2018 Washington Lakes Water Quality Report

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by

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Special Thanks to Midcoast Conservancy and
Lake Stewards of Maine/Volunteer Lake Monitoring Program

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This is a Discussion of Water Quality Data what it means and how our lakes compare with other Maine lakes. Courtesy of Lake Stewards of Maine and Volunteer Lake Monitoring Program

Executive Summary

This report is the fourth one compiled by WLWA volunteers to report on the Water Quality of Washington's lakes. It represents, in 2018, both increased frequency of sampling and more comprehensive data collection. It also reflects the objective of regular measurements of Crystal Lake which have not been done on a scheduled basis over the past few years. This is a volunteer effort at data collection and reporting (forced by economics) but we have endeavored to have it reviewed by water quality professionals.

2018 continues to add to our baseline data set. Many past years have featured only a few data points, if any, (especially on Crystal Lake), and so comparison and trend analysis over the entire open water season as a whole is difficult except on a grand scale. Each year brings us closer to our goal.

2018 continues to show that our lakes maintain above average water quality, with many water quality indicators continuing at a consistent level, while showing some improvement in some parameters. It is necessary to keep in mind that annual weather variations make long-term trend analysis uncertain in this regard. Based on this test data, Water Clarity is up, phosphorus levels seem to be consistent with historical reading. Dissolved Oxygen falls in the middle of historical ranges. Chlorophyll is in line with historical averages. All of these parameters help us monitor potential for algae bloom. Both Crystal Lake and Washington Pond appears to continue to be stable.

Dissolved oxygen depletion in the lower, colder regions of both water bodies was lesssignificant in the later summer weeks until "turnover" in mid- to late-September. This oxygen depletion has been observed historically in both water bodies and is also somewhat normal for shallow lakes. Analysis of data over the past five years indicates a downward (less depletion is good) trend in oxygen depletion. Oxygen levels below 5 ppm can also stress fish populations. See discussion below in the report under Dissolved Oxygen. The good news is we are better understanding the unique Crystal Lake properties which support a cold water fishery

Weather affects lake quality and chemistry. 2018 was hotter than normal, by 1,5-2.0 degrees Centigrade during the summer. Rainfall was about normal. It is likely that we will see increasing changes in these trends as climate change affects us. It is unclear just how this will affect the long term health of our lakes.

There were no invasive plant species inspections of either lake in 2018. ***This is a major weakness in our "preventative" activities and we urgently need volunteers to take on this important task***. It may be that we need to consider a closer WLWA relationship with Midcoast Conservancy to increase the resources available to Washington.

As in years past, we will close with this statement from Scott Williams, Executive Director of the Lake Stewards of Maine, LSM/VLMP:

> *The most effective way to insure that all indicators of water quality remain stable or even improve over time – is through watershed stewardship. This includes raising awareness among landowners about ways in which the effects of development on water quality can be minimized, and developing a community plan to protect and manage the watershed. Citizen watershed surveys can be very effective in raising community awareness and identifying and resolving land use problems. The Maine Volunteer Lake Monitoring Program offers workshops for groups interested in conducting watershed surveys.*

<u>With Climate Change, never has this been more important.</u>

Sampling Methodology

During the 2018 summer season, Washington Lakes Watershed Association (WLWA) volunteer took both Secchi Disk (water clarity) and dissolved oxygen readings at least every two weeks on Washington Pond. In prior years we did both monthly phosphorus surface grabs and an epilimnetic core sample annually. Having been advised that the surface grabs did little to add to meaningful sampling data, and to reduce costs we eliminated this in 2018 and will rely on core data (a sample of mixed water throughout the depths) which has been historically used.

Midcoast Conservancy has been extremely helpful in loaning us Dissolved Oxygen instrumentation for the entire summer. This has enabled bi-weekly DO data collection on both Washington Pond and Crystal Lake.

All water quality monitoring and sampling was completed by certified volunteer lake monitors and was completed in accordance with standard procedures for the monitoring of Maine lakes and ponds established by the Maine Department of Environmental Protection and the Maine Volunteer Lake Monitoring Program. We owe a great debt of gratitude to MVLMP for their support and training for certified monitors. The 2018 sampling was done in a manner consistent with the historical sampling of these bodies of water, and the results are comparable. All sampling data is filed with VLMP, checked by them, and becomes part of the Maine DEP database.

The annual comprehensive tests sequences were run by Garrison Beck, then Director of Water Quality at Midcoast Conservancy in early September, and we are indebted to him for doing this. We hope that this beneficial relationship with Midcoast will continue for 2019

2018 Weather Influences

Weather conditions can strongly influence indicators of water quality. In general high temperatures can increase bio-production (more algae growth) and more rainfall causes higher pollutant runoff (primarily adding phosphorus) resulting in more bio-productivity since phosphorous is the limiting nutrient in most Maine lakes. 2018 temperatures for the entire year were higher than normal, averaging 1.0 degree C above normal (compared with 0.75 degrees the prior year). *But summer temperatures were between 1.5 to 2.0 degrees higher.* Figure 1 shows the running mean temperature deviation for Portland.

While rainfall accumulation) for Belfast (Figure 2) shows overall annual precipitation about 2 inches above normal, the summer period was very close to normal. We are using the Belfast data this year because it correlates exactly with rainfall recorded on Washington Pond, In previous years we have found significant differences between Washington and Portland our previous reference.

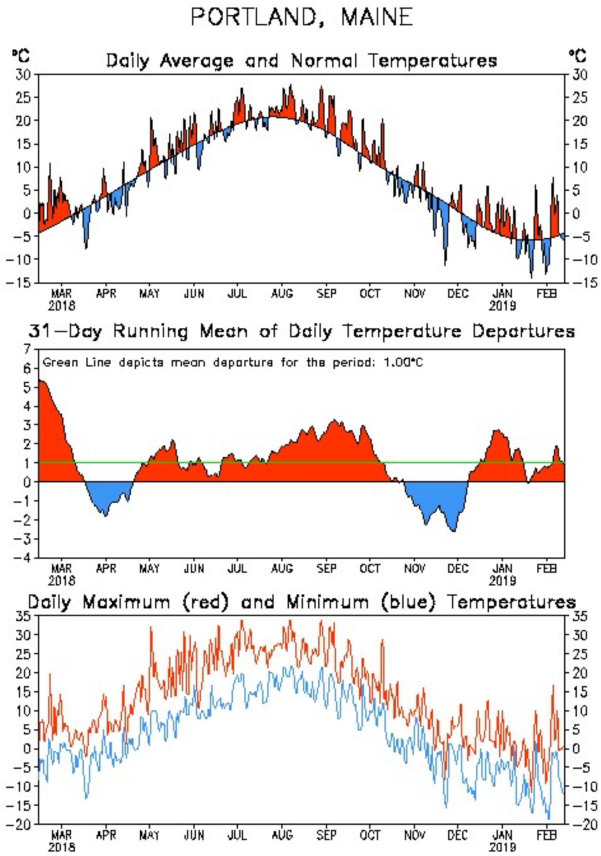


Figure 1

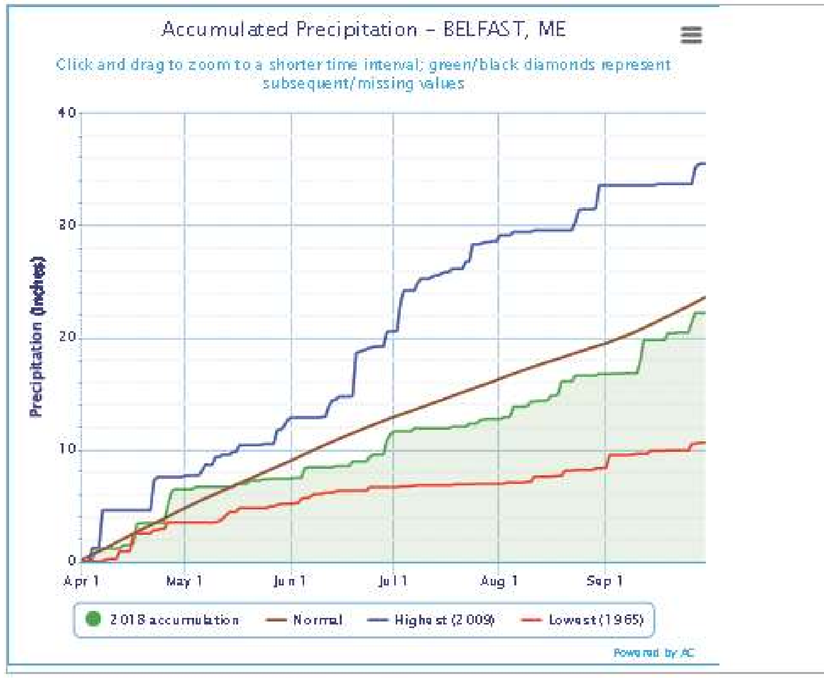


Figure 2

Washington Pond

The reader is referred to Appendix I for more detailed explanation of each measured parameter.

<u>Water Clarity</u>

Water clarity readings are made using a Secchi disk and monitoring scope to determine the depth at which the disk can still be seen. The higher the number (deeper sight depth), the clearer the water. Readings were taken multiple times per month during the 2018 season and added to previous years data for Washington Pond. The following graph (Figure 3) indicates monthly averages for the 2012-2018. 2018 is shown in black (no reading in October) and in general showed water clarity well above historical averages. This is good news as the temperature (both air and water) was well above historical levels yet there appeared to be lower bio-productivity levels. Water clarity is an important measure of lake quality, and this measurement keeps our lakes at about the 80 percentile of Maine lakes' clarity.

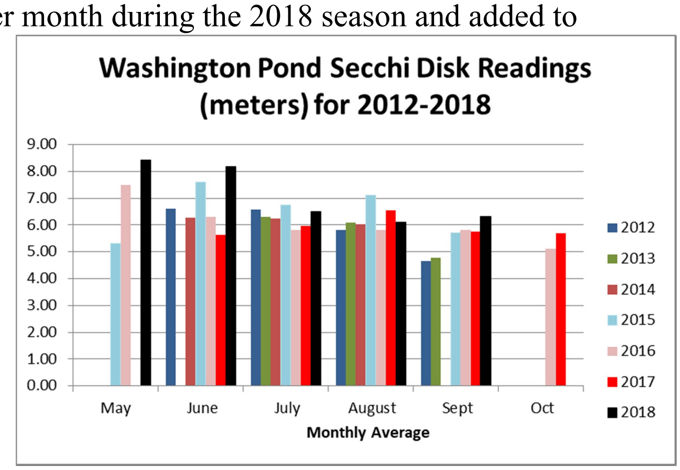


Figure 3

Dissolved Oxygen

We have the advantage that dissolved oxygen profiles were taken in some years since the 1990's on Washington Pond as well as those taken four times each the summer of 2015 through 2017 by the WLWA water quality team. For 2018 we have readings at least twice a month. To simplify presentation the graph in Figure 4 shows the results of DO readings in August for year to year comparison, current year in black, previous year in red. The last two years fall in the middle of the data set.

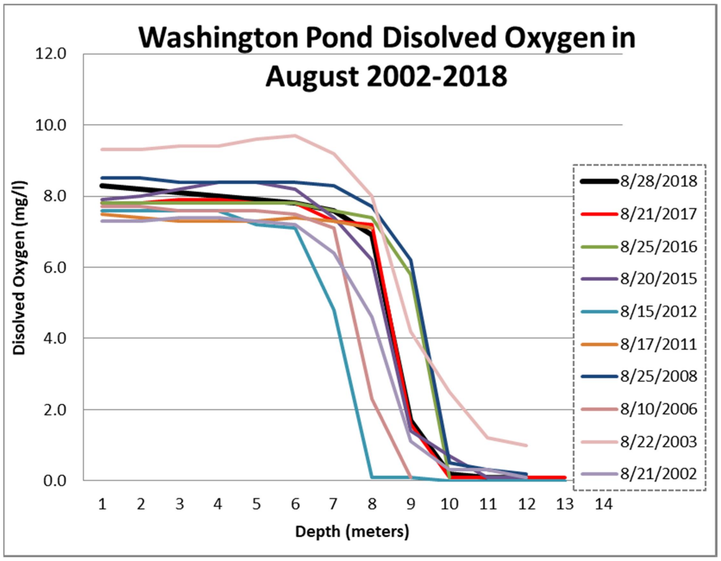


Figure 4

Higher DO concentration is good news. The oxygen levels throughout the lake were high in early and late summer, while the oxygen depletion became more significant in the mid to latter part of the summer in waters with temperature of 17 degrees Celsius or lower, the region desired by cold water fish such as trout. Figure 5 shows the temperature profiles that we saw for five of the DO readings in 2018.

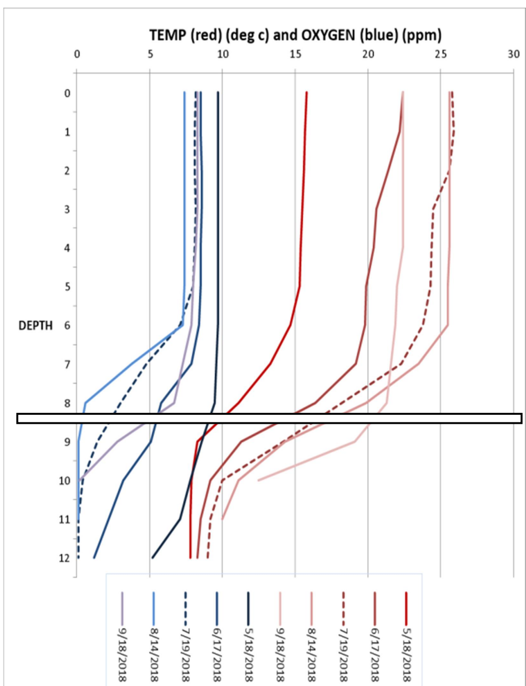


Figure 5

According to Inland Fisheries and Wildlife biologist Scott Davis, who presented at the 2015 annual meeting of WLWA. The observed lack of any cold water regions containing oxygen levels above 2-3 ppm (necessary for good fish health) is a concern for the viability of cold water fish stocking programs on Washington Pond, yet Davis has recorded population "holdover" from one year to the next on this lake in the past, and cold water species such as trout have also been caught in Crystal Pond. As an example take the July data (dotted lines), the horizontal bar is at 17 degrees for this data set. The corresponding oxygen reading is less than 3 ppm. This means that these fish are stressed in the latter part of the summer by not having enough oxygen at the cold levels they live. By August DO is close to zero below 17 deg.

See section on DO for Crystal for more analysis of this as we now understand it better and the differences between the two lakes. It is now believed that springs on the bottom of both lakes are providing cool water spots, holdover havens, for cold water fish species during the latter part of the summer. In general we are pleased with the profiles taken, as they at least show no degradation in oxygen levels from prior years

Low oxygen bottom conditions promote anoxic release of phosphorous that is bound in the bottom sediments into the water column and hence increase potential for higher bio-productivity of the lake. *This is a balance we must watch if climate change affects oxygenation.*

Phosphorus

A phosphorus sample taken from a 7-meter core water column sample measured 5 parts per billion (ppb), slightly below historical average of 6 ppb in core samples of 5 meters or more. As phosphorus is the nutrient that most directly influences the growth of algae in lakes and ponds and phosphorus concentrations in the 12-15 ppb range have been associated with algal blooms in some Maine lakes, these lower sample concentrations are a good trend. A bottom sample showed no significant change from past history. (Figure 6). Bottom samples help us understand the potential for anoxic release of phosphorus from the bottom sediments.

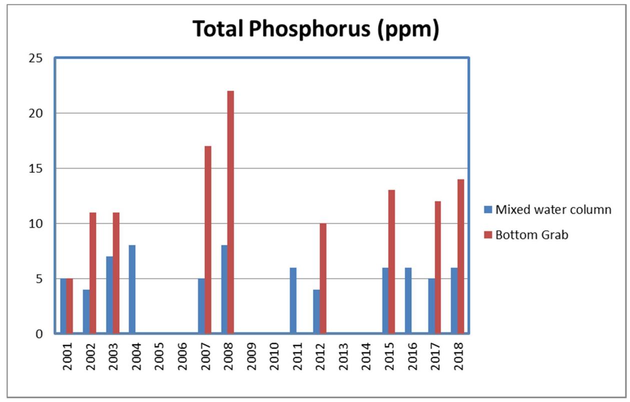


Figure 6

Chlorophyll a

Samples from a 7 meter core sample in August showed Chlorophyll at 3.0 ug/l, higher than last year but well within historical range of 1.8 to 5 so no significant change. Chlorophyll-a (CHL) is the pigment measured in lake water that is used to determine the concentration of algae in the water. Clorophyll is a good indicator of amount of algal bloom, so having it lower than historical average confirms the slightly improved quality, probably most influenced by the close to average rainfall amounts, and phosphorus nutrient being low, limiting the available nutrients.

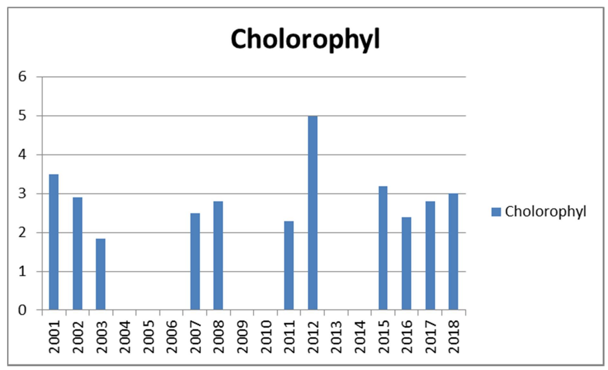


Figure 7

Alkalinity was 5.0, same as historical average. The pH of the sample was 6.7, typically average.

Color was also unchanged at 7, slightly lower than historical average.

Trophic State Index

Trophic State calculations (TSI) using collected data indicates a TSI based upon Secchi data at 31.5 (down from 34 – good!); based on Chlorophyll at 41.4 (slightly higher than 2017); and based on phosphorus at 29 (up from 2017). The average of these three remains at 34.0, same as last year. This places Washington Pond in an Oligotrophic State with an anoxic hyperlimnia due to bottom oxygen depletion. We would like to see the TSI remain under 40. Above 40 would push our classification into Mesotrophic.

Algae

Gloeotricchia echinulata, a planktonic blue-green algae that looks like small grains in the water, has been on the increase in Maine lakes in recent years. This phenomenon is not well understood. Gleo was sighted in Washington Pond for only about two weeks in late August of 2016, the first time it has been recorded in Washington Pond. We encountered it in 2017 for a longer period of time, but in relatively sparse densities mid August to late September. 2018 it started occurring in early July and peaked in early September. By mid-September it was completely gone.

Crystal Lake

Water Clarity

Secchi Disk readings were restarted in Crystal Lake in 2018. As can be seen in Figure 8, the readings, similar to Washington Pond, were above historical average. (see commentary above for Washington Pond). Crystal, although smaller, and shallower than Washington, remains a slightly clearer lake.

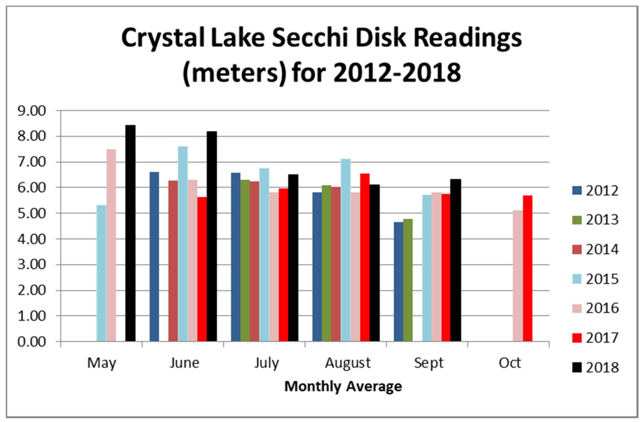
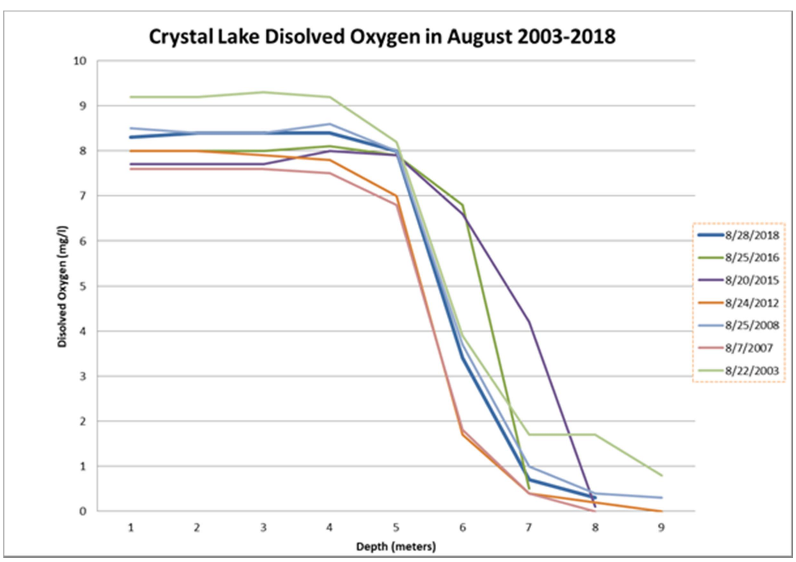
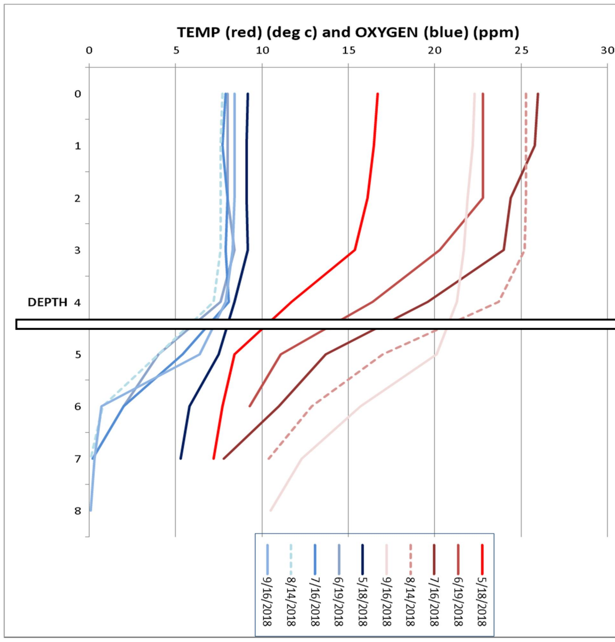


Figure 8

Dissolved Oxygen

This is the first year that Crystal has received a consistent series of DO readings over the course of the summer. Readings appear consistent with past data (Figure 9). With this full summer data it can be shown that although shallower than Washington, it is much cooler at 5-6 meters depth. (Compare Figure 10 for Crystal with Figure 5 for Washington). Also Crystal has a different oxygen profile, The horizontal bar is at 17 degrees for *August (being the lowest oxygen month)*, and yet the oxygen is at 4 ppm, sustaining cold water fish This explains why Crystal can maintain a significant habitat for cold water fish species. It is probable that Crystal has a proportionally larger inflow of springs than Washington, keeping it cooler. Crystal does appear to be only marginally anoxic at the bottom. This is clearly shown in the full summer set of data in Figure 11.





Crystal Lake Temperature and Oxygen Profiles

Figure 10

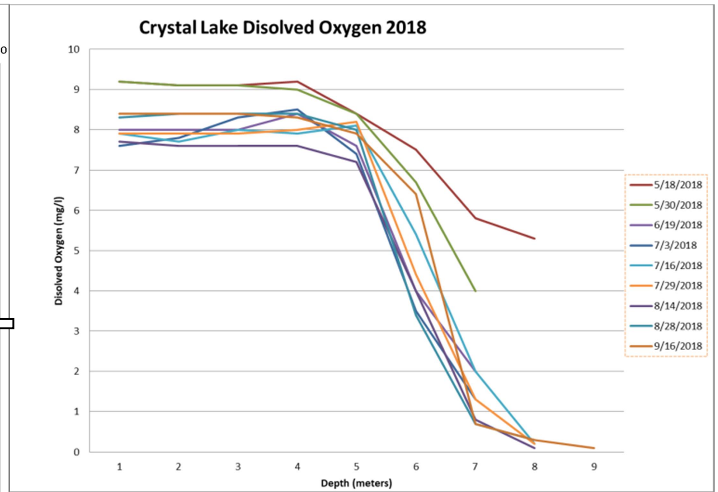
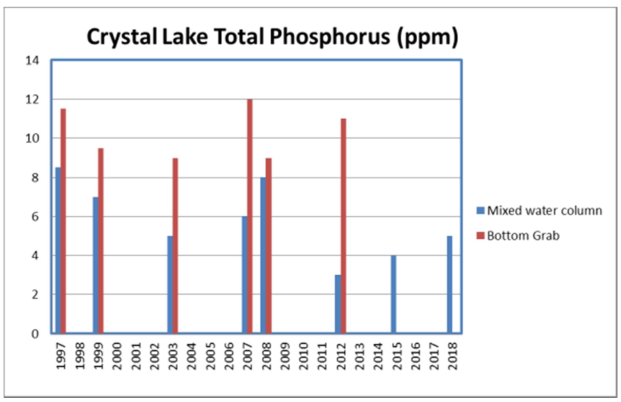


Figure 11

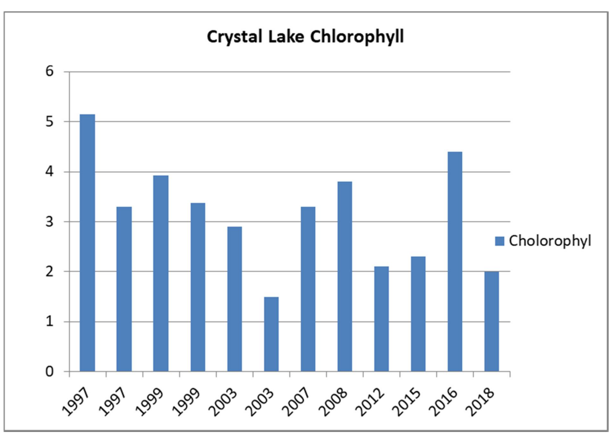
Phosphorus



Only a core sample was taken in 2018 and it shows no significant issues in Crystal.

Figure 12

Chlorophyll a



Chlorophyll was below historical average, although the lab indicated the test may not be reliable because of long processing delays.

Figure 13

Other Chemical Properties

No other tests were conducted by the lab on Crystal samples in 2018.

Algae

Gleo was sighted just once during the summer in mid-July in Crystal. This is the first reported occurrence.

Roger C. Cady
February 20, 2019

Distribution of Water Quality Data

Distribution of Water Quality Data

The data illustrated here are based on the long-term means (average of all the historical annual averages) for each parameter measured in Maine lakes. Every effort has been made to ensure that the data are representative.

How does LSM measure these indicators? – click here

Data Source: LSM and Maine DEP

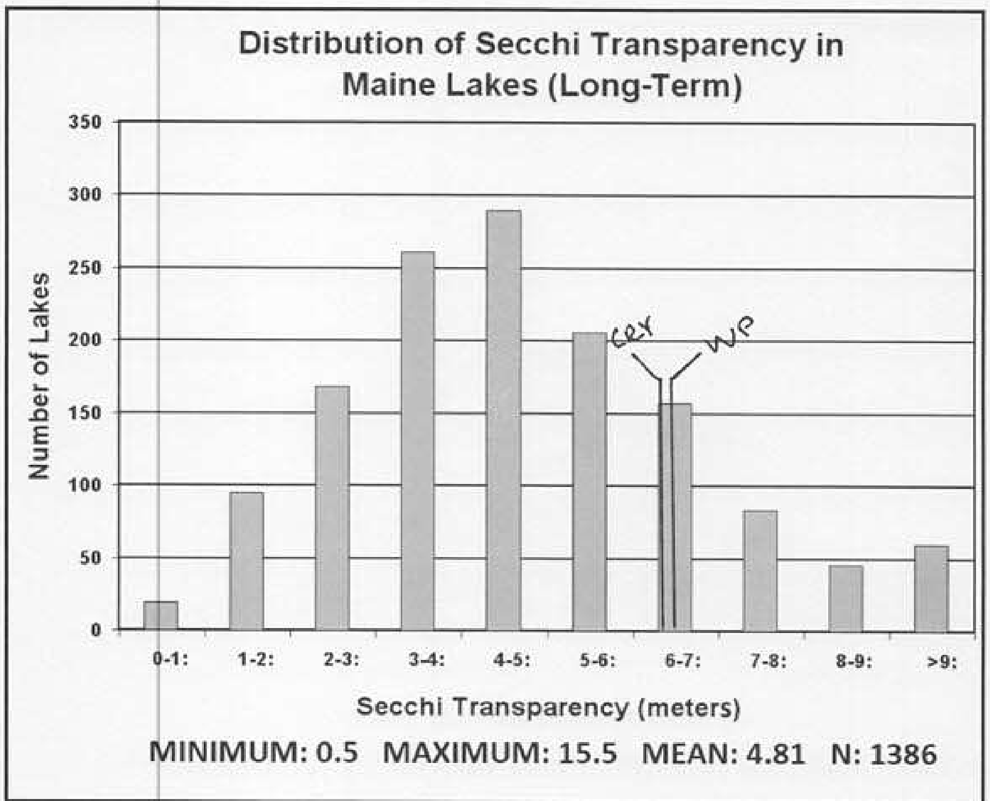
This page contains histograms (a graph that shows how the data are distributed for a particular variable) of the indicators of lake water quality for the lakes that have been included in each data set. The number of lakes sampled (N) varies for each lake quality indicator. The range of means, the statewide mean, and the number of lakes sampled are shown with each graph.

As you view this information, please be aware that lake water quality varies from year to year. However, the distribution of data in these graphs shows little change from year to year, because of the cumulative nature of the information being illustrated. Water quality indicators for individual lakes may show substantial annual variation.

Secchi Disk Transparency
A measure of water clarity; the distance one can see down into the water column (Figure 1).

Factors that affect transparency include algal growth, zooplankton, natural water color, and suspended silt particles. Because algae are the most abundant particles in most lakes, transparency indirectly measures algal growth. Transparency values vary widely in Maine lakes. Unless a lake is highly colored or turbid from suspended sediment, transparency readings of 2 meters or less generally indicates a severe algal bloom.

Figure 1
Distribution of Secchi Disk Transparency in Maine Lakes



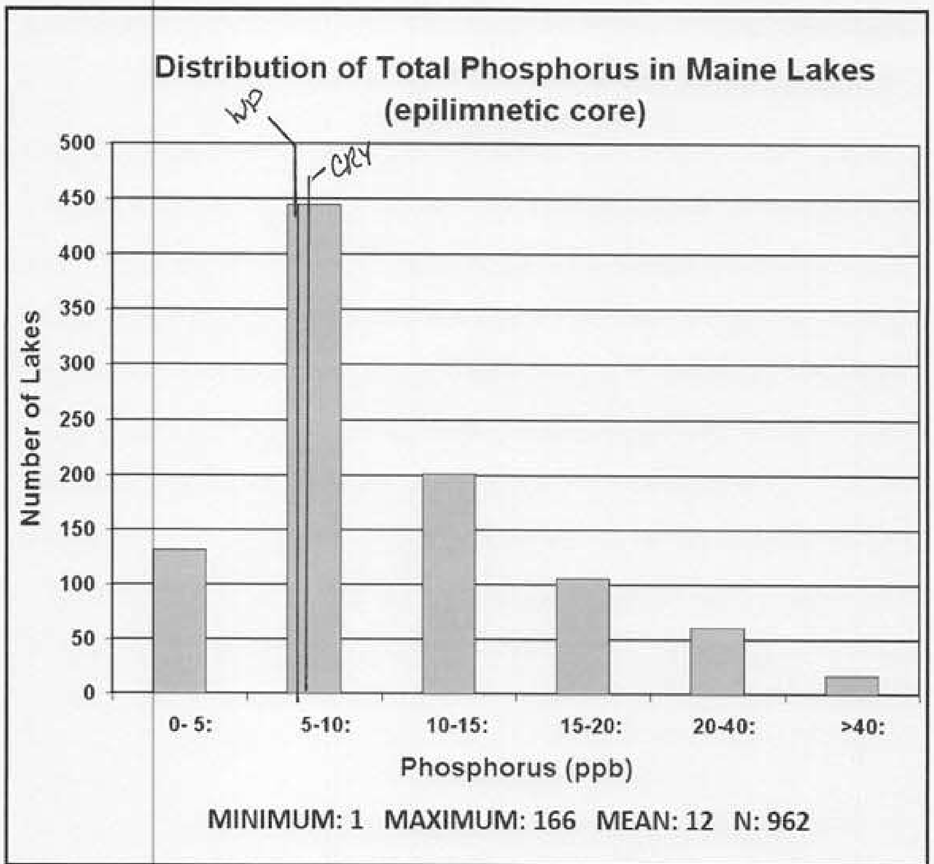
Total Phosphorus

A measure of all forms of phosphorus (organic and inorganic) in the water (Figure 2).

Phosphorus is one of the major nutrients needed for plant growth. Because it's natural occurrence in lakes is very small, phosphorus "limits" the growth of algae in lake ecosystems. Small increases in phosphorus in lake water can cause substantial increases in algal growth. Phosphorus is measured in parts per billion (ppb). Phosphorus concentrations may be based on samples taken from the surface of the lake or from discrete samples taken at specific depths, or from an integrated water column (epilimnetic core) sample.

Figure 2

Distribution of Total Phosphorus in Maine Lakes (epilimnetic core)



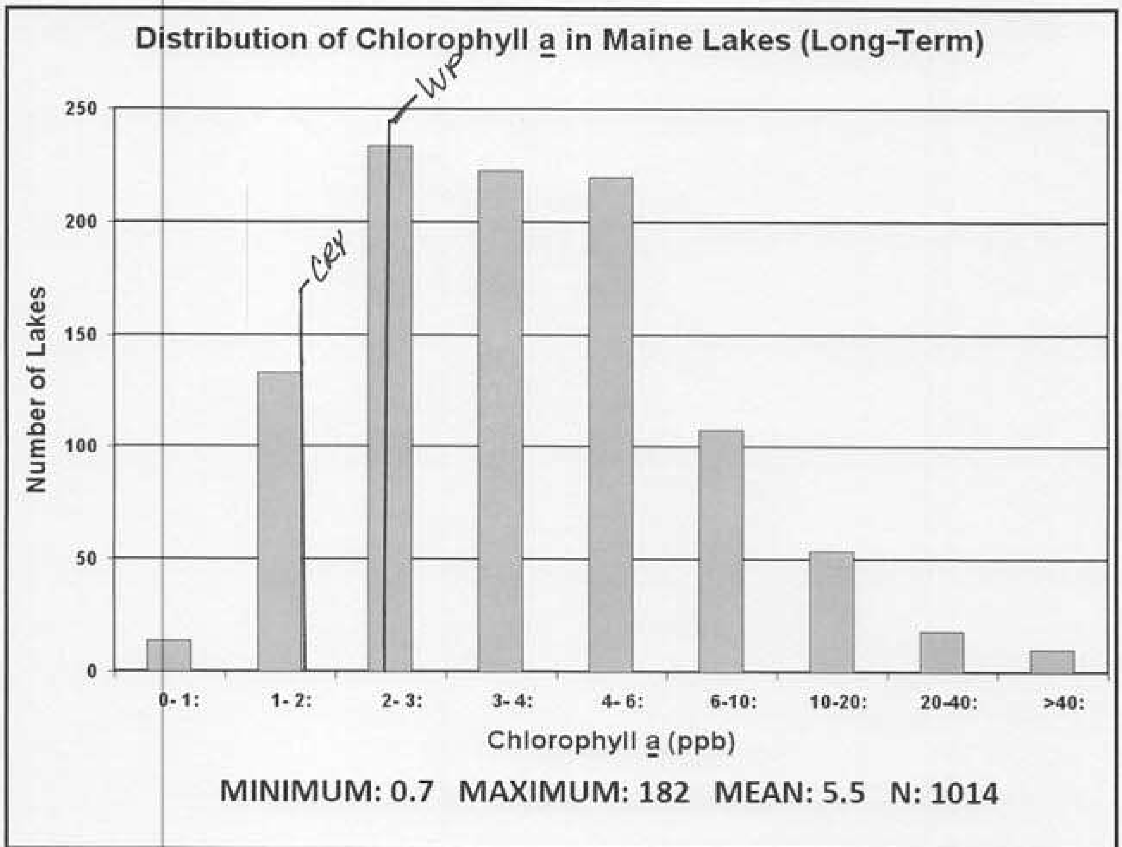
Chlorophyll a (CHL a)

A pigment found in algae and other plants used to estimate biological productivity of lake ecosystems. (Figure 3)

By measuring the concentration of CHL a in lake water, the algae population can be estimated. CHL a is measured in parts per billion (ppb). Figure 3 illustrates the distribution of Chlorophyll a in Maine lakes.

Chlorophyll a samples are generally obtained from an integrated water column sample because the greatest concentration of algal growth typically occurs from the surface of the lake to the bottom of the epilimnion or the top of the thermocline.

Figure 3
Distribution of Chlorophyll a in Maine Lakes



Transparency, total phosphorus, and chlorophyll a are sometimes referred to as "trophic state" indicators, or indicators of biological productivity in the lake ecosystem. Table 1 equates general levels of productivity for Maine lakes with levels or concentrations of the three trophic state indicators.

Table 1

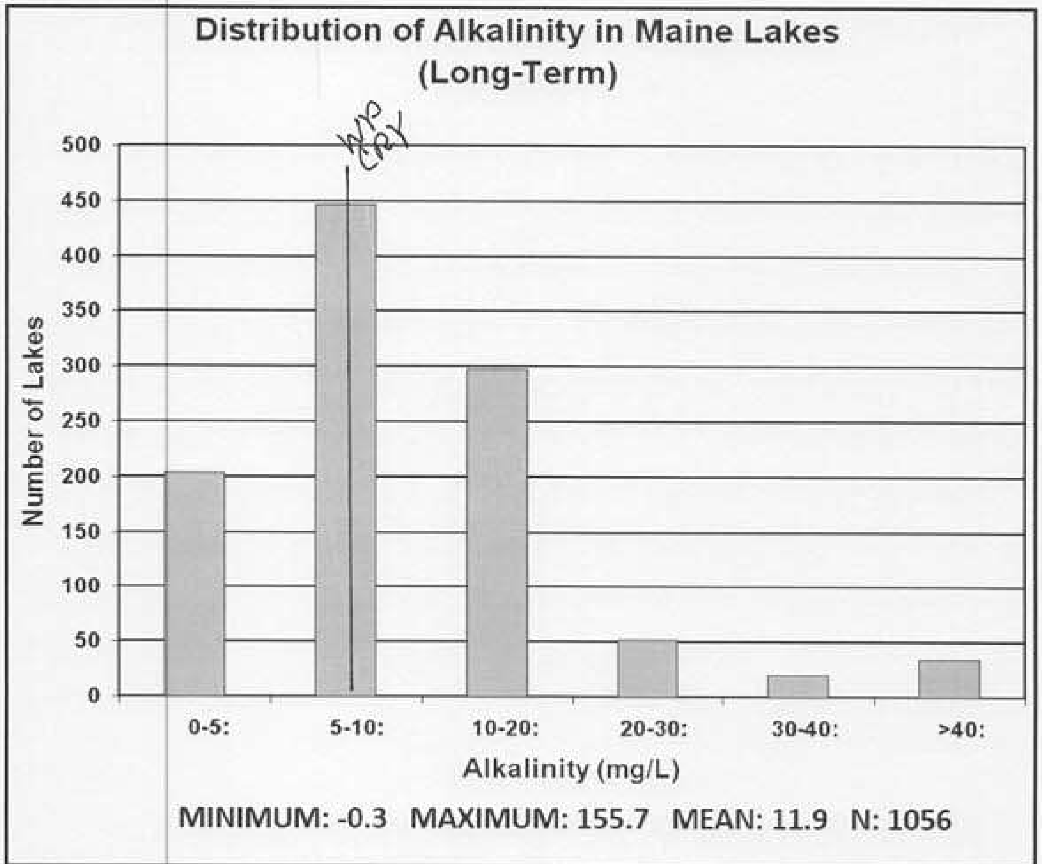
Level of Productivity	**Transparency (Meters)**	**Total Phosphorus (parts per billion)**	**Chlorophyll a (parts per billion)**
Low	>8.0	<4.5	<1.5
Medium	4.0 – 8.0	4.5 – 20	1.5 – 7.0
High	<4.0	>20	>7.0

Alkalinity

A measure of the capacity of water to neutralize acids, or buffer against changes in pH. (Figure 4)

Alkalinity is also referred to as "buffering capacity." It is a measure primarily of naturally available bicarbonate, carbonate, and hydroxide ions in the water. Alkalinity is measured in milligrams per liter (mg/l). Figure 4 illustrates the distribution of alkalinity in Maine lakes.

Figure 4
Distribution of Total Alkalinity in Maine Lakes

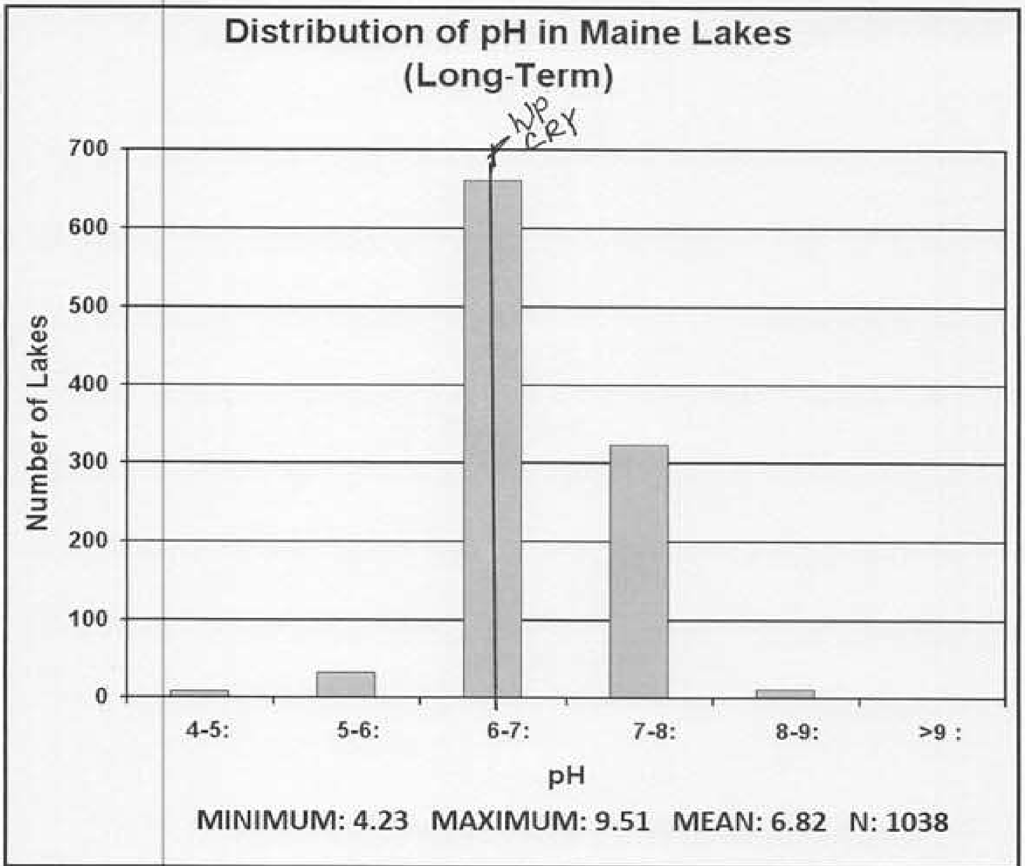


pH

A measure of the relative acid-base status of lake water. (Figure 5)

pH helps determine which plant and animal species can live in the lake, and it governs biochemical processes that take place. The pH scale ranges from 0-14, with 7 being neutral. Water is increasingly acidic below 7, and increasingly alkaline above 7. A one unit change in pH represents a tenfold change in acidity or alkalinity. The pH scale is the inverse log of the hydrogen ion concentration. Figure 5 illustrates the distribution of pH in Maine lakes.

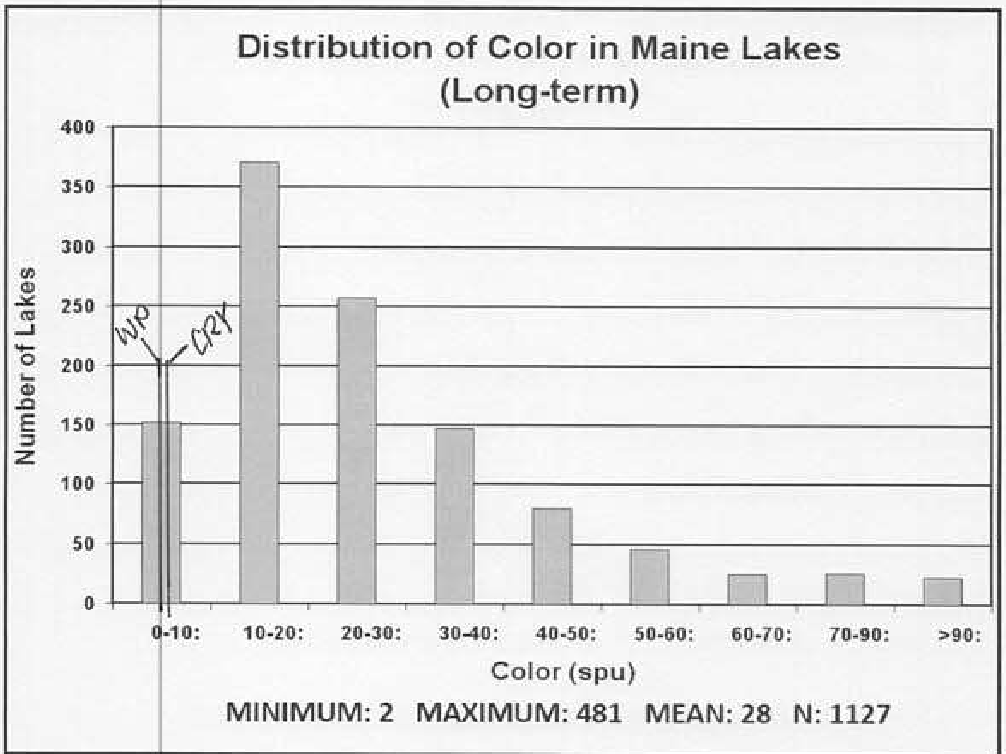
Figure 5
Distribution of pH in Maine Lakes



Apparent Color
The concentration of natural, dissolved, humic acids in lake water. (Figure 6)

Organic "Humic" acids leach from vegetation in the lake watershed. Color is measured in Standard Platinum Units (SPU). Lakes with color levels greater than 25 SPU are considered to be colored. This can cause transparency to be reduced, and phosphorus levels to be elevated. The water in highly colored lakes often has the appearance of tea. When lakes are highly colored, the best indicator of algal growth is Chlorophyll a. Figure 6 illustrates the distribution of color in Maine lakes.

Figure 6
Distribution of Apparent Color in Maine Lakes

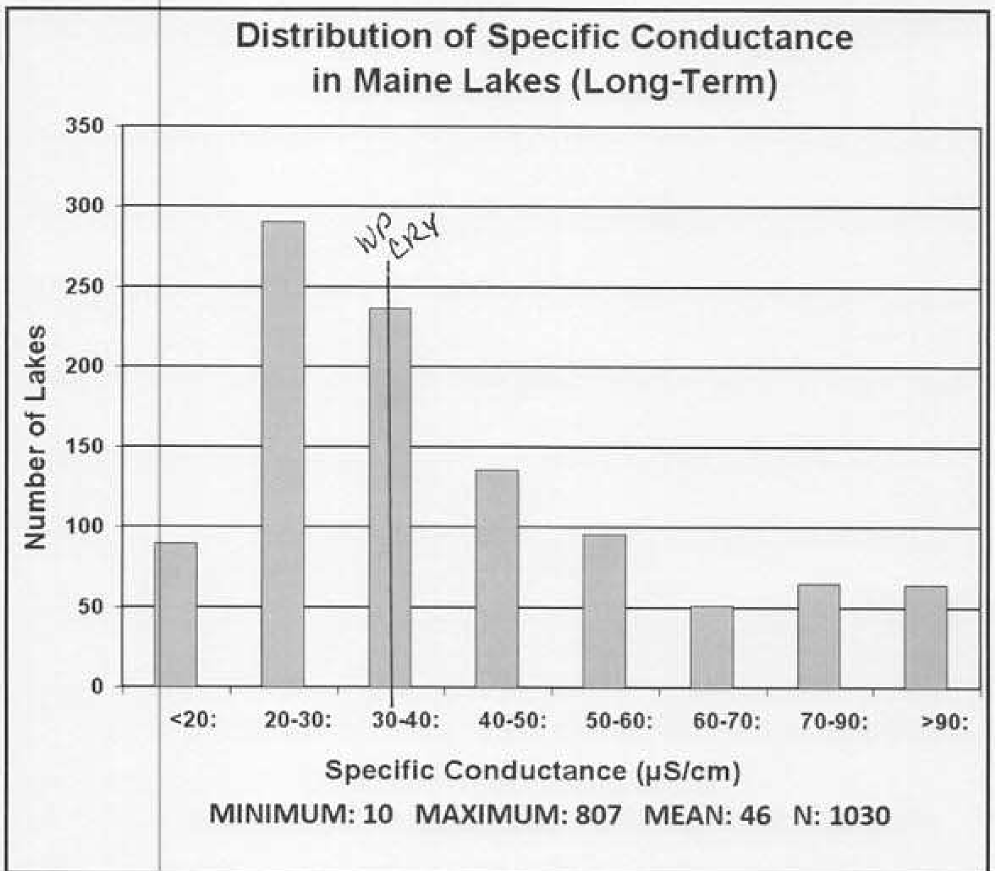


Specific Conductance

A measure of the ability of water to carry an electrical current. (Figure 7)

Conductivity is directly related to the level of dissolved ions in the water. Conductivity levels will generally increase if there is an increase in the concentration of pollutants in the water. Conductivity is measured in micro-siemens per centimeter (µS/cm). Figure 7 illustrates the distribution of specific conductance in Maine lakes.

Figure 7
Distribution of Specific Conductance in Maine Lakes



Trophic State Index

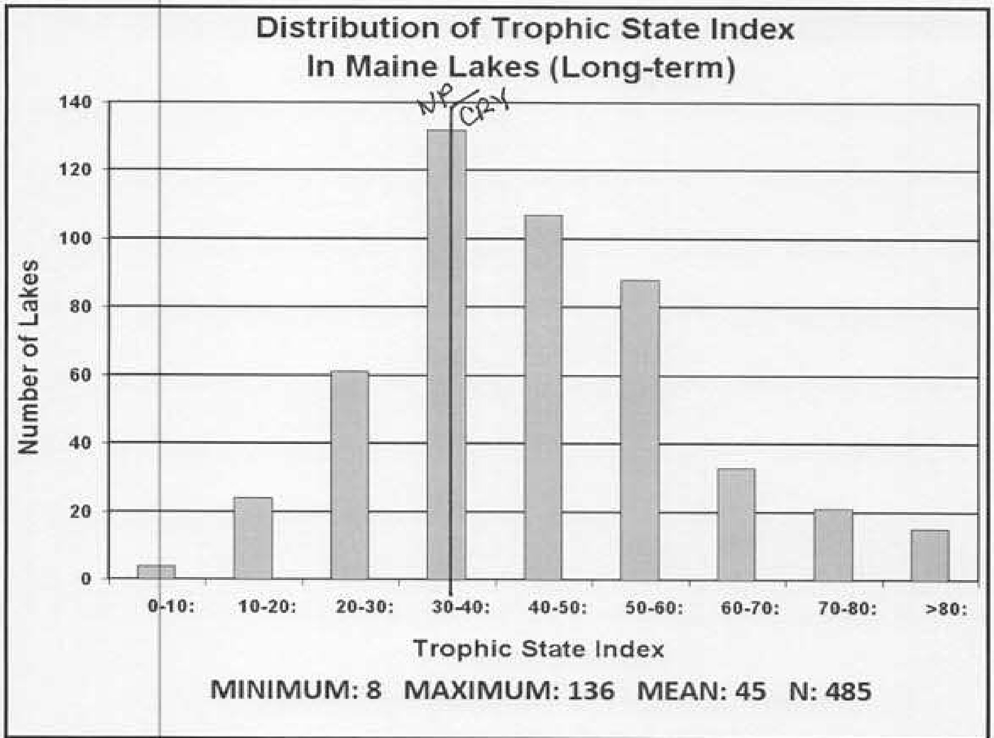
A simplified index of biological productivity in lakes. (Figure 8)

The Trophic State Index (TSI) was developed in 1977 by Robert Carlson as a means to be used for establishing a simple numerical scale for each of the three indicators of lake water quality that are commonly used to measure (directly or indirectly) lake productivity. Because the units of measurement and scale for Secchi disk transparency, total phosphorus and chlorophyll a differ, the TSI provides a convenient means by which the three indicators can be compared. The TSI converts raw data from each of the three indicators to standard numerical scales that range from 0 to over 100, with higher numbers representing increasing productivity, and typically poorer water quality. The TSI models developed by Carlson have been modified for Maine lakes, based on historical data for each indicator. Figure 8 illustrates the TSI distribution of Maine lakes from transparency data.

Figure 8

Distribution of Trophic State Index in Maine Lakes from Transparency Data

Appendix I



Our Mission

The Mission of the Lake Stewards of Maine (LSM) is to help protect Maine lakes through widespread citizen participation in the gathering and dissemination of credible scientific information pertaining to lake health. The LSM trains, certifies and provides technical support to hundreds of volunteers who monitor a wide range of indicators of water quality, assess watershed health and function, and screen lakes for invasive aquatic plants and animals. In addition to being the primary source of lake data in the State of Maine, LSM volunteers benefit their local lakes by playing key stewardship and leadership roles in their communities.

More...

The LSM is a non-profit 501(c)(3) organization committed to the collection of information pertaining to lake water quality. For 40 years, trained volunteers throughout Maine have donated their time so that we may all learn more about one of Maine's most beautiful and important resources — our lakes.