2019 White Lake Monitoring Results

Report Prepared by LIMNOSCIENCES
May 12, 2020

This report summarizes monitoring data for water quality (including nutrients), algae, aquatic vegetation, lake levels, and rainfall.

Water Quality Parameters

Monthly sampling was conducted from April-December at three established monitoring stations (Fig. 1). Grab samples for nutrients and chlorophyll a were taken at 0.5 and 2.0 m depths, so that a total of 6 samples were taken for each sample date. Algae samples were taken at 0.5 m depths. Sampling and analysis details are provided in the White Lake Quality Assurance Program Plan (QAPP) (available at www.whitelakewatch.com).

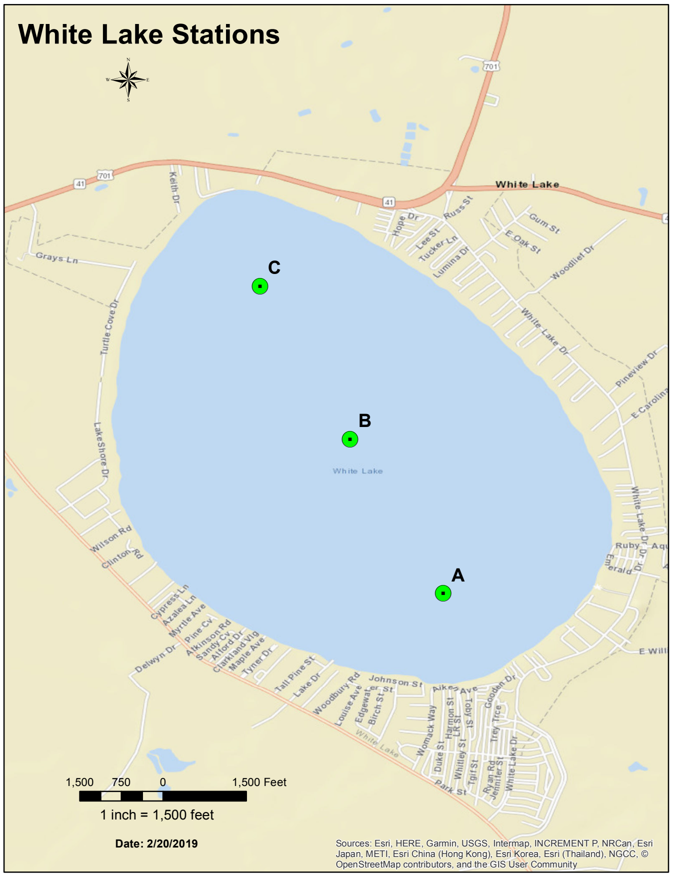

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Figure 1. Monitoring stations for White Lake, which correspond to NC DEQ stations (CPF155C, CPF155B, and CPF155A).

General Observations

Over the monitoring period, water-column algal biomass (measured as chlorophyll a) was lowest in April (mean of 1.8 µg/L) and highest in the month of August, at a mean of 10.3 µg/L; this month also had the highest turbidity, with a mean of 2.1 NTU, and the lowest Secchi readings, at 1.25 m (4.1 ft) (Table 1). Of note is the relatively rapid change in clarity in both the summer and fall: in July there was a reduction in visibility of around 1 m compared to June, while the opposite of that was seen in November, when water temperatures declined—an improvement of around a meter in Secchi depth compared to October, so that the Secchi disk was again visible on the bottom. Summertime (July-October) Secchi depths in 2019 were similar to values seen in 2018, after the alum treatment, with the remaining months having water clarity/Secchi visibility at the lake bottom (Fig. 2)

Table 1. Physical and chemical monitoring parameters for White Lake, March-December 2019. Samples were collected at two depths (0.5 and 2.0 m) at each of three stations (equivalent to the monitoring stations used by NC DEQ). As the depth of the lake is a function of lake level, which varies, when the Secchi is visible on the lake bottom it is recorded as a "yes" instead of a depth.

	3/18/19	4/17/19	5/23/19	6/25/19	7/10/19	8/14/19	9/12/19	10/10/19	11/21/19	12/18/19
Mean Temp (C)	17.1	20.8	27.0	29.0	29.0	30.3	28.9	21.7	10.1	11.3
Lake Level (gauge)	1.78	1.76	1.42	1.09	1.00	1.38	1.40	1.00	1.3	1.5
Secchi Depth (m)—					1.5	1.25	1.7	1.6		
Visible at Bottom?	Yes	Yes	Yes	Yes					Yes	Yes
Turbidity (NTU)					1.9	2.1	1.4	1.7	0.6	0.7
Mean DO (mg/L)	9.9	8.9	9	7.9	7.2	7.3	7.9	8.5	11.2	10.8
Mean DO % Sat.	103	99	99	103	93.5	97.4	102.8	97.1	99	99
Mean Sp. Cond.										
(uS//L)	32	31.8	32.6	34.0	34.4	33.1	31.5	33.1	35.5	34.4
Range pH (su)	6.4-6.8	6.3-6.7	6.2-6.6	6.2-6.7	6.5-6.6	6.3-6.6	6.8-7.0	6.3-6.6		6.7-6.9
Mean Chlorophyll a (µg/L)		1.8	2.9	5.5	8.5	10.3	6.7	8.2	2.5	4.6
Mean DOC (mg/L)					4.66	4.91	5.38	5.87	7.53	5.17
Mean Total N (mg/L)		0.304	0.330	0.481	0.616	0.548	0.719	0.613	0.407	0.642
NO3-NO2 (mg/L)		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.010
Mean Total P (mg/L)		0.017	0.014	0.014	0.015	0.027	0.022	0.023	0.013	0.020
SRP (mg/L)		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
# of Samples	3	6	6	6	6	6	6	6	6	6

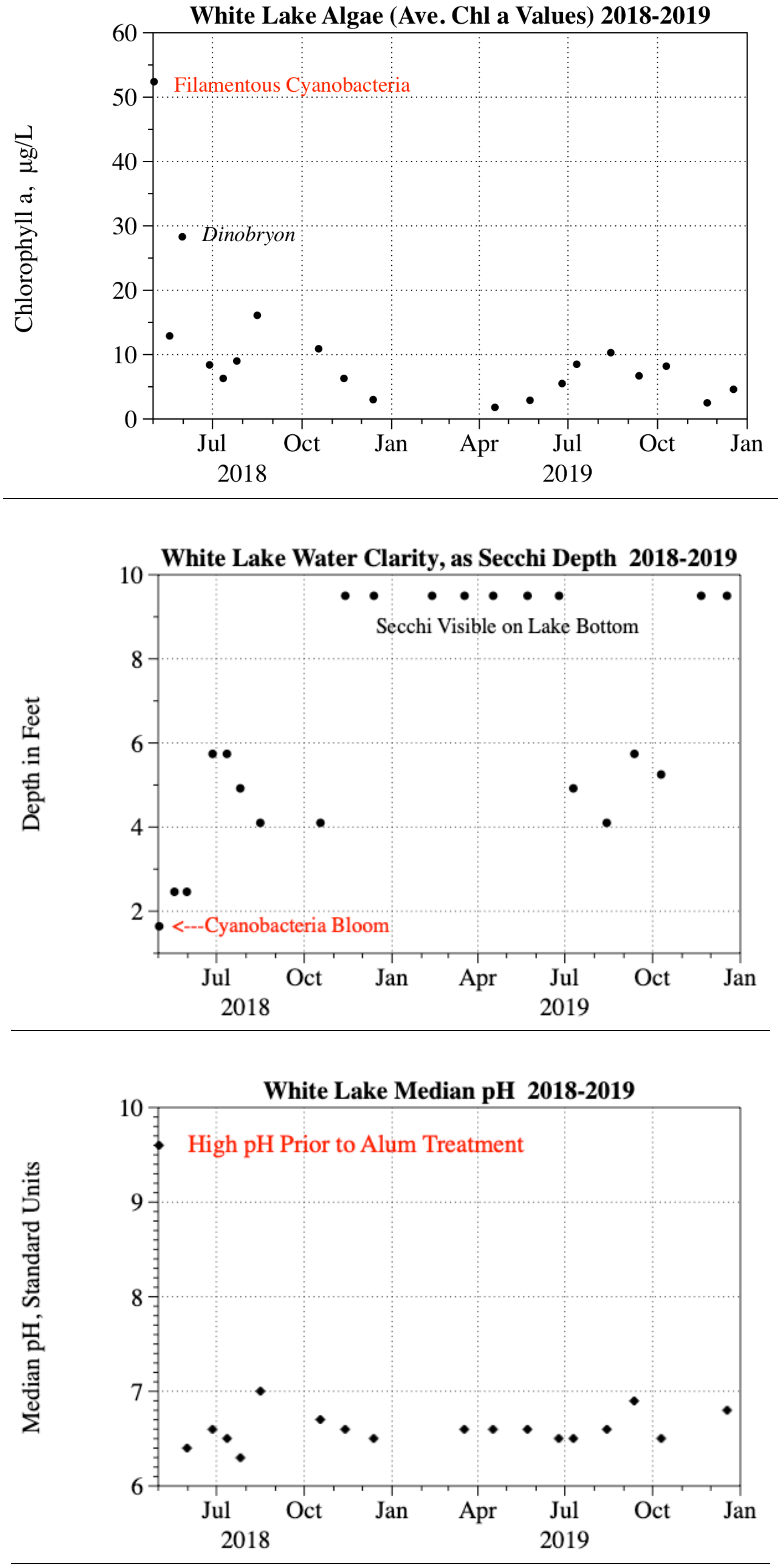


Figure 2. White Lake average chlorophyll a (µg/L), Secchi depths (ft), and median pH levels (SU), from May 2, 2018 (prior to alum treatment) to December 2019.

There was no substantial increase in pH over the summer months, with median pH levels remaining below 7 (Fig. 2). The highest median pH levels were found in September and December.

Nutrients

Total Nitrogen levels were low in April and May (means of 0.304 mg N/L in April and 0.330 mg N/L in May) and increased thereafter (Table 1). The majority of TN in White Lake is found in organic form (NC DEQ 2019) so includes what is contained in algal cells suspended in the water column; one form of inorganic nitrogen, nitrate-nitrite was analyzed and was below detection limits of 0.01 mg N/L in every month with the exception of November (Table 1).

The mean Total Phosphorus over the months sampled (April-December) was 0.018 mg P/L, with the highest monthly mean, 0.027 mg P/L found in August (Table 1). Total Phosphorus includes what is in algal cells, and this parameter tracks closely with chlorophyll levels. Soluble Reactive Phosphorus (SRP), a measure of what is readily available for algal uptake, was below detection limits of 0.001 mg P/L in every month with the exception of November, when it was at 0.001 mg/L (Table 1).

Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) have not been routinely analyzed by DEQ; in 2018, testing by Envirochem found that DOC comprised 90% of TOC on average from June through December, and ranged from 13.6 to 6.6 mg C/L; in 2019 DOC analysis was done from July through December, and mean values ranged from 4.66 to 7.53 mg C/L (Table 1).

Algae

Algal samples were taken at each station at 0.5 m depth; quantitative scans were done on April, May, July and September samples by Spirogyra Diversified Environmental Services. Very tiny cyanobacteria (picoplankton and nannoplankton) increased in abundance over time, with the highest cell densities found in September, when cyanobacteria comprised 72 % of total mean cell density (Table 2) and the highest number of cyanobacterial taxa were found (11; Appendix 1). The larger filamentous cyanobacteria that dominated in the bloom of 2017-2018 (Planktolyngbya and Aphanizomenon) were present but at very low densities.

The picoplankton-sized cyanobacteria that is abundant in White Lake is often important in oligotrophic waters and occasionally in more productive systems, and some species are "superior competitors for phosphorus" (Wehr and Sheath 2003). Because the species richness calculation is determined as the number of different species divided by the square root of the total number of algal cells in a sample, richness was lower in September even though the total number of different taxa found was highest in that month (Appendix 1).

The chlorophyll a values, which represent a measure of algal biomass, were higher in July and September when green algae cell densities were higher, as these algae are also larger by comparison with the small-celled cyanobacteria (Note: desmids were categorized as green algae although recent taxonomic changes have placed them in Class Charophyceae). Chrysophytes (mostly Dinobryon setularia), and diatoms were more abundant in April samples (Table 2).

Table 2. Summary data for Total algal abundance (cells/ml) and for the most abundant algal groups (Cyanos = Cyanobacteria, Greens = Chlorophyta + desmids, Chrysophytes = Chrysophyta, Diatoms = Bacillariophyta) species richness (Menhinick's Index of Richness, $D = s/\sqrt{N}$, where s = # of different species in a sample and N = total # of cells in a sample) and chlorophyll a (µg/L) in samples collected April 17, May 23, July 10, and September 12, 2019. Algal means calculated from three samples per month; each grab sample collected at 0.5 m depth. Chlorophyll means calculated from 6 samples per month; at each station one grab sample was collected at 0.5 m and one at 2.0 m.

	4/17/19	5/23/19	7/10/19	9/12/19
Mean chl a (µg/L)	1.8	2.9	8.5	6.7
Mean Total # cells/ml	17,164	15,665	38,001	65,604
Mean #cells/ml Cyanos	14,538	10,613	16,386	47,490
% of Total	84%	68%	43%	72%
Mean # cells/ml Greens	930	4,824	20,942	17,310
% of Total	5%	31%	55%	26%
Mean # cells/ml Chrysophytes	1,164	125	384	340
% of Total	7%	<1%	1%	<1%
Mean # cells/ml Diatoms	548	16	329	381
% of Total	3%	<1%	<1%	<1%
Species Richness	0.542	0.479	0.486	0.336

The benthic filamentous green alga Mougeotia appeared in November of 2018 as water temperatures decreased and the clarity of the water increased (Secchi visible on bottom). The mats persisted through mid-summer of 2019 and were not seen after that (Fig. 3).

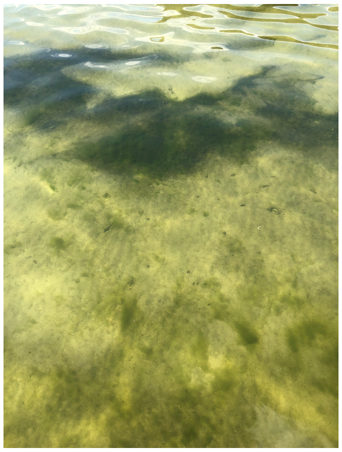


Figure 3. Filamentous algal mats in shallow water region of White Lake on March 18, 2019.

Aquatic Vegetation

The 2019 White Lake vegetation survey conducted by NCSU Aquatic Plant Management personnel found an increase in the percentage occurrence of aquatic vegetation compared to 2018, with two species—dwarf milfoil and spikerush—constituting the majority of the biomass (Table 3). Spikerush has been recorded from the lake as far back as vegetation sampling has been conducted (Tebo 1961).

Table 3. Aquatic vegetation found in annual whole-lake surveys of White Lake. Percentage occurrence is determined as the number of survey points in which each vegetation species is found divided by the total number of survey points (202) sampled (Table from 2019 NCSU White Lake Aquatic Vegetation Survey Report).

White Lake % Occurrence				
Species	**2014**	**2017**	**2018**	**2019**
Hydrilla	0%	84%	0.5%	1.5%
Dwarf Milfoil	0%	15%	20%	34%
Spikerush	40%	9%	56%	68%
Aquatic Moss	43%	63%	32%	6%
Chara	29%	66%	0%	0%
Low Milfoil	54%	0%	0.5%	0%
Bladderwort	14%	0%	0%	0%
No Vegetation	11%	6%	36%	16%
Vegetation	89%	93%	65%	84%

Hydrilla was found at three locations in 2019 at very low densities, with no floating fragments found. Its growth habit in White Lake is low—reaching a height of 6” or less—compared to other lakes where it can “top out”, reaching the surface of the water. So, while it appears that it does not do well, the tubers in the lake sediments were viable, sprouting some new growth. The stunted growth of Hydrilla in White Lake may be a consequence of the naturally-occurring aluminum found in the lake sediments, and/or the lower water-column pH (Dr. Rob Richardson, North Carolina State University, personal communication).

Lake Levels

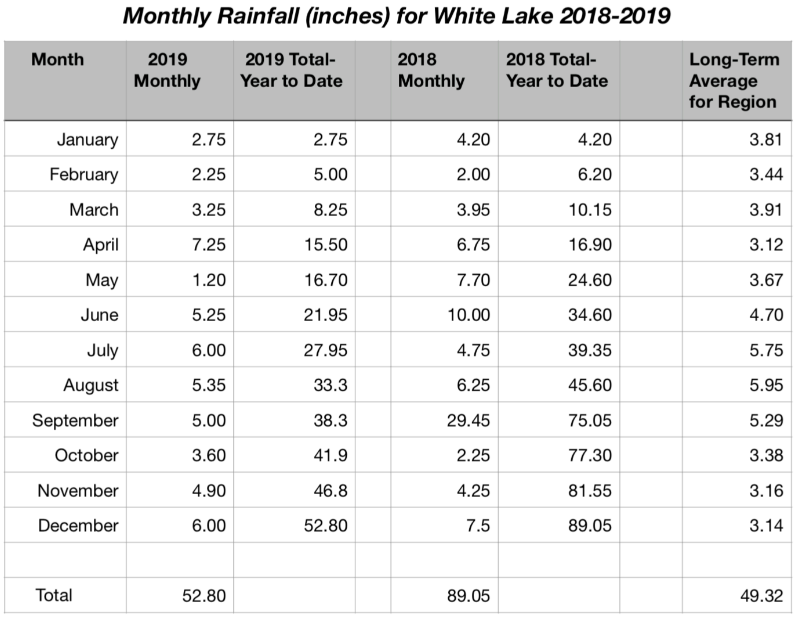
Lake levels in 2019 were consistent with the historical pattern of winter highs and summer lows, with an ordinary high-water level of 64.6 ft. above sea level seen on January 25, and a low of 63.54 ft. on July 9 (these elevations are measured using the current NAVD 88 datum, which is one-foot lower than the old NGVD 29 datum). This indicates that water depths also varied by nearly one foot (from a maximum of 9.4 ft. in January to 8.5 ft. in July). The greatest decline in lake levels—5.2 inches--was seen in the month of May.

The summer season was bookended by record-setting heat in May (the record in Fayetteville and Wilmington was 100 degrees Fahrenheit on May 23) and October (the record in Fayetteville was 99° on October 3). According to State Climatologist Kathie Dello and applied climatologist Corey Davis, 2019 was the hottest year on record for North Carolina; in a blog post they explain "where we are really seeing the heat isn't necessarily in the daytime temperatures, but the dominant trend is in our nighttime lows. It's those readings that have consistently pushed some of our recent warm years into the top ten warmest" (https://sciences.ncsu.edu/news/2019-the-warmest-year-in-n-c-history/?utm_medium=social&utm_source=twitter&utm_content=sciences&utm_campaign=socialhub) (web site accessed March 24, 2020).

Rainfall

Total rainfall for 2019 was 52.8 inches, slightly above the long-term average for the region (Table 4). The highest rainfall months were April, July and December. Below-average precipitation was seen across the Southeast during May, and in North Carolina, it was the 14th driest on record for the month (https://www.ncdc.noaa.gov/sotc/national/201905) (web site accessed March 24, 2020). At White Lake, May rainfall was a third of that month's long-term average for the region (Table 4.)

Table 4. Monthly rainfall at the White Lake Wastewater Treatment Plant in 2018 and 2019. The long-term average for the region is taken from data collected at Elizabethtown, which is posted at https://www.usclimatedata.com/climate/elizabethtown/north-carolina/united-states/usnc0205



Monthly Rainfall (inches) for White Lake 2018-2019

Month	2019 Monthly	2019 Total-Year to Date		2018 Monthly	2018 Total-Year to Date		Long-Term Average for Region
January	2.75	2.75		4.20	4.20		3.81
February	2.25	5.00		2.00	6.20		3.44
March	3.25	8.25		3.95	10.15		3.91
April	7.25	15.50		6.75	16.90		3.12
May	1.20	16.70		7.70	24.60		3.67
June	5.25	21.95		10.00	34.60		4.70
July	6.00	27.95		4.75	39.35		5.75
August	5.35	33.3		6.25	45.60		5.95
September	5.00	38.3		29.45	75.05		5.29
October	3.60	41.9		2.25	77.30		3.38
November	4.90	46.8		4.25	81.55		3.16
December	6.00	52.80		7.5	89.05		3.14
Total	52.80			89.05			49.32

Discussion

Sustained, long-term monitoring is critical to understanding lake dynamics, particularly with respect to the development of algae blooms, as variability due to weather can be difficult to distinguish from changes due to human impacts (Paerl 2014, Havens et al. 2016, Smol 2009). In addition, climate change-related increases in temperatures and greater hydrologic variability (more big rains and more droughts) can be expected to have significant impacts on a relatively shallow lake such as White Lake (with a mean depth of around 6.5 ft.).

In recent years there has been concern that changes in groundwater hydrology may be responsible for the changes in productivity that have been seen at White Lake, resulting in reductions in water clarity. The lake is often referred to as a spring-fed lake, on the basis of its clarity and the presence of features on the lake bottom—circles of white sand along the eastern shoreline, which can still be seen in aerial photography of the lake (Bladen GIS, 2013).

Recent groundwater modeling and isotope studies conducted by Shank and Zamora (2019) concluded that the majority of source water to White Lake is rainfall onto the lake surface (over 90% of the total), and that groundwater flow rates vary based on precipitation, which impacts groundwater levels (water table), but are relatively low. This is in agreement with what was known about White Lake hydrology as far back as the mid-1960s. There was no isotope evidence of deep, confined aquifer contributions to the lake—groundwater inflow comes from the surficial aquifer, and this conclusion is also supported by hydrogeological studies that have been done in the area (Shank and Zamora 2019; J. Perry, Lumber River Council of Governments, personal communication).

For 2019, the weather—both record-setting heat and low rainfall in May—contributed to the substantial drop in lake level seen that month, as losses due to evaporation from the lake surface were much higher than the inputs of water via rainfall.

Longer residence times and elevated temperatures are two of the characteristics which can contribute to the development of cyanobacterial blooms in lakes (Dokulil and Teubner 2000, Paerl and Otten 2013), although in shallow systems with very well-mixed water columns other factors are likely important . A comparison of monitoring data from the month of July over the period 2013-2019 suggests that rainfall may play a significant role, as the relatively high chlorophyll a levels of July 2013 (mean of 27.7 µg/L) were associated with high rainfall in the months of June and July (after a very dry period; B. Stafford, Town of White Lake, personal communication).

Aquatic ecosystems are dynamic rather than static systems—and sometimes changes can lead to a cascade of other changes. There have been substantial changes in atmospheric chemistry that have influenced rainfall chemistry, which directly impacts the chemistry of White Lake. Acid rain once made headlines as the biggest environmental problem in large parts of North America (including the mountain region of North Carolina) and the rain falling on White Lake was also very acidic. Since emissions of acid-producing pollutants have diminished significantly in recent years (Fig. 4), we have seen this change reflected in lake chemistry, as present lake pH levels substantially different from what they had been (from 4.5 to 6+).

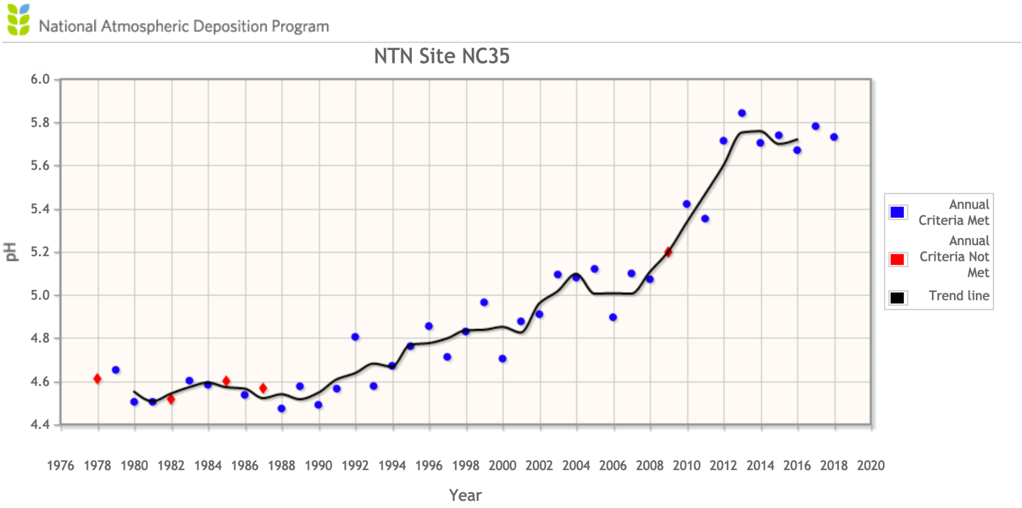


Figure 4. Annual rainfall pH at the National Atmospheric Deposition Program monitoring station at Clinton, NC (http://nadp.slh.wisc.edu/NTN/maps.aspx).

As the clarity of the source water to the lake—rainfall—has not changed, the clear water conditions of the past are still possible, but they are more transitory, and more likely to happen in winter months than summer months. Put another way: there tends to be more lake life in the water column when water temperatures are higher, and this influences clarity. Lake life associated with the lake bottom is generally more abundant during summer months as well, and filamentous algae and vegetation (as well as sediments) are often stirred up by boating activities in the lake, and this can also affect clarity.

This 2019 monitoring report represents a chapter in what should be a larger and longer story, that will likely evolve as we have more data from which to more reliably discern long-term trends. This is not a system in which the trophic classification system (oligotrophic/eutrophic) works well, as productivity (and nutrients) in the benthic zone are not assessed—what is quantified is only what is in the water column. We know from previous assessments that there have been times in which aquatic vegetation has been abundant, and times in which filamentous algae mats have been abundant—and this remains the case now that pH levels are higher as well. The annual variability in relative abundance of Hydrilla has been pronounced--the lake conditions would seem to favor the robust growth of this aquatic invasive weed, and yet it is subsisting, not thriving. Further studies are needed to understand the possible growth--limiting factors at play in this lake.

The Town of White Lake is to be commended for its support of the ongoing monitoring work, as science-informed management is widely recognized as the most effective.

Appreciation is also due to NC State Parks, NC Division of Water Resources, NC State University, Dr. Linda Ehrlich with Spirogyra Diversified Environmental Sciences, QA Officer Shannon Brattebo with Tetra Tech, and Dr. Damien Gadomski with IEH Analytical Laboratories.

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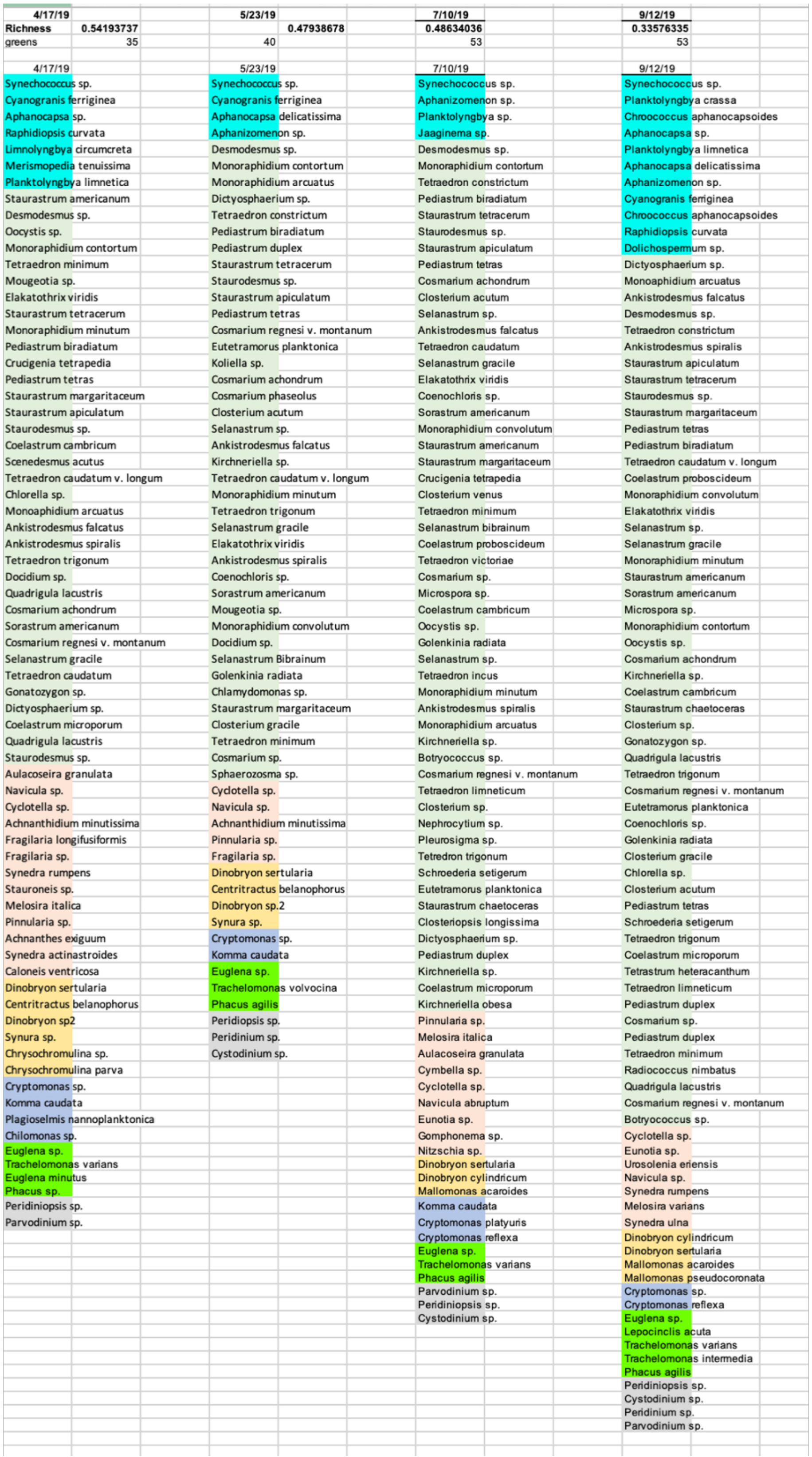
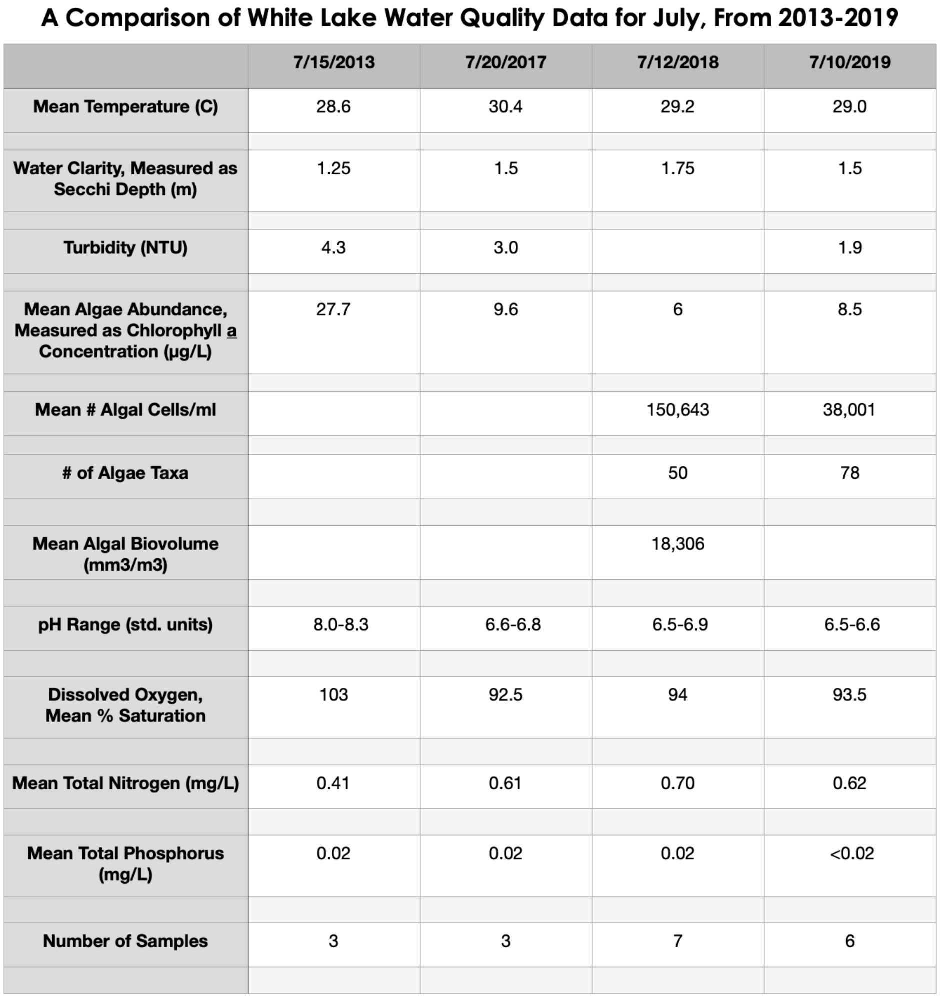
<u>Appendix 1</u>. White Lake algal taxa lists for April, May, July and September 2019, provided by Spirogyra Diversified Environmental Services.



4/17/19	5/23/19	7/10/19	9/12/19
Richness 0.54193737	0.47938678	0.48634036	0.33576335
greens 35	40	53	53
4/17/19	5/23/19	7/10/19	9/12/19
Synechococcus sp.	Synechococcus sp.	Synechococcus sp.	Synechococcus sp.
Cyanogranis ferriginea	Cyanogranis ferriginea	Aphanizomenon sp.	Planktolyngbya crassa
Aphanocapsa sp.	Aphanocapsa delicatissima	Planktolyngbya sp.	Chroococcus aphanocapsoides
Raphidiopsis curvata	Aphanizomenon sp.	Jaaginema sp.	Aphanocapsa sp.
Limnolyngbya circumcreta	Desmodesmus sp.	Desmodesmus sp.	Planktolyngbya limnetica
Merismopedia tenuissima	Monoraphidium contortum	Monoraphidium contortum	Aphanocapsa delicatissima
Planktolyngbya limnetica	Monoraphidium arcuatus	Tetraedron constrictum	Aphanizomenon sp.
Staurastrum americanum	Dictyosphaerium sp.	Pediastrum biradiatum	Cyanogranis ferriginea
Desmodesmus sp.	Tetraedron constrictum	Staurastrum tetracerum	Chroococcus aphanocapsoides
Oocystis sp.	Pediastrum biradiatum	Staurodesmus sp.	Raphidiopsis curvata
Monoraphidium contortum	Pediastrum duplex	Staurastrum apiculatum	Dolichospermum sp.
Tetraedron minimum	Staurastrum tetracerum	Pediastrum tetras	Dictyosphaerium sp.
Mougeotia sp.	Staurodesmus sp.	Cosmarium achondrum	Monoaphidium arcuatus
Elakatothrix viridis	Staurastrum apiculatum	Closterium acutum	Ankistrodesmus falcatus
Staurastrum tetracerum	Pediastrum tetras	Selanastrum sp.	Desmodesmus sp.
Monoraphidium minutum	Cosmarium regnesi v. montanum	Ankistrodesmus falcatus	Tetraedron constrictum
Pediastrum biradiatum	Eutetramorus planktonica	Tetraedron caudatum	Ankistrodesmus spiralis
Crucigenia tetrapedia	Koliella sp.	Selanastrum gracile	Staurastrum apiculatum
Pediastrum tetras	Cosmarium achondrum	Elakatothrix viridis	Staurastrum tetracerum
Staurastrum margaritaceum	Cosmarium phaseolus	Coenochloris sp.	Staurodesmus sp.
Staurastrum apiculatum	Closterium acutum	Sorastrum americanum	Staurastrum margaritaceum
Staurodesmus sp.	Selanastrum sp.	Monoraphidium convolutum	Pediastrum tetras
Coelastrum cambricum	Ankistrodesmus falcatus	Staurastrum americanum	Pediastrum biradiatum
Scenedesmus acutus	Kirchneriella sp.	Staurastrum margaritaceum	Tetraedron caudatum v. longum
Tetraedron caudatum v. longum	Tetraedron caudatum v. longum	Crucigenia tetrapedia	Coelastrum proboscideum
Chlorella sp.	Monoraphidium minutum	Closterium venus	Monoraphidium convolutum
Monoaphidium arcuatus	Tetraedron trigonum	Tetraedron minimum	Elakatothrix viridis
Ankistrodesmus falcatus	Selanastrum gracile	Selanastrum bibrainum	Selanastrum sp.
Ankistrodesmus spiralis	Elakatothrix viridis	Coelastrum proboscideum	Selanastrum gracile
Tetraedron trigonum	Ankistrodesmus spiralis	Tetraedron victoriae	Monoraphidium minutum
Docidium sp.	Coenochloris sp.	Cosmarium sp.	Staurastrum americanum
Quadrigula lacustris	Sorastrum americanum	Microspora sp.	Sorastrum americanum
Cosmarium achondrum	Mougeotia sp.	Coelastrum cambricum	Microspora sp.
Sorastrum americanum	Monoraphidium convolutum	Oocystis sp.	Monoraphidium contortum
Cosmarium regnesi v. montanum	Docidium sp.	Golenkinia radiata	Oocystis sp.
Selanastrum gracile	Selanastrum Bibrainum	Selanastrum sp.	Cosmarium achondrum
Tetraedron caudatum	Golenkinia radiata	Tetraedron incus	Kirchneriella sp.
Gonatozygon sp.	Chlamydomonas sp.	Monoraphidium minutum	Coelastrum cambricum
Dictyosphaerium sp.	Staurastrum margaritaceum	Ankistrodesmus spiralis	Staurastrum chaetoceras
Coelastrum microporum	Closterium gracile	Monoraphidium arcuatus	Closterium sp.
Quadrigula lacustris	Tetraedron minimum	Kirchneriella sp.	Gonatozygon sp.
Staurodesmus sp.	Cosmarium sp.	Botryococcus sp.	Quadrigula lacustris
Aulacoseira granulata	Sphaerozosma sp.	Cosmarium regnesi v. montanum	Tetraedron trigonum
Navicula sp.	Cyclotella sp.	Tetraedron limneticum	Cosmarium regnesi v. montanum
Cyclotella sp.	Navicula sp.	Closterium sp.	Eutetramorus planktonica
Achnanthidium minutissima	Achnanthidium minutissima	Nephrocytium sp.	Coenochloris sp.
Fragilaria longifusiformis	Pinnularia sp.	Pleurosigma sp.	Golenkinia radiata
Fragilaria sp.	Fragilaria sp.	Tetredron trigonum	Closterium gracile
Synedra rumpens	Dinobryon sertularia	Schroederia setigerum	Chlorella sp.
Stauroneis sp.	Centritractus belanophorus	Eutetramorus planktonica	Closterium acutum
Melosira italica	Dinobryon sp.2	Staurastrum chaetoceras	Pediastrum tetras
Pinnularia sp.	Synura sp.	Closteriopsis longissima	Schroederia setigerum
Achnanthes exiguum	Cryptomonas sp.	Dictyosphaerium sp.	Tetraedron trigonum
Synedra actinastroides	Komma caudata	Pediastrum duplex	Coelastrum microporum
Caloneis ventricosa	Euglena sp.	Kirchneriella sp.	Tetrastrum heteracanthum
Dinobryon sertularia	Trachelomonas volvocina	Coelastrum microporum	Tetraedron limneticum
Centritractus belanophorus	Phacus agilis	Kirchneriella obesa	Pediastrum duplex
Dinobryon sp2	Peridiopsis sp.	Pinnularia sp.	Cosmarium sp.
Synura sp.	Peridinium sp.	Melosira italica	Pediastrum duplex
Chrysochromulina sp.	Cystodinium sp.	Aulacoseira granulata	Tetraedron minimum
Chrysochromulina parva		Cymbella sp.	Radiococcus nimbatus
Cryptomonas sp.		Cyclotella sp.	Quadrigula lacustris
Komma caudata		Navicula abruptum	Cosmarium regnesi v. montanum
Plagioselmis nannoplanktonica		Eunotia sp.	Botryococcus sp.
Chilomonas sp.		Gomphonema sp.	Cyclotella sp.
Euglena sp.		Nitzschia sp.	Eunotia sp.
Trachelomonas varians		Dinobryon sertularia	Urosolenia eriensis
Euglena minutus		Dinobryon cylindricum	Navicula sp.
Phacus sp.		Mallomonas acaroides	Synedra rumpens
Peridiniopsis sp.		Komma caudata	Melosira varians
Parvodinium sp.		Cryptomonas platyuris	Synedra ulna
		Cryptomonas reflexa	Dinobryon cylindricum
		Euglena sp.	Dinobryon sertularia
		Trachelomonas varians	Mallomonas acaroides
		Phacus agilis	Mallomonas pseudocoronata
		Parvodinium sp.	Cryptomonas sp.
		Peridiniopsis sp.	Cryptomonas reflexa
		Cystodinium sp.	Euglena sp.
			Lepocinclis acuta
			Trachelomonas varians
			Trachelomonas intermedia
			Phacus agilis
			Peridiniopsis sp.
			Cystodinium sp.
			Peridinium sp.
			Parvodinium sp.

Appendix 2. Mean values for water quality parameters and algae from July sampling by NCDEQ (2013, 2017, 2018), Envirochem (2018) and LIMNOSCIENCES (2019).



A Comparison of White Lake Water Quality Data for July, From 2013-2019

	7/15/2013	7/20/2017	7/12/2018	7/10/2019
Mean Temperature (C)	28.6	30.4	29.2	29.0
Water Clarity, Measured as Secchi Depth (m)	1.25	1.5	1.75	1.5
Turbidity (NTU)	4.3	3.0		1.9
Mean Algae Abundance, Measured as Chlorophyll a Concentration (µg/L)	27.7	9.6	6	8.5
Mean # Algal Cells/ml			150,643	38,001
# of Algae Taxa			50	78
Mean Algal Biovolume (mm3/m3)			18,306	
pH Range (std. units)	8.0-8.3	6.6-6.8	6.5-6.9	6.5-6.6
Dissolved Oxygen, Mean % Saturation	103	92.5	94	93.5
Mean Total Nitrogen (mg/L)	0.41	0.61	0.70	0.62
Mean Total Phosphorus (mg/L)	0.02	0.02	0.02	<0.02
Number of Samples	3	3	7	6