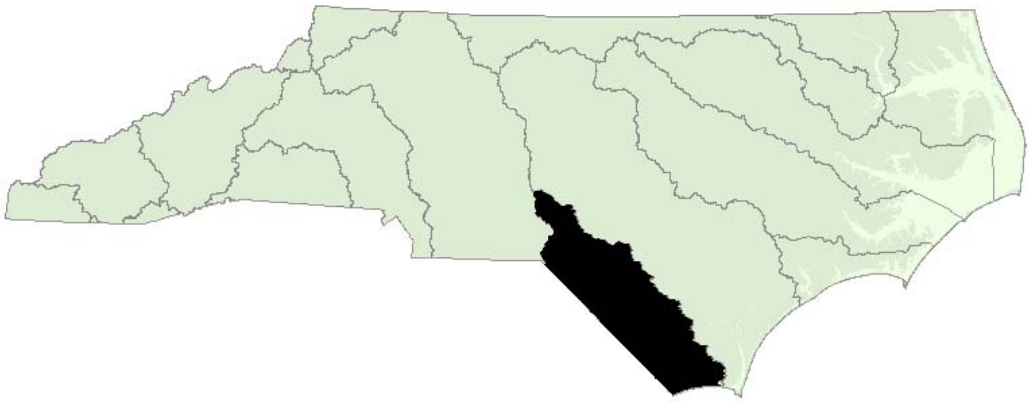
LUMBER RIVER BASINWIDE ASSESSMENT
April, 2007

CONTENTS



This document provides overviews from four program areas within the Environmental Sciences Section . They may be considered chapters or individual reports. The contributions from each unit are provided in the following order.

BASINWIDE ASSESSMENT REPORT

LUMBER RIVER BASIN

NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT
AND NATURAL RESOURCES
Division of Water Quality
Environmental Sciences Section

April 2007

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TABLE OF CONTENTS

Page

LIST OF APPENDICIES

LIST OF TABLES

LIST OF FIGURES

BASIN DESCRIPTION

The Lumber River basin lies along the North Carolina/South Carolina border at the southeast corner of the state (Figure 1). It is composed of four major drainage areas or watersheds: the Lumber River, the Little Pee Dee River headwaters, the Waccamaw River, and the coastal area rivers. The basin extends about 150 miles from the Sand Hills ecoregion in southern Moore and Montgomery counties to the Atlantic Ocean coastline in Brunswick County. Streams and rivers in the basin, except for the Lockwoods Folly and Shallotte Rivers, flow southwest into South Carolina and are tributaries of the Great Pee Dee River. The Great Pee Dee River flows into the Atlantic Ocean near Georgetown, South Carolina.

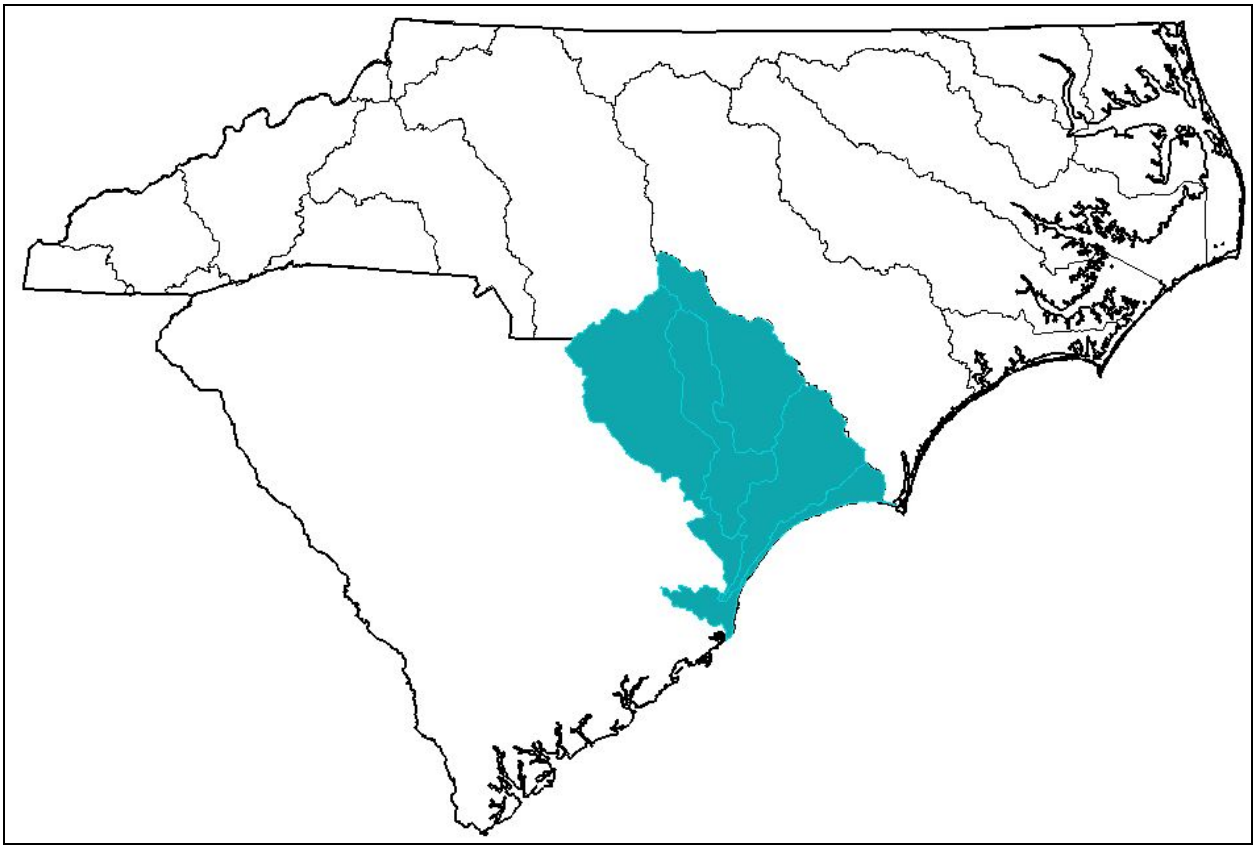


Figure 1. Geographical relationships of the Lumber River basin in North Carolina and South Carolina.

There are 2,283 miles of freshwater streams in the basin, 90% of which are supplementally classified as swamp waters. There are also 4,800 acres of waters along the coast that are classified as salt waters, about 90% of which are classified as SA. Most of the basin is forested (about 60%) or in agriculture (about 30%). The basin encompasses an area of 3,343 square miles in all or part of 10 counties including Brunswick, Columbus, Bladen, Robeson, Cumberland, Hoke, Scotland, Richmond, Moore and Montgomery. Larger municipalities include Lumberton, Laurinburg, Southern Pines, Pinehurst and Whiteville.

The dividing line between the Sand Hills and the Coastal Plain is located along a subtle escarpment called the Coats Scarp, which extends through central Hoke, Scotland, and northern Cumberland counties. The Sand Hills are located northwest of the line and the Coastal Plain is located to the southeast (Figure 2). Recent ecoregion delineations for North Carolina further subdivide the coastal plain, providing a basis for assessing differences in biological communities and water chemistry attributes.

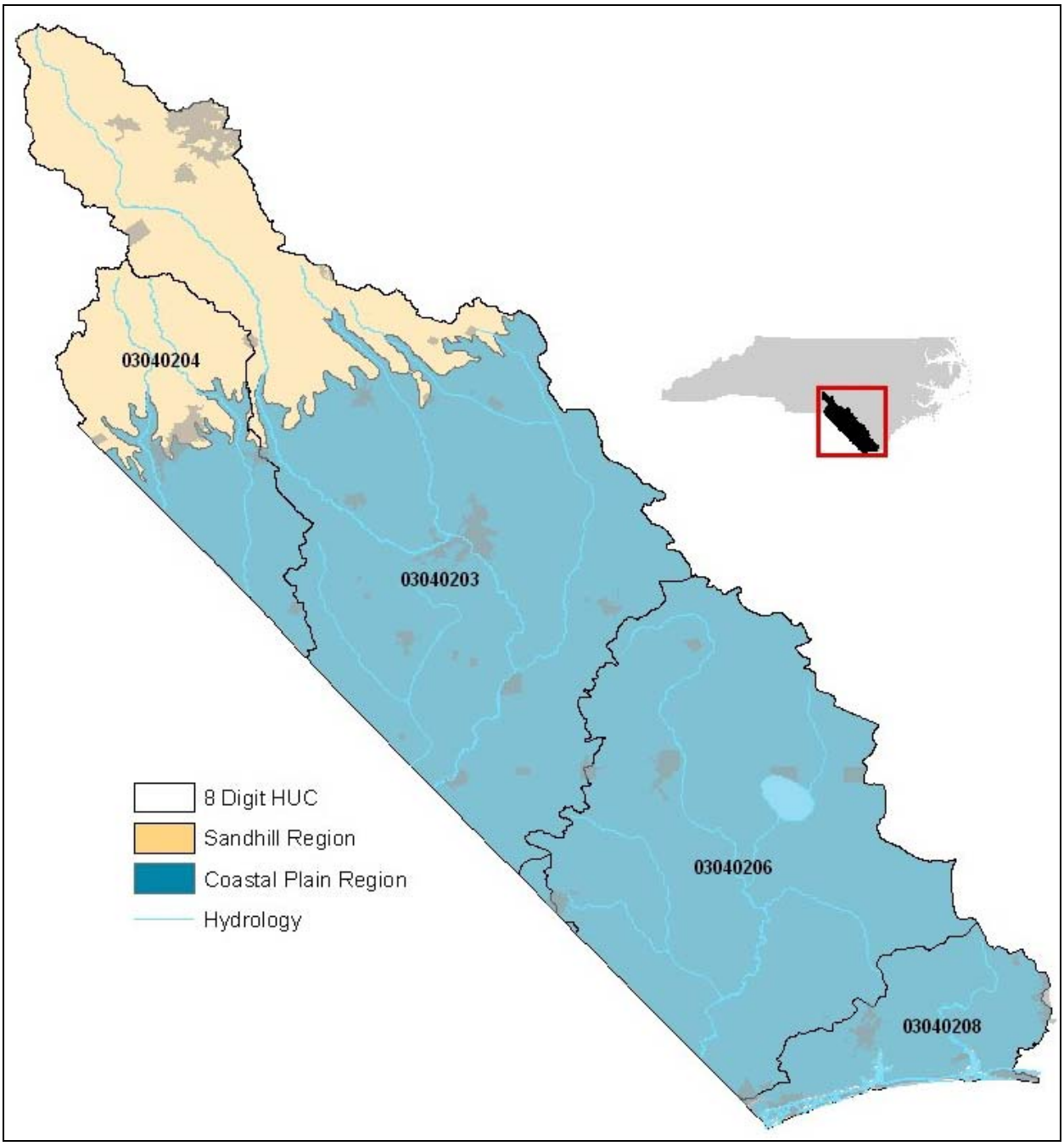


Figure 2. Geographical relationships of the Lumber River basin in North Carolina.

The Atlantic Southern Loam Plains ecoregion encompasses most of the upper coastal plain, except for the Southeastern and Mid-Atlantic Floodplains and Low Terraces ecoregions which are found in a narrow band adjacent to the Lumber River and the Waccamaw River. The Carolina Flatwoods ecoregion occurs below the Surry Scarp which runs southwest to northeast through Columbus County (west of Lake Waccamaw) and southern Bladen County. There are also areas of the Non-riverine Swamps and Peatlands ecoregion, with flat, poorly drained soils of peat and muck. The high percentage of hydric soils in the lower basin supports extensive wetlands, despite extensive man-made drainage.

INTRODUCTION TO PROGRAM METHODS

The Division of Water Quality uses a basinwide approach to water quality management. Activities within the Division, including permitting, monitoring, modeling, nonpoint source assessments, and planning are coordinated and integrated for each of the 17 major river basins within the state. All basins are re-assessed every five years. The Lumber River basin has been sampled by the Environmental Sciences Section (ESS) four times for basinwide monitoring: 1991, 1996, 2001, and 2006.

The ESS collects a variety of biological, chemical, and physical data that can be used in a myriad of ways within the basinwide planning program. In some program areas there may be adequate data to allow a fairly comprehensive analysis of ecological integrity or water quality. In other areas, data may be limited to one program area, such as only benthic macroinvertebrate data or only fisheries data, with no other information available. Such data may or may not be adequate to provide a definitive assessment of water quality, but can provide general indications of water quality. The primary program areas from which data were drawn for this assessment of the Lumber River basin include benthic macroinvertebrates and fish community for the period 2001 - 2006. Details of biological sampling methods (including habitat evaluation) and rating criteria can be found in Appendices B-1, and F-1 – F-7. Technical terms are defined in the Glossary.

The document is structured with physical, geographical, and biological data discussions presented by hydrologic units (HUCs). General water quality conditions are given in an upstream to downstream format. Lakes data, ambient chemistry data and aquatic toxicity data, with summaries, are presented in separate reports.

LUMBER RIVER HUC 03040203 – LUMBER RIVER

Description

The Lumber River HUC 03040203 contains DWQ's Subbasins 50 – 54 (Figure 3). Drowning Creek and all of its tributaries (Naked, Jackson, Deep, Aberdeen, Quewhiffle, and Mountain creeks) form the headwaters of the Lumber River, which begins at the confluence of Drowning and Buffalo creeks (Figure 1). Larger tributaries in the southern part of the watershed include Gum, Back, Bear, Porter, Gapway, Raft, and Big swamps. The upper part of the watershed is located entirely within the Sand Hills Level IV ecoregion; the middle and lower parts of the Lumber River watershed drain the coastal plain ecoregions of the Atlantic Southern Loam Plains and the Southeastern Floodplains and Low Terraces (Griffith, *et al*. 2002). Except during prolonged droughts, streams draining the Sand Hills have constant flow because of the large infiltration capacity of the sandy soil and the large ground-water storage capability of the sand aquifer. Streams/swamps in the eastern and southern portion of the watershed may cease flowing during the summer. Waters are typically tannin stained and are often referred to as "blackwater" systems.

Portions of the Naked Creek and Drowning Creek watersheds and segments of the Lumber River have been supplementally classified as either High Quality Waters or Outstanding Resource Waters. Most of the waters are also classified as Swamp Waters (Sw) and may have naturally low dissolved oxygen concentrations and pH (typically less than 4 mg/L or less than 6.0 s.u., respectively) . Portions of the Lumber River have been designated as a National Wild and Scenic River, as a state Natural and Scenic River System, and as part of the North Carolina state park system (Lumber River State Park).

Municipal areas within this HUC include Southern Pines, Aberdeen, Raeford, Laurinburg, Maxton, Red Springs, St. Pauls, Lumberton, Fairmont, and Fair Bluff. There are more than a dozen permitted NPDES facilities in this HUC, discharging a total of almost 50 MGD to the surface waters (Basinwide Information System query, 01/08/2007).

Overview of Water Quality

Twenty-one benthic macroinvertebrate and fish community samples were collected from the Lumber River and its tributaries during the 2006 basinwide cycle (Table 1). Bioclassifications and instream and riparian habitats were of high quality (Excellent or Good) at most of the mainstem river sites down to the City of Lumberton and at the tributaries draining the Sand Hills ecoregion. Several of the tributary sites were fish community reference sites and, although not rated, appeared to have healthy fish communities. The Pinewoods Darter and the Sandhills Chub, two species of Special Concern, were found at many of the tributary sites. In the Lumber River, the water quality declined from Excellent at the NC 41/72 site to Good-Fair below Lumberton at the NC 72. Between the two locales, an additional 25 million gallons per day of effluent are discharged to the river. The specific conductance, an indicator of pollution, increased from 78 µS/cm at the NC 41/72 site to 175 µS/cm at the NC 72 site. Improvement in water quality due to the assimilation of the waste was noted by the time the river reached the Town of Boardman. The specific conductance had decreased to 135 µS/cm and the bioclassification of the benthic community had increased from Good-Fair to Good. No long-term changes in water quality were noted along the Lumber River from its headwaters to the NC/SC state line.

Swamp streams were sampled for benthic macroinvertebrate and habitat assessments only. Low quality habitats (total habitat scores < 65) were associated with streams that were either channelized or had a predominantly organic muck substrate. Natural biological conditions were documented at 6 sites, Moderate conditions at 5 sites, and Severe conditions at 2 sites. Little Raft Swamp, 1.1 miles below the Town of Red Springs, was impacted by the town's waste water treatment plant discharge of 2.5 MGD. The benthic community was rated as Moderate in 2001 but declined to Severe in 2006. Porter Swamp, declined from Moderate in 2001 to Severe in 2006, but the decline might have been attributed more to high flow conditions than due to an actual change in water quality.

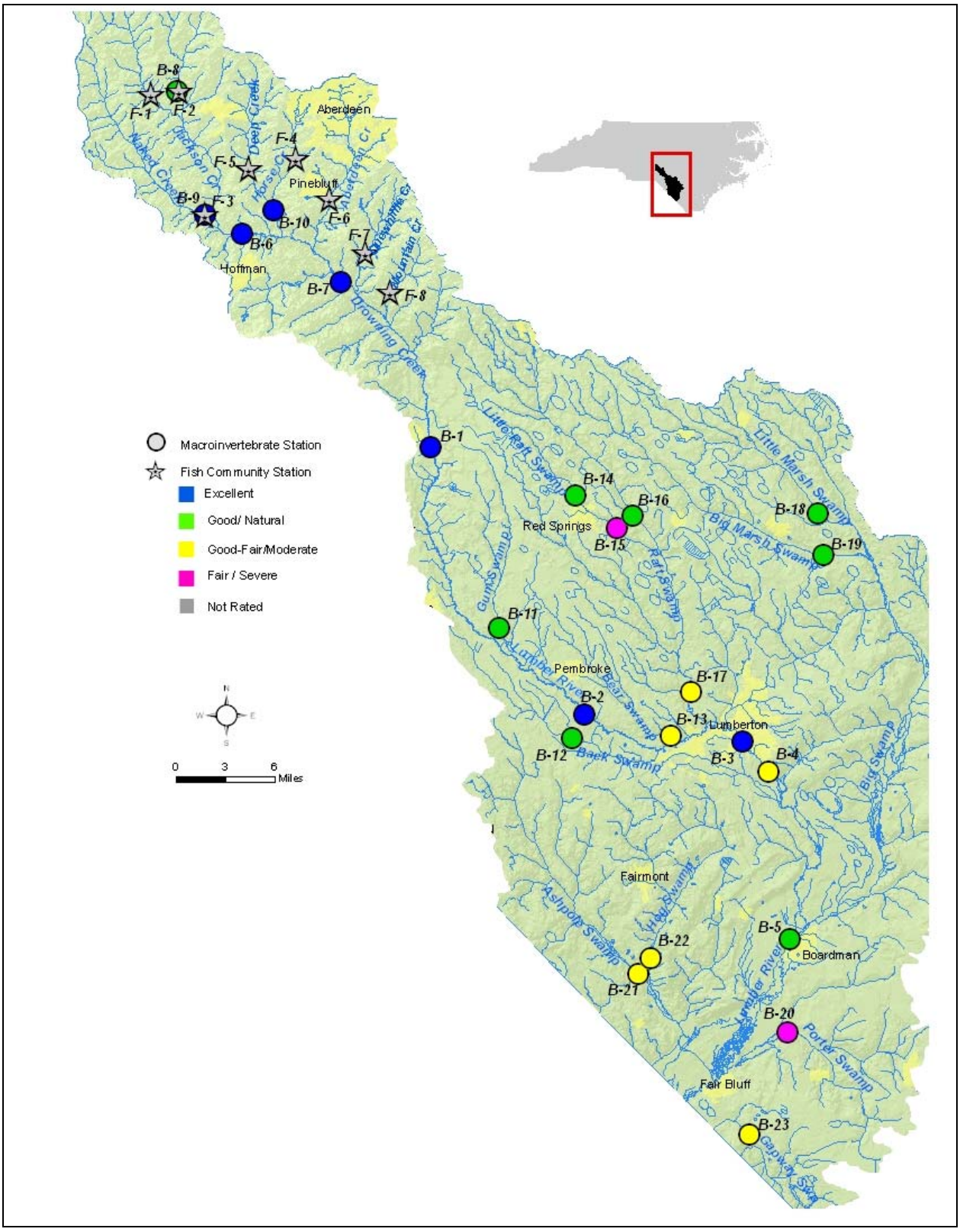


Figure 3. **Sampling sites in Lumber River HUC 03040203 in the Lumber River basin. Note: as a GIS-artifact to illustrate the terrain, the map is truncated at its extremities.**

No changes between 2001 and 2006 in the Natural conditions were noted at Gum, Little Raft (above the Town of Red Springs), Little Marsh, and at Big Marsh swamps. Bioclassifications declined from Natural to Moderate at Bear and Hog swamps. Declines noted at Bear Swamp may have been due to sampling under high flow conditions in 2006 rather than a true decline in water quality conditions; reasons for the decline at Hog Swamp were not known. No true changes were noted at Ashpole Swamp or a Gapway Swamp; both streams continued to be rated as Moderate.

Table 1. Waterbodies monitored in Lumber River HUC 03040203 in the Lumber River basin for basinwide assessment, 2001 and 2006.

Map #[1]	Waterbody	County	Location	2001	2006
B-1	Lumber R	Scotland	SR 1404	Excellent	Excellent
B-2	Lumber R	Robeson	SR 1003	Excellent	Excellent
B-3	Lumber R	Robeson	NC 41/72	Excellent	Excellent
B-4	Lumber R	Robeson	NC 72	Good-Fair	Good-Fair
B-5	Lumber R	Robeson	US 74	Excellent	Good
B-6	Drowning Cr	Richmond	SR 1004	Excellent	Excellent
B-7	Drowning Cr	Hoke	US 15/501	---	Excellent
B-8	Jackson Cr	Moore	SR 1122	Good	Good
B-9	Naked Cr	Richmond	SR 1003	Excellent	Excellent
B-10	Horse Cr	Moore	SR 1102	Good	Excellent
B-11	Gum Swp	Robeson	SR 1312	Natural	Natural
B-12	Back Swp	Robeson	SR 1003	Not Rated	Natural
B-13	Bear Swp	Robeson	SR 1339	Natural	Moderate
B-14	Little Raft Swp	Robeson	SR 1323	---	Natural
B-15	Little Raft Swp	Robeson	SR 1505	Moderate	Severe
B-16	Raft Swp	Robeson	SR 1505	Moderate	Natural
B-17	Raft Swp	Robeson	SR 1527	---	Moderate
B-18	Little Marsh Swp	Robeson	SR 1907	Natural	Natural
B-19	Big Marsh Swp	Robeson	SR 1924	Natural	Natural
B-20	Porter Swp	Columbus	SR 1503	Moderate	Severe
B-21	Ashpole Swamp	Robeson	NC 41	Natural	Moderate
B-22	Hog Swamp	Robeson	SR 2262	Natural	Moderate
B-23	Gapway Swp	Columbus	SR 1356	Moderate	Moderate
F-1	Drowning Cr	Moore	NC 73	Not Rated	Not Rated
F-2	Jackson Cr	Moore	SR 1122	Not Rated	Not Rated
F-3	Naked Cr	Richmond	SR 1003	Not Rated	Not Rated
F-4	Horse Cr	Moore	SR 1112	---	Not Rated
F-5	Deep Cr	Moore	SR 1113	Not Rated	Not Rated
F-6	Aberdeen Cr	Moore	SR 1105	Not Rated	Not Rated
F-7	Quewhiffle Cr	Hoke	SR 1225	Not Rated	Not Rated
F-8	Mountain Cr	Hoke	SR 1215	Not Rated	Not Rated

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.

River and Stream Assessment

Specific site summaries of the 21 benthic macroinvertebrate and fish community samples may be found at this link: **03040203**.

Special Studies

Benthic Macroinvertebrate Monitoring of the Bear Swamp and Mill Branch Watersheds (Robeson County)

Bear Swamp at NC 710, Watering Hole Swamp at Joseph H. Road, Moss Neck Swamp at SR 1570, and Mill Branch at NC 710 all in Robeson County were assessed in 2004 as part of an Ecosystem Enhancement Program study. There was no indications of severely degraded water quality in Bear Swamp (Good-Fair), Moss Neck (Good-Fair), or Mill Branch (Fair). Watering Hole Swamp was classified as “Not Rated” because it has an extremely small drainage area (0.8 square miles) and likely dries-up during the summer. As expected, the drying up of the stream also depresses the benthic community. However, this watershed also includes runoff from the Town of Pembroke, which may also be affecting the benthic community (Biological Assessment Unit Memorandum B-040524).

Benthic Macroinvertebrate Monitoring of Ashpole Swamp at NC 130 and at SR 2258, Robeson County

The Fayetteville Regional Office and the Planning Section requested additional sampling during the 2006 swamp season in Ashpole Swamp. Sites were chosen to fill in areas without data coverage. Ashpole Swamp at NC 130 is located approximately six miles upstream of a basin site (NC 41) and approximately 10 miles upstream of SR 2258, the other special study location in this part of the Lumber Basin. The site at SR 2258 integrates most of the entire Ashpole Swamp watershed (minus Indian Swamp) prior to its confluence with the Lumber River. Though both sites have very different watershed sizes they contain many of the same benthic fauna. Both the NC 130 and SR 2258 special study sites rated Moderate, with a fairly diverse but relatively tolerant (biotic index 7.1 and 7.2 respectively) benthos community. Crustacean and mollusk taxa were diverse at both sites (Biological Assessment Unit Memorandum B-070227).

LUMBER RIVER HUC 03040204 – LITTLE PEE DEE RIVER

Description

The Little Pee Dee River HUC contains DWQ's Subbasin 55, which lies in Scotland and northern Robeson counties (Figure 4). Streams in this HUC make up the headwaters of the Little Pee Dee River and drain the Sand Hills ecoregion with the lower portion of their watersheds in the Atlantic Southern Loam Plains ecoregion. These streams are characterized by sandy substrates and good, year round flow. The City of Laurinburg and the Town of Maxton are the largest urban areas and dischargers in this region.

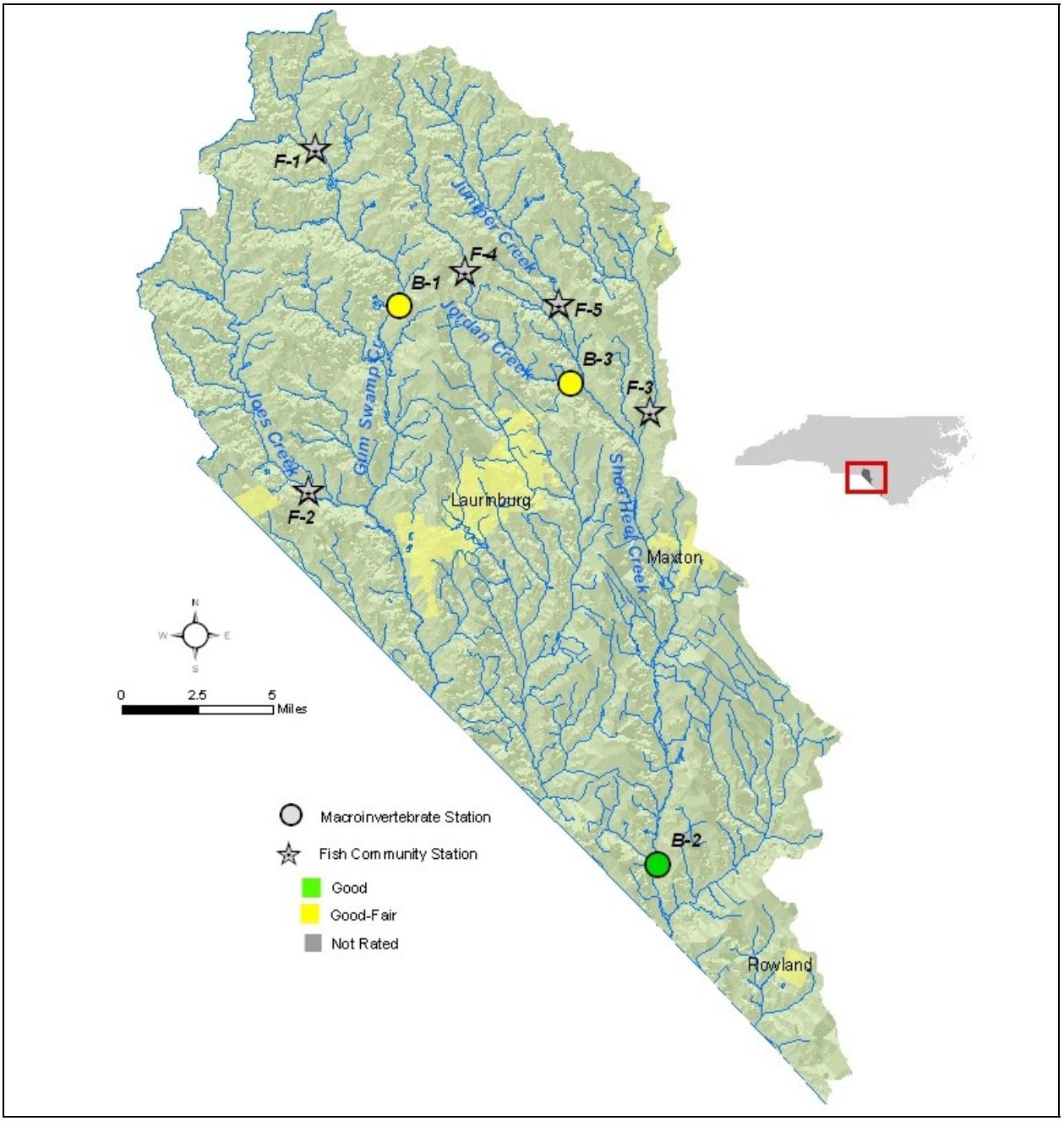


Figure 4. Sampling sites in Little Pee Dee River HUC 03040204 in the Lumber River Basin.

Overview of Water Quality

Water quality in the sandhills region has remained relatively stable since the 2001 basinwide assessment as indicated by the biological data. One basinwide site, Gum Swamp Creek at US 15/401, was not sampled due to high flow. The other site on Gum Swamp Creek was rated Good-Fair, a reduction from the 2001 Good bioclassification (Table 2). The upstream location had a Good–Fair rating in 1996, although the benthic community has increased in tolerance every year suggesting a slight decrease in water quality at that site. Shoe Heel Creek was the only stream sampled in this HUC that was rated Good in 2006. It received a Good in 2001 as well, although it has historically rated Excellent since 1987. Finally, Jordan Creek continued to rate Good-Fair suggesting no change in water quality.

Fish community samples were collected from Gum Swamp, Joes, Shoe Heel, Jordan, and Juniper Creeks. Species richness and abundances increased in every stream sampled indicating that no serious water quality issues were present. Typical Sandhills fish assemblages were found in all streams. This included low species richness and abundance, presence of intolerant species such as the pinewoods darter, and dominance by dusky shiners.

Table 2. Waterbodies monitored in Little Pee Dee River HUC 03040204 in the Lumber River basin for basinwide assessment, 2001 and 2006.

Map #[1]	Waterbody	County	Location	2001	2006
B-1	Gum Swamp Cr	Scotland	SR 1323	Good	Good-Fair
B-2	Shoe Heel Cr	Robeson	SR 1101	Good	Good
B-3	Jordan Cr	Scotland	US 401	Good-Fair	Good-Fair
F-1	Gum Swamp Cr	Scotland	SR 1344	Not rated	Not rated
F-2	Joes Cr	Scotland	NC 79	Not rated	Not rated
F-3	(Big) Shoe Heel Cr	Scotland	SR 1433	Not rated	Not rated
F-4	Jordan Cr	Scotland	SR 1324	Not rated	Not rated
F-5	Juniper Cr	Scotland	SR 1405	Not rated	Not rated

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.

River and Stream Assessment

Specific site summaries of the eight benthic macroinvertebrate and fish community samples may be found at this link: **03040204**. No benthic macroinvertebrate samples were collected at Gum Swamp Creek at US 15/401 in 2006 due to high flow.

Special Studies

Regional Office and Planning Section Requests 2006

Leith Creek at SR 1609, just southeast of Laurinburg, was sampled in 2006 to assess the effects of urbanization on the stream. It rated Moderately stressed suggesting that urban runoff is toxic to benthic macroinvertebrates (Biological Assessment Unit Memorandum B-070123).

LUMBER RIVER HUC 03040206 – WACCAMAW RIVER

Description

The Waccamaw River HUC contains DWQ's Subbasins 56 - 58 (Figure 5) and consists of Lake Waccamaw, Big Creek, Bogue Swamp, the lower Waccamaw River and its tributaries, and White Marsh and its tributaries. All tributary streams have braided channels, wide floodplains, and low flows in the summer due to poorly drained soils with little groundwater storage. Land use is mainly forest with some developed areas around Lake Waccamaw, Tabor City, Whiteville, and Chadbourn. Lake Waccamaw contains a high diversity of endemic fish and mollusks; it is the second largest natural lake in the state and is one of the most unique lakes in the southeastern United States. The western portion of this HUC is in Green Swamp, also a unique area of longleaf pine savanna harboring a large diversity of insectivorous plants. Tabor City has a wastewater treatment plant (1.1 MGD to Grissett Swamp *via* Town Canal) but Whiteville's WWTP is the largest discharger (3.0 MGD to White Marsh) in the HUC.

Overview of Water Quality

Four sites in this HUC were sampled in 2006: Friar Swamp at SR 1740, White Marsh at SR 1001, Elkton Marsh at SR 1710, and Grissett Swamp at SR 1141 (Table 3). Friar Swamp received a rating of Natural while Grissett Swamp, Elkton Marsh and White Marsh were rated as Moderately stressed.

Table 3. Waterbodies monitored in Waccamaw River HUC 03040206 in the Lumber Basin for basinwide assessment, 2001 and 2006.

Map#[1]	Waterbody	County	Location	2001	2006
B-1	Friar Swp	Columbus	SR 1740	Natural	Natural
B-2	White Marsh	Columbus	SR 1001	Moderate	Moderate
B-3	Elkton Marsh	Bladen	SR 1710	Moderate	Moderate
B-4	Grissett Swp	Columbus	SR 1141	Moderate	Moderate

[1]B = benthic macroinvertebrate monitoring sites.

River and Stream Assessment

Specific site summary of the four benthic macroinvertebrate samples may be found at this link: **03040206**. The Waccamaw River at SR 1928, NC 130, and NC 904 were not sampled in 2006 due to high flow conditions; they should be continued as basinwide sites in 2011.

SPECIAL STUDIES

Western Prong Creek at US 701 Bypass was sampled in February of 2006 at the request of the Planning Section to fill in gaps in our basinwide sampling regime. The site rated Moderate. See memorandum B-070123 for more information.

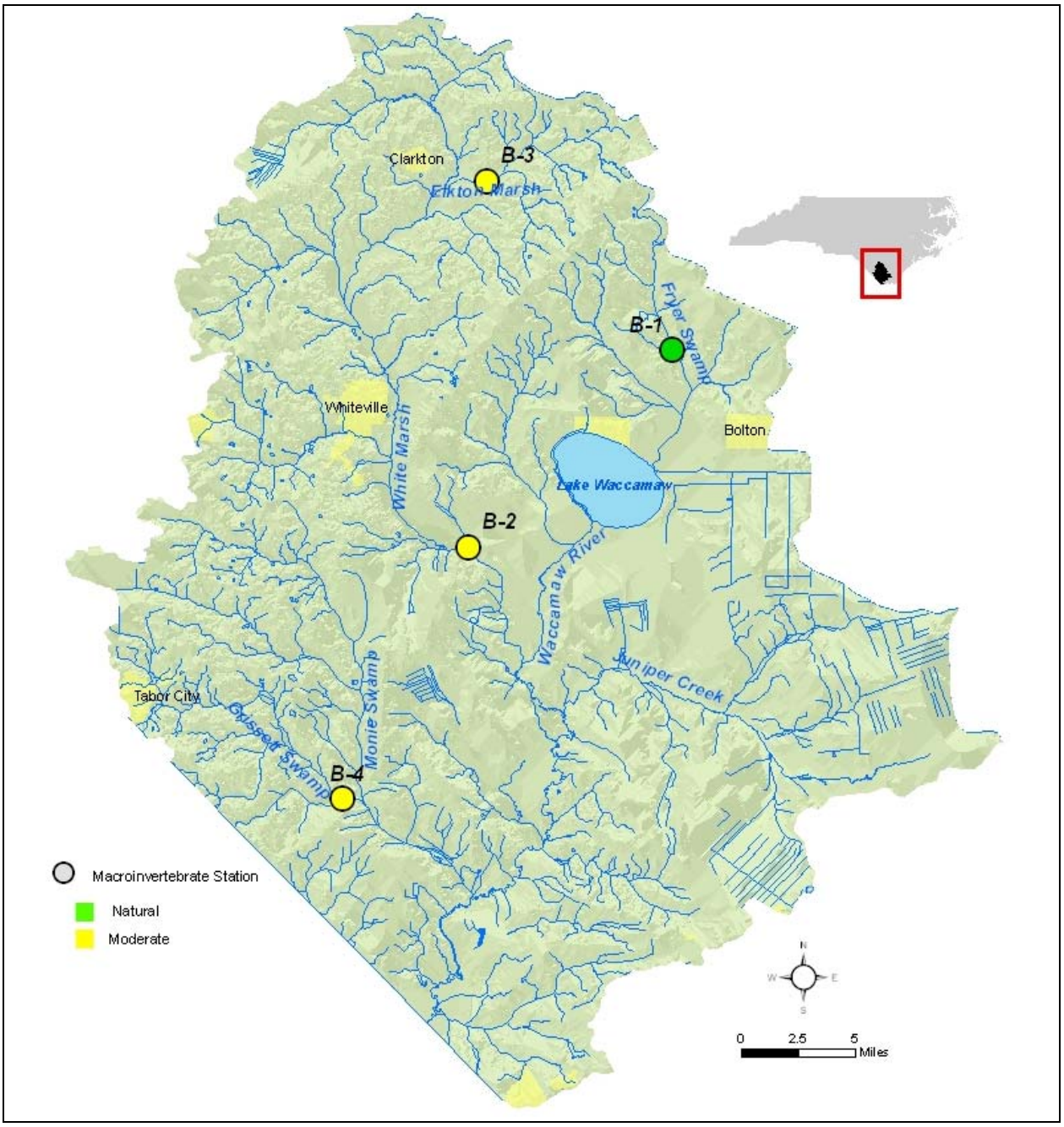


Figure 5. Sampling sites in Waccamaw River HUC 03040206 in the Lumber River Basin

LUMBER RIVER HUC 03040208 – LONG BAY/ATLANTIC OCEAN

Description

The Long Bay/Atlantic Ocean HUC 03040208 contains DWQ's Subbasin 59 (Figure 6) and includes the Lockwoods Folly and Shallotte rivers and their tributaries. The majority of this HUC lies in the Carolina Flatwoods ecoregion where poorly drained, sandy-loamy soils are characteristic. Most of the smaller tributary streams have no flow in the summer and are consequently sampled in the winter during higher flow. Both river systems are estuarine in their downstream sections with significant saltwater intrusions into otherwise freshwater systems. Land use is mainly forest and agriculture. Development is heaviest around the Town of Shallotte, the largest town in the area, as well as along coastal areas.

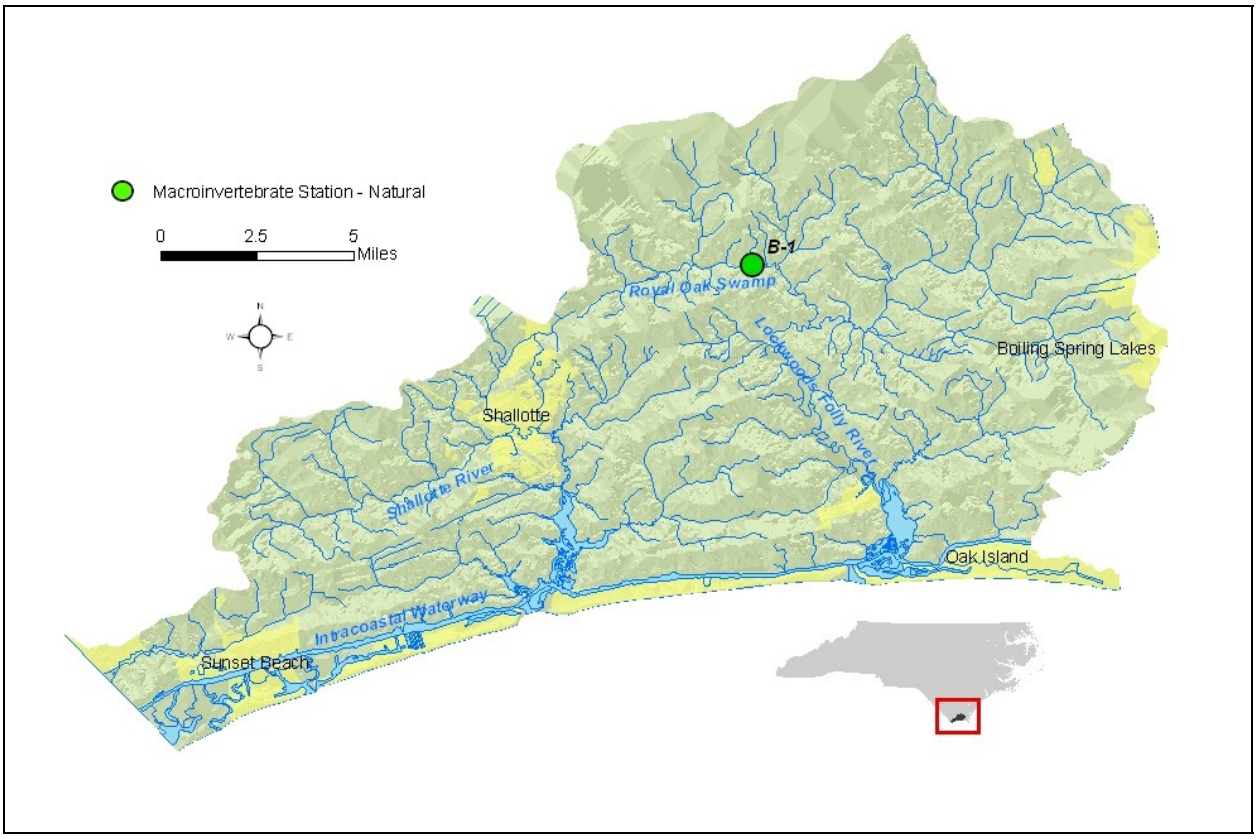


Figure 6. Sampling sites in the Long Bay/Atlantic Ocean HUC 03040208 in the Lumber River basin.

Overview of Water Quality

Benthos sampled from Royal Oak Swamp (Table 4) indicated a diverse and healthy community. This stream is used as a least-impacted reference site for this ecoregion and has a bioclassification rating of Natural. A summary may be found at this link: **03040208**.

Table 4. Waterbodies monitored in Long Bay/Atlantic Ocean HUC 03040208 in the Lumber River basin for basinwide assessment, 2001 and 2006.

Map #[1]	Waterbody	County	Location	2001	2006
B-1	Royal Oak Swp	Brunswick	NC 211	Natural	Natural

[1]B = benthic macroinvertebrate monitoring sites

River and Stream Assessment

Specific site summary of the benthic macroinvertebrate sample may be found at this link: ----. Due to the high occurrence of saltwater intrusions from Long Bay, the Shallotte River near US 17 has been removed from basinwide sampling. No benthic macroinvertebrate samples were collected at Lockwoods Folly River (headwaters) in 2001 and 2006 due to insufficient flow. This site was visited twice in 2001 using a small boat to search for suitable sampling areas. None were found. Royal Oak Swamp was not sampled for fish as efforts focused on Sand Hill streams.

Special Studies

The Shallotte River was sampled in September 2003 to verify that the Fair rating it received in 2001 was not drought related. The resample effort was postponed until 2003 due to subsequent high flows. Resampling resulted in a Good-Fair bioclassification. It was noted, however, that high salinity during the summer months was affecting the macroinvertebrate community and the site near US 17 was recommended to be dropped from basinwide sampling (Biological Assessment Unit Memorandum B-031027)

GLOSSARY

$7Q_{10}$	A value which represents the lowest average flow for a seven day period that will recur on a ten year frequency. This value is applicable at any point on a stream. $7Q_{10}$ flow (in cfs) is used to allocate the discharge of toxic substances to streams.
Bioclass or Bioclassification	Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups (EPT) and the Biotic Index value.
cfs	Cubic feet per second, generally the unit in which stream flow is measured.
CHL *a*	Chlorophyll *a*.
Class C Waters	Freshwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. All freshwaters shall be classified to protect these uses at a minimum.
Conductivity	In this report, synonymous with specific conductance and reported in the units of µmhos/cm at 25 ^{o}C. Conductivity is a measure of the resistance of a solution to electrical flow. Resistance is reduced with increasing content of ionized salts.
Division	The North Carolina Division of Water Quality.
D.O.	Dissolved Oxygen.
Ecoregion	An area of relatively homogeneous environmental conditions, usually defined by elevation, geology, vegetation, and soil type. Examples include Mountains, Piedmont, Coastal Plain, Sand Hills, and Carolina Slate Belt.
EPT	The insect orders (Ephemeroptera, Plecoptera, Trichoptera); as a whole, the most intolerant insects present in the benthic community.
EPT N	The abundance of Ephemeroptera, Plecoptera, Trichoptera insects present, using values of 1 for Rare, 3 for Common and 10 for Abundant.
EPT S	Taxa richness of the insect orders Ephemeroptera, Plecoptera and Trichoptera. Higher taxa richness values are associated with better water quality.
HQW	High Quality Waters. Waters which are rated Excellent based on biological and physical/chemical characteristics through Division monitoring or special studies, primary nursery areas designated by the Marine Fisheries Commission, and all Class SA waters.
Major Discharger	Greater than or equal to one million gallons per day discharge (≥ 1 MGD).
MGD	Million Gallons per Day, generally the unit in which effluent discharge flow is measured.
Minor Discharger	Less than one million gallons per day discharge (< 1 MGD).
NPDES	National Pollutant Discharge Elimination System.

NCBI (EPT BI)	North Carolina Biotic Index, EPT Biotic Index. A summary measure of the tolerance values of organisms found in the sample, relative to their abundance. Sometimes noted as the NCBI or EPT BI.
NCIBI	North Carolina Index of Biotic Integrity (NCIBI); a summary measure of the effects of factors influencing the fish community.
NSW	Nutrient Sensitive Waters. Waters subject to growths of microscopic or macroscopic vegetation requiring limitations on nutrient inputs.
NTU	Nephelometric Turbidity Unit.
ORW	Outstanding Resource Waters. Unique and special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses.
Parametric Coverage	A listing of parameters measured and reported.
SOC	A consent order between an NPDES permittee and the Environmental Management Commission that specifically modifies compliance responsibility of the permittee, requiring that specified actions are taken to resolve non-compliance with permit limits.
Total S (or S)	The number of different taxa present in a benthic macroinvertebrate sample.
UT	Unnamed tributary.
WWTP	Wastewater treatment plant

Appendix B-1. Summary of benthic macroinvertebrate data, sampling methods, and criteria.

DATA SUMMARY

There were 7 subbasins sampled for macroinvertebrates in the Lumber River Basin in 2006 and a total of 20 long-term basinwide benthos samples were collected (9 were swamp samples). Graphical representations of bioclassification trends in swamp, and non-swamp waters among the long-term basinwide benthos sites for each of the 7 subbasins and for each of the 5 HUCs for the periods: 1996, 2001, and 2006 are detailed below in Figures 2-6:-

Figure 2: Lumber River Basin HUC 03040203 (Subbasins 50, 51, 52, 53, 54): Long-Term Benthos Sites, Bioclassification Trends: 1996-2006.

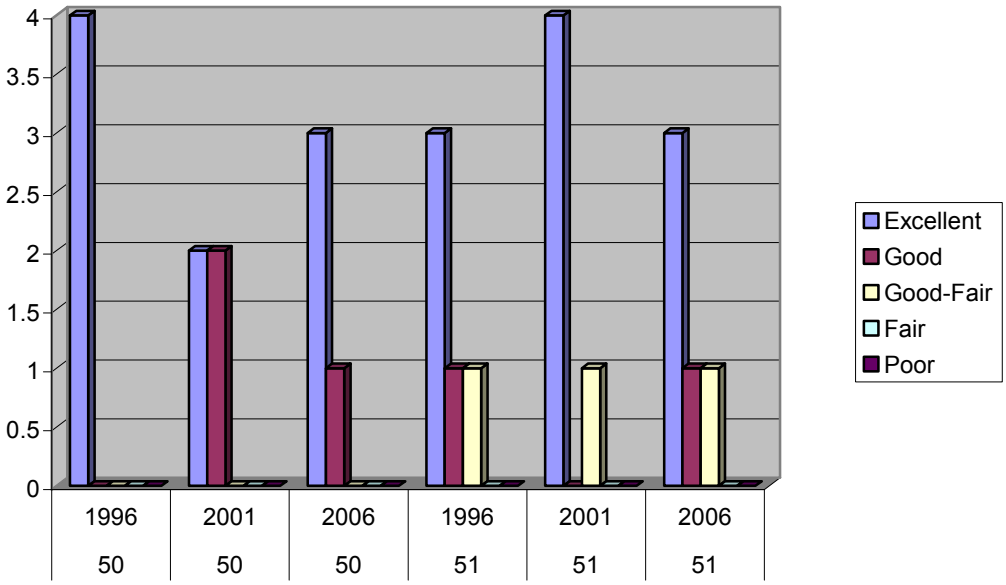


Figure 3: Lumber River Basin HUC 03040203 (Subbasins 50, 51, 52, 53, 54): Long-Term SWAMP Benthos Sites, Bioclassification Trends: 1996-2006.

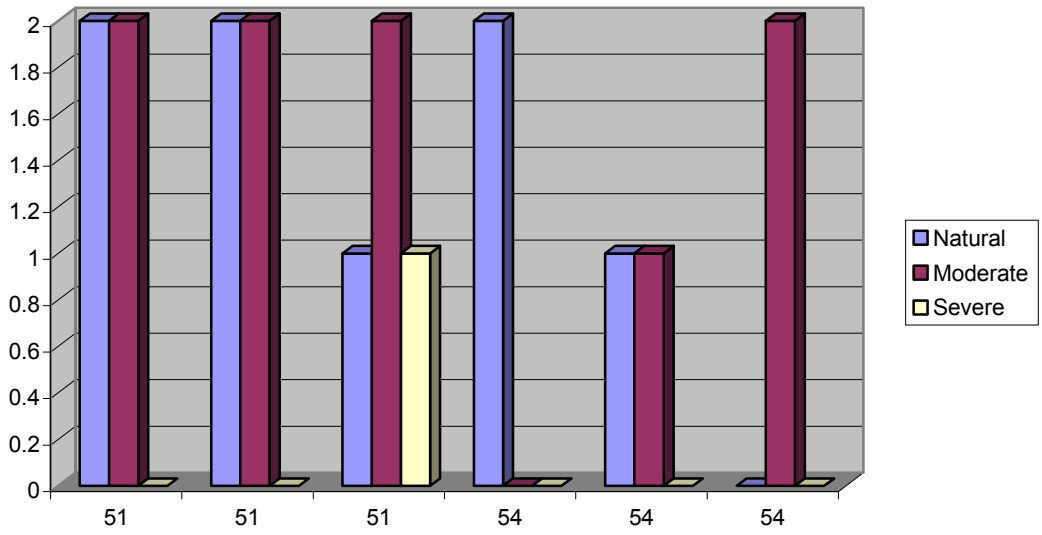


Figure 4: Lumber River Basin HUC 03040204 (Subbasin 55): Long-Term SWAMP Benthos Sites, Bioclassification Trends: 1996-2006.

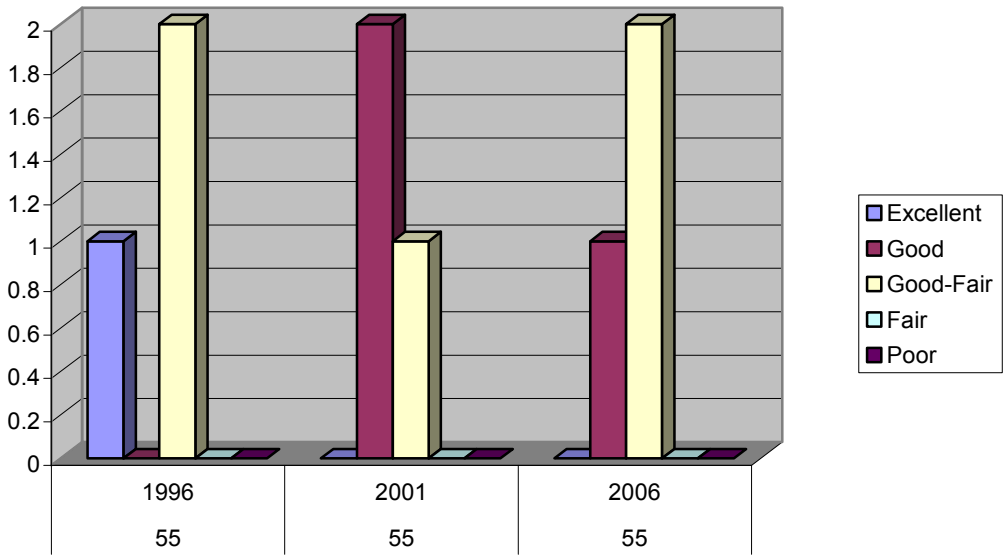


Figure 5: Lumber River Basin HUC 03040206 (Subbasins 56, 57, 58): Long-Term SWAMP Benthos Sites, Bioclassification Trends: 1996-2006.

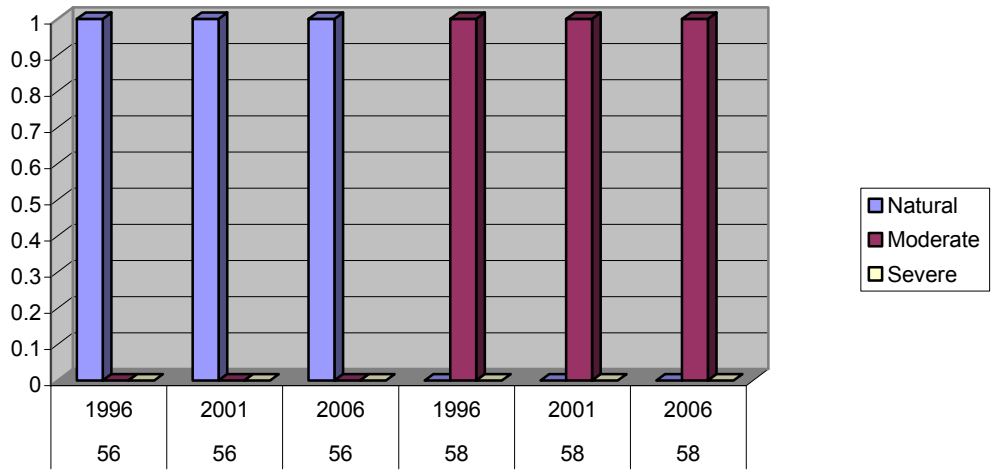
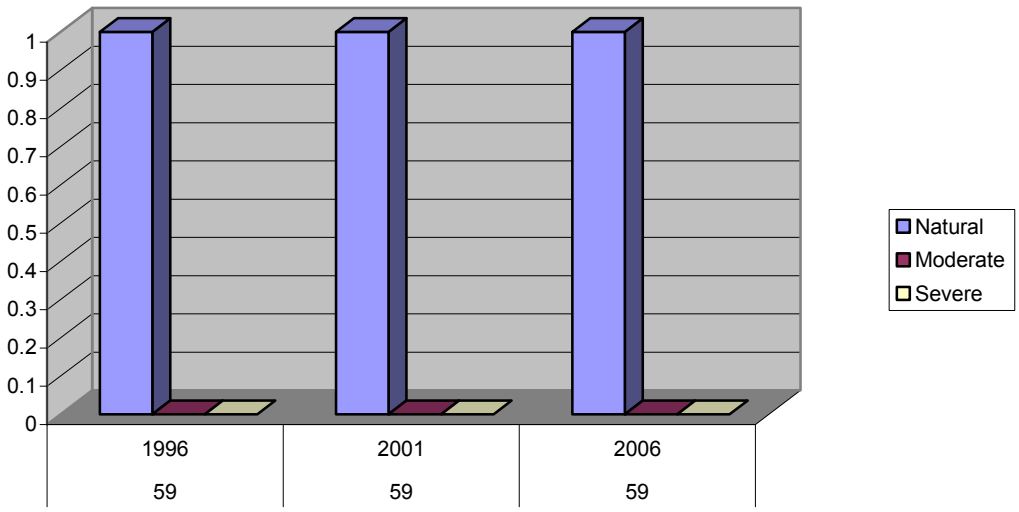


Figure 6: Lumber River Basin HUC 03040208 (Subbasin 59): Long-Term SWAMP Benthos Sites, Bioclassification Trends: 1996-2006.



In summary, the most significant bioclassification changes in 2006 from previous samples (1996 and 2001) were seen in the following subbasins:

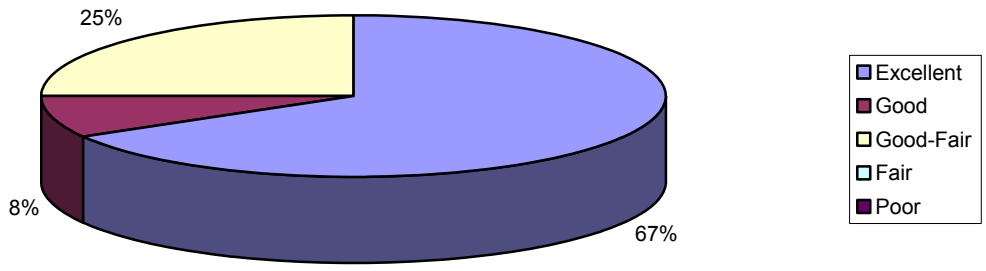
Subbasin 51: In 1996 and 2001 there were two Natural and two Moderate bioclassifications. In 2006, while two Moderate ratings remained, there was only one Natural rating and there was the addition of a Severe bioclassification.

Subbasin 54: In 1996, a total of two Natural ratings were observed. This level decreased to only one in 2001 with an addition of one Moderate rating. This declining trend continued in 2006 with zero Natural ratings, and two Moderate bioclassifications.

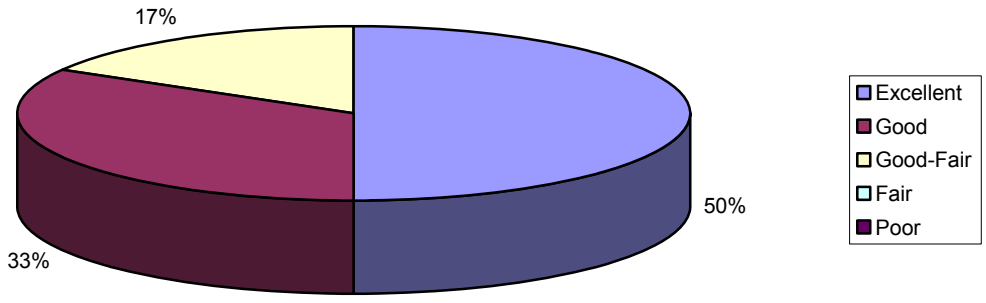
Subbasin 55: The single Excellent bioclassification seen in 1996 was lost in both 2001 and 2006. The two Good-Fair ratings in 1996 decreased to one in 2001 but rebounded to two for 2006. The two Good bioclassifications in 2001 decreased to one for 2006.

Historic bioclassification trends between the sampling periods 1996, 2001, and 2006 for long-term benthos sites (swamp and non-swamp) in the Lumber River Basin are presented below:

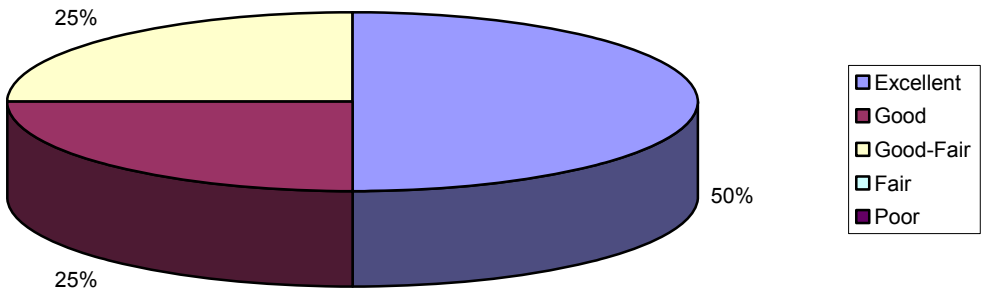
Lumber River basin Long-Term Benthos Sites: Total Bioclassifications (1996).



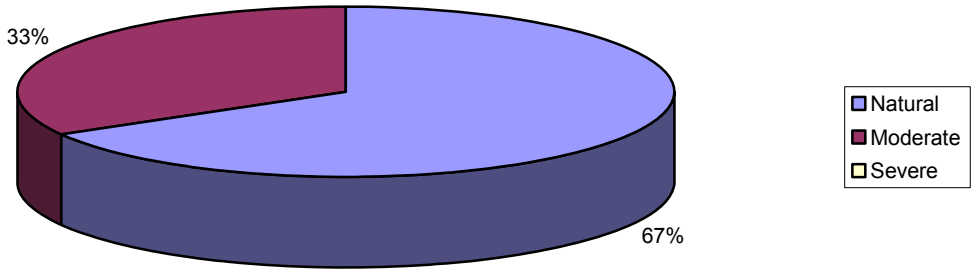
Lumber River basin Long-Term Benthos Sites: Total Bioclassifications (2001).



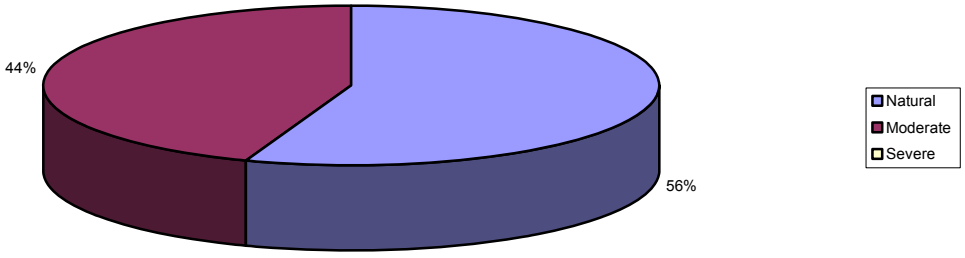
Lumber River Basin Long-Term Benthos Sites: Total Bioclassifications (2006).



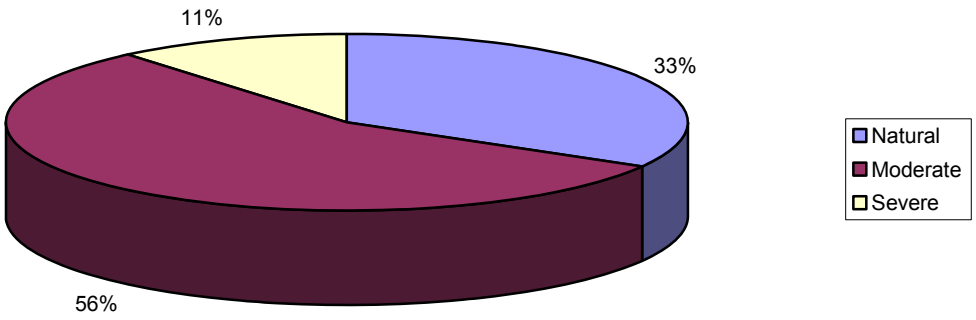
Lumber River Basin Long-Term SWAMP Benthos Sites: Total Bioclassifications (1996).



Lumber River Basin Long-Term SWAMP Benthos Sites: Total Bioclassifications (2001).



Lumber River Basin Long-Term SWAMP Benthos Sites: Total Bioclassifications (2006).



There were numerous significantly rare invertebrate taxa collected in the Lumber River basin in 2006 (Table 1):

Table 1. Significantly Rare Invertebrate Taxa: Lumber River Basin, 2006.

Taxon	Total Number of DWQ Collections	Collection Location(s)	First Time Collected in Lumber Basin?
Damselfly: *Telebasis byersi*	7	Western Prong Creek (US 701, Columbus)	Yes
Beetle: *Derrallus altus*	18	Western Prong Creek (US 701, Columbus)	Yes
Gastropod: *Planorbella scalare*	1	Western Prong Creek (US 701, Columbus)	Yes
Mayfly: *Eurylophella aestiva*	23	Naked Creek (SR 1003, Richmond)	No
Mayfly: *Pseudocentroptiloides usa*	19	Lumber River (SR 1003, Robeson)	No
Caddisfly: *Ceraclea tarsipunctata*	16	Bear Swamp, White Marsh	Yes
Caddisly: *Oecetis Sp E*	10	Lumber River (SR 1003, Robeson), Elkton Marsh (SR 1710, Bladen), White Marsh (SR 1001, Columbus)	No
Caddisfly: *Oecetis Sp D*	10	Lumber River (NC 72, Robeson)	Yes
Caddisfly: *Oxyethira Sp*	25	Lumber River (NC 41/72, Robeson)	No
Caddisfly: *Rhyacophila lobifera*	22	Back Swamp (SR 1003, Robeson), Gapway Swamp (SR 1356, Columbus), Gum Swamp (SR 1312, Robeson), Little Raft Swamp (SR 1323, Robeson), Raft Swamp (SR 1505, SR 1527, Robeson)	No
Caddisfly: *Triaenodes ochraceus*	12	Back Swamp (SR 1003, Robeson), Gum Swamp (SR 1312, Robeson), Little Marsh Swamp (SR 1907, Robeson)	No
Caddisfly: *Oecetis avara*	24	Naked Creek (SR 1003, Richmond)	No

SAMPLING METHODS

Standard Qualitative (Full Scale) Method

Benthic macroinvertebrates can be collected from wadeable, freshwater, flowing waters using three sampling procedures. The Biological Assessment Unit's standard qualitative (Full Scale) sampling procedure includes 10 composite samples: two kick-net samples, three bank sweeps, two rock or log washes, one sand sample, one leafpack sample, and visual collections from large rocks and logs (NCDENR 2003). The samples are picked on-site. The purpose of these collections is to inventory the aquatic fauna and produce an indication of relative abundance for each taxon. Organisms are classified as Rare (1 - 2 specimens), Common (3 - 9 specimens), or Abundant (≥ 10 specimens).

EPT Method

Benthic macroinvertebrates can also be collected using the EPT sampling procedure. Four rather than 10 composite qualitative samples are taken at each site: 1 kick, 1 sweep, 1 leafpack and visual collections (NCDENR 2003). Only EPT taxa are collected and identified and only EPT criteria are used to assign a bioclassification.

Swamp Stream Method

The Biological Assessment Unit defines “swamp streams” as those streams that are within the coastal plain ecoregion and that normally have no visible flow during a part of the year. The low flow period usually occurs during the summer; flowing water should be present in swamp streams during the winter. Sampling during the winter, high-flow period provides the best opportunity for detecting differences between natural and stressed benthic communities in these systems. The swamp stream must have visible flow in this winter period, with flow comparable to a coastal plain stream that would have acceptable flow for sampling in summer. Swamp streams with pH values of 4.0 s.u. or lower cannot be rated; those streams with pH values between 4.0 and 4.5 s.u. are difficult to evaluate.

The swamp sampling method utilizes a variety of collection techniques to inventory the macroinvertebrate fauna at a site. Nine sweep samples (one series of three by each field team member) are collected from each of the following habitats: macrophytes, root mats/undercut banks, and detritus deposits. If one of these habitat types is not present, a sweep from one of the other habitats is substituted. A sweep is defined as the area that can be reached from a given standing location. Each sweep should be emptied into a tub before the next sweep is collected, to prevent clogging of the net, but all three sweeps can be combined in the same tub. Three log/debris washes are also collected. Visual collections are the final technique used at each site.

For all three sampling methods (full-scale, EPT, and swamp), organisms are removed from each sample at the field site and preserved in 95% ethanol. The purpose of these collections is to inventory the aquatic fauna and produce an indication of relative abundance for each taxon. Organisms are classified as Rare (1 - 2 specimens), Common (3 - 9 specimens), or Abundant (≥ 10 specimens).

Habitat Evaluation

Habitat assessment forms have been developed by the Biological Assessment Unit to evaluate the physical habitat of mountain/piedmont and coastal streams. The habitat score, which ranges between 1 and 100, is based on the evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration, and riparian zone width. Higher numbers suggest better habitat quality, but no criteria have been developed to assign impairment ratings.

DATA ANALYSIS

Criteria for bioclassifications for standard qualitative (Full-Scale) samples in piedmont and Coastal Plain ecoregions are given below in Table 1 and are based on EPT S and the NCBI. Criteria for bioclassifications for the EPT sample method are provided in Table 2 and are based on EPT taxa richness.

Tolerance values for individual species and biotic index values have a range of 0 - 10, with higher numbers indicating more tolerant species or more polluted conditions. Water quality scores (5 = Excellent, 4 = Good, 3 = Good-Fair, 2 = Fair and 1 = Poor) assigned with the biotic index numbers are

averaged with EPT taxa richness scores to produce a final bioclassification. Criteria for piedmont and coastal plain streams are used for the Neuse River basin. EPT abundance and Total taxa richness calculations also are used to help examine between-site differences in water quality.

Table 1. Criteria for Standard Qualitative (Full Scale) Samples.

Score	BI Values Piedmont	BI Values Coastal Plain (CA)	EPT Values Piedmont	EPT Values Coastal Plain (CA)
5	<5.14	< 5.42	>33	>29
4.6	5.14—5.18	5.47—5.46	32-33	28
4.4	5.19—5.23	5.47—5.51	30-31	27
4	5.24—5.73	5.52—6.00	26-29	22-26
3.6	5.74—5.78	6.01—6.05	24-25	21
3.4	5.79—5.83	6.06—6.10	22-23	20
3	5.84—6.43	6.11—6.67	18-21	15-19
2.6	6.44—6.48	6.68—6.72	16-17	14
2.4	6.49—6.53	6.73—6.77	14-15	13
2	6.54—7.43	6.78—7.68	10-13	8-12
1.6	7.44—7.48	7.69—7.73	8-9	7
1.4	7.49—7.53	7.74—7.79	6-7	6
1	> 7.53	>7.79	0-5	0-5

Table 2. Criteria for EPT Samples.

Score	EPT Values Piedmont	EPT Values Coastal Plain (CA)
Excellent	>27	>23
Good	21-27	18-23
Good-Fair	14-20	12-17
Fair	7-13	6-11
Poor	0-6	0-5

Swamp Stream Criteria

Swamp stream criteria are used to evaluate a stream based on three benthic macroinvertebrate metrics (total taxa richness, EPT taxa richness, and the Biotic Index) and the coastal plain habitat score.

In the following, raw measures for total taxa richness, EPT richness, biotic index, and habitat are referred to as “values.” After adjustments are made for swamp criteria, the measures are referred to as “scores.” The convention is made to reduce confusion.

Swamps in the Lumber Basin are classified as A, S, and P swamp ecoregions and are dependent on geographic location (NCDENR 2003). The metric scores derived below depend on the swamp classification and, in some cases, pH.

Table 3. Determination of Corrected[1] Taxa Richness Scores for Swamp A, S, and P Streams

Swamp Ecoregion	A, P, and S		
Category	Natural	Moderate	Severe
Metric Score	5	3	1
pH			
≥5.5	>51	35-51	<35
5.4	>49	32-49	<32
5.3	>46	29-46	<29
5.2	>43	26-43	<26
5.1	>40	23-40	<23
5.0	>37	20-37	<20
4.9	>35	17-35	<17
4.8	>33	13-33	<13
4.7	>30	10-30	<10
4.6	>28	0-28	ND[2]
4.5	>26	0-26	ND
4.4	>23	0-23	ND
4.3	>20	0-20	ND
4.2	>17	0-17	ND
4.1	>14	0-14	ND

[1]Add (+) 8 to Total Taxa Richness for Braided Swamp Streams
[2]ND=No data (so Severe category is not used, and only a score of 3 or 5 is possible)

Table 4. Determination of Biotic Index Scores for Swamp A, S, and P Streams

Swamp Ecoregion	Metric Score	A, P, and S
Category		
Natural	**5**	<6.8
Moderate Stress	**3**	6.8-7.5
Severe Stress	**1**	>7.5

Table 5. Determination of Corrected[2] EPT Richness Scores for Swamp A, P, and S streams

Region	A and P			S		
Category	Natural	Moderate	Severe	Natural	Moderate	Severe
Metric Score	5	3	1	5	3	1
pH				Any pH value		
≥5.5	>17	7-17	0-6	>10	6-10	0-5
5.4	>15	6-15	0-5			
5.3	>13	5-13	0-4			
5.2	>11	4-11	0-3			
5.1	>9	3-9	0-2			
5.0	>8	0-8	ND			
4.9	>7	0-7	ND			
4.8	>6	0-6	ND			
4.7	>5	0-5	ND			
4.6	>4	0-4	ND			
4.5	>4	ND[2]	ND			

[2]Add (+) 2 for swamp streams with a braided channel
[3]ND=No data (so Severe category is not used, and only a score of 3 or 5 is possible)

Table 6. Determination of Habitat Scores for Swamp Streams.

Category	Natural	Moderate	Severe
Habitat Score	**>79**	**60-79**	**<60**

The site score for calculating swamp bioclassifications are calculated from the following:

Site Score = [(2xBI score + habitat score + EPT S score + Taxa Richness score) – 5]/2

Stress ratings based on the scores are:

Natural (9 - 10) **Moderate (4 - 8)** **Severe (1 - 3)**

Table 7. Benthic macroinvertebrate monitoring data collected in the Lumber River basin, 2001 – 2006. Basin sites are in bold.

Waterbody	Location	County	Index No.	Date	ST	EPT	BI	EPT BI	BioClass
HUC 03040203									
Lumber R	**SR 1404**	Scotland	14-(3)	07/17/06	81	36	4.7	3.4	Excellent
				07/17/01	90	36	4.6	3.5	Excellent
Lumber R	NC 71	Robeson	14-(4.5)	07/17/01	92	34	5.3	4.1	Excellent
Lumber R	**SR 1003**	Robeson	14-(7)	07/17/06	79	28	5.2	3.9	Excellent
				07/18/01	92	32	5.1	4.0	Excellent
Lumber R	**NC 41-72**	Robeson	14-(13)	08/04/06	86	31	5.7	4.3	Excellent
				07/18/01	91	30	5.8	4.6	Excellent
Lumber R	**NC 72**	Robeson	14-(13)	08/24/06	90	24	6.3	4.5	Good-Fair
				08/21/01	53	12	6.5	4.6	Good-Fair
Lumber R	**US 74**	Robeson	14-(21)	08/24/06	76	20	5.7	4.1	Good
				09/10/01	94	32	5.6	4.6	Excellent
Drowning Cr	**SR 1004**	Richmond	14-2-(6.5)	07/10/06	81	29	4.4	2.8	Excellent
				07/13/01	81	31	4.5	2.8	Excellent
Drowning Cr	**US 15-501**	Hoke	14-2-(10.5)	07/17/06	78	26	4.8	3.6	Excellent
Jackson Cr	**SR 1122**	Moore	14-2-5	07/10/06	23	23	3.0	3.0	Good
				07/09/01	23	23	3.2	3.2	Good
Naked Cr	**SR 1003**	Richmond	14-2-6	07/10/06	91	31	5.0	3.4	Excellent
				07/13/01	98	41	4.6	3.6	Excellent
Horse Cr	**SR 1102**	Moore	14-2-10	07/10/06	26	26	2.4	2.4	Excellent
				07/09/01	20	20	2.8	2.8	Good
Mountain Cr	SR 1219	Hoke	14-2-16-(2)	07/13/01	9	9	5.0	5.0	Not Rated
Gum Swp	**SR 1312**	Robeson	14-5	02/24/06	78	22	6.4	5.3	Natural
				02/07/06	84	28	6.3	5.2	Natural
				07/17/01	15	15	5.7	5.7	Not Impaired
				02/08/01	75	21	6.1	4.6	Natural
Mill Br	NC 710	Robeson	14-6	03/04/04	9	9	5.5	5.5	Fair
Back Swp	**SR 1003**	Robeson	14-8-(2.5)	07/11/06	71	16	6.0	5.0	Good-Fair
				02/07/06	59	22	6.1	4.9	Natural
				07/17/01	61	11	6.2	4.8	Not Rated
				02/08/01	80	25	6.1	4.9	Not Rated
Bear Swp	NC 710	Robeson	14-9-(1.5)	03/04/04	14	14	5.7	5.7	Good-Fair
Bear Swp	**SR 1339**	Robeson	14-9-(1.5)	02/08/06	48	7	6.8	5.0	Moderate
				07/18/01	11	11	6.3	6.3	Not Rated
				02/08/01	68	17	6.2	4.9	Natural
Moss Neck Swp	SR 1570	Robeson	14-9-3-(2)	03/04/04	14	14	4.5	4.5	Good-Fair
Raft Swp	**SR 1505**	Robeson	14-10-(1)	02/02/06	68	22	6.1	5.0	Natural
				02/07/01	82	20	6.0	4.3	Natural
Raft Swp	**SR 1527**	Robeson	14-10-(5.5)	02/07/06	42	12	6.5	5.8	Moderate
L Raft Swp	**SR 1323**	Robeson	14-10-5	02/06/06	62	16	6.1	5.3	Natural
L Raft Swp	**SR 1505**	Robeson	14-10-5	02/06/06	43	3	8.5	8.3	Severe
				02/07/01	64	9	7.5	5.8	Moderate
L Raft Swp	SR 1776	Robeson	14-10-5	02/21/01	48	8	7.5	7.1	Moderate
L Marsh Swp	**SR 1907**	Robeson	14-22-1-3	02/24/06	67	14	6.3	4.8	Natural
				02/07/01	67	17	6.0	4.5	Natural
Big Marsh Swp	**SR 1924**	Robeson	14-22-2	02/24/06	87	19	6.8	5.6	Natural
				02/07/01	77	20	6.3	4.7	Natural
Porter Swp	**SR 1503**	Columbus	14-27	02/08/06	38	1	8.5	3.5	Severe
				02/06/01	49	6	7.5	5.2	Moderate
Ashpole Swp	NC 130	Robeson	14-30	02/28/06	46	10	7.0	5.9	Moderate
Ashpole Swp	**NC 41**	Robeson	14-30	02/28/06	49	10	6.8	5.9	Moderate
				02/23/06	60	13	6.7	6.0	Moderate
				01/30/01	53	11	6.7	5.5	Natural
Ashpole Swp	SR 2258	Robeson	14-30	02/09/06	67	8	7.1	6.1	Moderate
Hog Swp	**SR 2262**	Robeson	14-30-7	02/23/06	60	5	7.4	6.4	Moderate
				01/31/01	52	11	6.7	6.4	Natural

Table 1 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	BI	EPT BI	BioClass
HUC 03040203									
Gapway Swp	**SR 1356**	Columbus	14-31	02/08/06	61	5	7.4	7.0	Moderate
				01/06/01	71	11	7.6	6.4	Moderate
Watering Hole Swp	Joseph H Rd	Robeson	14-34-11-1	03/04/04	1	1	7.8	7.8	Not Rated
HUC 03040204									
Gum Swamp Cr	SR 1323	Scotland	14-32-(7)	07/10/06	---	17	---	3.5	Good-Fair
				07/09/01	---	22	---	3.0	Good
Gum Swamp Cr	US 15/401	Scotland	14-32-(12)	07/09/01	---	20	---	2.9	Good
Shoe Heel Cr	SR 1101	Robeson	14-34	07/10/06	71	20	4.1	5.7	Good
				07/10/01	53	18	4.9	3.4	Good
Jordan Cr	US 401	Scotland	14-34-4-(2)	08/04/06		12		3.5	Good-Fair
				07/09/01	---	12	---	3.5	Good-Fair
HUC 03040206									
Waccamaw R	SR 1928	Columbus	15-(1)	07/17/01	---	18	---	5.1	Good
Waccamaw R	NC 130	Columbus	15-(1)	07/17/01	62	22	5.77	4.6	Good
Waccamaw R	AB NC 904	Columbus	15-(1)	05/09/01	84	21	6.52	5.0	Good-Fair
Waccamaw R	NC 904	Columbus	15-(1)	07/17/01	---	23	---	4.6	Good
Friar Swp	SR 1740	Columbus	15-2-6-3	02/21/06	64	13	6.7	6.4	Natural
				02/01/01	49	11	6.69	6.2	Natural
White Marsh	SR 1001	Columbus	15-4	02/22/06	50	9	7.16	5.8	Moderate
				02/01/01	33	2	7.04	6.7	Moderate
Elkton Marsh	SR 1710	Bladen	15-4-1-1-2	02/22/06	60	5	7.55	5.4	Moderate
				02/05/01	29	4	6.22	4.2	Moderate
Western Pr Cr	US 701 BYP	Columbus	15-4-2	02/23/06	52	2	8.07	8.1	Moderate
Grissett Swp	SR 1141	Columbus	15-17-1-(5)	02/21/06	47	5	7.66	7.3	Moderate
				02/05/01	36	6	7.41	5.5	Moderate
HUC 03040208									
Royal Oak Swp	NC 211	Brunswick	15-25-1-12	02/21/06	75	17	7		Natural
				07/11/01	---	13	---	5.5	Not Rated
				02/05/01	58	18	6	4.6	Natural
Shallotte R	US 17	Brunswick	15-25-2-(5)	07/11/01	31	6	6.8	6.1	Fair

Appendix F-1. Fish community sampling methods and criteria.

Sampling Methods
At each site, a 600 ft. section of stream was selected and measured. The fish in the delineated reach were then collected using two backpack electrofishing units and two persons netting the stunned fish. In 2006 Biological Assessment Unit Staff were assisted by a summer intern from North Carolina State University. After collection, all readily identifiable fish were examined for sores, lesions, fin damage, or skeletal anomalies, measured (total length to the nearest 1 mm), and then released. Those fish that were not readily identifiable were preserved and returned to the laboratory for identification, examination, and total length measurement. These fish have been deposited as voucher specimens with the North Carolina State Museum of Natural Sciences in Raleigh.

NCIBI (North Carolina Index of Biotic Integrity) Analysis, Evaluation, and Scoring Criteria
The NCIBI is a modification of the Index of Biotic Integrity initially proposed by Karr (1981) and Karr, *et al*. (1986). The IBI method was developed for assessing a stream's biological integrity by examining the structure and health of its fish community. The scores derived from this index are a measure of the ecological health of the waterbody and may not directly correlate to water quality. For example, a stream with excellent water quality, but with poor or fair fish habitat, would not be rated excellent. However, a stream rated excellent with the NCIBI should be expected to have excellent water quality.

Scoring criteria, metric performance, and community ratings are currently being revised for wadeable streams in the Sand Hills based upon the communities at regional reference sites. To qualify as a reference site, the site had to satisfy all seven watershed-based criteria in the order listed in Table 1; details on the habitat assessments are given in Appendix F-5. Reference sites represented the least impacted or the most minimally impacted streams and should represent the best overall biological conditions of the communities that are present (Table 2). For comparative and descriptive purposes only, metrics that are applied to the integrity of the fish communities in the adjacent Yadkin River basin are given for each of the sites sampled in the Lumber River basin in 2006 (Table 3). Sites that have been sampled in the Lumber River basin since 1990 are listed in Table 4; currently, all sites are classified as Not Rated.

Table 1. Reference site selection hierarchy for Sand Hills streams in the Lumber, Cape Fear, and Yadkin River basins -- a watershed-based approach for streams.

Criterion	Qualification
1 -- Habitat	Total habitat score ≥ 65
2 – NPDES dischargers	No NPDES dischargers ≥ 0.01 MGD above the site or if there are small dischargers (~≤ 0.01 MGD), the dischargers are more than one mile upstream
3 – Percent urbanization	< 10% of the watershed is urban or residential areas
4 – Percent forested	≥ 70% of the watershed is forested or in natural vegetation
5 – Channel incision	At the site, the stream is not incised beyond natural conditions
6 – Riparian zone integrity	No breaks in the riparian zones or, if there are breaks, the breaks are rare
7 – Riparian zone width	Coastal Plain/Sand Hill streams – width of the riparian zone along both banks is ≥ 18 m
Exception 1	If the site satisfied Criteria 1 - 6, except one of the two riparian widths was less than one unit optimal, then the site still qualified as a reference site
Exception 2	If the site satisfied Criteria 1 - 3 and 5 - 7, but the percentage of the watershed in forest or natural vegetations was ≥ 60% (rather than ≥ 70%), then the site still qualified as a reference site.

Table 2. Regional reference sites in the Sand Hills ecoregion of the Lumber River basin.

HUC/Waterbody	Station	County
03040203 Lumber River		
Drowning Cr	NC 73	Moore
Jackson Cr	SR 1122	Moore
03040204 Little Pee Dee River		
Gum Swamp Cr	SR 1344	Scotland
Joes Cr	NC 79	Scotland
Jordan Cr	SR 1324	Scotland
Juniper Cr	SR 1405 (NC 144)	Scotland

Table 3. Fish community metric values from 13 wadeable streams in the Lumber River basinwide monitoring program, 2006[1]. [Note: metrics that are applied to streams in the adjacent Yadkin River are given for descriptive and comparative purposes only; none of the sites is rated.]

HUC/Waterbody	Location	County	d. a. (mi^2)	Date	No. Species	No. Fish	No. Sp. Darters	No. Sp. Sunfish	No. Sp. Suckers	No. Intol. Sp.	% Tolerant	% Omni. +Herb.	% Insect.	% Pisc.	% DELT	% MA
03040203 Lumber River																
Drowning Cr	NC 73	Moore	31.9	05/22/06	20	155	2	4	2	2	6	10	84	5.81	0	50
Jackson Cr	SR 1122	Moore	18.1	05/22/06	17	65	2	4	2	2	8	5	78	16.92	0	41
Naked Cr	SR 1003	Richmond	38.0	05/22/06	17	89	3	4	1	2	9	0	89	11.24	0	41
Horse Cr	SR 1112	Moore	10.7	05/23/06	18	112	3	6	1	3	3	15	81	3.57	0	33
Deep Cr	SR 1113	Moore	19.8	05/22/06	12	36	2	1	2	2	17	3	89	8.33	0	17
Aberdeen Cr	SR 1105	Moore	28.4	05/23/06	15	27	1	3	2	0	26	7	78	14.81	0	13
Quewhiffle Cr	SR 1225	Hoke	17.8	05/23/06	7	15	2	1	0	1	7	7	93	0.00	0	14
Mountain Cr	SR 1215	Hoke	9.9	05/24/06	10	263	1	2	1	2	2	2	98	0.38	0	50
03040204 Little Pee Dee River																
Gum Swamp Cr	SR 1344	Scotland	16.0	05/25/06	11	54	2	3	0	1	2	2	91	7.41	0	45
Joes Cr	NC 79	Scotland	31.4	05/25/06	14	154	2	3	1	1	9	0	95	4.55	0	50
Big Shoeheel Cr	SR 1433	Scotland	22.7	05/24/06	14	90	1	6	1	1	11	0	99	1.11	0	43
Jordan Cr	SR 1324	Scotland	10.4	05/24/06	14	76	2	2	1	1	4	5	82	13.16	0	57
Juniper Cr	SR 1405 (NC 144)	Scotland	22.5	05/25/06	12	154	2	2	1	1	1	1	95	3.9	0	42

[1]Abbreviations are d. a. = drainage area, No. = number, Sp. = species, Intol. = intolerants, Omni. + Herb. = omnivores+herbivores, Insect. = insectivores, Pisc. = piscivores, DELT = disease, erosion, lesions, and tumors, and MA = species with multiple age groups.

Table 4. Fish community data collected from the Lumber River basin, 1990 – 2006. Current basinwide sites are in bold font. [Note: no sites have been assigned a rating.]

HUC/Waterbody	Station	County	Stream Index Number	Date
03040203 Lumber River				
Drowning Cr	NC 73	Moore	14-2-(1)	05/22/06
				06/06/01
				05/31/96
				03/25/96
Buffalo Cr	SR 1203	Hoke	14-2.5	06/05/01
Jackson Cr	SR 1122	Moore	14-2-5	05/22/06
				06/06/01
Naked Cr	SR 1003	Richmond	14-2-6	05/22/06
				06/06/01
				05/31/96
				03/25/96
Rocky Ford Br	SR 1424	Richmond	14-2-6-1	08/20/90
Horse Cr	SR 1112	Moore	14-2-10	05/23/06
Deep Cr	SR 1113	Moore	14-2-10-1-(1)	05/22/06
				06/07/01
Aberdeen Cr	SR 1105	Moore	14-2-11-(6)	05/23/06
				06/07/01
Quewhiffle Cr	SR 1225	Hoke	14-2-14	05/23/06
				06/05/01
Mountain Cr	SR 1215	Hoke	14-2-16-(2)	05/24/06
				06/05/01
Gum Swp	NC 71	Robeson	14-5	03/26/96
				09/30/91
Back Swp	SR 1003	Robeson	14-8-(2.5)	05/22/01
				03/26/96
				07/24/91
Porter Swp	SR 1503	Columbus	14-27	03/27/96
				04/29/92
Ashepole Swp	SR 2455	Robeson	14-30	10/22/92
				07/25/91
				03/26/96
Gapway Swp	SR 1356	Columbus	14-31	05/22/01
03040204 Little Pee Dee River				
Gum Swamp Cr	SR 1344	Scotland	14-32-(1)	05/25/06
				05/24/01
Joes Cr	NC 79	Scotland	14-32-14	05/25/06
				05/24/01
Big Shoeheel Cr	SR 1433	Scotland	14-34	05/24/06
				05/23/01
Little Shoeheel Cr	SR 1405	Scotland	14-34-3	03/25/96
				09/30/91
Jordan Cr	SR 1324	Scotland	14-34-4-(2)	05/24/06
				05/23/01
Juniper Cr	SR 1405 (NC 144)	Scotland	14-34-4-3	05/25/06
				05/23/01
03040206 Waccamaw River				
Friar Swp	SR 1740	Columbus	15-2-6-3	03/27/96
Brown Marsh Swp	SR 1760	Bladen	15-4-1-1	08/11/92
Brown Marsh Swp	SR 1700	Bladen	15-4-1-1	03/27/96
Juniper Cr	SR 1928	Columbus	15-7	12/11/91
Grissett Swp	SR 1141	Columbus	15-17-1-(5)	04/29/92
Toms Fork Cr	SR 1118	Columbus	15-17-1-10	04/29/92
Monie Swp	SR 1006	Columbus	15-17-1-12	04/29/92

Table 4 (continued).

HUC/Waterbody	Station	County	Stream Index Number	Date
03040208 Long Bay-Atlantic Ocean				
Lockwoods Folly R	US 17	Brunswick	15-25-1-(1)	04/02/96
				04/28/92
Royal Oak Swp	NC 211	Brunswick	15-25-1-12	05/21/01
				04/25/92
Cool Run	US 17	Brunswick	15-25-2-3	04/02/96
				04/28/92

Appendix F-2. A summary of fish community assessment data for 2006.

Monitoring efforts in 2006 can be summarized as:

- Thirteen sites were sampled in the Sand Hills Level IV ecoregion in late May 2006.
- Due to the ongoing revision in the NCIBI's scoring and rating criteria for the Sandhills, no fish community sites in this basin were rated.
- However, many of the sites could potentially qualify as regional fish community reference sites because of their primarily forested watersheds, moderate to high quality instream and riparian habitats, and absence of NPDES facilities in the watershed.
- Despite naturally low fish abundances and species diversity, most of these communities seemed to be characteristic of unimpacted and fully functioning streams and had not changed since the last basinwide assessment in 2001.
- The diversity and abundance of fish varied among the sites from 7 to 20 species and from 15 to 263 fish per site. Many sites had large individuals of Bowfin, Creek Chubsucker, Spotted Sucker, Yellow Bullhead, Flat Bullhead, Chain Pickerel, and Redbreast Sunfish.
- All sites, except Aberdeen Creek, had at least one intolerant species present (Sandhills Chub, Pinewoods Darter, or Piedmont Darter).
- Two Species of Special Concern, Sandhills Chub and Pinewoods Darter, were collected from many of the sites.

Appendix F-3. Fish distributional records for the Lumber River basin.

Based upon Menhinick (1991), the NC DWQ data, and data from other researchers, 71 species of fish are known from the Lumber River basin in North Carolina (Table 1). The known species assemblage includes 14 species of minnows, 9 species of catfish, 14 species of sunfish and bass, and 7 species of darters. Endemic species include the Thinlip Chub, Sandhills Chub, Pinewoods Darter, Broadtail Madtom, Waccamaw Silverside, Waccamaw Killifish, Waccamaw Darter, and Carolina Pygmy sunfish.

Table 1. Tolerance ratings and adult trophic guild assignments for fish in the Lumber River basin. Species collected in 2006 are highlighted in blue. Common and scientific names follow Nelson, *et al*. (2004).

Family/Species	Common Name	Tolerance Rating	Trophic Guild of Adults
Lepisosteidae	**Gars**		
Lepisosteus osseus	Longnose Gar	Tolerant	Piscivore
Amiidae	**Bowfins**		
Amia calva	Bowfin	Tolerant	Piscivore
Anguillidae	**American Eels**		
Anguilla rostrata	American Eel	Intermediate	Piscivore
Clupeidae	**Herrings**		
Alosa aestivalis	Blueback Herring	Intermediate	Insectivore
A. pseudoharengus	Alewife	Intermediate	Insectivore
A. sapidissima	American Shad	Intermediate	Insectivore
Dorosoma cepedianum	Gizzard Shad	Intermediate	Omnivore
Cyprinidae	**Carps and Minnows**		
Carassius auratus	Goldfish	Tolerant	Omnivore
Ctenopharyngodon idella	Grass Carp	Tolerant	Herbivore
Cyprinella sp. cf. *zanema*	Thinlip Chub	Intolerant	Insectivore
Cyprinus carpio	Common Carp	Tolerant	Omnivore
Hybognathus regius	Silvery Minnow	Intermediate	Herbivore
Nocomis leptocephalus	Bluehead Chub	Intermediate	Omnivore
Notemigonus crysoleucas	Golden Shiner	Tolerant	Omnivore
Notropis chalybaeus	Ironcolor Shiner	Intolerant	Insectivore
N. chiliticus	Redlip Shiner	Intermediate	Insectivore
N. cummingsae	Dusky Shiner	Intermediate	Insectivore
N. hudsonius	Spottail Shiner	Intermediate	Omnivore
N. maculatus	Taillight Shiner	Intolerant	Insectivore
N. petersoni	Coastal Shiner	Intermediate	Insectivore
Semotilus lumbee	Sandhills Chub	Intolerant	Insectivore
Catostomidae	**Suckers**		
Erimyzon oblongus	Creek Chubsucker	Intermediate	Omnivore
E. sucetta	Lake Chubsucker	Intermediate	Insectivore
Minytrema melanops	Spotted Sucker	Intermediate	Insectivore
Ictaluridae	**North American Catfishes**		
Ameiurus brunneus	Snail Bullhead	Intermediate	Insectivore
A. catus	White Catfish	Tolerant	Omnivore
A. natalis	Yellow Bullhead	Tolerant	Omnivore
A. nebulosus	Brown Bullhead	Tolerant	Omnivore
A. platycephalus	Flat Bullhead	Tolerant	Insectivore
Noturus gyrinus	Tadpole Madtom	Intermediate	Insectivore
N. insignis	Margined Madtom	Intermediate	Insectivore
N. sp. cf. *leptacanthus*	Broadtail Madtom	Intolerant	Insectivore
Pylodictis olivaris	Flathead Catfish	Intermediate	Piscivore
Esocidae	**Pikes**		
Esox americanus americanus	Redfin Pickerel	Intermediate	Piscivore
E. niger	Chain Pickerel	Intermediate	Piscivore
Umbridae	**Mudminows**		
Umbra pygmaea	Eastern Mudminnow	Intermediate	Insectivore
Aphredoderidae	**Pirate Perches**		
Aphredoderus sayanus	Pirate Perch	Intermediate	Insectivore
Amblyopsidae	**Cavefishes**		
Chologaster cornuta	Swampfish	Intermediate	Insectivore
Atherinopsidae	**New World Silversides**		
Labidesthes sicculus	Brook Silverside	Intermediate	Insectivore
Menidia beryllina	Inland Silverside	Intermediate	Insectivore
M. extensa	Waccamaw Silverside	Intolerant	Insectivore

Table 1 (continued)

Family/Species	Common Name	Tolerance Rating	Trophic Guild of Adults
Fundulidae	**Topminnows**		
Fundulus chrysotus	Golden Topminnow	Intermediate	Insectivore
F. lineolatus	Lined Topminnow	Intermediate	Insectivore
F. waccamensis	Waccamaw Killifish	Intolerant	Insectivore
Poeciliidae	**Livebearers**		
Gambusia holbrooki	Eastern Mosquitofish	Tolerant	Insectivore
Moronidae	**Temperate Basses**		
Morone americana	White Perch	Intermediate	Piscivore
M. saxatilis	Striped Bass	Intermediate	Piscivore
Centrarchidae	**Sunfishes**		
Acantharchus pomotis	Mud Sunfish	Intermediate	Insectivore
Centrarchus macropterus	Flier	Intermediate	Insectivore
Enneacanthus chaetodon	Blackbanded Sunfish	Intermediate	Insectivore
E. gloriosus	Bluespotted Sunfish	Intermediate	Insectivore
E. obesus	Banded Sunfish	Intermediate	Insectivore
Lepomis auritus	Redbreast Sunfish	Tolerant	Insectivore
L. gibbosus	Pumpkinseed	Intermediate	Insectivore
L. gulosus	Warmouth	Intermediate	Insectivore
L. macochirus	Bluegill	Intermediate	Insectivore
L. marginatus	Dollar Sunfish	Intermediate	Insectivore
L. microlophus	Redear Sunfish	Intermediate	Insectivore
L. punctatus	Spotted Sunfish	Intermediate	Insectivore
M. salmoides	Largemouth Bass	Intermediate	Piscivore
Pomoxis nigromaculatus	Black Crappie	Intermediate	Piscivore
Percidae	**Perches**		
Etheostoma fusiforme	Swamp Darter	Intermediate	Insectivore
E. mariae	Pinewoods Darter	Intolerant	Insectivore
E. olmstedi	Tessellated Darter	Intermediate	Insectivore
E. perlongum	Waccamaw Darter	Intolerant	Insectivore
E. serrifer	Sawcheek Darter	Intolerant	Insectivore
Perca flavescens	Yellow Perch	Intermediate	Piscivore
Percina crassa	Piedmont Darter	Intolerant	Insectivore
Elassomatidae	**Pygmy Sunfishes**		
Elassoma evergladei	Everglades Pygmy Sunfish	Intermediate	Insectivore
E. zonatum	Banded Pygmy Sunfish	Intermediate	Insectivore
E. boehlkei	Carolina Pygmy Sunfish	Intolerant	Insectivore

The eight species endemic to the river basin have been given special protection status by the U. S. Department of the Interior, the NC Wildlife Resources Commission, or the NC Natural Heritage Program under the NC State Endangered Species Act (G.S. 113-331 to 113-337) (LeGrand *et al*. 2006; Menhinick and Braswell 1997) (Table 2). In 2006, the Sandhills Chub was collected from Drowning, Jackson, Horse, Deep, Mountain, and Big Shoeheel creeks. The Pinewoods Darter was found at all sites, except for Aberdeen and Big Shoeheel creeks.

Table 2. Species of fish listed as threatened or of special concern in the Lumber River basin.

Species	Common Name	Status	State Rank
Cyprinella sp. cf. *zanema*	Thinlip Chub	Special Concern	S2
Semotilis lumbee	Sandhills Chub	Special Concern	S3
Noturus sp. cf. *leptacanthus*	Broadtail Madtom	Special Concern	S1
Fundulus waccamensis	Waccamaw Killifish	Special Concern	S1
Menidia extensa	Waccamaw Silverside	Threatened	S1
Etheostoma mariae	Pinewoods Darter	Special Concern	S3
E. perlongum	Waccamaw Darter	Threatened	S1
Elassoma boehlkei	Carolina Pygmy Sunfish	Threatened	S1

[1]S1 = Critically imperiled in North Carolina because of extreme rarity or because of some factor (s) making it especially vulnerable to extirpation from North Carolina. S2 = Imperiled in North Carolina because of rarity or because of some factor(s) making it very vulnerable to extirpation from North Carolina. S3 = rare or uncommon in North Carolina (LeGrand, et al. 2006).

In contrast to other river basins in the state, the indigenous fauna of the Lumber River basin is fairly intact. Only about eight percent (6 of the 71 species) of all species found in the basin are exotics

(nonindigenous species) and they were introduced either as sportfish, forage fish, baitfish, or for reasons unknown (Table 3). In 2006, only 1 of the 37 species collected was an exotic species; the Redlip Shiner was found in Drowning Creek as it has been during previous assessments. No exotic species were found at the other 12 sites.

Table 3. Exotic species in the Lumber River basin. Species collected in 2006 are highlighted in blue.

Family/Species	Common Name	Family/Species	Common Name
Cyprinidae	**Carps and Minnows**	**Ictaluridae**	**North American Catfishes**
Carassius auratus	Goldfish	*Pylodictis olivaris*	Flathead Catfish
Ctenopharyngodon idella	Grass Carp	**Centrarchidae**	**Sunfishes**
Cyprinus carpio	Common Carp	*Lepomis microlophus*	Redear Sunfish
Notropis chiliticus	Redlip Shiner		

In 2006, 37 of the 71 species were collected (Table 1). Species not collected included those found outside the Sand Hills (several species), or those that prefer larger rivers (e.g. American Shad), natural lakes (Waccamaw Silverside, Waccamaw Killifish, and Waccamaw Darter), or shallow, vegetated creeks and ditches (e.g., Blackbanded Sunfish, Banded Sunfish, and the Everglades Pygmy Sunfish). The most widely distributed species were the Dusky Shiner, Margined Madtom, Tessellated Darter, Pirate Perch, and Pinewoods Darter; these species were collected at 11 – 13 of the sites. Sixteen species were less widely distributed and collected only at 1 or 2 sites. The numerically dominant species was the Dusky Shiner; it accounted for almost 60 percent of all the fish collected and was the most abundant species at 12 of the 13 sites. By contrast, 12 of the rarer species were represented by only 1 or 2 individuals per species. Only two new county distributional records were recorded in 2006 from DWQ's fish community monitoring efforts (Table 4).

Table 4. New distributional records for the Lumber River Basin.

Family/Species	Common Name	County
Amiidae	**Bowfins**	
Amia calva	Bowfin	Richmond
Cyprinidae	**Carps and Minnows**	
Notropis petersoni	Coastal Shiner	Richmond, Moore

Appendix F-4. Water quality at 13 fish community sites in the Lumber River basin, 2006.

In 2006 water quality data (temperature, specific conductance, dissolved oxygen, and pH) were collected at every site during fish community assessments (Table 1). All dissolved oxygen concentrations were greater than the water quality standard of 5 mg/L. Dissolved oxygen saturation ranged from 80 percent at Aberdeen Creek to 90 percent at Drowning Creek. All pH measurements were ≤ 6.0 s.u., even though only Drowning, Joes, Big Shoeheel, Jordan, and Juniper creeks are supplementally classified as Swamp Waters (SW). Specific conductance ranged from 16 µS/cm at Jordan Creek to 37 µS/cm at Aberdeen Creek. All sites had naturally occurring darkly tannin stained waters (i.e., blackwater). Thus, in 2006 water conditions at these 13 sites were typical for streams draining the Sand Hills – low pH and low conductivity, and darkly stained waters.

Table 1. Water quality measurements at 13 fish community sites in the Lumber River basin, 2006.

HUC/ Waterbody	Location	County	Date	Temperature (˚C)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	Saturation (%)	pH (s.u.)
03040203 Lumber River								
Drowning Cr	NC 73	Moore	05/22/06	18.8	32	8.4	90	4.7
Jackson Cr	SR 1122	Moore	05/22/06	19.9	24	7.8	86	5.3
Naked Cr	SR 1003	Richmond	05/22/06	18.6	33	8.3	89	6.0
Horse Cr	SR 1112	Moore	05/23/06	18.0	31	8.2	87	5.9
Deep Cr	SR 1113	Moore	05/22/06	19.1	20	7.5	81	4.8
Aberdeen Cr	SR 1105	Moore	05/23/06	18.5	37	7.5	80	5.9
Quewhiffle Cr	SR 1225	Hoke	05/23/06	19.0	30	7.9	85	5.5
Mountain Cr	SR 1215	Hoke	05/24/06	16.3	36	8.0	82	5.7
03040204 Little Pee Dee River								
Gum Swamp Cr	SR 1344	Scotland	05/25/06	18.3	20	8.1	86	5.4
Joes Cr	NC 79	Scotland	05/25/06	19.1	21	7.8	84	5.4
Big Shoeheel Cr	SR 1433	Scotland	05/24/06	16.3	36	8.0	82	5.7
Jordan Cr	SR 1324	Scotland	05/24/06	20.8	16	7.3	82	5.8
Juniper Cr	SR 1405 (NC 144)	Scotland	05/25/06	19.9	19	7.9	87	5.3

At 9 of the 12 sites, the specific conductance in 2006 was slightly greater than what was measured in 2001 (Figure 1). Conductivity was about one-third lower in 2006 than in 2001 at Big Shoeheel Creek. The site on Big Shoeheel Creek is about two miles downstream of an industrial coolwater discharge (NPDES Permit No. NC0005762).

The pH values in 2006 at all sites in Moore, Richmond, and Hoke counties were lower than those in 2001 (Figure 1). By contrast, the pH values of the streams in Scotland County were slightly greater in 2006 than in 2001, except at Joes Creek. In 2001, samples were collected from Scotland County streams under very low flow conditions, whereas those in the upper part of the Sand Hills were collected following a rainy period. This may account for the slight difference in pH values.

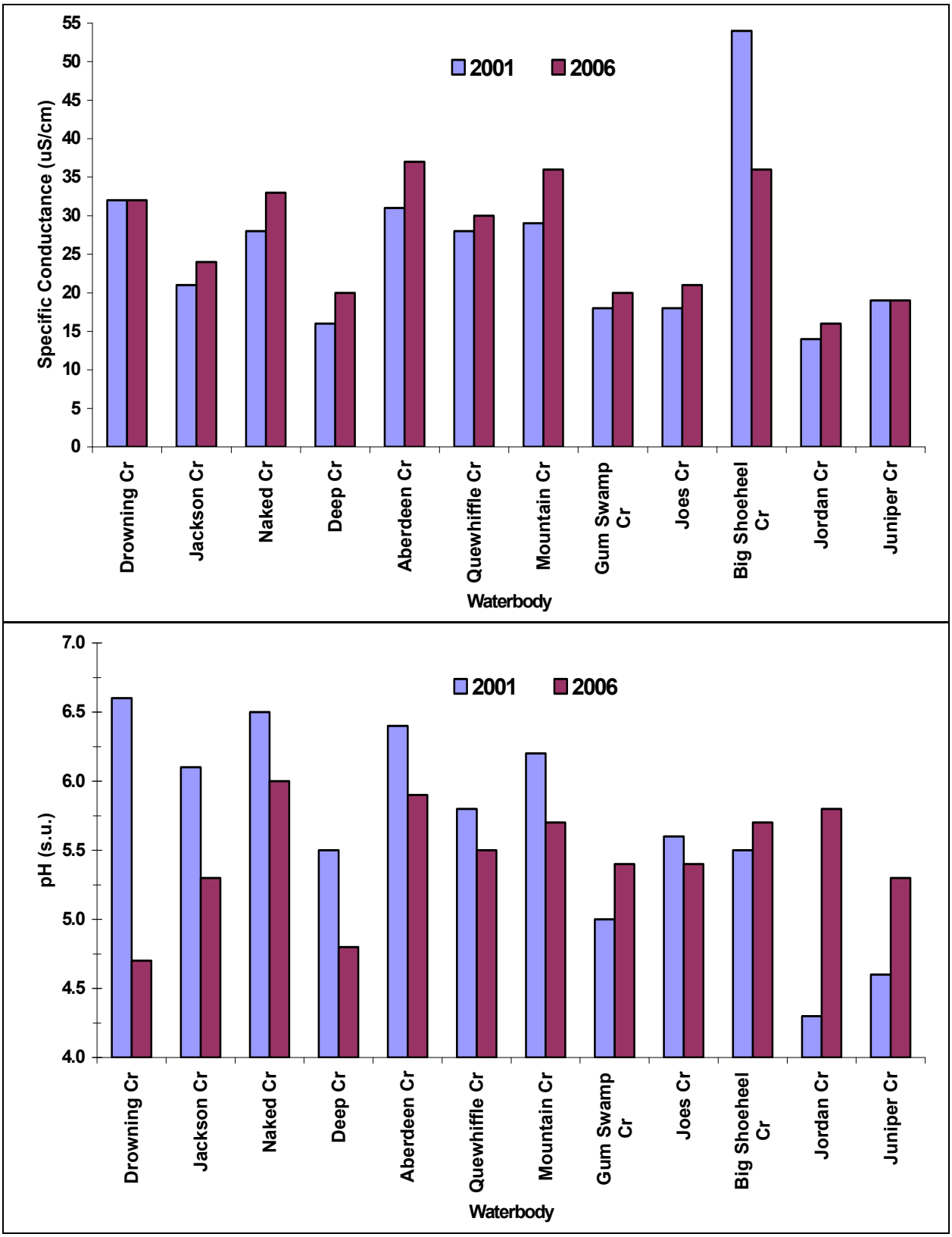


Figure 1. **Specific conductance (top) and pH (bottom) in 2001 and 2006 at 12 fish community sites in the Lumber River basin.**

Appendix F-5. Habitat evaluations and stream and riparian habitats at 13 fish community monitoring sites in the Lumber River basin, 2006.

Habitat Assessments

A method and scoring system has been developed by the BAU staff to evaluate the physical habitats of a stream (NCDENR 2001a). The narrative descriptions of eight habitat characteristics, including channel modification, amount of instream habitat, type of bottom substrate, pool variety, riffle frequency (not evaluated in Sand Hills and Coastal Plain streams), bank stability, light penetration, and riparian zone width, are converted into numerical scores. The total habitat score ranges between 1 and 100. Higher numbers suggest better habitat quality, but criteria have not been developed to assign ratings.

In 2006, basinwide fish community sampling was conducted at 13 sites within the Sand Hills ecoregion. Streams in this ecoregion drain low nutrient soils vegetated with pine (long leaf, short leaf, and loblolly)-oak (turkey and blackjack) and wiregrass scrub uplands and bottomland forests of holly, bay (red and Virginia), maple, sweetgum, and cypress. Other land uses besides forests include golf course, pastures, fruit orchards, and residential (retirement) communities. Many of the first and second order streams are impounded in their headwaters to form reservoirs for golf and resort communities. The permanently flowing moderate to swift waters are usually clear, but darkly stained with white quartz sand and gravel bottoms. Large, coarse woody debris and log jams often blocks the channel and submerged woody debris is also common. Aquatic macrophytes and macroalgae may be abundant in sun-lit areas (e.g., at bridge crossings and road and utility line right-of-ways) and include Spatterdock (*Nuphar luteum*), Pondweed (*Potamogeton*), Golden Club (*Orontium aquaticum*), Bur-Reed (*Sparganium*), Eel-Grass (*Vallisneria*), Sedges, Arrowhead (*Sagittaria)*, and a red alga (*Batrachospermum*).

Typically, the streams have year-round flow. However during prolonged droughts, streams draining even the larger watersheds may cease flowing. For example, during the 1998 – 2002 drought, the USGS gage site on Drowning Creek near Hoffman (drainage area = 183 square miles) recorded an all time new record low flow of 0 cfs on August 14, 2002 (Weaver 2005). It is thus likely that the smaller watersheds also ceased flowing or dried up.

The instream and riparian habitats of these streams were of particularly high quality (all habitat scores > 85, some sites > 95) (Table 1). Characteristics of these streams are:

- instream habitats composed of sticks, leafpacks, macrophytes (in sun-light areas near the bridges), snags and logs, and undercut banks and root mats;
- a mixed substrate of gravel, sand, detritus, and silt; and
- a natural channel, stable, vegetated banks providing a dense tree canopy, and a wide and intact riparian zone (Figure 1).

Figure 1. Sun-lit areas and aquatic macrophytes at Horse Creek at SR 1112, Moore County (left) and instream and riparian habitats at Mountain Creek at SR 1215 Hoke County (right).

Table 1. Habitat evaluations at 13 basinwide fish community sites in the Lumber River basin, 2006.

HUC	Stream	Location	County	Width (m)	Channel	Instream Habitat	Substrate	Pools	Bank Stability-L	Bank Stability-R	Shade	Riparian Zone-L	Riparian Zone-R	Total Score
03040203 Lumber River														
	Drowning Cr	Moore	NC 73	6	15	19	7	9	9	9	10	5	5	88
	Jackson Cr	Moore	SR 1122	6	15	18	10	10	7	9	8	5	5	87
	Naked Cr	Richmond	SR 1003	7	15	19	13	10	9	9	7	5	2	89
	Horse Cr	Moore	SR 1112	5	15	19	13	10	10	10	9	5	5	96
	Deep Cr	Moore	SR 1113	4	15	18	13	10	10	10	10	5	5	96
	Aberdeen Cr	Moore	SR 1105	7	15	15	13	10	10	10	10	5	5	93
	Quewhiffle Cr	Hoke	SR 1225	4	15	19	13	10	10	10	10	5	5	97
	Mountain Cr	Hoke	SR 1215	4	15	19	13	10	10	10	10	5	5	97
03040204 Little Pee Dee River														
	Gum Swamp Cr	Scotland	SR 1344	4	15	19	13	8	10	10	10	5	5	95
	Joes Cr	Scotland	NC 79	7	15	18	13	10	10	10	10	5	5	96
	Big Shoeheel Cr	Scotland	SR 1433	5	15	19	13	10	10	10	10	5	5	97
	Jordan Cr	Scotland	SR 1324	4	15	19	13	10	10	10	10	5	5	97
Maximum possible score					**15**	**20**	**15**	**10**	**10**	**10**	**10**	**5**	**5**	**100**

Appendix F-6. Web links.

NC Division of Water Quality, Stream Fish Community Assessment (including Habitat Assessment) Standard Operating Procedures
http://www.esb.enr.state.nc.us/BAU.html

NC Division of Water Resources, Drought Monitoring
http://www.ncwater.org/Drought_Monitoring/

NC Division of Water Quality (native and exotic freshwater fish in North Carolina)
http://www.esb.enr.state.nc.us/www.esb.enr.state.nc.us/Native and Introduced Freshwater Fish in North Carolina.2-1.htm

National Weather Service and North carolina State University's Marine, Earth, and Atmospheric Sciences Case Studies
http://www.meas.ncsu.edu/nws/www/cases/

US Geological Survey (real-time streamflow data for North Carolina)
http://waterdata.usgs.gov/nc/nwis/current?type=flow

Appendix F-7 Fish community references.

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Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
LUMBER R	**SR 1404**	**07/17/06**	**Excellent**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
SCOTLAND	51	03040203	14-(3)	345238	792044

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Southeastern Floodplains and Low Terraces	WS-IV, B, Sw, HQW	341.2	14	0.8

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Moore County Public Utilites	NC 0037508	6.7

Water Quality Parameters

Temperature (°C)	25
Dissolved Oxygen (mg/L)	6.9
Specific Conductance (µS/cm)	37
pH (s.u.)	6.3
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	18
Bottom Substrate (15)	12
Pool Variety (10)	10
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	7
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	90

Site Photograph

Substrate gravel 75%, sand 10%, silt 15%

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/17/06	9970	81	36	4.7	3.4	Excellent
07/17/01	8441	90	36	4.5	3.4	Excellent
07/09/96	7065	75	33	4.0	2.9	Excellent
05/03/94	6484	104	46	4.4	3.2	Excellent
09/10/91	5717	83	30	5.1	2.9	Excellent

Taxonomic Analysis

High diversity and intolerant taxa characterize this uppermost Lumber River site. Very pollution sensive taxa that were abundant here in 2006 include the stoneflies *Paragnetina fumosa* and *Pteronarcys dorsata*, the caddiflies *Chimarra, Helicopsyche borealis* and *Neophylax oligius*.

Data Analysis

The second lowest Biotic Index was recorded here of all the Lumber River basin sites sampled in 2006. There have been eight collections at this location on the Lumber River since 1985, all of which rated Excellent. There appears to be no indication of declining water quality here or upstream of SR 1404.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
LUMBER R	**SR 1003 nr Pembroke**	**07/17/06**	**Excellent**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	51	03040203	14-(7)	343830	791050

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Southeastern Floodplains and Low Terraces	WS-IV, B, SW, HQW	437	14	0.8

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Moore County Public Utilites	NC 0037508	6.7
Westpoint Stevens, Inc	NC 0005762	4.5
Laurinburg-Maxto Airport	NC 0044725	1.0
Pembroke Town WWTP	NC 0027103	1.33

Water Quality Parameters

Temperature (°C)	27.7
Dissolved Oxygen (mg/L)	6.3
Specific Conductance (µS/cm)	89
pH (s.u.)	6.4
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	13
Pool Variety (10)	10
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	7
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	88

Site Photograph

Substrate gravel 10%, sand 70%, silt 20%

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/17/06	9971	79	28	5.2	3.9	Excellent
07/18/01	8454	92	32	5.1	4	Excellent
07/09/96	7070	71	31	4.7	3.7	Excellent
09/11/91	5720	87	31	5.7	3.8	Excellent
08/07/90	5414	87	28	5.3	4.1	Excellent

Taxonomic Analysis

A diverse and pollution sensitive macroinvertebrate community resides at this site. The pollution sensitve mayfly *Heptagenia pulla* , was collected at this location in 2006. Another sensitive taxa only found here in 2006 was the caddisfly *Nectopsyche pavida* . Other high water quality indicators included the stoneflies *Neoperla* , *Paragnetina fumosa* , *P. kansensis* and *Pteronarcys dorsata* , and the caddisflies *Brachycentrus numerosus* and *Chimarra* .

Data Analysis

The Lumber River at SR 1003 rated Excellent in 2006, the same ratiing it received in 10 other samplings since 1983. No declining water quality trends were observed when all 11 collections were analyzed.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
LUMBER R	**NC 41-72**	**08/04/06**	**Excellent**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	51	03040203	14-(13)	343703	790040

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Southeastern Floodplains and Low Terraces	C, Sw	680.4	20	0.8

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	25	50	0	25

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Moore County Public Utilites	NC 0037508	6.7
Westpoint Stevens, Inc	NC 0005762	4.5
Laurinburg-Maxton Airport Commision	NC 0044725	1.0
Pembroke Town WWTP	NC 0027103	1.33
Red Springs Town WWTP	NC 0025577	2.5

Water Quality Parameters

Temperature (°C)	29.3
Dissolved Oxygen (mg/L)	6.04
Specific Conductance (µS/cm)	78
pH (s.u.)	6.2
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	7
Instream Habitat (20)	13
Bottom Substrate (15)	13
Pool Variety (10)	10
Left Bank Stability (10)	9
Right Bank Stability (10)	7
Light Penetration (10)	2
Left Riparian Score (5)	3
Right Riparian Score (5)	2
Total Habitat Score (100)	66

Site Photograph

Substrate rubble 10%, sand 70%, silt 20%

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
08/04/06	10036	86	31	5.7	4.3	Excellent
07/18/01	8464	91	30	5.7	4.5	Excellent
07/10/96	7071	73	30	5.4	4.3	Excellent

Taxonomic Analysis

The taxa collected at Lumber River NC 41/72 were diverse (second highest diversity of mainstem Lumber River sites) and pollution sensitive, very similar to the upstream sites in this watershed. However, two mayflies, *Baetisca* (abudant) and *Heptagenia* (common) were unique to this site and also highly intolerant to pollution. Another unique and intolerant taxon, *Oxyethira* , a caddisfly, was collected here in 2006. Baetid mayflies and hydropsychid caddisflies dominated the sample, as seen in the 2001 collection.

Data Analysis

Despite the urban nature of this location and low habitat score, this site rated Excellent in 2006 and in two previous collections. Intolerant taxa can persist here due to the Excellent water quality seen in the Lumber River basin upstream of this point. Any effects from urban runoff or degraded habitat were not seen in the macroinvertebrate data, though in-stream and riparian habitats were clearly affected by the urban nature of this site. In-stream habitat that was present here was highly colonized by aquatic macroinvertebrates.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
LUMBER R	**NC 72**	**08/24/06**	**Good-Fair**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	51	03040203	14-(13)	343528	785900

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Southeastern Floodplains and Low Terraces	C, Sw	724	20	5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Lumberton City WWTP	NC 0024571	20
Buckeye Lumberton, Inc	NC 0005321	1.8
Alamac Knit Fabrics, Lumberton	NC 0004618	2.56
Pembroke Town WWTP	NC 0027103	1.33
Laurinburg-Maxton Airport Commision	NC 0044725	1.0
Westpoint Stevens, Inc	NC 0005762	4.5
Moore County WSA/Moore Co WWTP	NC 0037508	6.7
Red Springs Town WWTP	NC 0025577	2.5

Water Quality Parameters

Temperature (°C)	26.3
Dissolved Oxygen (mg/L)	4.8
Specific Conductance (µS/cm)	175
pH (s.u.)	5.8
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	7
Pool Variety (10)	10
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	2
Left Riparian Score (5)	4
Right Riparian Score (5)	4
Total Habitat Score (100)	77

Site Photograph

Substrate sand 80%, silt 20%

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
08/24/06	10021	90	24	6.3	4.5	Good-Fair
08/21/01	8457	53	12	6.4	4.6	Good-Fair
07/11/96	7075	57	15	6.3	4.3	Good-Fair
07/16/86	3815	43	5	8	6.9	Poor
07/16/85	3003	65	15	7.3	4.1	Good-Fair

Taxonomic Analysis

A distinct change in the community structure occurs between downtown Lumberton (NC 41/72) and NC 72. Though intolerant fauna still persist, a much higher percentage of pollution tolerant species are present here. These would include chironomids (e.g. *Cryptotendipes* , tolerant of organic loading, *Polypedilum scalaenum* , t.v. = 8.4). Also, the nature of the the stream itself changes here, becoming slower and deeper as evidenced by the decrease in stonefly taxa and the novel presence of the burrowing chironomid *Axarus* . Diversity remains high here, but the Biotic Index shows that this site has the highest pollution-tolerant community of any of the Lumber River/Drowning Creek main stems.

Data Analysis

Within four miles upstream of this site, there are three major dischargers totaling 24.5 mgd of permitted flow. Yet this site rated Good-Fair in 2006, similar to most of the five sampling events since 1985. The numbers of EPT and total taxa were the highest recorded in 2006 while the Biotic Index was the lowest (tie-1996). This suggests that conditions are holding steady if not improving slightly at this site.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
LUMBER R	**US 74 @ Boardman**	**08/24/06**	**Good**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	51	03040203	14-(13)	342635	785738

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Mid-Atlantic Floodplains and Low Terraces	C, Sw	1224.5	25	2

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Lumberton City WWTP	NC 0024571	20
Buckeye Lumberton, Inc	NC 0005321	1.8
Alamac Knit Fabrics, Lumberton	NC 0004618	2.56
Pembroke Town WWTP	NC 0027103	1.33
Laurinburg-Maxto Airport Commision	NC 0044725	1.0
Westpint Stevens, Inc	NC 0005762	4.5
Moore County WSA/Moore Co WWTP	NC 0037508	6.7
Red Springs Town WWTP	NC 0025577	2.5
Croft Metals Inc, Lubmer Bridge (not discharging as of Jan 2007)	NC 0035530	0.095

Water Quality Parameters

Temperature (°C)	27.1
Dissolved Oxygen (mg/L)	3.9
Specific Conductance (µS/cm)	135
pH (s.u.)	5.4
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	5
Pool Variety (10)	10
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	4
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	79

Site Photograph

Substrate sand 90%, detritus 10%

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
08/24/06	10022	76	20	5.7	4.1	Good
09/10/01	8559	94	32	5.6	4.0	Excellent
07/11/96	7074	82	26	5.5	4.3	Good
09/10/91	5733	52	19	4.9	4.0	Good
07/13/88	4606	92	27	5.5	4.2	Good

Taxonomic Analysis

Stoneflies were notably absent in 2006. Typically between three and five species were noted in previous collections. The number of mayfly taxa decreased also from an average of 10 during the previous five collections to six in 2006. All other aquatic macroinvertebrate taxa groups collected in 2006 were similar to previous years. High water levels in 2006 disguised the areas of good flow and substrates where these two groups prefer. Freshwater mussels (e.g. *Lampsilis* sp) were collected here in 2006 as in previous years.

Data Analysis

The Lumber River at US 74 has partially recovered from the influences of upstream stress. The biotic index (BI) has improved to approximately where it was upstream at NC 41/72, though overall diversity is still lower. The six collections since 1986 generally indicate Good water quality. The reduced mayfly taxa and absent stonefly taxa result in a slightly higher BI in 2006 than in previous samples. Given the difficulty in finding flow and the increased depths, it would appear that water quality here has remained stable.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Drowning Cr	**NC 73**	**05/22/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Moore	50	03040203	351116	793855	14-2-(1)	Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
WS-II;SW,HQW	31.9	--	6	0.4	Yes

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Samarkand Manor (NC Dept. Juvenile Justice) inactive as of 06/25/2001	NC0027651	0.04

Water Quality Parameters

Temperature (°C)	18.8
Dissolved Oxygen (mg/L)	8.4
Specific Conductance (µS/cm)	32
pH (s.u.)	4.7

Water Clarity	Blackwater

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	19
Bottom Substrate (15)	7
Pool Variety (10)	9
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**88**

Site Photograph

Substrate Sand, gravel

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/22/06	2006-56	20	---	Not Rated
06/06/01	2001-55	18	---	Not Rated
05/31/96	96-66	15	---	Not Rated
03/25/96	96-02	12	---	Not Rated

Most Abundant Species Dusky Shiner

Exotic Species Redlip Shiner, only site in 2006 with an exotic species.

Species Change Since Last Cycle **Gains** -- Coastal Shiner, Spotted Sucker, Flat Bullhead, Chain Pickerel, and Pinewoods Darter. **Losses** -- Flier, Pumpkinseed, Largemouth Bass, and Piedmont Darter.

Data Analysis

Watershed -- begins near the Town of Candor and drains southwestern Moore and southeastern Montgomery counties, a majority of the watershed is forested. **Habitat** -- many snags, undercuts, and roots. **2006** -- most species of any site, but 9 of the 20 species were represented by only 1 or 2 fish per species; approximately twice as many fish collected in 2006 than in 2001. **1996 - 2006** -- species-rich, 25 species known from site; Dusky Shiner always the most abundant species. Species of Special Concern, Sandhills Chub collected in 2001 and 2006, and Pinewoods Darter collected in 1996 and 2006.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
DROWNING	**SR 1004**	**07/10/06**	**Excellent**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
RICHMOND	50	03040203	14-2-(6.5)	350357	793300

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Sand Hills	WS-II, Sw, HQW	125.5	10	0.5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none		

Water Quality Parameters

Temperature (°C)	21
Dissolved Oxygen (mg/L)	7.3
Specific Conductance (µS/cm)	26
pH (s.u.)	5.6
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	20
Bottom Substrate (15)	15
Pool Variety (10)	4
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	92

Site Photograph

Substrate gravel 50%, sand 40%, silt 10%

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/10/06	9967	81	29	4.4	2.8	Excellent
07/13/01	8437	81	31	4.5	2.8	Excellent
07/08/96	7064	74	34	4.5	3.2	Excellent
09/09/91	5711	90	39	4.5	2.8	Excellent
02/16/89	4829	40	40	n/a	2.6	Excellent

Taxonomic Analysis

Pollution intolerant taxa such as the mayfly *Paraleptophlebia* , the stonefly *Neoperla* , and the caddisflies B*rachycentrus numerosus, Helicopsyche borealis, Oecetis morsei* and *Psilotreta frontalis* have been collected here consistently since sampling first began in 1985. Unique taxa only collected here in 2006 within the Lumber River basin include the caddifly *Paranyctiophylax celta* , the beetle *Sperchopsis tessellatus* , and the chironomid *Stelechomyia perpulchra* .

Data Analysis

The lowest Biotic Index in the Lumber River Basin in 2006 was recorded here (among Full Scale and Swamp samples). Drowning Creek has rated Excellent since 1985, when it was first sampled. All seven samples collected here since then indicate that water quality has not declined in this reference stream.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
DROWNING	**US 15-501**	**07/17/06**	**Excellent**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
HOKE	50	3040203	14-2-(10.5)	350122	792636

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Sand Hills	C, Sw, HQW	242	10	0.8

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Moore County Public Utilites	NC 0037508	6.7

Water Quality Parameters

Temperature (°C)	25
Dissolved Oxygen (mg/L)	6.7
Specific Conductance (µS/cm)	53
pH (s.u.)	6.5
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	20
Bottom Substrate (15)	13
Pool Variety (10)	10
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	96

Site Photograph

Substrate gravel 10%, sand 70%, silt 20%

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/17/06	9969	78	26	4.81699	3.64222	Excellent

Taxonomic Analysis

A very simliar benthic community resides in Drowning Creek at US 15/501 as at SR 1004, approx. 10 miles upstream. Total taxa and Biotic Index values were similar and suggests that the pollution intolerant community found in the upper portions of the Lumber River Basin (Jackson Creek, Naked Creek, Horse Creek) continue downstream through this reach. Taxa found here that were not collected at other Lumber River basin sites in 2006 include the chironomid *Trissopelpia* and freshwater mussels (both common).

Data Analysis

Drowning Creek at US 15/501 was proposed as a new basinwide site as it was downstream of the Moore County Public Utilities discharge on Aberdeen Creek (approx. 3.5 miles upstream of US 15/501). The Excellent rating here suggests that any concerns about that facility should be looked at on Aberdeen Creek itself, where in 1987 a DWQ study found little difference between upstream and downstream collections associated with that discharger.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
JACKSON CR	**SR 1122**	**07/10/06**	**Good**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
MOORE	50	03040203	14-2-5	351128	793715

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Sand Hills	WS-II, HQW	17.6	5	0.8

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none		

Water Quality Parameters

Temperature (°C)	21
Dissolved Oxygen (mg/L)	8
Specific Conductance (µS/cm)	24
pH (s.u.)	6.2
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	20
Bottom Substrate (15)	10
Pool Variety (10)	6
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	1
Total Habitat Score (100)	85

Site Photograph

Substrate 20% gravel, 60% sand, 20% silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/10/06	9959	23	23	n/a	3.0	Good
07/09/01	8436	23	23	n/a	3.1	Good
07/08/96	7061	25	25	n/a	2.8	Excellent
02/16/89	4826	26	26	n/a	3.3	Good-Fair

Taxonomic Analysis

Many pollution intolerant taxa were collected here, including the caddisflies *Oecetis morsei, Psilotreta frontalis, Lepidostoma* sp, and *Brachycentrus chelatus;* the stoneflies, *Acroneuria carolina and Neoperla sp.;* and the mayflies *Paraleptophlebia* sp. and *Leucrocuta* sp. The mayfly *Plauditus cestus* (common), first collected in 2006, was the only record for this species in the Lumber River Basin in 2006. EPT taxa differed little among the three summer samples (1996, 2001, 2007). The caddisfly *Brachycentrus nigrosoma and the mayfly Leucrocuta* sp. (both common) were only collected here and at only one and two other locations, respectively, in the Lumber Basin this year.

Data Analysis

Jackson Creek rated Good in 2006 the same rating it recieved during the 2001 collection. The EPT community in 2006 was very similar to 2001 and 1996 suggesting that no large changes have occurred in this watershed to degrade water quality since 1996.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Jackson Cr	**SR 1122**	**05/22/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Moore	50	03040203	351130	793707	14-2-5	Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
WS-II,HQW	18.1	--	6	0.4	Yes

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	19.9
Dissolved Oxygen (mg/L)	7.8
Specific Conductance (µS/cm)	24
pH (s.u.)	5.3

Water Clarity	Blackwater

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	18
Bottom Substrate (15)	10
Pool Variety (10)	10
Left Bank Stability (10)	7
Right Bank Stability (10)	9
Light Penetration (10)	8
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**87**

Site Photograph

Substrate Sand, gravel, wood

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/22/06	2006-55	17	---	Not Rated
06/06/01	2001-56	14	---	Not Rated

Most Abundant Species Dusky Shiner

Exotic Species None

Species Change Since Last Cycle

Gains -- Sandhills Chub, Spotted Sucker, Tadpole Madtom, Pinewoods Darter, and Banded Pygmy Sunfish. **Losses** -- Flat Bullhead and Mud Sunfish.

Data Analysis

Watershed -- includes the rural area west and southwest of the Town of West End; a headwater tributary is impounded upstream as Lake Auman; tributary to Drowning Creek. **Habitat** -- right riparian zone logged within last 5 years; snags and roots. **2001 - 2006** -- a typical Sand Hills fauna; 19 species known from the site. Sandhills Chub and Pinewoods Darter, Species of Special Concern, collected in 2006.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
NAKED CR	**SR 1003**	**07/10/06**	**Excellent**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
RICHMOND	50	03040203	14-2-6	350455	793525

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Sand Hills	WS-II, ORW	37.1	8	0.5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none		

Water Quality Parameters

Temperature (°C)	21
Dissolved Oxygen (mg/L)	5.8
Specific Conductance (µS/cm)	30
pH (s.u.)	6.5
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	20
Bottom Substrate (15)	13
Pool Variety (10)	4
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	0
Total Habitat Score (100)	85

Site Photograph

Substrate trace of rubble, 30% gravel, 60% sand, 10 % silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/10/06	9966	91	31	5.0	3.4	Excellent
07/13/01	8438	98	41	4.5	3.6	Excellent
07/08/96	7062	81	33	4.7	3.6	Excellent
09/09/91	5710	94	35	4.6	2.9	Excellent
11/07/90	5499	83	31	5.1	3.8	Excellent

Taxonomic Analysis

A greater number of total taxa were collected at Naked Creek in 2006 than any other site with the Lumber River basin. Many of these taxa were both pollution intolerant and/or uncommon. Taxa collected here in 2006 that were not found anywhere else in the Lumber Basin this year include the mayflies *Attenella attenuata, Ephoron leukon* and *Eurylophella aestiva* ; the caddisfly *Oecetis avara* ; the beetle *Helichus* , and the dragonfly *Stylogomphus albistylus* .

Data Analysis

Naked Creek rated Excellent in 2006, the same rating it has received on 14 previous sampling efforts beginning in 1983. There does not appear to be any noticable changes in water quality at this sandhills reference site.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Naked Cr	**SR 1003**	**05/22/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Richmond	50	03040203	350455	793522	14-2-6	Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
WS-II;ORW	38	--	7	0.4	No

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	18.6
Dissolved Oxygen (mg/L)	8.3
Specific Conductance (µS/cm)	33
pH (s.u.)	6.0

Water Clarity	Blackwater

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	19
Bottom Substrate (15)	13
Pool Variety (10)	10
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	7
Left Riparian Score (5)	5
Right Riparian Score (5)	2
Total Habitat Score (100)	**89**

Site Photograph

Substrate Quartz gravel, white sand

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/22/06	2006-57	17	---	Not Rated
06/06/01	2001-57	12	---	Not Rated
05/31/96	96-65	16	---	Not Rated
03/25/96	96-01	8	---	Not Rated

Most Abundant Species Dusky Shiner

Exotic Species None

Species Change Since Last Cycle

Gains -- Bowfin, Coastal Shiner, Chain Pickerel, Redfin Pickerel, Mud Sunfish, Bluespotted Sunfish, and Warmouth. **Losses** -- Bluehead Chub and Dollar Sunfish.

Data Analysis

Watershed -- drains eastern Richmond and southwestern Moore counties; tributary to Drowning Creek; largest watershed assessed. **Habitat** -- right riparian zone was extensively logged less than 5 years ago, buffer remaining is less than 6 m wide; an abundance of woody debris in stream; undercuts, roots, snags, runs, pools; very dark, swift, and deep water. **2006** -- species collected for the first time were the Coastal Shiner, Chain Pickerel, Mud Sunfish, Bluespotted Sunfish, and Warmouth. **1996 - 2006** -- a typical Sand Hills fauna; 23 species known from the site; Dusky Shiner consistently the most abundant species. Pinewoods Darter, a Species of Special Concern, consistently collected.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Horse Cr	**SR 1112**	**05/23/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Moore	50	03040203	350756	792932	14-2-10	Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
WS-II;HQW	10.7	--	5	0.4	No

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	18.0
Dissolved Oxygen (mg/L)	8.2
Specific Conductance (µS/cm)	31
pH (s.u.)	5.9

Water Clarity	Blackwater

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	19
Bottom Substrate (15)	13
Pool Variety (10)	10
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	9
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**96**

Site Photograph

Substrate Sand, silt

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/23/06	2006-59	18	---	Not Rated

Most Abundant Species Dusky Shiner

Exotic Species None

Species Change Since Last Cycle N/A; new site in 2006.

Data Analysis

Watershed -- headwaters drain the Village of Pinehurst; impounded ~ 2.7 mi. upstream as Pinehurst Lake; tributary to Drowning Creek. **Habitat** -- *Sparganium/Valisneria* and *Potamogeton* at the culverts in the sun-lit areas; cobble rip/rap riffles upstream and downstream of culverts. A typical Sand Hills fauna. Sandhills Chub and Pinewoods Darter, Species of Special Concern, collected at the site.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
HORSE CR	**SR 1102**	**07/10/06**	**Excellent**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
MOORE	50	03040203	14-2-10	350512	793100

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Sand Hills	WS-II, HQW	40.6	7	0.3

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none		

Water Quality Parameters

Temperature (°C)	21.3
Dissolved Oxygen (mg/L)	8.1
Specific Conductance (µS/cm)	17
pH (s.u.)	5
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	18
Bottom Substrate (15)	13
Pool Variety (10)	4
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	90

Site Photograph

Substrate 80% sand, 20% silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/10/06	9974	n/a	26	n/a	2.4	Excellent
07/09/01	8435	n/a	20	n/a	2.8	Good
07/08/96	7063	n/a	28	n/a	2.8	Excellent
09/09/91	5712	n/a	26	n/a	2.3	Excellent

Taxonomic Analysis

Numbers of EPT taxa were in similar to the 1991 and 1996 collections. However, in 2006 only three mayfly taxa were collected, the lowest number seen when compared to the five, seven and eight taxa in previous collections. Baetid mayflies collected previously (e.g. *Acerpenna pygmaea, Pseudocloeon ephippiatum, P. frondale, Baetis intercalris*) were not seen in 2006. *Stenonema exiguum* (rare) was collected for the first time in 2006. The stonefly *Pteronarcys dorsata* abundant in 1991 and common in in 1996 has been absent since. The highest numbers of caddisflies were recorded in 2006 with a number of new taxa for this site (e.g. *Agarodes* , common).

Data Analysis

Horse Creek rated Excellent in 2006, an inprovement from the Good biolcassification in 2001. High water levels in 2001 made sampling difficult causing a decrease in taxa collected. In that year the Biotic Index remained similar to previous years supporting the conclusion that water quality did not decline. The absence of the shredder *Pteronarcys dorsata* could mean that less CPOM is retained in the stream. The absence of baetid mayflies remains a mystery, though could be related to low pH values.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Deep Cr	**SR 1113**	**05/22/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Moore	50	03040203	350723	793234	14-2-10-1-(1)	Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
WS-II,B;HQW	19.8	--	4	0.4	No

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	19.1
Dissolved Oxygen (mg/L)	7.5
Specific Conductance (µS/cm)	20
pH (s.u.)	4.8

Water Clarity	Blackwater

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	18
Bottom Substrate (15)	13
Pool Variety (10)	10
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**96**

Site Photograph

Substrate Sand

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/22/06	2006-54	12	---	Not Rated
06/07/01	2001-59	8	---	Not Rated

Most Abundant Species Dusky Shiner

Exotic Species None

Species Change Since Last Cycle

Gains -- American Eel, Spotted Sucker, Pirate Perch, and Chain Pickerel. **Losses** -- Banded Pygmy Sunfish.

Data Analysis

Watershed -- drains southwestern Moore County near the Foxfire Village community; tributary to Horse Creek which in itself is a tributary to Drowning Creek. **Habitat** -- snags, roots, coarse woody debris, sticks in current. **2001 - 2006** -- a typical Sand Hills fauna (low abundance and diversity); 13 species known from site. Sandhills Chub and Pinewoods Darter, Species of Special Concern, collected in 2001 and 2006.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Aberdeen Cr	**SR 1105**	**05/23/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Moore	50	03040203	350549	792722	14-2-11-(6)	Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C	28.4	--	7	0.75	No

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	18.5
Dissolved Oxygen (mg/L)	7.5
Specific Conductance (µS/cm)	37
pH (s.u.)	5.9

Water Clarity	Blackwater

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	13
Pool Variety (10)	10
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**93**

Site Photograph

Substrate Sand, silt, muck

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/23/06	2006-58	15	---	Not Rated
06/07/01	2001-58	15	---	Not Rated

Most Abundant Species Dusky Shiner, Redbreast Sunfish

Exotic Species None

Species Change Since Last Cycle

Gains -- Golden Shiner, Spotted Sucker, Flat Bullhead, Warmouth, and Largemouth Bass. **Losses** -- Bluehead Chub, Redfin Pickerel, Dollar Sunfish, Redear Sunfish, and Spotted Sunfish.

Data Analysis

Watershed -- drains the cities of Southern Pines, Aberdeen, and Pine Bluff and the US 1/US 15/501 corridor in south-central Moore County; impounded upstream to form Watson and Pages lakes; tributary to Drowning Creek. **Habitat** -- coarse woody debris, deep holes, good riparian. **2006** -- only 27 fish collected; 12 of 15 species represented by only 1 or 2 fish per species; Redfin Pickerel represented only by young-of-year; intolerant species absent. **2001 - 2006** -- 20 species known from the site. No Sandhills Chub or Pinewoods Darter, Species of Special Concern, collected from the site; only site in 2006 where neither species was collected.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Quewhiffle Cr	**SR 1225**	**05/23/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Hoke	50	03040203	350256	792501	14-2-14	Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C	17.8	--	3	0.4	No

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	19.0
Dissolved Oxygen (mg/L)	7.9
Specific Conductance (µS/cm)	30
pH (s.u.)	5.5

Water Clarity	Blackwater

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	19
Bottom Substrate (15)	13
Pool Variety (10)	10
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**97**

Site Photograph

Substrate Sand and organic silts

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/23/06	2006-60	7	---	Not Rated
06/05/01	2001-54	7	---	Not Rated

Most Abundant Species Pinewoods Darter

Exotic Species None

Species Change Since Last Cycle

Gains -- Yellow Bullhead, Swampfish, Mud Sunfish, and Banded Pygmy Sunfish. **Losses** -- American Eel, Chain Pickerel, Redbreast Sunfish, and Warmouth.

Data Analysis

Watershed -- drains the far western portion of Hoke and the southeast corner of Moore counties, southeast of the Town of Aberdeen; is a tributary to Drowning Creek. **Habitat** -- lots of woody debris; narrow, clear water, organic substrate, *Sparganium/Valisneria* in sun-lit areas. **2001 - 2006** -- fewest fish and species collected at any site in 2006; only 13 and 15 individual fish collected in 2001 and 2006; 11 species known from site; Chain Pickerel and Redfin Pickerel represented only by young-of-year. Pinewoods Darter, a Species of Special Concern, collected in 2001 and 2006.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Mountain Cr	**SR 1215**	**05/24/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Hoke	50	03040203	350051	792326	14-2-16-(2)	Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C	9.9	---	4	0.3	No

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
---	---	---

Water Quality Parameters

Temperature (°C)	16.3
Dissolved Oxygen (mg/L)	8.0
Specific Conductance (µS/cm)	36
pH (s.u.)	5.7

Water Clarity: Black water

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	19
Bottom Substrate (15)	13
Pool Variety (10)	10
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**97**

Site Photograph

Substrate: sand, detritus, organics

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/24/06	2006-61	10	---	Not Rated
06/05/01	2001-53	14	---	Not Rated

Most Abundant Species: Dusky Shiner

Exotic Species: None

Species Change Since Last Cycle: **Gains --** Dollar Sunfish. **Losses** -- Redfin Pickerel, Flat Bullhead, Tadpole Madtom, and Tessellated Darter.

Data Analysis

Watershed -- drains the western tip of Hoke County; a tributary to Drowning Creek. **Habitats** -- coarse woody debris, deadfalls, roots, undercuts, *Potamogeton* ; water clear, but stained. **2006** -- Dusky Shiner makes up 91% of the sample (vs. 73% in 2001); Chain Pickerel represented by young-of-year only. **2001 -2006** -- both intolerant species (Pinewoods Darter and Sandhills Chub) collected in both monitoring cycles; this stream is not rated, but the fish community in this forested watershed appears to be healthy.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
GUM SWP	**SR 1312**	**02/07/06**	**Natural**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	51	03040203	14-5	344303	791617

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	C	33	8	1

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none		

Water Quality Parameters

Temperature (°C)	9.1
Dissolved Oxygen (mg/L)	10.2
Specific Conductance (µS/cm)	59
pH (s.u.)	5.6
Water Clarity	clear

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	13
Bottom Substrate (15)	4
Pool Variety (10)	4
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	76

Site Photograph

Substrate mostly silt with some sand

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/07/06	9782	84	28	6.27	5.21	Natural
02/08/01	8378	75	21	6.10	4.64	Natural

Taxonomic Analysis

Ephemeroptera taxa are quite similar between 2001 and 2006. A notable difference in the mayfly community was the loss of *Paraleptophlebia* in 2006 from 2001 when it was abundant; the mayfly is quite intolerant to the presence of stressors (tolerance value of 0.9). An increase in the number of Plecoptera taxa occurred with additions of *Prostoia* , *Perlesta* , and *Clioperla clio* . There was also an increase in Trichoptera richness, with nine taxa in 2001 and 13 in 2006; *Paranyctiophylax moestus* , a caddisfly intolerant to the presence of stressors, was not recorded for 2001 but was abundant in 2006.

Data Analysis

The site is 4.6 miles ESE of the town of Maxton NC, 11.8 miles from the border with South Carolina, and 0.7 miles upstream of the Lumbee Recreation Center. The site is evaluated as Swamp A. The high number of EPT collected in 2006 is unusual for a swamp site. The benthic community appears to be fairly stable judging from results of the two sampling events. There is no indication of impact at the site.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
BACK SWP	**SR 1003**	**02/07/06**	**Natural**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	51	03040203	14-8-(2.5)	343713	791137

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Southeastern Floodplains and Low Terraces	WS-IV, Sw	28.6	6	0.2

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100			

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None		

Water Quality Parameters

Temperature (°C)	10.3
Dissolved Oxygen (mg/L)	11
Specific Conductance (µS/cm)	55
pH (s.u.)	5.3
Water Clarity	clear

Habitat Assessment Scores (max)

Channel Modification (15)	5
Instream Habitat (20)	10
Bottom Substrate (15)	7
Pool Variety (10)	4
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	64

Site Photograph

Substrate Sand, silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/07/06	9781	59	22	6.1	4.9	Natural
07/11/06	9968	71	16	6	4.9	Good-Fair
02/08/01	8377	80	25	6.1	4.9	Not Rated
07/17/01	8557	61	11	6.1	4.8	Not Rated

Taxonomic Analysis

This site has experienced a large decline in total taxa since the 2001 sampling event, dropping from 80 in 2001 to 59 in 2006. EPT taxa have remained fairly constant as have both overall and EPT biotic index. Most of the taxa lost were midges and caddisflies. These facts could indicate that habitat, versus water quality variables may be causing differences in the benthic community encountered.

Data Analysis

This is a highly channelized stream west of Lumberton and highways US 74 and I-95. Watershed land use is predominately agriculture. Riparian forest probably provides good canopy during summer months. Substrate at the site is predominately sand with very little woody debris present. A stormwater discharge enters the stream midsite. Banks are steep but not eroding badly. The reach sampled in 2006 was depauperate of woody debris and streamside root mats (the latter mostly out of the water due to low flow). Aquatic macrophytes, mentioned in previous sampling records, were absent during 2006 sampling.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
BEAR SWP	**SR 1339**	**02/08/06**	**Moderate**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	51	03040203	14-9-(1.5)	343722	790516

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	WS-IV, Sw	4.3	6	1

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	75	25		

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None		

Water Quality Parameters

Temperature (°C)	7.8
Dissolved Oxygen (mg/L)	10.8
Specific Conductance (µS/cm)	71
pH (s.u.)	5.7
Water Clarity	slightly turbid

Habitat Assessment Scores (max)

Channel Modification (15)	7
Instream Habitat (20)	8
Bottom Substrate (15)	4
Pool Variety (10)	4
Left Bank Stability (10)	4
Right Bank Stability (10)	10
Light Penetration (10)	8
Left Riparian Score (5)	2
Right Riparian Score (5)	5
Total Habitat Score (100)	52

Site Photograph

Substrate Silt, organic mud, detritus, sand

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/08/06	9785	48	7	6.9	5	Moderate
02/08/01	8376	68	17	6.2	4.9	Natural
03/14/96	7021	58	20	6.1	5.3	Natural

Taxonomic Analysis

A substantial drop in total and EPT taxa occurred at this site relative to previous sampling with the majority of loss occurring among mayflies, caddisflies and beetles. The overall biotic index climbed though the EPT biotic index rose only slightly. Several baetid and heptageniid mayflies previously present were absent as were many leptocerid caddisflies. Odonate taxa present in 2001 were completely replaced with different, yet fewer species.

Data Analysis

Prior sampling at this site indicated a substrate with a high percentage of sand. This was not observed during this sampling event with the sediment noted as being an organic mud with detritus. It is possible that either high flow events have altered the substrate or that the 2006 sampling event occurred during high water (which was the case) and that sampling occurred outside of the low-water stream channel. The 2001 sampling event noted significant land-clearing and removal of riparian forest.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
L RAFT SWP	**SR 1323**	**02/06/06**	**Natural**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	52	03040203	14-10-5	345005	791125

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	C, Sw	22	6	1

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none		

Water Quality Parameters

Temperature (°C)	7.8
Dissolved Oxygen (mg/L)	10.2
Specific Conductance (µS/cm)	34
pH (s.u.)	5.8
Water Clarity	clear/tannic

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	13
Pool Variety (10)	4
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	85

Site Photograph

Substrate sand 50%, silt 50%

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/06/06	9779	62	16	6.1	5.3	Natural

Taxonomic Analysis

A pollution sensitive and diverse community resides in this upper portion of Little Raft Swamp. A total of 16 EPT taxa were collected here, many of which were abundant. Unique taxa found only here within the Lumber River basin in 2006 included the caddisflies *Paranyctiophylax moestus* and *Wormaldia* , the chironomids *Zavrelimyia* and *Apsectrotanypus johnsoni* , and the dragonfly *Gomphaeschna* . This also is one of the few known locations of an undescribed species of *Eurylophella* first recognized in 2006.

Data Analysis

Little Raft Swamp at SR 1323 had the second lowest Biotic Index of any sampled swamp streamin the Lumber River Basin in 2006. Samples collected downstream from here in 2001 (SR 1776 and SR 1505) and 2006 (SR 1505) indicated degraded water quality (associated with stressors from the Town of Red Springs). The regional office requested that the site on Little Raft Swamp at SR 1776 be transferred upstream to establish a location above Red Springs, NC. Little Raft Swamp at SR 1323 provides a suitable upstream reference site.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
L RAFT SWP	**SR 1505**	**02/06/06**	**Severe**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	52	03040203	14-10-5	344822	790844

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	C-Sw	28.6	6	2

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100			

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Red Springs WWTP	NC0025577	2.5

Water Quality Parameters

Temperature (°C)	6.5
Dissolved Oxygen (mg/L)	6.1
Specific Conductance (µS/cm)	63
pH (s.u.)	5.8
Water Clarity	clear/tannic

Habitat Assessment Scores (max)

Channel Modification (15)	10
Instream Habitat (20)	10
Bottom Substrate (15)	1
Pool Variety (10)	4
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	7
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	62

Site Photograph

Substrate Silt, organic mud

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/06/06	9770	43	3	8.5	8.3	Severe
02/07/01	8375	64	9	7.5	5.8	Moderate

Taxonomic Analysis

Taxa at this site have declined dramatically since sampling in 2001. Total taxa have dropped from 64 to 43 and EPT taxa have decreased from 9 to 3, the latter with no remaining caddisflies or stoneflies. An increase in the biotic index of almost a full point indicate that this decline may be the result of declining water quality with more tolerant organisms gaining dominance in the community.

Data Analysis

This site is located approximately 1.1 miles downstream of the Town of Red Springs WWTP. A 2001 study compared macroinvertebrate community above and below the Red Springs WWTP and found no significant differences. Relatively high water was encountered at the site during the 2006 sampling event. Considering the water temperature measured at the site in 2006, the dissolved oxygen value recorded (6.1 mg/L) would be far below saturation, implying that oxygen demand in the water column was elevated.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
RAFT SWP	**SR 1505**	**02/02/06**	**Natural**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	52	03040203	14-10-(1)	344901	790743

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	C; Sw	56.3	6	1.5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	7.6
Dissolved Oxygen (mg/L)	10.5
Specific Conductance (µS/cm)	47
pH (s.u.)	5.6
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	6
Pool Variety (10)	4
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	80

Site Photograph

Substrate silt 90%, sand 10%

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/02/06	9778	68	22	6.1	5.0	Natural
02/07/01	8374	82	20	5.9	4.3	Natural

Taxonomic Analysis

Raft Swamp exhibited a relatively stable benthic community from 2001 to 2006. Taxonomic differences between the two collections were mostly changes in rare taxa. The benthic community residing in this reach consists of intolerant taxa such as the mayfly *Leptophlebia,* the stoneflies*Taeniopteryx* and *Shipsa rotunda* and the caddisflies *Oecetis georgia* and R*hyacophila lobifera* . Additionaly, a previously undescribed mayfly species (of the *Eurylophella temporalis* group) has been found here, among other locations in the Lumber River basin.

Data Analysis

Raft Swamp at SR 1505 received a Natural bioclassification, the same rating as in 2001. The biotic index and numbers of EPT taxa changed little from 2001 to 2006 (6.0 versus 6.1; 20 versus 22 respectively). This site is similar to another reference reach on Little Raft Swamp (SR 1323) where the biotic index also measured 6.1 in 2006. The habitat scorce here suggests little degradation. Antioch WTP, located approximately 11 miles upstream has no measureable influence on this site.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
RAFT SWP	**SR 1527**	**02/07/06**	**Moderate**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	52	03040203	14-10-(5.5)	343942	790357

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Southeastern Floodplains and Low Terraces	WS-IV; SW	158.7	15	0.5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	80	0	0	20 power line right-of-way

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Red Springs Town WWTP	NC 0025577	2.5

Water Quality Parameters

Temperature (°C)	7.7
Dissolved Oxygen (mg/L)	10.4
Specific Conductance (µS/cm)	55
pH (s.u.)	5.4
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	1
Pool Variety (10)	10
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	8
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	79

Site Photograph

Substrate 100% detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/07/06	9780	42	12	6.523077	5.752174	Moderate

Taxonomic Analysis

When compared to the upstream site on Raft Swamp (SR 1505, Natural bioclassification), fewer EPT and Total taxa were found here. Differences in EPT taxa between the two sites were mostly caddisflies such as *Chimarra* sp, *Chumatopsyche* sp, *Hydroptila* sp, *Hydropsyche decalda* , *Molanna tryphena* and *Oecetis georgia* . Odonates and Chironomids were two groups of benthic invertebrates that were species rich at SR 1505 but less common here (a total difference of 13 fewer taxa of those groups collected at SR 1527). The only collection of the Tipulid fly *Molophilus* sp was at SR 1527.

Data Analysis

Raft Swamp at SR 1527 rated Moderate in 2006. This new Lumber River Basin site integrates the entire Raft and Little Raft Swamp watersheds. It is located approx. 15 miles downstream of Red Springs WWTP. Though, in 2001, samples taken both above and below Red Springs WWTP showed little difference, in 2006, considerable differences existed between an upstream site (Natural bioclassification) and a site below both Red Springs and the WWTP there (Severe bioclassification). Waters from Raft Swamp (SR 1505 - Natural bioclassification) join with Little Raft (SR 1505 -Severe bioclassification) to yeild a Moderate rating (SR 1527 which is approximately nine miles below that confluence). Habitat differences can be ruled out as the upstream site on Raft Swamp (SR 1505) was only one point higher than this downstream, integrated site on Raft Swamp.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
L Marsh Swp	**SR 1907**	**02/24/06**	**Natural**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
Robeson	53	03040203	14-22-1-3	344908	785547

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	C, Sw	44.1	12	1.5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	60	0	0	40 (clearcut)

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	12.2
Dissolved Oxygen (mg/L)	9.87
Specific Conductance (µS/cm)	41
pH (s.u.)	5.3
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	12
Instream Habitat (20)	17
Bottom Substrate (15)	7
Pool Variety (10)	4
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	2
Left Riparian Score (5)	1
Right Riparian Score (5)	5
Total Habitat Score (100)	66

Site Photograph

Substrate silt and detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/24/06	9796	67	14	6.3	4.8	Natural
02/07/01	8372	67	17	6.0	4.5	Natural

Taxonomic Analysis

Sampled for only the second time, the EPT richness was lower than in 2001, although still high enough for a Natural rating. The biotic index increased modestly due in part to the increase in midges and decrease in EPT. Between the two sampling years, the benthic community remained relatively consistent though some taxa were replaced by other species or were absent altogether. Abundant taxa included the fairly intolerant mayfly *Eurylophella prudentalis* , the tolerant mayflies *Leptophebia* and *Stenacron interpunctatum* , as well as the intolerant caddisfly *Pycnopsyche* . Other taxa of note included the caddisflies *Ceraclea transversa* , *Ironoquia punctatissima* (first collection at this site), *Phylocentropus* and *Triaenodes ochraceus* (first collection at this site). Collected in 2001, the stonefly *Taeniopteryx metequi* was not found in 2006.

Data Analysis

Little Marsh Swamp at SR 1907 drains the small munincipality Parkton and the area to the west in northern Robeson County. This swamp stream had high fast flow during the sampling period thereby complicating the benthic collections. Due to this, the main channel thalweg was not sampled (though many side channels were). This may have potentially affected the number of organisms collected. Water quality at this site did not exhibit serious signs of degradation and therefore the Natural bioclassification rating was maintained. However, a large recent clearcut on the west side of the stream may alter the water quality in the future.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
Big Marsh Swp	**SR 1924**	**02/24/06**	**Natural**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
Robeson	53	03040203	14-22-2	344655	785525

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	C, Sw	56.8	15	1

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	90	0	0	10

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	12
Dissolved Oxygen (mg/L)	9
Specific Conductance (µS/cm)	60
pH (s.u.)	6
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	7
Pool Variety (10)	4
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	2
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	73

Site Photograph

Substrate silt and detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/24/06	9795	87	19	6.8	5.6	Natural
02/07/01	8373	77	20	6.3	4.7	Natural

Taxonomic Analysis

A remarkable number of EPT were collected in this swamp during both collection years. The increase in the biotic index in 2006 is due to an increase in number and abundance of tolerant EPT collected . The majority of the tolerant EPT were mayflies (*Maccaffertium modestum* and *Caenis*) whereas the intolerant taxa were primarily caddisflies most being rare to common (*Pycnopsyche* was the only abundant caddisfly found). Two new stonefly records for this site were *Perlesta* (abundant) and *Taeniopteryx burksi (rare)* .

Data Analysis

Big Marsh Swamp drains the munincipality of Saint Pauls and the area to the west and northwest of Robeson County. Although some minor dischargers exist on the stream (primarily Saint Pauls WWTP) they are distant enough to have little impact on the water quality at the site. Big Marsh Swamp supports a healthy and stable benthic community, although it appears that water quality has worsened since 2001 based upon the increasing tolerance of the EPT community.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
PORTER SWP	**SR 1503**	**02/08/06**	**Severe**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
COLUMBUS	51	03040203	14-27	342137	785745

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Mid-Atlantic Floodplains and Low Terraces	C, Sw	60.6	40	0.5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none		

Water Quality Parameters

Temperature (°C)	5.7
Dissolved Oxygen (mg/L)	7.9
Specific Conductance (µS/cm)	54
pH (s.u.)	5.5
Water Clarity	clear

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	12
Bottom Substrate (15)	4
Pool Variety (10)	0
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	71

Site Photograph

Substrate silt 100%

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/08/06	9783	38	1	8.5	3.5	Severe
02/06/01	8371	49	6	7.5	5.1	Moderate
03/15/96	7025	41	6	7.3	6.1	Moderate
03/05/92	5805	60	6	7.6	6.9	Not Rated
09/11/91	5736	n/a	3	n/a	6.5	Not Rated

Taxonomic Analysis

Total taxa has varied from a high of 60 in 1992 to a low of 38 in 2006, and 41 in 1996 (winter samples). Only one EPT, the caddisfly *Polycentropus* , was collected in 2006. Absent were the mayflies *Caenis* , *Leptophlebia* , and *Stenacron interpunctatum* . All three were present in the 2001, 1996 and 1992 collections. Over 42% of the the taxa collected in 2006 were chironomids. The uncommon caddisfly *Platycentropus* , collected three previous times was not found in 2006, though the uncommon beetle *Tropisternus quadristriatus* was seen.

Data Analysis

Given the difficulties of sampling in high water levels and the reduction of taxa normally seen with low water velocities (as in 2006), it is unclear as to whether this site has declined as much as the bioclassification would suggest. Previous reports had noted the low flows seen here relative to other swamp streams in this area. Reduced number of EPT, odonates and beetles, when compared to previous samplings, are one reason for the increased Biotic Index, since numbers of the largest group historically present at this site, chironomids, were present in numbers comparable to previous efforts.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
ASHPOLE SWP	**NC 41**	**02/28/06**	**Moderate**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	54	03040203	14-30	342443	790718

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	C-Sw	93.2	12	0.3

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100			

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None		

Water Quality Parameters

Temperature (°C)	9.7
Dissolved Oxygen (mg/L)	9.6
Specific Conductance (µS/cm)	72
pH (s.u.)	6.2
Water Clarity	clear

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	15
Bottom Substrate (15)	1
Pool Variety (10)	4
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	8
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	73

Site Photograph

Substrate Silt, organic mud/detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/28/06	9798	49	10	6.7	5.9	Moderate
02/23/06	9793	60	13	6.7	5.9	Moderate
01/30/01	8221	53	11	6.6	5.5	Natural
03/15/96	7023	53	10	6.6	5.8	Natural

Taxonomic Analysis

This site has maintained a fairly stable benthic community though its biotic index has increased slightly for the last two sampling periods. Abundant taxa include the mayflies *Leptophlebia* , *Pseudocloeon frondale* and *Stenacron interpunctatum* , the midges *Orthocladius oliveri* and *Tanytarsus spp.* , several crustacean and several snail taxa. A few sensitive taxa like *Pycnopsyche* , *Ceraclea transversa* , and *Micromenetus dilatatus* were present in lower numbers.

Data Analysis

This site assesses the quality of Ashpole Swamp immediately above the confluence of Hog Swamp. This forested watershed flows among a network of rural roads and diffuse farming activities. A broad floodplain provides relatively good buffer for the swamp system itself. biological data indicate fairly consistent conditions at this site for the previous ten years.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
HOG SWP	**SR 2262**	**02/23/06**	**Moderate**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
ROBESON	54	03040203	14-30-7-1	342534	790632

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	C, Sw	63.3	100	0.4

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
N/A		

Water Quality Parameters

Temperature (°C)	12.5
Dissolved Oxygen (mg/L)	6.1
Specific Conductance (µS/cm)	82
pH (s.u.)	6.5
Water Clarity	clear

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	14
Bottom Substrate (15)	3
Pool Variety (10)	5
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	77

Site Photograph

Substrate

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/23/06	9800	60	5	7.4	6.4	Moderate
01/31/01	8222	52	11	6.7	6.4	Natural
03/13/96	7022	51	13	6.7	6.1	Natural
09/22/91	5734	N/A	8	N/A	6.6	Not Rated

Taxonomic Analysis

Although three EPT taxa were not collected in 2006 that were found in all sampling dates previously, both *Ptilostomis* and *Paraleptophlebia* were collected for the first time at this site. Indicator taxa such as *Caenis* , *Asellus* , *Hyalella azteca* , *Physella* , *Simulium* , *Chironomus* , *Tanytarsus* , *Pisidium* and *Sphaerium* suggest that low DO and organic enrichment may be stressors at this location. *Paraleptophlebia* was the only intolerant taxa present at this location in 2006.

Data Analysis

Hog Swamp at SR 2262 is located just above the confluence of Ashpole Swamp. It rated Natural in 1996 and 2001 but the bioclasification fell to Moderate in 2006. This is due to both a lower EPT taxa richeness (5) and a higher Biotic index (7.4). This suggests decreasing water quality at this site in the past five years.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
GAPWAY SWP	**SR 1356**	**02/08/06**	**Moderate**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
COLUMBUS	51	03040203	14-31	341612	790012

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Carolina Flatwoods	C; Sw	25.7	8	1

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none		

Water Quality Parameters

Temperature (°C)	8.3
Dissolved Oxygen (mg/L)	10.3
Specific Conductance (µS/cm)	60
pH (s.u.)	5.7
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	5
Instream Habitat (20)	10
Bottom Substrate (15)	1
Pool Variety (10)	4
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	58

Site Photograph

Substrate silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/08/06	9784	61	5	7.40	6.99	Moderate
01/06/01	8370	71	11	7.62	6.40	Moderate
03/15/96	7024	57	16	7.11	5.98	Moderate

Taxonomic Analysis

There was a decline in the number of Ephemeroptera taxa, from nine to five to three, over three sampling events spanning 10 years. A similar loss occurred within Plecoptera, from two taxa to one followed by none in 2006. The number of Trichoptera taxa was the same between 1996 and 2001, with five recorded for each year; however, in 2006 the number dropped to two. While the EPT BI shows a steady increase across the three sampling events, the NCBI does not. The decrease in the NCBI between 2001 and 2006 is due in part to the occurrence of two new taxa to the site: *Caecidotea* sp. 3 and *Tanytarsus* sp. 4. Both taxa are intolerant to the presence of stressors (tolerance value of 4.0 for *Caecidotea* sp. 3, 2.7 for *Tanytarsus* sp. 4), and both were abundant in 2006 though not recorded for the prior two sampling events. Also driving the decrease in the NCBI between 2001 and 2006 is the loss of two tolerant taxa that were only recorded in 2001 and were abundant in that year: *Somatochlora* and *Dicrotendipes simpsoni* (tolerance values of 9.2 and 10.0 respectively).

Data Analysis

The site is 3.5 miles SSE of Fair Bluff NC and 1.3 miles from the border with South Carolina. The site is evaluated as Swamp A. EPT richness shows a sharp and steady decline over the three sampling events in 1996, 2001, and 2006. A steady increase in the EPT BI is also observed. The NCBI peaked with the 2001 sample, though the value is higher in 2006 than in 1996. Overall, a decline in water quality is indicated by the benthic data, though no specific stressor is indicated. The bioclassification for 2006 is Moderate though bordering on Severe.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Gum Swamp Cr	**SR 1344**	**05/25/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Scotland	55	03040204	345546	793423	14-32-(1)	Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C	16	---	4	0.3	Yes

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	---	---	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
---	---	---

Water Quality Parameters

Temperature (°C)	18.3
Dissolved Oxygen (mg/L)	8.1
Specific Conductance (µS/cm)	20
pH (s.u.)	5.4

Water Clarity	Black water

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	19
Bottom Substrate (15)	13
Pool Variety (10)	8
Riffle Habitat (16)	0
Left Bank Stability (7)	10
Right Bank Stability (7)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**95**

Site Photograph

Substrate	sand

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/25/06	2006-64	11	34	Not Rated
05/24/01	2001-51	8	32	Not Rated

Most Abundant Species	Pinewoods Darter	**Exotic Species**	None

Species Change Since Last Cycle

Gains -- Flier, Dollar Sunfish, Yellow Bullhead, Tessellated Darter

Data Analysis

Watershed -- drains the northwest edge of Scotland County, and part of the eastern edge of Richmond County. **Habitats** -- runs, snags; marl outcroppings in the stream; instream vegetation = *Potamogeton* , *Valisneria/Sparganium* , *Batrachospermum* ; clear but stained water; forested riparian. **2006** -- Dusky Shiner is no longer the most abundant species (was 65% of sample in 2001, now 22% of the sample); gain of two sunfish species, one catfish and one darter species. **2001-2006** -- this stream is not rated, but the fish community in this Sand Hills watershed appears healthy.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
GUM SWP CR	**SR 1323**	**07/10/06**	**Good-Fair**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
SCOTLAND	55	03040204	14-32-(7)	355112	793128

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	B	40	7	0.5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	80	20	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	22.8
Dissolved Oxygen (mg/L)	7
Specific Conductance (µS/cm)	18
pH (s.u.)	5.2
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	18
Bottom Substrate (15)	8
Pool Variety (10)	5
Left Bank Stability (10)	9
Right Bank Stability (10)	9
Light Penetration (10)	10
Left Riparian Score (5)	4
Right Riparian Score (5)	4
Total Habitat Score (100)	82

Site Photograph

Substrate mostly sand with some silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/10/06	9976	---	17	---	3.5	Good-Fair
07/09/01	8450	---	22	---	3.0	Good
07/10/96	7089	---	15	---	2.8	Good-Fair
09/09/91	5713	---	17	---	2.9	Good-Fair

Taxonomic Analysis

A reduction in the number of EPT has reduced the bioclassification rating for Gum Swamp Creek to Good-Fair. Additionally, the abundance of EPT has also decreased from previous years (to 65 from 75 in 2001 and 72 in 1996 and 1991). Only four taxa were abundant, the tolerant and ubiquitous mayfly *Maccaffertium modestum*, the fairly intolerant caddisflies, *Hydropsyche decalda* and *Chimarra,* as well as the sensitive caddisfly *Brachycentrus chelatus*. Some sensitive taxa were absent from the 2006 collection (the caddisflies *Paranyctiophylax* and *Oecetis scala* gr. and the stoneflies *Pteronarcys* and *Paragnetina immarginata*). Of note, the infrequently collected caddisfly *Oecetis morsei* was found at this site in 2006.

Data Analysis

Gum Swamp Creek watershed lies in east central Scotland County and southeastern Richmond County. The major landuse in this region is agriculture and forest (Sandhills State Game Lands). As habitat and flow were not restrictive to the benthic community, it is difficult to isolate the stressors on this stream. Increased urbanization upstream is not the probable cause as the specific conductance measured was very low (18 µS/cm). It is possible, however, that agricultural runoff is one factor as silt was evident in the stream.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Joes Cr	**NC 79**	**05/25/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Scotland	55	03040204	344555	793432	14-32-14	Atlantic Southern Loam Plains/Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;SW	31.4	---	7	0.4	Yes

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	90	10	---	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
---	---	---

Water Quality Parameters

Temperature (°C)	19.1
Dissolved Oxygen (mg/L)	7.8
Specific Conductance (µS/cm)	21
pH (s.u.)	5.4

Water Clarity	Black water

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	18
Bottom Substrate (15)	13
Pool Variety (10)	10
Riffle Habitat (16)	0
Left Bank Stability (7)	10
Right Bank Stability (7)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**96**

Site Photograph

Substrate	sand

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/25/06	2006-65	14	---	Not Rated
05/24/01	2001-50	13	---	Not Rated

Most Abundant Species	Dusky Shiner	**Exotic Species**	None

Species Change Since Last Cycle

Gains -- American Eel, Pirate Perch, Redbreast Sunfish, Bluegill, Margined Madtom, Eastern Mudminnow. **Losses** -- Creek Chubsucker, Bluespotted Sunfish, Dollar Sunfish, Lined Topminnow

Data Analysis

Watershed -- drains the westernmost corner of Scotland County and part of southeast Richmond County. **Habitats** -- side snags, rootwads, runs, pools, woody debris, deadfalls; water clear, but stained; nice forested riparian zones. **2006** -- 43% more fish collected than in 2001, mostly due to Dusky Shiner. **2001-2006** -- for a second time, Dusky Shiner made up about 65% of the fish population; total number of species collected from this stream is 18; although not rated, this forested Sand Hills stream appears to have a healthy fish population.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Big Shoeheel Cr	**SR 1433**	**05/24/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Scotland	55	03040204	344814	792236	14-34	Atlantic Southern Loam Plains/Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;SW	22.7	---	5	0.4	No

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	---	---	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
---	---	---

Water Quality Parameters

Temperature (°C)	16.3
Dissolved Oxygen (mg/L)	8.0
Specific Conductance (µS/cm)	36
pH (s.u.)	5.7

Water Clarity	Black water

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	19
Bottom Substrate (15)	13
Pool Variety (10)	10
Riffle Habitat (16)	0
Left Bank Stability (7)	10
Right Bank Stability (7)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**97**

Site Photograph

Substrate sand, gravel, detritus

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/24/06	2006-62	16	---	Not Rated
05/23/01	2001-47	6	---	Not Rated

Most Abundant Species Dusky Shiner

Exotic Species None

Species Change Since Last Cycle

Gains -- American Eel, Spotted Sucker, Flier, Bluespotted Sunfish, Sandhills Chub, Snail Bullhead, Margined Madtom, Tessellated Darter, Eastern Mudminnow, Chain Pickerel (young-of-year only)

Data Analysis

Watershed -- drains eastern-central Scotland County; swine operation near the upstream end of the reach. **Habitats** -- instream and riparian habitats are high quality, great riparian forest; woody debris, aquatic mosses; water was clear, but stained like tea. **2006** -- collected 10 more species than in 2001, including the intolerant Sandhills Chub; first collection of catfish (two species), Spotted Sucker and American Eel at this site; large specimens of Redbreast Sunfish; both Pickerel species represented by young-of-year only. **2001-2006** -- Dusky Shiner continues to be the most abundant species (43% of sample in 2001, and 62% in 2006); fish community in this system appears to be very healthy.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
Shoe Heel Cr	**SR 1101**	**07/10/06**	**Good**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
Robeson	55	03040204	14-34	343510	792218

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	C, Sw	114.2	4	0.3

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	23
Dissolved Oxygen (mg/L)	5.6
Specific Conductance (µS/cm)	46
pH (s.u.)	5.3
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	20
Bottom Substrate (15)	13
Pool Variety (10)	4
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	9
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	91

Site Photograph

Substrate sand, silt and detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/10/06	9977	71	20	5.7	4.1	Good
07/10/01	8453	53	18	4.9	3.4	Good
07/10/96	7087	68	25	4.5	3.5	Excellent
09/10/91	5715	75	26	5.5	3.7	Good
08/07/90	5416	80	28	5.4	3.8	Excellent
07/07/87	4130	73	24	4.9	3.6	Excellent
09/17/85	3617	70	21	5.0	3.9	Good

Taxonomic Analysis

The number of EPT collected increased slightly from the historical low seen in 2001. Following the increase in richness, EPT abundance also increased modestly from 85 in 2001 to 95 in 2006, although this is still much less than the abundances found prior to 2001 (153, 126, and 152 in 1990, 1991, and 1996 respectively). However, the biotic index also increased to the highest lever ever seen in Shoeheel Creek. This rise is due primarily to the decreasing richness and abundance of stonefly taxa (five in 1991-96, three in 2001, and two in 2006). Abundant intolerants were the caddisflies *Brachycentrus numerosus* and *Pycnopsyche* . Less abundant sensitive species included the caddisfly *Molanna tryphena* (rare) and the stoneflies *Neoperla* (rare) and *Paragnetina fumosa* (rare).

Data Analysis

Downstream of the Town of Maxton, Shoeheel Creek drains the sandhills ecoregion. The elevated conductivity seen (relative to other streams in the region) is probably a direct result of the Town of Maxtons WWTP effluent (0.4 MGD). Oscillating between Good and Excellent bioclassifications, no serious water quality problems are noted particularly as related to the benthic community.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Jordan Cr	**SR 1324**	**05/24/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Scotland	55	03040204	345214	792907	14-34-4-(2)	Atlantic Southern Loam Plains/Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;SW	10.4	---	4	0.3	Yes

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	---	---	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
---	---	---

Water Quality Parameters

Temperature (°C)	20.8
Dissolved Oxygen (mg/L)	7.3
Specific Conductance (µS/cm)	16
pH (s.u.)	5.8

Water Clarity	Black water

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	19
Bottom Substrate (15)	13
Pool Variety (10)	10
Riffle Habitat (16)	0
Left Bank Stability (7)	10
Right Bank Stability (7)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**97**

Site Photograph

Substrate sand

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/24/06	2006-63	14	---	Not Rated
05/23/01	2001-48	9	---	Not Rated

Most Abundant Species Dusky Shiner

Exotic Species None

Species Change Since Last Cycle **Gains** -- American Eel, Bluespotted Sunfish, Dollar Sunfish, Largemouth Bass, Chain Pickerel

Data Analysis

Watershed -- drains central Scotland County, north of Laurinburg. **Habitats** -- abundant woody debris, aquatic vegetation near bridge where the canopy is open. **2006** -- collected all of the 2001 species, including the intolerant Pinewoods Darter, plus five new species. **2001-2006** -- this site has excellent instream and riparian habitats; although not rated, the fish community in this forested Sand Hills watershed appears healthy.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
Jordan Cr	**US 401**	**07/09/06**	**Good-Fair**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
Scotland	55	03040204	14-34-4-(2)	344901	792527

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Atlantic Southern Loam Plains	C, Sw	18.9	5	0.3

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	20.4
Dissolved Oxygen (mg/L)	7.3
Specific Conductance (µS/cm)	25
pH (s.u.)	4.3
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	19
Bottom Substrate (15)	8
Pool Variety (10)	10
Left Bank Stability (10)	8
Right Bank Stability (10)	8
Light Penetration (10)	8
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	86

Site Photograph

Substrate mostly sand with some detritus and silt

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/09/06	9975	---	15	---	3.4	Good-Fair
07/09/01	8451	---	12	---	3.5	Good-Fair
07/10/96	7088	---	15	---	3.2	Good-Fair

Taxonomic Analysis

The EPT richness increased slightly to the pre 2001 level of 15. The EPT biotic index also decreased slightly due primarily to the reappearance of *Chimarra* , an intolerant caddisfly, along with *Acroneuria lycorias* , an infrequently collected stonefly (first record for this site). However, the loss of the intolerant caddisfly *Molanna tryphana* has served to mitigate the decrease in the EPT biotic index. Overall, EPT community has remained remarkably similar between sampling years.

Data Analysis

A tributary of Shoe Heel Creek, Jordan Creek drains a portion of the Sandhills in north central Scotland County. There are no NPDES dischargers on Jordan Creek and the major landuse is forest with some agriculture. The bioclassification has not changed since sampling commenced in 1996 indicating stable water quality. Water conditions, which worsened from 1996 to 2001, have stabilized, if not improved slighlty, from 2001 to 2006 as evidenced by the increase in EPT richness and EPT abundance (102 in 1996, 62 in 2001, and 70 in 2006).

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Bioclassification
Juniper Cr	**SR 1405 (NC 144)**	**05/25/06**	**Not Rated**

County	Subbasin	8 digit HUC	Latitude	Longitude	Index Number	Level IV Ecoregion
Scotland	55	03040204	345118	792549	14-34-4-3	Atlantic Southern Loam Plains/Sand Hills

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;SW	22.5	---	5	0.4	Yes

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	---	---	---

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
---	---	---

Water Quality Parameters

Temperature (°C)	19.9
Dissolved Oxygen (mg/L)	7.9
Specific Conductance (µS/cm)	19
pH (s.u.)	5.3

Water Clarity	Black water

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	19
Bottom Substrate (15)	13
Pool Variety (10)	10
Riffle Habitat (16)	0
Left Bank Stability (7)	10
Right Bank Stability (7)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	**97**

Site Photograph

Substrate sand

Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
05/25/06	2006-66	12	---	Not Rated
05/23/01	2001-49	7	---	Not Rated

Most Abundant Species Dusky Shiner

Exotic Species None

Species Change Since Last Cycle

Gains -- Pirate Perch, Mud Sunfish, Dollar Sunfish, Chain Pickerel, Yellow Bullhead, Pinewoods Darter.
Losses -- Warmouth

Data Analysis

Watershed -- drains north-central Scotland County; a tributary to Jordan Creek. **Habitats** -- shallow sandy runs, deep and fast pools at bends, some woody debris; great forested riparian on both sides; water clear, but stained. **2006** -- five more species collected than in 2001, including the intolerant Pinewoods Darter, and an 84% increase in total abundance. **2001-2006** -- although not rated, the fish community in this forested Sand Hills watershed appears healthy.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
FRIAR SWP	**SR 1740**	**02/21/06**	**Natural**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
COLUMBUS	56	03040206	15-2-6-3	342206	782737

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Carolina Flatwoods	C, Sw	20.5	4	0

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None		

Water Quality Parameters

Temperature (°C)	10.4
Dissolved Oxygen (mg/L)	9.2
Specific Conductance (µS/cm)	78
pH (s.u.)	6.3
Water Clarity	clear/tannic

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	19
Bottom Substrate (15)	8
Pool Variety (10)	5
Riffle Habitat (16)	0
Left Bank Stability (7)	10
Right Bank Stability (7)	10
Light Penetration (10)	9
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	86

Site Photograph

Substrate Silt, Sand

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/21/06	9790	64	13	6.7	6.4	Natural
02/01/01	8244	49	11	6.7	6.2	Natural
02/18/99	7819	45	10	6.5	5.2	Natural
03/03/98	7518	44	9	6.3	5.8	Natural
02/25/97	7255	48	13	6.5	6.1	Natural

Taxonomic Analysis

In 2006, the increase in taxa richness is largely due to an increase in the number of odonate and chironomid taxa collected. Seven odonate taxa and 21 chironomid taxa were collected; whereas, in previous years 1-4 odonate taxa and 11-15 chironomid taxa were collected. New taxa included *Aeshna* , *Epitheca* , *Ladona deplanata* , *Ablabesmyia mallochi* , *Apedilum* , *Cryptochironomus* , *Labrundinia pilosella* , *Orthocladius lignicola* , *Polypedilum halterale* group, *Polypedilum illinoense* group, *Paratanytarsus* , *Paratrichocladius* , *Stictochironomus* , *Tanytarsus* sp 14 and *Tribelos jucundum* .

Data Analysis

Friar Swamp is a minimally impacted system that has been used to set draft criteria for Swamp Region S, which includes swamp streams in the Lumber River subbasins 56-58. Benthic macroinvertebrates have been collected at this site six times in February or March since 1996. All six samples have rated Natural. With the exception of 2006, overall taxa richness and EPT richness have been fairly consistent since 1996.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
White Marsh	**SR 1001**	**02/22/06**	**Moderate**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
Columbus	58	03040206	15-4	341440	783704

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Mid-Atlantic Floodplains and Low Terraces	C, SW	293.7	8	0.6

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
City of Whiteville WWTP	NC0021920	3.0

Water Quality Parameters

Temperature (°C)	10.2
Dissolved Oxygen (mg/L)	9.4
Specific Conductance (µS/cm)	95
pH (s.u.)	6.4
Water Clarity	clear

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	18
Bottom Substrate (15)	5
Pool Variety (10)	5
Riffle Habitat (16)	
Left Bank Stability (7)	10
Right Bank Stability (7)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	83

Site Photograph

Substrate Silt, woody debris

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/22/06	9789	50	9	7.1	6	Moderate
02/01/01	8242	33	2	7	6.6	Moderate

Taxonomic Analysis

The 2006 sample resulted in three new mayflies not previously collected at this location (*Acerpenna pygmaea* , *Pseudocloeon frondale* , and *Caenis sp* .) as well as four new caddisflies (*Ceraclea tarsipunctata* , *Ceraclea transversa* , *Oecetis sp E* , and *Polycentropus sp.*). Indeed, the 2001 sample only produced two mayfly taxa (versus five in 2006) and zero caddisfly taxa in 2001 (versus four in 2006).

Data Analysis

As would be expected with seven previously uncollected mayfly and caddisfly taxa, the EPTBI dropped from 6.6 in 2001 to 6.0 in 2006. In addition, total taxa richness increased from 33 in 2001 to 50 in 2006, while the BI remained essentially unchanged. The additional EPT and non EPT taxa, combined with a very stable BI and lowered EPTBI, suggests improved conditions in White Marsh since 2001. Indeed, analysis of the Whiteville WWTP's self-reporting toxicity data from 1992 to present indicated a substantial reduction in Whole Effluent Toxicity failure rates since early summer of 2001.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
Elkton Marsh	**SR 1710**	**02/22/06**	**Moderate**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
Bladen	58	03040206	15-4-1-1-2	342832	783607

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Carolina Flatwoods	C, SW	37.3	4	0.3

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)

Water Quality Parameters

Temperature (°C)	11.4
Dissolved Oxygen (mg/L)	7.9
Specific Conductance (µS/cm)	65
pH (s.u.)	6.1
Water Clarity	clear/tannic

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	15
Bottom Substrate (15)	7
Pool Variety (10)	5
Riffle Habitat (16)	0
Left Bank Stability (7)	10
Right Bank Stability (7)	10
Light Penetration (10)	9
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	81

Site Photograph

Substrate Silt, sand

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/22/06	9791	60	5	8	5	Moderate
02/05/01	8386	29	4	6.2	4.1	Moderate
03/13/96	7019	37	5	7.1	6.4	Moderate

Taxonomic Analysis

Although EPT taxa richness values have been quite stable at this location since 1996, the same was not true for total taxa richness as the 2006 collection resulted in significantly more total taxa than collected previously. Nearly all of this difference was the result of additional beetle taxa (six in 2006 versus two in 1996 and 2001), odonate taxa (eight in 2006 versus none in 1996 and one in 2001), and mollusc taxa (seven in 2006 versus three in 1996 and one in 2001). The 2006 collection also resulted in the first time occurrence of the low dissolved oxygen indicator (gastropod) *Physella sp*. (abundant), and the chironomids *Kiefferulus dux* (abundant) and *Procladius sp*. (common). The abundance of these taxa suggest less dissolved oxygen in Elkton Marsh relative to previous years.

Data Analysis

While EPT taxa richness has been stable at this location since 1996, the large increase in BI, accompanied by the first time collection of low dissolved oxygen indicating taxa strongly suggest lowered dissolved oxygen levels at this location relative to previous collections and may indicate slightly deteriorating conditions in the this watershed.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
Western Prong Creek	**US 701, Bypass**	**02/23/06**	**Moderate**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
Columbus	58	03040206	15-4-2	342558	784353

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Mid-Atlantic Floodplains and Low Terraces	C, SW	28.9	100	0.4

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	70	20	0	10-Road

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)

Water Quality Parameters

Temperature (°C)	11.8
Dissolved Oxygen (mg/L)	5.1
Specific Conductance (µS/cm)	101
pH (s.u.)	6.5
Water Clarity	clear

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	17
Bottom Substrate (15)	3
Pool Variety (10)	5
Riffle Habitat (16)	0
Left Bank Stability (7)	10
Right Bank Stability (7)	10
Light Penetration (10)	10
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	80

Site Photograph

Substrate Silt, detritus, sand

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/23/06	9792	52	2	8	8	Moderate

Taxonomic Analysis

Only two EPT taxa were collected at Western Prong Creek: the mayfly (*Callibaetis sp*.) and the caddisfly (*Ptilostomis sp*.). Both taxa are capable of tolerating low dissolved oxygen levels and sluggish flow. In addition, the low dissolved oxygen indicator (gastropod) *Physella sp*. were dominant at this site. Other organic, and low dissolved oxygen indicators collected at this location included (chironomids) *Chironomus sp*. and *Procladius sp*. Of interest, the rare damselfly *Telebasis byersi* was collected here and is only the 7th time NCDWQ has observed this taxon. In addition, the (gastropod) *Planorbella scalare* was collected for only the second time in North Carolina (one previous collection by N. C. Museum of Natrual Sciences Staff). Telebasis and P. scalare are typically restricted to lentic, marsh-like waterbodies. These data clearly indicate the highly ephemeral flow regime present at this location.

Data Analysis

Although the EPTBI and BI were quite elevated at this site, the high total taxa richness (ST) helped secure a Moderate bioclassification at this location. While there are anthropogenic influences in this catchment, the primary factor likely influencing the benthic community in Western Prong Creek are the low seasonal flows and corresponding low dissolved oxygen levels although anthropogenic factors cannot be ruled out.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
GRISSETT SWP	**SR 1141**	**02/21/06**	**Moderate**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
COLUMBUS	57	03040206	15-17-1-(5)	340510	784253

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Mid-Atlantic Floodplains and Low Terraces	C-Sw	56.8	5	0.4

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	90			10-Clear-0cut

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Tabor City WWTP	NC0026000	1.1

Water Quality Parameters

Temperature (°C)	12.5
Dissolved Oxygen (mg/L)	9.5
Specific Conductance (µS/cm)	86
pH (s.u.)	6.2
Water Clarity	tannin stained

Habitat Assessment Scores (max)

Channel Modification (5)	15
Instream Habitat (20)	16
Bottom Substrate (15)	7
Pool Variety (10)	5
Riffle Habitat (16)	N/A
Left Bank Stability (7)	10
Right Bank Stability (7)	10
Light Penetration (10)	9
Left Riparian Score (5)	2
Right Riparian Score (5)	5
Total Habitat Score (100)	79

Site Photograph

Substrate Silt, organic mud/detritus, sand

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/21/06	9788	47	5	7.7	7.3	Moderate
02/05/01	8387	36	6	7.4	5.5	Moderate

Taxonomic Analysis

Increases in coleopteran and odonate taxa led changes in the benthic community at this site since 2001 to an increase in total taxa. A small decline in EPT taxa but a large increase in EPT biotic index caused an increase in the overall biotic index, indicating a more tolerant assemblage in 2006.

Data Analysis

This site is approximately 12 miles downstream of the Tabor City WWTP discharge. The site is a highly braided system with four closely-spaced bridges of SR 1141 spanning the site. The area is completely forested but some clear-cutting has occurred. Very low flows in summer months probably produce low dissolved oxygen, producing a benthic community tolerant of these conditions.

Benthic Macroinvertebrate Sample

Waterbody	Location	Date	Bioclassification
Royal Oak Swamp	**NC 211**	**02/21/06**	**Natural**

County	Subbasin	8 digit HUC	Index Number	Latitude	Longitude
Brunswick	59	03040208	15-25-1-12	340200	781649

Level IV Ecoregion	Stream Classification	Drainage Area (mi2)	Stream Width (m)	Stream Depth (m)
Carolina Flatwoods	C, SW	20.2	8	0.5

	Forested/Wetland	Urban	Agriculture	Other (describe)
Visible Landuse (%)	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
none	---	---

Water Quality Parameters

Temperature (°C)	9.8
Dissolved Oxygen (mg/L)	10
Specific Conductance (µS/cm)	125
pH (s.u.)	6.9
Water Clarity	clear

Habitat Assessment Scores (max)

Channel Modification (15)	15
Instream Habitat (20)	17
Bottom Substrate (15)	5
Pool Variety (10)	5
Left Bank Stability (10)	10
Right Bank Stability (10)	10
Light Penetration (10)	9
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	81

Site Photograph

Substrate Silt and detritus

Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
02/21/06	9787	75	17	7	6	Natural
02/05/01	8388	58	18	6	4.5	Natural
02/18/99	7820	75	21	6.4	5.1	Natural
03/03/98	7526	55	18	6.2	4.9	Natural

Taxonomic Analysis

Although the 2006 sample resulted in a Natural bioclassification, this sample also produced the lowest EPT total and highest EPTBI ever measured during winter sampling at this location. Notably intolerant caddisfly taxa absent from the 2006 sample but collected from all of the other winter samples (at common to abundant levels) included *Paranyctiophylax moestus* and *Phylocentropus sp*. Most significant was the absence of any stonefly taxa from the 2006 sample. Every previous winter sample produced at least one stonefly taxon (at least common) with the 1998 sample producing three taxa (*Acroneuria mela*, *Isoperla transmarina*, *Perlesta sp*.) the 1999 sample producing two taxa (*I. transmarina*, *Perlesta sp*.) and the 2001 sample one taxon (*Acroneuria mela*).

Data Analysis

The 2006 sample produced the lowest total quantity of EPT, the highest EPTBI, and the highest BI relative to all other previous winter samples. These data, (combined with the lack of any stonefly taxa) suggest that, while conditions are still overall favorable in the Royal Oak Swamp catchment, conditions may have deteriorated since sampling started here in 1998.

LAKE & RESERVOIR ASSESSMENTS
LUMBER RIVER BASIN

Pages Lake

Intensive Survey Unit
Environmental Sciences Section
Division of Water Quality
February 26, 2007

Overview

The Lumber River Basin, located along the North Carolina-South Carolina state border at the southeast corner of the state, consists of 2,283 miles of freshwater streams and rivers. The basin extends approximately 150 miles from the Sand Hills region of the state in southern Moore and Montgomery counties to the Atlantic Ocean coastline in Brunswick County. Streams and rivers in the Lumber River Basin (with the exception of Lockwoods Folly and Shallotte Rivers) flows southwest into South Carolina and are tributaries of the Great Pee Dee River, which flow into the Atlantic Ocean near Georgetown, South Carolina.

Three lakes were sampled in this river basin by DWQ staff in 2006. These lakes were Pages Lake, Lake Waccamaw and Lake Tabor. Lake Waccamaw is part of the Lake Waccamaw State Park and has an Outstanding Resource Water (ORW) designation. This unique Carolina Bay Lake supports populations of endemic fish, mussels and clams, and snails.

Pages Lake, from the backwaters of Pages Lake at normal lake elevation to the dam, was placed on the 303(d) List in 2000 for mercury in fish caught from the lake. Lake Waccamaw and Lake Tabor are also on the 303(d) List based on a mercury fish consumption advisory, as of 2006.

Insufficient samples were collected to rate these three lakes for aquatic life support. The Assessment Methodology Section describes the methods used for rating use support. It is followed by individual summaries for each of the lakes and two appendices that distill the information used to make the lakes use support assessments. For additional information on a particular lake, please go to http://www.esb.enr.state.nc.us/.

Assessment Methodology

For this report, data from January 1, 2002 through September 30, 2006 were reviewed. All lakes were sampled only during the summer of 2006 in 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.

On lakes without obvious segmentation or differences in hydrology and morphology between stations, all samples taken on a particular sampling date regardless of station are treated as replicates and the average concentration is used to determine if the standards are being met. Readings of pH are the only exception as it is inappropriate to average pH values. See the matrix at the end of this report for how the stations are grouped.

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, ten observations are needed to provide sufficient data to reasonably interpret 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.

Assessments by Subbasin

Subbasin 030750

Pages Lake

Pages Lake (Aberdeen Town Lake) is located on Aberdeen Creek west of US Hwy 1 in the Town of Aberdeen. The lake was built in the 1930's and is used for recreation, bank fishing, and canoeing. Swimming is not allowed at this lake. There is a town park adjacent to the lake and a wooden footbridge across the center of the lake. The waters of the lake are slightly tannin-stained (tea colored) and have a low pH (mean = 6.1 s.u., minimum = 4.0 s.u.) typical of Sand Hills streams and reservoirs.

Pages Lake was drained in the winter of 2006 for dredging and weed control, and the Town of Aberdeen plans to continue drawing down the lake in the winter months for weed control.

The lake was most recently sampled by DWQ four times in 2006. The NCTSI score for the 2006 sampling period indicated that the lake was moderately biologically productive (mesotrophic) for May and very productive (eutrophic) for July, August, and September. The biological productivity of a lake

influences the water quality of a lake, with more productive waters resulting in decreases in water clarity, algae blooms, and/or encroachment of aquatic plants (macrophytes).

There was a decrease in clarity over the summer in Pages Lake with the Secchi depth average decreasing from 1.4 meters in May to 1.0 meter in September. Water temperatures were less than the state water quality standard of 32°C for coastal and piedmont lakes. As noted above, surface waters in the Sand Hills have naturally lower pH, therefore, even though pH values got down to 5.2 in Pages Lake these values are not considered to be a violation of the standard.

The chlorophyll *a* values increased from 5 µg/L in May to 37.0 µg/L in July. Chlorophyll *a* values did not exceed the state water quality standard of 40 µg/L, however. Nutrient concentrations (nitrogen and phosphorus) were generally in the moderate range, with total phosphorus at an average of 0.04 mg/L, and total Kjeldahl nitrogen at 0.49 mg/L. Staff noted an increase in aquatic plants in the near shore area of the lake as the summer progressed. This lake continues to have excessive growths of Variable Leaf Water Milfoil in all but the deepest portions of the lake and Fragrant Water Lily and Cow Lily in the littoral zone.

In the past, there was some concern with contamination in Pages Lake from pesticide dumps used by three successive companies operating a pesticide formulation plant from the mid-1930s through 1987 on NC Hwy. 5. Of particular concern were dumpsites in the Fairway Six and Twin Sites Areas west of the lake. Between 1985 and 1999, the EPA conducted Superfund cleanup actions on the dumpsites and a superficial aquifer near the sites. An EPA Environmental News release of June 9, 1989 stated that pesticides identified in Pages Lake in Aberdeen, NC, presented no significant public health risk[1]. Re-sampling of sediment, surface water and fish from Pages Lake by the EPA in 2004 confirmed that this lake is not a risk to the public.

Pages Lake was placed on the 303(d) List in 2000 due to a fish consumption advisory for high levels of mercury found in Bowfin (Blackfish), Catfish, Chain Pickerel (Jack Fish), and Warmouth taken from surface waters located south and east of Interstate 85[2]. Largemouth bass are under a statewide fish consumption advisory due to mercury (see Endnote 2). The source of this mercury was determined to be from atmospheric deposition and not from a local source.

Based on the calculated NCTSI scores for 2006, Pages Lake was determined to be eutrophic (very biologically productive). Pages Lake is currently on the 303(d) List as impaired for fish consumption.

Subbasin 030756

Lake Waccamaw

Lake Waccamaw is one of the few natural lakes in North Carolina. Located in Columbus County, this is a shallow, elliptical lake owned by the State of North Carolina as part of the Lake Waccamaw State Park. Recreational uses include swimming, boating and fishing.

Lake Waccamaw, a Carolina Bay Lake, has been designated as an Outstanding Resource Water (ORW). Waters designated as ORW are recognized as having outstanding state or national recreational or ecological significance.

The term 'Bay' comes from the presence of bay trees commonly found growing in swampy oval depressions that may have been lakes at one time. Unlike the majority of Carolina Bay Lakes that have an acidic pH, Lake Waccamaw is unique for its neutral pH, which is important in the support of numerous endemic species including the Waccamaw Silverside (*Menidia extensa*), Waccamaw Darter (*Etheostema perlongum*), and Waccamaw Killifish (*Fundulus waccamensis*). This lake also has 15 species of mussels and clams including the endemic Waccamaw Fatmucket (*Lampsilis fullerkati)* and Waccamaw Spike (*Elliptio waccamawensis*). Two species of snails, the Waccamaw Amnicola (*Amnicola* sp.1) and the Waccamaw Siltsnail (*Cincinnatia* sp. 1) are also endemic to this lake. Lake Waccamaw provides high recreational and scenic value and is an important component of the Lake Waccamaw State Park[3].

Division staff sampled Lake Waccamaw monthly from May through September 2006. The water of Lake Waccamaw has a distinctive tea coloration commonly found in dystrophic lakes. The normally acidic water usually found in dystrophic lakes is buffered in Lake Waccamaw by the presence of limestone beneath the lake as well as exposed limestone along a segment of a bluff on the northern shore of the lake. Lake-wide mean Secchi depths ranged from 1.3 to 2.5 meters, indicating good water clarity. Individual Secchi depth readings were frequently close to or on the bottom of the lake. Water temperature, dissolved oxygen and pH values were within state water quality standards.

Total phosphorus concentrations were low in 2006 with the exception of one elevated value (0.11 mg/L) observed at the sampling site near the northeastern shore of the lake (LBR076K) on July 11, 2006. Total Kjeldahl nitrogen at this site (0.92 mg/L) was also elevated on this date. Similar elevated values for total Kjeldahl nitrogen and total phosphorus were observed at this sampling site on September 6, 2001. In general, total Kjeldahl nitrogen values in Lake Waccamaw in 2006 ranged from moderate to elevated while ammonia and nitrite + nitrate concentrations were frequently below DWQ laboratory detection levels.

Chlorophyll *a* values, an indicator of algae productivity, were consistently low. Algae in the lake's water column have to compete with the aquatic macrophytes and epiphytic algae for available nutrients. Aquatic macrophytes found in this lake include Spatterdock or Yellow Cow Lily, (*Nuphar lutea*), Maidencane (*Panicum* spp.), Stonewort (*Nitella* spp.), and Pondweed (*Najas* spp.). American Lotus and Water Pennywort are also found along the shoreline. Epiphytic algae are found on the leaves of Spatterdock, and may appear as long, green streamers attached to these plants. Benthic algae are found in the sand near the limestone outcrop along the northern shore. In the summer, the sand at this location may take on a green coloration due to these algae[4].

There was some concern in the past from town residents about the Spatterdock beds expanding in the northern sections of the lake; however, significant expansion of these plants has not occurred. Spatterdock, along with Maidencane, provide important habitat for the endemic fish found in this lake. Aquatic plants in the canals are a different matter for they have reached nuisance levels with excessive growth. Staff noted large rafts of Duckweed growing on the canals this summer. Other plants noted in the canals were Smartweed, Water Fern, and the blue-green algae, *Oscillatoria*. Corrective actions on the canals, such as connecting canals to increase water movement, spraying of weeds, work on the sewer system to prevent leaks, and efforts to reduce stormwater runoff into the canals to reduce nutrient loading, have been undertaken[5].

Lake Waccamaw was placed on the 303(d) List in 2006 based on a fish consumption advisory for high levels of mercury found in Bowfin (Blackfish), Catfish, Chain Pickerel (Jack Fish), and Warmouth east of Interstate 85 (see Endnote 2). Largemouth bass have a statewide mercury advisory. The source of this mercury was determined to be from atmospheric deposition and not from a local point source. In the past, the largest non-power plant source in coastal North Carolina was Holtrachem, a facility in Riegelwood, Columbus County that manufactured chlorine and sodium hydroxide. In 2000, the facility switched to a mercury-free process and the Lake Waccamaw air quality monitoring site recorded an immediate drop in air deposition of mercury[6]. However, it will take years before the fish tissue concentrations reach appropriate levels.

Based on the calculated NCTSI scores in 2006, Lake Waccamaw was determined to be predominantly mesotrophic (moderate biological productivity) with the exception of scores obtained for July when productivity increased to a small degree (eutrophic). Conditions in this lake in 2006 were similar to those

previously observed by DWQ staff. Lake Waccamaw is currently on the 303(d) List as impaired for fish consumption.

Subbasin 030757

Lake Tabor

Lake Tabor is a 70-acre shallow town lake located northeast of Tabor City at the US Hwy 701 Business/Bypass split. Recreational facilities at the lake include bait and tackle shop, piers, boat launches, picnic areas, and ball fields. The lake was built in 1952 from what had been an old millpond at the confluence of Grissett Swamp (a cypress gum swamp), Simmons Branch and Black Creek, and contains tannic swamp waters. The dam was breached in 1996 during Hurricane Fran, and rebuilt in 2000. There are houses around the lake with a residential area on the northwest; shoreline development is 50 to 75%.

The lake was sampled most recently sampled by DWQ staff in 2006 (May through September). Water temperature, dissolved oxygen and pH values were within state water quality standards. Lake data showed elevated nutrient concentrations throughout the lake. Chlorophyll *a* values at the lower end of the lake in July and August were greater than the state water quality standard of 40 ug/L (Appendix B). Lake Tabor has problems with nuisance aquatic plants such as Alligatorweed (*Alternanthera philoxeroides*) and Coontail (*Ceratophyllum demersum*). Controls being applied to these aquatic weeds include chemical herbicides, mechanical harvesting, and stocking the lake with Grass Carp.

Lake Tabor is under a Fish Consumption Advisory due to high levels of mercury found in Bowfin (Blackfish), Catfish, Chain Pickerel (Jack Fish), and Warmouth east of Interstate 85 (See Endnote 2). Largemouth bass have a statewide mercury advisory. The source of this mercury was determined to be from atmospheric deposition and not from a local source.

Lake Tabor was determined to have high biological productivity (eutrophic) based on the calculated NCTSI scores in 2006. Lake Tabor is located within a region of the state that is under a Fish Consumption Advisory and is listed as impaired for fish consumption[7].

Endnotes

[1] EPA. 2007. North Carolina NPL/NPL Caliber Cleanup Site Summaries: Aberdeen Pesticide Dumps. (http://www.epa.gov/region4/waste/npl/nplnc/aberdnnc.htm)

[2] For latest listing of impaired waters go to DWQ's web page on water quality assessments: http://h2o.enr.state.nc.us/tmdl/General_303d.htm and for latest information on Fish Consumption Advisories go to the Division of Public Health's website: http://www.epi.state.nc.us/epi/fish/current.html)

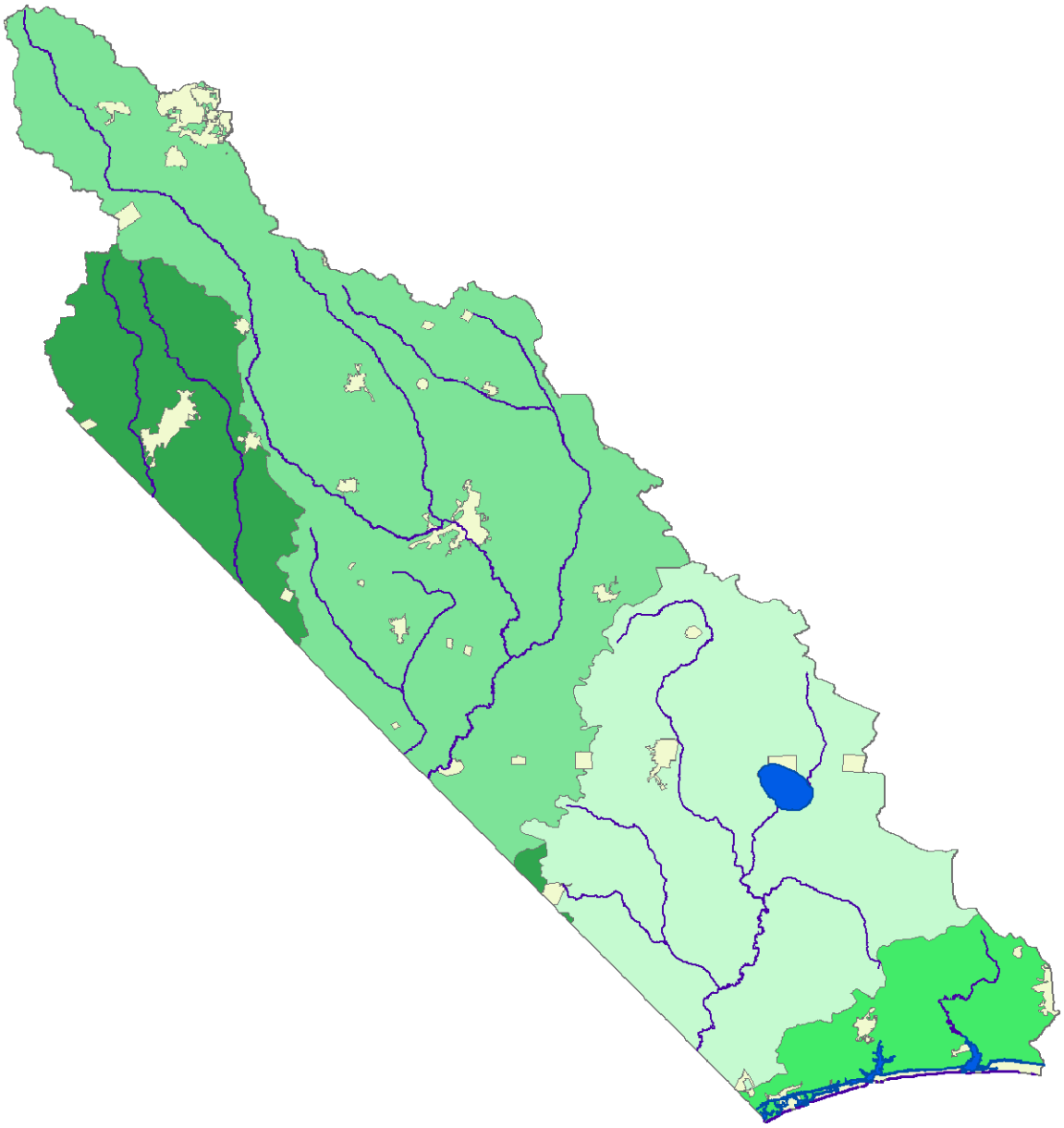
[3] For more information on Lake Waccamaw go to the Division of Parks and Recreation's web page at: (http://www.ils.unc.edu/parkproject/visit/lawa/home.html)

[4] J. C. STAGER and L. B. CAHOON. 1987. THE AGE AND TROPHIC HISTORY OF LAKE WACCAMAW, NORTH CAROLINA. The Journal of the Elisha Mitchell Scientific Society, 103(1), 1987, pp.1-13. (http://abob.libs.uga.edu/bobk/wacbay.html)

[5] DWQ. 2003. Lumber River Basinwide Water Quality Plan CHAPTER B7 - Lumber River Subbasin 03-07-56 Includes Lake Waccamaw, Big Creek and tributaries, upper Waccamaw River and Bogue Swamp. Available at: (http://h2o.enr.state.nc.us/basinwide/lumber/chapters/Chapter%20B7.htm)

[6] Information on Holtrachem is from the Department's Division of Pollution Prevention and Environmental Assistance Mercury web page: http://www.p2pays.org/mercury/.

[7] DWQ. 2006. North Carolina Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report). Available at DWQ's webpage: (http://h2o.enr.state.nc.us/tmdl/documents/2006IRPublicReviewDraft.pdf)



Lumber River Basin
Ambient Monitoring System Report

January 1, 2002 through December 31, 2006

TABLE OF CONTENTS

Evaluation Levels

In order to assist the reader in developing a rapid understanding of the summary statistics provided throughout this data review, concentrations of water quality variables may be compared to an Evaluation Level (EL). Evaluation levels may be a water quality standard, an action level, an ecological threshold, or simply an arbitrary threshold that facilitates a rapid data review. Evaluation levels are further evaluated for frequency to determine if they have been exceeded in more than 10 percent of the observed samples. This summary approach facilitates a rapid and straightforward presentation of the data but may not be appropriate for making specific use support decisions necessary for identification of impaired waters under the Clean Water Act's requirements for 303(d) listings. The reader is advised to review the states 303(d) listing methodology for this purpose. (see http://h2o.enr.state.nc.us/tmdl/General_303d.htm).

TABLES

FIGURES

APPENDIXES

SUMMARY

A general understanding of human activities and natural forces that affect pollution loads and their potential impacts on water quality can be obtained through routine sampling from fixed water quality monitoring stations. During this assessment period (January 1, 2002 through December 31, 2006) chemical and physical measurements were obtained by DWQ from 30 stations located throughout the Lumber River Basin.

In order to evaluate acceptable water quality criteria at least 10 observations are desired. If at least 10 results were collected for a given site for a given parameter, the results are then compared to water quality evaluation levels. The water quality evaluation level may be an ecological evaluation level, a narrative or a numeric standard. If less than 10 results were collected, then no comparison to evaluation levels was made. Historically, if more then 10% of results at a site exceeded the evaluation level, then the site was of concern. When this occurred, a binomial statistical test was employed to determine how much statistical confidence there is that the results at that site exceed the 10% criteria. If at least 95% confidence was found, then that is termed a statistically significant exceedance (SSE). This method was applied for all parameters with an evaluation level, except for fecal coliform bacteria, which uses a 20% criteria as well as a geomean criteria. See the Parameters section for an explanation of fecal coliform methods. The results of the data analysis are displayed in tables, box plots, scatter plots, and maps. For complete summaries on each station, reference the AMS Station Summary Sheets located in Appendix A.

This review of significant exceedances was performed using all data that were collected between January 1, 2002 and December 31, 2006. Stations with SSEs were found for total iron (six sites), dissolved oxygen (six sites), fecal coliform (five sites), pH (one site), turbidity (one site), and total copper (one site). For all parameters, six additional 10 percent violations that were not SSEs also occurred.

In general, problem areas are focused in the saltwater portion of the basin, in the Long Bay Hydrologic Unit (HUC). The only 10% exceedances outside of that HUC were for total iron. Turbidity is highly correlated with total iron concentrations in the basin. Turbidity may explain over 52% (r^2 = 0.522411) of the variation in total iron. This may indicate that the majority of the total iron in the water in this basin is caused by suspended particulates, i.e. muddy water.

In the Long Bay HU, dissolved oxygen and fecal coliform are the most common exceedances. The majority of sites in the Long Bay HU were already impaired for high fecal coliform concentrations before the current monitoring period. The dissolved oxygen violations may be explained as natural variation, as they occurred in waters that could be described as poorly flushed tidal streams and embayments.

Table 1 gives a summary of the problem areas using these criteria in the basin. While reading the table please note the following: The majority of the parameters listed are compared directly to their standards. There is one exception, however. The fecal coliform standard requires that 5 samples be taken in the span of 30 days, which was not done for this data. Therefore any fecal coliform reviews should be taken as a recommendation to collect the data at a frequency (5 in 30) required by the standard.

Table 1. Violations and Areas of Concern in the Lumber River Basin

Station	Location	Stream Class	Previously Impaired?	Parameter	%Exceed	% Conf
HUC 3040203: Lumber River						
I2090000	Drowning Crk At Us 1 Nr Hoffman	C Sw HQW	No	Total Iron (>1000)	25.0%	98.3%
I5370000	Big Swamp At Nc 211 Nr Richardson	C Sw	No	Total Iron (>1000)	35.3%	99.9%
I5690000	Lumber Riv At Us 74 At Boardman	C Sw	No	Total Iron (>1000)	11.8%	76.2%
I6290000	Ashpole Swamp At Sr 2258 Nr Barnesville	C Sw	No	Total Iron (>1000)	64.7%	>99.9%
I6410000	Lumber Riv At Nc 904 At Fair Bluff	B Sw	No	Total Iron (>1000)	11.8%	76.2%
HUC 3040204: Little Pee Dee River						
I0510000	Leith Crk At Sr 1615 Nr Smyrna Church	C Sw	No	Total Iron (>1000)	56.3%	>99.9%
HUC 3040206: Waccamaw River						
I8970000	Waccamaw Riv At Nc 130 At Freeland	C Sw	No	Total Iron (>1000)	50.0%	>99.9%
I9310000	Seven Crks At Nc 905 Nr Bug Hill	C Sw	No	Total Iron (>1000)	57.9%	>99.9%
HUC 3040207: Long Bay / Atlantic Ocean						
I9385000	Montgomery Slough At Sr 1105 Nr Long Beach	SA HQW	Yes[1]	Dissolved Oxygen (<5)	26.3%	>99.9%
				Fecal coliform (10% > 43)	62.1%	>99.9%
				Fecal coliform (Median > 14)	68	
				Turbidity (>25)	10.3%	64.0%
I9420000	Lockwood Folly Riv At Nc 211 At Supply	SC HQW	No	Dissolved Oxygen (<5)	41.1%	>99.9%
				pH (<6.8)	12.7%	82.0%
I9430000	Lockwood Folly Riv Nr Sandy Hill	SC HQW	No	Dissolved Oxygen (<5)	30.6%	>99.9%
I9440000	Lockwood Folly Riv At Varnum	SA HQW	Yes[1]	Fecal coliform (10% > 43)	35.6%	>99.9%
				Fecal coliform (Median > 14)	27	
I9480000	Lockwood Folly Riv At CM R6 W Ch Nw Sunset Harbor	SA HQW	Yes[1]	Fecal coliform (10% > 43)	12.0%	77.0%
I9700000	Shallotte Riv At Us 17 Bus At Shallotte	SC	No	Dissolved Oxygen (<5)	24.1%	>99.9%
				pH (<6.8)	29.3%	>99.9%
				Fecal coliform (20% > 400)	43.9%	>99.9%
				Fecal coliform (Geomean > 200)	444	
I9880000	Icw At Sr 1172 Nr Sunset Beach	SA HQW	Yes[1]	Dissolved Oxygen (<5)	24.1%	99.9%
				Fecal coliform (10% > 43)	18.5%	98.3%
				Fecal coliform (Median > 14)	16	
I9916000	Calabash Riv At Nc 179 Nr Calabash	SA HQW	Yes[1]	Dissolved Oxygen (<5)	27.1%	>99.9%
				Copper, total (>3)	45.0%	>99.9%
				Fecal coliform (20% > 400)	22.0%	71.8%
				Fecal coliform (10% > 43)	86.4%	>99.9%
				Fecal coliform (Median > 14)	150	
				Turbidity (>25)	42.4%	>99.9%

Blue indicates that the evaluation level displayed is a numerical standard. Black indicates that number given is a evaluation level only. The fecal coliform **standard** requires that 5 samples be taken within a 30-day window. The above data was taken monthly over five years, not meeting the requirements of the standard. Instead, we recommend that five and 30 data be taken at stations where the evaluation level was exceeded. The dissolved oxygen **standard** may not be applied in some areas, such as swamp or poorly flushed tidal areas, as low levels may be caused by natural conditions. Previous Impairment data was taken from the 2006 North Carolina Integrated Report.

[1]. These sites were previously impaired for shellfish harvesting due to high fecal coliform levels.

INTRODUCTION

The DWQ's Ambient Monitoring System (AMS) network of stream, lake, and estuarine stations are strategically located for the collection of physical and chemical water quality data. The stations are located at convenient access points (e.g. bridge crossings) that are sampled on a monthly basis. These locations were chosen to characterize the effects of point source dischargers and nonpoint sources such as agriculture, animal operations, and urbanization within watersheds.

The data are used to identify long term trends within watersheds, to develop Total Maximum Daily Loads (TMDLs) and to compare measured values with water quality standards to identify possible areas of impairment. Parametric coverage is determined by freshwater or saltwater waterbody classification and corresponding water quality standards. Under this arrangement, core parameters are based on Class C waters with additional parameters added when justified (Table 2).

Within this document, an analysis of how monitoring results compare with water quality standards and evaluation levels is presented. A conceptual overview of water quality standards is provided at: http://www.epa.gov/waterscience/standards. Specific information on North Carolina water quality standards is provided at: http://h2o.enr.state.nc.us/csu/swstdsfaq.html.

Water quality data are evaluated in five year periods. Some stations have little or no data for several parameters over the period. However, for the purpose of standardization, data summaries for each station are included in this report. DWQ monitored water quality and collected samples at 30 stations throughout the basin.

Table 2. Parametric coverage for the Ambient Monitoring System.[1]

Parameter	All Waters	Water Supply
Dissolved oxygen (s)	✔	✔
pH (s)	✔	✔
Specific conductance	✔	✔
Temperature (s)	✔	✔
Total phosphorus[2]	✔	✔
Ammonia as N[2]	✔	✔
Total Kjeldahl as N[2]	✔	✔
Nitrate+nitrite as N[2] (s)	✔	✔
Total suspended solids	✔	✔
Turbidity (s)	✔	✔
Fecal coliform bacteria (s)	✔	✔
Aluminum	✔	✔
Arsenic (s)	✔	✔
Cadmium (s)	✔	✔
Chromium, total (s)	✔	✔
Copper, total (s)	✔	✔
Iron (s)	✔	✔
Lead (s)	✔	✔
Mercury (s)	✔	✔
Nickel (s)	✔	✔
Zinc (s)	✔	✔
Manganese (s)	---	✔
Chlorophyll *a*[2] (s)	✔	✔

A check (✔) indicates the parameter is collected. 's' indicates the parameter has a standard.
[2]Chlorophyll *a* is collected in Nutrient Sensitive Waters (NSW) and some coastal areas. Since 2001, nutrient sampling likewise is only done in areas of concern, such as NSW, estuaries, and areas with known enrichment issues.

Table 3. Selected water quality standards[1]

	Standards for All Freshwater			Standards to Support Additional Uses		
Parameter (µg/L, unless noted)	Aquatic Life	Human Health	Water Supply Classifications	Trout Water	HQW	Swamp Waters
Arsenic		10				
Cadmium	2.0			0.4		
Chloride (mg/l)	230		250			
Chlorophyll *a* (corrected)	40[2]			15[2]		
Chromium, total	50					
Coliform, total (MFTCC/100 ml)[3]			50[2] (WS-I only)			
Coliform, fecal (MFFCC/100 ml)[4]		200[2]				
Copper, total	7					
Dissolved oxygen (mg/L)	4.0[5,6]			6.0		[2, 6]
Hardness, total (mg/L)			100			
Iron	1,000					
Lead	25[2]					
Manganese			200			
Mercury	0.012					
Nickel	88		25			
Nitrate nitrogen			10,000			
pH (units)	6.0 - 9.0[2, 6]					[2, 6]
Solids, total suspended (mg/L)					10 Trout, 20 other[7]	
Turbidity (NTU)	50, 25[2]			10[2]		
Zinc	50					

[1]Standards apply to all classifications. For the protection of water supply and supplemental classifications, standards listed under Standards to Support Additional Uses should be used unless standards for aquatic life or human health are listed and are more stringent. Standards are the same for all water supply classifications (Administrative Code 15A NCAC 2B 0200, eff. May 1, 2007).
[2]Refer to 2B.0211 for narrative description of limits.
[3]Membrane filter total coliform count per 100 ml of sample.
[4]Membrane filter fecal coliform count per 100 ml of sample.
[5]An instantaneous reading may be as low as 4.0 mg/L, but the daily average must be 5.0 mg/L or more.
[6]Designated swamp waters may have a dissolved oxygen less than 5.0 mg/L and a pH as low as 4.3, if due to natural conditions.
[7]For effluent limits only, refer to 2B.0224(1)(b)(ii).

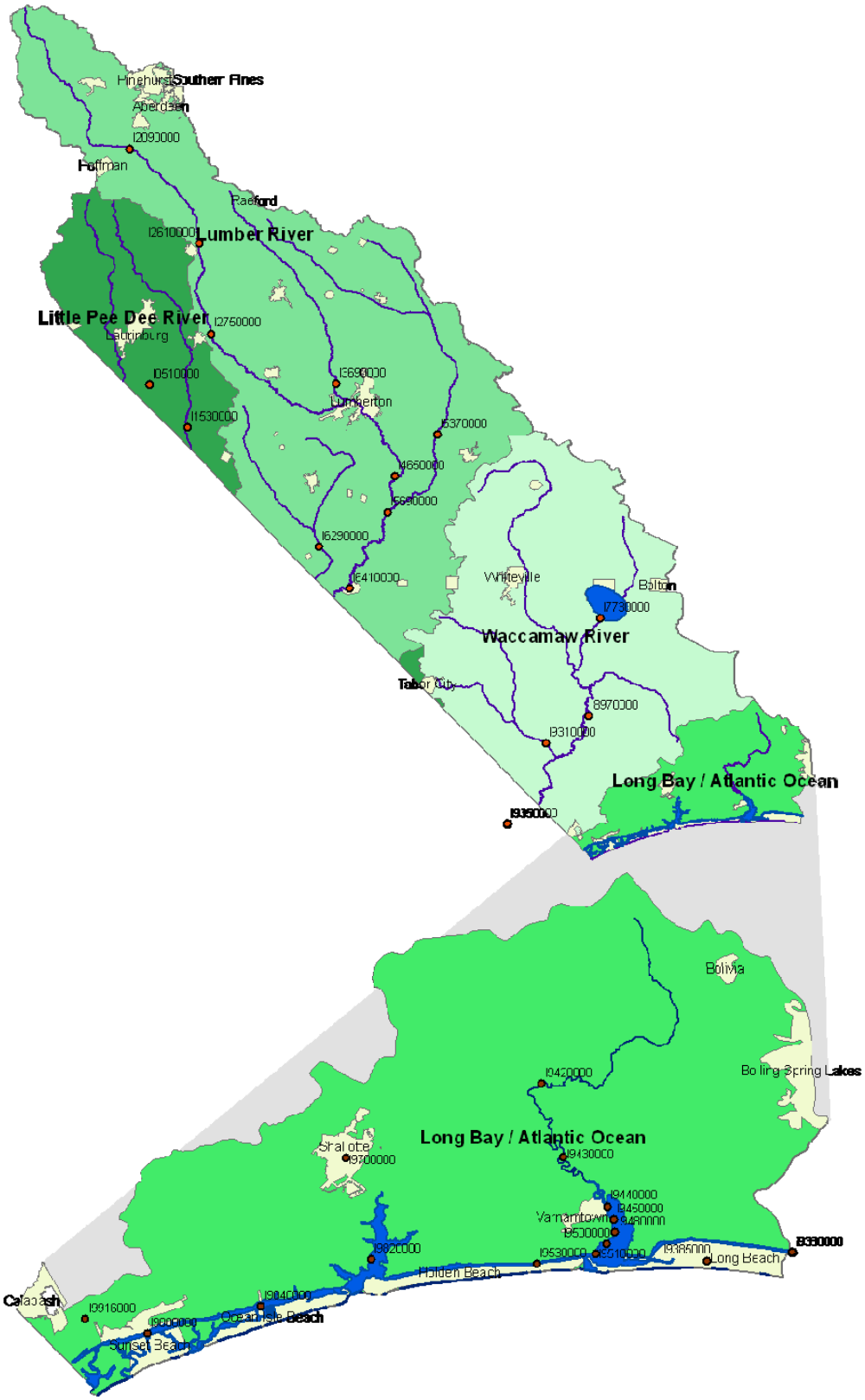


Figure 1. DWQ's Ambient Monitoring System in the Lumber River Basin.

Table 4. DWQ Monitoring stations in the Lumber River Basin, 2002 - 2006.

Station	Location	Stream Class	Latitude	Longitude
HUC 3040203: Lumber River				
I2090000	Drowning Crk At Us 1 Nr Hoffman	C Sw HQW	35.0610	-79.4939
I2610000	Lumber Riv At Us 401 Nr Wagram	WS-IV&B Sw HQW	34.9003	-79.3490
I2750000	Lumber Riv At Sr 1303 Nr Maxton	B Sw HQW	34.7470	-79.3246
I3690000	Raft Swamp At Sr 1527 Nr Moss Neck	WS-IV Sw	34.6616	-79.0658
I4650000	Lumber Riv At Sr 2121 Nr Kingsdale	C Sw	34.5040	-78.9444
I5370000	Big Swamp At Nc 211 Nr Richardson	C Sw	34.5749	-78.8572
I5690000	Lumber Riv At Us 74 At Boardman	C Sw	34.4430	-78.9596
I6290000	Ashpole Swamp At Sr 2258 Nr Barnesville	C Sw	34.3839	-79.1017
I6410000	Lumber Riv At Nc 904 At Fair Bluff	B Sw	34.3134	-79.0380
HUC 3040204: Little Pee Dee River				
I0510000	Leith Crk At Sr 1615 Nr Smyrna Church	C Sw	34.6597	-79.4501
I1530000	Shoe Heel Crk At Sr 1101 Nr Rowland	C Sw	34.5868	-79.3719
HUC 3040206: Waccamaw River				
I7730000	Lake Waccamaw At Dam Spillway Nr Lake Waccamaw	B Sw ORW	34.2611	-78.5232
I8970000	Waccamaw Riv At Nc 130 At Freeland	C Sw	34.0952	-78.5478
I9310000	Seven Crks At Nc 905 Nr Bug Hill	C Sw	34.0493	-78.6350
I9350000	Waccamaw Riv At Sc 9 Nr Longs Sc	FW	33.9119	-78.7147
HUC 3040207: Long Bay / Atlantic Ocean				
I9380000	Icw At CM R16 At Beaverdam Crk Nr Long Beach	SA HQW	33.9220	-78.1078
I9385000	Montgomery Slough At Sr 1105 Nr Long Beach	SA HQW	33.9178	-78.1609
I9420000	Lockwood Folly Riv At Nc 211 At Supply	SC HQW	34.0108	-78.2636
I9430000	Lockwood Folly Riv Nr Sandy Hill	SC HQW	33.9722	-78.2503
I9440000	Lockwood Folly Riv At Varnum	SA HQW	33.9465	-78.2232
I9450000	Lockwood Folly Riv At CM R8 At W Ch Dns Varnum	SA HQW	33.9395	-78.2192
I9480000	Lockwood Folly Riv At CM R6 W Ch Nw Sunset Harbor	SA HQW	33.9332	-78.2185
I9500000	Lockwood Folly Riv At West Channel Islands	SA HQW	33.9267	-78.2236
I9510000	Icw At CM R42 West Of Lockwood Folly Riv	SA HQW	33.9217	-78.2306
I9530000	Icw At Nc 130 Nr Holdens Beach	SA HQW	33.9170	-78.2676
I9700000	Shallotte Riv At Us 17 Bus At Shallotte	SC	33.9724	-78.3864
I9820000	Shallotte Riv At Shell Point Nr Shallotte	SA HQW	33.9197	-78.3711
I9840000	Icw At Nc 904 Nr Ocean Isle	SA HQW	33.8957	-78.4398
I9880000	Icw At Sr 1172 Nr Sunset Beach	SA HQW	33.8817	-78.5109
I9916000	Calabash Riv At Nc 179 Nr Calabash	SA HQW	33.8895	-78.5495

DATA ASSESSMENT AND INTERPRETATION

Monitoring and sampling results considered in this report represent samples collected or measurements taken at less than one-meter depth.

Percentile statistics were calculated for most of the data using JMP statistical software (version 5.01; SAS Institute, Cary, NC). Values less than the minimum reporting level (non-detects) were evaluated as equal to the reporting level. Box and whisker plots (constructed using SigmaPlot version 9) and maps are presented for most water quality parameters collected at each monitoring station. Significant trends in water quality parameters (constructed using Microsoft Excel) are illustrated as scatterplots. Significant trends are found by assessing the probability that the linear model explains the data no better then chance. If that chance is 5% or less (an observed significance probability of 0.05 or less) then that is considered evidence of a regression effect in this document. The strength of the regression effect is given as an r^2 value, the portion of the data that is explained by the linear model. There are many other types of modeling (non-linear) that can be used to explore trends, but they were not used in this document.

Analytical Considerations

One issue has been noted by the DWQ Laboratory Section as part of the analytical processes during this assessment period:

Chlorophyll a samples collected between 4/11/05 and 8/23/05 were incorrectly prepared for analysis, to the extent that the accuracy of the results is unknown. Therefore, the chlorophyll a results for this period were omitted from the dataset.

Providing Confidence in the Exceedances of Water Quality Standards

NC DWQ uses guidance provided by the US EPA for determining when the number of results that exceed a water quality standard indicate potential water quality issues. Historically, the US EPA has suggested that management actions be implemented when 10 percent of the results exceeded a water quality standard. This interpretation is the same whether 1 out of 10, or 5 out of 50, or 25 out of 250 results exceed a standard. Evaluating exceedances in this manner is termed the “raw-score” approach. Although this “10 percent exceedance criterion” defines a point where potential water quality issues may be present, it does not consider uncertainty. Some results are subject to chance or other factors such as calibration errors or sample mishandling. Uncertainty levels change with sample size. The smaller the sample size, the greater the uncertainty.

This document uses a nonparametric procedure (Lin *et al.* 2000) to identify when a sufficient number of exceedances have occurred that indicate a true exceedance probability of 10 percent. Calculating the minimum number of exceedances needed for a particular sample size was done using the BINOMDIST function in Microsoft Excel®. This statistical function suggests that at least three exceedances need to be observed in a sample of 10 in order to be [about] 95 percent confident that the results statistically exceed the water quality standard more than 10% of the time. For example, there is less statistical confidence associated with a 1 exceedance out of 10 (73 percent) than when there are 3 exceedances out of 10 (93 percent confidence) (Table 5).

Table 5. Exceedance Confidence

Number of Samples	Number of Exceedances																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
10	74%	93%	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**							
12	66%	89%	**97%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**					
14	58%	84%	**96%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**			
16	51%	79%	93%	**98%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	
18	45%	73%	90%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
20	39%	68%	87%	**96%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
22	34%	62%	83%	94%	**98%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
24	29%	56%	79%	91%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
26	25%	51%	74%	89%	**96%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
28	22%	46%	69%	86%	94%	**98%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
30	18%	41%	65%	82%	93%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
32	16%	37%	60%	79%	91%	**96%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
34	13%	33%	55%	75%	88%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
36	11%	29%	51%	71%	85%	94%	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
38	10%	25%	46%	67%	83%	92%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
40	8%	22%	42%	63%	79%	90%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
42	7%	20%	38%	59%	76%	88%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
44	6%	17%	35%	55%	73%	85%	93%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
46	5%	15%	31%	51%	69%	83%	92%	**96%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
48	4%	13%	28%	47%	65%	80%	90%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
50	3%	11%	25%	43%	62%	77%	88%	94%	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
52	3%	10%	22%	40%	58%	74%	86%	93%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
54	2%	8%	20%	36%	54%	71%	83%	91%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
56	2%	7%	18%	33%	51%	67%	81%	90%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
58	2%	6%	16%	30%	47%	64%	78%	88%	94%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
60	1%	5%	14%	27%	44%	61%	75%	86%	93%	**97%**	**99%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**
62	1%	5%	12%	24%	40%	57%	72%	84%	91%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**
64	1%	4%	11%	22%	37%	54%	69%	81%	90%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**
66	1%	3%	9%	20%	34%	51%	66%	79%	88%	94%	**97%**	**99%**	**99%**	**100%**	**100%**	**100%**	**100%**
68	1%	3%	8%	18%	31%	47%	63%	76%	86%	93%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**
70	1%	2%	7%	16%	29%	44%	60%	74%	84%	91%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**
72	0%	2%	6%	14%	26%	41%	57%	71%	82%	90%	**95%**	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**
74	0%	2%	5%	13%	24%	38%	54%	68%	80%	88%	94%	**97%**	**99%**	**99%**	**100%**	**100%**	**100%**
76	0%	1%	5%	11%	22%	35%	51%	65%	77%	86%	93%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**
78	0%	1%	4%	10%	20%	33%	48%	62%	75%	85%	91%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**
80	0%	1%	4%	9%	18%	30%	45%	59%	72%	83%	90%	**95%**	**97%**	**99%**	**99%**	**100%**	**100%**

Note: Bold entries indicate that there is at least 95% confidence that at least 10% of the possible samples exceed the evaluation level.

Methods Used to Summarize Results

Methods used to summarize the results in this report encompass both tabular and graphical formats. Individual summary sheets for each station provide details on station location, stream classification, along with specifics on what parameters were measured, the number of samples taken (i.e. sample size), the number of results below reporting levels, the number of results exceeding a water quality standard or evaluation level, statistical confidence that 10% of results exceeded the evaluation level, and a general overview of the distribution of the results using percentiles. These station summary sheets provide the greatest details on a station-by-station basis. They are included as **Appendix A** to this report.

PARAMETERS

Dissolved Oxygen

Dissolved oxygen is one of the most important of all the chemical measurements. Dissolved oxygen provides valuable information about the ability of the water to support aquatic life and the capacity of water to assimilate point and nonpoint discharges. Water quality standards for dissolved oxygen vary depending on the classification of the body of water. For freshwaters, 15A NCAC 02B .0211 (3)(b) specifies:

Dissolved oxygen: not less than 6.0 mg/l for trout waters; for non-trout waters, not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less that 4.0 mg/l; swamp waters, lake coves or backwaters, and lake bottom waters may have lower values if caused by natural conditions.

For saltwaters, 15A NCAC 02B .0220 (3)(b) applies instead:

Dissolved oxygen: not less than 5.0 mg/l, except that swamp waters, poorly flushed tidally influenced streams or embayments, or estuarine bottom waters may have lower values if caused by natural conditions.

Consistent patterns of low concentrations of dissolved oxygen can be subject to intense management review and corrective actions, if they do not appear to be naturally occurring.

pH

The pH of natural waters can vary throughout the state. Low values (<< 7.0 s.u.) can be found in waters rich in dissolved organic matter, such as swamp lands, whereas high values (>> 7.0 s.u.) may be found during algal blooms. Point source dischargers can also influence the pH of a stream. The measurement of pH is relatively easy; however the accuracy of field measurements is limited by the abilities of the field equipment, which is generally accurate to within 0.2 S.U. This is due, in part, because the scale for measuring pH is logarithmic (i.e. a pH of 8 is ten times less concentrated in hydrogen ions than a pH of 7). The water quality standards for pH in freshwaters consider values less than 6.0 s.u. or greater than 9.0 s.u. to warrant attention.

Conductivity

In this report, conductivity is synonymous with specific conductance. It is reported in micromhos per centimeter (µmhos/cm) at 25°C. Conductivity is a measure of the ability of water to conduct an electric current. The presence of ions and temperature are major factors in the ability of water to conduct a current. Clean freshwater has a low conductivity, whereas high conductivities may indicate polluted water or saline conditions. Measurements reported are corrected for temperature, thus the range of values reported over a period of time indicate the relative presence of ions in water. Conductivities in US fresh waters commonly vary between 50 to 1,500 µmhos/cm (APHA 1998). North Carolina freshwater streams have a natural conductance range of 17-65 µmhos/cm, however (USGS 1992).

Conductivity can be used to evaluate variations in dissolved mineral concentrations (ions) among sites with varying degrees of impact resulting from point source discharges. Generally, impacted sites show elevated and widely ranging values for conductivity. Water bodies that contain saltwater will also have high conductivities. Therefore those wishing to use conductivity as an indicator for problems must first account for salinity. The Lumber River Basin includes saltwaters.

Turbidity

Turbidity data may denote episodic high values on particular dates or within narrow time periods. These can often be the result of intense or sustained rainfall events; however elevated values can occur at other times. In coastal areas, tidal surges can also disturb shallow estuarine sediments and naturally increase turbidity. There are coastal areas in the Lumber River Basin.

Metals

A number of metals are essential micronutrients for the support of aquatic life. However, there are threshold concentrations over which metals can be toxic. During the current assessment period, DWQ monitored total (not dissolved) concentrations for aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, manganese (in water supply waters) and zinc. Aluminum and iron are commonly found in soils.

Nutrients

Compounds of nitrogen and phosphorus are major components of living organisms and thus are essential to maintain life. These compounds are collectively referred to as "nutrients." Nitrogen compounds include ammonia-nitrogen (NH_3-N), total Kjeldahl nitrogen (TKN) and nitrite+nitrate nitrogen (NO_2+NO_3-N). Phosphorus is measured as total phosphorus. When nutrients are introduced to an aquatic ecosystem from municipal and industrial treatment processes, or runoff from urban or agricultural land, the excessive growth of algae (algal blooms) and other plants may be accelerated.

In addition to the possibility of causing algal blooms, ammonia-nitrogen may combine with high pH water to form NH_4OH, a form toxic to fish and other aquatic organisms.

Fecal Coliform Bacteria

Concentrations of fecal coliform bacteria can vary greatly. The descriptive statistics used to evaluate fecal coliform bacteria data include the geometric mean and the median depending on the classification of the waterbody. For all sites in the Lumber River Basin, the standard specified in Administrative Code 15A NCAC 02B.0211 (3)(e) (May 1, 2007) is applicable:

"Organisms of the coliform group: fecal coliforms shall not exceed a geometric mean of 200/100ml (MF count) based upon at least five consecutive samples examined during any 30 day period, nor exceed 400/100ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the membrane filter technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results, the MPN 5-tube dilution technique shall be used as the reference method."

The application of the standard is often hindered because the monthly (*circa* 30 day) sampling frequency employed for water quality monitoring usually does not provide more than one sample per 30-day period. However, water quality problems can be screened using monthly sampling. Sites where the geometric mean was greater than 200 colonies/100ml, or where greater than 20 percent of the results exceed 400 colonies/100ml are indicated on the respective station summary sheets.

In addition, for all tidal salt waters, the following is applicable 15A NCAC 02B .0220 (3)(e) (May 1, 2007):

"*Enterococcus, including Enterococcus faecalis, Enterococcus faecium, Enterococcus avium, and Enterococcus gallinarium: not to exceed a geometric mean of 35 enterococci per 100 ml based upon a minimum of five samples within any consecutive 30 days.*"

The AMS does not collect Enterococcus samples. The N.C. Recreational Water Quality Program (NCRWQP) collects enterococcus samples. The NCRWQP began testing coastal waters in 1997. Their mission is to protect the public health by monitoring the quality of N.C.'s coastal recreational waters and notifying the public when bacteriological standards for safe bodily contact are exceeded. The coastal waters monitored include the ocean beaches, sounds, bays and estuarine rivers.

Enterococcus bacteria is an indicator organism found in the intestines of warm-blooded animals. While it will not cause illness itself, its presence is correlated with that of organisms that can cause illness. The program tests 241 ocean and sound-side areas. Swimming season begins on April 1st and ends Sept. 30th. All ocean beaches and high-use sound-side beaches (Tier 1) are tested weekly. Lower-use beaches (Tier 2 and Tier 3) are tested twice a month. All sites are tested twice a month in October and monthly from November through March. The NCRWQP currently uses single sample test to determine compliance with their rules 15A NCAC 18A .3402:

"*(a) The Enterococcus level in a Tier I swimming area shall not exceed either:*

(1) A geometric mean of 35 enterococci per 100 milliliter of water, that includes a minimum of at least five samples collected within 30 days; or

(2) A single sample of 104 enterococci per 100 milliliter of water.

(b) The enterococcus level in a tier II swimming area shall not exceed a single sample of 276 enterococci per 100 milliliter of water.

(c) The enterococcus level in a tier III swimming area shall not exceed two consecutive samples of 500 enterococci per 100 milliliter of water."

For waters where commercial shellfishing is done (Class SA), an additional standard is applied (15A NCAC 02B .0221 (3)(d) (May 1, 2007):

"*Organisms of coliform group: fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed and MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions."*

Class SA, non-SA tidal saltwaters, and other waters are present in the Lumber River basin. All sites where the geometric mean was greater than 200 colonies/100ml, or where greater than 20 percent of the results exceed 400 colonies/100ml are indicated on the respective station summary sheets. In addition, class SA sites where the median exceeds 14 colonies/100ml or where greater than 10 percent of the results exceed 43 colonies/100ml are indicated on the sheets.

Table 6. Summary of Evaluation Level Exceedances: Freshwater HUCs

Station		Class	pH (SU) <4.3	Water Temperature (°C) >32	Turbidity (NTU) >50	Copper, total (Cu) >7	Iron, total (Fe) >1000	Zinc, total (Zn) >50	Fecal coliform >400
HUC 03040203 : Lumber River									
I2090000	Drowning Crk At Us 1 Nr Hoffman	C Sw HQW	2.1%	0.0%	0.0%	0.0%	**25.0%**	0.0%	9.1%
I2610000	Lumber Riv At Us 401 Nr Wagram	WS-IV&B Sw HQW	2.1%	0.0%	0.0%	0.0%	0.0%	6.3%	2.2%
I2750000	Lumber Riv At Sr 1303 Nr Maxton	B Sw HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
I3690000	Raft Swamp At Sr 1527 Nr Moss Neck	WS-IV Sw	0.0%	0.0%	0.0%	0.0%	6.3%	0.0%	2.2%
I4650000	Lumber Riv At Sr 2121 Nr Kingsdale	C Sw	0.0%	0.0%	0.0%	5.9%	0.0%	0.0%	2.2%
I5370000	Big Swamp At Nc 211 Nr Richardson	C Sw	8.7%	0.0%	0.0%	0.0%	**35.3%**	0.0%	4.4%
I5690000	Lumber Riv At Us 74 At Boardman	C Sw	0.0%	0.0%	0.0%	5.9%	**11.8%**	0.0%	0.0%
I6290000	Ashpole Swamp At Sr 2258 Nr Barnesville	C Sw	0.0%	2.1%	2.1%	0.0%	**64.7%**	5.9%	6.7%
I6410000	Lumber Riv At Nc 904 At Fair Bluff	B Sw	0.0%	0.0%	0.0%	5.9%	**11.8%**	0.0%	0.0%
HUC 03040204 : Little Pee Dee River									
I0510000	Leith Crk At Sr 1615 Nr Smyrna Church	C Sw	0.0%	0.0%	0.0%	0.0%	**56.3%**	0.0%	6.5%
I1530000	Shoe Heel Crk At Sr 1101 Nr Rowland	C Sw	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HUC 03040206 : Waccamaw River									
I7730000	Lake Waccamaw At Dam Spillway Nr Lake Waccamaw	B Sw ORW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I8970000	Waccamaw Riv At Nc 130 At Freeland	C Sw	6.8%	0.0%	0.0%	5.0%	**50.0%**	0.0%	1.8%
I9310000	Seven Crks At Nc 905 Nr Bug Hill	C Sw	0.0%	0.0%	0.0%	0.0%	**57.9%**	0.0%	10.7%

Station I9350000 is not included in this table because it is located in South Carolina, and not subject to North Carolina standards. Unlisted parameters were not detected above the evaluation level, or did not meet the requirement of ten samples collected. Percentages greater than 10% are in **bold**.

Table 7. Summary of Evaluation Level Exceedances: Saltwater HUCs (1 of 2)

Station	Location	Class	D.O. (mg/L) <5	pH (SU) <6.8	Water Temperature (°C) >32	Turbidity (NTU) >25	Arsenic, total (As) >10	Cadmium, total (Cd) >5
HUC 03040207 : Long Bay / Atlantic Ocean								
I9380000	Icw At Cm R16 At Beaverdam Crk Nr Long Beach	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9385000	Montgomery Slough At Sr 1105 Nr Long Beach	SA HQW	**26.3%**	5.3%	1.8%	**10.3%**	5.0%	0.0%
I9420000	Lockwood Folly Riv At Nc 211 At Supply	SC HQW	**41.1%**	**12.7%**	0.0%	0.0%	0.0%	0.0%
I9430000	Lockwood Folly Riv Nr Sandy Hill	SC HQW	**30.6%**	6.3%	0.0%	7.8%	0.0%	0.0%
I9440000	Lockwood Folly Riv At Varnum	SA HQW	8.8%	1.8%	1.8%	0.0%	0.0%	0.0%
I9450000	Lockwood Folly Riv At Cm R8 At W Ch Dns Varnum	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9480000	Lockwood Folly Riv At Cm R6 W Ch Nw Sunset Harbor	SA HQW	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9500000	Lockwood Folly Riv At West Channel Islands	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9510000	Icw At Cm R42 West Of Lockwood Folly Riv	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9530000	Icw At Nc 130 Nr Holdens Beach	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9700000	Shallotte Riv At Us 17 Bus At Shallotte	SC	**24.1%**	**29.3%**	0.0%	3.4%	0.0%	0.0%
I9820000	Shallotte Riv At Shell Point Nr Shallotte	SA HQW	5.2%	0.0%	0.0%	1.7%	0.0%	0.0%
I9840000	Icw At Nc 904 Nr Ocean Isle	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9880000	Icw At Sr 1172 Nr Sunset Beach	SA HQW	**24.1%**	0.0%	0.0%	0.0%	0.0%	0.0%
I9916000	Calabash Riv At Nc 179 Nr Calabash	SA HQW	**27.1%**	5.1%	6.8%	**42.4%**	0.0%	0.0%

Unlisted parameters were not detected above the evaluation level, or did not meet the requirement of ten samples collected. Percentages greater than 10% are in **bold**.

Table 7 (Continued). Summary of Evaluation Level Exceedances: Saltwater HUCs (2 of 2)

Station	Location	Class	Chromium, total (Cr) >20	Copper, total (Cu) >3	Mercury, total (Hg) >0.025	Nickel, total (Ni) >8.3	Zinc, total (Zn) >86	Fecal coliform >400	Fecal coliform >43
HUC 03040207 : Long Bay / Atlantic Ocean									
I9380000	Icw At Cm R16 At Beaverdam Crk Nr Long Beach	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9385000	Montgomery Slough At Sr 1105 Nr Long Beach	SA HQW	0.0%	0.0%	0.0%	5.0%	5.0%	0.0%	**62.1%**
I9420000	Lockwood Folly Riv At Nc 211 At Supply	SC HQW	0.0%	5.3%	0.0%	0.0%	0.0%	14.3%	
I9430000	Lockwood Folly Riv Nr Sandy Hill	SC HQW	0.0%	0.0%	0.0%	0.0%	0.0%	3.9%	
I9440000	Lockwood Folly Riv At Varnum	SA HQW	0.0%	10.0%	0.0%	0.0%	5.0%	0.0%	**35.6%**
I9450000	Lockwood Folly Riv At Cm R8 At W Ch Dns Varnum	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9480000	Lockwood Folly Riv At Cm R6 W Ch Nw Sunset Harbor	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**12.0%**
I9500000	Lockwood Folly Riv At West Channel Islands	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9510000	Icw At Cm R42 West Of Lockwood Folly Riv	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9530000	Icw At Nc 130 Nr Holdens Beach	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9700000	Shallotte Riv At Us 17 Bus At Shallotte	SC	0.0%	5.0%	0.0%	0.0%	0.0%	**43.9%**	
I9820000	Shallotte Riv At Shell Point Nr Shallotte	SA HQW	0.0%	5.0%	0.0%	5.0%	0.0%	0.0%	6.9%
I9840000	Icw At Nc 904 Nr Ocean Isle	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I9880000	Icw At Sr 1172 Nr Sunset Beach	SA HQW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**18.5%**
I9916000	Calabash Riv At Nc 179 Nr Calabash	SA HQW	5.3%	**45.0%**	0.0%	0.0%	0.0%	**22.0%**	**86.4%**

Percentages greater than 10% are in **bold**.

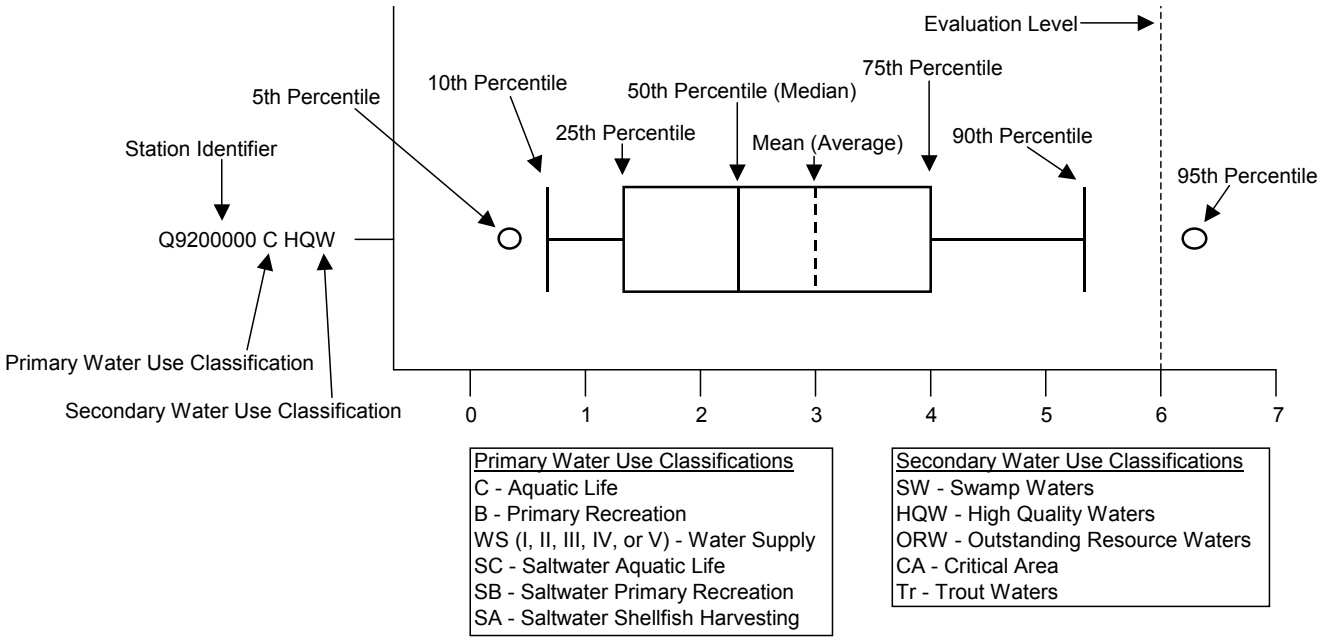


Figure 2. An Example Box Plot and Classification Summary Key

WATER QUALITY PATTERNS IN THE LUMBER RIVER BASIN

Box and whisker plots, scatterplots, and maps were used to depict data for a variety of water quality parameters throughout the basin. While graphs portray information visually, specific and accurate details can only be conveyed in tables. Individual station summary sheets should be consulted when exact information is needed. For the box plots, stations with fewer then 10 data points for a given parameter were not included. This occasionally occurred when a new station was added or an old station was moved in the basin.

Box and whisker plots were generated for each station for each water quality parameter that has an evaluation level, plus specific conductance, total nitrate/nitrite, total kjeldahl nitrogen, total ammonia, and total phosphorus. Maps were also generated for parameters with the most exceedances. In addition, a series of change over time graphs were generated which divided the basin into four hydrologic units (HUs), in order to observe basic regional differences that might be present in this basin.

Regional Trends and Comparisons

Change over time trends are illustrated in the following scatterplots. If there is at least 95% confidence that a particular linear trend explains the data better then chance (Prob > F of 0.05 or less) then that linear trend was included on the graph. The percentage of variance explained by the linear model (r^2 value) is displayed for each trend.

Samples were not collected in the Lumber River and Little Pee Dee HUCs from August 2003 to January 2004, and again from May 2004 through August 2004. During this period the staff position responsible for this area was vacant, and replacement staff was not available to collect the normal AMS samples. Although peaks or dips may have occurred during the gaps, and have therefore been missed, in general samples taken after the gaps are similar to samples taken before the gaps.

Comparisons of the four hydrologic units yielded the following:

- Drought Effect: The majority of North Carolina, including the Lumber River Basin, experienced drought in 2002, and significant rains in 2003. The low-flow drought, followed by a return to normal precipitation levels, has impacted trends for many parameters, including specific conductance, pH, turbidity, and fecal coliform. The trends illustrated in the scatterplots are reflecting the effect of drought primarily.
- Specific Conductance: Conductance peaked in 2002 during the drought, particularly in the Lumber River HU. By 2005 conductance had returned to typical levels. Downward trends in conductivity values are present in all four HUs, and appear to reflect the end of the drought.
- pH: In the Lumber River HU pH values peaked during the 2002 drought, and then returned to more typical values afterwards. This resulted in a downward trend in that HU. Trends were not observed elsewhere. The pH of waters in the Long Bay HU reflects the saltwater present in that HU.
- Turbidity spiked during the 2002 drought in the Lumber and Little Pee Dee HUs because of low water levels. After rains in 2003, Turbidity returned to normal and has stayed relatively even since then. The displayed trends are actually only reflecting the spike in 2002. A downward trend was also present in the Waccamaw HU.
- Fecal Coliform peaked during the 2002 drought in the Little Pee Dee River HU, which has shown up as a decreasing trend in that HU. The remainder of the HUs did not show a pattern, except that concentrations in Long Bay are typically higher then elsewhere.

In general, problem areas are focused in the saltwater portion of the basin, in the Long Bay HUC. The only 10% exceedances outside of that HUC were for total iron. Turbidity is highly correlated with total iron concentrations in the basin. Turbidity may explain over 52% (r^2 = 0.522411) of the variation in total iron. This may indicate that the majority of the total iron in the water in this basin is caused by suspended particulates, i.e. muddy water.

In the Long Bay HU, dissolved oxygen and fecal coliform are the most common exceedances. The majority of sites in the Long Bay HU were already impaired for high fecal coliform concentrations before the current monitoring period. The dissolved oxygen violations may be explained as natural variation, as they occurred in waters that could be described as poorly flushed tidal streams and embayments.

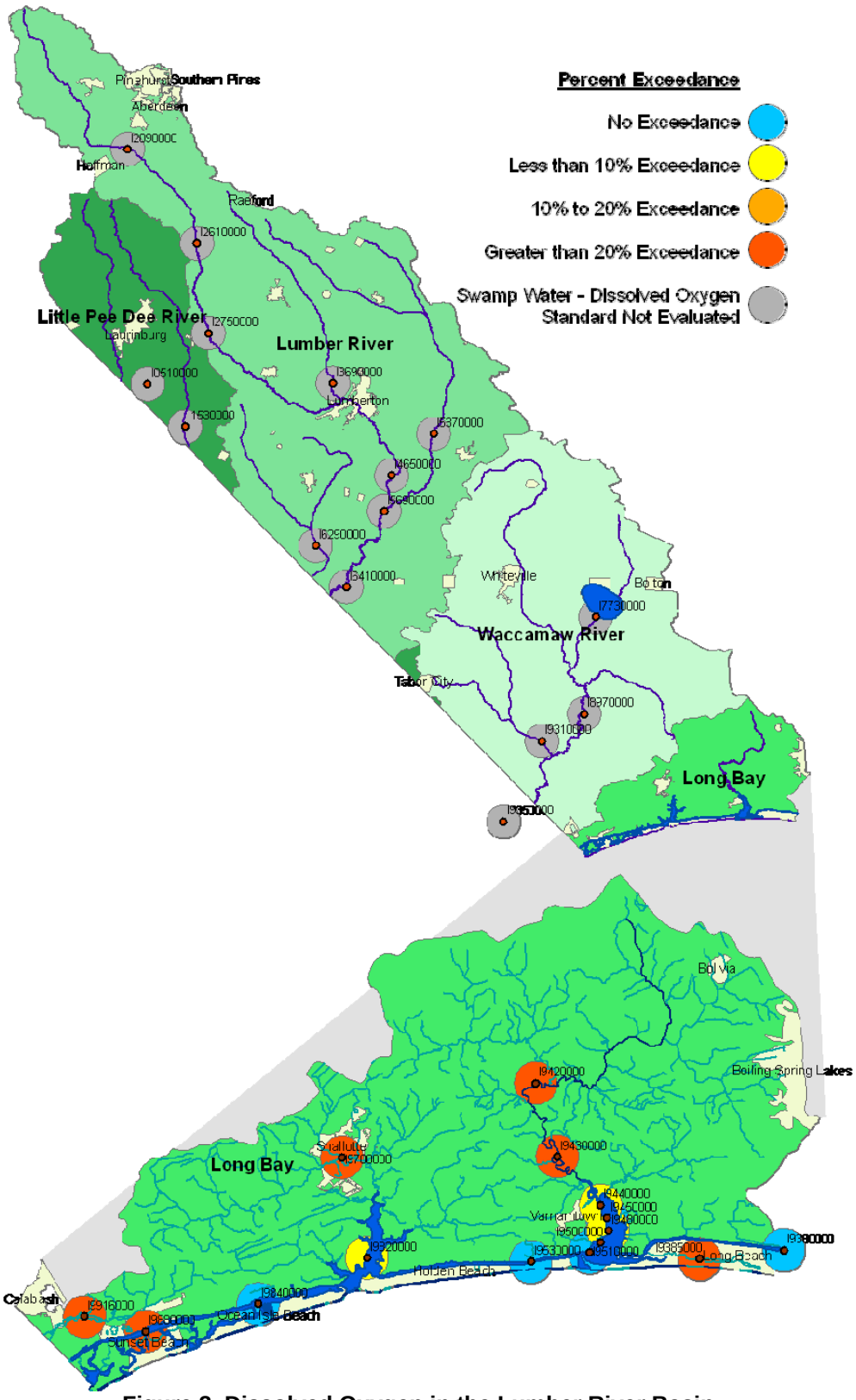


Figure 3. Dissolved Oxygen in the Lumber River Basin

The evaluation level for dissolved oxygen concentrations displayed on this map is 5 mg/L (applicable to saltwater sites). The grey sites are classified as swamp waters, which are not evaluated for dissolved oxygen.

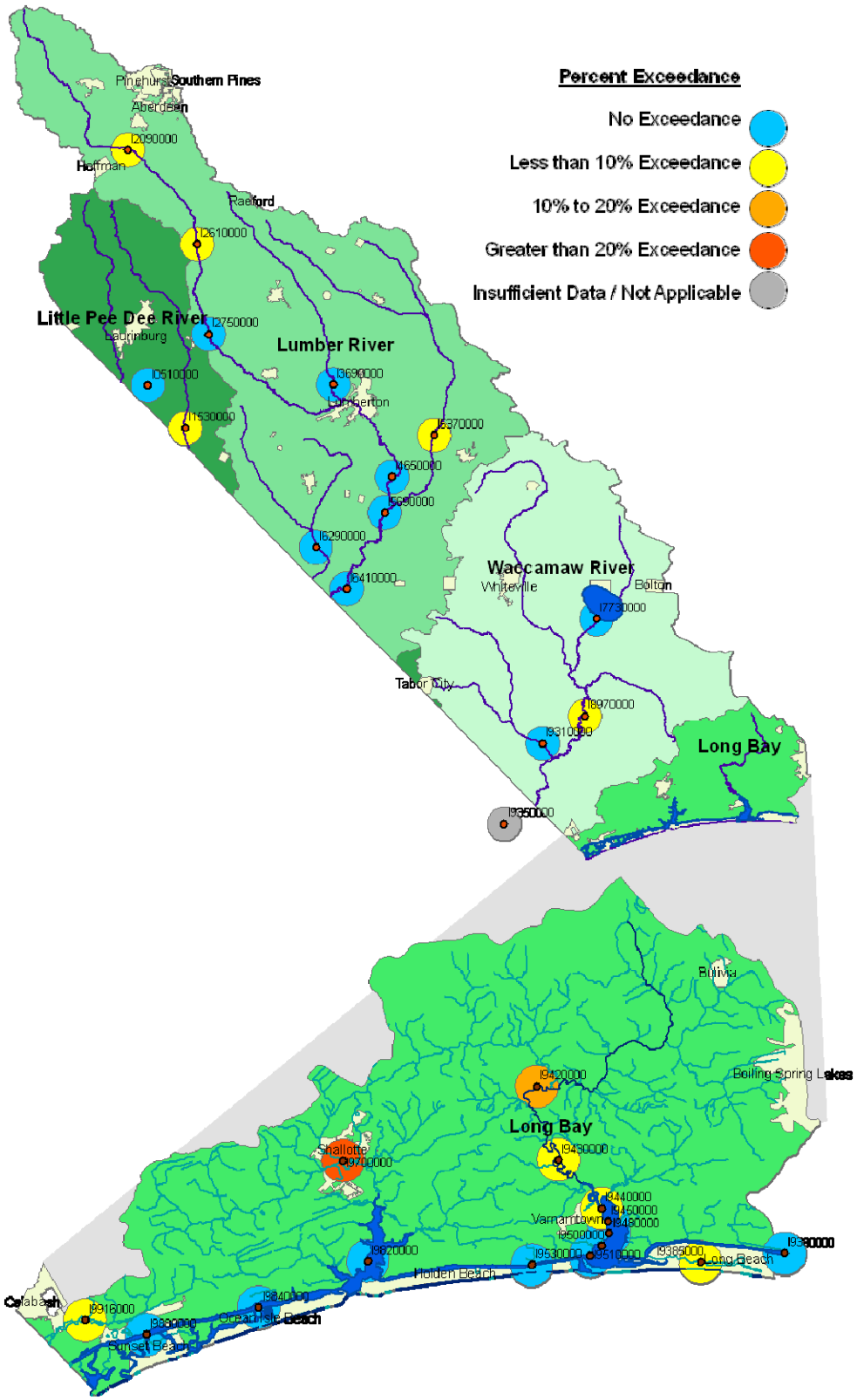


Figure 4. pH in the Lumber River Basin

The evaluation level for pH displayed on this map is 5 S.U. for saltwaters, and 4.3 S.U. for swampwaters.

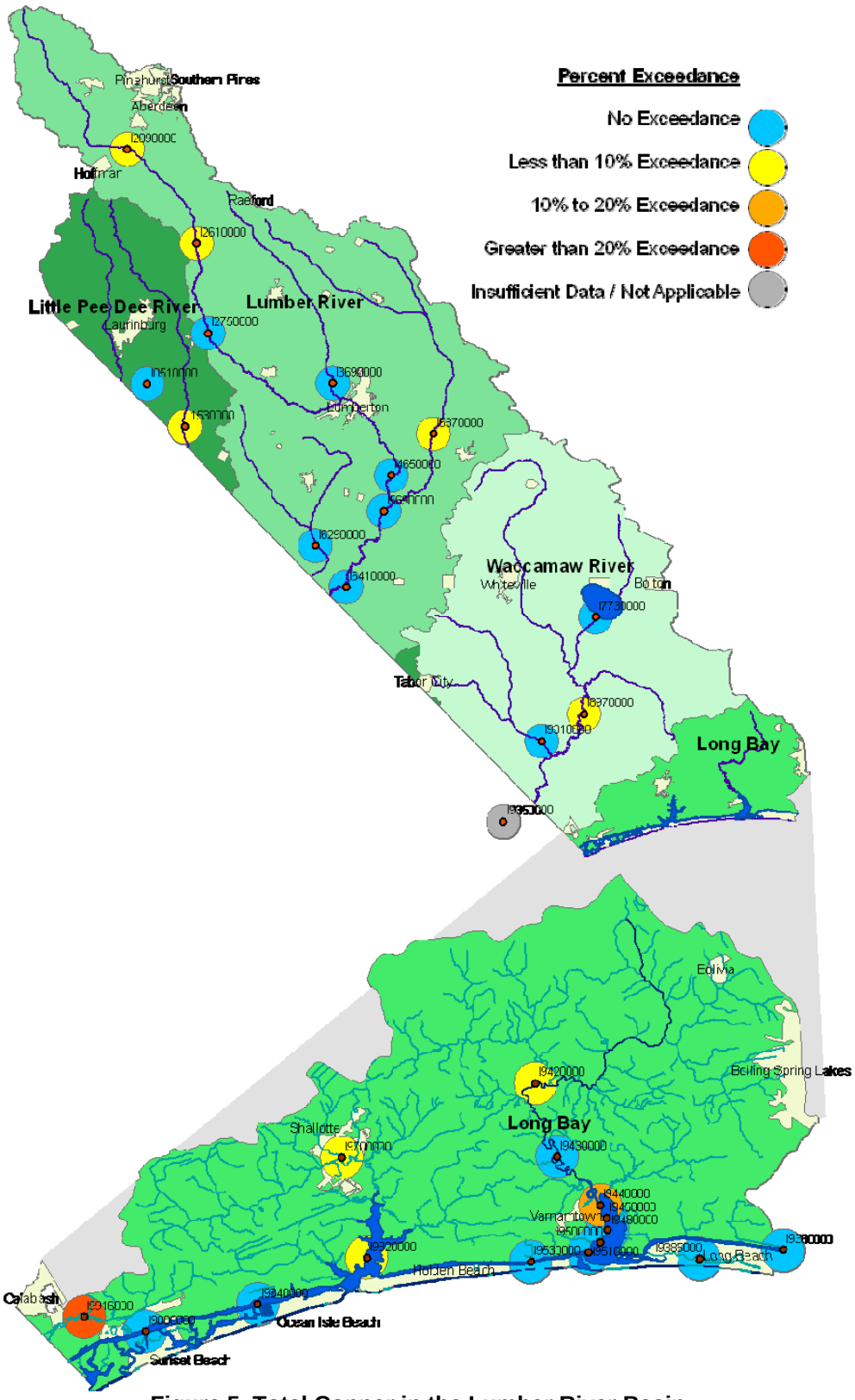


Figure 5. Total Copper in the Lumber River Basin

The evaluation level for total copper concentrations displayed on this map is 3 ug/L for saltwaters and 7 ug/L for freshwaters.

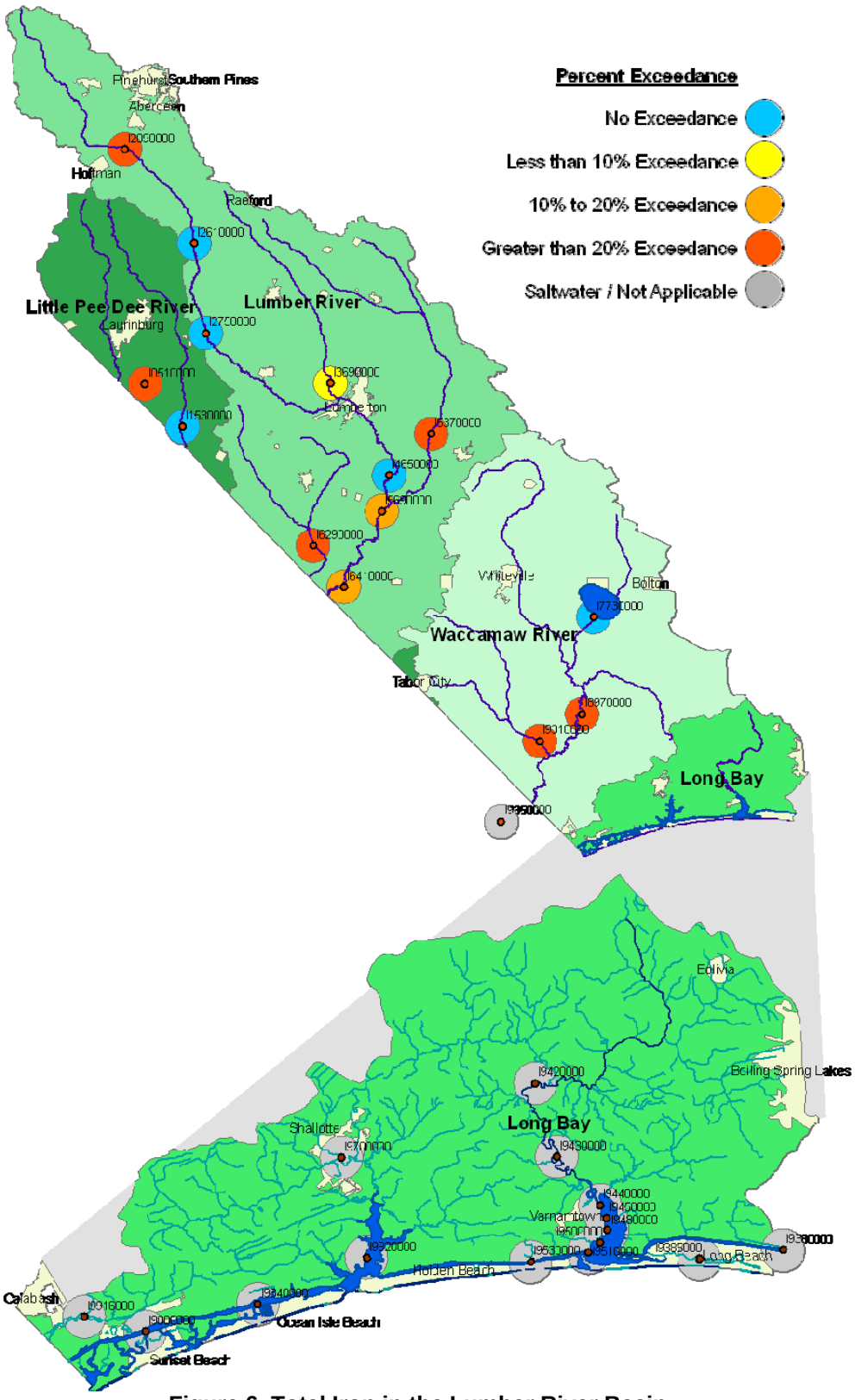
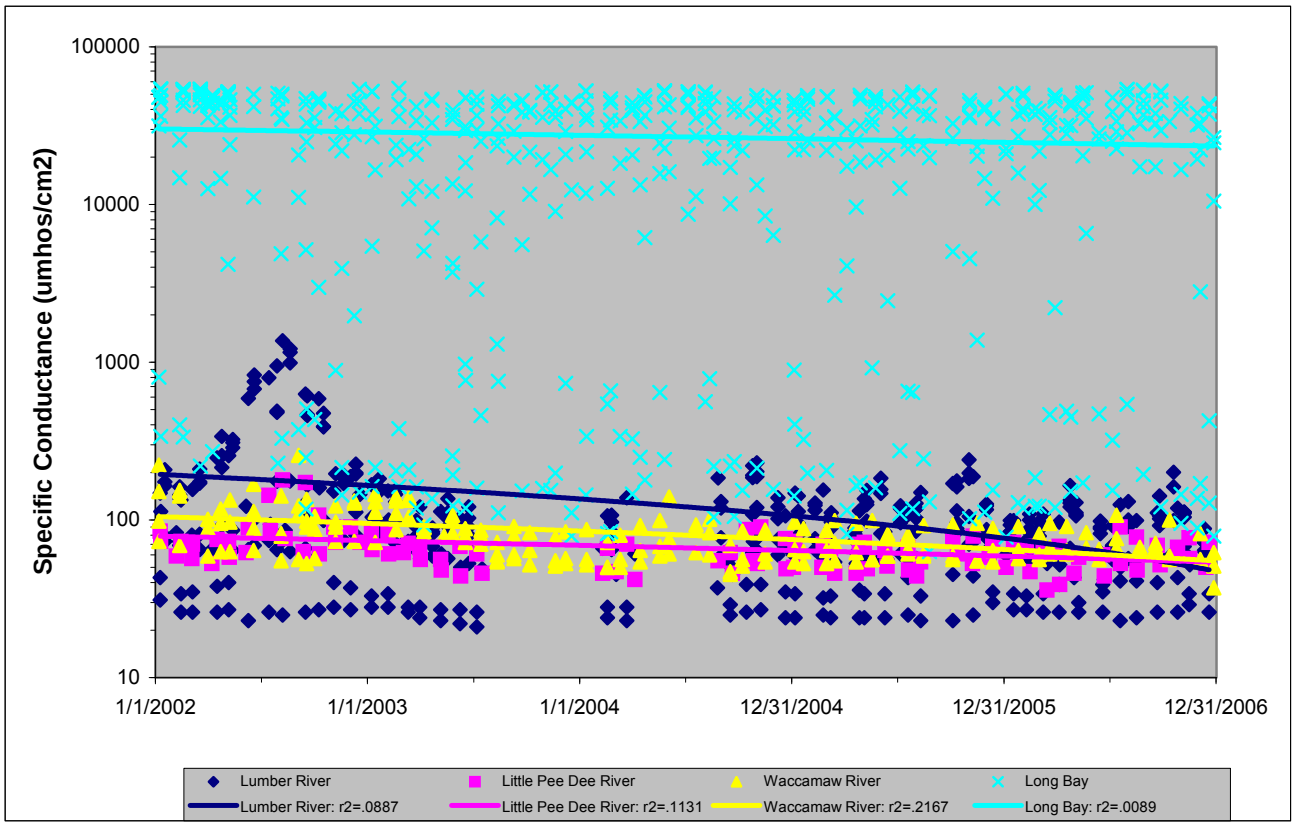


Figure 6. Total Iron in the Lumber River Basin

The evaluation level for total iron concentrations displayed on this map is 1,000 mg/L. The grey sites are classified as saltwaters, which are not evaluated for total iron.



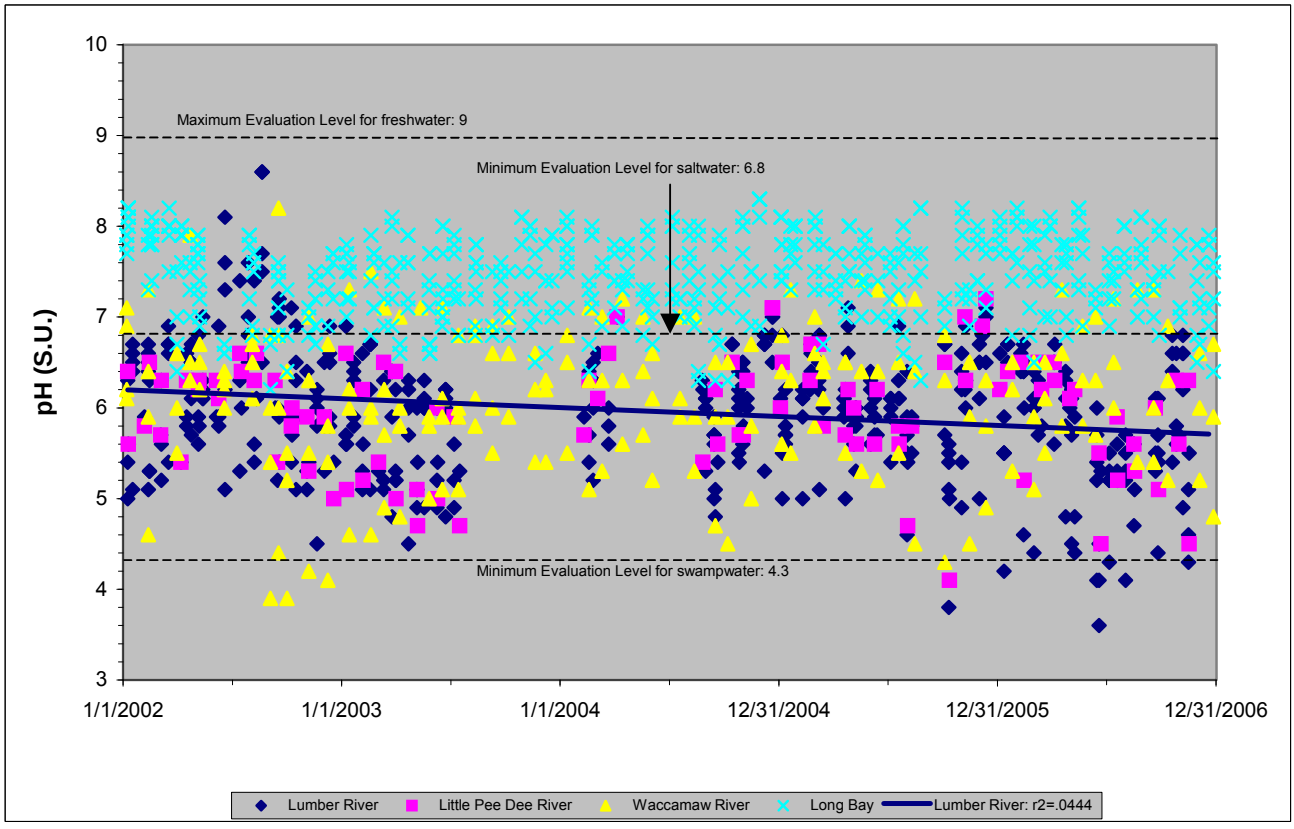


Figure 7. Specific Conductance and pH over time in the Lumber River Basin

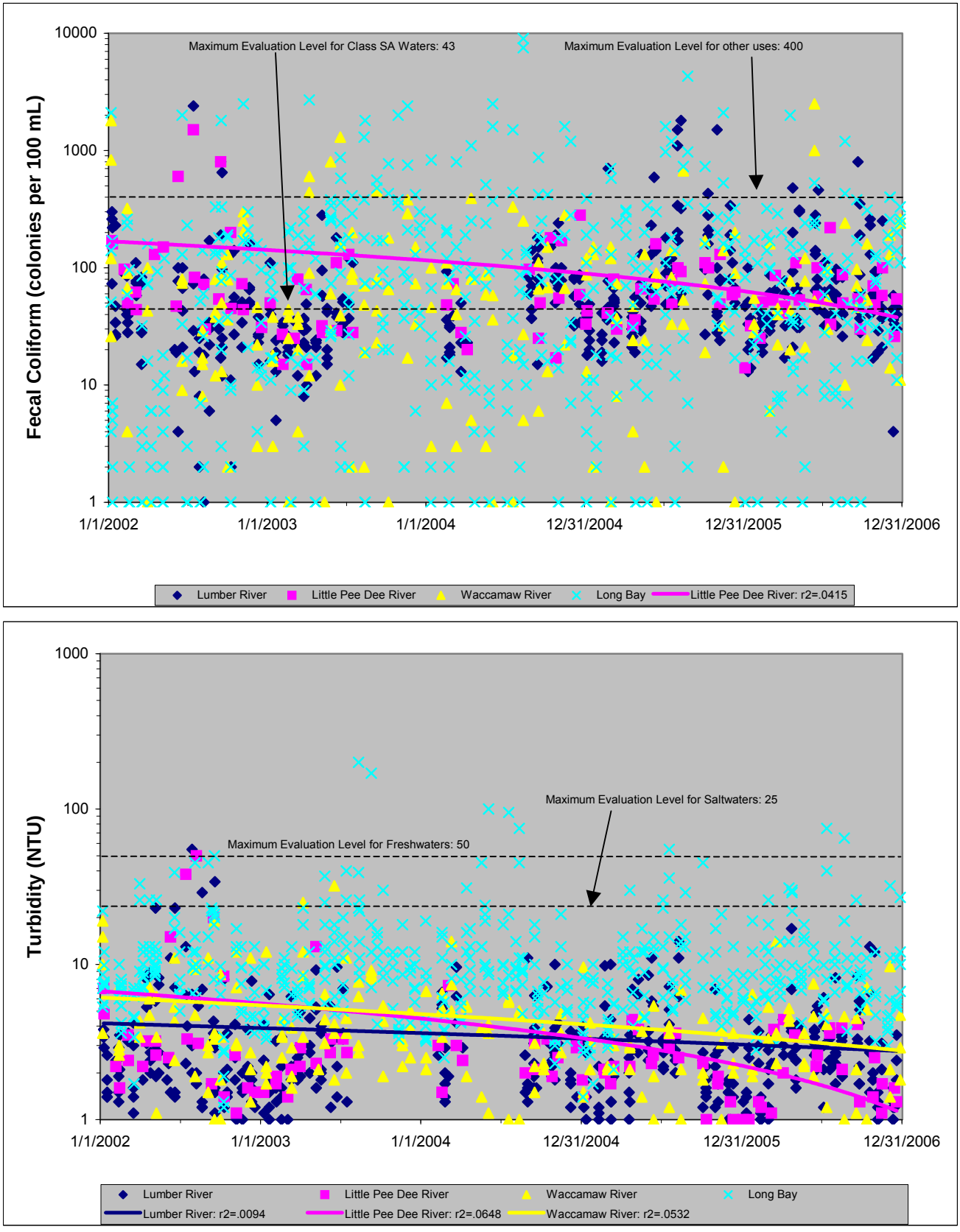
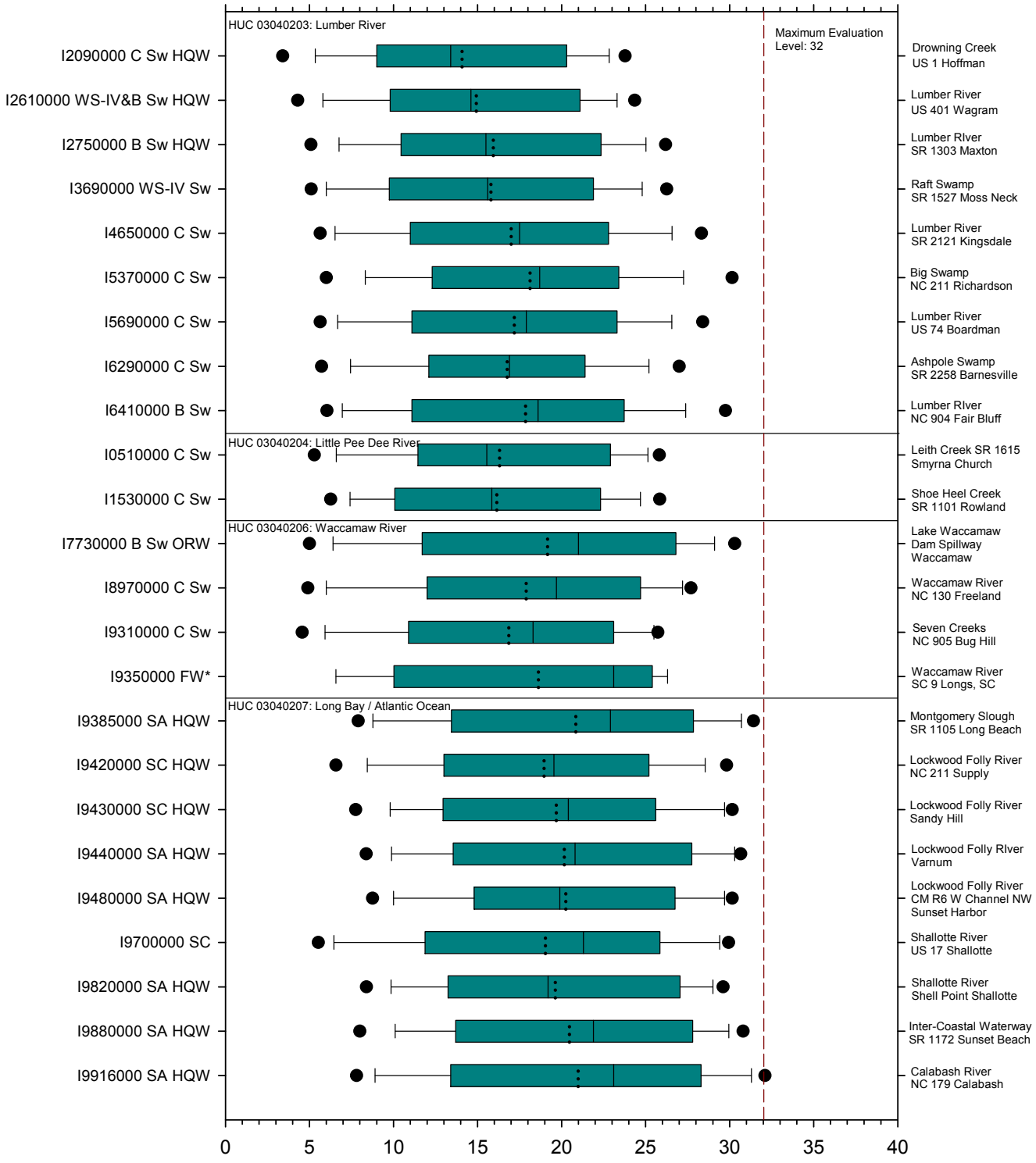
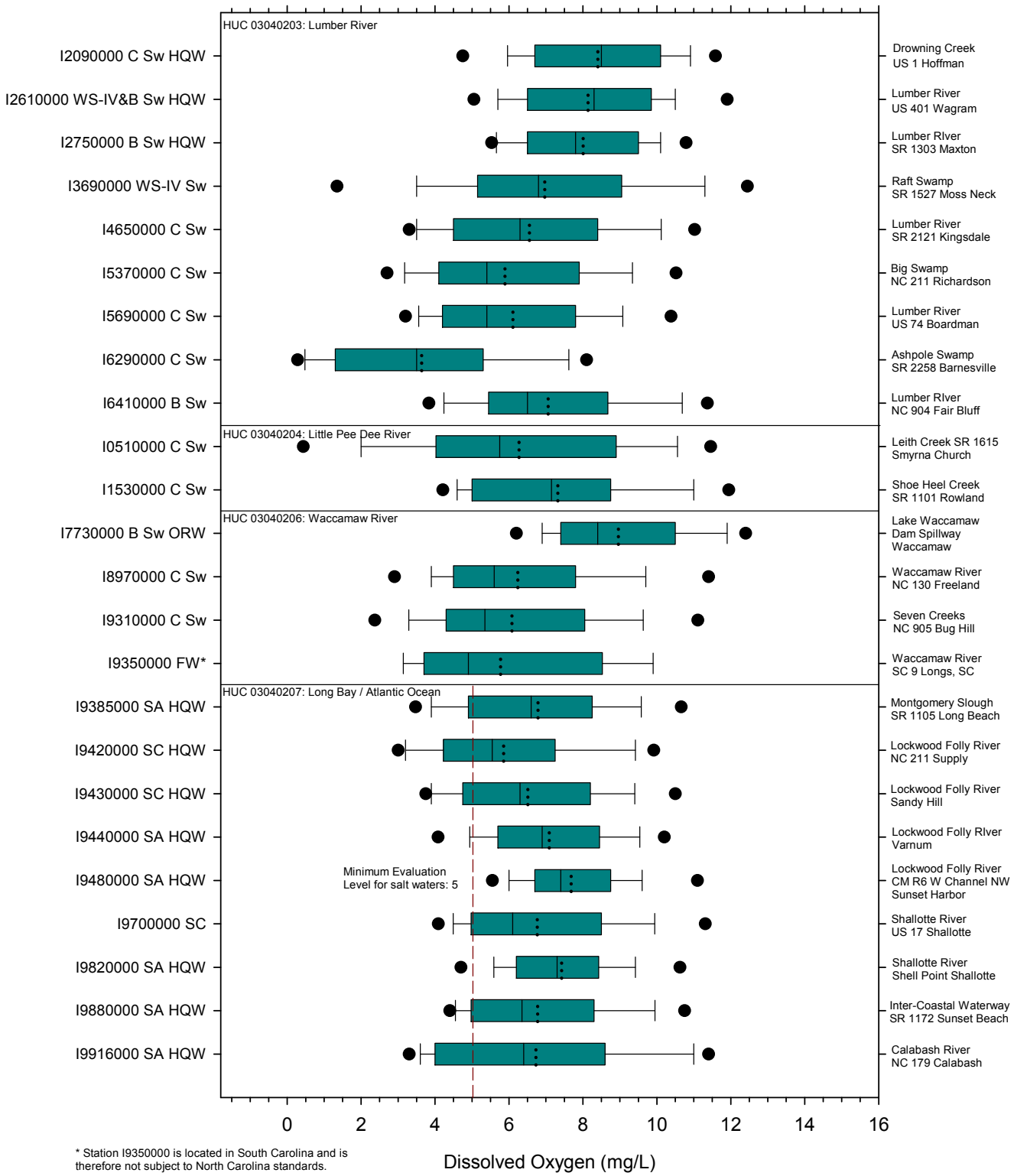


Figure 8. Fecal Coliform and Turbidity over time in the Lumber River Basin



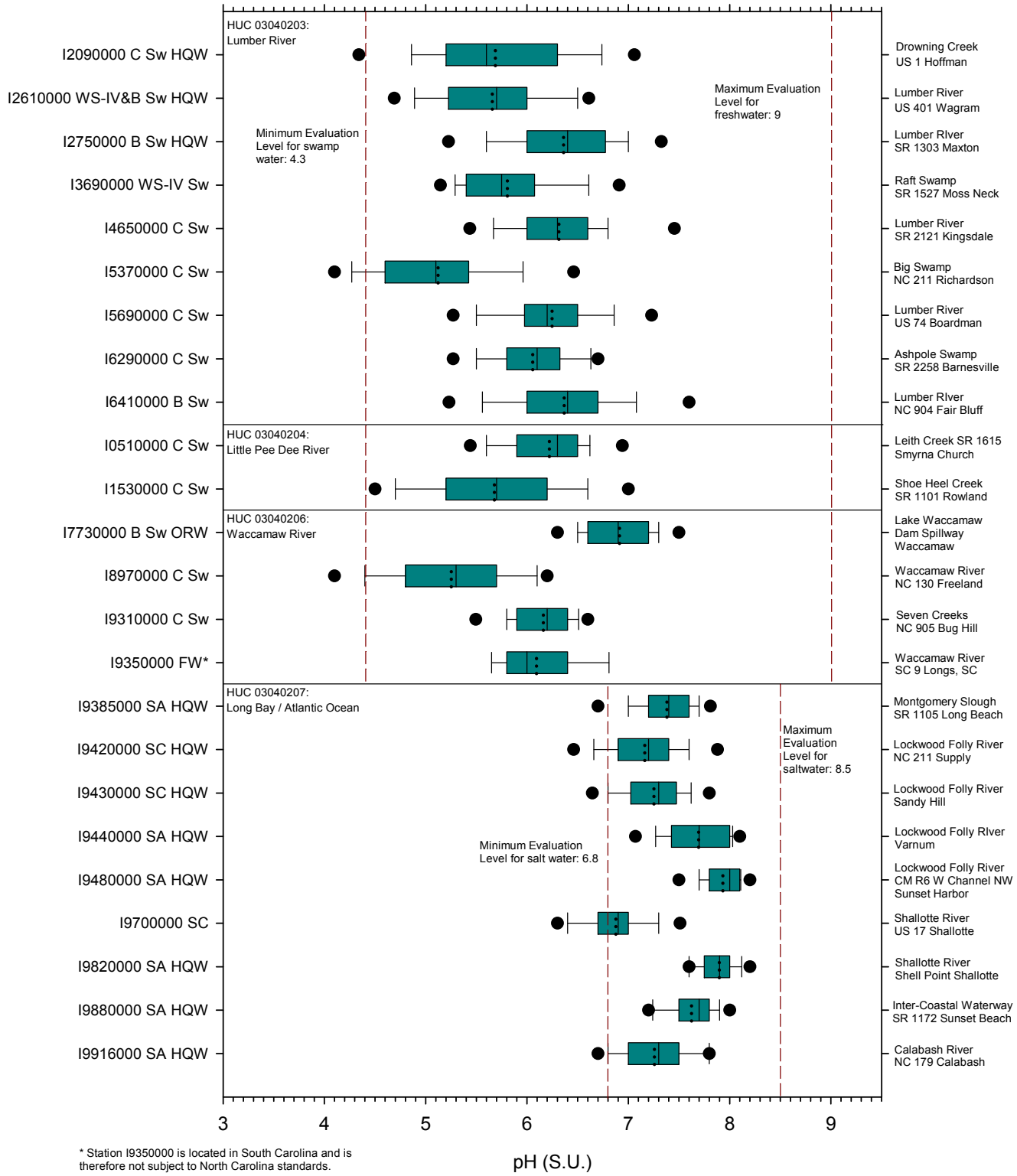
* Station I9350000 is located in South Carolina and is therefore not subject to North Carolina standards.

Figure 9. Box Plots of Water Temperature in the Lumber River Basin



* Station I9350000 is located in South Carolina and is therefore not subject to North Carolina standards.

Figure 10. Box Plots of Dissolved Oxygen in the Lumber River Basin



* Station I9350000 is located in South Carolina and is therefore not subject to North Carolina standards.

Figure 11. Box Plots of pH in the Lumber River Basin

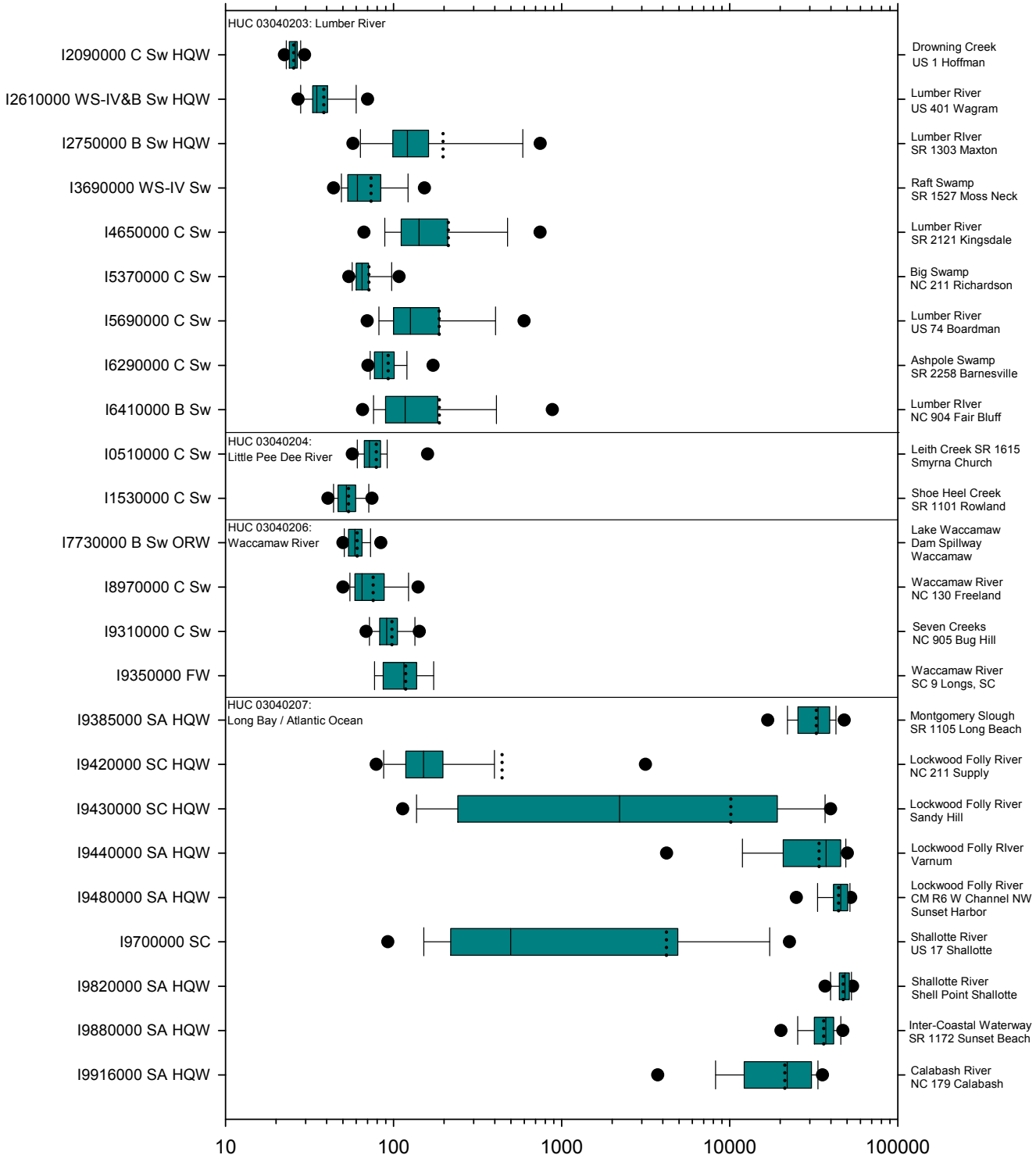
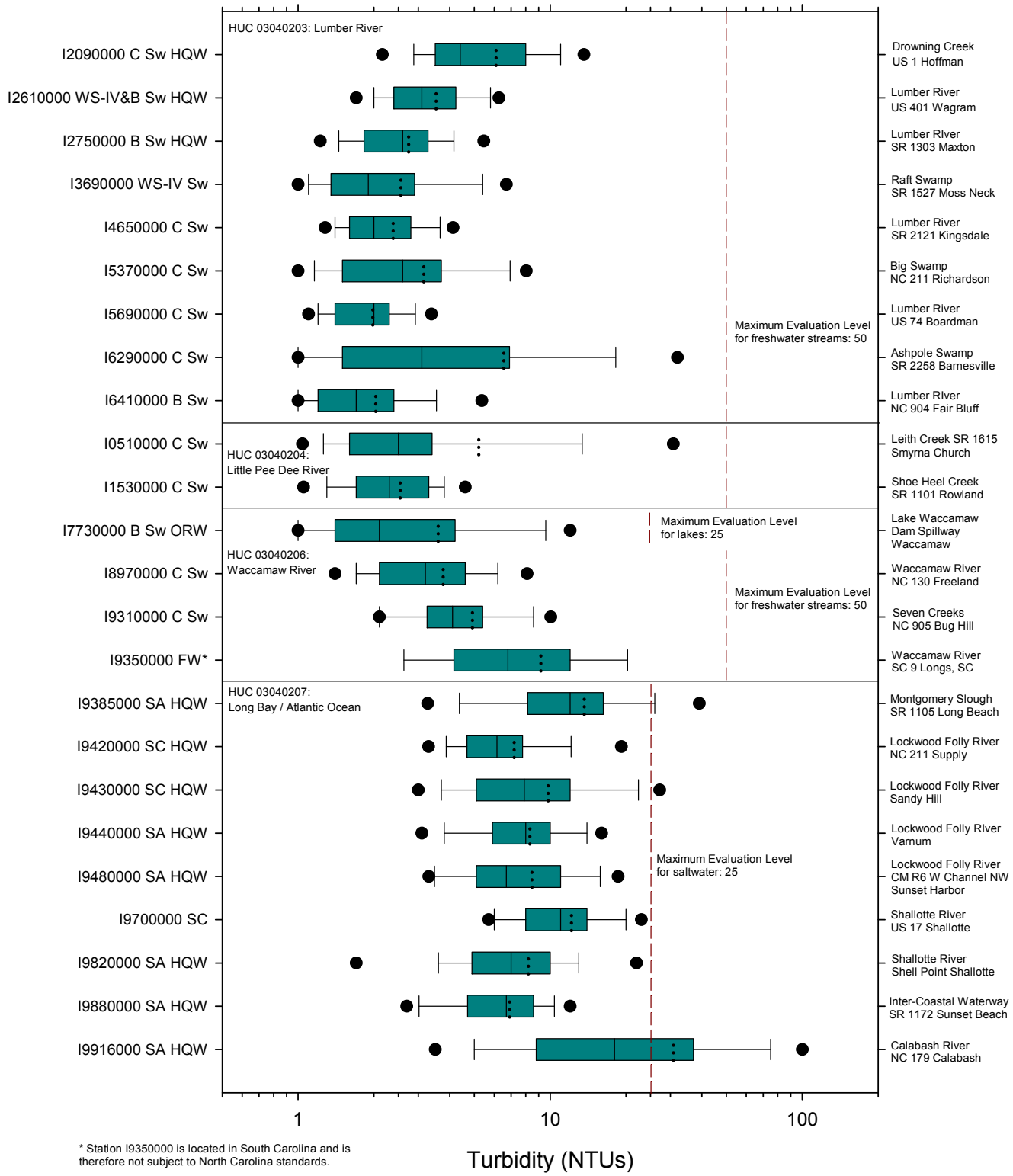


Figure 12. Box Plots of Specific Conductance in the Lumber River Basin



* Station I9350000 is located in South Carolina and is therefore not subject to North Carolina standards.

Figure 13. Box Plots of Turbidity in the Lumber River Basin

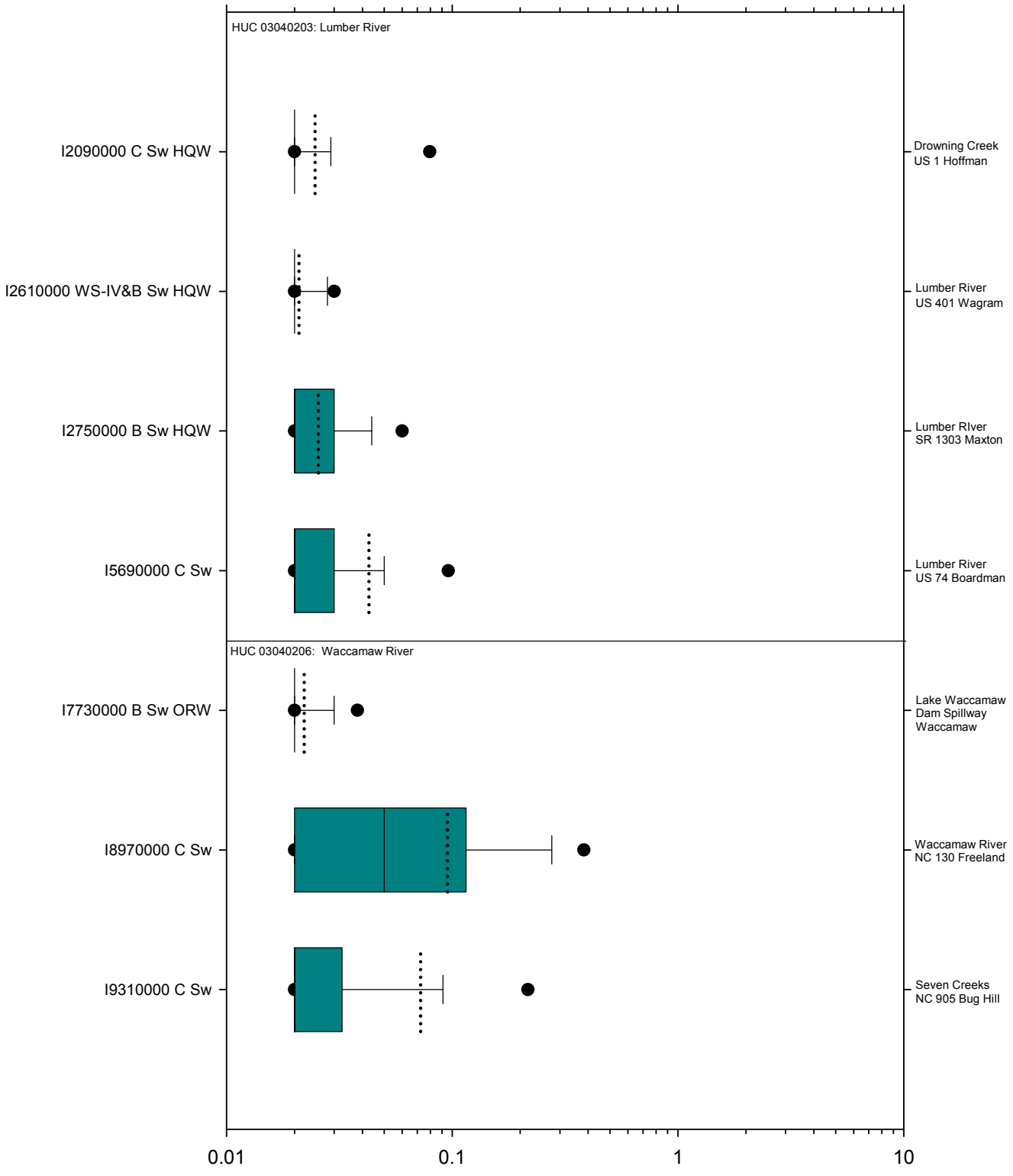


Figure 14. Box Plots of Ammonia as Nitrogen in the Lumber River Basin

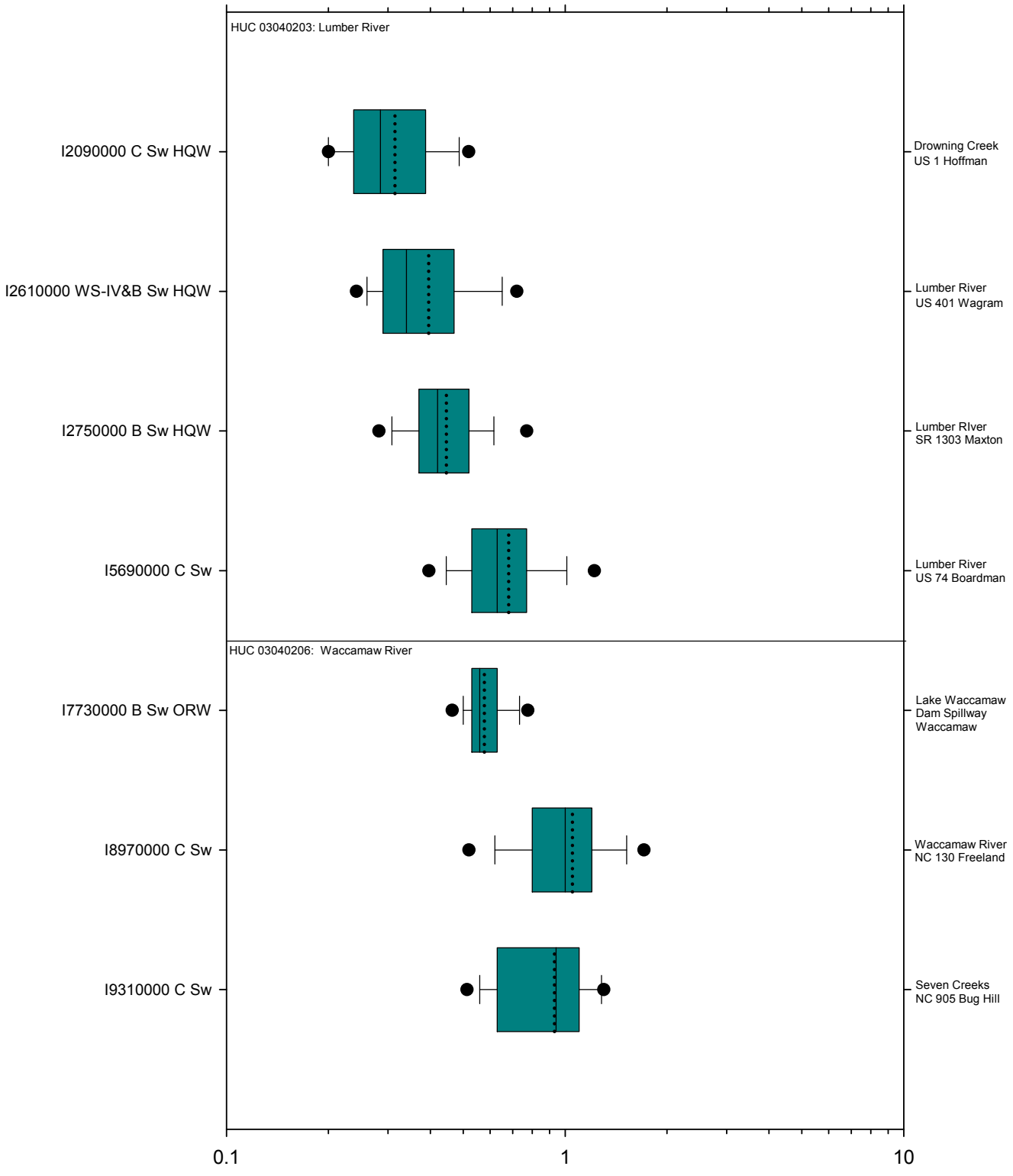


Figure 15. Box Plots of Total Kjeldahl Nitrogen as Nitrogen in the Lumber River Basin

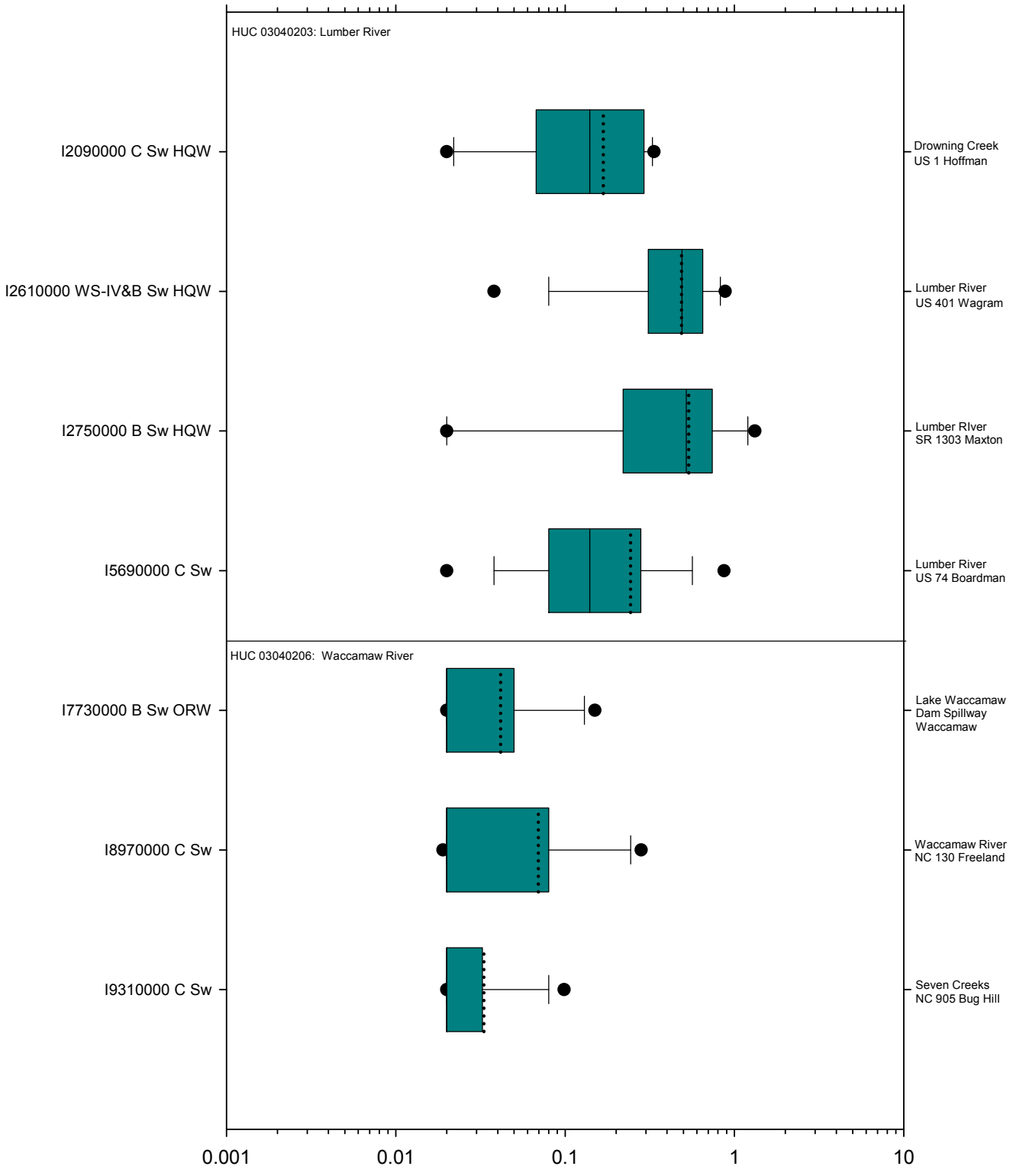


Figure 16. Box Plots of Total Nitrate and Nitrite as Nitrogen in the Lumber River Basin

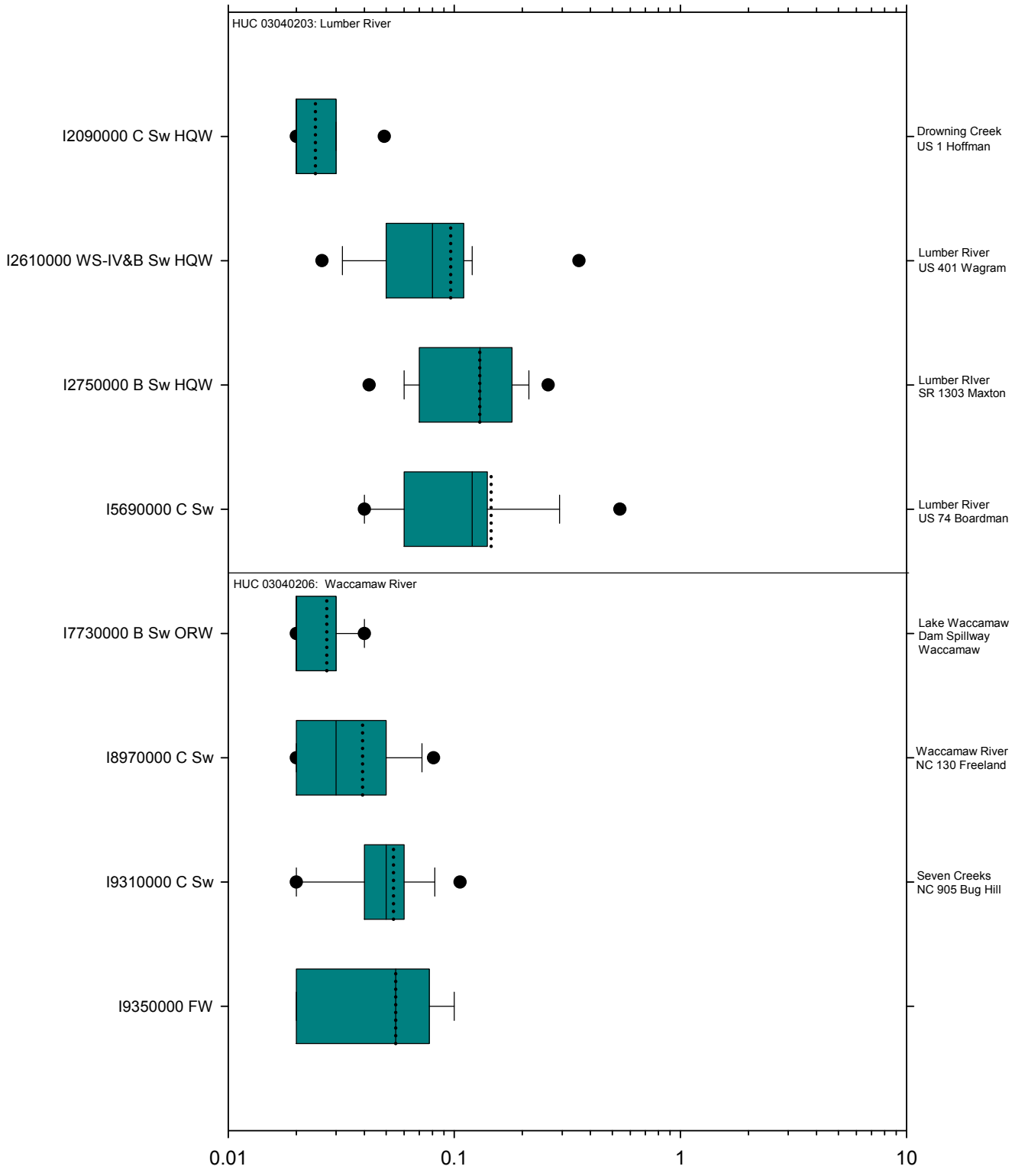
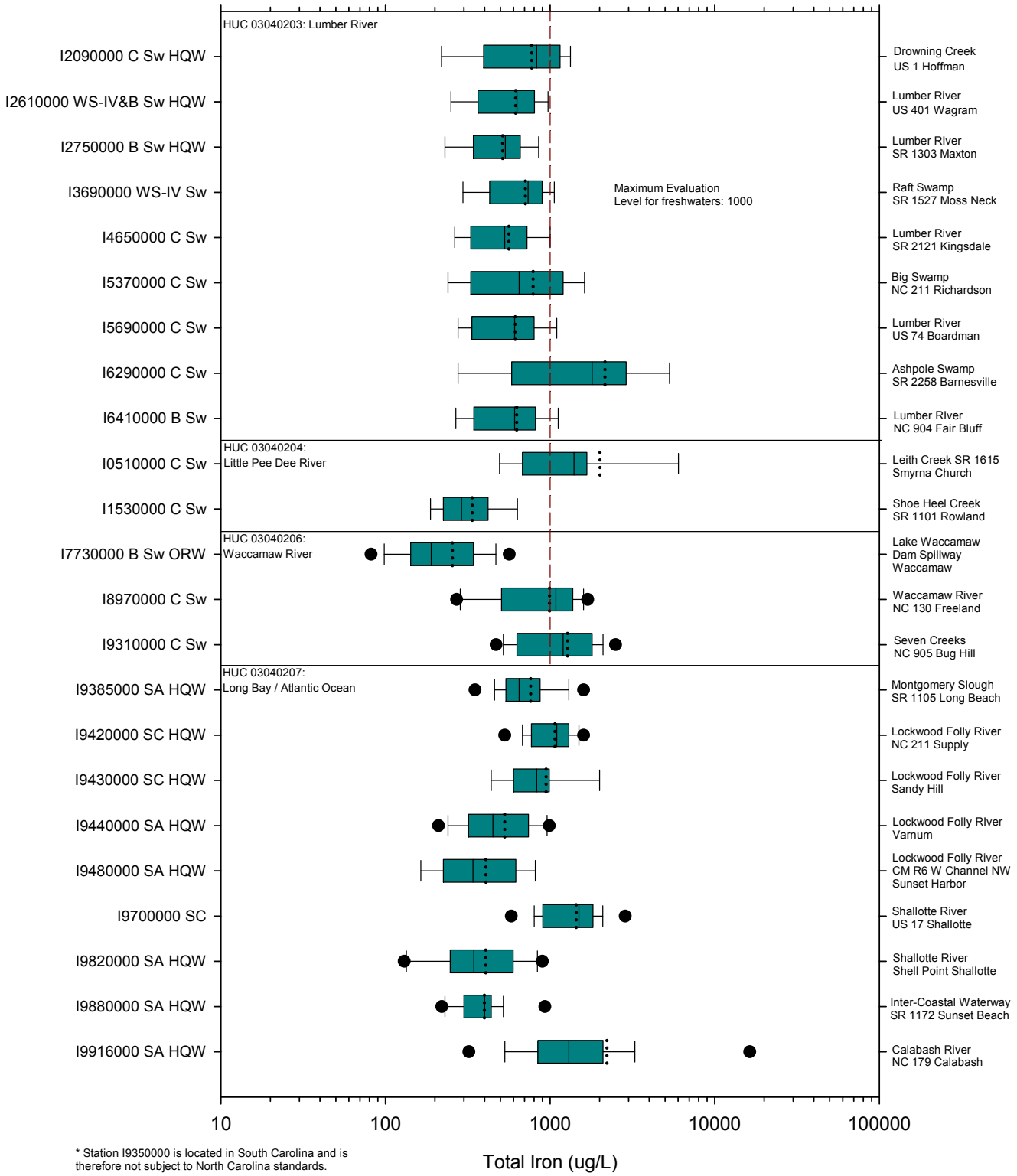
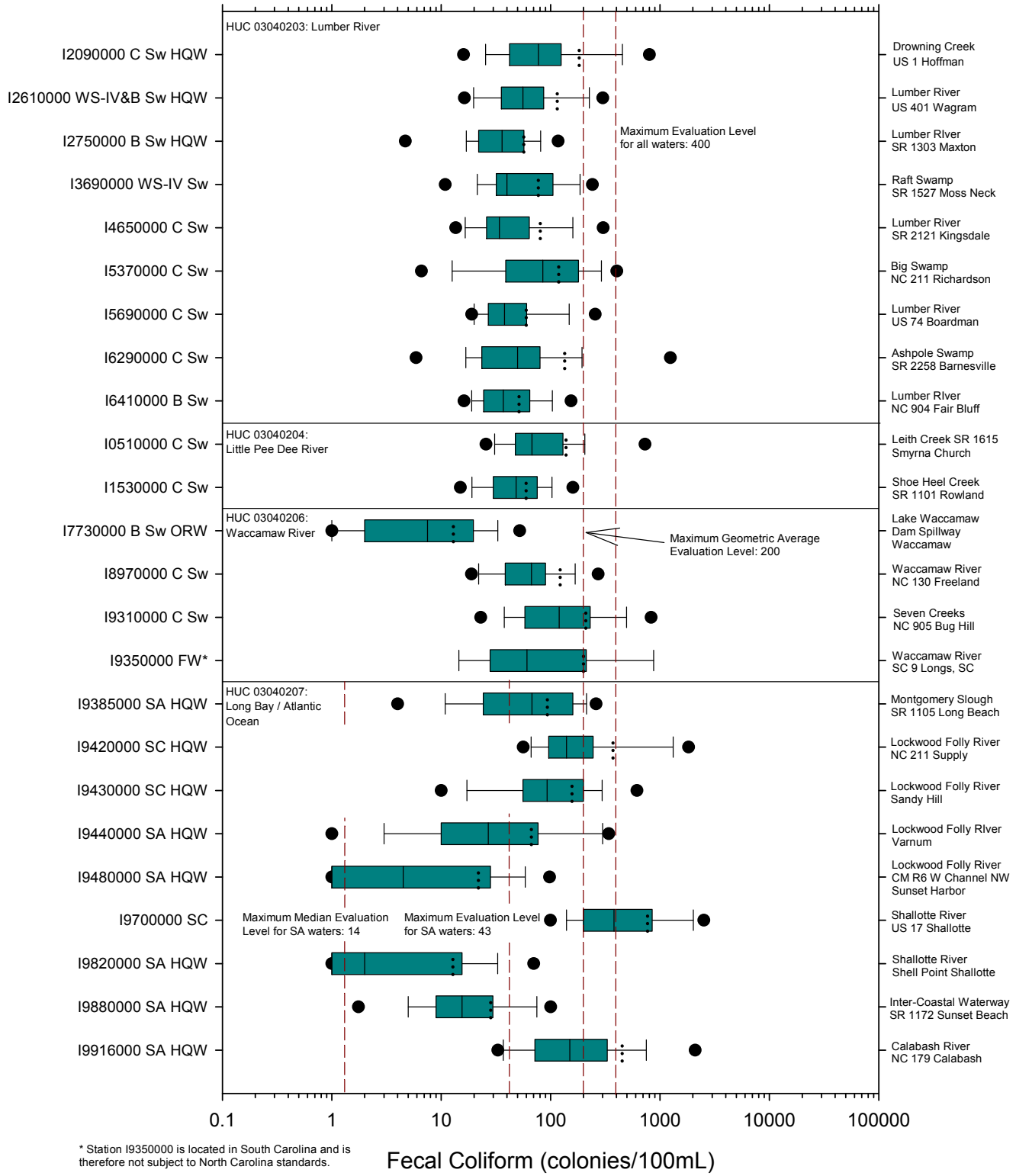


Figure 17. Box Plots of Total Phosphorus in the Lumber River Basin



* Station I9350000 is located in South Carolina and is therefore not subject to North Carolina standards.

Figure 18. Box Plots of Total Iron in the Lumber River Basin



* Station I9350000 is located in South Carolina and is therefore not subject to North Carolina standards.

Figure 19. Box Plots of Fecal Coliform in the Lumber River Basin

Appendix A: Station Summary Sheets

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LEITH CRK AT SR 1615 NR SMYRNA CHURCH
Station #: I0510000 **Hydrologic Unit Code:** 3040204
Latitude: 34.65965 **Longitude:** -79.45012 **Stream class:** C Sw
Agency: NCAMBNT **NC stream index:** 14-33

Time period: 01/09/2002 to 12/19/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	48	0	N/A				0.2	2	4	5.8	8.9	10.6	11.7
pH (SU)	47	0	<4.3	0	0		5.1	5.6	5.9	6.3	6.5	6.6	7.2
	47	0	>9	0	0		5.1	5.6	5.9	6.3	6.5	6.6	7.2
Spec. conductance (umhos/cm at 25°C)	48	0	N/A				54	61	67	72	84	92	179
Water Temperature (°C)	48	0	>32	0	0		2.6	6.6	11.5	15.6	22.9	25.1	26.6
Other													
TSS (mg/L)	16	7	N/A				2.5	2.5	2.5	2.6	3.2	12.1	31
Turbidity (NTU)	47	2	>50	0	0		1	1.3	1.6	2.5	3.4	13.4	50
Metals (ug/L)													
Aluminum, total (Al)	16	0	N/A				60	67	80	130	148	281	330
Arsenic, total (As)	16	16	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	16	16	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	16	16	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	16	12	>7	0	0		2	2	2	2	2	3	4
Iron, total (Fe)	16	0	>1000	9	56.2	100	340	494	680	1400	1675	6020	14000
Lead, total (Pb)	16	16	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	16	16	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	16	16	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	16	16	>50	0	0		10	10	10	10	10	10	10

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
46	80	3	7	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: SHOE HEEL CRK AT SR 1101 NR ROWLAND
Station #: I1530000 **Hydrologic Unit Code:** 3040204
Latitude: 34.58681 **Longitude:** -79.37192 **Stream class:** C Sw
Agency: NCAMBNT **NC stream index:** 14-34

Time period: 01/10/2002 to 12/14/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	50	0	N/A				3.9	4.6	5	7.2	8.8	11	13.7
pH (SU)	49	0	<4.3	1	2		4.1	4.7	5.2	5.7	6.2	6.6	7.1
	49	0	>9	0	0		4.1	4.7	5.2	5.7	6.2	6.6	7.1
Spec. conductance (umhos/cm at 25°C)	50	0	N/A				36	44	47	52	60	71	86
Water Temperature (°C)	50	0	>32	0	0		3.6	7.4	10.1	15.8	22.3	24.7	26.5
Other													
TSS (mg/L)	17	10	N/A				2.5	2.5	2.5	3	5	6	10
Turbidity (NTU)	49	1	>50	0	0		1	1.3	1.7	2.3	3.3	3.8	7.3
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				160	168	200	300	360	510	590
Arsenic, total (As)	17	17	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	17	17	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	17	17	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	17	14	>7	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	17	0	>1000	0	0		140	188	225	290	420	634	690
Lead, total (Pb)	17	17	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	17	17	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	17	17	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	17	14	>50	0	0		10	10	10	10	10	13	16

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
46	48	0	0	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: DROWNING CRK AT US 1 NR HOFFMAN
Station #: I2090000 **Hydrologic Unit Code:** 3040203
Latitude: 35.06100 **Longitude:** -79.49389 **Stream class:** C Sw HQW
Agency: NCAMBNT **NC stream index:** 14-2-(10.5)

Time period: 01/09/2002 to 12/19/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	48	0	N/A				4.1	6	6.7	8.5	10.1	10.9	13.1
pH (SU)	47	0	<4.3	1	2.1		4.1	4.9	5.2	5.6	6.3	6.7	7.1
	47	0	>9	0	0		4.1	4.9	5.2	5.6	6.3	6.7	7.1
Spec. conductance (umhos/cm at 25°C)	48	0	N/A				21	23	24	26	27	28	31
Water Temperature (°C)	48	0	>32	0	0		2.8	5.4	9	13.4	20.3	22.8	24.7
Other													
TSS (mg/L)	16	7	N/A				2.5	2.5	2.5	3.9	5	7.3	8
Turbidity (NTU)	47	0	>50	0	0		1.7	2.9	3.5	4.4	8	11	23
Nutrients (mg/L)													
NH3 as N	30	24	N/A				0.02	0.02	0.02	0.02	0.02	0.03	0.14
NO2 + NO3 as N	30	0	N/A				0.02	0.02	0.07	0.14	0.29	0.33	0.34
TKN as N	30	4	N/A				0.2	0.2	0.24	0.29	0.39	0.49	0.53
Total Phosphorus	30	6	N/A				0.02	0.02	0.02	0.02	0.03	0.03	0.06
Metals (ug/L)													
Aluminum, total (Al)	16	0	N/A				160	160	195	285	358	463	470
Arsenic, total (As)	16	16	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	16	16	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	16	16	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	16	14	>7	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	16	0	>1000	4	25	98.3	100	219	395	830	1150	1330	1400
Lead, total (Pb)	16	16	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	16	16	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	16	16	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	16	16	>50	0	0		10	10	10	10	10	10	10

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
44	84	4	9	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LUMBER RIV AT US 401 NR WAGRAM
Station #: I2610000 **Hydrologic Unit Code:** 3040203
Latitude: 34.90025 **Longitude:** -79.34900 **Stream class:** WS-IV&B Sw HQW
Agency: NCAMBNT **NC stream index:** 14-(3)

Time period: 01/09/2002 to 12/19/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Percentiles Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	49	0	N/A				4.9	5.7	6.5	8.3	9.9	10.5	12.8
pH (SU)	48	0	<4.3	1	2.1		3.6	4.9	5.2	5.7	6	6.5	6.9
	48	0	>9	0	0		3.6	4.9	5.2	5.7	6	6.5	6.9
Spec. conductance (umhos/cm at 25°C)	49	0	N/A				26	28	33	35	40	60	74
Water Temperature (°C)	49	0	>32	0	0		3.8	5.8	9.8	14.6	21.1	23.3	24.5
Other													
TSS (mg/L)	16	4	N/A				2.5	2.5	2.5	3.4	4	5.3	6
Turbidity (NTU)	48	0	>50	0	0		1.7	2	2.4	3.1	4.2	5.8	11
Nutrients (mg/L)													
NH3 as N	31	26	N/A				0.02	0.02	0.02	0.02	0.02	0.03	0.03
NO2 + NO3 as N	31	0	>10	0	0		0.02	0.08	0.31	0.49	0.65	0.83	0.9
TKN as N	31	0	N/A				0.23	0.26	0.29	0.34	0.47	0.65	0.72
Total Phosphorus	31	0	N/A				0.02	0.03	0.05	0.08	0.11	0.12	0.68
Metals (ug/L)													
Aluminum, total (Al)	16	0	N/A				140	147	195	240	288	370	440
Arsenic, total (As)	16	16	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	16	16	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	16	16	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	16	12	>7	0	0		2	2	2	2	2	3	3
Iron, total (Fe)	16	0	>1000	0	0		180	250	365	630	805	972	1000
Lead, total (Pb)	16	16	>25	0	0		10	10	10	10	10	10	10
Manganese, total (Mn)	16	2	>200	0	0		10	10	10	13	18	24	27
Mercury, total (Hg)	16	16	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	16	16	>25	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	16	0	>50	1	6.2		10	12	14	22	38	46	54

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
45	61	1	2	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LUMBER RIV AT SR 1303 NR MAXTON
Station #: I2750000 **Hydrologic Unit Code:** 3040203
Latitude: 34.74704 **Longitude:** -79.32455 **Stream class:** B Sw HQW
Agency: NCAMBNT **NC stream index:** 14-(4.5)

Time period: 01/09/2002 to 12/19/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	45	0	N/A				4.3	5.7	6.5	7.8	9.5	10.1	13
pH (SU)	44	0	<4.3	0	0		4.5	5.6	6	6.4	6.8	7	7.4
	44	0	>9	0	0		4.5	5.6	6	6.4	6.8	7	7.4
Spec. conductance (umhos/cm at 25°C)	45	0	N/A				39	64	99	121	162	588	1371
Water Temperature (°C)	45	0	>32	0	0		3.8	6.8	10.4	15.5	22.4	25	27.6
Other													
TSS (mg/L)	16	11	N/A				2.5	2.5	2.5	3.2	5	5.3	6
Turbidity (NTU)	44	0	>50	0	0		1.2	1.4	1.8	2.6	3.3	4.2	6.2
Nutrients (mg/L)													
NH3 as N	27	15	N/A				0.02	0.02	0.02	0.02	0.03	0.04	0.06
NO2 + NO3 as N	27	3	N/A				0.02	0.02	0.22	0.52	0.74	1.2	1.4
TKN as N	27	0	N/A				0.27	0.31	0.37	0.42	0.52	0.62	0.83
Total Phosphorus	27	0	N/A				0.03	0.06	0.07	0.13	0.18	0.21	0.28
Metals (ug/L)													
Aluminum, total (Al)	16	0	N/A				110	131	168	225	270	438	480
Arsenic, total (As)	16	16	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	16	16	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	16	16	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	16	7	>7	0	0		2	2	2	2	3	4	4
Iron, total (Fe)	16	0	>1000	0	0		160	230	342	535	660	853	860
Lead, total (Pb)	16	16	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	16	16	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	16	16	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	16	1	>50	0	0		10	11	16	21	30	44	45

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
41	34	1	2	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: RAFT SWAMP AT SR 1527 NR MOSS NECK
Station #: I3690000 **Hydrologic Unit Code:** 3040203
Latitude: 34.66158 **Longitude:** -79.06576 **Stream class:** WS-IV Sw
Agency: NCAMBNT **NC stream index:** 14-10-(5.5)

Time period: 01/10/2002 to 12/14/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	49	0	N/A				0.6	3.5	5.2	6.8	9	11.3	14.2
pH (SU)	48	0	<4.3	0	0		5	5.3	5.4	5.8	6.1	6.6	7
	48	0	>9	0	0		5	5.3	5.4	5.8	6.1	6.6	7
Spec. conductance (umhos/cm at 25°C)	49	0	N/A				42	49	54	61	84	122	196
Water Temperature (°C)	49	0	>32	0	0		2	6	9.8	15.6	21.9	24.8	27
Other													
TSS (mg/L)	16	11	N/A				2.5	2.5	2.5	2.5	5	9.9	10
Turbidity (NTU)	49	2	>50	0	0		1	1.1	1.4	1.9	2.9	5.4	12
Metals (ug/L)													
Aluminum, total (Al)	16	0	N/A				120	141	180	275	325	409	430
Arsenic, total (As)	16	16	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	16	16	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	16	16	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	16	16	>7	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	16	0	>1000	1	6.2		240	296	430	735	895	1062	1300
Lead, total (Pb)	16	16	>25	0	0		10	10	10	10	10	10	10
Manganese, total (Mn)	9	1	>200	0	0		10	10	12	19	26	31	31
Mercury, total (Hg)	16	16	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	16	16	>25	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	16	14	>50	0	0		10	10	10	10	10	14	16

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
45	51	1	2	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LUMBER RIV AT SR 2121 NR KINGSDALE
Station #: I4650000 **Hydrologic Unit Code:** 3040203
Latitude: 34.50397 **Longitude:** -78.94441 **Stream class:** C Sw
Agency: NCAMBNT **NC stream index:** 14-(13)

Time period: 01/17/2002 to 12/11/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	47	0	N/A				3.1	3.5	4.5	6.3	8.4	10.1	12.6
pH (SU)	46	0	<4.3	0	0		5.3	5.7	6	6.3	6.6	6.8	8.1
	46	0	>9	0	0		5.3	5.7	6	6.3	6.6	6.8	8.1
Spec. conductance (umhos/cm at 25°C)	47	0	N/A				57	89	111	142	210	477	1157
Water Temperature (°C)	47	0	>32	0	0		4.7	6.5	11	17.5	22.8	26.6	29
Other													
TSS (mg/L)	17	15	N/A				2.5	2.5	2.5	2.5	2.5	2.6	2.8
Turbidity (NTU)	47	0	>50	0	0		1.2	1.4	1.6	2	2.8	3.7	9.6
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				130	130	175	190	255	368	400
Arsenic, total (As)	17	17	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	17	17	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	17	17	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	17	7	>7	1	5.9		2	2	2	2	3	5	10
Iron, total (Fe)	17	0	>1000	0	0		240	264	330	530	725	1000	1000
Lead, total (Pb)	17	17	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	17	17	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	17	17	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	17	4	>50	0	0		10	10	10	14	15	19	26

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
45	45	1	2	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: BIG SWAMP AT NC 211 NR RICHARDSON
Station #: I5370000 **Hydrologic Unit Code:** 3040203
Latitude: 34.57487 **Longitude:** -78.85717 **Stream class:** C Sw
Agency: NCAMBNT **NC stream index:** 14-22

Time period: 01/17/2002 to 12/11/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	47	0	N/A				1.9	3.2	4.1	5.4	7.9	9.3	11
pH (SU)	46	0	<4.3	4	8.7		3.8	4.3	4.6	5.1	5.4	6	7.5
	46	0	>9	0	0		3.8	4.3	4.6	5.1	5.4	6	7.5
Spec. conductance (umhos/cm at 25°C)	47	0	N/A				52	57	60	65	71	98	170
Water Temperature (°C)	47	0	>32	0	0		5.4	8.3	12.3	18.7	23.4	27.3	31.8
Other													
TSS (mg/L)	17	7	N/A				2.5	2.5	2.5	3	5.5	10	10
Turbidity (NTU)	47	2	>50	0	0		1	1.2	1.5	2.6	3.7	6.9	8.5
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				230	302	395	450	550	702	750
Arsenic, total (As)	17	17	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	17	17	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	17	17	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	17	16	>7	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	17	0	>1000	6	35.3	99.9	240	240	330	650	1200	1620	1700
Lead, total (Pb)	17	17	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	17	17	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	17	17	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	17	15	>50	0	0		10	10	10	10	10	15	19

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
45	71	2	4	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LUMBER RIV AT US 74 AT BOARDMAN
Station #: I5690000 **Hydrologic Unit Code:** 3040203
Latitude: 34.44295 **Longitude:** -78.95959 **Stream class:** C Sw
Agency: NCAMBNT **NC stream index:** 14-(13)

Time period: 01/17/2002 to 12/11/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Percentiles Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	47	0	N/A				2.5	3.6	4.2	5.4	7.8	9.1	13.4
pH (SU)	46	0	<4.3	0	0		5.2	5.5	6	6.2	6.5	6.9	8.6
	46	0	>9	0	0		5.2	5.5	6	6.2	6.5	6.9	8.6
Spec. conductance (umhos/cm at 25°C)	47	0	N/A				57	82	100	126	187	405	1214
Water Temperature (°C)	47	0	>32	0	0		4.9	6.7	11.1	17.9	23.3	26.6	29.3
Other													
TSS (mg/L)	17	13	N/A				2.5	2.5	2.5	2.5	3.1	5	5.2
Turbidity (NTU)	47	1	>50	0	0		1	1.2	1.4	2	2.3	2.9	3.7
Nutrients (mg/L)													
NH3 as N	47	20	N/A				0.02	0.02	0.02	0.02	0.03	0.05	0.7
NO2 + NO3 as N	47	2	N/A				0.02	0.04	0.08	0.14	0.28	0.56	1.5
TKN as N	47	0	N/A				0.37	0.45	0.53	0.63	0.77	1.01	1.3
Total Phosphorus	47	0	N/A				0.02	0.04	0.06	0.12	0.14	0.29	0.87
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				170	170	205	270	345	472	480
Arsenic, total (As)	17	17	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	17	17	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	17	17	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	17	8	>7	1	5.9		2	2	2	2	3	5	9
Iron, total (Fe)	17	0	>1000	2	11.8	76.2	260	276	335	610	800	1100	1100
Lead, total (Pb)	17	17	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	17	17	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	17	17	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	17	4	>50	0	0		10	10	10	12	16	25	27

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
45	44	0	0	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: ASHPOLE SWAMP AT SR 2258 NR BARNESVILLE
Station #: I6290000 **Hydrologic Unit Code:** 3040203
Latitude: 34.38393 **Longitude:** -79.10166 **Stream class:** C Sw
Agency: NCAMBNT **NC stream index:** 14-30

Time period: 01/17/2002 to 12/11/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	47	0	N/A				0	0.5	1.3	3.5	5.3	7.6	9.5
pH (SU)	46	0	<4.3	0	0		5.1	5.5	5.8	6.1	6.3	6.6	6.7
	46	0	>9	0	0		5.1	5.5	5.8	6.1	6.3	6.6	6.7
Spec. conductance (umhos/cm at 25°C)	47	0	N/A				65	73	77	86	101	120	177
Water Temperature (°C)	47	0	>32	1	2.1		5.3	7.4	12.1	16.9	21.4	25.2	32.1
Other													
TSS (mg/L)	17	6	N/A				2.5	2.5	2.5	3	6.4	10.4	16
Turbidity (NTU)	47	8	>50	1	2.1		1	1	1.5	3.1	6.9	18.2	55
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				65	69	84	120	155	296	320
Arsenic, total (As)	17	17	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	17	17	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	17	17	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	17	16	>7	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	17	0	>1000	11	64.7	100	220	276	585	1800	2900	5320	6200
Lead, total (Pb)	17	17	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	17	17	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	17	17	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	17	14	>50	1	5.9		10	10	10	10	10	21	63

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
45	51	3	7	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
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%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LUMBER RIV AT NC 904 AT FAIR BLUFF
Station #: I6410000 **Hydrologic Unit Code:** 3040203
Latitude: 34.31342 **Longitude:** -79.03801 **Stream class:** B Sw
Agency: NCAMBNT **NC stream index:** 14-(28)

Time period: 01/17/2002 to 12/11/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	46	0	N/A				3	4.2	5.4	6.5	8.7	10.7	12.6
pH (SU)	45	0	<4.3	0	0		5.1	5.6	6	6.4	6.7	7.1	8.6
	45	0	>9	0	0		5.1	5.6	6	6.4	6.7	7.1	8.6
Spec. conductance (umhos/cm at 25°C)	46	0	N/A				64	76	90	118	184	410	993
Water Temperature (°C)	46	0	>32	0	0		5	7	11.1	18.6	23.7	27.4	31.6
Other													
TSS (mg/L)	17	13	N/A				2.5	2.5	2.5	2.5	4.6	6.4	8
Turbidity (NTU)	47	4	>50	0	0		1	1	1.2	1.7	2.4	3.5	6.6
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				150	166	205	260	345	438	510
Arsenic, total (As)	17	17	>10	0	0		5	5	5	5	10	10	10
Cadmium, total (Cd)	17	17	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	17	17	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	17	10	>7	1	5.9		2	2	2	2	3	4	8
Iron, total (Fe)	17	0	>1000	2	11.8	76.2	260	268	345	610	815	1120	1200
Lead, total (Pb)	17	17	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	17	17	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	17	17	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	17	9	>50	0	0		10	10	10	10	14	18	21

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
45	41	0	0	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LAKE WACCAMAW AT DAM SPILLWAY NR LAKE WACCAMAW
Station #: I7730000 **Hydrologic Unit Code:** 3040206
Latitude: 34.26107 **Longitude:** -78.52321 **Stream class:** B Sw ORW
Agency: NCAMBNT **NC stream index:** 15-2

Time period: 01/07/2002 to 12/27/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	59	0	N/A				5.5	6.9	7.4	8.4	10.5	11.9	13.6
pH (SU)	59	0	<4.3	0	0		6	6.5	6.6	6.9	7.2	7.3	8.2
	59	0	>9	0	0		6	6.5	6.6	6.9	7.2	7.3	8.2
Salinity (ppt)	59	3	N/A				0	0	0	0	0.01	0.02	0.2
Spec. conductance (umhos/cm at 25°C)	59	0	N/A				47	51	54	59	65	73	104
Water Temperature (°C)	59	0	>32	0	0		4.5	6.4	11.7	21	26.8	29.1	30.7
Other													
TSS (mg/L)	19	3	N/A				2.5	2.5	2.5	3.8	4	10	14
Turbidity (NTU)	59	5	>25	0	0		1	1	1.4	2.1	4.2	9.6	14
Nutrients (mg/L)													
NH3 as N	43	37	N/A				0.02	0.02	0.02	0.02	0.02	0.03	0.06
NO2 + NO3 as N	43	20	N/A				0.02	0.02	0.02	0.02	0.05	0.13	0.16
TKN as N	43	1	N/A				0.2	0.5	0.53	0.56	0.63	0.73	0.78
Total Phosphorus	48	3	N/A				0.02	0.02	0.02	0.02	0.03	0.04	0.1
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				68	70	84	130	202	390	430
Arsenic, total (As)	20	20	>10	0	0		5	5	5	10	10	10	10
Cadmium, total (Cd)	20	20	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	19	19	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	18	>7	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	20	0	>1000	0	0		81	98	142	190	342	469	570
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	20	20	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	19	>88	0	0		10	10	10	10	10	10	16
Zinc, total (Zn)	20	18	>50	0	0		10	10	10	10	10	18	40

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
56	7	0	0	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: WACCAMAW RIV AT NC 130 AT FREELAND
Station #: I8970000 **Hydrologic Unit Code:** 3040206
Latitude: 34.09518 **Longitude:** -78.54778 **Stream class:** C Sw
Agency: NCAMBNT **NC stream index:** 15-(1)

Time period: 01/07/2002 to 12/27/2006

	# result	# ND	EL	Results not meeting EL #	%	%Conf	Min	Percentiles 10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	59	0	N/A				2.5	3.9	4.5	5.6	7.8	9.7	11.5
pH (SU)	59	0	<4.3	4	6.8		3.9	4.4	4.8	5.3	5.7	6.1	6.4
	59	0	>9	0	0		3.9	4.4	4.8	5.3	5.7	6.1	6.4
Salinity (ppt)	59	3	N/A				0	0	0	0	0.02	0.03	0.2
Spec. conductance (umhos/cm at 25°C)	59	0	N/A				37	55	59	65	88	123	154
Water Temperature (°C)	59	0	>32	0	0		1.8	6	12	19.7	24.7	27.2	28.6
Other													
TSS (mg/L)	19	9	N/A				2.5	2.5	2.5	4	5	6	11
Turbidity (NTU)	59	0	>50	0	0		1.1	1.7	2.1	3.2	4.6	6.2	19
Nutrients (mg/L)													
NH3 as N	57	13	N/A				0.02	0.02	0.02	0.05	0.12	0.28	0.62
NO2 + NO3 as N	57	28	N/A				0.01	0.02	0.02	0.02	0.08	0.24	0.51
TKN as N	57	0	N/A				0.51	0.62	0.8	1	1.2	1.52	2.1
Total Phosphorus	57	3	N/A				0.02	0.02	0.02	0.03	0.05	0.07	0.1
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				340	385	488	625	750	869	1100
Arsenic, total (As)	20	20	>10	0	0		5	5	5	10	10	10	10
Cadmium, total (Cd)	20	20	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	19	19	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	18	>7	1	5		2	2	2	2	2	2	11
Iron, total (Fe)	20	0	>1000	10	50	100	270	285	508	1085	1375	1600	1700
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	20	20	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	20	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	20	17	>50	0	0		10	10	10	10	10	12	12

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
57	67	1	2	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: SEVEN CRKS AT NC 905 NR BUG HILL
Station #: I9310000 **Hydrologic Unit Code:** 3040206
Latitude: 34.04926 **Longitude:** -78.63496 **Stream class:** C Sw
Agency: NCAMBNT **NC stream index:** 15-17

Time period: 01/07/2002 to 12/27/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	58	0	N/A				1.5	3.3	4.3	5.4	8	9.6	11.9
pH (SU)	58	0	<4.3	0	0		5.4	5.8	5.9	6.2	6.4	6.5	6.8
	58	0	>9	0	0		5.4	5.8	5.9	6.2	6.4	6.5	6.8
Salinity (ppt)	58	3	N/A				0	0	0	0	0.03	0.1	0.2
Spec. conductance (umhos/cm at 25°C)	58	0	N/A				56	72	83	91	106	134	257
Water Temperature (°C)	58	0	>32	0	0		1.8	5.9	10.9	18.3	23.1	25.5	26.6
Other													
TSS (mg/L)	18	10	N/A				2.5	2.5	2.5	2.8	5	5.3	6.2
Turbidity (NTU)	58	0	>50	0	0		1.4	2.1	3.2	4.1	5.4	8.6	25
Nutrients (mg/L)													
NH3 as N	42	24	N/A				0.02	0.02	0.02	0.02	0.03	0.09	1.6
NO2 + NO3 as N	42	26	N/A				0.02	0.02	0.02	0.02	0.03	0.08	0.13
TKN as N	41	0	N/A				0.46	0.56	0.63	0.94	1.1	1.28	2.8
Total Phosphorus	47	1	N/A				0.02	0.02	0.04	0.05	0.06	0.08	0.15
Metals (ug/L)													
Aluminum, total (Al)	19	0	N/A				180	180	230	280	380	440	680
Arsenic, total (As)	19	19	>10	0	0		5	5	5	10	10	10	10
Cadmium, total (Cd)	19	19	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	18	18	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	19	16	>7	0	0		2	2	2	2	2	3	7
Iron, total (Fe)	19	0	>1000	11	57.9	100	470	520	630	1200	1800	2100	2500
Lead, total (Pb)	19	19	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	19	19	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	19	19	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	19	14	>50	0	0		10	10	10	10	11	14	20

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
56	123	6	11	

Key:
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%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: WACCAMAW RIV AT SC 9 NR LONGS SC
Station #: I9350000 **Hydrologic Unit Code:** 3040206
Latitude: 33.91194 **Longitude:** -78.71467 **Stream class:** FW
Agency: NCAMBNT **NC stream index:** N/A

Time period: 01/07/2002 to 09/10/2003

	# result	# ND	EL	Results not meeting EL #	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	18	0	N/A				2.6	3.1	3.7	4.9	8.5	9.9	10.8
pH (SU)	18	0	N/A				5.2	5.6	5.8	6	6.4	6.8	6.9
Salinity (ppt)	18	2	N/A				0	0	0	0	0.1	0.2	0.2
Spec. conductance (umhos/cm at 25°C)	18	0	N/A				60	77	87	116	138	174	223
Water Temperature (°C)	18	0	N/A				6.4	6.6	10	23.1	25.4	26.3	28.1
Other													
TSS (mg/L)	6	1	N/A				2.5	2.5	2.5	4.5	7.5	9	9
Turbidity (NTU)	18	0	N/A				2	2.6	4.2	6.8	12	20.3	32
Nutrients (mg/L)													
NH3 as N	6	2	N/A				0.02	0.02	0.02	0.06	0.21	0.26	0.26
NO2 + NO3 as N	6	0	N/A				0.02	0.02	0.1	0.13	0.21	0.28	0.28
TKN as N	4	0	N/A				0.96	0.96	1	1.25	1.62	1.7	1.7
Total Phosphorus	10	0	N/A				0.02	0.02	0.02	0.06	0.08	0.1	0.1
Metals (ug/L)													
Aluminum, total (Al)	6	0	N/A				490	490	580	650	708	790	790
Arsenic, total (As)	6	6	N/A				10	10	10	10	10	10	10
Cadmium, total (Cd)	6	6	N/A				2	2	2	2	2	2	2
Chromium, total (Cr)	6	6	N/A				25	25	25	25	25	25	25
Copper, total (Cu)	6	5	N/A				2	2	2	2	2	2	2
Iron, total (Fe)	6	0	N/A				470	470	478	1155	1725	1800	1800
Lead, total (Pb)	6	6	N/A				10	10	10	10	10	10	10
Mercury, total (Hg)	6	6	N/A				0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	6	6	N/A				10	10	10	10	10	10	10
Zinc, total (Zn)	6	4	N/A				10	10	10	10	16	26	26

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
18	74	3	17	

Key:
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: ICW AT CM R16 AT BEAVERDAM CRK NR LONG BEACH
Station #: I9380000 **Hydrologic Unit Code:** 3040207
Latitude: 33.92195 **Longitude:** -78.10780 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25

Time period: 01/10/2002 to 07/01/2002

	# result	# ND	Results not meeting EL	#	%	%Conf	Percentiles Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	5	0	<5	0	0		5.6	5.6	6.1	8	8.6	8.9	8.9
pH (SU)	5	0	<6.8	0	0		7.5	7.5	7.6	7.8	8	8	8
	5	0	>8.5	0	0		7.5	7.5	7.6	7.8	8	8	8
Salinity (ppt)	5	0	N/A				27	27	27.15	28.2	34.3	35.3	35.3
Spec. conductance (umhos/cm at 25°C)	5	0	N/A				41900	41900	42195	43871	52056	53422	53422
Water Temperature (°C)	5	0	>32	0	0		8.3	8.3	9.5	17.5	21.4	22.6	22.6
Other													
TSS (mg/L)	2	0	N/A				6	6	6	12	18	18	18
Turbidity (NTU)	6	0	>25	0	0		3.6	3.6	5.6	7	10.3	12	12
Metals (ug/L)													
Aluminum, total (Al)	2	0	N/A				280	280	280	530	780	780	780
Arsenic, total (As)	2	2	>10	0	0		10	10	10	10	10	10	10
Cadmium, total (Cd)	2	2	>5	0	0		10	10	10	10	10	10	10
Chromium, total (Cr)	2	2	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	2	2	>3	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	2	0	N/A				120	120	120	270	420	420	420
Lead, total (Pb)	2	2	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	2	2	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	2	2	>8.3	0	0		50	50	50	50	50	50	50
Zinc, total (Zn)	2	0	>86	0	0		54	54	54	60	66	66	66

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
4	1	0	0		1	0	0	

Key:
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: MONTGOMERY SLOUGH AT SR 1105 NR LONG BEACH
Station #: I9385000 **Hydrologic Unit Code:** 3040207
Latitude: 33.91777 **Longitude:** -78.16093 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25

Time period: 01/07/2002 to 12/27/2006

	# result	# ND	Results not meeting EL: EL	#	%	%Conf	Percentiles: Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	57	0	<5	15	26.3	100	3.1	3.9	4.9	6.6	8.2	9.6	12.7
pH (SU)	57	0	<6.8	3	5.3		6.7	7	7.2	7.4	7.6	7.7	7.9
	57	0	>8.5	0	0		6.7	7	7.2	7.4	7.6	7.7	7.9
Salinity (ppt)	57	0	N/A				7.3	13.25	15.5	21	25	27.78	33.76
Spec. conductance (umhos/cm at 25°C)	57	0	N/A				12680	22092	25481	33559	39312	42904	51274
Water Temperature (°C)	57	0	>32	1	1.8		5.7	8.8	13.4	22.9	27.8	30.7	32.4
Other													
Chlorophyll a (ug/L)	6	0	>40	2	33.3		6	6	8	18	46	60	60
TSS (mg/L)	19	0	N/A				14	16	21	29	49	56	83
Turbidity (NTU)	58	0	>25	6	10.3	64	2.6	4.4	8.2	12	16.2	26	55
Nutrients (mg/L)													
NH3 as N	6	2	N/A				0.02	0.02	0.02	0.04	0.08	0.13	0.13
NO2 + NO3 as N	6	2	N/A				0.02	0.02	0.02	0.03	0.04	0.06	0.06
TKN as N	6	1	N/A				0.2	0.2	0.34	0.74	1.1	1.1	1.1
Total Phosphorus	6	0	N/A				0.06	0.06	0.08	0.1	0.17	0.19	0.19
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				340	372	612	830	1350	1700	1900
Arsenic, total (As)	20	19	>10	1	5		5	5	10	25	50	50	100
Cadmium, total (Cd)	20	20	>5	0	0		2	2	2	10	10	10	10
Chromium, total (Cr)	19	19	>20	0	0		25	25	25	25	25	50	100
Copper, total (Cu)	20	20	>3	0	0		2	2	2	2	10	10	10
Iron, total (Fe)	19	0	N/A				350	460	540	650	870	1300	1600
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	18	50	50
Mercury, total (Hg)	20	20	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	19	>8.3	1	5		10	10	10	10	12	49	50
Zinc, total (Zn)	20	8	>86	1	5		10	10	10	13	30	75	530

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
58	55	0	0		68	36	62	100

Key:
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LOCKWOOD FOLLY RIV AT NC 211 AT SUPPLY
Station #: I9420000 **Hydrologic Unit Code:** 3040207
Latitude: 34.01077 **Longitude:** -78.26360 **Stream class:** SC HQW
Agency: NCAMBNT **NC stream index:** 15-25-1-(11)

Time period: 01/10/2002 to 12/19/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	56	0	<5	23	41.1	100	2.5	3.2	4.2	5.6	7.2	9.4	10.4
pH (SU)	55	0	<6.8	7	12.7	82	6.3	6.7	6.9	7.2	7.4	7.6	8.2
	55	0	>8.5	0	0		6.3	6.7	6.9	7.2	7.4	7.6	8.2
Salinity (ppt)	56	1	N/A				0	0	0	0.05	0.1	0.22	4.8
Spec. conductance (umhos/cm at 25°C)	56	0	N/A				63	88	118	151	197	399	8689
Water Temperature (°C)	56	0	>32	0	0		4	8.4	13	19.6	25.2	28.6	30.2
Other													
Chlorophyll a (ug/L)	7	1	>40	1	14.3		1	1	1	7	10	46	46
TSS (mg/L)	20	4	N/A				2.5	2.7	4.2	7	10.5	14	18
Turbidity (NTU)	58	0	>25	0	0		3	3.9	4.7	6.2	7.8	12.1	23
Nutrients (mg/L)													
NH3 as N	7	5	N/A				0.02	0.02	0.02	0.02	0.02	0.03	0.03
NO2 + NO3 as N	7	3	N/A				0.02	0.02	0.02	0.02	0.05	0.05	0.05
TKN as N	7	0	N/A				0.47	0.47	0.52	0.54	0.64	0.71	0.71
Total Phosphorus	7	0	N/A				0.04	0.04	0.04	0.04	0.05	0.08	0.08
Metals (ug/L)													
Aluminum, total (Al)	19	0	N/A				150	240	300	390	450	900	1100
Arsenic, total (As)	19	19	>10	0	0		5	5	5	10	10	10	10
Cadmium, total (Cd)	19	19	>5	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	19	19	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	19	17	>3	1	5.3		2	2	2	2	2	2	6
Iron, total (Fe)	19	0	N/A				530	680	770	1100	1300	1500	1600
Lead, total (Pb)	19	19	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	19	19	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	19	19	>8.3	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	19	14	>86	0	0		10	10	10	10	14	20	42

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
56	178	8	14	

Key:
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LOCKWOOD FOLLY RIV NR SANDY HILL
Station #: I9430000 **Hydrologic Unit Code:** 3040207
Latitude: 33.97220 **Longitude:** -78.25029 **Stream class:** SC HQW
Agency: NCAMBNT **NC stream index:** 15-25-1-(11)

Time period: 09/12/2002 to 12/19/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Percentiles Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	49	0	<5	15	30.6	100	3.3	3.9	4.8	6.3	8.2	9.4	11.3
pH (SU)	48	0	<6.8	3	6.2		6.4	6.8	7	7.3	7.5	7.6	8.1
	48	0	>8.5	0	0		6.4	6.8	7	7.3	7.5	7.6	8.1
Salinity (ppt)	49	0	N/A				0	0	0.1	1.19	11.73	23.4	29.5
Spec. conductance (umhos/cm at 25°C)	49	0	N/A				111	137	241	2216	19204	36951	46290
Water Temperature (°C)	49	0	>32	0	0		6	9.8	13	20.4	25.6	29.7	30.4
Other													
Chlorophyll a (ug/L)	7	0	>40	1	14.3		2	2	2	8	18	44	44
TSS (mg/L)	18	0	N/A				3.5	4	7	13	24.2	50.2	52
Turbidity (NTU)	51	0	>25	4	7.8		1.7	3.7	5.1	7.9	12	22.4	30
Nutrients (mg/L)													
NH3 as N	7	4	N/A				0.02	0.02	0.02	0.02	0.04	0.05	0.05
NO2 + NO3 as N	7	2	N/A				0.02	0.02	0.02	0.03	0.04	0.04	0.04
TKN as N	7	0	N/A				0.44	0.44	0.49	0.58	0.63	0.93	0.93
Total Phosphorus	7	0	N/A				0.04	0.04	0.06	0.07	0.09	0.1	0.1
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				230	270	405	510	745	1160	1400
Arsenic, total (As)	17	17	>10	0	0		5	5	5	10	10	30	50
Cadmium, total (Cd)	17	17	>5	0	0		2	2	2	2	2	12	20
Chromium, total (Cr)	17	17	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	17	16	>3	0	0		2	2	2	2	2	10	10
Iron, total (Fe)	17	0	N/A				400	440	600	830	990	2000	2000
Lead, total (Pb)	17	17	>25	0	0		10	10	10	10	10	18	50
Mercury, total (Hg)	17	17	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	17	17	>8.3	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	17	10	>86	0	0		10	10	10	10	16	23	32

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
51	95	2	4	

Key:
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LOCKWOOD FOLLY RIV AT VARNUM
Station #: I9440000 **Hydrologic Unit Code:** 3040207
Latitude: 33.94647 **Longitude:** -78.22324 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25-1-(16)

Time period: 01/10/2002 to 12/19/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	57	0	<5	5	8.8		3.8	4.9	5.7	6.9	8.4	9.5	11.5
pH (SU)	56	0	<6.8	1	1.8		6.7	7.3	7.4	7.7	8	8	8.3
	56	0	>8.5	0	0		6.7	7.3	7.4	7.7	8	8	8.3
Salinity (ppt)	57	0	N/A				2.1	6.81	12.42	23.75	29.77	32.18	34.4
Spec. conductance (umhos/cm at 25°C)	57	0	N/A				3940	11925	20822	37451	45754	49168	52110
Water Temperature (°C)	57	0	>32	1	1.8		8	9.9	13.6	20.8	27.8	30.3	32.6
Other													
Chlorophyll a (ug/L)	7	0	>40	0	0		3	3	4	10	13	14	14
TSS (mg/L)	21	0	N/A				7	8.1	12	17	33.5	45.8	84
Turbidity (NTU)	59	0	>25	0	0		1.9	3.8	5.9	8	10	14	18
Nutrients (mg/L)													
NH3 as N	7	5	N/A				0.02	0.02	0.02	0.02	0.02	0.04	0.04
NO2 + NO3 as N	7	3	N/A				0.02	0.02	0.03	0.03	0.1	0.1	0.1
TKN as N	7	0	N/A				0.4	0.4	0.41	0.44	0.49	0.52	0.52
Total Phosphorus	7	0	N/A				0.06	0.06	0.06	0.07	0.07	0.07	0.07
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				220	304	440	550	790	1180	1300
Arsenic, total (As)	20	20	>10	0	0		5	5	6	10	44	50	50
Cadmium, total (Cd)	20	20	>5	0	0		2	2	2	10	10	10	20
Chromium, total (Cr)	20	20	>20	0	0		25	25	25	25	25	48	100
Copper, total (Cu)	20	18	>3	2	10	67.7	2	2	2	4	10	10	25
Iron, total (Fe)	19	0	N/A				210	240	320	450	740	960	990
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	50	50	50
Mercury, total (Hg)	20	20	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	20	>8.3	0	0		10	10	10	10	18	50	50
Zinc, total (Zn)	20	11	>86	1	5		10	10	10	12	29	73	410

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
59	26	0	0		27	21	36	100

Key:
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%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LOCKWOOD FOLLY RIV AT CM R8 AT W CH DNS VARNUM
Station #: I9450000 **Hydrologic Unit Code:** 3040207
Latitude: 33.93949 **Longitude:** -78.21921 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25-1-(16)

Time period: 01/10/2002 to 07/01/2002

	# result	# ND	Results not meeting EL	#	%	%Conf	Percentiles Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	5	0	<5	0	0		5.8	5.8	6.6	7.6	8.7	9.3	9.3
pH (SU)	5	0	<6.8	0	0		7.7	7.7	7.8	8	8	8.1	8.1
	5	0	>8.5	0	0		7.7	7.7	7.8	8	8	8.1	8.1
Salinity (ppt)	5	0	N/A				29	29	29.95	33.1	34.8	35.6	35.6
Spec. conductance (umhos/cm at 25°C)	5	0	N/A				44702	44702	46072	50380	52675	53380	53380
Water Temperature (°C)	5	0	>32	0	0		8.6	8.6	9.6	14.6	19.2	20.6	20.6
Other													
TSS (mg/L)	2	0	N/A				15	15	15	18.5	22	22	22
Turbidity (NTU)	6	0	>25	0	0		4.6	4.6	6	7.2	8.2	8.9	8.9
Metals (ug/L)													
Aluminum, total (Al)	2	0	N/A				470	470	470	625	780	780	780
Arsenic, total (As)	2	2	>10	0	0		10	10	10	10	10	10	10
Cadmium, total (Cd)	2	2	>5	0	0		10	10	10	10	10	10	10
Chromium, total (Cr)	2	2	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	2	2	>3	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	2	0	N/A				250	250	250	335	420	420	420
Lead, total (Pb)	2	2	>25	0	0		50	50	50	50	50	50	50
Mercury, total (Hg)	2	2	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	2	2	>8.3	0	0		50	50	50	50	50	50	50
Zinc, total (Zn)	2	0	>86	0	0		61	61	61	65	69	69	69

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
6	3	0	0		4	0	0	

Key:
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%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LOCKWOOD FOLLY RIV AT CM R6 W CH NW SUNSET HARBOR
Station #: I9480000 **Hydrologic Unit Code:** 3040207
Latitude: 33.93319 **Longitude:** -78.21850 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25-1-(16)

Time period: 09/12/2002 to 12/19/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	49	0	<5	1	2		4.8	6	6.7	7.4	8.8	9.6	11.6
pH (SU)	48	0	<6.8	0	0		7.2	7.7	7.8	8	8.1	8.1	8.3
	48	0	>8.5	0	0		7.2	7.7	7.8	8	8.1	8.1	8.3
Salinity (ppt)	49	0	N/A				10.3	20.9	26.67	29.8	33.08	34.2	35.24
Spec. conductance (umhos/cm at 25°C)	49	0	N/A				17468	33367	41552	45793	50360	51890	53280
Water Temperature (°C)	49	0	>32	0	0		8	10	14.8	19.9	26.8	29.7	30.5
Other													
Chlorophyll a (ug/L)	7	0	>40	0	0		3	3	4	7	11	15	15
TSS (mg/L)	18	0	N/A				9	12.6	17.5	24	37	50.4	54
Turbidity (NTU)	51	0	>25	0	0		1.3	3.5	5.1	6.7	11	15.8	22
Nutrients (mg/L)													
NH3 as N	7	4	N/A				0.02	0.02	0.02	0.02	0.03	0.09	0.09
NO2 + NO3 as N	7	2	N/A				0.02	0.02	0.03	0.03	0.06	0.1	0.1
TKN as N	7	0	N/A				0.24	0.24	0.31	0.4	0.52	0.74	0.74
Total Phosphorus	7	0	N/A				0.05	0.05	0.06	0.07	0.07	0.08	0.08
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				290	290	415	500	765	1220	2100
Arsenic, total (As)	17	17	>10	0	0		5	5	25	25	50	50	50
Cadmium, total (Cd)	17	17	>5	0	0		2	2	6	10	10	12	20
Chromium, total (Cr)	17	17	>20	0	0		25	25	25	25	25	100	100
Copper, total (Cu)	17	17	>3	0	0		2	2	6	10	10	10	10
Iron, total (Fe)	17	0	N/A				140	164	225	340	620	814	830
Lead, total (Pb)	17	17	>25	0	0		10	10	10	20	50	50	50
Mercury, total (Hg)	17	17	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	17	17	>8.3	0	0		10	10	10	10	45	50	50
Zinc, total (Zn)	17	12	>86	0	0		10	10	10	10	25	42	52

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
50	6	0	0		4	6	12	77

Key:
result: number of observations
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: LOCKWOOD FOLLY RIV AT WEST CHANNEL ISLANDS
Station #: I9500000 **Hydrologic Unit Code:** 3040207
Latitude: 33.92672 **Longitude:** -78.22359 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25-1-(16)

Time period: 02/18/2002 to 07/01/2002

	# result	# ND	Results not meeting EL	#	%	%Conf	Percentiles Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	4	0	<5	0	0		6.9	6.9	7	7.6	8.2	8.4	8.4
pH (SU)	4	0	<6.8	0	0		7.8	7.8	7.8	7.9	8	8	8
	4	0	>8.5	0	0		7.8	7.8	7.8	7.9	8	8	8
Salinity (ppt)	4	0	N/A				32.1	32.1	32.53	34.7	35.9	36	36
Spec. conductance (umhos/cm at 25°C)	4	0	N/A				49091	49091	49638	52485	53855	53910	53910
Water Temperature (°C)	4	0	>32	0	0		11.4	11.4	12.1	15.9	21.5	22.8	22.8
Other													
TSS (mg/L)	2	0	N/A				10	10	10	16	22	22	22
Turbidity (NTU)	5	0	>25	0	0		4.6	4.6	5	6.4	9.2	10	10
Metals (ug/L)													
Aluminum, total (Al)	2	0	N/A				310	310	310	480	650	650	650
Arsenic, total (As)	2	2	>10	0	0		10	10	10	10	10	10	10
Cadmium, total (Cd)	2	2	>5	0	0		10	10	10	10	10	10	10
Chromium, total (Cr)	2	2	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	2	2	>3	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	2	0	N/A				130	130	130	230	330	330	330
Lead, total (Pb)	2	2	>25	0	0		50	50	50	50	50	50	50
Mercury, total (Hg)	2	2	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	2	2	>8.3	0	0		10	10	10	30	50	50	50
Zinc, total (Zn)	2	0	>86	0	0		56	56	56	58	60	60	60

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
5	1	0	0		1	0	0	

Key:
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: ICW AT CM R42 WEST OF LOCKWOOD FOLLY RIV
Station #: I9510000 **Hydrologic Unit Code:** 3040207
Latitude: 33.92170 **Longitude:** -78.23062 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25

Time period: 01/10/2002 to 07/01/2002

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	5	0	<5	0	0		6.2	6.2	7	7.9	8.6	9.2	9.2
pH (SU)	5	0	<6.8	0	0		7.8	7.8	7.8	8	8.1	8.1	8.1
	5	0	>8.5	0	0		7.8	7.8	7.8	8	8.1	8.1	8.1
Salinity (ppt)	5	0	N/A				28.2	28.2	31.05	35	36	36	36
Spec. conductance (umhos/cm at 25°C)	5	0	N/A				48337	48337	49798	53070	53970	54121	54121
Water Temperature (°C)	5	0	>32	0	0		8.5	8.5	9.8	14	20.5	20.8	20.8
Other													
TSS (mg/L)	2	0	N/A				11	11	11	13.5	16	16	16
Turbidity (NTU)	6	0	>25	0	0		6.3	6.3	6.9	8.2	12.2	13	13
Metals (ug/L)													
Aluminum, total (Al)	2	0	N/A				410	410	410	580	750	750	750
Arsenic, total (As)	2	2	>10	0	0		10	10	10	10	10	10	10
Cadmium, total (Cd)	2	2	>5	0	0		10	10	10	10	10	10	10
Chromium, total (Cr)	2	2	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	2	2	>3	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	2	0	N/A				190	190	190	290	390	390	390
Lead, total (Pb)	2	2	>25	0	0		50	50	50	50	50	50	50
Mercury, total (Hg)	2	2	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	2	2	>8.3	0	0		50	50	50	50	50	50	50
Zinc, total (Zn)	2	0	>86	0	0		59	59	59	64	70	70	70

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
6	1	0	0		1	0	0	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
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Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: ICW AT NC 130 NR HOLDENS BEACH
Station #: I9530000 **Hydrologic Unit Code:** 3040207
Latitude: 33.91699 **Longitude:** -78.26756 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25

Time period: 01/10/2002 to 07/01/2002

	# result	# ND	Results not meeting EL	#	%	%Conf	Percentiles Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	5	0	<5	0	0		6.3	6.3	6.8	7.6	8.4	8.9	8.9
pH (SU)	5	0	<6.8	0	0		7.7	7.7	7.8	7.9	8.1	8.2	8.2
	5	0	>8.5	0	0		7.7	7.7	7.8	7.9	8.1	8.2	8.2
Salinity (ppt)	5	0	N/A				31.8	31.8	32.4	33.6	34.9	35.9	35.9
Spec. conductance (umhos/cm at 25°C)	5	0	N/A				48705	48705	49138	50960	52833	54196	54196
Water Temperature (°C)	5	0	>32	0	0		8.7	8.7	10	15.4	20.4	22.1	22.1
Other													
TSS (mg/L)	2	0	N/A				10	10	10	17	24	24	24
Turbidity (NTU)	6	0	>25	0	0		4.5	4.5	4.9	6.5	9.4	13	13
Metals (ug/L)													
Aluminum, total (Al)	2	0	N/A				300	300	300	570	840	840	840
Arsenic, total (As)	2	2	>10	0	0		10	10	10	10	10	10	10
Cadmium, total (Cd)	2	2	>5	0	0		10	10	10	10	10	10	10
Chromium, total (Cr)	2	2	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	2	2	>3	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	2	0	N/A				130	130	130	300	470	470	470
Lead, total (Pb)	2	2	>25	0	0		50	50	50	50	50	50	50
Mercury, total (Hg)	2	2	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	2	2	>8.3	0	0		50	50	50	50	50	50	50
Zinc, total (Zn)	2	0	>86	0	0		55	55	55	65	75	75	75

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
6	3	0	0		3	0	0	

Key:
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: SHALLOTTE RIV AT US 17 BUS AT SHALLOTTE
Station #: I9700000 **Hydrologic Unit Code:** 3040207
Latitude: 33.97244 **Longitude:** -78.38641 **Stream class:** SC
Agency: NCAMBNT **NC stream index:** 15-25-2-(5)

Time period: 01/07/2002 to 12/27/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	58	0	<5	14	24.1	100	3.7	4.5	5	6.1	8.5	9.9	11.9
pH (SU)	58	0	<6.8	17	29.3	100	6.2	6.4	6.7	6.9	7	7.3	7.8
	58	0	>8.5	0	0		6.2	6.4	6.7	6.9	7	7.3	7.8
Salinity (ppt)	58	0	N/A				0	0.03	0.1	0.3	2.72	10.18	16.8
Spec. conductance (umhos/cm at 25°C)	58	0	N/A				79	152	219	498	4915	17326	27391
Water Temperature (°C)	58	0	>32	0	0		2.5	6.4	11.9	21.3	25.8	29.4	30.7
Other													
TSS (mg/L)	19	2	N/A				2.5	4	6	10	14	24	25
Turbidity (NTU)	59	0	>25	2	3.4		4.7	6	8	11	14	20	45
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				140	322	462	570	852	1290	3100
Arsenic, total (As)	20	20	>10	0	0		5	5	5	10	10	10	100
Cadmium, total (Cd)	20	20	>5	0	0		2	2	2	2	2	2	10
Chromium, total (Cr)	19	19	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	12	>3	1	5		2	2	2	2	2	9	26
Iron, total (Fe)	20	0	N/A				570	801	905	1500	1825	2090	2900
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	20	20	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	20	>8.3	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	20	13	>86	0	0		10	10	10	10	12	18	48

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:
57	444	25	44	100

Key:
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Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: SHALLOTTE RIV AT SHELL POINT NR SHALLOTTE
Station #: I9820000 **Hydrologic Unit Code:** 3040207
Latitude: 33.91966 **Longitude:** -78.37108 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25-2-(10)

Time period: 01/10/2002 to 12/19/2006

	# result	# ND	Results not meeting EL	#	%	%Conf	Percentiles Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	58	0	<5	3	5.2		4.1	5.6	6.2	7.3	8.4	9.4	11.5
pH (SU)	57	0	<6.8	0	0		7.4	7.6	7.8	7.9	8	8.1	8.3
	57	0	>8.5	0	0		7.4	7.6	7.8	7.9	8	8.1	8.3
Salinity (ppt)	58	0	N/A				17.6	25.47	28.74	31.61	34.08	35.01	36.2
Spec. conductance (umhos/cm at 25°C)	58	0	N/A				28490	39857	44891	48603	51545	53064	54630
Water Temperature (°C)	58	0	>32	0	0		8	9.8	13.2	19.2	27	29	30.2
Other													
TSS (mg/L)	20	0	N/A				8	9.5	16.2	25	44.5	63.4	110
Turbidity (NTU)	59	0	>25	1	1.7		1.2	3.6	4.9	7	10	13	29
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				280	314	382	600	890	2080	2200
Arsenic, total (As)	20	20	>10	0	0		5	10	25	25	50	50	50
Cadmium, total (Cd)	20	20	>5	0	0		2	2	4	10	10	10	20
Chromium, total (Cr)	20	20	>20	0	0		25	25	25	25	25	95	100
Copper, total (Cu)	20	19	>3	1	5		2	2	2	10	10	10	10
Iron, total (Fe)	20	0	N/A				130	134	248	345	598	837	900
Lead, total (Pb)	20	20	>25	0	0		10	10	10	40	50	50	50
Mercury, total (Hg)	20	20	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	20	>8.3	0	0		10	10	10	10	48	50	50
Zinc, total (Zn)	20	9	>86	0	0		10	10	10	14	36	64	72

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
58	4	0	0		2	4	7	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: ICW AT NC 904 NR OCEAN ISLE
Station #: I9840000 **Hydrologic Unit Code:** 3040207
Latitude: 33.89574 **Longitude:** -78.43981 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25

Time period: 01/10/2002 to 07/01/2002

	# result	# ND	Results not meeting EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	4	0	<5	0	0		6.3	6.3	6.6	7.6	8.2	8.3	8.3
pH (SU)	4	0	<6.8	0	0		7.8	7.8	7.8	8	8	8	8
	4	0	>8.5	0	0		7.8	7.8	7.8	8	8	8	8
Salinity (ppt)	4	1	N/A				0.2	0.2	7.82	32.35	34.08	34.1	34.1
Spec. conductance (umhos/cm at 25°C)	4	0	N/A				45950	45950	46248	49127	51485	51610	51610
Water Temperature (°C)	4	0	>32	0	0		11.2	11.2	12.4	17.8	20.8	21.3	21.3
Other													
TSS (mg/L)	2	0	N/A				6	6	6	14	22	22	22
Turbidity (NTU)	5	0	>25	0	0		3.4	3.4	3.6	7.2	10.8	12	12
Metals (ug/L)													
Aluminum, total (Al)	2	0	N/A				200	200	200	415	630	630	630
Arsenic, total (As)	2	2	>10	0	0		10	10	10	10	10	10	10
Cadmium, total (Cd)	2	2	>5	0	0		10	10	10	10	10	10	10
Chromium, total (Cr)	2	2	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	2	2	>3	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	2	0	N/A				100	100	100	215	330	330	330
Lead, total (Pb)	2	2	>25	0	0		50	50	50	50	50	50	50
Mercury, total (Hg)	2	2	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	2	2	>8.3	0	0		10	10	10	30	50	50	50
Zinc, total (Zn)	2	0	>86	0	0		56	56	56	61	66	66	66

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
5	2	0	0		2	0	0	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: ICW AT SR 1172 NR SUNSET BEACH
Station #: I9880000 **Hydrologic Unit Code:** 3040207
Latitude: 33.88168 **Longitude:** -78.51091 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25

Time period: 01/07/2002 to 12/27/2006

	# result	# ND	Results not meeting EL: EL	#	%	%Conf	Percentiles: Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	54	0	<5	13	24.1	99.9	4.4	4.6	5	6.4	8.3	10	11.9
pH (SU)	53	0	<6.8	0	0		7.1	7.2	7.5	7.7	7.8	7.9	8.1
	53	0	>8.5	0	0		7.1	7.2	7.5	7.7	7.8	7.9	8.1
Salinity (ppt)	53	0	N/A				7.2	15.4	19.62	23.8	26.82	29.9	31.93
Spec. conductance (umhos/cm at 25°C)	54	0	N/A				12085	25380	31862	37370	41579	45826	48798
Water Temperature (°C)	54	0	>32	0	0		6.5	10.1	13.7	21.9	27.8	30	31.5
Other													
TSS (mg/L)	18	0	N/A				7	7.9	12.8	17.5	29.5	36.4	40
Turbidity (NTU)	55	0	>25	0	0		2.1	3	4.7	6.7	8.6	10.4	22
Metals (ug/L)													
Aluminum, total (Al)	19	0	N/A				310	360	450	580	690	1000	2100
Arsenic, total (As)	19	19	>10	0	0		5	5	25	25	50	50	50
Cadmium, total (Cd)	19	19	>5	0	0		2	2	2	10	10	10	20
Chromium, total (Cr)	18	18	>20	0	0		25	25	25	25	25	55	100
Copper, total (Cu)	19	18	>3	0	0		2	2	2	10	10	10	10
Iron, total (Fe)	19	0	N/A				220	230	300	400	440	520	930
Lead, total (Pb)	19	19	>25	0	0		10	10	10	20	50	50	50
Mercury, total (Hg)	19	19	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	19	19	>8.3	0	0		10	10	10	10	50	50	50
Zinc, total (Zn)	19	8	>86	0	0		10	10	10	15	20	66	72

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
54	16	0	0		16	10	19	98.3

Key:
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Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: CALABASH RIV AT NC 179 NR CALABASH
Station #: I9916000 **Hydrologic Unit Code:** 3040207
Latitude: 33.88951 **Longitude:** -78.54947 **Stream class:** SA HQW
Agency: NCAMBNT **NC stream index:** 15-25-13

Time period: 01/07/2002 to 12/27/2006

	# result	# ND	Results not meeting EL				Percentiles						
			EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	59	0	<5	16	27.1	100	1.9	3.6	4	6.4	8.6	11	12.5
pH (SU)	59	0	<6.8	3	5.1		6.6	6.8	7	7.3	7.5	7.8	7.9
	59	0	>8.5	0	0		6.6	6.8	7	7.3	7.5	7.8	7.9
Salinity (ppt)	59	0	N/A				0.3	4.6	7.03	13.2	19	20.98	26.8
Spec. conductance (umhos/cm at 25°C)	59	0	N/A				543	8235	12190	21989	30708	33508	41714
Water Temperature (°C)	59	0	>32	4	6.8		5.3	8.9	13.4	23.1	28.3	31.3	34.1
Other													
TSS (mg/L)	19	0	N/A				15	18	27	29	51	90	440
Turbidity (NTU)	59	0	>25	25	42.4	100	2.9	5	8.8	18	37	75	200
Nutrients (mg/L)													
NH3 as N	1	1	N/A				0.02	0.02	0.02	0.02	0.02	0.02	0.02
NO2 + NO3 as N	1	1	N/A				0.02	0.02	0.02	0.02	0.02	0.02	0.02
TKN as N	1	0	N/A				1.8	1.8	1.8	1.8	1.8	1.8	1.8
Total Phosphorus	1	0	N/A				0.2	0.2	0.2	0.2	0.2	0.2	0.2
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				360	551	898	1200	2150	7340	13000
Arsenic, total (As)	20	19	>10	0	0		5	5	5	10	25	50	100
Cadmium, total (Cd)	20	20	>5	0	0		2	2	2	2	10	10	10
Chromium, total (Cr)	19	18	>20	1	5.3		25	25	25	25	25	25	27
Copper, total (Cu)	20	9	>3	9	45	100	2	2	3	7	10	15	21
Iron, total (Fe)	20	0	N/A				310	531	845	1300	2100	3280	17000
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	32	50	50
Mercury, total (Hg)	20	20	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	20	>8.3	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	20	4	>86	0	0		10	10	11	20	37	66	81

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	%Conf:	Median	# > 43	% > 43	%Conf
59	170	13	22	71.8	150	51	86	100

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
%Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Appendix B: References

North Carolina Division of Environmental Health, North Carolina Administrative Code Section 15A 18A .3402.

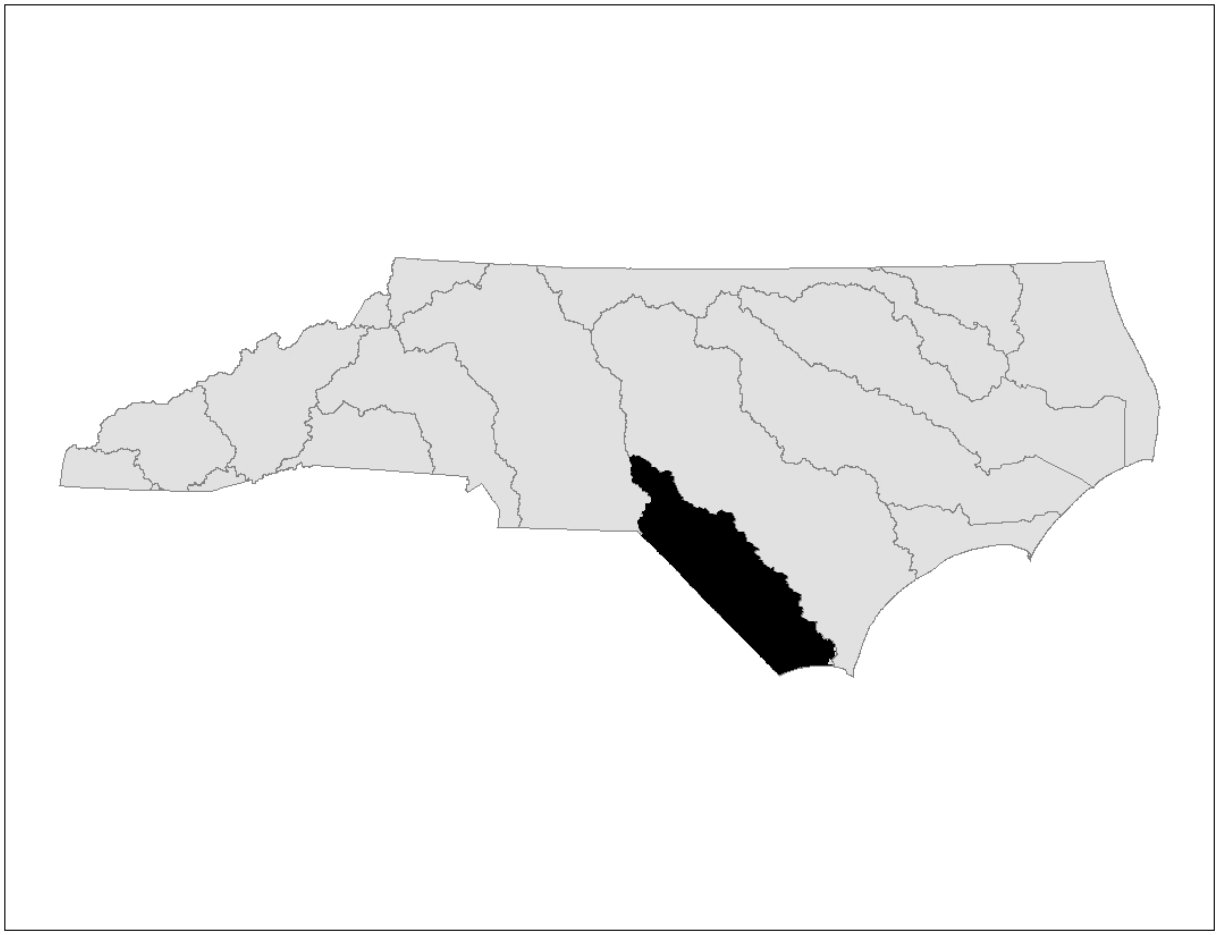
North Carolina Division of Water Quality, North Carolina Administrative Code Sections 15A 2B .0200, .0211, .0220, .0221 (Red Book).

North Carolina Division of Water Quality, Final North Carolina Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report), Approved May 17th, 2007.

Pi-Erh Lin, Duane Meeter, and Xu-Feng Niu, A Nonparametric Procedure for Listing and Delisting Impaired Waters Based on Criterion Exceedances, Florida State University,Tallahassee, FL., October 2000.

Lumber River Basin
Basinwide Assessment Report
Whole Effluent Toxicity Program

2002-2006



The Division of Water Quality's Whole Effluent Toxicity Monitoring Program

Acute and/or chronic toxicity tests are used to determine toxicity of discharges to sensitive aquatic species (usually fathead minnows or the water flea, *Ceriodaphnia dubia*). Results of these tests have been shown by researchers to be predictive of discharge effects to receiving stream populations.

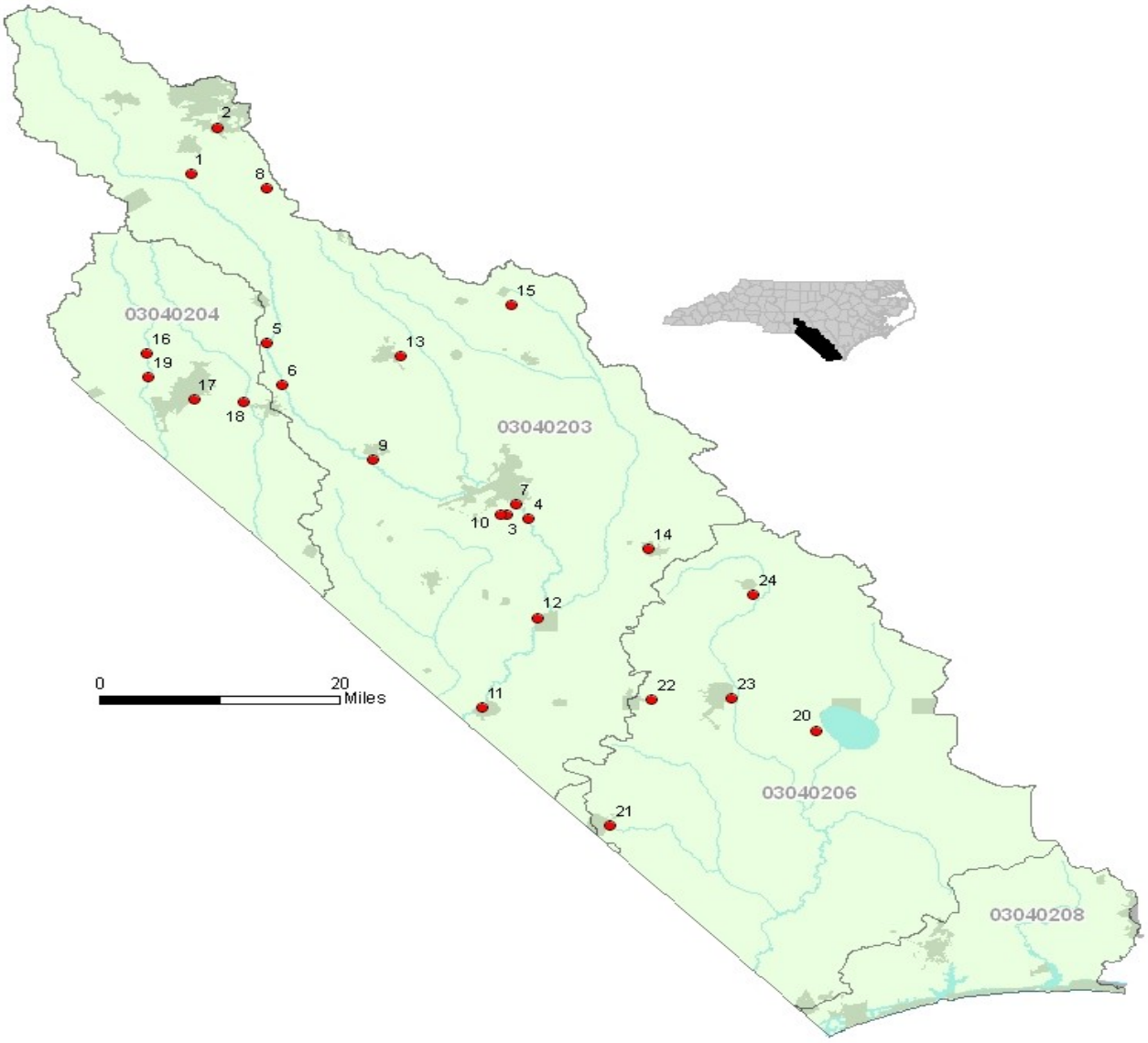
Many facilities are required to monitor whole effluent toxicity (WET) by their NPDES permit. Facilities without monitoring requirements may have their effluents evaluated for toxicity by DWQ's Aquatic Toxicology Laboratory. If toxicity is detected, DWQ may include aquatic toxicity testing upon permit renewal.

DWQ's Aquatic Toxicology Unit maintains a compliance summary for all facilities required to perform tests and provides a monthly update of this information to regional offices and WQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

WET Monitoring in the Lumber River Basin – 2002-2006

Twenty-Five facility permits in the Lumber River basin currently require whole effluent toxicity (WET) monitoring (Figure 1 and Table 1). Twenty-Three facility permits have a WET limit while two requires monitoring without a limit.

Figure 1. Lumber River basin facilities required to conduct whole effluent toxicity testing



Key

1	Moore County WWTP	7	Lumberton WWTP	13	Red Springs WWTP	19	Springs Industries
2	Aberdeen Pesticide D	8	Dept of Corrections(McCain)	14	Bladenboro WWTP	20	Lake Waccamaw WWTP
3	Lumberton Power, LLC	9	Pembroke WWTP	15	Parkton WWTP	21	Tabor City
4	CP&L-Weatherspoon	10	Alamac - Lumberton WWTP	16	Laurinburg Maxton Airport	22	Chadbourn WWTP
5	WestPoint Stevens	11	Fair Bluff WWTP	17	Laurinburg	23	Whiteville –Whitemarsh WWTP
6	Laurinburg-Maxton Ai	12	Fairmont Regional WW	18	Pilkington N A, Inc.	24	Clarkton WWTP

Table 1. Lumber River basin facilities required to conduct whole effluent toxicity testing

Subbasin/Facility	NPDES Permit No.	Receiving Stream	County	Flow (MGD)	IWC (%)	7Q10 (cfs)
03-07-50						
Moore County WWTP	NC0037508/001	Aberdeen Cr	Moore	6.7	40.54	15.2
Aberdeen Pesticide Dumps Site	NC0086398/001	Aberdeen Cr	Moore	0.72	2.5	4.3
03-07-51						
Lumberton Power, LLC	NC0058301/003	Lumber R.	Roberson	0.45	0.51	120
CP & L-Weatherspoon	NC0005363/001	Lumber R.	Robeson	NA	NA	122
WestPoint Stevens –Wagram WWTP	NC0005762/001	Lumber R.	Scotland	7.0	9.0	117
Laurinburg-Maxton Airport (LMAC) WWTP	NC0004475/001	Lumber R.	Scotland	2.0	2.72	111
Lumberton WWTP	NC0024571/001	Lumber R.	Robeson	20	21	120
Dept of Correction (McCain Hospital)	NC0035904/001	UT Mountain Cr.	Hoke	0.20	67.4	0.15
Pembroke WWTP	NC0027103/001	Lumber R.	Robeson	1.33	1.8	120
Alamac- Lumberton WWTP	NC0004618/001	Lumber R.	Robeson	2.5	3.2	128
Fair Bluff WWTP	NC0020729/001	UT Lumber R.	Columbus	0.23	0.257	138
Fairmont Regional WWTP	NC 0086550/001	Lumber R	Robeson	1.75	2.2	122
03-07-52						
Red Springs WWTP	NC0025577/001	Little Raft Swp	Robeson	2.5	98	0.07
Industrial & Agricultural Chemicals	NC0000236/001	UT Burnt Swp	Robeson	Var	NA	0
03-07-53						
Bladenboro WWTP	NC0026352/001	Byrant Swp	Bladen	0.50	100	0
Parkton WWTP	NC0026921/001	Dunn's Marsh	Robeson	0.2	1000	0
03-07-55						
Laurinburg Maxton Airport-Laurel Hill	NC0005479/001	Gum Swp Cr.	Scotland	0.3	1.5	31
Laurinburg- Leith Cr WWTP	NC0020656/001	Big Shoe Heel Cr.	Scotland	4.0	31	13.8
Pilkington NA, Inc-Plant 75	NC0049514/001	UT Shoe Heel Cr.	Scotland	VAR	100	0
Spring Industries	NC0005754/001	Gum Swp Cr.	Scotland	0.0105	0.14	34
03-07-56						
Lake Waccamaw WWTP	NC0021881/001	UT Bogue Swp	Columbus	0.4	100	0
03-07-57						
Tabor City	NC0026000/001	Town Canal	Columbus	1.1	100	0
03-07-58						
Chadbourn WWTP	NC0021865/001	Soules Swp	Columbus	1.0	90	0.15
Whiteville-Whitemarsh WWTP	NC0021920/001	White Marsh Swp	Columbus	3.0	50	4.7
Clarkton WWTP	NC0021610/001	UT Brown Marsh Swp	Bladen	0.24	100	0

The number of facilities in this basin with whole effluent toxicity limits has increased from 1985 (first year monitoring required) to 1995. The compliance rate of those facilities has generally risen since the inception of the program. In 2002, the compliance rate stabilized in the range of 98% (Figure 2 and Table 2).

Parkton WWTP, discharging to Dunn's Marsh (subbasin 53), began to experience frequent WET non-compliances since 2000. Evaluation of the facility shows that they are using chlorine tablets to chlorinate their system. This method of adding chlorine to the system is very hard to regulate the chlorine levels especially with the flow being 100% domestic and erratic. There has been a turn over in the operator-in- responsible charge position that has added to the problem of consistency. They are under a SOC review that is yet to be finalized.

Town of Red Springs, discharging to Little Raft Creek(subbasin 52), has had frequent WET non-compliance. Clayson Knitting, a Textile mill in the town, closed down as of February of 2006 and the toxicity issues have also ceased.

The Town of Clarkton, discharging into the unnamed tributary to Marsh Swamp (subbasin58), has been experiencing some WET non-compliance in 2006. The problem had been contributed to a de-chlorination system. A metering system had been installed for the de-chlorination liquid so that there is more reliability in the addition of the liquid.

Figure 2. NPDES facility whole effluent toxicity compliance in the Lumber River basin, 1985-2006. The compliance values were calculated by determining whether facilities with WET limits were meeting their ultimate permit limits during the given time period, regardless of any SOCs in force.

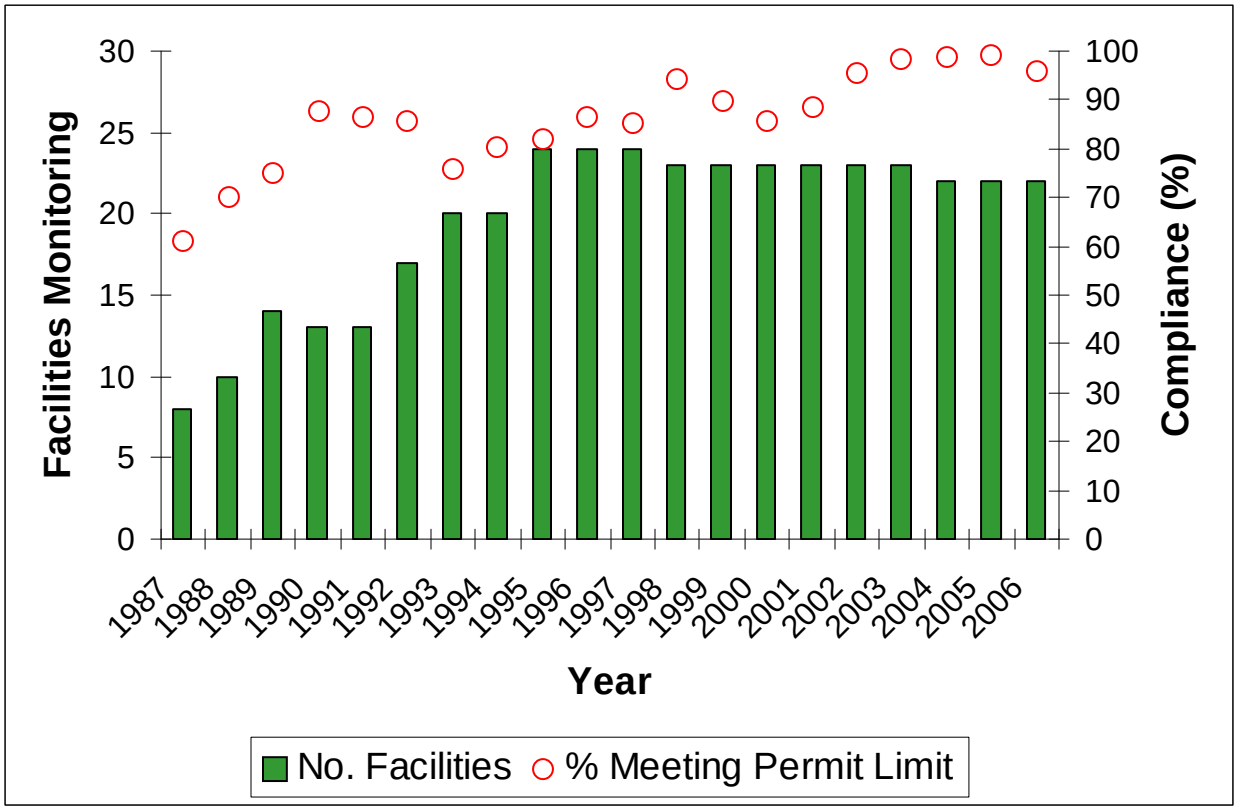


Table 2. Recent compliance record of facilities performing whole effluent toxicity testing in the Lumber River basin

Subbasin/Facility	NPDES	2002		2003		2004		2005		2006	
	Permit No.	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
03-07-50											
Moore County WWTP	NC0037508/001	4	0	4	0	4	0	4	0	4	2
Aberdeen Pesticide Dumps Site-* No Flow	NC0086398/001			*	*	*	*	*	*	*	*
03-07-51											
Lumberton Power, LLC	NC0058301/003	4	0	4	0	4	0	2	0	2	0
CP & L-Weatherspoon- No Flow*	NC0005363/001	*	*	*	*	*	*	*	*	*	*
WestPoint Stevens –Wagram WWTP	NC0005762/001	4	0	4	0	4	0	4	0	4	0
Laurinburg-Maxton Airport WWTP	NC0005479/001	4	0	4	0	4	0	4	0	4	0
Lumberton WWTP	NC0024571/001	4	0	4	0	4	0	4	0	4	0
Dept of Correction(McCain Hospital)	NC0035904/001	4	0	4	0	4	0	4	0	4	0
Pembroke WWTP	NC0027103/001	4	0	4	0	4	0	4	0	4	0
Alamac- Lumberton WWTP	NC0004618/001	4	0	4	0	4	0	4	0	4	0
Fair Bluff WWTP	NC0020729/001	4	0	4	0	4	0	4	0	4	0
Fairmont Regional WWTP	NC 0086550/001	4	0	4	0	6	0	4	0	4	0
03-07-52											
Red Springs WWTP	NC0025577/001	4	5	4	8	12	0	9	0	6	0
03-07-53											
Bladenboro WWTP	NC0026352/001	4	0	4	0	5	1	4	0	4	0
Parkton WWTP	NC0026921/001	4	2	5	3	4	0	5	1	3	3
03-07-55											
Laurinburg Maxton Airport-Laurel Hill	NC0005479/001	4	0	4	0	4	0	4	0	4	0
Laurinburg- Leith Cr WWTP	NC0020656/001	4	0	4	0	4	0	4	0	4	0
Pilkington NA, Inc-Plant 75	NC0049514/001	3	0	4	0	3	1	2	0	2	0
Spring Industries	NC0005754/001	4	1	4	0	4	0	4	0	4	0
03-07-56											
Lake Waccamaw WWTP	NC0021881/001	3	1	6	0	4	0	4	0	4	0
03-07-57											
Tabor City	NC0026000/001	6	2	4	0	7	1	5	1	5	1
03-07-58											
Chadbourn WWTP	NC0026000/001	4	0	4	0	6	0	4	0	4	0
Whiteville-Whitemarsh WWTP	NC0021920/001	6	5	12	0	10	0	4	0	4	0
Clarkton WWTP	NC0021610/001	4	0	4	0	4	0	4	0	3	3

Note that “pass” denotes meeting a permit limit or, for those facilities with a monitoring requirement, meeting a target value. The actual test result may be a “pass” (from a pass/fail acute or chronic test), LC_{50}, or chronic value. Conversely, “fail” means failing to meet a permit limit or target value.