2020 Range Ponds Water Quality Overview

Perspective:

The annual characterization of the water quality of Maine lakes has always been a challenge to lake scientists because aquatic ecosystems experience a high degree of "natural variability". One of the strongest influences on this natural process is the weather, and typically, foremost among the many forces of weather on lakes is precipitation. Many Maine lakes tend to be clearer during drier years, ostensibly because of reduced watershed stormwater runoff during such periods, and stormwater runoff is the vehicle that transports phosphorus and other pollutants from watersheds to lakes. Conversely, many lakes tend to be less clear during years when there is more precipitation during the period from January through the middle of summer.

While a majority of Maine's lakes "behave" this way, there are exceptions to this simplistic generalization, both in the degree of variability that occurs with individual lakes, and the fact that some lakes respond to precipitation in an opposite manner, for reasons having to do with other weather influences (temperature, wind, etc.), as well as factors pertaining to the unique characteristics of individual lake ecosystems, including the annual flushing rate, watershed geochemistry, bathymetry and much more. Highly productive lakes that experience regular algae blooms sometimes benefit from the diluting effects of precipitation, because phosphorus concentrations are already moderately high.

Climate warming is compounding the complexity of tracking, predicting and characterizing lake water quality. Reduced periods of ice cover, resulting in longer periods of light penetration, and warmer lake water, when combined with more severe weather events during the open water season, will almost certainly have a negative effect on the health of Maine's lakes over time. Some lakes that have historically been "on the edge", as well as some that were considered stable, have experienced a significant decline in recent years, very likely, in part to a warming climate.

Maine Lakes in 2020:

Maine experienced two simultaneous forms of extreme weather in 2020. Much of the State experienced moderate to extreme drought during the period. And by mid-July, lake surface water temperatures in southern and central Maine were as much as 10 degrees warmer than their historical average. "Fish kills" were documented in a number of lakes throughout the state. Maine DIF&W fishery pathologists indicated that the mortality was the result of parasitic infections enhanced by stress from the unusually warm water.

Multiple articles pertaining to the unusual weather influences on Maine lakes in 2020 can be found in the newsletter of Lake Stewards of Maine at the following link: https://www.lakestewardsofmaine.org/wp-content/uploads/2021/02/LSM-tWC-2020-21-WebR2.pdf

Range Ponds 2020 Overview and Summary of Findings:

LWRMA staff conducted comprehensive baseline sampling of the three Range Ponds in August 19, 2020. Due to constraints associated with the pandemic at that time, the sampling was limited to a single visit, even though two had been scheduled. The month of August is generally considered to be the most critical time period for conducting comprehensive baseline sampling of lakes. Information gathered at that time can be compared to sample results within the same historical sampling window.

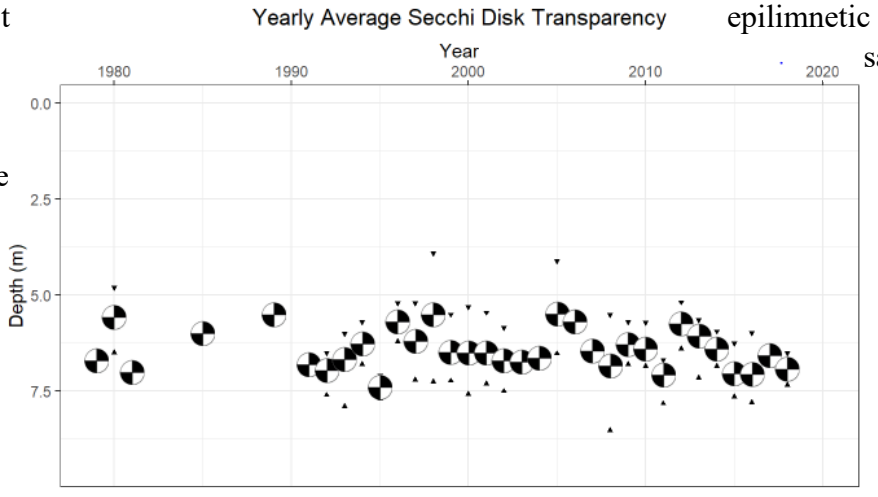
Upper Range Pond:

The following is based on sampling conducted on Upper Range Pond on August 19, 2020. Additional lake water clarity data gathered by LSM Certified Volunteer Monitor, Matt Brettler, have been included, as well. Historical data reference sources are the Maine Department of Environmental Protection, Lake Stewards of Maine (www.lakesofmaine.org), and LWRMA field records and reports.

Please refer to Table 1, below regarding all data obtained in 2020, and historical averages.

Overall, the water quality of Upper Range Pond continues to be relatively stable. In 2020, overall water quality was very close to the historical average for the lake. The 6.81 meter water clarity average was slightly clearer than the historical average (6.4M) for the lake. Figure 1 illustrates the considerable annual variability in water quality that has been documented in Upper Range Pond since 1980 (last updated by MDEP in 2018). Some of the variability that has occurred from year to year may be partially influenced by the frequency and timing of readings taken.

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



The single August epilimnetic core total phosphorus sample measured 6 ppb, which was slightly lower (better than) than the historical average (7.5ppb) for the lake. A samples taken near the bottom of the deepest point in the lake measured 14ppb, compared to the historical average of 13ppb. The lake was strongly thermally stratified on August 19, and dissolved oxygen was depleted only in the deepest 2 meters of the lake, similar to, and consistent with historical late summer conditions for Upper Range.

The chlorophyll-a (a direct measure of planktonic algae density) concentration in August measured 3.0 ppb lower than the historical average for the lake (3.9ppb), as indicated in the Figure 1 table below.

True Color, Total Alkalinity and Specific Conductance were not measured in 2020,due to the circumstances of the pandemic and limited staff availability through the Maine DEP laboratory in August.

Gloeotrichia (cyanobacteria) colonies were observed at the station 01 sampling location on August 19. The density of this cyanobacteria at that time was 1.0, on a scale from 1.0-6.0. Gloeotrichia is a form of bluegreen algae/cyanobacteria that has historically not been uncommon in a number of clear Maine lakes during the late summer-early fall period. In recent years, the presence of this alga has increased significantly in some lakes throughout New England. Research suggests that an increase in the presence of "Gloeo" may be associated with a negative change in water quality – possibly driven by a warming climate. The concentration observed in

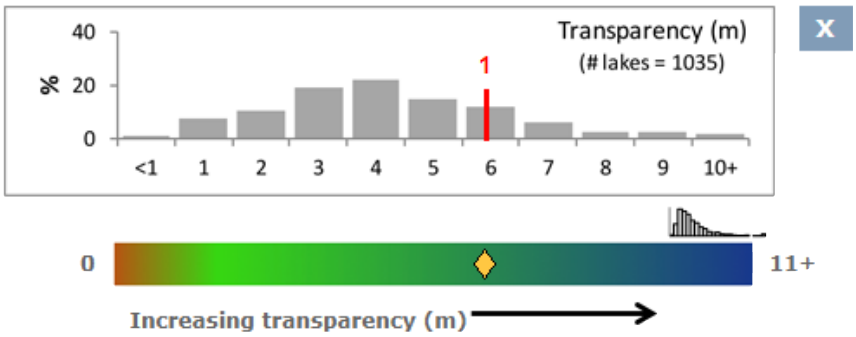
Table 1: 2020 and Historical Data Summary Information: Upper Range Pond

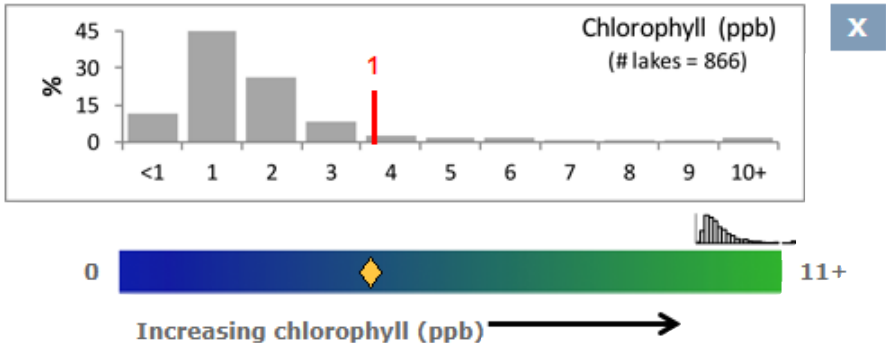
Indicator	Range: (Lowest to Highest)	2020 Average	Historical Average	Notes
Secchi Transparency in Meters	6.45-7.42	6.81 (2 Months limited data)	6.4	Clearer than historical average in 2020
Epilimnetic Core Total Phosphorus in ppb	6	6 (August sample)	7.5	Lower than historical average
Hypolimnetic Total Phosphorus grab in ppb	14	14 (August sample)	13	Close to historical average
Epilimnetic Chlorophyll-a in ppb	3.0	3.0 (August sample)	3.9	Measures planktonic algae
Gloeotrichia	1.0	1.0 (August observation)	N/A	Low density on August 19
Dissolved Oxygen mg/l	Depletion 10-11 meters depth in	N/A	Similar, but to a lesser degree	History of late summer

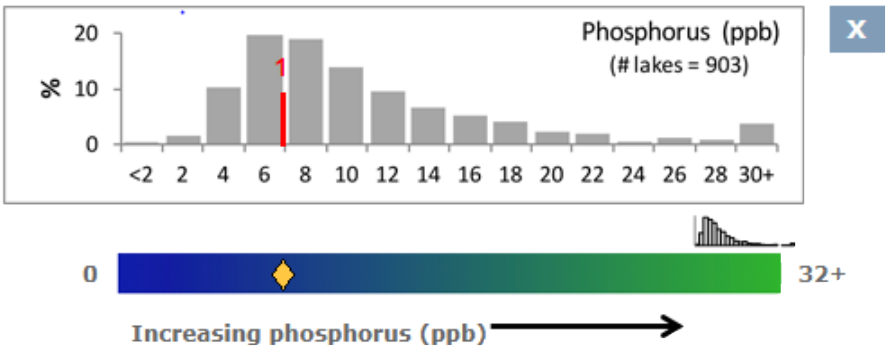
	August 19			hypolimnetic anoxia

The graphics below illustrate the historical average (yellow star) for each of the three primary lake water quality indicators (Secchi Transparency, Total Phosphorus and Chlorophyll-a). Each color "ramp" shows the continuum of data for Maine lakes. In each case, the long-term average for Upper Range Pond is indicated by the yellow diamond above the bar. Note that while "Increasing Transparency" (water clarity) indicates better water quality, the reverse is true for both chlorophyll (algae pigment) and phosphorus, which is why the diamonds are nearer the lower end of the scale for the latter two indicators. Graphics are courtesy of www.lakesofmaine.org .

The bar chart accompanying each color ramp is a histogram that illustrates the distribution frequency for Maine lakes for each indicator. The red line indicates the historical average for the lake. This graphic illustrates where the average is situated, relative to several hundred Maine lakes (indicated by "# of lakes)".





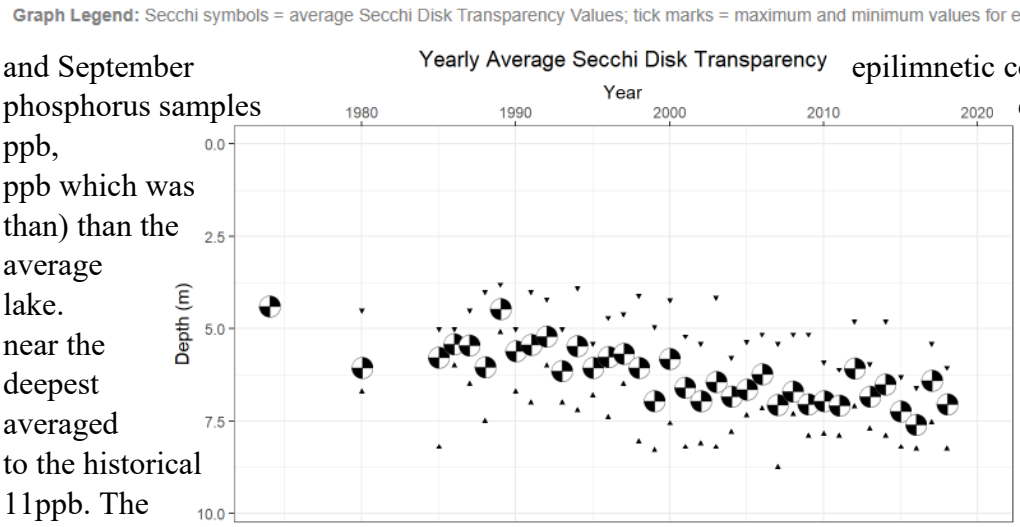


Middle Range Pond:

The following is based on sampling conducted on Middle Range Pond on August 19, 2020. Additional lake water clarity data gathered by LSM Certified Volunteer Monitor, Barry Kutzen have been included, as well. Historical data reference sources are the Maine Department of Environmental Protection, Lake Stewards of Maine (www.lakesofmaine.org), and LWRMA field records and reports.

Please refer to Table 2, below regarding all data obtained in 2020, and historical averages.

Overall, the water quality of Middle Range Pond continues to be relatively stable. In 2020, overall water quality was slightly above (better than) the historical average for the lake. The 6.6 meter water clarity average was clearer than the historical average (6.2M). Figure 1 illustrates the range of water clarity readings from May through October. Figure 2 illustrates the considerable annual variability in water quality that has been documented since 1974 (one reading), then from 1980. Some of the variability that has occurred from year to year may be partially influenced by the frequency and timing of readings taken. There is an apparent positive (improving) trend in the clarity of Middle Range Pond during the period, in that minimum, maximum and average readings have deepened.



August and September epilimnetic core total phosphorus samples each measured 6 ppb, averaging 6.0 ppb which was lower (better than) than the historical average (7.7ppb) for the lake. Samples taken near the bottom of the deepest point in the lake averaged 8ppb, compared to the historical average of 11ppb. The lake was strongly thermally stratified on both sample dates. Dissolved oxygen was depressed in the deepest few meters of the lake in August, and was depleted in the deepest few meters in early September, similar to, and consistent with historical late summer conditions for Upper Range – but somewhat less loss was noted in 2019, compared to recent years.

The chlorophyll-a (a direct measure of planktonic algae density) concentration in August and September (3 and 5 ppb – averaging 4.0 ppb) was very close to the historical average for the lake (3.9ppb), as indicated in the Figure 1 table below.

Gloeotrichia (cyanobacteria) colonies were observed at the deep sampling station on Middle Range Pond on August 19. Gloeotrichia is a form of bluegreen algae/cyanobacteria that has historically not been uncommon in a number of clear Maine lakes during the late summer-early fall period. In recent years, the presence and density of this alga has increased significantly in some lakes throughout New England. Research suggests that an increase in the presence of "Gloeo" may be associated with a negative change in water quality – possibly driven by a warming climate. Gloeo density in Middle Range measured 1.0 on a 1.0-6.0 scale. This density is not cause for concern, but it is worthy of noting and continuing to document.

Temperature and dissolved oxygen profiles taken on August 19 showed moderate dissolved oxygen loss, in the deepest area of the lake, similar to, but more severe than what has been documented in recent years. This may have been due to any of a number of influences, including extremely warm lake water temperatures in Maine lakes during July.

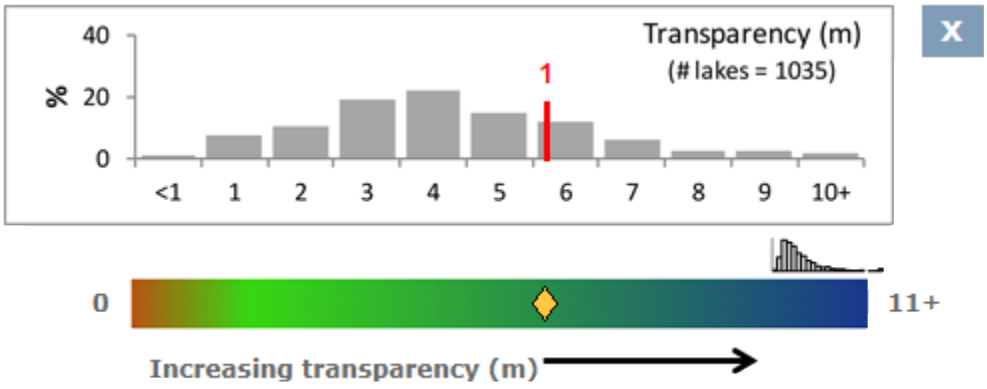
Table 2: 2020 and Historical Data Summary Information: Middle Range Pond

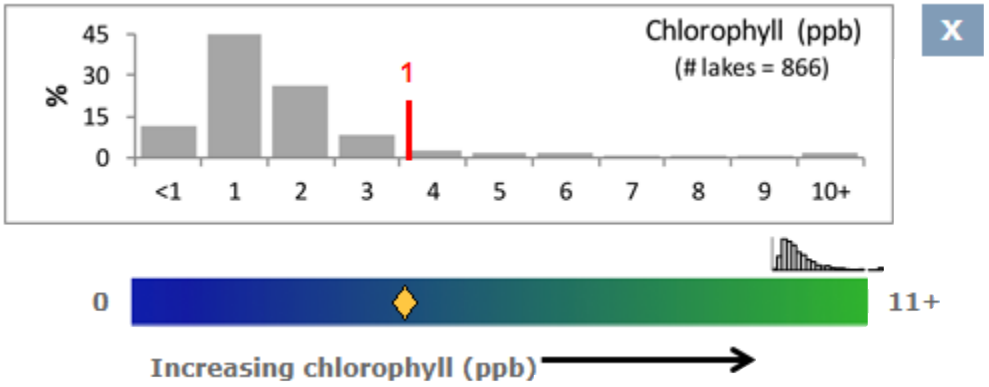
Indicator	Range: (Lowest to Highest)	2020 Average	Historical Average	Notes
Secchi Transparency in Meters	6.40 on May 1 to 8.10 on May 26	7.04	6.2	Very clear in 2020 – well above historical average

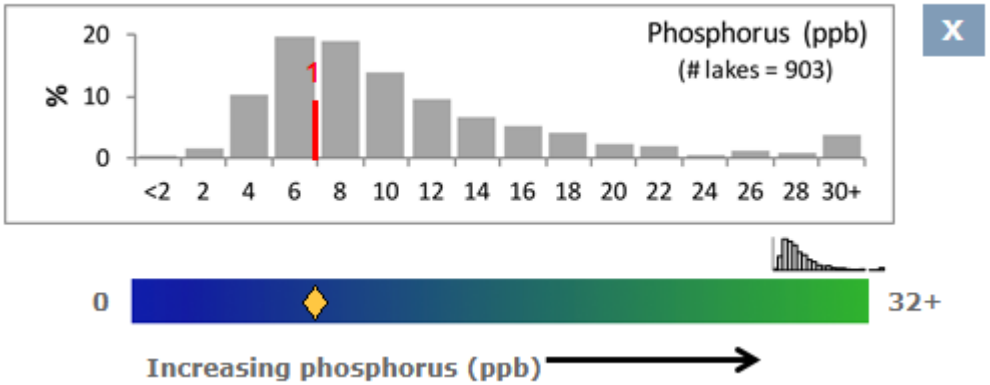
Epilimnetic Core Total Phosphorus in ppb	6.0 August 19	6.0	7.7	Lower than historical
Hypolimnetic grab total phosphorus	12 in August	12	11	Similar to historical
Chlorophyll-a in ppb	3.0 on Aug 19	3.0	3.9	Measures planktonic algae
Gloeotrichia	1.0	N/A	N/A	
Dissolved Oxygen mg/l	Significant depletion from 15-20 meters depth	Significant oxygen loss	Greater dissolved oxygen loss, possibly due to unusually warm summer	History of late summer hypolimnetic anoxia

The graphics below illustrate the historical average (yellow star) for each of the three primary water quality indicators (Secchi Transparency, Total Phosphorus and Chlorophyll-a). Each color "ramp" shows the continuum of data for Maine lakes. In each case, the long-term average for Middle Range Pond is indicated by the yellow diamond above the bar. Note that while "Increasing Transparency" (water clarity) indicates better water quality, the reverse is true for both chlorophyll (algae pigment) and phosphorus, which is why the diamonds are nearer the lower end of the scale for the latter two indicators. Graphics are courtesy of www.lakesofmaine.org .

The bar chart accompanying each color ramp is a histogram that illustrates the distribution frequency for Maine lakes for each indicator. The red line indicates the historical average for the lake. This graphic illustrates where the average is situated, relative to several hundred Maine lakes (indicated by "# of lakes)".





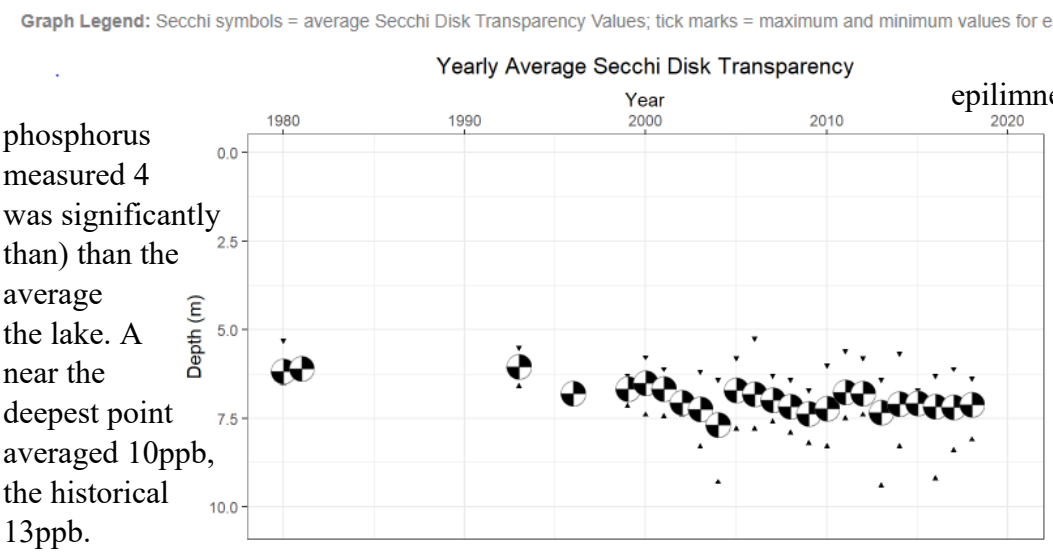


Lower Range Pond:

The following is based on sampling conducted on Lower Range Pond on August 19, 2020. Additional lake water clarity data gathered by LSM Certified Volunteer Monitor, Poppy Connor-Crouch have been included, as well. Historical data reference sources are the Maine Department of Environmental Protection, Lake Stewards of Maine (www.lakesofmaine.org), and LWRMA field records and reports.

Please refer to Table 3, below regarding all data obtained in 2020, and historical averages.

Overall, the water quality of Lower Range Pond continues to be relatively stable. In 2020, overall water quality was average to slightly above (better than) the historical average for the lake. The 6.8 meter water clarity average was very close to the historical average (6.9M). Figure 1 illustrates the range of water clarity readings from June through October. Figure 2 illustrates the considerable annual variability in water quality that has been documented since 1974 (one reading), then from 1980 (note significant gap from 1981-1993). Some of the variability that has occurred from year to year may be partially influenced by the frequency and timing of readings taken.



The August epilimnetic core total phosphorus sample measured 4 ppb, which was significantly lower (better than) than the historical average (7.1ppb) for the lake. A sample taken near the bottom of the deepest point in the lake averaged 10ppb, compared to the historical average of 13ppb.

The lake was strongly thermally stratified on both sample dates. Dissolved oxygen was depleted in the deepest several meters of the lake on August 19. While this was consistent with recent historical conditions, it is worth noting that historical and current sampling have taken place at the "deep hole" (appx. 14 meters depth) on Lower Range Pond – a relatively small percentage of the surface area of the lake. Most of the lake is substantially less deep, and is therefore not subject to the late summer oxygen depletion measured at the deep station. This limits the extent to which any negative implications of anoxic conditions will influence overall water quality.

The chlorophyll-a (a direct measure of planktonic algae density) concentration in August measured 1.0 ppb - very low for Lower Range. This is significantly lower (better) than the historical average of 3.6 ppb.

Gloeotrichia (bluegreen algae/cyanobacteria) colonies were observed on August 19, at the deep station (01) monitoring site. Gloeotrichia is a form of lake algae that has historically not been uncommon in a number of clear Maine lakes during the late summer-early fall period. In recent years, the phenology of this alga has changed dramatically in some lakes throughout New England. Research suggests that an increase in the presence of "Gloeo" may be associated with a negative change in water quality – possibly driven by a warming climate. The Gloeo concentration of 1.0 measured in August (1.0-1.6 scale) is relatively low, and not of concern at this time.

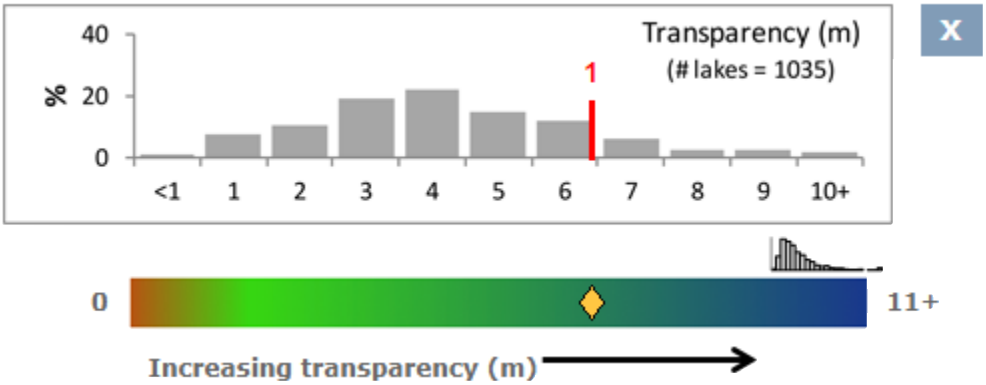
Table 3: 2020 and Historical Data Summary Information: Lower Range Pond

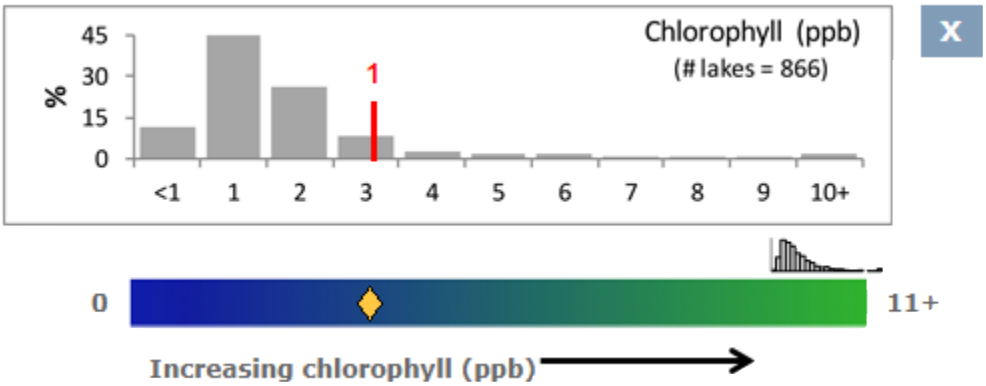
Indicator	Range: (Lowest to Highest)	2020 Average	Historical Average	Notes
Secchi	5.3 in July to	7.3	6.9	Very clear and

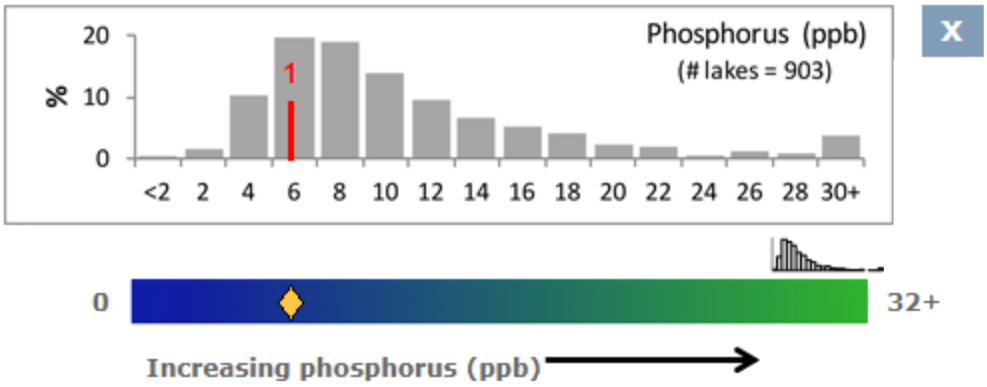
Transparency in Meters	7.6 in Sept.			slightly above average in 2019
Epilimnetic coreTotal Phosphorus in ppb	4.0 August 19	4.0	7.1	Significantly lower than the historical average
Hypolimnetic grab total phosphorus in ppb	10 August 19	10	13	
Epilimnetic core Chlorophyll-a in ppb	1.0 August 19	1.0	3.6	Unusually low CHL level in August, consistent with the excellent water clarity and lower phosphorus concentration
Gloeotrichia	1.0 August 19	1.0	N/A	Low density, but higher than has been observed in recent years
Dissolved Oxygen mg/l	Depleted below 7 meters depth	Depleted below 7 meters depth	Significant oxygen loss in deepest area of the lake	History of late summer hypolimnetic anoxia

The graphics below illustrate the historical average (yellow star) for each of the three primary water quality indicators (Secchi Transparency, Total Phosphorus and Chlorophyll-a). Each color "ramp" shows the continuum of data for Maine lakes. In each case, the long-term average for Lower Range Pond is indicated by the yellow diamond above the bar. Note that while "Increasing Transparency" (water clarity) indicates better water quality, the reverse is true for both chlorophyll (algae pigment) and phosphorus, which is why the diamonds are nearer the lower end of the scale for the latter two indicators. Graphics are courtesy of www.lakesofmaine.org .

The bar chart accompanying each color ramp is a histogram that illustrates the distribution frequency for Maine lakes for each indicator. The red line indicates the historical average for the lake. This graphic illustrates where the average is situated, relative to several hundred Maine lakes (indicated by "# of lakes)".







Summary and Recommendations:

Overall, the three Range Ponds experienced above average water quality in 2020, compared to their historical averages. Severe drought conditions throughout the summer and early fall very likely contributed to clearer than average conditions in the lakes, lower phosphorus concentrations, and lower algal density. However, unusually warm weather in July and throughout most of the summer may have contributed to greater dissolved oxygen loss in the deepest areas of the lakes during late summer.

We are fortunate to have three dedicated certified lake monitors on the three bodies of water. Matt Brettler, Barry Kutzen and Poppy Connor-Crouch have donated their time to add substantially to the body of historical data for Upper, Middle and Lower Range Ponds. Their good work on behalf of our understanding of the health of these lakes is invaluable.

The Range Ponds Environmental Association has undertaken a number of significant initiatives to protect the three lakes in recent decades, including a comprehensive watershed survey, and a mitigation project to resolve problems identified in the survey. The organization has also developed a long-term, comprehensive plan for the management of the watersheds for the three lakes.

The influences of climate change over time will likely stress the three Range Ponds in a number of ways in the future. As lakes warm, and weather events become more extreme, resulting in an increase in watershed soil erosion, the potential for increasing algae growth, and reduced water clarity from greater algae growth will likely increase. Warmer lake water and higher concentrations of phosphorus will likely favor the growth of cyanobacteria (bluegreen algae), increasing the potential for harmful algal blooms (HAB's) which may release toxins.

A high percentage of Maine's lakes could experience change in both expected and unanticipated ways in the future as a result of climate change. Our lakes may also be more highly colored (and less clear) from increasing humic acids. Reduced periods of ice cover may result in warmer water temperatures overall. In recent years, several lakes situated in southern and central Maine have experienced unanticipated, severe algal blooms.

Conservation practices that have been promoted by the Range Ponds Association, including the comprehensive watershed survey, and a mitigation project to resolve issues identified in the watershed will continue to serve the lakes well as our climate warms. The preservation of vegetated buffers throughout the shoreline and watershed is one of the most effective measures for offsetting the effects of a warming climate and protecting water quality. Minimizing sources of soil erosion and stormwater runoff will also continue to be very important, as will be efforts to control new shoreline and watershed development.

Prepared by Scott Williams

Senior LWRMA Limnologist