2017 Water Testing Report

Waterford Lakes and Ponds

Lakes Environmental Association

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Chapter 1—Routine Monitoring Results

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.

Invasive Plant Program

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, and in 2017 they began work on Long Lake after an infestation was found there. LEA's program has been a model for the entire state.

Environmental Education

LEA offers environmental education programs to local elementary, middle, and high schools, reaching over 1,000 students annually. LEA also hosts educational programs for all ages at the Holt Pond Preserve, Highland Lake Preserve and Pondicherry Park, all of which LEA played a key role in establishing.

Lake Water Testing

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.

Landowner and Municipal Assistance

LEA provides technical assistance to residents interested in preventing erosion on their property. This service 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.

Courtesy Boat Inspections

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.

Maine Lake Science Center

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.

Please Join LEA!

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 www.mainelakes.org.

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			N/A	—	AVG
BOG POND		N/A	N/A	N/A	N/A	N/A	—	AVG
BRANDY POND							—	MOD
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							—	MOD
HIGHLAND LAKE							Algae	HIGH
HOLT POND		N/A				N/A	—	AVG
ISLAND POND		N/A					—	MOD
JEWETT POND						N/A	—	MOD
KEOKA LAKE							Gloeo	HIGH
KEYES POND							—	MOD/HIGH
KEZAR POND		N/A	N/A			N/A	—	AVG
LITTLE POND		N/A	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/ Milfoil	HIGH
LONG POND		N/A				N/A	—	AVG
McWAIN POND		N/A				N/A	Gloeo	MOD
MIDDLE POND							—	MOD/HIGH
MOOSE POND (Main)							Gloeo/Al:Fe	HIGH
MOOSE POND (North)						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/HIGH
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
TRICKEY POND							—	HIGH
WEBBER POND		N/A	N/A	N/A	N/A	N/A	—	AVG
WOODS POND						N/A	—	MOD

Key to Water Quality at a Glance Table

Oxygen Depletion: Did the lake suffer from low oxygen conditions in 2017?

= severe = slight = none

High P at depth: Were deep-water phosphorus levels above 12 ppb in 2017?

= Yes = No N/A = not tested

Clarity, Phosphorus, and Chlorophyll-a trends: Data from 1996-2017 was analyzed to determine if these parameters are improving or worsening over time. N/A = no trend analysis

=Worsening = Improving = No change

Coldwater Fish: Did coldwater fish have 2 m of suitable habitat at all times of the year in 2017?

= No = Yes N/A = no coldwater 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 release from sediments

Algae: An algae bloom has occurred in the past

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

Milfoil: Invasive milfoil has been found in this lake

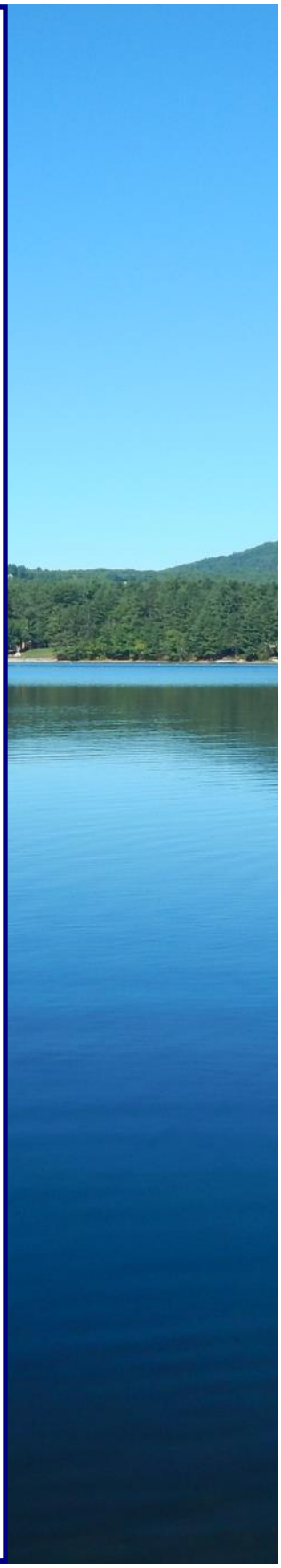
Degree of Concern: LEA's risk assessment for future lake water quality

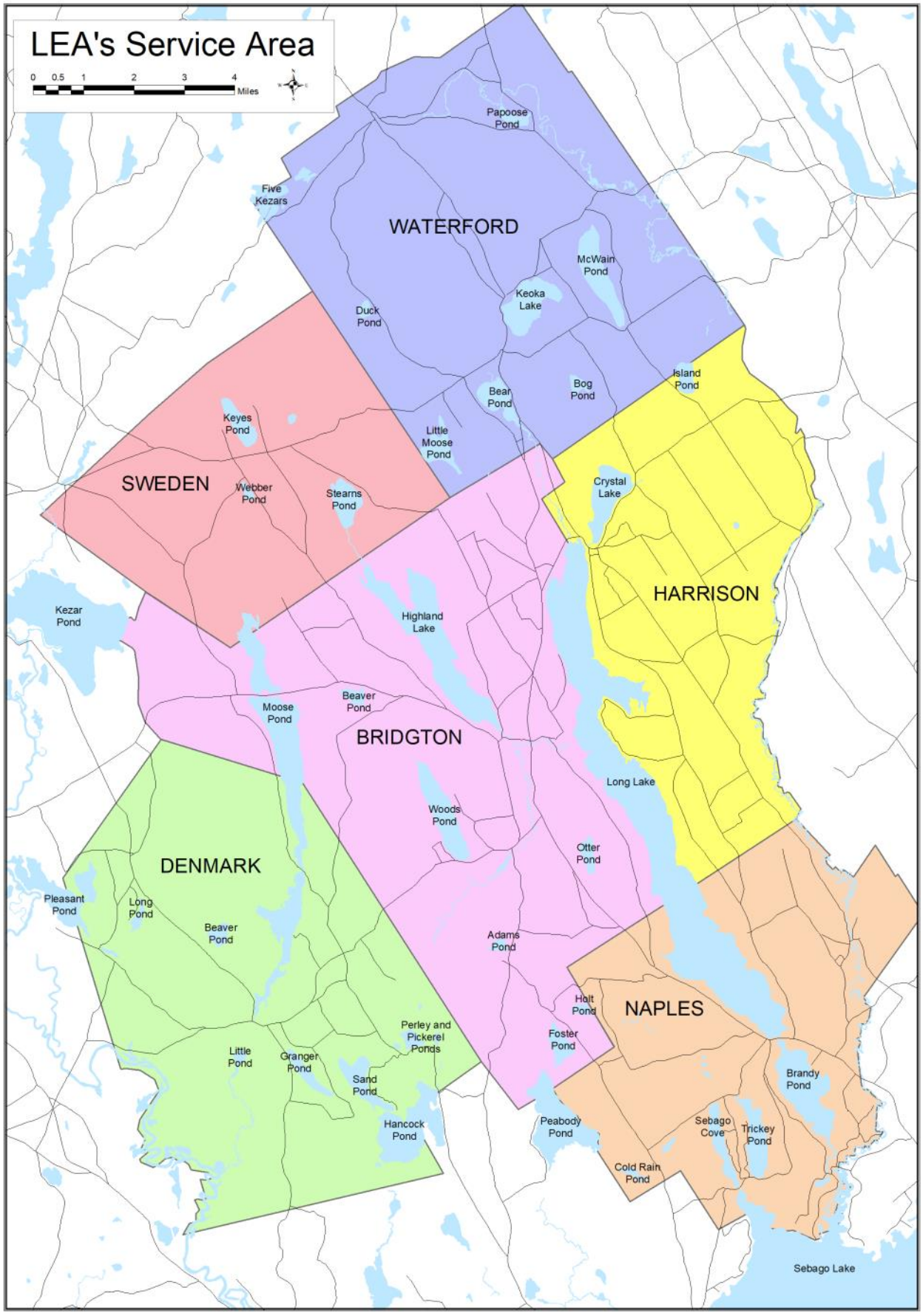
Average: none or 1

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
Bear Pond
Bog Pond
Island Pond
Keyes Pond
Little Moose Pond
Webber Pond
Stearns Pond
Crystal Lake
Kezar Pond
Highland Lake
Beaver Pond
Moose Pond
Long Lake
Woods Pond
Otter Pond
Pleasant Pond
Long Pond
Beaver Pond
Adams Pond
Holt Pond
Foster Pond
Perley and Pickerel Ponds
Little Pond
Granger Pond
Sand Pond
Hancock Pond
Brandy Pond
Peabody Pond
Sebago Cove
Trickey Pond
Cold Rain Pond
Sebago Lake

LEA would not be able to test the 41 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!**

2017 Volunteer Monitors and Lake Partners

Paul America
Bill Ames and Paulina Knibbe
Richard and Andy Buck
Steve Cavicchi
Jeff and Susan Chormann
Janet Coulter
David Ehrman
Jane Forde
Joe and Carolee Garcia
Carol Gestwicki
Shelly Hall
Carl and JoAnne Harbourt
Aiden Ireland
Jim Kelly
Kokosing
Lydia Landesberg
Amy March
Julie and Dan McQueen
Dorothy Mayberry
Bob Mahanor
Bob Mercier
Bill Muir
Papoose Pond Campground
Barry and Donna Patrie
Nancy Pike
Jean Preis
Don Rung
Stephanie Scearce
Arthur and Jean Schilling
Jane Seeds
Linda and Orrin Shane
Foster and Marcella Shibles
Bob Simmons
Barry Smith
Paul Stander
Carolyn Stanhope
Tom Stockwell
Tom Straub
Don and Pat Sutherland
Charlie Tarbell
David Thomae
Chip and Rhona Wendler
Camp Wigwam

2017 Water Testing Crew

Isabella Davis
Kayla Gray
Grace Kimzey
Erin Levasseur
Jacob Moulton
Chloe Wendler

Lake Association Partners Who Contribute to Advanced Testing Initiatives

Five Kezar Ponds Watershed Assoc.
Hancock and Sand Ponds Association
Island Pond 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 coldwater 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

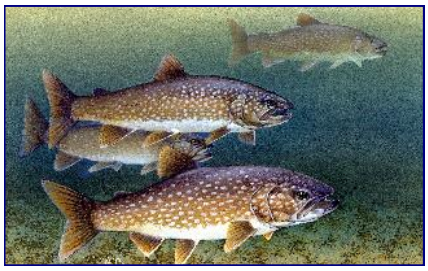
Epilimnion

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.



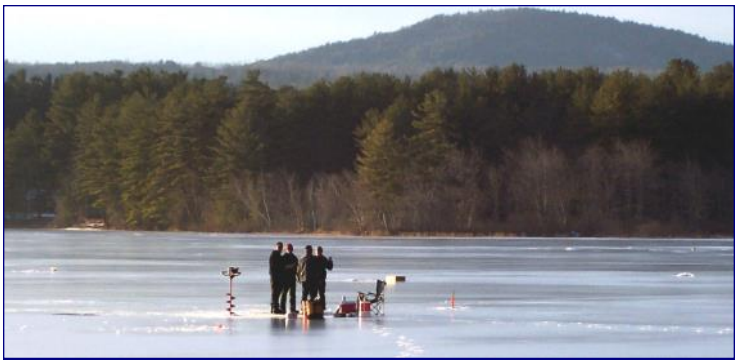
Lake trout, also known as togue

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.

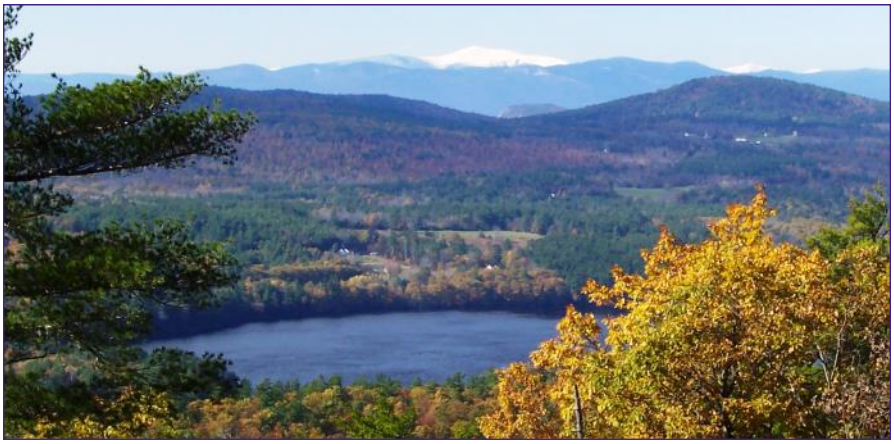


Spring is a period of rejuvenation for the lake. After the ice melts, all of the water is nearly the same temperature from top to bottom. During this period, strong winds can thoroughly mix the water column allowing for oxygen to be replenished throughout the entire lake.

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. Coldwater 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 water transparency. It is determined with a Secchi disk and measured in meters. Clarity is affected by water color and the presence of algae and suspended particles.

Chlorophyll-a is a pigment found in all algae. Chlorophyll (the –a is dropped for simplicity) sampling in a lake is used to estimate 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.

Phosphorus is a nutrient needed by algae to grow and reproduce. It is used to determine the potential for algae growth in a lake. Phosphorus is measured in parts per billion (ppb). Upper layer phosphorus samples are a composite (blended sample) of the top few meters of the water column, 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. It is measured in parts per million (ppm). Over the course of the summer, oxygen in the bottom waters is consumed through organic matter decomposition. If dissolved oxygen concentrations reach zero at the bottom of the lake, phosphorus can be released into the water column from bottom sediments, which can cause increased algal growth that fuels further lake oxygen depletion. Phosphorus release is inhibited in lakes with high sediment aluminum levels. Oxygen depletion can be a natural occurrence in some lakes due to the lake's shape. It is a special concern in lakes that support coldwater fish. In this report, "oxygen depletion" refers to dissolved oxygen levels below 4 ppm. 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.

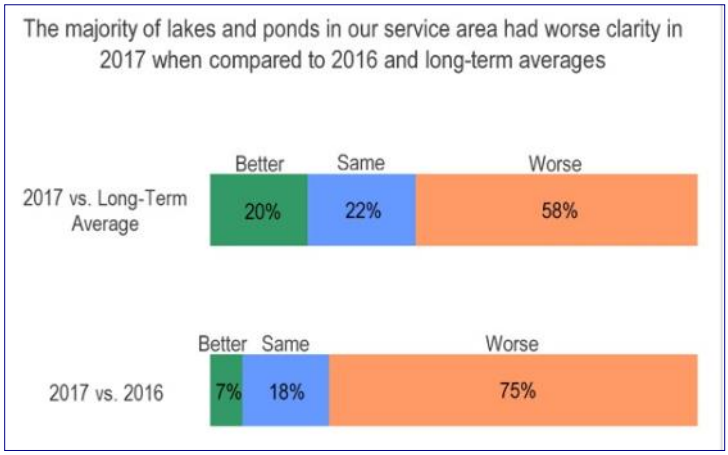
Temperature is measured at one-meter intervals from the surface to the bottom of the lake. This data is used to assess thermal stratification. Lakes deep enough to stratify will divide into three distinct layers: the epilimnion, metalimnion and hypolimnion. The epilimnion (upper layer) is comprised of 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.

Other Measurements: We collect data on these parameters, but they tend to remain stable over long periods time. They are not reported on unless unusual conditions were observed.

> **Conductivity** measures the ability of water to carry electrical current. Pollutants and minerals in the water will generally increase lake conductivity.
>
> **Color** is a measure of tannic or humic acids in the water.
>
> **pH** is important in determining the plant and animal species living in a lake. pH is used to measure the acidity of lake water.
>
> **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.

2017 as a Year

The water quality results for 2017 show a mediocre year for water quality in the lakes region. Several factors influenced the results seen in 2017. The winter of 2016-2017 deposited a larger than average amount of snow in the region, leading to higher water flows in the spring. There was also a significant amount of rainfall in the spring and early summer. More water running off into lakes meant more erosion bringing particulates and pollution, as well as higher water levels. Tornadoes in the Long Lake and Moose Pond watersheds in early July also caused severe erosion and extensive damage to shorefront property and vegetation. Relatively cold temperatures in the spring delayed stratification and meant that ice-out occurred around its average date, despite a trend of increasingly earlier ice-out over the last few decades. While rainfall was high early in the season, later in the summer the region experienced mild drought conditions. The lack of rain increased clarity in many lakes toward the end of the season, but because of low readings early in the season, the majority of lakes saw worse than average clarity in 2017.



Clarity, a measure of how transparent the water is, was the same or better on 42% of lakes and worse on 58% when compared to long-term averages. Chlorophyll-a, a measurement of the algae concentration in a lake, was stable or improved over the long-term average in 62% of lakes and worse than average on 38% of lakes. Phosphorus, the limiting nutrient that controls algae growth, was also the same or better in the upper layer of the water column on 62% of lakes and worse on 38%. Phosphorus levels at depth appeared to be lower overall in 2017 compared to previous years. This may be explained by the delay in the set up of stratification in the spring, which resulted in less severe oxygen depletion and meant there was less phosphorus release from lake sediments. Weather is often the driving force behind water quality in any given year. The weather in 2017 affected water quality in both positive and negative ways. Fortunately, no major water quality declines or algae blooms were reported in 2017.

On a longer timescale, water quality trends are impacted by climate, changes in land use, non-point source pollution, and best management practices. This means that any changes we make to protect our lakes — such as installing water bars, pumping septic systems, or planting a vegetated buffer on a shoreline — do not often result in visible benefits for several years, but are extremely important to the long-term health of our lakes. With strong support and investment in the future of our lakes, we can keep the Lakes Region resilient and protected for years to come.

Interpreting the Summaries

Water Quality Classification

Each lake's clarity, chlorophyll, and phosphorus readings will be discussed in the lake summaries. These three measurements are the basis for determining water quality classification. Most lakes in LEA's service area are in the moderate range for all three parameters. The following table shows the range of values in each category (low, moderate, etc.) for each parameter.

Clarity in meters (m)		Phosphorus in parts per billion (ppb)		Chlorophyll-a in parts per billion (ppb)	
10.0 +	excellent	less than 5.0	low	less than 2.0	low
7.1 – 10.0	good	5.1 – 12.0	moderate	2.1 – 7.0	moderate
3.1 – 7.0	moderate	12.1 – 20.0	high	7.1 – 12.0	high
less than 3.0	poor	20.1 +	very high	12.1 +	very high

Trends and Long-Term Averages

The lake summaries start with an explanation of clarity, chlorophyll, and phosphorus trends. These trends are a regression analysis of all the data LEA has collected on that lake or pond since 1996 (or later if data is unavailable for earlier years). If the p-value of the regression is less than 0.05, it is a worsening or improving trend (depending on the direction of the trend). If the p-value is above 0.05, there is no detectable trend. These trends show water quality changes over time.

The long-term average is a simple mean of all the data we have on record for each parameter (clarity, chlorophyll, and phosphorus). The long-term average doesn't tell us specifically how each parameter changes over time like the trend analysis does; it is instead used see how the current year's data compares to historical values. The long-term average uses all the data available, rather than just data collected in or after 1996.

This means that the trend and the long-term average can be at odds. For example, the overall clarity trend might be improving over time, but if the current year had particularly bad water clarity, the yearly average may be worse than the long-term average. The trend shows how the parameter has changed over time, while the long-term average is used as a benchmark to assess the current year's data.

Coldwater Fish Habitat

Suitable habitat is defined as being below 15.5 °C and above 5 ppm dissolved oxygen. Marginal habitat is between 15.5 and 20 °C and above 5 ppm oxygen. Coldwater fish habitat is considered a water quality issue in lakes with coldwater fisheries that do not have at least 2 meters' worth of suitable habitat at all times during the testing season.

Degree of Concern

Each lake is also given a degree of concern category ranking. 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. You can see more about these rankings in the "Water Quality at a Glance" table and key on pages 2 and 3.

Individual Lake Summaries

The following pages present 2017 routine monitoring data by lake. Where applicable, graphs or charts have been included in the individual summary information to help show particular conditions or trends. You will also see the following symbols in the top right corner of some pages. These symbols indicate that additional data from that lake is available in chapters 2–5.

This symbol indicates that the lake has a high-resolution monitoring buoy. Further information is available in chapter 2.

This symbol indicates that the lake has high levels of *Gloeotrichia* echinulata algae, which is discussed in more detail in chapter 3.

This symbol indicates that a series of temperature sensors was deployed in the lake in 2017. More information is available in chapter 4.

This symbol indicates that algae samples were taken from the lake in 2017. Algae monitoring results are discussed in chapter 5.

Additional Analyses Available

Back Pond

Back Pond Quick Statistics
2017 Average Versus the Long-term Average:

Clarity: Better at 6.5 meters
Chlorophyll: Worse at 2.2 ppb
Phosphorus: Better at 5.4 ppb

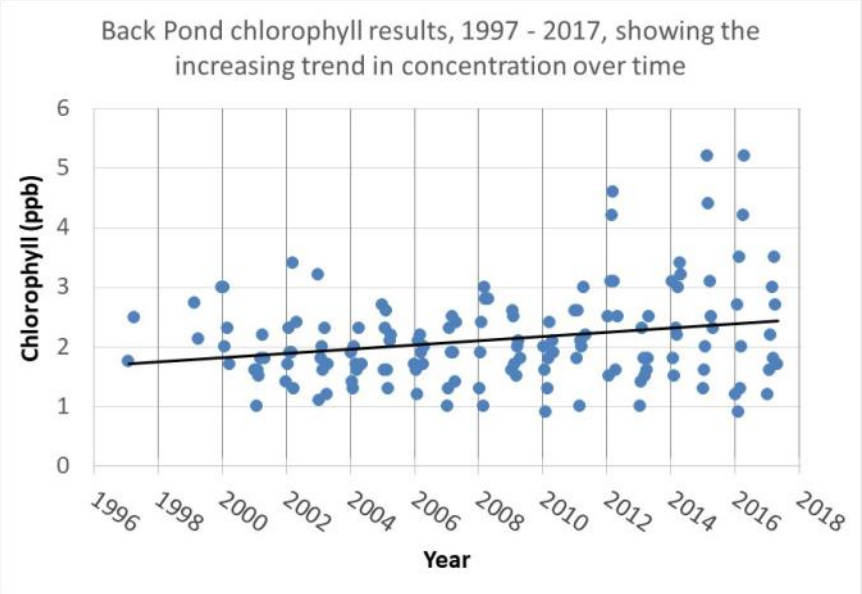
Surface Area:	62 acres
Maximum Depth:	33 feet
Watershed Area:	584 acres
Elevation:	572 feet

Water Quality Summary:

Long-term trends indicate clarity and phosphorus are both improving over time on Back Pond. However, chlorophyll has been increasing over time. This means that algae concentrations may be on the rise. The good news is that the 2017 chlorophyll average was only very slightly worse than the long-term average of 2.1 ppb, and Back Pond had some of the lowest average chlorophyll and phosphorus values of all the lakes and ponds in LEA's service area in 2017. Average values from all three parameters (chlorophyll, phosphorus, and clarity) are considered to be in the moderate range.

Previous sediment chemistry results show Back Pond has a higher potential for internal phosphorus release due to low sediment aluminum levels. Aluminum binds with phosphorus that is released from sediments that have become anoxic (lacking in oxygen), locking it away at the bottom of the lake. The low level of aluminum on Back Pond means that if phosphorus is released from sediments, it is likely to enter the pond and contribute to algae growth.

Fortunately, dissolved oxygen depletion in Back Pond is mild and relative sediment phosphorus concentrations are low. Still, the increasing chlorophyll trend and low sediment aluminum mean that Back Pond is more vulnerable than many other lakes and remains in LEA's HIGH degree of concern category.



Bear Pond

Bear Pond Quick Statistics
2017 Average Versus the Long-term Average:

Clarity: Worse at 5.6 meters
Chlorophyll: Better at 3.7 ppb
Phosphorus: Worse at 10.5 ppb

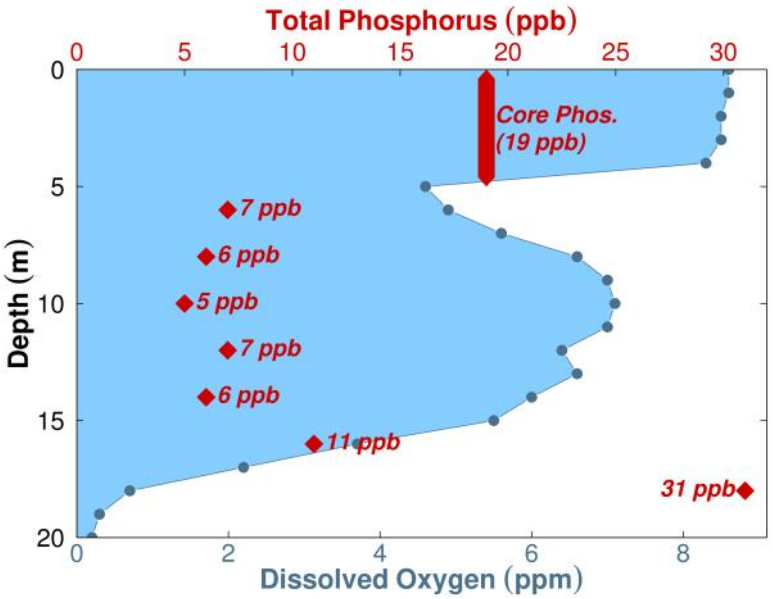
Surface Area:	250 acres
Maximum Depth:	72 feet
Mean Depth:	34 feet
Volume:	7,978 acre-feet
Watershed Area:	5,331 acres
Flushing Rate:	2.3 flushes per year
Elevation:	375 feet

Water Quality Summary:

Trend analysis shows clarity and phosphorus are stable on Bear Pond, but overall levels of chlorophyll are increasing. Despite these trends, in 2017 average clarity and phosphorus concentrations were worse than long-term averages and chlorophyll was slightly better than average. Average values for all three parameters were in the moderate range.

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

Due to the increasing chlorophyll trend, oxygen depletion, and high phosphorus levels at depth, Bear Pond is in LEA's HIGH degree of concern category.



Bear Pond water column phosphorus (red) and dissolved oxygen (blue) data on 8/30/2017. Upper layer phosphorus (bar) from 0 to 5 m composite water sample. Deep water phosphorus (diamonds) from depth-specific grab samples.

Bog Pond

Bog Pond Quick Statistics
2017 Versus the Long-term Average:

Clarity: To Bottom
Chlorophyll: Better at 3.3 ppb
Phosphorus: Better at 12.0 ppb

Surface Area:	57 acres
Maximum Depth:	5 feet
Perimeter:	1.4 miles
Elevation:	669 feet

Water Quality Summary:

LEA samples Bog Pond once per year. In 2017, clarity reached the bottom of the pond. Trend analysis could not be done for the pond because LEA has only been taking measurements since 2009. Chlorophyll and phosphorus levels were both better in 2017 than average levels since sampling began. The chlorophyll level is within the moderate range, while phosphorus is on the cusp of being in the high range. The pond is small, shallow and has a large wetland complex associated with it which may cause relatively high phosphorus readings. Due to a lack of significant water quality concerns, Bog Pond remains in LEA's AVERAGE degree of concern category.

Duck Pond

Duck Pond Quick Statistics
2017 Versus the Long-term Average:

Clarity: Similar at 3.0 meters
Chlorophyll: Worse at 7.9 ppb
Phosphorus: Better at 19.0 ppb

Surface Area:	38 acres
Maximum Depth:	10 feet
Mean Depth:	6 feet
Elevation:	1,069 feet

Water Quality Summary:

LEA has measured water quality on Duck Pond once per year since 2013. While there is not enough data to calculate trends, the chlorophyll level measured in 2017 was slightly higher than average and the phosphorus level was lower than average. Clarity was around 3 meters deep and did not reach the bottom of the pond. Duck Pond's water quality was poor in comparison to most of the lakes within LEA's service area. Chlorophyll and phosphorus were both in the high range and clarity was poor. However, Duck Pond is small in area, shallow, and highly colored. There is little development in its watershed. The water quality conditions observed are normal for this type of lake and are not a great concern. Therefore, the pond remains in LEA's in the AV-ERAGE degree of concern category.

Island Pond

Island Pond Quick Statistics
2017 Average Versus the Long-term Average:

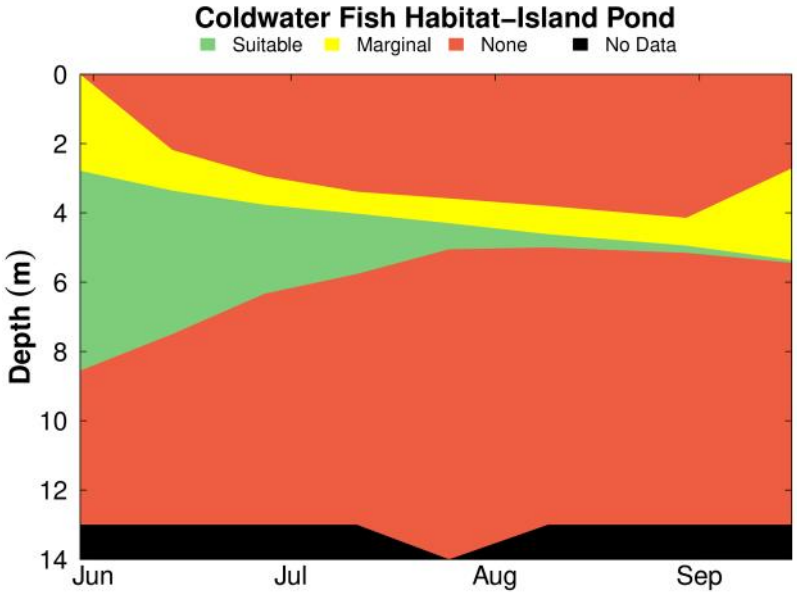
Clarity: Worse at 5.2 meters
Chlorophyll: Worse at 3.7 ppb
Phosphorus: Worse at 7.8 ppb

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

Water Quality Summary:

Trend analysis shows clarity, chlorophyll, and phosphorus have remained stable over time on Island Pond. These three parameters are the most important factors in determining water quality status. Average clarity, chlorophyll, and phosphorus were worse in 2017 than long-term average values. Consistently worse than average results over time will lead to declining clarity and increasing phosphorus and chlorophyll trends. Currently, average values for each of the three parameters are within the moderate range.

Island Pond's main water quality concerns are dissolved oxygen depletion and the effect this has on coldwater fish. In some years, the pond also exhibits high deep-water phosphorus levels. Deep-water phosphorus levels were not measured on Island Pond in 2017, so they could not be included in the pond's degree of concern assessment. Therefore, Island Pond has been downgraded to LEA's MODERATE degree of concern category.



Coldwater fish habitat availability in the lake between late May and early September 2017. Colored areas indicate thickness of water column that is good habitat (green), marginal and stressful for some species (yellow), and inhospitable due to low oxygen and/or warm water temperatures (red).

Jewett Pond

Jewett Pond Quick Statistics
2017 Versus the Long-term Average:

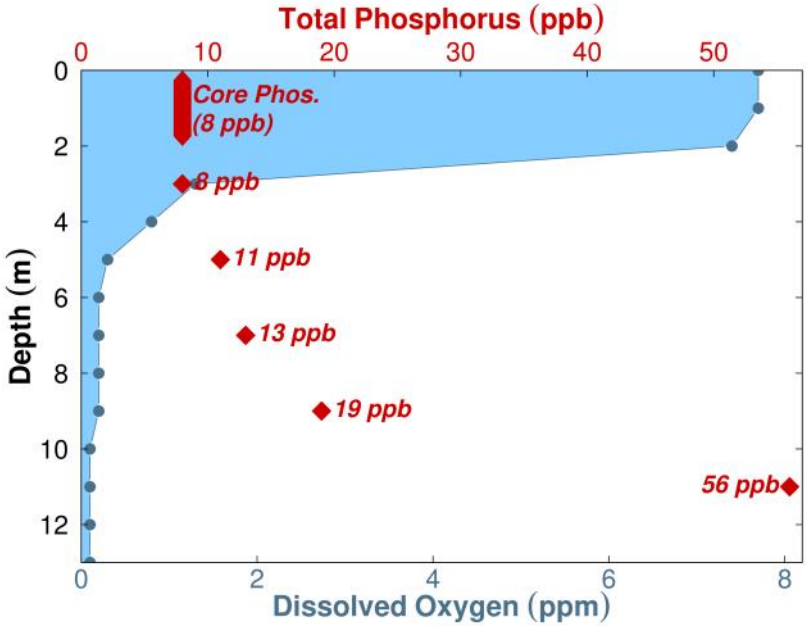
Clarity: Better at 4.6 meters
Chlorophyll: Better at 3.6 ppb
Phosphorus: Better at 8.0 ppb

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

Water Quality Summary:

Water quality in Jewett Pond is measured once a year in August. Trend analysis indicates that clarity, chlorophyll, and phosphorus are all stable. All three parameters were improved over their long-term averages in 2017. Values for clarity, chlorophyll, and phosphorus were all within the moderate range.

Jewett Pond's main water quality concerns are severe oxygen depletion and very high phosphorus levels in the deeper waters of the pond. Oxygen depletion can cause sediments to release phosphorus, so these two conditions are related to one another. These issues are the basis for Jewett Pond's MODERATE degree of concern rating.



Jewett Pond water column phosphorus (red) and dissolved oxygen (blue) data on 8/28/2017. Upper layer phosphorus (bar) from 0 to 2 m composite water sample. Deep water phosphorus (diamonds) from depth-specific grab samples.

Keoka Lake

Additional Analyses Available

Keoka Lake Quick Statistics
2017 Average Versus the Long-term Average:

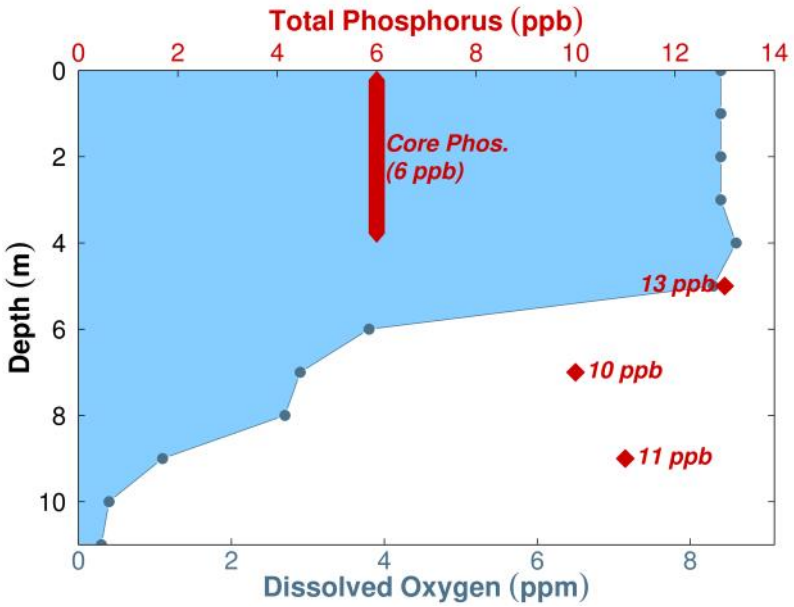
Clarity: Similar at 6.0 meters
Chlorophyll: Worse at 4.3 ppb
Phosphorus: Better at 7.0 ppb

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

Water Quality Summary:

Trend analysis shows that clarity, chlorophyll, and upper layer phosphorus are all stable on Keoka Lake. These three parameters are the most important factors in determining water quality status. Average values for all three measurements in 2017 were within the moderate range. LEA volunteer monitor Don Rung takes additional clarity measurements of Keoka Lake.

Keoka Lake's main water quality concerns are low oxygen levels and high deep-water phosphorus levels. Because of these low oxygen conditions, coldwater fish did not have adequate habitat during portions of the summer. Keoka Lake is also one of four lakes with elevated levels of *Gloeotrichia echinulata,* a cyanobacteria that can release toxins and form blooms. For these reasons, Keoka Lake has been elevated to the HIGH degree of concern level.



Keoka Lake water column phosphorus (red) and dissolved oxygen (blue) data on 8/25/2017. Upper layer phosphorus (bar) from 0 to 4 m composite water sample. Deep water phosphorus (diamonds) from depth-specific grab samples.

Little Moose Pond

Little Moose Pond Quick Statistics
2017 Average Versus the Long-term Average:

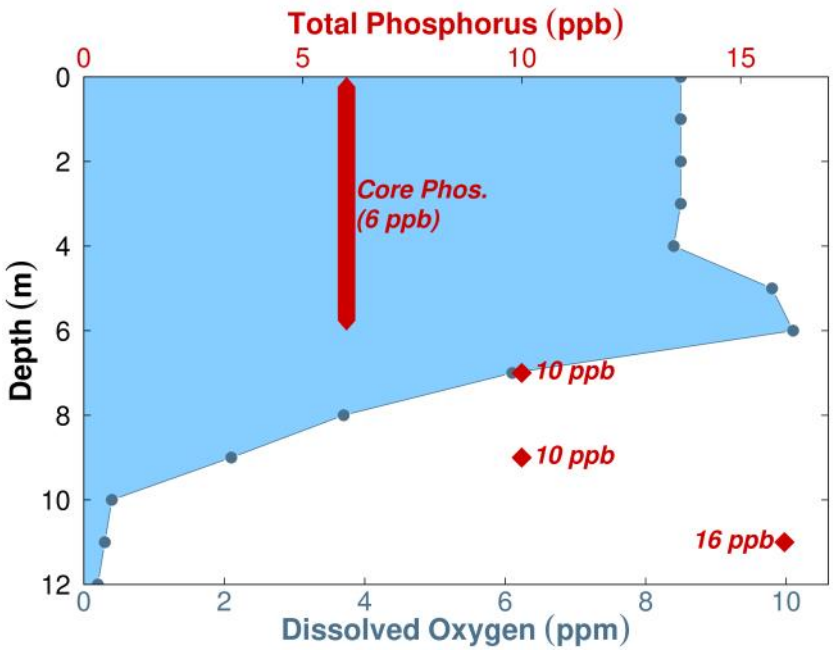
Clarity: Worse at 6.5 meters
Chlorophyll: Worse at 2.4 ppb
Phosphorus: Worse at 6.0 ppb

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

Water Quality Summary:

Trend analysis indicates that clarity, chlorophyll, and upper layer phosphorus are all stable on Little Moose Pond. However, average values for all three parameters were worse in 2017 compared to long-term averages. Consistently worse than average results over time will lead to declining clarity and increasing phosphorus and chlorophyll trends. Currently, the clarity, chlorophyll, and phosphorus averages are all within the moderate range.

The main water quality concerns on Little Moose Pond are oxygen depletion and high deep-water phosphorus levels. A high aluminum content in the sediments of the pond means it is unlikely that excess phosphorus is being released from the sediments, which can happen under zero oxygen conditions. However, the oxygen depletion and high phosphorus are still bad for the ecology of the lake. These issues put Little Moose Pond is in LEA's MODERATE degree of concern category.



Little Moose Pond water column phosphorus (red) and dissolved oxygen (blue) data on 8/22/2017. Upper layer phosphorus (bar) from 0 to 6 m composite water sample. Deep water phosphorus (diamonds) from depth-specific grab samples.

Little Mud Pond

Little Mud Pond Quick Statistics
2017 Versus the Long-term Average:

Clarity: Worse at 2.0 meters
Chlorophyll: Better at 5.6 ppb
Phosphorus: Better at 13.0 ppb

Surface Area:	45 acres
Maximum Depth:	35 feet
Mean Depth:	13 feet
Watershed Area:	1,661 acres
Elevation:	572 feet

Water Quality Summary:

Little Mud Pond is the second basin of Mud Pond, and one of the Five Kezar Ponds. LEA collects water quality data on Little Mud once a year in August. Trend analysis indicates clarity, phosphorus, and chlorophyll are all stable over time. The pond had poor clarity in 2017, and although it was better than the long-term average, the phosphorus value of 13 ppb was still within the high range. The chlorophyll level was within the moderate range.

The deeper waters suffered from dissolved oxygen depletion at the time of testing. Much of the pond's water quality is due to the large wetland complex associated with it, which causes the low clarity and high phosphorus readings. Little Mud Pond is in LEA's AVERAGE degree of concern category.

Additional Analyses Available

McWain Pond

McWain Pond Quick Statistics
2017 Average Versus the Long-term Average:

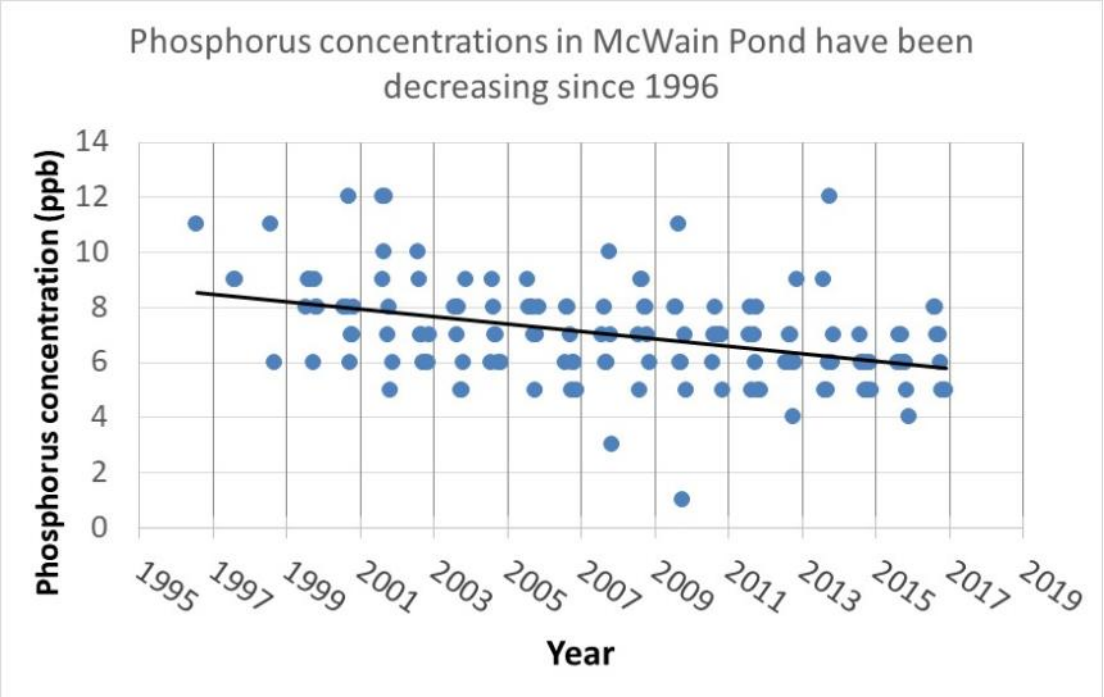
Clarity: Worse at 5.9 meters
Chlorophyll: Worse at 3.2 ppb
Phosphorus: Better at 6.4 ppb

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

Water Quality Summary:

Trend analysis indicates that clarity and chlorophyll are stable on McWain Pond while phosphorus has improved over time. The average phosphorus level in 2017 was a significant improvement over the long-term average, whereas clarity and chlorophyll averages were slightly worse than their long-term average values. All three parameters were within the moderate range in 2017.

The main water quality concerns on McWain Pond are oxygen depletion and *Gloeotrichia echinulata*, a cyanobacterial species that causes blooms and can produce toxins. In previous years, the pond has occasionally had elevated deep-water phosphorus levels. Deep-water phosphorus levels could not be measured on McWain Pond in 2017, so they were not included in the pond's degree of concern assessment. Because of this, McWain Pond has been downgraded to LEA's MODERATE degree of concern category.



Additional Analyses Available

Middle Pond

Middle Pond Quick Statistics
2017 Average Versus the Long-term Average:

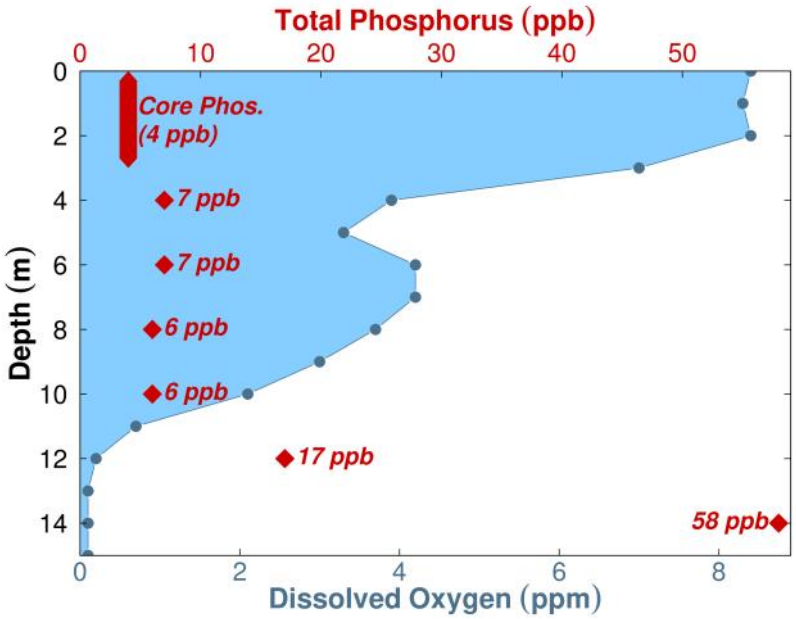
Clarity: Worse at 5.1 meters
Chlorophyll: Worse at 4.2 ppb
Phosphorus: Worse at 9.8 ppb

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

Water Quality Summary:

Trend analysis indicates improving clarity and stable chlorophyll and upper layer phosphorus concentrations over time on Middle Pond. However, all three parameters were worse than their long-term averages in 2017. Because of high values in 2017, phosphorus and chlorophyll have gone from improving trends to stable trends. Clarity, upper layer phosphorus, and chlorophyll averages were moderate in 2017.

The main water quality concerns in Middle Pond are oxygen depletion, high deep-water phosphorus levels, and a lack of coldwater fish habitat during a short period in late summer. All of these issues are interconnected: low oxygen levels exclude coldwater fish and can also induce sediments to release phosphorus, which raises levels of this nutrient in the deeper waters. Because coldwater fish habitat is shrinking, Middle Pond has been elevated to the MODERATE/HIGH degree of concern category.



Middle Pond water column phosphorus (red) and dissolved oxygen (blue) data on 8/21/2017. Upper layer phosphorus (bar) from 0 to 3 m composite water sample. Deep water phosphorus (diamonds) from depth-specific grab samples.

Mud Pond

Mud Pond Quick Statistics
2017 Versus the Long-term Average:

Clarity: Better at 3.9 meters
Chlorophyll: Better at 2.9 ppb
Phosphorus: Better at 7.0 ppb

Surface Area:	45 acres
Maximum Depth:	35 feet
Mean Depth:	13 feet
Watershed Area:	1,661 acres
Elevation:	572 feet

Water Quality Summary:

LEA conducts water testing on Mud Pond once per year. Trend analysis indicates that clarity, phosphorus, and chlorophyll are all stable. In 2017, all three readings were in the moderate range and were much improved over long-term averages.

The main water quality issue present on Mud Pond is dissolved oxygen depletion. It was very pronounced at the time of sampling, affecting the bottom 8 meters of the 10-meter-deep pond. However, the volume of deep water in the pond is very small, which means oxygen is quickly used up and cannot be replenished through wind mixing. Mud Pond is in LEA's AVERAGE degree of concern category.

Triploceras, a type of green algae.

Papoose Pond

Papoose Pond Quick Statistics
2017 Versus the Long-term Average:

Clarity: Worse at 3.3 meters
Chlorophyll: Better at 3.5 ppb
Phosphorus: Better at 10.0 ppb

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

Water Quality Summary:

Papoose Pond is sampled by LEA once per year in August. Trend analysis indicates that clarity is improving over time and phosphorus and chlorophyll are stable. Contrary to these overall trends, clarity was slightly worse than the long-term average in 2017 and chlorophyll and phosphorus were much improved over long-term average values. All three parameters were within the moderate range. Slight oxygen depletion does occur near the bottom of the pond. A lack of water quality concerns puts Papoose Pond in LEA's AVERAGE degree of concern category.