WC 9.5

9.25

U N D E R C   S U M M A R Y

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Purpose: To collect water and plankton samples from aquatic ecosystems, analyze these samples, and interpret and attempt to understand the system. Thereby gaining some insights into aquatic ecosystem relationships and also how these systems are analyzed.

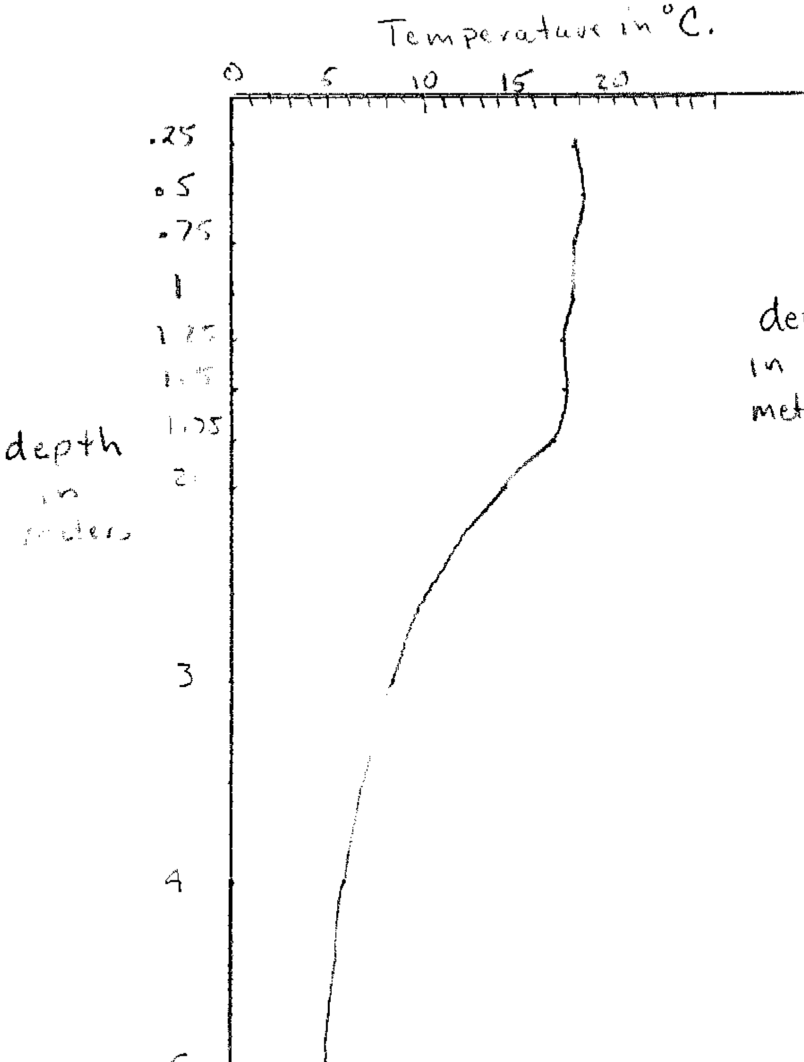
Materials: Hach kits, O_2 meter and probe, pH meter and probe, Kemmerer water sampler, plankton tow nets and funnels, appropriate bottles. Sedgewick-Rafter or Palmer cells, microscope and appropriate preparation material.

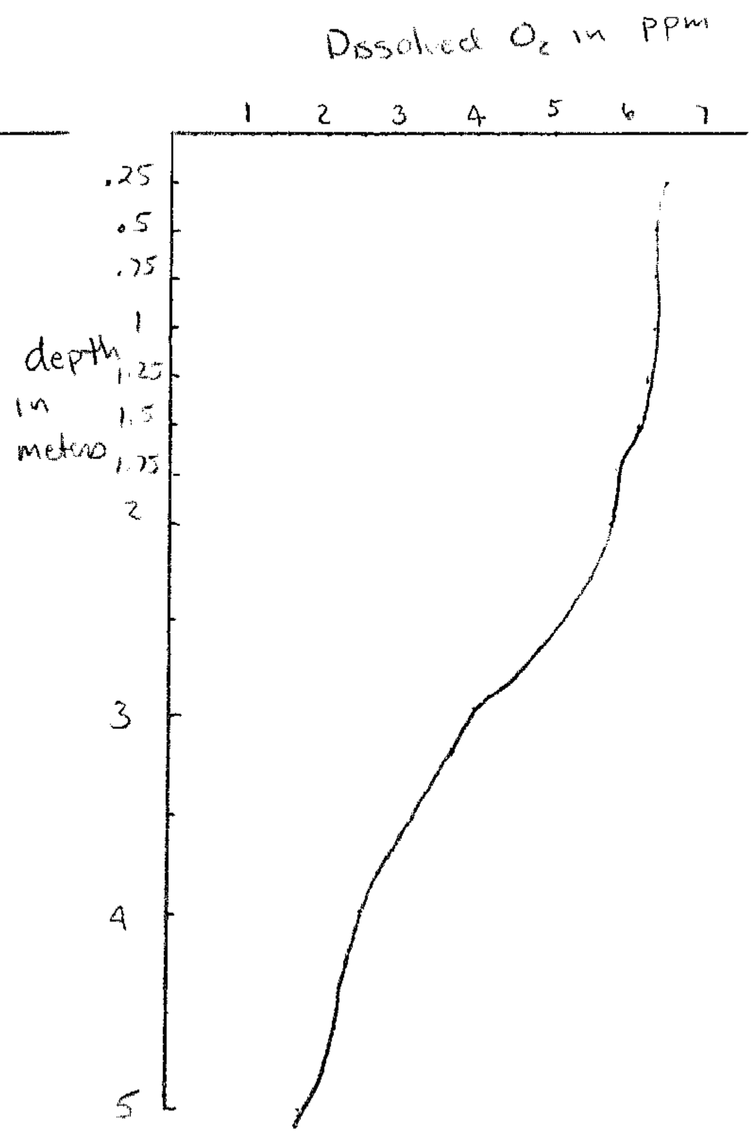
Methods: Using the temperature O2 meter, a depth profile on temperature and dissolved oxygen was run. Using a Kemmerer bottle, water samples were taken from above and below the thermocline. These samples were then analyzed for ortho and total phosphates, nitrates, sulfates, acidity, alkalinity, hardness, and apparent and true color, and specific conductivity, all using the methods of the Hach chemical kits. pH was measured using a pH meter. Phytoplankton samples were taken from the epilimnion by draining the contents of a Kemmerer bottle through a fine mesh plankton funnel. Zooplankton samples were collected by performing a 5 minute standard tow with a plankton tow net positioned at the surface. Plankton samples were analyzed quantitatively using either the Palmer or Sedgewick-Rafter cell and microscope. Computations are described on page 102 of Common Methods in Limnology. General shoreline surveys for periphyton and macrophyte presence were also made.

FOREST SERVICE BOG

Epilimnion samples from 1 meter, Hypolimnion samples from 5 meters.

DEPTH IN METERS	TEMPERATURE °C	O_2 ppm
air	20.5	
0.25	18	6.6
0.5	18.5	6.3
0.75	18	6.2
1.0	18	6.2
1.25	17.5	6.1
1.5	17.5	6.0
1.75	17	5.9
2.0	14.5	5.8
3.0	8.5	3.8
4.0	6	2.4
5.0	5	1.6





FOREST SERVICE BOG

WATER CHEMISTRY RESULTS

pH	Epilimnion	3.5 with pH 4 buffer
	Hypolimnion	3.4 with pH 4 buffer
Methyl Orange Acidity	Epilimnion	15mg/l $CaCO_3$
		12mg/l $CaCO_3$
	Hypolimnion	10mg/l $CaCO_3$
		10mg/l $CaCO_3$
Phenolphthalein Acidity	Epilimnion	35mg/l CaCO3
		38mg/l $CaCO_3$
	Hypolimnion	32mg/l $CaCO_3$
		38mg/l CaCO3
Calcium Hardness	Epilimnion	2.5mg/l $CaCO_3$
		2.4mg/l $CaCO_3$
	Hypolimnion	6mg/l $CaCO_3$
		5mg/l $CaCO_3$
Total Hardness	Epilimnion	4.2mg/l $CaCO_3$
		4.0mg/l $CaCO_3$
	Hypolimnion	6mg/l $CaCO_3$
		5mg/l $CaCO_3$
Total Alkalinity	Epilimnion	0mg/l $CaCO_3$
	Hypolimnion	0mg/l $CaCO_3$
Specific Conductance	Epilimnion	.05 micromhos/cm 5?
	Hypolimnion	.05 micromhos/cm
Apparent Color	Epilimnion	48
		45
	Hypolimnion	80
		85
True Color	Epilimnion	40
	Hypolimnion	55

Nitrates	Epilimnion	.3mg/1 Nitrate N
		.4mg/1 Nitrate N
	Hypolimnion	.6mg/1 Nitrate N
		.5mg/1 Nitrate N
Sulfates	Epilimnion	7mg/1 SO_4
		7mg/1 SO_4
	Hypolimnion	16mg/1 SO_4
		16mg/1 SO_4
Ortho Phosphates	Epilimnion	.01mg/1 PO_4
		.01mg/1 PO_4
		0mg/1 PO_4
	Hypolimnion	.03mg/1 PO_4
		.02mg/1 PO_4
		.01mg/1 PO_4
Total Phosphates	Epilimnion	.08mg/1 PO_4
		.09mg/1 PO_4
		.15mg/1 PO_4
	Hypolimnion	.2mg/1 PO_4
		.32mg/1 PO_4
		.18mg/1 PO_4

FOREST SERVICE BOG PLANKTON DATA

PHYTOPLANKTON

Phytoplankton Funnel Samples

Scenedesmus	319473 per liter of lake water
Dinobryon	31680 per liter of lake water
Agmenellum	473880 per liter of lake water

Phytoplankton from Morning Tow

Dinobryon	34,986,000 per standard tow
Asterionella	14,280,000 per standard tow
Rhizoclonium	23,800,000 per standard tow
Spirogyra (strands)	23,800,000 per standard tow
Ulothrix (strands)	23,800,000 per standard tow

Phytoplankton from Night Tow

Dinobryon	$3.528 * 10^8$ per standard tow
Ulothrix (strands)	$3.36 * 10^5$ per standard tow
Asterionella	$1.26 * 10^5$ per standard tow

ZOOPLANKTON

Zooplankton from Morning Tow

Keratella	$6.188 * 10^8$ per standard tow
Daphnia	$8.33 * 10^7$ per standard tow
Cladocerans	$1.154 * 10^7$ per standard tow
Chaoborus	$1.19 * 10^7$ per standard tow
Nauplius larvae	$4.76 * 10^7$ per standard tow

Zooplankton from Night Tow

Ploesoma	$7.98 * 10^8$ per standard tow
Keratella	$5.04 * 10^8$ per standard tow
Netrium	648000 per standard tow
Chaoborus	$1.26 * 10^7$ per standard tow
Cyclopoid Copepod	$4.2 * 10^5$ per standard tow
Nauplius larvae	$4.2 * 10^5$ per standard tow
Cladocerans	$4.2 * 10^4$ per standard tow

PERIPHYTON: Most of the periphyton in Forest Service Bog consisted of insects and these were limited to small beetles attached to lily pads. As lily pads were scarce so were the beetles.

SHORELINE: Forest Service Bog has an oval shoreline and also has a small floating island near the middle. The island is tied down and sphagnum moss has grown over the ropes to make the island stationary. The surrounding plants are the classic bog plants. Sphagnum moss is in great abundance and forms the usual bog mat. Located along the shore near the water is a good crop of the carnivorous sundew. Pitcher plants can be seen spread over the mat and are thickest near the boards providing access to the bog. Leather leaf is also very abundant.

This bog is fairly open as the tree cover is located back from open water by a good distance. Most of the trees are coniferous with Tamarack and Spruce predominating.

FOREST SERVICE BOG

Much of the water chemistry data for Forest Service Bog is unusual for a bog. The thermocline is located at almost two meters, fairly deep for a bog. The hypolimnion showed a substantial concentration of sulfate ions. Nitrate ions were well distributed in both the epilimnion and hypolimnion. In addition to these nutrient distributions the oxygen tension in the hypolimnion was high, especially for a bog. Hydrogen sulfide levels were low if present so it is doubtful that any interference produced the oxygen reading.

The above facts would tend to indicate that Forest Service Bog may have turned over this past spring. This is an unusual phenomenon in a bog but a look at the topography indicates it is possible. The bog is shallow by bog standards and not as well protected from wind as many of the other bogs on the property. The shallowness could allow all the water to reach the same temperature after ice-out. If this occurred, the wind would be able to mix the water and nutrients very easily, producing a turnover.

The data also shows many of the characteristics of a bog. The pH, hardness, and alkalinity are all low. pH is probably the key factor to discuss in a bog. The pH is low because of the high concentration of hydrogen ions. This concentration is high mostly as a result of the sphagnum moss which removes calcium ions from the water and exchanges hydrogen ion for it. This has several dramatic effects on the water chemistry. First, the removal of calcium ion decreases the hardness by limiting the amount of calcium carbonate which can form. Secondly, on the basis of the carbon dioxide and water equation it reduces the amount of available carbonate anions. This reduces the buffering capacity of the water as it is now more susceptible to drastic changes in pH. This is why the acidity is so low in bogs. They are not able to absorb great concentrations of acids or bases without changing the pH. Finally the conductivity of the water is lowered because fewer ions are available for conducting current.

In addition to the changes caused by the ion exchange of the sphagnum mat, the surrounding conifers effect the water. These trees release alot of organic material known as tannins which can lower the pH but also stain the water quite effectively. Very little decomposition occurs in bogs so a lot of detritus accumulates which can also account for the highly stained water.

The total alkalinity is zero for this bog. This was expected because the pH of the bog lies below the range of the indicators which are used to detect any alkalinity. At a pH of about 8.3 or less, carbon dioxide is free in water and thus tends to explain why alkalinity is nill. If the carbonate and bicarbonate ions are in scarce supply, the alkalinity should be limited. At the pH found in Forest Service Bog, one would expect that almost all the carbon would be in the dissolved carbon dioxide form, not carbonate or bicarbonate.

Bogs are traditionally known for poor production levels. Thus one would expect important nutrients like phosphates and nitrates to be in limited supply. In addition, the fact that decomposiion is limited would lead one to expect most of the available nutrients to be in the detritus which accumulates on the bottom. Hypolimnion levels would therefore tend to be higher than epilimnion values.

The phosphate levels are expressed in two ways. The ortho phosphates are generally considered to be the forms used by most organisms. Therefore the ortho phosphate counts can be useful in determining productivity. As would be expected, the ortho phosphate levels were quite low, about .01 mg/1. Total phosphates were also measured. This method converts various forms of phosphate into the ortho form by hydrolyzing with sulfuric acid. The results show the expected trend with the values being higher than the ortho phosphate levels. Also the total phosphate levels were higher in the hypolimnion than the eplimnion. The ortho phosphate levels were about equal in each layer. Because this form is quite soluble in water it would be expected to distribute evenly after a turnover. Total phosphates include the phosphate bound in living or dead matter which is hydrolyzed, and would be expected to be higher in the hypolimnion even if a turnover occurred.

In addition to phosphates, nitrates play a major role in lake production. Obviously nitrate levels are important as a nitrogen source for amino acid synthesis in organisms. If nitrogen as nitrates is in short supply, production will probably suffer. Nitrate levels were very low in both the epilimnion and hypolimnion. The main reason is probably still the lack of decomposition. Like the ortho phosphates, nitrate levels were roughly equivalent in the epilimnion and hypolimnion. If the bog did turn over this would explain this phenomenon. Ordinarily nitrate levels would probably be higher in the hypolimnion where most of the decaying process occurs.

Sulfur can occur largely in two major forms, as sulfates or sulfide. If oxygen is present the sulfur will tend to form sulfates which is a necessary nutrient. If no oxygen is present sulfide will exist which can interfere with the oxygen meter to show inflated values. Hydrogen sulfide has a potent odor which can be smelled by man in small concentrations. No smell was detected and the sulfate test showed moderate levels, all of this again supports the possibility of a turnover having occurred. The sulfate test can be inflated by stained water but the levels were high enough that it appears the sulfates were indeed present.

Through the various chemistry tests, a general discussion has shown what some of the physical properties of this bog are and when possible, explanations have been offered. Next, I will attempt to use this information to explain some of the trends in plankton distribution.

As has been mentioned several times, bogs are notoriously poor producers. The number of species present is usually small but those that are present tend to be very abundant because competition is limited. Any organism which lives in a bog must be able to withstand both a low pH and limited nutrient supply. Desmids tend to dominate bog waters, for what reason I don't know. Apparently they are able to thrive in the low nutrient environment. Unfortunately the plankton samples produced almost all green algae with a few diatoms present.

In the sample which was run through a plankton funnel, two green algae were very common; Scenedesmus and Agmenellum. Dinobryon was also detected but in much smaller quantities. In the morning Zooplankton tow, Dinobryon was by far the most abundant algae. Asterionella, a diatom was also very abundant. Spirogyra, Ulothrix, and Rhizoclonium were all found in smaller amounts. These three types of organisms produced sample counts of two per count, yet when calculated one predicts over two hundred thousand should be taken in a five minute standard tow. The night tow showed Dinobryon to be in increased numbers. Asterionella was again present but in reduced numbers. The only other algae present was Ulothrix.

Why was Dinobryon so abundant in the tow samples but not in the phytoplankton? First of all the tow does not allow us to calculate the volume of water sampled. Perhaps the numbers actually are roughly equivalent. In addition the tow was run at a higher depth. Phytoplankton are more likely to be found near the surface. Perhaps the one meter phytoplankton was below the densest area of Dinobryon.

Another question arises as to why Scenedesmus and Agmenellum were absent from the tows. The tow nets were designed primarily for trapping the larger zooplankton and therefore many algae can pass right thru the mesh. The phytoplankton used a smaller mesh net in the funnels to aid in retaining the algae.

In the zooplankton study, rotifers and cladocerans were the predominant organisms. In the morning, the rotifer Keratella was very prevalent as were the Daphnia and unidentified cladocerans. Chaoborus larvae and Nauplius larvae from the copepoda were also numerous. In the night tow, the rotifer Ploesoma was found in numbers that exceeded even Keratella. Chaoborus were also abundant. Cladoceran levels sank dramatically from the morning levels as did Nauplius larvae counts. Some cyclopoid Copepods were found also.

The movement of the cladocerans in this bog is puzzling. Ordinarily one would expect the zooplankton to be most active at night when predation pressure would be at its lowest. In addition, any phytoplankton consumed would not have had much time to respire the energy fixed during the day. Yet strangely the cladocerans, particularly the Daphnia were in diminished numbers in the night sample. The most logical explanation I can give is a flaw in the technique so that these animals were missed.

Another important organism in bogs is the Chaoborus larvae. Actually, these are insect larvae, not zooplanktors. These organisms spend much of the day in deeper water and at night swim to the surface. In well stratified systems like bogs, where turnover is rare, these organisms may provide the only means of nutrient exchange from the hypolimnion to the epilimnion.

Generally speaking, few types of organisms were present. Those that were present tended to be very abundant. Surprisingly absent were the desmids which ordinarily grow well in bogs. The bog phytoplankton was dominated by multicellular green algae. The zooplankton was dominated by rotifers, i.e. Keratella and Ploesoma.

Taking a brief look at Forest Service Bog one can note several oddities for a bog. The trees and shrubs are located back from open water. The water is not deeply stained and it is well oxygenated. The available nutrients are fairly evenly distributed. In short this bog almost doesn't seem like a bog. Its shallowness is unusual but could be the result of years of accumulation of peat. While very acid in pH, and surrounded by a well developed bog mat; something about Forest Service Bog strikes me as strange. The lack of hydrogen sulfide and staining just seem unusual to me for a bog. I would be curious to know how long this bog has been forming.

ED'S BOG

Epilimnion from 1 meter
Hypolimnion from 5 meters

DEPTH IN METERS	TEMPERATURE IN °C	O_2 in ppm
Air	23.5	
Surface	16.2	3.4
.25	15.5	3.6
.5	15.2	3.2
.75	15	2.8
1.0	15	2.9
1.25	14	1
1.5	13.5	.8
1.75	10.5	.7
2.0	8.2	.8
3.0	6.8	.9
4.0	5	1.1
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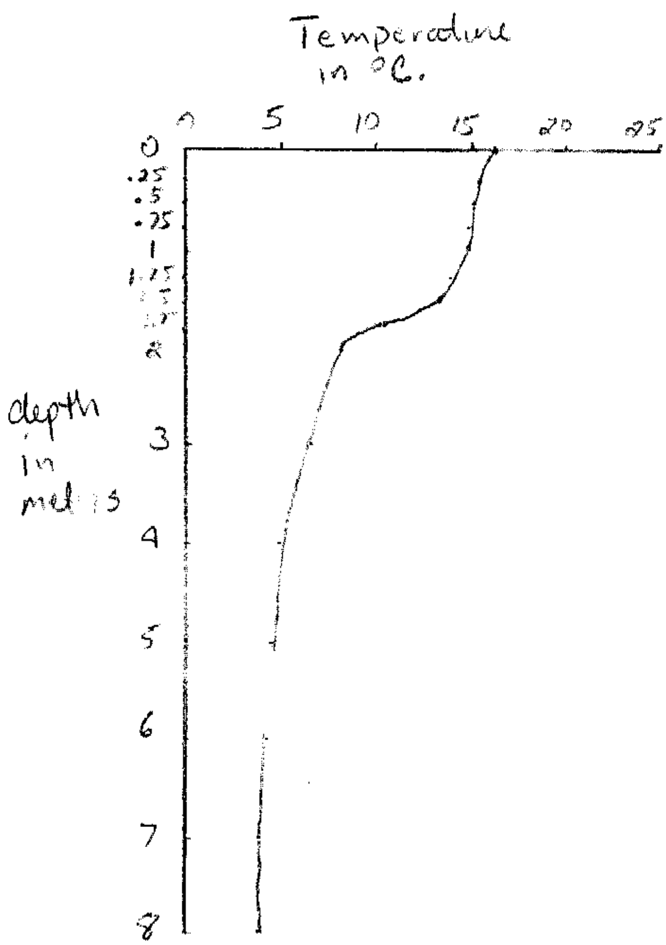
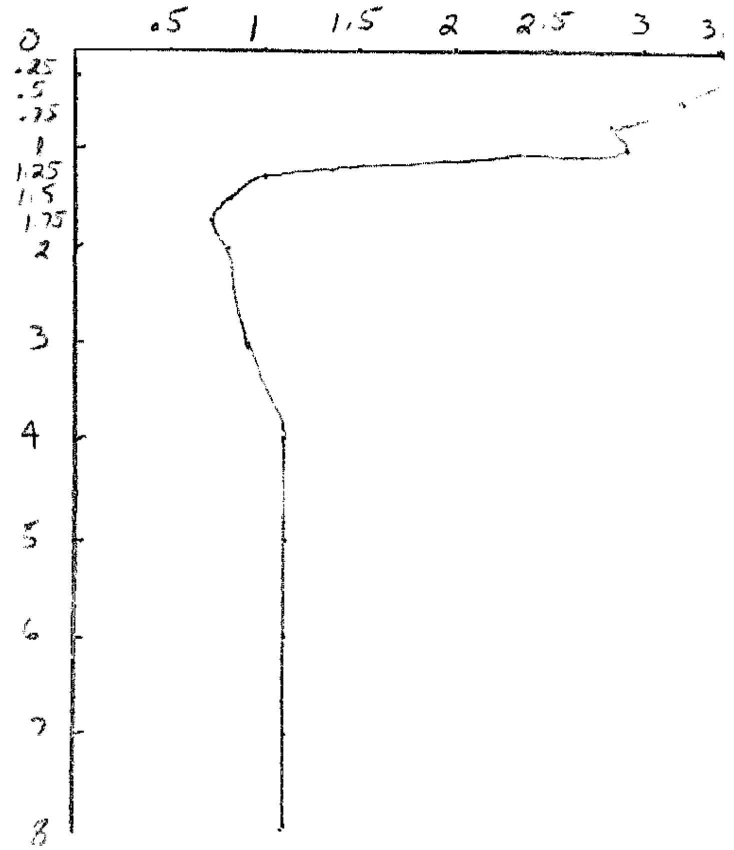
7.0	4.0	1.1
8.0	4.0	1.1





ED'S BOG

WATER CHEMISTRY

pH	Epilimnion	3.8
	Hypolimnion	4.1

Methyl Orange Acidity	Epilimnion	3.75mg/1 $CaCO_3$
		3.8mg/1 $CaCO_3$
	Hypolimnion	0mg/1
Phenolphthalein Acidity	Epilimnion	60mg/1 $CaCO_3$
		63mg/1 $CaCO_3$
	Hypolimnion	60mg/1 CaCO3
		63mg/1 CaCO3
Total Alkalinity	Epilimnion	0
	Hypolimnion	0
Calcium Hardness	Epilimnion	less than 2mg/1 $CaCO_3$
	Hypolimnion	less than 2mg/1 $CaCO_3$
Total Hardness	Epilimnion	less than 2mg/1 $CaCO_3$
	Hypolimnion	less than 2 mg/1 $CaCO_3$
Apparent Color	Epilimnion	130
	Hypolimnion	180
True Color	Epilimnion	130
	Hypolimnion	170
Specific Conductance	Epilimnion	28 micromhos/cm
	Hypolimnion	21 micromhos/cm

ED'S BOG

NUTRIENT DATA

Nitrates	Epilimnion	.4mg/1 Nitrate N
		.4mg/1 Nitrate N
	Hypolimnion	3.4mg/1 Nitrate N
		3.5mg/1 Nitrate N
Sulfates	Epilimnion	6mg/1 SO_4
		8mg/1 SO_4
	Hypolimnion	0mg/1 SO_4
Ortho Phosphates	Epilimnion	.02mg/1 PO_4
		.03mg/1 PO_4
		.02mg/1 PO_4
	Hypolimnion	.15mg/1 PO_4
		.12mg/1 PO_4
		.11mg/1 PO_4
Total Phosphates	Epilimnion	.1mg/1 PO_4
		.14mg/1 PO_4
		.15mg/1 PO_4
	Hypolimnion	.23mg/1 PO_4
		.225mg/1 PO_4
		.225mg/1 PO_4

ED'S BOG PLANKTON DATA

Phytoplankton from Funnel

Eadorina or Pleodorine	18729 per liter
Ulothrix (strands)	7488 per liter of lake water
Dinobryon	8430 per liter of lake water
Chlamydomonas	2808 per liter of lake water
Staurastrum	934 per liter of lake water

Phytoplankton from Morning Tow

Gymnozyga	$3.53 * 10^{7}$ per standard tow
Cosmarium	$1.72 * 10^{5}$ per standard tow
Micrasterias	$8.6 * 10^{4}$ per standard tow
Dinobryon	$1.763 * 10^{6}$ per standard tow
Fragilaria	$1.29 * 10^{5}$ per standard tow
Staurastrum	$2.623 * 10^{6}$ per standard tow
Ankistrodesmus	$2.365 * 10^{6}$ per standard tow
Green Algae	$3.87 * 10^{5}$ per standard tow
Netrium	$1.118 * 10^{6}$ per standard tow

Phytoplankton from Night Tow

Scenedesmus	$8.434 * 10^{5}$ per standard tow
Dinobryon	$6.954 * 10^{5}$ per standard tow
Peridinium	$2.881 * 10^{2}$ per standard tow
Anabena (strand)	$3.66 * 10^{3}$ per standard tow
Staurastrum	$2.031 * 10^{3}$ per standard tow
Netrium	$5.691 * 10^{3}$ per standard tow
Ankistrodesmus	$2.765 * 10^{5}$ per standard tow
Navicula	present in unknown density

ZOOPLANKTON

Zooplankton from Morning Tow

Daphnia	$1.29 * 10^{6}$ per standard tow
Daphnia longispina	$4.515 * 10^{6}$ per standard tow
Bosmina	$1.935 * 10^{6}$ per standard tow
Alona	$2.15 * 10^{6}$ per standard tow
Ceriodaphnia	$7.654 * 10^{6}$ per standard tow
Keratella	$4.73 * 10^{6}$ per standard tow
Nauplius larvae	$3.182 * 10^{6}$ per standard tow
Cladocerans	$9.03 * 10^{5}$ per standard tow
Diaptomous	$4.73 * 10^{5}$ per standard tow
Polyphemus	$1.29 * 10^{5}$ per standard tow
Chaoborus	$8.127 * 10^{6}$ per standard tow
Cyclops	$6.45 * 10^{5}$ per standard tow

Zooplankton from Night Tow

Ceriodaphnia	$9.76 * 10^6$ per standard tow
Chaoborus	$6.1 * 10^6$ per standard tow
Cyclops	$6.1 * 10^6$ per standard tow
Daphnia	$1.91 * 10^7$ per standard tow
Diaptomous	$2.44 * 10^6$ per standard tow
Keratella	$8.133 * 10^5$ per standard tow

ED'S BOG PERIPHYTON

As in Forest Service Bog, periphyton was limited. Large gel masses were located along the bog water edge. This gel contained *Stentor* with a symbiotic algae. The purpose of the gel is not known.

ED'S BOG SHORELINE

The bog mat, which is mostly leatherleaf and *Sphagnum*, is not as extensive as Forest Service. The amount of open water is very small and is well protected from wind by the trees which are fairly close to the water. Tamaracks and spruces are again the dominant trees. Macrophytes include the carnivorous *Ultricularia*. Some other aquatic grasses were present but not identified.

ED'S BOG

The temperature/oxygen data for Ed's Bog shows a fairly typical trend in bogs. The thermocline is usually shallow and oxygen levels start out low and diminish to almost zero. One notable fact is the rapid drop in oxygen between 1m and 1.25m. Perhaps a large amount of respiratory organisms were present here because the thermocline doesn't appear to begin until between 1.5m and 1.75m. Another anomalous piece of data is the rise in temperature between 5 and 6 meters. Being only one tenth of a degree, it could be the result of misreading. At a depth of about 1.75m the oxygen levels began to rise and leveled off by 4m. This is probably caused by hydrogen sulfide which can interfere with the meter to produce inflated results. Using the Hach kit, hydrogen sulfide was found to be present in a concentration of about 2mg/l. In concurrence with this, the sulfate reading at 5m was 0.

The pH values for the epilimnion and hypolimnion were 3.8 and 4.1 respectively. Correspondingly the alkalinity was zero and hardness was very limited. Also in accordance, the specific conductance was low. Methyl organge acidity was low because the pH was near the indicator end point and because the water is so poorly buffered. The hypolimnion should probably show some measurable methyl organge acidity. Due to the poor buffering capacity, the pH may have changed by the time the test was run.

In addition to the physical properties discussed to now, Ed's Bog had very heavily stained water. The shoreline is composed of the typical bog mat with a lot of conifers located near the water. The tannins released by these conifers could be responsible for much of this coloration.

Nutrient distribution shows the trends one would expect in any stratified body of water. The main exception is the absence of sulfates in the hypolimnion. The presence of hydrogen sulfide indicates that oxygen is not present. Since oxygen is a major component of sulfate ions, it is not surprising that sulfate levels are zero.

Nitrate levels were very low in the epilimnion but at higher levels in the hypolimnion. In a stratified lake most of the available nitrates would tend to be found in living or dead tissue. As dead matter tends to sink, so will the nitrate. Because decomposition is so slow in the bog, much of this nitrate is actually unavailable for life functions. Hence it is quite conceivable that nitrates could become a limiting nutrient in a bog.

Another possible limiting nutrient is phosphate. As would be expected in a bog the phosphate levels are low. The hypolimnion values exceed the epilimnion values as would again be expected. Phosphate is traditionally considered to be the limiting resource in aquatic ecosystems. While this is not necessarily true, when phosphate levels are as low as in Ed's Bog, it probably does hold. Phosphorus is used in so many of the cell's reactions that it is easy to understand why this might be so.

The phytoplankton in Ed's Bog showed a good number of different organisms. Chlomydomonas and the multicellular relatives Eudouna and Pleodouna were very abundant. The desmid Staurastrum was present in small quantities. Dinobryon and Ulothrix were also abundant. In the morning tow a fair assortment was collected.

Desmids included Gymnozyga, Micrasterias, Staurastrum, and Netrium. With the exception of Micrasterias these were all pretty abundant in the tow. The omnipresent Dinobryon was common as was Ankistrodesmus, Fragilaria, (a diatom) and Cosmarium. The presende of desmids is very characteristic of bogs. The night tow showed Dinobryon, Ankistrodesmus, and Netrium all in reduced numbers from the morning. New genera include Scenedesmus, Staurastrum, Anabena, Peridinium, and Navicula. All of these algae were in numbers much smaller than the morning quantities.

The zooplankton in morning tow in Ed's Bog consisted almost entirely of cladocerans. Genera include Daphnia, Alona, Bosmina, Ceriodaphnia, Diaptomous, and Polyphemus. Nauplius larvae and cyclops were present as were Chaoborus larvae. The rotifer Keratella was also prevalent. The night tow showed a similar trend but only Daphnia, Ceriodaphnia, and Diaptomous were present. Chaoborus larvae and the rotifer Keratella were also present. While the variety of cladocerans diminished, relative numbers of those present increased in the night tow. This is probably in response to predation needs. As mentioned earlier, the available energy of the phytoplankton would be highest shortly after dusk. Ordinarily zooplankton rise at night to feed, thereby avoiding predation. In a bog, predation on zooplankton is limited. As in Forest Service Bog the Chaoborus larvae tend to migrate up at night. The data doesn't indicate this but the trend does exist. Since this bog did not turn over, Chaoborus movements may be important in nutrient cycling.

CONCLUSIONS:

In this report I have tried to present the data obtained in sampling, and to analyze this data. While both bodies of water are classified as bogs, the two bogs differed markedly. Forest Service Bog is shallow, has a large surface area, the trees are located back from water and may have turned over. Ed's Bog is deeper, has a smaller water surface area, is well protected from wind by trees, and did not turn over.

The chemical nature of the two bogs was very similar. The major exception was how the nutrients were distributed. In both bogs the nutrient levels were low, but in Forest Service Bog the levels were uniform as compared with the strongly stratified distributions in Ed's Bog.

Plankton counts differed quite a bit. In Forest Service Bog green algae were predominant while desmids dominated Ed's Bog. Cladocerans in Forest Service were primarily Daphnia, contrasting to the wide variety found in Ed's Bog.

Even the shorelines differed, Forest Service Bog had a lot of sundew located near the water. The major trees were Tamarack and black spruce. While the trees were the same at Ed's Bog, no sundew was noted.

While by now means complete, I have attempted to show how some of the physical properties of these bogs relate. Plankton can no doubt be related to these properties but this exceeds my knowledge. Any species which lives in the bog must be able to tolerate some extreme environmental conditions. No fish were found in either bog. Most likely because most fish die at a pH of 5 or less. Other vertebrates such as frogs are present but only the immature stage needs to survive the stress of the acid water. The adult can withdraw from the water if it isn't suited to it. Apparently the frogs can handle this stress as Ed's Bog was filled with tadpoles. But most organisms can't withstand the harsh conditions and this is one reason bogs are such poor producers.