Northeast Aquatic Research, LLC

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October 22, 2020

TO: Town of East Hampton, CT
ATTN: David Cox, Town Manager
Jeremy Hall, Parks and Recreation Director
FROM: Hillary Kenyon Garovoy, Limnologist & Certified Lake Manager
George Knoecklein, Ph.D. Principal Limnologist

RE: Provisional Results from 2020 Water Quality Monitoring

The following text and data visualizations display the provisional water quality monitoring results from Lake Pocotopaug 2020 sampling. Please note that this summary does not constitute a detailed water quality data analysis, and is instead meant to provide a timely overview of information to report to the Town Council members for their October 27th meeting.

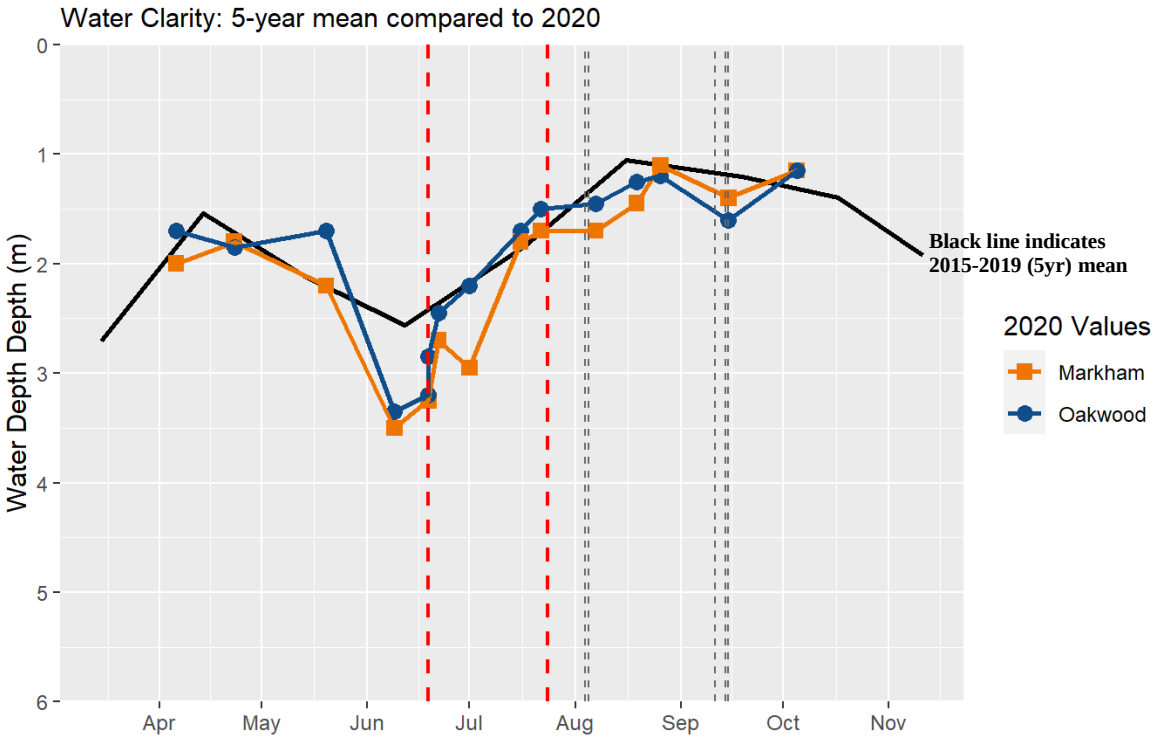
Overall, the destratification aeration system has done a good job circulating the lake. The system is sized correctly and was able to continuously circulate the lake and prevent anoxic (without oxygen) conditions across nearly the entire lake bottom, even during the peak-summer heat wave. Even on the very hot summer days at Pocotopaug, only the bottom 0.5-meters of water appeared to fluctuate between oxygenated and anoxic conditions. Overall, the data presents a successful aeration year.

Seasonal data from the deepest area of the lake, Oakwood station, is provided below. The horizontal red line indicates the normal summer anoxic boundary of the past few years, meaning that in recent years (2014-2019), almost complete oxygen loss occurred below the red line during summer months. Values less than 2mg/L in 2020 are highlighted in red to indicate little to no oxygen at that respective depth. Without the aeration system, all values below the red line would have likely been below that 2mg/L threshold. One can see that oxygen conditions in 2020 were dramatically improved.

Oakwood Dissolved Oxygen (mg/L) Profiles 2020													
[Measurements at 1m intervals, unless 0.5m needed]					Before Aeration	3hrs After	3 days after						
Depth (m)	4/6/2020	4/23/2020	5/20/2020	6/9/2020	6/19/2020		6/22/2020	7/1/2020	7/22/2020	8/7/2020	8/19/2020	9/15/2020	10/5/2020
0	11.6	12.1	10.8	8.8	9.4	9.7	8.8	7.6	9	7.7	7.7	8.9	9.3
1	11.6	12.1	10.8	8.8	9.4	9.7	8.6	7.5	8.6	7.7	7.7	8.8	9.3
2	11.6	12.0	10.7	8.8	9.4	10.0	8.6	7.4	8.5	7.6	7.5	8.7	9.3
3	11.6	11.9	10.7	8.5	9.6	9.6	8.5	7.3	8.4	7.6	7.4	8.7	9.2
4	11.6	11.9	10.7	7.7	8.8	9.5	7.8	7.3	8.2	7.6	7.4	8.6	9.2
5	11.6	11.9	9.5	4.6	3.3	6.8	7.4	7.4	8	7.6	7.4	8.6	9.1
6	11.5	11.8	8.7	2.1	0.3	1.6	6.6	7.4	7.2	7.6	7.3	8.5	8.9
7	11.5	11.8	8.6	2	0.3	0.4	5.1	7.4	6.4	7.5	7.4	8.5	8.9
8	11.2	11.7	7.9	0.8	0.3	0.4	0.3	7.4	5.2	6.7	6.5	8.5	8.9
9	10.5	11.7	6.9	0.4	0.3	0.3	0.3	7.2	3.2	7.1	6.3	8.4	8.4
10	9.3	11.7	2.6	0.3	0.3	0.3	0.3	0.4	0.4	7.1	4.2	8.3	6.6
~10.5	9.1	11.5	1.6	0.3	-	-	-	0.3	-	5.6	1.7	8.2	4.7

The impact of the destratification/circulation aeration system and BioBlast/PureAg treatments on water clarity, phytoplankton, and nutrient concentrations are less clear. The figure below shows the 2020 water clarity values, measured using a Secchi disk and view scope, compared to the mean clarity from the last five years (solid black line). The red vertical dashed lines demonstrate the dates when the aeration systems were turned on at Oakwood and Markham bays. The thin vertical dashed black lines indicate the dates of the BioBlast treatments.

From the graph below, one can see that the 2020 pattern of water clarity is very similar to the last five years. The circulation aeration system does not appear to have had a dramatic impact on water clarity.



A detailed discussion of water clarity was provided in the September 2020 monitoring summary, and is included below to reiterate potential explanations of observed clarity and lake color in 2020:

> "Accounts by residents about dramatically improved water clarity do not align with the measured open-water Secchi clarity values. We believe that residents are generally noting the dramatic change in water color in 2020 compared to previous years. In previous years, the lake has been bright green throughout, due to blue-green cyanobacteria accounting for the majority of the phytoplankton in the lake. In 2020, however, the lake has taken on a more brownish observed color. There are several potential reasons for this difference:

1. There were a higher number of diatom algae in the water column in summer, as a result of the circulation/destratification aeration diffusers. These diffusers create artificial lake mixing, which is favored by diatom algae and reduces the competitive advantage of certain types of cyanobacteria. While there were still high numbers of cyanobacteria in the lake, other types of algae were also present, which is not typical for a summer season at Pocotopaug.

2. The aeration diffusers initially brought a limited amount of "black water" to the surface, which caused an initial decline of water clarity as a result of colloidal minerals and organic matter that are formed in the chemically reducing anoxic environment of the normal hypolimnion (lake bottom) of Pocotopaug. The jar experiment to the right shows the formation of "back water" above settled Pocotopaug sediment when oxygen is depleted after 30 days. It is possible that some of the dissolved organic matter (<0.45µm) and/or colloidal minerals and organic matter (0.5-2µm) are still present in the water column because such tiny particles have a difficult time resettling. [For reference, medium sand is ~500µm.]

3. The BioBlast microbes were brown in color. The September sampling took place during the last day of BioBlast treatment, and the microbe-rich water applied to the surface made the lake visibly brown in recently treated areas. The bacteria were also visible under the microscope.

   In order to improve resident confidence in Secchi water clarity measurements, and to increase the number of water clarity readings across the lake throughout the season, we recommend that the Lake Commission and Town supports a Secchi disk volunteer monitoring program in 2021. Volunteers can be trained and equipped with Secchi disks and view scopes to measure water clarity themselves. Citizen monitoring data can then be reported to a central database and used in future lake monitoring reports. A training program could be initiated as an outdoor (and socially-distanced) event in spring 2021. Data ownership should improve resident confidence in ongoing lake management efforts."

The 2020 season provided extremely valuable data and insight into changes that occurred with the aeration and BioBlast treatments, and we expect that a second year of monitoring aeration and BioBlast will provide even greater understanding of the successes and limitations of the in-lake project. The long-term water clarity goal that we have been working towards is to maintain greater than 2 meters (6.5ft) of clarity for the entire year. Based on distinct differences in the 2020 water color and particulate material that determines clarity, this long-term goal should be revisited.

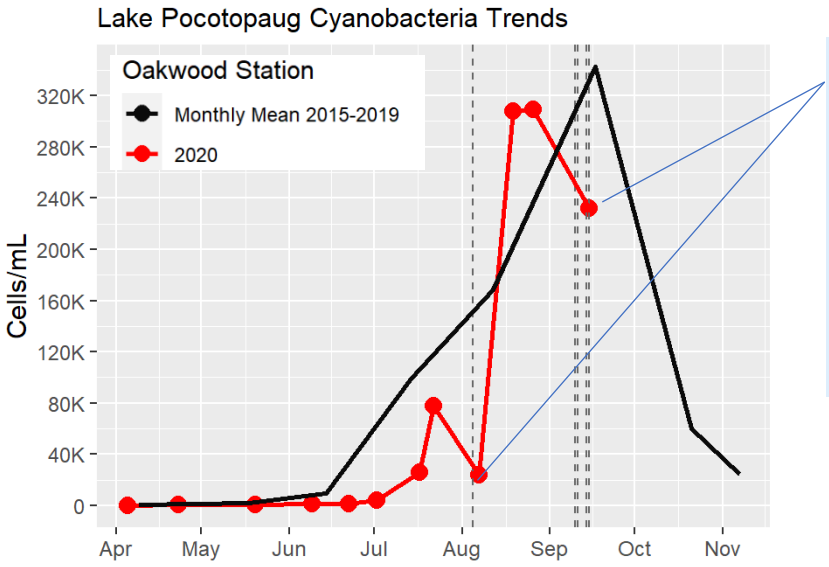
It is important to note that late spring to early summer water clarity was significantly better than the five-year mean. There are multiple physical, chemical, and biological factors that determine a June "clear-water phase" in New England lakes, but Pocotopaug does not typically experience a clear-water phase. The good clarity observed on June 9th, prior to the aeration system activation, was on par with the clear-water phase data collected only in 1993-1996 and 2016. Clear-water phases typically occur during the onset of summer stratification and when a lake has a healthy zooplankton population. This June 2020 clear-water could also be related to reduced watershed loading, but we do not yet have evidence compiled to support that hypothesis. The use of the circulation aeration system before June in 2021 will alter this period of water column stability, which limits the ability to compare spring and early-summer water quality to historical data. The aeration system and BioBlast treatments added two large variables that must be accounted for.

For that reason, the lake management advisory committee must agree on new metrics to track improvements in watershed loading and overall water quality. We anticipate multiple discussions to determine the best measurable milestones to discern water quality improvements, particularly to parse out the successes of watershed improvement projects versus the EverBlue system and treatments.

There were no visible surface scums of cyanobacteria until late October 2020. The Chatham Health District issued a cyanobacteria advisory late in the season, on September 3rd, based on visual assessment from the Sears

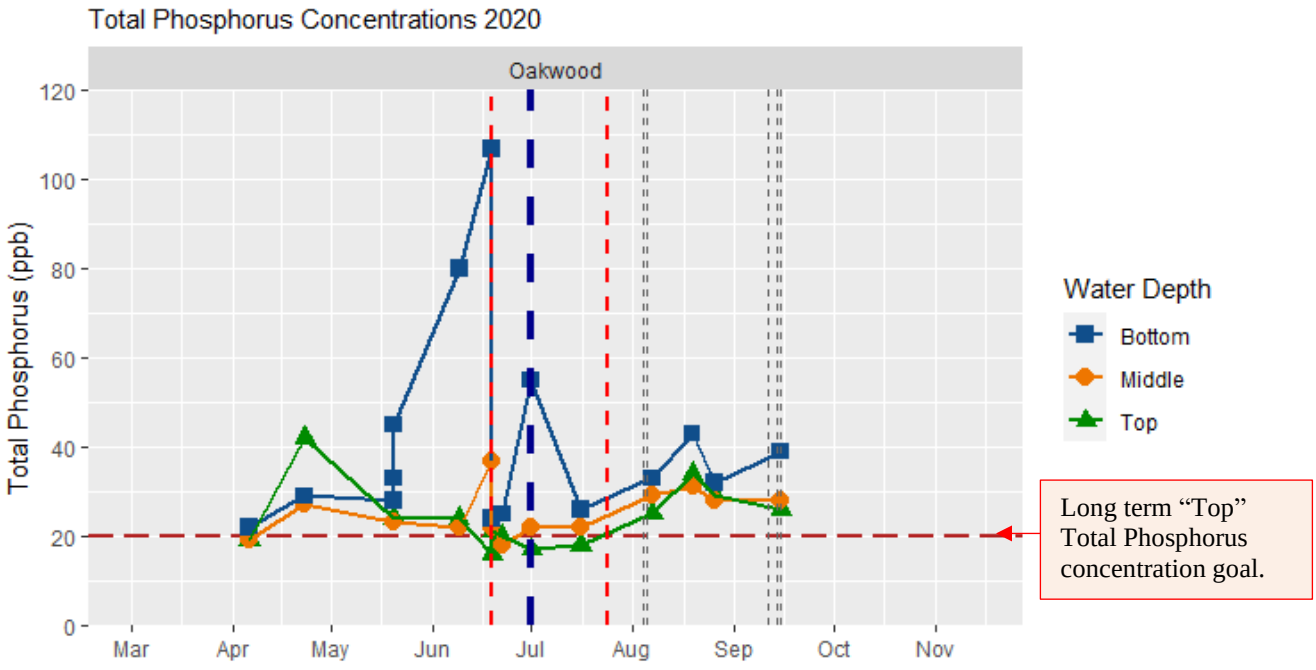
Park beach. It was also determined that the majority of the cyanobacteria present in the lake in 2020 were genera that are not known to produce cyanotoxins, so toxin testing was not performed in 2020.

The figure below demonstrates the 2020 cyanobacteria cell counts at Oakwood station, compared to the monthly mean from 2015-2019. This graph and description were originally produced as part of the September 2020 monitoring summary. Please note that this figure only shows cyanobacteria (blue-green algae) and does not show the differences in other types of phytoplankton from 2020. That additional information will be included in the year-end report.



Observed decrease in cyanobacteria cells/mL at Oakwood station after BioBlast treatments (vertical dashed lines). There appears to be a relationship between the BioBlast microbial treatment and a subsequent decrease in cyanobacteria. A modified water quality sampling design in 2021 would be able to further clarify this relationship.

Due to the time that it takes to get nutrient results from the specialty lab, the monthly summary reports did not include information on nutrient concentrations or overall nutrient mass. A brief overview of Phosphorus results is included below.



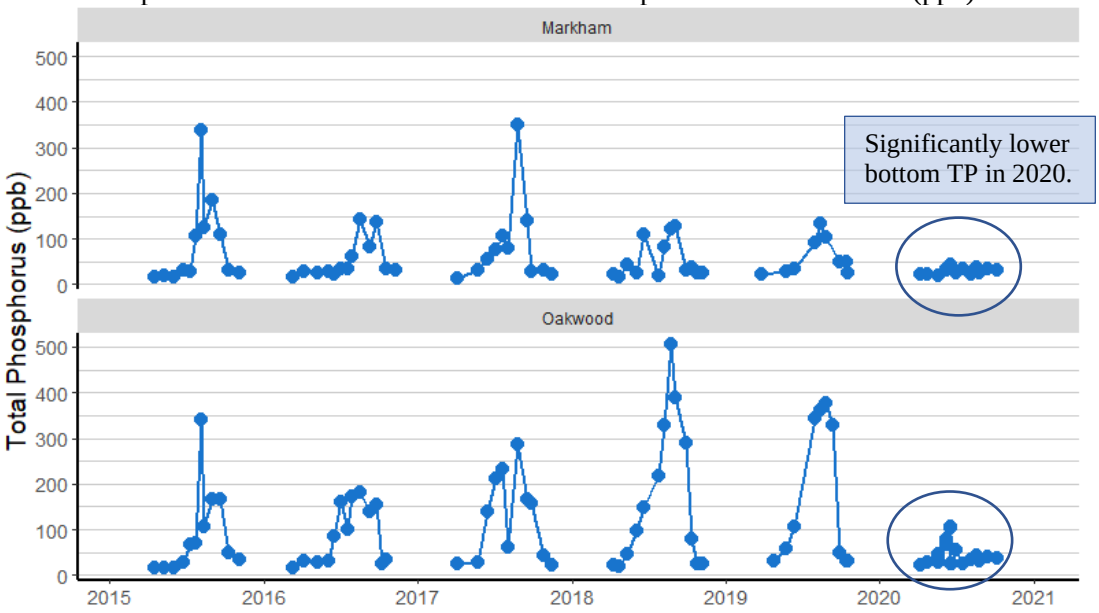
Long term "Top" Total Phosphorus concentration goal.

One can see from the above figure, above, that Oakwood bottom-water Total Phosphorus concentrations were significantly lower after the aeration system was turned on. There are two primary reasons for this:

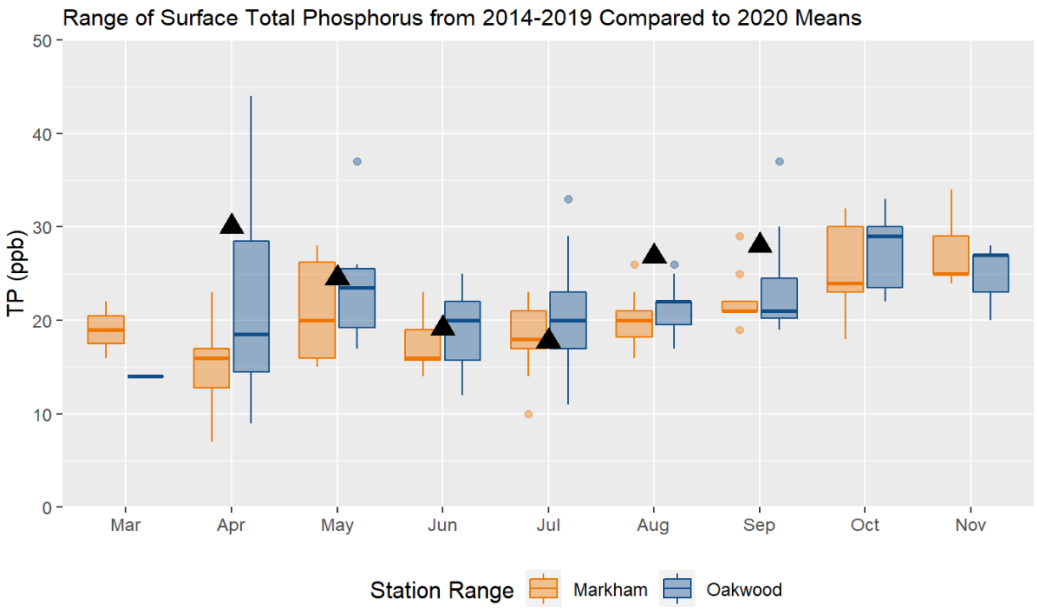
1. The aeration system may effectively limit the release of iron-bound phosphorus from the sediments
2. The phosphorus that is normally in the bottom-waters during summer months was partially mixed into the rest of the water column. This phenomenon is visible when the concentrations throughout the water column drastically changed when the Oakwood station circulation aeration system was turned on (first vertical red dashed line on above figure).

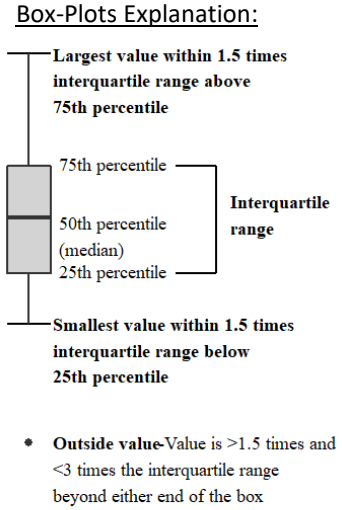
Bottom Phosphorus data from 2020 was dramatically lower than the summer 2015-2019 concentrations.

Comparison to Past Years – Bottom Total Phosphorus Concentrations (ppb)



This lower bottom-water Phosphorus occurred at the same time as slightly higher-than-normal summer surface concentrations. The range of Total Phosphorus concentrations in surface waters across both stations (2014-2019) is included in the figure below. Black triangles mark the 2020 average (mean) monthly surface concentrations.





Elevated August and September surface TP is, in part, a result of a more uniform distribution of Phosphorus throughout the water column, driven by the circulation aeration system. Bottom water Total Nitrogen results were very similar to the Phosphorus data.

More thoughtful nutrient data analysis and comparisons will be provided, and additional data can be explained at the Town Council meeting. We encourage Council members to ask questions, as one of our goals is continued and improved public education.

We are also pleased to present a new list of watershed management projects that will be funded by a second 319 grant. This funding was provided by the Clean Water Act, Section 319, Nonpoint Source Pollution Prevention effort, which was awarded to the Town of East Hampton in 2020. The new grant funds are allocated to phosphorus and nitrogen reduction projects and follow-up monitoring at:

1. Christopher Brook Pond
2. O'Neil's Brook
3. Fawn Brook
4. Edgewater Circle Pond

Each of these projects was carefully selected from the list of proposed watershed improvements from the Lake Pocotopaug Nine Element Watershed Based Plan. The projects all focus on enhancing wetlands and existing ponds to be able to trap and store phosphorus, nitrogen, and organic matter from the surrounding watershed. The 2020 year-end report will also include a full update to the Nine Element Watershed Based Plan, including more recent stormwater monitoring results.

Thank you for your continued dedication to monitoring and management of Lake Pocotopaug.

Sincerely,
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