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UNDERC Lake Survey
Kickapoo and Tender Bog

Presented to
Dr. Duman
and Dr. Greene

By
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UNDERC Lake Survey
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Introduction

Sometime in the middle of May nine students were given a tour of the property known as UNDERC. On this tour we saw many of the lakes on the property, and at that time each lake looked exactly like the other except for a few minor differences in the shoreline, area and perhaps the color of the lake. It seemed at the time that the lakes would all be similar in unseeable properties as well. Four weeks later a totally different outlook came over the UNDERC nine, no two lakes are exactly alike. Some of the lakes only showed slight differences while others were extreme opposites.

By experimenting with "unseen" properties in the lakes we were able to "see" the differences in them. Not only were we able to see the differences now, but we were able to apply them to the slight changes in the shoreline, area and even the color. The whole reason for being there was to discover the variations in the lakes, how they tie in with the surroundings and where they were going.

Finally we looked at what was alive in the lake. Not only did we discover the interactions between the organisms, but we saw the relationship of the organisms to the chemistry of the lakes. So as we try to gain a better understanding of the lakes and how one can not say " this makes it this kind of lake ", but rather that each little piece fits in somewhere, maybe we can work so as not to screw up the lakes as so many have been.

Methods

In general the way we went about taking samples was to split up into groups of twos (in one case three) and venture out into the unknown lakes in our meek john boats every morning. Again in general some experiments were done on the lake, if the equipment was available, while the rest ~~was~~ were done in the lab with samples obtained in a chemerer.

Experiments performed on the lakes were oxygen and temperature readings, pH, and hydrogen sulfide when necessary. Oxygen and temperature readings were done with a meter with a submersible probe calibrated for every meter. Oxygen readings could then be taken at the desired level without any loss by gas exchange or gain by disturbing the water. The meters had to be zeroed every morning and calibrated for the air temperature on the specific day before each test could be run.

The pH sample was taken with the chemerer and read in the field. The reason for using a portable meter was because of rapidness of the change in pH due to oxidation or hydrolisis. The pH meters were set to the water temperature because ionization and the electrode potentials vary with temperature. Buffers of seven and four were used fpr Kickapoo and Tender Bog, respectively.

The last test that was done on the field and using the HACH kits was hydrogen sulfide. We used an Alkaseltzer tablet and specially treated paper. Hydrogen sulfide reacts very quickly with the atmosphere and therefore must be done immediately on the field with a sample from the chemerer bottle.

In running the in lab tests for each one the HACH kits were used (for detail on the tests see the HACH manual). There were two major divisions in the tests that were run. The first were titrations and the second were spectrophotometry. The only other test was specific conductance just using the meter in the kit.

Tests using titration were methyl orange and phenolphthalein acidity, alkalinity and hardness. Alkalinity was done using sulfuric acid. Hardness employed the use of standard EDTA titration.

The spectrophotometry methods relied on a variety of wavelengths and a number of different powder pillows for each seperate test. The color tests merely used IR wavelength without powder pillows. True color was attained by centrifugation. Nitrate, sulfate and phosphate all required powder pillows. The HACH kits were used because often the normal tests run are not as accurate and these HACH tests are too difficult to prepare normally. The longest test was that of total phosphate which required a half an hour or more of heating.

The only other thing run out on the lake at this time were plankton samples. The first method of collecting was the zooplankton tow. Each tow was approximately five ~~meters~~ minutes long at approximately one meter in depth (depending on how fast we could row). A net was used with number twenty-five mesh in hopes to separate zooplankton from phytoplankton, but it did not necessarily do so. A tow was taken both at night and during the day. The night tow was at about 10:30 and the morning tow was between 9:00 and 11:00.

For phytoplankton a funnel with smaller mesh was used. Two liters of water from the chemerer were filtered through the funnel and ~~and~~ the twenty-five milliter sample was retained.

After obtaining the samples each was preserved with a formalin solution. This final solution was then counted using a Sedgwick-Rafter cell. Each cell held exactly one ml of sample and the slides were fifty milimeters long. Counts were made till a good number of organisms in moderate amounts were counted.

Data

Oxygen and Temperature Profiles

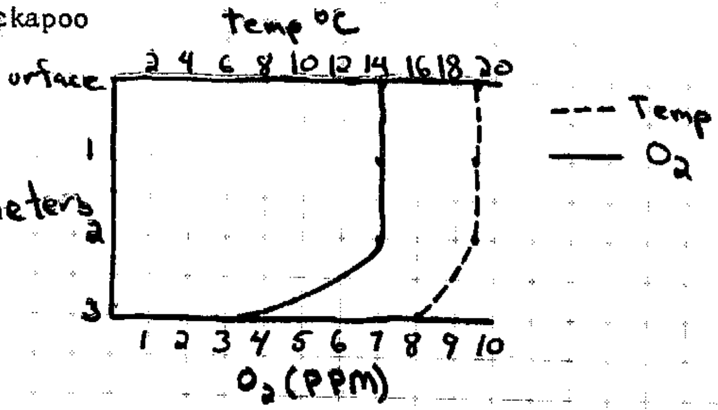
Kickapoo Lake

There appeared to be a sudden drop in the oxygen reading from two meters to three meters; however, Kickapoo was a shallow lake, not more than ten meters at some points, and it was thought that the probe had hit bottom or entered the plants that covered a large area of the bottom of the lake. So the oxygen may have dropped toward the bottom but not as significantly as the graph shows. (Kickapoo: graph 1)

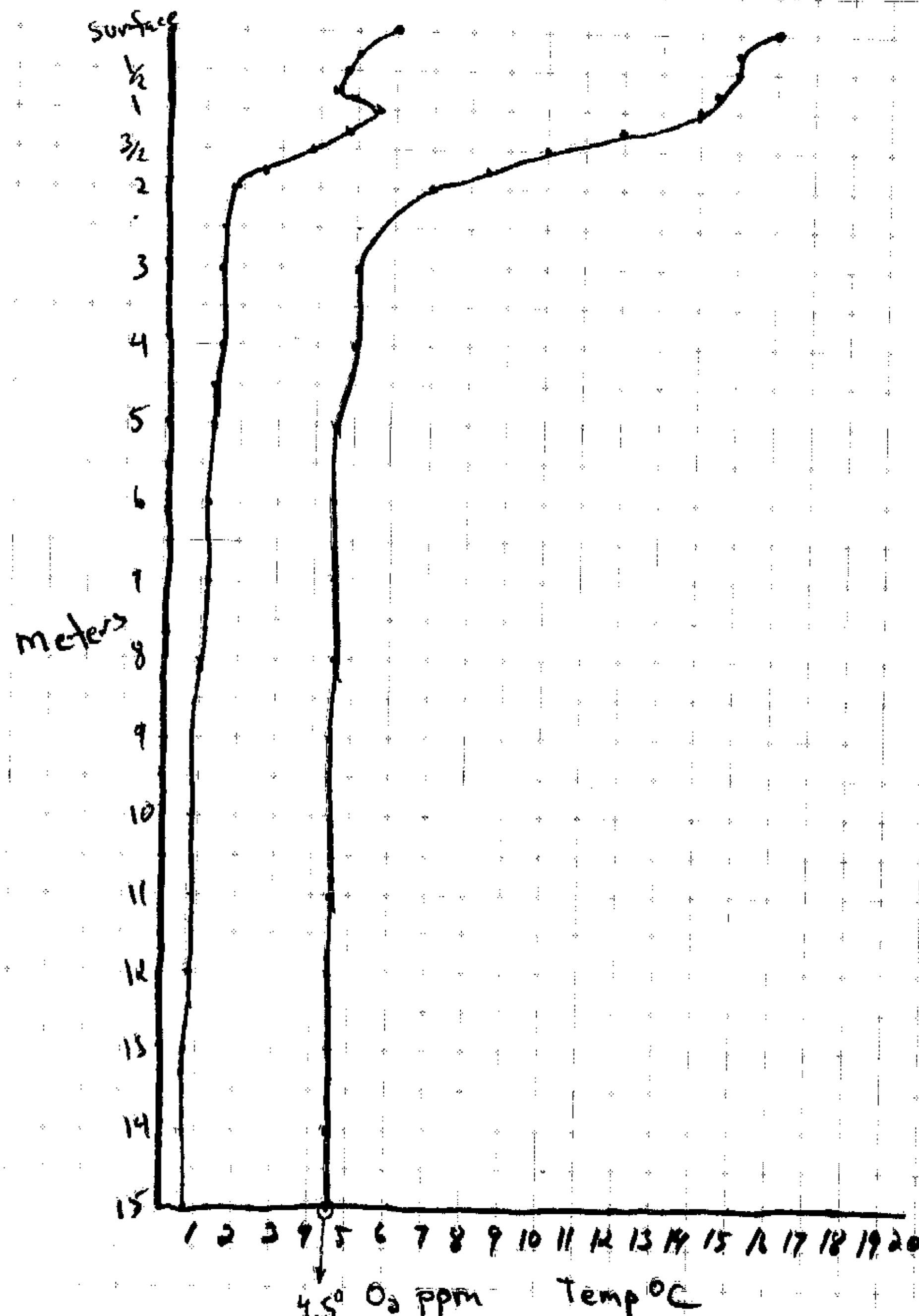
Tender Bog

The oxygen readings for Tender bog went really quite well; we only ran into two problems. The first was the probe would not go low enough for the depth of the bog; however, it appeared that the temperature and the oxygen leveled out. The second problem was that there appeared to be a jump from 4.4 to 5.6 on the oxygen reading. In this situation we decided to take to phytoplankton samples one at one meter and one at the surface. The results will be seen later on and discussed in the discussion. The only other problem is, even though it looked like a nice curve once the probe reached the hypolimnion, it was not picking up oxygen readings but rather hydrogen sulfide interference. (Tender Bog: graph 2)

Kickapoo



Tender Bog



Kickapoo

Samples taken at approximately 11:00
Tests run at approximately 1:00-3:00

Depth	1 meter		2 meters	
Test				
pH	7.5		7.3	
Methyl Orange Acidity	0		0	
Phenolpthalein "	2.5mg/ml	2.5mg/ml	2.5mg/ml	2.5mg/ml
Alkalinity	45mg/ml	45mg/ml	40mg/ml	38mg/ml
Relative Color	50units	45units	95units	95units
True Color	25units	25units	45units	50units
Specific Conductance	87micromhos/cm		90micromhos/cm	
Hardness Total	65mg/ml	70mg/ml	50mg/ml	45mg/ml
Hardness Ca	40mg/ml	30mg/ml	40mg/ml	40mg/ml
Hardness Mg	35mg/ml	30mg/ml	10mg/ml	5mg/ml
Nitrate	.4mg/ml	.3mg/ml	.5mg/ml	.4mg/ml
Sulfate	4mg/ml	1mg/ml	5mg/ml	5mg/ml
Phosphate Ortho	.16,.14,.14mg/ml		.07,.10,.18mg/ml	
Phosphate Total	.19,.25,.12mg/ml		.44,.42,.48mg/ml	

The data for Kickapoo turned out fairly well with few differences. The only major variance was in phosphate, as we discussed so many times due to the sensativity of the test contamination shows up readily.

Tender Bog

There appeared to be no sulfate in Tender Bog from the tests we ran, however this is doubtful. The water was so colored that the tint had an effect on the sulfate and actually produced negative readings. The other mess-up was a few of the phosphate tests. The last run for the ortho at nine meters was highly contaminated and the third readings on the total were negative results.

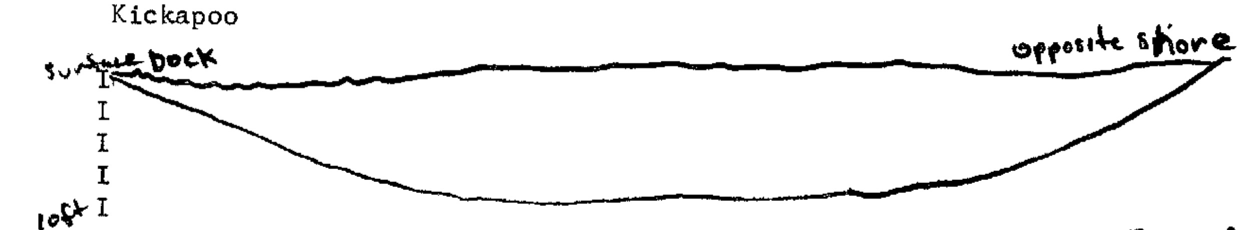
Tender Bog

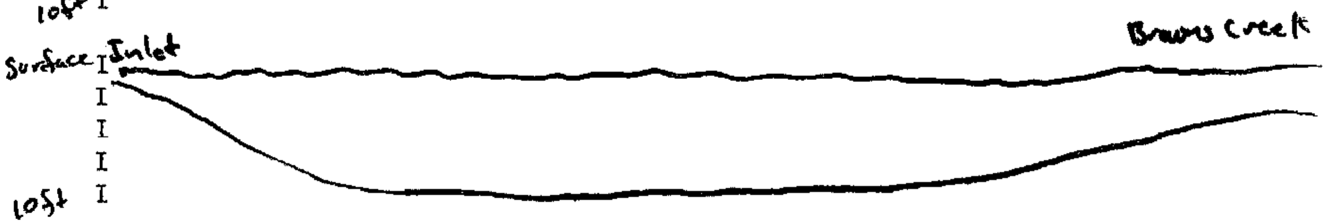
Samples taken at approximately 11:00
Tests run at approximately 1:00-3:00

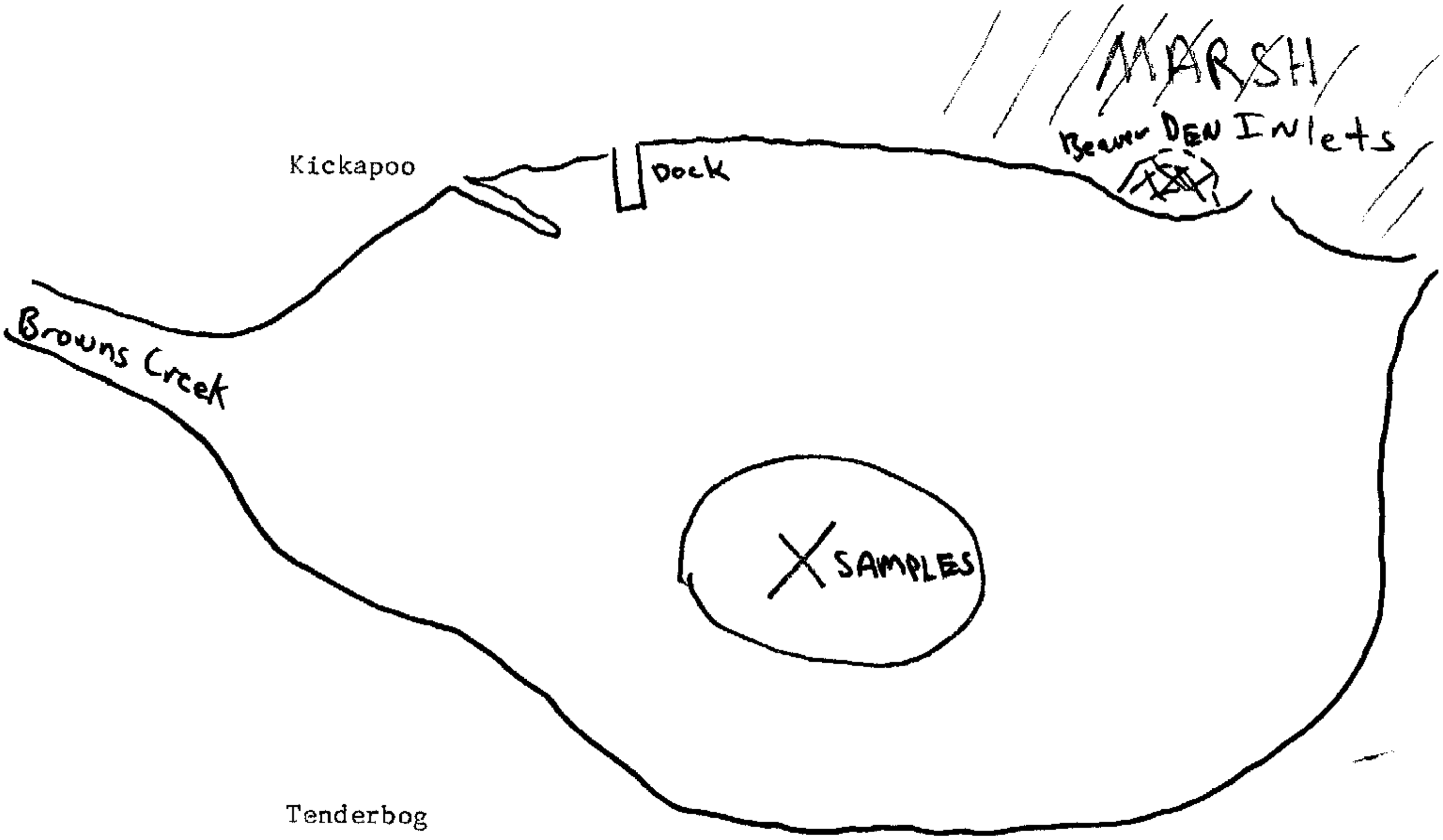
Depth	1 meter	2 meters
Test		
pH	4	4.2
Methyl Orange Acidity	5mg/1 5mg/ml	0 0
Phenolpthalein "	25mg/ml 25mg/ml	30mg/ml 30mg/ml
Alkalinity	0 0	5mg/ml 5mg/ml
Relative Color	145units 145units	160units 160units
True Color	140units 110units	160units 160units
Specific Conductance	35micromhos/cm	30micromhos/cm
Hardness Total	10mg/ml 10 mg/ml	10mg/ml 10mg/ml
Hardness Mg	5mg/ml 5mg/ml	5mg/ml 5mg/ml
Hardness Mg	5mg/ml 5mg/ml	5mg/ml 5mg/ml
Nitrate	.4mg/ml .2mg/ml	.8mg/ml .9mg/ml
Sulfate	0 0	0 0
Phosphate Ortho	.03,.03,.01mg/ml	.15,.15,.51mg/ml
Phosphate Total	.25mg/ml .18mg/ml	.19mg/ml .17mg/ml
H_2S	$<$.1mg/ml	$>$5mg/ml

Depth Profile and Maps

Kickapoo



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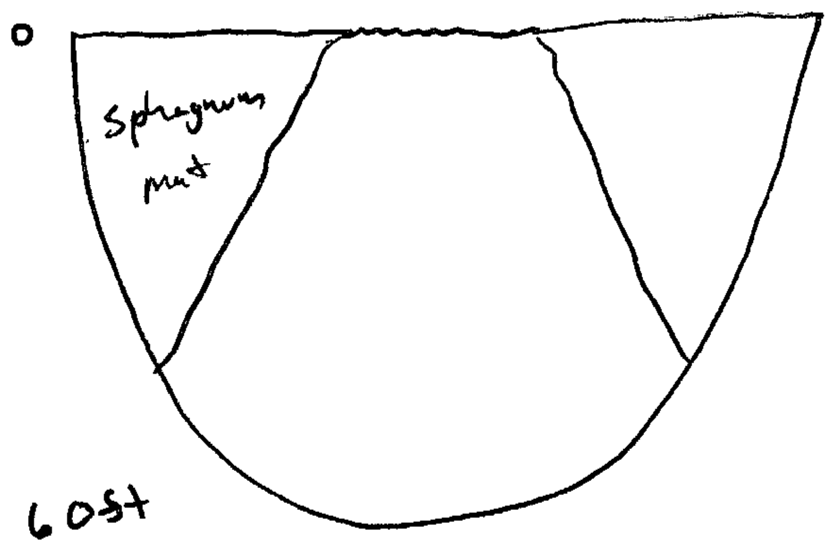
Beaver DEN Inlets
Kickapoo
Dock
Browns Creek
SAMPLES
Tenderbog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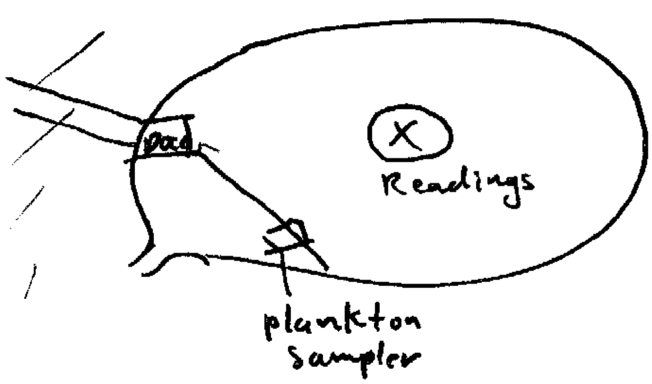
Sphagnum mat
60ft


Readings
plankton sampler

Kickapoo had a definite outlet called Brown's Creek. It was a relatively large creek yet still rather shallow. There are also inlets into Kickapoo but they are less obvious. There are several of these inlets and they pass through a marsh infested with beaver trails. Kickapoo is surrounded mostly by deciduous forest.

Tender Bog is quite small in area and has a small standing water branch from it into the mat. Its depth has been reported to be between sixty and eighty feet (I tend to believe the former). Tender Bog is entirely surrounded by conifers.

Plankton

Kickapoo zooplankton tow

	10:00AM	10:30PM
Dinobryon	4092	4114
Asterionella	834	793
Bosmini	19	11
Senecella	4	
Ceratium	20	30
Cyclops	10	7
Rhinoclonium	135	120
Frustulia	10	14
Pendenium	8	21
Novicula	1	1
Synura	29	11
Keratella	20	35
Dichotospherium	3	1
Eurodea	45	
Fragellaria	3	13
Anabaena	2	3
Nauplius	10	12
Volvox	1	2
Micrasterias	1	
Stuastrum	7	4
Eugleana	2	4
Chaoborus		2
Cosmerium		2
Testeaca		1
Meugotia		8
Eunotia		1
Daphnia		5
Diatoma		3
Cymbella		6

Phytoplankton

	Number of organisms/liter of lake water
Ankistodesmus	155,540
Dinobryon	8,799,120
Stuarstrum	222,200
Pendinium	422,180
Asterionella	6,132,720
Rhizoclonium	755,480
Meridium	133,320
Volvox	44,440
Frustulia	111,100
Fragalaria	155,540
Vortecella	177,760
Synura	222,200
Diatoma	88,880
Eudorina	44,440
Anabaena	44,440

General invertebrates: snails (Bulimnea megasoma), leeches and clams
Other: Fish Muskellunge, Yellow Perch, Crappies and Northern Pike
Macrophytes elodea and lily pads
Periphyton numerous diatoms and desmids

Tenderfoot zooplankton tow

	10:30AM	10:30PM
Daphnia	31	30
Keretella	12	18
Mougeotia	7	9
Nauplius	35	84
Stuarstrum	12	6
Diatoma	1	
Pleurotaenum	1	
Docidium	3	
Ulothrix	1	
Euastrum	2	
Anabaena	3	
Diaptomus	4	
Microspora	184	157
Bosmina	18	6
Epiphenes	1	
Volvox	2	
Chaoborus	7	6
Cyclops	1	
Osphratium		6
Fragallaria		3
Eugleana		9
Pediastrum		3
Frustulia		6
Micrastarias		9

Phytoplankton

	Number of organisms/liter of lake water	
	surface	1 meter
Merismopedia	1,066,560	3,999,600
Eudorina	88,880	1,577,620
Asterionella	22,220	599,990
Stuarstrum	133,320	22,220
Ankistrodesmus	44,440	577,720
Synura		288,860
Navicula		22,220
Caelebsphairum		22,220
Mugeotia		22,220
Frustulia		111,100
Pendenium		22,220

No vertebrates or even large invertebrates were found around Tender Bog. The major macrophytes were of coures sphagnum along with shrubs as well as pitcher plants and sundews.

Discussion

Kickapoo, being very shallow over its somewhat large surface area, was thought to have turned over. Not only was there a large surface area to depth ratio, but the shoreline was quite bare of trees allowing for the wind to come over the lake easily. With these factors combining with the fact it had a large outflow it would seem reasonable to assume it would overturn. The only thing remaining to confirm this hypothesis would be the oxygen profile, and it did.

With the exception of the three meter reading the oxygen as well as the temperature was consistant all the way down. It also showed a high oxygen reading of seven ppm which is a characteristic of a productive lake. How does one explain the three meter reading? There are two possibilities. One is that there is a epilimnion and hypolimnion, and in this case it is a very large epilimnion and a very shallow hypolimnion. There is the possibility of just having a metalimnion. The high productivity of Kickapoo as seen from other data, especially the plankton samples, may be accounted for for another reason. Any change in the lakes epilimnion is possibly due to inflow and outflow from the creeks. In this case all water exchange would be at the level of the epilimnion.

This theory is not really that likely for the reason that changes due to creek inflow and outflow are not that great. A more likely theory is that on the third reading the probe entered into the reeds or mud. This is more likely since the lake is so shallow and we drifted quite a bit. So even though the former is more scientific and the latter is more of a bungle, I think we bungled it.

The only test that seemed strange among those done with the HACH kit was phosphate. The data that appeared to be off was total phosphate at two meters. A simple explanation would seem to be there was contamination. This time there is a reasonable scientific explanation and makes more sense since the test had three consistent results. The total phosphate and and orthophosphate at one meter are very close; this is reasonable because total phosphate consists of 90% orthophosphate.* The orthophosphate at two meters is also consistant because it is close to that at one meter and would be consistent with a turnover. The reason for more total phosphate at two meters is due to the exchange of phosphates with the sediments. This is ~~docivable~~ conceivable for several reasons; one, because of the shallowness of the lake; two, because of the turbulance of the lake due to the stream and again the shallowness allows wind exposure, and three, because of the murkiness of the lake as seen by both the depth recording and the dredge.

From the zooplankton data there did appear to be some difference be-

* Wetzel pg 216

tween morning and evening tows. The most significant change was between that of the rotifers keretella and pendenium. Daphnia showed a substantial increase considering there were zero in the morning tows. Others showed little increase or even decrease. There were decreases in some of the larger zooplankton in which one would expect to find decrease. Resons for this might be; one, because of the fullness of the net with smaller plankton it was difficult for the larger to enter, and two, there might not be any change in the particular species, just a matter of not being able to make the sample random enough.

Now, all things considered Kickapoo showed to be a productive lake. Keeping in mind that not one factor influences whether it is productive or not it can still be said looking at everything together, plankton as well as chemistry, that Kickapoo is eutrophic.

A single element in telling productivity would be oxygen. This was already discussed and determined to be relatively high. The question is why? There are two factors which probably effect the oxygen content of the lake. The stream does bring in some oxygen but is surely not the major source. More important in the production of oxygen in the lake is photosynthesis. The most abundent photosynthesizing plankton in the lake were dinobryon, asterionella and a rhizoclonium algae*. Possibly more important were the macrophytes especially elodea.

Staying along the lines of living organisms for a moment; there was an abundance of all kinds of plankton. Included among these were Cyclops vernali, Cyclops bicuspidatus, Daphnia longspina, Bosmini coregoni and a large number of Nauplius. The other area we studied was periphyton which

* This algae keyed out to rhizoclonium but there were suspecions to its correctness.

compared to other lakes was quite abundent. This.also accounted for the abundance of snails and clams appearing on the shoreline. If one were to consider just the life on Kickapoo, one would say it is a productive lake, but one can not; therefore, one must talk of nutrients.

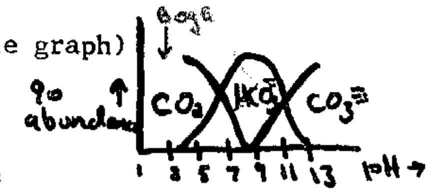
Nitrate and sulfate were not in great abundance, although they were not significantly small either. Sulfate and nitrate play an important role in nutrition,and since they could be greater it emphasizes the difference in the productivity of a small lake to one like that of Tenderfoot. The biggest limiting factor, as in all lakes, is phosphates. It also did not prove to be in great quantities. The reason Kickapoo is as productive as it appears is due to exchange with the sediments. Elodea and other macrophytes as well as the periphyton and benthos aid in this exchange.

The large hardness is again due to good exchange with the sediments. This gives the lake a high alkalinity and thus a good buffering capacity; this prevents a high acidity and gives the lake a high pH.

So Kickapoo is a highly productive lake as far as life goes, but is not so in terms of nutrients. Life is good, due to good nutrient exchange with the soil and the fact that the food chain may start here. More will be discussed in relation to Tender Bog later on.

The oxygen reading proved to be a good curve for planktonic organisms which are light inhibited. The graph began a steady decrease down to three-fourths of a meter, but at one meter the reading increased again. It was easy to hypothesize what caused this therefore we took to phytoplankton samples, one at the surface and one at one meter. This hypothesis proved correct for there were vast numbers more of merismopedia, eudorina, asterionella, ankistrodesmus and synura at one meter. Thus the phytoplankton mentioned above were photoinhibited enough to live down at one meter and in sufficient enough numbers to raise the oxygen level.

This hypothesis could also have been proven in another way. Fortunately carbon uptake was done on Tender Bog. Off hand it ended up that the highest count occured at one meter. Unfotunately we could not calculate the P_1, P_d, or P because the equation takes into account alkalinty which was zero. There is however a way to calculate it from carbon dioxide since this is the only form of carbon in the bogs.(from the graph)



Other than oxygen the rest of the data came out to be fairly straightforward. First of all there was a very shallow epilimnion and a very rapid thermocline. The lowest temperature reading we got was 4.5°c. After the oxygen dropped to about 1.4 it was assumed thereafter the readings were due to hydrogen sulfide.

As with all bogs there was a low pH due to the sphagnum mat. This low pH in itself from the active cation exchange in the walls of the sphagnum can account for the low abundance of life. Life which does exist in the bog is in the first two meters except perhaps for anaerobic bacteria. Associated with the low pH is the high acidity and extremely low, if any, buffering capacity ~~if any~~. There is no contribution to the alkalinity by calcium hardness because it, as well as total hardness, is so low.

Nutrients are also very low. Nitrates and phosphates are both low, also sulfate reads zero. This zero reading is not likely and is due to the obstuction in the test by dark color of the water. In this situation a series of reactions much too difficult for us to do must be utilized, but for the most part they can be assumed to be very low.

The only discrepancies in the phosphate test is lower ortho in the epilimnion than in the hypolimnion. The reason for this is the phosphates sink into the lower layers and are not used up. While those at the top are being used by the life in the first two meters. This is a very good charecteristic for all nutrients in a bog.

The low amounts of nutrients coincides with the low specific conductance showing relatively little ions in the water. Finally color seems interesting. It appears very dark in both true and apparent color. Accounting for this would be tannins entering the water from surrounding trees.

The only zooplankton showing a large change was nauplius. The fact that there was not this up and down motion was because there are no large or even small predators inhabiting the bog. This can also be seen with the existence of Chaoborus americanus a larva which seeks out water not inhabited with predators.

Tender Bog and Kickapoo are two bodies of water which in the future will no longer exsist. However Kickapoo will never be a bog and is "dying" in a totally different way than Tender Bog.

What is happening to tender bog is sphagnum moss is growing around the sides and closing in. As seen from the diagram of the bog it closes over the top and the bottom grows in later; eventually it will fill in all the way. The two main reasons Tender Bog is so low in productivity is one, it becomes so deep with so little surface area there is no possibility for turnover, and two, the sphagnum moss causes such a low pH as well as surrounding pines causing other problems it cannot sustain good life.

Kickapoo is completely different. There is no sphagnum around the edges to speak of; instead there are reeds all around. In fact there is already a marsh in a large area, probably where part of the lake used to exist. Eventually Kickapoo will be a large marsh most likely with a creek running through. The differance in Kickapoo filling in is the bottom fills in first and this builds up the sides. The two points in Kickapoo's favor are it is so shallow and open it will always turn over and the area will always be supplied with nutrients from the creeks.

When Kickapoo is a marsh it will still be maintaining a large variety of life as opposed to Tender which will be limiting its life more and more. To compare some of the data, Kickapoo had a high amount of oxygen with a deep epilimnion, if any thermocline at all. Tender had a very shallow epilimnion and a low amount of oxygen. Specific conductance was higher in Kickapoo relative to the amount of nutrients. Hardness and again the relative amount of alkalinity was higher in Kickapoo. Light inhibiting color from tannins were higher in Tender Bog.

As far as life goes, in the zooplankton tow in Kickapoo we had an innumerable amount of life with something new in every drop. Life on the shore was abundent,and even the beavers took advantage of this productivity. Tender Bog has little life left in it, only microorganisms and insects (excuse me Dr. Greene and Dr. Craig), even tadpoles could not be found. Thus are two bodies of water, heading to extinction as lakes, but only one is heading to extinction as a life supporter.

The End of this report
The End of this class
and
The End of me

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B

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UNDERC
7/1/77

(1) Charecterize (give your impression) of the UNDERC fish community-species; interactions, fish communities present, etc. Based on your chemical knowledge of UNDERC waters, what species are most suitable to bogs, eutrophic lakes, etc. and why? Why did we get so many small fish from the river than the lake?

(2) Starting with plankton communities (talking in general terms) explain why the pike in Morris are Approximately twenty inches at approximately four years of age? Also why so large a perch?

The largest communities of fish in the lakes are northern pike, large and small mouth bass and perch. A few other assorted fish occur in large numbers, but the above are better distributed.

In each of the lakes where larger fish were caught there were visible smaller fish. On both Morris and Bergner minnows could be seen around the dock or close to shore. As well as this small fish inhabited the streams that entered Bergner and Morris. A more specific case of actually catching smaller fish which interact with larger fish is Tenderfoot Creek. On the first day we seined we caught quite a few minnows and chubs both excellant food for the larger fish.

A good example of a well balanced lake would have to be Bergner. Even though few fish were caught in the gill nets the large mouth bass and the blue gills that were caught were of very good size. If one considers the interactions with Firestone there would be a veritable fortune of small fish easily preyed upon when entering Bergner. Not only can this be seen, but the communities of beaver and the evidence of birds and other small mammals that eat fish is high. Thus Bergner proves to be productive and balanced.

Bogs are probably the least productive lakes of all. The nutrients and pH are quite low thus providing a poor habitat for any living organism. If the bogs are far enough along they provide a haven for no fish. The bogs that are not to bad contain mudminnows or stickle backs. One exception to this is Bog Pot, it contains perch. They do not however reproduce there, apparently in time of high water they are able to swim from Bergner. Fish in bogs are there because they can stand the low pH and live on the planktonic communities present.

Some of the productive lakes, although not greatly productive, contain some of the better predators such as bass, pike and perch. The perch seem to live well among other predators feeding on what they missed. The pike and bass become dominant quite easily, eating the fish present often with limited resources. The lakes that these are in is a more withstandable pH but the nutrient production is still low.

Those lakes of higher production and pHs are not dominated by one particular fish. There always a large number of fish especially since the productive lakes are much larger. The more productive lakes have larger plankton populations , hence the food chains work out much better. Some of the fish that only appear to live in the more productive lakes with ultimate pHs are Walleye and Muskellunge. When you get into the higher pHs the fish that dominate are bluegills and sunfish.

There are several reasons we got so many small fish from the creek as compared with the lakes. The first is the method, it seems obvious that one would only get larger fish in a large gill net. However this does not explain why the largest fish we got in the creek was a small Walleye. First of all the creek does not supply a lot of nutrients for an abundent growth of larger fish. It is fast moving and inhibits the pedation of larger fish on the smaller ones. Secondly the fish that were caught upstream were a little larger, but the water was deeper and closer to the lake. When we collected downstream among the rocks minnows and chubs were dominant. The main reason for this was the ability to live in water in which they are capable of breathing and not running aground easily. Finally predation by birds and mammals along shore would be easy on larger fish, so they are safer in deeper lake water.

The producers in Morris lake are obviously the phytoplankton along with the macrophytes. These are readily consumed by zooplankton, often of the smaller types such as rotifers. The first plankton to be consumed by fish or large invertebrates are copepods and cladocera. These smaller fish are then consumed by the Northern Pike. Unfortunately when the lake was stocked with the pike the abundance of food probably caused overbreeding and thus the generation of four years ago did not have enough food and their growth is now stunted.

The perch that exist in Morris are so large because the smaller ones are preyed upon by the pike. The smaller ones will leave in the reeds or up the creek untill they are large enough to be out of danger. Their food requirements are surely different from Northern's and yet more abundent to allow them to grow so big.