LEA Expanded Sampling Results for Moose Pond

December 8, 2014

Gloeotrichia algae sampling results

For the second year in a row, LEA has conducted *Gloeotrichia echinulata* sampling on Moose Pond with the help of the Moose Pond Association. Two sample sites were added in the North and South basins this year. *Gloeotrichia echinulata* has been linked to water quality problems in low-nutrient, pristine waterbodies, and its prevalence has been increasing in this region. Below is a report on LEA's *Gloeotrichia* findings for Moose Pond.

Gloeotrichia background information:

Gloeotrichia echinulata levels in Maine lakes are generally low, but appear to be increasing over time. These cyanobacteria are cause for concern because they can cause blooms in low nutrient lakes and may be an indicator of declining water quality. In Maine, Long Pond, Great Pond and Auburn Lake have been reported to contain large average densities of *G. echinulata* in the summer months, with blooms on Long Pond of 250 colonies per liter. In general, however, colony densities on lakes sampled in Maine are less than 5 colonies per liter.

Six lakes in the western Maine Lakes Region were sampled roughly every two weeks throughout the summer of 2014. These six lakes were chosen because they contained the highest levels of *Gloeotrichia* out of the fifteen lakes originally sampled in 2013. Eighteen additional lakes were sampled once during the anticipated peak in *Gloeotrichia* abundance in late July/early August 2014. The largest density found was 72.4 colonies per liter in Keoka Lake. This level caused a visible bloom within the water column of the lake. Densities as low as 1 colony per liter are able to be seen due to the relatively large size of *G. echinulata* (about 1-3 mm). The peak in colony density occurred in early August at most of the sample sites.

Colonies of *Gloeotrichia echinulata* under magnification

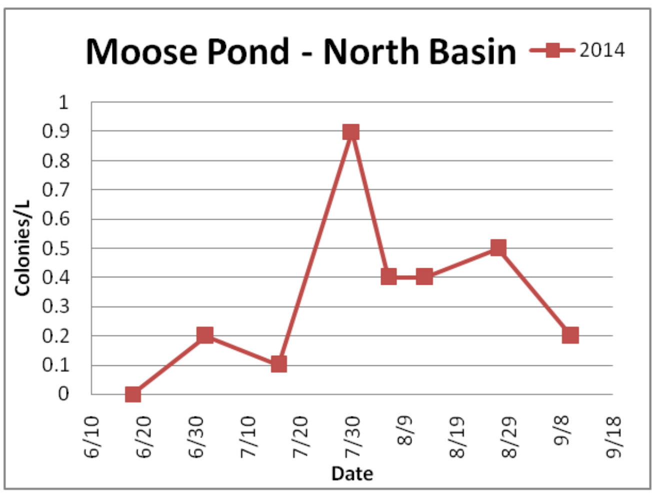
Moose Pond *Gloeotrichia* results:

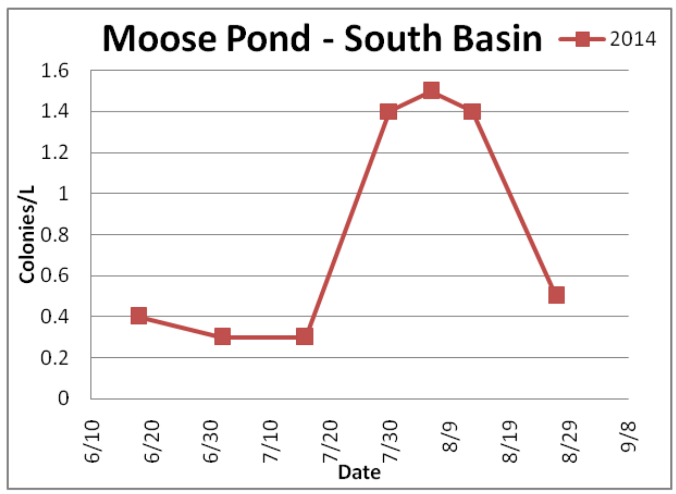
Three sites were sampled for *Gloeotrichia* on Moose Pond in 2014 (figures 1-3). These sites were located on the eastern shore in the north basin, the western shore in the middle basin, and the eastern shore in the southern basin. While the middle basin was sampled in 2013, the north and south basin sampling locations were added in 2014. A total of 23 samples were collected from these sites between June and September 2014. The north and south basins had low levels of the algae, with a maximum of

0.9 colonies per liter in the north and 1.5 colonies per liter in the south basin. In the middle basin, the maximum was 16.2 colonies per liter, nearly identical to the 16.6 colony per liter peak at this site in 2013 (table 1). The date of this peak was also nearly the same in both years, occurring within the first week of August. The middle basin *Gloeotrichia* peak came after 2 weeks of sustained higher temperatures, which likely triggered the algae growth (figure 4). The average level in the middle basin was 6.2 colonies per liter (up from an average of 4.1 colonies per liter in 2013). This site had the fourth highest peak and average *Gloeotrichia* levels of the 24 lakes sampled (figures 5 and 6). The north basin average was 0.3 and the south basin average was 0.8 colonies per liter.

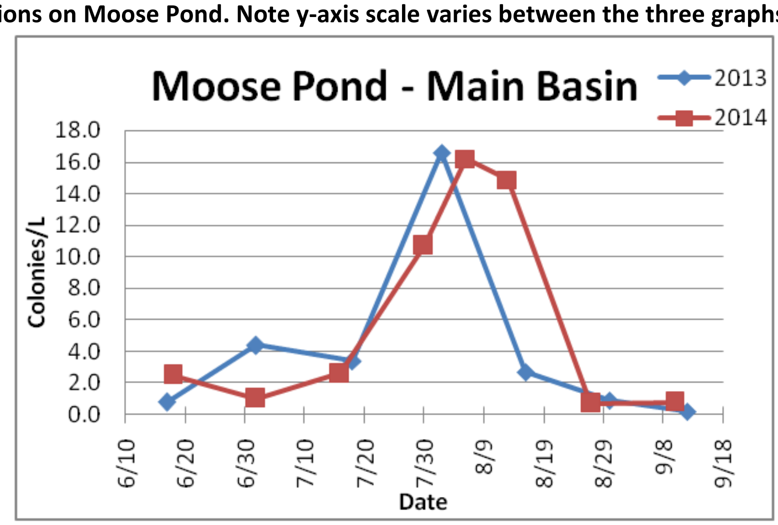
Plankton report: All basins tended to have a large amount of rotifers (asplanchna, conochilus, keratella). Zooplankton were not usually present in large numbers, especially early in the season; though samples often contained some copepods, nauplii, *Holopedium* and bosminidae. Ceratium (a type of dinoflagellate) were seen often. (See the glossary at the end of this report for more details on plankton).

Conclusion: *Gloeotrichia* levels were much higher in the middle basin than in the north or south basin, which suggests that the middle basin is the source of the *Gloeotrichia* on this lake, or that it is the only part of the lake with suitable conditions for growth. More monitoring is needed to determine if *Gloeotrichia* levels are being temperature, light, or nutrient limited, as suggested by the stable peak level of approximately 16 colonies per liter. Moose Pond is a monitoring priority for 2015.





Figures 1-3 Individual comparisons of 2013 and 2014 abundance of *Gloeotrichia echinulata* colonies at 3 sampling locations on Moose Pond. Note y-axis scale varies between the three graphs.



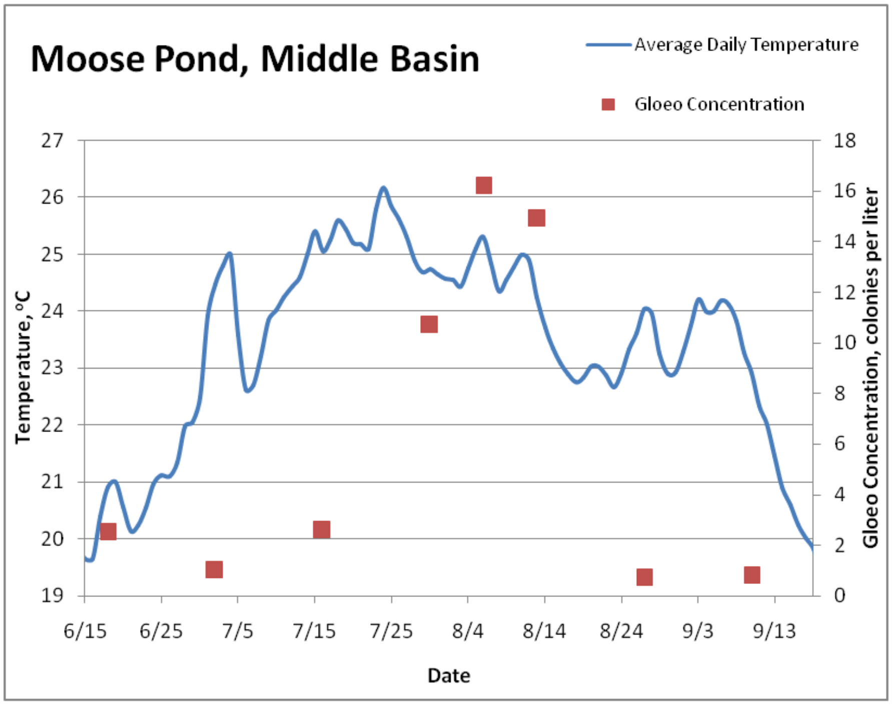


Figure 4: Comparison of ***Gloeotrichia echinulata*** abundance (red dots) and average daily in-lake temperature (blue line) over the summer of 2014. Higher temperatures are thought to trigger ***Gloeotrichia*** growth.

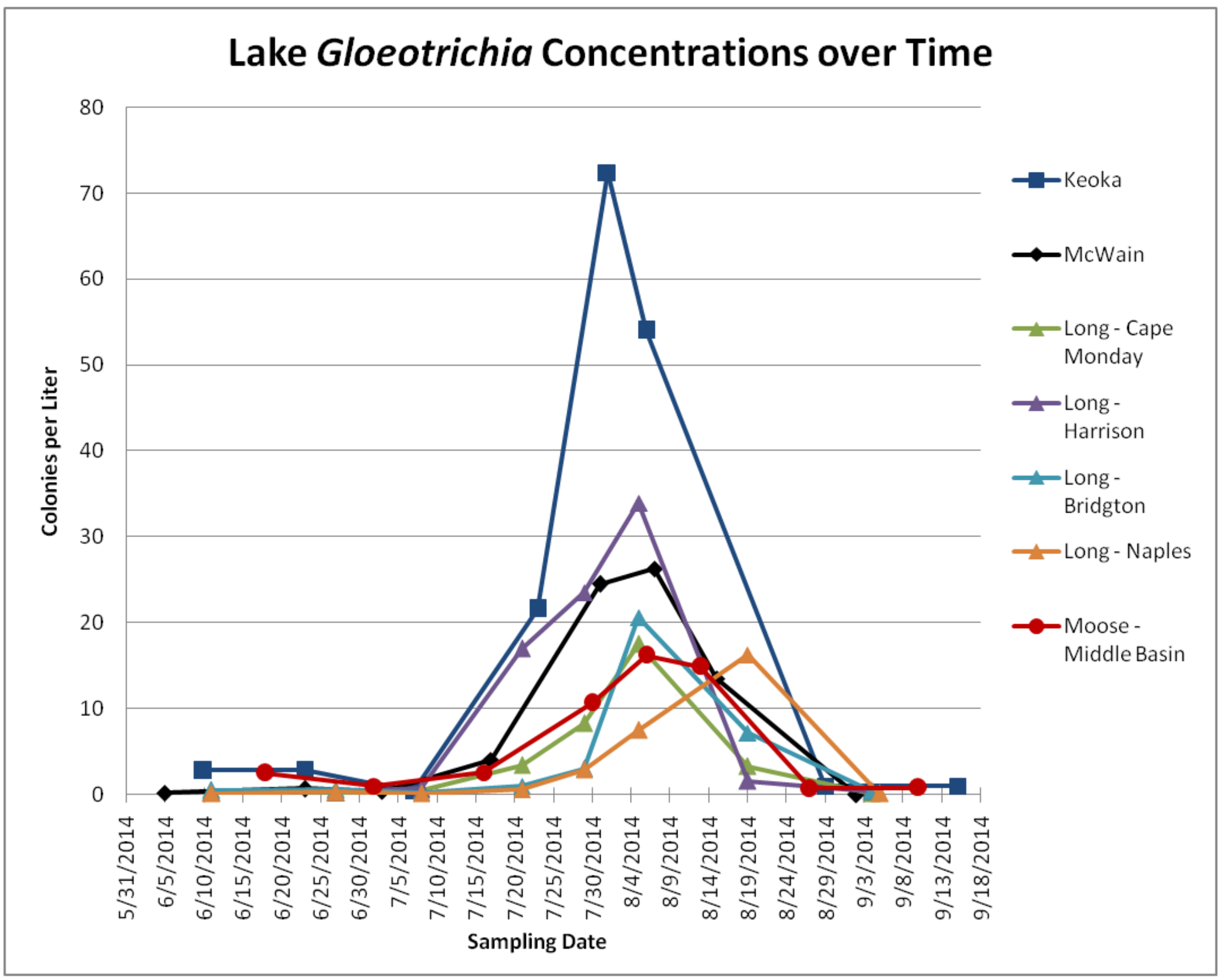


Figure 5: ***Gloeotrichia*** **concentrations over the sampling season in lakes with peak levels over 5 colonies per liter.**

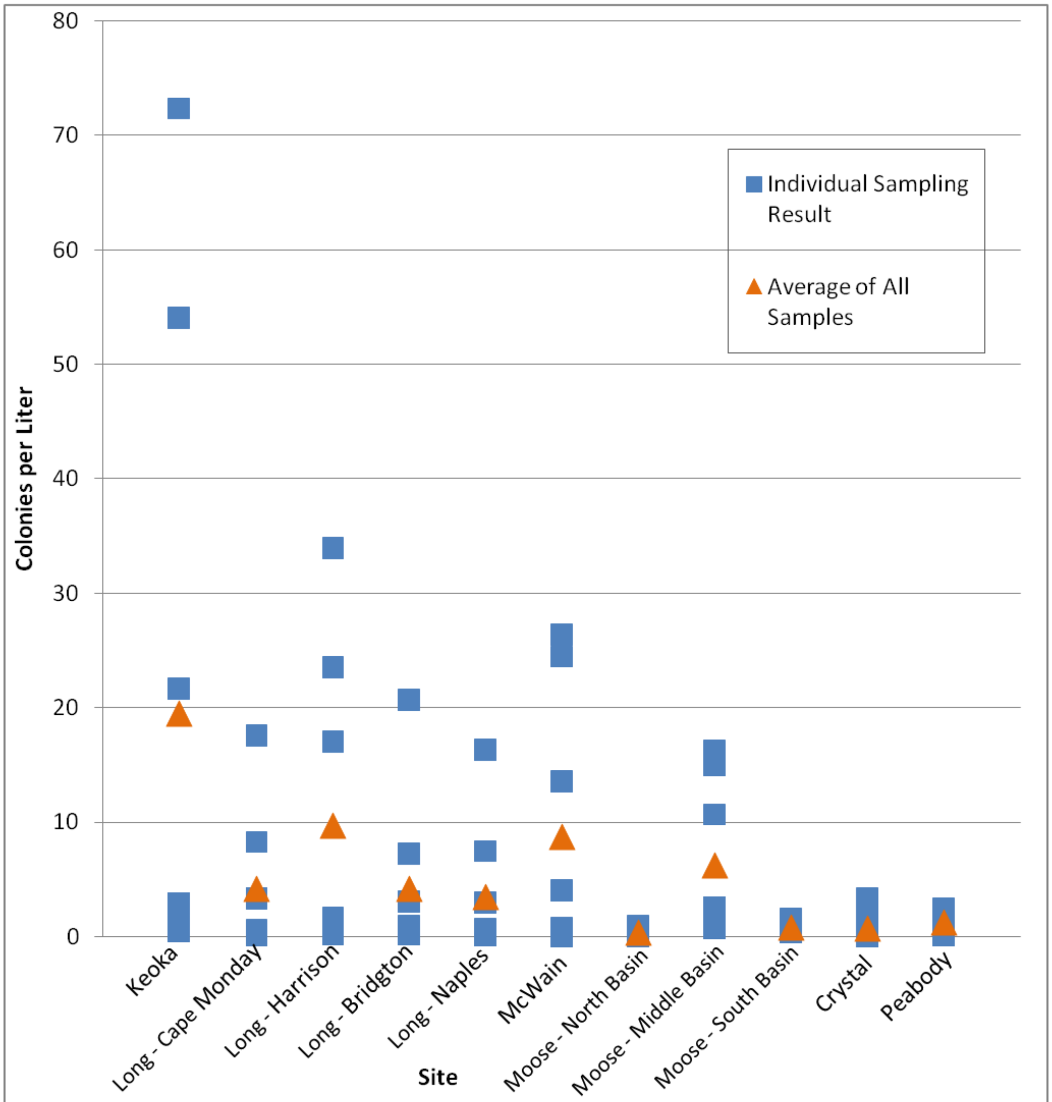


Figure 6: Concentrations of *Gloeotrichia* at each sample site during 2014 sampling. Blue squares indicate concentration on individual sampling dates, orange triangles represent the average of all samples.

Table 1: Comparison of peak Gloeo concentrations in 6 lakes with elevated Gloeo populations in 2013 and 2014.

Lake Name	Max. 2013 colonies/L	Max. 2014 colonies/L
Moose Pond (north basin)	Not tested	0.9
Moose Pond (middle basin)	16.6	16.2
Moose Pond (south basin)	Not tested	1.5
McWain Pond	9.4	26.3
Long Lake (site 3 – Bridgton)	8.0	20.6
Keoka Lake	6.1	72.4
Crystal Lake	2.5	3.3
Peabody Pond	1.9	2.4

Temperature monitoring results summary

LEA has recently begun using in-lake data loggers to acquire high resolution temperature measurements and began monitoring Moose Pond in 2013 with the help of the Moose Pond Association. We expanded testing to three basins in 2014. While we measure temperature using a field meter every two weeks in the summer during routine water testing, the new, relatively inexpensive sensors allow us to obtain important information that was previously out of reach because of the high cost of manual sampling. Using these small, digital data sensors to record temperature gives us both a more detailed and longer record of temperature fluctuations in the pond. This information will help us better understand the physical structure of the waterbody, water quality changes and the extent and impact of climate change in our region.

Background information:

Because of its role in physical, chemical, and biological processes, temperature is an important and informative lake measurement. In order to get a better idea of temperature patterns in and between lakes, LEA began monitoring lake temperature using in-lake digital data loggers in 2013. We have programmed the loggers, also known as HOBO sensors, to record temperature readings every 15 minutes. The data is stored on the sensors until we retrieve them in the mid to late fall. These measurements allow us to infer the effect of temperature on diverse lake characteristics such as stratification (lake layering), ecology, habitat, and nutrient loading. In addition, comparing temperature data over a number of years allows us to make observations about climate change in our region.

Thirteen sites at ten lakes (see box) were outfitted with a buoy apparatus, shown below. HOBO sensors were placed along the buoy line 2 meters apart from the bottom of the lake to the top. The buoys were placed at the deepest part of the lake or basin. Two additional ponds, Peabody and Stearns, contained shallow sensors at about 2 meters depth.

Buoy marking the temperature sensors

A HOBO temperature pendant data logger

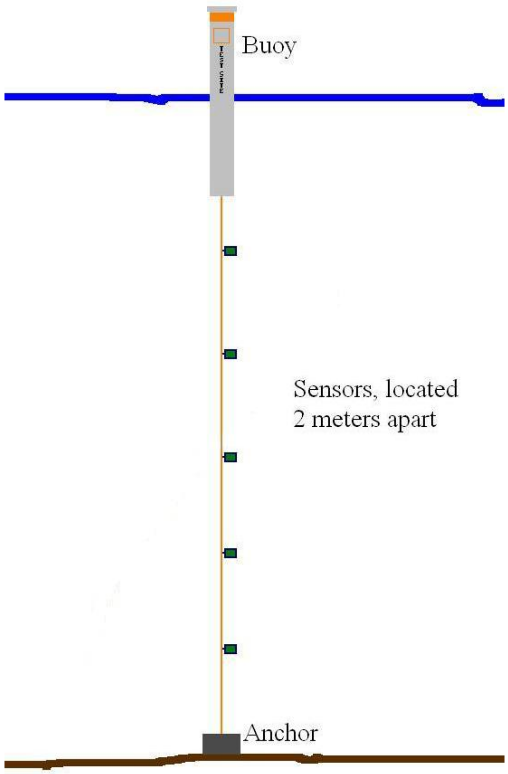


Diagram showing setup of temperature sensors attached to buoy.

Sites Containing Temperature Buoys:

- Long Lake – North & Middle Basins
- Moose Pond – North, Middle, and South Basins
- Sand Pond
- Trickey Pond
- Hancock Pond
- Island Pond
- Keoka Lake
- McWain Pond
- Woods Pond
- Back Pond

Moose Pond temperature overview:

The temperature on Moose Pond reached a maximum of 27.9 ^{o}C (82.2 ^{o}F) in the north basin on July 3rd and 18th, 27.0 ^{o}C (80.6 ^{o}F) in the middle basin on July 23rd, and 28.2 ^{o}C (82.8 ^{o}F) in the south basin on July 3rd (figures 7-9). The epilimnion, or top layer of water on the lake, was located between 0 and 5 meters for most of the summer in the middle and south basins, and between 0 and 3 meters in the north basin. The metalimnion, or middle layer, which is characterized by a large temperature change (known as the thermocline), was around 4 meters in the north basin, between 5 and 7 meters in the south basin, and between 5 and 9 meters in the middle basin. In each basin, the hypolimnion, or bottom layer, extended from the end of the metalimnion to the bottom of the lake. Stratification deepened in all basins in mid-September, signalling the beginning of fall turnover. Complete mixing (lake turnover) occurred in the north basin on September 12th, the middle basin on November 2nd, and in the south basin on October 22nd. As shown in figures 10 and 11, water testing data from the middle basin matched well with the data collected by the in-lake sensors. Figure 12 shows another view of how lake temperature and stratification changes over the period the sensors are deployed.

Deployment of temperature sensors and buoy in the spring

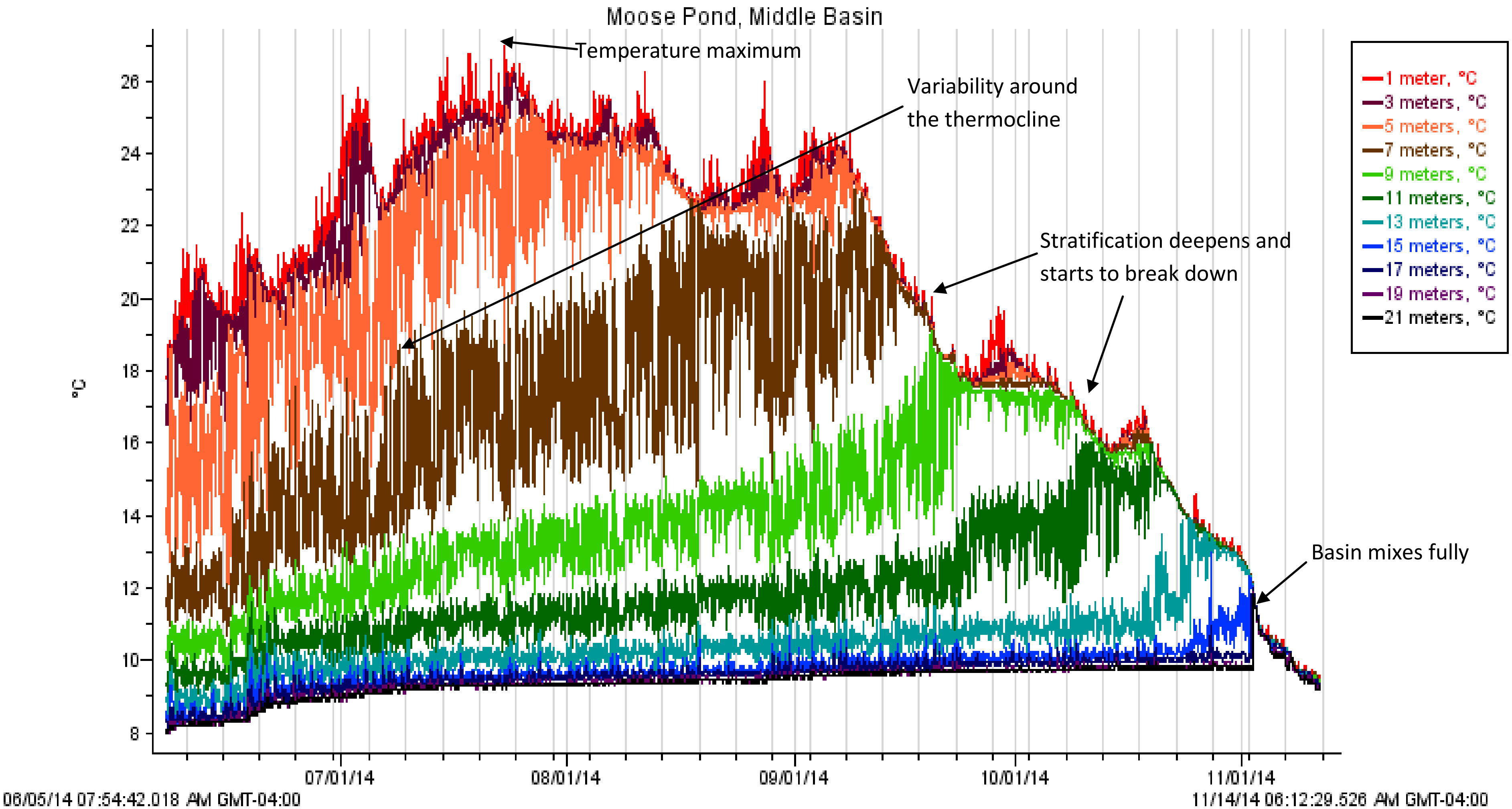


Figure 7: Graph of daily temperature readings in Moose Pond's middle basin from June 7th to November 11th, 2014. Note that 1 meter (red line) is just below the surface and that 21 meters is just off the bottom. When the temperature lines from different depths converge, it shows that the lake layering is breaking down and those depths are mixing with each other. This information is important because when deep water (which contains higher nutrient levels) mixes into the sunlit upper waters, algae populations can flourish. This basin did not fully mix until the beginning of November.

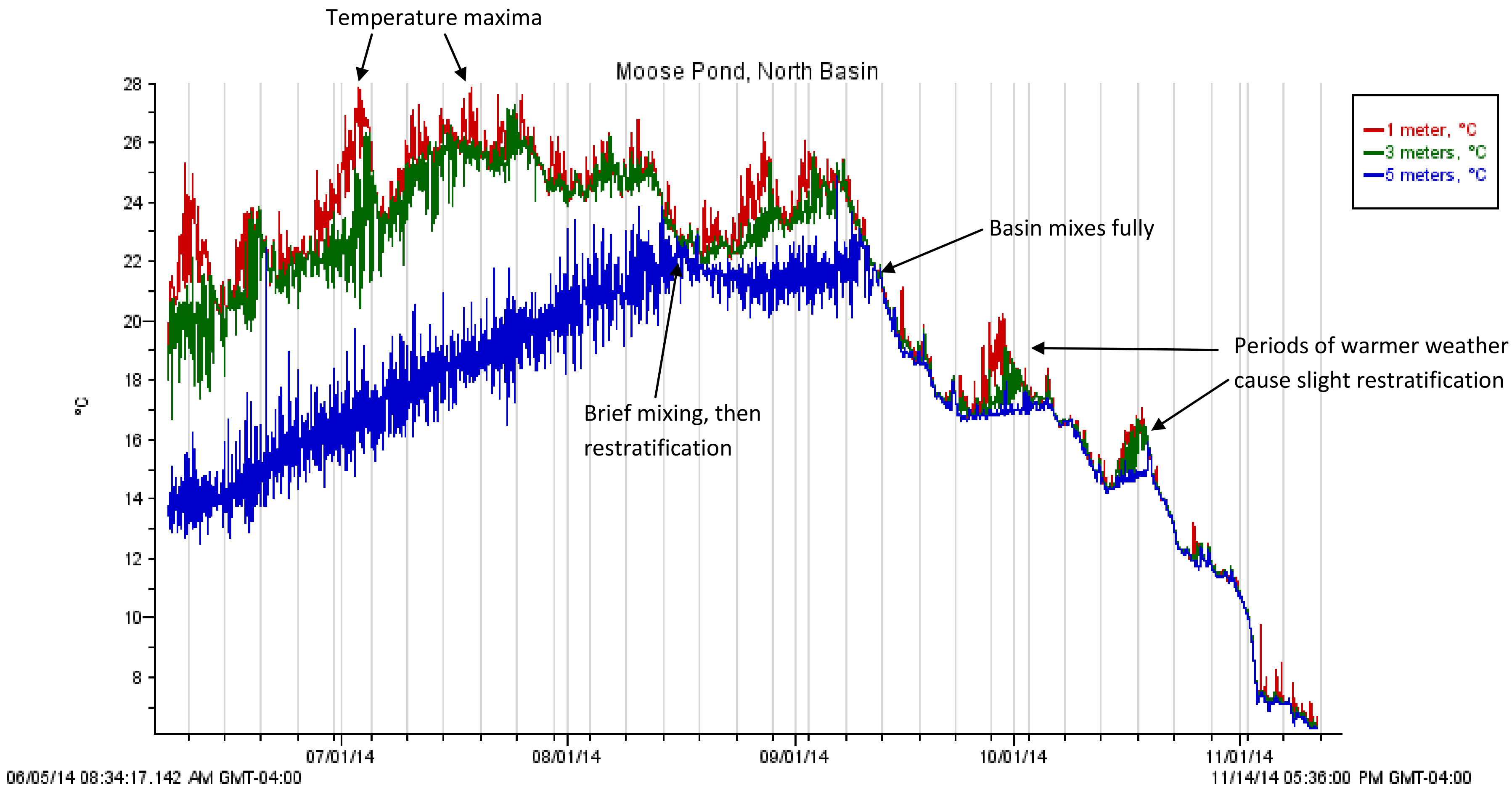


Figure 8: Graph of daily temperature readings in Moose Pond's north basin from June 7th to November 11th, 2014. Note that 1 meter (red line) is just below the surface and that 5 meters is just off the bottom. When the temperature lines from different depths converge, it shows that the lake layering is breaking down and those depths are mixing with each other. This information is important because when deep water (which contains higher nutrient levels) mixes into the sunlit upper waters, algae populations can flourish. This basin is very shallow, so it mixed the earliest, in mid-September.

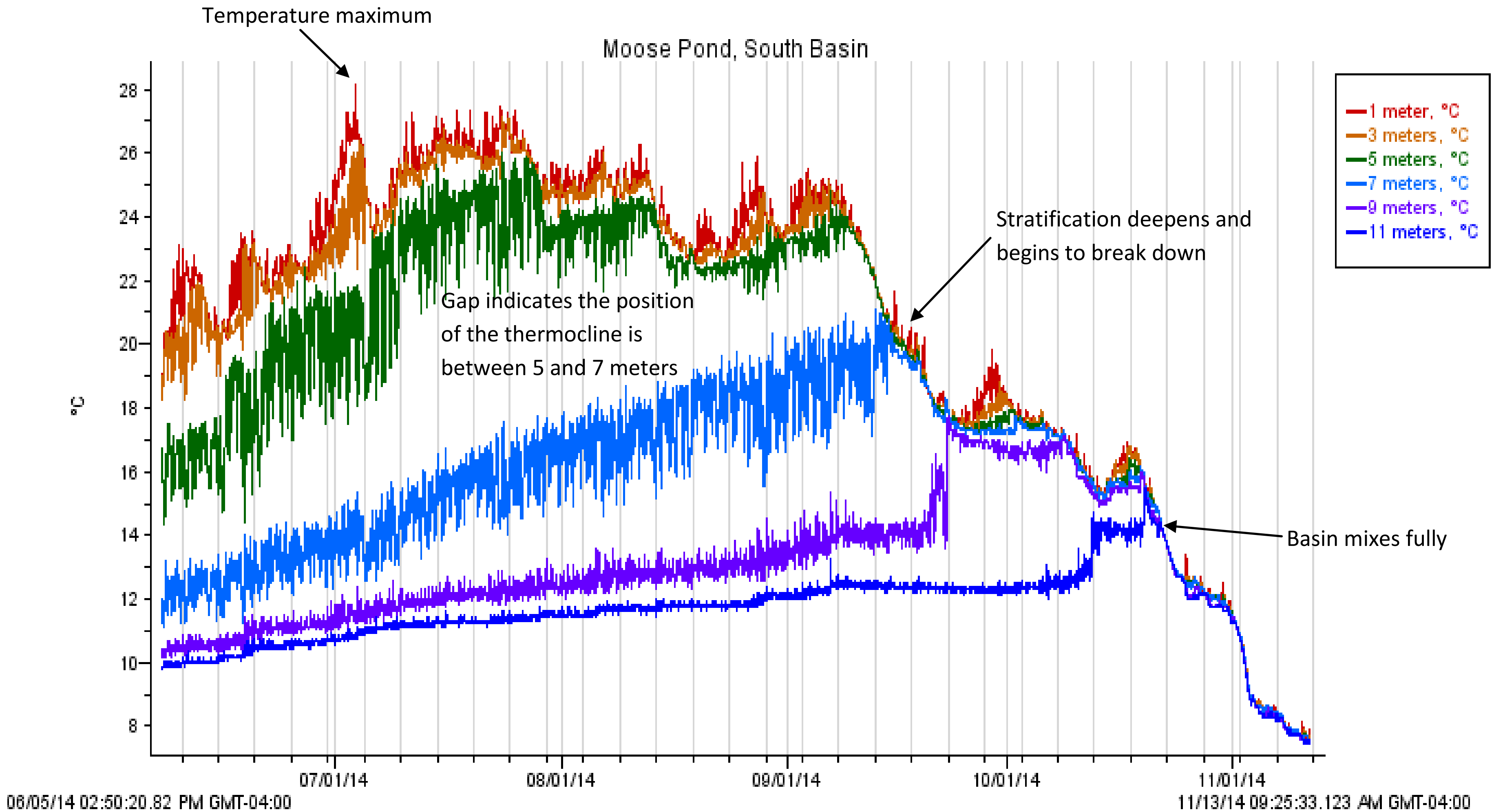


Figure 9: Graph of daily temperature readings in Moose Pond's south basin from June 7th to November 11th, 2014. Note that 1 meter (red line) is just below the surface and that 11 meters is just off the bottom. When the temperature lines from different depths converge, it shows that the lake layering is breaking down and those depths are mixing with each other. This information is important because when deep water (which contains higher nutrient levels) mixes into the sunlit upper waters, algae populations can flourish. This basin mixed completely on October 22nd.

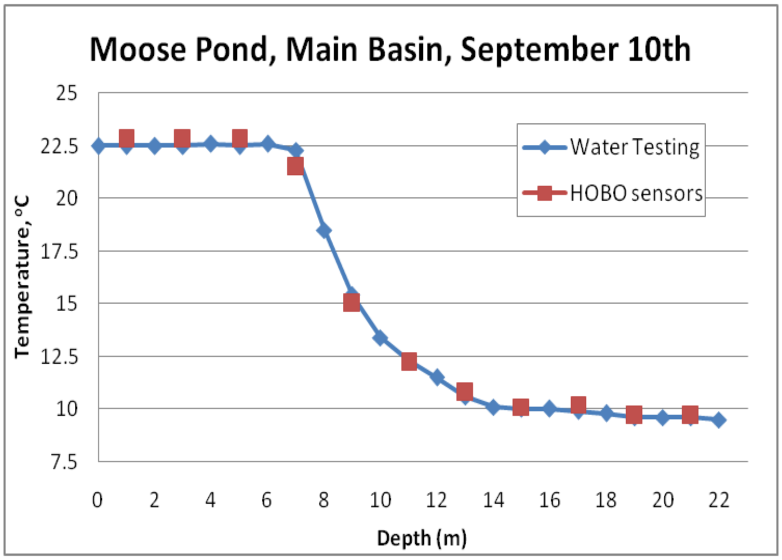


Figure 10: Graph comparing traditional water testing temperature data (using a YSI handheld field meter) and HOBO sensor data from Moose Pond's main basin on September 10th at 9:30 am. The red squares showing the sensor data match well with the water testing data (shown by the blue line). Slight differences are expected due to sensor calibration and range of tolerance. In the past, LEA was only able to take 8 temperature profiles like this per season. Because of these new in-lake loggers, we are now able to compare close to 12,000 of these profiles a year.

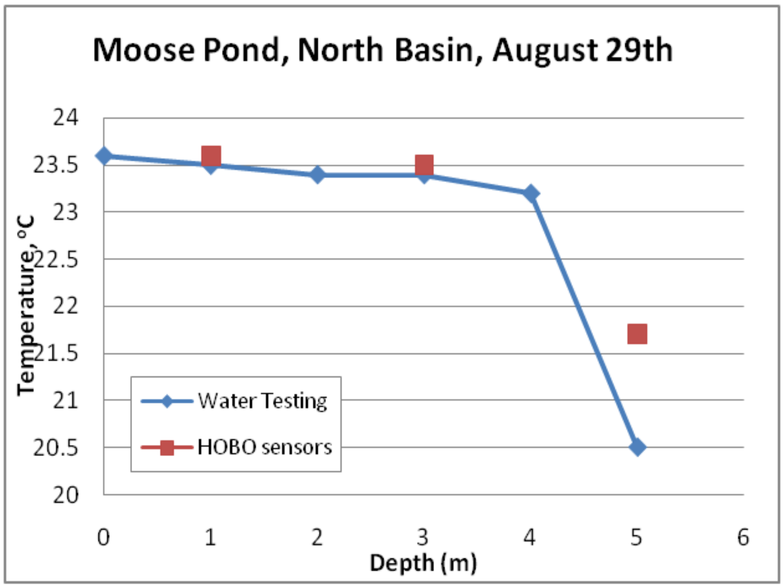


Figure 11: Graph comparing traditional water testing temperature data (using a YSI handheld field meter) and HOBO sensor data from Moose Pond's north basin on August 29th at 10:00 am. The red squares showing the sensor data match well with the water testing data (shown by the blue line) at 1 and 3 meters, but the temperature differs by over 1 degree at 5 meters. This difference could be attributable to variability around the thermocline.

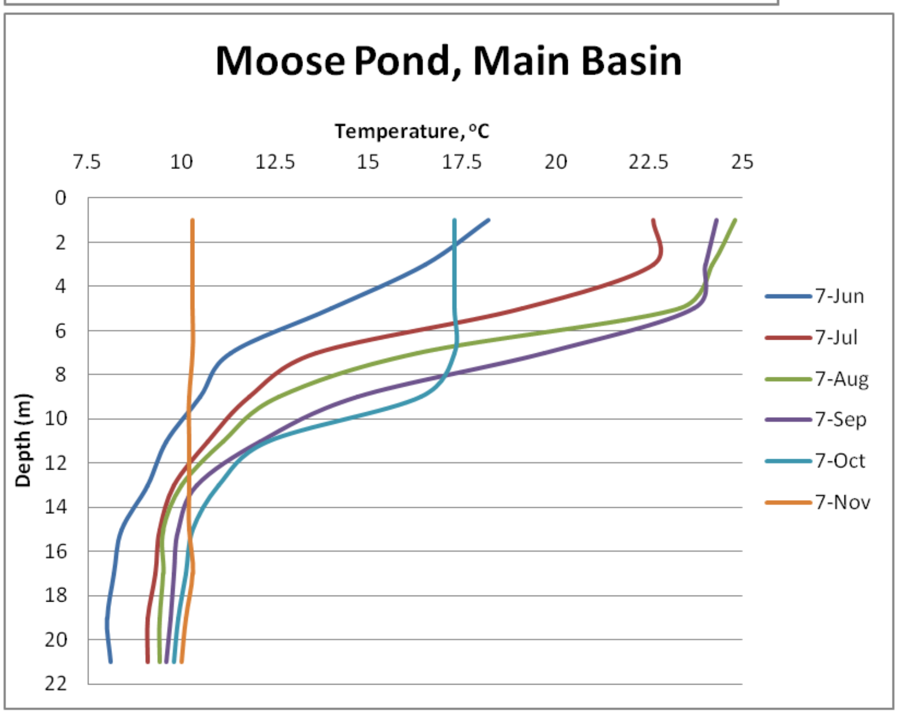
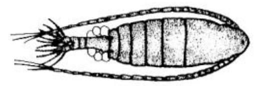
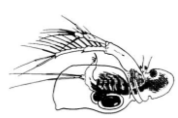


Figure 12: Temperature profiles in Moose Pond's main basin from each month the in-lake sensors were deployed. Note that the surface of the lake is at the top of the graph. Moose Pond was well stratified In July, August, and September. The weakening of stratification is evident in October, as surface temperature was much lower. Compete mixing is shown by the uniform November profile.

Gloeotrichia Report Glossary

- Anabaena – A species of algae which, like *Gloeotrichia*, is also a type of cyanobacteria.
- Bosminidae – A relatively small type of zooplankton. 
- Ceratium – A type of phytoplankton (algae). 
- Copepod – A common type of zooplankton in low-nutrient lakes. 
- Cyanobacteria – A category of algae containing over 1,000 species; commonly found in high nutrient lakes.
- *Daphnia* – A very common type of filter-feeding zooplankton; also known as water fleas.

- *Gloeotrichia echinulata* – Also known as Gloeotrichia or Gloeo. A species of algae linked to water quality decline.
- *Holopedium* – A genus of large zooplankton. 
- *Leptodora* – A type of very large zooplankton. 
- Nauplii – Baby copepods (larval stage). 
- Phytoplankton – plant-based plankton, otherwise known as algae. There are a number of sub-types.
- *Polyphemus* – A type of zooplankton. 
- Rotifer – A type of zooplankton common in all lakes. They can be single (such as keratella) or exist in colonies (such as conochilus). 
- Sididae – a type of zooplankton similar to *Daphnia*. 
- Zooplankton – Tiny, free-floating animals that live in the water and eat algae or other plankton.