2016 Water Testing Report

Lakes Environmental Association

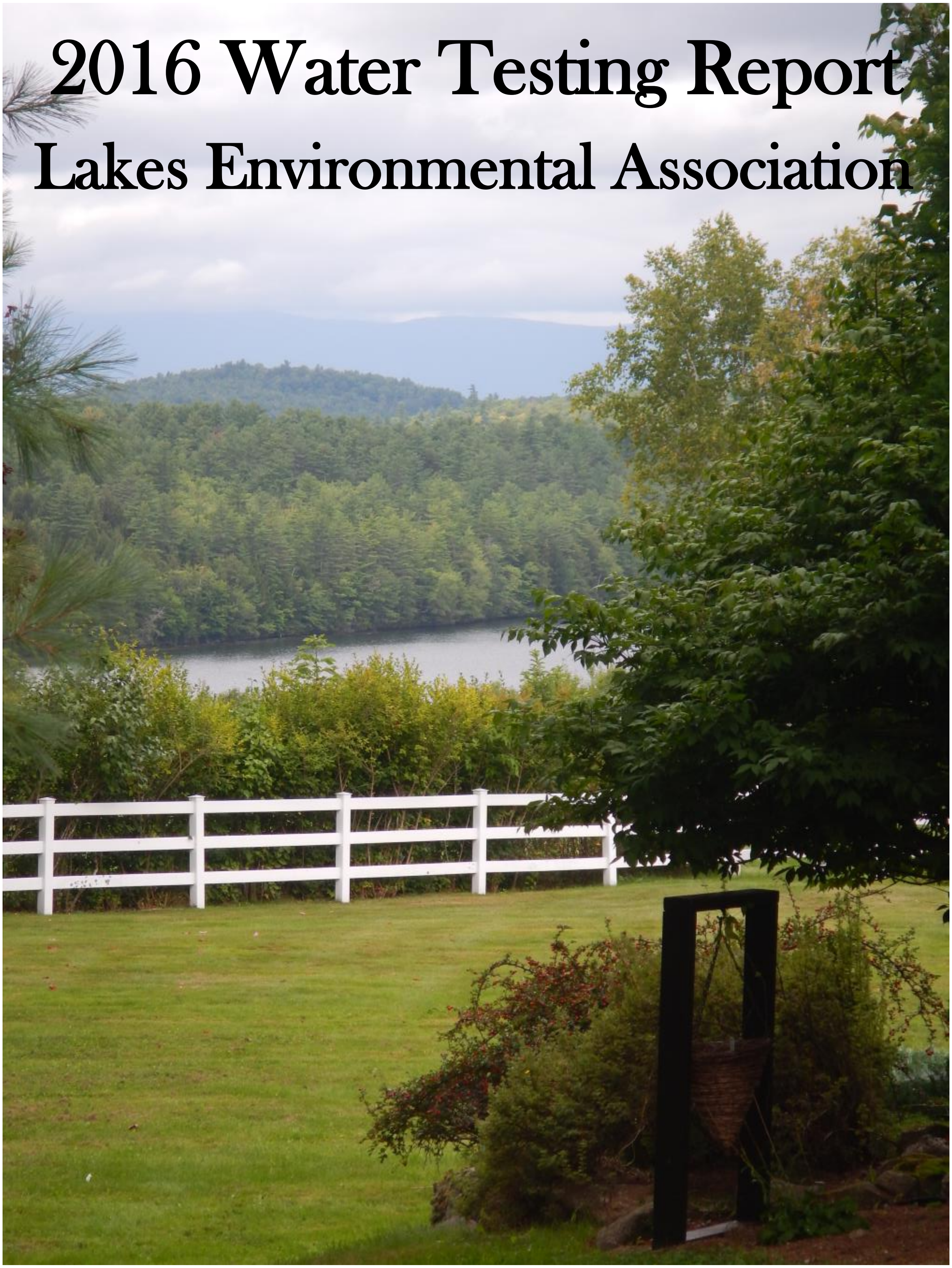


Table of Contents

About LEA

The Lakes Environmental Association (LEA) is a non-profit organization founded in 1970 with the goal of preserving and restoring the high water quality and the traditional character of Maine's lakes, watersheds and related natural resources. Headquartered in Bridgton, Maine, LEA focuses its efforts on 6 towns in the western Maine Lakes Region, although its reach and influence extends across the whole state.

<u>Invasive Plant Program</u>

LEA's Milfoil Control Team successfully eradicated invasive Variable Leaf Milfoil from Brandy Pond and the Songo River in 2015, after over a decade of hard work. The focus shifted to Sebago Cove in 2016, where a dense infestation threatens nearby waterbodies. LEA's innovative Invasive Plant Program has been a model for the entire state.

<u>Environmental Education</u>

LEA offers environmental education programs to local elementary, middle and high schools, reaching over 1000 students annually. LEA also hosts educational programs for all ages at the Holt Pond Preserve, the Highland Lake Preserve and Pondicherry Park, all of which LEA played a key role in establishing.

<u>Lake Water Testing</u>

Water testing on over 40 lakes and ponds in the area occurs every year through traditional and advanced testing initiatives. The results are presented in this report.

<u>Landowner and Municipal Assistance</u>

LEA provides free technical assistance to watershed residents interested in preventing erosion on their property. This service, called the "Clean Lake Check Up" helps educate landowners about simple erosion control techniques and existing land use regulations. LEA also works with municipalities on comprehensive planning, natural resources inventories and ordinance development.

<u>Courtesy Boat Inspections</u>

Every summer, LEA hires over 30 courtesy boat inspectors to educate boaters at public boat launches about invasive plants and help them perform inspections on their watercraft. This program, begun by LEA, has been adopted across the state.

<u>Maine Lake Science Center</u>

Opened in 2015, LEA's Maine Lake Science Center is a hub for lake research in the state. The center regularly hosts researcher retreats and other events at its remodeled and renovated energy-efficient headquarters located in Bridgton.

<u>Please Join LEA!</u>

LEA is a primarily member-funded operation. If you swim, boat, fish or simply believe Maine wouldn't be Maine without clear, clean lakes and ponds, please join the Lakes Environmental Association and protect Maine's lakes now and for future generations.

You can become an LEA member with a donation of any amount. Just mail a check to LEA, 230 Main St., Bridgton, ME 04009 or join online at <u>www.mainelakes.org</u>.

Water Quality at a Glance

Please See Key on the Next Page.

Lake	Oxygen Depletion	High P at depth	Clarity Trend	Phos. Trend	Chl-a Trend	Coldwater Fish	Other Issues	Degree of Concern
ADAMS POND	👎	👎	⚪	⚪	👎	🟡	—	HIGH
BACK POND	🟡	👎	👍	⚪	👎	🟡	Low Al:Fe	HIGH
BEAR POND	👎	👎	⚪	⚪	👎	👎	—	HIGH
BEAVER P. (Bridgton)	👎	👎	👍	⚪	👍	N/A	—	MOD
BEAVER P. (Denmark)	👍	N/A	⚪	⚪	⚪	N/A	—	AVG
BOG POND	👍	N/A	N/A	N/A	N/A	N/A	—	AVG
BRANDY POND	👎	👎	⚪	⚪	👎	👎	—	HIGH
COLD RAIN POND	👎	N/A	⚪	⚪	⚪	👎	—	MOD
CRYSTAL LAKE	🟡	👍	👎	⚪	⚪	🟡	Low Al:Fe	MOD
DUCK POND	👍	N/A	N/A	N/A	N/A	N/A	—	AVG
FOSTER POND	🟡	N/A	⚪	⚪	⚪	N/A	—	AVG
GRANGER POND	🟡	N/A	⚪	⚪	⚪	N/A	Algae	MOD
HANCOCK POND	👎	👍	👍	⚪	👎	👎	—	HIGH
HIGHLAND LAKE	👎	👎	👍	⚪	👍	👎	Algae	HIGH
HOLT POND	👎	N/A	⚪	👍	⚪	N/A	—	AVG
ISLAND POND	👎	👎	⚪	⚪	⚪	👎	—	MOD/HIGH
JEWETT POND	👎	👎	⚪	⚪	⚪	N/A	—	MOD
KEOKA LAKE	👎	👎	⚪	⚪	⚪	🟡	Gloeo	MOD/HIGH
KEYES POND	👎	👎	⚪	⚪	⚪	🟡	—	MOD
KEZAR POND	👍	N/A	⚪	⚪	👎	N/A	—	HIGH
LITTLE POND	👎	N/A	⚪	⚪	⚪	N/A	—	AVG
LITTLE MOOSE POND	👎	👎	⚪	⚪	⚪	N/A	—	MOD
LITTLE MUD POND	👎	N/A	⚪	⚪	⚪	N/A	—	AVG
LONG LAKE (3 BASINS)	👎	👍	⚪	⚪	⚪	👎	Gloeo/Al:Fe	HIGH
LONG POND	🟡	N/A	👎	⚪	👎	N/A	—	HIGH
McWAIN POND	👎	👎	⚪	👍	👍	N/A	Gloeo	MOD/HIGH
MIDDLE POND	👎	👎	👍	👍	👍	🟡	—	MOD
MOOSE POND (Main)	👎	👍	⚪	👍	👍	👎	Gloeo/Al:Fe	HIGH
MOOSE POND (North)	🟡	N/A	⚪	⚪	⚪	N/A	—	AVG
MOOSE POND (South)	👎	👎	N/A	N/A	N/A	N/A	—	MOD
MUD POND	👎	N/A	⚪	⚪	⚪	N/A	—	AVG
OTTER POND	🟡	N/A	👍	⚪	👍	N/A	—	AVG
PAPOOSE POND	🟡	N/A	👍	⚪	⚪	N/A	—	AVG
PEABODY POND	👎	👍	👍	⚪	⚪	🟡	Low Al:Fe	MOD
PERLEY POND	👎	N/A	⚪	👍	⚪	N/A	—	AVG
PICKEREL POND	🟡	N/A	⚪	👎	⚪	N/A	—	AVG
PLEASANT POND	🟡	N/A	⚪	⚪	⚪	N/A	—	AVG
SAND POND	👎	👎	👎	⚪	⚪	👎	Algae	HIGH
SEBAGO COVE	👍	N/A	N/A	N/A	N/A	N/A	Milfoil	AVG
STEARNS POND	👎	👎	👍	⚪	👍	👎	—	MOD/HIGH
TRICKEY POND	🟡	👍	👎	⚪	👎	🟡	—	HIGH
WEBBER POND	👍	N/A	N/A	N/A	N/A	N/A	—	AVG
WOODS POND	👎	👎	⚪	👎	⚪	N/A	—	MOD/HIGH

Key to Water Quality at a Glance Table

Oxygen Depletion: Did the lake suffer from low oxygen conditions in 2016?

= severe = slight = none

High P at depth: Were deep water phosphorus levels above 12 ppb in 2016?

= Yes = No N/A = not tested

Clarity, Phosphorus, and Chlorophyll-a trends: Data from 1996-2016 was analyzed to determine if these parameters are improving or worsening over time.

=Worsening = Improving = No change

Coldwater Fish: Did cold water fish have adequate habitat at all times of the year in 2016?

= No = Yes N/A = no cold water fishery

Other Issues: Additional risks that factor into the level of concern. Each issue =

Low Al/Fe: Lake is at a greater risk of phosphorus recycling

Algae: An algae bloom has occurred in the past

Gloeo: Lake has a history of elevated *Gloeotrichia echinulata* levels.

Milfoil: Lake is currently infested with invasive Milfoil.

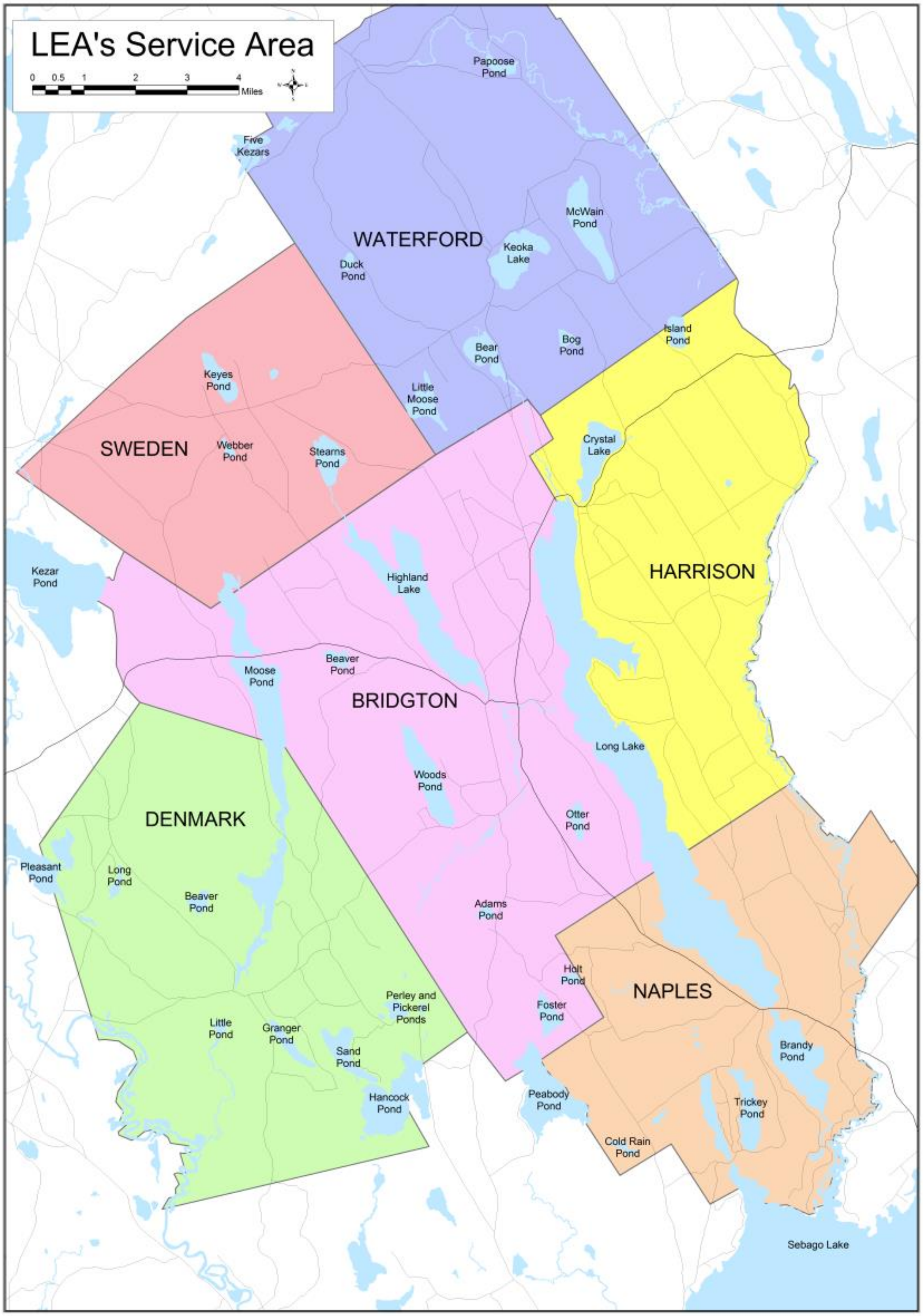
Degree of Concern: LEA's risk assessment for future lake water quality.

Average: none or 1

Moderate:

Moderate/High:

High: or a worsening chl-a trend.



LEA's Service Area
0 0.5 1 2 3 4 Miles
WATERFORD
SWEDEN
HARRISON
BRIDGTON
DENMARK
NAPLES
Papoose Pond
Five Kezars
McWain Pond
Keoka Lake
Duck Pond
Island Pond
Bear Pond
Bog Pond
Keyes Pond
Little Moose Pond
Crystal Lake
Webber Pond
Stearns Pond
Highland Lake
Kezar Pond
Beaver Pond
Moose Pond
Long Lake
Woods Pond
Otter Pond
Pleasant Pond
Long Pond
Beaver Pond
Adams Pond
Holt Pond
Perley and Pickerel Ponds
Foster Pond
Little Pond
Granger Pond
Sand Pond
Brandy Pond
Hancock Pond
Peabody Pond
Trickey Pond
Cold Rain Pond
Sebago Lake

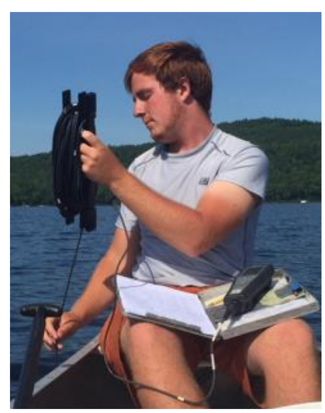
LEA would not be able to test the 40 lakes and ponds of this area without strong support from our surrounding community. Every year, we rely on volunteer monitors, lakefront landowners, summer interns and financial support from Lake Associations and the Towns of Bridgton, Denmark, Harrison, Naples, Sweden, and Waterford to continue to monitor and analyze lake water quality. **Thank you for all your help!**

2016 Volunteer Monitors and Lake Partners

Harold Arthur
Richard and Andy Buck
Adeline Casali
Steve Cavicci
Wells Carr
Jeff and Susan Chormann
Janet Coulter
Jane Forde
Joe and Carolee Garcia
Carol Gestwicki
Bill and Linda Grady
Shelly Hall
Carl and JoAnne Harbourt
Jim Kelly
Kokosing
Richard LaRose
Amy March
Long Lake Marina
Bob Mahanor
Bob Mercier
Richard and Daphne Meyer
Phil Neil
Papoose Pond Campground
Barry and Donna Patrie
Nancy Pike
Jean Preis
Carol and Stan Rothenberg
Don Rung
Jane Seeds
Carolyn Stanhope
Foster and Marcella Shibles
Arthur and Jean Schilling
Linda and Orrin Shane
Bob Simmons
Tom Straub
Don and Pat Sutherland
Camp Wigwam

2016 Water Testing Crew

Chris Beahm
Kristen McCarthy
Emma Toth
Amanda Pratt



Lake Association Partners Who Contribute to Advanced Testing Initiatives

Five Kezar Ponds Watershed Assoc.
Hancock and Sand Ponds Association
Keoka Lake Association
Keyes Pond Env. Prot. Assoc.
McWain Pond Association
Moose Pond Association
Peabody Pond Protective Assoc.
Trickey Pond Env. Prot. Assoc.
Woods Pond Water Quality Comm.

Lake Stratification 101

To understand much of LEA's water quality data, you must understand the concept of lake stratification.

Lake stratification is the separation of water in a lake or pond into distinct layers. This is caused by density differences in water at different temperatures. However, wind also plays a key role in maintaining and breaking down stratification. This layering happens in both the summer and winter and breaks down in the spring and fall, allowing for "turnover" — full mixing throughout the water column.

In Maine, three layers often form; the epilimnion, metalimnion (also called the thermocline), and the hypolimnion.

The epilimnion is the warm surface layer of the lake and the hypolimnion is the cold bottom layer. The thermocline is a narrow zone in between these layers where temperature and oxygen levels change rapidly. The exact depths of each layer change over the course of the summer and from lake to lake and year to year.

Due to the nature of stratification, which does not allow for exchange between the top and bottom layers, oxygen and nutrient concentrations often differ significantly between the upper and lower portions of a stratified lake. This is especially true in late summer.

This has several consequences for the lake. Light penetration is greatest near the top of the lake, meaning that algae growth primarily occurs in the epilimnion. Algae growth will sometimes peak near the thermocline, often in lakes with deep light penetration and higher hypolimnetic phosphorus levels.

Oxygen levels in the epilimnion are constantly replenished through wind mixing, but the hypolimnion is cut off from the atmosphere, leaving it with a fixed volume of oxygen which is slowly used up over the summer. This can affect cold water fish species in some lakes.

Phosphorus, the limiting element controlling algae growth in our lakes, is often more abundant in the hypolimnion because it is stored in sediments.

When oxygen levels are low at the bottom of the lake, as often happens later in the summer, a chemical reaction occurs that releases stored phosphorus from sediments. However, due to the density barrier at the metalimnion, these nutrients do not move easily into the epilimnion. This often causes a buildup of phosphorus in the hypolimnion.

Smallmouth Bass

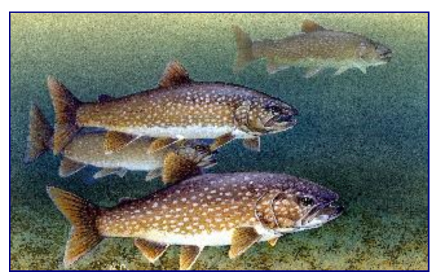
Epilimnion

The warm upper waters are sunlit, wind-mixed and oxygen rich.

Landlocked salmon

Metalimnion

This layer in the water column, also known as the thermocline, acts as a thermal barrier that prevents the interchange of nutrients between the warm upper waters and the cold bottom waters.



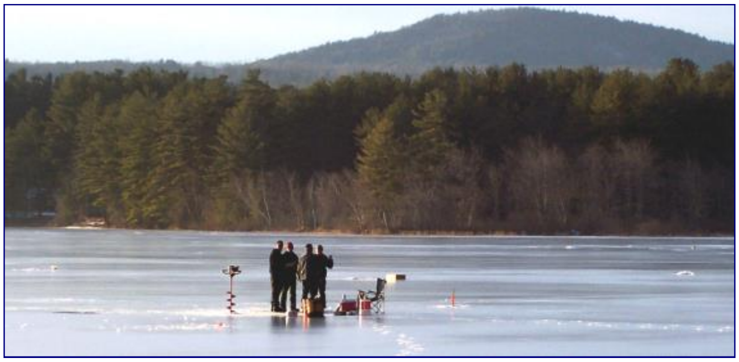
Lake trout, also known as togue

Hypolimnion

In the cold water at the bottom of lakes, food for most creatures is in short supply, and the reduced temperatures and light penetration prevent plants from growing.

A year in the life of a lake

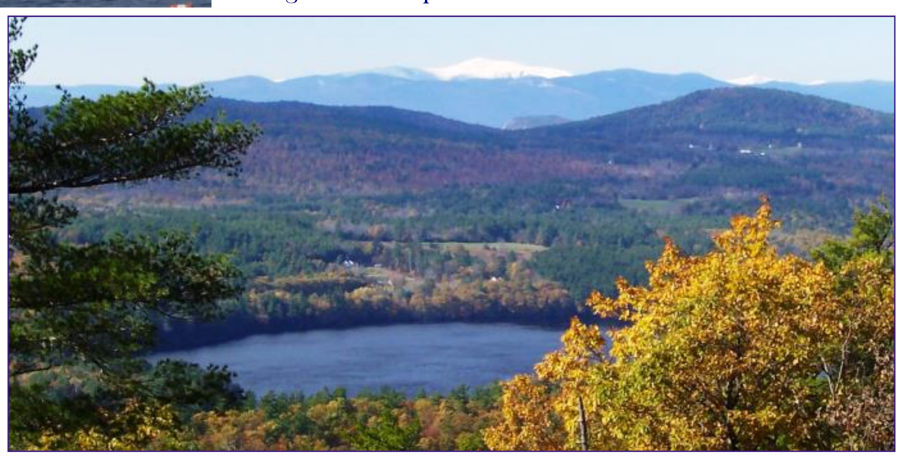
Winter is a quiet time. Ice blocks out the sunlight and also prevents oxygen from being replenished in lake waters because there is no wind mixing. With little light below the ice and gradually diminishing oxygen levels, plants stop growing. Most animals greatly slow their metabolism or go into hibernation.



Spring is a period of rejuvenation for the lake. After the ice melts, all of the water is nearly the same temperature from top to bottom. During this period, strong winds can thoroughly mix the water column allowing for oxygen to be replenished throughout the entire lake. This period is called spring turnover. Heavy rains, combined with snow melt and saturated soils are a big concern in the spring. Water-logged soils are very prone to erosion and can contribute a significant amount of phosphorus to the lake. Almost all soil particles that reach the lake have attached phosphorus.

Summer arrives and deeper lakes will gradually stratify into a warm top layer and a cold bottom layer, separated by a thermocline zone where temperature and oxygen levels change rapidly. The upper, warm layers are constantly mixed by winds, which “blend in” oxygen. The cold, bottom waters are essentially cut off from oxygen at the onset of stratification. Cold water fish, such as trout and landlocked salmon, need this thermal layering to survive in the warm summer months and they also need a healthy supply of oxygen in these deep waters to grow and reproduce.

Fall comes and so do the cooler winds that chill the warm upper waters until the temperature differential weakens and stratification breaks down. As in Spring, strong winds cause the lake to turn over, which allows oxygen to be replenished throughout the water column.



Water Quality Testing Parameters

LEA's testing program is based on parameters that provide a comprehensive indication of overall lake health. Tests are done for transparency, temperature, oxygen, phosphorus, chlorophyll, color, conductivity, pH, and alkalinity.

Clarity is a measure of transparency and is done using a Secchi disk. An 8 inch round disk divided into black and white quarters is lowered into the water until it can no longer be seen. The depth at which it disappears is recorded in meters. Clarity is affected by the color of the water and the presence of algae and suspended sediments.

Temperature is measured at one-meter intervals from the surface to the bottom of the lake. This sampling profile shows thermal stratification in the lake. Lakes deep enough to stratify will divide into three distinct layers: the epilimnion, metalimnion and hypolimnion. The epilimnion is comprised of the warm surface waters. The hypolimnion is made up of the deep, colder waters. The metalimnion, also known as the thermocline, is a thin transition zone of rapidly decreasing temperature between the upper and lower layers. Temperature is recorded in degrees Celsius.

Phosphorus is a nutrient that is usually present in only small concentrations in the water column. It is needed by algae for growth and reproduction and can therefore give an indication of the potential for an algal bloom. Algal blooms caused by excess phosphorus loading can deplete dissolved oxygen levels in deep water. Phosphorus is measured in parts per billion (ppb). Surface water phosphorus samples are a composite of the top layer of water, while deep water phosphorus samples are taken at individual depths using a grab sampler.

Dissolved oxygen is measured at one-meter intervals from the surface to the bottom of the lake. Over the course of the summer, oxygen is depleted in the bottom waters through the process of decomposition of organic matter like dead algae. When there is excessive decomposition, all available oxygen is used up and cold water fisheries are threatened. If dissolved oxygen concentrations are significantly depleted in bottom waters, a condition occurs which allows phosphorus to be released into the water column from bottom sediments. This is called phosphorus recycling and can cause increased algal growth to further deplete lake oxygen levels. In this report, "oxygen depletion" refers to dissolved oxygen levels below 4 ppm. it During the fall, cooler temperatures and winds cause the lake to de-stratify and oxygen is replenished in the deep waters as the lake mixes. Dissolved oxygen is measured in parts per million (ppm).

Chlorophyll-a is a pigment found in all algae. Chlorophyll sampling in a lake gives a measure of the amount of algae present in the water column. Chlorophyll concentrations are measured in parts per billion (ppb). Samples are a composite of the top layer of water in a lake.

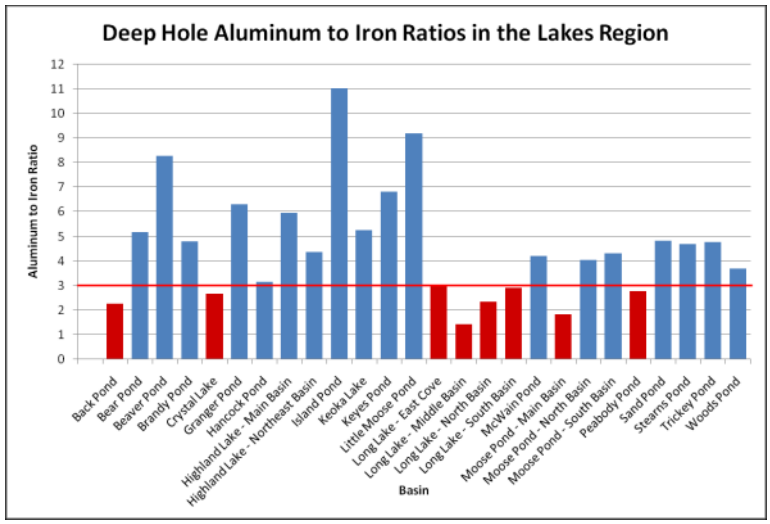
Conductivity measures the ability of water to carry electrical current. Pollutants in the water will generally increase lake conductivity. Fishery biologists will often use measurements of conductivity to calculate fish yield estimates. Conductivity is measured in micro Siemens (µs). It is not reported in the individual summaries unless unusual conditions were observed.

Color is a measure of tannic or humic acids in the water. These usually originate in upstream bogs from organic decomposition. Chlorophyll results are more important on lakes that are highly colored because phosphorus and transparency results in those lakes are less accurate. Color is measured in Standard Platinum Units (SPU). It is not reported in the individual summaries unless unusual conditions were observed.

pH is important in determining the plant and animal species living in a lake. pH is used to measure the acidity of lake water. Bogs or highly colored lakes tend to be more acidic (have a lower pH). It is not reported in the individual summaries unless unusual conditions were observed.

Alkalinity is a measure of the amount of calcium carbonate in the water and it reflects the ability of the water to buffer pH changes. In Maine lakes, alkalinity generally ranges from 4 - 20 parts per million (ppm). A higher alkalinity indicates that a lake will be able to withstand the effects of acid rain longer than lakes with lower alkalinity. If acidic precipitation is affecting a lake, a reduction in alkalinity will occur before a drop in pH. It is not reported in the individual summaries unless unusual conditions were observed.

Aluminum to Iron Ratio (Al:Fe) is a measure of metals in lake sediments. Research from the University of Maine has shown that lakes with ratios of Al:Fe above 3:1 do not release phosphorus from sediments, even under low oxygen conditions. This phosphorus instead gets bound to aluminum in the sediment. A ratio below 3:1 means that a lake is susceptible to phosphorus release from the sediments, although this may or may not actually happen and depends on other factors such as deep water oxygen levels. The graph to the right summarizes Al:Fe ratios for lakes in the Lake Region based on samples collected in 2013 at the deep-hole of each basin.



Water Quality Classification

While all lakes are sensitive to land use and activities within their watershed, the health and longevity of some lakes is more precarious than others. LEA classifies lakes into categories based on their overall health and susceptibility to algal blooms. The average, moderate, moderate/high, and high degree of concern categories are based on the number of water quality issues a lake faces. An increasing chlorophyll trend automatically puts a lake in the high degree of concern category. Recent algae blooms also raises a lake's degree of concern by one level.

The following criteria are used for reviewing transparency, phosphorus, chlorophyll and color data for each lake:

Transparency (m) in meters		Phosphorus (ppb) in parts per billion		Chlorophyll-A (ppb) in parts per billion		Color (SPU) Standard Platinum Units	
10.0 +	excellent	less than 5.0	low	less than 2.0	low	less than 10.0	low
7.1 – 10.0	good	5.1 – 12.0	moderate	2.1 – 7.0	moderate	10.1 – 25.0	moderate
3.1 – 7.0	moderate	12.1 – 20.0	high	7.1 – 12.0	high	25.1 – 60.0	high
less than 3.0	poor	20.1 +	very high	12.1 +	very high	60.1 +	very high

Advanced Testing

Beginning in 2012, LEA expanded its normal testing parameters and added new technology for measuring existing parameters. Many of the results from these efforts are included in this report, where applicable. Please read below for details on this new testing and how to interpret the resulting data. The data included in this report is tailored to each specific lake. More in-depth summaries for individual projects will be available in early 2017 at www.mainelakes.org.

Chlorophyll-*a* Profiling– LEA measures chlorophyll-*a* both through traditional sampling (see page 8) and qualitatively in the field using an instrument called a fluorometer. Chlorophyll is fluorescent, meaning it reacts strongly to certain wavelengths of light. The fluorometer measures this reaction. Higher fluorescence means more chlorophyll-*a*, which means more algae. A profile of readings is taken at every meter from the surface to the bottom of the lake, similar to how temperature and oxygen measurements are collected. Lakes that have had profiles taken in 2016 will contain a short discussion and graph in their individual testing summary.

***Gloeotrichia echinulata*—** Also known as "Gloeotrichia" or simply "Gloeo" (glee-oh), it is a type of algae belonging to a group called cyanobacteria (formerly referred to as "blue-green algae"). All lakes contain cyanobacteria, however high levels of these algae are associated with water quality problems and many species are capable of producing toxins. They are usually less prevalent in low-nutrient lakes such as those in the Lakes Region. However, Gloeo in particular is known to bloom in low-nutrient lakes. The reason for this is related to the algae's ability to absorb phosphorus from the sediment before floating into the water column and reproducing.

The lakes with and without Gloeo blooms have stayed consistent since LEA began sampling. It is likely that some lakes don't have the conditions to support larger blooms while others do. However, the characteristics and conditions needed for Gloeo blooms are not well understood.

Gloeo colonies look like tiny round balls and are much larger than other floating algae. They are therefore very visible, even in small amounts. Gloeo populations peak in late summer, usually between late July and early September.

LEA began sampling for Gloeotrichia in 2012. Samples are collected in shallow areas of lakes and ponds using a plankton tow net made of fine mesh, which strains the algae from the water. We measure abundance in a unit called "colonies per liter" (abbreviated col/L), which is just the number of Gloeotrichia you would see in an average liter of lake water (it helps to imagine the size of a 1 liter soda bottle). Anything below 5 col/L is very low and not a worry at this time.

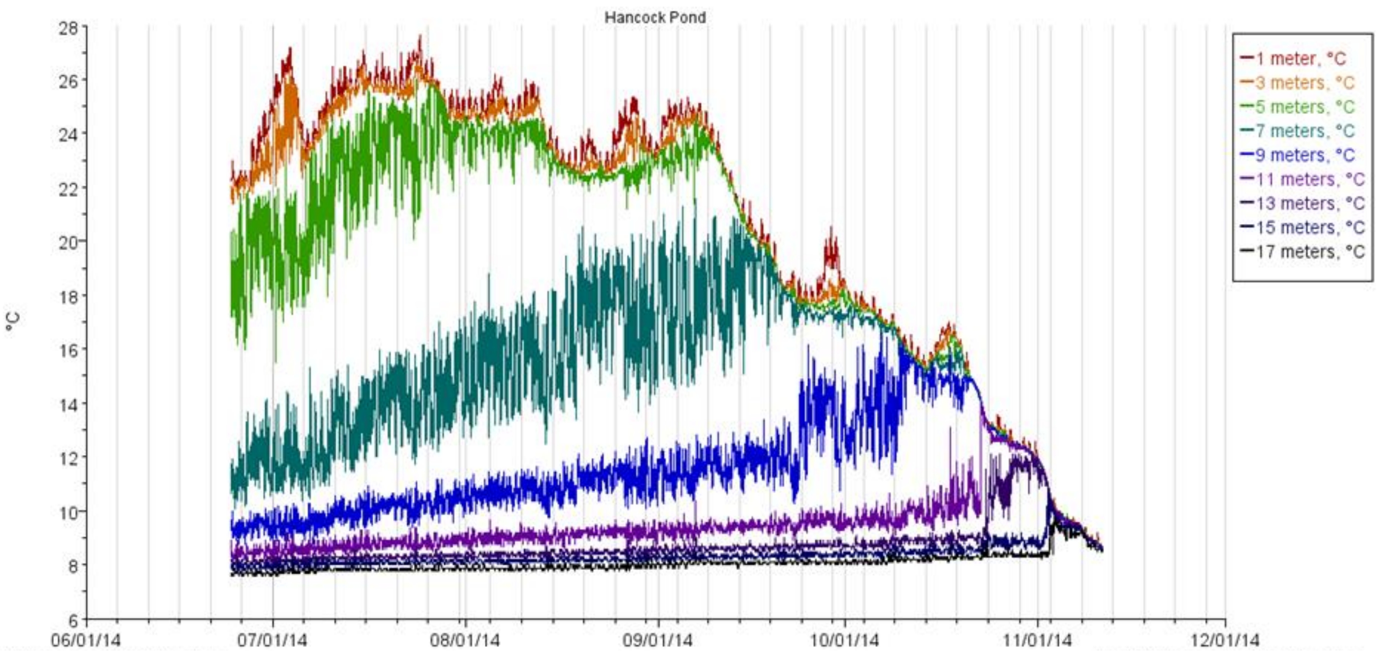
Lakes that were sampled for Gloeo in 2016 are listed to the right. Those with elevated levels are highlighted in red and a more detailed report is provided in the individual lake summaries. Those not highlighted have consistently had little to no Gloeo.

LEA will be releasing a separate overview of the 2016 Gloeotrichia sampling results in early 2017, which will be available at www.mainelakes.org.

Lakes Sampled for *Gloeotrichia:*
ADAMS POND
BACK POND
BEAR POND
BEAVER P. (Bridgton)
BRANDY POND
CRYSTAL LAKE
FOSTER POND
GRANGER POND
HANCOCK POND
HIGHLAND LAKE
ISLAND POND
JEWETT POND
KEOKA LAKE
KEYES POND
LITTLE MOOSE POND
LONG LAKE
McWAIN POND
MIDDLE POND
MOOSE POND
MUD POND
PAPOOSE POND
PEABODY POND
SAND POND
STEARNS POND
TRICKEY POND
WOODS POND

High-Resolution Temperature Monitoring

LEA measured temperature on a number of lakes in this report using small Onset® HOBO digital sensors (thermistors) attached to a line and anchored at the deepest part of the lake. The sensors are attached at roughly 6 foot (2 meter) intervals from the top of the lake to the bottom and collect a temperature reading every 15 minutes. The resulting graph can be tricky to understand, so here are a few pointers:

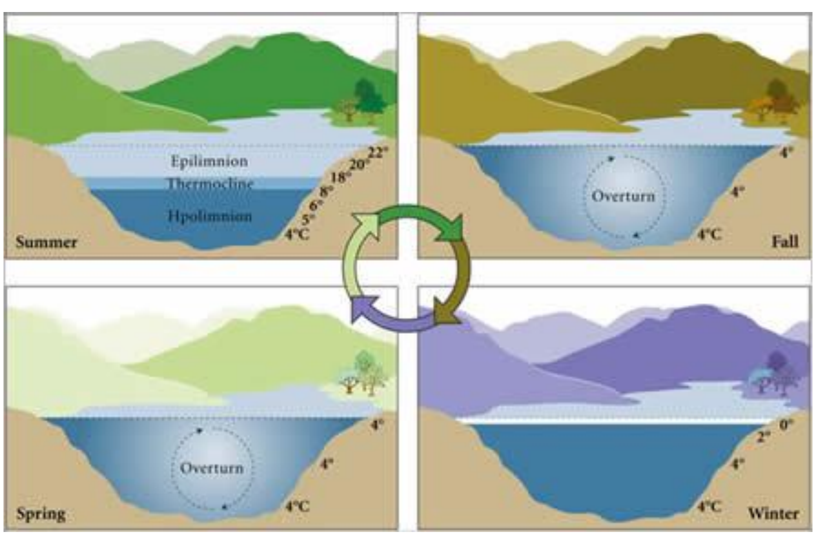


- Each colored line represents a different depth in the water. The topmost lines represent water near the top of the lake (red = 1 meter below the surface, etc.), with a difference of 2 meters (approx. 6 feet) in depth between each line.
- The graph shows temperature change over time – The horizontal axis shows the date, while the vertical axis shows the temperature (in degrees Celsius).
- When the lines are far apart, it means there is a large temperature difference between water at that depth and the water above and below it. So for example, in the above graph the teal line representing water temperatures at 7 meters has a large gap between it and the 5– and 9- meter lines throughout the first part of the graph. This large difference in temperature indicates an area of rapidly changing temperature known as the thermocline.
- On the above graph, the temperatures are fairly spread out to begin with. This indicates thermal stratification is occurring, which is the separation of water into distinct layers based on temperature: the epilimnion (warm upper water) and the hypolimnion (cold deep water). The thermocline (also known as the metalimnion) is the boundary between these layers.
- During stratification, the epilimnion does not easily mix with the hypolimnion (hence, these lines do not touch each other). It is only when the temperature of the upper water cools down that the lake can fully mix. You can see this at the right side of the graph: the temperatures near the surface get cooler and the lines converge one by one until the temperature is the same at each depth. This is known as lake turnover, which is the breakdown of thermal stratification. On the graph above, stratification fully broke down at the beginning of November.

Summaries for each of the 16 basins that contained sensors are included in this report. A full report summarizing this season's data will be available at www.mainelakes.org in early 2017.

Date of Fall Turnover (Complete Mixing) by Year				
LAKE	2013	2014	2015	2016
Back Pond	N/A	after 10/25	10/26	10/26
Hancock Pond	N/A	11/3	after 11/10	11/5
Highland Lake	after 10/11	10/12	10/11	10/10
Island Pond	N/A	11/2	after 10/27	After 10/27
Keoka Lake	N/A	10/22	10/23	10/25
Keyes Pond	N/A	N/A	10/26	10/25
Long Lake North	10/25	10/23	N/A	N/A
Long Lake Middle	9/16	9/12	9/28	9/2
Long Lake South	N/A	N/A	10/11	10/2
McWain Pond	N/A	10/19	10/18	10/10
Moose Pond Main	11/3	11/2	11/2	10/31
Moose Pond North	N/A	9/12	9/22	8/22
Moose Pond South	N/A	10/22	10/3	9/25
Peabody Pond	N/A	N/A	N/A	11/5
Sand Pond	N/A	after 10/30	10/31	10/26
Trickey Pond	N/A	11/2	after 11/5	10/31
Woods Pond	N/A	9/13	9/30	9/12

The table above summarizes the dates of lake mixing events over the past 4 years. This data comes from HOBO digital temperature sensors and, in the case of Highland Lake from 2014-2016, the remote sensing buoy. In cases where turnover is specified as "after" a certain date, this means that the lake had not fully mixed at the time the sensors were removed. More information on individual lake temperature patterns can be found in the lake summaries in this report.



Annual Pattern of Mixing
Young, M. (2004). *Thermal Stratification in Lakes*. Baylor College of Medicine, Center For Educational Outreach.

Algae Monitoring

Algae are a key parameter when it comes to measuring water quality. They 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 result from an over-abundance of nutrients or a lack of algae-eating organisms. Their decomposition also uses up oxygen in deeper parts of stratified lakes. Algal blooms are usually a sign of a water quality issue, and are generally bad for people (impacting recreation, fishing, aesthetics, etc.) and for the lakes themselves.

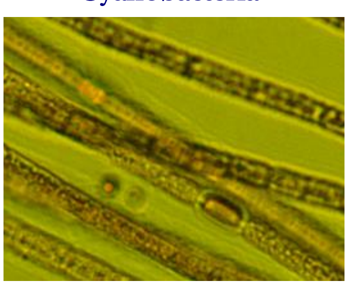
LEA began monitoring algae populations directly in several lakes in 2015. Samples from the epilimnion of these lakes were collected between June and September using a flexible coring (integrated sampling) tube. Samples were concentrated and then a subsample was counted. Algae were identified to genus level where possible and counted.

Although LEA also measures algae indirectly using chlorophyll-*a* concentrations, microscopic identification tells us much more about what's happening within a lake. In particular, we are interested in the amount of cyanobacteria in a lake and how this changes over the course of the summer. Cyanobacteria are the "bad guys" of the algae world because they often signal poor or declining water quality and many can produce toxins. There are five other main categories of algae: Green, Diatom, Golden, Dinoflagellate, and Cryptophyte. There are also several less common types.

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. Many of the lakes tested for algae were sampled on a monthly basis so these changes over time could be seen.

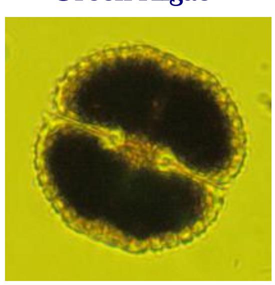
Lakes and ponds where algae testing occurred will have details provided in the individual lake summaries section of this report. Further information on LEA's algae monitoring program and overall results from 2016 monitoring will be compiled into a report which will be available in early 2017 at www.mainelakes.org.

Cyanobacteria



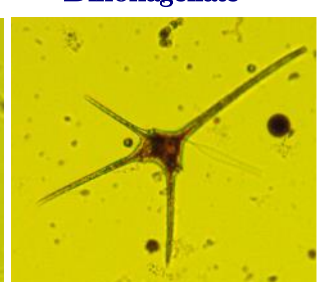
Aphanizomenon stained with iodine. (Long Lake)

Green Algae



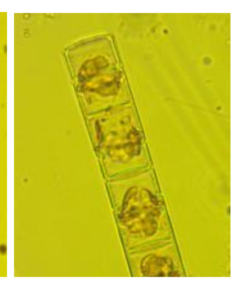
Cosmarium cell stained with iodine. (McWain Pond)

Dinoflagellate



Ceratium stained with iodine. (Highland Lake)

Diatom



Aulacoseira stained with iodine. (McWain Pond)

2016 as a Year

The prolonged drought that engulfed the lake region was likely the driving force behind 2016's better than average water quality. While the lack of precipitation caused water levels to drop lower than what we've seen in years, the absence of rain also meant that the usual nutrients and sediments that wash into our lakes stayed put in the watershed above.

Our three most telling water quality assessments all showed that 2016 was a good year. Secchi disk clarity readings were deeper than average on almost 70% of the ponds and lakes in the area. Deeper Secchi readings mean you can see down further into the lake, which generally indicates that there is less algae in the water. But we have a more direct way of measuring algae and that is through chlorophyll concentrations, which were also lower on a whopping 80% of our lakes. Not surprisingly, phosphorus, the nutrient that feeds algae, was lower than average on 72% of the waters LEA tests.

Beside the drought, there were a couple other unusual phenomena that occurred in our waters in 2016. The first was an extremely early ice-out. While early ice-out is not that unusual anymore (lakes in Maine now have ice-out 2 weeks earlier then historical averages), this year was one of the earliest recorded for the lakes in this region. After ice out, lakes quickly begin to warm and algae populations start to increase. Thus, early ice-out causes early stratification and this, coupled with a longer growing season leads to less oxygen in the deep waters. This is bad for aquatic life like salmon and trout and can also lead to nutrient re-suspension from the bottom waters. In 2016 however, the unseasonably early ice-out was partially negated by an unusual mixing event which occurred in June. After a week of cold weather and prolonged heavy winds, many of the waterbodies in our area turned over a second time in the spring, essentially resetting the stratification that had already started to form. This event brought needed oxygen down to the deep waters. However, mixing events that occur during the growing season can often bring up nutrients from the bottom which can then lead to algae blooms. While increased algae populations were observed after the mixing event by our automated monitoring buoy, no blooms were documented and this early season turn-over seemed to be primarily beneficial to the lakes in this area. June mixing events can be seen in the data we collected from waterbodies where strings of temperature sensors have been placed. Look for the different colored lines to converge in June in the individual temperature charts found in this report.

While early ice out and June mixing played a role in 2016 water quality, the prolonged drought was likely the driving factor for the better conditions documented by our water testing program. Because this improved water quality was chiefly weather driven, we can't expect the same trend every year. In fact, we can expect the opposite as heavy precipitation events become commonplace. Locally, we have seen an increase in big storms from our monitoring at the National Atmospheric Deposition site in Bridgton. The 2014 National Climate Assessment solidified these findings by showing that there has been a 71% increase in the amount of precipitation falling in very heavy events in New England. Knowing this information coupled with the value that lakes provide to the community and economy, hopefully we can all take action by controlling and infiltrating runoff so that our waters stay clean and clear every year.

Individual Lake Summaries

The following pages present 2016 data by lake, including results of routine monitoring and advanced testing. Where applicable, graphs or charts have been included in the individual summary information to help show particular conditions or trends.

Adams Pond

Adams Pond Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: Better at 7.9 meters
Chlorophyll: Worse at 3.3 ppb
Phosphorus: Better at 6.3 ppb

Surface Area:	43 acres
Maximum Depth:	51 feet
Mean Depth:	27 feet
Volume:	955 acres/feet
Watershed Area:	196 acres
Flushing Rate:	0.54 flushes per year
Elevation:	640 feet

Water Quality Summary:

Adams Pond had better than average clarity and surface water (epilimnetic) phosphorus results in 2016. Water clarity was considered good on average, while surface water phosphorus was moderate. However, the moderate levels of chlorophyll was higher than the long term average. The overall trend in chlorophyll values since 1996 indicates that chlorophyll is increasing over time. Indeed, Adams Pond has an unusually high level of oxygen around the thermocline each summer, which is an indicator of high algal productivity.

Another water quality concern on Adams Pond is oxygen depletion and high deep water (hypolimnetic) phosphorus concentrations. Coldwater fish still had suitable habitat despite the oxygen depletion, but phosphorus levels deeper within the water column were very high and averaged 49 ppb. High phosphorus is likely driving the algae growth near the thermocline.

Primarily due to the increasing chlorophyll trend, Adams Pond remains in LEA's HIGH degree of concern category.

Back Pond

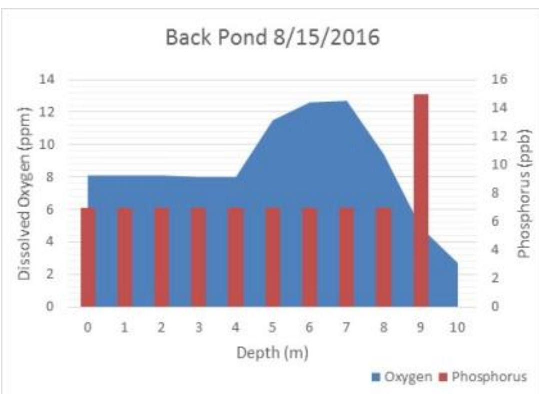
Back Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 7.1 meters
Chlorophyll: Worse at 2.6 ppb
Phosphorus: Better at 5.6 ppb

Surface Area:	62 acres
Maximum Depth:	33 feet
Watershed Area:	584 acres
Elevation:	572 feet

Water Quality Summary:

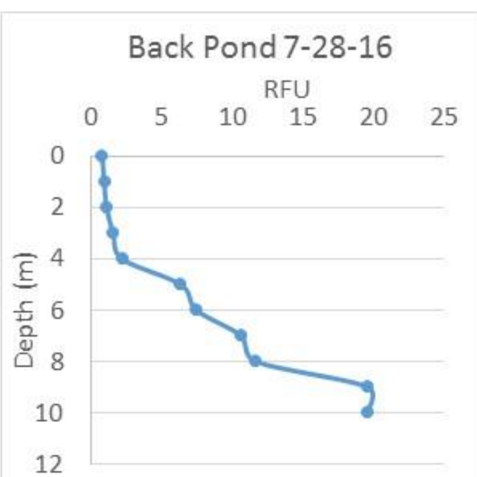
Clarity and surface water (epilimnetic) phosphorus were both better than the long term average in 2016. The overall clarity trend is improving, which is good news for Back Pond, which is one of the Five Kezar Ponds. The 2016 average of 7.1 meters is considered good, whereas the historical average of 6.4 meters is only moderate. Surface water phosphorus remains in the moderate category. The chlorophyll average was worse than it has been historically, and the overall trend indicates chlorophyll is increasing over time.

Back Pond is also at risk of internal phosphorus release due to low sediment aluminum levels. When oxygen is depleted at the bottom of a lake, the sediments will release phosphorus. Aluminum binds with this phosphorus to keep it in the sediment. Low aluminum levels mean the lake is more likely to release phosphorus into the water column, fueling algae growth.



The graph to the left shows phosphorus (red bars) increasing near the bottom of the pond as the dissolved oxygen (blue) decreases at depth. The deep water phosphorus value of 15 ppb is high and may be connected to the increasing trend in chlorophyll concentrations.

Luckily, dissolved oxygen depletion in Back Pond is not severe and relative sediment phosphorus concentrations are low. Still, Back Pond is more vulnerable than many other lakes and remains in LEA's HIGH degree of concern category.



Chlorophyll-a Profile:

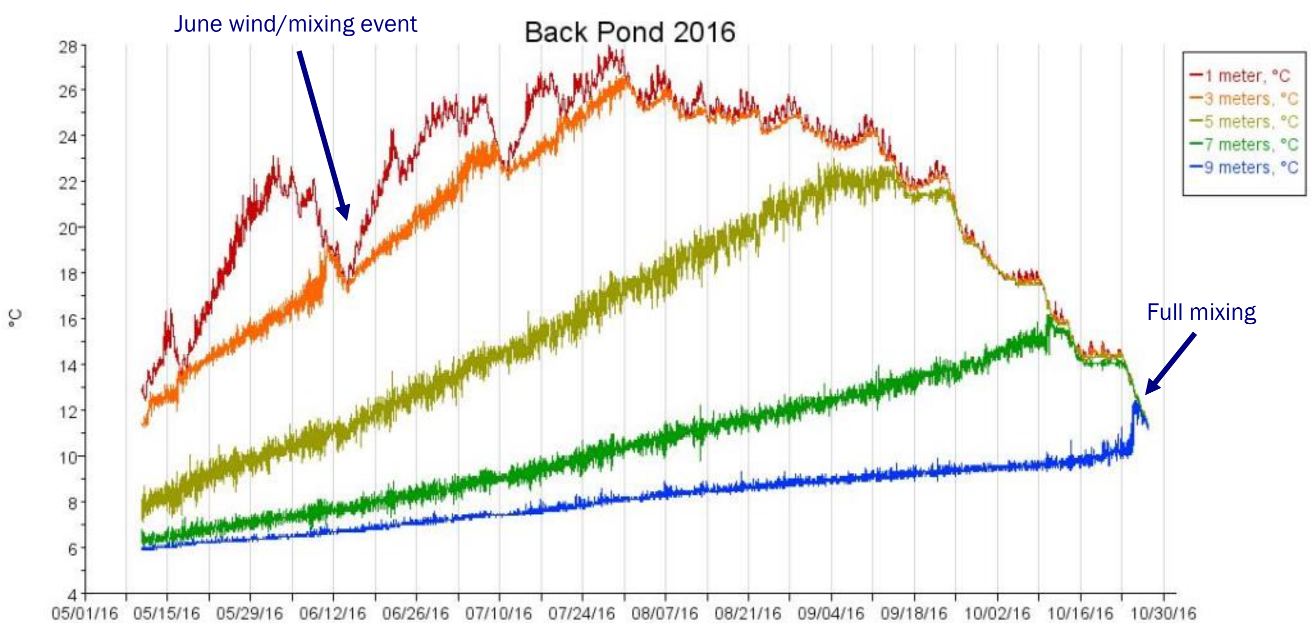
Results of a chlorophyll-a profile on Back Pond are shown in the graph to the left. The relative amount of chlorophyll increases as the lake gets deeper. On this date, the clarity reading was 7.69 meters, indicating that light penetrated very far into the water column. This could explain higher relative levels of chlorophyll near the bottom of the lake. Algae also fluoresce more strongly in low light conditions. The very high levels near the bottom could be due to sediment interference and/or live algae that had sunk to the bottom of the lake.

High-Resolution Temperature Monitoring:

Stratification began to set up on Back Pond prior to sensor deployment in early May. The epilimnion, or top layer of water, was located between 0 and 3 meters for most of the season. The temperature patterns in Back Pond were not strongly affected by the high wind conditions occurring around June 15th, although mixing was evident in the top few meters.

Stratification began to deepen in mid-September as air temperatures cooled, allowing the surface water temperature to decrease. This caused deeper waters to gradually mix into the upper water, a process known as destratification or lake turnover. The pond fully mixed in late October. The maximum temperature recorded at 1 meter deep was 28.0 °C (82.4 °F) on July 28th.

Date of Fall Turnover (Complete Mixing)			
	2014	2015	2016
Back Pond	after 10/25	10/26	10/26



Algae Monitoring:

Algae samples were collected from Back Pond on August 15th and September 1st. Algae levels increased in September, but overall were low to moderate compared to the other lakes sampled. Small flagellated algae such as *Chrysochromulina* and *Rhodomonas* were common, as were the cyanobacteria *Aphanocapsa* and *Merismopedia* and the green algae *Sphaerocystis*. This algae assemblage is characteristic of mesotrophic systems, meaning that Back Pond has a moderate level of productivity.

Bear Pond

Bear Pond Quick Statistics
2016 Average Versus the Long-term Average:
Clarity: Better at 6.3 meters
Chlorophyll: Better at 2.8 ppb
Phosphorus: Better at 7.3 ppb

Surface Area:	250 acres
Maximum Depth:	72 feet
Mean Depth:	34 feet
Volume:	7,978 acres/feet
Watershed Area:	5,331 acres
Flushing Rate:	2.3 flushes per year
Elevation:	375 feet

Water Quality Summary:

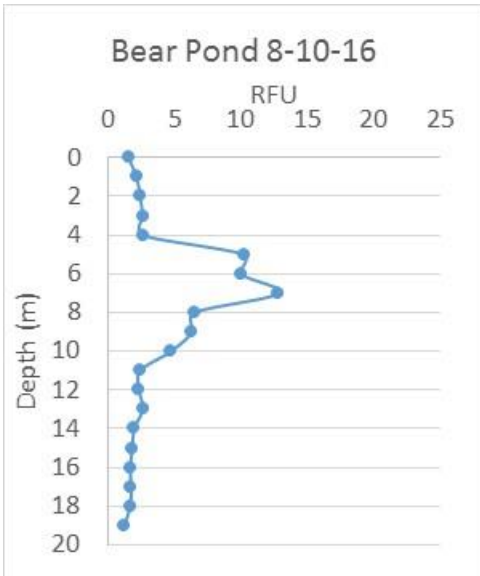
Clarity, chlorophyll, and surface water (epilimnetic) phosphorus levels were all better than historical averages in 2016. Average values for all three parameters were in the moderate range. Chlorophyll, in particular, was much improved over previous years. However, the long-term trend in chlorophyll is still increasing over time.

In addition to an increasing chlorophyll trend, Bear Pond also suffers from deep-water oxygen depletion and some elevated phosphorus levels at the bottom of the pond. However, there is still enough oxygen to support cold water fish species. Deep water phosphorus levels are generally moderate except at the very bottom of the pond, where levels are high.

Primarily due to the increasing chlorophyll trend, Bear Pond is in LEA's HIGH degree of concern category.

Chlorophyll-a Profile:

The graph on the right shows results of a chlorophyll-a profile done on Bear Pond. The horizontal axis shows the relative chlorophyll levels and the vertical axis shows lake depth in meters. There is a clear increase in relative chlorophyll between 5 and 10 meters. The oxygen data collected on this date (not shown) also shows an increased concentration at 5 meters, which indicates algal productivity.



Productivity is often high near the boundary zone between the upper and lower layers of the lake (which was around 5 -6 meters when this data was collected).

This is in part due to favorable conditions but can also be caused by a slowing of sinking rates. The bottom layer of the lake is much more dense than the top layer, so algae tend to float within the boundary layer for a while before they sink to the bottom of the lake.

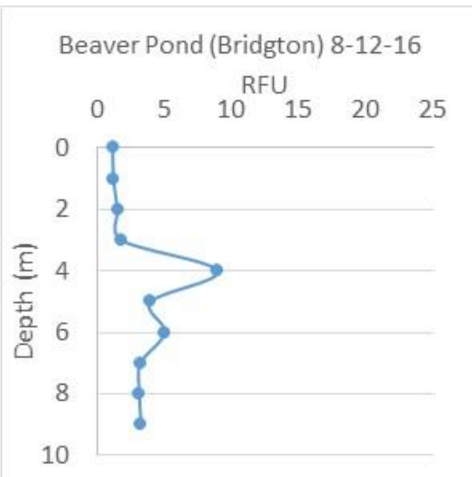
Beaver Pond (Bridgton)

Beaver Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 6.2 meters Chlorophyll: Better at 1.2 ppb Phosphorus: Better at 5.0 ppb

Surface Area:	69 acres
Maximum Depth:	35 feet
Watershed Area:	1,648 acres
Flushing Rate:	3.7 flushes per year
Elevation:	473 feet

Water Quality Summary:

Clarity, chlorophyll, and surface water phosphorus levels for 2016 all improved over long term average values. Clarity was moderate, while phosphorus and chlorophyll readings for 2016 were both low. In addition, clarity and chlorophyll trends both show significant improvement over time.



Oxygen depletion affected the lower half of the water column when sampling was done in August. Deep water phosphorus levels are also high on Beaver Pond, averaging 19 ppb. For these reasons, Beaver Pond is in LEA's MODERATE degree of concern category.

Chlorophyll-a Profile:

The graph to the left shows results of a chlorophyll-a profile done on Beaver Pond. It shows a spike in relative chlorophyll concentrations at 4 meters' depth. This spike is probably the result of microstratification, a narrow band of high productivity that is common in lakes.

Beaver Pond (Denmark)

Beaver Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: To Bottom Chlorophyll: Worse at 3.6 ppb Phosphorus: Better at 11 ppb

Surface Area:	80 acres
Maximum Depth:	7 feet
Watershed Area:	1,288 acres
Elevation:	397 feet

Water Quality Summary:

Clarity on Beaver Pond reaches to the bottom of the pond, which is about 7 feet deep. Beaver Pond's shallow water column was well oxygenated when sampled in late August. Both phosphorus and chlorophyll levels in the surface waters were moderate, however phosphorus levels were better than the long term average while the chlorophyll concentration was worse. Beaver Pond has been downgraded to the AVERAGE degree of concern category due to a lack of significant adverse water quality trends.

Bog Pond

Water Quality Summary:

The 2016 clarity reading on Bog Pond was 1.5 meters, which reached the bottom of the pond. Water quality testing has occurred once per year on Bog Pond since 2009. The phosphorus level in a 0.5 meter grab sample was 18 ppb, while the average over time is 15 ppb. The chlorophyll concentration was 5.2 ppb, higher than the average of 3.9 ppb. Phosphorus levels are considered high, while chlorophyll is moderate. Not enough data exists from Bog Pond to determine long-term trends. The pond is small, shallow and has a large wetland complex associated with it which causes some higher readings. Bog Pond remains in the AVERAGE degree of concern category.

Brandy Pond

Brandy Pond Quick Statistics
2016 Average Versus the Long-term Average:

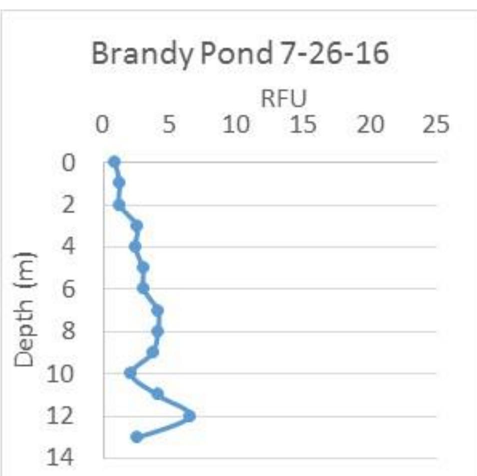
Clarity: Better at 7.2 meters
Chlorophyll: Better at 2.2 ppb
Phosphorus: Better at 5.4 ppb

Surface Area:	733 acres
Maximum Depth:	44 feet
Mean Depth:	16 feet
Volume:	11,789 acres/feet
Watershed Area:	2,300 acres
Flushing Rate:	10 flushes per year
Elevation:	267 feet

Water Quality Summary:

Brandy Pond's clarity was good on average in 2016, while chlorophyll and surface water phosphorus values were moderate. Overall trends indicate stable clarity and phosphorus, but worsening chlorophyll levels over time. Brandy Pond also has high deep water phosphorus levels and suffers from oxygen depletion. Oxygen conditions get bad enough that there is no habitat available for cold water fish in late summer.

Oxygen depletion, high deep water phosphorus, fishery impairment, and a worsening chlorophyll trend mean that Brandy Pond remains in LEA's HIGH degree of concern category.



Chlorophyll-a Profile:

The graph to the left is a chlorophyll profile that shows relative chlorophyll levels at 1 meter intervals on the pond. The results show consistently low chlorophyll throughout the water column, with a slight increase around 12 meters. This small increase could be sediment interference or a buildup of sunken algae cells. The gradual increase between 0 and 8 meters may be due to diminishing light penetration. This is because the chlorophyll signal is often stronger under low light conditions.

Cold Rain Pond

Cold Rain Pond Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: Better at 5.1 meters
Chlorophyll: Worse at 7.1 ppb
Phosphorus: Worse at 12 ppb

Surface Area:	36 acres
Maximum Depth:	36 feet
Mean Depth:	13 feet
Volume:	469 acres/feet
Watershed Area:	505 acres
Flushing Rate:	1.9 flushes per year
Elevation:	505 feet

Water Quality Summary:

Full water quality testing on Cold Rain Pond occurs once a year in August. Clarity is done several times a year with help from LEA volunteer monitors. In 2016, clarity was better than average but chlorophyll and surface water phosphorus were worse. Clarity and phosphorus were considered moderate while chlorophyll was in the high range. However, the long-term data does not show any worsening trends in clarity, chlorophyll, or phosphorus. Cold Rain Pond does, however, suffer from oxygen depletion which affects cold water fish species. The lack of long-term worsening trends has downgraded Cold Rain Pond to LEA's MODERATE degree of concern category.

Crystal Lake

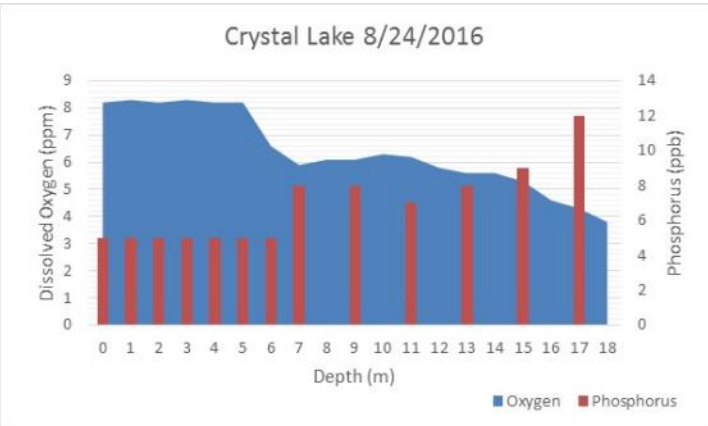
Crystal Lake Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: Better at 6.3 meters
Chlorophyll: Better at 1.9 ppb
Phosphorus: Better at 6.1 ppb

Surface Area:	446 acres
Maximum Depth:	65 feet
Mean Depth:	33 feet
Volume:	14,253 acres/feet
Watershed Area:	5,345 acres
Flushing Rate:	0.65 flushes per year
Elevation:	294 feet

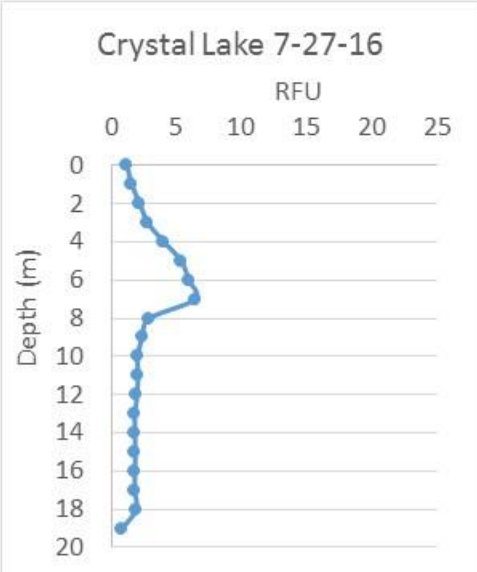
Water Quality Summary:

Clarity and surface water phosphorus averages were moderate on Crystal Lake in 2016, while chlorophyll was low on average. All three values were better than long-term averages, however the overall trend in clarity is worsening. There is slight oxygen depletion in Crystal Lake, but cold water fish still have adequate habitat.



Sediment chemistry indicates a greater risk for phosphorus to be released from sediments in Crystal Lake due to low aluminum levels. However, phosphorus can only be released under very low oxygen conditions. The mild oxygen depletion in Crystal Lake means there is little chance of this being a severe problem. The oxygen and phosphorus data in the graph on the left show only moderate deep water phosphorus levels, which is good news. Crystal Lake has been downgraded to LEA's MODERATE degree of concern.

Chlorophyll-a Profile:



The graph on the left depicts relative chlorophyll-a levels in Crystal Lake during sampling in July. Levels in the top layer of the lake (above 7 meters) gradually increase with depth until dropping down at 8 meters and remaining low. This drop in the bottom layer makes sense because lack of light and colder temperatures would inhibit algae growth. Overall values are low, which is consistent with the low chlorophyll–a average for 2016.

Duck Pond

Water Quality Summary:

Water quality monitoring has only been done on Duck Pond since 2013, so long term trends are not available. However, clarity is unlimited and reaches to the bottom of the shallow 2.8 meter deep pond in late summer. Surface water phosphorus and chlorophyll readings were very high at 31 ppb phosphorus and 13 ppb chlorophyll, but these results are expected on small, boggy ponds such as Duck Pond. Therefore, the pond remains in LEA's in the AVERAGE degree of concern category.

Foster Pond

Foster Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Worse at 6.6 meters Chlorophyll: Better at 2.1 ppb Phosphorus: Similar at 7.1 ppb

Surface Area:	149 acres
Maximum Depth:	28 feet
Mean Depth:	17 feet
Volume:	2,382 acres/feet
Watershed Area:	1,090 acres
Flushing Rate:	0.93 flushes per year
Elevation:	470 feet

Water Quality Summary:

Clarity, surface water phosphorus, and chlorophyll averages were all in the moderate range in 2016. An analysis of clarity, surface water phosphorus, and chlorophyll trends since 1996 indicate stable conditions on Foster Pond. Unusually low clarity was seen at the end of the 2016 testing season however a lack of other significant water quality issues on Foster Pond means that it has been downgraded to the AVERAGE degree of concern category.

Granger Pond

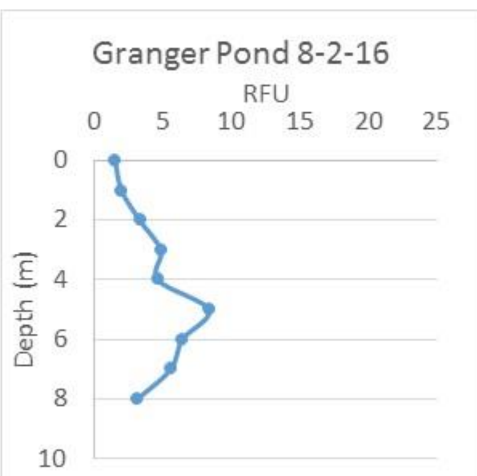
Granger Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 7.2 meters Chlorophyll: Better at 2.9 ppb Phosphorus: Better at 7.0 ppb

Surface Area:	125 acres
Maximum Depth:	28 feet
Watershed Area:	642 acres
Elevation:	525 feet

Water Quality Summary:

Average clarity on Granger Pond was good in 2016 at 7.2 meters, as compared to the long-term average of 6.7 meters which is considered moderate. Surface water phosphorus and chlorophyll values improved over long-term averages but are still in the moderate range of values. Long term trends appear to be stable.

Granger Pond experienced algae blooms in 2007 and 2008 and continued to have high chlorophyll-a levels in August through 2013. Although there are no other significant water quality issues, due of the risk of more algae blooms Granger Pond is in the MODERATE degree of concern category.



Chlorophyll-a Profile:

The graph to the right shows the results of a chlorophyll profile on Granger Pond in August. Relative chlorophyll values increase down to about 5 meters and then taper off. The top layer of water (down to about 6 meters on the date of sampling) is where much of the algae productivity occurs. The bottom layer is cold and very little sunlight reaches it, making it unsuitable for algae growth and resulting in the decrease in chlorophyll in the deeper waters.

Hancock Pond

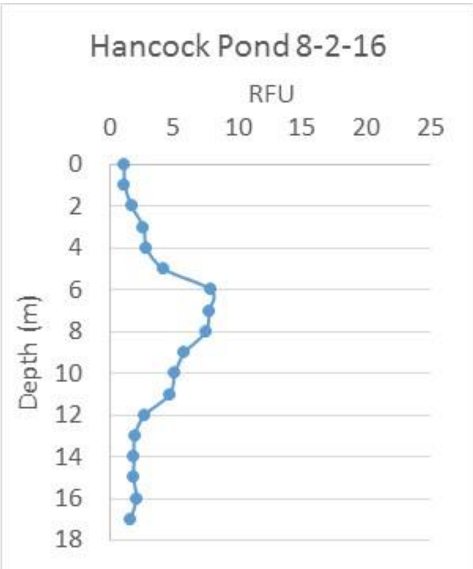
Hancock Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 7.7 meters
Chlorophyll: Better at 2.3 ppb
Phosphorus: Better at 5.4 ppb

Surface Area:	858 acres
Maximum Depth:	59 feet
Watershed Area:	2,222 acres
Elevation:	502 feet

Water Quality Summary:

The average 2016 water clarity in Hancock Pond was in the good range, while surface water phosphorus and chlorophyll were both moderate. All parameters were improved over long-term averages. LEA also assesses the long-term trend from 1996 to 2016, which shows that clarity has been improving while chlorophyll is worsening over time.

Dissolved oxygen depletion becomes severe quickly in the pond due to the relatively small volume of deep water. The lack of oxygen affects much of the cold water fish habitat in the pond. The worsening chlorophyll trend automatically puts Hancock Pond in the HIGH degree of concern category.



Chlorophyll-a Profile:

The graph to the right shows the results of a chlorophyll profile on Hancock Pond in August. This profile measured the areas where algae productivity was occurring. Relative chlorophyll values increased down to about 6 meters and then tapered off.

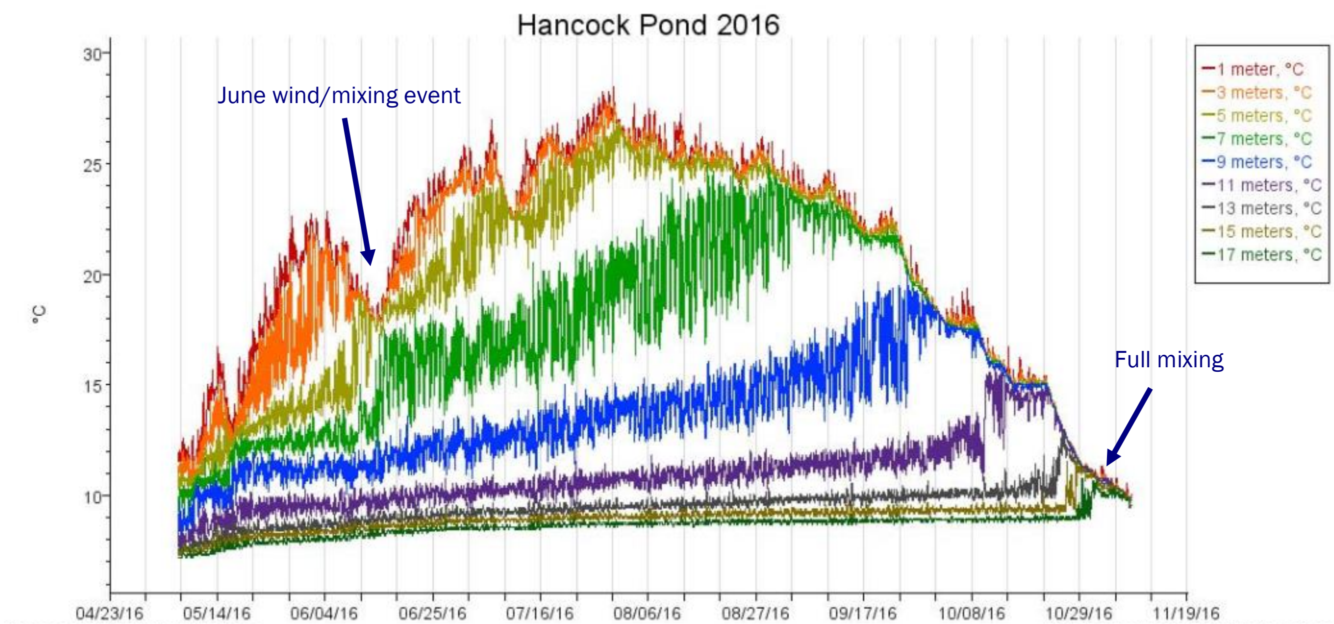
Oxygen levels (not shown) increased at 6 meters along with relative chlorophyll, which is another sign of higher algae productivity. The zone of higher productivity coincides with the boundary layer between warm upper layer and the cold bottom layer of the lake. Many algae prefer to live near this boundary and it is common to see an increase in productivity in this area.

High-Resolution Temperature Monitoring:

Temperature sensors were deployed in Hancock Pond at the beginning of May, shortly after the pond started to stratify (see graph below). For most of the stratified period the top layer of water, known as the epilimnion, reached from the top of the pond down to around 5 meters deep. High wind conditions around June 15 caused mixing within the first 5-7 meters of the pond and affected the whole water column by raising temperatures slightly.

The thermocline, a region of rapid temperature and density change, was around 7 meters deep. The waters below 7 meters were in the bottom layer, called the hypolimnion. Stratification began to break down in late August and continued as air temperatures cooled. Full mixing occurred in early November. The maximum temperature at 1 meter below the surface reached 28.5 °C (83.3 °F) on July 30.

Date of Fall Turnover (Complete Mixing)			
	2014	2015	2016
Hancock Pond	11/3	after 11/10	11/5



Algae Monitoring:

Four algae samples were collected from Hancock Pond between July and September. Algae abundance increased over the summer, and overall levels were low to moderate compared to other lakes studied. Flagellated algae were common in the samples collected, as were centric diatoms and *Urosolenia*, a non-centric diatom. Hancock Pond was notable for its cyanobacteria population, which lacked the common genus *Merismopedia* but consistently had elevated levels of *Coelosphaerium.* While *Coelosphaerium* is associated with water quality problems, it is also common in lower-nutrient waters and was not dense enough to cause concern. However, populations will be monitored closely in 2017 for any changes. The algae assemblage was indicative of a deep, clear lake with low– to moderate– productivity.

Highland Lake

Highland Lake Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: Better at 7.5 meters
Chlorophyll: Better at 2.1 ppb
Phosphorus: Better at 5.8 ppb

Surface Area:	1,334 acres
Maximum Depth:	50 feet
Mean Depth:	20 feet
Volume:	44,030 acres/feet
Watershed Area:	5,178 acres
Flushing Rate:	0.94 flushes per year
Elevation:	426 feet

Water Quality Summary:

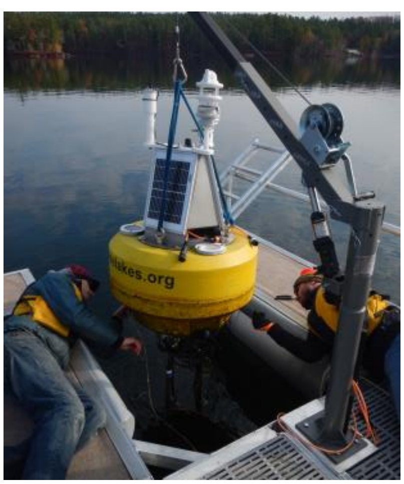
The average clarity on Highland Lake in 2016 was in the good range, an improvement over the long-term average, which was considered moderate. Clarity and chlorophyll trends show both parameters have improved significantly over time. The surface water phosphorus levels are moderate on average and the long term trend is stable.

A deep sediment core, which was used to measure changes in diatom algae preserved in sediments, suggests that Highland Lake has been experiencing longer periods of stratification starting in the 1950s. The drivers from this shift likely include lower wind strength, earlier ice-out, and/or warmer overall temperatures.

Highland Lake's biggest water quality issues are dissolved oxygen depletion and high phosphorus in the deeper waters. Low dissolved oxygen is pronounced and adversely affects cold water fish habitat. The northeastern cove also experienced a bloom of golden algae in July 2002. Because of these issues, Highland Lake is in LEA's HIGH degree of concern category.

Algae Monitoring:

One algae sample was collected from Highland Lake in early July. *Urosolenia*, a large diatom, was the most common type of algae counted. Golden algae such as *Chrysosphaerella* and *Dinobryon* were also common. The most common cyanobacteria was *Aphanocapsa*, a small, ubiquitous algae genus common in low-nutrient systems. There was some *Dolichospermum* (formerly known as *Anabaena*) present in the sample, but the overall amount was low. These algae indicate an oligo– to mesotrophic system with low to moderate levels of productivity.



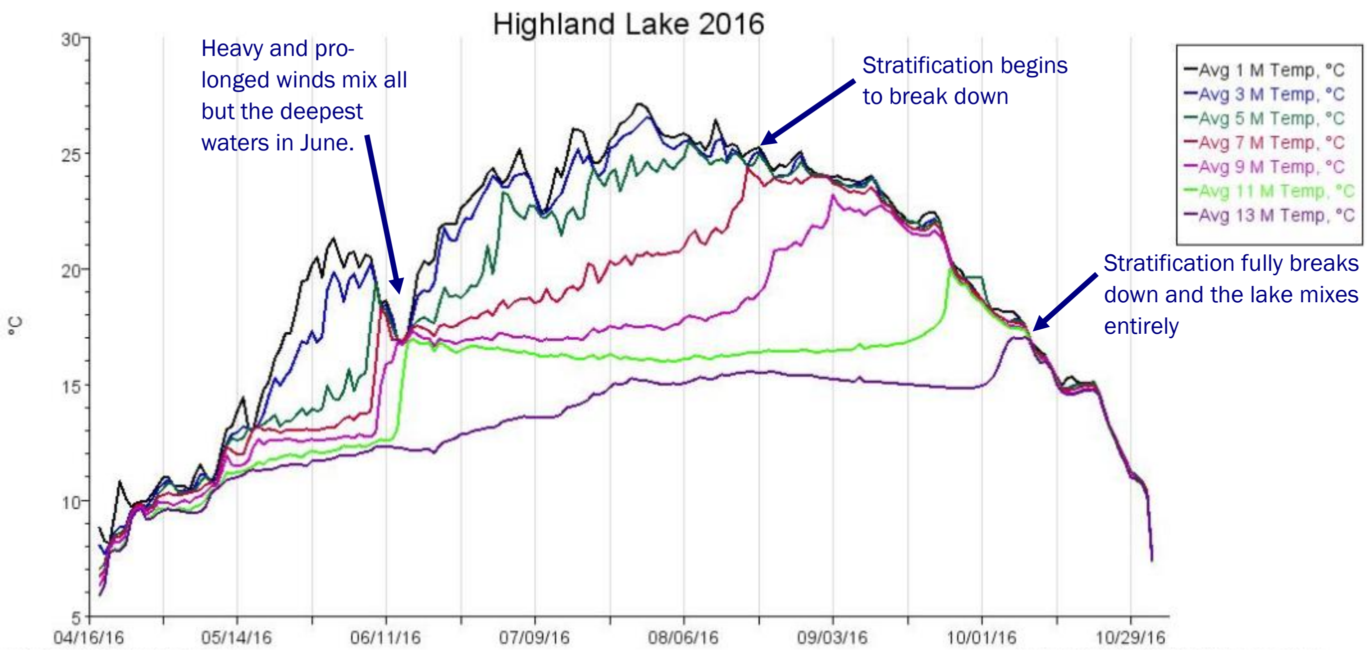
Highland Lake Automated Buoy

2016 was the third year of deployment for LEA's high-tech, automated sampling buoy on Highland Lake. The buoy monitors oxygen concentrations and temperature at every other meter from the surface to the bottom of the lake, chlorophyll concentrations via a fluorometer and relative clarity by monitoring light conditions in the air and underwater. The buoy takes readings every 15 minutes and sends those readings back to LEA through a cell signal. This information is coupled with live weather data from a weather station on the buoy and another station on Highland Ridge overlooking the lake.

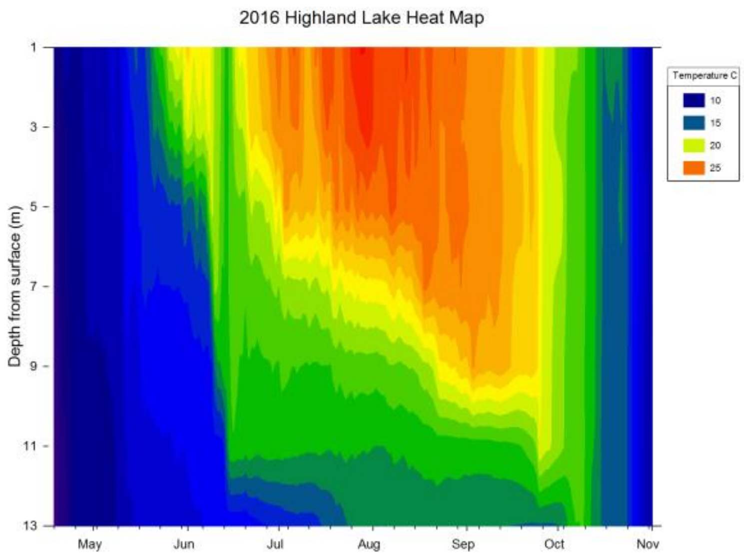
In 2016, the buoy was launched on April 18th and removed from the lake on November 2nd.

Temperature and Stratification: The warmest temperature recorded in the surface water was 27.9°C (82 °F). At installation, the surface of the lake was 9°C (48°F) and the bottom was 5°C (41°F). The entire water column was uniformly around 10°C (50 °F) when the buoy was removed. The lake was undergoing periods of slight stratification and mixing when the buoy was installed on April 18. By mid-May the lake has set up into distinct layers but a period of high winds in June broke down this layering and mixed all but the very bottom waters of the lake. However, stratification quickly reformed and remained strong until mid September when the upper waters began to cool slightly and mix with lower waters. A full breakdown of the lake's layers occurred on October 10th.

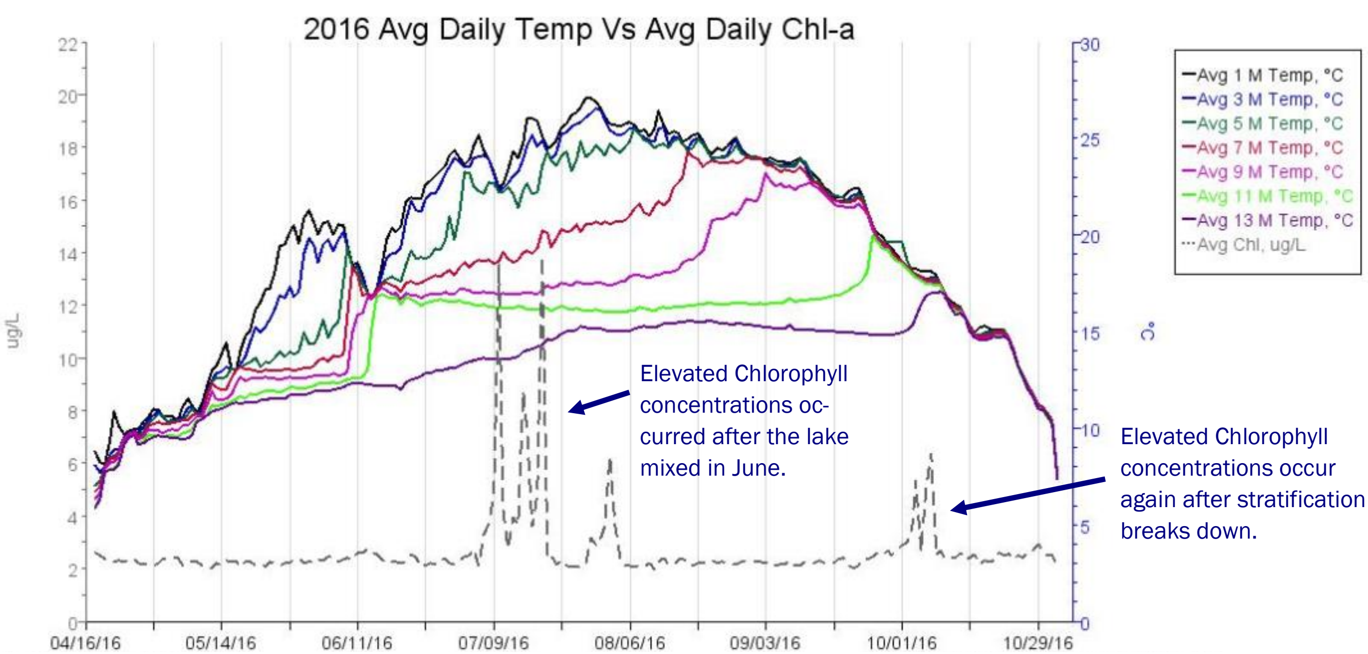
Date of Fall Turnover (Complete Mixing)				
	2013	2014	2015	2016
Highland Lake	after 10/11	10/12	10/11	10/10



Highland Lake Heat Map: The image to the right represents the temperature conditions in Highland Lake over the course of the summer. The top of the image is the top of the lake. Reds and oranges are warmer waters and blues and purples are colder waters. The blue/purple stretching from the top to the bottom shows how the lake was uniformly mixed in the early and late season. This image quickly expresses the duration and extent of warmed water over the course of the season.

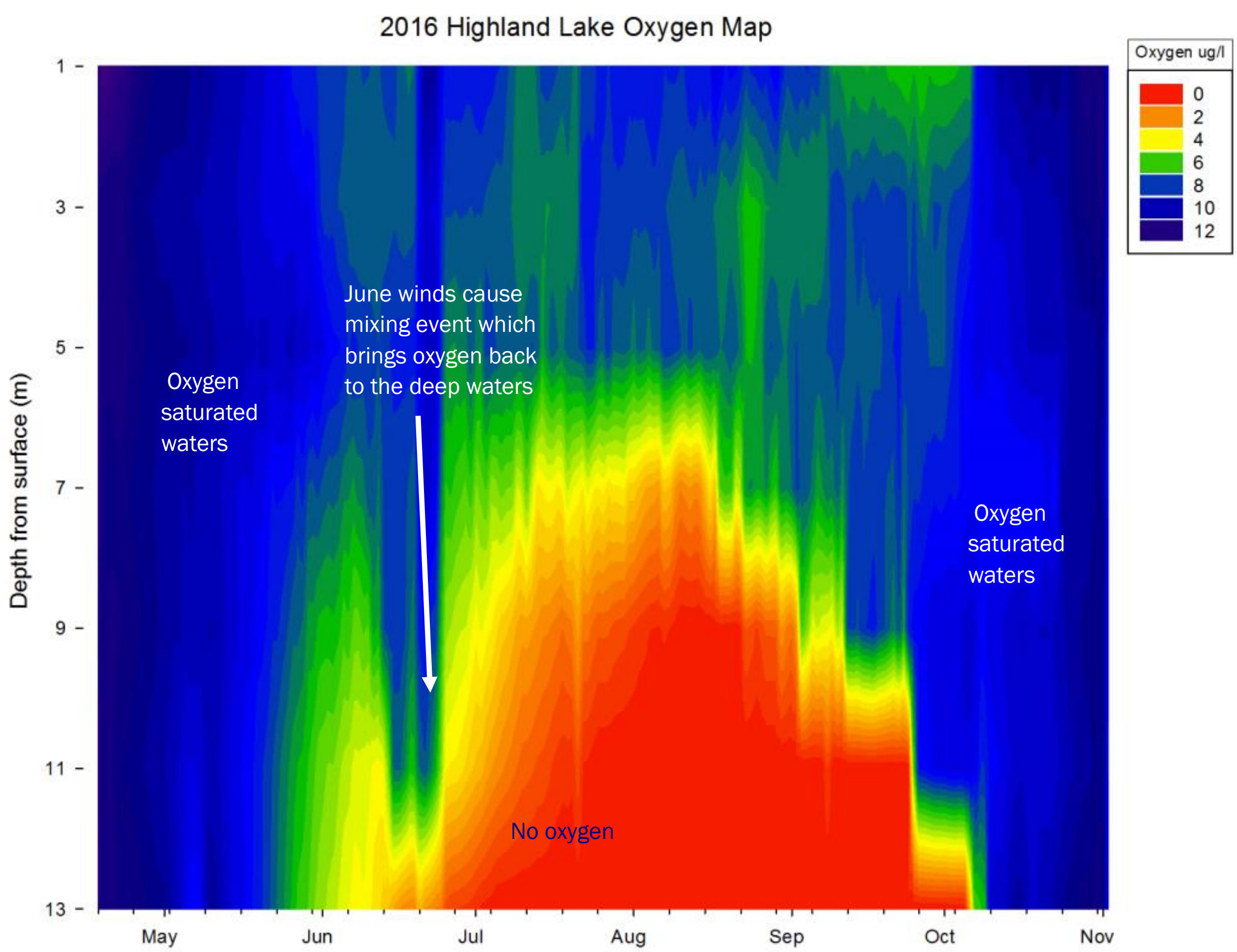


Chlorophyll/Algae growth: Chlorophyll, which is the green pigment in all plants and algae was measured with an optical fluorometer installed at 1.7 meters below the surface. Fluorometers can give immediate data on relative chlorophyll concentrations and while it is reported here in ug/l (which is the same as ppb), it is important to recognize these readings are relative and not the same as the results acquired through water samples analyzed through spectrophotometry (which is LEA's standard methodology for assessing chlorophyll concentrations). Elevated chlorophyll concentrations were observed in mid July, early August and early October. These peaks follow mixing events and are shown in the graph below. Average chlorophyll concentration at this depth for the season was 2.6 ug/l.



Precipitation: A correlation between precipitation events and chlorophyll concentrations was not easily discernible from data gathered in 2016. Overall, however, there was very little rain over the course of the growing season and algae populations were below average.

Oxygen Conditions: By having continuous oxygen monitoring from the surface to the bottom of the lake, we can better understand the extent and duration of oxygen depletion. The image below gives a quick overview of oxygen conditions in the lake throughout the season. Similar to the heat map already discussed, the top of the graphic represents the top of the lake and time from deployment to removal is represented along the bottom axis. Blues and purples represent fully oxygenated waters, green is moderately oxygenated and yellow and orange are severely depleted. Red indicates anoxia or no oxygen. Most aquatic life is unable to survive when oxygen levels are below 4 mg/l. Because of the June mixing event already discussed, the severity and breadth of oxygen depletion was not as robust as the last few summers. Notice that while oxygen depletion occurs in a linear progression in the early season (shown on the graph as relatively smooth, upward, rainbow-like curve from the bottom), re-oxygenation occurs in a more stepped fashion. This is a result of surface water cooling down and individual lake layers mixing and is shown on the graph in the September through October time period.



Holt Pond

Holt Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: To Bottom Chlorophyll: Worse at 5.1 ppb Phosphorus: Worse at 15 ppb

Surface Area:	41 acres
Maximum Depth:	10 feet
Mean Depth:	7 feet
Watershed Area:	2,118 acres
Flushing Rate:	46 flushes per year
Elevation:	455 feet

Water Quality Summary:

Holt Pond is sampled once per year in August. Clarity reached the bottom of the 10-foot (3 meter) deep pond at the time of testing. Despite a high phosphorus reading this year, the long-term trend shows that phosphorus is improving over time on Holt Pond. The chlorophyll level was moderate and both clarity and chlorophyll trends are stable.

Despite it's shallow depth, Holt Pond does suffer from oxygen depletion. However, wind mixing limits the duration of low-oxygen events. Holt Pond's large watershed, shallow depth and surrounding wetlands are likely accountable for much of the pond's water quality characteristics. Holt Pond remains in the AVERAGE degree of concern category.

Island Pond

Island Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 6.6 meters Chlorophyll: Better at 2.3 ppb Phosphorus: Better at 5.8 ppb

Surface Area:	115 acres
Maximum Depth:	48 feet
Mean Depth:	16 feet
Volume:	1,626 acres/feet
Watershed Area:	1,128 acres
Flushing Rate:	1.3 flushes per year
Elevation:	448 feet

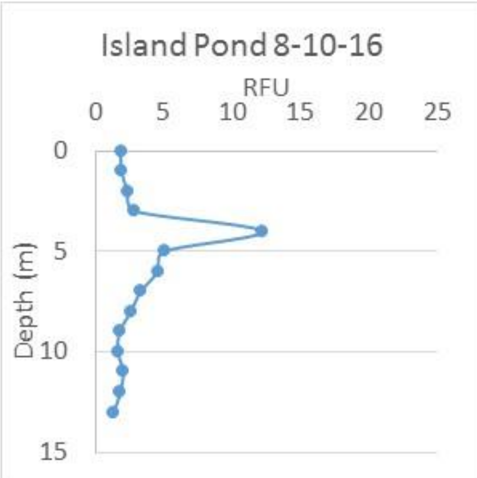
Water Quality Summary:

On average, clarity, surface water phosphorus and chlorophyll levels were considered moderate and better than long-term averages in 2016. Long-term trends are stable for all three parameters.

Island Pond's main water quality concerns are dissolved oxygen depletion, high deep-water phosphorus levels, and the effect of low oxygen on cold water fish. Because of these three issues, Island Pond is in LEA's MODERATE/HIGH degree of concern category. A lack of worsening trends means that the pond was lowered from its previous high concern ranking.

Results from chlorophyll-a profiling and high-resolution temperature monitoring are on the following page.

Chlorophyll-a Profile:



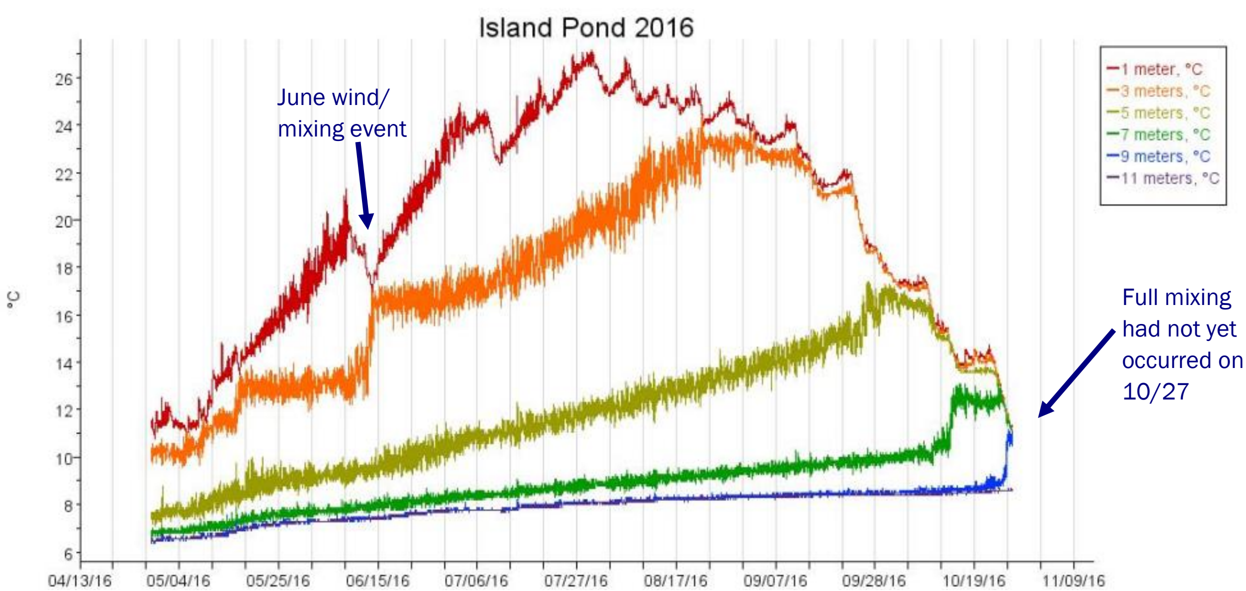
The graph on the left shows how relative chlorophyll (a measurement of algae abundance) changes with depth in Island Pond. The results show a common pattern of increasing chlorophyll around the boundary between the top and bottom layer of the pond.

The spike in chlorophyll is more pronounced than in some other lakes' profiles, which suggests this might be a microstratification layer—a thin zone of high algal biomass.

High-Resolution Temperature Monitoring:

Island Pond had already begun to stratify by the time temperature sensors were deployed in late April. The epilimnion (upper waters) was less than 3 meters deep for most of the summer, which is relatively shallow. The location of the thermocline is not obvious based on the graph, but according to water testing data, it was located at 3 meters at the beginning of the testing season in May and deepened to 5 meters for most of the summer. High winds around June 15th caused mixing between 0 and 3 meters. The sensor at one meter deep reached a maximum temperature of 27.2 °C (81.0 °F) on July 30th. Lake mixing (destratification) began in mid-August and continued as temperatures cooled in the Fall. Full mixing did not occur until late October or early in November.

Date of Fall Turnover (Complete Mixing)			
	2014	2015	2016
Island Pond	11/2	after 10/27	After 10/27



Jewett Pond

Jewett Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 5.2 meters Chlorophyll: Better at 3.8 ppb Phosphorus: Better at 8.0 ppb

Surface Area:	43 acres
Maximum Depth:	41 feet
Watershed Area:	638 acres
Elevation:	580 feet

Water Quality Summary:

Water quality in Jewett Pond, one of the Five Kezar Ponds, is measured once a year in August. Results from this year's sampling indicate that clarity, chlorophyll, and surface water phosphorus are all moderate and improved over long-term averages. Trend analysis of data from 1996-2016 show stable conditions on the pond.

Jewett Pond's main water quality concerns are severe oxygen depletion and high to very high phosphorus levels in the deeper waters of the pond. These conditions mean that Jewett Pond is in LEA's MODERATE degree of concern category. The pond was lowered from the high degree of concern category because of the stable trends in chlorophyll, surface water phosphorus, and chlorophyll.

Keoka Lake

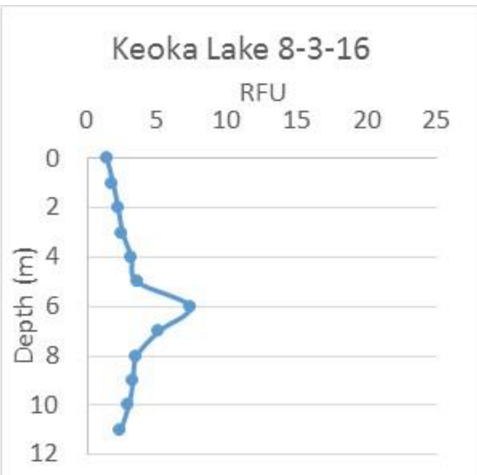
Keoka Lake Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 6.0 meters Chlorophyll: Better at 2.2 ppb Phosphorus: Better at 7.4 ppb

Surface Area:	460 acres
Maximum Depth:	42 feet
Mean Depth:	25 feet
Volume:	10,569 acres/feet
Watershed Area:	3,808 acres
Flushing Rate:	0.7 flushes per year
Elevation:	492 feet

Water Quality Summary:

Clarity, surface water phosphorus and chlorophyll averages were all moderate and better than long-term averages. Long term data trends show no significant change over time for any of these parameters, indicating that they are stable.

Keoka Lake's main water quality concerns are low oxygen levels and very high deep water phosphorus levels. Despite low dissolved oxygen, there is still some habitat available for tolerant cold water fish such as Brook Trout. Keoka Lake is also one of four lakes with levels of *Gloeotrichia echinulata* algae high enough to be of concern (see summary below). For these reasons, Keoka Lake has been elevated to the MODERATE/HIGH degree of concern level. It was previously in the moderate category.



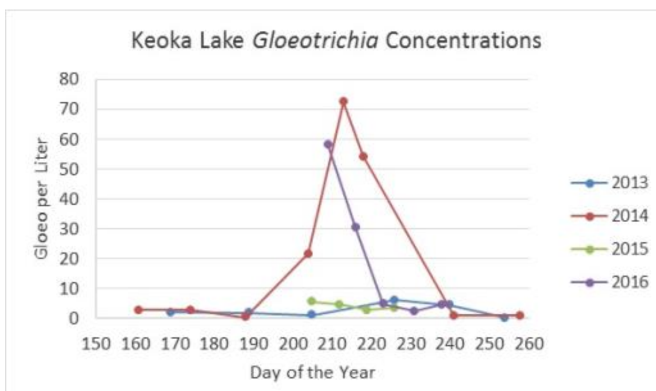
Chlorophyll-a Profile: The graph on the left shows the results of a chlorophyll-a profile. This profile measures the relative amount of chlorophyll (a way to measure algae concentrations) at various depths in the water column.

The graph shows low relative concentrations that increase gradually with a spike at 6 meters and then decline at depth. This is a common pattern indicating elevated productivity near the surface water/deep water boundary.

Algae often accumulate near this boundary because the high density of the colder deep water slows algae sinking rates.

Gloeotrichia echinulata:

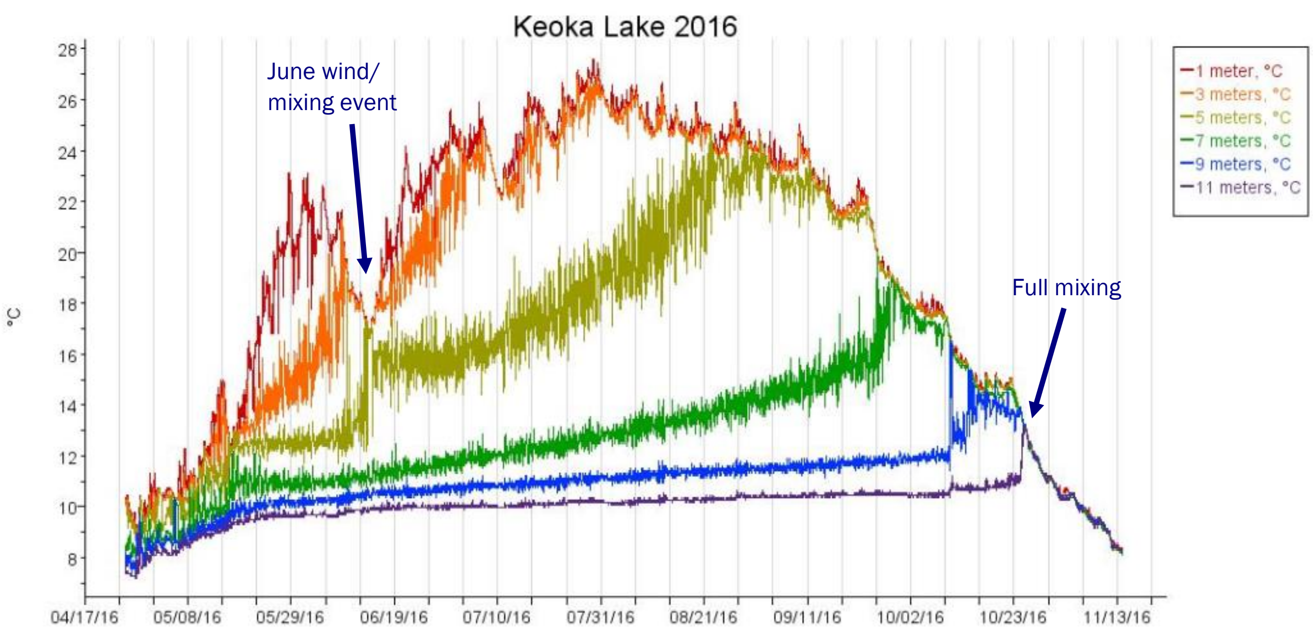
Keoka Lake was sampled five times in 2016 between July 27th and September 25th at a site near the public boat launch. The highest level of *Gloeotrichia* in these samples was 58 col/L on July 27th, and the average was 20 col/L. Concentrations of the algae in Keoka Lake vary greatly from year to year, with 2014 and 2016 having the highest levels of any of the lakes and ponds tested while 2013 and 2015 samples were all under 7 col/L.



High-Resolution Temperature Monitoring:

The graph below shows temperature patterns in Keoka Lake from April through November, 2016. The water was just beginning to stratify when sensors were deployed in late April. Warm, calm conditions in May allowed a temperature gradient to form. The warm upper layer of the lake was situated between about 0-5 meters for most of the summer. The boundary layer was right around 6 meters, and the lowest layer extended from 6 meters to the bottom of the lake. High winds on June 15th caused mixing down to five meters, which led to warmer temperatures around this depth for the rest of the season. The maximum temperature at 1 meters' depth was 27.6 °C (81.7 °F) on July 29th. Stratification deepened in late August and continued as air temperatures cooled. Full mixing, the point where stratification (lake layering) broke down completely and all of the water in the lake was uniform in temperature, occurred on October 25th, slightly later than in the past two years.

Date of Fall Turnover (Complete Mixing)			
	2014	2015	2016
Keoka Lake	10/22	10/23	10/25



Algae Monitoring:

Keoka Lake was sampled for algae five times between June and September. Overall abundance was moderate to high relative to the other lakes sampled in 2016. Common early summer algae included the diatoms *Asterionella*, *Tabellaria* and *Stephanodiscus*. Flagellated algae such as *Chrysochromulina* and *Rhodomonas* were common throughout the summer. Cyanobacteria were more abundant later in the season, including *Merismopedia*, *Chroococcus*, and *Aphanocapsa*. The algae assemblage indicates a moderate level of productivity within the system.

Keyes Pond

Keyes Pond Quick Statistics
2016 Average Versus the Long-term Average:

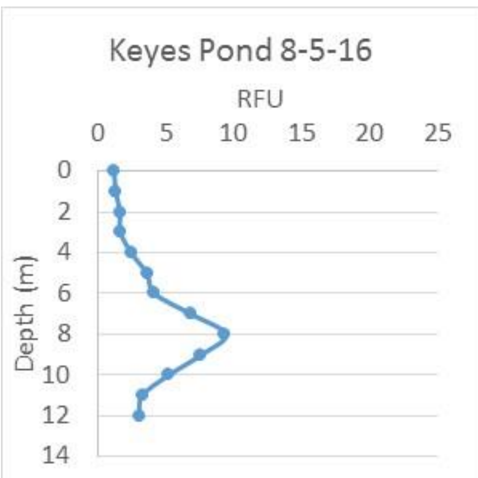
Clarity: Better at 7.3 meters
Chlorophyll: Better at 2.2 ppb
Phosphorus: Better at 6.5 ppb

Surface Area:	191 acres
Maximum Depth:	42 feet
Mean Depth:	17 feet
Volume:	3,333 acres/feet
Watershed Area:	1,213 acres
Flushing Rate:	0.8 flushes per year
Elevation:	508 feet

Water Quality Summary:

The average clarity on Keyes Pond was over one meter (3.3 feet) deeper than the long-term average, which is a big improvement. Average surface water phosphorus and chlorophyll levels were moderate. Trend analysis of clarity, surface water phosphorus and chlorophyll data since 1996 show that water quality is stable.

Keyes Pond has been downgraded from a high degree of concern to LEA's MODERATE degree of concern because of stable conditions. However, Keyes Pond does suffer from low oxygen within its deeper waters in the late summer as well as high deep water phosphorus levels. Despite the oxygen depletion, tolerant cold water fish such as Brook Trout still have some habitat available.

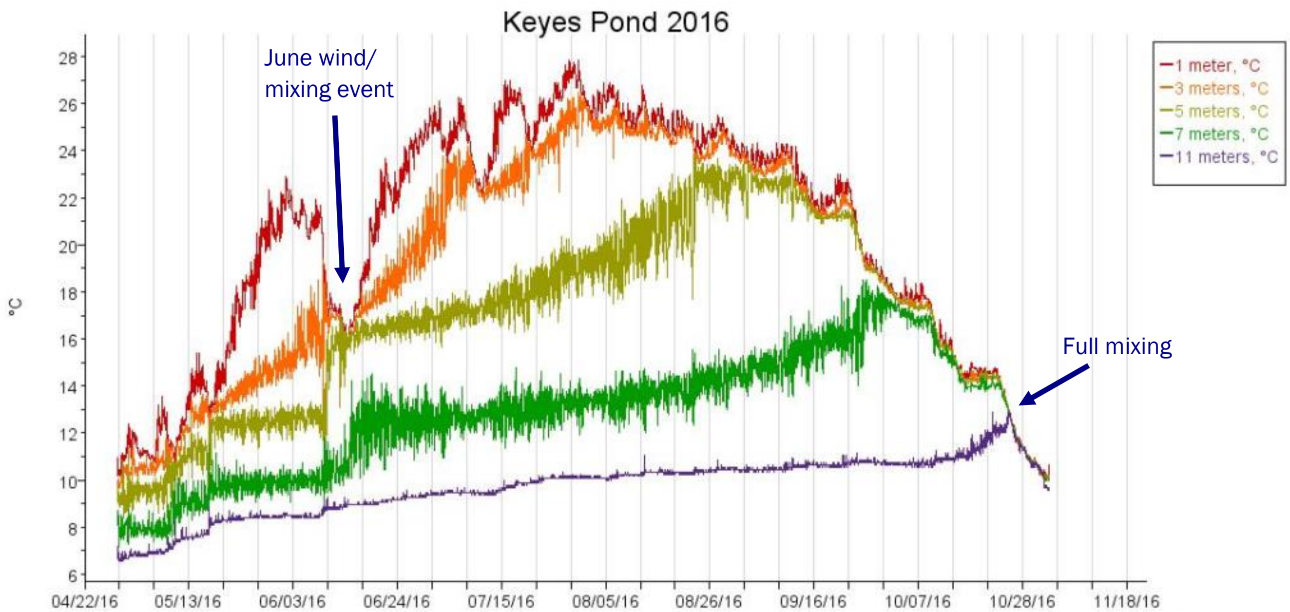


Chlorophyll-a Profile: The graph to the left shows relative chlorophyll levels at various depths on Keyes Pond. The purpose of the profile is to show the location and magnitude of algae productivity. The graph shows a common pattern of greater algae abundance near the boundary between the warm top layer of the lake and the cold bottom layer. Algae often accumulate in this zone because the high density of the cold water slows their sinking rate. Many heavier algae that are dependent on water currents to move them will end up sinking down and floating in the boundary zone on calm days.

High-Resolution Temperature Monitoring:

Sensors were deployed in late April, just as the pond was starting to stratify. The graph below shows temperature patterns at 2-meter depth intervals. Warm conditions from mid May to mid June accelerated the stratification process, then a high wind event around June 15th occurred. This event affected the entire lake, causing deep mixing and dramatically warming the water around 5 meters. The event even slightly increased the temperature at the bottom of the pond. Surface water temperature (1 meter deep) reached a high of 27.9°C (82.2 °F) on July 28th and 30th. Gradually cooling air temperatures caused water temperatures to fall and slowly the layers of stratification broke down. The pond mixed completely on October 25th.

Date of Fall Turnover		
	2015	2016
Keyes Pond	10/26	10/25



Kezar Pond

Kezar Pond Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: To Bottom
Chlorophyll: Worse at 4.6 ppb
Phosphorus: Better at 16.0 ppb

Surface Area:	1,851 acres
Maximum Depth:	12 feet
Watershed Area:	10,779 acres
Elevation:	369 feet

Water Quality Summary:

Water quality is measured once a year in August on Kezar Pond. Visibility reached to the bottom of the 3 meter deep pond. Phosphorus was in the high range, but the trend in phosphorus values has remained stable over time. However, chlorophyll levels were worse than the long term average and the chlorophyll trend is also worsening over time, which automatically puts Kezar Pond in LEA's HIGH degree of concern category.

Little Pond

Little Pond Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: To Bottom
Chlorophyll: Better at 2.5 ppb
Phosphorus: Better at 8 ppb

Surface Area:	33 acres
Maximum Depth:	13 feet
Watershed Area:	633 acres
Elevation:	360 feet

Water Quality Summary:

Water Quality on Little Pond is measured once a year in August. Visibility reached to the bottom of the 4.5 meter deep pond at the time of sampling. Phosphorus and chlorophyll levels were both in the moderate range and showed improvement over long term averages. Trend analysis shows stable water quality. Despite being a shallow pond, there was some oxygen depletion near the bottom. Little Pond is in the AVERAGE degree of concern category.

Little Moose Pond

Little Moose Pond Quick Statistics
2016 Average Versus the Long-term Average:

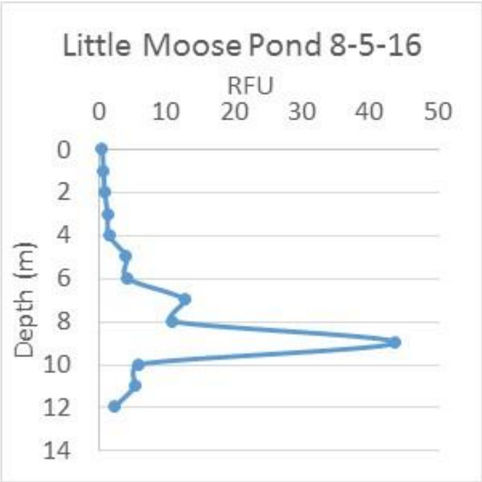
Clarity: Better at 7.9 meters
Chlorophyll: Similar at 2.3 ppb
Phosphorus: Better at 5.1 ppb

Surface Area:	195 acres
Maximum Depth:	43 feet
Mean Depth:	22 feet
Volume:	4,010 acres/feet
Watershed Area:	1,184 acres
Flushing Rate:	0.6 flushes per year
Elevation:	545 feet

Water Quality Summary:

Clarity on Little Moose Pond is good, while surface water phosphorus and chlorophyll are both moderate. Trend analysis shows stable clarity, surface water phosphorus and chlorophyll conditions. The main water quality concern on Little Moose Pond is oxygen depletion and high deep water phosphorus levels. Oxygen depletion affects the ecology of the pond and can cause phosphorus release from sediments. High phosphorus levels can lead to excess algae growth. Due to stable trends in water quality, Little Moose Pond has been downgraded to LEA's MODERATE degree of concern category.

Chlorophyll-a Profile:



The graph to the left shows relative chlorophyll-a levels at various depths. The purpose of the profile is to show where algae productivity is occurring. Little Moose Pond had the highest relative chlorophyll values of any of the lakes tested, with a huge spike at 9 meters. This could be a result of microstratification, which is a thin layer of high productivity. Algae often build up around the boundary between the top and bottom layers of water. High phosphorus levels from the deeper waters could be fueling some of the excess algae growth that appears to be occurring at this depth in Little Moose Pond.

Little Mud Pond

Water Quality Summary:

Little Mud Pond is the smallest of the Five Kezar Ponds. Clarity was poor in the pond at only 2.9 meters, surface water phosphorus was very high at 26.0 ppb, and chlorophyll was high at 12.0 ppb. Deeper waters also suffered from dissolved oxygen depletion. However, low clarity and high and elevated nutrient levels are primarily natural and likely a result of the large wetland complex that surrounds the pond. The organic tannins that leach out of these wetlands give the water its high color and low clarity but at the same time limit the amount of algae growth. Water quality trends remain stable and the pond is in LEA's AVERAGE degree of concern category.

Long Lake

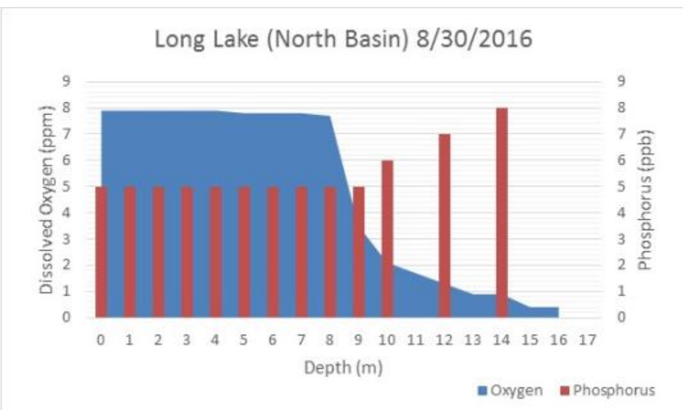
Long Lake (average of all basins) Quick Statistics 2016 Average Versus the Long-term Average:

Clarity: Better at 6.9—7.2 meters
Chlorophyll: Better at 2.3—2.6 ppb
Phosphorus: Better at 6.1—6.6 ppb

Surface Area:	4,935 acres
Maximum Depth:	59 feet
Mean Depth:	34 feet
Volume:	165,500 acres/feet
Watershed Area:	33,871 acres
Flushing Rate:	0.94 flushes per year
Elevation:	267 feet

Water Quality Summary:

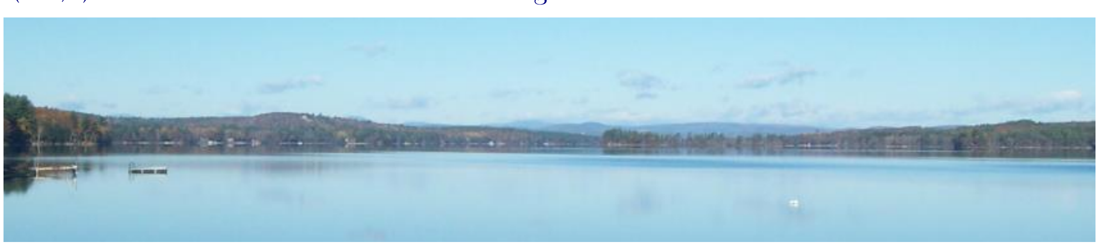
Basic water quality is similar in all three basins of Long Lake. Clarity is moderate in the north basin and good in the middle and south basins, although the season averages differ by only 0.3 meters. Surface water phosphorus and chlorophyll values were moderate in all three basins. Phosphorus levels differed by 0.5 ppb and chlorophyll by 0.3 ppb across the three basins. All three basins experienced oxygen depletion that left little habitat for Landlocked Salmon, although more tolerant species like Brook Trout were less limited. Clarity, surface water phosphorus and chlorophyll trends remain stable, with no significant changes since 1996.



The graph to the left shows oxygen (blue) and phosphorus (red bars) levels at various depths in Long Lake. Dissolved oxygen drops off dramatically at 9 meters, with a corresponding increase in phosphorus levels. Long Lake has low sediment aluminum levels, which makes the lake more at risk of sediment phosphorus release. However, phosphorus levels in the deeper waters of the lake remain moderate, which indicates that very little phosphorus release is actually happening.

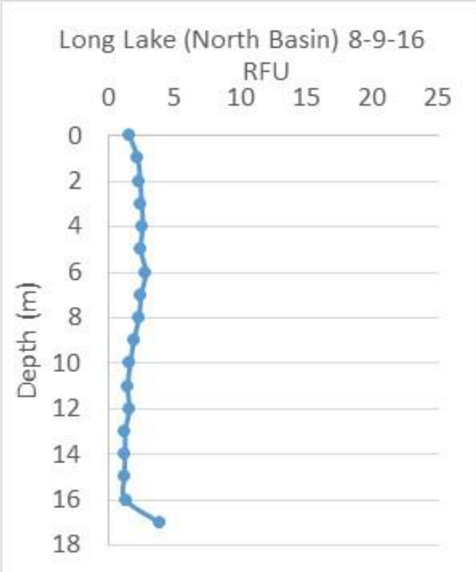
Long Lake is also among the four lakes with the highest *Gloeotrichia echinulata* algae populations in LEA's service area (see summary on the next page). Because of oxygen depletion that affects Landlocked Salmon as well has a high risk of sediment phosphorus release and high Gloeo levels, Long Lake is in LEA's HIGH degree of concern category.

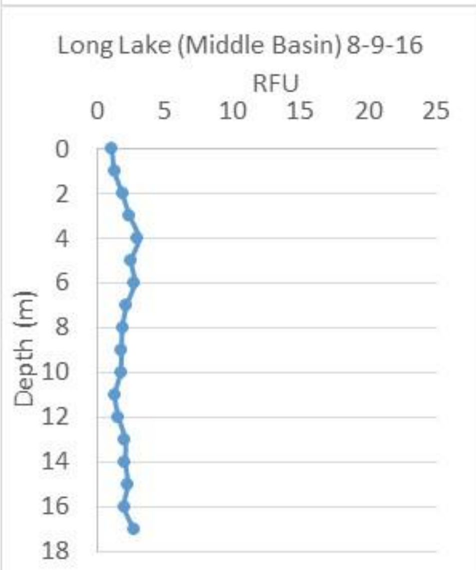
Deep Sediment Coring: A deep sediment core, which was used to measure changes in diatom algae preserved in sediments, suggests that Long Lake has been experiencing longer periods of stratification starting in the early 1900s. The drivers from this shift may include lower wind strength, earlier ice-out, and/or warmer overall temperatures. The diatom record also shows a small (2-4%) increase in nutrient levels occurring around 1950.

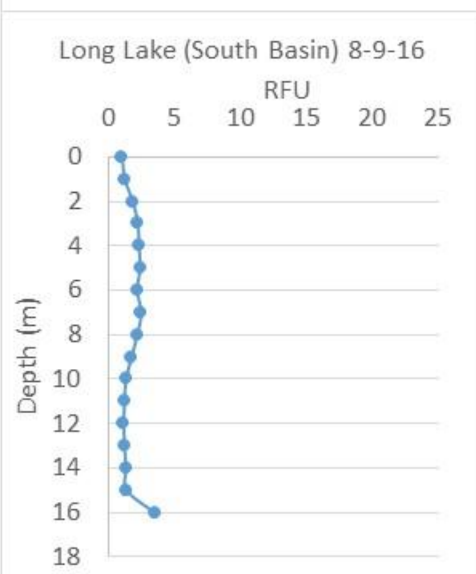


Chlorophyll-a Profiles:

The graphs to the left show the results of chlorophyll-a profiles in each of the three basins of Long Lake. The profiles are meant to show areas of algae productivity. Each of the basins had consistently low relative chlorophyll values throughout the water column. Levels decreased slightly with depth, which makes sense since much of the algae growth in a lake occurs in the upper waters. Higher levels at the very bottom in the north and south basins may be due to sediment interference.



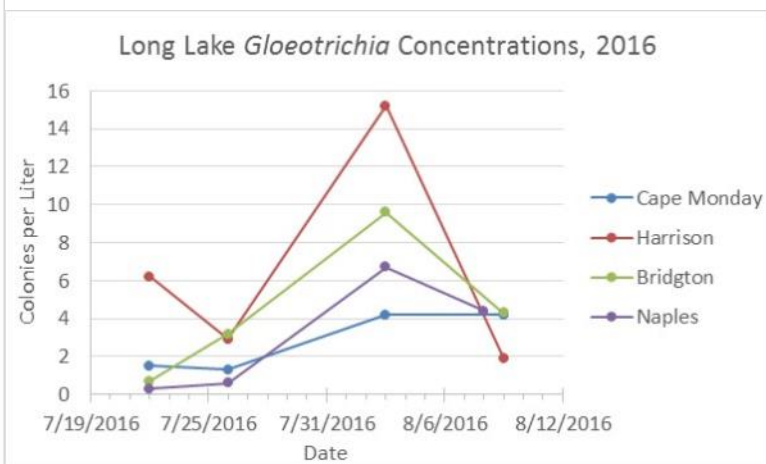




Gloeotrichia echinulata:

There are four sites sampled for *Gloeotrichia* on Long Lake. They are located in Cape Monday Cove on the eastern side of the lake, in Harrison on the northwest shore of the lake, in Bridgton on the west shore, and the Naples Causeway on the south shore. Each site was sampled four times in 2016 between July 22 and August 9. Results of 2016 sampling can be seen in the graph below. All three sites reached their highest concentrations on August 3rd. The Harrison site had the most *Gloeotrichia* of the three sites, followed by Bridgton, Naples, and Cape Monday. In four of the last five years of sampling, *Gloeotrichia* levels were highest at the northern end of the lake.

Peak *Gloeotrichia* concentrations ranged from a high of 15.2 col/L in Harrison to a low of 4.2 col/L in Cape Monday. These levels are similar to most other years of testing, with the exception of 2014, which saw very high peak concentrations at each site (all above 16 col/L).



High-Resolution Temperature Monitoring:

Long Lake's middle and south basins contained temperature sensors from mid-May through early November (see graphs on the next page). Wind events in May and June affected the entire depth of both basins, raising temperatures in the deeper parts of the lake significantly. This had the effect of weakening stratification because there was less of a difference in temperature between the top and bottom layers of water. The lake's size and shape give it unique temperature patterns. Even in normal years, Long Lake's basins have much warmer deep-water temperatures because the lake is able to mix much more easily than many others in the area.

The middle basin reached a high of 27.5 °C (81.5 °F) at one meters' depth on July 28th. The south basin high temperature of 28.3 °C (82.9 °F) was reached one day earlier.

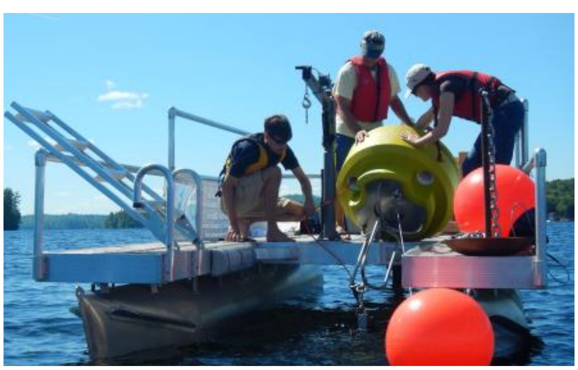
Destratification (complete mixing) occurred in the middle basin on September 2nd, which is very early. However, warm temperatures meant the basin was still slightly stratified for another two weeks afterward. Mixing in the south basin occurred a month later on October 2nd. Most other lakes of the same depth in this report destratify in early November, but because of the lakes size and shape, Long Lake mixed earlier.

Algae Monitoring:

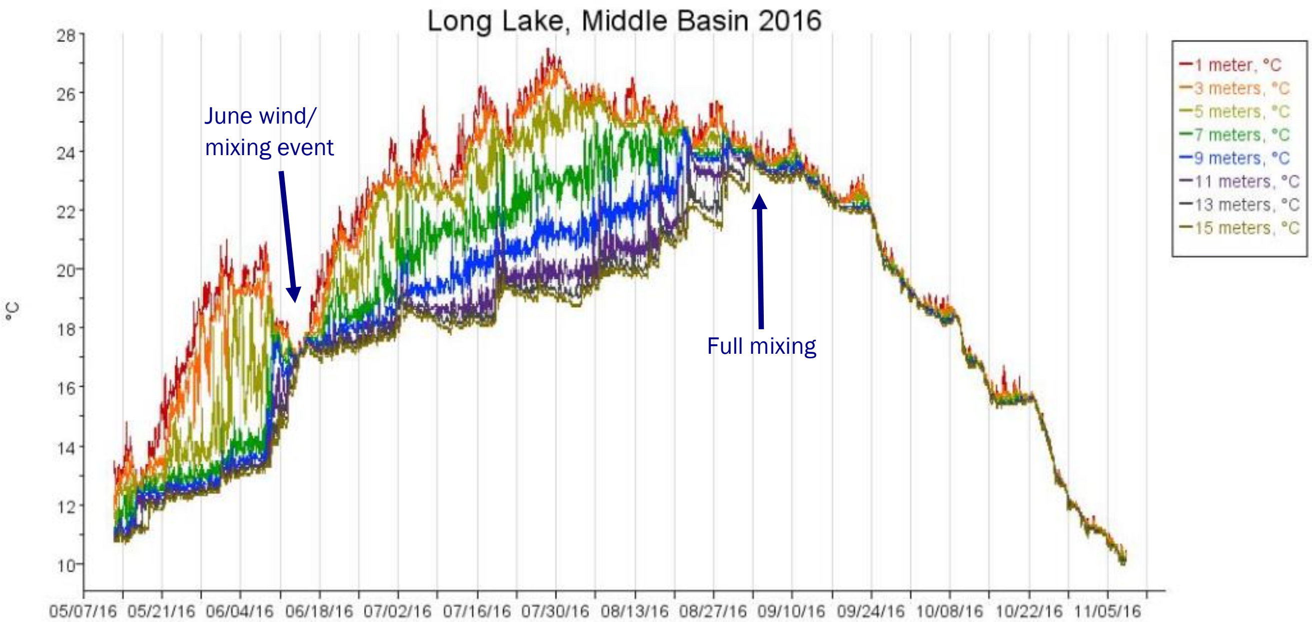
Each basin of Long Lake was sampled once for algae. The north basin and middle basins were sampled on August 30th while the south basin was sampled two weeks later in September. The relative abundance of algae in each basin was high compared to samples collected from other lakes. Flagellated algae such as *Rhodomonas* and *Chrysochromulina* were common in all three basins, with the next most common algae being cyanobacteria like *Aphanocapsa*, *Merismopedia*, and *Chroococcus.* The cyanobacteria *Aphanizomenon* was also seen in the samples, but was not abundant enough to be included in the algae count. The algae assemblages within Long Lake indicate a mesotrophic system with moderate levels of productivity.

Long Lake Automated Buoy

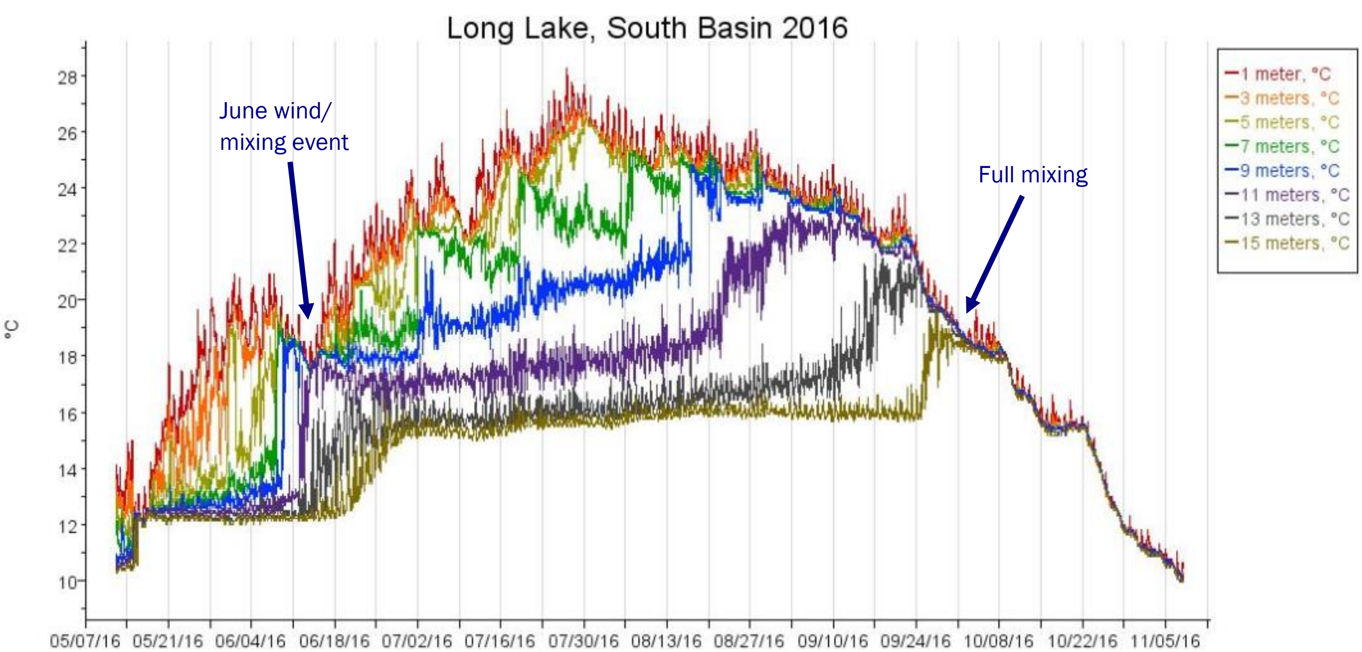
On August 19th, LEA launched a fully automated water testing buoy in the North Basin of Long Lake. The buoy monitors oxygen concentrations and temperature at every other meter from the surface down to 9 meters and chlorophyll concentrations via fluorometers at 3 different depths. Because the buoy was only in the water for part of the testing season, data are not being reported for 2016. A full analysis will be included in the 2017 water testing report.



Date of Fall Turnover (Complete Mixing)				
	2013	2014	2015	2016
Long Lake North	10/25	10/23	N/A	N/A



Date of Fall Turnover (Complete Mixing)				
	2013	2014	2015	2016
Long Lake Middle	9/16	9/12	9/28	9/2



Date of Fall Turnover (Complete Mixing)		
	2015	2016
Long Lake South	10/11	10/2

Long Pond

Long Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Worse at 4.8 meters Chlorophyll: Worse at 3.1 ppb Phosphorus: Better at 7.0 ppb

Surface Area:	44 acres
Maximum Depth:	20 feet
Watershed Area:	217 acres
Elevation:	401 feet

Water Quality Summary:

Clarity, surface water phosphorus, and chlorophyll are all moderate on Long Pond. Currently, LEA samples Long Pond once per year in August. Trend analysis of long term data (1997-present) shows that clarity and chlorophyll are both getting worse over time, while surface water phosphorus is stable. Because of the worsening chlorophyll trend, Long Pond is in LEA's HIGH degree of concern category.

McWain Pond

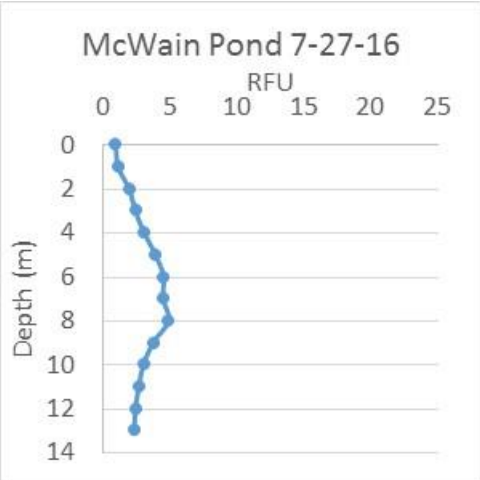
McWain Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 6.6 meters
Chlorophyll: Better at 2.2 ppb
Phosphorus: Better at 5.9 ppb

Surface Area:	445 acres
Maximum Depth:	42 feet
Mean Depth:	23 feet
Volume:	9,756 acres/feet
Watershed Area:	2,505 acres
Flushing Rate:	0.5 flushes per year
Elevation:	533 feet

Water Quality Summary:

Clarity, surface water phosphorus and chlorophyll averages for 2016 are all in the moderate range and are an improvement over long-term averages. Long-term trends indicate stable clarity and improving surface water phosphorus and chlorophyll, which is positive news. However, McWain Pond does suffer from oxygen depletion and high deep water phosphorus levels in late summer. Gloeotrichia algae concentrations have also been relatively high in McWain Pond (see summary below). These three issues mean that McWain Pond has been moved into the MODERATE/ HIGH degree of concern category.

Chlorophyll-a Profile:



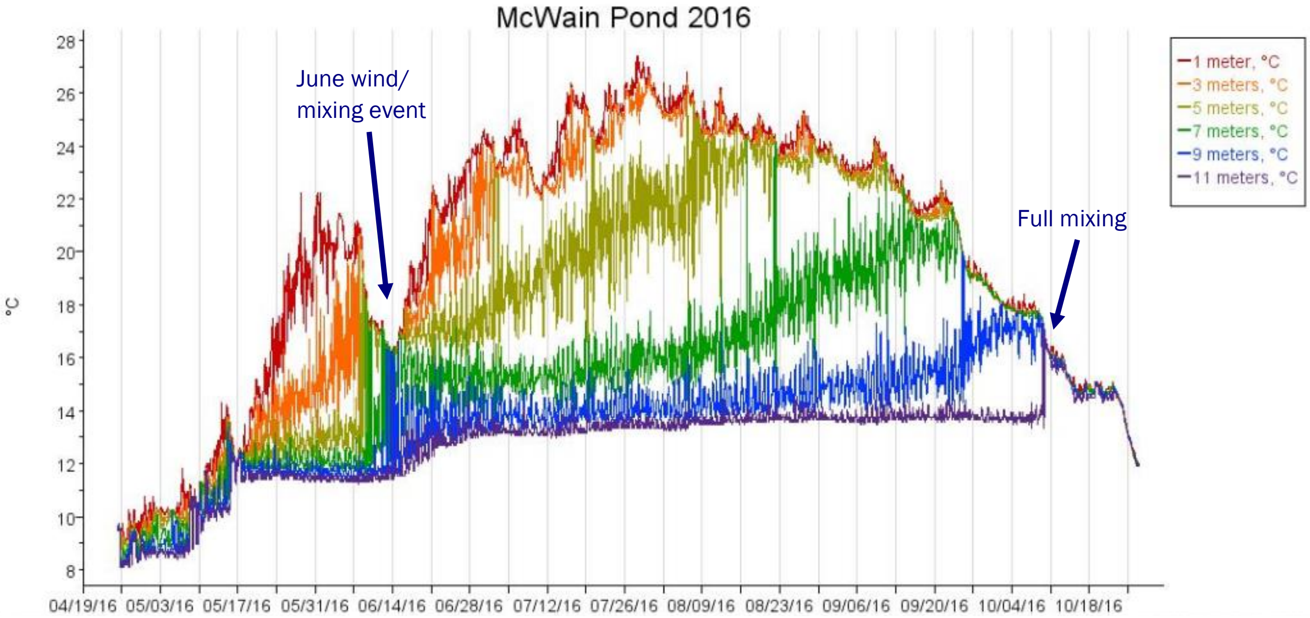
The graph to the left shows the results of a chlorophyll-a profile on McWain Pond. The purpose of the profile is to show areas of high algae productivity. Relative abundance of chlorophyll increases gradually to around 8 meters deep and then declines. This suggests low algae productivity, as there are no spikes in chlorophyll levels with depth. Most algae growth occurs in the upper, sunlit water, so the decline after 8 meters is expected.

Gloeotrichia echinulata:

Four samples were collected at a site on the western shore of McWain Pond between July 27 and August 18. *Gloeotrichia* levels were unusually low in 2016, peaking at only 4.1 col/L on July 27 and virtually disappearing from the water column in subsequent samples.

High Resolution Temperature Monitoring:

The graph on the following page shows temperature patterns at 2 meter depth intervals from April 25th to October 27th on McWain Pond. The pond had not yet started to stratify when a wind event occurred around May 16th that completely mixed the pond. Stratification began to form quickly after that, but the pond was mixed again on June 15th due to high winds. Each of these wind events raised the temperature of the deeper water, which ended up being around 13.5 °C near the bottom for the rest of the stratified period. Stratification began to weaken near the end of August and continued as air temperatures cooled throughout the fall. Complete mixing occurred over a week earlier than in the previous two years, likely due to the warmer bottom temperatures. The maximum temperature reached at a depth of 1 meter was 27.4 °C (81.3 °F) on July 28th.



Date of Fall Turnover (Complete Mixing)			
	2014	2015	2016
McWain Pond	10/19	10/18	10/10

Algae Monitoring:

Four algae samples were collected from McWain Pond between August and September. Algae abundance was high in these samples relative to other lakes sampled. Flagellated algae were common, including *Rhodomonas* and *Chrysochromulina*. *Sphaerocystis* was the most common green algae while *Urosolenia* and *Stephanodiscus* were common diatoms. The cyanobacteria *Pseudanabaena* was noted in all four samples but was rare to find in any of the other lakes. This population should be monitored closely in 2017. The algae assemblage in McWain Pond indicates moderate productivity (mesotrophic).

Middle Pond

Middle Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 6.5 meters Chlorophyll: Better at 2.9 ppb Phosphorus: Better at 6.4 ppb

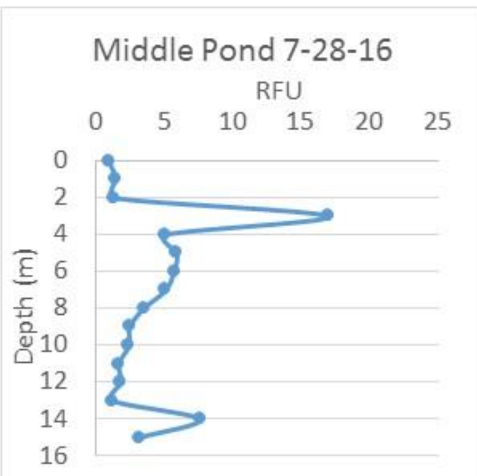
Surface Area:	72 acres
Maximum Depth:	50 feet
Watershed Area:	231 acres
Elevation:	572 feet

Water Quality Summary:

Middle Pond is the largest of the Five Kezar Ponds. Clarity, surface water phosphorus, and chlorophyll averages were moderate in 2016 and were all improvements over long-term averages. Trend analysis of data from 1996-2016 show all three parameters are improving over time. Middle Pond is the only lake LEA tests where all three measurements are improving long-term.

The main water quality concern in Middle Pond is dissolved oxygen depletion and high phosphorus in the deeper waters of the pond in late summer. Cold water fish still have some habitat despite the low oxygen conditions. Middle Pond is in LEA's MODERATE degree of concern category.

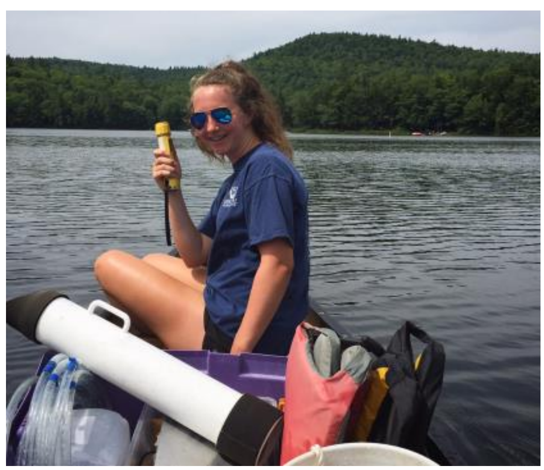
Chlorophyll–a Profile:



The graph on the left shows the results of a chlorophyll-a profile on Middle Pond. The purpose of the profile is to show areas of high algae productivity. In this profile, there were increases at 3 meters and 14 meters. The three meter increase corresponds with the boundary layer between the top and bottom layers of the pond. Oxygen levels (not shown) also spiked around this area, another indication of algae productivity. Algae levels remain elevated where there is still light penetration, between 4-9 meters. The other increase at 14 meters could be interference from sediment or algae that have sunk to the bottom of the pond.

Algae Monitoring:

Middle Pond was sampled twice in 2016, on August 15th and September 1st. Cell counts from both samples were similar and the relative abundance of algae was high compared to other lakes sampled. Flagellated algae such as *Monomastix*, *Rhodomonas*, and *Chrysochromulina* were very common. The overall assemblage indicates a system with moderate productivity (mesotrophic).



Moose Pond (Main Basin)

Moose Pond (Main Basin) Quick Statistics
2016 Average Versus the Long-term Average:

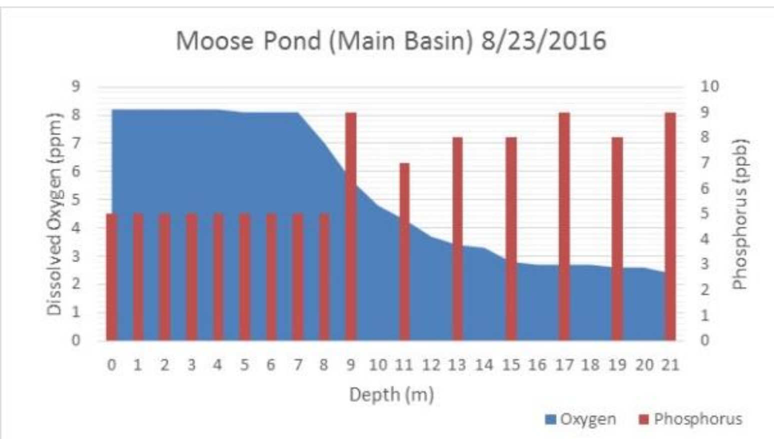
Clarity: Better at 8.2 meters
Chlorophyll: Better at 2.3 ppb
Phosphorus: Better at 5.0 ppb

Surface Area:	1,695 acres
Maximum Depth:	70 feet
Mean Depth:	20 feet
Volume:	30,722 acres/feet
Watershed Area:	11,170 acres
Flushing Rate:	3.69 flushes per year
Elevation:	418 feet

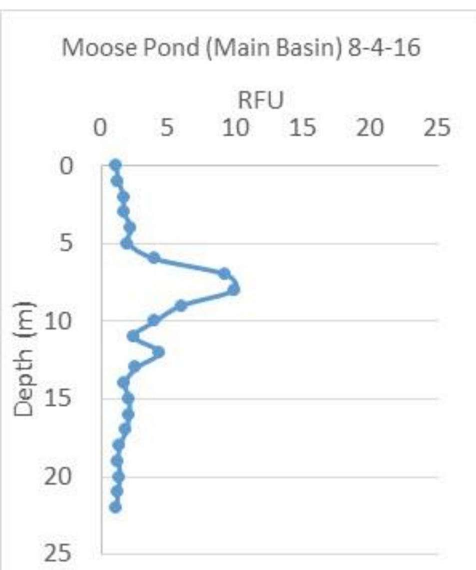
Water Quality Summary:

The average clarity of Moose Pond's main basin was good in 2016. Surface water phosphorus was low and chlorophyll was moderate on average. All three parameters improved over long term averages. Trend analysis of data from 1996-2016 show improving trends in surface water phosphorus and chlorophyll and stable clarity.

Water quality issues facing Moose Pond are oxygen depletion that affects cold water fish, high susceptibility to internal phosphorus release, and elevated levels of *Gloeotrichia echinulata* algae most summers. For these reasons, Moose Pond is in the HIGH degree of concern category.



The graph on the left shows dissolved oxygen (blue) and phosphorus levels (red bars) in Moose Pond over various depths (horizontal axis). Currently, phosphorus levels in the deeper waters of Moose Pond are moderate. However, because of relatively low aluminum levels in the sediment, dissolved oxygen depletion is more likely to cause phosphorus to be released from the sediments and into the water column, where it may fuel algae growth.



Chlorophyll-a Profile:

The graph on the left shows relative chlorophyll concentrations at various depths. Elevated levels of chlorophyll were present at 7-8 meters. Algae often accumulate near the boundary between the top and bottom layers of stratified lakes, which coincides with the location these increases. Oxygen levels (not shown) also spiked at 7 meters, another indication of algae productivity. Deeper waters have less chlorophyll because of the lack of light penetration.

Gloeotrichia echinulata:

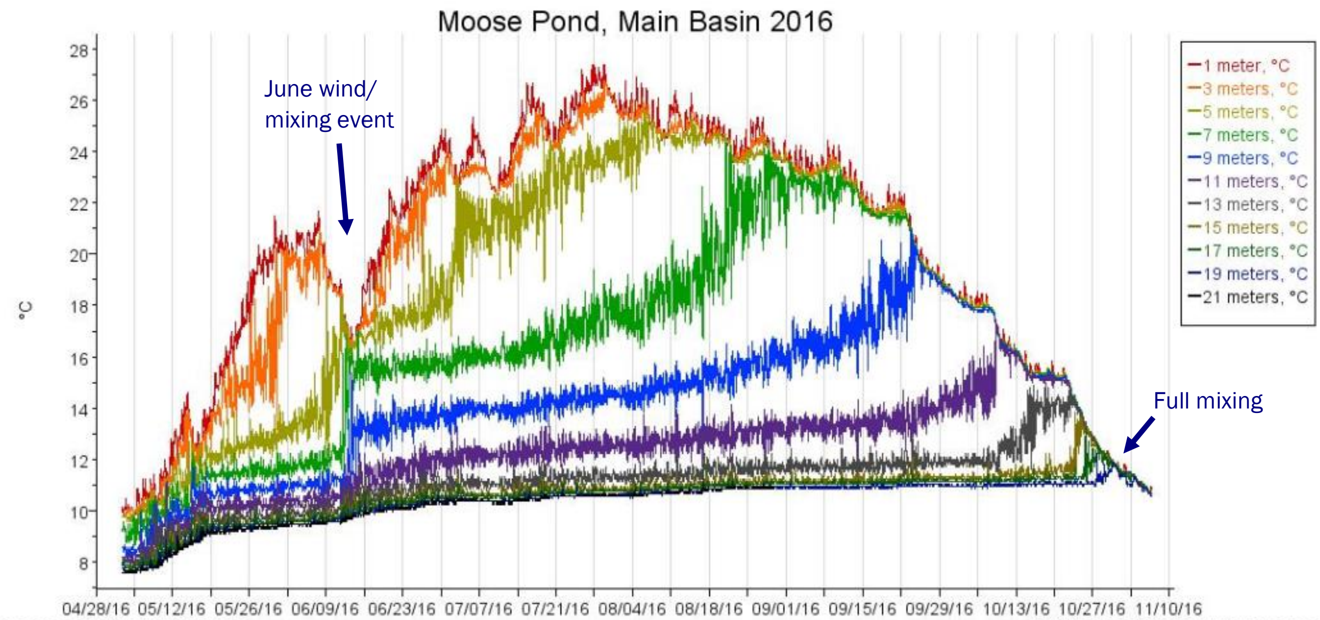
Five samples were collected weekly from the main basin of Moose Pond between July 18 and August 16. Concentrations were lower than in past years, peaking at 5.8 col/L on July 25th.

High-Resolution Temperature Monitoring:

When sensors were deployed at the beginning of May, there was a 2.5 °C temperature difference between the top and bottom of Moose Pond's main basin. Temperatures warmed more quickly in the upper waters and stratification began to set in, delayed briefly by wind events in mid-May and mid-June which caused deep mixing and dramatically warmed the lake down to 9 meters.

Stratification began to break down in August and continued throughout the fall as air temperatures cooled. The pond did not completely destratify until the end of October, slightly earlier than in previous years. Moose Pond's main basin reached its highest temperature on July 28th and 30th, with the temperature at a depth of 1 meter peaking at 27.4 °C (81.3 °F).

Date of Fall Turnover (Complete Mixing)				
	2013	2014	2015	2016
Moose Pond Main	11/3	11/2	11/2	10/31



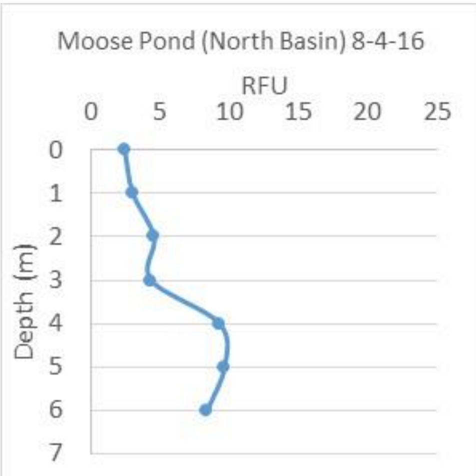
Algae Monitoring:

Five algae samples from the main basin of Moose Pond were collected between June and September. The overall abundance of algae was low to moderate compared to other lakes sampled. Small flagellated algae such as *Chrysochromulina* and *Rhodomonas* were common, as were the cyanobacteria *Merismopedia* and *Aphanocapsa*. There were relatively few diatoms, with the most common being *Tabellaria* and centric diatoms such as *Cyclotella* and *Stephanodiscus*. The most common green algae were *Monomastix* and *Sphaerocystis/Gloeocystis*. The overall assemblage indicates a system with moderate nutrient levels (mesotrophic).

Moose Pond (North Basin)

Water Quality Summary:

Clarity, surface water phosphorus and chlorophyll are all in the moderate range according to 2016 averages. Clarity was better than the long term average at 5.6 meters, phosphorus was similar to the long term average at 9.4 ppb and chlorophyll was improved over the long term average at 3.4 ppb. Long-term trends show stable water quality conditions. The basin does experience slight oxygen depletion in the summer, but a lack of other issues means that Moose Pond's north basin is in LEA's AVERAGE degree of concern category.



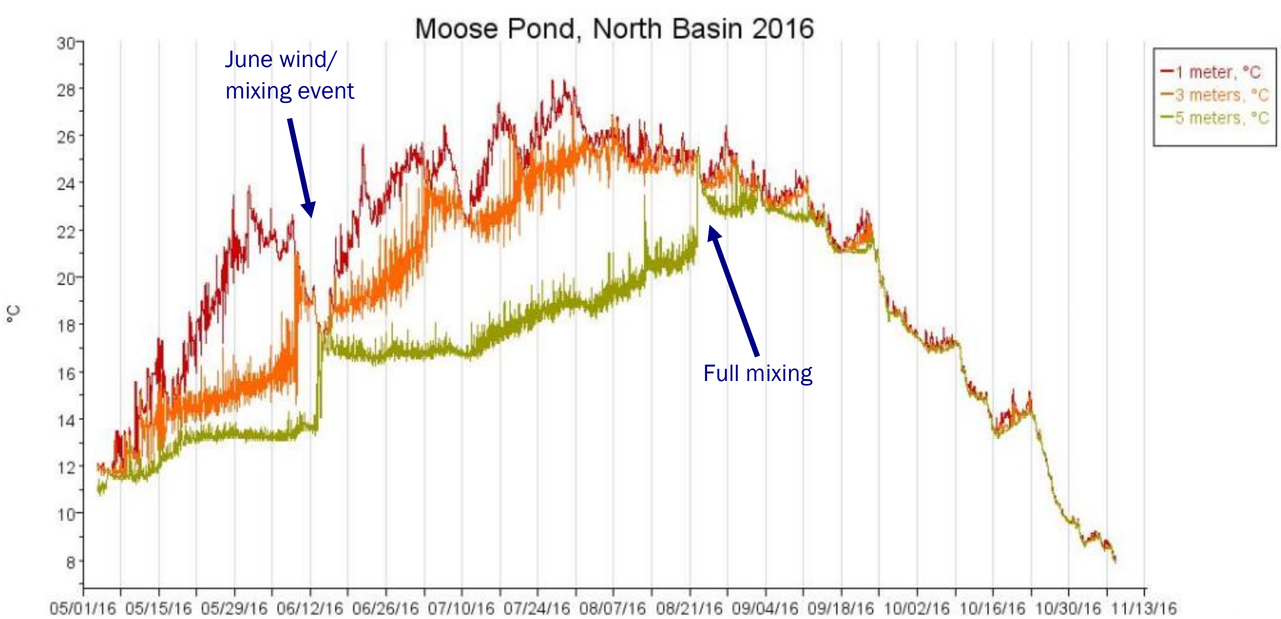
Chlorophyll-a Profile:

The graph on the left shows relative chlorophyll-a levels at various depths in the north basin. The basin is shallow at 6 meters, and light is able to reach to the bottom. Relative algae levels were higher in the bottom three meters of the pond.

High-Resolution Temperature Monitoring:

The graph below shows temperature patterns at 1, 3 and 5 meters deep from May 3—November 7. Stratification began to set in shortly after sensors were deployed. A strong wind storm fully mixed the basin on June 15th, raising bottom temperatures. As a result, the basin was not strongly stratified for most of the summer. Stratification broke down very early, on August 22nd. This mixing redistributed oxygen throughout the water column, shortening the duration of oxygen depletion. The north basin reached a maximum temperature of 28.4 °C (83.1 °F) at a depth of 1 meter on both July 26th and 28th.

Date of Fall Turnover (Complete Mixing)			
	2014	2015	2016
Moose Pond North	9/12	9/22	8/22



Algae Monitoring:

Four algae samples were collected from the north basin of Moose Pond between June and September. Relative algae abundance started out low and increased to a moderate level as the summer went on. Flagellated algae such as *Chrysochromulina* and *Monomastix* were common in each sample. Diatom populations were generally low, with *Urosolenia* and large centric diatoms being the most common. Cyanobacteria levels were relatively low and green algae were relatively high compared to other lakes sampled. The overall assemblage indicates a moderately productive system (mesotrophic).

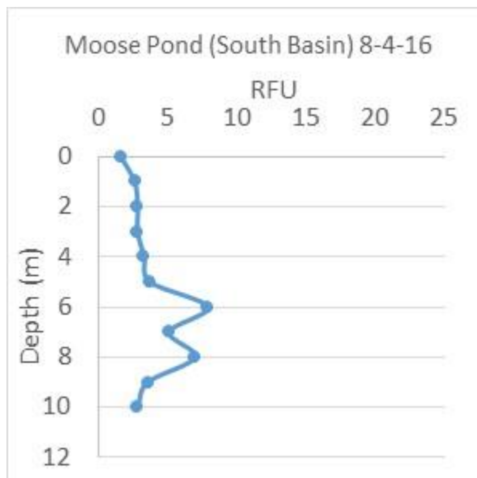
Moose Pond (South Basin)

Water Quality Summary:

The south basin of Moose Pond has only been sampled regularly since 2015, so long term data analysis is unavailable. Average clarity in 2016 was 6.8 meters, surface water phosphorus averaged 6.9 ppb and chlorophyll averaged 2.2 ppb. These values are all in the moderate range. The basin suffers from dissolved oxygen depletion and high deep water phosphorus concentrations in late summer, which puts it in the MODERATE degree of concern category.

Chlorophyll-a Profile:

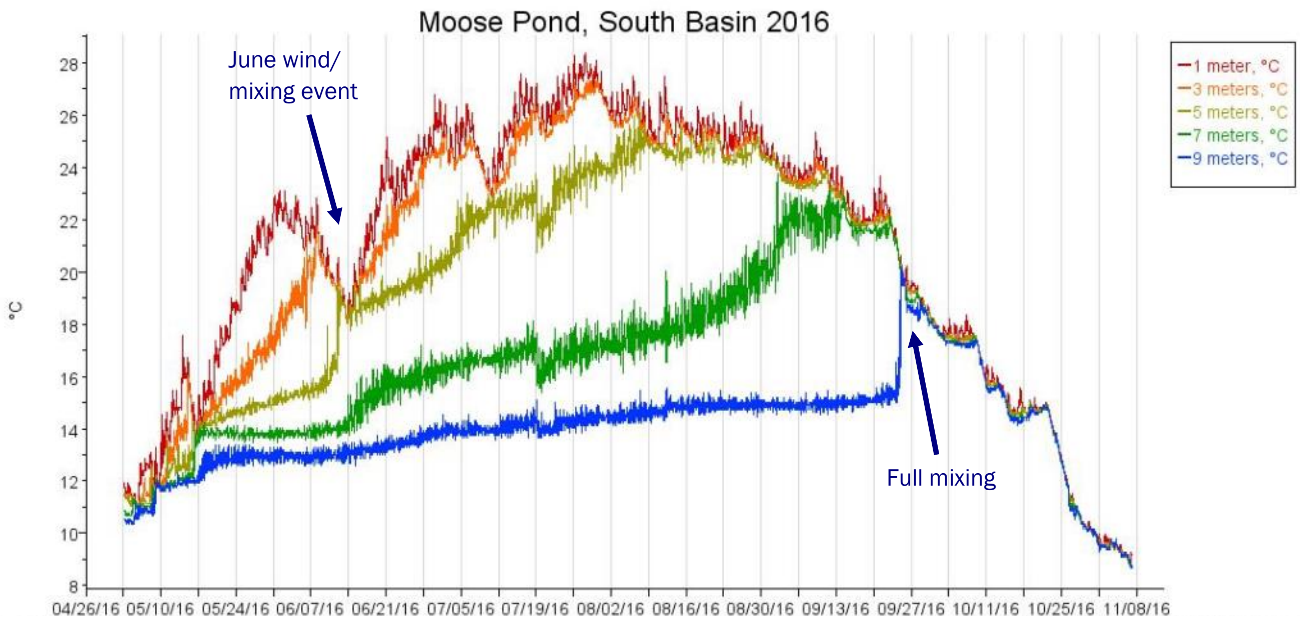
The graph on the right shows relative chlorophyll levels at various depths in Moose Pond's south basin. The purpose of the graph is to reveal areas of high algae productivity. In this graph, the highest levels are at 6 and 8 meters. This zone is deeper than where clarity and temperature data (not shown) would suggest greater algae abundance would be. These readings may be anomalous or the result of sediment re-suspension near the bottom of the pond.



High-Resolution Temperature Monitoring:

The graph on the following page shows temperature patterns from May 3rd—November 7th at various depths in the south basin of Moose Pond. Thermal stratification had just begun to set in at the beginning of May, but was altered by wind events in mid-May and mid-June, both of which caused strong mixing and a warming of deeper waters. This stratification broke down in late September—earlier than in previous years, likely due to the deep-water warming that occurred in May and June. The maximum temperature recorded at 1 meters' depth was 28.4 °C (83.1 °F) on July 28th.

Date of Fall Turnover (Complete Mixing)			
	2014	2015	2016
Moose Pond South	10/22	10/3	9/25


Moose Pond, South Basin 2016
June wind/
mixing event
Full mixing
°C
1 meter, °C
3 meters, °C
5 meters, °C
7 meters, °C
9 meters, °C
28
26
24
22
20
18
16
14
12
10
8
04/26/16
05/10/16
05/24/16
06/07/16
06/21/16
07/05/16
07/19/16
08/02/16
08/16/16
08/30/16
09/13/16
09/27/16
10/11/16
10/25/16
11/08/16

Mud Pond

Mud Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 5.0 meters
Chlorophyll: Better at 4.0 ppb
Phosphorus: Better at 10.0 ppb

Surface Area:	45 acres
Maximum Depth:	35 feet
Watershed Area:	1,661 acres
Elevation:	572 feet

Water Quality Summary:

Mud Pond is part of the Five Kezar Ponds and is sampled once per year in August. Clarity, surface water phosphorus, and chlorophyll were all within the moderate range in 2016. Trend analysis shows water quality is stable. Mud Pond's main water quality issue is dissolved oxygen depletion. It was very pronounced at the time of sampling, affecting the bottom 8 meters of the 10-meter-deep pond. Mud Pond is in LEA's AVERAGE degree of concern category.

Otter Pond

Otter Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 5.6 meters
Chlorophyll: Better at 2.5 ppb
Phosphorus: Worse at 17 ppb

Surface Area:	90 acres
Maximum Depth:	21 feet
Mean Depth:	10 feet
Volume:	814 acres/feet
Watershed Area:	790 acres
Flushing Rate:	0.7 flushes per year
Elevation:	392 feet

Water Quality Summary:

Otter Pond is sampled once per year in August. Clarity and chlorophyll levels were moderate in 2016, while surface water phosphorus was high. Clarity and chlorophyll are both improving significantly over time, while surface water phosphorus remains stable. Slight oxygen depletion was recorded at the time of sampling. Otter Pond is in LEA's AVERAGE degree of concern category.

Papoose Pond

Papoose Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Better at 3.7 meters
Chlorophyll: Better at 3.6 ppb
Phosphorus: Better at 12.0 ppb

Surface Area:	70 acres
Maximum Depth:	15 feet
Watershed Area:	192 acres
Elevation:	490 feet

Water Quality Summary:

Papoose Pond is sampled once per year in August. Clarity, surface water phosphorus, and chlorophyll were all moderate in 2016. Long-term trend analysis shows that clarity is improving while phosphorus and chlorophyll are stable. Dissolved oxygen depletion was slight and occurred only near the bottom of the pond. Papoose Pond has been downgraded to LEA's AVERAGE degree of concern category.

Peabody Pond

Peabody Pond Quick Statistics
2016 Average Versus the Long-term Average:

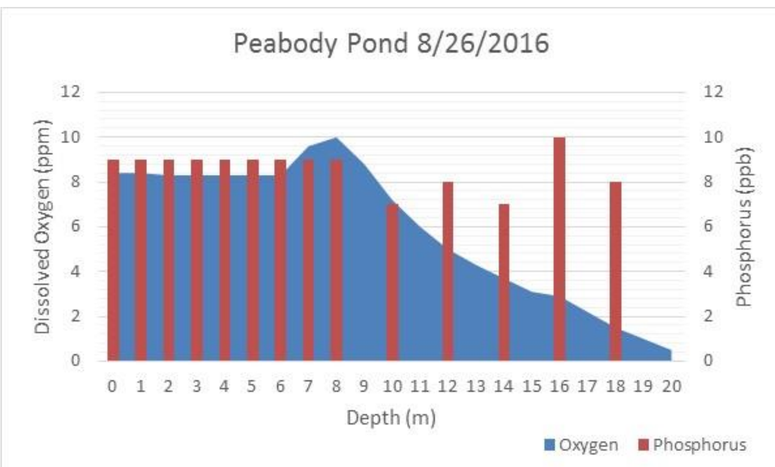
Clarity: Better at 8.7 meters
Chlorophyll: Better at 1.7 ppb
Phosphorus: Better at 5.6 ppb

Surface Area:	740 acres
Maximum Depth:	64 feet
Mean Depth:	45 feet
Volume:	24,510 acres/feet
Watershed Area:	2,522 acres
Flushing Rate:	0.3 flushes per year
Elevation:	460 feet

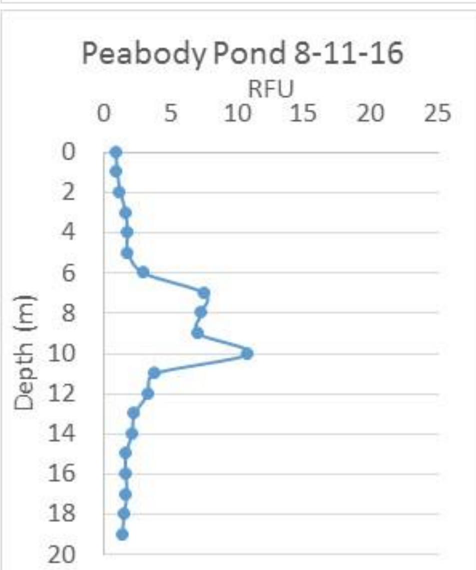
Water Quality Summary:

The average clarity on Peabody Pond was in the good range in 2016. Surface water phosphorus averaged within the moderate range, while average chlorophyll-a was low. All three parameters were improvements over long-term averages. Trend analysis of data from 1996-2016 shows that clarity has increased significantly while surface water phosphorus and chlorophyll are both stable.

The main water quality concerns in Peabody Pond are dissolved oxygen depletion and an increased risk of phosphorus release from sediments. Because of low sediment aluminum levels, the pond is more likely to release phosphorus stored in sediments when the bottom of the pond lacks oxygen. Oxygen depletion does occur on Peabody Pond, but the extent and duration are limited. The graph to the left shows oxygen (blue) and phosphorus concentrations (red bars) throughout the water column. Phosphorus levels in the deeper waters remain moderate despite the low oxygen conditions.



Peabody Pond is in the MODERATE degree of concern category.



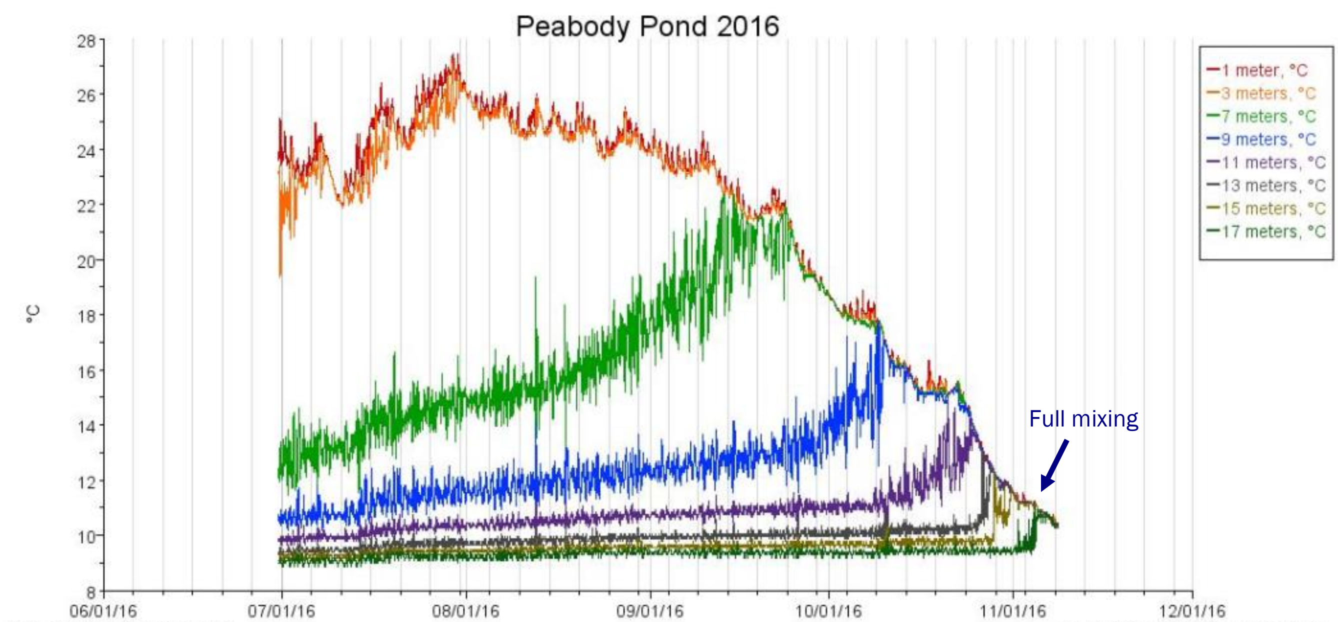
Chlorophyll-a Profile:

The graph on the left shows results of a chlorophyll-a profile on Peabody Pond. The purpose of the profile is to identify areas of algae productivity. This graph shows elevated chlorophyll between 7 and 10 meters. The boundary zone between the top and bottom layers of the pond was around 8 meters and clarity reached 9 meters on this particular date. Dissolved oxygen levels were elevated between 7 and 9 meters as well (similar to the data in the oxygen/ phosphorus graph above). Algae often settle around this boundary zone because the density difference between the pond's top and bottom layers does not allow algae to sink easily. Light was available at these depths for photosynthesis, allowing for increased algae growth.

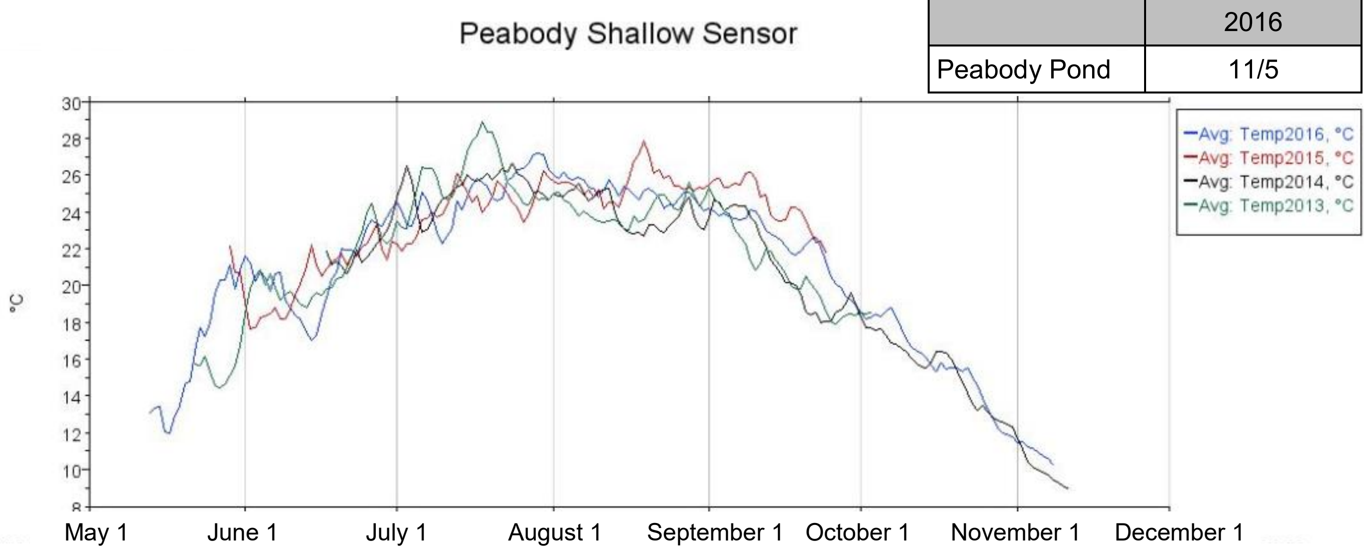
High-Resolution Temperature Monitoring:

The graphs below show temperature patterns in 2016 across a series of depths (top graph) and over four years at a single shallow depth (bottom graph). The deep water series of sensors were deployed in 2016 for the first time, and were installed much later than in other ponds (June 30). Unfortunately, the sensor at 5 meters came loose and was not able to be recovered, so this data is missing. The high temperature at one meters' depth was 27.9 °C (82.2 °F) on July 29th and 30th. The pond began to mix near the end of August and continued mixing as air temperatures cooled throughout the fall. The pond fully mixed at the beginning of November.

The bottom graph shows daily average shallow water temperature fluctuations from 2013—2016 from a sensor placed near the western shore at a depth of about 2 meters. The overall pattern and range is very similar, though clearly is affected by unique yearly weather patterns.



Date of Fall Turnover	
	2016
Peabody Pond	11/5



Algae Monitoring:

Two algae samples were collected from Peabody Pond, one in August and one a month later in September. The September sample contained more algae than the August sample. Flagellates such as *Rhodomonas* and *Chrysochromulina* were very common in both samples. The golden algae *Mallomonas* was relatively common compared to other lakes sampled. Cyanobacteria cell counts were higher in the September samples and were largely responsible for the increase between August and September. These cyanobacteria were all common types such as *Merismopedia* and *Aphanocapsa* and are not a water quality concern. The algae assemblage indicates low to moderate productivity (oligo– to mesotrophic conditions).

Perley Pond

Perley Pond Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: Better at 4.9 meters
Chlorophyll: Better at 3.4 ppb
Phosphorus: Better at 7.0 ppb

Surface Area:	68 acres
Maximum Depth:	27 feet
Watershed Area:	293 acres
Elevation:	521 feet

Water Quality Summary:

Perley Pond is sampled once per year in August. Clarity, surface water phosphorus and chlorophyll were all within the moderate range in 2016. Long-term trends show stable clarity and chlorophyll levels, while surface water phosphorus has significantly improved. Dissolved oxygen depletion is a concern for the pond, as it affected the bottom 4 meters of the 8-meter-deep pond. However, the pond is still within LEA's AVERAGE degree of concern category.

Pickerel Pond

Pickerel Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: Worse at 5.1 meters Chlorophyll: Better at 2.6 ppb Phosphorus: Worse at 11.0 ppb

Surface Area:	17 acres
Maximum Depth:	18 feet
Watershed Area:	290 acres
Elevation:	515 feet

Water Quality Summary:

Pickerel Pond is sampled once per year in August. Clarity, surface water phosphorus, and chlorophyll were all in the moderate range in 2016. Clarity and phosphorus were worse than long-term averages, while chlorophyll was better. Trend analysis for the years 1996-2016 show stable clarity and chlorophyll but a worsening surface water phosphorus trend. Dissolved oxygen depletion was slight and only observed at the bottom of the water column during late August sampling. Pickerel Pond is in LEA's AVERAGE degree of concern category.

Pleasant Pond

Pleasant Pond Quick Statistics 2016 Average Versus the Long-term Average:
Clarity: To Bottom Chlorophyll: Better at 3.3 ppb Phosphorus: Better at 17.0 ppb

Surface Area:	604 acres
Maximum Depth:	11 feet
Watershed Area:	4,624 acres
Elevation:	362 feet

Water Quality Summary:

Pleasant Pond is sampled once per year in August. Clarity reached to the bottom of the pond in 2016 and surface water phosphorus and chlorophyll were in the moderate range. Trend analysis shows that all three parameters are stable. Dissolved oxygen depletion was slight and only affected the very bottom of the pond at the time of sampling. Pleasant Pond is in the AVERAGE degree of concern category.

Sand Pond

Sand Pond Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: Worse at 6.0 meters
Chlorophyll: Better at 3.3 ppb
Phosphorus: Better at 8.1 ppb

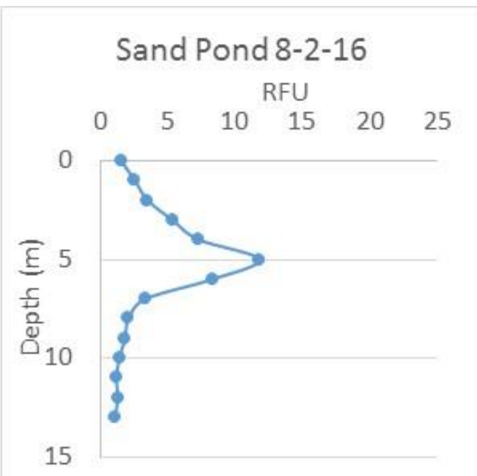
Surface Area:	256 acres
Maximum Depth:	49 feet
Watershed Area:	1394 acres
Elevation:	502 feet

Water Quality Summary:

Clarity, surface water phosphorus, and chlorophyll levels were all moderate in 2016. Average clarity was 6.0 meters, less deep than the long-term average of 6.3 meters, while the other two parameters were better than the long-term average. Trend analysis of data from 1996—2016 shows a worsening clarity trend but stable chlorophyll and surface water phosphorus.

Sand Pond suffers from substantial oxygen depletion in the summer, which leaves little to no habitat for cold water fish. Deep water phosphorus levels are also high, which is a risk factor for algae blooms. In late May/early June of 2016, Sand Pond did have a bloom of *Uroglena*, a golden algae. Sand Pond is in LEA's HIGH degree of concern category.

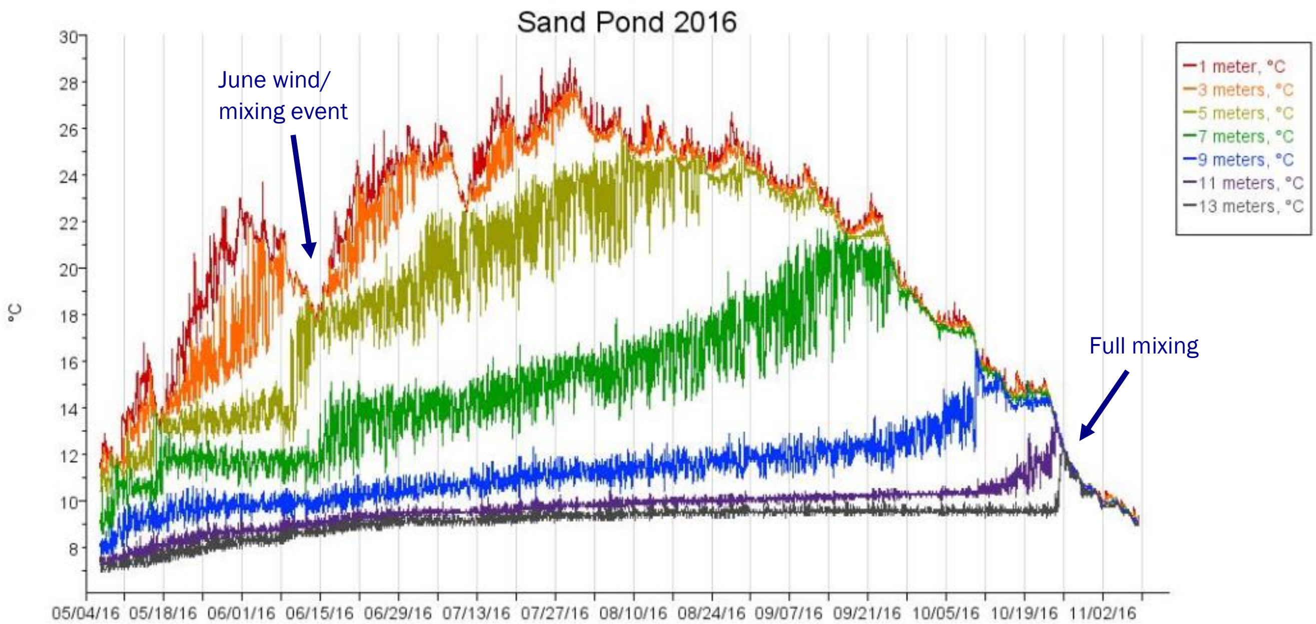
Chlorophyll-a Profile:



The graph on the left shows results of a chlorophyll-a profile on Sand Pond. The purpose of the profile is to show areas of algae productivity within the pond. Relative chlorophyll levels at various depths are shown. Chlorophyll increased to a depth of 5 meters and then declined. Temperature and oxygen data collected at the same time as this profile show that the boundary zone between the top and bottom layers of the pond was located at 5 meters. Algae often accumulate around this zone because the density of the cold, deep water slows their sinking rate. They can also take advantage of nutrients from the deeper waters to fuel their growth as long as there is still adequate light available.

High Resolution Temperature Monitoring:

The graph on the following page shows temperature patterns at various depths on Sand Pond from May 6th to November 8th, 2016. The pond had already begun to stratify (separate into layers based on temperature) when the sensors were deployed. High winds in mid-May and mid-June caused mixing that temporarily slowed the stratification process and permanently increased deep water temperatures. The pond reached a high temperature of 29.0 °C (84.2 °F) at 1 meters' depth on July 29th. Stratification began to break down near the end of August and continued as air temperatures cooled in the fall. Complete mixing occurred on October 26th, slightly earlier than in the previous two years.



Date of Fall Turnover (Complete Mixing)			
	2014	2015	2016
Sand Pond	after 10/30	10/31	10/26

Algae Monitoring:

Sand Pond was sampled for algae four times between July and September, 2016. Overall cell densities were low compared to other lakes sampled. Flagellates such as *Cryptomonas* and *Chrysochromulina* were common in all of the samples collected. *Urosolenia* was the most common diatom along with centric diatoms such as *Stephanodiscus* and *Aulacoseira. Tabellaria* was also seen in each sample. While *Uroglena* was not counted in the samples collected, high levels within the water column in late May and early June are common to stratifying oligo– to mesotrophic lakes with low available nutrients. The most common cyanobacteria were *Aphanocapsa* and *Chroococcus.* A small amount of *Dolichospermum* (formerly *Anabaena*) was also noted. Overall, the algae assemblage indicates low to moderate productivity (oligo– to mesotrophic conditions).

Sebago Cove

Water Quality Summary:

Water testing on Sebago Cove began in 2016 with one sampling trip in August. The clarity hit the bottom of the basin at 2.1 meters. A surface phosphorus grab had a concentration of 18.0 ppb, which is in the high range. The chlorophyll-a concentration was moderate at 4.7 ppb. LEA is currently working to remove an infestation of invasive Milfoil from the cove. Sebago Cove is in the AVERAGE degree of concern category.

Stearns Pond

Stearns Pond Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: Better at 6.1 meters
Chlorophyll: Better at 2.3 ppb
Phosphorus: Better at 7.9 ppb

Surface Area:	248 acres
Maximum Depth:	48 feet
Mean Depth:	27 feet
Volume:	6,585 acres/feet
Watershed Area:	4,116 acres
Flushing Rate:	1.6 flushes per year
Elevation:	444 feet

Water Quality Summary:

Clarity, surface water phosphorus and chlorophyll averages were all in the moderate range in 2016. The 2016 averages were all improvements over long term data averages. Trend analysis using data from 1996-2016 show that clarity and chlorophyll have improved significantly over time, while phosphorus levels have remained stable.

The main water quality concerns on Stearns Pond are dissolved oxygen depletion and high phosphorus levels in the deeper waters of the pond. Dissolved oxygen depletion is severe and restricts habitat for cold water fish species. Because of these concerns, Stearns Pond has been elevated to the MODERATE/HIGH degree of concern category.

Trickey Pond

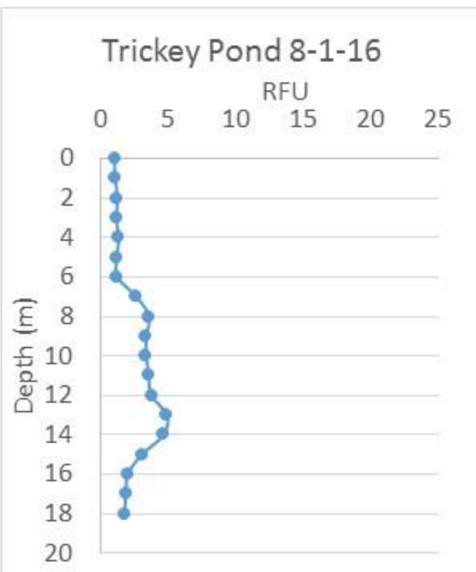
Trickey Pond Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: Worse at 9.7 meters
Chlorophyll: Better at 1.6 ppb
Phosphorus: Better at 4.9 ppb

Surface Area:	315 acres
Maximum Depth:	57 feet
Mean Depth:	34 feet
Volume:	10,108 acres/feet
Watershed Area:	555 acres
Flushing Rate:	0.1 flushes per year
Elevation:	360 feet

Water Quality Summary:

Clarity on Trickey Pond was good in 2016 and averaged 9.7 meters. However, the long-term average of 10.1 meters is considered excellent and trend analysis shows that clarity has significantly worsened on the pond since 1996. Chlorophyll and surface water phosphorus averages for 2016 were both in the low range and were improved over the long-term averages. However, the chlorophyll trend over time is still worsening. The surface water phosphorus trend is stable. Dissolved oxygen levels are good enough to support cold water fish species throughout the summer despite mild depletion near the bottom of the pond. Because of worsening clarity and chlorophyll trends, Trickey Pond is in the HIGH degree of concern category.

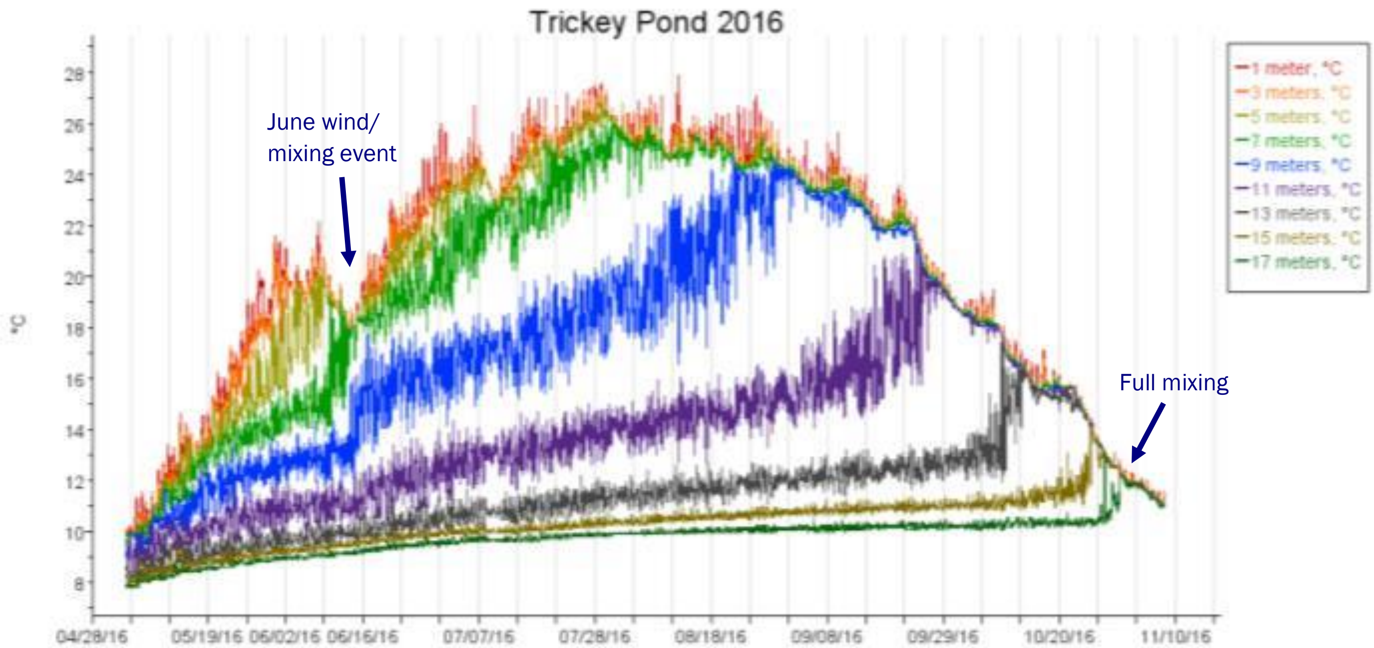


Chlorophyll-a Profile:

The graph on the left shows results of a chlorophyll profile on Trickey Pond. The purpose of the profile is to show areas of high algae productivity. Trickey Pond's levels appear to be relatively low at all depths, which was expected because of overall high clarity. However, levels do increase slightly with depth, indicating that most of the algae productivity is occurring between 8—14 meters. Water testing data (not shown) shows higher oxygen concentrations coinciding with these depths, another indicator of algae photosynthesis. Trickey Pond's high clarity means that light is able to reach deeper into the water and support modest algae growth below where it is seen on other lakes in the area.

High-Resolution Temperature Monitoring:

The graph on the following page shows temperature readings at various depths in Trickey Pond from May 7th—November 8th. Shortly before deployment, the pond was completely mixed and the temperature was uniform from the top to the bottom. Stratification can be seen setting up at the beginning of the data record as the temperature difference widens over time. Strong winds in mid-June cause mixing down to about 9 meters, which cools surface waters and warms the deeper depths. Temperature at 1 meter deep maxed out at 27.9 °C (82.2 °F) on August 12th. After this, temperatures gradually declined as air temperatures steadily cooled throughout the fall. Full mixing occurred on October 31st, slightly earlier than in previous years.



Date of Fall Turnover (Complete Mixing)			
	2014	2015	2016
Trickey Pond	11/2	after 11/5	10/31

Algae Monitoring:

Four algae samples were collected from Trickey Pond between June and September. Overall algae levels were low compared to other lakes sampled. Flagellates such as *Cryptomonas* and *Rhodomonas* were very common in each of the samples. *Gloeocystis, Sphaerocystis,* and *Monomastix* were common green algae. Cyanobacteria in the samples were mainly *Aphanocapsa* and *Aphanothece*, two small, ubiquitous algae common to low nutrient systems. Overall, the algae assemblage indicates low to moderate productivity levels.

Webber Pond

Water Quality Summary:

Webber Pond is sampled once per year in August. LEA has been sampling Webber Pond since 2013, so comparisons with long term averages and trend analysis are not available. In 2016, clarity reached the bottom of the shallow pond at 2.1 meters. Surface water phosphorus was high at 20.0 ppb and chlorophyll was moderate at 3.1 ppb. Webber Pond is in the AVERAGE degree of concern category.

Woods Pond

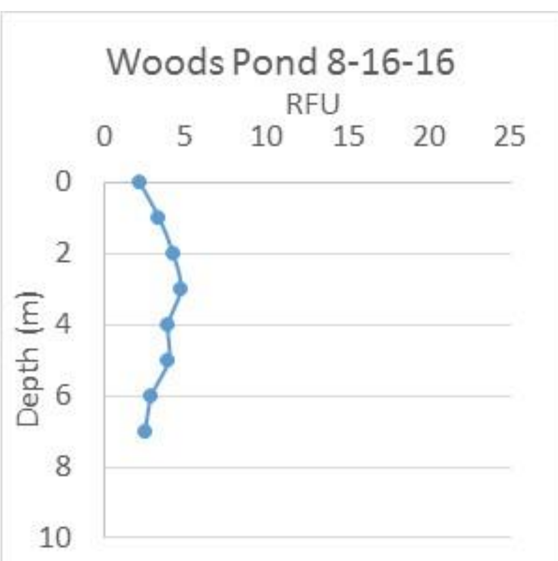
Woods Pond Quick Statistics
2016 Average Versus the Long-term Average:

Clarity: Better at 5.5 meters
Chlorophyll: Worse at 3.3 ppb
Phosphorus: Better at 7.4 ppb

Surface Area:	462 acres
Maximum Depth:	29 feet
Mean Depth:	17.5 feet
Volume:	17,890 acres/feet
Watershed Area:	3,329 acres
Flushing Rate:	0.77 flushes per year
Elevation:	456 feet

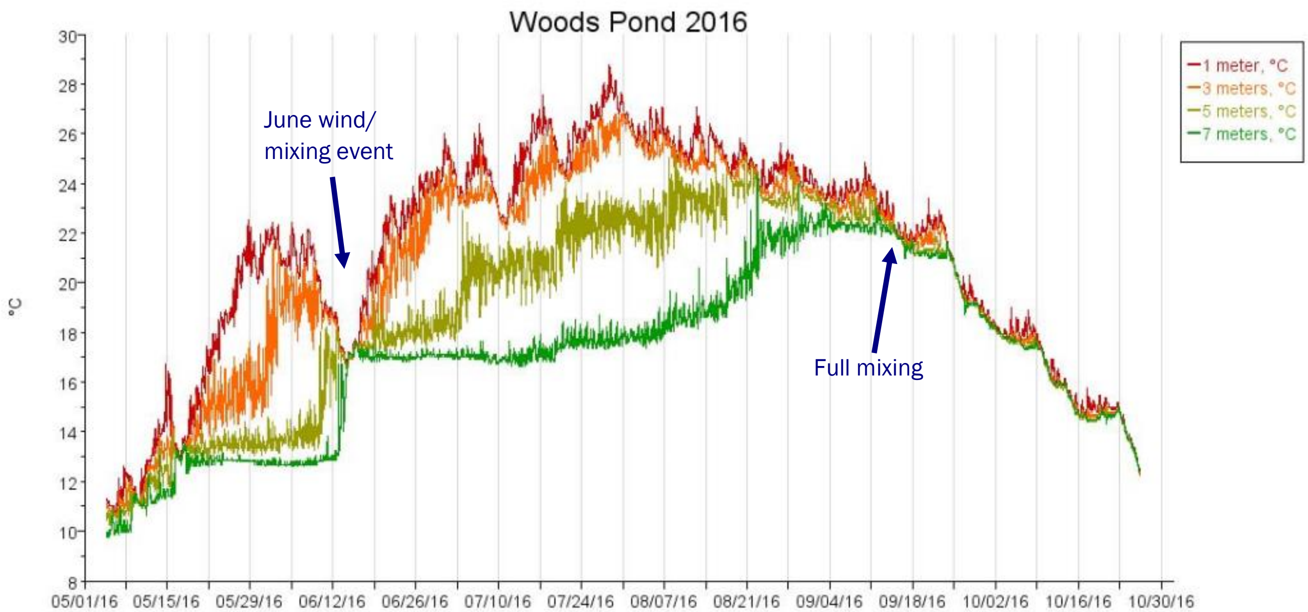
Water Quality Summary:

Average clarity, surface water phosphorus, and chlorophyll levels were all in the moderate range in 2016. Clarity and surface water phosphorus averages were improvements over long-term averages, while chlorophyll was slightly worse than the historical averages. Trend analysis of data from 1996-2016 found stable clarity and chlorophyll but worsening surface water phosphorus over time. Dissolved oxygen depletion is also an issue on Woods Pond. About half of the water column was affected by low oxygen conditions in August before conditions began to improve in September. The pond also has high deep water phosphorus levels. Woods Pond has been lowered from a high degree of concern to the MODERATE/HIGH degree of concern level.



Chlorophyll-a Profile:

The graph on the left shows results from a chlorophyll-a profile taken on Woods Pond, which measures relative chlorophyll levels at one meter intervals from the surface to the bottom of the pond. The purpose of the profile is to show areas of high algae productivity. According to the graph, relative chlorophyll levels are low and fairly uniform throughout the water column.



Date of Fall Turnover (Complete Mixing)			
	2014	2015	2016
Woods Pond	9/13	9/30	9/12

High-Resolution Temperature Monitoring:

The above graph shows temperature patterns at various depths on Woods Pond from May 4th—October 26th. At the beginning of May, the temperature differed by less than 2 °C from the top to the bottom. The temperature difference between top and bottom widened, but was interrupted by several wind events, the most dramatic of which happened in mid-June. At this point, stratification was already well established. The winds were so strong that they completely mixed the entire basin, equalizing the temperature and causing the surface waters to cool and the deeper waters to warm. This resulted in warmer than usual deep water temperatures for the duration of the summer which reduced the strength of stratification. The highest temperature reached at 1 meters' depth was 28.8 °C (83.8 °F) on July 28th. Deep water warming accelerated through August and full mixing occurred in mid-September.

Algae Monitoring:

Woods Pond was sampled for algae five times between June and September, 2016. Algae abundance was moderate compared to other samples collected and declined slightly over time. The most common algae were flagellates such as *Rhodomonas* and *Monomastix*. *Tabellaria*, *Urosolenia*, and centric forms such as *Stephanodiscus* were the most common diatoms. Mallomonas, a golden algae, was also relatively common compared to other lakes sampled. *Aphanocapsa* and *Merismopedia* were the most common cyanobacteria, both of which are not water quality concerns. Overall, the algae assemblage in Woods Pond indicates low to moderate productivity.

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