LAKE & RESERVOIR ASSESSMENTS
CHOWAN RIVER BASIN

Merchants Millpond

Intensive Survey Branch
Water Sciences Section
Division of Environmental Quality
February 24, 2021

TABLE OF CONTENTS

GLOSSARY

Algae Small aquatic plants that occur as single cells, colonies, or filaments. May also be referred to as phytoplankton, although phytoplankton are a subset of algae.

Algal biovolume The volume of all living algae in a unit area at a given point in time. To determine biovolume, individual cells in a known amount of sample are counted. Cells are measured to obtain their cell volume, which is used in calculating biovolume

Algal density The density of algae based on the number of units (single cells, filaments and/or colonies) present in a milliliter of water. The severity of an algae bloom may be determined by the algal density as follows:

Mild bloom = 10,000 to 20,000 units/ml
Mild bloom = 20,000 to 30,000 units/ml
Severe bloom = 30,000 to 100,000 units/ml
Extreme bloom = Greater than 100,000 units/ml

Algal Growth Potential Test (AGPT) A test to determine the nutrient that is the most limiting to the growth of algae in a body of water. The sample water is split such that one sub-sample is given additional nitrogen, another is given phosphorus, a third may be given a combination of nitrogen and phosphorus, and one sub-sample is not treated and acts as the control. A specific species of algae is added to each sub-sample and is allowed to grow for a given period of time. The dry weights of algae in each sub-sample and the control are then measured to determine the rate of productivity in each treatment. The treatment (nitrogen or phosphorus) with the greatest algal productivity is said to be the limiting nutrient of the sample source. If the control sample has an algal dry weight greater than 5 mg/L, the source water is considered to be unlimited for either nitrogen or phosphorus.

Centric diatom Diatoms are photosynthetic algae that have a siliceous skeleton (frustule) found in almost every aquatic environment including fresh and marine waters, as well as moist soils. Centric diatoms are circular in shape and are often found in the water column.

Chlorophyll *a* Chlorophyll *a* is an algal pigment that is used as an approximate measure of algal biomass. The concentration of chlorophyll *a* is used in the calculation of the NCTSI, and the value listed is a lake-wide average from all sampling locations.

Clinograde In productive lakes where oxygen levels drop to zero in the lower waters near the bottom, the graphed changes in oxygen from the surface to the lake bottom produces a curve known as clinograde curve.

Coccoid Round or spherical shaped cell

Conductivity This is a measure of the ability of water to conduct an electrical current. This measure increases as water becomes more mineralized. The concentrations listed are the range of values observed in surface readings from the sampling locations.

Dissolved oxygen A measurement of oxygen concentrations found at the sampling locations.

Dissolved oxygen saturation The capacity of water to absorb oxygen gas. Often expressed as a percentage, the amount of oxygen that can dissolve into water will change depending on a number of parameters, the most important being temperature. Dissolved oxygen saturation is inversely proportion to temperature, that is, as temperature increases, water's capacity for oxygen will decrease, and vice versa.

Eutrophic Describes a lake with high biological productivity and low water transparency.

Eutrophication	The process of physical, chemical, and biological changes associated with nutrient, organic matter, and silt enrichment and sedimentation of a lake.
Limiting nutrient	The plant nutrient present in lowest concentration relative to need limits growth such that addition of the limiting nutrient will stimulate additional growth. In northern temperate lakes, phosphorus (P) is commonly the limiting nutrient for algal growth
Manganese	A naturally occurring metal commonly found in soils and organic matter. As a trace nutrient, manganese is essential to all forms of biological life. Manganese in lakes is released from bottom sediments and enters the water column when the oxygen concentration in the water near the lake bottom is extremely low or absent. Manganese in lake water may cause taste and odor problems in drinking water and require additional treatment of the raw water at water treatment facilities to alleviate this problem.
Mesotrophic	Describes a lake with moderate biological productivity and water transparency
NCTSI	North Carolina Trophic State Index was specifically developed for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NRCD 1982). It takes the nutrients present along with chlorophyll *a* and Secchi depth to calculate a lake's biological productivity.
Oligotrophic	Describes a lake with low biological productivity and high water transparency.
pH	The range of surface pH readings found at the sampling locations. This value is used to express the relative acidity or alkalinity of water.
Photic zone	The portion of the water column in which there is sufficient light for algal growth. DWR considers 2 times the Secchi depth as depicting the photic zone.
Secchi depth	This is a measure of water transparency expressed in meters. This parameter is used in the calculation of the NCTSI value for the lake. The depth listed is an average value from all sampling locations in the lake.
Temperature	The range of surface temperatures found at the sampling locations.
Total Kjeldahl nitrogen	The sum of organic nitrogen and ammonia in a water body. High measurements of TKN typically results from sewage and manure discharges in water bodies.
Total organic nitrogen (TON)	Total Organic Nitrogen (TON) can represent a major reservoir of nitrogen in aquatic systems during summer months. Similar to phosphorus, this concentration can be related to lake productivity and is used in the calculation of the NCTSI. The concentration listed is a lake-wide average from all sampling stations and is calculated by subtracting Ammonia concentrations from TKN concentrations.
Total phosphorus (TP)	Total phosphorus (TP) includes all forms of phosphorus that occur in water. This nutrient is essential for the growth of aquatic plants and is often the nutrient that limits the growth of phytoplankton. It is used to calculate the NCTSI. The concentration listed is a lake-wide average from all sampling stations.
Trophic state	This is a relative description of the biological productivity of a lake based on the calculated NCTSI value. Trophic states may range from extremely productive (Hypereutrophic) to very low productivity (Oligotrophic).
Turbidity	A measure of the ability of light to pass through a volume of water. Turbidity may be influenced by suspended sediment and/or algae in the water.
Watershed	A drainage area in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Overview

The Chowan River basin is located in the northeastern coastal plain of North Carolina and includes all or parts of Northampton, Hertford, Gates, Bertie and Chowan Counties. The Chowan River is formed at the border of Virginia and North Carolina by the confluence of the Nottoway and Blackwater Rivers and flows southeastward into Albemarle Sound. The region in which the Chowan River flows has slow natural drainage, is heavy in clays and sand, and contains many man-made ditches to accommodate drainage for agriculture.

A statewide fish consumption advisory from the North Carolina Department of Health and Human Resources, Division of Public Health is in place due to mercury contamination (https://epi.dph.ncdhhs.gov/oee/fish/advisories.html) Fish such as blackfish (bowfin), largemouth bass and chained pickerel (jack fish) have been found to have high mercury levels.

Assessment Methodology

For this report, data from January 1, 2016 through December 31, 2020 were reviewed. Lake monitoring and sample collection activities performed by DWR field staff are in accordance with the Intensive Survey Unit Standard Operating Procedures Manual (https://files.nc.gov/ncdeq/Water%20Quality/Environmental%20Sciences/ISU/2014LakesAll.pdf). An interactive map of the state showing the locations of lake sites sampled by DWR may be found at http://www.arcgis.com/home/webmap/viewer.html?webmap=9dbc8edafb7743a9b7ef3f6fed5c4db0&extent=-87.8069,29.9342,-71.5801,38.7611.

All lakes were sampled during the growing season from May through September. Data were assessed for excursions of the state's Class C water quality standards for chlorophyll *a*, pH, dissolved oxygen, water temperature, turbidity, and surface metals. Other parameters discussed in this report include secchi depth and percent dissolved oxygen saturation. Secchi depth provides a measure of water clarity and is used in calculating the trophic or nutrient enriched status of a lake. Percent dissolved oxygen saturation gives information on the amount of dissolved oxygen in the water column and may be increased by photosynthesis or depressed by oxygen-consuming decomposition.

For algae collection and assessment, water samples are collected from the photic zone, preserved in the field and taken concurrently with chemical and physical parameters. Samples were quantitatively analyzed to determine assemblage structure, density (units/ml) and biovolume (m^3/mm^3).

For the purpose of reporting, algal blooms were determined by the measurement of unit density (units/ml). Unit density is a quantitative measurement of the number of filaments, colonies or single celled taxa in a waterbody. Blooms are considered mild if they are between 10,000 and 20,000 units/ml. Moderate blooms are those between 20,000 and 30,000 units/ml. Severe blooms are between 30,000 and 100,000 units/ml and extreme blooms are those 100,000 units/ml or greater.

An algal group is considered dominant when it comprises 40% or more of the total unit density or total biovolume. A genus is considered dominant when it comprises 30% or more of the total unit density or total biovolume.

Quality Assurance of Field and Laboratory Lakes Data

Data collected in the field via multiparameter water quality meters are uploaded into the Labworks® Database within five days of the sampling date.

Chemistry data from the DWR Water Quality Laboratory are uploaded into Labworks®. If there are data entry mistakes, possible equipment, sampling, and/or analysis errors, these are investigated and corrected, if possible. Chemistry results received from the laboratory that are given a qualification code are entered along with the assigned laboratory code.

Information regarding the WSS Chemistry Laboratory Quality Assurance Program is available on the ISB website (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa).

Weather Overview for Summer 2020

The weather in North Carolina in May, 2020 was cool and wet, especially in the central portion of the state. The average statewide temperature was 63.7° F, making May 2020 the 13th coolest May since 1895. Despite the lower than normal temperatures, two tropical storms formed during this month. Tropical Storm Arthur formed from a low system over the Bahamas on May 17th and tracked up the southeast coast parallel to the North Carolina coast before turning eastward. Tropical Storm Bertha formed similarly to Tropical Storm Arthur. It's track, however, took it onshore north of Charleston, South Carolina on May 27th. The remnants of Bertha moved inland, with the center of low pressure tracking through North Carolina. Rainfall from the system primarily focused on a track through the western and southern Piedmont, and little rain fell in the northeastern part of the state. With the two tropical storms and a series of slow-moving low pressure systems, the statewide average precipitation for the state in May was 7.5 inches.

The cool late-spring pattern and wetter than normal conditions continued into June. The statewide average temperature was 73.3° F. Average maximum temperatures across the state were four degrees below normal and the average minimum temperatures were near-normal to slightly above normal. These daily temperatures were an indication of the cloudy conditions which existed in June. Statewide average rainfall was 4.8 inches and the monthly average streamflow across the state remained near to above-normal in June.

The cooler than normal temperatures of May and June came to an abrupt end in July 2020 with the statewide average temperature reaching 79.7° F, making it the 6th warmest July since 1895. With the heat came a reduction in rainfall, (the statewide average dropping to 4.2 inches), making this month the 28th driest July out of the past 126 years. Of further concern was the comparison of the dry conditions across the state with those seen in 2007, which was the beginning of a multi-year extreme drought. However, unlike 2007 which experienced a dry and warm spring and early summer, the summer of 2020 started with cool, wet conditions that extended through June. Abnormally dry conditions formed in the northeastern Piedmont and northern Coastal Plain regions of the state by late July 2020 and streamflows in the Upper Tar and Chowan River Basins dropped below normal.

August statewide average temperature was 77.5° F. The month started with the arrival of Hurricane Isaias, which was the ninth named storm to form in the Atlantic before the end of July. Hurricane Isaias came onshore in Brunswick County, North Carolina on August 3rd and quickly traveled northward across the Coastal Plain, producing three to four inches of rain in the eastern part of the state.

The statewide average precipitation for August was 7.8 inches, making this month the 13th wettest August since 1895 and the wettest August since 1992. A low-pressure system on August 15th accompanied by several lines of thunderstorms produced a daily precipitation total of up to three inches of rain in in the northeastern portion of the state. August 31st brought a final round of slow-moving showers. All of this rainfall eliminated the abnormally dry conditions in the Northern Coastal Plain and brought the statewide streamflow to near or above normal.

September brought a cooling of temperatures. The statewide average temperature for the month was 69.8° F. Statewide average precipitation was 6.6 inches and ranked as the 15th wettest September since 1895. On September 16-18, the remnants of Hurricane Sally crossed North Carolina, bringing up to an inch of rain in the northern Coastal Plain. On September 25-26, the remnants of Tropical Storm Beta produced some rainfall in the northeastern part of the state. The state remained free of drought conditions through the month of September.

LAKE & RESERVOIR ASSESSMENTS

HUC 03010203

Merchants Millpond

Ambient Lakes Program Name	Merchants Millpond	
Trophic Status (NC TSI)	Eutrophic	
Mean Depth (meters)	1.2	
Volume ($10^6 m^3$)	0.22	
Watershed Area (mi^2)	79.0	
Classification	C NSW	
Station	CHO0153A	CHO0154A
Number of Times Sampled	5	5

Merchants Millpond, located in the coastal plain region of North Carolina (Gates County), has a rich and varied history. Originally called Norfleets Millpond, it was constructed in 1811 and contained a grist mill, a wheat mill and a saw mill. Merchants Millpond is a shallow lake with a maximum depth of five feet (1.5 meters). The major inflow is from Lassiter Swamp Creek. The millpond drainage area is characterized by flat or gently rolling terrain with the majority being forested or wetlands, approximately one quarter is urbanized, and some agriculture. The millpond, which is now part of Merchants Millpond State Park, is used for recreational canoe and kayak boating.

DWR field staff monitored Merchants Millpond once monthly from May through September 2020. Surface dissolved oxygen ranged from 0.7 to 7.8 mg/L, with five of ten observations (50%) below the state water quality standard of 4.0 mg/L for an instantaneous reading (Appendix A). This may be within the natural conditions for this millpond, which exhibits many characteristics associated with a Swamp Water such as tannic waters, buttressed trees, shallow depth, etc. Duck weed and water meal are present on the surface of Merchants Millpond while submerged aquatic macrophytes occur throughout the lake. Surface pH ranged from 6.2 to 7.1 s.u. in 2020. Total phosphorus concentrations ranged from 0.15 to 0.47 mg/L and total organic nitrogen ranged from 0.89 to 1.39 mg/L. Chlorophyll *a* values ranged from 1.1 to 96.0 *u*g/L. The chlorophyll *a* values at both lake sampling sites in July were greater than the state water quality standard of 40 *u*g/L.

In July, this lake exhibited highly elevated biological productivity (hypereutrophic conditions) and elevated biological productivity (eutrophic conditions in May, June, August and September based on the NCTSI scores. Overall, Merchants Millpond was eutrophic in 2020. This lake has consistently exhibited elevated biological productivity since it was first monitored by DWR in 1981.

Appendix A - Chowan River Basin Lakes Data
October 1, 2011 through September 31, 2015

Lake	Date	SURFACE PHYSICAL DATA							PHOTIC ZONE DATA										
		Sampling Station	DO mg/L	Temp Water C	pH s.u.	Cond. µmhos/cm	Secchi Depth meters	Percent SAT	TP mg/L	TKN mg/L	NH3 mg/L	NOx mg/L	TN mg/L	TON mg/L	TIN mg/L	Chla µg/L	Total Solids mg/L	Total Suspended Solids mg/L	Turbidity NTU
HUC 03010203																			
MERCHANTS MILLPOND	September 30, 2020	CHO0153A	0.7	21.0	6.6	79	0.5	7.4%	0.25	1.00	0.020	<0.02	1.01	0.98	0.03	<5.0	64	<8.3	3.6
	September 30, 2020	CHO0154A	1.8	20.7	6.6	78	0.5	19.6%	0.18	0.92	0.030	<0.02	0.93	0.89	0.04	15.0	102	8.5	3.3
	August 10, 2020	CHO0153A	7.8	26.6	6.3		0.7	97.1%	0.25	1.00	0.030	<0.02	1.01	0.97	0.040	4.5	101	<12.0	4.0
	August 10, 2020	CHO0154A	0.9	26.7	6.2	81	0.6	11.6%	0.24	1.10	0.030	<0.02	1.11	1.07	0.04	4.1	97	<6.2	4.0
	July 22, 2020	CHO0153A	2.1	24.7	6.3	86	0.6	25.2%	0.33	1.00	<0.02	<0.02	1.01	0.99	0.020	67.0	106		5.5
	July 22, 2020	CHO0154A	6.2	29.1	6.4	100	0.9	80.2%	0.47	1.40	<0.02			1.39		96.0	122	36.0	21.0
	June 9, 2020	CHO0153A	2.1	24.7	6.3	86	0.4	25.2%	0.30	1.00	0.030			0.97		8.2	96	7.0	5.6
	June 9, 2020	CHO0154A	1.8	26.2	6.2	88	0.8	21.9%	0.18	0.98	<0.02	<0.02	0.99	0.97	0.02	8.1	88	<6.2	3.1
	May 12, 2020	CHO0153A	5.0	16.4	6.5	85	0.8	50.3%	0.18	0.93	0.030	<0.02	0.94	0.90	0.040	1.1	88	<6.2	4.8
	May 12, 2020	CHO0154A	6.2	17.5	7.1	81	0.8	64.6%	0.15	0.94	0.020	<0.02	0.95	0.92	0.03	1.4	94	<6.6	3.9