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Report on the Health of Thompson Lake
2018

This report is a summary and analysis of findings of water quality monitoring of Thompson Lake from May through October, 2018. All of the readings, samples and observations were made at the deepest point in the lake, situated to the west of Hayes Point in Oxford, and referred to as "station 01" in this report. The majority of historical water quality data for Thompson Lake is also based on sampling that has taken place at the Hayes Point deep station.

In addition to the sampling that we conducted, Maine VLMP-certified volunteer lake monitor, Ron Armontrout, provided additional water clarity (Secchi transparency) readings throughout the period. The additional information has been very helpful in developing an overview of conditions in the lake during the 2018 monitoring season.

All sampling was conducted in accordance with protocol and quality assurance standards established by the Maine DEP and Lake Stewards of Maine (aka: Volunteer Lake Monitoring Program).

Overview: Overall, Thompson Lake experienced *substantially above average* water quality in 2018 (compared to historical averages for this waterbody), based on the clarity of the water, the concentration of the nutrient phosphorus, and the concentration of chlorophylla, a photosynthetic pigment found in planktonic algae cells.

Weather Influences:
Weather conditions typically have a strong influence in the variability that occurs for indicators of lake water quality, from season to season, and year to year.

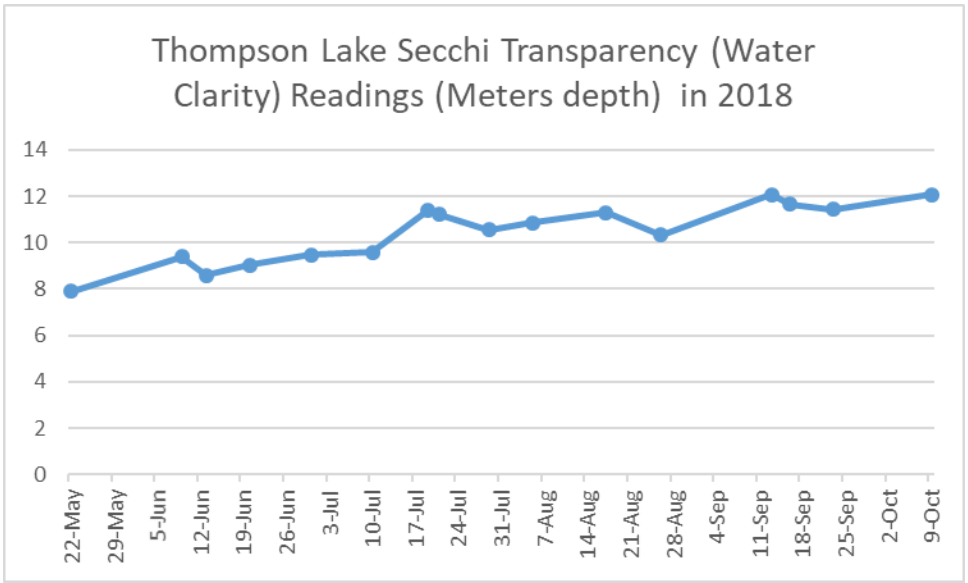
Changes in weather patterns that are likely associated with climate change appear to be influencing lakes in ways that are likely to have a profound, measurable effect on lake systems over time. Reduced periods of ice cover, overall warmer water temperatures, extended periods of drought, severe, localized storm events, a longer growing season for both aquatic and terrestrial plants, and other factors will likely change Maine's lakes as we have come to know them.

During the past decade, some Maine lakes that have historically been "on the edge" have declined significantly, and in recent years, some lakes that have historically been considered to have average to above average water quality have experienced severe algal blooms, during which water clarity is reduced to less than 2 meters depth (Maine DEP standard for a severe algal bloom).
Although the winter of 2018 provided abundant snow and spring runoff, the weather during the summer was dry and unusually warm. Maine has experienced four dry summers in a row, the cumulative effect of which has been to reduce stormwater runoff a nutrient loading for lakes. A significant percentage of Maine's lakes that have been monitored during this period appear to have responded to the weather by becoming clearer, as a result of less planktonic algae growth in the water. While clear lake water is generally highly valued, and is considered a positive water quality indicator, long-term trends in improving lake clarity caused by extreme weather may have negative effects of aquatic ecosystems as a result of increasing ultraviolet light penetration in lake water.

Surface water temperatures in lakes throughout Maine were elevated during the summer of 2018 as a result of many bright, warm days, with little relief from rain and cloud cover, with the exception of a number of documented highly localized severe thunderstorms, which in some cases resulted in severe watershed erosion and moderate runoff to lakes. Over time, increasing water temperatures in Maine lakes may result in longer periods of thermal stratification, lower concentrations of dissolved oxygen in lake water, and diminishing habitat for coldwater fisheries.

2018 Water Quality Monitoring Summary:

<u>Water Clarity (Secchi Transparency)</u>
A key indicator of biological productivity in lake systems is water clarity (aka Secchi transparency) Lake clarity is primarily influenced by the concentration of algae in the water. However, suspended sediment particles from eroded soil in the watershed can at times also influence clarity. The clarity of the water in Thompson Lake was consistently above average for the lake throughout the 6 month monitoring season from May through September. Some of the deepest water clarity readings on record for Thompson Lake were documented during the period.



During the course of the monitoring season, the distance that one could see down into the water from the lake surface (aka: Secchi

transparency) varied from exceptionally high (good) readings of 12.08 meters depth (nearly 40 feet!) on September 13 and 12.07 meters on October 9, to the lowest reading of the season – 7.89 meters, recorded on May 22. Readings taken in May are often the least clear for the season in Thompson Lake. But the May 2018 reading started the summer off with above average conditions in the lake. The exceptionally clear reading taken in September followed months of dry, calm weather, with little or no stormwater runoff occurring during the period. Water clarity readings of greater than 10 meters depth were recorded from the middle of July through October. *The average for the May through October period was 10.4 meters, nearly 1.5 meters higher/better/clearer than the Thompson Lake historical average of 9.0 meters, and one of the five clearest years on record since 1977, when documentation of annual lake clarity data was initiated for the lake.*

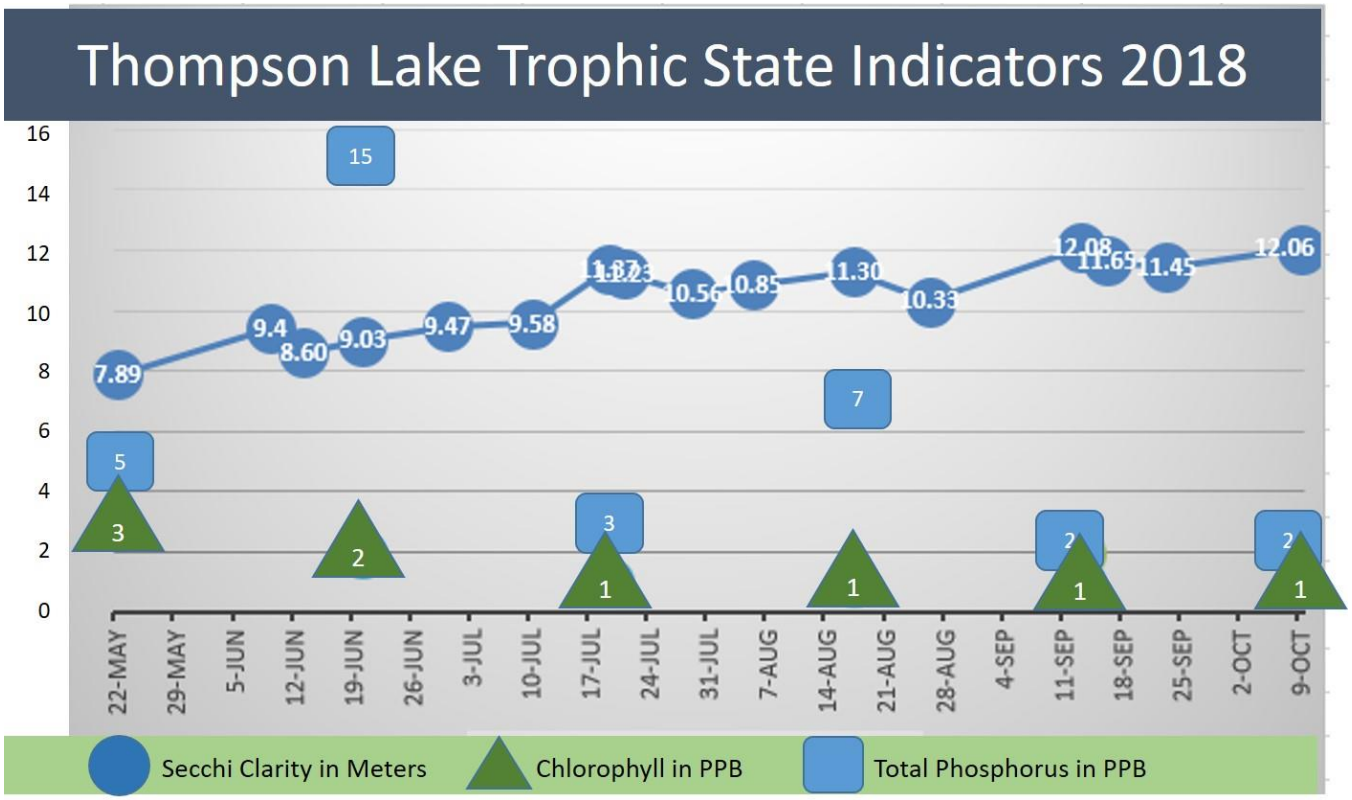
Total Phosphorus: The concentration of the nutrient phosphorus in lake water largely determines the growth of algae in the water, which in turn influences water clarity and oxygen levels. The average concentration of total phosphorus (TP = combined organic and inorganic forms) in the lake in 2018 was 5.7 parts per billion, slightly higher than the historical average for the lake of 5 ppb. *However, the 2018 average was skewed by an unusually high reading of 15 ppb on June 20.* The June sample appears to have been an anomaly, because it was substantially higher than the May (5 ppb) and July (3 ppb) concentrations. Other indicators from sampling on June 20, including Secchi transparency and chlorophyll values, are not consistent with such a high TP reading on that date. *Another possibility is that the high value in June was the result of a concentration of zooplankton (Daphnia) in the lake at the time.* Daphnia (aka: "water fleas") graze on planktonic algae in the water. Their presence in moderate density is often associated with clear lake water. Large bodied Daphnia were visible in the water column in June and July, ostensibly associated with the rapid clearing of the water that was occurring during the period. The zooplankton were undoubtedly present in the sample taken for TP on June 20, which would certainly have elevated the concentration of phosphorus in the sample. The August sample, while only half the concentration of the June sample, may have been influenced by the same conditions. *So, even though the TP concentration was high in June, and the number skewed the average for the year, it was caused by a natural process that was having a beneficial effect on the lake.* The lowest TP readings taken in 2018 measured 2 ppb, taken in both September and October.

Chlorophyll-a: The average concentration of chlorophyll-a, (CHL) a direct measurement of algae growth in the water was 1.5 ppb – a very low annual average for Thompson (and any) lake. The high reading of 3 ppb was recorded in May. The June 20 measurement was 2 ppb (low), and the measurements documented from July through October were each 1 ppb – very low, and correlating well with the exceptional water clarity measurements taken during the period.

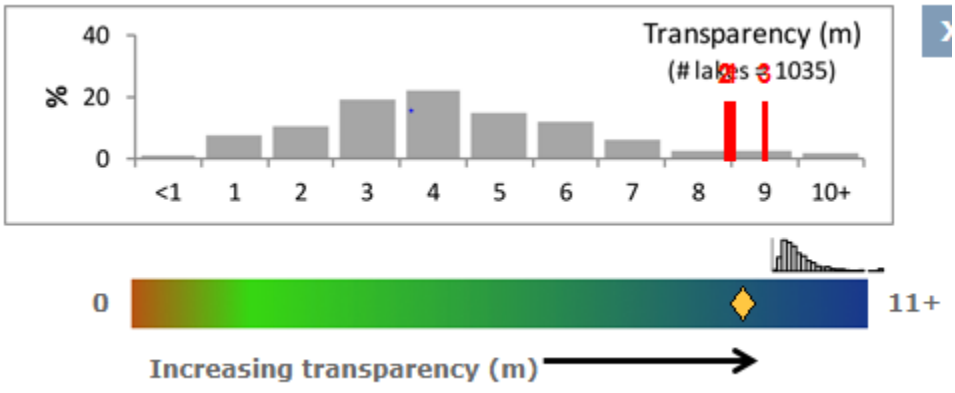
It is worth noting that while over time there is generally good correlation between water clarity and the concentration of total phosphorus and chlorophyll-a in lake water over time, the inter-related physical, chemical and biological processes that are represented through the water quality data do not necessarily correlate well when viewed as single monthly readings/samples. During a typical lake monitoring season, the sampling represents an instantaneous "snapshot" of conditions in the lake when the samples and readings were taken. But lake ecosystems are highly variable and dynamic, resulting in what may appear to be (and very likely are) temporal phase discontinuity between the indicators.

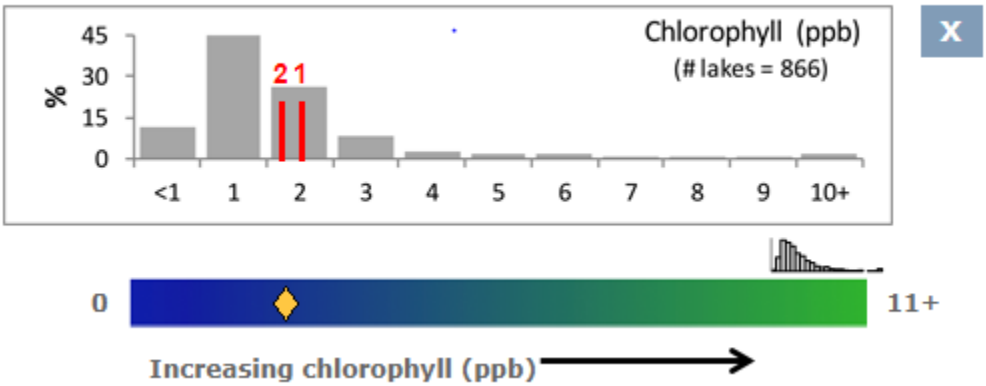
Another factor to be considered when comparing annual averages to historical is that historical averages are continuously changing, as each previous years' data is included in the calculation of the average

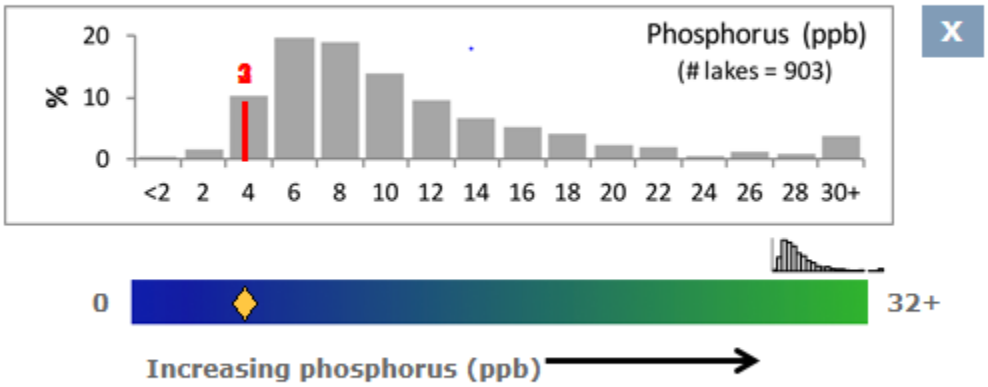
The graphic below illustrates the 2018 results for the three "trophic state" indicators (water clarity, total phosphorus and chlorophylla in Thompson Lake.



The following graphics from the www.lakesofmaine.org website (Lake Stewards of Maine) illustrate the position of Thompson Lake, relative to several hundred lakes in Maine for which historical data are available. The numbers shown on the horizontal color ramps represent the historical average for Thompson Lake (yellow diamond) for each of the three trophic state indicators. The histograms, (raised solid bars) show the distribution of each of the three indicator. The percentage of Maine lakes that fall within the ranges shown in each vertical bar are indicated. The historical averages for Thompson Lake are illustrated by the vertical red stripes. The numbers on top of the stripes indicate the monitoring station location on the lake. Most of the historical data have been gathered at station 1.





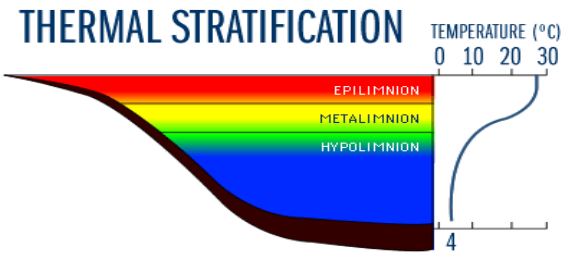


Natural Water Color: Lake water color represents the concentration of natual humic acids in the water, influenced primarily by the leaching of organic compounds from wetland vegetation in the watershed. High concentrations of lake color can have a complex influence on the dynamic relationship between trophic indicators in lakes. But the color concentration in Thompson has always been relatively low averaging about 11 SPU's (standard platinum/cobalt units) over the history of data collection from 1980-present. Some lake scientists have predicted that climate change may cause an increase in humic acid in lakes over time, resulting in the "browning" of lakes, as well as dysfunction for physical, chemical and biological processes in lake systems. Such increases could profoundly influence the ecological balance and health of lakes.

Dissolved Oxygen:
The amount of oxygen that is dissolved in the water in the deepest area of a lake during the late summer and early fall, until the lake mixes or "turns over" is a critical indicator of overall lake health. Thompson Lake has maintained high levels of dissolved oxygen through the summer/fall period for as long as data have been collected for the lake – even in the deepest, and most critical location of the "deep station"

near Hayes Point. This characteristic of exceptional water quality is the primary factor that allows coldwater fish to thrive in Thompson Lake over time.

Water temperature and dissolved oxygen profiles measured throughout the 6 month monitoring period *may* be showing a slight decline in oxygen in the deepest area of the lake during the month of September. This *could* be due to the combined influences of increasing lake water temperature, and a lengthening of the period of thermal stratification, during which cold, oxygen-rich water in the deep area of the lake is isolated from the atmosphere.



One climate-related factor that may negatively influence this process is the lengthening of the period of time during the year when the lake is free of ice cover. Warm ambient temperatures in the fall may cause deep lakes like Thompson to "turn over", or mix, in the fall, resulting in a longer period of time when the hypolimnion (deep, cold layer) is isolated from the atmosphere. Late mixing of the water in the fall could, and likely, will, result in lower dissolved oxygen levels prior to mixing. Earlier "ice-out" in the spring will likely result in the earlier onset of stratification. When combined with late mixing (destratification) in the fall, oxygen levels in the deepest area of the lake will almost certainly be lower at a critical time of the year for the coldwater fishery. Dissolved oxygen levels in Thompson Lake are currently high throughout the year, due primarily to low biological productivity, thereby providing the fishery and water quality with somewhat of a "buffer" against change. But the influence of climate change has already been thought to have had significant negative consequences on some Maine lakes.

Temperature and dissolved oxygen profiles taken monthly from May through October, 2018 showed strong thermal stratification from June through early October, although on October 9, lake surface temperatures had dropped significantly, compared to readings taken in September. Early cooling conditions in the fall of 2018 likely resulted in the turnover (mixing) of Thompson Lake during late October or early November, at which time oxygen would be replenished from exposure of the water to the atmosphere in the mixing process. One October 9, the lowest DO in the deepest area of the lake measured 6.6 mg/l at 30 meters depth. The retention of moderately high concentrations of DO well into the fall months is directly linked to the trophic state indicators, and the low overall biological productivity of the lake.

New Monitoring Data Gathered in 2018:
Last summer, we gathered and froze samples in August and September that were later analyzed using a sophisticated fluorometric device to measure the ratio between the photosynthetic pigment Phycocyanin, which is typically associated with cyanobacteria, and all other forms of chlorophyll in the water. Over time, a change in the ratio that indicates a relative increase in the concentration of phycocyanin may serve as an early warning indicator of a significant shift in the algal community in the lakes to species that are typically associated with algal blooms. This information is in our records, and will be tracked over time. Given that the first samples were taken in 2018, there is no historical reference for the lake, against which the data can be compared. This sampling will continue in future years.

Conductivity is a measure of the ability of lake water to pass an electrical current. It is a measure of the concentration of ions in the water. As lake watersheds become more developed, and indicators of water quality show evidence of a negative change, conductivity concentration generally increases. The historical conductivity concentration in Thompson Lake is 40 ms/cm, based on 11 samples taken since the 1970's. Samples taken in August, September and October 2018 averaged 59 ms/cm – significantly higher than the historical average. The increase may have been due to slow flushing conditions in the lake during the past several years, due to drought, as well as the effects of evaporation during the very warm summer.

pH measurements taken during the sampling period averaged 7.31.

Total Alkalinity - an indication of the buffering capacity of lake water against a downward shift in pH from acidified inputs, measured 8.5 mg/l on two occasions, compared to the historical average of 7.4 mg/l. Higher than average conditions were likely due to the same factors that influenced conductivity in 2018.

Gloeotrichia:
We continued to monitor the presence of Gloeotrichia in Thompson Lake in 2018. This blue-green algae has often appeared in Thompson historically at low densities during mid to late summer. "Gloeo" colonies are typically observed relatively close to the water surface, having the appearance of tiny, fuzzy, green-white dots. Gloeotrichia is sometimes described as having the appearance of "tapioca in lake water". It is found in many lake algal communities throughout Maine. However, Gloeo may be increasing in some lakes, and it has been possibly associated with water quality concerns in a small number of Maine lakes in recent years. Gloeo is the subject of current research, in an attempt to determine why it may be more prevalent in Maine lakes in recent years, and the possible implications for lake ecosystems.

Monthly observation/measurement of Gloeo density in Thompson documented zero colonies until September when colonies were reported at moderate density (2.5 on the Gloeo density scale) – significantly higher than densities that have been observed historically in the lake. By October, the density had dropped to 0.7. Because there has been some indication that Gloeo density is increasing in Thompson Lake, and because recent studies have shown that clear lakes appear to be most susceptible to increases in this alga, it is essential that the lake be routinely screened for this organism.

Summary:
Overall, the water in Thompson Lake was substantially clearer than the historical average for the lake in 2018. The concentration of phosphorus in the lake was slightly higher than the historical average, possibly due to a single anomalous sample, or to the moderate density of tiny organisms in the lake that consume algae. The overall concentration of planktonic algae in the lake was very low in 2018, consistent with the exceptional clear water throughout the period . Late summer oxygen levels in the deepest area of the lake remained well above critical thresholds for coldwater fishery habitat and water quality trigger points from surface to bottom throughout the 6 month monitoring period. However, this sensitive indicator of lake health should continue to be monitored closely, as it may be one of the first early warning indicators of the influence of climate change.

Thompson Lake continues to exhibit water quality that is significantly above the average for Maine lakes. The number, and complexity of threats to Maine lakes will very likely continue to grow as climate

change exacerbates the effects of everything from watershed development to the breadth of invasive species infestations. TLEA has played a critically important role in protecting the lake for more than four decades. The protection of our lakes is ultimately a local issue, and TLEA has the proven experience and capacity to assume the role of leadership in the Thompson Lake watershed community.

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