

THIS BOOK BELONGS TO
LIDIA JAREMOVIC

30B-008

VOLUME 4

THE LIMNOLOGY OF MORICE LAKE
RELATIVE TO THE PROPOSED KEMANO II
POWER DEVELOPMENT

BY

T.R. CLEUGH

B.C. LAWLEY

FISHERIES AND MARINE SERVICE
DEPARTMENT OF THE ENVIRONMENT
VANCOUVER, B.C.

FEBRUARY, 1979

PREFACE

As part of the overall assessment of the effects of the Kemano II hydroelectric development on the fisheries resource of the Morice River system, various biological surveys have been conducted by the Department of Fisheries and the Environment, Fisheries and Marine Service. This survey was to document existing limnological conditions within Morice Lake and to predict the impact of impoundment. Other surveys on the fisheries of the Morice system as well as surveys on the Nechako system have also been conducted. A compilation of all these reports and the B.C. Hydro proposal as well as the history of this development are presented in a further report entitled "Summary of Salmon Studies Conducted on Nechako, Morice and Nanika River Systems Relative to the Proposed Kemano II Power Development."

TABLE OF CONTENTS

<u>Content</u>	<u>Page</u>
Preface	i
Table of Contents	ii
List of Tables	iii
List of Figures	iv
List of Appendices	v
List to Abbreviations	vi
1.0 Introduction	1
1.1 Water Chemistry	1
1.2 Phytoplankton	2
1.3 Zooplankton	2
1.4 Zoobenthos	2
1.5 Morphometry of Morice Lake	3
2.0 Methods	4
2.1 Water Chemistry	4
2.2 Phytoplankton	7
2.3 Zooplankton	7
2.4 Zoobenthos	7
3.0 Results	8
3.1 Water Chemistry	8
3.2 Phytoplankton	19
3.3 Zooplankton	28
3.4 Zoobenthos	33
3.5 Trophic Level	38
4.0 Impact of Impoundment	38
5.0 Conclusions	40
Acknowledgements	43
References	44
Appendix 1	48
Appendix 2	61
Appendix 3	66
Appendix 4	75

LIST OF TABLES

		<u>Page</u>
1	Percent oxygen saturation of Morice Lake Water, 1974 - 1975.	8
2	Observed temperatures by station and date, Morice Lake, B.C.	10
3	Water transparencies for Morice Lake, June to September, 1974.	9
4	Mean of selected chemical parameters, Morice Lake, B.C.	13
5	Range, maximum-minimum, chemical parameters, Morice Lake, 1974 - 1975.	14
6	Comparison of selected chemical parameters from Morice and other regional lakes.	16
7	Chemical analysis, Nanika and Kidprice Lakes, 1974.	17
8	Chemical analysis of snow, Morice Lake, 1975.	18
9	Algal species list, Morice and Nanika lakes.	20
10	Nanika Lake phytoplankton biomass values.	27
11	Comparison of Morice Lake phytoplankton biomass values between July, 1974 and June, 1975.	29
12	List of zooplankton species found in net plankton of Morice Lake, B.C.	30
13	Comparison of zooplankton abundance in some Canadian lakes.	28
14	List of zooplankton species found in net plankton of Nanika Lake, B.C., 1974.	34
15	Distribution of benthic invertebrates in Morice Lake, by station and depth.	35
16	Distribution of Chironomidae in Morice Lake.	36
17	The Chironomidae from Morice Lake, B.C.	37

LIST OF FIGURES

		<u>Page</u>
1	Map of study area, including Nanika Lake sampling locations.	5
2	Morice Lake sampling stations.	6
3	Relative plankton biomass, 1974, Morice Lake, B.C. at 0.5 meters depth.	24
4	Phytoplankton biomass values, and temperatures, station 3 (0.5 m depth) at Morice Lake, B.C.	25

LIST OF APPENDICES

- 1 Chemical analysis Morice Lake Water, 1974 - 1975.
- 2 Morice Lake phytoplankton biomass values.
- 3 Identification of zoobenthos by station and depth, Morice Lake, B.C., 1975.
- 4 Morice Lake unpublished data collected during the Nanika River Hatchery program.

LIST OF ABBREVIATIONS

°C	degree(s) centigrade (temperature)
Ca	Calcium
Ca CO ₃	Calcium carbonate (water hardness)
cfs	cubic feet per second
Chl	chlorophyll
Cl	chlorine
cond./μmho/cm	conductivity measured in micromhos/cm.
cm	centimeter
Cu	copper
Fe	iron (Total)
Ind/cm ²	individuals per square centimeter
Ind/l	individuals per litre
K	potassium
l	litre
m (M)	metre
mg/l	milligrams per litre
mg/m ³	milligrams per cubic litre
Mg	magnesium
ml	millilitres
Mn	manganese
Na	sodium
NH ₃	ammonia
NO ₂	nitrite
NO ₃	nitrate
OP (OPO ₄)	ortho phosphate
Pb	lead
pH	hydrogen ion concentration
Si	silicon
sp	species
SO ₄	sulphate
TP	total phosphorus
TR	total residue (or total dissolved solids)
Zn	zinc
<	less than
>	greater than
$\frac{\mu}{x}$	micron(s) (metric) i.e., μg = micrograms
x	mean

1.0 Introduction

The impoundment of water on a natural lake causes environmental changes. The more important limnological effects occur at the land-water interface, usually due to flooding and or lake drawdown. The new water level regime can either create or destroy habitat for existing species of fish and other organisms. Shoreline and bank erosion, altered flow regime and other physical changes can have severe chemical and biological repercussions and cause radical changes in productivity.

As part of the Kemano II Environmental Study, the Fisheries and Marine Service initiated a program during 1974 - 1975 to inventory the existing water chemistry, plankton and benthic fauna of Morice Lake. The main objectives were to determine the present trophic level in terms of standing crop of organisms and water chemistry and to attempt to predict responses to an altered environment.

The limnological study was conducted during 1974 and 1975 and consisted of four parts as outlined below:

1.1 Water Chemistry

Water chemistry influences the basic biological components of any natural waters thereby affecting the natural productivity. The Kemano II project would alter the flow regime and may affect the water chemistry. This report attempts to characterize the water chemistry of Morice Lake from May, 1974 to August, 1975, and on the basis of these observations, attempts to quantitatively estimate changes in chemical parameters consequential to impoundment and diversion.

The water chemical budget of a reservoir usually depends upon the inflowing streams. However, during the formation period, flooding will leach chemical substances from the flooded shoreline soil and the submerged decayed vegetation. These leachates will modify the chemical composition of the water. These cause an increase in plankton biomass and lake productivity.

1.2 Phytoplankton

Phytoplankton are the primary utilizers of nutrients and are the primary food organisms. These primary producers utilize light and nutrients to initiate and sustain productivity rates of the algal community. Algal production, as well as influencing the quantity of secondary production, may also affect the quality of the water and the fishery. For Morice Lake the following components were examined: phytoplankton species composition, by season and region, standing crop or biomass of algae, and the identification of possible limiting factors. Nanika Lake was also sampled on July 31, 1974 for comparison.

1.3 Zooplankton

The zooplankton are essentially the second (after phytoplankton) trophic level in most lakes. They graze on the phytoplankton and are consumed ultimately by the fish. They are therefore an index to the general productivity of a lake and its capacity to produce fish.

1.4 Zoobenthos

Zoobenthos are those invertebrates that inhabit the bottom sediments of aquatic systems. This benthic community plays an important role in the ecosystem.

The quantity and quality of zoobenthos are also good indicators of the general productivity of a water body. Consequently, differences in abundance and composition of the zoobenthos in different parts of a lake can often provide useful information on the general productivity as well as indicate the capacity to support some species of fish.

The main objectives of this invertebrate survey were to determine the abundance and composition of the zoobenthos in Morice Lake and to compare the results to those found in other Bulkley Valley area lakes, relate abundance and distribution of zoobenthos to other biological components of the ecosystem and attempt to predict the impact of the proposed development on the abundance and composition of zoobenthos within Morice Lake.

1.5 Morphometry of Morice Lake

Other factors, especially lake morphometry, may also have profound influence on lake production (Rawson, 1957). The Morice Lake basin (altitude 793 m) lies in S.W. to N.E. axis, with the outflow to the north into the Morice River. The surrounding glaciated mountains are a conspicuous feature of the lake basin. The prevailing winds from the high (2000 m) Cascade Mountains follow the long axis of the lake and proceed down the Morice River. The glacial streams and the prevalence of strong winds on Morice Lake undoubtedly have increased the turbidity and affected the transparency of Morice Lake.

Morice Lake is 41.7 km. long by 4.5 km. wide and has an area of 10,360 hectares (shoreline development factor is 3.2). The lake has a maximum and mean depths of 236.2 and 99.7 meters respectively with a total volume of $10,327.5 \times 10^6$ cubic meters (Godfrey, 1955). The Morice River, outflow, had a mean monthly flow (for 1968 - 1973) of 2,655 cfs (D.O.E. Inland Waters Directorate, 1974). Assuming that the inflow equals the outflow, the theoretical exchange time for Morice Lake is then calculated at 4.36 years.

2.0 Methods

2.1 Water Chemistry

Water chemistry sampling stations were located on the Nanika and Morice lakes in the upper Morice River watershed. Figure 1 shows the general location of the Nanika Lake stations. Three sampling stations were also located on the major axis of Morice Lake (Figure 2) and on eleven of the streams that flow into the lake. Most stations were monitored on a monthly basis by boat or helicopter throughout the summer and winter months.

Samples were collected with a Nansen water sampler and shipped in dark 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, Environment Canada, Fisheries Service - Environmental Protection Service, Pacific Region, 1974.

Observations on dissolved oxygen were made four times during the survey, on 17 July 1974, 11 September 1974, 10 December 1974 and 28 May 1975. Measurements were made with an IBC (International Biophysics Corporation) dissolved oxygen field unit at 0.5, 7, 25 and 50 meter depths at stations 3, 4 and 5. The meter was calibrated by Winkler analysis.

Temperature was measured twelve times during the survey at three lake stations (four depths) and at eleven streams, Figure 2. Measurements were taken with a YSI (Yellow Springs Instrument) field temperature meter (Model 43). Observations on freeze-up, break-up and ice thickness were also recorded.

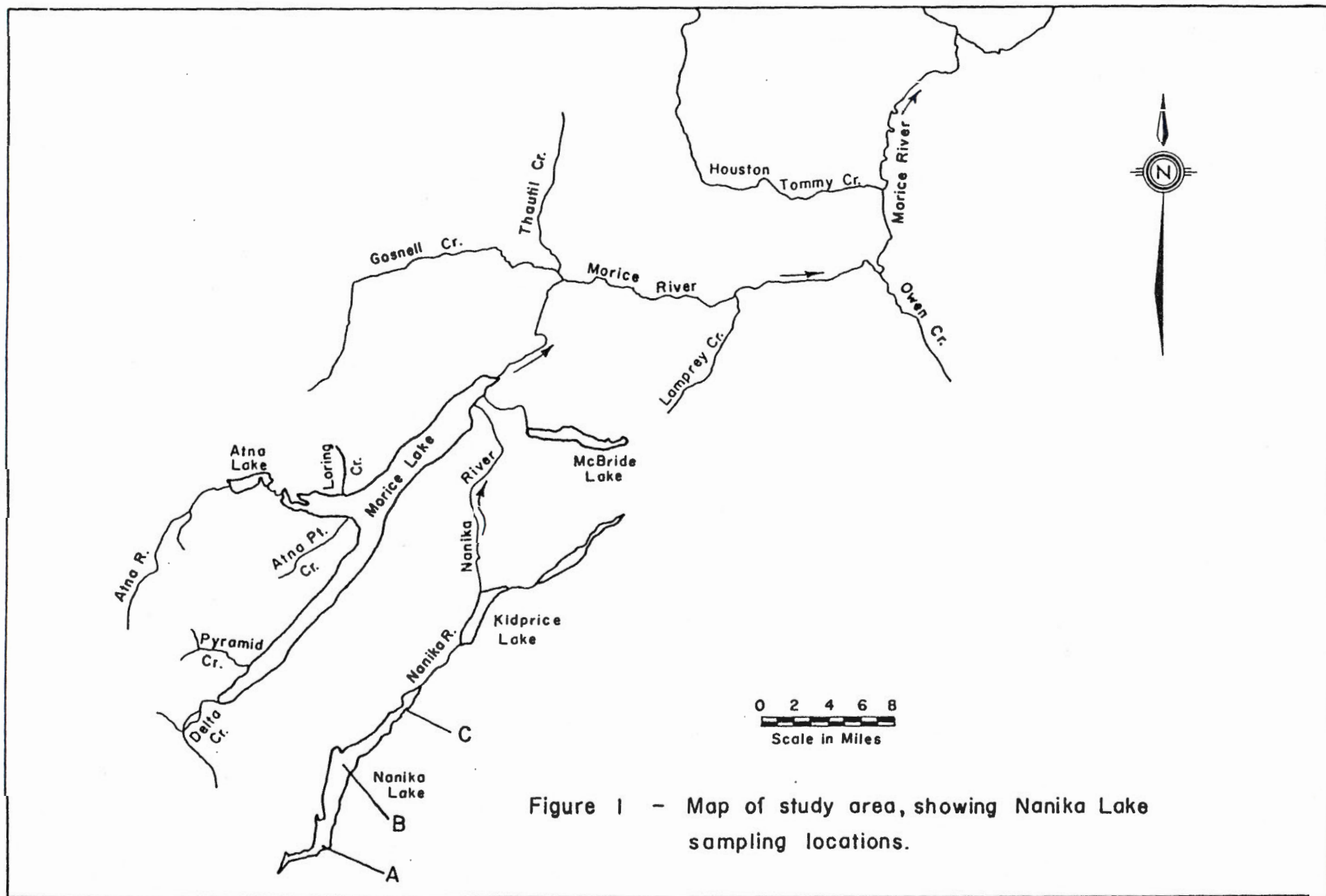


Figure 1 - Map of study area, showing Nanika Lake sampling locations.

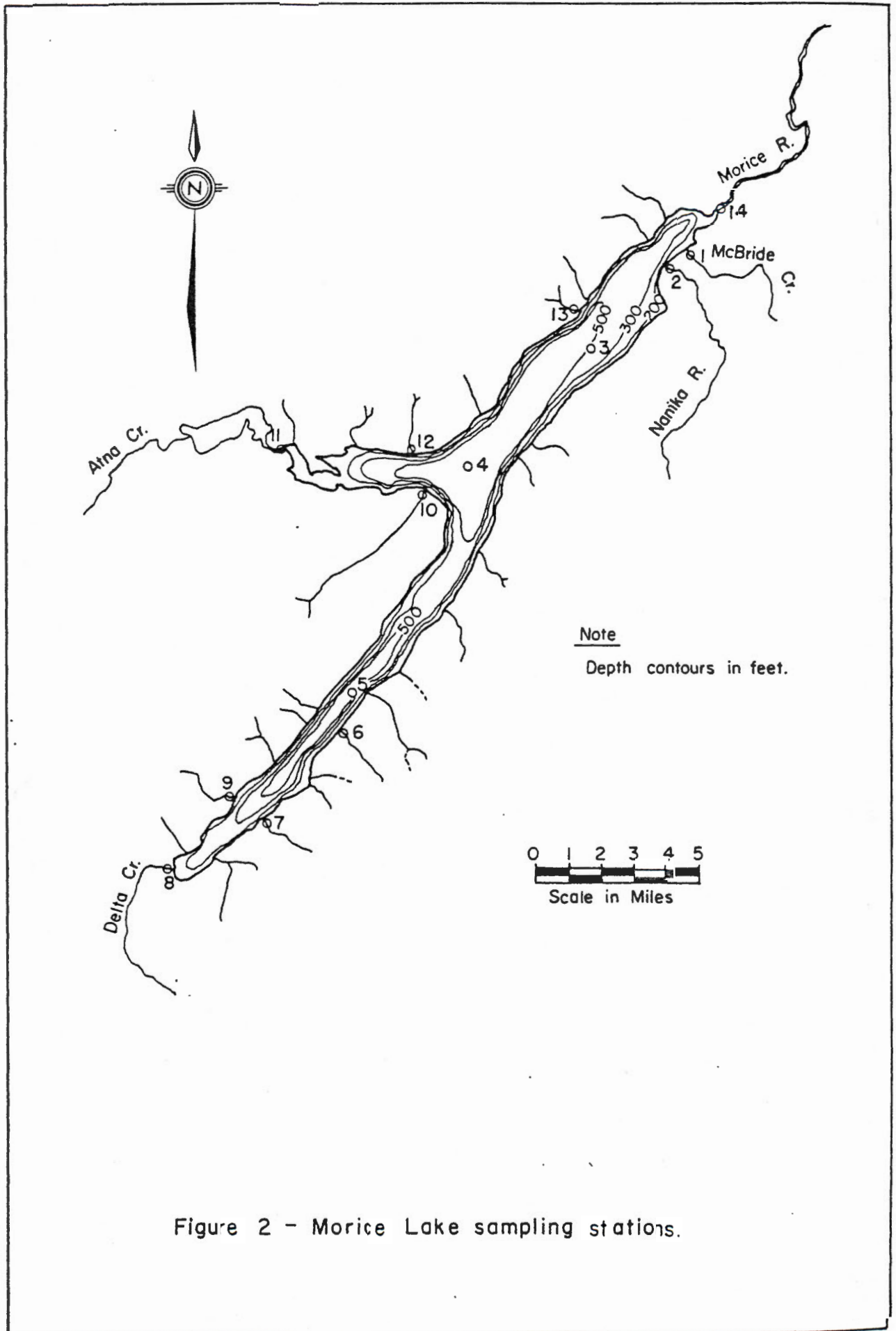


Figure 2 - Morice Lake sampling stations.

Transparency measurements were made with a standard black and white Secchi disc five times during 1974 at stations 3 and 5. Sampling dates were 18 June, 17 July, 31 July, 6 August and 11 September.

2.2 Phytoplankton

Samples were collected between July, 1974 and June, 1975 in 250 ml. bottles at stations 3, 4 and 5 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 (1968, 1969). Deep water samples were collected using a Nansen bottle.

2.3 Zooplankton

Samples were collected between July, 1974 and August, 1975, from stations 3, 4 and 5 on Morice Lake, see Figure 2. Ten meter vertical hauls were made at each station using a single net with a mouth diameter of 25 cm. and a mesh opening of 77 μ . The results are expressed as individuals per litre, (corresponding individuals per cm² 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, for example Cyclops bicuspidatus adults, copepodids and nauplii are added to give a final total.

2.4 Zoobenthos

The survey was conducted from 30 May to 6 June 1975. The three sampling sites were located near the lake water chemistry sampling stations. Sediments were field sieved using a Nitex nylon net (400 μ mesh) and the residue preserved in 5 - 7% formalin.

Laboratory samples were rinsed overnight to remove formalin and sorted using a stereomicroscope. Organism identification was accomplished using a stereo and a compound microscope depending upon size of the specimen. Copepoda, Cladocera, Ostrocooda and other orders with small (<400 μ) species were not enumerated because they were not sampled quantitatively in the field sieving net.

3.0 Results

3.1 Water Chemistry

Dissolved oxygen showed a 90 - 100% saturation at all stations and depths throughout the survey. At no time was oxygen super saturated or concentrations of less than 90.8% observed, the data are presented in Table 1.

TABLE 1 - PERCENT OXYGEN SATURATION OF MORICE LAKE WATER,
1974 - 1975

<u>Station</u>	<u>Depth</u> <u>m</u>	<u>17 July</u> <u>1974</u>	<u>11 Sept.</u> <u>1974</u>	<u>10 Dec.</u> <u>1974</u>	<u>28 May</u> <u>1975</u>
3	0.5	100.0	100.0	100.0	98.0
	7	99.0	100.0	100.0	98.0
	25	100.0	100.0	100.0	98.0
	50	98.0	100.0	97.2	94.1
4	0.5	100.0	100.0	100.0	95.0
	7	100.0	100.0	-	92.0
	25	100.0	100.0	-	92.0
	50	100.0	96.2	100.0	92.0
5	0.5	100.0	100.0	100.0	94.2
	7	100.0	100.0	94.1	91.0
	25	99.1	100.0	96.6	90.9
	50	92.1	94.6	92.1	90.8

Temperature observations are recorded in Table 2. Examination of the temperature profiles shows that at any time throughout the survey the north end of the lake (station 3) was the same as, or warmer than the south end of the lake (station 5). The inflowing streams have a cooler mean temperature than the lake and the maximum temperatures at all stations occurred in mid-August, 1975. The maximum vertical temperature gradient occurred in the summers of both 1974 and 1975. The maximum difference between 0.5 meters and 50 meters was only 5.8° C. (28/8/75) at station three. A previous survey by Brett and Pritchard (1946) indicated a mid-summer temperature gradient of 9° C. (14° C. at surface to 5° C. at 200 feet). However, Brett and Pritchard did not indicate station location or methods so that direct comparison is not possible. The relative uniform temperature during the present survey is attributed to lake circulation, likely due to the strong, south to north, prevailing winds throughout the survey.

Ice first appeared in the sheltered bays near the end of October, however, freeze-up did not occur until mid-February, 1975. Break up occurred approximately 6 - 10 weeks later, in late March to early May. Ice thickness at station three on March 2 1975 was approximately 24 centimeters (9 inches).

Water transparencies as shown by Secchi depths were observed throughout the spring and summer of 1974 and presented in Table 3. Station 4 was not observed for transparency due to wind interference throughout the sampling period.

TABLE 3 - WATER TRANSPARENCIES FOR MORICE LAKE, June to Sept. 1974.

	station 3	station 5
18 June	3.25 m.	3.6 m.
17 July	3.25 m.	3.7 m.
31 July	3.5 m.	2.0 m.
6 Aug.	6.0 m.	6.5 m.
11 Sept.	9.0 m.	9.75 m.

TABLE 2 - OBSERVED TEMPERATURES (°C) BY STATION AND DATE, MORICE LAKE, B. C.

Year		1974										1975		
Day-Month		18 June	17 July	31 July	6 Aug.	11 Sept.	21 Oct.	10 Dec.	3 Feb.	2 Mar.	28 May	25 June	24 Aug.	
STATION DEPTH meters														
1	0.5	8.9	10.1	11.0	-	12.0	3.9	1.0	-	1.0	9.0	-	12.1	
2	0.5	7.0	8.5	9.8	-	9.9	6.8	0.5	0.5	1.8	7.0	-	-	
3	0.5	7.8	9.0	10.6	12.7	12.3	7.1	4.8	1.8	1.9	6.0	7.2	12.0	
3	7	-	-	9.4	11.6	11.0	-	4.8	2.05	2.05	5.0	6.0	11.1	
3	25	5.5	6.0	7.8	11.0	8.9	6.4	4.8	2.05	3.0	4.0	5.8	7.2	
3	50	4.8	5.1	6.3	9.0	8.0	5.0	4.8	3.0	3.7	-	4.8	6.2	
4	0.5	6.8	7.8	10.0	12.3	12.1	7.1	4.8	-	-	-	-	10.8	
4	7	-	-	8.2	11.0	11.0	-	4.8	-	-	-	-	9.8	
4	25	5.5	6.0	-	11.0	8.8	6.4	4.8	-	-	-	-	6.5	
4	50	4.8	5.1	6.2	8.9	7.5	5.0	4.8	-	-	-	-	6.1	
5	0.5	6.5	7.0	9.8	11.5	11.0	7.1	4.8	-	1.0	5.0	6.2	10.5	
5	7	-	-	8.0	11.0	9.6	-	4.8	-	-	-	-	-	
5	25	5.2	5.8	7.0	10.0	7.9	6.3	4.8	-	-	-	4.8	-	
5	50	4.8	5.1	6.0	8.6	7.0	5.0	4.8	-	-	-	-	-	
6	0.5	5.1	7.0	7.0	-	7.0	-	-	-	-	-	5.2	7.5	
7	0.5	4.8	5.0	5.5	-	6.0	3.3	0.5	-	-	4.0	5.0	-	
8	0.5	5.5	5.1	4.5	-	4.0	2.0	0.2	-	-	4.5	5.2	-	
9	0.5	5.0	6.2	5.5	-	-	2.5	1.2	-	-	5.8	4.5	-	
10	0.5	5.1	6.0	4.0	-	4.0	2.2	0.1	-	-	5.0	5.5	-	
11	0.5	7.0	8.8	10.2	-	8.0	3.5	1.5	0.5	-	7.5	7.0	-	
12	0.5	4.6	4.0	4.0	-	5.0	2.8	1.5	-	-	-	4.6	-	
13	0.5	4.6	4.0	4.0	-	-	3.0	1.5	-	-	-	-	-	
14	0.5	7.0	-	-	-	-	7.0	4.8	-	1.5	5.5	7.0	-	

Seventeen chemical parameters were measured during this survey. The complete results of the chemical water analysis are recorded in Appendix 1. Mean values of selected chemical factors are summarized in Table 4, and a summary of annual range for all chemical parameters at each station is recorded in Table 5. A comparison with other regional lakes is presented in Table 6. Water chemistry results for Nanika and Kidprice Lakes are shown in Table 7.

Four cations; sodium, potassium, calcium and magnesium, were measured throughout the survey at all stations. Station 1, McBride Creek, had a greater input of sodium than all other stations. Mean yearly values for potassium were greater at McBride Creek and Atna Creek (station 11). Atna Creek also had higher yearly mean calcium. Magnesium input was higher at McBride, Nanika, Atna and station 13. However, other than these exceptions, little spatial or temporal variations occurred at the stations surveyed. Calcium and potassium had a yearly mean at the various stations of 4.18 - 5.79 mg/l and 0.14 - 0.38 mg/l respectively. Sodium had a yearly mean for all stations of 0.42 to 0.61 mg/l, except for station 1 which had a mean of 1.61 mg/l. Magnesium for stations 3 to 10, 12 and 14 had a yearly mean of from 0.30 - 0.47 mg/l; stations 1, 2, 11 and 13 had a yearly mean of 0.83, 0.57, 0.65, and 0.56 mg/l respectively.

Three anions were measured; chlorides, sulphates and silicon. Two of the ions, chlorides and sulphates, showed less than the detectable sensitivity of analytical methods. Concentrations of <1 mg/l for chlorides and <5 mg/l for sulphates were consistent at all stations throughout the survey.

A significant input of silicon from station 1, McBride Creek, was observed throughout the survey. A mean yearly value of 2.4 mg/l was observed from station 1 as compared to a mean value of 0.92 - 1.33 mg/l for all other stations. No other spatial or temporal trends could be observed for silicon.

Chlorophyll concentrations were measured at the three lake stations six times during the survey. The only detectable concentration of Chlorophyll was observed on 17 July 1974, where values of 0.1 mg/l were obtained at stations three and four at 0.5 meter depth. All other analyses showed less than 0.1 mg/l Chlorophyll at all stations, see appendix 1.

Nutrient values were generally lower than the sensitivity of our present analytical methods (see Laboratory Manual, D.O.E., 1974). Variations, spatial or temporal, were insignificant or undetected for NO_2 , NO_3 and OP. During the survey NH_3 was consistently <0.02 mg/l except from 18 June to 11 September 1974 where a measurable input from each stream station was evident. The analytical results for total phosphorus, with the exceptions of Nanika River (station 2), Delta Creek (station 8) and Pyramid Creek (station 9) was generally less than a detectable amount. Delta and Pyramid Creeks did indicate low input during part of the survey, however, since the water inflow from these creeks is low, the enrichment to Morice Lake is also low. Nanika River, however, contributes the majority (approximately 50%) of water inflow to Morice Lake and the analytical results also

TABLE 4 - MEAN OF SELECTED CHEMICAL PARAMETERS, MORICE LAKE, B.C., 1975

STATION	DEPTH m	HARDNESS		Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Si mg/l	NH ₃ mg/l	NO ₃ mg/l
		TR mg/l	mg/l CaCO ₃							
1	0.5	53	14	1.61	0.32	0.83	4.95	2.4	0.012	0.016
2	0.5	44	12	0.57	0.19	0.57	4.72	1.3	0.011	0.020
3	0.5	39	15	0.53	0.24	0.47	5.22	1.22	0.008	0.035
4	0.5	41	14	0.56	0.25	0.47	5.20	1.27	0.009	0.031
5	0.5	41	14	0.56	0.23	0.45	5.06	1.17	0.010	0.031
6	0.5	44	13	0.49	0.16	0.36	4.96	1.08	0.006	0.026
7	0.5	41	14	0.51	0.21	0.44	5.24	1.33	0.01	0.016
8	0.5	55	12	0.56	0.29	0.44	4.77	1.13	0.01	0.041
9	0.5	51	14	0.55	0.25	0.45	5.35	1.23	0.009	0.048
10	0.5	48	15	0.44	0.17	0.40	4.93	1.20	0.010	0.041
11	0.5	43	16	0.54	0.38	0.65	5.79	1.07	0.010	0.029
12	0.5	37	12	0.42	0.14	0.30	4.48	1.12	0.015	0.015
13	0.5	42	13	0.45	0.14	0.56	4.18	-	-	-
14	0.5	34	15	0.61	0.24	0.44	5.28	0.92	0.001	0.027

TABLE 5 - RANGE & MAXIMUM-MINIMUM OF CHEMICAL PARAMETERS, MORICE LAKE, 1974-75

STATION	DEPTH m	TR mg/l	HARD. mg/l Ca CO ₃	Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Cl mg/l	SO ₄ mg/l
1	0.5	31-89	10-20	1.2-2.3	0.21-0.50	0.27-1.10	3.0-9.0	<1	<5
2	0.5	24-57	10-19	0.2-1.2	0.02-0.40	0.50-1.00	3.2-6.5	<1	<5
3	0.5	17-64	12-20	0.1-1.5	0.22-0.31	0.26-0.50	4.3-5.9	<1	<5
4	0.5	31-55	11-19	0.2-1.3	0.25-0.31	0.29-0.53	3.7-6.1	<1	<5
5	0.5	29-56	13-19	0.2-1.4	0.18-0.31	0.40-0.53	3.9-6.2	<1	<5
6	0.5	31-64	10-20	0.2-0.9	0.10-0.33	0.26-0.70	2.5-7.6	<1	<5
7	0.5	16-62	10-20	0.2-0.9	0.10-0.90	0.21-0.58	2.5-9.6	<1	<5
8	0.5	24-83	10-20	0.3-1.9	0.10-0.53	0.24-0.70	2.3-8.0	<1	<5
9	0.5	30-78	10-20	0.2-1.4	0.10-0.46	0.24-0.70	2.7-8.6	<1	<5
10	0.5	24-73	10-20	0.1-1.6	0.08-0.60	0.16-0.50	2.2-7.3	<1	<5
11	0.5	13-78	10-20	0.2-1.3	0.20-0.52	0.24-1.10	3.3-8.0	<1	<5
12	0.5	19-52	10-20	0.2-0.8	0.14-0.30	0.20-0.40	3.6-5.2	<1	<5
13	0.5	32-54	10-20	0.2-0.8	0.16-0.40	0.40-0.70	3.0-6.2	<1	<5
14	0.5	<10-50	13-19	0.4-1.5	0.19-0.50	0.22-0.56	4.6-6.3	<1	<5

TABLE 5 (Cont'd) - RANGE & MAXIMUM-MINIMUM OF CHEMICAL PARAMETERS, MORICE LAKE, 1974 - 75

<u>STATION</u>	<u>DEPTH</u> m	<u>Si mg/l</u>	<u>NH₃ mg/l</u>	<u>NO₂ mg/l</u>	<u>NO₃ mg/l</u>	<u>OP mg/l</u>	<u>TP mg/l</u>
1	0.5	1.1-3.96	<.005-0.04	<.005-0.006	<.01-0.032	<.005-0.008	<.01-0.070
2	0.5	0.6-2.87	<.005-0.08	<.005	<.005-0.03	<.005-0.010	<.01-0.090
3	0.5	0.7-1.80	<.005-0.07	<.005-0.007	0.02 -0.05	<.005-0.011	<.01-0.045
4	0.5	0.8-1.65	<.005-0.03	<.005-0.007	<.005-0.06	<.005	<.01-0.058
5	0.5	0.7-1.70	<.005-0.06	<.005-0.007	0.018-0.05	<.005	<.01-0.045
6	0.5	0.7-1.40	<.005-0.02	<.005	0.02 -0.03	<.005	<.01-0.045
7	0.5	0.9-2.51	<.005-0.01	<.005	<.01-0.042	<.005-0.008	<.01-0.045
8	0.5	0.3-2.38	<.005-0.03	<.005-0.008	<.005-0.11	<.005-0.010	<.01-0.041
9	0.5	0.5-2.59	<.005-0.04	<.005-0.006	<.01 -0.14	<.005-0.010	<.01-0.055
10	0.5	0.5-2.38	<.005-0.03	<.005-0.010	<.01 -0.13	<.005-0.007	<.01-0.040
11	0.5	0.3-1.52	<.005-0.04	<.005-0.006	<.01 -0.05	<.005-0.011	<.01-0.043
12	0.5	0.7-1.40	<.005-0.02	<.005	<.01 -0.03	<.005-0.007	<.01-0.061
13	0.5	<.2-1.10	<.005-0.02	<.005	<.01	<.005	<.01
14	0.5	0.7-1.70	<.005-0.04	<.005-	<.01 -0.60	<.005-0.005	<.01-0.040

TABLE 6 - COMPARISON OF SELECTED CHEMICAL PARAMETERS FROM MORICE AND OTHER REGIONAL LAKES

	<u>MORICE LAKE</u> <u>X Station 3</u>	<u>BABINE LAKE</u> <u>3 Aug. 1972¹</u>	<u>BABINE LAKE</u> <u>20-26 Oct. 74²</u>	<u>BABINE LAKE</u> <u>14 Aug. 75³</u>	<u>KATHLYN LAKE</u> <u>13 Aug. 73⁴</u>	<u>NANIKA LAKE</u> <u>22 Oct. 74</u>	<u>KIDPRICE L.</u> <u>22 Oct. 74</u>
- Hardness mg/l CaCO ₃	15	-	36.3	-	16.60	17	19
- K mg/l	0.24	0.52	-	-	-	0.20	0.33
- Mg mg/l	0.47	-	-	2.5	1.05	0.40	0.91
- Ca mg/l	5.22	8.10	-	10.3	4.90	7.7	5.6
- Cl mg/l	<1	-	-	0.5	-	<1	<1
- SO ₄ mg/l	<5	-	-	<5	-	<5	6
- Si mg/l	1.22	-	-	4.3	-	1.4	1.48
- Na mg/l	0.53	1.37	-	1.9	-	0.54	0.68
- Cond. µmho/cm	30-50	-	57	78	44	-	-
- pH	7-7.6	6.8 -7.6	7.9	7.6	7.40	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.

TABLE 7 - CHEMICAL ANALYSIS, NANIKA AND KIDPRICE LAKES, 1974

STATION NUMBER	DEPTH m	TEMP °C	pH	Cu mg/l	Zn mg/l	Pb mg/l	TR mg/l	HARD. CaCO ₃ mg/l	Na mg/l	K mg/l	Mg mg/l	Ca mg/l	Mn mg/l	Fe 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
<u>OCTOBER 22</u>																						
KIDPRICE LK.	0.5	7	7.2	0.01	<.01	<.02	41	19	0.68	0.33	0.91	5.6	0.04	1.3	<1	6	1.48	-	<.005	<.01	-	0.065
BERGELAND CR.	0.5	2.3	7.3	0.01	<.01	<.02	55	-	0.70	-	0.96	11	<.03	0.25	<1	13	2.25	<.01	<.005	.014	-	0.016
NANIKA A*	0.5	3.2	7.3	<.01	<.01	<.02	46	-	0.29	-	0.25	4.4	<.03	0.5	<1	<5	0.9	<.01	<.005	.018	-	0.02
NANIKA C*	0.5	7	7.3	<.01	<.01	<.02	37	17	0.54	0.20	0.40	7.7	<.03	0.5	<1	<5	1.4	<.01	<.005	0.029	-	0.049
<u>DECEMBER 11</u>																						
KIDPRICE LK.	0.5	3.0	-	-	-	-	19	13	0.46	0.46	0.93	5.8	<.03	-	<1	<5	1.38	<.01	<.005	<.01	<.005	<.01
NANIKA C*	0.5	3.0	-	-	-	-	15	15	0.33	0.12	0.33	5.5	<.03	-	<1	<5	1.21	<.01	<.005	<.01	<.005	<.01

* See Figure 2 for station location

indicate a substantial (\bar{X} of 0.037 mg/l) input of total phosphorus. A substantial input was indicated during September to October which could be due to salmon carcasses as observed by Stockner and Shortreed, 1974, on Babine Lake.

Total hardness showed no spatial variations during the survey and ranged from 10 - 20 mg/l CaCO_3 . Conductivity was measured four times during 1975; values ranged from 30 - 50 $\mu\text{mho/cm}$ with no trends observed. Hydrogen ion activity was relatively similar between all stations throughout the survey and ranged from 7.0 to 7.6. Variations in total residue (T.R.) were insignificant; the mean yearly range for all stations was 34 - 55 mg/l.

A chemical analysis of snow on the lake was undertaken twice during 1975 to estimate the chemical input from this source. The results are reported in table 8.

TABLE 8. CHEMICAL ANALYSIS OF SNOW, MORICE LAKE, 1975.

	<u>February</u>	<u>March 2</u>
Na mg/l	0.01	0.01
K mg/l	0.02	0.03
Ca mg/l	<.03	<.03
Mg mg/l	0.02	0.03
Hardness (mg/l CaCO_3)	<.2	<.2
pH	7.0	7.0
Cond. $\mu\text{mho/cm}$	3.9	3.1
Cl mg/l	<1	<1
SO_4 mg/l	<5	<5
Si mg/l	<.01	<.01
NH_3 mg/l	<.02	<.02
NO_2 mg/l	<.005	<.005
NO_3 mg/l	<.01	<.01
OP mg/l	<.005	<.005
TP mg/l	<.01	<.01

Although only two samples were analyzed, the results indicate neutral acidity, low conductivity and a low input of all parameters measured. The snow on the lake would likely dilute the available chemical species in the natural run-off waters.

3.2 Phytoplankton

A listing of phytoplankton enumerated and a table of estimated biomass values by station and date appears in Table 9 and Appendix 2. The sampling was initiated in July 1974 and terminated in June, 1975. During the study period the chrysophyta were the dominant species. However, the chlorophyta occupied a fairly large percentage of the population during early spring. During the survey the biomass values reached 300 mg/m^3 only once, in September, 1974 and ranged to a low of 26 mg/m^3 during the winter. Figure 3 indicates the phytoplankton levels between the north and south end of Morice Lake. Figure 4 shows the estimated seasonal biomass and succession pattern for station 3, the most productive station. The relatively high phytoplankton biomass at station 3 is likely due to the input of nutrients from the Nanika River, as compared to the nutrient-poor streams in the remainder of the lake (see section 3.1).

Literature on phytoplankton biomass for this area is limited. Stockner and Shortreed (1974) however, have reported on Babine Lake phytoplankton succession and primary production. The lakes are not comparable since Babine is classified as being mixotrophic and Morice, according to Vollenweider's 1968 lake classification is ultra-oligotrophic (lower than 1000 mg/m^3 maximum plankton density). The lower phytoplankton productivity of Morice Lake could be due to the substantially lower temperatures. A previous study by Brett and Pritchard (1946) indicated that Morice Lake had a low productivity, however, no biomass values were reported. Kling (1975) and Schindler

TABLE 9 - ALGAL SPECIES LIST, MORICE AND NANIKA LAKES

(+ Indicates Presence)

	<u>MORICE LAKE</u>	<u>NANIKA LAKE</u>
<u>CYANOPHYTA</u>		
Synechococcus sp.	+	+
Anabaena sp.	+	+
Anabaena flos-aquae	+	+
Anabaena circinalis	+	+
Aphanizomenon flos-aquae	+	+
<u>CHLOROPHYTA</u>		
Oocystis lacustris	+	
Oocystis submarina var. variabilis	+	
Gloeocystis planctonicus	+	
Elakatothrix gelatinosa	+	+
Tetraedron minimum	+	+
Lagerheimia quadriseta	+	
Lagerheimia subsalsus	+	
Monoraphidium sp.	+	
Scenedesmus denticulatus var. linearis	+	
Scenedesmus sp.	+	
Nephrocytium aqardhianum	+	
Coelastrum microporum	+	
Chlamydomonas sp.	+	
Cosmarium depressum	+	
Pachycladon sp.	+	
<u>EUGLENOPHYTA</u>		
None		

TABLE 9 (Cont'd)

	MORICE LAKE	NANIKA LAKE
<u>CHRYSOPHYCEAE</u>		
Chrysococcus rufescens	+	
Chrysococcus sp.	+	+
Erkenia subaequiciliata	+	
Erkenia sp.	+	+
Chromulina sp.	+	+
Ochromonas sp.	+	+
Heterochromonas sp.	+	+
Rhizochrysis sp.	+	
Kephyrion sp.	+	+
Kephyrion bonale	+	+
Pseudokephyrion spirale	+	+
Mallomonas sp.	+	+
Synura sp.	+	+
Chrysoikos skujai	+	+
Dinobryon sertularia var. protrub	+	+
Dinobryon acuminatum	+	
Dinobryon njakjaurensis	+	
Dinobryon sociale var. americanum	+	
Dinobryon suecicum	+	
Dinobryon sp.	+	+
Botryococcus braunii	+	
<u>DIATOMAEAE</u>		
Synedra acus	+	+
Synedra acus var. radians	+	
Synedra acus var. angustissima	+	
Synedra sp.	+	+

TABLE 9 (Cont'd)

	MORICE LAKE	NANIKA LAKE
<i>Cyclotella comta</i>	+	+
<i>Cyclotella stelligera</i>	+	+
<i>Cyclotella keutzingiana</i>	+	+
<i>Cyclotella</i> sp.	+	+
<i>Cymbella</i> sp.	+	+
<i>Stauroneis</i> sp.	+	+
<i>Navicula</i> sp.	+	+
<i>Achnanthes</i> sp.	+	+
<i>Nitzschia acicularis</i>	+	+
<i>Stephanodiscus astreae</i>	+	+
<i>Eunotia</i> sp.	+	
<i>Epithemia</i> sp.	+	
<i>Cocconeis</i>	+	
<i>Melosira granulata</i>	+	
<i>Melosira distens</i>	+	
<i>Tabellaria finestrata</i>	+	
<i>Tabellaria floosculosa</i>	+	
<i>Asterionella formosa</i>	+	
<i>Rhizosolenia eriensis</i>	+	
<i>Rhizosolenia</i> sp.	+	
<u>CRYPTOPHYCEAE</u>		
<i>Cryptomonas erosa</i>	+	
<i>Cryptomonas rostratiformes</i>	+	
<i>Cryptomonas pusilla</i>	+	
<i>Rhodonomas minuta</i>	+	+
<i>Katablepharis ovalis</i>	+	+
<i>Cryptaulax</i> sp.	+	

TABLE 9 (Cont'd)

	MORICE LAKE	NANIKA LAKE
<u>PERIDINEAE</u>		
Gymnodinium helveticum	+	
Gymnodinium sp.	+	
Glenodinium poscheri	+	
Peridinium pusillum	+	

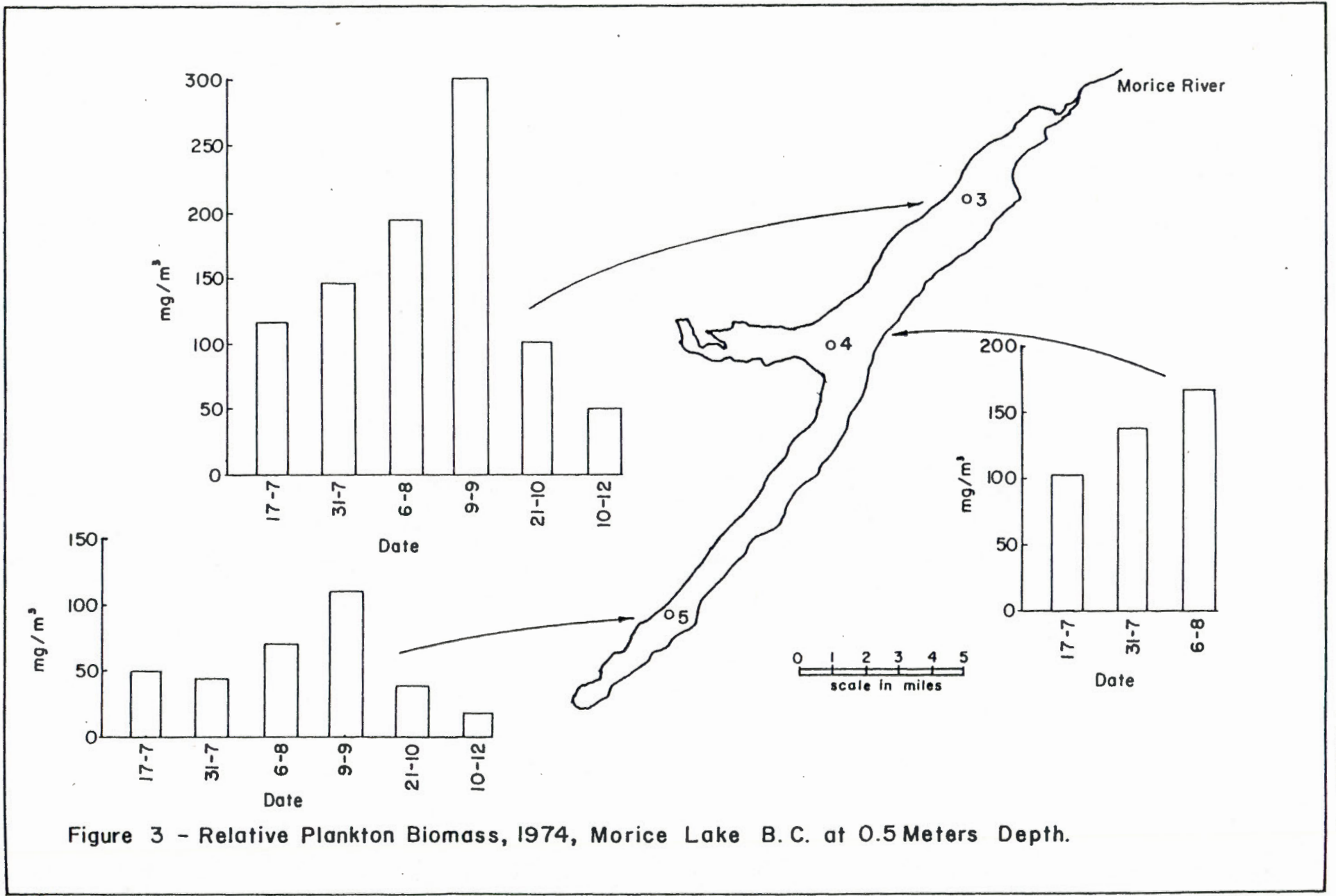


Figure 3 - Relative Plankton Biomass, 1974, Morice Lake B.C. at 0.5 Meters Depth.

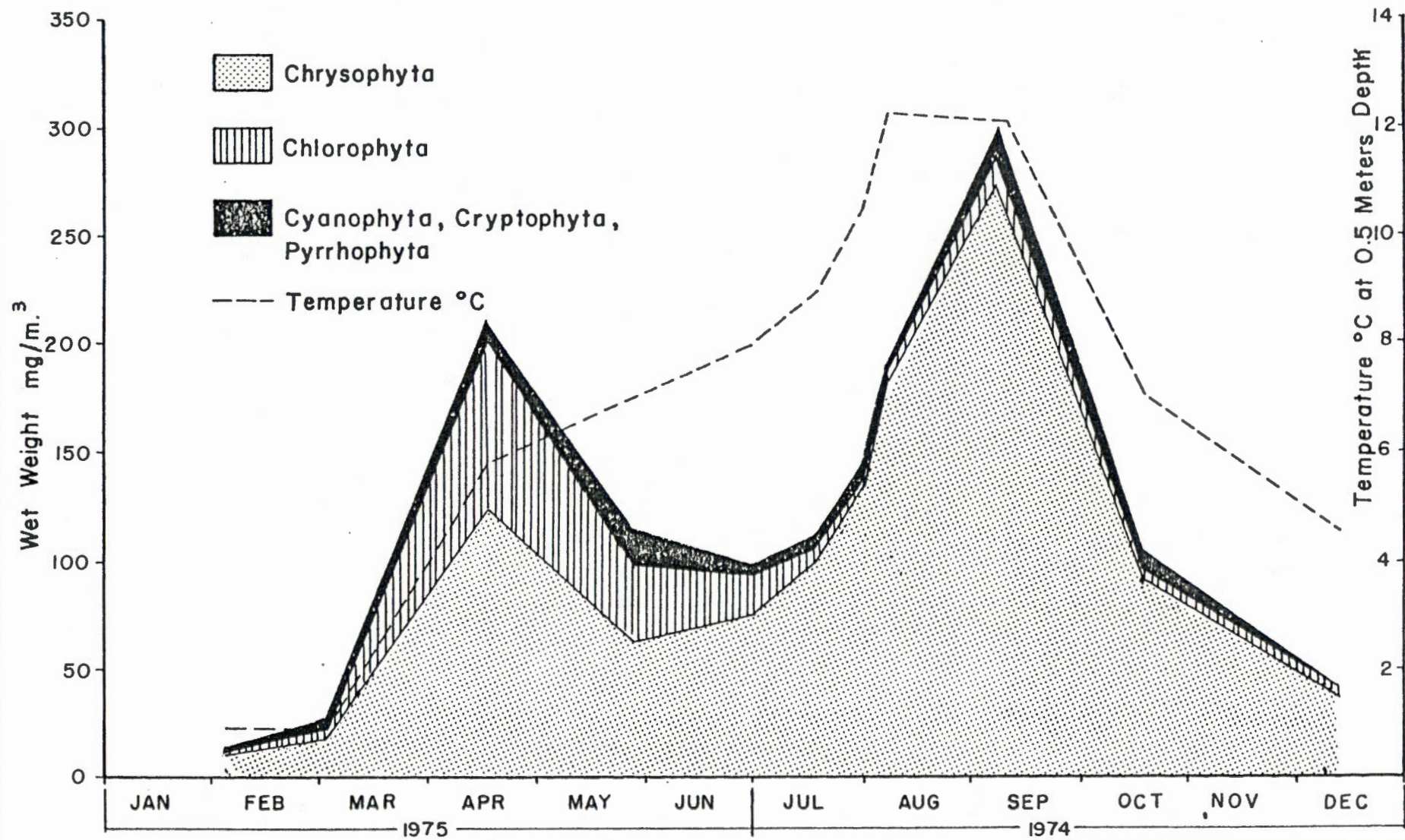


Figure 4 - Phytoplankton Biomass Values and Temperature, Station 3 (0.5 Meters), Morice Lake, B.C.

et.al. (1974) reported on several lakes with similar biomass values, however, these lakes are all located in the Northwest Territories and are likely not comparable due to the differences in amount of sunlight and degree of nutrient enrichment.

During most of the year it was impossible to sample the water column due to wind action. However, temperature data and the phytoplankton sampling on July 17, 1974 (Appendix 2) would indicate that the top 200 meters are relatively mixed. The apparent predominance of the negatively buoyant diatoms throughout the water column on July 17, 1974 would tend to confirm that wind mixing is a major factor within the lake.

Nanika Lake was also sampled once during the survey at stations A and B, on July 31, 1974. The results (Table 10) show it is similar in biomass to Morice Lake. A list of algae species present is given in Table 9.

Since measurable quantities of NH_3 , NO_2 , NO_3 , OP and TP were generally close to or below analytical detection limits, it is reasonable to assume that nutrients (except silicon) are a major limiting factor to phytoplankton production within Morice Lake. During the survey only Nanika River contributed any significant supply of TP.

Silicon is an important nutrient to Morice Lake since diatoms are the dominant phytoplankton group. According to Lund (1950, 54), silicon is limiting (to Asterionella formosa and Melosira italica) if the supply is lower than 0.5 mg/l. However, since the measurable quantity was never observed at this low level it is likely that silicon was not limiting in Morice Lake during the 1974 - 75 survey. Other chemical parameters measured do not appear to be present in sufficiently low levels

TABLE 10 - NANIKA LAKE PHYTOPLANKTON BIOMASS VALUES

DATE	JULY 31, 1974			
STATION*	A		B	
DEPTH m	0.5		0.5	
	mg/m ³	%	mg/m ³	%
CYANOPHYTA	9.5	16.6	28.8	15.4
CHLOROPHYTA	4.3	7.5	10.1	5.4
EUGLENOPHYTA	-	-	-	-
CHRYSOPHYCEAE	28.2	49.4	110.2	58.8
DIATOMEAE	15.1	26.4	36.1	19.2
CRYPTOPHYCEAE	-	-	2.1	1.1
PERIDINEAE	-	-	-	-
TOTAL	57.1	-	187.3	-

* See map of study area, Figure 1.

to reduce or limit production of diatoms (Lund, 1950). Phytoplankton biomass values are illustrated in Table 11.

3.3 Zooplankton

Based on data analyzed during this survey, the low number of zooplankton species (Table 12) is typical of alpine lakes and is believed to be a result of factors primarily connected with altitude such as low water temperature and reduced probability of distribution owing to isolation (Patalas, 1964).

Quantitatively, the planktonic abundance found in this lake is low, typical of alpine lakes. This decreased amount of plankton can be associated with increased altitude, decreased temperature and/or decreased total dissolved solids (TR). A comparison with other Canadian lakes is given in table 13 (Patalas et. al., 1973).

TABLE 13. COMPARISON OF ZOOPLANKTON ABUNDANCE
IN SOME CANADIAN LAKES.

<u>Lake</u>	<u>Total Crustacean Zooplanktonic Abundance, Ind/cm²</u>
Morice	0.37-8.96
Great Slave	15
Superior	43
Winnipeg	100
Okanagan	101-188
Huron	167
Ontario	306
Erie	400

TABLE 11 - COMPARISON OF MORICE LAKE PHYTOPLANKTON
BIOMASS VALUES BETWEEN JULY, 1974 TO
JUNE, 1975, (0.5 METERS)

	STATION 3 mg/m ³	STATION 4 mg/m ³	STATION 5 mg/m ³
July 17, 1974	119.1	102.9	53.8
July 31	146.0	136.2	44.3
Aug. 6	190.1	171.0	69.8
Sept. 9	300.6	-	111.1
Oct. 21	100.1	-	39.0
Dec. 10	50.5	-	20.1
Feb. 3, 1975	26.1	-	-
Mar. 2	49.8	-	-
Apr. 18	212.0	-	-
May 28	120.1	-	-
June 25	99.1	90.0	39.8

TABLE 12 - LIST OF ZOOPLANKTON SPECIES FOUND IN NET PLANKTON OF MORICE LAKE, B.C.

SPECIES	STATION 3			STATION 4			STATION 5		
	17 July 74	31 July 74	11 Sept. 74	17 July 74	31 July 74	11 Sept. 74	17 July 74	31 July 74	11 Sept. 74
<i>Epischura nevadensis</i> Lilljeborg	1.48	0.62	-	0.04	0.05	<0.01	-	0.21	0.01
<i>Cyclops bicuspidatus</i> thomasi S. A. Forbes	-	-	-	-	-	-	-	-	-
<i>Cyclops scutifer</i> Sars.	6.40	1.92	0.04	2.31	0.56	0.06	2.46	0.11	0.03
<i>Daphnia longiremus</i> Sars.	0.13	0.04	<0.01	0.11	0.03	0.04	0.04	0.05	0.09
<i>Bosmina coregoni longespina</i> Leudig	0.04	0.04	0.07	-	-	0.13	-	<0.01	0.18
<i>Wolopedium gibberum</i> Zaddach	0.91	0.83	1.27	0.80	0.59	0.53	0.16	0.38	0.38
TOTAL IND/1	8.96	3.45	1.38	3.26	1.23	0.82	2.66	0.75	0.69

TABLE 12 (Cont'd) - LIST OF ZOOPLANKTON SPECIES FOUND IN NET PLANKTON OF MORICE LAKE, B.C.

SPECIES	STATION 3				STATION 4		STATION 5		
	3 Feb. 75	28 May 75	25 June 75	24 Aug. 75	25 June 75	24 Aug. 75	28 May 75	25 June 75	24 Aug. 75
<i>Epischura nevadensis</i> Lilljeborg	-	-	-	0.03	-	<0.01	-	-	0.03
Diaptomidae nauplii	-	-	0.31	-	0.06	-	-	0.04	-
<i>Cyclops bicuspidatus</i> <i>thomasi</i> S. A. Forbes	-	-	-	0.06	-	-	-	-	-
<i>Cyclops scutifer</i> Sars	1.43	5.31	7.59	0.44	0.31	0.53	1.48	1.00	0.57
<i>Bosmina coregoni</i> <i>longispina</i> Leydig	<0.01	<0.01	0.05	0.18	-	0.10	-	-	0.03
<i>Holopedium gibberum</i> Zaddach	0.02	-	0.21	0.34	<0.01	0.07	-	0.06	0.13
Total Ind/l	1.45	5.31	8.16	1.05	0.37	0.70	1.48	1.10	0.76

The Diaptomidae nauplii are likely those of *Epischura nevadensis* as no other diaptomid species was encountered.

In comparison, on data presented to date, Morice Lake is poor in amount of zooplankton, both in the number of species present and the total amount of each species.

A probable pattern is exhibited in an increasing abundance in spring and early summer at all three stations, which is likely due to the increasing temperature and available nutrients from the spring run-off water, see table 12.

Zooplankton abundance also appears to decrease from north to the south end of the lake. The greatest zooplankton abundance occurs between May and July, probably as a direct result of the relatively large chlorophyta bloom.

There is a possibility of another diaptomid being present below 10 meters. The absence of Daphnia logniremis from the 1975 samples may be due to a lack of sampling of deeper water, especially in daytime sampling. In the Okanagan Lakes and the Great Lakes for example, 90% of the zooplankton are located between 0 - 50 meters (Patalas and Salki, 1973). However, after reviewing unpublished data collected during the Nanika River Hatchery program (Appendix 4, Table 4), the present data would appear to have missed a substantial amount of the total population.

Nanika Lake was also sampled on 31 July 1974 as a comparison to Morice Lake. The results are reported in Table 14.

3.4 Zoobenthos

The average density of benthic invertebrates in samples from Morice Lake was 1680 per square meter. If the upper 100 meters of water is considered, the density increased to 1992/m², 2812/m² for the upper 25 meters and 3366/m² for the uppermost 10 meters of littoral shore area. The density ranged from 6006/m² at station three at two meters depth to 42/m² at station five at 231 meters depth.

Tables 15 and 16 indicate that the chironomids constitute approximately 50% of the fauna of Morice Lake and that 66% occur in the top 25 meters. In most cases, the dominant species is Heterotrissocladus cf oliveri Saether. Saether (1975) indicates this species as strongly cold-stenothermic and ultra-oligotrophic.

No previous benthic invertebrate data for Morice Lake or other Bulkley Valley lakes could be located in the literature. Some zoobenthic literature for southern British Columbia is published but are incomparable in species composition and abundance. This is likely due to differences in altitude and climate.

Rawson (1957, 1958, 1960 a, 1960 b) and Koshinsky (1971) surveyed Churchill River lakes in Saskatchewan with similar climate and reported equal or lower densities of zoobenthos. The larger mesh for sample seining as used by Rawson and Koshinsky would result in reporting relatively lower population densities. Sampling techniques used on 15 small lakes in the Canadian Shield near Kenora, Ontario (Hamilton, 1971) were identical to those used on this study. Hamilton reported

TABLE 14 - LIST OF ZOOPLANKTON SPECIES FOUND IN NET PLANKTON OF NANIKA LAKE, B.C. 1974

SPECIES	STATION A	STATION B	STATION C
	31 July 74	31 July 74	31 July 74
<i>Epischura nevadensis</i> Lilljeborg	0.07	0.04	0.04
<i>Diaptomus arcticus</i> Marsh	0.04	0.02	-
<i>Diaptomus kenai</i> M. S. Wilson	0.37	0.14	0.05
<i>Cyclops bicuspidatus thomasi</i> S. R. Forbes	1.90	1.19	0.09
<i>Daphnia longispina hyalina</i> Leydig var <i>microcephala</i> Sars.	0.09	0.09	0.03
<i>Bosmina coregoni longispina</i> Leydig	0.02	<0.01	<0.01
TOTAL IND/1	2.49	1.49	0.21

TABLE 15 - DISTRIBUTION OF BENTHIC INVERTEBRATES IN MORICE LAKE,
 BY STATION AND DEPTH
 (S = Sand, C = Gray clay, O = Organic material, M = Brown mud)

STATION DEPTH (m)	THREE										FOUR				FIVE										Total
	2	8	16	23	35	55	75	115	162	12	35	100	234	2	5	7	9	14	25	37	66	81	231		
Chironomidae	109	40	73	54	14	26	22	5	4	200	6	37	21	10	6	10	32	39	32	36	68	70	2	916	
Empididae	55	10	-	1	-	-	-	-	-	3	-	-	-	-	5	-	2	-	2	-	-	-	-	78	
Oligochaeta	122	99	-	2	-	-	-	-	2	9	-	-	7	115	169	18	41	10	-	-	-	-	-	594	
Gastropoda	-	2	1	-	-	-	-	-	-	3	-	-	-	-	-	-	5	-	-	-	-	-	-	11	
Pelecypoda	-	6	16	8	2	-	-	-	-	7	2	-	-	-	-	4	15	3	28	9	-	-	-	100	
Nematoda	-	25	-	24	5	7	16	6	16	-	1	-	2	-	-	-	-	49	9	8	-	-	-	168	
Total	286	182	90	89	21	33	38	11	22	222	9	37	30	125	180	32	95	101	71	53	68	70	2	1867	
Substrate Type	M	M	M	M	S	S-M	M	C	M	M	S	C	C	S-M	O-M	S	M-O	M	M	C-M	C	C	C		
Organisms per square meter	6006	3822	1890	1869	441	693	798	231	462	4662	189	777	630	2625	3780	672	1995	2121	1491	1113	1428	1470	42	$\bar{X}=1680$	

TABLE 16 - DISTRIBUTION OF CHIRONOMIDAE IN MORICE LAKE

STATION	THREE												FOUR				FIVE									
	DEPTH (m)													2	5	7	9	14	25	37	66	81	231			
Procladius sp.	2	2	7	10	5	1	-	-	-	-	-	-	-	-	-	-	-	2	3	3	1	-	1	2		
Thienemannimyia group	7	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Paracladopelma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-		
Stictochironomus sp.	-	5	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-		
Micropsectra sp.	-	4	4	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Tanytarsus sp.	78	4	-	-	-	-	-	-	-	-	-	-	-	4	3	-	-	-	-	-	-	-	-	-		
Heterotrissocladius cf. oliveri saeth.	-	6	24	26	7	25	22	5	4	68	6	34	18	1	3	-	21	27	19	27	68	69	-			
Paracladius sp.	10	10	20	3	-	-	-	-	-	52	-	1	2	-	-	-	5	2	-	-	-	-	-			
Parakiefferiella sp.	-	-	8	14	1	-	-	-	-	48	-	2	1	-	-	-	4	2	6	8	-	-	-			
Psectrocladius sp.	11	2	-	-	-	-	-	-	-	16	-	-	-	-	-	-	5	4	-	-	-	-	-			
Monodiamesa cf. prolilabata saeth.	-	5	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-			
Protanypus cf. namiltani saeth.	-	-	-	-	1	-	-	-	-	4	-	-	-	3	-	-	-	-	-	-	-	-	-			
Potthastia longimanus (Kieff.)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-			
Sympotthastia sp.	3	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
	109	40	73	54	14	26	22	5	4	200	6	37	21	10	6	10	32	39	32	36	68	70	2			

TABLE 17 - THE CHIRONOMIDAE FROM MORICE LAKE, B.C.

Subfamily Tanypodinae

Procladius sp.

Thienemannimyia group cf. Conchapelopia sp.

Subfamily Chironominae

Tribe Chironomini

Paracladopelma sp.

Stictochironomus sp.

Tribe Tanytarsini

Micropsectra sp.

Tanytarsus sp.

Subfamily Orthocladiinae

Heterotrissocladius cf. oliveri Saeth.

Paracladius sp.

Parakiefferiella sp.

Psectrocladius sp.

Subfamily Diamesinae

Monodiamesa cf. prolilobata Saeth.

Protanypus cf. hamiltani Saeth.

Potthastia longimanus (Kieff.)

Sympotthastia sp.

an average of 1552 benthic organisms/m² with a range from 104 to 3556 organisms/m². These densities are similar to Morice Lake however, both the latitude (54°00' vs 49°30') and altitude (793 m vs 370 m) are lower. Welch (1976) reported on the ecology of chironomids from a polar lake which appeared to have a similar taxonomic representation to Morice Lake, however, the chironomid life cycle was 2 - 3 years as larvae. Therefore, a direct comparison is also not possible without further work on the Morice Lake invertebrate population.

3.5 Trophic Level

No attempt has been made to relate the available data on phosphorus input to the trophic level of Morice Lake. Phosphorus input is apparently so low that it was to a large degree below the measurable limit of the analytical facilities. The major tributary, the Nanika River, contributed the only measurable loading of total phosphorus to the lake.

4.0 Impact of Impoundment

Impoundment will create changes in the water chemistry of Morice Lake. The initial effect of impoundment will be an increase in nutrients because of leaching from the new littoral soils. Since the majority of the present shoreline of Morice Lake is bedrock and some gravel, the leaching effect will be minimal except where there is some organic accumulation at Delta and Atna Creeks and from the watersheds of the Nanika River and McBride Creek. The minimal nutrient leaching from these new flooded zones may result in a small increase in primary production. However, flooding (shoreline erosion) will also increase reservoir turbidity which will decrease primary production by decreasing the photosynthetic zone.

The Nanika River presently contributes approximately 50% of the water inflow into Morice Lake. The chemical water quality of Morice Lake, therefore, is substantially influenced by this river. This is evident from the relatively greater phytoplankton production in this area (station 3). Reduction of this water flow will likely cause a decrease in phytoplankton with eventual lowering of the upper food chain. However, if the salmon escapement is assured over the dam at the outlet of Morice Lake and continued spawning occurs in the Nanika River, the major supply of nutrients from salmon carcasses will not be lost to the system. Therefore, the decrease in the total supply of nutrients could be minimized. The zooplankton, which feed on littoral phytoplankton, will follow a similar pattern of production with a short time lag.

Similar surveys by Sinclair (1965) in British Columbia and by Grimas (1961) on numerous Swedish impounded lakes show some post impoundment changes in the benthos. Comparing their reports with the present survey enables some predictions of the consequences of impoundment on the benthic invertebrate community of Morice Lake. Water level fluctuations in their reports caused reductions of bottom fauna. This will be especially critical in Morice Lake since the maximum abundance of the benthic invertebrates inhabit the littoral lake environment which will be greatly affected by water level fluctuation. At high and low water levels, wave action and ice scouring will cause excessive erosion which will effectively limit benthos and plant development in this region. Changes may also occur in species type and abundance. Some species (e.g., Gastropoda) could become extremely reduced or eliminated, while other new species (perhaps not desirable to present fish community) may colonize this new territory. (McMynn and Larkin, 1953; Grimas, 1961; 1962; 1964; Hamilton, 1974; Sinclair, 1965).

Operation of a large capacity pump near the southern end of Morice Lake could result in changes in flow patterns and temperature regime within the lake, and possible changes in the overall lake productivity. These possible impacts were not investigated as part of this program and must be addressed if future consideration is given to pumping as part of the development proposal.

5.0 Conclusions

5.1 Water Chemistry and Temperatures

Morice Lake showed a high dissolved oxygen content (90 - 100%) and cool water temperatures. The maximum observed temperature was 12.7° C (55.3° F) on 6 August 1974. The north end of the lake (near Morice River) was consistently warmer (except during midwinter when the observations were similar) than the south end of the lake. Most measured nutrient values (Nitrogen as NO₂, NO₃, NH₃ and Phosphorus as OPO₄, T.P.) were generally lower than the sensitivity of our present analytical methods, silicon being the exception. Nanika River, which contributes about 50% of the total water inflow, was the only station to have a measurable phosphorus input into Morice Lake enrichment. Other parameters measured (total hardness, pH, conductivity, total residue) showed no significant spatial or temporal trends.

Impoundment and diversion of the Morice watershed into the Kemano system via whatever route currently being considered will have a marked effect on the water chemistry of Morice Lake. These effects will occur by any or all of the following ways: (a) flooding; (b) fluctuations of water levels; and (c) disruption of flow patterns.

The initial effect of flooding will be an increase in nutrients from the new littoral zone, due to leaching from the new flooded soils. However, since the majority of the Morice Lake shoreline is bedrock and gravel, the leaching effect could be minimal. The only areas which may be significantly affected will be adjacent to the present lake outlet, Atna Creek and Delta Creek. The increase in nutrients will increase production of the green algae.

However, fluctuations of water levels will also cause some shoreline erosion which will increase the lake turbidity and reduce the zone of production.

The Nanika River presently contributes about 50% of the total flow into Morice Lake. The water chemistry of Morice Lake, especially the more productive northerly end of the lake, is therefore substantially influenced by this river. A reduction in the flow of the Nanika River will likely cause a decrease in lake production due to the loss of chemical nutrients. This loss of nutrients will primarily effect the phytoplankton. Any diversion of the Nanika River will therefore cause a further decrease on the total productivity of Morice Lake.

5.2 Phytoplankton

The total estimated biomass reached a maximum of 300 mg/m^3 , indicating a very low phytoplankton productivity in Morice Lake. This could be due to the low water temperatures and the low nutrient content. Observations also indicate a higher productivity towards the north end of the lake. This relatively high biomass (as compared to the remainder of the lake) is likely due to the input of nutrients from Nanika River.

The impact on the phytoplankton due to impoundment will likely be twofold: (a) due to leachates from new flooded land an increase in nutrients will increase the productivity for a short term. The green algae will likely have the greatest increase from the nutrient leaching since silicon, the major nutrient for diatoms, does not appear to be limiting at present; (b) due to increased turbidity from erosion along the new shoreline, a decrease in the photosynthetic zone will decrease production due to the lack of sunlight.

5.3 Zooplankton

Zooplankton analysis showed that Morice Lake is low in the number of species and in total abundance. Eight species were identified with a maximum abundance of 8.96 individuals per litre. This decreased amount of plankton is probably due to: (1) low temperatures; (2) increased altitude; (3) low total dissolved solids; and (4) poor supply of nutrients.

The impact of lake impoundment and flow diversion on the zooplankton will likely be similar to the impact on phytoplankton since the two groups are usually completely interdependent. The short term impact will likely be an increase in abundance due to increased leachates after impoundment followed by a long term negative effect on the plankton due to a partial diversion of the Nanika River water.

5.4 Zoobenthos

The mean abundance of benthos in Morice Lake was 1,680 individuals per square meter. The littoral zone (0 - 10 meters depth) had a much greater abundance of benthic invertebrates of 3,366/m². The dominant group (the non-biting midges) observed were indicative of a very cold and high oxygen saturation lake typology.

The greatest impact of the proposed development will occur at the land-water interface due to continual lake flooding and drawdown. The impact will limit the invertebrate abundance and could influence species composition.

ACKNOWLEDGMENTS

The author would like to thank the many individuals who have contributed to this study. The technical assistance of C.C. Graham and R.A. McIndoe is gratefully acknowledged.

The benthic analysis under the direction of P. Chang, plankton analysis under the direction of H. Kling and A. Salki and chemical analysis under the direction of J. Davidson is greatly appreciated. These analyses were carried out in Environment Canada laboratories.

W.J. Schouwenburg, J. Stockner, C.E. Walker, B. Shepherd and R. Ferguson reviewed the manuscript. K. Johansen and R. Eliassen proof-read this report.

Special thanks to R.A. Robertson, the study manager, who provided technical and operational guidance.

References

- Anon., 1974. Laboratory Manual. Environment Canada, Fisheries Service - Environmental Protection Service, Pacific Region. 36 pp.
- Anon., 1974. Historical streamflow summary. British Columbia to 1973. D. O. E., Inland Waters Directorate, Water Resources Branch, Ottawa, Canada.
- Anon., 1975. Water Quality Report for Babine Lake. Environmental Laboratory, B. C. Water Resources Service. 1 January 1972 - 18 August 1975.
- Baillie, B. R. and R. J. Buchanan, 1974. An investigation of the condition of Kathlyn Lake, with suggestions for rehabilitation. Dept. of Lands, Forests and Water Resources, B. C. Water Res. Ser. M.S. 35 pp., 8 Tables, 14 Figs. and 1 Appendix.
- Brett, J. R. and A. L. Pritchard, 1946. Lakes of the Skeena River Drainage, II, Morice Lake. Fish. Res. Bd. Can. Progress Report 67: 23-26.
- Chau, Y. K. and P. T. S. Wong. M. S. Chemical and Biological Studies of Babine Lake, B. C., D. O. E., CCIW. 16 pp.
- Godfrey, H., 1955. On the ecology of Skeena River whitefish, Coregonus and Prosopium. J. Fish Res. Bd. Can. 12(4): 499-542.

- Grimas, U., 1961. The bottom fauna of natural and impounded lakes in northern Sweden. Instit. Freshwater Res. Drottningholm. 42: 183-237.
- Grimas, U., 1962. The effect of increased water level fluctuation upon the bottom fauna in Lake Blasjon, Northern Sweden. Rept. Inst. Freshw. Res. Drottningholm, 44: 14-41.
- Grimas, U., 1964. Studies on the bottom fauna of impounded lakes in Southern Norway (Tunnhoofd fjord, Poolsbuffjord and Rodungen). Rept. Inst. Freshw. Res. Drottningholm, 45: 94-104.
- Hamilton, A. L., 1971. The zoobenthos of 15 lakes in the Experimental Lakes Area in Northwestern Ontario. J. Fish. Res. Bd. Can. 28(2): 257-263.
- Hamilton, A. L., 1974. Zoobenthos survey of Southern Indian Lake. Lake Winnipeg, Churchill and Nelson Rivers Study Board. Appendix 5, Vol. 1 (G) 32 pp.
- Kling, H., 1975. Phytoplankton successions and species distribution in prairie ponds of the Erickson - Elphinstone district, Southwestern Manitoba. D. O. E., Fish. and Marine Service, Tech. Rept. 512: 1-31.
- Koshinsky, G. D., 1971. Trout and McIntosh Lakes: The comparative limnology and fisheries of a Churchill River lake and an adjacent Shield Lake in central Saskatchewan. Sask. Fish. Lab., Dept. Nat. Res. Sask., Fish. Rept., 97 pp.
- Lund, J. W. G., 1950. Studies on Asterocoinella formosa Hass. II. Nutrient depletion and the spring maximum. J. Ecol. 38(1): 15-35.

- Lund, J. W. G., 1954. The seasonal cycle of the plankton diatom Melosira italica (EhR.) Kutz. subsp. subartica D. Mull. J. Ecol. 42: 151-179.
- McMynn, R. G. and Larkin, P. A. 1953. The effects on fisheries of present and future water utilization in the Campbell River drainage area. Management Publication, B. C. Game Comm., 61 pp.
- Patalas, K., 1964. The crustacean plankton communities in 52 lakes of different altitudinal zones in Northern Colorado. Verh. Internat. Verein. Limnol. 15: 719-726.
- Patalas, K. and A. Salki, 1973. Crustacean plankton and the eutrophication of lakes in the Okanagan Valley, British Columbia. J. Fish. Res. Bd. Can. 30: 519-542.
- Rawson, D. S., 1957. Limnology and fisheries of five lakes in the upper Churchill drainage, Saskatchewan Dept. Nat. Res. Sask., Fish. Rept., 3: 1-61.
- Rawson, D. S., 1958. Indices to lake productivity and their significance in predicting conditions in reservoirs and lakes with disturbed water levels. In: The Investigations of Fish-Power Problems. H. R. MacMillan Lectures in Fisheries. U. B. C., pp. 27-48.
- Rawson, D. S., 1960 a. A limnological comparison of 12 large lakes in northern Saskatchewan. Limnol. and Oceanog. 5(2): 1-198.
- Rawson, D. S. 1960 b. Five lakes on the Churchill River near Stanley, Saskatchewan. Sask. Dept. Nat. Res., Fish. Rept. No. 5: 1-39.

- Saether, O. A., 1975. Nearctic and Palaeartic Heterotrissocladius (Diptera: Chironomidae). Bull. Fish. Res. Bd. Can. 193: 1-67.
- Schindler, D. W., J. Kalff, H. E. Welch, G. T. Brunskill, H. Kling and N. Kritsch., 1974. Eutrophication in the high Arctic - Meretta Lake, Corwallis Island (75° W. Lat.). J. Fish. Res. Bd. Can. 31: 657-662.
- Sinclair, D. C., 1965. The effects of water level changes on the limnology of two British Columbia coastal lakes, with particular reference to the bottom fauna. MSC. Thesis. U. B. C. 84 pp.
- Stockner, J. G. and K. R. S. Shortreed, 1974. Phytoplankton succession and primary production in Babine Lake, British Columbia. Fish. Res. Bd. Can., Tech. Rept., 417: 1-98.
- Vollenweider, R. A., 1968. Scientific fundamentals of the eutrophication of lakes and flowing waters, with particular reference to nitrogen and phosphorus as factors of eutrophication. OECD Rep. DAS/SSI. 68.27: 1-159.
- Vollenweider, R. A., 1969. A manual on methods for measuring primary production in aquatic environments. IBP Handbook No. 12, 213 pp.
- Welch, H. E., 1976. Ecology of Chironomidae (Diptera) in a Polar Lake. J. F. R. B. 33(2): 227-247.

APPENDIX I -- CHEMICAL ANALYSIS MORICE LAKE WATER , 1974 -- 1975

DATE - 31-5-74

STATION NUMBER	DEPTH M	TR mg/l	HARD. 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
1	0.5	-	-	2.0	-	-	4.0	<1	<5	-	<.02	<.005	-	<.005	<.01
2	0.5	-	19	1.2	-	-	-	<1	<5	-	<.02	<.005	-	<.005	0.01
3	0.5	64	15	1.5	0.12	0.56	5.2	<1	<5	-	<.02	<.005	0.05	<.005	<.01
4	0.5	55	19	1.3	0.20	0.41	6.1	<1	<5	-	-	<.005	0.06	<.005	<.01
5	0.5	56	19	1.4	0.21	0.42	6.2	<1	<5	-	<.02	<.005	0.05	<.005	<.01
5	5.0	56	16	1.5	0.18	0.50	5.8	<1	<5	-	<.02	<.005	0.05	<.005	<.01
6	0.5	-	-	-	-	-	-	<1	<5	-	<.02	<.005	0.03	<.005	<.01
8	0.5	59	15	1.9	0.35	0.32	6.5	-	<5	-	<.02	<.005	0.11	<.005	<.01
9	0.5	63	18	1.4	0.33	0.35	6.5	<1	<5	-	<.02	<.005	0.14	<.005	<.01
10	0.5	47	15	1.6	0.15	0.39	5.4	<1	<5	-	<.02	<.005	0.03	<.005	<.01
11	0.5	65	20	1.3	0.44	0.62	7.8	<1	<5	-	<.02	<.005	0.05	<.005	<.01
12	0.5	-	-	-	-	-	-	<1	<5	-	<.02	<.005	0.03	<.005	<.01
14	0.5	50	19	1.5	0.12	0.40	5.2	<1	<5	-	<.02	<.005	-	<.005	<.01

DATE - 18-6-74

STATION NUMBER	DEPTH M	TR mg/l	HARD. 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
1	0.5	67	10	1.5	0.33	1.0	3.0	<1	<5	-	0.04	<.005	-	<.005	<.01
2	0.5	49	10	0.5	0.24	0.6	3.2	<1	<5	-	0.08	<.005	-	<.005	<.01
3	0.5	46	13	0.4	0.28	0.4	4.6	<1	<5	-	0.07	<.005	-	<.005	<.01
4	0.5	41	13	0.4	0.27	0.5	4.7	<1	<5	-	0.03	0.007	-	<.005	<.01
5	0.5	40	13	0.4	0.22	0.4	4.6	<1	<5	-	0.06	<.005	-	<.005	<.01
6	0.5	46	13	0.4	0.15	0.4	4.7	<1	<5	-	0.02	<.005	-	<.005	<.01
7	0.5	45	10	0.3	-	0.3	2.5	<1	<5	-	0.11	<.005	-	<.005	<.01
8	0.5	77	10	0.3	0.32	0.4	2.3	<1	<5	-	0.03	0.005	-	<.005	<.01
9	0.5	63	10	0.4	0.19	0.5	2.7	<1	<5	-	0.04	<.005	-	<.005	<.01
10	0.5	45	13	0.3	0.13	0.4	4.6	<1	<5	-	0.03	-	-	<.005	<.01
11	0.5	51	16	0.4	0.45	0.6	5.3	<1	<5	-	0.04	<.005	-	<.005	<.01
12	0.5	40	10	0.4	0.16	0.4	3.6	<1	<5	-	0.02	<.005	-	<.005	<.01
13	0.5	40	10	0.4	0.16	0.4	3.6	<1	<5	-	0.02	<.005	-	<.005	<.01
14	0.5	40	13	0.4	0.20	0.4	4.6	<1	<5	-	0.04	<.005	-	<.005	<.01

DATE - 17-7-74

STATION NUMBER	DEPTH M	Chla mg/l	TR mg/l	HARD. 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
1	0.5	-	63	11	1.8	0.40	0.93	3.0	<1	<5	2.15	0.02	<.005	-	0.008	0.07
2	0.5	-	57	11	0.6	0.06	0.44	4.0	<1	<5	1.36	0.02	0.005	-	0.005	0.09
3	0.5	0.1	55	13	0.6	0.25	0.42	4.8	<1	<5	1.3	0.01	<.005	-	0.005	0.045
3	100	<0.1	55	13	0.2	0.26	0.42	4.7	<1	<5	1.3	0.01	<.005	-	<.005	0.048
3	200	<0.1	55	13	0.6	0.26	0.44	5.0	<1	<5	1.3	0.01	<.005	-	<.005	0.048
4	0.5	0.1	-	14	0.7	0.27	0.44	5.0	<1	<5	1.3	0.01	<.005	-	<.005	0.058
4	75	<0.1	67	14	0.7	0.24	0.42	4.9	<1	<5	1.3	0.01	<.005	-	<.005	0.043
4	150	<0.1	70	14	0.6	0.27	0.44	5.0	<1	<5	1.1	0.01	<.005	-	<.005	0.048
5	0.5	<0.1	-	14	0.6	0.26	0.42	4.7	<1	<5	1.2	0.02	<.005	-	<.005	0.045
5	175	<0.1	70	14	0.9	0.34	0.49	4.9	<1	<5	1.1	0.02	<.005	-	<.005	0.039
5	200	<0.1	-	14	0.8	0.27	0.44	4.9	<1	<5	1.2	0.01	<.005	-	0.005	0.039
6	0.5	-	64	14	0.9	0.19	0.44	5.1	<1	<5	1.1	<.01	<.005	-	0.008	0.045
7	0.5	-	62	11	0.5	0.09	0.36	3.7	<1	<5	1.1	0.02	<.005	-	0.007	0.045
8	0.5	-	71	10	0.4	0.33	0.36	3.2	<1	<5	0.9	0.02	<.005	-	0.010	0.041
9	0.5	-	66	10	0.5	0.23	0.31	3.2	<1	<5	1.2	<.01	<.005	-	0.008	0.055
10	0.5	-	73	14	0.1	0.16	0.30	3.2	<1	<5	1.1	0.02	<.005	-	0.007	0.040
11	0.5	-	78	14	0.5	0.44	0.50	5.0	<1	<5	1.1	0.02	<.005	-	0.006	<.01
12	0.5	-	52	10	0.5	0.09	0.30	4.7	<1	<5	1.22	0.02	<.005	-	0.007	0.061
13	0.5	-	-	-	0.8	-	-	3.0	<1	<5	-	-	<.005	-	-	<.01
14	0.5	-	-	14	0.6	0.27	0.40	-	<1	<5	-	-	<.005	-	<.005	0.04

DATE - 31-7-74

STATION NUMBER	DEPTH M	Chl mg/l	TR mg/l	HARD. 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
1	0.5	-	50	10	1.5	0.4	1.1	-	<1	<5	2.45	0.019	<.005	<.01	<.005	0.01
2	0.5	-	33	10	0.4	0.1	0.4	3.0	<1	<5	1.4	0.014	<.005	<.01	0.005	0.01
3	0.5	-	46	13	0.5	0.3	0.5	4.4	<1	<5	1.4	0.005	<.005	0.028	<.005	<.01
3	25	<0.1	-	12	0.5	0.3	0.5	3.9	<1	<5	1.4	0.007	<.005	0.015	<.005	<.01
3	175	-	<2.5	11	0.5	0.3	0.4	3.8	<1	<5	1.4	<.005	<.005	0.03	<.005	<.01
4	0.5	<0.1	46	11	0.4	0.3	0.5	3.7	<1	<5	1.4	<.005	<.005	0.018	<.005	<.01
4	25	-	<2.5	13	0.4	0.3	0.4	4.5	<1	<5	1.4	<.005	<.005	0.028	<.005	<.01
4	175	-	<2.5	12	0.6	0.3	0.6	3.9	<1	<5	1.4	<.005	<.005	0.035	<.005	<.01
5	0.5	<0.1	29	12	0.5	0.3	0.5	3.9	<1	<5	1.4	<.005	<.005	0.018	<.005	<.01
5	10	-	<2.5	13	0.4	0.3	0.5	4.2	<1	<5	1.4	<.005	<.005	0.015	<.005	<.01
5	75	-	<2.5	12	0.4	0.3	0.4	4.0	<1	<5	1.4	<.005	<.005	0.015	<.005	<.01
5	175	-	<2.5	13	0.5	0.3	0.4	4.2	<1	<5	1.4	<.005	<.005	0.029	<.005	<.01
6	0.5	-	37	11	0.6	0.1	0.3	4.0	<1	<5	1.4	<.005	<.005	0.029	<.005	<.01
7	0.5	-	55	10	0.4	0.3	0.5	3.0	<1	<5	1.4	<.005	<.005	<.01	<.005	<.01
8	0.5	-	55	10	0.4	0.1	0.4	-	<1	<5	1.2	0.009	<.005	<.01	<.005	<.01
9	0.5	-	40	10	0.2	0.2	0.4	-	<1	<5	0.6	<.005	<.005	<.01	<.005	<.01
10	0.5	-	57	10	0.4	0.1	0.3	3.8	<1	<5	1.2	<.005	<.005	<.01	<.005	<.01
11	0.5	-	30	13	0.2	0.4	0.7	3.9	<1	<5	1.0	<.005	<.005	<.01	<.005	<.01
12	0.5	-	19	10	0.5	0.1	0.2	-	<1	<5	1.2	<.005	<.005	<.01	<.005	<.01
13	0.5	-	32	13	0.2	0.2	0.7	3.9	<1	<5	1.1	<.005	<.005	<.01	<.005	<.01
14	0.5	-	-	-	0.6	0.3	0.4	4.0	<1	<5	-	<.005	<.005	<.01	<.005	<.01

DATE - 6-8-74

STATION NUMBER	DEPTH M	Chla mg/l	TR mg/l	HARD. 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
1	0.5	-	31	10	1.20	0.1	0.27	3.6	<1	<5	1.65	0.011	-	0.032	<.005	<.01
2	0.5	-	24	12	0.20	0.1	0.26	4.2	<1	<5	0.90	0.016	-	0.038	0.005	0.01
3	0.5	<.1	24	12	0.10	0.1	0.26	4.3	<1	<5	0.09	0.006	-	0.050	<.005	<.01
4	0.5	<.1	45	13	0.20	0.1	0.29	4.6	<1	<5	1.0	0.009	-	0.055	<.005	<.01
5	0.5	<.1	33	13	0.20	0.1	-	4.5	<1	<5	0.7	0.009	-	0.028	<.005	<.01
6	0.5	-	31	10	0.20	0.1	0.25	2.5	<1	<5	0.7	0.014	-	0.030	<.005	<.01
7	0.5	-	24	10	0.20	0.1	0.21	3.7	<1	<5	1.0	<.005	-	0.042	<.005	<.01
8	0.5	-	27	10	0.30	0.1	0.26	3.6	<1	<5	1.1	<.005	-	0.053	<.005	<.01
9	0.5	-	30	10	0.20	0.1	0.24	3.6	<1	<5	1.0	<.005	-	0.055	<.005	<.01
10	0.5	-	41	10	0.10	0.1	0.16	2.2	<1	<5	0.9	0.009	-	0.040	<.005	<.01
11	0.5	-	13	10	0.20	0.1	0.24	3.3	<1	<5	1.1	0.006	-	0.040	<.005	<.01
12	0.5	-	-	10	0.20	0.1	0.20	-	<1	-	-	-	-	-	-	-
14	0.5	-	24	10	0.40	0.1	0.22	-	<1	<5	1.0	0.009	-	0.05	<.005	<.01

DATE - 11-9-74

STATION NUMBER	DEPTH M	TR mg/l	HARD. 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
1	0.5	40	17	1.20	0.24	0.50	6.2	<1	<5	1.8	0.027	<.005	-	<.005	0.01
2	0.5	48	14	0.40	0.12	0.50	4.8	<1	<5	0.6	0.029	<.005	-	<.005	0.04
3	0.5	28	16	0.40	0.24	0.50	5.6	<1	<5	0.7	0.012	<.005	-	<.005	<.01
4	0.5	35	15	0.50	0.25	0.53	5.5	<1	<5	0.8	0.016	<.005	<.005	-	0.01
5	0.5	45	15	0.40	0.26	0.53	5.3	<1	<5	0.8	0.015	<.005	-	<.005	<.01
5	25	40	15	0.40	0.26	0.56	5.0	<1	<5	0.9	0.014	<.005	-	<.005	<.01
5	175	-	15	0.40	0.25	0.52	5.3	<1	<5	1.1	0.015	<.005	-	<.005	<.01
6	0.5	41	20	0.50	0.17	0.45	7.6	<1	<5	1.0	0.013	<.005	-	<.005	<.01
7	0.5	41	18	0.60	0.12	0.58	6.4	<1	<5	0.8	0.016	<.005	-	<.005	<.01
8	0.5	57	11	0.50	0.43	0.53	3.6	<1	<5	0.3	0.024	<.005	-	<.005	0.01
9	0.5	47	13	0.40	0.26	0.53	4.7	<1	<5	0.5	0.019	<.005	-	<.005	0.01
10	0.5	38	16	0.20	0.08	0.40	5.9	<1	<5	0.5	0.015	<.005	-	<.005	<.01
11	0.5	37	12	0.25	0.37	0.45	4.0	<1	<5	0.3	0.019	<.005	-	<.005	<.01
12	0.5	37	13	0.40	0.07	0.38	4.6	<1	<5	0.7	0.016	<.005	-	<.005	<.01
13	0.5	54	17	0.40	0.07	0.57	6.2	<1	<5	<.2	0.02	<.005	-	<.005	<.01
14	0.5	43	17	0.50	0.24	0.50	6.2	<1	<5	0.8	0.018	<.005	-	<.005	<.01

DATE - 21-10-74

STATION NUMBER	DEPTH M	Chla mg/l	TR mg/l	HARD. 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
1	0.5	-	89	19	1.7	-	1.1	4.5	<1	<5	3.2	<.01	<.005	<.01	-	0.01
2	0.5	-	38	14	0.6	-	0.8	5.2	<1	<5	1.5	0.01	<.005	<.01	-	0.22
3	0.5	<.01	38	14	0.4	-	0.5	5.9	<1	<5	1.4	<.01	<.005	0.026	-	<.01
4	0.5	<.01	32	14	0.6	-	0.52	5.8	<1	<5	1.4	<.01	<.005	0.028	-	<.01
5	0.5	<.01	-	14	-	-	-	-	-	-	1.4	<.01	<.005	0.027	-	<.01
7	0.5	-	44	20	0.6	-	0.5	7.5	<1	<5	1.8	<.01	<.005	<.01	-	<.01
8	0.5	-	39	15	0.5	-	0.8	6.3	<1	<5	1.6	<.01	<.005	0.03	-	0.01
9	0.5	-	41	15	0.7	-	0.7	7.1	<1	<5	1.8	<.01	<.005	0.03	-	0.02
10	0.5	-	48	15	0.4	-	0.5	-	<1	<5	1.6	<.01	<.005	0.06	-	<.01
11	0.5	-	42	16	0.6	-	1.1	-	<1	<5	1.4	<.01	<.005	0.02	-	0.04
14	0.5	-	33	13	0.5	-	0.56	6.2	<1	<5	1.4	<.01	<.005	0.03	-	<.01

DATE - 10-12-74

STATION NUMBER	DEPTH M	Ch1 mg/l	TR mg/l	HARD. 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
1	0.5	-	45	20	1.60	0.31	0.8	9.0	<.4	<5	3.96	0.01	0.006	<.01	<.005	0.01
2	0.5	-	53	14	0.60	0.40	1.0	4.0	<.4	<5	2.87	0.01	<.005	0.01	<.005	0.01
3	0.5	<.01	28	14	0.50	0.31	0.5	4.9	<.4	<5	1.8	0.01	0.007	0.02	<.005	<.01
4	0.5	<.01	31	14	0.50	0.25	0.5	4.9	<.4	<5	1.65	<.01	0.007	0.02	<.005	<.01
5	0.5	<.01	-	14	0.50	0.30	0.5	4.9	<.4	<5	1.7	<.01	0.007	0.02	<.005	<.01
5	50	<.01	-	14	0.50	0.27	0.5	4.9	<.4	<5	1.8	<.01	0.007	0.02	<.005	<.01
7	0.5	-	16	20	0.80	0.17	0.7	9.8	<.4	<5	2.51	<.01	<.005	<.01	<.005	<.01
8	0.5	-	24	20	0.60	0.53	0.4	8.0	<.4	<5	2.38	<.01	0.008	0.03	<.005	0.01
9	0.5	-	32	20	0.70	0.46	0.5	8.6	<.4	<5	2.58	<.01	0.006	0.02	<.005	<.01
10	0.5	-	24	15	0.60	0.11	0.6	-	<.4	<5	2.38	<.01	0.01	0.03	<.005	<.01
11	0.5	-	21	20	0.80	-	0.9	6.6	<.4	<5	1.52	<.01	0.006	<.01	0.006	<.01
14	0.5	-	-	14	0.50	0.30	0.5	5.0	<.4	<5	1.7	<.01	0.007	0.02	<.005	<.01

DATE - 4-2-75

STATION NUMBER	DEPTH M	Ch1a mg/l	TR mg/l	HARD. 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
2	0.5	<.01	-	18	0.5	0.28	0.64	6.1	<.04	<5	1.6	<.01	<.005	0.03	0.01	0.02
3	0.5	<.01	17	16	0.4	0.24	0.44	5.8	<.04	<5	1.3	<.01	<.005	0.005	-	<0.01
11	0.5	-	33	22	0.7	-	0.74	7.7	<.04	<5	1.5	<.01	<.005	0.06	0.011	0.01

DATE - 2-3-75

STATION NUMBER	DEPTH M	TR mg/l	HARD. 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
1	0.5	30	18	1.7	0.4	0.92	5.8	-	<5	3.1	<.01	<.005	0.01	0.005	<0.01
2	0.5	31	19	0.6	0.2	0.6	6.5	-	<5	1.7	<.01	<.005	0.03	0.005	<0.01
14	0.5	<10	18	0.6	0.3	0.5	6.3	<1	<5	1.4	<.01	<.005	0.04	0.005	<0.01

DATE - 28-5-75

STATION NUMBER	DEPTH M	TR mg/l	HARD. 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
1	0.5	65	12	1.2	0.21	0.58	3.9	<1	<5	2.2	<.01	<.005	0.013	<.005	<.01
2	0.5	56	14	0.7	0.13	0.50	4.9	<1	<5	1.5	<.01	<.005	0.028	0.009	0.03
3	0.5	48	15	0.5	0.22	0.45	5.4	<1	<5	0.9	<.01	<.005	0.042	0.011	<.01
5	0.5	42	15	0.5	0.18	0.43	5.2	<1	<5	0.8	<.01	<.005	0.042	<.005	<.01
7	0.5	42	13	0.6	0.10	0.37	4.6	<1	<5	1.1	<.01	<.005	<.01	<.005	<.01
8	0.5	83	11	0.4	0.23	0.24	4.0	<1	<5	0.9	<.01	<.005	0.070	<.005	0.03
9	0.5	78	16	0.6	0.31	0.50	5.7	<1	<5	1.3	<.01	<.005	0.078	<.005	0.03
10	0.5	55	18	0.4	0.08	0.39	6.7	<1	<5	1.0	<.01	<.005	0.138	<.005	<.01
11	0.5	57	20	0.6	0.52	0.70	8.0	<1	<5	0.8	<.01	<.005	0.050	<.005	<.01
14	0.5	35	16	0.6	0.19	0.47	5.7	<1	<5	0.1	<.01	<.005	0.047	<.005	<.01

DATE - 25-6-75

STATION NUMBER	DEPTH M	TR mg/l	HARD. 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
1	0.5	-	-	2.3	0.5	1.1	4.4	<1	<5	2.1	<.005	<.005	0.01	<.005	0.01
2	0.5	-	-	0.6	0.2	0.5	4.7	<1	<5	1.2	<.005	<.005	<.005	<.005	0.01
3	0.5	-	-	0.5	0.3	0.5	5.7	<1	<5	1.2	<.005	<.005	0.02	<.005	<.01
4	0.5	-	-	0.5	0.3	0.5	5.7	<1	<5	1.3	<.005	<.005	<.005	<.005	<.01
5	0.5	-	-	0.5	0.2	0.4	5.7	<1	<5	1.2	<.005	<.005	0.03	<.005	<.01
6	0.5	-	-	0.4	0.1	0.3	5.6	<1	<5	1.2	<.005	<.005	0.02	<.005	<.01
7	0.5	-	-	0.4	0.6	0.4	3.2	<1	<5	0.9	<.005	<.005	0.01	<.005	<.01
8	0.5	-	-	0.4	0.3	0.7	3.1	<1	<5	0.6	<.005	<.005	<.005	<.005	0.02
9	0.5	-	-	0.5	0.1	0.5	5.3	<1	<5	1.2	0.009	<.005	0.03	<.005	0.01
10	0.5	-	-	0.3	0.6	0.6	6.5	<1	<5	1.0	<.005	<.005	0.01	<.005	<.01
11	0.5	-	-	0.5	0.2	0.6	5.8	<1	<5	1.1	<.005	<.005	0.01	<.005	<.01
12	0.5	-	-	0.4	0.3	0.3	4.3	<1	<5	1.1	0.005	<.005	0.01	<.005	<.01

DATE - 24-8-75

STATION NUMBER	DEPTH M	HARD. 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
1	0.5	11	0.5	0.26	-	7.1	<1	<5	1.4	<.005	<.005	0.02	<.005	<.01
2	0.5	10	0.5	0.22	-	6.0	<1	<5	1.3	<.005	<.005	0.02	<.005	0.01
3	0.5	20	0.5	0.26	-	6.0	<1	<5	1.3	<.005	<.005	0.02	<.005	<.01
4	0.5	15	0.5	0.31	-	6.0	<1	<5	1.3	<.005	<.005	0.03	<.005	<.01
4	10	17	0.6	0.31	-	6.0	<1	<5	1.2	<.005	<.005	0.03	<.005	<.01
4	30	17	0.6	0.31	-	6.0	<1	<5	1.3	0.007	<.005	0.04	<.005	<.01
5	0.5	10	0.6	0.31	-	6.0	<1	<5	1.3	<.005	<.005	0.03	<.005	<.01
6	0.5	12	0.4	0.33	-	5.2	<1	<5	1.1	<.005	<.005	0.02	<.005	<.01
7	0.5	18	0.7	0.22	-	8.0	<1	<5	1.4	<.005	<.005	0.02	<.005	<.01
8	0.5	-	0.5	0.25	-	7.1	<1	<5	1.2	<.005	<.005	0.02	<.005	<.01
9	0.5	20	0.5	0.32	-	6.1	<1	<5	1.2	<.005	<.005	0.02	0.01	0.01
10	0.5	20	0.4	0.22	-	7.3	<1	<5	1.1	0.009	<.005	0.01	0.005	<.01
11	0.5	20	0.4	0.52	-	6.3	<1	<5	0.9	0.006	<.005	<.01	<.005	<.01
12	0.5	20	0.5	0.14	-	5.2	<1	<5	1.4	<.005	<.005	<.01	<.005	<.01
14	0.5	-	0.5	0.31	-	5.0	<1	<5	1.3	<.005	<.005	<.01	<.005	<.01

APPENDIX 2

MORICE LAKE PHYTOPLANKTON BIOMASS VALUES

DATE	JULY 17, 1974																		
STATION	3					4					5								
DEPTH M	0.5		100		-	0.5		75		100		-	0.5		175		200		
	mg/m ³	%	mg/m ³	%	INT*	mg/m ³	%	mg/m ³	%	mg/m ³	%	INT	mg/m ³	%	mg/m ³	%	mg/m ³	%	INT
CYANOPHYTA	5.7	5.3	-	-	2.8	2.9	2.5	7.3	7.6	6.8	6.3	6.1	1.4	2.1	-	-	-	-	0.6
CHLOROPHYTA	11.0	10.2	5.3	4.0	8.1	8.4	7.4	2.5	2.6	6.6	6.1	5.0	2.0	3.1	1.4	3.0	5.7	14.6	1.9
EUGLENOPHYTA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHRSOPHYTA																			
CHRSOPHYCEAE	55.2	51.0	86.9	66.2	70.7	81.2	71.7	50.3	52.7	24.4	22.7	51.3	34.5	53.5	22.3	48.0	10.1	25.9	26.8
DIATOMEAE	33.7	31.1	23.6	18.0	28.5	21.1	18.5	27.4	28.7	63.8	59.2	34.8	26.6	41.2	12.6	27.1	17.2	44.1	19.0
CRYPTOPHYTA																			
CRYPTOPHYCEAE	0.7	0.6	2.5	1.9	1.5	-	-	0.2	0.2	6.1	5.7	1.6	-	-	9.6	20.6	4.3	11.0	5.1
PYRRHOPHYTA																			
PERIDINIACEAE	1.9	1.8	12.9	9.8	7.4	0.6	0.5	7.8	8.2	-	-	4.0	-	-	0.6	1.3	1.7	4.4	0.4
TOTAL	108.2		131.2		119.1	114.2		95.5		107.7		102.9	64.5		46.5		39.0		53.8

*INTEGRATED

APPENDIX 2 (Cont'd)

MORICE LAKE PHYTOPLANKTON BIOMASS VALUES

DATE	JULY 31, 1974						AUGUST 6, 1974						SEPTEMBER 9, 1974			
STATION	3		4		5		3		4		5		3		5	
DEPTH M	0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5	
	mg/m ³	%	mg/m ³	%	mg/m ³	%	mg/m ³	%	mg/m ³	%	mg/m ³	%	mg/m ³	%	mg/m ³	%
CYANOPHYTA	5.7	3.9	0.7	0.5	-	-	2.8	1.4	0.6	0.4	0.5	0.7	0.7	0.2	16.1	14.5
CHLOROPHYTA	6.1	4.2	12.4	9.1	7.8	17.6	7.0	3.7	9.0	5.2	17.8	25.5	13.9	4.6	61.0	54.9
EUGLENOPHYTA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHRYSOPHYTA																
CHRYSOPHYCEAE	108.4	74.2	95.0	69.8	33.2	74.9	158.2	83.3	140.0	81.9	47.4	67.9	271.1	90.2	23.3	21.0
DIATOMEAE	25.8	17.7	21.8	16.0	2.5	6.0	22.1	11.6	20.0	11.7	3.0	4.2	7.6	2.6	10.5	9.5
CRYPTOPHYTA																
CRYPTOPHYCEAE	-	-	-	-	-	-	-	-	-	-	-	-	6.8	2.3	0.2	0.2
PYRRHOPHYTA																
PERIDINIACEAE	-	-	6.3	4.6	0.6	1.3	-	-	1.4	0.8	1.1	1.7	0.2	0.1	-	-
TOTAL	146.0	-	136.2	-	44.3	-	190.1	-	171.0	-	69.8	-	300.6	-	111.1	-

APPENDIX 2

MORICE LAKE PHYTOPLANKTON BIOMASS VALUES

DATE	OCTOBER 21, 1974				DECEMBER 10, 1974			
STATION	3		5		3		5	
DEPTH M	0.5		0.5		0.5		0.5	
	mg/m ³	%	mg/m ³	%	mg/m ³	%	mg/m ³	%
CYANOPHYTA	0.2	0.2	5.1	13.1	-	-	4.1	20.4
CHLOROPHYTA	5.1	5.1	15.1	38.7	4.0	7.9	5.9	29.4
EUGLENOPHYTA	-	-	-	-	-	-	-	-
CHRYSOPHYTA								
CHRYSOPHYCEAE	86.6	86.5	12.0	30.8	41.0	81.2	6.5	32.3
DIATOMACEAE	5.0	5.0	6.8	17.4	5.5	10.9	3.6	17.9
CRYPTOPHYTA								
CRYPTOPHYCEAE	3.0	3.0	-	-	-	-	-	-
PYRRHOPHYTA								
PERIDINIACEAE	0.2	0.2	-	-	-	-	-	-
TOTAL	100.1	-	39.0	-	50.5	-	20.1	-

APPENDIX 2

MORICE LAKE PHYTOPLANKTON BIOMASS VALUES

DATE	FEB 3, 1975		MAR 2, 1975		APR 18, 1975		MAY 28, 1975	
STATION	3		3		3		3	
DEPTH M	0.5		0.5		0.5		0.5	
	mg/m ³	%	mg/m ³	%	mg/m ³	%	mg/m ³	%
CYANOPHYTA	0.7	2.7	5.7	11.3	8.1	3.7	7.3	6.1
CHLOROPHYTA	2.0	7.6	5.1	10.2	65.0	31.0	29.1	24.2
EUGLENOPHYTA	-	-	-	-	-	-	-	-
CHRYSOPHYTA								
CHRYSOPHYCEAE	13.1	50.2	23.0	46.2	92.1	43.0	47.2	39.3
DIATOMACEAE	10.1	38.7	15.5	31.1	45.9	22.0	22.0	18.3
CRYPTOPHYTA								
CRYPTOPHYCEAE	-	-	0.4	0.8	0.3	0.2	4.7	3.9
PYRRHOPHYTA								
PERIDINIACEAE	0.2	0.8	0.2	0.4	0.6	0.3	9.8	8.2
TOTAL	26.1	-	49.9	-	212.0	-	120.1	-

APPENDIX 2 MORICE LAKE PHYTOPLANKTON BIOMASS VALUES

DATE	JUNE 25, 1975					
STATION	3		4		5	
DEPTH M	0.5		0.5		0.5	
	mg/m ³	%	mg/m ³	%	mg/m ³	%
CYANOPHYTA	5.1	5.1	3.2	3.6	1.1	2.8
CHLOROPHYTA	19.1	19.3	6.9	7.7	1.8	4.5
EUGLENOPHYTA	-	-	-	-	-	-
CHRYSOPHYTA						
CHRYSOPHYCEAE	45.0	45.4	51.0	56.7	26.1	65.6
DIATOMACEAE	28.9	29.2	28.5	31.6	10.8	27.1
CRYPTOPHYTA						
CRYPTOPHYCEAE	-	-	-	-	-	-
PYRRHOPHYTA						
PERIDINIACEAE	1.0	1.0	0.4	0.4	-	-
TOTAL	99.1	-	90.0	-	39.8	-

APPENDIX 3 - IDENTIFICATION OF ZOOBENTHOS, BY STATION AND DEPTH,
MORICE LAKE, B. C., 1975

(L = Larvae, P = Pupae, Niponic = Specimen in postembryonic stage)

<u>STATION AND DEPTH</u>	<u>IDENTIFICATION</u>	<u>NO. OF SPECIMENS</u>
St. 3 - 2 m.	Chironomidae	
	Paracladius sp.	10L
	Procladius sp.	2L
	Psectrocladius sp.	9L
	Psectrocladius sp.	2P
	Sympotthastia sp.	3L
	Tanytarsus sp.	78L
	Thienemannimyia group cf. Conchapelopia	7L
	Empididae	
	Hemerodromia sp.	38L
	Hemerodromia sp.	17P
	Oligochaeta	
	Tubificidae	
	Rhyacodrilus prob. montana	49
	Aulodrilus americanus	
	Enchytraeidae	5
	<hr/>	
St. 3 - 8 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	6L
	Monodiamesa cf. prolilobata	5L
	Micropsectra sp.	4L
	Paracladius sp.	10L
Procladius sp.	2L	

<u>STATION AND DEPTH</u>	<u>IDENTIFICATION</u>	<u>NO. OF SPECIMENS</u>
St. 3 - 8 m. (cont'd)	<i>Psectrocladius</i> sp.	2P
	<i>Stictochironomus</i> sp.	5L
	<i>Tanytarsus</i> sp.	4L
	Thienemannimy group cf. <i>Conchapelopia</i>	2L
	Empididae	
	<i>Hemerodromia</i> sp.	6L
	<i>Hemerodromia</i> sp.	4P
	Gastropoda	
	<i>Valrata sincere</i>	2
	Pelecypoda	
	<i>Pisidium casertanum</i>	4
	Niponic	2
	Oligochaeta	
	Tubificidae	
	<i>Rhyacodrilus</i> prob. <i>montana</i>	31
	<i>Aulodrilus americanus</i>	61
	<i>Potamothrix hammoniensis</i>	1
	Enchytraeidae	6
<hr/>		
St. 3 - 16 m.	Chironomidae	
	<i>Heterotrissocladus</i> cf. <i>oliveri</i>	24L
	<i>Micropsectra</i> sp.	4L
	<i>Paracladius</i> sp.	9L
	<i>Paracladius</i> sp.	11P
	<i>Parakiefferiella</i> sp.	8L
	<i>Procladius</i> sp.	7L
	<i>Sympotthastia</i> sp.	9L
	Thienemannimyia group cf. <i>Conchapelopia</i>	1L

<u>STATION AND DEPTH</u>	<u>IDENTIFICATION</u>	<u>NO. OF SPECIMENS</u>
St. 3 - 16 m. (cont'd)	Gastropoda	
	Valvata sincera	1
	Pelecypoda	
	Pisidium casertanum	14
	Niponic	2
	Nematoda	25
<hr/>		
St. 3 - 23 m.	Chironomidae	
	Heterotrissocladius cf. oliver	26L
	Paracladius sp.	3L
	Parakiefferiella sp.	14L
	Procladius sp.	10L
	Thienemannimyia group cf. Conchapelopia	1L
	Empididae	
	Hemerodromia sp.	1L
	Pelecypoda	
	Pisidium casertanum	4
	Niponic	4
	Oligochaeta	
	Aulodrilus americanus	2
	Nematoda	24
	<hr/>	
St. 3 - 35 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	7L
	Parakiefferiella sp.	1L
	Procladius sp.	5L
	Protanypus cf. hamiltani	1L
	Pelecypoda	
Pisidium casertanum	1	

<u>STATION AND DEPTH</u>	<u>IDENTIFICATION</u>	<u>NO. OF SPECIMENS</u>
St. 3 - 35 m.	Niponic	1
	Nematoda	5
St. 3 - 55 m.	Chironomidae	
	Heterotrissocladus cf. oliver	25L
	Procladius sp.	1L
	Nematoda	7
St. 3 - 75 m.	Chironomidae	
	Heterotrissocladus cf. oliveri	22L
	Nematoda	16
St. 3 - 115 m.	Chironomidae	
	Heterotrissocladus cf. oliveri	5L
	Nematoda	6
St. 3 - 162 m.	Chironomidae	
	Heterotrissocladus cf. oliveri	4L
	Oligochaeta	
	Rhyacodrilus prob. montana	2
	Nematoda	16
St. 4 - 12 m.	Chironomidae	
	Heterotrissocladus cf. oliveri	68L
	Micropsectra sp.	12L
	Paracladius sp.	52L
	Parakiefferiella sp.	48L
	Protanypus cf. hamiltani	4L
	Psectrocladius sp.	16P

<u>STATION AND DEPTH</u>	<u>IDENTIFICATION</u>	<u>NO. OF SPECIMENS</u>
St. 4 - 12 m. (cont'd)	Empididae	
	Hemerodromia sp.	3L
	Gastropoda	
	Valvata sincera	3
	Pelecypoda	
	Pisidium casertanum	1
	Niponic	6
	Oligochaeta	
	Rhyacodrilus prob. montana	5
	Aulodrilus americanus	4
<hr/>		
St. 4 - 35 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	6L
	Pelecypoda	
	Niponic	2
	Nematoda	1
<hr/>		
St. 4 - 100 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	34L
	Paracladius sp.	1L
	Parakiefferiella sp.	2L
<hr/>		
St. 4 - 234 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	18L

<u>STATION AND DEPTH</u>	<u>IDENTIFICATION</u>	<u>NO. OF SPECIMENS</u>
St. 4 - 234 m. (cont'd)	Paracladius sp.	2L
	Parakiefferiella sp.	1L
	Oligochaeta	
	Aulodrilus americanus	6
	Enchytraeids	1
	Nematoda	2
<hr/>		
St. 5 - 2 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	1L
	Paracladopelma sp.	1L
	Protanypus cf. himiltani	3L
	Potthastia longimanus	1L
	Tanytarsus sp.	4L
	Oligochaeta	
	Aulodrilus americanus	29
	Rhyacodrilus prob. montana	82
	Enchytraeids	4
<hr/>		
St. 5 - 5 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	3L
	Tanytarsus sp.	3L
	Empididae	
	Hemerodromia sp.	5L
	Oligochaeta	
	Aulodrilus americanus	46
	Rhyacodrilus prob. montana	97
	Enchytraeids	26

<u>STATION AND DEPTH</u>	<u>IDENTIFICATION</u>	<u>NO. OF SPECIMENS</u>	
St. 5 - 7 m.	Chironomidae		
	<i>Monodiamesa cf. prolilobata</i>	1L	
	<i>Stictochironomus sp.</i>	9L	
	Pelecypoda		
	Niponic	4	
	Oligochaeta		
	<i>Rhyacodrilus prob. montana</i>	16	
	<i>Aulodrilus americanus</i>	2	
	<hr/>		
	St. 5 - 9 m.	Chironomidae	
<i>Heterotrissocladius cf. oliveri</i>		21L	
<i>Paracladius sp.</i>		5L	
<i>Procladius sp.</i>		2L	
<i>Parakiefferiella sp.</i>		4L	
Empididae			
<i>Hemerodromia sp.</i>		2L	
Gastropoda			
<i>Valvata sincera</i>		5	
Pelecypoda			
<i>Pisidium casertanum</i>		3	
Niponic		12	
Oligochaeta			
<i>Aulodrilus americanus</i>		6	
<i>Rhyacodrilus prob. montana</i>		33	
Enchytraeids	2		

<u>STATION AND DEPTH</u>	<u>IDENTIFICATION</u>	<u>NO. OF SPECIMENS</u>
St. 5 - 14 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	27L
	Paracladius sp.	2L
	Parakiefferiella sp.	2L
	Procladius sp.	3L
	Psectrocladius sp.	5L
	Pelecypoda	
	Pisidium casertanum	2
	Niponic	1
	Oligochaeta	
	Rhyacodrilus prob. montana	8
	Enchytraeids	2
	Nematoda	49
St. 5 - 25 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	19L
	Parakiefferiella sp.	6L
	Procladius sp.	3L
	Psectrocladius sp.	4P
	Pelecypoda	
	Pisidium casertanum	4
	Niponic	5
	Nematoda	8
St. 5 - 66 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	68L

<u>STATION AND DEPTH</u>	<u>IDENTIFICATION</u>	<u>NO. OF SPECIMENS</u>
St. 5 - 81 m.	Chironomidae	
	Heterotrissocladius cf. oliveri	69L
	Procladius sp.	1L
<hr/>		
St. 5 - 231 m.	Chironomidae	
	Procladius sp.	2L
<hr/> <hr/>		

APPENDIX 4 - MORICE LAKE UNPUBLISHED DATA COLLECTED
DURING THE NANIKA RIVER HATCHERY PROGRAM

The following unpublished data on Morice Lake were collected by the Department of Fisheries during the summers of 1961 to 1967. The information was used to assist in determining the productivity of the lake for the Nanika River Hatchery which was in operation at that time. The program was carried out under the direction of R. Palmer, the biologist in charge of the Nanika River project. Sampling stations are located on figure A.

Sampling Methods

- (1) Zooplankton was sampled (100 meter vertical hauls) using a standard Wisconsin net (180 meshes per inch).
- (2) Temperature profiles were taken using a bathythermograph, a reversing thermometer or a telethermometer at various times throughout the survey.
- (3) Secchi disc readings were determined using a Standard 20 cm. diameter disc divided into alternate black and white quadrants.
- (4) Samples for dissolved oxygen measurements were taken with a water sampling bottle and O₂ readings were determined using the Standard Winkler method.

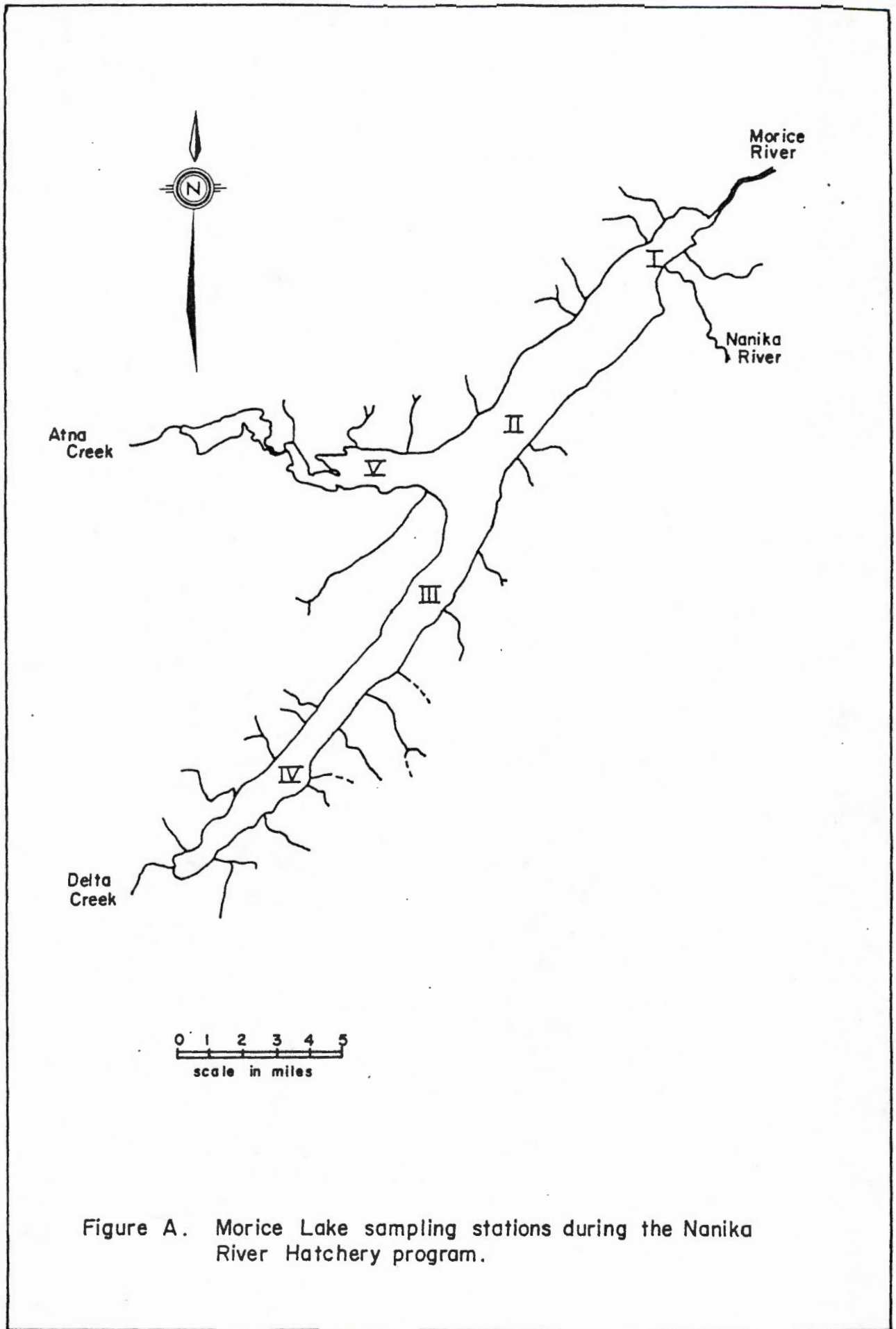


Figure A. Morice Lake sampling stations during the Nanika River Hatchery program.

TABLE 1 - MORICE LAKE TEMPERATURE PROFILE AND SECCHI TRANSPARENCY DEPTHS

JUNE 5, 1976

<u>DEPTH (F)</u>	<u>STATION</u>				
	<u>I</u> <u>TEMP. °F</u>	<u>II</u> <u>TEMP. °F</u>	<u>III</u> <u>TEMP. °F</u>	<u>IV</u> <u>TEMP. °F</u>	<u>V</u> <u>TEMP. °F</u>
0	39	39	39	38.5	39
10	39	39	39	38	39
20	39	39	38.5	37.5	38.5
30	38.5	38.5	38.5	37.5	38
40	38.5	38.5	38.5	37.5	38
50	38.5	38	38	37.5	38
60	38.5	38	38	37.5	38
70	38.5	38	38	37.5	38
80	38.5	38	38	37.5	38
90	38.5	38	38	37.5	38
100	38.5	38	38	37.5	38
110	38.5	38	38	37.5	38
120	38.5	38	38	37.5	38
130	38	38	38	37.5	38
140	38	38	37.5	37.5	38
Secchi Disc	10.36 M	9.75 M	10.06 M	7.62 M	11.58 M

TABLE 2 - MORICE LAKE DISSOLVED OXYGEN (%) SATURATION, 1961

	<u>DATE</u>	<u>SURFACE</u>	<u>50 METERS</u>	<u>100 METERS</u>
STAT. I	July 5	105%	98%	95%
	July 15	96%	97%	97%
	Aug. 17	112%	102%	99%
STAT. II	June 8	102%	98%	100%
	July 5	107%	98%	98%
	July 15	110%	97%	100%
	Aug. 17	113%	100%	100%
STAT. III	July 10	107%	100%	95%
	Aug. 18	116%	112%	100%
STAT. IV	Aug. 18	110%	100%	100%
STAT. V	Aug. 17	115%	110%	107%

TABLE 3 - MORICE LAKE SECCHI DISC OBSERVATIONS
1961 - 65

	<u>STATION I</u> <u>(M)</u>	<u>STATION III</u> <u>(M)</u>	<u>STATION V</u> <u>(M)</u>
June 8, 1961	11.3	7.5	-
July 5	6.6	-	-
July 15	8.5	-	-
July 24	7.8	4.9	5.5
Aug. 17	6.3	4.0	4.0
May 24, 1962	10.5	10.5	13.5
June 18	10.6	-	9.5
July 10	-	10.6	2.3
Aug. 29	5.5	5.5	6.0
Sept. 23	6.5	6.5	5.5
Apr. 21, 1963	13.3	12.8	14.0
May 21	15.5	15.5	15.0
June 7	11.5	11.5	12.0
July 21	8.8	3.5	9.5
Aug. 13	7.3	5.5	8.5
Apr. 24, 1964	12.0	12.0	-
May 3	14.0	14.0	-
May 20	7.0	7.0	-
June 13	6.4	6.4	7.6
July 4	5.3	5.3	5.5
Aug. 5	7.9	7.9	4.3
Aug. 17	7.9	7.9	-
May 28, 1965	13.7	14.0	11.6
June 14	10.0	9.8	8.2
July 13	5.8	5.5	6.1
July 23	6.1	3.7	3.4
Aug. 20	6.1	5.2	6.3
Sept. 3	4.0	3.4	3.4
Oct. 25	5.8	5.5	5.2

TABLE 4 - MORICE LAKE ZOOPLANKTON, 1961 - 64
100 METER HAUL, 180 MESHES PER INCH

<u>DATE</u>	<u>Pounds Per Acre</u>					<u>MEAN</u>	<u>mg/m³</u> <u>MEAN</u>
	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>		
<u>1961</u>							
June 5	2.14	7.57	2.82	-	-	4.18	4.77
July 5-12	3.57	3.98	5.00	7.02	6.60	5.23	5.97
July 24-25	5.98	11.96	9.72	22.79	13.45	12.78	14.59
Aug. 17-18	4.70	4.35	9.88	4.35	5.17	5.69	6.50
Mean	4.10	6.96	6.85	10.95	8.41		
<u>1962</u>							
May 24	2.61	-	-	5.98	1.00	3.20	3.65
June 16-18	7.64	-	-	-	6.78	7.21	8.23
July 10	-	-	-	3.31	4.12	3.72	4.25
Aug. 29	6.80	6.12	30.75	8.86	-	13.13	14.99
Sept. 23	3.35	6.59	5.98	4.45	-	5.09	5.81
Mean	5.10	6.35	18.36	5.65	3.97		
<u>1963</u>							
Apr. 21	5.00	5.02	-	5.70	6.00	5.18	5.91
May 21	5.10	6.61	5.50	5.20	6.60	5.80	6.62
July 21	3.72	15.70	-	13.33	12.25	11.25	12.85
Aug. 13	6.31	18.10	14.10	19.62	15.80	14.79	16.89
Mean	5.03	11.36	9.80	10.71	10.16		
<u>1964</u>							
May 3	5.00	-	3.20	4.50	-	4.23	4.83
May 20	4.45	4.55	3.66	4.45	3.66	4.15	4.74
June 10-13	4.57	4.35	5.06	2.26	4.36	4.12	4.70
July 4	4.48	10.66	5.74	5.92	4.94	6.35	7.25
Aug. 5-7	14.20	8.21	4.67	3.09	8.80	7.79	8.90
Aug. 17	14.70	-	18.70	7.00	-	13.47	15.38
Mean	7.90	6.94	6.84	4.54	5.44		