2015 Range Ponds Water Quality Report

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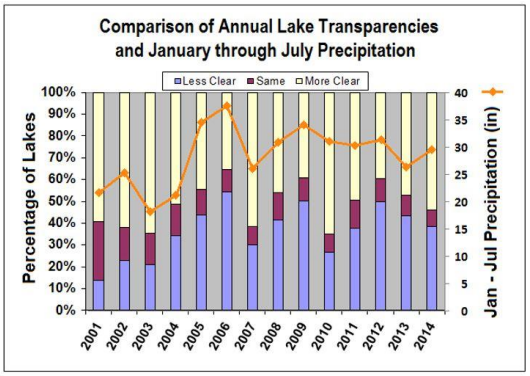
The Range Ponds Environmental Association continued to monitor the health of Upper, Middle and Lower Range Ponds in 2015 through the engagement of both professional lake scientists and a strong lake association and volunteer community that has focused on both water quality monitoring and watershed protection. 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.

*2015 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 amounts, 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) seem to have a significant correlation to precipitation.

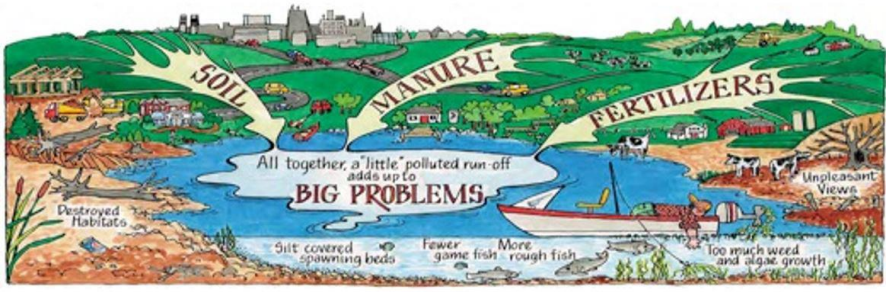
Figure 1 (right) illustrates the relationship between annual precipitation (January through July, Portland, Maine) and the annual average Secchi transparency for monitored Maine lakes over a period of fourteen years. There is an apparent inverse correlation between the two variables; in



other words, as annual precipitation increases, Secchi transparency decreases in most, but not all, years. Preliminary statistics indicate that one-third of the variation we see in lake transparency is due to precipitation.

The correlation is significant, but not perfect by any means, due, no doubt to the interaction of many variables that make each lake somewhat unique, including the fact that the precipitation data from the National Weather Service is from one region of the State of Maine (Portland), whereas the Secchi average includes lakes throughout the state. Maine is a large state, and weather can vary considerably from north to south, east to west, and in between. However, a substantial percentage of the lakes represented in the VLMP database are situated in the south/southwesterly area of Maine, relatively close to Portland. A stronger correlation might exist if the graph were to only represent lakes situated within a short distance of where the precipitation was measured.

Given the correlation discussed above—imperfect or no—it is reasonable to assume that, on average, a majority of Maine lakes will be less clear during high-precipitation years, especially if precipitation occurs the winter before and/or during the lake monitoring season. That is because lakes are the natural repository of much of the stormwater runoff that results from precipitation events. As stormwater (including snowmelt) moves across the landscape, it picks up pollutants that can negatively impact water clarity, such as phosphorus—which stimulates algal growth—and eroded soil particles. (See **Figure 2** below.)



A significant percentage of the annual phosphorus transported to Maine lakes typically occurs during the "spring runoff period", when the winter snowpack is melting, spring showers are taking place, and soils are often either frozen or saturated with water (resulting in greater runoff).

As suggested above, the correlation between precipitation and water clarity is not entirely straight forward. Qualitative factors, such as the timing and intensity of storm events can have a strong bearing on the extent to which precipitation runs off, as opposed to filtering slowly into the ground. Frequent low-intensity rain events cause less soil erosion and phosphorus export to lakes than high intensity storms, in which rain comes too fast to filter through the soil, often resulting in significant erosion and stormwater runoff to lakes. Also, for a relatively small group of lakes that experience internal phosphorus recycling, frequent rain events—by regularly flushing phosphorus-laden water from the lake—may actually have the opposite effect, causing an improvement in Secchi transparency.

2015 Weather Synopsis:

None of us need to be reminded that the winter of 2015 was long, cold and very snowy! However, precipitation in February and March was below normal in Portland, even though snowfall and the standing snowpack was above normal during that period. Very little melting occurred in February, and March was also colder than normal, the net effect of this being that in late winter/early spring, there was still a great deal of snow on the ground

throughout much of the state. All of this set the stage for potential flooding and heavy runoff in the spring– not the best scenario for lakes.

Fortunately, April was only slightly warmer than normal, and precipitation—the first rain since December—was less than an inch above normal. As a result, the snowpack continued to melt slowly, with little flooding, and minimal runoff to lakes from their watersheds, as the snow and rain slowly infiltrated into the gradually warming soils.

Although May was unusually warm, precipitation was below normal, and with the exception of one storm that produced just under an inch of rain, much of what fell from the sky in May was likely to have infiltrated into the soil.

June was unusually cool, and although rainfall for the month was above normal, year-to-date precipitation was only .02 inches above normal.

Temperatures moderated in July, but precipitation was substantially below normal, being one of the driest Julys in 145 years! During such conditions, very little, if any, stormwater runoff made it to Maine lakes.

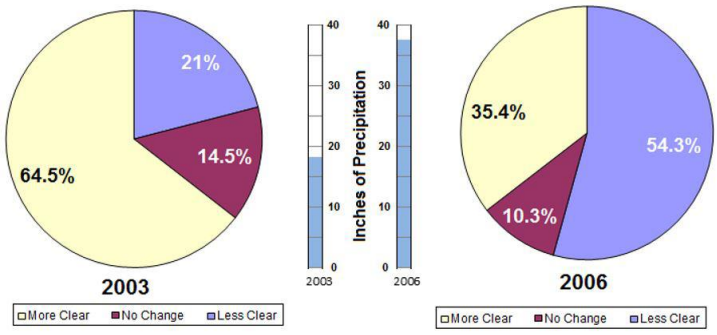
August was warmer than normal, but precipitation for the month remained below average, and conditions on the ground were becoming very dry. Once again, very little stormwater runoff occurred in the area. During the month of August, a number of volunteer lake monitors reported "better than average" Secchi readings for the month.

Warmer-than-average conditions persisted into September, and precipitation for the month was above normal, making it a notably wet month. However, much of the precipitation occurred in a 6 inch rain event on the 29th and 30th of September; too late to have any bearing on summer Secchi readings.

In summary, weather conditions in the Portland, Maine area during the first several months of 2015 would likely have had a favorable influence on lakes in the region, as a result of 1) relatively slow warm-up and snowpack melt in the spring, followed by 2) average, to below average rainfall during the mid and late summer period, likely resulting in relatively little runoff and soil erosion from lake watersheds during the period.

Note: The complete NWS narrative weather summary on which this information is based can be viewed at: http://www.mainevlmp.org/wp-content/uploads/2015/11/NWS-2015-Narrative-Summaries.pdf.

Now for some disclaimers: While the conditions noted above could have an overall beneficial effect for many lakes, weather is just one of a myriad of factors that determine how individual lakes will "behave" during the lake monitoring period. Moreover, Secchi transparency is only one indicator of lake water quality – albeit a pretty good one for gaging the overall health of a lake. For every year when a relatively high percentage of Maine lakes are clearer than they have been historically, many are also less clear, as the two pie charts in **Figure 3** below illustrate (note the differences in precipitation for the two years).



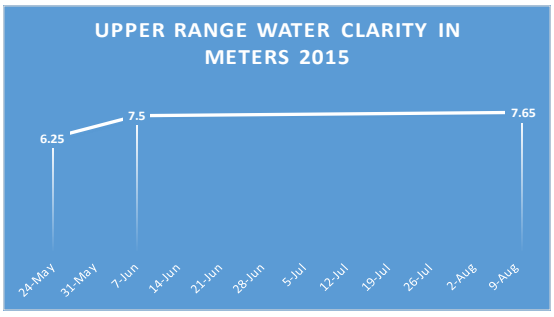
**Note: The weather synopsis above is excerpted from an article authored by Scott Williams in the 2015 edition of The Water Column, the newsletter of the Maine Volunteer Lake Monitoring Program.*

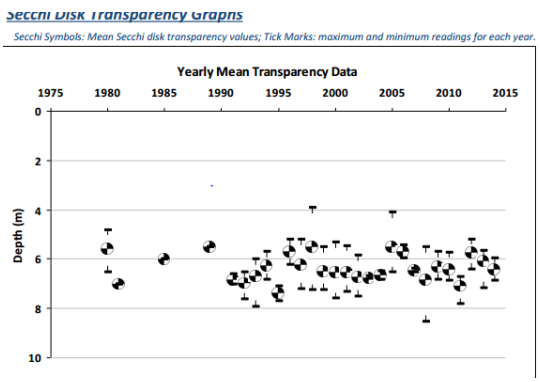
The following is a summary of findings for the three Range Ponds in 2015. Water clarity data are based on readings taken in August 10, 2015, as well as water clarity data provided by certified volunteer lake monitors for each of the Range Ponds. All other summary data were obtained by LWRMA lake scientists in August, at a time consistent with the historical gathering of "baseline" data for the Range Ponds.

Upper Range Pond:

Upper Range Pond water quality was above average again in 2015, compared to historical information for the lake. The water was clearer, the concentration of phosphorus in August was 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 showed some oxygen loss in the deepest area of the pond, but less so than in several previous years.

Water clarity averaged 7.2 meters (23.4 feet) in 2015 (compared to 6.4 in 2014), based on a reading from the August sampling, and from readings taken by certified VLMP lake monitor Matthew Brettler in May and June. The historical average for the lake is 6.4 meters (21 feet). Readings taken in 2014 ranged from 6.3 to 7.7 meters. The graphic on the left illustrates the changes in water clarity during 2015. The graph on the right from the Maine DEP and Maine Volunteer Lake Monitoring Program illustrates annual average lake water clarity through 2014. 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 concentration of total phosphorus (the nutrient that is responsible for the growth of algae in lakes) measured 5 parts per billion (ppb) in the single surface layer core sample taken on August 10, 2015. The historical average for Upper Range is 8 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. It is very important to note that the 2015 "average" was based

on only a single sample taken in August. It is quite likely that the concentration of phosphorus in the pond varied during the course of the summer.

A phosphorus sample taken near the bottom of the lake at the deep sampling station measured 12 parts per billion, a possible indication 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. 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.

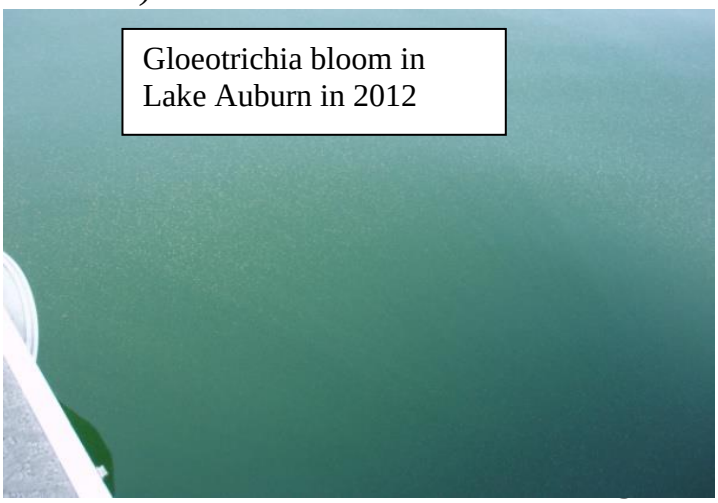
Chlorophyll-a (CHL) is a pigment that is measured to determine the concentration of algae in lake water. The August 2015 sample measured 3.6 parts per billion (ppb). The historical average for Upper Range is also 3.6 ppb. Annual CHL averages in Upper Range have varied from 2.4 ppb to 9.9 ppb. In many cases, the "average" is based on a single sample taken during the summer, as was the case, in 2015. A single sample taken in late summer often, but not always, represents the period when lakes are most biologically "productive", and algae concentrations in the water are highest for the monitoring period.

A temperature and dissolved oxygen profile taken on August 10 indicated that Upper Range was strongly thermally stratified, with water temperatures ranging from 25.4C at the surface to 8.6 C at 11 meters depth, approximately one half meter from the bottom of the sample station at the deepest point in the lake. Dissolved oxygen levels ranged from 8.2 parts per million (ppm) at the surface to a low level of 0.7 ppm at 11 meters depth. Late summer dissolved oxygen loss in Upper Range Pond has been minimal in past years, and conditions encountered in 2015 were somewhat typical for this lake, and oxygen levels were higher (better) than in some recent years.

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 August, 2015 measured 58 microsiemens/centimeter. The historical average for Upper Range is 46 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.*

Other water quality indicators that are measured to help support the primary data (pH, Total Alkalinity and Color) were within the normal range of historical values for Upper Range in 2015.

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 August 2015 site visit, nor was it detected in Middle or Lower Range in 2015. "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



Gloeotrichia bloom in Lake Auburn in 2012

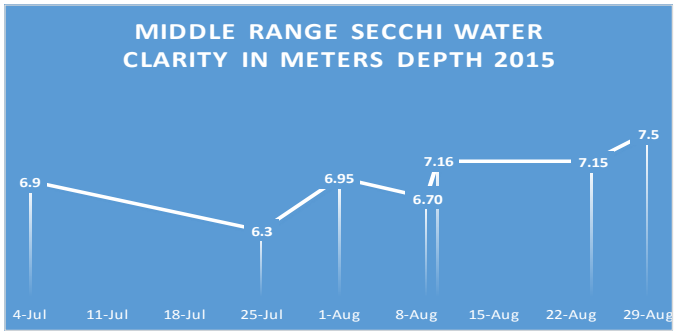
surface of Lake Auburn in 2012 during the peak of a Gloeotrichia bloom. Gloeo observations took place at the boat launch area and at the deep monitoring station for each of the three lakes.

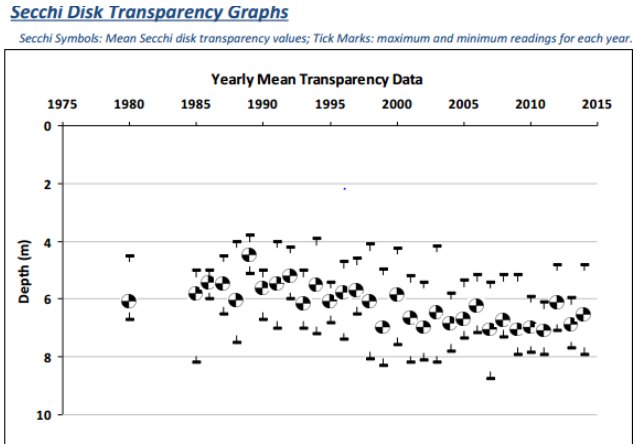
Middle Range Pond:

The water clarity of Middle Range Pond was <u>once again</u> very clear in 2015, compared to its historical average. The concentration of total phosphorus in the water was slightly higher than average, and the concentration of algae in the lake in early August (based on a single sample) was slightly higher than average. Overall, conditions were average for Middle Range Pond, largely due to what appears to be improving water clarity.

The average water clarity in 2015, based on data provided by VLMP certified lake monitor, Barry Kutzen (in addition to our August reading) was 7.1 meters (~ 23feet) – nearly one full meter higher (better/deeper) than the historical average for Middle Range of 6.2 meters!

The following graphics illustrates the changes in water clarity in Middle Range on the left, and long-term annual averages on the right:





The surface layer core *total phosphorus* concentration measured at the deep sampling station in August measured 7 parts per billion (ppb), 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 10 ppb, only one ppb higher than the surface core sample. There was no indication of phosphorus release from the bottom sediments.

The concentration of *chlorophyll-a (algae concentration in the pond)* was higher than the historical average for the lake, measuring 5.2 ppb in August, compared to the historical average of 3.7 ppb. Based on the clarity of the water, the concentration of phosphorus, and algae in the water, conditions in 2014 were improved, compared to both the most recent two years and the historical average for the lake.

A temperature and dissolved oxygen profile taken on August 9 indicated that Middle Range was strongly stratified, with water temperatures ranging from 25.6 degrees C at the surface to 5.9 C at 21 meters depth, near the bottom of the sample station at the deepest point in the lake. Dissolved oxygen levels ranged from 8.4 ppm at the surface to a low level of 1.0 ppm at 21 meters depth. Late summer oxygen levels in Middle Range are low, but are not yet critically so. 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 on the Maine VLMP/DEP "Gloeo" scale on August 10 at the deep monitoring station. In August, 2012, the concentration recorded was 1.0, and in August, 2013, 0.5. The scale for monitoring Gloeotrichia density runs from 0-6.0. Many Maine lakes have experienced late summer Gloeo concentrations in the 0.5 range.

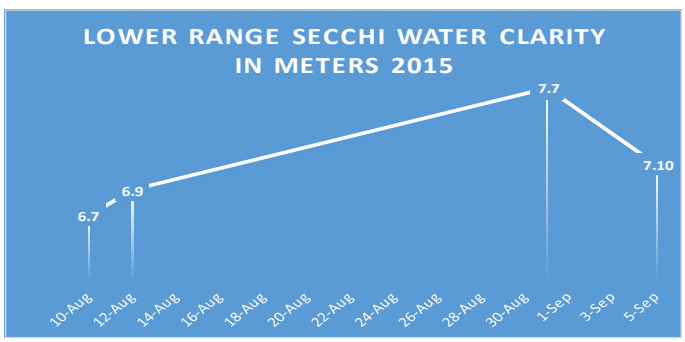
A sample for Specific Conductance (see above) measured 70 ms/cm, compared to the historical average for Middle Range of 50 ms/cm. Specific Conductance appears to be increasing in Middle Range, as is the case for Upper Range Pond. The apparent increase in this possible indicator of change in the lake bears watching and continued monitoring.

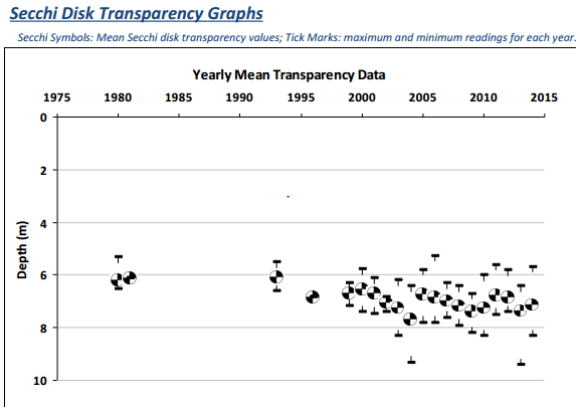
Other water quality indicators that are measured to help support the primary data (pH, Total Alkalinity and Color) were within the normal range of historical values for Middle Range Pond in 2015.

Lower Range Pond:

Overall, Lower Range Pond experienced a slightly above average year in 2015, in that the lake was slightly cleared than its historical water clarity average, the concentration of phosphorus was the same as the historical average for Lower Range, and the baseline chlorophyll (algae) concentration in August was very slightly (non significantly) higher the historical average, based on a single sample taken on August 10.

The lake was clearer than average in 2015, averaging 7.1 meters (~23 feet), compared to the historical average of 6.9 meters. The 2015 average was based on our August reading, plus additional readings taken by Maine VLMP certified lake monitor Poppy Connor-Crouch. The historical average for Lower Range is 6.9 meters, which 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 during the course of the 2015 monitoring season (left), and annual averages through 2014 on the right (source, MDEP and VLMP). Readings are in meters.





The total phosphorus concentration in Lower Range Pond last summer, based on the single August sample, was 7 ppb, compared to the historical average which is also 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) measured 4.0 parts per billion in August, 2015, compared to the historical average of 3.7 ppb – only a very small level above the average. CHL levels in Lower Range have ranged from 2.9-6.5 ppb, the highest reading having been measured in 1993.

A temperature and dissolved oxygen profile taken on August 10 indicated that Lower Range was strongly stratified, with water temperatures ranging from 25.5 degrees C at the surface to 8.7 degrees C at 14 meters depth, near the bottom of the sample station at the deepest point in the lake. Dissolved oxygen levels ranged from 8.4 ppm at the surface to a low level of 0.0 ppm, beginning at12 meters, and extending to the bottom at 14.2 meters depth. Late summer dissolved oxygen levels in Lower Range have been consistently depleted in the deepest area of the lake. A second phosphorus sample taken near the bottom of the deepest point in the pond measured 11 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.

Zero colonies of *Gloeotrichia echinulata* were observed in the water column on August 10. Many Maine lakes experience low density "Gloeo" growth in the late summer/early fall.

A sample taken to measure Specific Conductance (see above) measured 67 microsiemens/centimeter, compared to the historical average of 56 ms/cm for Lower Range. Specific conductance appears to be increasing for the three Range Ponds.

Additional supporting indicators of water quality were within the normal range of the historical data for Lower Range Pond in 2015.

It is important to note that our baseline sampling of the lake in 2015 was limited to the month of August, whereas much of the historical data for the three Range Ponds is based on both mid and and late summer sampling. This change in the sampling schedule may have influenced the 2015 averages for some of the indicators that were monitored, relative to historical levels for some indicators. However, volunteer lake monitors on the three lakes provided additional substantial water clarity (Secchi transparency) readings for the full summer monitoring season. It is important to keep the change in sampling frequency in mind when considering these results.

Summary:

Each of the three Range Ponds was overall above average in 2015, relative to the historical averages for indicators of water quality for the three lakes. This was likely due, in part, to weather conditions in 2015 that were favorable to Maine lake water quality, including the lenthy, cold winter, slow warm-up in the spring, and relatively late ice-out dates for Maine lakes in 2015. One of the reasons that lake water quality varies with the weather is that stormwater runoff from lake watersheds provides the means for watershed pollutants to reach lakes. Cool weather, combined with fewer runoff-producing storm events during the period preceding and during the spring, summer and fall period when lakes are most vulnerable, generally has a positive influence on lake water quality.

2016 Monitoring of the Range Ponds

Maine lake scientists are concerned about the implications of unusually warm weather in the fall of 2015, which resulted in late ice formation on Maine lakes, followed by a very warm 2016 winter, and unusually warm ambient conditions in the spring. Most Maine lakes experienced record early "ice-out" conditions in the spring, which will result in a longer growing season for algae, a possible lengthening of the period of thermal stratification for Maine lakes during the spring, summer and fall, and lower dissolved oxygen concentration in vulnerable lakes. Documenting such conditions is extremely important, so that we are able to better understand, and hopefully protect our lakes from such stresses in the future.

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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