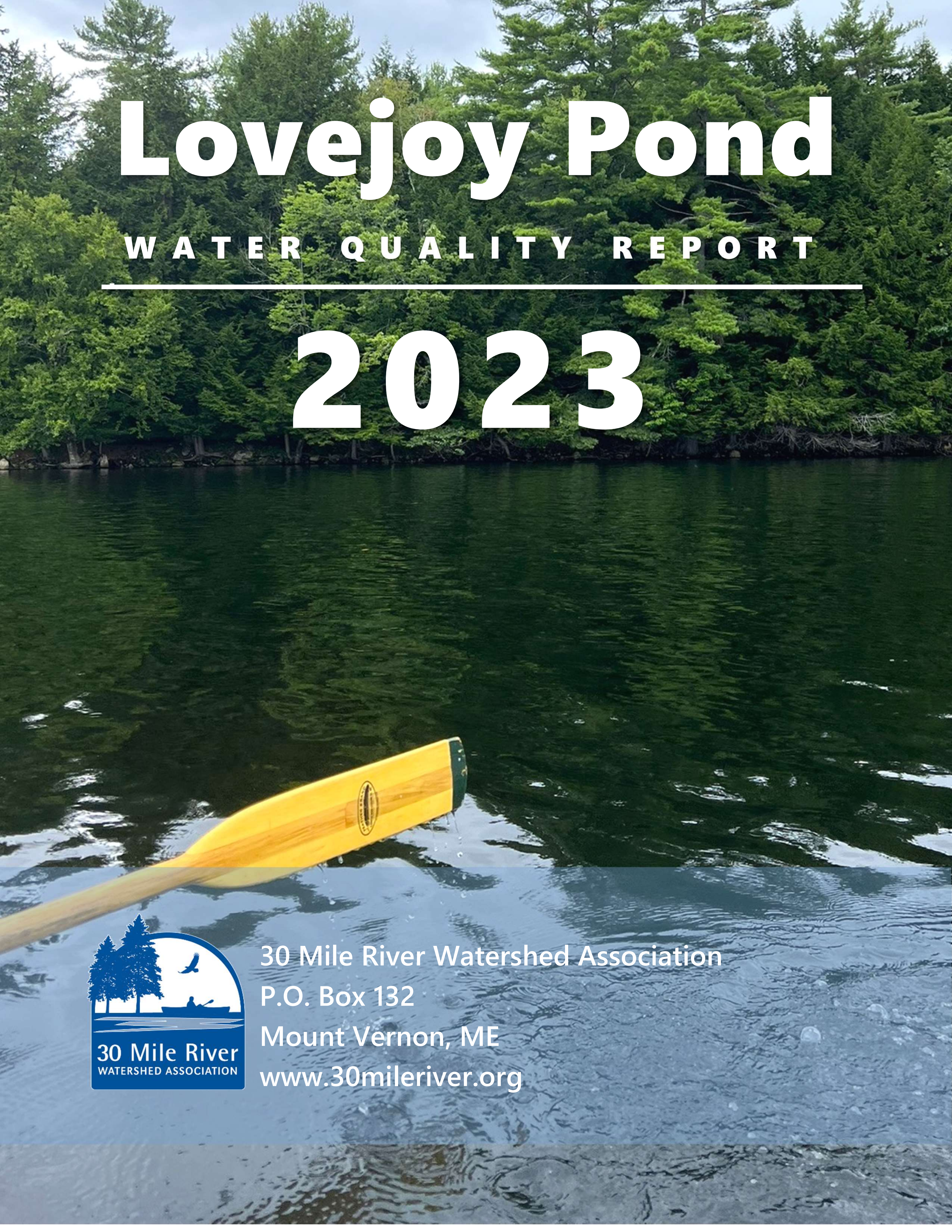

Lovejoy Pond

WATER QUALITY REPORT

2023

30 Mile River Watershed Association
P.O. Box 132
Mount Vernon, ME
www.30mileriver.org

2023 Lovejoy Pond Water Quality Report

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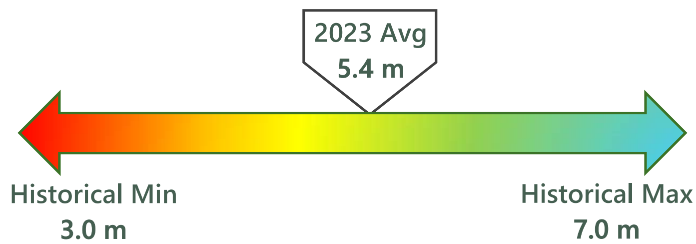
2023 Water Quality Summary[1]

Monitoring on Lovejoy Pond occurred on eight (8) dates between June and October 2023 by Whitney Baker and Silas Mohlar of 30 Mile River Watershed Association (30 Mile) and volunteers from the Lovejoy Pond Improvement Association (LPIA).

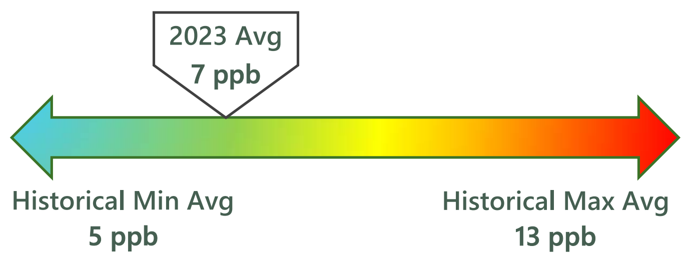
Water clarity readings in 2023 ranged from 4.9 meters (June 20th) to 6.5 meters (September 13th) with an annual average of 5.4 meters. Eight readings were collected in 2023.

Water Clarity (m)	
2023 Water Clarity Average	5.4
Historical SDT Average	5.5
Maine Lakes SDT Average	4.8



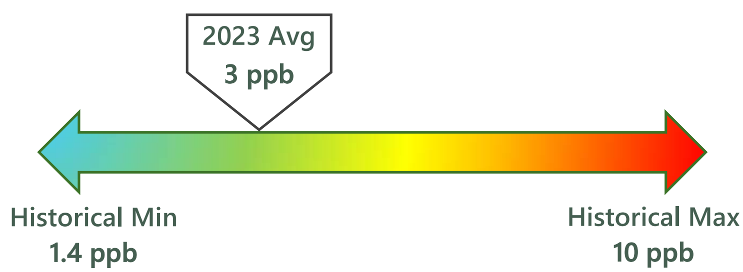
Four (4) samples were collected and analyzed for Total Phosphorus. Laboratory results ranged from 6 ppb (parts per billion) to 8 ppb with an average of 7 ppb.

Total Phosphorus (ppb)	
2023 TP Average	7
Historical TP Average	12
Maine Lakes TP Average	12



Chlorophyll was measured four (4) times in 2023. Results ranged from 3 ppb to 6 ppb with an annual average of 4 ppb.

Chlorophyll-a (ppb)	
2023 Chl-a Average	3
2023 Peak Chl-a	6
Historical Chl-a Average	3.3
Maine Lakes Chl-a Average	5.4



Eight (8) Dissolved Oxygen (DO) profiles were collected in 2023. Anoxia (DO <2 ppm) was first encountered in water 6 meters and deeper in early July, grew slightly to include all waters 5 meters and deeper by mid-August, and persisted in waters 6 meters and deeper through September.

[1] Scale bars illustrate the range of data collected for each parameter over the historical monitoring record for general comparison with the 2023 monitoring results. The blue end represents the historical minimum (best), and the red end represents the historical maximum (worst) of all monitoring data collected.

Overview

Lovejoy Pond is located in the towns of Readfield, Fayette, and Wayne in Kennebec County, Maine and has a direct watershed area of approximately 4 square miles. Its indirect, upstream watershed is very large (42 square miles) and includes the upstream drainages of Echo Lake, Taylor Pond, Minnehonk Lake, David Pond, Parker Pond, Flying Pond. Lovejoy Pond drains to a single outlet located at the south end of the lake that flows south to Pickerel Pond and Pocasset Lake in Wayne. Lovejoy does not have a public boat launch.

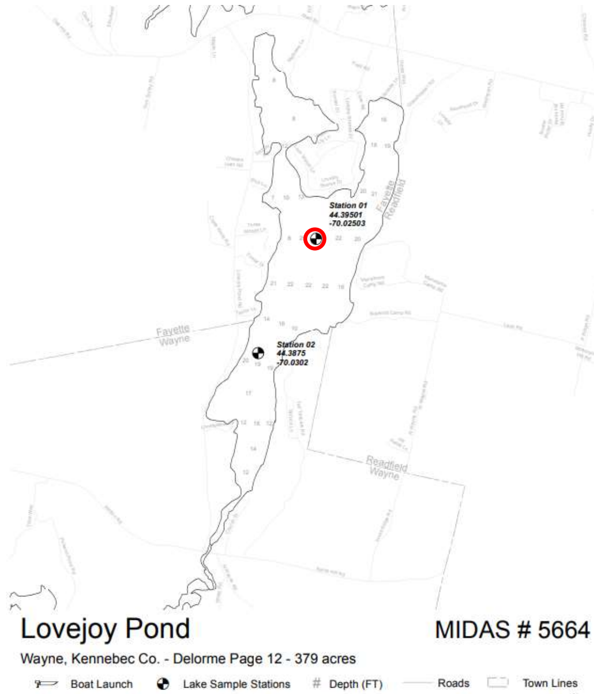


Figure 1. Lovejoy Pond Monitoring Stations. Station 01 in red.

Water Quality Monitoring in 2023

Water quality monitoring on Lovejoy Pond takes place at the deepest spot in the lake (Maine DEP Station 1), also known as the "deep spot." Station 1 is 7 meters (22 ft) deep (Figure 1). Monitoring in 2023 was completed by Whitney Baker and Silas Mohlar of 30 Mile River Watershed Association (30 Mile) and volunteers from the Lovejoy Pond Improvement Association (LPIA). A special thanks to the 2023 volunteers: Deb Aseltine and Ted & Mary Becker.

2023 water quality volunteer, Ted Becker

Water quality data was collected on eight dates between June and October. Parameters include Secchi disk transparency, dissolved oxygen and temperature, phosphorus, chlorophyll, and advanced chemistry parameters (pH, Alkalinity, Color, and Conductivity).

Secchi Disk Transparency (Water Clarity)

Secchi disk transparency (SDT) is an indicator of water clarity. To measure water clarity, a black and white disk is lowered into the water and the reading is taken at the depth at which it is no longer visible. Factors that affect water clarity include algal growth, zooplankton densities, natural water color, and suspended silt or sediment particles.

Water Clarity (m)	
2023 Water Clarity Average	5.4
Historical SDT Average	5.5
Maine Lakes SDT Average	4.8

Water readings in 2023 ranged from 4.85 meters (June 20th) to 6.50 meters (September 13th) with an annual average of 5.4 meters. Eight (8) readings were collected over eight (8) monitoring days in 2023 (Figure 2).

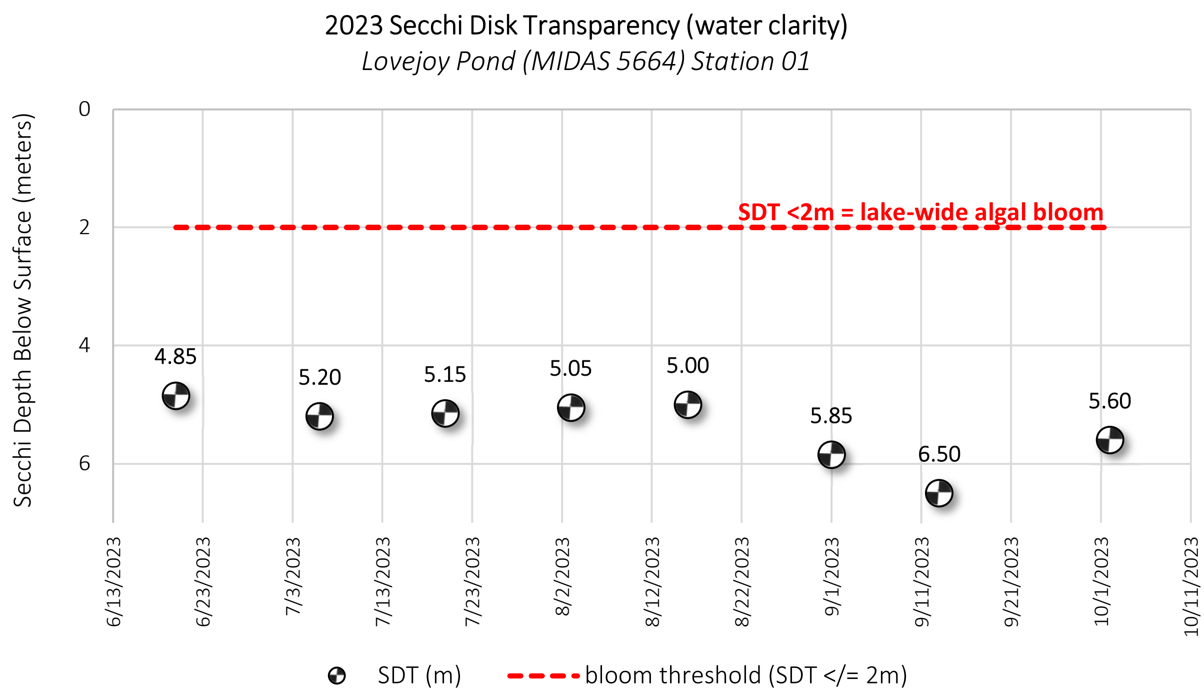


Figure 2. 2023 Secchi Disk Transparency, Station 01

SDT data has been collected during 36 years throughout the historical monitoring period spanning the past 47 years. SDT readings in Lovejoy Pond have ranged from 3.0 m (1984) to 7.0 m (2020) with an average annual reading of 5.5 m (Figure 3). It is important to note that water clarity readings in Lovejoy Pond can sometimes be physically restricted by the depth of the lake. Ocassionally, the secchi disk will touch the bottom of the lake while still visible. This year, the secchi disk reached the bottom once, on September 13th.

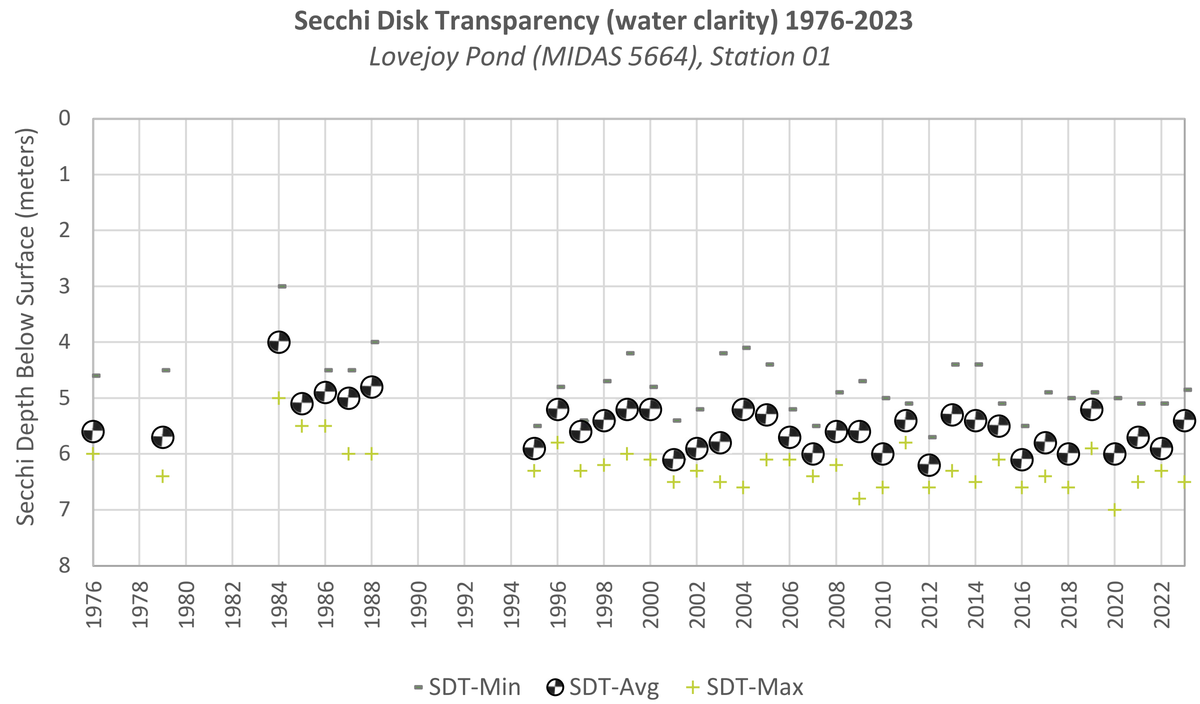


Figure 3. Average Annual Secchi Disk Transparency (water clarity), Station 01, 1976-2023

Dissolved Oxygen and Temperature

Dissolved oxygen (DO) is a critical indicator of the health of the lake system. DO is produced through photosynthesis, consumed during respiration and decomposition, and is influenced by wind, wave action, weather events, and lake productivity. A good supply of oxygen is essential for fish and other aquatic species, with most fish species requiring a DO concentration of 5 mg/L or more. Anoxia (no oxygen) occurs when DO falls below 2 mg/L. As lake water is warmed during the summer, deep lakes will form three distinct temperature layers. There is a warm layer at the surface (epilimnion), a thin transitional layer (metalimnion), and a deep cold layer (hypolimnion). The change in water temperature and density at the metalimnion acts as a physical barrier that prevents mixing of the upper and lower layers for several months during the open water season.

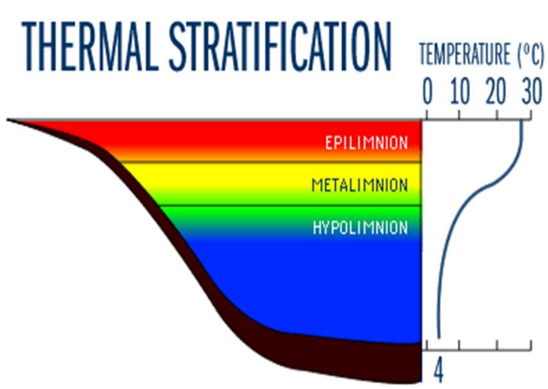


Figure 4. Thermal stratification in a deep lake. Image source: www.waterontheweb.org.

As the lake becomes more biologically productive in the summer, oxygen can decline in the hypolimnion as decomposition occurs in deep areas of the lake. Though some oxygen loss in deep lakes is considered normal, excessive loss of oxygen may indicate a stressed and changing ecosystem. Understanding the pattern and extent of oxygen loss in deep areas of the pond is important to understanding changes between years and throughout a single season, and is particular concerning for Lovejoy Pond in particular because the pond may be more vulnerable for internal phosphorus loading due to its unique sediment chemistry.[2]

Shallow lakes, like Lovejoy Pond, may experience weak or periodic occurrences of thermal stratification throughout the open water season as wind events can facilitate water mixing and easily disrupt thermal stratification and redistribute oxygen throughout the water column. Most often shallow lakes are homothermous with somewhat consistent temperature and dissolved oxygen levels from the water surface to the bottom. Lovejoy Pond does weakly stratify in the summer, and low levels of DO (DO <5 mg/L) have been documented in the bottom two meters of the pond in mid-summer. However, anoxic conditions (DO <2 mg/L) are much less common above 6 meters.

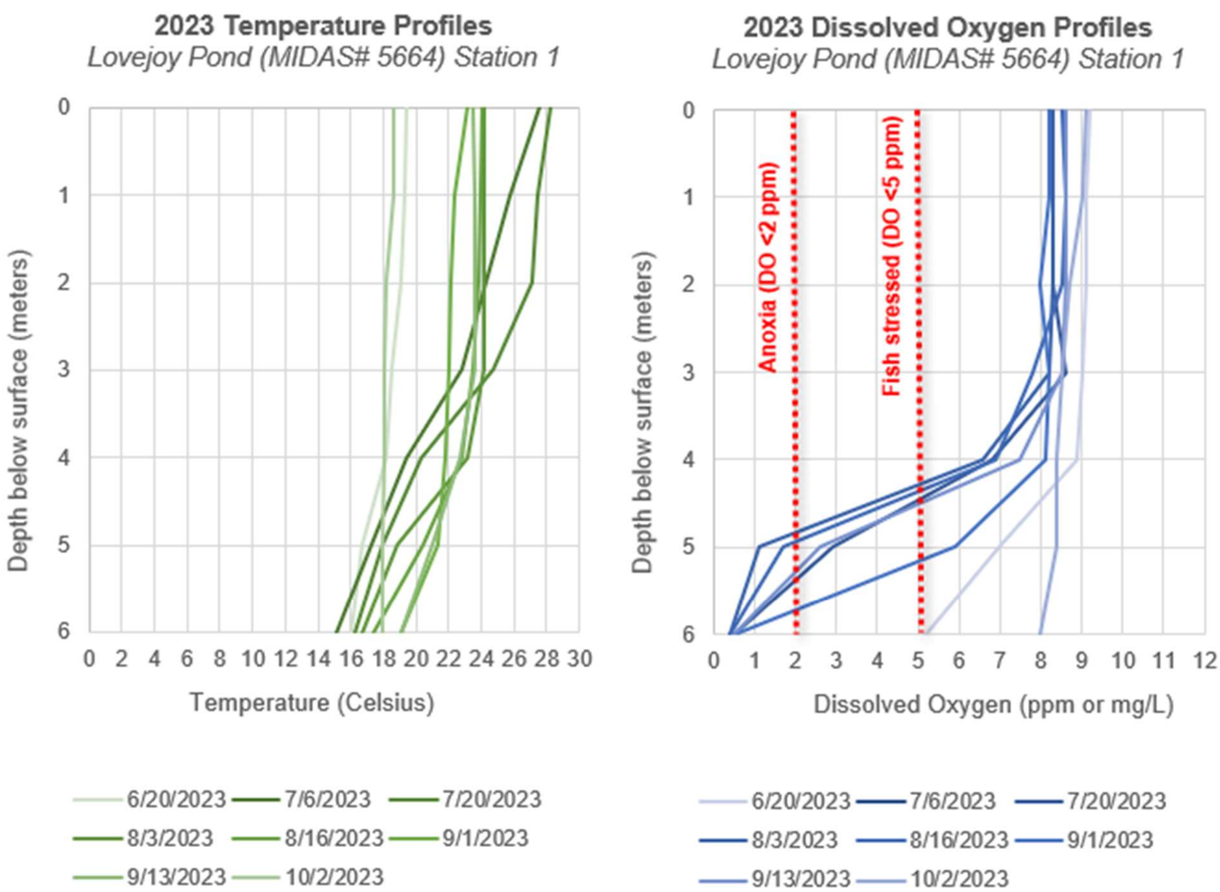


Figure 5. 2023 Dissolved Oxygen and Temperature Profiles, Station 01

[2]Lovejoy Pond appears on Maine DEP's list of "Threatened Lakes" on the NPS Priority Watersheds List (https://www.maine.gov/dep/land/watershed/nps_priority_list/NPS%20Priority%20List%20-%20Lakes20.pdf) due to its sediment chemistry. Sediment results suggest that Lovejoy Pond may be more vulnerable to internal phosphorus loading, a phenomenon that can occur when deep waters become anoxic (DO loss <2 mg/L) resulting is phosphorus release from the bottom sediments exposed to anoxic waters.

Eight (8) DO and temperature profiles were collected in 2023. DO <5 mg/L was documented in profiles collected in early July through mid-September in waters 5 meters and deeper. Anoxia (DO <2 mg/L) was first encountered in waters 6 meters and deeper in early July, grew slightly to include all waters 5 meters and deeper by mid-August, and persisted in waters 6 meters and deeper through mid-September (Figure 5).

Water surface temperatures through the monitoring season ranged from 18.6 C (65.5 F) to 28.2 C (82.8 F) with an average surface water temperature of 23.6 C (74.4 F) between June and October. Continued collection of bi-weekly DO and temperature profiles will identify trends and changes occurring in Lovejoy Pond in order to better understand variations in thermal stratification and the extent and severity of the low DO and anoxic zones throughout the monitoring season.

Total Phosphorus (TP)

Total Phosphorus (ppb)	
2023 TP Average	7
Historical TP Average	8
Maine Lakes TP Average	12

Phosphorus is the nutrient that most influences the growth of algae in lakes. Because its natural occurrence in lakes is very small, phosphorus "limits" the growth of algae in lake ecosystems. Small increases in phosphorus in lake water can cause substantial increases in algal growth, hindering lake health as well as the economic, recreational, and aesthetic value of the lake. Tracking in-lake phosphorus levels over time is another way of monitoring change in lake water quality trends.

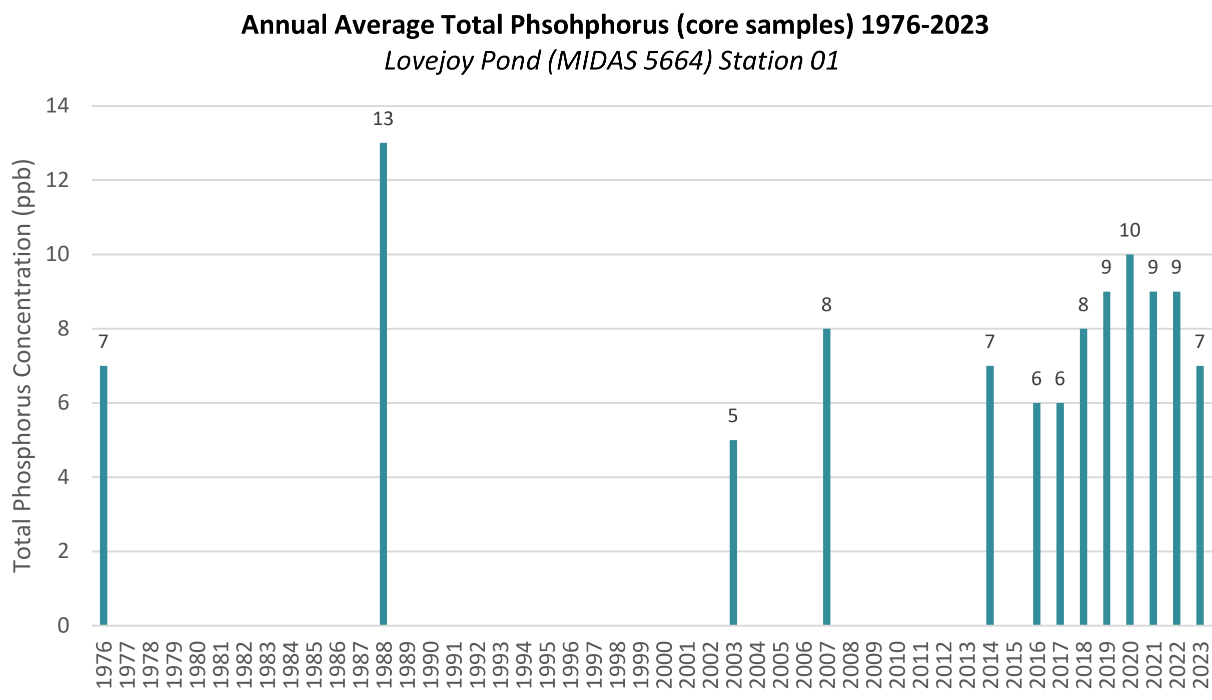


Figure 6. Annual Average Total Phosphorus data (epilimnetic core samples) collected 1976-2023, Station 01.

Four (4) Total Phosphorus (TP) samples were collected monthly between June and October from the pond's surface using an integrated core sampler and are referred to as "epilimnetic core samples". Laboratory results ranged from 6 ppb to 8 ppb with an annual average of 7 ppb.

Generally speaking, in-lake phosphorus concentrations (epilimnetic samples) less than 10 ppb are ideal. Lakes with in-lake phosphorus concentrations of 13 ppb or more are able to sustain algal blooms, and blooms become frequent as in-lake average concentrations approach 20 ppb. Historically, the annual average in-lake phosphorus concentration in Lovejoy Pond ranges from 5 ppb (2003) to 13 ppb (1988) with a historical annual average of 8 ppb (Figure 6).

In 2023, three (3) TP samples were collected from the bottom of Lovejoy Pond using a Kemmerer grab sampler; this type of sample is known as a "bottom grab". Bottom grabs are collected when anoxia is encountered anywhere in the dissolved oxygen profile and help us determine if there is active phosphorus release from bottom sediments exposed to anoxic conditions. Lab results for the three bottom grab samples collected in 2023 were 12 ppb (July 20th), 12 ppb (August 16th), and 11 ppb (September 13th) (Figure 7).

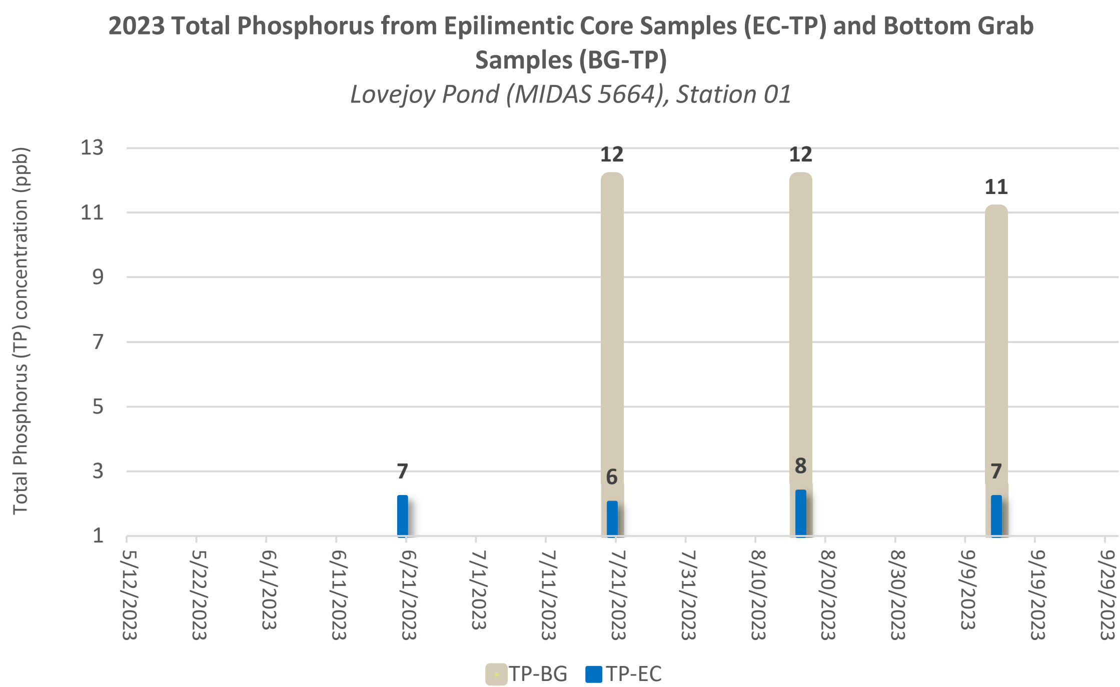


Figure 7. 2023 Total Phosphorus (epilimnetic core and bottom grab samples), Station 01

Chlorophyll (Chl-a)

Chl-a (ppb)	
2023 Chl-a Average	4
2023 Peak Chl-a	6
Historical Chl-a Average	3
Maine Lakes Chl-a Average	5

Chlorophyll is found in plants (including algae) and is used to convert sunlight into energy. Measuring the concentration of Chlorophyll in lake water helps us estimate the algae population in the lake. The higher the Chl-a value, the higher the amount of algae in the lake.

Chlorophyll was measured four (4) times in 2023. Results ranged from <1 ppb to 6 ppb, with a 2023 annual average of 3 ppb. Historically chl-a data has been collected during 11 years starting in 1998 and results have ranged between 1 ppb (2023) and 10 ppb (2022) with a historical annual average of 3.3 ppb.

pH

pH	
2023 pH	7.1
Historical pH Average	7.3
Maine Lakes Average	6.44

pH helps determine which plant and animal species can live in the lake, and it governs biochemical processes that take place. The pH scale ranges from 0-14, with 7 being neutral. Water is increasingly acidic below 7, and increasingly alkaline above 7. A one unit change in pH represents a tenfold change in acidity or alkalinity. The pH scale is the inverse log of the hydrogen ion concentration.

pH was measured one time during the 2023 season on August 16th with a result of 7.1. Historically, pH data has been collected nine (9) years starting in 1984, and results have ranged between 6.3 (1988) and 7.5 (1984 and 2017) with a historical annual average of 7.2.

True Color

Color (PCU)	
2023 Color	15
Historical Color Average	11
Maine Lakes Color Average	21

Water color refers to the concentration of natural dissolved organic acids. This includes natural tannins and lignins dissolved in the water, often resulting in "tea" or "root beer" colored water. “True Color” is measured in Platinum Cobalt Units (PCU) after all particulates (including algae cells) have been filtered out of the sample. Colored lakes (>25 PCU) can naturally have reduced transparency readings and increased phosphorus values. However, this does not mean the lakes produce more algae. The color simply reduces the transparency such that the reading is not a good measure of algal biomass. Chlorophyll-a (Chl-a) is the best indicator of algal productivity in colored lakes and should be used if possible.

One sample taken on August 16th was analyzed for true color and had a result of 15 PCU. Historically, true color data has been collected during seven (7) years starting in 2003, and results have ranged between 8 PCU (2022) and 15 PCU (2023) with a historical annual average of 11 PCU.

Conductivity

Conductivity (µMHOS/cm)	
2023 Conductivity	64
Historical Conductivity Average	57
Maine Lakes Conductivity Average	51

Conductivity measures the ability of water to carry electrical current and is directly related to the dissolved ions (charged particles) present in the water. Fishery biologists can use conductivity values to calculate fish yield estimates because conductivity will generally increase if there is an increase of pollutants entering the lake or pond. Stormwater runoff from developed areas and roadways is the most common pollutant in Maine lakes that can raise conductivity values. Conductivity is measured in micromhos per centimeter (µMHOS/cm).

One sample taken on August 16th was analyzed for conductivity and had a result of 64 µMHOS/cm. Historically, conductivity data has been collected during 10 years starting in 1985, and results have ranged between 37 µMHOS/cm (1985) and 75 µMHOS/cm (2022) with a historical annual average of 57 µMHOS/cm. The two highest conductivity results on the historical monitoring record were documented in 2022 and 2023.

Alkalinity

Alkalinity (mg/L)	
2023 Alkalinity	13
Historical Alkalinity Average	14
Maine Lakes Alkalinity Average	11.7

Alkalinity is also referred to as “buffering capacity.” It is a measure primarily of naturally available bicarbonate, carbonate, and hydroxide ions in the water and is measured in milligrams per liter (mg/L). Measuring alkalinity is important to determining a lake’s ability to neutralize acidic pollution from rainfall or snowmelt. Lakes with alkalinity values >20 mg/L are considered well buffered against pH changes over time. Lakes with low or zero alkalinity may have more variation in pH levels that can sometimes result in damage to aquatic life.

One sample taken on August 16th was analyzed for alkalinity and had a result of 13 mg/L. Historically, alkalinity data has been collected during 9 years of the 47-year monitoring period, with a historical average of 14 mg/L.

Discussion

Data presented in this report includes all monitoring data collected through 2022, submitted by volunteer monitors, 30 Mile staff, and other state agencies, which has undergone a thorough QA/QC process at Maine DEP. 2023 data included in this report is data collected by 30 Mile only.

2023 was 30 Mile's eighth year of monitoring Lovejoy Pond. Lovejoy Pond's water quality throughout the 2023 season remained consistent to prior years. The lowest Secchi reading came on our first trip of the season in June, which isn't surprising, given the unprecedented amount of precipitation the area received this spring. Secchi disk readings improved throughout the season and into the fall, to the point where the Secchi disk hit the pond bottom while still visible on September 13th (see Figure 2).

This season marked the first time since August of 1998 that the anoxic zone (DO <2 mg/L) at the bottom of the pond reached a depth of 5 meters. Anoxia has been observed in waters 6 meters and deeper, but has not grown to include waters 5 meters and deeper since 1998. DO data is limited prior to 2016 when 30 Mile began monitoring the pond annually with DO data collected during just 15 years starting in 1985 (1985, 1988, 1995, 1998, 2003, 2007, 2014, and 2016-2023). Anoxia has been observed in the bottom meter of the lake (6 meters and deeper) during just seven (7) years (1998, 2003, 2014, 2019, 2021, 2022, and 2023).

In 2023, anoxia was observed in 6 of the 8 profiles collected. As a result, three (3) TP bottom grabs were taken, averaging 12 ppb. Results changed very little between bottom grabs, indicating a very small internal phosphorus load from sediments during 2023 which could explain the increase in chlorophyll concentration in mid-September, and the reduced clarity reading collected in early October.

Five years of consecutive data collection for any given parameter will provide the baseline condition for water quality. 10 years of consecutive data collection is needed to meet the minimum data thresholds for determining trends over time. 30 Mile's monitoring program will continue to develop a robust dataset that can help our community identify and address water quality concerns in Lovejoy Pond.

Near real-time data for Lovejoy Pond's clarity (Secchi depth), and dissolved oxygen and temperature profiles can be found online at https://30mileriver.org/lovejoy-pond/, along with a link to the historical dataset and depth map.

Next Steps

1. Continue bi-weekly baseline monitoring between May and October each year to monitor seasonal and annual variability across all parameters, and better document changes and trends over time.

2. Develop a LakeSmart Team on Lovejoy Pond, providing education to shorefront property owners about polluted stormwater runoff, phosphorus, and the effects that watershed development can have on lake water quality.

3. Work with 30 Mile to further review the list of priority sites identified during the 2020 watershed survey and determine next steps to address remaining sites through LakeSmart and 30 Mile's Technical Assistance programs.