Pukaskwa National Park

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by

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Aquatic Resource Survey

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Abstract

Twenty-two lakes in Pukaskwa National Park were surveyed in 1972 in respect to their physical features, some chemical features and zooplankton and fish species. As might be expected in the precambrian shield the lakes were in rugged basins and had low concentrations of dissolved minerals with p-H values that tended toward the acidic. Correspondingly, productivity tended to be low, though it varied considerably between individual lakes.

Brief descriptions of the low reaches of three of the Park rivers flowing into Lake Superior are given together with evaluation of the fishing potentials for the areas investigated.

SUMMARY

The Canadian Wildlife Service conducted a preliminary limnological survey of the aquatic resources of Pukaskwa Park in early summer in 1972. In the three areas given priority twenty-two lakes were examined and the lower reached of three rivers that flow into Lake Superior at the southern end of the Park. Because many lakes were unnamed, a numbering system devised by a biologist in the Ontario Ministry of the Environment was used to identify the waters visited. The lakes examined were:

Northern Area: Louie Lake (6C23)
Lurch Lake (6D1)
Birch Lake (6D3)
Rye Lake (6D26)
North Soldier Lake (6D27)
South Soldier Lake (6D38)

Eastern Area: Widgeon Lake (4E1)

Coastal Area: Tagouche Lake (2B56)
Lakes 2A3, 2A2, 2A6, 2A9, 2A10, 2A11, 2A12, 2A13, 3A50, 3A51, 4B69 and 4B76.

Central Area: Cascade Lake (3B34)

At each lake the following information was gathered: morphometric characters (from which bathymetric maps were prepared), water chemistry (the major ions present in the water), dissolved oxygen and temperature-series, p-H, alkalinity, conductivity, hardness, turbidity

colour, zooplankton species, fish species, trout spawning areas, aquatic vegetation, shoreline cover, beach areas and potential campsites. A bench mark for monitoring water level changes was placed at each lake.

At each stream a brief appraisal of the fish species was made and of the angling potential.

The lakes can be divided into three classes based on their temperature and oxygen determinations, the general features of their lake basins, and productivity: - oligotrophic, mesotrophic or eutrophic.

Among the oligotrophic lakes were Rye, North and South Soldier, Cascade, 2A8 and 4B69. Those lakes showing characteristics that made them mesotrophic were Lurch and 2A2. Eutrophic lakes were the most common, and included: Louie, Birch, Widgeon, Tagouche, 2A3, 2A6, 2A9, 2A10, 2A11, 2A12, 2A13, 3A50, 3A51 and 4B71.

One total vertical haul from the deepest part of each lake to the surface was made to collect zooplankton. The preserved samples were sent to the Canadian Oceanographic Identification Centre for processing. A total of 23 species was identified and three genera for which the species could not be named. The most common species found in nearly all lakes were three Cladocera, Bosmina longispina, Daphnia galeata mendotae and Holopedium gibberum, two Calanoida; Diaptomus minutus and Epischura lacustris, and one Cyclopoida, Cyclops bicuspidatus thomasi;

one possible new record for North America, Encylops macrurus, was identified.

Fish species were captured with gill and seine nets, counted and identified; the preserved specimens submitted to the National Museum of Natural Sciences for the verification of the identifications. Those specimens are now deposited with the museum. The most abundant fish species were the suckers (Catostomus commersoni and C. catostomus) and the yellow perch (Perca flavescens). The Iowa darter (Etheostoma exile), lake chub (Couesuis plumbeus) and spotted shiner (Notropis hudsonius) were the most plentiful small species. Speckled trout (Salvelinus fontinalis) were found in nine lakes, northern pike (Esox lucius) in two lakes and lake trout (Salvelinus namaycush) in one. No rare species were found. The yellow perch are probably not native to the lakes where they were found, but were introduced by anglers using the species as live bait for trout.

A general description of each lake is given with the location, temperature and oxygen profiles, zooplankton and fish species captured, and a discussion of general information. A bathymetric map and also a map of sampling stations, bench mark locations and features of general interest is given for each lake.

Pictures are included in the appendix to illustrate some aspects of the country in which the surveys were made.

INTRODUCTION

Parks Canada requested the Canadian Wildlife Service to survey the aquatic resources of Pukaskwa National Park, a newly designated park on the north east shore of Lake Superior. Before the development plans are enacted a survey is needed of the actual and potential resources.

The survey was to gather data on the physical and chemical characteristics, fish populations, and aquatic flora and fauna of as many lakes and streams as time permitted. From these data it would be possible to generalise about the productivity of the waters examined and their potential to visitors in terms of scenic qualities, camping, boating, fishing, and features of special interst.

STUDY AREA

The Park lies on the north-east shore of Lake Superior between $85^{\circ}30'$ and $86^{\circ}15'$ west longitude and between $48^{\circ}0'$ and $48^{\circ}30'$ north latitude. It covers about 725 square miles (1878 km^2). The 70 miles (113 km) of Lake Superior shore that is within the park is rugged with many rocky islands and cliffs rising abruptly from the water's edge. When the surveys were taken (between June 6th and August 1st, 1972) there was still some uncertainty about the boundary of the park in relation to the islands along the coast, but in all likelihood they will fall within Park territory.

The elevation ranges from 602 feet (193.5 meters) at Lake Superior to 2120 feet (646.2 meters) at the peak of Tip Top Mountain. Typically the whole Park has extremely rugged terrain, and much of the interior is almost inaccessible except by aircraft. Rivers and streams descend rapidly with many rapids and low falls making river navigation difficult or impossible.

The general topography is typical of precambrian granite with glacially-cut valleys. The hills tend to be rounded from the north and east, the direction from which the ice came (Boissonneau, 1968), with sheer rock faces pointing south and west, particularily in the coastal areas. The lakes tend to be in deep, fiord-like depressions, generally running in a north-west to south-east direction along the coast, and in a more nearly north-south direction in the interior. There are between 700 and 800 water bodies in the Park.

There are eight major drainage systems, and many other minor ones along the coast, all of which drain the Park into Lake Superior. The drainage to which Birch, Lurch and Louie lakes belong first leads north into the Oskabukuta river, then into Lake Superior. The other waters all drain south and west.

Most of the Park area is heavily forested with jack pine (Pinus banksiana) and white spruce (Picea glauca). There are a few white pine (Pinus strobus) along the coastal areas that have survived the early

lumbering operations. Considerable stands of white cedar (Thuja occidentalis) are found in the wetter areas. Speckled alder (Alnus rugosa), some willow (Salix spp.) and a white birch Betula papyrifera) are common throughout the Park area. Black spruce (Picea mariana) dominate in the swampy places. Other tree species noted were aspen (Populus tremuloides), mountain maple (Acer spicatum) mountain ash (Sorbus americana), balsam fir (Abies balsamea), tamarack (Larix laricina), red pine (Pinus resinosa), serviceberry (Amelanchier spp) and pin cherry (Prunus pennsylvanica).

METHODS

We were able to survey 22 lakes between June 6 and August 1, 1972.

Water samples for oxygen determinations were collected with a model 1200 S. K. Kemmerer sampling bottle containing a mercury thermometer which recorded the temperatures of the samples. Temperatures were also taken with a Tele-thermometer (Yellow Springs Instrument Company, model 425E). Less accessible lakes were sounded with a transistorized sounder/locater, made by Lawrence Electronics. A Vexilar Sona-Graf model 155 recording sounder was also used on the larger lakes in the northern part of the Park. An inflatable rubber dingy was used on the smaller lakes and a 14-foot aluminum boat on the

larger ones; both were propelled by a 4 hp. outboard motor. Oxygen, total alkalinity, total hardness and carbon dioxide readings were made at the lakes with a model A6-36B Hach kit. Water samples were collected in one-litre poly bottles at a depth of 5 feet in all lakes, and where lakes were deep additional samples were taken at or near the bottom. The samples were sent to the Burlington laboratories of the Water Quality Division, Inland Waters Branch, Canada Department of the Environment, for detailed analyses, and smaller samples were also sent to J. J. Kerekes, CWS, Halifax for p-H, specific conductance and colourmetric determinations. Light penetration was determined with a black and white Secchi disc, 20 cm in diameter.

The sampling period restricted collections to only one or two samples from each lake, hence no attempt has been made to demonstrate seasonal changes.

Zooplankton samples were taken with a Wisconsin-type plankton net made from No. 20 bolting cloth. The plankton were preserved in 10% formalin, and sent to the National Museum of Natural Science, Ottawa, for identifications. Fish specimens were collected with 350 feet of monofilament gill net in mesh sizes ½", 3/4", 1", 2", 3", 4" and 5", and where possible, seine samples were collected with a 3/16" mesh net. The collected specimens were counted, preserved in 10% formalin and sent to the National Museum of Natural Sciences for identifications.

Transportation problems allowed us time for only one gill net set in Triangle harbour, and seining only at the mouths of the Pukaskwa River and Imogene Creek. Some angling was done in Otter Cove. Sampling of rooted aquatic plants was qualitative because the surveys were made prior to season of maximum growth, and few plants were seen. Those plants that were seen were identified when possible at the locations where they were found. Bench marks were made at all lakes by drilling a ½-inch hole in the most convenient exposed rockface with a star drill, and marking the spot with a circle of orange paint. Water levels were measured from the marks, and both the location of the marks and the water levels are indicated on the lake maps.

Considerable information on past and present conditions in the coastal areas was obtained from our boat operators, Bob Collins and Napoleon Michano, both of whom had worked in the area for many years and had guided fishing parties to most of the lakes near the Lake Superior shore.

Lake Numbering System

In the present study, unnamed lakes are identified by a system designed by Harrison (in Leiff, 1971). The system consists simply of numbering each lake or pond that could be recognized on a map within its township location, beginning with Number 1 in the northwest corner

and continuing back and forth across the township from west to east and east to west until all lakes were numbered, including those already named. Since the Pukaskwa area was mainly unsurveyed, the existing township lines were extended to form a grid across the Park. Each township in the grid was designated by a letter in the east-west direction and a number in the north-south direction. The grid system and the identification of townships in the Park area are shown on the map at the end of the report (Appendix G, Map No. 1). The numbers for the individual lakes are shown on a photo-copy of the composite "township" maps that Leiff obtained from the White River office of the Ministry of Natural Resources (Appendix G, Map No. 2).

The system of identifying the various lakes is considered adequate for Pukaskwa Park. A system devised by Kerekes (1971) for Kejimkujik National Park based on drainages would be cumbersome in Pukaskwa because of the large number of lakes.

RESULTS AND DISCUSSION

Water Chemistry and Fertility

Salinity

In general, the samples from the deeper waters had higher values for chemical constituents, but the differences in the sum of constituents were small, none amounting to more than 3 ppm. total

dissolved solids. In the following comparisons only the analyses results from the surface samples are used.

The sum of constituents ranged from 16. 9 p. p. m. (Rye Lake) to 56. 7 p. p. m. (Lake 2A6) in the 22 lakes examined. (Table 1). The salinity values found averaged slightly higher than those found by Kerekes (1967) in Terra Nova National Park in Newfoundland and Bourassa (1971) in La Mauricie National Park. The waters in Pukaskwa National Park will therefcre have slightly higher fertility levels than those in the other two parks.

Total alkalinity

Total alkalinity is considered one of the most important means of estimating lake fertility. The ratio of total alkalinity to the sum of constituents is often taken as a measure of the relative productivity of various waters (Ryder, 1964). This index is used to arrange the lakes examined in descending order of productiveness. (Table 1).

Of the waters tested, the total alkalinity values range from 5. 0 p. p. m. (Lake 4B69) to 38. 8 p. p. m. (Lake 2A6), while the ratios of total alkalinity to the sum of constituents range from 23: 100 (Lake 4B69) to 70: 100 (South Soldier Lakes) and averages 46: 100. These ratios were higher than those determined for the lakes of Terra Nova National Park, which averaged 23: 100 (Kerekes, 1967), but lower than

those calculated for Herbert Lake in Banff National Park (Anderson, 1969), where the average ratio was 90: 100.

Hydrogen ion concentration

The laboratory p-H values ranged from 6.2 (Birch Lake) to 7.3 (Lake 2A6), indicating that the sampled waters range from slightly acid to neutral. At the time of sampling the values were slightly higher, ranging from 6.4 to 7.5. The p-H normally drops somewhat after sampling when photosynthesis no longer occurs.

Total hardness

Total hardness values ranged from 9.7 p.p.m. to 44.3 p.p.m. (Table 1). Thus the water in all the lakes examined are classified as very soft (Thomas, 1953).

Ionic order of dominance

The ionic order of dominance is uniform in all the lakes, with minor exceptions. Calcium is the dominant cation in all the waters, usually followed by sodium, magnesium and potassium, (Ca > Na > Mg > K). In two lakes (South Soldier and Cascade) the magnesium ion replaces the sodium as the second most important cation, (Ca > Mg > Na > K).

The dominant anion is HCO_3 in all waters except the deep areas of Cascade Lake, Lake 4B69 and Lake 3A50 ($HCO_3 > SO_4 > Cl$) where the SO_4 anion becomes dominant ($SO_4 > HCO_3 > Cl$). No significance is attached to these variations as the differences are minor.

Table 1. Water Analyses of 22 Lakes in Pukaskwa National Park arranged in decreasing order of productivity as indicated by the ratio of Total Alkalinity to the Sum of Constituents represented in per cent. Only surface samples were used.

Lake	Total Alkalinity p.p.m.	Total Hardness p.p.m.	p-H (LAB)	Specific Conductance (umhos @ 25°c)	Silica p.p.m.	Sum of Constituents p.p.m.	Alkalinity Ratio	Salinity
South Soldier	25.8	36.8	7.1	63.3	2.9	36.8	70	.58
2A6	38.8	44.3	7.3	105.0	3.3	56.7	69	.54
2B56	34.1	44.3	7.1	102.0	3.6	54.9	63	.54
2A3	19.1	24.8	6.8	63.2	1.5	33.1	58	.53
Widgeon	10.6	21.9	6.2	33.8	0.7	10.9	56	.57
Louie	14.2	18.5	6.8	43.3	2.8	26.6	54	.61
2A12	23.6	32.1	7.0	80.8	4.5	45.9	51	.57
2A2	18.3	25.3	6.7	63.2	4.1	37.0	49	.59
North Soldier	10.4	21.7	6.6	36.8	2.5	21.7	48	.59
3A51	18.4	26.9	7.0	65.3	5.0	38.5	48	.59
2A13	16.0	24.8	6.9	59.4	3.1	33.7	47	.57
2A9	13.3	19.0	6.6	50.0	1.9	28.3	47	.57
2A11	14.4	20.3	7.0	55.6	2.8	32.8	44	.59
Cascade	10.4	23.4	6.3	33.0	2.9	23.4	44	.71
2A8	12.7	19.5	7.1	53.6	3.1	30.4	42	.57
2A10	14.1	21.4	6.9	59.6	3.8	35.9	39	.60
4B71	7.7	21.1	6.4	38.2	0.7	21.1	36	.59
Birch	5.9	10.2	6.2	28.7	3.1	17.5	34	.61
Lurch	5.4	12.2	6.6	28.4	3.1	18.7	29	.66
Rye	5.2	9.7	6.5	26.9	2.8	16.9	29	.63
3A50	9.0	25.3	7.0	61.3	4.3	37.8	24	.62
4B69	5.0	21.6	6.9	38.5	2.0	21.6	23	.60

1 $\frac{\text{Total Alkalinity} \times 100}{\text{Sum of Constituents}}$

2 Salinity ratio = Sum of Constituents/Specific conductance.

Specific conductance

Conductivity of water samples was determined by J. J. Kerekes, CWS, Halifax and by the Burlington Laboratories of the Water Quality Division, Inland Waters Branch, Canada Department of the Environment. The two sets of values found are almost identical, hence those given by the Burlington Laboratories are given, (Table 1). Values ranged from 26.9 (micromhos @ 25°c.) at Rye Lake to 105.0 umhos at Lake No. 2A6. The ratio of salinity or sum of constituents (p.p.m.) to the specific conductance (umhos @ 25°c.) falls between 0.55 and 0.70 for most waters (APHA 1965). In the Pukaskwa lakes examined the ratio varied from 0.53 to 0.71 (Table 1).

Silica

The silica values for the lakes varied from 0.7 p.p.m. in Widgeon and 4B371 lakes to 5.0 p.p.m. in Lake 3A51 (Table 1). Much of this variation could be due to utilization by diatoms (Hutchison, 1957).

Dissolved oxygen

The quantities of dissolved oxygen in the lakes was not a limiting factor to fish survival at the time of year the sampling was undertaken (June and July). That early in the year the levels remained relatively high, because decomposition processes that might be occurring were not sufficiently advanced to have used up the quantities of oxygen injected at the spring overturns. Oxygen levels usually become limiting

factors only late in the summer (August and September) when the thermocline is well formed, or during the winter when ice and snow cut off the oxygen supply from the atmosphere. Fish were found in all lakes except 2A12 suggesting that complete stagnation does not occur in these lakes though oxygen depletion could occur in the deep areas of some lakes, in either late summer or late winter thus preventing fish and some other aquatic organisms from using the entire lake. Because Lake 2A12 had a maximum depth of 10 feet and no fish population, it probably has oxygen depletion during winter after the ice cover forms. Other shallow lakes, such as 2A11 receive supplies of fresh oxygenated water from inlet streams so are less likely to stagnate in winter unless the stream dries up in late autumn.

Oxygen levels, determined when the lakes were surveyed, are presented later in the report when specific waters are discussed.

Potential Productivity

Because the base rock is granite, the waters of most lakes in Pukaskwa National Park are slightly acid with low total hardness readings and moderately brown stained. As a result their productivity is low. The low productivity potential is indicated by low specific conductance values (26.9 to 105 micromhos, corrected to 25°c.). Contrasting for example with a mean specific conductance value of 322 micromhos for Herbert Lake, a low-elevation lake in Banff National Park

(Anderson, 1971). The specific conductance values of Pukaskwa lakes were highly variable in contrast to those reported by Bourassa (1972) for lakes in La Mauricie National Park (16 to 35 micromhos) and by Johnson (1971) for several lakes at the southern edge of the Precambrian Shield in Saskatchewan (24-45 micromhos).

Physical Characteristics of the Lakes

A summary of physical factors observed in each lake is given in Table 2. The most significant physical factors in estimating total lake production are the mean depth, the shoreline length and the water transparency. The lake area is useful only in indicating the size of the water body; it limits the total production but not the unit productivity.

The transparency of the water influences light penetration and therefore can limit photosynthetic activity through the regulation of solar energy reaching the system. All the waters in the Park had high transparency readings. Some were slightly brown stained, with colour readings of 25 Hazen units or lower. The only water deeply stained was Cascade Lake with a colour reading of 45.

The turbidity in the samples was low, Lake 2A12 had the highest reading. As it is a shallow lake, wind-created currents can stir up the bottom mud into suspension.

Temperatures for the lake waters are not given on Table 2 but reported in the discussion on the individual lakes later in this report.

Table 2. Physical characteristics of 22 lakes in Pukaskwa National Park.

Lake	Surface in Acres	Length of Shoreline (miles)	Maximum Depth (feet)	Mean Depth (feet)	Trans-parency (feet)	Colour Hazen Units	Turbidity Jackson Units
6D38 (South Soldier)	112.8	2.62	100	39	20.5	5	0.4
2A6	37.0	1.25	40	21	14.0	5	0.3
2B56 (Tagouche)	41.8	1.28	39	22	18.0	10	0.4
2A3	25.8	1.08	12	8	12.0	5	0.6
4F1 (Widgeon)	367.6	5.60	55	23.5	21.0	5	0.6
6C23 (Louie)	146.0	3.33	36	15	9.0	20	0.6
2A12	4.8	0.37	11	7.3	9.0	12.5	12.5
2A2	15.5	0.79	45	23	13.0	20	0.3
6D27 (North Soldier)	102.0	3.11	71	26	18.0	10	0.4
3A51	17.7	1.12	30	12	11.0	25	0.4
2A13	15.6	0.68	18	6	10.0	20	0.5
2A9	19.6	1.05	20	8.4	14.0	2.5	0.7
2A11	17.1	1.00	10	5.5	10.0	4	0.5
3B34 (Cascade)	109.0	2.75	90	26	9.0	45	0.5
2A8	72.0	4.70	100	45	16.0	5	0.6
2A10	10.4	0.50	33	22	18.0	10	0.4
4B71	12.2	0.71	20	11	12.0	7	0.5
6D3 (Birch)	414.8	5.9	43	19	12.0	20	0.4
6D1 (Lurch	376.0	6.7	61	26	11.5	20	0.5
6D26 (Rye)	273.0	5.4	75	36	18.0	25	0.3
3A50	10.3	0.7	38	20	15.0	20	0.4
4B69	15.2	2.06	57	26	14.0	5	0.4

Rivers and Streams

Three streams in the Lake Superior coastal area were visited. The Pukaskwa River was examined for about 3 miles from its mouth by travelling on a portage trail that follows it, and the Cascade River and Imogen Creek, both bordered by heavy undergrowth and rugged terrain, were each examined for about one mile from the mouth.

Most of the rivers in Pukaskwa National Park are rough, turbulent swift-flowing streams. This applies to sections of the Pukaskwa and Cascade rivers, while the lower section of Imogen Creek is relatively placid. All provide suitable habitat for the native speckled trout (Salvelinus fontinalis) but are limited in their productive capacity by the underlying Precambrian rock which provides little nutrient material to the waters, thus limiting production of the aquatic food organisms needed to sustain quantities of fish. Growth is slow and fish do not obtain large sizes.

Each of the three streams examined supported speckled trout. Only fingerlings were noted for the first half-mile above the mouths but adults were noted farther upstream. They attained sizes up to 12 inches (30 cm.) in the Pukaskwa River and 8 inches (20 cm.) in the two other streams. Seining at the mouths of the Pukaskwa River and Imogen Creek produced some rainbow trout (Salmo gairdneri) fingerlings which confirmed that those two streams are used by adult rainbow on their spawning runs. Rainbow trout also come to the mouth of Cascade River but are prevented from going upstream by a falls. Some spawning

may occur on gravel shoals in Lake Superior near where the Cascade River enters. Rainbow trout are also reported to spawn in the Swallow and White Gravel rivers but these reports were not verified.

The three streams examined had good trout habitat. Fish populations seemed sparse, but sampling with seines was difficult and angling attempts were only moderately fruitful. Speckled trout were seen in a few of the pools so their presence was confirmed visually where none could be caught. Also, anglers reported catches from those streams earlier in the year.

Most small creeks tributary to the lakes studied were checked for suitable trout spawning areas. In many of them small trout were observed. Some would have been resident populations, and probably some were offspring from lake-inhabiting populations destined to return to the lake at the yearling stage. The creeks joining Rye Lake to Birch Lake and Birch Lake to Lurch Lake had no trout in them. The water temperature was too high (65^{o}F). Those creeks drain surface waters only, and do not have enough length to cool to temperatures favourable to speckled trout. The outlet from Lurch Lake has speckled trout below the falls and downstream where rapid evaporation had cooled water temperatures (5^{o}F).

Streams entering and leaving lakes were obstructed by beaver dams. In some cases the dams had the effect of restricting access of the lake-dwelling trout population to spawning areas. Some appeared to be old dams and they will eventually wash out, but others were of recent construction and may indicate active beaver colonies.

Only trout were collected from the streams. Other species would be present inasmuch as they were found in the lakes and it is assumed some of them arrived there by way of the streams. Some species may have been introduced by bait fishermen.

Fish Stocking in Park Waters

Leif (1971) presented a table of fish stocking carried out by the Ontario Department of Lands and Forests which he compiled from data obtained from the White River District Office. From a comparison of lake names and descriptions in Leif's table with the lake numbering map procured from the White River District Office, a Pukaskwa National Park headquarters office map of fish stocking made by the American Can Company and the Ontario Lands and Forests Pukaskwa River map, it is apparent that some corrections should be made to Leif's table. The following are suggested:

(1) Ross Lake was probably meant to be Rose Lake (4A6).

(2) Toot Lake should be Lake 2B76 rather than 2A76. There is no Lake 2A76 shown on the map.

(3) Budd Lake should be 4B71 instead of 3A71. There is no 3A71 on the map.

(4) Gilbert Lake is 4A2. The table shows it as 4AZ, probably a typographical error.

(5) Lake No. 1 would have to be Lake 5A31 judging from the description.

(6) Lake No. 2 - Holdem's Lake (4A1).

(7) Lake No, 3 - Probably Lockman Lake (4A3) rather than Gilbert's Lake which is 4A2.

A revised version of Leif's Table 1 is given as Table 3. Rein Lake has been omitted because it is outside Park boundaries.

The map referred to previously as having been obtained from the Park's office at Marathon and which shows some lakes that had been stocked by the American Can Company was compared to the lake numbering map. The following lakes were supposed to have received speckled trout: 2A3, 2A6, 2A8, 2A9, 2A10, 4B69, 4A12, 4B56, 4B57, 4A6, 4A9, 4A2, 4A3, 4A1, 2B75 and 2B76. It is not known how many or what size of fish were stocked. The maps also identifies some lakes as containing perch and pike populations (possibly stocked), namely Tagouche Lake (2B56), Lake 4A10 and the head of Otter Cove. Our investigations have shown that lakes 2A3, 2A9, 2A10 and 4B69 now contain perch and Lake 2A10 has pike also; 4B69 has a few speckled trout left along with its perch population and Budd Lake (4B71) contains only a few mature speckled trout.

Zooplankton Communities

At each lake one total vertical haul was made to collect zooplankton species. Table 4 lists all the species identified and gives estimates of their relative abundance. It will be noted that unidentified juvenile forms

Table 3. Dates and locations of fish stocking (speckled trout) in Pukaskwa National Park. Revised from Leif (1971).

Name	Location	Number	Age	Year Stocked
Rose L.	4A6	1,400	Fry	1955
Toot L.	4B76	1,400	Fry	July 5, 1955
Otter Head L.	Otter Cove (2A8, perhaps	10,000*	Fry	June 1952
	or in the cove itself)	200,000*	Fing	July 1953
Gilbert L.	4A2	2,000	Fry	June 17, 1953
Lake No, 1	5A31	2,000	Fry	July 25, 1957
Lake No. 2 (Holdems)	4A1	2,000	Fry	1957
Lake No, 3 (Lockman)	4A3	1,000	Fry	1957

* Numbers marked with asterisk were lake trout. Others were speckled trout.

Table 4. Abundance of zooplankton species in samples from 22 lakes in Pukaskwa National Park, 1972, identified by the Canadian Oceanographic Identification Centre, National Museum of Natural Sciences.

D-Dominant - over 50% by number
A-Abundant - 25-5-% by number
C-Common - 5-25% by number
F-Few - Less than 5% by number
X-Present - Parts in Residues

Group	Species	Louie (6C23)	Lurch (6D1)	Birch (6D3)	Rye (6D26)	- (2A3)	- (2A2)	- (2A6)	- (2A8)	- (2A12)	- (2A11)	- (2A10)	- (2A9)	- (3A50)	- (3A51)	Tagouche (2B56)	- (2A13)	- (4B69)	- (4B71)	Widgeon (4F1)	N. Soldier (6D27)	S. Soldier (6D38)	Cascade (3B34)
Cladocera	Bosmina longispina	D	D	A	D		C	D	A	C	D	A	C	C	C	C	C	D	C		C	X	
	Daphnia galeata mendotae	C	F	C		A	C	C	D		F		C	C	D	A	A	C	C	A	D	A	A
	Holopedium gibberum	A	C	D	A	A	A			D	C	A	D	C	C	A	A	C		F			F
	Daphnia retrocurva												F										
	Diaphanosoma leuchtenbergianum	F		F	F	C	A	C			F	C	C	A	C		F	C	D		C	A	C
	Leptodora kindtii			F		X								X					X	X			
	Ceriodaphnia lacustris					X					C	F		X	X	X	F						
	Daphnia longiremis		F																		C	C	D
	Daphnia pulex																			D		C	
	Latona sp.	F																					
	Polyphemus sp.				F																		
	Eurycercus lamellatus																		X				
Calanoida	Diaptomus minutus	C	A	C	F	D		D		D		D	A	C	A	C	C	A	D	A	C	F	C
	Epischura lacustris	F	F	F			F	X					F	F	F	F	C	F	F		F	F	F
	Diaptomus siciloides						D																
	Limnocalanus macrurus								C														
	Senecella calanoides								F														
	Diaptomus oregonensis										D	C	A	C	A	A	A				C		
	Diaptomus sp. (Juv.)	D	A	D	D	C	C	C	D	C	A	A	C	D	C	C	A	D	A	D	D	D	D
	Epischura sp. (Juv.)	C	C	C			C	F		X	F	F	F	F	F	F	C	C	C		C	C	F
	Eurytemora sp.				F																		
	Diaptomus sicilis								A														
Cyclopoida	Cyclops bicuspidatus thomasi		C	C	C			C				C		C	A	A	F	C			A	C	F
	Mesocyclops edax	F	F	C	C		C			C				C	A	A	C			A		C	C
	Cyclops scutifer	C	C		A		F							C	A	A	C			A		C	C
	Orthocyclops modestus									F													
	Eucyclops macrurus	C																					
	Cyclops sp. (Juv.)	D	D	D	D	X	D	D	X		X	D	X	D	A	A	D	D	X	D	D	D	D
	Mesocyclops sp. (Juv.)									D													
	Tropocyclops prasinus (Mexicanus)																				F		
Copepoda	Copepod nauplii (Unidentified)	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

of Diaptomus and Epischura (Calanoida group) and of Cyclops (Cycloppida group) were found in almost all the lakes in large numbers. They probably belong to species of which adults were identified from those lakes. No adult copepods were found although nauplii were found in all lakes except Rye Lake, and may have been present there also.

A few species were found in only one lake. Particular care should be taken to protect those lakes from pollutants so as to ensure the survival of the species. The cyclopoid species Eucyclop macrurus is possibly a new record for North America. It was collected only from Louie Lake.

Table 5 provides a summary of the percentage composition of the zooplankton communities in each of the lakes examined. Cladocerans dominate the population in only one lake (2A11) while the calanoids are predominant in eleven of the lakes and the cyclopoids in nine. Copepod nauplii dominate only in Lake 2A12 but are almost as plentiful as calanoids in Lake 2A9.

Fish Species

Twenty-seven species of fish from nine families were captured from the lakes and streams of Pukaskwa National Park and the adjacent shoreline area of Lake Superior. In addition several specimens of lake sturgeon (Acipenser fulvescens) were examined by the author

Table 5. Percentages by number of each group of zooplankton found in each of the 22 lakes examined in Pukaskwa National Park in 1972.

Lake		Group			
Name	Number	Cladocera	Calanoida	Cyclopoida	Copepoda Nauplii
Louie	6C23	24.7	22.6	48.4	4.3
Lurch	6D1	34.0	17.9	42.5	5.7
Birch	6D3	14.7	59.6	21.7	4.0
Rye	6D26	5.5	80.2	14.3	-
-	2A3	17.9	53.6	-	28.6
-	2A2	16.9	39.5	36.0	7.6
-	2A6	6.0	14.8	45.3	34.0
-	2A8	18.2	47.7	2.3	31.8
-	2A12	19.6	30.4	16.1	33.9
-	2A11	69.1	21.1	3.3	6.5
-	2A10	6.7	65.2	23.7	4.4
-	2A9	26.6	34.6	4.8	34.0
-	3A50	20.8	40.7	19.4	19.1
-	3A51	9.6	39.9	44.9	5.6
Tagouche	2B56	12.4	41.5	44.4	1.7
-	2A13	35.1	14.2	45.5	5.2
-	4B69	19.0	32.7	44.6	3.8
-	4B71	5.4	74.6	0.7	19.4
Widgeon	4F1	9.1	38.2	50.8	1.9
N. Soldier	6D27	16.3	44.0	37.3	2.4
S. Soldier	6D38	3.2	42.1	48.8	5.9
Cascade	3B34	10.1	57.5	26.6	5.8

from catches made by commercial fishermen in Lake Superior's coastal waters adjacent to the Park.

With the exception of three species, all the fish listed in the checklist in Appendix A. were taken by the limnology survey party. One specimen of brown trout (Salmo trutta) was captured in Otter Cove by L.E. Holly, and one specimen of carp (Cyprinus carpio) was taken in Oiseau Bay by Ted Schintz. Other anglers interviewed when they stopped over at Otter Island reported having taken walleye (Stizostedion vitreum) in the mouth of the White River.

A list of common names of the species captured from the individual lakes of the interior is given on the maps of the lakes. The lists may not contain every fish species present in the lakes but only those shown to be there by our collections. We could not seine some lakes because of rough shorelines, hence some minnow species may have been missed in those lakes. In some instances the gill nets could be set for only a few hours during the day while other survey procedures were being carried out, hence the numbers of fish taken by that method, compared to those taken by over-night sets, would not be commensurable.

Species collected by the party along the Lake Superior shore, which do not appear in any of the other lakes examined are: rainbow trout, lake whitefish, (Coregonus clupeaformis), burbot (Lota lota) and the slimy sculpin (Cottus cognatus).

Gruchy (1971) provided the Park Administration with a checklist of fish species that might be found in Pukaskwa National Park. He listed 56 species from 16 families. All the species collected in the present study appear on his list. It is very likely that more of the species he has listed will be found in future surveys.

None of the species collected so far are considered to be rare or endangered species.

The distributions and numbers of fish in each area are given when the individual waters are discussed later in the report.

Aquatic and Shoreline Plants

At most of the lakes surveyed there was little aquatic vegetation, even in the shallow waters. Yellow bullhead lilies (Nuphar variegatum) were seen at the outlet of Lurch Lake, and scattered plants of the species were also seen at Louie, 3A51, 2A9, 4B69 and North Soldier lakes. Bullrush (Scirpus sp.) were present at Louie and North Soldier lakes. Smartweed (Polygonum sp.) and coontail (Cerataphyllum demérsum) were also present in North Soldier Lake which, together with Louie Lake, appeared to have the greatest abundance of aquatic plants of all the lakes examined. At lake 4B69 and 3A51 where there was some shallow water and weak current flows there were scattered stands of bur reed (Sparganium sp.).

The shores of all lakes were rocky. Shoreline vegetation was made up mostly of cedar (Thuja occidentalis), often growing to the edge of the water in dense stands, pine (Pinus banksiana), spruce (Picea glauca) and some balsam fir (Abies balsamea). The few patches of sand or shelving shoreline on such lakes as 4B69, 4B71, 2B65 and 3A51 had wild iris (Iris virginica var. Shrevei), pitcher plants (Sarracenia pourpuria), and on Lake 3A51 sundew (Drosera rotundifolia) growing in the wet areas at the water's edge.

In future, if a comprehensive list of the aquatic plants in the Park is required the investigators should make their collections in August and September in most areas, and possibly in late July in the northern inland area around Louie and the Soldier lakes since the latter locations are farther from Lake Superior and tend to warm up earlier in the year.

Individual lakes

Louie Lake (6C23)

Louie Lake is part of the East Reverse Creek drainage systen in the north of the Park. The creek drains into Lake Superior through the Oskabukuta and White rivers.

The lake is wide and shallow with some irregularity of the shoreline (Figure 1A). Unlike other lakes in the Park the basin was sand except a small area of rock at the north end. The lake is exposed to

strong spring winds which stir the bottom sediments. The resulting suspended sediments explain why the transparency (Table 2) is lower than that of the other lakes in the area. The disturbance of the shallow water by the wind reduces the likelihood of oxygen depletion (Figure 1A) at the bottom by breaking up the thermocline in late summer. Productivity as estimated by the specific conductance (Table 1) was low although the lake was eutrophic.

Half the plankton sample was cyclopoids mostly juvenile Cyclops sp. There were about equal numbers of cladocerans and calanoidans with a small percentage of copepod nauplii (Tables 4 and 5).

The catch in an overnight gill net (Figure 1B) was dominated by white suckers (Catostomus commersoni). However, in two seine hauls redbelly dace (Chrosomus eos) was the principle species. An unidentified species of crayfish was found.

Eastern brook trout were scarce, probably partly as a result of competition from suckers and lake chub, but also because beaver dams blocked access to spawning grounds. However, even if angling is limited, the lake by virtue of its sandy beach at the northeast corner and shallow, hence warmer water for swimming is likely to be attractive to visitors. It is known as a favoured moose haunt, and has the remains of an old logging dam at the outlet.

Fig. 1A. Louie Lake; bathymetry, physical features, and fish species.

LOUIE LAKE (6C23)–PUKASKWA NATIONAL PARK

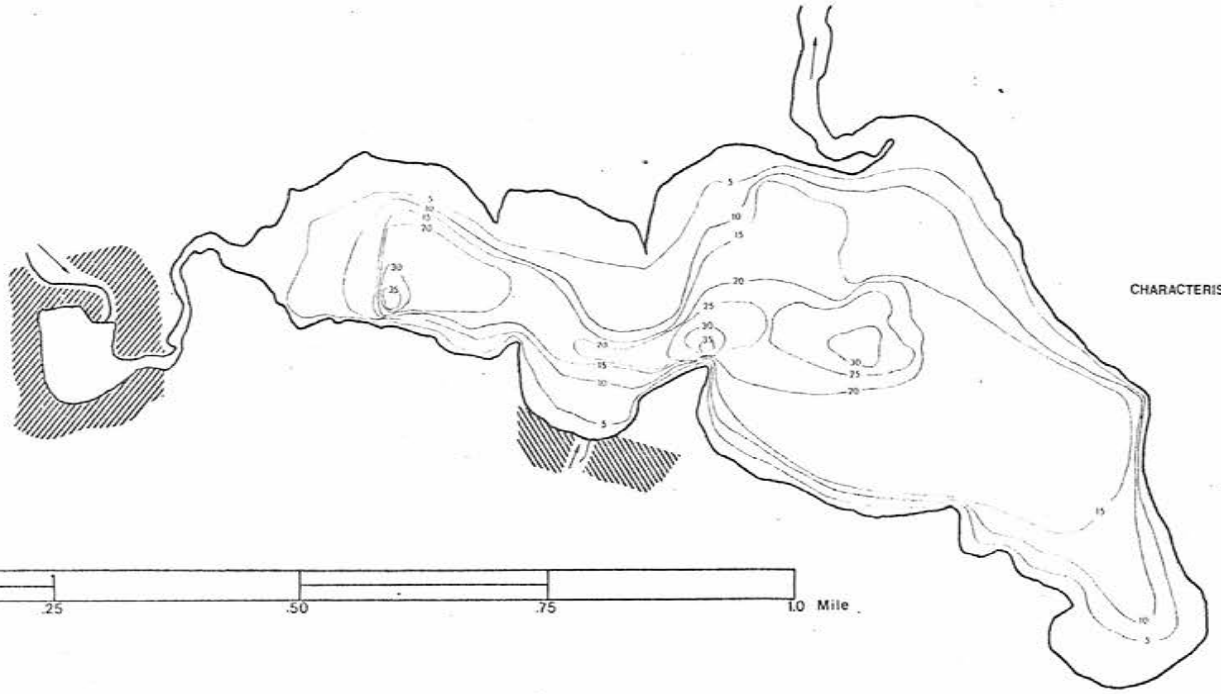
N. 48°25' & *W.* 85°52'

DEPTH CONTOURS IN FEET

Legend:

Water flow

Swampy area



Scale:

CHARACTERISTICS:

AREA–146 acres

MAXIMUM DEPTH–36 feet

MEAN DEPTH–15 feet

SECCHI DISK–9 feet

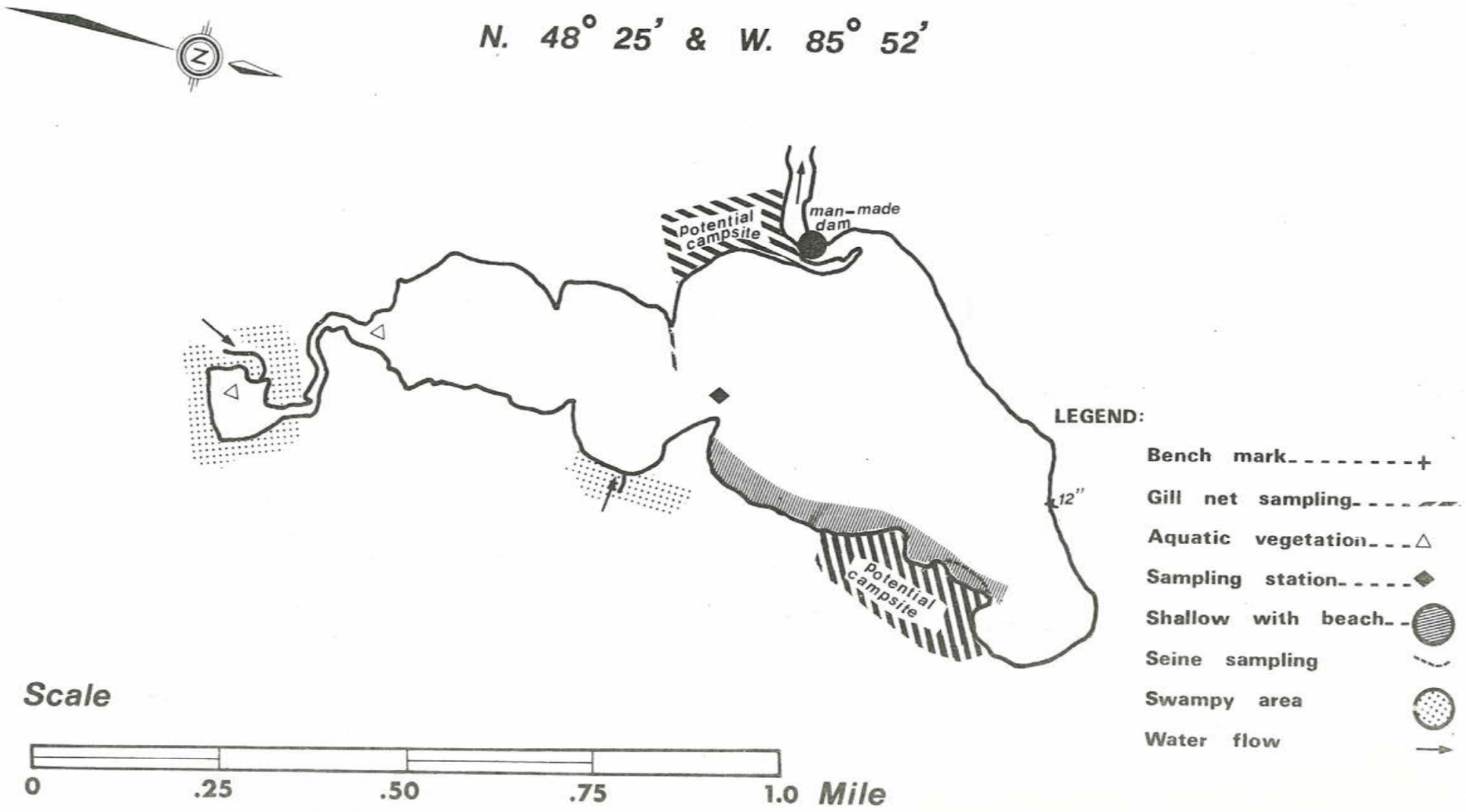
FISH SPECIES–Eastern Brook Trout
White Sucker
Northern Redbelly Dace
Finescale Dace
Lake Chub
Blacknose Shiner
Iowa Darter
Brook Stickleback

Date of Survey–October 3rd, 1972

Fig. 1B. Louie Lake; bench mark location, sampling stations, waterflows and landmarks of interest.

LOUIE LAKE(6C23)–PUKASKWA NATIONAL PARK

N. 48° 25' & W. 85° 52'



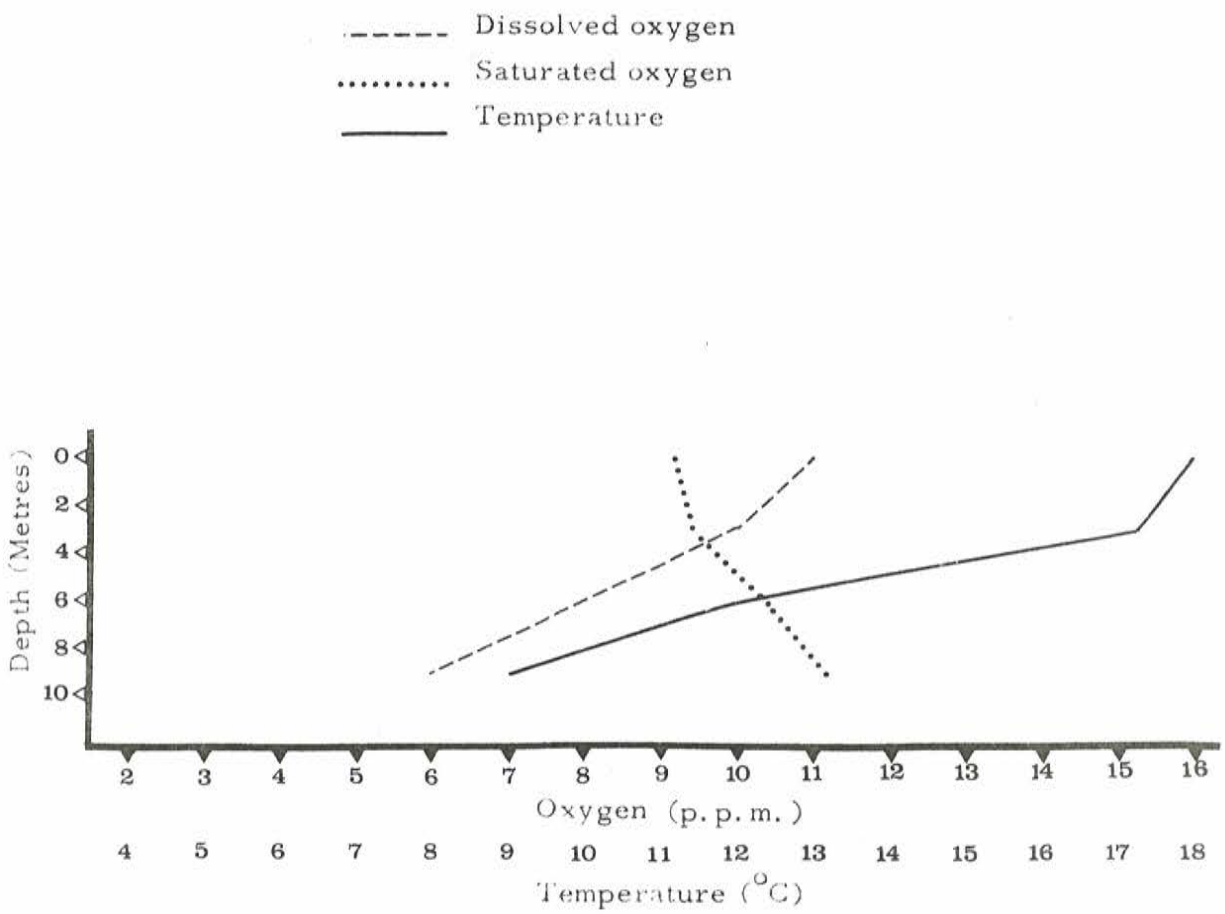


Figure 1C. Oxygen and temperature determinations. Louie Lake. June 7, 1972.

Lurch Lake (6D1)

Lurch Lake is a large rocky lake in the same area as Louie Lake. The shoreline is rocky and irregular except at the extreme north and south ends and a small swampy area in the outlet bay. The lake's outlet stream flows a short distance to the west then turns north for about 2½ miles to join the Oskabukuta River (Fig. 2B).

The small volume of deep water (Fig. 2A) compared to the surface area, the rock bottom and the higher flushing rate combined to give a specific conductance (Table 1) lower than Louie Lake, and Lurch Lake is classified as mesotrophic. Although the water colour was medium brown (Table 2), the same as Louie Lake, the transparency was greater because the deeper water was less stirred by the wind. For the same reason the thermocline would last all summer. Since the thermocline was 37 ft (12m) 70% of the lake would be warmed to the bottom. Trout would seek the cooler water below the thermocline out of the range of anglers. However gill netting suggested there were few trout. Suckers and lake chub dominated the catch (Fig. 2B).

In the plankton sample, cyclopoids were still the dominant group. Although there were four species of cladocera as compared to five in Lake Louie they were more numerous in the sample. Despite the vertical plankton haul being twice the length of the Lake Louie sample it caught less plankton, a reflection of the lower productivity (Tables 4 and 5).

Aquatic plants were not abundant at the time of our visit but there were a few yellow bullhead lilies beginning to appear in the shallows, and along the north side of the outlet bay there was broad leaved arrowhead (Sagittaria latifolia), both, shallow water plants that are sought after by moose. Reed beds (Eleocharis sp.) were common along the west shore and around the inlet creek from Birch Lake.

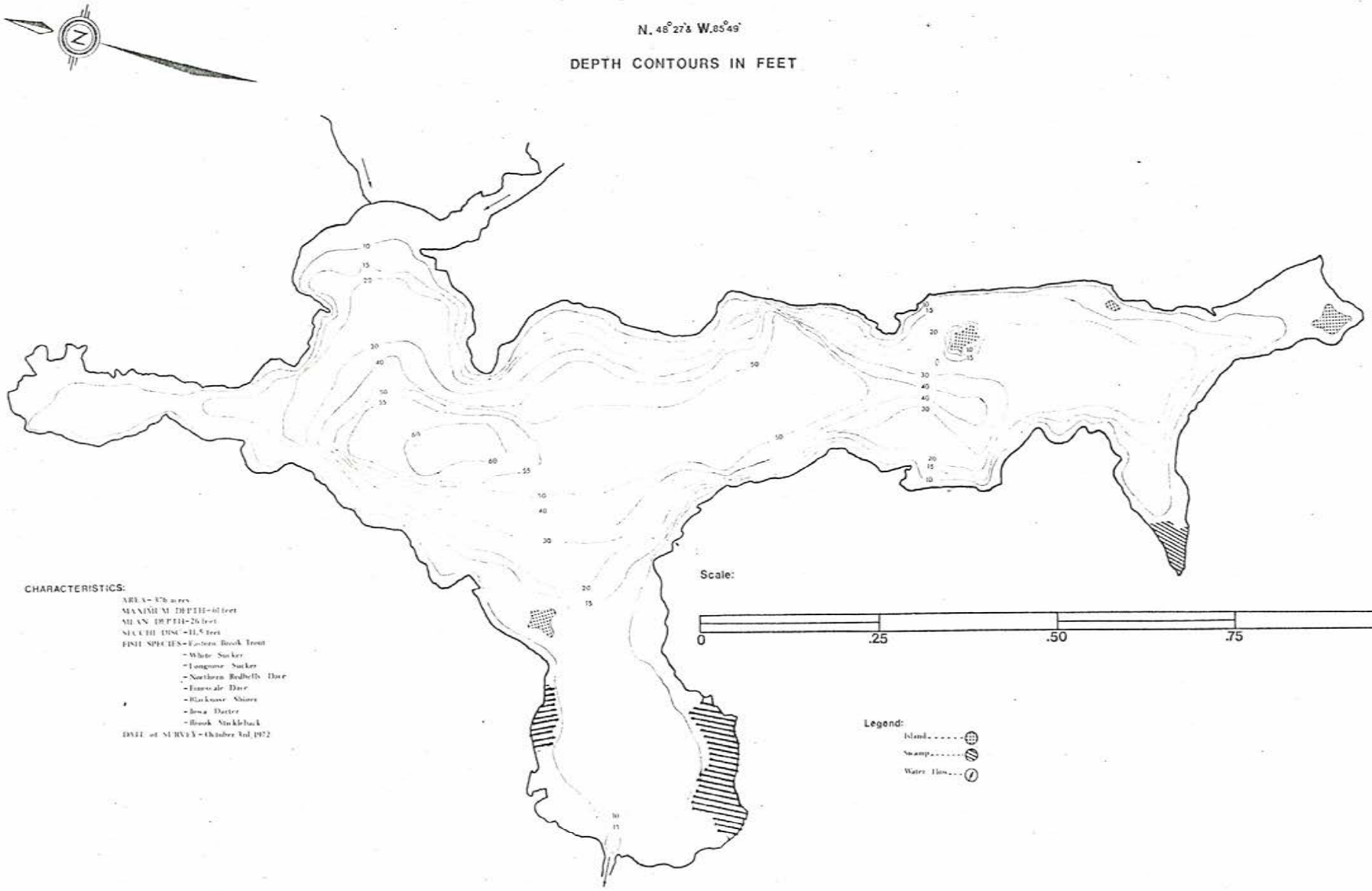
The lake contained few trout, and spawning grounds occurred only at the outlet. There were no beaches, all of the shoreline being rocky. Parts of the lake were favoured feeding areas of moose.

Fig. 2A. Lurch Lake; bathymetry, physical features, and fish species.

LURCH LAKE (6D1)–PUKASKWA NATIONAL PARK

N. 48°27' & W. 85°49'

DEPTH CONTOURS IN FEET



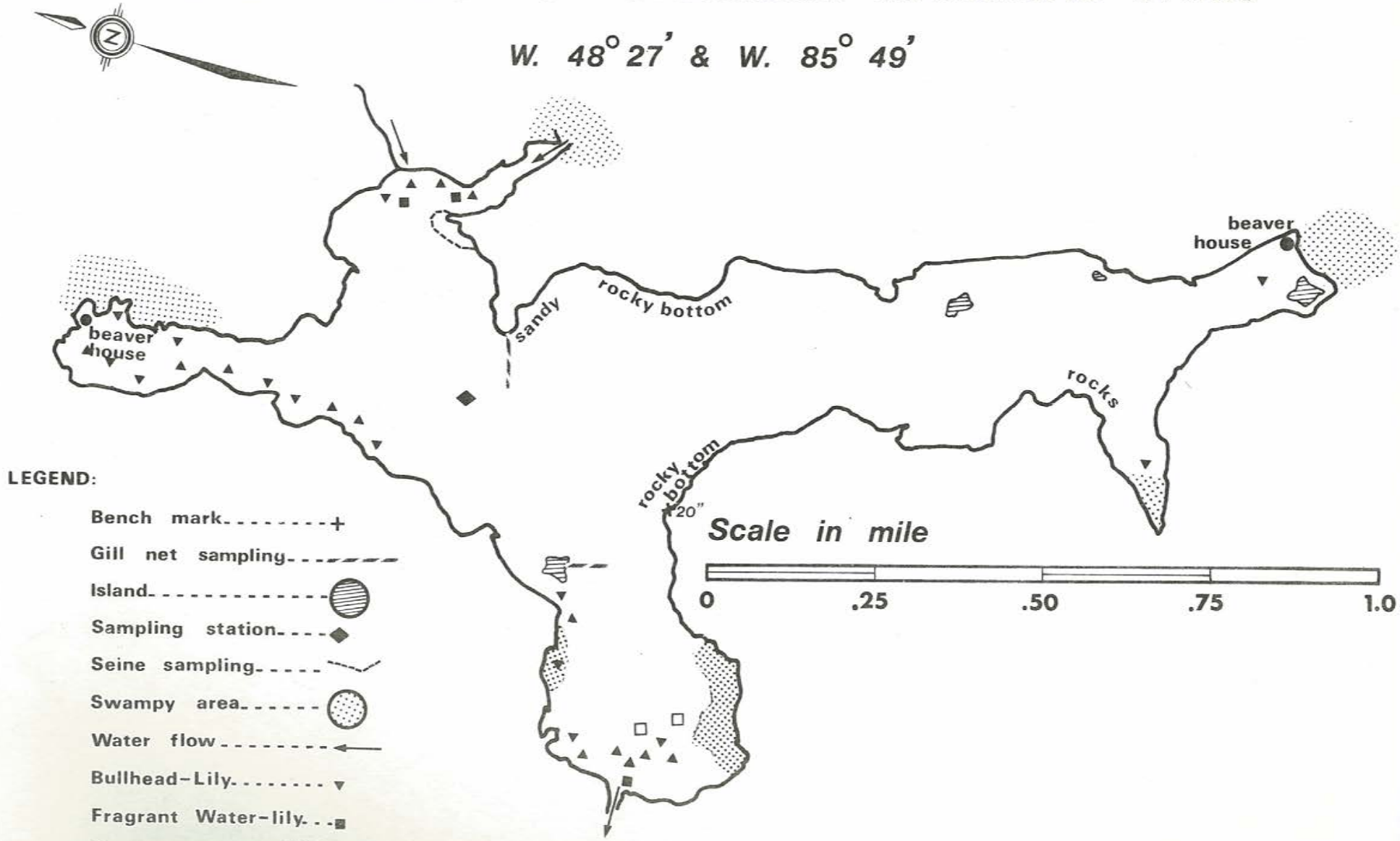
CHARACTERISTICS:

AREA – [illegible] acres
MAXIMUM DEPTH – 61 feet
MEAN DEPTH – 26 feet
SECCHI DISC – 11.5 feet
FISH SPECIES – Eastern Brook Trout
– White Sucker
– Longnose Sucker
– Northern Redbelly Dace
– Emerald Dace
– Blacknose Shiner
– Iowa Darter
– Brook Stickleback
DATE of SURVEY – October 3rd, 1972

Fig. 2B. Lurch Lake; bench mark location, sampling stations, waterflows and landmarks of interest.

LURCH LAKE(6D1)–PUKASKWA NATIONAL PARK

W. 48° 27' & W. 85° 49'



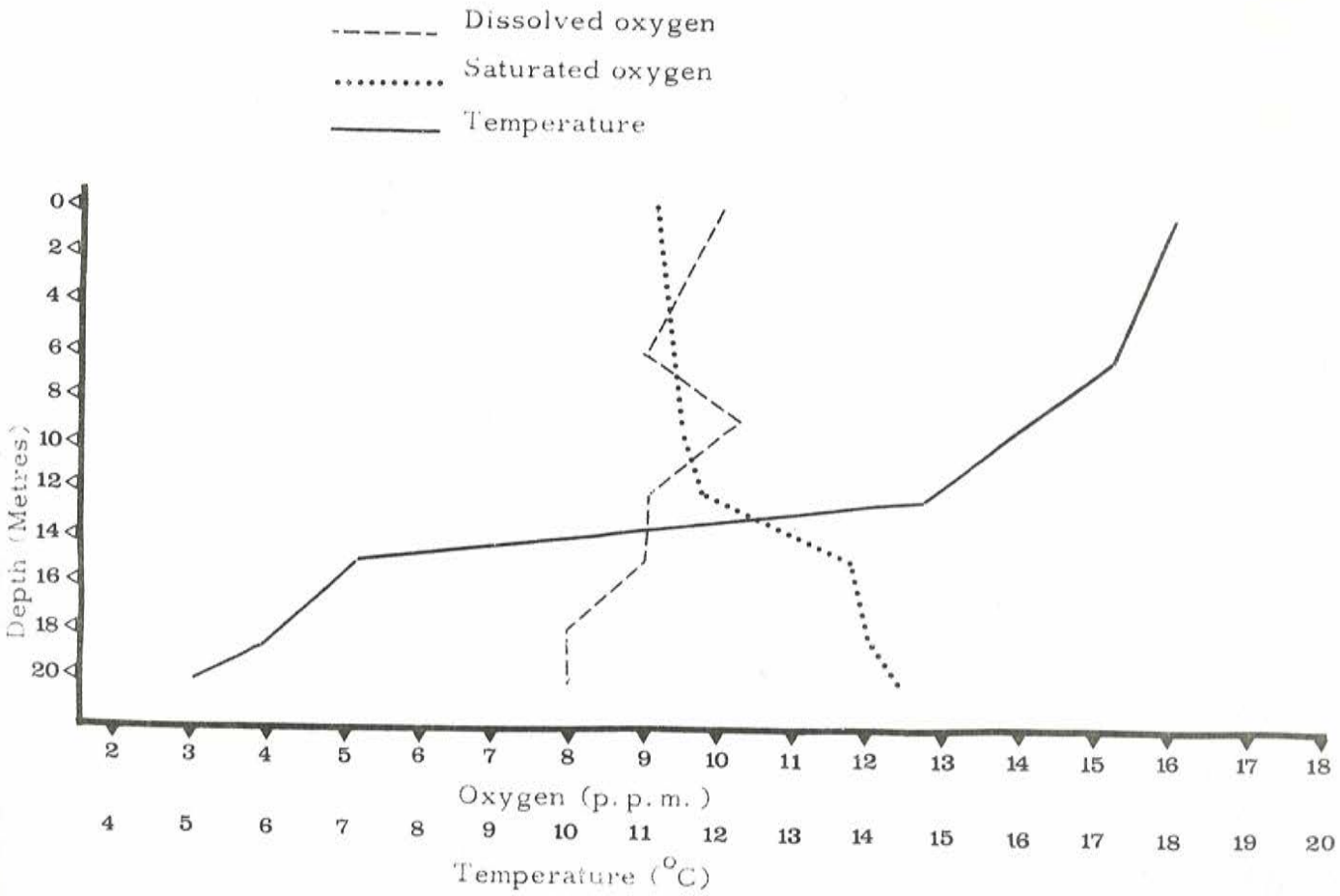


Figure 2C. Oxygen and temperature determinations. Lurch Lake. June 10, 1972.

Birch Lake (6D3)

Birch Lake is due east of and drains into Lurch Lake. The outlet stream for the first half mile is not navigable because of rapids, but for the remaining half mile to Lurch Lake it is passable by canoe or small boat.

Of the lakes examined it is the largest, but shallow (Fig. 3A) with a rocky shore and submerged rocks around the two small islands. As it is so shallow (Table 2) it is classified as eutrophic although the specific conductance (Table 1) was about the same as Lurch Lake. The water colour and transparency (Table 2) were the same as Lurch Lake. Although there was a thermocline between 13 to 20 feet (4 and 6 metres) the water was warmed at the bottom. Oxygen concentrations (Fig. 3C) were adequate for fish at all levels, and the carbon dioxide concentrations below the thermocline was only 10 p.p.m.

The plankton sample was three times as large as the sample from Lurch Lake, although the haul was only half as long. However, it is likely that the single sample reflects uneven distribution rather than high over-all plankton densities, since the productivity, as estimated by the specific conductance was not high. Calanoids were the dominant group forming 60% of the sample, while cyclopoida comprised 22% and cladocerans 15%. The balance was copepod nauplii.

Lake chub and blacknose shiners dominated the fish samples with only one speckled trout being caught. The lack of spawning grounds - the only stream that had gravel suitable for spawning was blocked by beaver dams - may explain the low trout population, as Birch Lake could be expected to be one of the most productive speckled trout lakes.

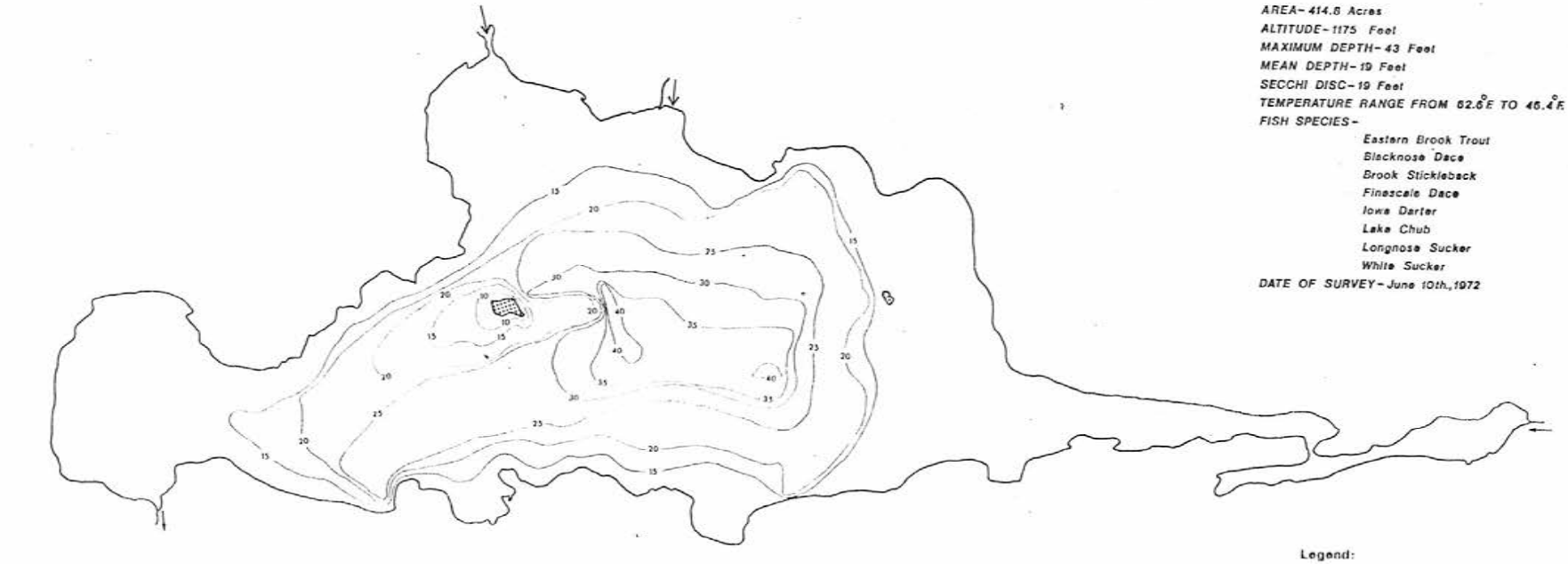
The lake has more sandy beaches than Lurch or Rye Lake. One of the sandy beaches is bisected by a spring-fed stream from Lake 6D14 which adds to its attraction as a picnic and swimming site. The shallows of the eastern shores and the submerged rocks around the islands would limit the use of the lake by power-boats (Fig. 3B).

Fig. 3A. Birch Lake; bathymetry, physical features, and fish species.

BIRCH LAKE (6D3) – PUKASKWA NATIONAL PARK

N. 48° 19' & *W.* 85° 48'

DEPTH CONTOURS IN FEET



CHARACTERISTICS:

AREA – 414.6 Acres
ALTITUDE – 1175 Feet
MAXIMUM DEPTH – 43 Feet
MEAN DEPTH – 19 Feet
SECCHI DISC – 19 Feet
TEMPERATURE RANGE FROM 62.6°F TO 46.4°F.
FISH SPECIES –

- *Eastern Brook Trout*
- *Blacknose Dace*
- *Brook Stickleback*
- *Finescale Dace*
- *Iowa Darter*
- *Lake Chub*
- *Longnose Sucker*
- *White Sucker*

DATE OF SURVEY – June 10th., 1972

Legend:

Island
Water flow

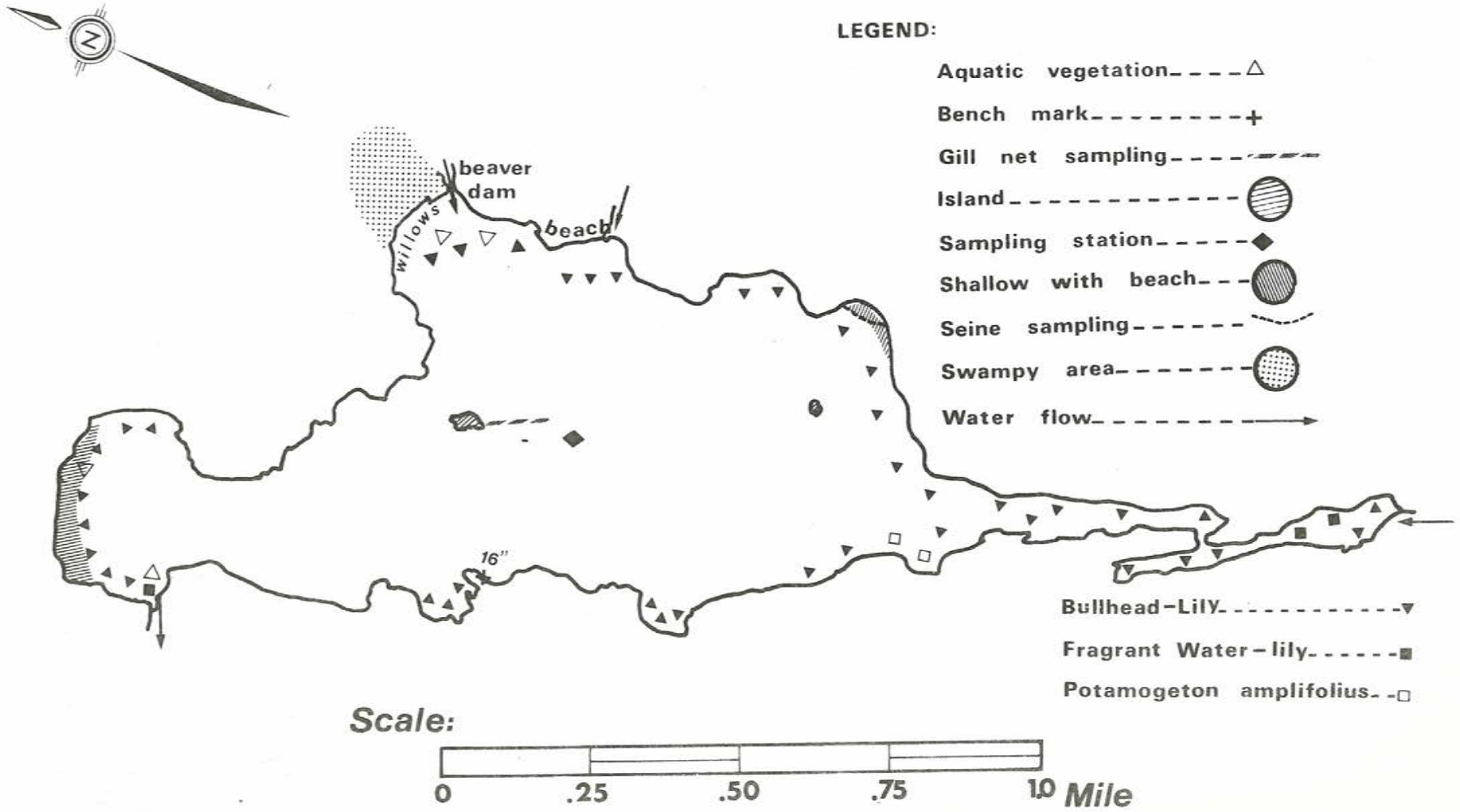
Scale:

0 .25 .50 .75 1.0 Mile

Fig. 3B. Birch Lake; bench mark location, sampling stations, waterflows and landmarks of interest.

BIRCH LAKE(6D3)–PUKASKWA NATIONAL PARK

N. 48° 19' & W. 85° 48'



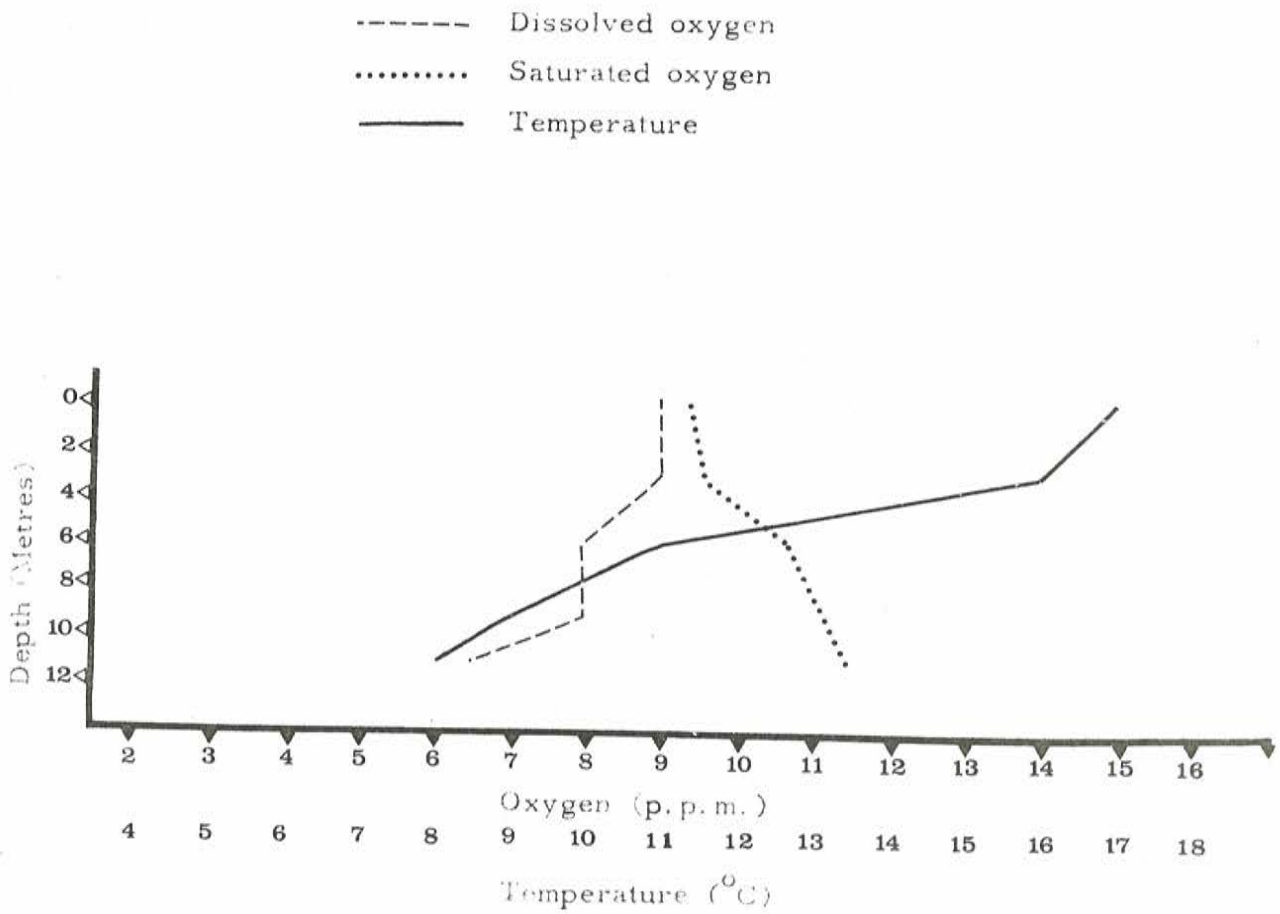


Figure 3C. Oxygen and temperature determinations. Birch Lake. June 11, 1972.

Rye Lake (6D26)

Of the three lakes in the same drainage system ie: Lurch, Birch and Rye lakes, Rye Lake is the smallest, deepest, and most scenic. The shoreline is precipitous rock except for a sandy area around the inlet of a creek on the west side; and two sandy strips on the east shore toward the north end. The outlet creek plunges over low falls immediately on leaving the lake, passes through a small lake and down a narrow deep channel to enter Birch Lake from the south half a mile away. Until the falls are reached the creek is navigable by a canoe (Fig. 4A and 4B).

The water was moderately brown, slightly darker than Birch and Lurch lakes. It was considerably more transparent partly due to its greater mean depth, nearly twice that of Birch Lake (Table 2). Between 20 and 26 feet (6 and 8 metres) there was a sharply defined thermocline below which temperatures fell to the minimum of 39°F at the bottom. Oxygen levels were high at all depths, the minimum being 71 per cent of saturation. Carbon dioxide levels were low being only 7 p.p.m. at the bottom. The specific conductance at 26.9 umhos was lower than those of Birch and Lurch lakes. The low specific conductance and the depth of lake classify it as oligotrophic (Table 1).

Plankton were scarce with only a quarter as many taken as in Birch Lake although the haul was twice as long. The sample was unique among all lakes sampled in that there were no copepod nauplii,

and unknown species of Polyphemus, and Eurytemora were taken which were not found in the other lakes. Calanoids, especially Diaptomus species, dominated the sample comprising 80 per cent, while 14 per cent were cyclopoids and 5 per cent cladocerans (Table 4 and 5.)

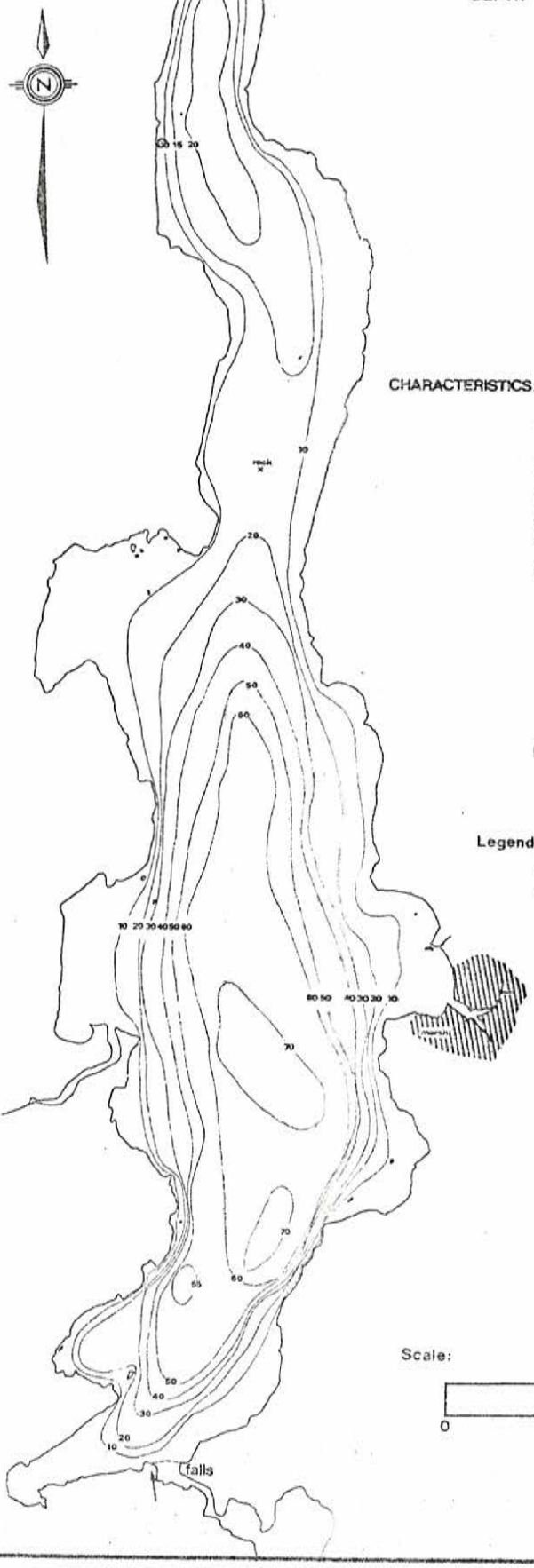
The gill net catch was dominated by suckers and the seine hauls by Iowa darters (Ethoestoma exile) and blacknose shiners (Notropis heterolepis). Pearl dace (Semotilus margarita), of which two were found, had not been taken from the other two lakes in the chain, but were found in North and South Soldier lakes which drain into Rye Lake. One small creek (Appendix F, 5) and possibly the inlet from the Soldier lakes have spawning grounds suitable for trout but the lake's low productivity would limit the size to which trout could grow. Some trout were found but the lake's principle attraction is its scenic qualities (Appendix F, 3). Potential camp sites at the south end, and the beach on the western side could be made available for camping and swimming respectively.

Fig. 4A. Rye Lake; bathymetry, physical features, and fish species.

RYE LAKE(6D26)–PUKASKWA NATIONAL PARK

N. 48° 19' & *W.* 85° 48'

DEPTH CONTOURS IN FEET



CHARACTERISTICS:

Area	273 acres
Altitude	1185 feet
Max. depth	75 feet
Mean depth	36 feet
Secchi disc	18 feet
Temp. range from	67°F to 39.2°F
Fish species	Eastern Brook Trout
	Blacknose Shiner
	Brook Stickleback
	Iowa Darter
	Longnose Sucker
	Northern Redbelly Dace
	Pearl Dace
Date of survey	June 12th., 1972

Legend:

Marshy area.....

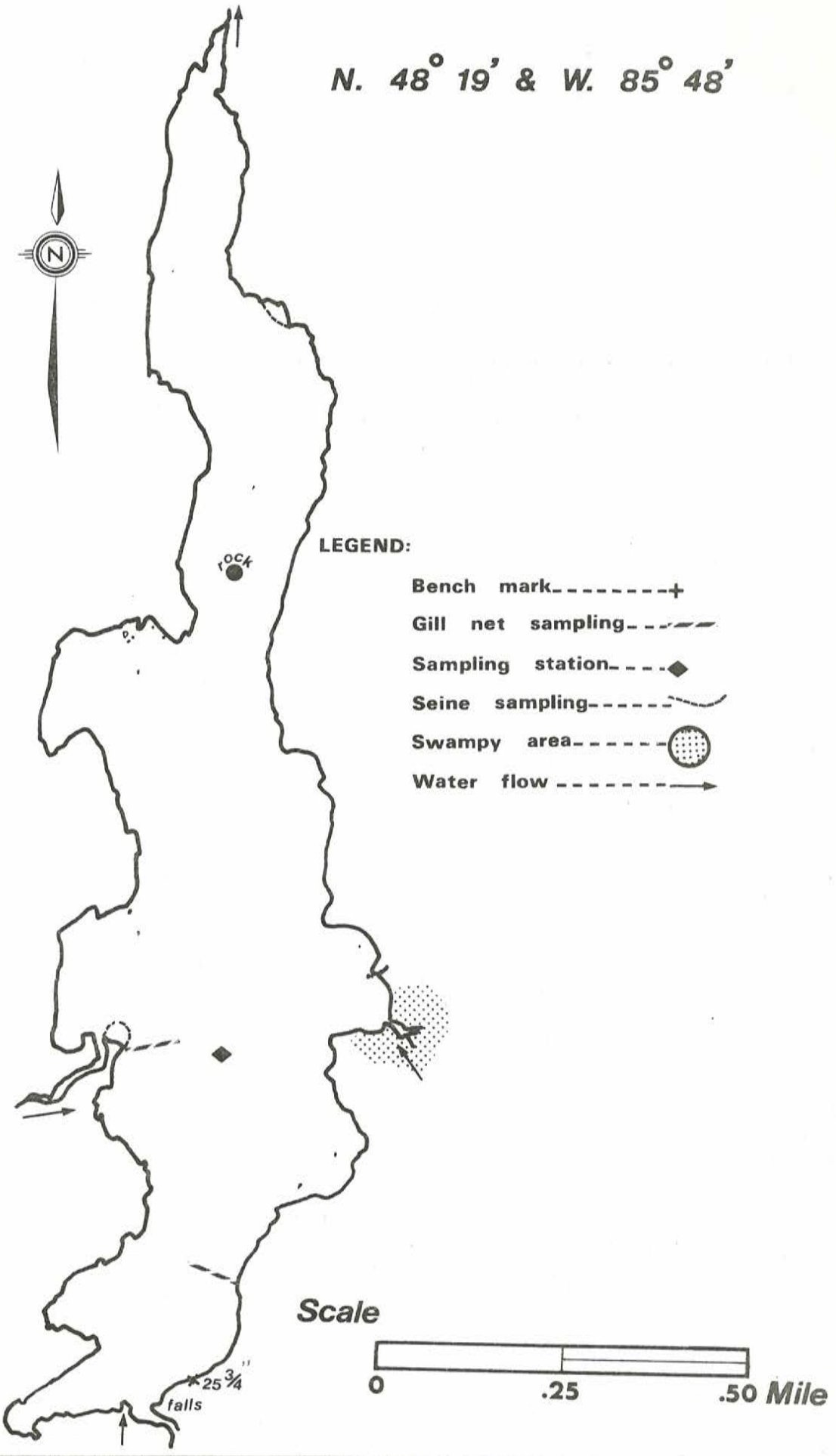
Water flow:.....

Scale:

0 .25 .50 Mile

Fig. 4B. Rye Lake; bench mark location, sampling stations, waterflows and landmarks of interest.

RYE LAKE(6D26)–PUKASKWA NATIONAL PARK



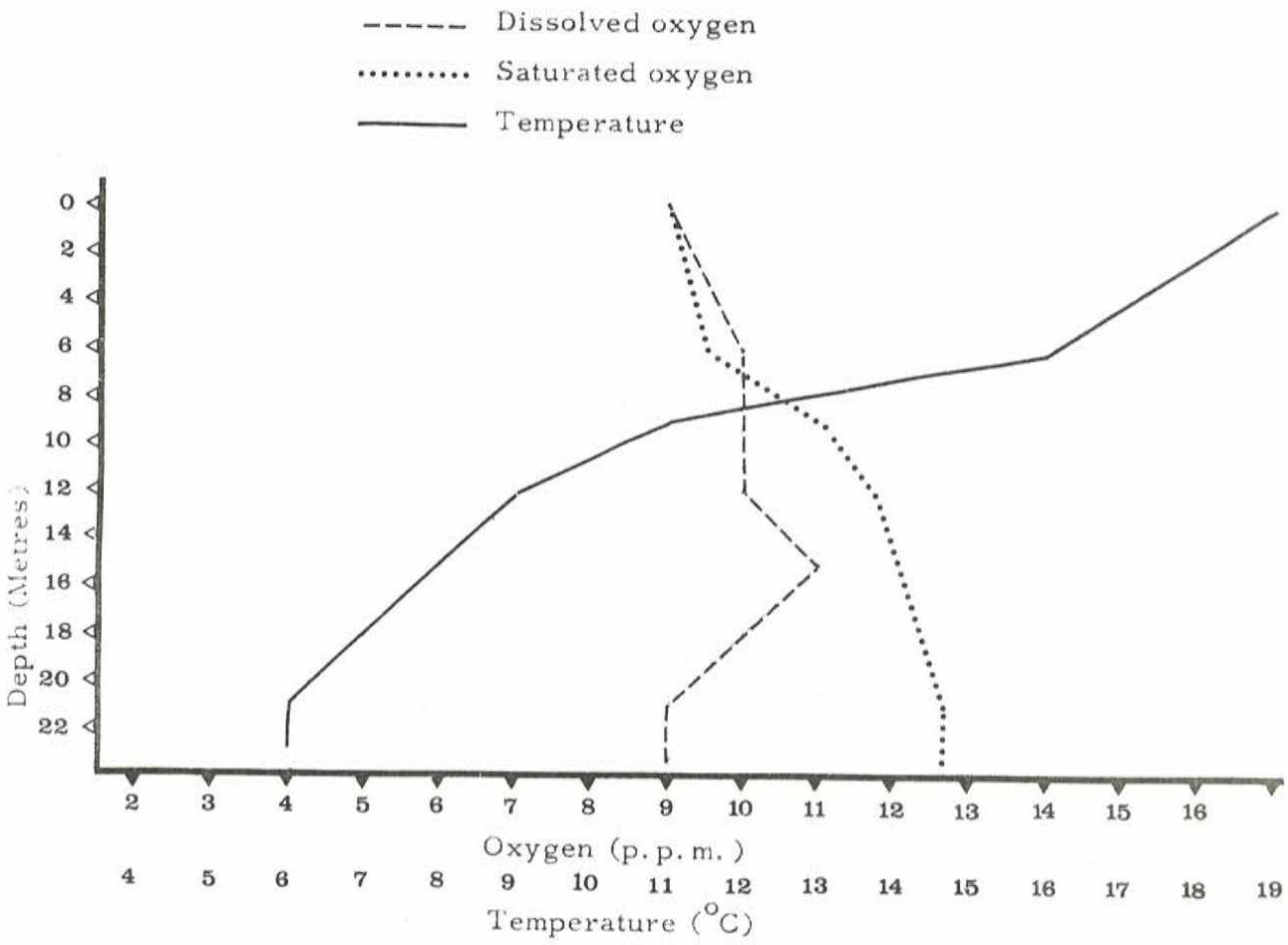


Figure 4C. Oxygen and temperature determinations. Rye Lake. June 12, 1972.

North Soldier Lake (6D27)

This lake is separated from South Soldier Lake by a swampy area. Both lakes belong to the same drainage system as the lakes previously described. The outlet creek flows through a swampy area on the east central shore into Rye Lake, two miles to the east (Fig. 5A and B).

North Soldier Lake is medium-sized with steep rocky shores except at the southern end. The water was not especially deep but was as transparent as Rye Lake. The water colour was light brown (Table 2). Although the specific conductance of 36.8 umhos (Table 1) was slightly higher than those of the previous described lakes, the lake was still classified as oligotrophic. The thermocline was located between 23 and 30 feet (7 and 9 metres). Oxygen levels (Fig. 5C) to the lake bottom were adequate for fish survival, but the carbon dioxide levels of 30 p.p.m. below 60 feet (20 metres) might interfere with the use of available oxygen supply by fish below that level.

The numbers of plankters caught was about the same as the numbers in Louie Lake although the haul was twice as long. Calanoids and cyclopoids made up 44 per cent and 37 per cent respectively, while 16 per cent consisted of cladocerans, and the remainder copepod nauplii. Although the calanoid Diaptomus oregonesis was common, North Soldier was the only northern lake in which it was found. In the residue of the sample a few Tropocyclops prasinus (Mexicanus) were found; the only occurrence of that species in the Pukaskwa samples (Tables 4 and 5).

The fish fauna appeared scarce with only one speckled trout and one chub (Couesius plumbeus) being taken in an overnight gill net. In a seine haul two pearl dace and 19 sticklebacks (Culaea inconstans) were caught. Although no suckers were found, their presence in South Soldier Lake suggests they probably are present in North Soldier Lake. The gill net was set where only part of it was in the warmer water above the thermocline where the suckers would have been most plentiful.

The lake is capable of supporting more speckled trout than it does at present. Beaver have been very active and their dams have cut off spawning areas in the inlet and outlet streams as well as raising the water level by 2.5 feet (0.6 metres) hiding any beaches that may have been present.

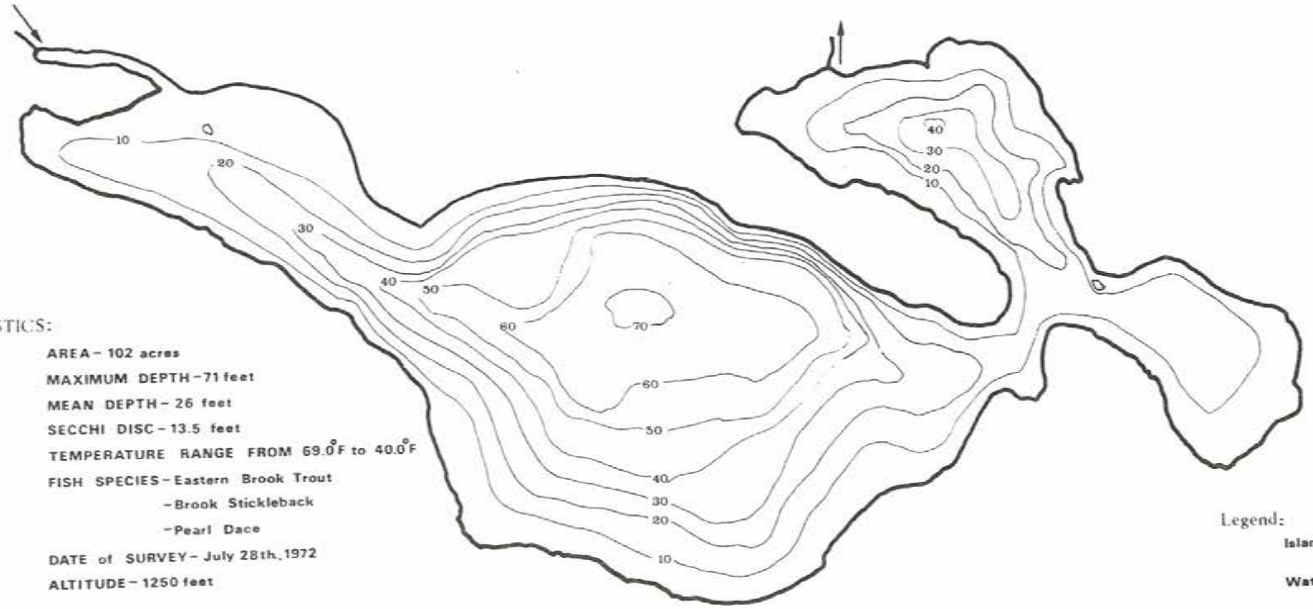
A few plants were identified in the shallow areas at the south end, namely the yellow bullhead lily, smartweed (Polygonum sp.), coontail (Ceratophyllum demérsum) and bull-rush.

Fig. 5A. North Soldier Lake; bathymetry, physical features, and fish species.

NORTH SOLDIER LAKE (6D27) – PUKASKWA NATIONAL PARK

N. 48° 25' & **W.** 85° 46'

DEPTH CONTOURS IN FEET



CHARACTERISTICS:

AREA – 102 acres
MAXIMUM DEPTH – 71 feet
MEAN DEPTH – 26 feet
SECCHI DISC – 13.5 feet
TEMPERATURE RANGE FROM 69.0°F to 40.0°F
FISH SPECIES – Eastern Brook Trout
– Brook Stickleback
– Pearl Dace
DATE of SURVEY – July 28th, 1972
ALTITUDE – 1250 feet

Legend:
Island
Water flow

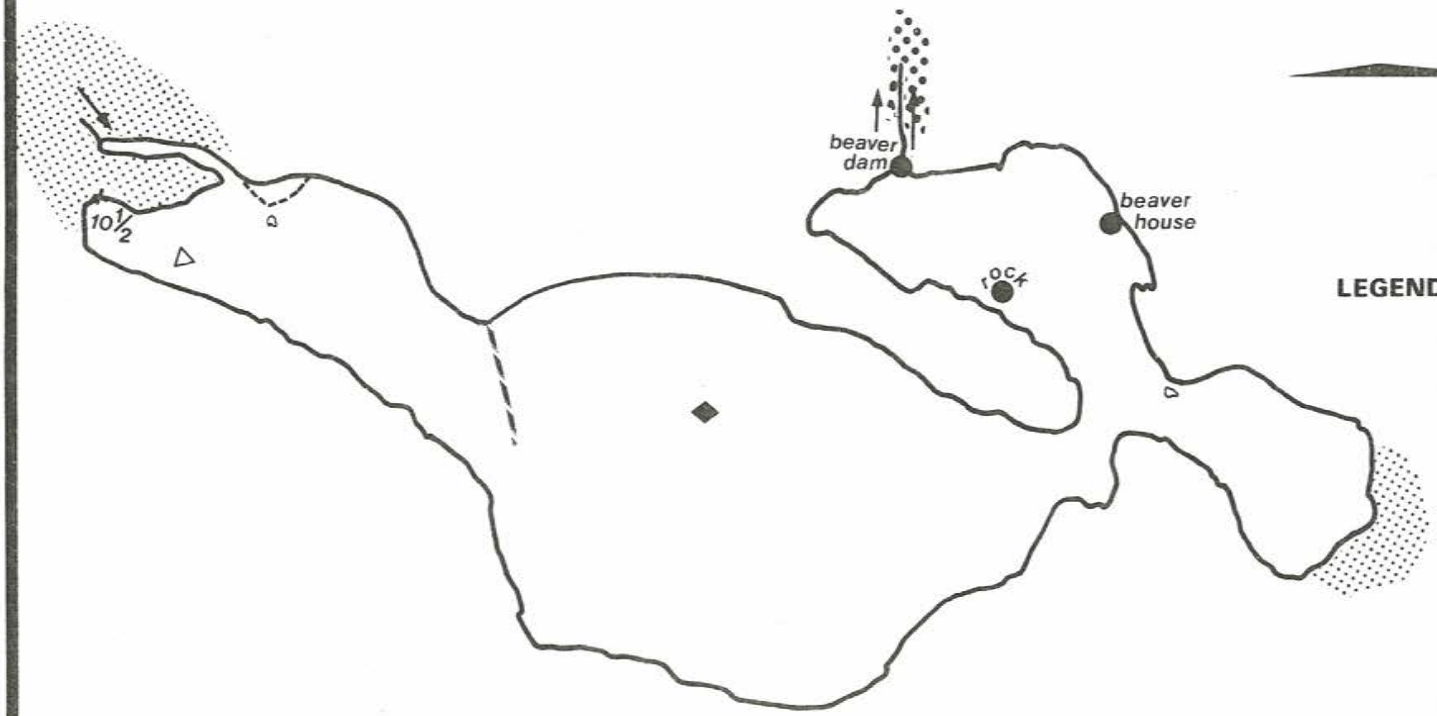
Scale:

0 .25 .50 .75 1.0 Mile

Fig. 5B. North Soldier Lake; bench mark location, sampling stations, waterflows and landmarks of interest.

NORTH SOLDIER LAKE(6D27)–PUKASKWA NATIONAL PARK

N. 48° 25' & W. 85° 46'



LEGEND:

- Aquatic vegetation
- Bench mark
- Gill net sampling
- Potential spawning area
- Sampling station
- Seine sampling
- Swampy area
- Water flow

Scale:

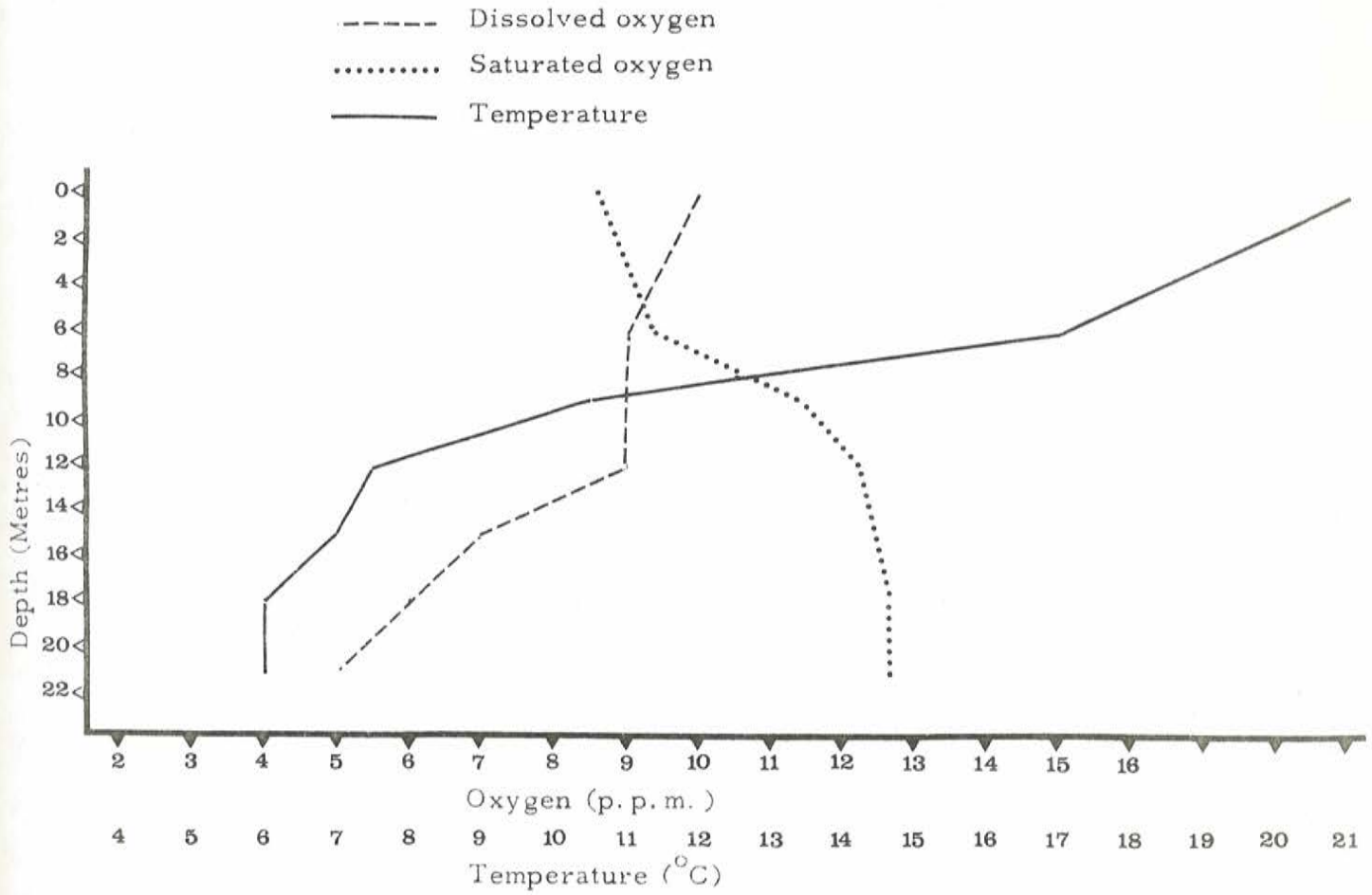


Figure 5C. Oxygen and temperature determinations. North Soldier Lake. July 28, 1972.

South Soldier Lake (6D38)

South Soldier Lake is separated from North Soldier Lake by about 300 feet of swamp through which water seeps, since no channel could be found connecting the two lakes at the present high water levels (Fig. 6A and 6B).

It is slightly the larger of the two lakes with a more regular shoreline, although it is also rocky with no discernible beach. The mean depth of 39 feet (12 metres) is greater than that of North Soldier Lake. It is also lighter brown, and has a higher Secchi disc reading (Table 2). A surprising feature was that the specific conductance was 63.3 umhos (Table 1), almost double that of the north lake although both are classified as oligotrophic. The difference suggests that the flow from the south to the north lake is small compared to the flow from other sources. Probably most of the flow is from lakes 6D28 and 29 to the east, and they probably, therefore, have low specific conductance values.

The thermocline was between 26 and 32 feet (8 and 10 metres) with high oxygen levels at all depths. At the bottom the oxygen concentration was almost 10 per cent higher than in the north lake. Carbon dioxide levels were low (10 p.p.m.) at the bottom (Fig. 6C).

The quantity of plankton was similar to the north lake although the haul was longer. There were more cycopoids (49 per cent) than

calanoids (42 per cent) in this lake and a few cladocerans (3 per cent) and copepod nauplii. The two lakes differed in species composition as well as the proportions of the orders (Tables 4 and 5).

The fish population appeared to be better balanced between numbers of species than in any of the other lakes examined in the northern part of the Park. Speckled trout dominated the overnight gill net catch. They were also taken in the seine hauls, as were suckers, pearl dace, brook sticklebacks, (Culaea inconstans) and redbelly dace. The last named were probably present in the north lake although not actually found during sampling. The inlet stream seemed to have sufficient spawning grounds to maintain the trout population in balance with the forage species at the present angling intensity.

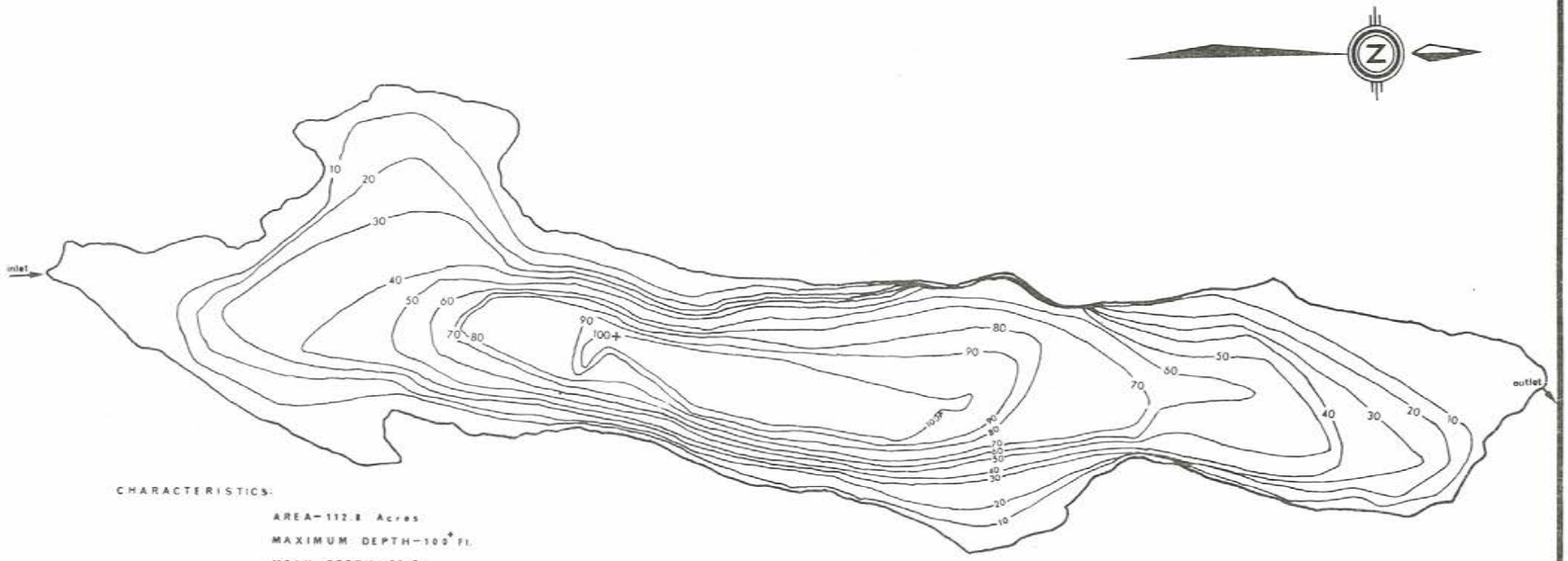
Aquatic vegetation was scarce with a few yellow bullhead lilies at the southern tip. The north end was fringed by bullrush and smartweed with coontail and yellow bullhead lilies in the shallows.

Fig. 6A. South Soldier Lake; bathymetry, physical features, and fish species.

S. SOLDIER LAKE(6D38)–PUKASKWA NATIONAL PARK

N. 48° 24' & W. 85° 46'

DEPTH CONTOURS IN FEET



CHARACTERISTICS:

AREA–112.8 Acres

MAXIMUM DEPTH–100+ Ft.

MEAN DEPTH–38 Ft.

SECCHI DISC–20.5 Ft.

TEMPERATURE–Range From 71°F to 43°F

FISH SPECIES–Eastern Brook Trout

–Brook Stickleback

–Northern Redbelly Dace

–Pearl Dace

–White Sucker

ALTITUDE–1250 Ft.

DATE of SURVEY–July 29th, 1972

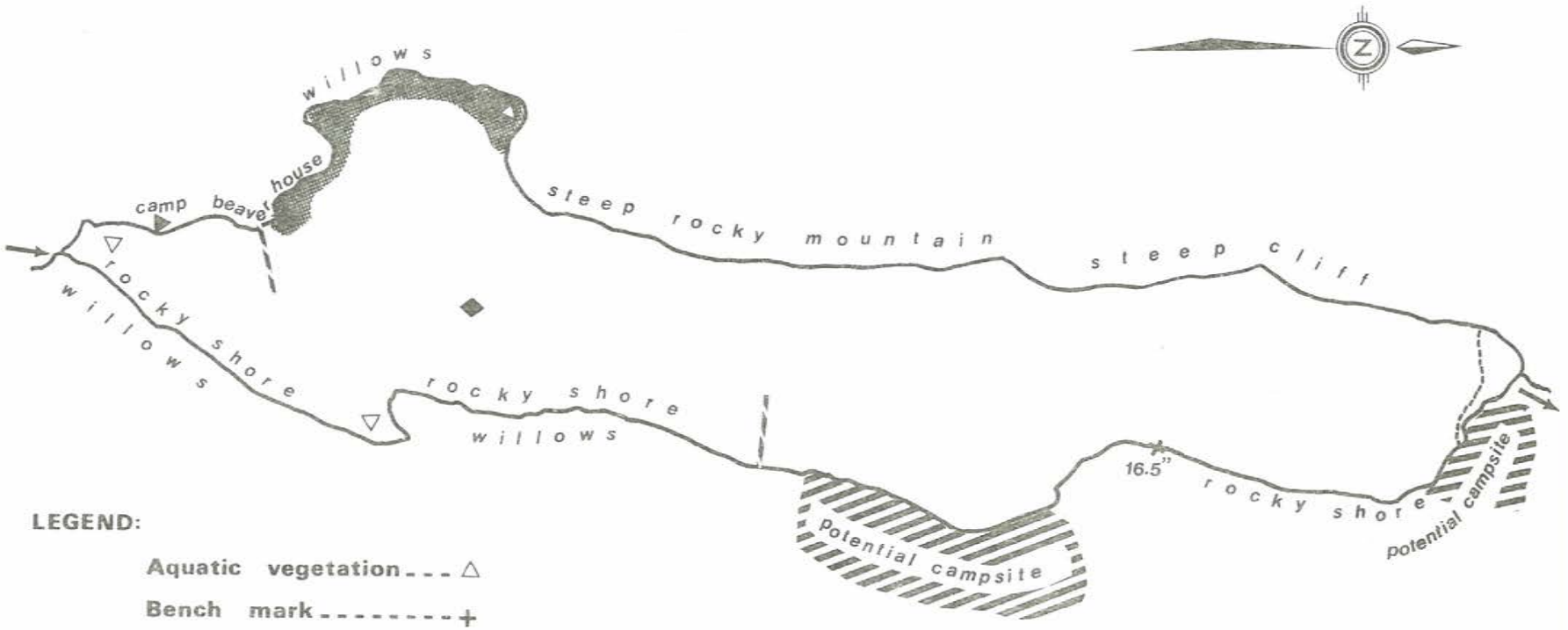
Scale:

0 .25 .50 Mile

Fig. 6B. South Soldier Lake; bench mark location, sampling stations, waterflows and landmarks of interest.

S. SOLDIER LAKE(6D38) - PUKASKWA NATIONAL PARK

N. 48° 24' & W. 85° 46'



LEGEND:

- Aquatic vegetation - - - △
- Bench mark - - - - - - - - +
- Gill net sampling - - - - - -
- Sampling station - - - - - ◆
- Seine sampling - - - - - -
- Shoals - - - - - - - - - - - - -
- Water sampling - - - - - - →

Scale:

0 .25 .50 Mile

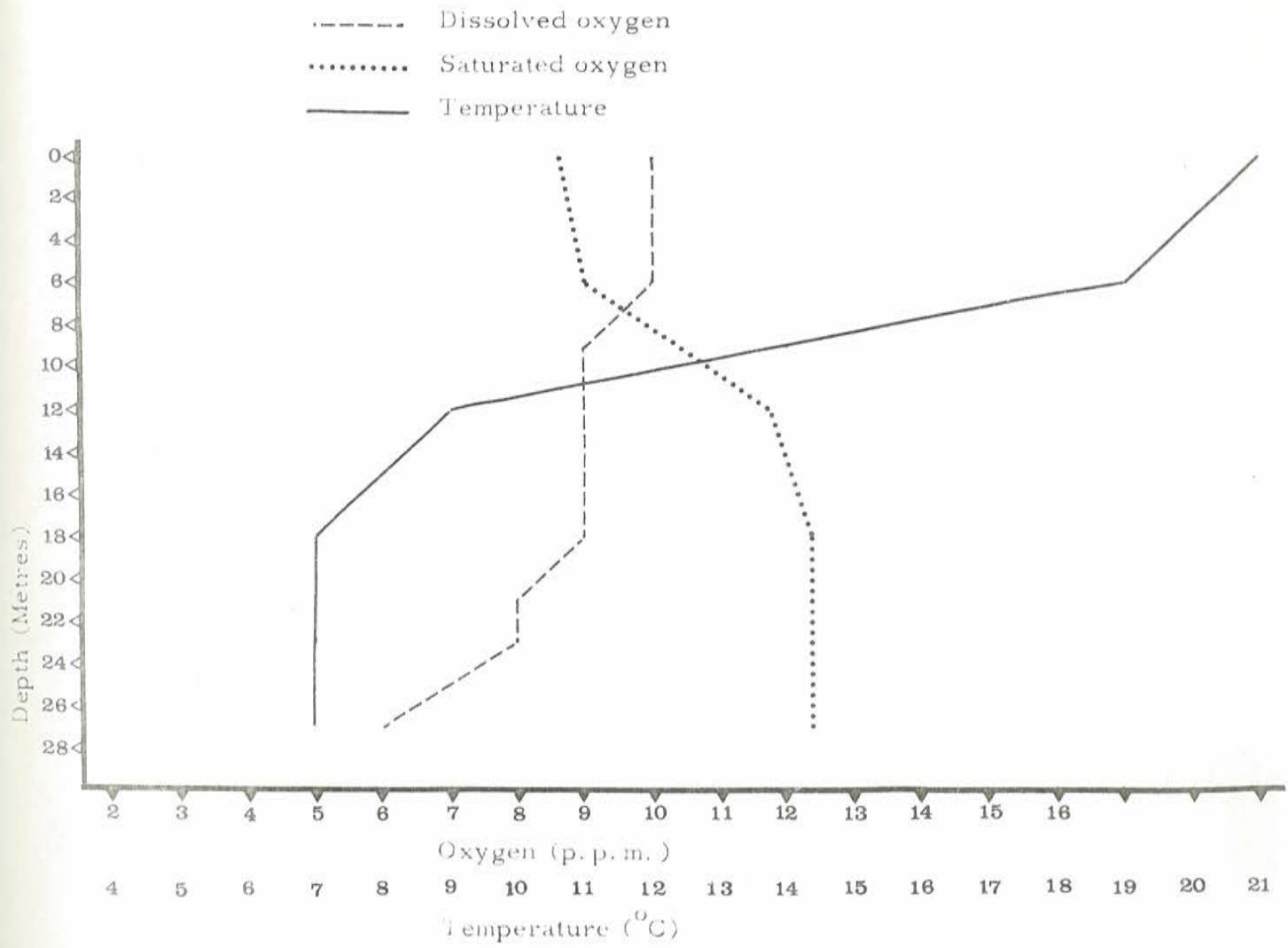


Figure 6C. Oxygen and temperature determinations. South Soldier Lake. July 29, 1972.

Widgeon Lake (4F1)

Widgeon Lake occupies an isolated position in that the Park boundary makes an eastward bulge to include the lake inside the Park. It is the only large lake in that area, and it is the third largest of the lakes examined (Table 2). Despite its size the lake is shallow with only one small area of deep water (Fig. 7A). Hence even though the specific conductance was low (33.5 umhos, Table 1), the lake is classified as eutrophic. The water was slightly brown and clear with a secchi disc reading of 21 feet (6 metres). Between 23 and 29 feet (7 and 9 metres) there was a thermocline, but there was considerable warming to the bottom. In the deep part of the lake oxygen levels were low (26.8 per cent saturation) (Fig. 7C) but carbon dioxide levels were also low (10 p.p.m.), and therefore fish would not be restricted by oxygen defficiency.

The number of plankton was high, being second only to Louie Lake. About half the sample consisted of calanoids, with 38 per cent cyclopoids, 9 per cent cladocerans and the remainder copepod nauplii. Both the first two groups were dominated by juveniles. Daphnia pulex dominated the cladocerans, and this species was only found in one other lake in the park (South Soldier). Widgeon Lake was one of the two lakes samples in which no Bosmina longispina were found (Table 4 and 5).

The only fish caught were speckled trout, suckers, pearl and redbellied dace. With the exception of South Soldier Lake the trout population was the highest found. There appeared to be suitable spawning grounds in the outlet. For the last few years Widgeon Lake has been a favourite lake for winter fishing; it may be that the numbers of trout taken reduced competition with the suckers as there appeared more small suckers than usual.

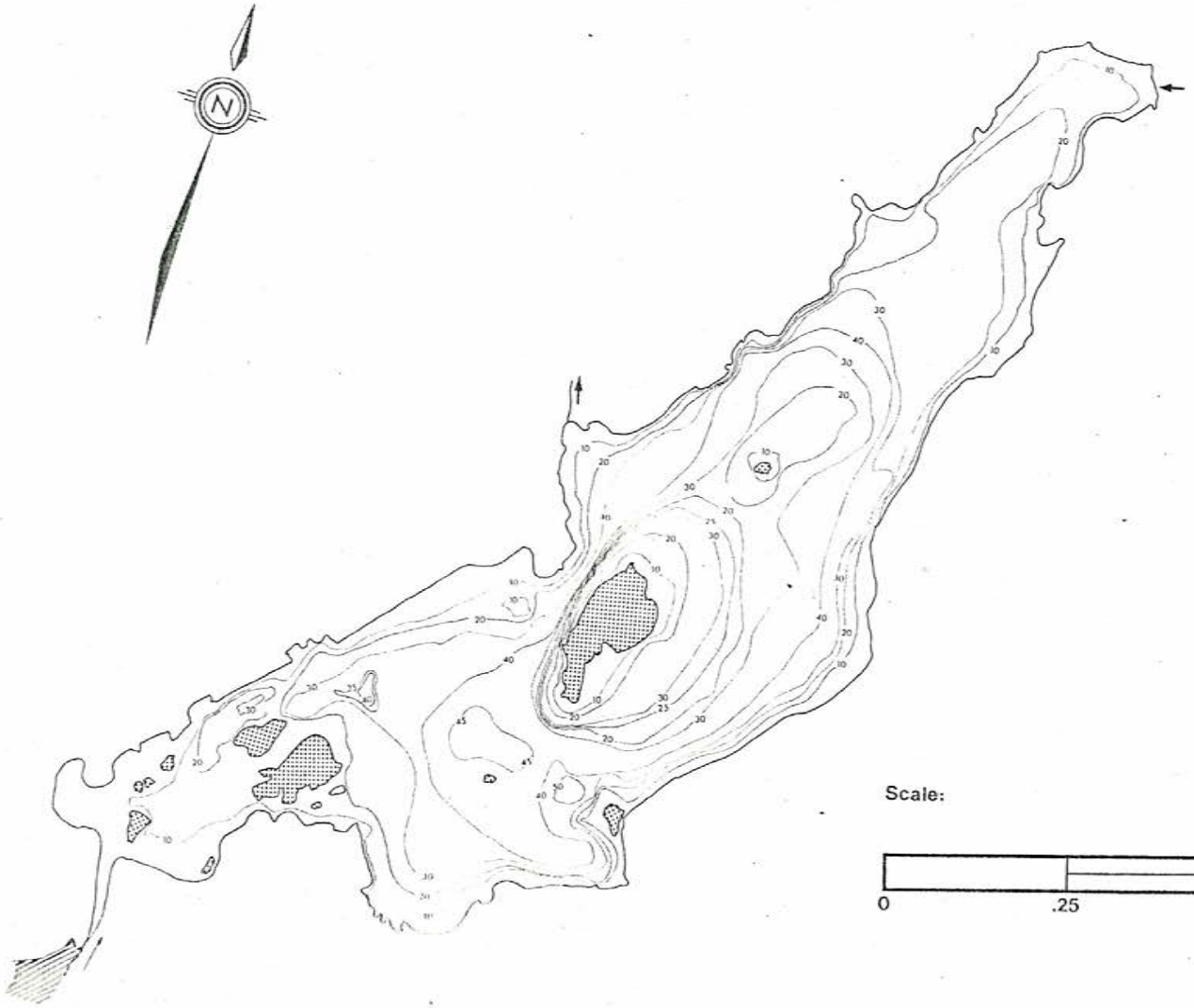
In the shallow swampy area smartweed and yellow bullhead lilies were growing (Fig. 7B).

Fig. 7A. Widgeon Lake; bathymetry, physical features, and fish species.

WIDGEON LAKE (4F1)–PUKASKWA NATIONAL PARK

N. 48° 16' & W. 85° 33'

DEPTH CONTOURS IN FEET



CHARACTERISTICS

AREA–367.6 Acres
ALTITUDE–850 Feet
MAXIMUM DEPTH–55 Feet
MEAN DEPTH–23.5 Feet
SECCHI DISC–21 Feet
TEMPERATURE RANGE FROM 66.5° F. to 45° F.
FISH SPECIES–
Eastern Brook Trout
White Sucker
Northern Redbelly Dace
Pearl Dace
DATE of SURVEY–JULY 26th., 1972

Legend:
Island
Swamp
Water flow

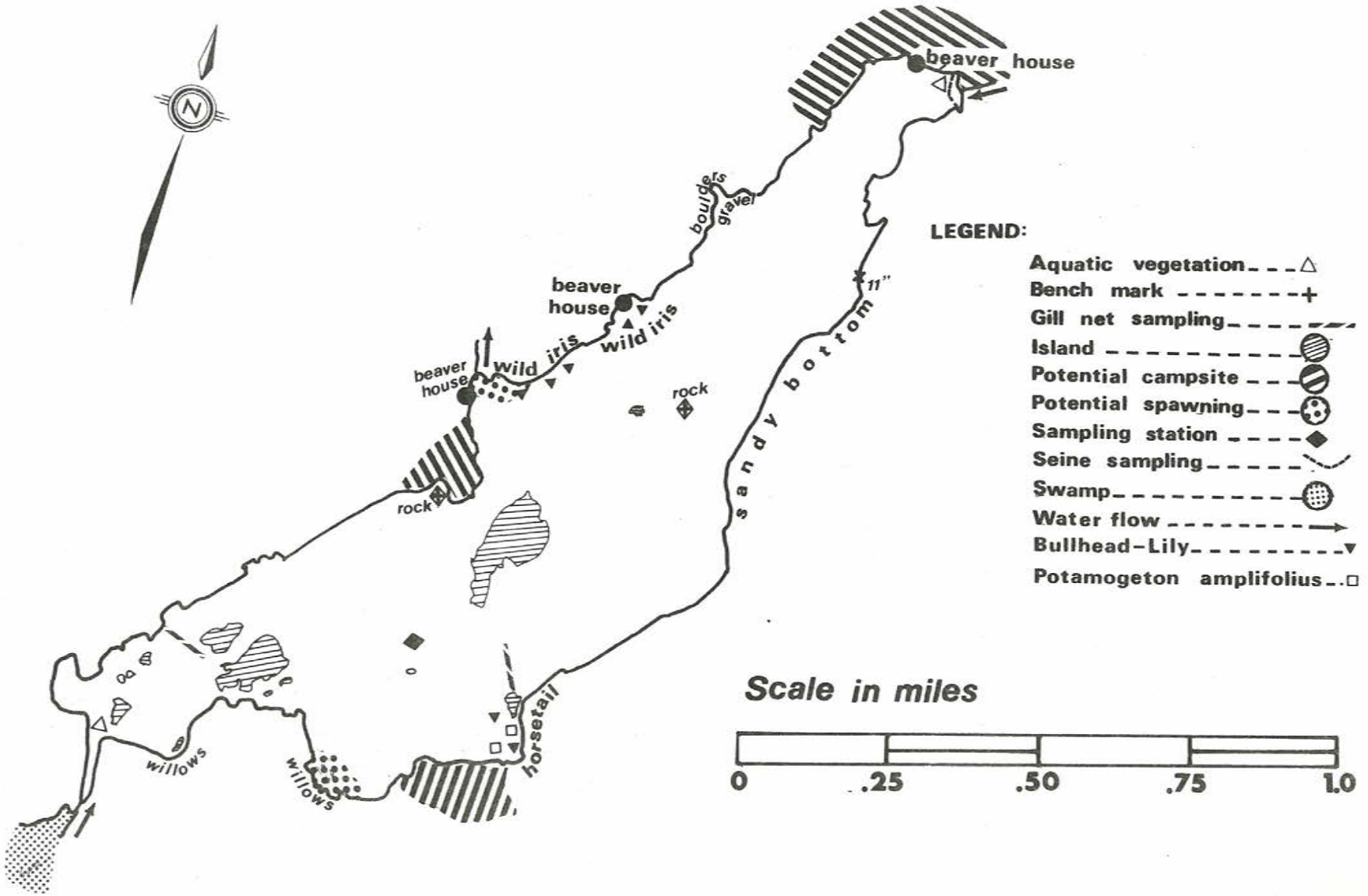
Scale:

0 .25 .50 .75 1.0 Mile

Fig. 7B. Widgeon Lake; bench mark location, sampling stations, waterflows and landmarks of interest.

WIDGEON LAKE(4F1) – PUKASKWA NATIONAL PARK

N. 48°16' & W. 85°33'



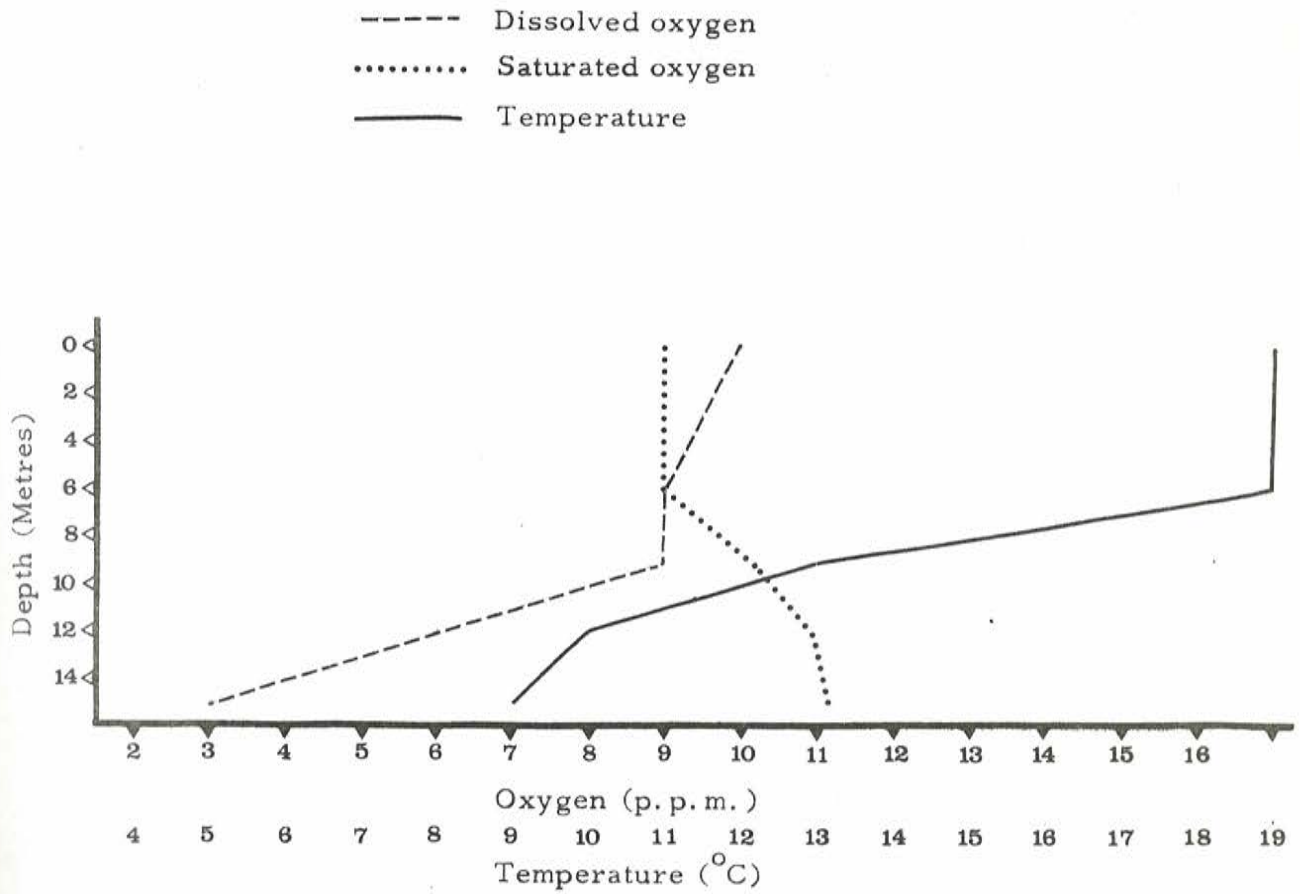


Figure 7C. Oxygen and temperature determinations. Widgeon Lake. July 26, 1972.

Cascade Lake (3B34)

This was the only lake in the southern interior of the Park large enough for an aeroplane to land. Although not one of the largest (Table 2) it was one of the deepest of the lakes examined. The shoreline was more regular than that of most lakes (Fig. 8A and B). The outlet stream drains to the west and joins the outlet from Scapula Lake before flowing northwest to meet the Cascade River near its mouth in Lake Superior.

The colour rating, 45 Hazen units, was more than double that of other lakes (Table 2). The deep brown water and greater than expected turbidity restricted the Secchi disc reading to 9 feet (3 metres). The deep water and low specific conductance (33 umhos) classify the lake as oligotrophic (Table 1).

The surrounding land shelters the lake surface from wind. This and the depth of the water may explain the shallow thermocline between 13 and 20 feet (4 and 6 metres). A further unusual factor was the coldness of the lake waters, the surface temperature was 11°F cooler than that of Widgeon Lake taken only 7 days before. The proximity of Lake Superior and the higher altitude may have a cooling influence though the 11°F difference seems greater than these factors could be expected to cause. Oxygen concentration was high at all depths, and carbon dioxide was only 2 p.p.m. near the bottom.

Although the productivity, as measured by specific conductance, was the same as that of Widgeon Lake the quantity of plankton in the 90 feet (28 metre) haul was only half as much. Reduced light penetration from the high turbidity and deep colour may have decreased the plankton production.

Calanoids made up over half the sample (58 per cent), cyclopoids 27 percent, cladocerans 10 per cent, and copepod nauplii the remainder. As in Widgeon Lake there were no Bosmina longispina but all other common species were collected (Tables 4 and 5).

Fish were scarce. Only two redbelly and one pearl dace were caught, and one fathead minnow (Pimphales promelas). There would appear to be some barrier preventing speckled trout and suckers reaching Cascade Lake, as conditions in the lake are suitable, and spawning grounds are available. The minnows may have been introduced by anglers using them as bait. Some small neighbouring lakes within the same drainage system probably also lack trout. It would be of interest to survey downstream from the lake to find how far speckled trout have penetrated up the stream and what barriers are responsible for keeping them out.

Aquatic vegetation was sparse but there was some smartweed (Polygonium sp.) adjacent to a small sandy beach at the inlet end on the east, yellow bullhead lilies in the small bay on the south side of the

lake, and three-square rush (Scirpus sp.) on the shoals between a small island and the shore on the southwest side.

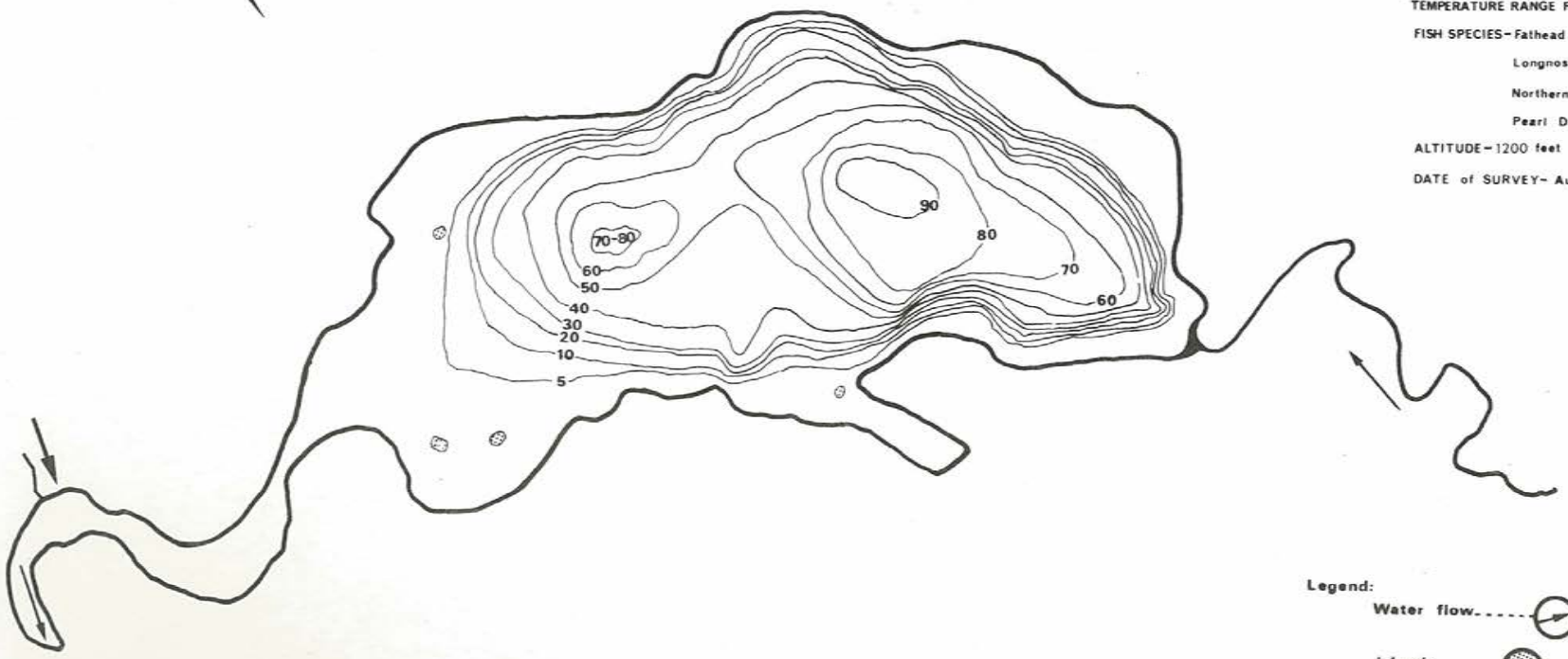
The lake was the only one in the southern interior large enough to be reached by aeroplane and it was selected for sampling in the hope that it would be typical of other lakes in the interior. However its great depth and other features make it unique rather than typical.

Fig. 8A. Cascade Lake; bathymetry, physical features, and fish species.

Cascade Lake (3B34)–Pukaskwa National Park

Depth Contours in Feet

N. 48° 6' & W. 85° 52'



CHARACTERISTICS:

AREA– 109 acres

MAXIMUM DEPTH– 90 feet

MEAN DEPTH–26 feet

SECCHI DISC– 9 feet

TEMPERATURE RANGE FROM 69° F to 39.5° F

FISH SPECIES– Fathead Minnow
Longnose Dace
Northern Redbelly Dace
Pearl Dace

ALTITUDE– 1200 feet

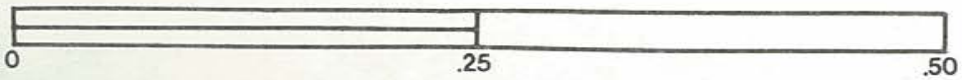
DATE of SURVEY– August 7th., 1972

Legend:

Water flow.....

Islands.....

Scale:

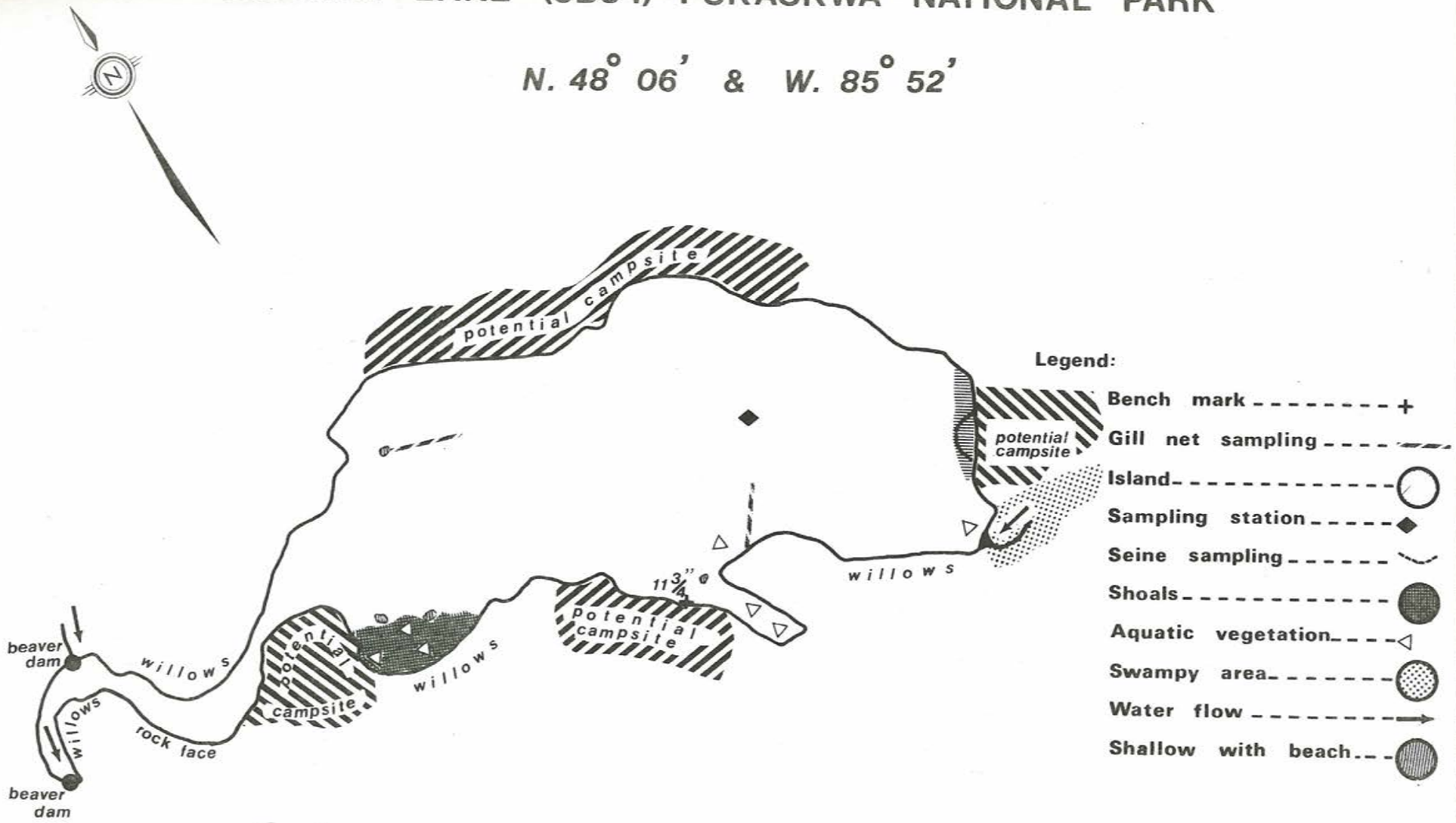


Mile

Fig. 8B. Cascade Lake; bench mark location, sampling stations, waterflows and landmarks of interest.

CASCADE LAKE (3B34)–PUKASKWA NATIONAL PARK

N. 48° 06' & W. 85° 52'



Scale:

0 .25 .50 Mile

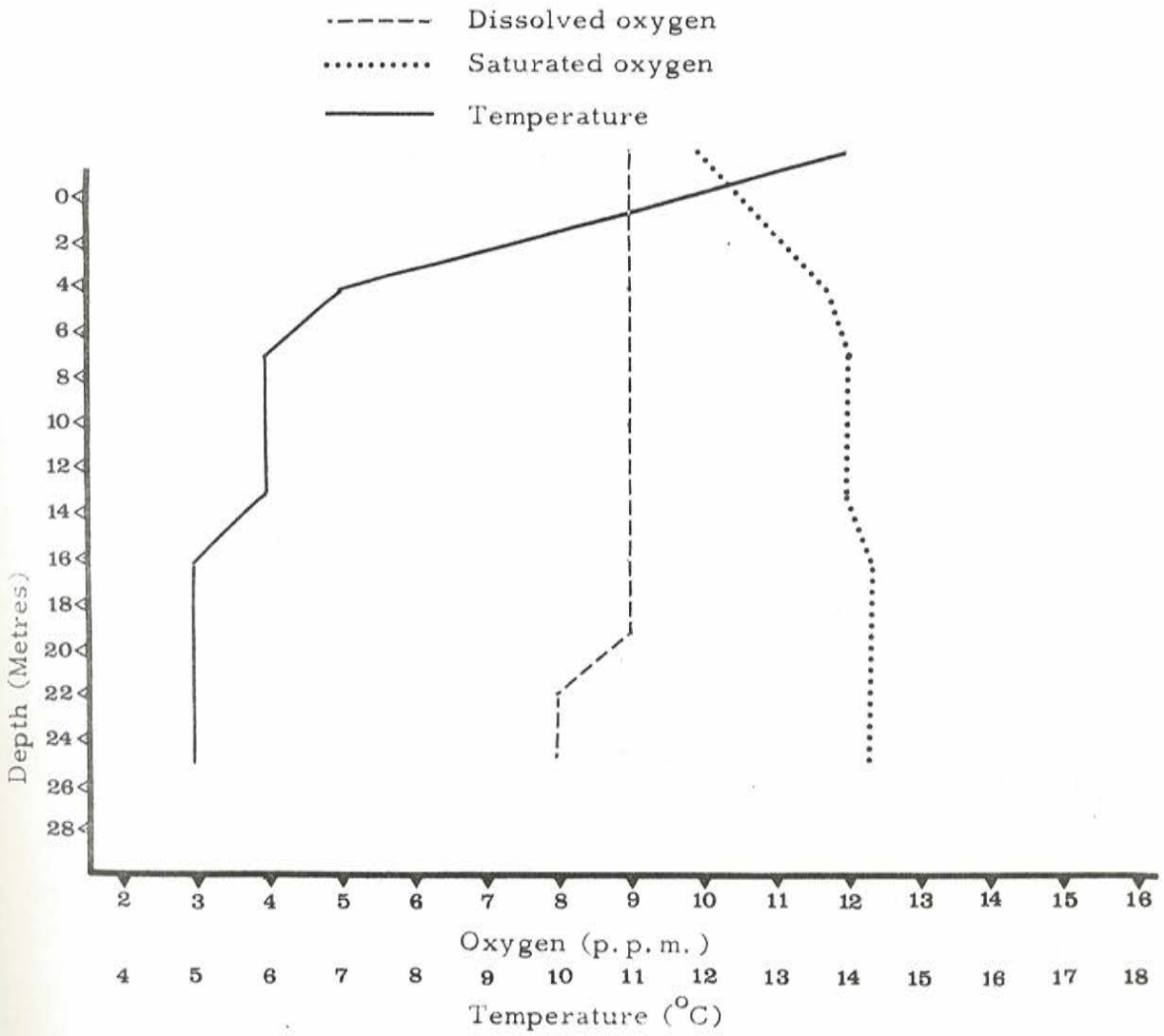


Figure 8C. Oxygen and temperature determinations. Cascade Lake. August 7, 1972.

Tagouche Lake (2B56)

This is a smaller lake one-quarter mile from Lake Superior, and the maps indicate that it drains into Lake Superior through Tagouche Creek. However, at the time of the survey there was a low beaver dam above the falls on the creek, and the water was flowing into Tagouche Lake. The shoreline was regular and muddy or sandy except for one rock face along the north side. The lake was of medium depth for its surface area (Fig. 9A and B).

The water was light brown and clear with a Secchi disc reading of 18 feet (5.8 metres) (Table 2). The specific conductance (102 umhos) was the second highest of the lakes examined (Table 1). It indicates a productivity two to three greater than most lakes examined in Pukaskwa National Park and equal to the productivity of Meach Lake, Gatineau Park (Currier 1969).

A broad thermocline was evident between 16 and 26 feet (5 and 8 metres). Below that there was little warming to the bottom. Oxygen concentrations were high (Fig. 9C) except in the bottom 6 feet (2 metres) where the level fell to 32 per cent of saturation. The carbon dioxide concentration did not exceed 10 p.p.m. at the bottom at the time of the survey. However, since the survey was made in early July it is likely some oxygen depletion would become evident by late summer, so the fish population may be excluded from the deeper bottom areas below the thermocline.

The plankton haul of 37 feet (11 metres) caught almost equal numbers of cyclopoids (44 per cent) and calanoids (41.5 per cent) with 12 per cent cladocerans, and copepod nauplii making up the balance. The total quantity was similar to that taken in Widgeon Lake. Ceriodaphnia lacustris, a cladoceran species, was found only in some lakes near the Lake Superior coast (Tables 4 and 5).

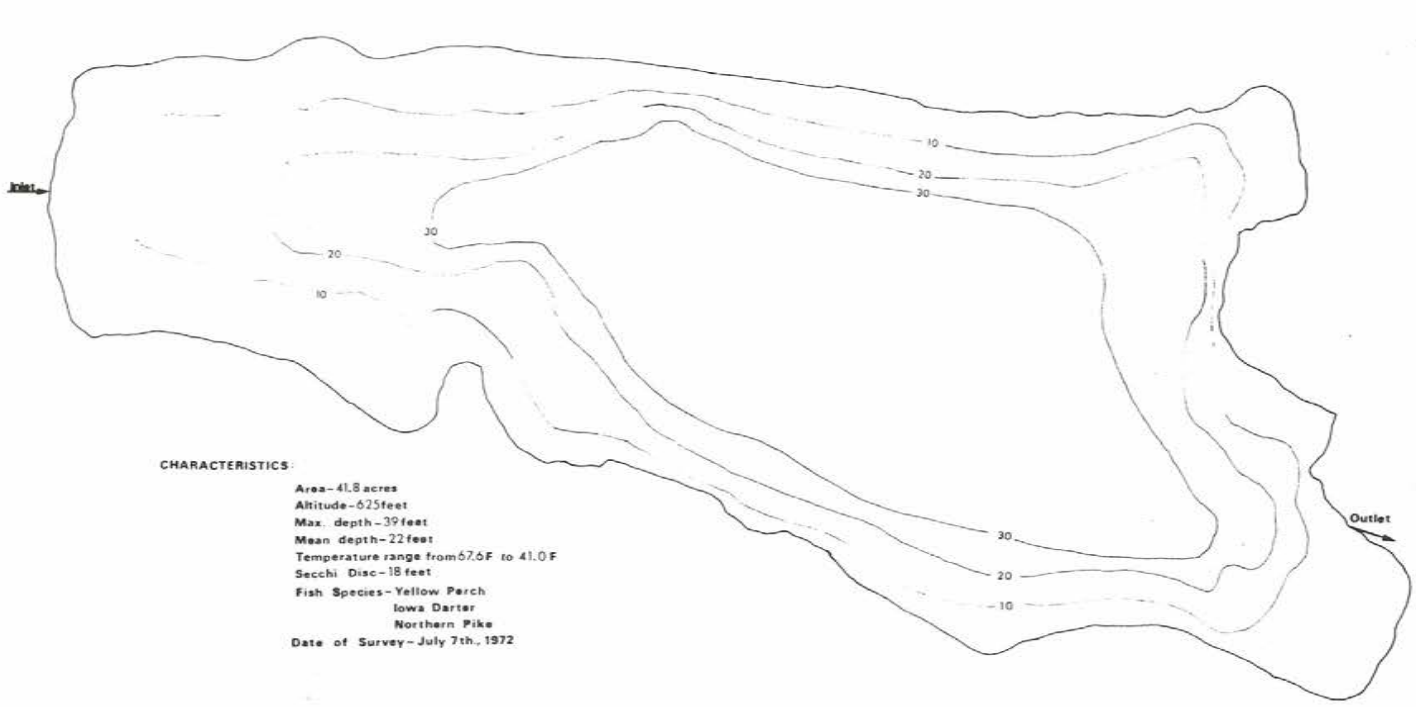
Few fish were caught and these were small yellow perch and northern pike. The latter attract anglers to the lake. From discussions with R. Collins and Napoleon Michano we learned that anglers have occasionally taken northern pike up to 10 pounds in weight. The lake has some beaches, mostly at the west end, which might be suitable for bathing. The lake also has an abundance of freshwater clams, the shells of which might cut the feet of people wading about in the water adjacent to the beach. Judging from the piles of old opened clam shells found at various places along the shore some animals have been using the clams as food, (possibly otter). Otter, mink and muskrats are fond of clams. Beaver might have heaped the shells up accidentally when preparing their scent mounds (Novakowski, personal communication).

Fig. 9A. Tagouche Lake; bathymetry, physical features, and fish species.

TAGOUCHE LAKE (2B56) – PUKASKWA NATIONAL PARK

N. 48° 3' 30" & W. 85° 57'

DEPTH CONTOURS IN FEET



CHARACTERISTICS

Area – 41.8 acres
Altitude – 625 feet
Max. depth – 39 feet
Mean depth – 22 feet
Temperature range from 67.6 F to 41.0 F
Secchi Disc – 18 feet
Fish Species – Yellow Perch
Iowa Darter
Northern Pike
Date of Survey – July 7th., 1972

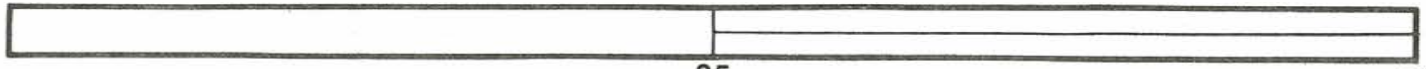
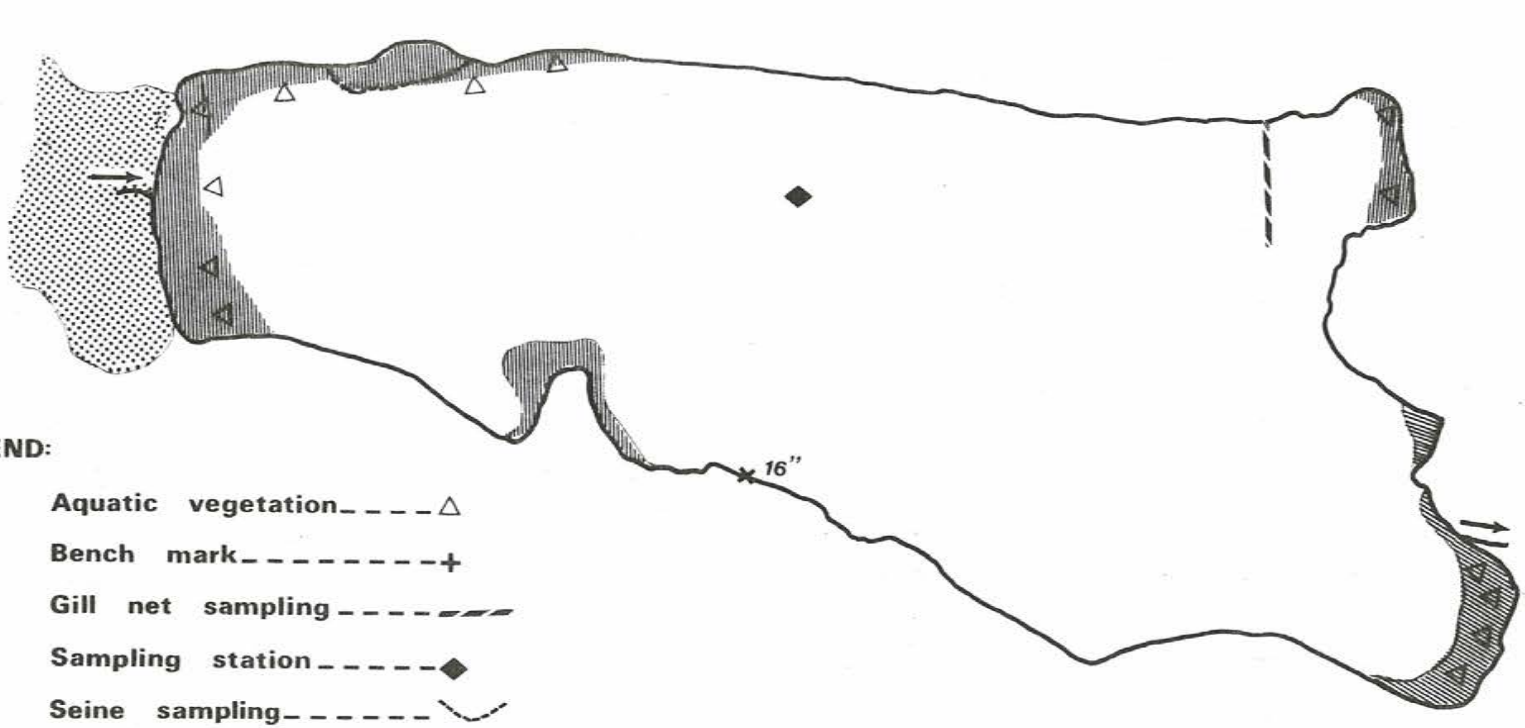


Fig. 9B. Tagouche Lake; bench mark location, sampling stations, waterflows and landmarks of interest.

TAGOUCHE LAKE(2B56)–PUKASKWA NATIONAL PARK

N. 48° 03' 30" & W. 85° 57'



LEGEND:

- Aquatic vegetation
- Bench mark
- Gill net sampling
- Sampling station
- Seine sampling
- Shallow with beach
- Swampy area
- Water flow

Scale:

0 .25 .50 Mile

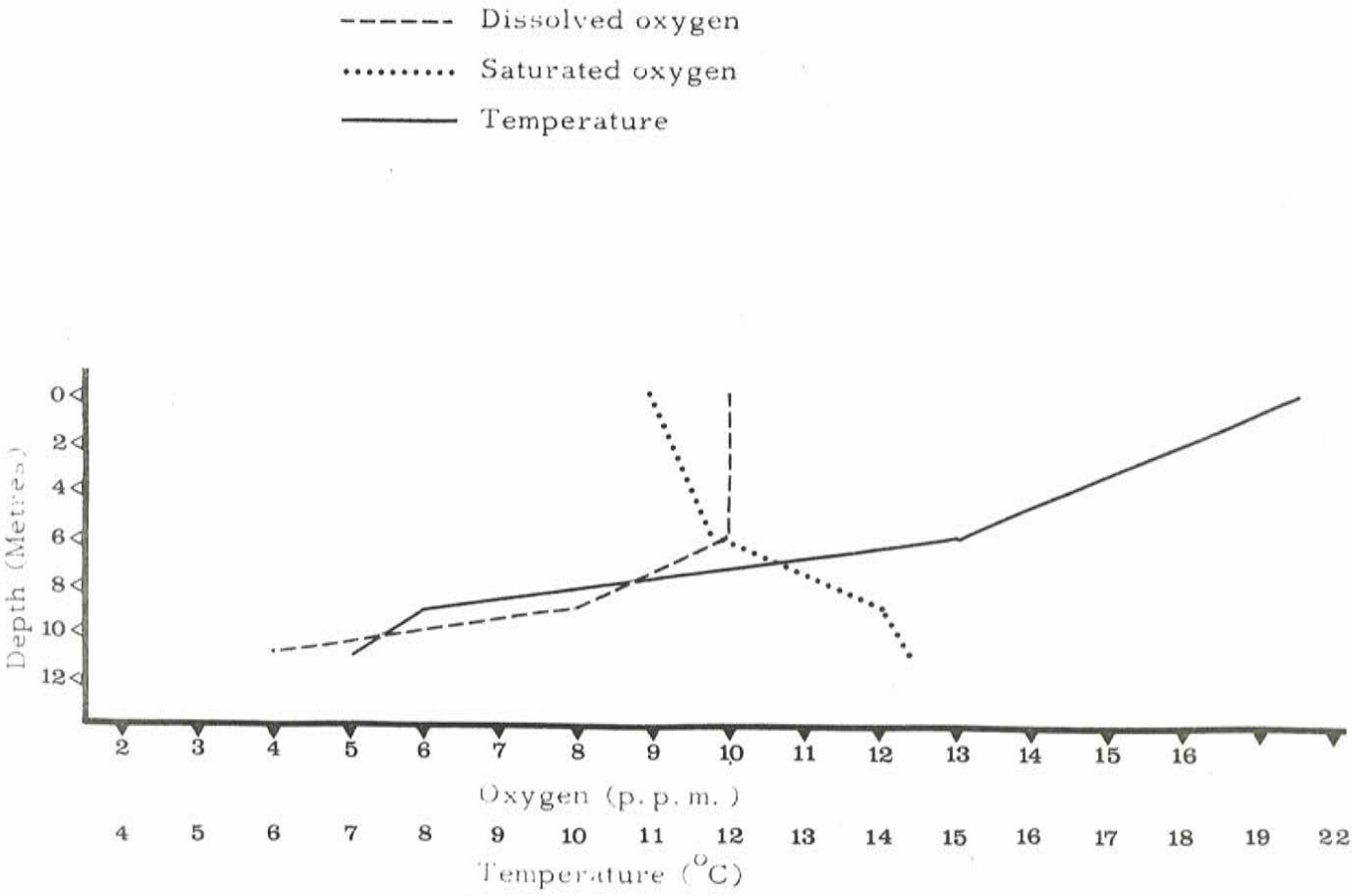


Figure 9C. Oxygen and temperature determinations. Tagouchi Lake. July 7, 1972.

Lake 2A3

This small lake is about one-quarter mile inland from Otter Cove behind Gus Weidman's old trapping cabin, from which the trail starts, and about half-way between Lake 2A2 and Lake Superior.

The lake is narrow and shallow with a slightly irregular shoreline (Figures 10A and B). The water colour was a moderate brown and fairly clear, with a Secchi disc reading to the bottom at 12 feet (3 to 6 metres) (Table 2). The specific conductance reading of 63.2 umhos indicates a chemical productivity about twice as great as that for Cascade Lake (Table 1). With this high a specific conductance, and shallow water, Lake 2A3 is classified as eutrophic. The lake warms to the bottom early in the year and the complete circulation that results prevents any oxygen depletion (Fig. 10C) during the summer. Some oxygen depletion may occur during the winter when the lake is ice-covered, but the presence of a fish population suggests that complete stagnation does not take place. Carbon dioxide readings of 5 p.p.m. were obtained at the surface and near the bottom of the lake.

The one short total vertical haul of 12 feet (4 metres) indicated a rather sparse zooplankton fauna. The Calanoida group was dominant, making up 53.6 per cent of the sample. Cladocerans contributed 17.9 per cent, and the remaining 28.6 per cent were copepod nauplii. No adult forms of the Cyclopoida were found but a few juveniles of a Cyclops species were recognized (Table 4 and 5).

Few fish were caught and these represented only two species - yellow perch and spottail shiners (Notropis hudsonius). None of the specimens caught were longer than five inches (15 centimeters).

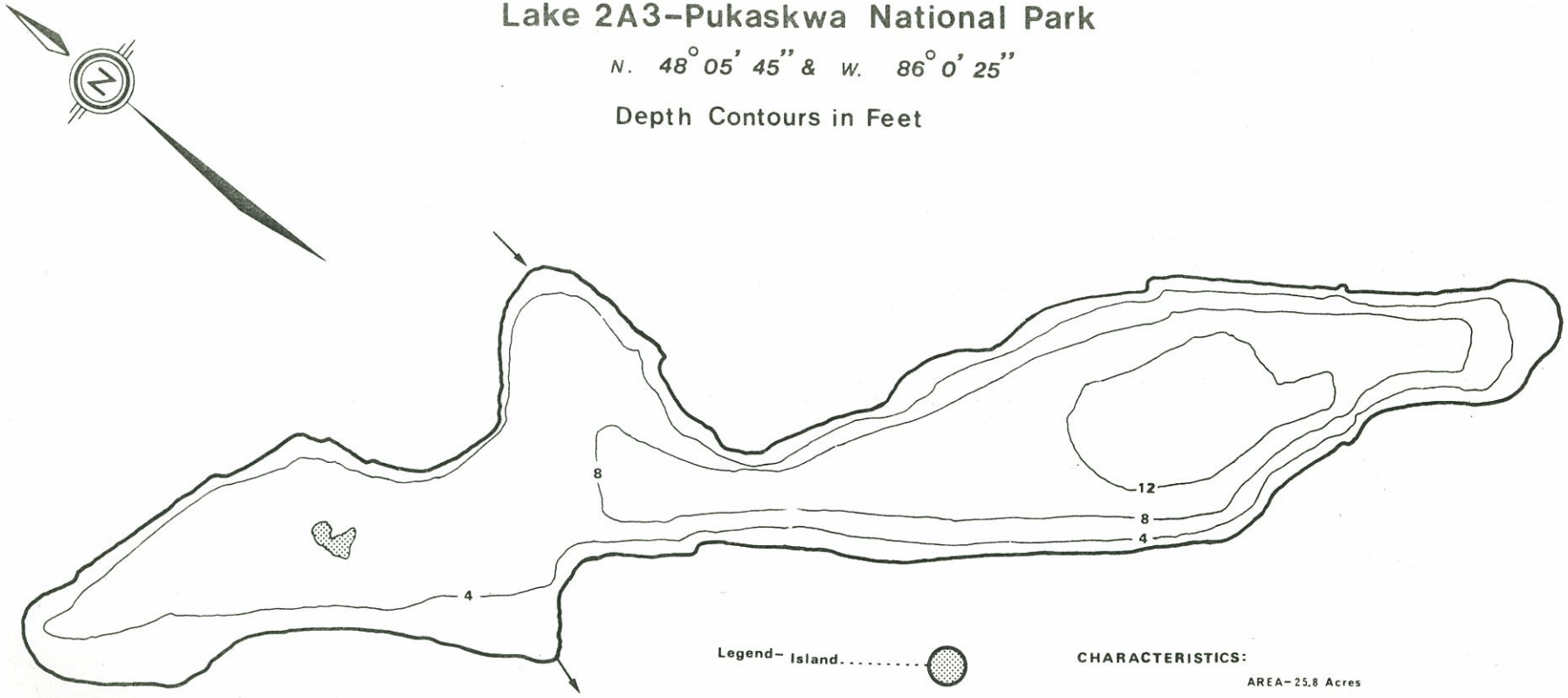
The presence of trout is precluded by the presence of yellow perch and the absence of spawning areas. In addition, because of the shallowness of the lake any prolonged periods of hot weather may raise the water temperature above 70°F (21°C), the level of tolerance of speckled trout. The possibility also exists that in some winters stagnation may reduce the oxygen level below trout requirements.

Fig. 10A. Lake 2A3; bathymetry, physical features, and fish species.

Lake 2A3-Pukaskwa National Park

N. 48° 05' 45" & W. 86° 0' 25"

Depth Contours in Feet



Legend- Island.....

Water flow.....

CHARACTERISTICS:

AREA- 25.8 Acres

MAXIMUM DEPTH- 12 feet

MEAN DEPTH- 8 feet

SECCHI DISC- 12 feet

TEMPERATURE RANGE FROM 64.4°F to 60.8°F

FISH SPECIES- Spottail Shiner

- Yellow Perch

ALTITUDE- 700 feet

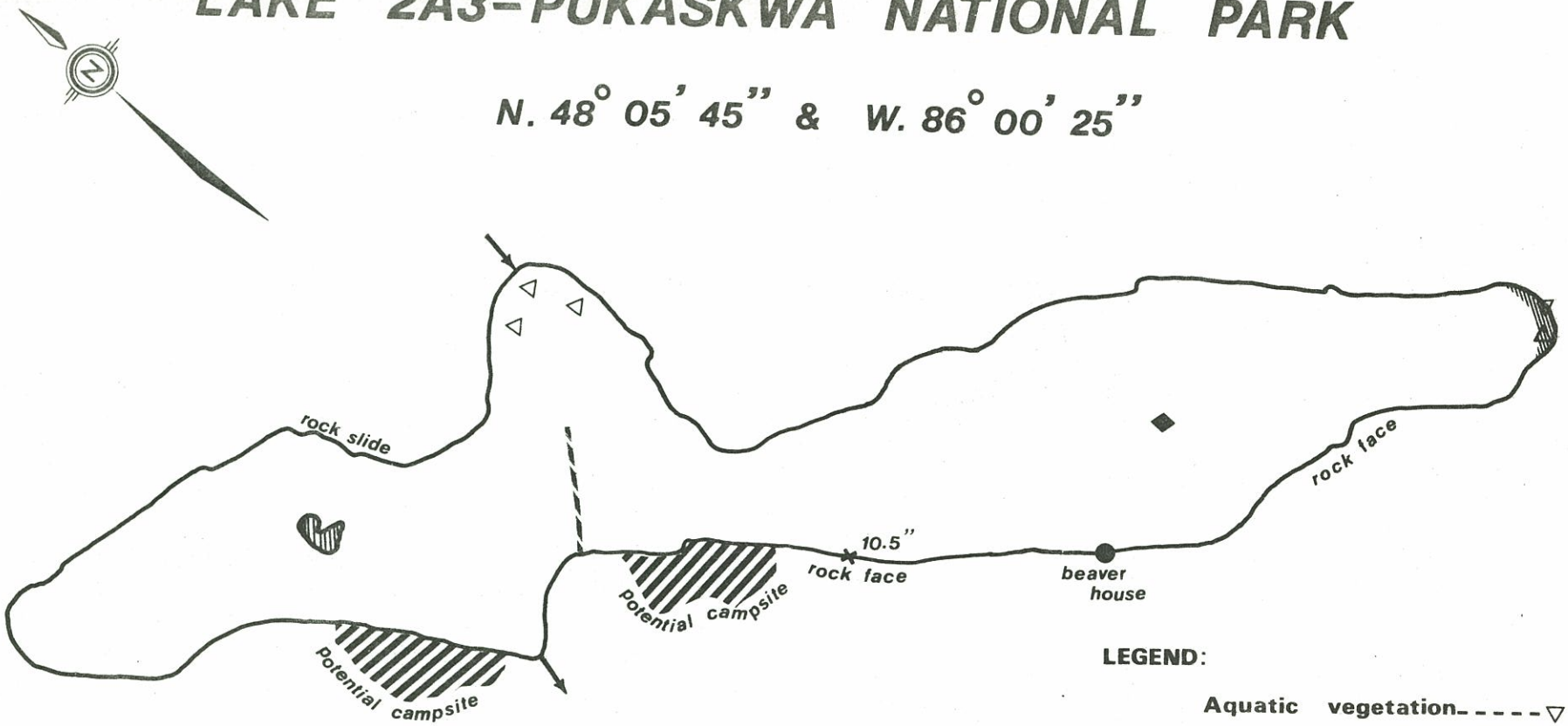
DATE OF SURVEY- June 21st., 1972

Scale:

Fig. 10B. Lake 2A3; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 2A3–PUKASKWA NATIONAL PARK

N. 48° 05' 45" & W. 86° 00' 25"



LEGEND:

- Aquatic vegetation
- Bench mark
- Gill net sampling
- Island
- Sampling station
- Shallow with beach
- Water flow

Scale:

0 .125 .25 Mile

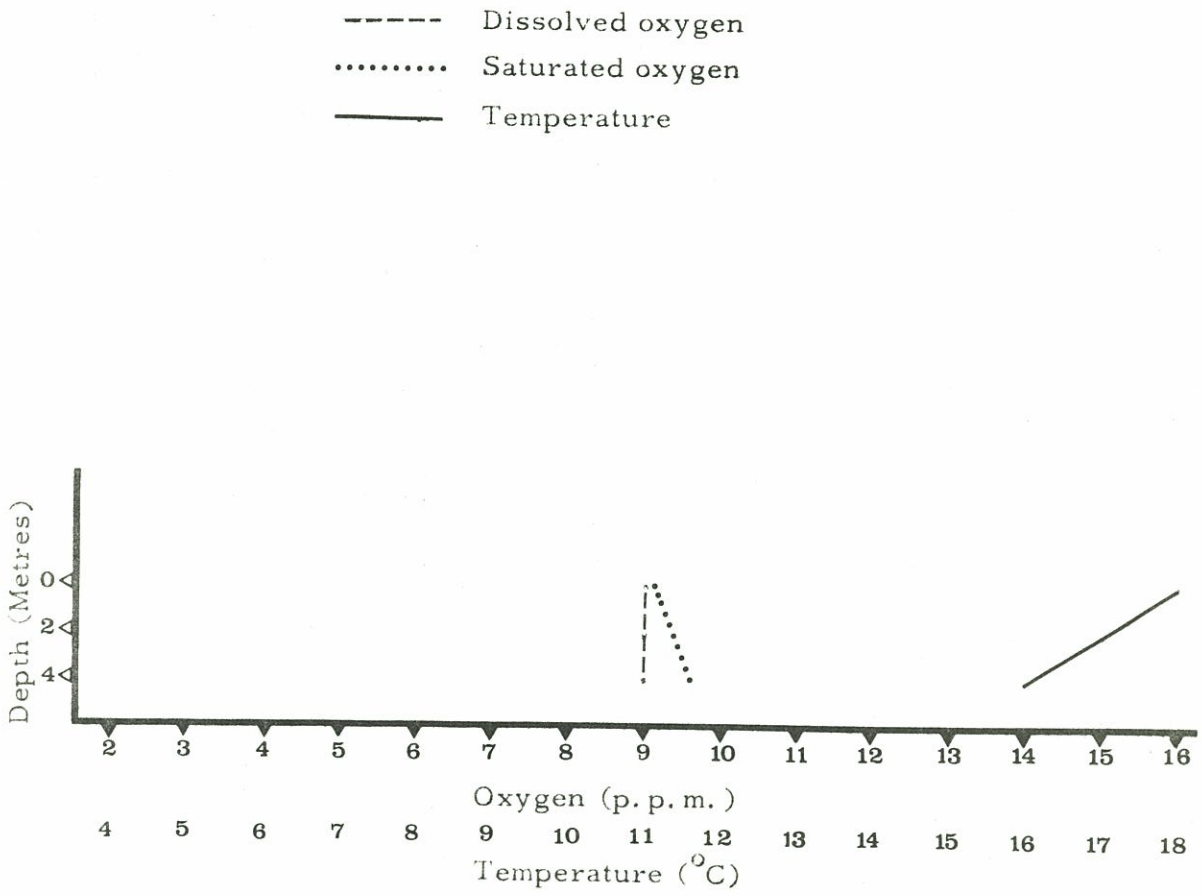


Figure 10C. Oxygen and temperature determinations. Lake 2A3. June 21, 1973.

Lake 2A2

This was a small oblong lake with regular shoreline, one-half mile inland from Otter Cove and one-quarter mile inland from and 250 feet (62 metres) above Lake 2A3. A small outlet stream leaves the lakes from the west end and flows northwest into Lake 3A51 (Fig. 11A).

The lake is deep for its area having a mean depth of 23 feet (7 metres) (Table 2). The water was medium brown in colour with a transparency of 13 feet (4 metres). The specific conductance was as high as Lake 2A3 (63.2 umhos) (Table 1) but the lake is classified as eutrophic from its depth proportionate to area, and oxygen and temperature regimes.

The temperature and oxygen determinations (Fig. 11C) indicate the difference that exists between Lake 2A2 and its neighbour 2A3. The surface temperature of 60°F (15°C) was 3 degrees lower than 2A3, and a well-defined thermocline was present lying between the 13 and 20 feet (4 and 6 metres) depths. Below the thermocline the water was cold, with no warming at the bottom. Oxygen levels were high to the thermocline but had dropped to 23.6 per cent of saturation at the lake bottom. By late summer oxygen levels below the thermocline may become too low to support fish so about half the area of the lake bottom would be lost as a feeding ground for a trout population. The carbon dioxide level of 10 p.p.m. near the bottom of the lake was low, giving some indication that there are not large amounts of organic matter decomposing in the bottom deposits.

The number of individuals and species in the plankton sample was greater than from the Lake 2A3 sample. Calanoids (40 per cent) were slightly more numerous than cyclopoids (36 per cent), which had scarcely been present in Lake 2A3. Cladocerans made up 17 per cent and copepod nauplii the remainder. The calanoids were dominated by Diaptomus siciloides, a species not found in other lakes in the Park (Table 4 and 5).

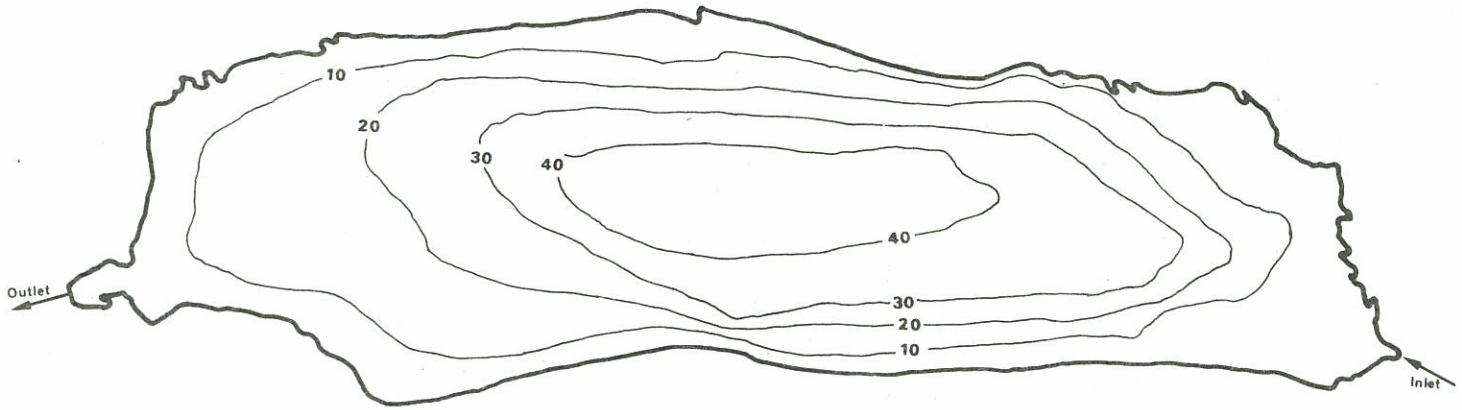
Netting caught mainly small yellow perch, all less than 6 inches (20 centimetres) in length, and some Iowa darters. A self-sustaining trout population is precluded by potential competition from perch (probably introduced by anglers using live bait), and the absence of spawning beds.

Fig. 11A. Lake 2A2; bathymetry, physical features, and fish species.

Lake 2A2-Pukaskwa National Park

N. 48° 06' & W. 86° 0' 25"

Depth Contours in Feet



CHARACTERISTICS:

AREA-15.5 Acres

MAXIMUM DEPTH-45 feet

MEAN DEPTH-23 feet

SECCHI DISC-13 feet

TEMPERATURE RANGE FROM 59.2°F to 39.2°F

FISH SPECIES-Yellow Perch
-Iowa Darter

ALTITUDE-950 feet

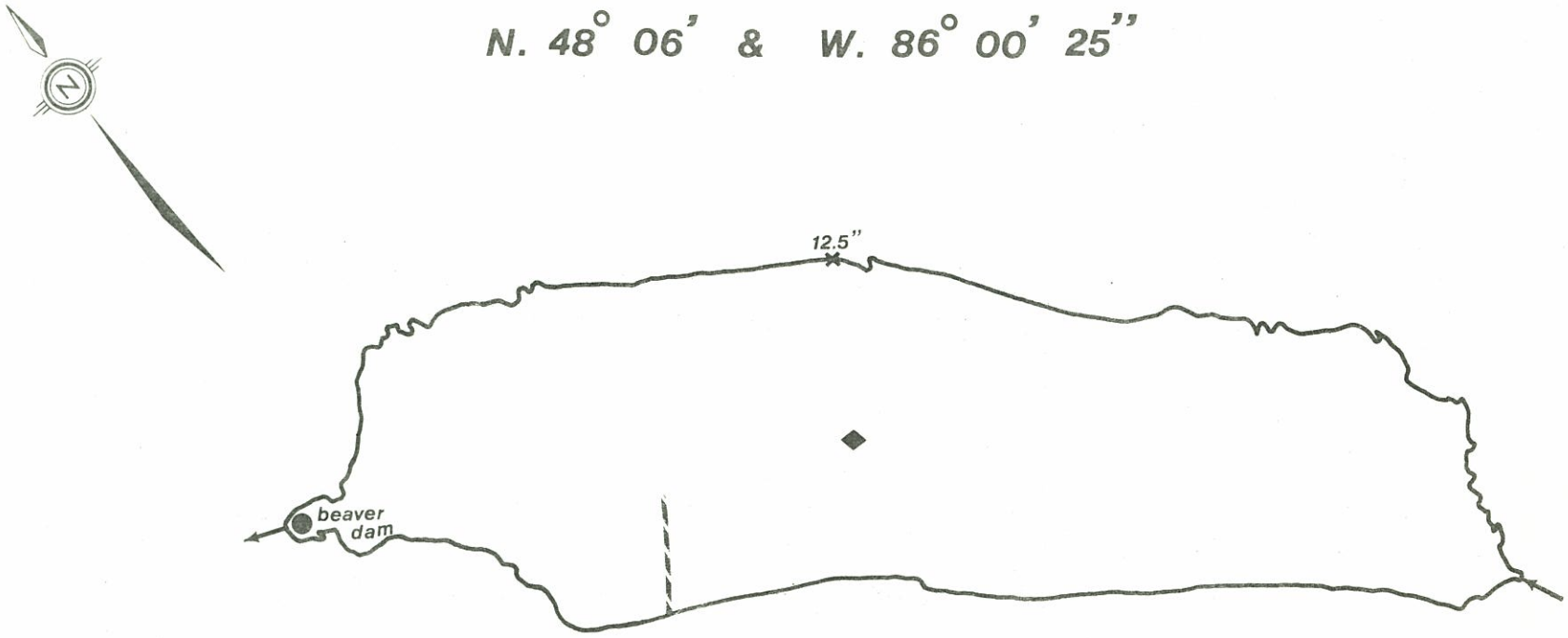
DATE OF SURVEY-June 22nd., 1972

Scale:

Fig. 11B. Lake 2A2; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 2A2-PUKASKWA NATIONAL PARK

N. 48° 06' & W. 86° 00' 25"



Scale:

LEGEND:

Bench mark - - - - - - +

Gill net sampling - - - - - -

Sampling station - - - ◆

Water flow - - - - - - - →

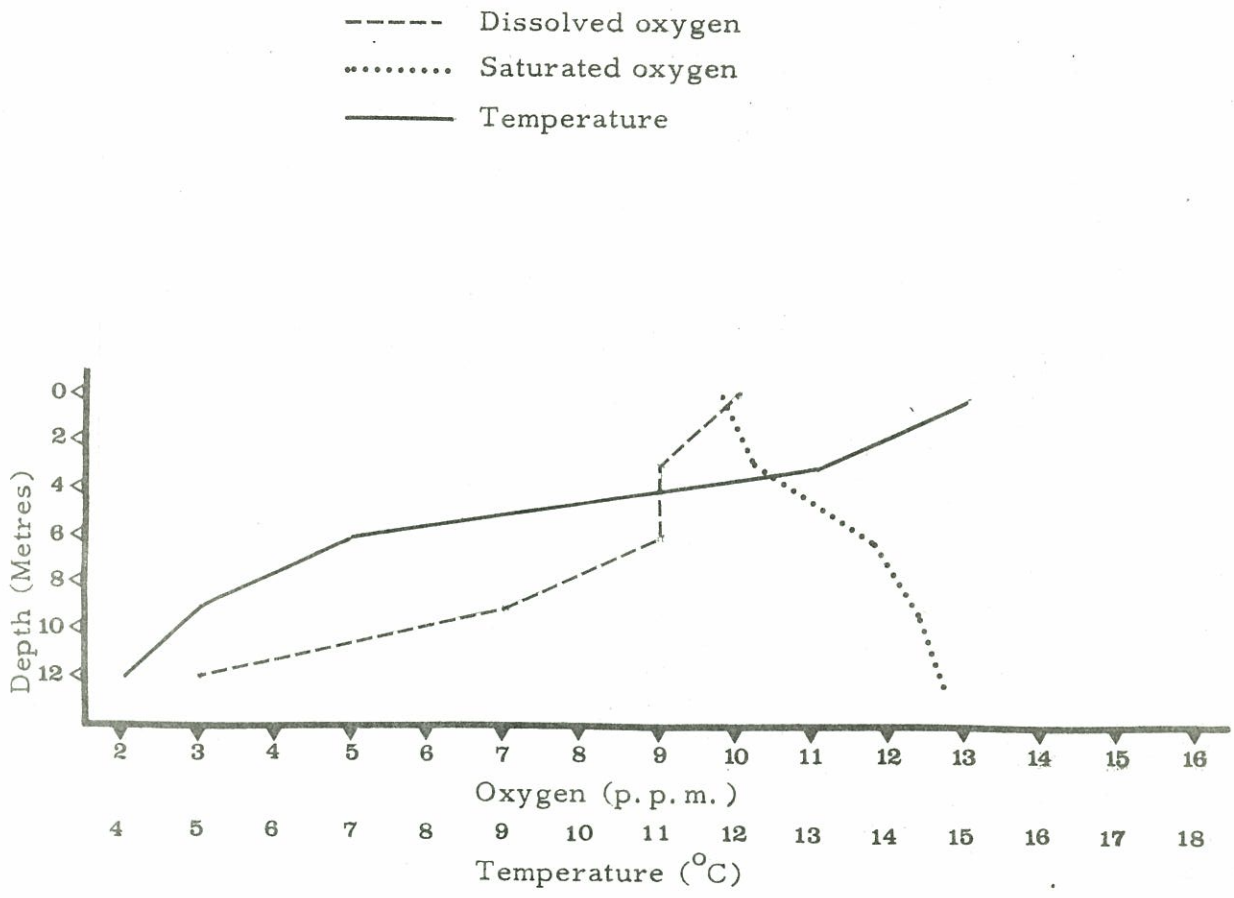


Figure 11C. Oxygen and temperature determinations. Lake 2A2. June 22, 1972.

Lake 2A6

This is a small basin-shaped lake with regular shoreline one-third mile from Otter Cove into which the outlet flows (Fig. 12B). The outlet is partially blocked at the lake by the remains of old beaver dams though during spring floods fish can probably move out of the lake. Since there is a difference of only 23 feet (7 metres) between the height of the lake and Lake Superior the flow of the outlet creek is not rapid enough to be a barrier to fish movement up the creek.

Although the shores are rocky they do not have sheer rock faces characteristic of many of Park's lakes. The water was only slightly stained brown and was clear, with a secchi disc reading of 14 feet (4.3 metres) (Table 2). The specific conductance determination of 105 umhos is the highest found at any of the Park lakes (Table 1) examined. The lake is classified as eutrophic and its chemical productivity is comparable to some Gatineau Park lakes (Cuerrier, 1969).

A broad thermocline existed at the time of the survey between 19 and 26 feet (6 and 8 metres) levels, below which there was some slight warming to the bottom. The shape of the lake basin and its orientation (Fig. 12A) and exposure to the prevailing winds may cause the lake to be warmed to the bottom in late summer. Oxygen levels were high at all depths (Fig. 12C) and the carbon dioxide determinations were only 5 p.p.m. at the surface and the bottom.

The plankton sample was notable for its paucity of species; for example there was only one cyclopoid species although it made up 45 per cent of the total sample. The next most numerous groups were copepod nauplii (34 per cent), calanoids (15 per cent) and cladocerans (6 per cent) (Table 4 and 5).

Fish were scarce and the seine catch was dominated by Iowa darters. At the outlet a mottled sculpin (Cottus bairdi) was caught. It was probably from Lake Superior.

The single cisco (Coregonus artedi) taken in the gill net was unusual in that although common to Lake Superior it is not often found in small lakes. That the lake is one of the few lakes in the Otter Cove area without perch, even though they could move up from Lake Superior, suggests that the lakes that do contain perch, have them as a result of careless live-bait angling. In terms of dissolved nutrients the lake seemed to be potentially the most productive lake examined. It would certainly be suitable for brook trout although the beaver dam would block access to the spawning beds. It is likely that there used to be a trout population, but that it died out from lack of breeding success. It would appear that it has only been in recent times that the beaver dams have been breached to allow entry of Lake Superior fish during high water periods. As the two suckers captured had not attained spawning age, and no young suckers were captured or seen, they had not been in

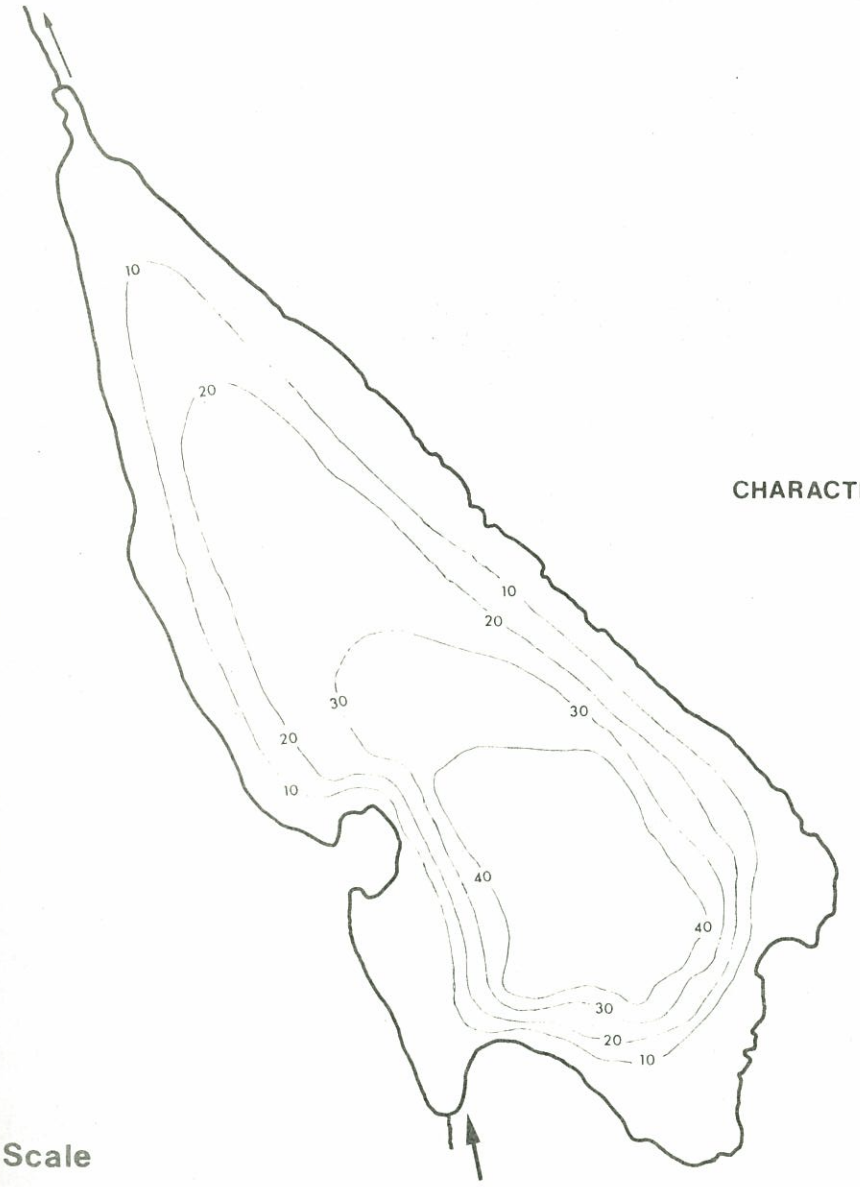
the lake long. In a few years the lake may be full of suckers once the few present start to reproduce. Also, other fish species may find their way from Lake Superior now that the way is open, and the composition of the fish population may be changed considerably in the next few years.

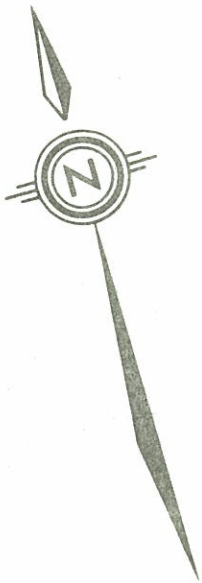
Fig. 12A. Lake 2A6; bathymetry, physical features, and fish species.

LAKE 2A6–PUKASKWA NATIONAL PARK

N. 48° 4' 30" & W. 85° 58' 30"

DEPTH CONTOURS IN FEET





CHARACTERISTICS:

AREA – 37 Acres
ALTITUDE – 625 Feet
MAXIMUM DEPTH – 40 Feet
MEAN DEPTH – 21 Feet
FISH SPECIES –
Cisco
Iowa Darter
Mottled Sculpin
White Sucker
DATE OF SURVEY – June 23rd., 1972

Legend:
Water flow.....

Scale

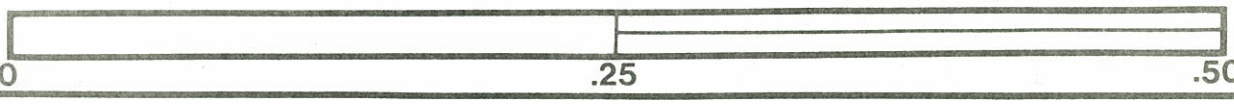
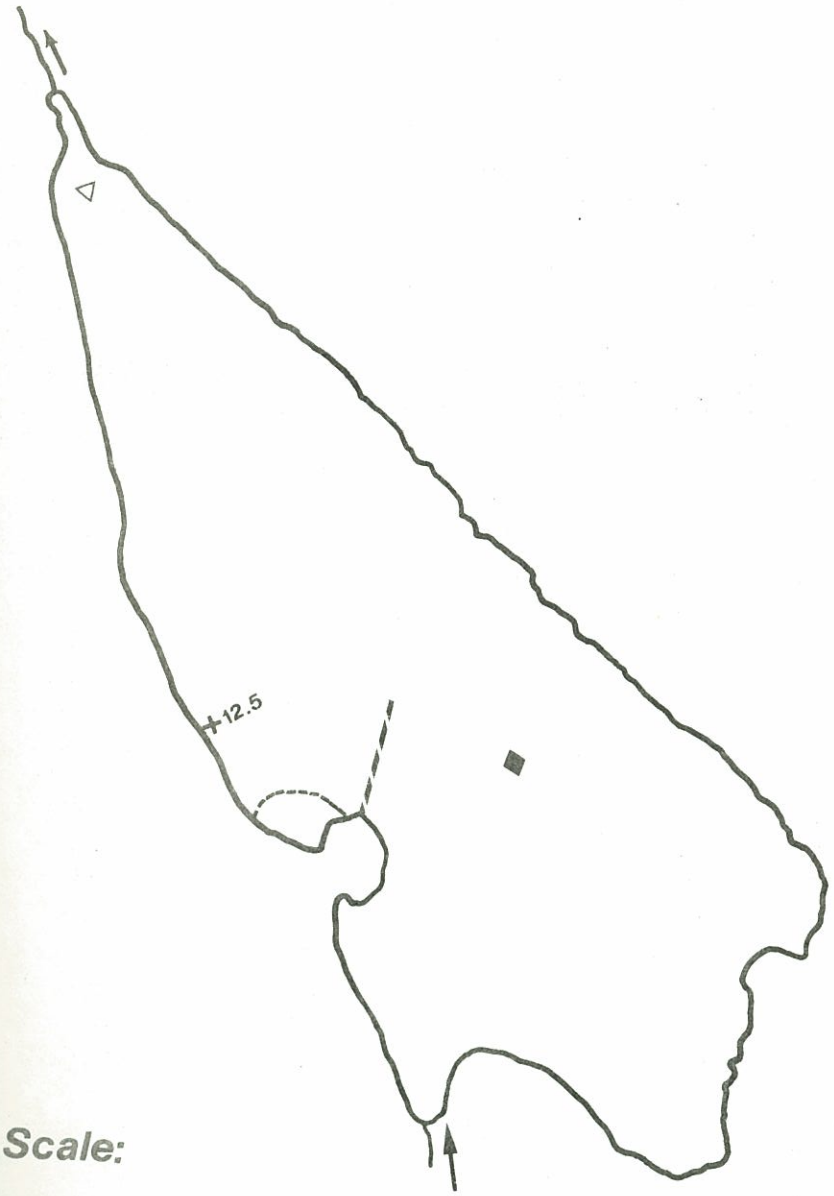


Fig. 12B. Lake 2A6; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 2A6-PUKASKWA NATIONAL PARK

N. 48° 04' 30" & W. 85° 58' 30"



LEGEND:

- Aquatic vegetation
- Bench mark
- Gill net sampling
- Sampling station
- Seine sampling
- Water flow

Scale:

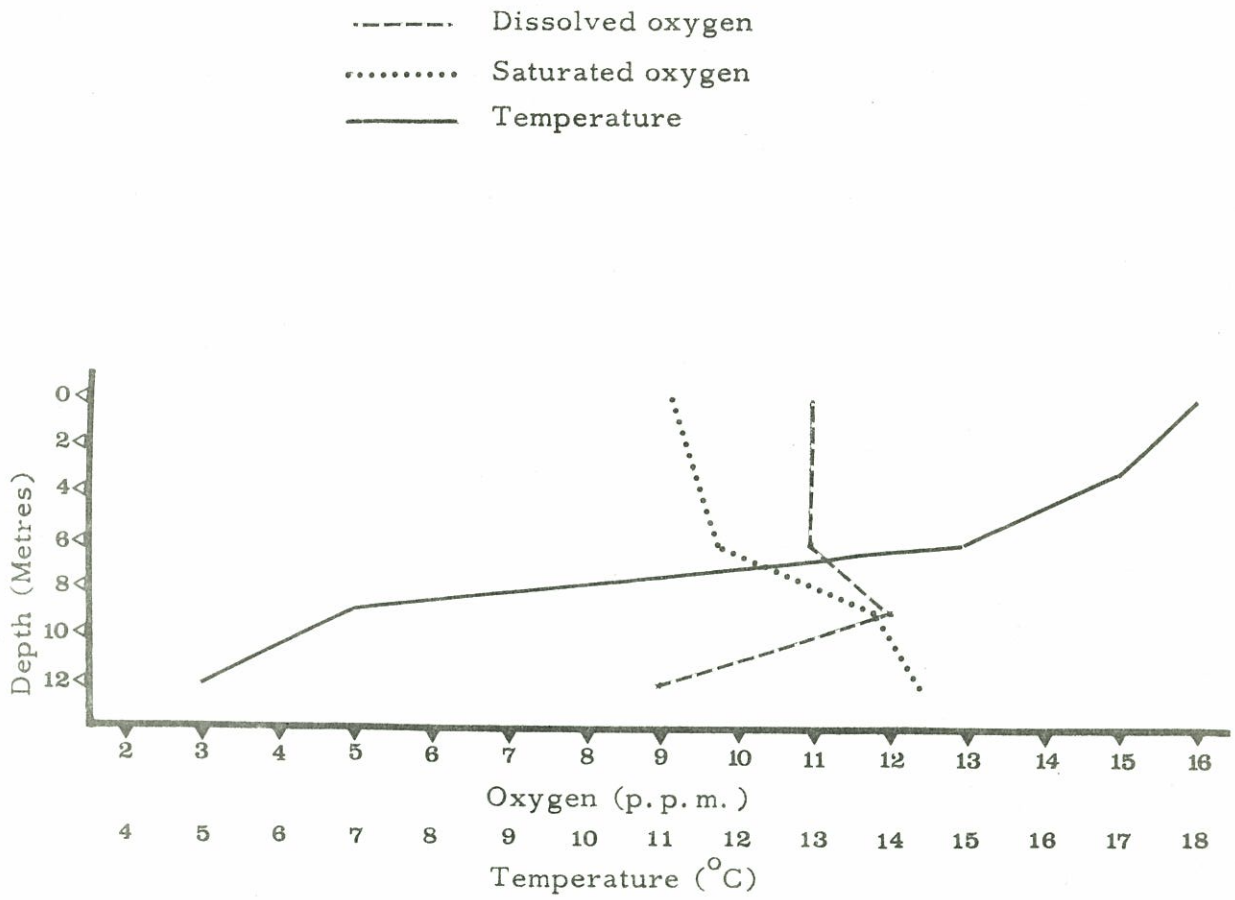


Figure 12C. Oxygen and temperature determinations. Lake 2A6. July 23, 1972.

Lake 2A8

The lake is at the summit of the rocky edge that becomes Otter Head and is the largest deepest lake in that area (Table 2). At the time of the survey there was a small inlet supplying water to the lake at the northwest end and no visible outlet. However, an underground outlet was found where it surfaces about 100 feet from the south side of the lake and flows a short distance into Lake 2A12. During the spring high water period there would probably be an overflow down the same path the underground stream takes.

The lake, which is divided into two basins, (Figures 13A and B) separated by a narrow gap, has a rocky precipitous shore especially around the smaller basin. With a maximum depth of 100 feet (30 metres) and a mean depth of 45 feet (14 metres) it is evident there is very little shallow water littoral zone in relation to the total area of the lake. The water was light brown and clear, with a Secchi disc reading of 16 feet (4.9 metres) (Table 2). The specific conductance determination was 53.6 umhos, suggesting chemical productivity about half as great as was found at Lake 2A6 (Table 1). A broad thermocline was present between the 20 and 27 feet depths (6 and 8 metres). Below that temperatures fell off to a steady 40°F (5°C). The slight warming of the water below the thermocline to the lake bottom probably took place during the spring overturn when there were strong winds. By its location the lake is

exposed to wind particularly from the west or north-west. Oxygen levels were high at all depths (Fig. 13C). Carbon dioxide readings were only 5 p.p.m. at the surface and 7.5 p.p.m. at the bottom.

The number of individuals in the plankton haul was only about one-eighth that taken from Lake 2A6. As in Lake 2A6, copepod nauplii were particularly important as compared to many lakes, forming 32 per cent of the catch. Half (48 per cent) of the catch consisted of three species of calanoids which did not occur in any of the other lakes surveyed. Diaptomus sicilis was the most abundant form identified, Limnocalanus macrurus was common and Senecella calanoides was present in small numbers. Cladocerans formed 19 per cent of the catch and the remainder (2 per cent) were juvenile Cyclops (Tables 4 and 5).

Only four species of fish were caught during gill-netting and seining; lake trout, chub and white suckers were taken in about equal numbers with one ninespine stickleback (Pungitius pungitius). The lake trout were probably planted, but it has not been possible to find a record of the stocking. Old stocking records of the American Can Company were examined and they indicated the lake had been planted with speckled trout, yet none of that species were recovered. The suckers and lake chub now in the lake could have resulted from releases of bait fish by anglers. The outlet stream, even when swollen by the addition of any direct overflow coming from the lake in spring would

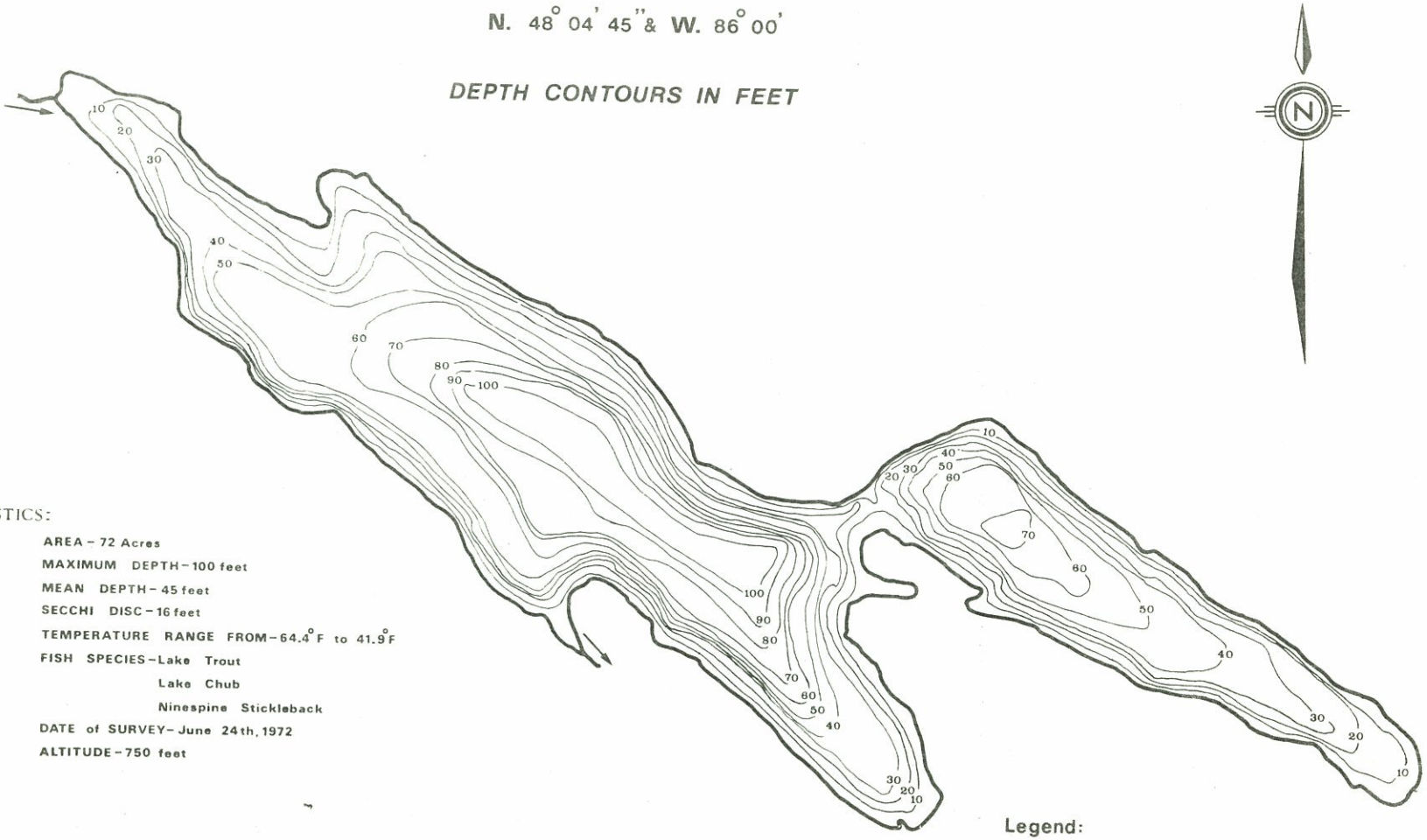
offer a difficult means of entry, since that creek flow consists mostly of a series of low waterfalls throughout its short length. The sticklebacks may have entered the lake naturally, because they are often able to find their way into waters other species cannot reach. They too, could have been introduced by bait fishermen.

Fig. 13A. Lake 2A8; bathymetry, physical features, and fish species.

LAKE 2A8–PUKASKWA NATIONAL PARK

N. 48° 04' 45" & W. 86° 00'

DEPTH CONTOURS IN FEET



CHARACTERISTICS:

AREA – 72 Acres
MAXIMUM DEPTH – 100 feet
MEAN DEPTH – 45 feet
SECCHI DISC – 16 feet
TEMPERATURE RANGE FROM – 64.4°F to 41.9°F
FISH SPECIES – Lake Trout
Lake Chub
Ninespine Stickleback
DATE of SURVEY – June 24th, 1972
ALTITUDE – 750 feet

Legend:

Water flow.....

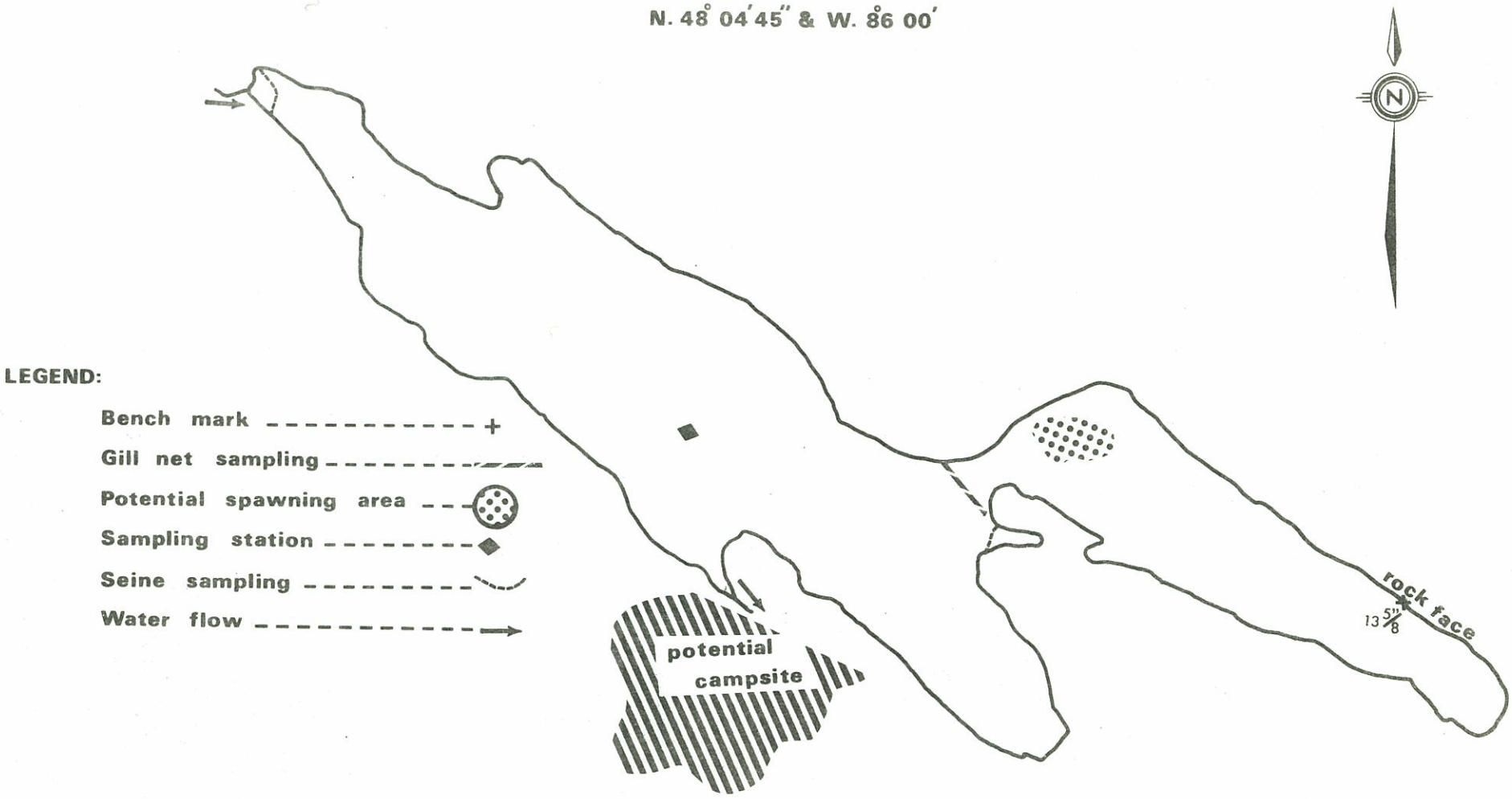
Scale

0 .25 .50 Miles

Fig. 13B. Lake 2A8; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 2A8–PUKASKWA NATIONAL PARK

N. 48° 04′45″ & W. 86° 00′



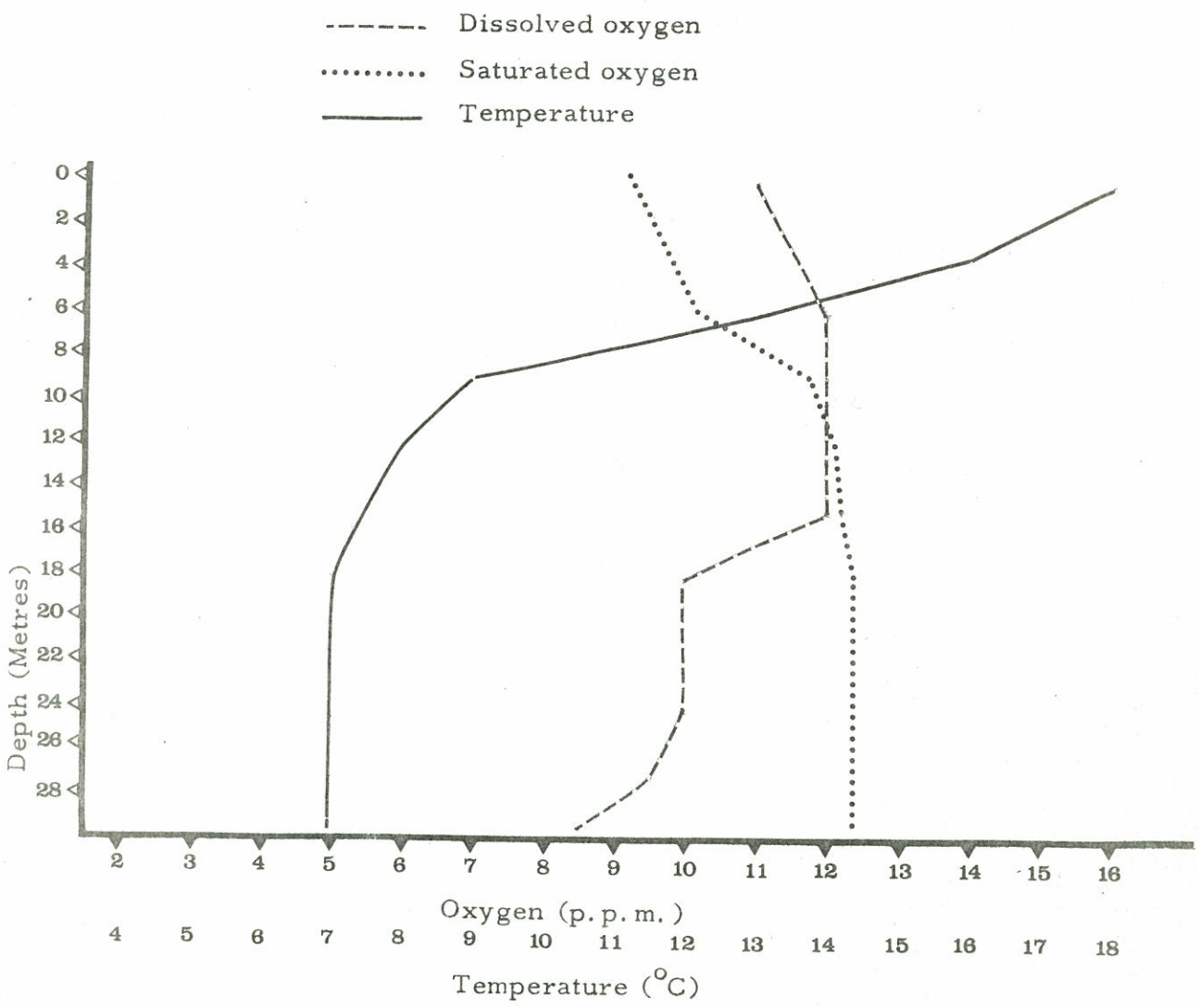


Figure 13C. Oxygen and temperature determinations. Lake 2A8. June 24, 1972.

Lake 2A9

A trail from Deep Harbour follows to this lake, which is one quarter mile west of the north-west end of Lake 2A8. It is a small shallow lake with irregular shores. A small outlet creek exists from the south-west end and flows into Lake 2A10 (Fig. 14A and B).

The water had the least colour found during the surveys, with only a light trace of brown stain (Table 2). It was also clear with a Secchi disc reading of 14 feet (4.3 metres) (Table 1). The specific conductance of 50 umhos indicates that the lake is about average for the Park in chemical productivity potential, but because the extended shores and shallow water increase its potential productiveness relative to its area, it is classified as eutrophic.

The water was too shallow for the formation of a thermocline, and the temperature at the bottom was only $9^{\circ}F$ ($4^{\circ}C$) lower than the surface temperature. Oxygen levels were exceptionally high (Fig. 14C). Some oxygen depletion may occur during winter but the presence of a large fish population indicates that complete stagnation does not happen. Carbon dioxide determinations revealed the concentration to be only 5 p.p.m. at the surface and the lake bottom.

The number of plankton taken was similar to the sample from Lake 2A6 but the proportion of the orders was different between the two lakes. Calanoids and copepod nauplii were equally numerous (35 and

34 per cent respectively). Cladocerans made up 27 per cent, and cyclopoids less than 5 per cent. Daphnia retrocurva, a cladoceran, was found in only this one lake during the survey (Tables 4 and 5).

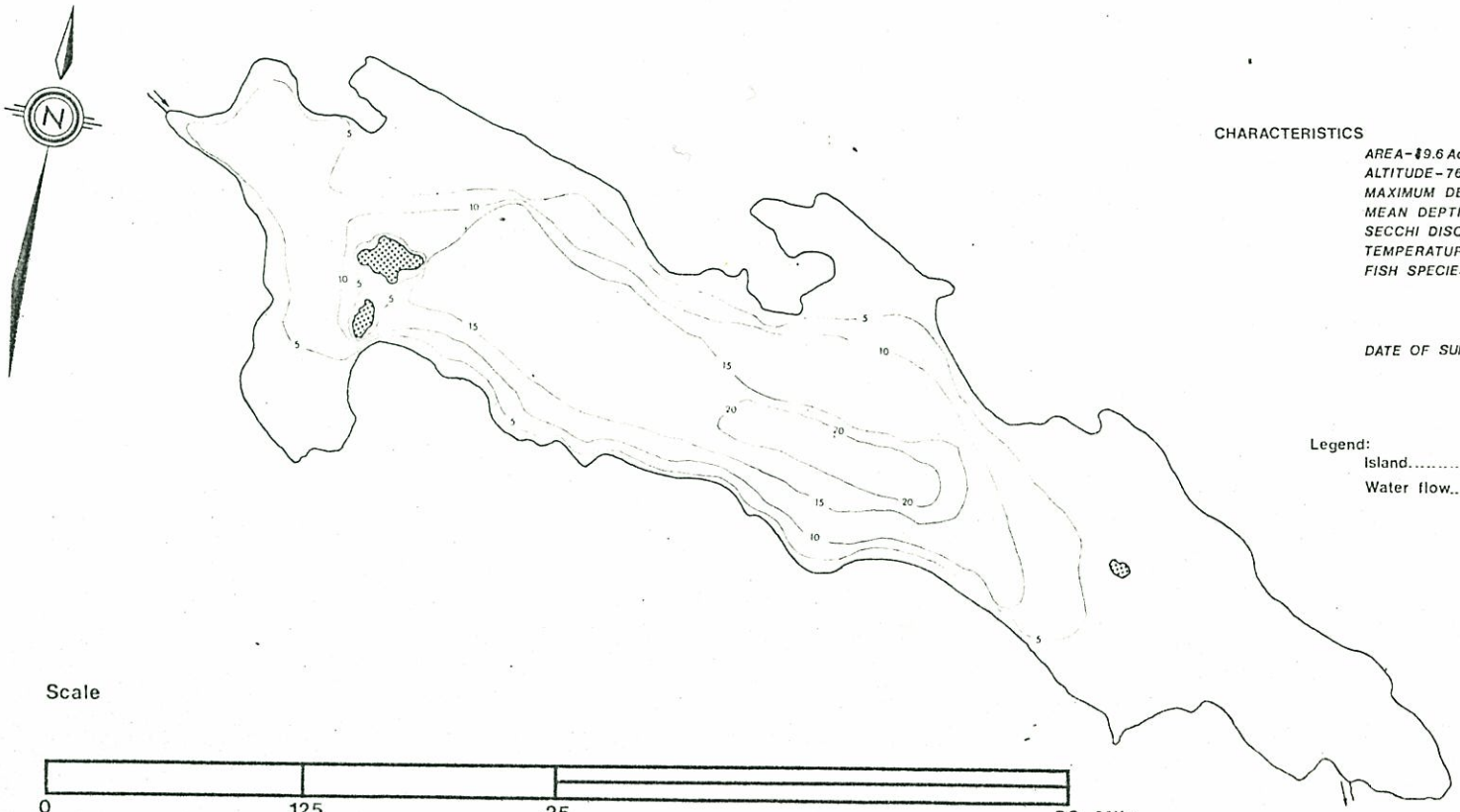
Small perch, all less than 6 inches (18 centimeters), dominated the gill-net catch, but lake chub were taken as well. The Iowa darter was the most numerous species seined but spotted shiners and mottled sculpins were also caught. Speckled trout are precluded from the lake by its shallowness and high summer temperatures.

Fig. 14A. Lake 2A9; bathymetry, physical features, and fish species.

LAKE 2A9-PUKASKWA NATIONAL PARK

N. 48° 4' & W. 86° 0' 30"

DEPTH CONTOURS IN FEET



CHARACTERISTICS

AREA-89.6 Acres
ALTITUDE-761 Feet
MAXIMUM DEPTH-20 Feet
MEAN DEPTH-8.4 Feet
SECCHI DISC-14 Feet
TEMPERATURE RANGE FROM 66°F. TO 59°F.
FISH SPECIES-
Spottail Shiner
Iowa Darter
Yellow Perch
DATE OF SURVEY-June 27th., 1972

Legend:
Island.....
Water flow....

Fig. 14B. Lake 2A9; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 2A9-PUKASKWA NATIONAL PARK

N. 48° 04' W. 86° 00' 30"

LEGEND

- Bench mark +
- Gill net sampling
- Island
- Sampling station
- Seine sampling
- Shoals
- Water flow

Scale:

0 .125 .25 .50 Mile

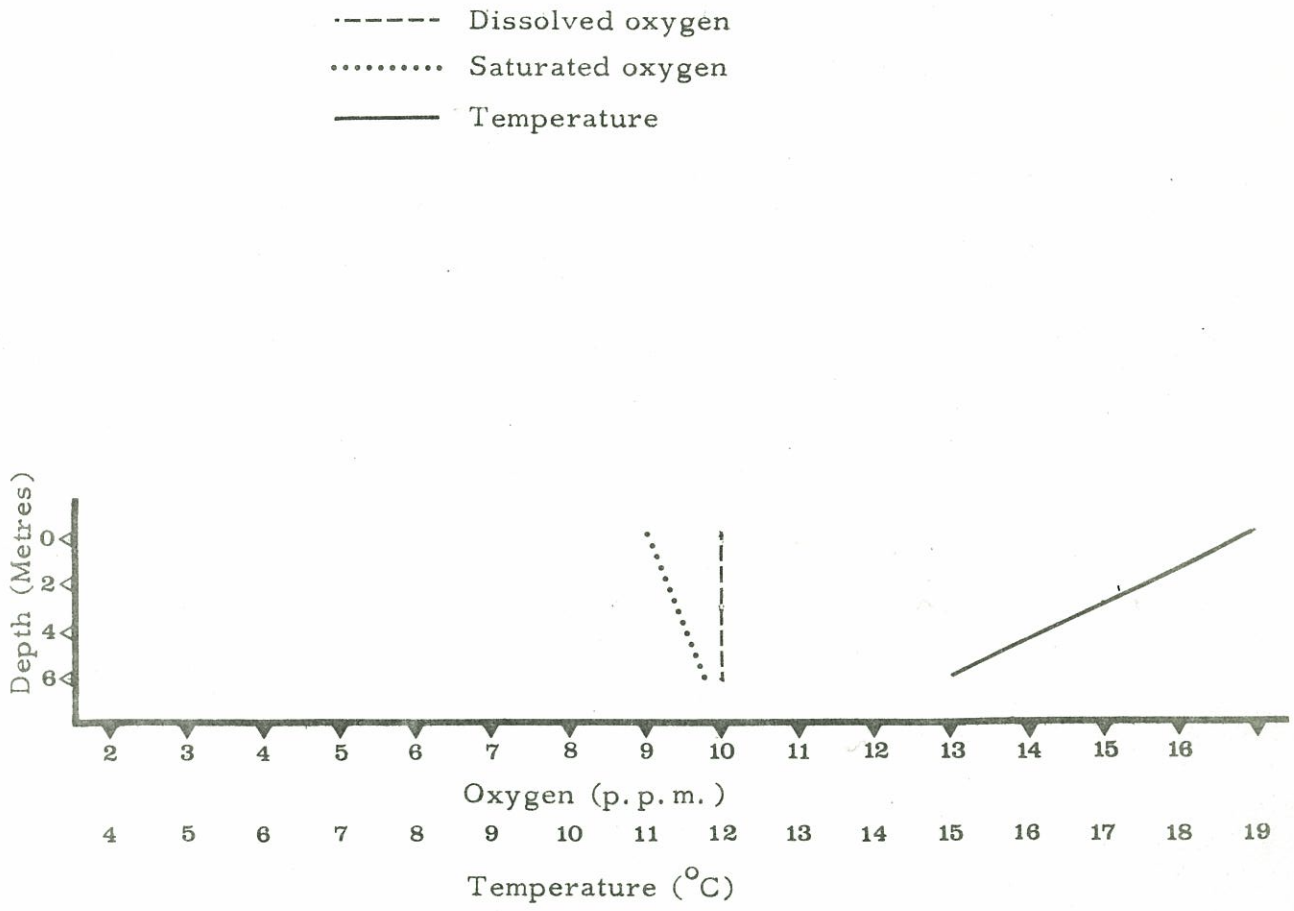


Figure 14C. Oxygen and temperature determinations. Lake 2A9. June 27, 1972.

Lake 2A10

This was a small deep lake about one-eighth mile east of Deep Harbour on the Otter Head peninsula. The outlet creek flows into Deep Harbour adjacent to the start of the trail that leads to the lake (Fig. 15A and B). The shoreline is irregular and rocky, and the depth greater than would be expected from a surface area of 10 acres (4.0 ha). The water colour was light brown and clear with a Secchi disc measurement of 18 feet (5.5 metres) (Table 2). The specific conductance measurement of 59.6 umhos was slightly higher than that for Lake 2A9 (Table 1). However, the total alkalinity measurement was higher also making the chemical productivity measurement of Lake 2A10 slightly below that of 2A9. Depth in relation to the surface area, temperature and oxygen regimes and water chemistry combine to place the lake on the borderline between a mesotrophic and a eutrophic lake. A well-defined narrow thermocline was present between the 13 and 20 feet (4 and 6 metre) which is shallow for late June. The lake is partly sheltered from the influence of the prevailing winds, so there is little water circulation. The warming influence of the air currents are therefore less effective than if the wind blew the length of the lake rather than across it. Below the thermocline temperatures dropped rapidly as did the oxygen concentrations (Fig. 15C). Some stagnation probably developes under the thermocline in late summer, and the storage of oxygen would prevent

the fish population from entering the deeper waters at that time. In a lake like 2A10 that has steep shores and a limited littoral zone, the amount of feeding area available to a fish population can be severely reduced. Some oxygen depletion probably occurs in winter also, but apparently there is enough reserve to maintain the fish population over that period. The carbon dioxide level of 10 p.p.m. at the bottom was not high considering the oxygen level there, suggesting that the bottom sediments are low in decaying organic matter.

The plankton were about half as numerous as those collected at lakes 2A6 and 2A9. Calanoids made up 65 per cent of the sample followed by the cyclopoids (24 per cent) and cladocerans (7 per cent). Unidentified copepod nauplii comprised 4.4 per cent of the sample (Tables 4 and 5).

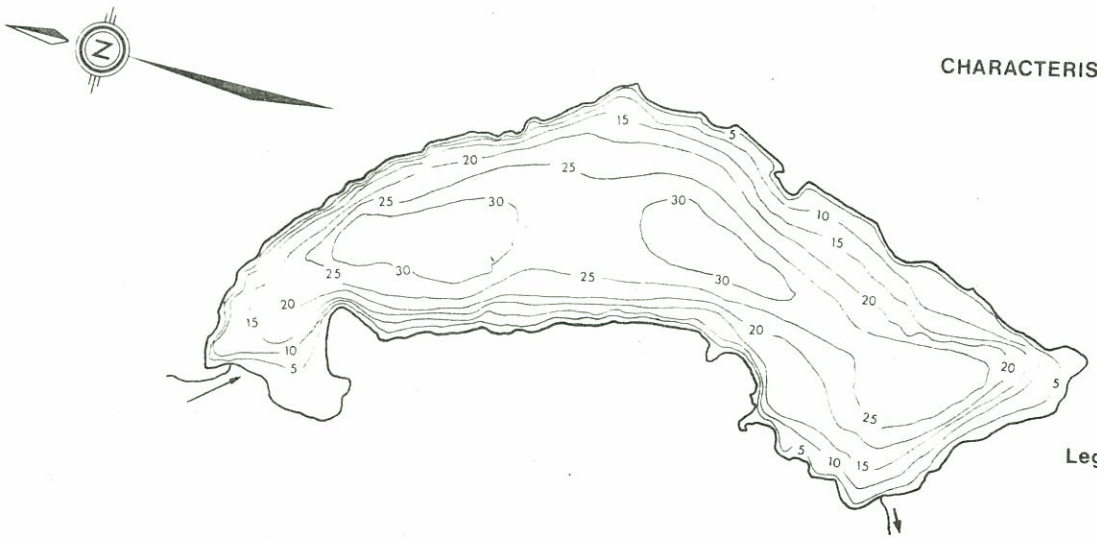
The only fish collected by gill-netting were northern pike and many small perch. The steep rocky shores made it impossible to collect minnow samples with a seine. Probably the same species would have been found as in Lake 2A9 since the two lakes share the same drainage system.

Fig. 15A. Lake 2A10; bathymetry, physical features, and fish species.

LAKE 2A10-PUKASKWA NATIONAL PARK

N. 48° 05' & W. 86° 01'

DEPTH CONTOURS IN FEET



CHARACTERISTICS:

AREA- 10.4 Acres
ALTITUDE- 676 Feet
MAXIMUM DEPTH- 33 Feet
MEAN DEPTH- 21.7 Feet
SECCHI DISC- 18 Feet
TEMPERATURE RANGE FROM 65°F. TO 42°F.
FISH SPECIES-
Northern Pike
Yellow Perch
DATE OF SURVEY- June 26th., 1972

Legend:
Water flow

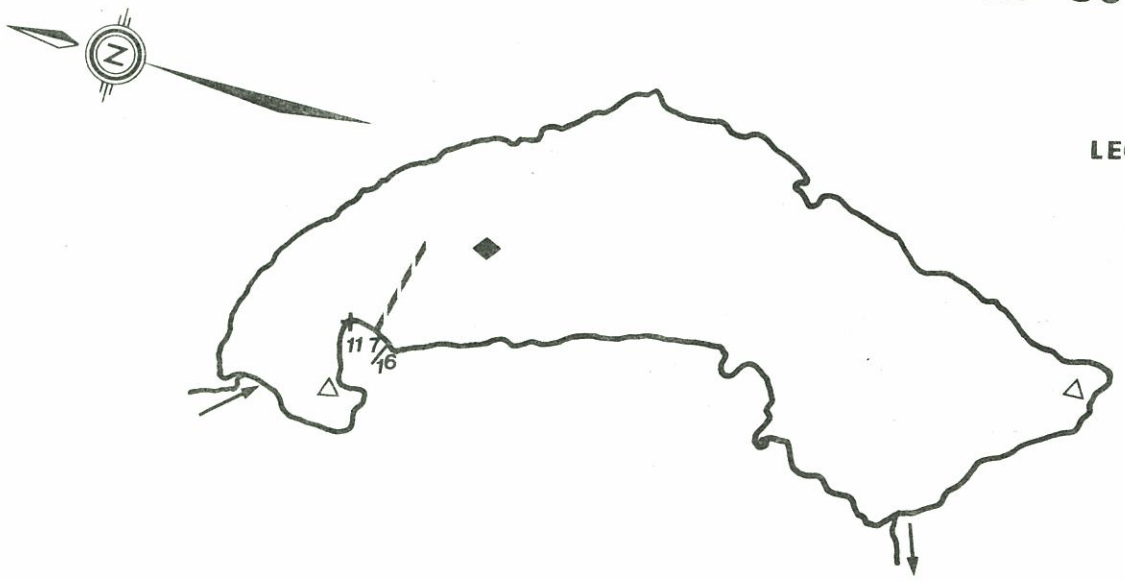
Scale:

0 .125 .25 Mile

Fig. 15B. Lake 2A10, bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 2A10–PUKASKWA NATIONAL PARK

N. 48° 05' & W. 86° 01'



LEGEND:

- Aquatic vegetation . . . △
- Bench mark . . . . . +
- Gill net sampling . . . . . ▰▰▰
- Sampling station . . . . . ◆
- Water flow . . . . . →

Scale:

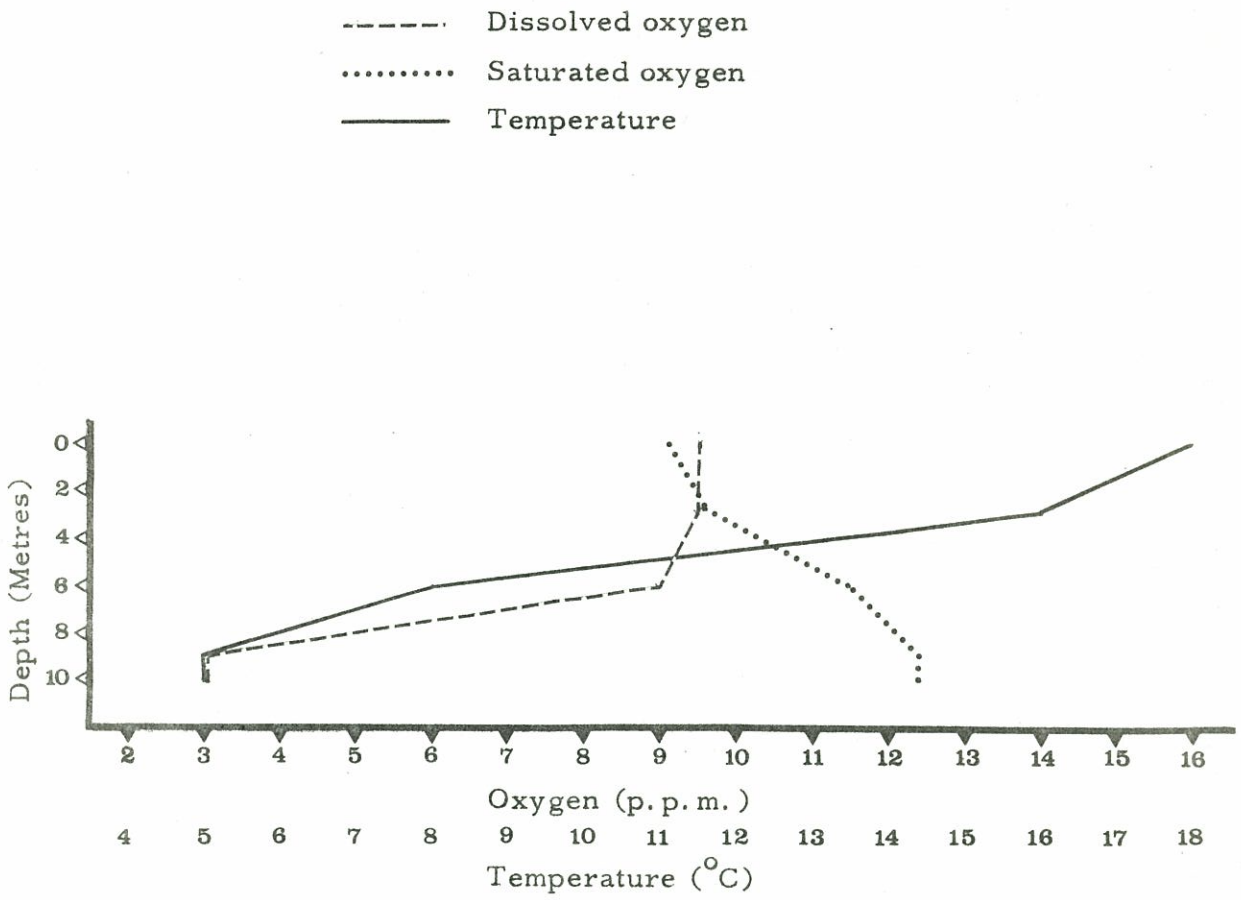


Figure 15C. Oxygen and temperature determinations. Lake 2A10. June 26, 1972.

Lake 2A11

This is a small lake only about 100 feet (30 metres) from the shore of Lake Superior in the Otter Head area. The outlet drops 8 feet (2.5 metres) from the level of the lake to Lake Superior but its short passage is partially blocked by an old beaver dam (Figures 16A and B).

The lake is shallow and markedly irregular in outline. It is sheltered from the wind by thick tree growth and high rocks, hence despite its shallowness it is not turbid, but transparent to the bottom and has light brown water colour (Table 2). It is eutrophic with a specific conductance (55.6 umhos) about average for the area of the Park near the Lake Superior shore (Table 1).

As to be expected in a shallow lake the water warms to the bottom and oxygen levels do not vary greatly (Fig. 16C). Stagnation in winter may be partially alleviated by fresh waters from the inlet creek. Carbon dioxide concentration was low and did not exceed 5 p.p.m.

Relative to the length of the haul the plankton sample was the richest in the number of individuals of the lakes examined. It was the only lake where cladocerans contributed over half the sample (69 per cent). Calanoids formed 21 per cent, copepod nauplii 7 per cent and juvenile Cyclops the remaining 3 per cent. This is the only lake in which the cladoceran, Ceriodaphnia laustis formed more than 5 per cent of the plankton sample.

The only fish caught were one lake chub and several spottail shiners and Iowa darters. The lake is too warm in summer to support trout. The fishes present are small in both size and numbers suggesting that their numbers are periodically reduced by winter stagnation.

Fig. 16A. Lake 2A11; bathymetry, physical features, and fish species.

LAKE 2A11–PUKASKWA NATIONAL PARK

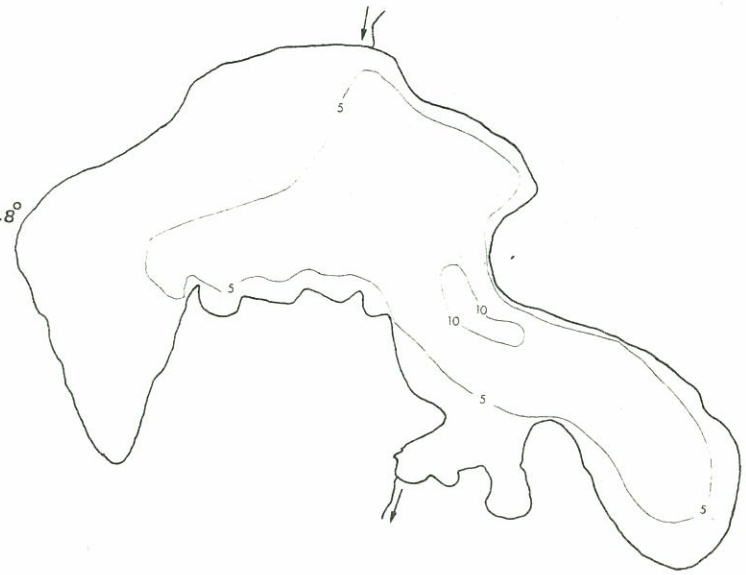
N. 48° 04' 15" & **W.** 86° 00'

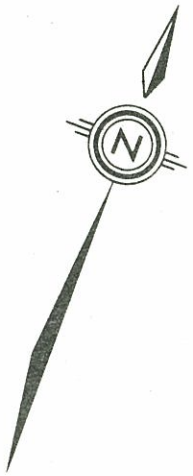
DEPTH CONTOURS IN FEET

CHARACTERISTICS

AREA–17.1 Acres
ALTITUDE– 601 Feet
MAXIMUM DEPTH–10 Feet
MEAN DEPTH–5.5 Feet
SECCHI DISC–10 Feet
TEMPERATURE RANGE FROM 66.2°F. TO 60.8°
FISH SPECIES–
Spottail Shiner
Iowa Darter
DATE OF SURVEY– June 25th., 1972

Legend:
Water flow.....





Scale:

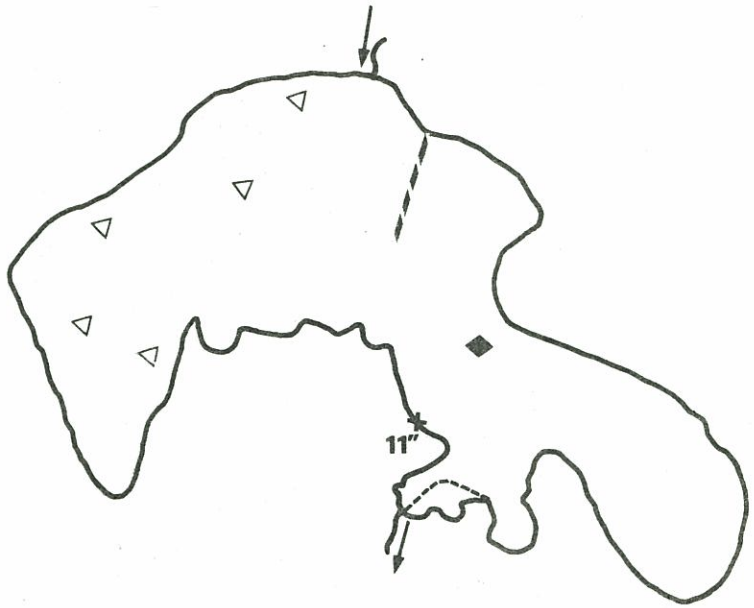
Fig. 16B. Lake 2A11; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 2A11–PUKASKWA NATIONAL PARK

N. 48° 04' 15" & W. 86° 00'

LEGEND:

- Aquatic vegetation. . . △
- Bench mark. . . . . +
- Gill net sampling. . . . .
- Sampling station. . . . . ◆
- Seine sampling. . . . . ~
- Water flow. . . . . ←



Scale:

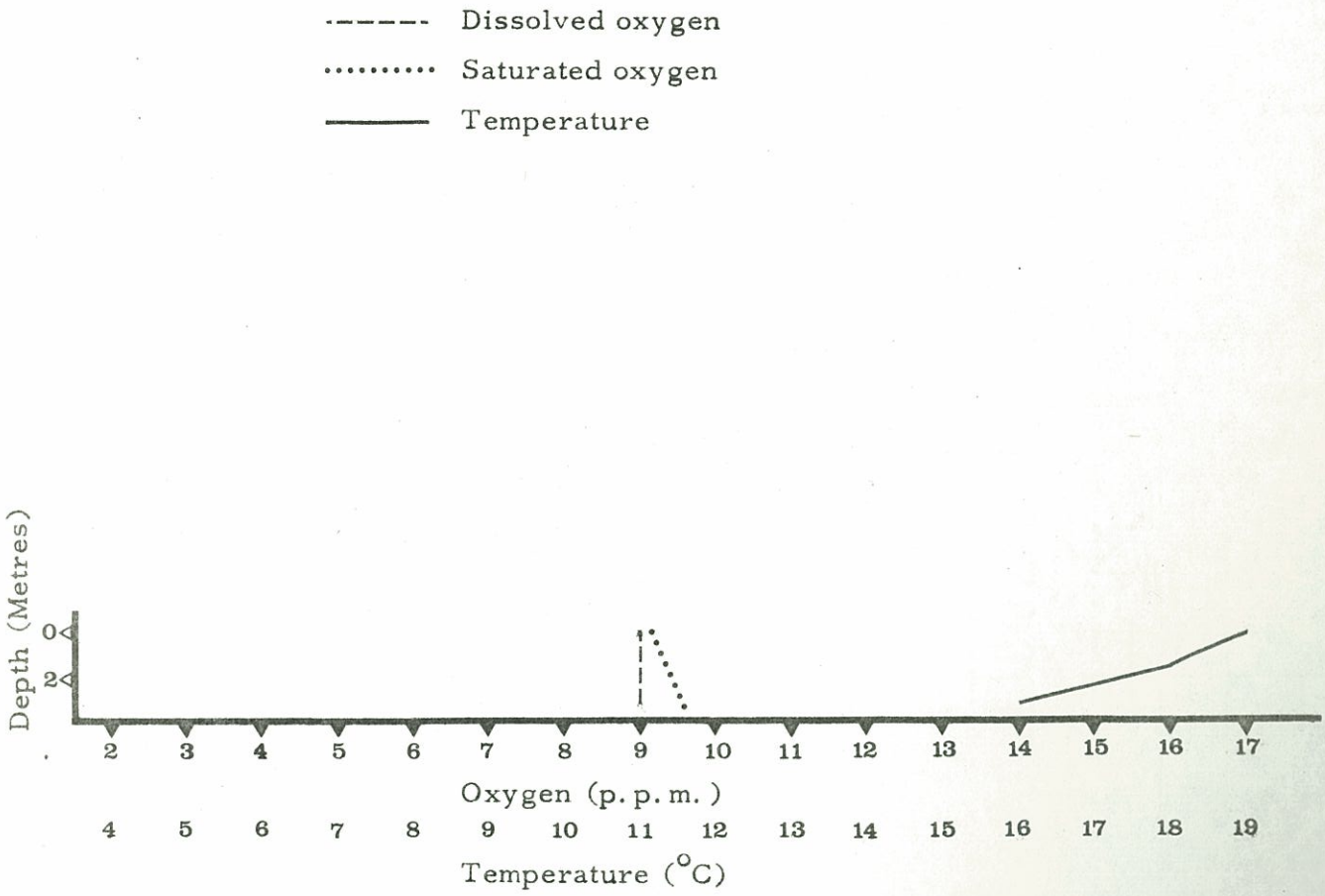


Figure 16C. Oxygen and temperature determinations. Lake 2A11. June 25, 1972.

Lake 2A12

The lake is less than one-quarter mile south of Lake 2A8 and about one-quarter mile inland from Lake Superior. The outlet creek from Lake 2A8 flows into this lake and then continues on into Lake Superior. The last 100 yards of the creek flows through coarse gravel and the creek is not visible when it reaches Lake Superior (Fig. 17A and B).

The lake has a round shape with a regular shoreline and a surface area of slightly less than 5 acres (2.0 ha). It was the smallest lake surveyed in 1972 (Table 2).

The maximum depth was only 11 feet (3.6 metres) but the mean depth of 7.3 feet (2.2 metres) indicated that the shore dropped rapidly. The water in the lake was medium brown although it had flowed from 2A8 where the water was only light brown. This suggests that there must be considerable organic matter on the bottom which increased the colour and turbidity - the Secchi disc reading was only 9 feet (2.7 metres). The specific conductance measurement, 80.0 umhos, was higher than for most lakes including Lake 2A8 (Table 1). Possibly the flow from Lake 2A8 into Lake 2A12 dries up in early summer so that without any dilution effect over a major portion of the year, evaporation has caused the concentration of dissolved salts. Over a period of many years this could result in an increase in the specific conductance. The depth of the lake, temperature and oxygen regimes, and specific conductance classify the lake as eutrophic.

The lake was too shallow for stratification to occur, and there was only a 5°F (2°C) difference between the surface water temperature and the bottom. Oxygen levels were high at all depths (Fig. 17C) and carbon dioxide levels were low, being below 5 p.p.m.

The amount of plankton taken in the sample was small. Unidentified copepod nauplii and calanoids each accounted for about one third of the sample. The remainder consisted of 20 per cent cladocerans and 16 per cent cyclopoids. A species of the latter, Orthocyclops modestus, was found in no other lake surveyed (Tables 4 and 5).

One gill net set for a few hours caught no fish. Seining was attempted but the lake shore was unsuitable for such an operation and no specimens were obtained. No small fish were seen along the shore. However, it is likely that some minnow species live in the lake, unless the inflow ceases during winter and oxygen depletion beneath the ice is severe enough to suffocate any fish that enter.

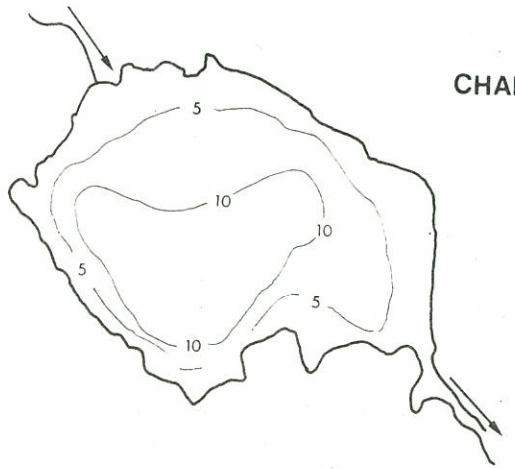
The lake is scenically attractive with some pleasant areas for campground development at both inlet and outlet ends, possibly the most attractive sites in the Otter Head area.

Fig. 17A. Lake 2A12; bathymetry, physical features, and fish species.

LAKE 2A12-PUKASKWA NATIONAL PARK

N. 48° 4' 20" & W. 85° 59'

DEPTH CONTOURS IN FEET



CHARACTERISTICS

AREA-4.8 Acres
ALTITUDE-701 Feet
MAXIMUM DEPTH- 11 Feet
MEAN DEPTH- 7.3 Feet
SECCHI DISC- 9.0 Feet
TEMPERATURE RANGE FROM 64.4°F. to 60.8°F.
FISH SPECIES-
NONE
DATE OF SURVEY- June 25th., 1972

Legend:
Water flow.....

Scale:

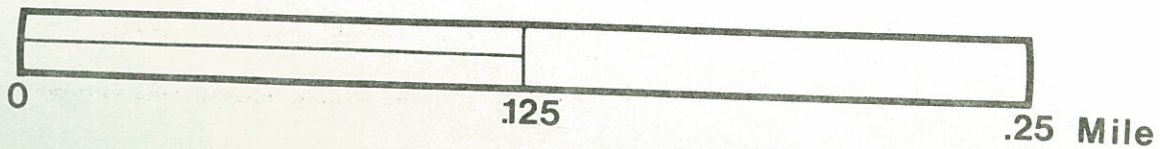
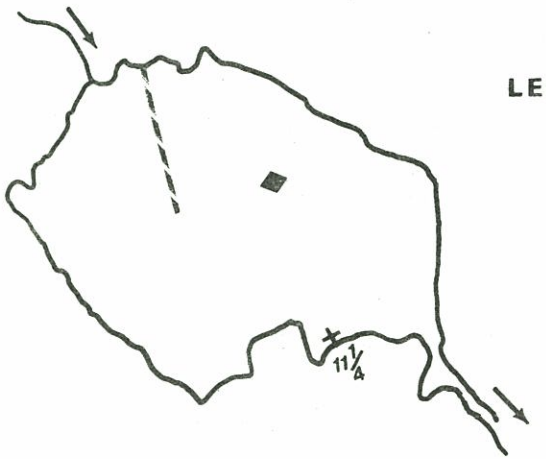


Fig. 17B. Lake 2A12; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 2A12-PUKASKWA NATIONAL PARK

N. 48°04'20" & W. 85° 59'



LEGEND:

Bench mark ------- +

Gill net sampling - - - -

Sampling station - - - - ◆

Water flow - - - - - - - →

Scale:

0 .125 .25 Mile

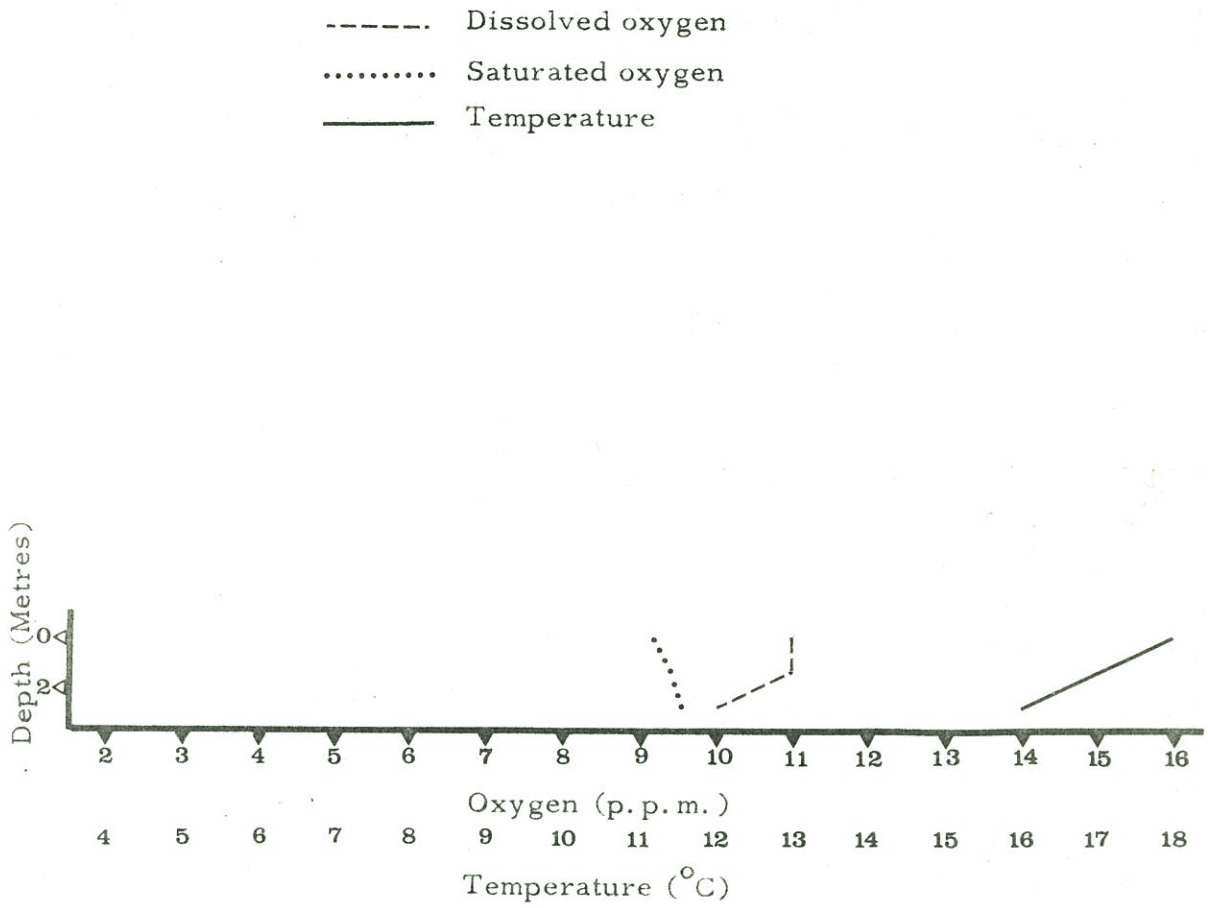


Figure 17C. Oxygen and temperature determinations. Lake 2A12. June 25, 1972.

Lake 2A13

Lake 2A13 is about 600 feet (183 metres) inland from Lake Superior and about one mile up the coast north-west of Tagouche Creek. There is one small inlet creek but no visible outlet. Water could be heard running through the rocks near the beach on Lake Superior adjacent to the lake, so there is probably an underground outlet. The map shows the outlet leading into Tagouche Creek through a slough adjacent to that creek but no outlet could be found there. The stream located in the area where the outlet was shown was flowing into the lake (Fig. 18A and B).

The lake is relatively small and square in shape with one small shallow bay connected to the main body of the lake by a narrow channel. The lake is shallow except for a deep pool at the north end. Most of the lake is transparent to the bottom with a Secchi disc reading of 10 feet (3 metres) (Table 2). The water was stained medium brown and the specific conductance was 59.4 umhos which was average for lakes in the Otter Head area (Table 1).

The surface temperature was warm and near the lake bottom was fairly cool, but no thermocline had developed. The oxygen level (Fig. 18C) near the bottom has fallen to only 18 per cent of saturation indicating only a weak circulation in the deep hole. Carbon dioxide levels were a constant 5 p.p.m. at all depths. Some winter stagnation may occur.

The quantity of plankton was similar to that taken in Lake 2A6. Almost half (46 per cent) of the sample consisted of cyclopoids, about a third (35 per cent) were cladocerans, and the remainder were calanoids (14 per cent) and copepod nauplii (5 per cent). Two oligochaete worms (Nais sp. and Pristina sp.) were found in the residue, probably taken when the plankton net accidentally touched the lake bottom (Tables 4 and 5).

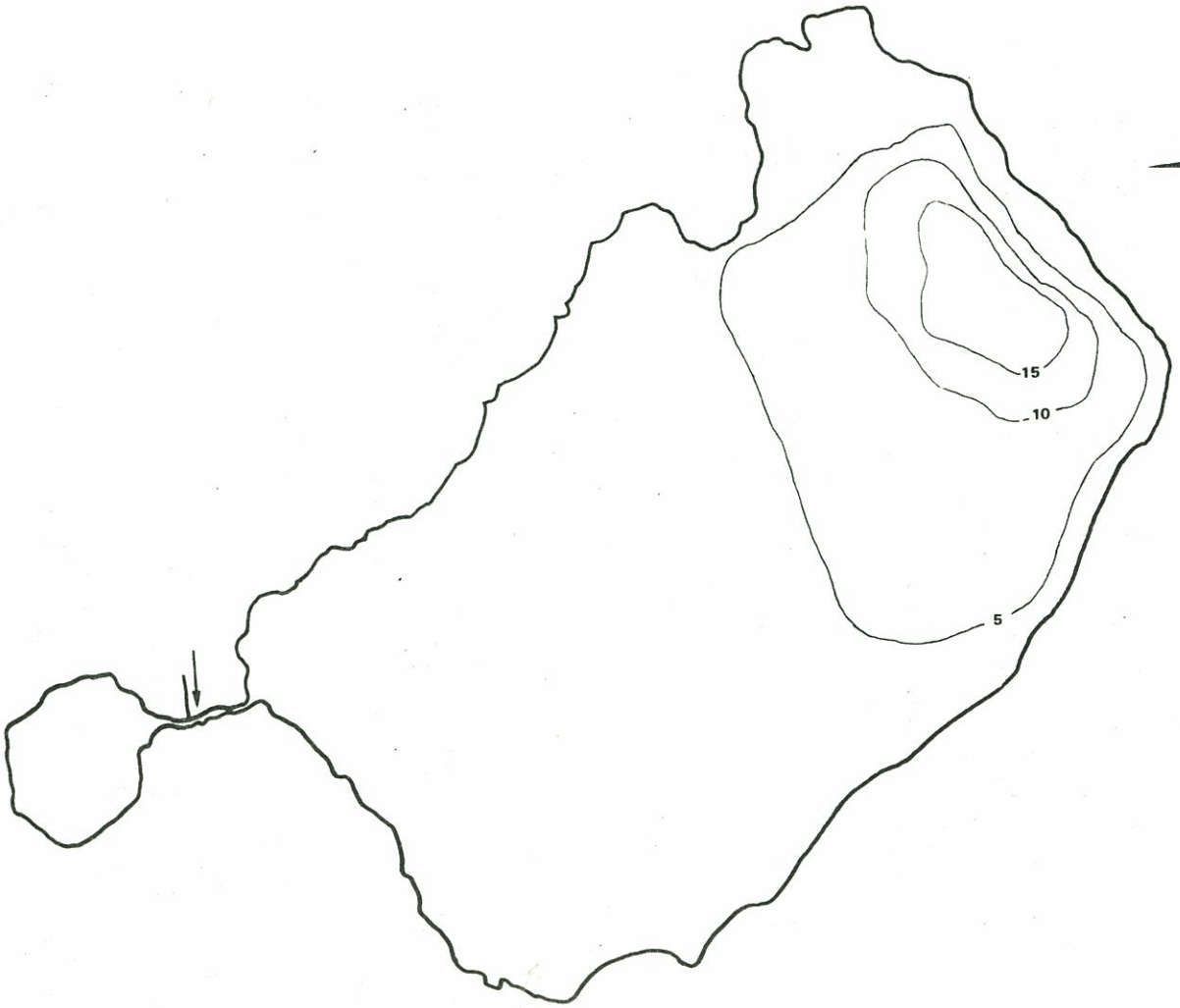
The only fish collected were small yellow perch. The lake and surrounding area are known favourite haunts of moose.

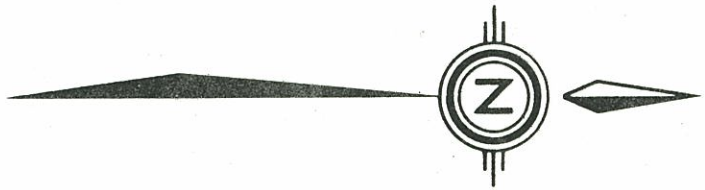
Fig. 18A. Lake 2A13; bathymetry, physical features, and fish species.

LAKE 2A13 – PUKASKWA NATIONAL PARK

N. 48° 4' 5" & W. 85° 57'

Depth Contours in Feet





CHARACTERISTICS:

AREA – 15.6 ACRES
ALTITUDE – 676 FEET
MAXIMUM DEPTH – 18 FEET
MEAN DEPTH – 6 FEET
SECCHI DISC – 10 FEET
TEMPERATURE RANGE FROM 68° F. TO 50° F.
FISH SPECIES – YELLOW PERCH
SURVEYED JULY 8, 1972.

Legend:

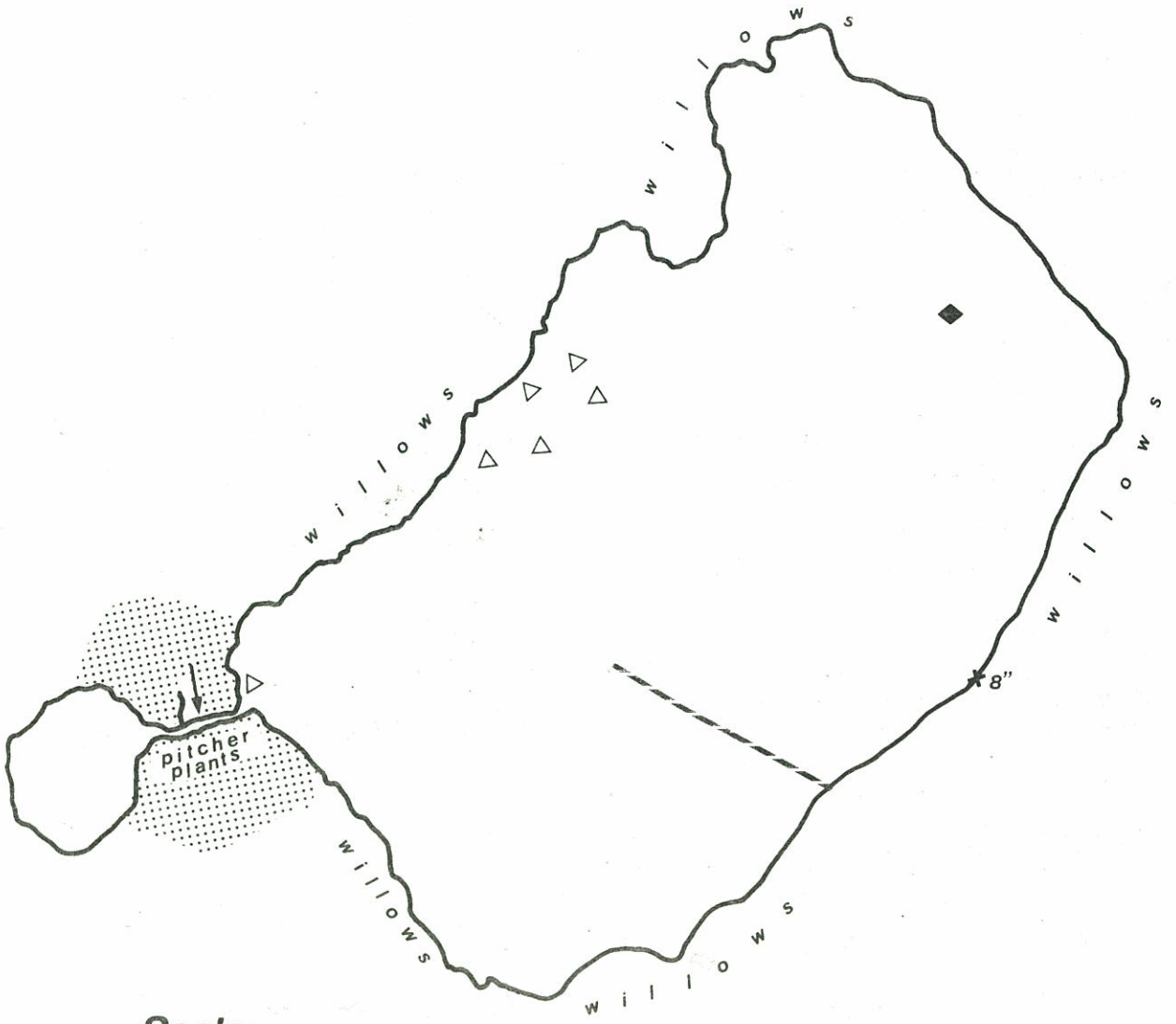
Direction of water flow:

Scale:

Fig. 18B. Lake 2A13; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 2A13-PUKASKWA NATIONAL PARK

N. 48° 4' 5" & W. 85° 57'



LEGEND:

- Aquatic vegetation - - - △
- Bench mark - - - - - - - - +
- Gill net sampling - - - ▰▰▰
- Sampling station - - - - ◆
- Swampy area - - - - - -
- Water flow - - - - - - - ←

Scale:

0 .125 .25 Mile

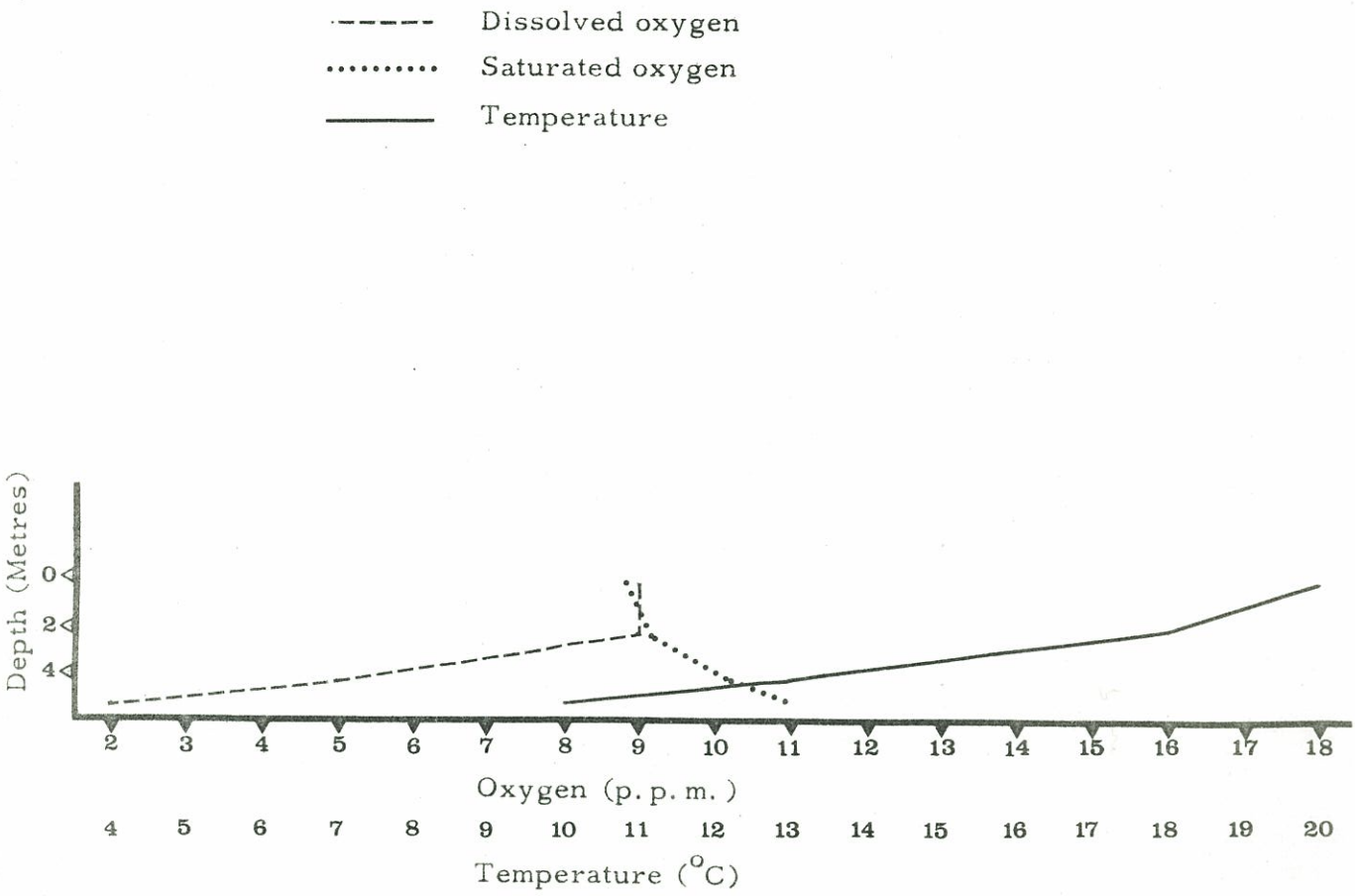


Figure 18C. Oxygen and temperature determinations. Lake 2A13. July 8, 1972.

Lake 3A50

This small lake is about one-quarter mile inland from Lake Superior into which it drains direct by a small creek; however, an old beaver dam partially blocks the exit of the creek from the lake (Fig. 19A and B).

The lake is deep for its surface area and has only a narrow littoral area. The water was coloured medium brown but was clear with a Secchi disc reading of 14 feet (4.3 metres) (Table 2). The specific conductance of 61.3 umhos was about average for lakes in the Otter Bay region, but the lake rated low in the productivity index because of its low total alkalinity measurement of 9 p.p.m. (Table 1).

Between 13 and 23 feet (4 and 7 metre) levels there was a broad thermocline below which there was considerable cooling of the water to the lake bottom. The oxygen readings were high (Fig. 19C) but later in the summer there would be depletion of the reserves, and in winter some stagnation would occur in deep water. The carbon dioxide concentration (10 p.p.m.) at the bottom would also probably increase during the summer as oxygen levels below the thermocline decreased. The lake can be classified as eutrophic.

The plankton sample had a similar number of individuals as taken from Lake 2A6 but with a different proportion of groups. The sample was dominated by calanoids (41 per cent), and the rest of the samples was

equally divided between cyclopoids (19 per cent), cladocerans (21 per cent) and copepod nauplii (19 per cent). The cladoceran sample included Leptodora kindtii and Ceriodaphnia lacustris, both rare species (Table 4 and 5).

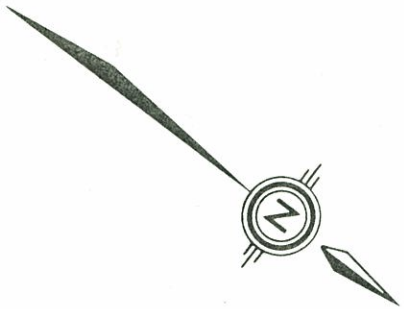
The only fish caught were yellow perch, white suckers and spottail shiners. No trout were seen although the lake is suitable for them It is not a productive lake because of the limited littoral zone and low total alkalinity, but it could provide some angling. The small inlet creek has some spawning areas suitable for trout, providing it runs all year. It is such a small stream it may dry up in late fall or freeze in winter. On the edge of the lake by the inlet stream is an attractive camp-site suitable for five or six tents on an old logging camp area. Along the outlet creek is a trail giving easy access to the lake.

Fig. 19A. Lake 3A50; bathymetry, physical features, and fish species.

Lake 3A50–Pukaskwa National Park

N. 48° 07' 25" & W. 86° 01' 45"

Depth Contours in Feet



CHARACTERISTICS:

AREA–10.3 Acres

MAXIMUM DEPTH–38 feet

MEAN DEPTH–20 feet

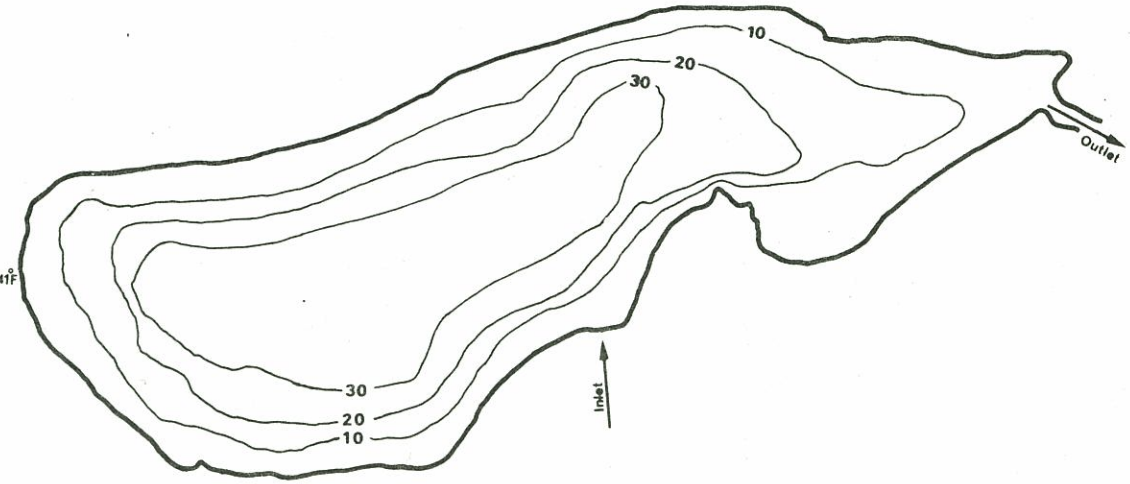
SECCHI DISC–15 feet

TEMPERATURE RANGE FROM 65°F to 41°F

FISH SPECIES–Yellow Perch
Spottail Shiner
White Sucker

ALTITUDE– 650 feet

DATE OF SURVEY–July 5th., 1972



Scale:

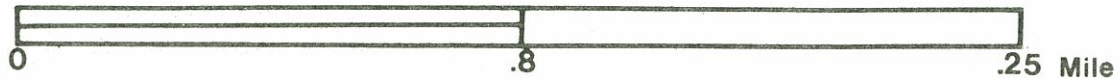
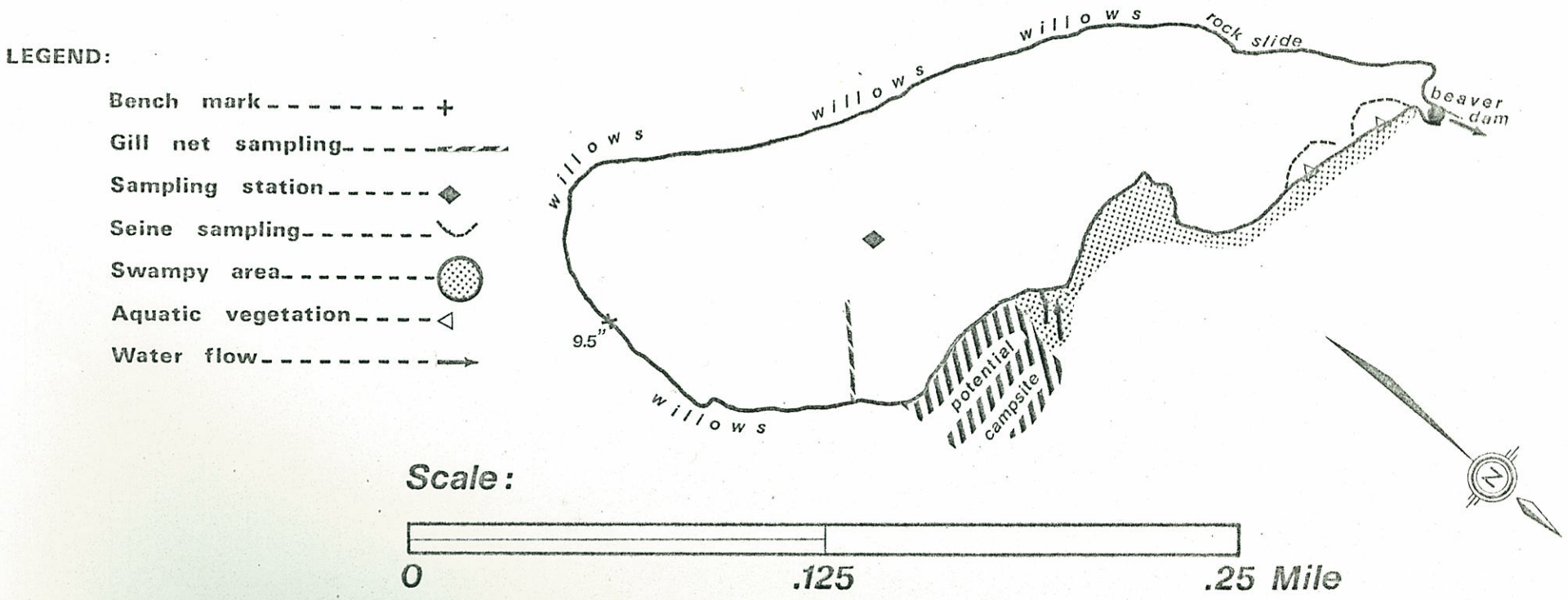


Fig. 19B. Lake 3A50; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 3A50-PUKASKWA NATIONAL PARK

N. 48° 07' 25" & W. 86° 01' 45"



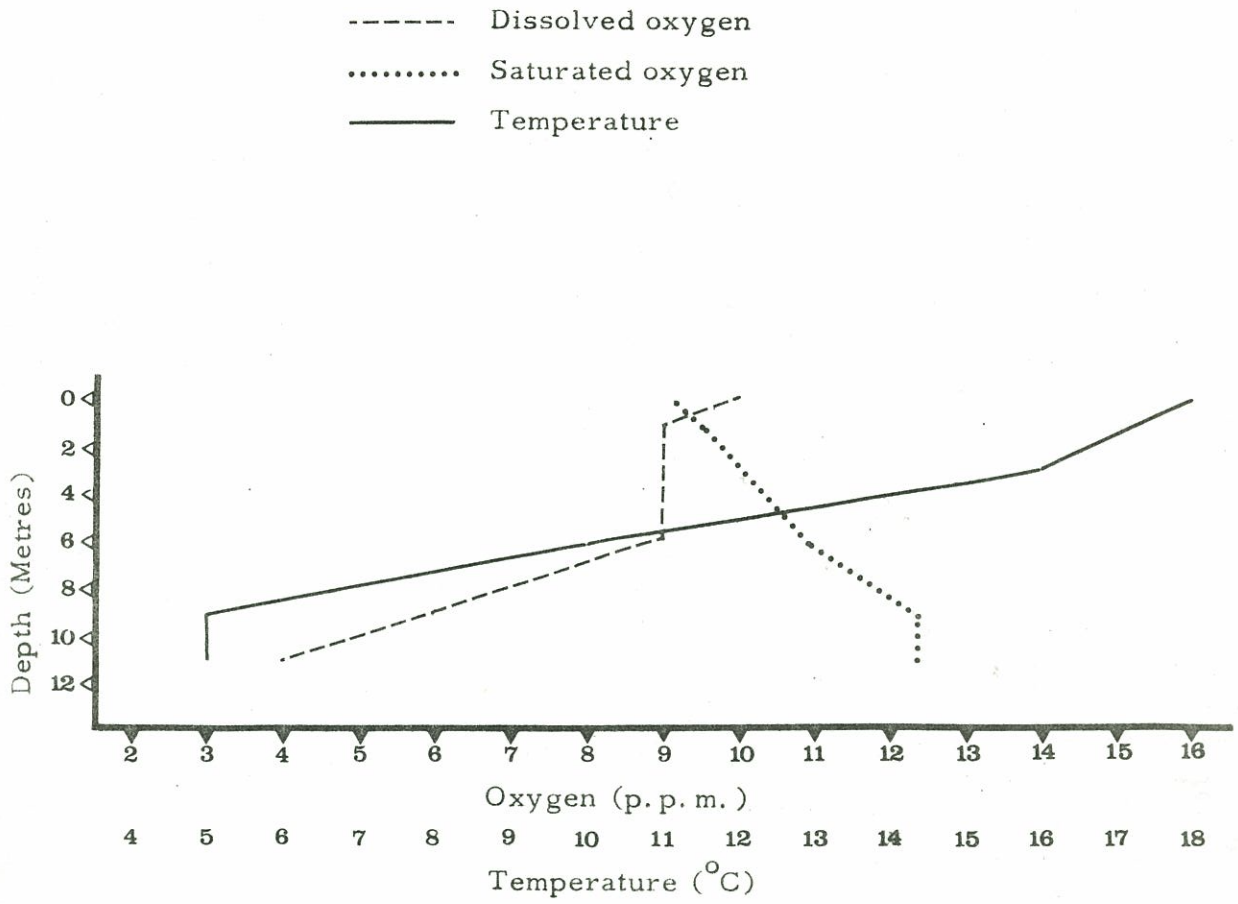


Figure 19C. Oxygen and temperature determinations. Lake 3A50. July 5, 1972.

Lake 3A51

Like most of the lakes in the Otter Cove area Lake 3A51 is a long narrow lake lying in a north-west south-east direction. The lake is one-quarter mile east of Lake 3A50 and one-half mile from the Lake Superior shore.

The lake is divided into two basins connected by a shallow narrow channel (Fig. 20A and B). The north basin is about half the size and not as deep as the south basin. Although the larger basin has a greater maximum depth, the deep area is restricted to the south end leaving half the basin less than 10 feet (3 metres) deep. The small outlet creek flows into Lake 3A50 while one of the inlet creeks comes from Lake 2A2. Where the outlet leaves the lake there is an old beaver dam.

The water was a coloured darker brown than all lakes examined except Cascade Lake. The water was relatively clear with a Secchi disc reading of 11 feet (3.4 metres) (Table 2). The specific conductance was 65.3 umhos, slightly above the mean for the lakes studied in the Park (Table 1). The alkalinity reading of 18.4 p.p.m. was double that of Lake 3A50, which gave Lake 3A51 a much higher productivity rating than Lake 3A50. The lake is classed as eutrophic. A very well-defined narrow thermocline was present between the 12 and 18 feet (4 and 6 metre) depths, below which there was no warming to the lake bottom. The oxygen level (Fig. 20C) below the thermocline was only 15.9 per

cent of saturation, hence fish would not occupy the area of the lake below the 20-foot contour. In Lake 3A51 that is not a large part of the lake.

The carbon dioxide reading of 15 p.p.m. in the deeper water would also tend to reinforce the low oxygen concentration in repelling fish from the water. High carbon dioxide levels inhibit a fish's ability to use oxygen otherwise available to it.

The volume of the plankton sample caught was not exceptional. Cyclopoids and calanoids, 45 and 40 per cent respectively, dominated the catch. Cladocerans (10 per cent) and copepod nauplii (5 per cent) made up the remainder (Tables 4 and 5).

Only the seine net caught any fish and this catch was only one blacknose shiner and five small suckers. The netting suggests that the total fish population is small and that if perch have reached the lake their population also must be low. If perch are absent trout could survive in the lake but would be unlikely to maintain their numbers by natural reproduction.

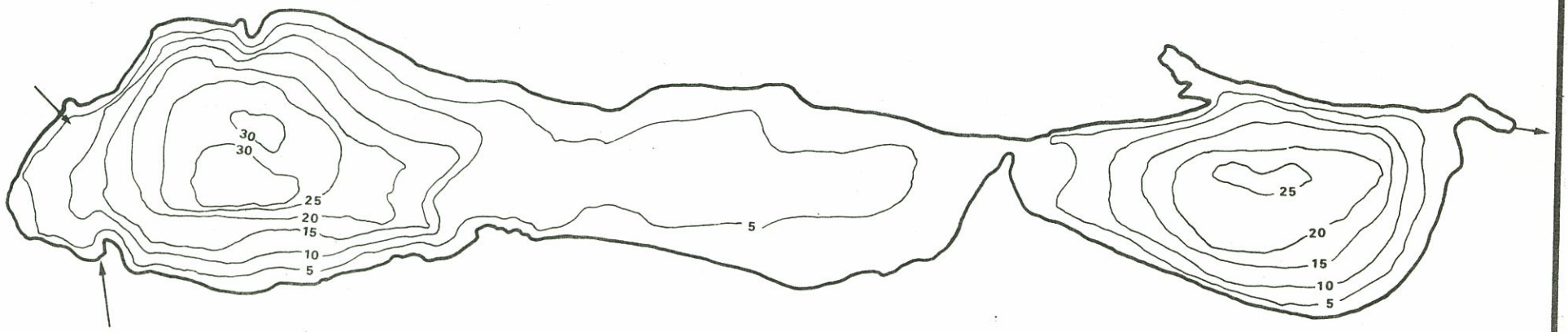
The large shallow area on the north end of the larger basin had scattered yellow bullhead lilies over most of it. They may increase in numbers later in the season. There were many larger flag iris (Iris versicolor) around the north shore of the lake. The point that separates the two basins at the narrows is sandy and might serve as a beach for swimmers. Also, a good level campsite area is available at the outlet end of the lake.

Fig. 20A. Lake 3A51; bathymetry, physical features, and fish species.

Lake 3A51-Pukaskwa National Park

N. 48° 07' 25" & W. 86° 01'

Depth Contours in Feet



Legend:

Water flow

CHARACTERISTICS:

AREA- 17.7 acres

MAXIMUM DEPTH- 30 feet

MEAN DEPTH- 12 feet

SECCHI DISC- 11 feet

TEMPERATURE RANGE FROM 66.2°F to 39.2°F

FISH SPECIES-
Blacknose Shiner
White Sucker

ALTITUDE- 700 feet

DATE of SURVEY- July 6th., 1972

Scale:

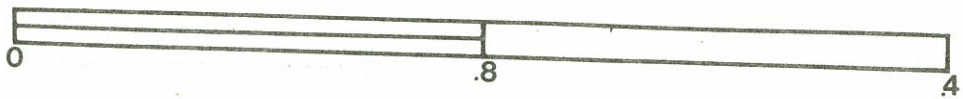
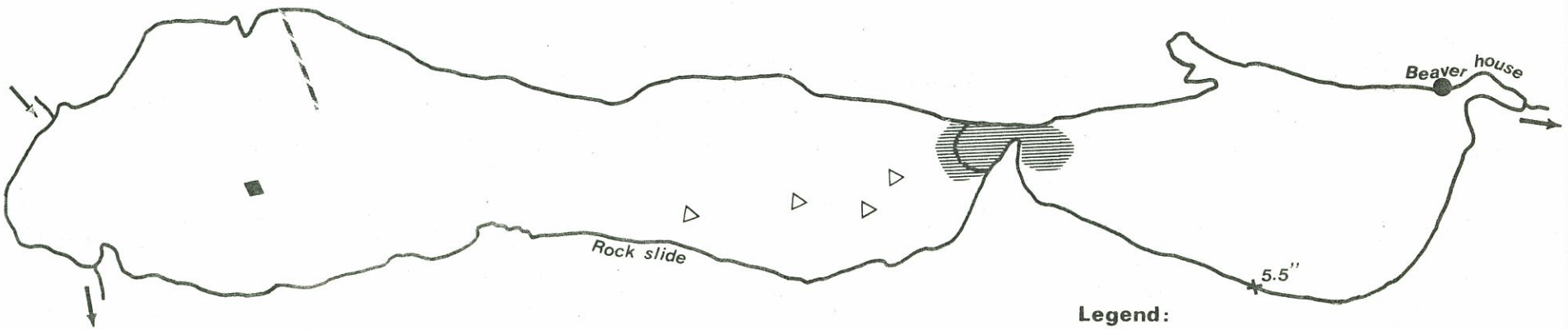


Fig. 20B. Lake 3A51; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 3A51-PUKASKWA NATIONAL PARK

N. 48° 07′ 25″ & W. 86° 01′



Legend:

- Bench mark ×
- Gill net sampling
- Sampling station
- Seine net sampling
- Shallow with beach
- Aquatic vegetation
- Water flow

Scale:

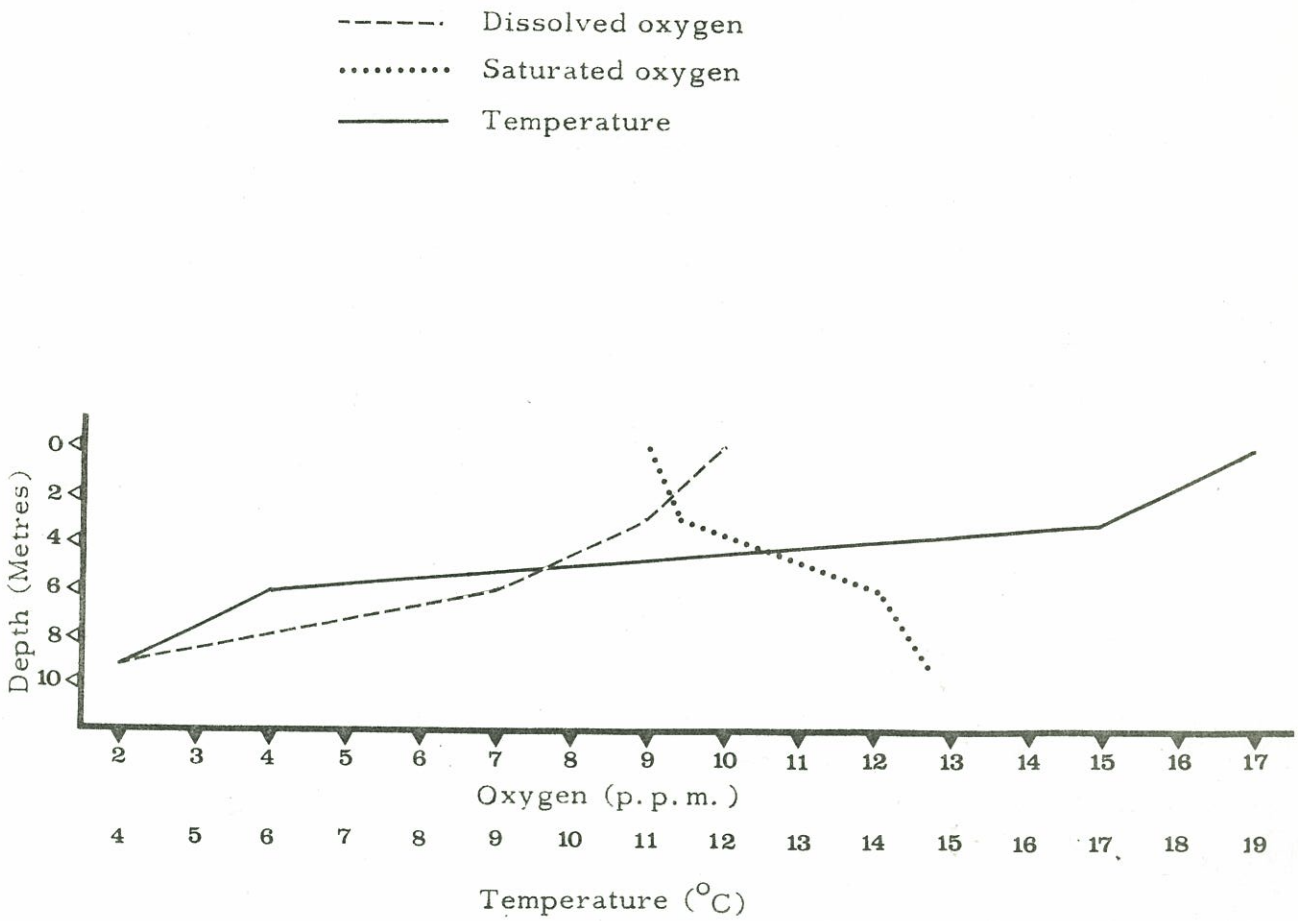


Figure 20C. Oxygen and temperature determinations. Lake 3A51. July 6, 1972.

Lake 4B69

The lake is small and deep with an irregular shoreline including one large island. It is about one-and one-half miles directly north of the mouth of the Swallow River into which it drains. There is an active beaver dam blocking the outlet which raises the water level in the lake by 3 feet (one metre).

Relative to its surface area the lake is deep with steep shores so that only in the two large bays at the south end is there a littoral zone (Fig. 21A and B).

The colour of the water was a very light brown. It was clear with a Secchi disc reading of 14 feet (4.3 metres) (Table 2). The specific conductance was 38.5 umhos which was considerably lower than the average for other lakes near the Lake Superior coast. That, coupled with a total alkalinity of only 5 p.p.m. and a sum of constituents value of only 21.6 p.p.m. placed Lake 4B69 lowest in the lake productivity evaluations for Park lakes surveyed in 1972 (Table 1). The low productivity and other related factors place the lake in the oligotrophic class.

The quantity of plankton obtained in the 57-foot total vertical haul was about average for the lakes in the Park. Most of the sample (44.6 per cent) were cyclopoids, with calanoids contributing 32.7 per cent and cladocerans 19.0 per cent. Copepod nauplii made up 3.8 per cent of the catch. Only a few species were present. The cyclopoids

were all either Cyclops bicuspidatus thomasi or unidentified juvenile Cyclops species (Tables 4 and 5).

The overnight gill net caught a few speckled trout, yellow perch, and cisco. Only yellow perch were taken in the seine net. Lake 4B69 was the only lake examined where yellow perch and speckled trout were found together. The only speckled trout taken were specimens of good size over two pounds (1 kilogram) in weight, and the perch too were larger than any captured elsewhere, running up to 8 inches (25 centimetres) in length. No trout spawning ground could be located, but there may be spring-fed areas at the south end of the lake where a limited amount of spawning takes place. There seems to be a greater outflow of water than there is inflow entering by the one inlet stream found. Perch were numerous, and attempts to angle for trout were constantly frustrated by the perch attacking the bait or lure. Before perch were introduced the lake was probably exceptionally fine for trout.

The lake was accessible from a trail that starts about two-and-one half miles north-west along the Lake Superior coast from the mouth of the Swallow River and follows the outlet creek to Lake 4B69.

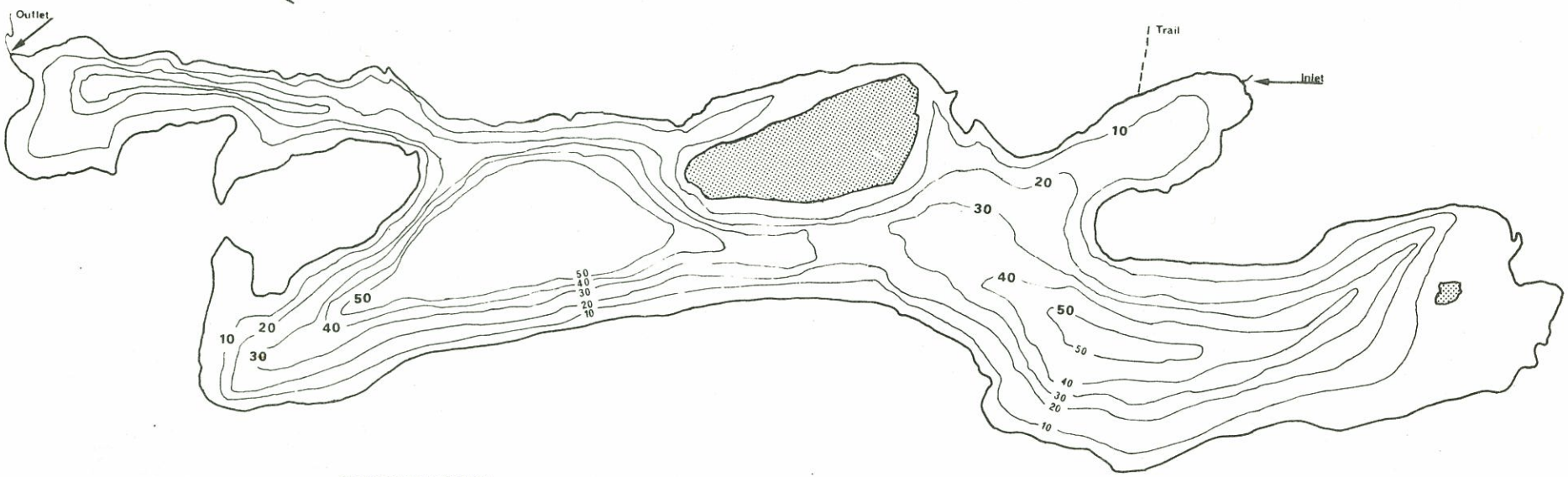
The survey party observed a caribou swimming to the island. From discussion with N. Mishano, it was our impression that caribou are commonly found in the area around the mouth of the Swallow River.

Fig. 21A. Lake 4B69; bathymetry, physical features, and fish species.

LAKE 4B69-PUKASKWA NATIONAL PARK

N. 48° 11' 75" & W. 86° 05' 20"

DEPTH CONTOURS IN FEET



CHARACTERISTICS:

Area-15.2 acres
Altitude-750 feet
Max. depth-57 feet
Mean depth-26 feet
Secchi Disc-14 feet
Temperature range from 66.2°F to 41.0°F
Fish species - Eastern Brook Trout
- Yellow Perch
- Shallow water Cisco
Date of survey- July 9th., 1972

LEGEND:

Island

Water flow

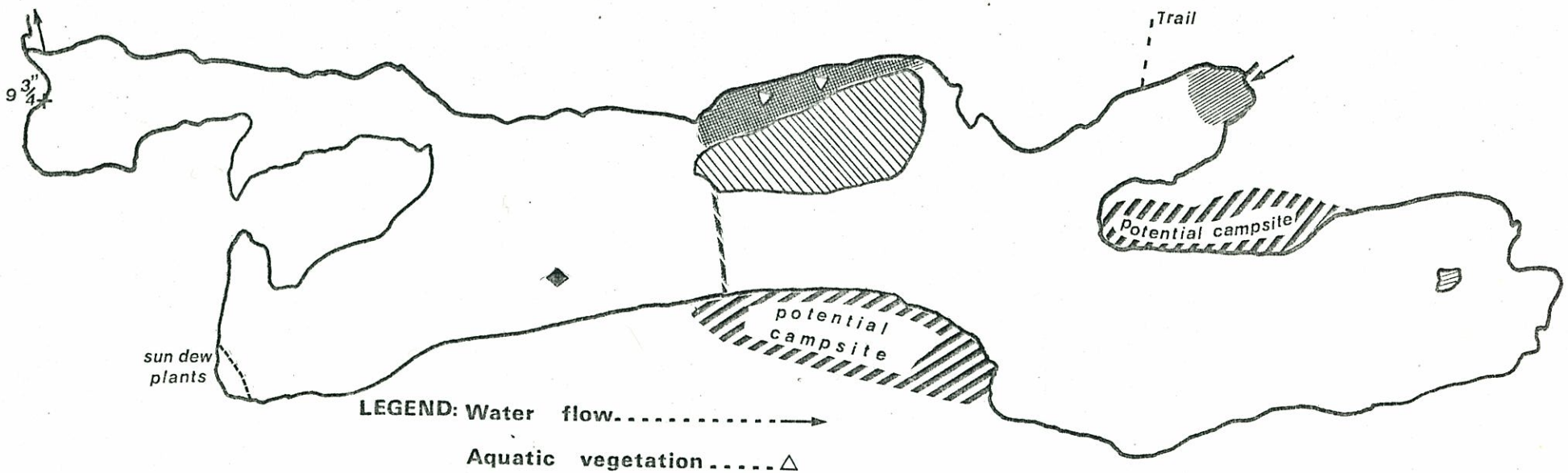
Scale:

0 .25 .50 Mile

Fig. 21B. Lake 4B69; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 4B69–PUKASKWA NATIONAL PARK

N. 48°11'75" & W. 86°05'20"



LEGEND:
- Water flow
- Aquatic vegetation △
- Bench mark +
- Gill net sampling
- Island
- Sampling station ◆
- Shoals
- Seine sampling
- Shallow with beach

Scale:

0 .25 .50 Mile

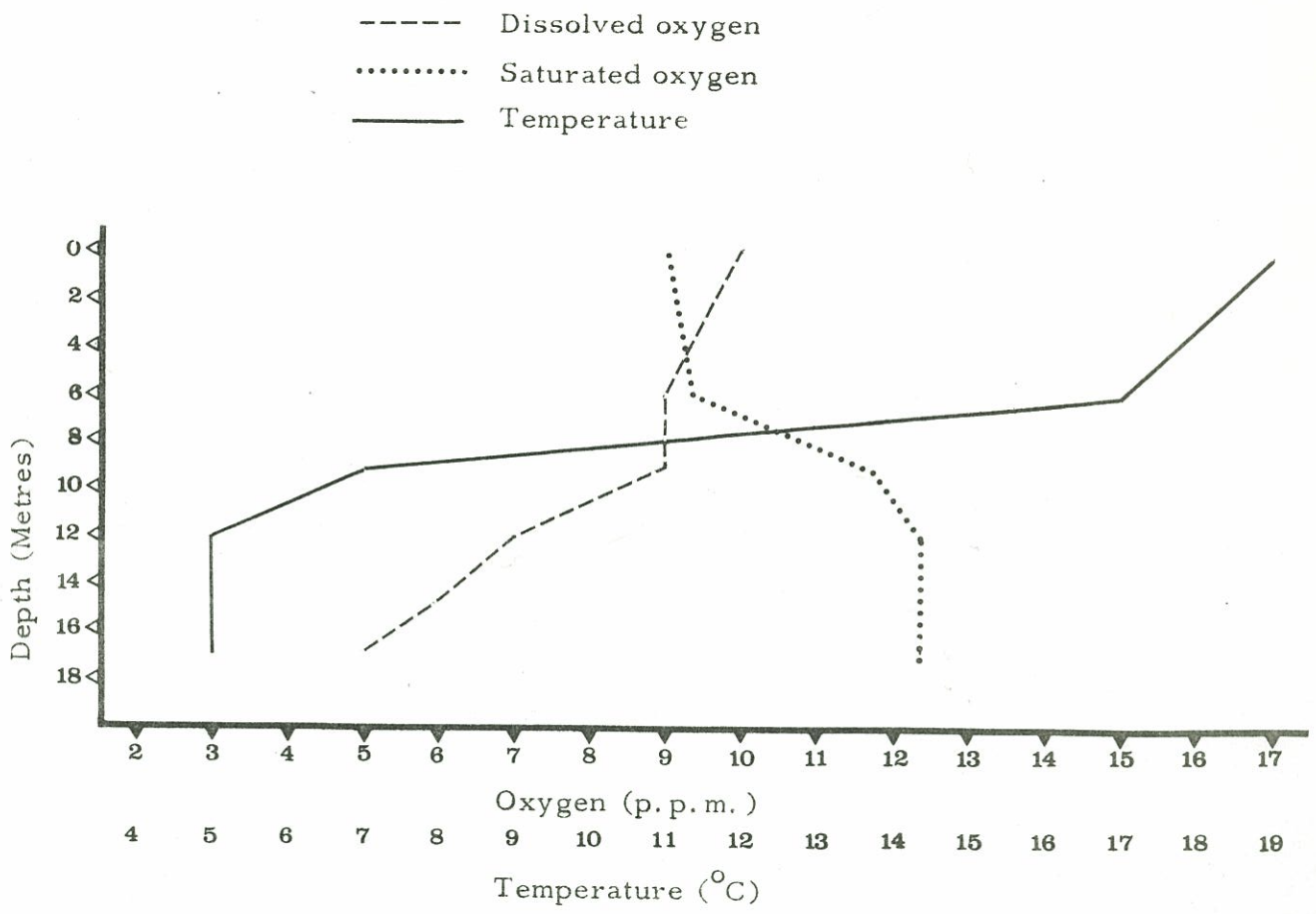


Figure 21C. Oxygen and temperature determinations. Lake 4B69. July 9, 1972.

Lake 4B71

The lake is about one-half mile east of Lake 4B69, and there is a trail between them. They are not part of the same drainage system as the outlet creek of Lake 4B71 drains directly south into Lake Superior (Fig. 22A and B).

The lake shores and lake basin are regular in shape and the depth is about average for the surface area, 12.2 acres (4.93 ha). The water's colour was a light brown. The Secchi disc reading was 12 feet (3.7 metres) indicating little turbidity (Table 2). The specific conductance was measured at 38.2 umhos, almost the same as that measured in Lake 4B69 (Table 1). However, the total alkalinity, 7.7 p.p.m., was slightly higher than that measured at Lake 4B69. The lake becomes warm at the surface, and cools only a few degrees towards the bottom. There was no thermocline, and at the time of sampling no serious shortage of oxygen in the bottom waters (Fig. 22C). However, the carbon dioxide concentration near the bottom was 15 p.p.m. showing the beginning of a build-up of that gas from decomposition of bottom organic materials. Some stagnation probably also occurs in winter which may bring about a partial winter-kill of fish in some years.

The plankton sample was the largest sample taken of all the lakes surveyed. Three-quarters of the sample was Calanoida, mainly Diaptomus minutus and unidentified Diaptomus sp. Copepod nauplii (19 per cent),

cladocerans (5 per cent) and cyclopoids (1 per cent) made up the rest of the sample (Tables 4 and 5).

One gill net was set for 5 hours, and caught two speckled trout, each of which weighed about two pounds (1 kilogram). No seine samples were obtained as no suitable sites for the operation could be found. However, several ninespine sticklebacks were seen in the shallows among the rocks. Other small fish species could have escaped detection.

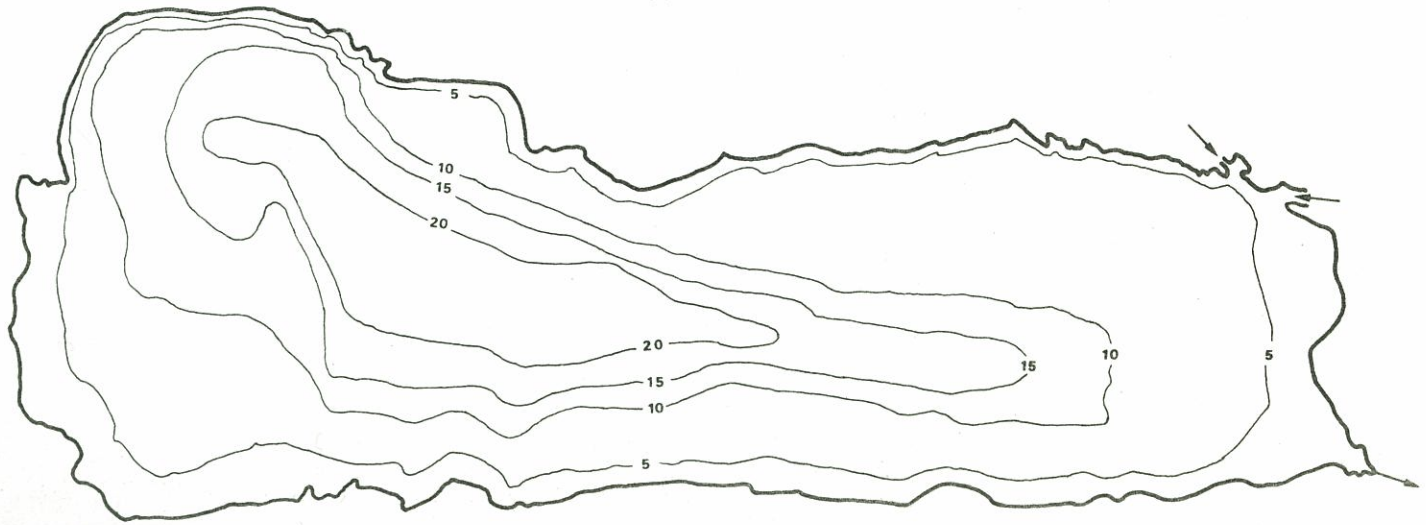
No trout spawning grounds were located and since the only two fish captured were large trout, it was initially thought they might have come from an earlier stocking. It was noted (Leiff, 1971) that the lake had been stocked with trout in 1955, but no subsequent plantings were recorded. The generally accepted maximum age attained by speckled trout is nine to ten years, and rarely do specimens reach these ages, so it seems improbable that the fish caught during the survey were from the 1955 planting. A more detailed-study will be needed before any answer to that puzzling situation can be offered.

Fig. 22A. Lake 4B71; bathymetry, physical features, and fish species.

Lake 4B71–Pukaskwa National Park

Depth Contours in Feet

N. 48° 11' 30" & W. 86° 04' 50"



CHARACTERISTICS:

AREA – 12.2 Acres

MAXIMUM DEPTH – 20 feet

MEAN DEPTH – 11 feet

SECCHI DISC – 12 feet

TEMPERATURE RANGE FROM 68°F to 57.2°F

FISH SPECIES – Eastern Brook Trout

Trout – perch

Ninespine Stickleback

DATE of SURVEY – July 10th, 1972

Altitude – 800 feet

Legend:

Water flow

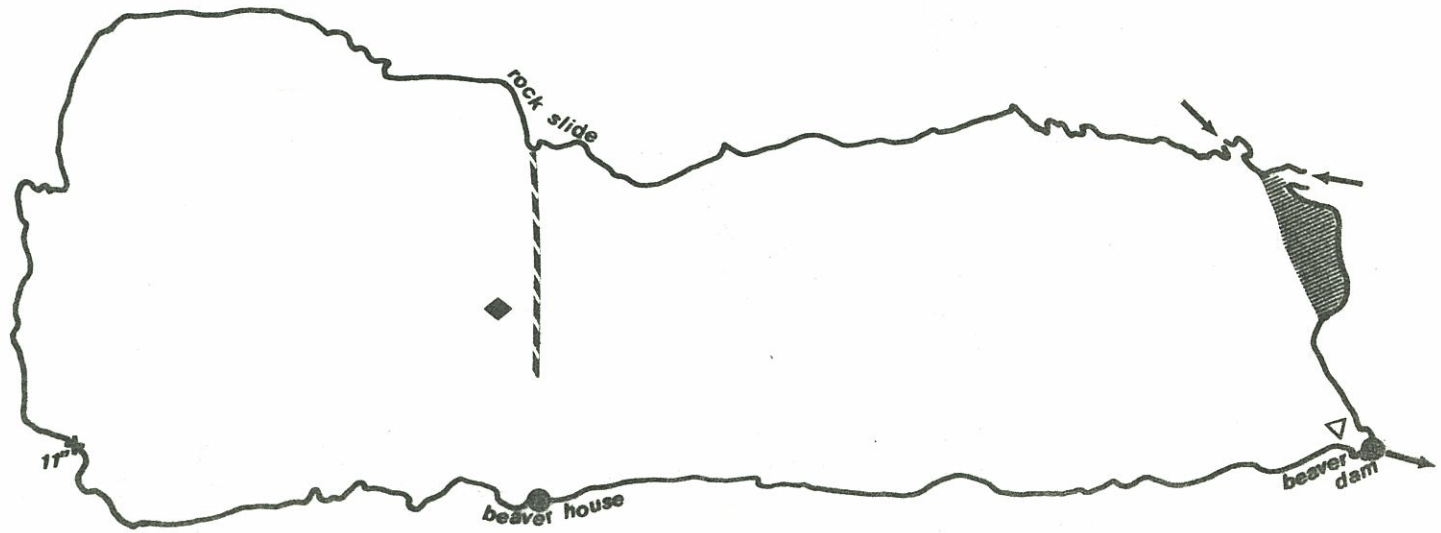
Scale:

0 .8 .4 Mile

Fig. 22B. Lake 4B71; bench mark locations, sampling stations, waterflows and landmarks of interest.

LAKE 4B71–PUKASKWA NATIONAL PARK

N. 48° 11' 30" & W. 86° 04' 50"



LEGEND:

- Aquatic vegetation
- Bench mark
- Gill net sampling
- Sampling station
- Shallow with beach
- Water flow

Scale in miles

0 .125 .25

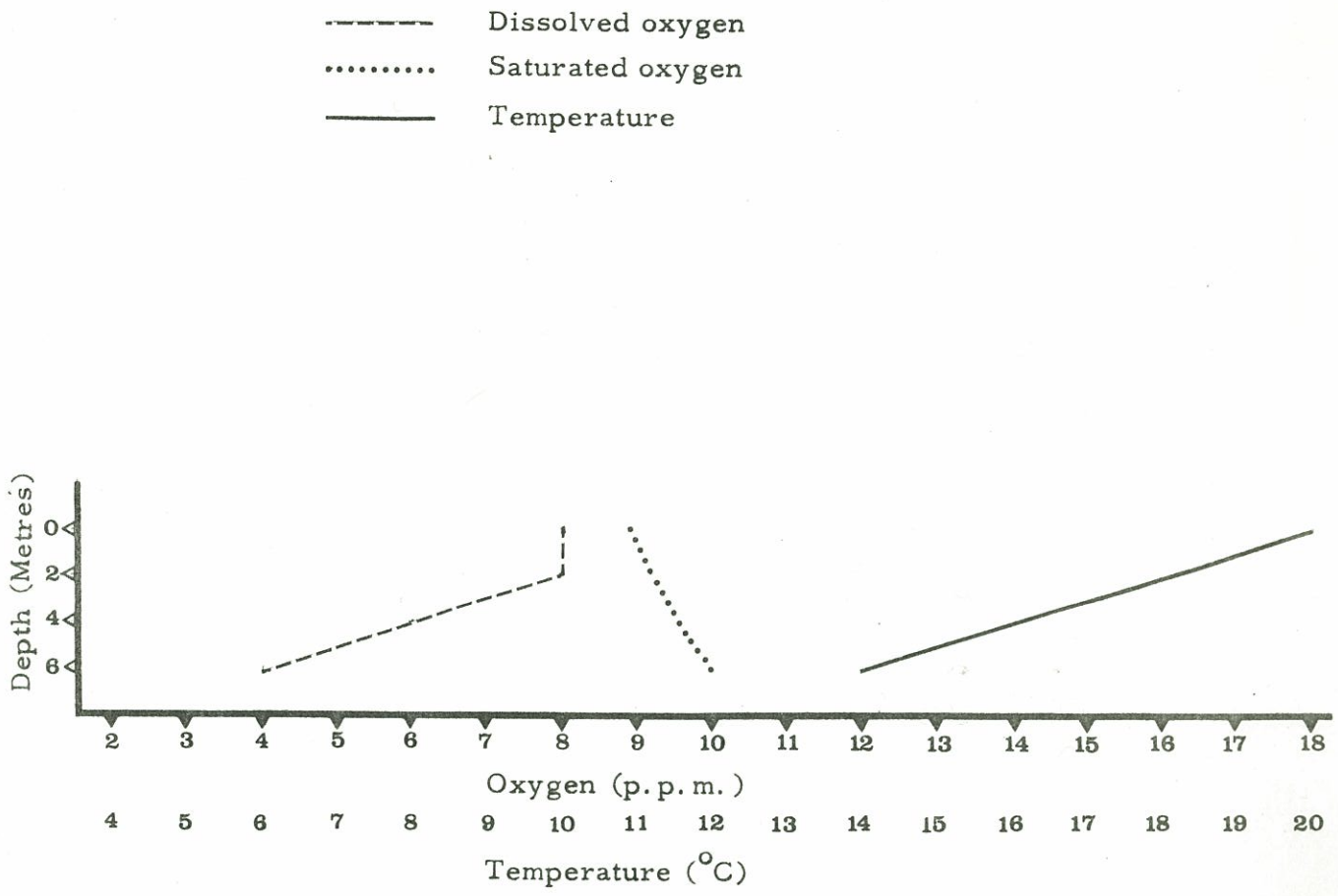


Figure 22C. Oxygen and temperature determinations. Lake 4B71. July 10, 1972.

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APPENDICES

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Appendix A

Recommendations

After having spent about eight weeks in Pukaskwa National Park in 1972 collecting specimens and information on the aquatic resources, and a large part of the winter and spring of 1973 collating and analysing the data, the following observations are listed for the consideration of those involved in the planning of future studies:

1. Time and resources were limited for the first aquatic survey. As a result several facets of a typical survey were not covered while others were not given the attention needed to gather complete information, e. g.

(a) Bottom sampling was not done because of the difficulty of transporting the necessary equipment.

(b) Aquatic plant communities were not surveyed because many identifications depend on fruiting bodies available only in late summer.

(c) Fish and plankton sampling was done only to obtain specimens for identification and not to get quantitative measurements. More concentrated efforts are needed to assess quantities and evaluate populations.

(d) Water chemistry can change considerably with the season. Some of these changes have been predicted but need confirmation from future surveys.

(e) No phytoplankton samples were collected because no authority could be found to carry out the identifications; a highly specialized task for which the author does not feel qualified.

All these gaps in the information on the lakes already examined should be filled to the degree that is justified by the requirements of the Park's resource inventories. The lakes that may be utilized by anglers or encroached upon by development should receive the most attention as they are the ones most likely to be changed by use.

2. The various drainage basins of the Park should be mapped, their areas assessed, and the main streams examined for the bottom fauna and fish species. All lakes need not be examined but enough in each drainage basin so species maps could be prepared to show the distributions. Such a study may require several years' work.

3. At those lakes where angling will be acceptable, the fish populations should receive special study, particularly in connection with their ability to withstand fishing pressure and their opportunities to reproduce themselves.

4. In the larger lakes at the north end of the Park, Louie, Lurch, Birch and Rye lakes in particular, beaver dams are favouring suckers at the expense of trout. The balance could be shifted to permit higher trout numbers and thus better angling opportunities. The shift could be accomplished by a program of beaver dam removal to allow trout access

to spawning areas, and sucker trapping to reduce competition with the trout population. The operations could be done without the complete decimation of the beavers or suckers. Trout require access only to those streams where spawning areas are available, which are few in that area, so only one or two streams would be affected. The procedure of trapping suckers on their spawning runs reduces the adult population but does not eliminate the species. Some spawning is permitted in areas unsuitable for trapping. Further observations are required during the time of the sucker spawning runs to find out which streams can be successfully trapped.

5. Most park visitors prefer to camp near lakes and streams. The waters visited in 1972 showed no obvious signs of pollution. Great care must be taken in selecting campsites and in regulating the disposal of wastes.

6. People like to identify a lake by name. Unnamed lakes in areas being prepared for visitor use should be named. Colourful local names should be used where possible (some lakes are named on maps put out by the Province of Ontario but not named on Park maps). Attractive signs should be erected to identify lakes.

7. National Park waters have greater values than their potential as producers of fish. If the author seems to have emphasized angling it is only because he has found from past experience that few

"outdoor-type" people can look at or travel over a lake without feeling a strong urge to catch a fish from it. To guard against unintentional over-use, a substantial knowledge of what fishing pressure each area can stand is needed to devise adequate protective measures.

J.C. Ward,

Limnologist.

Appendix B

Checklist of Zooplankton Species Collected in Pukaskwa National Park in 1972.

'A' equals abundant, 'C' equals common, 'F' equals few, and 'R' equals rare.

	General Abundance in Park
Cladocera:	
Bosmina longispina	A
Daphnia galeata mendotae	A
Holopedium gibberum	A
Daphnia retrocurva	R
Diaphanosoma leuchtenbergianum	C
Leptodora kindtii	F
Ceriodaphnia lacustris	F
Daphnia longiremis	F
Daphnia pulex	F
Eurycercus lamellatus	R
Lotona sp.	R
Polyphemus sp.	R
Calanoida:	
Diaptomus minutus	A
Epischura lacustris	F
Diaptomus siciloides	R
Limnocalanus macrurus	R
Senecella calanoides	R
Diaptomus oregonensis	C
Diaptomus sicilis	R
Eurytemora sp.	R
Cyclopoida:	
Cyclops bicuspidatus thomasi	C
Mesocyclops edax	C
Cyclops scutifer	C
Orthocyclops modestus	R
Eucyclops macrurus*	R
Tropocyclops prasinus (Mexicanus)	R

*Possibly a new record for North American (Canadian Oceanographic Identification Centre, Nat. Museum of Natural Sciences, Ottawa).

Appendix C

Checklist of Fish Species Collected in Pukaskwa National Park in 1972.

Salmonidae:	Trouts and Whitefishes
Coregonus artidii	cisco
Coregonus clupeaformis	lake whitefish
Salmo gairderii	rainbow trout
Salmo trutta	brown trout
Salvelinus fontinalis	brook trout
Salvelinus namaycush	lake trout
Esociadae	Pikes
Esox lucius	northern pike
Cyprinidae	Minnows
Chrosomus eos	northern redbelly dace
Chrosomus neogaeus	finescale dace
Couesius plumbeus	lake chub
Cyprinus carpio	carp
Notropis heterolepis	blacknose shiner
Notropis hudsonius	spottail shiner
Pimephales promelas	fathead minnow
Rhinichthys cataractae	longnose dace
Semotilus margarita	pearl dace

Catostomidae	Suckers
Catostomus catastomus	longnose sucker
Catostomus commersoni	white sucker
Percopsidae	Trout-perches
Percopsis omiscomaycus	trout-perch
Gadidae	Cods
Lota lota	burbot
Gastrosteidae	Sticklebacks
Culea inconstans	brook stickleback
Pungitius pungitius	ninespine stickleback
Percidae	Perches
Etheostoma exile	Iowa darter
Perca flavescens	yellow perch
Stizostedion vitreum	walleye
Cottidae	Sculpins
Cottus bairdi	mottled sculpin
Cottus cognatus	slimy sculpin

Appendix D

Water sample analyses carried out by the Burlington Laboratories of the Water Quality Division, Inland Waters Branch, Canada. Department of the Environment.

ANALYSIS OF WATER SAMPLE(S)

(milligrams per litre)

Location	Pukaskwa National Park		
Source of Water	Louis Lake	Lurch Lake	Lurch Lake
~~Sampling Point~~ Field No.	1	2	2A
Reference			
Laboratory Number	4429	4430	4431
Date of Sampling	June 7/72	June 10/72	June 13/72
Date Sample Received	July 21/72	July 21/72	July 21/72
Date of Analyses	July 25/72	July 25/72	July 25/72
*Storage Period, (days)	48	45	42
Temp. at Sampling (°C)			
Temp. at Testing (°C)	21.4	21.4	20.4
Alkalinity, Phenolphthalein ($CaCO_3$)	0.0	0.0	0.0
Alkalinity, Total ($CaCO_3$)	14.2	5.4	6.8
Aluminum (Al)			
Bicarbonate (HCO_3)	17.3	6.6	8.3
Calcium (Ca)	6.8	4.5	4.7
Carbonate (CO_3)	0.0	0.0	0.0
Carbon Dioxide, Calculated (CO_2)	4.4	2.6	5.3
Carbon, Total Organic (C)			
Chloride (Cl)	0.3	1.0	0.2
Colour (Hazen Units)	5.	5.	5.
Copper (Cu)			
Fluoride (F)			
Hardness, Total ($CaCO_3$)	18.5	12.2	12.2
Hardness, Non Carbonate ($CaCO_3$)	4.3	6.8	5.4
Iron (Fe) Extractable			
Dissolved			
Magnesium (Mg)	0.4	0.2	0.1
Manganese (Mn) Extractable			
Dissolved			
Nitrogen, Ammonia (N)			
Nitrogen, Nitrate + Nitrite (N)	0.00	0.05	0.13
Nitrogen, Organic (N)			
Nitrogen, Total (N)			
Oxygen, Consumed from $KMnO_4$			
Oxygen Demand, Chemical (COD)			
pH	6.8	6.6	6.4
Phosphate Inorganic (PO_4)			
Phosphate Ortho (PO_4)			
Phosphorus Total (PO_4)			
Potassium (K)	0.2	0.1	0.1
Residue, Filterable (105°C)			
Residue, Fixed Filterable (550°C)			
Residue, Nonfilterable (105°C)			
Residue, Fixed Nonfilterable (550°C)			
Silica (SiO_2)	2.8	3.1	3.8
Sodium (Na)	0.5	0.4	0.4
Specific Conductance (μmhos/cm at 25°C)	43.3	28.4	32.6
Sulphate (SO_4)	7.1	5.9	7.7
Turbidity (Jackson Units)	0.6	0.5	0.4
Zinc (Zn)			
Sum of Constituents	26.6	18.7	21.7
% Sodium	5.5	6.6	6.6
Saturation Index at Test Temperature	-2.7	-3.4	-3.6
Stability Index at Test Temperature	12.1	13.5	13.5
Sodium Absorption Ratio (SAR)	0.1	0.1	0.1
Level	5	5	55

ANALYSIS OF WATER SAMPLE(S)

(milligrams per litre)

Location	Pukaskwa National Park		
Source of Water	Birch Lake	Rye Lake	Lake No. 2A3
Sampling point Field No.	3	4	5
Reference			
Laboratory Number	4432	4433	4434
Date of Sampling	June 11/72	June 12/72	June 21/72
Date Sample Received	July 21/72	July 21/72	July 21/72
Date of Analyses	July 25/72	July 25/72	July 25/72
*Storage Period, (days)	44	43	34
Temp. at Sampling (°C)			
Temp. at Testing (°C)	20.4	20.2	20.4
Alkalinity, Phenolphthalein ($CaCO_3$)	0.0	0.0	0.0
Alkalinity, Total ($CaCO_3$)	5.9	5.2	19.1
Aluminum (Al)			
Bicarbonate (HCO_3)	7.2	6.3	23.3
Calcium (Ca)	4.0	3.8	9.0
Carbonate (CO_3)	0.0	0.0	0.0
Carbon Dioxide, Calculated (CO_2)	7.3	3.2	5.9
Carbon, Total Organic (C)			
Chloride (Cl)	0.5	0.2	0.5
Colour (Hazen Units)	5.	5.	5.
Copper (Cu)			
Fluoride (F)			
Hardness, Total ($CaCO_3$)	10.2	9.7	24.8
Hardness, Non Carbonate ($CaCO_3$)	4.3	4.5	5.7
Iron (Fe) Extractable			
Dissolved			
Magnesium (Mg)	0.1	0.1	0.6
Manganese (Mn) Extractable			
Dissolved			
Nitrogen, Ammonia (N)			
Nitrogen, Nitrate + Nitrite (N)	0.00	0.05	0.10
Nitrogen, Organic (N)			
Nitrogen, Total (N)			
Oxygen, Consumed from $KMnO_4$			
Oxygen Demand, Chemical (COD)			
pH	6.2	6.5	6.8
Phosphate Inorganic (PO_4)			
Phosphate Ortho (PO_4)			
Phosphorus Total (PO_4)			
Potassium (K)	0.1	0.1	0.1
Residue, Filterable (105°C)			
Residue, Fixed Filterable (550°C)			
Residue, Nonfilterable (105°C)			
Residue, Fixed Nonfilterable (550°C)			
Silica (SiO_2)	3.1	2.8	1.5
Sodium (Na)	0.3	0.4	1.4
Specific Conductance (μmhos/cm at 25°C)	28.7	26.9	63.2
Sulphate (SO_4)	5.9	6.2	8.1
Turbidity (Jackson Units)	0.4	0.3	0.6
Zinc (Zn)			
Sum of Constituents	17.5	16.9	33.1
% Sodium	6.0	8.1	10.9
Saturation Index at Test Temperature	-3.9	-3.7	-2.4
Stability Index at Test Temperature	14.0	13.8	11.7
Sodium Absorption Ratio (SAR)	0.1	0.1	0.1

Level

ANALYSIS OF WATER SAMPLE(S)

(milligrams per litre)

Location	Pukaskwa National Park		
Source of Water	Lake #2A2	Lake #2A6	Lake #2A8
~~Sampling point~~ Field No.	6	7	8
Reference			
Laboratory Number	4435	4436	4437
Date of Sampling	June 22/72	June 23/72	June 24/72
Date Sample Received	July 21/72	July 21/72	July 21/72
Date of Analyses	July 25/72	July 25/72	July 25/72
*Storage Period, (days)	33	32	31
Temp. at Sampling (°C)			
Temp. at Testing (°C)	20.4	20.4	20.4
Alkalinity, Phenolphthalein ($CaCO_3$)	0.0	0.0	0.0
Alkalinity, Total ($CaCO_3$)	18.3	38.8	12.7
Aluminum (Al)			
Bicarbonate (HCO_3)	22.3	47.3	15.5
Calcium (Ca)	9.8	16.8	7.5
Carbonate (CO_3)	0.0	0.0	0.0
Carbon Dioxide, Calculated (CO_2)	7.1	3.8	2.0
Carbon, Total Organic (C)			
Chloride (Cl)	0.5	0.6	0.4
Colour (Hazen Units)	5.	5.	5.
Copper (Cu)			
Fluoride (F)			
Hardness, Total ($CaCO_3$)	25.3	44.3	19.5
Hardness, Non Carbonate ($CaCO_3$)	7.0	5.5	6.8
Iron (Fe) Extractable			
Dissolved			
Magnesium (Mg)	0.2	0.6	0.2
Manganese (Mn) Extractable			
Dissolved			
Nitrogen, Ammonia (N)			
Nitrogen, Nitrate + Nitrite (N)	0.01	0.12	0.04
Nitrogen, Organic (N)			
Nitrogen, Total (N)			
Oxygen, Consumed from $KMnO_4$			
Oxygen Demand, Chemical (COD)			
pH	6.7	7.3	7.1
Phosphate Inorganic (PO_4)			
Phosphate Ortho (PO_4)			
Phosphorus Total (PO_4)			
Potassium (K)	0.1	0.2	0.2
Residue, Filterable (105°C)			
Residue, Fixed Filterable (550°C)			
Residue, Nonfilterable (105°C)			
Residue, Fixed Nonfilterable (550°C)			
Silica (SiO_2)	4.1	3.3	3.1
Sodium (Na)	1.1	1.7	1.0
Specific Conductance (μmhos/cm at 25°C)	63.2	105.	53.6
Sulphate (SO_4)	10.2	9.7	10.2
Turbidity (Jackson Units)	0.3	0.3	0.6
Zinc (Zn)			
Sum of Constituents	37.0	56.7	30.4
% Sodium	8.6	7.7	9.9
Saturation Index at Test Temperature	-2.5	-1.4	-2.4
Stability Index at Test Temperature	11.7	10.0	11.9
Sodium Absorption Ratio (SAR)	0.1	0.1	0.1
Level		6!	5!

ANALYSIS OF WATER SAMPLE(S)

(milligrams per litre)

Location	Pukaskwa National Park		
Source of Water	Unnamed Lake #1 2A11	Unnamed Lake #2 2A12	Lake #2A10
~~Sample~~ Field No.	9	10	11
Reference			
Laboratory Number	4438	4439	4440
Date of Sampling	June. 25/72	June. 27/72	June/72
Date Sample Received	July. 21/72	July. 21/72	July. 21/72
Date of Analyses	July. 25/72	July. 25/72	July. 25/72
*Storage Period, (days)	30	28	
Temp. at Sampling (°C)			
Temp. at Testing (°C)	20.4	20.2	20.2
Alkalinity, Phenolphthalein ($CaCO_3$)	0.0	0.0	0.0
Alkalinity, Total ($CaCO_3$)	14.4	23.6	14.1
Aluminum (Al)			
Bicarbonate (HCO_3)	17.6	28.8	17.2
Calcium (Ca)	7.7	12.1	8.3
Carbonate (CO_3)	0.0	0.0	0.0
Carbon Dioxide, Calculated (CO_2)	2.8	4.6	3.5
Carbon, Total Organic (C)			
Chloride (Cl)	1.2	0.8	0.9
Colour (Hazen Units)	5.	5.	5.
Copper (Cu)			
Fluoride (F)			
Hardness, Total ($CaCO_3$)	20.3	32.1	21.4
Hardness, Non Carbonate ($CaCO_3$)	6.5	8.5	7.3
Iron (Fe) Extractable			
Dissolved			
Magnesium (Mg)	0.4	0.5	0.2
Manganese (Mn) Extractable			
Dissolved			
Nitrogen, Ammonia (N)			
Nitrogen, Nitrate + Nitrite (N)	0.01	0.03	0.06
Nitrogen, Organic (N)			
Nitrogen, Total (N)			
Oxygen, Consumed from $KMnO_4$			
Oxygen Demand, Chemical (COD)			
pH	7.0	7.0	6.9
Phosphate Inorganic (PO_4)			
Phosphate Ortho (PO_4)			
Phosphorus Total (PO_4)			
Potassium (K)	0.1	0.2	0.4
Residue, Filterable (105°C)			
Residue, Fixed Filterable (550°C)			
Residue, Nonfilterable (105°C)			
Residue, Fixed Nonfilterable (550°C)			
Silica (SiO_2)	2.8	4.5	3.8
Sodium (Na)	1.0	1.6	1.4
Specific Conductance (μmhos/cm at 25°C)	55.6	80.8	59.6
Sulphate (SO_4)	10.9	11.9	12.2
Turbidity (Jackson Units)	0.5	1.2	0.4
Zinc (Zn)			
Sum of Constituents	32.8	45.9	35.9
% Sodium	9.4	9.7	12.2
Saturation Index at Test Temperature	-2.4	-2.0	-2.5
Stability Index at Test Temperature	11.8	11.0	11.9
Sodium Absorption Ratio (SAR)	0.1	0.1	0.1
Level	5'	5'	

ANALYSIS OF WATER SAMPLE(S)

(milligrams per litre)

Location	Pukaskwa National Park		
Source of Water	Lake #2A9	Lake #3A50	Lake #3A51
Sampling point Field No.	12	13	14
Reference			
Laboratory Number	4441	4442	4443
Date of Sampling	June 29/72	July 5/72	July 6/72
Date Sample Received	July 21/72	July 21/72	July 21/72
Date of Analyses	July 25/72	July 25/72	July 25/72
*Storage Period, (days)	26	20	19
Temp. at Sampling (°C)			
Temp. at Testing (°C)	20.2	20.4	20.2
Alkalinity, Phenolphthalein ($CaCO_3$)	0.0	0.0	0.0
Alkalinity, Total ($CaCO_3$)	13.3	9.0	18.4
Aluminum (Al)			
Bicarbonate (HCO_3)	16.2	11.0	22.4
Calcium (Ca)	7.4	9.4	10.4
Carbonate (CO_3)	0.0	0.0	0.0
Carbon Dioxide, Calculated (CO_2)	6.5	1.8	3.6
Carbon, Total Organic (C)			
Chloride (Cl)	0.4	0.5	0.6
Colour (Hazen Units)	5	10	10
Copper (Cu)			
Fluoride (F)			
Hardness, Total ($CaCO_3$)	19.0	25.3	26.9
Hardness, Non Carbonate ($CaCO_3$)	5.7	16.3	8.5
Iron (Fe) Extractable			
Dissolved			
Magnesium (Mg)	0.1	0.5	0.2
Manganese (Mn) Extractable			
Dissolved			
Nitrogen, Ammonia (N)			
Nitrogen, Nitrate + Nitrite (N)	0.00	0.02	0.03
Nitrogen, Organic (N)			
Nitrogen, Total (N)			
Oxygen, Consumed from $KMnO_4$			
Oxygen Demand, Chemical (COD)			
pH	6.6	7.0	7.0
Phosphate Inorganic (PO_4)			
Phosphate Ortho (PO_4)			
Phosphorus Total (PO_4)			
Potassium (K)	0.2	0.2	0.2
Residue, Filterable (105°C)			
Residue, Fixed Filterable (550°C)			
Residue, Nonfilterable (105°C)			
Residue, Fixed Nonfilterable (550°C)			
Silica (SiO_2)	1.9	4.3	5.0
Sodium (Na)	1.0	1.0	1.2
Specific Conductance (μmhos/cm at 25°C)	50.0	61.3	65.3
Sulphate (SO_4)	9.3	16.5	9.7
Turbidity (Jackson Units)	0.7	0.4	0.4
Zinc (Zn)			
Sum of Constituents	28.3	37.8	38.5
% Sodium	10.2	7.9	8.8
Saturation Index at Test Temperature	-2.9	-2.5	-2.2
Stability Index at Test Temperature	12.3	12.1	11.4
Sodium Absorption Ratio (SAR)	0.1	0.1	0.1
Level	5'	5'	5'

ANALYSIS OF WATER SAMPLE(S)

(milligrams per litre)

Location	Pukaskwa National Park	
Source of Water	Tagoosh Lake Lake #2B56	Lake #2A13
Sampling point	15	16
Reference		
Laboratory Number	4444	4445
Date of Sampling	July 7/72	July 8/72
Date Sample Received	July 21/72	July 21/72
Date of Analyses	July 25/72	July 25/72
*Storage Period, (days)	18	17
Temp. at Sampling (°C)		
Temp. at Testing (°C)	20.4	20.4
Alkalinity, Phenolphthalein ($CaCO_3$)	0.0	0.0
Alkalinity, Total ($CaCO_3$)	34.1	16.0
Aluminum (Al)		
Bicarbonate (HCO_3)	41.6	19.5
Calcium (Ca)	16.8	9.4
Carbonate (CO_3)	0.0	0.0
Carbon Dioxide, Calculated (CO_2)	5.3	3.9
Carbon, Total Organic (C)		
Chloride (Cl)	1.6	0.5
Colour (Hazen Units)	20	5
Copper (Cu)		
Fluoride (F)		
Hardness, Total ($CaCO_3$)	44.3	24.8
Hardness, Non Carbonate ($CaCO_3$)	10.2	8.8
Iron (Fe) Extractable		
Dissolved		
Magnesium (Mg)	0.6	0.3
Manganese (Mn) Extractable		
Dissolved		
Nitrogen, Ammonia (N)		
Nitrogen, Nitrate + Nitrite (N)	0.02	0.02
Nitrogen, Organic (N)		
Nitrogen, Total (N)		
Oxygen, Consumed from $KMnO_4$		
Oxygen Demand, Chemical (COD)		
pH	7.1	6.9
Phosphate Inorganic (PO_4)		
Phosphate Ortho (PO_4)		
Phosphorus Total (PO_4)		
Potassium (K)	0.3	0.2
Residue, Filterable (105°C)		
Residue, Fixed Filterable (550°C)		
Residue, Nonfilterable (105°C)		
Residue, Fixed Nonfilterable (550°C)		
Silica (SiO_2)	3.6	3.1
Sodium (Na)	1.6	1.1
Specific Conductance (μmhos/cm at 25°C)	102	59.4
Sulphate (SO_4)	9.9	9.4
Turbidity (Jackson Units)	0.4	0.5
Zinc (Zn)		
Sum of Constituents	54.9	33.7
% Sodium	7.2	8.7
Saturation Index at Test Temperature	-1.6	-2.4
Stability Index at Test Temperature	10.3	11.7
Sodium Absorption Ratio (SAR)	0.1	0.1
Level	5'	5'

ANALYSIS OF WATER SAMPLE(S)

(milligrams per litre)

Location	Pukaskwa National Park		
Source of Water	Lake 4B69	Lake 4B71	Widgeon Lake
Coll. No.	17	18	19
Reference			
Laboratory Number	5016	5017	5018
Date of Sampling	July 9/72	July 10/72	July 26/72
Date Sample Received	Aug. 28/72	Aug. 28/72	Aug. 28/72
Date of Analyses	Sept. 12/72	Sept. 12/72	Sept. 12/72
*Storage Period, (days)	65	64	48
Temp. at Sampling (°C)			
Temp. at Testing (°C)	25.1	25.0	24.9
Alkalinity, Phenolphthalein ($CaCO_3$)	0.0	0.0	0.0
Alkalinity, Total ($CaCO_3$)	5.0	7.7	10.6
Aluminum (Al)			
Bicarbonate (HCO_3)	6.1	9.4	12.9
Calcium (Ca)	5.0	5.3	5.1
Carbonate (CO_3)	0.0	0.0	0.0
Carbon Dioxide, Calculated (CO_2)	1.2	6.0	5.2
Carbon, Total Organic (C)			
Chloride (Cl)	0.5	0.8	0.3
Colour (Hazen Units)	5.	5.	5.
Copper (Cu)			
Fluoride (F)			
Hardness, Total ($CaCO_3$)	14.3	13.8	13.7
Hardness, Non Carbonate ($CaCO_3$)	9.3	6.1	3.1
Iron (Fe) Extractable			
Dissolved			
Magnesium (Mg)	0.5	0.13	0.2
Manganese (Mn) Extractable			
Dissolved			
Nitrogen, Ammonia (N)			
Nitrogen, Nitrate + Nitrite (N)	0.02	0.03	0.00
Nitrogen, Organic (N)			
Nitrogen, Total (N)			
Nitrogen, Total Kjeldahl (N)			
Oxygen Demand, Chemical (COD)			
pH	6.9	6.4	6.6
Phosphorus Inorganic (P)			
Phosphorus Ortho (P)			
Phosphorus Total (P)			
Potassium (K)	1.0	1.0	0.1
Residue, Filterable (105°C)			
Residue, Fixed Filterable (550°C)			
Residue, Nonfilterable (105°C)			
Residue, Fixed Nonfilterable (550°C)			
Silica (SiO_2)	2.0	0.7	0.7
Sodium (Na)	0.8	0.8	0.2
Specific Conductance (μmhos/cm at 25°C)	38.5	38.2	33.8
Sulphate (SO_4)	8.8	7.6	6.0
Turbidity (Jackson Units)	0.4	0.5	0.6
Zinc (Zn)			
Sum of Constituents	21.6	21.1	19.0
% Sodium	10.1	10.4	3.1
Saturation Index at Test Temperature	-3.0	-3.3	-3.0
Stability Index at Test Temperature	12.9	13.0	12.6
Sodium Absorption Ratio (SAR)	0.1	0.1	0.0
Depth	5'	5'	5'

ANALYSIS OF WATER SAMPLE(S)

(milligrams per litre)

Location	Pukaskwa National Park		
Source of Water	Widgeon Lake	North Soldier Lake	South Soldier Lake
Coll. No.	19A	20	21
Reference			
Laboratory Number	5019	5020	5021
Date of Sampling	July. 26/72	July. 28/72	July. 29/72
Date Sample Received	Aug.. 28/72	August. 28/72	Aug.. 28/72
Date of Analyses	Sept.. 12/72	Sept.. 12/72	Sept.. 12/72
*Storage Period, (days)	48	46	45
Temp. at Sampling (°C)			
Temp. at Testing (°C)	25.0	25.0	25.0
Alkalinity, Phenolphthalein ($CaCO_3$)	0.0	0.0	0.0
Alkalinity, Total ($CaCO_3$)	9.6	10.4	25.8
Aluminum (Al)			
Bicarbonate (HCO_3)	11.7	12.7	31.5
Calcium (Ca)	5.2	5.9	10.5
Carbonate (CO_3)	0.0	0.0	0.0
Carbon Dioxide, Calculated (CO_2)	11.8	5.1	4.0
Carbon, Total Organic (C)			
Chloride (Cl)	0.2	0.2	0.2
Colour (Hazen Units)	5.	10.	5.
Copper (Cu)			
Fluoride (F)			
Hardness, Total ($CaCO_3$)	14.2	17.2	29.3
Hardness, Non Carbonate ($CaCO_3$)	4.6	6.8	3.5
Iron (Fe) Extractable			
Dissolved			
Magnesium (Mg)	0.3	0.6	0.8
Manganese (Mn) Extractable			
Dissolved			
Nitrogen, Ammonia (N)			
Nitrogen, Nitrate + Nitrite (N)	0.36	0.01	0.00
Nitrogen, Organic (N)			
Nitrogen, Total (N)			
Nitrogen, Total Kjeldahl (N)			
Oxygen Demand, Chemical (COD)			
pH	6.2	6.6	7.1
Phosphorus Inorganic (P)			
Phosphorus Ortho (P)			
Phosphorus Total (P)			
Potassium (K)	0.1	0.1	0.4
Residue, Filterable (105°C)			
Residue, Fixed Filterable (550°C)			
Residue, Nonfilterable (105°C)			
Residue, Fixed Nonfilterable (550°C)			
Silica (SiO_2)	1.5	2.5	2.9
Sodium (Na)	0.3	0.1	0.3
Specific Conductance (μmhos/cm at 25°C)	36.1	36.8	63.3
Sulphate (SO_4)	6.9	6.0	6.2
Turbidity (Jackson Units)	0.5	0.4	0.4
Zinc (Zn)			
Sum of Constituents	21.9	21.7	56.8
% Sodium	4.4	1.3	2.2
Saturation Index at Test Temperature	-3.4	-2.9	-1.8
Stability Index at Test Temperature	13.1	12.5	10.7
Sodium Absorption Ratio (SAR)	0.0	0.0	0.0
Depth	51'	5'	5'

ANALYSIS OF WATER SAMPLE(S)

(milligrams per litre)

Location	Pukaskwa National Park		
Source of Water	South Soldier Lake	Cascade Lake	Cascade Lake
Coll. No.	21A	22	22A
Reference			
Laboratory Number	5022	5023	5024
Date of Sampling	July 29/72	Aug. 1/72	Aug. 1/72
Date Sample Received	Aug. 28/72	Aug. 28/72	Aug. 28/72
Date of Analyses	Sept. 12/72	Sept. 12/72	Sept. 12/72
*Storage Period, (days)	45	42	42
Temp. at Sampling (°C)			
Temp. at Testing (°C)	24.9	25.0	25.1
Alkalinity, Phenolphthalein ($CaCO_3$)	0.0	0.0	0.0
Alkalinity, Total ($CaCO_3$)	29.6	10.4	3.6
Aluminum (Al)			
Bicarbonate (HCO_3)	36.1	12.7	4.4
Calcium (Ca)	11.7	5.5	5.2
Carbonate (CO_3)	0.0	0.0	0.0
Carbon Dioxide, Calculated (CO_2)	11.5	10.1	11.3
Carbon, Total Organic (C)			
Chloride (Cl)	0.3	0.3	1.0
Colour (Hazen Units)	5.	40.	30.
Copper (Cu)			
Fluoride (F)			
Hardness, Total ($CaCO_3$)	35.2	18.4	16.7
Hardness, Non Carbonate ($CaCO_3$)	5.6	8.0	13.1
Iron (Fe) Extractable			
Dissolved			
Magnesium (Mg)	1.5	1.1	0.9
Manganese (Mn) Extractable			
Dissolved			
Nitrogen, Ammonia (N)			
Nitrogen, Nitrate + Nitrite (N)	0.10	0.03	0.29
Nitrogen, Organic (N)			
Nitrogen, Total (N)			
Nitrogen, Total Kjeldahl (N)			
Oxygen Demand, Chemical (COD)			
pH	6.7	6.3	5.8
Phosphorus Inorganic (P)			
Phosphorus Ortho (P)			
Phosphorus Total (P)			
Potassium (K)	0.4	0.4	0.5
Residue, Filterable (105°C)			
Residue, Fixed Filterable (550°C)			
Residue, Nonfilterable (105°C)			
Residue, Fixed Nonfilterable (550°C)			
Silica (SiO_2)	4.0	2.9	4.4
Sodium (Na)	0.3	0.2	0.2
Specific Conductance (μmhos/cm at 25°C)	70.7	33.0	29.9
Sulphate (SO_4)	5.4	6.6	7.4
Turbidity (Jackson Units)	14.	0.5	0.7
Zinc (Zn)			
Sum of Constituents	41.8	23.4	23.1
% Sodium	1.8	2.3	2.5
Saturation Index at Test Temperature	-2.1	-3.3	-4.3
Stability Index at Test Temperature	10.9	12.6	14.3
Sodium Absorption Ratio (SAR)	0.0	0.0	0.0
Depth	90'	5'	90'

Appendix E

Tables of oxygen and temperature regimes of individual lakes (Tables 6 - 27). Saturated oxygen concentrations are from Truesdale, et al. Feb. 1955.

Table 6. Louie Lake.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.)			
		Measured	Saturated	Deficit	Percent Saturation
0	18	11	9.18	+1.82	119.8
3	17	10	9.37	+0.63	106.7
6	12	8	10.43	2.43	76.7
9	9	6	11.19	5.19	53.6

Table 7. Lurch Lake.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.)			
		Measured	Saturated	Deficit	Percent Saturation
0	18	10	9.18	+0.82	108.9
6	17	9	9.37	0.37	96.0
9	16	10	9.56	+0.44	104.6
12	15	9	9.76	0.76	92.2
15	7	9	11.87	2.76	76.5
18	6	8	12.06	4.06	66.3
20	5	8	12.37	4.37	64.7

Table 8. Birch Lake.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.)			
		Measured	Saturated	Deficit	Percent Saturation
0	17	9	9.37	0.37	96.0
3	16	9	9.56	0.56	94.6
6	11	8	10.67	2.67	74.9
9	9	8	11.19	3.19	71.5
11	8	6.5	11.47	4.97	56.7

Table 9. Rye Lake.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	19	9	9.01	.01	100.0
6	16	10	9.56	+0.44	104.6
9	9	10	11.19	1.19	89.4
12	7	10	11.76	1.76	85.0
15	6	11	12.06	1.06	91.2
18	5	10	12.37	2.37	80.8
21	4	9	12.70	2.70	70.9
23	4	9	12.70	3.70	70.9

Table 10. North Soldier Lake.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	21.0	10	8.68	+1.32	115.2
6	17.0	9	9.37	0.37	96.1
9	8.5	9	11.33	233	79.4
12	5.5	9	12.22	3.22	73.6
15	5.0	7	12.37	5.37	56.6
18	4	6	12.70	6.70	47.2
21	4	5	12.70	7.70	39.3

Table 11. South Soldier Lake.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	21	10	8.68	+1.32	115.1
6	19	10	9.01	+0.99	110.9
9	12	9	10.43	1.43	86.3
12	7	9	11.76	2.76	76.5
15	6	9	12.06	3.06	74.6
18	5	9	12.37	3.37	72.7
21	5	8	12.37	4.37	64.6
23	5	8	12.37	4.37	64.6
27	5	6	12.37	6.37	48.7

Table 12. Widgeon Lake.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	19	10	9.01	+0.99	110.9
6	19	9	9.01	.01	100.0
9	13	9	10.2	.8	88.2
12	10	6	10.92	4.92	54.9
15	9	3	11.19	8.19	26.8

Table 13. Cascade Lake.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	14	9	9.98	0.98	90.2
6	7	9	11.76	2.76	76.5
9	6	9	12.06	3.06	74.6
12	6	9	12.06	3.06	74.6
15	6	9	12.06	3.06	74.6
18	5	9	12.37	3.37	72.7
21	5	9	12.37	3.37	72.7
24	5	8	12.37	4.37	64.6
27	5	8	12.37	43.7	64.6

Table 14. Tagouche (2B56) Lake.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	19.5	10	8.93	+1.07	111.9
6	15	10	9.76	+0.24	102.4
9	6	8	12.06	4.06	66.3
11	5	4	12.37	8.37	32.3

Table 15. Lake 2A3.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.)			
		Measured	Saturated	Deficit	Percent Saturation
0	18	9	9.18	0.18	98.0
2	17	9	9.37	0.37	96.0
4	16	9	9.56	0.56	94.6

Table 16. Lake 2A2.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.)			
		Measured	Saturated	Deficit	Percent Saturation
0	15	10	9.76	+0.24	102.4
3	13	9	10.20	0.8	88.2
6	7	9	11.76	2.76	76.5
9	5	7	12.37	5.37	56.6
12	4	3	12.70	9.70	23.6

Table 17. Lake 2A6.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.)			
		Measured	Saturated	Deficit	Percent Saturation
0	18	11	9.18	+1.82	119.8
3	17	11	9.37	+1.96	117.4
6	15	11	9.76	+1.24	112.7
9	7	12	11.76	+0.24	102.0
12	5	9	12.37	3.37	72.7

Table 18. Lake 2A8.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.)			
		Measured	Saturated	Deficit	Percent Saturation
0	18	11.0	9.18	+1.82	119.8
3	16	11.5	9.69	+1.81	118.7
6	13	12.0	10.20	+1.80	117.6
9	7	12.0	11.76	+0.24	102.0
12	6	12.0	12.06	0.06	99.5
15	5.5	12.0	12.22	0.22	98.2
18	5	10.0	12.87	2.37	80.8
21	5	10.0	12.37	2.37	80.8
24	5	10.0	12.37	2.37	80.8
27	5	9.5	12.37	3.37	76.8
29	5	8.5	12.37	4.37	68.7

Table 19. Lake 2A9.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.)			
		Measured	Saturated	Deficit	Percent Saturation
0	19	10	9.01	+0.99	110.9
3	17	10	9.37	+0.63	106.7
6	15	10	9.76	+0.24	102.4

Table 20. Lake 2A10.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.)			
		Measured	Saturated	Deficit	Percent Saturation
0	18	9.5	9.18	+0.32	103.5
3	16	9.5	9.56	0.06	99.4
6	8	9.0	11.47	2.47	78.4
9	5	3.0	12.37	9.37	24.2
10	5	3.0	12.37	9.37	24.2

Table 21. Lake 2A11.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	19	9	9.01	0.01	100.0
1.5	18	9	9.18	0.18	98.0
3	16	9	9.56	0.56	94.6

Table 22. Lake 2A12.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	18	11	9.18	+1.82	119.8
1.5	17	11	9.37	+1.63	117.4
3	16	10	9.56	+0.44	104.6

Table 23. Lake 2A13.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	20	9	8.84	+0.16	101.8
2	18	9	9.18	0.18	98.0
4	13	5	10.20	5.20	49.0
5	10	2	10.92	8.92	18.2

Table 24. Lake 3A50.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	18	10	9.18	+0.82	108.9
3	16	9	9.56	0.56	94.6
6	10	9	10.92	1.92	82.4
9	5	6	12.37	6.37	48.7
11	5	4	12.37	8.37	32.3

Table 25. Lake 3A51.

Depth (Meters)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	19	10	9.01	+0.99	110.9
3	17	9	9.37	0.37	96.0
6	6	7	12.06	5.06	58.0
9	4	2	12.70	10.70	15.8

Table 26. Lake 4B69.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	19	10	9.01	+0.99	110.9
6	17	9	9.37	0.37	96.0
9	7	9	11.76	2.76	76.5
12	5	7	12.37	5.37	56.6
15	5	7	12.37	6.37	48.7
17	5	5	12.37	7.37	40.4

Table 27. Lake 4B71.

Depth (Metres)	Temp. (°C)	Oxygen (p.p.m.) Measured	Saturated	Deficit	Percent Saturation
0	20	8	8.84	0.84	90.5
2	18	8	9.18	1.18	87.1
4	16	6	9.56	3.56	62.7
6	14	4	9.98	5.98	40.1

Appendix F

Pictures in Pukaskwa National Park.

1. A typical bench mark similar to those made at all lakes as a reference point from which to measure fluctuations in water levels in future years.

2. Measuring and examining trout taken in gill nets from South Soldier Lake.

3. South end of Rye Lake showing the rugged shoreline typical of many of the lakes in Pukaskwa National Park.

4. Lake 4B69 and surrounding terrain typical of the coastal areas. This lake contains a large yellow perch population and a few speckled trout.

5. Small tributary creek flowing into west side of Rye Lake showing excellent trout spawning beds available.

6. Outlet stream from Lurch Lake. Some trout spawning would be possible here.

7. Seining for species of small fish along the shore of South Soldier Lake. Places suitable for seining were scarce.

8. Typical shoreline of Lake Superior coast in Pukaskwa National Park. Areas like this offer some angling for "coasters" - large speckled trout.

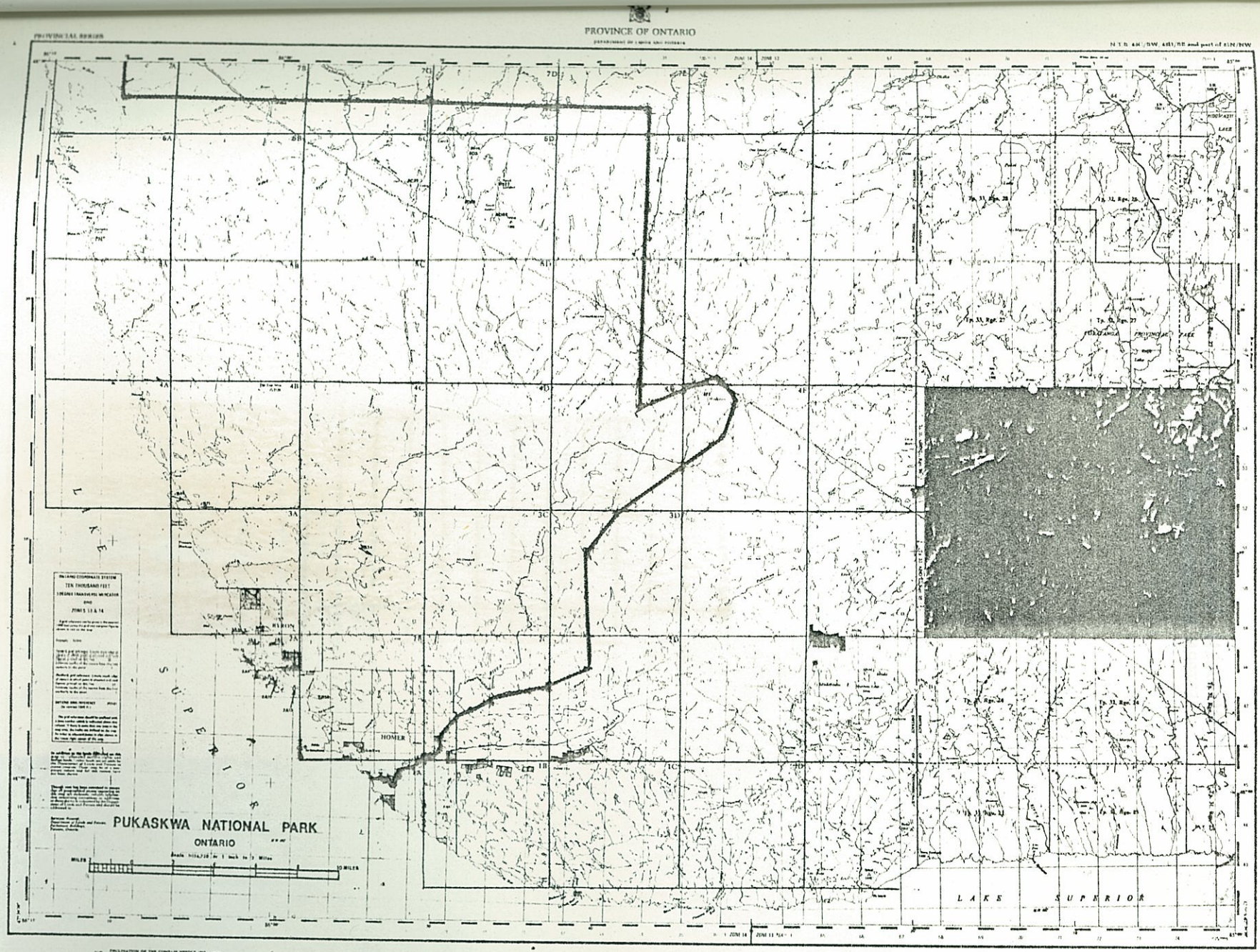
9. Working the limnology boat up the creek between Birch and Lurch lakes.

10. Outlet of Birch Lake.

11. Lichens covering rocks at east side of Lurch Lake.

Appendix G

Map numbering system.



Map 1. Grid system and identification of townships.

PUKASKWA NATIONAL PARK

PARK BOUNDARY: ▪▪▪▪▪▪▪