A Comparison of

Ed's Bog and

Raspberry Lake

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I. General Description

A. Raspberry Lake

Raspberry lake is located in Gogebic County (Michigan), with the coordinates R42W T45N section 36. The lake is relatively small, approximately 200 meters at its longest point, and averages about 100meters in width.

The water of the lake is very clear. A secchi disc reading of four meters was obtained. The lake has a diverse phytoplankton and zooplankton populations, along with a fish population that includes Yellow Berch, Pumpkinseeds, and small-and large mouth bass.

The surroundings include small hills that slope toward the lake. The vegetation around the lake includes a small sphagnum mat, tamaracks, black spruce, and hardwoods further back. None of these surroundings protect the lake from the forces of the wind. The lake apparently turns over every year, but the lake is probably on its way to becoming a bog lake.

The lake is relatively deep, six meters where we sampled, and drains into the Peter/ Paul lakes which then drains into the Cisco Chain.

B. Ed's Bog

Ed's bog is a small old bog located in Gogebic County (Michigan), with coordinates R42W T44N section 1. It has a very small surface area, approximately ten meters wide and twenty meters in length.

The bog is a seepage lake and is very stained. It is a dark tea color, with a secchi disc reading of only 1.3 meters. The lake apparently has a diverse phytoplankton and zooplankton poputlation. We were not permitted to take a plankton sample from this bog because a graduate student is doing a study of the plankton of the bog lake. No fish study was done.

The surroundings are typical of an old well developed bog lake. A well developed sphagnum mat surrounds the entire area, with leatherleaf, tamaracks, black spruce and balsam fir. There are no hardwoods in the immediate area. The entire area was at one time probably a bog lake. As it is now, the area is very well protected from any wind.

II. Water Chemistry

A. Raspberry Lake

	Epilimnion	Hypolimnion
Acidity		
methyl orange	-	-
phenolphthalein	90	90
Alkalinity	-	-
Apparent color	5	25
True color	1	10
Calcium hardness	10	10
Mg hardness	-	-
Total hardness	10	10
Nitrates	.2	.2
Phosphates(ortho)	.1	.1
Total phosphates	.13	.13
pH	5	5
Specific conductance	15.3	16.8
Sulfates	1	1
H_2S	-	-
Secchi disc	4.0 meters	

B. Ed's Bog

	Epilimnion	Hypolimnion	Bulge
Acidity			
methyl orange	5	5	5
phenolphthalein	70	65	73
Alkalinity	-	-	-
Apparent color	10	20	20
True color	5	10	10
Calcium hardness	8	8	8
Mg hardness	-	-	-
Total hardness	8	8	8
Nitrates	-	-	-
Phosphates	NA	NA	NA
Specific Conductance	21	21	18
Sulfates	4	-	1
pH	5	5	5
H_2S	-	yes	-
Secchi disc	1.3 meters		

III. Temperature and Oxygen Profiles

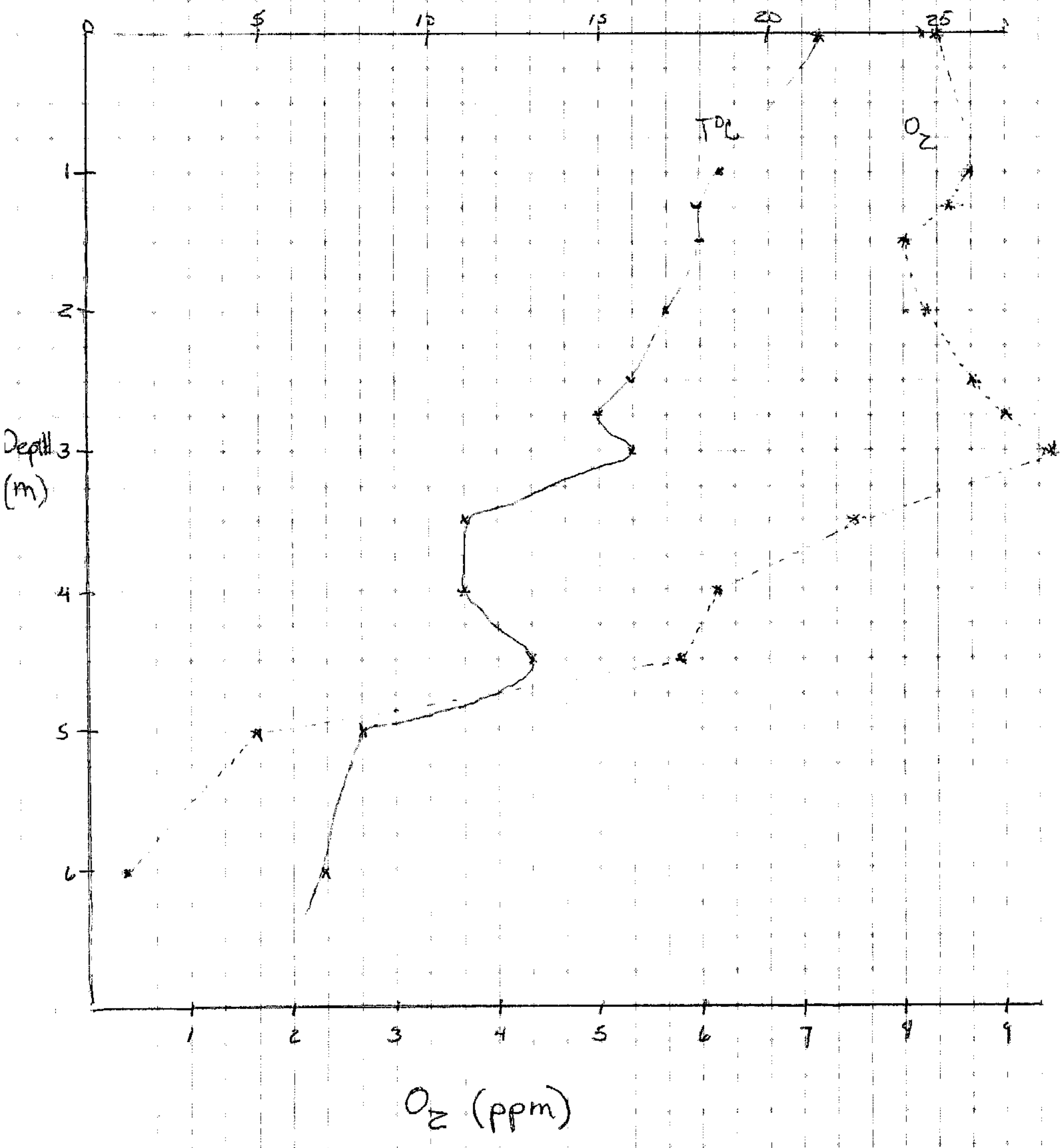
A. Raspberry Lake

Depth (m)	O_2 (ppm)	Temp (°C)
Atmosphere	-	25
Surface	8.2	21.5
1.0	8.6	18.5
1.25	8.4	18.0
1.5	8.0	18.0
2.0	8.2	17.0
2.5	8.6	16.0
2.75	9.0	15.0
3.0	9.4	16.0
3.5	7.5	11.0
4.0	6.2	11.0
4.5	5.7	13.0
5.0	1.6	8.0
6.0	0.4	7.0

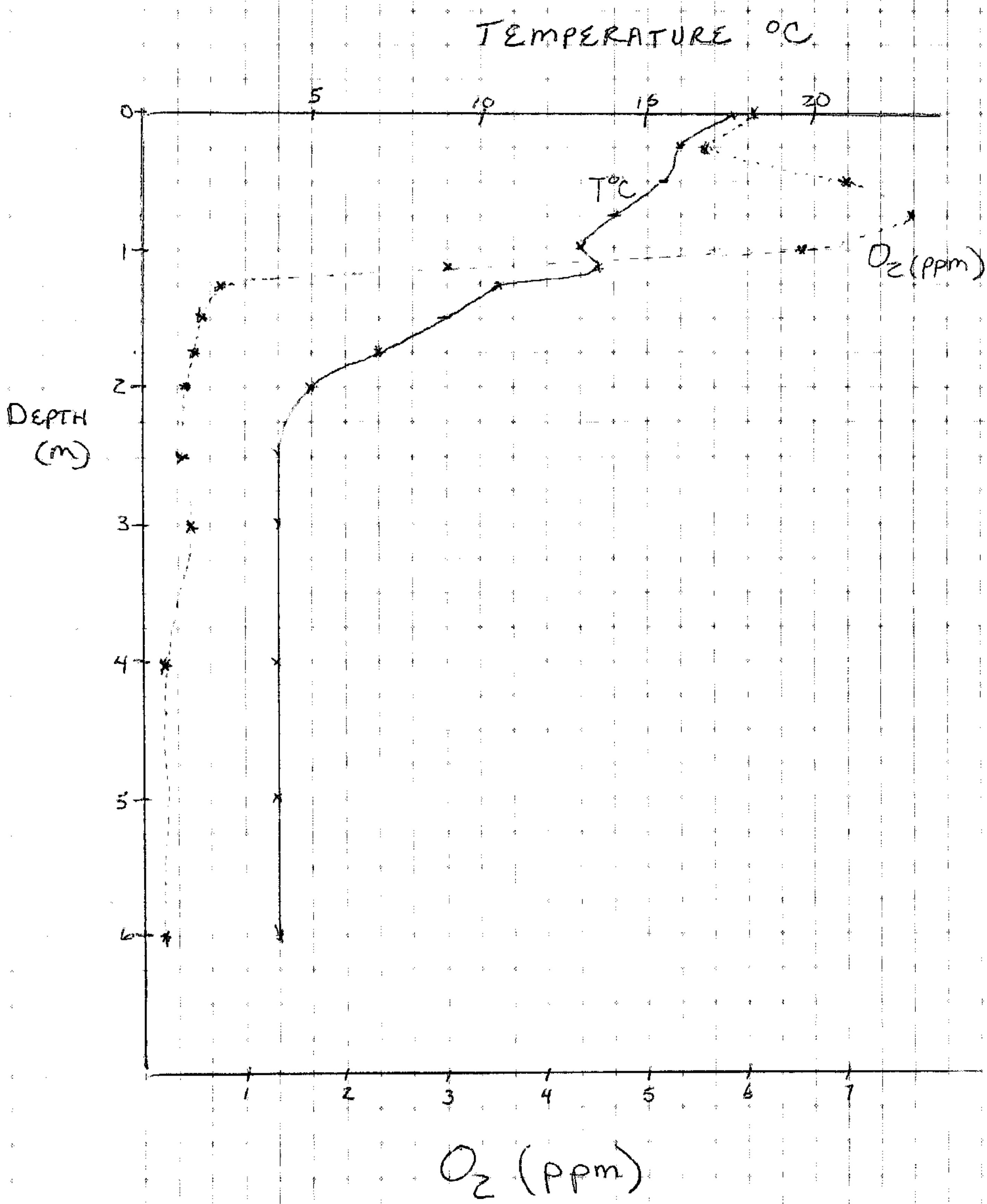
B. Ed's Bog

Depth (m)	O_2 (ppm)	Temp (°C)
Atmosphere	-	23.0
Surface	6.1	17.5
0.25	5.5	16.0
0.50	7.0	15.5
0.75	7.6	14.0
1.0	6.5	13.0
1.125	3.0	13.5
1.25	0.7	10.5
1.5	0.6	9.0
1.75	0.5	7.0
2.0	0.4	5.0
2.5	0.3	4.0
3.0	0.4	4.0
4.0	0.2	4.0
6.0	0.2	4.0

C. RASPBERRY LAKE TEMPERATURE °C



D. Edi's Lake


TEMPERATURE °C
5
10
15
20
0
1
2
3
4
5
6
DEPTH (m)
T°C
O_2 (ppm)
1
2
3
4
5
6
7
O_2 (ppm)

IV. Plankton List

A. Raspberry Lake

1. Phytoplankton

	#/1 ml
Dinobryon	1045
Staurastrum	165
Anabaena	150
Asterionella	66
Volvox	22
Tabalaria	22

2. Zooplankton

	#/1 ml
Keratella cochlearis	495
Daphnia	121
Bosmina	44
Cyclops	44
Holopedium gibberum	44

B. Ed's Bog

Data not available

V. Acidity

The acidity of a lake is a measurement of the lake's ability to donate hydrogen ions. "The main source of hydrogen ions within natural waters is carbonic acid in its various forms."[1] Both of the lakes examined had moderately high acidities, and therefore probably had other sources of hydrogen ions.

There are three likely sources of hydrogen ions. The first would be the ion exchange occurring between the sphagnum mat and the water. "As the water trickles through the peat (derived from the Sphagnum moss) calcium is absorbed and the plant material concurrently yields hydrogen ions."[2]

The second source of hydrogen ions could be the organic acids, or humic acids. These acids are commonly found in soil that eventually would reach the lake by run-off. It is doubtful that much of the acidity in either Ed's bog or Raspberry lake is due to humic acid because from the information available to me, humic acids are relatively strong acids, and would have resulted in a much higher acidity than was obtained. ? "Generally, the acidity of northern bog lakes of North America is due to H_2SO_4, and humic acids are less important."[3]

The third source of hydrogen ions is from the sky. The presence of SO_2 and NO_2 in the atmosphere causes the problem of acid rain. The two gases are extremely soluble in water and react readily to form H_2SO_4 and HNO_3, respectively.

All three of these factors could have contributed to the acidities of two lakes. The higher methyl orange acidity of Ed's bog is probably due to the much more developed Sphagnum mat that surrounds it , as opposed to the relatively "new" mat that surrounds Raspberry lake. Realizing that both lakes receive similiar, if not identical rainfall, and that their acidities are probably not affected greatly by humic acids, the variation between the two is most likely caused by the differences in the sphagnum mats. The higher acidity of the bog is a common charcteristic of bogs and is one of the major factors as to why they become so "dead". There is a very limited number of animals and plants that can survive the acidic conditions of northern bog lakes.

VI. Alkalinity

Alkalinity is a measure of the hydroxide concentration of a water sample, and is usually used to determine the bufferinig capacity of the water. That is, how much acid can the water react with without a change in pH. "Alkalinity is customarily expressed in terms of equivelent bicarbonate or carbonate."[4] The carbonate ion, HCO_3^-, comes usually from the reaction of carbon dioxide and water with the alkline earth metals calcium and magnesium.

$$MeCO_3 + CO_2 + H_2O \longrightarrow Me^{++} + HCO_3^- \qquad 5$$

One area of alkalinity that was not taken into account in class was that in some waters , other ions besides carbonates can also buffer the water. "In some dystrophic bogs and other waters rich in humic acids, the occurence of humates precludes the valid conversion of alkalinity to carbonate."[6] Therefore it is not entirely correct to say that the alkalinity reflects only the amount of bicarbonate being released from the substrate, rather the entire buffering capacity of the water. With this in mind, one could say from the overall low alkalinity readings of these lakes that the lakes were low in free carbonates, bicarbonates, humates, different phosphate ions, nitrates, and sulfates.[7]

The most important reason for the low alkalinity of the two lakes is still the fact that the substrates of the lakes are granite left over from the retreat of the glaciers. There is very little calcium carbonate and magnesium carbonate under the lakes, and it is these two chemicals that make up the bulk of the buffering capacities of all water systems.

VII. Hardness

Hardness is a measure of the Mg concentration and the Ca^{++} concentration. In both lakes the concentrations were very small. There are three probable reasons for this. First, and most importantly, because of the substrates of the lakes, there is little Mg or Ca available. As was stated before, these lakes are on granite rather than limestone. It is this lack of calcium that is another of the major factors in the evolution of the lakes in the area. As was noted in the famous study of the Peter/Paul lakes, calcium can clear the color and raise the pH along with other things. The second reason for the lack of calcium and magnesium, would have to be the ion exchange with the sphagnum mat. It is probable the any free Mg or Ca^{++} ions would be "absorbed" by the surrounding Sphagnum.

The third reason, which is probably not as significant as the first two, would be the fact that the ions could be complexed with other ions such as sulfates and nitrates. Calcium sulfate is one of the reactants in the formation of hydrogen sulfide, which was present in the hypolimnion of Ed's bog.

VIII. Specific Conductance

The specific conductance of a water sample measures the ability of a sample to carry a flow of electrons. Thus, specific conductance gives one a way of measuring the dissolved inorganic ion concentration of a sample.[7] One must keep in mind when measuring specific conductance that "the flow between electrodes in a solution of electrolytes is increased with temperature elavation; a compensating factor of 0.25 mhos for every degree rise has been suggested."[8] I don't know how the Hoch kits measure the specific conductance , and whether the kit takes temperature into consideration or not, yes but both samples were measured at room temperature.

The relatively low specific conductance readings would indicate that there are very low amounts of dissolved inorganic ions in the water. The low readings are in line with the fact that there were very few calcium, magnesium, and carbonate ions present. The lower readings found in the bulge at Ed's bog, and in the epilimnion of Raspberry lake, would indicate that the ions in these areas were being absorbed or used by something. Most likely the phytoplankton in the bulge at Ed's were responsible for the uptake of the inorganic ions. The same could be said for Raspberry even though we did not take a sample specifically in the bulge, the sample did come from the upper bulge.

IX. Color

There are two color measurements, true and apparent. Apparent color comes from both living and non-living materials in the water, which when combined with the true color of the water yields a different color. It is this color that we see when we look at water.[9] The true color of the water is what is measured after all particulate matter has been centrifuged out, leaving only the "stain" of the water as color.

The apparent color of Raspberry Lake was very low, five in the epilimnion, and 25 in the hypolimnion. This would be in accordance with our secchi disc reading of four meters. Also the large ratio between apparent color and true color, 5/1 and 2.5/1 would indicate that there was a relatively abundant amount of filterable matter in the water. Cole stated that many times apparent color was do to the phytoplankton in the water, and if this was the cause of the apparent color in Raspberry then it is interesting to note that the secchi disc went out of sight just below the oxygen bulge which presumably was caused by an abundance of phytoplankton.

The measured colors of Ed's bog, although repeated in the lab two times, should be regarded as questionable. Whether the spectrophotometer by this time was starting to go bad or not, the low color readings recorded were not in line with the tea color of the water. The water was tea colored and unclear enough for us to have a secchi disc reading of only 1.3 meters. Once again this depth corresponds to the depth of the oxygen bulge caused by the phytoplankton. To the naked eye there appeared to be little difference between the sample before and after it was centrifuged. Once again, I would not rely upon the data of Ed's bog because it was not in line with what was seen and what one would normally expect from a bog.

An interesting note can be made when one examines the reasons for the drastic differences between the colors of the two bodies of water. The characteristic tea color of the bog is from the "humic substances leached in from soil, peat, or lake sediments."[10] As Dr. Duman had stated, most of the color comes from the conifers that surround the lakes. Given that the two lakes have similiar vegatation surrounding them, the stark difference in color seems odd. An explanation for this could be that the two lakes have different drainage patterns. The water from Raspberry lake drains into Peter/Paul and then into the Cisco chain. Ed's bog, on the other hand, appears to be like its neighbor, Bolger bog, a seepage lake. Thus the only way water leaves Ed's is via evaporation, which I would presume takes longer than the drainage of Raspberry. Thus the water in Ed's remains "in the tea bag" longer and develops a darker stain than the water in Raspberry.

X. Sulfates and Nitrates

These two inorganic ions are discussed together, not only because they often times have similiar origins, that is man dumping them into the sky, but also because of the common effects their acids have upon lakes. "Coal cumbustion is especially notorious, and copper smelting and paper manufacturing also produce gases and runoff rich in sulfur compounds."[11] The sulfur and nitrogen in the atmsphere can rain as H_2SO_4 and HNO_3 which lowers the pH of lakes that have little or no buffering capacity. It is interesting to note that although we had attributed, at least in our classromm discussions, the lower pH in some of the lakes to acid rain, none of our lakes showed any dramatic amounts of sulfates or nitrates. In fact, the sulfates and nitrates in Raspberry and Ed's were minimal at best. Therefore, if the rain in the area of these lakes does contain sulfates and nitrates, these ions must be being complexed with other positive ions, most likely Ca^{++} and Mg^{++}. This then would offer another explantion as to why the hardness would be so low. Not only would any calcium present be "absorbed" by the Sphagnum mat, but it would also be complexed with the sulfates and nitrates.

XI. Temperature

A comparison of the temperatures of the two bodies of water shows some characteristic differences between a bog and a lake. The first thing one notices between the two graphs is the relative "simplicity" of the Ed's bog graph, as compared to ~~to~~ the complexity of the Raspberry lake curve.

Ed's bog, with its dark color, and small, well protected surface area, is subject to very few disruptive forces. The light energy can penetrate only to a depth of a few meters and the energy from the wind has a hard time getting to the bog. The only time when the bog could possibly be mixed is when it freezes over in the winter. At that point the water temperature would be relatively uniformly set at four degrees centigrade except for that water closest to the ice which would be slightly below four degrees, and above zero. At this point the water would be free to mix, but since the water is sealed by the ice very little mixing probably occurs. As the ice melts, the water is warmed, but only a meter or two deep because light cannot penatrate through the dark stain. This lack of mixture is a key characteristic of bogs and helps give bogs their "deadness" in the lower depths. Since water with fresh O_2 never reaches the lower depths very few decompository bacteria can exist in such depths. Only anaerobic "sulfur bacteria" can exist in these conditions. "When oxygen is absent and redox potential falls below 0.1 volt, the sulfate-reducing microbes begin their work... Desulfovibrio desulfuricans is one of these... while transforming sulfate to sulfur and hydrogen sulfide, precipitates Ca CO3 at the same time." Ref?

The temperature profile of Raspberry lake is much more complex than that of Ed's. This fact is due mainly to the same factors that lead to Ed's profile; color of the water, and the enviroment surrounding the lake.

The clearness of Raspberry lake has allowed for the energy from the sun to reach deep down. From the data it is obvious that the sun has warmed the waters and the wind has turned it over effectively, evidenced by temperatures of 8°C at depths of five meters. Most likely Raspberry experiences what Cole terms "dimictic" that is, it mixes twice a year.

> The typical dimictic lake stratifies directly during the warm months... the onset of cold weather starts the cooling of surface water that eventually destroys the stratification and initiates complete circulation. During the fall overturn chilling of the entire water mass occurs until ideally, the whole lake is at 4°C. (Ice then forms which begins winter stagnation) With the warming days of spring the ice melts, and a cold lake, with stability near zero, lies exposed to wind action. The result is vernal overturn, a circulation period that continues until ended by the direct temperature stratification of summer.[12]

This is the cycle Raspberry lake was in when we measured it. The circulation period was coming to an end, because it appears that the lake is well on its way to being stratified except for the two "temperature bulges" found at three meters and 4.5 meters. Apparently the water there is still mixing and hasn't become stratified yet. The only curves I could find in any books that resembled the curve found on Raspberry lake was characteristic of saline lakes. I doubt we had any salt much less seaweed as was found in Roach lake!

One other observation concerning temperature is the difference in the surface temperatures. Raspberry was significantly warmer than Ed's bog by four degrees. I would attribute this to the amount of energy capable of penetrating the two bodies of water. The clear water of Raspberry allows light energy to penetrate deeply, wheras the darkness of Ed's screens much of the energy out. Therefore, the water below the surface in Raspberry would be warmer than the very cold water below the surface of Ed's. So as the surface of Ed's absorbs energy, it would be quickly cooled by the underlying waters, while the surface of Raspberry is capable of transforming much of that energy into heat. I do not know whether it is characteristic of bogs to be cooler than a lake such as Raspberry, but given the condition of these two lakes, with relatively equal depths (~6m in the areas we measured) and very different colors, the generalization would follow. I also do not know enough about the physics of heat and related areas, but it did seem strange to me that the body of water with the smaller surface area would be cooler. The concept of cooling from beneath was the only one that made sense to me.

XII. Oxygen Profile

The readings of both lakes show oxygen bulges at approximately one meter, and Raspberry shows another bulge at three meters.

In Ed's bog the curve shows the effects of phytoplankton, most likely a blue-green algae, in the large bulge. "The blue-green algae thrive in the dim light of the metalimnion; much of the oxygen they produce accumulates because photosynthesis exceeds respiration and turbulance is at a low level."[13] The curve then "dives off" to almost zero (it most likely was zero and we were just measuring H_2S) because "great quantities of dead and dying organic matter effect a severe drain on the oxygen in the hypolimnion."[14] Since the lakes "turnover" is so mild (if you can say the lake actually does turnover. It is probably more like an equalizing of temperature throughout, but then there is no energy to mix it up) the hypolimnion's O_2 is never replenished. Cole states that this lack of O_2 in the hypolimnion is characteristic of "stratified eutrophic lakes." Though I do not have any plankton data, nor any other data on prodution

I think I would be pushing it to say that this bog is eutrophic. Rather the situation most likely exists simply from the lack of an annual turnover. The situation is simply characteristic of a bog.

Raspberry lake, on the other hand, has an interesting "double bubble" phenomenon at around one meter and three meters. This condition is most likely a temporary one, but none-the-less, a very real one. The two bulges are probably due to phytoplankton, but for two different reasons. The upper peak is probably due to optimum light conditions for the different phytoplankton, while the lowere bulge is most likely due to "favorable nutrient accumulation in addition to light penetration."[14]

The O_2 level in Raspbarry eventually went down to a level that could have been influenced by H_2S, but there was no H_2S present in our water sample. This would support the concept that this lake has turned over this year, and probably for many years, with considerable mixing of the two layers.

XIII. Plankton

The first thing that one notices when looking over the species lists of the two bodies of waters is the stark contrast of the phytoplankton. Because of the studies being done on Ed's bog I must rely on old data, but from this old data some interesting notes can be made. First one must realize that the phytoplankton of the two lakes are growing in very different enviroments. Ed's is dark, relatively cold, and oxygen deficient. Raspberry is clear, warmer, and rich in oxygen to depths of at least four meters.

There are only two phytoplankton that are common to both lakes; Dinobryon, and Anabaena. Why these two appear in both lakes is not certain, but some observations can be made.

"The presence of *Anabaena* is sometimes, but not invariably, suggestive of pollution."[15] If *Anabaena* is sometimes suggestive of pollution, it most likely means that *Anabaena* is a "rugged" phytoplankton , capable of withstanding extremes of conditions. This perhaps is why it appears in the two very different bodies of water. Why it is more abundant in the "clearer" lake is not certain.

Dinobryon is interesting to note because of its ability to tolerate low levels of phosphates. In past years *Oscillatoria* has been found, apparently in abundant levels in Raspberry lake, this year I found none. Rather than attribute this to my incapability of using a Sedgwick-Raffter cell, an interesting relationship has been noted between *Oscillatoria* and *Dinobryon*. According to Wilhelm Rodhe, *Oscillatoria* needs a higher phosphate level than *Dinobryon*. So as *Oscillatoria* uses up the phosphates, *Dinobryon* should take over as the dominant species. This fluctuation he says has been noticed within a year cycle, and if phosphates build up high enough, *Asterionella* could even take over. "Phosphate increase favours the increase of *Asterionella*, which occurred rarely in the plankton sample of May 30th. When *Asterionella* and other algae had consumed sufficient phosphates (by July 9th), *Dinobryon* could again reach a high production."[16] So in Raspberry lake there exists this possibility, especially since the phosphate level should change as the lake turns over, that *Oscillatoria*, *Dinobryon*, and maybe *Asterionella* could share a cycle of dominance.

In Ed's bog however, this probably does not occur because of the fact that the phosphates in that bog does not get regenerated like they do in Raspberry. Rather, the phosphates "fall" into the hypolimnion and are lost to there forever.

As opposed to the phytoplankton, the zooplankton appears to have a good "cross mixture." Four of the eight zooplankters that occur in Ed's bog also occur in Raspberry lake.

It is not surprising to find Daphnia and Bosmina in both lakes, because "Cladocera are always present in ponds and lakes and often in great diversity of species, only a few of which are strictly 'Daphnias.'"[17] It is also not unusual for the Cyclops to be found in both because, "the Crustacea (notably the copepods) are usually dominant in lakes and ponds."[18]

omnivorous, yes predaceous, no!

The Keratella, one of the predatious rotifers, also appears to be very common. When one examines data from years ago, it is obvious that Keratella is also a very "rugged" zooplankter, and exists in a variety of different enviroments.

The most likely reason that there is a greater "cross mix" among the zooplankters is that they are not as dependent upon the light conditions as are the phytoplankters. The phytoplankton cannot exist if light conditions are not correct, but I would assume that as long as there are nutrients in the water, or in the case of the predatious zooplankters, phytoplankton in the water, the zooplankters can exest regardless of light.

FOOTNOTES

[1]Gerald A. Cole, Textbook of Limnology (St. Louis: The C. V. Mosby Company, 1975), p. 192.

[2]Cole, p. 192.

[3]Cole, p. 193.

[4]Cole, p. 187.

[5]Cole, p. 188.

[6]Cole, p. 189.

[7]Cole, p. 209.

[8]Cole, p. 210.

[9]Cole, p. 120.

[10]Cole, p. 120.

[11]Cole, p. 214.

[12]Cole, p. 133.

[13]Cole, p. 170.

[14]Cole, p. 176.

[15]Robert E. Coker, Streams, Lakes, Ponds (New York and Evanston: Harper and Row, 1954) p. 206.

[16]Wilhelm Rodhe, Enviromental Requirements of Fresh-Water Plankton Algae (Uppsala A.-B. Lundequistska Bokhandeln, 1948), p. 83.

[17]Coker, p. 228.

[18]Coker, p. 210.

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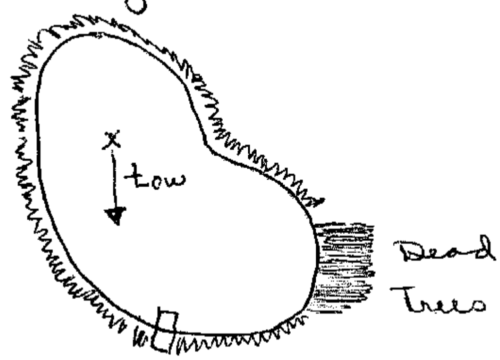
Cole, Gerald A. Textbook of Limnology St. Louis: The C.V. Mosby Company, 1975.

Rodhe, Wilhelm. Enviromental Reqirements of Fresh-Water Plankton Algae Uppsala A.-B. Lundequistska Bokhandeln,, 1948.

Raspberry Lake

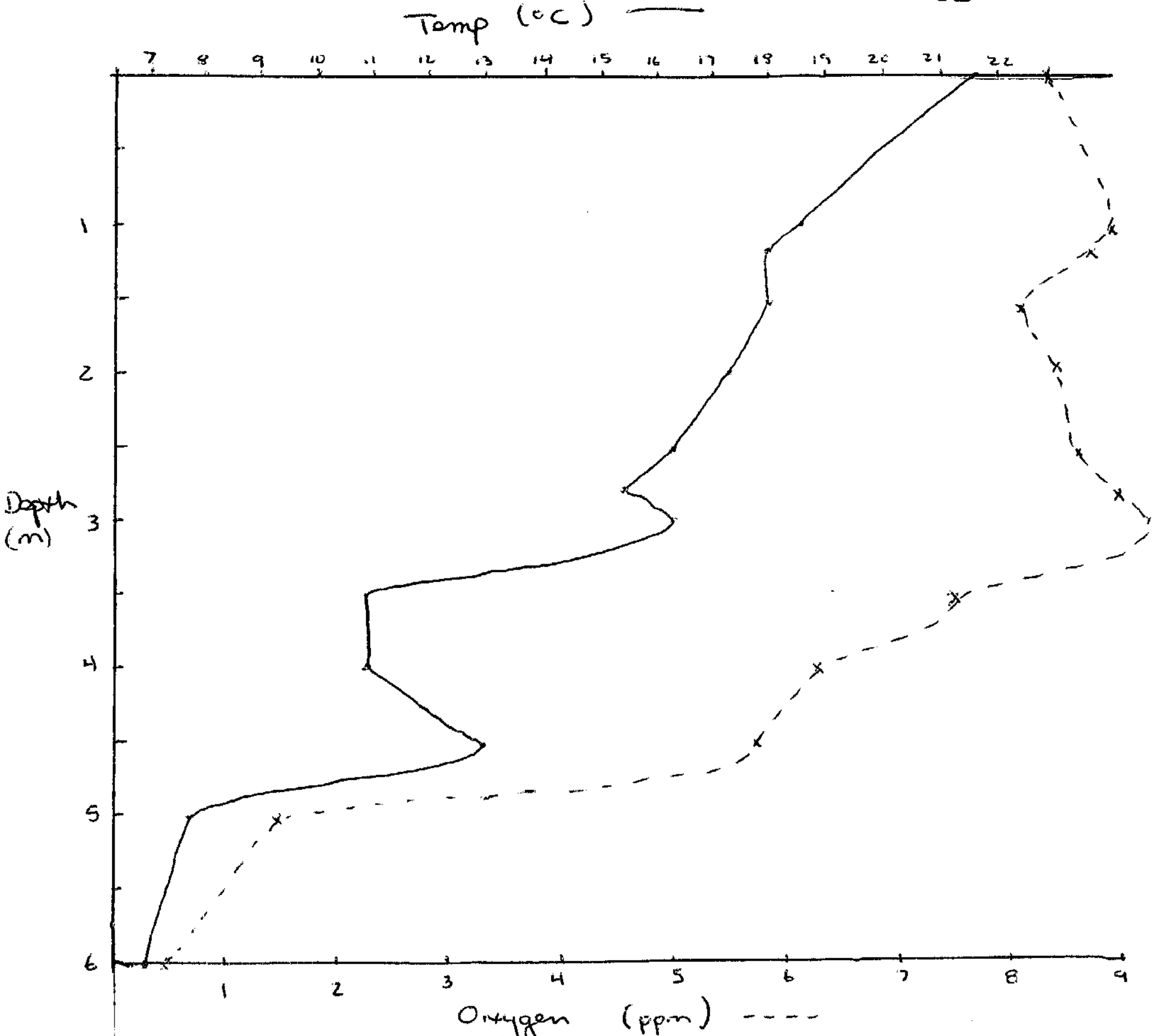
6/2/81
~ 9:00 AM



Weather: mostly sunny, gentle but steady breeze
Surroundings: Sphagnum, Tamaracks, black spruce
hardwoods further back

H_2O Chemistry	Epilimnion	Hypolimnion
Acidity		
methyl orange	—	—
phenolphthalein	90	90
Alkalinity	—	—
Apparent Color	5	25
True Color	1	10
Calcium Hardness	10	10
Mg Hardness	—	—
Total Hardness	10	10
Nitrates	.2	.2
Phosphates (ortho)	.1	.1
Total Phosphates	.13	.13
pH	5	5
Specific Conductance	15.3	16.8
Sulfates	1.0	1.0
Secchi disc	4 m	
plankton tow	very rich	
H_2S	—	—

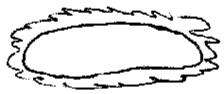
Raspberry Lake
YSI
TC
GL



Tim Cogan
Greg Liebscher

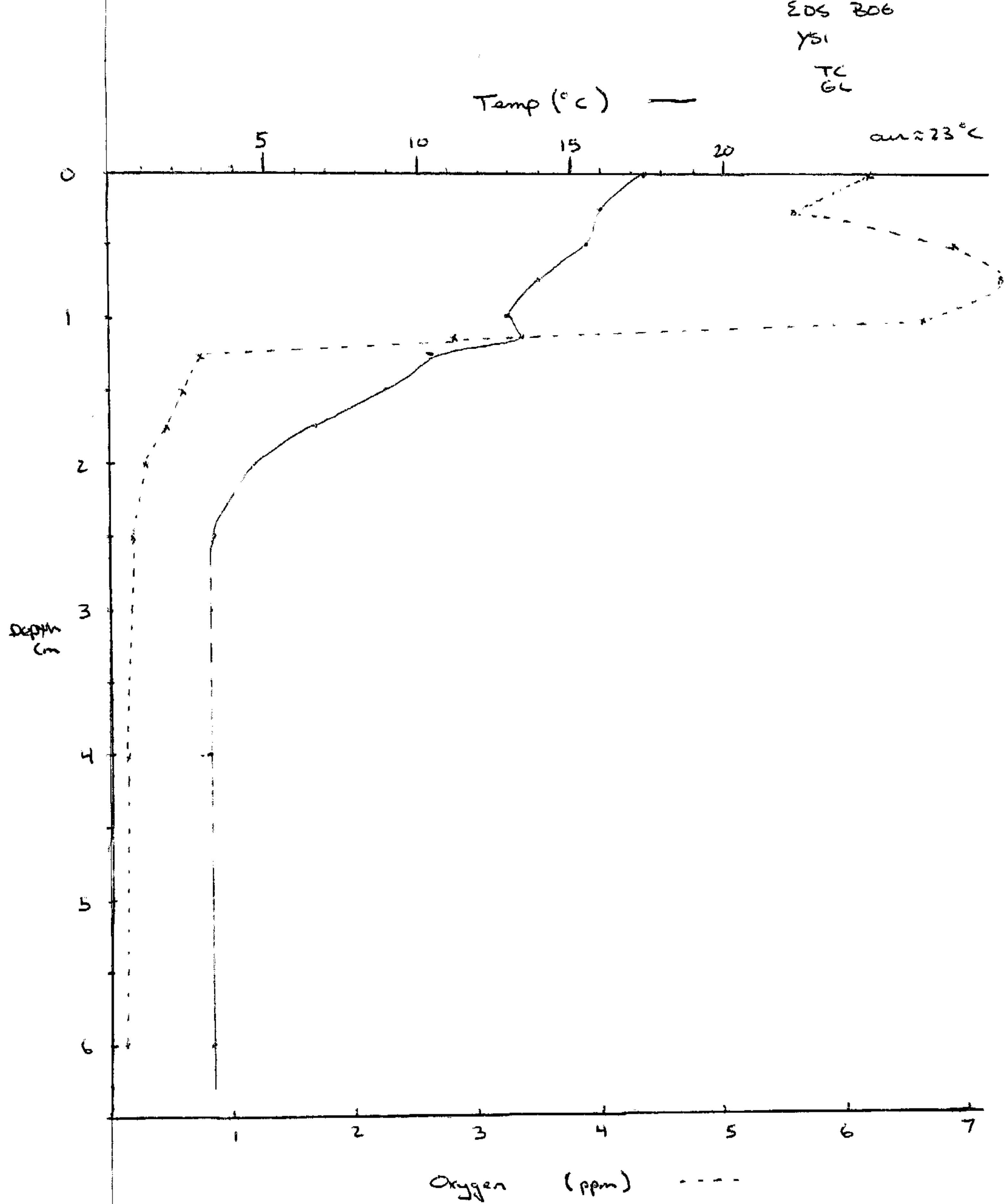
Ed's Bog

6/4/81
~ 9:00 am



Weather: bright sunshine, very calm
Surroundings: sphagnum, leatherleaf, tamaracks, black spruce, balsam fir. Very protected. Well developed, classic bog.

H_2O chemistry	Epilimnion	Bulge (3/4 m)	Hypolimnion
Acidity			
methyl orange	5	5	5
phenolphthalein	70	73	65
X Alkalinity	0	0	0
Apparent Color	10	20	20
True Color	5	10	10
x Calcium Hardness	8	8	8
x Mg Hardness	—	—	—
x Total Hardness	8	8	8
Nitrates	—	—	—
phosphates	NA	NA	NA
Specific Conductance	21	18	21
Sulfates	4	1	0
pH	5	5	5
secchi disc	1.3 m		
H_2S	—	—	present



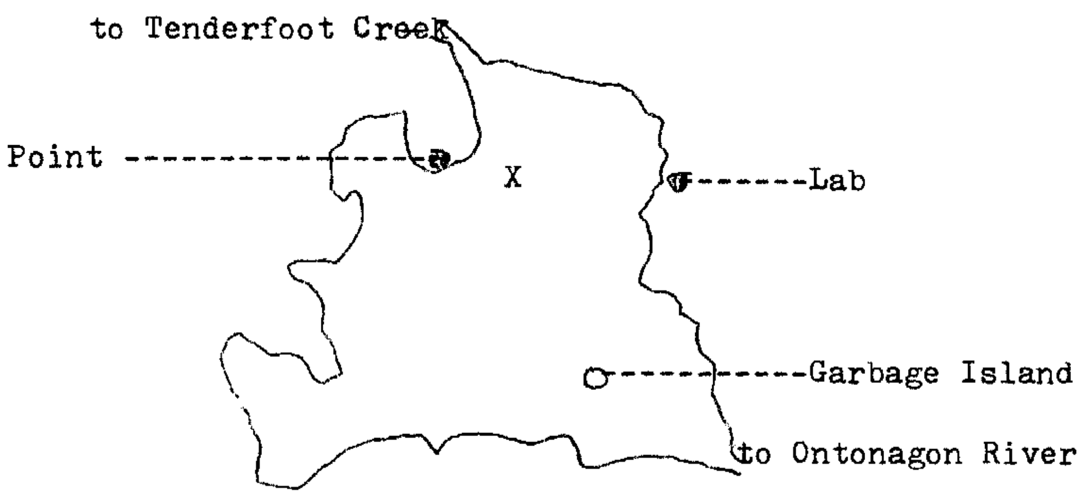
EOS BOG
YSI
TC
GL
Temp (°C)
air ≈ 23°C
5
10
15
20
0
1
2
3
4
5
6
Depth
(m
1
2
3
4
5
6
7
Oxygen (ppm)

Temperature and Oxygen YSI Data

Tenderfoot Lake 6/4/81 2:00 PM

Tim Cogan Greg Liebscher

Depth (m)	Oxygen (ppm)	Temperature (^{o}C)
air	---	23.0
surface	8.2	20.5
1.0	8.2	19.0
2.0	8.3	17.5
3.0	8.1	17.0
4.0	7.9	16.5
5.0	6.2	14.0
6.0	4.8	11.0
6.5	2.1	10.5
7.0	1.7	10.0
*8.0	0.3	10.5
*9.0	0.2	10.5
*10.0	0.15	10.5

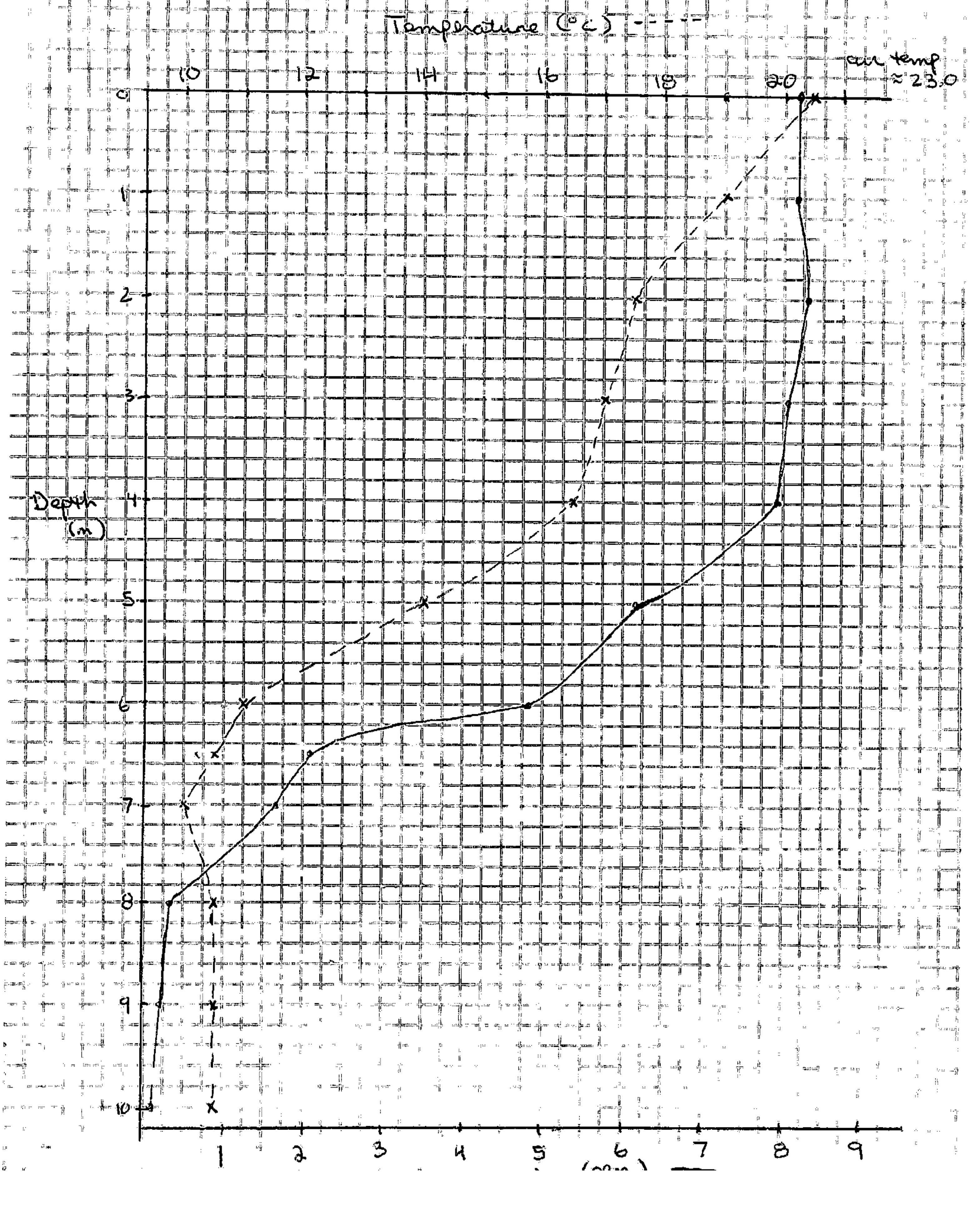


*-These recordings may actually be from the bottom of the lake since it was difficult to determine when the YSI probe was actually on the bottom.

Weather - sunny and not very windy.

X - recording site

Tenderfoot Lake



Temperature and O_2

Depth (m)	O_2 (ppm)	T °C
air	—	25
surface	8.2	21.5
1.0	8.6	18.5
1.25	8.4	18.0
1.5	8.0	18.0
2.0	8.2	17.0
2.5	8.6	16.0
2.75	9.0	15.0
3.0	9.4	16.0
3.5	7.5	11.0
4.0	6.2	11.0
4.5	5.7	13.0
5.0	1.6	8.0
6.0	0.4	7.0

O_2 and Temperature

Depth (m)	T°C	O_2 (ppm)
Surface	17.5	6.1
.25	16.0	5.5
.50	15.5	7.0
.75	14.0	7.6
1.00	13.0	6.5
1.125	13.5	3.0
1.25	10.5	0.7
1.50	9.0	0.6
1.75	7.0	0.5
2.00	5.0	0.4
2.50	4.0	0.3
3.00	4.0	0.4
4.00	4.0	0.2
6.00	4.0	0.2