Northeast Aquatic Research, LLC

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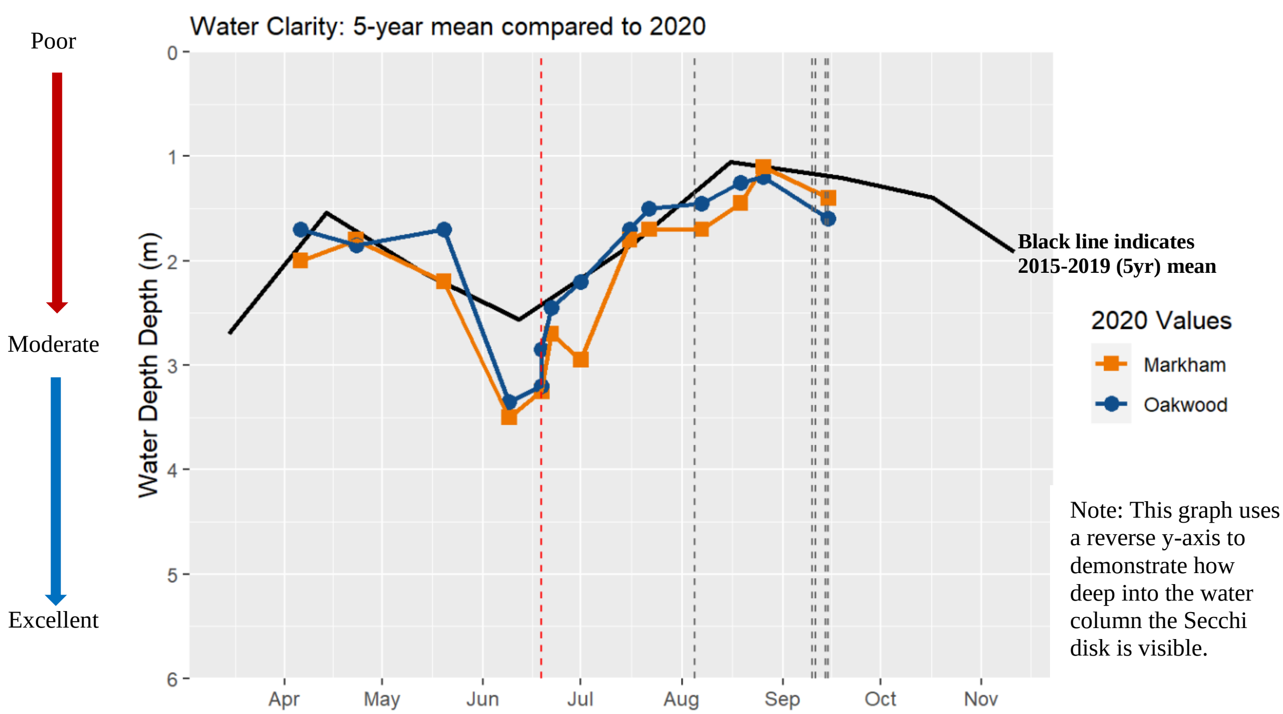
October 1, 2020

TO: Residents of East Hampton, CT
ATTN: Town of East Hampton Conservation Lake Commission
FROM: Hillary Kenyon Garovoy, Limnologist & Certified Lake Manager
George Knoecklein, Ph.D. Principal Limnologist

RE: Results from September 2020 Water Quality Monitoring

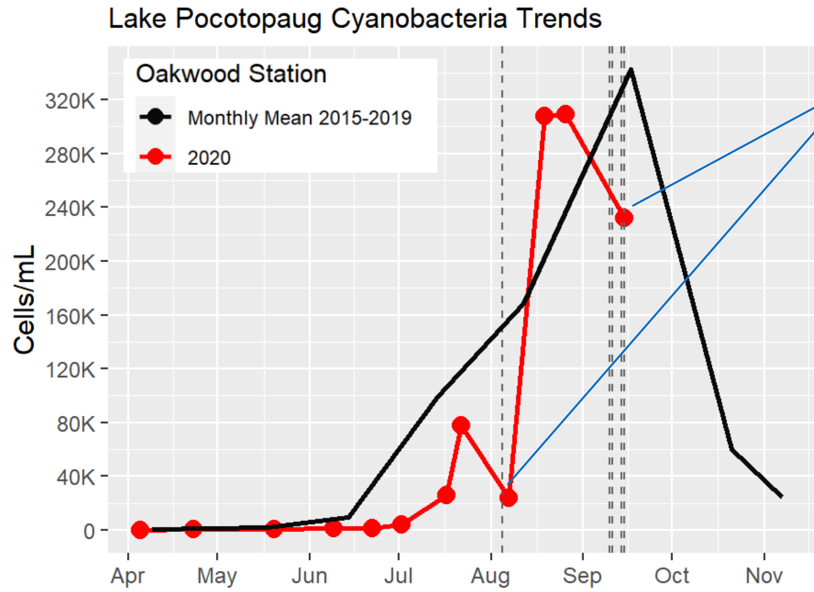
The following results display data collected on September 15, 2020. Only one September monitoring visit was conducted because three visits were done in August and the 2020 sampling budget had approved four monitoring visits in August through September. The next monitoring visit will take place on the first week in October. September water quality sampling included Secchi water clarity, phytoplankton, temperature, dissolved oxygen, conductivity, nutrient samples, and chlorophyll-a at the Oakwood, Markham, and 'Island' station. The Island station was a newly added sampling location to comply with CT Department of Energy and Environmental Protection (DEEP) permit requirements. Raw profile data is included at the end of this summary letter. This summary does not constitute a full water quality data analysis and is simply meant to provide the Town and residents with timely information prior to a full analysis at the end of the season.

Water clarity, measured with a Secchi disk and view scope, was slightly better than the 2015-2019 September mean clarity. Though, this improved September clarity was not statistically significant across the six years of sampling, in part due to the limited number of September data points.



The red vertical dashed line indicates the date when the Oakwood circulation aeration system was first turned on. The vertical dashed grey lines indicate the dates of BioBlast treatment. The amount of BioBlast microbial additives applied on each date is not yet available but should be reported by EverBlue.

Cyanobacteria cell counts from September 2020 were lower than the 5-year mean and demonstrated a notable decrease in abundance from mid to late August. Cyanobacteria were still present above the 100,000 cells/mL threshold that is frequently used to indicate potential toxin presence. However, it should be noted that the type of cyanobacteria dominant in September 2020 (*Planktolyngbya limnetica*) is not known to produce cyanotoxins. Variations in cyanobacteria cell counts between Northeast Aquatic Research (NEAR) and EverBlue is likely a result of different laboratory methods and inconsistencies from one microscope observer to another, explained in detail on page 3.

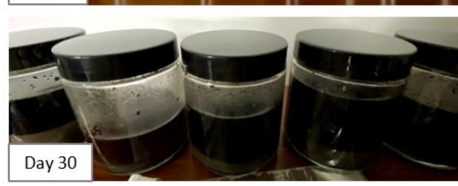


Observed decrease in cyanobacteria cells/mL at Oakwood station after BioBlast treatments (vertical dashed lines). A similar observed decrease in cyanobacteria was noted after the first BioBlast treatment in August. While there are still a number of confounding factors that should be considered, there may 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.

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.]

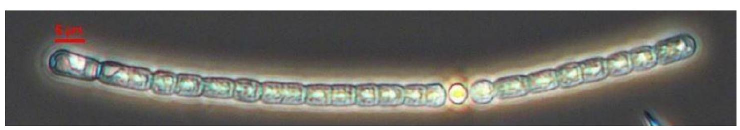


3. The BioBlast microbes are brown in color. The September sampling took place during the last day of BioBlast treatment, and the microbe-rich water applied to the surface made the lake visibly brown in recently treated areas. The bacteria were also visible under the microscope.

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.

In reference to the differences between NEAR and EverBlue cyanobacteria counts that have confused a number of concerned citizens, it is normal for two qualified individuals to get up to a 20% difference between algae and cyanobacteria counts of the same sample. The unusually wide variation in cyanobacteria results between NEAR and EverBlue results over the course of the summer is probably related to the definition of a cyanobacteria "cell." The type of cyanobacteria dominant in Pocotopaug have extremely small cells (e.g. *Planktolyngbya*). A filament of *Planktolyngbya* may look like a tiny strand with no divisions at 100x or 200x microscope power. It is only at 400x+ that one is able to see the cell divisions in the thread-like filaments. Counting a filament as just one "cell" is technically inaccurate and would result in dramatic differences in final cell counts. It is more appropriate to report a *Planktolyngbya* filament as a 'natural unit' or simply as 'filament.' Other cyanobacteria types present in Pocotopaug, such as *Chrysosporum* and *Dolichospermum* (previously named *Anabaena*) have slightly larger cells. *Dolichospermum* cell divisions in a filament are visible at as low as 100x microscope power, making it an easier cyanobacterium to count than *Planktolyngbya*. The following photos show the relative size differences between three of the dominant cyanobacteria found in Pocotopaug. The photos included below were taken by GreenWater laboratories. Note the scale bar on each photo. We believe that the large differences in cell counts between NEAR and EverBlue are related to this dilemma. At present, there is no state or federal standard for microscopes or for reporting cyanobacteria. Unfortunately, this could result in dramatically different counts between two labs but it should still present similar patterns across both seasonal counts.

Planktolynbya 400x (scale bar = 2µm)


Chrysosporum 400x (scale bar = 5µm)

Dolichospermum 400x (scale bar = 5µm)

It is important to acknowledge that cyanobacteria advisories and beach closures are primarily based on visual assessments in CT. Cell counts are supplemental information and can be potentially used to terminate an advisory. The CT DEEP and Department of Public Health (DPH) guidance document veers away from using cell counts because there is no laboratory or individual certification process, and there are also great differences in cell sizes and colony types for various cyanobacteria. The cell counts provided in the CT guidelines are just estimates associated with a potential visual Category. Certain types of cyanobacteria are also much more likely to form dense

and toxigenic shoreline scums (e.g. *Microcystis* and *Dolichospermum*). Please refer to the CT DEEP and DPH cyanobacteria guidelines for recreational waters for more information.
https://portal.ct.gov/-/media/Departments-and-Agencies/DPH/dph/environmental_health/BEACH/Blue-Green-AlgaeBlooms_June2019_FINAL.pdf?la=en

After the August data summary received harsh criticism from concerned citizens, we felt it was important to increase our literature review of microbial additives for lake management. This review is currently in progress and will expand over the next year. While the Pocotopaug BioBlast treatments were the impetus for this scientific investigation, this literature review is being completed outside of the scope of work with the Town of East Hampton because such information is applicable to the general fields of limnology and lake management.

Preliminary research has found no peer-reviewed published case studies of lakewide microbial treatments for muck reduction or internal phosphorus control, and there seems to be few publications about lake microbial treatments for cyanobacteria control. However, there is an abundance of microbiological research that supports that certain strains of naturally occurring bacteria, particularly bacteria in the *Bacillus* genera (including certain species listed on the BioBlast PureAg product label), that are capable of reducing cyanobacteria. Much of this scientific literature comes from agricultural sciences, and some research stems from the wastewater or drinking water treatment fields. Based on information collected in 2020, it would be wise for the Town to seek volunteers in 2021 to increase the amount of data collected without increasing sampling costs. With the appropriate data, it is possible that Pocotopaug could become one of the first well-documented case studies of combined circulation aeration and microbial treatments for lake management.

The raw Secchi clarity and profile data are included at the end of this document. No anoxia was present at the three monitoring stations on September 15th. At the end of the season, we intend to compare our profile data to the data collected by EverBlue.

Thank you,
Hillary Kenyon, CLM

Date: 09/15/2020

Markham Station (41.59949, -72.49493)
Water clarity: **1.4 meters** (4.6 feet)
Water depth: 8.0 meters (26.2 feet)
Weather: calm, clear, chilly
Notes: 9:15am, small accumulations of surface bubbles, last day of active BioBlast/PureAg treatment by EverBlue, water looks much more brown than usual

Depth (m)	Temp (°C)	Oxygen (mg/L)	Oxygen Saturation %	Conductivity (µS)
0	21.8	8.8	100	210
1	22.1	8.6	98	208
2	22.3	8.5	98	207
3	22.4	8.5	98	207
4	22.4	8.5	98	207
5	22.4	8.5	97	207
6	22.5	8.4	97	207
7	22.4	8.4	96	207
8	22.1	8.2	94	207

Island Station (41.59668722, -72.50117)
Water clarity: **1.5 meters** (4.9 feet)
Water depth: 6 meters (19.7 feet)
Weather: calm, sunny
Notes: water less brown here, more green

Depth (m)	Temp (°C)	Oxygen (mg/L)	Oxygen Saturation %	Conductivity (µS)
0	21.2	9.1	102	208
1	21.4	9.0	101	207
2	21.6	9.0	101	207
3	21.7	8.9	101	207
4	21.7	8.9	100	207
5	21.7	8.8	100	207
6	21.6	8.6	98	207

Oakwood Station (41.59758, -72.50849)
Water clarity: **1.6 meters** (5.2 feet)
Water depth: 10.5 meters (34.4 feet)
Weather: Sunny, hazy, slight breeze
Notes: BioBlast treatment in progress in this bay

Depth (m)	Temp (°C)	Oxygen (mg/L)	Oxygen Saturation %	Conductivity (µS)
0	21.7	8.9	101	208
1	22.0	8.8	100	207
2	21.1	8.7	99	207
3	22.2	8.7	99	207
4	22.2	8.6	99	207
5	22.2	8.6	98	207
6	22.2	8.5	98	207
7	22.1	8.5	97	207
8	22.1	8.5	97	206
9	22.0	8.4	96	206
10	21.9	8.3	94	206
10.5	21.8	8.2	93	207