plankton S
fish - B

LAKE REPORT :

A LOOK AT LONG LAKE AND BOLGER BOG

Russell Richards
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INTRODUCTION :

This report is a comparison between two bodies of water, Long Lake and Bolger Bog, which are found on the UNDERC property. These two were part of an indepth study which our class conducted on some 25 lakes and bogs in this area. Each of the bodies of water were analized to determine it's particular water chemistry and qualitative lists of the zooplankton and phytoplankton species were made. Four of these were then chosen to represent the different types of lakes in the area. From these a sample of the fish population was taken and the condition of aech species was checked.

The area in which these lakes are found is approximately 46°15' N latitude, 89°30' W longtitude along the Wisconcin and Michigan borders. The lakes in this part of the country were formed some 15,000 years ago during the Pleistocene epoch when the great Wisconcin ice began to retreat. As the melting glacier progressed northward thousands of lakes, including the Great Lakes were left in it's wake. Since the lakes in this study were formed in glacial ground moraine it is possible to have two very different types of lakes within short distances of each other. The lakes on the UNDERC property are a good example of this since, many are chains of well drained lakes while others are deep kettles or seepage lakes.

The locations of Long Lake and Bolger Bog, as well as the other bodies of water covered in the study, are quiet important. It should be noted that they are situated directly east of Diluth, a very large industrial city. Since the weather comes mostly from the west the city could have a dramatic effect on the condition of the waters at UNDERC. Also, the entire area was heavily lumbered around the early 1900's. This stripping of the climax timber and subsequent establishment of a second growth forest could have a direct effect on the development of the local lakes. With these major factors, as well as more localized effects, in mind we will examine and attempt to explain the condition of the two lakes.

Section I. WATER CHEMISTRY

SAMPLING METHODS :

Samples for chemical analysis were collected using a Kemerer which was lowered to various depths in each lake depending on the temperature zones of the lake. To determine the zones, a temperature profile was established by measuring the water temperature at various depths from the surface to the bottom.(Tables A-D) Since stratifications occured, a sample was taken from both the Epilimnion and the Hypolimnion layeres in each lake. Once the water was collected, the sample to be tested was placed in a polyethylene bottle for transport back to the lab. Before leaving though, the pH and H_2S of each sample was measured. This was done so no change would occur between the time the sample was collected and when it was tested. When back in the lab the samples were analized using a Hach water chemistry kit.

RESULTS :

Long lake is a rather unique body of water for, as it's name implies, it is a very long narrow lake running east to west with deep basins at either end. This gives it a more or less dumb-bell shaped appearance. The lake is lined with a thin band of conifers behind which are found many maple and beech trees. The bog mat around the immediate shoreline is very minimal. Also, there are a number of fallen trees jutting out from the shore into the water. Overall, the lake is pretty exposed which allows it to be greatly effected by such elements as wind and sunlight.

The samples from the lake were taken at both ends in the deep basins and in the center directly out from the dock. (Fig. 1 A,B,C)

The drainage pattern in Long Lake shows that it is what is called a seepage lake. There is no significant drainage except that which percolates through the surrounding terrain.

LONG LAKE

East End :

Table A.

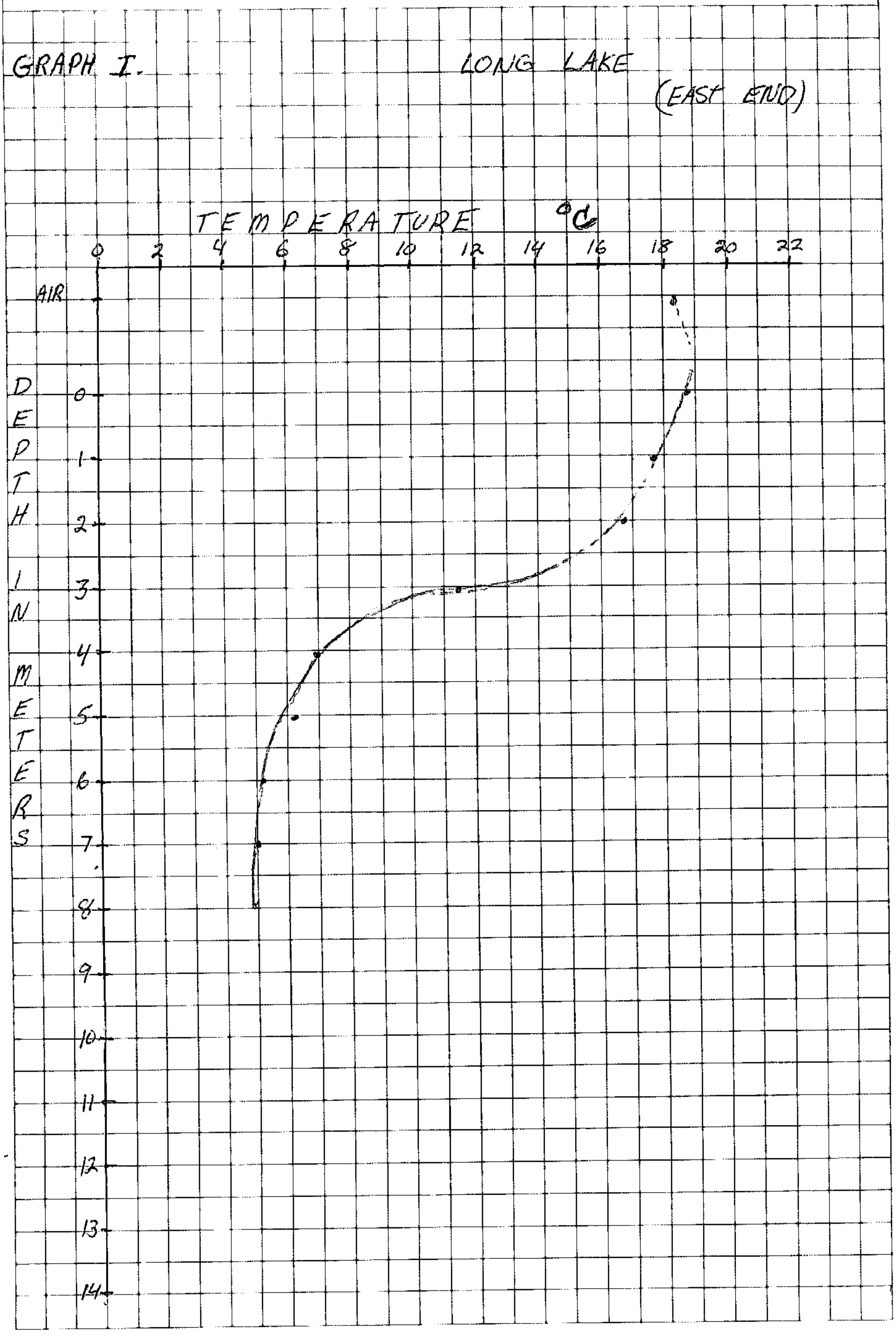
Depth (m)	Temp. (°C)	Depth (m)	Temp. (°C)
Air	18.2°C	4	7.0
Surf.	18.7	5	6.2
1m	17.7	6	5.2
2	16.8	7	5.0
3	11.5	8	4.9

General Data ;

- Data was taken at 4:00 PM on 6/4/79 -
- Secchi Disc reading was 3.45m taken with light cloud cover and a slight breeze. -

		EPILIMNION	HYPOLIMNION
ACIDITY		125 mg/l	120 mg/l
ALKALINITY		$<$10 mg/l	$<$10 mg/l
COLOR	True	90nm	90nm
	Apparent	115nm	100nm
SPECIFIC CONDUCTANCE		23 μmhos	19 μmhos
HARDNESS	Ca^{++}	5 mg/l	5 mg/l
	Mg^{++}	5 mg/l	3.5 mg/l
	Total	10 mg/l	8.5 mg/l
NITRATE		.33 mg/l	.35 mg/l
TOTAL PHOSPHATE		.20 mg/l	.30 mg/l
pH		5.7	5.5
Depth Taken		1.5m	6.0m
Temp.		17.0°C	5.2°C
H_2S		Neg.	Pos.

NAME EXPERIMENT NO.



CENTER :

Table B

Depth (m)	Temp. (°C)	Depth (m)	Temp. (°C)
Air	19.0	3	12.0
Surf	17.7	4	8.9
1	16.5	5	Bottom
2	15.1		

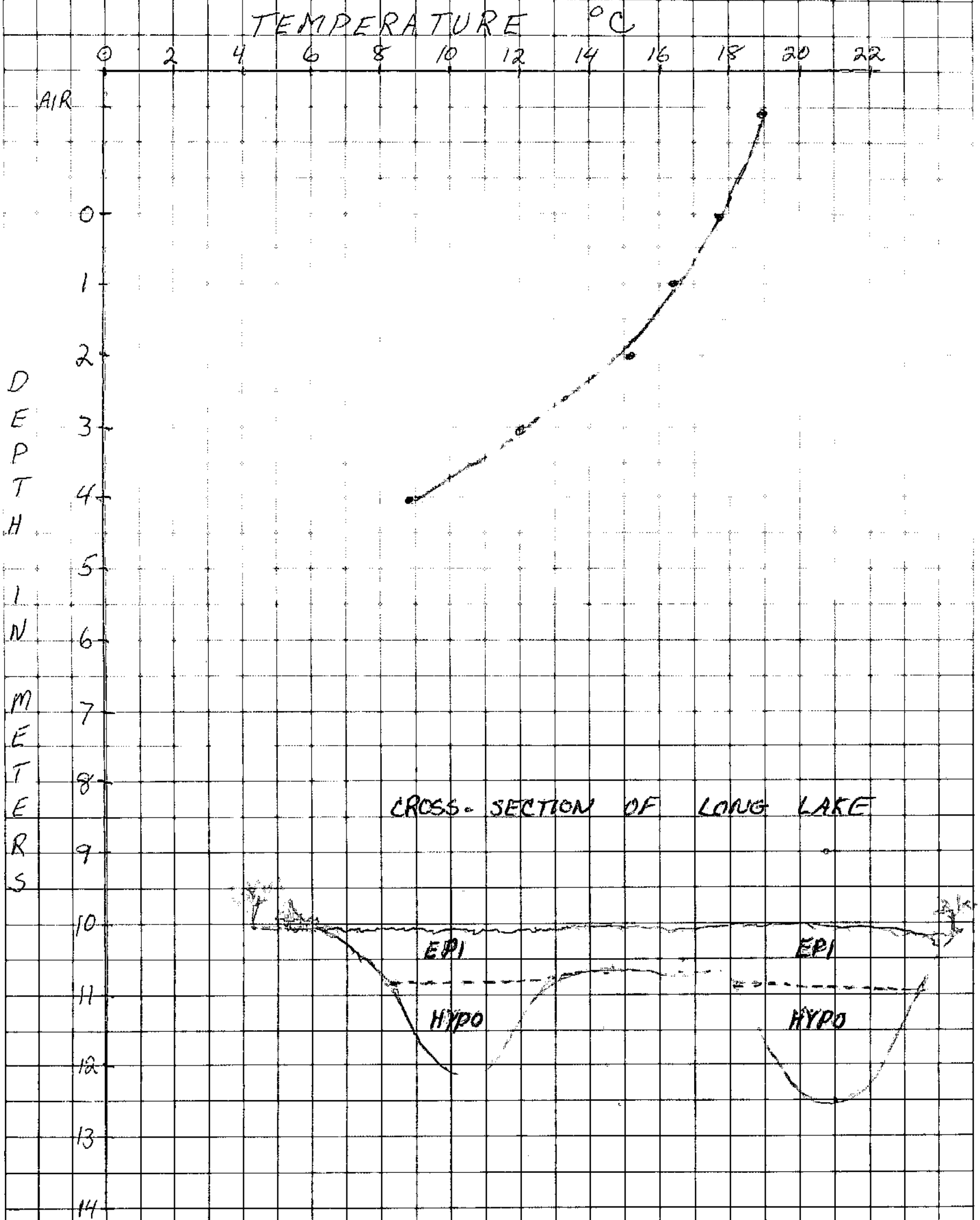
General Data :

- Data was taken at 10;00 AM on 6/4/79 -
- Secchi Disc reading was 1m and it was taken with cloudy skies and a slight breeze -

		EPILIMNION
ACIDITY		140 mg/l
ALKALINITY		<10 mg/l
COLOR	True	80 nm
	Apparent	95 nm
SPECIFIC CONDUCTANCE		28 µmhos
HARDNESS	Ca^{++}	4 mg/l
	Mg^{++}	3 mg/l
	Total	7 mg/l
NITRATE		.4 mg/l
TOTAL PHOSPHATE		.34 mg/l
PH		5.5 at 1.5m and 16.5°C
H_2S		Slightly Present

NAME EXPERIMENT NO.

GRAPH II LONG LAKE (CENTER)



WEST END :

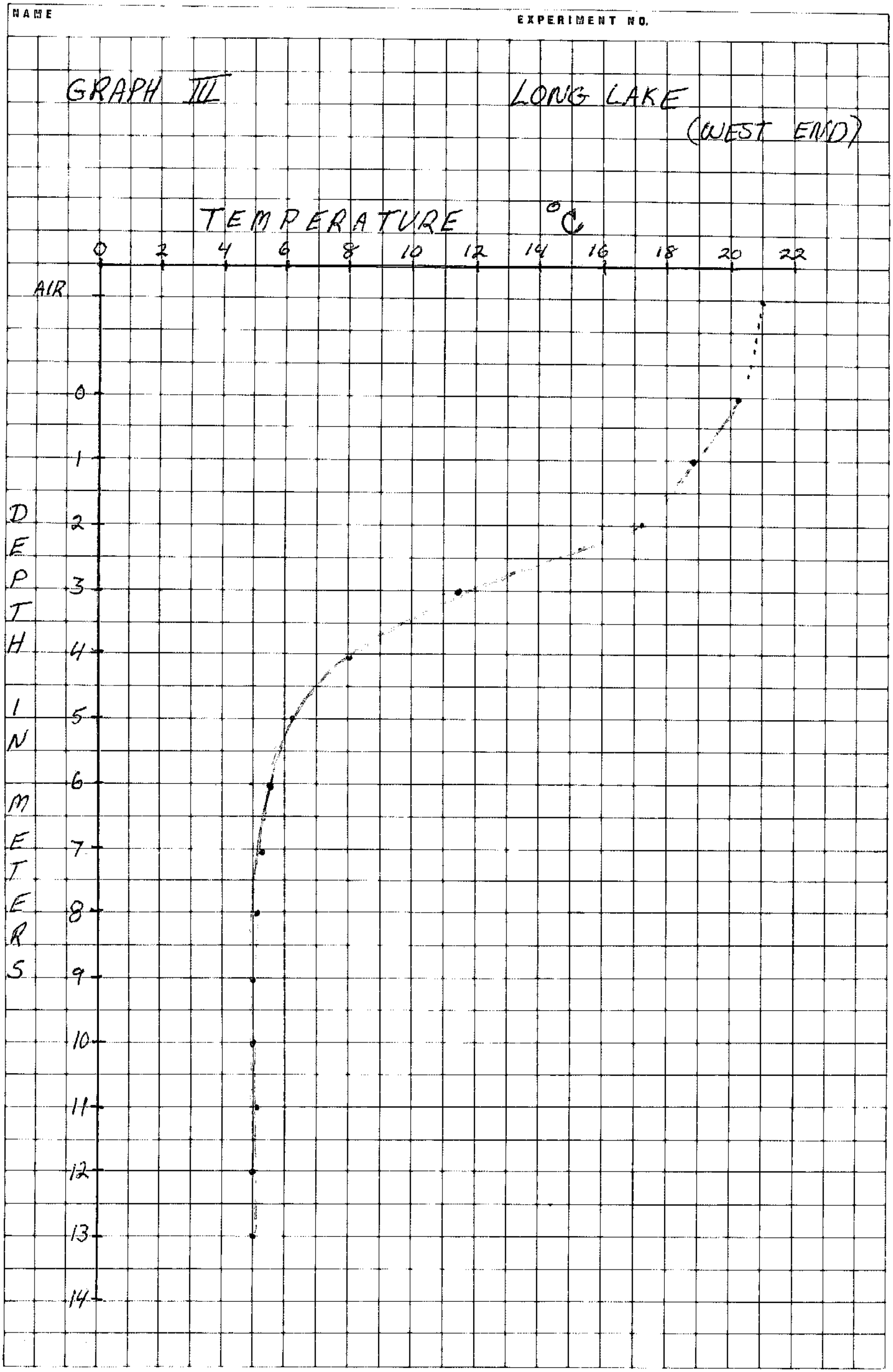
Table C.

Depth (m)	Temp. (°C)	Depth (m)	Temp. (°C)
Air	21.0	7	5.3
Surf	20.2	8	5.1
1	18.9	9	5.0
2	17.3	10	5.0
3	11.5	11	5.0
4	8.0	12	5.0
5	6.1	13	5.0
6	5.6		

General Data ;

- Data taken at 4;00 PM on 6/4/79 -
- Secchi Disc was 3.4m with slight clouds and breeze -

		EPILIMNION	HYPOLIMNION
ACIDITY		130 mg/l	150 mg/l
ALKALINITY		< 10 mg/l	< 10 mg/l
COLOR	True	80 nm	88 nm
	Apparent	95 nm	95 nm
SPECIFIC CONDUCTANCE		27 μmhos	25 μmhos
HARDNESS	Ca^{++}	5 mg/l	4.5 mg/l
	Mg^{++}	3 mg/l	2 mg/l
	Total	8 mg/l	6.5 mg/l
NITRATE		.33 mg/l	.4 mg/l
TOTAL PHOSPHATE		.4 mg/l	.32 mg/l
PH		5.8 < 2.5m, 14°C	5.5 < 10m, 6.0°C
H_2S		Neg.	Pos.



NAME
EXPERIMENT NO.
GRAPH III
LONG LAKE
(WEST END)
TEMPERATURE °C
0
2
4
6
8
10
12
14
16
18
20
22
AIR
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
DEPTH IN METERS

Bolger Bog is a much smaller body of water than is Long Lake. It is a round lake situated down in a hallow very much sheltered from the wind. There is an exstensive bog mat around the entire perimeter containing many of the common bog type flora. Just in from the edge of the mat and extending up most of the banks are the more wet habitat type conifers such as the White Ceder, Jack Pine and Black Spruce. Only up near the top of the banks are there any of the hardwood type trees. The conifers towering up around the edges of the bog gives the feeling of a completely closed in and protected basin. Indeed the basin appears to be sealed off from any outside water influence. Only water filtering through the surrounding conifers and sphagnum mat can enter the bog. Until recently this area was virtually inaccessible. A road was just cut through the woods and this is the first time the bog has been studied.

The samples for this lake were taken from only one site. Because of the shape and the more or less uniform contour to the bottom it was not neccessary to take additional samples.This was the deepest spot found while checking the temperature profile. (Fig. 2,A)

BOLGER BOG :

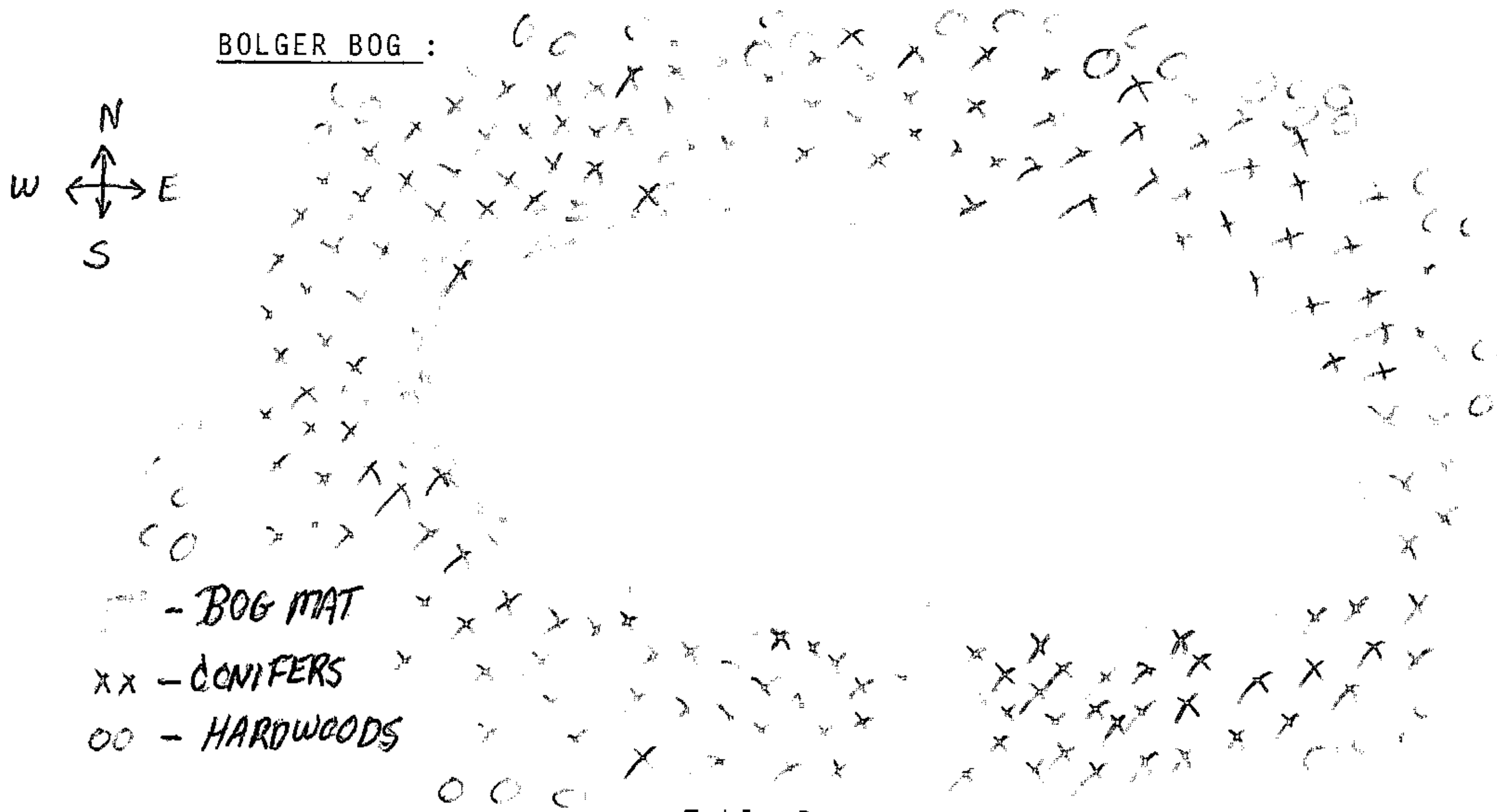


Table D

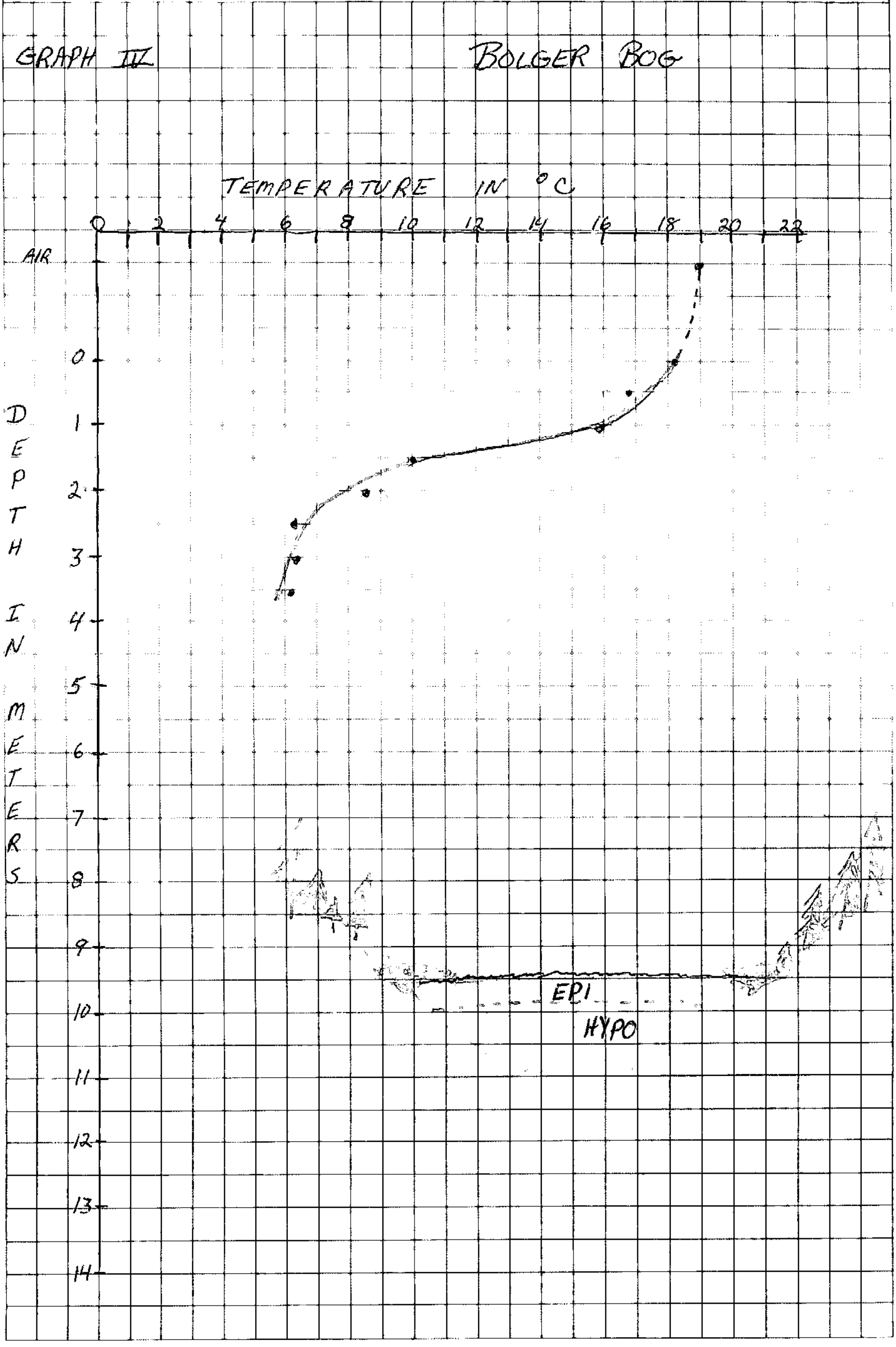
Depth (m)	Temp. (^{0}C)
Air	19.0
Surf	18.2
.5	16.5
1	16.0
1.5	10.5
2.0	8.5
2.5	6.2
3.0	6.2
3.5	6.2

General Data :

- Sample was taken at 10:30 AM on 6/7/79 -
- The Secchi Disc reading was .75m , the weather was very cloudy and it was raining heavily at times. -

		EPILIMNION	HYPOLIMNION
ACIDITY		170 mg/l	160 mg/l
ALKALINITY		$<$10 mg/l	20 mg/l
COLOR	True	233 nm	277 nm
	Apparent	255 nm	315 nm
SPECIFIC CONDUCTANCE		44 μ mhos	132 μ mhos
HARDNESS	Ca^{++}	13 mg/l	43 mg/l
	Mg^{++}	9 mg/l	20 mg/l
	Total	22 mg/l	63 mg/l
NITRATE		.7 mg/l	1.7 mg/l
TOTAL PHOSPHATE		.48 mg/l	.3 mg/l
pH		5.4	5.2
	Depth Sampled	.5m	2.5m
	Temp.	16.0°C	6.2°C
H_2S		Neg.	Pos.

NAME EXPERIMENT NO.



Discusion :

Comparing the sets of data for Long Lake and Bolger Bog it is clear that there are some major differences. First of all looking at the acidity of the two there appears to be a greater concentration in Bolger Bog. This could be due to many factors, but there are at least some possible sources in the area which could allow for such high concentrations. A major source of ions, at least within natural waters, would be the various forms of carbonic acid. Large amounts of CO_2 in the water would be hydrated to form the carbonic acid. When this acid dissociates into bi-carbonate and hydrogen ions it brings about a higher acidity and also a lower pH. (Since total acidity includes the ionized component, free acidity which causes pH, and the undissociated protons, it would be safe to discuss pH and acidity together.) But this does not explain the story completely, this only accounts for pH values slightly below 6.0.

Another source of the relatively high acidity, in both Long Lake and Bolger Bog, could be what is called acid rains. As was mentioned earlier, the UNDERC property lies directly downwind from the city of Diluth. It has been known for years that the industrial city has been pouring out tons of sulfurous fumes into the air. These gases are readily oxidized to form H_2SO_4 which falls in the form of acid rains on many of the lakes in the area. The effects can be seen most directly in the lakes, which already have a low buffering capacity. These lakes are unable to absorb the excess ions as they enter the water. This results in a continuous decrease in the PH of the lake. The end results of this drop in PH could be drastic if allowed to fall low enough. Almost all organisms would be killed off. Many of the lakes on the UNDERC property are showing signs of this continuous PH drop. Looking at previous years, it is noted that Long Lake has had a slightly higher PH (about 6.1)

The high acidity of Boger Bog could also be explained by the large sphaggnum mat which encircles the bog. As runoff waters from the surrounding area filters down through the sphagnum an ion exchange occurs. The runoff water which contains calcium sulfate would loss the Ca^{++} ion in exchange for some hydrogen ions. The resulting H_2SO_4 would continue on into the bog and the Ca^{++} would be taken up by the plants in the area.

It should be noted that recently a road was cut into the area to gain access to Bolger Bog. The poor construction of this roadway resulted in the stripping of some trees along a section of one bank. This section is much to steep for driving vehicles down but it has allowed for greater amout of runoff.

Organic acids, called humic acids are also abundent around sphagnum material. These acids arise from plant material and could greatly effect the acidity. Such acids cause the water to be a brown tea color which is the result of the dissolved humus . This would be the cause for the high apparent and true color of Bolger Bog as well as the shallow Secchi Disc readings. Long Lake does not contain these humic acids and thus has a much lower apparent and true color, a deeper Secchi reading and also a higher PH.

As was mentioned earlier, the terrain on which these lakes are situated was carved from granite by glacial action. This means that the soil overlying this granite base is going to have a poor buffering capacity. This is contrasted by lakes found on calcarious soils and limestone bases, which allow for ion exchange to occur and thus neutralize any acidity. The lack of the ability to buffer the added acid would explain a low PH and be reflected by the low alkalinity readings. Both lakes show this inability to convert carbonate to bicarbonate and bicarbonate to undissociated H_2CO_3. The following equation tells the whole story behind the buffering systems in lakes.

$$H_2O + CO_2 \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons H^+ + CO_3^=$$

Because of the above mentioned factors, this equation has been pushed far to the right. Continual addition of acid will be reflected in PH drops for both Long and Bolger.

The hardness data for the two lakes show thwt there are two types of water present. Long Lake appears to be a member of the soft water group, which is characterized by a hardness reading of about 10 mg/l. The lake also shows only a slight stratification in the Ca^{++} reading between Epilimnion and Hypolimnion samples which is common among soft water systems. The low Ca^{++} measurments are supported by the clearness of the water and seems to help indicate an oligotrophic condition.

In Bolger there appears there exists a hard water system. The hardness measurements are very high and there is a great increase in Ca^{++} when going from Epilimnion to Hypolimnion. The rich Ca^{++} condition as well as other data seems to indicate a eutrophic lake.

Nitrogen and Phosphorous are two raw materials which are critical for the synthesis of protein. Since this is an essetial part of any ecosystem both nitrogen and phosporous are very important indicators and they should be examined. The two should be directly related to the productivity of a lake, but it is not that easy. There are many problems in fallowing the cycle of either nitrogen or phosporous and measureing their rate of transfer could be difficult.

Looking at the Nitrate and total Phosphates in the system could be of some help. As to the amount of nutrients available in the lake. Long Lake contains a relatively low quantities of nitrates and phosphates which would indicate a small amount of productivity and low nutrient supply. These factors also seem to indicate an oligotrophic condition. The similarity between readings in the epilimnion and hypolimnion layers would indicate that spring mixing has restored a uniform distribution of the nutrients.

On the other hand, Bolger Bog contains a very large supply of nitrates and total phosphates. Also there is a great difference between the measurements in the epilimnion and hypolimnion layers. This seems to show that no complete mixing has occured. A positive H_2S reading would seem to back this up as well. This can be explained as follows: The phytoplankton in the upper layers have reduced the supply of nitrates and phosphates. In the lower layer there is a continual increase of nutrients due to dead organisms sinking to the bottom. In fact, the difference between the nutrients in each zone could continue to increase until as the data shows, there is much more nutrients and phosphates in the hypolimnion as compared to the epilimnion.

SECTION II. PHYTOPLANKTON AND ZOOPLANKTON

SAMPLING METHODS :

The method for collecting phytoplankton and zooplankton was quite simple. A Wisconsin Net was towed behind the rowboat for about 5 minutes. The pace was kept steady so that the net remained only about one foot below the surface. This was done twice for each of the lakes, once during the day and again at night. When the sampling was completed the specimens were rinsed into a plastic bottle and transported back to the lab where they were preserved in 4% formalin.

RESULTS :

The fallowing is a detailed listing of the different species of phytoplankton and zooplankton found in Long Lake and Bolger Bog.

Bolger Bog --	AM	PM
Phytoplankton		
Asterionella	some	few
Dinobryon	many	many
Ceratium	0	7
Zooplankton		
Cyclops	10	8
Senecella	5	20
Canthocamptus	0	3

Bolger Bog Zooplankton cont'n

	AM	PM
Keratella	some	many
Asplanchna	5	few

LONG LAKE :

Phytoplankton

	AM	PM
Staurastrum	20	35
Dynobryon sociale	some	50
Asterionella	many	very many
Tabellaria	many	vey many
Ceratium	1	5
Desmidium	0	some
Quadrigula	0	2

Zooplankton

	AM	PM
Keratella	several	many
Asplanchna	some	few
Daphnia longispina	some	several
Bosmina coregoni	0	2
Cyclops	some	some
Brachionius	0	1
Holopedium	0	few

By comparing the AM with the PM samples for each lake it is clear that there is somewhat of a difference. The PM samples seem to contain more of a variety and in more numbers too. It turns out that this difference can quite easily be explained. Most of the preditors that feed on the phytoplankton and zooplankton are sight feeders, that is they will feed on organisms they see swimming around. So many of the species of plankton will only come out at night.This is certainly reflected in the different species which were collected at night.

Looking at the North American lakes in general, one finds many representatives from both the oligotrophic and eutrophic type conditions. The deep oligotrophic lakes such as Long Lake are characterized by Clorophycean, chlorophyll containing, type organisms and many desmids. The shallower eutrophic lakes like Bolger Bog are more characterized by Myxophycean, bacterial types, and diatoms. Also common in theses waters are the coverings of plankton "blooms" during the warmer summer weather. As far as controlling the plankton it seems that both nitrates and phosphates are the limiting factors. In Long Lake the nutrient level is pretty low thus the plankton species reflect this by showing up in lesser quantities. Bolger Bog on the other hand reflects more bacterial types because of it's very high nitrate and phosphate content.

SECTION III. FISH ANALYSIS

SAMPLING METHODS :

To examine the fish populations in the area the group desided to use four different sampling sights. This was done in order to get a random sample from all the different types of lakes on the property. The four lakes which were chosen were Long, Bergner, Morris, and Bolger. For collecting specimens from these lakes it was neccessary to use various trapping techniques. The main type of net used was a Fyke net which was placed in both Bergner and Long. This was good for catching several perch and some bass. Another type of trap used was the common minnow trap, here several were placed in Bergner,Long, and Bolger. These were good for collecting a variety of minnow, sticklebacks, and baby perch. The final technique used for sampling was the fishing pole. These were only used on Morris Lake where several pike and one or two perch were caught. All fish were then taken to the lab where complete condition analyses were done.

RESULTS :

The following is the data for the bass which were collected. All were from Long Lake except the Rock Bass which was from Tenderfoot Creek.

Micropterus salmoides	Total Length	Forked Length	Age
(Largemouth Bass)			
1)	216	209	2+
2)	315	306	3+

cont'n

(Largemouth Bass)	Total Length	Forked Length	Age
3)	205mm	197mm	2+
4)	205	197	2+
5)	209	203	2+
6)	205	199	2+
7)	220	212	2+

- Average Forked length for the Largemouh Bass in the area at age 2+ was 210mm , The average forked length for the ones taken from Long Lake was also 210mm.

<u>Micropterus dolomieue</u> (Smallmouth Bass)	Total Length	Forked Legth	Age
1)	420mm	405mm	5+

- The average forked length for a Smallmouth Bass at age 5+ is 408mm ,

<u>Micropterus rupestris</u>

(Rock Bass)

1)	203	200	2+

- This was also average for the Rock Bass in the area.

In the northern areas of the United States the Largemouth Bass reaches a total weight of about 8 pounds. When they are caught in the mud bottom lakes such as Long Lake, the bass is a dark olive brown to black color. These fish seem to realy thrive in small-medium sized hard water lakes with clear waters. The shore-lineshould contain alot of weed beds which can produce food and hide the smaller fish which the bass like.

The Largemouth Bass feeds on all types of aquatic insects and any small minnows which they can catch. As they get older they tend to feed more on little perch, minnows, small sunfish and even frogs.

As for the smallmouth Bass it appears it only reaches a weight of somewhere near 4 pounds and a length of about 15 in. The prefered habitat is a medium sized clear water lake with relatively clean bottoms. These fish seem to like deeper waters then do the Largemouth, but they feed on basically the same things.

The Rock Bass is a fish very much resembling a type of sunfish. It reaches a length of about 8-10 inches and feeds primarily on small crayfish and aquatic insect larvae. These fish seem to travel in schools and are found along weedy margins of small lakes . They are not uncommon in mud-bottom lakes and creeks.

It appears from the data that was collected on the bass that it is very much at home in Long Lake. The fish which were caught were very much average for the UNDERC property. All the neccessary food is available in Long as well as the cover needed for proper feeding.

From the number of bass caught it seems that maybe the lake could contain too many of them. The lengths and weights were all average, but from the data on the lakes water chemistry and plankton samples it seems they should be doing better. The conditions could be more above average if some of the fish were removed. As a possible solution to this slight overpopulation problem the lake should be used more for fishing. By removing some of the average sized fish, it would give more room for the remaining ones to grow to more impressive sizes.

Tha fertility of a lake is determined by the amount of dissolved phosphates and nitrates in the water. This is the main controlling factor for the numbers of fish a lake can support. Long lake, showing oligotrophic conditions has a small amount of these nutrients. This makes the carring capacity of the lake a bit lower then it could be. If the population density could be kept low for a while the food supply could increase thus allowing the species of fish in the lake to have a greater growth rate.