Peter and Bergner Lakes

John Paraskos

UNDERC '81

Peter Lake is found at the north end of the property in T45N R42W section 36 (Michigan). Peter has a sister lake, Paul, which feeds the water into Peter through a culvert below the isthmus between them. The lake drains through several small streams located at the north side of the lake. These streams (which also collect water from Raspberry Lake on the property) eventually flow into the Cisco chain of lakes.

The lake is approximately 2.6 ha in area and is basically surrounded by a Sphagnum mat. In some places the mat is very long and has a strong hold on the lake. The vegetation on the immediate banks goes along with the succession of the bog mat. Pitcher plants grow commonly along the mat along with swamp laurel and sundew. Floating water lilies can be found along the waters edge.

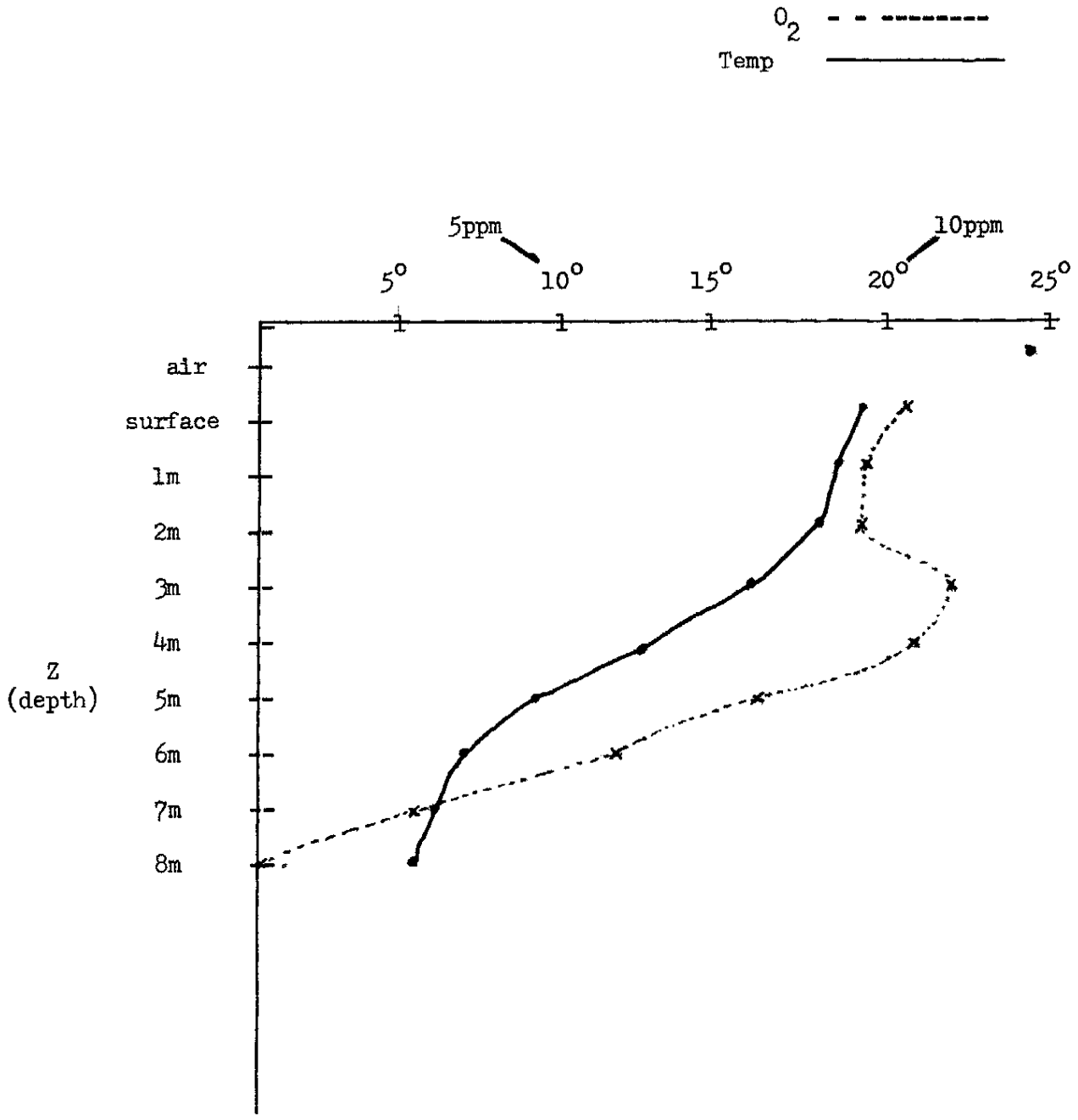
The hardwood and softwood trees slope down on a bank to the lake. Black spruce and other conifers dominate the area with a few tamaracks. The major kind of fish in the lake is the bass; largemouth bass may be seen in large schools in the lake. The snapping turtle and common garter may be commonly found around and in the lake.

The lake has been involved in a study by Strass and Hasler to determine the effects of lime on lake metabolism (Limnology and Oceanography 5(3): 265. (1960)). The experiment involved liming Peter Lake to determine the effects on its metabolism. Paul, Peter's sister lake, was kept as a control. Peter was limed for a three year period (1951-1954) and has been intermittently limed since then, the last being the Spring of 1980.

Peter O_2 - Temperature Profiles

Air Temperature 24°C

Z	T^0	O_2
surface	19.5°C	10.5ppm
1.0m	18.5°C	9.8ppm
2.0m	17.8°	9.8
3.0m	15.2°	11.8
4.0m	12.5°	11.0
5.0m	9.5°	8.4
5.5m	8.0°	6.2
6.0m	7.3°	2.4
7.0m	6.0°	0.0
8.0m	5.3°	0.0


O_2
Temp
5ppm
10ppm
5°
10°
15°
20°
25°
air
surface
1m
2m
3m
4m
5m
6m
7m
8m
Z
(depth)

Data Interpretation - Peter Lake

From the O_2 - temperature profiles, Peter Lake has not been turned over yet and remains stratified. The lake is somewhat protected by hills and is not large enough itself to allow a large wind to build up to distribute heat from the surface to the lower depths of the lake. The thermocline (from 4m to 6m) thus indicates the limit of the mixing currents which are derived from the surface. It is my prediction that this lake will stay stratified throughout the summer.

The oxygen profile follows the general path of the temperature profile the first 2 meters. Obviously, the epilimnion is directly exposed to the unlimited source of oxygen found in the air. At the 3m and 4m depths, however, there is a surge in the amount of dissolved oxygen. This oxygen is derived from photosynthetic activity by phytoplankton:

$$6CO_2 + 12H_2O \text{ ----- } C_6H_{12}O_6 + 6O_6 + 6H_2O$$

Since the maximum oxygen production usually occurs at midday on clear days (when this reading was taken), the surge in the O_2 level would most likely not be there during the night.

The readings of zero O_2 ppm at the 7m and 8m depths are most likely due to the fact that meter entered the muck and soft sediments at the bottom of the lake.

Peter Data

The samples taken and tested at Peter were from 1 meter, 3.5 meters and 7 meters. Each level was tested independently and recorded as such.

Acidity

	Methyl Orange	Phenolpthalein
1.0m	0 mg/l	50 mg/l
3.5m	0	60
7.0m	0	60

Alkalinity

1.0m	25mg/l
3.5m	20
7.0m	40

Hardness

Calcium	Magnesium	Total
10mg/l	5mg/l	15mg/l
15	4	19
20	1	21

Color

Apparent	True
55 units	55 units
55	55
55	55

Conductivity

36 umhos
37
42

Nitrate	Sulfate	pH
.7mg/l	1mg/l	5.1
.8	3	5.0
.8	3	5.0

secchidisc - 5.1 meters

Peter - Data Interpretation

As stated earlier, Peter Lake was involved with extensive liming for many years and this has affected its chemistry. Peter Lake appears to be evolving into a bog with a sphagnum mat taking hold around the lake. The low pH of 5.0 can be attributed somewhat from the mat as the -COOH group releases H^+ and picks up Ca^{++} ions. This helps explain why the hardness is so low (both calcium and magnesium) as the sphagnum mat ties up the hardness.

The alkalinity of Peter follows the normal trend with 25mg/l in the epilimnion and 40mg/l in the hypolimnion. Thus with the settling of the lime added, the lower depths contain a greater capacity to bring about a shift in the pH toward the alkaline side of the pH range. An interesting note is the lime added in the spring of 1980 was extra rich in magnesium but the magnesium level in the lake did not rise at all. This simply shows the difficulty the lake has in holding on to the magnesium as most of it just settles right to the bottom.

The conductivity also follows the trend of the alkalinity. The lower the depth the higher the specific conductance thus showing a higher concentration of ions at the lower depths (HCO_3^- and $CO_3^=$).

In general, the acidity is not extremely high but the buffering capacity is not strong enough to hold the pH up.

The color data shows that the majority of color is due to a stain or dissolved particles rather than particulate matter since the centrifuge did not precipitate any matter (the true and apparent are the same). Also, the lake appears to be uniform throughout. The staining could be due to the many conifers that surround the lake and release humic acid which is tough to break down.

The high secchi disk reading of 5.1 meters could be attributed to the calm day and the bright sun.

Peter - Relative abundance of Plankton per milliliter of sample

	# per ml
Copepoda	
Diaptomidae, Diaptomus sp	715
Nauplius larva	323
Ochromonadaceae, Dinobryon cylindricum	242
Rotifera, Keratella cochlearis	37
Cladocera	
Daphnia pulex	18
Holopedium gibberum	7
Chlorophyceae Staurastrum limneticum	11
Protozoa Ceratium hirundinella	4

The first point to be made about the relative numbers of plankton sampled is the incredible numbers of problems faced in analyzing the material. First is the collection itself, the time of day, the weather conditions, the temperature etc. All factors affect the plankton caught - including the length of the tow and the netting used. On the whole, few exact statements may be made but some generalizations may be realized.

The most abundant plankton is Diaptomus sp. Interestingly, however, it may not be concluded that this is the most abundant plankton in the lake. In 1938, Langford reported a complex diurnal movement of Diaptomus minutus which corresponded to the light. The conclusion drawn was that in intense light the organisms were at a maximum at the surface.[1] The plankton sample taken was during midday on a very sunny day at the surface. Thus, Diaptomus sp may be most abundant just at the surface, just at this time.

Peter Lake is known to have a large bass population. This may correlate with the low number of Cladocerans found. Being the largest zooplankton they would fall easy prey to the young bass and depending on the minnow population, they may be heavily fed upon. Foods of fingerling largemouth bass are principally the cladocerans, copepds and ostracods. Thus if the bass population is going strong, it must be concluded that the zooplankton is doing well also.

An interesting note is the fact that no Bosmina and little Daphnia was found. Most sources refer to these as the most abundant animal mass in plankton. Again the large fish population may be holding this type of plankton's population down. Also from this, the "smaller size" plankton are able to become more numerous as the Daphnia and larger plankton use them as a food source.

Bergner Lake

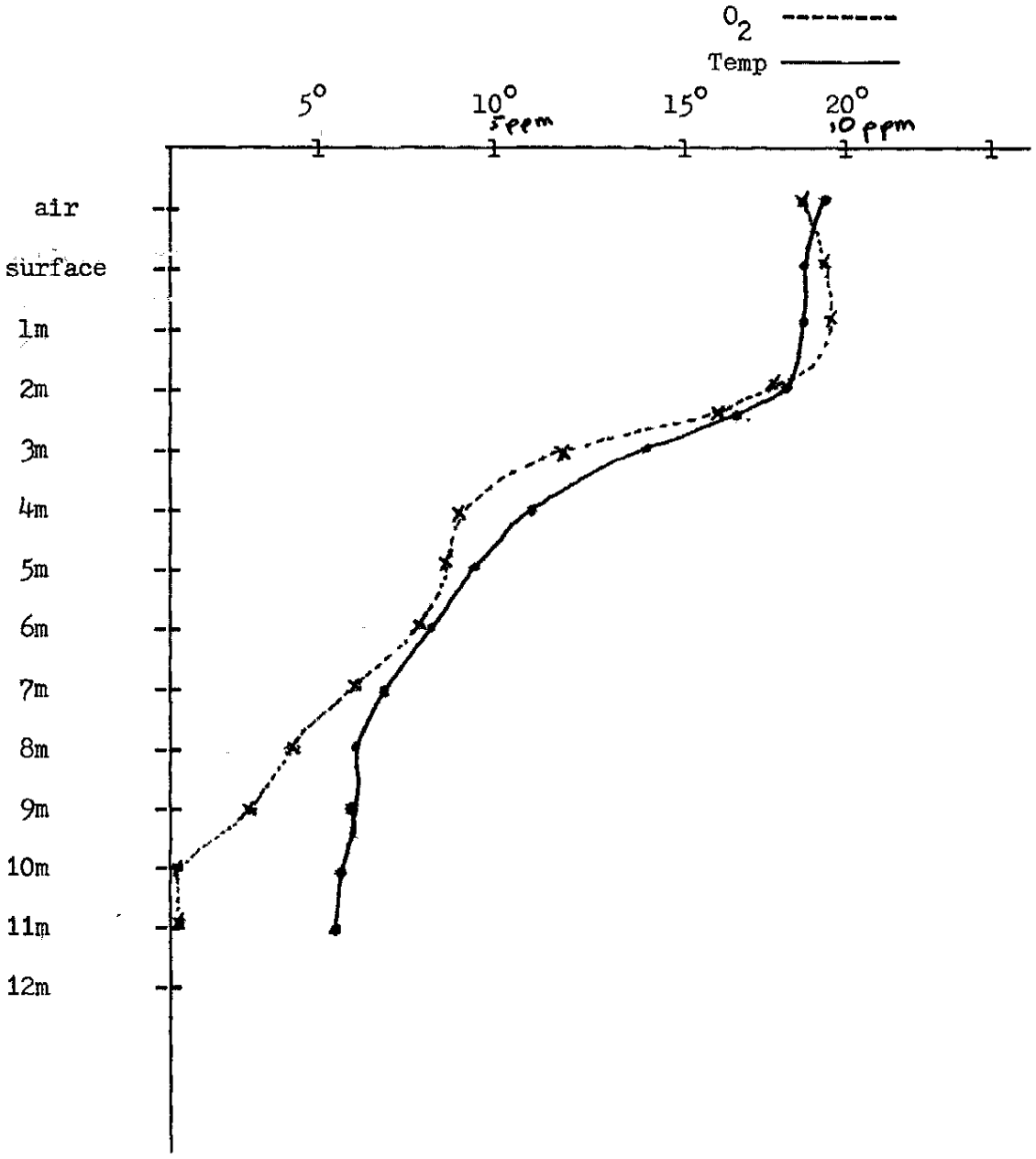
Bergner Lake is located in the north central portion of the UNDERC property in T45N R42W sections 35 and 2. The lake is dumbbell shaped with a deep hole in the southern portion of the lake. The rest of the lake remains relatively shallow. The banks of the lake are flat and the lake remains open to the wind.

Bergner Lake drains into Firestone Lake which eventually runs into Tenderfoot Creek. Firestone's drainage is controlled by beaver dams, thus the water height of Bergner can be controlled by the control of the dams on Firestone.

The surrounding terrain is mostly coniferous with a thick mat of shrubs on the banks. The fish population is very large with bass, yellow perch, bluegills and many species of minnows. (During the 1950's the lake was stocked with bass).

Bergner O_2 - Temperature Profiles

Z	T °C	O_2
air	19.5°C	9.25ppm
surface	18.8°C	9.60ppm
1.0m	18.8°C	9.70ppm
2.0m	17.8°	8.80
2.5m	16.5°	8.1
3.0m	13.5°	5.8
4.0m	11.0°	4.4
5.0m	9.8°	4.6
6.0m	8.4°	4.1
7.0m	7.0°	2.8
8.0m	6.5°	2.3
9.0m	6.5°	1.7
10.0m	6.3	0
11.0m	6.3°	0


O_2
Temp
5°
10°
15°
20°
5 ppm
10 ppm
air
surface
1m
2m
3m
4m
5m
6m
7m
8m
9m
10m
11m
12m

Bergner - Data Interpretation

The first point to be made about the readings at Bergner Lake is the position at which they were taken. Bergner Lake is very shallow rarely reaching depths below 3 meters. However, the sample readings were taken from a hole located on the southern portion of the lake.

The change in te mperature from the surface to 3 meters is not that great because the lake is very open to wind and is very shallow. From the temperature profile and the above facts, Bergner Lake has turned over this spring. Interestingly, the hole found in the lake has warmed up but most likely it has never turned over with the rest of the lake.

The oxygen content follows the same pattern as the thermo pattern. The surface and shallow areas (most of the lake) have a very high concentration of oxygen with super saturation reaching one meter. Then at 3 meters the oxygen content drops quickly and thus continues to drop. This again is only in the hole. It is a collecting spot for a lot of decaying matter and used up nutrients.

Bergner Data

The samples taken from Bergner were 1 meter and 7 meters.

	1m	7m
Alkalinity	0.0	0.0
Total Hardness	10.0	17.5
Calcium	7.0	10.0
Magnesium	3.0	7.5
pH	5.0	5.0
Acidity		
methyl orange	10.0	10.0
phenolpthalein	60.0	80.0
Nitrate	.6	.7
Conductivity	33.0	120.0
Sulfate	10.0	19.5
H_2S	No	No
Color		
Apparent	77.5	77.5
True	60.0	57.5

Secchi disk 2.6m

Bergner - Data Interpretation

The pH of Bergner is 5.0 which is kept low due to the lack of buffer within the lake system. The alkalinity and hardness are just too low to help keep the pH up. The acidity is high with a reading of ten on the methyl orange scale and an average of 70 on the phenolpthalein scale. The high potential the lake has for giving off H^+ ions is carried out, again, because of the lack of buffer and shows up with the low pH.

The conductivity of 33 is reasonable but the 120 reading in the hypolimnion must be attributed to experimental error. The nitrate and sulfate readings are average and not much can be concluded from them.

The fact that no H_2S was found (by smell) can be easily attributed to the fact the lake is shallow. Since it is also open to wind the water is easily mixed. Since oxygen has a greater affinity than sulfur, any H_2S that might come about would be quickly oxidized.

The depth of the water can also be the cause of the difference in the apparent and true colors of the water. The mixing of the water would make it easier for particulate matter, both organic (Seston) and inorganic (Tripton) to be present in the water.

The secchi disk reading of 2.6 meters goes along well with the apparent color.

Bergner Lake - Population of Plankton

	# per ml
Nauplius larva	345
Copepoda *Diaptomus sp.*	257
Protozoa *Ceratium curvirostre*	183
Cladocera	
Holopedium gibberum	84
Bosmina coregoni	55
Rotataria	
Keratella cochlearis	22
Monostyla sp.	22
Phytoplankton	
Tabellaria	11
Zygnema	?
Asterionella	4

Berger Lake - Plankton Analysis

The most abundant plankton found in Bergner's sample is the Copepods andthe nauplius larva. The fish population may be limiting the size of the Cladocerans as their numbers are low. Again, the large number of Diaptomus could be due to the optimal migration when the light is greatest (as the sample was taken on a sunny afternoon).

It is not suprising to see a small zooplankton like Ceratium curvirostre become abundant in Bergner. Since the lake is so populated with fish, including many centrarchids, it is no wonder a small protozoa that has developed spinous projections for flotation (no obvious movement for fish to notice) would flourish here.

What is surprising is the very small numbers of phytoplankton as compared tothe zooplankton. Since the lake is obviously doing well (significant zooplankton and significant fish population) one would conclude that the primary food source (phytoplankton) is doing well. The volume of nannoplankton is greater than that of netplankton, and in lakes of temperate North America, phytoplankton volume usually exceeds that of zooplankton by two to six times.[2] Therefore the phytoplankton must be mainly nannoplankton or else at depths other than sampled.

General Discussion

At first glance, Peter and Bergner Lake appear to be very similar in chemical make-up. However, from the data collected, some apparent differences between Peter and Bergner Lake stand out. First, Peter is definitely evolving into a bog. The liming of the lake may be delaying the process but the conditions are too strong for even extensive liming to prevent the continuation of the Sphagnum mat already present. The hills surrounding the lake and the relative size and depth all point toward the evolution of a bog. Bergner, on the other hand, does not show any signs of turning into a bog. Even though the pH is low enough, the conditions are not right for a bog. Unlike Peter, Bergner is very shallow and very open so its water is easily mixed by winds and choppy waves. The used up organic materials do sink into the hypolimnion, but they are usually restored to the usable depths of the lake when it turns over. Some day in the very distant future the hole located in the southern portion of the lake may close up and become a bog. The data shows there is a collection of waste in the hole. For now, however, the lake is big enough to compensate for the materials lost in this portion of the lake.

An example of the difference in the wind factor on the two lakes is the data on Color. Both lakes have approximately the same true color. However, Bergner's apparent color is much higher than Peter's. Again, by being easily mixed by the winds and being shallow, more seston and tripton will be found at all depths.

The plankton samples of Peter and Bergner are very similar. This is not surprising considering the similarity in chemical properties of the lakes. In both lakes the Copepods hold the upper hand as far as numbers go. The Cladoceran population appears to be held down in both lakes. But, again, both lakes have a similar property to help explain this- a large fish population.

As stated earlier, the large number of Diaptomus collected could be due to vertical migration since both somples were taken on sunny days when surface concentration of Diaptomus is greatest.

The only striking difference is in the phytoplankton. Peter has a large number mainly from Dinobryon cylindricum. Bergner, on the other hand, has relatively few phytoplankton. The only conclusion I can draw is the collecting at Bergner was not optimal for catching phytoplankton. The Dinobryon collected from Peter were evidently at the right depth at the right time. In Bergner, the phytoplankton may have been at different depths during the collection. Or as stated earlier, a majority of the phytoplankton at Bergner is nannoplankton.

ENDNOTES

[1]Problems of Lake Biology, Forest Ray Moulton, ed., (Lancaster, PA: The Science Press, 1939), p. 88.

[2]George K. Reid, Ecology of Inland Waters and Estuaries, (New York: Chapman and Hall Ltd., 1961), p. 297.

Paul Lake

6-2-81 10:30am

Fiani, Brashos, Verbalen

Test	1 meter	3.5 meter	7 meter
acidity	50	47	47
pH	5.5	5.5	5.5
alkalinity	0	0	0
Ca	5	7.5	7
Mg	3	1.5	5
Total Hardness	8	9	12
Nitrates	.9	.9	.8
Phosphates - ortho	.08	.07	.08
- total	.04	.08	.05
sulfates	1.5	3.0	2.5
conductivity	17.5	18.0	28.0
H_2S	0	0	0
secchi disc	3.4 meters		
color - apparent	65	50	80
- true	65	50	80

Depth (m)	Temperature (°C)	O_2 concentration (ppm)
air	23.0	9.2
surface	19.0	9.4
0.5	18.0	9.8
1.0	17.8	9.7
2.0	16.0	10.6
3.0	12.0	12.0
3.5	8.8	12.8
4.0	8.0	12.4
4.5	6.2	9.8
5.0	6.5	2.4
6.0	5.2	1.8
7.0	4.5	1.8
8.0	4.2	1.8

Peter Lake
6-2-81 10:30am

Saini, Parashos, Verhalen

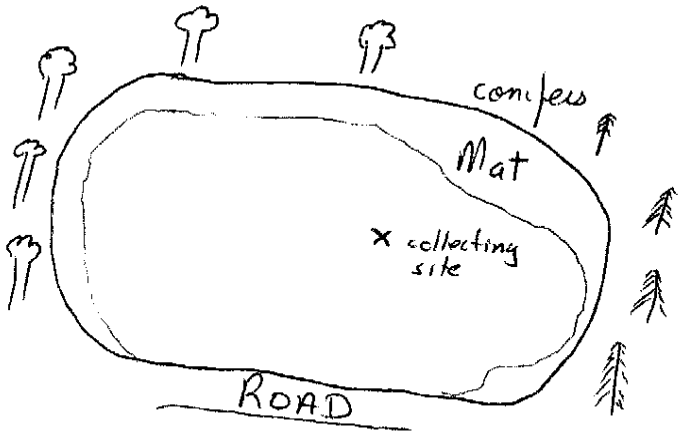
Test	1 meter	3.5 meter	7 meter
acidity	50	60	60
pH	5.1	5.0	5.0
alkalinity	25	20	40
Ca	10	15	20
Mg	5	4	1
Total Hardness	15	19	21
Nitrates	.7	.8	.8
Phosphate - ortho	.08	.06	.09
- total	.04	.03	.04
Sulfates	1	3	3
Conductivity	36	37	42
H_2S	0	0	0
secchi disc		5.1 meters	
color - apparent	55	55	55
- true	55	55	55

Depth (m)	Temperature (°C)	O_2 Concentration (ppm)
air	24	8.6
surface	19.5	10.5
1	18.5	9.8
2	17.8	9.8
3	15.2	11.8
4	12.5	11.0
5	9.5	8.4
5.5	8.0	6.2
6	7.3	2.4
7	6.0	0
8	5.3	0
9	5.0	0

verhalen
Faini
Paraskos

Peter Lake

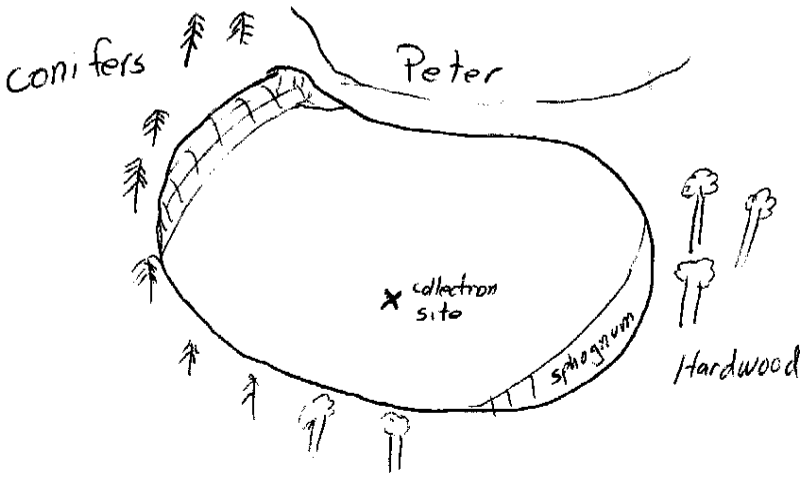
The sphagnum mat on Peter is starting to take hold Conifers line the east and north shores while hardwoods and a road line the south and west.



The weather was fair (sunny) with a mild wind but nothing appreciable.

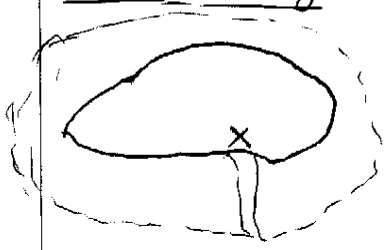
Paul Lake

Paul has a sphagnum mat that is just beginning. The south side is a combination of conifers and hardwoods



The weather was fair with relatively no wind

Tender Bog

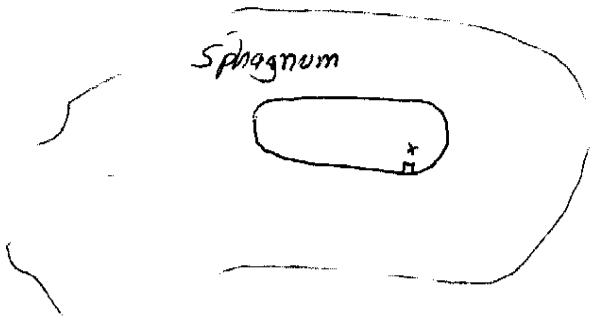


Tender Bog is well protected from wind by a forest of conifers. A thick sphagnum mat, populated with small, scraggly shrubs, ringed the open water.

The water sample and O_2 and temperature data were collected near the dock. The day was sunshiny.

Beaver Bog

Beaver Bog is very small with only a 15 m by 50 m oval with open water



The weather was sunny and warm. The bog was well protected from any wind. There was an abundance of tadpoles swimming around.

Kickapoo Lake

Kickapoo Lake is surrounded by a marsh mat. Conifers line one side of the lake while hardwoods dominate the other side. Kickapoo has inlets from Plum and Emeline Lakes, and drains into Brown Creek.

The water sample and O_2 and temperature data were taken from the middle of the lake. The day was sunshiny and there was no wind.

Bergner Lake

Bergner Lake is an open lake. The shores are flat and covered with shrubs. Conifer trees surround the shrubs.

The lake is relatively shallow. However, the water samples and O_2 and temperature data were collected from a hole extending eleven meters deep.

The sun was shining. The wind was blowing and the water was choppy.

Tender Bog
6-1-81 2pm

Mary Fiene
John Paradoa
Frances Verhalen

Test	1 meter	3 meter
acidity	115	115
pH	4.5	4.5
alkalinity	0	0
Ca	5	5
Mg	15	15
Total Hardness	20	20
Nitrate	.8	.9
Phosphate - ortho	.077	.210
- total	.025	.020
Sulfates	0	0
Conductivity	62	30
H_2S	0	0
Secchi disc	1.5m	
Color - apparent	190	190
- true	190	190

Depth (m)	Temperature (°C)	O_2 concentration (ppm)
air	25.0	8.4
surface	16.8	4.5
$\frac{1}{4}$	16.3	4.3
$\frac{1}{2}$	14.8	2.6
3/4	13.6	2.47
1	11.3	2.3
$1\frac{1}{2}$	7.5	1.2
2	5	0.7
3	4	0.6
4	3	0.6

Beaver Bog — Faini, Brashos, Vechalen

6-4-81 10:30 am

Test	1 meter	2.5 meter
Acidity - phenolphthalen	190	300
- methyl orange	10	10
pH	4.75	4.75
alkalinity	0	0
Ca	2.5	5.5
Mg	2.5	4.5
total hardness	5.0	10.0
conductivity	24	27
H_2S	0	yes
nitrates	0.8	0.7
sulfates	2.75	2.50
color - apparent	185	240
- true	165	210
secchi disc	1.5 meters	

Depth (m)	Temperature (°C)	O_2 concentration (ppm)
air	25.0	9.4
surface	19.0	6.8
1	12.5	0.0
2	4.4	0.0
3	4.0	0.0

Kickapoo Lake — Teine, Carachos, Verhalen

6-3-81 8:30am

Test	1 meter	2.5 meter
acidity	30	20
pH	5.5	5.5
alkalinity	23	29
Ca	27	30
Mg	13	20
total hardness	40	50
conductivity	45	45
nitrate	0.4	0.3
sulfate	9.5	2.5
H_2S	0	0
secchi disc	1.8 meter	
color - apparent	80	115
- true	75	90

Depth (m)	Temperature (°C)	O_2 concentration (ppm)
air	16.8	
surface	17.1	8.8
1.00	17.0	8.6
1.50	17.0	8.7
1.75	16.2	7.2
2.00	15.2	6.0
2.25	14.5	3.8
2.50	14.0	0.7
3.00	14.0	0.0

Bergner Lakes — Faini, Parashos, Verbalen

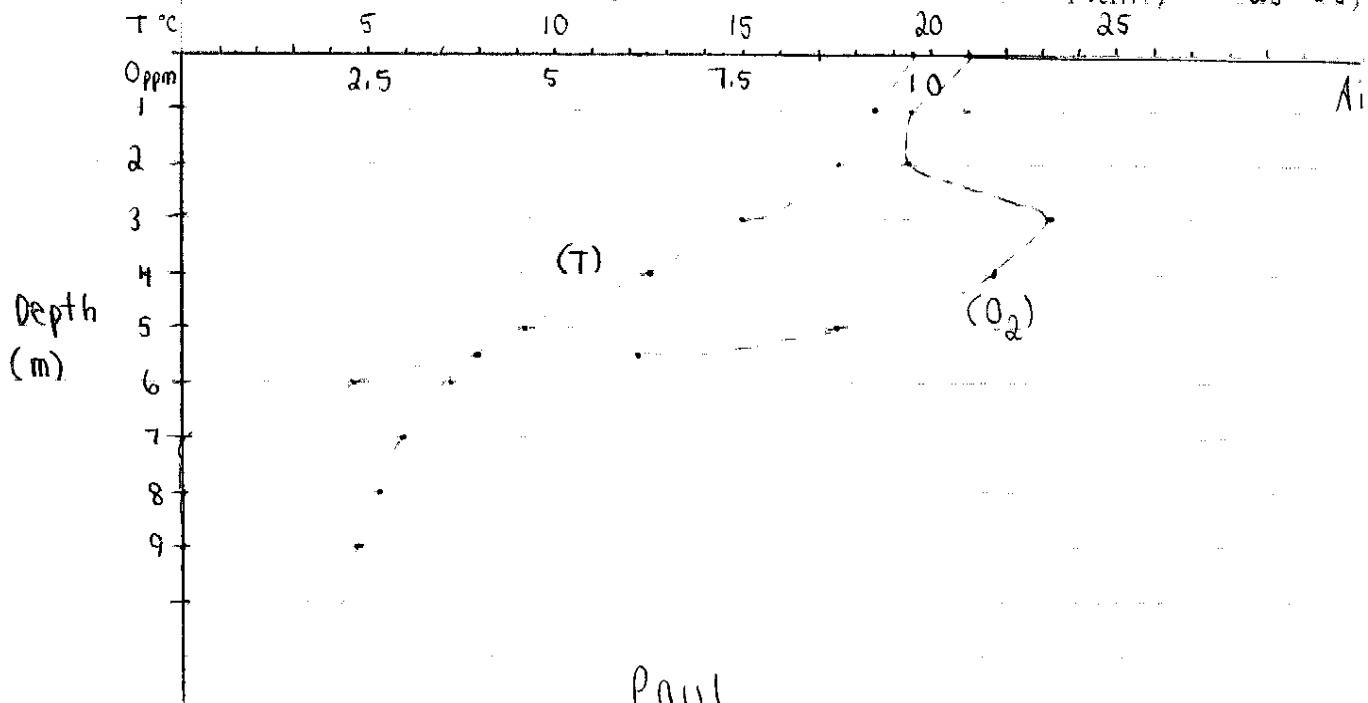
6-5-81 8:30am

Test	1 meter	7 meters
acidity - pherolphthalen	60	80
methyl orange	10	10
alkalinity	0	0
Ca	7	10
Mg	3	7.5
total hardness	10	17.5
Conductivity	33	120
pH	5.0	5.0
nitrates	0.6	0.7
sulfates	10.0	19.5
H_2S	no	no
secchi disc	2.6 meters	
color - apparent	77.5	77.5
- true	60.0	57.5

Depth (m)	Temperature (°C)	O_2 concentration (ppm)
air	19.5	9.25
surface	18.8	9.60
1.0	18.8	9.70
2.0	17.8	8 80
2.5	16.5	8.10
3.0	13.3	6.00
4.0	11.0	4.30
5.0	9.8	4.60
6.0	8.4	4.10
7.0	7.0	2.80
8.0	6.5	2.30
9.0	6.5	1.70
10.0	6.3	0.00
11.0	6.3	0.00

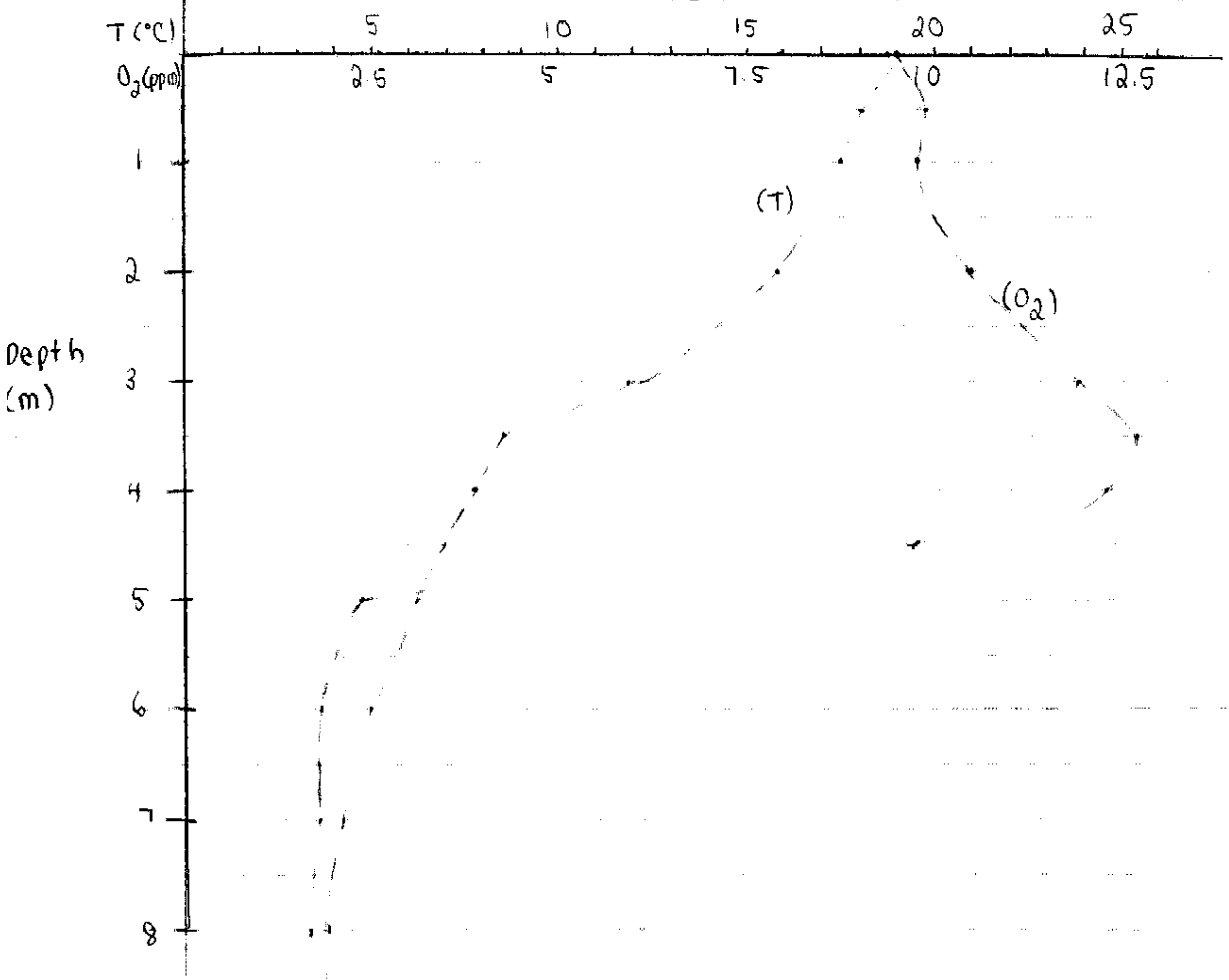
Peter

Faini, Paraskos, Verhalen



Air temp. = 24°C
O_2 = 8.6 ppm

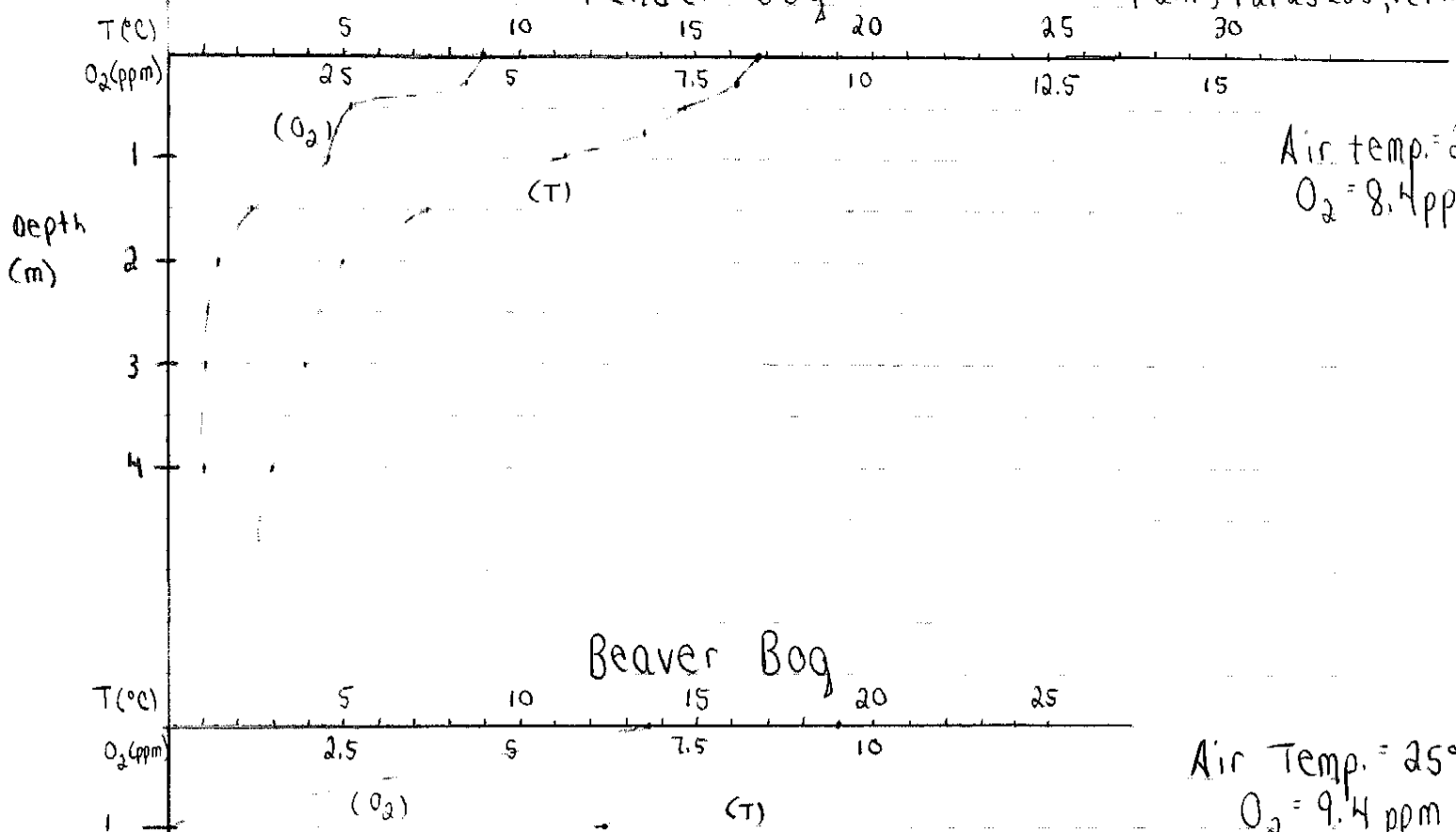
Paul



Air temp = 23°C
O_2 = 9.2 ppm

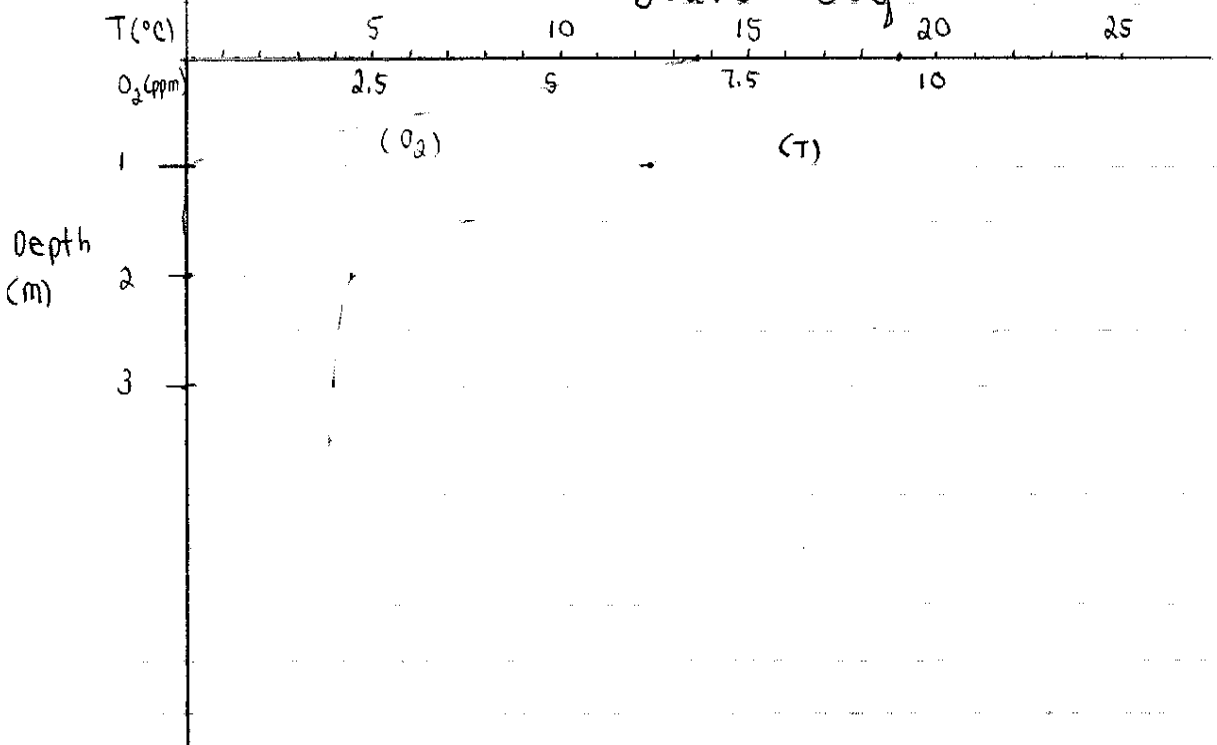
Tender Bog

Faini, Paraskos, Verhalen



Air temp. = 25°C
O_2 = 8.4 ppm

Beaver Bog

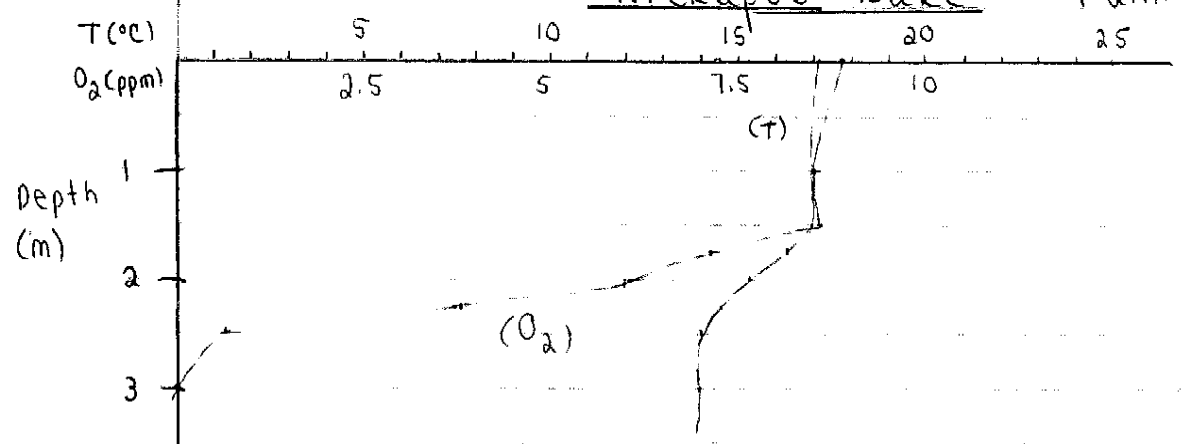


Air Temp. = 25°C
O_2 = 9.4 ppm

Kickapoo Lake

Faini, Verhalen, Paraskos

Air Temp = 16.8°C



Bergner Lake

Air temp = 19.5°C

O_2 = 9.25