



*Lake & Watershed Resource Management Associates
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**2018 Report on the Water Quality of Ellis (Roxbury) Pond
Prepared for, and Supported by the Silver Lake Campowners Association, and the Town of
Roxbury**

This monitoring and assessment summary report for Roxbury Pond is based on baseline sampling that took place on August 3 and September 7, 2018 by LWRMA Senior Limnologist, Scott Williams. Additional water clarity, and temperature and dissolved oxygen data gathered from May through October were provided by certified volunteer lake monitors, Ross Swain.

Critical indicators of lake water quality that have been monitored during past years were measured, sampled and assessed using methods and protocol for lake assessment established by the Maine Department of Environmental Protection and Lake Stewards of Maine (Maine Volunteer Lake Monitoring Program).

Overview:

Based on the clarity of the water from May 6 through October 13, 2017, as well as the concentrations of algae and the nutrient phosphorus, and dissolved oxygen in the deepest area of the pond in the late summer, Roxbury/Ellis Pond water quality was above average, compared to historical data averages gathered from 1982 to the present. The water was slightly clearer, and the concentrations of the nutrient phosphorus and algae in the lake were lower than the historical average.

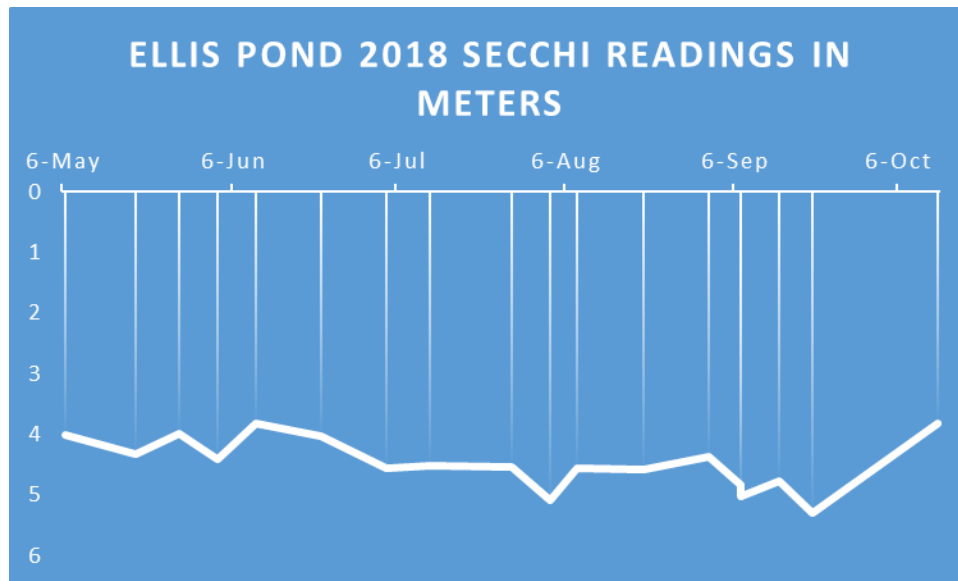
Each lake and pond responds in a unique way to the influences of weather, changes in land use in the watershed, and other forces upon the ecosystem. The wide range of physical, chemical and biological characteristics of each lake basin and its watershed combine with weather, the influence of watershed land use and other factors to help explain the moderate natural annual variability that occurs within lakes over time.

Stormwater runoff is the primary means by which the nutrient phosphorus is transported to lakes from their watersheds. Most of the annual phosphorus “loading” to lakes typically takes place from the period of spring snowmelt through early summer, when watershed soils are generally frozen or saturated with water, resulting in a higher percentage of runoff from rain events during the period. References to rainfall that was measured in the Ellis Pond watershed during the monitoring period appear in the analysis below.

Record ambient air and water temperatures were observed on many Maine lakes during the months of July and August.

Summary of Findings:

The average of the May through October **water clarity** (aka: Transparency) readings (the distance one can see down into the water) taken in Ellis/Roxbury Pond in 2018 was 4.36 meters (~14 feet). The historical average for the lake is 4.0 meters. The clearest reading during the 2018 monitoring season was 5.31 meters, taken on September 20, and the least clear reading of 3.82 meters was taken on June 10 and October 13. Both readings were taken by Ross Swain. The highest reading was higher than the highest in 2017, and the lowest was not as low as the lowest reading taken in 2017. The following graphic illustrates the range of water clarity in the lake, and the variability that occurred during the monitoring period.



The annual average clarity of the pond in 2018 may have been influenced by any or all of the following:

1. Variability in the number of monthly readings, relative to the historical average (greater number of readings may favor detection of improving clarity)
2. Cumulative drought conditions that have persisted during the past 3-4 summers
3. Reduced stormwater runoff from the watershed, due to #2 above and to recent remediation efforts in the watershed undertaken by the SLCOA, individual property

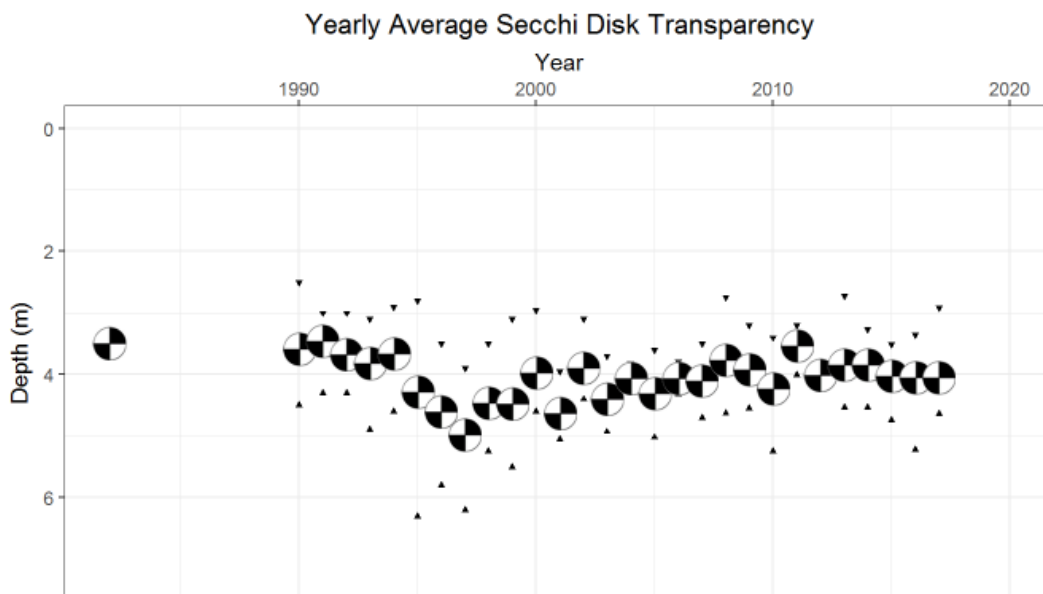
owners and the towns, which over time should have a measurable positive effect on water clarity.

It is worth noting that Ross Swain documented the presence of “green particles” suspended in the water along the shoreline on September 14. The particles appeared to be the same cyanobacterium that has been identified in the pond in recent years during the early fall, ostensibly at a time when the lake has recently mixed, and any internally-released phosphorus would have been integrated with the surface water, where it could have stimulated the algal growth.

On two occasions last summer, samples taken from the lake were frozen, and later analyzed using a fluoroscopic device to measure the concentration of phycocyanin (PCY), a photosynthetic pigment found in algae. The ratio of the concentration of PCY was measured against all other forms of chlorophyll (CHL) in the sample. We will continue to measure this ratio over time as a possible early warning indicator that a shift in the lake algal community toward cyanobacteria is taking place. The samples taken in August and September represent the initial baseline readings for Ellis Pond.

The graph below illustrates the variation of water clarity in the lake from 1982 through 2017 (2018 graphic not available at the time of preparation of this report). The hatched disk represents the average for the year. Small markers above and below the disks represent the lowest and highest readings for each year represented. Note that for some years during the period, annual averages are based on only a few readings (for example, only one reading was taken in 1982, and only two readings were taken on several years). Some of the annual variability is likely influenced by the relatively small number of readings for individual years. For the past several years, certified volunteer lake monitors have submitted full seasons of Secchi transparency data. (Source: Maine DEP/LSM).

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



User perception surveys that have been conducted in Maine, and throughout the U.S., have consistently shown that the characteristic of lakes that is most highly valued by the public is “clear water”. Water clarity, also referred to as “Secchi transparency”, is the distance that one can see down into a lake from the surface. It is one of several key indicators used to assess the quality of Maine lakes.

Phosphorus is the nutrient in lakes that most directly influences the growth of algae in the water, which in turn influences water clarity. Integrated (mixed/average) epilimnetic core total phosphorus samples taken at the sample station located in the deepest point in the lake measured 9 parts per billion (ppb) in August, and 12 ppb in September, averaging 10.5 ppb for the year (11.5 ppb in 2017). The historical average for the pond is 12 ppb. *Annual* average phosphorus concentrations for Ellis Pond have ranged from a high of 14 ppb in 1993, 2000 and 2009, to a low of 9 ppb in 1995, 2014 and 2015. Variation of one or two parts per billion from year to year is well within the range of seasonal and annual natural variability for Maine lakes. The average of 12 ppb for this lake is considered moderate.

Phosphorus samples taken near the bottom of the deepest point in the lake in August and September showed only a slight increase in concentration, compared to the surface sample in August (13 ppb at 11 meters depth compared to 9 ppb at the surface layer), and no increase (12 ppb surface and deep) in September, likely due to recent mixing of the water column. This sampling process helps determine whether or not the low dissolved oxygen levels in the lake (see below) are causing phosphorus to be released from the bottom sediments-and potentially stimulating the growth of algae. The higher concentrations of phosphorus in the bottom during late summer when dissolved oxygen has been depleted in the deepest area of the lake may

indicate that under the right circumstances, this phenomenon does occur in Ellis/Roxbury Pond. This is consistent with historical samples from the lake, which have also suggested that phosphorus recycling from the bottom sediments may take place when oxygen levels are low.

This could be a potential cause for future concern, because lake sediments generally contain a significant reservoir of phosphorus, capable of causing a negative change in water quality under certain circumstances. The recycling of phosphorus from the bottom sediments in Ellis Pond may not be significant at this point in time, largely due to the total sediment area in the pond that is exposed to anoxic conditions during the late summer (a relatively small percentage of the lake bottom is exposed to low-oxygen conditions, due to the overall shallow depth of the lake). However, stress to the lake ecosystem caused by additional phosphorus inputs from development in the watershed has the potential to increase the risk factor for internal phosphorus release. The combined effect of both internal and external phosphorus loading could result in a decline in water quality.

Chlorophyll-a is a pigment that is found in plant cells. Measured in lake water, it is a direct indication of the amount of algae growing in the water. The August and September chlorophyll-a (CHL) samples measured 3.0 ppb on both dates, resulting in an average of 3.0 ppb for the summer. The historical average for Ellis is 4.2 ppb. The 2018 average is one of the lowest annual averages for several years. 2016 was also relatively low at 2.8 ppb. Because each of the readings and samples represent “instantaneous” conditions in the lake, the primary water quality indicators may not always appear to be in phase with each other. A full season of sampling might provide a better understanding of the water quality dynamics of the lake.

Temperature and dissolved oxygen profiles were taken in July and August by LWRMA staff, and throughout the May-October monitoring period by certified lake monitor, Ross Swain. As noted above, and documented through the full season of temperature and oxygen data gathered by Ross Swain, thermal stratification in this lake is “ephemeral”, meaning that the relatively shallow depth profile for the lake is such that although thermal stratification does take place, it takes relatively little energy from the wind to mix and destratify the water column. This can be a significant risk factor for lakes that also experience the release of phosphorus associated with low DO during the open water period.

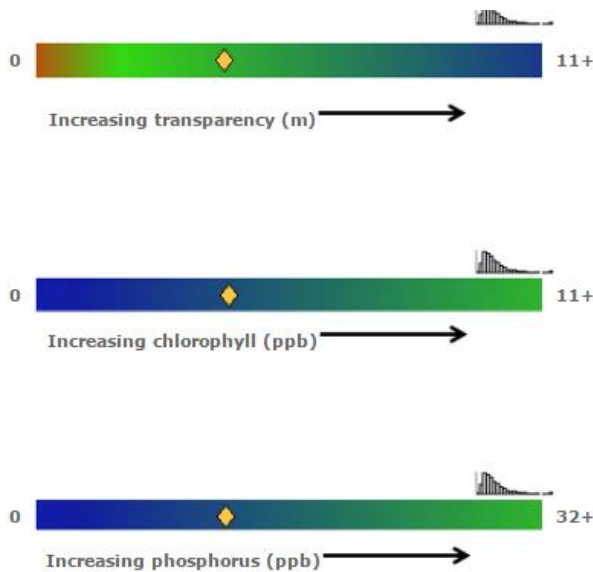
Oxygen loss in this lake during the summer months has the potential to overshadow otherwise somewhat stable water quality conditions, if the phenomenon worsens over time. The loss of oxygen is linked to algae growth, which at the present time is low to moderate, based on recent CHL levels. Algae growth is linked to phosphorus levels in the water, which in turn is related to watershed development. The use of watershed conservation practices to minimize soil erosion from private and public roads, and which encourage land owners to maintain vegetated “buffers” to reduce stormwater runoff to the pond from developed areas can be an effective long-term strategy for reducing algae growth and protecting the pond from a future water quality decline.

Following ice-out on May 2, the onset of thermal stratification was documented in mid-May, and early indications of significant dissolved oxygen loss associated with stratification were evident by the middle of July. Oxygen loss in the deepest area of the lake continued steadily through July

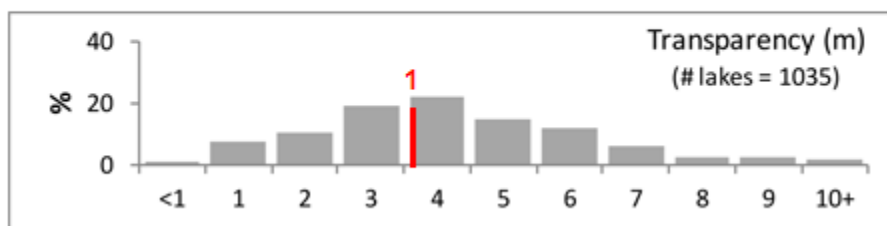
until the middle of September when evidence of de-stratification and re-oxygenation of the water column were evident.

Full, or partial mixing of the water column may result in short, and sometimes extended periods of reduced lake clarity, in part due to the turbulence of the event, and the suspension of material in the water from the bottom sediments. Strong wind (20-25 mph gusts) was documented on June 9, apparently sufficient to nearly cause mixing and re-oxygenation of the water column. The periodic partial mixing of Ellis Pond complicates the analysis of internal phosphorus release and mixing with the overlying water.

The following graphics, taken from the Lake Stewards of Maine’s www.lakesofmaine.org website, illustrate the position of Roxbury/Ellis Pond for the primary indicators of lake productivity, aka “trophic state” (long-term averages). Each bar below represents a range of values for each indicator, with increasing values from left to right. Please note that while an increase in water clarity (transparency) is generally equated with good water quality, an increase in phosphorus and chlorophyll are more likely to be associated with declining water quality. The yellow diamond represents the historical average for Roxbury/Ellis for each indicator.

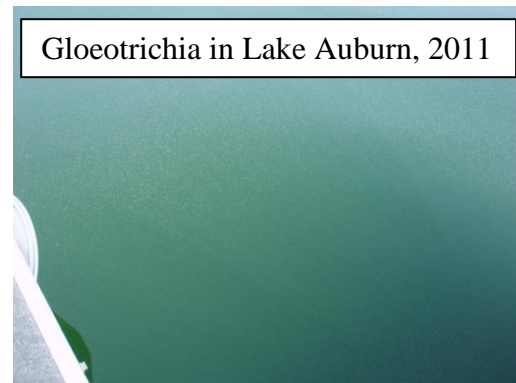


A histogram is a graphic that illustrates the frequency distribution for, in this case, a given indicator of water quality. For example, the histogram below for Ellis Pond shows the position of this lake on the continuum of water clarity/transparency for Maine lakes(1035 lakes). The average transparency for the lake falls within the low end (4.2 meters) of the 4-5 meter range, as shown by the red bar.



Water Color is a natural phenomenon that is caused by dissolved humic acids in the water that leach from wetland and terrestrial vegetation in the lake and watershed. High concentrations of water color impart the appearance of weak tea or coffee to lake water. The organic compounds that influence lake water color can reduce water clarity, increase phosphorus levels, and influence dissolved oxygen as color levels increase. Color (apparent) in Ellis/Roxbury Pond averaged 17.5 SPU in 2018, compared to the historical average of approximately 30 SPU for the lake. The relatively low color in 2018 may have been the result of cumulative drought, and reduced flushing of wetlands in the watershed.

Gloeotrichia echinulata is a bluegreen algae cyanobacteria) that has occurred historically in Maine lakes during late summer, in relatively densities. However, during the past several *Gloeotrichia* (pronounced: glee-o-tricky-ah) concentrations have increased dramatically in lakes in the state, and based on recent research, it is thought that under certain circumstances, *Gleo* has the potential to be a causative factor in the decline of lake water in some lakes. We looked for *Gleo* colonies Ellis Pond in both August and September, 2018, and found none. We will continue to screen the lake for this alga during future monitoring visits.



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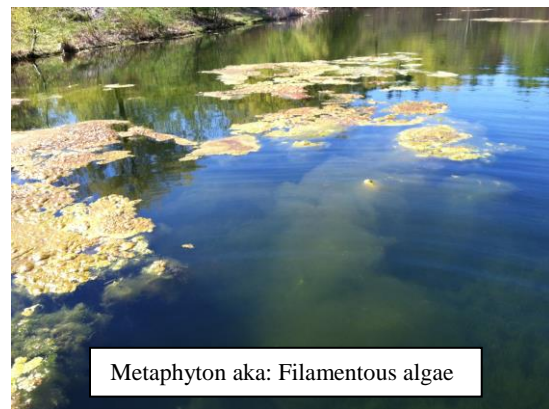
A sample to measure the **Specific Conductance** (SC) of the water in Ellis/Roxbury Pond was taken in September. SC is a measure of the ability of water to pass an electrical current. In turn, this reflects the concentration of specific ions in the water. As lake watersheds develop over time, many lakes experience an increase in SC. The September sample measured 36 microsiemens per centimeter 34 in 2017). The historical average for this indicator is 23 ms/cm. based on samples ranging from 13-29 ms/cm collected during the past 23 years. Higher than average conditions in recent years may be linked to the concentrating effects of drought on this indicator.

Additional water quality indicators monitored in 2018 (pH: 6.71 in August, total alkalinity: 5.0 mg/l in August) were within the average historical range of values for the lake, and generally supported the primary indicators of water quality discussed above.

Metaphyton is a term that is used to collectively refer to a number of species of algae, consisting of long, stringy filaments that form green to yellow “clouds” or “pillows”, having the appearance of “green cotton candy”. This form of algae is observed primarily in shallow areas of lakes, where the filaments become entangled in the stalks of rooted aquatic plants, sticks, and other debris in the water (see photos). During peak growth periods, gasses that form as a byproduct may cause mats to form on the lake surface. Eventually, the mats decompose and sink, forming brown sludge to form along the bottom of the lake in shallow areas.

In recent years, some residents of Roxbury/Ellis Pond believe they have observed an increase in metaphyton in shallow, protected coves. While not new to Maine lakes, and not an invasive species, many people from lakes throughout Maine have speculated that metaphyton density has been increasing during the past decade. However, because no quantitative studies have been conducted, virtually all of the information on this alga are based on observational reports.

The ecology and life cycle of metaphyton is not entirely understood. There does not appear to be a relationship between the concentration of phosphorus and planktonic algae in lakes and resulting metaphyton abundance. The shortening of the period of ice cover in lakes, which results in early warming of shallow areas, may provide metaphyton with a competitive advantage over the planktonic algae that are abundant throughout the open water areas of lakes.



Please note that the Lake Stewards of Maine has developed a simple methodology that can be used by volunteers from Maine lake communities to document metaphyton growth in their lakes. Information pertaining to this method can be found at: www.lakestewardsofmaine.org

The Ellis/Roxbury Pond community, which consists of shoreline property owners, watershed residents and community officials who make decisions regarding development in the watershed must share the responsibility of long term stewardship for this exceptional resource. The Silver Lake Camp Owners Association has taken a leadership role in this undertaking. The results of a watershed survey that was organized and conducted by SLCOA and members of the community in 2013, have been used to successfully leverage grant funding for a watershed mitigation project, the effect of which will be to further reduce external pressures on the health of the lake.

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