8.2

plankton 7

W.C. 8

Didn't attempt to correlate water chem. with plankton.

7.5

Survey of Raspberry and Long Lake

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Raspberry and Long Lakes are two lakes located on the Notre Dame Environmental Research Center property in Gogebic county, Michigan. During June of 1977 various sampling techniques were used on the lakes in order to gather data to be used in a general survey of all of the lakes on the Notre Dame land.

Chemical tests were done on various properties of the water. The living material, (zooplankton, phytoplankton and fish) in the lakes were also studied along with the surrounding vegetation and animal life. All of these various aspects were studied in order to try to understand the lake as a whole ecological system.

Methods:

The equipment used in collecting the water samples was a Kemmerer sampler. A Kemmerer sampler is a tube that will close on both ends when messengers are sent down a line attached to the tube. A Kemmerer allows samples to be taken at whatever depth is desired. Samples were then stored in covered glass bottles and refrigerated until testing was ready to begin.

Oxygen readings were taken in each lake with the use of an oxygen and temperature meter. The oxygen meter was calibrated each time it was used in order to obtain standard results. On the back of the meter is a chart that gives the O_2 in ppm for certain temperatures. This number is multiplied by the number which corresponds to the altitude of the lake. This product gives a conversion factor to which the meter is calibrated. The oxygen and temperature readings are then taken by dropping the probe into the water at meter intervals.

The pH of the lakes was taken using a pH meter. The meter was zeroed before use by using a buffer of pH 7 or in the case of the bogs a buffer of pH 4 was used.

Depth recordings of the lake were taken using a depth meter. The depth meter operated on a sonar principle. A mechanism which emitted sound was attached to the back of the boat in the water. The sound waves would travel through the water then bounce off the bottom surface and be read by the meter. The depth was calculated through the amount of time that it took the sound to travel to the bottom and them back up again to the surface.

The life in the lake was studied by means of phytoplankton and zooplankton samples. A phytoplankton sample was collected by obtaining a water sample from the desired depth by using a Kemmerer sampler. The amount in the water sample was recorded and used in later calculations. This water sample was run through a funnel which had netting with extremely small openings on both sides of it. After the excess water had run off the plug was pulled and aproximately 25 ml. of water passed into a sample bottle. The sides of the funnel were then washed with distilled water to remove any of the remaining phytoplankton.

A zooplankton sample was obtained by towing a plankton net behind the boat for a timed period. The speed of the boat was adjusted in order that the net was pulled just below the surface. The net was towed for usually five or ten minute periods. The zooplankters were trapped in the net and in a small vial attached to the end of the net.

The actual water chemistry tests were performed using prepared chemicals from the Hach kits.

Long Lake

Zooplankton am

Organism	Number per ml.
Keratella	1,640
Polyarthra	784
Nauplius	93
Trichocera	62
Daphnia	31
Difflugia Globosa	21
Eudorina	21
Bosmina	10
Crytomona	19

Zooplankton pm

Organism	Number per ml.
Keratella	1,476
Daphnia	330
Nauplius	268
Eudorina	62
Hydra	52
Trichocera	21
Ceriodaphnia	10
Kellicotta	10

Phytoplankton

Organism	Number per ml.
Agmenellum (Merismopodium)	35,728
Anabaena	23,080
Dinobryon	8,617
Volvox	1,331
Protococus	1,238
Scenedesmus	970
Polycystis	691
Navicula	495
Coelospharium	351
Botryoccocus	258
Staurastrum	258
Diatoma	175
Tabellaria	124
Astrionella	103
Uroglena	93
Cosmarium	52
Ceratium Hirundinella	41
Desmidius	41
Micraspora	31
Ulothrix	31
Flagellaria	31
Anacystis Colonies	21
Nostoc	10

Long Lake

Water Chemistry Data

	1 Meter	8 Meter
Specific Conductivity	40 μ Mhos	62 μ Mhos
Methyl Orange Acidity	20 mg/l	13 mg/l
Phenolpthalien Acidity	37 mg/l	32 mg/l
Alkalinity	0 mg/l	5 mg/l
Hardness Calcium	5 mg/l	5 mg/l
Hardness Total	5 mg/l	7.5 mg/l
Hardness Magnesium	0 mg/l	2.5 mg/l
Aparent Color	35 units	100 units
True color	33 units	95 units
Nitrate	.4 mg/l	.9 mg/l
Sulfate	17 mg/l	9 mg/l
Ortho Phosphate	.05 mg/l	.31 mg/l
Total Phosphate	.15 mg/l	.46 mg/l
pH	7.2	7.8

Temperature and O_2 readings

Depth in Meters	Temperature	Oxygen in ppm
0	19	7.9
1	19	7.7
2	18.5	7.7
3	16	6.8
4	10	4.3
5	7	3.3
6	5	1.7
7	4	.9
8	4	.6
9	4	.5

Raspberry Lake

Zooplankton am

Organism	Number per 1 ml.
Holopidium Gibberum	103
Ploesoma	36
Keratella	23
Nauplius	7
Daphnia	4
Bosmina	4
Diaptomus	4
Cyclops	2

Zooplankton pm

Organism	Number per 1 ml.
Ploesoma	2539
Keratella	857
Daphnia	206
Vernalis Cyclops	186
Nauplius	134
Diaptomus	114
Holopidium Giberum	103
Bosmina	41
Podophyra	31

Phytoplankton

Organism	Number per 1 ml.
Agnemellum	17,166
Anabaena	1,311
Navicula	68
Staurastrum	31
Dinobryon	14
Asterionella	14
Cosmarium	10
Pediastrum	10
Eustrum	10

Raspberry Lake

Water Chemistry Data

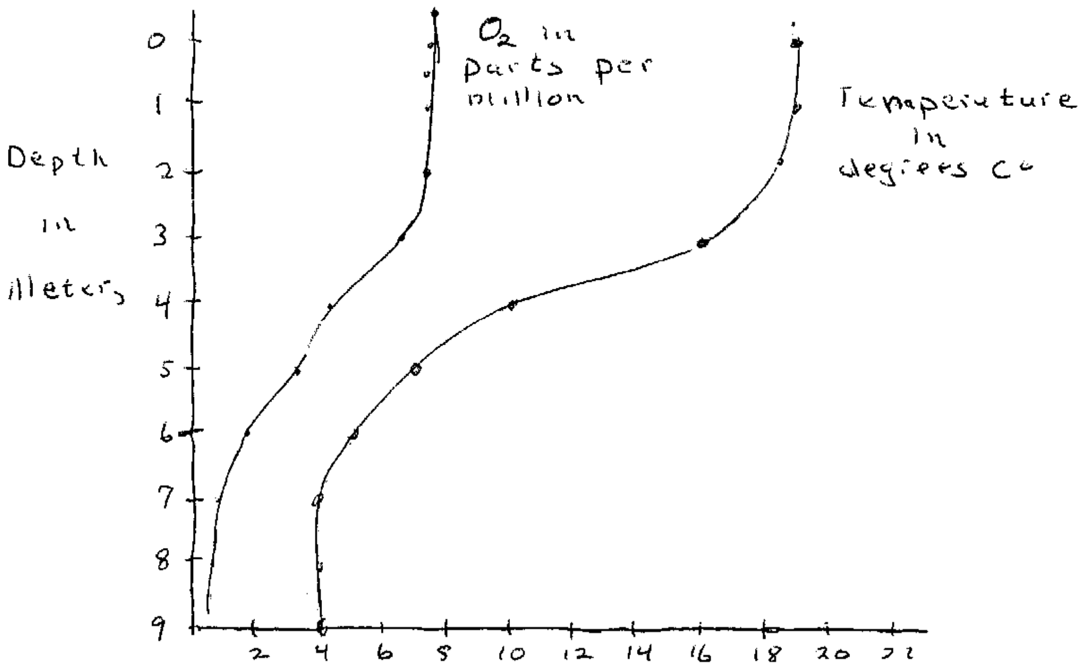
	2 Meters	5 Meters
Specific Conductivity	19 μ MHOS	18.5 μ MHOS
Methyl Orange Acidity	None	None
Phenolpthalien Acidity	25 mg/l	20 mg/l
Alkalinity	10 mg/l	10 mg/l
Hardness Calcium	5 mg/l	5 mg/l
Hardness Total	10 mg/l	12.5 mg/l
Hardness Magnesium	5 mg/l	7.5 mg/l
Apparent Color	25 units	55 units
True Color	20 units	40 units
Nitrate	.65 mg/l	.45 mg/l
Sulfate	2 mg/l	6.5 mg/l
Ortho Phosphate	.15 mg/l	.23 mg/l
Total Phosphate	.40 mg/l	.37 mg/l
pH	7.6	7.2

Temperature and O_2 readings

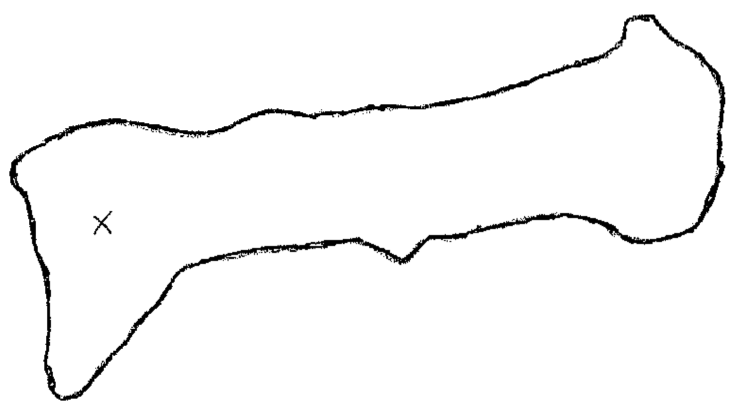
Depth in Meters	Temperature	Oxygen in ppm
2	22	8
3	17	9.2
4	12	10
5	8.5	7.8
6	7	5.4
7	6.5	3.0
8	6.5	1.8
9	6.5	1.4

Long Lake

Depth vs Temperature
Depth vs O_2

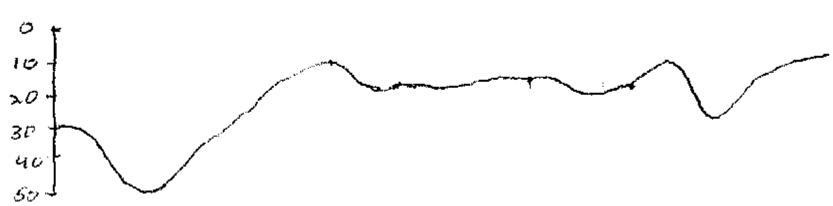


x location where samples taken



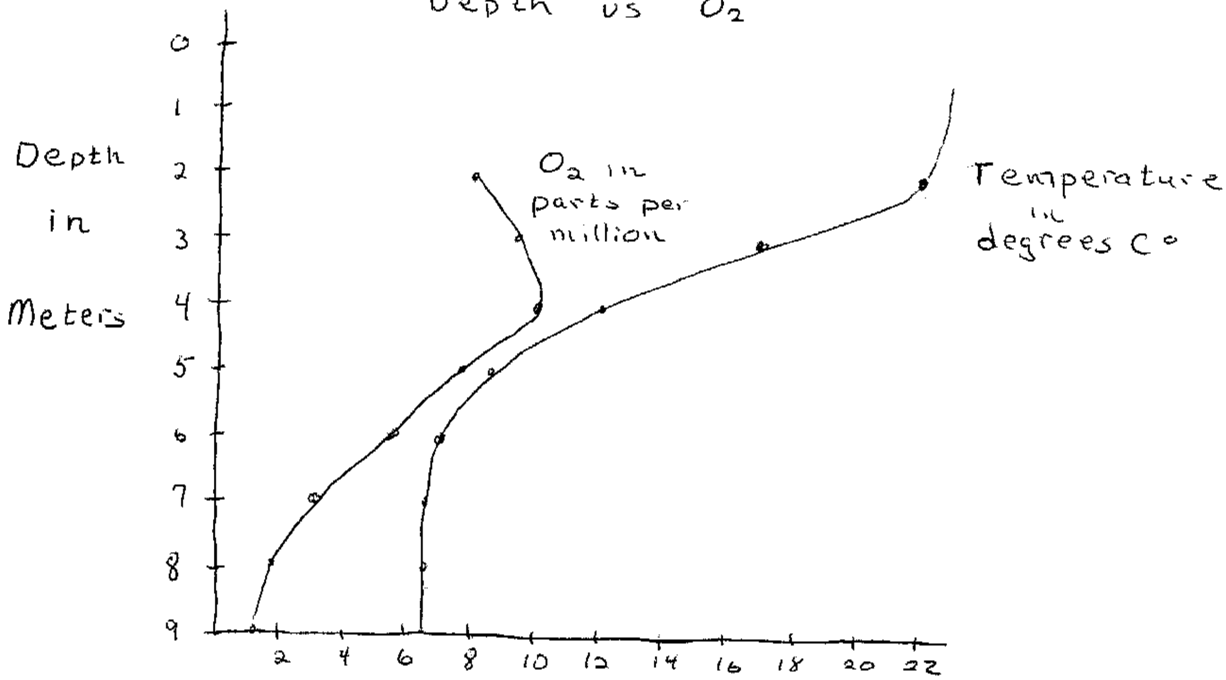
Dock? North? What am I looking at?

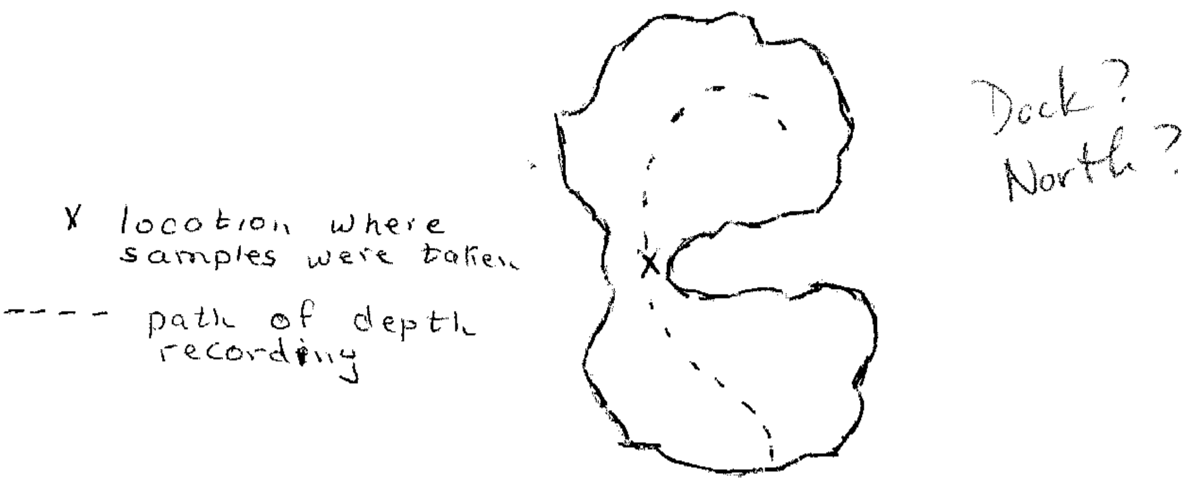
Depth



Raspberry Lake

Depth vs Temperature
Depth vs O_2





Discussion:

Chemical tests were performed on Raspberry and Long Lake in order to try to establish trends to the system of each lake. Epilimnion and Hypolimnion samples were taken in both lakes, In Long Lake the epilimnion sample was taken a 1 meter and the hypolimnion sample was taken at 8 meters In Raspberry Lake the epilimnion sample was taken at 2 meters and the hypolimnion sample at 5 meters.

In Long Lake a thermocline exists. The epilimnion extends for about the first 3 meters of the lake with temperatures ranging from 18° at the surface to 16° at 3 meters. The temperature then begins to drop off and at 4 meters it is down to 10°. The temperature continues to drop with depth until about 7 meters at which the temperature is 4°. The temperature remains at 4° throughout the rest of the depth of the lake.

The oxygen graph follows a similar profile to the temperature graph of starting high and moving lower. Long Lake's oxygen curve resembles what is knows as a clinograde oxygen curve. The oxygen begins to drop in the thermocline and remains low in the hypolimnion. Oxygen in lakes come from two sources. Oxygen is absorbed from the atmosphere at the water-air interface. In this case winds help to mix and spread the oxygen to water below the surface. As the temperature of the water increase, the solubility of oxygen in the water also increases thus allowing the water to hold more oxygen. The second way in which most of the oxygen in the lake is formed is as a byproduct of photosynthesis. The general equation for photosynthesis is: $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$.
It is the phytoplankton in lakes which contribute the majority of the oxygen supply. Algae in the epilimnion contain the chlorophyll which is necessary to produce the oxygen.

As the depth increases in Long Lake the oxygen decreases. Atmospheric oxygen cannot go to lower depths because the winds are not able to stir up large amounts of water. Oxygen is not produced through photosynthesis at lower depths because the sunlight, which is necessary for photosynthesis is not able to penetrate to the lower depths.

Raspberry Lake shows a temperature thermocline which is generally similar to Long Lake. The epilimnion of Raspberry Lake extends from the surface to approximately 3 meters. The hypolimnion reaches a low temperature of around 6° at about 8 meters. Raspberry's hypolimnion does not reach as low a temperature as Long's, but that is possibly due to the greater depth of Long Lake. In the area that sampling was carried out Long Lake hit a depth of 50 feet as compared to Raspberry's depth of 27 feet.

The oxygen profile of Raspberry Lake is very different from the oxygen curve of Long Lake. The oxygen in Raspberry lake begins at about 6.5 ppm at 2 meters. It then begins to increase with depth until it peaks at 4 meters with a reading of 10 ppm. After this peak the O_2 then decreases with depth. The peak of the O_2 curve falls within the region of the thermocline for this lake. This type of an oxygen curve is known as a positive heterograde. The most likely explanation of this peak of oxygen at this depth is the presence of a large group of photosynthesizing phytoplankton. The phytoplankton could be an algal bloom located at this depth. Whatever type of phytoplankton, however it must be able to photosynthesize under slightly reduced sunlight conditions, since between 3 and 4 meters the amount of sunlight penetrating the water is reduced. The oxygen accumulates at this layer because photosynthesis exceeds respiration.

The pH in the epilimnion of Long Lake was 7.2 and in the hypolimnion was 7.8. The pH of Raspbery's epilmnion was 7.6 and of the hypolimnion was 7.2. The pH is a measure of the Hions present in the water. Both of these bodies of water have low hydrogen ion content. However this does not mean that the waters are extremely alkaline. Alkalinity is a measure of the carbonate in the water. Alkalinity measures the H_2CO_3, HCO_3^-, and the CO_3 present in the water. The following equation

$$CO_2 + H_2O \rightleftharpoons HCO_3 + H^+$$
$$\Updownarrow$$
$$CO_2 + H^+$$

shows the interaction of the water with the carbonate.

As the data shows Long Lake has a pH above 7, low alkalinity, but it also has a considerable methyl orange and phenolpthalien acidity. This indicates that when the water is titrated with an alkaline compound it has the ability to accept a considerable amount of anions without changing the pH. The alkaline buffering capacity is high due to the presence of acidity in the water. The pH is not low, however because the hydrogen ions are not free ions. The alkalinity measures the buffering capacity of the water.

In Raspberry the pH is again above 7 but the alkalinity is a bit higher than in Long Lake. This indicates that Raspberry has a bit more carbonate present than Long. It does not have methyl orange acidity present, but does have phenolpthalien acidity. Raspberry's waters are slightly acidic but it also contains more buffering capacity which would interact to bring the water to a level closer to neutral.

The specific conductance is a measure of the waters ability to conduct a flow of electrons through it. The specific conductance of Raspberry was around 19 μ MHOS in both the epilimnion and the hypolimnion. This is considered low. The specific conductance of Long was higher. In the epilimnion it was 40μMHOs and in the hypolimnion it was 62. This corresponds with the higher finding of methyl orange and phenolpthalien acidity. There are more compounds present which will dissociate to ions in order to carry an electric current. The higher specific conductance in the hypolimnion could be a reflection of the type of bottom of the lake. The rock on the bottom of the lake could contain calcium carbonate.

Both Raspberry and Long Lake contain water that is very soft. Long Lake's hardness due to Calcium is only 5 mg/l. The calcium is present in the water in the form of $CaCO_3$. Long Lake's hardness due to magnesium is also very low being 0 mg/l in the epilimnion and 2.5 mg/l in the hypolimnion. Raspberry has a higher magnesium content in its water and thus has a slightly higher total hardness.

Apparent color is the color due to the solution as it is taken from the lake. This includes the suspended particles in the water which come from decaying material. This decaying material is known as humic acid and is made up of plant material and lignin. The true color reading is the reading after the suspended material has been centrifuged from the water. Raspberry's water is not highly colored, with apparent color reading of 25 units in the epilimnion and 55 units in the hypolimnion. However the difference between apparent color and true color is greater in the hypolimnion which indicates the presence of more vegetation which has droped to the bottom and is decaying.

Long Lake has a relatively low apparent color and true color in the epilimnion of 35 and 33 respectively. But in the hypolimnion it has a high color content. The difference between apparent and true color is very low which would indicate that the color is due to the chemical nature of the water. A possible explanation of the color could be high sulfate content in Long Lake. However the sulfate content is higher in the epilimnion than the hypolimnion which does not follow with the color data.

Nitrogen is usually found in the nitrate state (NO_3) in water. Nitrogen from the atmosphere is oxidized by bacteria and made into the soluable nitrate form. Raspberry Lake contains .65 mg/l nitrate in the epilimnion and .45 mg/l in the hypolimnion. Long Lake on the other hand has .4 mg/l in the epilimnion and .9 mg/l in the hypolimnion. The differences in location of the nitrates could be due to differences in location of bacterial populations that do fix nitrogen.

Sulfate in the form of SO_4^{--} is a very common anion in bodies of water. Sulfate can combine with alkali earth metals to form compounds and it is also found in combination with hydrogen ions. Long Lake has much higher sulfate readings than Raspberry. These higher sulfate readings could correspond to the higher acidity that is also found in Long Lake if the sulfate ions are found in combination with hydrogen ions in the form of sulfuric acid.

Phosphate is very important to lakes in terms of productivity. Phosphate is the limiting factor. Both Long and Raspberry have higher phosphate contents in the hypolimnion than in the epilimnion. This is to be expected since phosphate is used by plants for synthesis. Productivity would be higher closer to the surface because of the need for sunlight in photosynthetic activities. Therefore the phosphate level would be lower because much of the phosphate would be taken up by plants. At lower depths the phosphate level would be higher because productivity would not be as great and the plants would not be taking up phosphate.

In Long Lake the phytoplankton sample showed large numbers of Agmenellum (Merismopodium) and Anabaena both of which are blue green algae. Anabaena is known to be able to fix nitrogen and many of the other blue green algae are known to function in the chemical cycles of the lake. Dinobryon, a golden brown algae, which exists in the colonial form, was present in large quantities as well as were Volvox. Dinobryon have been found to be intolerant of high phosphate levels. This information would correspond to the water chemistry data taken in the epilimnion. Some other phytoplankters found in reasonable numbers included the desmid Staurastrum, the green algae Scenedesmus and the diatoms Tabellaria and Astrionella.

In the zooplankton samples certain definite trends can be found between the am and pm samples. Keratella, a rotifer, was abundant both during the day and at night. During the am sample the other most abundant zooplankter was Polyarthra, another rotifer. Other animals such as Nauplius, Daphnia and Bosmina appeared but in very reduced quantities during the day. However at night organisms such as Daphnia, and Nauplius, which are copepod larva, appear in great abundance. These organisms are the larger of the zooplankton and serve as prey for the fish. This lake contains large and small mouth bass along with yellow perch. The reason that the larger zooplankters do not come up near the surface until night time is a response to predation pressure. At night it is harder for the fish to see them than it is during the day time at the surface.

Raspberry Lake contains a much smaller variety of phytoplankton than Long Lake. However in Raspberry also, the blue green algae Agmenellum (Merismopodium) and Anabaena are the most abundant. Navicula, Staurastrum Dinobryon and Asterionella were also present but not in large numbers.

Raspberry's zooplankters shows an even greater trend in their am and pm appearance than Long Lake's. During the day Holopedium gibberum and Ploesoma are present in the largest numbers. Keratella, Nauplius, Daphnia, and Cyclops are also present but in very small numbers. At night it turns out that Ploesoma and Keratella are the most abundant, but in numbers much greater than those during the day. Daphnia, Vernalis Cyclops, Nauplius, Diaptomus, and Bosmina all also appear in much larger numbers during the night. Holopedium Giberum appears at about the same rate during the day as at night. Holopodium Giberum is found only in waters with very low calcium levels, which Raspberry does have. Once again the larger number of zooplankters at night as compared to the day is due to the predation pressures of fish. The fish that are present in Raspberry Lake include large and small mouth bass and blue gills.