spotty with usual predators reported."
1957	"Distribution was spotty, usual predators and many spring were reported as ascending many tributary streams and spawning in these streams."
1958	"The springs arrived early in September but soon dropped downstream and entered the Nautley River and thence into the Stellako River where they eventually spawned."
1959	"The springs evidently pulled out of the Nechako and spawned in the Stallako River."
1960-62	"Salmon spawning distribution was reported as spotty and mostly in upper portion of river. Usual predators were present."
1963-66	"Distribution of spawning salmon was spotty with usual predators."
1967	"Distribution of spawning salmon —> spotty with usual predators. More springs are coming back to this river as the water clears. Similarly, fewer springs are spawning in the Stellako River."
1968-73	"Distribution of spawning salmon over the stream-bed described as spotty, mostly above Copely Creek with usual predators present."
1974	"Distribution of spawning salmon was spotty with usual bear and eagle predators. Due to very low water conditions above Fort Fraser, the springs spread out in slightly different spawning areas. Most fish stayed in their tradional spawning sites but due to changing water velocities, due to low water, fish at these sites either moved upstream or downstream from the traditional sites. Also, on September 15-16 some 50 springs suddenly appeared in the Stellako River and commenced spawning immediately."

Year	Observations (continued):
1974 (cont'd)	"In all years prior to 1974, some 60 to 70 percent of the Spring run to the Nechako (Vanderhoof to Cheslatta Falls) have always spawned above Fort Fraser. This year, possibly due to low water conditions and higher than normal water temperatures and possibly flow of water from the Nautley River (Fraser Lake) only some 40-45% of the run spawned above Fort Fraser. The number of springs seen in the area some 5 miles above Vanderhoof ... best since 1952. It was also noted that the springs which have traditionally spawned on the gravel bar just below the old ferry crossing at Engen, found little or no water covering these gravel bars this year ... however seen spawning 3/4 mile upstream from the old ferry crossing site."
1975	"Spawning salmon distribution spotty with usual predators present. Due to fishermen's strike ... the run tripled in size from 1971."
1976-77	"Spawning salmon distribution spotty with usual predators present."
1978	"Distribution of spawning salmon over the stream-bed was in 3 main areas: Upper Nechako (Greer Creek to Cheslatta Falls) Engen area and area 4 miles above Vanderhoof."

Appendix 5a Annual Indian Food fishery catch of sockeye produced from Nechako River tributaries (from FMS and IPSFC, 1979)

YEAR	NADINA RIVER		STELLAKO RIVER
	Early run	Late run	
1952	424	6	6,770
1953	3,008	1,602	4,747
1954	246	93	17,459
1955	208	17	13,101
1956	274	14	6,590
1957	3,574	3,282	4,361
1958	73	63	9,562
1959	189	91	8,142
1960	362	32	8,415
1961	3,281	2,948	8,020
1962	106	239	19,068
1963	688	1,155	21,939
1964	866	49	14,008
1965	849	2,446	8,531
1966	15	292	16,840
1967	462	1,653	15,105
1968	988	401	14,482
1969	916	2,946	10,448
1970	88	4,377	15,476
1971	1,483	5,823	10,127
1972	1,346	4,908	8,969

Appendix 5b. Annual Commercial Catch of sockeye produced from the Nechako tributaries (from FMS and IPSFC, 1979)

YEAR	NADINA RIVER		STELLAKO RIVER
	Early Run	Late Run	
1952 *	8,097	108	146,128
1953 **	168,747	89,858	151,599
1954 **	11,167	4,232	750,794
1955 **	6,745	558	319,944
1956 **	5,759	296	150,257
1957 **	141,239	129,680	132,839
1958 **	4,806	4,173	1,036,135
1959 **	6,201	2,982	583,055
1960 **	6,880	616	200,200
1961 **	106,605	96,352	115,973
1962 **	1,359	3,067	187,543
1963 **	5,067	8,593	370,408
1964 **	11,018	619	119,599
1965 **	27,772	80,768	110,352
1966 **	549	10,272	464,550
1967 **	21,173	42,578	624,427
1968 **	12,035	11,327	139,413
1969 **	20,388	65,955	172,315
1970	265	25,155	287,624
1971	24,121	110,059	504,875
1972	7,466	56,622	98,641

* Does not include Johnstone Strait catches or non-Convention troll catches

** Does not include non-Convention troll catches

Tagetochlain Creek is included in the Late Nadina River run.

Nithi, Endako, Uncha and Ormonde Rivers are included in the Early Nadina River run.

Appendix 6 Chinook Juvenile Tagging Summary for 1979. (E.V.S. Consultants Ltd., 1979b)

1) Number held: 14,000 chinook fry

2) Location: floating net pens in the Nechako River mainstem.

3) Food Source: O.M.P.

4) Specific Growth Rate: .738 in pen 1, expressed as percent daily change in length. Stream-reared natural fry had a growth rate of .270 for the same period. The pen-reared fry grew 2.7 times faster than the natural reared fry.

5) Mortality factors: None significant.

6) Tag Rejection: 0-4% nightly

7) Releasals: 12,351 fry marked with binary-coded wire nose tags were released on July 21-22, 1979 to the Nechako River at Greer Creek.

8) Calculated population estimates from the initial release and recapture of marked fry from (I) Chapman (1948), (II) Schnabel (1938) and (III) Schumacher and Eschmeyer (1943) are:

Watercourse	I	II	III	AVERAGE
Swan Creek below Bridge	738	1,081	1,261	1,027
Swan Creek above Bridge	513	1,016	1,124	884

Appendix 7a. Recommended Fish Culture Limits(R.F.C.L.)

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

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

+ in mg/l except where otherwise specified

Appendix 7b. Sources of Recommended Fish Culture Limits

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

Appendix 8. Persons Contacted and Information Sources.
Nechako River Watershed.

ENHANCEMENT RATIONALE

B.G. Shepherd
A/New Projects Head 6th floor
Biological Criteria for Nechako 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

CLIMATE

Environment Canada

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

Pacific Region(Atmos. Env. Serv.)
Norm Penny 732-4875
Sinclair 732-4856
information regarding temp. and precip.

WATERSHED GEOLOGY

British Columbia,
Ministry of Mines and Petroleum Resources
Dr. Nick Carter 569-387-5975
Publications 569-387-5631
more information/studies - Regional Stream Sediment and Water Accelerated Geochemical Survey, B.C.(no more on Nechako 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

Appendix 8 . Persons Contacted and Information Sources.
Nechako 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 Company
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. History	B.C. Ministry of Economic Development B.C. Regional Atlas
2. Logging	Roger Crosby Houston Forest Products Ltd. 845-2322
	Dennis Bell Babine Forest Products Ltd. 692-7177
	Ray Abersek Bond Brothers Ltd. 567-2261
	Lloyd Larson L&M Lumber Ltd. 567-4912
	George Hicks Fraser Lake Sawmills 699-6235

Appendix 8 . Persons Contacted and Information Sources
Nechako River Watershed.
(Cont'd)

2. Logging(cont'd)

Al Gorley
Ministry of Forestry
District Manager
694-3432

Wayne Selewski
Ministry of Forestry
District Manager
567-1281

George Meets
Ministry of Forestry
District Manager
562-8131

3. Mining

J. Arsenault, HPD.
Information on bedrock exploration

4. Population and Industry

British Columbia Regional Index
Some Sources unknown

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 Manuscrip Maps, B.C.

F. Hedgi
Forestry Information

Appendix 8 . Persons Contacted and Information Sources.
Nechako River Watershed.

STREAMFLOWS

Mary Cowey 666-3716
- supplied NAQUADAT Flow Data for Nechako River @ Ootsa Lake
@ Ft. Fraser
@ Isle Pierre

Historical Streamflow Summary, B.C. to 1973
Summary of monthly means, Maximums and minimums

SEDIMENT LOADS

Mike Flynn
HPD
- no information

Carl Halstead
Geohydrologist for Inland Waters
- No more information

Inland Waters Directorate
Water Survey of Canada
1001 W. Pender 666-3610

Inland Waters Directorate
Water Survey of Canada
New Westminster Lab 524-7241
- no information on Nechako

Steve MacFarland
HPD
- no information

Resource Analysis Branch
Regional Stream Sediment and Water Accelerated
Geochemical Survey, B.C. 1978
- no data on Nechako

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

Rob Russel
HPD
- no information

Appendix VI.B. Persons Contacted and Information Sources.
Nechako River Watershed.

STREAMFLOWS(cont'd)

Nelson Wood
Water Survey of Canada
- sent Historical Sediment Data Summary
  Canadian Rivers
  1977

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 Stataion List
- User's Manual for NAQUADAT System

Appendix 8. Persons Contacted and Information Sources.
Nechako River Watershed.

NAOUADAT(Computer File for Canadian Water Quality Data)

Peter Wong
Pollution Control Branch Laboratory
NH_3 Information

Dr. M.J.R. Clark
Branch Environmental Chemist
Services Unit
Resource Recovery Section
Waste Management Branch
- data for Environmental Site, Nechako River

Fish Culture Limit Table - recommended values compiled from:
- Pollution Sampling Handbook, 1976(PEI)
- R. Brett(1952)
- Tom Cleugh(memo)
- M^c^Kee and Wolf(1971)
- Robbins(1976)
- Ted Perry and Bill McLean(memo) DFO
- Bill McLean(MS)
- Newton(1944)
- 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 DFO

General Personnel
Laboratory Services
4195 Marine Drive
West Vancouver, B.C.
- Pollution Sampling Handbook
- Water Quality Analysis Handbook

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

Howard Singleton 387-5321
Aquatic Services Branch
- Taking samples of fish form the Fraser River

John Balkwill 387-5318
Aquatic Services Division
Resource Analysis Branch
- Limnological data available for B.C. waters

Appendix 8. Persons Contacted and Information Sources.
Nechako River Watershed.

Mr. Quaker
- contact to request data on specific well

GENERAL WATERSHED RECONNAISSANCE

B.G. Shepherd
A/New Projects Coordinator
History of Watershed Reconnaissence, 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.

DFO Memorandum, file 5830-13-13, Oct. 1979. Stuart - Nechako Rivers Bio-engineering Reconnaissance.

DFO Memorandum, file 5903-35-N75. R.M.J. Ginetz and G.O. Nielsen. Nechako River Feasibility.

DFO Memorandum, file 5903-85-N75. August 1979. R.M.J. Ginetz and G.O. Nielsen. Proposed Nechako River Hatchery.

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 on spawning grounds
   Sex ratios

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.

Appendix 8 . Persons Contacted and Information Sources
Nechako River Watershed.

4. Obstructions

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

E.V.S. Consultants Ltd., 1980. Olmstead, 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.

P. Fee and M. Sheng, 1978. Nechako River Chinook fry and spawning survey.

Envirocon Ltd, 1980. Preliminary Results of chinook salmon studies in the Nechako River. Interim Report

FMS and IPSFC, 1979. Salmon studies associated with Kemano II Hydroelectric Development.

Internation 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
Nechako Stock timing through the lower Fraser River Fishery(Area 29)
Annual Fraser River Catch(native, sport and commercial)

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

Appendix 8. Persons Contacted and Information Sources.
Nechako Rvier Watershed.

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.

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

W.R. Olmstead
Discussions regarding 1979 bio-baseline studies on the Nechako River.

DFO Prince George District Office
Information regarding commercial, native and sport catch on the Nechako River.

Internation 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, Olmstead, W.R., P.W. Slaney and G.A. Vigers, prepared for DFO. Chinook Salmon(*Oncorhynchus tshawytscha*) Fry and Smolt Enumeration/Marking Projest, 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.

E.V.S. Consultants Ltd., 1980(b). Olmstead, 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 ratios, fork lenghths and postorbital-hypural lenghth regressions
2. Chinook eggs
3. Fecundity
4. Calculated egg deposition
5. Chinook egg survival and spawning capacity

Appendix 8. Persons Contacted and Infromation Sources.
Nechako River Watershed.

P.Fee and M.Sheng, 1978. Nechako River Chinook Fry and Spawning Survey.

1. Chinook spawning distribution
2. Fecundity
3. Egg retention and pre-spawning mortality

Fisheries and Marine Service and the International Pacific Salmon Fisheries Commission, 1979. Salmon Studies Associated with the Potential Kenamo II Hydroelectric Development, Volume 1,Summary.

Fisheries and Marine Service, Department of Fisheries and the Environment, 1979. Salmon Studies Associated with the Potential Kemano II Hydroelectric Development, Volume 3, Chinook Salmon Studies on the Nechako River.

1. Fry emergence timing
2. Post-emergent fry distribution
3. Adult migration and spawning timing, distribution and abundance
4. Commersial catch of sockeye from Nechako tributaries
5. Indian food fishery of sockeye from Nechako River tributaries
6. Summary of sockeye escapement to Nechako River district

Envirocon Ltd., 1980. Preliminary Results of Chinook Salmon Studies in the Nechako River, Volume I - of Interim Report.

1. Post-emergent fry rearing and in-stream distribution

Tutty, B.D., and F.Y.E. Yole, 1978.
- age composition of adult chinook

DFO Scale Bank, DFO, Vancouver.
- age composition of adult chinook