Citizen-Led Environmental Observatory (CLEO)

At Lake Lillinonah

2018 Annual Report

FRIENDS OF THE LAKE

Fairfield UNIVERSITY

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Questions/Comments?

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Acknowledgements

The Citizen-Led Environmental Observatory (CLEO) at Lake Lillinonah is sustained by the volunteers who have dedicated their time and effort to the program. Special thanks go to the 2018 monitors: the Boodry Family , Ken Dougherty, Greg Bollard, the Marcus family, Rebekah White, and Kendra Kilson. This program could not function without you!

CLEO is funded by Friends of the Lake and the Fairfield University Biology Department.

Thank you to Rebekah White who runs the volunteer training program and manages the summer data collection.

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2. Executive Summary

The Citizen-Led Environmental Observatory (CLEO) was established in 2006 to monitor water quality on Lake Lillinonah, an impoundment on the Housatonic River, located in western Connecticut. The goals of the program are to

1) Provide credible information on water quality conditions to state and local agencies
2) Educate the public on water quality issues
3) Build a constituency of involved "citizen scientists".

The purpose of this report is to present the data collected during the summer of 2018. A brief summary of water quality conditions is presented here in the executive summary. The methods of collecting and results involving the data are presented in the main body of the report.

Across all sites, water temperature followed a seasonal pattern with the water warming sharply in June and peaking in early July. There was a second warming period in early August and a third warming period in September. Most sites in 2018 had average secchi depth between 1.0-2.0 meters making most of the lake qualify as eutrophic, except at one site where it classifies as Late Mesotrophic. In 2018, recreation potential related to algae growth was worse than 2017 with more days recorded as "minor aesthetic problems" or "recreation impaired", and a few days recorded as "recreation impossible". Surface algae varied greatly depending on the location in the lake. Percentage of days with surface algae varied from 7% to upwards of 60% depending on location.

In 2018, there were several severe algal blooms reported during August and September. These blooms represent the worst water quality of the year and had levels of microcystin at or above the recreational guideline set by the CT Department of Public Health.

Many CLEO volunteers made notes related to growth of Eurasian water milfoil, an invasive aquatic plant. These notes, combined with observations from other lake stakeholders, show increasing recreational impairment due to aquatic plants.

We recommend continued monitoring to track changes in water quality over time. Based on previous work on Lillinonah (Klug and Whitney 2015), we recommend stakeholders continue to emphasize the importance of decreasing nutrient loading from the upstream watershed as well as shoreline sources such as lawn fertilizer and septic systems. Reduced nutrient input should help alleviate growth of both algae and aquatic plants. In addition, we recommend that stakeholders continue their outreach to lake users cautioning them to minimize contact with surface blooms of algae.

3. Introduction

Lake Lillinonah was created in 1955 as a result of the construction of the Shepaug Dam whose purpose was to pond water for hydroelectricity generation. Lake Lillinonah extends 12 miles in West Central Connecticut and is surrounded by six towns: Bridgewater, Brookfield, New Milford, Newtown, Roxbury and Southbury. Since its creation, Lake Lillinonah has been a eutrophic system, with high nitrogen and phosphorus concentration and large summer algal blooms (Klug and Whitney 2015). Lake Lillinonah's watershed is large and as such the point and non-point sources of nutrient input to the lake are numerous. Summer algal blooms can be severe enough to impair recreation and create an oxygen depleted environment in deeper parts of the lake. Additionally, there is increasing concern that secondary compounds produced by certain algal groups may pose a danger to dogs and humans using the lake (CTDPH and CTDEEP 2013).

The Citizen-Led Environmental Observatory (CLEO) was established in 2006 to monitor water quality in Lake Lillinonah. Friends of the Lake (FOTL), a non-profit organization along with faculty and students from Fairfield University's Biology Department jointly manage the monitoring program.

Friends of the Lake is a volunteer based organization that encourages "citizen scientists" to provide water quality information to state and local organizations and to educate the public. The primary goals of the organization are as follows;

1) To increase the recreation potential for those who use the lake
2) To work towards having the lake meet the standards of the Clean Water Act
3) To implement long-term environmental goals that protect the lake and its watershed.

FOTL works closely with many local and federal organizations including Lake Lillinonah Authority, CT Department of Energy and Environmental Protection, the Housatonic Valley Association, United States Geological Survey, Environmental Protection Agency, Global Lakes Observatory Network, First Light Power Resources and Federal Energy Regulatory Commission. Through these relationships, they hope to promote community awareness about lake pollution and debris issues. They welcome membership from those who are eager to help protect the lake. More information about Friends of the Lake can be found at www.friendsofthelake.org.

4. Methods

Volunteers collect data from dock locations on water temperature, secchi depth, water color, debris, recreation potential, trash, particle type and surface scum from Memorial Day through Labor Day. To facilitate comparison among sites and because values of many of the variables may change throughout the course of the day (e.g. temperature), data are collected between 3:00pm and 7:00pm. In addition, volunteers collect water samples for chemical analysis of total phosphorus, total nitrogen and algal toxin concentration. Detailed methods are presented in the individual variable sections. A copy of the data sheet used by volunteers is provided in Appendix A.

Volunteers are required to attend a training session each spring. In the classroom portion of the training session, volunteers are educated on proper technique for recording each measurement and on the basic ecological meaning behind each variable. In the field component of the training session, volunteers practice taking each measurement. In addition to the training program, program managers maintain contact with volunteers through email and occasional group meetings and presentations. Volunteers return their completed data sheets to Jen Klug via email, postal mail or in person. Fairfield University interns or research students enter the data and data analysis is completed by Fairfield University faculty and students. Results are compiled into an annual report and distributed to all interested parties.

For categorical variables (e.g. recreation potential, surface algae, color, debris, and trash) we calculate the % of total monitored days falling in each category. For continuous variables (e.g. secchi depth) we present an average and time series for each site. In addition, we use a trophic status rubric published by the Department of Energy and Environmental Protection (DEEP) to classify sites based on total nitrogen, total phosphorus and secchi depth (Table 1, CTDEP 1991). The DEEP categories are oligotrophic, early mesotrophic, mesotrophic, late mesotrophic, eutrophic and highly eutrophic and represent the degree to which a lake is impaired due to excessive nutrient loading and/or poor water clarity.

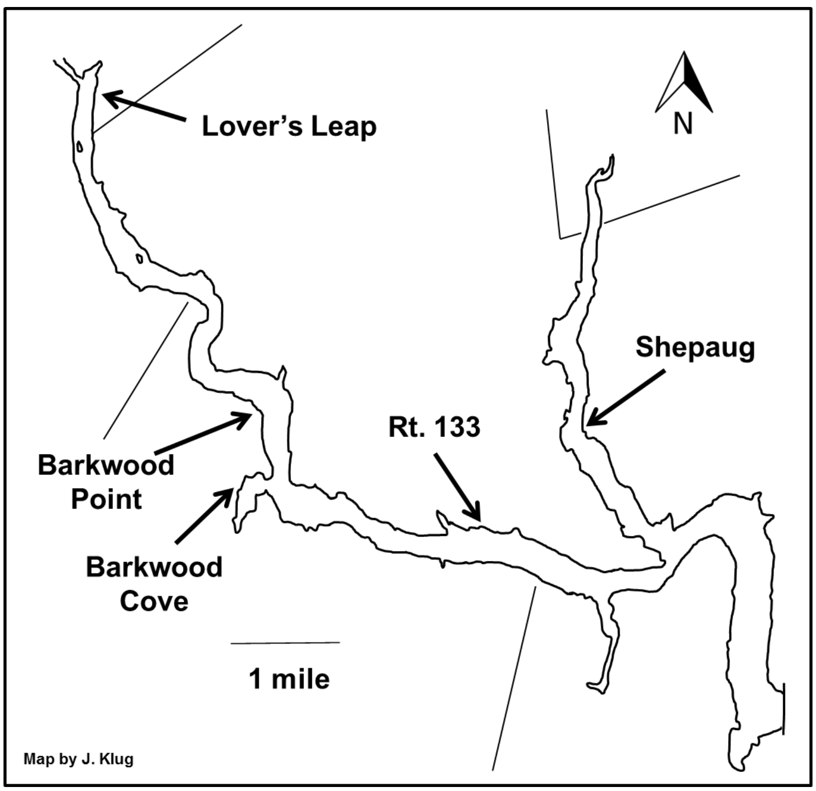

Figure 1: 2018 Site Locations on Lake Lillinonah

In 2018, there were five dock sites (Figure 1) on the lake and there were 1-3 volunteers at each dock. Data was recorded throughout the week. Some volunteers chose to record data more frequently and/or beyond the required Memorial Day through Labor Day timeframe. For the purpose of comparability across sites, summary data includes only the data collected from Memorial Day to Labor Day, May 28, 2018-September 3, 2018. The total number of days that data was collected at each site and the number of days that data was collected from Memorial Day to Labor Day is listed in Table 2. Water samples for nutrient concentration and algal toxin concentration were collected according to the schedule listed in Table 3.

Table 1: DEEP Water Quality Classification for Trophic Status

	Oligotrophic	Early Mesotrophic	Mesotrophic	Late Mesotrophic	Eutrophic	Highly Eutrophic
Secchi Depth (m)	>6	>4-6	>3-4	>2-3	>1-2	<1
Total Nitrogen (µg/L)	0-200	>200-300	>300-500	>500-600	>600-1000	>1000
Total Phosphorus (µg/L)	0-10	>10-15	>15-25	>25-30	>30-50	>50

Table 2: Number of Days Data was Collected and Number of Days from Memorial Day to Labor Day 2018

Site	Number of Days Data Collected	Number of Days Memorial Day-Labor Day
Barkwood Point	54	42
Rt 133	105	86
Shepaug	56	47
Barkwood Cove	36	35
Lover's Leap	39	34

Table 3: 2018 Water Sample Collection Dates.

Up to three extra toxin samples were collected during algal blooms.

Date	Nutrients	Toxins
May 19	X	X
June 2	X	X
June 16	X	X
June 30	X	X
July 14	X	X
July 28	X	X
August 11	X	X
August 25	X	X
September 8	X	X
September 22	X	X

5. Water Temperature

Water temperature in a lake is important in understanding the types of organisms that can survive, their biological activity and the amount of oxygen available (Dodds 2010). Predictable temperature changes occur at different depths of the lake, at different times of the day and at different times of the year. Water temperature is positively correlated to an increase in algal growth, as higher temperatures are optimal for algae growth. Related to this, water temperature affects the amount of oxygen that is available for organisms to use. As temperatures become warmer, the amount of available oxygen decreases because warm water holds less oxygen than cold water. Finally, temperature monitoring can be especially important in understanding the impact of storms and any other unusual weather patterns.

At the beginning of the summer, the volunteer tied the provided thermometer to the dock so that the bottom of the thermometer was 1 meter below the water. Throughout the summer, once a month, the volunteer checked the depth of the thermometer to make sure that it was still at 1 meter. When sampling, he or she pulled the thermometer up and recorded the temperature to the nearest 0.5 degree Celsius. The volunteer quickly recorded the reading because of the temperature change that occurs once the thermometer is taken out of water.

Water temperature peaked at all sites by the third week in July. Temperature fell sharply in late August but warmed again in mid-September (Figure 2). During the period from Memorial Day to Labor Day, the temperatures ranged from a minimum of 18.0℃ (at Lover's Leap) to a maximum of 31.0℃ (at Barkwood Point).

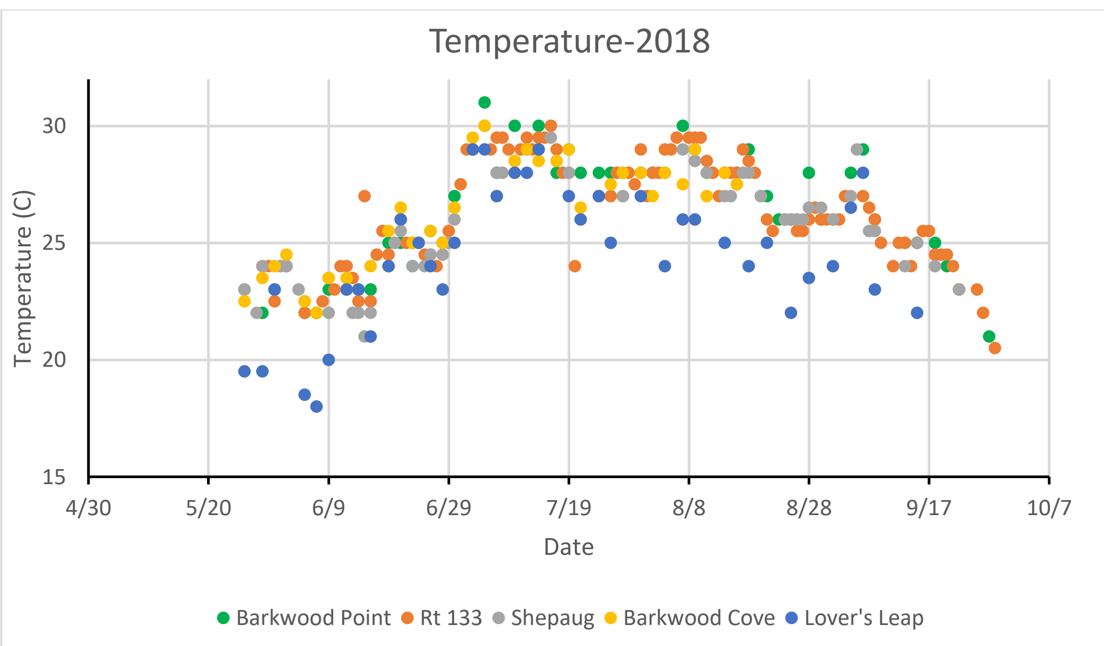

Figure 2: Water temperature across all sites

6. Secchi Disk Depth Monitoring

Secchi disk depth is a common measure of water clarity. It is directly related to the presence or absence of algae and other particles such as sediment. This is due to the fact that when light enters a lake, it can either be transmitted, absorbed or reflected. Light is reflected off and absorbed by particles and as the number of particles increases, less light will be transmitted (Dodds 2010). Consequently, a lake with more particles has lower secchi depth. Secchi depth can help interpret information regarding particle content and recreation potential. Additionally, water color can be important in determining if algae or silt is the main factor behind a lower secchi depth. Changes in secchi depth follow seasonal changes that are most closely coordinated with temperature and algal growth. Typically, as the weather gets warmer in the summer, secchi depth decreases. It is generally lowest in mid-summer and then slowly begins to increase in the fall.

When taking a reading, the volunteers stood on the dock and lowered the secchi disk over the shady side of the dock. They slowly lowered the secchi disk into the water until they could no longer see it (no white glow). They then lowered it a little further and raised it to the point of which the white just reappears. The disk was slowly pulled up and down until the exact disappearing point was reached. The volunteers leaned over to see the disk but did not kneel or sit until they were ready to mark the rope. They then used their fingers to pinch or clip a clothespin to the rope at the point at which the rope hits the water. They pulled the disk up and recorded the depth to the nearest ¼ meter. They also noted whether the secchi disk hit the bottom of the lake and what depth it hit.

In 2018, all of the sites, except for Shepaug, had average Memorial Day – Labor Day secchi depths between 1 and 2 meters classifying them as eutrophic (Figure 3). Shepaug had an average secchi depth of about 2.7 meters, classifying it as late mesotrophic. In early summer, the water depth at Barkwood Point was frequently too shallow to measure secchi depth.

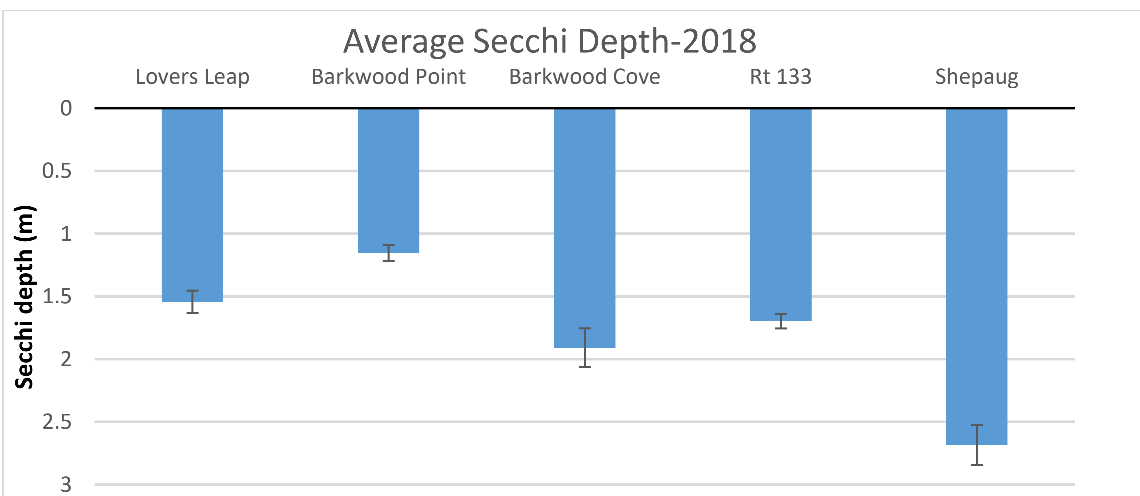

Figure 3: Average Secchi Depth across Sites

Figure 4 shows the time series of secchi depth at all sites. As in past years, water clarity (secchi depth) was typically greater at the Shepaug site.

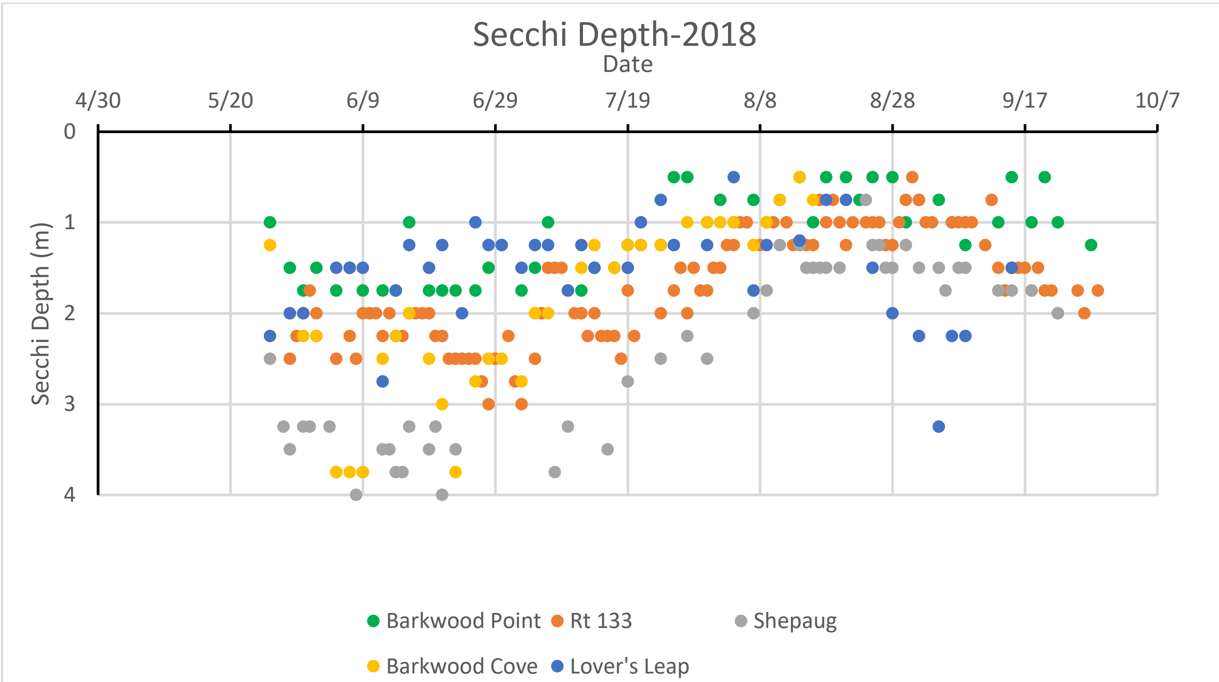

Figure 4: Secchi Depth over time

7. Debris Monitoring

The presence of large floating debris (trees, logs etc.) is a recurring problem in Lake Lillinonah. The debris poses a hazard to boaters and impairs recreation. Nonetheless, submerged debris can provide shoreline habitat for many organisms, including fish (Dodds 2010). Floating debris is particularly prevalent during high water periods when wood floats off the shores or out of coves into the main channel of the lake. The purpose of debris monitoring is to observe the presence or absence of floating woody material at each sampling.

The volunteer looked around the general vicinity of the dock when judging the level of debris. They then used a rubric to classify the amount of debris present. The first category of the rubric says "No debris present". The second category says "Some debris present but not enough to affect boating". The third category says that water is "Boating impaired because of debris".

In Figure 5 we can see that for most sites, the majority of lake days were free in terms of debris. Barkwood Point reported the most days with debris (~33%). This is down from ~50% of days in 2017. Other sites reported less than 10% of days with debris. Only Lover's Leap and Barkwood Cove reported any days of boating being impaired by debris.

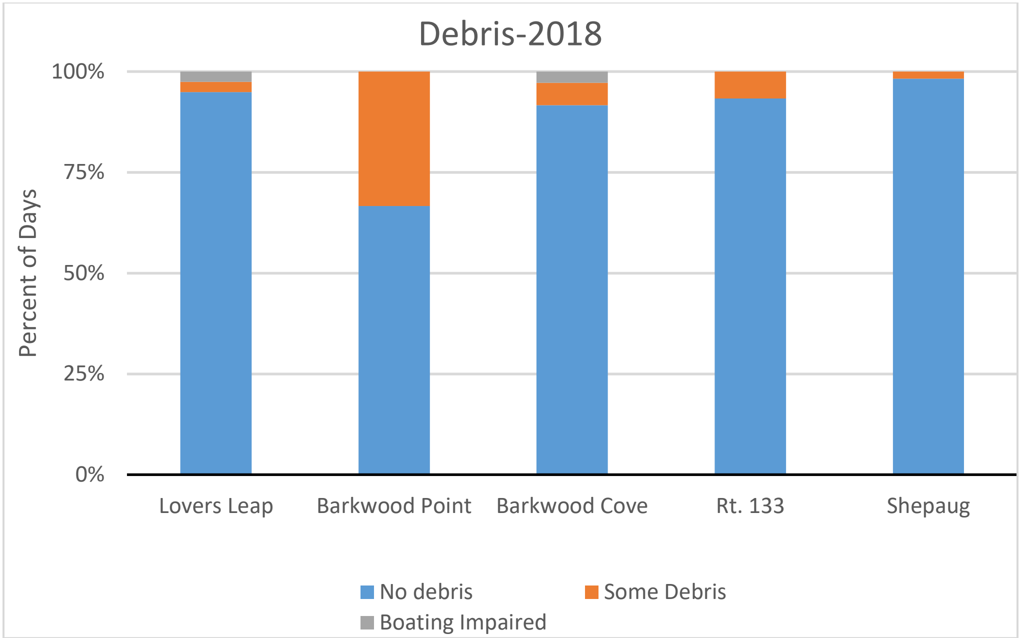

Figure 5: % of Days of Particular Debris Content from Memorial Day to Labor Day

8. Trash

This was the fourth year volunteers were asked to record observations of manmade trash on the lake. Volunteers were told to keep an eye out for bottles, tires, plastic bags etc. and to record their observations by putting either a 1, 2 or 3 in the trash column of their observations. The numbers respectively represent "no trash present", "some trash present but not enough to affect recreation" and "recreation impaired due to trash". Across all sites, there were 14 days throughout the summer months which reported trash presence, which is the same number of days reported in 2017. There were no days where recreation was impeded by trash.

9. Water Color Monitoring

Water color can be an important indication of water quality and can be especially important in determining what is in the water. Water color is not definitive but gives us an idea of what types of materials may be in the water. Using a chart provided by the Colorado Volunteer Lake Monitoring Program, specific guidelines were utilized for matching a certain water color with a particular lake condition. For example, brown can indicate the presence of sediment or diatom algae and blue-green can indicate cyanobacteria. The color categories are brown, blue-green, green, yellow-green, light blue and clear. Light blue is indicative of certain types of sediment that are not typically seen in Lake Lillinonah. Water color has been especially important in post-storm analysis where secchi depth was low due to sediment in the water column.

The volunteers recorded the water color and particle reading after taking the secchi depth reading. Using the same location that they took the secchi depth reading, they lowered the secchi disk into the water to one half of the secchi depth. E.g. If secchi depth is 1 meter, then the color reading was taken at 0.5 meters. This ensured that the color was observed at the same light level at each sampling period. They observed the water color against the white part of the disk and then chose the color on the color chart that most closely corresponded to the color observed. The volunteer kneeled or sat when taking the color and particle readings.

The color chart that the volunteers used has been widely used in other monitoring programs such as Colorado Volunteer Lake Monitoring Program. In this report however, we combined the green, blue-green and yellow-green categories into one general "green" category. The modification was used because difference in the shades of green may have been indistinguishable to some volunteers and we were most interested in whether the lake was green due to algae, brown due to sediment, or clear.

Green was the dominant color recorded across all sites. This color is indicative of the presence of a diversity of algae. Lover's Leap, Barkwood Point, Barkwood Cove, and Shepaug also noted some days with brown color which likely indicates sediment in the water column. Lover's Leap reported 49% of days as brown, Shepaug reported 13% brown days, Barkwood Cove reported 8% brown days, and Barkwood Point reported 2% brown days. Across years, Lover's Leap is most variable in the number of days with brown water color (values range from a low of ~3% in 2012 and 2013 to ~40% in 2014).

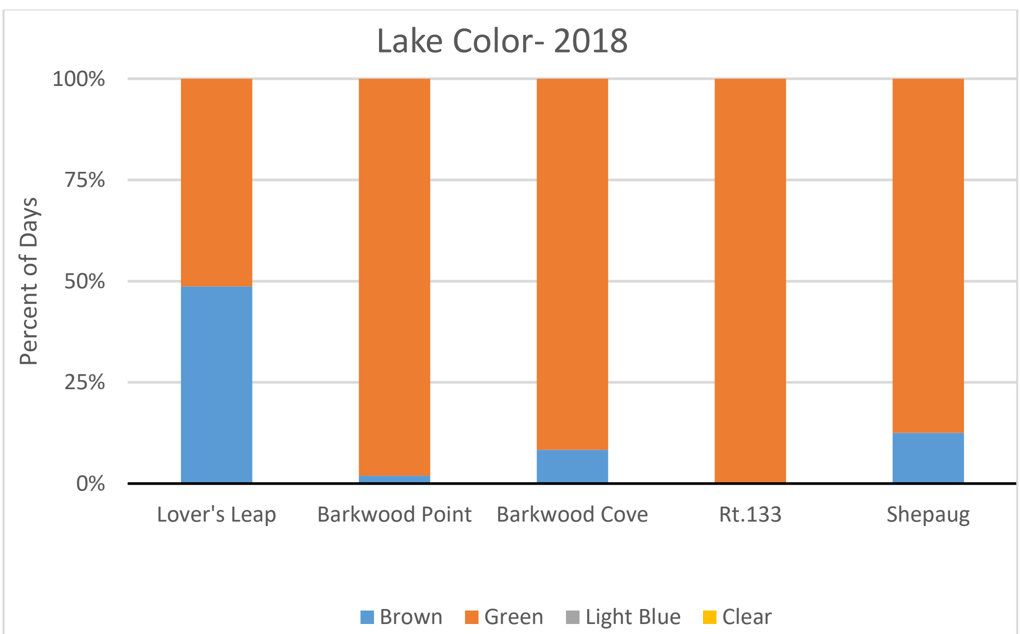

Figure 6: % of Days of Particular Color Across all Sites

10. Particle Monitoring

Particle type is important in knowing whether potential bloom forming algae are present and in what quantities. The assigned categories that volunteers could choose from were "none", "unidentified particles", "visible algae" and "algae bloom". The "none" category was chosen when the water had no visible particles. The "unidentified particle" category was chose when the volunteers could see particles but couldn't tell whether they were sediment or algae. The "visible algae" category was recorded when they could see particles that were distinctly green. Here, they determined that there were clear patches between the algal particles. The "algal bloom" category was chosen when they could see green particles and there were no clear spots between the clumps. The water is typically determined to be cloudy and has been described as looking like pea soup.

In determining the presence or absence of particles, the volunteer kept the secchi disk in the water at ½ secchi depth. They looked at the white part of the disk and noted whether they could see particles in the water. They then chose the value on the particle chart that most closely corresponded to the particles that were observed in the water.

Particles were noted in the water column on most days in 2018. None was the most common particle type recorded at Barkwood Point. Unidentified particles were the most common particle type recorded at Lover's Leap and Barkwood Cove. Visible algae was the most dominant particle type at Shepaug. Algal bloom was the most common particle type recorded at Rt. 133.

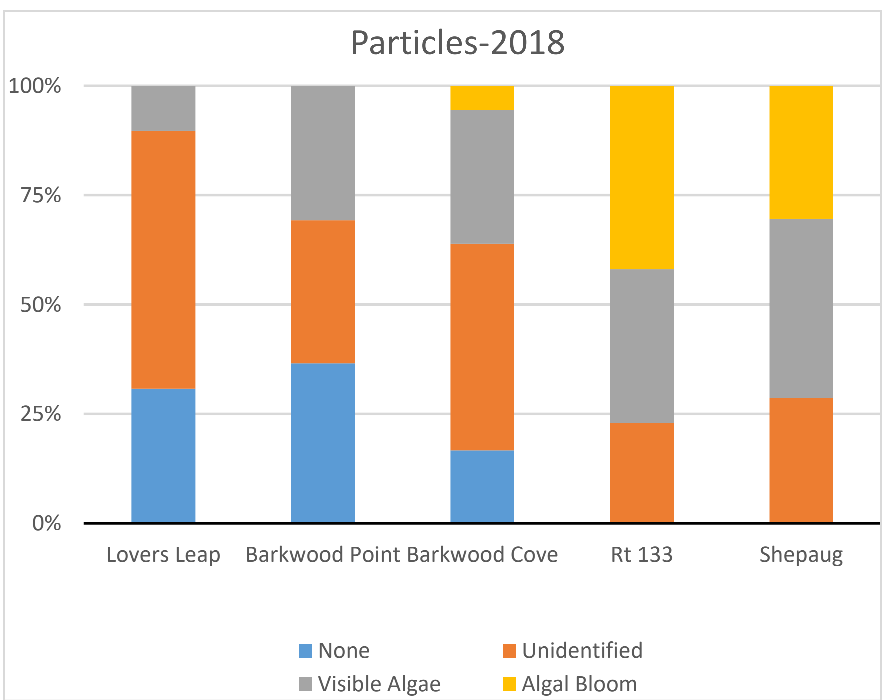

Figure 7: % of Days of Particular Particle Content Across all Sites

11. Recreation Potential Monitoring

Recreation potential relates lake conditions to the aesthetic qualities of the system and the ability of people to use the lake. Recreation potential of Lake Lillinonah is particularly important because the lake is highly utilized and enjoyed by both those that live on the lake and those that visit the area. Recreation potential is an important variable at Lake Lillinonah as it may either encourage or discourage boating, swimming and fishing. Recreation potential may be correlated with other variables, including algal levels and secchi depth. Documentation of poor recreation potential can be used to convince local officials that initiatives must be taken to better protect the lake and the people using it. Similarly, increased recreational use of the lake may subsequently lead to people having a greater incentive to protect the lake.

Recreation potential is based on the volunteer's opinion of general lake conditions with a specific focus on algal content. Four categories were established with the best possible recreation potential being "beautiful could not be better" (Smeltzer and Heiskary, 1990). From there the categories go from "minor aesthetic problems due to algae, still good for swimming and boating", "desire to swim and enjoyment of lake substantially reduced because of algae (boating still ok)" and "swimming and aesthetic enjoyment of lake nearly impossible because of algae". Recreation potential may be the most influential category concerning citizen's use of the lake.

Although most sites had >25% of days between Memorial Day and Labor Day with minor aesthetic problems due to algae or impaired recreation, there were very few days where recreational was impossible. Rt. 133 had the most days with aesthetic or recreation problems (~70%).

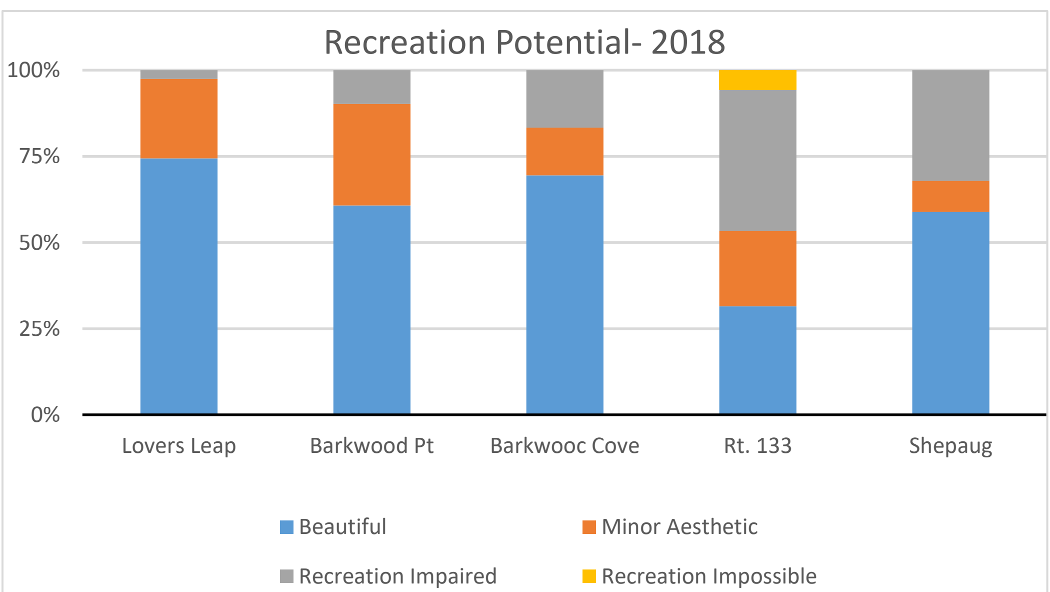

Figure 8: % of Days of Particular Recreation Potential Across all Sites

12. Surface Algae Monitoring

Algal scums represent a concentration of algae on the surface of water and may be indicative of high cyanobacteria concentrations. Scum is also related to weather as the presence of wind will cause the surface algae to mix more into the water column.

Volunteers observed the water surrounding their sample site and recorded what they saw. They knew that they may not see surface algae at the exact secchi depth location because they had disturbed that part of the water. They recorded that surface algae was present if they saw algae concentrated on the surface of the water in the general vicinity of their sampling site. They were given two categories to choose from. The first was "no algae concentrated on the surface of the water". The second was "algae concentrated on the surface of the water".

For most sites, the % of days with surface algae was similar to that in 2017. Barkwood Cove is the exception where the % of days with surface algae decreased from ~73% to ~11%.

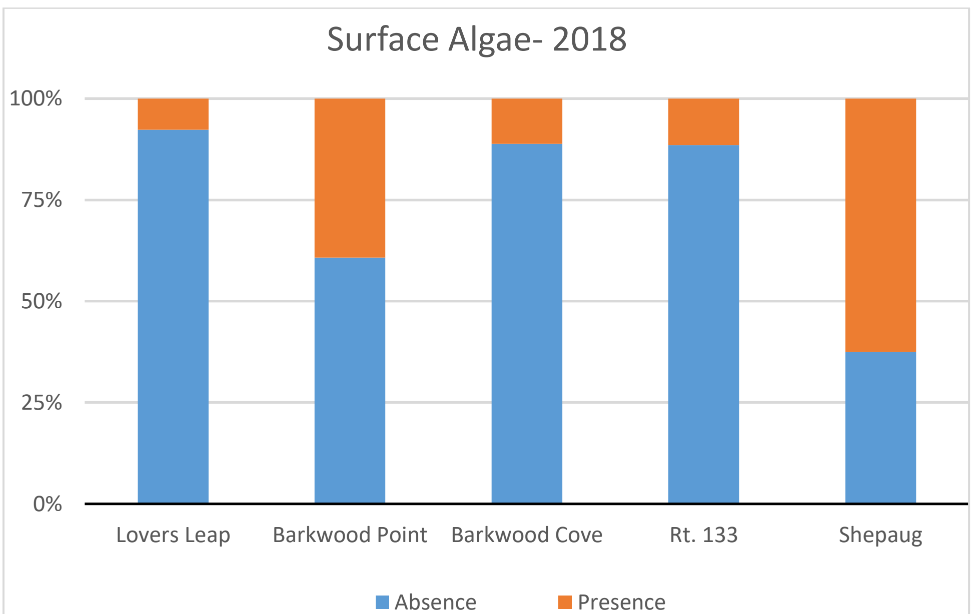

Figure 9: % of Days with Presence or Absence of Surface Algae Across all Sites

13. Nutrient Monitoring

Phosphorus and nitrogen are essential nutrients whose increased levels foster growth of plants and algae. As total phosphorus and total nitrogen levels increase, the presence of algal blooms also tends to increase. Lower secchi depth and thus lower water clarity, results from this increase in algal biomass. In many freshwater systems, phosphorus is considered the most important nutrient limiting algal growth but nitrogen also plays a role (Dodds 2010).

Nitrogen and phosphorus are transported to lakes from a variety of sources, including fertilizer runoff and wastewater treatment plants. Lake Lillinonah has a very large watershed and nutrients are collected from a large number of point and non-point sources. Understanding how nutrient concentration within the lake changes over time and across sites will help us evaluate how changes in watershed management have affected water quality.

Total phosphorus and total nitrogen concentration was measured at all sites. To collect nutrient samples, the volunteers were given bottles that were pre-labeled with date and location. They wrote the name of the collector with a permanent marker in the space provided. They then rinsed the bottle three times with lake water. From there, they submerged the bottle upside down until their wrist was in the water and then turned it right side up to fill it. They poured some of the water out until the bottle was 2/3 full and placed the bottles in the freezer. Samples were sent to the University of Connecticut’s Center for Environmental Sciences and Engineering for analysis.

Nutrient concentrations are presented in two ways. Average (Memorial Day-Labor Day) concentrations are presented in the first graph whereas the second graph for each nutrient shows all data collected. Breaks in the line indicated dates for which no sample was collected for that particular site.

Average (Memorial Day-Labor Day) total nitrogen (TN) concentrations were highest at Barkwood Point and lowest at Shepaug (Figure 10). The high average TN concentration at Barkwood Point is due to very high concentrations in August and early September. For the rest of the summer, TN concentration at Barkwood Point was more similar to the other sites. TN was also high in early September at Shepaug (Figure 11).

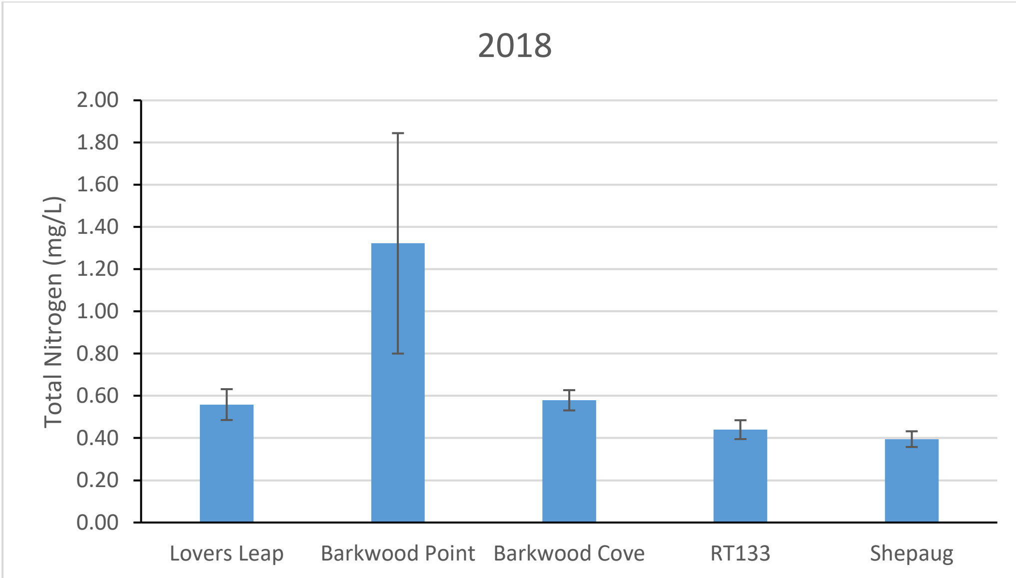

Figure 10: Average (Memorial Day – Labor Day) Total Nitrogen Concentration.

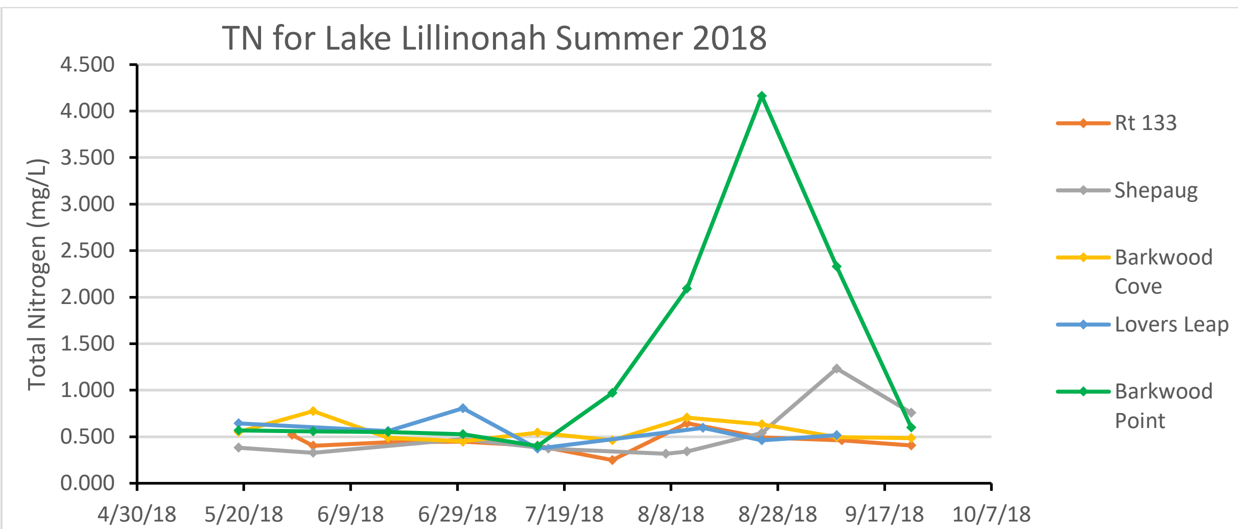

Figure 11: Total Nitrogen Concentration across all sites.

Average total phosphorus (TP) concentration in 2018 shows a similar pattern to TN (Figure 12). The time course in Figure 13 shows that generally, Barkwood Point has the highest TP concentration with very high values in August and early September. Similar to TN, Shepaug also had a spike in TP concentration in early September.

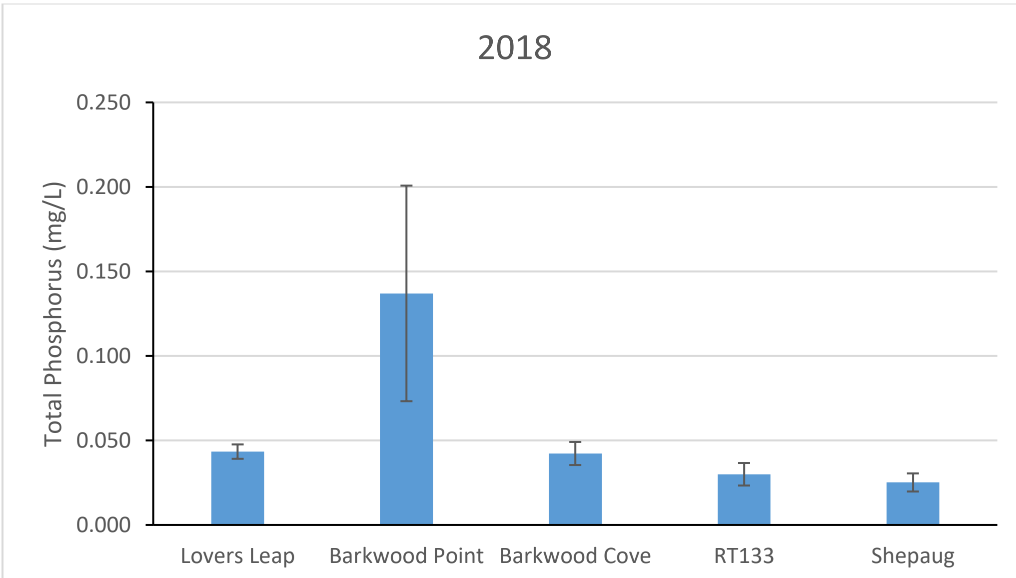

Figure 12: Average (Memorial Day – Labor Day) Total Phosphorus Concentration.

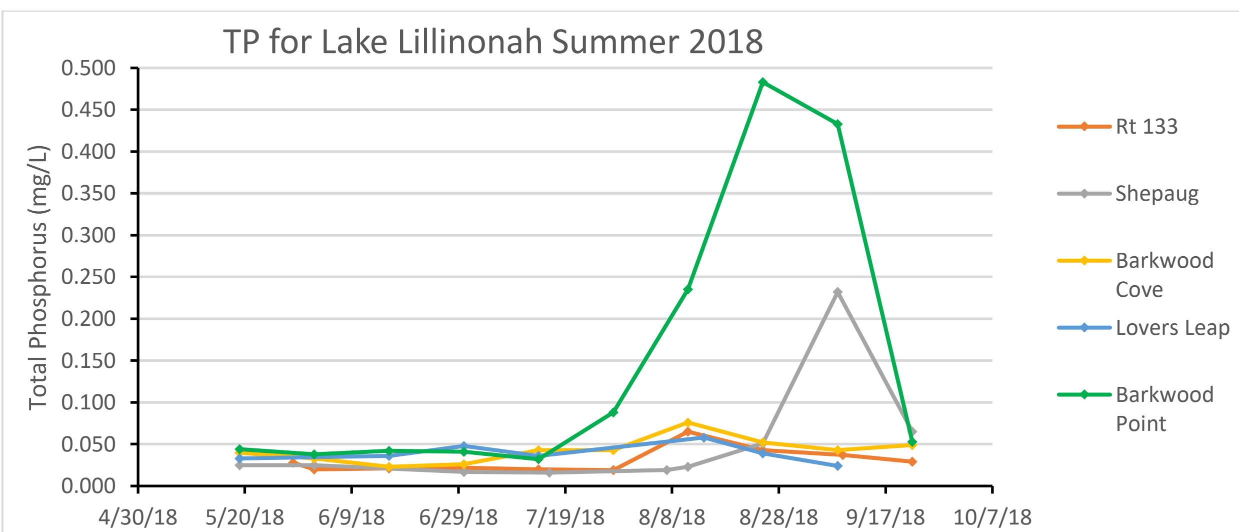

Figure 13: Total Phosphorus Concentration across all sites.

14. Algal Toxin Concentration Monitoring

The type of phytoplankton that forms the surface algal blooms that we see in Lake Lillinonah is called cyanobacteria. As their name suggests they are a form of bacteria, though they are typically grouped with algae because they are ecologically very similar. Many of the bloom-forming cyanobacteria produce compounds that may be harmful to aquatic organisms as well as other organisms, including humans and their pets, which drink or swim in the water. Several hypothesis exist for the ecological role of the toxins including

1. That they are a chemical defense against being eaten by zooplankton.
2. That they are chemicals that harm other algal competitors giving the cyanobacteria more access to light and nutrients
3. That they serve an unknown physiological purpose for the cyanobacteria cell.

Regardless of their ecological role, water quality managers have become increasingly concerned that during bloom conditions, toxin concentration may reach levels that could pose a threat to public health. Many of the species that are common in algal blooms in Lake Lillinonah have the potential to produce toxins. These include: *Anabaena, Aphanizomenon, Lyngbya and Microcystis*. Worldwide, the most well studied toxin is microcystin which is produced by two common Lake Lillinonah species, *Microcystis* and *Anabaena*.

The World Health Organization (WHO) guideline for microcystin in drinking water is 1 µg/L. Although water from Lake Lillinonah is not used for drinking, accidental ingestion of toxins through recreational contact is common and it is possible that repeated ingestion could lead to sub-lethal liver damage (Chorus 2001). In addition, microcystin has been implicated in a number of dog deaths in New England. The WHO does not have an official recommendation for recreational contact but states there is a "moderate probability of adverse health effects" when recreating in waters with microcystin concentration above 20µg/L (WHO 2003). The Connecticut Department of Energy and Environmental Protection has recently published guidance for local health departments recommending that beaches in Connecticut be closed at microcystin concentrations greater than 15µg/L (CTDPH and CTDEEP 2013).

Samples for toxin analysis were collected fortnightly. Volunteers were given pre-labeled bottles which they were told to rinse three times with water, submerge the bottle upside down until their wrist was in the water and then fill it up. They then poured out some of the water until the bottle was 2/3 full to allow room for expansion once the sample was frozen. Volunteers were given several extra bottles and instructed to take samples of algal blooms.

Water samples were analyzed using the EnviroLogix QualiTube Kit for microcystin by Fairfield University students under the supervision of Jen Klug. The kit is used to detect levels of microcystin from 0.5-3.0 ppb. Microcystin concentrations were evaluated based on color development and an analysis of absorbance. The analysis allows us to place each sample into one of three categories: less than 0.5 ppb, between 0.5 ppb and 3 ppb, and above 3 ppb. Samples above 3 ppb were diluted and re-run to give us more information about whether concentrations in those samples approached or exceeded the recreational guidance of 15 ppb. Results were then grouped into 4 categories: no detect (less than 0.5 ppb), low detect (between 0.5 ppb and 3 ppb), medium detect (between 3 ppb and 15 ppb) and high detect (15 ppb).

Table 4 shows results from microcystin analysis. These results present all toxin samples collected, including those collected before Memorial day or after Labor Day. The routine fortnightly samples show that the toxin concentration varies over time and location. The majority of routine samples in June and early July had microcystin concentrations below detection. In contrast, the majority of routine samples in August and early September had medium or high concentrations. Both medium and high concentrations are near or above the EPA draft recreational contact guideline of 4 ppb. Volunteers also collected water samples on days other than the fortnightly samples if they noticed an algal bloom. Each spot sample came back with some level of microcystin, except the one at Barkwood Cove. Barkwood Point had the highest number of samples with detectable microsystin whereas Lover's Leap only had one sample with detectable microcystin.

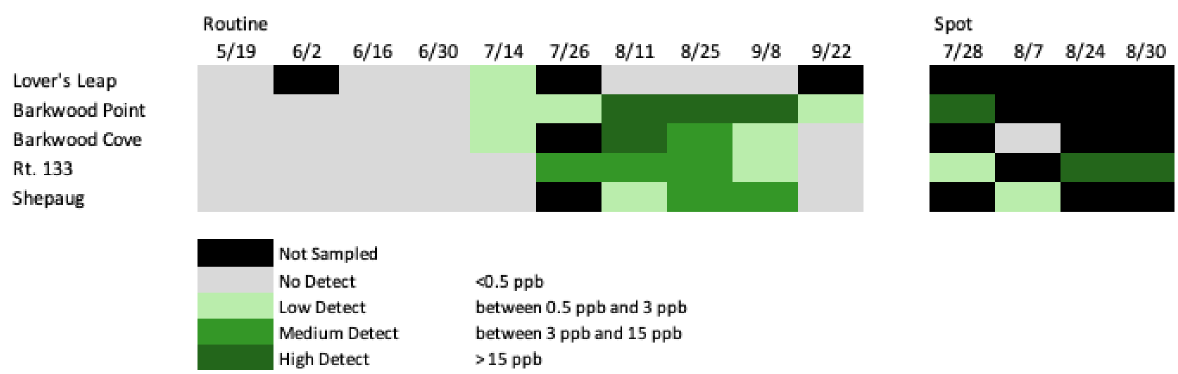

Table 4: Microcystin concentration across sites- Summer 2018

15. Conclusions

As in past years, the data collected from lake volunteers has allowed us to compile an overall assessment of Lillinonah's water quality. Using the ten variables discussed, we are able to better assess what is happening to the lake environment and ecosystem. The various lake sites allow us to monitor the status of the lake as a whole which allows us to have a fuller understanding of Lake Lillinonah.

Table 5: Classification of Lake Sites Based on DEEP Trophic Status Classification (see Table 1)

Site	Average Secchi Depth	Average Nitrogen Level	Average Phosphorus Level
Lovers Leap	Eutrophic	Late Mesotrophic	Eutrophic
Barkwood Point	Eutrophic	Highly Eutrophic	Highly Eutrophic
Barkwood Cove	Eutrophic	Late Mesotrophic	Eutrophic
Rt. 133	Eutrophic	Mesotrophic	Eutrophic
Shepaug	Late Mesotrophic	Mesotrophic	Late Mesotrophic

Based on the classification system used by the Connecticut Department of Energy and Environmental Protection, Lake Lillinonah in 2018 was mostly Eutrophic (based on secchi depth and total phosphorus concentration) or mostly late mesotrophic (based on total nitrogen concentration). Although as in past years, Shepaug had the highest water clarity across sites, TN and TP concentrations at Shepaug were more similar to the other sites.

In terms of visual indicators (recreation potential and surface algae) water quality at most sites in 2018 was worse in terms of recreation potential but similar in the presence of surface scum when compared to 2017 (Figs. 8 and 9, Klug et. al. 2018).

Algal blooms occur when nutrient concentrations are sufficient and certain physical conditions are met (high temperature and calm conditions). Results from CLEO volunteers as well as other observers suggest that algal blooms in 2018 were more common than in past years during the summer months. The severe blooms (along with high algal toxin concentration) observed in lake July, August, and September highlight the fact that Lake Lillinonah continues to be impaired. In order to reduce both algal blooms and nuisance plant growth, lake stakeholders should continue their focus on reducing nutrient loading from the watershed.

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Citizen-Led Environmental Observatory: Lillinonah Data sheet — **Site name:** ______ **Year:** ______

Date	Time	Name of Observer	Temp	Secchi	Color	Particles	Surface scum	Recreation Potential	Debris	Trash	Notes
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	
					1 2 3 4 5 6	1 2 3 4	1 2	1 2 3 4	1 2 3	1 2 3	

Use the Notes column to record any other observations (weather events etc.) **Circle only one number per column**

Abbreviated instructions are found on the back of this data sheet. For more detailed instructions please see the CLEO protocol in your binder

Contact the volunteer coordinator with any questions or concerns.

Thank you for your commitment to help us better understand Lake Lillinonah!