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Walker Pond Water Quality Assessment

Executive Summary:

An assessment of the water quality of Walker Pond was undertaken in July and August, 2022. A number of critical indicators of lake health were sampled and measured to determine current conditions in the lake, which generally reflect existing and ongoing development or disturbances that are taking place in the land area that drains to the lake (watershed), as well as the extent to which lake conditions may be exacerbated by a warming climate.

At this time, Walker Pond continues to exhibit overall "above average" water quality, when compared to other lakes throughout Maine. However, in recent years, a number of lakes throughout the State that have historically been considered to be healthy and stable, have experienced unanticipated precipitous declines, very likely due to the combined effects of watershed development or disturbances, and unusual weather associated with climate warming.

In July, 2022, Walker Pond's surface temperature was approaching 80 degrees F – possibly the warmest summer temperature that has been documented for this lake. Persisting warm summer temperatures appear to have been associated with the very high level of phosphorus that was measured at the deepest point in the lake in August.

The very real threat posed to Walker Pond and other Maine lakes by climate warming can be minimized through the consistent use of appropriate conservation practices throughout the lake

watershed – for both new and existing development. The protection of natural vegetation is especially important because vegetated buffers provide shade and minimize the heating of soils and water flowing to the lake from its tributaries.

“Development” refers to changes to the natural characteristics of the watershed associated with residential and commercial development, roads, agriculture and forestry operations. Water quality conservation practices designed to protect lakes, have been established by the Maine Departments of Environmental Protection, Conservation (includes Forestry) and Transportation, as well as county soil and water conservation districts.

Permits issued to land owners within the Walker Pond watershed by towns and the state should include information to permittees regarding the required adherence to standard conservation practices. Code Enforcement Officials should inspect development sites, and if necessary, seek the technical assistance of state, county or local soil and water conservation professionals to assist them in evaluating developed sites. Similarly, property owners/developers should be advised to contact professional assistance to guide them through the appropriate use of conservation measures in the Walker Pond watershed.

All forms of existing development in the Walker Pond watershed should also be revisited periodically because conservation practices that have been adequate to protect lake water quality in the past, may fail to do so in light of the extreme erosive storm events associated with climate warming. State and Federal soil and water conservation engineers have recently upgraded road culvert standards used to manage stormwater runoff because existing designs have been proven to be inadequate in the face of extreme runoff events.

Once a lake goes over its “tipping point’, restoration may be difficult, uncertain, and extremely costly. Costs associated with the restoration of lakes must be matched at the local level by state and federal funds that are available. Lake restoration initiatives always begin within the watershed.

Given the rapid manner in which change may occur, vigilance in monitoring and protecting Walker Pond should continue to be a high priority. Preventing and documenting disturbances in the watershed are especially important – particularly the loss of critical “buffer” vegetation, which can help offset increasing lake water temperatures.

Lake Water Quality in the Era of a Warming Climate:

Lake water quality conditions may be influenced at any point in time by a wide range of both natural and anthropogenic factors. The combined effect is responsible for the extent to which monthly, seasonal and annual “natural variability” occurs in many of the indicators that are used to assess lake ecosystems.

Annual weather fluctuations and trends in temperature, wind, and precipitation typically have a strong bearing on short and long-term conditions that occur in individual lakes. The extent to which each of these powerful weather and climate influences affects each lake is dependent on both the natural characteristics of the lake, and the degree to which the lake and watershed have been disturbed through development. Natural characteristics include, but are not limited to the bathymetry (depth profile) and shape of the lake basin, and its orientation to prevailing winds, as well as the geographic area, soil chemistry, and hydrologic characteristics of the watershed. The presence of natural features such as wetlands within the watershed can also be a significant influence. The interactions and combined effect of these natural characteristics plays a role in the sensitivity and response of individual lakes to external influences, including watershed development.

Foremost among the influences of weather on Maine's lakes are precipitation and temperature, both of which are now becoming intensified through the process of climate warming. In recent years, unusually warm ambient temperatures throughout the year have resulted in historic high summer lake water surface temperatures (mid 80's F in southern and central Maine), later formation of ice cover in the fall/winter, and earlier "ice out" in the spring. The overall reduced period of ice cover on lakes will likely have, and undoubtedly is already having, a profound influence on Maine's lakes, compared to historical conditions.

Precipitation patterns are becoming more extreme. Multiple years of moderate to severe drought have occurred throughout much of Maine during the past two decades. Among other impacts, drought reduces the inflow of water to lake basins from their watersheds, resulting in low water levels, which can cause the desiccation of sensitive, beneficial aquatic plants and other habitat in littoral areas. Drought may also increase shoreline erosion, and through evaporation, the concentration of various substances in the lake.

Periods of drought have increasingly been punctuated by localized extreme precipitation events, during at which time high-velocity, erosive stormwater runoff from the watershed can reach lakes, carrying with it elevated concentrations of soil particles and nutrients. In recent years, unusual algal blooms that have been observed and documented in a number of Maine lakes have been determined to have been triggered by the combined effects of extreme weather.

Historically, it has generally been accepted that clear lake water is an indication of a healthy lake ecosystem. This may not always be the case in the era of climate change.

Many Maine lakes tend to be clearer during drier years, ostensibly due to reduced stormwater runoff from their watersheds during such periods, resulting in less algal growth.

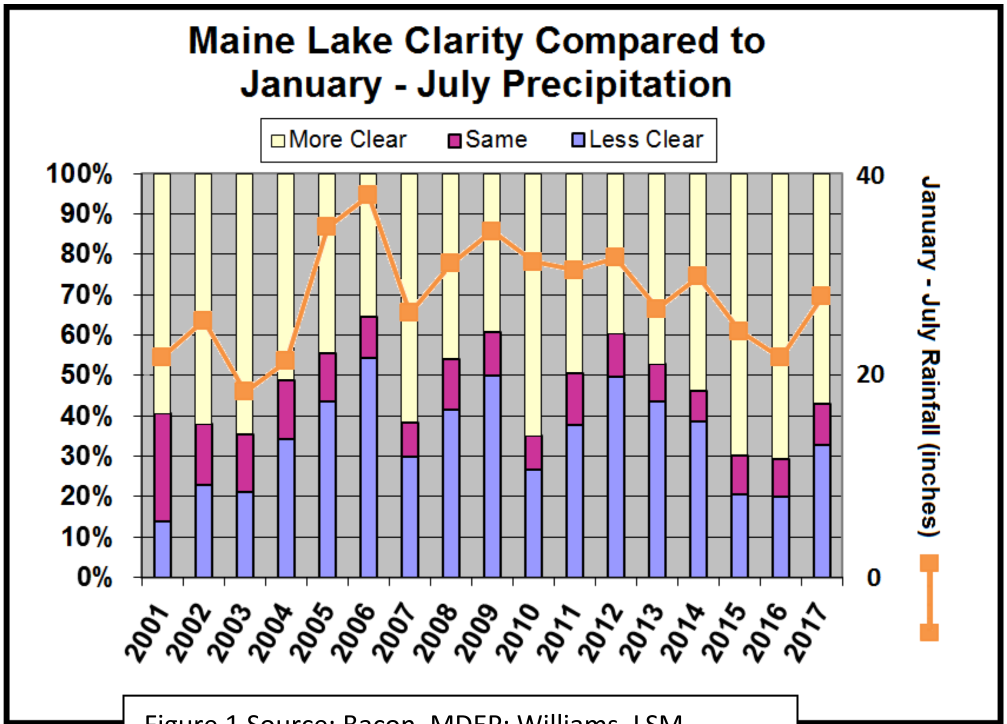


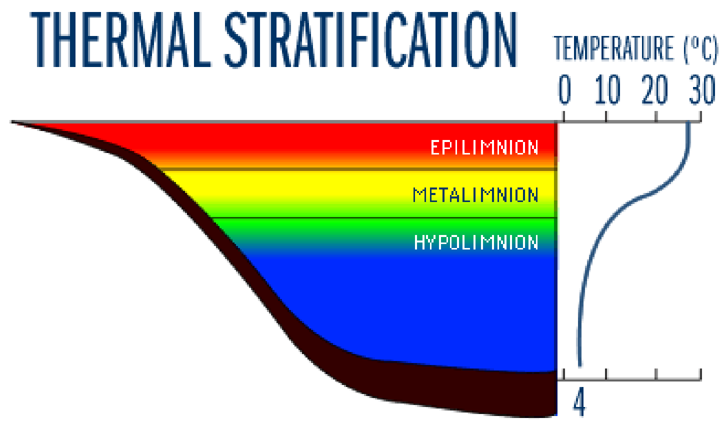
Figure 1 Source: Bacon, MDEP; Williams, LSM

An observational analysis of the Secchi transparency (water clarity) of Maine lakes from 2001 through 2017 (Linda Bacon/MEP; and Scott Williams/LSM) showed that a significant number of Maine lakes were clearer, to varying degrees, during drier years (Figure 1). Stormwater runoff is the vehicle by which phosphorus and other pollutants are transported from watersheds to lakes. Conversely, a significant number of Maine lakes have been less clear during years when there is more precipitation during the period from January through mid- summer.

Periods of drought may be deceptively causing apparent improving trends in water quality for some lakes in Maine, based on deeper Secchi disk readings, and lower concentrations of phosphorus and planktonic algae. Because of this, it will become increasingly important to take into account the influence of weather extremes associated with a warming climate when assessing lake water quality in the future.

While a majority of Maine's lakes appear to be clearer during drier years, smaller groups of lakes are either unchanged, or in some cases, are less clear than their historical average. This may be due, in part, to the fact that warming lake water temperatures may result in longer periods of thermal stratification, and that some relatively shallow lakes that have undergone little or no stratification in the past are now experiencing this phenomenon.

An extended period of thermal stratification typically results in greater loss of dissolved oxygen in the lake water column during the period. If the oxygen loss drops to a critical level, phosphorus in the lake sediments may be released to the overlying water. The “pulse” of phosphorus associated with this internal release process may result in an increase in planktonic algal growth, and reduced water clarity, especially during the warm summer and early fall period.



Typical Summer Temperature Profile in a Thermally Stratified Lake

Another small group of lakes that may actually be clearer during wet years are those that are highly productive, and which experience persistent severe algae blooms. These lakes may actually benefit from the diluting effects of precipitation, because phosphorus concentrations in the body of water are higher than incoming levels in stormwater runoff.

Climate warming, and the associated extreme weather events may compound (and confound) the complexity of tracking, predicting and characterizing lake water quality. In recent years, an increasing number of lakes that have historically experienced relatively “good” water quality, and which have otherwise been considered to be stable, have experienced a significant decline, very likely due to the de-stabilizing influence of a warming climate. Although in some cases it may be possible to predict the manner in which individual lakes will respond to climate change, the process through which warming effects complex lake ecosystems may not always be evident in advance of the changes.

Possible Weather Influences in 2022:

Maine once again experienced a relatively dry summer in 2022. While the extent of the drought varied, most of the state experienced below average precipitation for the first several months of the year. For the past few years, Maine has experienced drought ranging from “abnormally dry conditions” to “moderate and severe drought” (source: Drought.gov).

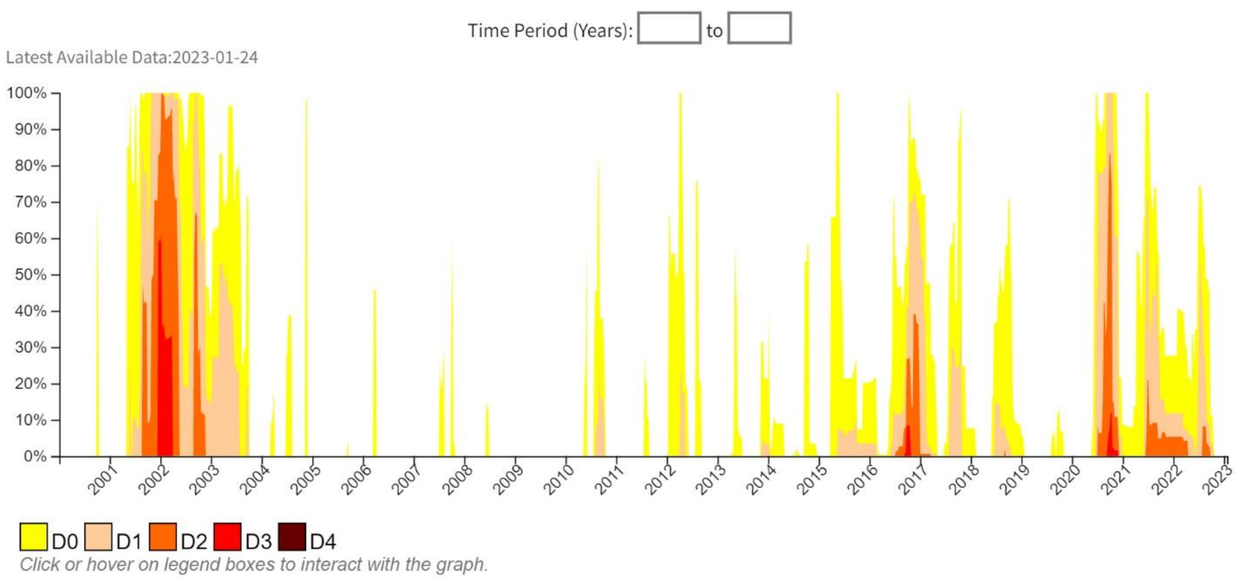
The effects of drought on lakes tends to be cumulative, depending on the amount of time that it takes (on average) for the volume of water in a lake to be replaced, or “flushed” (not to be confused with “turning over”, which takes place when the water in a lake “mixes” due to the combined effects of temperature, wind and wave action). Because this natural process is relatively slow, a dry year may continue to influence water quality and ecological effects for a year or more following the period of drought. The effects of Maine's multiple year drought will likely continue.

Drought conditions in Maine changed dramatically during the last months of 2022, which has been characterized as one of the wettest periods in more than a century. The abrupt reversal, resulting from multiple heavy precipitation events, may result in many lakes being less clear than their historical average in 2023 – depending, in part on conditions during the spring runoff period, following snowmelt.

The graphic below (Source: Drought.gov) illustrates the significant drought conditions in Maine from 2000-present (January, 2023). The color box in the lower left begins with "abnormally dry" in yellow, to more extreme conditions in the far right boxes. Note that many years since the severe drought period of 2001-2003, show significant drought conditions.

2000 - Present (Weekly)

The U.S. Drought Monitor (USDM) is a national map released every Thursday, showing parts of the U.S. that are in drought. The USDM relies on drought experts to synthesize the best available data and work with local observers to interpret the information. The USDM also incorporates ground truthing and information about how drought is affecting people, via a network of more than 450 observers across the country, including state climatologists, National Weather Service staff, Extension agents, and hydrologists. Learn more.



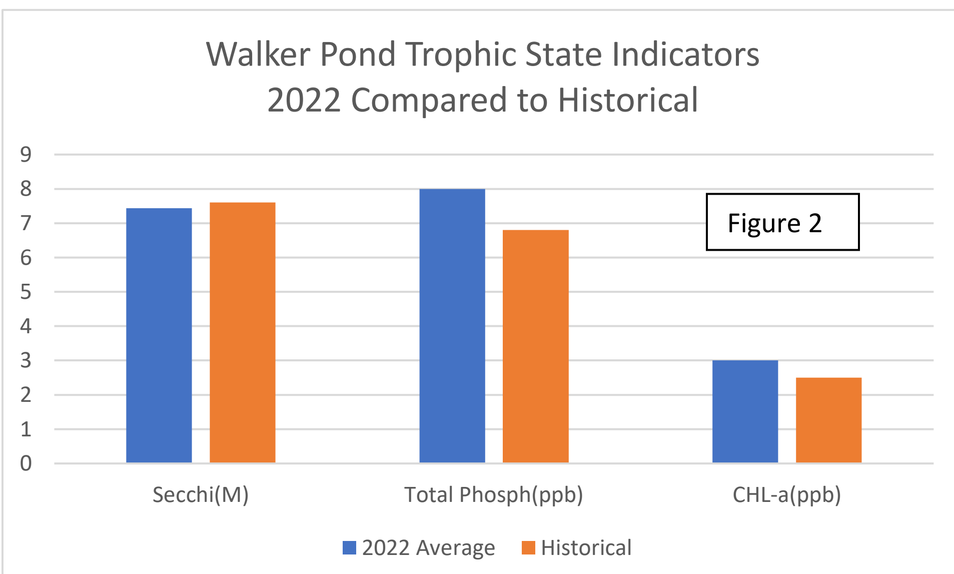
2022 Overview and Summary of Findings for Walker Pond:

The following summary information is the product of "baseline" sampling and assessment that was conducted at Walker Pond in Brooksville, ME (MIDAS # 4640) in July and August, 2022 by LWRMA staff.

Water quality monitoring/sampling was conducted on July 10 and August 26 at the "deep hole" station - the deepest known location in the lake, and the area where the greatest volume of historical data have been gathered and documented for several decades. Walker Pond is a single basin lake. The basin is open, without restrictions to circulation. The single sample station is representative of overall conditions in the lake.

For most Maine lakes, August and early September sampling is generally considered to be the most critical period of the year because potentially stressful conditions in the lake associated with several months of warm weather are typically most evident. Statistically, in order to confidently be able to detect an unusual short-term event (such as an impending algal bloom), as well as long-term trends, five continuous months of data are necessary during the open water period from May through September or October. Such data density are often not feasible, due to both budgetary and logistical limitations. 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.

The characterization of changes that take place in a lake from one year to the next is a somewhat nuanced process. The terms "above and below average" may be relevant for one or more critical indicators of water quality, but not necessarily all. In 2022, the three primary "trophic state": water quality indicators measured were somewhat close to the long-term (historical) averages for Walker Pond. Secchi transparency (water clarity) was very close to the historical average, and the concentration of total phosphorus,, a key nutrient that has a bearing on algae growth, was slightly higher than the historical average, as was chlorophyll-a, which is a direct measure of planktonic algal density in the lake. Note that the 2022 averages are based on two sampling visits to the lake in July and August. Figure 2 illustrates the average for each of the primary trophic state indicators for the lake in 2022, compared to the historical average value for each indicator.



Unusually high lake water temperatures were documented in lakes throughout Maine during the summer of 2022. On July 10, the water surface temperature of Walker Pond was 24.2 degrees Celsius (nearly 76 degrees F.), very likely one of the warmest surface temperatures on record for the lake. On August 26, the surface temperature had increased to 24.5C.

On July 10, Walker Pond was strongly thermally stratified, with a thermal gradient of nearly 10 degrees (24.2 surface to 15.4 at 14 meters.. Dissolved oxygen (DO) was nearly depleted near the deepest point (14.2 meters) at the sampling station. On August 26, DO was depleted (0.0 mg/l) from 10 through 15 meters depth. A total phosphorus sample taken at the deepest point in the lake in August was substantially higher (93ppb) than the concentration (9 ppb) from an integrated core sample taken from the lake surface to 7 meters depth, suggesting a likely release of P from the bottom sediments, triggered by low (depleted) DO. Figure 3 illustrates the temperature and DO profiles taken on August 26, showing both the strong thermal stratification and the severe oxygen loss at that time.

Figure 4 illustrates the progressive loss of dissolved oxygen in the lake between July 10 and August 26. Walker Pond may have remained stratified well into the month of September, in which case, additional phosphorus would likely have been released from the bottom sediments. The percentage of the lake bottom that was exposed to low oxygen conditions is relatively small – only areas where the lake depth exceeded 9 meters (approximately 30 feet). Figure 5is a bathymetric map of Walker Pond, showing depths throughout the lake.

Over time, warming climatic conditions could result in an earlier onset of thermal stratification, lasting well into September, in which case, the percentage of the water column that becomes anoxic could increase, and accordingly, the percentage of the lake bottom exposed to anoxia, resulting in the release of phosphorus, could also increase. In turn, this phenomenon could result in a significant increase in algal growth in the lake, resulting in reduced water clarity. Warm water temperatures, combined with a higher phosphorus concentration in the lake could favor the growth of cyanobacteria (bluegreen algae).

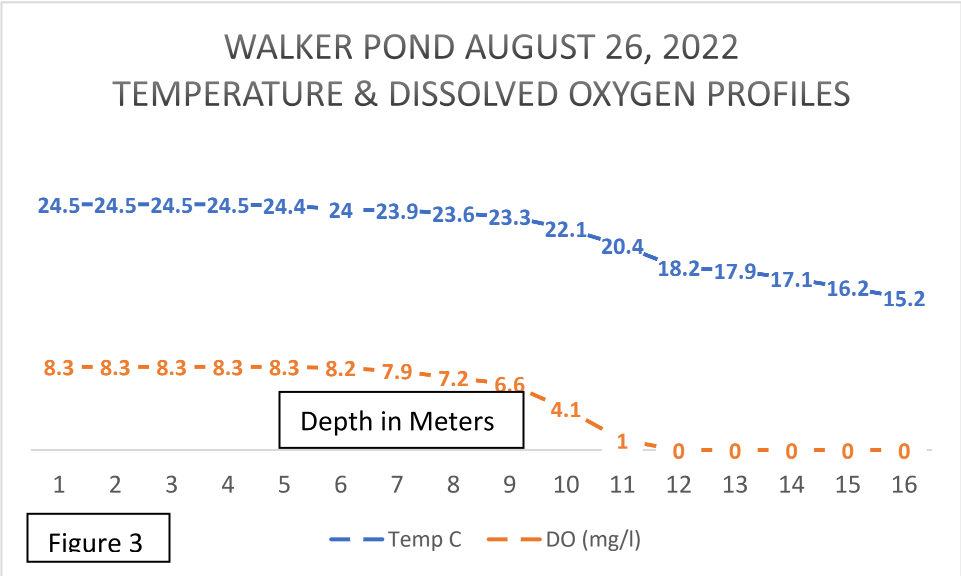


Figure 3

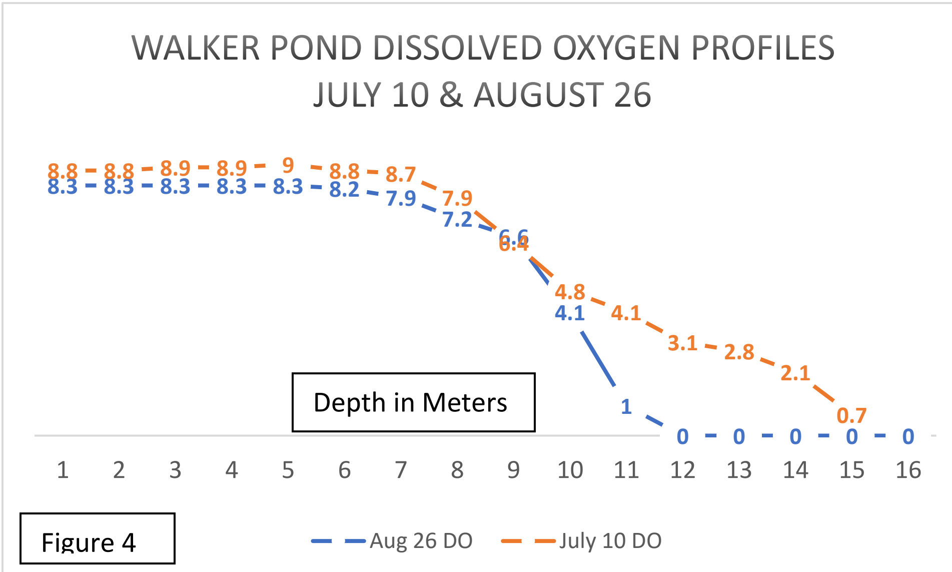
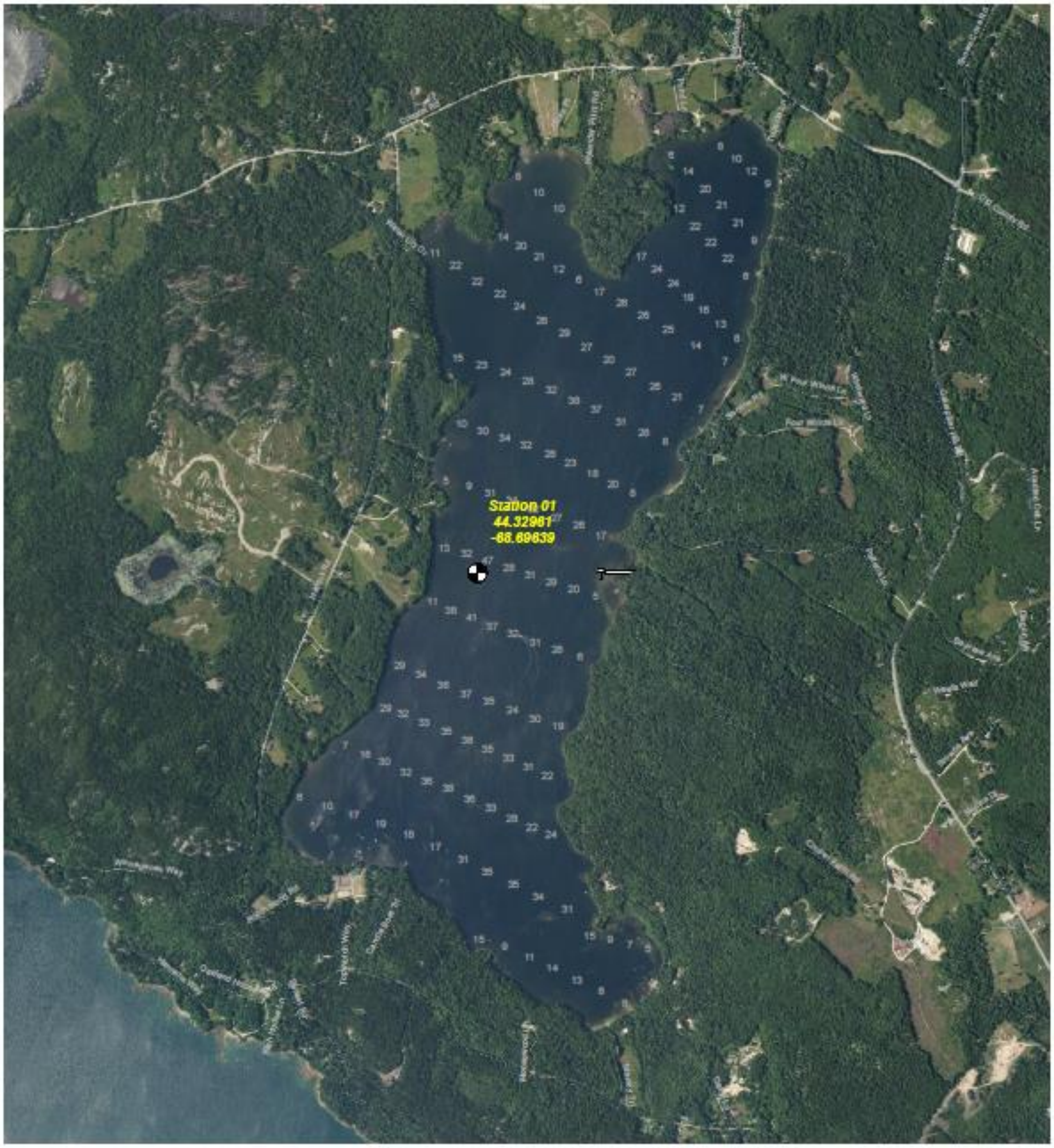

WALKER POND DISSOLVED OXYGEN PROFILES
JULY 10 & AUGUST 26
Depth in Meters
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
8.8 8.8 8.9 8.9 9 8.8 8.7 7.9 6.4 4.8 4.1 3.1 2.8 2.1 0.7
8.3 8.3 8.3 8.3 8.3 8.2 7.9 7.2 6.6 4.1 1 0 0 0 0 0
Aug 26 DO
July 10 DO
Figure 4

Figure 5



Walker Pond

MIDAS # 4640

Sedgwick, Hancock Co. - Delorme Page 15 - 693 acres

Boat Launch | Lake Sample Stations | # Depth (FT)

0 | 0.4 | 0.8 | 1.2 | 1.6 | 2 Miles

N W E S

Lake water temperatures that are substantially higher than in past years are a significant risk factor for an increase of potentially harmful (toxic) algal blooms in Maine's lakes. Unusually warm lake water also stresses the biota, and has been linked to fish mortality in a number of Maine lakes in recent years.

"Metaphyton" (filamentous algae that forms cotton candy-like green/yellow clouds in shallow areas) was less abundant in 2022 in the littoral (shallow) areas to either side of the Walker Pond public boat launch area. To date, a complete survey of the Walker Pond littoral area was not done.

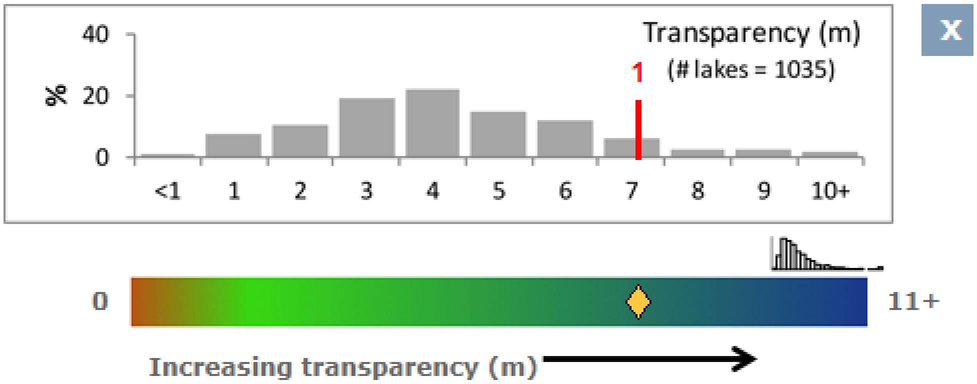
The algae that constitute metaphyton are common in lakes throughout Maine. They provide food and beneficial habitat for a wide range of lake Fauna. However, many lake communities, volunteer lake monitors, and professional lake scientists have reported a substantial increase in metaphyton abundance in recent years. The significance of this increase is not fully known. Continued monitoring and reporting unusual changes in the abundance and location of this algae will hopefully lead to a better understanding of its ecological significance.

Data Summaries:

Secchi disk Transparency (water clarity) varied from a high reading of 7.75 meters on August 26 to the lowest reading of 7.12 meters on July 10. The average for the period was 7.4 meters, compared to the historical average of 7.6 meters for Walker Pond.

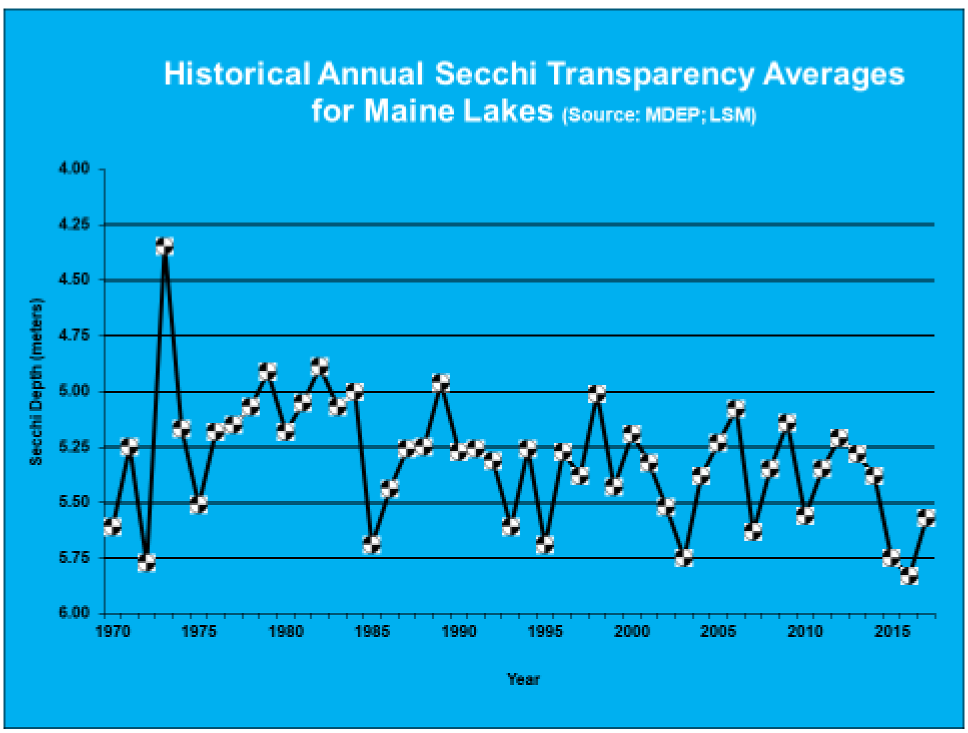
The "color ramps" below, produced on the www.lakesofmaine.org website, illustrate the range of lake clarity for several hundred Maine lakes. The bar chart above each color ramp is a histogram that illustrates the distribution frequency for Maine lakes for each indicator. The red line in each indicates the historical average for this lake. This graphic shows where the lake is situated, relative to the total number of Maine lakes assessed/represented (indicated by "# of lakes").

The first ramp shows water clarity (Transparency in meters), ranging from least clear on the left, to clearest on the right. The yellow diamond depicts the historical average for Walker Pond, relative to more than 1,000 Maine lakes. The bar graph (histogram) situated illustrates the position of Walker relative to other lakes in the group.



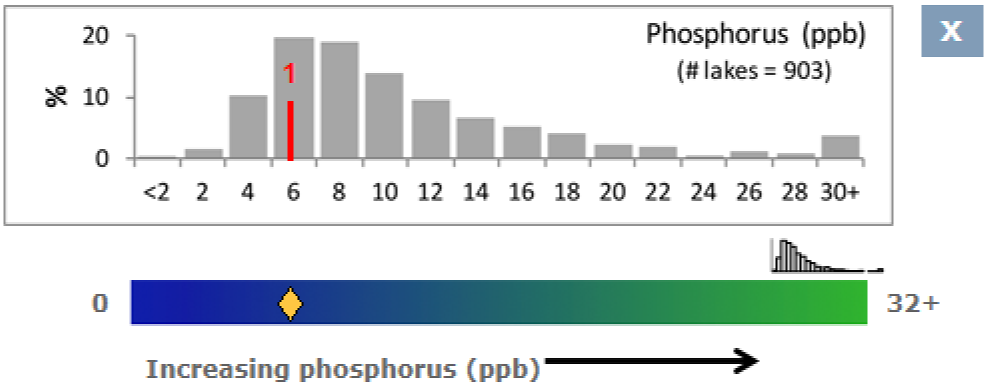
The historical water clarity (Secchi Transparency) average for Maine lakes (based on data from numerous sources for more than 1,000 lakes) has varied in the 5.0-5.75 meter range for the past few decades.

The following graphic illustrates the annual average Secchi value for Maine lakes, based on the number of lakes for which data were available for the individual years.

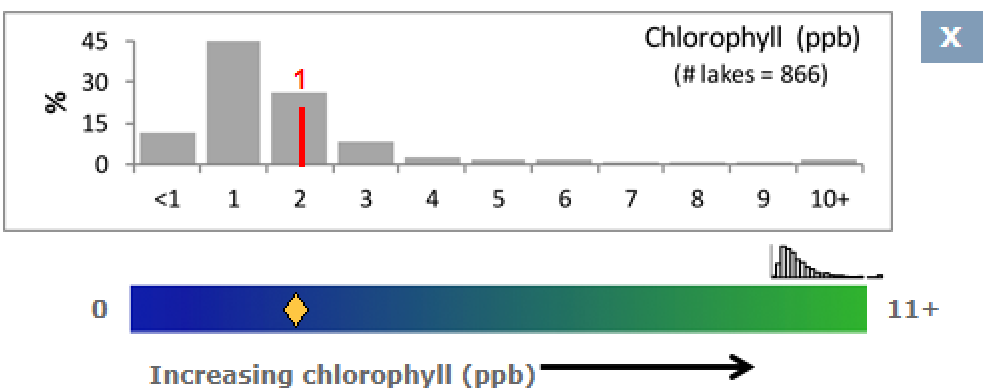


Phosphorus is the limiting nutrient that most influences algae growth in Maine lakes. The integrated (mixed) epilimnetic core concentration of total (organic and inorganic forms) phosphorus in Walker Pond varied from 7 ppb on both July 10 to 9 ppb on August 25, averaging

8 ppb, compared to the historical average of 6.8 ppb for Walker Pond. A sample taken near the bottom of the deepest point in the lake on August 26 was substantially higher (93 ppb) than TP levels from the epilimnetic core sample, suggesting that phosphorus may have been released from the bottom sediments during anoxic conditions.



Chlorophyll-a (CHL) epilimnetic core samples taken in 2022 measured 3 ppb on both the July and August sample dates, compared to the historical average for Walker Pond of 2.5 ppb.



Gloeotrichia echinulata is a bluegreen algae (cyanobacteria) that has been observed/documented historically in a number of relatively clear Maine lakes. However, historical concentrations of this species, which forms colonies that are visible to the naked eye, have been very low. In recent years, "Gloeo" has been documented in an increasing number of less clear lakes at higher densities. The significance of this increase is unknown, but some information suggests that it may be influenced by factors associated with climate warming and historical watershed land use.

Gloeo was documented in moderate to high densities in the severe algal bloom that occurred in Lake Auburn in 2012. *No Gloeotrichia colonies were observed in Walker Pond in 2022.*

A Magnified Gloeotrichia Colony

Natural Color is a measure of the concentration of humic compounds in lake water. Such compounds typically leach from wetland vegetation, and from decaying leaves from hardwood trees along the shoreline. 2022 color levels in Walker Pond ranged from 5-8 CPU (Cobalt Platinum Units), averaging 6.5 CPU compared to the historical average of 8.2 SPU. High concentrations of natural color in some lakes (generally greater than 25 CPU) can influence water clarity, and disrupt the normal relationships between water clarity, phosphorus, and chlorophyll.

Total Alkalinity is a measure of the capacity of water to buffer acidified precipitation and water entering the lake from its watershed. Alkalinity, measured in August was 4.5 mg/l –compared to the historical average of 5.9 mg/l.

Prepared by LWRMA Limnologist, Scott Williams