

LAKE & RESERVOIR ASSESSMENTS WHITE OAK RIVER BASIN



Catfish Lake

Intensive Survey Unit
Environmental Sciences Section
Division of Water Quality
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HUC 03020106	
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**Appendix A. White Oak River Basin Lakes Use Support Matrix
For 10/1/2005 – 9/31/2009**

Appendix B. White Oak River Basin Lakes 2009 Use Support Data

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 many be determined by the algal density as follows: 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 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 photosynthetic algae that have a siliceous skeleton (frustule) and are found in almost every aquatic environment including fresh and marine waters, soils, in fact almost anywhere moist. 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.
Cocoid	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	The range of surface 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 dissolved 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 plant 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 north 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 plant 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 plant 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. DWQ 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

This 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 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 and Great Lake were sampled in this river basin by DWQ staff in 2009. Both of these lakes are classified as Carolina Bay Lakes and are notable for their elliptical shape, shallow, tea-colored water and low pH values due to underlying layers of peat. Catfish and Great Lakes are located within the Croatan National Forest.

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 (<http://www.schs.state.nc.us/epi/fish/current.html>). Blackfish (bowfin), largemouth bass and chained pickerel (jack fish) in this area have been found to have high mercury levels.

Following the description of the assessment methodology used for the White Oak River Basin, there are individual summaries for each of the lakes and a two-paged matrix that distills the information used to make the lakes use support assessments. For additional information on a particular lake (including sampling data), please go to <http://www.esb.enr.state.nc.us/>.

Assessment Methodology

For this report, data from January 1, 2005 through September 30, 2009 were reviewed. All lakes were sampled during the summer from May through September of 2009. Data were assessed for excursions of the state's class C water quality standards for chlorophyll *a*, pH, dissolved oxygen, water temperature, and turbidity. 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.

A water quality standard is exceeded (denoted by CE in matrix) if data values do not meet the state's water quality standard for more than 10% of the samples where the sample size consists of 10 or more observations for the basinwide assessment period. Ideally, 10 observations are needed to provide sufficient data for a reasonable interpretation of water quality conditions within the lake or reservoir. Fewer observations increase the possibility of misinterpreting random unusual conditions as representative of ongoing water quality trends. If the water quality standard is exceeded, either in less than 10% of the data collected during the assessment period or if the sample observation size is less than 10 for the basinwide assessment period, then the water quality standard for that parameter is designated exceeded (E in the matrix).

Additional data considered as part of the use support assessment include historic DWQ water quality data, documented algal blooms and/or fish kills, problematic aquatic macrophytes, or listing on the EPA's 303(d) List of Impaired Waters.

Lakes receive an overall rating of Supporting or Impaired when 10 or more samples per water quality criteria are collected for evaluation within the basinwide assessment period. Otherwise, the lake is considered as Not Rated. The exception is for a lake listed on the 303(d) List of Impaired Waters or where additional data indicates water quality problems not captured during sampling. These lakes are listed as Impaired along with the reason for the impairment.

For a more complete discussion of lake ecology and assessment, please go to <http://www.esb.enr.state.nc.us/>. The 1990 North Carolina Lake Assessment Report (downloadable from this website) contains a detailed chapter on ecological concepts that clarifies how the parameters discussed in this review relate to water quality and reservoir health.

LAKE & RESERVOIR ASSESSMENTS

HUC 03020106



Catfish Lake

Catfish Lake is a natural blackwater Carolina Bay Lake in the Croatan National Forest. Although the lake is large (950 acres), 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 2009, DWQ staff sampled Catfish Lake once monthly from May through September. Physical water data was similar to those observed in the past for this lake. Surface dissolved oxygen ranged from 6.9 and 8.5 mg/L and surface water temperatures ranged from 21.6 to 30.1 C. The surface pH values for Catfish Lake are acidic (range = 3.9 to 5.7 s.u.) and these values are typical for Carolina Bay Lakes. The dark, tea-colored water is also a natural feature of these lakes.

Nutrient concentrations in 2009 ranged from very low to elevated. The highest nutrient levels were observed in May and may have been due to windy conditions on the day Catfish Lake was sampled. This lake has an average depth of 1.5 meters, making it easy for suspension of nutrient-rich bottom sediments from wind-induced waves. Field notes from the May sampling trip indicate that sediment and organic particles (mostly peat particles) were present in the collected water samples. If elevated turbidity values are related to natural background condition for this shallow lake, the standard is not violated unless turbidity values exceed natural conditions [15A NCAC 02B .0211 (3) (k)]. The Secchi depths recorded during the May sampling trip were also very low (0.3 and 0.2 meters) as compared with the Secchi depths of subsequent trips which ranged from 0.5 to 1.0 meter, suggesting that the lake water was turbid due to the suspended sediments and organic materials from the lake bottom.

Chlorophyll a values in 2009 were low and ranged from 4.2 to 11.0 µg/L. These values were similar to chlorophyll a concentrations observed since 1981 when Catfish Lake was first monitored by DWQ. Due to the dystrophic nature of this lake, an accurate North Carolina Trophic State Score cannot be determined. Data from the 2009 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.



Great Lake

Great Lake is a natural blackwater lake located within the Croatan National Forest. Like other Carolina Bay Lakes, it is a large (39.9 km²), shallow (1.0 meter) body of water with acidic tannic water. Great Lake has no major tributaries and relies primarily on precipitation for recharge. This lake is currently classified C and is used for recreational purposes.

Great Lake was monitored monthly from May through September by DWQ staff. Surface dissolved oxygen ranged from 9.1 mg/L in May to 6.8 mg/L in August. Like Catfish Lake, Great Lake has naturally occurring low pH values. In 2009, the surface pH readings ranged from 4.1 to 4.4 s.u. Secchi depths ranged from 0.1 to 0.3 meter and were similar to Secchi depths observed for this lake since it was first monitored by DWQ staff in 1981. Field notes from the May sampling trip indicate that exceptionally windy conditions suspended sediment and organic particles (mostly peat particles) into the lake water. This resulted in very elevated turbidity levels (range = 75 to 120 NTU). The large surface area and shallow depth of Great Lake contribute to the suspension of peat sediments into the water column through wind and/or storm events. If elevated turbidity values are related to natural background condition for this shallow lake, the standard is not violated unless turbidity values exceed natural conditions [15A NCAC 02B .0211 (3) (k)].

Total phosphorus, total Kjeldahl nitrogen and nitrite plus nitrate nitrogen were elevated but were within the same ranges previous observed on previous sampling trips. Chlorophyll *a* values were also similar with the exception of a value of 31 µg/L, which was observed at the northern side of the lake (WOK026G) on June 11th. This was the highest chlorophyll *a* concentration recorded for Catfish Lake since 1981, but was less than the state water quality standard of 40 µg/L. An analysis of a phytoplankton sample collected at WOK026G indicated the presence of a mild bloom of *Chlamydomonas* sp. This is a common unicellular flagellated green alga found in surface waters throughout North Carolina. Blooms of *Chlamydomonas* sp. may cause a discoloration of the water, but no adverse environmental or human health risks have been associated with this alga.

Due to the dystrophic nature of this lake, an accurate North Carolina Trophic State Score cannot be determined. Data from the 2009 sampling trips, with the exception of the one elevated chlorophyll *a* value in June, indicate that there have not been any substantial changes in the nutrient and physical data since 1981 and that Great Lake continues to maintain the same water quality as observed on the first DWQ sampling trips.

References

NCDENR. April 2005. White Oak River basinwide assessment report. Biological Assessment Unit. North Carolina Department of Environment and Natural Resources. Division of Water Quality. Water Quality Section. Environmental Sciences Branch. Raleigh, NC.

NCDENR. May 1, 2007. Administrative Code Section: 15A NCAC 2B .0200 Procedures for Assignment Of water Quality Standards. Environmental Management Commission, Raleigh, NC.

APPENDIX A

WHITE OAK RIVER BASIN AMBIENT LAKES USE SUPPORT MATRIX FOR 10/1/2005 - 9/31/2009

8 Digit HUC		03020106	
Lakes Ambient Program Name		Cattfish Lake	Great Lake
Trophic Status (NC TSI)			
Mean Depth (meters)		1.5	1.0
Volume (10 ⁶ m ³)		0.58	1.2
Watershed Area (km ²)		39.9	
Assessment Unit Name		From source to Black Swamp Creek	Hunters Creek from source to White Oak River
Classification		C	C
Assessment Unit		20-9-1	20-17
Stations in Assessment Unit		WOK026D, WOK026E	WOK026G, WOK026H
Number of Sampling Trips		5	5
Water Quality Standards			
Chlorophyll a	>40 ug/L	NCE	NCE
Dissolved Oxygen	<4.0 mg/L	NCE	NCE
pH	<6 s.u. or > 9 s.u.	NCE*	NCE*
Turbidity	>25 NTU	NCE*	NCE*
Temperature	>32°C Coastal Plain	NCE	NCE
Metals (excluding copper, iron & zinc)	15A NCAC 2B .0211	NE	NE
Other Data			
% Saturation DO	>120%	N	N
Algae	Documented blooms during 2 or more sampling events in 1 year with historic blooms	N	N
Fish	Kills related to eutrophication	N	N
Chemically/Biologically Treated	For algal or macrophyte control - either chemicals or biologically by fish, etc.	N	N
Aesthetics complaints	Documented sheens, discoloration, etc. - written complaint and follow-up by a state	N	N
TSI	Increase of 2 trophic levels from one 5-yr period to next	N	N
303(d)	Listed on 303(d) [year listed]	N	N
AGPT	Algal Growth Potential Test 5-9 mg/L = concern 10 mg/L or more = problematic	NE	NE
Macrophytes	Limiting access to public ramps, docks, swimming areas; reducing access by fish and other aquatic life to habitat	N	N
Taste and Odor	Public complaints or taste and odor causing algal species are dominant	NA	NA
Sediments	Clogging intakes - dredging program necessary; frequent public/agency complaints - visual observation	NA	NA
Rating:		S	S

RATING KEY:

S = Supporting
I = Impaired
NR = Not Rated

Not Rated is used where there are <10 samples and other data indicate potential problems

* Elevated turbidity and low pH values due to natural conditions and dystrophic nature of the lakes. Please see lake reports for more information.

KEY:

E = Criteria is exceeded in less than 10% of the measurements or criteria exceeded but n<10
CE = Criteria Exceeded - parameter is problematic, highly productive or exceeds the standard in >10% of samples
NCE = No Criteria Exceeded
- = Standard not applicable based on Classification
ND = No Data - sample not taken for this parameter
Y = In Other Data portion, indicates that the parameter has exceeded target or has occurred
N = In Other Data portion, indicates that the parameter is within target or has not occurred per available information
NE = Not Evaluated

Appendix B
White Oak River Basin Lakes 2009 Use Support Data

State Water Quality Standards

COASTAL PLAIN	DO mg/L	Water Temp C	pH s.u.	Percent SAT	Chla µg/L	Turbidity NTU	Chloride mg/L
C & B Criteria	<4.0*	32	<6** or >9	120%	40	25	-

* Swamp waters may naturally have DO values less than 4.0 mg/L.

** Not applicable to waters designated as Swamp Waters where low pH values are part of the natural conditions of the waters.

Region	Lake	AU	Date m/d/yr	Sampling Station	SURFACE PHYSICAL DATA				PHOTIC ZONE	
					DO mg/L	Water Temp C	pH s.u.	Percent DO SAT	Chla µg/L	Turbidity NTU
COASTAL PLAIN	CATFISH LAKE	20-9-1	May 14, 2009	WOK036D	8.4	21.6	3.9	95.4%	11.0	55.0
COASTAL PLAIN	CATFISH LAKE	20-9-1	May 14, 2009	WOK036E	8.5	21.8	4.2	96.9%	7.4	23.0
					8.5	21.7	4.1	96.2%	9.2	39.0
COASTAL PLAIN	CATFISH LAKE	20-9-1	June 11, 2009	WOK036D	7.5	29.1	4.2	97.7%	8.2	15.0
COASTAL PLAIN	CATFISH LAKE	20-9-1	June 11, 2009	WOK036E	7.1	30.1	4.1	94.1%	8.4	11.0
					7.3	29.6	4.2	95.9%	8.3	13.0
COASTAL PLAIN	CATFISH LAKE	20-9-1	July 16, 2009	WOK036D	6.9	27.4	4.2	87.2%	4.2	8.3
COASTAL PLAIN	CATFISH LAKE	20-9-1	July 16, 2009	WOK036E	6.9	28.2	4.2	88.5%	3.9	7.2
					6.9	27.8	4.2	87.9%	4.1	7.8
COASTAL PLAIN	CATFISH LAKE	20-9-1	August 12, 2009	WOK036D	7.1	30.0	4.1	94.0%	11.0	22.0
COASTAL PLAIN	CATFISH LAKE	20-9-1	August 12, 2009	WOK036E	7.3	29.7	4.1	96.1%	11.0	13.0
					7.2	29.9	4.1	95.1%	11.0	17.5
COASTAL PLAIN	CATFISH LAKE	20-9-1	September 16, 2009	WOK036D	7.7	26.9	5.7	96.5%	5.0	8.0
COASTAL PLAIN	CATFISH LAKE	20-9-1	September 16, 2009	WOK036E	7.7	26.3	4.2	95.5%	4.7	8.1
					7.7	26.6	5.0	96.0%	4.9	8.1
				N=	5	5	5	5	5	5
				% EXCEED =	NCE	NCE	NCE *	NCE	NCE	NCE

Appendix B
White Oak River Basin Lakes 2009 Use Support Data

Region	Lake	AU	Date m/d/yr	Sampling Station	SURFACE PHYSICAL DATA				PHOTIC ZONE	
					DO mg/L	Water Temp C	pH s.u.	Percent DO SAT	Chla µg/L	Turbidity NTU
COASTAL PLAIN	GREAT LAKE	20-17	May 14, 2009	WOK026G	8.7	21.8	4.1	99.2%	7.6	120.0
COASTAL PLAIN	GREAT LAKE	20-17	May 14, 2009	WOK026H	9.1	22.1	4.4	104.3%	5.8	75.0
					8.9	22.0	4.3	101.8%	6.7	97.5
COASTAL PLAIN	GREAT LAKE	20-17	June 11, 2009	WOK026G	7.6	30.0	4.2	100.6%	31.0	40.0
COASTAL PLAIN	GREAT LAKE	20-17	June 11, 2009	WOK026H	7.6	28.6	4.2	98.2%	16.0	50.0
					7.6	29.3	4.2	99.4%	23.5	45.0
COASTAL PLAIN	GREAT LAKE	20-17	July 16, 2009	WOK026G	7.3	28.6	4.2	94.3%	11.0	40.0
COASTAL PLAIN	GREAT LAKE	20-17	July 16, 2009	WOK026H	7.4	28.3	4.2	95.1%	9.4	40.0
					7.4	28.5	4.2	94.7%	10.2	40.0
COASTAL PLAIN	GREAT LAKE	20-17	August 27, 2009	WOK026G	6.8	29.4	4.2	89.1%	6.5	37.0
COASTAL PLAIN	GREAT LAKE	20-17	August 27, 2009	WOK026H	6.8	29.7	4.2	89.5%	6.5	38.0
					6.8	29.6	4.2	89.3%	6.5	37.5
COASTAL PLAIN	GREAT LAKE	20-17	September 16, 2009	WOK026G	7.5	29.4	4.2	98.2%	5.9	38.0
COASTAL PLAIN	GREAT LAKE	20-17	September 16, 2009	WOK026H	7.3	26.6	4.1	91.0%	3.7	40.0
					7.4	28.0	4.2	94.6%	4.8	39.0
N=					5	5	5	5	5	5
% EXCEED =					NCE	NCE	NCE *	NCE	NCE	NCE

* Elevated turbidity and low pH values due to natural conditions and dystrophic nature of the lakes. Please see lake reports for more information.

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- NR = Not Rated

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