CHOWAN RIVER BASINWIDE ASSESSMENT
MAY, 2006

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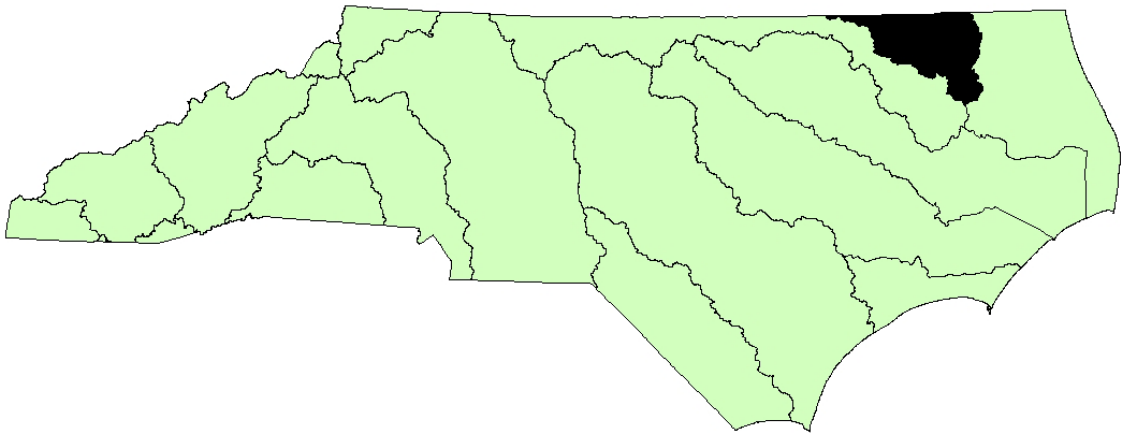

This document provides overviews from four program areas within the Environmental Sciences Section . They may be considered chapters or individual reports. The contributions from each unit are provided in the following order.

BASINWIDE ASSESSMENT –Provides basin and subbasin overviews of water quality and detailed information on collections of benthic macroinvertebrates, fish community structure, and fish tissue analyses.
Biological Assessment Unit 36 pages

AMBIENT MONITORING SYSTEM ASSESSMENT-Provides results of analyses from DWQ fixed station Ambient Monitoring System and Coalition Data, including temporal and spatial trends of chemical, hydrological, and physical data where appropriate.
Ecosystems Analysis Unit 56 pages

WHOLE EFFLUENT TOXICITY PROGRAM-Provides an overview of permits requiring (WET), compliance information, and brief summaries of actions by individual facilities and/or DWQ in response to WET limit failures.
Aquatic Toxicology Unit 3 pages

Basinwide Assessment Report
Chowan River Basin

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

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CHOWAN RIVER BASIN

Executive Summary

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 reassessed every five years, and the Environmental Sciences Section sampled the Chowan River basin in 1995 and 2000, prior to this assessment in 2005.

The Environmental Sciences Section 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 areas there may be adequate data from several program areas 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 Chowan River basin include benthic macroinvertebrates and fish tissue monitoring for the period 2000-2005. Details of biological sampling methods and rating criteria can be found in the appendices to this report. Technical terms are defined in the Glossary. Studies conducted prior to 2000 were previously summarized in NCDENR (2001).

The document is structured with physical, geographical, and biological data discussions presented by subbasin. General water quality conditions are given in an upstream to downstream format.

The Chowan River basin is located in the northeastern coastal plain of North Carolina and includes all or parts of Northampton, Hertford, Gates, Bertie and Chowan Counties (Figure 1). The Chowan River is formed at the border of Virginia and North Carolina by the confluence of the Nottoway and Blackwater Rivers and flows southeastward into Albemarle Sound. Nearly the entire watershed of the Chowan River in North Carolina is located in the Middle Atlantic Coastal Plain ecoregion, the majority of which is the Mid-Atlantic Flatwoods subecoregion (Griffith *et al*. 2002). This subecoregion has slow natural drainage, is heavy in clays and sand, and contains many man-made ditches to accommodate drainage for agriculture. Along the Chowan River is the Mid-Atlantic Floodpains and Low Terraces subecoregion, characterized by large, sluggish, deepwater swamps, oxbow lakes and alluvial deposits with abrupt textural changes. The northwestern portion of the watershed in North Carolina is contained within the Rolling Coastal Plain subecoregion, an area of better drainage and slightly more relief within the Southeastern Plains ecoregion.

The Chowan basin includes over 2,500 square miles in North Carolina, but the largest part of the drainage basin (3,575 square miles) lies in Virginia. Major tributaries to the Chowan River include: the Meherrin River and its largest tributary, Potecasi Creek; the Wiccacon River and its largest tributary, Ahoskie Creek. The Meherrin River flows into North Carolina from Greensville County, Virginia. There are over 803 stream miles in the Chowan River basin.

Murfreesboro, Ahoskie and Edenton are the largest urban areas in the basin. The total human population (2000 Census) of the basin is 61,034 resulting in a population density of just over 44 persons per square mile. Land use within the basin is mainly forest and agriculture. Important natural resources include wetlands, anadromous fish spawning areas, and Merchant's Millpond State Park.

No waterbodies in the Chowan River Basin have been given the supplemental “Swamp” classification by DWQ. However, for the purposes of biological assessments of waterbodies in the Chowan River basin, the Biological Assessment Unit uses a swamp criterion to assign a bioclassification to waterbodies that have visible flow in winter but stop flowing for some portion of the year. A current review is needed of the

waterbodies in this basin to determine which ones should have the "Swamp" classification, as the dissolved oxygen and pH standards are different for swamp streams.

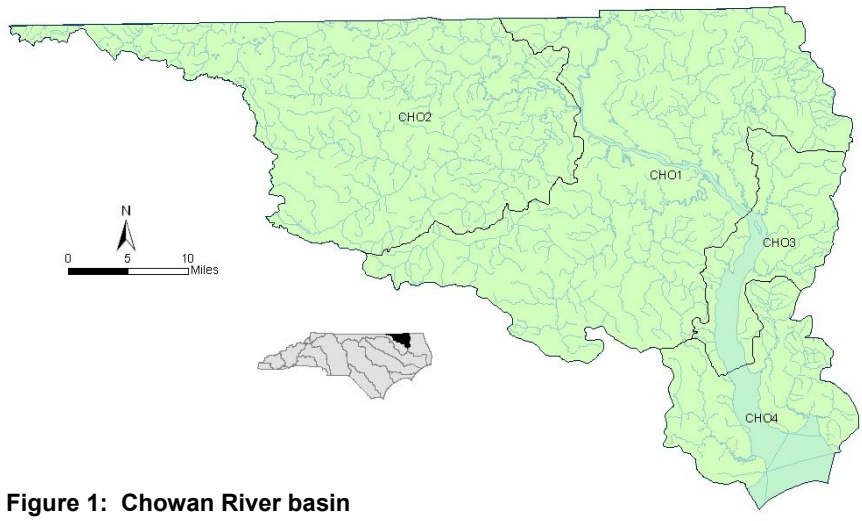

Figure 1: Chowan River basin

Chowan River Basin Water Quality Overview

The three large rivers in this basin (Chowan, Meherrin, and Wiccacon) showed no discernable pattern from the results of benthic macroinvertebrate sampling between the 2000 and 2005 collections. Of the five benthic sampling locations on the three large rivers, two sites improved in bioclassification, two sites decreased in bioclassification and one site remained the same bioclassification using draft Coastal B criteria. The biotic index at these five sites increased at only one site (US-17; by 0.1 units) while it decreased (between 0.2 and 0.4 units) at the other four boat sites, suggesting stable if not slightly improved water quality overall in the large rivers of the Chowan River basin. Three sampling points are located on the Chowan River, from upstream near the Virginia border (near Riddicksville), through the middle part of the basin (near Gatesville) and just before the Chowan empties into Albemarle Sound (US 17). The Riddicksville and US 17 sampling locations on the Chowan River showed an increase in bioclassification from Good-Fair to Good. However, the Gatesville sampling location declined in bioclassification from 2000 (Good) to 2005 (Fair). The Meherrin River decreased from Good to Good-Fair in 2005. The Wiccacon River showed little change and remained Fair in 2005. BAU has a well-established data record on these rivers going back to 1983 and 1984. At least one benthic sample was collected from each of these three rivers in seven different years.

Like the large rivers in the Chowan River basin, Swamp streams also showed little change from 2000 to 2005. Ten swamp streams were sampled in 2005. Eight of the ten sites sampled in 2005 were sampled in 2000. Five of these sites showed an increase in the biotic index while three showed decreases. Four of the eight sites showed an increase in total taxa collected while four showed a decrease. No trends were seen with the number of EPT taxa collected in 2005 compared with 2000. Four sites showed decreases while three had an increase in EPT taxa and one site remained the same. Of the ten sites sampled in 2005, five had been both sampled and rated in 2000. Four of those five sites did not change in bioclassification in the past five years. One site, Kirbys Creek declined in bioclassification from Natural to Moderate. The coastal A/swamp stream transitional sites, Ahoskie Creek at NC 42 and Cutawhiskie

Swamp at SR 1141 remain Not Rated. Additional data are needed in both winter and summer periods to determine the most appropriate time to assess these waterbodies.

Surveys conducted by the NCDWQ and other researchers have identified two tissue contaminant issues within the Chowan River basin -- dioxin and mercury. The Chowan River from the Virginia border to Albemarle Sound was placed under a fish consumption advisory in 1990 for all species except herring and shad due to dioxin contamination from Union Camp's Franklin, Virginia paper mill. Yearly monitoring by Union Camp in North Carolina indicated that dioxin levels gradually decreased in fish from the Chowan River and Meherrin Rivers after new bleaching technologies were instituted in 1990 to improve effluent quality. In March 1998, the advisory was partially lifted, leaving carp and catfish as the only two species still considered unsafe to eat. The advisory was completely lifted in early 2000 after dioxin toxicity equivalents (TEQ – the sum of 2,3,7,8 TCDD and 2,3,7,8 TCDF congeners) from all stations and species remained below 3 pg/g (recommended level for North Carolina) for two consecutive years.

Mercury has been identified as a widespread contaminant in fish from all North Carolina coastal river basins (NCDEHNR 1996c). In the Chowan River basin, elevated mercury levels have been measured in long-lived piscivores such as largemouth bass and bowfin. Research indicates that atmospheric mercury deposition is a significant source for the observed mercury levels (USEPA 1997). Currently, there are no basin-specific fish consumption advisories for the Chowan River basin. However, a mercury advisory is in place east of Interstate 85 for largemouth bass, bowfin, and chain pickerel. These species are found throughout the Chowan basin.

The NCDWQ has systematically monitored and reported on fish kill events across the state since 1996. Field investigators reported 6 fish kill events in the Chowan River basin from 2001 to 2005. Kill activity and fish mortality in the basin has remained light through the years compared to coastal basins. Most fish kill events were caused by low dissolved oxygen levels and most often affected largemouth bass, sunfishes, and catfishes.

Kirbys Creek and Chinkapin Creek support the most sensitive macroinvertebrate communities of the sites sampled in the Chowan River basin. Bennetts Creek and the Wiccacon River contain macroinvertebrate communities that are the most tolerant. The Chowan River, Ahoskie Creek and Cutawhiskie Swamp contained the greatest macroinvertebrate diversity of waterbodies in the Chowan River basin in 2005. Several new taxa to the Chowan River itself were recorded in 2005, though only a few are unusual records. EPT diversity was lacking in Potecasi Creek, Bennetts Creek, Cole Swamp, Eastmost Swamp and the Wiccacon River in 2005.

Fourteen ambient monitoring stations are currently operating in the Chowan River basin, six are located on the Chowan River itself in North Carolina and an additional site in Virginia on the Nottoway River approximately three miles before the confluence with the Blackwater River (at which point they become the Chowan River). In the Chowan River basin, two ambient parameters commonly exceed water quality parameters, total iron and dissolved oxygen.

Many of the waterbodies in the Chowan River basin experience low dissolved oxygen concentrations in summer in violation of water quality standards. Also, pH measurements exceed water quality standards in some of these streams. The fact that many of these streams cease to flow or have low natural pH is not the result of any anthropogenic interference but due to their nature. This area of the Middle Atlantic Coastal Plain ecoregion is classified as Mid-Atlantic Flatwoods and Mid-Atlantic Floodplains, and Low Terraces. Low gradient, poor drainage and swamp conditions are common here. Though many streams are swamp-like in nature, no swamp stream supplemental classifications are assigned to any streams in the Chowan River Basin (15A NCAC 2B .0314).

Low dissolved oxygen levels are significant in the Blackwater River Branch of the upper Chowan basin, typically dropping to below 5 mg/l (40% of records) and occasionally below 4 mg/l (15% of the records). Ambient monitoring data show that Potecasi Creek (at NC 11) has a serious problem with low dissolved oxygen levels, with readings below 5 mg/l over 44% of the time and lower than 4 mg/l over 25% of the

time. This is not surprising since BAU field crews have observed this waterbody in a stagnant, non-flowing status on more than one occasion. The statistically significant dissolved oxygen problems continue downstream in the Potecasi Creek watershed to the Meherrin River at Parkers Ferry, also a macroinvertebrate monitoring site. Here, dissolved oxygen levels were below 5 mg/l over 25% of the time. The low dissolved oxygen levels found here continue into the Chowan River through Winton, NC (20% of the readings here were below 5 mg/l). Between the Gatesville and Holiday Island ambient stations on the Chowan River, the dissolved oxygen levels appear to return to above 5 mg/l and remain so out into the Albemarle Sound. These low dissolved oxygen levels are significant for benthic organisms.

CHOWAN RIVER SUBBASIN 01

Description

Subbasin 01 is located in the Middle Atlantic Coastal Plain ecoregion (Figure 2). The Chowan River is formed near the border of Virginia and North Carolina by the confluence of the Nottoway and Blackwater Rivers and it flows southeast towards Albemarle Sound. The basin includes 1,315 mi^2 in North Carolina, but the largest part of the drainage basin (3,575 mi^2) lies in Virginia.

Portions of Merchant's Millpond State Park and Chowan Swamp State Natural Area are located in this subbasin. The largest municipalities include Winton, Aulander and Ahoskie, largest of the three. Aulander and Ahoskie had population declines from 1990 to 2000 but Winton showed an increase during that time. Population density is lowest (44 persons per square mile) in Subbasin 01 compared with the other three Chowan River subasins.

The major tributary to the Chowan River in this subbasin is the Wiccacon River. The major tributaries to the Wiccacon River include Ahoskie Creek and Chinkapin Creek. The largest urban area is Ahoskie. Land use within this subbasin is mainly forested wetlands and agriculture.

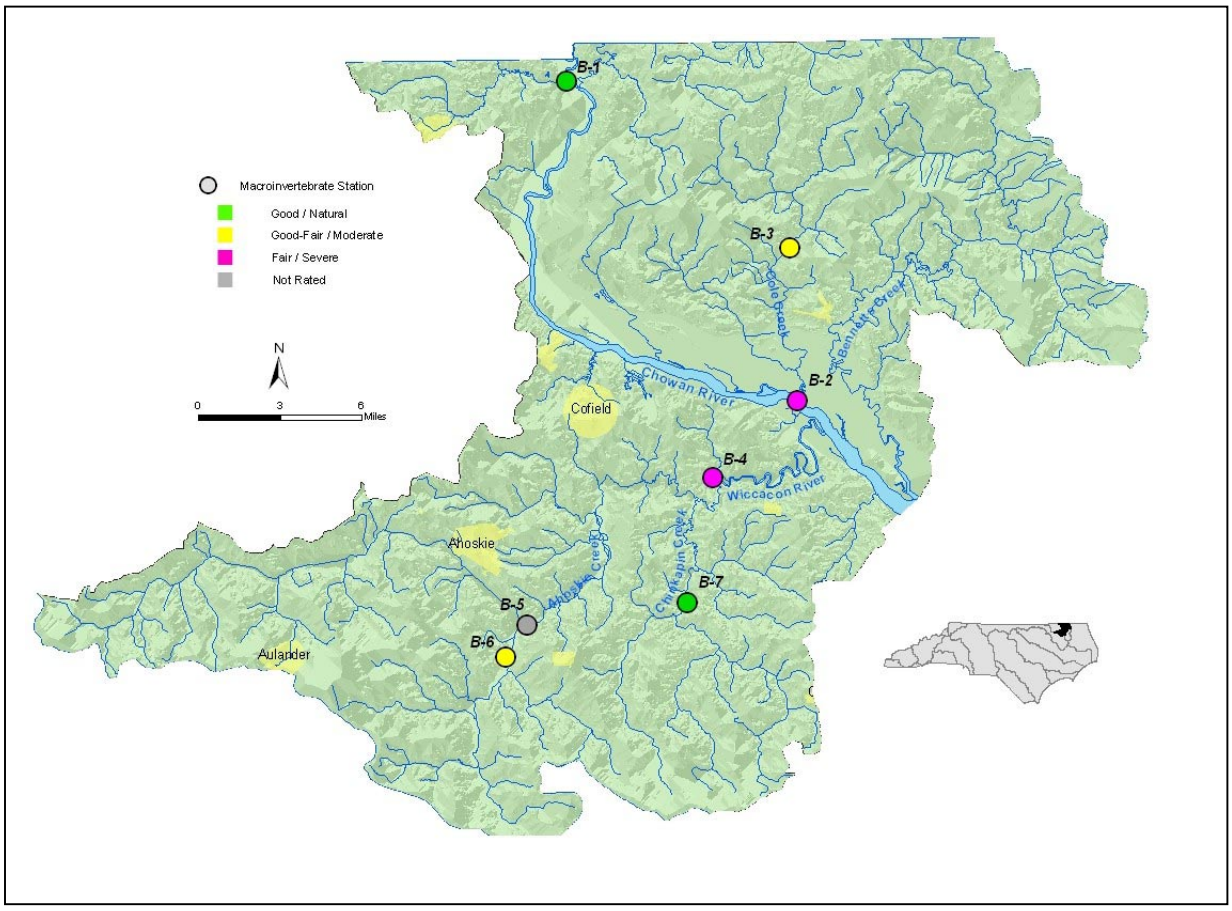

Figure 2: Chowan River subbasin 01, basinwide sampling locations

Overview of water quality

Aquatic habitats sampled in this subbasin include the Chowan and Wiccacon Rivers, swamp streams (with a fairly natural channel), and channelized streams (Table 1). Nearly all these systems receive large amounts of agricultural runoff, precluding the establishment of any "unimpacted" reference sites. The aquatic macroinvertebrate fauna had the highest diversity in riverine habitats, provided dissolved oxygen maintained an adequate level through the summer. Given the swamp-like nature of streams in this subbasin, it is not surprising that summer dissolved oxygen levels are in Potecasi Creek, and in the Wiccacon, Meherrin and Blackwater (VA) Rivers. Nearly all of these streams cease flowing during dry periods, and are expected to have very low dissolved oxygen concentrations during summer low-flow (i.e. swamp streams).

Eight sites were sampled for benthic macroinvertebrates in this subbasin in 2005 (with one site sampled twice). Overall, conditions in this subbasin appear similar to 2000. Six of the sites sampled in 2005 were sampled in 2000. Four of six sites showed a decrease in Biotic Index, but the sites were split evenly with respect to increases or decreases in the number of EPT collected in 2005 versus 2000. River sites sampled indicated better water quality in the upper Chowan River (Good) than in the Wiccacon River (Fair) or middle reaches of the Chowan River (near Gatesville, Fair). The macroinvertebrate community in the Wiccacon River indicated problems caused by nutrient enrichment and low dissolved oxygen. There appears to be little change in the benthic community of the Wiccacon River since the first sample was collected in 1983. The uppermost site on the Chowan (Riddicksville) improved from Good-Fair to Good in 2005. However, this improvement in the upper Chowan River was tempered by a decrease from Good to Fair at Gatesville, possibly the result of degraded water quality from the Meherrin, though this site is directly downstream of Nucor Corporation and CF Industries (an EPA Superfund Site).

All of the basinwide swamp streams in subbasin 01 have been sampled at least twice. Three of four streams sampled during the winter swamp period in this subbasin rated Moderate (swamp rating) in 2005. There were no clear trends from 2000 to 2005. Biotic index scores and the number of EPT taxa and total taxa appeared to vary only slightly at the three swamp streams (Cole Creek, Stony Creek and Chinkapin Creek).

Chinkapin Creek received a Natural bioclassification again in 2005. Two other swamp streams that were sampled for the first time in 2000, though not Natural in bioclassification, do not show any serious water quality problems, Cole Creek and Stoney Creek. The coastal A/swamp stream transitional site, Ahoskie Creek at NC 42 remains Not Rated. Additional data are needed in both winter and summer periods to determine the most appropriate time to assess this waterbody.

There are only five small permitted dischargers in this subbasin, all of which are minor. There is one facility that is required to perform whole effluent toxicity (WET) Testing. Aluminum Casting Technology (NC 0086231), a minor discharger, has had no flow since September 2004. Since 2002, there were no violations or enforcement actions for this facility. The other four facilities discharge 6000 gallons per day or less and are associated with Gatesville County Schools. These include: Gatesville Elementary School WWTP (NC 0033782), which discharges to Bennetts Creek (Merchant's Millpond); Sunbury Primary School WWTP (NC 0033791) and T.S. Cooper Elementary School WWTP (NC 0033804), which discharge to Raynor Swamp and Buckland Elementary School (NC 0043974), which discharges to Cole Creek (Lilleys Millpond).

Three of the dischargers (Gatesville Elementary School WWTP, T.S. Cooper Elementary School WWTP and Sunbury Primary School WWTP) have a history of water quality violations according to the North Carolina Basinwide Information Management System (BIMS). To date, there have been 17 enforcement actions against Gatesville Elementary School WWTP, 23 against T.S. Cooper Elementary School WWTP and six against Sunbury Primary School WWTP.

Table 1. Waterbodies monitored in Subbasin 01 in the Chowan River basin for basinwide assessment, 2000-2005.

Map #[1]	Waterbody	County	Location	2000	2005
B-1	Chowan R	Hertford	near Riddicksville	Good-Fair	Good
B-2	Chowan R	Hertford	near Gatesville	Good	Fair
B-3	Cole Cr	Gates	US 158[2]	Not Rated	Moderate
B-4	Wiccacon R	Hertford	SR 1433	Fair	Fair
B-5	Ahoskie Cr	Hertford	NC 42	Not Sampled	Not Rated
B-6	Stony Cr	Bertie	SR 1235	Moderate	Moderate
B-7	Chinkapin Cr	Hertford	SR 1432	Natural	Natural

[1]B = benthic macroinvertebrate monitoring sites.
[2]Cole Cr at US 158 erroneously labeled as US 58 in 2000 sampling.

River and Stream Assessment

Chowan River near Riddicksville, Hertford/Gates County

The Chowan River site near Riddicksville is located near the Virginia state line. The sampling location is approximately one mile downstream of the confluence of the Blackwater and Nottoway Rivers. This location was first sampled in 2000 and is approximately one mile above the prior sampling location on the Chowan River (SR 1319). The drainage area above the sampling point is over 2,400 square miles.

The substrate of this large, slow-moving coastal river is mostly sand with some silt. Previous samplings in the upper Chowan River observed a scoured central channel of hardpan clay and gravel. No such channel diversity was seen in 2005, perhaps due to low flows over the past five years (including the drought of 2002). The water itself was clear and humic-colored during the 2005 sampling. Snags were common along both banks and aquatic macrophytes were abundant but tended to be concentrated on the inside bends of the river and near backwater areas. The pH measured 5.9 and reflected the lower pH conditions of the swamp streams that flow into it from Virginia. Previous samplings in the upper Chowan River noted lowered dissolved oxygen levels (< 4mg/l) and 2005 was no exception (2.9 mg/l). Specific conductance was slightly elevated (187 μmhos/cm), but not atypical for large coastal rivers in North Carolina. Salinity influences are rare this far upstream on the Chowan River (maximum salinity recording during 2000-2005 was only 0.32 ppt). Riparian vegetation appeared natural and undisturbed and the stream banks were stable. Overall, the habitat scored 78 out of 100.

Table 2. Flow and bioclassifications for the Chowan River near Riddicksville, Hertford County.

Year	Flow	Rating
2005	Normal-Low	Good
2000	Normal-High	Good-Fair
1995	Normal	Good-Fair
1990	Normal	Excellent
1988	Normal	Good
1986	Low	Good
1984	High	Good

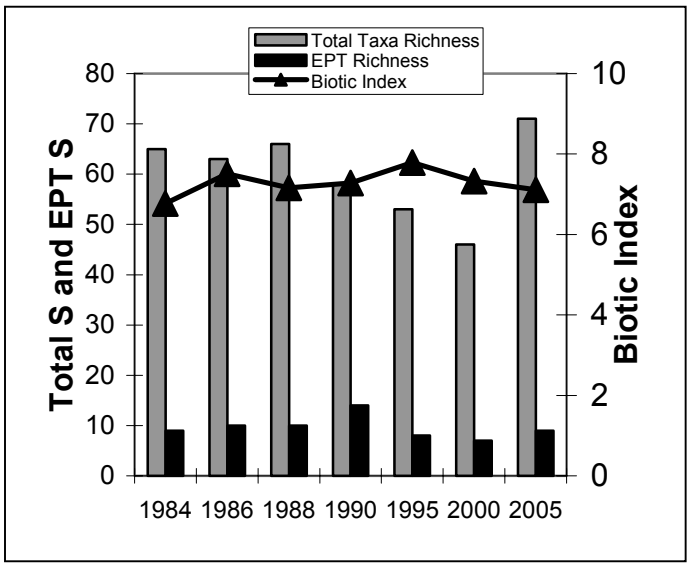

Figure 3: Chowan River near Riddicksville, NC 1984-2005.

The Chowan River near Riddicksville rated Good in 2005. This site was rated based only on EPT taxa richness using draft criteria for non-flowing (Coastal B) rivers. This is an improvement from the Good-Fair bioclassification in 2000 (Table 2), and reverses the trend of decreasing total taxa that has been observed since 1990 (Figure 3). The biotic index improved slightly from 7.3 in 2000 to 7.1 in 2005. The number of EPT taxa increased from seven in 2000 to nine in the 2005 collection. This section of the Chowan River has been sampled seven times since 1984, resulting in the cumulative collection of over 157 taxa. Many of those taxa were collected in more than one sample, and some, such as the mayflies *Caenis*, *Hexagenia*, and *Stenacron interpunctatum* have been collected on each of the seven samplings. Other EPTs collected frequently at this site include *Polycentropus*, *Oecetis*, and *Phylocentropus*. Overall, the mayfly taxa here remain fairly consistent while the caddisfly taxa come and go from one collection to the next.

Chowan River near Gatesville, Hertford/Gates County

The Gatesville site is located approximately 15 miles downsteam of the Riddicksville site, and approximately three miles upstream of where the Wiccacon River joins the Chowan. The drainage area is over 2,500 square miles. This sampling area is within one half to one mile downstream of CF Industries and Nucor Corporation. This section of the river is very different from the Riddicksville site. The channel profile change results in slower velocities and notably greater depths in the channel (>10 meters in places). There is also a greater tendency for particulate organics to settle out, potentially resulting in an increase in sediment oxygen demand. Evidence of this, in the form of black sediments in the mid-channel area (and a lack of *Corbicula fluminea* in dredge samples), was noted during the 2000 sampling effort. However no evidence of an increased sediment oxygen demand was seen in 2005. Benthic substrate consisted of mostly sand with some silt. Like most large rivers in this part of North Carolina, the sampling reach consisted entirely of deep water run habitat, that is, no riffle or pool sequences. Specific conductance was slightly lower here than at the Riddicksville site (157 μmhos/cm) and pH was closer to neutral (6.5) reflecting the greater distance of this sampling point from the lower pH, swamp-like conditions in the headwater areas. Both banks were dominated by forested wetlands. Overall, the habitat scored 77 out of 100.

The Chowan River at Gatesville rated Fair in 2005 using draft Coastal B criteria. This is a decrease of two bioclassifications from the Good rating it received in 2000. The reason for this decline was the

absence of several caddisflies that were present in 2000; *Ceraclea enodis*, *C. transversa*, *Cyrnellus fraternus*, *Orthotrichia* and *Oecetis cinerascens*. Another caddisfly, *Triaenodes ochraceus* was first collected in 2005. It is associated with aquatic macrophytes that were common at the collection site. The biotic index actually decreased in 2005 (6.9) from 2000 (7.2) suggesting that conditions here may not be much different from 2000. One possible explanation for the lack of caddisflies in the 2005 samples is that the samples were taken at the end of September (9/27), while the 2000 sampling was done nearly two months prior in the year (8/1). *Epoicocladius* was collected for the first time in 2005. These midges live commensally or parasitically on *Hexagenia*. Enrichment indicator species *Dicrotendipes simpsoni* was abundant in 2005, as in 2000, but *Polypedilum illinoense*, also abundant in 2000 was not collected in 2005. The typical macrophyte grazers (*Cricotopus sylvestris* group), abundant in 2000, were collected in 2005.

Cole Creek, US 158, Gates County

The sampling location of Cole Creek at US 158 in 2000 was erroneously labeled as NC 58 in the prior basinwide report. This swamp stream was sampled at the same location in 2005. It is an eastern tributary of Sarem Creek, and has a braided channel that flows into a single cut (approximately five to seven meters wide) before flowing under US 158. From this channel cut (pictured) downstream, the waterbody has been straightened and channelized (>2 meters deep), though not recently. The swamp above this point appears to be in a more natural condition, averaging 0.5 to 1 meter in depth. The drainage area here is 32 square miles.

Two aspects of this site were most notable, the first being the confined basin of the swamp itself. This waterbody appears to be located in a depression or bowl on the landscape (> 20 meters wide), and exits this confinement through one artificial cut (pictured). Flow was observed at this point though not noticeable throughout much of the upper portions of the swamp reach. Second, the dominance of thick filamentous algae on all logs sticks and tree trunks (including coontail, *Ceratophyllum demersum*). The benthic surface was a mixture of silt/clay/muck. No deep-water run habitat was present. Specific conductance measured 98 μmhos/cm and the pH was 6.4. Overall the habitat scored 67 out of 100 the third lowest site score in the Chowan basin in 2005.

In 2005, Cole Creek rated Moderate, the same rating as when it was first sampled in 2000. Total taxa decreased from 47 in 2000 to 46 in 2005 while Biotic Index showed slight improvement (7.6 to 7.4). Most taxa collected in 2000 were found in 2005, including an unusual caddisfly, *Platycentropus*. This site remains the only locale for this taxon in the Chowan River Basin. Other EPT present in 2005 include the mayfly *Caenis* and the caddisfly *Ironoquia punctatissima*. *Polycentropus* and *Ptilostomis*, both rare in 2000 were not collected in 2005. Taxa found to be abundant in 2005 but not collected in 2000 include the chironomids *Orthocladius oliveri*, *Polypedilum illinoense* and *Zalutschia* nr *opsepta*. However, based on the taxa similarities of the two collections, Cole Creek appears to have a stable fauna. Low EPT abundance (5) and a high biotic index (7.44) suggested some moderate stress at this site. Some of the dominant taxa indicated enrichment (*Dicrotendipes simpsoni*) and low dissolved oxygen (*Physella* and *Sphaerium*).

Wiccacon River, SR 1433 (and NC 45), Hertford County

Before August 1995, the access point for the site was located on private property off NC 45, but in 1995, the sampling site was accessed by a NC Wildlife Resources Commission boat ramp off SR 1433 (approximately one and a half miles downstream). In 2005, the same wildlife boat ramp was used to access the river, but samples were taken at the historic location (pictured). The drainage area here is 253 square miles.

The most conspicuous aspect of the Wiccacon River was the large algal bloom (*Wolffia*) occurring during the collection effort. The water was cloudy and tannic colored. The channel appeared to have natural sinuosity and no evidence of dredging could be seen. In-stream habitat was abundant and diverse including sticks, logs, snags, undercut banks, macrophytes and root mats. The benthic substrate was dominated by silt and clay, but small amounts of gravel were present in the four to five meter deep channel. Benthic dissolved oxygen was low, measuring 2.8 mg/l. Specific conductance was elevated (106 µmhos/cm) and pH (7.2) reflected both an agricultural influence and the ongoing algal bloom. The habitat scored 70 out of 100.

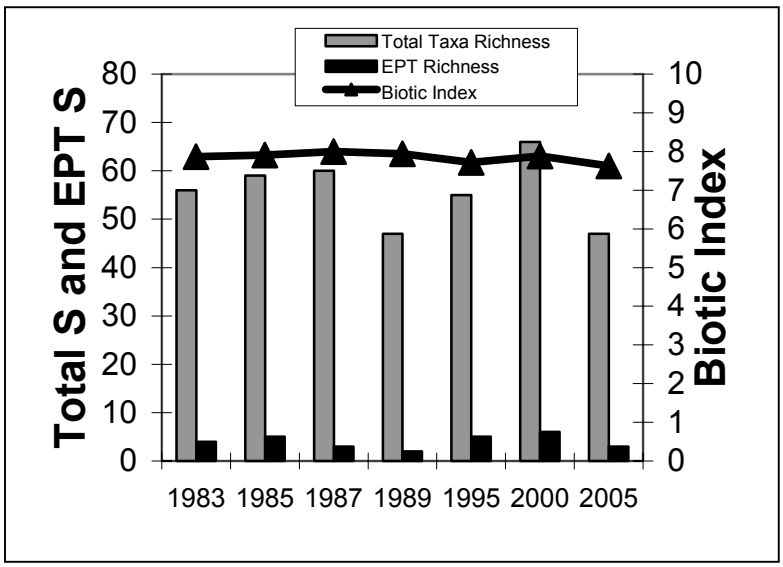

Figure 4: Wiccacon River 1983-2005

Including the 2005 collection, there have been eight benthic samples taken on the Wiccacon River since 1983 (Figure 4). In 2005, the site rated Fair, the same rating it received in 2000 and 1995. In 1989 the site rated Poor after receiving a Fair bioclassification in 1983, 1985 and 1987. A paucity of aquatic macroinvertebrates was noted during the 2005 collection; in particular Chironomids were reduced in numbers. *Chironomus* (abundant in 2000 and either abundant or common in each of the past seven sampling efforts) was not collected in 2005. Other chironomidae taxa not collected in 2005 include *Stenochironomus* (abundant in 2000), *Parachironomus* and *Phaenopsectra* sp 3. (both common

in 2000). The most abundant chironomids in 2005 suggest nutrient enrichment (*Dicrotendipes simpsoni*), degraded water quality (*Procladius* tolerance value = 9.1) and low dissolved oxygen. The only EPT taxa collected were the mayflies *Caenis* and *Callibaetis* and the caddisfly *Oecetis cinerascens*. The previous basinwide report suggested that anoxic benthic conditions might exist in this river due to the lack of *Corbicula fluminea*, an exotic and widely distributed clam. The high numbers of *Chaoborus* and *Chironomus* in deeper water in 2000 also support this possibility. Though no *Chironomus* were found in 2005, large numbers of *Chaoborus* were present. Further evidence of low dissolved oxygen conditions in the Wiccacon River in both 2000 and 2005 was the abundance of freshwater sponge on snags. At least ten types of leeches have been found at this site (five in 2005), including one uncommon species (*Placobdella translucens*- in 2000*).* A native freshwater clam, *Musculium* was collected in 2005. It represents the first record of this taxon in the Chowan River basin by DWQ.

Ahoskie Creek, NC 42, Hertford County

Ahoskie Creek at NC 42 is a channelized, sand bottom stream approximately seven meters wide with a 12-meter wide channel. The only operating USGS stream gauge in the entire Chowan River basin is located here. The drainage area of Ahoskie Creek at NC 42 is 125 square miles. The stream is highly incised and lacks in-stream habitat such as logs/snags and leaf packs. Undercut banks and remnants of non-woody plants along the banks appear to be the only refugia for macroinvertebrates in this stream. The riparian zone on one side was lacking any type of native woody vegetation. The stream was visited two times in 2005: once in February during the swamp sampling period, and once in August during the summer basinwide sampling period. Ahoskie Creek at NC 42 is a transitional site between Coastal A and Swamp classification. The habitat score was 42 during the winter swamp sampling period. Specific conductance measured 91 µmhos/cm in February and 111 µmhos/cm in August. The pH varied from 6.2 in February to 6.7 in August.

Ahoskie Creek at NC 42 has been rated using swamp stream criteria in the past but due to the transitional nature of this waterbody at this location, a Not Rated bioclassification was assigned until further data can be collected. The site was also Not Rated during the previous sampling effort here (in 1995). The biotic index differed little between the February 1995 sample (6.9) and in 2005 (6.7). In both years (during the February swamp sampling period) the taxa collected were very similar. A total of 59 taxa were found in 1995 compared with 50 in 2005. Seven EPT taxa were collected in 2005 compared with eight in 1995. Abundant EPT taxa collected in both years were *Stenonema modestum*, *Cheumatopsyche* and *Nectopsyche exquisita*. The caddisfly *Hydroptila* was abundant in February 1995 but not collected in 2005 winter samples (though it was found later in 2005 during the August sampling). The stonefly *Shipsa rotunda* was first collected here in February 2005. Two species of orthoclad Chironomidae collected here in February 2005, *Gymnometriocnemus* and *Rheosmittia*, were the first records of these taxa in the Chowan River Basin. *Gymnometriocnemus* are typically found in springs and seeps, but can also be semi-aquatic or terrestrial. *Rheosmittia* is a species known to inhabit the type of shifting sand substrates that are found throughout the sampling reach.

The August 2005 sampling effort in Ahoskie Creek at NC 42 resulted in a Not Rated bioclassification until further data can be collected. This is consistent with the February effort and the August 1995 sample (the first time it was sampled during the summer basinwide sampling period).

In August 2005, the biotic index measured 6.9; lower than in 1995 (7.6) and suggesting slightly improved water quality. A total of 72 total taxa were collected in August 2005, the highest total to date of the four samples (winter and summer). Sixty-one total taxa were collected in 1995. Eleven EPT were collected in

2005 compared to seven in 1995. Abundant EPT taxa in August 2005 include *Pseudocloeon propinquum*, *Caenis*, *Stenonema modestum*, and *Cheumatopsyche*. EPT taxa collected in August 2005 that were not collected at any time previously (winter or summer) include *Pseudocloeon propinquum*, *Procloeon* (common), *Tricorythoodes* (rare), *Oecetis* sp D, and *O*. sp E. Twenty-two Chironomidae taxa were collected in summer 2005 and summer 1995, but only *Dicrotendipes* was abundant in both collections. Other dominant chironomids that were common in one summer sample and abundant in the other include *Cryptochironomus*, *Polypedilum halterale*, and *P*. *scalaenum*.

Ahoskie Creek at NC 42 has been sampled a total of four times, twice in 1995 and twice in 2005 (swamp period and summer wadeable sampling). Preliminary data suggest that Ahoskie Creek at NC 42 is better suited for a summer sampling effort (see below). However, additional sampling is needed to ensure that a proper decision can be made regarding the most appropriate sampling period for this waterbody.

Of the ten swamp streams sampled in the Chowan basin in 2005, the Ahoskie Creek winter sampling would rank third in the number of EPT taxa, behind only Chinkapin Creek and Kirby's Creek. Chinkapin Creek received a Natural rating, the highest swamp rating possible, and Kirby's Creek is a reference site for this part of North Carolina, containing some rare and unusual taxa. Comparing the summer sample at Ahoskie Creek to the swamp samples taken in February of 2005 reveals that Ahoskie Creek would rank the highest (with 11 EPT). Also, a greater number of total taxa were collected in summer (61 and 72) versus winter in 1995 and 2005 (59 and 50). Kirby's Creek and Chinkapin Creek cease to flow in August while Ahoskie Creek not only is flowing, but also has a higher number of taxa than its winter collection. This is the opposite of swamp streams in North Carolina that have higher diversity in winter and no flow in summer (thus lower diversity in summer). It should be noted that many species collected in Ahoskie Creek can be found in either summer or winter, and that other species have been collected only once or exclusively in summer or winter.

Stony Creek, SR 1235, Bertie County

Stony Creek is a southern tributary of Ahoskie Creek and drains an area of 39 square miles. Approximately three and a half miles downstream from SR 1235 is the sampling location for Ahoskie Creek (NC 42). Stony Creek had a channel width of 10 meters in 2005, but includes extensive cypress wetlands adjacent to the stream on both banks. Active forestry operations were observed in the watershed and a clear-cut was visible on the eastern riparian zone of this site. This stream had a benthic surface comprised almost exclusively of silt and fine particles (95%) with some sand (5%). Sticks, snags, undercut banks, root mats and macrophytes were all common and provided good in-stream habitat for macroinvertebrate colonization. Specific conductance measured 71μmhos/cm and pH was 6.2. The habitat score here was 76 out of 100.

Stony Creek rated Moderate in 2005, the same bioclassification as in 2000. The biotic index measured 7.4, similar to 2000 (7.2). One difference was the number of EPT taxa found in 2005 (6) versus 2000 (2). The total number of taxa found in 2005 was an increase from 2000 (56 versus 43). Both EPT taxa found in 2000 were collected in 2005: the mayfly *Leptophlebia*, and the caddisfly *Ptilostomis*. Additionally, the winter stonefly *Taeniopteryx*, and the mayflies *Caenis*, *Paracloeodes* and *Stenacron interpunctatum* were collected in 2005. Abundant taxa collected in 2005 include *Tvetenia* sp NC, *Orthocladius oliveri*, the beetle *Neoporus*, the damselfly *Ischnura* the Isopod *Lirceus* and the snail *Amnicola*.

In the 2000 report, there was some concern that low flows here may have precluded some EPT taxa, but the biotic index for the 2000 sampling did not suggest any serious water quality problems. The community structure also did not indicate a problem with either enrichment or low dissolved oxygen.

Some taxa found at Stony Creek do not appear to have been collected anywhere else in the Chowan River Basin in 2005. These include the chironomids *Polypedilum flavum* and *Psectrocladius sordidellus*, the dipteran *Limonia*, the beetles, *Scirties*, *Tropisternus blanchardi*, and *Cybister fimbriolatus*, two leeches *Desserobdella phalera* and *Placobdella monifera*. In 2000 two other unusual taxa were noted, the beetle *Bidessonotus* and the isopod *Asellus* (= *Caecidotea*) *laticaudatus*.

Chinkapin Creek, SR 1432, Hertford County

Chinkapin Creek is a southern tributary of the Wiccacon River, with a distinct channel (8-10 meters wide) and good winter flow. The drainage area here is 50 square miles. The benthic substrate is composed of silt and woody debris (85%), with some small areas of sand. The area around this site is completely wooded although there are areas in agricultural use in the upper portions of the catchment. Specific conductance measured 114 μmhos/cm and pH was 6.7. The habitat scored 85 out of 100, the highest in the Chowan River basin in 2005. This site had a mix of substrate types, lack of channel alterations, nearly complete canopy and an unaltered riparian zone.

Chinkapin Creek had a high invertebrate taxa richness (52), resulting in a Natural bioclassification, the same rating as in 2000. There were eight EPT taxa present in 2005 (and 2000). Five of those taxa were found in 2000. New EPT found in 2005 include the mayfly *Stenonema modestum* (common), and the caddisflies *Ironoquia punctatissima* (common) and *Pycnopsyche* (abundant). The Biotic Index measured 6.5, indicating that this stream supports an intolerant macroinvertebrate community. A high diversity of crustaceans were noted in the 2000 collection (10). In 2005 only five crustacean taxa were collected. Abundant or common crustaceans from 2000 not found in 2005 include *Caecidotea forbesi*, *C. obtuss, C. Racovitzai australis, Crangonyx serratus* and *Procambarus* (O.) *acutus*. The 2000 collection recorded the first occurance in the Wiccacon River catchment of the crayfish *Orconectes virginiensis*. This species was collected here again in 2005. The benthos community structure did not indicate a problem with either enrichment or low dissolved oxygen.

SPECIAL STUDY

Bennetts Creek, SR 1400, Gates County

The Washington Regional Office (WRO) requested that Bennett's Creek at NC 37 be sampled during the 2005 sampling period. WRO was concerned about the dischargers in this watershed (Gatesville and T.S. Cooper Elementary, and Sunbury Primary Schools). The three are minor dischargers accounting for less than 15,000 gallons per day (combined limit), but all have a history of water quality violations (North Carolina Basinwide Information Management System). The biological condition of this waterway was not known, as no previous samples had been taken by BAU. The requested site could not be sampled (NC 37) due to depth, so an alternate wadeable location was found (SR 1400).

The sampling location on Bennett's Creek is just below the outfall of the millpond, downstream of SR 1400, and drains an area of 74 square miles. This site was sampled in February 2005 during the swamp sampling period. The sampled section of Bennett's Creek was upstream of one of the discharges in this

watershed (Gatesville Elementary School WWTP), but downstream of the other two. Overall, the habitat at the site was less disturbed, scoring 73 out of 100.

This site rated Moderate. A total of 40 taxa were collected in Bennett's Creek at SR 1400, the lowest total taxa of any stream or river in the Chowan Basin in 2005. EPT taxa included *Caenis* sp. (abundant), *Callibaetis* (common, and the only record in Chowan swamps in 2005), and *Cheumatopsyche* (rare). Of the ten chironomid species collected, the three that were abundant were species that are highly tolerant to pollution, *Paratanytarsus dissimilis, Hydrobaenus* and *Polypedilum illinoense. P. illinoense* can also tolerate low dissolved oxygen levels though none were recorded in the present study. The biotic index of this sample measured 8.2, indicating highly pollution tolerant biological community here overall, and was the highest biotic index in this basin in 2005. This site however, was the only collection in the Chowan basin in 2005 for: the dragonfly *Epitheca*, the chironomid *Glyptotendipies*, the Hemipteran bug *Pelocoris*, and the isopod *Caecidotea forbesi*.

The biological community in Bennett's Creek, below Merchant's Millpond, is missing intolerant taxa found in similar streams nearby in the same subbasin. The study was unable to determine to what extent the millpond itself affected the biological community in the sampling reach. Impoundments such as the one creating Merchant's Millpond create a situation where downstream reaches have lowered dissolved oxygen levels and flows, and increased temperatures. In winter those effects are minimized, so this sampling efforts would likely have not recorded them. Also, the large size of the millpond relative to Bennett's Creek could act as a sink for upstream contaminants masking any effects from the two upstream NPDES facilities (BAU memo B-051219).

Description

Subbasin 02 includes the Meherrin River and its tributary streams in North Carolina (Figure 5), although much of the river's catchment is in Virginia. The subbasin encompasses 494 square miles (NCDENR 2002). The largest of the North Carolina tributaries are Kirbys Creek and Potecasi Creek. Murfreesboro is the largest urban area in this subbasin. Other municipalities include Gaston and Rich Square. Population density (46 persons per square mile) in Chowan River subbasin 2 is similar to subbasins one and three (NCDENR 2002).

The subbasin is primarily contained within two ecological areas: the Middle Atlantic Coastal Plains; and the Southeastern Plains (Griffith *et al* 2002). Aquatic habitats in this subbasin include the Meherrin River, swamp streams (with a fairly natural channel) and channelized streams. Swamp streams normally cease flowing during dry periods, and are expected to have very low dissolved oxygen concentrations during these low-flow periods. Streams in the northern part of this subbasin are located in areas with well-drained, loamy soils, while streams to the south are in areas with poorly-drained clay soils. These regional differences may have substantial effects on both the amount of direct runoff into streams and stream permanence. Land use is mainly forestry and agriculture. There are no permitted dischargers.

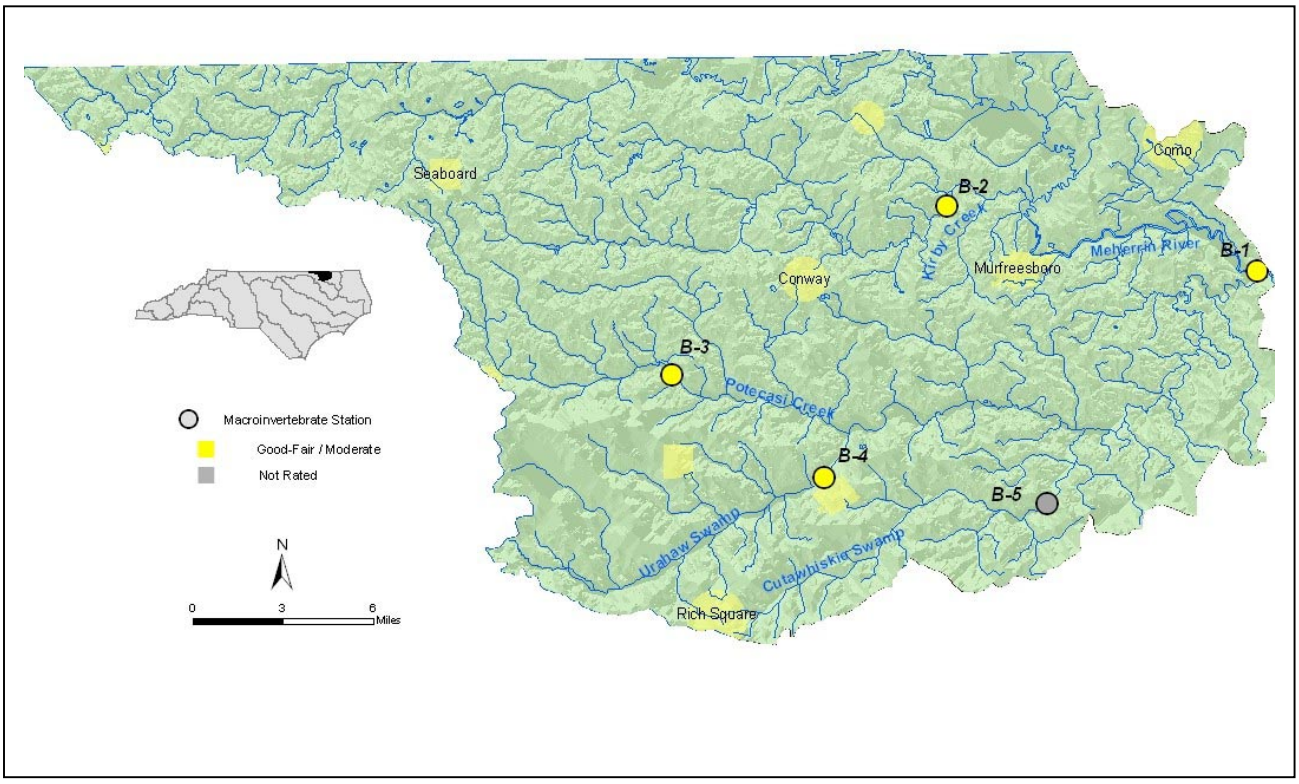

Figure 5: Chowan River subbasin 02, basinwide sampling locations

Overview of Water Quality

Macroinvertebrate data show that there has been little change in the benthic community of this subbasin since it was last sampled in 2000. The bioclassifications of the Meherrin River and Kirbys Creek decreased by one bioclassification in 2005 (Table 3). Of the four sites sampled in both 2000 and 2005, a greater number of total macroinvertebrate taxa were collected in 2005. Also, a greater number of total taxa were collected in 2005 when compared with 1995 (for the three sites in common between 2005 and 1995). The increase in total taxa from 2000 to 2005 though, was offset by a moderate increase in the biotic index from 2000 to 2005. The 2005 biotic index was slightly lower than 1995. No trend was observed with the number of EPT taxa collected at sites between 2000 and 2005 or between 1995 and 2005.

Potecasi Creek and Cutawhiskie Swamp were sampled but not rated in 2000. In 2005 they received bioclassifications of Moderate and Not Rated, respectively. Based on a preliminary analysis of current and historical data for Cutawhiskie Swamp, the most appropriate time period to sample this waterbody appears to be the summer sampling period, but additional data need to be collected in both summer and winter sampling periods to confirm this. The Meherrin River and Kirbys Creek support a large number of rare invertebrate species.

Ambient monitoring data show that Potecasi Creek (at NC 11) has a serious problem with low dissolved oxygen levels. Potecasi Creek is on the 303(d) list as an impaired stream, with low dissolved oxygen and low pH as the problem parameters. Over 44% of the samples from 2000-2005 were below five mg/l and over 25% were below four mg/l. The pH standard was violated in 22% of the readings (<6 s.u.). The dissolved oxygen problems in this subbasin continue downstream into Meherrin River. The Parker's Ferry ambient monitoring station reported that over 25% of the dissolved oxygen readings were below five mg/l and over five percent were below four mg/l.

Table 3: Waterbodies monitored in Subbasin 02 in the Chowan River basin for basinwide assessment, 2000-2005.

Map #[1]	Waterbody	County	Location	2000	2005
B-1	Kirbys Creek	Northampton	SR 1362	Natural	Moderate
B-2	Potecasi Creek	Northampton	SR 1504	Not Rated	Moderate
B-3	Urahaw Creek	Northampton	NC 35	Moderate	Moderate
B-4	Cutawhiskie Swamp	Hertford	SR 1141	Not Rated	Not Rated
B-5	Meherrin River	Hertford	SR 1175	Good	Good-Fair

[1]B = benthic macroinvertebrate monitoring sites.

Meherrin River, SR 1175 (Parker's Ferry), Hertford County

The sampling location on the Meherrin River at SR 1175 is just upstream of the NC DOT ferry operation (pictured). The river is over 200 meters wide here. The area around the site is forested with few breaks in the riparian zone. Most of the river has full sunlight with shading only on the 15% near each bank. The substrate consisted of 70% sand and 30% silt and other fine particles. Dissolved oxygen in this reach measured 4.38 mg/l, typical of other rivers in lower coastal plain of North Carolina in summer. Specific conductance measured 101 μmhos/cm and pH was 6.4. Overall, the habitat scored 75 out of 100. The drainage area at this location is 143 square miles.

The Meherrin River at SR 1175 received a bioclassification of Good-Fair in 2005 using draft Coastal B criteria. This is a decline from the Good bioclassification it received in 2000. The number of EPT, upon which the draft Coastal B criteria are based, declined from 10 in 2000 to 8 in 2005. The biotic index however, decreased from 7.7 in 2000 to 7.4 in 2005.

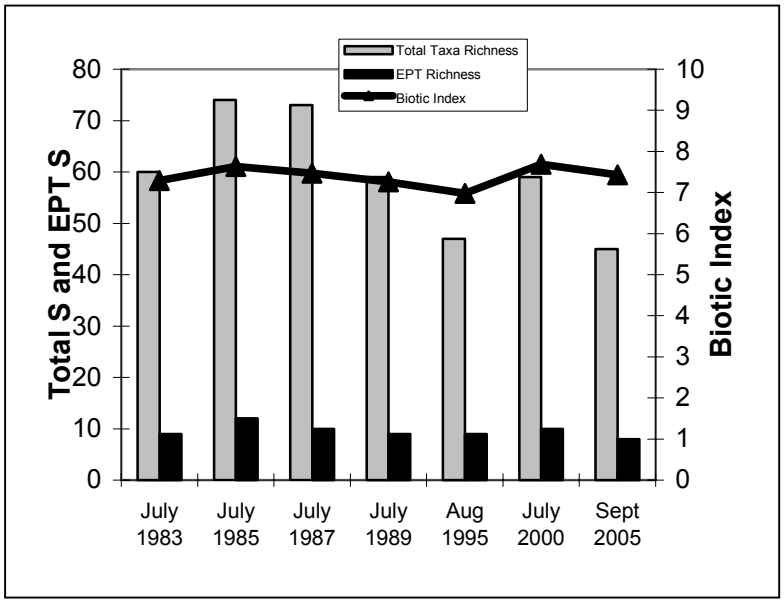

Figure 6: Meherrin River at SR 1175, 1983-2005.

The Meherrin River has been sampled eight times since 1983, seven of which have been in the summer basinwide sampling period (Figure 6). During that time the number of EPT has remained relatively stable (ranging from 8 to 12 taxa). Also, the biotic index varied little (from 7.0 to 7.7) during that same time period.

Many rare or unusual taxa have been collected from the Meherrin River. Noteable taxa included a mayfly (*Brachycercus*), a caddisfly (*Ceraclea transversa* group), a dragonfly (*Celithemis eponina)*, five midges (*Ablabesmyia simpsoni*, *Epoicocladius* (commensal on *Hexagenia* nymphs), *Hyporhygma quadripunctatum*, *Labrundinia johanseni*, and *Microchironomus)*, a crayfish (*Orconectes virginiensis*), a mussel (*Elliptio lanceolata* group), a snail (*Gyraulus deflectus)*, and in 2005, an estuarine isopod (*Cyathura polita*). Most of the taxa collected in 2005 had been found previously at the site. Besides the estuarine isopod, the caddisfly *Paranyctiophylax moestus,* and the leech, *Desserobdella phalera*, were first collected in 2005.

The Excellent rating recorded in 1985 and the subsequent increase in total taxa (many of which were rare species collected only in that year) was likely due to lower flows (decreased runoff) in that year. The previous basinwide report stated that this site might have had temporal increase in the dissolved oxygen concentration of the bottom waters. This was due to the fact that two low dissolved oxygen indicators were abundant in dredge samples only prior to 1989: *Chaoborus* (1983 - 1987) and *Limnodrilus* (1985). But in 2005, *Chaoborus* was abundant and *Limnodrilus hoffmiesteri* was common, suggesting that slow-moving or stagnant conditions may persist here for long periods of the year.

Kirbys Creek, SR 1362, Northampton County

Kirbys Creek is a swamp stream benthic reference site. This stream is close to the Coastal A category, but USGS records and DWQ observations indicate that seasonal flow interruptions may occur during summer droughts. Winter flows were strong, fast, and deep, such that sampling had to occur on the sides of the channel, rather than midstream. There was a considerable amount of snags and logs in the channel, which is somewhat braided upstream of the bridge. Root mats, undercut banks and leafpacks were present also. There is a recent (< five years) clear cut just upstream of the sampling reach that may be contributing some of the woody debris seen here. This reach has a higher gradient than the other swamp streams in the Chowan Basin that were sampled in 2005. Specific conductance measured 92 μmhos/cm and pH was 6.4. The habitat here scored 78 out of 100.

Kirby's Creek rated Moderate in 2005 after rating Natural in 1997 and 2000. The reason for the decline appears to be a lower habitat score and a decrease in the number of EPT taxa: from 12 in 2000 to 9 in 2005. The number of mayflies collected in 2005 was similar to previous years (six), with four of those taxa abundant, *Acerpenna pygmaea*, *Eurylophella doris, Leptophlebia* sp, and *Stenonema modestum*. But in 1997 and 2000, four and three stoneflies, respectively, were collected compared with only one in 2005 (the winter stonefly *Taeniopteryx*, which was abundant). Caddisfly numbers ranged from eight in 1997 to four in 2000, while only two were found in 2005 (*Pycnopsyche* and *Cheumatopsyche*). The biotic index measured 6.19, the lowest in the Chowan River Basin in 2005. However the low biotic index similar to previous samples taken here (range of 5.78 (1997) to 6.69 (1995)). The number of total taxa found in Kirby's Creek was 49. This is slightly lower than the average of 56 total taxa from the prior three samples. A large number of rare and unusual species have been found at Kirbys Creek in the past. In general, this area does not support wide populations of stoneflies, yet five winter species have been collected here since 1995 (*Amphinemura, Clioperla clio, Isoperla transmarina* group, *Perlesta*, and *Taeniopteryx*). Other unusual taxa collected here included the caddisflies *Agarodes*, *Ceraclea tarsipunctata*, and *Rhyacophila ledra* and the leech *Piscicola*. Though this site did not receive a bioclassification of Natural in 2005, it continues to harbor a healthy and intolerant aquatic community.

Potecasi Creek, SR 1504, Northampton County

Potecasi Creek had been sampled for benthos at NC 11, near Union until 1989. This site, however, was characterized by low summer flows, or was too deep, and was difficult to assign a rating using Coastal A criteria. For the 2000 and 2005 basinwide collections, winter swamp sampling was conducted further upstream on Potecasi Creek southwest of Creeksville NC. The site was located on SR 1504 at the second bridge crossing. The stream is braided at this location and separates into two distinct channels. Specific conductance measured 53 μmhos/cm, the lowest recorded value in 2005 in the Chowan River basin and indicating less human disturbance in the watershed. The habitat here appeared less disturbed than other sites in the Chowan River basin, scoring 84 out of 100, the second highest habitat score in the Chowan Basin in 2005. Improved habitat here that was not seen at other swamp sites includes natural channel morphology, intact riparian zone with a mature forest on each side,

and a large percentage of the reach available for macroinvertebrate colonization. The drainage area is 32 square miles.

Potecasi Creek was sampled but was assigned a bioclassification of Not Rated in 2000. It rated Moderate in 2005. Only one EPT was collected, the caddisfly *Ptilostomis* (rare). This compares to 2000 when another caddisfly, *Ironoquia punctatissima* was the only EPT collected at Potecasi Creek. Abundant taxa in 2005 were the dytiscid beetle, *Neoporus*, the chironomids *Tvetenia* sp NC and *Paratanytarsus dissimilis*, a black fly, *Simulium*, and the amphipods *Asellus* sp 2 and *Crangonyx*. Another dytiscid beetle collected here, *Ilybius*, was first recorded from the Chowan River basin in 2005. It has since been collected at only one other site, Bennetts Creek (Chowan subbasin 01). The biotic index measured 7.3 in 2005 and indicates a pollution tolerant community residing in Potecasi Creek.

Urahaw Swamp, NC 35, Northampton County

Urahaw Swamp joins Potecasi creek near Woodland, NC, approximately one and a half miles downstream of NC 35. The drainage area of the swamp at NC 35 is 55 square miles. Riparian vegetation was absent on the left stream bank. North of NC 35, the swamp habitat appeared much less disturbed. Conductivity measured 58 µmhos/cm, the second lowest reading in the Chowan River basin in 2005. The benthic substrate of this 10 meter wide braided stream consisted of an even mix of sand and silt. The habitat scored 70 out of 100.

This site was first sampled in 2000 when it received a Moderate bioclassification. This rating did not change in 2005 despite of the collection of five EPT taxa (compared with zero in 2000). Collected in 2005 were the mayflies *Caenis,* and *Stenacron interpunctatum* and the caddisflies*, Ptilostomis, Cheumatopsyche*, and *Polycentropus*. Over two and a half times the number of total taxa were collected in 2005 (52 versus 20). Many groups of aquatic macroinvertebrates that were not collected in 2000 were found in 2005, including beetles (two taxa), Odonates (four taxa), non-chironomid dipterans (four taxa) and megalopterans (one taxa). Also, only one species of gastropod was collected in 2000. In 2005, six gastropods were discovered. Crustaceans, diverse and numerous in 2000, continue to be collected here in large numbers. The biotic index increased from 6.8 in 2000 to 7.2 in 2005, indicating a pollution tolerant community residing in Urahaw Swamp.

Cutawhiskie Swamp, SR 1141, Hertford County

This site was visited two times in 2005: once in February during the swamp sampling period and one time in August during the summer basinwide sampling period. Prior to 2005, Cutawhiskie Swamp at SR 1141 was sampled twice in 1995 (February and August) and once in 2000 (February). Specific conductance measured 80 µmhos/cm and pH was 6.2.
Cutawhiskie Swamp is six meters wide, with a substrate of mostly coarse sand. The drainage area at SR 1141 is 36 square meters. The stream is incised (and channelized). Downstream of the bridge the substrate is uniform clay with overlying detritus, whereas upstream the bridge sand dominates. The water was turbid at the time of the February sampling. Pools were lacking in this reach. Bank erosion was common on the right side of the stream likely due to a riparian zone that contained few trees and many breaks (including a

small hog operation). Overall, the habitat score for this site was low (46). This is similar to February 2000 when the habitat scored 51 out of 100. Cutawhiskie Swamp at SR 1141 is a transitional site between Coastal A and Swamp classification. Specific conductance was higher in summer (114μmhos/cm) than winter (80μmhos/cm) in 2005 and in 1995 (125 μmhos/cm and 72 μmhos/cm).

Cutawhiskie Swamp received a bioclassification of Not Rated in February 2005. The site was Not Rated in February 2000 or February 1995. The biotic index measured 7.0 in 2005, slightly higher than in 2000 (6.9), but lower than in 1995 (7.2). Based on the biotic index of the three samples, a fairly tolerant tolerant macroinvertebrate community resides in Cutawhiskie Swamp. The macroinvertebrate taxa composition found in 2000 and 2005 were very similar. Overall, 59 total taxa were collected in 2005, compared with 49 in 2000 and 46 in 1995. Five EPT taxa were collected in 2005, compared with three in 2000 and 1995. The three EPT taxa collected in 2000 and 1995 (the mayfly *Stenonema modestum*, the stonefly *Taeniopteryx* and the caddisfly *Cheumatopsyche*) were all collected in 2005. The caddisflies *Phylocentropus* and *Pycnopsyche* were first collected here in February 2005. *Phylocentropus* was collected here both in February and August and this collection remains the only record of this taxon in 2005 in the Chowan River basin, though it was collected at three sites in the 2000 during the swamp sampling period. Filter-feeders are abundant here, including *Cheumatopysche,* the black fly *Simulium*, and the chironomids *Rheotanytarsus* and *Tribelos* (also known to tolerate enriched conditions).

In August 2005 Cutawhiskie Swamp was Not Rated due to the ongoing investigation into the most appropriate classification and subsequent sampling effort needed to properly rate this waterbody (see below). In 1995 the site also received a Not Rated bioclassification. The site was not sampled in August 2000. The biotic index was similar in 2005 (6.7) and 1995 (6.8). The number of EPT taxa collected in 2005 (eight) was twice as many as were found in 1995 (four), though EPT abundance was nearly the same (28 and 31). A greater number of total taxa were collected in 2005 (71) than 1995 (49). All four of the EPT taxa collected in August 1995 were collected in August 2005. These were the mayflies *Stenonema modestum, Centroptilum/Procloeon* and *Stenacron interpunctatum* and the caddisfly *Cheumatopsyche*. In August 2005 the mayflies *Pseudocloeon propinquum* and *Caenis* and the caddisflies *Phylocentropus* and *Pycnopsyche* were also collected. The diversity of Mollusca increased from four taxa to 10 in 2005.

Cutawhiskie Swamp at SR 1141 has been sampled five times, twice in 1995 (February and August), once in 2000 (February) and twice in 2005 (February and August). Cutawhiskie Swamp at SR 1141, like Ahoskie Creek at NC 42 (Chowan River Subbasin 01), is a transitional stream (somewhere between swamp and coastal A) and more data are needed to determine the most appropriate time period to sample this waterbody.

Preliminary analyses reveal that Cutawhiskie Swamp differs from Ahoskie Creek in that low EPT numbers were seen in winter here (an average of four taxa). But the two streams are similar in that a greater number of total taxa were collected in summer than winter. This is atypical for a true swamp stream where lack of flow or no flow at all would decrease the overall number of aquatic macroinvertebrates present. In August 2005, 71 total taxa were collected at Cutawhiskie Swamp. This would equal the Chowan River (at Riddicksville, subbasin 01) and is only one taxon fewer than Ahoskie Creek (August sample), the highest total taxa count in Chowan River Basin in 2005. The preliminary anaysis, like those at Ahoskie Creek, suggested that if only one sample be taken from this site per year, that it be taken in summer from Cutawhiskie Swamp. However, more data collection in both summer and winter is needed to properly classify Cutawhiskie Swamp at SR 1141.

CHOWAN RIVER SUBBASIN 03

Description

This subbasin contains the middle section of the Chowan River, above Rockyhock Creek and below Bennett's Creek, and includes the Indian Creek and Catherine Creek tributaries (Figure 7). Land use is mainly forested wetlands and agriculture. The largest municipality in the subbasin is Colerain with a population of approximately 221 persons. This subbasin closely compares to subbasins one and two with an average population density of 47-persons/square mile (NCDENR 2002).

Like the other subbasins of the Chowan River basin, subbasin 03 is designated as Nutrient Sensitive Waters. This subbasin contains the Colerain/Cow Island Swamp and Slopes Natural Heritage Areas. Perhaps the most important wetland community in this Chowan River subbasin is Tidal Cypress-Gum Swamp, which is found along much of the shoreline of the Chowan River.

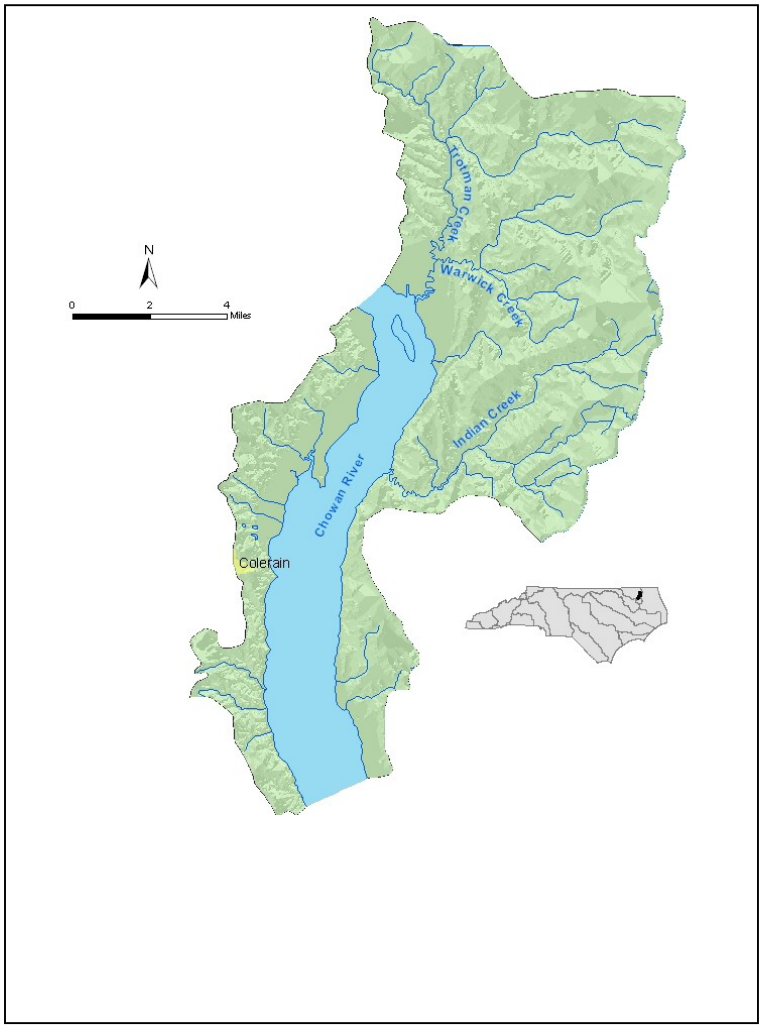

Figure 7: Chowan River subbasin 03

Overview of Water Quality

The Chowan River is 303(d) listed from below Holiday Island near Harrellsville, NC to the subbasin 03-04 boundary. Nutrients, Industrial point sources, and a municipal point source are listed as the reasons for the listing. Most of the historical information about water quality in this subbasin has come from two ambient monitoring stations and phytoplankton sampling.

Two ambient monitoring stations exist on the Chowan River in subbasin 03, one at Colerain and the other at Holiday Island. These show elevated iron levels, a common occurrence in this basin. Dissolved oxygen and pH standards were not exceeded in most cases, unlike the upper portions of the Chowan River (subbasin 01). Some salinity occurs in this stretch of the Chowan River, with readings as high as

3.0 ppt. In the previous basinwide report phytoplankton blooms were mentioned as a frequent problem in this portion of the Chowan River (especially from 1970-1978). Apparently a reduction in nutrient inputs has led to a steady decline in both the frequency and intensity of algal blooms (NCDENR 2002). This trend is evident in comparing recent data from the Chowan River near Colerain (1995-2000) to data from 1980-1994 (NCDENR 1997).

There are currently two NPDES permit holders in the basin, one minor, Perry-Wynns Fish Company in Bertie County (NC0002402), and one major, Edenton Dyeing and Finishing LLC in Chowan County (NC 0003867). In addition, three facilities with individual storm water permits exist.

Perry-Wynns Fish Company, classified as a Industrial Process and Commercial facility, discharges 24000 gal/day to the Chowan River. Edenton Dyeing and Finishing LLC discharges 150,000 gal/day into the Chowan River. The latter is required to conduct whole effluent toxicity testing. The facility experienced failing chronic toxicity tests in 2004 and 2005 and enforcement action was taken on five separate occasions. Currently they are in compliance with the WET limit.

No collections of benthic macroinvertebrate or fish community structure have been made in this subbasin. Previous reports have stated that fish tissue is monitored by Union Camp and that it has shown significant dioxin contamination, especially in catfish, but levels along the lower Chowan River seemed to be decreasing as a result of mill improvements. In 2000, a fish consumption advisory was lifted after dioxin fish tissue concentrations were shown to be a safe levels for two consecutive years (1998-1999).

Due to the lack of biological sampling in this subbasin, reconnaissance was conducted in 2005 to determine potential sites for future sampling (Table 4).

Table 4: Potential biological sampling locations in Subbasin 03 in the Chowan River basin for future basinwide assessments

Waterbody	Location	County
Chowan River	Holiday Island	Chowan
Chowan River	below Arrowhead Beach	Chowan
Indian Creek	NC 32 (Welch Road)	Chowan
UT Warwick Creek	NC 32 (Welch Road)	Chowan
Warwick Creek	SR 1232 (Cannon Ferry/Catherine's Creek Road)	Gates/Chowan
Trotman Creek	SR 1100 (Carters Road)	Gates

CHOWAN RIVER SUBBASIN 04

DESCRIPTION

This subbasin contains the lower Chowan River (near Edenton) and a few small tributaries including: Salmon Creek (the largest of these tributaries), Edenton Bay and Pembroke Creek. Also in this subbasin is a small northwest portion of Albemarle Sound, including the west side of the mouth of the Chowan River, below US 17 (Figure 8). This subbasin contains portions of the Chowan Game Land, a track managed by the Wildlife Resources Commission. This property is one of four publicly owned conservation lands in the subbasin.

Subbasin 04 has a population density of 67 persons/square mile, making it the most densely populated subbasin in the entire Chowan River basin (NCDENR 2002). Edenton is the largest municipality in the subbasin. Currently there are three NPDES minor permits and nine general permits. No facilities are required to conduct whole effluent toxicity testing under their permit conditions.

The three minor dischargers, all of who are located in Chowan County, are Valhalla WTP (NC0032719), Freemason WTP (NC0007552) and Beaver Hill WTP (NC0086291). The Valhalla facility discharges to Rockyhock Creek, while Freemason and Beaver Hill discharge to Pembroke Creek. There are no violations recorded for the three facilities.

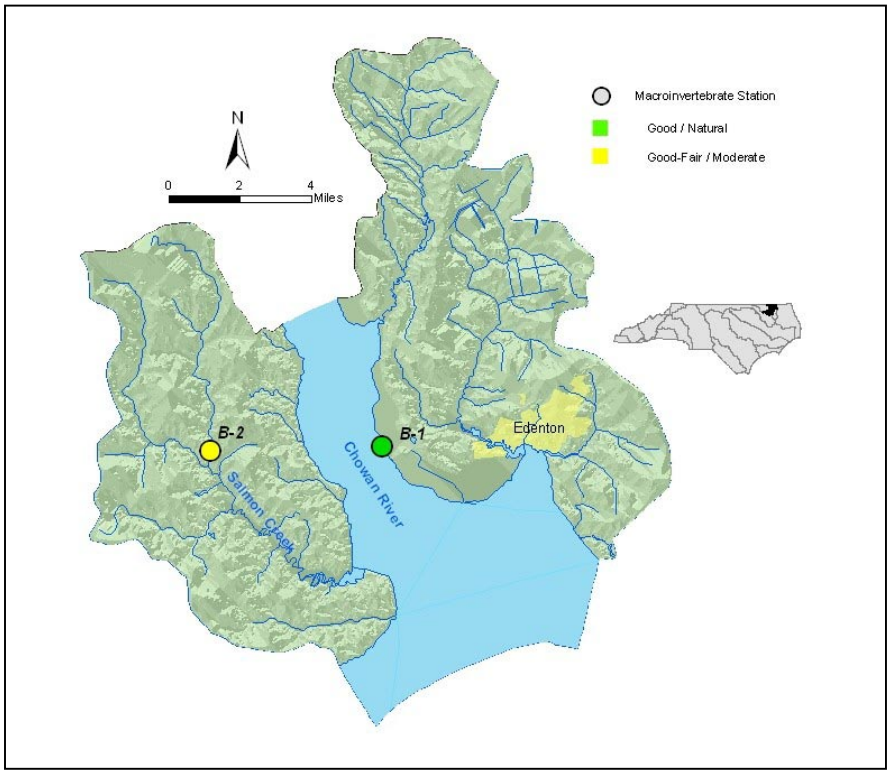

Figure 8: Map of Chowan River subbasin 04, basinwide sampling locations

Overview of Water Quality

Aquatic macroinvertebrate data from the two sampling locations in this subbain suggest little change in water quality from 2000 to 2005. A sampling location near US 17 on the Chowan River improved from Good-Fair in 2000 to Good in 2005. The only other site in this subbasin, Eastmost Swamp, received the same bioclassification in 2005 as in 2000 (Moderate). Benthic macroinvertebrates collected in the Chowan River were diverse and indicated no problems with dissolved oxygen, nutrients or pH.

Four ambient monitoring stations exist in this subbasin, three in Albemarle Sound and one near the benthic site on the Chowan River at US 17. Dissolved oxygen and pH do not appear to be a problem in this stretch of the Chowan River. Salinities as high as 3.63 ppt have been recorded at Edenhouse from 2000-2005, with 10% of the readings here above 3.0 ppt. The Chowan River is 303(d) listed for nutrients from the boundary of subbasins 03 and 04 to Albemarle Sound.

Table 5. Waterbodies monitored in Subbasin 04 in the Chowan River basin for basinwide assessment, 2000-2005.

Map #[1]	Waterbody	County	Location	2000	2005
B-1	Chowan River	Chowan	US 17	Good-Fair	Good
B-2	Eastmost Swamp	Bertie	SR 1361	Moderate	Moderate

[1]B = benthic macroinvertebrate monitoring sites

RIVER AND STREAM ASSESSMENT

Chowan River, US 17, Chowan County

This site near Edenton is located at the mouth of the Chowan River before it empties into Albemarle Sound, a drainage area of over 2,550square miles. The river is ~ 1 mile wide here, shallow at the margins, and subjected to occasional salt-water intrusions. Salt-water of up to 3.6 ppt have been recorded here (during the drought period of 2001 and 2002). During the past five years of monthly ambient monitoring, salinity values over 3.0 ppt have only been recorded 10% of the time. In the past, this site was classified both as a freshwater site and an “oligohaline” site (i.e. an estuarine classification with a salinity from 0.5 to 5.0 ppt). Historically, it was considered as estuarine because an oligohaline clam (*Rangia cuneata*) and several oligohaline crustaceans (*Cyathura polita* and several other isopods) frequently occurred here. Conductivity values, however, have not consistently been representative of an estuarine system. With the exception of 1985, 1986 and 2005, all invertebrate samples have been collected at a specific conductance < 350 µmhos/cm. Due to this low salinity all samples were assigned a bioclassification based on Coastal B Criteria (Appendix). Given the most current data collection in combination with the historical record, the Chowan River at US-17 should continue to be sampled as a freshwater site; that is, a freshwater system with saltwater intrusions from 0.5 to 5.0 ppt, which is referred to as “oligosaline” (Cowardin et al. 1979). Specific conductance was 400 µmhos/cm in 2005 and dissolved oxygen measured 5.6 mg/l with pH near neutral (6.9 units).

The Chowan River at US 17 has been sampled for macroinvertebrates nine times since 1983. Bioclassifications at this site have ranged from Fair (1985) to Good (1990, 2005), but only beginning in 1995 were draft Coastal B Criteria used. In 2005, the Chowan River at US 17 received a bioclassification of Good using draft Coastal B Criteria. This is an improvement from Good-Fair in 2000 and reflects the addition of the four EPT taxa collected in 2005 for a total of ten (Figure 9).

EPT taxa collected in both 2000 and 2005 were the mayflies *Pseudocloeon ephippiatum* and *Stenonema integrum* (both Abundant in both years), and the microcaddisfly *Hydroptila* (Rare in 2000, Abundant in 2005). EPT taxa collected in 2005 that were not found in 2000 include the mayflies *Caenis* and *Stenacron interpunctatum* (both Common) and the caddisflies *Ceraclea maculata,* (Rare) *Cyrnellus fraturnus* (Rare), *Neotrichia* (Rare), *Oecetis cinerascens* (Common), and *Triaenodes injustus* (Rare). The collection of *Neotrichia* is noteworthy as there are only 15 records for it in North Carolina.

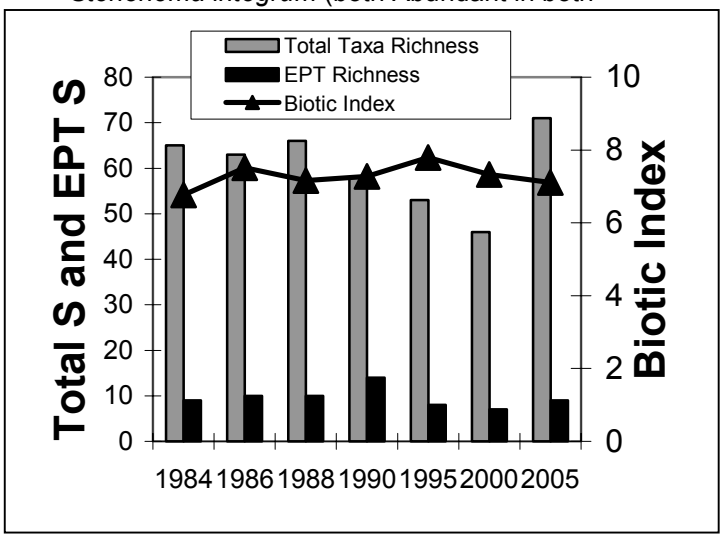

Figure 9: Chowan River at US 17, 1983-2005

Besides *Neotrichia* some other new taxa were found here in 2005. These included the caddisfly *Oecetis cinerascens*, the chironomid *Cricotopus vieriensis* group, the oligochaete worm *Pristinella*, the crustacean *Edotea triloba* and the pelecypod *Mytilopsis leucophaeta*. Taxa found in all of the nine samples taken here since 1983 included the mayfly *Stenonema integrum*, the estuarine crustacean *Cyathura polita*, and the exotic clam *Corbicula fluminea*. The biotic index was similar in 2000 (6.62) and 2005 (6.72) suggesting that water quality changed little during that time. During the period of record, the biotic index has ranged from 6.3 (1990) to 7.1 (1983).

Eastmost Swamp, SR 1361, Bertie County

Eastmost Swamp had a distinct channel near the bridge (six meters wide) though was braided upstream. The depth averaged 0.3 meter. A beaver dam alters the channel within the sampling reach. A beaver dam was also present during the 2000 sampling. Recent desnagging operations occurred upstream of the site limiting some in-stream and riparian habitats. Other in-stream habitat such as undercut banks, detritus and aquatic weeds were common. At least three types of macrophytes were found in the pools, and filamentous algae were abundant. There were few pools, although water was impounded behind the beaver dam. The

substrate consisted of mostly silt and clay, with sand accounting for only 30%. The drainage area at SR 1361 is 12 square miles. The habitat scored 76 out of 100.

Eastmost Swamp at SR 1361 rated Moderate in 2005 and 2000. The biotic index changed little between 2000 (7.4) and 2005 (7.3), indicating a tolerant aquatic community residing in Eastmost Swamp. Macroinvertebrates collected here were similar in both years with 47 total taxa found in 2005 compared with 56 in 2005. Three EPT were collected in 2005 compared with five in 2000, the mayfly *Caenis*, the winter stonefly *Taeniopteryx* and the caddisfly *Ironoquia punctatissima*. All three EPT taxa collected in 2005 were abundant. The mayfly *Leptophlebia* and the caddisflies *Cheumatopsyche* and *Ptilostomis* were collected in 2000 but not in 2005. Eight species of crustaceans were collected in 2000 but only four were collected in 2005. *Caecidotea forbesi* and *Hyalella*, abundant in 2000, were not collected in 2005.

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GLOSSARY

Bioclass	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.
CHL *a*	Chlorophyll *a*.
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, and soil type. Examples include Southern Outer Piedmont, Carolina Flatwoods, Sandhills, and 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 as 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.
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.
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. Benthic Macroinvertebrate Sampling Methods and Criteria.

Standard Qualitative (Full Scale)
Benthic macroinvertebrates can be collected from wadeable, freshwater, flowing waters using two 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).

Boat Sampling
Most collections are in wadable streams, but there are some locations where a boat is required. These are usually large coastal plain rivers, like the Chowan River Basin. In such habitats, petite ponar dredge sampling replaces kick-net samples, but all other standard qualitative collection techniques are still useable. Most of these localities have little or no visible current. Coastal B criteria are used to evaluate such sampling sites.

The standard boat method still aims at a total of 10 composite samples per site. Sweeps, epifaunal collections, visuals, part of leaf-pack/debris sample are preformed along the edges in wadeable depths, while the petite ponar samples are collected from deeper areas using the boat, along with at least part of leaf-pack/debris sample, part of one epifaunal wash,and part of visuals (logs in the current). Petite ponars are collected at thee locations between midstream and the bank, with three replicates at each locations (a total of nine samples). The three locations should include a variety of depths, with at least one location in the 2-3 meter range. No petite ponars are collected from the area normally sampled during shore work, i.e., <2 meters in depth.

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. This low flow period usually occurs during the summer, but flowing water should be present in swamp streams during the winter. Sampling during winter, high flow periods provides the best opportunity for detecting differences in communities from what is natural, and only winter (February to early March) benthos data can be used when evaluating swamp streams. 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 s.u. or lower cannot be rated, and even those below 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 (1 series of 3 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. Samples are picked on site. The primary output for this sampling method is a taxa list with an indication of relative abundance (Rare, Common, Abundant) for each taxon.

Habitat Evaluation
Assessment forms have been developed by the Biological Assessment Unit to better 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

Standard Qualitative (Full Scale)
Criteria for bioclassifications for standard qualitative and EPT samples are given in Tables B-1 – B-3. EPT S and the NCBI are used for rating standard qualitative samples. Bioclassifications for EPT samples are based solely on EPT S.

Table B-1. Criteria for Standard Qualitative (Full Scale) Method.

Score	Biotic Index Values	EPT Values
	Coastal Plain (CA)	Coastal Plain (CA)
5	< 5.42	> 28
4.6	5.42 - 5.46	28
4.4	5.47 - 5.51	27
4	5.52 - 6.00	22 - 26
3.6	6.01 - 6.05	21
3.4	6.06 - 6.10	20
3	6.11 - 6.67	15 - 19
2.6	6.68 - 6.72	14
2.4	6.73 - 6.77	13
2	6.78 - 7.68	8 - 12
1.6	7.69 - 7.73	7
1.4	7.74 - 7.79	6
1	> 7.79	≤ 5

Table B-2. Biotic Index corrections for non-summer data. Summer = Jun – Sep; Fall = Oct – Nov; Winter = Dec – Feb; and Spring = Mar – May.

Region	Season		
	Fall	Winter	Spring
Piedmont	+0.1	+0.1	+0.2
Coastal A	+0.2	+0.2	+0.3

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 mountain, piedmont and coastal plain streams are used for the Roanoke River basin. EPT abundance and Total taxa richness calculations also are used to help examine between-site differences in water quality.

EPT S and BI values can be affected by seasonal changes. DWQ criteria for assigning bioclassification are based on summer sampling: June - September. For samples collected outside summer, EPT S can be adjusted by subtracting out winter/spring Plecoptera or other

adjustment based on resampling of summer site. The BI values also are seasonally adjusted for samples outside the summer season.

Boat Samples, Coastal B Rivers Criteria

The Biological Assessment Unit has limited data on Coastal B, thus, draft criteria have been developed based only on EPT taxa richness.However, biotic index values and total taxa richness values were also evaluated for between year and among site comparisons. The criteria that are presented here will continue to be evaluated, and any bioclassifications derived from them should be considered tentative and not used for use support decisions.

Table B-3 Draft Criteria for Coastal B Rivers

Bioclassification	EPT S
Excellent	> 11
Good	9-11
Good-Fair	6-8
Fair	3-5
Poor	<3

Swamp Stream Criteria

Swamp stream criteria evaluate a stream based on three benthic macroinvertebrate metrics (Total taxa richness, EPT taxa richness, and Biotic Index) and the coastal plain form habitat value. The values for each of these metrics is used to derive a score for each metric, using the tables and graphs below. There are only three possible scores for each metric. A score of 5 is assigned if the metric value falls within the range for Natural, a score of 3 is assigned to values in the range for Moderate and a score of 1 is assigned to values in the range given for Severe. The final site score is derived by the formula:

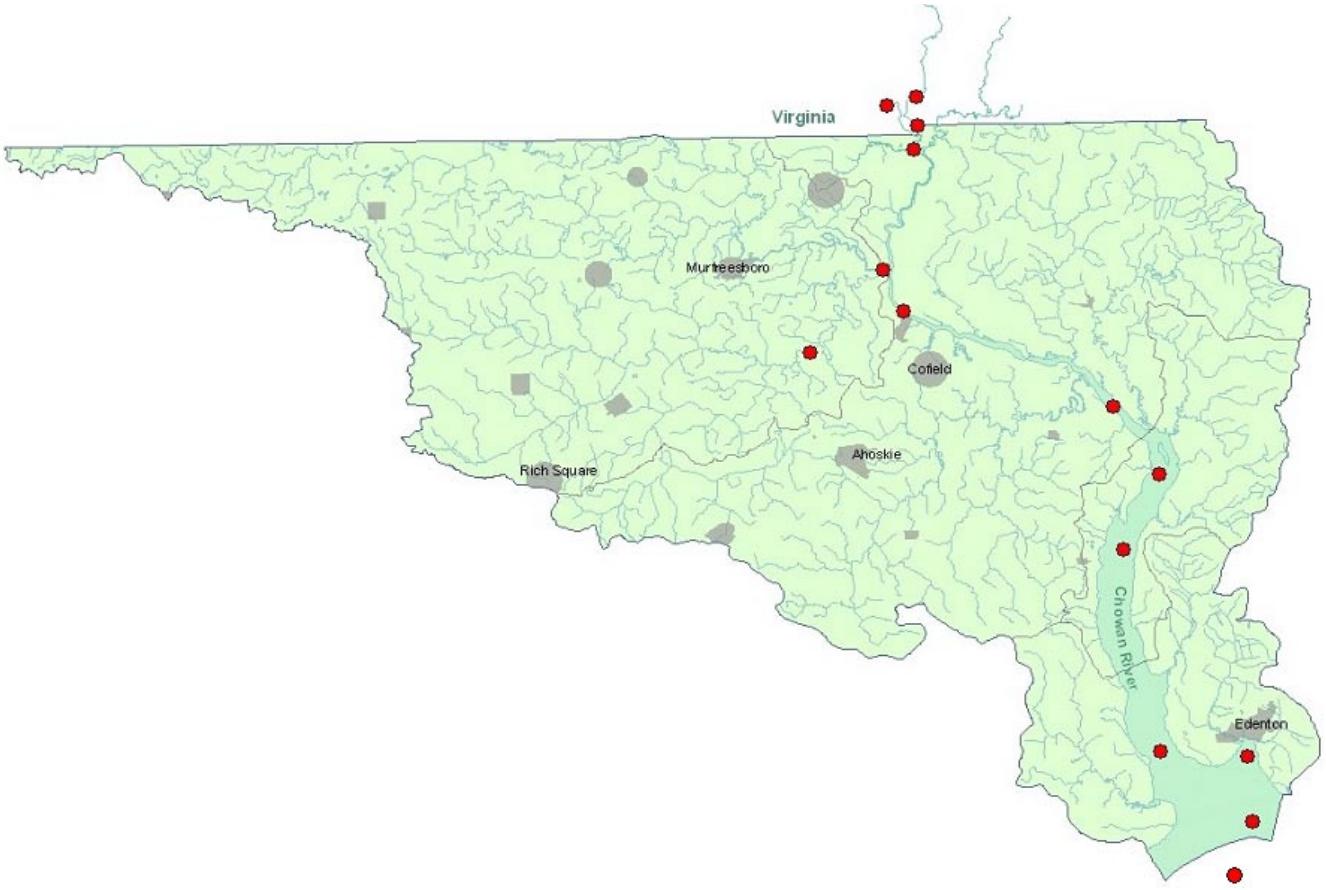
Site Score = [(2xBI score + Habitat Score + EPT S score + Taxa Richness Score) – 5]/2

Stress ratings based on the scores are: Natural (9 - 10), Moderate (4 - 8) and Severe (1 - 3).

Appendix B-2. Benthic macroinvertebrate data collected in the Chowan River basin, 2000 – 2005. Basinwide monitoring sites are in bold.

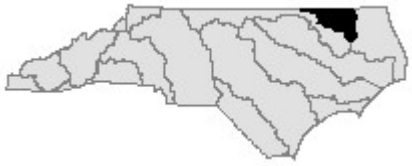
Subbasin/ Waterbody	Location	County	Map #	Index No.	Date	S	EPT S	BI	EPT BI	BioClass
01										
Chowan R	nr Riddicksville	Hertford	B-1	25	09/28/05	71	9	7.11	5.61	Good
					07/31/00	46	7	7.33	5.84	Good-Fair
Chowan R	nr Gatesville	Gates	B-2	25	09/27/05	49	5	6.85	4.82	Fair
					08/01/00	62	9	7.22	4.70	Good
Cole Cr	US 158*	Gates	B-3	25-12-7	02/05/05	46	3	7.43	7.7	Moderate
					02/10/00	47	4	7.60	7.00	Moderate
Wiccacon R	SR 1433	Hertford	B-4	25-14	08/22/05	47	3	7.63	7.61	Fair
					08/01/00	66	6	7.88	6.80	Fair
Ahoskie Cr	NC 42	Hertford	B-5	25-14-1	02/09/05	50	7	6.70	4.95	Not Rated
					08/25/05	72	11	6.94	5.94	Not Rated
Stony Cr	SR 1235	Bertie	B-6	25-14-1-6	02/10/05	56	6	7.40	6.46	Moderate
					02/10/00	43	2	7.21	6.34	Moderate
Chinkapin Cr	SR 1432	Hertford	B-7	25-14-3	02/10/05	56	6	7.40	6.46	Natural
					02/10/00	60	8	6.98	6.22	Natural
Bennetts Cr	SR 1400	Gates	B-8	25-17	02/09/05	40	3	8.20	7.82	Moderate
02										
Kirbys Cr	SR 1362	Northampton	B-1	25-4-4	02/07/05	49	9	6.19	5.04	Moderate
					02/17/00	54	12	6.25	5.10	Natural
Meherrin R	SR 1175	Hertford	B-2	25-4-(5)	09/27/05	45	8	7.42	5.9	Good-Fair
					07/31/00	59	10	7.68	6.41	Good
Potecasi Cr	SR 1504	Northampton	B-3	25-4-8	02/07/05	44	1	7.31	6.40	Moderate
					02/09/00	24	1	6.97	7.78	Not Rated
Urahaw Swp	NC 35	Northampton	B-4	25-4-8-4	02/07/05	52	5	7.19	6.31	Moderate
					02/09/00	20	0	6.83	-	Moderate
Cutawhiskie Swp	SR 1141	Hertford	B-5	25-4-8-7	02/08/05	59	5	6.97	5.50	Not Rated
					08/26/05	71	8	6.70	5.56	Not Rated
					02/02/00	49	3	6.88	5.80	Not Rated
04										
Chowan R	US 17	Chowan	B-1	25	08/22/05	41	10	6.71	5.54	Good
					08/01/00	29	6	6.61	4.65	Good-Fair
Eastmost Swp	SR 1361	Bertie	B-2	25-24-1	02/10/05	47	3	7.32	6.86	Moderate
					02/22/00	56	5	7.42	6.68	Not Rated

*Cole Cr at US 158 erroneously listed at US 58 in 2000 sampling.



Chowan River Basin
Ambient Monitoring System Report

September 1, 2000 through August 31, 2005



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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 examined 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 (September 1, 2000 through August 31, 2005) chemical and physical measurements were obtained by DWQ from 14 stations located throughout the Chowan River Basin. One additional location is monitored for bacterial issues by the N.C. Recreational Water Quality Program. 241 are monitored statewide. Information on the program can be found here: http://www.deh.enr.state.nc.us/shellfish/Water_Monitoring/RWQweb/home.htm. The program meets all the requirements of the EPA national beach rule.

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 numeric standard, or an action level as specified in 15A NCAC 2B .0200 (Table 3). If less then 10 results were collected, then no comparison to evaluation levels was made. When more than 10 percent of the results exceeded the evaluation level, a binomial statistical test was employed to determine if there was sufficient statistical confidence (95% confidence) to conclude that the results statistically exceed the 10% criteria. When that is found to be true, it is termed a *statistically significant exceedance* (SSE). This criterion was applied to all parameters with an evaluation level, except for fecal coliform bacteria. The criteria for fecal coliform varied based on the classification of the water body. 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.

All data were collected between September 1, 2000 and August 31, 2005. Stations with SSEs were found for dissolved oxygen < 4 mg/L (one site), dissolved oxygen < 5 mg/L (five sites), pH (one site), and total iron (11 sites). For all parameters, two additional 10 percent violations (both for dissolved oxygen) that were not SSEs also occurred.

No 10 percent violations occurred for chlorophyll a during the assessment period. This represents a significant improvement over the historical problems faced in the Chowan Basin concerning algal blooms. All point sources were removed from the Chowan River basin during corrective actions in the 1970's and 1980's, which over time has resulted in reductions in chlorophyll a and nutrient concentrations.

Among the 14 stations in the basin, D4150000, Potecasi Creek, has the lowest median dissolved oxygen and pH concentrations, and the highest turbidity, total kjeldahl nitrogen, total phosphorus, fecal coliform, and iron. This station has three SSEs, for dissolved oxygen (<4), pH, and iron. In addition, this station has significant upward trends in total kjeldahl nitrogen, total phosphorus, and fecal coliform. Concerning pH, the trend information indicates that violations of the standard occurred nearly entirely during the drought, and may be attributable to it.

The following table gives a summary of the problem areas using these criteria. While reading the table please note the following: The majority of the parameters listed are compared directly to water quality standards, and those are highlighted in blue. There are two exceptions, 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 violations should be taken as a recommendation to collect the data required by the standard. The second exception is the dissolved oxygen (< 5 mg/l) standard. For fresh waters, the 5 mg/l standard is a daily average. The 4 mg/l standard applies to all waters and all samples.

Table 1. Exceedances in the Chowan River Basin

Subbasin / Station ID	Location	Class	Parameter / Evaluation Level	% Exceed	% Conf
1	**Chowan River - Upper Section and Blackwater River**				
D0001800	Blackwater Riv .5 Mi Ups Mouth Nr Wyanoke	B NSW	Dissolved Oxygen (<4)	15.1%	92.2%
			Dissolved Oxygen (<5)*	39.6%	100.0%
			Total Iron (>1000)	70.6%	100.0%
D0010000	Chowan Riv Nr Riddicksville	B NSW	Dissolved Oxygen (<5)*	33.3%	100.0%
			Total Iron (>1000)	66.7%	100.0%
D6250000	Chowan Riv At Us 13 At Winton	B NSW	Dissolved Oxygen (<5)*	20.0%	99.3%
			Total Iron (>1000)	94.4%	100.0%
D8356200	Chowan Riv At Cm 16 Nr Gatesville	B NSW	Dissolved Oxygen (<5)*	10.7%	67.4%
			Total Iron (>1000)	75.0%	100.0%
2	**Meherrin River and Potecasi Creek**				
D4150000	Potecasi Crk At Nc 11 Nr Union	C NSW	Dissolved Oxygen (<4)	25.4%	100.0%
			Dissolved Oxygen (<5)*	44.1%	100.0%
			pH (<6)	22.0%	99.8%
			Total Iron (>1000)	95.0%	100.0%
D5000000	Meherrin Riv At Sr 1175 Parkers Ferry Nr Como	B NSW	Dissolved Oxygen (<5)*	25.5%	100.0%
			Total Iron (>1000)	71.4%	100.0%
3	**Chowan River - Middle Section**				
D8430000	Chowan Riv At Cm 12 Dns Holiday Island	B NSW	Total Iron (>1000)	63.2%	100.0%
D8950000	Chowan Riv Cm 7 At Colerain	B NSW	Total Iron (>1000)	57.1%	100.0%
4	**Chowan River - Lower Section and Albemarle Sound**				
D9490000	Chowan Riv At Us 17 At Edenhouse	B NSW	Total Iron (>1000)	40.0%	100.0%
D999500C	Albemarle Sound Nr Edenton Mid Channel	B NSW	Total Iron (>1000)	30.0%	99.8%
D999500N	Albemarle Sound Nr Edenton N Shore	B NSW	Total Iron (>1000)	23.8%	98.6%

Blue entries indicate violations of standards. Black entries indicate violations of evaluation levels.

* Applies to saltwater (class SA, SB, and SC) primarily, and to freshwater (class B, C, and WS) as a daily average (and therefore not blue for violations in freshwater areas).

INTRODUCTION

The DWQ's Ambient Monitoring System is a network of stream, lake, and estuarine stations 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. Currently the DWQ does not conduct probabilistic (random) monitoring.

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 14 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)	✔	✔

[1]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.

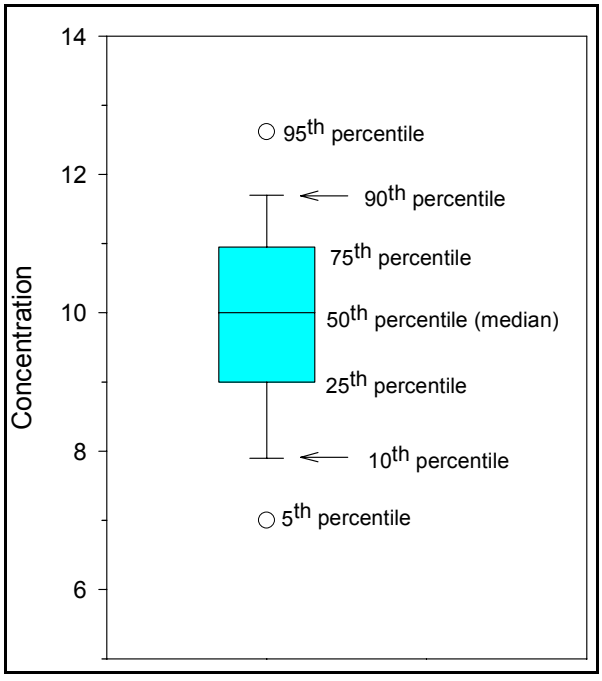


Figure 1. Explanation of box plots.

Table 3. Selected standards for parameters sampled as part of the Ambient Monitoring System.[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. August 1, 2004).
[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).

	Standards for All Saltwater			Standards To Support Additional Uses	
Parameter (µg/L, unless noted)	Aquatic Life	Human Health[1]	Class SA[2]	HQW	Swamp Waters
Arsenic		10			
Cadmium	5.0				
Chlorophyll *a* (corrected)	40[3]				
Chromium, total	20				
Coliform, fecal (MFFCC/100ml)[4]		200[3]	14[3]		
Copper, total	3[5]				
Dissolved oxygen (mg/L)	5.0[9]			6.0	[3, 6]
Lead	25[3]				
Mercury	0.025				
Nickel	8.3				
PH (units)	6.8 - 8.5[6]				[3, 6]
Selenium	71				
Silver	0.1[5]				
Solids, total suspended (mg/L)				10 PNA[7], 20 other[8]	
Turbidity (NTU)	25[3]				
Zinc	86[5]				

[1]Standards are based on consumption of fish only unless dermal contact studies are available, see 2B.0208 for equation.
[2]Class SA = shellfishing waters, see 2B.0101 for description.
[3]See 2B.0220 for narrative description of limits.
[4]MFFCC/100ml means membrane filter fecal coliform count per 100 ml of sample.
[5]Values represent action levels as specified in 2B.0220.
[6]Designated swamp waters may have a dissolved oxygen less than 5.0 mg/L and a pH as low as 4.3 s.u., if due to natural conditions.
[7]PNA = Primary Nursery Areas.
[8]For effluent limits only, see 2B.0224.
[9]Swamp waters, poorly flushed tidally influenced streams, or embayments, or estuarine bottom waters may have lower values if caused by natural conditions.

Table 4. DWQ Monitoring stations in the Chowan River Basin, 2000 - 2005.

Subbasin/ Station ID	Location	Class	Lat.	Long.
1	**Chowan River - Upper Section and Blackwater River**			
D0000050	Nottaway River at US 258 near Riverdale, Virginia	II Estuarine	36.56683	-76.94646
D0001200	Blackwater River at Horseshoe Bend at Cherry Grove, Virginia	II Estuarine	36.57341	-76.91795
D0001800	Blackwater River .5 MI upstream of Mouth near Wyanoke	B NSW	36.55118	-76.91711
D0010000	Chowan River near Riddicksville	B NSW	36.53201	-76.92096
D6250000	Chowan River at US 13 at Winton	B NSW	36.40263	-76.93434
D8356200	Chowan River at CM 16 near Gatesville	B NSW	36.32360	-76.73354
2	**Meherrin River and Potecasi Creek**			
D4150000	Potecasi Creek at NC 11 near Union	C NSW	36.37121	-77.02591
D5000000	Meherrin River at SR 1175 Parkers Ferry near Como	B NSW	36.43653	-76.95332
3	**Chowan River - Middle Section**			
D8430000	Chowan River at CM 12 downstream of Holiday Island	B NSW	36.26890	-76.69140
D8950000	Chowan River near CM 7 at Colerain	B NSW	36.20983	-76.72677
4	**Chowan River - Lower Section and Albemarle Sound**			
D9490000	Chowan River at US 17 at Edenhouse	B NSW	36.04760	-76.69611
D999500C	Albemarle Sound near Edenton Mid-Channel	B NSW	35.99002	-76.60920
D999500N	Albemarle Sound near Edenton North Shore	B NSW	36.04216	-76.61279
D999500S	Albemarle Sound near Edenton South Shore	SB	35.94793	-76.60793

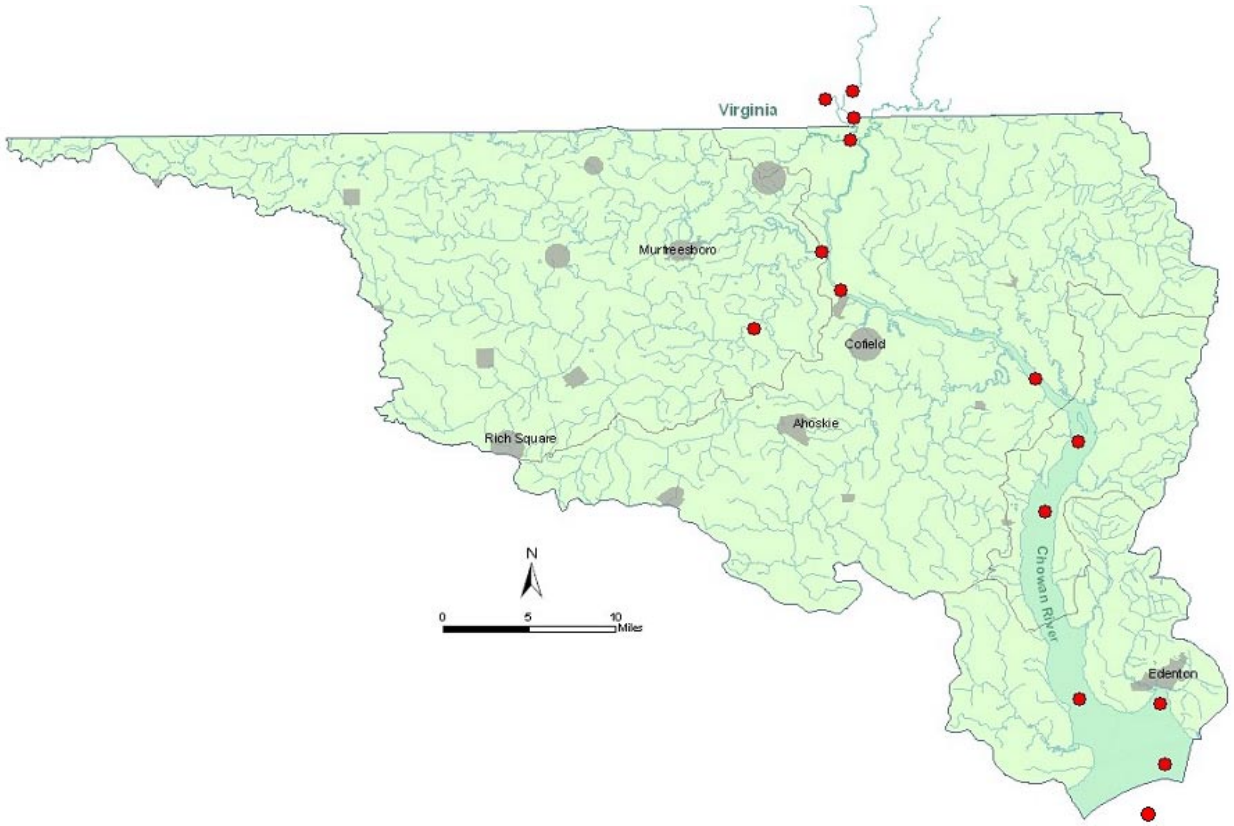


Figure 2. DWQ's Ambient Monitoring System in the Chowan River Basin.

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-detected) were evaluated as equal to the reporting level. Box and whisker plots (constructed using SigmaPlot version 8.02) 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

Three issues were noted by the DWQ Laboratory Section as part of the analytical processes during this assessment period:

1) Between February and April 2001, improved analytical techniques and protocols for nutrient samples were implemented. No nutrient samples were processed during the period when the techniques and protocols were being implemented.
2) In early 2001 the Laboratory Section reviewed their internal QA/QC programs and some of the analytical methods. This effort resulted in a temporary increase in reporting levels for certain parameters. New analytical equipment and methods were subsequently acquired to establish more accurate reporting levels and rigorous quality assurance. Because of the improvements, the reporting levels quickly declined back down to or near the previous reporting levels. Nutrients were especially affected by these changes (Table 5).
3) 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.

Table 5. Changes in the Laboratory Section's reporting levels for nutrients.

	Reporting Level By Date (mg/l)			
Parameter	**Pre-2001**	**3/13/2001 to 3/29/2001**	**3/30/2001 to 7/24/2001**	**7/25/2001 to present**
NH_3	0.01	0.5	0.2	0.01
TKN	0.1	1.0	0.6	0.20
NO_2+NO_3	0.01	0.5	0.15	0.01
TP	0.01	0.5	0.1	0.02

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 7).

Table 6. 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 and shaded entries indicate that there is at least 95% confidence that at least 10% of the possible samples exceed the standard/action 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.

Use Support Assessment Considerations

1) The freshwater dissolved oxygen concentrations of 5.0 mg/L and 4.0 mg/L are presented as evaluation levels. Instantaneous concentrations of 4.0 mg/L or less (5.0 mg/L in salt water) are in violation of the standard unless caused by natural (e.g. swampy) conditions. The 5.0 mg/L evaluation level is based upon a freshwater standard which specifies "not less than a daily average of 5.0 mg/L" (15A NCAC 2B.0200).
2) The standards specify that action levels are to be used used for copper, iron, and zinc in salt waters. Where appropriate, follow-up toxicological work may need to be conducted.
3) The geometric mean and median statistics were calculated for fecal coliform results for each station as appropriate for stream class.

Specific information on water quality standards and action levels can be found in 15A NCAC 2B.0200 (August 1, 2004).

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 [see, for example: 15A NCAC 02B.0211(1)(b) and 15A NCAC 02B.0220 (1)(b)] but generally results less than 4.0 mg/L can be problematic. Consistent patterns of low concentrations of dissolved oxygen can be subject to intense management review and corrective actions, although patterns of low dissolved oxygen can occur naturally in and near swamp waters, in estuarine waters under salt wedge conditions, or during droughts.

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; whereas in salt waters pH values less than 6.8 or greater than 8.5 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. However, 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.

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. Tidal surges can also disturb shallow estuarine sediments and naturally increase turbidity.

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. Currently the DWQ monitors total (not dissolved) concentrations for aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, manganese (Water Supply waters only), nickel, and zinc. Aluminum and iron are commonly found in North Carolina soils, therefore high aluminum and iron concentrations are typically correlated with high turbidity.

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.

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 Chowan River Basin, the standard specified in Administrative Code 15A NCAC 02B.0211 (3)(e) (August 1, 2005) 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 discerned using monthly sampling.

There are no SA class waters in the Chowan River Basin. Non-SA class 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 November 2004 the EPA promulgated a national rule for bacteria in coastal recreational waters. Instead of a rule for fecal coliform as a group, they chose to specifically target Enterococci and E. coli. EPA listed geomeans for E. coli in freshwater, and for Enterococci in both fresh and saltwater. Four levels of single sample maximum allowable densities were also given for those three (freshwater Enterococci, saltwater Enterococci, and freshwater E. coli) categories. The N.C. Recreational Water Quality Program (NCRWQP) has incorporated compliance with this national rule into their operations.

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.

The NCRWQP tests for enterococcus bacteria, 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, most of them on a weekly basis. Swimming season runs from April 1 to Sept. 30 - all ocean beaches and high-use sound-side beaches are tested weekly. Lower-use beaches are tested twice a month. All sites are tested twice a month in October and monthly from November through March. The one site monitored by the NCRWQP in the Chowan River Basin has exceeded the beach bacteria standard.

Table 7. Summary of Evaluation Level Exceedances at DWQ Stations

Subbasin / Station	Class	Percentage of Results that Exceeded the Evaluation Limit										
		Dissolved Oxygen (<5)[1]	Dissolved Oxygen (<4)[2]	pH (combined)[3]	Water Temperature	Chlorophyll A	Turbidity	Copper	Iron	Nickel	Zinc	Fecal Coliform
1												
D0000050	II Estuarine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D0001200	II Estuarine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D0001800	B NSW	36%	**15%**	6%	2%	2%	0%	0%	**71%**	0%	0%	2%
D0010000	B NSW	33%	9%	4%	0%	2%	0%	0%	**67%**	0%	0%	2%
D6250000	B NSW	20%	4%	6%	0%	0%	0%	0%	**94%**	0%	0%	2%
D8356200	B NSW	11%	4%	5%	0%	0%	0%	0%	**75%**	0%	0%	0%
2												
D4150000	C NSW	44%	**25%**	**22%**	0%	0%	3%	5%	**95%**	0%	5%	5%
D5000000	B NSW	26%	6%	6%	0%	0%	0%	0%	**71%**	0%	0%	0%
3												
D8430000	B NSW	5%	2%	5%	0%	0%	0%	0%	**63%**	0%	0%	0%
D8950000	B NSW	4%	0%	5%	0%	0%	2%	5%	**57%**	0%	0%	0%
4												
D9490000	B NSW	0%	0%	2%	0%	0%	0%	0%	**40%**	0%	0%	2%
D999500C	B NSW	0%	0%	0%	0%	0%	0%	0%	**30%**	0%	0%	5%
D999500N	B NSW	0%	0%	0%	2%	0%	0%	5%	**24%**	0%	10%	2%
D999500S	SB	2%	NA	9%	0%	0%	0%	5%	NA	5%	0%	0%

Notes:

Bold entries indicate at least 10% (at least 20% for fecal coliform not in SA waters; for SA fecal bold indicates at least 10%) of results exceeded the evaluation level.

Underlined entries indicate 95% confidence that site conditions exceed the evaluation level at least 10% of the time, with a minimum of 10 results required before determination.

NA: Not Applicable. The evaluation level is not applicable to this station.

BT: Below Threshhold. This station was not evaluated because less than 10 samples/measurements were collected for this paramter.

[1] Applies to saltwater (class SA, SB, and SC) primarily, and to freshwater (class B, C, and WS) as a daily average. Not considered critical (therefore not bolded for violations) in freshwater areas.

[2] Applies to freshwater (class B, C, and WS) only.

[3] If both the maximum pH (9, or 8.5 for saltwater) and the minimum pH (6, or 6.8 for saltwater) were exceeded at a site, the total of the two is displayed.

WATER QUALITY PATTERNS IN THE CHOWAN 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.

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 for stations which exhibit trends of interest.

Basinwide Trends and Distributions

Two basinwide patterns of interest were identified: spiking specific conductance between 2001 and 2003, and decreasing ammonia. The specific conductance spike is related to the drought which took place in North Carolina between late 2001 and early 2003.

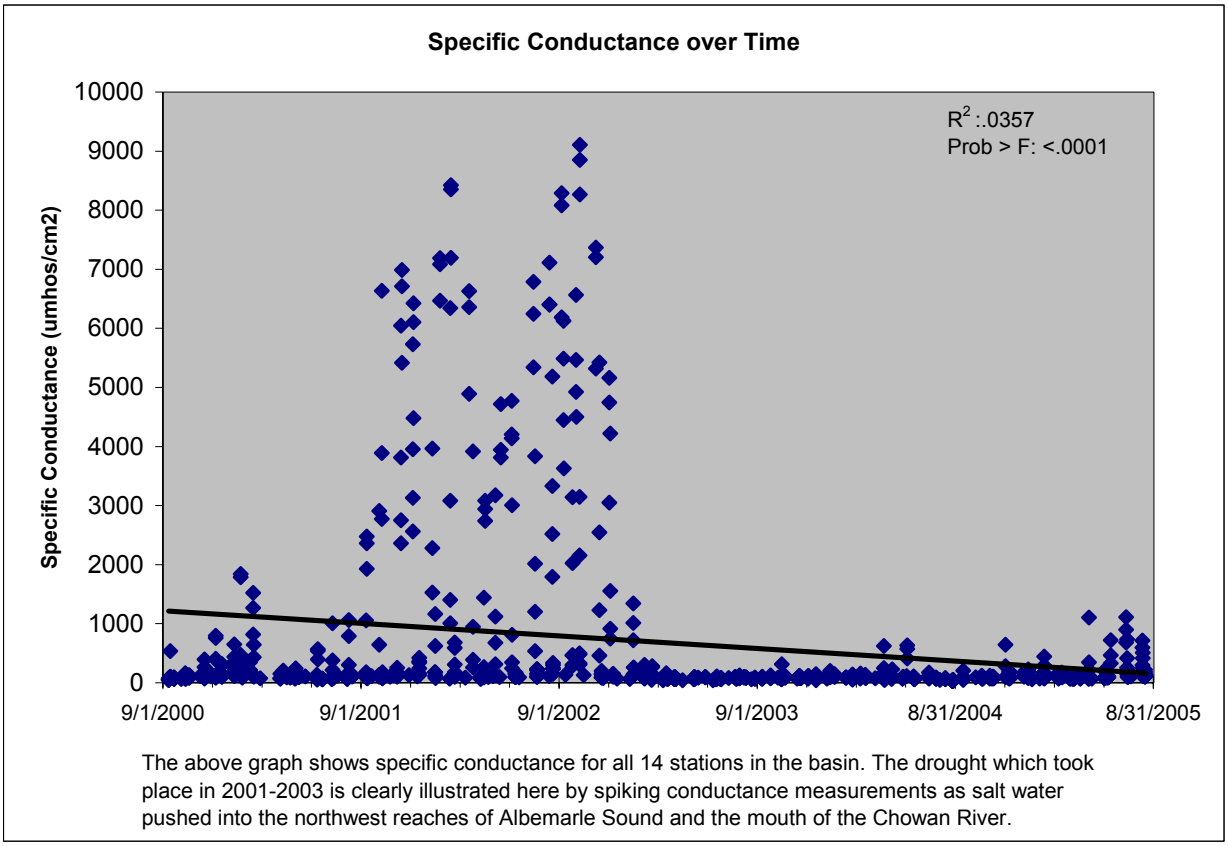


Figure 3. Specific Conductance over Time at 14 Stations in the Chowan River Basin.

The decreasing ammonia trend appears to be related to two things: Removal of all point sources from the Chowan River Basin during corrective action in the 1970's and 80's, and sediment washing by frequent hurricanes.

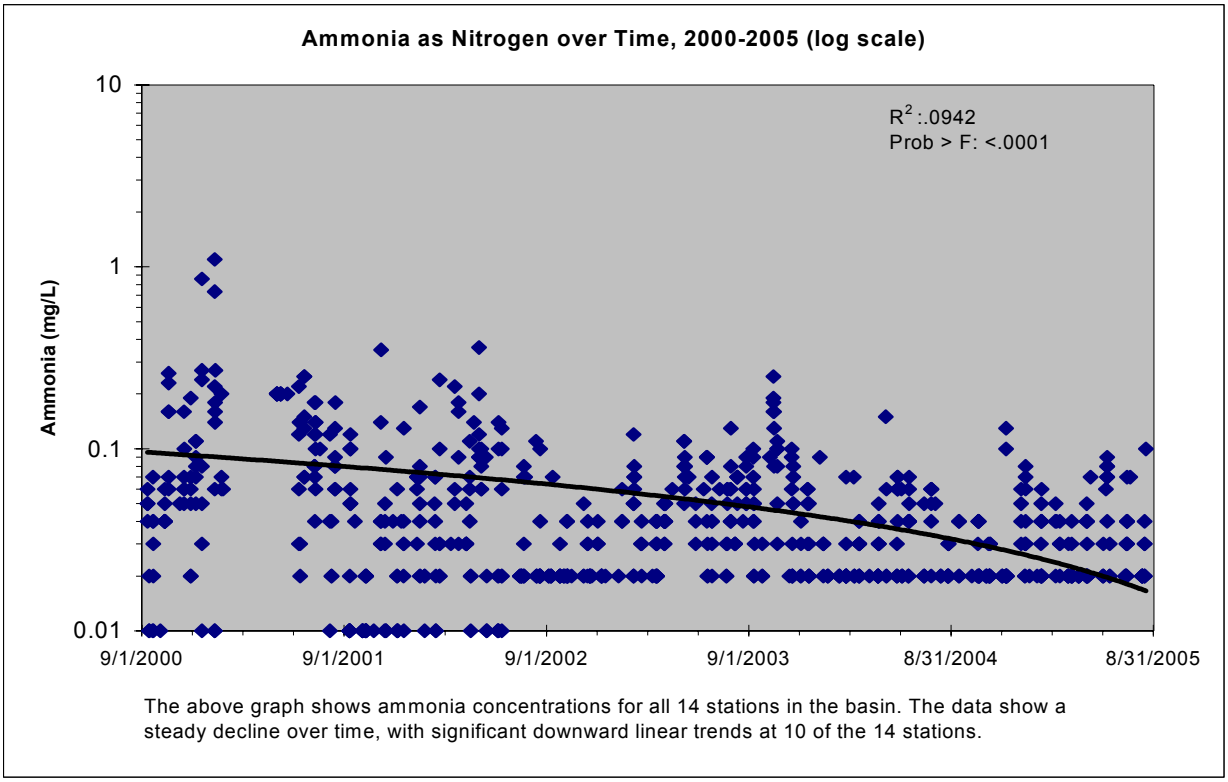


Figure 4. Ammonia as Nitrogen over Time at 14 Stations in the Chowan River Basin.

A look at the full historical record gives the broader trend.

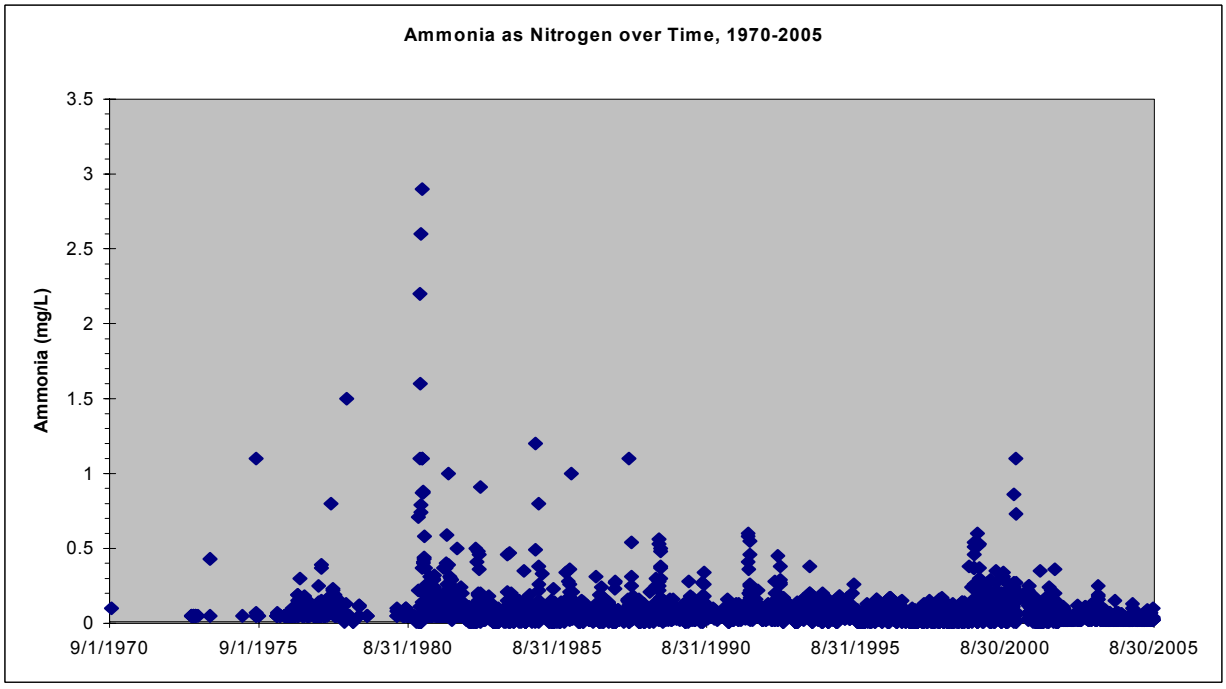
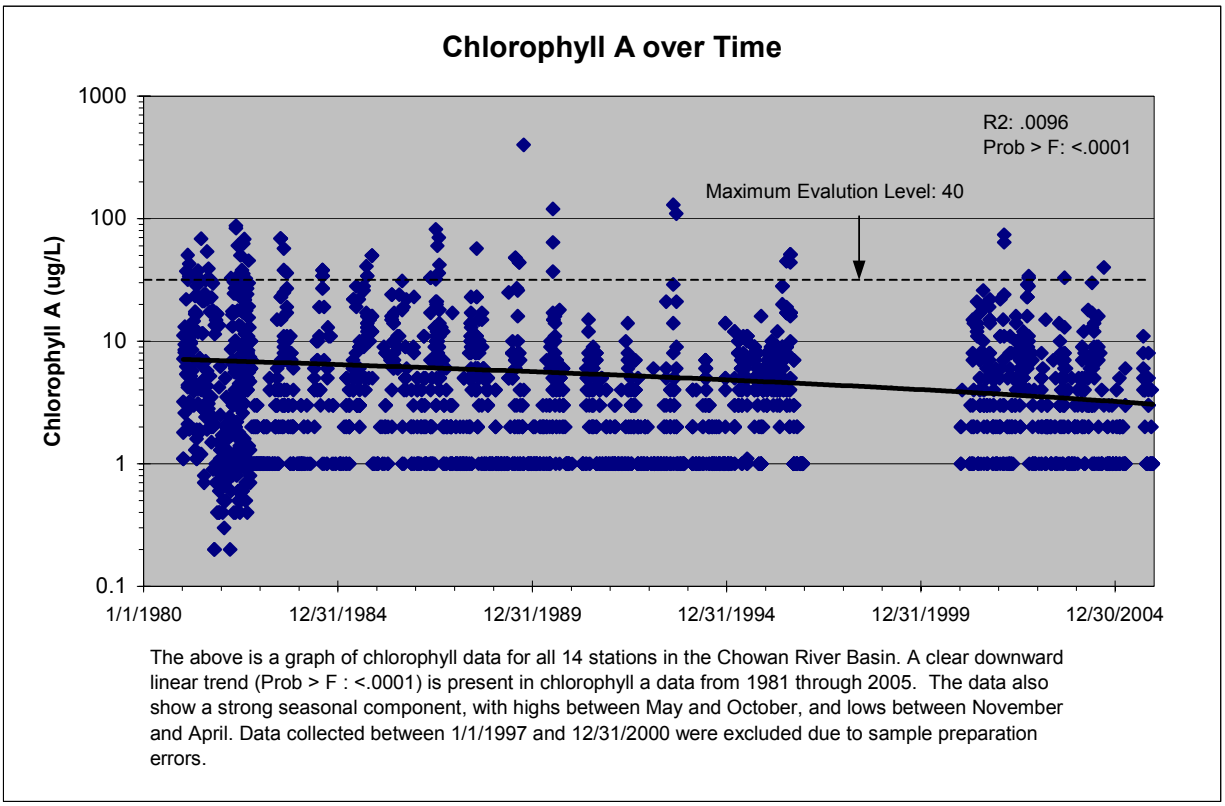


Figure 5. Ammonia as Nitrogen over Time, 1970-2005.

The removal of sources and the subsequent reduction in nutrient concentrations has also resulted in a reduction in chlorophyll a concentrations over time.



The above is a graph of chlorophyll data for all 14 stations in the Chowan River Basin. A clear downward linear trend (Prob > F : <.0001) is present in chlorophyll a data from 1981 through 2005. The data also show a strong seasonal component, with highs between May and October, and lows between November and April. Data collected between 1/1/1997 and 12/31/2000 were excluded due to sample preparation errors.

Figure 6. Ammonia as Nitrogen over Time, 1970-2005.

Maps were used to display the geographic distribution of evaluation level exceedances for dissolved oxygen, pH, iron, and fecal coliform.

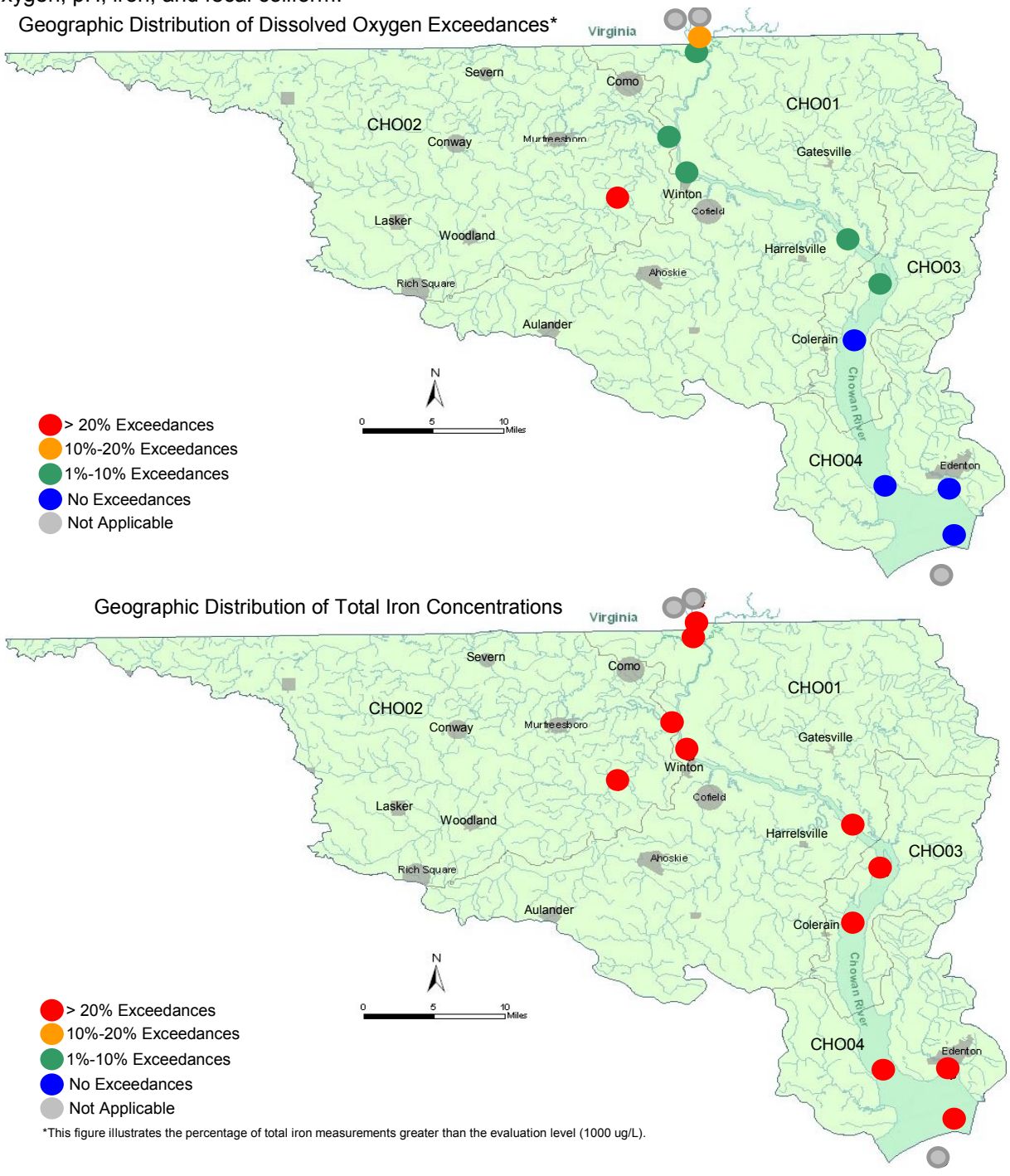


Figure 7. Geographic Distributions of Dissolved Oxygen and Total Iron.

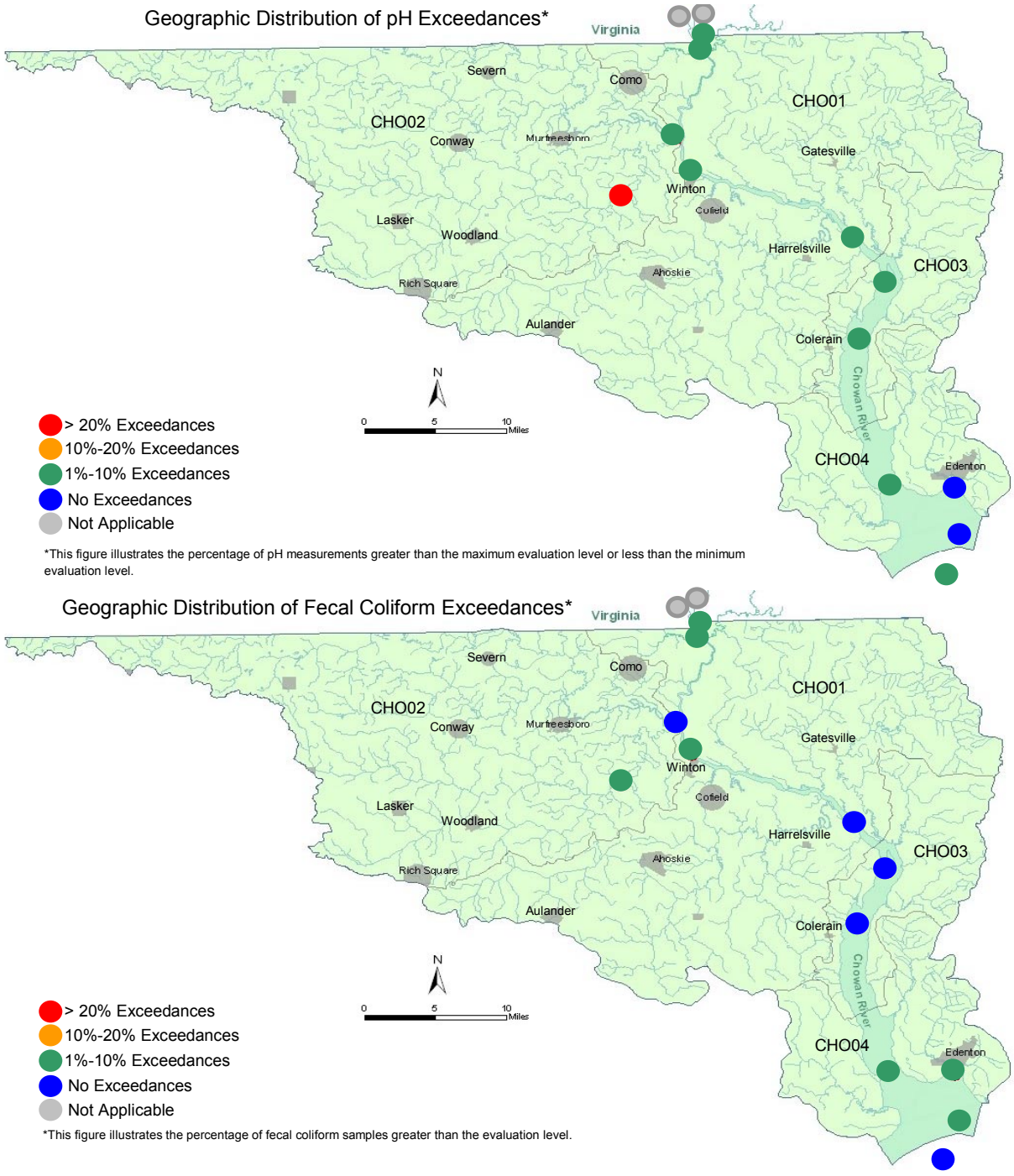
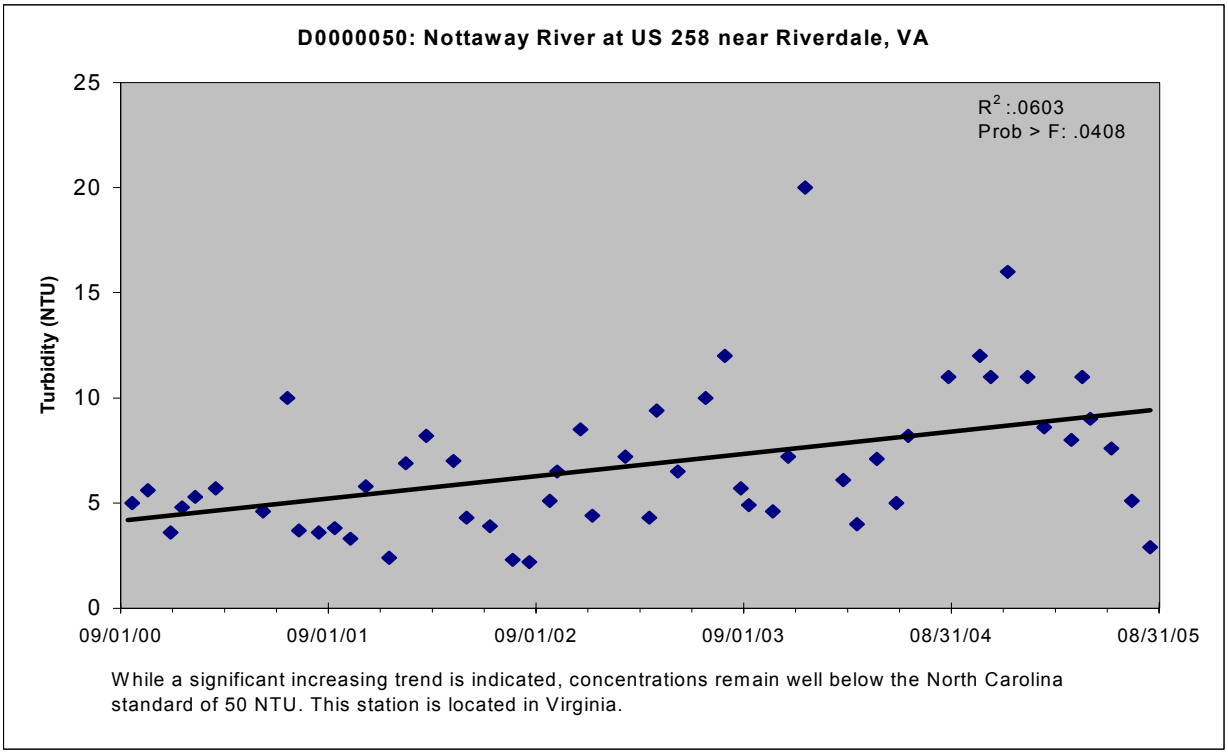


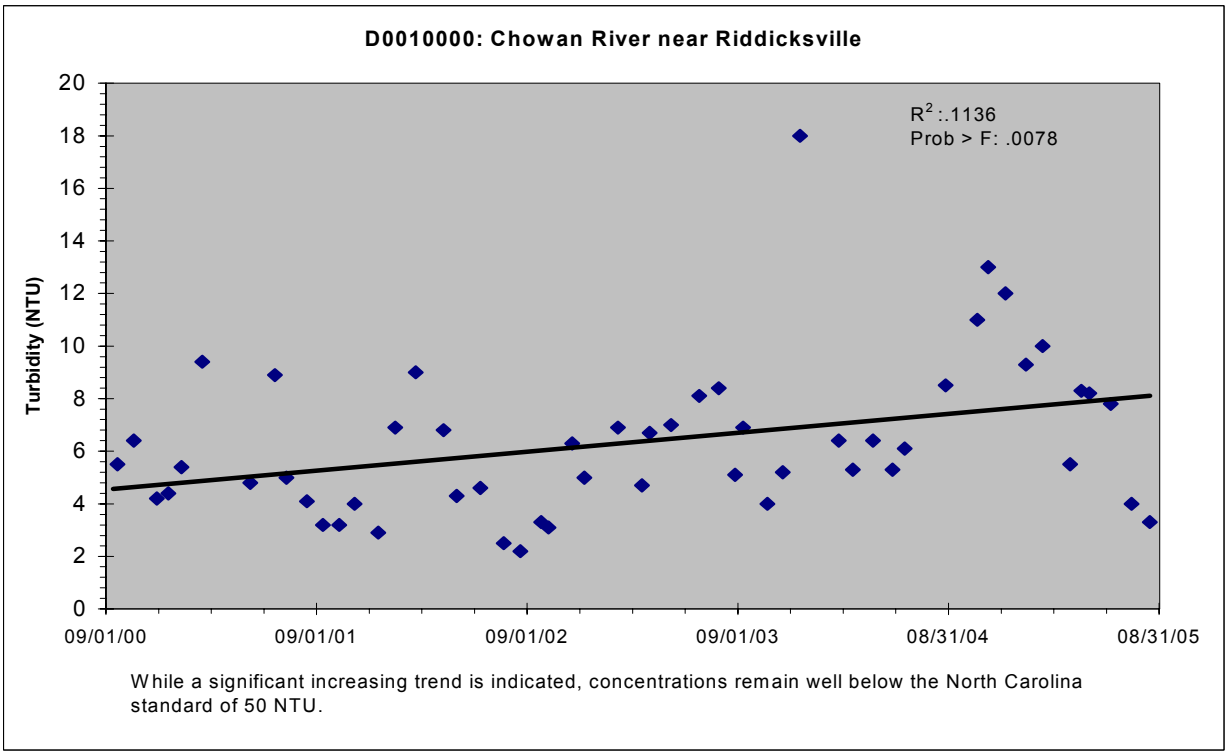
Figure 8. Geographic Distributions of pH and Fecal Coliform.

Individual Stations

Four stations were found to have trends of increasing turbidity.

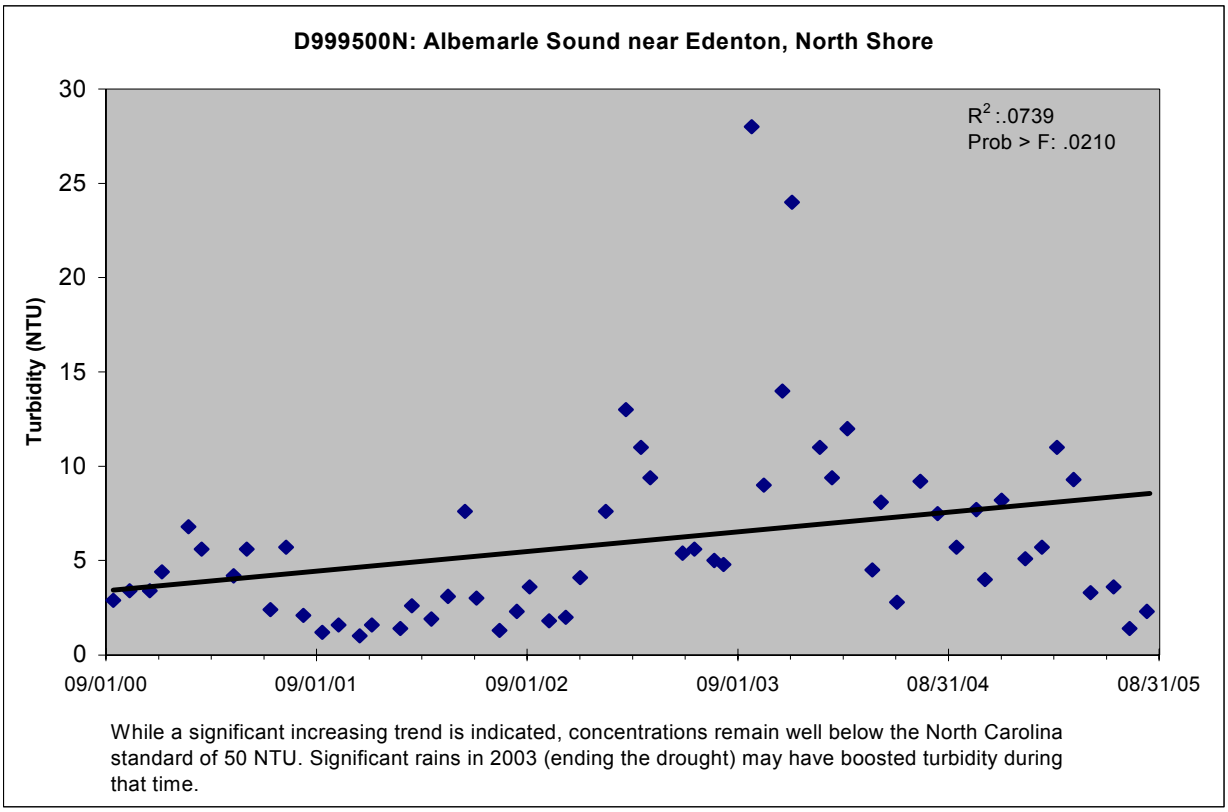


While a significant increasing trend is indicated, concentrations remain well below the North Carolina standard of 50 NTU. This station is located in Virginia.

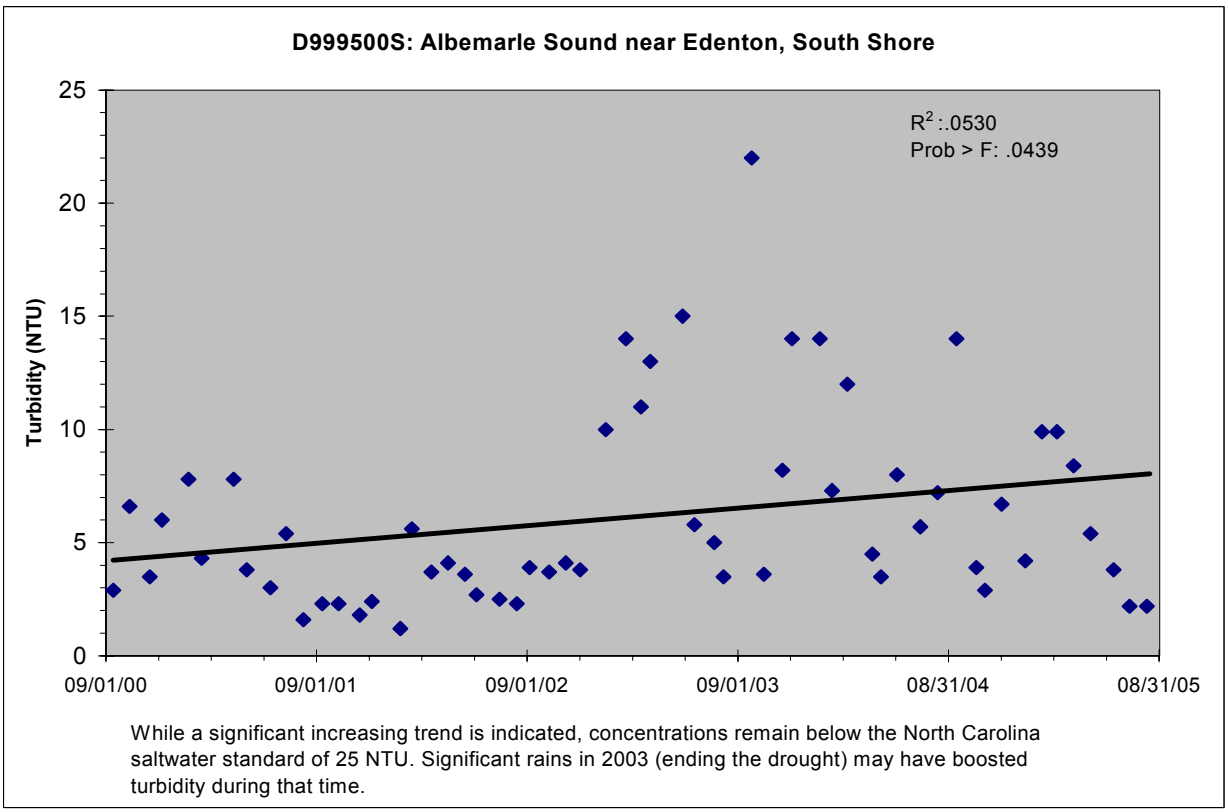


While a significant increasing trend is indicated, concentrations remain well below the North Carolina standard of 50 NTU.

Figure 9. Turbidity over Time at Selected Stations. (1 of 2)



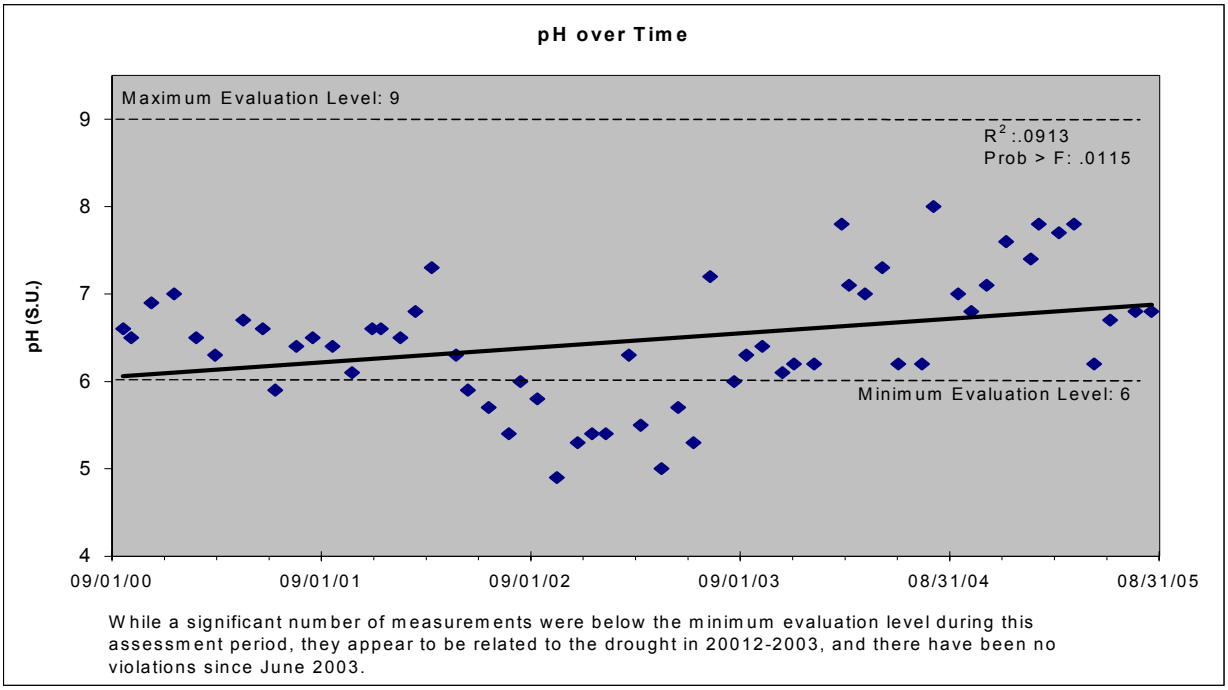
While a significant increasing trend is indicated, concentrations remain well below the North Carolina standard of 50 NTU. Significant rains in 2003 (ending the drought) may have boosted turbidity during that time.



While a significant increasing trend is indicated, concentrations remain below the North Carolina saltwater standard of 25 NTU. Significant rains in 2003 (ending the drought) may have boosted turbidity during that time.

Figure 10. Turbidity over Time at Selected Stations. (2 of 2)

The 14 stations were compared using box plots to evaluate whether any stations are particularly troubled by comparison. Box plots are included in Appendix B of this report. Based on this, D4150000, Potecasi Creek at NC 11 near Union, bears watching. Among the 14 stations, D4150000 has the lowest median dissolved oxygen and pH concentrations, and the highest turbidity, total kjeldahl nitrogen, total phosphorus, fecal coliform, and iron. This station has three SSEs, for dissolved oxygen (<4), pH, and iron. In addition, this station has significant upward trends in total kjeldahl nitrogen, total phosphorus, and fecal coliform. Concerning pH, the trend information indicates that violations of the standard occurred nearly entirely during the drought, and may be attributable to it.



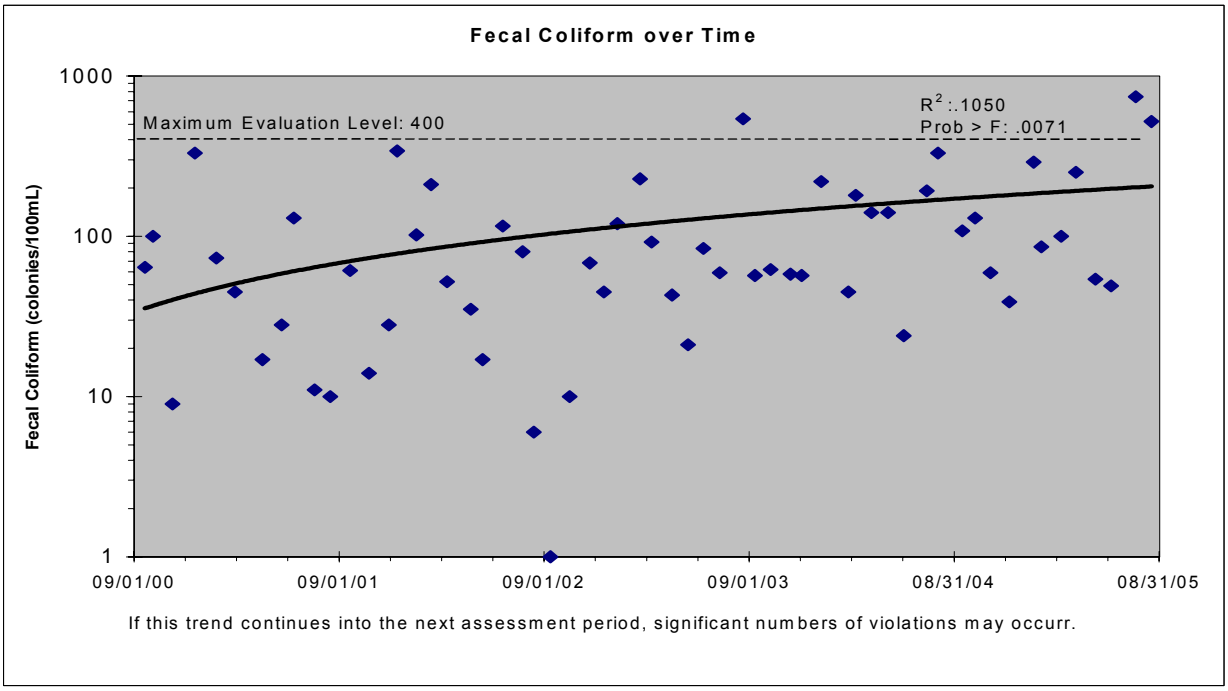
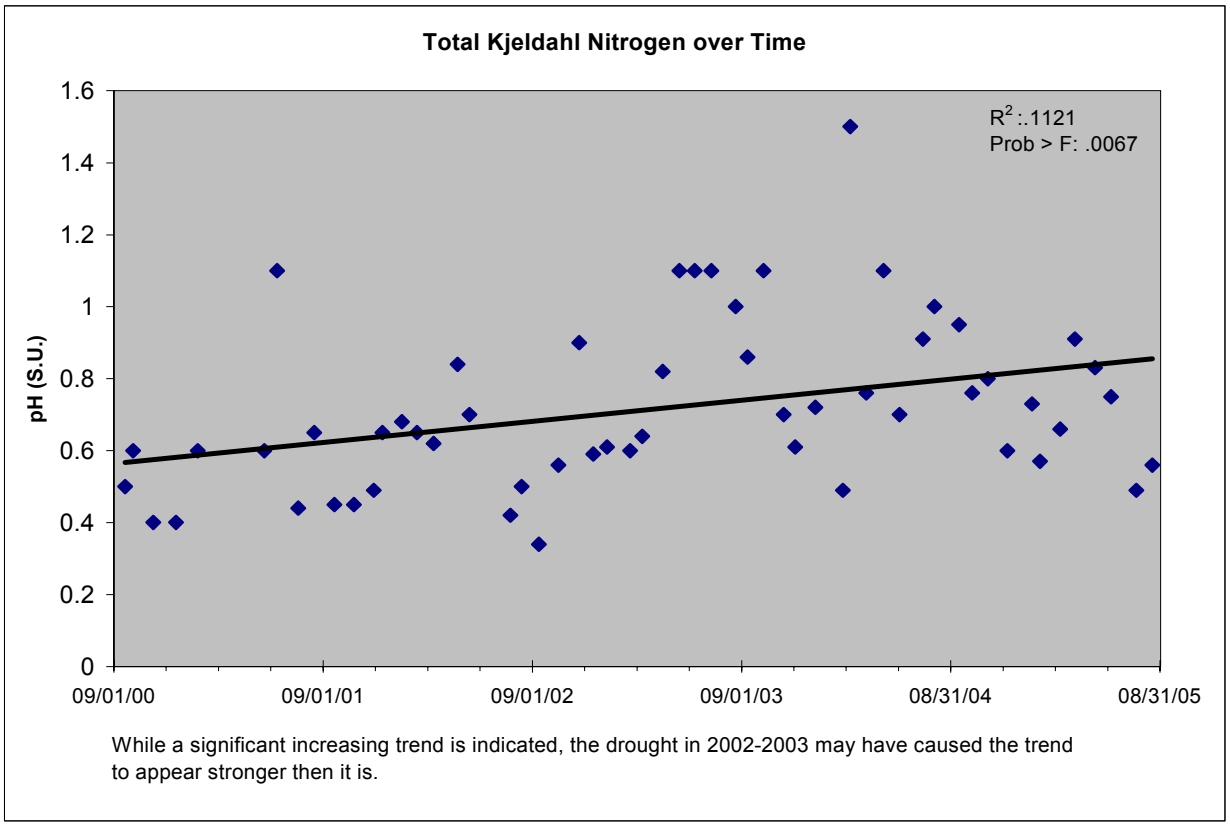
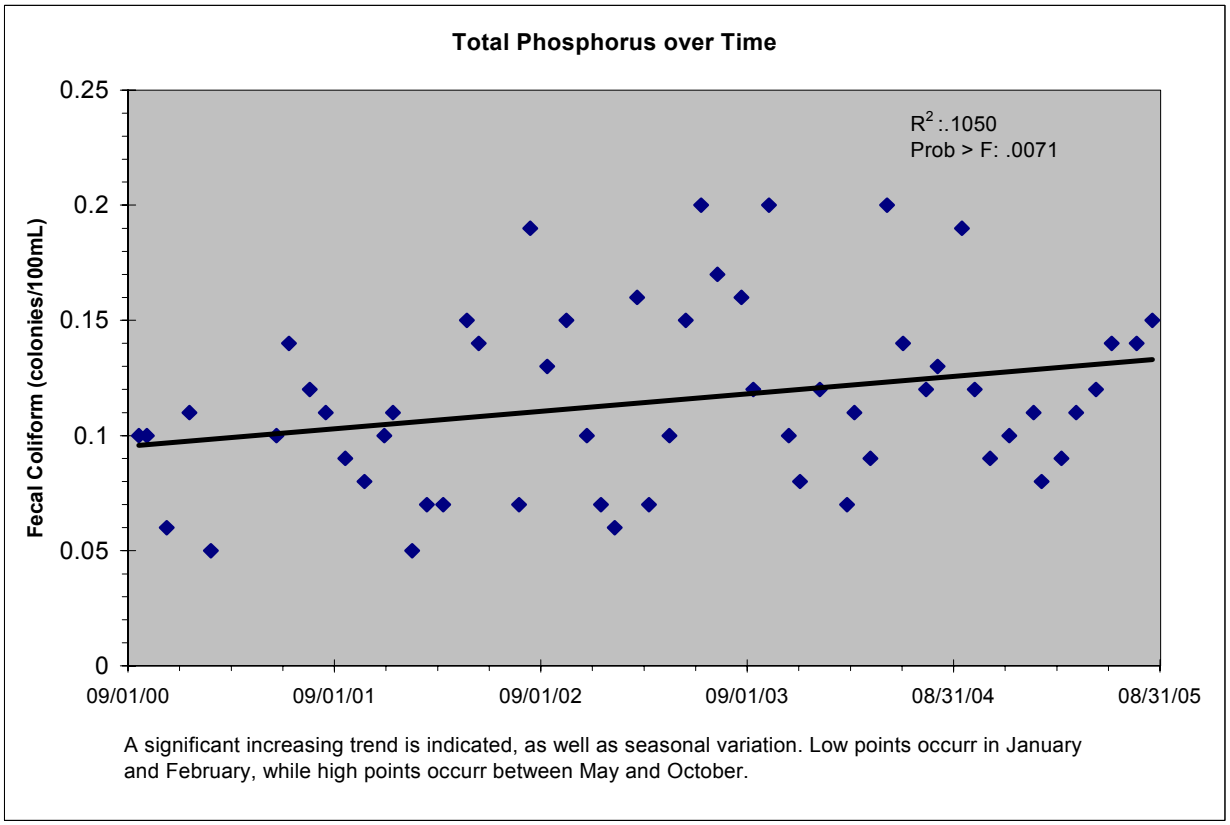


Figure 11. Selected Parameters at Station D4150000, Potecasi Creek. (1 of 2)



While a significant increasing trend is indicated, the drought in 2002-2003 may have caused the trend to appear stronger then it is.



A significant increasing trend is indicated, as well as seasonal variation. Low points occurr in January and February, while high points occurr between May and October.

Figure 12. Selected Parameters at Station D4150000, Potecasi Creek. (2 of 2)

Appendix A: Station Summary Sheets

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

Location: NOTTAWAY RIV AT US 258 NR RIVERDALE VA
Station #: D0000050 **Subbasin:** CHO01
Latitude: 36.56683 **Longitude:** -76.94646 **Stream class:** II Estuarine
Agency: NCAMBNT **NC stream index:**

Time period: 09/21/2000 to 08/15/2005

	# result	# ND	EL	Results not meeting EL #	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	54	0	N/A				3.7	4.7	5.3	6.5	9.5	11.3	12.8
pH (SU)	54	0	N/A				5.6	6	6.4	6.6	6.9	7	7.5
Salinity (ppt)	53	15	N/A				0.01	0.02	0.02	0.04	0.2	0.2	0.2
Spec. conductance (umhos/cm at 25°C)	54	0	N/A				38	61	72	94	132	240	421
Water Temperature (°C)	54	0	N/A				1.5	5.9	10.1	16.9	25.3	29.3	31.6
Other													
Chlorophyll A (ug/L)	44	13	N/A				1	1	1	1	3	12	28
Hardness (mg/L as CaCO3)	2	0	N/A				34	34	34	35	36	36	36
TSS (mg/L)	21	9	N/A				2	2	2	3	5	7	10
Turbidity (NTU)	53	0	N/A				2	3	4	6	9	11	20
Nutrients (mg/L)													
NH3 as N	52	16	N/A				0.01	0.02	0.02	0.03	0.05	0.09	0.2
NO2 + NO3 as N	52	6	N/A				0.02	0.02	0.07	0.1	0.15	0.22	0.24
TKN as N	51	2	N/A				0.2	0.3	0.35	0.42	0.48	0.59	0.65
Total Phosphorus	52	1	N/A				0.04	0.04	0.06	0.07	0.08	0.09	0.1
Metals (ug/L)													
Aluminum, total (Al)	21	0	N/A				78	112	155	220	305	556	750
Arsenic, total (As)	21	21	N/A				5	5	10	10	10	10	10
Cadmium, total (Cd)	21	21	N/A				2	2	2	2	2	2	2
Chromium, total (Cr)	21	21	N/A				25	25	25	25	25	25	25
Copper, total (Cu)	21	17	N/A				2	2	2	2	2	2	3
Iron, total (Fe)	21	0	N/A				510	600	795	1300	1800	2080	2300
Lead, total (Pb)	21	21	N/A				10	10	10	10	10	10	10
Mercury, total (Hg)	21	21	N/A				0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	21	21	N/A				10	10	10	10	10	10	10
Zinc, total (Zn)	21	17	N/A				10	10	10	10	10	14	24

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
53	14	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
95% : States whether there is 95% 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: BLACKWATER RIV AT HORSESHOE BEND AT CHERRY GROVE VA
Station #: D0001200 **Subbasin:** CHO01
Latitude: 36.57341 **Longitude:** -76.91795 **Stream class:** II Estuarine
Agency: NCAMBNT **NC stream index:**

Time period: 09/21/2000 to 08/15/2005

	# result	# ND	EL	Results not meeting EL #	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	54	0	N/A				2.4	3.7	4.6	5.8	9.2	11.2	12.8
pH (SU)	54	0	N/A				5.6	6.1	6.2	6.6	6.7	6.9	7.5
Salinity (ppt)	53	16	N/A				0.01	0.02	0.03	0.05	0.2	0.2	0.2
Spec. conductance (umhos/cm at 25°C)	54	0	N/A				47	70	88	106	139	167	332
Water Temperature (°C)	54	0	N/A				1.2	6.1	10.8	17.3	24.5	29.4	31.4
Other													
Chlorophyll A (ug/L)	43	17	N/A				1	1	1	2	3	12	33
Hardness (mg/L as CaCO3)	3	0	N/A				32	32	32	36	54	54	54
TSS (mg/L)	16	7	N/A				1	2	2	3	5	5	6
Turbidity (NTU)	54	0	N/A				2	2	4	5	6	10	15
Nutrients (mg/L)													
NH3 as N	51	13	N/A				0.01	0.02	0.02	0.03	0.06	0.11	0.2
NO2 + NO3 as N	51	3	N/A				0.02	0.07	0.11	0.18	0.25	0.41	0.66
TKN as N	50	1	N/A				0.35	0.4	0.49	0.56	0.67	0.84	1.1
Total Phosphorus	51	1	N/A				0.03	0.03	0.05	0.06	0.08	0.11	0.13
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				90	95	105	150	180	378	450
Arsenic, total (As)	17	17	N/A				5	5	8	10	10	10	10
Cadmium, total (Cd)	17	17	N/A				2	2	2	2	2	2	2
Chromium, total (Cr)	17	17	N/A				25	25	25	25	25	25	25
Copper, total (Cu)	17	13	N/A				2	2	2	2	2	23	96
Iron, total (Fe)	17	0	N/A				800	816	1100	1400	1900	2320	2400
Lead, total (Pb)	17	17	N/A				10	10	10	10	10	10	10
Manganese, total (Mn)	1	0	N/A				71	71	71	71	71	71	71
Mercury, total (Hg)	17	17	N/A				0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	17	15	N/A				10	10	10	10	10	79	99
Zinc, total (Zn)	17	11	N/A				10	10	10	10	12	692	1900

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
53	17	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
95% : States whether there is 95% 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: BLACKWATER RIV .5 MI UPS MOUTH NR WYANOKE
Station #: D0001800 **Subbasin:** CHO01
Latitude: 36.55118 **Longitude:** -76.91711 **Stream class:** B NSW
Agency: NCAMBNT **NC stream index:** 25

Time period: 09/21/2000 to 08/15/2005

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	53	0	<4	8	15.1	No	1.6	3.6	4.4	5.8	8.9	10.3	12.7
	53	0	<5	21	39.6	Yes	1.6	3.6	4.4	5.8	8.9	10.3	12.7
pH (SU)	53	0	<6	3	5.7		5.7	6.1	6.3	6.6	6.8	7.5	7.7
	53	0	>9	0	0		5.7	6.1	6.3	6.6	6.8	7.5	7.7
Salinity (ppt)	52	11	N/A				0.01	0.03	0.04	0.08	0.2	0.25	0.61
Spec. conductance (umhos/cm at 25°C)	53	0	N/A				48	72	96	119	214	476	1162
Water Temperature (°C)	53	0	>32	1	1.9		2	6.1	10.8	17.2	23.9	28.9	32.5
Other													
Chlorophyll A (ug/L)	44	17	>40	1	2.3		1	1	1	2	3	18	74
TSS (mg/L)	16	8	N/A				1	2	3	4	5	15	33
Turbidity (NTU)	53	0	>50	0	0		2	3	4	5	8	11	23
Nutrients (mg/L)													
NH3 as N	52	6	N/A				0.01	0.02	0.03	0.05	0.1	0.19	0.86
NO2 + NO3 as N	52	6	N/A				0.02	0.02	0.09	0.16	0.24	0.38	0.86
TKN as N	51	1	N/A				0.2	0.4	0.5	0.59	0.7	0.9	1.4
Total Phosphorus	52	1	N/A				0.03	0.05	0.06	0.09	0.11	0.15	0.74
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				92	106	145	180	355	608	920
Arsenic, total (As)	17	17	>10	0	0		5	5	10	10	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	3	3
Iron, total (Fe)	17	0	>1000	12	70.6	Yes	620	620	855	1400	1850	2200	2200
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	16	26

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
53	24	1	2	

Key:
result: number of observations
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95% : States whether there is 95% 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: CHOWAN RIV NR RIDDICKSVILLE
Station #: D0010000 **Subbasin:** CHO01
Latitude: 36.53201 **Longitude:** -76.92096 **Stream class:** B NSW
Agency: NCAMBNT **NC stream index:** 25

Time period: 09/21/2000 to 08/15/2005

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	54	0	<4	5	9.3		3.1	4	4.6	6.2	9	11	12.3
	54	0	<5	18	33.3	Yes	3.1	4	4.6	6.2	9	11	12.3
pH (SU)	54	0	<6	2	3.7		5.6	6.1	6.3	6.6	6.8	7.4	7.7
	54	0	>9	0	0		5.6	6.1	6.3	6.6	6.8	7.4	7.7
Salinity (ppt)	53	12	N/A				0	0.02	0.03	0.06	0.2	0.2	0.32
Spec. conductance (umhos/cm at 25°C)	54	0	N/A				41	72	78	106	192	387	624
Water Temperature (°C)	54	0	>32	0	0		1.4	6	10.8	17.6	24.9	28.3	31.3
Other													
Chlorophyll A (ug/L)	43	15	>40	1	2.3		1	1	1	1	4	13	64
TSS (mg/L)	17	8	N/A				1	1	2	2	4	6	8
Turbidity (NTU)	53	0	>50	0	0		2	3	4	6	8	10	18
Nutrients (mg/L)													
NH3 as N	52	8	N/A				0.01	0.02	0.02	0.04	0.08	0.18	0.26
NO2 + NO3 as N	52	3	N/A				0.02	0.05	0.08	0.12	0.19	0.26	0.45
TKN as N	51	2	N/A				0.2	0.39	0.45	0.51	0.6	0.67	0.99
Total Phosphorus	52	1	N/A				0.04	0.05	0.06	0.08	0.1	0.15	0.41
Metals (ug/L)													
Aluminum, total (Al)	18	0	N/A				98	154	178	240	345	516	1200
Arsenic, total (As)	18	18	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	18	18	>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)	18	14	>7	0	0		2	2	2	2	2	3	3
Iron, total (Fe)	18	0	>1000	12	66.7	Yes	660	750	878	1400	1700	2100	2100
Lead, total (Pb)	18	18	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	18	18	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	18	18	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	18	13	>50	1	5.6		10	10	10	10	13	32	110

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
53	19	1	2	

Key:
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95% : States whether there is 95% 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: POTECASI CRK AT NC 11 NR UNION
Station #: D4150000 **Subbasin:** CHO02
Latitude: 36.37121 **Longitude:** -77.02591 **Stream class:** C NSW
Agency: NCAMBNT **NC stream index:** 25-4-8

Time period: 09/20/2000 to 08/17/2005

	# result	# ND	EL	Results not meeting EL #	%	95%	Min	Percentiles 10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	59	0	<4	15	25.4	Yes	0.5	2.5	3.9	5.7	8.8	10.8	15.9
	59	0	<5	26	44.1	Yes	0.5	2.5	3.9	5.7	8.8	10.8	15.9
pH (SU)	59	0	<6	13	22	Yes	4.9	5.4	6	6.5	7	7.6	8
	59	0	>9	0	0		4.9	5.4	6	6.5	7	7.6	8
Salinity (ppt)	58	17	N/A				0.01	0.02	0.02	0.04	0.2	0.2	0.2
Spec. conductance (umhos/cm at 25°C)	59	0	N/A				44	56	69	81	103	117	156
Water Temperature (°C)	59	0	>32	0	0		1.2	4.4	9.3	15.7	22.1	25.1	26
Other													
Chlorophyll A (ug/L)	48	16	>40	0	0		1	1	1	1	2	4	40
TSS (mg/L)	20	2	N/A				2	3	3	5	8	12	19
Turbidity (NTU)	59	0	>50	2	3.4		5	8	10	14	18	27	60
Nutrients (mg/L)													
NH3 as N	56	10	N/A				0.01	0.02	0.02	0.04	0.07	0.12	0.2
NO2 + NO3 as N	56	8	N/A				0.01	0.02	0.03	0.09	0.17	0.22	0.3
TKN as N	56	1	N/A				0.34	0.45	0.56	0.66	0.86	1.1	1.5
Total Phosphorus	56	0	N/A				0.05	0.07	0.09	0.11	0.14	0.18	0.2
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				140	192	262	420	1800	2580	3100
Arsenic, total (As)	19	19	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	20	20	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	20	20	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	13	>7	1	5		2	2	2	2	3	5	37
Iron, total (Fe)	20	0	>1000	19	95	Yes	280	1420	1800	2750	3450	3980	5200
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	29
Zinc, total (Zn)	20	8	>50	1	5		10	10	10	10	15	19	520

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
59	66	3	5	

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

Location: MEHERRIN RIV AT SR 1175 PARKERS FERRY NR COMO
Station #: D5000000 **Subbasin:** CHO02
Latitude: 36.43653 **Longitude:** -76.95332 **Stream class:** B NSW
Agency: NCAMBNT **NC stream index:** 25-4-(5)

Time period: 09/21/2000 to 08/15/2005

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	55	0	<4	3	5.5		3.6	4.2	4.9	6.1	8.7	11.1	12.7
	55	0	<5	14	25.5	Yes	3.6	4.2	4.9	6.1	8.7	11.1	12.7
pH (SU)	55	0	<6	3	5.5		5.7	6	6.3	6.7	6.9	7	7.7
	55	0	>9	0	0		5.7	6	6.3	6.7	6.9	7	7.7
Salinity (ppt)	54	15	N/A				0	0.02	0.03	0.03	0.2	0.2	1.15
Spec. conductance (umhos/cm at 25°C)	55	0	N/A				34	63	72	84	101	120	2156
Water Temperature (°C)	55	0	>32	0	0		1.4	6.3	11.4	18.3	25.9	28.9	31.4
Other													
Chlorophyll A (ug/L)	44	12	>40	0	0		1	1	1	2	4	8	14
TSS (mg/L)	20	6	N/A				1	2	2	3	5	7	25
Turbidity (NTU)	53	0	>50	0	0		3	4	5	7	10	13	25
Nutrients (mg/L)													
NH3 as N	52	11	N/A				0.02	0.02	0.02	0.04	0.07	0.14	0.25
NO2 + NO3 as N	52	3	N/A				0.02	0.03	0.08	0.15	0.2	0.28	0.42
TKN as N	52	1	N/A				0.27	0.3	0.39	0.47	0.54	0.67	1.2
Total Phosphorus	52	1	N/A				0.04	0.04	0.05	0.07	0.08	0.09	0.11
Metals (ug/L)													
Aluminum, total (Al)	21	0	N/A				91	106	170	230	330	810	1300
Arsenic, total (As)	21	21	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	21	21	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	21	21	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	21	15	>7	0	0		2	2	2	2	2	3	3
Iron, total (Fe)	21	0	>1000	15	71.4	Yes	740	832	990	1500	1900	2400	2800
Lead, total (Pb)	21	21	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	21	21	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	21	21	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	21	17	>50	0	0		10	10	10	10	10	13	32

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
53	14	0	0	

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

Location: CHOWAN RIV AT US 13 AT WINTON
Station #: D6250000 **Subbasin:** CHO01
Latitude: 36.40263 **Longitude:** -76.93434 **Stream class:** B NSW
Agency: NCAMBNT **NC stream index:** 25

Time period: 09/21/2000 to 08/15/2005

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	55	0	<4	2	3.6		3.8	4.4	5.1	6.7	9.2	11	11.8
	55	0	<5	11	20	Yes	3.8	4.4	5.1	6.7	9.2	11	11.8
pH (SU)	55	0	<6	3	5.5		5.6	6	6.3	6.8	7.2	7.5	8.7
	55	0	>9	0	0		5.6	6	6.3	6.8	7.2	7.5	8.7
Salinity (ppt)	54	13	N/A				0	0.02	0.03	0.04	0.2	0.2	1.7
Spec. conductance (umhos/cm at 25°C)	55	0	N/A				37	65	78	90	142	257	3145
Water Temperature (°C)	55	0	>32	0	0		1.5	6.2	11.4	19	25.8	28.7	31.2
Other													
Chlorophyll A (ug/L)	45	14	>40	0	0		1	1	1	2	4	12	24
TSS (mg/L)	18	5	N/A				2	2	2	3	4	7	17
Turbidity (NTU)	53	0	>50	0	0		1	4	5	6	9	11	22
Nutrients (mg/L)													
NH3 as N	53	10	N/A				0.01	0.02	0.02	0.04	0.06	0.18	1.1
NO2 + NO3 as N	53	2	N/A				0.02	0.04	0.07	0.12	0.18	0.22	0.37
TKN as N	53	1	N/A				0.29	0.38	0.44	0.52	0.6	0.67	1.1
Total Phosphorus	53	1	N/A				0.04	0.04	0.06	0.07	0.09	0.1	0.24
Metals (ug/L)													
Aluminum, total (Al)	18	0	N/A				110	137	155	235	310	557	890
Arsenic, total (As)	18	18	>10	0	0		5	5	9	10	10	10	10
Cadmium, total (Cd)	18	18	>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)	18	12	>7	0	0		2	2	2	2	3	4	4
Iron, total (Fe)	18	0	>1000	17	94.4	Yes	420	1032	1200	1350	1725	2200	2200
Lead, total (Pb)	18	18	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	18	18	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	18	18	>88	0	0		10	10	10	10	10	14	50
Zinc, total (Zn)	18	13	>50	0	0		10	10	10	10	10	20	35

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
54	8	1	2	

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

Location: CHOWAN RIV AT CM 16 NR GATESVILLE
Station #: D8356200 **Subbasin:** CHO01
Latitude: 36.32360 **Longitude:** -76.73354 **Stream class:** B NSW
Agency: NCAMBNT **NC stream index:** 25

Time period: 09/11/2000 to 08/11/2005

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	56	0	<4	2	3.6		3.6	4.4	6	7.4	9.6	11.6	12.5
	56	0	<5	6	10.7	No	3.6	4.4	6	7.4	9.6	11.6	12.5
pH (SU)	56	0	<6	3	5.4		5.5	6.2	6.6	6.8	7.1	7.4	7.8
	56	0	>9	0	0		5.5	6.2	6.6	6.8	7.1	7.4	7.8
Salinity (ppt)	55	13	N/A				0	0.02	0.03	0.08	0.2	0.86	2.46
Spec. conductance (umhos/cm at 25°C)	56	0	N/A				34	67	75	91	238	1609	4500
Water Temperature (°C)	56	0	>32	0	0		2.6	5.6	9.6	18.8	26.8	29.4	31.9
Other													
Chlorophyll A (ug/L)	43	5	>40	0	0		1	1	1	2	7	18	30
TSS (mg/L)	21	9	N/A				1	2	2	4	5	8	10
Turbidity (NTU)	58	0	>50	0	0		2	3	5	6	9	12	21
Nutrients (mg/L)													
NH3 as N	53	11	N/A				0.01	0.02	0.02	0.04	0.07	0.12	0.27
NO2 + NO3 as N	53	9	N/A				0.02	0.02	0.05	0.1	0.16	0.21	0.41
TKN as N	54	2	N/A				0.3	0.38	0.43	0.5	0.61	0.73	1
Total Phosphorus	54	2	N/A				0.02	0.03	0.05	0.07	0.1	0.11	0.5
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				100	113	192	355	418	626	900
Arsenic, total (As)	20	20	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	20	20	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	20	20	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	16	>7	0	0		2	2	2	2	2	3	3
Iron, total (Fe)	20	0	>1000	15	75	Yes	360	584	1025	1400	1600	1900	2100
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	16	>50	0	0		10	10	10	10	10	15	21

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
58	4	0	0	

Key:
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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
95% : States whether there is 95% 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: CHOWAN RIV AT CM 12 DNS HOLIDAY ISLAND
Station #: D8430000 **Subbasin:** CHO03
Latitude: 36.26890 **Longitude:** -76.69140 **Stream class:** B NSW
Agency: NCAMBNT **NC stream index:** 25

Time period: 09/11/2000 to 08/11/2005

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	57	0	<4	1	1.8		3.8	5.6	6.8	8	10.2	11.7	14
	57	0	<5	3	5.3		3.8	5.6	6.8	8	10.2	11.7	14
pH (SU)	57	0	<6	3	5.3		5.6	6.3	6.6	6.9	7.1	7.5	7.7
	57	0	>9	0	0		5.6	6.3	6.6	6.9	7.1	7.5	7.7
Salinity (ppt)	56	12	N/A				0	0.02	0.03	0.08	0.2	1.25	2.7
Spec. conductance (umhos/cm at 25°C)	57	0	N/A				33	68	75	95	250	2330	4922
Water Temperature (°C)	57	0	>32	0	0		2.9	5.1	10	18.1	26.1	28.5	30.1
Other													
Chlorophyll A (ug/L)	43	7	>40	0	0		1	1	1	2	5	9	19
TSS (mg/L)	19	7	N/A				1	2	2	4	5	6	9
Turbidity (NTU)	58	0	>50	0	0		2	3	5	6	9	12	17
Nutrients (mg/L)													
NH3 as N	54	10	N/A				0.01	0.02	0.02	0.04	0.08	0.14	0.2
NO2 + NO3 as N	54	8	N/A				0.02	0.02	0.04	0.1	0.16	0.2	0.38
TKN as N	54	2	N/A				0.3	0.35	0.43	0.5	0.6	0.68	1
Total Phosphorus	55	2	N/A				0.02	0.02	0.06	0.07	0.1	0.12	0.5
Metals (ug/L)													
Aluminum, total (Al)	19	0	N/A				60	77	190	270	480	840	1100
Arsenic, total (As)	19	19	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	19	19	>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)	19	14	>7	0	0		2	2	2	2	2	6	6
Iron, total (Fe)	19	0	>1000	12	63.2	Yes	140	380	810	1300	1500	1900	2100
Lead, total (Pb)	19	19	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	18	18	>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	19	22

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
58	4	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
95% : States whether there is 95% 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: CHOWAN RIV CM 7 AT COLERAIN
Station #: D8950000 **Subbasin:** CHO03
Latitude: 36.20983 **Longitude:** -76.72677 **Stream class:** B NSW
Agency: NCAMBNT **NC stream index:** 25

Time period: 09/11/2000 to 08/11/2005

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	57	0	<4	0	0		4.2	6.3	7.3	8.7	10.5	12.7	14
	57	0	<5	2	3.5		4.2	6.3	7.3	8.7	10.5	12.7	14
pH (SU)	57	0	<6	3	5.3		5.8	6.4	6.9	7.1	7.2	7.5	7.9
	57	0	>9	0	0		5.8	6.4	6.9	7.1	7.2	7.5	7.9
Salinity (ppt)	56	11	N/A				0	0.02	0.03	0.12	0.28	1.9	3.02
Spec. conductance (umhos/cm at 25°C)	57	0	N/A				33	69	74	107	530	3428	5488
Water Temperature (°C)	57	0	>32	0	0		2.9	4.7	9.9	17.6	25.7	29	31.7
Other													
Chlorophyll A (ug/L)	43	4	>40	0	0		1	1	1	3	7	11	19
TSS (mg/L)	21	10	N/A				1	1	2	3	4	6	13
Turbidity (NTU)	58	1	>50	1	1.7		1	2	4	6	8	11	76
Nutrients (mg/L)													
NH3 as N	54	10	N/A				0.01	0.02	0.02	0.04	0.07	0.11	0.25
NO2 + NO3 as N	54	12	N/A				0.01	0.02	0.02	0.11	0.16	0.21	0.29
TKN as N	55	2	N/A				0.32	0.38	0.4	0.5	0.57	0.69	1
Total Phosphorus	55	4	N/A				0.01	0.02	0.05	0.07	0.1	0.11	0.5
Metals (ug/L)													
Aluminum, total (Al)	21	0	N/A				63	85	180	350	420	684	920
Arsenic, total (As)	21	21	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	21	21	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	21	21	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	21	14	>7	1	4.8		2	2	2	2	3	9	20
Iron, total (Fe)	21	0	>1000	12	57.1	Yes	73	146	770	1100	1450	1940	2000
Lead, total (Pb)	21	21	>25	0	0		10	10	10	10	10	10	50
Mercury, total (Hg)	21	21	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	21	21	>88	0	0		10	10	10	10	10	10	50
Zinc, total (Zn)	21	16	>50	0	0		10	10	10	10	11	26	29

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
58	4	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
95% : States whether there is 95% 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: CHOWAN RIV AT US 17 AT EDENHOUSE
Station #: D9490000 **Subbasin:** CHO04
Latitude: 36.04760 **Longitude:** -76.69611 **Stream class:** B NSW
Agency: NCAMBNT **NC stream index:** 25

Time period: 09/11/2000 to 08/11/2005

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	56	0	<4	0	0		5.5	7	7.5	9	10.5	12.8	13.3
	56	0	<5	0	0		5.5	7	7.5	9	10.5	12.8	13.3
pH (SU)	56	0	<6	1	1.8		5.9	6.6	7	7.3	7.6	7.8	8
	56	0	>9	0	0		5.9	6.6	7	7.3	7.6	7.8	8
Salinity (ppt)	55	10	N/A				0	0.03	0.03	0.13	0.72	3.07	3.63
Spec. conductance (umhos/cm at 25°C)	56	0	N/A				36	70	84	122	1344	5516	6563
Water Temperature (°C)	56	0	>32	0	0		2.4	5.6	11.4	18.2	25.8	28.3	29.7
Other													
Chlorophyll A (ug/L)	43	7	>40	0	0		1	1	1	4	6	10	15
TSS (mg/L)	21	6	N/A				2	2	2	3	4	5	5
Turbidity (NTU)	58	0	>50	0	0		1	2	3	5	8	10	13
Nutrients (mg/L)													
NH3 as N	52	17	N/A				0.01	0.01	0.02	0.03	0.05	0.1	0.2
NO2 + NO3 as N	53	17	N/A				0.01	0.01	0.02	0.1	0.18	0.23	0.27
TKN as N	54	2	N/A				0.24	0.34	0.41	0.45	0.57	0.66	1
Total Phosphorus	54	5	N/A				0.01	0.02	0.04	0.06	0.08	0.1	0.5
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				76	84	122	285	502	609	940
Arsenic, total (As)	20	20	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	20	20	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	20	20	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	15	>7	0	0		2	2	2	2	2	3	5
Iron, total (Fe)	20	0	>1000	8	40	Yes	65	111	385	945	1375	1790	2000
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	10	>50	0	0		10	10	10	10	15	28	33

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
58	4	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
95% : States whether there is 95% 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: ALBEMARLE SOUND NR EDENTON MID CHANNEL
Station #: D999500C **Subbasin:** CHO04
Latitude: 35.99002 **Longitude:** -76.60920 **Stream class:** B NSW
Agency: NCAMBNT **NC stream index:** 26

Time period: 09/14/2000 to 08/10/2005

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	59	0	<4	0	0		5.7	7.2	7.7	9.1	11	12.8	13.6
	59	0	<5	0	0		5.7	7.2	7.7	9.1	11	12.8	13.6
pH (SU)	59	0	<6	0	0		6.2	6.8	7.2	7.4	7.6	7.9	8.2
	59	0	>9	0	0		6.2	6.8	7.2	7.4	7.6	7.9	8.2
Salinity (ppt)	58	4	N/A				0.02	0.04	0.05	0.2	1.7	3.61	4.7
Spec. conductance (umhos/cm at 25°C)	59	0	N/A				66	96	103	314	2740	6467	8354
Water Temperature (°C)	59	0	>32	0	0		3	6.8	11	18.5	26.1	27.8	30.3
Other													
Chlorophyll A (ug/L)	49	0	>40	0	0		1	2	3	5	8	14	22
TSS (mg/L)	20	7	N/A				2	2	3	4	6	13	14
Turbidity (NTU)	59	2	>50	0	0		1	2	3	4	8	16	23
Nutrients (mg/L)													
NH3 as N	57	24	N/A				0.01	0.01	0.02	0.02	0.04	0.09	0.2
NO2 + NO3 as N	57	16	N/A				0.01	0.01	0.02	0.11	0.16	0.23	0.3
TKN as N	57	1	N/A				0.26	0.3	0.34	0.4	0.45	0.6	0.78
Total Phosphorus	57	6	N/A				0.02	0.02	0.03	0.05	0.08	0.09	0.12
Metals (ug/L)													
Aluminum, total (Al)	20	1	N/A				50	85	152	230	522	799	850
Arsenic, total (As)	20	20	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	20	20	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	20	20	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	12	>7	0	0		2	2	2	2	2	3	6
Iron, total (Fe)	20	1	>1000	6	30	Yes	50	86	232	845	1200	1570	2100
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	10	10	50
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	25
Zinc, total (Zn)	20	13	>50	0	0		10	10	10	10	20	34	40

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
59	6	3	5	

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
95% : States whether there is 95% 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: ALBEMARLE SOUND NR EDENTON N SHORE
Station #: D999500N **Subbasin:** CHO04
Latitude: 36.04216 **Longitude:** -76.61279 **Stream class:** B NSW
Agency: NCAMBNT **NC stream index:** 26

Time period: 09/14/2000 to 08/10/2005

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	59	0	<4	0	0		5.7	7.2	7.7	8.8	10.9	12.5	13.1
	59	0	<5	0	0		5.7	7.2	7.7	8.8	10.9	12.5	13.1
pH (SU)	59	0	<6	0	0		6.2	6.9	7.2	7.3	7.5	7.7	8.4
	59	0	>9	0	0		6.2	6.9	7.2	7.3	7.5	7.7	8.4
Salinity (ppt)	58	6	N/A				0.01	0.03	0.04	0.2	1.67	3.91	5.12
Spec. conductance (umhos/cm at 25°C)	59	0	N/A				48	86	109	251	2940	6988	9108
Water Temperature (°C)	59	0	>32	1	1.7		3	6	11.6	19.7	26.8	28.8	32.1
Other													
Chlorophyll A (ug/L)	2	0	>40	0	0		4	4	4	8	11	11	11
TSS (mg/L)	22	4	N/A				1	1	2	3	5	6	11
Turbidity (NTU)	59	1	>50	0	0		1	2	3	5	8	11	28
Nutrients (mg/L)													
NH3 as N	55	27	N/A				0.01	0.01	0.02	0.02	0.04	0.08	0.2
NO2 + NO3 as N	55	20	N/A				0.01	0.01	0.02	0.08	0.18	0.23	0.29
TKN as N	55	1	N/A				0.28	0.31	0.34	0.42	0.52	0.59	0.77
Total Phosphorus	55	5	N/A				0.02	0.02	0.04	0.06	0.08	0.1	0.17
Metals (ug/L)													
Aluminum, total (Al)	21	0	N/A				67	70	105	220	405	548	750
Arsenic, total (As)	21	21	>10	0	0		5	5	10	10	10	42	50
Cadmium, total (Cd)	21	21	>2	0	0		2	2	2	2	2	8	10
Chromium, total (Cr)	21	21	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	21	13	>7	1	4.8		2	2	2	2	3	5	22
Iron, total (Fe)	21	1	>1000	5	23.8	Yes	50	78	175	860	1030	1200	1300
Lead, total (Pb)	21	21	>25	0	0		10	10	10	10	10	42	50
Mercury, total (Hg)	21	21	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	21	21	>88	0	0		10	10	10	10	10	42	50
Zinc, total (Zn)	21	13	>50	2	9.5		10	10	10	10	21	48	310

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
59	5	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
95% : States whether there is 95% 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: ALBEMARLE SOUND NR EDENTON S SHORE
Station #: D999500S **Subbasin:** CHO04
Latitude: 35.94793 **Longitude:** -76.60793 **Stream class:** SB
Agency: NCAMBNT **NC stream index:** 30

Time period: 09/14/2000 to 08/10/2005

	# result	# ND	Results not meeting EL EL	#	%	95%	Min	Percentiles 10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	59	0	<5	1	1.7		2.4	6.9	7.9	9.1	10.9	12.2	13
pH (SU)	59	0	<6.8	5	8.5		6.2	6.8	7.1	7.3	7.6	7.8	8.2
	59	0	>8.5	0	0		6.2	6.8	7.1	7.3	7.6	7.8	8.2
Salinity (ppt)	58	4	N/A				0.03	0.04	0.05	0.2	1.55	3.04	4.98
Spec. conductance (umhos/cm at 25°C)	59	0	N/A				80	97	118	347	3052	6185	8852
Water Temperature (°C)	59	0	>32	0	0		3	6	11	18.9	25.9	27.4	30.3
Other													
Chlorophyll A (ug/L)	1	0	>40	0	0		11	11	11	11	11	11	11
TSS (mg/L)	19	3	N/A				2	2	4	5	8	9	13
Turbidity (NTU)	59	0	>25	0	0		1	2	4	4	8	14	22
Nutrients (mg/L)													
NH3 as N	55	21	N/A				0.01	0.02	0.02	0.02	0.04	0.06	0.22
NO2 + NO3 as N	55	12	N/A				0.01	0.02	0.03	0.1	0.16	0.21	0.55
TKN as N	55	1	N/A				0.22	0.34	0.36	0.42	0.49	0.59	0.73
Total Phosphorus	55	2	N/A				0.02	0.02	0.04	0.05	0.06	0.08	0.13
Metals (ug/L)													
Aluminum, total (Al)	21	0	N/A				61	110	125	210	310	516	550
Arsenic, total (As)	21	21	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	21	21	>5	0	0		2	2	2	2	2	2	10
Chromium, total (Cr)	21	21	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	21	14	>3	1	4.8		2	2	2	2	2	3	3
Iron, total (Fe)	21	0	N/A				83	140	395	550	700	1068	1100
Lead, total (Pb)	21	21	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	21	21	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	21	20	>8.3	1	4.8		10	10	10	10	10	10	20
Zinc, total (Zn)	21	15	>86	0	0		10	10	10	10	16	34	36

Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
59	3	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
95% : States whether there is 95% 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: Box Plots

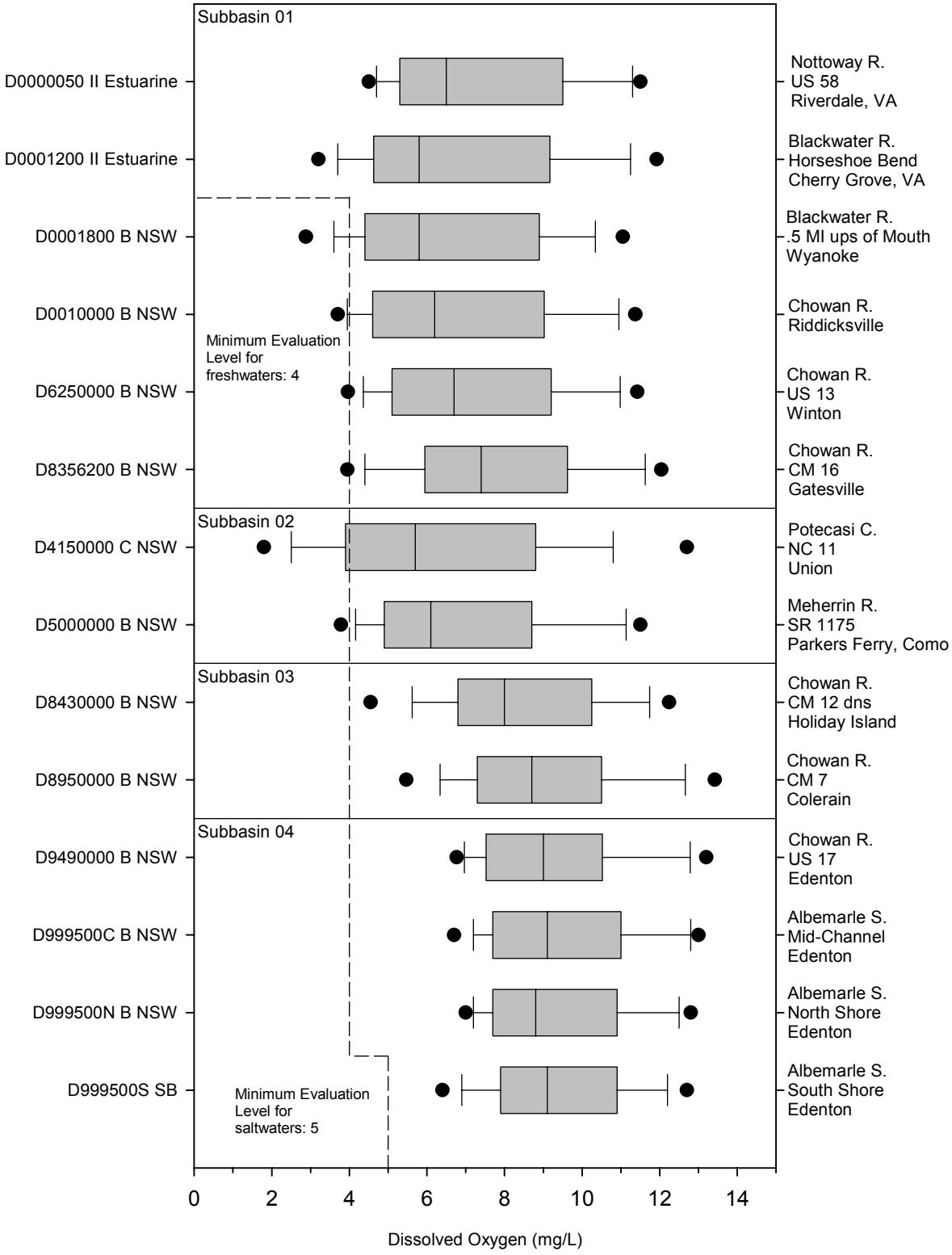


Figure 13. Box Plots of Dissolved Oxygen in the Chowan River Basin

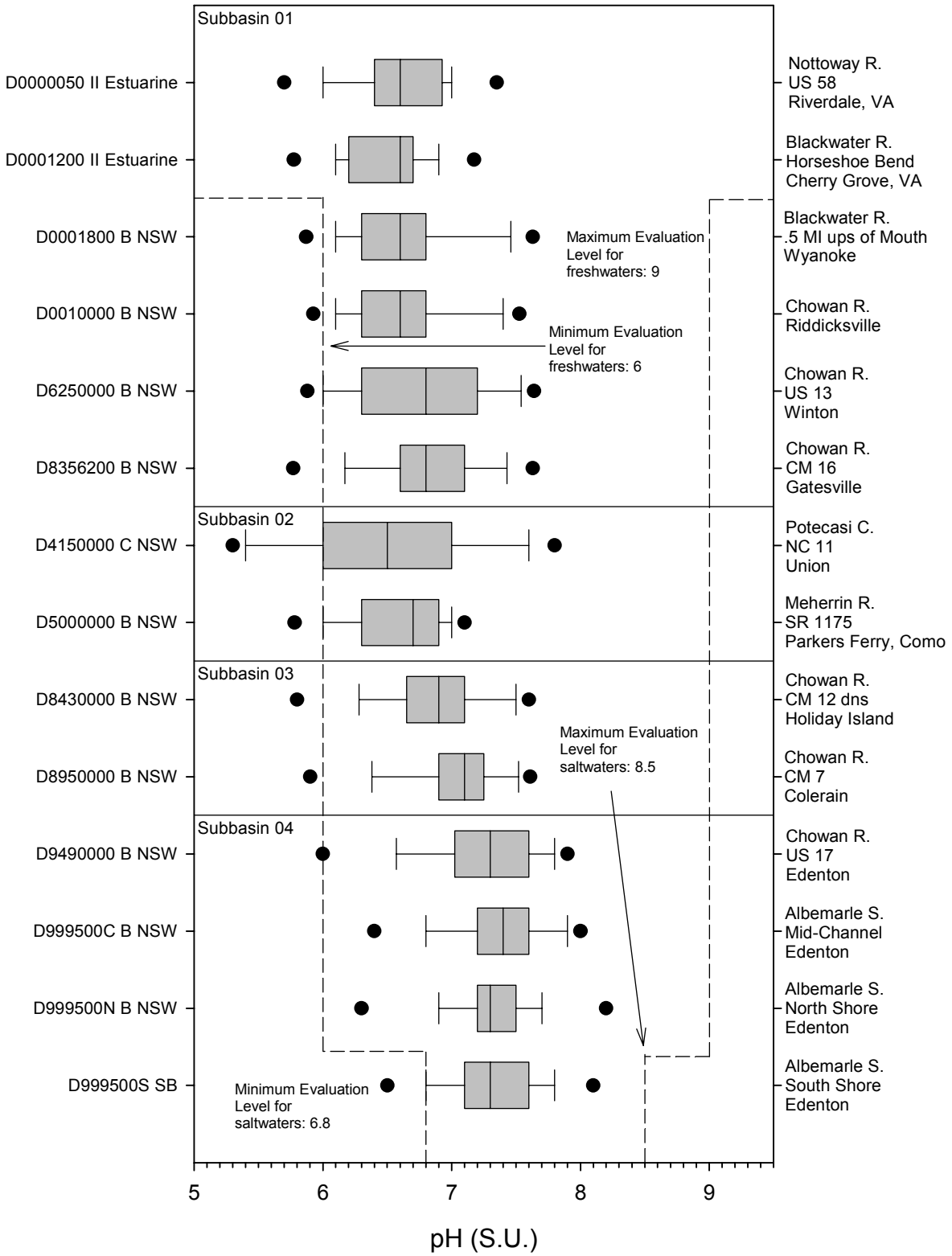


Figure 14. Box Plots of pH in the Chowan River Basin

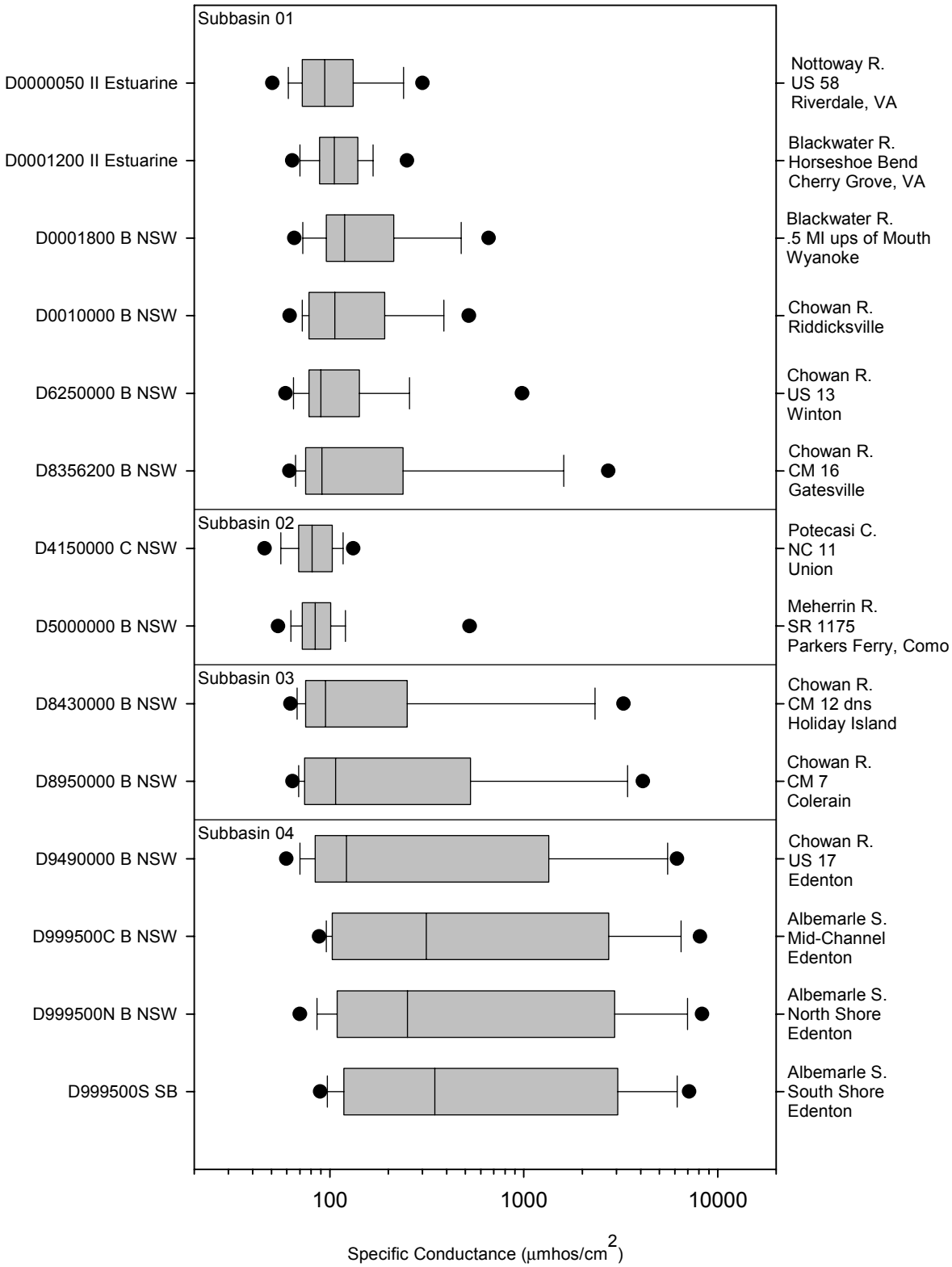


Figure 15. Box Plots of Specific Conductivity in the Chowan River Basin

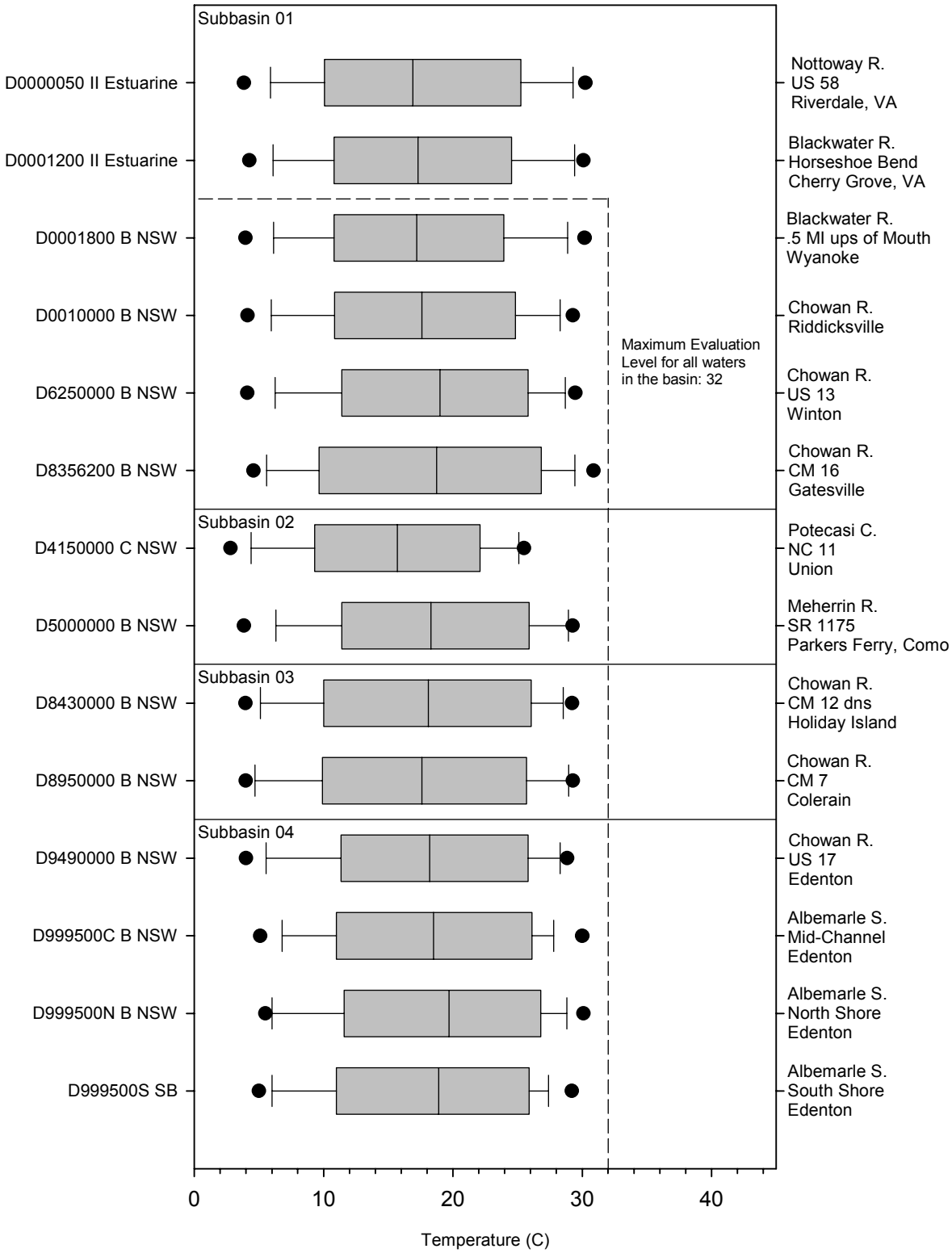


Figure 16. Box Plots of Water Temperature in the Chowan River Basin

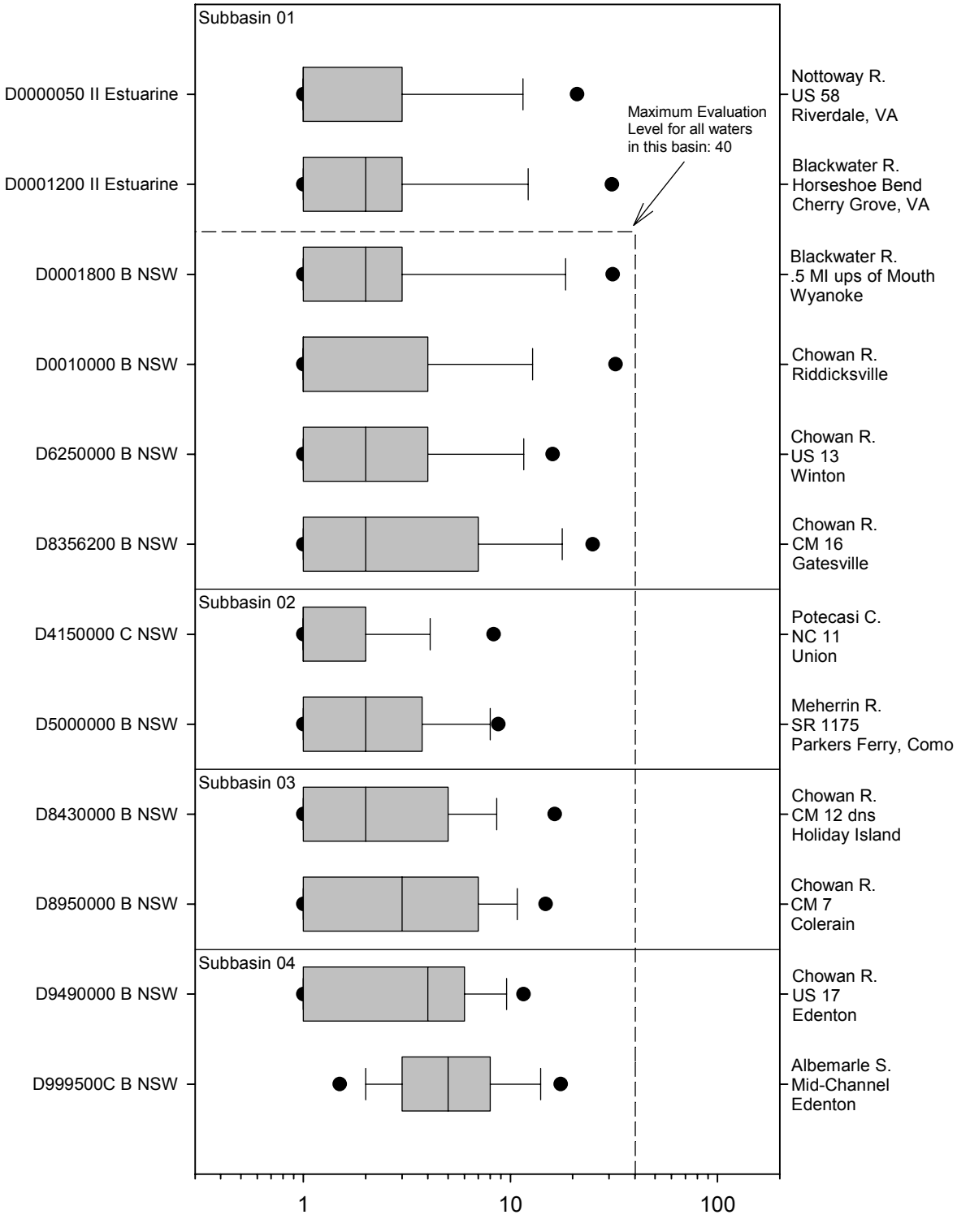


Figure 17. Box Plots of Chlorophyll A in the Chowan River Basin

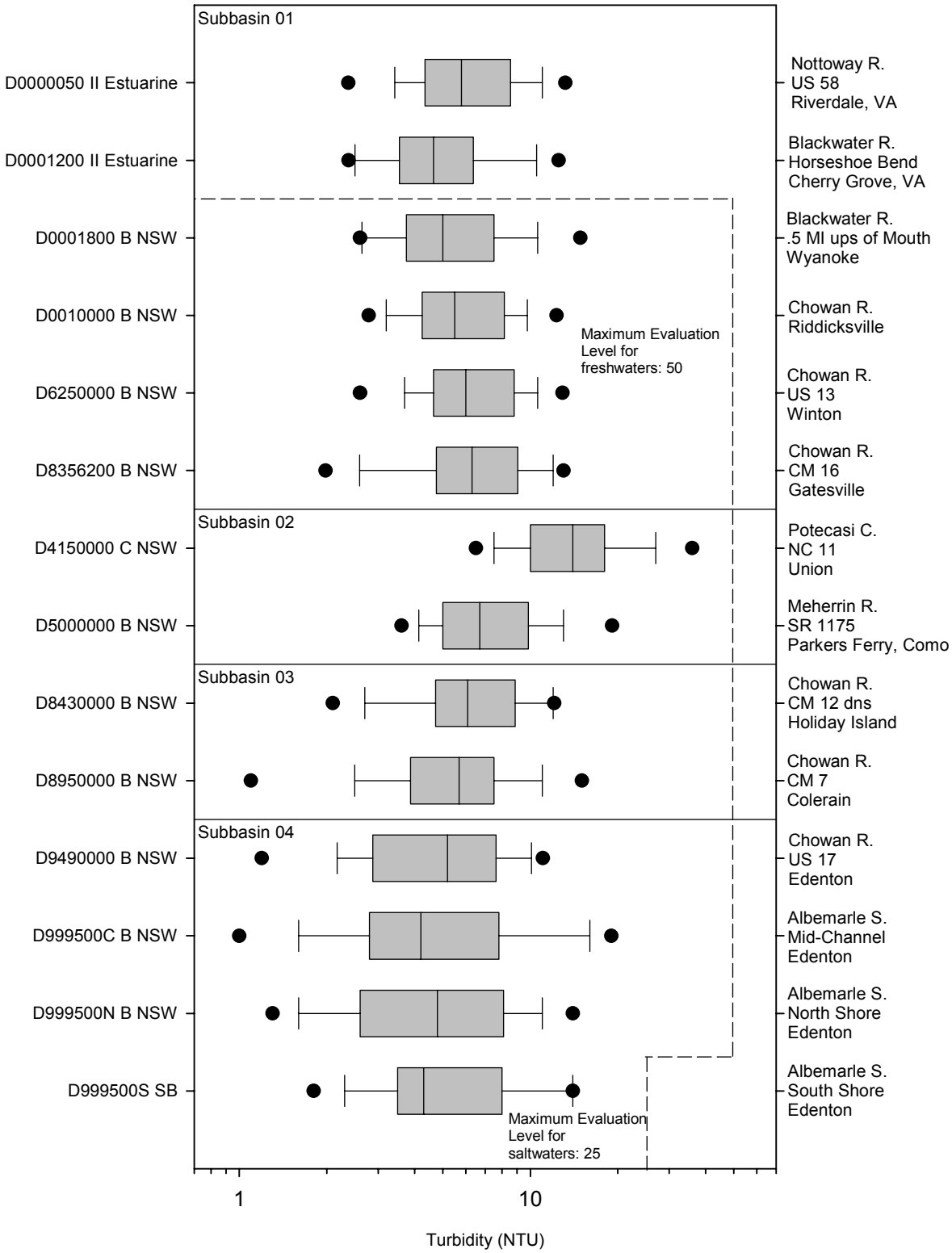


Figure 18. Box Plots of Turbidity in the Chowan River Basin

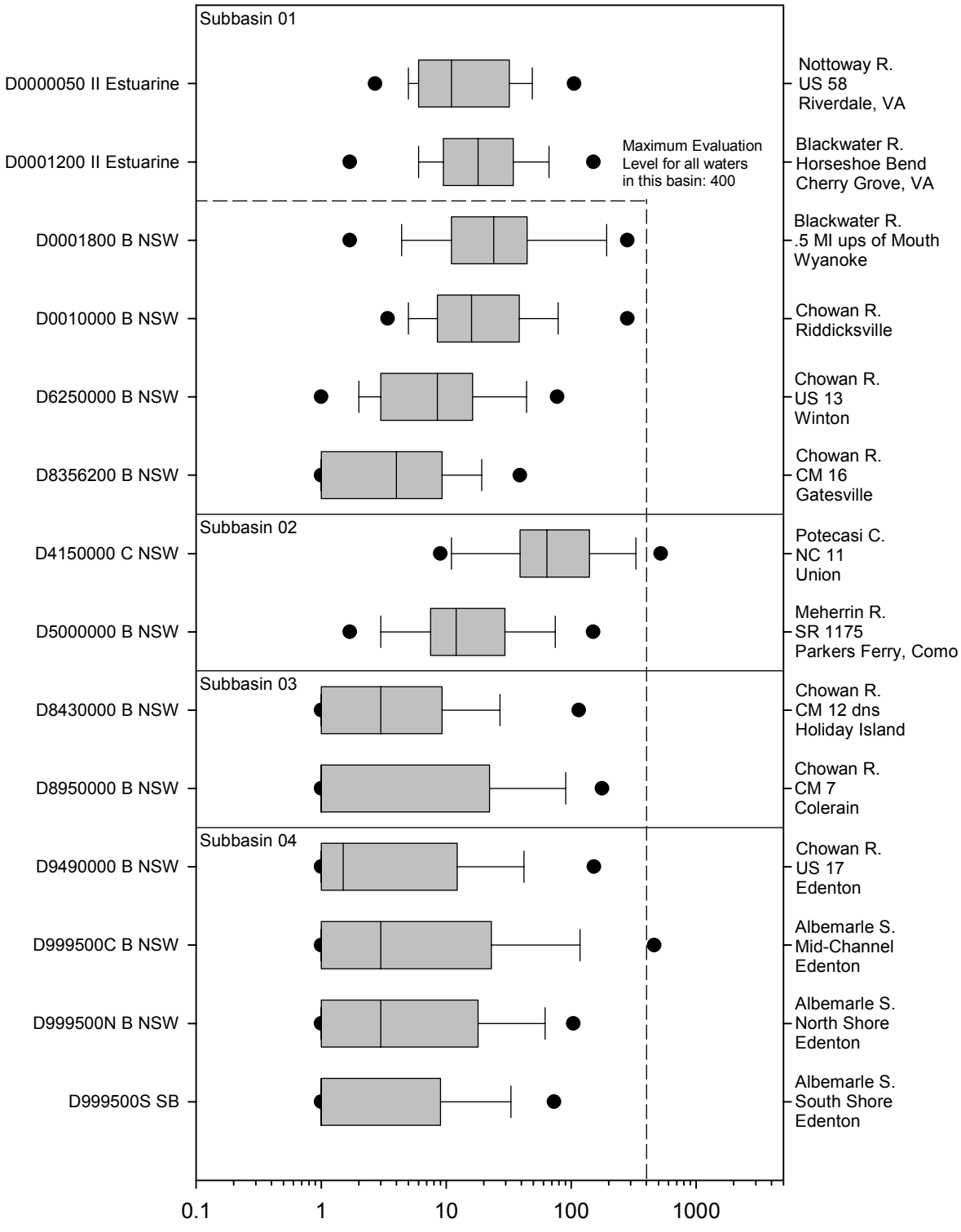


Figure 19. Box Plots of Fecal Coliform in the Chowan River Basin

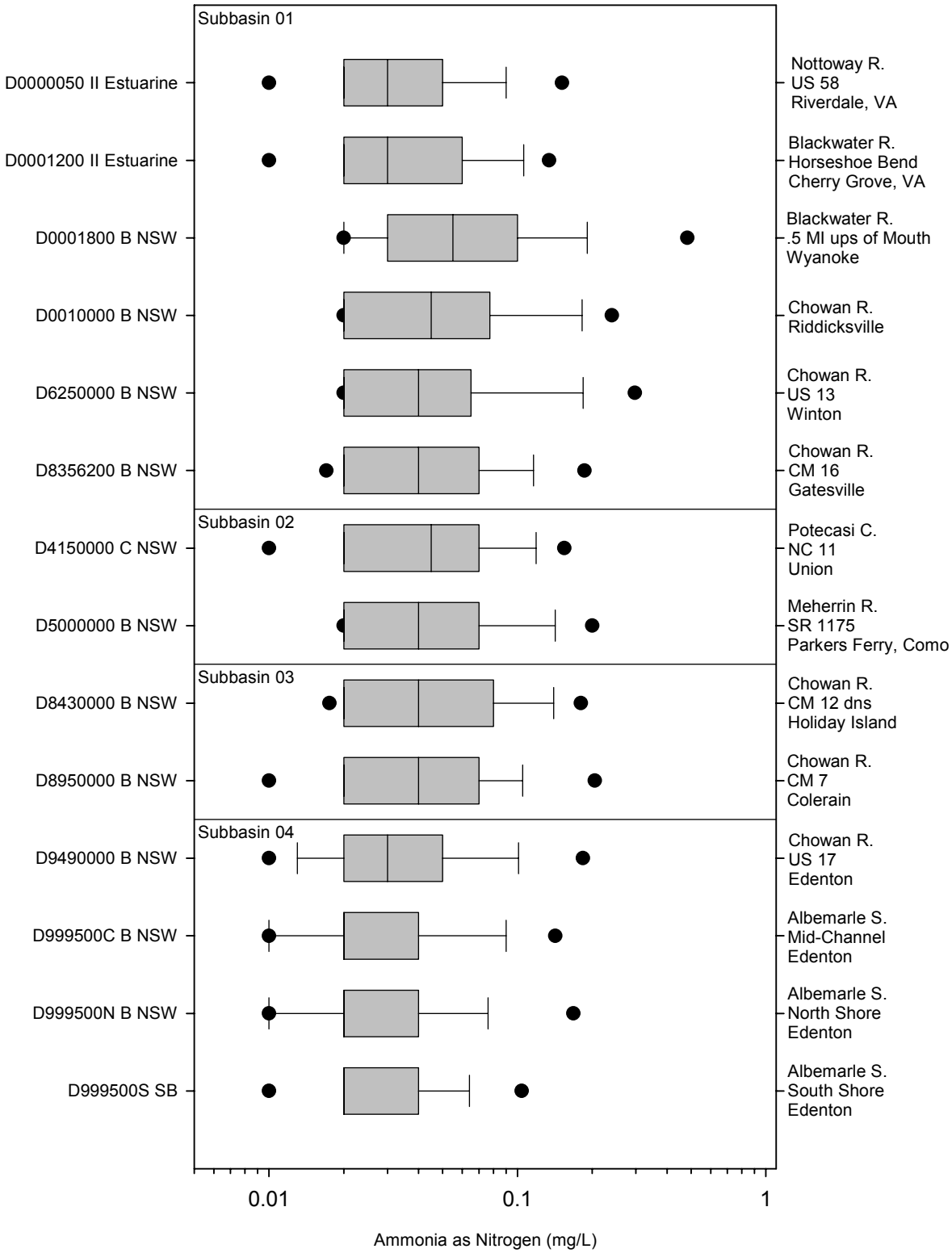


Figure 20. Box Plots of Total Ammonia in the Chowan River Basin

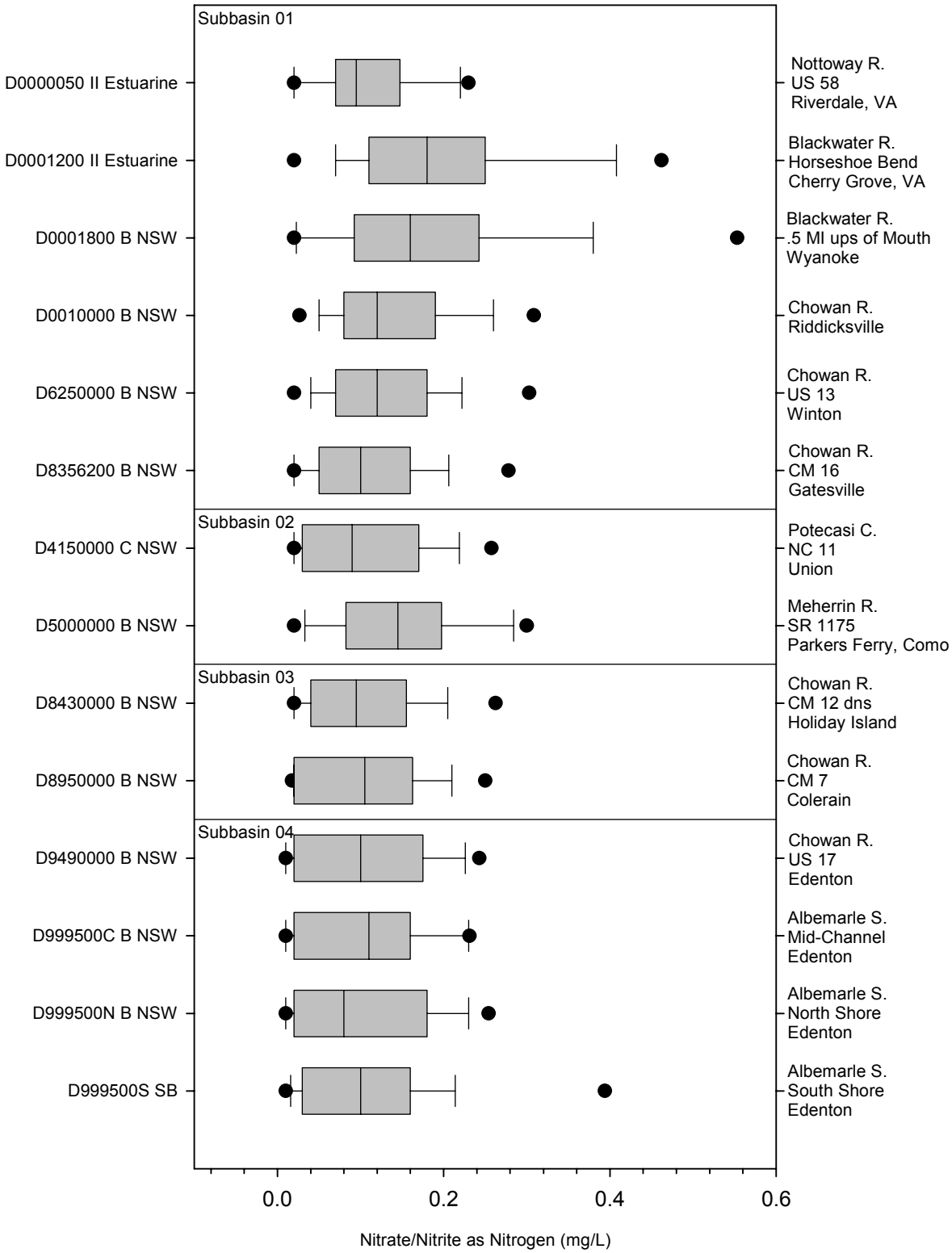


Figure 21. Box Plots of Total Nitrate/Nitrite in the Chowan River Basin

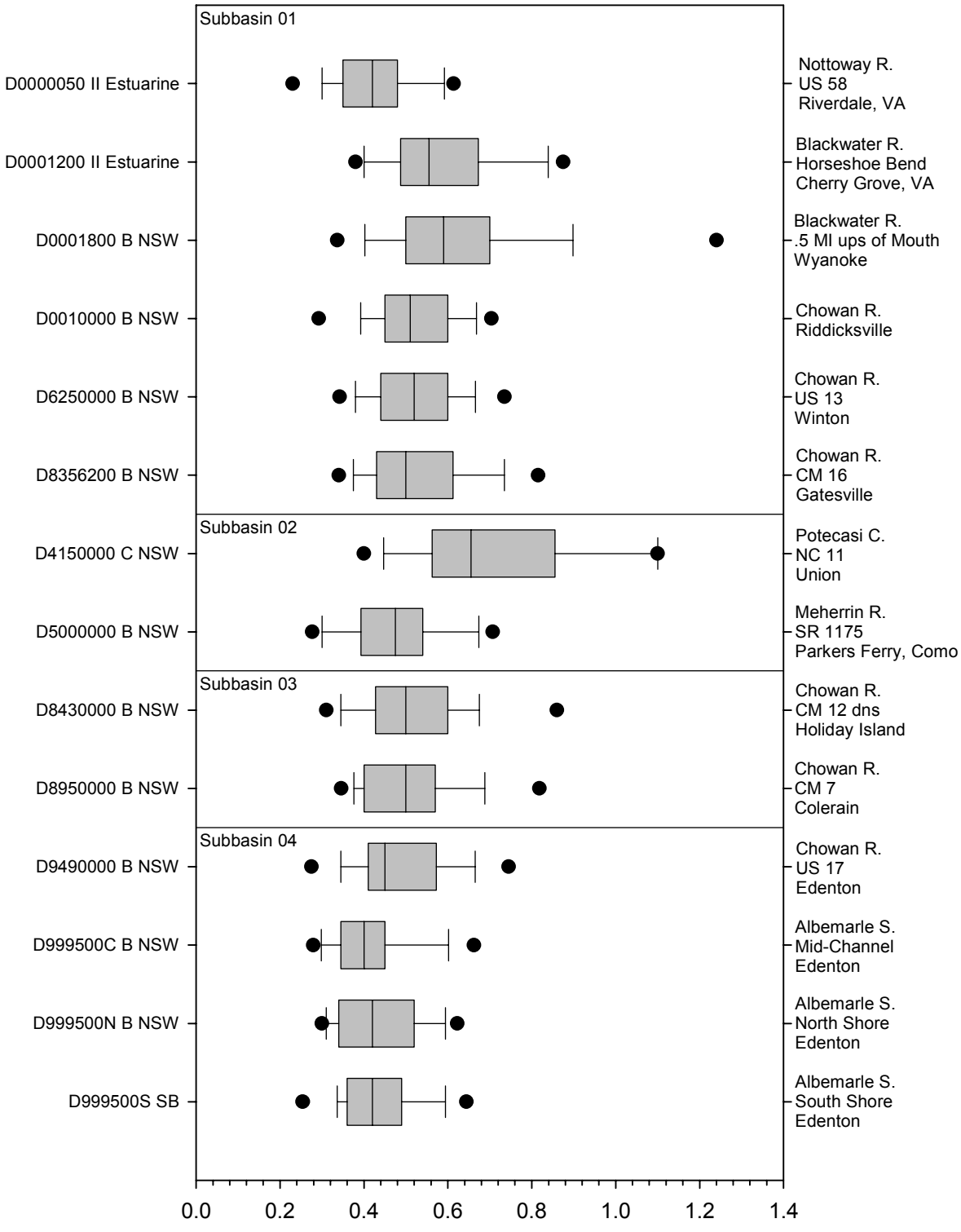


Figure 22. Box Plots of Total Kjeldahl Nitrogen in the Chowan River Basin

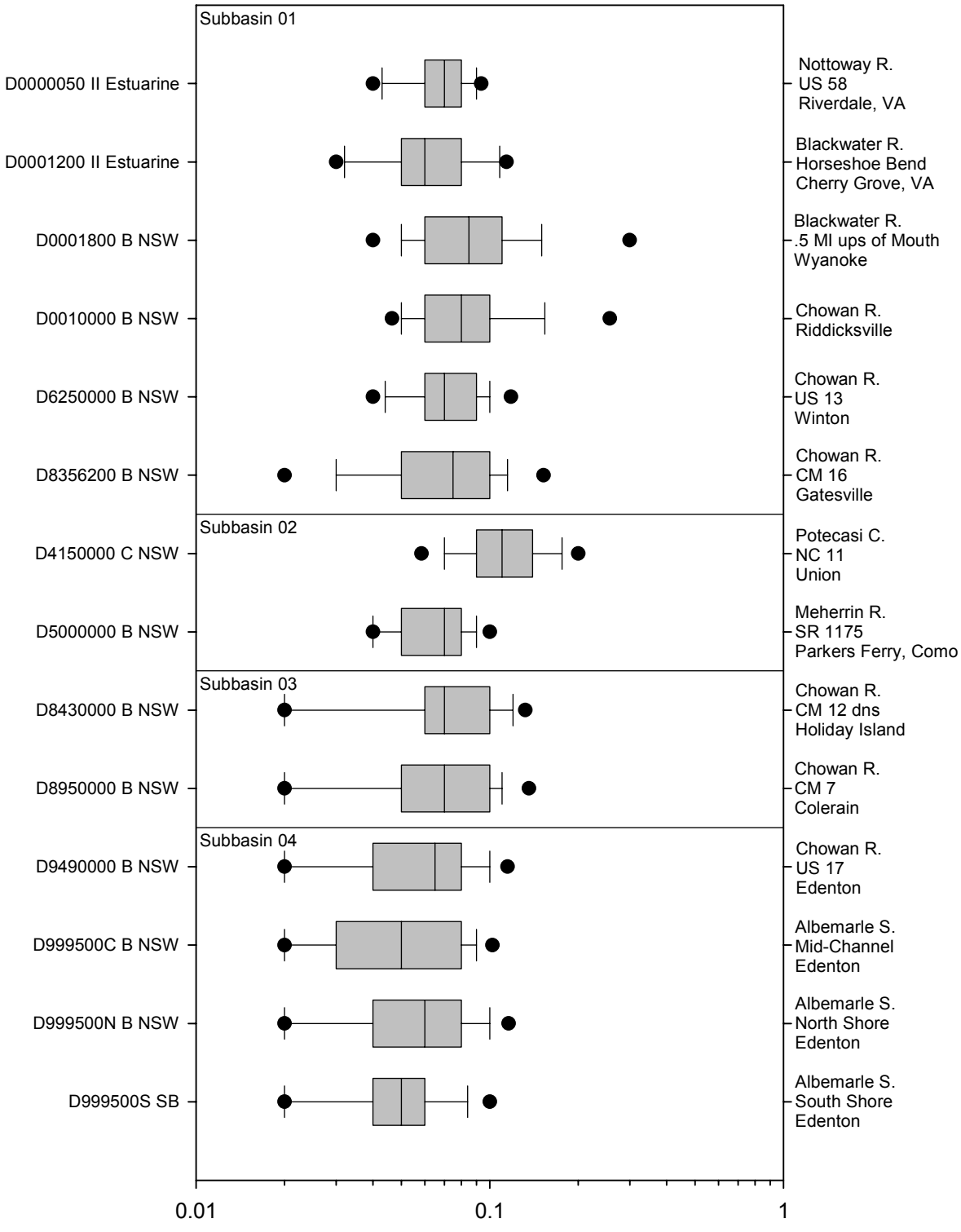


Figure 23. Box Plots of Total Phosphorus in the Chowan River Basin

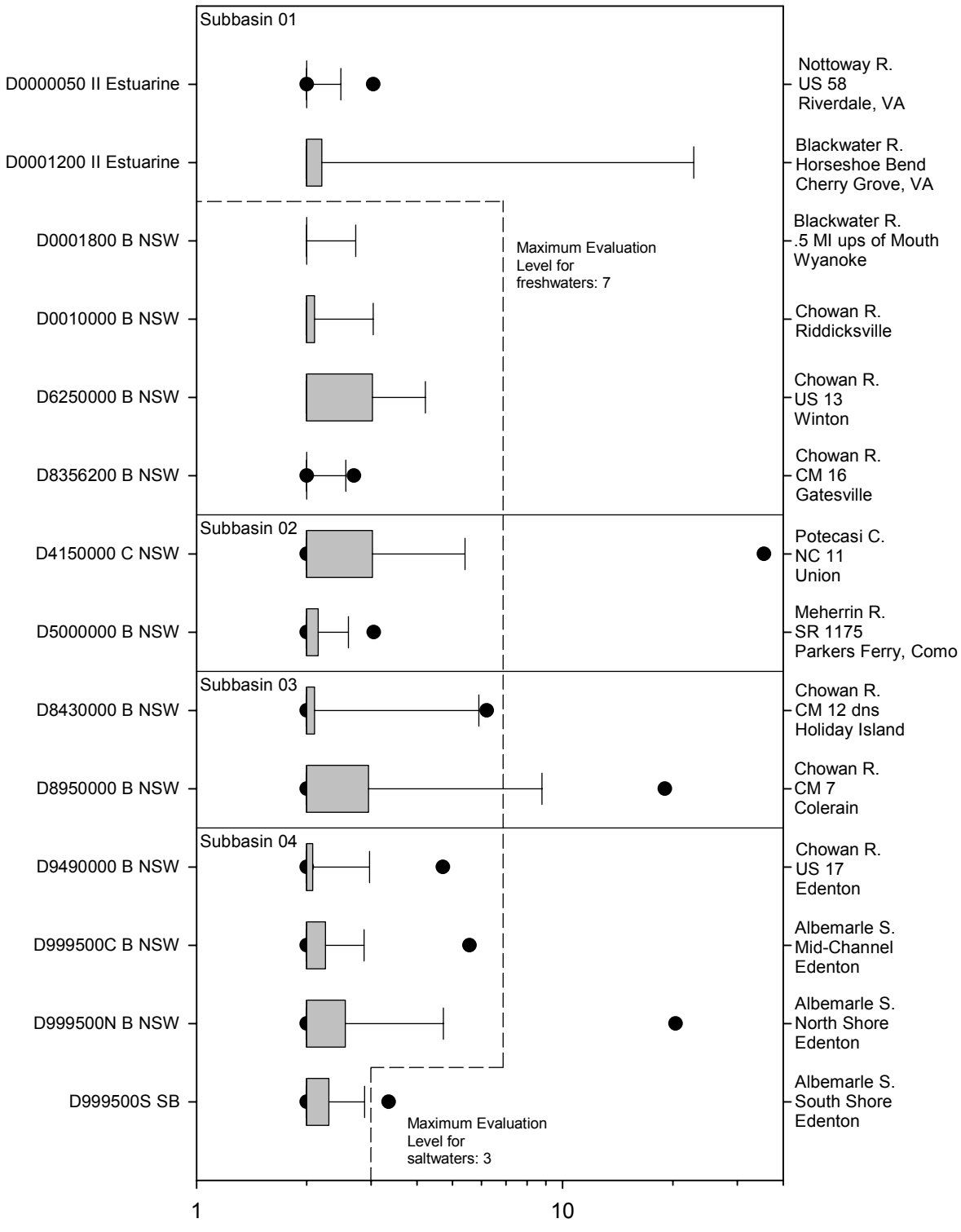


Figure 24. Box Plots of Total Copper in the Chowan River Basin

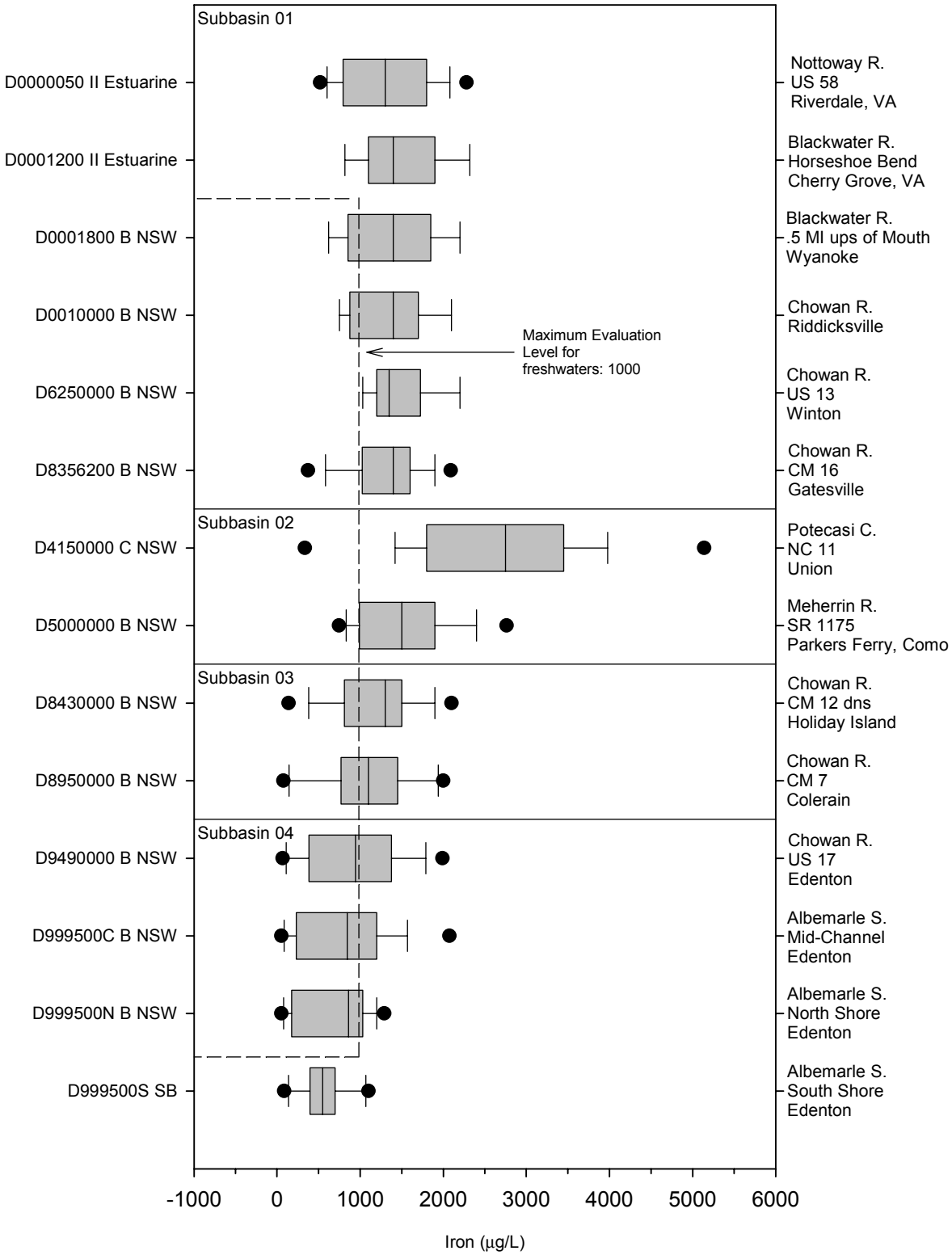


Figure 25. Box Plots of Total Iron in the Chowan River Basin

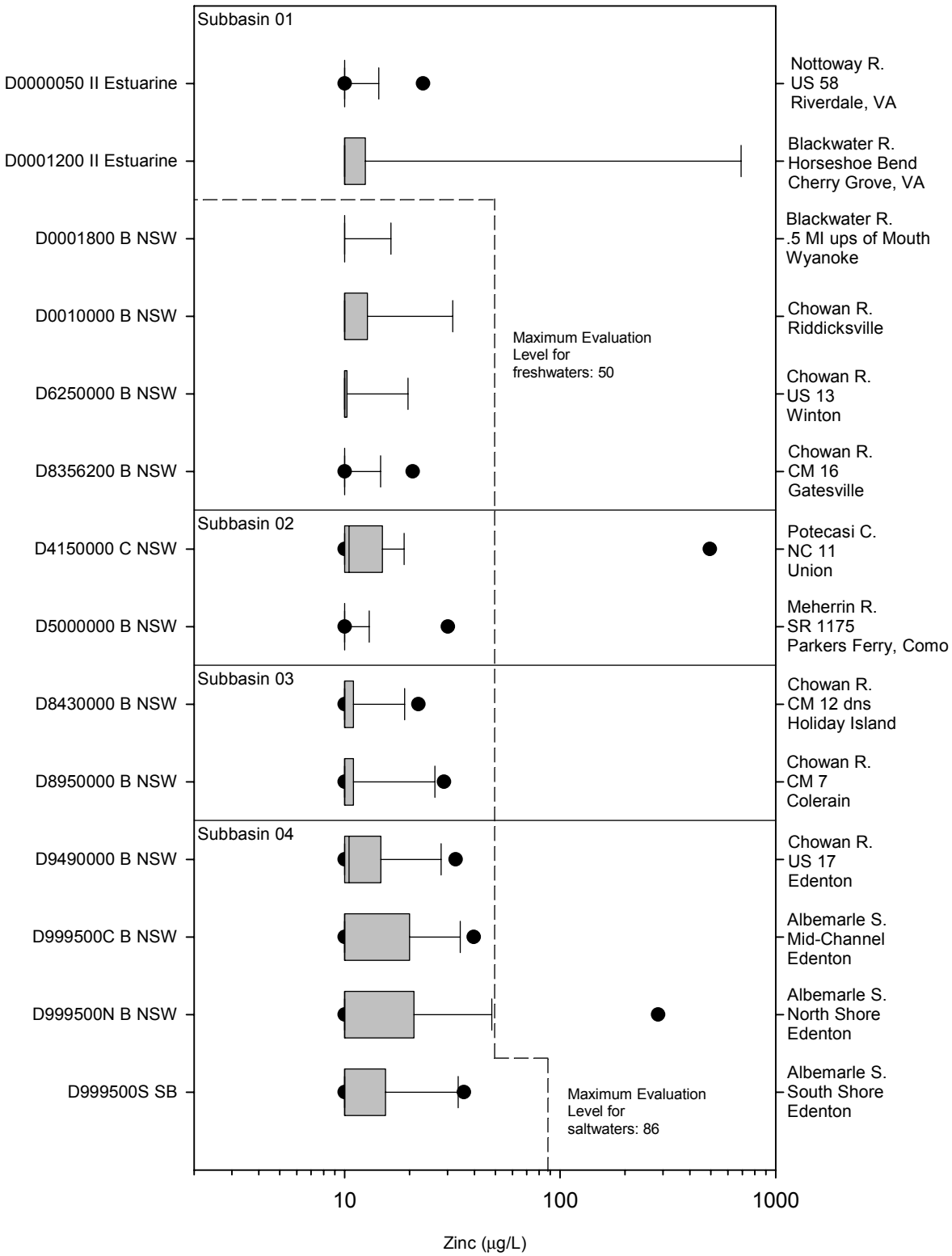
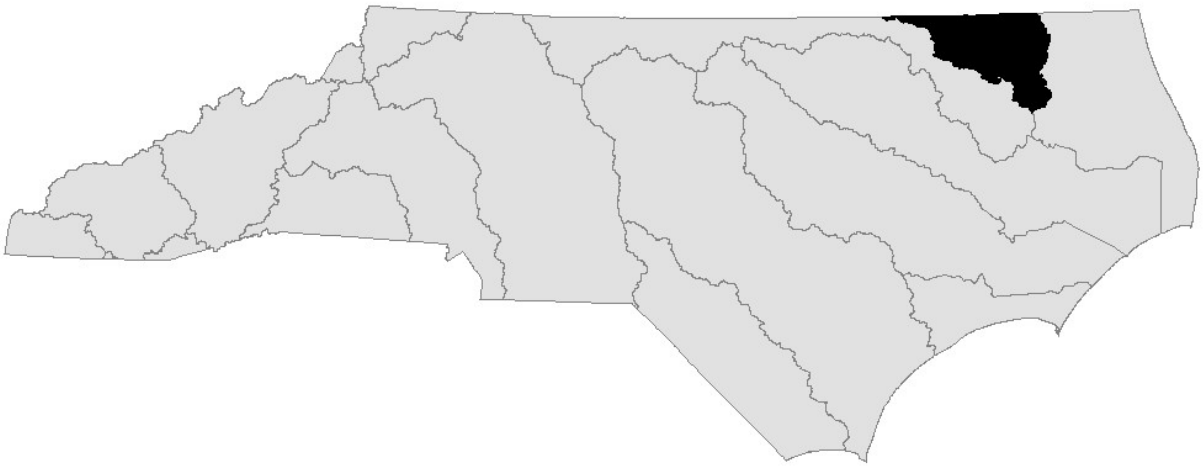


Figure 26. Box Plots of Total Zinc in the Chowan River Basin

Chowan River Basin
Basinwide Assessment Report
Whole Effluent Toxicity Program

2001-2005



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 Chowan River Basin – 2001-2005

Two facility permits in the Chowan River basin currently require whole effluent toxicity (WET) monitoring (Figure 1 and Table 1). Both facility permits have a WET limit.

Figure 1. Chowan River basin facilities required to conduct whole effluent toxicity testing

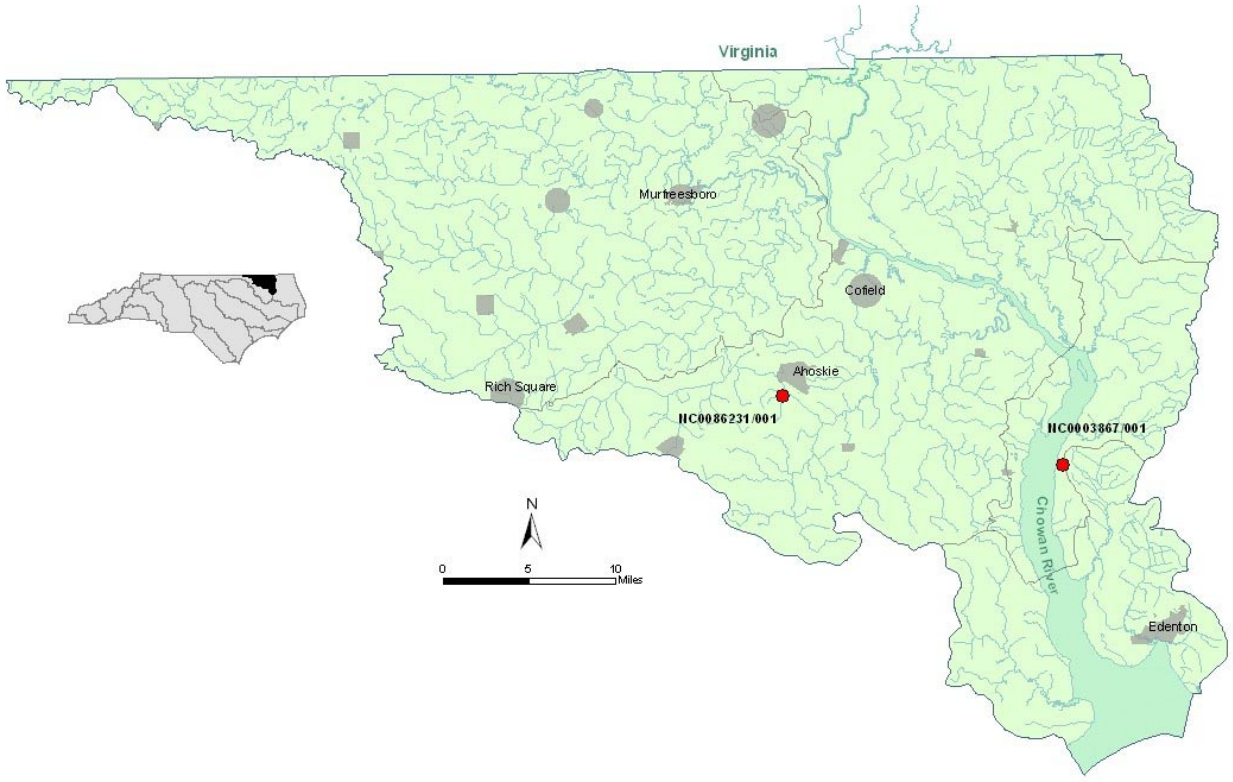


Table 1. Chowan River basin facilities required to conduct whole effluent toxicity testing

Subbasin/Facility	NPDES Permit No.	Receiving Stream	County	Flow (MGD)	IWC (%)	7Q10 (cfs)
03-01-01						
Aluminum Casting Tech. WWTP	NC0086231/001	Ahoskie Cr.	Hertford	0.024	2.4	1.5
03-01-03						
Edenton Dyeing and Finishing, LLC	NC0003867/001	Chowan R.	Chowan	1.5	NA	Tidal

The compliance rate of those facilities has near perfect through the middle of 2004 (Figure 2 and Table 2).

Beginning in November of 2004, Edenton Dyeing and Finishing, discharging to the Chowan River (subbasin 03), began to consistently fail its WET test, producing seven consecutive non-compliances through June 2005. The facility's investigations into sources of toxicity identified a phenolic-based surfactant as a likely contributor to toxicity; the facility has ceased use of that product. In addition, the facility adjusted its wastewater treatment plant operation with regard to wasting of aeration basin solids in order to improve treatment efficiency. The facility has been compliant with its WET limit for its last four monitoring events, beginning in July 2005 through February 2006.

Aluminum Casting Technology, discharging to Ahoskie Creek (subbasin 01), has ceased operation and likely will apply to rescind its NPDES permit in the near future.

Figure 2. NPDES facility whole effluent toxicity compliance in the Chowan River basin, 1990-2005. 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.

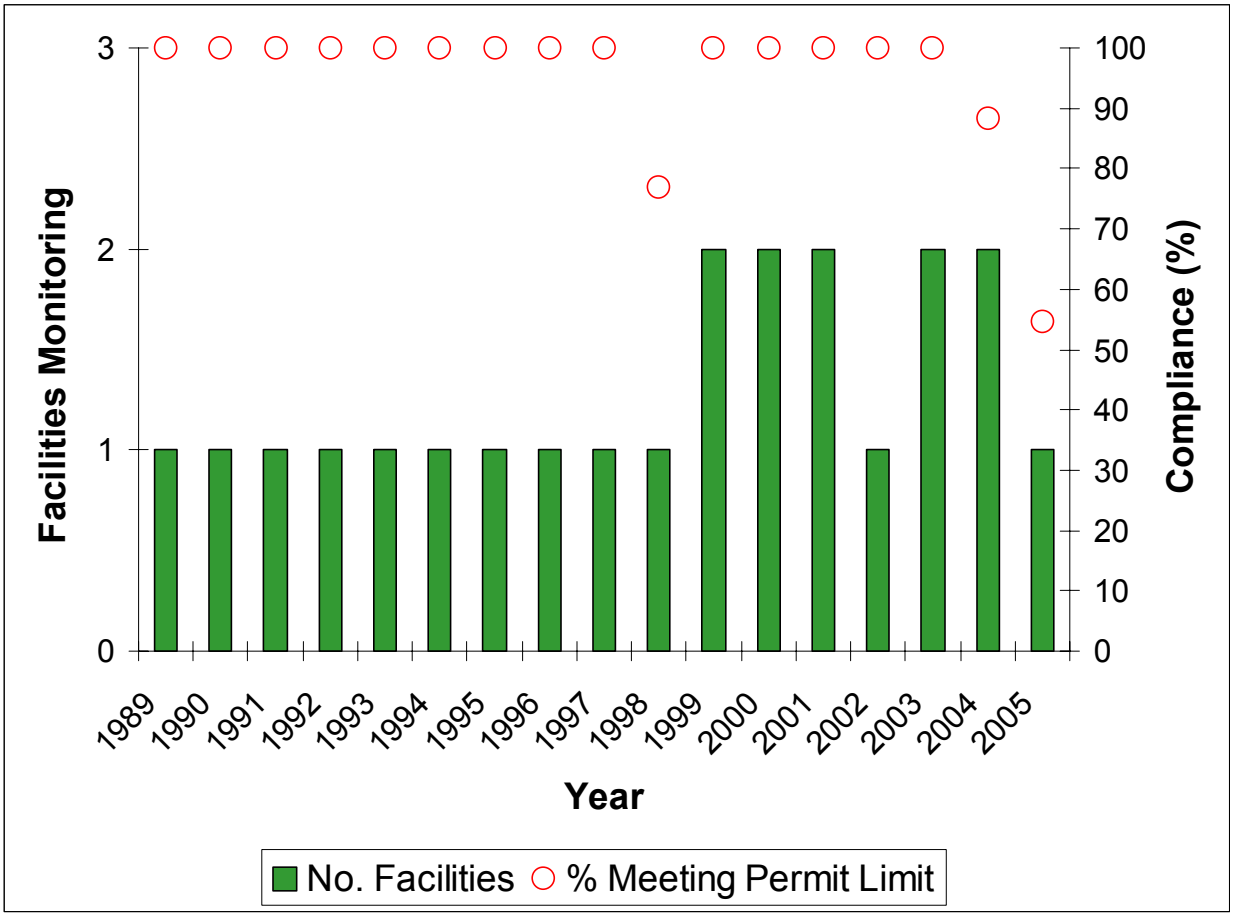


Table 2. Recent compliance record of facilities performing whole effluent toxicity testing in the Chowan River basin

Subbasin/Facility	NPDES Permit No.	2001- 2004 Passes	2001- 2004 Fails	2005 Passes	2005 Fails
03-01-01					
Aluminum Casting Technology WWTP	NC0086231/001	7	0	0	0
03-01-03					
Edenton Dyeing and Finishing, LLC	NC0003867/001	16	2	3	5

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.