2018 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 2018 through the engagement of both professional lake scientists and a strong lake association and volunteer community that has historically 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 (Lower Range), for their significant contributions to the data discussed in this report.

Monitoring and sampling of the lakes took place from early May through September, during the time of year when lakes and ponds are typically 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 (Lake Stewards of Maine).

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, in that many Maine lakes tend to be clearer during dry years, and less clear when

winter runoff and early summer rainfall are greater. However, not all lakes follow such a trend, especially those that receive a percentage of their annul nutrient (phosphorus) load from internal sources (lake sediments), in addition to external (watershed) loading.

The extended severe drought that occurred throughout 2015 and 2016 officially ended during the winter of 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. Once again, much of Maine experienced a very dry summer in 2018. Temperatures were very warm throughout the period, with lake surface temperatures soaring.

2018 Monitoring Results for the Range Ponds:

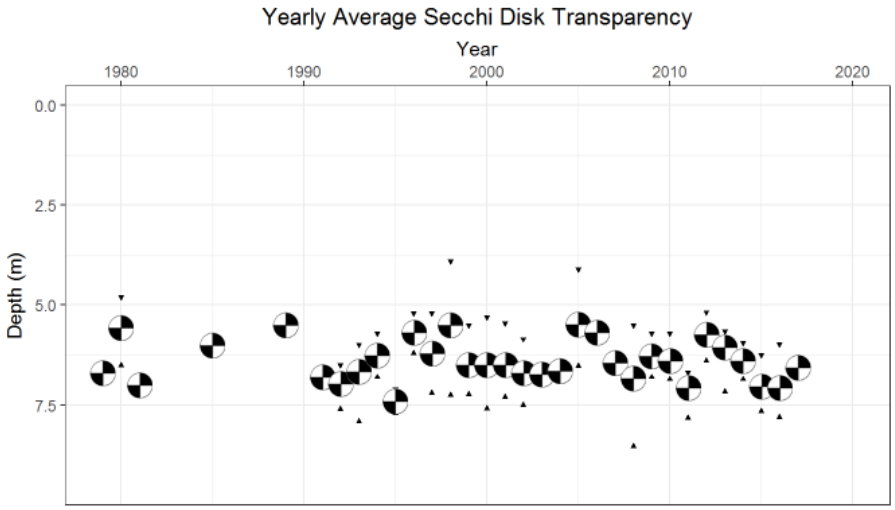
The following is a summary of findings for the three Range Ponds in 2018. Extensive water clarity (Secchi transparency) readings were taken for several months by the certified volunteer monitors mentioned above. All other summary baseline data discussed in this report were obtained by LWRMA lake scientists 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 slightly above average in 2018, relative to historical data for in the lake. The water was very clearer, the concentration of phosphorus in August and September was lower, and algae density in the lake was lower than the average, based on data gathered for the lake from 1979 to present. The August and Septembner dissolved oxygen profiles indicated significant depletion of dissolved oxygen in the deepest area of the pond, somewhat similar to that of recent years, but somewhat less severe. The lake was likely clearer than it has been as a result of extended summer drought.

Water clarity (Secchi transparency) averaged 6.9 meters (about 23 feet) in 2018. The 2018 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. The 2018 graphic had not been generated at the time of the preparation of this report.

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

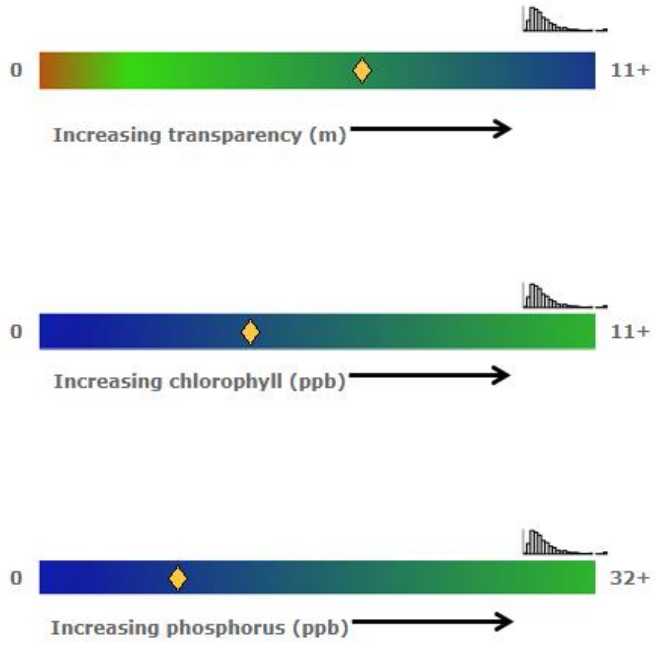


The concentration of total phosphorus (the nutrient that is responsible for the growth of algae in lakes) measured 6 parts per billion (ppb) in the surface layer core sample taken in August and 5 ppb in September, averaging 5.5 ppb for the two samples. The historical average for Upper Range is 7.5 ppb. 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.

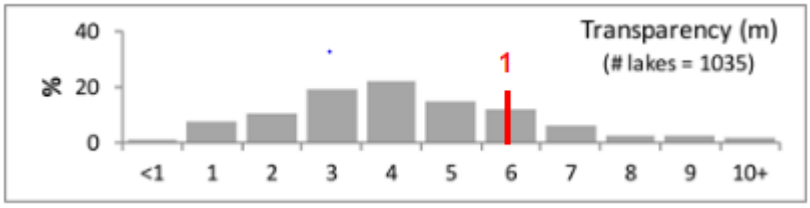
A phosphorus sample taken near the bottom of the lake at the deep sampling station in September, measured 12 parts per billion, possibly indicating that phosphorus was being released from the bottom sediments as a result of the low concentration of dissolved oxygen in the water at that depth. However, 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 3.0 parts per billion, and the September sample measured 2.0 ppb, averaging 2.5 ppb. Both samples were substantially lower (more algae) than those taken in 2017. The historical average for Upper Range is 2.5 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 2018, 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 becomes contaminated, and provides an overall better picture of conditions in the lake.

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 18 degrees C in August, and approximately 17 degrees in September.

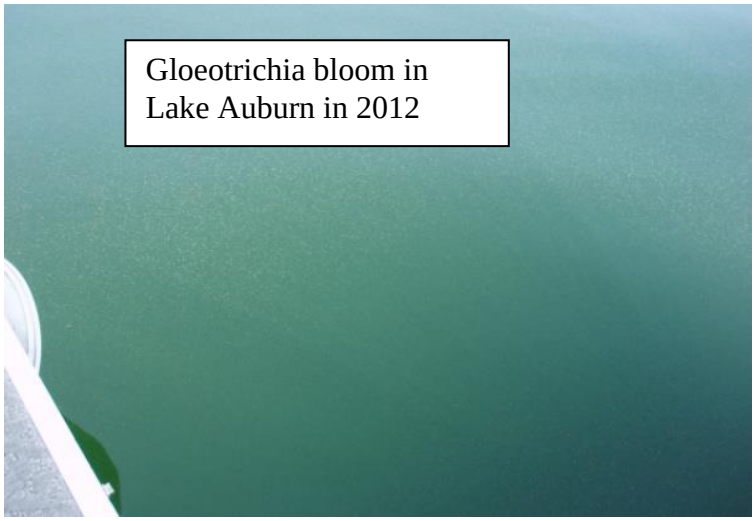
The concentration of dissolved oxygen was near saturation at the surface on both dates, showing some oxygen depression in August in the last few meters closest to the bottom at the deep station, and significantly greater oxygen loss in the same region of the water column in September, ostensibly due to the longer period of time during which the deep layer of water had

been isolated from the atmosphere. Although oxygen depletion was documented on both dates at the very deepest point in the lake (~11 meters), the loss of dissolved oxygen was less severe than it has been in some past years, very likely due to the lower concentration of algae and decaying organic matter in the water in 2018.

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, 2018 measured 69 microsiemens/centimeter (73 in 2017). 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 samples during the past three years may have been exacerbated as a result of high level of evaporation of lake water during the persistent drought, resulting in a concentration of ions in the lake.*

Other water quality indicators that are measured to help support the primary data (pH: 7.45, Total Alkalinity: 14.0 mg/l and Color: average 8 SPU) were within the normal range of historical values for Upper Range in 2018.

The bluegreen alga/cyanobaceria, (*Gloeotrichia echinulata)* that is a current focus of research in New England Lakes, was not observed in Upper Range on either of the two site visits in 2018.



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.

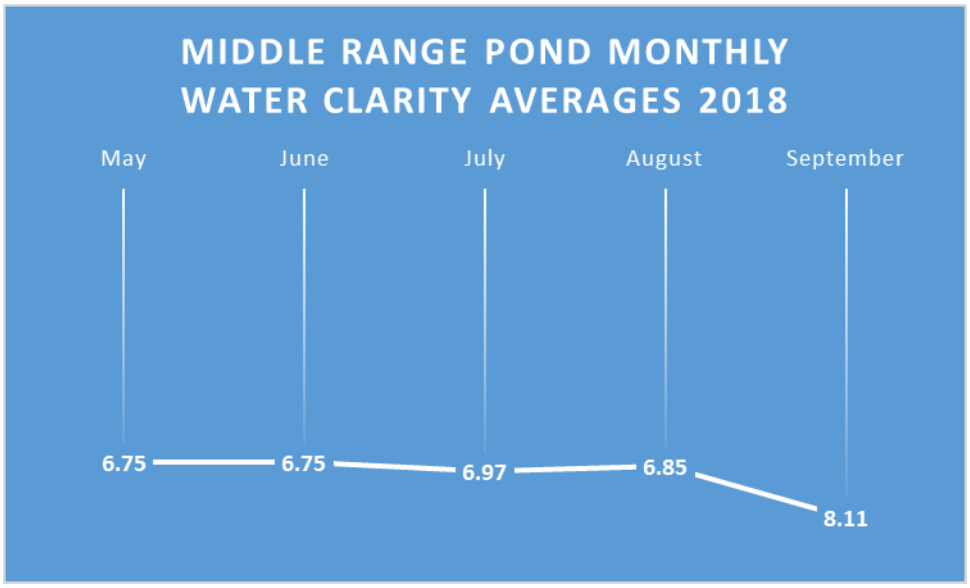
Middle Range Pond:

The water clarity of Middle Range Pond was significantly higher (better) than the historical average for the lake in 2018. The concentration of total phosphorus in the water was lower than the average, and the concentration of algae in the lake was slightly lower in August and September. The 2018 samples and readings mark a return to the excellent above average conditions documented in Middle Range for the past several years. In 2017, conditions were

more like the historical average for the lake, but 2018 was once again an above average year for the lake.

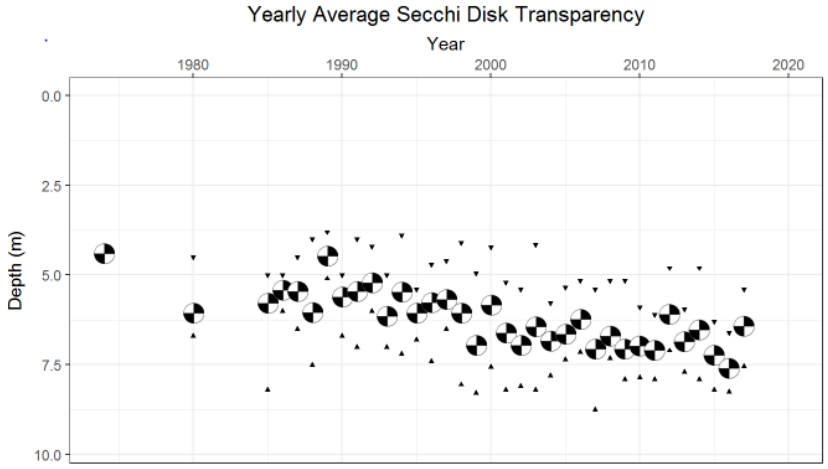
The average water clarity in 2018, based on a full season of data provided by VLMP/LSM certified lake monitor, Barry Kutzen (in addition to our August and September readings) was 7.1 meters, compared to the historical average of 6.2 meters for Middle Range.

The following graphic illustrates the changes in water clarity during the six month period in Middle Range Pond. Each symbol represents an average of readings for the month shown. The dramatic increase in water clarity during the month of September had a strong influence on the improved annual average for the lake.



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 2018 map had not been prepared at the time that this report was generated.

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



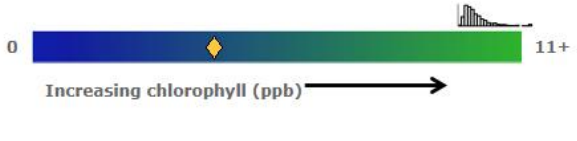
The graphic above shows an apparent improvement in the clarity of Middle Range Pond during the period.

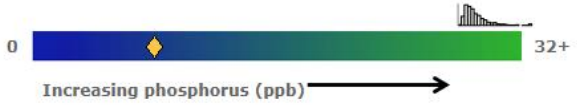
The surface layer core *total phosphorus* concentration measured at the Middle Range deep sampling station measured 6 parts per billion (ppb) in both August and September, compared to the historical average for the lake of 7.8 ppb. Historical phosphorus levels in Middle Range Pond have varied from 5-12 ppb since samples have been collected starting in 1985.

A total phosphorus sample taken in September near the bottom of the deepest spot in Middle Range measured 14 ppb, more than double the concentration in the surface core sample, which may indicate that phosphorus is being released from the sediments in the zero oxygen environment. To date, there has been little indication to suggest that any release of P from the sediments is having a significant effect on the lake. It is not unusual for phosphorus concentrations taken close to the bottom sediments in the deepest area of a thermally stratified lakes to be slightly to somewhat higher than in the surface layer, due to the nearly continuous downward settling of organic and inorganic detritus.

The concentration of *chlorophyll-a (algae concentration in the lake)* was lower in 2018 than in 2017 measuring 4.0 ppb in August, and 3.0 ppb in September, averaging 3.5 ppb for the year, compared to the historical average of 4 ppb. Based on the clarity of the water, the concentration of phosphorus, and algae in the water, conditions in 2018 were above (better than) the historical average for this lake.

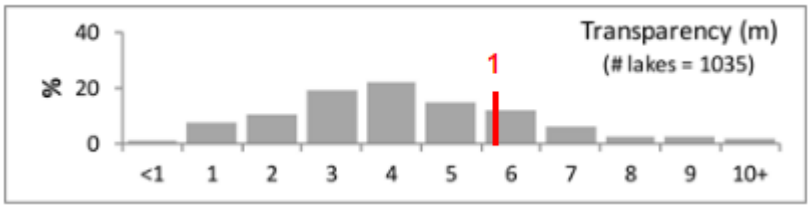
The adjacent graphics, taken from the Maine Volunteer Lake Monitoring Program/LSM www.lakesofmaine.org website, illustrate the position of Middle Range Pond for the primary indicators of lake productivity, aka



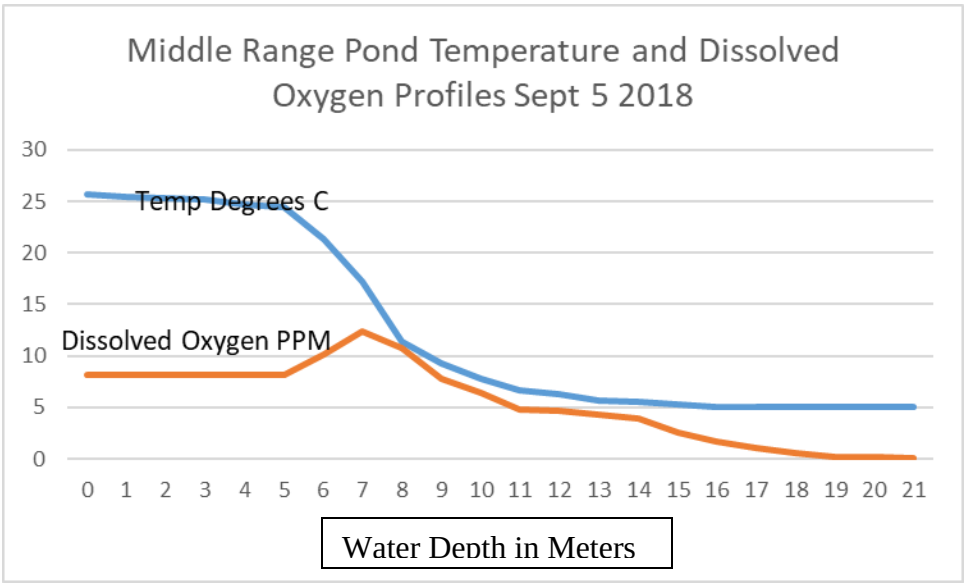


"trophic state". Each bar below represents a range of values for each indicator, with increasing values from left to right. Please note that while an increase in water clarity (transparency) is generally equated with good water quality, an increase in phosphorus and chlorophyll are more likely to be 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 26.7 degrees C at the surface in September, to about 4 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 1.3 ppm in August at 19 meters. On September 5, the temperature range from the surface to 21 meters depth was 25.7-5.0 degrees C., and dissolved oxygen ranged from 8.2 ppm at the surface to 0.1 ppm at 21 meters. The surface temperature in September was nearly 5 degrees higher than at the same time in 2017. Late summer oxygen levels in Middle Range Pond were critically low in the deepest 8 meters of the lake in September (graphic below). Continued efforts to protect the water quality of Middle Range may help prevent DO levels from declining further in the future.



The concentration of the bluegreen algae, *Gloeotrichia echinulata* (see above) measured 0.0 on the Maine VLMP/DEP "Gloeo" scale on August 2 at the deep monitoring station. On September 5, the concentration was estimated at 0.5. Similar concentrations of Gloeo have been documented in Middle Range Pond in August and September in recent years. Historically, 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 86 ms/cm, compared to the historical average for Middle Range of 58 ms/cm. The 2018 reading is the second 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. However, it is possible that 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.

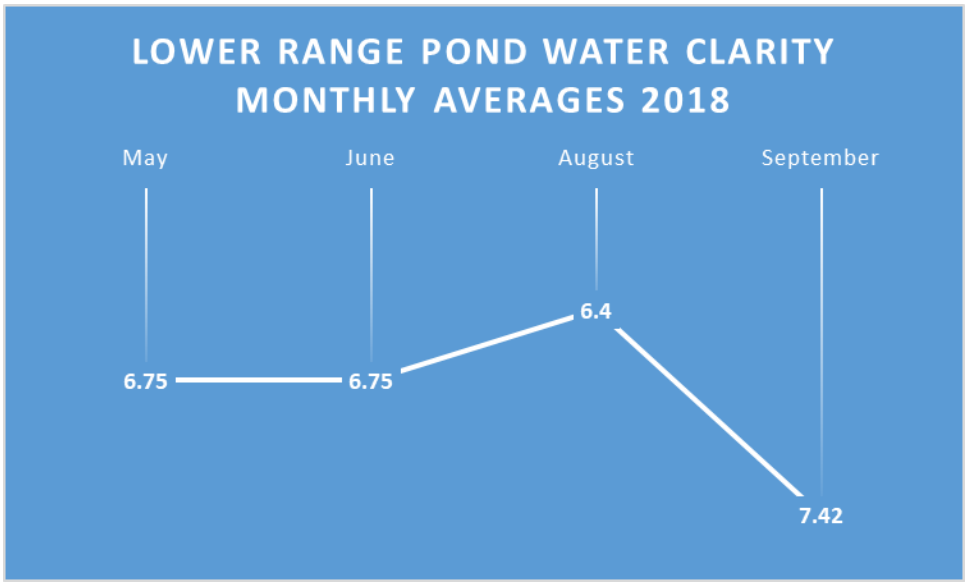
Other water quality indicators that are measured to help support the primary data (pH: 7.48, Total Alkalinity: 14.0 mg/l and Color: 9 average) were within the normal range of historical values for Middle Range Pond in 2018. The concentration of the humic acids that are responsible for color in lake water appear to have been declining in recent years, possible due to the significant reduction in stormwater runoff during drought conditions.

Lower Range Pond:

Overall, Lower Range Pond experienced average to above average water quality in 2018, in that the lake was very close to its historical water clarity average, the concentration of phosphorus was slightly lower than the historical average for Lower Range, and the baseline chlorophyll (algae) concentration was also slightly lower (less algae) than the historical average, based on samples and readings taken in August and September, except for additional Secchi clarity readings taken by Poppy Connor-Crouch in May and June, which were very helpful in the analysis of the data. Late summer dissolved oxygen concentrations in the deepest area of the lake continued to be extremely in areas below 7 meters depth, which represents an extremely small percentage of the lake bottom. .

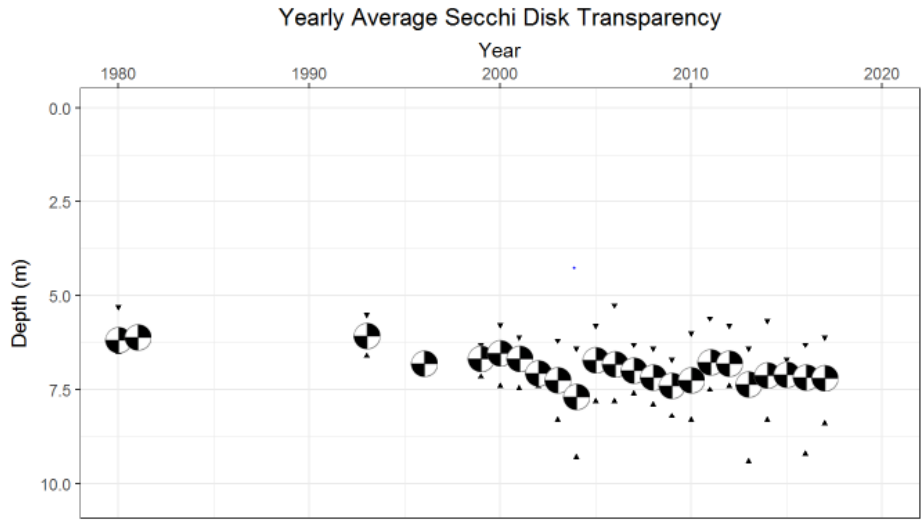
The lake was in line with the historical clarity average in 2018, averaging 6.83 meters, compared to the historical average of 6.9 meters. The 2018 average was based on our August and September readings, in addition to those provided by Poppy Connor-Crouch. The historical average of 6.9 meters has recently 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 2018 monitoring season. Note that the symbols indicate averages for the month indicated.



The graphic below illustrates the history of Secchi transparency (water clarity) readings for Lower Range Pond, from 1980-2017. Shown on the graph are maximum (clearest), minimum (least clear) and averages for the years indicated. The 2018 graphic prepared by the Maine DEP was not yet available when this report was generated.

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

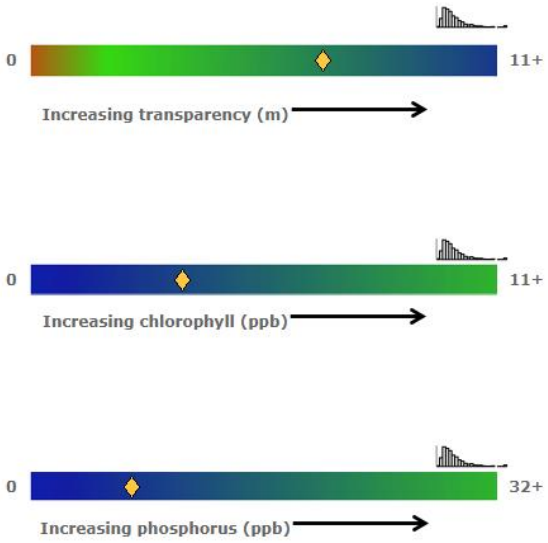


The total phosphorus concentration average in Lower Range Pond last summer, based on samples taken in August and September was 6.5 ppb. The historical average is 7.1 ppb.

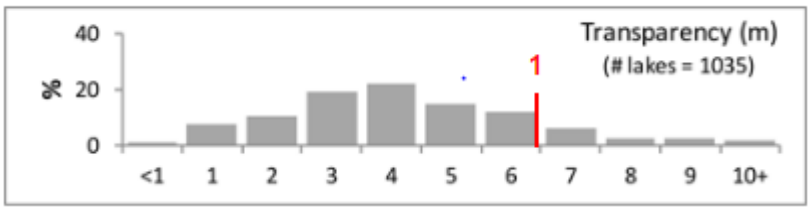
Phosphorus levels have ranged from 5- 15 ppb in Lower Range since 1981. The very high 15 ppb sample was taken in 1981, and none of the samples taken since have approached this level, most years falling in the 6-9 ppb range, except for the lowest sample (5 ppb) measured in 2014.

Chlorophyll-a (a photosynthetic pigment used to estimate algal growth in the water) averaged 3.0 parts per billion in August and September, 2018, 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 5 indicated that Lower Range was strongly thermally stratified on both dates. Dissolved oxygen concentrations ranged from near saturation at (~8ppm) 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 10 ppb – Somewhat 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.

However, the percentage of lake bottom area in Lower Range that is experiencing oxygen depletion is very small, reducing the current threat of phosphorus release. However, any increase in the overall nutrient loading to the lake, and resulting algal growth, could result in a broader area of the lake being affected by this phenomenon.

No colonies of *Gloeotrichia echinulata* were observed in the water column in August or September.

A sample taken to measure Specific Conductance (see above) measured 90 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. However, the increases measured during the past few years may be due, in part, to severe drought conditions. Drought may cause significant evaporation, resulting in the concentration of ions in the water that are measured in this water quality indicator.

Additional supporting indicators of water quality were within the normal range of the historical data for Lower Range Pond in 2018: pH measured 7.32 in September; total alkalinity was 14.0 mg/l, and average water color for the two dates was 8 SPU.

The increase in the frequency of late summer baseline monitoring of the Range Ponds in 2016, 2017 and 2018 has enhanced our ability to understand the dynamics of these lake systems, and will improve our ability to document future changes to the ponds.

Volunteer lake monitors on two of the 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:

Overall, water quality conditions in the three Range Ponds in 2018 were average to above average. Sotrmwater runoff from lake watersheds provides the means for watershed pollutants – primarily the nutrient phosphorus and sediment particles - to reach lakes. Summary information regarding conditions in several hundred Maine lakes in 2015, 2016, 2017 and 2018 suggests that

many lakes were clearer than their historical averages during the persistent severe summer drought period

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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