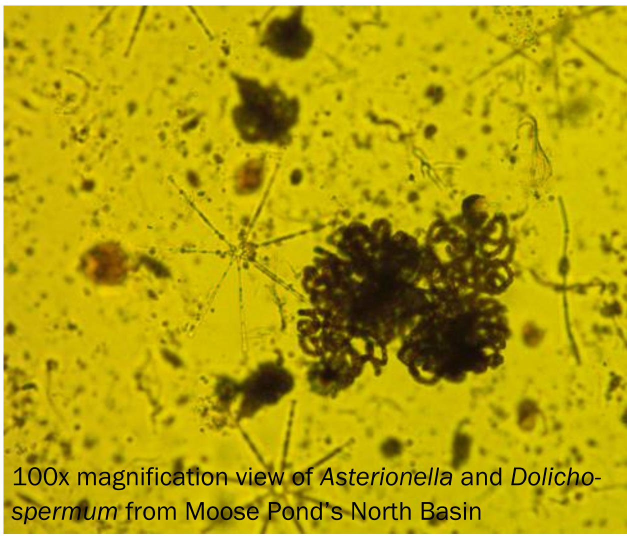
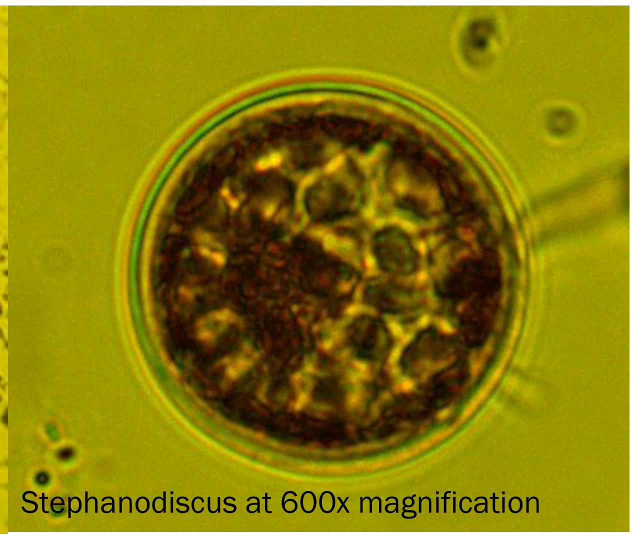
Lakes Environmental Association
2017 Water Testing Report

Chapter 5—Algae Monitoring



100x magnification view of *Asterionella* and *Dolicho-spermum* from Moose Pond's North Basin



Stephanodiscus at 600x magnification

LEA's Algae Monitoring Program

Sample Sites
Back Pond
Hancock Pond
Keoka Lake
McWain Pond
Middle Pond
Moose Pond (Main Basin)
Moose Pond (North Basin)
Moose Pond (South Basin)
Peabody Pond
Sand Pond
Trickey Pond
Woods Pond

Studies of algae populations are a good way for lake managers to glean information about lakes: their nutrient levels, stratification, and a host of complex details are all made more clear through the study of phytoplankton (the technical term for free-floating algae). Algae are the foundation of lake food webs, meaning that they are the food source that directly or indirectly supports much of the animal life existing in a lake. Of course, algae are also the source of algal blooms, which usually result from an over-abundance of nutrients and can cause a host of problems within a lake system. Algal blooms are often a sign of a water quality issue, and are generally bad for people (impacting recreation, fishing, and aesthetics) and for the lakes themselves.

The goal of LEA's algae testing program is to identify the kinds of algae present in our lakes, quantify them, and study how they change over time. The focus is on planktonic algae, which are free-floating in the water, rather than attached to rocks or other material. In 2017, algae samples were collected from twelve lakes once per month for five months (May—September). Samples consisted of lake water from the top layer (ranging from 3-10 meters deep) of the water column. The depth of the sample differed depending on the location of the thermocline in each lake. Collection and analysis of algae samples was made possible by support from local lake associations.

Samples were preserved using Lugol's Iodine at the time of collection. Samples were settled within 3 weeks of collection using an Utermöhl chamber, which consists of a 100 mL tube set over a modified microscope slide. Slides were examined with an inverted microscope at 600x total magnification. Algae were identified to genus level (the level above species) where possible. Random fields were counted until a total of 400 natural algae units was reached. The number of cells per milliliter (cells/mL) was calculated for each sample.

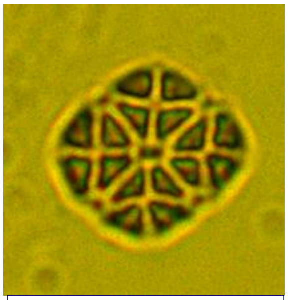
Algae are incredibly diverse, but in general 5-6 algae species will make up about 90% of the biomass in a lake at any given time. The dominant algae change over the course of the summer due to several factors including temperature, nutrient levels, and predation by zooplankton. Samples are taken on a monthly basis to monitor how populations shift throughout the summer.

One important water quality indicator that we can determine through collecting algae samples is the amount of cyanobacteria in a lake. Cyanobacteria are not technically algae, but rather photosynthetic bacteria. Nevertheless, they are treated as a type of algae because they have many of the same characteristics. High levels of cyanobacteria are often correlated with high phosphorus levels, and cyanobacteria such as *Aphanizomenon*, *Dolichospermum* (formerly *Anabaena*), and *Microcystis* are the most common causes of harmful cyanobacterial blooms that can be toxic to both people and animals. Cyanobacteria tend to be most common in the later part of the summer, when temperatures are warmest. Colonial cyanobacterial genera such as *Aphanocapsa*, *Aphanothece,* and *Merismopedia* are common in low-nutrient lakes such as those in the Lakes Region and do not contribute to toxic blooms, although they do contribute to relatively high cell counts in some lakes.

It is important to note that although LEA continues to measure chlorophyll-a concentrations in water as a proxy for algae abundance, lab-based chlorophyll-a measurements are not comparable to cells/mL concentrations found in these summaries because of differences in the amount of chlorophyll-a in algae cells of varying types and conditions.

The Difference Between Natural Units and Cell Counts

The summaries on the following pages discuss results in terms of both natural units and cell counts. One natural unit can be one cell or one colony. Natural units treat all algae equally, no matter how many cells they are made up of. Cell counts are simply a count of all cells. A single-celled algae would be counted as one natural unit and one cell, whereas a colony of cells will be counted as one natural unit and, say, 16 cells (or however many cells are present within the colony). There are several cyanobacterial genera that are large colonies made up of many tiny cells, or long, filamentous chains of cells. Because of this, cyanobacteria dominate cell counts in many algae samples. Colonial cyanobacteria such as *Aphanocapsa* and *Aphanothece* are common in our lakes and can lead to high cell counts, but because they are colonies of picoplankton (tiny cells around 1 µm wide), they contribute little biomass to the algae assemblage and do not often cause water quality issues.



This *Crucigenia* would be counted as one natural unit made up of 16 cells.

Natural units give a clearer picture of which algae are present, regardless of whether they are colonies or individual cells. Most samples were dominated by flagellated algae, which are single-celled algae with a "tail" called a flagella that they use to swim. Their populations are better represented when looking at natural unit counts, since they are single-celled. Cell counts allow for a better understanding of colonial algae presence and are necessary to calculate cells/mL accurately, which allows for better comparisons of results between lakes and over time. Colonies, even of the same genera, often vary greatly in the number of cells they contain – one natural unit of *Dinobryon* could be two cells or one hundred, and knowing this information is important in lake assessment.

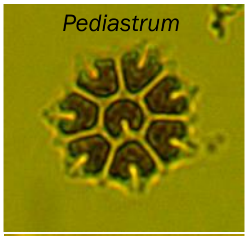
Why we Monitor Algae

One reason for the algae testing program is to collect baseline data. Baseline sampling is important because it provides a record of conditions to which future data can be compared. This data will help in assessing changes over time and determining what a typical algae population looks like in each lake. Because these lakes currently have good water quality, knowing which algae are present, and in what concentrations, is especially important. Any water quality changes in the future will be easier to assess if current water quality conditions are understood.

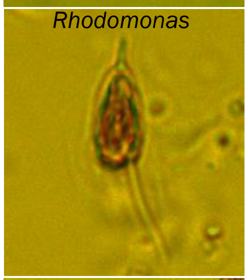
The other reason for algae sampling is to gain more information about water quality. Certain types of algae are only present when specific water quality conditions exist, which makes them good environmental indicators. For example, algae such as *Dolichospermum* and *Aphanizomenon*, two cyanobacterial genera which form algae blooms, are good indicators of eutrophication. Additionally, the dominant algae in a sample can be very informative, since different algae will dominate under varying water quality conditions. Collecting samples at different times throughout the summer enables us to record which algae are present under different conditions for a more complete account of each lake's algae population.

The 6 Main Types of Algae

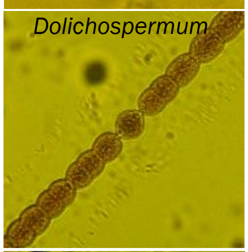
Note: Algae appear brown with a yellow background in photos because they are preserved with iodine.


Pediastrum

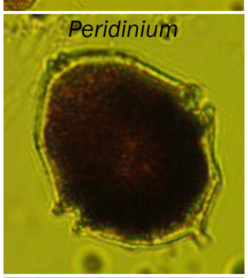
Green algae (Chlorophyta) are the most diverse group of algae present in freshwater habitats. They come in a variety of sizes and shapes: round or filamentous, single-celled or colonial, and flagellated or unflagellated. Green algae can be identified by their deep green grassy color and rigid cell walls.


Rhodomonas

Cryptomonads (Cryptophyta) are one-celled algae with two flagella (tails) that allow them to move through water. In this report, Haptophytes (of which only the genus *Chrysochromulina* was identified) and Euglenoids (rare in samples) are counted among the cryptomonads.


Dolichospermum

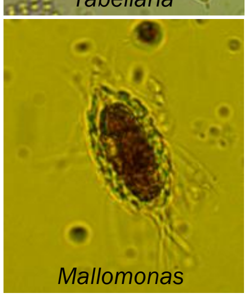
Cyanobacteria (Cyanophyta/blue-green algae) are not algae but prokaryotic bacteria that can photosynthesize. Most forms are colonial, and are usually either round or filamentous. While Cyanobacteria are present in all waters and many of them are harmless, there are several species that can produce toxins and will form blooms when nutrient levels are high.


Peridinium

Dinoflagellates (Dinophyta) are a group made up of large, motile algae. Large numbers of Dinoflagellates indicate high nitrate and phosphate levels. Most Dinoflagellates are covered in armor-like plates that serve as a protective shell.


Tabellaria

Diatoms (Bacillariophyta) are easily identified by their hard silica-based outer shells. Diatoms are either centric (round) or pennate (long, thin rectangles or canoe-like shapes). Because their shells make them heavy, diatoms often settle out of the water column during the calm summer months. Most diatoms are single-celled, but a few of the common genera are colonial.

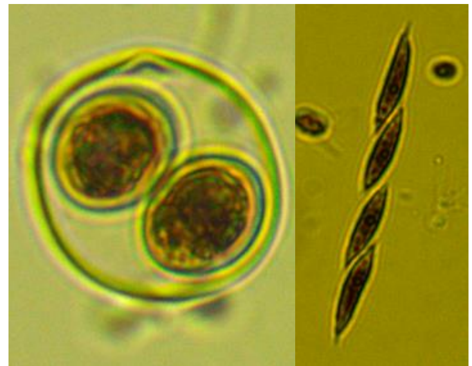

Mallomonas

Golden algae (Chrysophyta) are common in lakes with low to moderate nutrient levels, low conductivity and alkalinity, moderate color and slightly acidic pH. Golden algae can be identified by their brown to yellow color and the delicate nature of their cells. They are often colonial and a few of the common genera are relatively large in size.

Images are not to scale

Back Pond

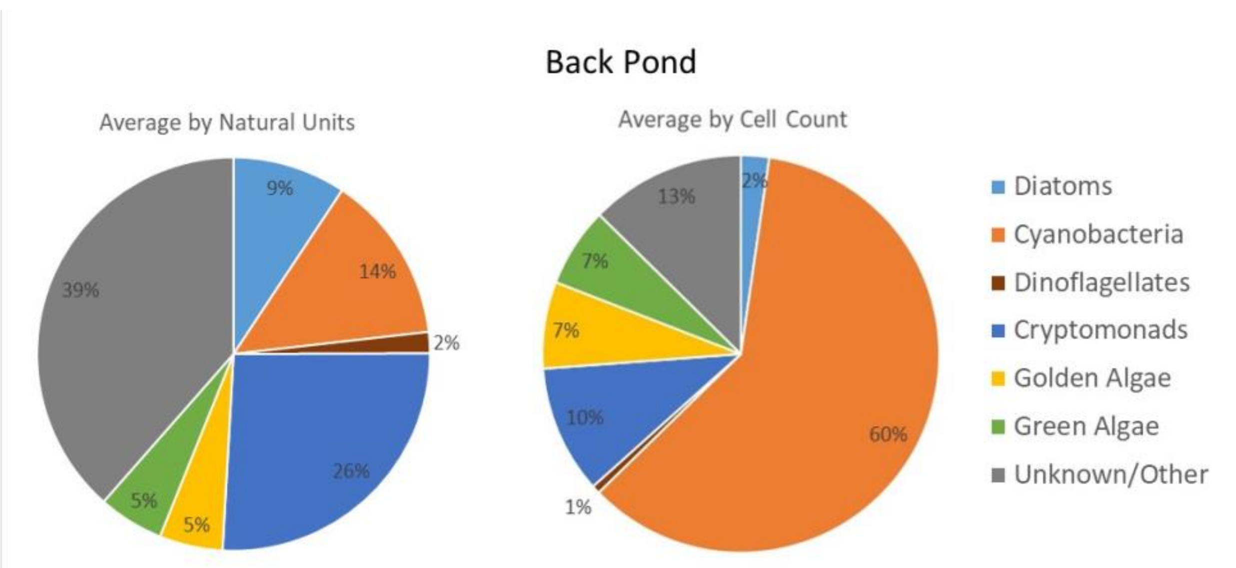
Algae samples were collected from Back Pond once per month from May through September, 2017. Cell counts started off low in May and peaked in July. Some of the most common genera seen in the samples were *Stephanodiscus* (diatom, photo on title page, right), *Aphanocapsa* (cyanobacteria), *Dinobryon* (golden), *Chrysochromulina* and *Rhodomonas* (cryptomonads, see photo on page 4).



The green algae *Oocystis* (left) and *Elakatothrix* (right).

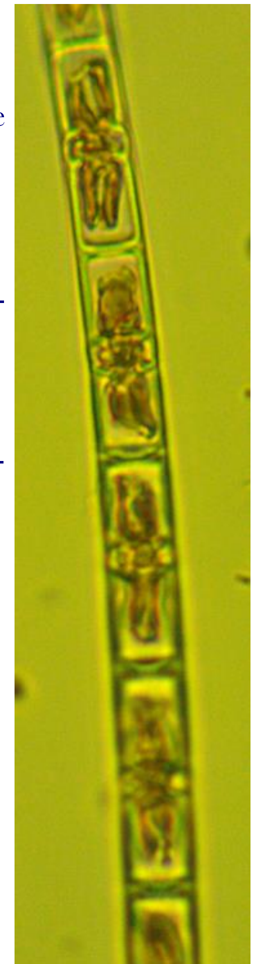
In the pie charts below, most of the "unknown/other" category are tiny flagellated algae of various types. Cryptomonads are also flagellates, so flagellates make up the majority of the algae assemblage based on natural units. Flagellates, which are single-celled algae with "tails" (flagella) that help them swim, constitute a good basis for the pond's food web because they are a high quality food source for zooplankton, the tiny crustaceans that eat algae and are eaten by larger aquatic organisms.

The algae present in Back Pond are broadly characteristic of a mesotrophic system, indicating a moderate level of productivity. While the level of cyanobacteria was relatively high, especially in the cell counts, there were no nuisance species recorded beyond a small amount of *Dolichospemum, Microcystis* and *Trichodesmium.* The majority of the cyanobacteria were colonies of tiny cells in the genus *Aphanocapsa. Aphanocapsa* is actually an indicator of low nutrient levels in lakes. The large number of cells in these colonies adds a lot to the cell count calculation, but they do not contribute much to the biomass of algae in the pond because their cells are so small.



images are not to scale

Hancock Pond

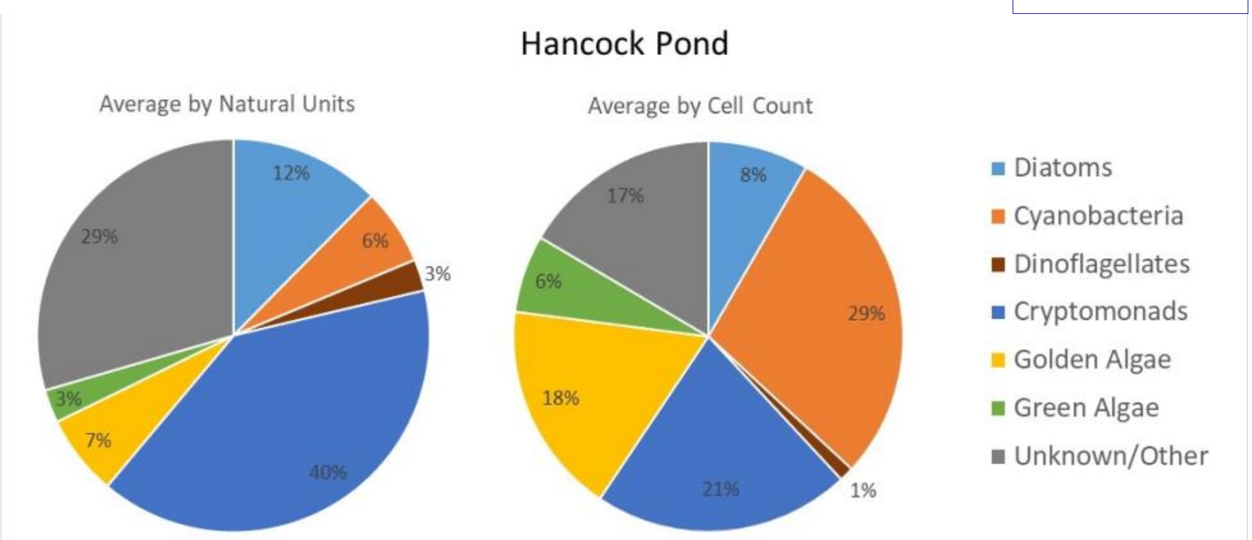


The chain diatom *Aulacoseira.*

Samples were collected from Hancock Pond once per month between May and September, 2017. Cell counts remained low throughout the testing season and peaked in August. Hancock Pond contained the largest average percentage (by cell count) of diatoms, cryptomonads, and golden algae of all the lakes tested, and the lowest amount of cyanobacteria based on cell counts. Small flagellated algae (which often belong to different algal groups) were also common in the samples collected, and constitute the majority of the "unknown/other" category in the pie charts below.

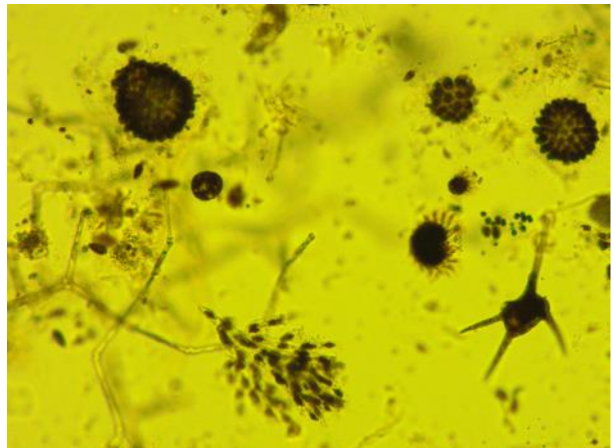
Hancock Pond was the only pond tested that had none of the common cyanobacteria *Merismopedia* both in 2016 and 2017. The only cyanobacteria of concern noted were two natural units of *Dolichospermum*, both containing few cells. The most common cyanobacteria found in Hancock Pond were *Aphanocapsa* and *Chroococcus*.

The algae assemblage found at Hancock Pond was indicative of a deep, clear lake with low to moderate productivity. Relatively large amounts of golden algae and flagellates, as well as genera like *Aphanocapsa*, are typical of northern temperate lakes. Additionally, flagellates are a good-quality food for zooplankton and indicate a healthy basis for the lake's food web.



Keoka Lake

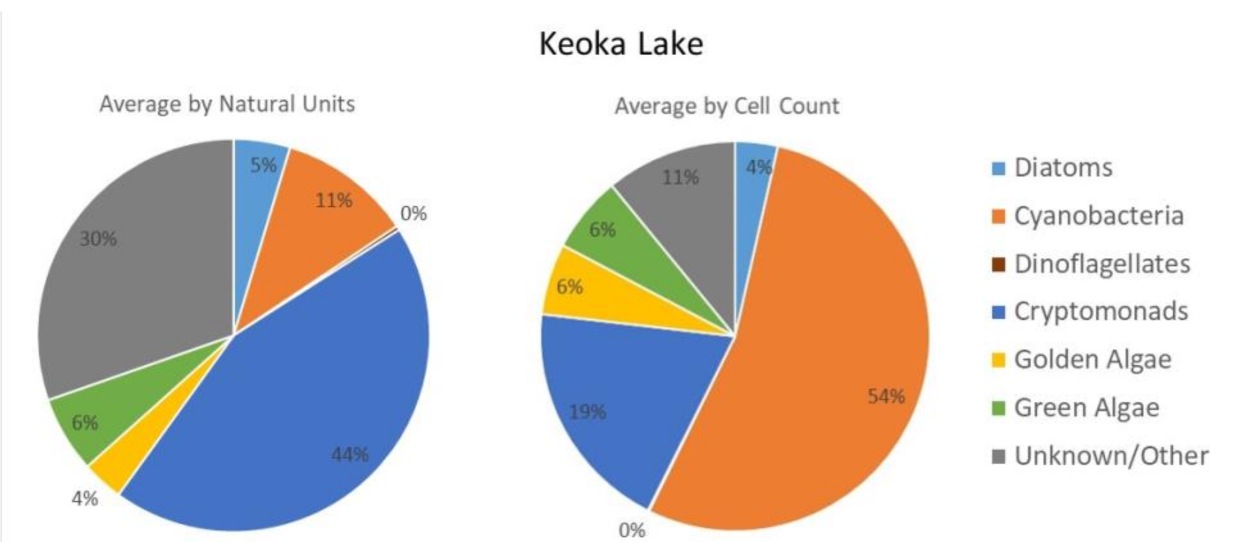
Keoka Lake was sampled for algae once per month between May and September, 2017. Cell counts were highest in July, and overall algae levels were moderate compared to other lakes.



A view of Keoka Lake algae at 100x magnification, containing algae from several groups: *Tabellaria, Dinobryon, Chrysosphaerella, Ceratium,* and *Cryptomonas*.

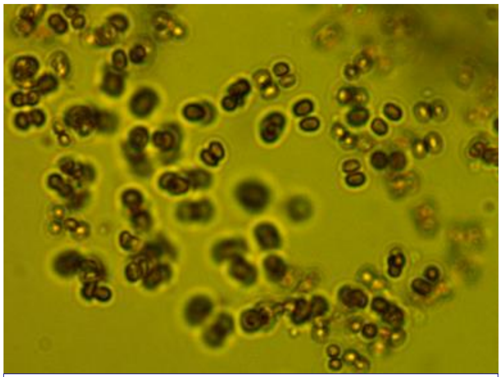
Cryptomonads were the most common algae in Keoka Lake based on natural units. Keoka Lake also had the highest percentage of this type of algae compared to the rest of the lakes and ponds sampled (in terms of natural unit percentage). Cryptomonads are flagellated algae (single-celled, with flagella, or "tails") that include *Cryptomonas, Rhodomonas,* and *Chrysochromulina*. Many of the "unknown/other" algae category in the pie charts below are also flagellates of various types. These algae make an excellent basis for the lake food web that support all of the larger creatures that live in and on the lake.

The cyanobacteria present in Keoka Lake were mainly *Aphanocapsa*, a colonial genus made up of many tiny cells. This means that cell counts were high, but the overall biomass of the algae assemblage as a whole remained low because *Aphanocapsa* cells are very small. Cyanobacteria such as *Aphanocapsa,* when common in a lake, actually indicate low productivity. Two nuisance cyanobacteria were noted in Keoka Lake: *Gloeotrichia* and *Dolichospermum*. *Gloeotrichia* is also a sign of low nutrient status (see report in chapter 3), and the amount of *Dolichospermum* seen was small and not of concern at this time.



McWain Pond

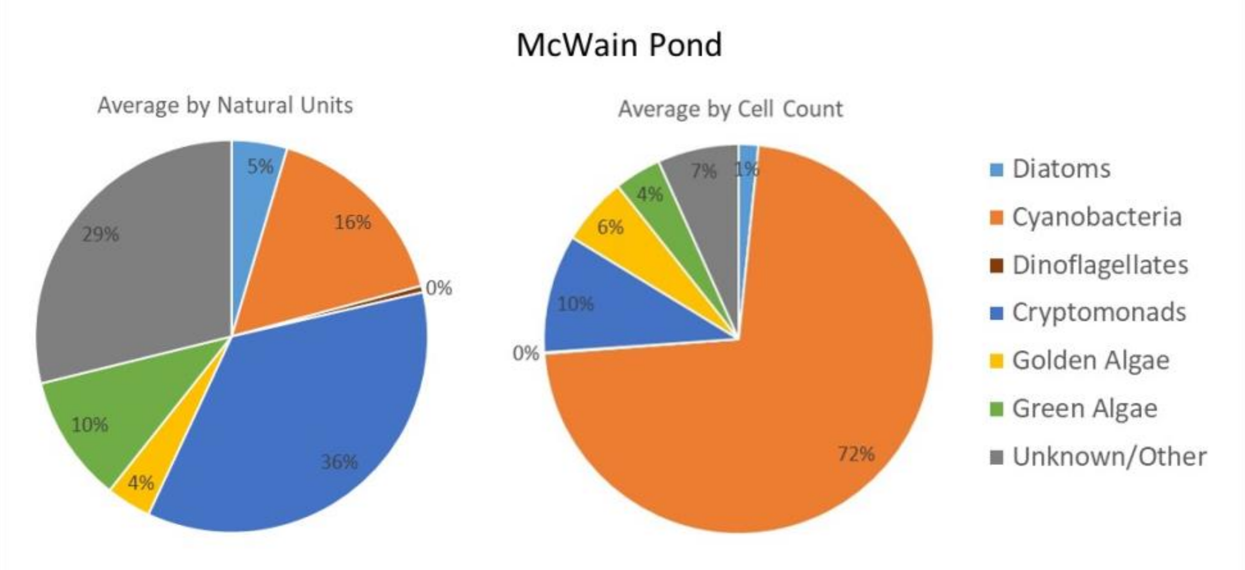
Algae samples were collected from McWain Pond once per month between May and September, 2017. Algae abundance was relatively high in these samples compared to other lakes sampled. Cell counts were highest in July, although they remained fairly consistent from June through September.



The cyanobacteria *Chroococcus*.

McWain Pond had the highest average percentage of Cyanobacteria based on cell counts, but not based on natural units (although the percentage by natural units was also high at 16%). This means that many of the colonies of cyanobacteria had large numbers of cells. Cyanobacteria that contributed to the high cell count include *Aphanocapsa, Aphanothece, Chroococcus* (pictured), *Coelophaerium, Merismopedia, and Rhabdoderma*, none of which cause harmful blooms. There were few nuisance or problem cyanobacteria noted in samples beyond a small amount of *Dolichospermum*, although McWain Pond does have elevated levels of *Gloeotrichia* in most years (see chapter 3).

Flagellated algae (one-celled algae with flagella, or "tails") were common in each sample, especially the cryptomonad *Rhodomonas* (all crytomonads are flagellates). Small flagellated algae also make up much of the "unknown/other" category in the pie charts below, which means, when assessing by natural units, that flagellates made up a majority of the algae assemblage in the lake. Flagellates are good quality food and constitute a solid basis for the lake food web that supports fish and other wildlife.



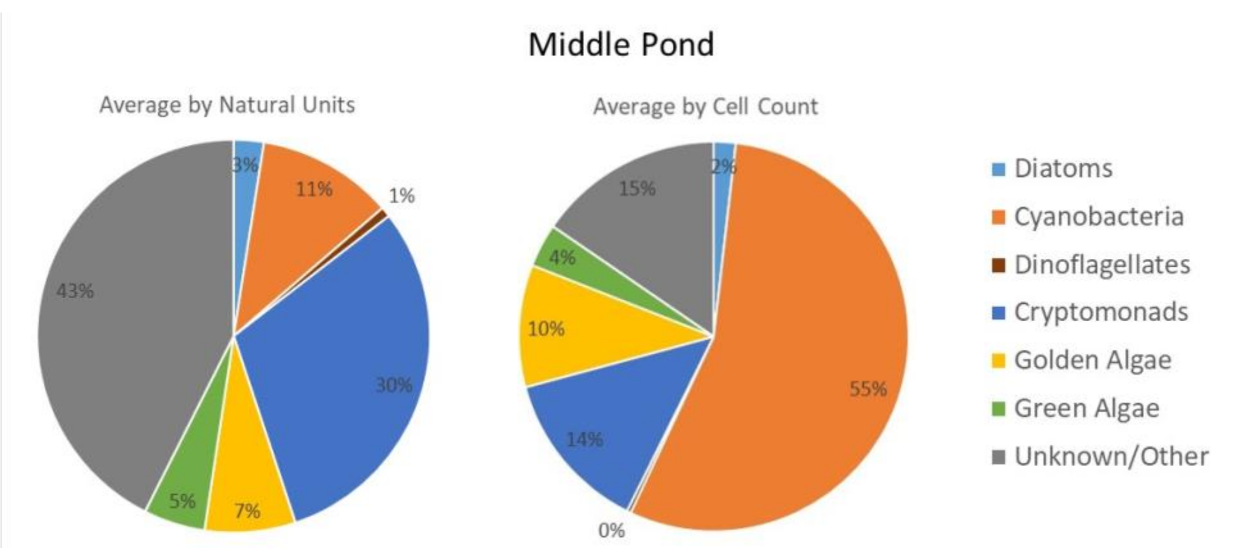
Middle Pond

Middle Pond was sampled once per month between May and September, 2017. Cell counts were low in May and June, peaked in July, and stayed elevated in August and September. The average and maximum cell counts were moderate compared to the other lakes sampled.

The flagellate *Chrysochromulina.*

The most common algae based on natural units were in the "unknown/other" category. Most of the algae in that category were flagellates (single-celled algae with flagella, or "tails") of different algae types. The second most common algae were cryptomonads, flagellated algae that include *Cryptomonas, Rhodomonas,* and *Chrysochromulina*. Between these two categories, flagellates made up the majority of algae based on natural units. Flagellates are good quality food and provide a solid basis for lake food webs.

Cyanobacteria colonies were responsible for 11% of the algae within the lake, but they contributed 55% of all of the cells counted. Although cyanobacteria made up a majority of the algae assemblage based on cell counts, there was very little evidence of nuisance or problem cyanobacteria in Middle Pond. The most common cyanobacteria in the pond were *Aphanocapsa* and *Merismopedia*, both of which are colonial forms that can contain hundreds of cells in each colony, which bulks up cell counts but doesn't add much to algal biomass because the cells are very small. Both of these genera are often seen in abundance in low-nutrient lakes.



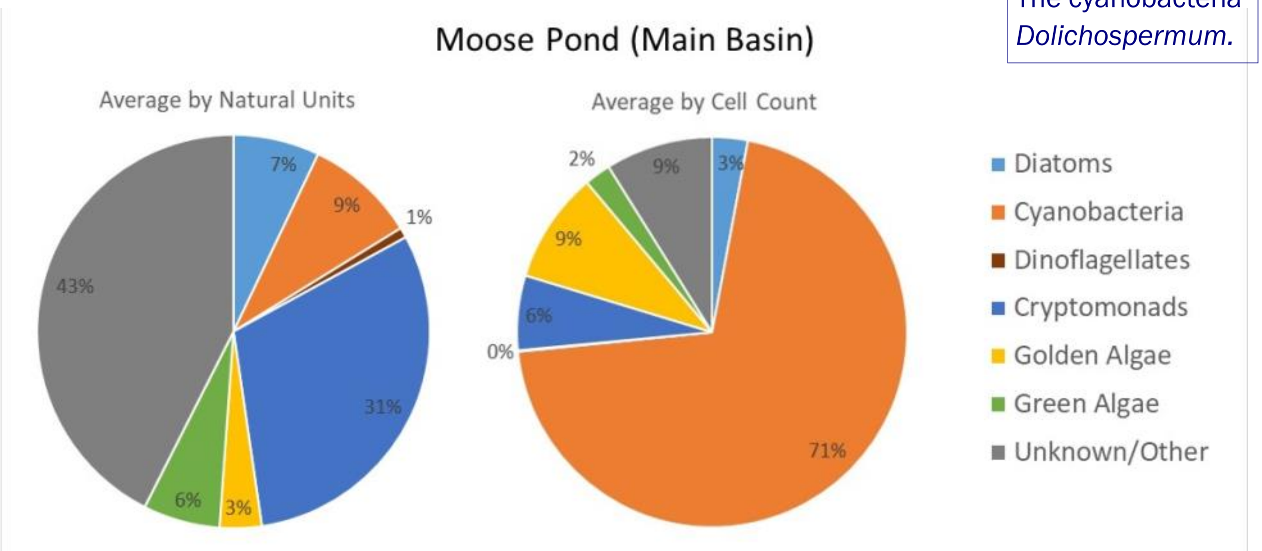
Moose Pond (Main Basin)

Five algae samples from the main basin of Moose Pond were collected between May and September, 2017. Cell counts were lowest in May and highest in July, with the overall average for the season being high compared to the other lakes sampled.

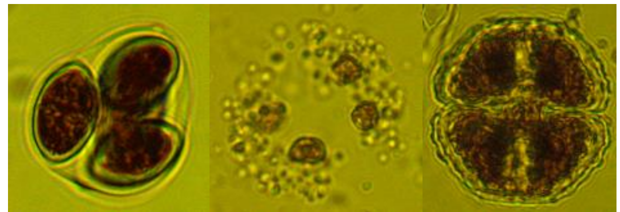
The most common algae based on natural units were in the "unknown/other" category. Most of the algae in the "unknown/other" category are flagellates (single celled algae with flagella or "tails" that allow them to swim) of different algae types. The second most common algae were Cryptomonads, flagellated algae that include *Cryptomonas, Rhodomonas,* and *Chrysochromulina.* Between these two categories, flagellates made up the majority of algae based on natural units. Flagellates are good quality food for zooplankton, the tiny crustaceans that are in turn eaten by small fish and insects.

Although cyanobacteria made up a majority of the algae assemblage based on cell counts, many of the common genera were not the kinds that cause blooms or produce toxins. The most common cyanobacteria in the pond were *Aphanocapsa, Aphanothece, Chroococcus* and *Merismopedia.* Colonies of cyanobacteria made up only 9% of the algae present in Moose Pond's main basin, but because these colonies can contain hundreds of cells each, they made up 71% of the total cells counted. The cyanobacteria of concern present in Moose Pond's main basin were *Gloeotrichia* (see chapter 3) and *Dolichospermum* (pictured to the right), which was present in all samples at low concentrations.

The cyanobacteria *Dolichospermum.*



Moose Pond (North Basin)



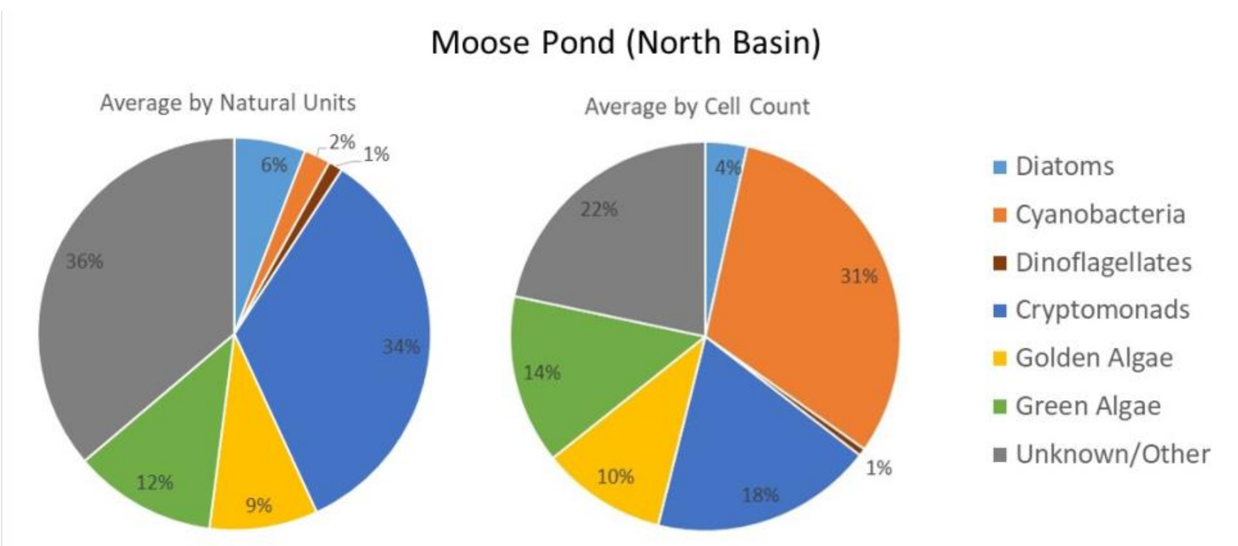
From left to right: *Oocystis* (green algae), *Chrysostephanosphaeria* (golden algae), and *Cosmarium* (green algae).

Algae samples were collected from the north basin of Moose Pond once per month between May and September, 2017. The average cell count for the north basin was the lowest of all the lakes sampled. The cell count peaked in August, but was still very low compared to other sample sites.

Moose Pond's north basin had the highest average percentage of both green and golden algae of all the lakes sampled based on natural units (and cell counts, in the case of green algae). *Crucigenia, Monomastix, Oocystis,* and *Pediastrum* were common green algae seen in samples and *Chrysosphaerella, Dinobryon, Mallomonas, Paraphysomonas,* and *Synura* were common golden algae.

The north basin also had the smallest percentage of cyanobacteria based on natural units. Most of the cyanobacteria noted were *Aphanocapsa* and *Merismopedia*. A very small amount of *Dolichospermum*, a cyanobacterium that can cause harmful blooms in high nutrient systems, was noted.

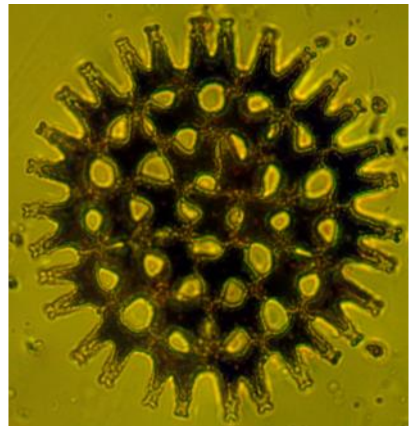
The most common algae based on natural units were in the "unknown/other" category, at 36%. Most of the algae in this category are flagellates (single celled algae with "tails" called flagella that help them swim) of different algae types. An almost equal percentage, 34%, were cryptomonads, flagellated algae that include *Cryptomonas* and *Rhodomonas*. Between these two categories, flagellates made up the majority of the algae present based on natural units. Flagellates are good quality food for zooplankton, the tiny crustaceans that are in turn eaten by small fish and insects.



*images are not to scale

Moose Pond (South Basin)

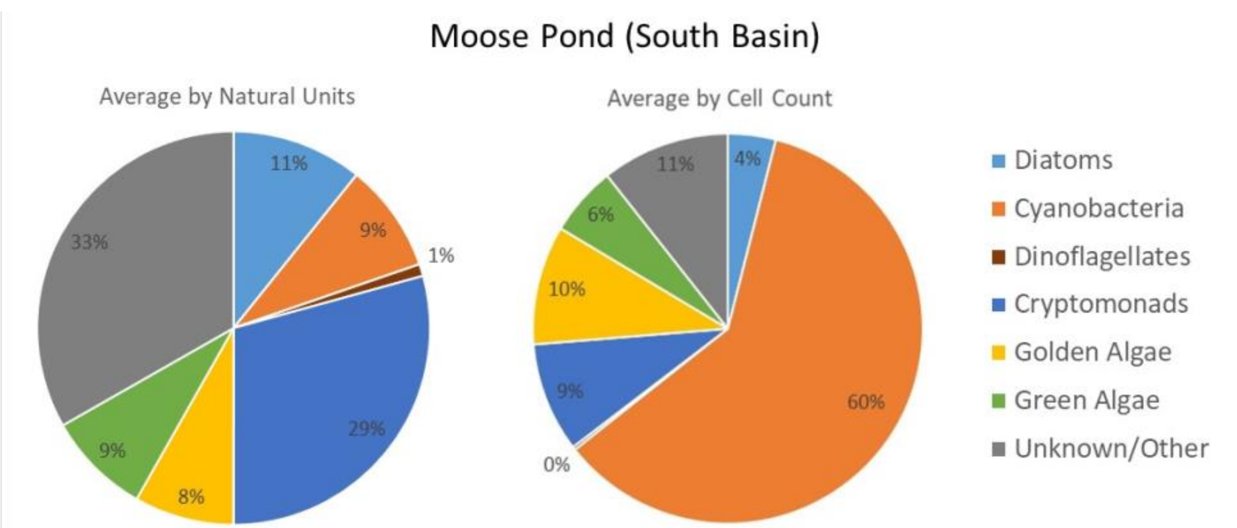
Algae samples were collected once per month between May and September, 2017. Cell counts increased month after month, peaking in September. The average cell count was moderate compared to other sampling sites.



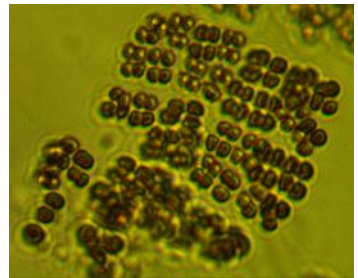
A *Pediastrum* (green algae) colony seen in a sample from Moose Pond's south basin.

The pie charts below show the most common types of algae seen on average in the five samples, both by natural units and by number of cells. In natural units, "unknown/other" and "cryptomonads" were the most common categories. The "unknown/other" category mainly consists of small flagellated algae of various algae types. Crytomonads are, by definition, flagellates, so the majority of algae present in the samples were various types of flagellated algae. This kind of algae are good quality food for the larger organisms that eat algae.

By cell count, cyanobacteria were the most abundant algae in the samples from Moose Pond's south basin, despite making up only 9% of the algae by natural units. This is because the pond had a lot of small colonial cyanobacteria such as *Aphanocapsa* and *Merismopedia.* These cyanobacteria do not add much to the biomass of lakes because their individual cells are small; however, they can add a lot to cell counts because they are often made up of hundreds of cells. There were a few nuisance cyanobacteria noted in some samples, including *Dolichospermum* and *Aphanizomenon*, however, they were at very low concentrations and are not currently a concern. There is also a relatively small amount of *Gloeotrichia* present in the south basin each summer (see chapter 3).



Peabody Pond

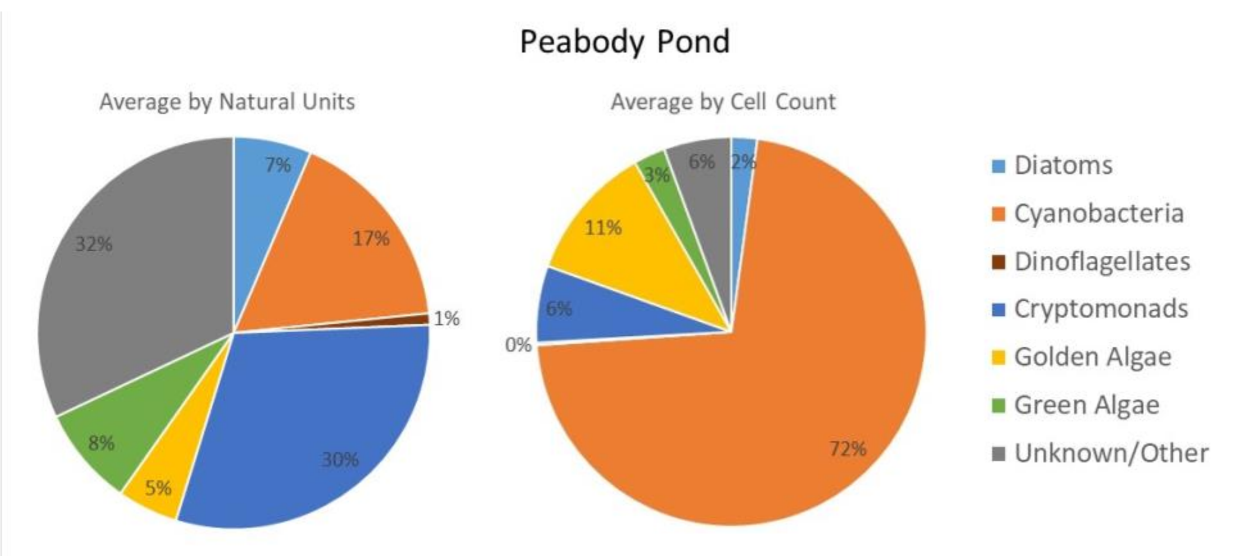


The cyanobacteria *Merismopedia*. This genus was common in most lakes.

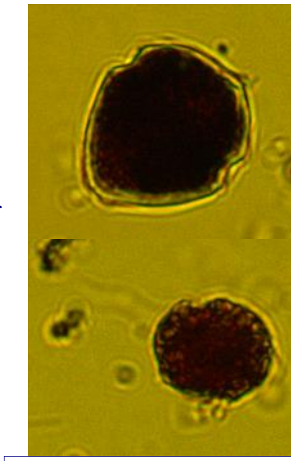
Algae samples were collected from Peabody Pond once per month from May-September. Algae counts peaked in July and were relatively high overall compared to the other lakes sampled.

The pie charts below show the most common types of algae seen on average in the five samples, both by natural units and by number of cells. In terms of natural units, "unknown/other" and "cryptomonads" were the most common categories. The "unknown/other" category mainly consists of small flagellated algae of various types. Flagellated algae are those with "tails" called flagella that they use to move around. Crytomonads are, by definition, flagellates as well, so the majority of algae present in the samples were flagellated algae. These algae are good quality food for larger organisms such as zooplankton, and provide a solid basis for the lake's food web.

Peabody Pond had the highest level of cyanobacteria of any of the lakes sampled based on natural units, and the level based on cell counts was also one of the highest. Most of the cyanobacteria counted were not nuisance genera, but the Pond did have a fair amount of *Dolichospermum* (formerly called *Anabaena*) present in samples, although not nearly enough to form a bloom. The Pond also sees low levels of *Gloeotrichia* in the water column in late summer (see chapter 3). Many of the cyanobacteria seen in Peabody Pond in 2017 are actually indicative of low nutrients and are not usually bloom-forming. *Aphanocapsa* and *Merismopedia* (pictured) were two of the most common. These cyanobacteria are colonial and are made up of very small cells, so they add a lot to the cell counts in the Pond but do not add much to the total algal biomass.



Sand Pond

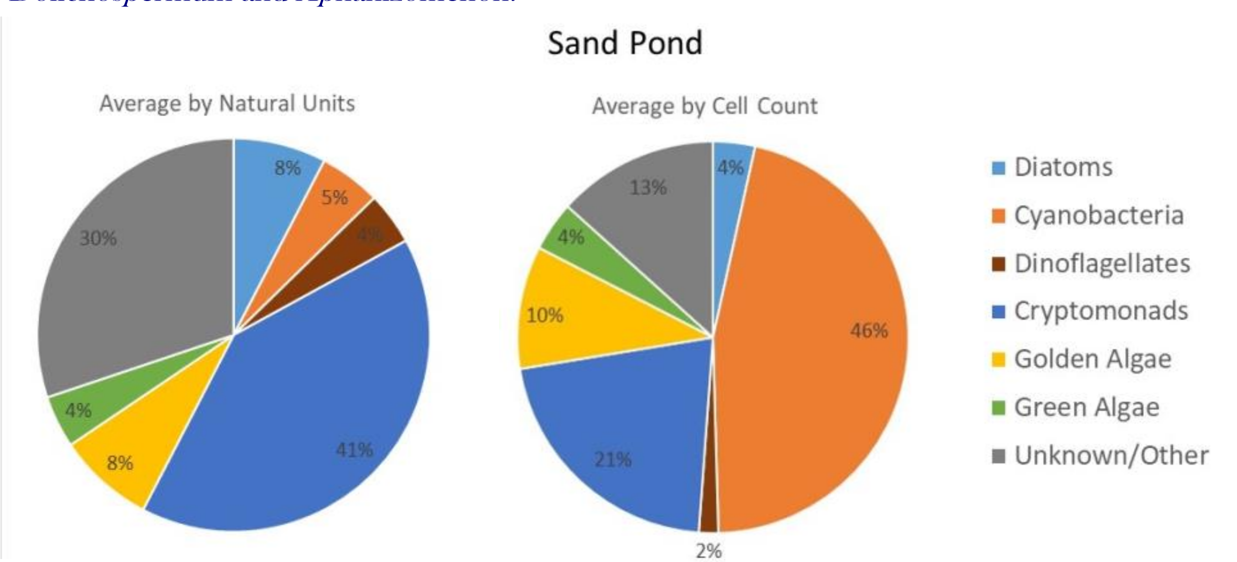


Peridinium (top) and *Gymnodinium* (bottom) are both dinoflagellates.

Sand Pond was sampled once per month between May and September, 2017. Cell counts peaked in July and the average cell count across the five samples was low. Sand Pond contained the highest average percentage of dinoflagellates (pictured to the right) of any of the lakes sampled, both in terms of natural units and cell counts. It also had the highest cell counts for cryptomonads along with its neighbor, Hancock Pond.

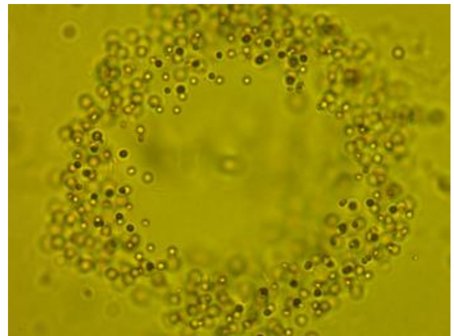
Cryptomonads are small, flagellated algae that are common in northern temperate lakes such as Sand Pond. The term "flagellated" or "flagellate" refers to an organism that has flagella— tail-like appendages that facilitate movement (flagellated algae can move themselves around in the water column, unlike most algae that are at the mercy of water currents). In the pie charts below, the "unknown/other" category mainly consists of other types of flagellated algae, so overall, the most abundant type of algae in Sand Pond in terms of natural units are flagellates. These algae make excellent quality food for consumers, providing a solid basis for the lake's food web.

Sand Pond had a relatively small amount of cyanobacteria compared to the other lakes tested. Cyanobacteria made up roughly half of the cell counts in Sand Pond because most cyanobacteria are colonial and made up of many cells. The most common cyanobacteria in Sand Pond were *Aphanocapsa, Aphanothece,* and *Chroococcus.* The first two genera are made up of numerous tiny cells, so they add a lot to cell counts but do not add much to the total algal biomass present in the pond. Very few nuisance cyanobacterial species were noted, other than a small amount of *Dolichospermum* and *Aphanizomenon.*



*images are not to scale

Trickey Pond

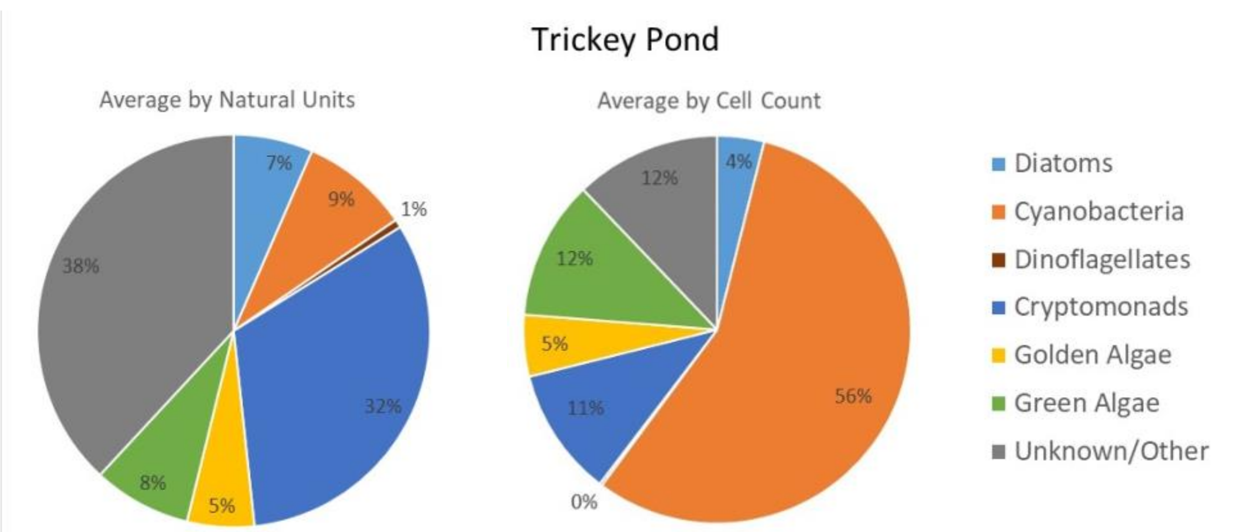


Aphanocapsa is a colonial cyanobacteria made up of tiny cells. It was seen in all the lakes sampled in 2017.

Algae samples were collected once per month on Trickey Pond between May and September, 2017. The highest cell count occurred in the month of July. Overall, cell counts were low compared to the other lakes and ponds sampled.

The pie charts below show the most common types of algae seen on average in the five samples, both by natural units and by number of cells. In terms of natural units, "unknown/other" and "cryptomonads" were the most common categories. The "unknown/other" category mainly consists of small flagellated algae (those with tail-like appendages that help them swim) of various types. Crytomonads are, by definition, flagellates as well, so the majority of algae present in the samples were types of flagellated algae. This kind of algae are good quality food and provide a solid base for the food web.

By cell count, cyanobacteria were the most abundant algae in the samples from Trickey Pond. This is because the pond had a lot of small colonial cyanobacteria such as *Aphanocapsa* (pictured), *Chroococcus,* and *Rhabdoderma.* Genera such as *Aphanocapsa* do not add much to the biomass of lakes because their individual cells are small; however, they can add a lot to cell counts because they are often made up of hundreds of cells. This is clear when you compare the percentage of the algae in Trickey Pond that were colonies of cyanobacteria, at 9%, to the percentage of cells at 56% of the total share. There were a few nuisance cyanobacteria noted in some samples, including *Dolichospermum* and *Oscillatoria,* however, they were at very low concentrations and are not currently a concern.



Woods Pond

Aphanizomenon was rarely seen in 2017. It is a cyanobacteria that often forms blooms when nutrient levels are high and can also produce toxins.

Woods Pond was sampled once per month from May to September, 2017. The highest cell count was reached in July, and was the highest level reached on any of the lakes and ponds sampled in 2017. This high count was due primarily to a large amount of *Merismopedia* present in the month of July.

The pie charts below show the most common types of algae seen on average in the five samples, both by natural units and by number of cells. In terms of natural units, "unknown/other" and "cryptomonads" were the most common categories. The "unknown/other" category mainly consists of small flagellated algae (those with tail-like appendages that help them swim) of various types. Crytomonads are, by definition, flagellates as well, so the majority of algae present in the samples were types of flagellated algae. This kind of algae are good quality food and provide a solid base for the food web.

Compared to other lakes sampled, cyanobacteria made up a relatively large share of the algae in terms of natural units, again primarily because of the proliferation of *Merismopedia* in July. Interestingly, the July event did not significantly affect clarity, chlorophyll-a, or total phosphorus levels on Woods Pond, possibly because there were fewer algae of other types present. The cyanobacterial genera that contributed to the high cell count are generally harmless and often abundant in low nutrient lakes. As for nuisance cyanobacteria, *Dolichospermum* was relatively abundant compared to other lakes and ponds sampled, but was not at a level that should cause concern. Some *Aphanizomenon* (pictured) was also noted in one sample.