Citizen-Led Environmental Observatory

At Lake Lillinonah

2015 Annual Report

Prepared by

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Questions/Comments?

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Acknowledgements

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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 2015. 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 throughout the summer, peaking in late July before beginning to decline. Most sites in 2015 had average secchi depths between 1-1.5 meters making most of the lake qualify as eutrophic. Recreation potential related to algae growth was lower in 2015 compared to 2014. In 2014, the majority of days at all sites were recorded as being “beautiful” and no days were recorded as having “recreation impossible due to algae”. In contrast, in 2015 at all sites except Lover’s Leap, recreation was impaired or impossible 20 to 45% of days depending on site. This is a large change from previous years.

Surface algae varied greatly depending on the location in the lake. Percentage of days with surface algae varied from <4% to upwards of 75% depending on location. There was also significant variability in algal toxin concentration levels depending on where and when they were taken. Concentrations in bloom samples were higher than in routine twice monthly samples. Some of the blooms samples had concentrations significantly higher than the Connecticut recreational guidelines (CTDPH and CTDEEP 2013).

Monitors observed little debris in 2015. The highest percentage of debris days observed was ~15%. Three days were reported as being recreationally impaired by debris in the lake. Trash is a new variable which was introduced in 2014 so volunteers would be able to distinguish between manmade and natural debris. Only five instances were reported as having some trash out of all five sites.

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. 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, th Housatonic Valley Association, United States Geological Survey, 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.

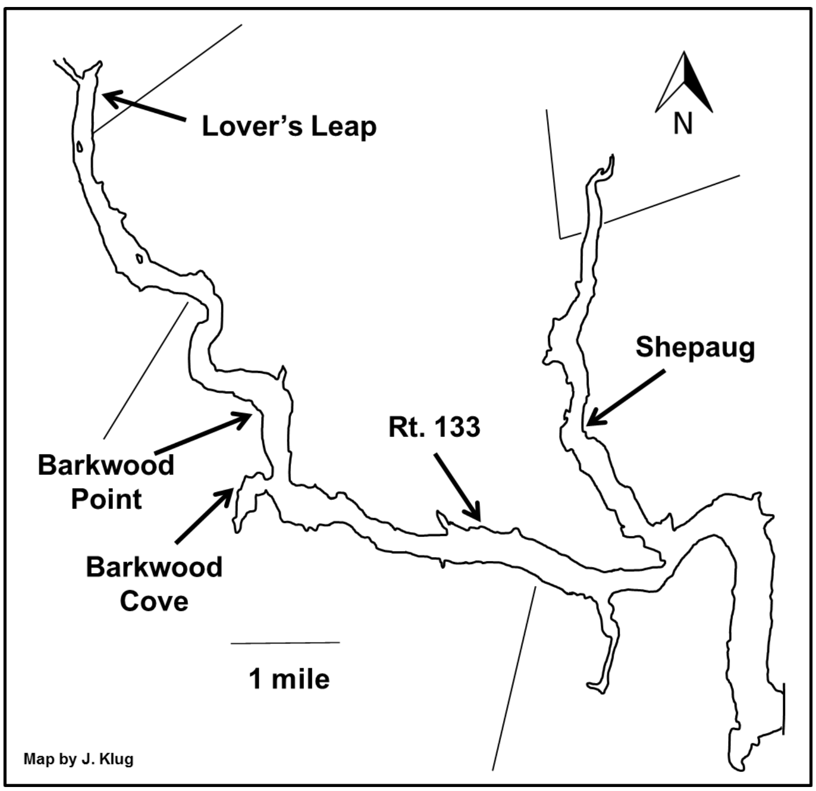

Figure 1: 2015 Site Locations on Lake Lillinonah

In 2015, 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 25, 2015-September 7, 2015. 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.

To compare with in-lake samples, water samples were collected for toxin and nutrient analysis at the GMS Rowing Center along the main stem of the Housatonic River upstream of the confluence of the Still River. No other data were collected at this site.

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	>15-20	>25-30	>30-50	>50

Table 2: Number of Days Data was Collected and Number of Days from Memorial Day to Labor Day 2015

Site	Number of Days Data Collected	Number of Days Memorial Day-Labor Day
Barkwood Point	48	45
Rt 133	99	90
Shepaug	92	82
Barkwood Cove	48	45
Lover’s Leap	44	42

Table 3: 2015 Water Sample Collection Dates.

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

Date	Nutrients	Toxins
May 30	X	X
June 13	X	X
June 27	X	X
July 11	X	X
July 25	X	X
August 8	X	X
August 22	X	X
September 5	X	X
September 19	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 then 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 late July and were in steady decline by August (Figure 2). During the period from Memorial Day to Labor Day, the temperatures ranged from a minimum of 15.5℃ (at Lover's Leap) to a maximum of 30℃ (at Barkwood Cove and Rt.133). Water temperature was consistently lower at Lover's Leap than at the rest of the sites, as also seen in previous years.

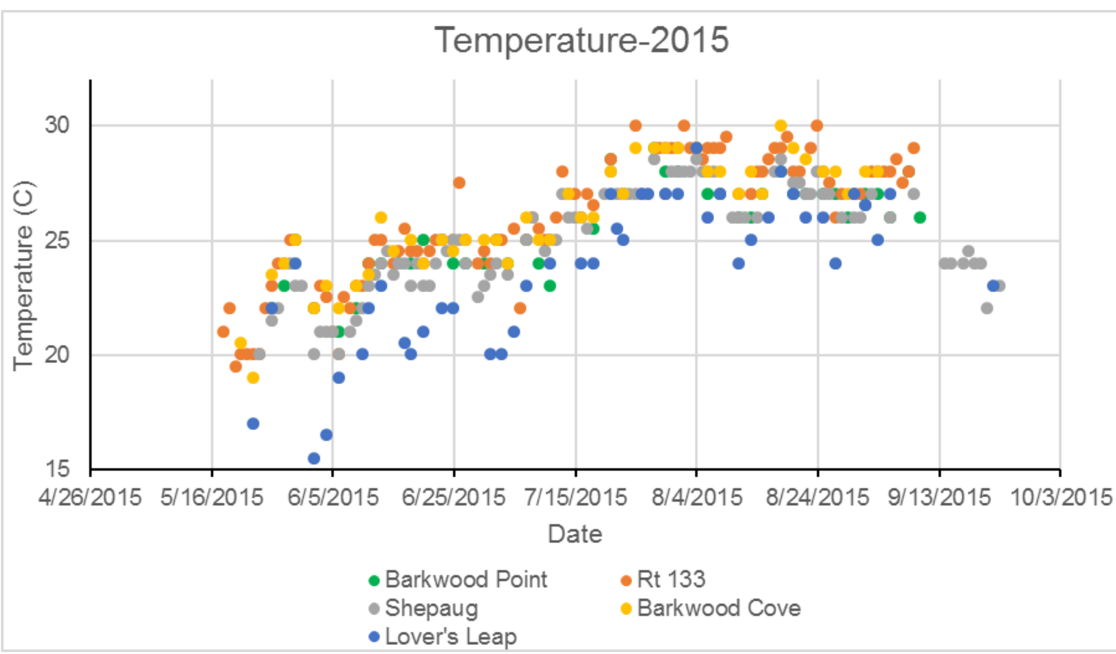

Figure 2: Water temperature across all sites

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 2015, all sites had average secchi depths between 1 and 2 meters classifying them as eutrophic (Figure 3).

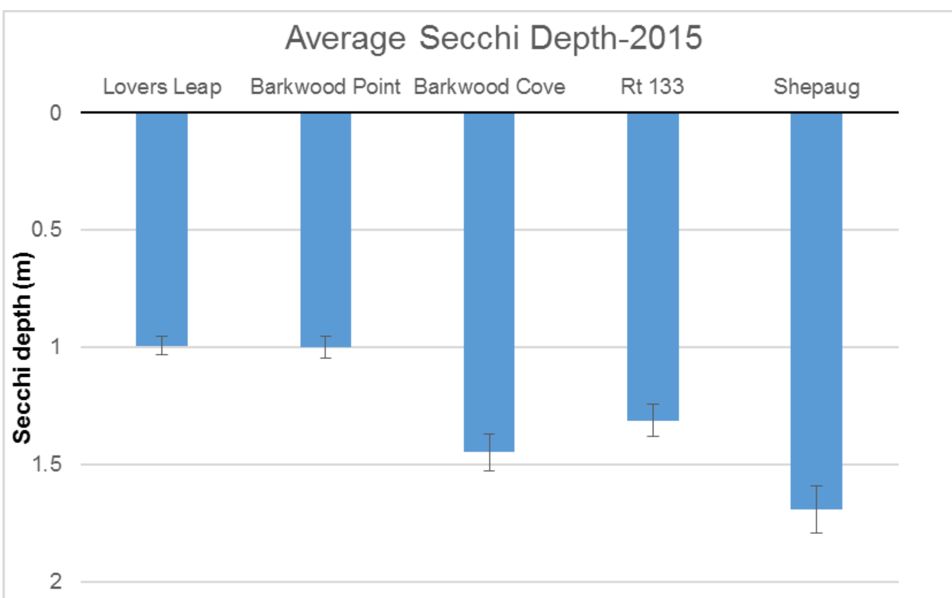

Figure 3: Average Secchi Depth across Sites

Figure 4 shows the time series of secchi depth at all sites. The distinct high values in late spring (early to mid June for 2015) correspond to the clear water phase, a seasonal marker characterized by low algal concentration due to high zooplankton abundance (Dodds 2012). In most years, Lover's Leap has the lowest water clarity and Shepaug has the highest water clarity throughout the year. This pattern was evident early in the year but by early July, water clarity was similar across all sites until Labor Day.

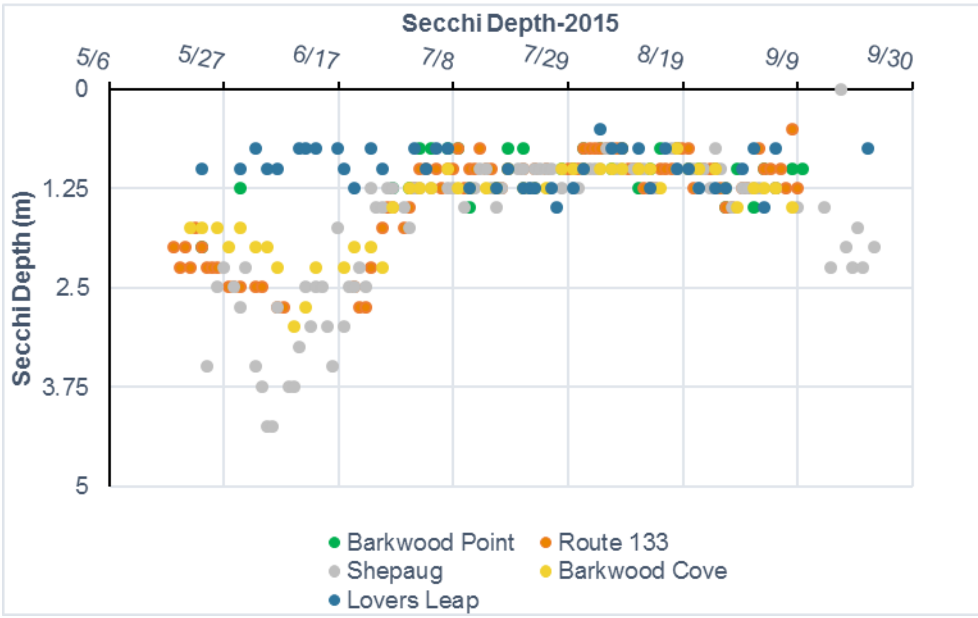

Figure 4: Secchi Depth over time

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, it can also 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 the majority of lake days were free in terms of debris. Lover's Leap, Barkwood Point and Rt. 133 reported the most days with debris (~10%). Lover's Leap and Shepaug were the only sites that reported days of boating being impaired by debris.

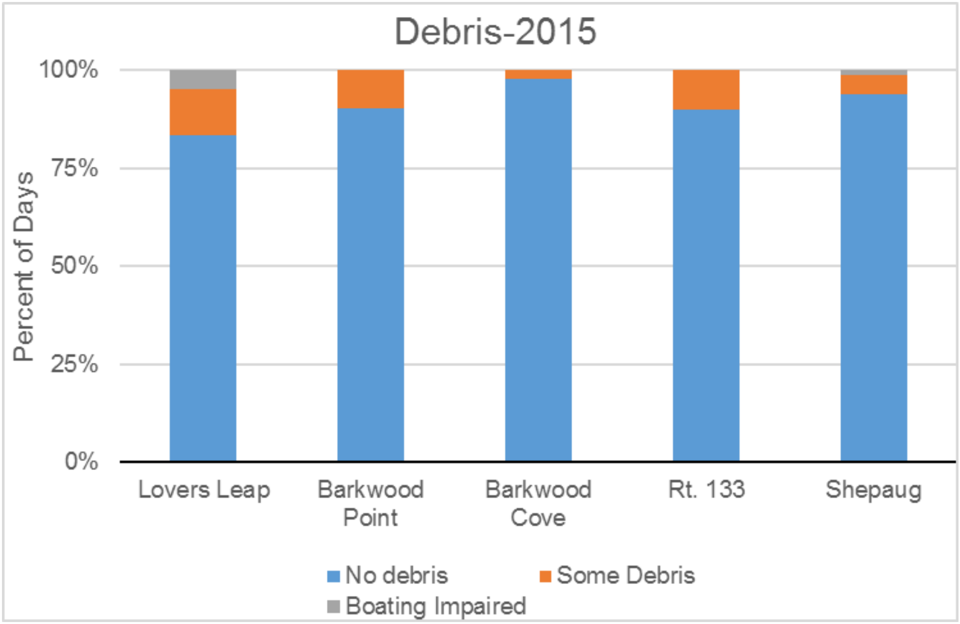

Figure 5: % of Days of Particular Debris Content from Memorial Day to Labor Day

8. Trash

This was the second 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". There were only five days throughout the summer months which reported any trash presence, none of which impeded recreation.

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 color that was most predominantly recorded across all sites. This color is indicative of the presence of a diversity of algae. All sites except for Rt.133 also reported several brown days. The percentage of brown days at Lover's Leap is higher in 2014(~40%) and 2015 (~25%) than in past years. For example, in 2013 and 2012 this site reported 2.6% and ~3% brown days respectively. The frequency of brown days at Lover's Leap in 2015 suggests that some of the days with low secchi depth were caused by sediment in the water column rather than algae.

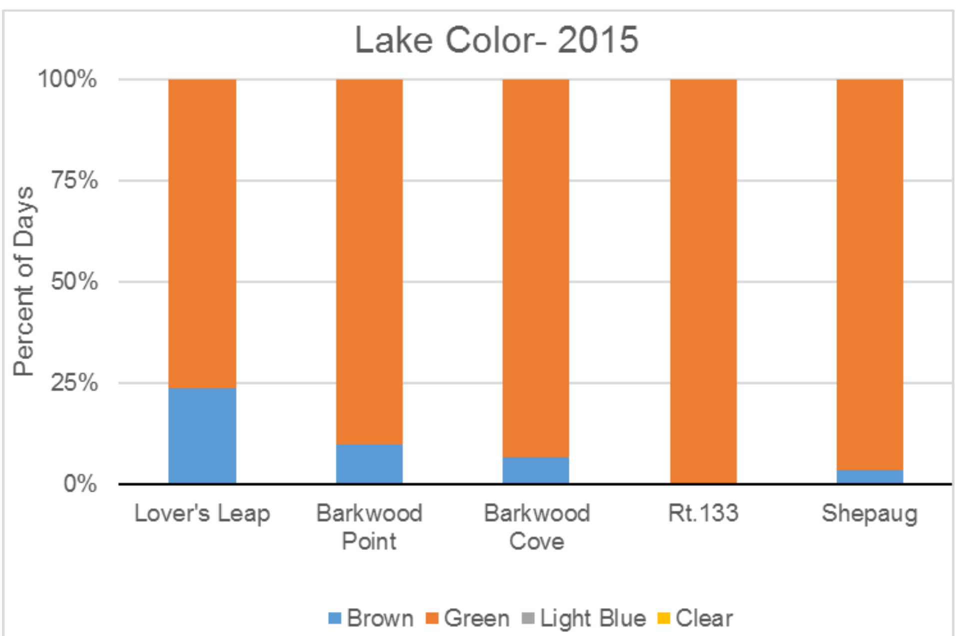

Figure 6: % of Days of Particular Color Across all Sites

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 2015. Lover’s Leap was the only site at which unknown particles were most common. Visible algae was the most common particle type at the other sites. Three sites (Barkwood Cove, Rt. 133, and Shepaug) also reported days with algal blooms. The presence of algal blooms at Rt. 133 and Shepaug was higher than in past years.

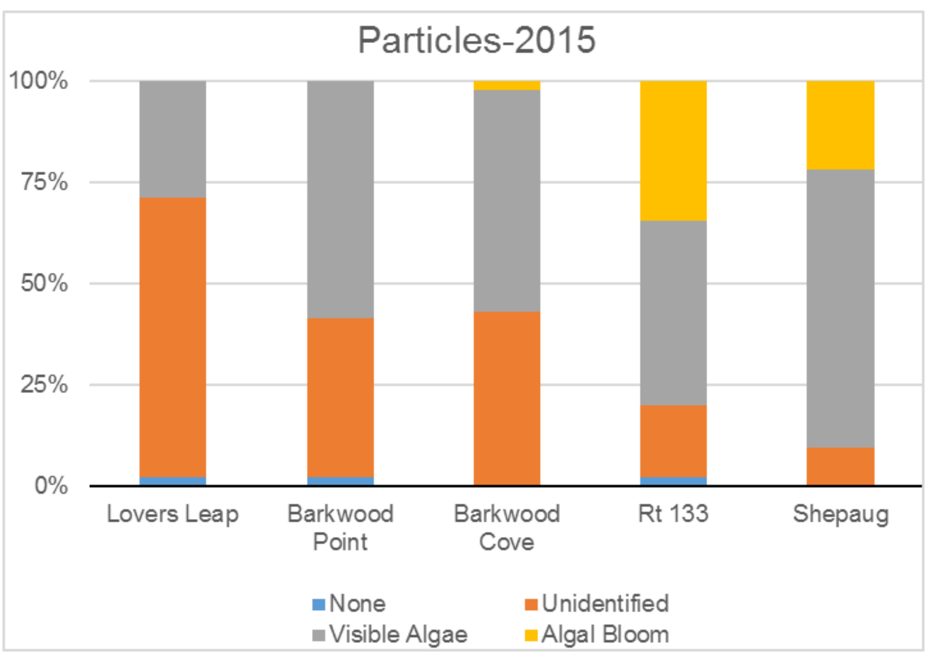

Figure 7: % of Days of Particular Particle Content Across all Sites

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.

Most sites had diminished recreation potential compared with 2014. In 2014, the majority of days at all sites were recorded as being "beautiful" and no days were recorded as having "recreation impossible". In contrast, in 2015 at all sites except Lover's Leap, recreation was impaired or impossible 20 to 45% of days depending on site.

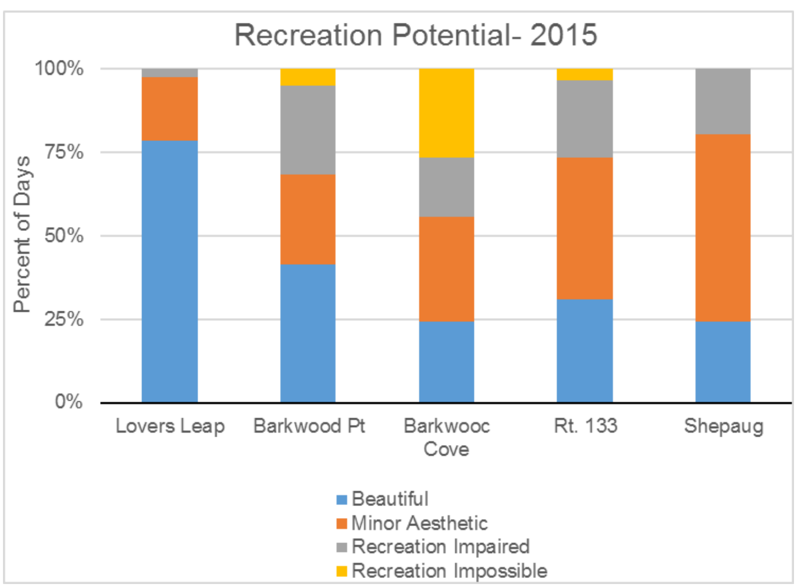

Figure 8: % of Days of Particular Recreation Potential Across all Sites

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".

In 2015 (between Memorial Day to Labor Day), Lover's Leap and Rt. 133 had very few days with surface algae. The other sites had between 50 and 75% of days with presence of surface algae.

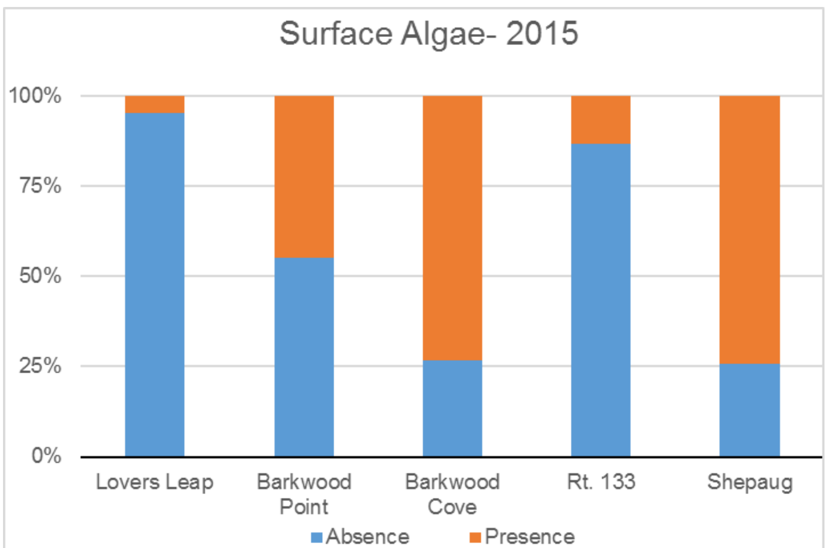

Figure 9: % of Days with Presence or Absence of Surface Algae Across all Sites

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 total nitrogen concentration was relatively similar across sites in 2015 (Fig. 10). Figure 11 shows the variability in concentration across time. Some sites had their lowest values in mid-summer (e.g., Lover's Leap) whereas others had their highest values in mid-summer (e.g., Shepaug).

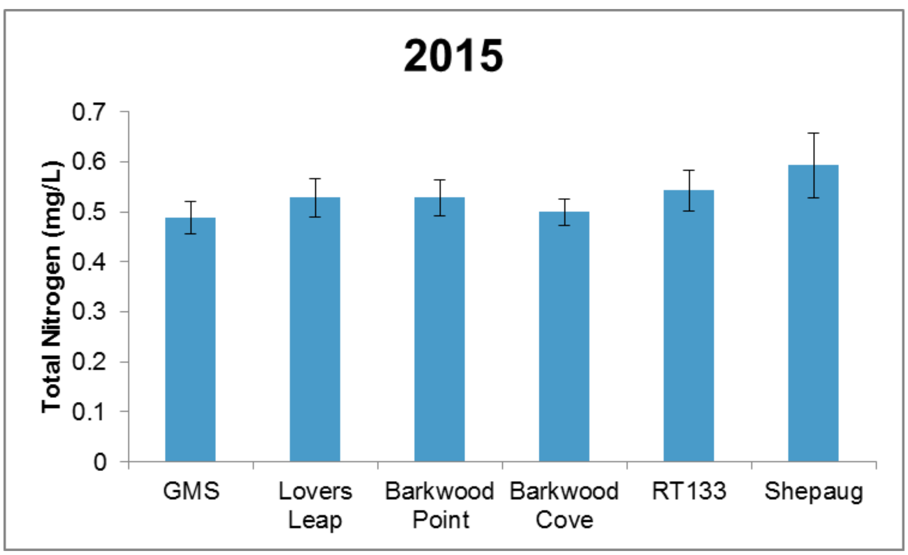

Figure 10: Average (Memorial Day – Labor Day) Total Nitrogen Concentration.

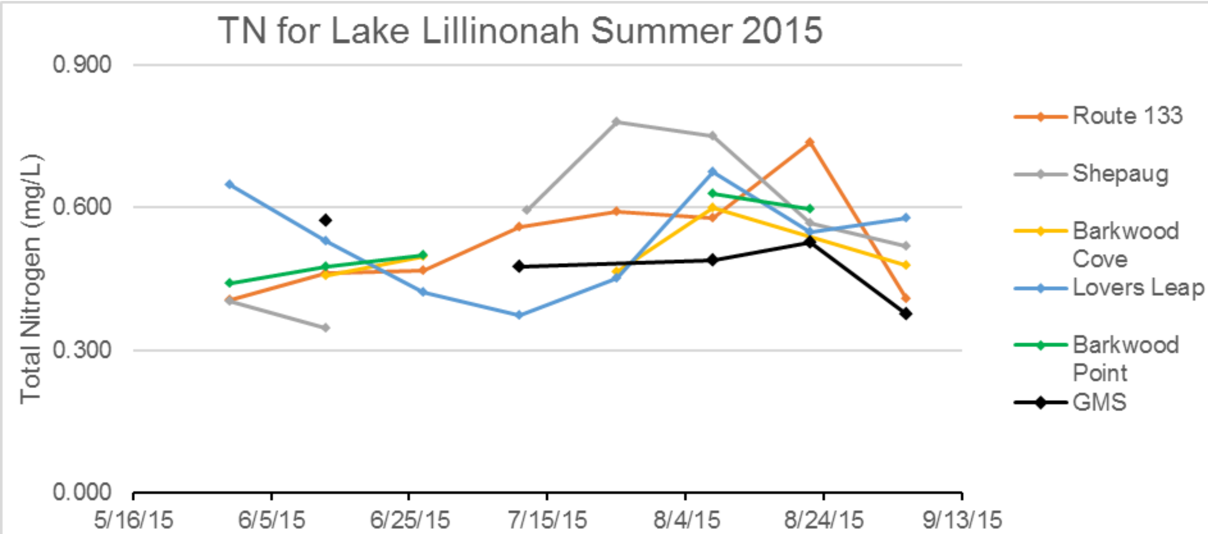

Figure 11: Total Nitrogen Concentration across all sites.

As we've observed in past years, average total phosphorus concentration was highest at Lover's Leap (Fig. 12). Figure 13 shows that phosphorus concentration at Lover's Leap was higher than the other sites until mid-summer. Concentrations at Lover's Leap later in the summer were more similar to the other in-lake sites. Mid-July through early-September, concentrations at the upstream site (GMS) were lower than the in-lake sites.

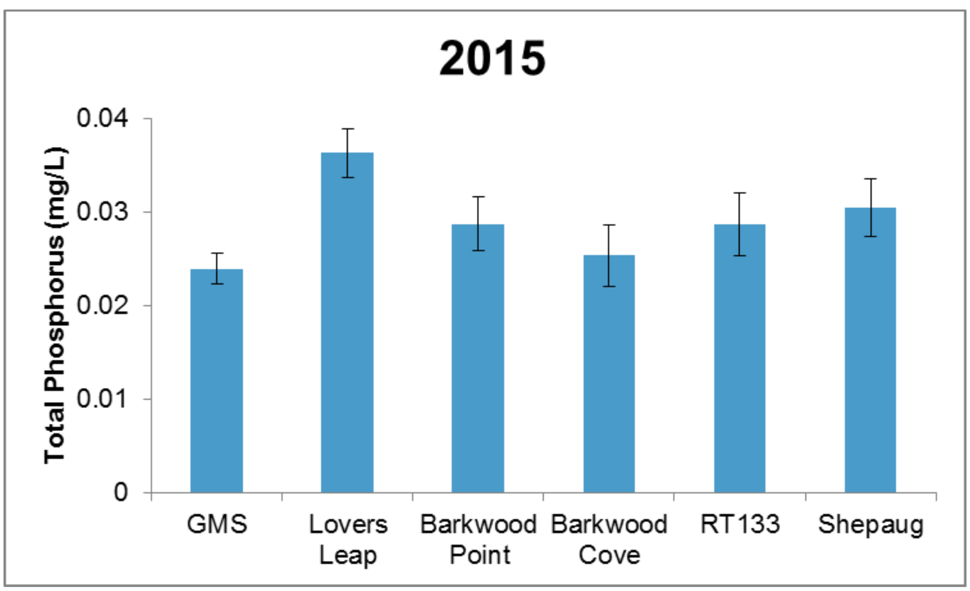

Figure 12: Average (Memorial Day – Labor Day) Total Phosphorus Concentration.

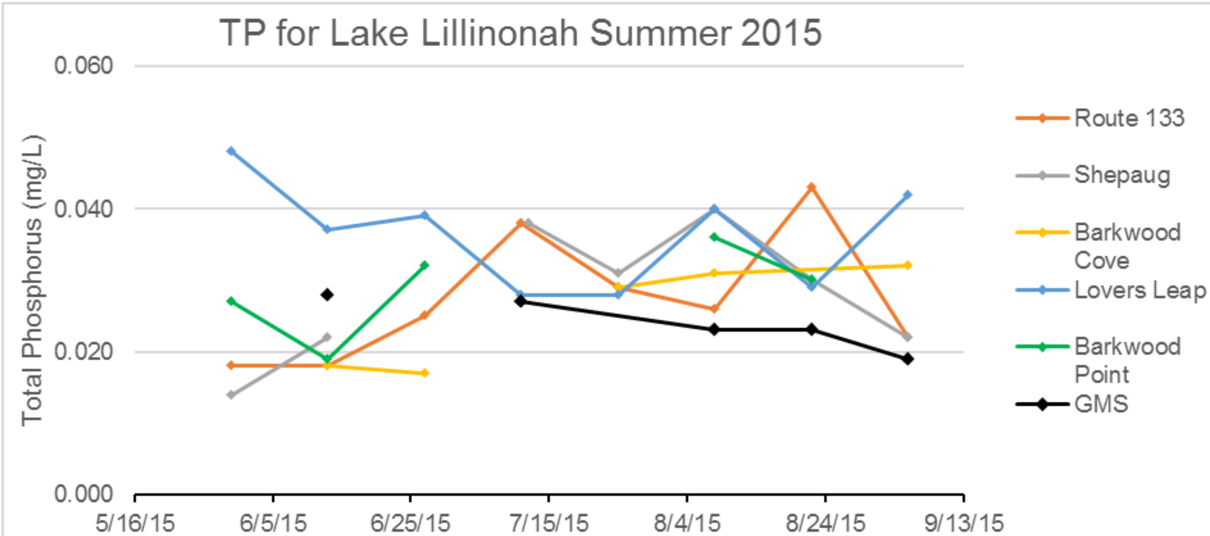

Figure 13: Total Phosphorus Concentration across all sites.

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).

A subset of samples was sent to the University of Connecticut Center for Environmental Sciences and Engineering Laboratory for analysis using a combination of liquid chromatography and mass spectrometry (UPLC/MS/MS).

Table 4 shows results from microcystin analysis. These results present all toxin samples collected, including those collected after Labor Day. The color coding represents ELISA results from samples analyzed at Fairfield University. The numbers in Table 4 represent the subset of samples analyzed using UPLC/MS/MS.

The routine fortnightly samples show that the toxin concentration varies over time and location. The samples taken at GMS for instance were all within the "not detectable range" whereas those at Rt. 133 were all low detects (Table 4). Volunteers also collected water samples on days other than the fortnightly samples if they noticed an algal bloom. In all cases except two, these spot samples had microcystin concentration greater than 3 ppb suggesting that poor visual condition is associated with higher microcystin concentrations. In some cases, microcystin concentration was near or above the recreational guideline of 15 ppb. Overall, the ELISA and UPLC/MS/MS results were highly consistent at microcystin concentrations at or above 1 ppb. At low levels, the ELISA results reported slightly higher (~0.1-0.4 ppb) concentrations in half of the cases.

Routine

	5/30	6/13	6/27	7/11	7/25	8/8	8/22	9/5	9/19
GMS				0				0	
Lover's Leap				0				0.47	
Barkwood Point									
Barkwood Cove				0.22				0.66	
Rt. 133				0.12	0.17	0.13	0.35	0.21	0.38
Shepaug				0.12*	0.18	0.33	0.19	0.24	0.83

*7/12

Spot

	6/23	7/9	7/13	7/21	8/31	9/1	9/8	9/16	9/20
GMS									
Lover's Leap									
Barkwood Point	9.37			18.43		5.04			
Barkwood Cove									
Rt. 133		11.59			4.81		545.8	212.2	
Shepaug			10.52		0.98				1.01

Legend		
Not sampled		
No detect	<0.5 ppb	
Low detect	between 0.5 ppb and 3 ppb	
Med detect	between 3 and 15 ppb	
High detect	> 15 ppb	

Table 4: Microcystin concentration across sites- Summer 2015

16. 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 discuss 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	Late Mesotrophic	Late Mesotrophic
Barkwood Cove	Eutrophic	Late Mesotrophic	Late Mesotrophic
Rt. 133	Eutrophic	Late Mesotrophic	Late Mesotrophic
Shepaug	Eutrophic	Late Mesotrophic	Late Mesotrophic

Based on the classification system used by the Connecticut Department of Energy and Environmental Protection, Lake Lillinonah in 2015 was a late mesotrophic (based on nutrient concentration) or eutrophic (based on secchi depth) body of water (Table 5). In past years, we have seen more variability among sites, with Lover's Leap often classified as more eutrophic than other sites and Shepaug often classified as having higher water quality than other sites. It is too soon to tell whether there is a trend towards higher water quality at Lover's Leap or poorer water quality at Shepaug but this is something that should be monitored.

In terms of visual indicators (recreation potential and surface algae) water quality at most sites in 2015 was worse than in 2014 (Figs. 8 and 9, Johnson and Klug 2015). In addition, toxin concentrations during algal blooms were elevated suggesting that lake users and their pets should minimize contact with surface scums.

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 2015 were particularly intense. Lake Lillinonah continues to be impaired due to the presence of algal blooms and 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**

Abreviated 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!