# Androscoggin Lake

## WATER QUALITY REPORT

# 2022

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# 2022 Androscoggin Lake Water Quality Report

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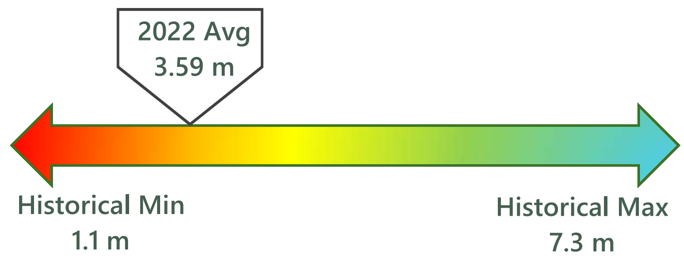
## 2022 Water Quality Summary[1]

Monitoring on Androscoggin Lake occurred on 13 dates between late May and mid November 2022 by Whitney Baker of the 30 Mile River Watershed Association (30 Mile) and volunteers from the Androscoggin Lake Improvement Corporation (ALIC).

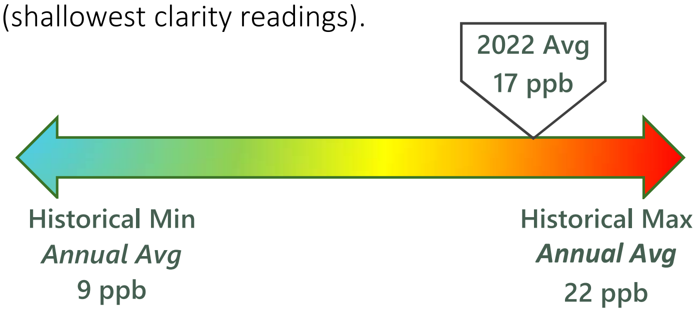
Water clarity (Secchi Disk Transparency or SDT) readings in 2022 ranged from 2.25 m (October 4th) to 5.55 meters (July 14th) with an annual average of 3.59 meters. 26 total readings were collected in 2022. Water clarity did not fall below 2 meters depth in 2022[2], but near-lake-wide bloom conditions (SDT 2-3m) were observed between mid-September and mid to late October.

| Water Clarity (m) | |
|---|---|
| 2022 Water Clarity Average | 3.59 |
| Historical SDT Average | 4.2 |
| Maine Lakes SDT Average | 4.8 |



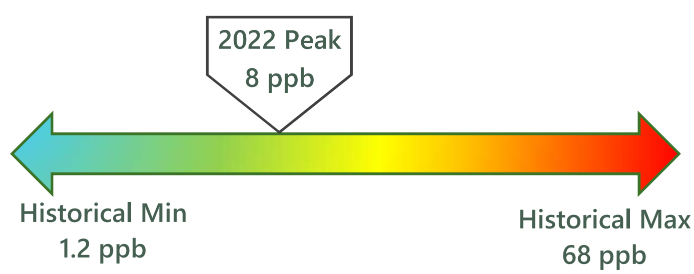

Ten epilimnetic core samples were collected and analyzed for Total Phosphorus in 2022. Laboratory results ranged from 13 ppb (parts per billion) (May 20th) to 19 ppb (September 19th) with an annual average of 17 ppb. Peak phosphorus concentrations in 2022 coincided with most significantly reduced water clarity readings (shallowest clarity readings).

| Total Phosphorus (ppb) | |
|---|---|
| 2022 TP Average | 17 |
| Historical TP Average | 14 |
| Maine Lakes TP Average | 12 |




Chlorophyll was measured 10 times in 2022. Results ranged from 3 ppb to 8 ppb with an annual average of 6 ppb.

| Chlorophyll-a (ppb) | |
|---|---|
| 2022 Chl-a Average | 6 |
| 2022 Peak Chl-a | 8 |
| Historical Chl-a Average | 5.8 |
| Maine Lakes Chl-a Average | 5.4 |




[1] Scale bars illustrate the range of data collected for each parameter over the historical monitoring record for general comparison with the 2022 monitoring results. The blue end represents the historical minimum (best), and the red end represents the historical maximum (worst) of all monitoring data collected.

[2] Maine DEP's definition of a "lake-wide algal bloom" is when SDT (water clarity) is less than 2 meters as measured at the deepest point in the lake (monitoring station 1, Figure 1).

## Overview

Androscoggin Lake is located in the towns of Wayne and Leeds, and is the terminal waterbody in the greater 30 Mile River Watershed chain of lakes with an indirect, upstream watershed of nearly 60 square miles, and a direct watershed drainage area of roughly 23 square miles.

Androscoggin Lake has a single outlet, the Dead River, located on the western shore. Under normal flow conditions, the Dead River flows for approximately six miles before its confluence with the Androscoggin River. However, due to the gradient of the land between Androscoggin Lake and the Androscoggin River, a rise in stage in the Androscoggin River can result in conditions that allow for flow reversal (back flow) of the Dead River into the lake, which occurred near the end of the 2022 monitoring season in late October.

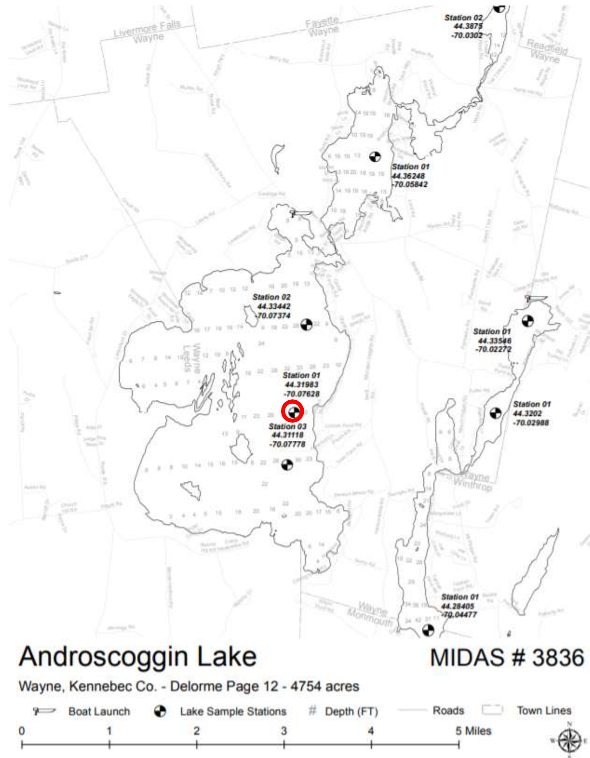



*Figure 1. Androscoggin Lake Monitoring Stations.*

Androscoggin Lake is relatively shallow with a maximum depth of 12 m (38 ft) and an average depth of 4 m (14 ft). The lake has a very large surface area covering nearly 4,000 acres, making it a popular destination for boaters, both locally and from away. The lake supports a warmwater fishery and is utilized heavily for recreation, including boating, fishing, swimming, birding, and hunting, and can be accessed via three public boat launches (state launch on Route 133, a town-owned launch on Stinchfield Beach Road in Leeds (Leeds residents only), and at a town-owned launch at the Androscoggin Yacht Club in Wayne.

## Water Quality Monitoring in 2022

Monitoring on Androscoggin lake takes place at the deepest spot in the lake (Maine DEP Station 01), located southwest of Lincoln Point in Wayne. Station 01 is just over 12 meters (38 ft) deep (Figure 1). Monitoring in 2022 was competed by Whitney Baker of the 30 Mile River Watershed Association (30 Mile) and volunteers from the Androscoggin Lake Improvement Corporation (ALIC). A special thanks to the 2022 volunteers: Patt Koscinski, Allen & Cynthia Unrein, John (Buddy) Cummings, and Ian Barclay.

*2022 Androscoggin Lake water quality volunteers, Patt Koscinski and Allen Unrein.*

In 2022, water quality monitors collected data on 13 dates between late May and early November. Parameters collected include Secchi disk transparency, dissolved oxygen and temperature profiles, phosphorus, chlorophyll-A, and advanced chemistry parameters (pH, alkalinity, color, and conductivity). Phosphorus profile grab samples were collected in 2022 to measure the volume-weighted mass of phosphorus in the lake and provide an estimate of internal loading of phosphorus from bottom sediments. Phytoplankton (algae) samples were collected using a plankton net and analyzed under a microscope to identify the dominant bloom-forming cyanobacteria species present throughout the monitoring season. Monthly, between July and October, water samples were collected from various tributaries to Androscoggin Lake, the primary inlet (Mill Pond), and from several locations in the Dead River; all samples were analyzed for phosphorus.

## 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) | |
|---|---|
| 2022 Water Clarity Average | 3.5 |
| Historical SDT Average | 4.2 |
| Maine Lakes SDT Average | 4.8 |

The Maine Department of Environmental Protection (Maine DEP) defines a “lake-wide algal bloom” as SDT less than 2 m (meters) deep, or ~6 feet, when collected at the deep spot monitoring station. Water clarity readings in 2022 ranged from 2.25 m (October 4$^{th}$) to 5.6 m (July 14$^{th}$) with an annual average of 3.6 m. 26 total readings were collected over 13 monitoring days in 2022 (Figure 2).

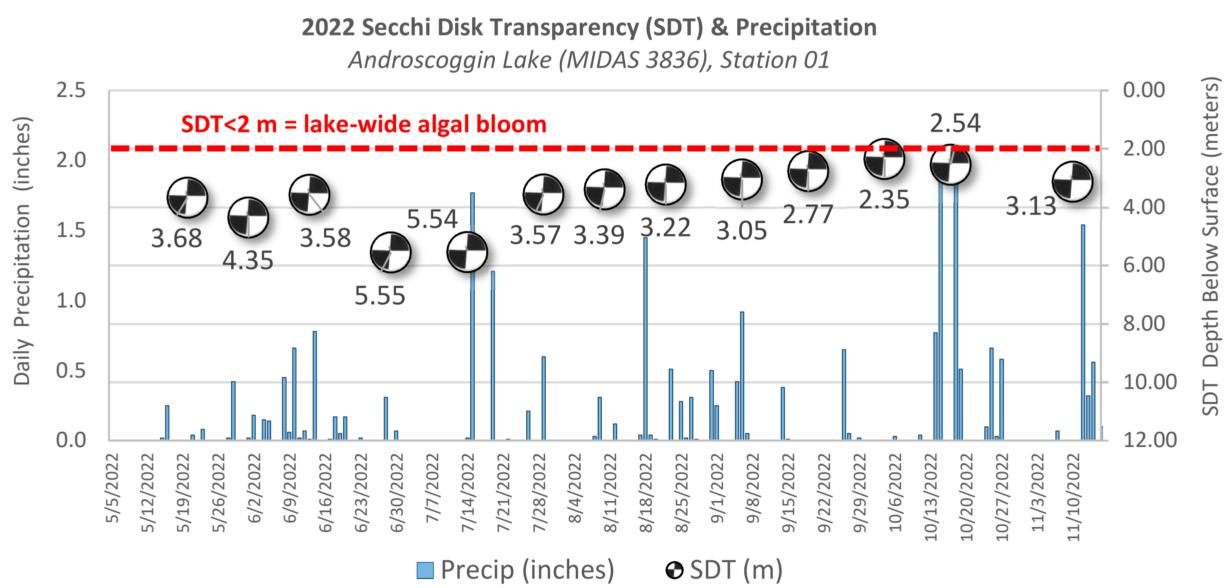



*Figure 2. 2022 Secchi Disk Transparency, Station 1, and daily precipitation, Wayne, ME*

A similar water clarity pattern was observed in 2022 when compared to 2021, when the lake experienced a severe lake-wide algal bloom that began in late summer and persisted through the fall. In 2022, water clarity did not reach "lake-wide bloom" status (SDT <2 m @ station 1) as defined by Maine DEP, but came very close (2.25 m on October 4th). Near-bloom conditions (SDT 2-3 m) started in September and persisted through the month of October, with the last water clarity reading collected on November 11th showing slight improvement with water clarity reaching 3.13 m.

*Volunteer ALIC monitor, Patt Koscinski, collects clarity data using a Secchi disk and scope.*

SDT data has been collected since 1971, during 48 of the past 52 years. Clarity readings have ranged from 1.1 m (1999) to 7.3 m (1972) with an average annual reading of 4.2m. Androscoggin Lake has a history of reduced water clarity readings during summer months. Looking at the distribution of data collected since 1970, near-bloom conditions (SDT 2-3 meters deep) were documented during 16 years, including 2022, with lake-wide bloom conditions (SDT ≤ 2 m) documented just three years in 1991, 1999, and 2021 (Figure 3).

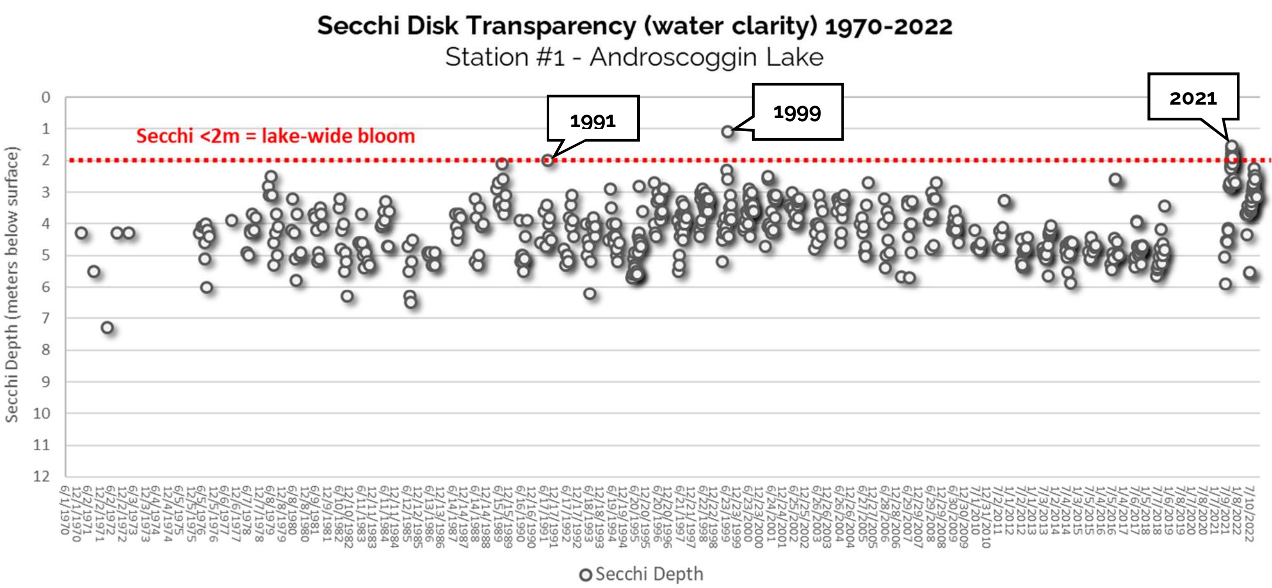



*Figure 3. Historical Secchi Disk Transparency in Androscoggin Lake, Station 1, 1970-2022*

## 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

*30 Mile's water quality program manager, Whitney Baker, prepares to collect a dissolved oxygen and temperature profile in Androscoggin Lake using a handheld optical DO meter.*

fish and other aquatic species, with most cool and cold-water fish species requiring a DO concentration of 5 mg/L or more to survive, and even higher levels to for reproduction and growth.

As lake water is warmed during the open water season, many lakes experience a phenomenon known as thermal stratification. During stratification, surface waters are warmed by the sun and are oxygenated from contact with the air and wind. Deeper waters cannot be warmed by the sun and are typically colder in temperature. This zone of deep, cold water is known as the hypolimnion and remains isolated from the lake surface, the sun, and any resupply of oxygen, while the lake is thermally stratified. In Androscoggin Lake, the hypolimnion typically includes waters roughly 8 meters and deeper.

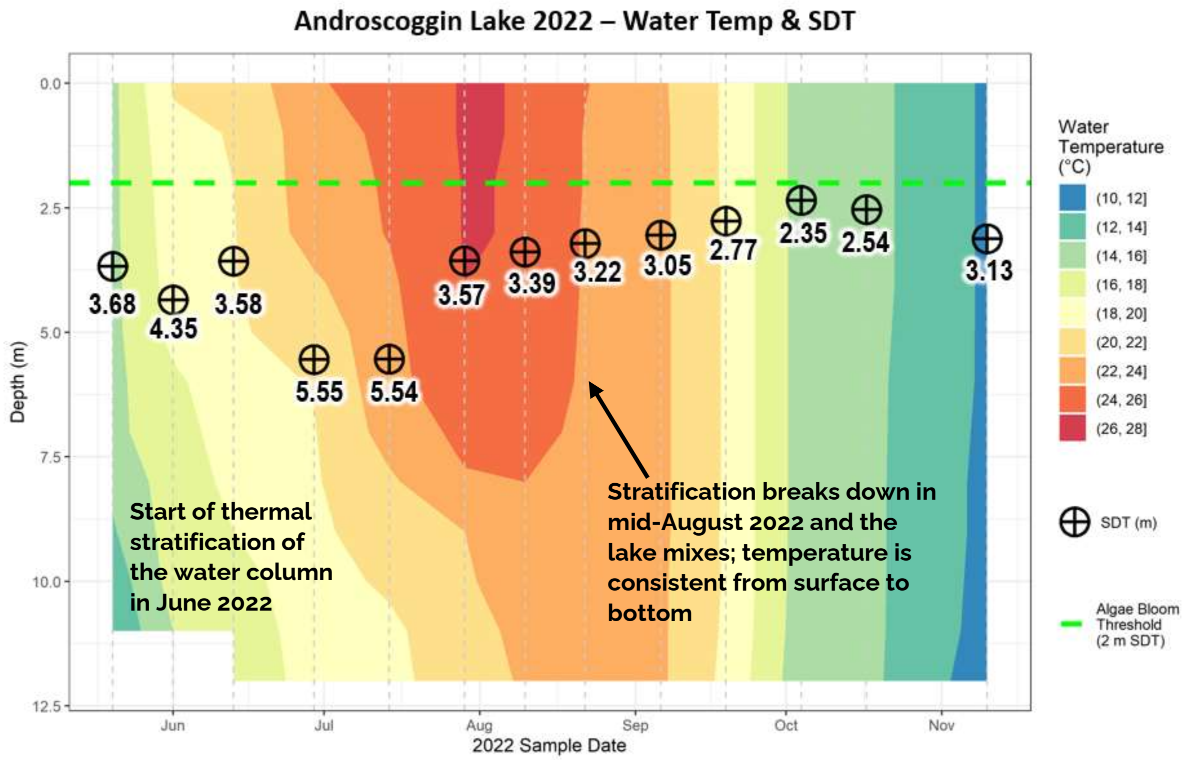
When lakes are more productive in the summer months, decomposition occurs at the lake bottom, a process that consumes oxygen in the hypolimnion. Therefore, the more productive the lake, the less oxygen there is at the lake bottom. In some lakes, decomposition can use up all of the oxygen supply at the lake bottom, causing the water in the deep areas to become anoxic (DO concentrations <2 mg/L). Understanding the pattern and extent of oxygen loss in deep areas of Androscoggin Lake is particularly important because the lake is more vulnerable to internal phosphorus loading[3] due to its unique sediment chemistry.

In Androscoggin Lake, anoxia, when DO concentrations are <2 mg/L, is typically documented in the deeper waters in July and August. In 2022, anoxia was first documented in mid-July in water 11 m and deeper. However, the anoxic area grew to include all water 8 m and deeper until the lake mixed in mid-August. The lake remained well-mixed. having a consistent temperature from surface to bottom, for the rest of the monitoring season (Figure 4).

For comparison, in 2021, the lake experienced a severe lake-wide algal bloom. Though DO and temperature patterns observed in 2021 and 2022 were similar, in 2021 the lake was stratified for a much longer period of time and anoxia persisted 21 days longer than in 2022 (Figure 5).

Continued collection of bi-weekly DO and temperature profiles during the open-water season will help us better understand the seasonal and annual variations in thermal stratification and anoxia so we can develop a new baseline for the current condition and identify trends over time.

[3] Androscoggin Lake 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 sampling results suggest that the lake is more vulnerable 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.



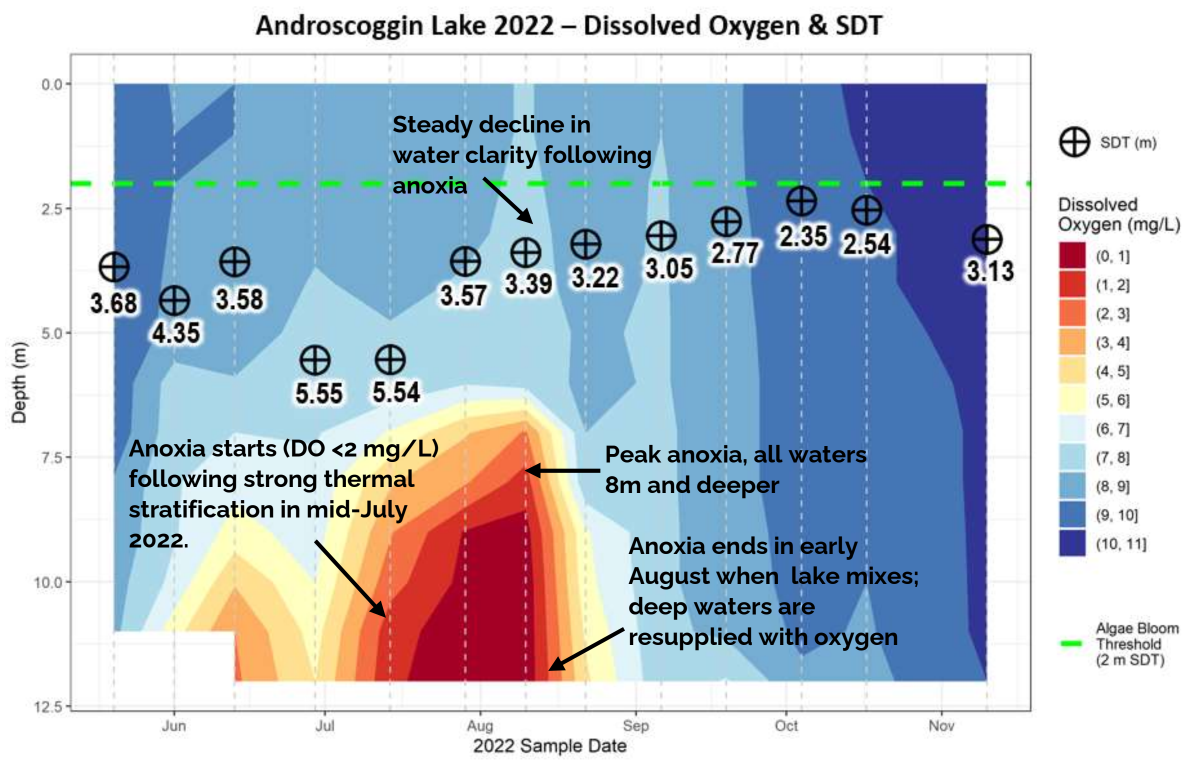
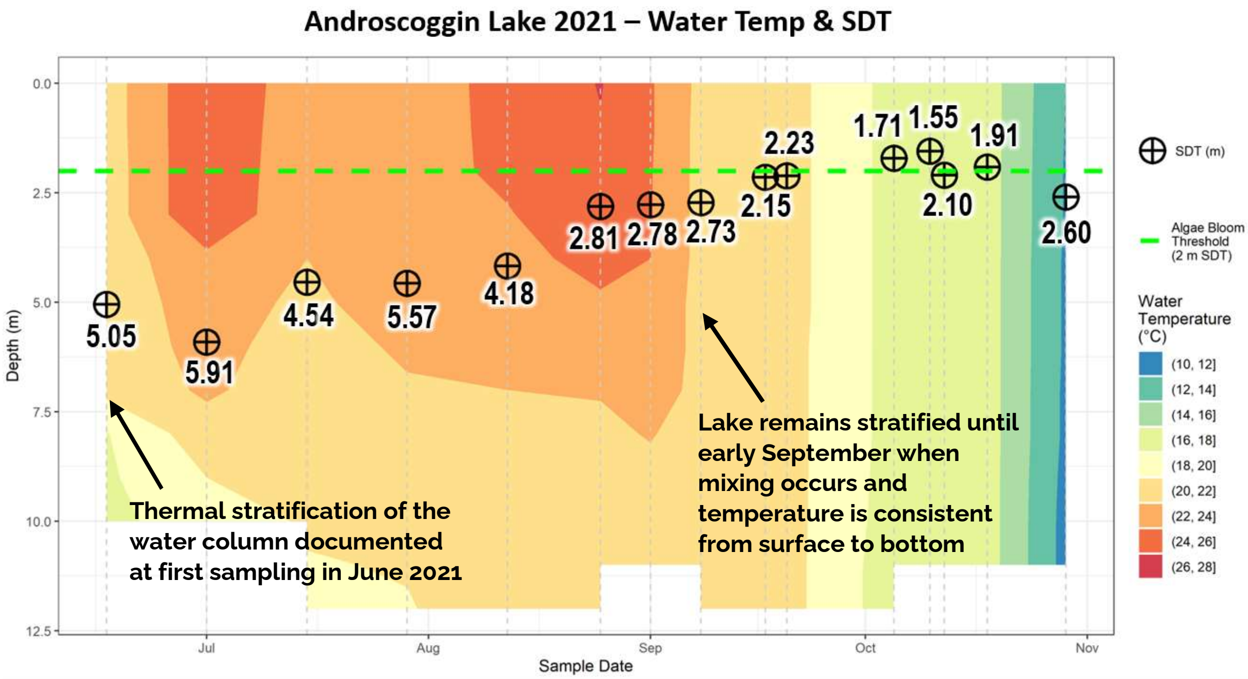




*Figure 4. Heat maps of Temperature (top) and Dissolved Oxygen (bottom) profiles with Secchi Disk Transparency (SDT) collected at Station 1 in 2022. Heat maps created by Jeremy Deeds (Maine DEP) using DO/Temp data collected by 30 Mile staff and ALIC water quality volunteers, and labeled what do you mean by labeled? by 30 Mile.*



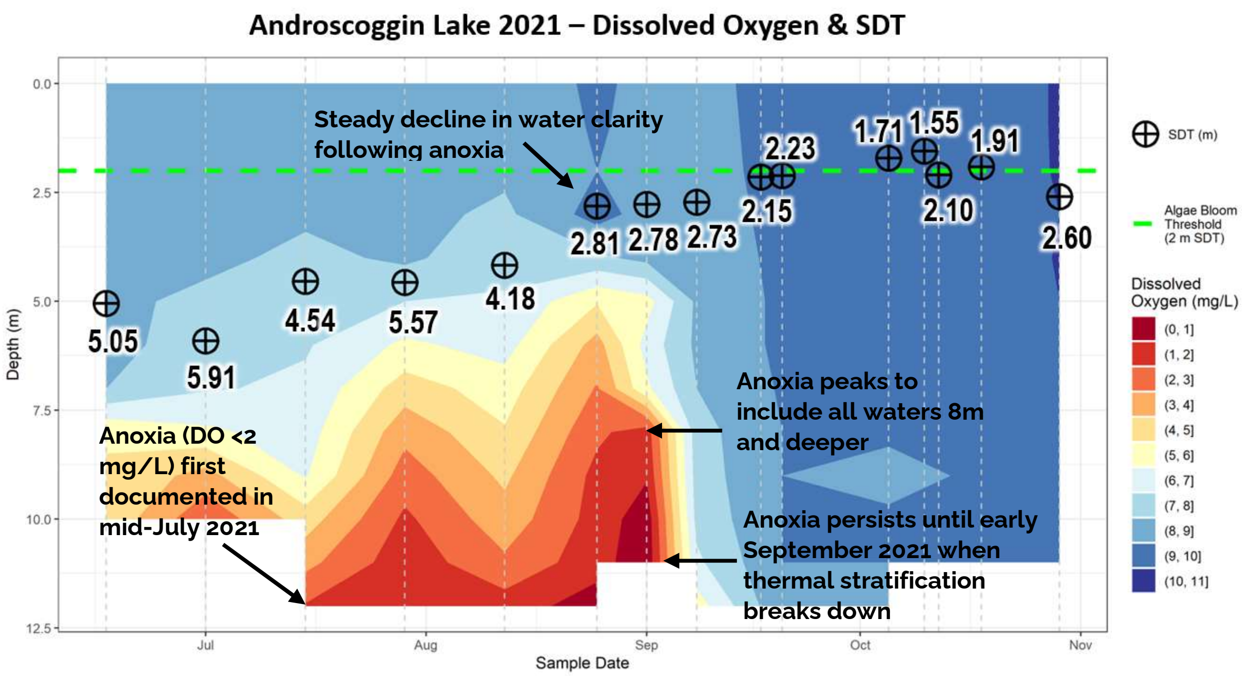




*Figure 5. Heat maps of Temperature (top) and Dissolved Oxygen (bottom) profiles with Secchi Disk Transparency (SDT) collected at Station 1 in 2021. Heat maps created by Jeremy Deeds (Maine DEP) using DO/Temp data collected by 30 Mile staff and ALIC water quality volunteers and labeled by 30 Mile.*

## Schmidt Stability Index (SSI)

In 2022, an analysis of the Schmidt Stability Index (SSI) was completed for all years with available data. SSI refers to the strength of thermal stratification, and is a measure of the energy required to completely mix the water column. SSI is based on the temperature of the water at various depths and the area-weighted density of each layer of water based on temperature and bathymetric data. Higher values indicate stronger thermal stratification, and a value of zero means the water column is completely mixed. The Schmidt stability for all years in the monitoring record can be found in Appendix C. The last six years of SSI data is shown below in Figure 6.

During most years, SSI data illustrates a gradual transition of lake cooling leading into the fall, with SSI slowly decreasing as thermal stratification breaks down in the water column. However, in 2021, an abrupt mixing event occurred during a period strong stratification and anoxia. This demonstrates the unique conditions observed in 2021, when lake experienced the most severe bloom in its history.

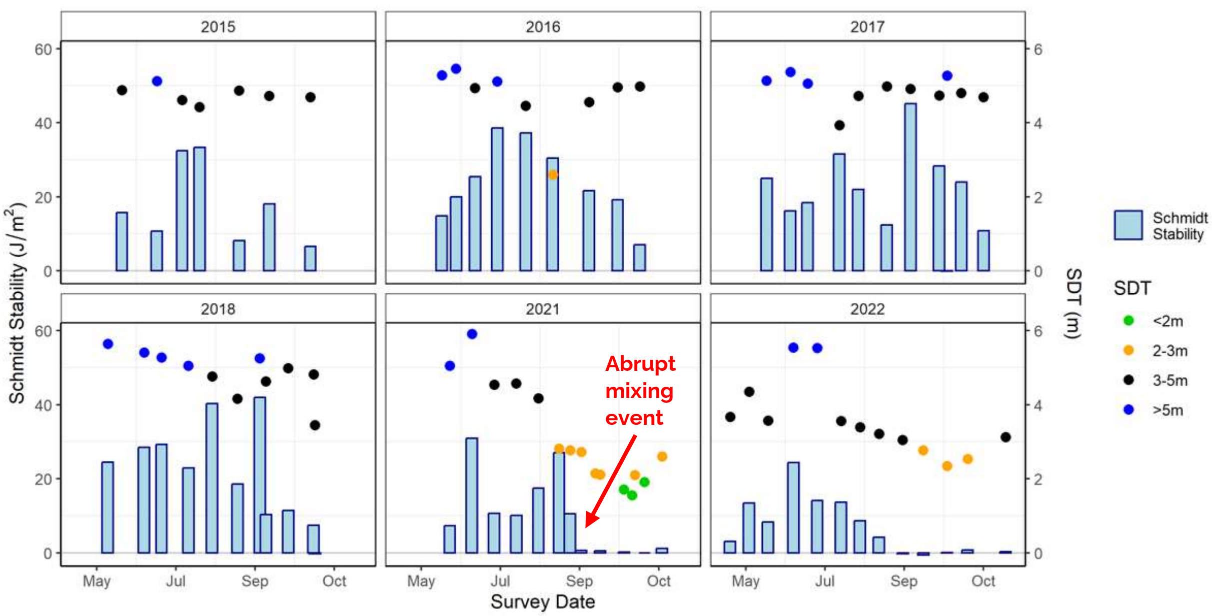



*Figure 6. Schmidt Stability Index (SSI) and Secchi Disk transparency (SDT) in Androscoggin Lake, Station 1, 2015-2022. Plots created by Jeremy Deeds, Maine DEP, 2023.*

## Total Phosphorus (TP)

| Total Phosphorus (ppb) | |
|---|---|
| 2022 TP Average | 17 |
| Historical TP Average | 14 |
| 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. Even small increases in phosphorus in lake water can cause substantial increases in algal growth, which hinders not only the overall health of the lake system, but also the economic, recreational, and aesthetic values. Tracking in-lake phosphorus levels over time is another way of monitoring change in lake water quality trends. Generally speaking, in-lake phosphorus concentrations less than 10-12 ppb are ideal. Lakes with in-lake phosphorus concentrations of 13 ppb or more are known to sustain algal blooms, and blooms become more frequent as in-lake average concentrations approach 20 ppb.

TP samples have been collected from the upper waters of the lake (epilimnion) since 1976 during 31 of the past 52 years. Annual average phosphorus concentrations have ranged from 9 ppb (1978 and 2013) to 22 ppb (2003) with an overall historical average of 14 ppb (Figure 7).

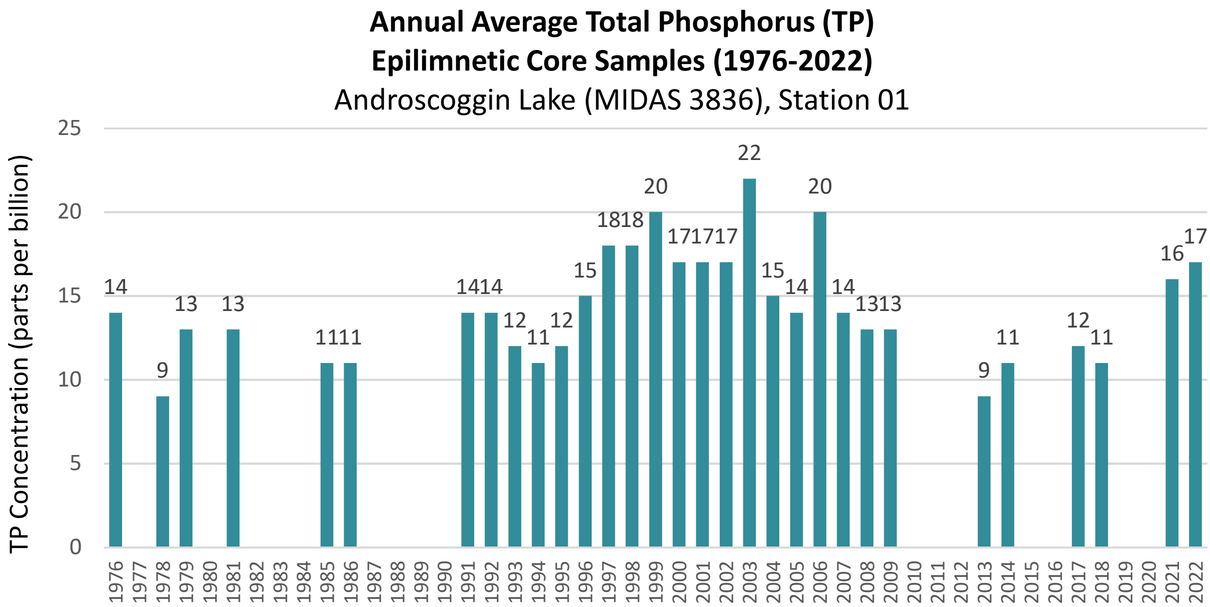



*Figure 7. Average annual total phosphorus concentration in epilimnetic core water samples collected 1976-2022 in Androscoggin Lake (MIDAS 3836).*

Laboratory results for epilimnetic core samples collected in 2022 ranged from 13 ppb (May 20th) to 19 ppb (June 13th, August 22nd, and September 19th) with an average of 17 ppb for the 2022 monitoring season. For comparison, core samples collected in 2021 ranged from 11 ppb to 20 ppb with an average of 16 ppb.

## TP Profile Samples

In 2022, phosphorus profile samples were collected from specific depths in the water column in Androscoggin Lake. Using a Kemmerer grab sampler, water was collected at every other meter in depth, from the lake surface to the bottom, for a total of six samples collected at depths of 1 m, 3 m, 5 m, 7 m, 9 m, and 11 m. Profile sample collection was completed 11 times between May and November at the lake deep spot (Station 01) and collected samples were analyzed for total phosphorus (concentration in ppb).

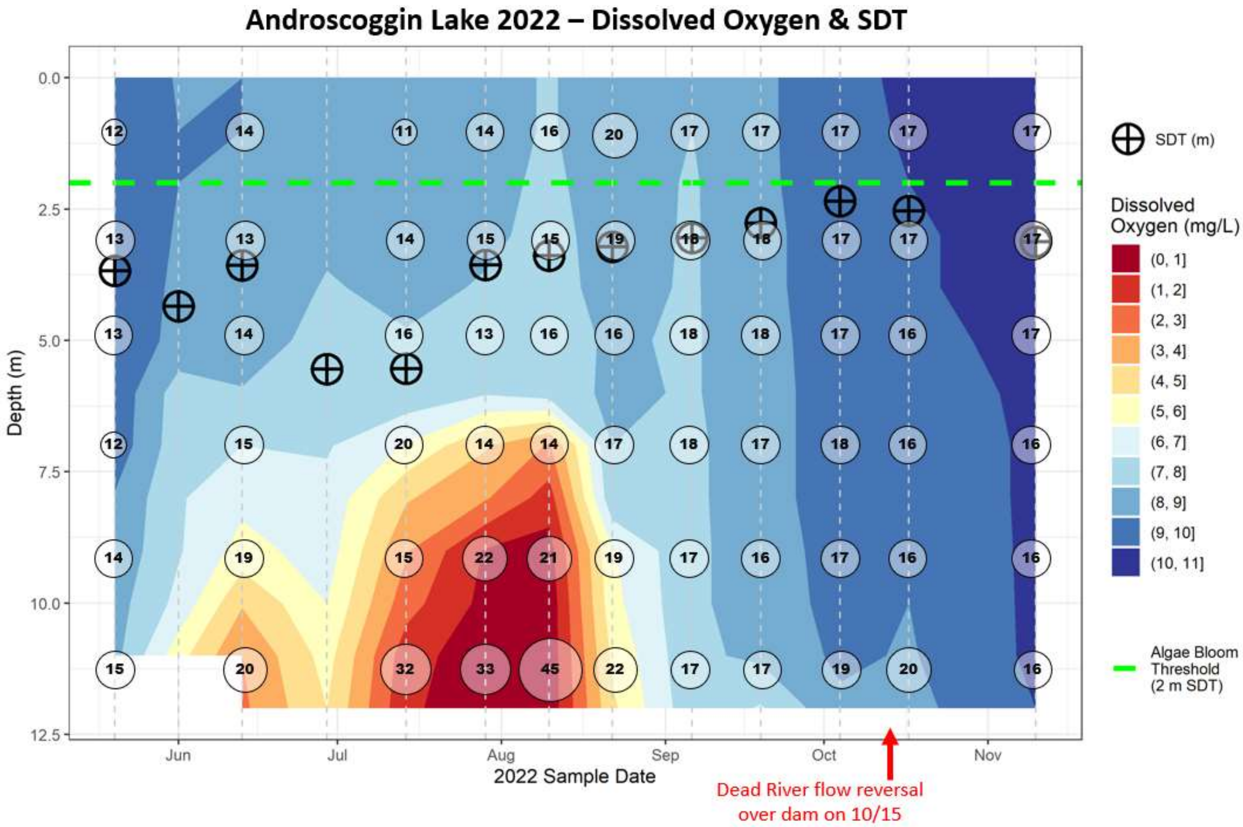



*Figure 8. Phosphorus profile sample results in ppb (white circles) overlayed on the 2022 Dissolved Oxygen heat map to demonstrate the accumulation of phosphorus in the hypolimnion during thermal stratification as a result of anoxia-induced internal loading from lake sediments.*

Overlaying the results (ppb) of TP profile samples on top of the 2022 DO heat map (Figure 8, above) shows the accumulation of phosphorus in the hypolimnion resulting from internal loading from lake sediments exposed to anoxic waters. Subsequent mixing of the lake water column in August resupplied deep waters with oxygen, ending anoxia and internal loading. However, water column mixing redistributes the accumulated phosphorus, once confined to only the deep waters of the hypolimnion, upward and into the surface waters of the lake where it can be consumed by algae and fuel algae growth. This is made evident by the decline in water clarity that has followed a late summer mixing event following a period of anoxia in both 2021 and 2022.

## Phosphorus Mass (P mass) Calculations & Internal Load Estimate

Phosphorus profile sampling results can also help us understand the distribution of the mass of phosphorus within the water column of the lake. This is important because even though higher concentrations of phosphorus were documented in the deepest waters of the lake in 2022, the volume of water associated with this zone of the lake is relatively small when compared to the total volume of the lake or the volume associated with other, shallower depth intervals. Using the TP profile results and bathymetry data (volume), we are able to calculate the volume-weighted mass (kg) of phosphorus for each depth interval of Androscoggin Lake by multiplying the phosphorus concentration by the volume of water associated with each depth interval where the profile sample was collected (Figure 9).

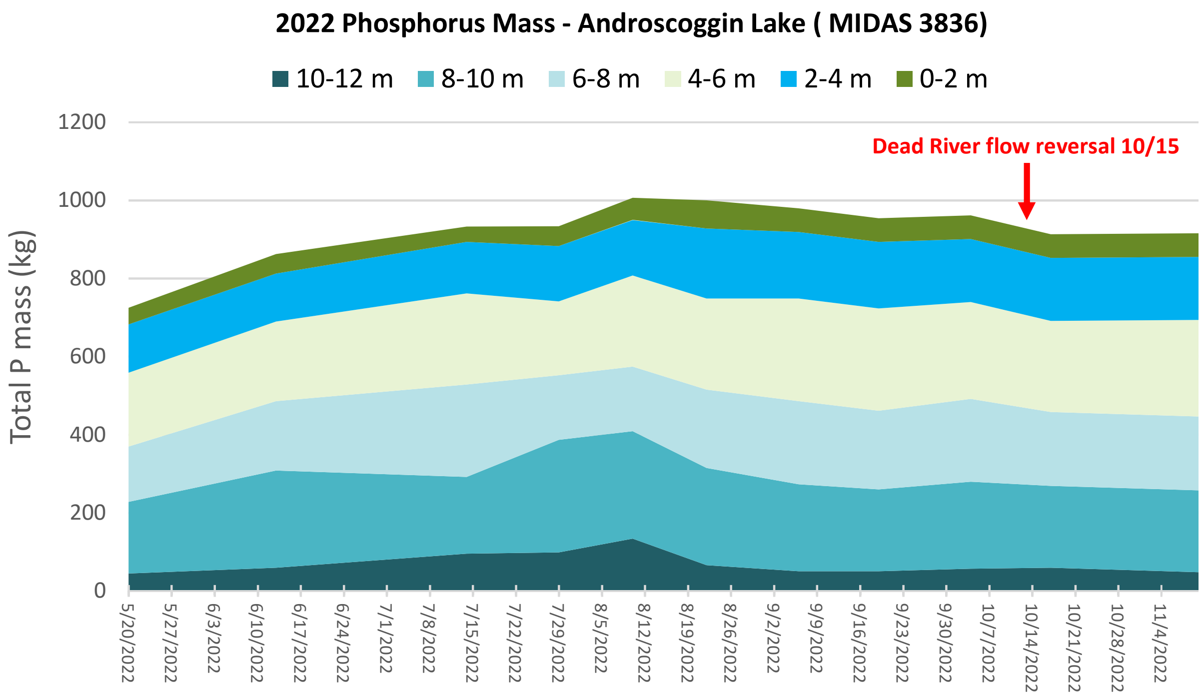



*Figure 9. Phosphorus Mass (kg) in Androscoggin Lake, May-November 2022*

The hypolimnion of Androscoggin Lake (water 8 m and deeper) represents less than 30% of the total lake volume and contained between 27-41% of the total P mass in 2022. The upper waters of the lake (0-8 m depth) represent a little more than 70% of the total lake volume and contained between 59-73% of the total P mass in 2022. Overall, in 2022 we documented a steady increase in P mass between May and July (725 kg – 933 kg). Phosphorus peaked in August (1,007 kg) and continued to decline after that until the last sampling on November 10$^{th}$ (916 kg). Two sampling events were completed following the flow reversal event in October to document any resulting changes in the lake. No major change in P mass was documented following the Dead River flow reversal - only a slight reduction of less than 50 kg.

The distribution of phosphorus mass within the lake can also provide us with an estimate of the annual internal load (P released from sediments). This is done by comparing the buildup of P mass in the hypolimnion in early spring and during peak summer anoxia. In 2022, the internal phosphorus load from lake sediments was 181 kg.

While the largest increase in P mass was observed in the hypolimnion in water 8-10 m deep, it's important to note that the most of the P Mass in Androscoggin Lake is somewhat evenly distributed throughout the upper waters between 2 and 8 meters deep, indicating that a large portion of the phosphorus in Androscoggin Lake is from watershed inputs and not the annual internal P load. At this time, it appears that P mass in Androscoggin Lake may be watershed driven, while years with significant internal loading (like in 2021) provide enough biologically-available P to push the lake past its tipping point to support lake-wide bloom conditions.

Reducing phosphorus sources from the watershed through remediation at identified erosion sites and replacement of failing septic systems is needed to lower in-lake ambient phosphorus concentrations and increase the margin of safety during years where conditions promote extended periods of internal loading. Profile grab sampling and P mass calculations should be repeated annually for at least 3-5 years to document variability of weather, base flow conditions, and Dead River influence.

## Chlorophyll-a (Chl-a)

| Chl-a (ppb) | |
|---|---|
| 2022 Chl-a Average | 6 |
| 2022 Peak Chl-a | 8 |
| Historical Chl-a Average | 5.8 |
| 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 10 times in 2022.

Results ranged from 3 ppb (July 14$^{th}$) to 8 ppb (September 6$^{th}$ through October 17$^{th}$) with an annual average of 8 ppb (Figure 10). In 2021, peak chl-a concentrations during the bloom were two times higher than what we documented in 2022.

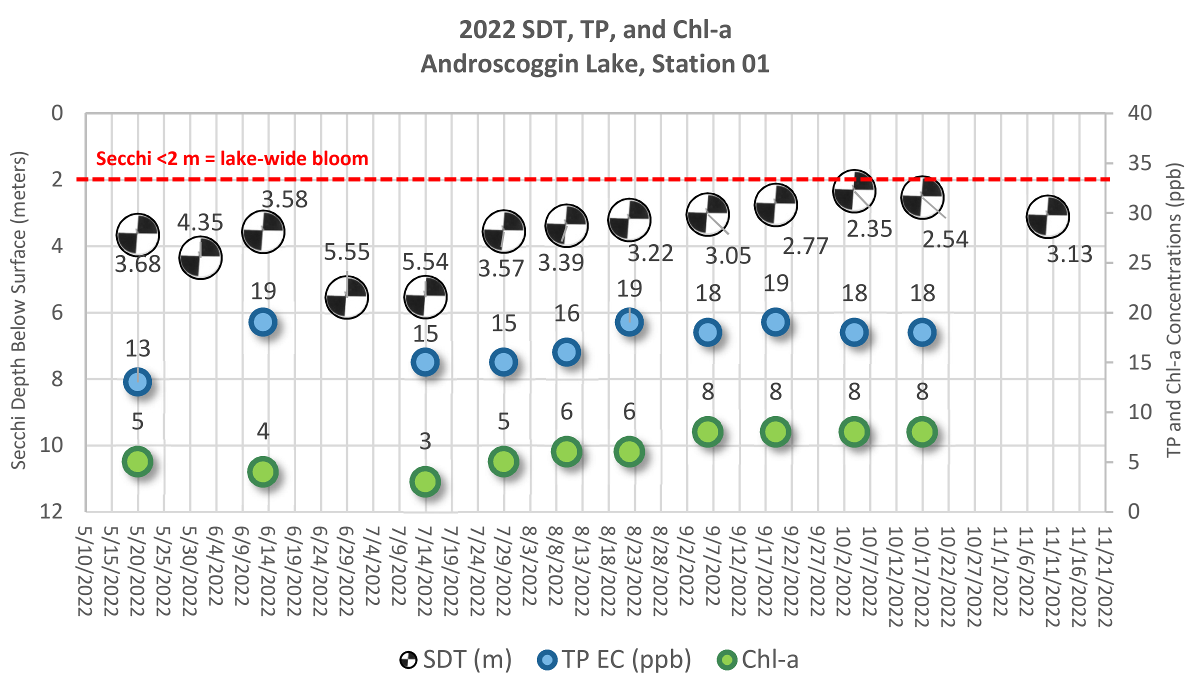



*Figure 10. 2022 Chlorophyll, Phosphorus, and Water Clarity Results*

## Dead River Flow Reversal in 2022

Under typical flow conditions, Androscoggin Lake drains to a single outlet, the Dead River, which flows west for seven miles to the Androscoggin River. However, due to the relatively flat gradient between the lake surface and the Androscoggin River at normal water level (stage), a rise in stage in the Androscoggin River from precipitation and/or spring thaw results in flow reversal (or back flushing) of water from the Androscoggin River into Androscoggin Lake via the Dead River. In other words, when flood waters rise in the Androscoggin River watershed, the Dead River reverses its flow, and Androscoggin Lake acts as a flood storage reservoir for the Androscoggin River.

Due to this phenomenon of flow reversal, the Dead River Dam (aka the Dead River Pollution Control Facility or PCF) was built in the 1930s to limit the flow of severely-polluted Androscoggin River water into the lake, which in the past occurred several times per year on average, and most recently in October 2022.

The Androscoggin River Watershed above the Dead River includes more than 2,500 square miles of drainage area and 11 licensed wastewater discharges (8 municipal, 3 industrial). Androscoggin Lake may be the only lake in the state that receives floodwaters from a Class C river[4] (the Androscoggin) through the natural flow reversal phenomenon previously described.

*The Dead River PCF in October 2021 (top) and flow reversal in October 2022 (bottom) after heavy rains caused a significant rise in stage in the Androscoggin River and water flowed over the PCF and into Androscoggin Lake.*

Past studies have linked poor water quality in the lake mainly to the repeated inputs of phosphorus from the Androscoggin River via flow reversal in the Dead River. Though historically, inputs from the Dead River have undoubtedly contributed to both the elevated phosphorus levels in the lake water and legacy phosphorus currently stored within the lake sediments (internal load source), past watershed loading models have also concluded that the current ambient phosphorus concentrations in the lake are high enough to support algal bloom conditions even *without* the

[4] The State of Maine has four classes for freshwater rivers: AA, A, B, and C. Class AA is the highest classification and Class C the lowest. The higher the class, the lower the risk of ecosystem breakdown or loss of use due to a natural or human-related stressor. Class AA rivers involve very little risk to water quality since activities such as waste discharges and impoundments are prohibited, and water quality criteria are high. Alternatively, Class C rivers have the least restrictions on use and lower water quality criteria; therefore a much smaller margin for error before significant water quality decline might occur due to the introduction of a new natural or human-related stressor.

influence of the Dead River due to phosphorus loading from the direct watershed and internal phosphorus loading from the sediments alone.

This was evident in the last two years (2021 and 2022), where lake monitoring efforts documented some of lowest consecutive water clarity (SDT) readings on the historic monitoring record, while flow reversal in the Dead River had not occurred since the spring of 2020. This is not a typical occurrence as most years indicate at least one flow reversal in the Dead River each year (Figure 11).

As P loading from watershed sources continues, the ambient P concentration in the lake will increase over time. The effects of climate change will likely continue to create the perfect conditions for longer periods of thermal stratification and anoxia. This will likely result in higher internal P load released from bottom sediments, leading to more frequent blooms. Work in the watershed to mitigate phosphorus (fixing erosion sites and failing septic systems) must move forward in order to lower in-lake P and help reduce the frequency of blooms.

It may be that both extremes of Dead River influence have a negative impact on the lake. Without the occasional influence of flooding, the lake has a lower flushing rate, and an overall lower baseflow condition throughout the entire watershed during dry years which might promote longer periods of thermal stratification and internal P loading from sediments. Furthermore, phosphorus released from lake sediments is typically more biologically available for algae (soluble reactive phosphorus). Alternatively, years with significant or frequent flooding deliver a significantly larger overall phosphorus load to the lake. However, the flushing rate increases during these years, and the phosphorus in the Androscoggin River/Dead River flood waters is likely to be higher in particulate forms of phosphorus (attached to sediment particles) and is less biologically available to fuel algal growth. However, even particulate forms of phosphorus will settle to the lake bottom and become stored in lake sediments where it can be released during future episodes of internal loading when deep waters become anoxic.

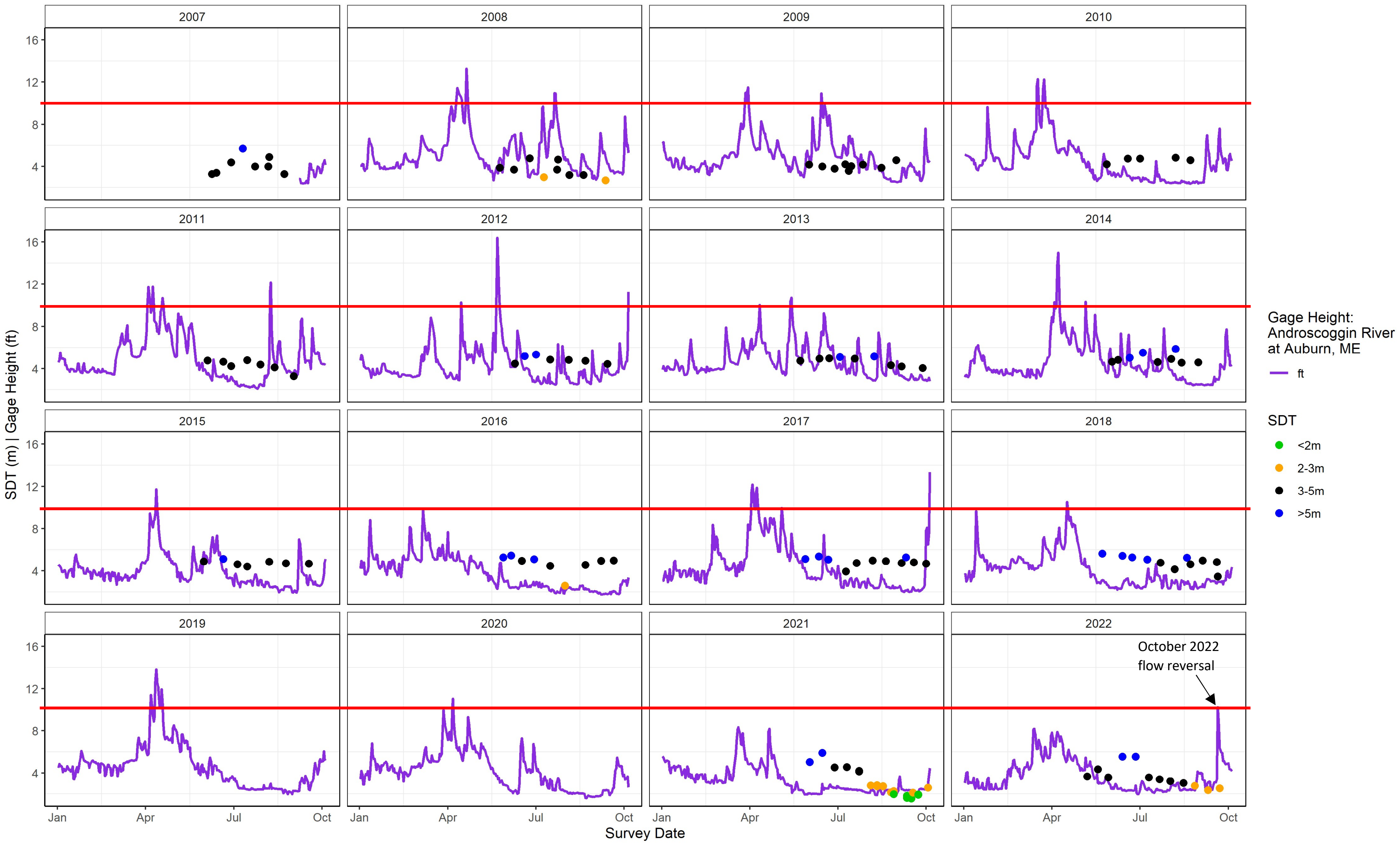



*Figure 11. Secchi Disk Transparency (SDT) at monitoring Station 01 in Androscoggin Lake, and Androscoggin River Gage Height (Auburn, ME gage) 2007- 2022. Data plots created by J. Deeds, Maine DEP. Flow reversal over the top of the Dead River PCF as Androscoggin River (Auburn, ME) gage height approaches 10 feet (red line).*

## Tributary & River Monitoring

*View south of Bog Brook; upstream of 2022 tributary monitoring station (Bog-01) located at the Bog Brook culvert crossing on Wilson Pond Road in Monmouth.*

Between July and October 2022, water samples were collected from monitoring locations in tributaries that drain directly to Androscoggin lake, its main inlet from Pocasset Lake, and from several locations in the Dead River (Figure 13, next page).

Collected samples were analyzed for total phosphorus (TP) and results are presented in Figure 13 (below) along with the in-lake phosphorus concentration at Station 01 on the same sample date, for comparison.

While the in-lake phosphorus concentration throughout the monitoring season ranged from 13 ppb to 19 ppb, phosphorus concentrations in the tributaries draining to the lake ranged from 7 ppb to 89 ppb. TP concentrations in the Dead River, including the monitoring site at the Dead River delta in Frenchman's Cove (FC-01), ranged from 13 ppb to 22 ppb. The Mill Pond monitoring location at the outlet of Pocasset Lake (MP-01) had the lowest consistent TP concentrations ranging from 8 ppb (July 16, August 10, and October 4) to 11 ppb (September 6) (Figure 12).

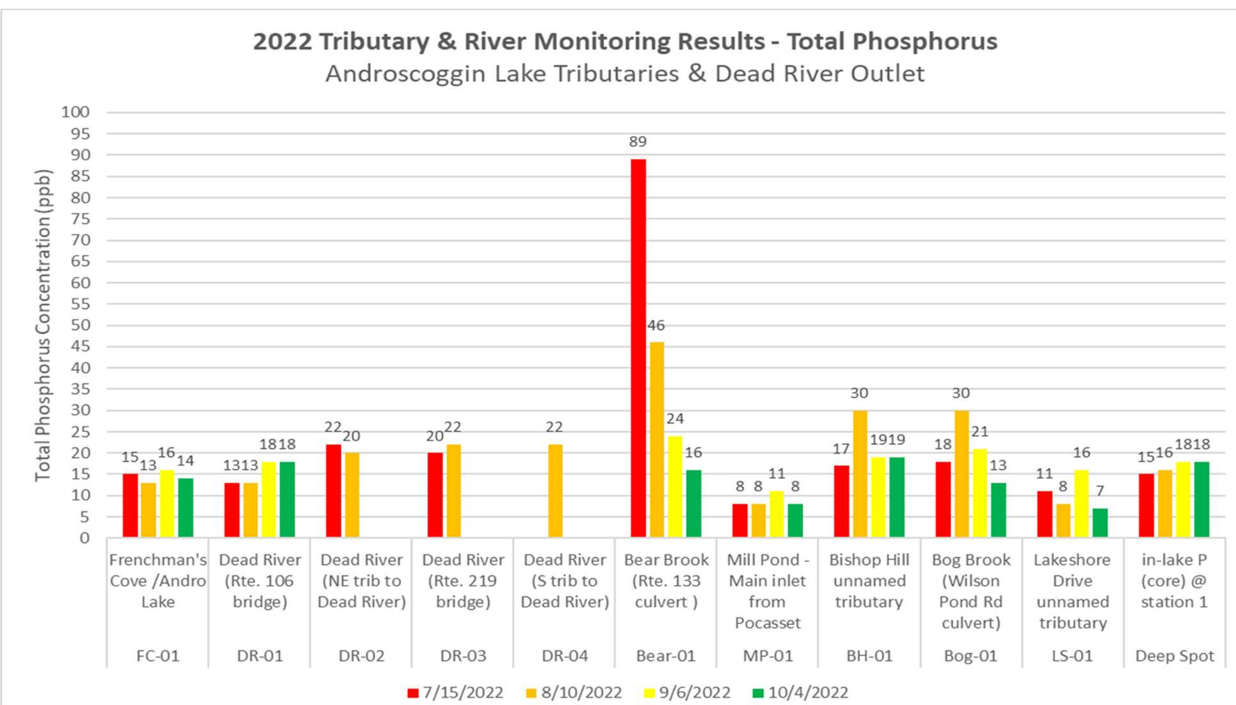



*Figure 12. Androscoggin Lake Tributary and River Monitoring Phosphorus Results*

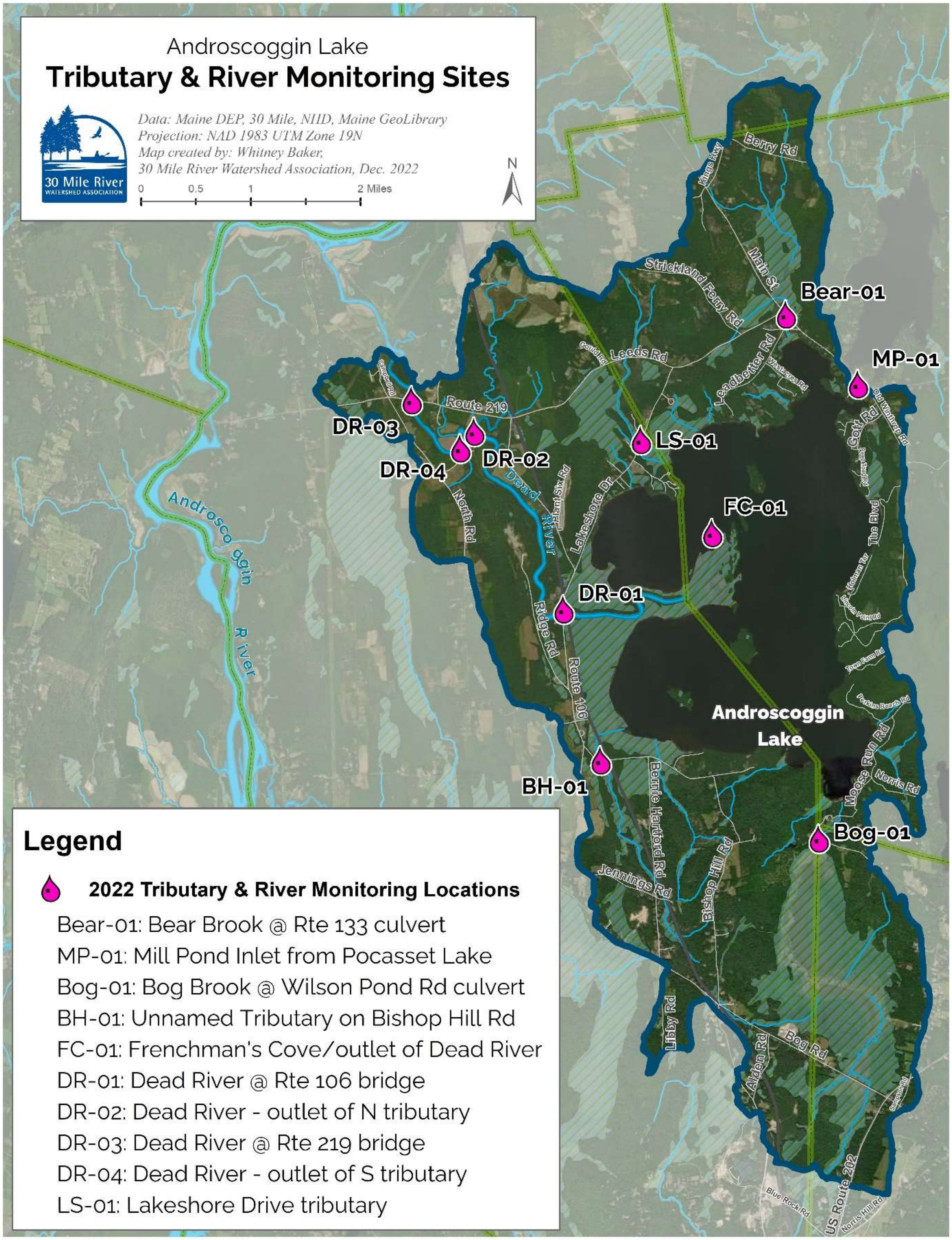



*Figure 13. Androscoggin Lake tributary & river monitoring locations in 2022.*

Phosphorus concentrations were also low in the unnamed stream crossing under Lakeshore Drive at the north western shore of the lake (LS-01) ranging from 7ppb (October) to 16 ppb (September). The highest phosphorus concentrations documented in 2022 where collected from the unnamed stream located in the north end of the watershed and draining to the inner cove in Wayne (Bear-01). Results ranged from 16ppb (October) to 89 ppb (July).

## 2022 Algae Identification

Phytoplankton (algae) samples were collected at Station 01 eight times between July and October using a plankton net. Collected samples were used to prepare slides for viewing under a microscope to identify dominant cyanobacteria species present in the lake (Figure 14, next page).


***Dolichospermum planctonicum***
(formerly known as *Anabaena planctonica*)

Cyanobacteria are a type of algae formerly called blue-green algae because dense blooms will turn the water green or blue-green. Cyanobacteria are a natural and important part of the lake ecosystem, and are found in lakes all over the world. However, when nutrient levels (e.g. phosphorus) are high enough, and conditions are just right, their population can explode. The result is what we call a “cyanobacteria bloom” or “algal bloom.”

The species of cyanobacteria causing the bloom in 2021, and near-bloom conditions in 2022has been identified as *Dolichospermum* (formerly known as Anabaena), a common bloom-forming species in Maine lakes. Microscope photos (below) show the algae filaments consisting of multiple bead-like cells of three distinct cell types. Heterocysts are specialized cells that convert dissolved nitrogen gas into ammonium that can be used for cell growth. Akinetes are resting cells that are resistant to cold temperatures and a variety of other unfavorable environmental conditions, and can overwinter in lake sediments. The dark brown cells appear mottled in the photo and contain gas vesicles that allow these algae to control their buoyancy and position in the water column.

*Dolichospermum* species can produce toxins under certain environmental conditions. However, of all the toxin samples Maine DEP has collected from Maine lakes over the past decade, there were only a few open water samples that exceeded EPA’s Drinking Water standard for the algal toxin microcystin for infants and non-school-age children. None of the samples exceeded the standard for school-age children or adults, and no open water samples have exceeded EPA’s Recreational Standard – even when collected from lakes with blooms that are chronic and severe.

However, Maine DEP has detected *very high* concentrations of the algal toxin microcystin in other lakes within down-wind algal scums that can accumulate along shorelines. This is why DEP advises everyone to stay away from any concentrated scums or accumulations along shorelines. Do not inadvertently drink the water in these areas, and do not let small children, pets, or livestock play in or drink the water. Always shower after swimming, and do not use lake water for household uses like cooking or drinking. *Out of an abundance of caution: When in doubt -stay out!*

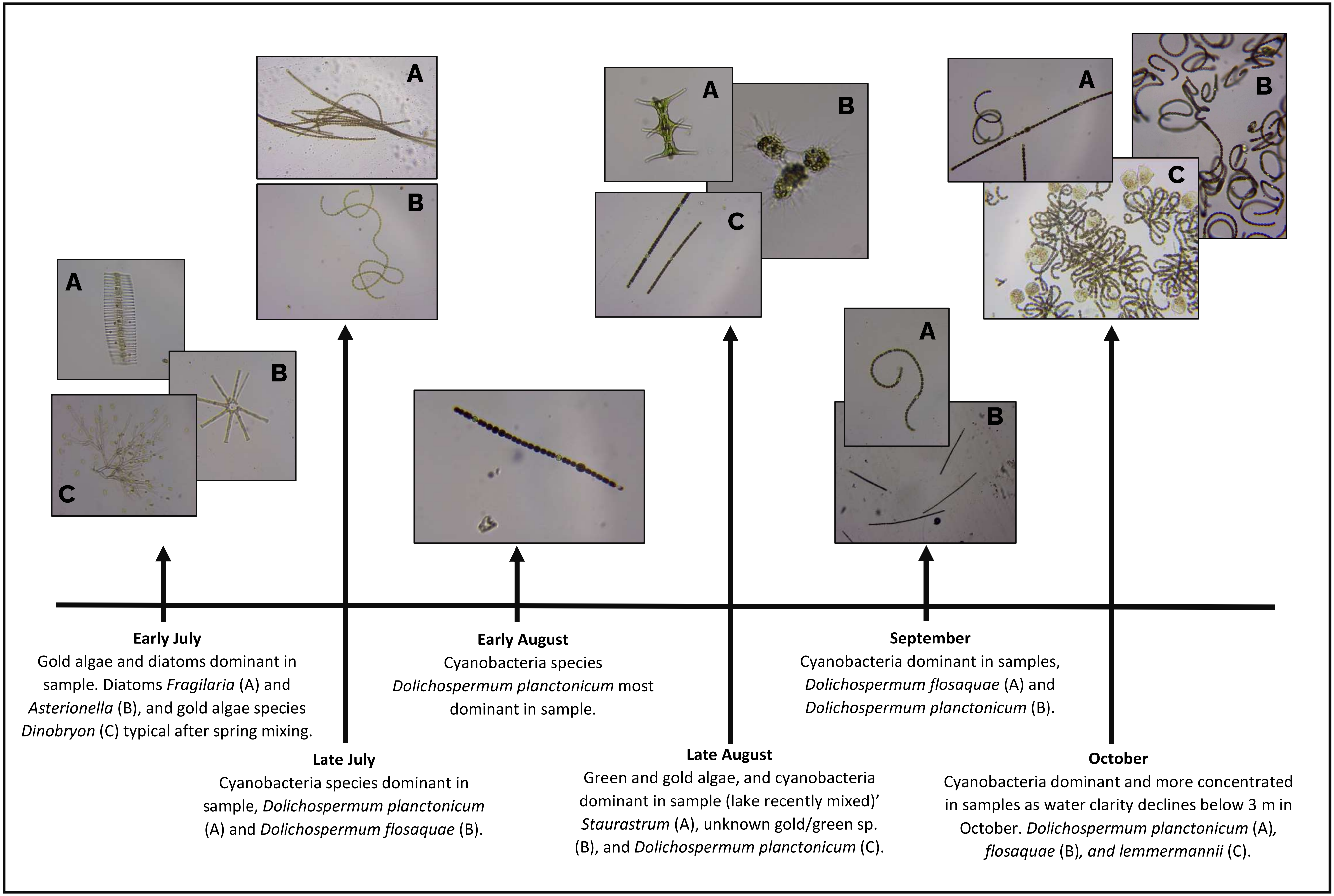



*Figure 14. Timeline of algae sample identification in 2022 in Androscoggin Lake, Station 01, July-October 2022.*

## Next Steps

1. Apply for and implement a Section 319 grant from Maine DEP/US EPA to fund remediation work at high P export erosion sites identified during the 2022 watershed survey.

2. Work with watershed towns to create a septic system database to prioritize outreach, action, and offer technical assistance to landowners with failing or malfunctioning systems.

3. Continue and ramp up ALIC's LakeSmart program and promote the services of 30 Mile's Youth Conservation Corps (YCC) program to bring education and solutions to lakefront property owners to reduce their collective impact.

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

5. Continue collection of phosphorus profile grab samples and complete P mass calculations for 3-5 years to develop a recent baseline for phosphorus mass and internal loading that captures variabile weather patterns, base flow conditions, and influence of the Dead River.

6. Continue collection of water quality samples from tributaries and the Dead River. Resample the 2022 monitoring sites in spring 2023 to document P conditions in May and June. Select new monitoring locations to sample in 2023, and consider analysis for additional parameters.

7. Collect DO and temperature profiles at the deepest point in the Dead River to assess degree of anoxia/oxygen levels within the river.

8. Collect water samples from the Dead River to document P concentrations during a flow reversal event.

9. Complete a landcover-based P-loading analysis utilizing new statewide, high-resolution land cover data (tentative release date in summer 2023) to calculate a current estimate of the watershed P load to the lake.

## More about Androscoggin's Water Quality Data

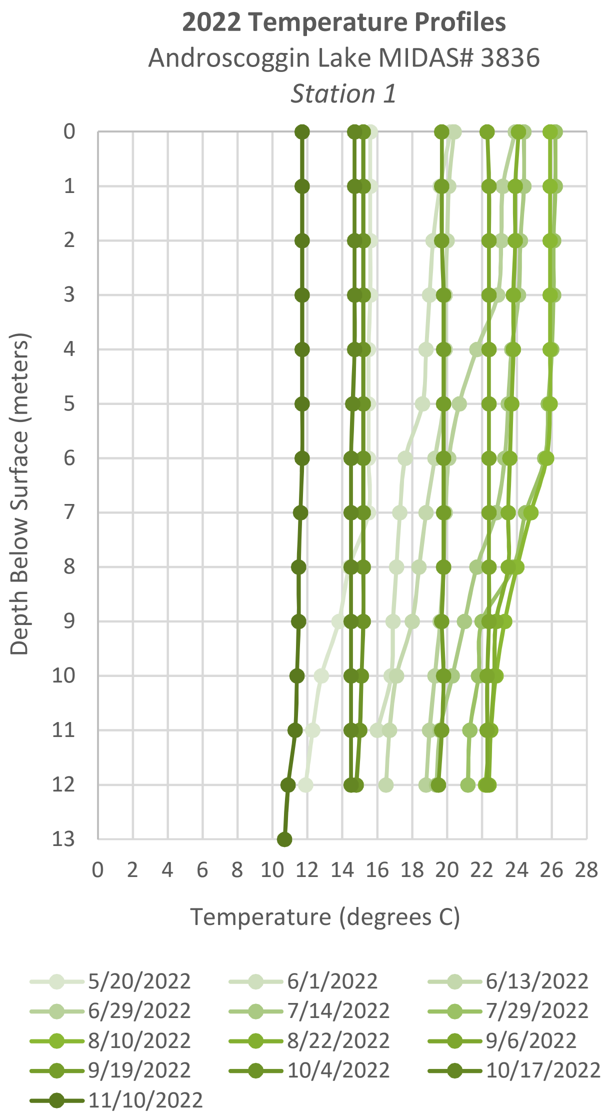
2022 was 30 Mile's second year of monitoring Androscoggin Lake. Data presented in this report prior to 2021 includes all monitoring data collected on Androscoggin Lake through 2018, submitted to Maine DEP by both volunteer monitors and state agencies, that has undergone a thorough QA/QC process. Data collected in 2019 and 2020 is currently in holding at Maine DEP for QA/QC and will be included in the next annual water quality report, if available at that time.

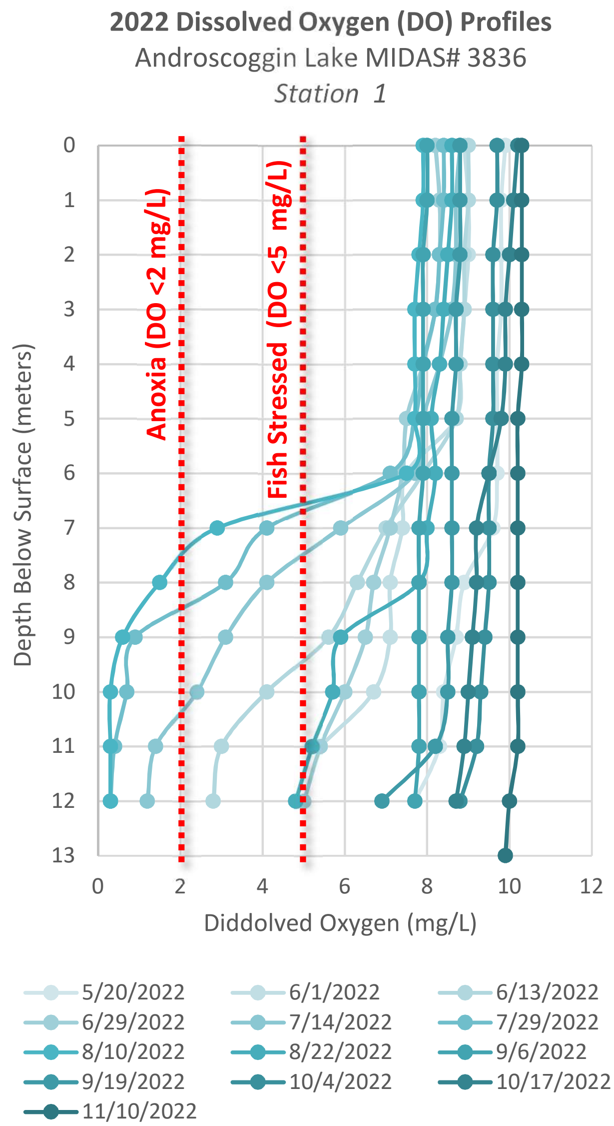
Five years of consecutive data collection for any given parameter will provide a baseline condition of the lake. 10 years of consecutive data collection is needed to meet the minimum data thresholds for determining trends over time. This effort will continue to develop a robust dataset that can help the community identify and address water quality concerns in Androscoggin Lake.

Near real-time data for Androscoggin Lake's clarity (Secchi depth), and dissolved oxygen and temperature profiles can be found online at https://30mileriver.org/androscoggin-lake/, along with a link to the historical dataset, depth maps, and past water quality reports.

# Appendices

## Appendix A: 2022 Androscoggin Lake DO & Temperature profiles

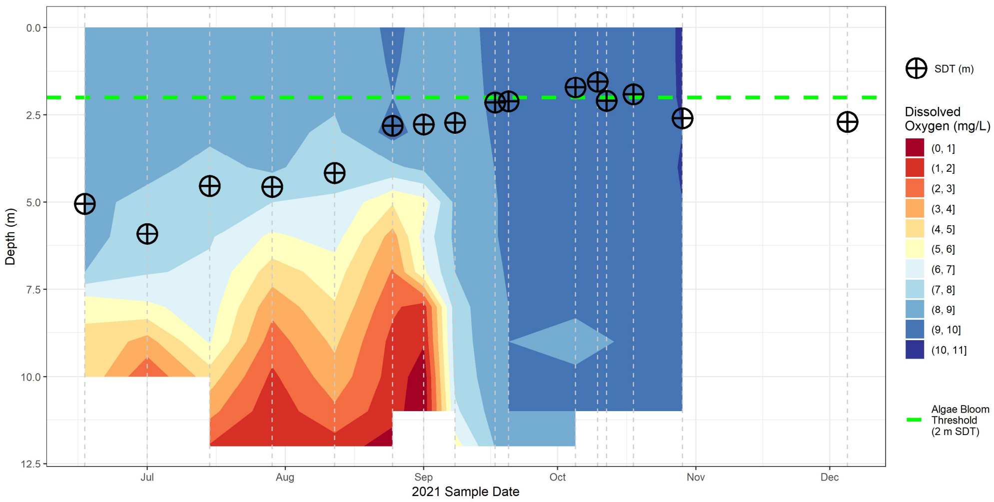


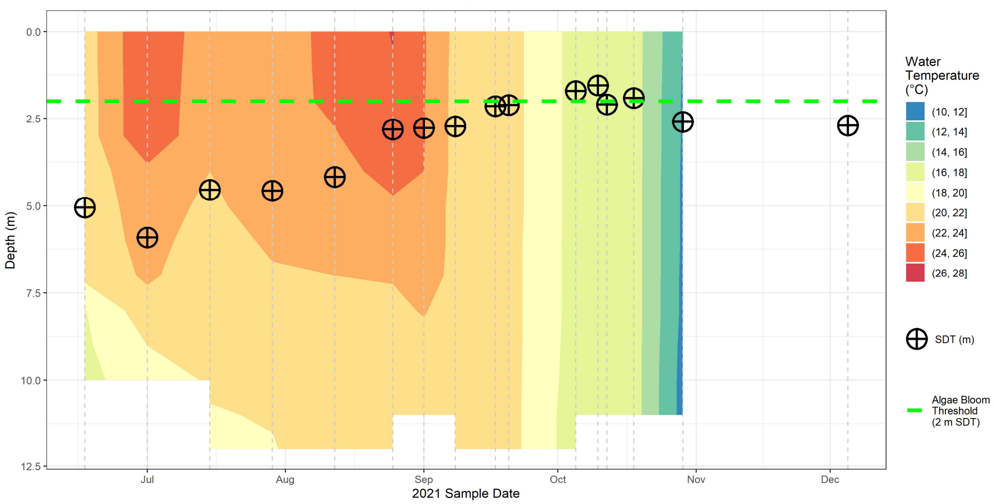



# Appendix B: 2021 & 2022 Heat Maps for DO & Temperature (Maine DEP)

## 2021 Heat Maps

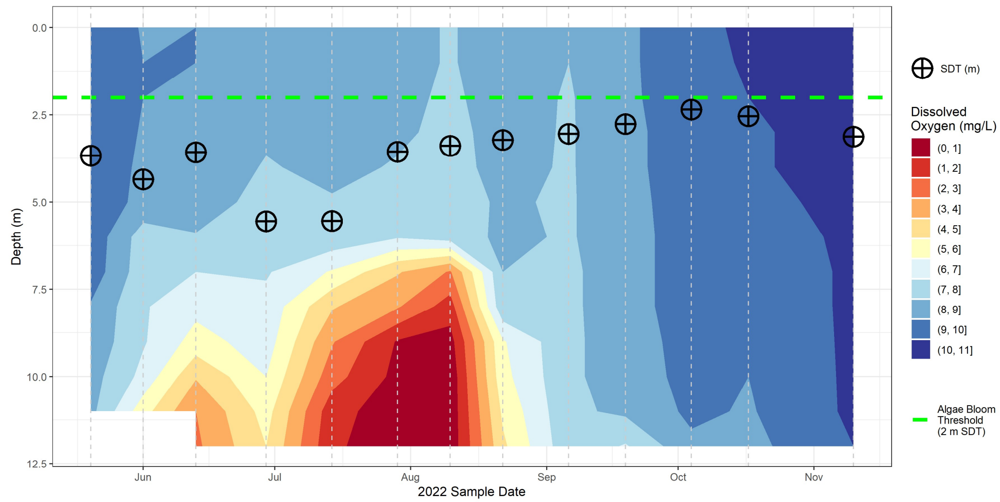
*DO & SDT (top) and Water Temp & SDT (bottom)*

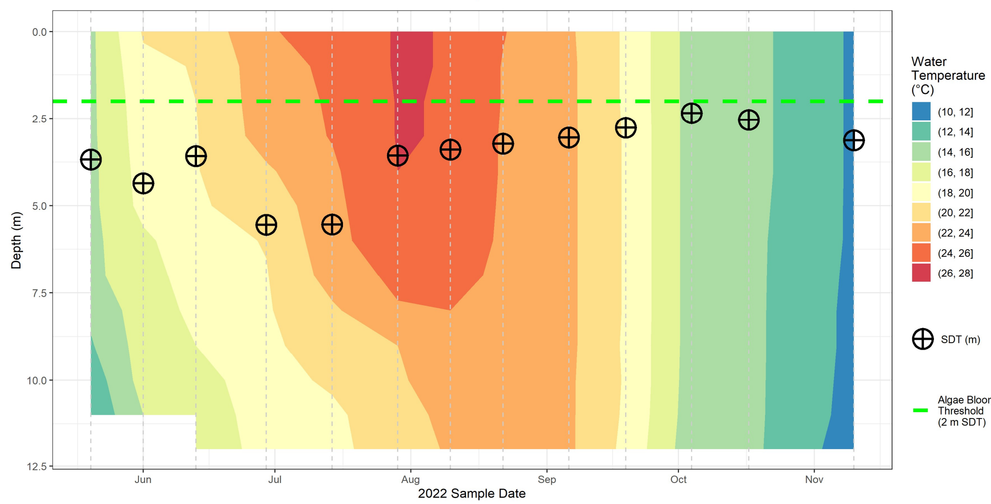



## 2022 Heat Maps

*DO & SDT (top) and Water Temp & SDT (bottom)*



# Appendix C: Androscoggin Lake Schmidt Stability & Secchi Disk Transparency (SDT), 1991-2022