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Ellis (Roxbury) Pond 2021 Water Quality Assessment

April 2022

Perspective:

The annual characterization of the water quality of Maine lakes can be challenging to lake scientists because lake ecosystems experience a high degree of "natural variability". One of the strongest influences on this sometimes confounding factor is the weather, and typically, foremost among the many forces of weather on lakes is precipitation. Many Maine lakes tend to be clearer during drier years, ostensibly because of reduced stormwater runoff during such periods, and stormwater runoff is the vehicle that transports phosphorus and other pollutants from watersheds to lakes. Conversely, lakes tend to be less clear during years when there is more precipitation during the period from January through the middle of summer.

While a majority of Maine's lakes "behave" this way, there are always a significant number of exceptions to this generalized prediction, both in the degree of variability that occurs with individual lakes, and the fact that some lakes respond to precipitation in an opposite manner, for reasons having to do with other weather influences (temperature, wind, etc.), as well as factors pertaining to the unique characteristics of individual bodies of water, including the annual flushing rate, watershed (and lake sediment) geochemistry, bathymetry (depth variability) and much more. Some highly productive lakes that experience regular severe algae blooms can actually benefit from the diluting effects of precipitation, because phosphorus concentrations in the body of water are already high.

Climate warming, and associated extreme weather events, such as drought, unusually warm weather, and high-intensity precipitation events, compound the complexity of tracking, predicting and characterizing lake water quality. Reduced periods of ice cover, resulting in longer periods of light penetration, and warmer lake water, when combined with additional unusual weather events during the open water season, will almost certainly have a negative effect on the health of many of Maine's lakes over time. In recent years, some lakes that have historically been "on the edge", as well as others that were considered stable, have experienced a significant decline, very likely, in part, to the influences of a warming climate.

Possible Weather Influences in 2021:

The most probably overall influence of weather on Maine lakes in 2021 is likely to have taken place in 2020, when much of Maine experienced moderate to severe drought conditions. Drought influences the indicators used to assess lake water quality in a number of ways, most notably in that many (but not all) Maine lakes appear to be clearer during drought years, very likely due to reduced runoff and phosphorus loading from their watersheds. The effects of drought can last well into the following years, especially in lakes that have relatively low flushing rates. However, the natural flushing rate for Ellis Pond is 3.86 flushes/year – a relatively high rate, compared to other Maine lakes for which data are available. Flushing rate is a function of the volume of an individual lake, relative to the area of its watershed, combined with annual average precipitation for the area. The watershed area for Ellis Pond (26 square miles), relative to the volume of this relatively small (916 acres surface area) and shallow (average 9 feet) body of water account for the moderately high flushing rate.

2021 Overview and Summary of Findings for Ellis Pond:

The following summary information is based on "baseline"sampling and assessment conducted for Ellis Pond on August 27, 2021. Sampling was conducted at the "deep hole" station (approximately 43 feet depth), where the greatest volume of historical data have been gathered for several decades. Limited sampling in 2021 was due to logistic and safety restrictions associated with the COVID 19 pandemic, as well as a personal health limitation. Late summer/early fall sampling of Maine lakes is often the most critical period of the year for conducting critical baseline water quality monitoring, because conditions in the lake associated with stresses associated with several months of warm weather are often most evident. However, the ability to effectively identify long term trends generally requires greater sampling frequency over a period of several months and multiple years.

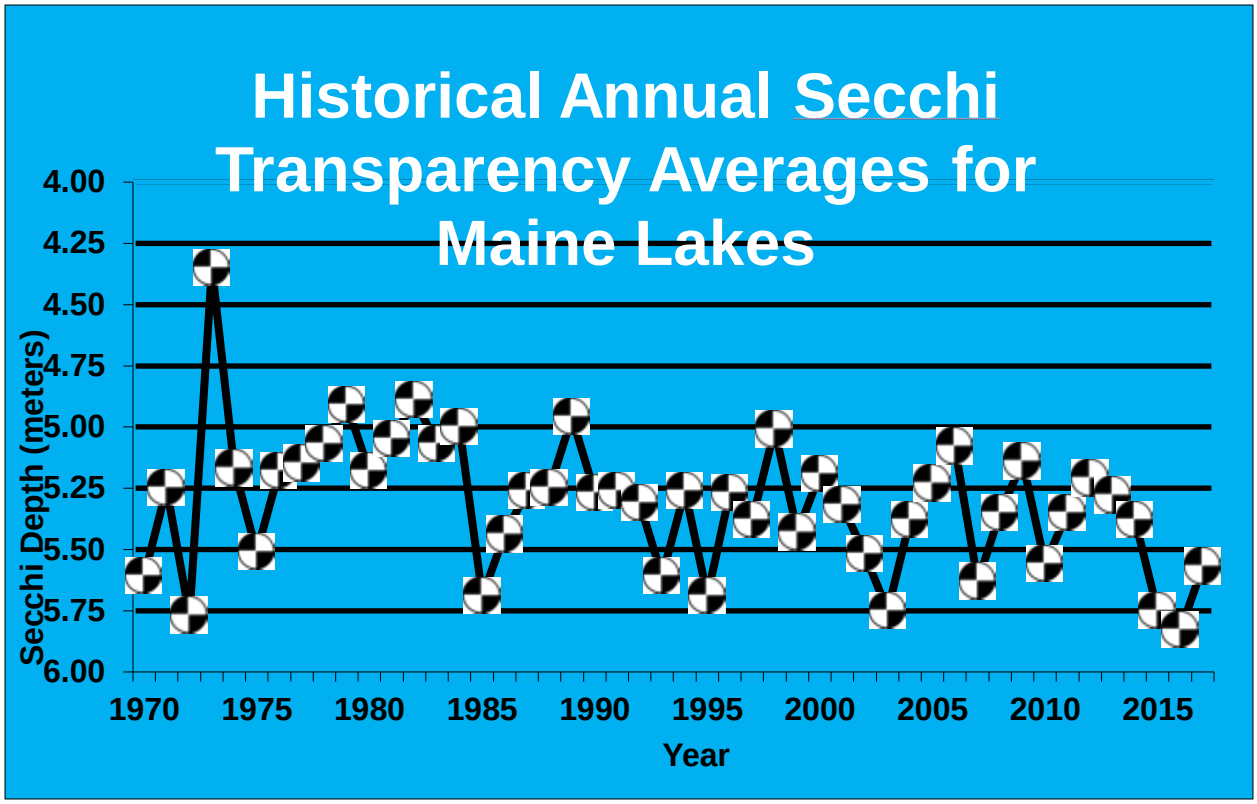
Historical data sources referenced are from the Maine Department of Environmental Protection, Lake Stewards of Maine (www.lakesofmaine.org), and LWRMA field records and reports.

Additional data used in this assessment included extensive information gathered by LSM certified volunteer lake monitor, Ross Swain. This data has been very helpful in interpreting the conditions leading up to, and following the baseline conditions documented on August 27.

Based on our baseline water quality monitoring of Ellis Pond on August 27, 2021, conditions in the lake appear to have been approximately average to slightly above average in 2021. Our Secchi transparency (water clarity) reading on that date measured 5.90 meters depth. When combined and averaged with the Secchi data gathered by Ross Swain from May through October, the average for the season was 4.34 meters, compared to the historical average for the lake of 4.1 meters. A single reading taken in November was not included because very few November readings have been used in the calculation of the historical average. Epilimnetic core (surface to several meters depth) total Phosphorus (combined organic and inorganic forms) measured 7 parts per billion, significantly lower (better) than the historical average of 11 ppb. A deep grab sample, taken one meter from the lake bottom measured 9 ppb, lower (better) than the historical average of 15 ppb. The deep grab sample may be an indication that some phosphorus had been released from the bottom sediments as a result of anoxic dissolved oxygen concentrations near the bottom. Epilimnetic Core chlorophyll-a (a measure of planktonic algae abundance) measured 4.0 ppb, only slightly lower (better) than the historical average of 4.2 ppb.

Trophic State Indicators:

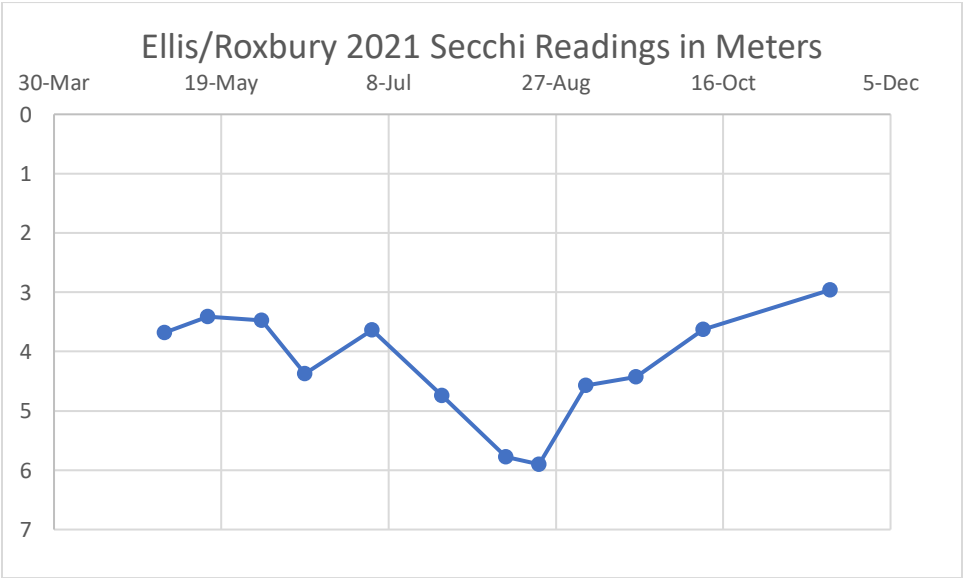
Over a period extending from May 2 through November 17, water clarity (Secchi transparency – the distance one can see down into the water from the surface) Ranged from a low reading of 2.96 meters on November 7 (at which time there was significant algal turbidity in the water column), to a high reading of 5.90M on August 22. The historical average for Ellis Pond, which extends back in time to 1981 is 4.1 meters. The historical average is based on variable sampling frequencies for the years during the period. The historical water clarity average for all Maine lakes has varied in the 5.0-5.75 meter range for the past few decades. Ellis Pond water clarity/Secchi Transparency has been slightly lower than the State average, compared to other Maine lakes for which data are available. See graphic on following page.



Historical Annual Secchi Transparency (lake water clarity) for Maine Lakes Over Time

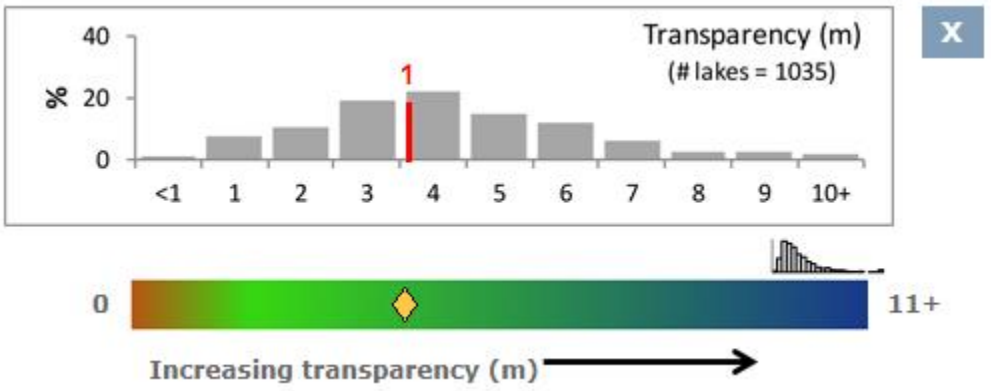
(Data source: Maine DEP)

The graphic below illustrates the variability in Secchi Transparency (water clarity) measured in Ellis Pond from May to November, 2021. With the exception of the August 22 reading, all data were gathered by Ross Swain.

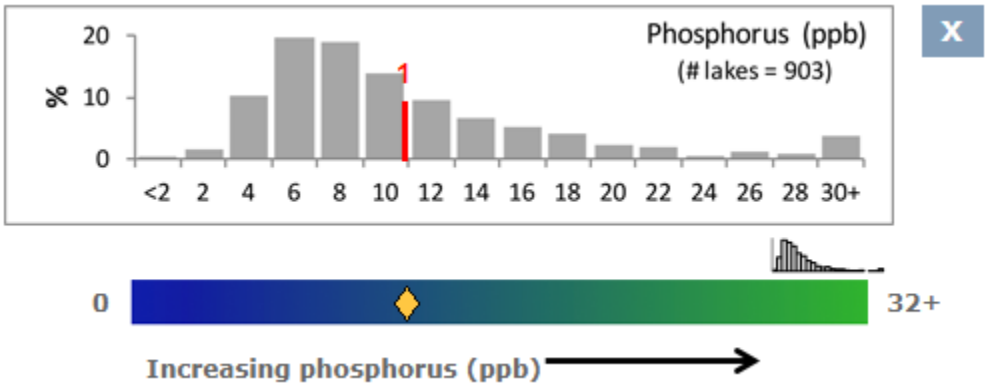


The “color ramps” and bar graph histograms below, produced for the www.lakesofmaine.org website, illustrate the range of lake clarity for several hundred Maine lakes.

The first ramp shows water clarity, ranging from least clear on the left, to clearest on the right. The yellow diamond depicts the historical average for Ellis Pond, illustrating that this lake falls within the end of the water clarity spectrum. The bar graph above the ramp is a histogram which illustrates the distribution of approximately 1,000 Maine lakes within each of the water clarity ranges, represented by the vertical bars. The average for Ellis Pond (red line) is within the high low of the 4-5 meter water clarity range.



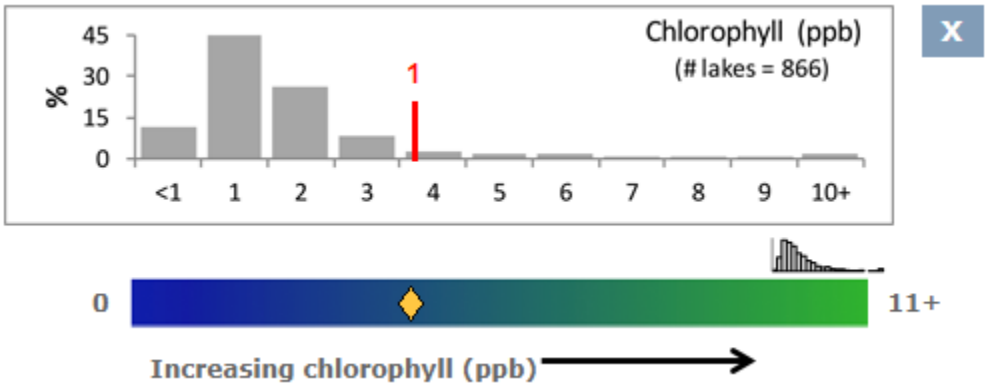
The total phosphorus integrated water column (epilimnetic core) sample taken in August, 2021 measured 7 parts per billion (micrograms per liter). The historical average for the lake is 11 ppb. The long term historical average for Ellis Pond is just below the mid range of the color spectrum. Phosphorus is the critical “limiting nutrient” that most influences the growth of algae in Maine lakes. The histogram graphic illustrates that the average for Ellis Pond is moderate. However, a percentage of the phosphorus in the lake may be bound in non-reactive, naturally occurring humic compounds (natural lake color).



A separate total phosphorus “grab” sample taken near the lake bottom measured 9ppb. This concentration was only slightly higher than the integrated core sample closer to the surface, it is possible that phosphorus had been released from the bottom sediments as a result of recent

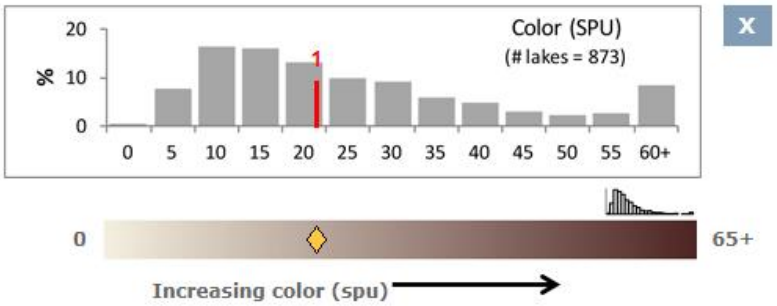
anoxic (zero concentration) conditions in the deepest area of the water column. The phosphorus concentration at that depth was similar somewhat lower than the historical average for samples taken near the bottom of the lake during similar conditions.

An epilimnetic Chlorophyll-a (CHL) sample taken On August 22, 2021 measured 4.0 ppb, a low to moderate concentration, indicating low to moderate density algae growth in the lake at the time. The historical average CHL concentration for Ellis Pond is 4.2ppb. The red bar labeled "1" represents the historical average for Ellis Pond at the Deep sample station 01.



The three "trophic state indicators" of biological productivity (above) in lakes (Secchi transparency, total phosphorus and chlorophyll-a) correlated well in 2021. It is important to note that "instantaneous" samples or "snapshots" taken at a given point in time do not always capture indicators of lake water quality in a state of equilibrium or homeostasis.

Natural lake water color is due primarily to the concentration of dissolved humic acids released from the decomposition of wetland plants in the lake and watershed drainage area. Average color levels of 25 SPU (Standard Platinum Cobalt Units) and, higher, can reduce water clarity, increase total phosphorus and influence chlorophyll levels in lake water. The historical color average for Ellis Pond is 24 SPU. Color fluctuated from year to year, and within seasons. The average level in Ellis Pond is sufficiently high to take into consideration when evaluating trophic water quality indicators. The graphic below illustrates the color average for Ellis Pond.

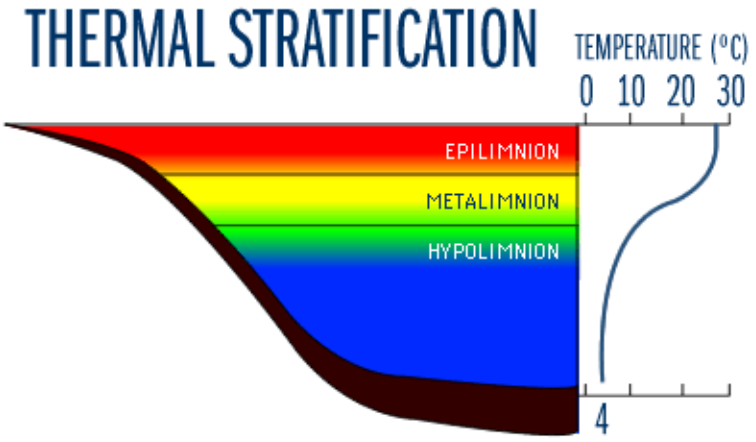


Water Temperature and Dissolved Oxygen:

Temperature and dissolved oxygen profiles were taken from May through November, 2021. Readings were taken from the lake surface to the bottom of the lake (approximately 43 feet depth) at 1 meter intervals. The profiles taken during the 7 month period clearly demonstrated that thermal stratification in Ellis pond is ephemeral, due primarily to the overall shallow depth (9 feet average) of the lake, and the exposure of the lake to prevailing wind from the west and north. Thermal stratification was disrupted due to strong wind on multiple occasions during the summer period, resulting in partial or complete mixing or "turnover' of the water column. In turn, the mixing of the water resulted in replenishment of dissolved oxygen levels in the deepest area of the lake.

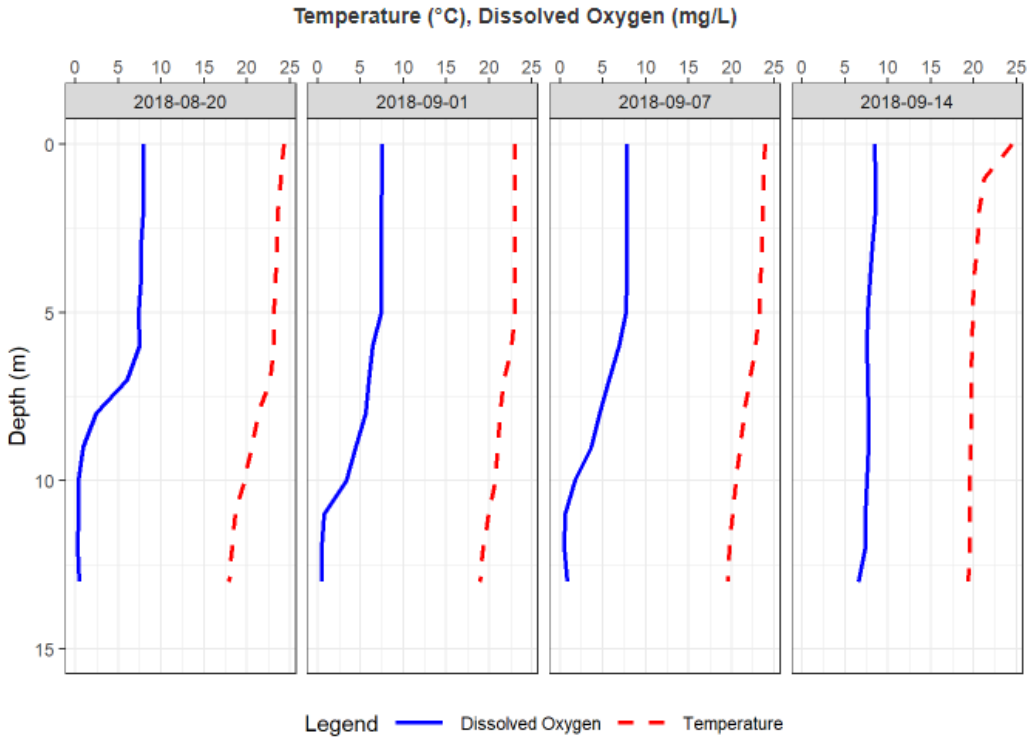
Thermal stratification was first documented on May 31, at which time dissolved oxygen was only slightly depressed (below saturation) at the deepest readings at approximately 12 meters depth. By July 3, DO was anoxic (zero oxygen) at 11 and 12 meters depth. By July 24, anoxic conditions existed from 10-12.5 meters depth (lake bottom). However, on July 12, it was evident that partial mixing of the water column had recently taken place, because DO concentrations at the deepest readings had risen somewhat. By September 5, the temperature gradient from the surface to the bottom of the lake was approximately 0.5 degrees C. It was evident that the lake had completely mixed, as DO concentrations from the surface to the bottom of the lake were nearly uniform, and close to saturation (relative to the water temperature). The temperature gradient for the remainder of the season remained very small, and DO conditions throughout the water column were high.

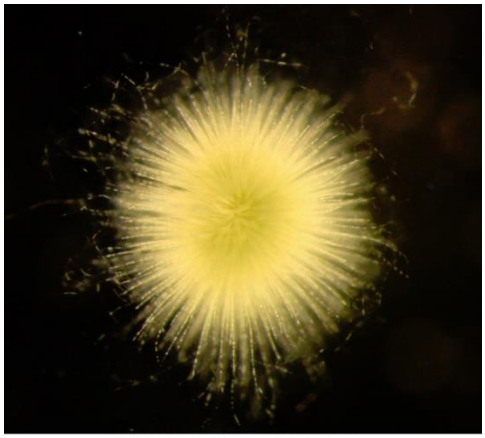
Some loss of dissolved oxygen in the deepest area of the lake during the late summer is not unexpected in most lakes that experience thermal stratification during the summer months. The extent of DO loss during this period can be used as an indicator of stress and vulnerability in the lake. The DO loss documented in Ellis Pond in August, 2021 was not as serious as has been noted in some previous years, due primarily to moderate wind during the early and mid summer period, resulting in frequent partial mixing of the lake.



.**Typical Lake Summer Temperature Profile in a Thermally-Stratified Lake**

The graphics below illustrate recent late summer temperature and dissolved oxygen profiles for Ellis Pond, similar to those obtained in 2021. (Source: Historical data from LWRMA and MDEP).





Gloeotrichia echinulata -- Front-lit colony
Photo by Jonathan Dufresne, University of New Hampshire, USA

Gloeotrichia echinulata is a colonial cyanobacteria (aka: bluegreen algae) that has been observed and documented in low densities in some of Maine, and New England's clearest lakes during the late summer (Aug-Sept) for at least four decades. In recent years, there has been a significant increase in the density of this organism in many lakes in the region. The presence of "Gloeo" in lakes does not appear to be tied to lake productivity, or to anthropogenic influences in lake watersheds. High density Gloeo has been documented in a number of lakes throughout the country where there is virtually no human activity in the watersheds of the lakes. The increase in the presence and abundance of this organism in lakes is the subject of ongoing research. There has been speculation that some aspect of climate change may

be involved in the phenomenon. *No Gloeotrichia colonies were observed in Ellis Pond on August 22, 2021.*

Summary and Recommendations:

Although limited baseline sampling was conducted for Ellis Pond in late August, 2021, conditions at that time suggested that the lake experienced slightly above average water quality during the summer. Water quality continues to appear to be relatively stable, and is approximately average, based on statistical summaries for Maine lakes (Maine DEP).

However, during the past decade, several otherwise healthy Maine lakes have experienced a rapid and unanticipated decline in water quality. Climate warming is likely to have been a factor in this phenomenon. On at least two occasions, residual indications of an "ephemeral cyanobacteria bloom" have been documented in Ellis Pond during the late summer/early fall. The accumulation of concentrated dying cells along the shoreline (captured in photos), the appearance of a colored sheen on the water surface, and microscopic confirmation of the dominance of cyanobacteria cells suggests that conditions in the lake were favorable to the support the events. While not of immediate concerns, the blooms may be an early warning indicator of longer lasting events in the future. This phenomenon may be the result of the influences of climate warming.

Water quality conservation practices, including maximization of vegetated buffers along the shoreline, along tributary streams, and throughout the watershed can help to mitigate the effects of climate warming on lakes. Ongoing efforts to protect the lake should focus on buffer enhancement, the prevention and control of soil erosion, and the treatment of stormwater runoff associated with both existing and new development throughout the watershed. This is a critically important role that the Silver Lake Campowners Association should continue to play in the future.

Prepared by LWRMA Senior Limnologist, Scott Williams