Chemical, Biological and Physical Characteristics of Lakelse Lake, B.C.

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CHEMICAL, BIOLOGICAL AND PHYSICAL CHARACTERISTICS OF LAKELSE LAKE, B. C.

T.R. CLEUGH, C.C. GRAHAM, AND R.A. McINDOE

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ABSTRACT

The chemical, biological and physical characteristics of Lakelse Lake, B.C., were investigated during 1974-1975. This report also summarizes relevant fisheries - limnological information published on this watershed. The survey was initiated to help resolve fishery resource and land use conflict problems within the watershed by establishing the present trophic status.

Data suggests there is sufficient phosphorus present in Lakelse Lake for it to become eutrophic. However, nitrogen and a high flushing rate were identified as limiting to lake production. Therefore any factor which increases the inorganic nitrogen or impedes the flushing rate could increase the lake trophic status.

Phytoplankton biomass was classified as being oligotrophic. Zooplankton was poor in both the number of species and total abundance.

Relative to a 1946 report the benthic community increased threefold per square meter of substrate in a limnetic zone of nearly twice the depth.

Key words: Lakelse Lake (B.C.); fisheries; limnology; Land Use.

RÉSUMÉ

Les caractéristiques chimiques, biologiques et physiques du lac Lakelse (C.-B.) ont fait l'object d'une etude en 1974 et en 1975. Le présent rapport résume les renseignements publiés sur la pêche et la limnologie de ce bassin hydrographique. L'étude visait à déterminer son état trophique actuel afin de résoudre des incompatibilités entre la pêche et l'utilisation des terres avoisinantes.

S'il faut en croire les données, il y a suffisamment de phosphore dans le lac Lakelse pur qu'il s'eutrophise. Sa faible concentration d'azote et le renouvellement élevé de ses eaux y limitent toutefois la production. Tout facteur qui, par conséquent, augmenterait sa teneur en azote inorganique ou qui réduirait le renouvellement de ses eaux pourrait contribuer à l'eutrophiser.

La biomasse du phytoplancton est typique d'un milieu oligotrophe. Le zooplancton est pauvre tant du point de vue numérique que spécifique.

En regard du rapport de 1946, la communauté benthique a triplé par mètre carré de substrat dans une zone limnétique presque deux fois plus profonde.

Mots-clés: lac Lakelse (C.-B.); peche; limnologie; utilisation des terres.

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In 1973, representatives of Fisheries and Marine Service and the Regional District of Kitimat - Stikine met to discuss the resource and land use conflict problems on Lakelse Lake and within the Lakelse River watershed. As a result, members of the Northern Habitat Protection Unit embarked on a series of investigations to establish the trophic status of Lakelse Lake. These studies continued during 1973 and 1974 on a limited basis. The results of these studies were reported in The Case of Lakelse Lake by W.F. Sinclair (PAC/T-74-10).

This report is a summary and a consolidation of all relevant fisheries-limnology information published on this watershed as well as a further brief survey on Lakelse Lake during February - October, 1975. These further studies include an up-to-date sounding of the lake, additional water chemistry, aquatic vegetation mapping, zooplankton and phytoplankton and a benthic invertebrate biomass estimate.

1. DESCRIPTION OF STUDY AREA

1.1 Location and Topography

Lakelse Lake, 54°30'N., 128°49'W., is located on the eastern margin of the Coast Range Mountains at an elevation of 72 meters (National Topographic Map Series - 103 1/7 East). The lake is situated approximately 9.7 kilometers south of the city of Terrace (Figure 1). To the west and east, mountains rise to over 1,500 meters above sea level and form a basin with a width of 3.2 km. and a length of 11.3 km. At the south end of the lake, the topography rises to an elevation of 182 metres, which forms the drainage barrier between Lakelse Lake watershed and the Kitimat River watershed.

1.2 Drainage History

The Lakelse Lake area has undergone a complex glacial history. In pre-glacial times, it was most probable that the ancestral Nass and Skeena Rivers flowed through the Kalum Valley to Kitimat Arm (Duffell and Souther, 1964). Since that time, indications are that at least two major glacial advances and two prolonged halts occurred in the final recession of the ice.

Duffel and Souther (1964) describe the glacial history as follows:

> During the advance of Pleistocene ice the Kalum-Kitimat Valley was scoured and most of the original deposits were removed. Ice filled the valley and moved southward down Kitimat Arm. Towards the end of Glaciation the ice receded northward and was followed inland by an arm of the sea that drowned the valley up to at least the 600-foot contour. It is not known how far the glacier retreated up Skeena Valley as no marine deposits have been recognized beyond Williams Creek. During this retreat the thick deposits of marine clay were deposited. Melting icebergs dropped their load of sand and boulders onto the muddy bottom where it was buried along with the shells of marine molluscs. Along the margins

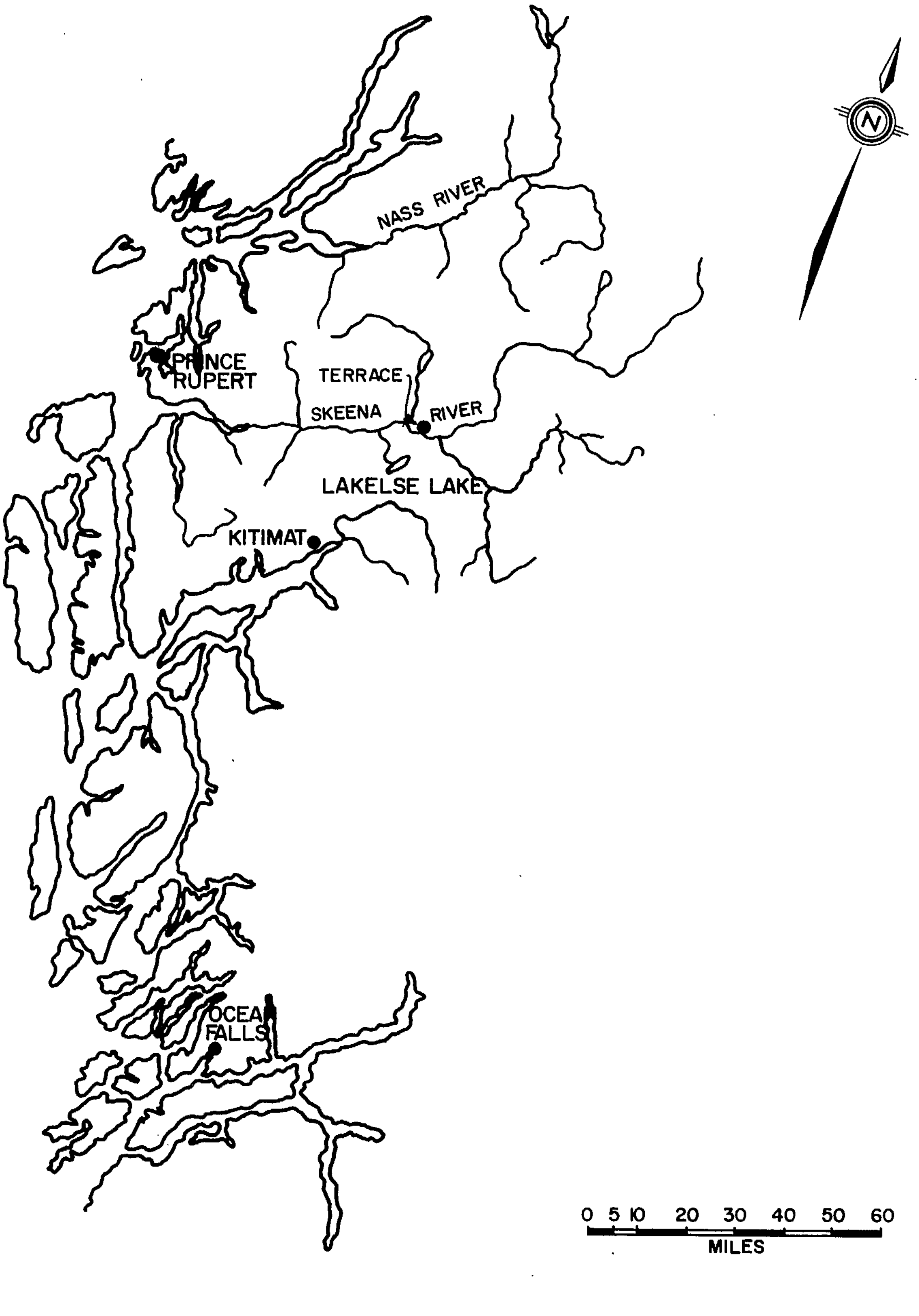

FIGURE I—LOCATION OF LAKELSE LAKE IN THE SKEENA RIVER SYSTEM of the estuary, deltas of sand and gravel were built on top of the finer sediments and some of these have been preserved as terraces along the valley walls between 600 and 700 feet above sea level.

The glacial retreat was followed by a rapid advance which brought the icefront to a point 3 miles south of Lakelse where it stagnated in a curving arc between Forceman Ridge and End Lake. A prolonged halt in ice movement followed, during which time the great kettled plain south of Lakelse was built. The surface of this plain must once have been a broad tidal flat at the head of a fiord.

This period of stagnation was followed by a steady recession of the glacier. As the glacier retreated northward a lake must have formed between its nose and the ice-contact face that forms the northern edge of the pitted outwash plain. For a short time this lake continued to drain southward through the shallow meltwater channel near Onion Lake but the present westward drainage must have been established shortly after the ice receded to a point north of Lakelse River. As the ice receded it deposited a thin boulder till which is preserved on top of the deltaic deposits formed during the earlier marine submergence.

A second prolonged halt in the recession of the ice is indicated by the ice-contact face that crosses Skeena Valley east of the Terrace airport. During this time the extensive sand and gravel deposits north of Lakelse were laid down. Unlike the flat surface of the kettled plain south of Lakelse, this surface slopes gently toward the southwest. Steeply dipping forest beds along the western and southern perimeter of the plain indicate that the flood plain was deposited in water that flooded the Skeena Valley up to at least the 600-foot contour. Although no fossils have been found in these deposits, it is probable that the water was an arm of the sea extending up Skeena Valley. This is suggested by the nearly identical elevation of the deltas in this flood plain and the surface of the pitted outwash plain south of Lakelse.

1.3 Geology

The bedrock in this region is made up mainly by rocks of the Coast Range batholith. They consist of diorite, granodiorite, granite and porphyritic granite and intrude and include highly metamorphosed limestones, marbles, cherty quartzites and argillities of probable Triassic Age (Marshall, 1926). The basin itself is mainly aluvium and glacial silt deposited more recently in the Pleistocene time.

1.4 Hot Springs

A number of hot springs occur on the eastern side of Lakelse Lake. The water produces a thick cloud of vapour due to its temperature (85^{o}C) and is said to contain medicinal value (very small percentage of sulphur) (Marshall, 1926). The water chemistry of the hot springs is given in Table 1.

1.5 Climate

The climate of Lakelse Lake area can be extrapolated from the records taken at the meteorological station at the Terrace Airport. The data reported in Table 2 was taken over a 15 - 19 year period between 1941 - 1970. The data for monthly hours of bright sunshine was for three years and was recorded at the Kitimat Townsite (Table 3) (twenty miles south of the lake).

The annual mean temperature for the Terrace Airport was 6.0^{o}C with a mean daily maximum of 9.9^{o}C and mean daily minimum of 2.4^{o}C. The annual mean precipitation for the same period was 130.1 cm. A considerable percent of this precipitation fell as snowfall. Tables 2 and 3 compare monthly mean daily temperature, monthly mean total precipitation and rainfall and the monthly hours of bright sunshine (B.C. Dept. of Agriculture - Climate Reports).

TABLE 1 : Water analysis of Skoglund Hotsprings
(from SKOGLUND HOTSPRINGS RESORT LTD., Terrace, B.C.)

	mg/1
Ca.	46.6
Mg.	50.2
Na.	320.6
HCO_3	43.6
CO_3	2.3
SO_4	457.2
Cl.	215.9
F.	3.3
SiO_2	5.6
Alkalinity ($CaCO_3$	20.3
TDS	1109.6
T. Fe	18.2
T.P.	8.2
Li	10.2

Table 2. Climate Data for Lakelse Area Taken at Terrace Airport[1]

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Mean Daily Temperature °F.	21.3	30.3	35.2	42.3	50.3	57.2	61.1	60.0	53.4	43.3	32.4	25.9	42.8
Mean Daily Max.Temperature °F.	25.7	34.9	41.5	50.7	59.9	66.8	70.6	68.5	60.6	48.1	35.8	29.3	49.4
Mean Daily Min.Temperature °F.	17.9	25.7	28.8	33.8	40.5	47.5	51.5	51.5	46.0	38.6	28.9	22.5	36.1
Mean Rainfall (inches)	1.86	2.35	1.65	1.93	1.53	1.54	2.32	2.23	3.89	8.92	4.77	3.61	36.6
Mean Snowfall (inches)	38.4	26.2	14.6	5.4	0.2	0.0	0.0	0.0	0.0	2.1	18.3	41.0	14.6
Mean Total Precipitation (inches)	5.70	4.97	3.11	2.47	1.55	1.54	2.32	2.23	3.89	9.13	6.60	7.71	51.22

Table 3. Monthly Hours of Bright Sunshine Recorded at Kitimat Townsite[2]

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1973	47	66	124	157	211	201	217	173	123	62	37	29	1447
1972	40	61	116	170	207	185	225	151	128	79	36	19	1417
1971	32	65	75	140	262	113	272	178	118	71	23	49	1398
MEAN	39.7	64.0	105.0	155.7	226.7	166.3	258.3	167.3	123	70.7	32.0	32.3	1420.7

[1] B. C. Dept. of Agriculture -- Climatic Normals -- 1941-1970.

[2] B. C. Dept. of Agriculture -- Climate Reports -- 1971, 1972 and 1973.

1.6 Hydrology

Lakelse Lake is fed by thirteen small creeks. The main stream drainage comes from Williams Creek. The outlet is via the Lakelse River which flows to the Skeena River. According to Brett (1950) "lake and stream levels have been found to rise more in accordance with hours of sunlight (melting snow) than with precipitation, a relation which is gradually supplanted by the effect of precipitation alone with the progress of the seasons into the late summer months".

Inland Waters Directorate has supplied some discharge data for the Lakelse River in Table 4.

1.7 Vegetation

The vegetation in this area has been broadly classified by Krajina (1965) as coastal western hemlock, based on macro-climatic and zonal-soil features. At lower elevations, the watershed consists mainly of hemlock and spruce with lesser amounts of cedar, balsam, pine, cottonwood and alder. The timber line extends up to approximately 4,000-foot level.

1.8 Fisheries Resource

All five species of Pacific salmon; pink (Oncorhynchus gorbuscha), coho (Oncorhynchus kisutch), chinook (Oncorhynchus tshawytscha), chum (Oncorhynchus keta), and sockeye (Oncorhynchus nerka) utilize the Lakelse River watershed to some extent. The watershed also supports a variety of other fish species: cutthroat trout (Salmo clarki), rainbow trout (Salmo gairdneri), Dolly Varden char (Salvenlinus malma), squawfish (Ptychocheilus oregonense), rocky mountain whitefish (Prosopium williamsoni), peamouth chub (Mylocheilus caurinum), large-scale suckers (Catostomus macroocheilus), redside shiners (Richardsonius balteatus), threespine stickleback (Gasterosleus aculeatus), prickly sculpin (Cottus asper) and river lamprey eels (Lampetra ayresi) (Brett and Pritchard, 1946).

The ten year average salmon adult escapement (1966-75 inclusive)

TABLE 4: MONTHLY MEAN DISCHARGE IN CUBIC FEET PER SECOND FOR LAKELSE RIVER FOR PERIOD OF RECORD[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1948	-	-	-	-	-	-	460	-	-	-	-	-
1949	-	-	-	-	1300	1160	669	482	372	-	-	-
1950	-	-	-	-	608	1390	-	-	-	-	-	-
1954	-	-	-	342	801	1230	931	578	672	1100	-	-
1955	-	-	-	370	468	-	-	-	-	-	-	-
Mean	-	-	-	356	817	1260	687	530	522	1100	-	-

1 Data provided by Inland Waters Directorate publication, Historical Streamflow for British Columbia, 1974.

TABLE 5: LAKELSE RIVER WATERSHED TEN YEAR AVERAGE ADULT ESCAPEMENTS[1] (1966-1975 inclusive).

	PINK	SOCKEYE	CHUM	COHO	CHINOOK
Lakelse River[2]	521,000		373	15,000	280
Williams/Sockeye Creeks		4,203	20	520	
Shulbuckland Creek		2,090	20	188	
Clearwater Creek		170		600	
Herman Creek	155			253	
Total Watershed	521,355	6,463	413	16,561	280

1 ESCAPEMENT FILES DATA, FISHERIES AND MARINE SERVICE, VANCOUVER, B.C.

2 See Figure 3 for stream location.

for this system is as follows: pinks - 521,355; coho - 16,561; chinook - 280; chum - 413; sockeye - 6,463 (Table 5). The pink salmon spawn mainly in the Lakelse River while the sockeye spawn in some of the tributaries of Lakelse Lake. Salmonid beach spawning has not been observed. Other small streams in the watershed are of minimal importance as salmon spawning grounds.

Sinclair (1974) reported that the Lakelse Lake watershed makes an approximate annual contribution to the total Skeena salmon escapement of 56% of the pinks, 36% of the coho, 9% of the chum and 2% of the sockeye. Adult Pacific salmon upstream migrants arrive in this system during overlapping time periods (according to species variation) within the time frame of late July to late December. The salmonid fry emerge from the gravel in late spring, chum and pink fry immediately migrate downstream to the sea, while coho, chinook, sockeye and steelhead fry rear in the system year round (Forester, 1968).

The steelhead trout population has been reported to be of two distinct spawning stocks; a lesser summer run entering the system in late August to early October, (approximately 200 fish) and a winter run entering from November to January (approximately 700 fish) (Pinsent and Chudyk, 1973).

1.9 Land Use

Lakelse Lake and its surrounding watershed is used for both commercial and recreational use. The property surrounding the lake is used for two commercial resorts, a seaplane base, a public campsite and picnic grounds, approximately 200 privately owned residences and cottages and the remainder under various forms of forest tenure (Figure 2). The lake itself is used for sewage disposal, transportation, water supply and a variety of recreational activities.

Apart from septic sewage drainage from permanent residences and the park sites, the only known point source of sewage effluent is from the Skoglund Hot Springs. This source of sewage drains through a man made ditch and into the lake, and was sampled as station IV during this survey.

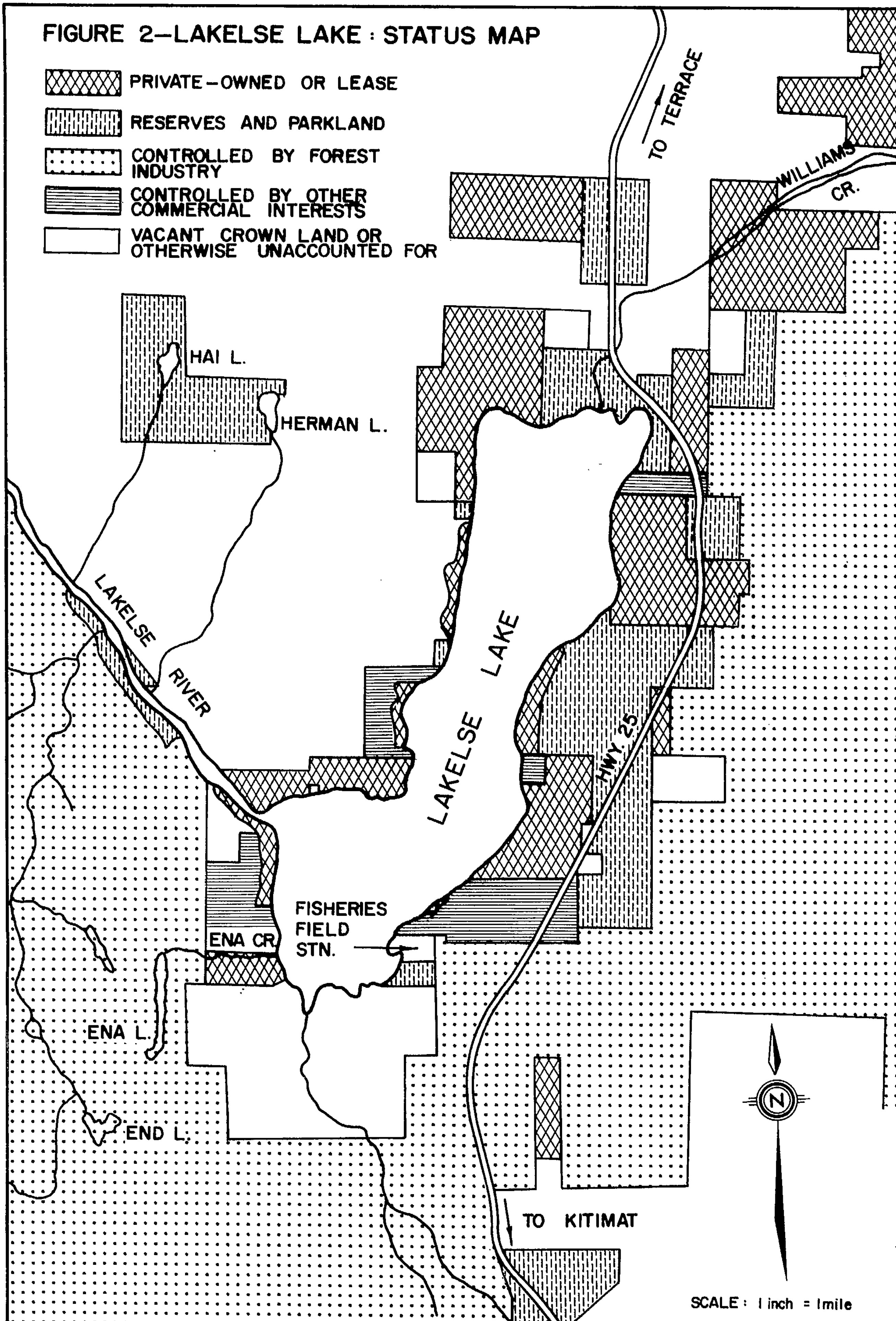
FIGURE 2–LAKELSE LAKE : STATUS MAP
PRIVATE–OWNED OR LEASE
RESERVES AND PARKLAND
CONTROLLED BY FOREST INDUSTRY
CONTROLLED BY OTHER COMMERCIAL INTERESTS
VACANT CROWN LAND OR OTHERWISE UNACCOUNTED FOR
TO TERRACE
WILLIAMS CR.
HAI L.
HERMAN L.
LAKELSE RIVER
LAKELSE LAKE
HWY 25
FISHERIES FIELD STN.
ENA CR
ENA L.
END L.
TO KITIMAT
N
SCALE : 1 inch = 1mile

Sinclair (1974) points out that during 1973, nearly 88 percent of the Terrace household, 82 percent of the Kitimat households and slightly over 54 percent of Prince Rupert households visited Lakelse Lake for recreational purposes. In addition, the lake provided an important camping or resting area for non-residents during the summer.

2. CURRENT STUDIES

During the early 1970's it became apparent to this Service that in the Lakelse Lake watershed there were several existing and proposed land and water use conflicts. These increased land use problems consisted of mining, logging, transmission lines, agriculture, recreational activities, permanent residences, and sewage, all of which affect, in various ways, the fisheries resources.

To resolve some of these existing and potential conflicts the Fisheries Service initiated a study to identify priorities and serve as a guideline for these and other watersheds. This study, by Sinclair, was published in 1974 and was presented to the Regional District as a multiple use concept for integrated management of this lake.

Since the publication of this report it became apparent that some of the biological studies should be expanded to further increase and document the knowledge of this lake basin. Therefore due to the continual effect upon the fisheries resource a second biological - limnological study of Lakelse Lake was undertaken. The parameters used to document the tropic level and the biological production are outlined below:

2.1 Lake Morphometry

Morphometric parameters are of primary concern in most aquatic habitats. The physical characteristics of a lake can influence the biological and chemical environment thus affecting the lake productivity (Rawson, 1955).

2.2 Water Chemistry

Water chemistry influences the basic components of any natural waters thereby affecting the natural productivity. This study attempts to characterize the water chemistry of Lakelse Lake during 1974 - 1975.

2.3 Phytoplankton

Phytoplankton are the primary utilizers of nutrients and are the consequential primary food organisms. These primary producers, by utilizing light and nutrients, initiate and sustain the trophic level of the biological community. The algae production as well as influencing the quantity of secondary production, may also effect the quality of the water and the fishery.

2.4 Zooplankton

Zooplankton are the second trophic level in an aquatic system. They are usually interdependent upon the phytoplankton and are an essential link in the food chain to the fishery.

2.5 Zoobenthos

Zoobenthos refers to those invertebrates that inhabit the bottom sediments of aquatic systems. This benthic community contributes an important role in the ecosystem. Quantity and quality of zoobenthos are also good indicators of the general productivity of a water body.

2.6 Aquatic Vegetation

The luxuriant growth of plants in a lake is caused by enrichment of nutrients into the lake. A study of aquatic plants is therefore a further indication of lake productivity.

2.7 Trophic Level

The eutrophication of natural waters and the ensuing deterioration of the water quality is an increasing problem in developed countries. This study will attempt to establish the trophic level of Lakelse Lake.

3. METHODS

3.1 Morphometry of Lakelse Lake

The bathymetric map of Lakelse Lake was prepared from sonar transects between shore stations located on a topographic map. The lake outline map was enlarged to a scale of 3.75 inches to the mile. The horizontal control was achieved using a range finder between shore stations. A Furuno FG 200 sounder was calibrated using a sounding line. Replicate sonar transects were made and several horizontal control measurements were obtained. A total of 50 transects were obtained on the lake.

General morphometric parameters for Lakelse Lake were obtained in the following manner. Areas of water were calculated using a polar planimeter and a dot grid measurement. Shoreline lengths were determined from an altimeter calibrated to Water Survey of Canada benchmark numbers 1871 J and 1872 J. Lake volumes of contour delimited segments were calculated on a Hewlett-Packard plotter by the equation (1) below and the basin volume determined by summation.

$$(1) \quad V = \frac{h}{3}\left(a_1 + a_2 + \sqrt{a_1 \cdot a_2}\right) \quad \text{(Hutchinson 1957)}$$

where

V = volume in cubic feet

h = depth between contours in feet

a_1 = area of contour 1 in square feet

a_2 = area of contour 2 in square feet.

Shoreline development factor was calculated from formula (s) below:

$$(2) \quad SDF = \frac{S}{2\sqrt{A\pi}} \qquad \text{(Hutchinson 1957)}$$

where

SDF = shoreline development factor

S = length of shoreline in miles

A = area of lake in square miles.

Mean depth was determined using total volume and surface area of water. Maximum depth was taken directly from the contour map. The mean rate of flow of water at the outlet has not been continuously monitored. The estimated flow was extrapolated from the available data for the years 1949-1950, 1954, 1955 (Table 4). For calculation of the lake exchange time, the complete mixing of the lake water was assumed.

3.2 Water Discharge from Lakelse Watershed

There is limited information available concerning the discharge of water from the Lakelse watershed. Water Survey of Canada flow data are recorded for only seven months. No discharge information is available for the winter months, November to March. Therefore, in order to compute the lake water exchange time, which requires knowledge of discharge, information was extracted from the Kitsumkalum watershed. This river although it is six times as large, was selected on the basis of:

a) the availability of annual information,
b) the climatic comparability,
c) the physiographic similarities and
d) its geographic proximity to the Lakelse River system.

3.3 Macrophytes

The objectives of this survey were to describe the lake macrovegetation and to estimate the total plant coverage. Since luxuriant plant growth is a sign of eutrophic water quality, the survey results were used as a qualitative indicator of lake productivity.

Two independent surveys as described by Kershaw 1971 and Wood 1975, were undertaken. The first survey consisted of a scuba divers transversing the entire lake on twenty-five predetermined transect lines. An estimate of total plant cover was assessed by both divers and relayed to a third party who plotted the coverage on a depth contour map. Various coverage estimates were photographed with infrared film and checked for accuracy. The shoreline was completely photographed at ± 100 feet from which shoreline coverage was assessed. Samples of each plant were collected and submitted to the laboratory for identification.

The second method consisted of assessing the abundance (number) and coverage of an area. This method required that forty quadrats, each 100 square meters, were randomly located in Lakelse Lake. Scuba divers were requested to count the number of plants by species and grouping within each quadrat and estimate the coverage.

3.4 Water Chemistry

Nine water chemistry sampling stations were established on Lakelse Lake, Lakelse River and the major tributaries, (Figure 3). The stations were monitored 7 times between December 1974 to October 1975.

Samples were collected with a Nansen water sampler and shipped in dark, ice packed coolers to the chemistry laboratory, Department of the Environment, Fisheries and Marine Service, Vancouver, B. C. Samples were generally analyzed within 24 hours of collection. For detailed methods see Laboratory Manual, Fisheries Service - Environmental Protection Service, Pacific Region, 1974.

Additional samples were taken on February 1975, June 1975 and August 1975 in order to assess the water quality of the precipitation. The February sample consisted of snow collection (from Station III) into large plastic bags, kept frozen and returned to Vancouver Laboratory for analysis. The June and August samples were rain water collected into a water sampling bottle using a large screened funnel. Both these samples were collected (at Station VIII) over one night each and sent to the chemistry laboratory for analysis.

3.5 Phytoplankton

Three samples were collected in a 250 ml bottle from 0.5 meters depth and preserved in Lugol's solution. The algae were identified and enumerated using the Utermohl technique. Biomass was estimated by multiplying volume by number of cells per unit volume. This method is described in Vollenweider (1969). Samples were collected from one lake station.

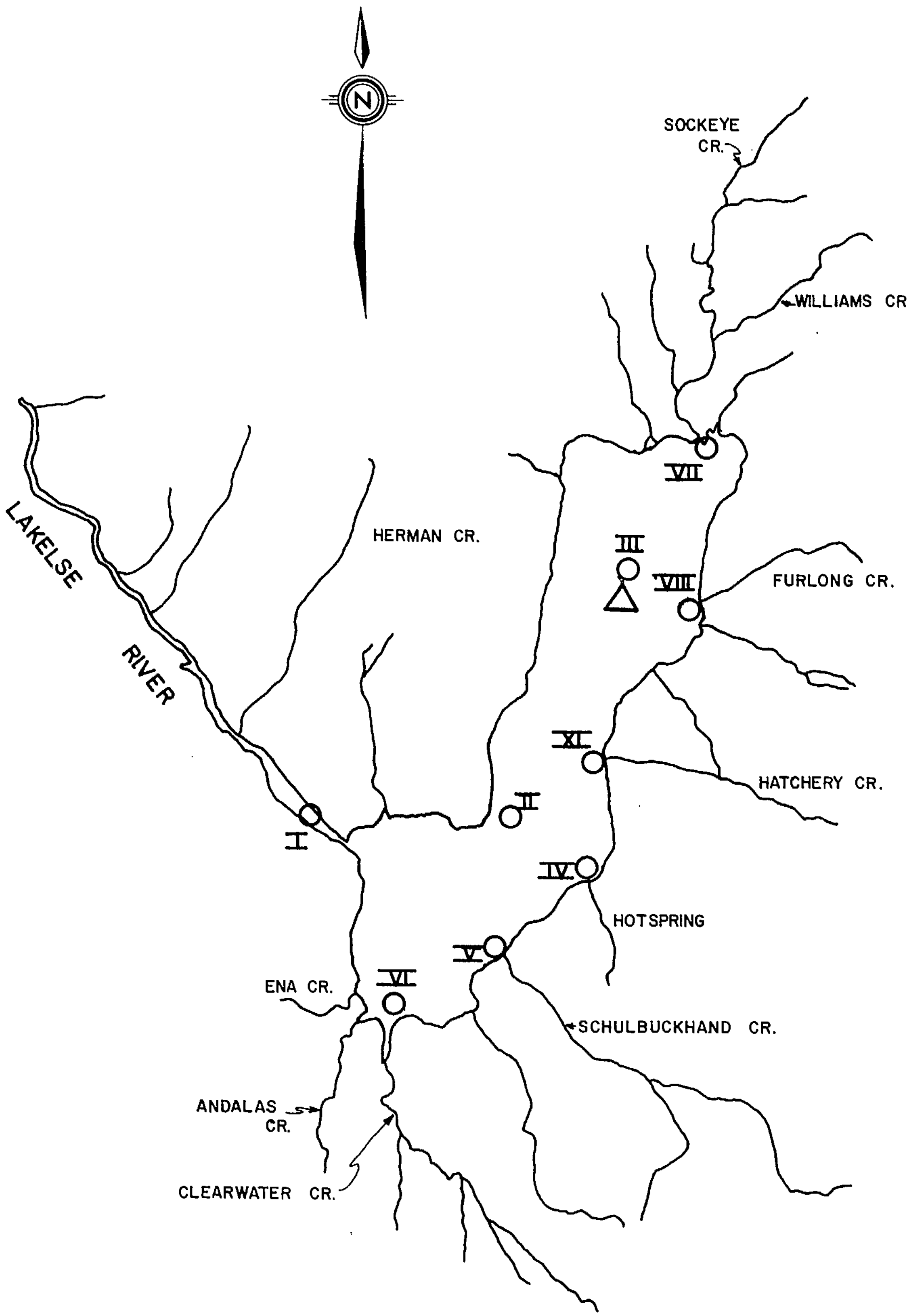

Figure 3 Lakelse Lake sampling stations, 1974-75.

3.6 Zooplankton

Data were collected between February and August 1975 at two stations on Lakelse Lake (Figure 3). Ten meter vertical hauls were made at each station using a single net with a mouth diameter of 25 cm. and a pore opening of 77 u. The results are expressed as individuals per litre. Corresponding individuals per cm^2 values are identical, since hauls were taken from depths of 10 meters. The figure given for each species represents the accumulated total of various life stages.

3.7 Zoobenthos

The survey was conducted during June 1976. The sample site was located at Station III, and a series of dredgings were collected from various depths within the lake profile, using a standard ponar dredge. Sediments were field sieved using a Nitex nylon net (400 u mesh) and the residue preserved in 5 to 7% formalin. Laboratory samples were rinsed overnight to remove formalin and sorted with a steriomicroscope. Organism identification was accomplished using a stereo and a compound microscope depending upon size of the specimen. Copepoda, Cladocera, Ostrocoda and other small (<400 u) species were not enumerated because they were not sampled quantitatively in the field seining net.

4. RESULTS

4.1 Morphometry of Lakelse Lake

Results of the morphometric parameters of Lakelse Lake are reported in Table 6, a comparison to the original survey by Brett 1950 is given in Table 7. The bathymetric map prepared from this survey is presented on the inside of the back cover. The total water volume and area by contours is presented in Tables 8 and 9.

During the bathymetric survey, special effort was made using the sounder to locate the boundaries of the May 25, 1962 landslide into Lakelse Lake. Location of the slide was very obvious on the sounding chart due to the large number of submerged trees. The sounding

TABLE 6: MORPHOMETRIC PARAMETERS OF LAKELSE LAKE, 1976.

	Lakelse Lake
1. Total area - acres	3,500 (1416 ha.)
2. Maximum depth - feet	104 (32 metres)
3. Mean depth - feet	28.2 (8.6 metres)
4. Volume - acre feet	98,900 (1.2×10^8 cu. m.)
5. Flow, mean monthly*	
cfs to the lake	704 (estimated)
cfs at the Skeena River	764 (estimated)
6. Exchange time - days	69
7. Number of islands	0
8. Shoreline length - miles	16.7 (26.87 km.)
9. Shoreline development	1.83
10. Altitude - feet	237 (72.2 m.)

* See section 4.2

TABLE 7: Comparison of morphometric parameters on Lakelse Lake between 1950 and 1976.

	1950*	1976
Area (sq. miles)	5.47	5.47
(ha.)	1416	1416
Maximum depth (ft.)	98	104
(m.)	29.87	31.7
Mean depth (ft.)	24	28.2
(m.)	7.32	8.6
Volume (cu. yds.)	141.3×10^6	159.5×10^6
(cu. m.)	108×10^6	121.9×10^6
Shoreline development	1.83	1.83
Elevation (ft.)	220	237
(m.)	67.06	72.2

* Brett 1950

TABLE 8: Volume of water between lake contours

Depth-Feet		Volume-Acre feet
0 - 5	=	16,649
5 - 10	=	14,931
10 - 15	=	12,878
15 - 20	=	10,864
20 - 25	=	9,041
25 - 30	=	7,076
30 - 35	=	5,623
35 - 40	=	4,693
40 - 45	=	3,812
45 - 50	=	3,046
50 - 55	=	2,447
55 - 60	=	1,997
60 - 65	=	1,568
65 - 70	=	1,184
70 - 75	=	950
75 - 80	=	757
80 - 85	=	577
85 - 90	=	423
90 - 95	=	281
95 - 100	=	102
100 - 104	=	0.6
Total of Lake		98,899.6 (1.2 x 10^8 cu.m.)

TABLE 9: Total area of Lakelse Lake by lake contour

F.T. SHORE	ACREAGE	HECTARE
5	3500.94	1416.76
10	3161.36	1279.33
15	2814.50	1138.97
20	2006.07	811.82
25	1617.33	654.50
30	1222.21	495.60
35	1029.66	416.68
40	850.31	344.10
45	677.79	274.28
50	543.05	219.76
55	437.45	177.03
60	362.34	146.63
65	267.20	108.13
70	207.57	83.99
75	172.98	70.00
80	130.64	52.87
85	100.60	40.71
90	69.65	28.19
95	43.70	17.68
100	4.10	1.66

information was cross referenced using a hand dredge and examining the retrieved materials. The natural lake substrate was mainly fine mud-clay silt whereas the slide material was mainly gravel and a large amount of organic debris. The boundaries are presented in Figure 4 and the area estimated (using a dot grid) to be 285 ha/acres of slide materials.

4.2 Annual Discharge from Lakelse Lake

The mean annual discharge on the Lakelse River was extrapolated from the Kitsumkalum River on the basis of drainage area. Mean annual water yield from the Kitsumkalum system was computed at 4 cfs per square mile of drainage area, Table 10. The drainage area of Lakelse River was then measured at 191 square miles, which would give an estimated annual discharge of 763 cfs. Estimating the direct drainage into the lake of 176 square miles would give mean annual lake outflow of approximately 704 cfs. The lake exchange was then computed at:

$$\frac{\text{Lake Volume}}{\text{Discharge}} = \frac{\text{98900 acre feet}}{\text{508780* acre feet/yr.}} = \begin{matrix}\text{0.19 yrs.} \\ \text{(71 days)}\end{matrix}$$

* where flow of 704 cfs = 1394 acre feet over 24 hours

or = 508780 acre ft./yr.

The theoretical lake exchange of 0.19 years or 71 days is based on a mean flow throughout the year. However, since natural river discharge is not constant a more accurate estimate was attempted using accumulated lake discharge by month to mean lake water volume. This figure shows that the lake does not completely exchange every 71 days (5 times per year) as the computed exchange indicates. Figure 10 shows the lake exchanges four times during the late spring to summer period (6 months) and only once during the remaining fall to spring period (6 months), Figure 5.

4.3 Aquatic Macrophytes

The survey was conducted during August 1975. The overview survey by the divers was completed successfully, however, the second technique, was only partially successful due to the extreme labour

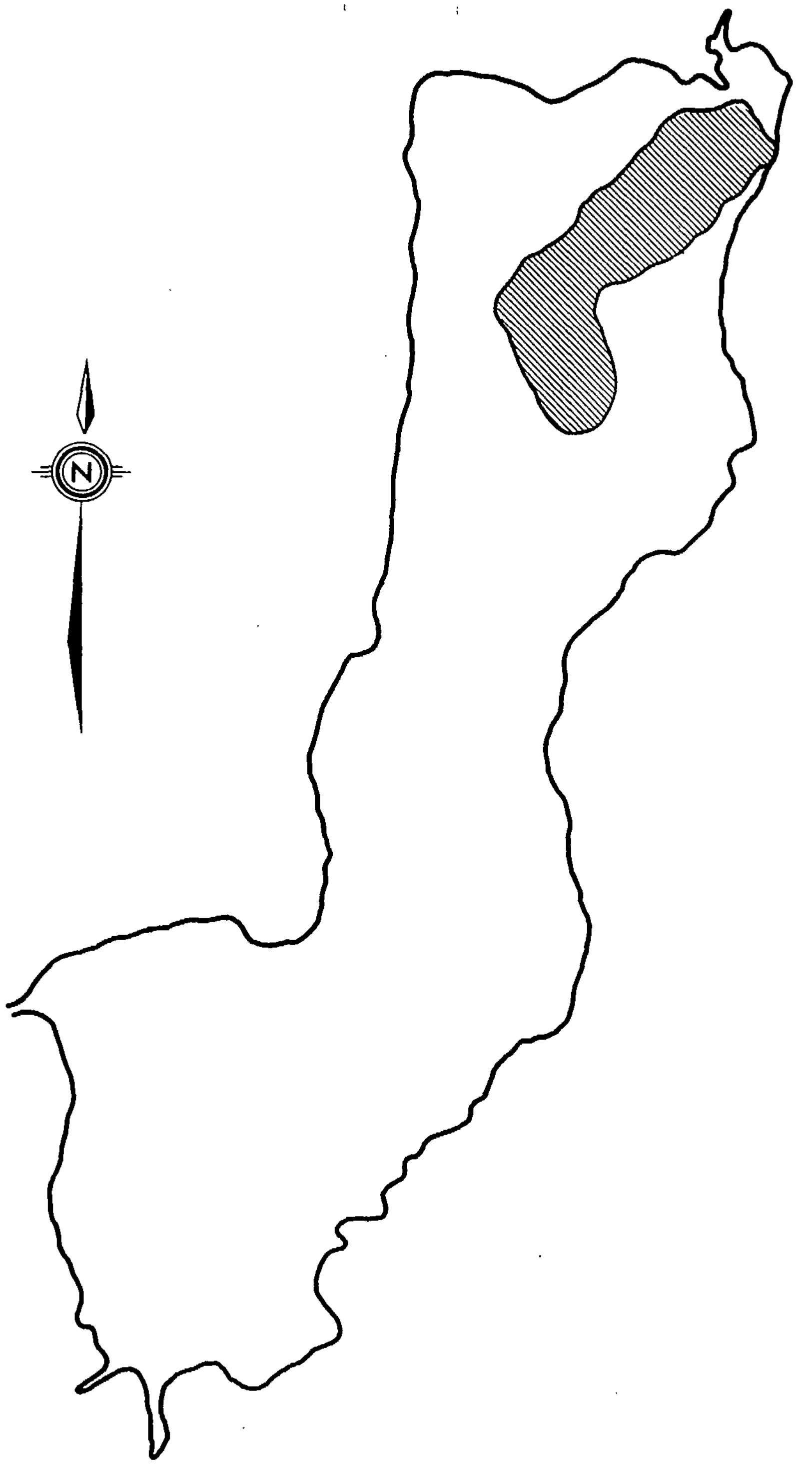

FIGURE 4 — APPROXIMATE AREA PRESENTLY AFFECTED BY THE 1962 SLIDE INTO LAKELSE LAKE

TABLE 10 MEAN MONTHLY DISCHARGE OF LAKELSE AND KITSUMKALUM SYSTEMS.

	Kitsum-Kalum[1] River cfs	Lakelse[2] River cfs	Lakelse R.[2] cfs Extrapolated	Discharge[3] cfs from Lakelse L.	Discharge from Lakelse L. Acre-Feet	Accumulated Lakelse Lake Discharge Acre-Feet
January	1330	-	232.9	214.2	12857	12857
February	1080	-	189.1	174.0	10440	23297
March	438	-	76.7	70.6	4234	27531
April	1930	356	338.0	310.9	18657	46188
May	6250	817	1094.6	1007.0	60420	106608
June	10100	1260	1768.8	1627.3	97639	204247
July	8400	687	1471.1	1353.4	81204	285451
August	6620	530	1159.4	1066.6	63997	349448
September	5210	522	912.4	839.4	50366	399814
October	5080	1100	889.7	818.5	49110	448924
November	3660	-	640.9	589.7	35382	484306
December	2121	-	371.5	341.7	20503	504809
Mean	4360	-	763	702	-	--
Drainage Area	1090	191	191	175.7	175.7	175.7

1 From Water Survey of Canada. Inland Waters. Historical Stream Flow Survey, British Columbia, 1974.

2 Extrapolated from Kitsumkalum River discharge using the ratio of 4 cfs per square mile of drainage basin.

3 Discharge from Lakelse Lakes is 92% of total watershed.

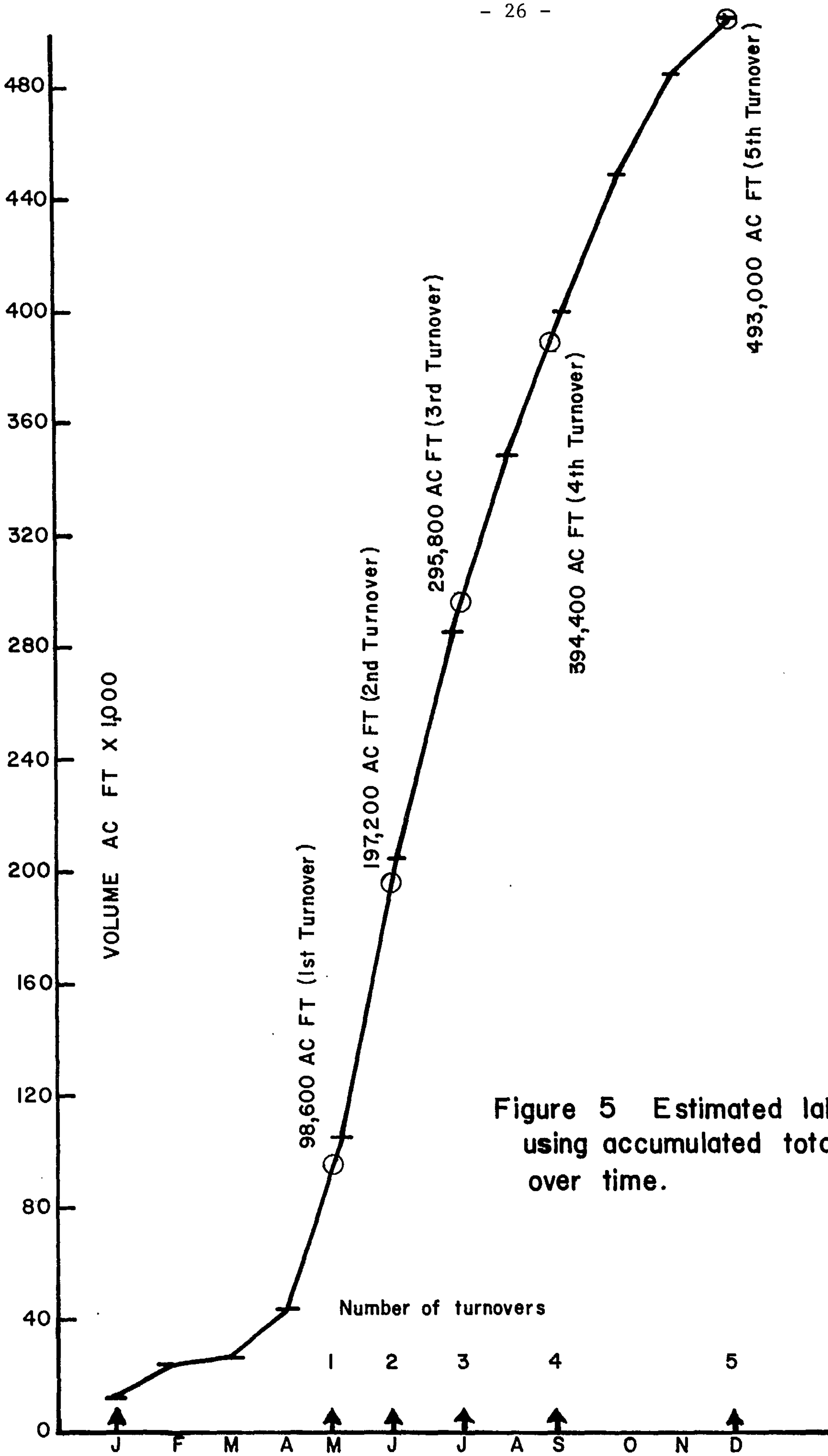

Figure 5 Estimated lake exchange using accumulated total water volume over time.

requirement. The second technique was cancelled after five quadrats were examined and the results presented are those of the first method.

A sample of each predominant aquatic macrophyte observed in Lakelse Lake was returned to Vancouver laboratory and keyed to genus. A list of these plants is presented in Table 11. From diver estimates the dominant species throughout the lake were Elodea and Potamogeton.

The observations, by the divers, were plotted on the lake outline and are presented in Figure 6. It is apparent from this figure that macrophytes are abundant to approximately the 15 foot contour. Plant life was very sparce after the 20 foot depth. In some areas, especially the south end of the lake, the plants were extremely dense and a large degree of plant overlapping was evident. Also, due to the sampling technique, smaller and many subsurface plants were unavoidably missed when estimating the total plant coverage. The estimate of plant coverage on Figure 6 is therefore a very conservative estimate.

The west side of the lake was chiefly vegetated with a thin band of bullrushes (Scirpus sp.) which grew to a maximum depth of 5 feet. The north end of Lakelse Lake had a poor coverage of plants probably due to the strong wave action and the prevailing wind. The Williams Creek bay contained a substantial number of acquatic macrophytes. The predominant plant in this area was Elodea. On the eastern shore some bullrushes (Scirpus sp.) and cattails (Typha sp.) grow in isolated bays however, macrophyte growth is generally sparce. This is likely due to the heavy land use on these shorelines. The southern shoreline is sheltered from most winds and is relatively shallow. This area has the greatest coverage and the greatest diversity of macrophytes in this lake. The most dominant plants in number and coverage were identified as Potamogeton sp. and Elodea sp.

4.4 Water Chemistry

The complete results of chemical analysis of water from Lakelse Lake are recorded in Table 12. A summary of the annual range for all chemical parameters are recorded in Table 13. Station locations are indicated on Figure 3. A comparison with other Skeena River lakes is

TABLE 11: List of predominant aquatic plants observed in Lakelse Lake, 1975.

Potamogeton sp.

Elodea sp.

Nuphar sp.

Scirpus sp. (bullrush)

Myriophyllum sp.

Sagittaria sp. (arrowhead)

Chara sp.

Typha latifolio L. (cat-tail)

TABLE 12: CHEMICAL ANALYSIS OF LAKELSE LAKE WATER 1974 - 1975

LAKELSE LAKE

DATE - DECEMBER 11, 1974

STATION NUMBER	DEPTH M	TEMP. °C	pH	COND. µmho/cm	TR mg/l	NFR mg/l	HARDNESS mg/l $CaCO_3$	Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Si mg/l	NH_3 mg/l	NO_2 mg/l	NO_3 mg/l	OP mg/l	TP mg/l
II	0.5	4.0	-	-	41	-	21	2.0	0.52	0.77	7.0	3.0	5	2.7	-	<.005	0.01	<.005	0.02
III	0.5	4.0	-	-	65	-	26	4.5	0.50	0.83	8.2	6.9	10	2.7	0.02	<.005	0.01	<.005	0.026
	10.0	3.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IV	0.5	6.2	-	-	265	-	36	44.0	1.10	1.40	13.0	16.5	65	6.4	0.04	<.005	0.01	0.005	0.034
V	0.5	3.5	-	-	21	-	18	0.84	0.33	0.48	6.3	0.8	<5	2.7	<.01	<.005	0.04	<.005	<.01
VII	0.5	3.8	-	-	24	-	26	0.98	0.38	0.72	9.0	1.7	<5	2.8	<.01	<.005	0.02	<.005	<.01
IX	0.5	3.0	-	-	22	-	15	0.95	0.23	0.36	5.4	-	<5	2.7	<.01	<.005	0.02	<.005	<.01

DATE - FEBRUARY 3, 1975

STATION NUMBER	DEPTH M	TEMP. °C	pH	COND. µmho/cm	TR mg/l	NFR mg/l	HARDNESS mg/l $CaCO_3$	Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Si mg/l	NH_3 mg/l	NO_2 mg/l	NO_3 mg/l	OP mg/l	TP mg/l
III	0.5	0.2	7.2	55	54	<10	23	2.4	0.66	0.72	7.9	2.6	5	2.7	0.02	<.005	0.05	<.005	0.02
	2	0.5	-																
	4	0.6	-																
	7	1.0	-																
	20	3.5	-																
V	0.5	0.5	7.4	51	54	<10	22	1.2	0.42	0.66	7.9	-	5	3.1	<0.01	<.005	0.04	<.005	<.01
VII	0.5	0.5	7.2	64	71	<10	28	1.6	0.33	0.82	10.0	-	5	3.1	<0.01	<.005	0.04	<.005	<.01
VIII	0.5	0.2	7.3	34	53	<10	14	1.0	0.27	0.47	5.0	-	5	3.2	<0.01	<.005	<0.01	<.005	<.01
IX	0.5	0.2	7.2	38	57	<10	16	0.9	0.29	0.35	5.9	-	5	-	<0.01	<.005	0.04	<.005	<.01

TABLE 12: CHEMICAL ANALYSIS OF LAKELSE LAKE WATER 1974 - 1975

LAKELSE LAKE

DATE - March 3, 1975

STATION NUMBER	DEPTH M	TEMP. °C	pH	COND. µmho/cm	TR mg/l	NFR mg/l	HARDNESS mg/l $CaCO_3$	Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Si mg/l	NH_3 mg/l	NO_2 mg/l	NO_3 mg/l	OP mg/l	TP mg/l
III	0.5	0.5	7.0	26	26	<10	10	2.2	0.3	0.4	3.4	3.8	5	2.2	0.01	<.005	0.02	<.005	0.02
	10.0	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IV	0.5	5.2	6.5	229	210	38	32	32.0	1.2	1.5	12.0	16.0	55	5.8	0.045	<.005	0.05	0.011	0.045
V	0.5	2.2	7.3	52	61	<10	23	0.9	0.4	0.7	8.2	1.4	<5	3.2	<.01	<.005	0.03	<.005	<.01
VII	0.5	3.2	7.3	41	45	<10	29	1.3	0.4	0.9	10.0	1.3	<5	2.8	<.01	<.005	0.02	<.005	<.01
VIII	0.5	2.8	7.5	57	46	<10	23	1.6	0.5	0.7	8.0	1.3	<5	3.2	<.01	<.005	0.03	<.005	<.01
IX	0.5	1.5	7.0	55	71	<10	19	0.9	0.3	0.4	7.0	1.5	<5	3.4	<.01	<.005	0.03	<.005	<.01

DATE - May 28, 1975

STATION NUMBER	DEPTH M	TEMP. °C	pH	COND. µmho/cm	TR mg/l	NFR mg/l	HARDNESS mg/l $CaCO_3$	Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Si mg/l	NH_3 mg/l	NO_2 mg/l	NO_3 mg/l	OP mg/l	TP mg/l
II	0.5	12.0	7.5	56	46	<10	20	2.5	0.39	0.45	7.5	3.0	5	2.6	0.01	<.005	0.01	<.005	0.044
III	0.5	12.0	7.6	74	45	<10	26	5.2	0.52	-	8.5	5.9	5	2.4	<0.01	<.005	0.02	<.005	0.066
IV	0.5	13.9	6.4	240	190	38.0	30	38.0	1.4	1.20	12.0	17.0	52	6.0	0.04	<.005	<.01	0.02	0.044
V	0.5	5.5	7.3	26	43	<10	11	0.9	0.22	0.27	4.0	1.3	<5	1.9	<0.01	<.005	0.07	<.005	0.017
VII	0.5	7.0	7.4	36	44	<10	16	0.7	0.21	0.45	5.8	2.1	<5	1.9	<0.01	<.005	0.07	<.005	0.013
IX	0.5	5.0	7.2	26	32	<10	11	0.8	0.27	0.22	3.9	1.7	-	2.6	<0.01	<.005	0.04	<.005	0.010

TABLE 12: CHEMICAL ANALYSIS OF LAKELSE LAKE WATER 1974 - 1975

LAKELSE LAKE

DATE - June 29, 1975

STATION NUMBER	DEPTH M	TEMP. °C	pH	COND. µmho/cm³	TR mg/l	NFR mg/l	HARDNESS mg/l $CaCO_3$	Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Si mg/l	NH_3 mg/l	NO_2 mg/l	NO_3 mg/l	OP mg/l	TP mg/l
III	0.5	14.8	-	-	-	-	-	2.80	0.37	-	6.4	-	5	1.9	<.005	<.005	0.02	<.005	0.01
V	0.5	6.0	-	-	-	-	-	1.51	0.24	-	3.7	-	<5	1.7	<.005	<.005	0.01	<.005	<.01
VII	0.5	5.8	-	-	-	-	-	1.62	0.23	-	5.6	-	<5	1.7	0.010	<.005	0.01	<.005	<.01
VIII	0.5	9.2	-	-	-	-	-	1.60	0.38	-	7.7	-	<5	1.9	0.015	<.005	0.01	<.005	<.01
IX	0.5	7.0	-	-	-	-	-	1.46	0.26	-	3.4	-	<5	1.4	<.005	<.005	0.01	<.005	<.01

DATE - August 19, 1975

STATION NUMBER	DEPTH M	TEMP. °C	pH	COND. µmho/cm³	TR mg/l	NFR mg/l	HARDNESS mg/l $CaCO_3$	Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Si mg/l	NH_3 mg/l	NO_2 mg/l	NO_3 mg/l	OP mg/l	TP mg/l
I	0.5	16.0	-	-	40	<10	-	1.7	0.31	-	-	-	<5	1.7	0.005	<.005	<.01	0.005	<.01
II	0.5	16.5	-	-	36	<10	-	2.5	0.31	-	-	-	7	1.7	0.005	<.005	0.01	0.008	0.01
III	0.5	16.8	-	-	34	<10	-	2.5	0.30	-	-	-	9	1.6	0.006	<.005	0.02	0.017	0.01
	1	16.8	-	-	41	<10	-	2.6	0.36	-	-	-	9	1.6	0.018	<.005	0.02	0.011	0.01
	7	15.2	-	-	37	<10	-	-	0.30	-	-	-	-	1.6	0.008	<.005	0.01	0.008	0.01
	10	12.7	-	-	47	<10	-	2.5	0.30	-	-	-	10	1.9	0.010	<.005	0.01	0.005	0.01
	20	12.5	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-
	30	10.0	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-
IV	0.5	15.9	-	-	303	39	-	68.0	1.94	-	-	-	53	7.4	0.070	<.005	<.01	0.011	0.026
V	0.5	11.0	-	-	30	<10	-	0.9	0.34	-	-	-	<5	1.8	0.007	<.005	<.01	0.005	<.01
VI	0.5	12.8	-	-	58	<10	-	1.4	0.50	-	-	-	<5	1.6	0.005	<.005	<.01	0.005	<.01
VII	0.5	10.9	-	-	49	<10	-	1.9	0.40	-	-	-	<5	1.8	0.007	<.005	<.01	0.005	<.01
VIII	0.5	14.4	-	-	64	<10	-	1.1	0.50	-	-	-	<5	1.7	0.009	<.005	<.01	0.005	<.01
IX	0.5	9.0	-	-	23	<10	-	0.9	0.30	-	-	-	<5	1.7	0.006	<.005	<.01	0.005	<.01

TABLE 12: CHEMICAL ANALYSIS OF LAKELSE LAKE WATER 1974 - 1975

LAKELSE LAKE

DATE - October 13, 1975

STATION NUMBER	DEPTH M	TEMP. °C	pH	COND. µmho/cm³	TR mg/l	NFR mg/l	HARDNESS mg/l $CaCO_3$	Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Si mg/l	NH_3 mg/l	NO_2 mg/l	NO_3 mg/l	OP mg/l	TP mg/l
I	0.5	11	7.1	36	25	<10	21	2.1	0.37	-	7.0	1.2	<5	1.9	<.005	<.005	0.01	<.005	<.01
II	0.5	11.9	7.5	52	30	<10	26	3.2	0.37	-	9.0	3	10	1.9	<.005	<.005	<.01	<.005	0.01
III	0.5	12.0	7.5	55	30	<10	24	3.1	0.42	-	9.8	3	10	1.9	0.010	<.005	<.01	<.005	0.01
IV	0.5	14.0	6.3	260	280	38	32	54.0	1.80	-	12	16.0	60	7.0	0.080	<.005	<.01	0.010	0.024
V	0.5	9.5	7.2	38	20	<10	19	1.0	0.37	-	7.2	1.6	<5	2.0	0.010	<.005	<.01	<.005	<.01
VI	0.5	11.0	7.3	42	30	<10	22	2.0	0.38	-	4.9	1.7	<5	2.1	<.005	<.005	<.01	<.005	<.01
VII	0.5	10.0	7.1	36	25	<10	24	2.0	0.37	-	5.9	1.4	<5	1.9	<.005	<.005	<.01	<.005	<.01
VIII	0.5	11.8	7.5	38	20	<10	22	2.1	0.37	-	7.1	1.2	<5	1.9	<.005	<.005	<.01	<.005	<.01
IX	0.5	11.8	7.2	40	25	<10	22	1.9	0.37	-	6.2	1.3	<5	1.9	<.005	<.005	<.01	<.005	<.01

TABLE 13: RANGE OF CHEMICAL PARAMETERS, LAKELSE LAKE WATER, 1974 - 1975

	I	II	III	IV	V	VI	VII	VIII	IX
pH	7.1	7.5	7.0-7.6	6.3-6.5	7.2-7.4	7.3	7.1-7.4	7.3-7.5	7.0-7.2
COND. µmho/cm^2	36	52-56	26-74	229-260	26-52	42	36-64	34-57	26-55
TR mg/l	25-40	30-46	26-65	190-303	20-61	30-58	24-71	20-64	22-71
NFR mg/l	<10	<10	<10	38-39	<10	<10	<10	<10	<10
HARD. mg/l $CaCO_3$	21	20-26	10-26	30-38	11-23	22	16-29	14-23	11-22
Na mg/l	1.7-2.1	2-3.2	2.2-5.2	32-68	0.84-1.51	1.4-2.0	0.72-2.0	1.0-2.1	0.83-1.9
K mg/l	0.31-0.37	0.31-0.52	0.30-0.66	1.1-1.94	0.22-0.42	0.38-0.50	0.21-0.40	0.27-0.50	0.23-0.37
Mg mg/l	-	0.45-0.77	0.30-0.83	1.2-1.5	0.27-0.70	-	0.45-0.90	0.47-0.70	0.22-0.40
Ca mg/l	7.0	7.0-9.0	3.4-9.8	12-13	3.7-8.2	4.9	5.6-10	5.0-8.0	3.4-7.0
Cl mg/l	1.2	3.0	3.0-6.9	16-17	0.8-1.6	1.7	1.3-2.1	1.2-1.3	1.3-1.7
SO_4 mg/l	<5	5-10	5-10	52-65	<5	<5	<5	<5	<5
Si mg/l	1.7-1.9	1.7-2.7	1.6-2.7	5.8-7.4	1.7-3.2	1.6-2.1	1.7-3.1	1.7-3.2	1.4-3.4
NH_3 mg/l	<.005-0.005	<.005-0.01	<.005-0.02	0.04-0.08	<.005-0.01	<.005-0.005	<.005-0.01	<.005-0.015	<.005-0.006
NO_2 mg/l	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
NO_3 mg/l	<.01-0.01	<.01-0.01	<.01-0.05	<.01-0.05	<.01-0.07	<.01	<.01-0.07	<.01-0.03	<.01-0.04
TP mg/l	<.01	<.01-0.044	<.01-0.066	0.024-0.045	<.01-0.017	<.01	<.01-0.013	<.01	<.01-0.01
OP mg/l	<.005-0.005	<.005-0.008	<.005-0.017	0.005-0.02	<.005-0.005	<.005-0.005	<.005-0.005	<.005-0.005	<.005-0.005

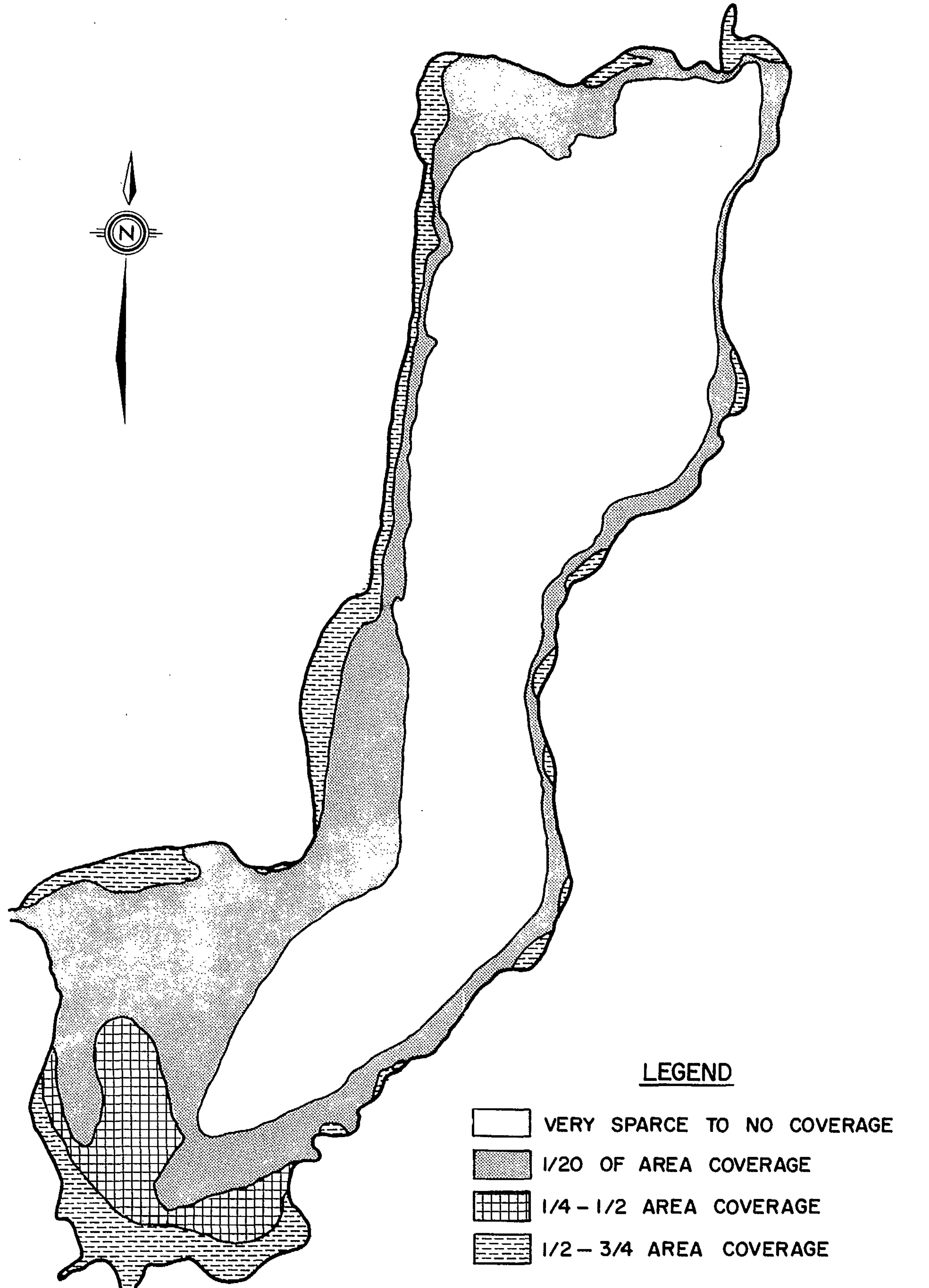

FIGURE 6 - EXTENT OF PLANT COVERAGE IN LAKELSE LAKE
AUGUST 1975

presented in Table 14.

4.4.1 Oxygen

Dissolved oxygen observations were obtained three times (March 3, June 29, October 13, 1975) at two depths (0.5 and 20 meters) from station 3. At one half meter depth the dissolved oxygen (expressed as percent saturation) was recorded at 78% on March 3, 95% on June 29 and 98% on October 13, 1975. The oxygen saturation decreased with depth. The percent saturation for the three sampling dates (at 20 m) were 51, 85, and 90 respectively.

4.4.2 Thermal Regime

Temperature observations are recorded in Table 12. A total of seven observations were taken from most stations between 11 December, 1974 to 13 October, 1975. In most large lakes heat transfer through the lake's surface is the overwhelming source of heat income while heat contributed by inflows is minor (Hutchinson 1957). This also appears true for Lakelse Lake since the lake (at 0.5 m) temperatures were consistently greater than any (except the minor inflow of the hot springs canal) of the natural streams between freshet (May) and October of 1975. The lake maximum temperature recorded was 16.8^{o}C on August 19, 1975. There was 6.8^{o}C of stratification in 30 meters of water at this time and a weak thermocline occurred between 7 (15.2^{o}C) and 10 (10.7^{o}C) meters.

4.4.3 pH

Hydrogen ion activity ranged between 6.2 to 6.5 units at the hotsprings canal (Station IV). The pH at all other stations was relatively similar ranging from 7.0 - 7.5 pH units.

4.4.4 Conductivity

Specific conductance ranged 21 - 65 umho/cm^2 at all stations and samplings except station IV (hotsprings canal) which ranged between 210 - 265 umho/cm^2 over four observations.

TABLE 14: COMPARISON OF SELECTED CHEMICAL PARAMETERS FROM LAKELSE AND OTHER SKEENA RIVER LAKES

	LAKELSE LAKE STATION III MAR. 13/75	LAKELSE LAKE STATION IV MAR. 3/75	BABINE LAKE AUG. 3/72[1]	BABINE LAKE OCT. 20-26/74[2]	BABINE LAKE AUG. 14/75[3]	KATHLYN LAKE AUG. 13/73[4]	MORICE LAKE $\bar{X}$ STATION 3[5]	NANIKA LAKE OCT. 22/74	KIDPRICE LAKE OCT. 22/74
- Hardness mg/l $CaCO_3$	10	32	-	36.3	-	16.6	15	17	19
- K mg/l	0.3	1.2	0.52	-	-	-	0.24	0.20	0.33
- Mg mg/l	0.4	1.5	-	-	2.5	1.05	0.47	0.40	0.91
- Ca mg/l	3.4	12	8.1	-	10.3	4.9	5.22	7.7	5.6
Cl mg/l	3.8	16	-	-	0.5	-	<1	<1	<1
SO_4 mg/l	5.0	55	-	-	<5	-	<5	<5	6
Si mg/l	2.2	5.8	-	-	4.3	-	1.22	1.4	1.48
Na mg/l	2.2	32	1.37	-	1.9	-	0.53	0.54	0.68
Cond. mho/cm	26	210	-	57	78	44	30-50	-	-
pH	7.0	6.5	6.8-7.6	7.9	7.6	7.4	7-7.6	7.3	7.2

1 Stockner and Shortreed, 1974

2 Chau and Wong (Station 4) N.D.

3 B.C. Water Resources Station 4 at 1 m, 1975

4 Baillie and Buchanan (2.5 m), 1974

5 Cleugh, In Press

Total Residue and Hardness

Total residues were less than 100 mg/l at all stations and samplings except at the hotsprings canal where the recorded concentrations ranged between 165 - 303 mg/l on five observations.

Water hardness (mg/l $CaCO_3$) is a component of total residues (total dissolved solids) and is mainly attributed to the calcium or magnesium ions. Generally the productivity of a body of water can be correlated with its hardness, although hardness has no biological significance but is simply a function of combinations of elements present in the water. In Lakelse Lake the waters are relatively "soft" and were recorded at less than 50 mg/l $CaCO_3$ at all stations and samplings.

Non-Filterable Residue

Station IV (hotsprings canal) ranged between 36 - 39 mg/l of non-filterable residues on five samplings, all other stations had less than 10 mg/l of non-filterable residues.

Cations

Station IV (hotsprings canal) had a positive input of all measured cations throughout the survey. Recorded observations were 32 - 68 mg/l of sodium; 1.1 - 1.94 mg/l of potassium; 1.2 - 1.5 mg/l of magnesium and 12 - 13 mg/l of calcium. The recorded concentrations of cations at all other stations were 0.72 - 5.2 mg/l of sodium; 0.21 - 0.66 mg/l potassium; 0.22 - 1.0 mg/l magnesium; and 3.4 - 10 mg/l calcium. No specific indications of any seasonal variations were observed.

Anions

Chloride values in Lakelse Lake, based on five observations ranged between 2.6 - 6.9 mg/l. This is relatively a large concentration compared to other Skeena drainage lakes (see Table 14) and also indicates some accumulation of this ion within the lake considering the lower stream input of <0.04 - 2.1 mg/l. Input from the hotsprings (station IV) was very high at 16 - 17 mg/l.

Sulfate also appears to accumulate within the lake basin. The recorded values were 5 - 10 mg/l in the lake and less than 5 mg/l input from the streams. Sulfate input from the hotsprings (station IV) ranged from 52 - 65 mg/l.

Silicon (as SiO_2) values in the hotsprings canal ranged between 5.8 - 7.4 mg/l in five samples. The streams and lake stations ranged from 1.4 - 3.4 mg/l. The streams appear to have a higher concentration of silicon during the winter than the summer. The concentration of silicon within the lake waters was also higher during the winter. Lower summer concentrations are likely related to either or both of (1) increased production or (2) increased flushing rate.

Nitrogen

Nitrite concentrations were always less than our analytical detection limit.

Nitrate values in the hotsprings canal (station IV) ranged from less than 0.01 to 0.05 mg/l, all other stations had concentrations of from less than 0.01 to a maximum of 0.07 mg/l in seven samples.

Ammonia-nitrogen (as NH_3 - N) values ranged 0.04 - 0.08 mg/l from the hotsprings canal. Stream stations were recorded at less than 0.005 to 0.15 mg/l with the greatest input occurring during the summer sampling. Lake concentrations were less than 0.005 to 0.02 mg.1 with winter values being greater than summer ammonia concentrations.

Phosphorus

Ortho phosphate was recorded at 0.005 to 0.02 mg/l from the hotsprings canal. Lake and stream concentrations were very low (<0.005 mg/l) except during the August sampling.

Total phosphorus in the hotsprings over five samples ranged from 0.024 to 0.045 mg/l. Stream stations were less than 0.01 mg/l at all stations and samplings, except during freshet when concentrations ranged from 0.01 to 0.017 mg/l of total phosphorus.

The analysis is based on two lake stations, and complete mixing of the lake waters was assumed. However, this is likely not the case and some spatial variation of phosphorus throughout the lake is possible. There are bays within the lake basin which might have increased phosphorus levels due to the fact that they do not exchange water as often as the main lake basin on a yearly average, and the reverse (that of lower phosphorus levels) may also be true.

Lake values of phosphorus did not appear to be the limiting factor to production of algae; concentrations ranged from 0.01 - 0.66 mg/l occurring in May during freshet. The arithmetic and geometric means were 0.023 and 0.028 mg/l respectively. Considering we can only identify the source of 0.010 mg/l of phosphorus, from the streams input, then approximately 0.013 mg/l of total phosphorus in Lakelse Lake is from an unidentified source. On a yearly basis this amounts to approximately:

Amount = 23 ug/l - 10 ug/l = or 0.013 g/m^3

Area = 98900 acre ft x 1233.5 m^3/acre ft = 1.22×10^8 m^3

Annual loading = $1.22 \times 10^8 m^3 \times 0.013\ g/m^3 = 1.586 \times 10^6$ g

$$\frac{1.586 \times 10^6\ g}{0.19\ yr} = 8.34 \times 10^6\ g/yr$$

$$= 8.34 \times 10^3\ Kg/yr$$

$$= 8.34\ tonnes/yr.$$

The chemical analysis of precipitation was undertaken three times during the survey and reported in Table 15. Although only three samples were analyzed the results are very similar and indicate a very low level of input for all parameters measured, as well as normal pH and low conductivity. This low level input would effectively dilute the available chemical species in the natural run-off waters.

4.5 Phytoplankton

A listing of the phytoplankton counts and an estimate of the biomass values for station III appears in Tables 16 and 17. Those samples were taken, each with two replicates and the averages reported. Sampling occurred on February 3, 1975 (mid winter), June 28, 1975 (after spring run-off) and August 19, 1975 (mid summer). During the survey the

TABLE 15: CHEMICAL ANALYSIS OF PRECIPITATION FROM LAKELSE LAKE AREA, 1975

PARAMETER	February, 1975 (SNOW)	June, 1975 (RAIN)	August, 1975 (RAIN)
Na mg/l	0.015	0.010	0.011
K mg/l	0.04	0.03	0.02
Ca mg/l	<0.03	<0.03	<0.03
Mg mg/l	0.03	0.02	0.01
Hardness mg/$CaCO_3$	≤0.2	≤0.2	≤0.2
pH	7.0	6.8	6.7
Cond. µmho/cm	4	4	4
Cl mg/l	<0.4	<0.4	<0.4
SO_4 mg/l	<5	<5	<5
Si mg/l	<0.1	<0.5	<0.1
NH_3 µg/l	0.03	0.02	0.02
NO_2 mg/l	<0.005	<0.005	<0.005
NO_3 mg/l	0.055	0.05	0.05
OP mg/l	<0.005	<0.005	<0.005
TP mg/l	<0.01	<0.01	<0.01

TABLE 16: Lakelse Lake phytoplankton biomass values (mg/m^3) by groups, 1975, Station III.

	3 Feb.	28 June	19 Aug.
Cyanophyta	0	0	0
Chlorophyta	1.4	0.1	30.5
Euglenophyta	0	0	0
Chrysophyceae	7.2	18.6	152.2
Diatomeae	3.3	63.1	21.5
Cryptophyceae	15.5	0.3	10.8
Peridineae	1.5	0.6	38.9
TOTAL	26.4	82.7	270.5

TABLE 17: Phytoplankton species composition and abundance, Lakelse Lake, 1975, Station III, 0.5 m.

Group/Species	3 Feb.	28 June	19 Aug.
Chlorophyta			
Chlamydomonas sp	1.4		
Pyramidomonas Tetrarhynechnus			3.6
Chlorella sp			*
Stichococcus cf minutissimus			*
Oocystis sp.			*
Tetraedron minimum v. tetralobulum			25.5*
Scenedesmus quadricauda		.1	
Total group	1.4	.1	30.5 mg/m^3
Chrysophyceae			
Chromulina cf microplankton			*
Chromulina cf minima			17.2*
Chromulina sp.	3.4	7.9	
Kephyrion boreale			*
Kephyrion spirale		.7	*
Kephyrion cupiliforme			15.1*
Chrysoikos skujai			1.4
Ochromonas sp	3.4	8.6	77.6
Dinobryon borgei		1.4	5.0
Dinobryon sociale v. americanum			34.5
Stenokalyx monilifera 7.5	.4		
Bitrichia chodatii			1.4
Total group	7.2	18.6	152.2 mg/m^3

... Cont'd.

TABLE 17 Cont'd.

Group/Species	3 Feb.	28 June	19 Aug.
Diatomeae			
Melosira distens	.4		
Melosira varians	.5		13.3
Cyclotelia commensis	1.1		1.0
Cyclotelia stelligera		57.5	
Synedra acus	.5	5.6	6.8
Diatome hiemale v. mesodon	.8		
Tabellaria fenestrata			.4
Total group	3.3	63.1	21.5 mg/m^3
Cryptophyceae			
Cryptomonas erosa		.3	
Cryptomonas marsonni	.2		9.4
Rhodomonas minuta v. nannoplanktica	14.7		
Katablepharis ovalis			1.4
Cryptaulax sp.	.6		
Total group	15.5	.3	10.8 mg/m^3
Peridineae			
Peridinium goslaviense	1.5		
Peridinium inconspicum			13.1
Peridinium pusillum		.6	
Gymnodinium cf palustre			7.2
Gymnodinium veris			10.1
Gymnodinium sp.			8.5
Total group	1.5	.6	38.9 mg/m^3
Total/take	26.4	82.7	270.5 mg/m^3

* indicates the species combined.

Where there is only sp indicated after a genus it means that it was impossible to identify the organism in a preserved sample.

Chrysophyceae and Diatomeae were the dominant phytoplankton. The total biomass was low and ranged from 26.4 to 270.5 ug/1. A previous study on Morice Lake (Cleugh, 1978) which is also on the Skeena drainage, has similar low plankton productivity.

4.6 Zooplankton

Based on data analyzed during this survey, planktonic abundance appears to be low. Copepods make up the majority of the limnetic planktors, except near the lake outlet. The most predominant copepod was Cyclops bicuspidatus thomasi. Cladocerns were present to a minor extent. The predominant cladocerns were Holopedium gibberum and Bosmina longirostus (O.F. Muller). The abundance of cladocerns in the sample changes near the outlet of the lake where Bosmina longirostus (Muller) comprised 20% of the total. Epischura nevadensis occur to only a minor extent although the Diaptomidae naplii are likely those of Epischura nevadensis as no other diaptomial species was encountered during the survey.

TABLE 18: TOTAL INDIVIDUALS/LITRE IN LAKELSE LAKE STATION III, 1975

DATE	IND/L.
February 4	0.01
June 28	16.49
August 19	3.38

The species composition present in the lake compares favourably to that found by McMahon (1954) except in the absence of copepod Cyclops serrulatus and cladoceran Daphnia longispina (O.F. Muller). The absence of these species may be due to a lack of sampling of deeper water. A probable pattern is exhibited in a decreasing tend in total abundance from spring to fall at Station III (see Table 19).

TABLE 19 - SPECIES COMPOSITION OF ZOOPLANKTON IN LAKELSE LAKE - FEB.-AUG., 1975

SPECIES (ind/l)	STATION 5			OUTLET
	4.II.75	28.VI.75	19.VIII.75	19.VIII.75
COPEPODA				
Cyclops biruspidatus thomasi (S.A. Forbes)	0.01	13.63	2.56	1.86
Cyclops species copepodid	-	0.09	-	-
Epischura nevadensis (Lelljeborg)	-	0.01	0.02	0.42
Diaptomidae nauptii	-	2.48	0.75	1.64
Total ind/l	0.01	16.21	3.33	3.92
CLADOCERA				
Bosmina longirostus (O.F. Müller)	-	0.03	0.27	1.06
Diaphanosoma leuchtenbergianum (Fischer)	-	0.07	0.09	0.40
Holopedium gibberum	-	0.18	-	-
Total ind/l	-	0.28	0.36	1.46
Total copepoda & cladocera (ind/l)	0.01	16.49	3.38	5.38

4.7 Zoobenthos

The results presented in Table 20 indicate a trend towards reduced organism numbers and species diversity as depth increases. The organism densities indicate that 71 percent of the organisms occur in the top 9 meters. The predominant organisms in these shallow samples (4, 6, 8, 9 meters) appear to be crustaceans and insects. The distribution of these groups are presented in Table 21 and 22 respectively. Crustacean populations appear to be dominated by family Holopedidae while the insect populations are dominated by family Chironomidae.

The results also show a large number of oligochaeta in the limnetic zone of the lake. The predominant species was *Naidium bilongata*. This family (Naididae) is usually associated with aquatic vegetation. This would appear to be the case in Lakelse Lake where the vegetation and these oligochaetes are sparse below the twenty foot contour.

The bottom fauna of Lakelse Lake was previously examined in 1946 by Godfrey, (1955). This survey, although obtained using different dredging and screening methods,is comparable to the present study. Both surveys show greater abundance in the limnetic zone and a very unproductive profundal zone. The species observed, considering the different time and possible location of sampling, are also very similar in both types present and relative numbers of each species. However, the present survey records a much greater abundance of organisms per square meter of substrate and it appears that the limnetic zone has increased in size to approximately the 9 meter depth. Godfrey reports the limnetic zone at shoreline to a depth of 5 meters and records the greatest benthos abundance in this region at 1045 organisms per square meter. The present survey observed the greatest abundance to a depth of 9 meters with a benthic abundance of approximately 3200 organisms per square meter. This amounts to a threefold increase per square meter of substrate in a limnetic zone of nearly twice the depth.

TABLE 20 - DISTRIBUTION OF BENTHIC INVERTEBRATES AT STATION III IN LAKELSE LAKE

ORGANISMS	DEPTH (METERS)						
	4	6	9	14	24	28	30
OLIGOCHAETA	43	36	5	6	4	4	20
HIRUDINEA	1	6	-	-	-	-	-
MALACOSTRACA	-	9	-	-	-	-	2
OSTRACODA	33	9	6	1	26	27	17
COPOPODA	12	3	-	2	2	-	2
BRANCHIOPODA	54	3	179	6	-	1	1
PELECYPODA	44	12	5	8	7	25	3
GASTROPODA	3	-	-	-	-	-	-
DIPTERA	65	39	13	10	46	9	42
EPHEMEROPTERA	2	-	-	-	-	-	-
TRICHOPTERA	1	-	-	-	-	-	-
NEMATODA	61	12	-	1	1	-	1
ARACHNIDA	6	6	1	-	-	-	-
TOTAL	325	135	209	34	86	66	88
SUBSTRATE TYPE	Organic Matter Mud	Organic Matter Sand Mud	Mud	Mud	Mud	Mud	Mud
ORGANISMS/M^2	4,664	1,937	2,999	488	1,234	947	1,263

TABLE 21 - DISTRIBUTION OF CRUSTACEANS IN BENTHIC INVERTEBRATES

CRUSTACEANS	DEPTH (METERS)						
	4	6	9	14	24	28	30
MALACOSTRACA							
MYSIDACEA	-	9	-	-	-	-	2
OSTRACODA							
PODOCOPA							
CYPRIDAE	1	9	5	1	26	27	17
CYTHERIDAE	32	-	1	-	-	-	-
COPEPODA							
CYCLOPOIDA							
CYCLOPIDAIS	12	3	-	2	2	-	2
BRANCHIOPODA							
CONCHOSTRACA							
LYNCEIDAE	1	-	-	-	-	-	-
CLADOCERA							
BOSMINIDAE	-	-	3	-	-	-	-
HOLOPEDIDAE	52	3	176	6	-	1	1
CHYDORIDAE	1	-	-	-	-	-	-

TABLE 22 - DISTRIBUTION OF INSECTS IN BENTHIC INVERTEBRATES

INSECTS	DEPTH (METERS)						
	4	6	9	14	24	28	30
DIPTERA							
CHIRONOMIDAE	59	30	7	8	46	8	41
CERATOPOGONIDAE	6	6	3	2	-	1	1
EMPIDIDAE	-	3	3	-	-	-	-
EPHIMEROPTERA							
EPHEMERIDAE	1	-	-	-	-	-	-
NEDEPHEMERIDAE	1	-	-	-	-	-	-
TRICHOPTERA							
PYSCHOMYIIDAE	1	-	-	-	-	-	-

TABLE 23: BENTHIC INVERTEBRATES. LAKELSE LAKE, 1975.

Lakelse Lake 4 m.	No. of organisms
Class - Pelecypoda	
Order - Shaeridae	
Family - Pissidium	44 + 1 glochidium
Class - Gastropoda	
Order - Clenobranchiata	
Family - Valvatidae	
Genus - Valvata	3 + 2 empty shells
	47
Class - Aphasmidia	
Order - Chromadorida	
Family - Cyatholaimidae	
Genus - Ethomolaimus	3
Order - Enoplida	
Family - Doryliamidae	
Genus - Doryliamus	58
Class - Hirudinea	
Order - Rhynchobdellida	
Family - Glossiphonidae	
Genus - Placobdella	
Sp. - montifera	1
Class - Oligo chaeta	
Order - Plesiopora	
Family - Naididae	
Genus - Naiduim	
Sp.-bilongata	18
Family - Enchytraiidae	23
Family - Aeolosomatidae	
Genus - Aeolosoma	2
Order - Ostracoda	
Family - Cytheridae	
Genus - Metacypris	1
Family - Cypridae	
Genus - Cypridoprinae	13
Genus - Ilocyprinae	19
Order - Cladocera	
Family - Holopedidae	
Genus - Holopedium	
Sp.-gibberum	49 + 3 immature

<u>Lakelse Lake 4 m</u> (cont'd.)

Family - Chydoridae	
Genus - Eurycercus	
Sp.-glacialis	1
Order - Conclostraca	
Family - hynceidae	
Genus - hynceus	1
Order - Copepoda	
Family - Cyclopidae	
Genus - Eucyclops	
Sp. - agilis	3
Genus - Orthocyclops	
Sp. - modestus	9
	99

(No. represents larvae unless otherwise stated)

Order - Diptera	
Family - Tendipedidae	
Subfamily - Pelopiinae	
Genus - Anatopynia	
Sp. - Dyari	3
Subfamily - Pentaneura	
Sp. - monilis	1
Subfamily - Orthocladiinae	14
Subfamily - Tendipedinae	
Genus - Tendipes	
Subgenus - Glyptotendipes	
Sp. - senilis	25
Subgenus - Cryptochironomus	
Sp. - stylifera	7
Subfamily - Diamasinae	8
Subfamily - Tanytarsics	1 + 1 adult (no head) possibly Tendipedidae
Order - Diptera	
Family - Ceratopogonidae	4
Genus - Palyomyia	
Bezzia	
Probezzia	

Lakelse Lake 4 m. (cont'd.)

Family - Empididae	
Genus - Hemerodromia	
Sp. - seguyi	2
	65
Order - Ephemeroptera	
Family - Ephemeridae	
Genus - Potamanthus	1
Family - Caeridae	
Genus - Caeris	1
Order - Trichoptera	
Family - Psychomyiidae	
Genus - Psychomyia	1
Class - Arachnoidea	
Order - Hydracarina	
Family - Sperchonidae	
Genus - Sperchonopris	1
Family - Limnesiidae	
Genus - Limnesia	2
Family - Pionidae	
Genus - Forelea	2
Family - Lebertiidae	
Genus - Lebertia	1
Total Organisms	325

Lakelse Lake 6 m	No. of organisms
Order - Diptera	
Family - Ceratopogonidae	
Genus - (Polypomia, Bezzia, Probezzia)	7
Family - Tendipedidae	
Genus - Pelopiinae	1
Genus - Tendipes	1
Genus - Chironomus	
Subgenus - Cryptochironomus Stylifern	2
Subfamily - Orthocladinae	2
Family - Enipididae	1 (skin)
Class - Pelecypoda	
Family - Pisidium	4
Subclass - Molacostraca	
Order - Mysidacea	1
Order - Cladocera	
Family - Holopedidae	
Genus - Holopedium gibberum	1
Order - Ostracoda	
Family - Cypridae	
Genus - Ilyocyprinae	3
Order - Mysidacea	
Genus - Neymysis Mercedis	2
Order - Copepoda	
Family - Cyclopidae	
Genus - Eucyclops Agilis	1

NEMATODA

Class - Aphasmidia	
Order - Chromadorida	
Family - Cyatholaimidae	
Genus - Ethmolaimus	1
Order - Enoplida	
Family - Doryliamidae	
Genus - Doryliamus	3
Class - Oligochaeta	
Order - Plesiopora	
Family - Naididae	
Genus - Naidium	
- bilongata	2
Family - Enchytraeidae	10
Order - Hirundinea	
Family - Piscicolidae	
Genus - Illinobdella	
Sp. - moori	2
Class - Arachnoidea	2

Lakelse Lake 9 m	No. of Organisms
Class - Pelecypoda	
Order - Sphaeriidae	
Family - Pisideum	5
Class - Oligochaeta	
Order - Plesiopora	
Genus - Naidium	
bilongata	5
Order - Cladocera	
Family - Holopedidae	
Genus - Holopedium	
Sp. - gibberum	172 + 4 immature
Family - Bosminidae	
Genus - Bosmina	
Sp. - coregoni	3
Order - Ostracoda	
Family - Cypridae	
Genus - Ilyocyprinae	1
Family - Cytheridae	
Genus - Limnocythere	
Sp. - saneti-patrici	1
Family - Cypridae	
Genus - Candona	
- elliptia	1
Family - Cypridae	
Genus - Potamoypris	
lyboforma	2
Family - Cypridae	
Genus - Cypridipsinae	1
Order - Diptera	
Family - Empididae	
Genus - Hemerodromia	
Sp. - seguyi	1 + 2 skins
Family - Ceratopogonidae	
Genus - Polypomia, Bezzia, Probezzia	2 + pupil case (1)
Family - Orthocladiinae	
Genus - Psectrocladius	4
Family - Tendipedinae	

Lakelse Lake 9 m (cont'd.)

Subfamily - Tenypodinae	
Genus - Anatopymia	
dyari	1
Genus - Pseudocheronomus	
richardson	1
Genus - Chironomus	
tribelos	1
Class - Arachnodea	
Order - Hydracarina	
Family - Hydryphantidae	
Genus - Hydryphantes	1
	11
Total no. of organisms	206

Lakelse Lake 14 m	No. of organisms
Class - Pelecypoda	
Order - Sphaeriidae	
Family - Pisidium	8
Class - Oligochaeta	
Order - Plesiopora	
Family - Naididae	
Genus - Naidium	
bilongata	4
Family - Enchytraiidae	2
Class - Aphasmida	
Order - Enoplida	
Family - Dorylaimoidae	
Genus - Dorylaimus	1
Order - Cladocera	
Suborder - Calyptomera	
Tribe - Clenopoda	
Genus - Holopedidae	
gibberum	6
Order - Ostracoda	
Family - Cypridae	
Genus - Ilyocyprinae	1
Order - Copepoda	
Family - Clyclopidae	
Genus - Eycyclops	
agilis	2
	9

(No. represents larvae unless otherwise stated)

Order - Diptera	
Family - Tendipedidae	
Subfamily - Pelopinae	
Genus - Anatopynia	
dyari	3
Subfamily - Tanypodinae	
Genus - Procladius	1
Subfamily - Tendipedinae	
Genus - Cyptochironomus	2

Lakelse Lake 14 m (cont'd.)

Family - Orthodadiinae	2
Family - Heleidae	
Subfamily - Helcinae	
Genus - Culicoides	2
	10
Total No. of organisms	34

Lakelse Lake 24 m	No. of Organisms
Class - Pelecypoda	
Order - Sphaeriidae	
Family - Pisidium	7
Class - Aphasmidia	
Order - Chromadonida	
Family - Cyatholaimidae	
Genus - Ethmolaimus	1
Class - Oligochaeta	
Order - Plesiopona	
Family - Naididae	
Genus - Naidium bilongata	4
Family - Enchytraidae	12
Order - Ostracoda	
Family - Cypridae	
Genus - Candona indigena	8
Genus - Potamocypris Sp. - lyboforma	18
Order - Copepoda	
Family - Cyclopidae	
Genus - Eucyclops agilis	2
	28
Order - Diptera	
Family - Tendipedidae	
Subfamily - Orthocladiinae	
Genus - Spaniotoma	1
Subfamily - Tendipedinae	
Genus - Tanytarsus	1
Genus - Tendipes hyperboreus	1
Genus - Chironomus tribelos	40
Genus - Chironomus Sp. B.	1

Lakelse Lake 24 m (cont'd.)

Subfamily - Pelopiinae	
Genus - Anatopynia	
dyari	2
	46
Total no. of organisms	98

Lakelse Lake 28 m	No. of organims
Class - Pelecypoda	
Order - Sphaeriidae	
Family - Pisidium	25
Class - Oligochaeta	
Order - Plesiopora	
Family - Enchytraeidae	4
Order - Cladocera	
Family - Holopedidae	
Genus - Holopedium	
Sp. - gibberum	1
Order - Ostracoda	
Family - Cypridae	
Genus - Potamocypris	
Sp. - lyboforma	6
Order - Ostracoda	
Family - Cypridae	
Genus - Candona	
indigena	21
	28
Order - Diptera	
Family - Culicidae	
Genus - Mochlionyx	
Sp. - cinetipes	1 pupae
Family - Tendipedidae	
Subfamily - Hydrobaeninae	
Genus - Hydrobaenus	2
Subfamily - Tendipedinae	
Genus - Pseudocheronomus	1
Subfamily - Tendipidinae	
Genus - Tendipes	
tribelos	3
	9
Total no. of organisms	66

Lakelse Lake 30 m	No. of organisms
Class - Pelecypoda	
Order - Spaeriidae	
Family - Pisidium	3
Class - Aphasmidia	
Order - Chromadorida	
Family - Cyatholaimidae	
Genus - Ethomolaimus	1
Class - Oligochaeta	
Order - Plesiopora	
Family - Naididae	
Genus - Naidium	
bilongata	1
Family - Enchtraeidae	19
Order - Ostraeoda	
Family - Cypridae	
Genus - Candona	
indigena	11
Genus - Potamocypris	
lyboforma	6
Order - Cladocern	
Family - Holopedidae	
Genus - Holopedium	
Sp. - gibberum	1
Order - Copepoda	
Family - Cyclopidae	
Genus - Eucyclops	
Agilis	2
Order - Mysidacea	
Genus - Neomysis	
mercedis	2
	22

Lakelse Lake 30 m (cont'd).	No. of organisms
Order - Diptera Family - Culicidne	(no. represents larvae unless otherwise stated)
Subfamily - Chaoborinae Genus - Mochlonyx Sp. - cinctipes	1 pupae
Family - Tendipidae	
Subfamily - Pelopiinae	1 pupae (no head)
Subfamily - Pelopiinae Genus - Anatopynia dyari	8 + 2 heads only
Subfamily - Podonominae	3
Subfamily - Tendipedinae Genus - Pseudochironomus richardsoni	1
Genus - Tendipes	1 pupae
Genus - Tendipes Sp. - chironomus	18
Genus - Tendipes tribelos	9
	42

5. DISCUSSION

Vollenweider demonstrated using several techniques that the total production within a body of water generally increases as a function of increased phosphorus. His classification of lakes was as follows:

LEVEL OF LAKE PRODUCTION	TOTAL P mg/m^3	INORGANIC N mg/m^3
Ultra - oligotrophic	<5	<200
Oligo - mesotrophic	5-10	200-400
Meso-eutrophic	10-30	300-650
Eu-polytrophic	30-100	500-1500
Polytrophic	>100	>1500

Vollenweider (1971, p. 65) also states that "waters with total phosphorus and bound inorganic nitrogen concentrations in excess of 20 mg/m^3 and 300 mg/m^3, respectively, may be regarded as in danger". In Lakelse Lake total phosphorus concentrations never appeared to be limiting to production in this survey or in previous surveys by Ableson, 1976 and McIndoe and Knapp, 1974. Spring overturn value of phosphorus at Station III (mid-lake) was recorded at 0.066 mg/l or 66 mg/m^3. The minimal T.P. recorded was 0.01 mg/l during mid-winter, also at Station III. The mean value for this lake station was 0.026 mg/l or 26 mg/m^3 of total phosphorus. This concentration of T.P. would indicate the level of lake production to be meso-eutrophic and likely transition to eutrophic status during freshet. Inorganic nitrogen however had a spring overturn value of 0.02 to 0.05 mg/l and a mean concentration of 0.021 mg/l or 21 mg/m^3. This is well below Vollenweider's danger level and in this instance (Lakelse Lake) may be the limiting element in lake production.

The tropic level may also be indicated through many other parameters. Chlorophyll was initially proposed until it was realized that the cholorophyll content is not a reliable measure of plankton (the primary producers) since the pigment content depends on species type, physiological state of the environment, etc. Therefore actual density counts and species identification were made and related to the trophic categories of Wetzel (1975). The density values recorded from Lakelse Lake were 26.4 - 270.5 mg/l and Chrysophyceae and Diatameae were the dominant phytoplankton. Both of these facts indicate an oligotrophic condition. However, mention should be made to the biological competition occurring between macrophyte formation and biocenotic formations. The macrophytes can obviously absorb large quantities of nutrients which would impoverish the plankton community (Hasler and Jones 1949; Vollenweider 1961).

A further method utilized by Ableson (1976) in attempting to establish the trophic level of Lakelse Lake was to investigate the phosphorus-chlorophyll relationships. This method proposed by Sakamoto (1966) was used by Dillon and Rigler (1975) to establish development capacity on Pre Cambrian lakes. Ableson used spring (May 9, 1974) overturn values of 0.01 mg/l^{-1} (or 10 mg/m^3) and calculated a chlorophyll range of 2 - 4 ug/l^{-1} which falls within the lowest level of classification by Dillon and Rigler (1975). The present study indicated spring overturn (28 May 1975) values at 0.066 mg/l of T.P. This would place Lakelse Lake on Dillon and Rigler's development capacity at a much higher level of production. It would therefore appear that this lake is not similar to Pre Cambrian lakes (Dillon and Rigler) or there is a further limiting factor on Lakelse Lake.

Nutrient input levels from the inflow streams were low (with the exception of the hotspring canal). McIndoe and Knapp (1974) and Ableson (1976) also reported similar low input levels. Phosphorus levels, however, in Lakelse Lake are high, and indicate (Wetzel 1975) a meso-eutrophic trophic status. The impact of human population as proposed by Sinclair (1974) of 161,965 overnight visits and 258,815 day visits annually could be an appreciable source of this nutrient. McIndoe and Knapp (1974) estimate the total summer loading from this source at 2.2×10^3 Kg of total phosphorus.

The water flow from the hotsprings into Lakelse Lake is calculated at 0.28 cfs, or 1/2500 of the total outflow from the lake. It is therefore unlikely that this source has a substantial effect on the waters of Lakelse Lake, based on the current chemical composition of these waters.

6. SUMMARY

1. Based on the present study as well as those of Ableson 1976 and McIndoe and Knapp 1974, there is sufficient phosphorus present in Lakelse Lake for it to become eutrophic. However, it appears that there are two limiting factors, the low level of nitrogen and the high flushing rate of the lake. Therefore any factors which could increase inorganic nitrogen or could impede the flushing rate may increase the lake trophic status.

2. Phytoplankton biomass was low, with a maximum observed value of 270.5 mg/m^{-3}. This indicates a low productivity for the lake and using Vollenweider's (1971) lake classification indicates an oligotrophic phytoplankton productivity (lower than 1000 mg/m^{-3} maximum plankton density).

The zooplankton, based on the present data, appears in Lakelse Lake, to be poor in both the number of species present and on the total abundance of each species. This low density is very probably related to the low phytoplankton biomass.

3. Bottom fauna of Lakelse Lake was examined in 1946, comparative data from 1975 indicates a three fold increase in the number of organisms per square meter (1045 to 3200) and an increase of the limnetic zone of nearly twice the depth.

7. RECOMMENDATIONS

It seems clear that the rapid expansion of the macrophyte and benthic communities is related to the uncontrolled release of nutrients into Lakelse Lake. The only areas where it seems feasible to control these releases are the areas of intensive public use. It is recommended therefore that serious consideration be given to sewage collection with transport to an outside treatment system from recreational and commercial developments, such as park and camp sites, resorts and food outlets. Existing private dwellings could be excluded provided that these same restrictions are included for any new private dwellings.

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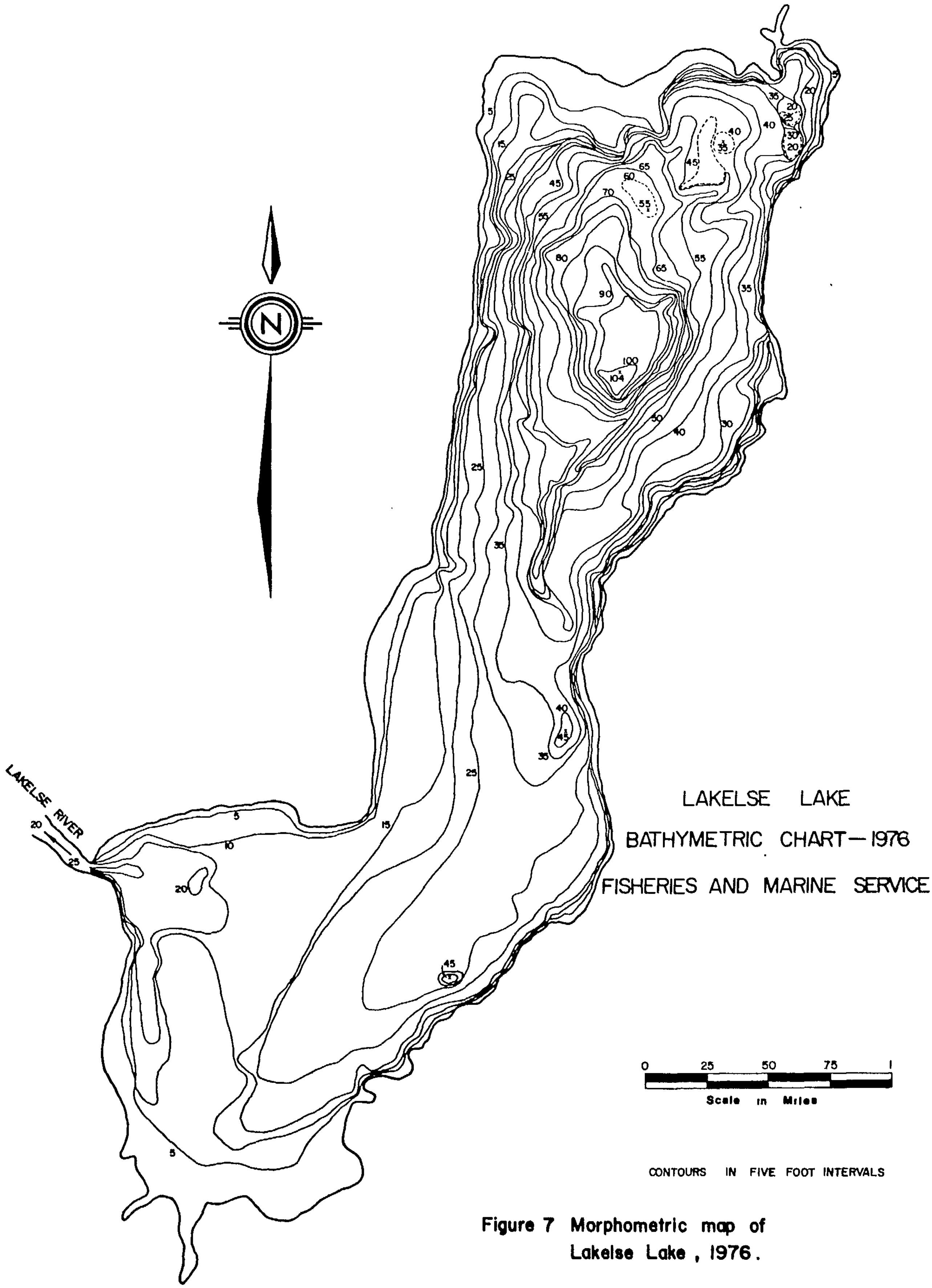

Figure 7 Morphometric map of Lakelse Lake, 1976.