

## Water Testing Summary

## Lakes Environmental Association

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LEA would not be able to test the 41 lakes and ponds in our service 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!

## 2023 Volunteer Monitors and Lake Partners

| Richard and Andy Buck | Bill Ames and Paulina Knibbe | Jean Preis |
| :---: | :---: | :---: |
| Papoose Pond Campground | Bob Mahanor | Schilling \& Kloos Family |
| Steve Cavicchi | Amy March | Linda and Orrin Shane |
| Jeff and Susan Chormann | Julie and Dan McQueen | Foster and Marcella Shibles |
| Janet Coulter | Bob Mercier | Bob Simmons |
| Joe and Carolee Garcia | Barry and Donna Patrie | Tom Straub |
| Carol Gestwicki | Nancy Pike | Shelley \& Richard Hall |
| Island Pond Association | Keoka Lake Association | Moose Pond Association |
| Hancock and Sand Ponds | McWain Pond Association | Peabody Pond Protective |
| Association | Keysociation Pond Environmental | Trickey Pond Environmental |
| Five Kezar Ponds Watershed | Protection Association | Protection Association |
| Association | Woods Pond Association |  |

## LEA's 2023 Water Testing Team

Maggie Welch
Staff Limnologist

Dr. Ben Peierls
Research Director

Rachel Harper
Field Tech

Annie O'Connor
Intern



## Overview of LEA's Water Testing Program

Lakes Environmental Association (LEA) is a non-profit organization founded in 1970. LEA's mission is to preserve and restore the exceptional water quality of Maine's lakes, ponds, rivers, streams, and wetlands and the integrity of their watersheds. LEA works towards accomplishing this mission through our Courtesy Boat Inspector and Invasive Plant Programs, our land use and advocacy work, and watershed based educational programming. For more information about these programs please visit our website: www. mainelakes.org. This report focuses on the water testing programs that LEA reports on annually. Each program is represented by a unique image. If you see these images in the top right corner of individual lake summaries, then that lake is included in other program reports.

## Automated Monitoring Buoy



Each year, LEA deploys two fully automated monitoring buoys - one on Highland Lake and one on Long Lake (north basin). These buoys collect temperature, oxygen, and chlorophyll data at multiple depths every 15 minutes throughout the spring, summer, and fall. Because this data is live, we can see current conditions in the lake anytime.

## Winter Water Quality Monitoring



Monitoring what is happening in our lakes during the winter months can help us better understand lake patterns and conditions during the rest of the year. We also know that ice cover duration is decreasing for most Maine lakes. To document and understand how this will affect our waters, we monitor the larger lakes in our service area during the winter. Data from this program are summarized in a separate report published in the spring. LEA visits 13 lakes during winter.

## Long-term Water Quality Monitoring

$\circlearrowleft$
Water testing on 41 lakes in LEA's service area occurs every year through traditional and advanced testing initiatives. Data collected and summarized in this report contribute to our long-term understanding of lake/pond behavior and health. Our data are available to the public through Maine's Department of Environmental Protection and LEA's annual water quality reports.

## Algae Monitoring Via Fluorometry



Algae either directly or indirectly support much of the life existing in a lake and are considered the foundation of aquatic food webs. LEA uses a fluorometer to measure chlorophyll fluorescence at discrete depths throughout the water column. Monthly fluorometer profiles were collected from participating lakes from May through September.

## High Resolution Temperature Monitoring

(1)Water temperature is critical to the biological function of lakes, as well as the regulation of chemical processes. Each year, we attempt to capture the entire stratified period within the temperature record, from when stratification begins to form in the spring to when the lake mixes in the fall. With funding and support from local lake associations, LEA has deployed temperature sensors at sixteen sites on 13 lakes.

You can support lake science by becoming 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.

## Maine Lake Science Center

After water samples have been collected, they are brought back to LEA's Maine Lake Science Center for analysis. We produce all of our own data and perform our own lab analyses from basic water chemistry, like pH and conductivity to more complex processes like nutrient and chlorophyll-a concentrations. We also do algae identification, flow imaging microscopy, bacterial monitoring, and cyanobacterial toxin analysis.

## Lake Science and Helpful Terms

To understand much of LEA's water quality data, it is helpful to be familiar with some of the properties that make water unique. When water is in its liquid state, its molecules move around freely. As liquid water cools from room temperature to about $4^{\circ} \mathrm{C}$, water molecules slow down and move more closely together. This allows more water molecules to fit in an area resulting in higher water density. As water cools below $4^{\circ} \mathrm{C}$ water molecules lock into a rigid position creating open spaces between molecules, the result is when water freezes, it expands and becomes less dense than liquid water. Water's ability to change density with temperature plays a critical role in the natural processes and ecosystems that LEA monitors.
Over the course of a year, many lakes shift between having a uniform temperature from top to bottom, to being separated into distinct, temperature-dependent layers. This layering, also called stratification, occurs because water density changes with water temperature. The warmer, shallowest layer is called the epilimnion and is the least dense layer. The middle layer, is the thermocline/ metalimnion and is where water density and temperature changes rapidly. The coldest, deepest layer is the hypolimnion and is the densest layer. The exact depths of each layer change over the course of the summer and from lake to lake and year to year.
In a lake, warm shallow water will not mix with cold deep water because the density difference between the two layers is so different that they can not mix. Stratification prevents oxygen exchange between upper and bottom layers, which often results in significant differences in oxygen and nutrient concentrations. This is especially true in late summer when the warm, well-oxygenated epilimnion and the cold hypolimnion are cut off from each other by the metalimnion.


Winter- Ice blocks out sunlight and prevents winds from mixing oxygen into upper waters. With little light below the ice and gradually diminishing oxygen levels, plants stop growing. The water does stratify, with coldest waters near the surface and warmest near the bottom.


Spring - After the ice melts, rising air temperatures warm shallower waters until they are nearly the same temperature as deeper waters. When water temperature is similar from top to bottom, aided by strong winds, shallow and deep waters mix together, redistributing nutrient and oxygen concentrations throughout the water column.


Summer- As air temperature increases, deeper lakes will gradually stratify into a warm upper layer and a cold bottom layer, separated by a thermocline, a zone of rapid temperature and oxygen level change. The upper, warm layers are constantly mixed by winds, which "blend in" oxygen. After stratification, the thermocline prevents colder, deeper waters from mixing with wind-mixed shallower waters and are cut off mixing events that could provide additional oxygen. This can result in deep water oxygen depletion, which may negatively affect cold-water fisheries. When oxygen levels are low at the bottom of the lake, a chemical reaction occurs that releases stored phosphorus from sediments. However, due to the density barrier at the thermocline, these nutrients do not move easily into the epilimnion. This often causes a buildup of phosphorus in the deep waters.


Fall - As air and wind temperatures decrease, shallower waters cool until they are nearly the same temperature as deeper waters. As in Spring, when water temperature is similar from top to bottom, strong winds cause the lake to turn over, which allows oxygen to be replenished throughout the water column

Due to the nature of stratification, which does not allow for oxygen 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. Lack of nutrient and oxygen exchange 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.

## Helpful Terms

Epilimnion is the shallowest layer in a stratified lake. This layer is sunlit, wind mixed, and oxygen rich.
Metalimnion is the middle layer in a stratified lake. This layer acts as a thermal barrier that prevents the interchange of nutrients between the warm upper waters and the cold bottom waters.
Hypolimnion is the deepest layer in a stratified lake. This layer contains the cold water at the bottom of lakes. Food for most creatures in in short supply and the reduced temperatures and light penetration prevent plants from growing.
Clarity is a measure of water transparency. Clarity is measured by lowering a Secchi disk into the water until it can no longer be seen. Higher Secchi values indicate clearer water. Clarity is reported in meters.
Temperature is measured by lowering a probe into the water. The probe is allowed to adjust to temperature conditions at one-meter intervals from the surface to the bottom of the lake. Temperature data are recorded and used to assess thermal stratification.
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). For information about oxygen levels on your particular lake, refer to Chapter 4 or our water testing reports or reach out to LEA staff.
Chlorophyll-a is a pigment found in all plants, including algae. Chlorophyll is used to estimate the amount of algae present in the water column. Samples are collected from the top layer (epilimnion) of a lake and brought to MLSC for analysis. Chlorophyll concentrations are measured in parts per billion (ppb).
Epilimnetic Total Phosphorus is a measure of all forms of phosphorus in the epilimnion. It is measured in order to determine the potential for algae growth in a lake. Phosphorus samples are collected from the lake's upper layer (epilimnion) and are brought to MLSC for analysis. Epilimnetic total phosphorus samples tell us how much phosphorus is available for algae in the sunlit portion of a lake, where the algae grow. Phosphorus is measured in parts per billion (ppb).
Deep Water Total Phosphorus samples are collected at specific depths below the thermocline (middle layer) in late August. Deep water samples showing high phosphorus levels (10 ppb or higher than upper layer phosphorus samples) indicate that sediments may be releasing phosphorus and that the lake is potentially susceptible to future algal blooms.
Gloeotrichia echinulata density is a visual estimate of the number of individual Gloeotrichia echinulata (Gloeo) colonies floating in surface waters. Gloeo is a type of cyanobacteria (blue-green algae) commonly found in lownutrient waters. Gloeo density is reported as a value ranging from $0-6$, based on the number of Gloeo colonies seen through a Secchi scope. Higher values indicate more Gloeo colonies.



Water Quality Summary


## Introduction to LEA's Water Quality Monitoring Program

For decades, Lakes Environmental Association has watched over the water quality of as many as 41 lakes in our service area (see page 4). Traditional baseline water quality monitoring in LEA's service area occurs every year from late spring through early fall. This monitoring consists of either biweekly or annual visits to a lake, where we measure lake water and environmental conditions at the deepest portion of the waterbody. Water samples are also collected for further processing and analysis at our Maine Lake Science Center (MLSC). This information contributes to our long-term understanding of lake dynamics and health.

Much of this report focuses on the current conditions and long-term trends of three baseline water quality indicators: chlorophyll-a concentration, total phosphorus concentration, and water clarity. When considered together, these three measurements help us to describe water quality conditions in a waterbody, and multiple years of measurements allow us to monitor water quality changes over time. The combination of service area size and frequency of site visits produces a large amount of data, which has been summarized in this report. Our data are also shared with Maine's Department of Environmental Protection and are made available to the public through the Lakes of Maine website. If you have any questions about data presented here or about data not included in this report, please call or visit LEA's website.


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Left: LEA's chlorophyll filtering apparatus. Filters are placed on a small pedestal held in place by a funnel.

Right: the filter holds whatever algae was suspended in the water sample. Analysis of the filter is used to determine how much chlorophyll was in the original water sample.

## Field Methods:

LEA visits 22 lakes biweekly from May through September. We visit an additional 19 sites in late August. For each lake visited, we travel by boat to the deepest portion of the waterbody to collect: a clarity measurement, a Gloeotrichia echinulata density estimate, weather observations, and temperature and oxygen profiles. We also collect a water sample from the epilimnion, (the warm, sunlit, upper waters) which is brought back to the Maine Lake Science Center for chlorophyll-a, total phosphorus, and basic water chemistry analysis ( pH , alkalinity, color, and conductivity).

## Data Analysis Methods

Long-term Trend Analysis for Clarity, Chlorophyll-a and Total Phosphorus. Available data from 1996-2023 were analyzed to determine if clarity, chlorophyll-a, and total phosphorus data are changing over time. Both chlorophyll-a and total phosphorus are measured in parts per billion (ppb). Clarity is measured in meters ( m ). Data trends help us estimate the relationship between a water quality parameter and time. For example, to determine the clarity trend on any given lake, all of the clarity readings we have collected for that lake since 1996 are plotted on a graph with time on the horizontal axis and Secchi depth on the vertical axis. A trend analysis draws a 'best fit' line through the data. If the direction of the line trends up, it is a positive trend, a flat line indicates no trend, and a downward line indicates a negative trend.

|  | Trend Interpretation |  |  |
| :--- | :--- | :---: | :--- |
|  | Increasing | Stable | Decreasing |
| Clarity | Deeper clarity readings <br> over time | No trend | Shallower clarity <br> readings over time |
| Chlorophyll-a | Higher chlorophyll <br> concentrations over time | No trend | Lower chlorophyll <br> concentrations over time |
| Total <br> Phosphorus | Higher total phosphorus <br> concentrations over time | No trend | Lower total phosphorus <br> concentrations over time |

2023 and Long-Term Water Quality Classification. Clarity, chlorophyll-a, and total phosphorus data from both the 2023 monitoring season and our long-term dataset were averaged and classified according to LEA's water quality index, outlined below. The 2023 average is a simple mean of all data collected for each parameter in 2023. The longterm average is a simple mean of all the data we have on record for each reported parameter. The long-term average doesn't tell us how each parameter changes over time; it is instead used to see how the current year's data compares to historical values.

| LEA's Water Quality Index |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Clarity in meters (m) |  | Phosphorus in parts <br> per billion (ppb) |  | Chlorophyll-a in parts <br> per billion (ppb) |  |
| $10.1+$ | Very high | less than 5.1 | Low | less than 2.1 | Low |
| $7.1-10.0$ | High | $5.1-12.0$ | Moderate | $2.1-7.0$ | Moderate |
| $3.1-7.0$ | Moderate | $12.1-20.0$ | High | $7.1-12.0$ | High |
| less than 3.1 | Low | $20.1+$ | Very high | $12.1+$ | Very high |

## Lake Summaries and Interpreting Data Graphics

The following pages report water quality summaries for each lake visited by LEA in 2023. LEA uses violin graphs to visually compare 2023 data to historic data (1996-2022). The vertical axis (y-axis) indicates the relative abundance of readings at that level while the horizontal axis (x-axis) represents reported values. Three different parameters are being reported on the same graph, which results in the units of the horizontal axis varying, based on results. Area thickness increases as more measurements are reported at that value. Thus, thicker areas indicate that several measurements have been reported at that value, while thinner areas indicate that fewer measurements have been reported at that value.


1. Long-term minimum value - far left edge of colored area, lowest value on record
2. Long-term maximum value - far right edge of colored area, highest value on record
3. Long-term average value - vertical black bar bisecting colored area
4. 2023's average value - large red dot
5. 2023's raw values - smaller red dots
6. Thickness of colored area - amount of past measurements at that value

* Horizontal axis units


## 2023 Water Quality Overview



The summer of 2023 was wet in the Lakes Region. In fact, according to the National Weather Service, it was the second wettest summer on record, with August 2023 being the wettest August on record. Our water monitoring interns, Annie O'Connor and Rachel Harper, worked through unpleasant weather for the majority of the summer and were instrumental in LEA's efforts to collect the large quantity of data used to assess overall water quality of lakes and ponds in LEA's service area.
Summer began with heavy rains and flooding, which brought influxes of sediment and debris into area streams and lakes via runoff. Unsurprisingly, throughout LEA's service area, clarity readings were generally lower, while total phosphorus concentrations and chlorophyll concentrations were generally higher. However, even though average water quality was lower compared to last year, it was generally still within the same water quality range as the longterm average for most service area lakes. The table below summarizes which percentage of service area lakes fall within each water quality category.

| 2023 Service Area Water Quality Overview |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: |
| Clarity |  |  |  |  |
| Reading <br> Frequency | Low | Moderate | High | Very High |
| Bi-weekly | $0 \%$ | $96 \%$ | $4 \%$ | $0 \%$ |
| Annual | $33 \%$ | $67 \%$ | $0 \%$ | $0 \%$ |
| Total Phosphorus |  |  |  |  |
|  | Low | Moderate | High | Very High |
| Bi-weekly | $0 \%$ | $96 \%$ | $4 \%$ | $0 \%$ |
| Annual | $0 \%$ | $37 \%$ | $58 \%$ | $5 \%$ |
| Chlorophyll |  |  |  |  |
|  |  |  |  |  |
| Bi-weekly | Low | Moderate | High | Very High |
| Annual | $5 \%$ | $36 \%$ | $0 \%$ | $0 \%$ |

Thanks to those who facilitate our work by providing lake access and/or boat access to LEA staff!

## Overall Long-term Results - Biweekly Monitoring

See page 8 for interpretation guide

| Lake | Clarity |  | Total Phosphorus |  | Chlorophyll |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Long-term Average | Change Over Time | Long-term Average | Change Over Time | Long-term Average | Change Over Time |
| Adams Pond | High | Stable | Moderate | Stable | Moderate | Stable |
| Back Pond | Moderate | Increasing | Moderate | Stable | Moderate | Stable |
| Bear Pond | Moderate | Stable | Moderate | Stable | Moderate | Stable |
| Brandy Pond | Moderate | Decreasing | Moderate | Stable | Moderate | Stable |
| Crystal Lake | Moderate | Decreasing | Moderate | Stable | Moderate | Decreasing |
| Foster Pond | Moderate | Decreasing | Moderate | Stable | Moderate | Stable |
| Granger Pond | Moderate | Increasing | Moderate | Stable | Moderate | Stable |
| Hancock Pond | High | Stable | Moderate | Stable | Moderate | Decreasing |
| Highland Lake | Moderate | Increasing | Moderate | Stable | Moderate | Decreasing |
| Island Pond | Moderate | Decreasing | Moderate | Increasing | Moderate | Stable |
| Keoka Lake | Moderate | Stable | Moderate | Decreasing | Moderate | Stable |
| Keyes Pond | Moderate | Stable | Moderate | Stable | Moderate | Stable |
| Little Moose Pond | High | Decreasing | Moderate | Stable | Moderate | Stable |
| Long Lake (North) | Moderate | Decreasing | Moderate | Stable | Moderate | Decreasing |
| Long Lake (Middle) | Moderate | Stable | Moderate | Stable | Moderate | Decreasing |
| Long Lake (South) | Moderate | Stable | Moderate | Decreasing | Moderate | Decreasing |
| McWain Pond | Moderate | Stable | Moderate | Stable | Moderate | Decreasing |
| Middle Pond | Moderate | Increasing | Moderate | Stable | Moderate | Decreasing |
| Moose Pond (Main) | High | Stable | Moderate | Stable | Moderate | Decreasing |
| Moose Pond (North) | Moderate | Decreasing | Moderate | Stable | Moderate | Stable |
| Moose Pond (South) | Moderate | Decreasing | Moderate | Increasing | Moderate | Stable |
| Peabody Pond | High | Stable | Moderate | Stable | Moderate | Decreasing |
| Sand Pond | Moderate | Decreasing | Moderate | Stable | Moderate | Stable |
| Stearns Pond | Moderate | Decreasing | Moderate | Stable | Moderate | Stable |
| Trickey Pond | High | Decreasing | Moderate | Stable | Moderate | Stable |
| Woods Pond | Moderate | Stable | Moderate | Increasing | Moderate | Stable |

## Overall Long-term Results - Annual Monitoring

See page 8 for interpretation guide

| Lake | Clarity |  | Total Phosphorus |  | Chlorophyll |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Long-term Average | Change Over Time | Long-term Average | Change Over Time | Long-term Average | Change Over Time |
| $\begin{aligned} & \text { Beaver Pond } \\ & \hline \text { (Bridgton) } \end{aligned}$ | Moderate | Stable | Moderate | Stable | Moderate | Decreasing |
| $\begin{aligned} & \text { Beaver Pond } \\ & \hline \text { (Denmark) } \end{aligned}$ | * |  | High | Stable | Moderate | Stable |
| Bog Pond | * |  | High | Stable | Moderate | Stable |
| Cold Rain Pond | Moderate | Stable | Moderate | Stable | Moderate | Increasing |
| Duck Pond | * |  | Very High | Stable | High | Stable |
| Holt Pond | * |  | High | Stable | Moderate | Stable |
| Jewett Pond | Moderate | Stable | Moderate | Stable | Moderate | Stable |
| Kezar Pond | * |  | High | Stable | Moderate | Stable |
| Little Pond | * |  | Moderate | Stable | Moderate | Stable |
| Little Mud Pond | Low | Decreasing | Very High | Decreasing | Moderate | Decreasing |
| Long Pond | * |  | Moderate | Stable | Moderate | Stable |
| Mud Pond | Low | Stable | Moderate | Stable | Moderate | Decreasing |
| Otter Pond | Moderate | Increasing | High | Stable | Moderate | Decreasing |
| Papoose Pond | Moderate | Increasing | High | Stable | Moderate | Stable |
| Perley Pond | Moderate | Stable | Moderate | Decreasing | Moderate | Stable |
| Pickerel Pond | Moderate | Stable | Moderate | Increasing | Moderate | Stable |
| Pleasant Pond | * |  | High | Stable | Moderate | Stable |
| Sebago Cove | * |  | High | Stable | Moderate | Stable |
| Webber Pond | * |  | High | Stable | Moderate | Stable |
| * | Indicates that the Secchi disk touched the pond bottom but was still visible during sampling. When the Secchi disk touches the bottom but is still visible, the resulting reading does not represent an accurate water clarity measurement. Clarity trends are not reported when the Secchi disk hits bottom |  |  |  |  |  |

## Adams Pond - MIDAS 3396



Adams Pond surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 6.7 meters, which falls into the moderate clarity range. The average total phosphorus reading was 7.5 ppb , which falls into the moderate range. The average deep water phosphorus value is more than 10 ppb above average surface water phosphorus values, which indicates phosphorus recycling may be an issue. The chlorophyll-a average of 2.2 falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Adams Pond are stable, total phosphorus concentrations are stable, and clarity readings are stable. Gloeotrichia echenulata colonies were not observed in Adams Pond in 2023.

| Adams Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a <br> Trend |  |
| Analysis <br> Result | 21.6 | Stable | Stable | Stable |  |
| Interpretation | Deep water phosphorus higher <br> than expected; potential <br> phosphorus recycling | Neither deeper nor <br> shallower clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Neither more nor <br> less chlorophyll <br> over time |  |



Back Pond surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 5.5 meters, which is in the moderate range. The average total phosphorus reading of 8.1 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.6 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Back Pond are stable, total phosphorus concentrations are stable, and clarity readings are increasing. Gloeotrichia echenulata colonies were not observed in Back Pond in 2023.

| Back Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 9.9 | Increasing | Stable | Stable |  |
| Interpretation | Within acceptable <br> range | Deeper clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |  |

Bear Pond - MIDAS 3420


Bear Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 4.4 meters, which falls into the moderately clear range. The average total phosphorus reading of 11.2 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 3.3 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Bear Pond are stable, total phosphorus concentrations are stable, and clarity readings are stable. Bear Pond's Gloeotrichia echenulata density ranged from 0 through 1 with the highest density occurring in early August.

| Bear Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a <br> Trend |  |
| Analysis <br> Result | 9.4 | Stable | Stable | Stable |  |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Neither more nor <br> less chlorophyll over <br> time |  |

## Beaver Pond, Bridgton - MIDAS 5582



Beaver Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Bridgton's Beaver Pond is sampled by LEA once per year in August. The long-term average and trend analysis reflect data from 1996 to 2023. The Secchi disk reading for 2023 was 3.4 meters, which falls into the moderately clear range. The total phosphorus reading was higher than normal at 14.7 ppb , which falls into the high range. The average deep-water phosphorus value was less than 10 ppb than surface water phosphorus values. However, because of elevated phosphorus concentrations in the surface waters when we sampled, it is difficult to evaluate the potential for phosphorus recycling in 2023. The chlorophyll-a average of 2.9 ppb falls into the moderate range. Longterm trend analysis indicates chlorophyll-a concentrations in Beaver Pond are decreasing, total phosphorus concentrations are stable, and clarity readings are stable. Gloeotrichia echenulata colonies were not observed in Beaver Pond in 2023.

| Bridgton's Beaver Pond's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a <br> Trend |
| Analysis <br> Result | 20.7 | Stable | Stable | Decreasing |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity readings <br> over time | Neither more nor <br> less phosphorus <br> over time | Less chlorophyll <br> over time |

## Beaver Pond, Denmark - MIDAS 3124



Beaver Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Denmark's Beaver Pond is sampled by LEA once per year in August. The long-term average reflects data from 1997 to 2023. The Secchi disk reading for 2023 was 2.7 meters. The Secchi disk did hit the bottom, indicating that Secchi depth is not a reliable indicator of water clarity. The total phosphorus reading of 11.2 ppb falls into the moderate range. The chlorophyll-a reading of 2.8 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Beaver Pond are stable and total phosphorus concentrations are stable. Gloeotrichia echenulata colonies were not observed in Beaver Pond in 2023.

| Denmark's Beaver Pond's 2023 Quick Stats |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | Not reported | Stable | Stable |
| Interpretation | Secchi disk hit bottom making <br> clarity trend unreliable | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |

## Bog Pond - MIDAS 3450



Bog Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Bog Pond is sampled by LEA once per year in August. The long-term average reflects data from 2009 to 2023. The Secchi disk reading for 2023 was 1.6 meters. The Secchi disk did hit the bottom, indicating that Secchi depth is not a reliable indicator of water clarity. The total phosphorus reading of 12.7 ppb falls into the high range. The chlorophyll-a reading of 3.8 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Bog Pond are stable and total phosphorus concentrations are stable. Gloeotrichia echenulata colonies were not observed in Bog Pond in 2023.

| Bog Pond's 2023 Quick Stats |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | Not reported | Stable | Stable |
| Interpretation | Secchi disk hit bottom, making <br> clarity trend unreliable | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |

## Brandy Pond - MIDAS 9685



Brandy Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 5.4 meters, which falls into the moderately clear range. The average total phosphorus reading of 7.3 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.9 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Brandy Pond are stable, total phosphorus concentrations are stable, and clarity readings are decreasing. Brandy Pond's Gloeotrichia echenulata density ranged from 0 through 1 with the highest density occurring in late August.

| Brandy Pond's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | 11.1 | Decreasing | Stable | Stable |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Neither more nor less <br> chlorophyll over time |

## Cold Rain Pond - MIDAS 3376



Cold Rain Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Cold Rain Pond is sampled by LEA once per year in August. The long-term average reflects data from 1996 to 2023. The Secchi disk reading for 2023 was 3.8 meters, which falls into the moderately clear range. The total phosphorus reading of 11.9 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a reading of 6.3 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Cold Rain Pond are increasing, total phosphorus concentrations are stable, and clarity readings are stable. Gloeotrichia echenulata colonies were not observed in Cold Rain Pond in 2023.

| Cold Rain Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a <br> Trend |  |
| Analysis <br> Result | 16.1 | Stable | Stable | Increasing |  |
| Interpretation | Within acceptable <br> range | Neither deeer nor <br> shallower clarity readings <br> over time | Neither more nor <br> less phosphorus over <br> time | More chlorophyll <br> over time |  |

## Crystal Lake - MIDAS 3452



Crystal Lake's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 4.5 meters, which falls into the moderately clear range. The average total phosphorus reading of 9.8 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.3 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Crystal Lake are decreasing, total phosphorus concentrations are stable, and clarity readings are decreasing. Crystal Lake's Gloeotrichia echenulata density ranged from 0 through 1 with the highest density occurring throughout August.

| Crystal Lake's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | 10.9 | Decreasing | Stable | Decreasing |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Less chlorophyll over <br> time |

## Duck Pond - MIDAS 3228



Duck Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Duck Pond is sampled by LEA once per year in August. The long-term average reflects data from 2013 to 2023. The Secchi disk reading for 2023 was 3.2 meters, which falls into the moderate clarity range. The Secchi disk did not hit bottom this year but has in years past, indicating that long-term average Secchi depth may not be a reliable indicator of historical water clarity. The total phosphorus reading of 17.0 ppb falls into the high range. The chlorophyll-a reading of 3.2 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Duck Pond are stable and total phosphorus concentrations are stable. Gloeotrichia echenulata colonies were not observed in Duck Pond in 2023.

| Duck Pond's 2023 Quick Stats |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | Not reported | Stable | Stable |
| Interpretation | Secchi disk often hits bottom <br> making clarity trend unreliable | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |

## Foster Pond - MIDAS 3188



Foster Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 6.4 meters, which falls into the moderate clarity range. The Secchi disk did hit the bottom once this year, indicating that average Secchi depth may not be a reliable indicator of water clarity; however, the clarity trend is still reported because the majority of Secchi measures did not hit bottom. The average total phosphorus reading of 8.0 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.2 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Foster Pond are stable, total phosphorus concentrations are stable, and clarity readings are decreasing. Gloeotrichia echenulata colonies were not observed in Foster Pond in 2023.

| Foster Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 8.3 | Decreasing | Stable | Stable |  |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |  |

## Granger Pond - MIDAS 3126



Granger Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 6.7 meters, which falls into the moderate clarity range. The Secchi disk did hit the bottom once this year, indicating that average Secchi depth may not be a reliable indicator of water clarity; however, the clarity trend is still reported because the majority of Secchi measures did not hit bottom. The average total phosphorus reading of 8.6 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.3 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Granger Pond are stable, total phosphorus concentrations are stable, and clarity readings are increasing. Gloeotrichia echenulata colonies were not observed in Granger Pond in 2023.

| Granger Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 7.5 | Increasing | Stable | Stable |  |
| Interpretation | Within acceptable <br> range | Deeper clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |  |



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Hancock Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 6.3 meters, which falls into the moderate clarity range. The average total phosphorus reading of 6.5 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.7 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Hancock Pond are decreasing, total phosphorus concentrations are stable, and clarity readings are stable. Gloeotrichia echenulata colonies were not observed in Hancock Pond in 2023.

| Hancock Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a <br> Trend |  |
| Analysis <br> Result | 7.4 | Stable | Stable | Decreasing |  |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Less chlorophyll <br> over time |  |



Highland Lake's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 6.1 meters, which falls into the moderate clarity range. The average total phosphorus reading of 8.2 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.6 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Highland Lake are decreasing, total phosphorus concentrations are stable, and clarity readings are increasing. Gloeotrichia echenulata colonies were not observed in Highland Lake in 2023.

| Highland Lake's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 9.8 | Increasing | Stable | Decreasing |  |
| Interpretation | Within acceptable <br> range | Deeper clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Less chlorophyll over <br> time |  |

## Holt Pond - MIDAS 3370



Holt Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Holt Pond is sampled by LEA once per year in August. The long-term average reflects data from 2000 to 2023. The average Secchi disk reading for 2023 was 2.7 meters, which falls into the low clarity range. The Secchi disk did not hit bottom in 2023, however, it has in years past. This indicates that long-term Secchi depth may not be a reliable indicator of historical water clarity. The total phosphorus reading of 15.7 ppb falls into the high range. The chlorophylla reading of 1.6 ppb falls into the low range. Long-term trend analysis indicates chlorophyll-a concentrations in Holt Pond are stable and total phosphorus concentrations are stable. Gloeotrichia echenulata colonies were not observed in Holt Pond in 2023.

| Holt Pond's 2023 Quick Stats |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | Not reported | Stable | Stable |
| Interpretation | Secchi disk often hits bottom <br> making clarity trend unreliable | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |

Island Pond - MIDAS 3448


Island Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 4.2 meters, which falls into the moderately clear range. The average total phosphorus reading of 10.8 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 3.6 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Island Pond are stable, total phosphorus concentrations are increasing, and clarity readings are decreasing. Gloeotrichia echenulata colonies were not observed in Island Pond in 2023.

| Island Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (pp) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 12.6 | Decreasing | Increasing | Stable |  |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | More phosphorus over <br> time | Neither more nor less <br> chlorophyll over time |  |

## Jewett Pond - MIDAS 3198



Jewett Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Jewett Pond is sampled by LEA once per year in August. The long-term average reflects data from 1997 to 2023. The Secchi disk reading for 2023 was 3.2 meters, which falls into the moderately clear range. The total phosphorus reading of 11.1 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a reading of 2.5 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Jewett Pond are stable, total phosphorus concentrations are stable, and clarity readings are stable. Gloeotrichia echenulata colonies were not observed in Jewett Pond in 2023.

| Jewett Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 18.1 | Stable | Stable | Stable |  |
| Interpretation | Within acceptable range | Neither deeper nor <br> shallower clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Neither more nor less <br> chlorophyll over time |  |



Keoka Lake's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 202's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 4.8 meters, which falls into the moderately clear range. The average total phosphorus reading of 9.1 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 4.4 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Keoka Lake are stable, total phosphorus concentrations are decreasing, and clarity readings are stable. Keoka Lake's Gloeotrichia echenulata density ranged from 0 through 1 with the highest density occurring throughout July and early August.

| Keoka Lake's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a Trend |
| Analysis <br> Result | 10.4 | Stable | Decreasing | Stable |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity <br> readings over time | Less phosphorus <br> over time | Neither more nor less <br> chlorophyll over time |

Total Phosphorus in ppb (lower is better)


Keyes Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 4.8 meters, which falls into the moderately clear range. The average total phosphorus reading of 9.7 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 4.1 ppb falls in the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Keyes Pond are stable, total phosphorus concentrations are stable, and clarity readings are stable. Gloeotrichia echenulata colonies were not observed in Keyes Pond in 2023.

| Keyes Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 11.2 | Stable | Stable | Stable |  |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Neither more nor less <br> chlorophyll over time |  |

## Kezar Pond - MIDAS 9709



Kezar Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Kezar Pond is sampled by LEA once per year in August. The long-term average reflects data from 1996 to 2023. The Secchi disk reading for 2023 was 3.1 meters, which falls into the moderate clarity range. The Secchi disk did not hit the bottom this year but has in years past, indicating that average Secchi depth may not be a reliable indicator of water clarity. The total phosphorus reading of 17.0 ppb falls into the high range. The chlorophyll-a reading of 6.3 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Kezar Pond are stable and total phosphorus concentrations are stable. Gloeotrichia echenulata colonies were not observed in Kezar Pond in 2023.

| Kezar Pond's 2023 Quick Stats |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | Not Reported | Stable | Stable |
| Interpretation | Secchi disk often hits bottom, <br> making clarity trend unreliable | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |

## Little Pond - MIDAS 3128



Little Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison.
Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Little Pond is sampled by LEA once per year in August. The long-term average reflects data from 1997 to 2023. The Secchi disk reading for 2023 was 3.3 meters, which falls in the moderate range. The Secchi disk did not hit bottom this year but has in years past, indicating that Secchi depth is not a reliable indicator of water clarity. The total phosphorus reading of 13.2 ppb falls into the high range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a reading of 21.0 ppb falls into the very high range. Long-term trend analysis indicates chlorophyll-a concentrations in Little Pond are stable and total phosphorus concentrations are stable. Gloeotrichia echenulata colonies were not observed in Little Pond in 2023.

| Little Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a <br> Trend |  |
| Analysis <br> Result | 20.6 | Not reported | Stable | Stable |  |
| Interpretation | Within acceptable <br> range | Secchi disk often hits <br> bottom, making clarity <br> trend unreliable | Neither more nor <br> less phosphorus <br> over time | Neither more nor <br> less chlorophyll over <br> time |  |

## Little Moose Pond - MIDAS 3424



Little Moose Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 6.0 meters, which falls into the moderate clarity range. The average total phosphorus reading of 7.0 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.9 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Little Moose Pond are stable, total phosphorus concentrations are stable, and clarity readings are decreasing. Gloeotrichia echenulata colonies were not observed in Little Moose Pond in 2023.

| Little Moose Pond's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | 8.2 | Decreasing | Stable | Stable |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over <br> time | Neither more nor <br> less phosphorus <br> over time | Neither more nor less <br> chlorophyll over time |

## Little Mud Pond - MIDAS 3422



Little Mud Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Little Mud Pond is sampled by LEA once per year in August. The long-term average reflects data from 1997 to 2023. The Secchi disk reading for 2023 was 2.8 meters, which falls into the low clarity range. The total phosphorus reading of 18.2 ppb falls into the high range. The deep-water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a reading of 4.0 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Little Mud Pond are decreasing, total phosphorus concentrations are decreasing, and clarity readings are decreasing. Gloeotrichia echenulata colonies were not observed in Little Mud Pond in 2023.

| Little Mud Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 27.4 | Decreasing | Decreasing | Decreasing |  |
| Interpretation | Within acceptable range | Shallower clarity <br> readings over time | Less phosphorus <br> over time | Less chlorophyll over <br> time |  |

## Long Lake, North Basin - MIDAS 5780



Long Lake north basin's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 5.1 meters, which falls into the moderately clear range. The average total phosphorus reading of 8.4 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.7 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Long Lake's north basin are decreasing, total phosphorus concentrations are stable, and clarity readings are decreasing. The north basin's Gloeotrichia echenulata density ranged from 0 through 3.5 with the highest density occurring in early August.

| Long Lake North Basin's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | 9.4 | Decreasing | Stable | Decreasing |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Less chlorophyll over <br> time |

## Long Lake, Middle Basin - MIDAS 5780



Long Lake middle basin's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 5.5 meters, which falls into the moderately clear range. The average total phosphorus reading of 7.9 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.4 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Long Lake's middle basin are decreasing, total phosphorus concentrations are stable, and clarity readings are stable. The middle basin's Gloeotrichia echenulata density ranged from 0 through 3 with the highest density occurring in early August.

| Long Lake Middle Basin's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | 7.7 | Stable | Stable | Decreasing |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Less chlorophyll over <br> time |

## Long Lake, South Basin - MIDAS 5780



Long Lake south basin's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 5.6 meters, which falls into the moderately clear range. The average total phosphorus reading of 7.3 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.7 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Long Lake's south basin are decreasing, total phosphorus concentrations are decreasing, and clarity readings are stable. The south basin's Gloeotrichia echenulata density ranged from 0 through 1 with the highest density occurring in early August.

| Long Lake South Basin's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | ChlorophyIl-a <br> Trend |  |
| Analysis <br> Result | 6.4 | Stable | Decreasing | Decreasing |  |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity readings <br> over time | Less phosphorus <br> over time | Less chlorophyll <br> over time |  |

## Long Pond - MIDAS 3084



Long Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Long Pond is sampled by LEA once per year in August. The long-term average reflects data from 1997 to 2023. The Secchi disk reading for 2023 was 5.0 meters, which falls into the moderate clarity range. The Secchi disk did not hit bottom this year but has in years past, indicating that Secchi depth may not be a reliable indicator of historical water clarity, however, the clarity trend is still reported because the majority of Secchi measures did not hit bottom. The total phosphorus reading of 9.4 ppb falls into the moderate range. The chlorophyll-a reading of 2.1 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Long Pond are stable and total phosphorus concentrations are stable, while clarity trend is decreasing. Gloeotrichia echenulata colonies were not observed in Long Pond in 2023.

| Long Pond's 2023 Quick Stats |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | Decreasing | Stable | Stable |
| Interpretation | Secchi disk often hits bottom, <br> making clarity trend unreliable | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |



McWain Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 4.9 meters, which falls into the moderate clarity range. The average total phosphorus reading of 8.9 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.9 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in McWain Pond are decreasing, total phosphorus concentrations are stable, and clarity readings are stable. McWain Pond's Gloeotrichia echenulata density ranged from 0 through 1 with the highest density occurring in mid-August.

| McWain Pond's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a <br> Trend |
| Analysis <br> Result | 8.5 | Stable | Stable | Decreasing |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Less chlorophyll <br> over time |



Middle Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 3.9 meters, which falls into the moderately clear range. The average total phosphorus reading of 9.8 ppb falls into the moderate range. The average deep water phosphorus value was greater than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling may be problematic. The chlorophyll-a average of 4.4 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Middle Pond are decreasing, total phosphorus concentrations are stable, and clarity readings are increasing. Gloeotrichia echenulata colonies were not observed in Middle Pond in 2023.

| Middle Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a <br> Trend |  |
| Analysis <br> Result | 22.0 | Increasing | Stable | Decreasing |  |
| Interpretation | Deep water phosphorus higher <br> than expected; potential <br> phosphorus recycling | Deeper clarity <br> readings <br> over time | Neither more nor <br> less phosphorus <br> over time | Less chlorophyll <br> over time |  |



Moose Pond middle basin's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 6.3 meters, which falls into the moderate clarity range. The average total phosphorus reading of 7.3 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.7 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Moose Pond's main basin are decreasing, total phosphorus concentrations are stable, and clarity readings are stable. The middle basin's Gloeotrichia echenulata density ranged from 0 through 5 , with the highest density occurring in mid-August.

| Moose Pond middle basin's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 8.1 | Stable | Stable | Decreasing |  |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Less chlorophyll over <br> time |  |



Moose Pond north basin's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 4.0 meters, which falls into the moderately clear range. The average total phosphorus reading of 11.0 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 4.5 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations are stable, total phosphorus concentrations are stable, and clarity readings are decreasing. The north basin's Gloeotrichia echenulata density ranged from 0 through 1 with the highest density occurring in early September.

| Moose Pond north basin's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | 20.3 | Decreasing | Stable | Stable |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |



Moose Pond south basin's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 6.0 meters, which falls into the moderately clear range. The average total phosphorus reading of 7.5 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 4.9 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations are stable, total phosphorus concentrations are increasing, and clarity readings are decreasing. This trend analysis is based on our 9 -year long dataset and may not accurately represent long-term trends; however, trend analysis will be more precise as our dataset grows. The south basin's Gloeotrichia echenulata density ranged from 0 through 3 with the highest density occurring in mid-August.

| Moose Pond south basin's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | 12.3 | Decreasing | Increasing | Stable |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | More phosphorus <br> over time | Neither more nor less <br> chlorophyll over time |

## Mud Pond - MIDAS 3422



Mud Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Mud Pond is sampled by LEA once per year in August. The long-term average reflects data from 1997 to 2023. The Secchi disk reading for 2023 was 2.9 meters, which falls into the low clarity range. The total phosphorus reading of 14.5 ppb falls into the high range. The average deep water phosphorus value was less than 10 ppb above surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a reading of 4.1 ppb fell into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations are decreasing, total phosphorus concentrations are stable, and clarity readings are stable. Gloeotrichia echenulata colonies were not observed in Mud Pond in 2023.

| Mud Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a <br> Trend |  |
| Analysis <br> Result | 23.5 | Stable | Stable | Decreasing |  |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Less chlorophyll <br> over time |  |

## Otter Pond - MIDAS 3458



Otter Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Otter Pond is sampled by LEA once per year in August. The long-term average reflects data from 1996 to 2023. The Secchi disk reading for 2023 was 3.6 meters, which falls into the moderate clarity range. The total phosphorus reading of 9.7 ppb falls into the moderate range. The deep-water phosphorus value was greater than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling may be problematic. The chlorophyll-a reading of 3.8 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations are decreasing, total phosphorus concentrations are stable, and clarity readings are increasing. Gloeotrichia echenulata colonies were not observed in Otter Pond in 2023.

| Otter Pond's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a <br> Trend |
| Analysis <br> Result | 22.8 | Increasing | Stable | Decreasing |
| Interpretation | Deep water phosphorus higher <br> than expected; potential <br> phosphorus recycling | Deeper clarity <br> readings over <br> time | Neither more nor <br> less phosphorus <br> over time | Less chlorophyll <br> over time |

## Papoose Pond - MIDAS 3414



Papoose Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Papoose Pond is sampled by LEA once per year in August. The long-term average reflects data from 1996 to 2023. The Secchi disk reading for 2023 was 2.7 meters, which falls into the low clarity range. The Secchi disk did not hit bottom this year but has in years past, indicating that average Secchi depth may not be a reliable indicator of water clarity; however, the clarity trend is still reported because the majority of Secchi measures did not hit bottom. The total phosphorus reading of 17.3 ppb falls into the high range. The average deep water phosphorus value was greater than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling may be problematic. The chlorophyll-a reading of 8.2 ppb falls into the high range. Long-term trend analysis indicates chlorophyll-a concentrations are stable, total phosphorus concentrations are stable, and clarity readings are increasing. Gloeotrichia echenulata colonies were not observed in Papoose Pond in 2023.

| Papoose Pond's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a Trend |
| Analysis <br> Result | 28.4 | Increasing | Stable | Stable |
| Interpretation | Deep water phosphorus higher <br> than expected; potential <br> phosphorus recycling | Deeper clarity <br> readings over <br> time | Neither more nor <br> less phosphorus <br> over time | Neither more nor less <br> chlorophyll over time |



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Peabody Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 6.5 meters, which falls into the moderate clarity range. The average total phosphorus reading of 7.3 ppb falls in the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 2.1 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Peabody Pond are decreasing, total phosphorus concentrations are stable, and clarity readings are stable. Peabody Pond's Gloeotrichia echenulata density ranged from 0 through 1 with the highest density occurring in early August and early September.

| Peabody Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a <br> Trend |  |
| Analysis <br> Result | 9.7 | Stable | Stable | Decreasing |  |
| Interpretation | Within acceptable <br> range | Neither shallower nor <br> deeper clarity <br> readings over time | Neither more nor <br> less phosphorus <br> over time | Less chlorophyll <br> over time |  |

## Perley Pond - MIDAS 3140



Perley Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Perley Pond is sampled by LEA once per year in August. The long-term average reflects data from 1996 to 2023. The Secchi disk reading for 2023 was 4.5 meters, which falls into the moderate clarity range. The total phosphorus reading of 7.7 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a reading of 8.4 ppb falls into the high range. Long-term trend analysis indicates chlorophyll-a concentrations are stable, total phosphorus concentrations are decreasing, and clarity readings are stable.
Gloeotrichia echenulata colonies were not observed in Perley Pond in 2023.

| Perley Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 14.8 | Stable | Decreasing | Stable |  |
| Interpretation | Within acceptable <br> range | Neither deeper nor <br> shallower clarity <br> readings over time | Less phosphorus <br> over time | Neither more nor less <br> chlorophyll over time |  |

## Pickerel Pond - MIDAS 9687



Pickerel Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Pickerel Pond is sampled by LEA once per year in August. The long-term average reflects data from 1996 to 2023. The Secchi disk reading for 2023 was 5.8 meters, which falls into the moderate clarity range. The Secchi disk did not hit the bottom this year but has in the past, indicating that Secchi depth is not a reliable indicator of water clarity. The total phosphorus reading of 9.3 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a reading of 2.3 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations are stable and total phosphorus concentrations are increasing. Gloeotrichia echenulata colonies were not observed in Pickerel Pond in 2023.

| Pickerel Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 9.7 | Not reported | Increasing | Stable |  |
| Interpretation | Within acceptable <br> range | Secchi disk often hits <br> bottom, making clarity <br> trend unreliable | More phosphorus <br> over time | Neither more nor <br> less chlorophyll over <br> time |  |

## Pleasant Pond - MIDAS 3252



Pleasant Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Pleasant Pond is sampled by LEA once per year in August. The long-term average reflects data from 1997 to 2023. The Secchi disk reading for 2023 was 2.8 meters, which falls into the low clarity range. The total phosphorus reading of 20.5 ppb falls into the very high range. The average deep water phosphorus value was less than 10 ppb above surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a reading of 8.5 ppb falls into the high range. Long-term trend analysis indicates chlorophyll-a concentrations are stable, total phosphorus concentrations are stable, and clarity readings are decreasing. Gloeotrichia echenulata colonies were not observed in Pleasant Pond in 2023.

| Pleasant Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 18.1 | Decreasing | Stable | Stable |  |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |  |



Sand Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 5.1 meters, which falls into the moderate range. The average total phosphorus reading of 9.0 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 3.7 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Sand Pond are stable, total phosphorus concentrations are stable, and clarity readings are decreasing. Gloeotrichia echenulata colonies were not observed in Sand Pond in 2023.

| Sand Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 9.5 | Decreasing | Stable | Stable |  |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |  |

Sebago Cove - MIDAS 5786


Sebago Cove's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Sebago Cove is sampled by LEA once per year in August. The long-term average reflects data from 2016 to 2023. The Secchi disk reading for 2023 was 2.4 meters. The Secchi disk did hit the bottom, indicating that Secchi depth is not a reliable indicator of water clarity. The total phosphorus reading of 15.6 ppb falls into the high range. The chlorophyll-a reading of 4.0 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Sebago Cove are stable and total phosphorus concentrations are stable. This trend analysis is based on our 7-year-long dataset and may not accurately represent long-term trends; however, trend analysis will be more precise as our dataset grows. Gloeotrichia echenulata colonies were not observed in Sebago Cove Pond in 2023.

| Sebago Cove's 2023 Quick Stats |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis <br> Result | Not reported | Stable | Stable |
| Interpretation | Secchi disk hit bottom, making <br> clarity trend unreliable | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |

## Stearns Pond - MIDAS 3234



Stearns Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 3.9 meters, which falls into the moderate range. The average total phosphorus reading of 12.7 ppb falls into the high range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 3.9 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Stearns Pond are stable, total phosphorus concentrations are stable, and clarity readings are decreasing. Gloeotrichia echenulata colonies were not observed in Stearns Pond in 2023.

| Stearns Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 13.1 | Decreasing | Stable | Stable |  |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |  |



Trickey Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 9.0 meters, which falls into the high clarity range. The average total phosphorus reading of 5.7 ppb falls into the moderate range. The average deep water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 1.2 ppb falls into the low range. Long-term trend analysis indicates chlorophyll-a concentrations in Trickey Pond are stable, total phosphorus concentrations are stable, and clarity readings are decreasing. Gloeotrichia echenulata colonies were not observed in Trickey Pond in 2023.

| Trickey Pond's 2023 Quick Stats |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Average Deep-Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |  |
| Analysis <br> Result | 7.0 | Decreasing | Stable | Stable |  |
| Interpretation | Within acceptable <br> range | Shallower clarity <br> readings over time | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |  |

## Webber Pond - MIDAS 3236



Webber Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value.

## 2023 Water Quality Highlights

Webber Pond is sampled by LEA once per year in August. The long-term average reflects data from 2013 to 2023. The Secchi disk reading for 2023 was 2.1 meters, which falls in the low clarity range; however, the Secchi disk did hit the bottom, indicating that Secchi depth is not a reliable indicator of water clarity. The total phosphorus reading of 15.9 ppb falls into the high range. The chlorophyll-a reading of 4.2 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Webber Pond are stable and total phosphorus concentrations are stable. Gloeotrichia echenulata colonies were not observed in Webber Pond in 2023.

| Webber Pond's 2023 Quick Stats |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Clarity Trend | Phosphorus Trend | Chlorophyll-a Trend |
| Analysis Result | Not reported | Stable | Stable |
| Interpretation | Secchi disk hit bottom, making <br> clarity trend unreliable | Neither more nor less <br> phosphorus over time | Neither more nor less <br> chlorophyll over time |



Woods Pond's surface water chlorophyll (ppb), phosphorus (ppb), and Secchi depth (meters) data comparison. Colored areas represent the long-term range of values, from minimum to maximum. Area thickness indicates frequency of measurements at that value. Area thickness increases as more measurements are reported at that value. The vertical black line represents the long-term average value. The large red dot represents 2023's average value. The small red dots represent individual readings taken in 2023.

## 2023 Water Quality Highlights

The average Secchi disk reading for 2023 was 4.3 meters, which falls into the moderately clear range. The average total phosphorus reading of 9.2 ppb falls into the moderate range. The average deep-water phosphorus value was less than 10 ppb above average surface water phosphorus values, which suggests phosphorus recycling is not problematic. The chlorophyll-a average of 3.2 ppb falls into the moderate range. Long-term trend analysis indicates chlorophyll-a concentrations in Woods Pond are stable, total phosphorus concentrations are increasing, and clarity readings are stable. Gloeotrichia echenulata colonies were not observed in Woods Pond in 2023.

| Woods Pond's 2023 Quick Stats |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Average Deep <br> Water <br> Phosphorus (ppb) | Clarity Trend | Phosphorus <br> Trend | Chlorophyll-a Trend |
| Analysis <br> Result | 15.9 | Stable | Increasing | Stable |
| Interpretation | Within acceptable <br> range | Neither deeper nor shallower <br> clarity readings over time | More phosphorus <br> over time | Neither more nor less <br> chlorophyll over time |



## Chapter 2

Automated Monitoring Buoy Summary


## LEA's Automated Buoys



Highland Lake buoy

Each year, LEA deploys two fully automated monitoring buoys - one on Highland Lake and one on Long Lake in the north basin (see map next page). These buoys collect water quality information at 15 -minute intervals throughout the spring, summer, and fall. This data is transmitted to us in real time, so we can see conditions change on the lake as they happen. The goals of LEA's monitoring buoy program are to better understand the condition of our lakes, to raise awareness of water quality issues locally, and to contribute to worldwide research and knowledge on lakes.
The Highland Lake buoy was first deployed in 2014 and has seven combined temperature and oxygen sensors mounted at 2-meter ( 6.6 -ft) intervals from the surface of the lake to near the bottom. Also mounted on the buoy are two solar radiation sensors and a single chlorophyll sensor. The Long Lake buoy was first deployed in August 2016. Like the Highland Lake buoy, it has oxygen and temperature sensors at 2-meter intervals (total of eight) and a single chlorophyll sensor. Both buoys use three 10-watt solar panels and a rechargeable battery as their power supply (see schematic next page).
The advantages of these buoys are that they automate and enhance the water quality monitoring process. Our traditional (boat-based) water testing program collects data once every two weeks from each lake, usually around the same time of day. In contrast, the buoys automatically record readings from each sensor every 15 minutes, or 96 times per day and can be left in the water longer than the traditional monitoring season. Even though the buoys measure fewer water quality parameters than the testing program does (for instance phosphorus is not measured), the wealth of additional data gives us an incredibly detailed picture of what is happening in the lake at any given time throughout the open-water season. The simultaneous measurements of water temperature, dissolved oxygen, and algae (chlorophyll) conditions lets us see the effects of air temperature, wind, and precipitation events in real time, thus allowing us to better interpret how these factors affect lake conditions.
Another aspect of the buoy program is our ability to collaborate with researchers on a larger scale by sharing ideas and methods and contributing to research. Buoys similar to LEA's can be seen in lakes throughout New England and the world. An international organization called GLEON (Global Lake Ecological Observatory Network) helps to connect researchers that collect and use lake data, particularly from automated monitoring buoys, for a variety of projects. GLEON's mission is "to understand, predict, and communicate the impact of natural and anthropogenic influences on lake and reservoir ecosystems".
LEA could not have acquired either buoy without a great deal of support from several sources. The Highland buoy was funded by a grant from an anonymous foundation and contributions from landowners around Highland Lake. The Long Lake buoy was funded by a very generous donation from a resident of Long Lake, foundation funding, and contributions from lakefront landowners. LEA worked closely with Colby College professor Dr. Whitney King and Fondriest
 Environmental to design and set up the buoys.


Map of buoy locations


## 2023 GLEON Buoy Deployment

We present the latest buoy findings in three sections beginning with a summary of weather conditions that impacted local lakes followed by a general summary of the deployment and data in 2023. Those data are then presented for each lake in the remaining two sections.

## Deployment Weather

Local weather conditions play a major role in controlling lake water quality. Since we no longer have weather sensors on the Highland buoy, we used data from our land-based weather station (near the east shore of Highland Lake, between 1.5 and 3.5 km from the buoys) for background data on temperature, wind, and rain during the deployment. A nearby weather station in Fryeburg was used as comparison and to fill in periods missing from the LEA weather record.


Air temperature is important for understanding the heating, cooling, stability, and evaporation of lakes. Warm weather favors stable, stratified lake conditions, while cooler temperatures reduce the energy needed to mix water layers. Air temperature at the LEA station ranged from -3.4 to $33.2^{\circ} \mathrm{C}\left(25.9\right.$ to $\left.91.8^{\circ} \mathrm{F}\right)$ and averaged $17.2^{\circ} \mathrm{C}\left(63.0^{\circ} \mathrm{F}\right)$ during the deployment. The daily mean values (above, top panel) followed a typical seasonal pattern with several large departures from normal for the area (1991-2020 average, gray dashed line above; source: Global Historical Climatology Network, Station USC00170844 Bridgton). Mean air temperature was more often above normal during July, September, and October, while May, June, and August were closer to normal on average.

Wind also has a significant impact on lake conditions. Wind (along with temperature) controls the physical structure of a lake, including the timing and strength of stratification. Wind-driven waves can cause erosion in certain situations. Our weather station wind data tends to be reduced by nearby trees, so data from the Fryeburg station was examined
instead. The middle panel of the figure above shows the record of daily maximum five-second wind speed in meters per second, which ranged from 2.7 to $16.1 \mathrm{~m} / \mathrm{s}$ ( 6.0 to 36 mph ); the highest gust occurred on September 16 when Hurricane Lee crossed the Gulf of Maine and transitioned to a post-tropical system. Other notable strong winds occurred during May, early June, late July, early August, and early September.

Rain adds water directly to a lake and also indirectly through watershed runoff. Rain is important in maintaining lake levels, but sediment and nutrients can be delivered along with it, depending on rain amount and intensity. The bottom panel in the figure above shows daily rainfall in mm at both the LEA and Fryeburg weather stations. The two records overlap quite well, with the Fryeburg station receiving slightly more rain on average. Overall, the season was significantly wetter than normal. Total rain recorded at Fryeburg during the time of the buoy deployment was about $828 \mathrm{~mm}(32.6 \mathrm{in})$, which was more than in 2022 and the 30 -year (1991-2010) normal rainfall of $611 \mathrm{~mm}(24.0 \mathrm{in})$ for the same months. June, July, and August were all wetter than average, and over four and half inches of rain fell between April 29 and May 5 causing serious flooding in some areas. High intensity storm events have the most impact on water quality because of the erosion and pollution potential. Most of the time when rain fell, rain intensity at the LEA site was about 1.5 mm per hour ( $0.059 \mathrm{in} / \mathrm{hr}$ ), but a maximum of 20 mm per hour ( $0.80 \mathrm{in} / \mathrm{hr}$ ) happened on July 29. Climate change models predict that along with warming air and water temperature, Maine will experience more precipitation and more periods of high intensity rainfall; this could lead to increases in phosphorus loading to lakes.

## Deployment and Results Summary



We installed the buoys at their fixed mooring sites on April 28 and May 9 for Long Lake and Highland Lake, respectively. The buoys remained in place recording data until November 2, when they were both removed from the lakes. Combined, the buoys collected 34,993 sets of sensor readings during their 177 to 188 days on the water. Much of this data was available in real time on our website.
During deployment, we did three to four onsite visits to each buoy for maintenance and sensor replacements. During each visit, we also collected sonde data to serve as an independent standard to correct the buoy data for calibration drift. On Highland, one temperature-oxygen sensor failed and had to be replaced, and we needed to correct the gain setting for the chlorophyll sensor in the field. Three different temperature-oxygen sensors on the Long Lake buoy either failed outright, failed part way through the deployment, or became too noisy to be usable; the two replacement sensors failed also. Thanks to the generosity of the Anonymous Foundation, we now have a new set of sensors for Long Lake for the 2024 season.

Water temperature patterns in both lakes showed the same basic response to the wetter and somewhat warmer-than-average conditions of 2023. At the start of the deployment, both lakes were weakly stratified, which strengthened (i.e., greater temperature difference with depth) as temperatures warmed. Stratified conditions lasted through until October, punctuated throughout by wind mixing events that deepened the upper mixed layer. The upper layer in both lakes cooled in August in response to cooler air temperatures. Still, the water temperature patterns did vary between the two lakes due in large part to contrasting size and shape. For example, the thermocline depth (location in the water column where temperature changes most rapidly) was often greater at the deeper Long Lake site. Also, complete mixing (lake turnover) occurred in Long Lake 9 days later than in Highland Lake.

In both lakes, dissolved oxygen declined as temperature increased and as stratification strengthened. Anoxia (absence of dissolved oxygen) occurred in each system in 2023, but as in previous years, Highland Lake's greater oxygen consumption rate meant that it developed anoxia sooner (early July as opposed to early September) and lasted longer than in Long Lake.

Chlorophyll fluorescence, which is an estimate of algal abundance, was very similar between Highland Lake and Long Lake, even though the Long Lake sensor was twice as deep. Highland Lake had slightly higher chlorophyll in June, and did not show the higher variability in September that was seen in Long Lake. Both lakes had generally low chlorophyll levels throughout, which confirmed the lack of algal blooms in these systems.

Overall, the 2023 season was quite successful, and despite a few technical issues, we were able to monitor both lakes for much of the open water season using these automated buoys. Staff members Ben Peierls, Maggie Welch, Shannon Nelligan, and interns Rachel Harper and Annie O'Connor provided technical support in the field. We sincerely thank all who were involved and have supported the buoys in the past.


## Highland Lake - MIDAS 3454

## Highland Lake Water Temperature

Water temperature data forms the foundation for most water quality measures and is essential for understanding lake physical dynamics, nutrient cycling, metabolic rates, and habitat availability for fish and other aquatic organisms. Lake water temperature varies in response to heating, cooling, and winds. During ice-free periods, lakes in our area tend to stratify into a warm, upper layer (epilimnion) and a cooler, deep layer (hypolimnion).


The figure above shows daily mean temperature data interpolated across depth and time in Highland Lake. Temperature is represented by colored contours, where the blue to red color gradient represents a low to high temperature range. Daily mean values were used to create smoother lines and easier visualization, since lake water temperature can vary by a degree or more in a matter of hours, depending on conditions. During the deployment, temperature ranged from $10.2^{\circ} \mathrm{C}\left(50.4^{\circ} \mathrm{F}\right)$ on May 9 at 13 m depth to $28.1^{\circ} \mathrm{C}\left(82.6^{\circ} \mathrm{F}\right)$ on July 29 at 1 m depth, which was cooler than the 2022 maximum.
Lake stratification was just starting to set in when the buoy was deployed in early May, though the small temperature difference makes it difficult to see in the figure. Stratified conditions (where figure colors change with depth and contour lines appear more horizontal) continued into October. Warm, strongly stratified conditions stand out as darker red and orange areas throughout the summer. The area where contours come closest together (i.e., temperature changes most rapidly with depth) is called the thermocline. The downward sloping contours show that the upper layer (epilimnion) and thermocline generally deepened throughout the summer; thermocline depths ranged from about 1.5 $m$ in May to 12 m before fall turnover.
Partial water column mixing caused by cooling and/or high winds (seen as sharp dips in the contour lines) happened throughout the season, for example in June and mid-September (a in figure). Calm, warm periods caused the lake to re-stratify after these short mixing events. Surface waters cooled in August, which weakened stratification and deepened the epilimnion ( $b$ in figure). Stronger stratification returned in early September following warm conditions (c in figure). Complete mixing (fall turnover; contour lines vertical from top to bottom) occurred on October 14 following cooling and strong winds around that time. By comparison, Long Lake mixed 9 days later on October 23.

Date of Fall Turnover (Complete Mixing) by Year:

| YEAR | $\mathbf{2 0 1 3}$ | $\mathbf{2 0 1 4}$ | $\mathbf{2 0 1 5}$ | $\mathbf{2 0 1 6}$ | $\mathbf{2 0 1 7}$ | $\mathbf{2 0 1 8}$ | $\mathbf{2 0 1 9}$ | $\mathbf{2 0 2 0}$ | $\mathbf{2 0 2 1}$ | $\mathbf{2 0 2 2}$ | $\mathbf{2 0 2 3}$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Turnover <br> Date | after <br> $10 / 11$ | $10 / 12$ | $10 / 11$ | $10 / 10$ | $11 / 4$ ? | $10 / 16$ | $10 / 9$ | $10 / 8$ | $10 / 24$ | $9 / 24$ | $10 / 14$ |



## Highland Lake Dissolved Oxygen

Dissolved oxygen (DO) is an important constituent of lake water that impacts the chemistry and biology of lake ecosystems. The main source of oxygen in lakes is the atmosphere, with temperature governing the amount that can dissolve in the water. Since oxygen is a byproduct of photosynthesis, algae and aquatic plants are another source of dissolved oxygen in lakes. In contrast, deep water oxygen is reduced when microbes, fish, and plants respire or "breathe" and thermal stratification prevents oxygen from being replenished from the atmosphere. Fish tend to avoid and are stressed when moving through hypoxic (see Definitions) areas. Anoxic (see Definitions) bottom waters can allow phosphorus trapped in sediments to be released into the water column for use by algae.

## Definitions:

Hypoxic: having low dissolved oxygen concentration detrimental to aquatic organisms (below about 2-4 mg/L) Anoxic: having complete absence of dissolved oxygen ( $0 \mathrm{mg} / \mathrm{L}$ )


The figure above shows daily mean DO concentration data interpolated across depth and time in Highland Lake; we have reversed the color scheme from the previous plot so that red and blue signify low and high DO, respectively. The data has been corrected for sensor drift and biofouling using independent, discrete DO measurements at the same location.

The contour plot clearly highlights the pattern of lower DO concentrations in summertime deep waters and provides a quick visual gauge of when and where hypoxic water occurred. Some of the decrease in DO is due to warming, since cold water can contain more DO than warm water, all else being equal. Oxygen in the deep waters, however, decreased more rapidly, and by early July the water at 13 m became anoxic. Water as shallow as $9 \mathrm{~m}(\sim 30 \mathrm{ft})$ experienced anoxia during the summer. Prior to lake turnover, occasional wind events aerated deep waters through downward mixing of surface water, seen for example in the DO contours dips in August and September (circled areas). By mid-October, the water column was completely saturated with oxygen after temperatures decreased and winds fully mixed the lake (turnover).

## Highland Lake Chlorophyll (Algal Biomass)

The Highland Lake buoy has one sensor mounted 1.5 m below the lake surface that measures chlorophyll concentrations using fluorescence (same as the field fluorometer used on regular testing trips and discussed in Chapter 4 of this report). The amount of this pigment (found in all plants and algae and used for photosynthesis) can be used as a proxy for algae biomass and as a measure of lake productivity. It is important to note that field fluorescence is a relative measure and not always as accurate as lab-based chlorophyll a measurements reported in Chapter 1.


2023
The figure above shows fluorescence-based daily mean chlorophyll concentration, after correcting for a faulty sensor setting and filtering out extreme outliers. Chlorophyll ranged from about 0.78 to $3.6 \mu \mathrm{~g} / \mathrm{L}$, and averaged $1.6 \mu \mathrm{~g} / \mathrm{L}$ (or parts per billion), which is considered generally low chlorophyll. Chlorophyll will often increase (i.e., algae can grow) if enough nutrients (phosphorus) and light are available. Heavy rain early in the season may have provided a source of phosphorus that stimulated algal growth and increased chlorophyll levels in June. The decrease in chlorophyll after June could be due to losses from zooplankton (tiny animals that eat algae) grazing or a lack of available nutrients. Chlorophyll continued to drop and remained low through October, which coincided with a deepening epilimnion (upper mixed layer of the water column). Mixing during fall turnover can introduce bottom water phosphorus into sunlit areas causing late season blooms. For Highland, this was not evident in the chlorophyll record, likely because deep-water phosphorus concentrations were not much greater than surface-water concentrations this year (see Chapter 1).

As was mentioned before, chlorophyll fluorescence is a relative measure and often shows variation with depth (see Chapter 4). Still, buoy chlorophyll fluorescence at one discrete depth and extracted chlorophyll a in an integrated sample from the epilimnion (upper mixed layer and represented as points in the figure above) were within about one $\mu \mathrm{g} / \mathrm{L}$ (or parts per billion) of each other during the period. Both records confirm that there was no lake-wide algal bloom on Highland Lake in 2023.

## Highland Lake Light Attenuation (Water Clarity)

Light attenuation is a function of material that absorbs or reflects light like humic and tannic acids, soils and sediments, algae, and even water itself. The Highland buoy has two light sensors, one mounted on top of the buoy and one mounted at 1.5 m depth below the water surface. Both sensors measure the amount of light at visible wavelengths ( $400-700 \mathrm{~nm}$ ) reaching them, but the underwater sensor receives less light because the water and the matter it contains reduces or attenuates the sunlight. This decrease in light with depth is quantified using the diffuse light attenuation coefficient (or $\mathrm{K}_{\mathrm{d}}$ ), which is calculated using the above- and below-water sensor readings. $\mathrm{K}_{\mathrm{d}}$ is a measure of water transparency like Secchi depth, except smaller $K_{d}$ values indicate clearer water.


The above figure shows daily mean $\mathrm{K}_{\mathrm{d}}$ values calculated from the buoy light sensor measurements. Daily mean $\mathrm{K}_{\mathrm{d}}$ varied from 0.77 to $1.3 \mathrm{~m}^{-1}$ with an overall mean of $1.08 \mathrm{~m}^{-1}$. This small $\mathrm{K}_{\mathrm{d}}$ range is equivalent to a photic zone (where light is sufficient for algal growth) range of about 6.0 to 3.5 m . $\mathrm{K}_{\mathrm{d}}$ values generally increased (decreasing clarity) from May through September, and then slightly decreased (increasing clarity) throughout the rest of the deployment. Overall $\mathrm{K}_{\mathrm{d}}$ values were greater (lower water clarity) than in 2022 (mean $0.76 \mathrm{~m}^{-1}$ ), which confirmed public reports that lakes in the area seemed darker in color during 2023. This finding is also consistent with lower-than-average Secchi depth readings on Highland Lake (and many other lakes in this area) in 2023 (See Chapter 1). Waves and wind speed may explain some of the high variation in $\mathrm{K}_{\mathrm{d}}$ at daily time scales. For instance, $\mathrm{K}_{\mathrm{d}}$ sometimes decreased following low winds and vice versa (compare circled areas with the wind plot), but no direct correlation was found.

Long Lake, North Basin - MIDAS 5780

## Long Lake Water Temperature

Water temperature data forms the foundation for most water quality measures and is essential for understanding lake physical dynamics, nutrient cycling, metabolic rates, and habitat availability for fish and other aquatic organisms. Lake water temperature varies in response to heating, cooling, and winds. During ice-free periods, lakes in our area tend to stratify into a warm, upper layer (epilimnion) and a cooler, deep layer (hypolimnion).


The figure above shows daily mean temperature data interpolated across depth and time in Long Lake. Temperature is represented by colored contours, where the blue to red color gradient represents a low to high temperature range. Daily mean values were used to create smoother lines and easier visualization, since lake water temperature can vary by a degree or more in a matter of hours, depending on conditions. During the deployment, temperature ranged from $5.7^{\circ} \mathrm{C}\left(42.3^{\circ} \mathrm{F}\right)$ on April 28 at 15 m depth to $27.7^{\circ} \mathrm{C}\left(81.9^{\circ} \mathrm{F}\right)$ on July 28 at 1 m depth, which was cooler than the 2022 maximum.

Lake stratification was just starting to set in when the buoy was deployed in late April, though the small temperature difference makes it difficult to see in the figure. Stratified conditions (where figure colors change with depth and contour lines appear more horizontal) continued into October. Warm, strongly stratified conditions stand out as darker red and orange areas throughout the summer. The area where contours come closest together (i.e., temperature changes most rapidly with depth) is called the thermocline. The downward sloping contours show that the upper layer (epilimnion) and thermocline generally deepened throughout the summer; thermocline depths ranged from about 1.5 m in June to almost 14 m before fall turnover.

Partial water column mixing caused by cooling and/or high winds (seen as sharp dips in the contour lines) happened throughout the season, for example in June and mid-September (a in figure). Calm, warm periods caused the lake to re-stratify after these short mixing events. Surface waters cooled in August, which weakened stratification and deepened the epilimnion ( $b$ in figure). Stronger stratification returned in early September following warm conditions (c
in figure). Complete mixing (fall turnover; contour lines vertical from top to bottom) occurred on October 23 following cooling and strong winds around that time. By comparison, Highland Lake mixed 9 days earlier on October 14.

Date of Fall Turnover (Complete Mixing) by Year

| YEAR | $\mathbf{2 0 1 3}$ | $\mathbf{2 0 1 4}$ | $\mathbf{2 0 1 5}$ | $\mathbf{2 0 1 6}$ | $\mathbf{2 0 1 7}$ | $\mathbf{2 0 1 8}$ | $\mathbf{2 0 1 9}$ | $\mathbf{2 0 2 0}$ | $\mathbf{2 0 2 1}$ | $\mathbf{2 0 2 2}$ | $\mathbf{2 0 2 3}$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Turnover <br> Date | $10 / 25$ | $10 / 23$ | N/A | N/A | $11 / 4$ | $10 / 18$ | $10 / 18$ | $10 / 8$ | $10 / 27$ | $10 / 14$ | $10 / 23$ |



## Long Lake Dissolved Oxygen

Dissolved oxygen (DO) is an important constituent of lake water that impacts the chemistry and biology of lake ecosystems. The main source of oxygen in lakes is the atmosphere, with temperature governing the amount that can dissolve in the water. Since oxygen is a byproduct of photosynthesis, algae and aquatic plants are another source of dissolved oxygen in lakes. In contrast, deep water oxygen is reduced when microbes, fish, and plants respire or "breathe" and thermal stratification prevents oxygen from being replenished from the atmosphere. Fish tend to avoid and are stressed when moving through hypoxic (see Definitions) areas. Anoxic (see Definitions) bottom waters can allow phosphorus trapped in sediments to be released into the water column for use by algae.

## Definitions:

Hypoxic: having low dissolved oxygen concentration detrimental to aquatic organisms (below about 2-4 mg/L) Anoxic: having complete absence of dissolved oxygen ( $0 \mathrm{mg} / \mathrm{L}$ )


The figure above shows daily mean DO concentration data interpolated across depth and time in Long Lake; we have reversed the color scheme from the previous plot so that red and blue signify low and high DO, respectively. The data has been corrected for sensor drift and biofouling using independent, discrete DO measurements at the same location.

The contour plot clearly highlights the pattern of lower DO concentrations in summertime deep waters and provides a quick visual gauge of when and where hypoxic water occurred. Some of the decrease in DO is due to warming, since cold water can contain more DO than warm water, all else being equal. Oxygen in the deep waters, however, decreased more rapidly, and by early September the water at 13 m became anoxic. Water as shallow as 11 m ( $\sim 36$ ft ) experienced anoxia during the summer. Prior to lake turnover, occasional wind events aerated deep waters through downward mixing of surface water, seen for example in the DO contours dips in September and October (circled areas). By mid-October, the water column was completely saturated with oxygen after temperatures decreased and winds fully mixed the lake (turnover).

## Long Lake Chlorophyll (Algal Biomass)

The Long Lake buoy has one sensor mounted 3 m below the lake surface that measures chlorophyll concentrations using fluorescence (same as the field fluorometer used on regular testing trips and discussed in Chapter 4 of this report). The amount of this pigment (found in all plants and algae and used for photosynthesis) can be used as a proxy for algae biomass and as a measure of lake productivity. It is important to note that field fluorescence is a relative measure and not as always as accurate as lab-based chlorophyll a measurements reported in Chapter 1.


The figure above shows fluorescence-based daily mean chlorophyll concentration, after correcting for a decrease in sensor response in August and filtering out extreme outliers. Chlorophyll ranged from about 0.69 to $2.5 \mu \mathrm{~g} / \mathrm{L}$, and averaged $1.4 \mu \mathrm{~g} / \mathrm{L}$ (or parts per billion), which is considered generally low chlorophyll. Chlorophyll will often increase (i.e., algae can grow) if enough nutrients (phosphorus) and light are available. On Long Lake, chlorophyll did not show a response to phosphorus loading from the early season rainfall, and stayed between one and two $\mu \mathrm{g} / \mathrm{L}$ until late August. Chlorophyll showed more extreme changes after that time and then dropped to quite low levels from late-September to the end of the deployment. Zooplankton (tiny animals that eat algae) grazing and wind-driven mixing in September may have had a role in the observed variation, but changes in sensor sensitivity may have also played a role, especially in the very low readings at the end. There was no apparent impact of fall turnover on chlorophyll, which was because Long Lake deep-water phosphorus was similar to surface water concentrations (See Chapter 1) and unlikely to fuel an algal bloom.

As was mentioned before, chlorophyll fluorescence is a relative measure and often shows variation with depth (see Chapter 4). Still, buoy chlorophyll fluorescence at one discrete depth and extracted chlorophyll a in an integrated sample from the epilimnion (upper mixed layer and represented as points in the figure above) were within about one $\mu \mathrm{g} / \mathrm{L}$ (or parts per billion) of each other during the period. Both records confirm that there was no lake-wide algal bloom on Long Lake in 2023.


## Chapter 3

High Resolution Temperature Monitoring Summary

## Introduction to LEA's High-Resolution Temperature Monitoring

Temperature has a direct impact on the metabolism, growth, and behavior of aquatic organisms. Different species have specific temperature ranges within which they thrive, and deviations can affect their survival and reproduction. Additionally, temperature influences the physical, chemical, and biological characteristics of lake water, making it an important parameter to measure and track.
Over the course of a year, many lakes shift between having a uniform temperature from top to bottom and having separated layers with different temperatures. This layering, also called stratification is described in detail on page 4. The warmest and most shallow layer is called the epilimnion while the coldest, deepest layer is called the hypolimnion. In between those is a layer called the metalimnion (or thermocline), where temperature rapidly decreases with depth.
Lake temperature and stratification are greatly influenced by the weather. Air temperature, precipitation, and wind speed and direction can all affect water temperature and stratification patterns from year to year. Lake size, depth, and shape also greatly impact stratification timing and strength. LEA began using in-lake temperature sensors to acquire high-resolution temperature measurements in 2013. The sensors, which are also interchangeably referred to as HOBO sensors, are used to provide a detailed record of temperature fluctuations, as well as stratification, within lakes and ponds in our service area


Left: Temperature buoy.
Right: LEA's Rachel Harper after she just finished removing a temperature monitoring buoy, which had been deployed all season.

## Methods

In 2023, LEA deployed temperature sensor arrays at 16 sites on 13 lakes with funding and support from local lake associations. Each array consists of several HOBO temperature sensors attached to a floating line that is held in place by a regulatory style buoy and an anchor. The sensors are attached at 2-meter intervals, beginning one meter from the bottom and ending approximately one meter from the top. Each buoy apparatus is deployed at the deepest point of the basin it monitors. The setup results in the sensors being located at odd numbered depths throughout the water column (the shallowest sensor is approximately 1 meter deep, the next is 3 meters, etc.).

The HOBO data sensors are programmed to record temperature readings every 15 minutes and we deploy them from spring to fall in order to capture stratified conditions. LEA also uses


A HOBO temperature sensor a handheld YSI meter to collect water temperature data on each of the traditional boat-based water testing trips. This method yields more temperature data with depth but it is time intensive and produces only eight temperature profiles a year. While temperature sensor arrays require an initial time investment, once deployed, the sensors record over 15,000 profiles before they are removed in the fall. This wealth of data provides much greater detail and clarity than the traditional method ever could. Daily temperature fluctuations, brief mixing events caused by storms, the date and time of stratification set up and breakdown, and the timing of seasonal high temperatures are all valuable and informative events that traditional sampling cannot adequately capture.


Left: Schematic of HOBO sensor placement on temperature buoy.

Right: Sensor lines ready for deployment

## High-resolution Temperature Monitoring Summaries: How to Read the Graphs

Temperature monitoring summaries on the following pages include a temperature heat map for each lake, displaying all the data collected in the 2023 season. Temperature heat maps show temperature across depth and time and were generated using daily mean temperature values, smooths out noisy data. Temperature is represented by colored contours, where the red to blue color range corresponds to a high to low temperature range. The vertical bar on the right side of the temperature map indicates the temperature each color represents in degrees Fahrenheit ( ${ }^{\circ}$ F). The horizontal axis shows the months sensors were deployed, while the left-hand vertical axis shows sensor depth (in meters) below the water's surface.

Temperature stratification shows up as areas of the plot where colors change in the vertical direction and contour lines are tilted more towards horizontal (from June through early November). The area where temperature changes most rapidly with depth is often referred to as the thermocline. Vertical contour lines indicate mixed conditions, and areas of a single color from top to bottom (such as late October into November) indicate completely mixed conditions. Warm, stratified conditions stand out as darker red areas. Large gaps between lines means there is a large temperature difference between depths.

During stratification, the shallower waters do not easily mix with the deeper waters. It is only when the temperature of the upper water cools down that the lake can fully mix. You can see this process happening on each graph: the temperatures near the surface get cooler and the deeper waters get warmer as the barrier between the two layers weakens and the waters begin to mix. The lines converge one by one until the temperature is the same at each depth. This is known as lake turnover or de-stratification.


## 2023 General Temperature Patterns



This year, sensors were deployed in service area lakes by mid-May. Multiple shades of blue before June indicate that stratification had started on the majority of lakes by the time sensors were deployed (box A). As summer progressed from June through early August, warming in shallow waters can be seen on the graph as colors near the top shift from blue to orange and red (box B). During that same timeframe, deeper waters, while warming slightly, generally stayed much cooler, which is noted by blue shades (box C). This indicates that stratification became more distinct as surface water temperatures increased. While surface waters stayed warm through mid-September, colors shifting from dark orange to lighter orange indicate that surface waters began cooling by mid-August before a late season warming event in mid-September (box D). During this time, stratification persisted as deep waters maintained their consistent cool temperatures, indicated by blue shades (box E) this persistent large temperature differences between shallow and deep waters limits cooler, nutrient-rich deep waters from mixing with warmer surface waters. Surface waters began to cool steadily from mid-September through to the end of deployment in early November. This can be seen as shallow waters change from orange back to shades of light blue. As surface waters cooled, they began mixing with waters a few meters down. This can be seen on the graph as lighter blue colors extend a little farther down the graph (box F). However, stratification persisted during this time, noted by multiple shades of blue (box G). Several lakes were still stratified when the arrays were retrieved, and this is noted as multiple shades of blue in November (box H). When lakes are fully mixed at buoy removal time, one color can be seen from top to bottom.


Back Pond's 2023 temperature profile.
A. The water column of Back Pond was weakly stratified when sensors were deployed. Surface water temperatures increased in mid-May and gradually got warmer until cooling down for a short time in early June. Deep waters stayed cold but began to warm slightly in early June.
B. Surface water temperature increased steadily from mid-June through early August before cooling slightly in mid to late August. Deep waters continued to warm slightly but stayed cold enough to maintain stratification.
C. Surface waters responded to a late season heat wave by warming again. Peak surface water temperature often occurs in July or August however, Back Pond's peak surface water temperature occurred on Sept. 9 $\left(26.6^{\circ} \mathrm{C} / 79.8^{\circ} \mathrm{F}\right)$. Deep waters continued to warm slightly but stayed cold enough to maintain stratification.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm slightly. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column were becoming more uniform but temperature differences in the deep waters indicate that full mixing had not yet occurred when sensors were retrieved in late October.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :--- | :---: |
| $5 / 3 / 2023$ | $26.6 / 79.8$ | After Retrieval | $10 / 31 / 2023$ |

## Bear Pond - MIDAS 3420



Bear Pond's 2023 temperature profile.
A. The water column of Bear Pond was weakly stratified when sensors were deployed in early May. Shallower waters gradually warmed until a slight, short cool down in early June. Temperatures of deep waters stayed consistently cold until mid-August.
B. Surface water temperature increased steadily from early June throughout July with peak temperature occurring on July $25\left(26.3^{\circ} \mathrm{C} / 79.3^{\circ} \mathrm{F}\right)$.
C. Surface waters began cooling slightly throughout August but responded to a late season heat wave by reaching near peak temperatures in early September. Deep waters began to warm slightly but stayed cool enough to maintain strong stratification.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but continued to warm slightly.
E. Temperatures throughout the water column were becoming more uniform but temperature differences in the deep waters indicate that full mixing had not yet occurred when sensors were retrieved in late October.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :--- | :---: |
| $5 / 4 / 2023$ | $26.3 / 79.3$ | After Retrieval | $10 / 31 / 2023$ |



Hancock Pond's 2023 temperature profile.
A. The water column of Hancock Pond was weakly stratified when sensors were deployed in mid-May. Shallower waters gradually warmed throughout May before a short cool down in early June. Deep waters stayed consistently cold.
B. Surface water temperature increased steadily from mid-June throughout July with peak temperature occurring on July $8\left(28.3^{\circ} \mathrm{C} / 82.9^{\circ} \mathrm{F}\right)$.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures again in early September.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm slightly. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column were becoming more uniform but temperature differences in the deep waters indicate that full mixing had not yet occurred when sensors were retrieved in early November.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 16 / 2023$ | $28.3 / 82.9$ | After Retrieval | $11 / 6 / 2023$ |



Island Pond's 2023 temperature profile.
A. The water column of Island Pond was weakly stratified when sensors were deployed in early May. Shallower waters gradually warmed throughout May before a slight, short cool down in early June. Deep waters stayed consistently cold.
B. Surface water temperature increased steadily from mid-June through early August before cooling slightly in mid to late August. Deep waters began warm slightly in July but stayed cold enough to maintain stratification.
C. Surface waters responded to a late season heat wave by warming again. Peak surface water temperature often occurs in July or August however, Island Pond's peak surface water temperature occurred on Sept. 9 $\left(26.8^{\circ} \mathrm{C} / 80.2^{\circ} \mathrm{F}\right.$ ).
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm slightly. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column were becoming more uniform but temperature differences in the deep waters indicate that full mixing had not yet occurred when sensors were retrieved in late October

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 5 / 2023$ | $26.8 / 80.2$ | After Retrieval | $10 / 23 / 2023$ |



Keoka Lake's 2023 temperature profile.
A. The water column of Keoka Lake was weakly stratified when sensors were deployed in early May. Shallower waters gradually warmed throughout May before a short cool down in early June. Deep waters stayed cold but warmed slightly in early June.
B. Surface water temperature increased steadily from mid-June throughout July with peak temperature occurring on July $29\left(28.1^{\circ} \mathrm{C} / 82.5^{\circ} \mathrm{F}\right)$. Deep waters began to slowly and slight warm but stayed consistently cold.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures in early September. Due to sensor failure, data describing water temperatures at 9 m is absent from late August through November. We used data collected during regular water monitoring visits to supplement sensor data at that depth.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm more rapidly than earlier in the year. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column were becoming more uniform but temperature differences in the deep waters indicate that full mixing had not yet occurred when sensors were retrieved in early November.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 4 / 2023$ | $28.1 / 82.5$ | After Retrieval | $11 / 6 / 2023$ |

Keyes Pond 2023
Daily Mean Water Temperature
${ }^{\circ} \mathrm{F}$


## Keyes Pond's 2023 temperature profile.

This year, the 1 meter and 3 meter temperature sensors malfunctioned. Note that in the graph above, the shallowest water depth is $5 \mathrm{~m}(16 \mathrm{ft})$. The following data analysis relies on both working sensors and regular water monitoring data to characterize Keyes Pond's 2023 temperature profiles. The water column of Keyes Pond was stratified when sensors were deployed in early May. In June, surface water temperatures began a steady increase, which continued through late July with peak temperature occurring on July $19\left(26.0^{\circ} \mathrm{C} / 78.8^{\circ} \mathrm{F}\right)$. During the summer months, little temperature change was seen in Keyes Pond's deep waters, creating large temperature differences between shallow and deep waters. This large temperature difference limits cooler, nutrient-rich deep waters from mixing with warmer surface waters. When these two layers mix, it provides algae with an additional food source. Please note that the watershed can still contribute phosphorus to the lake, regardless of stratification. Keyes Pond's shallower waters began to cool in August but experienced a late season warm spell in mid-September. In late September through October, shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm slightly. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover. While temperatures throughout the water column were becoming more uniform, temperature differences in the deep waters indicate that full mixing had not yet occurred when sensors were retrieved in late October.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 4 / 2023$ | $26.0 / 78.8$ | After Retrieval | $10 / 31 / 2023$ |



Long Lake's Middle Basin's 2023 temperature profile.
A. The water column of Long Lake's middle basin was not stratified when sensors were deployed in early midMay. Shallower waters gradually warmed throughout May before a slight, short cool down in early June. Deep waters warmed slightly as the lake began to stratify.
B. Surface water temperature increased steadily from mid-June throughout July with peak temperature occurring on July $28\left(27.7^{\circ} \mathrm{C} / 81.8^{\circ} \mathrm{F}\right)$.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures in early September. Deep waters continued to warm but stayed cold enough to maintain stratification.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm slightly. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column became uniform resulting in lake mixing in mid-September.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 12 / 2023$ | $27.7 / 81.8$ | $9 / 14 / 2023$ | $11 / 1 / 2023$ |



Long Lake's South Basin's 2023 temperature profile.
A. The water column of Long Lake's south basin was weakly stratified when sensors were deployed in mid-May. Shallower waters gradually warmed throughout May before a slight, short cool down in early June. Deep waters stayed cold but warmed slightly in early June.
B. Surface water temperature increased steadily from mid-June throughout July with peak temperature occurring on July $26\left(27.7^{\circ} \mathrm{C} / 81.8^{\circ} \mathrm{F}\right)$.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures in early September.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm slightly. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column became uniform resulting in lake mixing in early October.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 12 / 2023$ | $27.7 / 80.3$ | $10 / 14 / 2023$ | $11 / 1 / 2023$ |



McWain Pond's 2023 temperature profile.
A. The water column of McWain Pond was weakly stratified when sensors were deployed in early May.

Shallower waters gradually warmed throughout May before a short cool down in early June. Deep waters stayed cold but warmed slightly in late May.
B. Surface water temperature increased steadily from mid-June throughout July with peak temperature occurring on July $29\left(28.1^{\circ} \mathrm{C} / 82.5^{\circ} \mathrm{F}\right)$. Deep waters stayed consistently stable and cold.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures again in early September. Deep waters remained cold but began to warm slightly.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm slightly. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column became uniform resulting in lake mixing in late October.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 5 / 2023$ | $28.1 / 82.5$ | $10 / 21 / 2023$ | $10 / 23 / 2023$ |



Moose Pond's Middle Basin's 2023 temperature profile.
A. The water column of Moose Pond's middle basin was weakly stratified when sensors were deployed in early May. Shallower waters gradually warmed throughout May before a slight, short cool down in early June. Deep waters stayed cold but warmed slightly in early June.
B. Surface water temperature increased steadily from mid-June throughout July with peak temperature occurring on July $8\left(27.9^{\circ} \mathrm{C} / 82.3^{\circ} \mathrm{F}\right)$. Deep waters stayed consistently cold.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures again in early September. Deep waters stayed consistently cold.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm slightly. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column were becoming more uniform but temperature differences in the deep waters indicate that full mixing had not yet occurred when sensors were retrieved in early November.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 8 / 2023$ | $27.9 / 82.3$ | After Retrieval | $11 / 1 / 2023$ |



Moose Pond's North Basin's 2023 temperature profile.
A. The water column of Moose Pond's north basin was not stratified when sensors were deployed in early May. Shallower waters gradually warmed throughout May before a slight, short cool down in early June. Deep waters gradually warmed as the lake stratified.
B. Surface water temperature increased steadily from mid-June throughout July with peak temperature occurring on July $7\left(28.6^{\circ} \mathrm{C} / 83.4^{\circ} \mathrm{F}\right)$. Deep waters continued to warm but stayed cold enough to maintain stratification.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures in early September. Deep waters continued to warm but stayed cold enough to maintain stratification.
D. The shallow water column fully mixed in late September followed by a brief but mild re-stratification due to colder waters at depth.
E. Temperatures throughout the water column again became uniform and the basin fully mixed in early October.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 8 / 2023$ | $28.6 / 83.4$ | $10 / 09 / 2023$ | $11 / 1 / 2023$ |



Moose Pond's South Basin's 2023 temperature profile.
A. The water column of Moose Pond's south basin was mildly stratified when sensors were deployed in early May. Shallower waters gradually warmed throughout May before a short cool down in early June. Deep waters stayed cold but warmed slightly in early June
B. Surface water temperature increased steadily from early June throughout July with peak temperature occurring on July $8\left(28.6^{\circ} \mathrm{C} / 83.4^{\circ} \mathrm{F}\right)$. Deep waters continued to warm but stayed cold enough to maintain stratification.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures again in early September. Deep waters continued to warm but stayed cold enough to maintain stratification.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm slightly. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover
E. Temperatures throughout the water column were became uniform resulting in basin mixing in October.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 8 / 2023$ | $28.6 / 83.4$ | $10 / 13 / 2023$ | $11 / 1 / 2023$ |



Peabody Pond's 2023 temperature profile.
A. The water column of Peabody Pond was weakly stratified when sensors were deployed in mid-May. Shallower waters gradually warmed throughout May before a slight, short cool down in early June. Deep waters stayed cold but warmed slightly in late May.
B. Surface water temperature increased steadily from mid-June throughout July with peak temperature occurring on July $25\left(27.4^{\circ} \mathrm{C} / 81.4^{\circ} \mathrm{F}\right)$. Deep waters were still cold but warming slightly.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures again in early September. Deep waters stayed cold but continued to warm slightly.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but had started to warm slightly. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column were becoming more uniform but temperature differences in the deep waters indicate that full mixing had not yet occurred when sensors were retrieved in early November.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathbf{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 12 / 2023$ | $27.4 / 81.4$ | After Retrieval | $11 / 3 / 2023$ |



Sand Pond's 2023 temperature profile.
A. The water column of Sand Pond was weakly stratified when sensors were deployed in mid-May. Shallower waters gradually warmed throughout May before a slight, short cool down in early June. Deep waters stayed cold but warmed slightly in late May.
B. Surface water temperature increased steadily from mid-June throughout July with peak temperature occurring on July $29\left(27.1^{\circ} \mathrm{C} / 80.7^{\circ} \mathrm{F}\right)$. Deep waters stayed cold but began to warm slightly.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures in early September. Deep waters stayed cold and stable.
D. Shallow waters began to cool and mix with waters from the middle depths. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column were becoming more uniform but temperature differences in the deep waters indicate that full mixing had not yet occurred when sensors were retrieved in early November.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 16 / 2023$ | $27.1 / 80.7$ | After Retrieval | $11 / 6 / 2023$ |



Trickey Pond's 2023 temperature profile.
A. The water column of Trickey Pond was weakly stratified when sensors were deployed in mid-May. Shallower waters gradually warmed through May and June. Deep waters stayed cold but warmed slightly during this period.
B. Surface water temperatures increased rapidly in July with peak temperature occurring on July $29\left(26.6^{\circ} \mathrm{C} /\right.$ $79.9^{\circ} \mathrm{F}$ ) and continued to be very warm through mid-August. Deep waters stayed consistently cold.
C. Surface waters began cooling later in August before briefly warming again in early September. Deep waters were cold but began to warm slightly.
D. Shallow waters began to cool and mix with waters from the middle depths. Deep waters were still cold but continued to warm. The decrease in temperature difference between shallow and deep waters is a precursor to fall turnover.
E. Temperatures throughout the water column were becoming more uniform but temperature differences in the deep waters indicate that full mixing had not yet occurred when sensors were retrieved in early November.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 12 / 2023$ | $26.6 / 79.9$ | After Retrieval | $11 / 3 / 2023$ |



Woods Pond's 2023 temperature profile.
A. The water column of Woods Pond was not stratified when sensors were deployed in early May. Shallower waters gradually warmed throughout May before a short cool down in early June. Deep waters gradually warmed as the lake stratified.
B. Surface water temperature increased steadily from early June throughout July with peak temperature occurring on July $26\left(27.9^{\circ} \mathrm{C} / 82.2^{\circ} \mathrm{F}\right)$. Deep waters continued to warm but stayed cold enough to maintain stratification.
C. Surface waters began cooling slightly throughout August before reaching near peak temperatures again in early September. Deep waters continued to warm but stayed cold enough to maintain stratification.
D. As warm, surface waters cooled, stratification continued to push down until the entire water column mixed in mid-September. A warm spell caused surface waters to heat up again and mild stratification returned for a brief spell in early October.
E. Surface waters cool back down and the entire water column fully mixed again and continued to cool.

| Deployment Date | Peak Temperature $\left({ }^{\circ} \mathrm{C} /{ }^{\circ} \mathrm{F}\right)$ | Full Mixing | Retrieval Date |
| :---: | :---: | :---: | :---: |
| $5 / 9 / 2023$ | $27.9 / 82.2$ | $9 / 19 / 2023$ | $11 / 10 / 2023$ |



## Chapter 4

Algae Monitoring via Fluorometry


## Introduction to LEA's Algae Monitoring Via Fluorometry Program

Not only do algae form the base of the aquatic food web, providing essential nutrients for various organisms, they contribute significantly to oxygen production through photosynthesis, influencing the overall oxygen levels in aquatic environments Because algae are sensitive to and respond quickly to changes in their habitat, they are considered indicators of water quality. Fluorometric data allows for a better understanding of where the highest concentrations of chlorophyll can be found, which helps us interpret changes in oxygen concentrations and assess overall water quality.

This report focuses on estimating algal populations via fluorometry. LEA began using a fluorometer to estimate chlorophyll concentrations in lakes in 2016. The fluorometer works by emitting blue light at a specific wavelength, which causes chlorophyll molecules inside of algal cells to enter a high-energy ("excited") state. When the molecules return to their normal state, they give off light (fluoresce) at a different wavelength. The fluorometer measures the strength of this return fluorescence. The stronger the fluorescence, the more chlorophyll is present.

Fluorometric chlorophyll monitoring in LEA's service area occurs every year during late spring through early fall. Monitoring consists of monthly visits to the deepest spot in participating lakes, where we measure relative chlorophyll concentrations in lake water using a fluorometer. This information contributes to our long-term understanding of algal presence throughout the water column.


Left: Turner Designs Cyclops 7 hand held Fluorometer

Right: Rachel Harper and Annie O'Connor on the water collecting data

## Field Methods

Once a month, during regular water monitoring visits, chlorophyll fluorescence profiles were collected by lowering a Cyclops 7 submersible fluorometer into the water Readings were collected at one-meter intervals from the surface to the bottom of the lake. This data provides a detailed record of fluorescence variation throughout the water column.


## Annie O'Connor collecting

 temperature and oxygen data.
## Data Analysis Methods

The fluorometer reports results in Relative Fluorescence Units (RFUs). This is converted to a concentration based on the calibration of the instrument. Fluorescence profiles were then combined with dissolved oxygen and temperature profiles to allow us to better interpret fluorescence data. Unlike the lab chlorophylla samples LEA collects, which are composite samples from the upper layer of each lake, the fluorometer measures chlorophyll at discrete depths from the top of the water column to the bottom. From this data, we can graph relative chlorophyll concentrations to see where algae are concentrated within the lake.

It is important to note that fluorometric measurements are not a direct comparison to data obtained through the chlorophyll-a sampling done on each lake during regular water testing. Chlorophyll-a concentrations measured by the fluorometer are to be treated as approximate; the instrument provides a relative chlorophyll concentration which is not as accurate as lab-based testing but is very useful for viewing patterns within a lake.


Rachel Harper and Annie O'Connor in the lab after returning from the lakes

Lake Fluorometry Summaries and Interpreting Data Graphics


Graphs have been included for each test site to visually compare fluorometer, temperature, and oxygen profiles from May through September. The vertical axis (y-axis) indicates depth below the surface, while the horizontal axis (x-axis) represents reported values. Three different parameters are being reported on the same graph, which results in the value units for the horizontal axis varying, based on parameter. Units are noted in parentheses in the legend.

Each graphic contains five graphs, one for every month in LEA's water monitoring season. Each graph contains a green line, representing chlorophyll concentration, a blue line, representing dissolved oxygen concentration, and a red line, representing temperature. The shape of each line changes from month to month as each parameter changes. Some typical features seen in the data are:

1 = Rapid change in temperature (thermocline)
2 = Fluorescence increase
$3=0 x y g e n$ increase
4 = Oxygen decrease

2023 General Fluorometry Patterns


In 2023, fluorometer profiles were collected monthly, from May through September, during LEA's regular water monitoring visits. By the time water monitoring began, several service area lakes had already started to stratify, noted by the presence of a steep decline in temperature in May. As the summer progressed, the thermocline deepened into the water column until September, when waters near the bottom began to warm and/or waters near the surface cooled enough to mix with waters within the thermocline. Throughout the season, many lakes contained a chlorophyll maximum near the metalimnion. There are a few reasons why this tends to happen. One, is that there is a large density difference between warm, upper-layer water and cold, bottom-layer water, so algae that sink down from the upper layer tend to slow down and accumulate at the metalimnion. While the metalimnion is a common place to see increased algae concentrations, algae can, and do, grow deeper in the water column where there are often more nutrients. An increase in oxygen concentration is frequently noted near the fluorescence peak each month on most lakes. This oxygen is a by-product of algal photosynthesis. Over the course of the season, oxygen below the thermocline consumed by organisms living in deep waters. The difference in density between warm, oxygen-rich surface waters and cold, deep waters prevents mixing of the two. This can be seen from month to month as deep water oxygen concentrations decline.


May - LEA's water testing team collected the first fluorometer profile in mid-May. At that time, Back Pond was stratified. In the upper waters, fluorescence increased with depth until 6 m . An increase in dissolved oxygen can be seen right above where fluorescence was at its highest. This oxygen is likely produced by algae as a by-product of photosynthesis. In the deep waters, fluorescence began to decrease with depth.
June - In the upper waters, fluorescence values gradually increased with depth, reaching their peak near the thermocline at 5 meters. Another small increase in dissolved oxygen can be seen near thermocline, right above where algae concentrations were at their highest. In the deep waters, algae concentrations began to decrease with depth. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
July - Warm surface waters provided more favorable growing conditions for algae, noted by slightly elevated fluorescence readings in the upper waters. Another increase in dissolved oxygen can be seen near the thermocline, right above a fluorescence peak at 7 m . This is likely where the colder, denser water provided algae a place to "sit". In the deep waters there was a sharp decline in fluorescence until the bottom, where increased fluorescence values are likely caused by interference from bottom sediments.
August - Warm surface waters continued to provide algae favorable growing conditions, noted by the elevated fluorescence values throughout the upper and middle waters. Fluorescence values were highest at 3 meters and six meters. In the deeper waters, fluorescence values decreased with depth. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
September - Fluorescence values increased with depth and then starting at 4 meters, increased rapidly reaching high values and at 6 meters. Back Pond's highest algae concentrations were recorded this month. In the deep waters, fluorescence values returned to low levels.
Synopsis: Algae concentrations are quite variable throughout the season with elevated readings in June and July and high readings in September. However, these higher concentrations were fairly deep (between 5 and 7 meters) and not in portion of the water column that people usually use. High readings in the bottom waters were likely caused by sediment interference.


May - LEA's water testing team collected the first fluorometer profile in late May. At that time, Hancock Pond was weakly stratified. In the upper waters, fluorescence values increased until reaching mild peaks at 4 meters and 6 meters. This fluorescence increase occurred just above the thermocline, where rapidly changing water density provided algae a place to "sit". In the middle waters, fluorescence gradually decreased and in the deep waters, it remained low and uniform.
June - Although there were slightly more algae in the upper waters, fluorescence values remained fairly uniform and low. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
July -. Warm surface waters provided algae favorable growing conditions, noted by the elevated fluorescence readings in the upper waters. Fluorescence values increased until reaching their peak at 3 meters and 4 meters. This is likely where the colder, denser water provided algae a place to "sit". In the middle and deep waters fluorescence values remained fairly uniform until the bottom, where increased fluorescence values are likely caused by interference from bottom sediments.
August - Warm surface waters continued to provide algae favorable growing conditions, noted by the elevated fluorescence values throughout the upper waters. Fluorescence values were highest at 5 meters. In the middle waters, fluorescence values decreased. A slight fluorescence increase was noted at 13 meters but fluorescence remained fairly uniform and low until the bottom where increased fluorescence values are likely caused by interference from bottom sediments.
September - A late season warm spell, provided algae favorable growing conditions, noted by the elevated fluorescence values in the upper waters. Fluorescence values were highest just above the thermocline at 6 meters, likely sitting on a "shelf" created by the denser, lower temperature waters. Below this peak, fluorescence values quickly decreased and then remained fairly uniform throughout the deep waters.

> Synopsis: Algae concentrations were low throughout the water column in May, June, and July. Moderate readings were seen at around 5 meters in August and September. High readings in the bottom waters were likely caused by sediment interference.


May - LEA's water testing team collected the first fluorometer profile in late May. At that time, Keoka Lake was stratified. In the upper waters, fluorescence values increased until reaching their peak at 6 meters. This fluorescence increase occurred near the thermocline where the rapidly changing water density provided algae a place to "sit". In the middle and deep waters, fluorescence gradually decreased.
June - No clear fluorescence peak was noted this month. Fluorescence values oscillated between higher and lower from one meter to the next but generally remained uniform throughout the water column.
July - Warm surface waters provided algae favorable growing conditions, noted by the elevated fluorescence readings in the upper waters. Fluorescence values increased until reaching their peak at 2 meters. This is likely where the colder, denser water provided algae a place to "sit". In the middle waters fluorescence values gradually decreased and remained uniform throughout the deep waters.
August - In the upper waters, fluorescence values gradually increased until reaching their peak at 3 meters.
Fluorescence values were highest at 5 meters and then gradually decreased in the middle waters. Fluorescence was low and fairly uniform throughout the deeper waters. The fluorescent spike at the bottom was likely caused by interference from sediments.
September - In the upper waters, fluorescence values gradually increased until reaching their peak at 3 meters. In the middle waters, fluorescence values decreased. Fluorescence was low and fairly uniform throughout the deeper waters. The spike in values at the bottom was likely caused by sediment interference.
Synopsis: Algae concentrations were low to moderate throughout the water column and the season. The greatest concentrations were seen between 2 and 6 meters in depth and the highest (but still moderate) reading was seen near the surface in July. High readings in the bottom waters were likely caused by sediment interference.

## Keyes Pond - MIDAS 3232



May - LEA's water testing team collected the first fluorometer profile in late May. At that time, Keyes Pond was stratified. In the upper waters, fluorescence values increased until reaching their peak at 3 meters. In the middle and deep waters, fluorescence gradually decreased. A sharp decrease in dissolved oxygen can be seen at 6 meters. This oxygen decrease could have been produced by decomposing algae sitting on top of colder, denser water or it could be an anomaly.
June - In the upper waters, fluorescence values increased until reaching their peak at 2 meters. Below the peak, fluorescence values decreased and remained fairly uniform throughout the rest of the water column.
July - Warm surface waters provided algae favorable growing conditions, noted by the elevated fluorescence readings in the upper waters. Fluorescence values increased until reaching their peak at 5 meters. This is likely where the colder, denser water provided algae a place to "sit". In the middle waters fluorescence values gradually decreased. Values in the bottom waters were low and remained fairly uniform. The spike in values at the bottom was likely caused by sediment interference.
August - Warm surface waters continued to provide algae favorable growing conditions, noted by the elevated fluorescence values throughout the upper waters. Fluorescence values were highest at 4 meters. In the middle waters, fluorescence values decreased before increasing slightly in the deeper waters. The slight fluorescence increase at the bottom could have been caused by interference from bottom sediments.
September - In the upper waters, fluorescence values gradually increased until reaching their peak at 2 meters. In the middle waters, fluorescence values gradually decreased. Values in the bottom waters were low and fairly uniform. The increased fluorescence values at the bottom were likely caused by sediment interference.
Synopsis: Algae concentrations were moderate in the upper water column throughout the season. An elevated reading was observed near the thermocline in July. Algae concentrations in the deeper waters were low to moderate. High readings in the bottom waters were likely caused by sediment interference.


May - LEA's water testing team collected the first fluorometer profile in late May. At that time, mild stratification had just started to form in the very deepest waters. In the upper waters, fluorescence values increased until reaching their peak at 2 meters where plenty of sunlight was available for photosynthesis. In the middle and deep waters fluorescence values remained fairly uniform. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
June - In the upper waters, fluorescence values gradually increased until again reaching a peak at 2 meters. In the middle and deep waters, fluorescence values remained uniform throughout the rest of the water column. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
July - In the upper waters, fluorescence values increased until reaching their peak at 3 meters. This is likely where the colder, denser water provided algae a place to "sit". In the middle waters fluorescence values gradually decreased. There was only minor variability in fluorescence throughout the deep waters. The spike in values at the bottom was likely caused by sediment interference.
August - Fluorescence values were highest in the upper waters and reached a peak at 3 meters. Below the peak, algae concentrations gradually decreased. In the bottom waters, fluorescence values were low and remained uniform.
September - In the upper waters, fluorescence values gradually increased until reaching a very mild peak at 3 meters. In the middle waters fluorescence values gradually decreased and then they remained uniform throughout the deep waters.
Synopsis: Algae concentrations were low to moderate throughout the water column and the season. The highest (but still moderate) readings were found at 3 meters in depth and then moved down to 4 meters in depth as the season progressed. High readings in the bottom waters were likely caused by sediment interference.


May - LEA's water testing team collected the first fluorometer profile in mid-May. At that time, Middle Pond was stratified. In the upper waters, fluorescence values increased until reaching their peak at 4 meters. This fluorescence increase occurred near the thermocline where the rapidly changing water density provided algae a place to "sit". After this peak, fluorescence rapidly decreased and then they remained at lower levels throughout the deep waters.
June - There was slightly more fluorescence in the upper, sunlit waters, but overall values were low and fairly uniform throughout the water column. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
July - Warm surface waters provided algae favorable growing conditions, noted by the elevated fluorescence readings in the upper waters. An increase in dissolved oxygen can be seen near the second fluorescence peak at 7 m , likely a byproduct of photosynthesis. In the deep, fluorescence decreased and became uniform throughout the rest of the water column.
August - Warm surface waters provided algae favorable growing conditions, noted by the elevated fluorescence values in the upper waters. Fluorescence values were highest at 2 meters. In the middle waters, fluorescence values decreased before increasing again at 9 meters. This second fluorescence peak is accompanied by an increase in oxygen. This oxygen is likely produced by algae as a by-product of photosynthesis.
September - Warm surface waters continued to provided algae favorable growing conditions, noted by the elevated fluorescence values throughout the upper waters. Fluorescence values were highest at 3 meters and 10 meters. The second, deeper fluorescence peak is again accompanied by an increase in oxygen. This oxygen is likely produced by algae as a by-product of photosynthesis.
Synopsis: Algae concentrations were moderate and quite variable throughout the water column and the season. Favorable conditions for algae growth are often observed near the surface waters and sometimes below the thermocline.


May - LEA's water testing team collected the first fluorometer profile in mid-May. At that time, Moose Pond's middle basin was not stratified. Increasing fluorescence can be seen in the sunlit, upper waters. In the middle and deep waters, fluorescence values remained relatively uniform until the bottom where increased fluorescence values are likely caused by interference from bottom sediments.
June - In the upper waters, fluorescence values gradually increased until reaching their peak at 7 meters. In the middle and deep waters, fluorescence values remained uniform. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
July - Warm surface waters provided algae favorable growing conditions, noted by the elevated fluorescence readings in the upper waters. Fluorescence values increased until reaching their peak at 5 meters. This is likely where the colder, denser water provided algae a place to "sit". In the middle waters, fluorescence values rapidly decreased and then they remained uniform throughout the deep waters.
August - In the upper waters, fluorescence values gradually increased until reaching a mild peak at 4 meters. Throughout the rest of the water column fluorescence values remained fairly uniform and low.
September - The fluorescent profile was similar to the previous month. In the upper waters, fluorescence values gradually increased until reaching a mild peak again at 4 meters. Throughout the rest of the water column fluorescence values remained fairly uniform and low.
Synopsis: With the exception of a moderate-level fluorescent peak in July, algae concentrations were fairly low throughout the season. Growing conditions were most favorable for algae between 4 and 7 meters deep. High readings in the bottom waters were likely caused by sediment interference.


May - LEA's water testing team collected the first fluorometer profile in mid-May. Fluorescence values remained low and uniform throughout the water column at this time.
June - In the upper waters, fluorescence values increased with depth, reaching a peak at 2 meters. In the deeper waters, algae concentrations returned to low levels.
July - In the upper waters, fluorescence values gradually increased with depth, reaching a peak near the thermocline at 3 meters. Below the peak, algae concentrations, quickly dropped and returned to low levels.
August - No clear fluorescence peak was noted this month. Fluorescence values remained fairly low and uniform throughout the water column.
September - In the upper waters, fluorescence values gradually increased until reaching a mild peak at 2 meters. Overall, fluorescent values remained fairly low throughout the water column.
Synopsis: Algae concentrations were fairly low throughout the water column in May, August, and September. There were distinct upticks in algae growth between 2 and 3 meters in June and July bringing concentrations to moderate levels at those depths.


May - LEA's water testing team collected the first fluorometer profile in mid-May. At that time, Moose Pond's south basin was beginning to stratify. In the upper waters, fluorescence values increased until reaching their peak at 7 meters. This fluorescence increase occurred near the thermocline where the rapidly changing water density likely provided algae a place to "sit". In the deep waters, fluorescence gradually decreased.
June - In the upper waters, fluorescence values gradually increased with depth, reaching a peak at 4 meters. In the deep waters, algae concentrations returned to low levels.
July - Warm surface waters provided algae favorable growing conditions, noted by the elevated fluorescence readings in the upper waters. Fluorescence values increased until reaching a peak at 5 meters and then gradually declined. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
August - Warm surface waters continued to provided algae favorable growing conditions, however there was noticeable variation with depth and two mild fluorescent peaks can be seen at 3 meters and 6 meters. In the deep waters, algae concentrations returned to low levels.
September - In the upper waters, fluorescence values gradually increased until reaching a mild peak at 4 meters. In the deeper waters, fluorescence values decreased and values remained fairly low and uniform.
Synopsis: Algae concentrations were low to moderate throughout season and variable throughout the water column. Similar to the other two basins of Moose Pond, highest algae concentrations were observed in the upper waters during July sampling. High readings in the bottom waters were likely caused by sediment interference.


May - The water column of Peabody Pond was already weakly stratified. There was a mild fluorescent peak at 2 meters, then levels went back down before again increasing in concentration between 5 and 9 meters. In the deep waters, algae concentrations went back down to low levels. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
June - Fluorescence values gradually increased with depth until reaching a peak near 8 meters. Below that, values gradually fell and retuned to very low levels. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
July - Algae concentrations increase rapidly, and a distinct fluorescent peak is seen at 5 meters. This is likely where the colder, denser water provided algae a place to "sit". Below this peak, values fall back down to low levels. The spike in values at the bottom was likely caused by sediment interference.
August - Fluorescence values were highest in the thermocline at 6 meters. In the deeper waters, fluorescence values were very low. The small spike at the bottom was again likely caused by sediment interference.
September - In the upper waters, fluorescence values gradually increased until reaching a peak at 7 meters. The fluorescence peak was accompanied by an oxygen decrease. This oxygen decrease could be produced by decomposing algae sitting where the colder, denser water provided the algae a place to "sit". Below 7 meters, fluorescence values decreased and remained uniform throughout the deeper waters.
Synopsis: With the exception of a moderate-level fluorescent peak in July, algae concentrations were fairly low throughout the season. Growing conditions were most favorable for algae between 5 and 8 meters deep. High readings in the bottom waters were likely caused by sediment interference.


May - LEA's water testing team collected the first fluorometer profile in late May. At that time, Sand Pond was already stratified. In the upper waters, fluorescence increased with depth until 3-4 meters. Below that, fluorescence gradually decreased and remained fairly uniform.
June - In the upper waters, fluorescence values increased slightly with depth but no obvious peak was noted. Fluorescence values remained uniform throughout the middle and deeper waters. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
July - Warm surface waters provided algae favorable growing conditions, noted by the elevated fluorescence readings in the upper waters. Fluorescence values increased until reaching their peak at 3 meters. This is likely where the colder, denser water provided algae a place to "sit". In the middle waters fluorescence values gradually decreased and then remained uniform throughout the deep waters. The spike in values at the bottom was again likely caused by sediment interference.
August - Warm surface waters again provided algae favorable growing conditions, noted by the elevated fluorescence readings in the upper waters. Fluorescence values increased until reaching their peak at 4 meters. This is likely where the colder, denser water provided algae a place to "sit". In the middle waters fluorescence values gradually decreased and then remained uniform throughout the deep waters. The spike in values at the bottom was again likely caused by sediment interference.
September - In the upper waters, fluorescence values gradually increased until reaching their peak again at 4 meters. Below this peak, fluorescence values quickly decline to low levels and oxygen reaches near zero values.
Synopsis: Algae concentrations were low to moderate throughout season. Peak algae growth was seen between 3 and 4 meters in depth with July, August, and September being the most productive months. High readings in the bottom waters were likely caused by sediment interference.


May - Tricky Pond was stratified when LEA's water testing team collected the first fluorometer profile in late May. In the upper waters, fluorescence values remained fairly uniform. In the middle waters fluorescence values gradually increased to a small peak at 10 meters. This fluorescence increase occurred near the thermocline where rapidly changing water density likely provided algae a place to "sit". Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
June - In the upper and middle waters, fluorescence values remained uniform. In the deep waters, fluorescence values increased until reaching their peak at 12 meters. This fluorescence increase occurred near the thermocline where the rapidly changing water density provided algae a place to "sit". Increased fluorescence values near the bottom are likely caused by interference from bottom sediments.
July - Fluorescence values remained fairly uniform throughout the water column. The spike in values at the bottom was again likely caused by sediment interference.
August - In the upper waters, fluorescence values remained uniform. In the middle waters, fluorescence values increased to a small peak at 9 meters. This peak was accompanied by a small increase in oxygen. This oxygen was likely produced by algae as a by-product of photosynthesis. In the deep waters, fluorescence began to decrease with depth. The spike in values at the bottom was again likely caused by sediment interference.
September - Fluorescence values were low and varied little throughout the water column. The highest (but still low) values were seen in the thermocline where pressure differences and nutrient availability may have allowed for better growing conditions. Increased fluorescence values near the bottom were likely caused by interference from bottom sediments.
Synopsis: Likely because of Trickey Pond's excellent clarity, the highest algae concentrations were quite deep in the water column, where there are more nutrients and still ample light. Most fluorometry values were low, with some moderate readings below 7 meters in depth. High readings in the bottom waters were likely caused by sediment interference.


May - LEA's water testing team collected the first fluorometer profile in late May. At that time, Woods Pond was not stratified. In the upper waters, fluorescence values increased until reaching their peak at 2 meters where plenty of sunlight was available for photosynthesis. In the deep waters, fluorescence values remained fairly uniform. Increased fluorescence values near the bottom are likely caused by interference from bottom sediments. June - In the upper waters, fluorescence values gradually increased until reaching their peak at 4 meters. In the deeper waters, fluorescence values decreased with depth. Increased fluorescence values near the bottom are again likely caused by interference from bottom sediments.
July - Overall fluorescence values remained low but gradually increased until reaching a slight peak at 2 meters and then decreased with depth.
August - Warm surface waters provided algae favorable growing conditions, noted by the slightly elevated fluorescence readings in the upper waters. Below 4 meters, fluorescence values steadily decreased until the bottom where increased fluorescence values are likely caused by interference from bottom sediments.
September - In the upper waters, fluorescence values gradually increased until reaching a peak at 2 meters. This fluorescence increase occurred near the thermocline where the rapidly changing water density may have provided algae a place to "sit". In the deeper waters, fluorescence gradually decreased with depth.

Synopsis: Algae concentrations were low to moderate throughout season. Peak algae growth was seen near the surface between 1 and 4 meters in depth with May and September being the most productive months. High readings in the bottom waters were likely caused by sediment interference.


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