2017 Range Ponds Water Quality Report

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The Range Ponds Environmental Association continued to monitor the health of Upper, Middle and Lower Range Ponds in 2017 through the engagement of both professional lake scientists and a strong lake association and volunteer community that has focused on both water quality monitoring and watershed protection. Special thanks are due to certified volunteer lake monitors Barry Kutzen (Middle Range), and John and Poppy Connor-Crouch, for their significant contributions to the data discussed in this report.

Monitoring and sampling of the lakes took place from early May through October, during the time of year when lakes and ponds are the most biologically productive, water quality problems are most evident, and "worst case scenario" conditions may exist.

The sampling and assessing process followed standard lake monitoring protocol established by the Maine Department of Environmental Protection and the Maine Volunteer Lake Monitoring Program.

Weather Influences:

Weather conditions prior to, and during the annual lake monitoring period can strongly influence the indicators used to assess lake water quality, and often account for a significant percentage of the "annual variability" that occurs in lakes. Temperature, wind, sunlight, and precipitation also influence the biology, chemistry and physical aspects of lakes throughout the year. Understanding how weather-related variability affects lakes from year to year can be daunting. Factors include: 1) duration of ice cover, 2) long and short-term precipitation, 3) storm event intensity, 4) fluctuations of lake water levels, 5) timing of the onset, and duration of thermal stratification, and others. Lake water clarity (and corresponding Secchi transparency readings) appear to have a significant correlation to precipitation.

The extended severe drought that occurred throughout 2015 and 2016 officially ended during the winter or 2017. Heavy snowfall, followed by moderate rain in the spring and early summer helped to offset the effects of the two year drought. However, very dry conditions redeveloped from mid-summer through the end of the monitoring season in October.

2016 Monitoring Results for the Range Ponds:

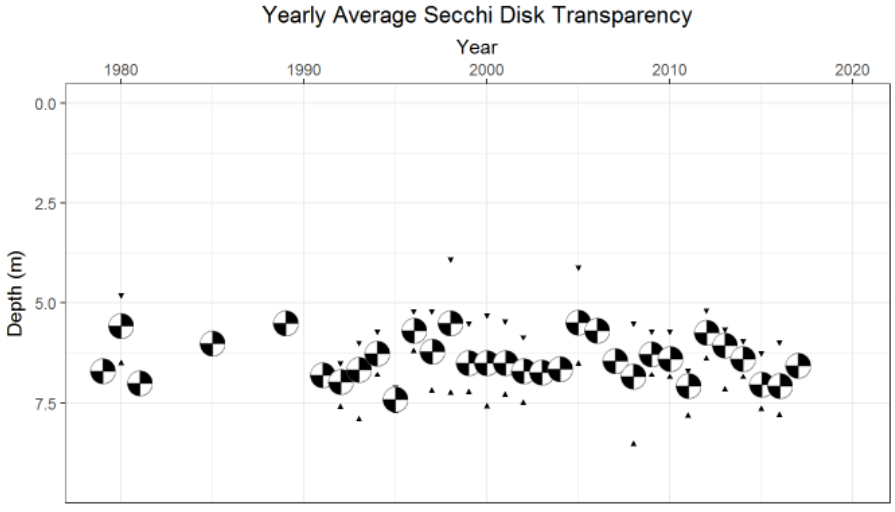
The following is a summary of findings for the three Range Ponds in 2017. Extensive water clarity (Secchi transparency) readings were taken for several months by the certified volunteer monitors mentioned above. All other summary baseline data discussed in this report were obtained by LWRMA lake scientists in August and September during a period of time consistent with the historical gathering of such critical data for the Range Ponds.

Upper Range Pond:

Upper Range Pond water quality was average to slightly above average in 2016, relative to historical data for in the lake. The water was very slightly clearer, the concentration of phosphorus in August was slightly lower, and algae density in the lake in August was approximately average for these critical indicators of lake water quality. The August dissolved oxygen profile significant depletion of oxygen in the deepest area of the pond, somewhat similar to that of recent years. The lake was less clear than it was during the previous two years during the extended drought.

Water clarity averaged 6.6 meters (about 21.5 feet) in 2017. The 2017 average is based on readings taken by LWRMA lake scientists in August and September. The historical average for the lake is 6.4 meters (21 feet). The graph below from the Maine DEP and Maine Volunteer Lake Monitoring Program illustrates annual average lake water clarity from 1979 through 2017. The crossed hatches represent the average for the year. Small bars above and below the circle represent high and low readings for each year. The graph shows the positive influence of the 2015-2016 drought on the clarity of the lake, including one of the clearest reading on record for Upper Range.

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

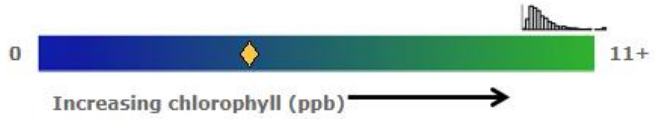


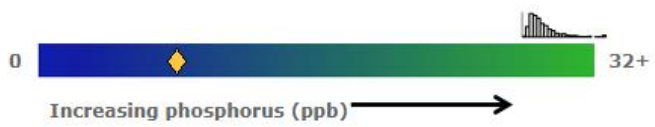
The concentration of total phosphorus (the nutrient that is responsible for the growth of algae in lakes) measured 7 parts per billion (ppb) in the surface layer core sample taken in both July and August, averaging 7 ppb for the two samples. The historical average for Upper Range is 7.5 ppb. Total phosphorus concentrations in Upper Range Pond have ranged from 5-16 ppb since 1979, when phosphorus samples were first measured on this body of water.

A phosphorus sample taken near the bottom of the lake at the deep sampling station in September, measured 12 parts per billion, possibly indicating that phosphorus was being released from the bottom sediments as a result of the low concentration of dissolved oxygen in the water at that depth. However, the increase over the surface core concentration was relatively small. Phosphorus that is released from bottom sediments during anoxic conditions in the lake has the potential to bring about an increase in algae growth in the overlying water when the lake mixes.

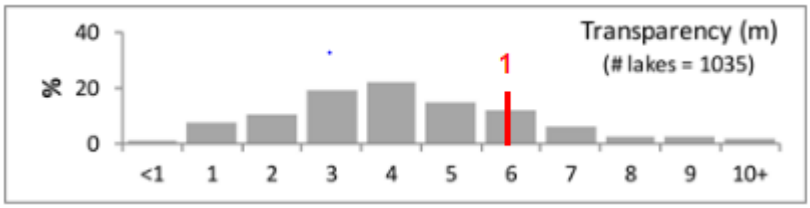
Chlorophyll-a (CHL) is a pigment that is measured to determine the concentration of algae in lake water. The August sample measured 3.6 parts per billion, and the September sample measured 4.0 ppb, averaging 3.8 ppb. Both samples were substantially higher (more algae) than those taken in 2016. The historical average for Upper Range is 3.9 ppb. Annual CHL averages in Upper Range have varied from 2.4 ppb to 9.9 ppb. The increase in the frequency of sampling in 2017, in addition to providing multiple readings for determining the average, serves as a safeguard in the event that one of the samples appears to be an anomaly, or has been contaminated, and provides an overall better picture of conditions in the lake in 2017.

The graphics below, taken from the Maine Volunteer Lake Monitoring Program's www.lakesofmaine.org website, illustrate the relative position of Upper Range Pond for the primary indicators of lake productivity, aka "trophic state". 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 this lake for each indicator.



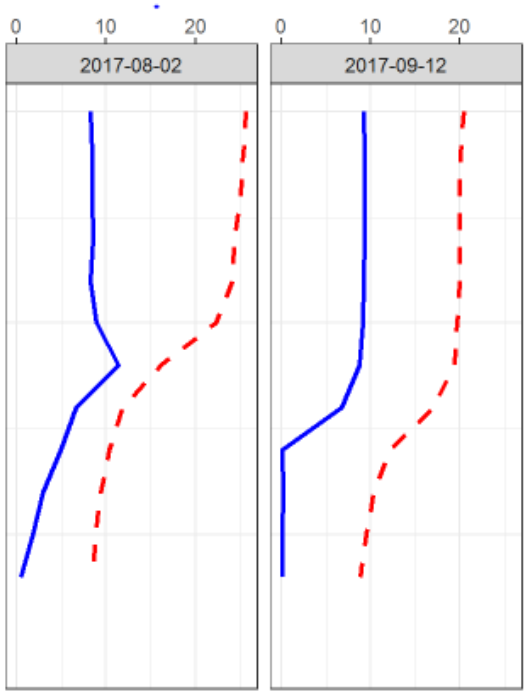


A histogram is a graphic that illustrates the frequency distribution for, in this case, a given indicator of water quality. For example, the histogram below for Upper Range Pond shows the position of this lake on the continuum of water clarity/transparency for Maine lakes(1035 lakes). The average transparency for the lake falls within the 6-7 meter range, as shown by the red bar. The percentage of the lakes included in each range is shown on the vertical axis.



Temperature and dissolved oxygen profiles taken in August and September showed strong thermal stratification on both dates, with a range in temperatures from the surface to the bottom of the deepest point in the lake of approximately 17 degrees C in August, and approximately 11 degrees in September.

The concentration of dissolved oxygen was near saturation at the surface on both dates, showing some oxygen depression in August in the last few meters closest to the bottom at the deep station, and significantly greater oxygen loss in the same region of the water column in September, ostensibly due to the longer period of time during which the deep layer of water had been isolated from the atmosphere. The graphics below illustrate the temperature and dissolved oxygen profiles for both dates (Graphics generated through MDEP; MVLMP; LakesofMaine.org):

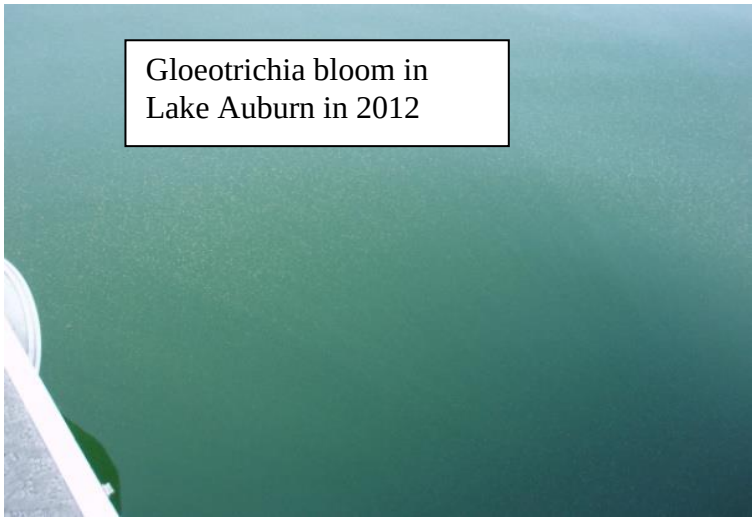


Temperature (red) in degrees C; Dissolved Oxygen (blue) in mg/l (ppm)

Specific Conductance/Conductivity is a measure of the extent to which water is able to pass an electrical current, which is an indication of the concentration of ions in the water. An increase in conductivity over time may correlate with watershed development. A conductivity sample taken in September, 2017 measured 73 microsiemens/centimeter. The historical average for Upper Range is 54 ms/cm. *This water quality indicator appears to be increasing in Upper Range Pond. We will continue to measure this indicator annually to document a possible trend. The high conductivity sample in both 2016 and 2017 may have been exacerbated as a result of high level evaporation of lake water during the severe drought, resulting in a concentration of ions in the lake.*

Other water quality indicators that are measured to help support the primary data (pH: 7.43, Total Alkalinity: 12.0 mg/l and Color: average 17 SPU) were within the normal range of historical values for Upper Range in 2017.

The bluegreen alga/cyanobaceria, (*Gloeotrichia echinulata)* that is a current focus of research in New England Lakes, was not observed in Upper Range on the September 19 site visit, at a relatively low density (0.25 on the Gloeo scale of 0-5). This would be a "typical" low level density for this organism during late summer.



Gloeotrichia bloom in Lake Auburn in 2012

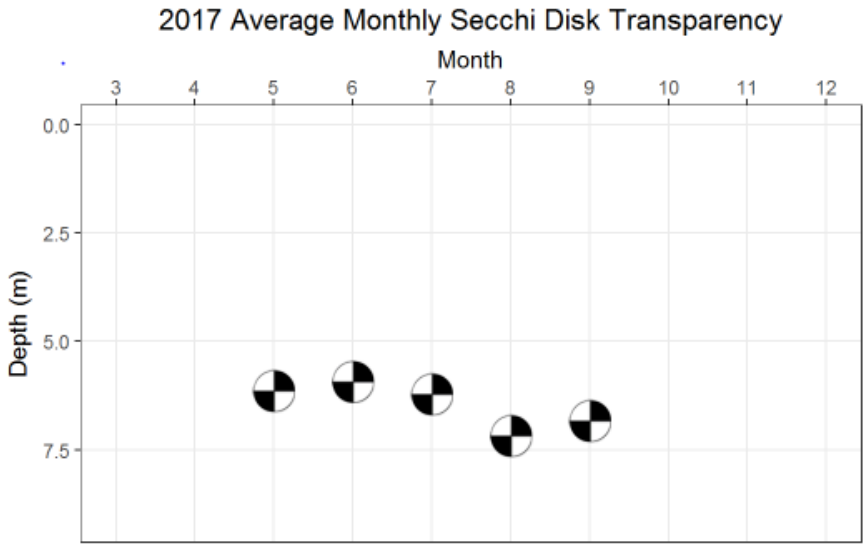
"Gloeo" appears to have been on the increase in some Maine lakes in recent years. The implications of this increase are not well understood, however, recent research has suggested that this alga may have the potential to play a role in changing lake water quality. The adjacent photo was taken at the surface of Lake Auburn in 2012 during the peak of a Gloeotrichia bloom. Gloeo observations took place at the boat launch area and at the deep monitoring station for each of the three lakes.

Middle Range Pond:

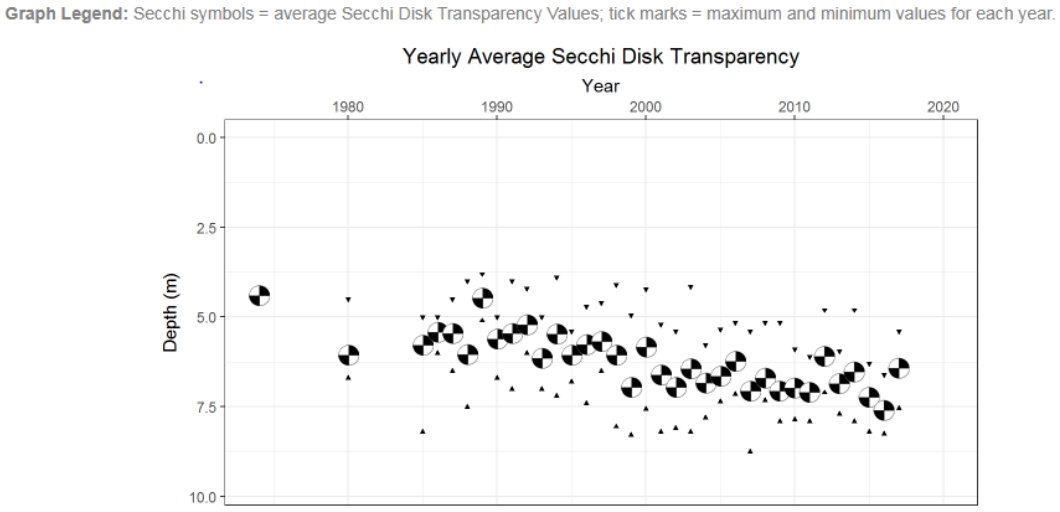
The water clarity of Middle Range Pond was very close to the historical average for the lake in 2017. The concentration of total phosphorus in the water was approximately average, but the concentration of algae in the lake was lower in August and September. The decline from substantially above average conditions overall during the previous year was likely the result of the end of the historical drought, brought about by significant precipitation and stormwater runoff in 2017.

The average water clarity in 2017, based on a full season of data provided by VLMP certified lake monitor, Barry Kutzen (in addition to our August and September readings) was 6.4 meters, compared to the historical average of 6.2 meters for Middle Range.

The following graphics illustrate the changes in water clarity during the six month period in Middle Range Pond (Source MDEP; VLMP; www.lakesofmaine.org). Each symbol represents an average of readings for the month shown.



The following graphic illustrates the Secchi transparency (lake water clarity) history for Middle Range Pond, including the maximum (clearest), minimum (least clear) and annual average for most years from 1974-2017. (Source MDEP; MVLMP; www.lakesofmaine.org)



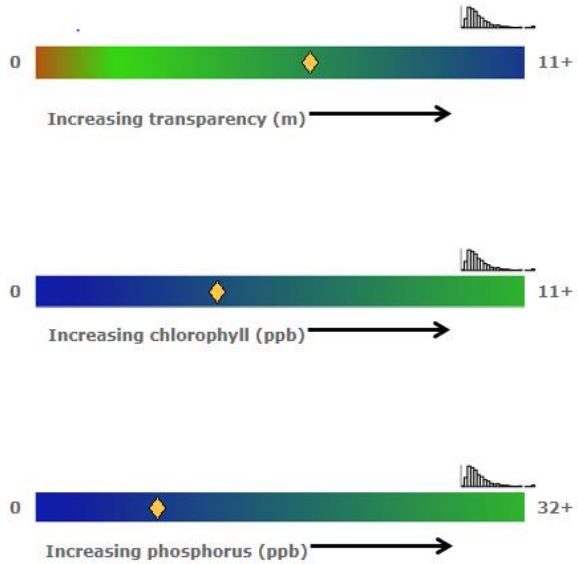
The graphic above shows an apparent improvement in the clarity of Middle Range Pond through the period.

The surface layer core *total phosphorus* concentration measured at the Middle Range deep sampling station measured 6 parts per billion (ppb) in both August and September, compared to the historical average for the lake of 8 ppb. Historical phosphorus levels in Middle Range Pond have varied from 5-12 ppb since samples have been collected starting in 1985.

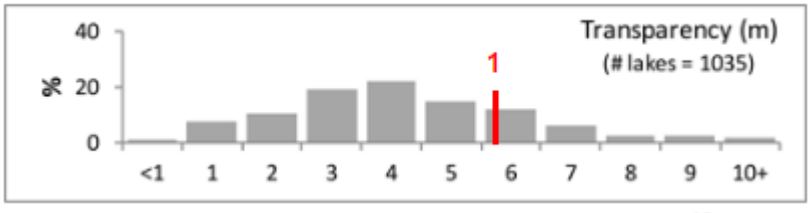
A total phosphorus sample taken near the bottom of the deepest spot in Middle Range measured 7 ppb. While higher than the surface core sample of 6 ppb, there has been little information to suggest that phosphorus is being released from the bottom sediments in this lake. It is normal for phosphorus concentrations in thermally stratified lakes to be slightly higher than in the surface layer, due to the nearly continuous downward settling of organic and inorganic detritur.

The concentration of *chlorophyll-a (algae concentration in the lake)* was substantially higher in 2017 measuring 2.1 ppb in August, and 4.3 ppb in September, averaging 3.2 ppb for the year, compared to 2.2 ppb in 2016 and the historical average of 4 ppb. Based on the clarity of the water, the concentration of phosphorus, and algae in the water, conditions in 2017 remained above the historical average for this lake.

The adjacent graphics, taken from the Maine Volunteer Lake Monitoring Program's www.lakesofmaine.org website, illustrate the position of Middle Range Pond for the primary indicators of lake productivity, aka "trophic state". 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 this lake for each indicator.

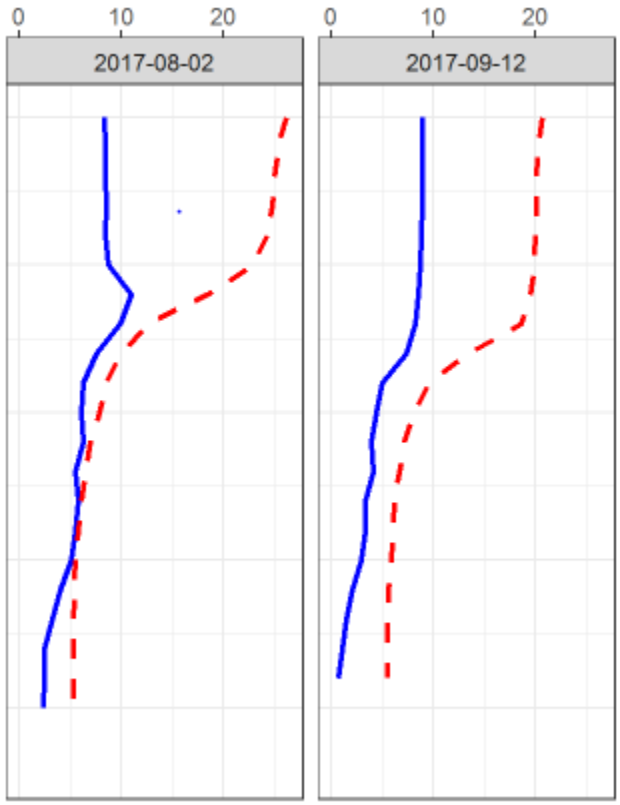


A histogram is a graphic that illustrates the frequency distribution for, in this case, a given indicator of water quality. For example, the histogram below for Middle Range Pond shows the position of this lake on the continuum of water clarity/transparency for Maine lakes(1035 lakes). The average transparency for the lake falls within the 6-7 meter range, as shown by the red bar. The percentage of the lakes included in each range is shown on the vertical axis.



Temperature and dissolved oxygen profiles taken in August and September indicated that Middle Range was strongly thermally stratified, with water temperatures ranging from close to 26 degrees C at the surface in September, to about 5 degrees C at 21 meters depth, near the bottom of the sample station at the deepest point in the lake. Dissolved oxygen levels ranged from the 8.0+ ppm range at the surface to a low level of 2.3 ppm in August at 20 meters. On September 12, the temperature range from the surface to 19 meter depth was 20.7-5.5 degrees C., and dissolved oxygen ranged from 8.9 ppm at the surface to 0.1 ppm at 19 meters. Late summer oxygen levels in Middle Range are low, but are not yet critically so. Continued efforts to protect the water quality of Middle Range may help prevent DO levels from declining further in the future. The lake water level was very low in August.

The graphics below (Source: MDEP; VLMP; www.lakesofmaine.org) illustrate the changes in temperature and dissolved oxygen levels from the surface to the bottom of the deep station on Middle Range in August and September.



Temperature (red) in degrees C; Dissolved Oxygen (blue) in mg/l (ppm)

The concentration of the bluegreen algae, *Gloeotrichia echinulata* (see above) measured 1.0 on the Maine VLMP/DEP "Gloeo" scale on August 2 at the deep monitoring station. Similar concentrations of Gloeo have been documented in Middle Range Pond in August in recent years. Many Maine lakes have experienced late summer Gloeo concentrations in the 0.5 range. The

concentration in Middle Range is sufficiently high to warrant continued monitoring of this organism.

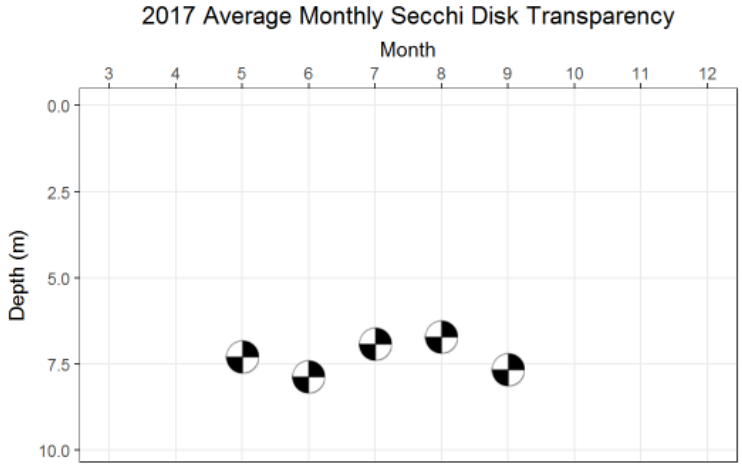
A sample for Specific Conductance in September (see above) measured 93 ms/cm, compared to the historical average for Middle Range of 58 ms/cm. The 2017 reading is the highest on record for Middle Range Pond. Specific Conductance appears to be increasing in Middle Range, as is the case for Upper Range Pond. The apparent increase in this possible indicator of change in the lake bears watching and continued monitoring. However, drought conditions during the past two years may also be contributing to higher specific conductance as a result of evaporation and concentration of ions in the lake during the summer.

Other water quality indicators that are measured to help support the primary data (pH: 7.47, Total Alkalinity: 12.5 mg/l and Color: 15 average) were within the normal range of historical values for Middle Range Pond in 2017.

Lower Range Pond:

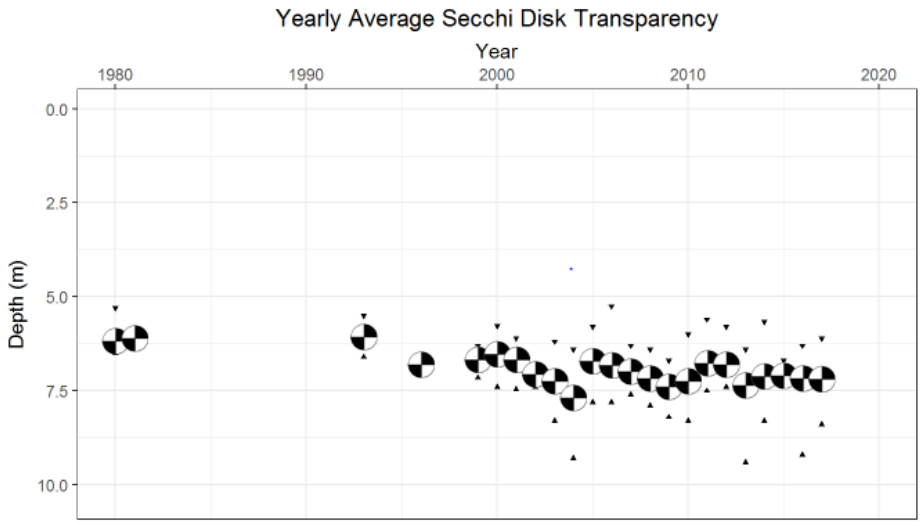
Overall, Lower Range Pond experienced average to above average water quality in 2017, in that the lake was clearer than its historical water clarity average, the concentration of phosphorus was near the historical average for Lower Range, and the baseline chlorophyll (algae) concentration was lower (less algae) the historical average, based on samples and readings taken in August and Septmber. However, late summer dissolved oxygen concentrations in the deepest area of the lake continued to be extremely low (zero oxygen).

The lake was clearer than average in 2017, averaging 7.2 meters (~23.6 feet), compared to the historical average of 6.9 meters. The 2017 average was based on our August and Septemnber readings, in addition to readings taken by Maine VLMP certified lake monitors Poppy Connor-Crouch and John Crouch throughout the summer. The historical average of 6.9 meters has recently increased slightly as a result of several very clear years for the lake. The graphic below illustrates the changes in Secchi disk transparency readings during the course of the 2017 monitoring season. (Source VLMP; MDEP). Note that the symbols indicate averages for the month indicated.



The graphic below illustrates the history of Secchi transparency (water clarity) readings for Middle Rand Pond, from 1980-2017. Shown on the graph are maximum (clearest), minimum (least clear) and averages for the years indicated.

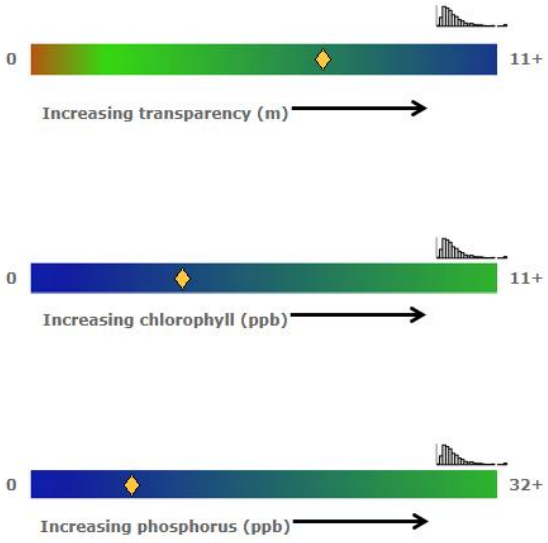
Graph Legend: Secchi symbols = average Secchi Disk Transparency Values; tick marks = maximum and minimum values for each year.



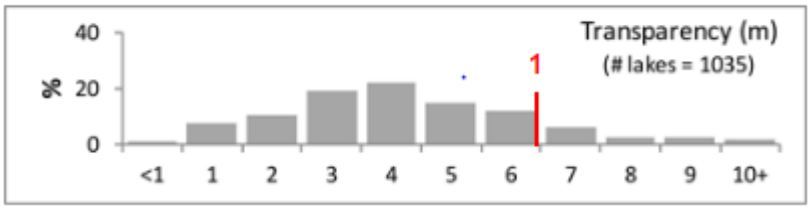
The total phosphorus concentration in Lower Range Pond last summer, based on samples taken in August and September was 6 ppb on both sample dates, resulting in an average of 6 ppb for the year. The historical average is 7 ppb. Phosphorus levels have ranged from 5- 15 ppb in Lower Range since 1981. The very high 15 ppb sample was taken in 1981, and none of the samples taken since have approached this level, most years falling in the 6-9 ppb range, except for the lowest sample (5 ppb) measured in 2014.

Chlorophyll-a (measuring algal growth in the water) averaged 2.8 parts per billion in August and September, 2017, compared to the historical average of 3.6 ppb. CHL levels in Lower Range have ranged from 2.8-6.5 ppb, the highest reading having been measured in 1993, and the lowest in 2016.

The adjacent graphics, taken from the Maine Volunteer Lake Monitoring Program's www.lakesofmaine.org website, illustrate the position of Lower Range Pond for the primary indicators of lake productivity, aka "trophic state". 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 this lake for each indicator.



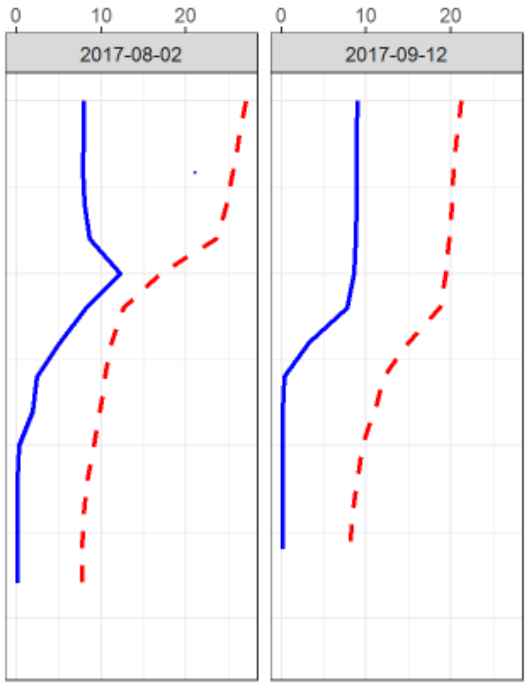
A histogram is a graphic that illustrates the frequency distribution for, in this case, a given indicator of water quality. For example, the histogram below for Lower Range Pond shows the position of this lake on the continuum of water clarity/transparency for Maine lakes (1035 lakes). The average transparency for the lake falls within the 6-7 meter range, as shown by the red bar. The percentage of the lakes included in each range is shown on the vertical axis.



Temperature and dissolved oxygen profiles taken on August 2 and September 12 indicated that Lower Range was strongly thermally stratified on both dates, as illustrated by the graphics below. Dissolved oxygen concentrations ranged from near saturation at (~8ppm - 9ppm) at the surface to depletion (0 ppm) in the deepest area of the lake on both dates.. Late summer dissolved oxygen levels in Lower Range have been consistently depleted in the deepest area of the lake for a number of years. The oxygen loss may be partially associated with moderate concentration of the natural water color, caused by humic acids released by decomposing wetland vegetation in the watershed.

A second phosphorus sample taken in September near the bottom of the deepest point in the pond measured 18 ppb – substantially higher than the concentration near the surface. Some of the bottom samples from previous years have shown moderately higher concentrations of phosphorus near the bottom of this lake. This may suggest that oxygen depletion is causing phosphorus to be released from the bottom sediments, a phenomenon that has the potential to negatively impact the overall health of the lake over time. Aggressive measures to protect water quality through the identification and mitigation of sources of phosphorus in the watershed may help to stabilize or improve late summer DO loss in Lower Range.

The adjacent graphic illustrates temperature (degrees C. in red) and dissolved oxygen (mg/l or ppm in blue) concentrations from the surface to the bottom of the deepest area of the lake for Lower Range Pond in August and September, 2017. Source: MDEP; VLMP; www.lakesofmaine.org



Colonies of *Gloeotrichia echinulata* were observed in the water column in both July and August, measuring 1.0 on the VLMP/DEP Gloeotrichia density scale.

A sample taken to measure Specific Conductance (see above) measured 82 microsiemens/centimeter, compared to the historical average of 63 ms/cm for Lower Range. Specific conductance appears to be increasing for the three Range Ponds. The increases measured during the past two years may be due, in part, to severe drought conditions. Drought may cause significant evaporation, resulting in the concentration of ions in the lake.

Additional supporting indicators of water quality were within the normal range of the historical data for Lower Range Pond in 2017: pH measured 7.31 in September; total alkalinity was 13.0 mg/l, and average water color for the two dates was 11 SPU.

The increase in the frequency of late summer baseline monitoring of the Range Ponds in 2016 and 2017 enhances our ability to understand the dynamics of the lake system, and will improve our ability to document changes to the ponds.

Volunteer lake monitors on the three lakes provided substantial additional water clarity (Secchi transparency) readings for the full summer monitoring season. The importance and value of the work of Maine's certified volunteer lake monitors cannot be overstated!

Summary:

While the three Range Ponds were not as clear as they were in 2016, ostensibly due to the end of the historical drought, and greater stormwater runoff in the spring of 2017, overall conditions were average to slightly above average for the three lakes. Runoff from lake watersheds provides the means for watershed pollutants to reach lakes. Summary information regarding conditions in several hundred Maine lakes in 2015, 2016 and 2017 suggests that many lakes were clearer than their historical averages during the severe drought period, with substantially fewer above average in 2017. Greater densities of the cyanobacteria (bluegreen algae) were observed in the three lakes than in recent years during the late summer monitoring period. The significance of the increase of Gloeo in Maine lakes in recent years is the focus of ongoing research.

The Range Ponds Association has demonstrated steadfast and effective stewardship for the three Range Ponds and their watersheds for several decades. In addition to supporting comprehensive annual water quality monitoring of the ponds, and landowner education and outreach, the association has conducted surveys of the watersheds to identify and remediate soil erosion problems, and has produced a Watershed Management Plan to provide landowners, community planners and others with guidance for the long-term protection of the Range Ponds.

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