Androscoggin Lake

WATER QUALITY REPORT

2021

30 Mile River Watershed Association
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2021 Androscoggin Lake Water Quality Report

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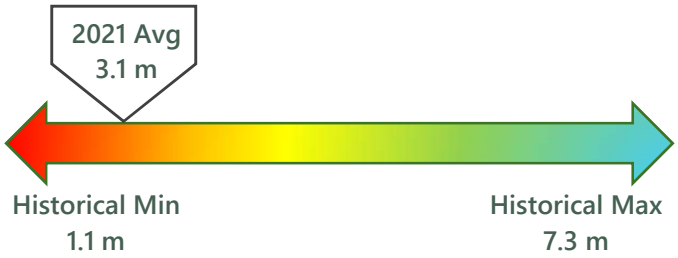
2021 Water Quality Summary[1]

Monitoring on Androscoggin Lake occurred on 16 dates between June and December 2021 by Whitney Baker of the 30 Mile River Watershed Association (30 Mile) and volunteers from the Androscoggin Lake Improvement Corporation (ALIC).

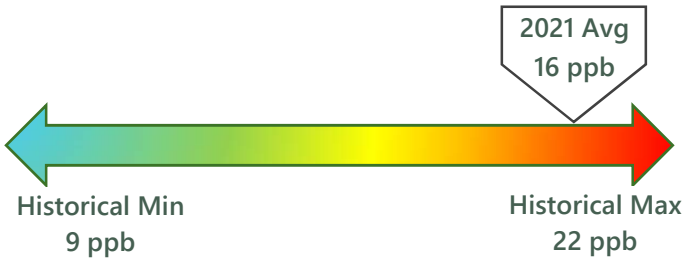
Water clarity readings in 2021 ranged from 1.55 meters (October 10th) to 5.91 meters (July 1st) with an annual average of 3.1 meters. 26 total readings were collected in 2021. Water clarity fell below 2 meters depth in late September, documenting the second **lake-wide algal bloom** in the lake's historical record. The bloom persisted through October.

Water Clarity (m)	
2021 Water Clarity Average	3.1
Historical SDT Average	4.3
Maine Lakes SDT Average	4.8



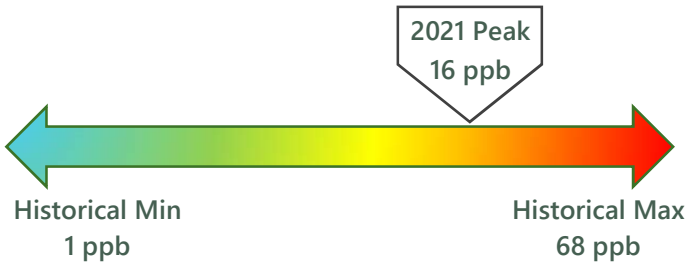
Seven (7) samples were collected and analyzed for **Total Phosphorus**. Laboratory results ranged from 11 ppb (parts per billion) to 20 ppb with an average of 16 ppb. Peak phosphorus concentrations in 2021 coincided with most significantly reduced water clarity readings.

Total Phosphorus (ppb)	
2021 TP Average	16
Historical TP Average	14
Maine Lakes TP Average	12



Chlorophyll was measured six (6) times in 2021. Results ranged from 3 ppb (June 17th, July 15th, and August 12th) to 16 ppb (October 5th) with an annual average of 7.8 ppb. Peak chlorophyll concentrations align with lowest water clarity readings and highest in-lake phosphorus samples.

Chlorophyll-a (ppb)	
2021 Chl-a Average	7.8
2021 Peak Chl-a	16.0
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 2021 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

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.

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.

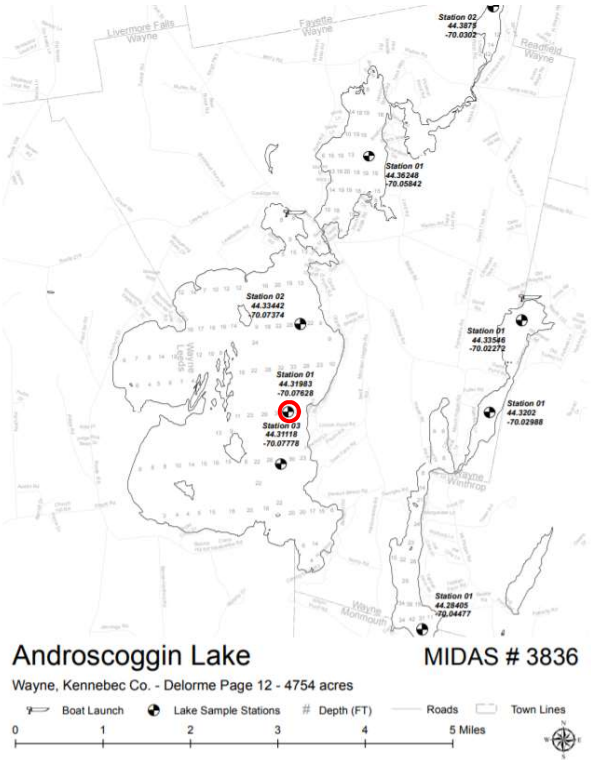


Figure 1. Androscoggin Lake Monitoring Stations.

Androscoggin Lake is relatively shallow with a maximum depth of 12m (38 ft) and an average depth of just 4m (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 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 2021

Water quality monitoring on Androscoggin lake takes place at the deepest spot in the lake (Maine DEP Station 1), located southwest of Lincoln Point in Wayne. Station 1 is just over 12 meters (38 ft) deep (Figure 1). Monitoring in 2021 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 2021 volunteers:

Patt Koscinski
Allen & Cynthia Unrein
Buddy Cummings
Tom Wells & Martha Hoddinott
Jim & Kathy Laptewicz
Todd Perkins

Androscoggin Lake's 2021 water quality volunteers, Patt Koscinski and Allen Unrein.

In 2021, water quality monitors collected data on 16 dates between June and December. Parameters collected include Secchi disk transparency, dissolved oxygen and temperature, phosphorus, chlorophyll-A, 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)	
2021 Water Clarity Average	3.1
Historical SDT Average	4.3
Maine Lakes SDT Average	4.8

The Maine Department of Environmental Protection (Maine DEP) defines a "lake-wide algal bloom" as Secchi disk transparency less than 2 meters (~6 ft) deep, when collected at the deep spot monitoring station. Water clarity readings in 2021 ranged from 1.55 meters (October 10th) to 5.91 meters (July 1st) with an annual average of 3.1 meters. 26 total readings were collected over 16 monitoring days (Figure 2).

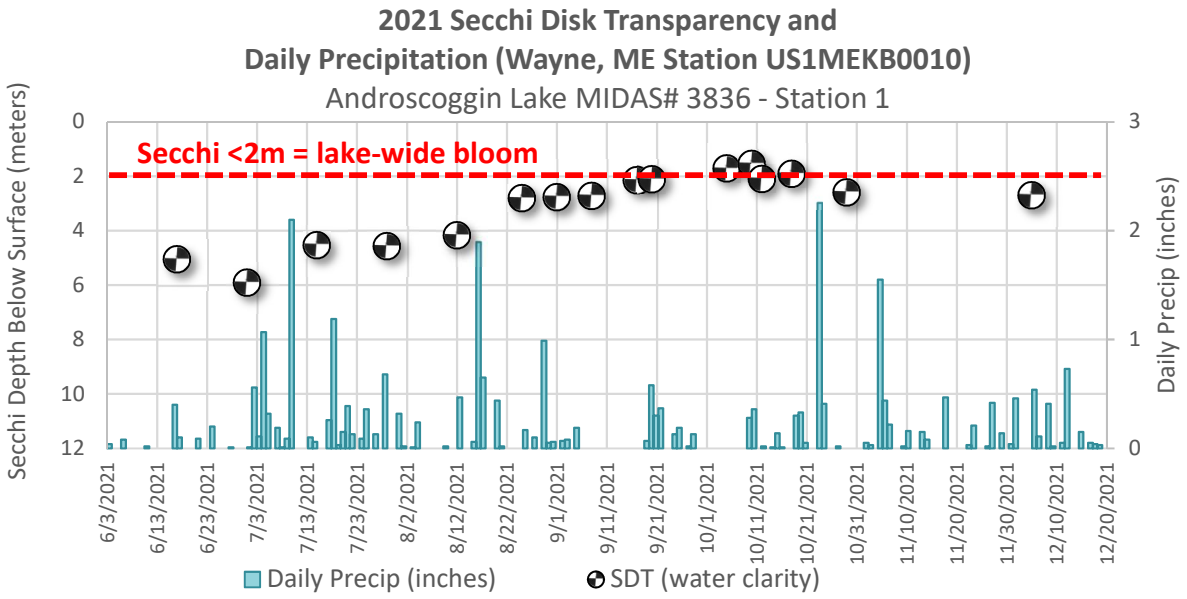


Figure 2. 2021 Secchi Disk Transparency, Station 1, and daily precipitation, Wayne, ME

Starting in late August, 30 Mile and ALIC received reports of localized algal blooms in coves and along down-wind shorelines. These isolated ephemeral blooms are concentrated by the wind, disperse quickly, and are not uncommon on Maine lakes during the hot summer months, especially after rain events. Though water clarity was significantly reduced within these ephemeral

blooms, it was late September when water clarity had officially reached lake-wide bloom status (SDT < 2m at Station 1) as defined by Maine DEP. Clarity remained below or just above 2 meters at Station 1 through October and November, with the last water clarity reading collected on December 5th showing only a slight improvement at 2.7 meters.

Volunteer monitor, Patt Koscinski, collects clarity data using a Secchi disk and scope in September, 2021.

Historically, SDT data was collected on Androscoggin during 47 of the past 52 years. Readings ranged from 1.1 m (1999) to 7.3 m (1972) with an average annual reading of 4.3 m. 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 15 years with lake-wide bloom conditions (SDT <2 meters) documented just two years in 1999 and 2021 (Fugure 3).

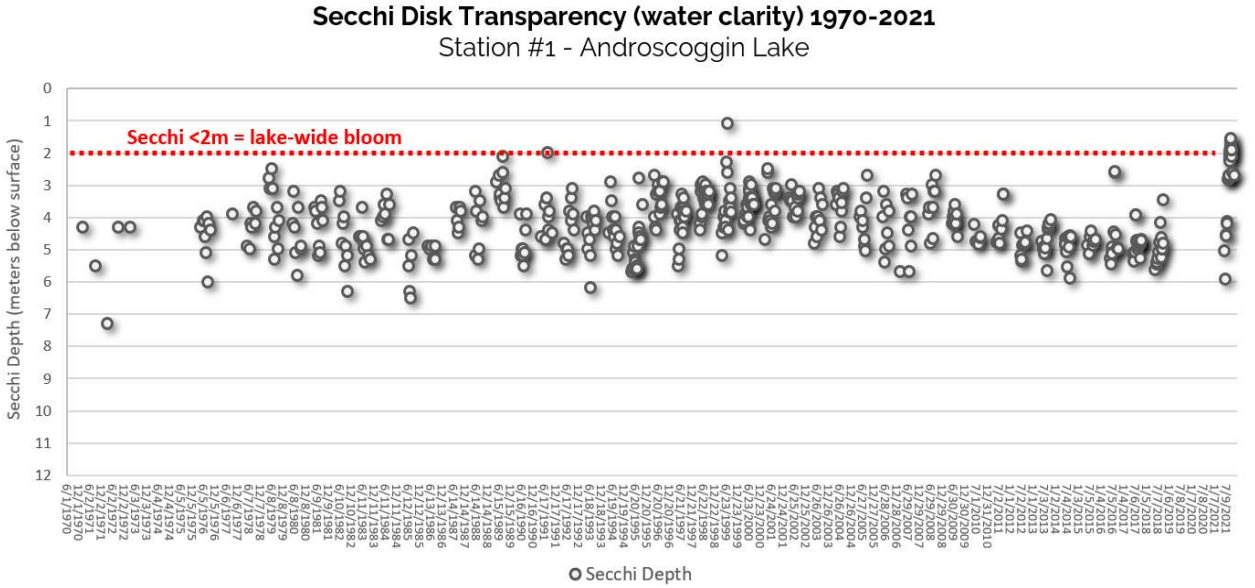


Figure 3. Historical Secchi Disk Transparency, Station 1, 1970-2021

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 ppm (parts per million) or more. As lakes become more biologically productive in the summer, oxygen can decline as decomposition occurs in deep areas of the lake. Loss of oxygen may indicate a stressed and changing ecosystem. Understanding the pattern and extent of oxygen loss in deep areas of

Androscoggin Lake is particularly important because the lake is more vulnerable for internal phosphorus loading due to its unique sediment chemistry.[2]

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). Shallow lakes may experience brief or periodic occurrences of thermal stratification throughout the open water season, but most often shallow lakes are homothermous, with consistent temperature and dissolved oxygen levels from the lake surface to the lake bottom. Androscoggin Lake is considered a homothermous lake. However, in 2021 the lake appeared to be stratified (weakly) from mid-late July through the month of August. During this time, DO levels <2 ppm were documented in deep water to a depth as shallow as 8 meters.

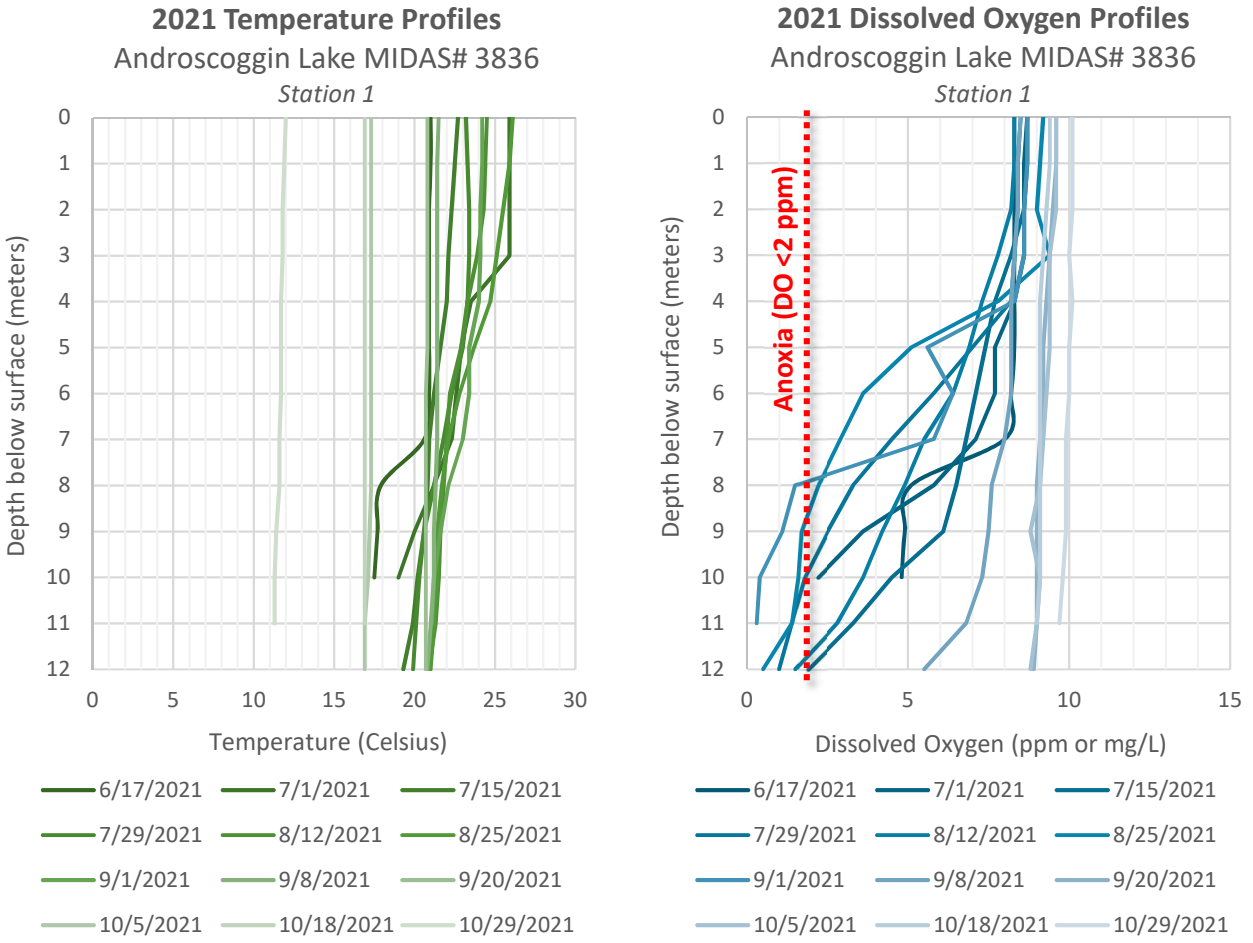


Figure 4. 2021 Dissolved Oxygen and Temperature Profiles, Station 1

[2] 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 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 ppm) resulting in phosphorus release from the bottom sediments exposed to anoxic waters.

DO levels <5 ppm were documented in every profile collected in 2021 starting in June through September. Water surface temperatures at his time ranged from 20.8 C (69 F) on September 20th to 26.1 C (79 F) on August 25th with an average surface water temperature of 23.3 C (74 F). Continued collection of bi-weekly DO and temperature profiles will identify trends and changes occurring in Androscoggin Lake in order to better understand variations in stratification and the area of seasonal anoxia in deep waters.

Total Phosphorus (TP)

Total Phosphorus (ppb)	
2021 TP Average	16
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. 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.

Nine (9) samples were collected by 30 Mile staff this year and analyzed for Total Phosphorus (TP). Samples were collected monthly between June and October. Seven (7) of these were collected from the lake surface using an integrated core sampler and are referred to as "epilimentic core samples". Laboratory results for epilimnetic core samples collected in 2021 ranged from 11 ppb (parts per billion) to 20 ppb with an average of 16 ppb (Figure 6).

Generally speaking, in-lake phosphorus concentrations (epilimnetic core samples) 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 frequent as in-lake average concentrations approach 20 ppb. Historically, annual average in-lake phosphorus concentration in Androscoggin Lake ranged from 9 ppb (1978 and 2013) to 22 ppb (2003) with an average historical average of 14 ppb (Figure 5).

Two (2) samples were collected from the bottom of Androscoggin Lake 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 to determine if there is active phosphorus release from bottom sediments exposed to anoxic conditions. TP laboratory results for the two bottom grabs collected in 2021 were 24 ppb (July 15th) and 34 ppb (August 12th) with an annual average of 29 ppb. Internal P loading from bottom sediments did occur this summer during periods of anoxia, but it was not well documented through the collection of just two bottom grab samples in 2021 indicating elevated P concentrations at one location (deep spot) of the lake at this time.

Historically, bottom grab phosphorus samples have been collected during 17 years starting in 1994, but recently have only been collected two years since 2008 (2014 and 2021). Annual average

bottom phosphorus concentrations have ranged from 8 ppb (2014) to 36 ppb (1999) with 2021 documenting the second highest average on the historical record.

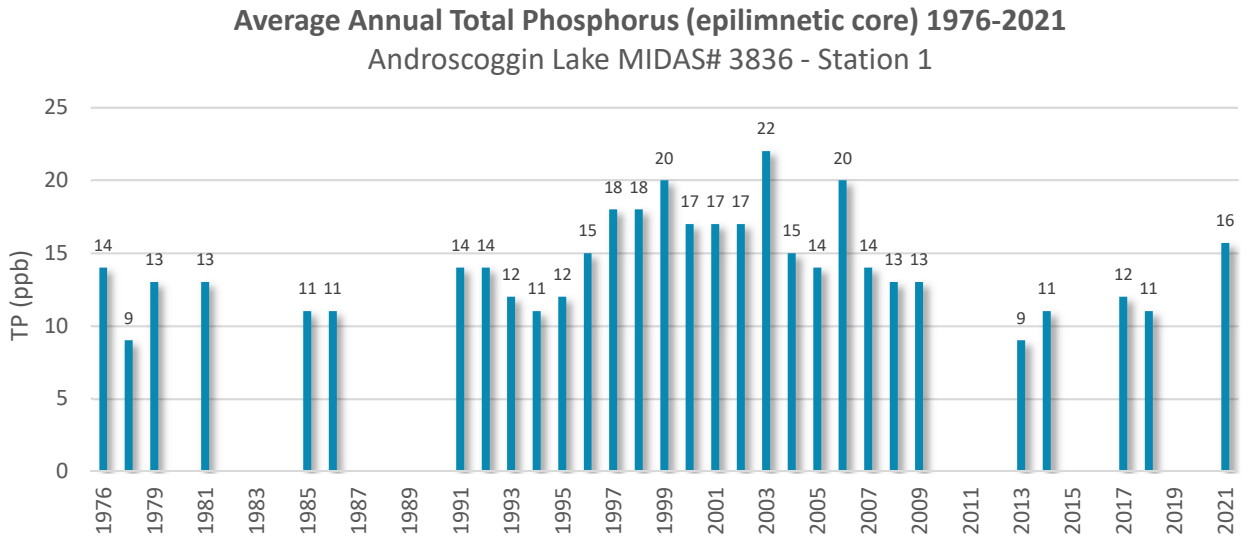


Figure 5. Annual Average Total Phosphorus data (epilimnetic core samples) collected 1976-2021, Station 1

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. Chlorophyll was measured six (6) times in 2021.

Chl-a (ppb)	
2021 Chl-a Average	7.8
2021 Peak Chl-a	16
Historical Chl-a Average	5.8
Maine Lakes Chl-a Average	5.4

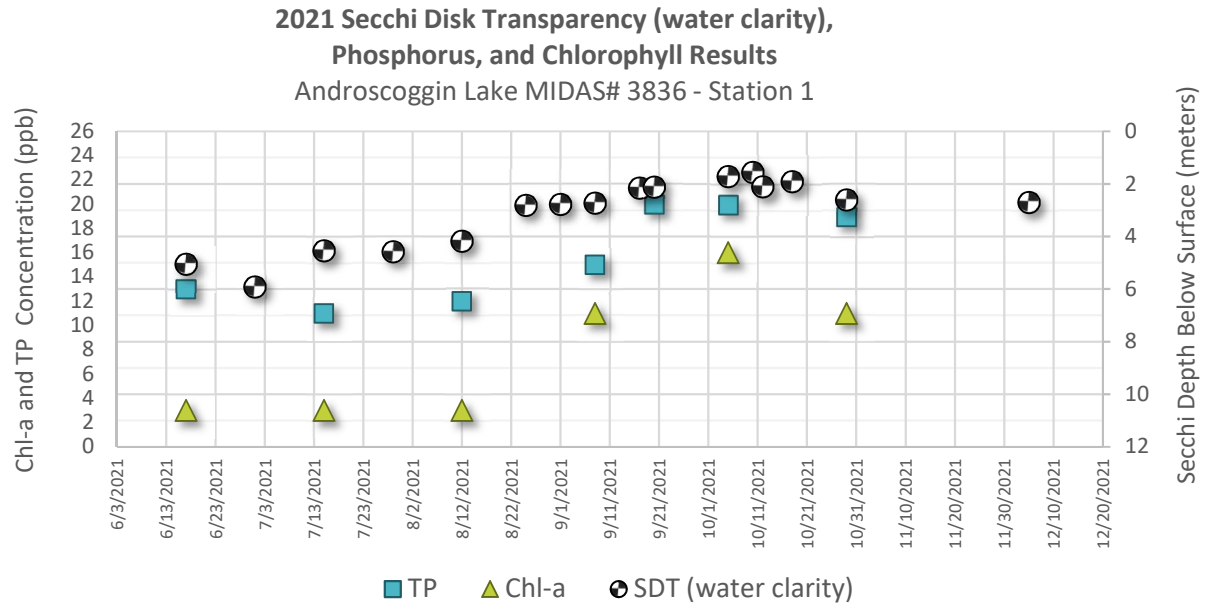


Figure 6. 2021 Chlorophyll, Phosphorus, and Water Clarity Results

Results ranged from 3 ppb (June 17th, July 15th, and August 12th) to 16 ppb (October 5th) with an annual average of 7.8 ppb (Figure 6). Historical monitoring data collected between 1976-2021 ranged from 1 ppb to 68 ppb with a historical annual average of 5.8 ppb (Figure 7).

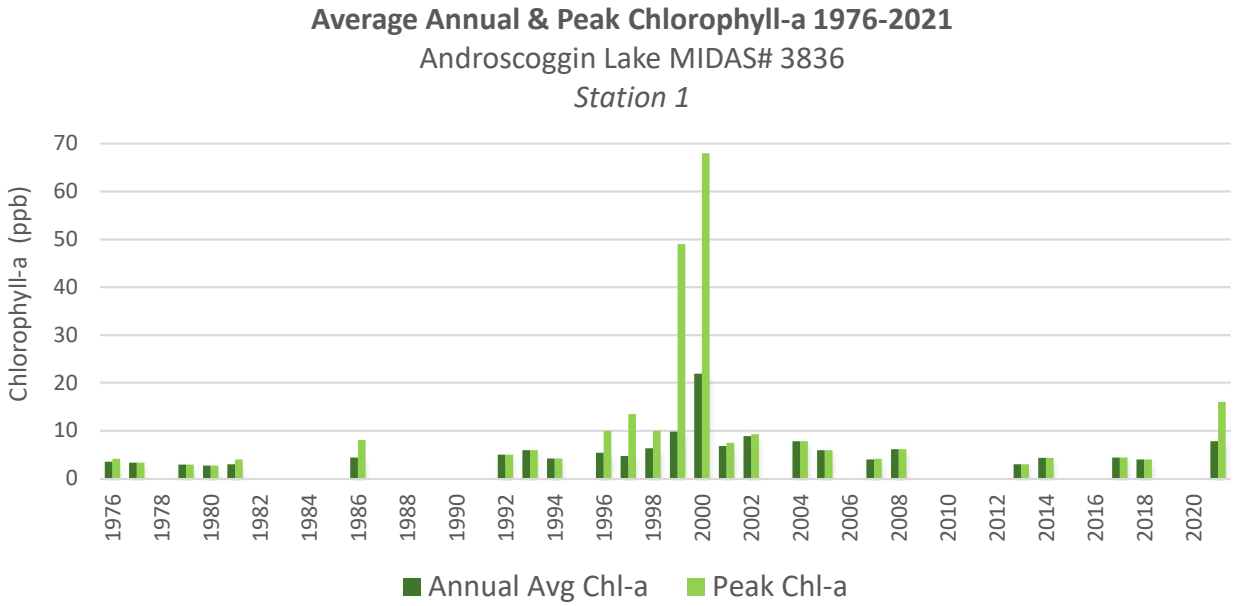
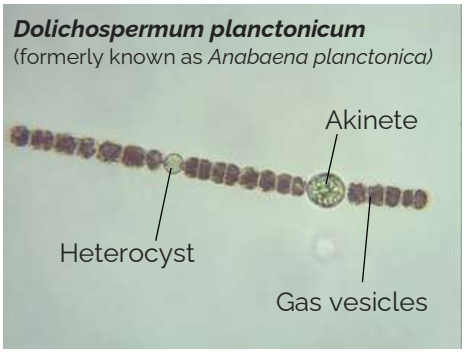
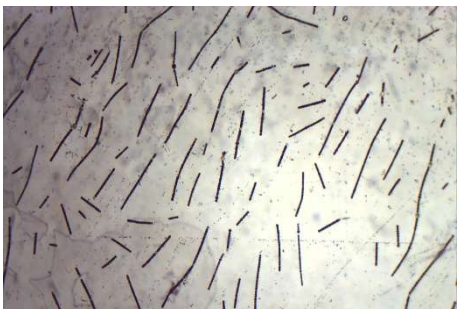


Figure 7. Annual average and peak chlorophyll-a, station 1, 1976-2021

Discussion

The bloom in 2021 was caused by cyanobacteria, 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 stormwater runoff from the watershed (the surrounding land draining to the lake) brings in enough nutrients (e.g. phosphorus), and conditions are just right, their population can explode. The result is what we call a "cyanobacteria bloom" or "algal bloom."





Microscope images courtesy of R. Windecker, 2021

The species of cyanobacteria causing the bloom in 2021 has been identified as *Dolichospermum* (formerly known as Anabaena), a common bloom-forming species in Maine lakes. Microscope photos (right) 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 can produce toxins under certain environmental conditions.

The species causing this bloom has the ability to produce toxins, but we do not have toxin results at the time of this report. 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. No open water samples have exceeded EPA's Recreational Standard – even when collected from lakes with blooms that are chronic and severe.

Shoreline scum formation at the public boat launch on Route 133 in Wayne – October 13, 2021.

However, Maine DEP has detected *very high* concentrations of the algal toxin microcystin on other lakes in down-wind algal scums that can accumulate along shorelines. This is why we advise everyone to stay away from any concentrated scums or accumulations near shorelines or in down-wind coves. Do not inadvertently drink the water in these areas, and do not let small children, pets, or livestock play in these areas or drink from the lake. 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!*

Our current understanding is that the bloom was caused by phosphorus loading from the surrounding watershed. Every time it rains, water flows over the land and flows downhill into the ditches, streams, and the Lake. This overland flow of rainwater is often called stormwater runoff. When stormwater flows over a developed area, it picks up pollutants, sediment, and nutrients (e.g. phosphorus) and carries them to the lake. Polluted stormwater runoff is of great concern in the Androscoggin Lake watershed because when too much phosphorus enters the lake, excess algae growth occurs. With the average in-lake phosphorus concentration already at 15 ppb, even small increases can provide a perfect environment for an algal bloom.

The watershed areas most likely to have an impact on water quality are the direct watershed surrounding the lake and the Dead River upstream of the Dead River dam, which this summer may have flowed into the lake instead of into the Androscoggin River due to several unusual factors.

Cyanobacteria rely on three things: light, temperature, and phosphorus. It is likely that the high air and water temperatures this summer, in addition to the ongoing input of phosphorus as a result of stormwater runoff during summer rain storms, created the perfect environment for an algal bloom. To prevent another algal bloom, we must greatly reduce the phosphorus flowing into the lake from the watershed.

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

Five years of consecutive data collection for any given parameter will provide the 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 our 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 and depth map.

Next Steps

1. Assess the watershed to find problem areas potentially impacting water quality. This will be accomplished by facilitating a Watershed Survey in the direct watershed of Androscoggin Lake, planned for May 2022.

2. Develop a Watershed-Based Protection Plan and apply for a Section 319 grant through Maine DEP to fund remediation work at high-export sites.

3. Continue bi-weekly 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.

4. Calculate the internal phosphorus load released from bottom sediments in a given year by collecting TP profile grabs at Station 1 on a bi-weekly schedule from May to October.

5. Consult dam management experts to review the current dam management strategies, and determine if changes are needed to prevent flow reversal during low-flow conditions.

6. Continue and ramp up LakeSmart programming to bring education and solutions to lakefront property owners.

7. Work with watershed towns to create a septic system database to prioritize outreach and offer technical assistance to landowners with failing or improperly designed/installed systems.