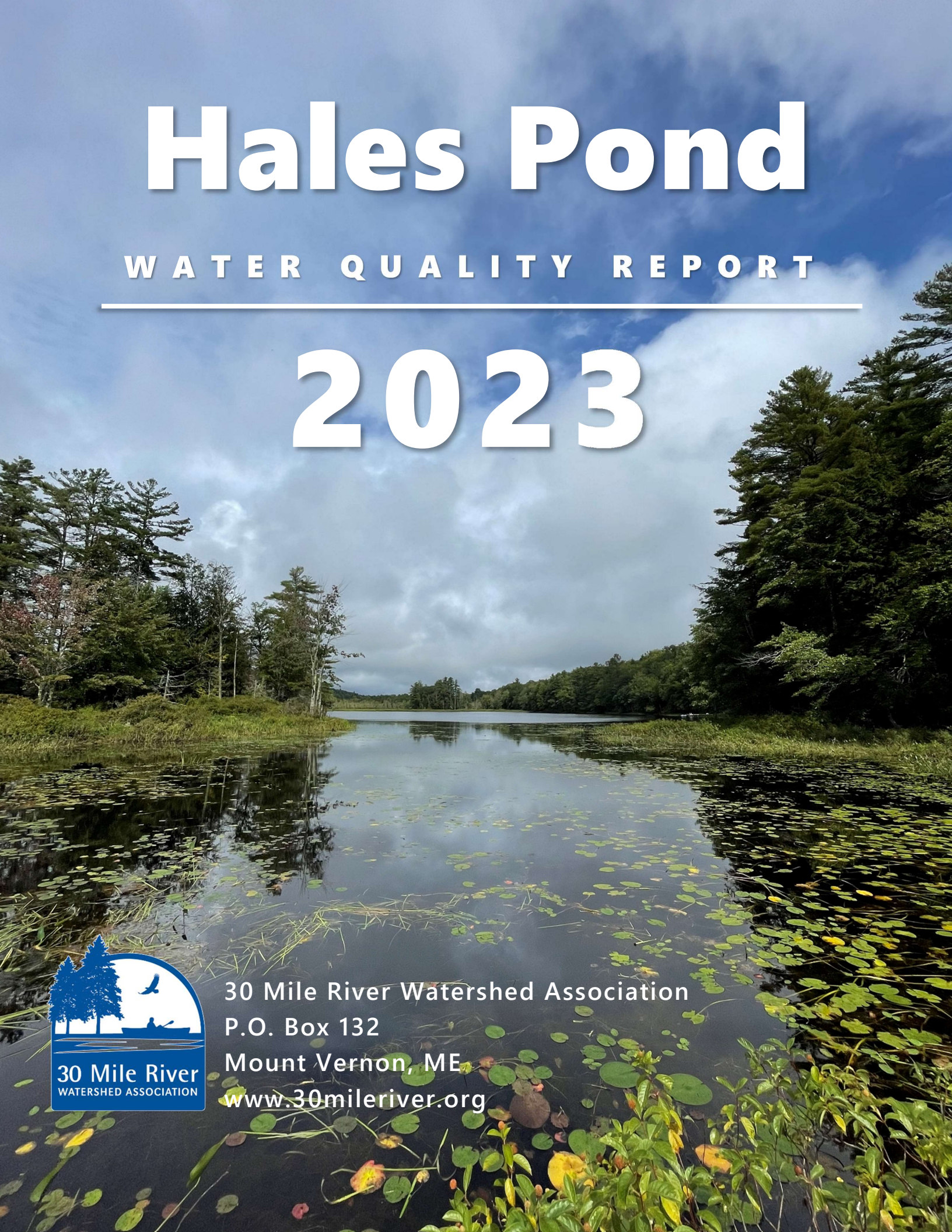
Hales Pond

WATER QUALITY REPORT

2023



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2023 Hales Pond Water Quality Report

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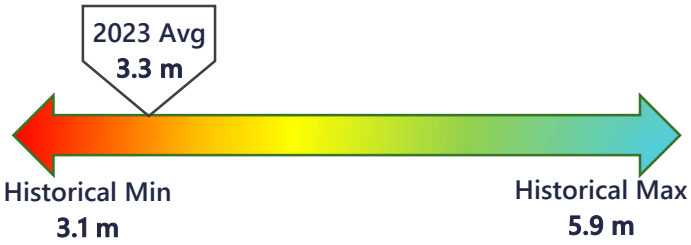
Monitoring on Hales Pond occurred monthly July through September in 2023 by Whitney Baker and Silas Mohlar of 30 Mile River Watershed Association (30 Mile).

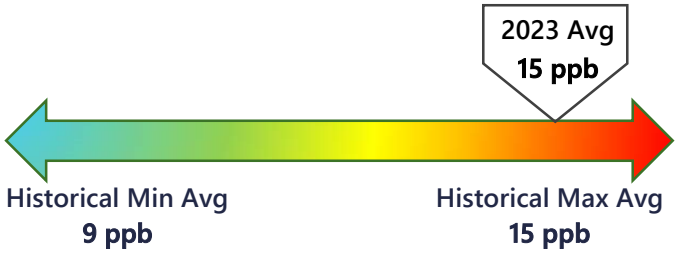
Water clarity readings in 2023 ranged from 3.1 meters (July 19th) to 3.4 meters (September 13th) with an annual average of 3.3 meters. Three (3) total readings were collected over three monitoring days in 2023.

Water Clarity (m)	
2023 Water Clarity Average	3.3
Historical SDT Average	4.4
Maine Lakes SDT Average	4.8



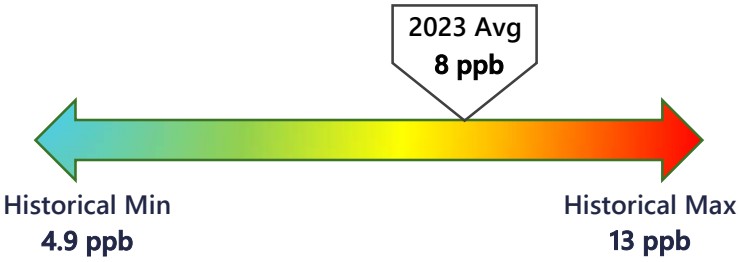
Three (3) samples were collected and analyzed for **Total Phosphorus**. Laboratory results were 15 ppb (parts per billion)(July 19th), 17 ppb (August 14th), and 12 ppb (September 13th) with an annual average of 15 ppb.

Total Phosphorus (ppb)	
2023 TP Average	15
Historical TP Average	12
Maine Lakes TP Average	12



Chlorophyll was measured three (3) times in 2023. Results ranged from 5 ppb (July 19th) to 13 ppb (September 13th) with an annual average of 8.3 ppb.

Chlorophyll-a (ppb)	
2023 Chl-a Average	8
2023 Peak Chl-a	13
Historical Chl-a Average	7
Maine Lakes Chl-a Average	5



Three (3) **Dissolved Oxygen (DO)** profiles were collected in 2023. A zone of anoxia (no oxygen, DO <2 mg/L) was observed in all waters just 2 meters and persisted through September in all waters 3 meters and deeper.

[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

Hales Pond is a small 76-acre pond located in the town of Fayette in Kennebec County, ME. Hales Pond has a maximum depth of 15 m (48 ft) and an average depth of just 4 m (13 ft). The watershed area draining to the pond is roughly 3.5 square miles and includes the smaller drainages of several intermittent and perennial streams that drain directly to the pond. Water from Hales Pond flows to a single outlet located at the south end of the pond, Hales Brook, that flows south into Pocasset Lake, which then flows into Androscoggin Lake.

2023 was 30 Mile's first year collecting data on Hales Pond. Prior to 2023, water quality data was collected during only four (4) years between 2001 and 2004 by Maine DEP and volunteers monitors certified through Lake Stewards of Maine.

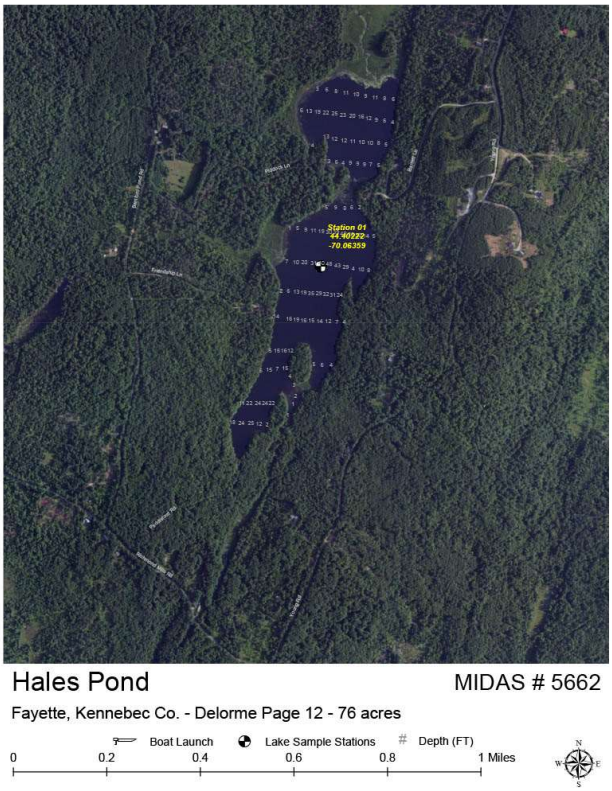


Figure 1. Station 01, Hales Pond, Fayette, Maine.

Water Quality Monitoring in 2023

In 2023, 30 Mile River staff Whitney Baker and Silas Mohlar visited Hales Pond monthly, July through September (three (3) times total). Parameters collected include Secchi disk transparency, dissolved oxygen and temperature, phosphorus, chlorophyll, and advanced chemistry parameters (pH, Alkalinity, Color, and Conductivity). Monitoring on Hales Pond takes place at the deepest spot in the pond - aka Station 01 (Figure 1).

30 Mile Program Manager, Whitney Baker, collects a bottom grab sample using a Kemmerer during a monitoring trip On Hales Pond.

Secchi Disk Transparency (Water Clarity)

Water Clarity (m)	
2023 Water Clarity Average	3.3
Historical SDT Average	4.4
Maine Lakes SDT Average	4.8

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 readings in 2023 ranged from 3.1 meters (7/19/2023) to 3.4 meters (9/13/2023) with an annual average of 3.3 meters. Three (3) total readings were collected over three monitoring days in 2023 (Figure 2). Historically, SDT readings have ranged from 3.1 m (2023) to 5.9 m (2003) with an average annual reading of 4.4 m. (Figure 3).

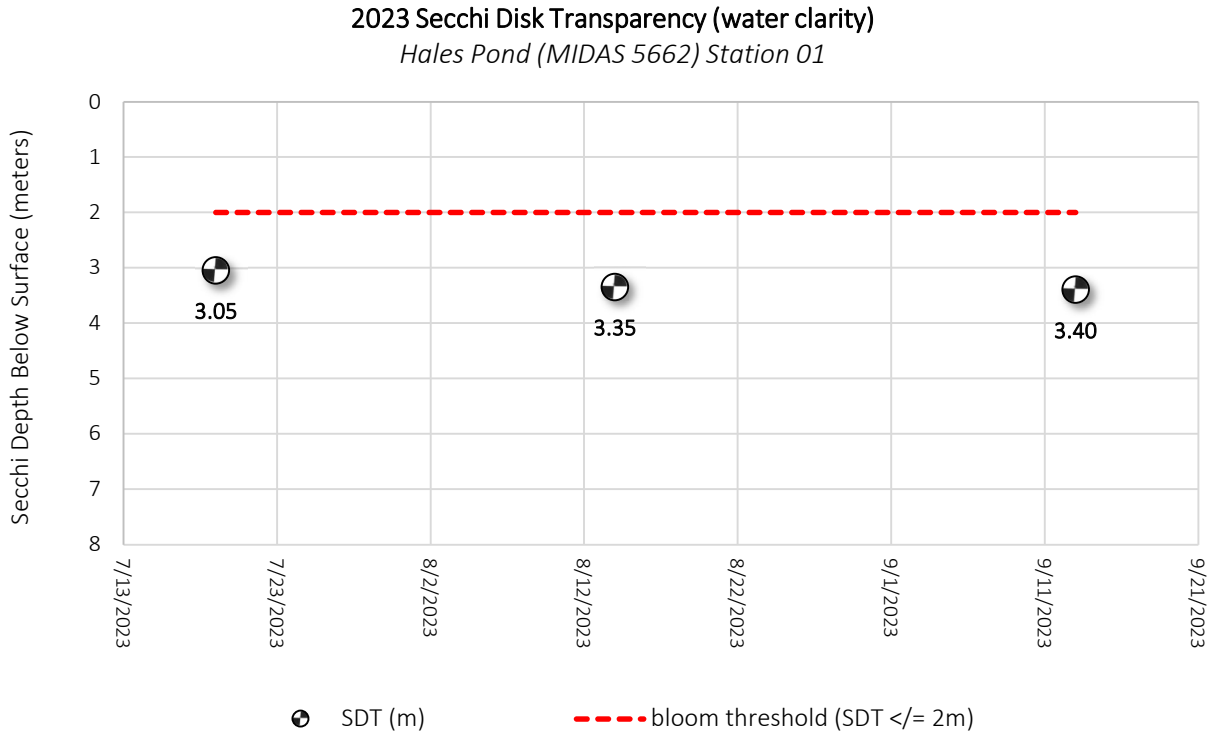


Figure 2. 2023 Secchi Disk Transparency, Hales Pond, Station 01

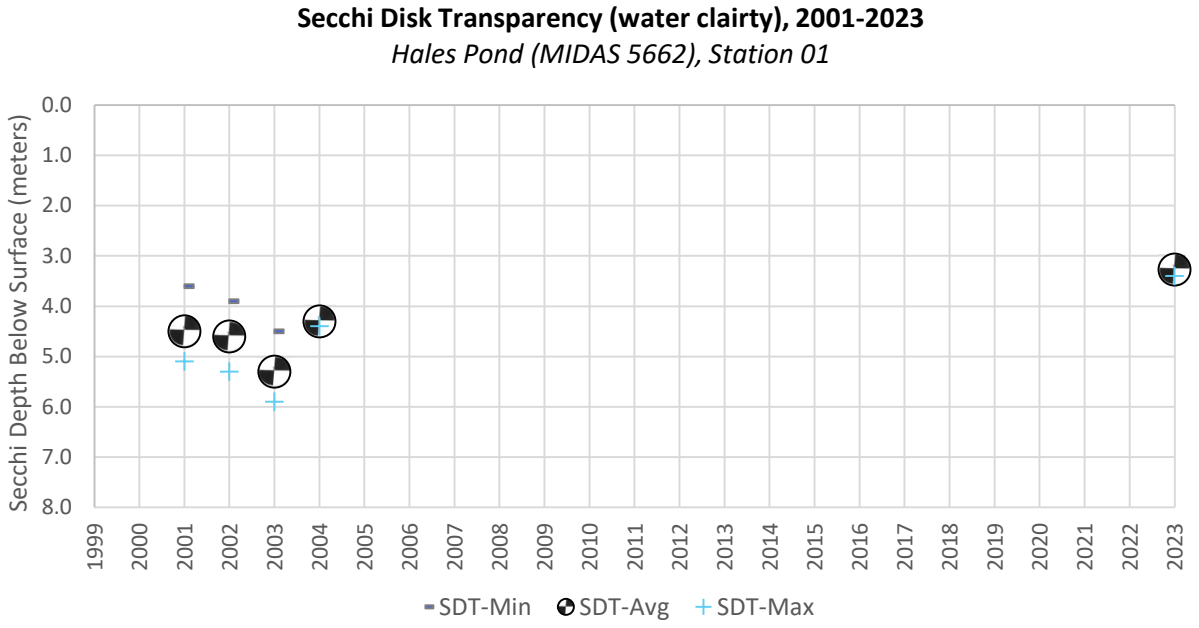


Figure 3. Hales Pond Historical Secchi Disk Transparency, Station 01, 2001-2023.

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. 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 warm summer months.

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 Basin Pond is important to understanding changes between years and throughout a single season, and is particular concerning for lakes that may be more vulnerable for internal phosphorus loading due to

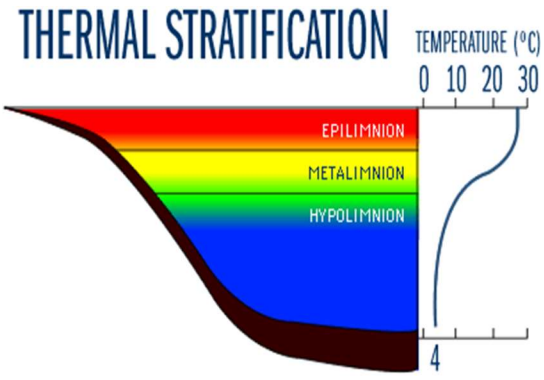


Figure 4. Thermal stratification in a deep lake. Image source: www.waterontheweb.org.

unique sediment chemistries.[2] In Hales Pond, severe oxygen loss in all three layers is has been documented throughout the summer and early to late fall.

Three (3) DO and temperature profiles were collected in 2023. DO <5 mg/L was documented in every profile collected and observed in all waters 2 meters and deeper. DO <2 mg/L (anoxia) was first documented at a depth of just 2 meters in July, with the zone of anoxic water persisting in waters 3 meters and deeper through August and September (Figure 4). DO and temperature data collection is quite limited with 2023 being only the second year with DO and temperature data collection. The only other DO and temperature profile was collected in August 2004 and documented anoxic conditions in all waters 4 meters and deeper.

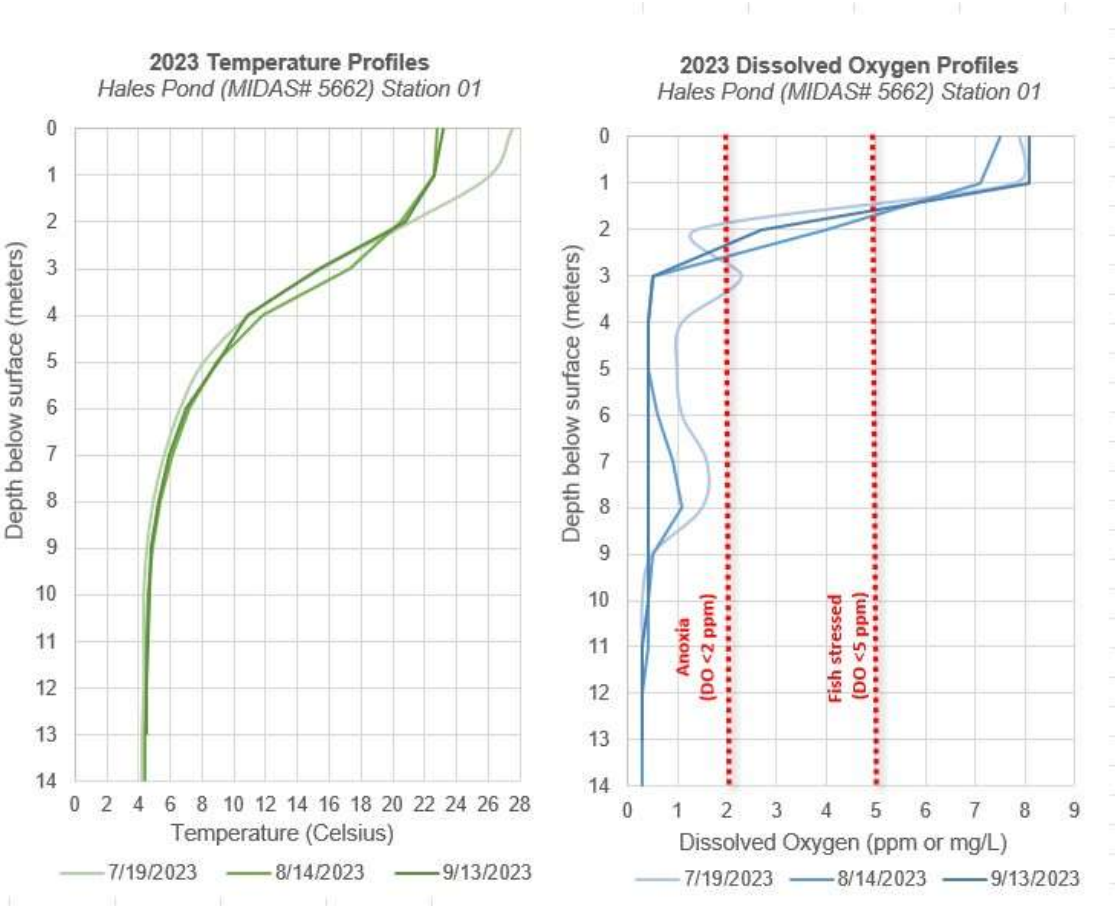


Figure 5. 2023 Hales Pond Dissolved Oxygen and Temperature Profiles, Station 01.

Oxygen depletion is not uncommon in Hales Pond, making it very unsuitable for cold-water fish species that rely on deep, cold-water refuge in the summer months with an adequate oxygen supply. Hales Pond does support a warm water fishery, as it has excellent habitat for bass, pickerel, and other warm water fish. Smallmouth bass were introduced by the department of Inland

[2]Some lakes in Maine may be more vulnerable than others to internal phosphorus loading, a phenomenon that can occur when deep waters become anoxic (DO loss <2 ppm) resulting in phosphorus release from the bottom sediments exposed to anoxic waters.

Fisheries and Wildlife in 1972 and now provide an excellent fishery[3]. These warmwater fish are able to withstand lower oxygen levels and warmer waters nearer to the surface of Hales Pond. Other species may capitalize on cold water springs and cooler water near tributary outlets in the summer.

Water surface temperatures through the monitoring season ranged from 22.8 C (73.0 F) to 27.5 C (81.5 F) with an average surface water temperature of 24.5 C (76.1 F) July and September. Continued collection of bi-weekly DO and temperature profiles will identify trends and changes occurring in Hales 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	15
Historical TP Average	12
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.

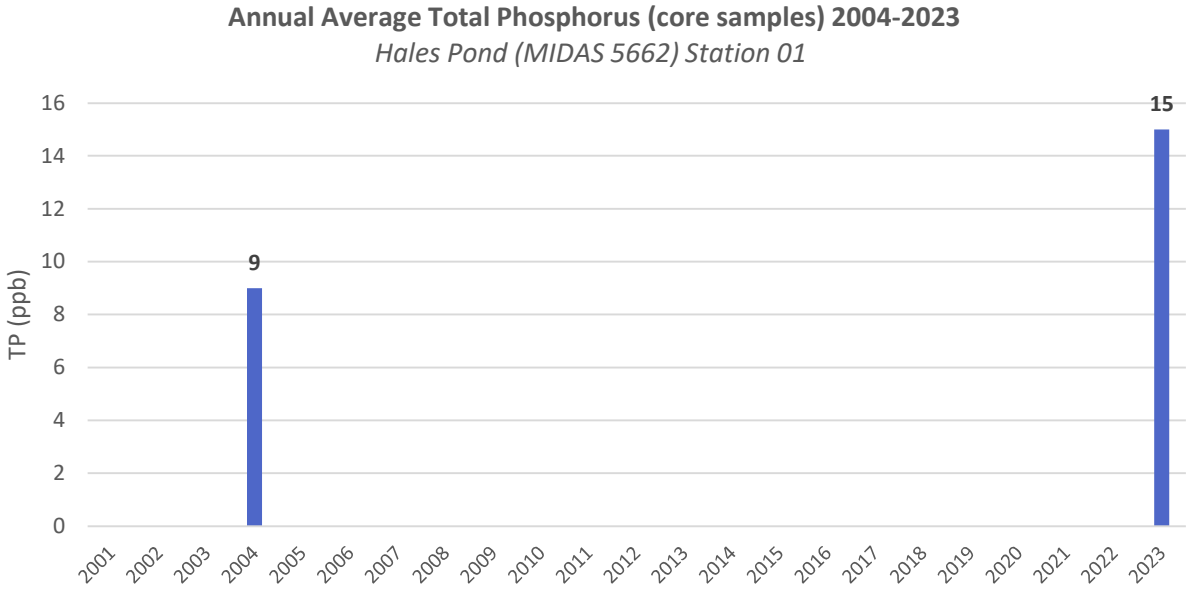


Figure 6. Annual Average Total Phosphorus data (epilimnetic core samples), 2004-2023, Station 01.

[3] Maine Department of Inland Fisheries & Wildlife. Lake Survey Maps – Hales Pond. Accessed online: https://www.maine.gov/ifw/docs/lake-survey-maps/kennebec/hales_pond.pdf.

Six (6) samples were collected by 30 Mile staff this year and analyzed for Total Phosphorus (TP). Samples were collected monthly between July and September. Three (3) of the phosphorus samples were collected from the top layer of Hales Pond using an integrated core sampler and are referred to as "epilimnetic core samples". Laboratory results for epilimnetic core samples collected in 2023 ranged from 12 ppb (9/13/23) to 17 ppb (8/14/23) with annual average of 15 ppb.

Generally speaking, in-lake phosphorus concentrations (epilimnetic core 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, phosphorus samples have only been collected during two years (2004 & 2023) with annual averages of 9 ppb (2004) and 15 ppb (2023) (Figure 5).

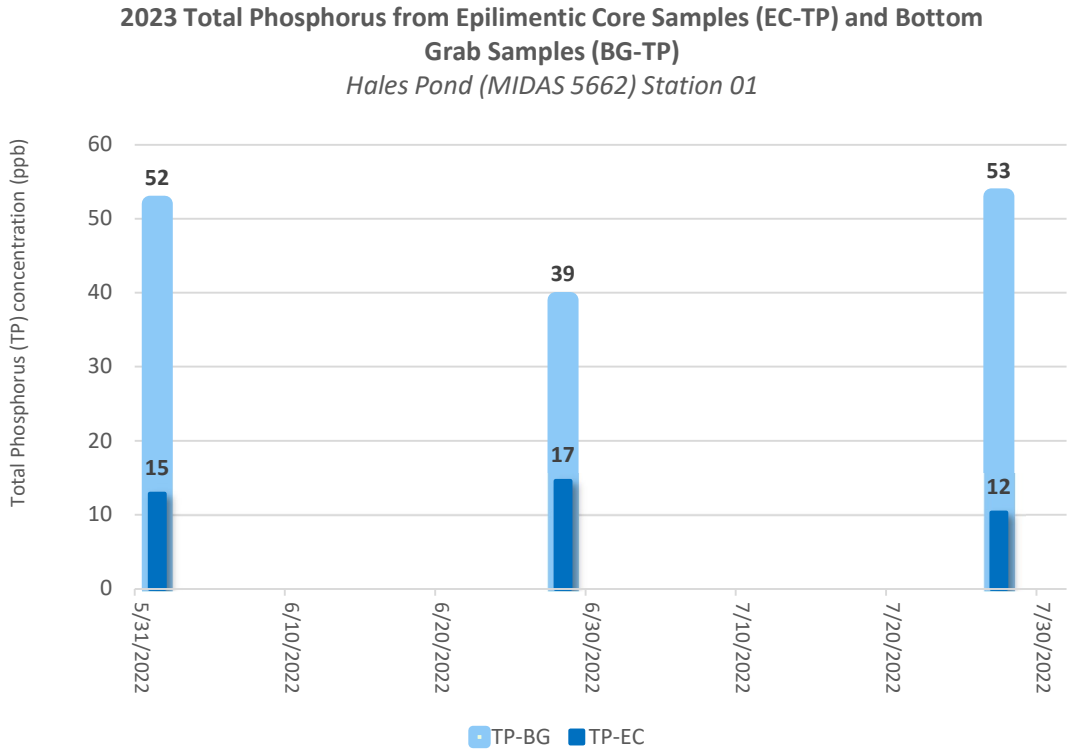


Figure 7. 2023 Total Phosphorus core sample and TP bottom grab sample results from Hales Pond.

In 2023, three (3) samples were collected from the bottom of Hales 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. Laboratory results for bottom grab samples collected in 2023 were 52 ppb (7/19/23), 39 ppb (8/14/23), and 53 ppb (9/13/23) with an annual average of 48 ppb. Historically, bottom grab samples have only been collected in 2004 and 2023. Annual averages were 17 ppb (2004) and 48 ppb (2023) respectively.

Chlorophyll (Chl-a)

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-a (ppb)	
2023 Chl-a Average	8.3
2023 Peak Chl-a	13
Historical Chl-a Average	7
Maine Lakes Chl-a Average	5.4

Chlorophyll was measured three (3) times in 2023. Results ranged from 5 ppb (7/19/23) to 13 ppb (9/13/23), with a 2023 annual average of 8.3 ppb. Chl-a on Hales Pond has only been analyzed during one other year (2004), results ranging between 4.9 ppb and 6.2 ppb with and an annual average of 5.6 ppb.

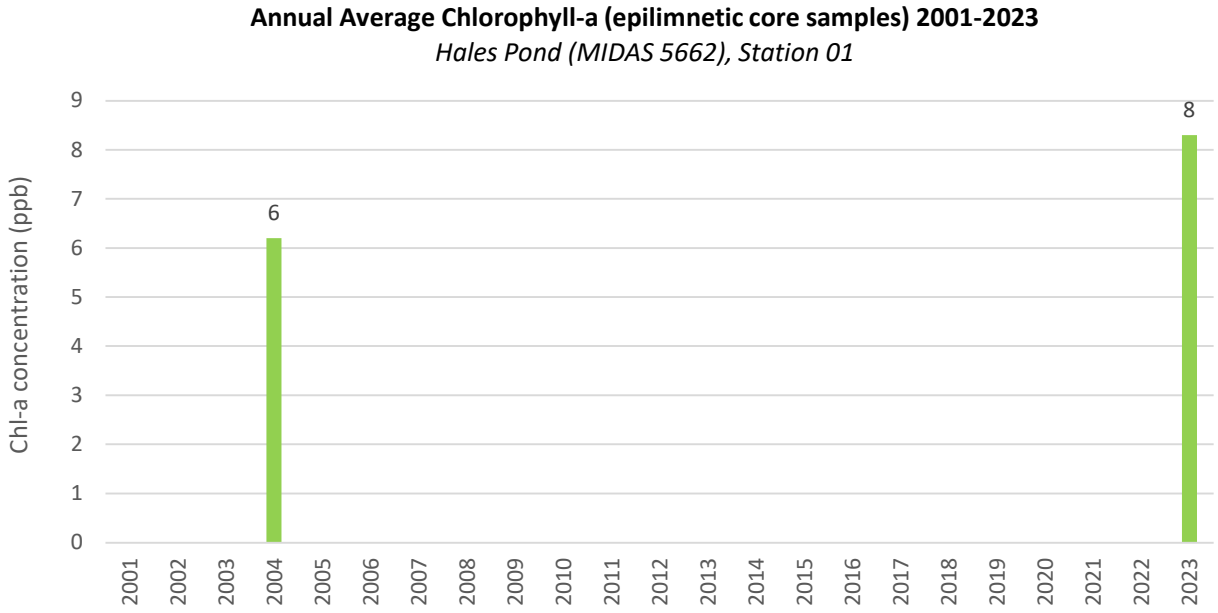


Figure 8. Annual Average Chl-a, 2001-2023, Hales Pond, Station 01.

pH

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	
2023 pH	7.1
Historical pH Average	7.1
Maine Lakes Average	6.4

pH was measured 1 (one) time during the 2023 season on August 14th with a result of 7.1. Historically, pH has only been analyzed one other year (2004), with a result of 7.1.

True Color

Color (PCU)	
2023 Color	85
Historical Color Average	65
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 in very colored lakes. “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 these 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 whenever possible.

One sample taken on August 14th was analyzed for true color and had a result of 85 PCU. Historically, true color has only analyzed one other year (2004), with a result with a result of 44 PCU. Hales Pond is considered a colored lake.

Conductivity

Conductivity (µMHOS/cm)	
2023 Conductivity	68
Historical Conductivity Average	72
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 14th was analyzed for conductivity and had a result of 68 µMHOS/cm Historically, conductivity has only analyzed one other year (2004), with a result of 77 µMHOS/cm.

Alkalinity

Alkalinity (mg/L)	
2023 Alkalinity	11
Historical Alkalinity Average	
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 14th was analyzed for alkalinity and had a result of 11 mg/L. Historically, alkalinity has been only analyzed one other year (2004), with a result of 12 mg/L.

Discussion

Thanks to a grant from the John Sage Foundation, 30 Mile was able to make 2023 the organization's first year monitoring Hales Pond. Historical data presented in this report includes all monitoring data collected on Hales Pond through 2022, submitted by both volunteer monitors and state agencies, that has undergone a thorough QA/QC process at Maine DEP. Data collected in 2023 was collected by 30 Mile only.

Hales Pond is a unique body of water. In appearance, Hales Pond has very dark, tea-colored water, and with a color result of 85 PCU, and is considered a 'colored' body of water. Water color, and the source of the dissolved organic acids that give the water it's dark color are likely the cause of the severe oxygen deficiency we documented this season. Colored lakes contain higher levels of organic carbon. Lakes process excess carbon through the decomposition process that occurs at the lake bottom. Decomposition requires oxygen, and colored lakes are known to have higher rates of decomposition that results in lower levels of oxygen. Additionally, colored lakes often support lower rates of photosynthesis by microscopic algae (which creates oxygen) since sunlight cannot penetrate as deep into the dark water.

Dark colored waters can also heat up more quickly following ice out in the spring and maintain very strong thermal stratification for a longer period of time in late spring, summer, and fall. This means a longer period of stratification where the hypolimnion of the lake is isolated from any oxygen resupply. The effects of a changing climate can undoubtedly exacerbate these conditions as more frequent and intense storms increase the runoff of nutrients and organic matter (carbon) from the surrounding terrestrial landscape.

Five years of consecutive data collection for any given parameter will provide the baseline condition of the pond. 10 years of consecutive data collection is needed to meet the minimum

data thresholds for determining trends. This effort will continue to develop a robust dataset that can help our community identify and address water quality concerns in Hales Pond.

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

Next Steps

1. Continue monthly baseline monitoring three times each summer to monitor seasonal and annual variability across all parameters, and better document changes and trends over time.

2. Deliver LakeSmart programming to the landowners on Hales Pond, to provide education about polluted stormwater runoff and the effects of watershed development on lake water quality. For more information about this awesome program visit: https://www.lakes.me/lakesmart. To request a free LakeSmart evaluation from 30 Mile staff visit: https://30mileriver.org/lakesmart/