# Forest Service Bog

# and

# Raspberry Lake

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Practicum in Aquatic Biology
September 1, 1982

On the property of the University of Notre Dame Environmental Research Center, a unique collection of aquatic habitats are present. These waters offer the opportunity to study and compare lakes and bogs of different stages of development while keeping the latitude and weather conditions constant. In July of 1982, two of these bodies of water, Forest Service Bog and Raspberry Lake, were sampled. Tests were done to determine some of the physical and chemical aspects of the waters and plankton tows were taken in order to determine the species composition and populations of phytoplankton and zooplankton present. Comparing Forest Service Bog and Raspberry Lake gives the unique opportunity to compare a bog with a well developed sphagnum mat to a small lake in the process of becoming a bog.

# Forest Service Bog

## Description

Forest Service Bog is located in a well protected area. Hills surround the bog and these hills are covered with both deciduous and coniferous trees. The bog is isolated in that it has no drainge into or out of its basin. The bog mat itself is extensive, leaving only a small area of open water. The mat is predominately Sphagnum and with it grows tamarack, black spruce, pitcher plants, sundew and several members of the Ericaceae. At one time there was a floating island of Sphagnum. A researcher tied the island to the shore and eventually it merged with the shore forming a peninsula. The most notable feature about the organisms in the water is the lack of fish, making the only organisms predacious on small invertebrates a large population of predacious beetles, specifically Dytiscidae and Gyrinus.

July 29, 1982, the sampling day, was partly cloudy and the waters were calm.

## Physical Data

The oxygen and temperature data is listed in Table I. The thermocline for the bog occurred between 2 and 3 meters deep. The Secchi disk reading was 2.5 meters.

Table I

| depth | T (°C) | $O_2$ (ppm) |
|---|---|---|
| surface | 22.5 | 5.7 |
| 1 m | 22.5 | 5.6 |
| 2 m | 21.0 | 2.8 |
| 2.5 m | 17.0 | 2.4 |
| 3 m | 13.5 | 2.6 |

Chemical Data

The chemcial data ~~is~~ listed in Table II. Hydrogen sulfide was not found in the bog.

Table II

| | 1 m | 2.5 m |
|---|---|---|
| acidity (mg/l) | 12.5 | 15.0 |
| alkalinity (mg/l) | 2.5 | 2.2 |
| pH | 5.9 | 5.5 |
| hardness calcium (mg/l) | 2.8 | 3.0 |
| hardness magnesium (mg/l) | 0.4 | 0.5 |
| iron (mg/l) | 0.06 | 0.09 |
| sulfate (mg/l) | 0.5 | 0.5 |
| nitrate (mg/l) | 0.5 | 0.5 |
| orthophosphate (mg/l) | 0.52 | 0.18 |
| total phosphate (mg/l) | 0.71 | 0.30 |
| apparent color (units) | 30 | 50 |
| true color (units) | 20 | 49 |
| specific conductance (umhos/cm) | 38 | 113 |

Plankton Data

Phytoplankton and zooplankton counts are given in Table III. A one minute tow was taken in Forest Service Bog.

Table III

| Phytoplankton | organisms/ml | |
|---|---|---|
| Desmidium | 1683+ | |
| Mougeotia | 183+ | |
| Staurastrum | 22 | |
| Tabellaria | 20 | |
| Ceratium | 13 | |
| Asterionella | 6 | |
| TOTAL | 1927+ | (3854)* |

| Zooplankton | | |
|---|---|---|
| Keratella cochlearis | 735 | |
| Polyarthra | 196 | |
| Lecane | 44 | |
| Bosmina longirostrus | 40 | |
| Ploesoma | 29 | |
| Nauplius | 20 | |
| Copepodite | 18 | |
| Paracyclops | 7 | |
| Notommata | 7 | |
| Enteroplea | 6 | |
| Asplanchna | 4 | |
| Kellicotia longispina | 4 | |
| Testudinella | 2 | |
| TOTAL | 1112 | (2224)* |

*Approximate number of plankton that would have been found if a two minute tow was taken.

## Raspberry Lake

### Description

Raspberry Lake is a small kettle lake with a surface area of 2.9 ha. Raspberry lake drains into the Cisco chain of lakes, but has no drainage into it. The lake is surrounded by a small sphagnum mat composed mainly of Sphagnum and tamarack. The area surrounding Raspberry lake is made up of small rolling hills covered with deciduous trees, making it somewhat protected from wind action. Of the three species of fish found in the lake, largemouth bass (Micropterus salmoides) predominates. Yellow perch (Perca flavescens) and pumpkinseed (Lepomis gibbosus) are also found.

It was partly cloudy on the sampling day, 27 July, 1982, and the water was calm.

### Physical Data

The oxygen and temperature data is given in Table IV. The thermocline was between 3 and 5 meters. The Secchi disk reading was 3.5 meters.

Table IV

| depth | T (°C) | $O_2$ (ppm) |
|---|---|---|
| surface | 22.0 | 7.1 |
| 1 m | 22.0 | 9.3 |
| 2 m | 22.0 | 9.1 |
| 3 m | 20.5 | 6.7 |

| depth | T (°C) | $O_2$ (ppm) |
|---|---|---|
| 4 m | 15.9 | 5.0 |
| 5 m | 12.0 | 4.3 |
| 6 m | 9.5 | 4.2 |
| 7 m | 9.0 | 4.3 |

Chemical Data

The chemical data ~~is~~ are given in Table V. No hydrogen sulfide was found in the lake. The test for true color was not done because centrifuge tubes were not available at the time of the testing.

Table V

| | 1 m | 3.5 m | 5 m |
|---|---|---|---|
| acidity (mg/l) | 21.0 | 5.5 | 7.0 |
| alkalinity (mg/l) | 4.7 | 5.0 | 5.0 |
| pH | 5.3 | 5.9 | 5.8 |
| hardness calcium (mg/l) | 5.0 | 5.0 | 5.0 |
| hardness magnesium (mg/l) | 1.0 | 5.0 | 1.0 |
| iron (mg/l) | 0.08 | 0.14 | 0.40 |
| sulfate (mg/l) | 0.0 | 0.0 | 2.7 |
| nitrate (mg/l) | 0.05 | 0.07 | 0.07 |
| orthophosphate (mg/l) | 0.93 | 1.04 | 1.07 |
| total phosphate (mg/l) | 1.10 | 0.85 | 1.02 |
| apparent color (units) | 0 | 40 | 50 |
| true color (units) | -- | -- | -- |
| specific conductance (umhos/cm) | 16.1 | 14.5 | 19.1 |

Plankton Data

Phytoplankton and zooplankton counts are given in Table VI. A two minute tow was taken on Raspberry Lake.

Table VI

| Phytoplankton | organisms/ml |
|---|---|
| Chrysosphaerella* | 5720 |
| Dinobryon* | 3234 |
| Anacystis* | 1309 |
| Asterionella | 352 |
| Staurastrum | 198 |
| Tabellaria | 88 |
| TOTAL | 10,901 |

| Zooplankton | |
|---|---|
| Keratella cochlearis | 429 |
| Polyarthra | 88 |
| Daphnia pulex | 44 |
| Bosmina longirostrus | 33 |
| Copepodite | 33 |
| Kellicotia longispina | 33 |
| Asplanchna | 11 |
| Cyclops | 11 |
| Nauplius | 11 |
| Ploesoma | 11 |
| TOTAL | 715 |

*Organisms were counted by colony, not individual.

## Discussion

Forest Service Bog showed a slightly higher pH than would be expected from a similar sphagnum bog. It has been shown that the humus material producing the acid reaction in bogs comes from the bottom sediments (Welch, 1935). Forest Service Bog is so well protected that the humus material on the bottom may not have been disturbed by water movement enough to release large amounts of humic acid.

The pH of Raspberry Lake at depth was more basic than Forest Service Bog. This may be due to the more extensive sphagnum mat of Forest Service Bog. The sphagnum exchanges hydrogen ions for other ions in the water, usually $Ca^{++}$ and $Mg^{++}$. This increases the acidity of the water, lowers the pH, and makes the water softer if no other conditions prevail. This was reflected for the most part in the data for the acidity, pH and hardness of the two lakes. Forest Service Bog is more affected by the sphagnum because its mat is much more extensive. The lower pH at 1 meter in Raspberry Lake was probably due to the photosynthesizing of phytoplankton. The removal of $CO_2$ from the water produces hydrogen ions by shifting the equilibrium of the equation

$$H_2O + CO_2 \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons H^+ + CO_3^=$$

to the left. The greater amount of phytoplankton found in Raspberry Lake supports this.

The lower alkalinity found in Forest Service Bog correlates to the higher acidity of the bog. The buffering capacity of Forest Service Bog was less than that of Raspberry Lake allowing an increased acidity and lower pH.

In looking at the Secchi disk readings and colors of the two lakes, it is evident that Raspberry Lake was clearer as would be expected of a body of water without an extensive bog mat. For a bog with such an extensive mat, though, Forest Service Bog would be expected to have a higher color and lower Secchi disk reading. The amount of electrolytes in the water was also comparatively high for such a bog, as shown by the specific conductance. Generally, calcium deficiency is the factor causing stained water because it blocks the action of bacteria in decomposing detritus creating a large amount of humus material. This humus material becomes suspended in the water causing a "tea" color (Cole, 1979). Because Forest Service Bog is so small and well protected, the movement of the water is minimal, allowing this humus material to settle to the bottom, resulting in very clear water (Welch, 1935). The small difference between the apparent and true color points to this also.

The appparent color of Raspberry Lake was similar to Forest Service Bog. Although Raspberry Lake is larger and more exposed to wind action, it probably remains relatively

clear because it has a higher amount of $Ca^{++}$ allowing more bacterial decomposition to take place.

In bogs with high color, a shallow thermocline is expected because of little light penetration. The thermoclines in both Raspberry Lake and Forest Service Bog were not particularly shallow (Figs. 1 and 2), again indicating clearer waters than what would be expected for those types of habitats.

In comparing the oxygen profiles of the two lakes (Figs. 1 and 2), Raspberry Lake had consistently higher oxygen levels. This can be attributed to the size and location of Raspberry Lake -- it is more open to wind action and mixing, and higher concentrations of phytoplankton. The bulge in the oxygen profile at 1 meter in Raspberry Lake indicates a high concentration of phytoplankton at that depth.

In looking at the plankton tow data, Raspberry Lake had much more phytoplankton while Forest Service Bog had more zooplankton. In Raspberry Lake blooms of Chrysosphaerella and Dinobryon composed the main portion of the phytoplankton. When looking at the nutrient levels of the two lakes, the phosphates were higher in Raspberry Lake. In Raspberry Lake the total phosphate level was found to be lower than the orthophosphate level. This discrepancy

is due to some error, but the phosphate levels will be assumed to be in that range. Phosphates are most frequently the limiting factor in phytoplankton population growth. The lower phosphate level in Forest Service Bog and lesser amount of phytoplankton indicate that phosphates may have been limiting in Forest Service Bog. Sulfates and nitrates were higher in Forest Service Bog than Raspberry Lake showing that they were not the limiting factor in Forest Service Bog, but may have been in Raspberry Lake. The iron levels in both lakes were sufficient.

The large numbers of zooplankton in Forest Service Bog were composed mainly of Keratella and other rotifers, as would be expected in a bog (Welch, 1935). The population in Raspberry Lake had a large number of rotifers also, but a higher percentage of copepods and cladocerans were also found indicating a less bog-like condition in Raspberry Lake (Welch,1935).

Because the tows were both done at approximately the same time of day (9:00 A.M.), the larger numbers of zooplankton in Forest Service Bog cannot be attributed to vertical migrations. Zooplankton is the food source for many organisms. In looking at the fish populations of the two lakes, Forest Service Bog has no fish to feed on the zooplankton while Raspberry Lake has three species of fish, Micropterus

salmoides, Perca flavescens, and Lepomis gibbosus. In gut analyses, it was found that the Perca flavescens fed on zooplankton and insects. Lepomis gibbosus fed on insects which often feed on zooplankton. The presence of these predators may have been a factor in keeping the zooplankton population down in Raspberry Lake. The predators of the zooplankton in Forest Service Bog consists of insects only.

Another factor in controlling the zooplankton population is the phytoplankton population. Much of the zooplankton population is made up of size specific feeders. Asplanchna, Keratella and Polyarthra have all been found to feed on specific sizes of algae (Welch, 1935). Others are indiscriminate feeders such as Bosmina and Daphnia (Welch, 1935). The population size of an individual species may depend on its food source. The large numbers of zooplankton found in Forest Service Bog may have been due to a recent algal bloom that had already died when the tow was taken, but the population of the grazers on that bloom had not yet been reduced. A plot of the population sizes of zooplankton and phytoplankton against time often shows a one or two week lag in the zooplankton population following the phytoplankton population (Reid and Wood, 1976).

## Conclusion

By looking at the differences and similarities of Forest Service Bog and Raspberry Lake, predictions can be made of some aspects of the future of Raspberry Lake. The chemistry of the water is already similar in some aspects to Forest Service Bog. As the sphagnum mat develops on Raspberry Lake, an increase in acidity can be expected as well ~~as well~~ as a decrease in the pH, alkalinity and hardness. The water color of Raspberry Lake should become less clear. As the $Ca^{++}$ decreases in the water, bacterial decomposition will decrease causing the presence of more humus material in the water. Also the lake is more open to wind action and it does have drainage, both of which cause the movement of water. This water movement will not allow the humus material to settle to the bottom as it does in Forest Service Bog. The future nutrient composition of Raspberry Lake cannot be predicted because of dissimilarities in present plankton populations and insufficient testing. Changes in species composition and population sizes of phytoplankton and zooplankton cannot be predicted because of differences in predators and chemical dissimilarities.

# Forest Service Bog

## Oxygen / Temperature Profile

July 29, 1982

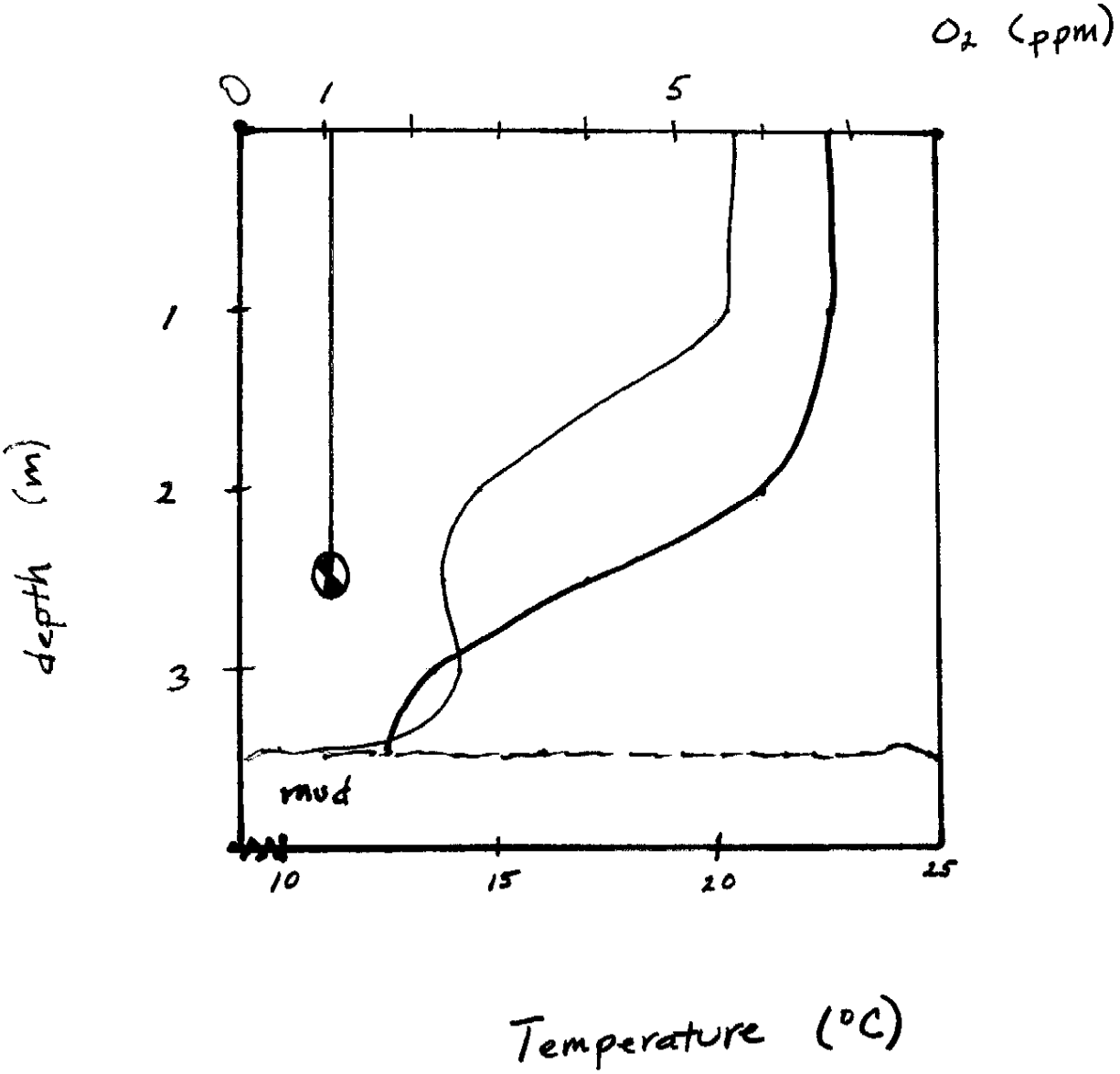


Fig. 1

# Raspberry Lake
## Oxygen/Temperature Profile

July 27, 1982

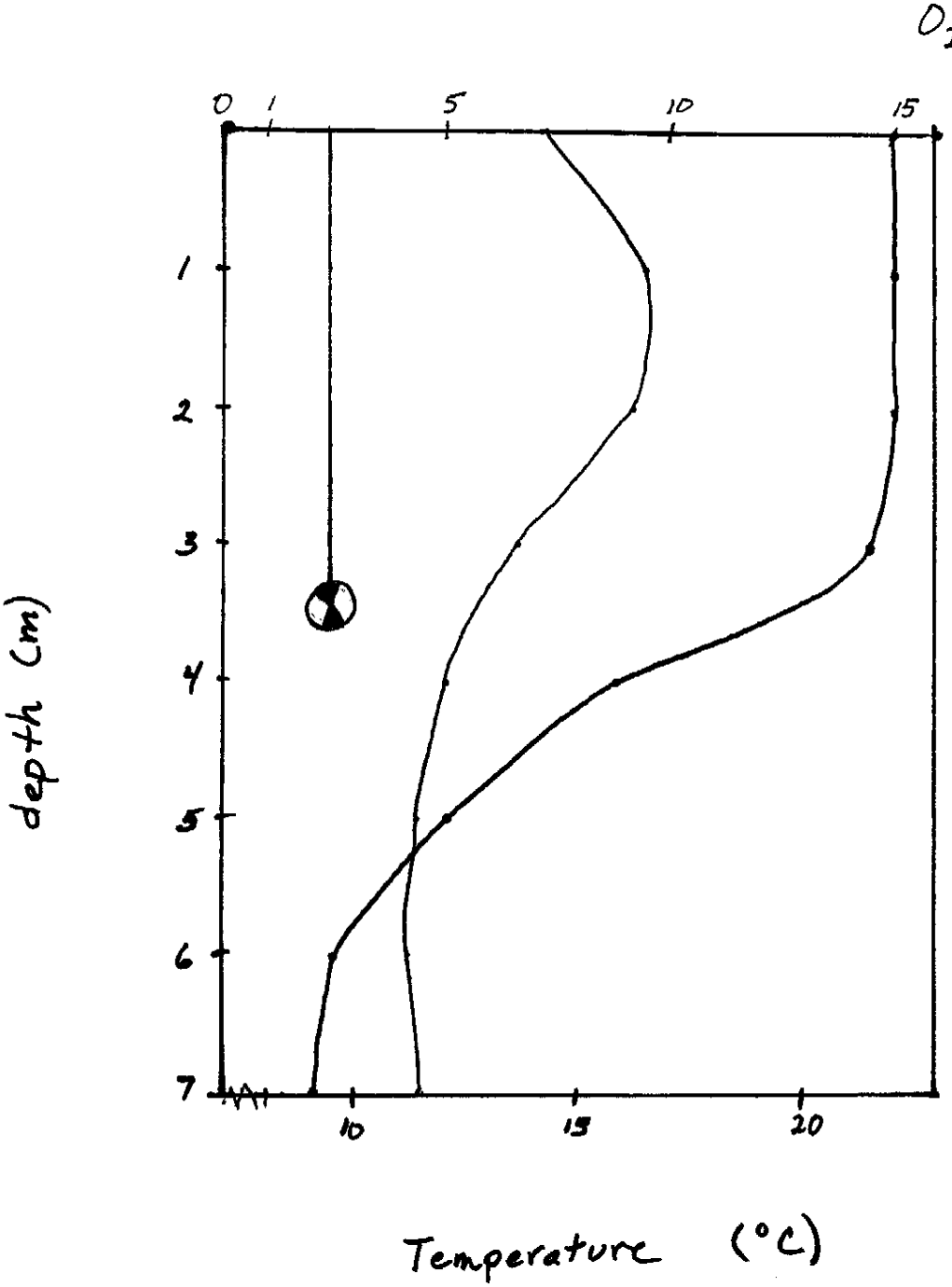


Fig. 2

# Bibliography

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