1982

INKPOT LAKE

AND

ED'S BOG

A Comparitive Study

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Biology 569

INTRODUCTION

Inkpot lake and Ed's Bog are two very different habitats. This fact is evident at every level of inquiry. At the macro level, observation of the two lakes shows differences in size, color, morphology, macrophytes, and surrounding terrestial vegetation. At the micro level, analysis of chemical and biological data reveals differences not only in the water chemistry of the two lakes, but also differences in the organisms they support. Knowing that these differences occur does nothing to explain why they occur. It is difficult to postulate expla nations based scley on the data gathered during the summer of 1982. However, ~~this~~ these data enables the lakes to be classified into particular categories. Then explanations concerning the differences between categories can be determined and applied to the two lakes under consideration. Whenever possible, this approach was taken during the task of analyzing the data gathered and drawing probable conclusions.

GENERAL DESCRIPTION

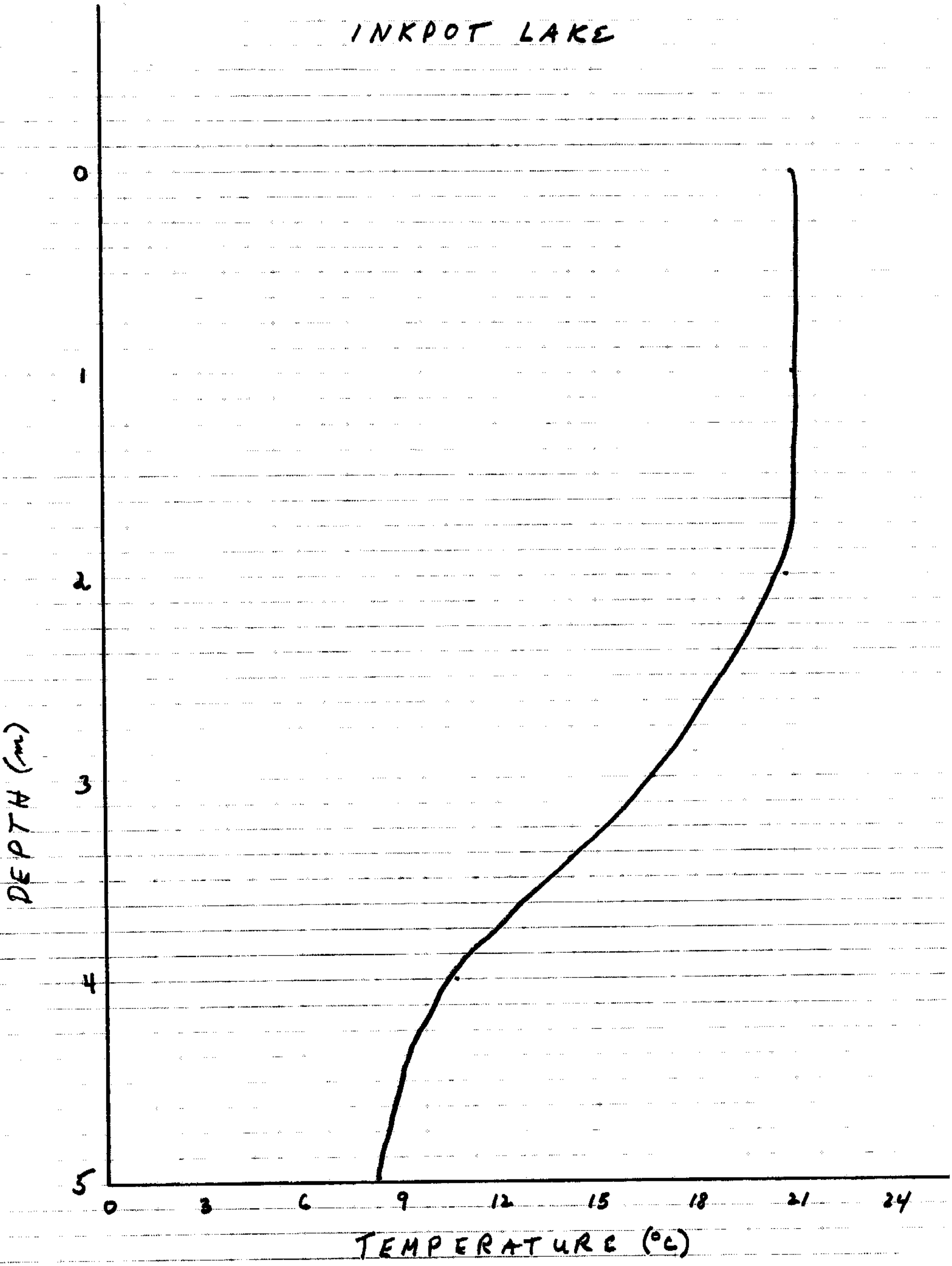
INKPOT LAKE

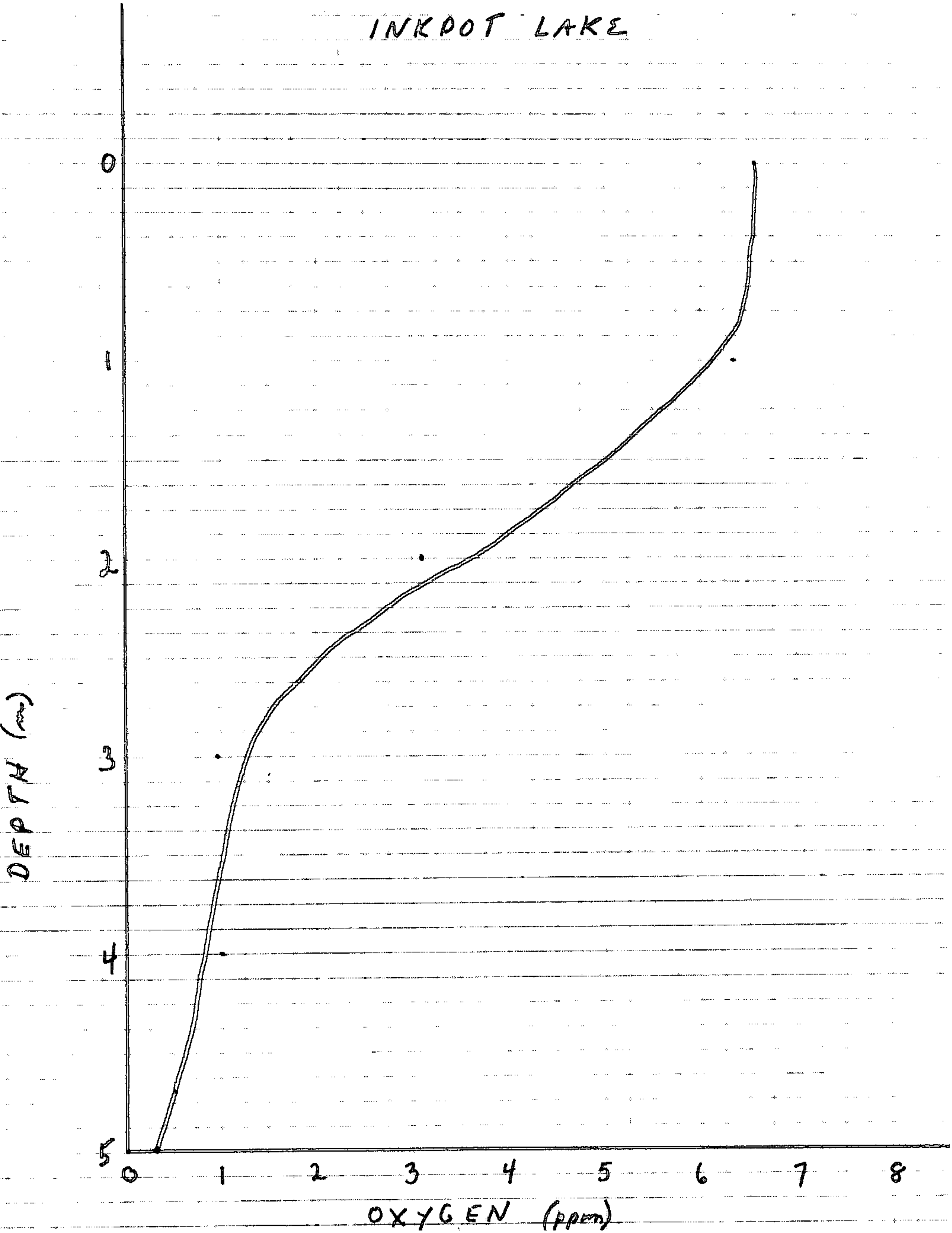
Inkpot Lake is a relatively small lake (surface area 7.6 ha.) located in the southeast quadrant of the UNDERC property. Excluding the bogs Inkpot has the most darkly stained water of all the lakes on the property. Inkpot gets its source water from Moccasin lake and drains into Plum lake via a rather large culvert. Visible macrophytes in the lake include the following robust types: yellow water lillies, Sparganium fluctuans, Potamogeton alpinus, Potamogeton richardsonii, Potamogeton amplifolius, Potamogeton prelongous, Potamogeton zosteriformis, and Najas flexilis. These large macrophytes provide excellent cover for the northern pike, yellow perch, walleye, and muskellunge which inhabit Inkpot Lake. A marsh stretches along approximately 100 meters of shoreline at the northwest corner of the lake. Hardwood forest lines the perimeter of this marsh. In contrast the rest of Inkpot Lake proper is surrounded by conifer forest consisting of white spruce, black spruce, and cedar.

WATER CHEMISTRY

INKPOT LAKE

	EPILIMNION	HYPOLIMNION
Acidity (mg/L)		
Methyl Orange	0.0	0.0
Phenolphthalein	6.7	9.2
Alkalinity (mg/L)	35.0	60.0
Color		
Apparent	100.0	75.0
True	80.0	60.0
Hardness (mg/L)		
Ca^{++}	35.0	45.0
Mg^{++}	20.0	23.0
Total	55.0	68.0
Nitrate (mg/L)	0.005	0.005
Sulfate (mg/L)	0.0	0.15
Phosphate (mg/L)		
Ortho	0.2	0.125
Total	0.31	0.30
Specific Conductance (Mho/cm)	70.0	120.0
Sulfide	Negative	Negative
pH	6.65	6.6
Secchi (m)	1.5	
Iron (mg/L)	0.2	0.25


INKPOT LAKE
DEPTH (m)
0
1
2
3
4
5
0
3
6
9
12
15
18
21
24
TEMPERATURE (°C)



INKPOT LAKE
DEPTH (m)
0
1
2
3
4
5
0
1
2
3
4
5
6
7
8
OXYGEN (ppm)

PLANKTON COUNT

INKPOT LAKE

Phytoplankton	Number per ml
Anabaena (filiments)	341
Aphaenizomenon	
Colonies	440
Isolated filiments	495
Asteroihella	88
Chrysosphaerella	715
Dinobryon	1485
Mougeotia	550
Peridinium	176
Ulothrix	506

Zooplankton	Number per ml
Bosmina	33
Cyclops	44
Kellicottia	11
Keratella	99
Nauplius larvae	11
Polyarthra	77

GENERAL DESCRIPTION

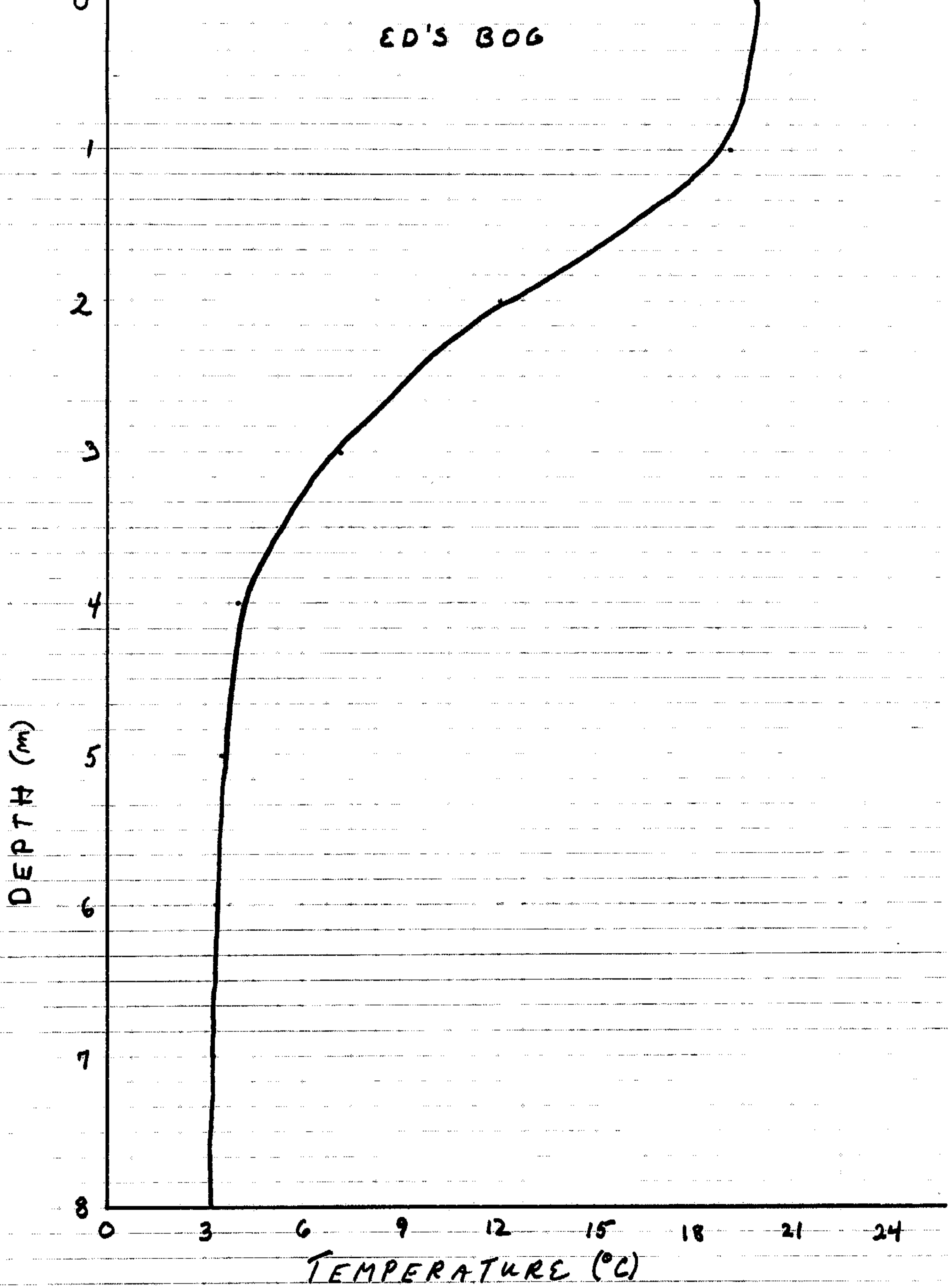
ED'S BOG

Ed's Bog is located near the eastern boundary of the UNDERC property. One of the smallest of bogs on the property (approximately a 10 x 20 meter oval), Ed's is also one of the deepest, 8 meters. The bog's hearty mat consists mostly of Sphagnum moss growing in an unorganized network of tamarack and leatherleaf roots. Also growing in abundance on the mat are common bladderwort plants, sedges, grasses, and pitcher plants. Not only do the tamarack trees provide a skeleton around which a dense mat grows, but also in conjunction with black spruce trees they provide protection from the wind by growing rather densely very close to the edge of the water. Since Ed's Bog has no streams either feeding it or providing an outlet channel, it is classified as a seepage lake. It loses some of its water through evaporation, but most of the drainage occurs through seepage into the surrounding ground water. No fish are known to live in Ed's Bog.

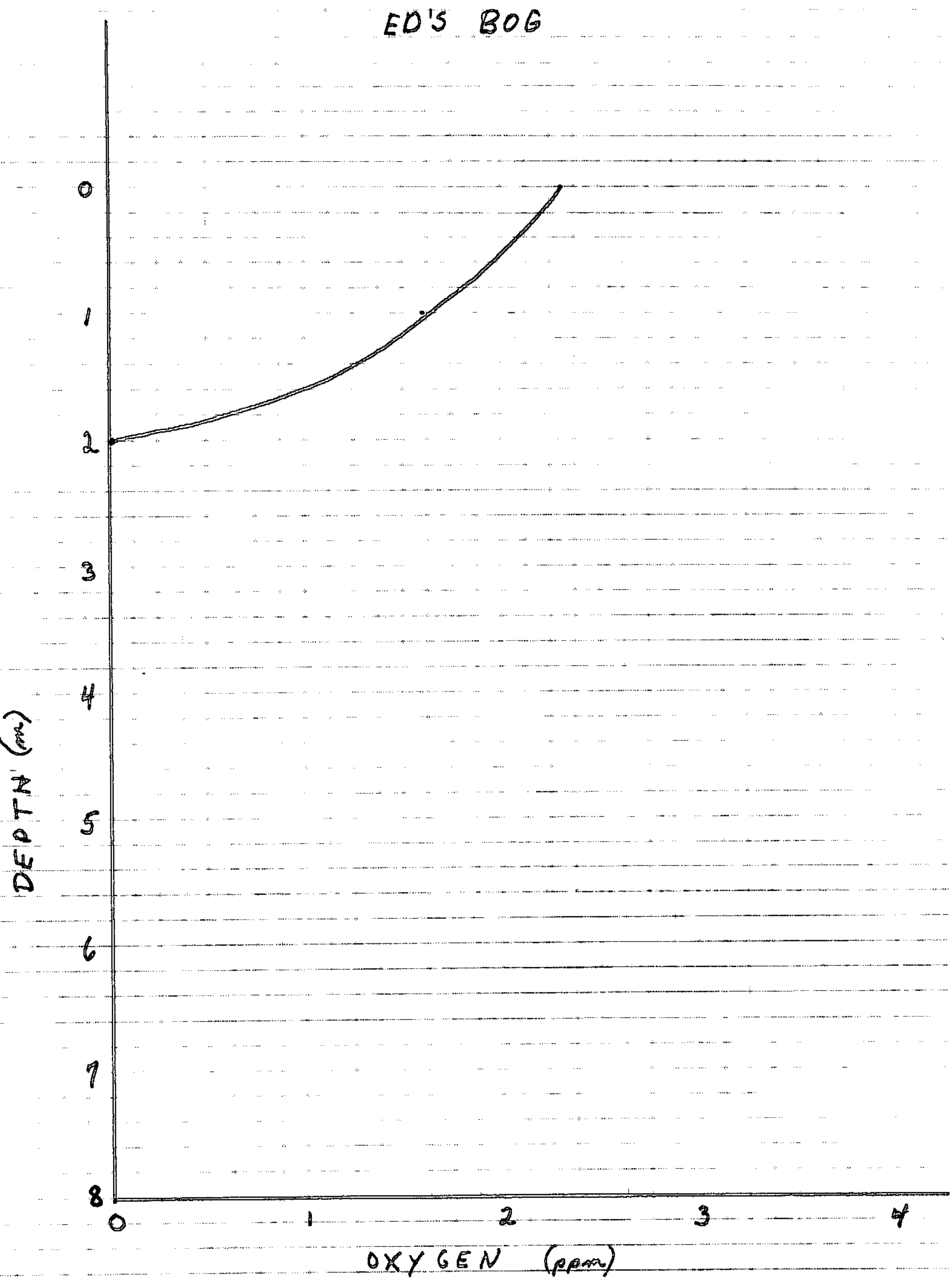
WATER CHEMISTRY

ED'S BOG

	EPILIMNION	HYPOLIMNION
Acidity (mg/L)		
Methyl Orange	0.0	0.0
Phenolpathalein	21.0	53.0
Alkalinity (mg/L)	3.3	6.7
Color		
Apparent	90.0	140.0
True	90.0	125.0
Hardness (mg/L)		
Ca++	5.0	5.0
Mg++	5.0	0.0
Total	10.0,	5.0
Nitrate (mg/L)	0.5	0.6
Sulfate (mg/L)	0.0	0.0
Phosphate (mg/L)		
Ortho	0.08	0.1
Total	0.18	0.15
Specific Conductance (Mho/cm)	15.0	17.0
Sulfide	Negative	Positive
pH	5.4	4.9
Secchi (m)	1.4	
Iron (mg/L)	0.1	0.4



ED'S BOG
DEPTH (m)
0
1
2
3
4
5
6
7
8
0
3
6
9
12
15
18
21
24
TEMPERATURE (°C)


ED'S BOG
DEPTH (m)
0
1
2
3
4
5
6
7
8
0
1
2
3
4
OXYGEN (ppm)

PLANKTON COUNT

ED'S BOG

Phytoplankton	Number per ml
Anabaena (filiments)	66
Anacystis	880
Desmidium	6600
Dinobryon	440
Microspora	99
Mougeotia	1540
Peridinium	308
Staurastrum	55
Ulothrix	1100

Zooplankton	Number per ml
Bosmina	198
Chaoborus larvae	11
Cyclops	33
Daphnia	132
Keratella	1980
Nauplius larvae	11
Polyarthra	11

DISCUSSION

The chemical and biological data on Inkpot Lake and Ed's Bog ~~was~~ were gathered during the last week of July, 1982. The time of the sampling is important because the chemical and biological properties of a body of water change with time. Much of this change is due to seasonal variation, and therefore is predictable. However, it is important to note that not only does the chemistry of a lake affect its organisms, but also the organisms can alter the chemistry of the water both in the short and long term.

CHEMISTRY

INKPOT LAKE

An analysis of the chemical data coupled with a visual examination of the lake clearly indicate that Inkpot is a productive lake. Visually, many robust macrophytes and large amounts of suspended organic material are present. Chemically, Inkpot has all the characteristics of a productive lake.

The temperature profile provides evidence. The profile shows a large epilimnion and a small hypolimnion which allows for a minimal amount of cold water. The biological advantages of this situation will be discussed in the biology section of this report. The temperature profile also shows Inkpot to be a relatively shallow lake which allows storm winds to "turn over" the water every spring and fall. The fall turnover is especially important to productive lakes: it regenerates O_2 at depth and liberates much needed nutrients (isolated during summer stratification) for use in the upper region of the water column. The spring and fall turnovers can occur only when the temperature of the water column is homogeneous at 4^oC. When isothermal conditions exist, the density of the water throughout the column is almost constant, so mixing can occur easily. However, during the summer months after thermal stratification has taken place, the density of the water in the epilimnion is much less than that of the hypolimnion. Consequently, there is no mixing between the water in the epilimnion and the hypolimnion. This situation is exaggerated when a large thermocline exists as does in Inkpot. This fact causes some crucial chemical consequences. For instance, since the hypolimnion is devoid of any source of O_2, it could become anoxic during the summer months if the rate of decomposition is high enough. The O_2 profile for Inkpot indicates that the hypolimnion is close to becoming anoxic, a characteristic of productive lakes. Isolation of epilimnion and hypolimnion waters also creates problems for the epilimnion. Although plenty of O_2 is available in the epilimnion (the main sources being atmospheric mixing and O_2 derived from the large amount of photosynthetic activity), limiting nutrients for primary productivity can get "locked up" in the hypolimnion. Not surprisingly, the epilimnion can run out in late summer, and this situation seems to be occuring in Inkpot.

Aquatic plants and animals require a variety of nutrients for ~~there~~ their growth and reproduction. Nitrogen is one of the most important of these nutrients due to its crucial function during protien synthesis. Nitrogen has a very low solubility in water.

As a result, most nitrogen is lakes occurs in the form of nitrates which are produced by bacteria working on NH_3, a major breakdown product of plant and animal protiens. Also certain bacteria and blue-green algae which can fix nitrogen contribute significant amounts of nitrogen to the water. Because nitrates are produced by different sources, the amount of nitrates in the water varies. A more important reason for the variation is the fact that the organisms in the lake use up the nitrates in a predictable way. As the summer progresses the nitrates become depleted. The chemistry data from Inkpot in late July show very low amounts of nitrates indeed, .005 (mg/L).

A second nutrient essential for protien synthesis as well as other vital functions in the cells of aquatic organisms is sulfur. Important sources include atmospheric SO_2 and sedimentary stores. As expected for late July, low quantities of sulfate were found in Inkpot due to the productive nature of the lake. The epilimnion contained no sulfates, and the small amount in the hypolimnion .15 (mg/L) was probably due to the presence of O_2 at the bottom of the lake. Any H_2S that would be present under anoxic conditions must have oxidized to sulfates.

A third and one of the most important nutrients to aquatic biota is phosphorus. Its importance lies in the fact that it is considered the limiting nutrient in most fresh waters. As a result, it would be expected that the organisms of productive lakes would use up this nutrient quickly as the summer progresses. Phosphates in Inkpot were down but not to the degree that other nutrients were depleted. So, at the time of testing, enough phosphorous was present to sustain the high productivity that was visible in Inkpot.

Most phosphorus in lakes comes from the leaching of phosphorus-containing rocks and soils in the watershed of the lake. Thus, the geochemistry of the area becomes important. Regions with underlying sedimentary rocks usually yield more phosphorus than areas having an igneous bedrock. UNDERC sits on the Canadian Shield which is primarily granite, an igneous rock, so relatively low amounts of phosphorus in these northern waters are expected. However, UNDERC also sits on a thick layer of glacial till which geochemically acts like sedimentary strata. This till supplies Inkpot with sufficient quantities of phosphorus to allow it to be the productive lake it is.

This phosporus occurs in lake waters mainly in the form of phosphates, and the amounts of free (ortho) phosphate are usually low in comparison to the total (ortho + organic) quantities. The situation occurs because aquatic organisms are able to absorb and store more phosphate thanthey immediately need. This phenomenon is reflected in the phosphate values for Inkpot. The difference between the total and ortho phosphate readings should be even greater than it is. Undoubtably some phosphates were lost due to boiling over that occured during the necessary boiling step of the total phosphate test. Also, some of the ortho-phosphate that would have existed in Inkpot was precipitated to the bottom muds as ferric phosphates. This can only occur when ferrous iron exists with ortho-phosphate under areobic conditions such as those in Inkpot during the time of testing. So, not only is much of Inkpot's ortho-phosphate tied up in the biota, but also much is immobilized in the bottom muds in the form of ferric phosphates.

Iron then becomes important in the cycling of phosphorus and other nutrients. It also plays an important role in the metabolism of many aquatic organisms. Iron is widespread in the earth's crust, but only under certain conditions does it show up in lake water. The ferrous form is stable only the absence of O_2, and the ferric form is insoluble. When the ferrous form occurs with O_2, oxidation to insoluble ferric hydroxide takes place via ferrous bicarbonate. It is important to realize that if significant amounts of ferrous iron are present this oxidation process can be a large contributing factor in the depletion of dissolved O_2.

Inkpot does contain a small amount of dissolved iron, but the fact that O_2 exists in both the epilimnion and the hypolimnion raises some question as to how dissolved iron can exist in the presence of O_2. It turns out that pH strongly affects the solubility of iron, the lower the pH, the greater the solubility. Inkpot's pH is slightly below neutral, and this could allow increased solubility of iron even in the presence of O_2.

Furthermore, some of the iron in Inkpot must occur in organic compounds as a colloid. Humic acids, which are responsible for the stained waters of Inkpot, form stable colloidally dissolved humates with iron even in the presence of O_2 when the pH is below neutral. This could be a major source of dissolved iron in Inkpot.

Two of the most apparent characteristics of a lake are its color and its clarity. Clarity is a measure of light penetration measured with a Secchi disc. Inkpot had an exceptionally shallow Secchi disc reading, 1.5 m. There are several reasons for the lack of clarity of Inkpot's water. Although it was clear and sunny the day the Secchi disc reading was taken, there was a slight breeze which caused the surface of the water to reflect more sunlight than would have been the case if the water was clear. Also, the eyesight of the person performing the test may not have been normal, but this is doubtful because the tester's vision was corrected to 20/20 with contact lenses. A more important reason for the lack of clarity is that during the time of the test, there was a rather dense bloom of the blue green algae, *Occilatoria* occuring. Finally, the lack of clarity can be explained by the high index of color found Inkpot's waters which are stained a tea brown color by humus material. The apparent color of lakewater is due to sediments and phytoplankton while the true color of the lakewater is due to colliodally disolved particles and humus materials. In the epilimnion of Inkpot, the apparent color of the water is 20 units higher than the true color. This shows that there is a considerable amount of sediment material and/or phytoplankton in the epilimnion. The two color readings were more compatable in the hypolimnion.

The result of the lack of clarity and high color content of Inkpot is obvious, sunlight isn't penetrating very deeply into Inkpot's waters. Photosynthesis can occur only to the depth at which the light intensity is 1% of that of the incident light at the water's surface. That depth is 2x the Secchi reading or 3 m. for Inkpot. So it is doubtful that any macrophytes or phytoplankton would be found below 3 m. in Inkpot. Most importantly, this finding is consistent with the O_2 profile which shows plenty of O_2 (produced as a product of photosynthesis) down to a depth of 3 m. After 3 m., the O_2 concentration begins to decline, because it can't be replenished by photosynthetic organisms at that depth.

The chemistry of productive lakes generally shows high values for alkalinity, hardness, and specific conductance. This happens because the three properties are all related to each other. Being a productive lake, Inkpot is no exception. Its chemistry revals high values for these three related properties.

Hardness can be considered a measure of the concentration of Ca^{++} and Mg^{++} ions in the water. These ions are released to the lake via ground water during weathering processes of the bedrock underlying the lake and its watershed. Because Ca^{++} and Mg^{++} are so important to aquatic biota, the hardness of a lake is a good indicator of procuctivity. Mg^{++} is the "heart" of the chlorophyll molecule, and Ca^{++} can be a limiting nutrient for the primary decomposers. Inkpot with its high concentration of Ca^{++} and Mg^{++} is definitely a hard-water lake. The hardness of Inkpot's water is a key factor responsible for the lake's productivity.

It comes as no surprise that Inkpot has a high specific conductance. Specific conductance is a measure electrolyte concentration and gives some indication of total dissolved solids present in a lake. In general, high values for hardness and alkalinity help produce high specific conductance values. The chemistry data from Inkpot show it to be no exception. Even the large difference in the conductivities of the epilimnion and the hypolimnion can be attributed to the differences in the hardness and alkalinity differences for the two isolated regions of the water column.

The third of the three related properties in water chemistry is alkalinity. Alkalinity is a measure of OH^- and HCO_3^- ions, the key buffers in most natural waters. The main source of the HCO_3^- ion is the lake's surrounding watershed. When CO_2 and H_2O attack carbonate rocks, such as those found in glacial till, some of the carbonate is dissolved out to form bicarbonate solutions. One of the most common sources of bicarbonate is limestone: $CaCO_3 + H_2O + CO_2 \longrightarrow Ca^{++} + 2HCO_3^-$. Again, the geochemistry of the watershed becomes important. Those lakes surrounded by thick sedimentary deposits of carbonate containing rocks or glacial till will have more HCO_3^- than lakes with a predominately igneous watershed. This is especially important because the amount of HCO_3^- is directly proportional to the buffering capicity of a lake.* Most natural waters use the carbonic acid buffering system which makes use of the following coupled reactions: $CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons H^+ + CO_3^=$. Because all the reactions are reversible, the system has a buffering effect in the lake. When acids are added to the system, they are buffered by the $CO_3^=$ and HCO_3^- and the reaction is driven toward the formation of undissociated H_2CO_3. When strong bases are added to the system they are buffered by the H_2CO_3 which forms a bicarbonate salt and carbonate. The high alkalinity of Inkpot allows this buffer system to be especially effective. Thus, Inkpot has the ability to resist changes in pH and and the associated dangers to its aquatic life.

The pH is a measure of the H^+ concentration. The main source of H^+ in natural waters is carbonic acic and its varied

*Buffering capacity refers to the ability to resist changes in pH.

forms. When large amounts of photosynthetic activity deplete the CO_2 in the water, the pH can be elevated. An examination of the buffering system reactions shows why. As CO_2 is removed, the equilbrium shifts to the left toward the production of more CO_2. So high pH values would be expected for productive lakes if the sample was taken on a clear sunny day. The only problem is that productive lakes like Inkpot characteristically have high alkalinities and therefore, high buffering capacities which resist the elevation of pH.

The pH can also be lowered, many times as a result of acid precipitation. However, Inkpot's buffering ability allows it to withstand acidic insults. Other lakes on the UNDERC property are not as well buffered as Inkpot. As a result, they are experiencing acidification and its associated dangers.

The acidity of a lake is a measure of its ability to donate H^+ ions. It is important to realize that two lakes could have the same pH values and yet have very different acidities. Inkpot shows a higher acidity value for the hypolimnion than the epilimnion. This is common. Because CO_2 is released during decomposition, and the majority of the primary decomposers work in the hypolimnion, it is common for the CO_2 to accumulate there in large amounts. Again, an examination of the buffering system reactions show that an increase in CO_2 will shift the equilibrium to the right toward the production of carbonic acid.

CHEMISTRY

ED'S BOG

The chemistry of Ed's Bog is much different than that of Inkpot Lake. The difference arises because of the peculiar environment and flora of a bog give it its own special chemistry. While the chemistry of Inkpot shows it to be a rather productive lake, Ed's Bog has the characteristics of a low productivity or dystrophic type lake.

The temperature profile for Ed's Bog shows the presence of a very small epilimnion and a very large hypolimnion. This means that the majority of the water is very cold, not the ideal situation for biological productivity. It is interesting to note that is exactly the opposite of the situation in Inkpot. The profile also shows Ed's to be very deep. Because Ed's is so deep and so well protected from the wind, it is not able to "turn over" every spring and fall. Consequntly, nutrients can't be brought to the top and O_2 can't be regenerated at depth.

A very striking situation becomes evident upon examination of the O_2 profile. No oxygen exists below a depth of two meters. There are several reasons for this phenomenon. The principle one being that no photosynthetic organisms cant live at depths of greater than 2.8 meters in Ed's Bog. This is because the clarity of the water is so low (Secchi = 1.4 meters) that light simply can not penetrate very deeply. This fact coupled with the great depth of Ed's Bog explains why the temperature drops so fast with depth.

The lack of clarity of the water is due mainly to the fact that the water is deeply stained to a brownish color. This staining is caused by colloidally dissolved particles and humus materials. Because the apparent and true color readings are identical for the epilimnion, it can be stated with confidence that there is not much in the way of sediments or phytoplankton responsible for the color in the epilimnion. The hypolimnion shows some degree of sedimentation, some of which may be due to zooplankton lurking in the depths waiting for darkness so they can vertically migrate to the epilimnion. Probably not.

Another striking yet characteristic property of Ed's Bog is the very high acidity. This situation is primarily a result of the presence of Sphagnum moss which makes up a large percentage of the floating bog mat. The uronic acid in Sphagnum (both living and dead) acts as a hugh water softener based on ion exchange. Ca^{++} and Mg^{++} are absorbed by the acid in the moss which then yields H^{+} in their place.

Uronic acid ion exchange is not the only source of acidity in bogs. Other humic acids also act in a similar manner. These acids which are so abundant in peaty material (Uronic acid can make up as much as 30% of the dry weight Sphagnum) arise from plant materials in a process facilitated by bacterial enzymes. The plant material is first decomposed into more simple compounds, then the bacteria help synthesize high molecular weight, tea-brown polymers. Since these humic acids are stronger than carbonic acid, they have the ability to lower the pH down to around 4. The pH of Ed's Bog was below neutral, 4.9 in the hypolimnion and 5.4 in the epilimnion. It is important to realize that the pH in Ed's Bog can fluctuate rather easily because it is so poorly buffered. The reasons for this situation are quite obvious. First, the humic acids absorb much of the Ca^{++} Mg^{++}. This explains the very low values for hardness in Ed's Bog. Secondly, because the basin of Ed's is sealed off, it has a very small watershed, and therefore influence from the surrounding area is minimized. This means that the very important HCO_3^- ion can't be obtained easily by Ed's Bog. Under these conditions it is not surprising that the alkalinity values for Ed's are so low.

Because specific conductance is related to alkalinity and hardness, and both of these are low in Ed's, it would be expected that the specific conductance would also be low. The chemistry data show this to be the case for Ed's Bog.

Minimal influence from the surrounding watershed helps account for the low nutrient values for Ed's. Nitrates, phosphates, and iron are all very low indeed, and no sulfates were found in the bog. This is because they all were reduced to H_2S which was present in large quantities at the time of sampling. Low Ca^{++} concentration is also a contributing factor to the low nutrient situation in Ed's. Ca^{++} is a limiting nutrient for many primary decomposers. Since it isn't available in the necessary quantities, organic materials which reach the bottom of the bog can't be decomposed, consequntly; their nutrients are not released. Even if they were released, they would have a hard time getting dispersed since Ed's Bog doesn't turn over.

The preceeding discussion of the chemistry of Ed's Bog clearly reveals that the waters of Ed's Bog aren't capable of sustaing substantial amounts of biological productivity even though the productivity of the surrounding mat is quite high.

BIOLOGY

INKPOT LAKE

A visual examination when coupled with an anylsis of the chemical and biological data clearly indicate that Inkpot is a productive lake. Visually, many robust macrophytes and large amounts of suspended organic matter are present. The macrophytes are visible far out in the lake (as far as 20 meters in some areas), which indicates a rather gently sloping bottom with large areas of shallow water. This is important because the greater the amount of shallow water, the greater the biological productivity. The principle factor enabling large productivity is the close "superposition of the photosynthetic zone over the decomposition zone." When the slope of the bottom is gentle, dead organic material from the photosynthetic zone sinks to the bottom direcly below this zone, and it stays there. Once on the bottom, decomposers can break down the organic matter and release the valuable nutrients to the plants for their immediate use. So the nutrients are cycled between the two zones in such a way as to benefit both. Such cycling is not nearly as efficient when the slope of the bottom is so steep that it causes the removal of dead organic matter to deeper water. This seperates the photosynthetic zone from the decomposition zone, as a result; the nutrients become isolated from the zone where they are needed most.

The temperature profile for Inkpot shows the presence of a large epilimnion and a relatively small hypolimnion. This situation allows minimal valumes of cold water to be present in Inkpot. The importance of this phenomenon to biological productivity cannot be underestimated. Since the organisms in Inkpot are pykilotherms, higher temperature mean higher metabolic rates. This translates to high productivity in the presence of sufficient nutrients which Inkpot has.

Because Inkpot his a hard water, alkaline lake with plenty of nutrients available, it supports many robust type macrophytes which are not found in some softer more acidic lakes with low hardness and alkalinities. The abundance of macrophytes facilitates fish life in Inkpot by providing cover and nesting areas during the Spring.

Before an evaluation of the primary productivity of Inkpot can occur, it must be understood that underlying the productivty of any orgnanism are trophic relations along with competitive predatory interactions which cause varying success rates among the species. A brief and very much siplified statement of Inkpot's food chain will facilitate an understanding of why certain organisms, particularly the plankters, are abundant or depleted in Inkpot. Phytoplankton are responsible for the primary production. Zooplankton, primary consumers, then eat the phytoplankton. The zooplankton is preyed upon by small fish, yellow perch and other low level consumers which are in turn preyed upon by the walleye, northern pike, and muskellunge.

An examination of the simplified version of Inkpot's food chain shows that phytoplankters are responsible for transferring energy from the sun into usable forms for other organisms. Thus, phytoplankton productivity to a large extent controls the productivity of higher trophic levels. Several factors affect the procuctivity of phytoplankton: water clarity, abundance of CO_2, and the concentrations of other key nutrients. As mentioned during the chemistry discussion, Inkpot has all the chemical characteristics necessary for high levels of primary productivity. This fact enables the zooplankters, which utimately provide food for the fish population, to flourish.

The phytoplankton data for late July show 8 different genera in Inkpot with Aphaenizomenon dominating and large populations of Dinobryan and Chrysosphaerella. However, the data for late June of the year before, 1981, show not only more species of phytoplankton were present, but also more species were prsent in large numbers. This inconsistency brings up an important point concerning plankton data in general. The species of plankton undergo seasonal successions, so not only does the population of certain phytoplankton change over time, but also the species themselves change. Each species has one or two periods during the year in which it reproduces rapidly, thus the population reaches a maximum.

The seasonal cycle of phytoplankton is the critical factor which determines the zooplankton populations. At the time of sampling, far less zooplankton was found in Inkpot than phytoplankton. A reasonable explaination for this situation is a seasonal minima for zooplankton or a seasonal maxima for phytoplankton. However, a better explantion is that the perch and other low level consumers in Inkpot were eating up the large species of zooplankton. The smaller species are harder for the fish to see, but they are also harder for the human eye to see. As a result, very small plankters could have been overlooked during the counting procedure.

The inconsisties in the plankton data of the two counts are not due solely to the seasonal maxima and minima of the plankton species. Even if the same species were present in the same quantities during the sampling times, chances are the counts would not show this to be true. First, it must be remembered that plankters are drifting organisms, so their position is at the mercy of water currents and the wind. Either or both of these forces can concentrate the plankton in certain areas of the lake. Even the motile plankton can't swim against water currents, however; they can and will swim to areas of the lake where nutrients are more concentrated. Selective predation of plankton also helps change the distribution of plankton in a lake.

Two of the most important variables which can produce inconsistent plankton data are the depth of tow, and the time of day of the tow. The depth is important because there is a verticle distribution of plankton in the water column. The distribution depends on many factors such as the species preference for light, temperature, food, and dissolved gases.

The time of the tow is most important because most zooplankton exhibit a phenomen called vertical migration during the dark periods of the day. Many species reside in the dark, cold hypolimnion during the day to avoid predation and also to conserve energy (lower metabolic rates). After dark, they migrate up the warmer surface waters and feast on the phytoplankton. So, depending on the time of sampling, very different plankton counts will occur.

BIOLOGY

ED'S BOG

Ed's Bog is in one of the final stages of its ecological succession. Ideally suited for bog formation, the geographic region of Ed's is rich in basins formed by glacial action. In order for a bog to form, the basin must exhibit two important features. It must be well protected form the wind, and the influence of outside groundwater must be minimal. Ed's bog is well protected from the wind by hills and forests. Years ago, this protection allowed bog vegetation to become established. Once established, mat forming associations developed and began to encroach on the open water and deposit peat below. As the encroachment aroud the edge of Ed's Bog continues and more and more peat is deposited on the bottom, the bog will eventually fill in and become extinct.

Most aquatic organisms have difficulty functioning in the harsh chemical enviroment of bogs like Ed's. The waters are extremely acidic and devoid of any oxygen at depths greater than 2 meters. So any areobic organism is forced to live in near the surface, a hard task to accomplish during the winter months when ice takes up most of the oxygenated level of the water. The lack of oxygen in the deeper waters of Ed's becomes quite apparent during the Spring when thousands of tadpoles can be seen treading water at the surface but not swimming at depth. Aquatic organisms living in Ed's must also deal with the acidity. Water boatmen and whirligig beetles do this quite well, however;

most organisms can't survive in hyperacidic environments. The primary effect of the acid is at the molecular level where pH-dependent ezymatic activity can be abolished when the pH is altered. In other words, lowered pH denatures protiens which are the backbone of biological activity. In light of the previous statements, it is not surprising that no fish are found in Ed's Bog.

The fact that Ed's is missing one of the higher level consumers (fish), has important implications for the menbers of the lower trophic levels, insects and more importantly zooplankton. Since fish aren't present to eat the large zooplankters, it would be expected that large zooplankton would be found in Ed's. This is the case. There were more and larger species of zooplankters found in Ed's than in Inkpot which has many fish.

An enourmous population of the rotifer Keratella was found in Ed's. Although it is a characteristic of bogs to be dominated by Keratella, domination does not describe the huge numbers of this rotifer found Ed's. Keratella is also the most common of all rotifers in North America, but this too fails to explain the situation Ed's. What does explain the situation is the occurance of a seasonal maximum coupled with seasonal minima for the other genera of zooplankters found in Ed's. Certainly there were plenty of phytoplankters available at the time of sampling to satisfy the apetite of even the most voracious filter feederes.

One final issue remains to be addressed, and that is the problem ef explaining the presence of larger amounts of phytoplankton in the less productive lake. Seasonal maxima and mimima for the various species could account for some of this unexpected data. The presence of fish in Inkpot also could be a factor. It is possible that the perch and other low level consumers had just devoured large quantities of zooplankton just before the time of sampling. In turn, these zooplankters could have eaten large amounts of the phytoplankton just before the sampling. These possibilities are not out of the question, however; they are only guesses (of which many more could be made) which try to explain the occurance of data which runs counter to theory. With so many opportunities for error and inconsistency in the plankton collecting and counting methods used, it is not shocking to find a peice of data which does not agree with theories of productivity.

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