Northeast Aquatic Research

Lake Pocotopaug
2019 Water Quality Report

Prepared for the Town of East Hampton, CT
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Introduction

Northeast Aquatic Research (NEAR) began water quality monitoring at Lake Pocotopaug in the spring of 2014. In-lake and watershed monitoring from 2014 – 2016 culminated in the development and approval of a Nine Element Watershed-Based Management Plan. As a result of the Watershed Management Plan, the Connecticut Department of Energy and Environmental Protection (CT DEEP) provided grant funding for numerous watershed-improvement construction projects that utilize creative Low Impact Design (LID) to treat poor-quality stormwater before it flows into and contaminates the lake. A number of watershed projects are currently underway and a second grant application has been submitted to the CT DEEP for a second phase of watershed improvements. To date, the Watershed Management Plan and resulting grant funding have established public-private partnership projects for the betterment of Lake Pocotopaug. For more information about current and planned watershed projects, please reach out to the Town of East Hampton Land Use Department.

Over the past 5 years, 2014 through 2019, NEAR has also maintained a comprehensive lake monitoring program, including at least monthly in-lake water quality monitoring visits and several stormwater and baseflow inlet sampling events per year. Both the watershed and in-lake monitoring are critical to evaluating the success of the watershed improvement projects. Continued water quality monitoring is a key part of enacting the management plan.

In 2019, NEAR conducted water quality monitoring at Lake Pocotopaug once per month from March through July, and twice per month from August through October. Water quality data was collected from the two established deep-water sampling stations, Markham and Oakwood, to track compliance with the Connecticut DEEP water quality standards and evaluate parameters related to cyanobacteria blooms (**Table 1**).

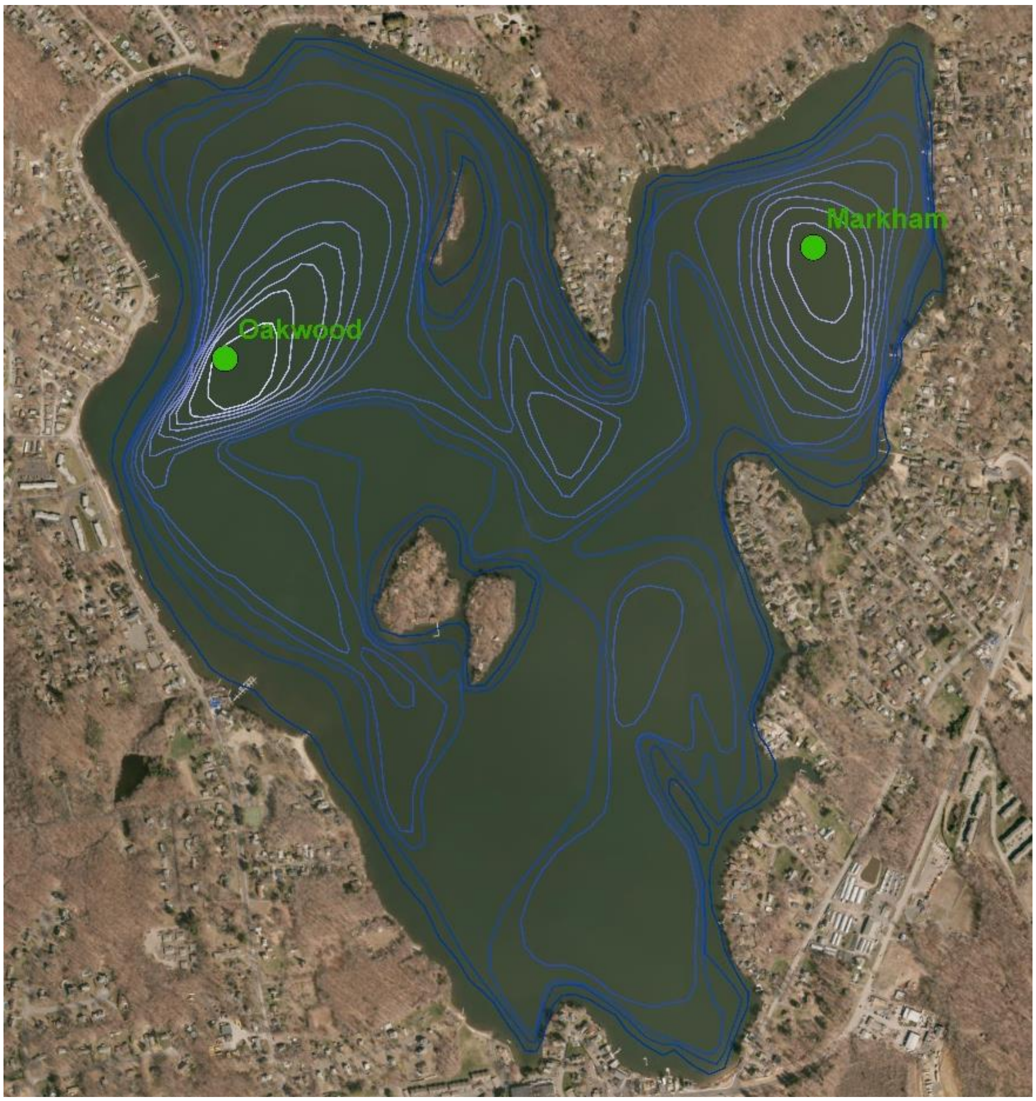
Markham station is located in the northeast basin and has a maximum depth of 30ft (~9 meters) (**Figure 1**). Oakwood station is located in the northwest basin and is the deeper of the two stations, with a maximum depth of 36ft (~11 meters).

Dissolved oxygen and water temperature were measured at 1-meter depth increments from the surface to the bottom of the water column at each station. Water clarity was measured at each station using a Secchi disk and view scope. Vertical composite cyanobacteria and zooplankton samples were collected from Markham and Oakwood stations, as well as outside the Sears Park swimming area. Water samples were collected from the top, middle, and bottom of each station. The sample depths at Markham station were 1m, 4m, and 7m. The sample depths at Oakwood station were 1m, 5m, and 9m. All water samples were tested for total phosphorus concentrations. The top and bottom water samples were also tested for concentrations of total nitrogen, ammonia nitrogen, and nitrate nitrogen.

Table 1. Parameters and defining ranges for trophic states of lakes in Connecticut.

Trophic state=>	Oligotrophic	Mesotrophic-	Eutrophic	Highly Eutrophic
TP -ppb	0 - 10	10 – 30	30 – 50	>50
TN -ppb	0 - 200	200 - 600	600 - 1000	>1000
Secchi -meters	>6	6 - 2	2 – 1	<1
Chlor.-*a* -ppb	0 - 2	2 – 15	15 – 30	>30

Figure 1. Bathymetric map of Lake Pocotopaug, with locations of the two in-lake sampling stations.



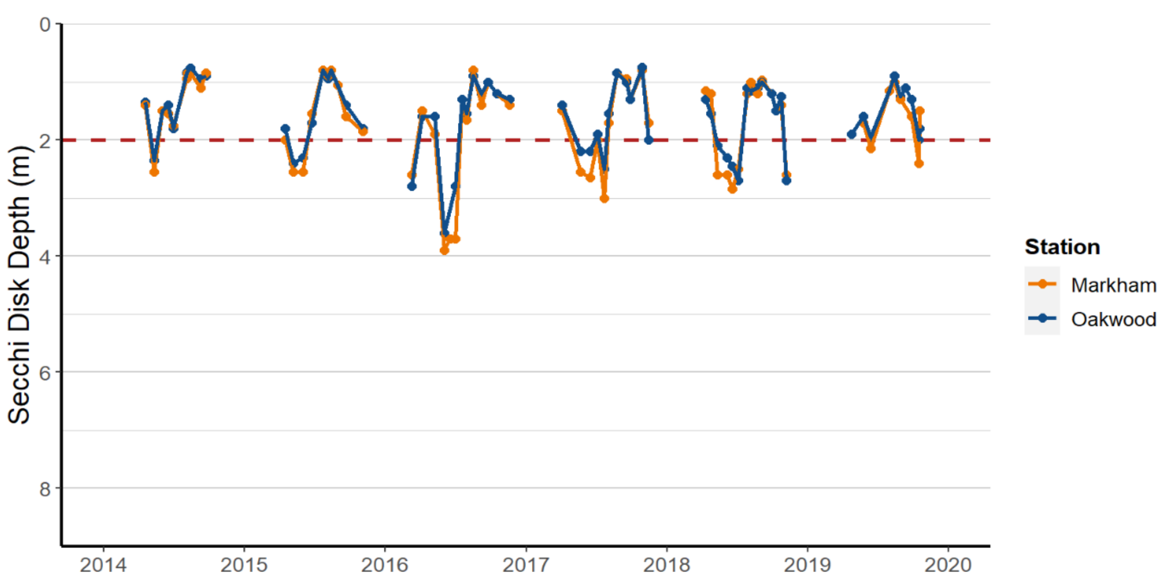
Water Quality Results

Water Clarity

Water clarity is the primary parameter used to assess the water quality of lakes. Clear water implies low nutrient concentrations and fewer phytoplankton. Water clarity of less than 2 meters is considered very poor, and indicates eutrophic conditions and cyanobacteria phytoplankton dominance. Water clarity in Lake Pocotopaug should ideally remain better than 2 meters for the entire sampling season. Yet, monitoring data shows that actual clarity at Pocotopaug is typically very poor. Lake management and watershed improvement projects attempt to limit nutrient inputs to minimize phytoplankton growth and improve clarity.

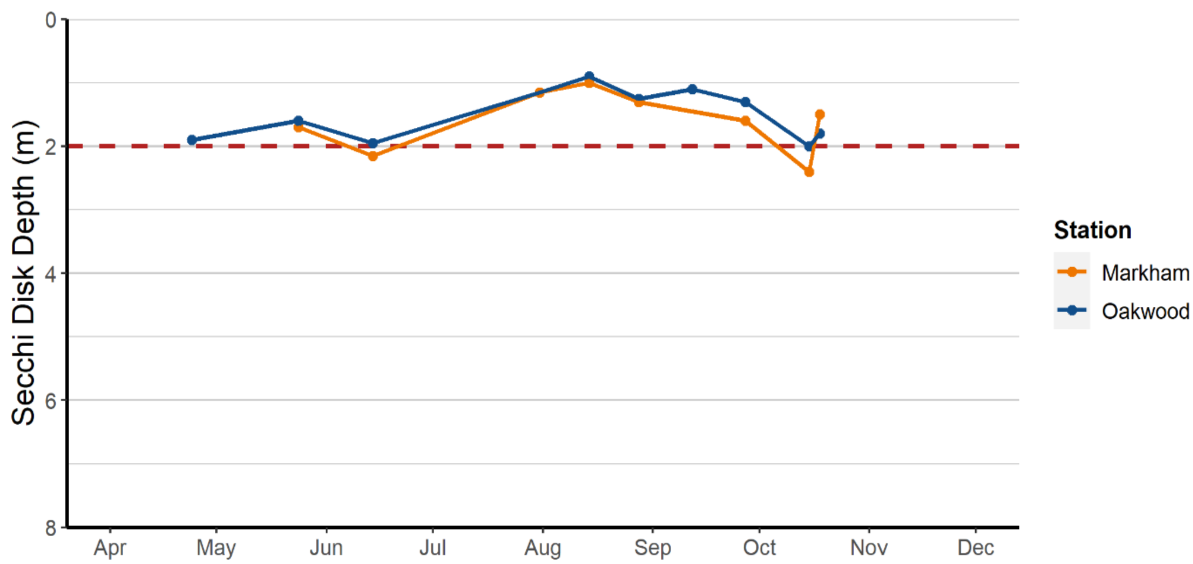
The water clarity in the lake follows a similar pattern each year (**Figure 2**). Generally, clarity is poor in the early spring as the result of spring watershed nutrient loading. The lake usually goes through a slight 'clear-water phase' in June, and then clarity deteriorates in mid-summer, generally becoming worse than in the spring. This poor clarity in summer is caused in-part by internal nutrient loading due to anoxic water at the lake bottom. Deep-water sediments begin to release nutrients at about the same time of the year as when the two main inlets to the lake, Christopher and Hales Brooks, typically dry up. With little to no baseflow in streams during the summer, most of the water entering the lake is stormwater, which has much higher nutrient concentrations than baseflow. Similarly, the dam is also closed at around the same time, which may exacerbate the accumulation of nutrients during the summer because there is no flow out of the lake for several weeks. Clarity tends to improve again in October and November, as the result of fall turnover, when oxygen is replenished to bottom-waters. Yet, clarity is still generally poor, usually only slightly better than 2m in the spring and fall months where the lake is fully oxygenated.

Figure 2. Secchi disk depths at Markham and Oakwood stations, 2014 – 2019.



Water clarity in 2019 was poor at both stations for the entire monitoring season, with Secchi disk depths ranging from 0.9 meters to just 2.4 meters between March and October (**Figure 3**). Figure 3 demonstrates the summer decrease in clarity, designating months where the lake is dominated by cyanobacteria. Though, in October 2019, sampling conducted before and after a large rain event indicated that the lake clarity diminished considerably following the storm event, and that the storm appears to have affected the Oakwood station more than the Markham station. This decrease in clarity affirms that although internal loading exists, the watershed is still a considerable source of nutrients and that the lake may have poor clarity even if the bottom water is fully-oxygenated.

Figure 3. Secchi disk depths at Markham and Oakwood stations, 2019.



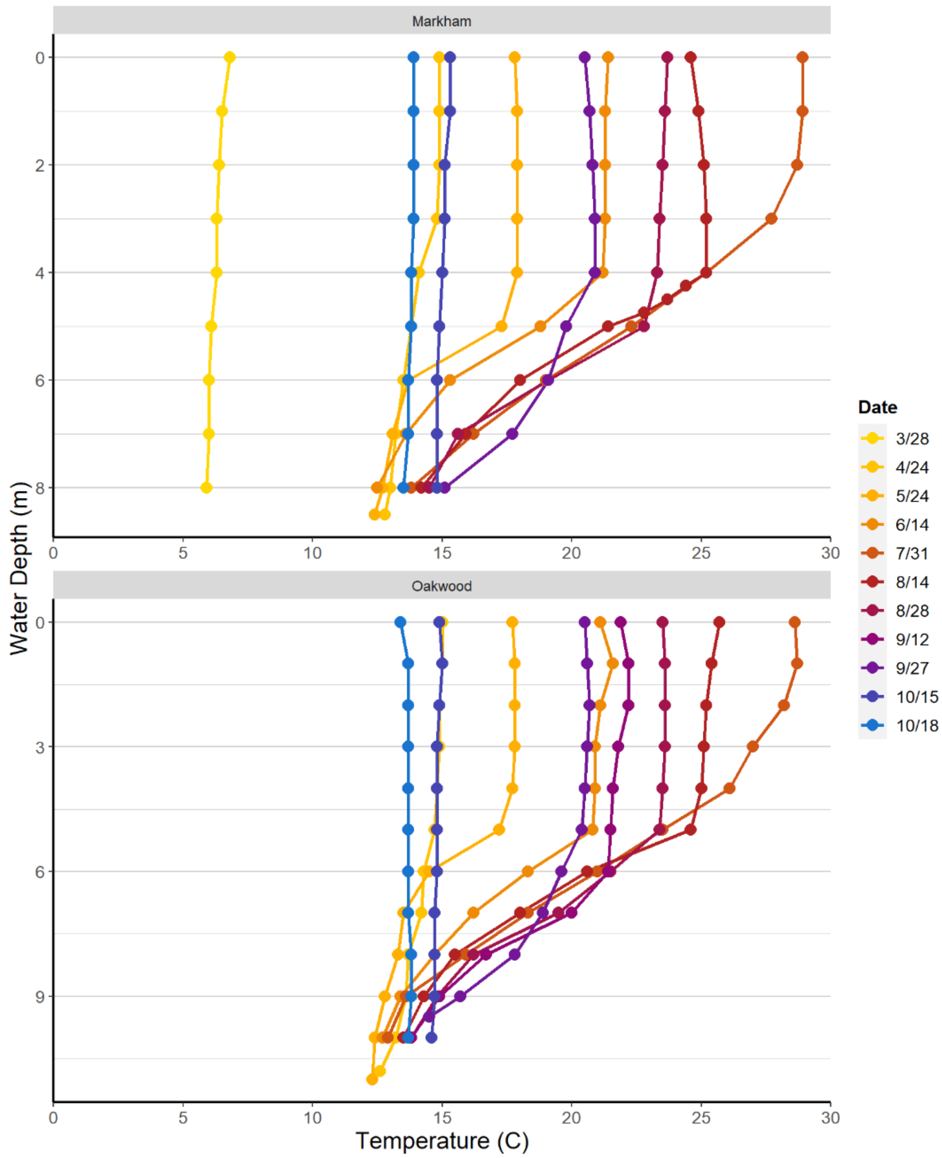
Water Temperature

Water temperature in lakes and ponds in the northeast follows a seasonal pattern of warming and cooling. As the sun's rays penetrate the water column during the summer, the water warms; but the depth extent of this warming is dependent on the water's clarity. Clearer water allows for more sunlight penetration and deeper water column warming.

The water column was thermally mixed in March (**Figure 4**). By late April, the water column was semi-stratified, with slight temperature variation along the water column. By May, a thermocline had developed at approximately 5.5 meters at both stations.

The top uppermost layer of the water column is known as the Epilimnion. Below the Epilimnion, the temperature decreases, and the temperature in the bottom water, known as the hypolimnion, remains cold through the summer due to stratification (or a lack of mixing) between the upper and lower layers of the water column.

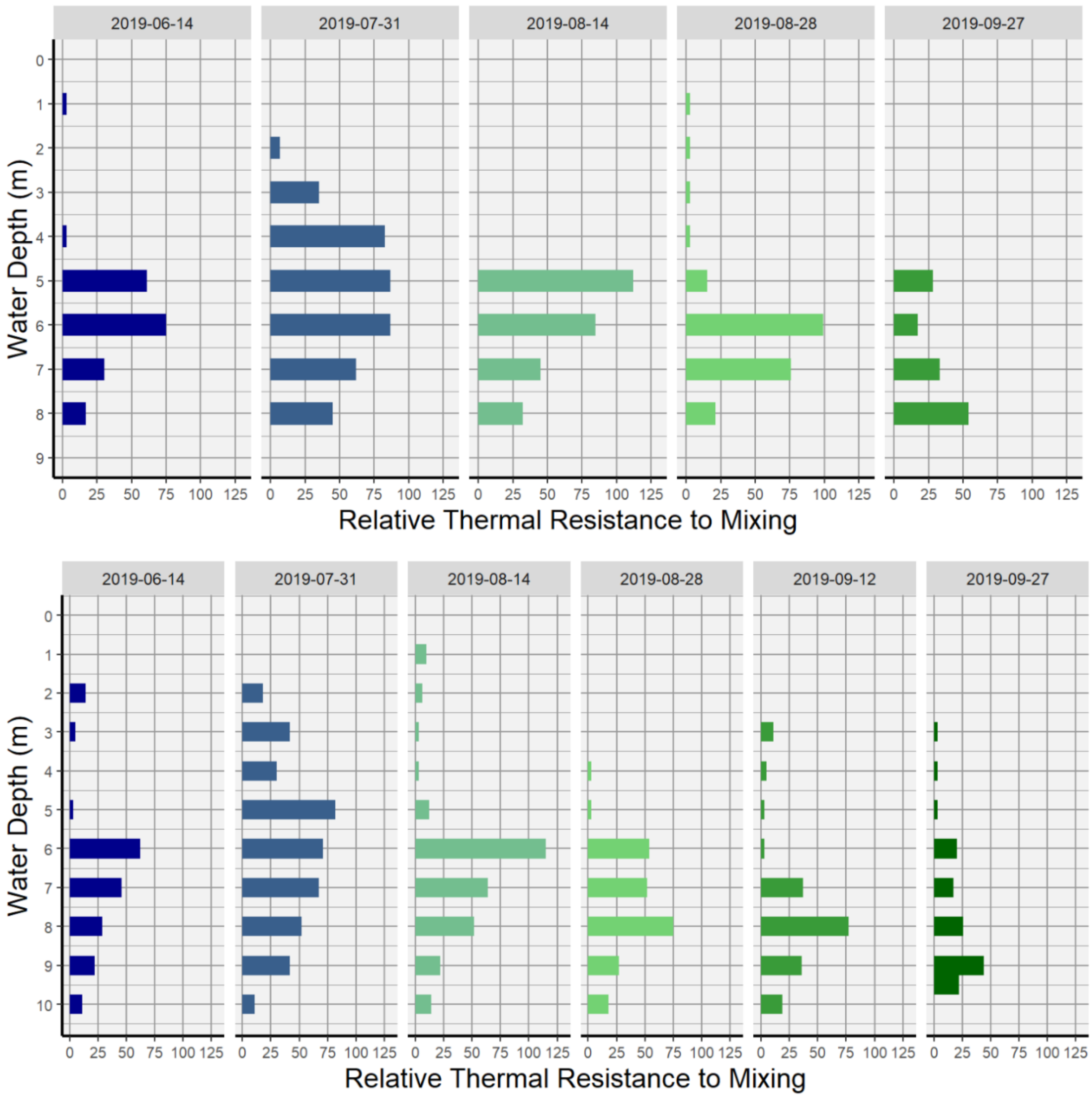
Figure 4. Water temperature profiles, Markham and Oakwood stations, 2019.



During the summer months, the lake was strongly stratified, as indicated by the Relative Thermal Resistance to Mixing (RTRM) values displayed in Error! Not a valid bookmark self-reference.. Relative Thermal Resistance to Mixing is a unit-less ratio that describes the difference in water density between each meter. Higher numbers indicate stronger thermal stratification, which is the result of warming surface waters being less dense than cold deeper water. RTRM values, displayed as horizontal bars in the figure, depict the amount of energy required to mix two adjacent waters of different temperatures or densities. Longer bars indicate progressively more energy required to mix the two layers of water.

The temperature within the Epilimnion began to decrease in August, until the water column returned to a fully mixed state at both stations by mid-October.

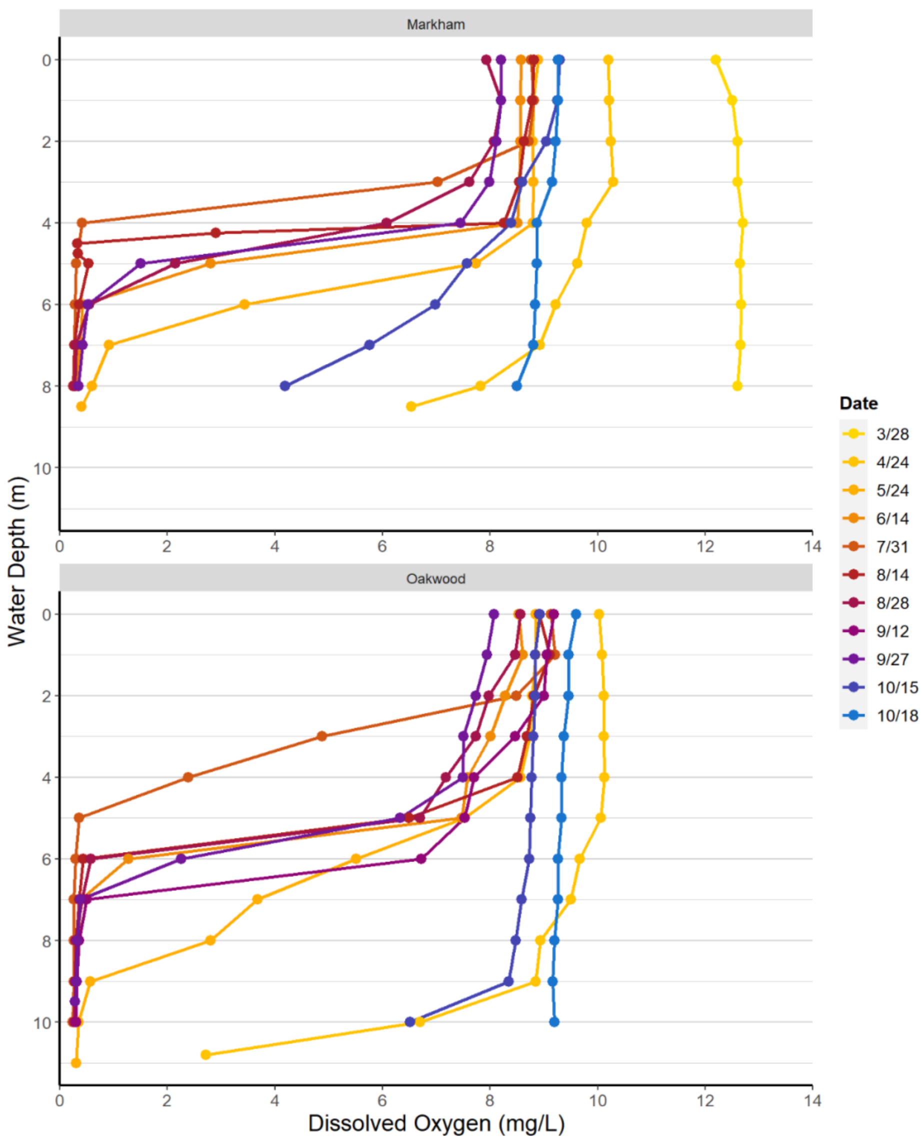
Figure 5. Thermal resistance to mixing in the water column at Markham and Oakwood stations.



Dissolved Oxygen

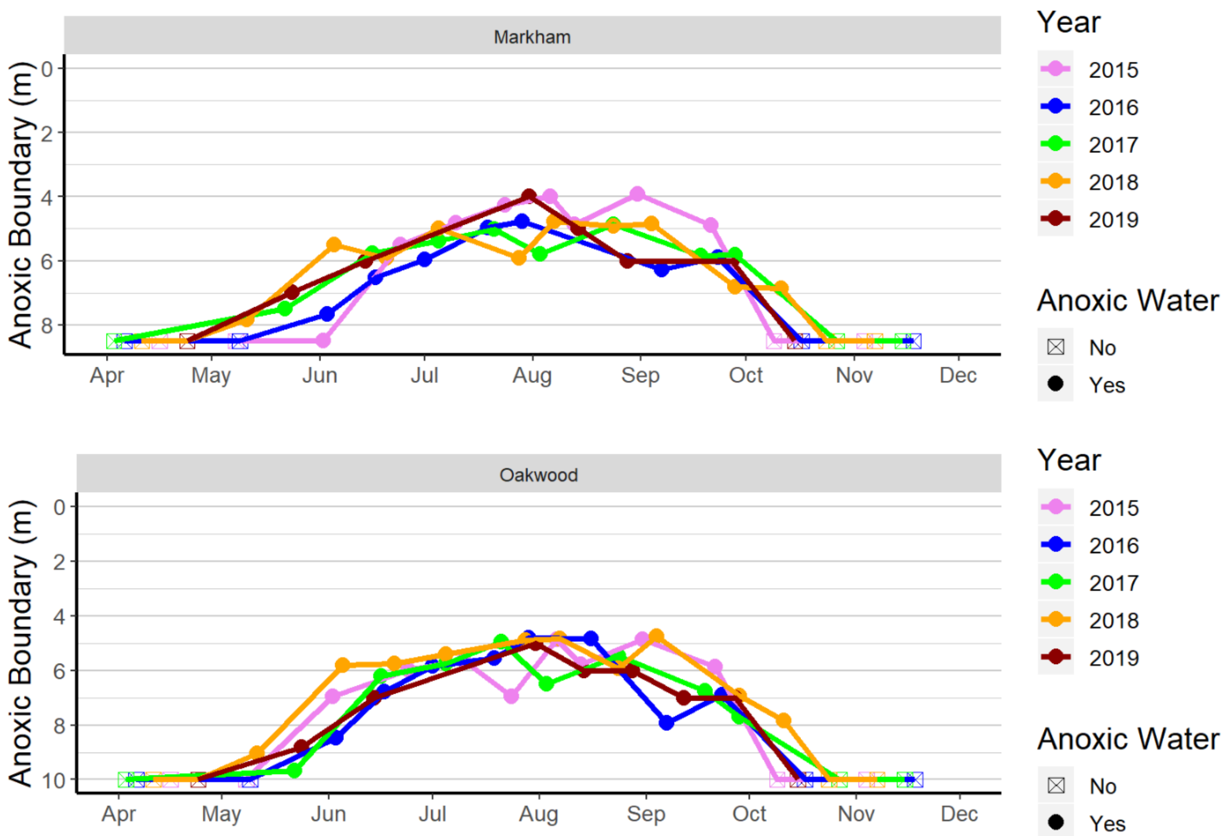
Dissolved oxygen (DO) in a lake is essential to aquatic organisms. At the surface of the lake, the water is in contact with the air, and atmospheric oxygen is dissolved into the water as a result of diffusion and wind mixing. As water mixing takes place, the dissolved oxygen is circulated throughout the water column. The decomposition of rooted aquatic plants and algae by bacteria requires dissolved oxygen (Biological/biochemical Oxygen Demand) and can deplete the oxygen levels in the bottom waters below the thermocline. This phenomenon leads to anoxic (<1 mg/L of DO) conditions in the deeper waters of Lake Pocotopaug for most of the summer season. As previously explained, the loss of oxygen in deep-waters allows for the release of previously iron-bound phosphorus, and also ammonia nitrogen, both of which contribute to cyanobacteria blooms. The 2019 seasonal oxygen patterns are displayed in **Figure 6**.

Figure 6. Dissolved oxygen profiles at Markham and Oakwood stations, 2019.



The anoxic boundary designates the point in the water column where there is no longer dissolved oxygen. The anoxic boundary begins at the lake bottom and rises as oxygen loss worsens through peak summer. The anoxic boundary rose to a maximum height for the 2019 season of 3.9 meters from the surface at Markham and 4.6 meters from the surface at Oakwood (**Figure 7**). The duration and height of the anoxic boundary in 2019 followed a similar trend as seen in recent years, although the anoxic boundary at Markham station did reach slightly higher in the water column than it had in the previous three years.

Figure 7. Anoxic boundary depths at Markham and Oakwood stations, 2015 – 2019.



Nutrient Results

Phosphorus and nitrogen are the two key nutrients that drive aquatic plant and algae growth in lakes. Nutrients can come from the watershed in the form of natural wetland inputs, septic leachate or leaking wastewater pipes, farm runoff, lawn fertilizers, and sedimentation from roads or streams. In freshwater systems, phosphorus tends to be the limiting factor for productivity and is more heavily monitored for the health of inland ecosystems. Lakes with very good water clarity usually have less than 10ppb of total phosphorus and less than 200ppb of total nitrogen (**Table 1**). Nutrient results are compared to identify patterns in internal sediment release versus external watershed loading.

Phosphorus

Total phosphorus (TP) at the top and middle of the water column ranged from 17ppb to 40ppb at the two stations for the entire season, and the bottom waters at both stations had high phosphorus during the summer (**Figure 8**, **Figure 9**). However, the difference in concentration in the bottom water at the two stations does not correspond with significant differences in concentration in the surface water.

TP concentrations in the bottom water at Oakwood station were on the high end of normal in most months, reaching concentrations around 350ppb in July, August, and September. At Markham, TP concentrations were more in-line with prior years.

Figure 8. Top and bottom total phosphorus concentrations at Markham and Oakwood stations, 2015 – 2019.

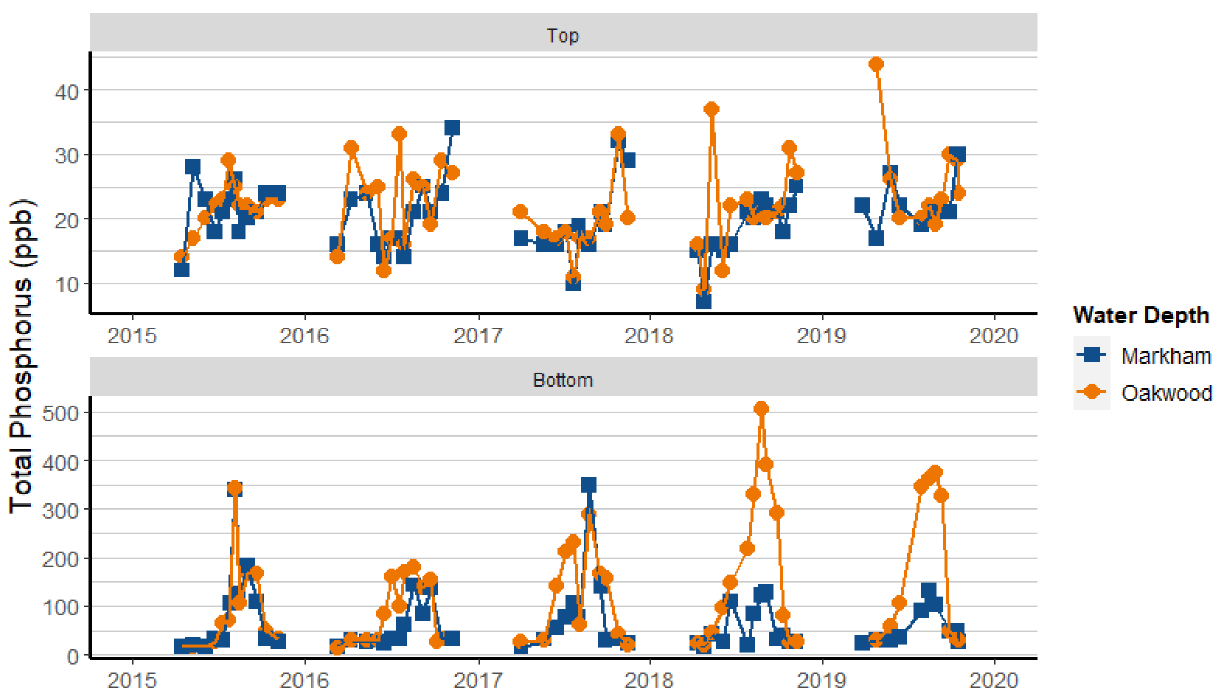
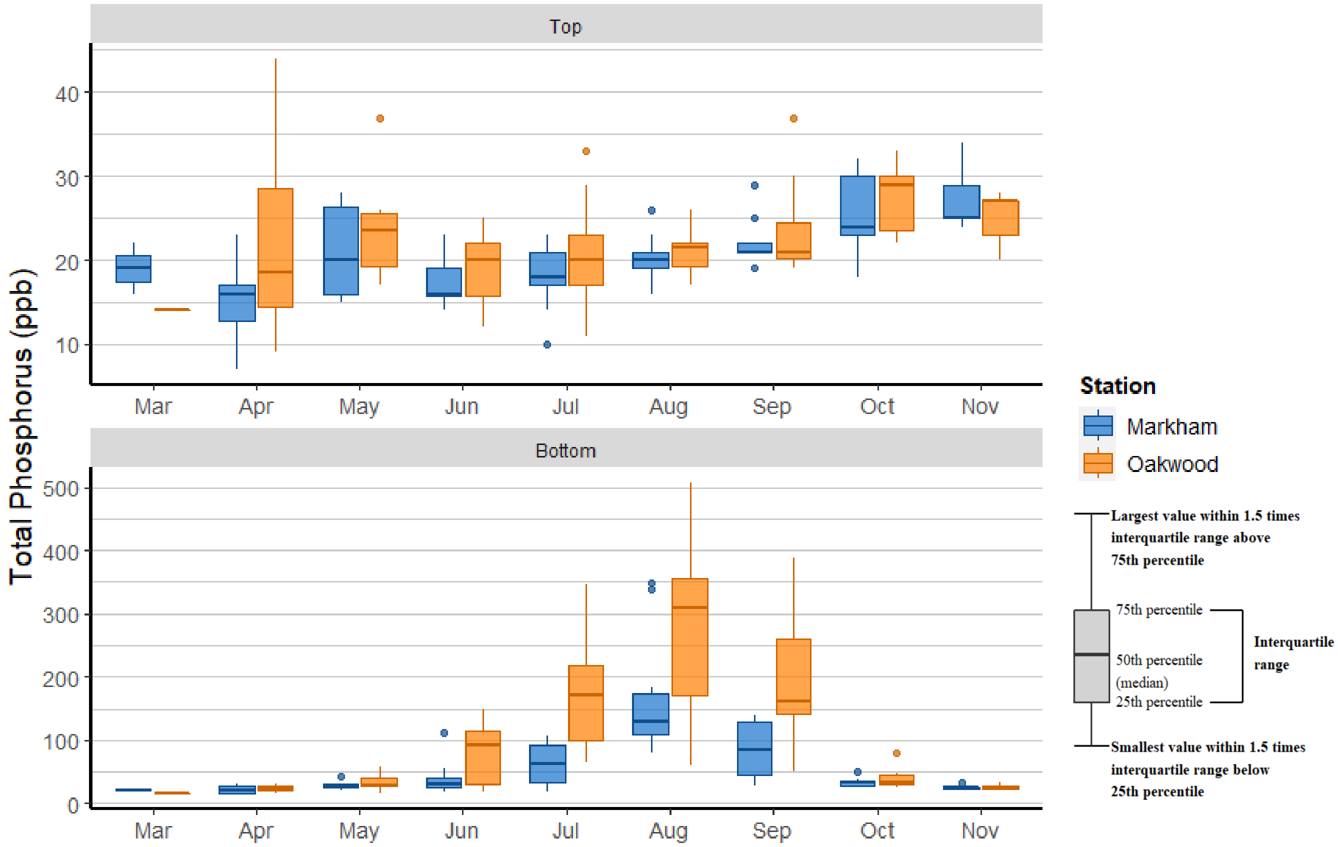


Figure 9. Markham and Oakwood station top and bottom TP concentrations. Outliers do not represent any single year.



Phosphorus Mass

Phosphorus reported in parts-per-billion (ppb) is a unit of concentration and, as such, is an intensive variable that is independent of the size of the water body. Concentration can be converted into Weight or Mass, that accounts for the total amount of P in the lake in kilograms (kg) by factoring in the volume of water that each sample represents.

Water samples were collected from Markham station at 1, 4, and 7 meters, while samples were collected from Oakwood station at 1, 5, and 9 meters. For the purpose of calculating lake-wide mass, the sampling depths of the two stations were combined and treated as one, integrated water column. This means the integrated water column mass model had nutrient data from 1, 4, 5, 7, and 9 meters. Both stations had data from 1 meter, so the 1-meter data from the two stations was averaged for each sampling date.

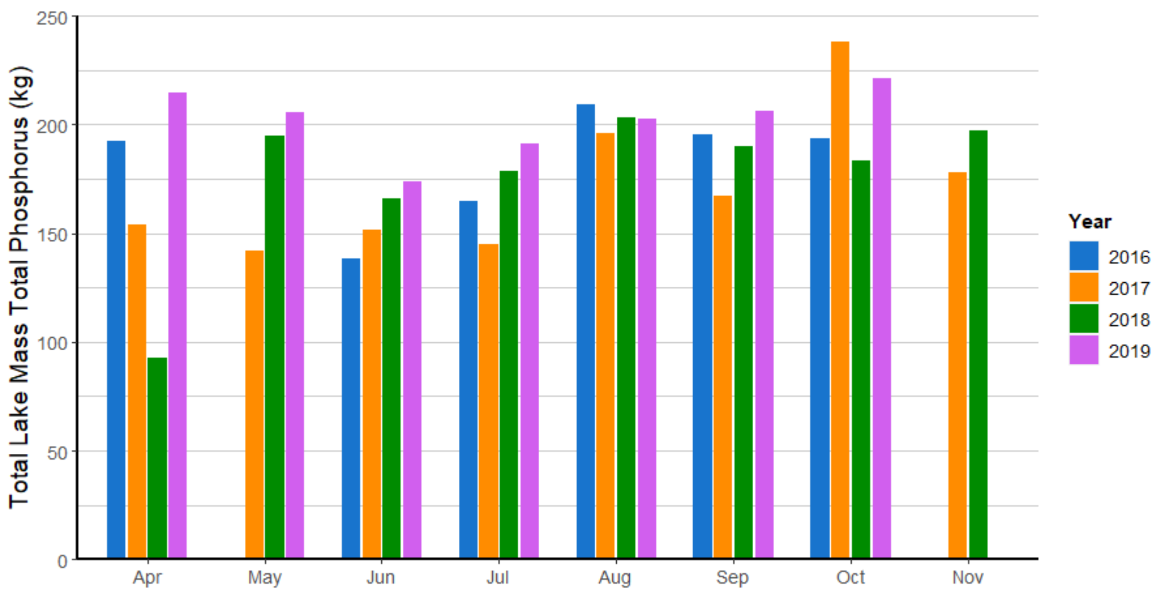
A morphometry table created from the lake's bathymetric contours was used to calculate the volumes of 3ft stratum from the surface to the bottom of the deepest point in the lake. These volumes were interpolated in the programming software 'R', to create an output of water volume for each 1-meter layer in the water column, from 1 meter to 10 meters.

To conduct the mass calculation for each data point, the volume was converted from acre feet to cubic meters. The nutrient concentration in milligrams/cubic meter was then multiplied by the volume in cubic meters to obtain nutrient mass, which was converted to kilograms.

Due to the lake's bathymetry, the vast majority of phosphorus in the lake is confined to the top approximately 3 meters of water, despite the very high concentrations in bottom waters during the summer. This is because the bottom waters represent a very small volume of water compared to the epilimnion. In most months, the total mass of lake-wide TP was higher in 2019, compared to the previous three years, with the most notable annual variance occurring in April and May, which can be attributed to watershed load variability from year to year (

Figure 10)[1].

Figure 10. Lake-wide total TP mass estimates, 2016 – 2019.



[1] Mass estimates utilize a similar, but slightly different model than the initial mass loading estimates from the 2017 report. The interpolation is a more detailed model, but yielded comparable results to those previously reported.

Nitrogen

For the entire 2019 season, Total Nitrogen (TN) was near or above 300 ppb at both the top and bottom of the water column (**Figure 11**). During the 2019 season, TN was recorded over 600ppb during three sampling events at Markham station (in July, August and October) and during four sampling events at Oakwood station (in July, August, September and October).

Total nitrogen in the bottom water peaks around September of each year, due to ammonia release from bottom sediments resulting from prolonged anoxic conditions in deep-waters. In the 2019 season, TN rose steadily over the summer months until reaching maximum concentrations of 2,644ppb at Markham and 3,304ppb at Oakwood in September. Based on historical data, when TN in the bottom water rises above ~1,300ppb, the Secchi disk depth does not exceed 1.5 meters (**Figure 12**).

By October, TN in the bottom water had decreased drastically at both stations, though it remained slightly elevated after fall turnover.

Figure 11. Total nitrogen concentrations at Markham and Oakwood stations, 2015 – 2019.

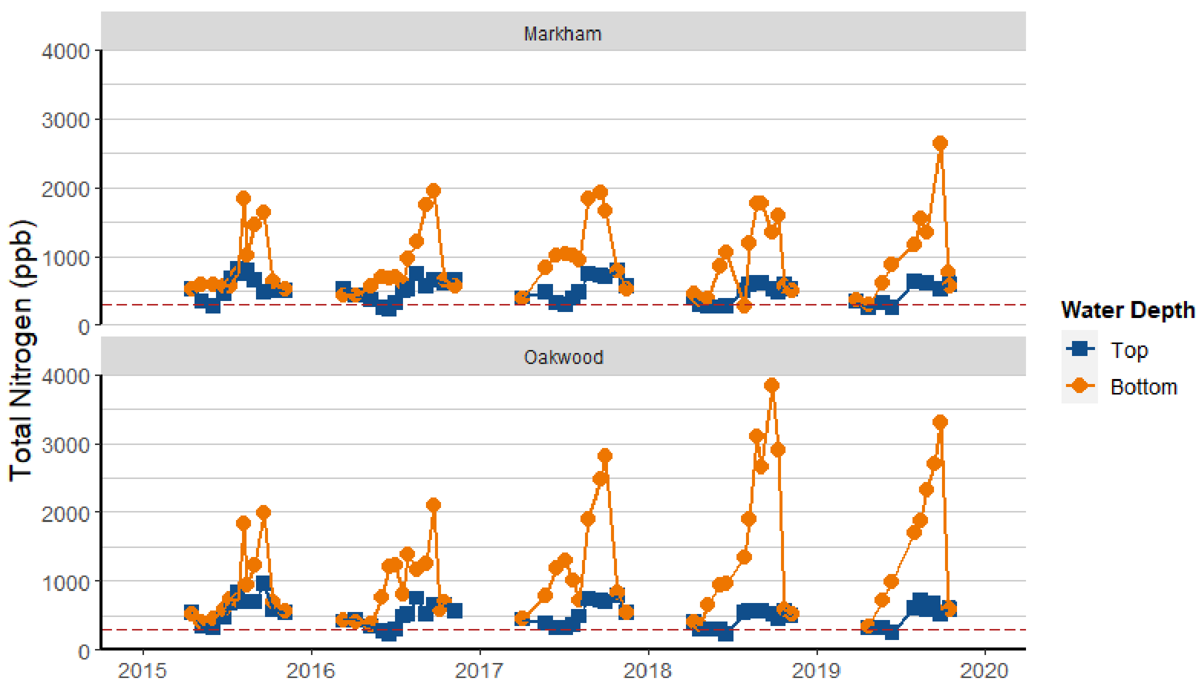
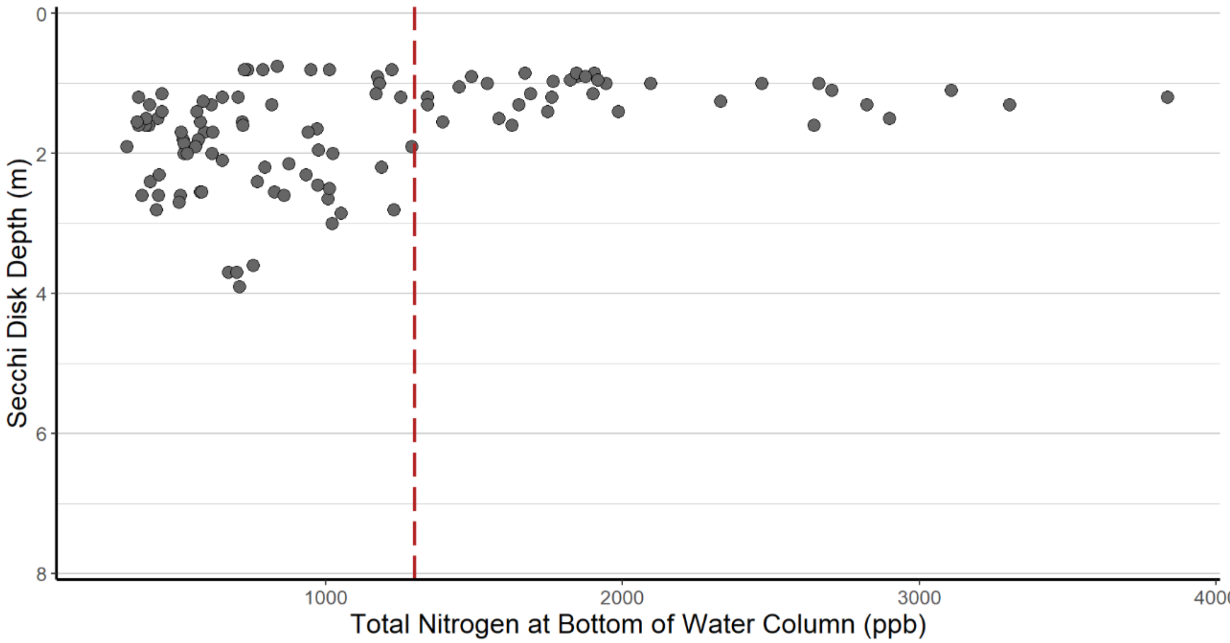


Figure 12. Correlation between water clarity and bottom water total nitrogen concentrations, 2014 – 2019. R-sq = 0.1546, p < 0.001.



Ammonia

Ammonia nitrogen (NH_3- as N) is a part of the Total Nitrogen measurement. Ammonia nitrogen is an inorganic form of nitrogen and its concentrations are strongly correlated with water clarity at Lake Pocotopaug. Ammonia in the bottom water increases in concentration over the summer season, until reaching maximum concentration in September (**Figure 13**).

In 2019, maximum bottom water ammonia was on the high end of normal, with concentrations of 3,240ppb and 2,480ppb at Oakwood and Markham, respectively. Ammonia concentrations at the top of the water column are significantly lower, rarely exceeding 50ppb from April through September (**Figure 14**). During fall turnover around October, nutrients from the bottom water mix throughout the water column, causing a spike in ammonia in the surface water.

Figure 13. Bottom water ammonia concentrations at Markham and Oakwood stations, 2015 – 2019.

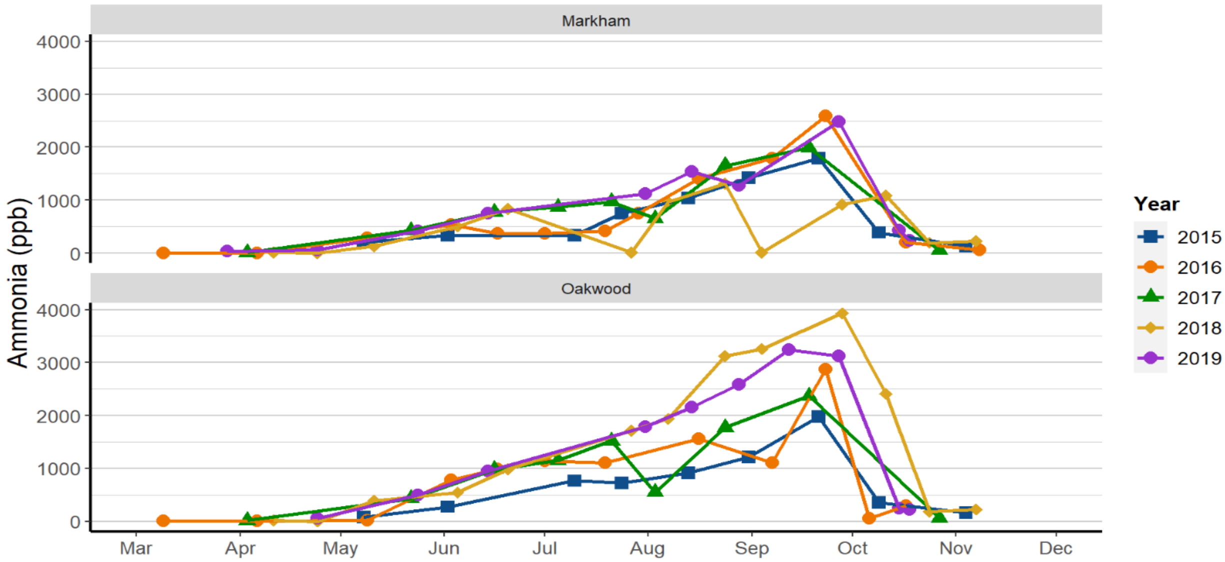
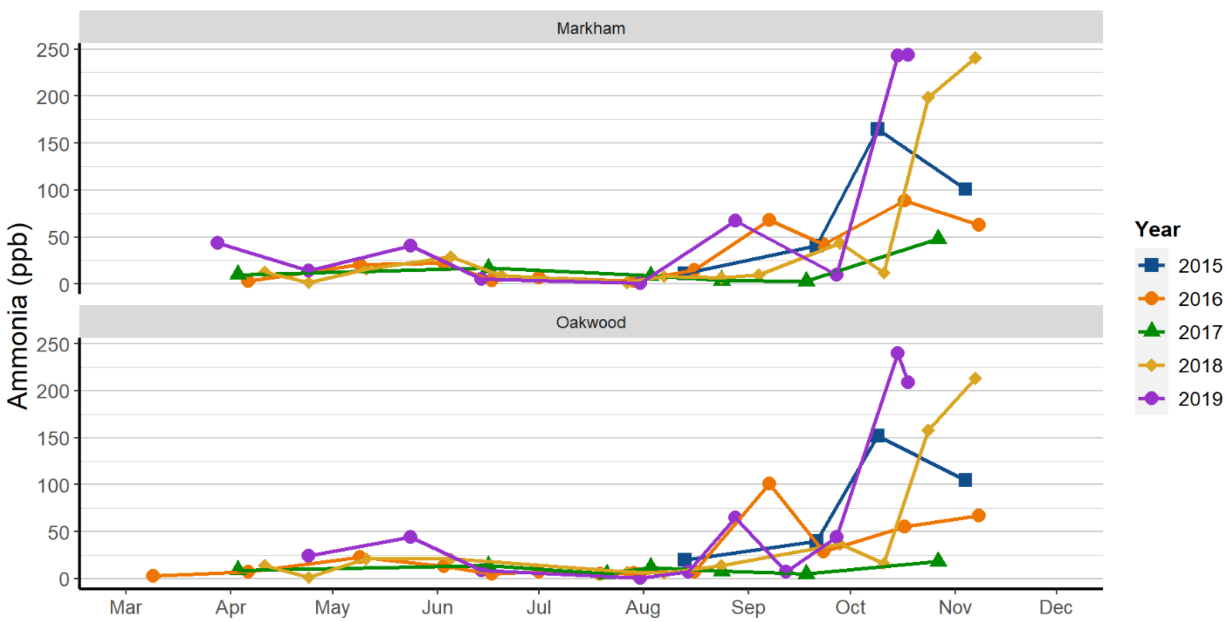


Figure 14. 1-meter ammonia concentrations at Markham and Oakwood stations, 2015 – 2019.



Cyanobacteria

Cyanobacteria numbers in Pocotopaug should ideally remain below 20,000 cells/mL. The upper tolerable level for cyanobacteria is 70,000 cells/mL, indicative that the lake has yet to reach CT Public Health Guidelines Visual Category 3 status. While the Category 3 status is a primarily a visual assessment, it is the cell counts that are used to remove any posted swimming advisories. The lake needs to have less than 70,000 cyanobacteria cells/mL for two consecutive weeks in order to remove a cyanobacteria health advisory, which is posted by the Chatham Health district and the Town.

The CT Department of Public Health and several local health districts across the state have been sending samples to Northeast Labs in Berlin, CT (not associated with Northeast Aquatic Research). To date, Chatham Health District has relied on Visual assessments to post cyanobacteria swimming advisories and has used the Northeast Labs cyanobacteria cell counts to decide when the health advisory should be lifted. Unfortunately, there have been multiple years of confusing results from the Berlin Northeast Labs, and in 2019 Chatham Health decided to split samples between the Berlin Northeast Labs, Northeast Aquatic Research, and a third party, Green Water Labs from FL. The 3-way split sample results from a sample collected by Chatham Health at Sears Park Beach on July 24, 2019 are included below. The results confirm that the Berlin Northeast Labs consistently underreports cyanobacteria in Lake Pocotopaug. While there was still roughly a 29,000 cells/ml difference between the Northeast Aquatic Research and Green Water Labs results, these counts were much more similar to one another. Generally, there is about a +/-25,000 cells/ml range in results that is within acceptable scientific accuracy for a scientist counting the same sample, which requires subsampling. That +/- range may be slightly higher if there are a larger number of cells in a sample, but the drastic difference in the cells reported by Berlin Northeast Labs compared to the other labs suggests that their results are simply inaccurate. For that reason, Chatham Health will continue to rely mostly on visual observations and documentation for the 2020 season.

Table 2 Three-Way Sample Split Cyanobacteria Count Results 7/24/19

Firm	Total Cyanobacteria cells/mL
Northeast Aquatic Research	234,490
Green Water Labs	263,612
Berlin Northeast Labs	83,000

The CT public health guidelines for cyanobacteria in recreational waters can be accessed at:

https://portal.ct.gov/-/media/Departments-and-Agencies/DPH/dph/environmental_health/BEACH/Blue-Green-AlgaeBlooms_June2019_FINAL.pdf

The guidelines provide a level of caution in the face of uncertainty. High toxins have never been found at Pocotopaug, but the cell counts suggest that there *could* be toxins and the CT public health guidelines are conservative. Toxin testing is expensive and usually has at least a four-day turn-around-time so it is not possible to rely on toxin tests alone. High toxins have been found in many lakes in CT with similar or better water quality than lake Pocotopaug. The Town of East Hampton should continue their public education efforts to notify residents of the current cyanobacteria levels so that residents can make their own decisions regarding recreational use of the lake during summer months.

Residents should also be aware that some genera of cyanobacteria have much smaller cells than others. Pocotopaug happens to be dominated by cyanobacteria that have very small cells relative to the size of some of the larger bloom and toxin-forming cyanobacteria. Cyanobacteria with smaller cell size are usually more efficient at regulating their buoyancy in the water column compared to some other larger-celled types. This is one of the reasons why Pocotopaug, despite very high cell counts, tends to not have thick surface scums of cyanobacteria. The species of cyanobacteria that form larger colonies more frequently lose control of their buoyancy and get stuck at the surface, thus they tend to be more susceptible to wind action and scum formation than the types of cyanobacteria that tend to dominate at Pocotopaug (in 2019: *Chrysosproum, Limnothrix, Planktolyngbya,* and *Planktothrix*).

The following results are from the Northeast Aquatic Research cyanobacteria cell counts. Figure 15 indicates where in the lake the sample was taken.

Cyanobacteria were scarce in May (**Figure 15**). From July through September, cyanobacteria counts were above the 70,000 cell/mL threshold at all stations sampled. Cyanobacteria reached a maximum concentration of ~850,000 cells/mL in mid-September (**Table 3**). At the Sears Park swimming area, cyanobacteria reached a maximum concentration of ~450,000 cells/mL in August. The large difference in cell counts between Sears Park Beach and the open water sites of Markham and Oakwood Bay are normal and not the same type of lab error as mentioned above. Samples collected at different parts of the lake will have different cell counts because of wind-action and dispersion or accumulation of cells at the surface. Some other CT lakes that monitor for cyanobacteria take three samples weekly to monitor the variability within the lake.

The remaining non-cyanobacteria phytoplankton groups were present in much lower quantities relative to cyanobacteria (**Figure 16**). Dinoflagellates are not included in the following analyses but were present in minimal quantities or not found in 2019.

Figure 15. Cyanobacteria counts at Markham, Oakwood, and Sears Park in 2019.

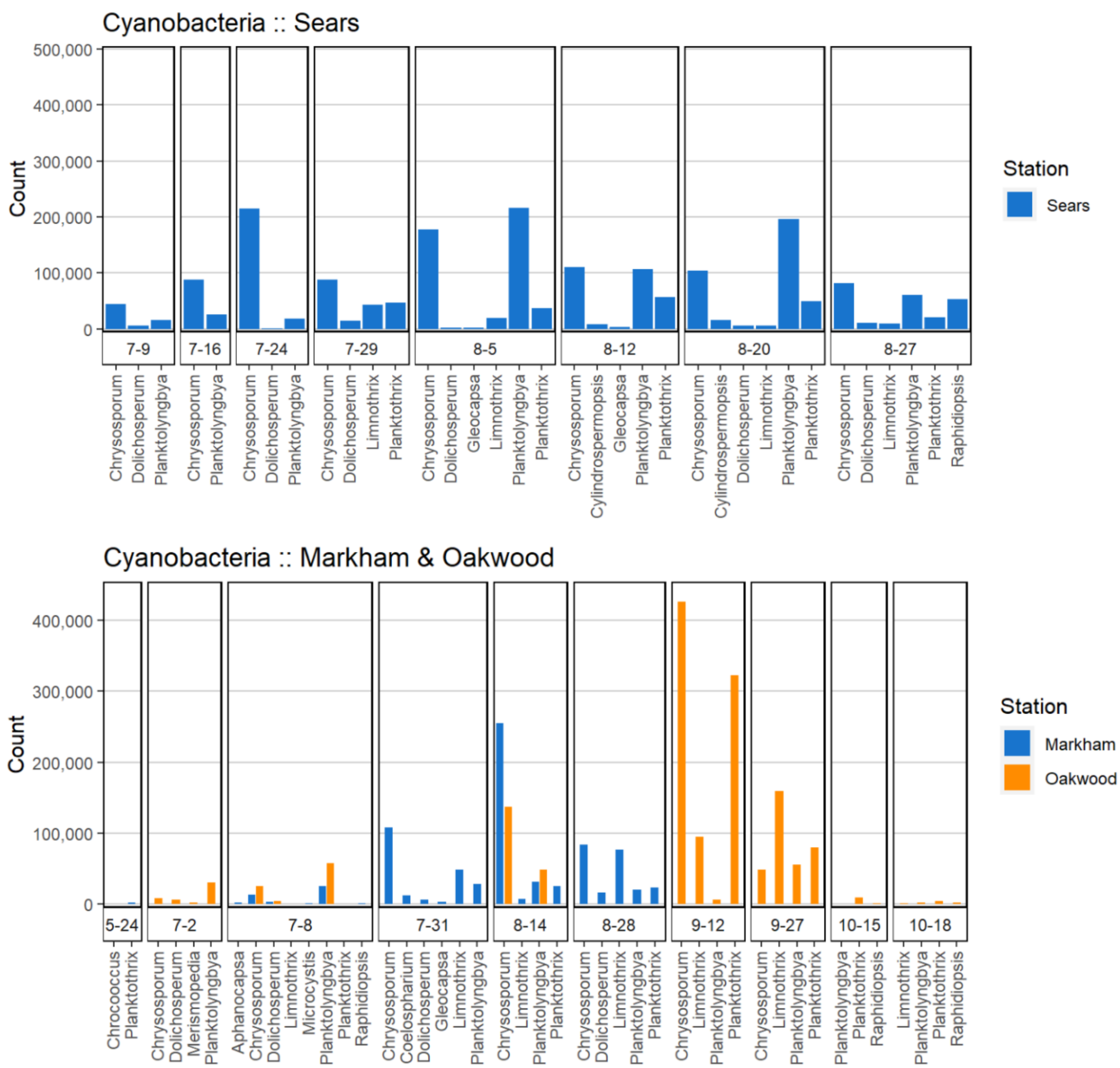


Table 3. Cyanobacteria counts at Markham, Oakwood, and Sears Park in 2019.

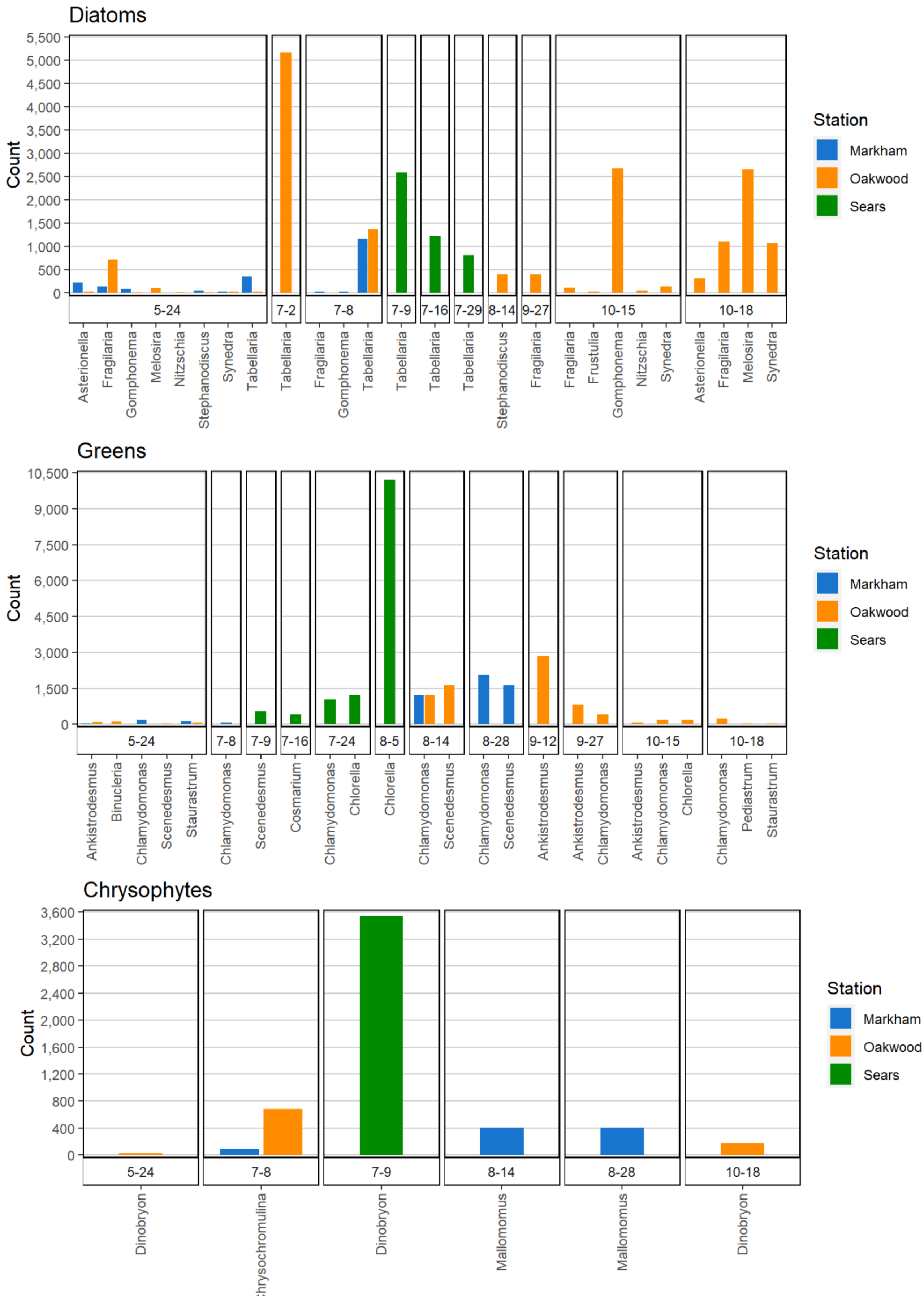
Markham	
5/24/2019	2,216
7/8/2019	47,639
7/31/2019	207,755
8/14/2019	319,183
8/28/2019	219,592

Oakwood	
5/24/2019	44
7/2/2019	46,938
7/8/2019	87,755
8/14/2019	185,306
9/12/2019	850,205
9/27/2019	342,449
10/15/2019	10,029

Sears	
7/9/2019	65,578
7/16/2019	113,605
7/24/2019	234,490
7/29/2019	192,857
8/5/2019	454,287
8/12/2019	284,489
8/20/2019	376,530

10/18/2019	9,476		8/27/2019	234,694

Figure 16. Diatom, Greens, and Chrysophyte phytoplankton alae counts in 2019.



Inlets & Watershed Updates

Inlets and storm-drains around Lake Pocotopaug have been sampled periodically during precipitation events since 2014. Analysis of the data collected from 2014 through 2016 is included in the Lake Pocotopaug 9 Elements Watershed Based Plan.

In 2019, inlet sampling was conducted in January, April, and June. The April and June samples measured baseflow conditions. Additionally, a groundwater well seep in the lake's northeast corner was sampled in August, and stormwater flow was sampled next to the Sears Park boat launch in September. This Sears Park boat launch sample had very elevated TP (790ppb), as a result of the runoff having flowed through the dirt parking lot prior to entering the lake. Eroding soil has very high phosphorus. The Sears Park parking lot reconstruction project scheduled for 2020 aims to diminish the amount of runoff and to reduce the nutrient content flowing to the lake. In January, April, and June, several inlets had total nitrogen concentrations exceeding 500ppb.

The Town continues to move forward with allocating 319 grant funding towards watershed improvement projects incorporated into the Phase I 319 Watershed Based Plan Implementation. Stormwater improvement projects scheduled for construction in summer 2020 will take place at the following locations:

Clark Hill Road
Boulder Road
Mott Hill Road
Baker Hill Condominiums
Skyline Estates
Seven Hills Estates
Wangonk Trail Beach catch basin
South Wangonk Beach
Sears Park Swale
Sears Park Secondary BioSwale
Sears Park PVC permeable pavers
Sears Park Areas A,B,C
Hawthorne
Sears Place
West Point

For more updated information and plans for each of these projects please contact the Town of East Hampton Land Use Department.

Figure 17. Locations of inlets sampled in 2017, 2018 and 2019.

In addition to the Phase I Watershed Improvement Projects, the Town has submitted another Clean Water Act Section 319 grant application to the CT Department of Energy and Environmental Projection for the hopeful completion of four large stormwater projects at the following locations:

1. Christopher Brook Pond - Wetland Filtration Enhancement Project

2. O'Neil's Brook Created Wetland Filtration System and Plan for Nutrient Reduction Best Management Practices at upstream Plant Nursery

3. Fawn Brook Raised Culvert and Wetland Improvement, in partnership with Middlesex Land Trust

4. New Town Hall Stormwater Detention Pond – maximize stormwater holding and treatment capacity

Lake Management Discussion

At the time of this report preparation, an aeration project is fully underway at Lake Pocotopaug. The aeration project came about because residents hope to improve the lake's water quality by directly increasing oxygen conditions at the lake bottom. The aeration project was brought to the Town's attention by the Lake Pocotopaug Project, a local environmental conservation organization that is active with many residents in the East Hampton community, and members of the East Hampton Conservation Commission. The idea of adding air to a lake bottom is not new, and the Town of East Hampton has considered aeration projects in the past but historically decided that an aeration system was too costly and infeasible for such a large lake. Similarly, the in-lake and watershed monitoring work completed in the last ten years all points to the fact that watershed loading is a considerable source of nutrients to the lake.

Yet, because cyanobacteria conditions at the lake continue to deteriorate and have resulted in swimming advisories for multiple weeks a year, residents felt strongly that the internal nutrient load must be addressed concurrently with the watershed improvement projects. The community understands that watershed improvement takes much longer to control cyanobacteria compared to in-lake nutrient management techniques. Thus, the aeration project gained public support and the project was approved by the Town Council in early 2020.

There are various types of aeration and/or oxygenation systems that can be used and we felt that it was our responsibility, as the Town's lake management consultant, to voice initial concerns over the type of aeration system and the additional proposed 'bio-blast' treatment, as advertised by the selected contractor, EverBlue Lakes. Our intention was not to outright oppose a lake aeration system, we simply wanted to explain to residents that there are various types of systems and various ways aeration technologies aim to achieve cyanobacteria control.

Ultimately, the system chosen for Lake Pocotopaug is a destratification aeration system. Compressed air will be pumped into as many as fifty air diffuser plates placed on the lake bottom, in both deep basins. Air lines lying on the bottom of the lake will deliver pressurized air from the shore compressors to the diffusers where the air is released to return to the surface as a bubble train. Compressed air only has 21% oxygen, which is the difference between an aeration versus an *oxygenation* system. *Oxygenation* is the term used for delivering higher oxygen content gas to the lake bottom. Some oxygenation projects use liquid oxygen in order to get 100% oxygen delivery. Many aeration projects aim to reduce bubble size in order to increase oxygen transfer.

The term *destratification* implies that the goal of the aeration system is not just to add oxygen to the lake bottom. Instead, destratification systems use the compressed air to create a stream of rising bubbles that artificially form upwelling currents. While the compressed air itself does not efficiently transfer oxygen to water, the current creation allows for artificial mixing of the water column and brings the deep-water to the surface. This deep water is cold compared to the surface water, and due to higher density of colder water, the water will eventually travel back down. The cold water brought to the surface will form currents across the lake surface until reaching the edge of the bubble streams, where it will return to the bottom. The currents of bottom water seeking the edge of the upwelling will gain dissolved oxygen from contact with the atmosphere. In this way the returning water has more dissolved oxygen than when initially lifted to the surface.

The continuation of the process throughout the season allows creation of an artificial current in the lake from top to bottom, which will eventually distribute heat energy throughout the water column, instead of it accumulating at the surface above the thermocline per usual. All the heat the lake gains from now on will be distributed to all depths in the lake instead of just in waters above the natural thermocline of the lake. By disrupting the thermocline during the summer, atmospheric oxygen can be mixed to the bottom due to increased circulation and diffusion of atmospheric oxygen into the water while it's at the surface. The mixing then allows for atmospheric oxygen to be constantly delivered to the lake bottom to hopefully overcome sediment oxygen demand, thus simulating the natural conditions of spring and fall lake turnover, which is when the bottom of the lake naturally regains oxygen. A key difference than the overturn during spring and fall, however, is that instead of normal mixing occurring when the water is very cold, this artificial mixing occurs when the lake water is the warmest for the season. The increased water temperatures at the lake bottom may cause a dramatic increase in respiration rate of sediment bacteria. This will result in the release of much higher rates of anaerobic respiration by-products: ammonia, iron, manganese, sulfide, and methane.

An additional potential benefit of a destratification system is that the mixing of lake water may also allow other non-cyanobacteria algae to out-compete cyanobacteria. Diatom and green phytoplankton algae prefer the active mixing of the water column, while cyanobacteria are specially adapted to thrive while the lake is stratified. Therefore, a destratification system may push the lake into being dominated by another form of algae instead of cyanobacteria but not necessarily improve clarity. However, there are also multiple potential problems that can arise from improper use of destratification aeration systems.

Our initial hesitation around the destratification system was because Lake Pocotopaug has extremely high concentrations of nutrients in the lake bottom, and it is a common symptom of undersized destratification aeration systems to accidentally mix high-nutrient waters from the bottom to the surface, where algae are more readily able to use those nutrients. This usually happens when a destratification system is turned on too late in the season. If a destratification system were to be started late in the summer, the result could be to bring very polluted water to the surface, releasing noxious odors from built up hydrogen sulfide gas. Similar issues can arise if the system were to stop working for a week or two and then be turned back on. The best-case scenario would be if the system were turned on before June, but that is not possible in 2020 due to project logistics.

Overall, the destratification system at Lake Pocotopaug will be one of the state's largest lake management projects. Water quality data collection will continue throughout 2020 and it will be very interesting to see if the destratification aeration system prevents cyanobacteria blooms as intended. Data will be tabulated and presented in the 2020 water quality monitoring report. Data summaries will be provided monthly for the 2020 summer season.