A Limnological Comparison of Two Systems Found at the University of Notre Dame's Environmental Research Center (UNDERC)

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The purpose of this paper is to make a limnological comparison of two of the freshwater systems found on the property of the University of Notre Dame's Environmental Research Center (UNDERC). The comparison will include the topography of each lake, oxygen and temperature profiles, chemical analysis of water samples, and plankton analyses.

The first system bears the name Morris Lake, and its US Land Survey location is given by N½ Sec35 T45N R42W (Gogebic County, Michigan). Morris Lake is a shallow lake with a large littoral zone around much of its perimeter. The single exception to this is a large hill at the southeastern end of the lake which causes a steep bank and a comparatively small littoral zone on that shore. The lake is surrounded by a large number of speckled alder (Alnus rugosa), some black spruce (Picea mariana), and a few tamarack (Larix laracina). The hill and the tree cover offer some protection from the wind, but the lake is open and shallow enough to undergo a significant amount of mixing. Water drains from the south into Morris from Ward Lake, and then drains out of Morris northward into Tenderfoot Creek. Morris Lake also supports a large population of stunted Northern Pike (Esox lucius) and a few Yellow Perch (Perca flavescens).

The second system is known as Forest Service Bog and its location is given by the US Land Survey as NE¼ Sec16 T43N R8E (Vilas County, Wisconsin). Forest Service is an acid bog which is surrounded by a large, quaking Sphagnum mat. The bog is approximately four Meters in depth, the last 1-1½ Meters of which is a false bottom of silt. The mat and its perimeter support a large number of black spruce and tamatack trees, and also Pink Lady Slippers (Cypripedium acuale), Sundew (Drosera rotundifolia), and Pitcher Plants (Sarracenia purpurea). The bog is surrounded on all sides by steep hills which afford a great deal of protection from the wind, and the bog, therefore, recieves very little mixing. Forest Service Bog does not recieve drainage from any other body of water, and it does not drain into any other body of water. The bog supports no fish with the possible exception of the Central Mudminnow (Umbra limi).

The following data was gathered at Morris Lake on June 2, 1981, at Forest Service Bog on June 4, 1981.

The Oxygen and Temperature profiles which are given in Table 1 were done with a YSI meter and probe and they are illustrated in Graphs 1-3.

TABLE 1:

Morris Lake (6/02/81) Site 1 - the deepest part of the lake

DEPTH	*PPM O_2	**T°C
air	9.2	20
surface	9.8	17
½M	9.8	17
1M	9.6	17
1½M	9.6	16.5
2M	11.2	14
2½M	9.0	11.5
3M	1.2	8.5
3½M	.6	7.5
4M	.4	7
4½M	.4	6.5

*PPM O_2 represents parts per million oxygen in the sample depth

**T°C represents the temperature in degrees Centigrade

TABLE 1 (cont.)

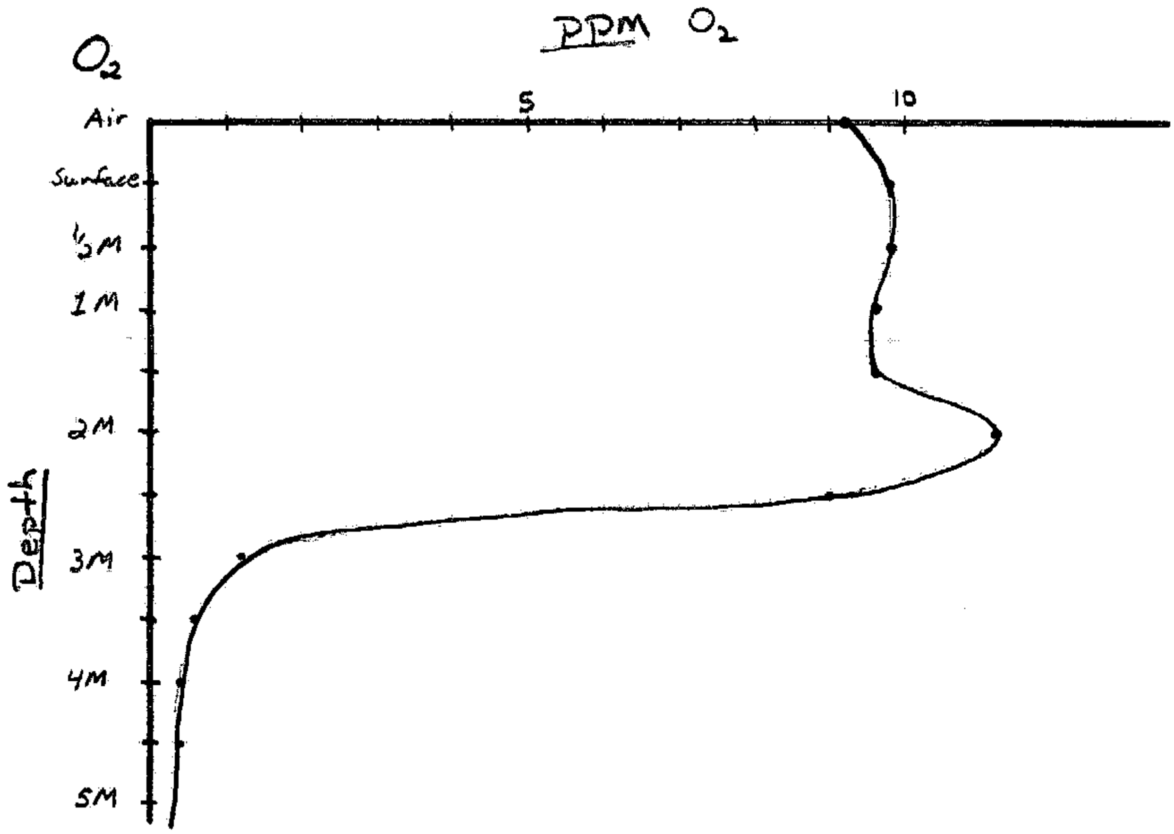
Morris Lake (6/02/81) Site 2 - Fifteen feet from shore

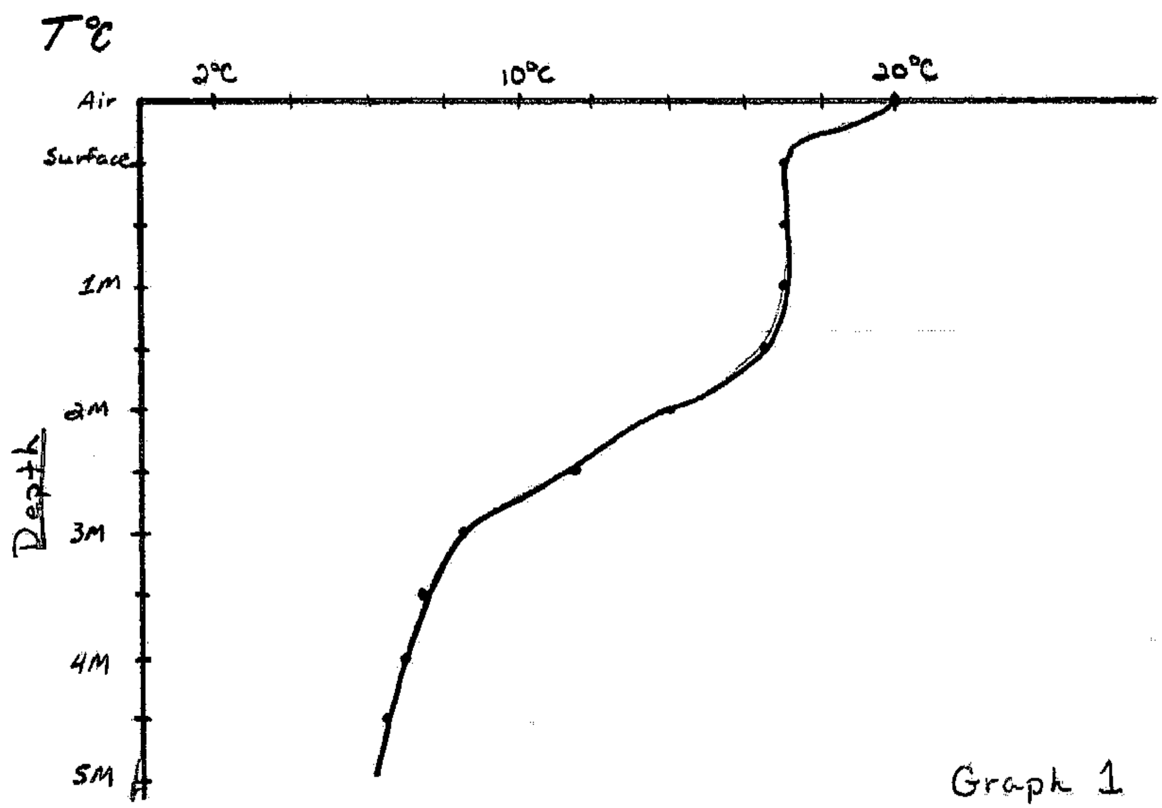
DEPTH	PPM O_2	T°C
air	9.2	20
surface	9.0	17
½M	9.3	17.5
1M	9.0	17
1½M	9.0	17.5
2M	10.2	14
2½M	5.5	11
3M	0.6	10.5

Forest Service Bog (6/04/81)

DEPTH	PPM O_2	T°C
air	9.2	20
surface	5.4	18.5
½M	5.4	18
1M	4.6	17.8
1½M	0.9	16.3
2M	0.0	13.5
2½M	0.0	11
3M	0.0	9

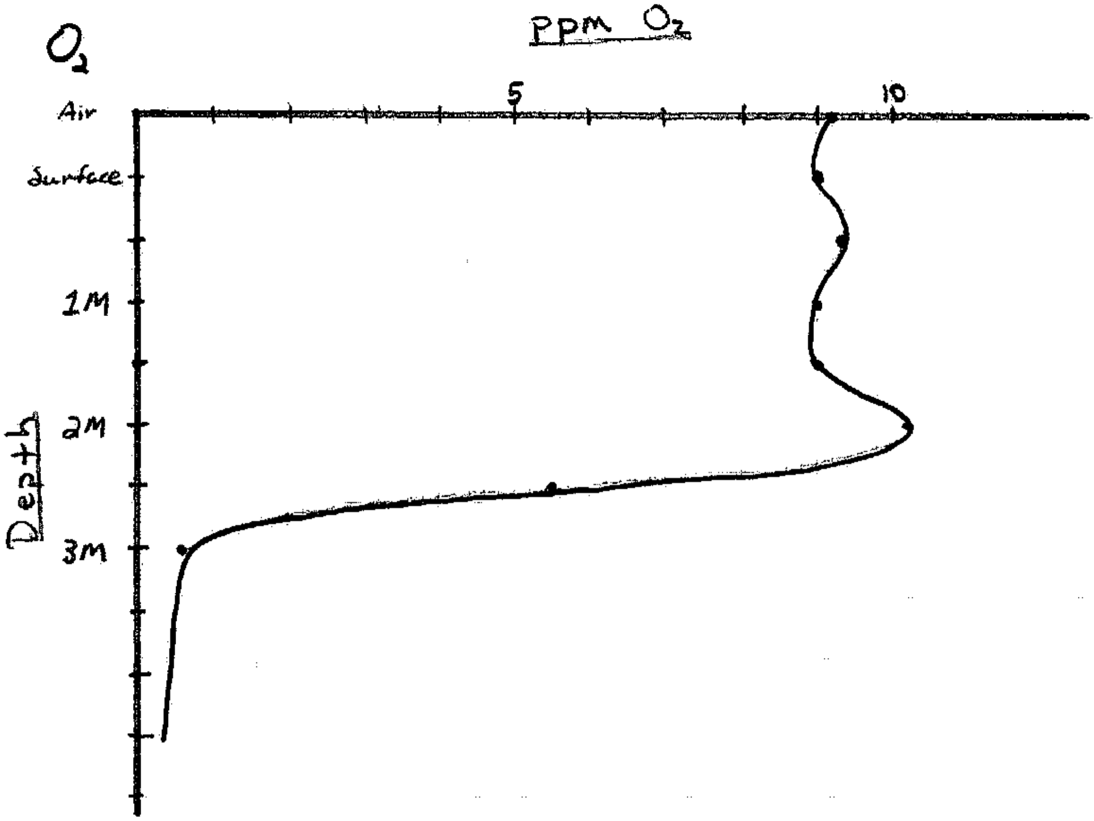
Morris Lake O₂ and T°C Profiles : Site 1

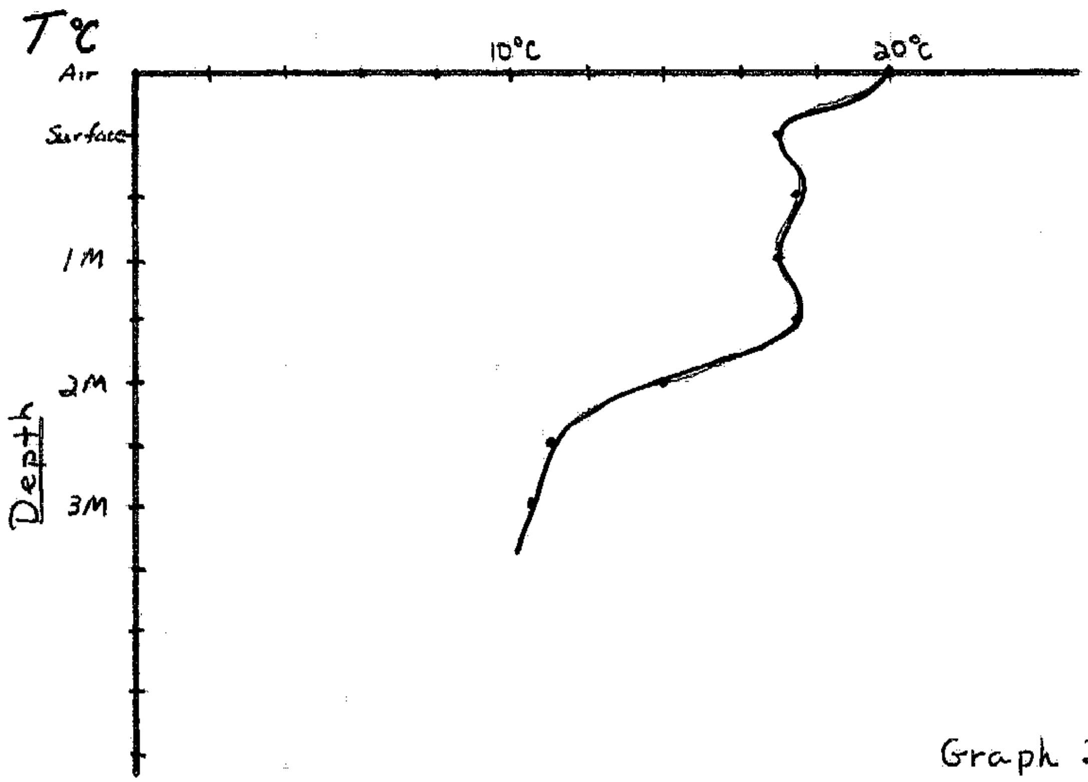




Graph 1

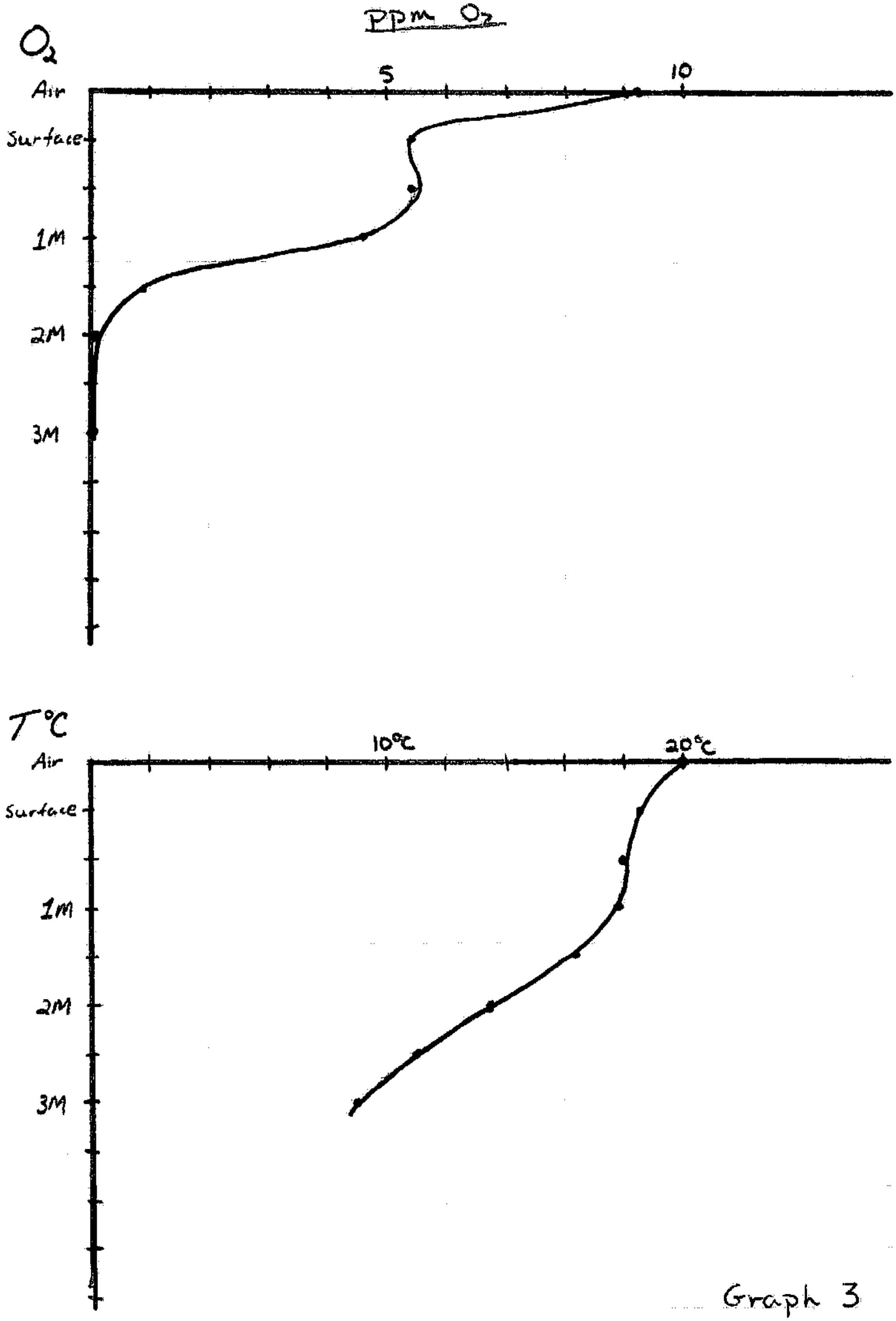
Morris Lake O_2 and T°C Profiles: Site 2





Graph 2

Forest Service Bog O_2 and T °C Profiles



Graph 3

The data given in Table 2 is the result of tests done with a Hot Kit, including spectrophotometer, on water samples taken in Kemmerer bottles at the indicated depths.

Table 2: Water Chemistry Data

Morris Lake	1M	2M	3M
<u>Test Type</u>			
Alkalinity	50mg/l	45mg/l	40mg/l
Acidity (Phenolphthalein)	60mg/l	47mg/l	50mg/l
pH	5.8	5.8	5.8
Hardness (Ca)	38mg/l	35mg/l	38mg/l
(Mg)	10mg/l	10mg/l	12mg/l
(total)	48mg/l	45mg/l	50mg/l
Phosphates	0.2mg/l	0.1mg/l	0.1mg/l
Nitrates	.7mg/l	.5mg/l	.6mg/l
Sulfates	1mg/l	.5mg/l	2mg/l
Specific Conductance	42umhos	41umhos	42umhos
Color (Apparent)	80 units	80.5units	90units
(True)	80 units	80 units	90units
Secchi Disk	1.3 M		
H_2S	None	None	None

Forest Service Bog	1M	2½M
<u>Test Type</u>		
Alkalinity	3mg/l	3mg/l
Acidity (methyl orange)	5.5mg/l	5.5mg/l
Acidity (phenolphthalein)	130mg/l	125mg/l
pH	4.8	4.8
Hardness (Ca)	0.0mg/l	0.0mg/l
(Mg)	5mg/l	5mg/l
(total)	5mg/l	5mg/l
Nitrates	.4mg/l	.5mg/l
Sulfates	2mg/l	2mg/l
Specific Conductance	11.2umhos	15.6umhos
Color (Apparent)	40 units	45units
(True)	30units	30units
Secchi Disk	3M	
H_2S	None	None

Table 3 gives the Phytoplankton and Zooplankton found in each of the two systems. The plankton was collected using a standard plankton net which was towed by a rowboat for a period of four minutes.

TABLE 3:

Morris Lake Plankton (6/02/81)

Phytoplankton	Number in 1 milliliter sample
Asterionella	2300
Ceratium hirundella	1125
Desmids	15
Dinobryon bavaricum	850
Fragillaria	75
Oscillatoria	75
Synedra	75
Tabellaria sp. a	2225
sp. b	75
sp. c	50
sp. d	125
Zooplankton	
Asplanchna	150
Bosmina coregoni	125
Cyclops bicuspidatus	25
Keratella cochlearis	8925
Kellicottia longispina	125
Nauplius larvae	975
Sinantherina	775
Trichocerca	75

Forest Service Bog Plankton (6/04/81)

Phytoplankton	
Desmidium	10
Dinobryon	20
Oscillatoria	10
Volvox	13
Zooplankton	
Daphnia	26
Epichura locustris	36
Holopedium gibberum	90
Keratella cochlearis	235
Nauplius larvae	61
Sinantherina	186

From the data presented, it is obvious that the two systems vary greatly. What do the variations mean? By looking at differences individually, then collectively, the productivity and possible succession pattern of each system will be seen. The water chemistry, oxygen, and plankton all show great differences and all are very interrelated.

In the water chemistry section, the alkalinity measurement refers to the quantity and kinds of compounds present in the water which collectively shift the pH toward the alkaline side. The property of alkalinity is usually imparted by bicarbonates (HCO_3^-), carbonates ($CO_3^{=}$), and hydroxides (OH^-).[1] The following equilibrium system is the major buffering system in fresh waters.

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

The alkalinity measurement, therefore, tests the buffering capacity of the system. Morris Lake shows an alkalinity of 45mg/l which is fifteen times that of Forest Service Bog. This means that Morris can more effectively buffer acids such as those received in acid rainfall and the lake can therefore stabilize its pH and continue to support many pH "change intolerant" forms of life. Forest Service Bog, however, is unable to effectively buffer acids and things such as acid rain may lower the bog's pH and have possibly harmful effects upon the bog life.

The acidity measurement in fresh water systems is caused by uncombined CO_2, organic acids such as tannic, humic, and uronic acids, mineral acids, and salts of strong acids and weak bases.[2] The acidity itself is a measure of the amount of H^+ ions able to be donated in a sample. The acidity levels found in Morris probably result from a little CO_2, some humic acid, mineral acids, and some acid rainfall. The same sources which contribute acidity to Morris also contribute to the acidity of Forest Service Bog. Forest Service, however, has a much higher acidity level. True, the greater number of conifers which surround Forest Service contribute more humic acid than the few that surround Morris Lake, but Morris probably recieves more mineral acids by the drainage of groundwater, whereas Forest Service receives only surface runoff. The higher acidity levels in the bog result slightly from the organic acids which live <u>Sphagnum</u> secretes but most of the H^+ ion concentration results from the active cation exchange in the walls of <u>Sphagnum</u>, during which H^+ is released.[3]

$$\text{SPHAGNUM}—COOH \rightleftharpoons COO^- + H^+ \rightleftharpoons COO^-Ca^{++} + H^+$$

pH is a measure which is determined by the concentrations of the acidity and alkalinity causing compounds present and the ratios of one to another. The pH of natural waters is governed to a large extent by the interaction of H^+ ions from the dissociation of H_2CO_3 and from OH^- ions resulting from the hydrolysis of bicarbonate.[4] Morris Lake contains most all of its alkalinity as bicarbonate and carbonate and uses them to buffer acids in the following way. When carbonate is present, adding H^+ ions neutralizes hydroxyl ions formed by the dissociation of HCO_3^- and $CO_3^{=}$, but more are formed immediately by reaction of the carbonate with water as long as the reservoir of carbonate ion is present. The pH remains essentially the same until the supply of carbonate and/or bicarbonate is exhausted.[5] Morris maintains its pH at 5.8. Forest Service

Bog has little buffer and with its greater acidity has a pH of 4.8, which is ten times more acidic than that of Morris.

The term water hardness has often been used as an assessment of the quality of the water supplies. A water's hardness is determined by the content of calcium and magnesium salts. The hardness is contributed to by the rock runoff of the drainage basin, atmospheric precipitation, and the balances between evaporation and precipitation. Seepage systems like Forest Service Bog are generally lower in hardness as compared to drainage systems like Morris Lake because the salinity (Ca and Mg salts) of groundwater is generally much higher than that of surface runoff.[6] Also, the Sphagnum mat of the bog system removes Ca^{++} and Mg^{++} ions from the water in its cation exchange process which was mentioned earlier.

The Specific Conductance of the sample refers to the sample's ability to conduct an electrical current. This measure, therefore, determines the concentration of inorganic ions in the sample. It may also be related to alkalinity and hardness. Inorganic ions OH^-, $CO_3^=$, HCO_3^- and Ca^{++} and Mg^{++} would cause the conductivity. Therefore high hardness and high alkalinity values would lead one to expect high conductivity readings. Morris Lake which has much higher alkalinity and hardness readings than Forest Service Bog also has a much greater specific conductance and bears out the hypothesis.

The color reading is given for both an apparent color and a true color. The true color is the color reading after the sample has been centrifuged for ten to fifteen minutes to remove suspended particles. The color remaining is functionally the result of light scattered upward from the lake after it has passed through the water to various depths and undergone selective absorption enroute. Most of the color of lake waters results from dissolved organic matter and its rapid selective absorption of the shorter wavelengths of the visible spectrum. The result is a dominance of emitted scattered light in the green portion of the spectrum and, with increasing concentrations of organic matter, especially humic compounds, an increase in yellows and reds.[7] The color of Forest Service Bog is probably due to humic compounds. The higher color reading in Morris Lake must be due to matter picked up as water drains into the lake because Morris does not recieve even an equivalent amount of humic material from its surroundings as compared to Forest Service.

The Secchi disk reading is an approximate evaluation of the transparency of water to light. The depth at which it is possible to see the disk can be linked with the amount of dissolved organic matter and, therefore, the water color. Forest Service Bog which has a color ½ that of Morris Lake has a Secchi disk reading more than twice as great. This reading is not always a good, accurate measure due to irregular sunlight, shadows, and the individual taking the reading.

The H_2S reading was taken merely by smelling the sample. H_2S should have been found in both the deep water samples where no oxygen was found. In areas where oxygen is present the hydrogen sulfide is oxidized to sulfate. None was found in the samples taken, but this data should be regarded with suspicion.

Analysis of the oxygen and temperature profiles of Morris Lake reveals that the lake shows both oxygen and temperature stratification. The lake shows an epilimnion (an upper stratum of more or less uniformly warm, circulating, and fairly turbulent water), a metalimnion or thermocline, and a hypolimnion (a deep, cold, and relatively undisturbed region). The readings taken near shore in Morris found oxygen plentiful (9.0ppm) down to 2½meters, but found none at 3 meters (a YSI reading of .6 is more likely due to H_2S interference than to oxygen). The conclusion reached here is that the 3 meter reading was taken in the muck of the bottom and that there is oxygen distributed throughout the water column in the shallow areas. The temperature at this site ranged from 17°C at the surface to 10.5°C at the bottom in the hypolimnion. The distribution of oxygen and the comparatively warm water at the bottom lead to the conclusion that the lake underwent spring turnover and is now restratifying. This would have occurred after the ice-melt when most of the water column had warmed to approximately 4°C. When all the water was at the maximum density (4°C), there was relatively little thermal resistance to mixing and only small amounts of wind energy woud have been required to mix the water column.[8] As spring has progressed, the surface waters have heated more rapidly than the distribution of heat has been brought about by mixing and stratification has begun to occur.(a few warm, calm days probably accomplished this). Once the surface waters heated and became less dense, thermal resistance to mixing was increased greatly and the lake began to achieve stability.

At the other testing site in Morris Lake (the deepest part of the lake) a large number of differences are found. Below a depth of 3 meters, there is no oxygen at all. There is also a much greater temperature difference between the epilimnionic and hypolimnionic waters (17°C at the surface, 6.5°C at 4½ M). This information is somewhat contradictory with the information from the shallow site in that the conclusion reached here is that the lake did not undergo spring turnover. The complete lack of oxygen in the hypolimnion verifies this. Had the lake turned over, there would still have been a significant amount of oxygen in the hypolimnion at the time sampling was done. It is probable, then, that the lake received sufficient wind and heat to mix it to a depth of about 3 meters. This degree of mixing would have been sufficient to completely turn over the shallow areas which comprise most of the lake, but would have been insufficient to effect a turnover of the deeper areas.

In Forest Service Bog, analysis also reveals that stratification is present. The data from the sampling site reveals that there is little oxygen below a meter and a half and none below 2 meters. Although the temperature at the bottom is fairly high, it is safe to assume that the bog has not undergone spring turnover. The bog is so well protected that it does not receive sufficient wind action to even mix much below a single meter. The fairly high temperature can be accounted for because sunlight penetrates all the way down to the silt (Secchi seen to bottom) so that the entire water column receives heat.

What does it mean when a lake does or does not turn over? The turning over of a lake remixes the nutrients (sulfates, phosphates, nitrates) which have settled to the bottom. Mixing also gets oxygen down to the lower levels of the lake, most importantly to the sediment-water interface where bacterial decomposition is the greatest. This is important because bacterial decomposition is accomplished much more effectively when done under aerobic rather than anaerobic conditions.[9] This allows the lake to replenish nutrients which otherwise would have accumulated as dead organic matter on the bottom. In a bog environment like Forest Service, no oxygen ever reaches the sediment-water interface and bacterial decomposition is greatly hindered and must always be accomplished anaerobically. This is the reason there is such a large accumulation of dead organic matter in a bog system. In lakes that do turn over, even if only to a degree, most of the oxygen which is consumed is consumed by bacterial decomposition.[10] Plant and animal respiration consume much less. This is the reason that as the season progresses, the oxygen concentration becomes greatly reduced in the hypolimnion where bacterial oxidation of organic matter occurs. The more productive the lake (more organic matter reaching the hypolimnion), the more quickly oxygen will be used in the hypolimnion.

The next point to notice in the profile of Morris Lake is a distinct oxygen bulge at a depth of 2½ (2.5) to 3 meters. This can be accounted for in two major ways. The solubility of the oxygen in the epilimnion decreases with the increasing temperature as summer arrives. Also, the oxygen consumption in the hypolimnion results in a reduction of oxygen with depth. The result is an absolute maximum in the metalimnion which may or may not be at or above saturation.[11] The second possibility and the more probable answer is that the oxygen maxima is the result of oxygen produced by algal population that develop more rapidly than they are lost from the zone of increased density by sinking. The algae are usually well adapted to growing well at low temperatures and light intensities and often they have access to nutrient concentrations that are higher in the lower metalimnion. Blue-green algae, especially Oscillatoria which is found in Morris, are major contributors to this phenomenon.[12] A third and minor possibility for the oxygen bulge is that water in Morris's large littoral zone, enriched with oxygen, dissipates into the metalimnion layer of equal density and contributes to the oxygen peak.

The plankton samples which were taken from each system also show a great deal of difference. The different environments the lakes present undoubtedly cause this. The most striking fact is that there are much greater numbers of plankton found in Morris Lake. Keratella cochlearis, a retifer, is the most abundant species in both systems, but is 37 times more plentiful in Morris than in Forest Service Bog. The much greater abundance is due to parameters which have already been discussed. Morris has a higher oxygen level, it turns over to some degree, it has a large littoral zone, a more neutral pH, a drainage source, and a greater number of circulating nutrients.

In addition to the numbers present, the types of plankton present also differ. An example of this is the two differing types of Dinobryon found. Dinobryon bavaricum is often found in hard or semi-hard waters[13] and is present in the harder -

watered Morris system and not in Forest Service Bog. Dinobryon cylindricum is most likely the species found in Forest Service and it is more adapted to softer waters and is the species more often found in bog waters. Desmidium favors a bog environment and low calcium waters and is found in the low calcium Forest Service Bog. Contrastingly, three major genera of diatoms are common to waters with high calcium content -- Fragilaria, Asterionella, and Tabellaria;[14] these genera are found in the higher calcium waters of Morris and not in Forest Service. Volvox globator is found in Forest Service Bog and is known to be found in the shallow water of bogs, ponds, and ditches, especially where nitrogen content is high.[15]

The zooplankton is dominated by three major groups in freshwater systems, and these three dominated this study. The two subclasses of Crustacea and especially the rotifers dominated the samples. Since the reproduction rate of rotifers is strongly related to quality and abundance of food,[16] it is as expected that they are in much greater numbers in Morris Lake. Several points can also be made about the cladoceran distribution. Holopedium, for example, is found in bog systems and is present in the Forest Service sample. Bosmina is a much smaller cladoceran than Daphnia, and although both would be adapted to Morris Lake's chemistry, the larger Daphnia fall prey to the Northern Pike population in Morris as these zooplankters migrate up and down the water column each day. In areas where fish limit the zooplankton, it is common to find small cladocerans like Bosmina and also large numbers of rotifers.[17]

It has been shown that the two freshwater systems at UNDERC which were studied are very different in many ways. Morris

Lake is a much more eutrophic system than Forest Service Bog. It supports a much larger plankton population, many more aquatic macrophytes, and a fish population. Forest Service Bog is a seepage system; it is cut off from other sources of water and must rely on itself and its immediate environment for nutrients. Morris, however, is a drainage system and has a constant supply of fresh nutrients coming in. Also, Morris Lake is able to undergo some degree of turnover, whereas Forest Service Bog is not and Morris is therefore able to decompose more effectively and keep its nutrients circulating. Due to its inability to decompose and the large amounts of sedimenting organic matter found in Forest Service Bog, it is likely that the bog will eventually fill up and the wet habitat will support, at least for a time, a black spruce forest. Morris Lake shows a very different type of succession. The shallow lake with its large littoral zone and somewhat more eutrophic nature (Morris is more productive than Forest Service Bog, but is not productive enough to be considered a eutrophic lake) will most likely succeed to a marsh and then to a beech-maple forest.

FOOTNOTES

[1]Robert G. Wetzel, *Limnology*, (W.B. Saunders Company: Philadelphia, 1975) p. 172

[2]Wetzel, p. 173

[3]Wetzel, p. 175

[4]Wetzel, p. 174

[5]Wetzel, p. 168

[6]Wetzel, p. 133

[7]Wetzel, p. 61

[8]Wetzel, pp. 68-69

[9]Wetzel, p. 128

[10]Wetzel, p. 126

[11]Wetzel, p. 129

[12]Wetzel, p. 130

[13]G. W. Prescott, *Algae of the Western Great Lakes Area: Exclusive of the Desmids and Diatoms*, (Cranbrook Institute of Science: Bloomfield Hills, Michigan, 1951) p.136

[14]Wetzel, p. 154

[15]Prescott, p. 64

[16]Wetzel, p. 473

[17]Wetzel, p. 477

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Prescott, G. W. _Algae of the Western Great Lakes Area: Exclusive of the Desmids and Diatoms_ (Bloomfield Hills, Michigan: Cranbrook Institute of Science, 1951)

Wetzel, Robert G. _Limnology_ (Philadelphia: W. B. Saunders Company, 1975)

Water Chemistry Data
UNDERC 1981
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Morris Lake (6/2/81)

Topography: Mostly surrounded by conifers with some hardwoods. There is small brush and reeds around the shoreline and there is a large hill to the SE.

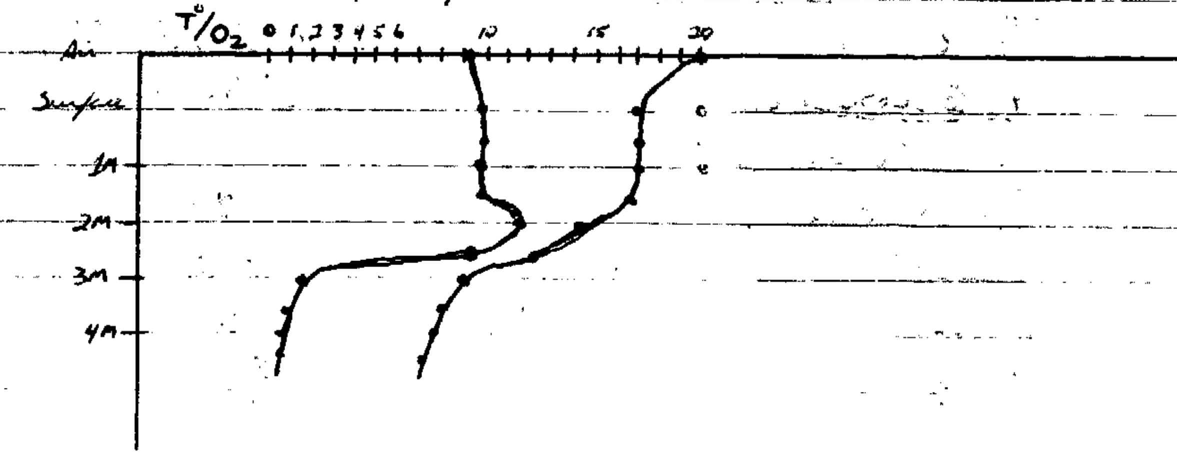
Testing Conditions: Nice day with a slight wind.

YSI Data:

Depth	PPM ①	PPM ②	T°C ①	T°C ②
Air	9.2	9.2	20°C	20°C
Surface	9.8	9.0	17	17
½ M	9.8	9.3	17	17.5
1 M	9.6	9.0	17	17
1½ M	9.6	9.0	16.5	17.5
2 M	11.2	10.2	14	14
2½ M	9.0	5.5	11.5	11
3 M	1.2	.6	8.5	10.5
3½ M	.6	~~NR~~	7.5	~~NR~~
4 M	.4	—	7	—
4½ M	.4	—	6.5	—

① Was a sampling area in the deepest part of the lake

② Was a sampling area near the shore



Secchi Disc 1.3 M
pH 6.0
H_2S Negative

Test	1M	2M	3½ M
Acidity	60 mg/l	47 mg/l	50 mg/l
Alkalinity	50 mg/l	45 mg/l	40 mg/l
Hardness (Total)	48 mg/l	45 mg/l	50 mg/l
Ca^{++}	38 mg/l	35 mg/l	38 mg/l
Mg	10 mg/l	10 mg/l	12 mg/l
Sulfate	8 mg/l	0 mg/l	2 mg/l
Nitrate	.7 mg/l	.5 mg/l	.6 mg/l
Phosphate (Total)	.2 mg/l	.1 mg/l	.1 mg/l
— Ortho	.075 mg/l	.06 mg/l	.085 mg/l
Specific Conductance	42 units (mhos)	41 units (mhos)	42 units (mhos)
Color Apparent	80 units	80.5 units	90 units
True	80 units	80 units	80 units

Plankton	#/ml
Keratella cochlearis	8925
Bosmina coregoni	125
Trichocerca	75
Asplanchna	150
Nauplius Larvae	975
Dinobryon bavaricum	850
Ceratium hirundella	1125
Tabellaria	2225, 75, 50, 125
Asterionella	2300
Synanthera	775
Desmidium	25
Oscillatoria	125
Synedra	75
Fragellaria	75
Cyclops bicuspidatus	25
Kellicottia longispina	125

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Long Lake (6/3/81)

Topography: Surrounded mainly by conifers with a few hardwoods. It is protected well from side to side but may get a lot of wind from end to end.

Testing Conditions: Fairly quiet - little wind

YSI Data	①	②	①	②
Depth	PPM		T°C	
Air	8.6	9.3	22	19
Surface	9.2	9.0	18	19
½ M	8.8	9.0	17.5	19
1 M	9.0	9.5	18	18.8
1½ M	8.9	8.6	18	18
2 M	9.0	8.6	17	17.5
2¼ M	8.8	—	16	—
2½ M	9.5	9.4	15	16
2¾ M	9.0	—	14	—
3 M	9.2	10.	13	13
3¼ M	8.4	9	11.5	11
3½ M	8.0	8.8	11	10.5
3¾ M	7.0	—	10	—
4 M	4.5	< 4	9.5	9
5 M	0	0	8	7.5
6 M	0	0	7	—
8 M	0	—	6.5	—

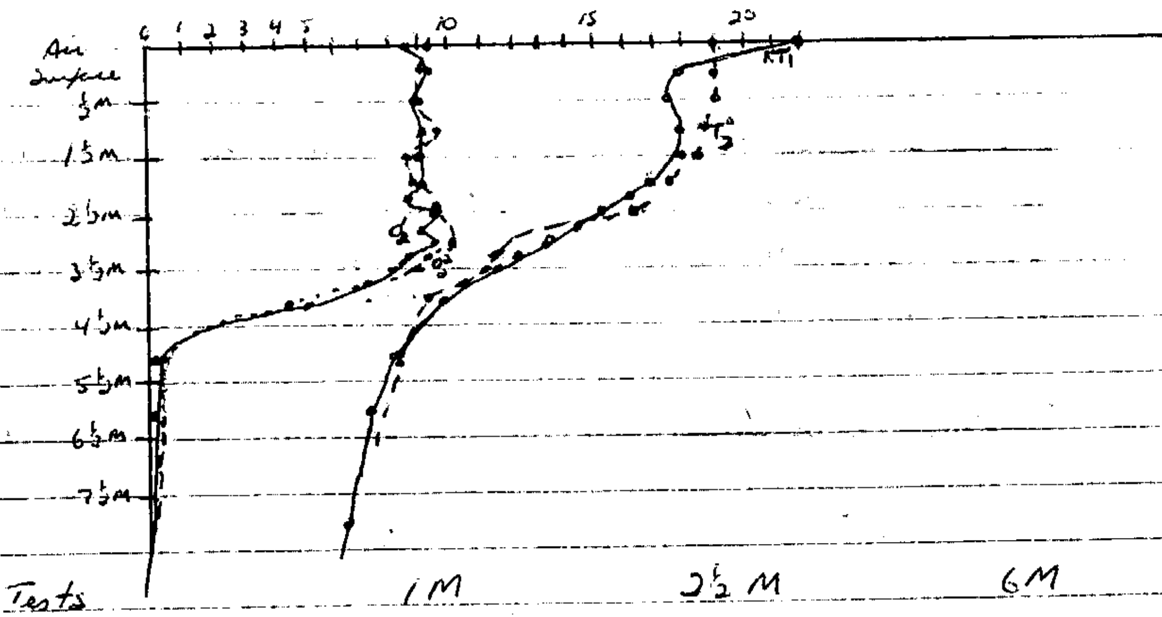
One sample taken at each end of Long Lake

Secchi Disc 3¼ M (sunny) 2½ M (cloudy)

pH 5.0

H_2S positive at 6 M

T°/O₂



Tests	1M	2½ M	6M
Acidity	125 mg/l	100 mg/l	120 mg/l
Alkalinity	0 mg/l	0 mg/l	0 mg/l
Color Apparent	50 units	50	50
True	48 units	48	48
Hardness (Total)	14 mg/l	15 mg/l	14 mg/l
Ca++	8 mg/l	9 mg/l	8 mg/l
Mg	6 mg/l	6 mg/l	6 mg/l
Nitrate	.5 mg/l	.5 mg/l	.4 mg/l
Sulfate	5.5 mg/l	8.0 mg/l	6.0 mg/l
Specific Conductance	9.6 mhos	9.0 mhos	9.5 mhos

Plankton Sample

#/ml

Dinobryon cylindricum	657	Asplanchna	15
Keratella cochlearis	183	Cyclops vernalis	15
Asterionella	126	Oscillatoria	12
Volvox	30	Metanauplius larvae	9
Tabellaria	48, 24, 12	Holopedium gibberum	12
Desmidium	15	Kellicottia longispina	9
Diatoma	12	Daphnia longispina	12
Staurastrum	6		

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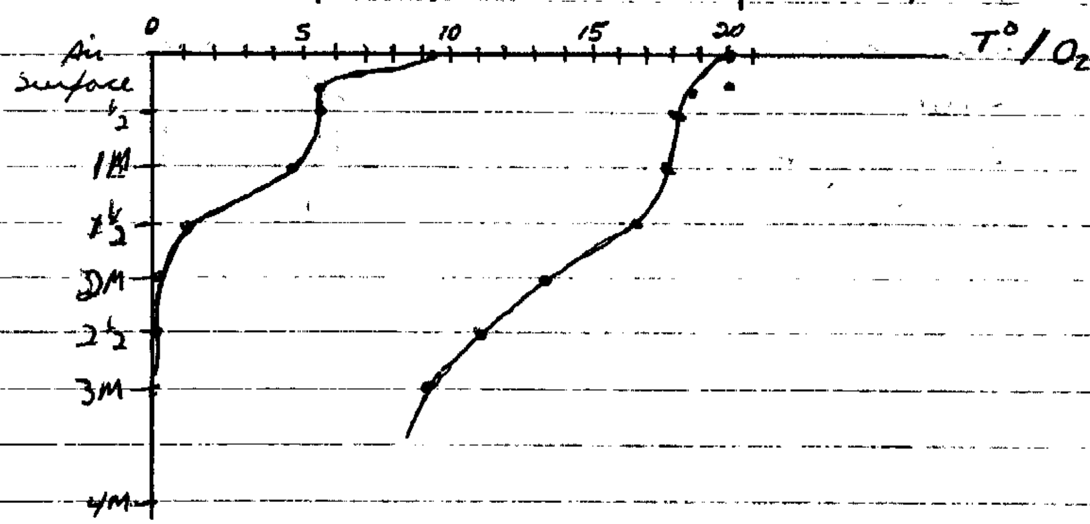
Forest Service Bog (6/4/81)

Topography: Sheltered by hills - it sits very low and is very protected. It has a very large bog mat at whose inner edge are dead spruce trees and at whose outer edge are black spruce and larch trees.

Testing Conditions: Very Calm and Sunny

YSI Data:

Depth	PPM	T°C
Air	9.2	20
Surface	5.4	18.5
½	5.4	18
1	4.6	17.8
1½	.9	16.3
2	0	13.5
2½	0	11
3	0	9



Secchi disc 3M (Bottom)
pH 4.8
H_2S Negative

Test	1 M	2 ½ M
Acidity MO	5.5 mg/l	5.5 mg/l
Acidity Phenolphthalein	130 mg/l	125 mg/l
Alkalinity	3 mg/l	3 mg/l
Hardness (Total)	5 mg/l	5 mg/l
Ca^{++}	0	0
Mg	5 mg/l	5 mg/l
Color Apparent	40 units	45 units
True	30 units	30 units
Nitrates	.4 mg/l	.5 mg/l
Sulfates	2 mg/l	2 mg/l
Specific Conductance	11.2 mhos	15.6 mhos

Plankton Sample

Epischura lacustris	36 /ml
Keratella cochlearis	235 /ml
Oscillatoria	10 /ml
Holopedium gibbernum	90 /ml
Nauplius larva	61 /ml
Sinantherina	186 /ml
Desmidium	10 /ml
Daphnia	26 /ml
Dinobryon	20 /ml
Volvox	13 /ml

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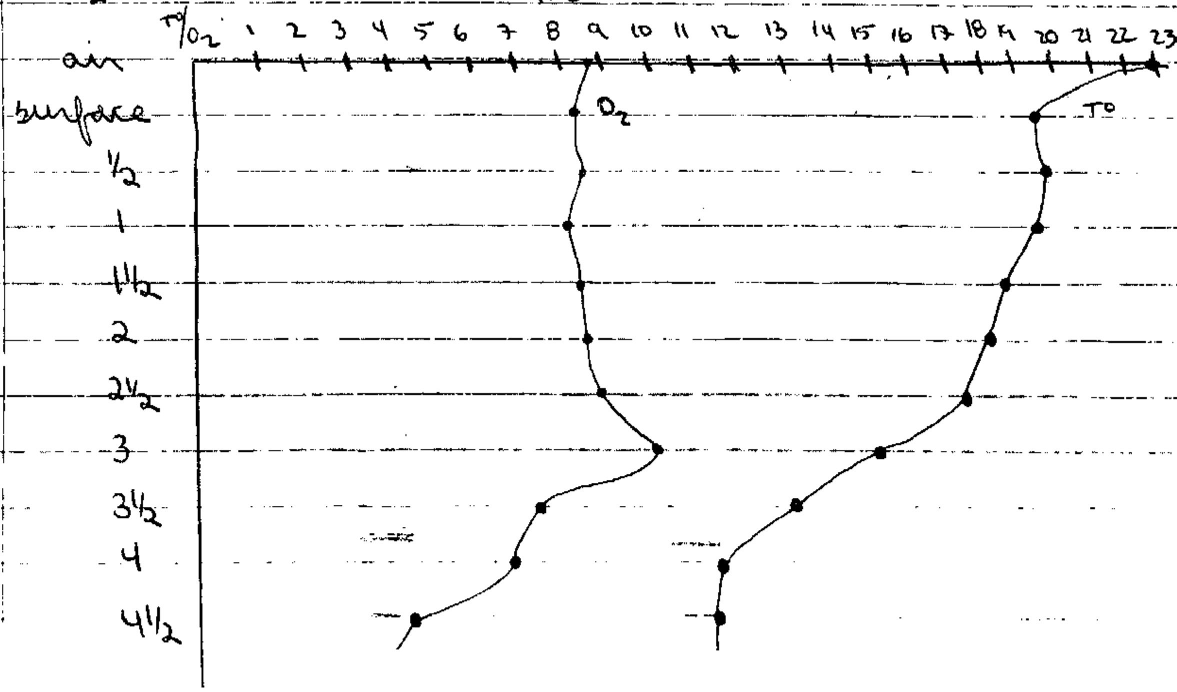
Bay Lake (6/5/81)

Topography: Large, fairly open lake with many bays; one sample was done in an arm of one of those bays which is nearly cut off by a spit of land.

Testing Conditions: Very Windy, but sunny

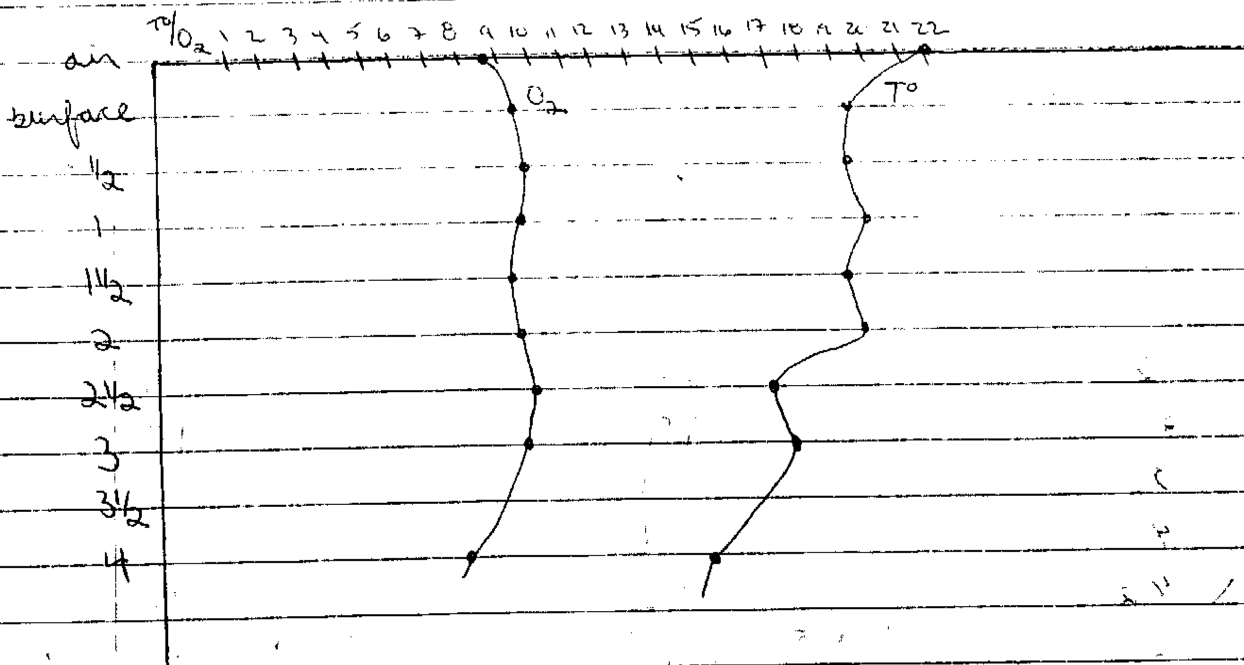
YSI (closed in part)

Depth	PPM	T °C
Air	8.7	23°
Surface	8.3	19.5
½	8.3	19.5
1	8.0	19.2
1½	8.2	18.5
2	8.3	18
2½	8.5	17.5
3	9.9	15
3½	6.9	13
4	6.4	11
4½	4.0	11



YSI (outside of closed in part)

depth	T°	O_2
air	22°	8.6
surface	19.5	9.2
½	19.5	9.4
1	19.8	9.3
1½	19.2	9.0
2	19.5	9.2
2½	17	9.5
3	17.5	9.4
4	15	7.8



YSI (middle of lake)

depth	T°	O_2
air	22°	8.6
surface	20°	9.3
½	20°	9.4
1	20°	9.3
1½	19.5	9.3
2	19.5	9.4
2½	~~18.2~~	~~9.5~~
3	18.2	9.5
3½	14	10.7
4	11	7

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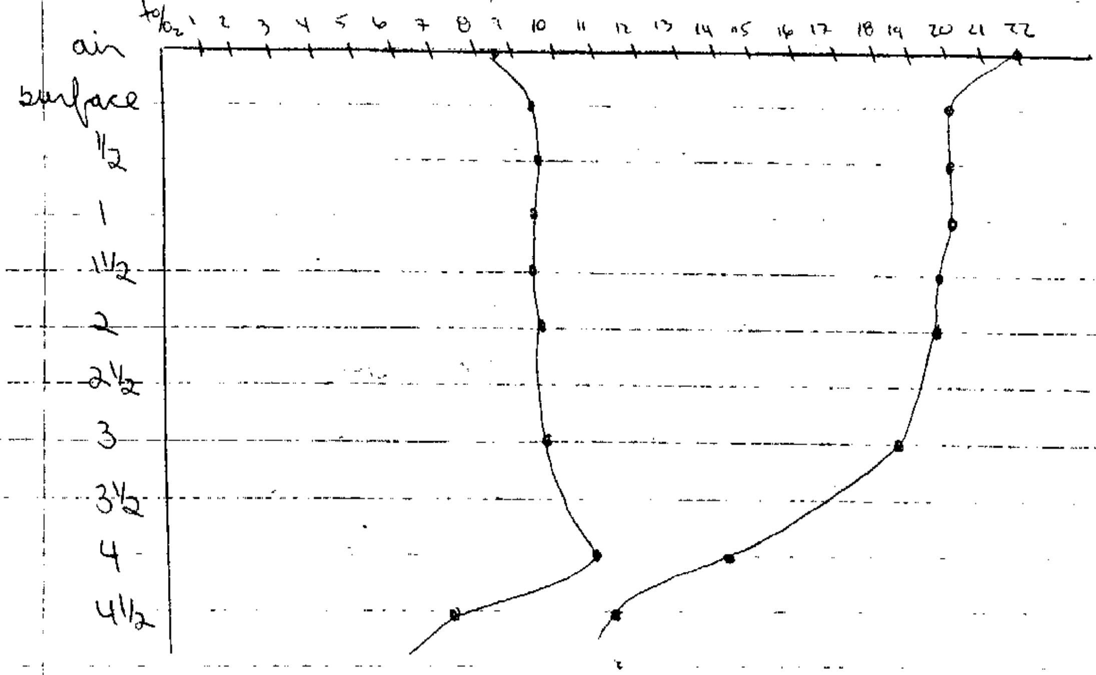
Bay Lake (continued)



Tests	closed in part			outside of closed in part	
	1m	bulge	4m	1m	3 1/2 m
acidity	50	45	50	55	55
alkalinity	6	6	6	6	6
color (true)	25	25	25	25	25
(apparent)	25	25	30	25	25
Mg^{++}	6	5	6	6	6
Ca^{++}	8	8	8	8	8
total	14	13	14	14	14
sulfate	5	4	4	4	3
nitrate	.6	.5	.6	.5	.5
conductance	19	19	19	21	19
pH	5.8 →				
secchi	4m			4m	

We tested two parts of Bay Lake. One part was becoming closed off by vegetation, and the other was outside of this area. We did both to determine if this segregation would change the water chemistry →

Our water chemistry tests came out almost identical for both parts of the lake, but our O_2 readings differed greatly.

The O_2 reading in the closed in part went down to four, whereas the outer part only went down to seven. This means that the inner part stratifies more easily because it is closed in. The outside part is very open and subjected to the wind which turns over the water easily, thus giving us a fairly high O_2 reading as low as 4 1/2 meters