LAKE & RESERVOIR ASSESSMENTS
WHITE OAK RIVER BASIN

Catfish Lake

Intensive Survey Branch
Water Sciences Section
Division of Water Resources
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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 White Oak River basin lies entirely within the southern outer coastal plain, where 1,233 square miles of watershed drain into the New, White Oak, Newport, and North rivers. The basin contains 267 miles of freshwater streams and rivers. The basin also contains extensive estuarine areas in Bogue and Core sounds. The White Oak River watershed is east of the New River. Much of the watershed lies within the Croatan National Forest and the Hoffman State Forest. Extensive pocosins, (wetlands characterized by deep acidic, sandy peat soils that are seasonally saturated with water), dominate much of the landscape. Water quality is generally good in these areas. Streams flowing through these forests, including Holston Creek, Hunters Creek, and Pettiford Creek, have naturally low pH, turbidity, and conductivity values. The west side of the river is more developed, so streams on this side, such as Starkeys Creek and Webb Creek, have higher pH and conductivity values and support benthic communities more tolerant to pollution than streams on the east side of the river (NCDENR, April 2005).

Catfish Lake, which is located within the Croatan National Forest, was sampled in this river basin by DWQ staff in 2019. Sampling of Great Lake was not conducted due to access problems related to a road culvert washout caused by Hurricane Florence. Catfish Lake is classified as Carolina Bay Lake and is notable for its elliptical shape, shallow, tea-colored water and low pH values due to underlying layers of peat.

Lakes in the White Oak River Basin located south and east of I-85 have been placed under a fish consumption advisory by the North Carolina Department of Health and Human Resources, Division of Public Health due to mercury contamination (https://epi.dph.ncdhhs.gov/oee/fish/advisories.html). Blackfish (bowfin), largemouth bass and chained pickerel (jack fish) in this area have been found to have high mercury levels.

Assessment Methodology

For this report, data from January 1, 2015 through December 31, 2019 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 (http://portal.ncdenr.org/c/document_library/get_file?uuid=522a90a4-b593-426f-8c11-21a35569dfd8&groupId=38364) 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 2019

May 2019 brought summer-like heat across the state, resulting in the 3rd warmest May since 1895. A strong Bermuda high pressure system sitting of the southeast coast produced and ongoing flow of warm, moist Atlantic and Gulf of Mexico air into the state. The preliminary statewide average temperature for May was 71.0°F, which was 5.1°F above the 1981 to 2010 average. The Coastal Plains experienced elevated temperatures and humidity. Precipitation was on the dry side with the statewide average of 2.6", making May 2019 the 17th driest May out of the past 125 years. The Coastal Plain region of the state saw very limited rainfall such that by May 28th Abnormally Dry to Moderate Drought conditions were present.

June brought a return of regular rainfall in North Carolina. The statewide precipitation average was 7.1" (8th wettest June since 1895). The White Oak River Basin, along with the southeastern Coastal Plain region, remained abnormally dry. Due to the relaxing of the Bermuda high and the frequent rainfall events, temperatures in June were lower with the high temperatures one to two degrees below normal. Temperatures rose the final week of June into the upper 90s.

Elevated temperatures continued into July. Overnight temperatures ranked particularly high in the Mountains where much of the month was spent in a humid air mass that kept temperatures and dew points elevated. In New Bern, the seven hours of heat index values of 110°F or greater were the most since 2012. The rainfall in July followed a typical hit or miss summertime pattern. Rainfall in the southeastern Coastal Plain remained limited in July, however.

The summer heat retreated slightly in August as the Bermuda high system remained far to the east, allowing for more moderate temperatures across the state. Rainfall was scattered throughout the state

leaving some areas wet while others remained dry. As August came to a close, Hurricane Dorian formed in the Atlantic and headed east toward the US Southeast Coast.

Hurricane Dorian struck the northern Bahama Islands as a Category 5, then closely approached the Florida east coast before turning north and traveling up toward North Carolina. Dorian lost a great deal of its strength after striking the Bahamas and reached the southern coast of the state on September 5th as a Category 2 storm. Turning to the northeast, the eyewall of the hurricane traveled from the Cape Fear to Cape Lookout and then to Cape Hatteras before turning out to sea. Rainfall from the hurricane produced approximately six to eight inches of rain in the White Oak River Basin.

September was exceptionally warm. The preliminary average statewide temperature of 74.1°F ranked this as tie 8th-warmest September in the past 125 years. For the month as a whole, the average highs were 10 degrees above normal and the western two-thirds of the state were at least five degrees above normal. The eastern portion of the state that was impacted by rainfall from Hurricane Dorian earlier in the month was the only section of the state that received significant widespread rainfall in September.

LAKE & RESERVOIR ASSESSMENTS

HUC 03020106

Catfish Lake

Ambient Lakes Program Name	Catfish Lake	
Trophic Status (NC TSI)	Dystrophic	
Mean Depth (meters)	1.5	
Volume ($10^6 m^3$)	0.58	
Watershed Area (mi^2)	40	
Classification	C	
Stations	WOK026D	WOK026E
Number of Times Sampled	5	5

Catfish Lake is a natural blackwater Carolina Bay Lake in the Croatan National Forest. Although the lake is large, it is uniformly shallow with a maximum depth of approximately 1.5 meters. Having no feeder stream, the lake level is maintained by rainfall and groundwater recharge. The land surrounding the lake is flat, swampy and forested. Catfish Lake is classified as C.

In 2019, DWR staff sampled Catfish Lake once monthly from May through September. As to be expected for a blackwater lake, secchi depths ranged from 0.1 to 0.2 meter (Appendix A). Surface dissolved oxygen concentrations ranged from 7.1 to 8.2 mg/L and surface water temperature ranged from 22.2 C° to 29.6 C°. Surface pH ranged from 4.2 to 4.3 s.u., which is normal for this lake.

Nutrient concentrations in Catfish Lake were similar to those previously observed. Total phosphorus ranged from 0.04 to 0.07 mg/L and total Kjeldahl nitrogen ranged from 0.65 to 0.85 mg/L. Total organic nitrogen ranged from 0.64 to 0.84 mg/L and chlorophyll *a* raged from 1.8 to 32.0 µg/L. Turbidity values ranged from 34 to 65.0 NTU. Turbidity values greater than the state water quality standard of 25 NTU are due to the shallowness of the lake and wind induced wave activity that easily suspends particles of sediment and organic material into the water column.

Data from the 2019 sampling trips indicate that there have not been any substantial changes in the nutrient and physical data since 1981 and that Catfish Lake continues to maintain the same water quality as observed on the first DWQ sampling trips. Due to the dystrophic nature of this lake, an accurate North Carolina Trophic State Score cannot be accurately determined.

Appendix A - White Oak River Basin Lake Data
January 1, 2014Through December 31, 2019

Lake	Date	Sampling Station	SURFACE PHYSICAL DATA DO mg/L	Temp Water C	pH s.u.	Cond. µmhos/cm	Depth Secchi meters	Percent SAT	PHOTIC ZONE DATA TP mg/L	TKN mg/L	NH3 mg/L	NOx mg/L	TN mg/L	TON mg/L	TIN mg/L	Chla µg/L	Solids Total mg/L	Total Solids Suspended mg/L	Turbidity NTU
HUC 03020002																			
CATFISH LAKE	September 30, 2019	WOK026D	7.3	27.5	4.3	44	0.2	92.0%	0.06	0.75	<0.02	0.20	0.95	0.74	0.21		85	20.0	65
	September 30, 2019	WOK026E	7.3	27.4	4.2	44	0.2	91.2%	0.06	0.83	<0.02	0.20	1.03	0.82	0.21		84	18.0	60
	August 7, 2019	WOK026D	7.3	29.6	4.3	44	0.1	95.8%	0.04	0.67	<0.02	0.15	0.82	0.66	0.16	4.0	52	<6.2	38
	August 7, 2019	WOK026E	7.1	29.0	4.3	45	0.2	92.6%	0.05	0.68	<0.02	0.15	0.83	0.67	0.16	1.8	52	<6.2	40
	July 9, 2019	WOK026D	7.2	28.4	4.3	42	0.1	92.5%	0.07		0.04	0.11			0.15	15.0	74	26.0	55
	July 9, 2019	WOK026E	7.2	28.1	4.3	42	0.1	92.1%	0.07		0.04	0.11			0.15	14.0	71	22.0	50
	June 24, 2019	WOK026D	7.4	27.2	4.2	44	0.1	92.5%	0.07	0.85	<0.02	0.11	0.96	0.84	0.12	31.0	67	16.0	50
	June 24, 2019	WOK026E	7.7	27.4	4.3	44		97.2%	0.05	0.78	<0.02	0.12	0.90	0.77	0.13	32.0	51	<12.0	34
	May 16, 2019	WOK026D	8.2	22.5	4.2	43	0.2	94.2%	0.07	0.81	<0.02	0.14	0.95	0.80	0.15	6.1	71	16.0	50
	May 16, 2019	WOK026E	8.0	22.2	4.3	43	0.2	91.7%	0.05	0.65	<0.02	0.14	0.79	0.64	0.15	3.9	59	7.2	35