plankton 9.5
water chem. 9.5
9.5

A BRIEF STUDY OF MORRIS AND LONG LAKES

Robert L. Kerby
30 June 1978
Biology 569
Dr. Richard W. Greene

Five thousand years ago, the Wisconsin ice sheet relinquished for the last time the frozen land it had molded for millennium. The slowly retreating glacier left its wake strewn with embedded ice chunks and gaping cavities. The slowly melting ice chunks would form kettle lakes. Long Lake and Morris Lake, along with the majority of small lakes in North America, are kettle lakes. A brief survey of both lakes, which are situated in Gogebic Co., MI., was conducted on May 30, 31, and June 9, 1978.

LAKE DESCRIPTIONS

LONG LAKE - As its name implies, Long Lake is long compared to its width. (approximately 800 meters long by 60 meters across). It has a surface area of $7.6 \times 10^4 m^2$.[1] Along most of its northern edge, at the crest of the steep bank, runs an unimproved dirt road. The southern, western, and eastern boundries are relatively flat. See figure I. [2] The lake is composed of three distinct areas: a long, narrow, and shallow sill which diverges at either end into two deeper basins. The forest along the shoreline is mostly comprised of evergreens with a sprinkling of white birch (Betula papyrifera) and tamarack (Larix laricina). No brouse line is evident. The bank directly east of the dock ~~are~~ is faced with leatherleaf (Chamaedaphne calyculata). Also present along the west, northwest, and northeast shores is sedge (Carex sp.). Fragrant waterlilies (Nymphaea odorata) mainly grow in the shallows east of the dock, spreading out from the leatherleaf, while a few grow west of the dock.

---

[1] Richard W. Greene. 1976. A Brief Guide to the University of Notre Dame Environmental Research Center. Department of Biology University of Notre Dame, Notre Dame, IN. All further references to previous (1976) information on Long Lake or Morris Lake ~~is~~ are also from this source.

[2] Origional map presented to the Univ. of Notre Dame by J. Bruce Allen. Survey by W.E. Johnson, Univ. of Wisconsin.

Except for the waterlilies no other aquatic macrophytes ~~(aquatic)~~ were noted. The lake appeared sterile; its clear waters yeilding to a generally barren muck bottom in the sill area. Occasionly fresh water sponges were found encrusting submerged logs and branches. The submerged wood was slimy with periphyton. Two rock lined bass nesting sites and several unidentified fish were observed. Although Long Lake has no obvious inlets or outlets, characteristics of the northeast corner suggest seepage between it and Bay Lake. The bank here is a gentle slope covered with ferns and a few tamarac. The proximity of a section of Bay Lake supports the possibility. An area on the west basin may also be a tributary or seepage site.

MORRIS LAKE - In contrast to Long Lake, Morris Lake (Figure II), though smaller ($5.7x10^4 m^2$), appears larger as it is not divided into three distinct areas. Its obvious distinguishing feature is a prominent point jutting from the north bank. The northern, western, and southern banks are relatively level while the southeastern and eastern shores are steeply banked. Most of Morris, unlike Long, is surrounded by high hedges or low trees with only a few evergreen stands and an occasional deciduous tree. Most of the trees are on the point. The presence of at least four beaver lodges, including an active one, is probably a reason for the scarcity of trees around the lake. Growing from the lake's muck bottom is extensive littoral growth and submerged macrophytes (especially waterweed, Elodea sp.). Minnows and northern pike (Esox lucius) swim in the murky waters. Of the more than fifty fish caught this summer, all were n. pike. Morris Lake is probably fed by seepage from Ward Lake and drains into Tenderfoot Creek. A stream runs from the northeast corner of Morris from Reddington Lake.[3] The actual direction of flow wasn't determined.

METHODS AND MATERIALS

All chemical procedures are described in the Hach kit manual. Water samples were retrieved using a liter Kemmerer and stored in polyethylene jars. All plankton samples were collected with a Plankton Net towed a few centimeters beneath the surface of the water for 2 minutes. Approximate sampling areas are marked on the maps. Plankton counts were performed with a Sedgewich-Rafter counting cell at 200X magnification. One horizontal strip was counted per sample.

RESULTS

Physical-Chemical Limnology - All data are presented in graphs I through V and Tables I and II.

LONG LAKE - Long Lake was actually sampled twice. On 30 May 1978, an overcast, windy day with light rainfall, temperature and oxygen data were taken in the west basin and water samples obtained for chemical analysis shortly after 11 AM. On 9 June 1978, a bright and cloudless day, temperature and oxygen data were taken between 5 to 6 PM for the west and east basins as well as for the sill.

Graph I shows the west basin clearly stratified with a thermocline between 2 - 3 meters. The water temperature decreases from 17.2°C at 2 meters to 12.0°C at 3 meters. The dissolved oxygen curve has a maximum directly above the themocline which is discussed in the Biological limnology section. Graph III shows the west basin 10 days later. The thermocline

---

3. A C.S.C. provided the name of the lake. The correct spelling may be Redington.

is no longer smooth as multiple metalimnion have formed. The deeper metalimnion is the initial spring metalimnion which "stabilizes at a depth characteristic of the lake morphometry and prevailing meteorological conditions"[4] while the upper, or secondary, metalimnion is transitory and forms during calm and hot weather. The thermocline from 30 May is included (in red) for comparison.

The dissolved oxygen in graph III no longer sports a bump at 2.5 meters. Note, however, that the bump has not actually diminished. Rather, the dissolved oxygen from the surface to 2.5 meters has increased to 9 ppm. Although H_2S is found at 10 meters, as origionally reported, later sampling found H_2S present at seven meters.

To see if any significant differences exist between the east and west basins, the areas were sampled on 9 June 1978. The temperature graphs are very similar for both basins and the sill. These data, in conjunction with the contour map of Long, do not prove whether the hypolimnion of both basins extends across the sill. Assuming the thermocline is at 2.5 meters, the map does not show that the sill is at least 2.5 meters deep along some area for its full length.[5] Three other factors must also be considered. First, certain areas of the sill are at least 4 meters deep so the chance that a 2.5 meter contour line exists within the 2 meter line is fair. Second, the thermocline is not a fixed or abrupt line. It varies according to the season and to the recent weather. Strong winds often set up external and internal seiches,

---

4. R.G. Wetzel. 1975. Limnology. Saunders Co., Publisher, Philadelphia, Penna. p. 79.

5. Unfortuanately, this was not determined this summer either.

for example. Third, the ~~position of the~~ thermocline is, within limits, a zone of ~~an~~ arbitrary choice. The hypolimnion of both basins in Long are probably connected for periods each year. How long they are connected requires further study.

The dissolved oxygen graphs for the west basin and the sill are very similar (to 4 meters) while that of the east basin decreases slightly more quickly.

The alkalinity, specific conductance, and hardness of the water samples from Long's west basin are uniformly low. The uniformity of these measurments is to be expected since specific conductance is a measurment of the concentration of ionized salts present [6] while hardness and alkalinity measure the concentration of cations (usually Ca^{2+} and Mg^{2+} in fresh water) and anions (usually HCO_3^- and CO_3^{2-} in fresh water). Although the alkalinity is no doubt low, the zero reading probably results from the insensitivity of the method. Total hardness less than 10 mg $CaCO_3$/l H_2O is indicative of oligotrophic waters while quantities in excess of 25 mg $CaCO_3$/l H_2O is indicative of eutrophic waters.[7] As calcium concentrations in softwater (Ca^{2+}less than 20 mg/l) tend to fluxuate little over time [8] and the specific conductivity reported in 1976 was 20 uMhos/cm, these tests place Long in a low mesotrophic classification.

---

6. At low concentrations anyways. See O.T. Lind. 1974. Handbook of Common Methods In Limnology. The C.V. Mosby Company, Publisher, Saint Louis, MO. p. 74.

7. Ibid., p. 57.

8. Wetzel, p. 155.

Uncombined CO_2 (note pH of 5.7) and humic acids (from evergreen leaves) are probably responsible for the high acidity. Since evergreen leaves are refractory, the lake's color should be high. In 1976 Long was the area's most highly colored lake (150 color units). The color measured on 30 May 1978, curiously, was 30 color units. The lack of buffering capacity is evident in the lake's acidic pH. As CO_2 is metabolized the pH should decrease slightly. In August 1976 Long Lake had a pH of 6.1.

Long Lake had sufficient phosphates and nitrates in the samples drawn. Nitrates are slightly higher in the hypolimnion than epilimnion while nearly all of the phosphates are in the epilimnion. The phosphorus to nitrogen ratio (P/N) in the 1 meter sample is 3/10, more than adequate and even ~~just~~ sufficient for "luxury uptake".

MORRIS LAKE - Morris Lake was sampled on 31 May 1978, an overcast and windy day, in the area shown in figure II.

At the time of sampling Morris was stratified with a thermocline around two meters. This thermocline is more defined and slightly shallower than that of Long. Morris' higher color (150 color units, true color) would sharply attenuate light penetration resulting in the thermocline characteristics. The color is double that found in 1976. The dissolved oxygen curve shows a steady oxygen concentration down to the thermocline followed by ~~the~~ considerably lower concentrations below the thermocline. This oxygen pattern represents a clinograde distribution. Although H_2S was origionally reported at 5 meters, results from the community metabolism data show hydrogen sulfide at 4 meters.

The alkalinity, specific conductance, and hardness of the samples are much higher than those found in Long Lake. The water is definitely "hard" and the calcium concentrations characteristic of eutrophic waters. In contrast to the stability of softwater calcium concentrations, hardwater concentrations tend to be much more seasonal. Typically, uniform calcium concentrations exist during the spring and fall overturns but calcium concentrations and alkalinity decrease from May through September as a result of $CaCO_3$ precipitation.[9] The specific conductance found in 1976 (97 uMhos/cm) falls between the two values found in 1978.

Morris' pH of 6.5 was significantly lower than that found in 1976 (pH of 8.2). Here again the pH should increase as photosynthesis uses CO_2. The recent rains probably contributed to the lower pH also.[10]

Once again the two major nutrients phosphorus and nitrogen are available in sufficient quantities. In bothe nutrients the concentration of the hypolimnion is double that of the epilimnion. The P/N ratio of the epilimnion is 0.18, above the critical level of 0.10 but not as plentiful a ratio as found in Long Lake.

Biological Limnology - Plankton counts are listed in tables III, IV, and V.

LONG LAKE - The dissolved oxygen maximum just above the thermocline in graph I is probably formed either by ~~a~~ phytoplankton ~~bloom~~ resting on the thermocline or photoinhibition in the upper meter of water. Photoinhibition is unlikely since the sampling day was overcast.

---

9. Ibid., p. 155.

10. Whether the amount of rain was sufficient to significantly affect the lake is unknown.

While the recent wind and rain would have been expected to mix the epilimnion and the plankton, this has not happened.[11]

Tables III and IV are designed to first, list the species found, second, rank the species, and third, compare the counts of two people on the same sample.[12] The larger plankton tend to be the species found for at least three reasons. The major reason is the inefficiency of a Plankton net. Up to 77% of the primary producers either pass through the bolting silk or are pushed out of the way by the net's back-pressure. Finally, the power at which the counting is done is a trade-off between the counter's stamina and accuracy.

Other factors beside those of the collection device influence the types of plankton caught. Out of necessity phytoplankton exist in the lighted euphotic zone. Zooplankton, which depend on the phytoplankton, are also concentrated in this region. Vertical stratification in the euphotic zone further separates plankton populations. Organisms migrate vertically depending on first, environmental factors including light, temperature, chemical levels, and second, the organism's structure. [13] Clearly one two minute tow may not suffice to give an accurate plankton cross section even if the method is flawless. An accurate statistical analysis of plankton populations is not possible with only two samples.

Since Long is a softwater lake and has a high pH, a high desmid concentration

---

11. A plankton sample was taken from two meters and left to settle. It was never found.

12. The multiplier to get organisms/ml is 26.5. All results were rounded.

13. G.K. Reid and R.D. Wood. 1976. Ecology of Inland Waters and Estuaries. D. Van Nostrand Company, Publisher, New York, NY. p. 381.

would be expected.[14] In actuality only one desmid, Staurastrum sp., was identified. Both Nancy Nousek (column NN) and the author (column RK) ranked it 10th out of 11 in the PM sample. No desmidium were found in the AM sample. In 1976, Staurastrum and Desmidium were found in Long Lake. As the tows were taken in the warm surface waters, diatoms, which do best in cool waters, were low. Rotifers, blue - green algae and green algae were the major constituents of the samples.

In general, Ms. Nousek's and the author's count's are similar, though far from complete agreement. She identifies more species than the author in both samples: in table III the author identifies 16 organisms while Ms. Nousek identifies 21; in table IV the author identifies 17 species while Ms. Nousek finds 23. As variation exists within the AM and PM counts, so also is there variation in the changes from the AM to PM counts. For example, the number of Dinobryon sertularia in the AM and PM counts in column RK are similar (change of 9805). The number decreases in the NN column fivefold from the AM to PM samples (change of 50,111). Though the samples are uniform, human abilities are not.

As for plankton migration patterns Keratella cochlearis, Daphnia pulex, Eucyclops sp., and Bosmina coregoni decreased in the PM sample compared to the AM sample. Polyarthra sp. and Daphnia longispina remained the same in the two samples and Asplanchna sp. increased in one person's sample and decreased in the other person's sample.

MORRIS LAKE - The plankton counts from Morris Lake is presented in table V. In all, 13 species are listed in the AM sample while 20

---

14. Wetzel, p. 154.

are listed in the PM sample.[15] As could be expected from Morris' hardness and pH, desmids are not found in the samples. On the other hand, diatoms, which do best in waters below 15°C,[16] are ~~not~~ found in the samples. *Asterionella sp.*, which ranked 4^{th}, *Synedra sp.*, which ranked 5^{th}, *Tabellaria sp.*, which ranked 8^{th}, and *Melosira sp.*, which ranked 12^{th} (all in AM sample) were all colledted from waters of temperature over 20°C. While the temperature may not favor diatom metabolism, the hardness and pH of Morris does. *Asterionella* and *Tabellaria* do best in waters with high calcium levels.[17] The uptake of phosphates by *Asterionella* is greatest at a pH between 6 and 7.[18]

At first glance, plankton migrations are evident. The rotifers and crustaceans *Keratella c.*, *Asplanchna sp.*, *Paracyclops fimbratus*, *Ectocyclops phaleratus*, *Eucyclops agilis*, "unidentified rotifer", *Bosmina c.*, and *Senecella calenoides* all increased in the PM sample. *Polyarthra sp.* is the only rotife to decrease. Notice however, that while the zooplankton, as expected, generally increase in the PM sample compared to the AM sample, so does almost everything else. Of the 23 PM sample species listed, 18 increase in the PM sample compared to the AM sample while 5 decrease. Of the 18, 8 are rotifers or crustaceans.

Finally, community metabolism data were taken for Morris and are

---

15. The Morris PM sample was the first sample counted by the author.

16. Wetzel, p. 328.

17. *Ibid.*, p. 161.

18. *Ibid.*, p. 235.

portrayed in graph VI. The results show net respiration (P/R = 0.71) implying that Morris is an allotrophic lake.

DISCUSSION

Only a fraction of each lake's biology has been looked at. The sequence of chemical levels, the sequence of community levels, and the sequence of seasons all affect a lake:

> changes in distribution of nutrients result in rapid growth of many organisms capable of taking atvantage of changes in nutrient availability. Population responses may be temporary and transient.[19]

Often the actual concentration of a chemical matters less than the ratio of that chemical to another. According to Wetzel, for example, Ca^{2+} and Mg^{2+} concentrations are less important than the monovalent to divalent cation ratio.[20] Although calcium is clearly involved in metabolism and gross concentration differences of calcium often affect invertebrate distribution, true causality between calcium concentration and metabolism is lacking.[21] At least as important as a chemical's concentration is its cycling rate. In a lake where physical and biological cycling quickly return nutrients to the epilimnion, low concentrations of chemicals may support large populations. To accurately describe a lake, a multitude of intertwining factors need to be examined.

Trophic classifications are commonly used to describe lakes and are

---

19. Wetzel, p. 123.

20. _Ibid._, p. 161.

21. _Ibid._, p. 154.

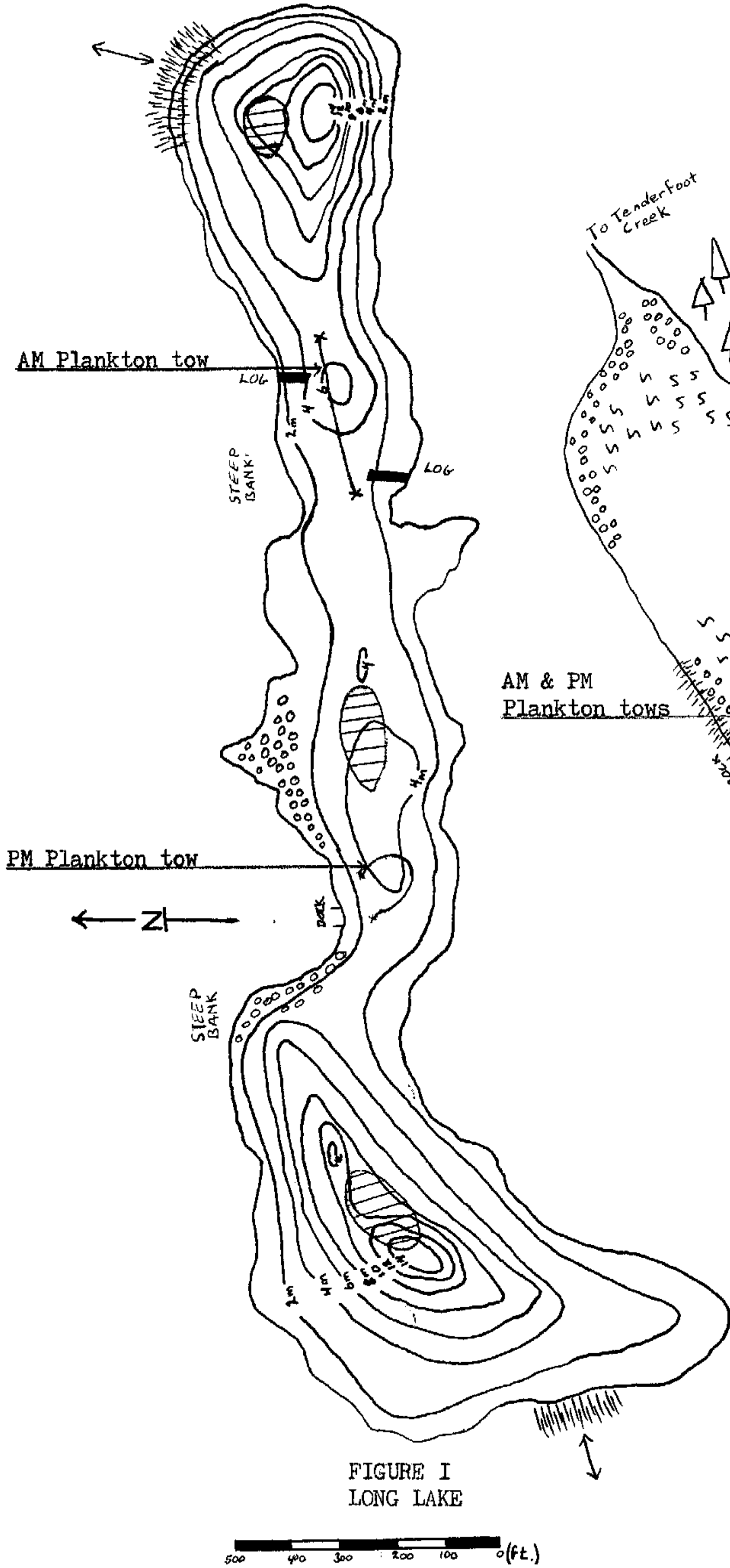


FIGURE I
LONG LAKE

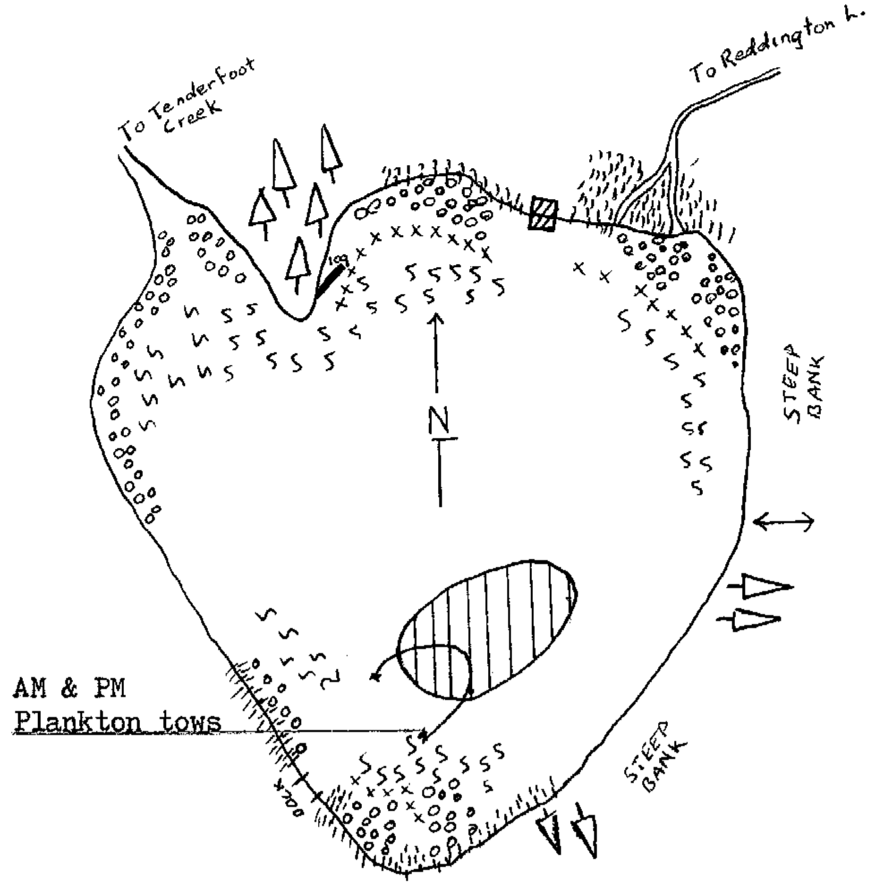
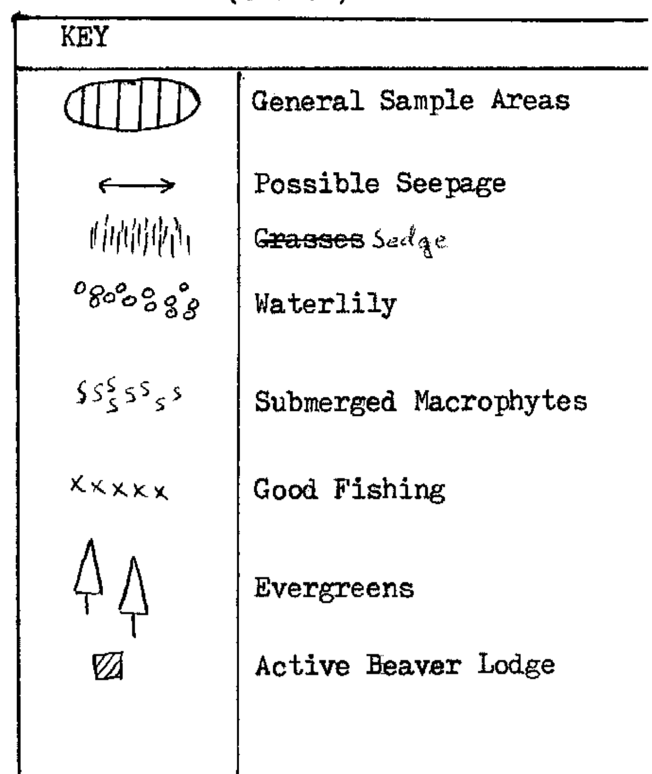
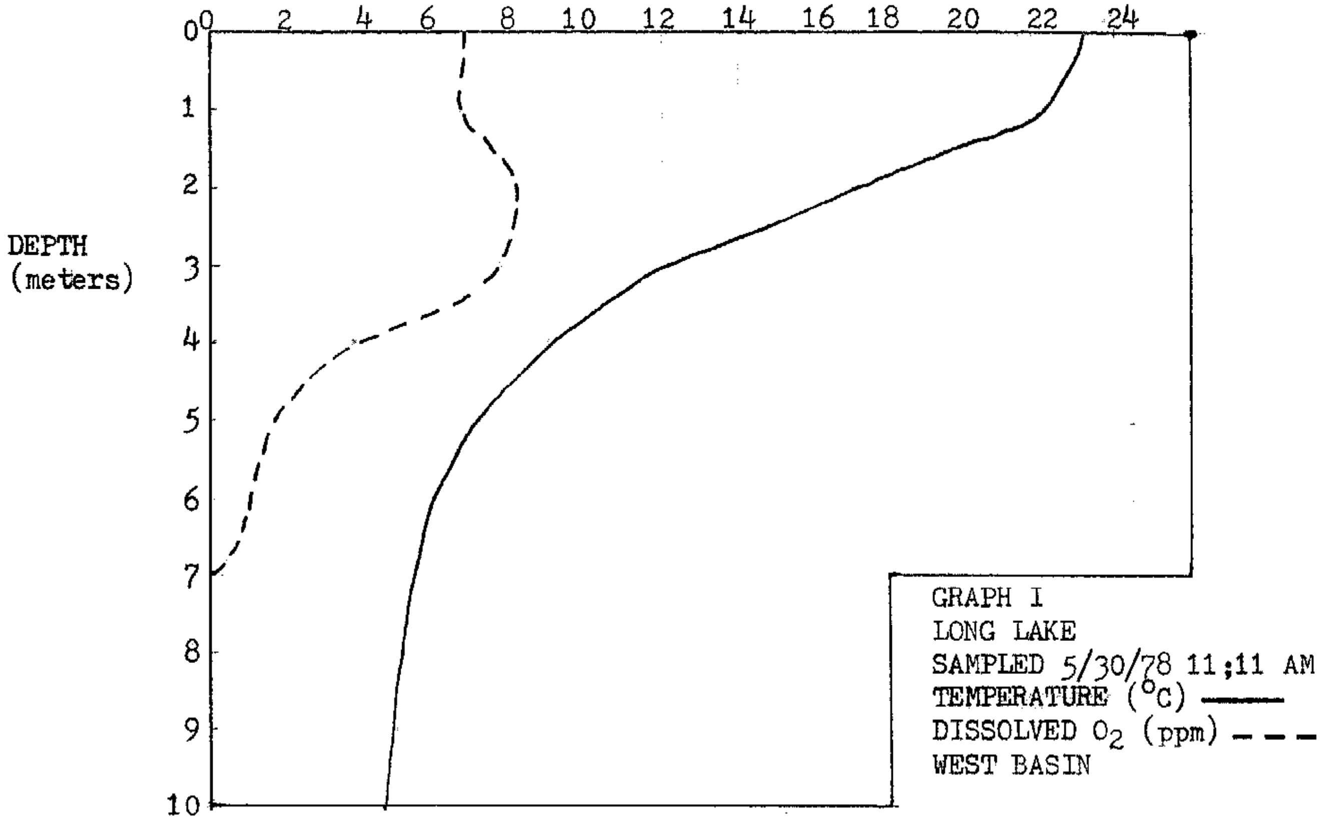
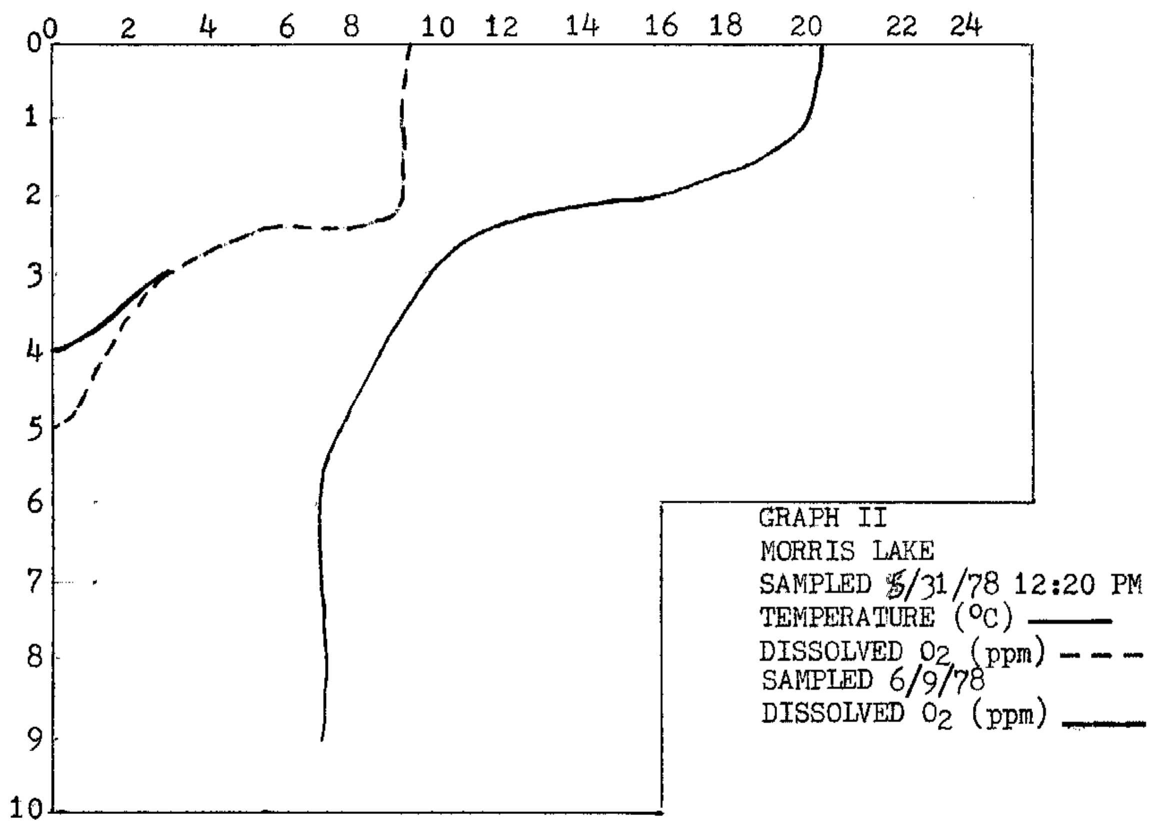
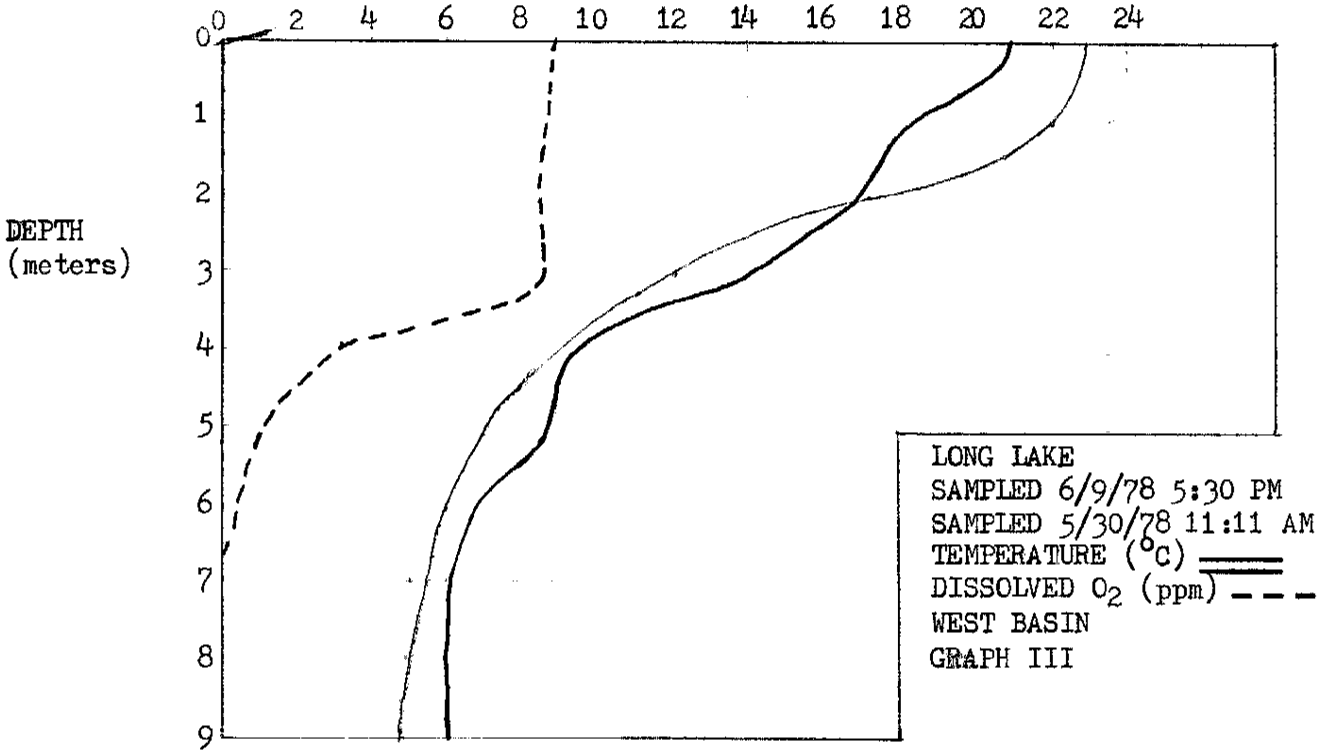


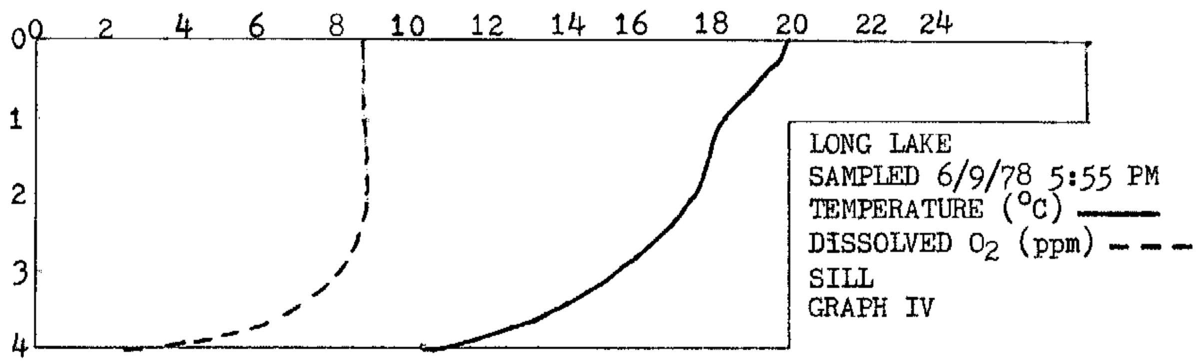
FIGURE II
MORRIS LAKE (sketch)




0 2 4 6 8 10 12 14 16 18 20 22 24
DEPTH
(meters)
0 1 2 3 4 5 6 7 8 9 10
GRAPH I
LONG LAKE
SAMPLED 5/30/78 11;11 AM
TEMPERATURE (°C)
DISSOLVED O2 (ppm)
WEST BASIN


0 2 4 6 8 10 12 14 16 18 20 22 24
0 1 2 3 4 5 6 7 8 9 10
GRAPH II
MORRIS LAKE
SAMPLED 5/31/78 12:20 PM
TEMPERATURE (°C)
DISSOLVED O2 (ppm)
SAMPLED 6/9/78
DISSOLVED O2 (ppm)


DEPTH
(meters)
0 2 4 6 8 10 12 14 16 18 20 22 24
0 1 2 3 4 5 6 7 8 9
LONG LAKE
SAMPLED 6/9/78 5:30 PM
SAMPLED 5/30/78 11:11 AM
TEMPERATURE (°C)
DISSOLVED O2 (ppm)
WEST BASIN
GRAPH III


0 2 4 6 8 10 12 14 16 18 20 22 24
0 1 2 3 4
LONG LAKE
SAMPLED 6/9/78 5:55 PM
TEMPERATURE (°C)
DISSOLVED O2 (ppm)
SILL
GRAPH IV

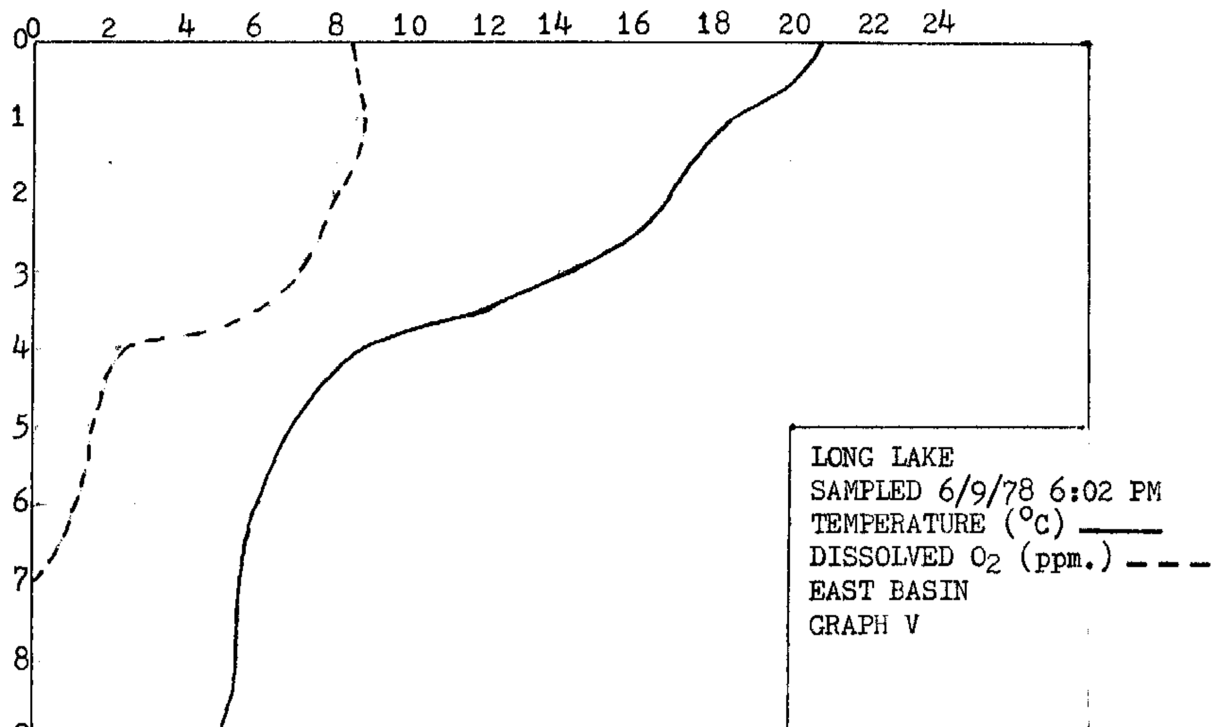

0 2 4 6 8 10 12 14 16 18 20 22 24
0 1 2 3 4 5 6 7 8
LONG LAKE
SAMPLED 6/9/78 6:02 PM
TEMPERATURE (°C)
DISSOLVED O2 (ppm.)
EAST BASIN
GRAPH V

TABLE I
CHEMICAL LIMNOLOGY
LONG LAKE Sampled 5/30/78 11:11 AM

Depth (meters)	1	7
Acidity (mg $CaCO_3$/l H_2O)	125	120
Alkalinity "	0	0
Color (color units)	30	45
Specific Conductance (umhos/cm)	18	18
Hardness (mg $CaCO_3$/l H_2O)		
Total	10	15
Calcium	10	10
Magnesium	0	5
Hydrogen Sulfide (mg H_2S/l H_2O)		0.3 (from 10 meters)
Nitrate (mg NO_3/l H_2O)	3.96	4.40
pH	5.7	5.6
Phosphate (mg PO_4/l H_2O)	0.82	0.05
Secchi Disk (meters)	3	

Weather: overcast, light rain, windy.

TABLE II
CHEMICAL LIMNOLOGY
MORRIS LAKE Sampled 5/31/78 12:20 PM

Depth (meters)	Surface	5
Acidity (mg $CaCO_3$/l H_2O)	60	60
Alkalinity "	30	30
Color (color units)	150	235
Specific Conductance (umhos/cm)	81	115
Hardness (mg $CaCO_3$/l H_2O)		
Total	50	65
Calcium	30	35
Magnesium	20	30
Hydrogen Sulfide (mg H_2S/l H_2O)		present at 4 meters
Nitrate (mg NO_3/l H_2O)	2.64	5.06
pH	6.5	6.5
Phosphate (mg PO_4/l H_2O)	0.34	0.62
Secchi Disk (meters)	1.5	

Weather: overcast, windy.

TABLE III
PLANKTON COUNT
LONG LAKE Sampled 5/30/78 11:11 AM

RANK Column RK	RANK Column NN	PLANKTON	R.K. (units/ml)[1]	N.N. (units/ml)[1]
1	1	Dinobryon sertularia	120602	131440
2	2	Dinobryon bavarium	901	3180
3	3	Anabaena rotifer [2]	424	583
4	6	Keratella cochlearis	345	133
5	4	Aphanocapsa sp. (colonies)	292	477
5	7	Anabaena sp. (filaments)	292	106
6	8	Unidentified rotifer	186	53
7	6	Daphnia pulex	159	133
8	10	Volox globator (colonies)	133	0
9	10	Mougeotia sp.	106	0
10	9	Nauplius	53	27
11	10	Chrysosphaerella longispina	27	0
11	10	Polyarthra sp.	27	0
11	9	Asplanchna sp.	27	27
11	9	Keratella quadrata	27	27
11	10	Volvox tertius (colonies)	27	0
12	9	Bosmina coregoni	0	27
12	8	Daphnia longispina	0	53
12	9	Eucyclops sp.	0	27
12	6	Synura sp. (colonies)	0	133
12	8	Volvox sp.[3] (colonies)	0	53
12	9	Melosira sp.	0	27
12	5	Microcystis aeruginosa	0	212
12	8	Botryoccoccus sp. (colonies)	0	53
12	6	Collosphaerium sp. (colonies)	0	133
12	9	Merismopedia elegans (colonies)	0	27

---

1. All numbers refer to individual organisms per ml unless otherwise noted.
2. Unidentified rotifers usually found attached to Anabaena sp. filaments.
3. Note Volvox tertius and Volvox globator listed in column RK.

TABLE IV
PLANKTON COUNT
LONG LAKE Sampled 5/30/78 PM

RANK Column RK	Column NN	PLANKTON	R.K. (units/ml)[1]	N.N. (units/ml)[1]
1	1	Dinobryon sertularia	110797	81329
2	2	Dinobryon bavarium	875	2120
3	11	Merismopedia sp.	848	0
4	4	Keratella cochlearis	292	371
5	7	Anabaena sp. (filaments)	239	159
6	8	Unidentified rotifers	133	106
7	10	Tabellaria sp.	106	27
8	10	Asterionella sp. (colonies)	80	27
9	8	Aphanocapsa sp. (colonies)	53	106
9	3	Anabaena rotifers[2]	53	530
10	11	Lacinularia socialis (colonies)	27	0
10	11	Polyarthra sp.	27	0
10	10	Daphnia pulex	27	27
10	11	Ankistrodesmus sp.	27	0
10	11	Kellicottia longispina	27	0
10	10	Staurastrum sp.	27	27
10	11	Volvox tertius (colonies)	27	0
11	9	Daphnia longispina	0	53
11	10	Cyclops bicuspidatus	0	27
11	8	Asplanchna sp.	0	106
11	10	Keratella quadrata	0	27
11	6	Synura sp. (colonies)	0	239
11	10	Chrysophaerella longispina	0	27
11	9	Synedra sp.	0	53
11	10	Melosira sp.	0	27
11	10	Volvox sp.[3] (colonies)	0	27
11	10	Botryoccoccus sp. (colonies)	0	27
11	8	Unidentified filamentous blue-green algae	0	106
11	5	Microcystis aeruginosa	0	292

---

1. All numbers refer to individual organisms per ml unless otherwise noted.
2. Unidentified rotifers usually found attached to Anabaena sp. filaments.
3. Note Volvox tertius and Volvox globator listed in column RK.

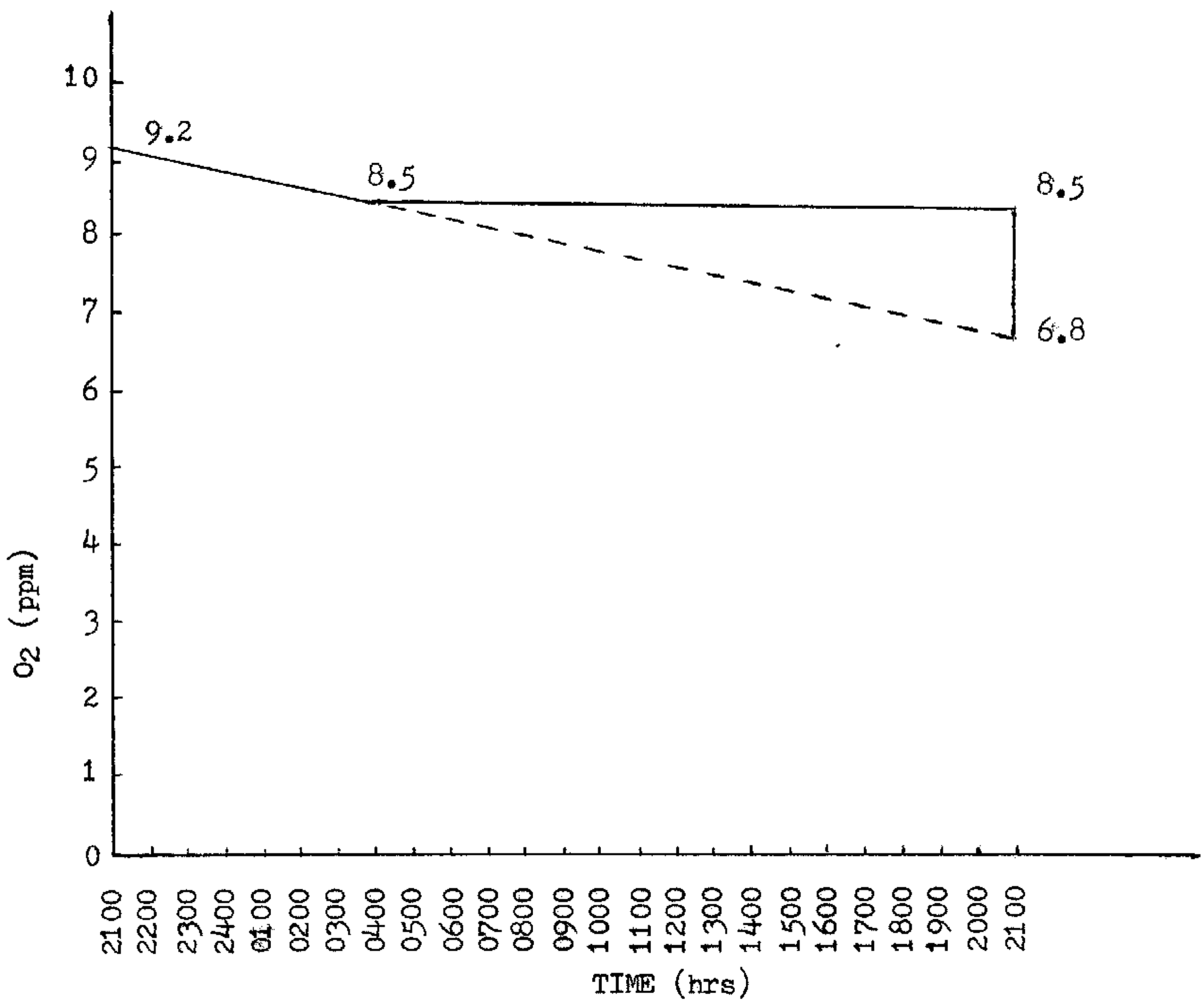
TABLE V
PLANKTON COUNT
MORRIS LAKE Sampled 5/31/78

RANK Column AM	RANK Column PM	PLANKTON	AM (units/ml)[1]	PM (units/ml)[1]
1	1	*Dinobryon sertularia*	99031	165705
2	2	*Keratella cochlearis*	2995	4532
3	8	*Polyarthra sp.*	663	318
4	3	*Asterionella sp.* (colonies)	557	1564
5	7	*Synedra sp.*	424	345
6	6	*Ankistrodesmus sp.*	265	557
7	4	*Asplanchna sp.*	186	636
7	6	*Oscillatoria anagusta*	186	557
8	13	*Tabellaria sp.*	133	0
9	13	*Chrysosphaerella longispina*	80	0
10	13	*Ceratium hirundinella*	53	0
11	11	*Synura uvella* (colonies)	27	53
11	10	*Dinobryon bavarium*	27	106
12	12	*Ectocyclops phaleratus*	0	27
12	9	*Paracyclops fimbratus*	0	133
12	12	*Vorticella sp.*	0	27
12	12	*Volvox globator* (colonies)	0	27
12	11	*Senecella calenoides*	0	53
12	11	*Bosmina coregoni*	0	53
12	12	*Peridinium sp.*	0	27
12	12	*Eucyclops agilis*	0	27
12	5	Unidentified rotifer	0	583
12	11	*Melosira sp.*	0	53

---

[1] All numbers refer to individual organisms per ml unless otherwise noted.

GRAPH VI
MORRIS LAKE - COMMUNITY METABOLISM



CALCULATIONS

Community Photosynthesis = (8.5-6.8)/24 = 1.7/24
Community Respiration = (9.2-6.8)/24 = 2.4/24
P/R = 1.7/2.4 = 0.71

All samples were taken at a depth of 1 meter.
Sampling started on 9 June 1978 and concluded the following evening.

therefore useful. According to Russel-Hunter:

> The most generally accepted biological classifications of lakes are based on the midwinter amounts of, and recycling rates of, inorganic plant nutrients in their waters.[22]

The data for Long and Morris Lakes do not take into account cycling rates and were not obtained in midwinter.

Both lakes are bathymetrically eutrophic. Although Long and Morris have deep holes, they are for the most part relatively shallow. Both lakes have a clinograde oxygen distribution characteristic of eutrophy. Both lakes have ample nitrates and phosphates with more than adequate P/N ratios. While Long's high acidity supports a dystrophic classification, the phosphate and nitrate concentrations are much to high. The sampling method did not permit determination of plankton densities. The hardness, conductivity, and alkalinity appear to distinguish the lakes. Long's low hardness (conductivity and alkalinity similarly) is characteristic of oligotrophic lakes. Morris' high hardness is characteristic of eutrophic lakes.[23] Morris Lake's more extensive littoral and submerged macrophyte growth also suggests a more productive lake.

The data show Long having both eutrophic and oligotrophic characteristics. A compromise classiifies Long as a mesotrophic lake. Long's steep bank along the northern shore, ~~and~~ its dense surrounding vegitation and high phosphorus and nitrogen levels raise the possibility of high allotrophy.

---

22. W.D. Russell-Hunter. 1970. Aquatic Productivity. The Macmillan Company, Publisher, New York, NY. p. 116.

23. Lind, p. 57.

The conclusions are mostly speculative. Lakes are much too complex to be surveyed once and expect accurate conclusions. Moreover, as time goes on, the conclusions will necessarily change - the lakes certainly will. The complexity and diversity of each magnificent microcosm allows for somecomparisons of Morris Lake and Long Lake, not a full evaluation.

Bibliography

Eddy, S., and A.C. Hodson. 1961. Taxonomic Keys to the Common Animals of the North Central States. Burgess Publishing Company, Minneapolis, Minn.

Greene, R.W.,Ed.1976. A Brief Guide to the University of Notre Dame Environmental Research Center. Department of Biology University of Notre Dame, Notre Dame, IN.

Lind, O.T. 1974. Handbook of Common Methods In Limnology. The C. V. Mosby Company, Publisher, Saint Louis, MO.

Needham,J.G. and P.R. Needham. 1978. A Guide to the Study of Fresh-Water Biology. Holden-Day, Inc., Publisher, San Francisco, CA.

Reid, G.K. and R.D. Wood. 1976. Ecology of Inland Waters and Estuaries. D. Van Nostrand Company, Publisher, New York, NY.

Russell-Hunter, W.D. 1970. Aquatic Productivity. The Macmillan Company, Publisher, New York, NY.

Wetzel, R.G.1975.Limnology. Saunders Co., Publisher, Philadelphia, Penna.