LAKE & WATERSHED RESOURCE MANAGEMENT ASSOCIATES

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2020 Water Quality Overview for Ellis (Roxbury, Silver Lake) Pond

Perspective:

The annual characterization of the water quality of Maine lakes has always been a challenge to lake scientists because aquatic ecosystems experience a high degree of "natural variability". One of the strongest influences on this natural process 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 exceptions to this simplistic generalization, 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 lake ecosystems, including the annual flushing rate, watershed geochemistry, bathymetry, geospatial orientation, and others. Highly productive lakes that experience regular algae blooms sometimes benefit from the diluting effects of precipitation, because phosphorus concentrations are already moderately high.

Climate warming is clearly compounding the complexity of tracking, predicting and characterizing lake water quality. Reduced periods of ice cover, resulting in longer periods of sunlight penetration, and warmer lake water, when combined with more severe weather events during the open water season, will very likely have adverse ecological effects on the health of Maine's lakes over time. Some lakes that have historically been "on the edge", as well as others

that have been considered stable, but which have known risk factors, have experienced a significant decline in recent years, very likely, in part to a warming climate.

Maine Lakes in 2020:

Maine experienced two simultaneous forms of extreme weather in 2020. Much of the State experienced moderate to extreme drought during the period. And by mid-July, lake surface water temperatures in southern and central Maine were as much as 10 degrees warmer than their historical average. "Fish kills" were documented in a number of lakes throughout the state. Maine DIF&W fishery pathologists indicated that the mortality was the result of parasitic infections enhanced by stress from the unusually warm water.

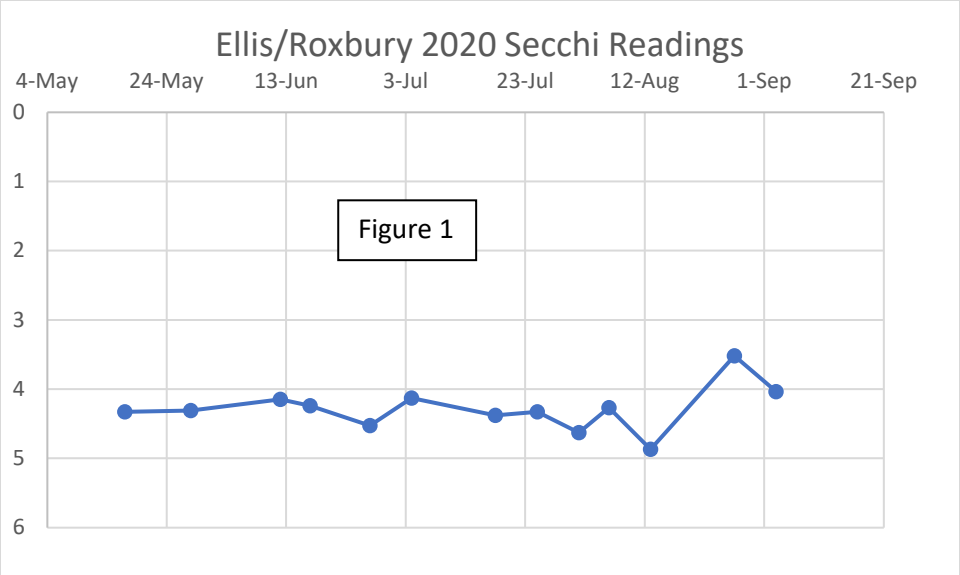
Multiple articles pertaining to the unusual weather influences on Maine lakes in 2020 can be found in the newsletter of Lake Stewards of Maine at the following link: https://www.lakestewardsofmaine.org/wp-content/uploads/2021/02/LSM-tWC-2020-21-WebR2.pdf

Ellis (Roxbury, Silver) Pond 2020 Overview and Summary of Findings:

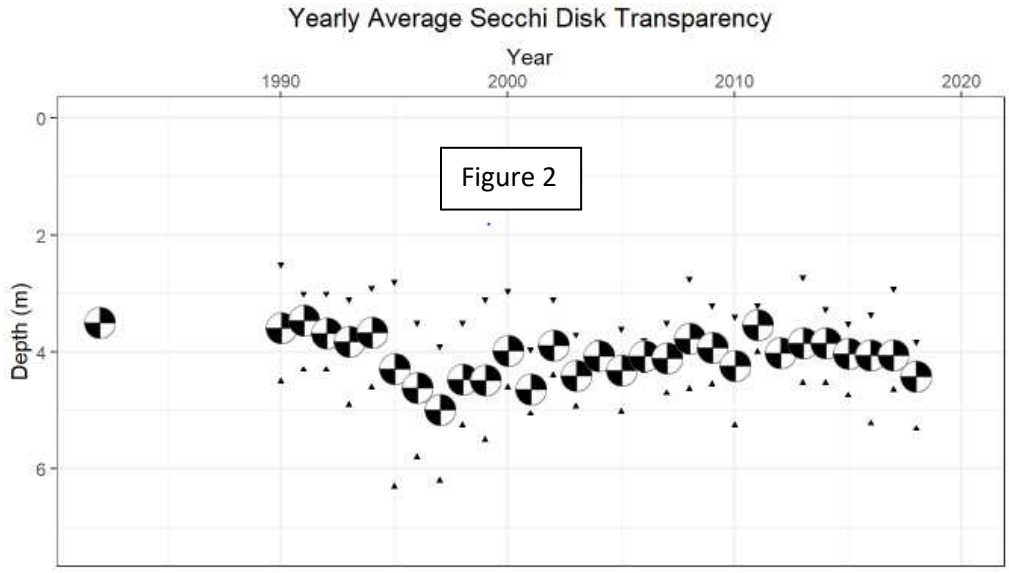
The following summary information is based on sampling conducted on Ellis Pond by LWRMA staff on August 6 and 27, 2020. Significant additional Water clarity/Transparency and temperature and dissolved oxygen data gathered by Certified LSM Lake Monitor, Ross Swain from May through September have also been included in the analysis and preparation of this report. Summary historical data reference sources are the Maine Department of Environmental Protection, Lake Stewards of Maine (www.lakesofmaine.org), and LWRMA field records and reports.

Please refer to Table 1, below regarding all data obtained in 2020.

Overall, the water quality of Ellis Pond in 2020 was slightly better than the historical average for the lake, in that the water was slightly clearer, and the concentration of total phosphorus and chlorophyll-a (algal pigment) were close to, or lower than the historical average for the lake (Table 1). The two graphics below illustrate the annual and seasonal variability in water clarity that occurs in the lake. Figure 1 illustrates the variability that occurred from May through September, 2020. Figure 2 illustrates annual variability since 1990 (including a single reading in 1982). Some of the changes that have taken place from year to year may be partially influenced by the frequency and timing of readings taken. Note that the vertical axes of both graphs are inverted. Seasonal and annual transparency in lakes is common.



Graph Legend: Secchi symbols = average Secchi Disk Transparency Values; tick marks = maximum and minimum values for each year.



The total phosphorus average for the two months (10ppb and 11ppb epilimnetic core samples on August 6 & 27) was slightly lower than the historical average (11ppb) for the lake. Phosphorus samples taken near the bottom of the deepest point in the lake on both sample dates were slightly higher (11 ppb) than surface readings on August 6, and significantly higher (17 ppb) than the surface core reading on August 27at which time the concentration of dissolved oxygen was critically low (0 mg/l) in the deepest area of the lake. This may indicate that that the low oxygen had triggered the release of phosphorus from the bottom sediments. The lake was strongly

thermally stratified in early August, but appears to have partially mixed on August 27, which may account for the decline in Secchi transparency on that date to 3.52 meters, which was the most shallow reading of the season.

The chlorophyll-a (a measure of planktonic algae density) average (3 ppb) for the two samples taken was slightly lower than the historical average of 4.2 ppb for the lake, as indicated in the Figure 1 table below.

True Color, measured in August (10 SPU) was significantly lower than the historical average of 24 SPU. This may also have been a factor that positively influenced lake clarity in 2020, and was likely linked to drought conditions during the summer.

No Gloeotrichia (cyanobacteria) colonies were observed in 2020 on the two August sampling dates. Gloeo colonies have only been observed on a few occasions in this lake, and have been at low densities when observed.

A green/yellow "scum" that had been concentrated along the shoreline in the lake in early summer was confirmed to be composed on the cyanobacteria/bluegreen algae, microcystis. The scum formation quickly dissipated, due to wind and wave action. Any scum formation that is observed in the lake should be considered potentially toxic, especially if ingested by people or pets. The brief appearance of the scum on Ellis Pond did not represent a significant health or water quality threat, because overall water clarity (Secchi disk readings) at the time were well above the threshold (2.0 meters), below which toxic algal blooms have been documented in Maine lakes. More frequent, and longer lasting surface scum in the lake should be document by any observer who has a camera, and the location and time should be noted.

Temperature and dissolved oxygen profiles taken in early and late August showed severe dissolved oxygen loss as early as July 18, and continuing through late summer and early September, although indications of partial destratification (mixing) were evident on August 27. (Thanks to data documented by Ross Swain throughout this period) It is likely that periodic partial mixing of the lake occurred during significant wind events during the summer months. However, oxygen depletion was documented in the deepest 3-4 meters of the lake for several weeks. Phosphorus samples taken close to the bottom at the deepest area in late August were significantly elevated from surface levels, suggesting that anoxic conditions may have triggered the release of P from the sediments.

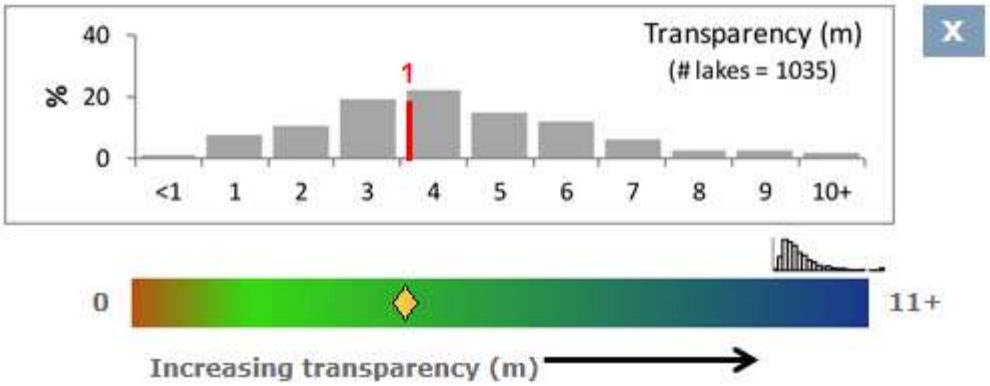
The baseline ratio of the photosynthetic pigment phycocyanin, to other forms of chlorophyll was not measured in 2021, due to the circumstances of the COVID pandemic, and limited available laboratory support. The purpose of this analysis is to observe the extent to which the ratio may changes over time – a possible indicator of a shift from the normal assemblage of algal species in the lake to one that is more dominated by cyanobacteria/bluegreen algae.

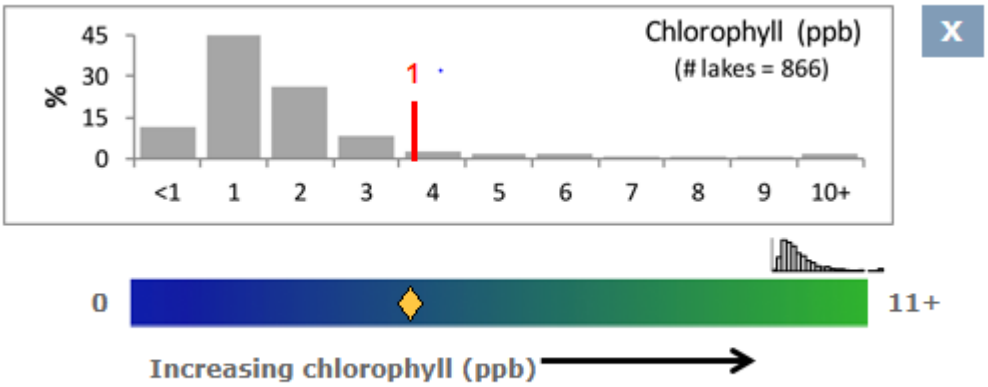
Table 1

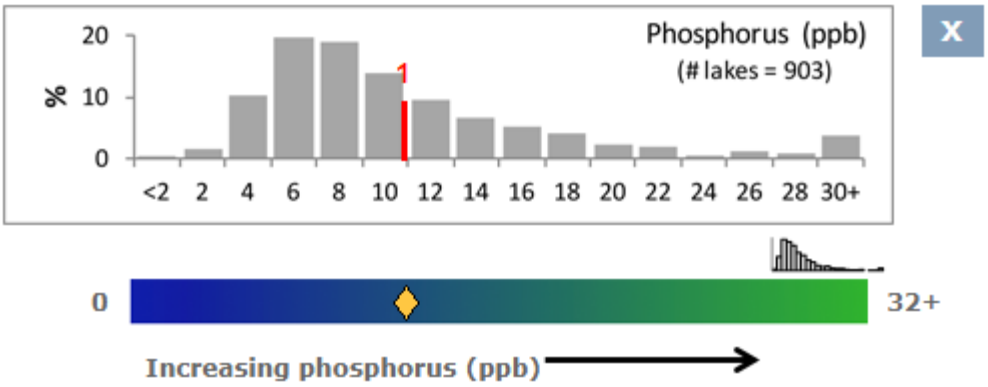
Indicator	Range	2020 Average	Historical Average	Notes
Secchi Transparency in Meters	3.52 (Aub 27) to 4.87 ((Aug 6)	4.04	4.1	
Epi-Core Total Phosphorus in ppb	10 (Aug 6) 11 (Aug 27	10.5	11	
Chlorophyll-a in ppb	3.0 on both Aug 3 & 27	3	4.2	
True Color (SPU)	10 (Aug 27)	10	24	
Dissolved Oxygen mg/l	Lowest readings of 0.1 on several dates	N/A	N/A	
Phycocyanin and CHL Ratio	N/A	N/A	N/A	

The graphics below illustrate the historical average (yellow star) for each of the three primary water quality indicators (Secchi Transparency, Total Phosphorus and Chlorophyll-a). Each color "ramp" shows the continuum of data for Maine lakes. In each case, the long-term average for Ellis Pond is indicated by the yellow diamond above the bar. Note that while "Increasing Transparency" (water clarity) indicates better water quality, the reverse is true for both chlorophyll (algae pigment) and phosphorus, which is why the diamonds are nearer the lower end of the scale for the latter two indicators. Graphics are courtesy of www.lakesofmaine.org .

The bar chart accompanying each color ramp is a histogram that illustrates the distribution frequency for Maine lakes for each indicator. The red line indicates the historical average for Ellis Pond. This graphic shows where the average is situated, relative to several hundred Maine lakes (indicated by "# of lakes)".


Transparency (m)
(# lakes = 1035)
%
40
20
0
1
<1 1 2 3 4 5 6 7 8 9 10+
0
11+
Increasing transparency (m)


Chlorophyll (ppb)
(# lakes = 866)
%
45
30
15
0
1
<1 1 2 3 4 5 6 7 8 9 10+
0
11+
Increasing chlorophyll (ppb)


Phosphorus (ppb)
(# lakes = 903)
%
20
10
0
1
<2 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30+
0
32+
Increasing phosphorus (ppb)

Summary and Recommendations:

The water quality of Ellis Pond continues to relatively stable, although indicators including persistent dissolved oxygen loss, which may be associated with the release of phosphorus from the bottom sediments, and documented evidence of very brief early and late season cyanobacteria algal scums on the lake surface represent a compelling reason to undertake every effort to protect and improve the health of the lake. Toward that end, substantial efforts to address nonpoint sources of soil erosion in the watershed have been successfully undertaken by the Silver Lake Camp Owners Association for multiple decades. As a result, public awareness of the nature of threats to the health of Ellis Pond has improved, as have very specific efforts to resolve a wide range of issues.

The influences of climate change over time could exacerbate summer oxygen loss in Ellis Pond, thereby increasing the risk factor for future problems, primarily in the form of increasing planktonic algae growth, reduced water clarity, and an earlier occurrences and longer duration of cyanobacteria blooms. Warmer water temperatures and higher concentrations of phosphorus may shift algae dominance in the lake to bluegreen.cyanobacteria species.

A high percentage of Maine's lakes could experience change in both expected and unanticipated ways in the future as a result of climate change. Our lakes may be more highly colored (and less clear) from increasing humic acids, and also less clear from increasing planktonic algae growth, caused by reduced periods of ice cover and warmer water temps. Some lakes will experience severe cyanobacteria/bluegreen algae blooms, which can result in toxic conditions in the lake. In recent years, several lakes situated in southern and central Maine have experienced unanticipated, severe algal blooms.

Conservation practices that have been promoted by the SLCOA will continue to serve the lake well as our climate warms. The preservation of vegetated buffers throughout the shoreline and watershed is one of the most effective measures for offsetting the effects of a warming climate. Minimizing sources of soil erosion and stormwater runoff will also continue to be very important, as will be efforts to control new shoreline and watershed development.

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