Flying Pond

WATER QUALITY REPORT

2023

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

2023 Flying Pond Water Quality Report

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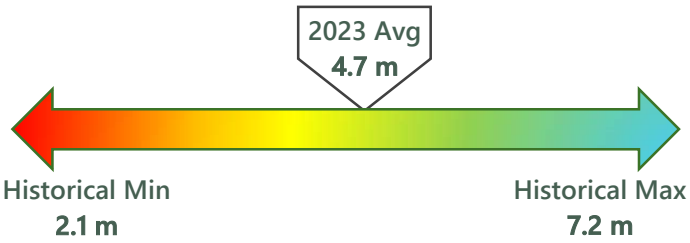
2023 Water Quality Summary[1]

Monitoring on Flying Pond occurred on 12 dates between May and November 2023 by Whitney Baker and Silas Mohlar of 30 Mile River Watershed Association (30 Mile) and volunteers from the Flying Pond Improvement Association (FPIA).

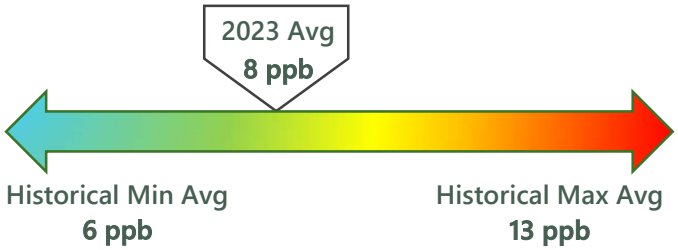
Water clarity readings in 2023 ranged from 4.1 meters to 5.35 meters with an annual average of 4.7 meters. A total of 14 readings were collected in 2023.

Water Clarity (m)	
2023 Water Clarity Average	4.7
Historical SDT Average	4.7
Maine Lakes SDT Average	4.7



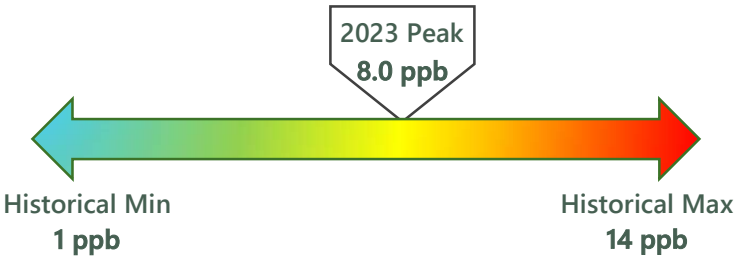
Seven (7) samples were collected and analyzed for **Total Phosphorus**. Laboratory results ranged from 6 ppb (parts per billion) to 11 ppb with an average of 8 ppb.

Total Phosphorus (ppb)	
2023 TP Average	8
Historical TP Average	9
Maine Lakes TP Average	12



Chlorophyll was measured seven (7) times in 2023. Results ranged from 2 ppb (8/23) to 8 ppb (10/17) with an annual average of 5 ppb.

Chlorophyll-a (ppb)	
2023 Chl-a Average	5
2023 Peak Chl-a	8
Historical Chl-a Average	3.2
Maine Lakes Chl-a Average	5.4



Twelve (12) **Dissolved Oxygen (DO)** profiles were collected in 2023. Anoxia (DO <2 ppm) was first encountered in deep waters at a depth of 23 meters in July, but this zone of anoxia grew to include waters as shallow as 9 meters and deeper by November. A strong metalimnetic oxygen minimum was observed in 2023, with anoxia encountered in the shallower water range of 6-9 meters from September through the end of the monitoring season in November.

[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

Flying Pond is located in the town of Vienna in Kennebec County, Maine and has a total watershed area of 14 square miles, which includes the upstream drainages of Boody Pond, Kimball Pond, Mill Pond, and Black Pond. Flying Pond has a single outlet, located east of Russ Point, which flows south to Minnehonk Lake in Mount Vernon.

Flying Pond is a relatively deep lake with a maximum depth of 24m (80 ft) and an average depth of 8m (25 ft). The lake has a surface area covering approximately 403 acres and can be accessed via a public launch located on the eastern shoreline on Route 41, just north of Demariano Road.

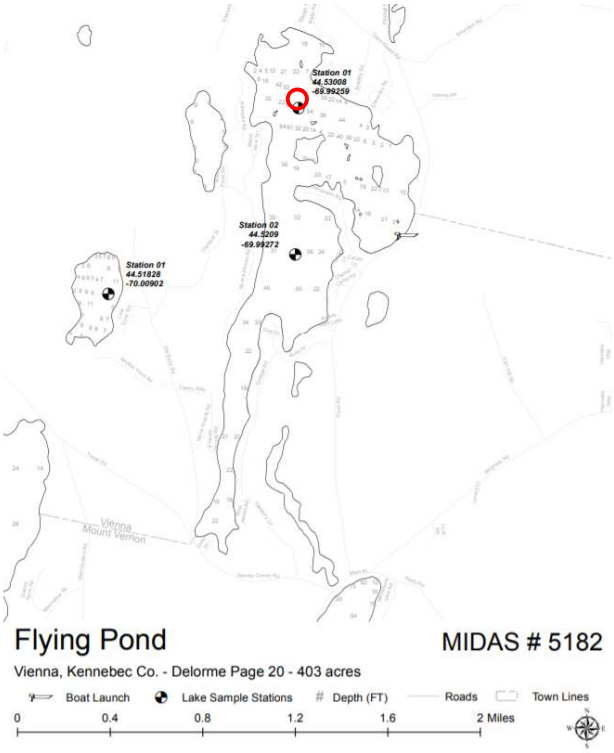


Figure 1. Flying Pond Monitoring Stations. Station 01 circled in red.

Water Quality Monitoring in 2023

2023 water quality volunteer, Steve Trehu

Water quality monitoring on Flying Pond takes place at the deepest spot in the lake (Maine DEP Station 1), also known as the "deep spot", located on the north side of Big Island. Station 1 is just over 24 meters (80 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 Flying Pond Improvement Association (FPIA). A special Thanks to the 2023 volunteers:

Nancy Hemphill
Bill Murphy
Randy & Wendy Oakley
Len & Deb Roe
Steve Trehu

Water quality data was collected on twelve dates between May and November. 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	4.7
Historical SDT Average	4.7
Maine Lakes SDT Average	4.7

Water clarity readings in 2023 ranged from 4.1 meters (11/2) to 5.35 meters (8/23) with an annual average of 4.7 meters. 14 total readings were collected over twelve monitoring days in 2023 (Figure 2).

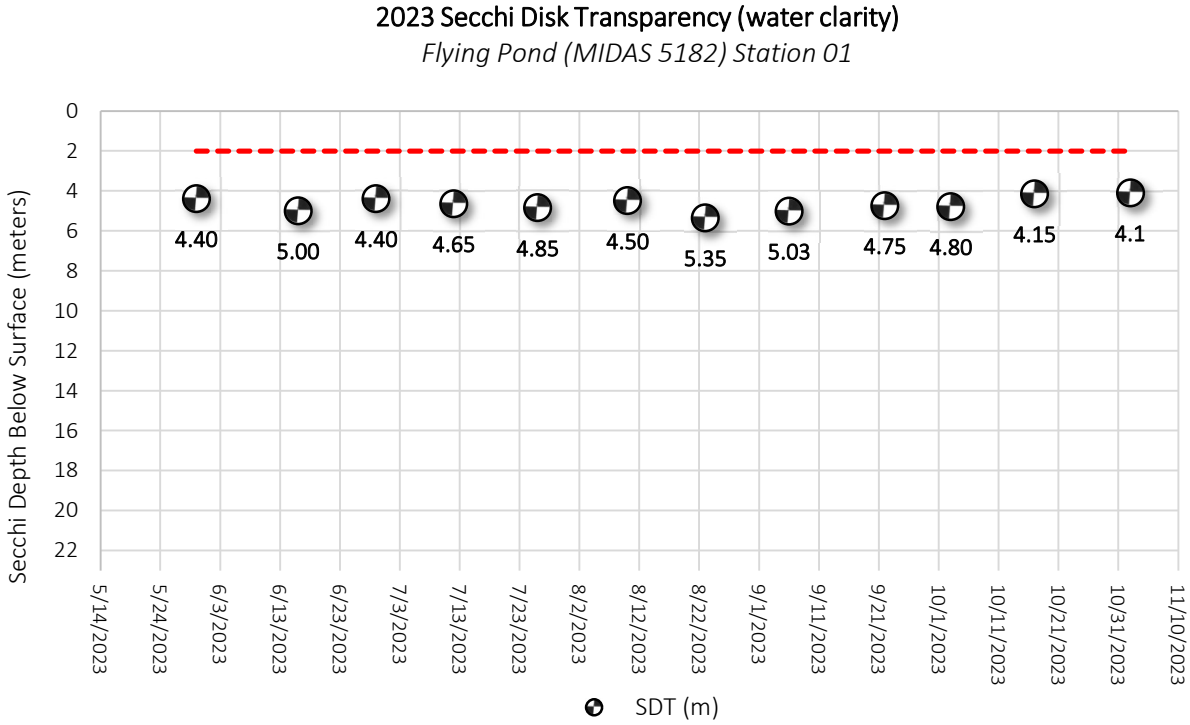


Figure 2. 2023 Secchi Disk Transparency, Station 01

Historically, SDT readings have ranged from 2.1 m (1989) to 7.2 m (2017) with an average annual reading of 4.7 m. (Figure 3).

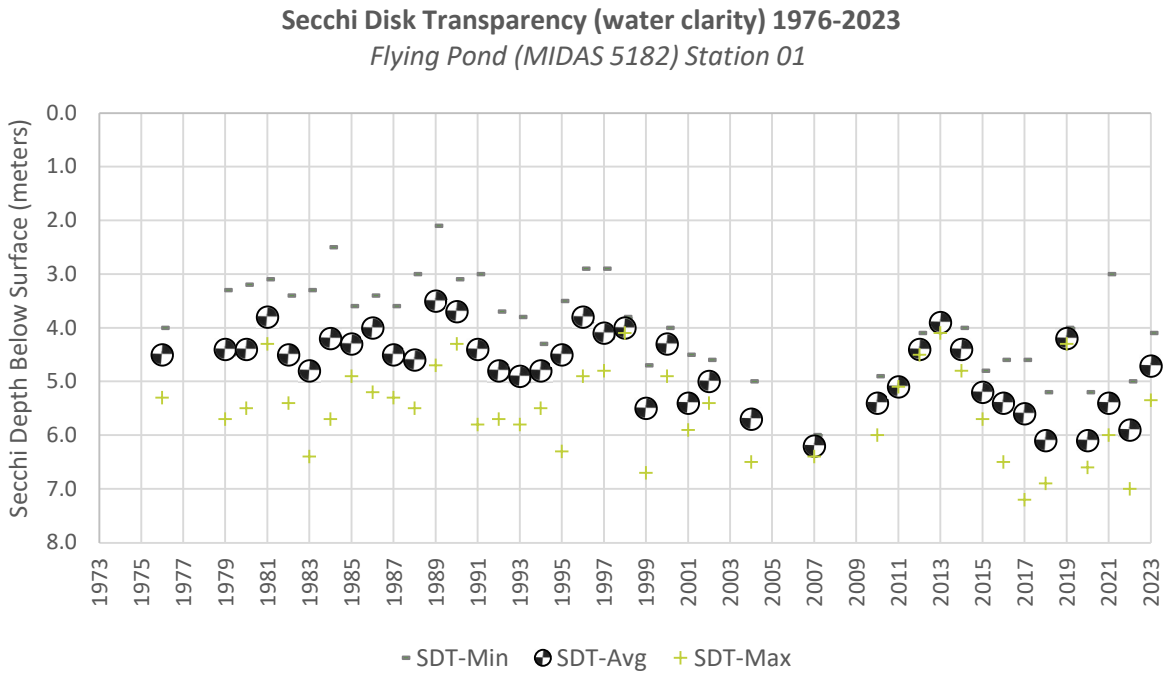


Figure 3. Historical Secchi Disk Transparency, Station 01, 1976-2023

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* can occur when DO drops 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 or thermocline), 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 summer and early fall.

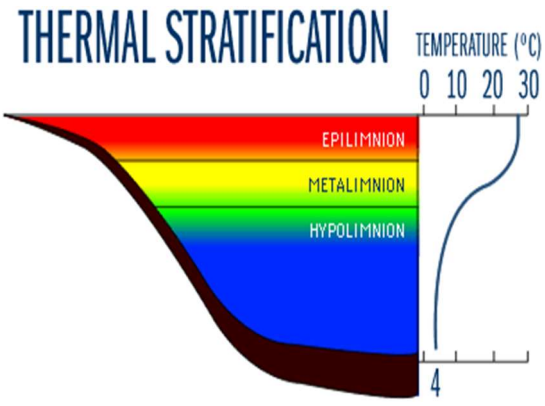


Figure 4. Thermal Stratification in a deep lake. Image source: www.waterontheweb.org.

As lakes become more biologically productive in the summer, oxygen can decline as decomposition occurs in deep areas of the lake. While oxygen loss at the bottom of a deep lake is common in the summer months, excessive loss of oxygen may indicate a stressed and changing ecosystem. Monitoring the pattern and extent of oxygen loss in deep areas of Flying Pond is important to understanding changes

between the years and throughout a single season and is particularly important for lakes that may be more vulnerable for internal phosphorus loading due to unique lake sediment chemistry.[2]

Twelve (12) DO and temperature profiles were collected in 2023 (Figure 5). Along with anoxic conditions (DO < 2 mg/L) observed in the deep waters of the hypolimnion, an isolated zone of anoxic water, called a metalimnetic oxygen minima (MOM), was documented in the waters between 6 meters and 9 meters deep. A MOM is an isolated area of anoxic water within the lake's metalimnion or thermocline. This can be a result of algae die-off in the upper waters of the lake with decomposition consuming oxygen, or an increase in zooplankton productivity with respiration consuming oxygen, or both of these two things occurring simultaneously.

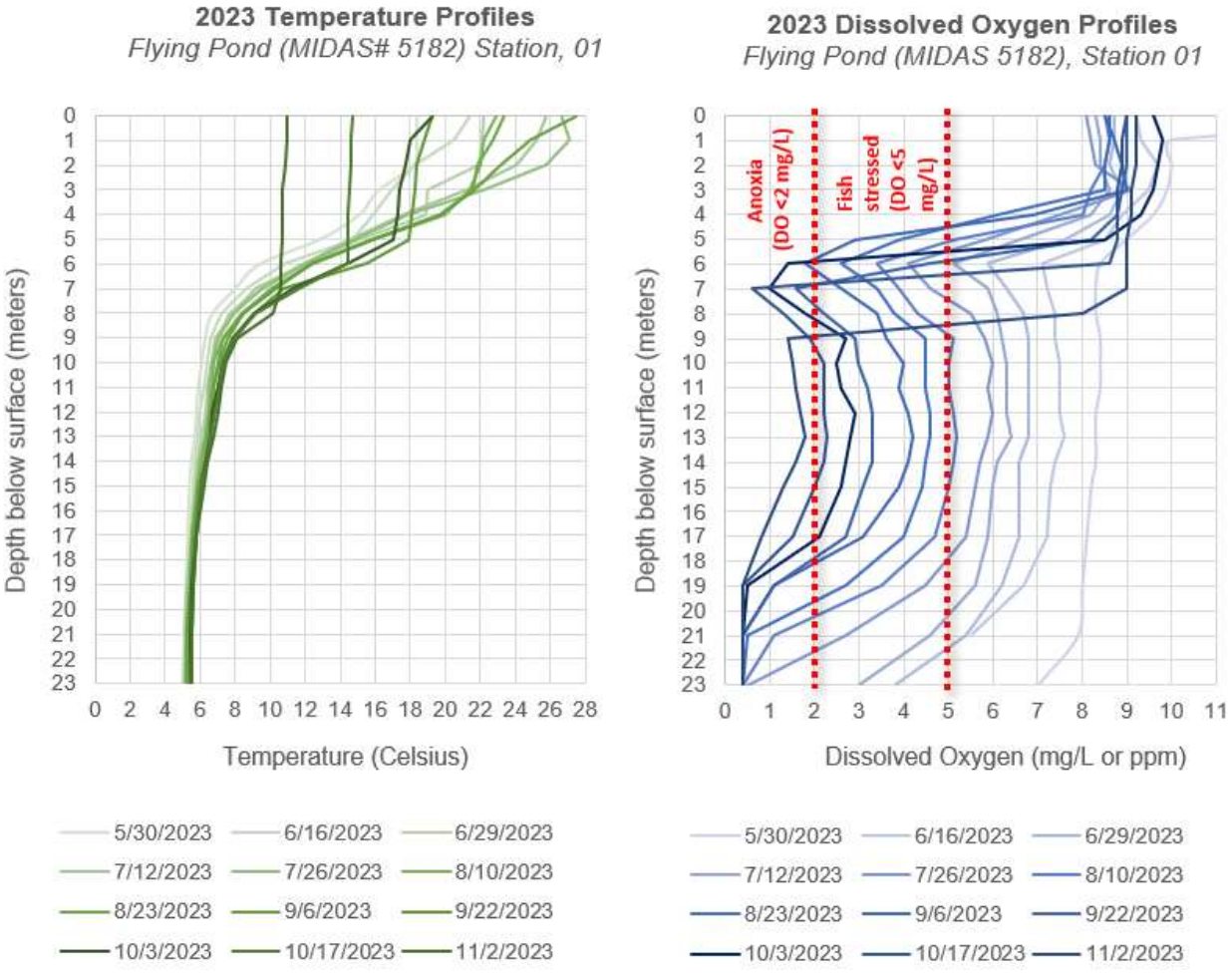


Figure 5. 2023 Dissolved Oxygen and Temperature Profiles, Station 01

[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 mg/L) resulting in phosphorus release from the bottom sediments exposed to anoxic waters.

DO <5 mg/L was first documented on July 26th in waters 6 meters deep (within the metalimnion or thermocline). This was the onset of a metalimnetic oxygen minima that persisted throughout the entire monitoring season in waters between 6 meters and 9 meters deep, eventually becoming anoxic (DO <2 mg/L) in early September.

In the hypolimnion, DO <5 mg/L was first documented on June 29th at 23 meters, and this zone of low DO grew to include all waters 5 meters and deeper by September. Anoxia (DO < 2 mg/L) in the hypolimnion was first documented at a depth of 23 meters in July, but this zone of deep-water anoxia grew to include all waters 9 meters and deeper by November when the entire hypolimnion and metalimnion of Flying Pond were anoxic (Figure 4).

Oxygen depletion in Flying Pond is not uncommon and is why the pond is only marginally suited to support cold-water fish species that rely on deep, cold-water refuge in the summer months with an adequate oxygen supply. Past stockings of salmon and lake trout have not produced a quality fishery in Flying Pond[3], however Maine Department of Inland Fisheries & Wildlife currently stocks brown trout, brook trout, and landlocked salmon.[4]

Water surface temperatures through the monitoring season ranged from 11.0 C (51.8 F) to 27.5 C (81.5 F) with an average surface water temperature of 21.1 C (69.9 F) between May and November. Continued collection of bi-weekly DO and temperature profiles will identify trends and changes occurring in Flying 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	8
Historical TP Average	9
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.

Twelve (12) samples were collected by 30 Mile staff this year and analyzed for Total Phosphorus (TP) in 2023. Samples were collected monthly between May and November. Seven (7) of the phosphorus samples were collected from the top layer of Flying Pond using an integrated core

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

[4] Maine Department of Inland Fisheries & Wildlife. Annual Fish Stocking Reports. Accessed online: https://www.maine.gov/ifw/fishing-boating/fishing/fishing-resources/fish-stocking-report.html.

sampler and are referred to as “epilimnetic core samples”. Laboratory results for epilimnetic core samples collected in 2023 ranged from 6 ppb (7/26) to 11 ppb (5/30) with annual average of 8 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, the annual average in-lake phosphorus concentration in Flying Pond ranges from 6 ppb (1993 and 2007) to 13 ppb (1996 and 2012) with a historical average of 9 ppb (Figure 6).

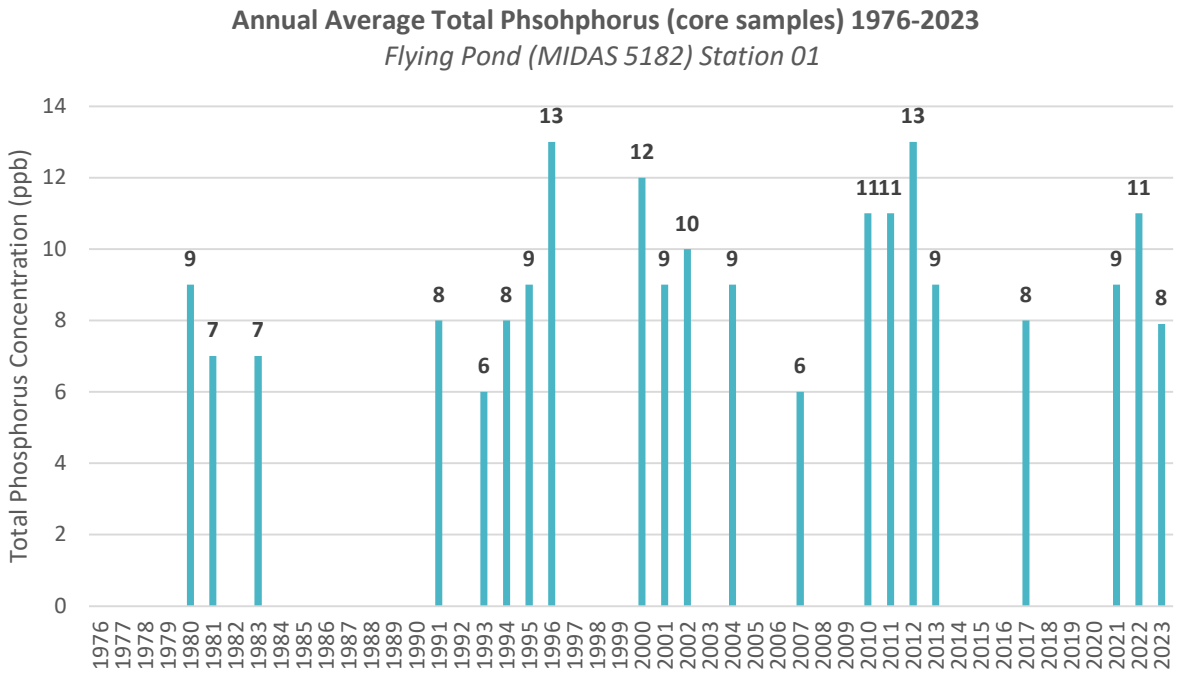


Figure 6. Annual Average Total Phosphorus data (epilimnetic core samples) collected 1976-2023, Station 01.

In 2023, five (5) samples were collected from the bottom of Flying 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 26 ppb (7/26), 11 ppb (8/23), and 29 ppb (9/22), 30 (10/17), and 26 (11/2) with an annual average of 24 ppb.

Historically, bottom grab samples were collected during 12 years throughout the 47-year monitoring record (2023, 2022, 2021, 2018, 2013, 2001, 1996, 1995, 1994, 1983, 1981, and 1980). The historical annual average bottom grab TP concentration ranges from 7 ppb (1983) to 37 ppb

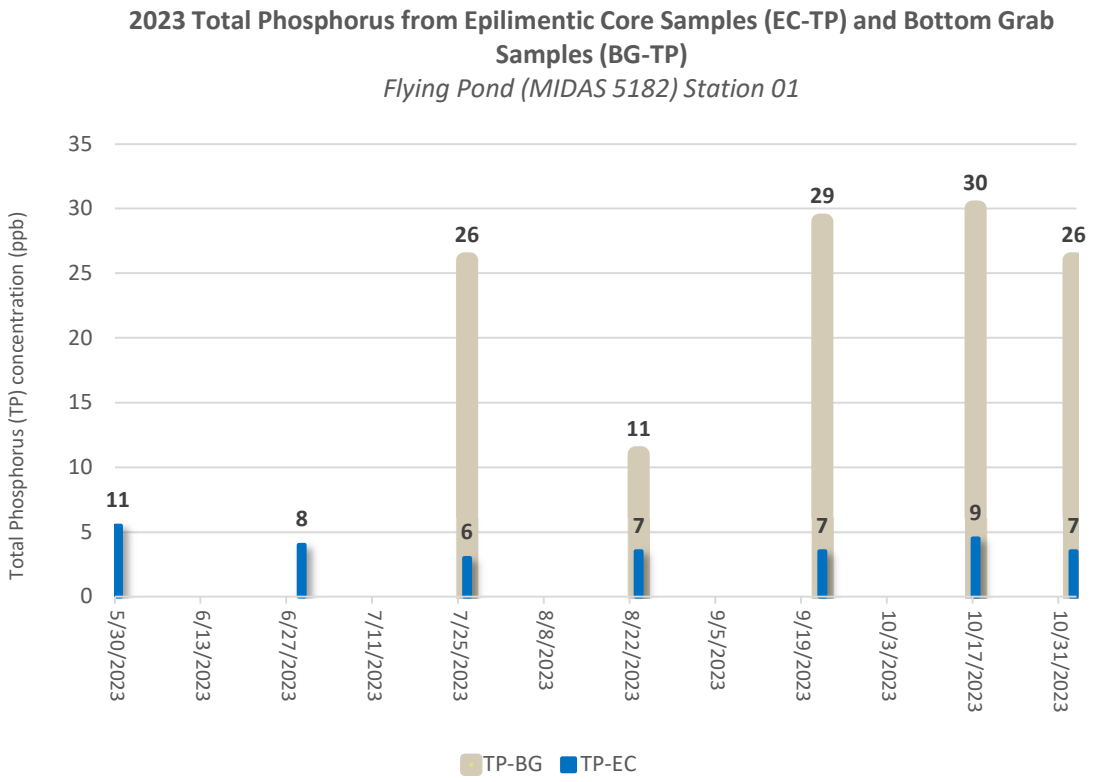


Figure 7. 2023 TP core sample and TP bottom grab sample results.

(2022) with a historical annual average of 17.3 ppb. The three highest bottom grab TP concentrations where documented in the past three years (2021, 2022, and 2023).

Chlorophyll (Chl-a)

Chl-a (ppb)	
2023 Chl-a Average	5.0
2023 Peak Chl-a	8.0
Historical Chl-a Average	3.2
Maine Lakes Chl-a Average	5.4

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.

Chlorophyll was measured seven (7) times in 2023. Results ranged from 2 ppb to 8 ppb, with a 2023 annual average of 5.0 ppb. Historically, chl-a data collected has been collected during 19 of the 47-years between 1976-2023 with results ranging from 1 ppb (1994, 2001, and 2004) to 14 ppb (2010), with a historical annual average of 3.3 ppb (Figure 6). 2023 documented the second highest chl-a concentration recorded in Flying Pond (14 ppb in 2010).

pH

pH	
2023 pH	7.1
Historical pH Average	7.2
Maine Lakes Average	6.4

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.

One sample taken on August 23rd was analyzed for pH and had a result of 7.1. Historically, pH has only been analyzed nine (9) years (1991, 1993, 2001, 2006, 2007, 2012, 2013, 2022, 2023) starting in 1991 and ranged between 6.5 (2012) and 7.4 (2001, 2006, and 2007) with a historical annual average result of 7.2.

True Color

Color (PCU)	
2023 Color	26
Historical Color Average	20
Maine Lakes Color Average	21

True 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 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 23rd was analyzed for true color and had a result of 26 PCU. Historically, true color has been analyzed during just five (5) years (2006, 2007, 2013, 2022, and 2023) ranging between 11 PCU (2022) and 29 PCU (2013) with a historical average annual result of 20 PCU.

Conductivity

Conductivity (µMHOS/cm)	
2023 Conductivity	62
Historical Conductivity Average	50
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 23rd was analyzed for conductivity and had a result of 62 µMHOS/cm. Historically, conductivity has been analyzed during 11 years (1980, 1991, 1993, 1996, 2001, 2006, 2007, 2012, 2013, 2022, and 2023) since 1980 and has ranged between 9 µMHOS/cm (1996) and 74 µMHOS/cm (2022) with a historical annual average of 50 µMHOS/cm. The two highest conductivity readings documented in Flying Pond were collected in 2022 and 2023.

Alkalinity

Alkalinity (mg/L)	
2023 Alkalinity	14
Historical Alkalinity Average	14
Maine Lakes Alkalinity Average	12

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 23rd was analyzed for alkalinity and had a result of 14 mg/L. Historically, alkalinity has been analyzed during 15 years since 1980. Annual average alkalinity has ranged between 8 mg/L (1998) and 40 mg/L (2004) with a historical average of 14 mg/L. The two highest alkalinity readings documented in Flying Pond were collected in 2022 and 2023.

Discussion

2023 was 30 Mile's third year of monitoring Flying Pond. Historical data presented in this report includes all monitoring data collected on Flying Pond through 2022, submitted by 30 Mile staff, volunteer monitors, and state agencies, which has undergone a thorough QA/QC process at Maine DEP. 2023 data presented here is from 30 Mile only.

This year's monitoring season, from late May to early November, was the longest monitoring season completed on Flying Pond since 30 Mile began monitoring in 2021.

In 2023, water clarity ranged from 4.1 m to 5.4 m, with an overall average of 4.7 m. For comparison, Secchi readings collected in 2022 ranged from 5.0 m to 7.0 m with an annual average of 6.1 m. Though we saw noticeably reduced water clarity in 2023, this year's readings are still within the expected range of historical data collected in Flying Pond since 1976 that ranges from 2.1 m (1989) to 7.2 m (2017). However, looking at the previous 10 years of Secchi data, this year's readings are below average in comparison.

Historically, it is common to observe a slight metalimnetic oxygen minima (MOM) in Flying Pond – low DO (DO <5 mg/L) in the metalimnion between 7- and 9-meters depth in late summer. However, severe oxygen loss, or anoxia (DO <2 mg/L), in the metalimnion is much less common, and has only been documented recently in 2021 and 2023. In 2023, a much stronger MOM was observed, compared to years prior.

Flying Pond has a watershed to lake surface area ratio of 22:1 - a relatively high value. Lakes with ratios greater than 10:1 more often experience water quality problems. As watershed area increases in relation to the size of the lake, the potential volume of polluted surface runoff entering the lake is greater. For this reason, Flying Pond may be more sensitive to inputs of stormwater runoff from intense rain events like those we experienced this spring . This could explain the below average clarity we documented throughout the 2023 season. Additionally, increased runoff likely also increased the mass of algae in the lake this year, which resulted in more biological productivity (respiration) and resulting decomposition – two processes that consume oxygen in the water.

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 Flying Pond.

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

Next Steps

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

2. Continue to deliver LakeSmart programming on Flying 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 review the list of priority sites identified during the 2014 watershed survey and determine next steps to address remaining sites through LakeSmart and 30 Mile's Technical Assistance Program.