BASINWIDE ASSESSMENT REPORT

NEUSE RIVER BASIN

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

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NCDENR

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EXECUTIVE SUMMARY

This document presents a water quality assessment of the Neuse River basin based primarily upon data collected by the NC Division of Water Quality (NCDWQ). Other information reported by outside researchers and other agencies may also be presented. The NCDWQ monitoring programs covered within this report include benthic macroinvertebrates, fish community and fish tissue, lakes assessment, phycology, ambient chemistry monitoring, and aquatic toxicity for the period 1996 - 2000. Data collected before 1996 were previously summarized in NCDEHNR (1992, 1997).

This document is structured with physical, geographical, and water quality overviews given at the beginning of each subbasin section. Specific data and descriptions of information covered by these summaries can be found in the individual subbasin sections and the appendices, or in the separate ambient monitoring and aquatic toxicity sections located after the subbasin sections. General water quality conditions are presented in an upstream to downstream format. Subbasins are described by a six digit code (030401 - 030414), but are often referred to by their last two digits (e.g. Subbasin 01).

The Neuse River basin is the third largest basin in North Carolina and is one of only three basins that is located entirely within the state (Figure 1). The basin covers 6,192 square miles in 19 counties. The Neuse River originates northwest of Durham in Person and Orange counties in the piedmont ecoregion (Figure 2). The upper 22 miles of the river's mainstem is impounded behind Falls of the Neuse Reservoir dam, a large multi-use reservoir located a few miles northeast of Raleigh. Below the dam, the river flows about 185 miles southeasterly past the cities of Raleigh, Smithfield, Goldsboro, and Kinston until it reaches tidal waters near Street's Ferry, upstream of New Bern. Below Street's Ferry, the river broadens dramatically, changing into a tidal estuary that eventually flows into Pamlico Sound. Much of the land area in the basin is agriculture or forests, while urban development is concentrated around Raleigh, Durham, and Cary in the upper basin, and Goldsboro, Kinston and New Bern in the lower basin.

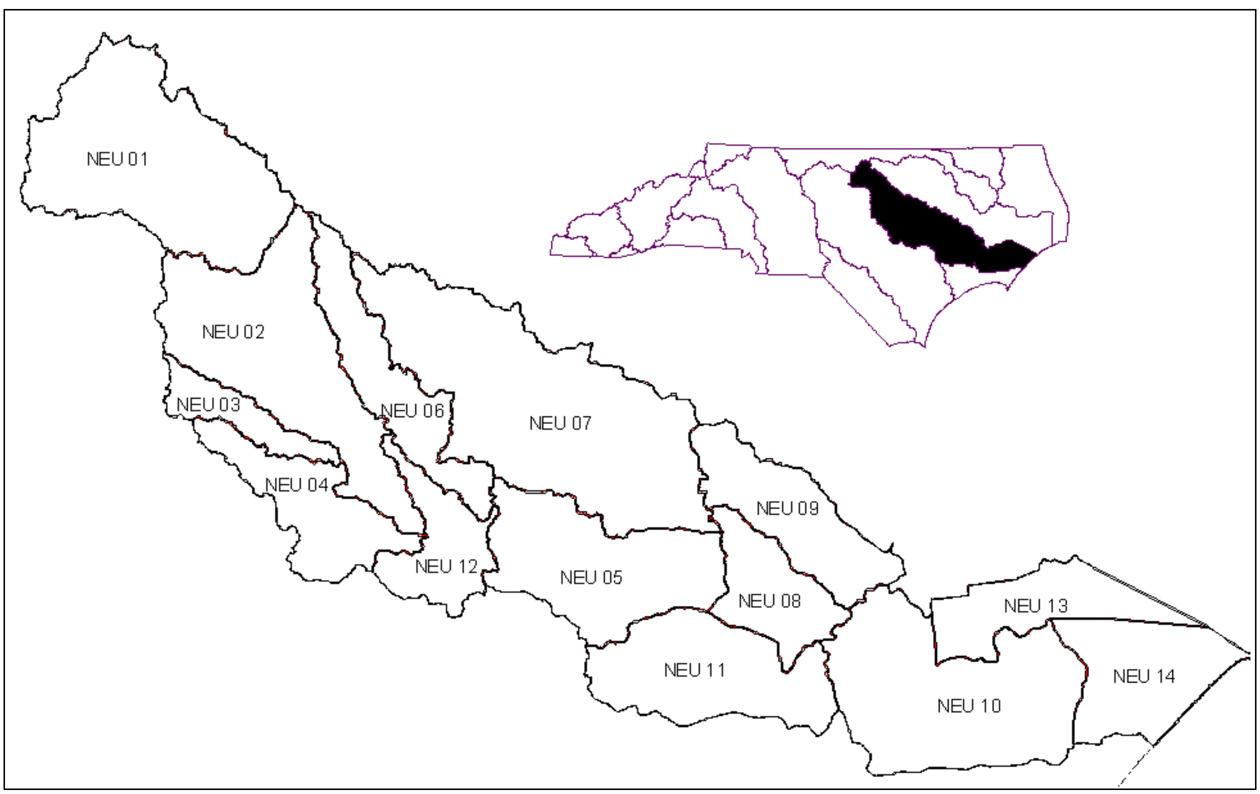


Figure 1. Geographical relationships of the Neuse River basin.

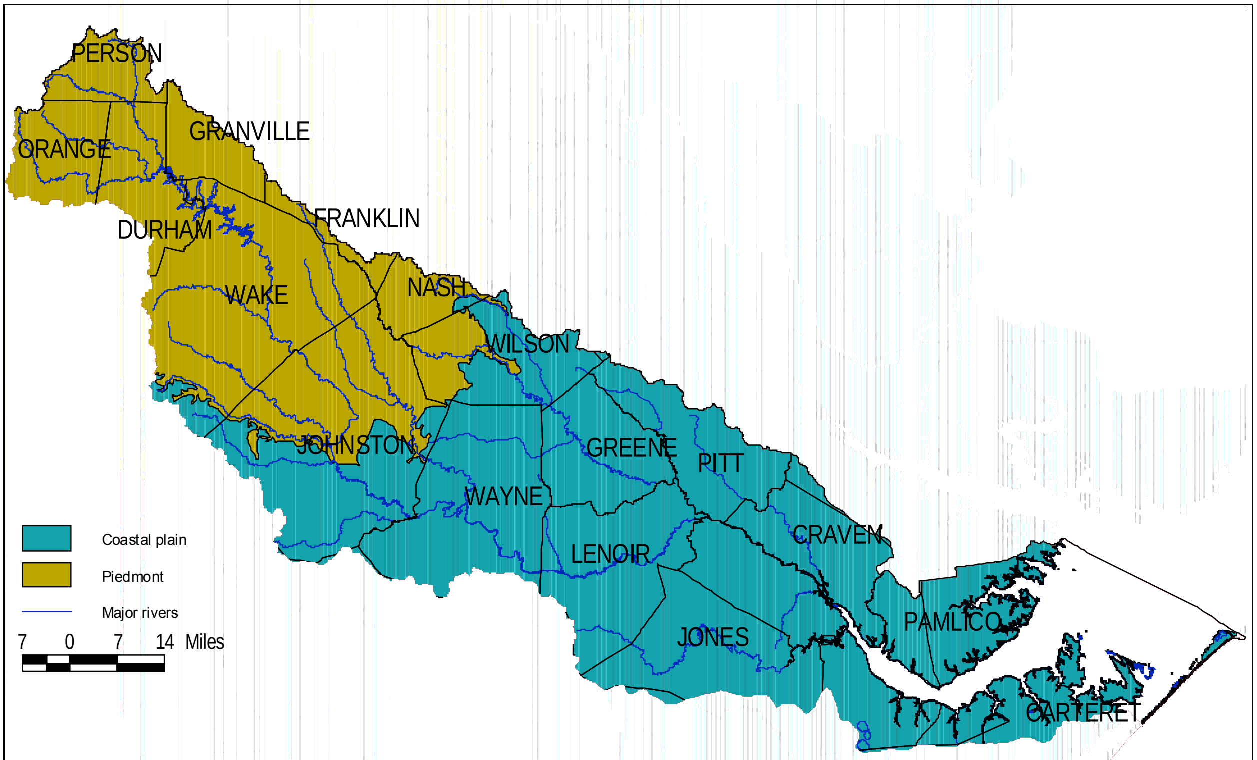


Figure 2. **Physiographic regions in the Neuse River basin.**

THE UPPER NEUSE RIVER BASIN

Falls of the Neuse Reservoir Watershed (Subbasin 01)

The Falls of the Neuse Reservoir (Falls Lake) watershed includes the cities of Durham and Hillsborough. The Flat, Eno, and Little Rivers drainages of Falls Lake are in the Slate Belt ecoregion. A narrow band of Triassic basin rocks run through the middle of this area, including Ledge, Beaverdam, and Lick Creeks. Smaller streams in the slate belt and Triassic regions are especially susceptible to lack of flow during dry periods. This natural stress may obscure some of the effects of point and nonpoint source runoff. The area south of Falls Lake is within a more typical portion of the piedmont ecoregion; streams in this area have sandier substrates.

Overall, biological sampling showed no evidence of major changes in water quality for this subbasin between 1995 and 2000. Of the 23 stream sites sampled for benthic invertebrates, or fish, or both in 2000, 16 (70%) rated either Good or Excellent. Of the 18 sites sampled in both 1995 and 2000, 7 (39%) retained the same bioclassification, 7 (39%) increased by one bioclassification, and 4 (22%) decreased by one bioclassification. None of the eight lakes sampled in 2000 indicated any significant change in water quality between 1995 and 2000.

High water quality is found in the Eno, Flat, and Little Rivers systems. This is due to a combination of Slate Belt geology and a general lack of disturbance. Macroinvertebrate and fish collections produced Good or Excellent ratings for most sites on these rivers. Point source dischargers contributed to severe problems in some tributaries near Durham, especially Ellerbe and Knap of Reeds Creeks. Ellerbe Creek, however, is also severely impacted by urban runoff. Urban runoff from Durham affects both Lick and Little Lick Creeks. The Durham Lick Creek WWTP ceased discharge in 1995, but Little Lick Creek still had a Poor rating in 2000.

In 1999, the City of Raleigh funded a water quality study of the lower reach of Falls Lake downstream of NC 50. The chemical quality of this region was very good with no pesticides and no extractable or volatile organic compounds; and very few trace metals had concentrations greater than detection limits. Chlorophyll *a* concentrations were not greater than the water quality standard. Algal biomass, however, was found to range from moderate to high and was dominated by nuisance blue green algae. Falls Lake began filling in 1983, and it has had algal blooms nearly every year since.

Monthly water chemistry data were collected from eight sites in this subbasin. Knap of Reeds and Ellerbe Creeks both exhibited consistently high specific conductance and nitrate+nitrite-nitrogen levels. The primary influence at these sites was likely the John Umstead Hospital WWTP (Butner) and the Northern Durham Water Reclamation Facility.

Neuse River (Falls Lake to southern Johnston County) and Swift and Crabtree Creeks (Subbasin 02)

This area contains the most urbanized land in the entire basin, including the greater Raleigh metropolitan area of Cary, Garner, Clayton and Smithfield. Significant tributaries to the Neuse River in this subbasin are Crabtree Creek, Walnut Creek (including Lakes Johnson and Raleigh) and Swift Creek (including Lakes Wheeler and Benson). The largest discharger is the Raleigh Neuse River WWTP, with a design flow of 60 MGD.

This subbasin contains primarily piedmont streams. The piedmont section is subdivided into two geologic areas: the headwaters of Crabtree Creek lie within the Raleigh Belt and most of the middle section lies within the Eastern Slate Belt. Smaller streams in these two geological areas have a tendency to dry up under low flow conditions. A small portion of the inner coastal plain can be found east of Clayton.

Nonpoint runoff from both urban areas (stormwater and suspended sediments) and agricultural areas are the main contributors to water quality degradation, in addition to the many permitted dischargers in this subbasin. Chemical data indicated tributaries were a major source of many pollutants to the Neuse River. The highest turbidity in the basin was found in Crabtree Creek, likely due to urban development. Swift Creek also had elevated turbidity from development in south Raleigh and rapidly urbanizing Johnston County. The Neuse River mainstem showed a spike in nitrate+nitrite-nitrogen below Raleigh, which declined with distance downstream. Total phosphorus was high in much of Crabtree Creek as was ammonia (median > 0.15mg/L for both nutrients). The Neuse River mainstem showed peak ammonia concentrations just below Falls Lake, with levels declining with distance downstream.

Benthos data collected since 1995 in this subbasin resulted in 61% of the streams rated either Poor or Fair, 29% Good-Fair, and 10% Good. Water quality seems stable, because these percentages were almost identical to what was found in 1995. Of the 24 streams sampled for benthos in 2000 that had been previously sampled in 1995 or 1996, 20 (83%) showed no change in water quality between years. Of the four remaining stations, two -- Walnut Creek and Neuse River at NC 42 -- showed improved water quality from 1995 to 2000, while Smith Creek and Hare Snipe Creek had declining water quality.

Fish community sampling presented a very different picture, and suggested high and improved water quality in this subbasin. All four stations sampled for fish in both 1995 and 2000 showed improvements of one or more bioclassifications. Additionally, none of the five sites sampled in 2000 indicated water quality problems (Poor or Fair ratings) while Smith, Crabtree, and Marks Creeks indicated Excellent water quality.

Aquatic toxicity data (self-monitoring) of the 35 facilities in this subbasin required to perform whole effluent toxicity testing showed over 90 percent of the facilities have passed toxicity tests since 1995. The largest facility to have problems with toxicity is the Cary WWTP, which is currently undertaking a Toxicity Reduction Evaluation to determine the source of the toxicity.

Infestations of *Hydrilla verticillata* have been recorded in most of the lakes in this subbasin. It was present at nuisance levels in Reedy Creek Lake, Big Lake, Sycamore Lake, and Lake Raleigh. In 2000, it also was documented in Crabtree Creek at NC 54. During the past five years, only a single algal bloom has been confirmed. In 1999, a bloom of blue-green algae, an indicator of eutrophic conditions, was documented in Lake Crabtree.

Seven of the 11 lakes in this subbasin were monitored in 2000, all were classified eutrophic in 1995. Lake Crabtree, Lake Benson and Sycamore Lake were unchanged from 1995. Big Lake, Apex Reservoir, and Lake Wheeler had concentrations of total organic nitrogen in 2000 greater than in

1995. Reedy Creek Lake showed some improvement in total phosphorus concentrations.

Middle Creek (Subbasin 03)
The Middle Creek watershed is located in southern Wake and central Johnston counties. The watershed is still experiencing high residential development in its upper reaches, which contains portions of the the towns of Cary, Fuquay-Varina and Apex. Middle Creek generally has moderate flow, though it has changed character since Hurricane Fran in 1996. However, many tributaries to Middle Creek are slow moving and exhibit coastal plain ecoregion characteristics.

Middle Creek was rated Good-Fair at two sites in 2000, based on benthos data, suggesting a slight improvement at the upper site. Middle Creek at NC 50 is an ambient site and water chemistry data suggested some water quality problems, with elevated nutrient values.

Black and Mill Creeks and Neuse River Mainstem in southern Johnston County (Subbasin 04)
This subbasin is located in the inner coastal plain ecoregion. Major tributaries include Hannah, Black, Stone, and Mill Creeks. The topography in this area is very flat with numerous slow-moving streams and swamps. The streams in this subbasin are mostly small and seemed to incur some natural stress due to low flows during drought periods. Further stresses in this subbasin may have resulted from the effects of Hurricanes Bertha and Fran in 1996, and Hurricane Floyd in 1999. The combined effects were evident during fish community and benthos sampling. Notable increases of tree blowdowns in most streams have exacerbated already slow flowing streams. There has been an increase in the amount of silt and sand deposited in the streams and extensive bank erosion. These changes precluded all fish community sampling. Based upon benthos sampling, Hannah Creek was given a Fair bioclassification, while Mill Creek retained the Good-Fair rating found in 1995.

Neuse River Mainstem - above Goldsboro to Craven County and Tributaries (Subbasins 05 and 12)
This area is in the coastal plain ecoregion of North Carolina. There are extensive agriculture and animal operations, as well as the urban areas of Kinston, portions of Goldsboro, and the small town of LaGrange. The Neuse River has moderate to slow flow throughout the year, but many tributaries become stagnant during periods of low rainfall. The major tributaries include Bear, Falling, Beaverdam, and Southwest Creeks, and Thoroughfare Swamp. The municipalities of Kinston, Goldsboro, and LaGrange all have WWTP discharges to the Neuse River or its tributaries in this area.

The Neuse River at NC 58 near Kinston has received a Good rating (using benthic invertebrate data) from 1988 to 2000, while the Neuse River at US 117 near Goldsboro was Good-Fair in both 1995 and 2000. Stoney Creek receives runoff from the City of Goldsboro and from Seymour Johnson Air Force Base. This stream received a Fair rating, which is an improvement from 1995 when it was rated Poor. Fish diversity at Stoney Creek also increased slightly from 13 species in 1995 to 15 species in 2000. Bear Creek received a Good-Fair benthos rating, which is an improvement from the 1995 Fair rating. Fish community data at Bear Creek have remained steady between 1995 and 2000 despite temporary hurricane impacts. Falling Creek received a Fair rating in 2000, but it was rated Good-Fair in 1995 for benthos. Fish data were taken downstream at SR 1340. The fish community was quite diverse and showed little difference between 1995 and 2000.

Twenty fish tissue samples were taken from the Neuse River near Kinston in 2000. Metal concentrations were less than laboratory detection levels or were less than state and federal regulatory criteria.

Cliffs of the Neuse Lake was sampled three times during the summer of 2000. Acidity in this lake is quite low, but indicative of the Black Creek Formation aquifer and is a natural condition. Other limnological variables were representative of a normal oligotrophic lake.

There are two ambient monitoring stations on the Neuse River in this area: near Goldsboro and at Kinston. For the period of 1996 - 2000, these sites had elevated concentrations of nutrients and also had very low recorded levels of dissolved oxygen during the reporting period (0.8 mg/L at Goldsboro and 0.4 mg/L at Kinston).

Little River (Subbasin 06)
The Little River watershed includes segments in Franklin, Wake, Johnston, and Wayne counties. Land use throughout the subbasin is primarily a combination of agriculture and forestry, with

scattered small towns that are experiencing increased development. The character of the river changes rapidly in the upper segment as it flows from the piedmont into the coastal plain, and runs over several different rock types. Some smaller streams in this area have poor groundwater storage and are, therefore, susceptible to lack of flow during dry periods. Buffalo Creek is a major tributary of the Little River. This stream starts within the piedmont, but most of the stream has coastal plain characteristics. The lower segment now has many beaver dams, reducing the amount of flowing-water habitat.

The Little River has a diverse mussel population, including a number of rare species: *Alasmidonta heterodon*, *Villosa constricta*, *Elliptio lanceolata*, and *Fusconaia masoni*. A population of the endangered Tar River Spiny mussel (*Elliptio steinstansana*) has been recently found in the Johnston County portion of the river.

Water quality of the Little River in 1995 and 2000 was generally Good-Fair based on macroinvertebrate samples. However, in 2000, a Good bioclassification was assigned to a portion of the river in Johnston County. This middle section also supports many rare insect and mollusc species. Nonpoint runoff seemed to have the greatest potential to affect water quality in this area.

Recent hurricanes have had a drastic effect on stream habitat, and these changes were reflected by a recent decline in the fish communities of Buffalo Creek and the upper Little River. The bioclassification based on fish data dropped two categories between 1995 and 2000 in both these areas.

Contentnea Creek (Subbasin 07)

The Contentnea Creek watershed includes Buckhorn Reservoir and its two primary tributaries -- Moccasin Creek and Turkey Creek. Buckhorn Reservoir was expanded in 1999 (from 750 acres to 2,300 acres), flooding some stream sites that had been sampled by THE NCDWQ in 1995. Agriculture is the primary land use with scattered forested areas and some small towns. There are many hog facilities with the greatest concentrations along lower Contentnea Creek, Sandy Run/Little Contentnea Creek, and Nahunta Swamp. The streams in the western part of the watershed have piedmont characteristics, while those to the east of US 301 were considered in the coastal plain and swamp-like.

Fish samples produced an Excellent bioclassification for Moccasin Creek in 1995 and 2000, with a very high number of fish species (26) in 2000. Macroinvertebrates gave a lower rating to this stream in 2000 (Good-Fair) and this rating has been consistent in four summer benthos samples since 1991. Invertebrate sampling of Turkey Creek produced a Fair rating, although this rating may have been influenced by low flows earlier in the summer, and hurricane damage.

Macroinvertebrate samples from Contentnea Creek in 2000 produced a Good-Fair rating for sites near Stantonsburg and Grifton. The Stantonsburg site has had either a Fair or Good-Fair rating since 1986, while the Grifton site has had either a Good or Good-Fair rating since 1983.

Macroinvertebrate sampling produced Fair ratings for Nahunta Swamp, Toisnot Swamp, and Little Contentnea Creek. These streams were found to have adequate habitat (at the selected sampling site), but low EPT taxa richness. All three of these streams have some channelized segments upstream of the collection site.

Contentnea Creek ambient chemistry sites had high nutrient concentrations, and these high levels caused elevated nutrients at Neuse River sites downstream of Contentnea Creek. Contentnea Creek (especially the Grifton site) and Little Contentnea Creek also may have low summer dissolved oxygen concentrations.

LOWER NEUSE RIVER BASIN

Neuse River Mainstem and Tributaries - Craven County (Subbasin 08)

This subbasin consists of the Neuse River and its tributaries from Contentnea Creek to New Bern (approximately 22 river miles) within Craven County. The two largest tributaries are Core Creek and Batchelor Creek. The headwaters of Core Creek have been channelized to promote drainage. Land use is largely agriculture or forest. The Neuse River flood plain includes an extensive swamp forest, usually dominated by tupelo gum. Although most of this area has been logged, it still is an important natural area for many rare plant and animal species. There are some urban areas in the headwaters of Batchelor Creek. The only major discharger in this subbasin is

Weyerhaeuser. The facility has a permitted flow of 32 MGD into the Neuse River above New Bern.

High flows in 2000 precluded benthos sampling of the Neuse River at Street's Ferry. Core Creek was Fair in 1991 and 2000 based on benthos data, but a Poor rating was associated with low dissolved oxygen concentrations in 1995. There was no evidence of a long-term change in water quality. Samples from Flat Swamp in 2000 also suggested nonpoint source problems due to low dissolved oxygen and enrichment. Chemical monitoring data from several locations on the Neuse River documented sporadic violations of state standards for some parameters, including dissolved oxygen and fecal coliform counts.

The Neuse River at Fort Barnwell and Street's Ferry had frequent algal blooms in the 1970's and 1980's. But no blue-green blooms were reported at the Street's Ferry site from 1995-2000, although a chrysophyte bloom was noted in 1997. While phytoplankton biovolume usually peaks during summer months, there was no consistent pattern for the dominant species.

Swift Creek (Subbasin 09)
Much of the Swift Creek catchment has been channelized, resulting in year-round flow, and higher dissolved oxygen concentrations than natural swamp streams in the watershed. Primary land use is agriculture with patchy forested areas. There are many hog farms, especially in the northwestern portion of the subbasin. There are only a few small towns in this subbasin and little concentrated development.

Swift Creek had a Good-Fair benthos rating in 1991, but only a Fair rating in 1995 and 2000. Analysis of these data, however, did not indicate a long-term change in water quality. Based on benthos samples, there was some evidence of a decline in water quality in Clayroot Swamp since 1991. A watershed survey of Clayroot Swamp in October 2000 showed that most of the catchment is severely channelized. Other problems identified included nutrient enrichment and bank erosion. Palmetto Swamp had higher invertebrate taxa richness due to both a higher flow rate and higher pH than Creeping Swamp. Creeping Swamp, however, had a unique fauna associated with low pH swamp streams.

Monthly water chemistry information was collected from four sites in this subbasin including two sites on Swift Creek and one site on Creeping Swamp. The lower site on Swift Creek (near Askin) is an area where the stream becomes much deeper and slow-moving, hence more prone to phytoplankton blooms and low dissolved oxygen concentrations. Creeping Swamp has very low dissolved oxygen during summer months, with mean yearly values less than 5 mg/L. These low values reflect, in part, natural conditions for a swamp stream.

Trent River (Subbasin 11)
The primary land use in the Trent River watershed is agriculture and forest with a small urban area around Trenton. There are no major permitted discharges in the subbasin. The number of hog operations, however, has been increasing in the Trent River catchment, especially in the headwater area near the Jones/Lenoir county boundary. Streams within this subbasin are usually blackwater, with a substrate composed of sand, silt, and organic debris. Most streams are confined to a distinct channel. Recent hurricanes had a severe effect on the riparian zones of most streams with many trees knocked down by the high winds.

Because of the limestone bedrock throughout this area, many streams do not have the low pH values that are usually associated with swamp waters. However, streams draining the Hoffman State Forest (south of the Trent River) may have pH as low as 3.6 (e.g., Crooked Run). A portion of the Croatan National Forest also is located within this subbasin.

Winter benthos information indicated water quality problems in the upper Trent River, Beaver Creek, and Musselshell Creek. The best water quality was found in Beaverdam Creek, Mill Run, and Island Creek. Crooked Creek (flowing out of the Hoffman State Forest) seemed to have good water quality, but the fauna was limited by very low pH.

Phytoplankton blooms were reported in the lower Trent River in 1986, 1988, and 1993 - 1995. During the last basin cycle, however, summer blooms were observed only in 1998.

Monthly water chemistry data are collected from three sites on the Trent River in this subbasin: near Trenton, near Oak Grove, and near Pollocksville. These sites can experience very low dissolved oxygen concentrations during summer months.

OUTER COASTAL PLAIN

Neuse River Estuary - New Bern to Pamlico Sound (Subbasin 10)

This subbasin consists of the lower Neuse River and its tributaries from Streets Ferry to Pamlico Sound. This subbasin was severely affected by Hurricanes Dennis and Floyd in 1999. These storms caused widespread flooding and produced large amounts of nonpoint source runoff. The effect of hurricanes could be observed by the high concentrations nitrate+nitrite-nitrogen in the fall and winter of 1999 -2000.

Most of the waters in this subbasin are estuarine, including the Neuse River and the downstream portion of all tributaries. Freshwater is confined to the upper reaches of some tributary streams and wetlands/pocosins.

Land use in the subbasin is mostly forest and agriculture. The largest agricultural area is a portion of Open Grounds Farm, which includes much of the land on the outer Pamlico peninsula. Much forested land has been clear-cut, especially near Clubfoot Creek and Cedar Creek. There have been recent efforts to control runoff from Open Ground Farms. This area continues to practice no till farming; all cattle (> 2,000 head) have been removed; and over 90 flashboard risers have been installed to control drainage. More natural lands include a portion of the Croatan National Forest (south of New Bern) and the Light Ground Pocosin (north of Oriental).

Many organizations conduct investigations of water quality in the lower Neuse River. All studies are in agreement that the fauna of the lower Neuse River is controlled by periods of very low dissolved oxygen (hypoxia) during summer months. Hackney, *et al.* (1998) looked at EMAP sediment data from the Neuse River, and suggested that high contaminant levels also may influence the benthic fauna in this area.

The number of algae blooms has increased over time in this part of the river, often accompanied by extreme swings in dissolved oxygen concentrations and pH values greater than 9.0. Mean pH values greater than 8.0 s.u. were found in the middle portion of Neuse River from Broad Creek to the mouth, but the lowest dissolved oxygen concentrations were recorded from the upper part of the river from New Bern to Riverdale.

Phytoplankton blooms occur throughout the year, but the greatest problems were associated with summer blooms. Most blooms occurred in the Neuse River between Broad Creek and Oriental, with few blooms occurring near the mouth of the river. The mesohaline section of the river becomes strongly stratified in summer, leading to oxygen depletion of bottom waters. Summer algae blooms (especially dinoflagellates) have been a common and chronic problem in this subbasin for many years. During the prior basin cycle, the most severe algal blooms occurred during 1990 and 1995. Both years were periods of high flow in spring and early summer, followed by a period of prolonged summer low flow. Blooms during the current basin cycle were less dependent on spring flows, partially due to repeated hurricane inputs during the preceding fall and winter and partially due to recycling of nutrients from the sediments. Almost all summer low-flow periods during 1997 - 2000 produced high algal biovolumes and algal blooms. The lowest summer algal populations were found during 1996 – a year with both normal spring and summer flows.

The NCDWQ's Neuse River Rapid Response Team, located in New Bern, is responsible for monitoring water quality conditions in the lower Neuse River watershed below Kinston. The team's primary charge is rapid evaluation of acute water quality-related events like fish kills and algal blooms. During routine operations, the team performs regular monitoring duties along the river, collecting monthly ambient water quality samples at long term sites, and working collaboratively with other research agencies in monitoring field water quality parameters (e.g. dissolved oxygen, pH, temperature, and salinity). The Team, which began operations in June 1997, has been involved with field aspects of Pfiesteria research. Team members frequently interact with the public in an educational capacity to pass along a better understanding of water quality issues.

The NCDWQ began tracking fish kill activity closely in North Carolina's river basins in 1996. Field reports since 1996 have shown frequent fish kill activity in the Neuse River, especially in shallow and poorly flushed sections of the lower Neuse. Most events occurred in the mainstem of the Neuse River from Flanner's Beach to Minnesott Beach. These kills often involved large schools of menhaden and were associated with advanced lesions on the species. These sections often experience eutrophication, stratification, and associated dissolved oxygen depletion that lead to numerous kill events during the warm months of the year.

The NCDWQ conducted benthic swamp sampling at three sites during the winter months of 2000. Due to differences in geology and soil type, swamp streams in this subbasin cannot be easily compared with reference swamp streams in other portions of the coastal plain. Streams on the northern side of the Neuse River (Goose and Broad Creeks) are subjected to low pH, which limits the diversity of the fauna. Streams on the southern side (e.g., South West Prong Slocum Creek) have higher pH, and appeared most similar to streams in the White Oak River basin. Based on benthic data, South West Prong Slocum Creek had high water quality. Broad Creek and Goose Creek were harder to evaluate, but did not show any major water quality problems.

Bay River (Subbasin 13)
This subbasin consists of Pamlico Sound and its tributaries Broad Creek, Bay River, and Jones Bay in Pamlico County. Land use in the subbasin is mostly agriculture and most of the waters are estuarine. Freshwater is confined to the upper reaches of the many tributary streams, which are swamp-like in nature with ephemeral flow.

The limited water quality data for this subbasin comes from the Bay River near Vandemere ambient water chemistry site. The Division of Environmental Health's Shellfish Sanitation Branch has reported DMF closure to shellfishing of 2850 acres of the 28,000 acres of waters in this subbasin. This is 525 acres fewer than in 1995.

West Bay (Subbasin 14)
All the waters in this subbasin are estuarine and consist of Pamlico Sound, upper Core Sound, and West Bay and their embayments and tributaries in Carteret County. Many of these waters have been classified as Outstanding Resource Waters because of their high fisheries value. Land use in the area is mostly agriculture (including a portion of Open Grounds Farm) or undeveloped. These undeveloped areas include a military bombing range and the Cedar Island National Wildlife Refuge.

Monthly water chemistry data are collected from West Thorofare Bay and Thorofare Canal. The Division of Environmental Health's Shellfish sanitation branch has reported DMF closure to shellfishing of only 25 acres in the 85,000 acres of waters in this subbasin.

EXECUTIVE SUMMARIES BY PROGRAM AREA

BENTHIC MACROINVERTEBRATES
Bioclassifications and Water Quality Changes
Benthic macroinvertebrates have been collected at 161 rated sites in the Neuse River basin since 1983 (Table 1). Data are also available from an additional 43 sites that have been listed as "Not Rated" either because they were too small (n = 13) or because they were swamp streams with intermittent flow (n = 30). Although these sites did not receive a bioclassification, the macroinvertebrate community often can be used to show spatial and temporal changes in water quality.

Table 1. Most recent ratings for all ratable benthos sites in the Neuse River basin sampled since 1983.

	Bioclassification				
Subbasin	Excellent	Good	Good-Fair	Fair	Poor
01 Falls Lake tribs	3	14	14	9	3
02 Upper Neuse	---	6	12	19	19
03 Middle Cr	---	1	4	2	---
04 Black/Mill Cr	---	---	2	2	---
05 Neuse at Kinston	---	2	3	3	1
06 Little R	---	2	10	---	1
07 Middle Neuse tribs	---	-	6	9	2
08 Neuse R/Core Cr	---	-	1	1	---
09 Swift Cr	---	-	1	1	---
11 Trent R	---	3	2	1	---
12 Neuse at Goldsboro	---	1	1	1	1
Total (#)	3	29	55	46	28
Total (%)	2	18	34	29	17

For the 2000 collections, the greatest number of the samples (n = 66) received a Good-Fair or Fair rating (Figure 3). The distribution of the 2000 ratings was similar to the distribution of water quality ratings for all sites sampled since 1983, although specific sites showed both positive and negative trends in water quality.

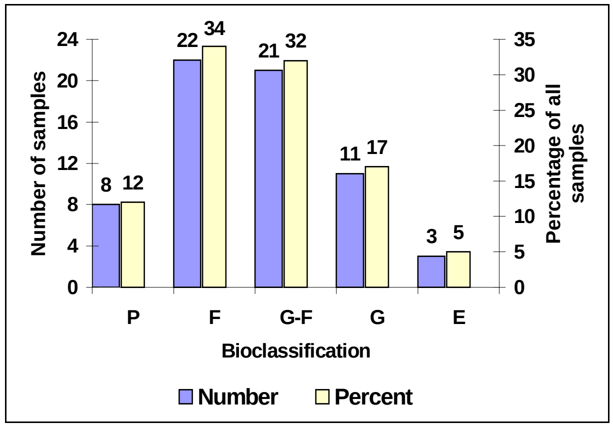


Figure 3. Distribution of bioclassifications for benthic macroinvertebrate samples collected in the Neuse River basin, 2000.

Between-year changes in water quality were evaluated at over 50 sites in the basin, although some of these sites could only be evaluated for short-term changes over the last five years (i.e., 1995 *vs*. 2000) (Figure 4).

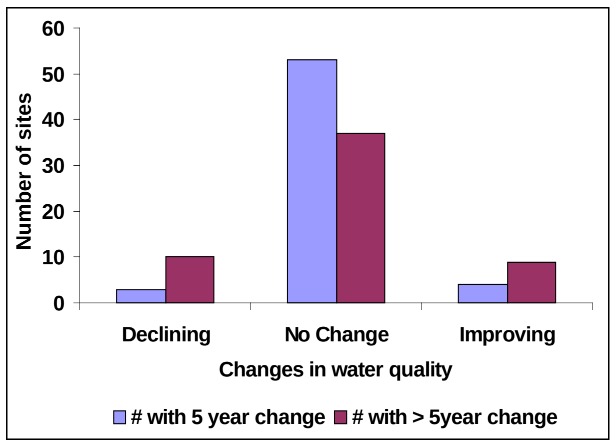


Figure 4. Number of benthos sites with a between-year (sampling period) change in bioclassification.

Except for a few sites, the majority of sites had no changes in water quality since the last basinwide survey, other than flow-related changes in bioclassification (Tables 2 and 3).

Table 2. Benthos sites with improving water quality in the Neuse River basin.

Subbasin/ Stream	5-year change	> 5 year change	Known or Suspected Cause
01			
N Fk Little R, SR 1519	Fair→G-F	No data	Unknown
Knap of Reeds Cr	None	Poor→Fair	WWTP upgrade
Ellerbe Cr	Poor→Fair	Improving	WWTP upgrade
02			
Neuse R, US 401	None	Fair→G-F	WWTP upgrade and reservoir
Neuse R, NC 42	None	G-F→ Good	WWTP management?
Crabtree Cr, in state park	Fair→G-F	See Table ---	WWTP management?
Walnut Cr, SR 2551	Fair→G-F	Improving	Unknown (WWTP?)
03			
Middle Cr	Slight improvement?	Fair→G-F	WWTP upgrade/ management
06			
Buffalo Cr	No data	Fair→G-F	WWTP removal

Table 3. Benthos sites with declining water quality in the Neuse River basin.

Subbasin/ Stream	5 year change	> 5 year change	Known or Suspected Cause
01			
N Fk Little R, SR 1538	Good→G-F	No Data	Unknown, residential area
Upper Barton Cr	None	Good→G-F	Unknown, residential area
02			
Smith Cr, SR 2045	G-F→Fair	unknown, spill effect?	Unknown, residential area
Toms Cr, SR 2044	None	Good→Fair	Unknown, residential area
Crabtree Cr, in state park	Improving	Declining vs. 1980	Unknown, residential area
Hare Snipe Cr	Fair→Poor	No data	Unknown, residential area
Swift Cr, US 1	None	Fair→Poor	Multiple causes, residential area
06			
Little R	None	Good→G-F	Multiple causes
07			
Nahunta Cr	None	G-F→Fair	Uknown, agricultural area
Contentnea Cr, SR 1800	None	Good→G-F	Subtle change, agricultural affects?
09			
Clayroot Swp	None	Fair→Poor	Uknown, agricultural area
11			
Trent R, nr Comfort	No data	Declining vs. 1979	Uknown, agricultural area
Trent R, NC 58	No data	Good→G-F	Flow?, agricultural area

Whether a change is flow-related is decided on a site-by-site basis, looking at:

- Flow in the prior month, using the most comparable daily flow records from USGS gaging stations. Areas primarily affected by nonpoint source runoff are expected to have a decline in water quality after high flow, but may improve during low flow. The exception to this rule is the smaller headwater streams, which may cease flowing during extreme droughts. Streams primarily by point source dischargers may improve after high flow (with dilution of the effluent) and decline after low flows. These changes, however, are usually produce a between-year change of only one bioclassification.
- Changes throughout the subbasin. Flow-related changes usually affect a whole group of sites, not just single sites.
- Changes in species composition. Real changes in water quality are usually reflected in a significant change in the composition of the invertebrate community.

Repeated damage from hurricanes, combined with an increasing beaver population, has often changed the character of some streams in the basin. This change was particularly evident in Subbasin 04, where few flowing streams could be found in 2000.

In looking at site-specific changes in water quality, several trends were immediately evident:

- the greatest number of changes occurred in the most developed subbasins (Subbasins 01 and 02);
- changes were most apparent over a time span greater than five years;
- positive changes usually resulted from upgrades or management of wastewater treatment plants;
- negative changes were most often associated with development; and
- the spread of residential development has had the most serious impact on water quality in the upper portion of the basin.

Watersheds with Significant Biological Diversity

Several areas stand out as significant areas for conservation of biodiversity, having many rare and/or intolerant species:

- headwaters rivers (Subbasin 01), including the upper Flat River (including the North Fork Flat River, South Fork, Flat River, and Deep Creek), the Little River, and the Eno River;

- the middle portion of the Little River in Johnston County (Subbasin 06);
- the middle portion of the Neuse River. This is a unique habitat, containing many species not found in tributary streams. In spite of habitat problems, this portion of the river has fairly good water quality; and
- better tributaries of the Trent River in Subbasin 11, especially Island Creek.

New Species and Distributional Records for the Benthic Invertebrate Fauna

Several rare or unusual invertebrate species have been collected in the basin during NCDWQ surveys. Some of the more significant invertebrate taxa collected were:

- **Ephemeroptera** (mayflies)
  - *Ephemerella* berneri. Rare in larger rivers, especially in *Podostemum* growths. Recently collected only from the Flat River (1993), although there are old records (pre 1980) from the Eno River.
  - *Ephemerella needhami.* Possibly a distinct species from the taxon found at mountain sites. Little River (Subbasin 01), Flat River, Deep Creek, and Little River (Subbasin 06).
  - *Eurylophella enoensis.* A spring species, found primarily in the Flat, Little and Eno rivers area in Person and Durham counties.
  - *Eurylophella prudentalis*. A spring species, collected from Beaverdam Creek (Subbasin 11) and South West Prong Slocum Creek (Subbasin 10).
  - *Leptohyphes robacki*. This unusual species is largely confined to the Neuse River in Johnston, Lenoir and Wayne counties.
  - *Nixe* sp. This is mainly a mountain species, with a disjunct record from Deep Creek, Person County.
  - *Rhithrogena* sp. This is mainly a mountain taxon, with a disjunct record from Deep Creek, Person County.
  - *Procloeon rubropictum*. A single record from Deep Creek, Person County, 1995.
  - *Stenonema lenati*. In the Neuse River basin, this species is found only in the Neuse River and Flat River in Durham County.
- **Plecoptera** (stoneflies)
  - *Isoperla burksi*. A poorly known winter species confined to the slate belt ecoregion. In the Neuse River basin, it is confined to a few streams in Person and Durham counties.
- **Trichoptera** (caddisflies)
  - *Agapetus rossi*. A few records from Deep Creek and both Little Rivers. Rearing by Dr. David Etnier (University of Tennessee) discovered this disjunct population.
  - *Agraylea multipunctata*. Single record from the Flat River, 1990.
  - *Ceraclea* nr. *excisa*. A spring species collected the Little and Eno rivers.
  - *Ceraclea ophioderus*? Rare in the middle portion of the Neuse River, usually on snags.
  - *Dibusa angata*. A spring species known form the Eno River and both Little Rivers.
  - *Glossosoma nigrior*. This is a common mountain species with a disjunct record from the Little River in Durham County.
  - *Matrioptila jeanae*. Little River, Johnston County, March 1988. There have been no recent spring collections from this area, so the present status of this species is unknown.
  - *Micrasema charonis*/*rusticum*. Collected from the Little, Flat, and Eno rivers area in Subbasin 01 and the Little River in Subbasin 06.
  - *Neotrichia* sp. Eno River, 1989.
  - *Protoptila* sp. Little River and Neuse River in Johnston County.
  - *Stactobiella* sp. There are old records from Crabtree Creek, but more current records are confined to the Flat River and South Flat River.
- **Coleoptera** (beetles)
  - *Oulimnius latiusculus*. This species is common in the mountains, but uncommon in the piedmont. Recent records include The North Flat River (1993), Smith Creek in Granville County (1995) and the Eno River (2000). This species was much more widespread in 1984 - 1987.
- **Odonata** (dragonflies/damselflies)
  - *Neurocordulia molesta*. This is a riverine species, confined in this basin to the middle segment of the Neuse River.
  - *Gomphaeschna* sp. NCDWQ collections include a single record from Goose Creek, Pamlico County.
- **Chironomidae** (midges)
  - C*hernovskia orbicus*. Rare in coarse sand in larger streams and rivers, including single records from Contentnea Creek and the Neuse River. Not collected since 1983.

- Diamesinae Genus P (Doughman). A winter species, collected from Deep Creek and South Flat River, 1993.
- **Gastropoda** (snails)
  - *Lioplax subcarinata*. NCDWQ records include a single collection from the Little River, Johnston County, 1983.
- **Pelecypoda** (clams, mussels). The greatest mussel diversity occurs in the Flat River and the Little River in Johnston County. For more information, see the North Carolina Atlas of Freshwater Mussels at: www.ncwildlife.org.
  - *Alasmidonta heterodon*. Occurs in the Tar and Neuse River basins, mainly near the Fall Line. The best population occurs in the Little River, Johnston County.
  - *Fusconaia masoni*. Little River, Johnston County and the Flat River, Person and Durham counties.
  - *Elliptio lanceolata*. Occurs in the Tar and Neuse River basins, mainly near the Fall Line. Known from the Middle, Swift, and Mill Creek subbasins, but rare and declining in this area.
  - *Lampsilis cariosa*. In the Neuse River basin, this species is found in the Flat, Little, and Eno rivers in Subbasin 01 and the Little River in Johnston County.
- **Cambaridae** (crayfish)
  - *Cambarus davidi*. This species was recently described by Cooper (2000) from the headwaters of the Cape Fear and Neuse River basins. It is known from many small streams in Wake County with a few records in Durham and Orange counties.
  - *Orconectes carolinensis*. This species occurs in both the Tar and Neuse River basins, but occurs mainly at river locations, especially in the Neuse River.

FISHERIES

Fish Community Assessment

In 2000, 30 sites (31 samples) in subbasins 01, 02, and 05-11 were sampled between April and August. Twenty seven of the sites were wadeable sites (Figure 5). The remaining three sites were non-wadeable, small boat sites which were sampled as part of a special study.

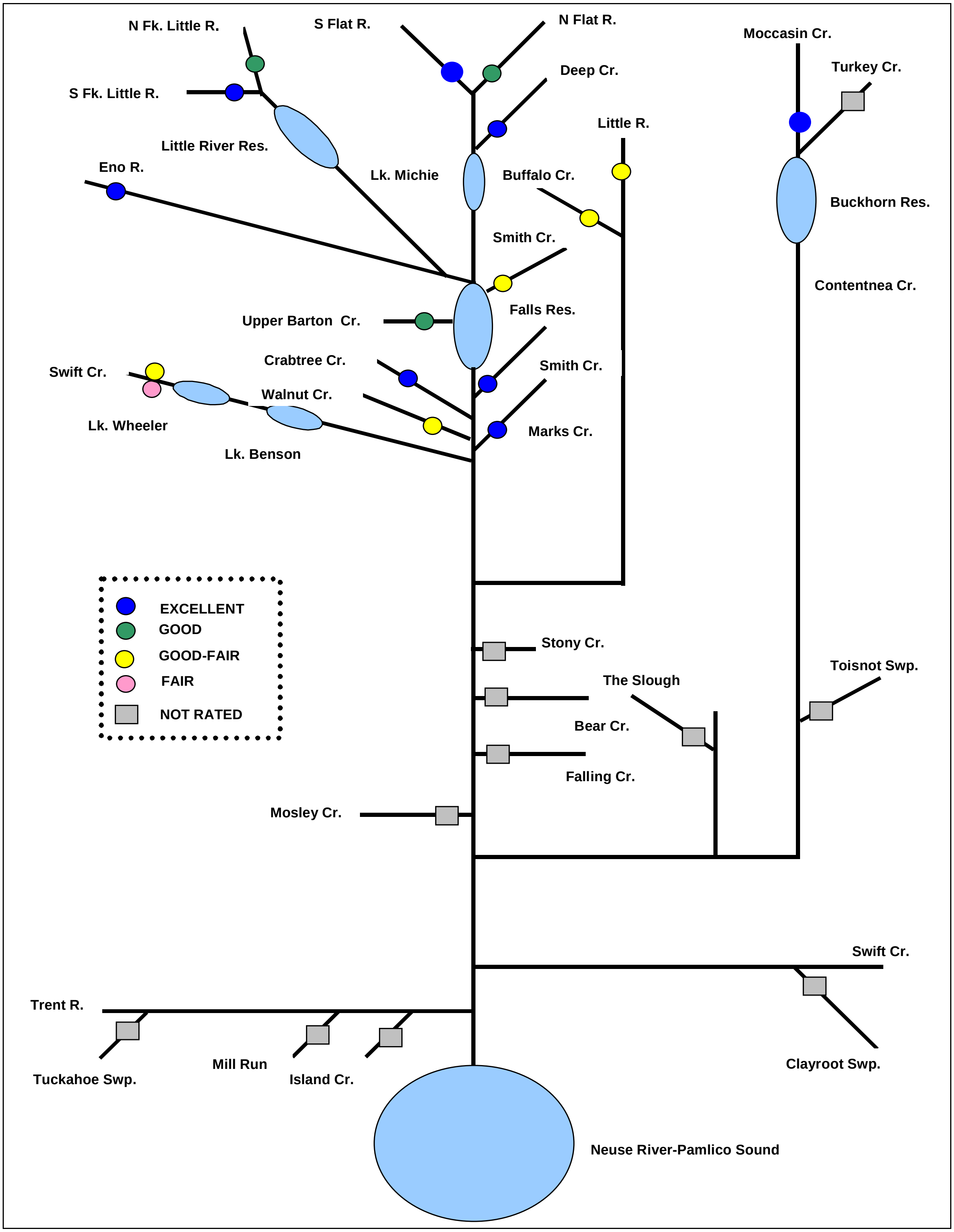


Figure 5. **Schematic map of the fish community assessment sites in the Neuse River basin, 2000.**

Ten of the 16 piedmont sites had been previously sampled during the first or second cycle of basinwide monitoring in 1991 and 1995, while the remaining six sites represented new monitoring stations. The new sites were selected to represent possible regional reference sites, or to expand data coverage.

Many additional sites in the coastal plain were examined but could not be sampled because: 1) the stream hydrology and morphometry had been altered by recurring hurricanes since the mid-late 1990s; 2) damming effects due to the increase of beaver populations during the 1980s and 1990s; and 3) nuisance levels of exotic aquatic macrophytes. Examples of altered morphometry and hydrology included lentic rather than lotic conditions, swamp-like braided channels, channels obstructed by deadfalls and blowdowns, increased channel depths, and change in bottom substrates from sand to silt and muck.

Seventeen of the 31 samples were evaluated and rated using the North Carolina Index of Biotic Integrity (NCIBI) (Appendices F1-F3) (Figure 6). Ratings were given only to the streams within the piedmont portion of the basin. Criteria are being developed for the coastal plain streams.

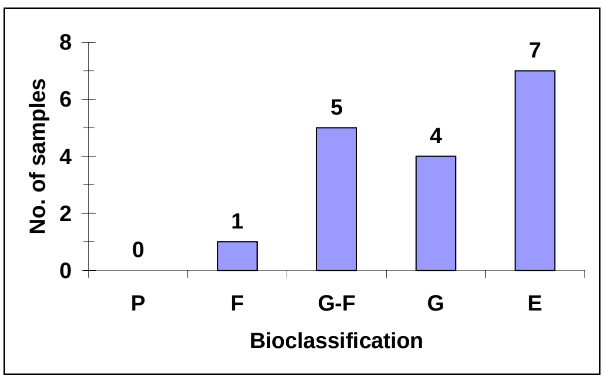


Figure 6. Bioclassifications of 17 fish community samples collected in the Neuse River basin, 2000.

Eleven of the sites were sampled during the 1995 and 2000 basinwide monitoring cycles. Ratings did not change at three sites, increased 1 or 2 classifications at four sites, and decreased 1 or 2 classifications at three sites (Figures 7 and 8).

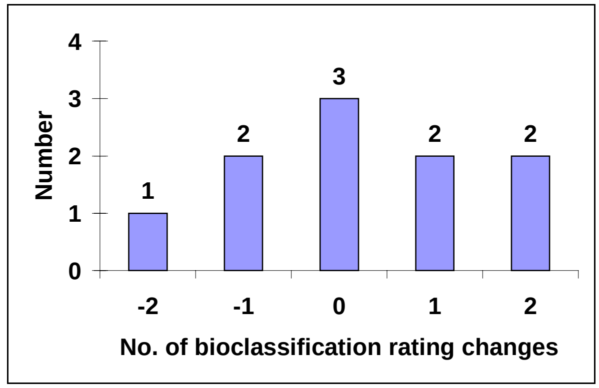


Figure 7. Bioclassification rating changes between 1995 and 2000 at 11 ratable fish community sites in the Neuse River basin.

Three sites, Walnut Creek, Marks Creek, and Moccasin Creek, were sampled during each of the three basinwide monitoring cycles. Moccasin Creek has consistently been rated Excellent; Marks Creek has gradually increased from Good to Excellent; and Walnut Creek has fluctuated--being rated Good in 1991, Fair in 1995, and Good-Fair in 2000 (Figure 8).

Eastern North Carolina has been beset with several hurricanes between the last two basinwide monitoring cycles. The impacts from these storms (e.g., altered hydrology and stream morphometry from the high flows and hurricane force winds, increased nutrient and contaminant concentrations and their transport, and depressed dissolved oxygen levels for extended periods of time) have not always had a detrimental effect on the fish communities in small wadeable streams in the piedmont and coastal plain regions of the Neuse River basin. At least 11 streams from which at least two samples have been collected showed no long-term impact from the hurricanes; three streams seem to have been enhanced, and three streams seemed to have been negatively impacted by the effects from the storms (Table 4).

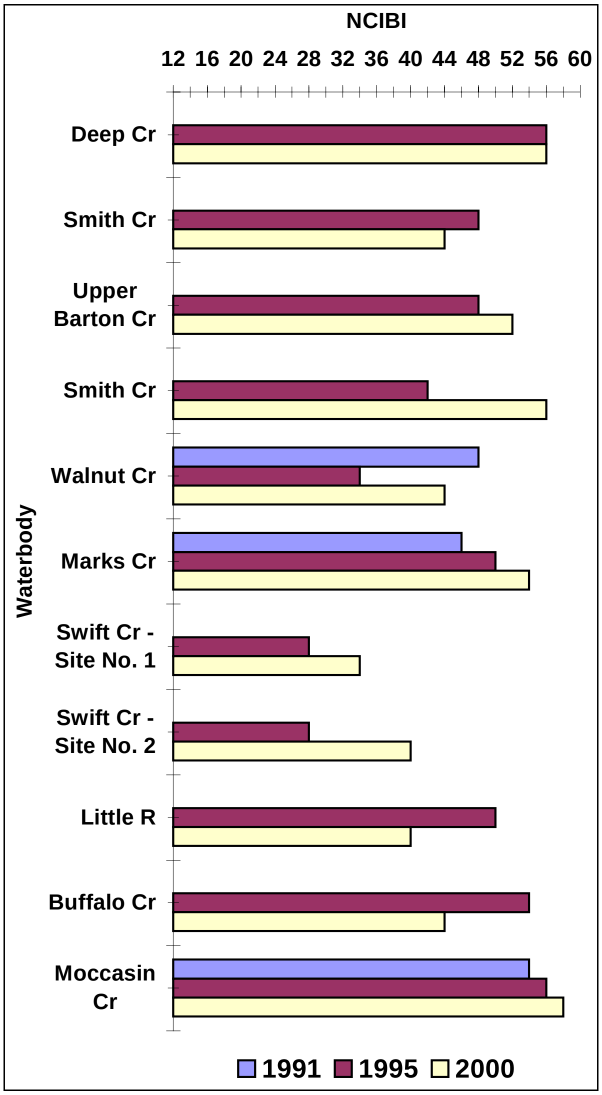


Figure 8. Changes in bioclassifications between 1991, 1995, and 2000 at 11 ratable fish community sites in the Neuse River basin.

Table 4. Responses to recent hurricanes in the Neuse River basin at repeat fish community basin sites (comparing 1995 to 2000).

Response	Waterbody
Negative Impact	Smith Cr (Granville Co.), Little R (Subbasin 06), Buffalo Cr
No Impact	Deep Cr, Upper Barton Cr, Walnut Cr, Marks Cr, Swift Cr (Wake Co.), Moccasin Cr, Moseley Cr, Falling Cr, Bear Cr, Clayroot Swp, Island Cr
Positive Impact	Smith Cr (Wake Co.), The Slough, Toisnot Swp

Negative responses of the communities to the storms' effects included decreased abundance, species diversity, altered trophic structures, and loss of year classes. Conversely, positive effects included increased diversity and abundance and a shift in trophic composition.

In 2000, at the wadeable sites, the most widely distributed species (collected at the most sites) was the redbreast sunfish. The most abundant species were the redbreast sunfish, bluehead chub, American eel, and satinfin shiner.

The most diverse fish communities were found at South Fork Little River, Moseley Creek, Falling Creek, Moccasin Creek, and The Slough. Each of these streams has 24-26 species of fish. In contrast, the least diverse (n = 11 species) fish community was found at the Little River (Subbasin 06).

Based upon Menhinick (1991) and NCDWQ data, 97 species of fish are known from the basin. Five of the 97 species have been given special protection by the North Carolina Wildlife Resources Commission and the North Carolina Natural Heritage Program under the North Carolina State Endangered Species Act (G.S. 113-311 to 1130337 (LeGrand and Hall 1999; Menhinick and Braswell 1997) (Table 5). Additional information on these five species may be found in Menhinick and Braswell (1997).

Table 5. Species of fish listed as special concern in the Neuse River basin.

Species	Common Name	State Rank[1]
Lampetra aepyptera	Least brook lamprey	S2
Acipenser oxyrhynchus	Atlantic sturgeon	S3
Notropis bifrenatus	Bridle shiner	SH
Noturus furiosus	Carolina madtom (Neuse River population)	S2
Etheostoma collis lepidinion	Carolina darter (eastern piedmont population)	S2

[1]S2 = imperiled in North Carolina because of rarity or because of some factor(s) making it very vulnerable to extirpation from North Carolina; S3 = rare or uncommon in North Carolina; and SH = of historical occurrence in North Carolina, perhaps not having been verified in the past 20 years, and still suspected to be still extant (LeGrand and Hall 1999).

During 2000, one specimen of the Carolina darter was collected at Smith Creek (Granville County) and three specimens of the Bridle shiner were collected from Batchelor Creek (Craven County).

Fish Tissue

Elevated mercury levels have been measured in long-lived piscivores (largemouth bass and bowfin) collected throughout the Neuse River drainage – a problem that has also been observed throughout other eastern river basins in the state (NCDENR, 1996). Research indicated that atmospheric mercury deposition and a cycle of bioaccumulation in the aquatic environment have provided a significant source for the observed mercury levels (USEPA 1997a). In June of 1997, the North Carolina State Health Director issued a statewide fish consumption advisory for bowfin in due to elevated mercury. The advisory stated:

- the general population should consume no more than two meals of the fish per month; and
- children and child-bearing women should consume no fish.

From August 1998 through August 1999, NC Division of Marine Fisheries collected samples of king mackerel off the coast for mercury contaminant analysis. The samples were collected at the request of NC Division of Epidemiology after health agencies in Texas and Florida recently issued consumption advisories for king mackerel due to potentially harmful levels of mercury.

Fish larger than 95 cm or 6.5 kg were found to have concentrations of mercury in excess of the North Carolina criteria of 1 µg/g. Based on these results, North Carolina, joined together with South Carolina, Georgia and Florida in March 2000 to issue a joint health advisory concerning high levels of mercury in large king mackerel. The advisory states:

- king mackerel less than 33 inches fork-length (from nose to where the tail forks) are safe to eat;
- king mackerel over 39 inches should not be eaten;
- people should limit their consumption of 33 to 39 inch fish:
- women of child bearing age and children age 12 and younger should eat no more than one, 8-ounce portion a month; and
- other adults should eat no more than four, 8-ounce portions a month.

The advisory does not prevent commercial fisherman or recreational anglers from landing king mackerel. Recreational anglers are allowed to land three fish/person/day with a minimum-size limit of 24-inch fork length. Federally permitted commercial fishermen are limited to 3,500 pounds/trip with a 24-inch fork length minimum size.

Since 1995, the NCDWQ has conducted two fish tissue surveys in the basin. Fish samples were collected from the Neuse River at Goldsboro and at Kinston during May 2000. The survey was conducted as part of a metals contaminant assessment in eastern North Carolina following Hurricane Floyd (1999). Except for one older largemouth bass collected at Kinston, metals contaminants were non-detectable or at levels less than state and federal criteria. The largemouth bass collected at Kinston exceeded the state and federal criteria for mercury.

Fish Kills

The NCDWQ began tracking fish kill activity closely in 1996. Field reports since 1996 have documented frequent fish kill activity in the Neuse River basin, especially in shallow and poorly flushed sections of the lower Neuse River (Subbasin 10). These sections often experienced eutrophication, stratification, and associated dissolved oxygen depletion that lead to numerous kill events during the warm months of the year.

Since 1995, several large storm events in North Carolina have resulted in widespread flooding, depletion of dissolved oxygen, and subsequent fish kills throughout many basins, including the Neuse.

Field investigators reported 73 fish kill events in the Neuse basin from 1996 to 2000 (Figure 9). Most events occurred in the coastal plain (Subbasin 10) portions of the basin (NCDENR 2000).

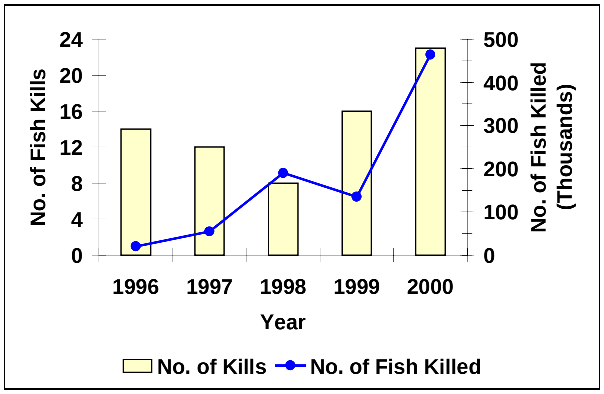


Figure 9. Total fish kill events and mortality in the Neuse River basin, 1996 - 2000.

LAKE ASSESSMENT

Nineteen lakes in the Neuse River basin were monitored as part of the Lakes Assessment program (Table 6). In 2000, each lake was sampled one to three times during the summer months. Total phosphorus concentrations ranged from 0.01 mg/L to 0.13 mg/L; total organic nitrogen concentrations ranged from 0.2 mg/L to 0.99 mg/L, and Secchi disk transparency ranged from 0.2 m to 2.4 m (Figure 10)

In January 2001, the NCDWQ discovered quality assurance issues with chlorophyll *a* laboratory analyses for samples from 1996 through February 2001. The NCDWQ tracking efforts have identified several different quality assurance issues. In some circumstances, laboratory data for chlorophyll *a* will require re-calculation efforts. In other cases, chlorophyll *a* data cannot be recovered from the laboratory methods that were utilized. For lakes monitored as part of this time period, all previously reported chlorophyll *a* laboratory analyses have been withheld pending a sufficient quality assurance evaluation and/or re-calculation of chlorophyll *a* values. As a result of this dilemma, there are no North Carolina Trophic State Index (NCTSI) values available for this time period.

Table 6. Lakes and reservoirs monitored in the Neuse River basin in 2000.

Subbasin/Lake	County	Classification	Surface Area (Ac)	Mean Depth (ft)	Volume (X 10^6 m^3)	Watershed (mi^2)
01						
Lake Michie	Durham	WS-III NSW CA	541.1	26.2	15.6	169.9
Little River Reservoir	Durham	WS-II NSW CA	528.8	24.6	18.0	97.7
Lake Butner	Granville	WS-II NSW CA	373.1	29.5	1.4	30.1
Lake Rogers	Granville	WS-II NSW CA	140.8	8.5	0.5	17.4
Lake Ben Johnson	Orange	WS-II NSW CA	29.7	4.9	0.02	64.9
Lake Orange	Orange	WS-II NSW CA	155.7	13.1	0.3	10.0
Corporation Lake	Orange	WS-II NSW CA	27.2	3.3	0.9	40.9
Falls of the Neuse Reservoir	Wake	WS-III NSW CA	12,490.7	16.4	176.6	769.9
02						
Lake Benson	Wake	WS-III NSW CA	439.8	9.8	3.6	64.9
Lake Wheeler	Wake	WS-III NSW	551.0	13.1	7.6	28.2
Big Lake	Wake	B NSW	61.8	6.6	0.1	6.9
Reedy Creek Lake	Wake	B NSW	19.8	6.6	0.1	4.2
Sycamore Lake	Wake	B NSW	22.2	23.0	0.2	9.7
Apex Reservoir	Wake	WS-III NSW	74.1	9.8	0.3	2.3
Lake Crabtree	Wake	B NSW	518.9	6.6	0.5	51.4
05						
Cliffs of the Neuse Lake	Wayne	B NSW	9.9	29.5	0.1	0.4
07						
Lake Wilson	Wilson	WS-III NSW	81.5	4.9	0.7	40.2
Toisnot Reservoir	Wilson	WS-III NSW CA	9.9	4.9	0.1	50.0
Wiggins Mill Reservoir	Wilson	WS-III NSW CA	200.1	1.6	0.6	237.1

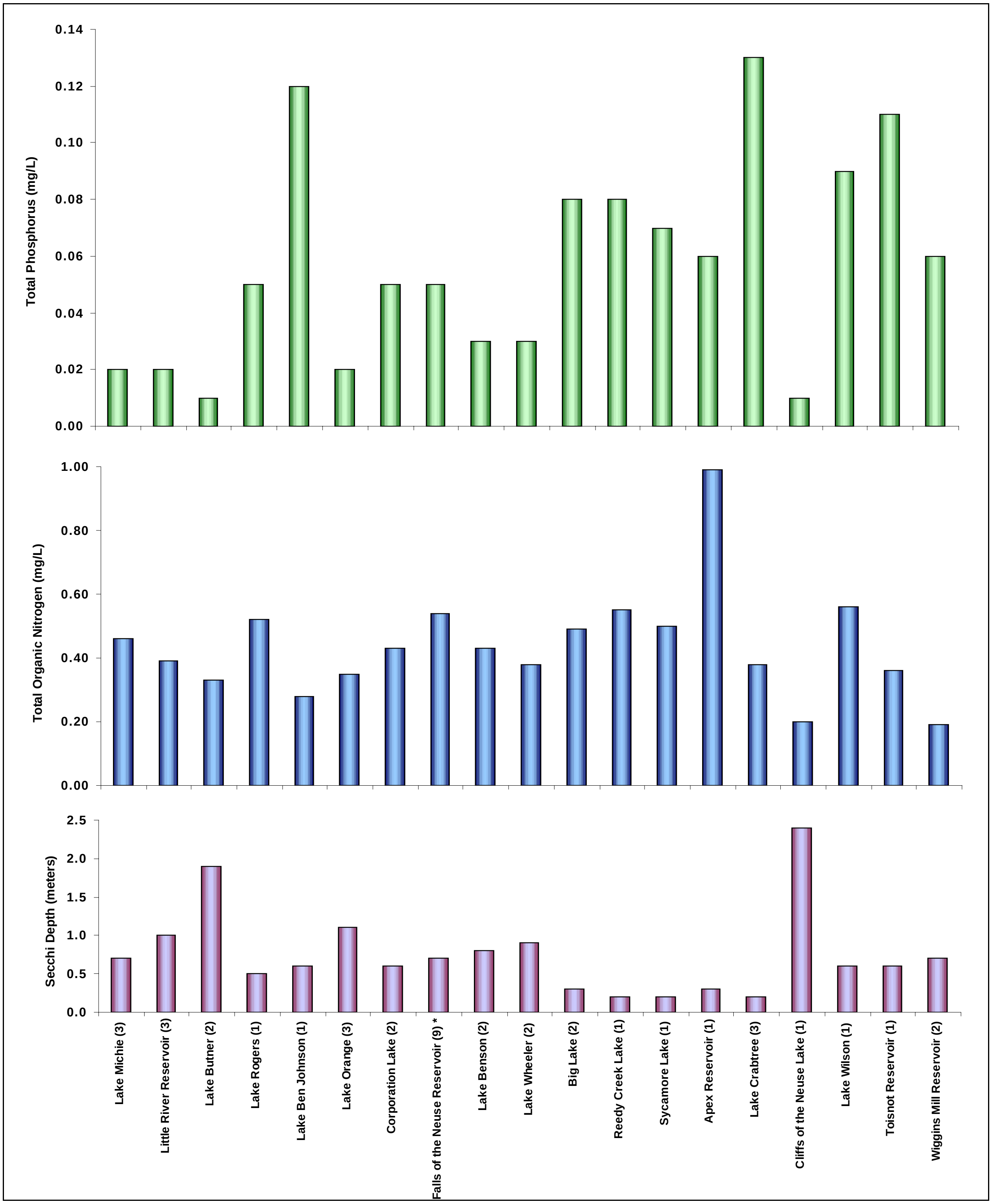


Figure 10. **Most recent total phosphorus and total organic nitrogen concentrations and Secchi depth from reservoirs in the Neuse River basin, 2000. Number following lake name is the number of sampling sites. Falls of the Neuse Reservoir was most recently sampled on September 29, 2000 following a turnover event. Because of this, data shown for this reservoir are from August 2000.**

PHYTOPLANKTON MONITORING

The NCDWQ analyzes algal samples to document blooms, to investigate the causes of fish kills, and to identify unusual or suspicious growths. Most samples were collected as part of the ambient monitoring program (Figure 11).

The majority of the algal samples (87%) came from the lower Neuse River in Subbasins 08 and 10. Phytoplankton assemblages from seven ambient monitoring sites in these two subbasins are routinely analyzed.

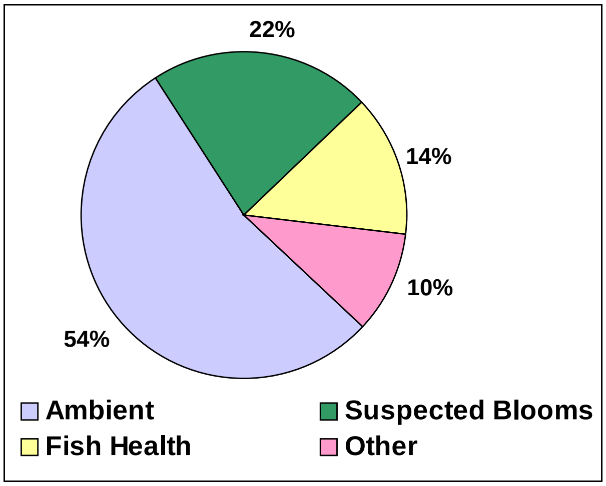


Figure 11. Phytoplankton sample types collected from the Neuse River basin, 1996 - 2000, n = 515. Note: other includes 4% films and foams; 3% special studies; 2% reference sites; and 1% floating mats.

Another set of the samples (11%) came from the reservoirs in the piedmont (Subbasins 01, 02, and 05). These samples were analyzed to support lake characterization studies and are discussed in the appropriate lakes' sections. The remaining samples (2%) came from Subbasins 06, 07, 09, and 11 - 14. These samples were sporadic and were generally in response to field reports of floating mats, films, and/or odors.

Algal Blooms

Algal blooms can occur throughout the year in response to favorable environmental conditions, such as an abundance of nutrients (eutrophication). Some bloom-forming taxa, such as diatoms, prefer the cooler waters of the winter months while others, such as the cryptomonads, are tolerant of a wider range of environmental conditions and can bloom during any season. The majority of the observed algal blooms occur in the hot, long days of summer -- conditions which favor greens, blue greens, and dinoflagellates.

Surface Films and Foams

Surface films and foams commonly develop during dry periods when detritus, which is rich in nutrients, collects on the water surface and is colonized by algae, bacteria and fungi. Although these may be unsightly, they are not known to be harmful. Surface films and foams are a natural part of aquatic ecosystems, but when persistent, they can indicate eutrophic and stagnant conditions.

Euglenoids are common in surface films. These motile algae migrate to the surface during the day, creating an oily film or "spilled paint" like appearance. Surface films were recorded in Subbasins: 01, 02, 07, and 10.

Algae and Fish Kills

Algal assemblages can have adverse effects on fish health when the normal processes of photosynthesis, respiration, and decomposition become extreme.

During photosynthesis, algae produce oxygen, thus increasing the concentration of dissolved oxygen (DO). Concentrations of DO over 140% saturation can be acutely fatal to fish (Post 1987). Conversely, during algal respiration or decomposition, DO levels decrease. This may cause fish and other aquatic organisms to suffocate. Small lakes and ponds are particularly susceptible to DO fluctuations, especially when these systems are eutrophic. Two such cases occurred in 2000 where high densities of algae likely contributed to fish kills in Subbasins 02 and 05.

Several types of algae are known to produce toxins. In the Neuse River estuarine system, *Pfiesteria* has received much notoriety. To investigate the association of fish kills and potentially toxic algae, 68 algal samples from 47 fish health events in the lower Neuse River were examined over the five-year sampling period. Of these events, two were reported positive for *Pfiesteria*.

AMBIENT MONITORING SYSTEM

The Ambient Monitoring System (AMS) is a program in which specific locations are routinely visited to collect data on the physical and chemical properties of surface water. In the Neuse River basin 59 stations are monitored monthly by the

NCDWQ. Complementing the AMS are about 50 stations monitored by a coalition of industries and municipalities. The overall focus of the AMS and coalition monitoring is to identify sites with water quality problems and elucidate long term water quality patterns. Significant observation included:

- Monitoring efforts have improved tremendously with coalition data and automated sampling devices. Over 100 sites within the basin are being monitored.
- Most all stations with a relatively high proportion (> 10%) of dissolved oxygen concentrations < 5.0 mg/L are classified as Swamp waters (Sw).
- All sites monitoring along Crabtree Creek in Raleigh showed high turbidities and elevated concentrations for total suspended solids. Dissolved oxygen concentrations, however, were high.
- Median nitrate+nitrite nitrogen and total phosphorus concentrations from stations along the mainstem portion of the Neuse River increased dramatically beginning at the monitoring station near Clayton.
- Median nitrate+nitrite nitrogen concentrations were elevated (greater than 1.0 mg/L) from tributary stations at Knap of Reeds Creek, Ellerbe Creek near Durham, Pigeon House Creek in Raleigh, and Middle Creek near Clayton.
- Median total Kjeldahl nitrogen concentrations were elevated (greater than 0.5 mg/L) at Knap of Reeds Creek, Ellerbe Creek near Durham, Little Contentnea Creek near Farmville, Contentnea Creek at Grifton, Creeping Swamp near Vanceboro, and Back Creek near Merrimon. Ammonia nitrogen concentrations also were elevated at these latter two stations.
- In general, tributary stations with median total phosphorus concentrations greater than 0.1 mg/L also had elevated concentrations of one of the nitrogen forms. Noteworthy was the station at Knap of Reeds Creek with a median total phosphorus concentration greater than 0.5 mg/L.

AQUATIC TOXICITY MONITORING

Seventy-two facility permits in the Neuse River basin currently require whole effluent toxicity (WET) monitoring. Forty-five facility permits have a WET limit; the majority of the other facilities have episodic discharges and their permits specify monitoring with no limit. Since 1991, the compliance rate of those facilities with limits has stabilized at approximately 90 - 95%.

Two facilities have had difficulty meeting their toxicity limits:

- The City of New Bern's WWTP (Subbasin 10) **--** This facility, which discharges into the Neuse River, has experienced problems consistently meeting its whole effluent toxicity limit since 1994. The City has speculated that the failures are associated with ammonia. The plant currently uses trickling filters for its secondary treatment. This technology is deficient for ammonia removal. The City has negotiated a Special Order by Consent with NCDWQ's Washington Regional Office to upgrade treatment works for advanced nitrogen and phosphorus removal using a Bardenpho process.
- The Town of Cary’s South WWTP (Subbasin 02) **--** This facility, which discharges into Middle Creek, has experienced recent problems with whole effluent toxicity. The Town is currently undertaking a toxicity reduction evaluation and believes the failures may be related to a toxic fungus or algae.

INTRODUCTION TO PROGRAM METHODS

The North Carolina Division of Water Quality (NCDWQ) uses a basinwide approach to water quality management. Activities within NCDWQ, 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 Neuse River basin was sampled by the Environmental Sciences Branch in 1991, 1995, and 2000.

The Environmental Sciences Branch (ESB) 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 Neuse River basin include benthic macroinvertebrates, fish community, fish tissue, lake assessment, phycology, ambient monitoring, and aquatic toxicity monitoring.

QUALITY ASSURANCE

Laboratory measurements play a key role in the assessment and protection of water quality. Laboratory analyses are needed to identify problems and to monitor the effectiveness of management strategies to abate these problems. The relative accuracy and precision of laboratory data must be considered as part of any data interpretation or analysis of trends and use support. Absolute certainty in laboratory measurements can never be achieved. However, it is the goal of quality assurance and quality control efforts to quantify an acceptable amount of uncertainty. The evaluation of data quality is thus a relative determination. What is high quality for one situation could be unacceptable in another.

The NCDWQ's Chemistry Laboratory has recently established rigorous internal quality assurance evaluations. These evaluations may have significant implications on interpretation of historical data and how new data are generated and reviewed. The NCDWQ will continue to work on ensuring the quality of water analyses in North Carolina. It is obviously beneficial to generate the highest quality information to apply a statistical level of significance to water quality observations. In addition to quantification limits, lower limits of detection, method detection limits, and instrumentation detection limits must be evaluated on a continuing basis to ensure sound data and information. Because each of these detection limits can represent different levels of confidence, water quality evaluations may change from time to time based on improved laboratory instruments, analytical methods, and improved quality assurance and quality control applications.

BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom substrates of rivers and streams. These organisms are primarily aquatic insect larvae. The use of benthos data is a reliable monitoring tool, because benthic macroinvertebrates are sensitive to subtle changes in water quality. Because many taxa in a community have life cycles of six months to one year, the effects of short term pollution (such as a spill) will generally not be overcome until the following generation appears. The benthic community also integrates the effects of a wide array of potential stressors.

Sampling methods and criteria (Appendix B1) have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample from flowing fresh waters based on the number of taxa present in the intolerant groups Ephemeroptera, Plecoptera and Trichoptera (EPT S) (Appendix B1) and the value of the North Carolina Biotic Index (NCBI (BI)). This index summarizes tolerance data for all taxa in each collection. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is not assessed as well by a taxa richness analysis. Different criteria have been developed for different ecoregions (mountains, piedmont, and coastal) within North Carolina for freshwater flowing waterbodies.

Bioclassifications listed in this report (Appendix B2) may differ from older reports because evaluation criteria have changed since 1983. Originally, total taxa richness and EPT taxa richness criteria were used, then just EPT taxa richness, and now NCBI as well as EPT taxa richness criteria are used for flowing freshwater sites. Refinements of the criteria continue to occur as more data are gathered. Criteria for swamp streams are under development.

FISHERIES

Fish Community Structure

The NCIBI is a modification of the Index of Biotic Integrity initially proposed by Karr (1981) and Karr, *et al.* (1986) (Appendix F1). The IBI method was developed for assessing a stream's biological integrity by examining the structure and health of its fish community. The scores derived from this index are a measure of the ecological health of the waterbody and may not directly correlate to water quality. For example, a stream with excellent water quality, but with poor or fair fish habitat, would not be rated excellent with this index. However, a stream which rated excellent on the NCIBI should be expected to have excellent water quality.

The Index of Biological Integrity incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition. The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. Species composition measurements reflect habitat quality effects. Information on trophic composition reflects the effect of biotic interactions and energy supply. Fish abundance and condition information indicate additional water quality effects. It should be noted, however, that these responses may overlap. For example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, not necessarily a change in water quality.

Fish Tissue

Because fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Contamination of aquatic resources have been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation, either directly or through aquatic food webs, and may accumulate in fish and shellfish tissues. Results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water.

Since 1991, fish tissue surveys have been conducted as part of the Basinwide Assessment Program. Fish tissue were sampled for metals and organic contaminants throughout the year's scheduled basins with the intent of assessing as many waterbodies as possible. While this included efforts to assess suspected "trouble spots" in a basin, significant time and resources were spent in gathering data from areas where few fish tissue contaminants were historically detected. Review of data after the first round of basin assessments were completed revealed that, except for mercury, there were no widespread fish contaminant issues in the state that warranted basinwide-style investigations.

In 1999, the scope of fish tissue surveys were revised and shifted from basinwide assessments to areas where contaminants exist or are suspected. This shift has resulted in less basinwide coverage, but has focused resources on known contaminant issues within a basin.

All fish samples were collected according to NCDWQ's standard operating procedures (NCDEHNR 1997). Analysis results are used as indicators for human health concerns, fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem (Appendix FT1).

Fish Kills

Fish kills investigation protocols were established in 1996 to investigate, report, and track fish kill events throughout the state. Fish kill and fish health data collected by trained NCDWQ and other resource agency personnel are recorded on a standardized form. Fish kill investigation forms and supplemental information are compiled in a database where the data can be managed and retrieved for use in reporting to concerned parties. Information on fish kills in other basins may be found on NCDWQ's website.

LAKE ASSESSMENT

Lakes are valued for the multiple benefits they provide to the public, including recreational boating, fishing, drinking water, and aesthetic enjoyment. Assessments have been made at publicly accessible lakes, at lakes which supply domestic drinking water, and lakes (public or private) where water quality problems have been observed.

Data are normally used to determine the trophic state of each lake, a relative measure of nutrient enrichment and productivity. These determinations will not be possible for this report based on chlorophyll *a* laboratory issues from the most recent summertime sampling (Appendices L1 - L3).

PHYTOPLANKTON MONITORING

Phytoplankton samples were collected and analyzed in accordance with standard operating procedures (NCDEHNR 1992; NCDENR 1998) (Appendix P1). Due to analytical problems discovered with chlorophyll *a*, no chlorophyll *a* results are reported for the period 1996 - 2000.

***Pfiesteria* and *Pfiesteria*-like dinoflagellates**

The term "*Pfiesteria*-like dinoflagellate" refers to all cells that bear a cursory resemblance to the dinoflagellates *Pfiesteria piscicida* and *Pfiesteria shumwayae* (collectively referred to as "*Pfiesteria*"). Multiple dinoflagellate species tend to look like *Pfiesteria*. It is difficult to discern *Pfiesteria* from other look-alike dinoflagellates under light microscopy. Therefore, cell counts reported by the Environmental Sciences Branch (ESB) are only presumptive and include all cells that resemble *Pfiesteria*.

During late June 1999, ESB obtained equipment to view phytoplankton samples under epifluorescence microscopy (FM). This method excites chlorophyll *a* under 397 to 563 µm light frequencies. FM allows for the documentation of photosynthetic dinoflagellates from heterotrophic dinoflagellates. Photosynthetic dinoflagellates always contain chloroplasts and glow throughout their cell when viewed under FM. *Pfiesteria*, a heterotroph, does not contain its own chloroplasts. It instead relies on ingested algae, small aquatic invertebrates, and fish substances for nutrition. Therefore, *Pfiesteria* does not characteristically fluoresce unless it temporarily retains chloroplasts from algae it has ingested (Burkholder and Glasgow 1997, Burkholder, *et al*. 1998). However, definitive identification of *Pfiesteria* requires the examination of its sub-membrane plate structure under electron microscopy. The NCDWQ does not have this capability, which is generally available only to research institutions.

Unpreserved samples collected from a potential fish health event are examined under FM upon the day of their arrival. To calculate total cell densities of all *Pfiesteria*-like dinoflagellates, preserved aliquots are examined under a light microscope without fluorescence. Any cell that visually resembles *Pfiesteria* is counted as a *Pfiesteria*-like dinoflagellate. Samples collected from fish kills are often given to researchers at the North Carolina State University's Center for Applied Aquatic Ecology (for fish bioassays and scanning electron microscopy) and the University of North Carolina at Greensboro (for RNA probes) to confirm the presence or absence of *Pfiesteria piscicida* or *Pfiesteria shumwayae* (Glasgow, *et al*., 2001) during a fish health event.

AMBIENT MONITORING SYSTEM

Assessments of water quality can be obtained from information about the fish and benthic invertebrate communities present in a body of water or from chemical measurements of particular water quality parameters. This section summarizes the field and laboratory chemical measures of water quality, typically referred to as ambient water quality measures.

The Ambient Monitoring System is a network of stream, lake, and estuarine stations strategically located for the collection of physical and chemical water quality data. 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 appended when justified (Table 7).

Water quality data collected at all sites were evaluated for the previous five year period. Some stations have little or no data for several parameters. However, for the purpose of standardization, data summaries for each station include all parameters. These chemistry data summaries are found at the end of the Ambient Monitoring Section.

Data collected from January 1996 to September 2000 were displayed in box plots. Box plots provide measures of central tendency and variation (Figure 12). The parameters presented in this report were also presented in the previous basin assessment report (NCDEHNR 1996a).

Table 7. Freshwater parametric coverage for the ambient monitoring system.[1]

Parameter	All freshwater	Water Supply
Dissolved oxygen (s)	✔	✔
pH (s)	✔	✔
Conductivity	✔	✔
Temperature (s)	✔	✔
Total phosphorus	✔	✔
Ammonia as N	✔	✔
Total Kjeldahl as N	✔	✔
Nitrate+nitrite as N (s)	✔	✔
Total suspended solids	✔	---
Total dissolved solids (s)	---	✔
Turbidity (s)	✔	✔
Hardness, total (s)	✔	✔
Chloride (s)	✔	✔
Fecal coliform bacteria (s)	✔	✔
Total 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 and an 's' indicates the parameter has a standard or action level.
[2]Chlorophyll *a* is collected in Nutrient Sensitive Waters (NSW).

The water quality reference value may be a narrative or numeric standard, or an action level as specified in the North Carolina Administrative Code 15A NCAC 2B .0200 (Table 8). Zinc is not included in the summaries for metals because recent (since April 1995) sampling or laboratory analyses may have been contaminated and the data may be unreliable.

In this report, conductivity is synonymous with specific conductance. It is reported in micromhos per centimeter (µmhos/cm) at 25 °C.

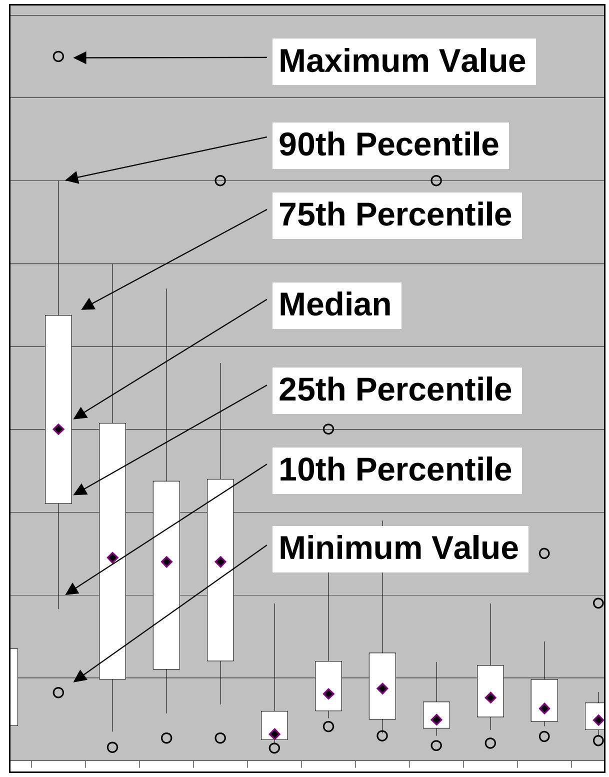


Figure 12. Explanation of box and whisker charts.

AQUATIC TOXICITY MONITORING

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 several researchers to be predictive of discharge effects on receiving stream populations.

Many facilities are required to monitor whole effluent toxicity by their NPDES permit or by administrative letter. Facilities without monitoring requirements may have their effluents evaluated for toxicity by the NCDWQ's Aquatic Toxicology Laboratory. If toxicity is detected, the NCDWQ may include aquatic toxicity testing upon permit renewal.

The NCDWQ'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 NCDWQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

Table 8. Selected water quality standards for freshwater (top) and saltwater (bottom).[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	50					
Cadmium	2.0			0.4		
Chloride	230,000[2]		250,000			
Chlorophyll *a*, corrected	40[3]			15[3]		
Chromium, total	50					
Coliform, total (MFTCC/100 ml)[4]			50[3]			
Coliform, fecal (MFFCC/100 ml)[5]		200[3]				
Copper, total	7[2]					
Dissolved oxygen (mg/L)	5.0[6]			6.0	[7]	[3, 7]
Hardness, total (mg/L)			100			
Iron (mg/L)	1[2]					
Lead	25[3]					
Manganese			200			
Mercury	0.012					
Nickel	88		25			
Nitrate nitrogen			10,000			
pH (units)	6.0 - 9.0[3, 7]					[3, 7]
Selenium	5					
Solids, total dissolved (mg/L)			500			
Solids, total suspended (mg/L)					10 Trout, 20 other[8]	
Turbidity (NTU)	50, 25[3]			10[3]		
Zinc	50[2]					

[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. April 1, 2001).
[2]Action level.
[3]Refer to 2B .0211 for narrative description of limits.
[4]Membrane filter total coliform count per 100 ml of sample.
[5]Membrane filter fecal coliform count per 100 ml of sample.
[6]An instantaneous reading may be as low as 4.0 mg/L, but the daily average must be 5.0 mg/L or more.
[7]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.
[8]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	50				
Cadmium	5.0				
Chlorophyll *a*	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, 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.

NEUSE RIVER SUBBASIN 01

Description

This subbasin consists of the Eno, Flat, and Little Rivers watersheds from their origins to the Neuse River (impounded as Falls of the Neuse Reservoir (Falls Lake) (Figure 13). The western portion of the subbasin is primarily in the Slate Belt ecoregion, especially the Flat, Eno, and Little Rivers drainages.

Land use in the upper half of the subbasin is mostly agricultural and forest. The lower half includes the cities of Hillsborough and Durham and Falls Lake and its tributary streams. Land use around the lake is mostly forest, but includes some of Raleigh's newest residential developments. Other impoundments present are on the Little River (Little River Reservoir) and the Flat River (Lake Michie).

Most streams have some type of water supply classification: WS-II, -III, or -IV. WS-II waters have the most protective regulations, and have the same management strategy as a High Quality Water classification. High quality WS-II waters in the subbasin include the Eno River and tributaries above Hillsborough and the Little River and its tributaries above Little River Reservoir.

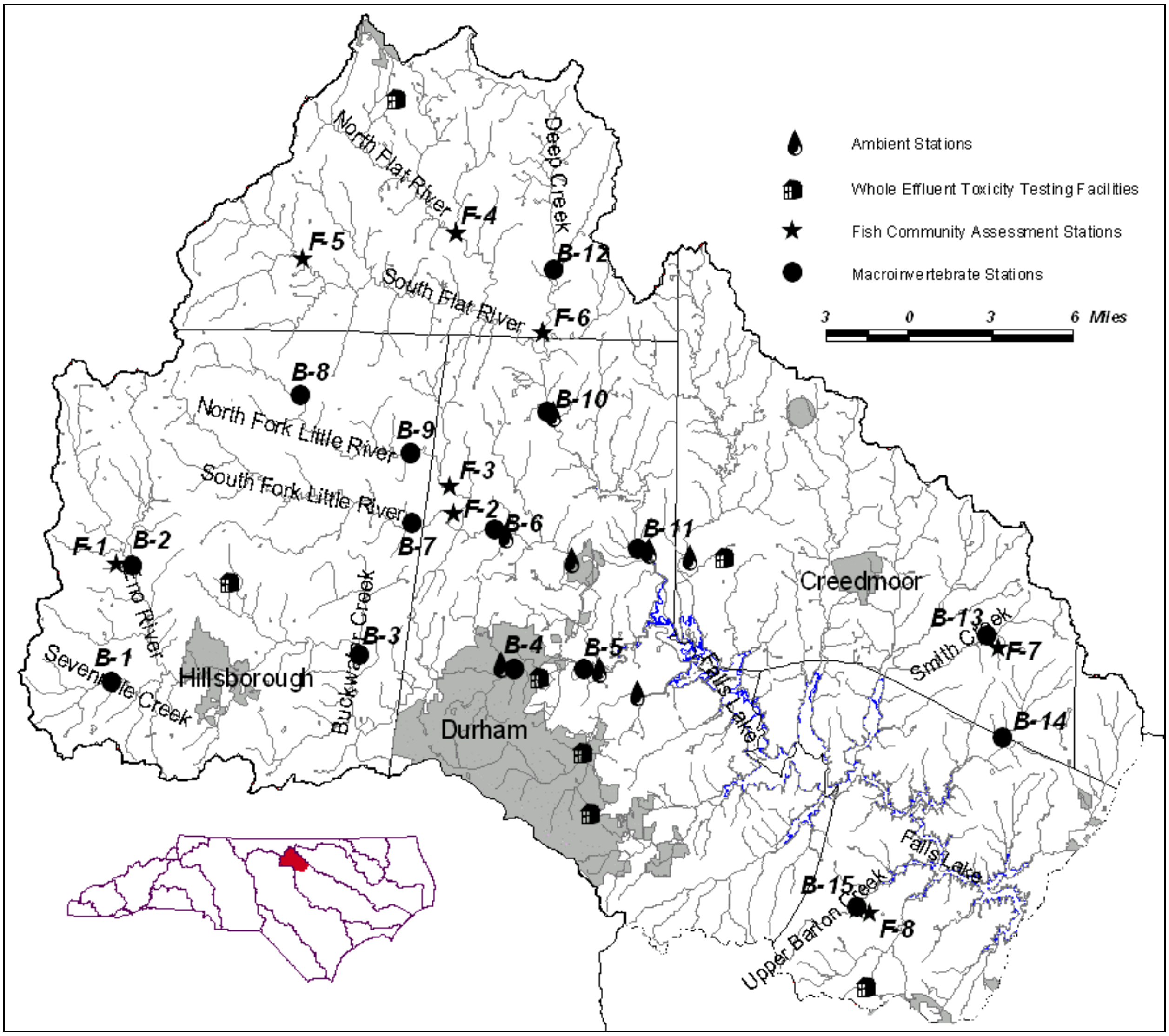


Figure 13. Sampling sites in Subbasin 01 in the Neuse River basin.

A narrow band of the Triassic Basin runs through the middle of this subbasin. Through this band flows Ledge Creek, Beaverdam Creek, and Lick Creek. Smaller streams in the Slate Belt and Triassic regions are especially susceptible to lack of flow during dry periods. This natural stress may obscure some of the effects of point and nonpoint source runoff.

Larger streams in the Slate Belt, however, usually have high-quality habitat and are characterized by boulder-rubble substrate. Erosion from Slate Belt soils can produce high turbidity from inputs of suspended clays, but little sandy material accumulates as bedload (Mulholland and Lenat 1992). The area south of Falls Lake is within a more typical portion of the Piedmont ecoregion; streams in this area have sandy substrates.

The Eno River Corridor contains some of the most scenic and biologically important natural areas within the entire eastern piedmont (NCDEHNR 1995). Its diverse wildlife includes a nationally significant fauna of freshwater mussels, snails, salamanders, fish, and other aquatic species. Upstream in Orange County, the Eno River forms links with the Hillsborough division of Duke Forest, Occonneechee Mountain, and the extensive wildlands of the Eno River Uplands – now partially protected as part of the Eno River State park. The Little River joins the Eno River downstream from Penny's Bend. The Flat River joins the Eno River to form the Neuse River just west of the Wake County line. A large portion of the land along the Eno River has been set aside as protected natural areas extending from the Eno River State Park to the Falls of the Neuse Gamelands.

Overview of Water Quality

All the streams sampled for benthic invertebrates in this subbasin were classified using Piedmont criteria. Unusually good water quality is found in the Eno, Flat, and Little Rivers systems (Table 9). This is due to a combination of Slate Belt geology and a general lack of disturbance. Macroinvertebrate and fish collections produced Good or Excellent ratings for most sites on these rivers.

Point source dischargers contributed to severe problems in some tributaries near Durham, especially Ellerbe Creek and Knap of Reeds Creek. Ellerbe Creek, however, is also severely impacted by urban runoff. Urban runoff from Durham affects both Lick Creek and Little Lick Creek. Biological studies have suggested that upgrades of the Hillsborough WWTP (Eno River) and the Butner WWTP (Knap of Reeds Creek) resulted in some corresponding improvements in water quality through 1991. The Durham Lick Creek WWTP ceased discharge into Little Lick Creek in 1995, but Little Lick Creek has not shown any recovery.

Overall, biological sampling showed no evidence of major changes in water quality for this subbasin between 1995 and 2000. Of the 23 stream sites sampled for benthic invertebrates and/or fish in 2000, 16 (70%) rated either Good or Excellent. Of the 18 sites sampled in both 1995 and 2000, 7 (39%) retained the same bioclassification, 7 (39%) increased by one bioclassification, and 4 (22%) decreased by one bioclassification.

Stream habitat scores ranged from 55 in New Light Creek to 88 in the Eno River at Cabes Ford. Most streams scored in the 70's-80's range indicating generally good stream habitat conditions available for aquatic life colonization. The low score in New Light Creek was due to excessive sedimentation from agricultural activity in the riparian zone and bank erosion and instability. At other benthic invertebrate monitoring sites, other low scores were attributed to sandy bottom streams with few riffle and pool areas (South Fork Little River, North Fork Little River, and the Flat River).

None of the eight lakes sampled in 2000 indicated any significant change in water quality between 1995 and 2000.

In 1999, the City of Raleigh funded a water quality study of the lower reach of the Falls of the Neuse Reservoir downstream of NC 50. The chemical quality of this region was very good with no pesticides and extractable or volatile organic compounds; and very few trace metals had concentrations greater than detection limits. Chlorophyll *a* concentrations were not greater than the water quality standard. Algal biomass, however, was found to range from moderate to high and was dominated by nuisance blue green algae (SDES 1999).

Monthly water chemistry data were collected from eight sites in this subbasin. Knap of Reeds and Ellerbe Creeks both exhibited consistently high specific conductance and nitrate+nitrite-N levels.

The primary influence at these sites were likely the John Umstead Hospital WWTP (Butner) and the Northern Durham Water Reclamation Facility. Also, more than 40 percent of the samples analyzed for fecal coliform bacteria at these two stations were above the standard criterion. More detailed information is presented in the Ambient Monitoring section of this report.

Table 9. Waterbodies monitored in Subbasin 01 in the Neuse River basin for basinwide assessment, 1995 - 2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Sevenmile Cr[2]	Orange	SR 1120	Good	Good-Fair
B-2	Eno R[2]	Orange	SR 1336	Good-Fair	Good
B-3	Eno R[2]	Orange	SR 1569	Excellent	Excellent
B-4	Eno R[2]	Durham	US 15/501	Good	Excellent
B-5	Eno R[2]	Durham	SR 1004	Good	Good
B-6	Little R[2]	Durham	SR 1461	Good	Excellent
B-7	S Fk Little R	Orange	SR 1538	Good-Fair	Good
B-8	N Fk Little R	Orange	SR 1519	Fair	Good-Fair
B-9	N Fk Little R	Orange	SR 1538	Good	Good-Fair
B-10	Flat R[2]	Durham	S 1614	Excellent	Good
B-11	Flat R[2,3]	Durham	SR 1004	Fair	Fair
B-12	Deep Cr[2]	Person	SR 1715	Good	Good
B-13	Smith Cr[2]	Granville	SR 1710	Good-Fair	Good
B-14	New Light Cr	Wake	SR 1912	Good-Fair	Good
B-15	Upper Barton Cr[2]	Wake	NC 50	Good-Fair	Good-Fair
F-1	Eno R	Orange	SR 1336	---	Excellent
F-2	S Fk Little R	Durham	SR 1461	---	Excellent
F-3	N Fk Little R	Durham	SR 1461	---	Good
F-4	N Flat R	Person	SR 1715	---	Excellent
F-5	S Flat R	Person	NC 157	---	Good
F-6	Deep Cr[2]	Person	SR 1734	Excellent	Excellent
F-7	Smith Cr	Granville	SR 1710	Good	Good-Fair
F-8	Upper Barton Cr	Wake	NC 50	Good	Good
	Lake Orange	Orange		Mesotrophic	---
	Corporation Lake	Orange		Mesotrophic	---
	Lake Ben Johnson	Orange		Eutrophic	---
	Little River Reservoir	Durham		Eutrophic	---
	Falls of the Neuse Res.	Wake		Eutrophic	---
	Lake Michie	Durham		Eutrophic	---
	Lake Butner	Granville		Mesotrophic	---
	Lake Rogers	Granville		Eutrophic	---

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available before 1995, refer to Appendix B2 or Appendix F3.

Except for the month of April, spring and summer 2000 mean monthly flows in Subbasin 01 were slightly lower than the historic mean flow for the period of record (Figure14).

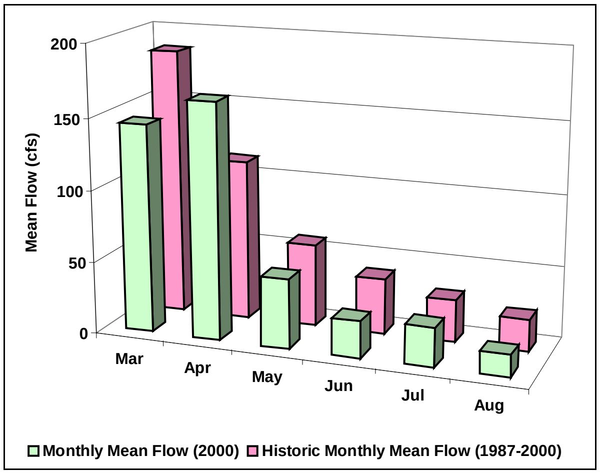
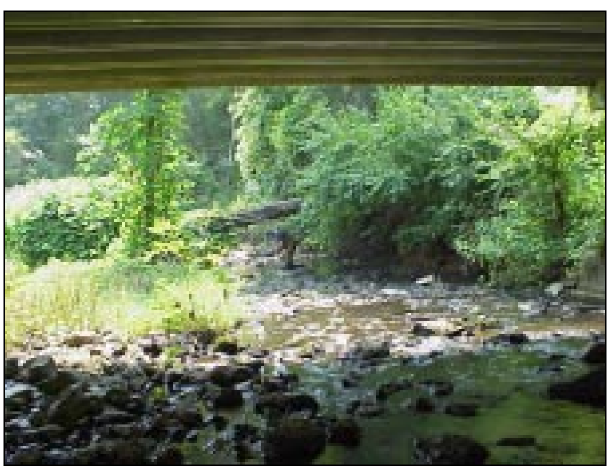


Figure 14. Spring and summer monthly mean flow and historic monthly mean flow at the Little River at SR 1461, Durham County.

Seven Mile Creek, SR 1120

Sevenmile Creek is a tributary to the Eno River, just west of Hillsborough. This stream at this location is a four meters wide, rocky, Slate Belt stream. Land use surrounding the site is mainly forest and the habitat here is good (score = 85).



Seven Mile Creek at SR 1120, Orange County.

EPT abundance increased between 1995 (89) and 2000 (116), but the total number of EPT taxa collected decreased by three, resulting in the bioclassification change from Good to Good-Fair. This site was rated Good-Fair when sampled in 1991. These bioclass fluctuations are likely flow related rather than water quality related.

Eno River, SR 1336

The Eno River at this site, upstream of Hillsborough, was five meters wide during the summer low flow period. Land use is mostly forest and residential. Although not evident in the August 2000 photograph because of the high turbidity, the substrate was an even mix of boulder/rubble and sand/gravel. This stream was very turbid at the time of sampling, although flows were normal. The only habitat problems here were the lack of well defined and frequent riffle areas, bringing the habitat score down to 79.

Eno River at SR 1336, Orange County, August 2000.

EPT taxa richness increased by one taxa to 21, in 2000, bringing the bioclassification up to borderline Good. In 1995 and 1991, the stream was rated Good-Fair. This bioclassification change does not represent a real change in water quality.

This site was sampled for fish for the first time in 2000. In April , the site was approximately 10 meters wide, and although the substrate is mixed, there is a large amount of sand. The habitat score was 81.

Lower reach of Eno River at SR 1336, Orange County with predominantly sand substrate, April 2000.

Upper reach of the Eno River at SR 1336, Orange County with rocky substrate, April 2000.

As indicated by the NCIBI score of 54 and the Excellent rating, the fish community at this location was healthy. Only 5 percent of the fish collected were tolerant individuals, while two intolerant species (pinewoods shiner and Roanoke darter) were collected. The most common fish was the swallowtail shiner.

Eno River at Cabes Ford, near SR 1569

The Eno River at this site is 25m wide. Instream habitat is good, however the gravel/cobble substrate is embedded, bringing the habitat score down to 88. This site is located within the Eno River State Park, downstream from the City of Hillsborough.

Eno River at Cabes Ford, near SR 1569, Orange County.

This site has been rated either Good or Excellent since 1988 and was assigned a bioclassification of Excellent in 2000. The Good bioclassification was retained even when sampled in 1996, five weeks after Hurricane Fran that resulted in the highest flows on record (500 year flood).

Total taxa richness and EPT taxa richness have declined over the years, but the EPT abundance has increased and the Biotic Index was the lowest ever in 2000, indicating a slightly less tolerant macroinvertebrate community. This is reflected in the absence of certain less tolerant midge taxa from the 2000 sample that were common or abundant in previous collections (e.g., *Cricotopus bicinctus, Polypedilum illinoense,* and *Tribelos*).

Eno River, US 15/501

This Eno River site is located inside West Point on the Eno park in Durham.

Eno River at US 15/501, Durham County.

Since 1984, the site has consistently been assigned a Good bioclassification. The 2000 benthos collection resulted in an increase in overall taxa richness and in EPT taxa richness changing the bioclassification to Excellent. However, the Biotic Index increased slightly. These minor fluctuations indicated no real change in water quality.

Eno River, SR 1004

The Eno River at this location is 20 m wide. Areas immediately upstream and downstream of this riffle were sandy, deep and slow moving.
This site, located just before the river enters Falls Lake, is characterized by an embedded sandy substrate with some boulder/rubble and infrequent pools and riffles. Instream habitat was good and the riparian zone was undisturbed.

Eno River at SR 1004, Durham County.

The site has consistently been assigned a benthos bioclassification of Good since first sampled in 1985. Taxa richness and abundance values and the Biotic Index have varied little since 1985.

Little River, SR 1461

The Little River near Orange Factory is about 25m wide with a substrate of mostly bedrock. This site has been rated either Good or Excellent since it was first sampled in 1989. The most recent sampling event resulted in a bioclassification of Excellent, up from a Good rating in 1995. The 1995 collection resulted in the lowest EPT taxa richness (28) and the highest NCBI (5.72) ever recorded here (Figure 15). This site was rated Good in both 1989 and 1995, all other collections resulted in Excellent ratings. These "Good" years were also years with high flow conditions during sampling.

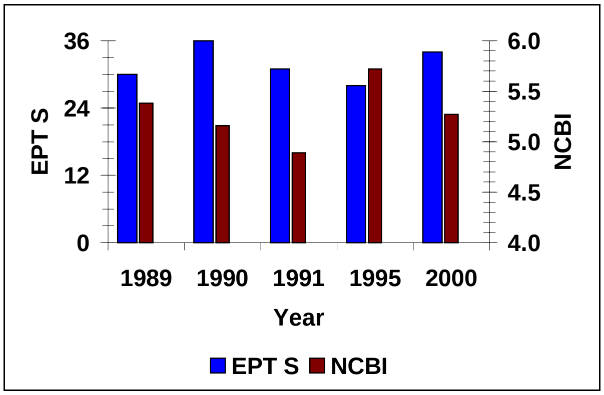


Figure 15. EPT taxa richness (EPT S) and biotic index (NCBI) for the Little River at SR 1461, Durham County.

This most upstream access on the Little River is too wide to be sampled for fish community assessment using the two backpack electrofishing units typically used by the NCDWQ. Instead two sites on the North Fork Little River and South Fork Little River were chosen because their size falls within the limits set by NCDWQ standard operating procedures.

South Fork Little River, SR 1461

The South Fork Little River at this location flows through a series of pastures and grassy lawns with a narrow riparian area along the stream. The fish community collection segment of the stream was largely a series of runs with patchy pool and riffle habitat. The substrate was primarily cobble and the stream was estimated to be 12 meters wide. The habitat score at this site was 75.

Upstream view of the South Fork Little River at SR 1461, Durham County.

Pasture adjacent to the South Fork Little River at SR 1461, Durham County.

The South Fork Little River is considered a regional fish community reference location. The Excellent fish community rating and highest possible NCIBI score (60) supported the reference designation. Twenty-four species were collected including three intolerant species: pinewoods shiner, Neuse River darter, and Roanoke darter. The Roanoke darter was the second most commonly collected fish behind the redbreast sunfish.

South Fork Little River, SR 1538

This tributary to the Little River in northern Durham County was first sampled for benthos in 1995, resulting in a rating of Good-Fair. In 2000, an increase in EPT taxa richness from 19 to 23 resulted in a bioclassification of Good. The stream at this site averages about 10m wide, is very shallow, and has a rocky substrate with few pool areas.

South Fork Little River at SR 1538, Durham County.

North Fork Little River SR 1519

This four meter wide headwater section of the North Fork Little River was sampled for benthos in 1995 resulting in a rating of Fair. In 2000, the stream was rated Good-Fair due to an increase in the number of EPT taxa which were collected (11 in 1995 to 17 in 2000).

Land use here is a mixture of forest and agriculture. The low habitat score here (63) reflected a stream with limited instream habitat, few riffles and pool areas and eroding, unstable banks.

North Fork Little River at SR 1519, Orange County.

North Fork Little River, SR 1538

This tributary to the Little River was also first sampled in 1995 and received a rating of Good. The five meter wide site was turbid at the time of sampling in 2000. A reduction in EPT taxa richness, from 29 to 20, resulted in a rating of Good-Fair in 2000. EPT taxa abundance also decreased between years. Changes in the structure of the benthic community suggested a decrease in water quality since 1995. These changes were the disappearance of intolerant taxa such as *Centroptilum, Diplectrona modestum, Hydroptila* and *Psilotreta*.

Land use surrounding the site is half residential and half forest and horse pasture.

North Fork Little River at SR 1538, Orange County.

North Fork Little River, SR 1461

This site on the North Fork Little River was located less than one half mile from the South Fork Little River at SR 1461 and had the same stream width (12 m), but had a more rocky substrate. The habitat score for the North Fork Little River location was 86.

Downstream view of North Fork Little River at SR 1461, Durham County.

The fish community was also quite different from the South Fork Little River site. The North Fork Little River community was composed of fewer species (14 *vs*. 24 species at the South Fork) and while no species constituted more than 29 percent of the total community at the South Fork, the North Fork community was dominated by the omnivorous bluehead chub (51 percent of total individuals). Such high percentages of bluehead chub are usually associated with nutrient enriched streams. The abundance of river weed (*Podostemum*) and periphyton present were also indicative of nutrient enrichment in the stream. The North Fork Little River had an NCIBI score of 48 and had a fish community rating of Good.

Flat River, SR 1614

The Flat River at Quail Roost is an ambient monitoring location, approximately 20 m wide, that has been sampled for benthic macroinvertebrates 12 times since in 1984. This site has consistently maintained a rating of either Good or Excellent. The minimal bioclassification rating variations between years has been attributed to variations in stream flow.

The benthic community may become stressed during drought years by the low current, and any effects of nonpoint runoff will be greatest during high flow. However, this site retained its Good bioclassification when sampled in 1996, five weeks after Hurricane Fran produced the highest flows on record.

Certain current-dependent mayflies may only be collected in high flow years (*Heterocloeon* and *Serratella deficiens*). Likewise, some taxa which prefer low flow will be most abundant in those years (*Tribelos* and *Hydroptila*).

The habitat score of 68 reflected the infrequency of pool areas and riffles.

Flat River at SR 1614, near Quail Roost, Durham County.

Flat River, SR 1004

This site is 1.4 miles downstream of Lake Michie, and the fauna is influenced by releases from the dam. The fauna is also impacted by low dissolved oxygen resulting from the dam releases (Figure 16).

Flat River at SR 1004, Durham County.

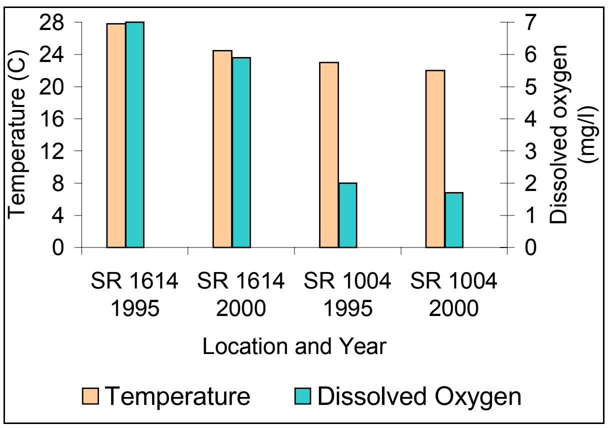


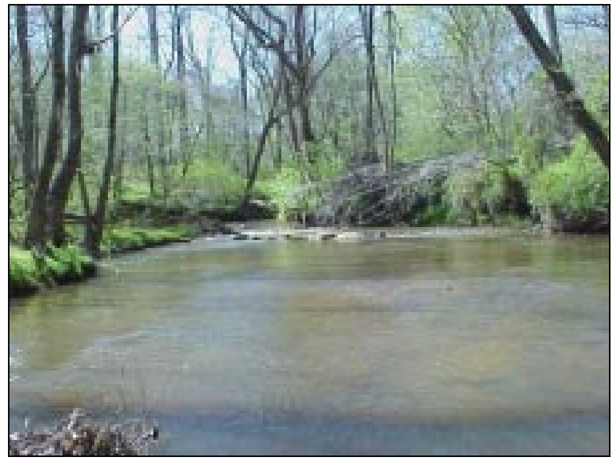
Figure 16. **Comparisons of temperature and dissolved oxygen above (Flat River at SR 1614) and below Lake Michie (Flat River at SR 1004) collected during benthos sampling 1995 and 2000.**

The benthic community here is dominated by pollution tolerant filter-feeders. The substrate here was covered with mats of *Rheotanytarsus* tubes. The rating has been consistently Fair since 1985.

This site should no longer be sampled as part of the basinwide monitoring program but should continue to be monitored as a Special Study to further examine the influence of the dam release on the benthic community.

North Flat River, SR 1715

The North Flat River just above SR 1715 has a variable width, averaging 10 m. The predominantly rocky substrate includes large areas of bedrock. This site was assigned a habitat score of 86.



Upstream view of the North Flat River at SR 1715, Person County.

This location on the North Flat River was sampled as part of a special study in 1999 before being included in the 2000 basinwide monitoring program. The NCIBI score and subsequent rating both increased from 50 and Good in 1999 to 56 and Excellent in 2000. This was due largely to a better balance between the percentage of omnivores and insectivores in 2000. The scarcity of piscivorous fish was documented during both years with only one largemouth bass collected in 2000.

Similar to the situation in the Little River system, the fish community sites on the North Flat River and the South Flat River were selected over any location on the Flat River proper due to the large size of the most upstream Flat River site.

South Flat River, NC 157

An operational feed mill is located beside the South Flat River at this site. The old mill dam has been reduced to rubble in the stream. The area around the old dam has some exposed bedrock and other cobble, but the substrate for the lower portion of the sampling reach is sand. The stream averages nine meters in width. The total habitat score for the site was 66.

Lower reach of the South Flat River at NC 157, Person County with sand substrate.

Upper reach of the South Flat River at NC 157, Person County with rocky substrate.

The fish community seemed generally healthy with an NCIBI score of 48 and a Good rating. Abundant, thick growths of periphyton suggested enrichment at this site. A moderately high percentage (42 percent) of omnivores also indicated enrichment in the stream.

Two downstream locations on the South Flat River, at SR 1120 and SR 1123, were not suitable for fish community sampling because of areas too deep to wade.

Deep Creek, SR 1734

The 2000 collection marked the third time the fish community has been sampled at this Deep Creek site. The sampling area is approximately 12 meters wide and has a rocky substrate. The site received a habitat score of 81.

Upstream view of Deep Creek at SR 1734, Person County.

Deep Creek at SR 1734 is considered a regional reference site and an Excellent fish community has always been documented. Although the NCIBI score was higher (60) in 1990 than the other two years (56 in 1995 and 2000), roughly half the number of fish (225) were collected during that sampling event as contrasted to the 1995 (472 individuals) and 2000 (411 individuals) collections. Twenty-two species were collected in 1990 and 2000 and 21 species were collected in 1995. Three intolerant species (pinewoods shiner, Neuse River darter, and Roanoke darter) have been collected every time.

Deep Creek, SR 1715

This tributary to the Flat River, in southern Person County, is a Slate Belt stream surrounded by forest and agricultural land use. The creek at this site is 10 meters wide and has a good variety of habitats suitable for macroinvertebrate colonization (habitat score of 81).

This stream has been rated either Excellent or Good since first sampled for benthos in the spring of 1990. Summer collections in both 1995 and the latest in 2000 resulted in a bioclassification of Good. Rare taxa recorded from this site include *Rhithrogena, Nixe, Wormaldia,* and *Micrasema rusticum*.

Smith Creek SR 1710

Smith Creek, located southeast of Creedmoor, is a small sand bottom stream that is 4 - 8 m in width. The fish community habitat score for the site was 68. The land use surrounding the site is mostly forest with some agriculture

Upstream view of Smith Creek at SR 1710, Granville County.

Upstream view of Smith Creek at SR 1710, Granville County.

Eight benthos samples have been collected since 1984, with the majority of collections occurring in winter or spring and resulting in a rating of Good. The stream received a bioclassification of borderline Good in 2000 (one more EPT than required to receive a Good-Fair rating). The summer collections in 1991 and 1995 resulted in bioclassifications of Good and Good-Fair, respectively. The benthic community has remained basically the same reflecting no real change in water quality. However erosion from agricultural lands continued to have some effect on the benthic biota of the stream.

There was a slight decrease in the diversity and abundance of the fish community from 1995 to 2000 (Figure 17).

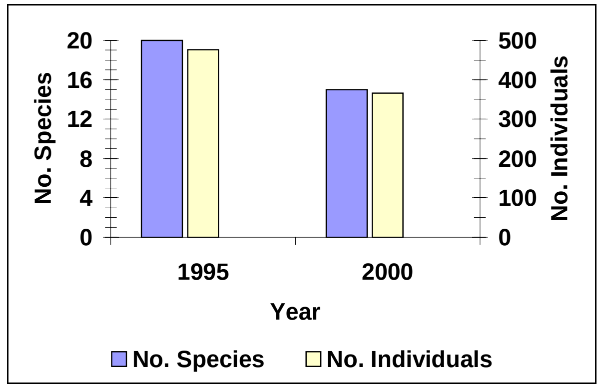


Figure 17. Number of species of fish and individuals at Smith Creek, SR 1710, Granville County.

While not collected in large numbers in 1995, two species of suckers and two species of piscivores were collected in 1995 and no individuals of either group were collected in 2000. These differences were enough to cause the NCIBI score and rating to drop slightly from 48 and Good, in 1995 to 44 and Good-Fair, in 2000. The white shiner and bluehead chub were the most abundant fish in both years.

Newlight Creek, SR 1912

This six meter wide, sandy bottom stream is located in northeastern Wake County. The stream here is heavily sedimented, with rocks that are 50 percent embedded in the sand. There is an agricultural field within 12 meters of the left bank. Instream habitat is sparse; there were few riffle areas and the stream banks were eroded.

Newlight Creek at SR 1912, Wake County

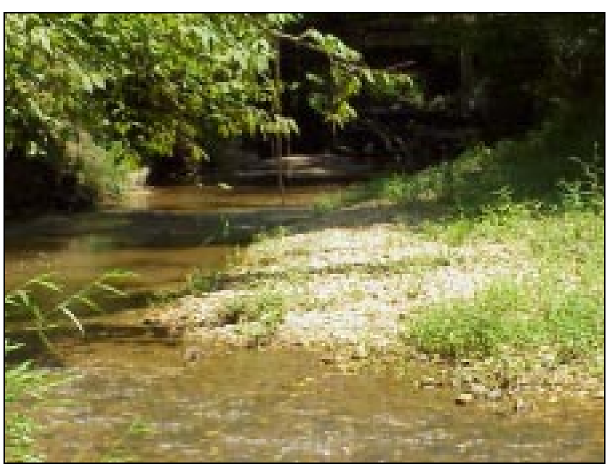
It was first sampled for benthos in the spring of 1995 resulting in a rating of Good-Fair. The latest collection rated the site Good. Although there were more EPT taxa collected in 1995, they were winter taxa and not included in the total for rating purposes.

Upper Barton Creek, NC 50

At this site, Upper Barton Creek is a small stream (eight meters wide) with a mixed substrate of sand, gravel, and rock outcrops. During fish community and benthos monitoring, the habitat scores were 76 and 84, respectively.

Upstream view of Upper Barton Creek at NC 50, Wake County.

During benthos sampling, the stream was turbid, although there had been no recent rain events. The substrate is becoming a predominate combination of sand and silt because the amount of development occurring in the watershed continues to increase. Noticeable habitat changes from previous years have included the riffles which are becoming embedded with sediment and the pools which are filling in with sediment.



Upper Barton Creek at NC 50, Wake County.

The number of EPT taxa in summer samples has continued to decrease since 1991 and the NCBI has increased, reflecting a more tolerant EPT community. The benthic community structure is changing, suggesting a long-term water quality decline since 1991: the reduction or loss of intolerant species such as *Isonychia, Nyctiophylax moestus* and *Pycnopsyche,* and increases in more tolerant taxa such as *Hydropsyche betteni, Baetis,* and *Caenis.*

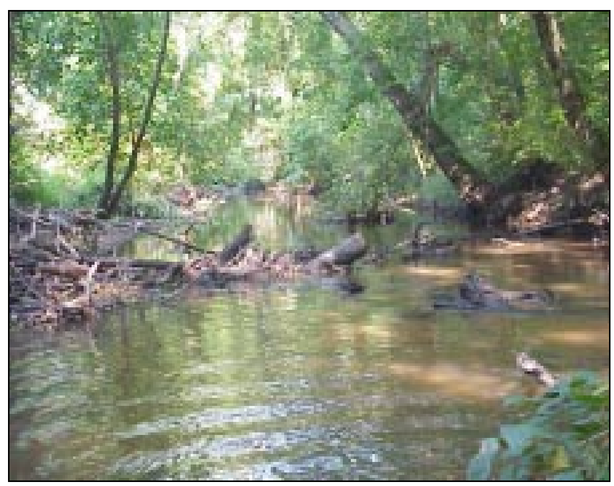
Although the fish community NCIBI rating was Good in 1995 and 2000, the NCIBI score increased from 48 in 1995 to 52 in 2000. This change was largely a response to more species of sunfish being collected in 2000 than in 1995. The most commonly collected fish in both years were the bluehead chub and white shiner.

SPECIAL STUDIES

303 (d) List Streams (NCDENR 2000)

1. Knap of Reeds Creek, below Butner WWTP

Since 1982, this site has been the subject of numerous NCDWQ studies to investigate the effects of the Butner WWTP on Knap of Reeds Creek The stream at this site is nine meters wide with a predominately sand substrate and no riffle areas.



Knap of Reeds Creek, below Butner WWTP, Granville County.

All benthos surveys conducted upstream of the discharge have resulted in a Fair rating. Up until 1991, all benthos surveys at this downstream site rated Poor.

Since 1991, after improvements at the WWTP, this site has consistently been rated Fair. There has been a marked increase in both EPT and Total taxa richness, and a decline in the Biotic Index. Reductions in such toxic/enrichment indicator taxa as *Cricotopus bicinctus*, *Chironomus,* and *Polypedilum illinoense*, suggested a real long-term improvement in water quality.

2. Ellerbe Creek, SR 1636

This site is located downstream of the Durham WWTP which has a permitted discharge of 20 MGD. Here, Ellerbe Creek is about 14 m wide with few riffles (one at the bridge). The remaining areas were deep with little flow. Instream habitat was sparse, and the substrate was nearly all sand.

This site has historically produced ratings of Poor, but in 2000 the site was rated Fair. A gradual increase in both EPT and Total taxa, as well as a decrease in NCBI has been seen here since the first benthos sample was collected in 1985. This is reflected in the decline in the presence of many tolerant aquatic worms and midges. Some relatively intolerant taxa were collected for the first time in 2000: *Hydroptila* and *Ironoquia punctatissima*.

3. Little Lick Creek, SR 1814

This small (four meter wide) stream just east of Durham is listed as impaired because of low concentrations of dissolved oxygen. This stream is also severely affected by urban runoff, especially after periods of high flow. The low habitat score of 45 reflected a stream with no riffle areas, severely eroded banks, a narrow riparian zone with breaks in the riparian zone common, and a substrate made up mostly of sand. The effluent from the Durham WWTP that previously discharged into this stream was relocated in 1995. However, this site still retains a Poor bioclassification.

4. Lick Creek, SR 1905

This small (3 -4 m) stream drains an urban area of Durham and is also listed as impaired. The habitat here is poor: no riffle areas, severe erosion, a deeply entrenched channel, no effective riparian zone, little instream habitat, and a substrate composed mostly of sand. Predictably, the habitat score was 44.

Both Little Lick Creek and Lick Creek have little or no flow during summer months, so collections were made in winter. The sparse fauna and high Biotic Index yielded a Fair rating in 1995 and 2000. The benthic fauna is dominated by low flow or enrichment indicator taxa such as *Caenis, Cricotopus bicinctus,* and *Asellus.*

Post Hurricane Fran

The Biological Assessment Unit conducted sampling to determine the amount of damage to North Carolina streams and rivers from Hurricane Fran which passed through the state in September, 1996. Sites from this subbasin included the Eno River at SR 1569, Orange County, the Flat River at SR 1614, Durham County, Upper Barton Creek at NC 50, Wake County, and Horse Creek SR 1923, Wake County (Biological Assessment Unit Memorandum B970117).

Eno River State Park

In 1998, fish community samples were collected from the Eno River at SR 1569 in Orange County and at SR 1003 in Durham County at the request of the state park personnel (Biological Assessment Unit Memorandum F980917). The primary purpose of the sampling effort was to inventory the fish species found in the river within the state park. Both sites were rated Excellent with the highest possible NCIBI score of 60 for each location. Twenty-one species were collected at SR 1569 and 24 species at SR 1003. Three intolerant species (pinewoods shiner, Neuse River darter, and Roanoke darter) were collected at both sites.

Lake Assessment

Lake Orange
Lake Orange, a water supply reservoir for the City of Hillsborough, is located on the East Fork Eno River (Figure 18). Approximately 30 to 45% of the shoreline is developed (residential). Private homes are located close to the lake along both arms. Public access to the lake is controlled and only fishing and boating are allowed.

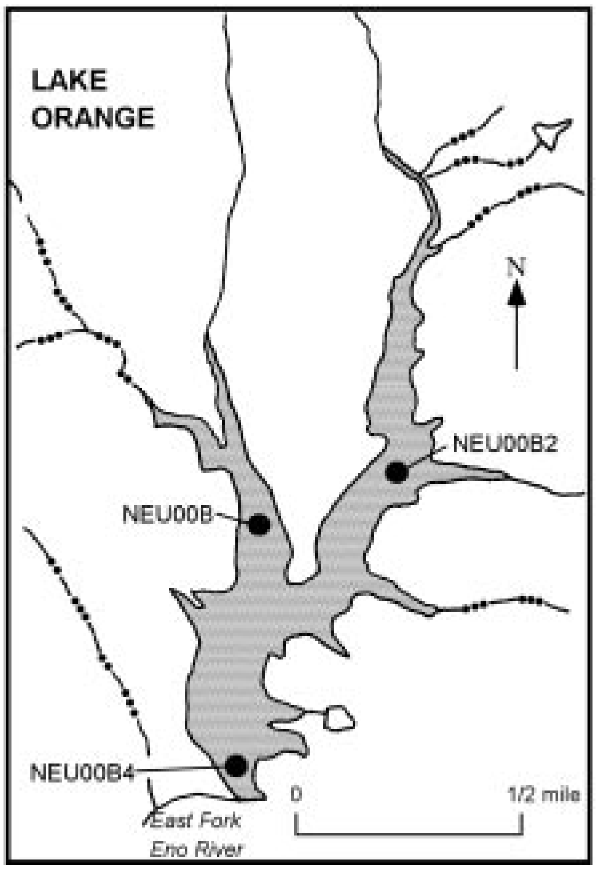


Figure 18. Monitoring sites at Lake Orange, Orange County.

The reservoir was most recently monitored in June and July 2000 (Table 10). Secchi depths in June were less than those observed in July, however mean Secchi depths were approximately 1 m on both sampling dates (Appendix L2). The greatest nitrogen concentrations in June and July were observed at Station NEU00B2 (Appendix L3). Surface metals were low, except for manganese (130 µg/L in June and 120 µg/L in July). These manganese concentrations, however, were less than the water quality standard of 200 µg/L for water supply lakes.

In 1995, the lake was also eutrophic. The mean chlorophyll *a* concentration was greater than the water quality standard of 40 µg/L. Water clarity, as determined by Secchi depth, was slightly greater in 1995 than in 2000. Better availability of light within the photic zone coupled with sufficient nutrients likely provided more favorable conditions for algal growth in 1995 than in 2000.

Data collected from 1988 through 2000 for three constituents of the NCTSI were summarized using box and whisker plots (Figure 19).

Table 10. Biological and water chemistry data for Lake Orange, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
07/18/2000	---	---	0.02	0.35	---	1.1
06/13/2000	---	---	0.05	0.35	---	1.0
08/14/1995	1.8	Eutrophic	0.04	0.37	56	1.5

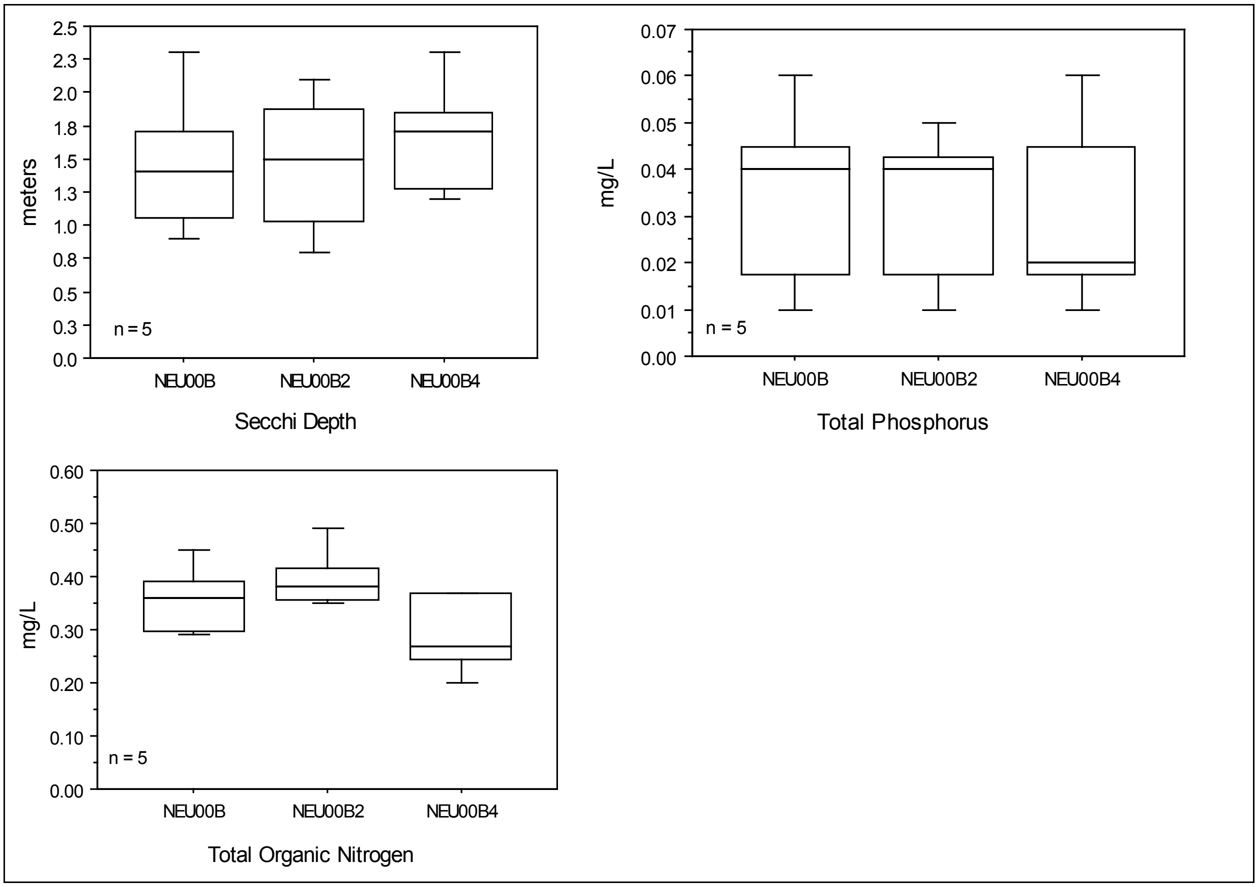


Figure 19. Spatial relationships among biological and water chemistry data from Lake Orange, 1988 – 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.

Corporation Lake

Corporation Lake is a water supply reservoir located on the Eno River downstream of Lake Orange (Figure 20). This lake was built in 1967 by the Orange-Alamance Water Authority. McGowan Creek is a major tributary to this reservoir. The watershed is composed of forested and agricultural areas with rolling topography.

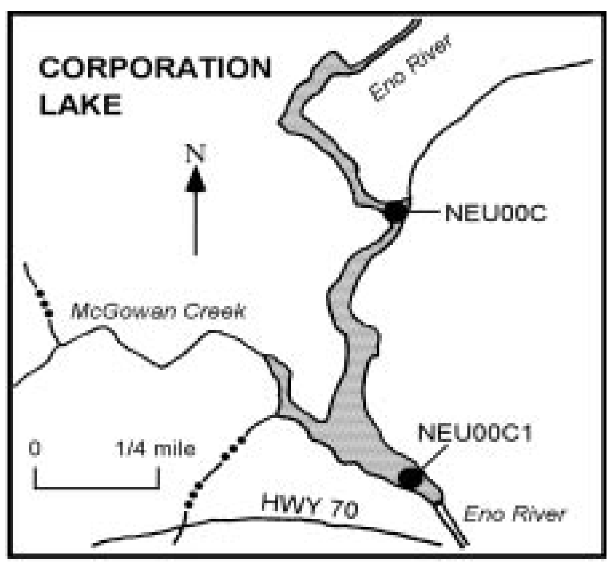


Figure 20. Monitoring sites at Corporation Lake, Orange County.

The reservoir was most recently monitored in June, July, and August, 2000 (Table 11). Total phosphorus was elevated during the sampling period with the greatest concentration (0.12 mg/L) at Station NEU00C1 (Appendix L3). Nitrogen concentrations were elevated in June and decreased by August. Secchi depths were less than 1 meter at both sites. As described in the field notes, this lake had a "muddy appearance". Suspended sediments may reduce light penetration in the water column. Manganese in June (380 µg/L) was greater than the water quality standard (200 µg/L) for a water supply reservoir.

In 1995, total organic nitrogen concentrations were much lower than the 2000 concentrations. The mean Secchi depth was slightly greater in 1995 than 2000. Increased nutrient loading in 2000 with an increase in chlorophyll *a* concentrations may warrant continued monitoring.

Data collected from 1988 through 2000 for three constituents of the NCTSI were summarized using box and whisker plots (Figure 21). Median values from 1988 through 2000 were relatively similar between the two sites.

Table 11. Biological and water chemistry data for Corporation Lake, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/09/2000	---	---	0.05	0.43	---	0.6
07/18/2000	---	---	0.05	0.31	---	0.6
06/26/2000	---	---	0.09	0.28	---	0.5
08/14/1995	-0.5	Mesotrophic	0.05	0.15	9	0.8

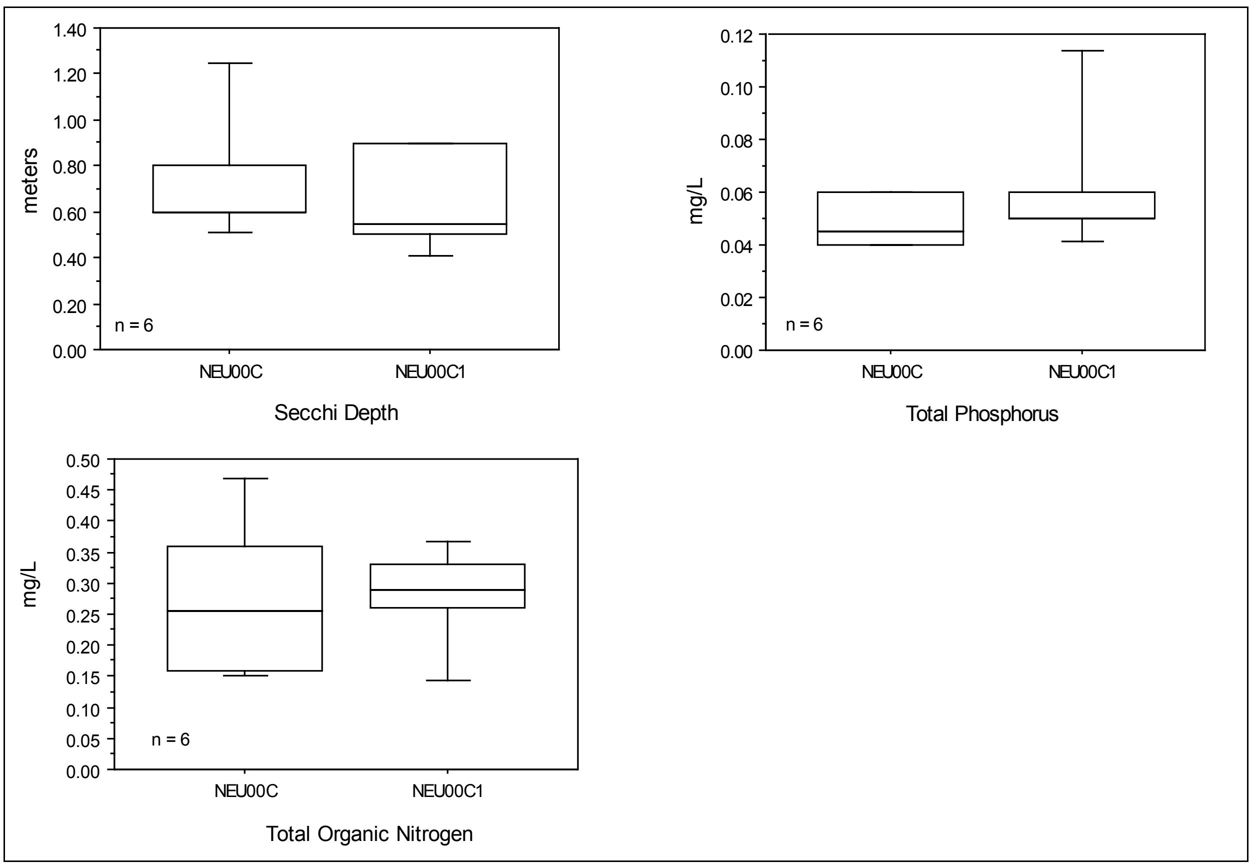


Figure 21. Spatial relationships among biological and water chemistry data from Corporation Lake, 1988 – 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.

Lake Ben Johnson
Lake Ben Johnson is formed by a run-of-the-river dam on the Eno River downstream of Corporation Lake (Figure 22). The reservoir's watershed consists of agricultural, urban, and forested areas. The City of Hillsborough owns the lake and uses it as a back-up water supply source.

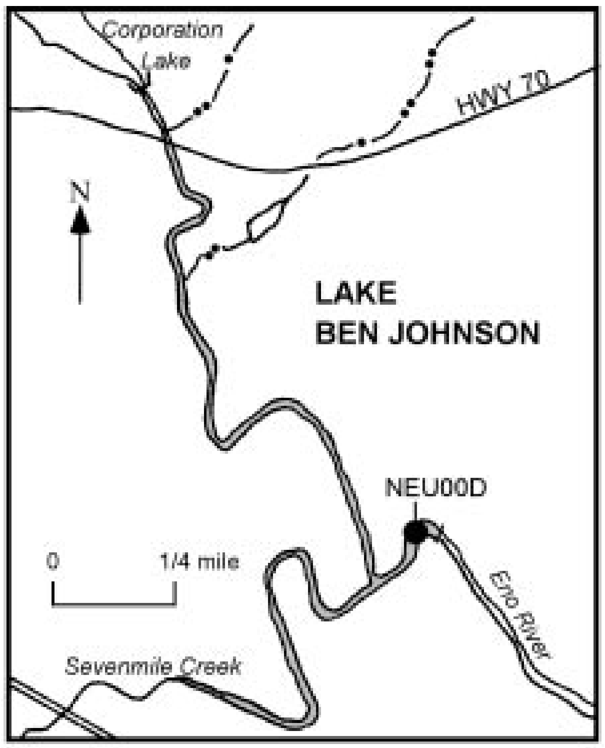


Figure 22. Monitoring sites at Lake Ben Johnson, Orange County.

The reservoir was most recently monitored in June and August, 2000 (Table 12). Secchi depths were less than 1 m on each sampling date. Due to an error in sample collection, no nutrient data were obtained for July. Total phosphorus was elevated with concentrations ranging from 0.04 mg/L in June to 0.12 mg/L in August. Nitrite plus nitrate was also elevated (range = 0.3 - 0.16 mg/L). Manganese concentrations in June (290 µg/L) and July (220 µg/L) were greater than the water quality standard of 200 µg/L for water supplies. The presence of manganese at these levels may have been due to low dissolved oxygen near the bottom of the lake which contributed to the movement of the metal from the sediment into the water column.

In 1995, nutrient values were elevated and the concentration of chlorophyll *a* was 17 µg/L. As compared with 1995 and previous sampling dates in 1991 and 1988, nutrient concentrations were greater in 2000. The increase in nutrient loading suggests a potential concern for the water quality of this lake.

Table 12. Biological and water chemistry data for Lake Ben Johnson, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/09/2000	---	---	0.12	0.28	---	0.6
07/18/2000	---	---	**no data**	**no data**	---	0.9
06/26/2000	---	---	0.04	0.40	---	0.6
08/14/1995	2.1	Eutrophic	0.05	0.56	17	1.1

Little River Reservoir

Little River Reservoir is a water supply for the City of Durham. Completed in 1988, this reservoir has a retention time of 74 days. The watershed consists of agricultural, forested and residential areas. Mountain Creek, Buffalo Creek, North Fork and South Fork Little River are the major tributaries (Figure 22).

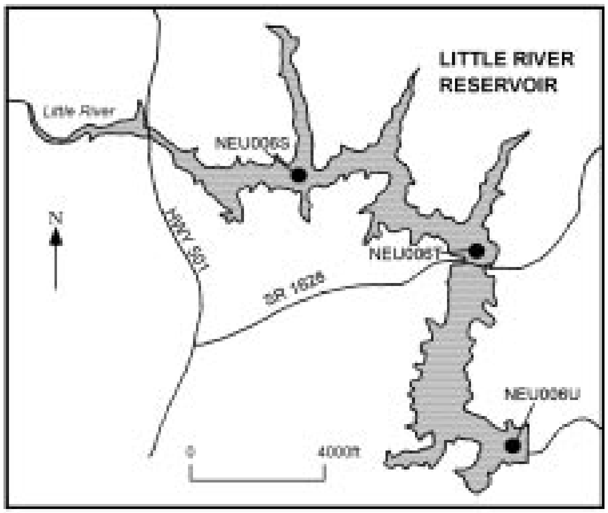


Figure 23. Monitoring sites at Little River Reservoir, Durham County.

The reservoir was most recently monitored in June and August, 2000 (Table 13). Sampling was not conducted in July due to rain. In June, this reservoir was stratified with surface dissolved oxygen ranging from 9.4 to 11.2 mg/L. Dissolved oxygen concentrations decreased to less than 1.0 mg/L at a depth of 8 m at the mid-lake site (depth to bottom was 14.9 meters). Surface pH values were also elevated, range = 8.4 - 8.9 s.u. Field notes indicated that the water was green. This observation along with the elevated surface dissolved oxygen and pH values suggested an algae bloom was occurring.

The mean total phosphorus (02 mg/L) was low while the mean concentrations for total organic nitrogen (0.49 mg/L), total Kjeldahl nitrogen (0.5 mg/L), and ammonia (0.04 mg/L) were elevated. Metals were generally below laboratory detection levels, except for manganese (99 µg/L), which was less than the water quality standard of 200 µg/L for a water supply reservoir.

In August, mean nitrogen concentrations were lower than those observed in June, while the mean total phosphorus concentrations were similar. Surface dissolved oxygen (range = 6.0 - 7.1 mg/L) and pH values (range = 6.8 - 7.0 s.u.) were also lower in August as compared with June. These changes may have been the result in a shift in the composition of the algae community and/or the beginning of a decline of the bloom suspected in June.

Little River Reservoir was previously monitored by the NCDWQ in 1995 - 1997. In 1997, nutrient concentrations generally ranged from low to moderate. In August, 1997, the surface dissolved oxygen at NEU006T (3.8 mg/L) was lower than the state water quality standard of 4.0 mg/L for an instantaneous reading. In 1996, nutrient concentrations were lower than those observed in 1997. In 1995, this lake was eutrophic. Secchi depths were less than a meter at each of the lake sampling sites. Total organic nitrogen concentrations were elevated and concentrations of total phosphorus were moderate.

Data collected from 1988 through 2000 for three constituents of the NCTSI were summarized using box and whisker plots (Figure 24). Median total phosphorus was generally greater at the most upstream site as compared with the mid-lake and near dam sites. Median total organic nitrogen concentrations were greater at the site near the dam and median Secchi depths were similar at all sites.

Table 13. Biological and water chemistry data for Little River Reservoir, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/14/2000	---	---	0.02	0.39	---	1.0
06/14/2000	---	---	0.02	0.49	---	1.1
09/17/1997	---	---	0.03	0.34	---	0.9
07/15/1997	---	---	0.03	0.31	---	1.1
06/12/1997	---	---	0.06	0.30	---	1.0
08/16/1996	---	---	0.01	0.46	---	1.2
07/18/1996	---	---	0.01	0.26	---	1.1
06/20/1996	---	---	0.03	0.33	---	1.3
08/21/1995	0.9	Eutrophic	0.04	0.43	7	0.8

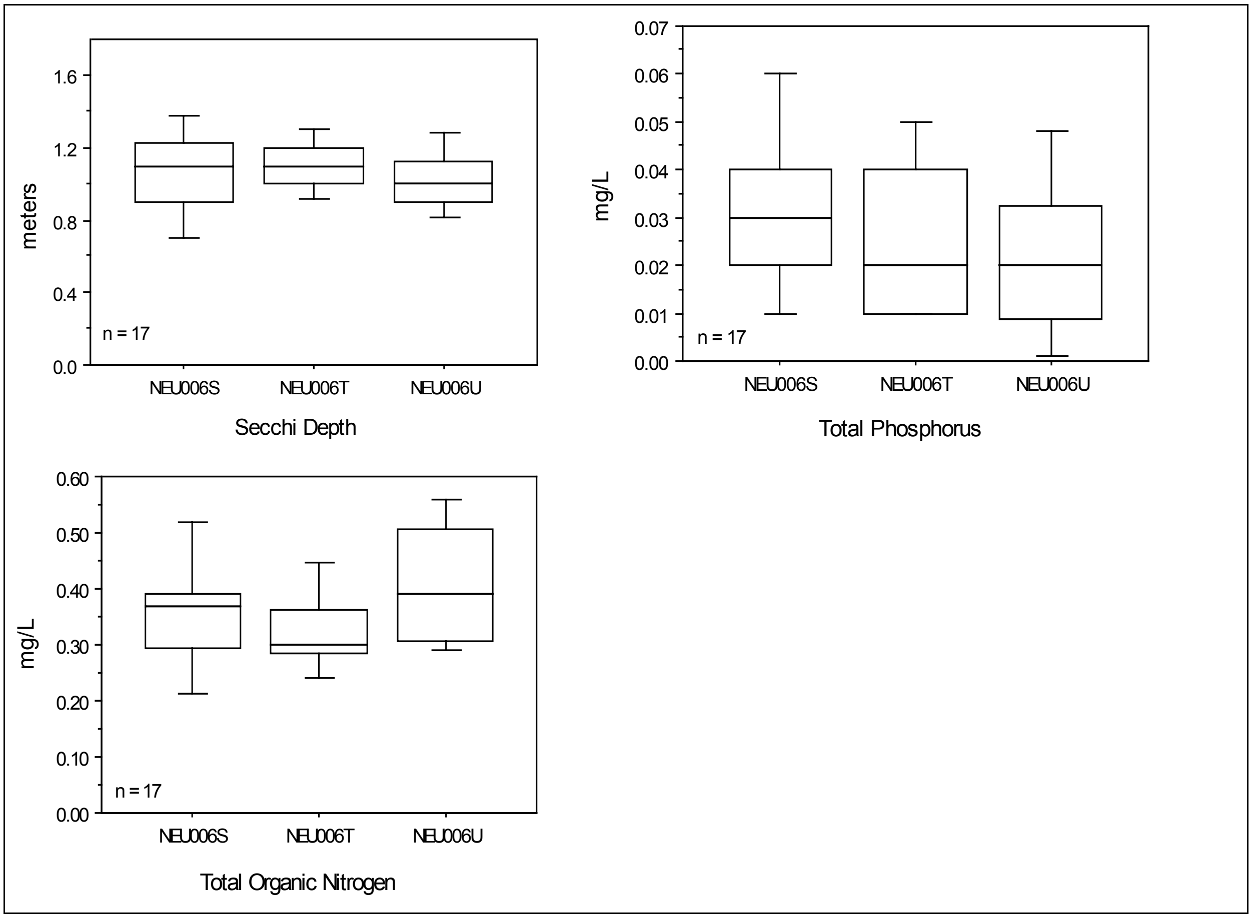


Figure 24. Spatial relationships among biological and water chemistry data from Little River Reservoir, 1988 – 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.

Falls of The Neuse Reservoir

Falls of the Neuse Reservoir is located near the origin of the Neuse River in Durham, Granville and Wake counties (Figure 25). This reservoir was constructed by the US Army Corps of Engineers and filled in 1988. This multi-purpose reservoir provides flood control, recreational opportunities, and serves as the City of Raleigh's primary water supply.

The watershed, which consists of agricultural, forested and urban areas, is rapidly developing. Major tributaries include the Eno, Flat and Little Rivers, Knap of Reeds, Ellerbe, Ledge, Lick, Little Lick, and Beaverdam Creeks. The lake is wide and shallow upstream of NC 50 and becomes narrower and deeper below the highway.

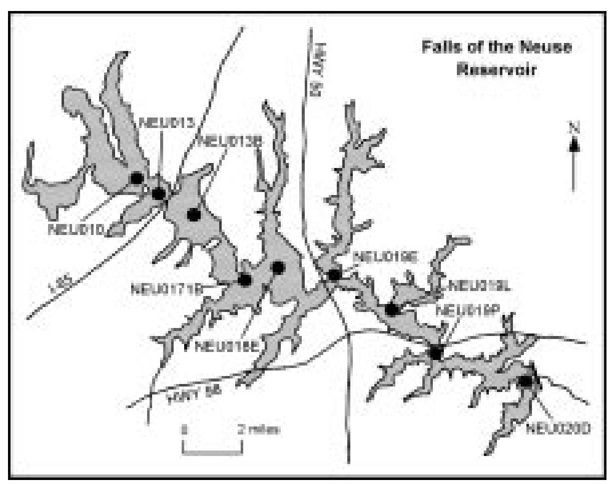


Figure 25. Monitoring sites at Falls of the Neuse Reservoir, Wake, Granville Durham Counties.

The reservoir was most recently monitored in June, August, and September, 2000 (Table 14). On June 7, Secchi depths at 5 of the 6 sites were less than 1 m (Appendix L2) and field notes described the upper end of the reservoir as "muddy". Total phosphorus and turbidity values were also greater at the upper end of the reservoir, suggesting a sediment load was entering this lake from the Neuse River.

Nutrient concentrations were sufficient for supporting increased algal productivity. Fecal coliform bacteria concentrations were less than 10 colonies/100 ml at all the sampling sites except Station NEU010, where a concentration of 45 colonies/100 ml was observed.

Similarly, in August, Secchi depths were less than 1 m at 4 of the 5 sites. Turbidity and total phosphorus values were greater at Station NEU010 and decreased downstream toward the dam (Appendix L3). Total Kjeldahl nitrogen and total organic nitrogen were at elevated concentrations. Fecal coliform bacteria concentrations were less than 10 colonies/100 ml in August.

On September 28, surface dissolved oxygen concentrations from mid-reservoir downstream to the dam were very low (range = 3.4 - 5.9 mg/L). The lowest concentration was observed at Station NEU019L and was less than the water quality standard of 4.0 mg/L for an instantaneous reading. The lack of dissolved oxygen and temperature stratification suggested that the water column had turned over as a result of previous colder weather conditions. This natural event brought anoxic bottom water up towards the surface, which contributed to lowering of dissolved oxygen concentrations throughout the entire water column of the mid and lower portions of the lake. The upper end of the lake did not demonstrate these characteristics. As with the lower end of the reservoir, the upper end did not exhibit dissolved oxygen or temperature stratification.

Secchi depths on September 28 were less than 1 m at all sites except the site near the dam (1.1 m). Although total phosphorus concentrations were less than those observed in August, the same upstream to downstream gradient was observed, with values at the upper end of the reservoir greater than those at the lower end. The concentration of ammonia at Station NEU019P (0.16 mg/L) was elevated.

Based on the NCTSI scores, the reservoir was eutrophic in 2000. This reservoir receives nutrients from the Neuse River and its tributaries at concentrations suitable for supporting nuisance algae blooms during the summer months. Sediment entering the upper end of the reservoir decreases water clarity and gives the reservoir a "muddy" appearance.

The reservoir was previously sampled in the summer of 1997, 1996 and 1995. Nutrient concentrations were similar to those observed in 2000 and Secchi depths were generally less than 1 m, which indicated poor water clarity. Based on the NCTSI scores, the reservoir was consistently rated eutrophic in 1995.

Table 14. Biological and water chemistry data for Falls of the Neuse Reservoir, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
09/29/2000	---	---	0.04	0.38	---	0.7
08/23/2000	---	---	0.05	0.54	---	0.7
06/07/2000	---	---	0.02	0.42	---	0.6
09/16/1997	---	---	0.03	0.40	---	0.7
08/25/1997	---	---	0.06	0.46	---	0.7
07/14/1997	---	---	0.06	0.42	---	0.7
06/26/1997	---	---	0.06	0.27	---	0.8
07/10/1996	---	---	0.06	0.29	---	0.9
06/25/1996	---	---	0.05	0.32	---	0.8
09/25/1995	2.2	Eutrophic	0.05	0.51	9	0.5
08/31/1995	2.7	Eutrophic	0.05	0.61	10	0.5
07/31/1995	1.8	Eutrophic	0.06	0.43	7	0.6
06/28/1995	1.7	Eutrophic	0.06	0.38	10	0.6

Data collected from 1988 through 2000 for three constituents of the NCTSI were summarized using box and whisker plots (Figure 26). Median Secchi depths demonstrated a typical reservoir phenomenon: a longitudinal increase from the upper to the lower end of the reservoir. Median total phosphorus presented an opposite trend with concentrations decreasing from the upper to the lower end of the reservoir. Median total organic nitrogen seemed to increase from Station NEU010 to Station NEU013, then gradually decreased towards the dam. The increase in median total phosphorus and total organic nitrogen suggested the possibility of nutrient loading from Ellerbe Creek, which enters the reservoir at this site.

In 1999, the City of Raleigh funded a water quality study of the lower reach of the reservoir downstream of NC 50. The chemical quality of this region was very good with no pesticides and extractable or volatile organic compounds; and very few trace metals had concentrations greater than detection limits. Chlorophyll a concentrations were not greater than the water quality standard. Algal biomass, however, was found to range from moderate to high and was dominated by nuisance blue green algae (SDES 1999).

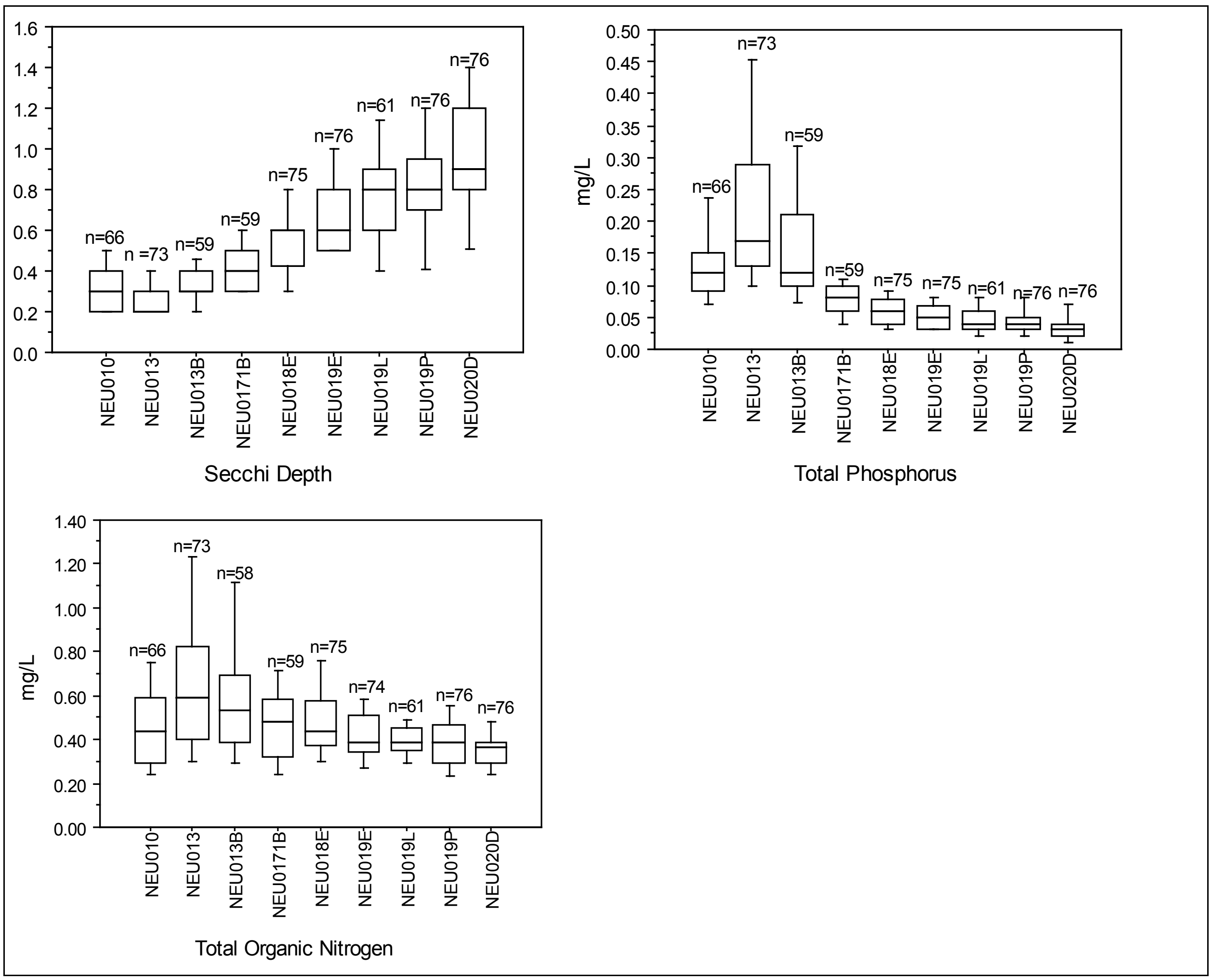


Figure 26. Spatial relationships among biological and water chemistry data from Falls of the Neuse Reservoir, 1981 – 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.

Lake Michie

Constructed in 1926, Lake Michie serves as a water supply for the City of Durham. This reservoir is an impoundment of the Flat River in northeastern Durham County (Figure 27). The watershed consists of primarily forested and agricultural areas with some residential development. Lake Michie flows into the Falls of the Neuse Reservoir.

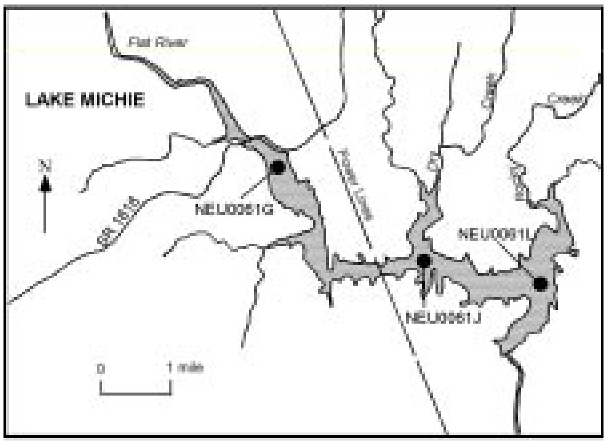


Figure 27. Monitoring sites at Lake Michie, Durham County.

The lake was most recently monitored in June and August, 2000 (Table 15). Secchi depths in June were greater than 1 m while depths recorded in August were less than 1 m at all sites. Total phosphorus concentrations were generally the same in June and August while ammonia and nitrite plus nitrate decreased in August as compared with June (Appendix L3). Surface dissolved oxygen and pH values were also greater in June as compared with August (Appendix L2). These data suggested an algae bloom was occurring in June with either a shift in the algae species composition in August or the beginning of a decline in the growth rate. Surface metals were either low or less than laboratory detection levels.

The lake was previously monitored in 1995. Mean total phosphorus was moderate to elevated while mean total organic nitrogen was elevated.

Data collected from 1988 through 2000 for three of the NCTSI were summarized using box and whisker plots (Figure 28). Median Secchi depth increased from upstream to downstream while the median concentrations of total phosphorus and total organic nitrogen were greater at the upstream lake sampling sites as compared with the sites further down reservoir.

Table 15. Biological and water chemistry data for Lake Michie, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/14/2000	---	---	0.02	0.46	---	0.7
06/14/2000	---	---	0.02	0.34	---	1.6
08/21/1995	0.9	Eutrophic	0.04	0.46	6	1.3

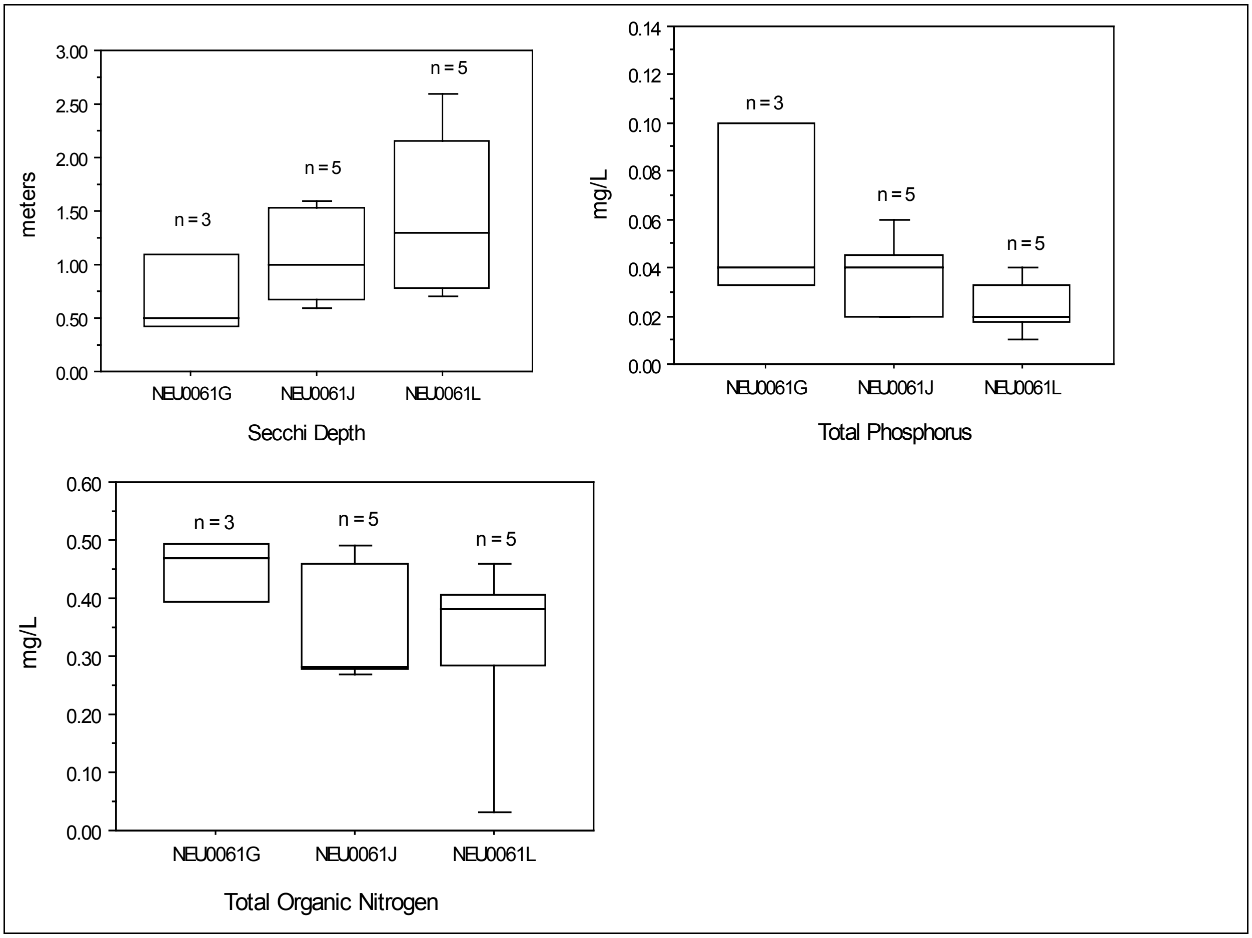


Figure 28. **Spatial relationships among biological and water chemistry data from Lake Michie, 1988 – 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.**

Lake Butner

Lake Butner is located on Knap of Reeds Creek in Granville County (Figure 29). The Town of Butner uses this lake for recreation and as a water supply. The watershed is characterized by rolling topography composed of farmland and forests.

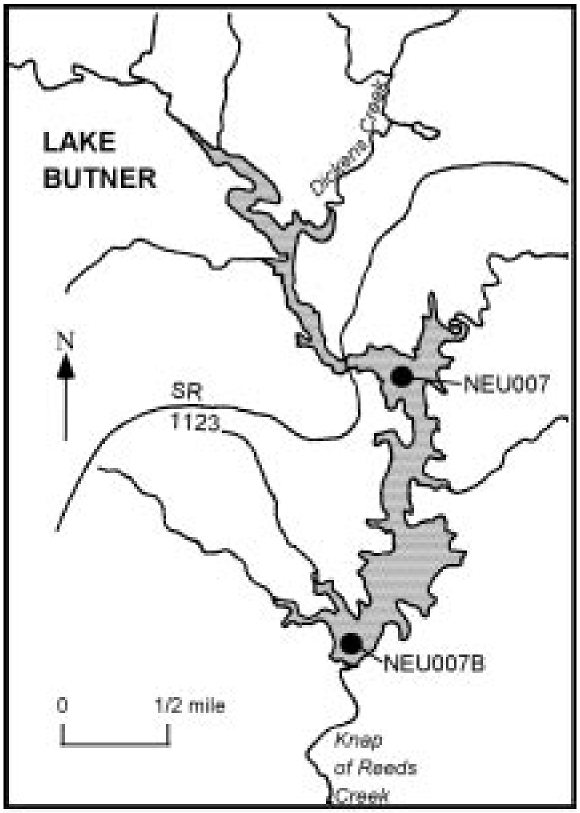


Figure 29. Monitoring sites at Lake Butner, Granville County.

The lake was most recently monitored in July and August, 2000 (Table 16). Mean Secchi depths were the same for both sampling dates. Total phosphorus was the same at both lake sampling sites in July and August with an overall decrease in concentration in August (Appendix L3). Total Kjeldahl nitrogen and nitrite plus nitrate mean concentrations were the same in July and August, while the mean ammonia concentration decreased from 0.07 to 0.02 mg/L from July to August. The lake was stratified on both sampling dates with hypoxic conditions occurring at a depth of 3 to 4 m from the surface. Surface metals were low or less than the laboratory detection limits.

The lake was previously monitored in 1995. Both sites were stratified with hypoxic conditions observed at a depth of three meters from the surface. Nutrient concentrations were generally low with the exception of total Kjeldahl nitrogen which was elevated (0.5 mg/L at both sites).

Data collected from 1988 through 2000 for three constituents of the NCTSI were summarized using box and whisker plots (Figure 30). Median values for all four parameters were similar between the two sites.

Table 16. Biological and water chemistry data for Lake Butner, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/14/2000	---	---	0.01	0.33	---	1.9
07/20/2000	---	---	0.02	0.33	---	1.9
08/17/1995	-0.6	Mesotrophic	0.02	0.50	6	1.3

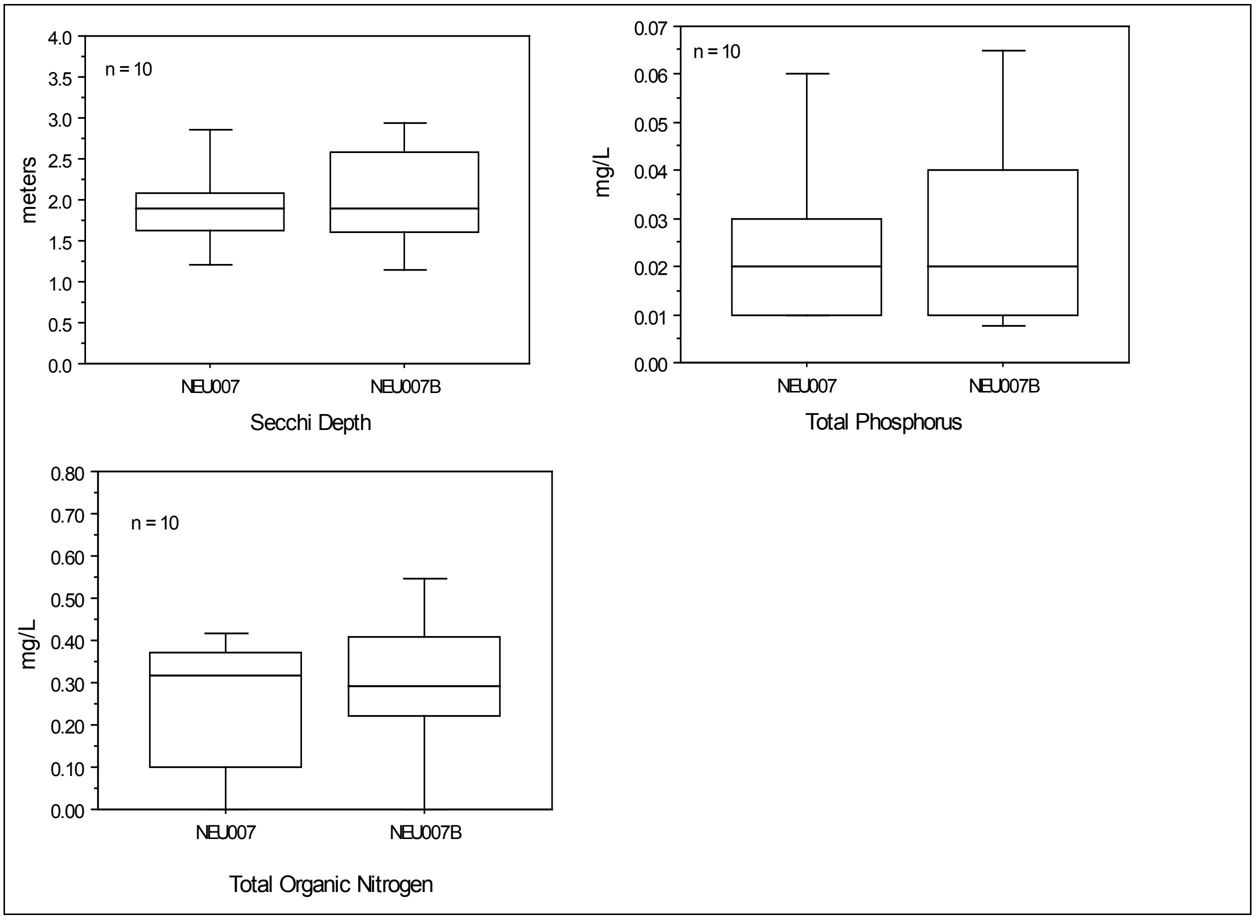


Figure 30. **Spatial relationships among biological and water chemistry data from Lake Butner, 1988 – 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.**

Lake Rogers

Lake Rogers is a shallow water supply source for the Town of Creedmoor. The reservoir was built in 1939. Tributaries to the lake include Ledge Creek and Holman Creek (Figure 31). The watershed consists of forested areas as well as some residential, agricultural, and wetland areas. Problematic aquatic weeds, including *Hydrilla*, have been identified in the reservoir and grass carp have been used for biological control.

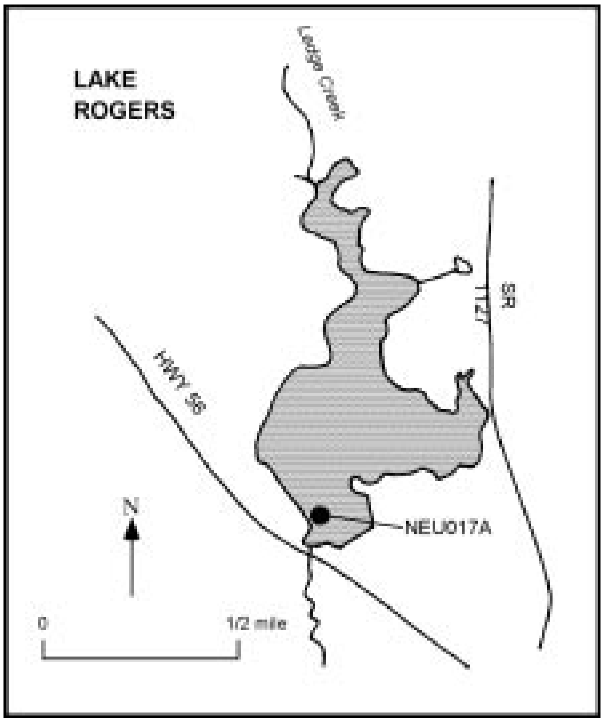


Figure 31. Monitoring sites at Lake Rogers, Granville County.

The lake was most recently monitored in July and August, 2000 (Table 17). Secchi depth was very shallow in July (0.2 m) and nutrient concentrations, with the exception of nitrite plus nitrate, were elevated (Appendix L3). Surface dissolved oxygen was 5.7 mg/L and decreased to 4.5 mg/L near the bottom of the lake, at a depth of two meters. Metals were less than laboratory detection levels, except for manganese (620 µg/L) which was greater than the water quality standard for a water supply reservoir (200 µg/L).

In August, nutrient concentrations were lower than those observed in July, but still at elevated levels. The Secchi depth was slightly improved from July (0.5 meter). Surface dissolved oxygen was 5.4 mg/L and decreased to 4.5 mg/L near the bottom of the lake (depth to bottom = 1.7 m). Surface pH was near neutral (7.1 s.u.).

The lake was previously monitored by the NCDWQ in 1995. Nutrient concentrations were elevated, however, the chlorophyll *a* concentration was much lower than what was observed in 2000. The surface dissolved oxygen value of 4.9 mg/L was greater than the water quality standard of 4.0 mg/L for an instantaneous reading.

Table 17. Biological and water chemistry data for Lake Rogers, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/14/2000	---	---	0.05	0.52	---	0.5
07/20/2000	---	---	0.08	0.71	---	0.2
08/17/1995	4.7	Eutrophic	0.10	0.85	14	0.3

Phytoplankton Monitoring

Falls of the Neuse Reservoir -- Special Study

The phytoplankton assemblage was assessed twice in 1996 (June and July) and five times in 1997 (May through September). The sites were located at the upper (Station J1370000) and lower (Station J1727000) ends of the lake. The upper end of the lake consistently showed poor water quality as indicated by the number of algal blooms (n = 7). Water quality usually improved by the time it reached the lower end of the lake as indicated by the fewer number of blooms (three total).

In June and July of 1996, the blooms in the upper end of the lake were dominated by the filamentous blue green *Oscillatoria* and the golden flagellate *Chrysochromulina*.

In May and June of 1997, the algal assemblages included a diverse group of blue greens, greens, diatoms and golden flagellates. However, later that year, from July to September, the assemblages reverted back to a predominance of the same two genera found in 1996, *Oscillatoria* and *Chrysochromulina*. Many of the taxa encountered in the blooms, such as *Oscillatoria*, *Lyngbya*, *Trachelomonas* and *Dictyosphaerium,* are indicators of eutrophic conditions. Some of these taxa are also known to cause taste and odor problems in treated drinking water.

NEUSE RIVER SUBBASIN 02

Description

This subbasin contains the most urbanized areas in the entire basin, including the greater Raleigh metropolitan area (Figure 32). Significant tributaries to the Neuse River in this subbasin are Crabtree Creek, Walnut Creek (including Lakes Johnson and Raleigh) and Swift Creek (including Lakes Wheeler and Benson).

This subbasin contains primarily piedmont streams. The piedmont section is subdivided into two geologic areas: the headwaters of Crabtree Creek lie within the Raleigh Belt and most of the middle section lies within the Eastern Slate Belt. Smaller streams in these two geological areas have a tendency to dry up under low flow conditions. A small portion of the inner coastal plain can be found east of Clayton.

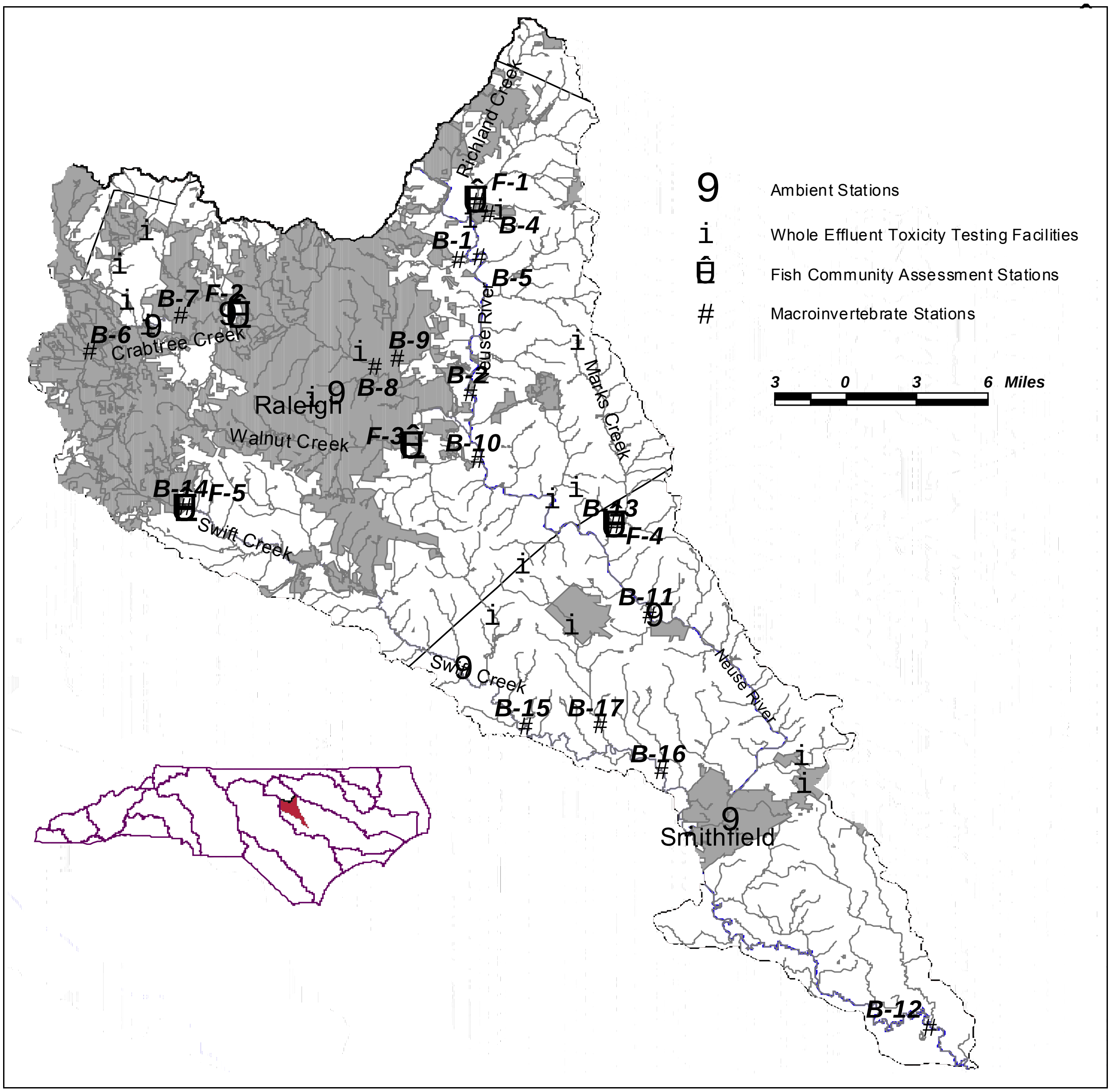


Figure 32. **Sampling sites in Subbasin 02 in the Neuse River basin.**

Overview of Water Quality

Benthos data collected from 85 sites in this subbasin suggested severe water quality problems (Appendix B2). Since 1995, 61% of the streams were rated either Poor or Fair, 29% were Good-Fair, and 10% were Good (Table 18). Water quality seemed stable, because these percentages were almost identical to the percentages in 1995. Of the 24 streams sampled for benthos in 2000 that had been previously sampled in 1995 or 1996, 20 (83%) showed no change in water quality between years. Of the four remaining stations, two -- Walnut Creek and Neuse River at NC 42, showed improved water quality from 1995 to 2000, while Smith Creek and Hare Snipe Creek had declining water quality.

Fish community sampling, however, suggested high and improved water quality in this subbasin. All four stations collected for fish in both 1995 and 2000 showed improvements of one or more bioclasses. Additionally, none of the five sites sampled in 2000 indicated water quality problems (Poor or Fair ratings) while three of the five samples indicated Excellent water quality.

Nonpoint runoff from both urban areas (stormwater and suspended sediments) and agricultural areas are the main contributors to water quality degradation. There are 49 permitted dischargers in this subbasin. Most dischargers are small. However, there are six facilities whose permitted discharge is more than 1.5 MGD. Four of the six, Johnston County WWTP (4.5 MGD), Raleigh WWTP (60 MGD), Riverplace II (5MGD) and Wake Forest WWTP (2.4 MGD), discharge into the Neuse River. Clayton WWTP (1.9 MGD) discharges into Little Creek and Cary WWTP (12 MGD) discharges to Crabtree Creek.

Table 18. Waterbodies monitored in Subbasin 02 in the Neuse River basin for basinwide assessment, 1995 - 2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Neuse R[2]	Wake	US 401	Good-Fair	Good-Fair
B-2	Neuse R[2]	Wake	US 64	Good-Fair	Good-Fair
B-3	Smith Cr[2]	Wake	SR 2045	Good-Fair	Fair
B-4	Toms Cr[2]	Wake	SR 2044	Fair	Fair
B-5	Perry Cr	Wake	SR 2006	Fair	Fair
B-6	Crabtree Cr[2]	Wake	NC 54	Poor	Poor
B-7	Crabtree Cr[2]	Wake	Umstead Park	Good-Fair	Good-Fair
B-8	Crabtree Cr[2]	Wake	US 1	Fair	Fair
B-9	Marsh Cr[2]	Wake	near US 1	Fair	Poor
B-10	Walnut Cr[2]	Wake	SR 2551	Fair	Good-Fair
B-11	Neuse R[2]	Johnston	NC 42	Good-Fair	Good
B-12	Neuse R[2]	Johnston	SR1201	Good	Good
B-13	Marks Cr[2]	Johnston	SR 1714	Good-Fair	Good-Fair
B-14	Swift Cr[2]	Wake	SR 1152	Fair	Fair
B-15	Swift Cr	Johnston	SR 1555	Good-Fair	Good-Fair
B-16	Swift Cr[2]	Johnston	SR 1501	Good	Good
B-17	Little Cr[2]	Johnston	SR 1562	Fair	Fair
F-1	Smith Cr	Wake	SR 2045	Good-Fair	Excellent
F-2	Crabtree Cr	Wake	SR 1664	---	Excellent
F-3	Walnut Cr[2]	Wake	SR 2544	Fair	Good-Fair
F-4	Marks Cr[2]	Johnston	SR 1714	Good	Excellent
F-5	Swift Cr	Wake	SR 1152	Poor	Fair/Good-Fair
	Lake Crabtree	Wake		Eutrophic	---
	Reedy Creek Lake	Wake		Eutrophic	---
	Big Lake	Wake		Eutrophic	---
	Sycamore Lake	Wake		Eutrophic	---
	Apex Lake	Wake		Eutrophic	---
	Lake Wheeler	Wake		Eutrophic	---
	Lake Benson	Wake		Eutrophic	---

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available before 1995, refer to Appendix B2 or Appendix F3.

Aquatic toxicity data (self-monitoring) of the 35 facilities in this subbasin required to perform whole effluent toxicity testing showed substantial improvements over a 10 year period. Most facilities showed some test failures during 1988 - 1992, but over 90 percent of the facilities have passed toxicity tests since 1995. The largest facility to have problems with toxicity is the Cary WWTP, which is currently undertaking a Toxicity Reduction Evaluation to determine the source of the toxicity. Two other, smaller, dischargers have also had toxicity problems in 2000. Phillips Pipeline has failed 4 of the 5 toxicity tests it has performed, including its only test in 2000. RDU Airport discharge No. 2 has only failed 3 of 11 tests, however, 2 of the 3 failures occurred in 2000.

Infestations of *Hydrilla verticillata* have been recorded in most of the lakes in this subbasin. It was present at nuisance levels in Reedy Creek Lake, Big Lake, Sycamore Lake, and Lake Raleigh. In 2000, it also was documented in Crabtree Creek at NC 54. Because of these nuisance growths, these four lakes were evaluated as only Partially Supporting their designated uses. Spraying with herbicides and/or lake drawdown achieved only temporary control in some areas, but stocking with grass carp has been effective in controlling *Hydrilla* in Lake Wheeler and Lake Benson. During the past five years, only a single algal bloom has been confirmed. In 1999, a bloom of blue-green algae, indicators of eutrophic conditions, was documented in Lake Crabtree.

Seven of the 11 lakes in this subbasin were monitored in 2000, all were classified as eutrophic in 1995. Lake Crabtree, Lake Benson and Sycamore Lake were unchanged from 1995. Big Lake, Apex Reservoir, and Lake Wheeler had concentrations of total organic nitrogen in 2000 greater than in 1995. Reedy Creek Lake showed some improvement, with total phosphorus concentrations in 2000 less than 0.01 mg/L (0.04 mg/L in 1995).

This subbasin is a major source of many pollutants to the Neuse River. The highest turbidity in the basin was found in Crabtree Creek, likely due to development. Swift Creek also had elevated turbidity from development in Cary, south Raleigh and rapidly urbanizing Johnston County. Specific conductance was high in Crabtree Creek, however Pigeonhouse Branch, which drains downtown Raleigh, had the highest specific conductance in the freshwater portion of the basin. Pigeonhouse Branch also had the highest nitrate+nitrite-nitrogen concentrations in the subbasin. The Neuse River mainstem showed a spike in nitrate+nitrite-nitrogen below Raleigh which then declined with distance downstream. Total phosphorus was high in much of Crabtree Creek as was ammonia-nitrogen (median > 0.15mg/L for both nutrients). The Neuse River mainstem showed peak ammonia-nitrogen concentrations just below Falls Lake, with levels declining with distance downstream.

The entire Neuse River was declared Nutrient Sensitive Waters in 1988 and a statewide phosphate detergent ban went into effect. Macroinvertebrate data from one site (the Neuse River near Clayton) suggested that these new restrictions and other management strategies have improved water quality up to 1991. Improvements also were observed for the Neuse River at US 64 (Raleigh) from 1986 - 1995. The Neuse River in Johnston County (NC 42 and SR 1201) was assigned a Good bioclassification in 2000 based on macroinvertebrate collections.

River and Stream Assessment

Antecedent flows have been relatively similar during the last three years this subbasin has been assessed (1991, 1995, and 2000). In all three years, flows from January through May were normal or below normal. In June and July of 1991 and 1995, the period just before and during benthos sampling, were periods of high flow when water quality problems from nonpoint sources were magnified and point sources were reduced. In 2000, high flows did not start until mid-July, so while most sites were sampled for benthos during a high flow period, like previous years (Figure 33), sites in northern and western Wake County (the Neuse River at US 401, Smith Creek, Toms Creek, Perry Creek, upper Crabtree Creek and Swift Creek) were sampled under low flow conditions.

These differing flow conditions must be taken into account in trying to ascribe cause to changes in the benthic macroinvertebrate community noted at any of the sites sampled under different flow regimes.

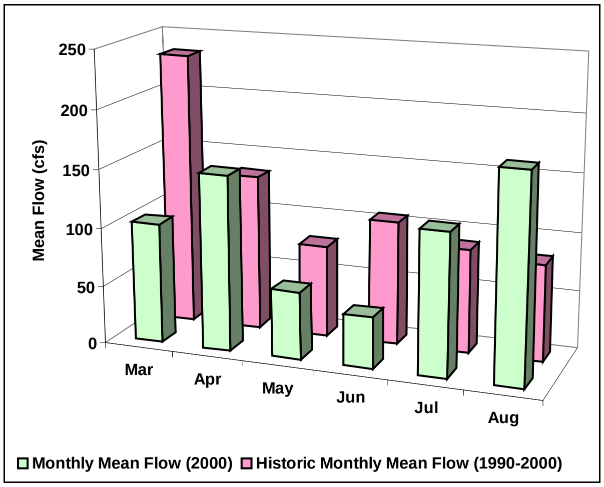


Figure 33. Spring and summer monthly mean flow and historic monthly mean flow at Crabtree Creek at US 1, Wake County.

Neuse River, US 401

The Neuse River at US 401 is 40 meters wide with a sandy substrate.

Downstream view of the Neuse River at US 401, Wake County.

Water quality has been stable at Good-Fair over the seven times it has been sampled for benthos since 1983. There is some indication that water quality is improving slowly here over the last decade, evidenced by the declining biotic index and increasing EPT abundance at this site since 1989 (Figure 34).

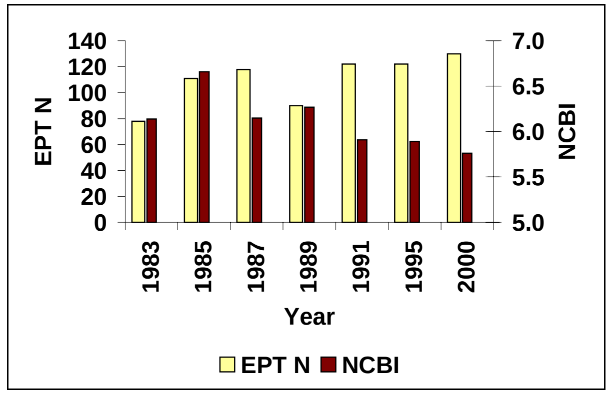


Figure 34. EPT abundance (EPT N) and biotic index (NCBI) at the Neuse River at US 401, Wake County, 1983 - 2000.

Neuse River, US 64

This site was initially sampled in 1986 following a dairy waste spill, when it was rated Fair. Recovery was documented in 1991 to Good-Fair and in 1995 to Good. Water quality declined to Good-Fair following Hurricane Fran in 1996. In 2000, it was still Good-Fair, with further signs of water quality degradation (decreased EPT S and increased NCBI) (Figure 35).

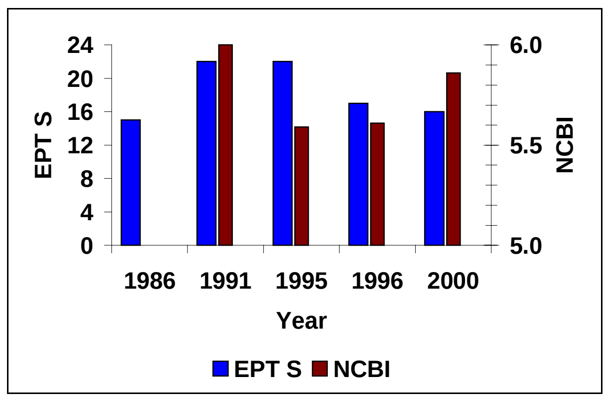


Figure 35. EPT taxa richness (EPT S) and biotic index (NCBI) at the Neuse River at US 64, Wake County, 1986 - 2000.

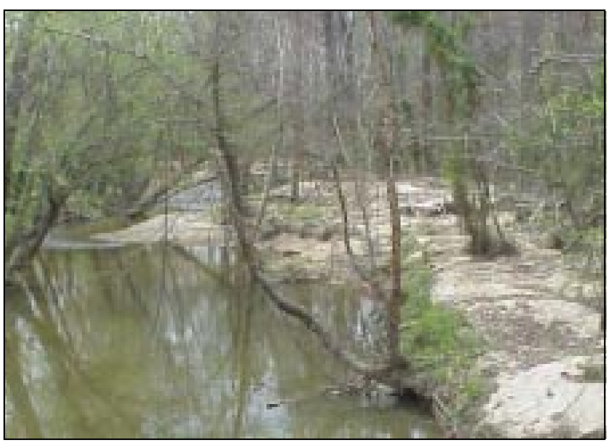
Considering the stable water quality upstream at US 401, and the lack of major tributaries between these two sites, it is unclear why this site has not recovered like other Neuse River stations upstream and downstream of this location.

Smith Creek, SR 2045

Land use in the catchment of this seven-meter wide, shallow (0.2 meters deep), sandy stream is primarily agricultural, however the headwaters also include the rapidly developing Wake Forest and

Rolesville areas At this site (0.8 mi. above its mouth), the riparian zone is wide, shaded, and forested. The substrate is primarily sand with some stick-type riffles; and there was much evidence of sand deposition in the flood zone following the recent hurricanes. During fish community sampling, the habitat score was 52.

Smith Creek looking upstream of the bridge at SR 2045, Wake County.



Smith Creek looking downstream of the bridge at SR 2045, Wake County.

Based upon the benthos sample, this site was given a Fair bioclassification. Twelve EPT taxa were collected in 2000. This was down slightly from 1995 (15 EPT taxa, Good-Fair), but still up significantly from 1986 (4 EPT taxa, Poor), when this site was affected by a dairy spill.

Despite the recent frequent flooding events, the fish community was not impacted but rather greatly improved. In 2000, the community was rated Excellent (NCIBI = 56); in 1995, it was rated Good-Fair (NCIBI = 42).

In 2000, the community was more diverse (more total species, species of darters, sunfish, and intolerant species) and the trophic composition balanced in contrast to the community which existed in 1995. The frequent flooding events may have breached any upstream beaver dams, thus restoring more continuous flow to the stream.

Toms Creek, SR 2044

Upstream construction continued to plague Toms Creek. Rocky riffle areas in this five-meter wide stream supported 17 EPT taxa in 1991, including several abundant intolerant taxa. Nearby development in 1995 buried the riffles and eliminated the intolerant taxa, dropping EPTS to 10 and a Fair rating. No recovery was evident in 2000 -- in either the habitat or the benthic community. Eleven EPT taxa were collected in 2000 and the bioclassification remained Fair.

Toms Creek at SR 2044, Wake County.

The NCDWQ's Watershed Assessment and Restoration Project has found that the relatively undeveloped headwaters of Toms Creek has better water quality than the rest of the catchment. Other nearby streams have been subjected to development and loss of riparian buffers.

Perry Creek, SR 2006

The benthic community is consistently Fair at this sandy, channelized, seven-meter wide stream. Riffles and pools had been filled in with sediment, leaving snags and root mats as the only available habitat. During high flow events, the Neuse River backs up over this site, causing this site to stop flowing. This phenomenon was observed in February 2000, adding an additional stress to an already stressed stream. Very abundant filamentous algae were observed in the stream, suggesting excessive nutrient inputs. The conductivity (150 µmhos/cm) is high at this site, second only to Crabtree Creek for streams in this subbasin that are five meters and larger. This is indicative of inputs into the stream.

This site received a Fair rating in 1995 and 2000, with eight EPT taxa collected each time.

Crabtree Creek, NC 54, Morrisville
The stream here was relatively wide (10 meters), very shallow (0.2 meters) and had a slow current. The few gravel riffles were embedded and silty. Land use in this area was mostly residential. The dissolved oxygen was low (4.6 mg/L) and conductivity high (170 µmhos/cm). *Hydrilla* was also collected from this site.

Crabtree Creek at NC 54 near Morrisville, Wake County.

This site was given a high Poor bioclassification in 2000; unchanged from 1995 and 1988. The low Fair rating assigned to this site in 1991 was due primarily to the presence of the mayfly *Centroptilum.* This taxon has been collected here neither before nor since and probably did not represent a change in water quality.

Crabtree Creek in Umstead State Park
This eight meter wide site, located below Cary's North WWTP, was rated Good-Fair in 2000 and 1995 . It was rated Fair in 1987 and 1994. This improvement may be attributed to facility upgrades in 1994. However, conductivity at this site (360 µmhos/cm) was the highest in the subbasin and the odor of the effluent was distinct.

In 2000, taxa richness and the NCBI were most comparable to 1984 (14 EPTS, 6.18 NCBI) before the facility went online (Figure 36).

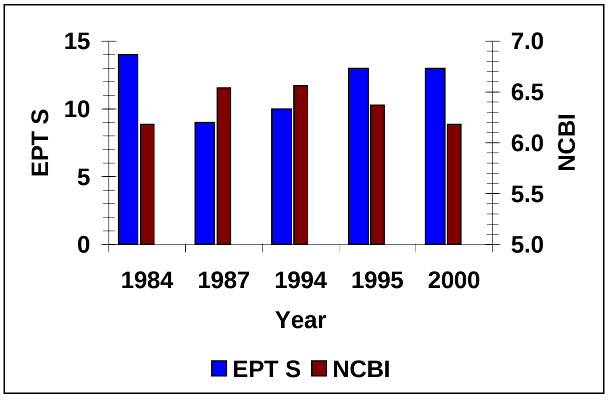


Figure 36. EPT taxa richness (EPT S) and biotic index (NCBI) at Crabtree Creek, Umstead State Park, Wake County, 1984 - 2000.

Several taxa also reflect this change in water quality. The caddisflies *Hydroptila* and *Triaenodes ignitus*, the mayfly *Baetis propinquus,* and the midge *Synorthocladius* were all present in 1986, before the WWTP went online. These taxa were absent for a decade until their return in 1995 or 2000 following the facility upgrade.

Crabtree Creek, SR 1664
This basinwide monitoring site was moved eight miles upstream from the 1995 site at US 1/401 to the 2000 site because the former location was too wide to effectively sample with two electrofishers and two netters.

The watershed of Crabtree Creek at the present location includes the urbanized areas of northwest Raleigh, Morrisville, and north and west Cary. The site is approximately 6.5 miles below Cary's North WWTP (12 MGD) and 0.7 miles below the stream's confluence with Richland Creek. Overall, the instream and riparian habitats were good (habitat score = 75), although there were infrequent riffles and the gravel and cobble substrate was slightly embedded.

Crabtree Creek looking downstream of the bridge at SR 1664 (Duraleigh Road), Wake County.

Unexpectedly for a stream flowing through such a developed watershed, the fish community was rated Excellent. The fact that Crabtree Creek flows for approximately 5.5 miles through Umstead State Park immediately above the monitoring site may help explain why this stream was rated so high. There was a low percentage of tolerant fish; a balanced trophic structure was present; the community was diverse with few exotic species; and there were no diseased or deformed fish. The most abundant species was the swallowtail shiner.

Crabtree Creek, US 1

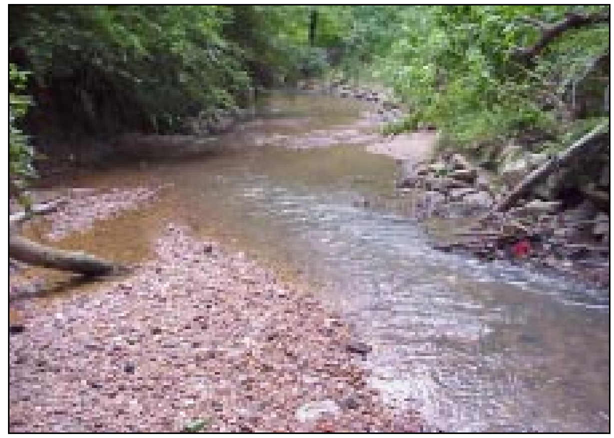
Crabtree Creek at this location receives non point runoff from the City of Raleigh. This site has been rated Fair in each of the five summer benthos samples since 1984.

Instream habitat in this 12-meter wide stream suffered greatest from sediment, which embedded the small gravel riffle. The flashy nature of the stream, due to the large amount of impervious surfaces in the watershed, keeps the banks vertical. The riparian zone in this stream varies from having occasional breaks in places to being almost nonexistent in others.

Marsh Creek, near US 1

Marsh Creek is a small (4 meters wide) stream draining a mostly residential section of North Raleigh.

Based on the number of blown down trees near the stream and the six foot vertical clay banks with an unusual number of exposed roots, it appeared that this stream has been severely impacted by scour. The large amount of impervious surfaces in the watershed, which increase runoff rates, combined with several unusually high flow events, including hurricanes Fran and Floyd, seemed to exacerbate the scour problem in 2000.



Marsh Creek, near US 1, Wake County.

The benthos fauna was very sparse and this site was rated Poor in 2000, down from Fair in 1995, and comparable to 1983 and 1984 (both Poor).

Walnut Creek, SR 2544

Although the adjacent riparian zone of the monitoring site is forested, the watershed of Walnut Creek includes the northeast portion of Cary and the urban core of Raleigh. The substrate is sand and there are infrequent riffles and pools (primarily runs).

Walnut Creek looking upstream of the bridge at SR 2544, Wake County.

The fish community has been sampled during every basinwide monitoring cycle (Figure 37).

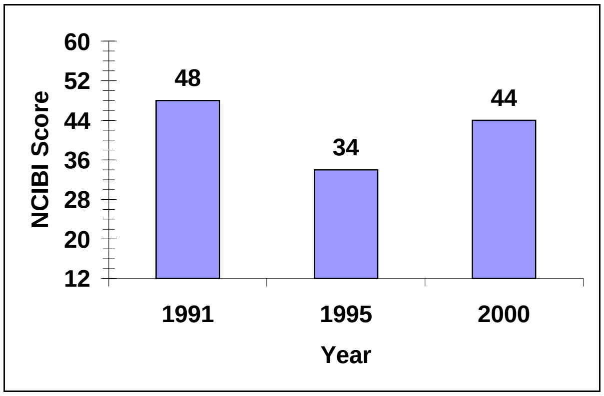


Figure 37. NCIBI scores at Walnut Creek, SR 2544, Wake County, 1991 - 2000.

In 2000, the community was rated Good-Fair. Improvements in the community between 1995 (Fair) and 2000 were noted in an increase in the total species and darter diversity, the abundance and catch rate of fish, and a decrease in the percentage of tolerant fish. The community continued to be trophicly unbalanced (too few omnivores and a preponderance of insectivores) and no suckers were present. Like Crabtree Creek, the fish community in this urban stream was abundant, diverse, and only one exotic fish was collected. No diseased or deformed fish were noted. The most abundant species in 2000 was the swallowtail shiner (41 percent of the total fish). In 1995, the most abundant species was the tolerant satinfin shiner (44 percent of the total fauna). In 2000, it represented only 7 percent of the total fauna.

The tolerant and exotic green sunfish was not present in 2000; the species had constituted approximately 6-8% of the fauna in 1991 and 1995. A 195 mm (total length) flathead catfish was collected which meant that this exotic species is probably now distributed throughout the middle and lower part of the basin in the larger tributaries.

Walnut Creek, SR 2551

The catchment of this stream drains heavily developed eastern Cary, and southern Raleigh, including Lake Johnson. The watershed contains a large amount of impervious surfaces. As a result, this 10 meter wide sandy stream is very flashy – quick to rise and quick to fall. Scour is a major problem for the macroinvertebrate community.

Walnut Creek at SR 2551, Wake County.

The benthos bioclassification of Good-Fair in 2000 is up from the Fair rating given on three previous occasions and reverses a trend of declining water quality in this stream. Improvement in 2000, contrasted to 1995, were real (Figure 38).

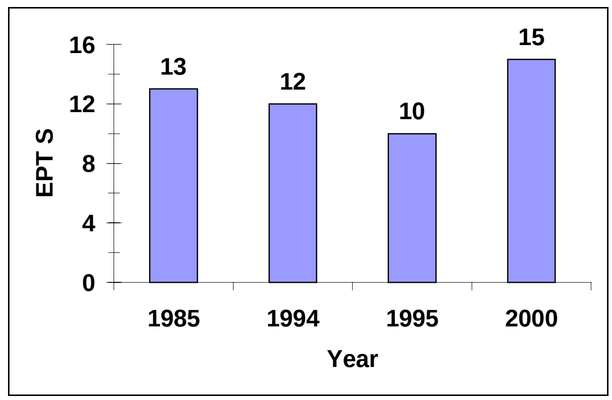
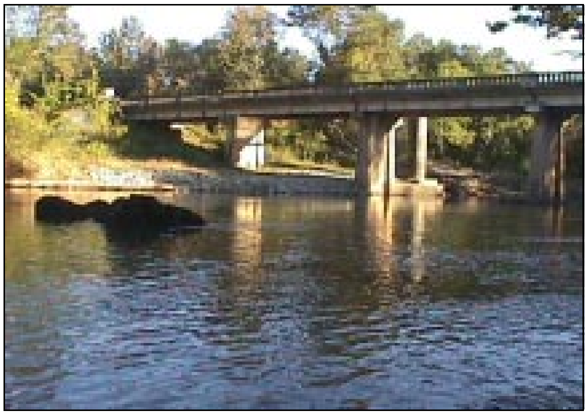


Figure 38. EPT taxa richness (EPT S) at Walnut Creek, SR 2551, Wake County, 1985 - 2000.

While the taxa that were abundant or common only in 1985 were mostly winter species, the taxa that were abundant or common in 1995 and absent in other years were confined to tolerant taxa (the midges *Chironomus*, *Natarsia* and *Polypedilum illinoense,* plus the amphipod *Hyalella azteca*). Two moderately intolerant caddisflies, *Hydrophysche venularis* and *Oecetis persimilis*, were common in 2000, but not previously collected. *Baetis intercalaris*, a slightly intolerant mayfly, was abundant in 1985 and 2000, but absent or rare in other years, also indicating a period of lower water quality in the intervening years.

Neuse River, NC 42
The Neuse River near Clayton was nearly 40 meters wide and almost one meter deep at this site. Except for the infrequent riffle, the substrate was sand with few pools.



Neuse River at NC 42, Johnston County.

Water quality improved to Good in this part of the Neuse River, up from the 1980s, when it was rated Good-Fair. The most consistent marker of this improvement was the Biotic Index, which has steadily declined from 6.24 in 1983 to 5.59 in 2000 (Figure 39).

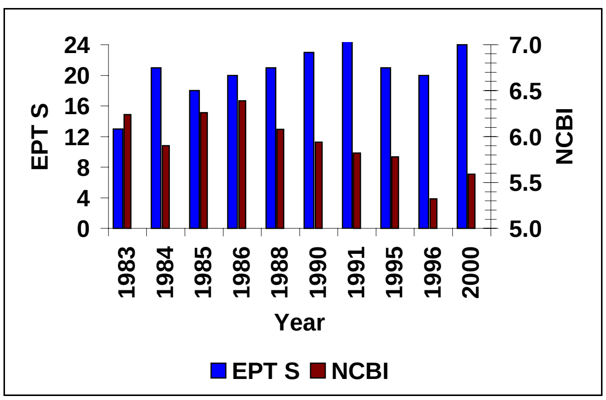


Figure 39. EPT taxa richness (EPT S) and biotic index (NCBI) at the Neuse River at NC 42, Johnston County, 1983 - 2000.

Other indicators of improved water quality were three intolerant stoneflies: *Paragnetina fumosa*, *P. kansensis*, and *Pteronarcys dorsata.* All were absent before 1990 and common by 2000.

Neuse River, SR 1201,
The Neuse River was 35 meters wide and about 1.4 meters deep at this most downstream site in the subbasin. Habitat at this sandy site was limited mostly to snags.

Neuse River at SR 1201, Johnston County.

In the three times since 1991 that this site has been sampled, it has consistently received a Good bioclassification. The intolerant stoneflys *Neoperla* and *P. kansensis* were abundant here and this is one of the few sites in the basin where the caddisfly *Ceraclea ophioderus* was found.

Marks Creek, SR 1714
Marks Creek is a nine-meter wide stream that drains a primarily agricultural area. Rural and suburban areas are also present. A low conductivity (~70 µmhos/cm) indicated the absence of development in most of the watershed. This site is located approximately 1.4 miles above the stream's confluence with the Neuse River.

Within the past five years, the immediate upstream watershed was logged, leaving a narrow riparian buffer zone and a thin canopy along both shorelines. The banks, however, have remained stable. The instream habitat included stick and woody debris riffles, boulders, and a sandy substrate. During fish community monitoring, the habitat score was 56. During benthos sampling, large amounts of silt deposited along the banks and around the edges of pools were observed.

Upstream view of Marks Creek at SR 1714, Johnston County.

Based upon the benthic invertebrate data, water quality remained Good-Fair at this site, unchanged from 1995 and 1991. Approximately 1/3 of the taxa collected at this site in 2000 belonged to the mayfly family Baetidae.

The fish community has been sampled during every basinwide monitoring cycle (Figure 40). In 2000, the community was rated Excellent. Slight improvements in the community between 1995 (Good) and 2000 were noted in an increase in the abundance and catch rate of fish, an increase in the percentage of species showing multiple ages, and a decrease in the percentage of tolerant fish.

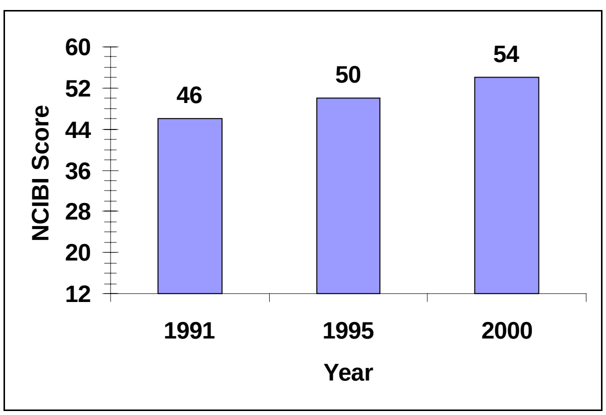


Figure 40. NCIBI scores at Marks Creek, SR 1714, Johnston County, 1991 - 2000.

Species showing notable increased abundances between 1995 and 2000 were the American eel, white shiner, swallowtail shiner, and tessellated darter. Stick and woody debris shallow riffles were attractive to the tessellated darter. No common species decreased in abundance between the two sampling periods. The most abundant species in 2000 were the swallowtail shiner and the tessellated darter. Lastly, two adult sea lampreys were collected at this site in 2000. The species is not often collected this far up in the river basin.

Swift Creek, SR 1152

Most of the watersheds of the cities of Cary and Apex drain into Swift Creek. The benthos and fish community monitoring site is approximately 1.5 miles above the backwaters of Lake Wheeler.

Flow fluctuations, infrequent riffles, and a high substrate embeddedness characterize this site. The northwest and southeast riparian quadrants at this site were logged within the past five years leaving a narrow riparian buffer zone. During benthos sampling, heavy periphyton on the gravel indicated some nutrient inputs and the conductivity (~75 - 140 µmhos/cm) also indicated some impacts from upstream development.

Upstream view of Swift Cr at SR 1152, Wake County.

Upstream view (from the bridge) of Swift Creek at SR 1152, Wake County.

Based upon benthic invertebrate data, this site has received a bioclassification of Fair in each of the three years it has been sampled (1989, 1995, and 2000). An increase in EPT abundance (42 in 1989, 54 in 1995, and 72 in 2000) as well as the increase in EPT S (7 summer taxa in both 1989 and 1995 and 9 in 2000) has been documented. These increases may indicate a slight improvement in water quality, or may merely reflect reduced nonpoint source inputs because of low flows in early July 2000.

Surveys as part of the NCDWQ's Watershed Assessment and Restoration Project found the best water quality in Speight Creek (a tributary) and the headwaters of Swift Creek above Williams Creek. Williams Creek was the most heavily impacted part of the catchment.

The fish community has been sampled 11 times since 1995 as part of two special studies (see Special Studies section). In 2000, the stream was monitored at two sites below the bridge. The monitoring site was moved from above the bridge to below the bridge because a large debris dam, begun during the Hurricane Floyd flooding and enlarged during the winter, now obstructed the channel and passage above the bridge.

Debris dam across Swift Creek above the crossing at SR 1152, Wake County.

The two 2000 sites were separated by approximately 300 ft and had similar instream and riparian habitats. Even following recent flooding events, there remained good snag and undercut bank-type pools. The habitat scores were 64 and 63.

Downstream view of Swift Creek, approximately 1,500 ft. below the bridge) at SR 1152, Wake County.

In 2000, one site was rated Fair and the other Good-Fair (NCIBI = 34 and 40, respectively). The difference, in this instance six units (Metric Nos. 1 and 11) was not sufficient to consider the two sites substantially different. The difference in scores resulted from seven species (American eel, gizzard shad, creek chubsucker, yellow bullhead, brown bullhead, margined madtom, and yellow perch) which were present at one site but not the other. Five of the seven species were represented by 1 or 2 fish per species. Two of the species had probably migrated up from Lake Wheeler--one yellow perch and a school of 23 gizzard shad. Also a greater percentage of the fish (3% *vs*. 0.8%), all 1 and 2 year old bluegill, were diseased at one of the sites and not at the other. The fish exhibited "popeye" symptoms (exophthalmos) which can be caused by several types of bacterial and viral infections. There was no differences in the other 10 metrics and the dominant species abundances differed by only 17 fish (358 *vs*. 341) between the two sites.

In 1995, the fish community was rated Poor (NCIBI = 28). This sample was the only sample from this site when the swallowtail shiner, at least one species of catfish, warmouth, redear sunfish, largemouth bass, and Johnny darter were not collected. The sample also had the fewest species (9) and the fewest fish (165) collected than the other 10 samples. It is possible that turbidity interfered with fish collection, but information on water clarity at the time of collection was not recorded. It is also possible that some event impacted the community before sampling and the community has since recovered to what is observed today. No watershed improvement or stream enhancement projects would have accounted for an increase in the rating between 1995 and 1999/2000. And residential and commercial growth in the watershed has only increased since 1995.

Based upon all the data that has been collected from this site, the fish community is characterized as having a low species diversity at any particular time (including only 1 species of darter, usually 1, or rarely 2, species of suckers, and no intolerant species), an abundance of fish, a high diversity of sunfish species (6), and an altered trophic structure (usually only 1% omnivores and ~ 98% insectivores). Typically, the incidence of disease is low and there is evidence of multiple age classes by a majority of the species. Only one young-of-year bluehead chub (a widely distributed, abundant, and omnivorous piedmont species) has ever been collected from this site. Three exotic species (green sunfish, redear sunfish, and fathead minnow) have been collected at this site. The ratings usually fluctuate between Fair (34-38) and Good-Fair (40-42).

Swift Creek, SR 1555

This 14 meter wide site was moved one bridge downstream from the 1995 sample (SR 1525) at the request of the NC Wildlife Resources Commission, in an effort to avoid disturbing rare and endangered mussels in this watershed. While there was a good mix of boulder and rubble here, rocks were heavily embedded and out of the current. Sedimentation also had filled in most of the pools. The water was noticeably turbid. A Good-Fair bioclassification was given to this site, the same as the segment just upstream of here in 1995. However, two additional mayfly taxa found in 2000, may suggest a slight improvement in water quality.

Swift Creek, SR 1501

This site, in the most downstream portion of Swift Creek, is in an area intermediate between the piedmont and coastal plain ecoregions. As with the upstream sites, sedimentation is a problem, filling in most of the pools. There were few rocks present and most of the habitat was limited to snags.

NCBI and EPT taxa richness have been fairly stable at this site. The bioclassification at this site increased from Good-Fair in 1991 to Good in 1995 and 2000 due to an increase in EPT abundance (Figure 41). Because 1995 and late summer 2000 were higher flow periods than 1991, this improvement in water quality is probably real. Higher flows should reduce, rather than enhance, EPT abundance in areas with sedimentation problems.

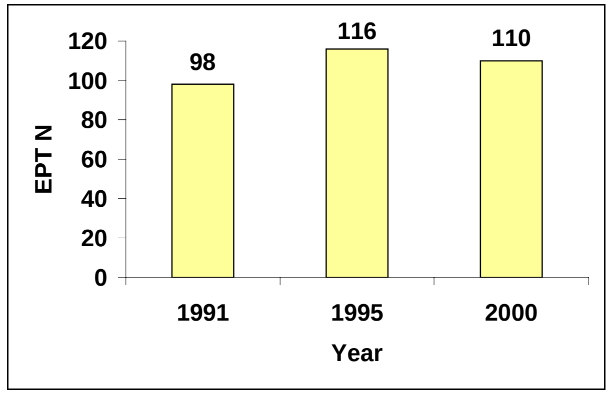


Figure 41. **EPT abundance (EPT N) at Swift Creek, SR 1501, Johnston County, 1991 - 2000.**

Little Creek, SR 1562

This seven meter wide site exhibited many of the characteristics of a coastal plain stream (sand substrate, low gradient, pH < 7.0, and snags for habitat) except for one, 10 meter reach that cut through an old stream bed to form a riffle. As a result, Piedmont criteria were used to assign a Fair bioclassification at this site for all years.
It would seem that high flow was a problem in 1995, when scour reduced the baetid mayfly community to a single individual. In 1991 and 2000, four taxa were present including the abundant *Baetis propinquus*.

EPT taxa richness was less in 2000 contrasted to 1991 because of a lack of slow water-Trichoptera (*Oecetis*, *Triaenodes,* and *Nectopsyche*). This could be due to a lack of habitat, or, more likely, many of these taxa had emerged by September 2000, when the sample was collected. Empty cases of *Oecetis*, *Hydroptila,* and a pupating *Neophylax* were collected in 2000. If stream flows had come down sooner so this site could have been sampled earlier, before pupation and emergence, these three extra taxa would have been enough to rate this stream Good-Fair.

SPECIAL STUDIES

Small Stream Basin Assessments

Six small tributaries, most considered to be not flowing in summer, were sampled in 2000 to monitor changes in water quality from 1995:

- With the exception of 1996, when scour from Hurricane Fran degraded water quality to Fair, Richland Creek at US 1 has had stable (Good-Fair) water quality since 1991.
- Black Creek at Weston Parkway was rated as Fair, unchanged since 1994.
- Hare Snipe Creek above US 70 declined from Fair in 1995 to Poor in 2000.
- Mine Creek below Shelly Lake was Poor in 1995 and 2000, as was Pigeon House Creek at Fenton Street.
- Swift Creek above US 1 was Poor in 1995 and 2000 when the site was moved adjacent to a parking lot. Before that, in 1989 and 1991 when the site was at US 1, the site was rated Fair.

UT Turkey Creek
Samples were collected above and below the Delta Ridge development in July 2000. The purpose was to determine if sediment escaping from the development was impacting the benthic community. Sediment deposits were so thick in the area immediately downstream of the development that it was impossible to sample. Further downstream, the invertebrate community showed a 38 percent decline in taxa richness from the upstream site (Biological Assessment Unit Memorandum B000728).

UT Poplar Creek
In 1998, Kings Grant WWTP had been discharging excess chlorine and causing toxicity problems in UT Poplar Creek. The facility had a severe effect on the macroinvertebrate community, with a sharp decline in EPT taxa and a shift to highly tolerant species (Biological Assessment Unit Memorandum B98116).

UT Swift Creek
During logging and road building at the Old Stage Golf and County Club in 1997, erosion resulted in massive siltation in one unnamed tributary to Swift Creek between Lake Wheeler and Lake Benson. Siltation severely impacted the tributary, eliminating over one-half of the EPT taxa and 78 percent of the abundance of macroinvertebrates in the stream (Biological Assessment Unit Memorandum B970620).

Richlands Creek
During roadbed construction of the Edwards Mill Extension and the Raleigh Entertainment and Sports Arena in 1996, large amounts of sediment eroded into Richlands Creek. This stream flows through NCSU's Schenk Forest. The macroinvertebrate community at the area receiving the sediment was highly stressed, with low taxa richness, low abundance, and was dominated by tolerant species (Biological Assessment Unit Memorandum B960903).

Impacts of Hurricane Fran
Several sites were sampled in October 1996 to determine the impact of Hurricane Fran -- the Neuse River at US 64, the Neuse River at NC 42, and Crabtree Creek at US 1. There were no significant declines at these sites. This indicated that sites without low dissolved oxygen concentrations after hurricanes should recover quickly (Biological Assessment Unit Memorandum B970117).

Spatial and Temporal Variability in the NCIBI
In 1999, a special fish community study was conducted at Swift Creek to determine the spatial and temporal variability in the NCIBI. Two sites within 300 ft. of one another with no differences in water quality or habitat were sampled once a month every other month between April and October.

The study concluded there were no significant spatial differences in the mean individual metric values or in the overall total NCIBI Scores ($p > 0.05$). There was also no significant temporal differences in the mean total NCIBI scores at this stream ($p > 0.05$). The mean NCIBI at this stream was 38.5 ± 0.8 (S.E.) with ratings fluctuating between Fair and Good-Fair. The study also concluded that the NCIBI is a robust index where slight sampling period or spatial variability and natural phenomenon (at this particular site - summer drought conditions, hurricanes Dennis and Floyd, and several mid- to late-summer bankfull events) do not affect the overall scoring of the community (Biological Assessment Unit Memorandum 20001017).

Potential for Reducing Fish Community Streamside Sample Processing Time
In 2000, a study was designed to determine if streamside sample processing time could be reduced by not measuring every fish for the calculation of Metric No. 12. Two sites at Swift Creek, which were separated by approximately 300 ft. and which had similar instream and riparian habitats, were sampled once a month every other month between April and October. Only the April samples were collected. The April results did not show a time savings and the remainder of the study was not conducted.

Lake Crabtree

Lake Crabtree was built in 1989 by the Soil Conservation Service as 1 of 11 proposed lakes to be constructed for flood control in the Crabtree Creek watershed. A county-owned public park surrounds the lake; and the lake is used extensively for recreation. Three tributaries, Crabtree Creek, Haleys Branch, and Stirrup Iron Creek, drain portions of Cary, Morrisville and the Raleigh-Durham International Airport (Figure 42). Several point source discharges and numerous construction sites in the watershed contribute to the drainage area of the lake.

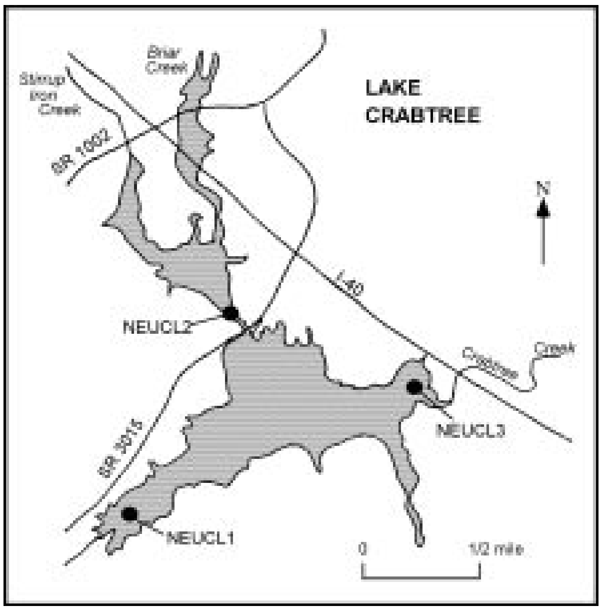


Figure 42. Monitoring sites at Lake Crabtree, Wake County.

The reservoir was most recently monitored in July and twice in August, 2000 (Table 19) This shallow lake is nearly always turbid and Secchi depths in July and August were ≤ 0.5 m. On August 7, a surface dissolved oxygen of 3.8 mg/L was observed at Station NEUCL1. This concentration was less than the water quality standard of 4.0 mg/L for an instantaneous dissolved oxygen measurement. Total phosphorus concentrations were elevated throughout the lake on all dates while nitrogen concentrations were generally moderate to elevated. Fecal coliform bacteria concentrations were less than 10 colonies/100 ml in July and on August 24. On August 7, bacterial concentrations ranged from 27 to 180 colonies/100 ml.

The lake was previously monitored in 1995 and 1996. In 1996, field reports indicated that the lake exhibited severely high sediment levels with floating scums on the water's surface. Secchi depths were 0.2 m at all the sites. Ammonia concentrations ranged from < 0.01 mg/L at the most upstream site (Station NEUCL1) to 0.14 mg/L near the dam (NEUCL3). Total phosphorus concentrations ranged from 0.05 mg/L at Station NEUCL3 to 0.10 mg/L at Station NEUCL2. Fecal coliform bacteria counts ranged from 9 to 64 colonies/100 ml.

In 1995, turbidity values were greater than the water quality standard of 25 NTU at all sites (Appendix L3). Secchi depth at each site was 0.2 m, further indicating poor light penetration due to sediment in the water. Lakewide mean total phosphorus and total organic nitrogen values were elevated. However despite the available nutrients, the chlorophyll *a* concentration only ranged from 8 to 13 µg/L. Poor light penetration due to suspended sediments may have inhibited algal growth. Fecal coliform bacteria values were less than 10 colonies/100 ml.

Data collected from 1988 through 2000 for three constituents of the NCTSI were summarized using box and whisker plots (Figure 43). Secchi depths have always been less than 1 m. Median total phosphorus and total organic nitrogen have always been elevated.

Table 19. Biological and water chemistry data for Lake Crabtree, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/24/2000	---	---	0.13	0.38	---	0.2
08/07/2000	---	---	0.11	0.57	---	0.2
07/12/2000	---	---	0.08	0.50	---	0.4
08/21/1996	---	---	0.07	0.47	---	0.2
08/17/1995	4.8	Eutrophic	0.12	0.68	11	0.2

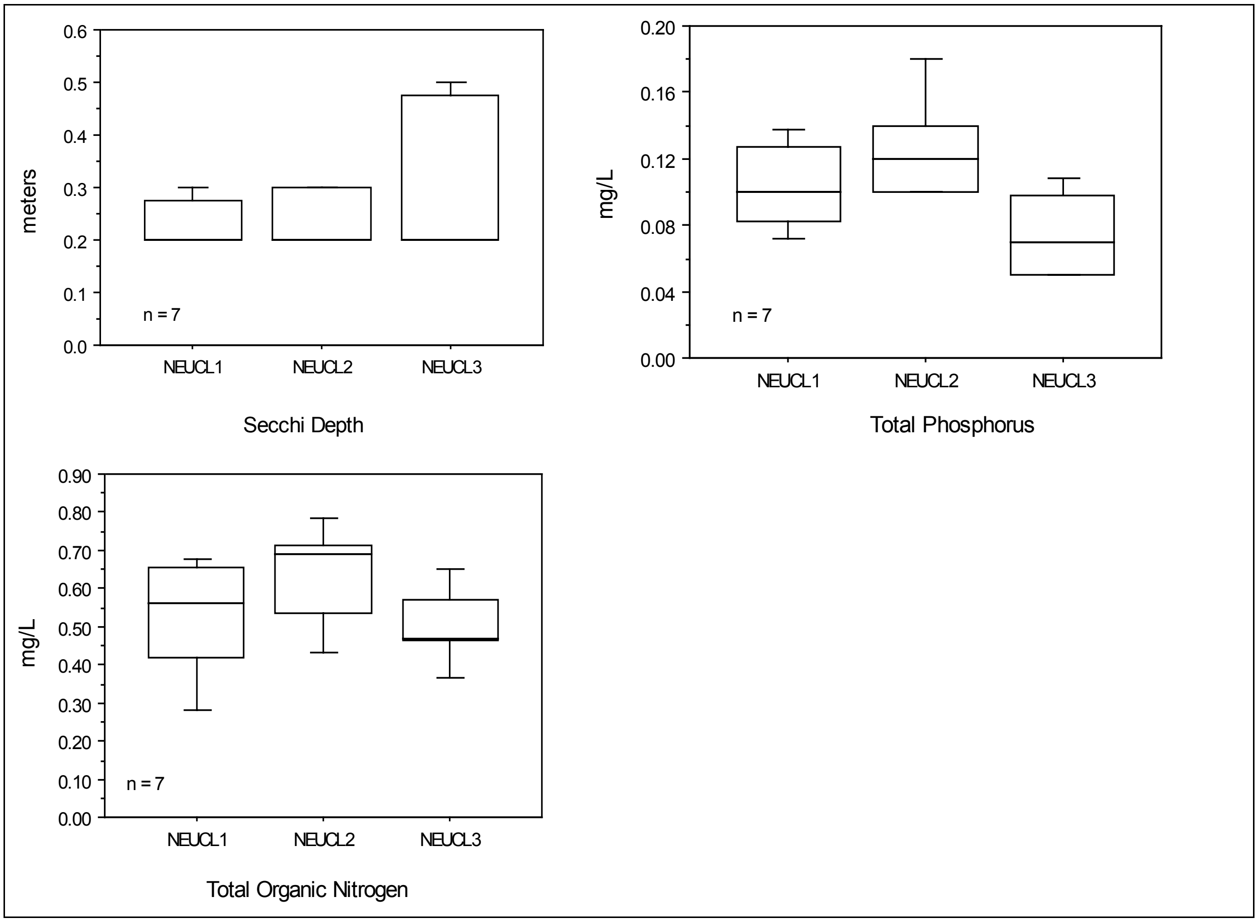


Figure 43. **Spatial relationships among biological and water chemistry data from Crabtree Lake, 1990– 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.**

Reedy Creek Lake

Reedy Creek Lake is located in Umstead State Park, which is adjacent to the Raleigh-Durham International Airport (Figure 44). The watershed consists primarily of areas of forest and agriculture with increasing urbanization. Reedy Creek Lake is one of three lakes located within the park and has a retention time of 11 days. Fishing is allowed and swimming by group campers is allowed only with a special permit from the park office.

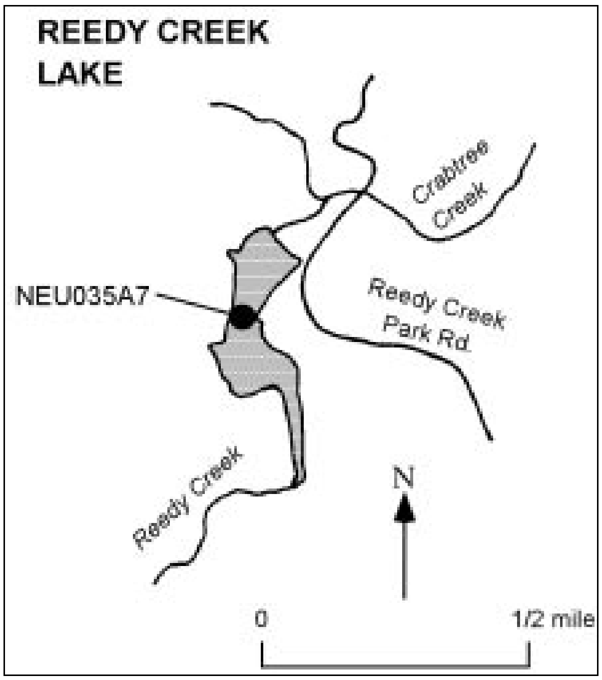


Figure 44. Monitoring sites at Reedy Creek Lake, Wake County.

The reservoir was most recently monitored in June, July, and August, 2000 (Table 20). The Secchi depth in June was greater than 1 m, but decreased to less than 1 m in July and August (Appendix L2). Total phosphorus concentrations increased from 0.01 mg/L in June to 0.08 mg/L in August (Appendix L3). This increase along with an increase in solids and turbidity and a decrease in Secchi depth suggested an increase in sediment loading in July and August due to rainfall events in the watershed. Field notes indicated the lake appeared "muddy" in July and August.

Nitrogen concentrations were greatest in August. Surface dissolved oxygen (10.4 mg/L) and pH (8.2 s.u.) were elevated and suggested the possibility of increased algal activity. *Hydrilla* was observed along the shoreline of the lake. However, due to the turbidity, it was difficult to estimate how far from the shoreline this nuisance aquatic plant had spread. Fecal coliform bacteria counts were approximately 10 colonies/100 ml during the monitoring period.

The lake was previously monitored in 1995. Secchi depth was less than 1 m. Total phosphorus concentrations were elevated (0.4 mg/L) and nitrogen concentrations were moderate to low. Chlorophyll *a* concentrations were also low (6 µg/L). In 1995, *Hydrilla* was estimated to cover 50 percent of the littoral zone. The NCTSI score in 1995 indicated the lake was eutrophic.

Reedy Creek Lake is on the 2000, 303 (d) List as impaired due to excessive aquatic macrophyte growth (NCDENR 2000). The abundance of *Hydrilla* in all three lakes in Umstead State Park has become a problem according to the Park Superintendent. Triploid grass carp had been stocked in previous years. But a decrease in feeding rates of the aging fish, coupled with increased nutrient loading from urban runoff, particularly from Raleigh-Durham International Airport, were believed to have provided more favorable conditions for the growth of *Hydrilla* in recent years (Martha Woods, Park Superintendent, pers. com.).

Table 20. Biological and water chemistry data for Reedy Creek Lake, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/07/2000	---	---	0.08	0.55	---	0.2
07/12/2000	---	---	0.04	0.14	---	0.8
06/27/2000	---	---	0.01	0.32	---	1.2
08/10/1995	0.8	Eutrophic	0.40	0.40	6	0.7

Big Lake

Big Lake is located within Umstead State Park in northwestern Wake County, adjacent to the Raleigh-Durham International Airport. Land use within the watershed is primarily forest and agriculture with urban development rapidly occurring within the watershed in recent years. This lake is an impoundment of Sycamore Creek and is located upstream of Sycamore Lake (Figure 45). The lake has a retention time of approximately 25 days.

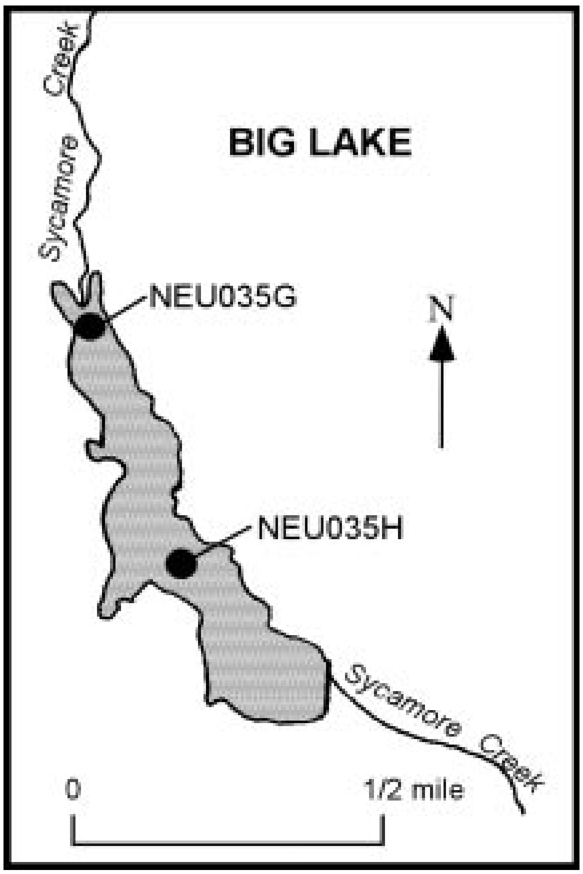


Figure 45. Monitoring sites at Big Lake, Wake County.

This lake was most recently monitored in June, July and August, 2000 (Table 21). Mean Secchi depth ranged from 0.3 to 1.0 m. In August, rainfall within the watershed the previous week had increased the sediment loading and turbidity of the lake which decreased light penetration. Total phosphorus increased from June to August. This pattern was also observed in Reedy Creek Lake. Fecal coliform bacteria counts in June and July were less than 10 colonies/100 ml.

In August, surface dissolved oxygen at the mid-lake sampling site was 10.1 mg/L and surface pH was 7.8 s.u. Nutrient concentrations in August were moderate to elevated. Fecal coliform bacteria counts in August were 18 and 27 colonies/100 ml.

The lake was previously sampled in 1995 and 1996. In both years, Secchi depths were less than 1 m. Concentrations of total phosphorus, nitrite plus nitrate and ammonia were moderate to low. In 1995, the mean chlorophyll *a* concentration was 62 µg/L. In 1995, surface dissolved oxygen concentrations ranged from 8.7 to 9.1 mg/L and surface pH ranged from 8.2 to 8.5 s.u. These values along with the elevated chlorophyll *a* concentration indicated increased algae activity in the lake. *Hydrilla* was observed along the shoreline. Based on the NCTSI scores, the lake was eutrophic in 1995.

Data collected from 1988 through 2000 for the four constituents of the NCTSI were summarized using box and whisker plots (Figure 46). Median concentrations for total phosphorus and total organic nitrogen, were similar between the two sites.

Table 21. Biological and water chemistry data for Big Lake, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/07/2000	---	---	0.08	0.49	---	0.3
07/12/2000	---	---	0.04	0.44	---	1.0
06/27/2000	---	---	0.02	0.78	---	0.7
08/21/1996	---	---	0.02	0.44	---	0.7
08/10/1995	0.7	Eutrophic	0.03	0.39	10	0.8

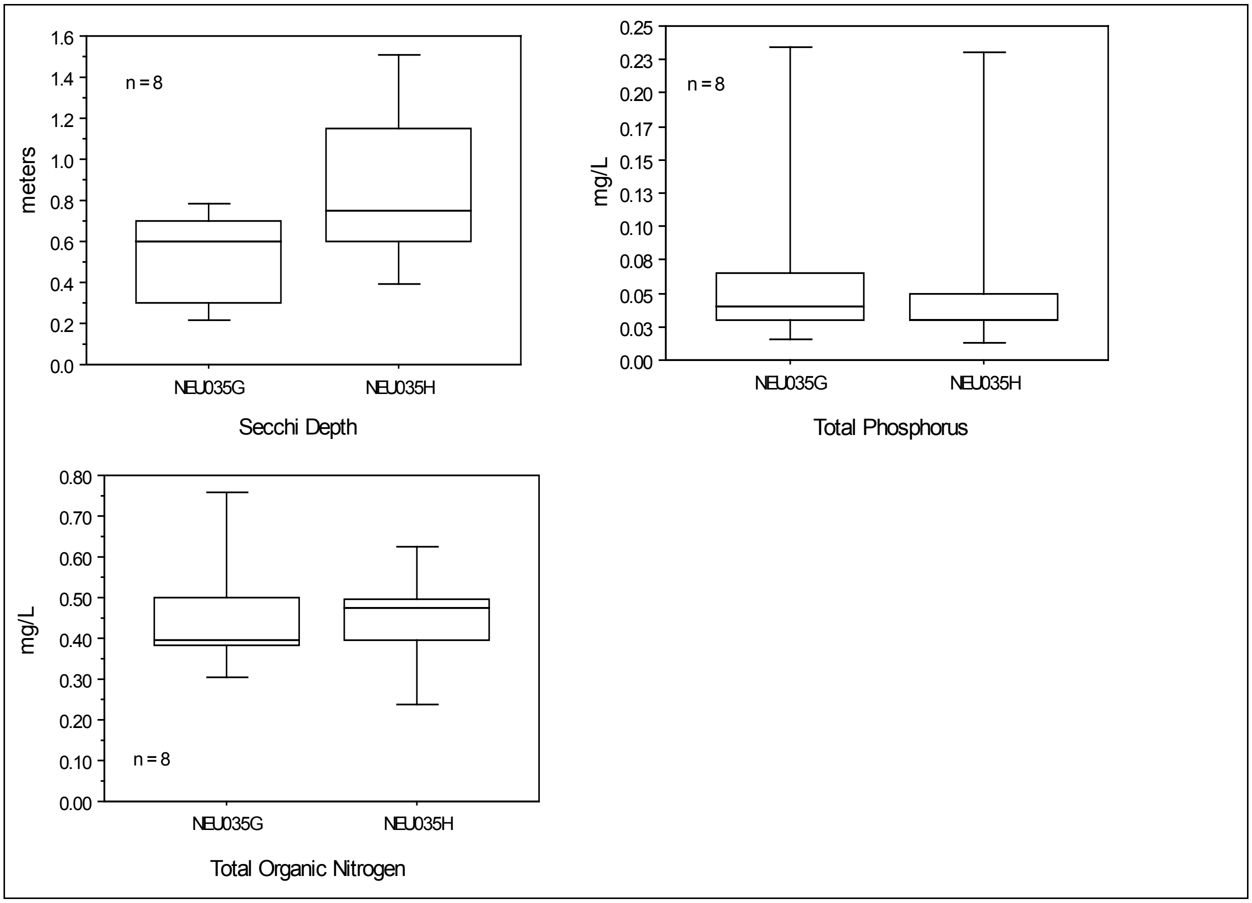


Figure 46. **Spatial relationships among biological and water chemistry data from Big Lake, 1988 – 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.**

Sycamore Lake
Sycamore Lake is the third of the three lakes monitored by the NCDWQ in Umstead State Park (Figure 47). This small lake, also located on Sycamore Creek, is downstream of Big Lake. The watershed is primarily forest and agriculture with urban development rapidly occurring within the watershed in recent years.

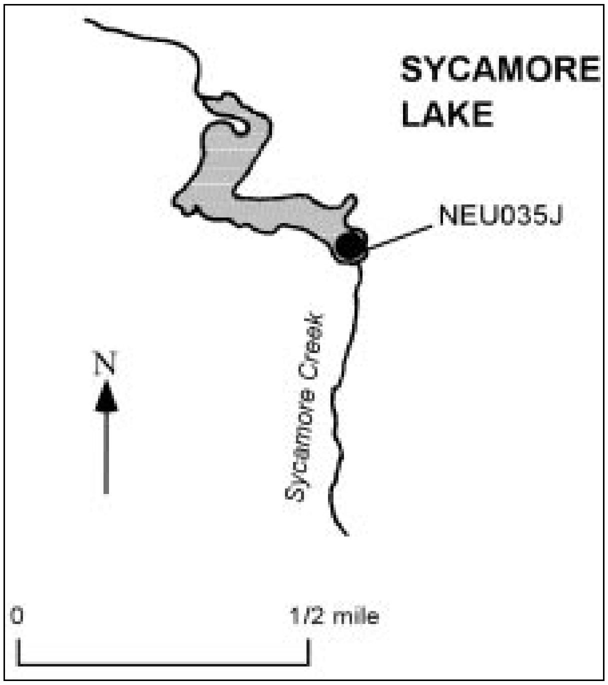


Figure 47. Monitoring sites at Sycamore Lake, Wake County.

The lake was most recently monitored in June, July and August, 2000 (Table 22). In June, the Secchi depth was 1.3 m. The total phosphorus concentration was very low (< 0.01 mg/L), while the concentrations of total Kjeldahl nitrogen, ammonia and total organic nitrogen were moderate to elevated (Appendix L3).

In July, the Secchi depth increased slightly. Total phosphorus increased to 0.02 mg/L, while the nitrogen concentrations generally decreased.

In August, Secchi depth decreased to 0.2 m and total phosphorus and turbidity increased significantly. This may have been due to rainfall within the watershed the previous week which increased sediment loading to the lake. Nitrogen concentrations increased slightly. Surface dissolved oxygen also increased to 9.6 mg/L and surface pH was 7.8 s.u.

Fecal coliform bacteria concentrations in June and July were low. As with Reedy Creek Lake and Big Lake, *Hydrilla* was observed along the shoreline of Sycamore Lake in 2000.

Fecal coliform bacteria sampling was conducted by Umstead State Park personnel in July and August 2000. Bacteria concentrations were less than 10 colonies/100ml with the exception of samples collected on August 2 following rainfall in the lake's watershed. Bacterial concentrations were then 3,400 and 1,800 colonies/100ml.

Sycamore Lake was previously monitored in 1995. Nuisance growths of *Hydrilla* were observed; Secchi depth was 1 m and nutrient concentrations were low to moderate.

Table 22. Biological and water chemistry data for Sycamore Lake, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/07/2000	---	---	0.07	0.50	---	0.2
07/12/2000	---	---	0.02	0.21	---	1.4
06/27/2000	---	---	<0.01	0.58	---	1.3
08/10/1995	0.2	Eutrophic	0.02	0.40	11	1.0

Apex Reservoir
Apex Reservoir, impounded in 1926 on Williams Creek, served as the water supply for the Town of Apex until 1990 (Figure 48). The lake is now part of a public park. The watershed has changed rapidly from primarily forest and agriculture to residential and commercial uses. The immediate shoreline is forested on the eastern and northern sides. A large apartment complex is located near the southwest corner of the lake.

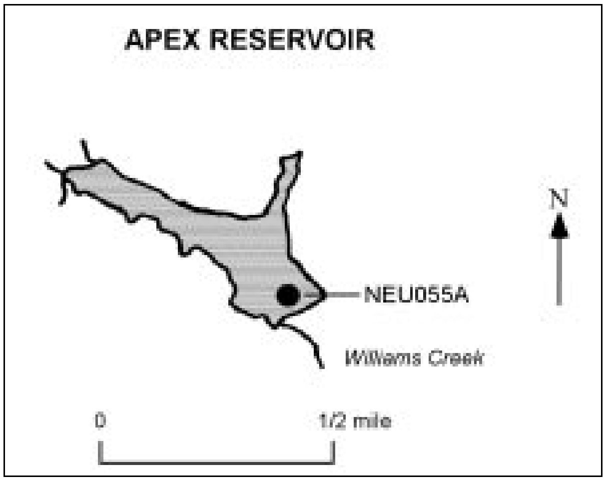


Figure 48. Monitoring sites at Apex Reservoir, Wake County.

Apex Reservoir was most recently monitored on July 12, 2000 (Table 23). The Secchi depth was less than 0.5 m. The lake was strongly stratified; surface dissolved oxygen was 7.9 mg/L and decreased to 0.6 mg/L at 2 m (depth to bottom = 3.2 m). Surface pH was 8.5 s.u. Total phosphorus was elevated as were total organic nitrogen and total Kjeldahl nitrogen (1.0 mg/L). Surface metals were low or less than laboratory detection levels.

This reservoir was previously monitored in 1995 (Table 23). The Secchi depth was less than 1 m; concentrations of total phosphorus, total organic nitrogen and total Kjeldahl nitrogen (0.7 mg/L) were elevated.

Between 1995 and 2000, adjacent lands have undergone dramatic development. In 1995, the area was forested and rural in character. In 2000, the watershed had become urbanized with a large apartment complex located on one side of the lake and new residential and commercial development located within the watershed. The changing land use of the watershed and along the immediate shoreline may be increasing nutrient loading and sedimentation *via* stormwater runoff and land development activities.

Table 23. Biological and water chemistry data for Apex Reservoir, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
07/12/2000	---	---	0.06	0.99	---	0.3
07/27/1995	2.1	Eutrophic	0.07	0.62	7	0.9

Lake Wheeler

Lake Wheeler is located in southwestern Wake County, upstream of Lake Benson on Swift Creek (Figure 49). The watershed includes forested areas as well as residential and urban areas. The lake has a retention time of 72 days and is an important recreational lake as well as a future water supply for the City of Raleigh. In recent years, this lake has become very popular with boaters. The number of power boats on the lake, particularly during the weekends, has resulted in public concerns regarding water pollution from fuel and oil, safety issues, and noise.

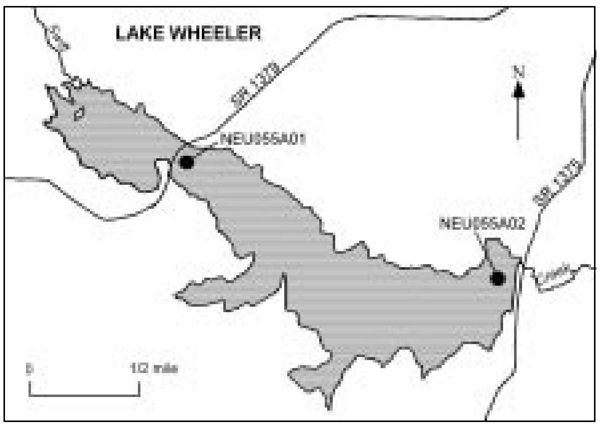


Figure 49. Monitoring sites at Lake Wheeler, Wake County.

Lake Wheeler was most recently monitored in June, July and August, 2000 (Table 24). Mean Secchi depths during all three months was 0.9 m. Mean total phosphorus concentrations ranged from low in June and July to moderate in August. Nitrite plus nitrate concentrations were very low (< 0.01 mg/L) while other mean nitrogen concentrations generally increased from June to August.

Metal concentrations in the surface waters were less than the laboratory detection levels, except for manganese. In June, the concentration of manganese was 230 µg/L, which was greater than the water quality standard of 200 µg/L for a water supply reservoir.

The lake was previously sampled in 1995 (Table 24). Secchi depth was less than one meter at both sites. Nutrient concentrations were low to moderate and the mean chlorophyll *a* concentration was 14 µg/L. The lake was also eutrophic in 1995 based on the NCTSI score.

Data collected from 1988 through 2000 for the four constituents of the NCTSI were summarized using box and whisker plots (Figure 50). Median total phosphorus was slightly greater at the upstream site while the median values of the other three variables were similar.

In the late 1980's, approximately 50 percent of the surface area of the lake, primarily upstream of the SR 1379 bridge, was infested with *Hydrilla*. Grass carp were stocked in 1985 and 1987 for biological control of the macrophyte. In the early 1990's, the biomass of *Hydrilla* had decreased by 50 percent (NCDNRCD, 1988; NCDEHNR, 1992).

Table 24. Biological and water chemistry data for Lake Wheeler, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/09/2000	---	---	0.03	0.38	---	0.9
07/18/2000	---	---	0.02	0.44	---	0.9
06/07/2000	---	---	0.02	0.25	---	0.9
08/08/1995	0.1	Eutrophic	0.03	0.26	14	0.9

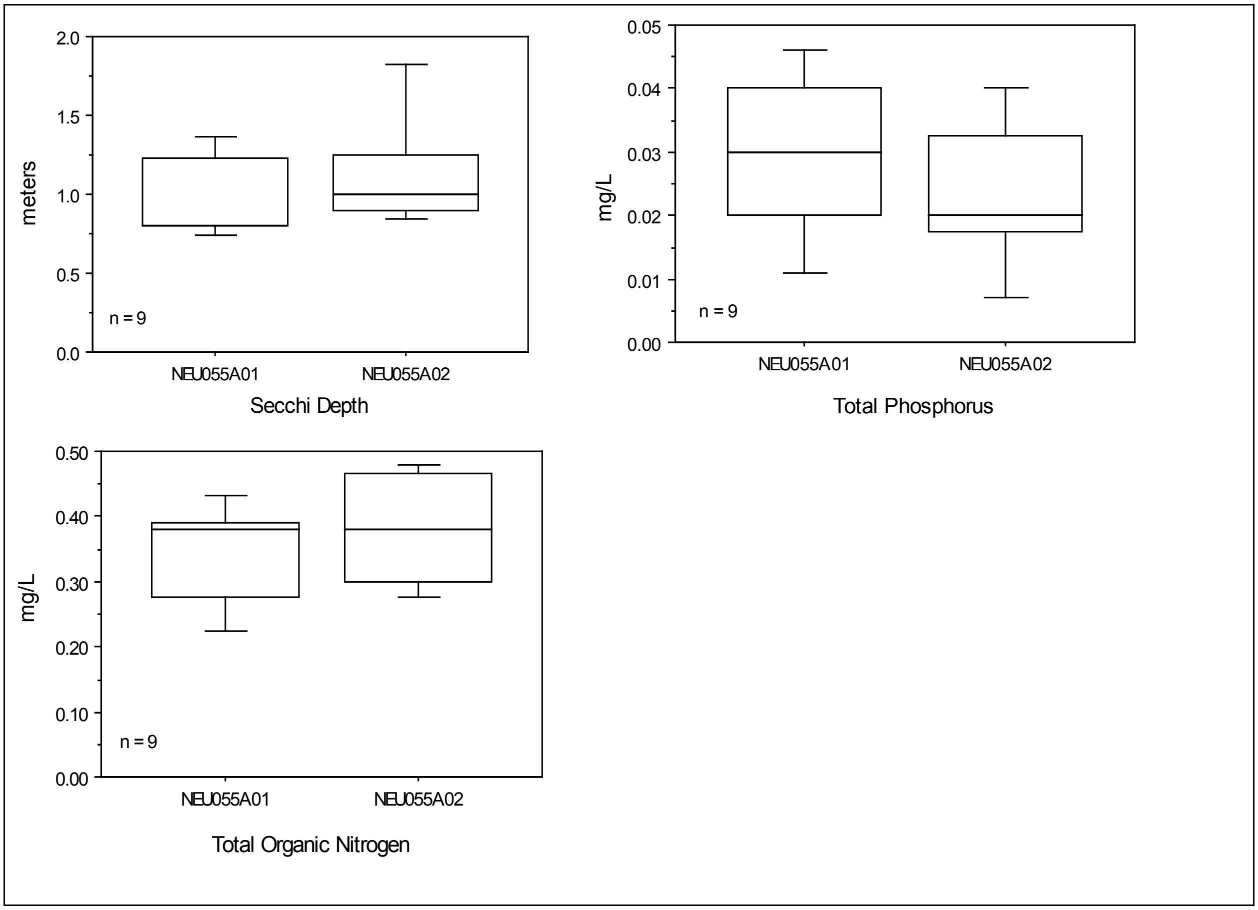


Figure 50. **Spatial relationships among biological and water chemistry data from Lake Wheeler, 1981 – 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.**

Lake Benson

Lake Benson is an impoundment located on Swift Creek in southern Wake County (Figure 51). The first impoundment on this site, Rand's Pond, was built in 1844. In 1927, the City of Raleigh purchased the land and the pond for use as a water supply. The pond was expanded in 1953 to bring the total storage capacity up to its current level. It remains as a future water supply for the city. Currently, the lake is used only for recreational purposes.

The topography of the immediate drainage area is characterized by rolling hills with approximately half being forested. Urban land use planning will undoubtedly play a major role in the development of the watershed.

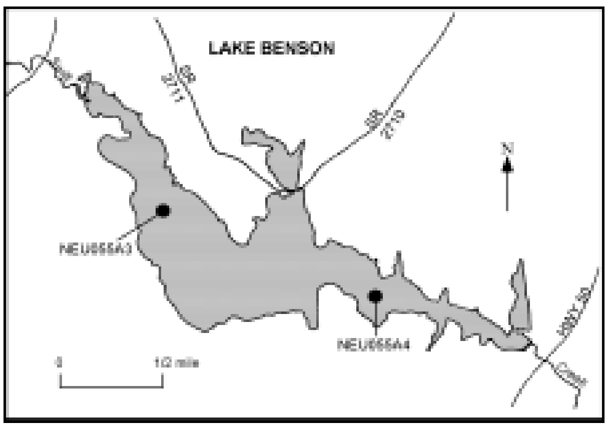


Figure 51. Monitoring sites at Lake Benson, Wake County.

The lake was recently monitored in June, July and August, 2000 (Table 25). Secchi depths were always less than 1 m. Mean total phosphorus, total Kjeldahl nitrogen, and total organic nitrogen concentrations ranged from moderate to elevated. Surface metals were less than laboratory detection levels, except for manganese in June and July (440 and 260 µg/L, respectively). These concentrations were greater than the water quality standard of 200 µg/L for a water supply reservoir.

The lake was previously monitored in 1996 and 1995 (Table 25). In 1996, Secchi depths were less than 1 m; total phosphorus and ammonia concentrations were 0.03 mg/L; and total Kjeldahl nitrogen concentrations were approximately 0.5 mg/L.

In 1995, chlorophyll *a* concentrations were low. Total phosphorus concentrations values at both lake stations and moderate total Kjeldahl nitrogen values. Metals values were below the NCDWQ laboratory detection levels except for copper (6.2 µg/l) and zinc (24 µg/l). These values were not greater than the applicable state water quality action levels.

Based upon NCTSI scores, the lake was also eutrophic in 1995 and 1996.

Data collected from 1988 through 2000 for the four constituents of the NCTSI were summarized using box and whisker plots (Figure 52). Median values for the these parameters were similar between the two lake sampling sites.

Table 25. Biological and water chemistry data for Lake Benson, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/09/2000	---	---	0.03	0.43	---	0.8
07/18/2000	---	---	0.04	0.40	---	0.5
06/07/2000	---	---	0.05	0.45	---	0.6
08/30/1996	---	---	0.03	0.42	---	0.4
09/01/1995	2.4	Eutrophic	0.04	0.23	9	0.6

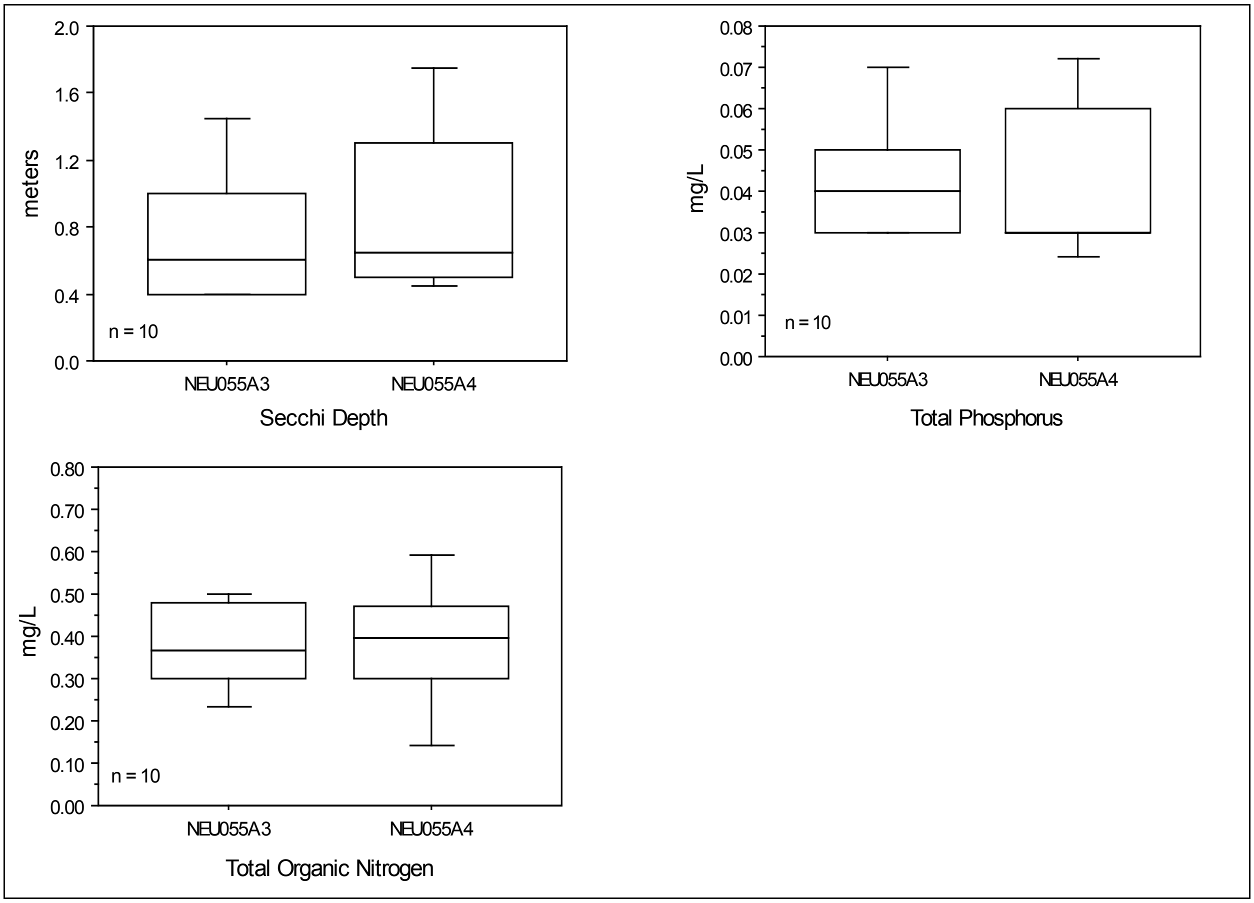


Figure 52. Spatial relationships among biological and water chemistry data from Lake Benson, 1981 – 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.

Phytoplankton Monitoring

Algal Bloom - Lake Crabtree
A bloom of the blue greens *Anabaena* and *Aphanocapsa* was documented in Lake Crabtree during August 1999. These taxa are indicators of eutrophic conditions and are know to cause taste and odor problems.

NEUSE RIVER SUBBASIN 03

Description

This subbasin is located in southern Wake and central Johnston counties and is experiencing rapid growth in residential development. The greatest development is occurring in the upper reaches of the Middle Creek watershed, which contains the cities of Cary, Fuquay-Varina and Apex (Figure 53).

Middle Creek is the largest stream in this subbasin. It generally has moderate flow, and it is rated with piedmont criteria. However, many tributaries to Middle Creek are slow moving and exhibit coastal plain ecoregion characteristics. Many of these tributaries to Middle Creek drain agricultural areas.

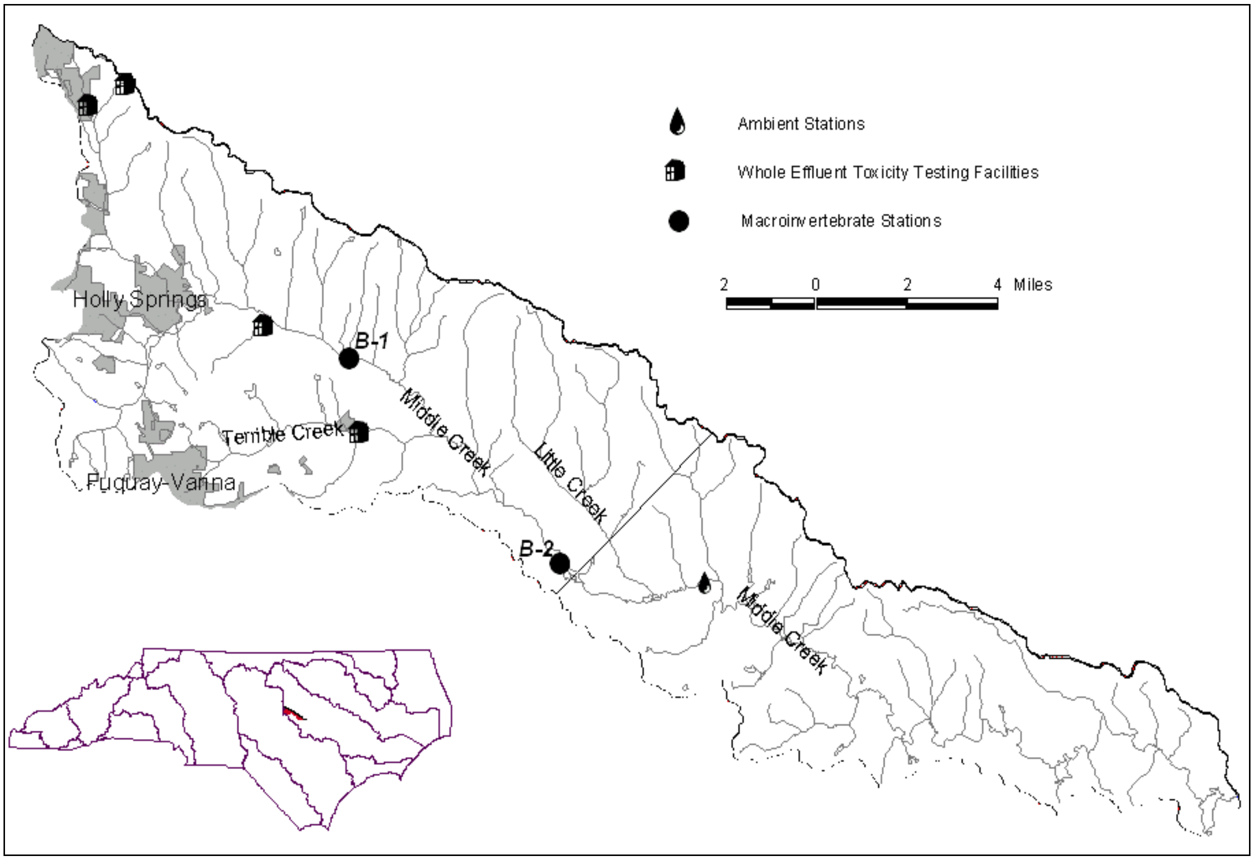


Figure 53. Sampling sites in Subbasin 03 in the Neuse River basin.

Overview of Water Quality

Middle Creek is the only stream in this subbasin with enough flow to assess using current benthos criteria. Middle Creek was sampled at several locations between 1986 and 1995, during both special studies and basin assessments. It was rated Fair at two sites using benthic invertebrate data in 1986 and 1995 (SR 1375) and in 1987 (NC 50) (Table 26). At SR 1375, Middle Creek rated Good-Fair in 1991, Fair in 1995, and Good-Fair in 2000.

Middle Creek at NC 50 (near Clayton) is the only ambient station in this subbasin. Data for 1996 - 2000 seemed to indicate some water quality problems. For example, nitrate+nitrite-nitrogen concentrations have been elevated and were in the 90th percentile at 4.6 mg/L; maximum concentrations of Total Kjeldahl nitrogen were 12 mg/L. Both nutrient concentrations were the highest recorded in the basin (among ambient monitoring sties) for this reporting period.

In addition, this site also had somewhat elevated measurements of specific conductance with 90th percentile levels at 326 µmhos/cm and maximum measurements at 530 µmhos/cm. More detailed information is presented in the Ambient Monitoring section of this report.

Since March 25, 1996, the Cary South WWTP, which discharges upstream of the SR 1375 and NC 50 sites, has failed 3 of 25 toxicity tests. Other facilities in this subbasin which are required to test their effluent's toxicity include the Apex WWTP, the Fuquay-Varina WWTP, and Star Enterprise. None of these facilities were having serious difficulty consistently passing the toxicity tests.

Table 26. Waterbodies monitored in Subbasin 03 in the Neuse River basin for basinwide assessment, 1995 - 2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Middle Cr[2]	Wake	SR 1375	Fair	Good-Fair
B-2	Middle Cr[2]	Wake	NC 50	Good-Fair	Good-Fair

[1]B = benthic macroinvertebrate monitoring sites.
[2]Data are available before 1995, refer to Appendix B2.

River and Stream Assessment

Flows in Subbasin 03 for the 2000 spring through summer (March-August) sampling period were lower than historic monthly flow means (1939 - 2000) for the same period except August 2000 when the monthly flow exceeded the historic August monthly flow mean (Figure 54).

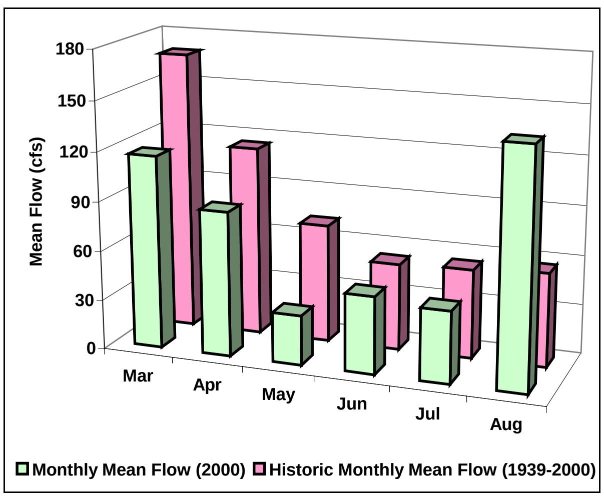


Figure 54. Spring and summer monthly mean flow and historic monthly mean flow at Middle Creek near Clayton, Johnston County.

Middle Creek, SR 1375

Middle Creek at this site has unstable banks and several breaks in the riparian zone. These factors may lead to greater bank erosion and increased levels of nonpoint pollution. Middle Creek also had a very sandy substrate (more than 50 percent sand). At the time of the 2000 sampling, flows had receded to normal levels, although just two weeks prior, this subbasin had experienced high levels of rainfall.

Middle Creek at SR 1375, Wake County

This site was first sampled for benthos in 1986 as part of a special study to assess water quality in the Middle Creek watershed before the Town of Cary's new southeast WWTP began discharging (Biological Assessment Unit Memorandum B870515). It has been sampled three times since then. In 1991, it became part of the basinwide monitoring program to monitor water quality in the upper section of the watershed. Improvements in the wastewater treatment plant were made in 1987, and in 1991, the bioclassification improved from Fair to Good-Fair. Bioclassification in 1995 reverted back to Fair but it has improved to Good-Fair for 2000. This was based upon the EPT abundance increasing from 42 to 89.

Major changes in taxa between 1995 and 2000 include the addition of four new mayflies (*Caenis, Tricorythodes, Centroptilum,* and *Stenonema exiguum*). As a result, the EPT BI decreased and the EPT S and Total S increased between 1995 and 2000 (Figure 55).

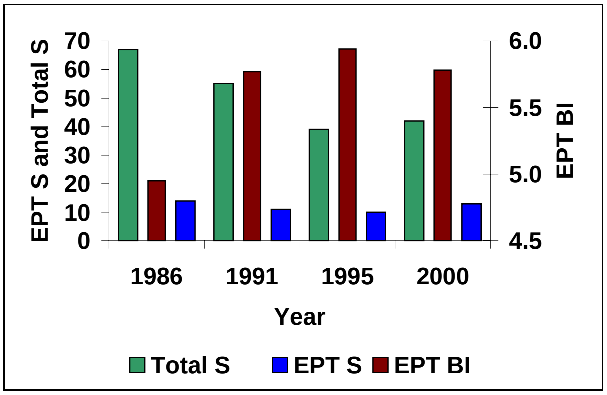


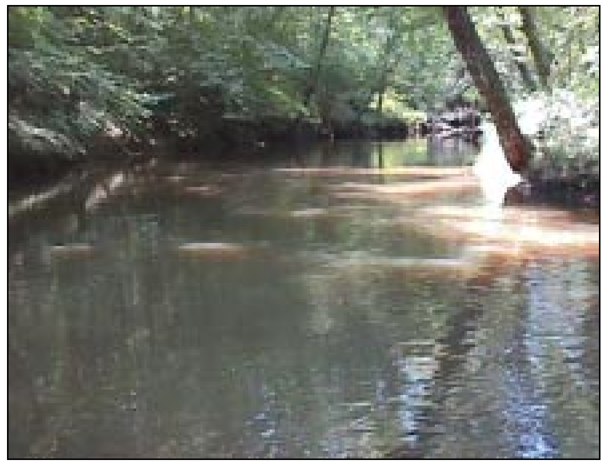
Figure 55. Total (Total S) and EPT (EPT S) taxa richness and EPT Biotic Index (EPT BI) at Middle Creek, SR 1375, Wake County, 1986 - 2000.

Increased diversity of intolerant mayfly taxa and the decrease of the EPT BI from 1995 to 2000, may indicate slightly improving water quality at this site.

Middle Creek, NC 50

This ambient monitoring station has been sampled for benthos six times since 1987. The station is located just before Middle Creek's confluence with the Neuse River. Overall, physical conditions of the stream appeared generally healthy: the banks were stable, the riparian zone had few breaks, and there was cover for fish and other organisms. However, there is a very high percentage of sand in the substrate (approximately 75 percent) and riffles are poorly defined.

The sediment load in this stream is most likely from development and agriculture practices throughout this watershed. In fact, recent research (Trimble 1997) has demonstrated that instream bank erosion is a major contributor to a stream's overall sediment load and can actually account for as much as two-thirds of total bed load. Because this watershed is experiencing rapid growth, incursions into the riparian zone and increased peak flows can be expected because the amount of impervious surface continues to increase. Corresponding increases in bank erosion and instream sedimentation should also be expected to occur.



Middle Creek at NC 50, Wake County.

This site is monitored to integrate water quality over the entire Middle Creek watershed. Water quality ratings improved here after improvements were made to upstream wastewater treatment facilities in 1987. Bioclassifications at this site have been Good-Fair since 1990 and this site also received a Good-Fair benthos rating in 2000.

NEUSE RIVER SUBBASIN 04

Description

This subbasin is located in the inner coastal plain ecoregion. Major tributaries include Stoney Creek, Mill Creek, Hannah Creek, and Black Creek (Figure 56). The topography in this area is very flat with numerous slow-moving streams and swamps.

Agriculture (including animal operations) is the major land use. Benson is the largest town in the subbasin and its WWTP has a permitted discharge of 1.5 MGD into Hannah Creek.

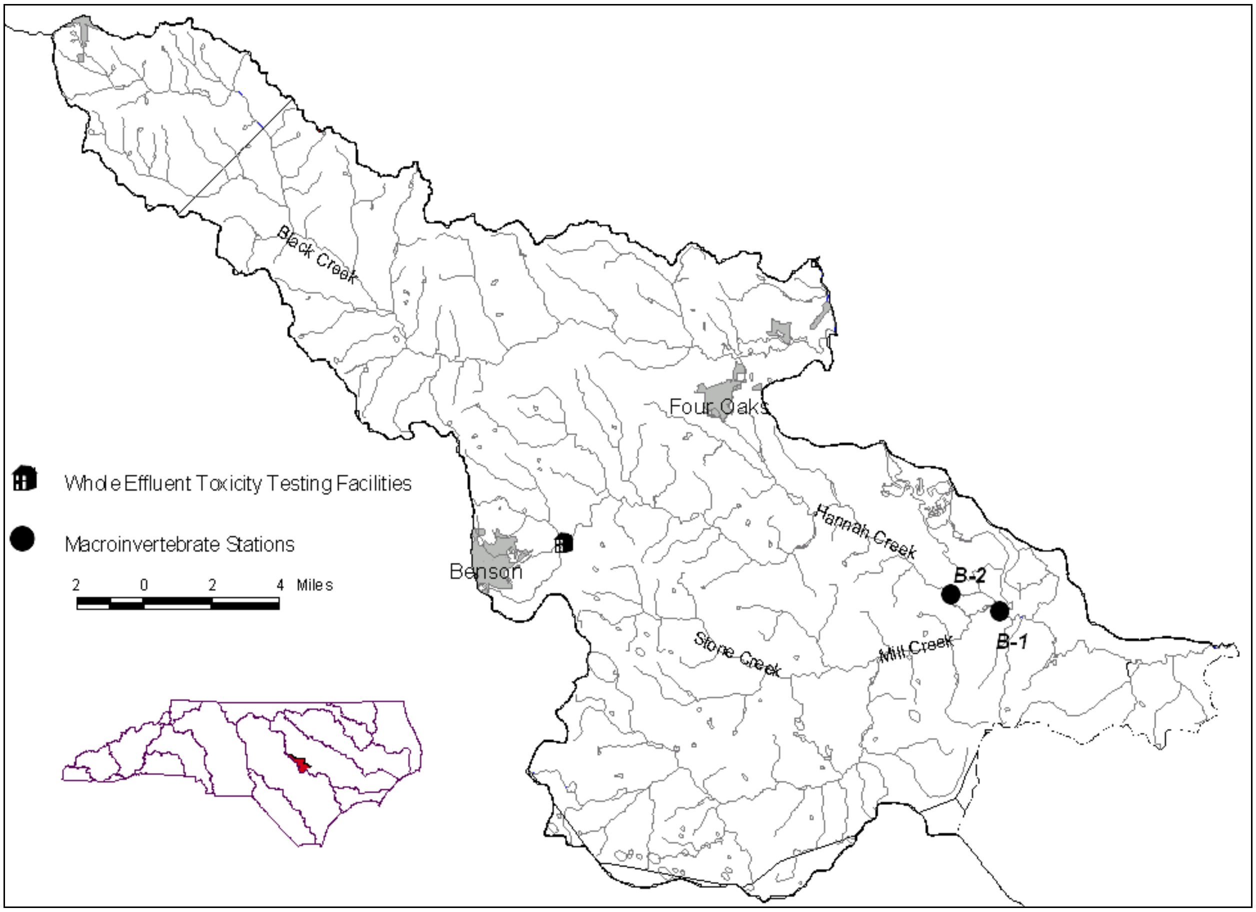


Figure 56. Sampling sites in Subbasin 04 in the Neuse River basin.

Overview of Water Quality

In 1995, four streams were sampled for benthic macroinvertebrates in this subbasin: Black Creek received a Fair rating, while Mill Creek, Stone Creek, and Hannah Creek received Good-Fair ratings. In 2000, Black Creek and Stone Creek were not sampled due to apparent hurricane effects; Mill Creek maintained its Good-Fair rating, while Hannah Creek declined to Fair (Table 27).

The streams in this subbasin are mostly small and seemed to incur some natural stress due to low flows during drought periods. In addition, the substrates are consistently a homogeneous mixture of sand and silt. The instream habitat was generally sparse and offered little refuge for benthos during high flows.

Further stresses in this subbasin may have resulted from the effects of Hurricanes Bertha and

Fran in 1996, and Hurricane Floyd in 1999. The combined effects were evident during sampling. Notable increases of tree blowdowns in most streams have exacerbated already slow flowing streams. In addition, observations between 1995 and 2000 seemed to indicate there has been a drastic increase in the amount of silt and sand deposited in the streams. Further, there was extensive bank erosion found throughout this subbasin.

These factors have combined to change the physical structure of several of the sites to such an extent as to make them unsuitable for sampling. Examples of these differences from pre-hurricane 1995 conditions to 2000 conditions were seen in Black Creek and Stone Creek. At these two sites, the changed conditions resulted in lack of flows and no benthos collections.

The Town of Benson is the only major NPDES permitted discharger in this subbasin. Benson's WWTP had 38 pre 2000 whole effluent toxicity passes and 12 pre 2000 fails. However, recent data revealed that the facility has yet to fail a test in 2000.

Table 27. Biological sampling in Neuse River Subbasin 04 for basinwide assessment, 1995 - 2000.

Map #	Waterbody	County	Location	1995	2000
B-1	Mill Cr	Johnston	SR 1009	Good-Fair	Good-Fair
B-2	Hannah Cr[2]	Johnston	SR 1009	Good-Fair	Fair

[1]B = benthic macroinvertebrate monitoring sites.
[2]Data are available before 1995, refer to Appendix B2 or Appendix F3.

River and Stream Assessment

Monthly mean gage heights in Subbasin 04 for the 2000 spring through (March-August) sampling period were slightly higher than corresponding monthly mean gage heights for the same period from 1999 (Figure 57).

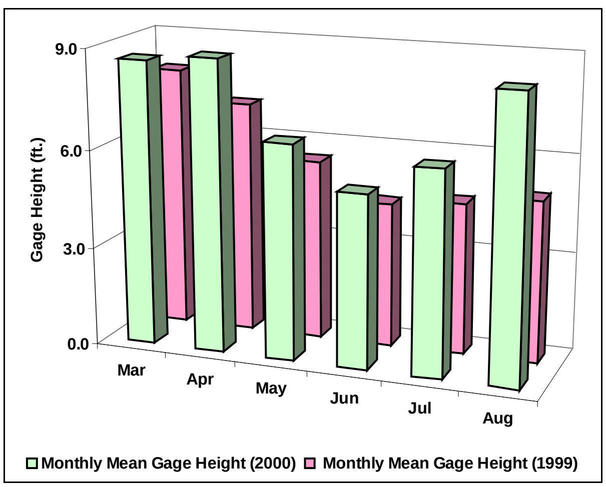


Figure 57. Spring and summer monthly mean gage height, 1999 and 2000, at the Neuse River at Smithfield, Johnston County.

Many streams in this subbasin have been impacted by the effects of hurricanes since 1996. This is particularly true in areas of Johnston County. In many cases, the downed trees along with an increase in the beaver population, have dammed up portions of the streams. Fish community samples were not collected at seven sites due to the combination of deadfall and beaver dams: Hannah Creek at SR 1162; Mill Creek and SR 1122 and SR 1124; Jumping Run at NC 96; Stone Creek at SR 1138, SR 1140, and NC 96. Other sites evaluated but not sampled were Black Creek at SR 1330 (non wadeable stretches) and Hannah Creek at SR 1162 (water restricted to areas approximately one meter wide and a couple of inches deep).

Mill Creek, SR 1009

Mill Creek drains an area that is primarily forested and has no permitted dischargers. Mill Creek has a well-defined channel, approximately eight meters wide, with moderate flow and abundant dissolved oxygen level (6.8 mg/L).

Instream habitat was good, although the substrate was a nearly homogeneous mix of sand and silt. The riparian zone was intact and the stream banks were stable with no indication of erosion.

Mill Creek at SR 1009, Johnston County.

This site has been sampled twice for benthos since 1991 and has always maintained a Good-Fair rating. It also received a Good-Fair for 2000 using Coastal Plain A Criteria. The EPT taxa richness (12) was identical over the 1995 - 2000 sample period, indicating no change in water quality.

Although the habitat at this site is good and the upstream land use is essentially undisturbed, the Good-Fair rating would seem to indicate some degradation. However, this rating may represent the pinnacle of benthic communities for streams of this size in this subbasin. Reasons for this likely include summer low flows and corresponding oxygen depressions. Although the dissolved oxygen and the flow were good during the August sample, the sample did follow an extensive period of rainfall. In addition, the water was quite tannic and this was reflected in the stream's pH (5.9). All these factors tended to indicate a swamp-like system which are known to support generally depauperate and tolerant benthic communities.

Hannah Creek, SR 1009

Hannah Creek was similar to Mill Creek in that the channel was well defined and there was moderate flow. However, despite these characteristics, the dissolved oxygen concentration was only 2.9 mg/L during the August 8, 2000 sample. Instream habitat was good with large quantities of root mats, undercut backs, and snags. However, as is the case with most streams in this subbasin, the substrate was a nearly homogeneous mix of sand and silt. There was no indication of bank erosion and the riparian zone was intact and without breaks.

Hannah Creek at SR 1009, Johnston County.

This site has been sampled three times for benthos since 1991. An EPT sample in 2000 produced 11 taxa and a Fair bioclassification. This was a decline from Good-Fair (13 taxa) in 1995. In 1991, Hannah Creek also rated Fair. These apparent cyclical changes in bioclassification are likely not the result of changes in flow. Monthly mean flows in July 1991 and 1995 were 70.7 cfs. and 88.2 cfs, which exceeded historical July means by 14.2 and 33 cfs, respectively. In addition, the 30-day mean flow before the August 15, 2000 sample was 147.7cfs which was also extremely high.

Higher than normal flows from all three sampling periods, coupled with changes in bioclassification, may indicate that the changes in the EPT community were due to small changes in water quality. This flow-independent bioclassification conclusion is further supported by the EPT abundance which has been essentially identical among the three sampling periods (Figure 58).

Although the 1995 sample had three intolerant taxa present which were not collected in 1991 or 2000 (the mayfly *Paraleptophlebia* sp.*,* and the caddisflies *Nyctiophylax moestus* and *Triaenodes injusta*), the dominants at this site (the mayfly *Stenonema modestum*, and the caddisfly *Cheumatopsyche* sp.) have remained essentially unchanged through all three samples. Indeed the EPT taxa richness actually reflect only very small and subtle changes—not generally indicative of drastic community alterations (Figure 58).

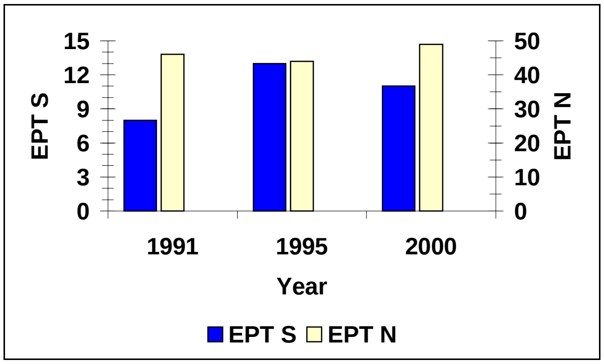


Figure 58. EPT taxa richness (EPT S) and abundance (EPT N) at Hannah Creek at SR 1009, Johnston County.

While the bioclassification changes from 1991 - 2000 may be due to very subtle water quality effects, these changes may also be the result of sampling artifacts or natural variation.

Special Studies

Black Creek, SR 1330

Black Creek is the largest stream in the subbasin with a drainage area of 73.3 mi^2. The creek was reconnoitered at every Johnston County bridge crossing. Dissolved oxygen concentrations were very low (range = 1.8 mg/L at US 701 to 2.6 mg/L at SR 1330). With the exception of the SR 1330 site, all sections had no visible flow. Although the SR 1330 site technically had some flow, it was extremely slow despite recent rainfall. Additionally, the SR 1330 site had a very homogeneous substrate of nearly all sand and silt.

Black Creek at SR 1330, Johnston County.

These observations, coupled with the low dissolved oxygen observed throughout the drainage, indicated that this waterbody is likely a swamp stream and should not be sampled during the summer. The possibility of using swamp-sampling methods on Black Creek may also prove ineffective, as summer water levels were quite high. It is expected that water levels during the winter would be even higher, therefore making it unsafe to sample.

This site was rated Fair in both 1991 and 1995 based on benthos data and has only been sampled on these two occasions. No suitable sampling sites were found in 2000. The prior bioclassifications should be changed to Not Rated because of this new information.

Stone Creek, SR 1138

Stone Creek was added in 1995 to complement fish community data. It is a small stream with a strongly braided channel. Although this stream was rated Good-Fair in 1995, no suitable sampling sites were found during 2000. All sites lacked flow, had poorly defined channels, and low dissolved oxygen concentrations and pH. For example, at SR 1338 the dissolved oxygen was 1.8 mg/L, the pH was 5.8, the channel was extremely braided and there was very poor flow.

Stone Creek at SR 1138, Johnston County.

Based on changes in this site between 1995 and 2000, it seemed that hurricane effects (in the form of massive instream sedimentation and tree blow down) have drastically restricted already weak flows and had shifted this stream to a more swamp-like system. Consequently, Stone Creek was not sampled. Furthermore, the stream was very deep during the summer and sampling in the winter, when water levels are higher, may prove unsafe. The prior Good-Fair bioclassification should be changed to Not Rated because of this new information.

NEUSE RIVER SUBBASIN 05

Description

This subbasin is in the coastal plain ecoregion of North Carolina (Figure 59). The predominant land use is agriculture and animal operations but also include the urban areas of Kinston, portions of Goldsboro and the small town of LaGrange.

The Neuse River in this subbasin has moderate to slow flow throughout the year, but many tributaries become stagnant during periods of low rainfall. The major tributaries include Bear Creek, Falling Creek, and Southwest Creek.

The cities of Kinston, Goldsboro, and LaGrange all have WWTP discharges to the Neuse River and tributaries to the Neuse River in this subbasin.

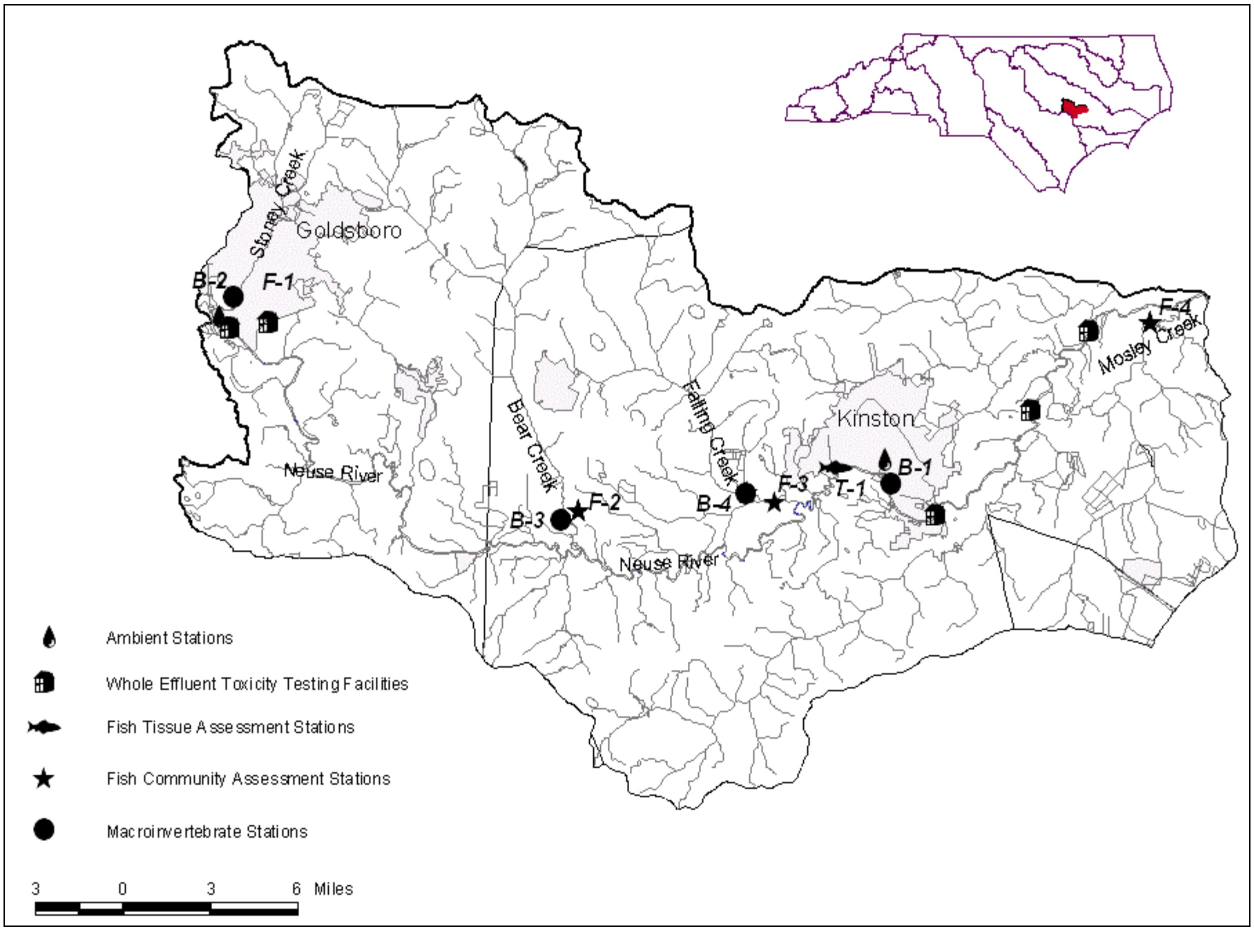


Figure 59. Sampling sites in Subbasin 05 in the Neuse River basin.

Overview of Water Quality

The Neuse River at NC 58 near Kinston has received a Good rating (using benthic macro-invertebrate data) from 1988 to 2000 (Table 28).

Stoney Creek receives runoff from the City of Goldsboro and from Seymour Johnson Air Force Base. This stream received a Fair rating, which is an improvement from 1995 when it was rated Poor. Fish diversity at Stoney Creek also increased slightly from 13 species in 1995 to 15 species in 2000 and fish abundance also increased from 112 individuals in 1995 to 259 individuals in 2000.

Bear Creek received a Good-Fair rating, which is an improvement from 1995 when it was rated

Fair. Fish community data at Bear Creek have remained steady between 1995 and 2000 despite temporary hurricane impacts.

Falling Creek received a Fair rating in 2000, but it was rated Good-Fair in 1995 for benthos. Fish data were taken downstream at SR 1340. The fish community was quite diverse and showed little difference between 1995 and 2000, although abundance increased between years.

Southwest Creek was not sampled for benthos in 2000 due to a lack of flow. Reconnaissance of the creek in 2000 revealed that this waterbody had low dissolved oxygen levels (2.5 mg/L) and little or no flow. This is a low-gradient swamp system and should be evaluated with swamp criteria after the criteria are finalized.

Twenty fish tissue samples were taken from the Neuse River near Kinston in 2000. Metal concentrations were less than laboratory detection levels or were less than state and federal regulatory criteria.

Cliffs of the Neuse Lake was sampled three times during the summer of 2000. Acidity in this lake is quite low, but indicative of the Black Creek Formation aquifer and is a natural condition. Other limnological variables were representative of a normal oligotrophic lake.

There are two ambient monitoring stations on the Neuse River in this subbasin: near Goldsboro and at Kinston. For the period of 1996 - 2000, these sites had elevated concentrations of nitrate+nitrite (NO_3+NO_2-N) with 90th percentile levels of 1.4 mg/L (at Goldsboro) and 1 mg/L (at Kinston). Both concentrations were among the highest in the basin. Maximum concentrations at these sites were also high -- 1.9 mg/L (at Goldsboro) and 2 mg/L (at Kinston. Furthermore, the second greatest maximum concentration of Total Kjeldahl nitrogen (6.1 mg/L) and the highest concentration of total phosphorus (1.7 mg/L) were measured at the Kinston site.

Not surprisingly, both these sites also had very low recorded levels of dissolved oxygen during the reporting period (0.8 mg/L at Goldsboro and 0.4 mg/L at Kinston). In addition, specific conductance values at Kinston had among the highest maximum measurement in the basin, excluding the estuarine ambient sites (1,903 µmhos/cm). More detailed information is presented in the Ambient Monitoring section of this report.

In this subbasin, eight NPDES permitted facilities are required to test the effluent's toxicity. The only discharger having obvious trouble passing toxicity tests is the Celotex/GAF Materials Corporation. Celotex discharges to an unnamed tributary of the Neuse River and has failed 34 pre 2000 toxicity tests while passing only 14. For 2000, the facility has passed and failed one test each. It seems that this facility is having severe compliance problems and may be having deleterious effects on receiving waters.

Table 28. Waterbodies monitored in Subbasin 05 in the Neuse River basin for basinwide assessment, 1995 - 2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Neuse R	Lenoir	NC 58	Good	Good
B-2	Stoney Cr	Wayne	SR 1920	Poor	Fair
B-3	Bear Cr	Lenoir	SR 1311	Fair	Good-Fair
B-4	Falling Cr	Lenoir	SR 1519	Good-Fair	Fair
F-1	Stoney Cr	Wayne	SR 1920	Not rated	Not rated
F-2	Bear Cr[2]	Lenoir	SR 1311	Not rated	Not rated
F-3	Falling Cr	Lenoir	SR 1340	Not rated	Not rated
F-4	Moseley Cr[2]	Craven	SR 1475	Not rated	Not rated
T-1	Neuse R	Lenoir	at Kinston	---	---
	Cliffs of the Neuse Lake	Wayne		Oligotrophic	---

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available before 1995, refer to Appendix B2 or F3.

Flows in Subbasin 05 for the 2000 spring through summer (March-August) sampling period were lower than all historic monthly flow means (1987-2000) for this period (Figure 60).

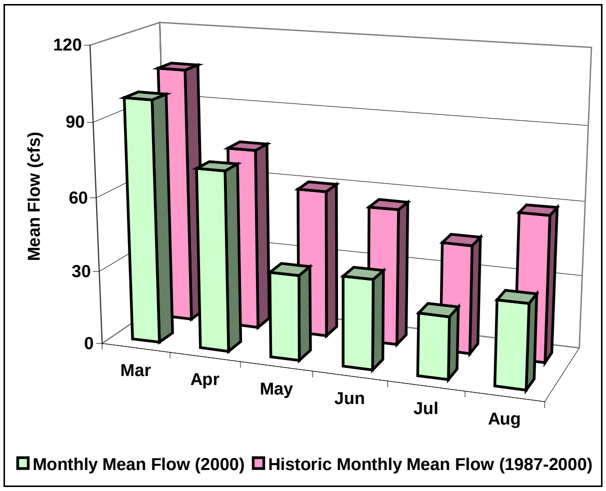


Figure 60. Spring and summer monthly mean flow and historic monthly mean flow at Bear Creek, near Mays Store, Lenoir County.

Three locations on Southwest Creek were not sampled for fish community assessment due to the stream being too wide and/or deep. The sites evaluated but not sampled were at SR 1804, NC 58, and US 258, all in Lenoir County.

A NCIBI metric and scoring criteria revision is currently underway for the North Carolina coastal plain ecoregion. Therefore, no fish community sites in this subbasin were assigned ratings.

Neuse River, NC 58

The Neuse River at Kinston is very wide (approximately 80 meters), has a sandy substrate and little instream habitat for benthos or fish. There was massive bank erosion and the riparian zone was largely not intact. The river at this point receives the discharge from Kinston's WWTP, as well as all the urban and agricultural runoff from the entire watershed (approximately 2,700 mi^2) above Kinston.

Neuse River at NC 58 Kinston, Lenoir County

Despite these apparent stresses, it received a Good rating for 2000 and has historically demonstrated the ability to support a moderately intolerant macroinvertebrate community by consistently rating Good since 1988, using piedmont criteria.

Stoney Creek, SR 1920

Stoney Creek is a small, sandy bottom, tannin-stained stream that drains a large portion of Goldsboro as well as Seymour Johnson Air Force Base.

Upstream view of Stoney Creek at SR 1920, Wayne County.

The flow in this steam was very good when sampled for fish and benthos in 2000. Instream habitats were good with large quantities of root mats, snags, and macrophytes. The riparian zone was largely intact although there were some breaks associated with the military base. Despite the fact that stream drains a large portion of Goldsboro; the stream banks were stable. The minimally disturbed nature of the site is evidenced in the habitat score of 86.

This stream was sampled using EPT methods in 1995 and received a Poor rating. A Full Scale sample taken in June 2000 resulted in a Fair rating. An additional EPT sample from August 2000 also resulted in a Fair rating. In fact, the 1995 EPT taxa richness was four while the 2000 EPT taxa richness doubled to eight. Notable EPT additions for 2000 included the edge dwelling leptocerid caddisflies *Oecetis persimilis, Triaenodes ignitus,* and two additional baetid mayflies, *Baetis intercalaris* and *B. propinquus.*

The trend at this site seems to be a slight improvement in water quality. However, it still seemed to be impaired.

While the number of fish species increased only slightly from 13 in 1995 to 15 in 2000, the number of individual fish collected more than doubled from 112 in 1995 to 259 in 2000. The most abundant fish for both years was the American eel. American eels constituted 41 percent of the fish collected in 1995 and 29 percent in 2000. No intolerant species were collected in either year.

Bear Creek, SR 1311

Bear Creek, which flows just west of the Town of LaGrange, is an eight meter wide, sandy bottom tributary to the Neuse River. The area near SR 1311 is mostly forested, although there are agricultural activities in the upper watershed. Instream habitat was good with snags, root mats, and undercut bank habitat. The substrate was nearly all sand and the riparian zone was intact. During the fish community monitoring, the habitat score was 81.

Bear Creek at SR 1311, Lenoir County.

Bear Creek at SR 1311, Lenoir County.

Bear Creek rated Good-Fair in 2000 for benthos, Fair in 1995 and Good-Fair in 1991. The fluctuating ratings exhibited over the last three sampling cycles may be attributable to differences in flow between years (Figure 61). These flow data, combined with the correlating changes in EPT taxa richness (Figure 62), suggested that changes in bioclassification at Bear Creek may be flow related.

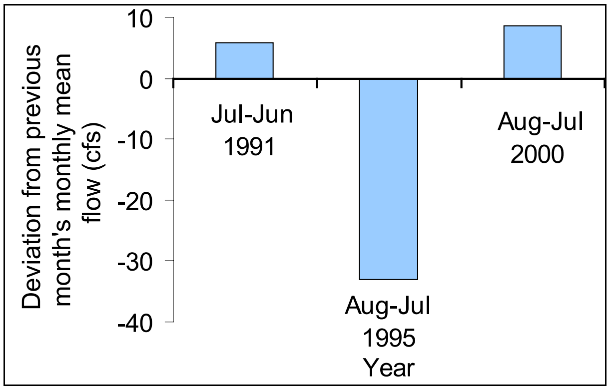


Figure-61. Bimonthly flow deviations for Bear Creek at SR 1311, Lenoir County.

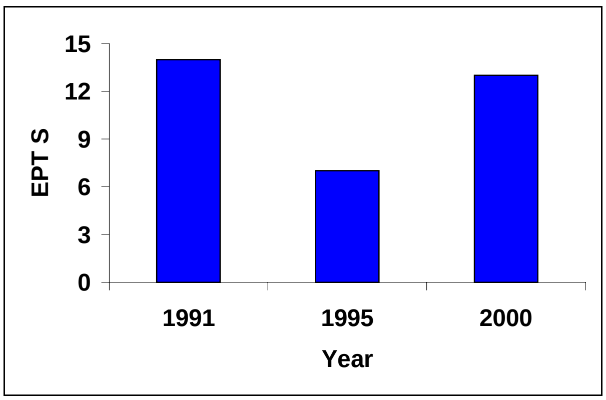


Figure 62. EPT taxa richness (EPT S) at Bear Creek, SR 1311, Lenoir County, 1991 - 2000.

Notable additions in taxa for 2000 include three baetid mayfly species (*Baetis intercalaris, B. propinquus,* and *Acerpenna pygmaeus),* the mayfly *Stenacron interpunctatum* and the perlid stonefly *Perlesta* sp. All these taxa were absent from the 1995 sample when flows were highest. Their absence was likely the result of scour effects. Conversely, all these taxa, except for *B. intercalaris* and *A. pygmaeus*, were collected from the lower flow years of 1991 and 2000.

Regarding the fish community at Bear Creek, this site was sampled as part of the post Hurricane Fran study in the fall of 1996 in addition to the 1995 and 2000 basin wide surveys. When contrasted to the other data, the post hurricane sampling event showed an impacted fish community with only 12 species and 88 individuals collected (Figure 63). However, the fish communities in 1995 and 2000 were very similar in terms of diversity and abundance.

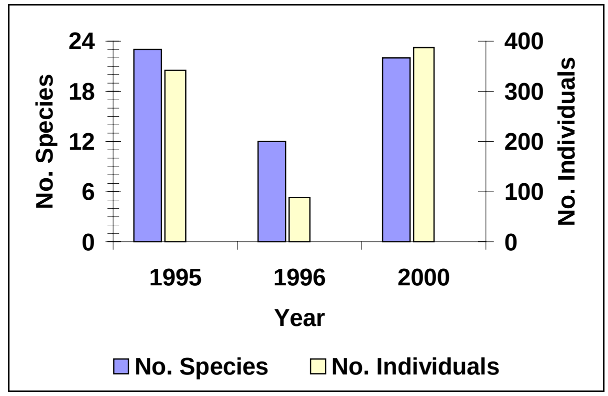


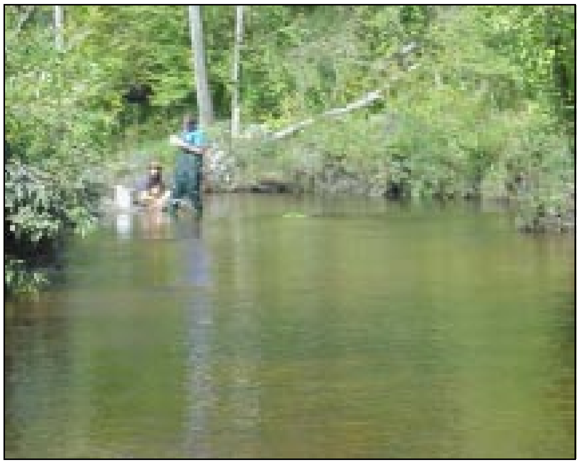
Figure 63. Number of species and individuals of fish at Bear Creek at SR 1311, Lenoir County.

The fish communities in 1995 and 2000 were also similar in that the dominant species was the satinfin shiner. It accounted for 42 percent of the fish collected in 1995 and 41 percent in 2000. These data indicated that although the fish community at this site was temporarily impacted in 1996 by Hurricane Fran, there were no long term impacts from Fran or the hurricanes of 1999.

Falling Creek, SR 1519

In 1991 and 1995, benthos samples were collected from Falling Creek at SR 1340. This site is approximately one mile from its confluence with the Neuse River. During several reconnaissance trips in 2000, this site had high water levels and no discernible flow. The site's proximity to the Neuse River subjects it to periods of high water and no flow during times when the Neuse River is high. This may result in spurious bioclassifications, related more to flow than to pollutants.

As a result, the benthos sample site was moved further upstream to SR 1519 where the river's influence is minimized. The new site at SR 1519 is still downstream of Mosley Creek which is the receiving stream for the Town of La Grange's WWTP. The substrate at the SR 1519 site has a homogeneous mix of sand and silt. The riparian zone was intact and there were no indications of bank erosion.



Falling Creek at SR 1519, Lenoir County.

In 2000, the stream was rated Fair. However, for a Fair rating, the range in EPT taxa is 6 to 11. This site had 11 EPT taxa which is also extremely close to the Good-Fair rating which requires at least 12 EPT taxa. In fact, EPT taxa richness in 1991 and 1995 was 14 and 12, respectively at the SR 1340 site. As a result, there is little difference between the two sites. Another site between these two was sampled in November 1999 after Hurricane Floyd. It also received a Good-Fair bioclassification.

Notable taxa at this site include the intolerant mayfly *Eurylophella* sp. The most intolerant species at this site was the mayfly *Acerpenna pygmaea* and it was common. The very slight decrease in EPT taxa richness was likely not due to La Grange's WWTP discharge because intolerant EPT taxa were also found.

Falling Creek, SR 1340

Although the Falling Creek catchment is largely agricultural, the area around this site is completely wooded. The stream was six meters wide with a sand substrate and clear tannin water. The habitat score was 95. This portion of the stream had been desnagged since Hurricane Fran.

Downstream view of Falling Creek at SR 1340, Lenoir County.

Both surveys have documented a very diverse fish community. The number of species of fish was similar in both years, but the number of individuals was drastically higher in 2000 than in 1995 (Figure 64). In 2000, 35 percent of the individuals collected were American eels.

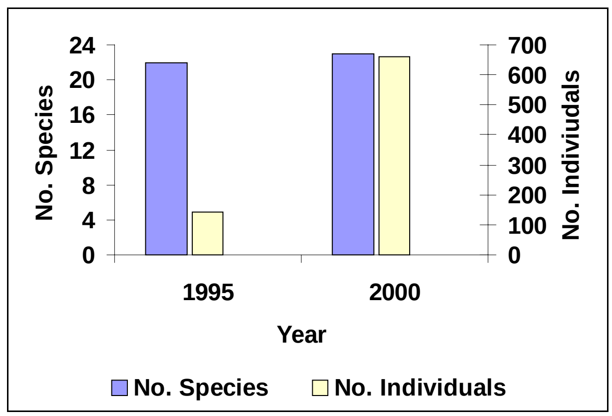


Figure 64. Number of species and individuals of fish at Falling Creek at SR 1340, Lenoir County.

Moseley Creek, SR 1475

The fish community at this site has been sampled four times; for the basin wide surveys in 1991, 1995, and 2000 and as part of the post Hurricane Fran study in 1996. In June 2000, the stream had a sand bottom and an estimated width of 12 meters. The habitat score was 61. During the post Hurricane Fran October 1996 collection, the width was estimated to be only eight meters with some areas of gravel substrate.

Upstream view of Moseley Creek at SR 1475, Craven County.

The number of individuals collected during the first two basin surveys and the 1996 study were similar, ranging from 188 in 1991 to 208 in 1996 (Figure 65).

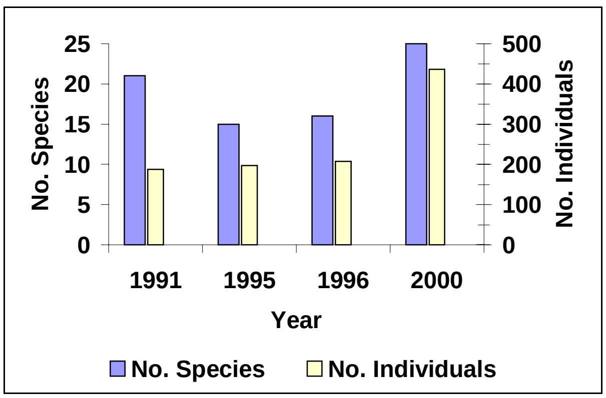


Figure 65. Number of species and individuals of fish at Moseley Creek at SR 1475, Craven County.

The number of species decreased from 21 in 1991 to 15 in 1995 and 16 in 1996 (Figure 65). The greatest number of species (25) and individuals (436) collected at this site were recorded in 2000, indicating a healthier fish community than in the past.

A different species has been most abundant for each of the four times this site has been sampled. In 1991, the redbreast sunfish was most abundant, in 1995, the eastern silvery minnow, in 1996, the mosquito fish, and in 2000, the satinfin shiner.

Special Studies
Southwest Creek, SR 1804

Southwest Creek is a tannin-stained, slow-moving stream that drains the area southeast of Kinston. Although this stream was sampled in 1991 and 1995, it was removed from the 2000 303 (d) List because it is a swamp stream and should be sampled and rated using swamp methods and criteria (NCDENR 2000).

This stream was reconnoitered again in the summer of 2000 and was found to have no flow and a poorly defined channel. Dissolved oxygen levels were 2.5 mg/L. As a result, it was not sampled.

Southwest Creek at SR 1804, Lenoir County.

Hurricane Fran Impacts

Three sites in this subbasin were assessed in October 1996 as part of the post Hurricane Fran study: Bear Creek at SR 1311, Falling Creek near SR 1546, and Moseley Creek at SR 1475 (NCDWQ 1997). The affects at Bear Creek and Moseley Creek were addressed previously.

At Falling Creek, a fish community sample was not collected at the basin monitoring site due to physical alterations: downed trees and changes in the flow patterns. Sampling was conducted at a site upstream near SR 1546 (Lenoir County) . The extremely low number of species (six) and individuals (51) collected clearly indicated the storm had a severe short-term impact on this fish community.

Falling Creek was sampled for benthic invertebrates in January 1997 to further evaluate the effects of Hurricane Fran. This stream received a Poor rating at this time, but recovered to Good-Fair in November 1999 (Biological Assessment Unit Memorandum 9915203).

Fish Tissue

Neuse River at Kinston

Twenty samples from the Neuse near Kinston were collected during May 2000 and analyzed for metals contaminants. The samples were collected as part of the NCDWQ efforts to monitor pollutants introduced into the Neuse basin following Hurricane Floyd. Likely sinks of many of the pollutants introduced by the storm (organics, pesticides, petroleum products, and nutrients) included bottom sediments and tissues of fish and shellfish. The Kinston site included areas where significant spills occurred, urban areas, and areas of hydrologic deposition.

Concentrations of metals in the fish tissue were less than laboratory detection levels or were below current USEPA, USFDA, and North Carolina criteria. (Appendices FT1 and FT2).

Lake Assessment

Cliffs of the Neuse Lake

Cliffs of the Neuse Lake is locate within Cliffs of the Neuse State Park in Wayne County (Figure 66) Mill Creek, the only significant tributary, was impounded in 1953 to form the lake. The watershed is completely forested and contained entirely within the park. This lake is used swimming and natural resource education.

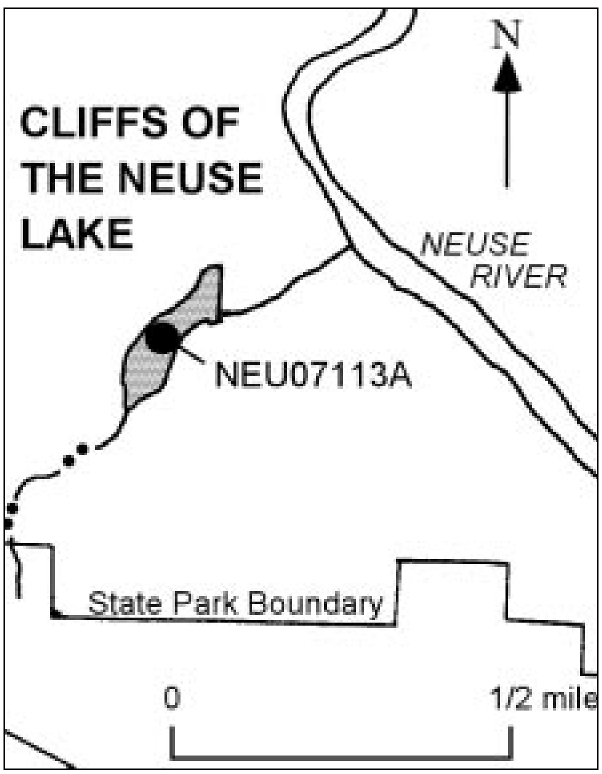


Figure 66. Monitoring sites at Cliffs of the Neuse Lake, Wayne County.

The lake was most recently monitored twice in July and once in August, 2000 (Table 29). Surface pH values were very low (4.4 s.u.). This lake is partially spring fed. The Black Creek Formation (aquifer) is located beneath Cliffs of the Neuse State Park. Water from this aquifer contains iron sulfite and organics. Iron sulfite forms sulfuric acid, making the water from the aquifer naturally acidic. Water from the springs in the lake are fed by the Black Creek Formation and this accounts for the low pH values (Bill Hoffman, State Geologist, pers.com.). In addition to the acidity, the lake is unusual in that benthic productivity is greater than planktonic productivity. This may also be due to the low pH of the water which does not provide favorable growing conditions for the planktonic algal commonly.

In July, Secchi depths were 2.4 and 3.1 m. The surface dissolved oxygen concentration on July 11 was 8.9 mg/L and increased to 9.3 mg/L at a depth of three meters. At four meters, the dissolved oxygen concentration decreased to 6.2 mg/L. This indicated that the greatest algal activity was occurring within the photic zone. Clumps of greenish-brown algae were observed at the surface. Samples were collected, however due to the deteriorated condition of the algae, species identification could not be made. This algae appeared to originate at the bottom of the lake.

Nutrient concentrations were low to moderate, except for nitrite plus nitrate which was elevated on July 11 (0.08 mg/L). Fecal coliform bacteria concentrations were less than 10 colonies/100 ml.

On August 16, surface dissolved oxygen was 8.3 mg/L. Clumps of more brownish algae were again observed on the surface. This algae appeared to be in a more deteriorated state as compared with observations made in July.

Table 29. Biological and water chemistry data for Cliffs of the Neuse Lake, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/16/2000	---	---	0.01	0.20	---	2.4
07/28/2000	---	---	< 0.01	0.38	---	2.4
07/11/2000	---	---	< 0.01	0.10	---	3.1
07/25/1995	-3.2	Oligotrophic	0.03	0.16	6	2.5

NEUSE RIVER SUBBASIN 06

Description

This subbasin consists of the Little River catchment, including segments in Franklin, Wake, Johnston, and Wayne counties (Figure 67). The character of the river changes rapidly in the upper segment as it flows from the piedmont into the coastal plain, and runs over several different rock types. Some smaller streams in this area have poor groundwater storage and are, therefore, susceptible to lack of flow during dry periods.

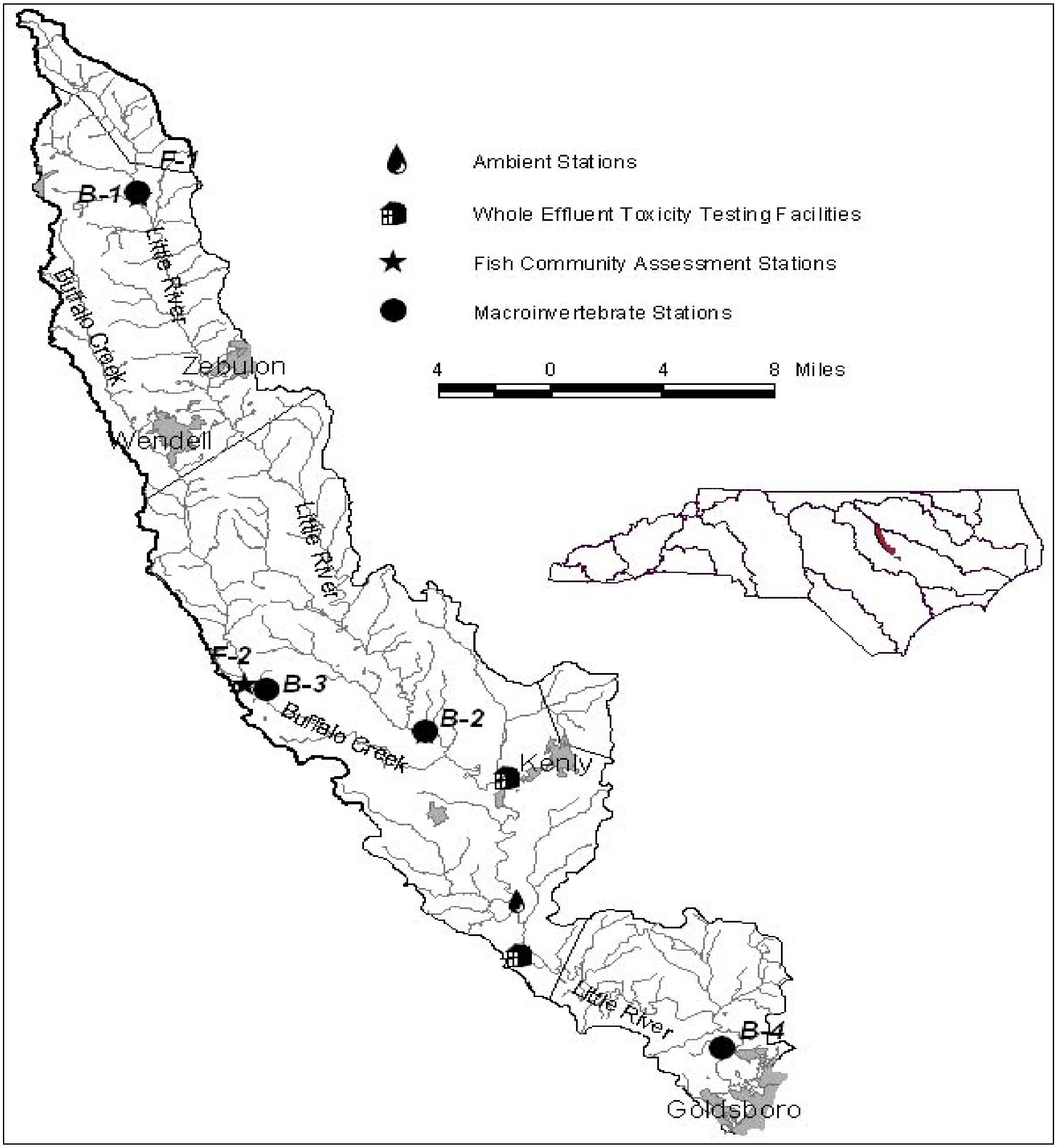


Figure 67. Sampling sites in Subbasin 06 in the Neuse River basin.

The upper segment of the river has fairly fast-flowing water, dropping out of the piedmont with a slope of 27 ft/mi. in the first two miles and 6 ft/mi. in the next 10 miles. This part of the catchment is underlain by granitic bedrock, often with a thin overlying soil layer. The Rolesville Outcrop is the largest expanse of granitic flatrock in the state, and this part of the subbasin includes land that is managed by the North Caroline Division of Parks and Recreation (LeGrand 1987).

The lower segment of the river has a lower gradient with a slope of only 2.6 ft/mi. for the last 61 miles of the river. These sections of the Little River (Johnston and Wayne counties) are evaluated as coastal plain sites.

Buffalo Creek is the major tributary of the Little River. This stream starts within the piedmont, but most of the stream has coastal plain characteristics. The upper segment (north of Wendell) is one of few locations in Wake County with large stands of bald cypress (LeGrand 1987). The lower segment now has many beaver dams, reducing the amount of flowing-water habitat.

The Little River has a diverse mussel population, including a number of rare species: *Alasmidonta heterodon*, *Villosa constricta*, *Elliptio lanceolata*, and *Fusconaia masoni*. A population of the endangered Tar River Spiny mussel (*Elliptio steinstansana*) has been recently found in the Johnston County portion of the river (John Alderman, pers. comm.). The Carolina madtom (*Noturus furiosus*) has been collected from the river in Johnston and Wayne Counties in the 1980s, although there are no data on its present distribution in this area. Invertebrate collections from the Little River in Wake and Johnston counties also included a number of unusual mayfly and caddisfly records: *Ephemerella needhami*, *Dibusa angata*, *Matrioptila jeanae*, *Protoptila*, and *Agapetus*. Rare invertebrates have usually been collected in spring samples, possibly due to low summer flows in most of the river.

Land use throughout the subbasin is primarily a combination of agriculture and forestry, with scattered small towns. The are four permitted dischargers in the subbasin, but only two with a permitted flow greater than 0.1 MGD: Princeton WWTP (0.3 MGD) and Kenly Regional WWTP (0.5 MGD). Both facilities discharge to the Little River.

Overview of Water Quality

Water quality of the Little River in 1995 and 2000 was generally Good-Fair based on macroinvertebrate samples (Table 30). However, in 2000, a Good bioclassification was assigned to a portion of the river in Johnston County. This middle section also supports many rare insect and mollusc species. Nonpoint runoff seemed to have the greatest potential to affect water quality in this area.

Recent hurricanes have had a drastic effect on stream habitat, and these changes were reflected by a recent decline in the fish communities of Buffalo Creek and the upper Little River. The bioclassification based on fish data dropped two categories between 1995 and 2000 in both these areas.

Macroinvertebrate data, however, indicated fairly stable water quality in the Little River, although there are some indications of a slight decline in water quality for the lower portion of the river. An improvement (2000 *vs*. 1991) in water quality was found for lower Buffalo Creek, coincident with the removal of the Wendell WWTP in 1994.

Table 30. Waterbodies monitored in Subbasin 06 in the Neuse River basin for basinwide assessment, 1995 - 2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Little River[2]	Wake	NC 96	Good-Fair	Good-Fair
B-2	Little River[2]	Johnston	SR 2130	Good-Fair	Good
B-3	Buffalo Cr	Johnston	SR 1941	Fair (1991)	Good-Fair
B-4	Little R[2]	Wayne	NC 581	Good-Fair	Good-Fair
F-1	Little R	Wake	NC 96	Good	Good-Fair
F-2	Buffalo Cr	Johnston	SR 1941	Excellent	Good-Fair

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available before 1995, refer to Appendix B2.

Two facilities conduct whole effluent toxicity tests in this subbasin: the Kenly and Princeton WWTPs. Both facilities had some failures before 2000 (about 15 percent of all tests). No test failures, however, were reported in 2000.

Monthly water chemistry data are collected from one site in this subbasin: Little River at Princeton. Detailed information is presented in the Ambient Monitoring section of this report.

River and Stream Assessment

Stream flows were very high before the August 2000 macroinvertebrate collections (Figure 68), and all sites would be expected to have higher scour in 2000 than in 1995. This area, however, had lower than normal flow in May - June 2000. Most sites also had suffered hurricane damage between 1995 and 2000..

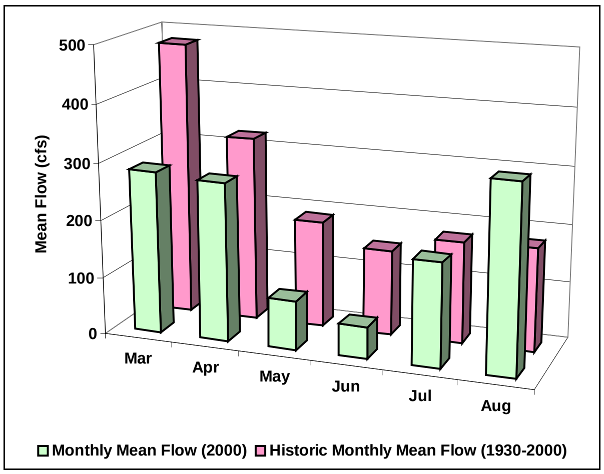


Figure 68. **Spring and summer monthly mean flow and historic monthly mean flow at the Little River at Princeton, Johnston County.**

Sites for fish community analysis which were examined but could not be sampled because of various factors (water was too deep, the stream was too wide, or the stream was altered due to the effects from the recent hurricanes) included the Little River at SR 2127, SR 1934, NC 39, NC 231, and SR 1722 (all in Johnston county).

Little River, NC 96

The rural and suburban northeast portion of Wake County serves as the upper watershed for the Little River. The forested site at the NC 96 crossing exhibited substantial riparian alteration (deadfalls, blowdowns, and an open canopy) from the recent hurricanes. The site continued to be mostly forested and there remained good riparian and instream habitats. The substrate was bedrock outcroppings and gravel. The habitat score was 74.

Downstream view of the Little River (approximately 100 yards below the bridge) at NC 96, Wake County, April 2000.

Average channel width is about 10 meters, but the width is highly variable within this segment of the river. Both periphyton and an unidentified macrophyte were very abundant in August 2000 and the water had a slightly humic color.

Little River (downstream of the bridge) at NC 96, Wake County, August 2000.

The NC 96 site has been intensively sampled for macroinvertebrates, including monthly sampling from September 1983 to June 1984 (Lenat 1987).

Several rare invertebrate species are known from this site, including the caddisfly *Dibusa angata*. Unusual invertebrates in the 2000 collection included the caddisfly *Triaenodes marginalis* (1st basin record) and the mayfly *Baetis armillatus*.

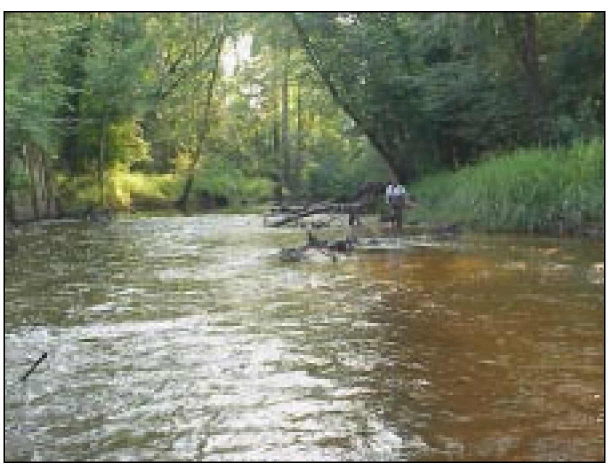
This site has been consistently given a Good-Fair rating using benthic macroinvertebrates from summer collections in 1983, 1984, 1991, 1995 and 2000. All these summer samples had an EPT taxa richness between 18 and 21. Spring and winter collections have produced a Good rating with maximum EPT taxa richness of 32 in April, 1984.

In 1995, the fish community was rated Good (NCIBI = 50); in 2000, it was rated Good-Fair (NCIBI = 40). The fish community seemed to have been altered by the recent hurricanes. The 10 unit decrease in the total score was due to a decrease in species diversity (from 17 to 11), an absence of suckers and intolerant species, and a slight shift in trophic composition.

In 1995 and 2000, the dominant species were the redbreast sunfish and the swallowtail shiner. Species present in 1995 but absent in 2000 were the creek chubsucker, golden shiner, dusky shiner, chain pickerel, Roanoke darter, and eastern mosquitofish.

Little River, SR 2130

The Little River at SR 2130 is about 10 meters wide. The bottom is mostly sand and gravel, but an upstream area (an old mill site) has some boulder-rubble substrate. Both pools and riffles are infrequent.



Little River (upstream of bridge) at SR 2130, Johnston County.

Summer benthos samples produced a Good rating in 1991 and 2000, but a Good-Fair rating in 1995. The lower rating in 1995 may have been associated with a period of extreme low flow. Several changes in the benthic community structure suggested a slight long-term decline in water quality since 1991: loss of the caddisfly *Brachycentrus nigrosoma* (abundant in 1991) and loss of the snail *Elimia* (common to abundant in 1991 and 1995).

This portion of the river supports a large number of rare mussel species (see Description). Likewise, spring collections in 1988 recorded a number of unusual invertebrate species, including three caddisflies (*Agapetus* probably *hessi*, *Protoptila*, and *Matrioptila jeanae*) and one mayfly (*Ephemerella needhami*). The continued presence of *Agapetus* was confirmed by reconnaissance sampling during spring 2000.

Buffalo Creek, SR 1941

This stream is on the eastern edge of the piedmont and it drains the fast-growing southeastern portion of the Triangle, including the suburbanizing regions of eastern Wake and northern Johnston counties. This forested site, like the Little River at NC 96 site, also exhibited an altered riparian zone after the hurricanes. Changes included more abundant blow-downs and deadfalls, a more open canopy, and numerous snags within the stream channel. Overall, however, the instream and riparian habitats remained in good condition (habitat scores = 80 and 90).

Buffalo Creek (upstream of the bridge) at SR 1941, Johnston County.

This portion of Buffalo Creek was nine meters wide, with a sand-gravel substrate. The water was humic in color, with slight foaming. Benthic macroinvertebrate sampling showed a significant improvement at this site from Fair in 1991 (9 EPT) to Good-Fair in 2000 (15 EPT taxa).

This change is probably due to the elimination of an upstream discharge. The Kenly WWTP previously discharged to Buffalo Creek and had problems with biochemical oxygen demand, total phosphorus, and ammonia nitrogen. This facility had operated under a Special Order of Consent until going off-line in 1994.

Also like the Little River fish community site, it is believed that the fish community at Buffalo Creek was altered by the recent hurricanes. In 1995, the fish community was rated Excellent (NCIBI = 54); in 2000, it was rated Good-Fair (NCIBI = 44). The 10 point decrease in the total score was due to a decrease in species diversity (from 21 to 15), a decrease in abundance (from 181 to 139), a decrease in sunfish diversity (from 4 to 3), an absence of suckers, and a decrease in the percentage of omnivores (from 13% to 3%).

In 2000, the dominant species were the redbreast sunfish and the dusky shiner. In 1995, there were seven co-dominant species: redbreast sunfish, tessellated darter, pinewoods shiner, creek chubsucker, American eel, pirate perch, and dusky shiner. Common ($n \geq 5$) species present in 1995 but absent in 2000 were the pirate perch, creek chubsucker, and largemouth bass.

Little River, NC 581

This lower segment of the Little River was about 20 meters wide with a variety of substrate types. While most of the river is sandy, patches of boulder-rubble were found about 150 meters above the bridge. Additionally, there were abundant macrophytes (at least three kinds), numerous snags, and good root mats. The channel had infrequent bends, and there was recent silt deposition near the banks and on the rocks.

Little River (150 m upstream of bridge), NC 581, Wayne County.

Benthic macroinvertebrate data indicated a decline in water quality relative to the upstream site in Johnston County. While the Johnston County site has a Good rating, the NC 581 site has received a Good-Fair rating in both 1995 and 2000. No mussels were collected at this site in 2000, although some dead shells were observed. Several invertebrate species were abundant at SR 2130, but not collected at the NC 581 site, notably *Paragnetina fumosa*.

NEUSE RIVER SUBBASIN 07

Description

This subbasin contains all the Contentnea Creek catchment, including Buckhorn Reservoir and its two primary tributaries, Moccasin Creek and Turkey Creek (Figure 69). Buckhorn Reservoir was expanded in 1999 (from 750 Ac to 2,300 Ac), flooding some stream sites that had been sampled by THE NCDWQ in 1995.

The streams in the western part of the subbasin (approximately west of US 301) have piedmont characteristics, while those to the east of US 301 were considered in the coastal plain. Many of the streams in the coastal plain portion of this subbasin are slow-flowing and swamp-like.

towns. The are many hog facilities with the greatest concentrations along lower Contentnea Creek, Sandy Run/Little Contentnea Creek, and Nahunta Swamp. Most of this subbasin has a high nonpoint source pollution potential, including runoff from cropland, forageland, and animals operations (NRCS 1995).

Water quality in this subbasin is potentially affected by a combination of nonpoint source runoff and 19 NPDES permitted dischargers. The four major dischargers are: Zebulon (1.85 MGD to UT Moccasin Creek), Wilson WWTP (12.0 MGD to Contentnea Creek), Farmville WWTP (3.5 MGD to Little Contentnea Creek), and Contentnea District

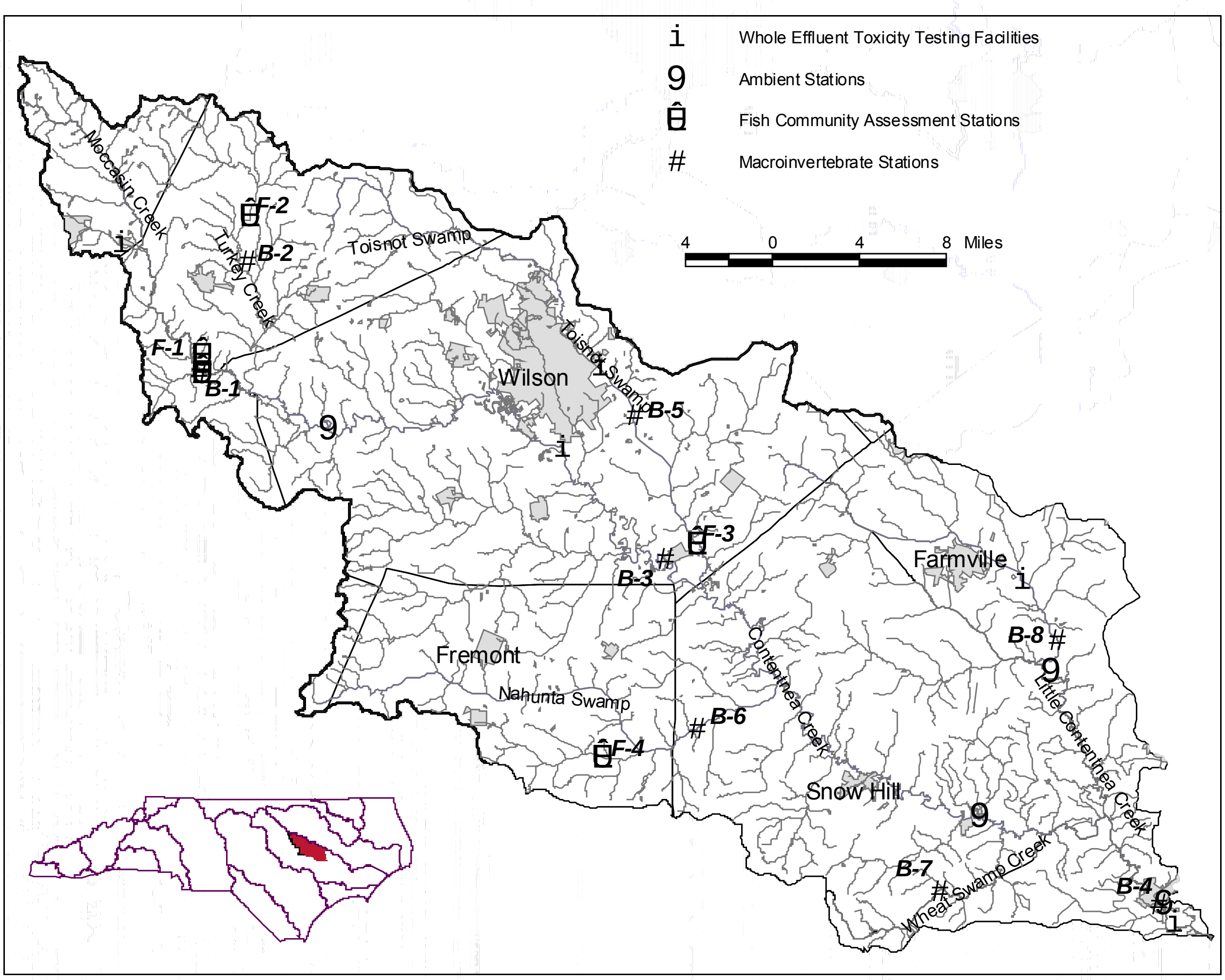


Figure 69. Sampling sites in Subbasin 07 in the Neuse River basin.

Overview of Water Quality

Moccasin Creek and Turkey Creek are the two major tributaries that flow into Buckhorn Reservoir and these two streams form the headwaters of Contentnea Creek. Fish samples have consistently assigned an Excellent bioclassification to Moccasin Creek (Table 31), and this site had a very high number of fish species (26) in 2000. Macroinvertebrates gave a lower rating to this stream in 2000 (Good-Fair) and this rating has been consistent in four summer benthos samples since 1991. Invertebrate sampling of Turkey Creek produced a Fair rating, although this rating may have been influenced by low flows during May and June.

Macroinvertebrate samples from Contentnea Creek in 2000 produced a Good-Fair rating for sites near Stantonsburg and Grifton. The Stantonsburg site has had either a Fair or Good-Fair rating since 1986, while the Grifton site has had either a Good or Good-Fair rating since 1983. Most of this variation seemed flow-related, but some change in community structure indicated a long-term decline in water quality at Grifton.

Macroinvertebrate sampling produced Fair ratings for Nahunta Swamp, Toisnot Swamp, and Little Contentnea Creek. These streams were found to have adequate habitat (at the selected sampling site), but low EPT taxa richness. All three of these streams have some channelized segments upstream of the collection site.

Fish collections from tributaries to Contentnea Creek are presently listed as "Not Rated. Of the four fish sites sampled in 2000, only Turkey Creek appeared to have significant hurricane damage. Analyses based on fish community structure indicated higher water quality in Moccasin Creek and Toisnot Swamp than analyses based on the macroinvertebrate community.

Surveys were conducted on Wiggins Mill Reservoir, Toisnot Reservoir, and Lake Wilson in 2000, although older data are available for two additional lakes. Trophic state could not be assigned to the 2000 data due to problems with the chlorophyll data, but all lakes were eutrophic in 1995.

Monthly water chemistry information is collected from four sites in this subbasin: Contentnea Creek at Lucama, Hookerton, and Grifton, plus Little Contentnea Creek near Farmville. Contentnea Creek sites had high nutrient concentrations, and these high levels caused a spike at Neuse River sites downstream of Contentnea Creek. Contentnea Creek (especially the Grifton site) and Little Contentnea Creek also may have low summer dissolved oxygen concentrations. Detailed information is presented in the Ambient Monitoring section of this report.

Table 31. Waterbodies monitored in Subbasin 07 in the Neuse River basin for basinwide assessment, 1995 - 2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Moccasin Cr[2]	Johnston	NC 231	Good-Fair	Good-Fair
B-2	Turkey Cr	Nash	SR 1109	---	Fair
B-3	Contentnea Cr[2]	Wilson	NC 222/NC58	Fair	Good-Fair
B-4	Contentnea Cr[2]	Pitt	SR 1800	Good-Fair	Good-Fair
B-5	Toisnot Swp	Wilson	US 264	---	Fair
B-6	Nahunta Swp[2]	Greene	SR 1058	Fair	Fair
B-7	Wheat Swamp Cr	Lenoir	NC 58	---	Not Rated
B-8	Little Contentnea Cr	Pitt	US 264A	---	Fair
F-1	Moccasin Cr[2]	Johnston	NC 231	Excellent	Excellent
F-2	Turkey Cr	Nash	SR 1131	---	Not rated
F-3	Toisnot Swp	Wilson	NC 222	Not rated	Not rated
F-4	The Slough	Wayne	SR 1535	Not rated	Not rated
	Lake Wilson	Wilson		Eutrophic	---
	Toisnot Reservoir	Wilson		Eutrophic	---
	Wiggins Mill Reservoir	Wilson		Eutrophic	---

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available before 1995, refer to Appendix B2 or Appendix F3.

Five facilities conduct whole effluent toxicity tests in this subbasin, including the wastewater treatment plants for Contentnea, Farmville, Wilson and Zebulon. All these WWTPs had some failures before 2000, with substantial problems found for the Farmville and Wilson discharges. No test failures, however, were reported in 2000.

River and Stream Assessment

Flow conditions in 2000 were highly variable with many streams experiencing both extreme high flows in August and extreme low flows in June and July (Figure 70). Most invertebrate sites were sampled in August, although some sites were not low enough to sample until September or October.

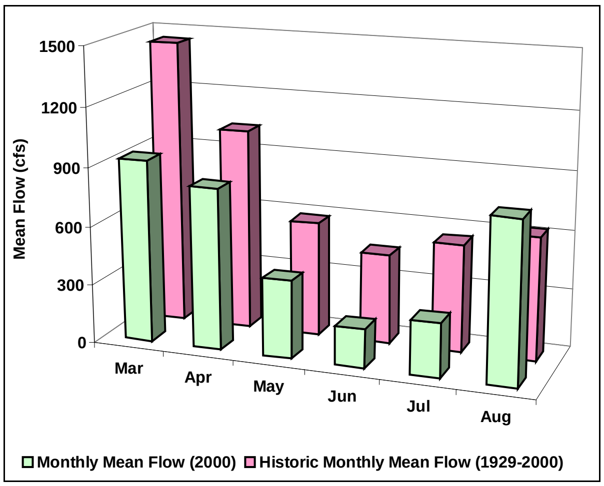


Figure 70. Spring and summer monthly mean flow and historic monthly mean flow at Contentnea Creek near Hookerton, Greene County.

Sites for fish community analysis which were examined but could not be sampled because of various factors (water was too deep, the stream was too wide, or the stream was altered due to the effects from the recent hurricanes) included Hominy Swamp at SR 1606 (Wilson County), Little Contentnea Creek at SR 1228 (Pitt County), and Sandy Run at US 258/13 (Greene County).

Moccasin Creek, NC 231

Moccasin Creek is located in northern Johnston County, on the eastern edge of the piedmont. Its watershed includes parts of southern Franklin, eastern Wake, southern Nash, and northeastern Johnston counties. This site, while exhibiting signs of past hurricane damage (scouring floods, blowdowns, and large woody debris dams) still had relatively high quality instream and riparian habitats (habitat scores = 70 and 88 during 2000).

Moccasin Creek (below the bridge and looking upstream) at NC 231, Johnston County.

This site has been sampled three times for benthic macroinvertebrates since 1995, producing a rating of Fair after Hurricane Fran in 1996, and two Good-Fair ratings in 2000. Although some intolerant invertebrate species have been collected, the benthos consistently produced a lower evaluation of water quality than the fish community.

The fish community has been sampled during every basinwide monitoring cycle plus an additional time to assess the impacts from Hurricane Fran in late October 1996 (NCDWQ 1997) (Figure 71). In 2000, the community was again rated Excellent (NCIBI = 58). Despite the recent hurricanes, the community is very stable, elastic (returns to prior conditions after a perturbation), and is persistent across years and after major flood events.

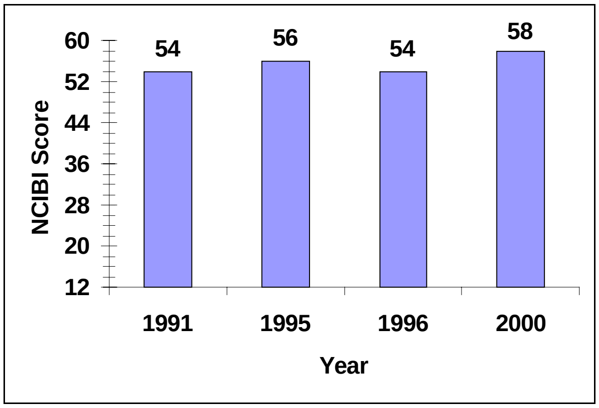


Figure 71. NCIBI scores at Moccasin Creek, NC 231, Johnston County, 1991 - 2000.

This fish community is also one of the most diverse sites of all sites in the river basin. Thirty-three species have been collected from this site, including 7 species of minnows, 11 species of sunfish, and 4 species of darters. The fauna includes species associated with the piedmont such as the pinewoods shiner, Roanoke darter, chainback darter, and white shiner; and species associated with the coastal plain such as the bluespotted sunfish, flier, tadpole madtom, and American eel. In 2000, 26 species were collected.

Turkey Creek, SR 1131

Although on the eastern edge of the piedmont, Turkey Creek at SR 1131 is very much a coastal plain-type stream (tannin stained water, sandy and clay substrate, stick and woody-debris riffles, *etc*.).

Upstream view of Turkey Creek, approximately 100 yards above SR 1131, Nash County.

Like other coastal plain sites, this site exhibited signs of past hurricane damage (scouring floods, deadfalls and blowdowns, and large woody debris dams). It continued to have good instream and riparian habitats (habitat score = 86). Habitat and watershed characteristics qualified the site as a regional fish community reference site for future development of metrics applicable to coastal plain wadeable streams.

The fish community was not rated and seemed to have been affected by the recent hurricanes. Few species (n = 13) and fish (n = 77) were collected, and of those species collected, few (23 percent) showed multiple ages (i.e., an absence of year classes). The most abundant species was the bluegill (40 percent of all the fish were of this species).

Turkey Creek, SR 1109

Although fish and benthos were collected at slightly different locations, these sites appeared very similar in size and habitat. Here, Turkey Creek was about six meters wide with a sand/silt substrate.

Turkey Creek at SR 1109, Wilson County.

Invertebrate collections also indicated stressed conditions (Fair rating), with only 11 EPT taxa collected.

Prior benthos collections had also produced a Fair rating at SR 1101 (Nash County, May 1991). Further downstream at SR 1126 (Wilson County), the stream was rated Good-Fair. This lower part of the stream is now flooded by Buckhorn Reservoir.

Contentnea Creek, NC 222

Contentnea Creek near Stantonsburg has been sampled at two different locations: NC 222 and NC 58. Better habitat and flow was observed at the NC 222 site in 2000, so this site was selected for macroinvertebrate collections. Both locations are upstream of the Stantonsburg WWTP. This part of the stream was 25 meters wide with a sand/silt substrate.

Contentnea Creek, NC 222, Wilson County.

These two sites have been sampled for benthic macroinvertebrates six times since 1986 (Figure 72). All collections have produced a Fair (1988, 1990, and 1995) or a Good-Fair (1986, 1991, and 2000) rating.

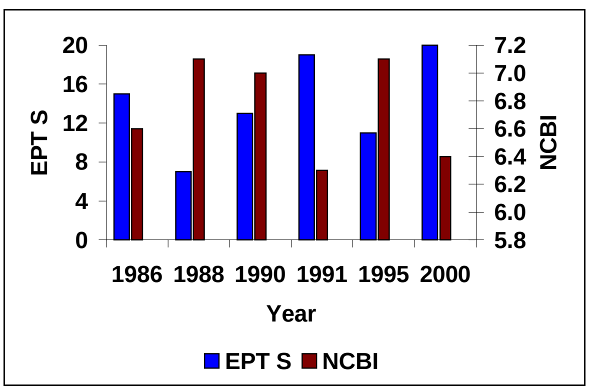


Figure 72. EPT taxa richness (EPT S) and biotic index (NCBI) at Contentnea Creek at NC 222, Wilson County, 1986 - 2000.

Some of the early Fair ratings (1988 and 1990) may have reflected stress associated with extreme low flow. The Fair rating in 1995 may have reflected the problems associated with nonpoint source runoff during high flow in June and July 1995. High flows in 2000 did not have the same effect, and this part of Contentnea Creek showed full recovery back to a Good-Fair rating.

There is no indication of any long-term change in water quality. This site still has some water quality problems, as evidenced from the complete absence of Plecoptera in all samples.

Contentnea Creek, SR 1800

Contentnea near Grifton was sampled for benthos by boat, with access *via* the boat ramp at the end of SR 1800. This site is about 30-35 meters wide, with a sand and silt substrate.

Contentnea Creek at SR 1800 near Grifton, Pitt County.

The midstream area is largely coarse sand, with silt deposits observed along the banks. The water is humic-colored, and the 2000 collection was preceded by a long period of high flow. These high flows had caused considerable over-bank sand deposition. De-snagging after the recent hurricanes removed much of the large woody debris in this portion of the stream.

Improvements were documented in the macroinvertebrate rating from 1983 to 1991 (Good-Fair to Good), but the ratings went back to Good-Fair in 1995 and 2000. This recent decline may be related to higher flows (Table 32), therefore it is difficult to assess any true long-term trend (Figure 73).

Table 32. Flow and bioclassifications for Contentnea Creek, Wilson County.

Year	Flow	Rating
2000	High	Good-Fair
1995	Low	Good-Fair
1991	Low	Good
1987	Low	Good
1985	Low	Good-Fair
1983	Low	Good-Fair

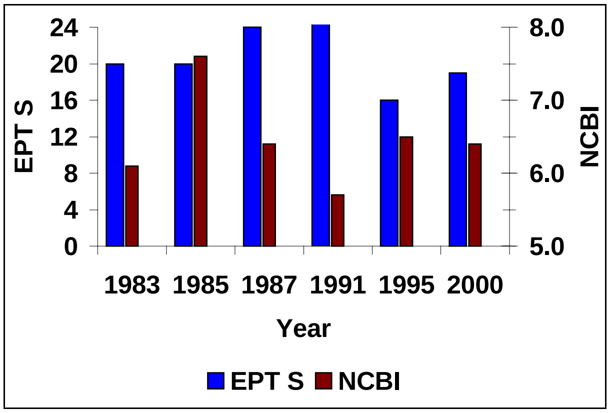


Figure 73. EPT taxa richness (EPT S) and biotic index (NCBI) at Contentnea Creek at SR 1800, Wilson County, 1983 - 2000.

Two patterns, however, point to a decline in water quality at this site: comparisons with the Stantonsburg site and changes in the composition of the invertebrate community.

The Stantonsburg and Grifton sites were sampled during the same year on three occasions: 1991, 1995, and 2000. In 1991 and 1995, there was an increase in bioclassification between the Stantonsburg site to the Grifton site, suggesting a gradual downstream recovery. In 2000, however, there was no difference between these two sites.

Water quality problems were observed in all years, as evidenced by the absence of stoneflies. Several of the more intolerant EPT taxa were collected only before 1991, suggesting a decline in water quality after 1991. These taxa include the mayfly *Heptagenia* (previously rare or common), the mayfly *Isonychia* (previously common to abundant), and the caddisfly *Macrostemum* (previously abundant).

Toisnot Swamp, US 264

Toisnot Swamp at US 264 was 10 meters wide with a sandy substrate. Downstream from the bridge area, this stream had good flow and a habitat score of 66. There were few bends (suggesting some channel modification) and pools were infrequent. The banks were eroding, but there were good snag and root habitats.

Toisnot Swamp at US 264, Wilson County.

Benthic macroinvertebrates were abundant, but not diverse. Only nine EPT taxa were collected, producing a Fair rating. Because nonpoint source pollution seemed to be the primary problem in this catchment, recovery might be expected during a drier year. No pollution indicator groups were abundant at this site.

Toisnot Swamp, NC 222

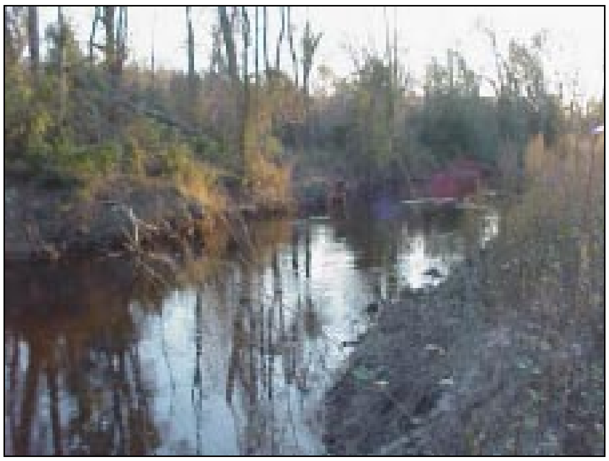
In eastern Wilson County, Toisnot Swamp has an urban (draining the Town of Wilson) and agricultural watershed. At the NC 222 crossing (approximately 2.7 miles above its confluence with Contentnea Creek and in the lower part of the watershed), the site is well forested along both shorelines and the instream habitats continued to be of high quality.

The fish community was not rated, but Toisnot Swamp had one of the most diverse (n = 24 species) communities of all the sites in the river basin. The fauna included 5 species of darters (the most of any site), 4 species of sunfish, and 5 species of minnows. However, 13 of the 24 species were represented by only 1 or 2 fish per species.

The site was monitored in 1995 and 2000. In 1995 and 2000, the two most abundant species were the tessellated darter and the redbreast sunfish. In 2000, four more species were collected than in 1995, more fish (421 vs. 241), 2 more species of sunfish, and 1 species of sucker. Rather than being negatively impacted by the recent hurricanes, the fish community seemed to have been enhanced.

Nahunta Swamp, SR 1058
Nahunta Swamp was 10 meters wide with a sandy substrate. It is a channelized stream in an agricultural catchment. The overall habitat is similar to Toisnot Swamp, with a habitat score of 69. This site has infrequent bends and pools, eroding banks, and narrow riparian zone on one side. This is somewhat offset by good flow and good snag and root habitats.

This site has been sampled for benthos six times since 1988, including November 1999 and August 2000. The 1999 collection was intended to help evaluate recent hurricane damage in the basin.



Nahunta Swamp at SR 1058, Greene County.

This site has fluctuated between a Fair and Good-Fair rating, with only Fair ratings in recent years. There is, however, no clear long-term trend in water quality. Although this site is located downstream of many hog farms, the invertebrate community did not suggest either organic loading or enrichment as problems.

The Slough, SR 1535
Draining the agricultural region of north central Wayne County, The Slough is a small tributary to Nahunta Swamp. The stream, although channelized a long time ago, has good riparian and instream habitats. There was no physical evidence of hurricane damage, unlike other streams in the subbasin.

The Slough (looking upstream from the bridge) at SR 1535, Wayne County.

The fish community was not rated, but The Slough was one of the most diverse (n = 26 species) sites of all the sites in the river basin in 2000. The fauna included 3 species of darters, 6 species of sunfish, and 8 species of minnows.

The site was monitored in 1995 and 2000. In 1995 and 2000, the two most abundant species were the redbreast sunfish and the dusky shiner. In 2000, 12 more species were collected than in 1995. Also, more fish (321 vs. 150) and four more species of sunfish were collected in 2000 than in 1995. The trophic composition did not change between the two sampling periods. The community did not seem to have been negatively impacted by the recent hurricanes; rather it seemed to have been enhanced.

Wheat Swamp Creek, NC 58
Wheat Swamp was sampled for benthos in the summer of 1991 (at SR 1091), but a lack of flow indicated that this site should be sampled in the winter with swamp methods. Wheat Swamp is located in a different geologic area (Black Creek Formation) than other streams sampled for benthos in this subbasin. This may be the reason this stream is more likely to cease flowing during the summer than the other streams.

Due to higher flows in 2000 than in 1992, the 2000 sample was collected further upstream at NC 58, about four miles upstream of SR 1091. Collections from both sites suggest stressed conditions, especially low EPT abundance values (10 and 27). The low total taxa richness in 2000 (48) also suggested water quality problems.

Little Contentnea Creek, US 264A
Little Contentnea Creek originates near the Town of Farmville and this portion of the stream is channelized.

Little Contentnea Creek, east of the Town of Farmville, Pitt County.

Reconnaissance of this area in August 2000 indicated that water was not flowing at this site. Abundant growths of periphyton and macrophytes were also observed. A site more suited to benthos sampling was located downstream at US 264A.

The site at US 264A was completely different from the area near Farmville. This portion of the stream was 10 meters wide with good flow. It had a relatively high habitat score (72) with good snag and bank habitats. The major habitat problem was a lack of pools; the stream was a uniform run.

Little Contentnea Creek at US 264A, Pitt County.

The stream was given a Fair rating based on a low EPT taxa richness (six). In spite of the good habitat found at this site and this being the only part of the stream that had flow, the invertebrate community reflected problems further upstream in the catchment.

SPECIAL STUDIES
Contentnea Creek Catchment
Five sites in were sampled in August 1996 as part of a USGS survey of the Contentnea Creek catchment: Bloomery Swamp at NC 42 (Good-Fair), Toisnot Swamp at NC 222 (Fair), Great Swamp at SR 1634 (Fair), Contentnea Creek at NC 42 (Good-Fair), and Contentnea Creek at SR 1606 (Fair). The rating for Great Swamp may reflect summer low flow and swamp conditions, therefore, this rating has not been used for use attainability.

Impacts of Hurricane Fran
Bloomery Swamp and Moccasin Creek were sampled in September 1996 to help evaluate the impacts of Hurricane Fran on North Carolina streams. Bloomery Swamp declined from a Good-Fair rating in August 1996 to a Poor rating after the hurricane, while Moccasin Creek declined from Good-Fair to Fair. These changes supported a hypothesis that many small coastal plain streams were severely affected by low dissolved oxygen concentrations immediately after Hurricane Fran (Biological Assessment Unit Memorandum B092495).

2000 303 (d) List Investigations
To help determine if Beaverdam Creek should remain on the 2000 303 (d) List (NCDENR 2000), invertebrate samples were collected from Beaverdam Creek at SR 1111 (Nash County) and from Bull Branch at SR 2110.

Bull Branch was too small to rate, but it supported a surprisingly intolerant invertebrate community. The NC Biotic Index was 5.0 which was within the range expected for an Excellent bioclassification. The low biotic index value reflected the abundance of intolerant taxa, including two caddisflies (*Diplectrona modesta* and *Psilotreta labida)* and one stonefly (*Eccoptura xanthenes)*.

Beaverdam Creek seemed to alternate between a Fair and a Good-Fair rating, depending on flow. It thus seems inappropriate to place this stream on the 2002 303 (d) List.

Lake Wilson

Lake Wilson is a small impoundment of Toisnot Swamp (Figure 74). This lake is a water supply source for the City of Wilson. The watershed consists of agricultural, forested, and residential areas. The lake is open to the public for boating and fishing, but not swimming.

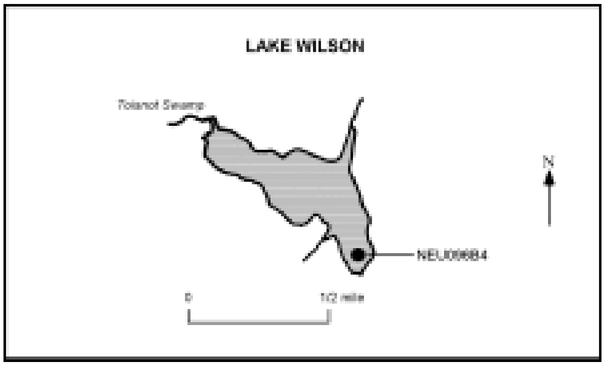


Figure 74. Monitoring sites at Lake Wilson, Wilson County.

The lake was most recently monitored in June, July, and August, 2000 (Table 33). The Secchi depth was consistently 0.6 m; the water is tannin stained. Surface pH values, however, were close to neutral. Nutrient concentrations increased slightly between June and July (Append L3).

Metal concentrations in the surface waters in June and July were less than the laboratory detection levels, except for copper and manganese. Copper concentrations in June (18 µg/L) and July (88 µg/L) were greater than the water quality action level of 7.0 µg/L. Manganese concentrations in June (81 µg/L) and July (100 µg/L) were less than the water quality standard of 200 µg/L for water supply reservoir.

The lake was previously sampled in 1995. The lake was stratified with dissolved oxygen concentrations decreasing from 7.4 mg/L at the surface to 0.2 mg/L at two meters (depth to bottom was four meters). Secchi depth was less than 1 m. Total phosphorus and total organic nitrogen concentrations were 0.12 mg/L and 0.61 mg/L, respectively. Despite the availability of nutrients, the chlorophyll *a* concentration was 10 µg/L. Metals were less than laboratory detection levels except for copper (4.3 µg/L).

Table 33. Biological and water chemistry data for Lake Wilson, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
07/11/2000			0.09	0.56		0.6
06/28/2000			0.04	0.60		0.6
07/25/1995	3.9	Eutrophic	0.12	0.59	10	0.8

Toisnot Reservoir

Toisnot Reservoir was constructed in 1963 as a back up water supply for the City of Wilson. Located downstream of Lake Wilson on Toisnot Swamp, the drainage area for this lake is swampy and flat with land uses which include agricultural, urban, and residential areas. The land immediately adjacent to Toisnot Reservoir is part of a city park. Toisnot Swamp is the primary tributary (Figure 75).

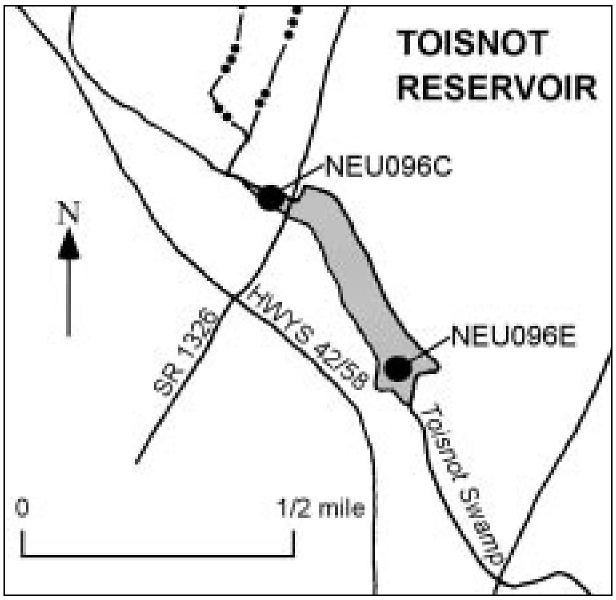


Figure 75. Monitoring sites at Toisnot Reservoir, Wilson County.

The reservoir was most recently sampled in June, July and August, 2000. A pedestrian bridge crosses the middle of the lake, linking the two sides of the city park. Because of this bridge, a boat can no longer travel from the dam to the sampling site at the upper end. Sampling in June was conducted at the water intake structure near the dam (Station NEU096E) and at the SR 1326 bridge (Station NEU096C). Both sites were exceptionally shallow (less than 1 m). In July and August, samples were collected at the pedestrian bridge access.

Secchi depths were to the bottom at both sites in June 2000 and at the single site in July. The surface dissolved oxygen concentration near the dam was 5.1 mg/L; and 1.4 mg/L at the SR 1326 bridge. This latter concentration was less than the water quality standard of 4.0 mg/L for an instantaneous reading. Numerous ducks and geese were present at this site.

Nutrients were moderate to elevated in June and July Metals were less than the laboratory detection levels, except for copper (4.3 µg/L in June and 28 µg/L in July); manganese (170 and 570 µg/L) and iron in August (3,200 µg/L). These concentrations were greater than the water quality standard or action level for a water supply reservoir (manganese = 200 µg/L, copper = 7.0 µg/L, and iron = 1000 µg/L).

The lake was previously sampled in 1995. Secchi depth was less than 1 m at both sites and nutrient concentrations were elevated. Chlorophyll *a* concentrations ranged from 21 µg/L near the dam to 8 µg/L at the upstream site.

Table 34. Biological and water chemistry data for Toisnot Reservoir, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/16/2000	---	---	0.11	0.36	---	0.6
07/11/2000	---	---	0.13	0.77	---	0.6
06/28/2000	---	---	0.07	0.52	---	0.7
08/07/1995	4.7	Eutrophic	0.23	0.58	15	0.4

Wiggins Mill Reservoir

Wiggins Mill Reservoir is an impoundment of Contentnea Creek (Figure 76). Constructed in 1915, the original dam was raised an additional foot in 1955 to increase the lake's volume to its current size. The watershed consists of areas of forest, agriculture, and urban development. The reservoir serves as the water supply for the City of Wilson and access is limited to boats with electric motors. No swimming is allowed.

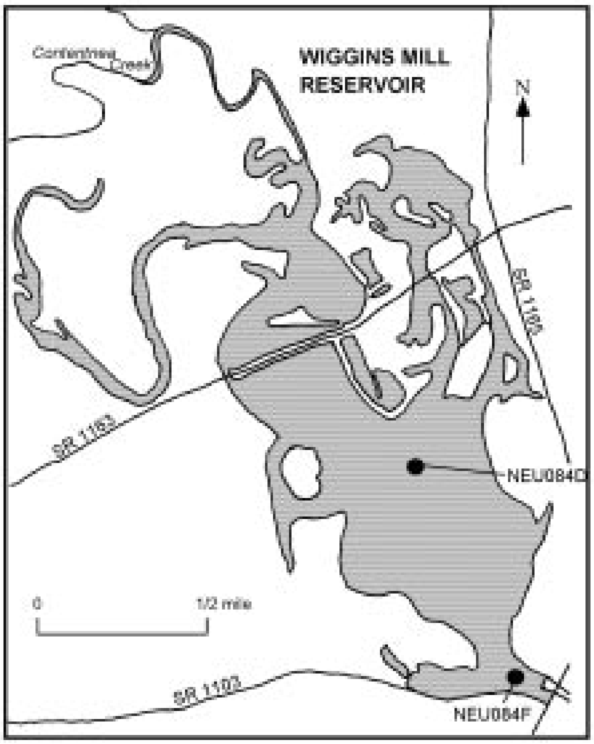


Figure 76. Monitoring sites at Wiggins Mill Reservoir, Wilson County.

This lake was most recently monitored in June, July, and August, 2000 (Table 35). The water is tannin stained which is characteristic of coastal plain waterbodies. Surface pH values were close to neutral, however, and not acidic. Secchi depths were less than 1 m. Nutrient concentrations increased from June to August.

Metals were less than laboratory detection levels, except for manganese (range = 110 to 180 µg/L). These concentrations were not in excess of the water quality standard of 200 µg/L for a water supply reservoir. An iron concentration of 2,000 µg/L was observed in August, which was greater than the water quality action level of 1,000 µg/L.

The reservoir was previously sampled in 1995 (Table 35). Secchi depths were less than 1 m and surface dissolved oxygen concentrations ranged from 5.4 to 5.9 mg/L. The mean concentrations of total phosphorus and total organic nitrogen were elevated as was the mean concentrations of total Kjeldahl nitrogen (0.7 mg/L). The mean chlorophyll *a* concentration, however was low (8 µg/L). Concentrations of metals in the surface waters were less than the laboratory detection levels except for copper (4.9 µg/L). It was however, less the water quality action level (7.0 µg/L).

Data collected from 1981 through 2000 for three constituents of the NCTSI were summarized using box and whisker plots (Figure 77). Medians for all the variables were similar between the sites.

Table 35. Biological and water chemistry data for Wiggins Mill Reservoir, 1995 – 2000.

Date	NCTSI	Rating	TP (mg/L)	TON (mg/L)	CHL *a* (µg/L)	Secchi (m)
08/16/2000	---	---	0.06	0.19	---	0.7
07/11/2000	---	---	0.05	0.30	---	0.9
06/28/2000	---	---	0.01	0.40	---	0.8
07/27/1995	3.6	Eutrophic	0.13	0.67	8	0.5

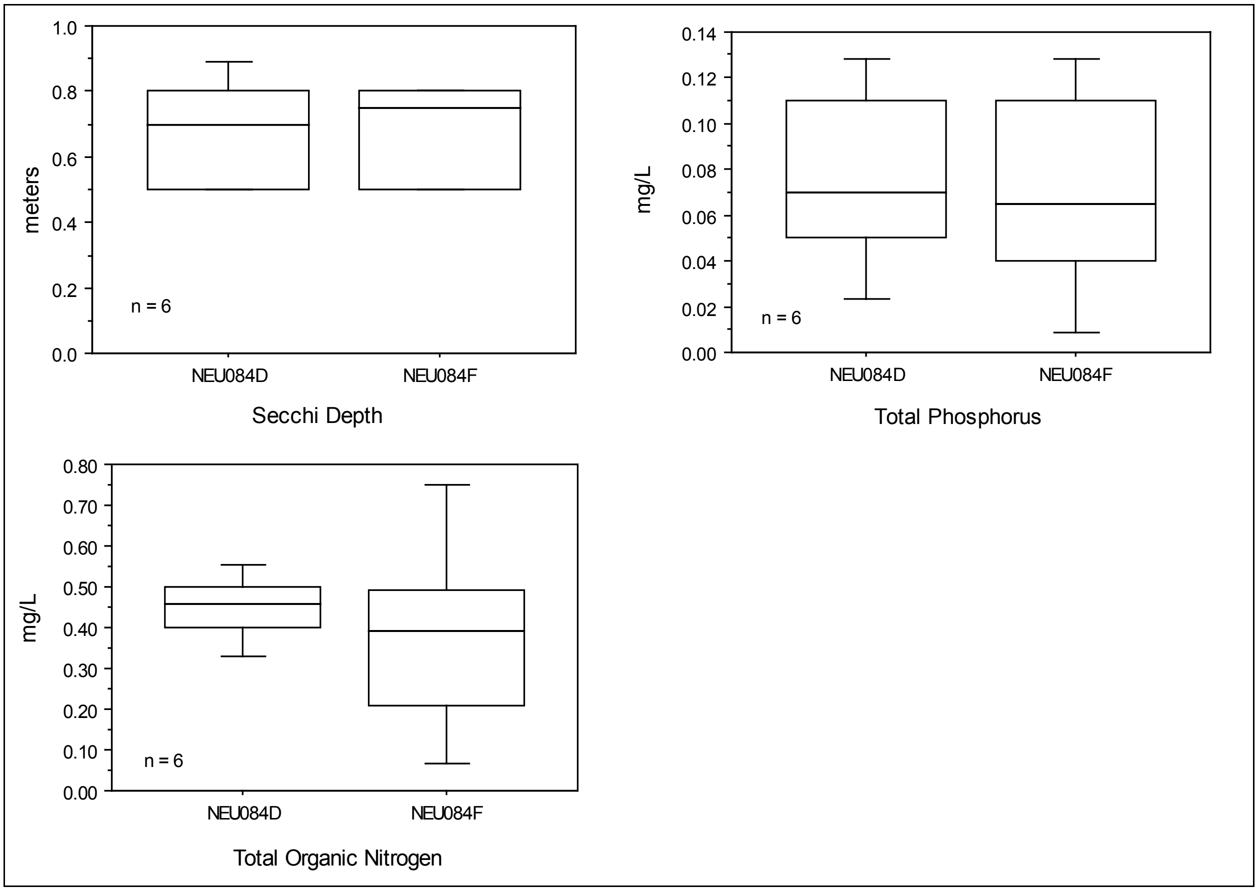


Figure 77. Spatial relationships among biological and water chemistry data from Wiggins Mill Reservoir, 1981 – 2000. Chlorophyll *a* data were deleted due to ongoing concerns regarding analytical errors.

NEUSE RIVER SUBBASIN 08

Description

This subbasin consists of the Neuse River and its tributaries from Contentnea Creek to New Bern (approximately 22 river miles) (Figure 78). Most of this subbasin lies within Craven County. The two largest tributaries in this subbasin are Core Creek and Batchelor Creek. The headwaters of Core Creek have been channelized to promote drainage.

Land use is largely agriculture or forest. There are some urban areas in the headwaters of Batchelor Creek. The only major discharger in this subbasin is Weyerhaeuser. The facility has a permitted flow of 32 MGD into the Neuse River above New Bern.

The Neuse River flood plain includes an extensive swamp forest, usually dominated by tupelo gum. Although most of this area has been logged, it still is an important natural area for many rare plant and animal species (MacDonald, *et al.* 1981). Another significant natural area is Dover Bay, an unusual, double Carolina bay.

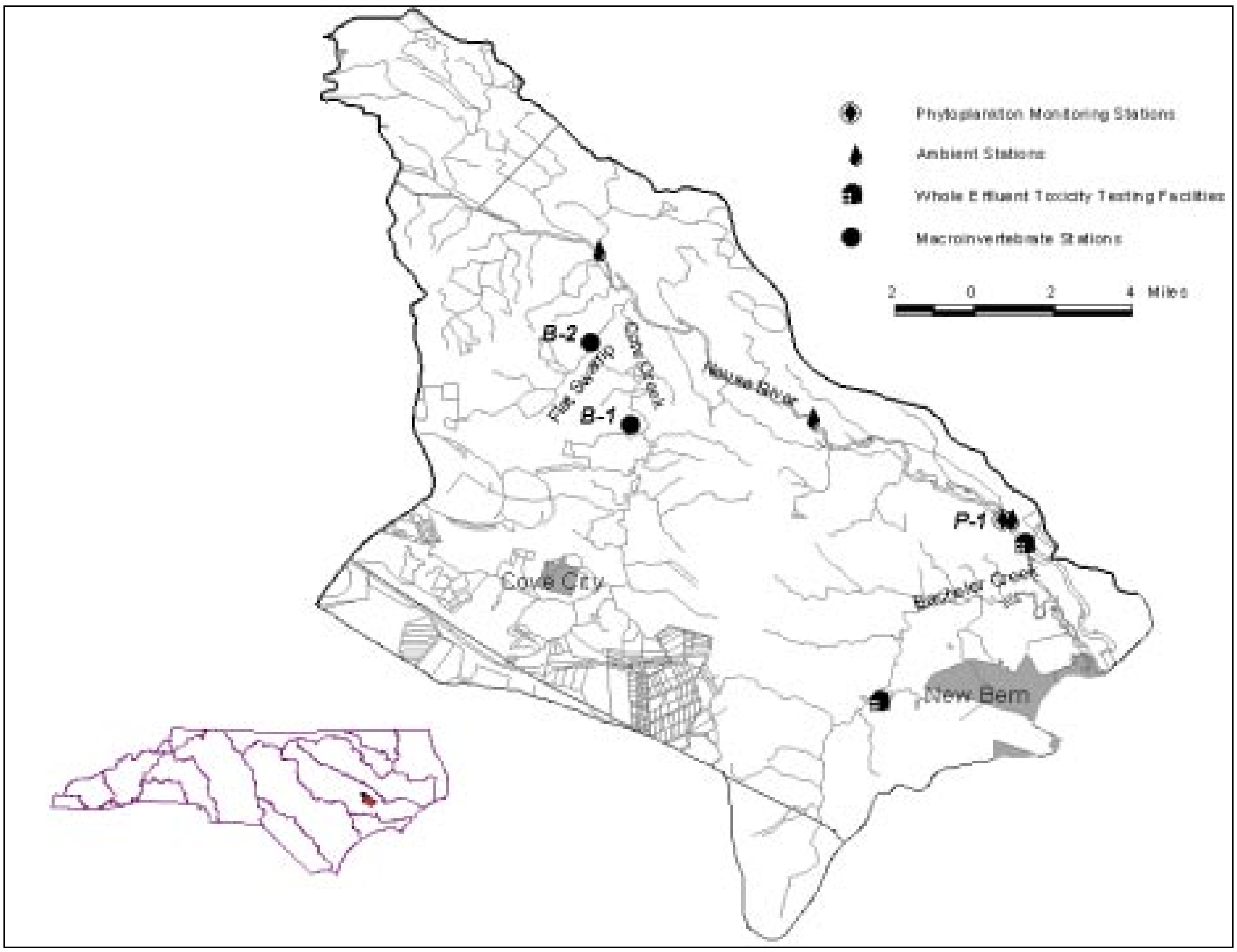


Figure 78. Sampling sites in Subbasin 08 in the Neuse River basin.

Overview of Water Quality

The Neuse River in this subbasin has Good-Fair water quality based on macroinvertebrate samples near Streets Ferry from 1983 to 1995. No samples could be collected from this site in 2000 due to extremely high flows.

There may be substantial differences between streams in this subbasin based on the amount of flow contributed by groundwater. Surveys of three tributaries of Batchelor Creek in 1988-1989 (Rollover Creek, Caswell Branch and Beaverdam Creek) showed that two of these streams seemed to support more intolerant taxa due to greater groundwater inputs. All three streams had good populations of a mussel (*Elliptio complanata*) that was absent from other streams in subbasin 08. This observation is based on old data, and these streams may have changed since 1989.

Core Creek was Fair in 1991 and 2000 based on benthos data, but a Poor rating was associated with low dissolved oxygen concentrations in 1995 (Table 36). There was no evidence of a long-term change in water quality. Samples from Flat Swamp in 2000 also suggested nonpoint source problems due to low dissolved oxygen and enrichment.

Chemical monitoring data from several locations on the Neuse River documented sporadic violations of state standards for some parameters, including dissolved oxygen and fecal coliform counts.

The Neuse River at Fort Barnwell and Streets Ferry had frequent algal blooms in the 1970's and 1980's, with the worst blue-green bloom occurring in August 1983. Since the impoundment of Falls Reservoir in 1984 and the statewide phosphate detergent ban in 1988, no major blue-green blooms have been reported in this part of the Neuse River. Elevated chlorophyll-a levels were recorded during periods of low flow in September 1990 and August 1993. No blue-green blooms were reported at the Streets Ferry site from 1995-2000, although a chrysophyte bloom was noted in 1997. While phytoplankton biovolume usually peaks during summer months, there is no consistent pattern for the dominant species. The composition of the phytoplankton community may have been influenced by a shift in the nutrient composition when total Kjeldahl-nitrogen replaced nitrate+nitrite-nitrogen as the principle form of nitrogen after 1989.

Monthly water chemistry information is collected from six Neuse River sites from Fort Barnwell to the Narrows. Detailed information is presented in the Ambient Monitoring section of this report

Two facilities conduct whole effluent toxicity tests in this subbasin: Craven County Wood Energy and Weyerhaeuser. The former facility had a failure rate of about 50 percent before 2000, while the Weyerhaeuser facility passed almost all tests No test failures were reported for either facility in 2000.

Rare benthos species in this area have been collected mainly from sites on the Neuse River. THE NCDWQ surveys have recorded several rare aquatic insects in the Neuse River, including both mayflies (*Procloeon viridoculare* and *Pseudocentroptiloides usa*) and midges (*Chernovskia orbicus* and Chironomini Genus B). Surveys by the NC Wildlife Resources Commission (NCWRC, 2001) recorded three rare mussel species in this part of the Neuse River: *Elliptio marsupiobesa*, *E. roanokensis*, and *Lampsilis radiata*. The NCWRC surveys also recorded “lanceolate *Elliptio*” in Core Creek and in a small Neuse River tributary.

Table 36. Waterbodies monitored in Subbasin 08 in the Neuse River basin for basinwide assessment, 1995 - 2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Core Cr[2]	Craven	NC 55	Poor	Fair
B-2	Flat Swp	Craven	NC 55	---	Not Rated
P-1	Neuse R	Craven	SR 1400	---	---

[1]B = benthic macroinvertebrate monitoring sites; P = phytoplankton monitoring sites.
[2]Data are available before 1994, refer to Appendix B2.

A fish community sample was not collected in 2000 from Core Creek at SR 1001 (Craven County) due to high water levels and an extremely mucky substrate. A collection at this site in 1995 did not indicate any significant water quality problems.

Core Creek, NC 55
Core Creek is 9-13 meters wide, and the nature of the channel seemed to have been affected by the recent hurricanes. All waters within 100 meters of the NC 55 bridge had very low flow in 2000, although an area with good flow was found further upstream.

Core Creek (300 meters upstream of NC 55) Craven County.

Under extreme low flow conditions, this stream may have very low dissolved oxygen concentrations. The dissolved oxygen was only 1.5 mg/L during the 1995 macroinvertebrate collection. In 2000, it was 5.5 mg/L. Specific conductance was high on both occasions: 190 and 210 µmhos/cm. During the 2000 collection, abundant growths of the macrophyte *Hydrilla w*ere observed. This exotic plant is considered an invasive pest species.

Core Creek has been sampled for macroinvertebrates three times during summer months: 1991, 1995, and 2000. At NC 55, the stream is large enough to have flowing water throughout the year, and is rated with Coastal A Criteria. This stream has received either a Fair rating (1991 and 2000) or a Poor rating (1995).

EPT taxa richness was low in 1995 (three), and some of the abundant midge species reflected low dissolved oxygen concentrations (*Chironomus*, and *Dicrotendipes modestus*). EPT taxa richness increased to 10 in 2000, including three *Oecetis* species. The invertebrate community in 2000 was similar to that observed in 1991, indicating no long-term change in water quality.

Flat Swamp, NC 55
Flat Swamp had a channel width of seven meters, but the channel became braided away from the bridge. This site was sampled for benthos in February 2000 using swamp methods. Although this stream drains part of the Dover Pocosin, high pH (6.4) and high specific conductance (121 µmhos/cm) indicated this stream may be affected by agricultural runoff.

Both USGS topographic maps and GIS coverage confirmed that this stream's watershed has large amounts of agricultural land. This site had a high biotic index relative to reference swamp streams (7.9), and was dominated by tolerant Chironomidae: *Chironomus*, *Conchapelopia*, *Dicrotendipes simpsoni*, *Glyptotendipes*, and *Procladius*. The benthic community indicated both enrichment and low dissolved oxygen, although the dissolved oxygen was very high (12 mg/L) at the time of the collection.

SPECIAL STUDY
Boat IBI
Batchelor Creek above NC 43 in Craven County was sampled as part of an ongoing project to develop a method to assess fish communities in small nonwadeable streams using an electrofishing boat. Batchelor Creek is a typical slow-moving lower coastal plain stream with slightly tannin water. Stream width was 25 to 30 meters and the habitat score was 71.

A fairly diverse fish community was observed. Sixteen species were collected, including typical coastal plain species such as pirate perch, bluespotted sunfish, and chain pickerel. Two species of sunfish, redear sunfish and bluegill, were the most abundant fish at this site.

Phytoplankton Monitoring

Neuse River, SR 1400
Phytoplankton assemblages and nutrient samples were analyzed from the Neuse River at SR 1400 at Streets Ferry (Station J7930000).

Phytoplankton assemblages varied each year during the five year sampling period, but a few simple patterns were apparent. Cryptomonads were dominant during the winter, and diatoms, cryptomonads, and flagellated chrysophytes were usually common from June through September (Figure 79). Assemblage biovolumes were low (< 5,000 mm^3/m^3), ranging from 10 to 4,040 mm^3/m^3 with annual peaks usually during August (Figure 80). Inorganic nitrogen (NO_2+NO_3-N) decreased as overall organic nitrogen concentrations (TKN) increased (Figure 81). Total phosphorus concentrations exhibited minimal change (Figure 82).

The phytoplankton biovolumes were very low during June and July 1996, ranging from 10 to 80 mm^3/m^3. Small diatoms, chrysophyte flagellates, and the cryptomonad *Cryptomonas ovata* were predominant. During 1997, biovolume increased to 2,560 mm^3/m^3 during August and then dropped to 130 mm^3/m^3 by November. In June 1997, cryptomonads and the chain-forming diatom *Melosira*, and the green alga *Ankistrodesmus falcatus* were prevalent. In August, a bloom of the chrysophyte *Mallomonas akrokomos* dominated the assemblage, but in September, the assemblage shifted primarily to the chain-forming diatom *Skeletonema potamos*.

In 1998, biovolume ranged from 50 mm^3/m^3 in June to 4,040 mm^3/m^3 during August. Cryptomonads were common in February and November. Diatoms, predominately *Rhizosolenia* and *Melosira*, were common June through August. *Mallomonas* chrysophytes were prevalent during July, September, and November.

During 1999, biovolume ranged from 160 to 3,710 mm^3/m^3. The biovolume in February was notably higher (2,430 mm^3/m^3) than in February for 1998 and 2000 (350 mm^3/m^3 and 530 mm^3/m^3, respectively). Cryptomonads (*C. ovata*) and dinoflagellates (*Gymnodinium*) were predominant during this month. During early July, *C. ovata* and the colonial green alga *Pandorina morum* were common, but by the end of the month, the assemblage shifted to a lower biovolume (190 mm^3/m^3) and was dominated by small chrysophyte flagellates. Later in August, the assemblage shifted back towards *P. morum.* This contributed to the annual biovolume peak in August (3,710 mm^3/m^3). Biovolumes were again low during September with small chrysophytes prevalent. Cryptomonads were common during November.

Biovolumes remained low throughout the 2000 sampling season, ranging from 200-850 mm^3/m^3 with small chrysophytes common from February through September. Unlike preceding years, biovolume did not peak during August but instead peaked in November. Cryptomonad *C. ovata* was prevalent during November.

Algal Blooms
Five samples were collected as blooms in this subbasin:

- A diatom bloom of *Cyclotella* at the mouth of Swift Creek near Askin (Station J8210000) was documented during July 1997.
- During the August 1997 ambient sampling run, a bloom of the chrysophyte *Mallomonas akrokomos* was documented at Station J7930000.
- A fish health event was investigated at Sandy Point at New Bern during October 1997 but was not attributed to toxic algae.
- Hypoxic water led to an odor complaint in a canal during October 1997. The sample collected contained filaments of the blue green alga *Phormidium*, but it was not a bloom.
- During June 1998, a diatom and chrysophyte bloom of *Skeletonema potamos* and *Ochromonas*, was documented at Station J8210000 (Appendix P1). These taxa are common in local estuaries and generally do not create ecological problems.

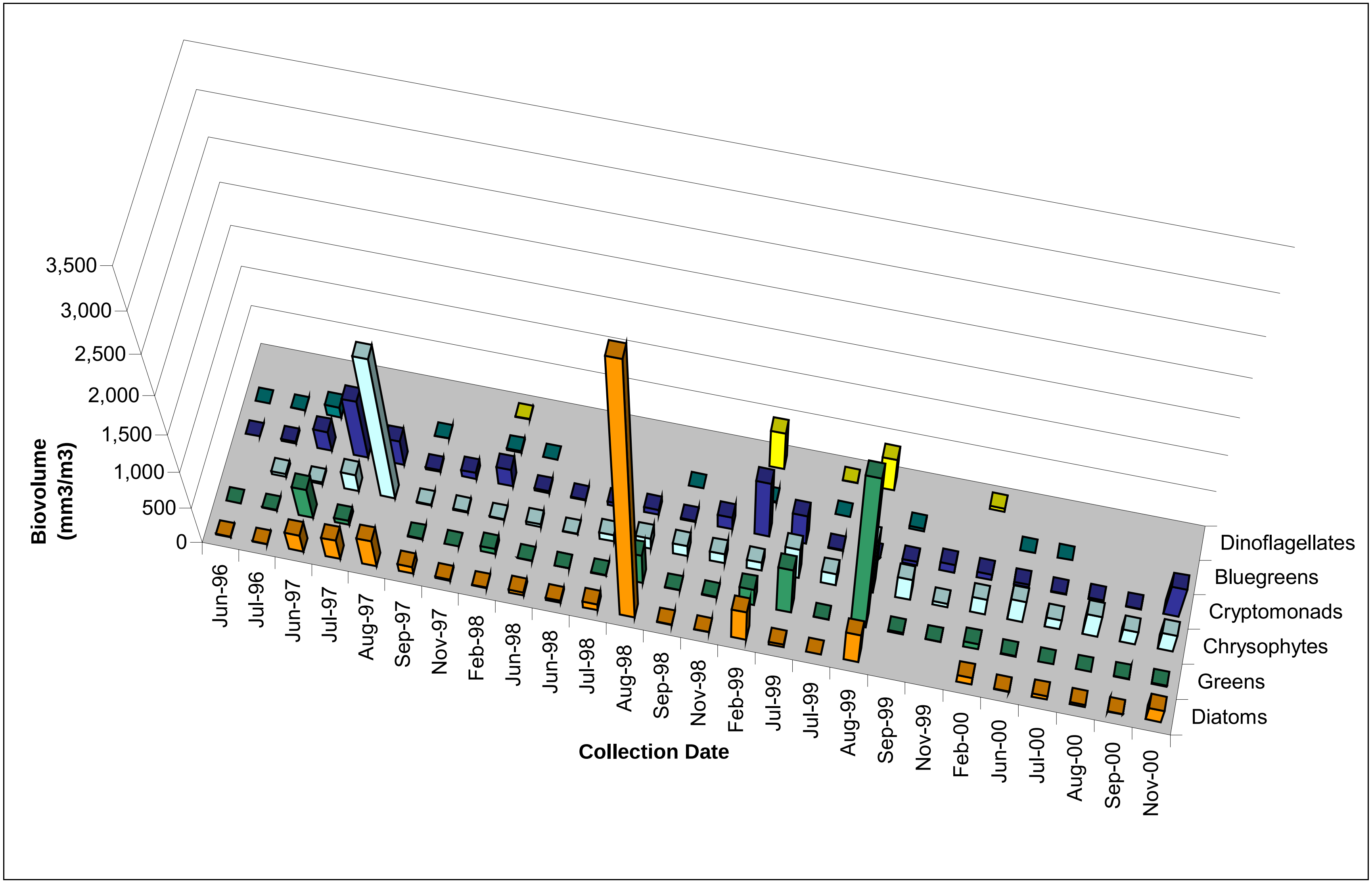


Figure 79. **Biovolumes of phytoplankton divisions from the Neuse River at SR 1400, Craven County, 1996 - 2000**

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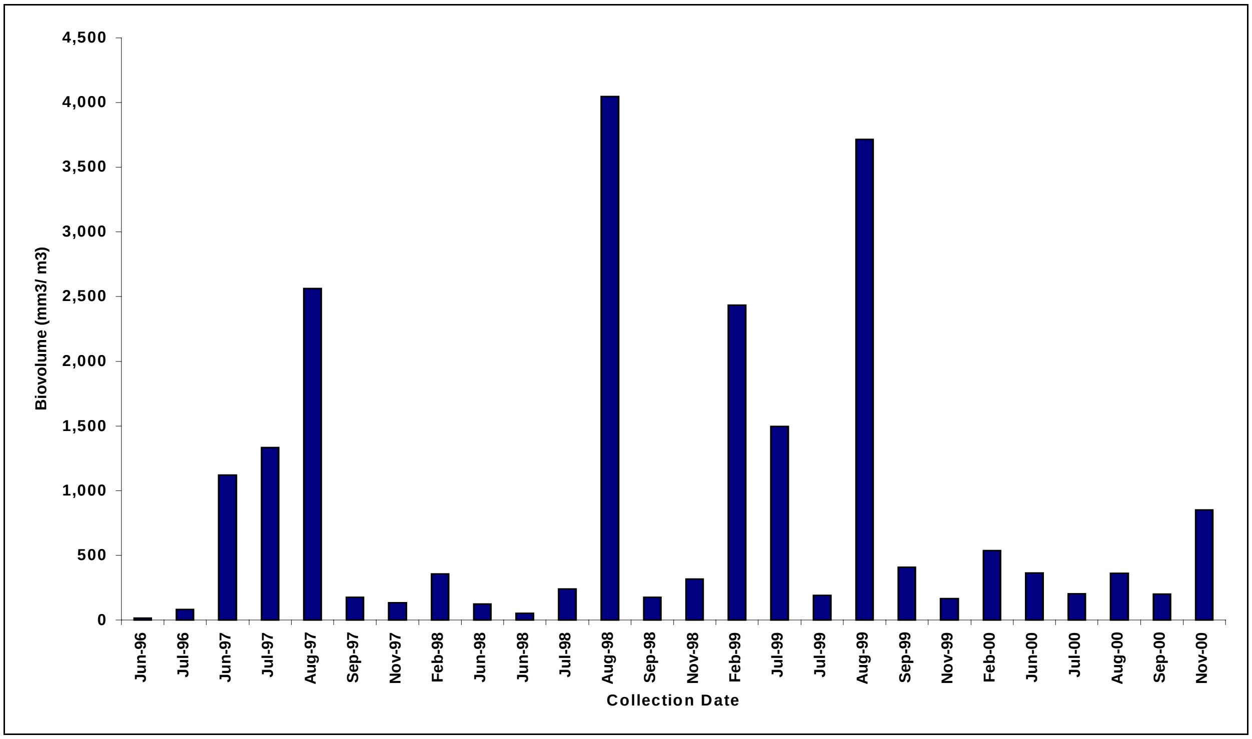


Figure 80. **Phytoplankton biovolume from the Neuse River, at SR 1400, Craven County, 1996 - 2000.**

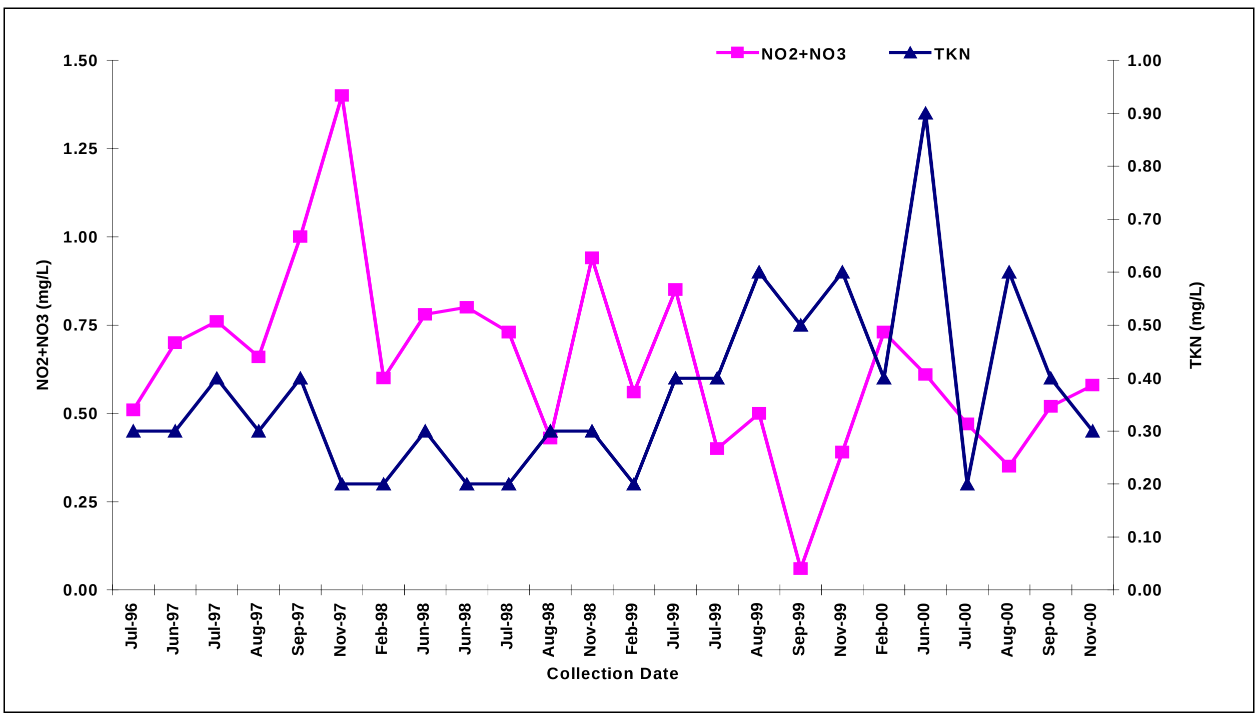


Figure 81. **Nitrite+nitrate and total Kjeldahl nitrogen from the Neuse River, at SR 1400, Craven County, 1996 - 2000.**

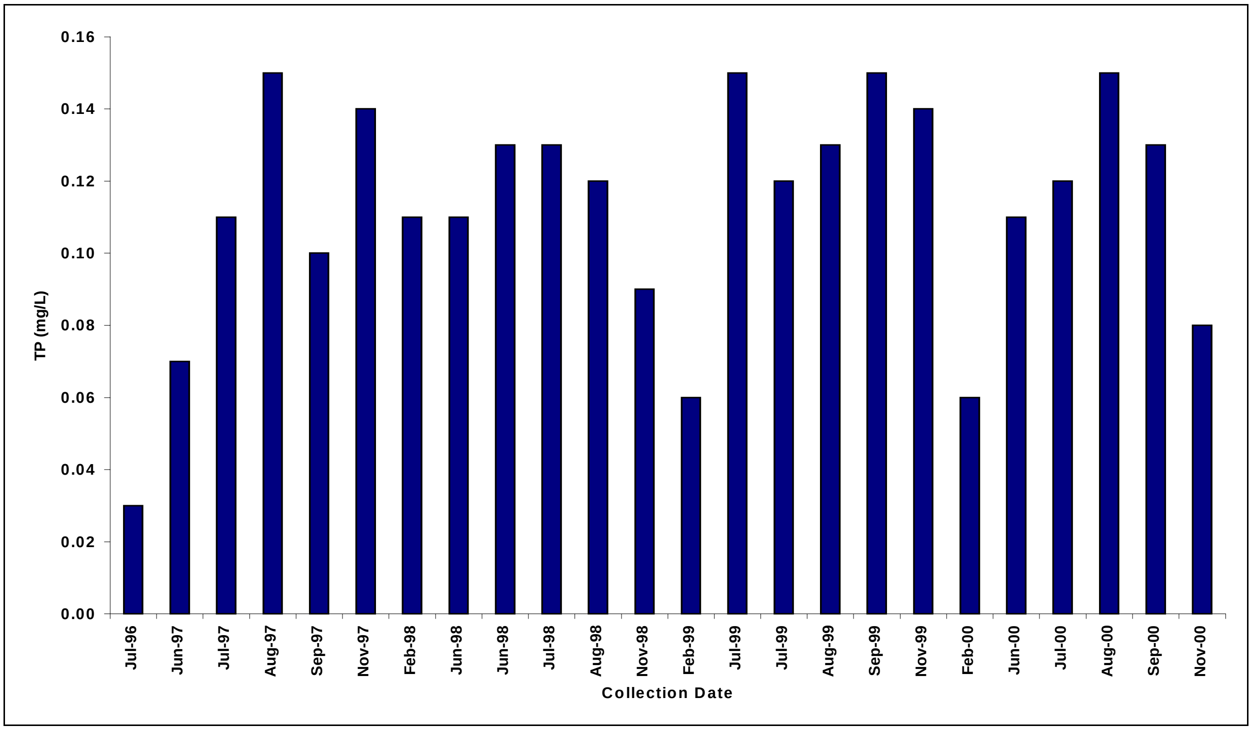


Figure 82. **Total phosphorus from the Neuse River, at SR 1400, Craven County, 1996 - 2000.**

NEUSE RIVER SUBBASIN 09

Description

This coastal plain subbasin contains Swift Creek and its tributaries (Figure 83). Much of the Swift Creek catchment has been channelized, and a US Department of Agriculture study indicated moderate nonpoint-source pollution potential (USDA 1995). Primary land use for the subbasin is agriculture with patchy forested areas. Many hog farms are located in the subbasin, especially in the northwestern portion.

There are only a few small towns in this subbasin and little concentrated development. There are no major dischargers; the largest discharger is the Vanceboro WWTP (0.25 MGD) into Mauls Swamp.

MacDonald, *et al.* (1981) listed Creeping Swamp as an important natural area. This is one of the few large, non-channelized streams in this part of the state. It was extensively studied as a site for comparisons with nearby channelized streams (Chapin 1975, Kuenzler, *et al.* 1977, Maki, *et al.* 1980). These studies demonstrated the detrimental effects of channelization, including a large increase in nutrient export and loss of wildlife habitat. Natural swamp streams tend to stop flowing during summer months, and may have very low dissolved oxygen concentrations. Channelized streams in this part of the state, however, will have year-round flow, and usually maintain high dissolved oxygen concentrations.

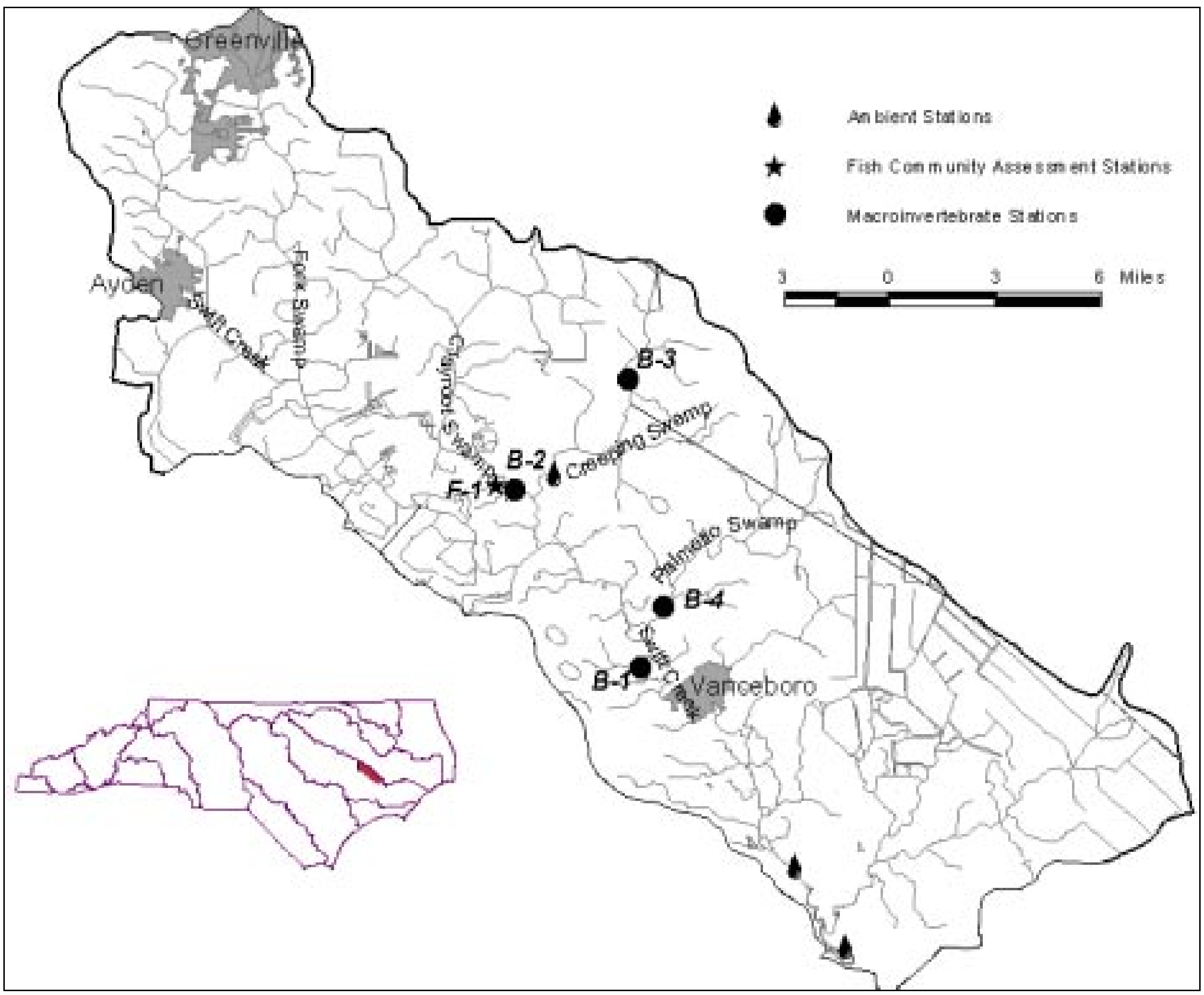


Figure 83. **Sampling sites in Subbasin 09 in the Neuse River basin.**

Summer macroinvertebrate collections resulted in Poor or Fair ratings for both Coastal A sites (Table 37), reflecting the effects of agricultural runoff and channelization. Swift Creek had a Good-Fair benthos rating in 1991, but only a Fair rating in 1995 and 2000. Analysis of these data, however, did not indicate a long-term change in water quality. Based on benthos samples, there was some evidence of a decline in water quality in Clayroot Swamp since 1991.

Creeping Swamp and Palmetto Swamp seemed to be only slightly impacted (relative to reference site benthos data). But, Palmetto Swamp had higher invertebrate taxa richness due to both a higher flow rate and higher pH than Creeping Swamp. Creeping Swamp, however, had a unique fauna associated with low pH swamp streams.

A watershed survey of Clayroot Swamp in October 2000 showed that most of the catchment is severely channelized. Other problems identified included nutrient enrichment and bank erosion.

Monthly water chemistry information is collected from four sites in this subbasin including two sites on Swift Creek and one site on Creeping Swamp. The lower site on Swift Creek (near Askin) is an area where the stream becomes much deeper and slow-moving, hence more prone to phytoplankton blooms and low dissolved oxygen concentrations. Detailed information is presented in the Ambient Monitoring section of this report. Creeping Swamp has very low dissolved oxygen during summer months, with mean yearly values less than 5 mg/L. These low values reflect, in part, natural conditions for a swamp stream.

Ambient water chemistry data from Swift Creek has shown occasional low dissolved oxygen values, with some values less than 3 mg/L each year. Other research (Kuenzler, *et al*. 1977) has shown that channelized streams in this catchment export large amounts of nitrogen and phosphorus to downstream systems, especially where there were hog and poultry farms.

No blue-green algal blooms were reported for this area, although diatom blooms were recorded in lower Swift Creek in 1997 and 1998.

Table 37. Waterbodies monitored in Subbasin 09 in the Neuse River basin for basinwide assessment, 1995 - 2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Swift Cr[2]	Craven	NC 118	Fair	Fair
B-2	Clayroot Swp[2]	Pitt	SR 1941	Fair	Poor
B-3	Creeping Swp	Pitt	NC 102	---	Not Rated
B-4	Palmetto Swp	Craven	NC 43	---	Not Rated
F-1	Clayroot Swp[2]	Craven	SR 1941	Not rated	Not rated

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available before 1995, refer to Appendix B2 or F3.

Flow conditions were generally normal in spring of 2000 (Figure 84), but normal to high for July and August. Invertebrate collections followed a period of high flow.

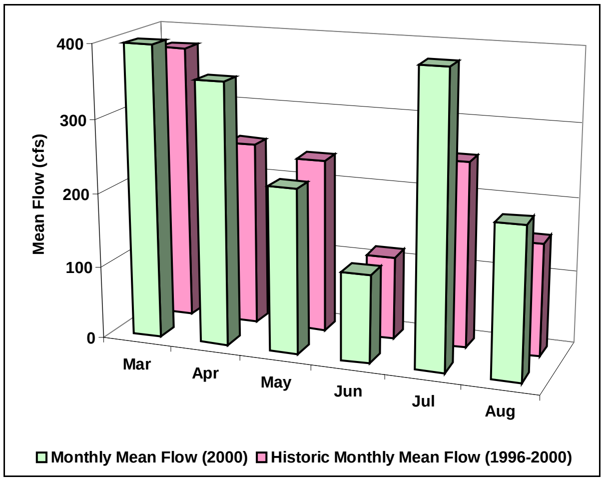


Figure 84. Spring and summer monthly mean flow and historic monthly mean flow at Swift Creek near Streets Ferry, Craven County.

Two sites were evaluated as fish community sites but not sampled. Fish were not collected from Swift Creek at NC 102 and from Fork Swamp at NC 102, both in Pitt County, due to extremely heavy growths of Brazilian elodea (*Egeria densa*) that covered the majority of the streams' surface.

Brazilian elodea, *Egeria densa*, at Swift Creek at NC 102, Pitt County.

Swift Creek, NC 118

USGS topographic maps and GIS land use information indicate large amounts of agricultural land upstream of this site. Much of the catchment has been channelized. Swift Creek had been sampled for benthos at SR 1478 from 1983 to 1987, but this site did not have sufficient flow to be evaluated with Coastal A Criteria.

In 1991, the monitoring site was moved upstream to NC 118. Here, the stream has good flow and good snag habitat. Habitat problems observed at this site included few pools and a relatively uniform silty substrate. The stream channel is about 13 meters wide, although the stream also flows through the adjacent swamp forest during moderate to high flow.

Swift Creek at NC 118, Craven County.

Sampling in 2000 was delayed until October due to an extended period of high flow during most of the summer. The stream was very turbid at this time and silt/clay sediment had been deposited throughout the floodplain. Most of the invertebrate fauna was found on snags located above the stream bottom. Sponge growths were abundant on the snags, suggesting low dissolved oxygen concentrations.

The stream rating decreased from Good-Fair in 1991 to Fair in 1995 and 2000. Comparisons of the 1991 and 2000 data, however, indicated that between sampling period differences in the benthic community were too small to support any long-term change in water quality. Sampling in a more normal flow year is recommended before placing this stream on the 2002 303 (d) List.

Clayroot Swamp, SR 1941

Clayroot Swamp has a width of four meters under low-flow conditions, although the width increases to eight meters at higher flows. Most of the catchment is agricultural, including cotton (80%), soybeans, and corn (Intensive Survey Unit Memorandum 20001102). At least 12 hog operations are located upstream of this site.

Habitat scores in 2000 were very low (32 and 49). Habitat problems included a lack of bends, no canopy, uniform sandy runs, very little instream habitat, no riffles or pools, and poor riparian buffer on one bank.

Clayroot Swamp at SR 1941, Pitt County.

Abundant periphyton growths were present during the summer, resulting in high pH (> 8 s.u.) and high daytime dissolved oxygen concentrations (13 mg/L). Specific conductance recorded during fish or macroinvertebrate collections were usually less than 150 µmhos/cm, but much high values were recorded on two occasions: June 2000 (250 µmhos/cm) and August 1995 (330 µmhos/cm). Both these records coincided with low stream flow.

Clayroot Swamp was sampled twice for benthos during 2000 – once in winter using swamp methods and once in summer when this site could be rated with Coastal A Criteria. The four benthos collections since 1991 have alternated between Poor and Fair ratings, and there was some evidence for a long-term decline in water quality. Some of the EPT taxa abundant in 1991 were rare or absent in subsequent collections: *Baetis propinquus*, *Tricorythodes*, *Caenis*, and *Oecetis persimilis*. All mayflies were rare or absent in the summer collections in 1995 and 2000.

Surprisingly, mussels (*Elliptio* sp.) were abundant in the August 2000 survey and a diverse fish fauna has consistently been found at this site. The insect-specific nature of this water quality problem suggested that pesticides might be having some effect on the benthic fauna. A crop duster was observed spraying adjacent fields during the 1995 collections.

A Clayroot Swamp watershed survey was conducted in October 2000 (Intensive Survey Unit Memorandum 20001102). Most of Clayroot Swamp and its tributaries now function as agricultural drainage ditches. The potential for high nutrient and sediment loading, and the presence of excessive periphyton growths were observed. Sediment problems were most apparent in the lower part of the catchment, near the SR 1941 site.

Fish community samples have been collected at this site for all three basinwide surveys. Given the minimal instream habitat, an unexpectedly diverse fish community has been documented for each sampling event. The number of species collected ranged from 27 in 1991 to 20 in 1995 and then increased to 23 in 2000. The number of individuals collected has ranged from 486 in 1995 to 815 in 2000. The American eel was the most abundant fish for the last two collections, accounting for 37 percent of the individuals in 1995 and 38 percent in 2000.

Although a large number of species have been collected from this site, many of these have been tolerant species. Six tolerant species were collected in 1991, five in 1995, and seven in 2000. The five tolerant species collected in all three years were redbreast sunfish, green sunfish, satinfin shiner, yellow bullhead, and eastern mosquitofish.

Creeping Swamp, NC 102

Using swamp methods, this site was sampled for benthos for the first time in February 2000. Here, the stream was four meters wide at the bridge, but away from the bridge, the stream flows through a swamp forest with a braided channel. The low pH (5.4) and low specific conductance (52 µmhos/cm) reflected lower disturbance than nearby channelized streams. Creeping Swamp may have no flow for up to four consecutive months (Kuenzler, *et al.* 1977).

This stream had a habitat score (85) and a NC Biotic Index (6.87) similar to reference sites. But total taxa richness (30) and EPT abundance (11) were below the expectations for this type of unimpacted swamp stream. The abundant taxa were typical of acidic swamp streams, including two isopods (*Lirceus* and *Asellus obtusus*) and six chironomids (*Orthocladius obumbratus*, *Zalutschia*, *Hydrobaenus*, *Psectrocladius*, *Polypedilum tritum*, and *Stenochironomus*). All these taxa were rare or absent at nearby Clayroot Swamp.

Palmetto Swamp, NC 43

This site was sampled for benthos in February 2000 using swamp methods; there were no prior NCDWQ data from this site. Palmetto Swamp has a width of eight meters at the bridge, but had a braided channel further upstream. This site had both a higher pH (6.2) and a higher specific conductance (93 µmhos/cm) than Creeping Swamp. This pattern may reflect either differences in soil type or a greater amount of agricultural land use in the Palmetto Swamp watershed than in the Creeping Swamp watershed.

Palmetto Swamp also seemed to have a much greater baseflow, allowing the development of some abundant filter-feeders, especially *Cheumatopsyche*. Kuenzler, *et al.* (1977) determined that Palmetto Creek usually has higher flow than Creeping Swamp, and shorter periods of no flow.

The combination of higher flow and pH produced much higher taxa richness in Palmetto Swamp than in Creeping Swamp, but biotic index values were similar (6.9 *vs*. 7.1). For example, the higher pH allowed the development of a diverse mollusc community at Palmetto Swamp (eight taxa), while molluscs were absent at Creeping Swamp. Both sites seemed to have some slight impacts when compared with similar reference swamps.

NEUSE RIVER SUBBASIN 10

Description

This subbasin consists of the lower Neuse River and its tributaries from Streets Ferry to Pamlico Sound (Figure 85) Most of the waters in this subbasin are estuarine, including the Neuse River and the downstream portion of all tributaries. Freshwater is confined to the upper reaches of some tributary streams and wetlands/pocosins except under extreme hydrological events.

Land use in the subbasin is mostly forest and agriculture. The largest agricultural area is a portion of Open Grounds Farm, which includes much of the land on the outer Pamlico peninsula. Much forested land has been clear-cut, especially near Clubfoot Creek and Cedar Creek. Runoff remains the most important cause of nonpoint source pollution, although there have been recent efforts to control runoff from Open Ground Farms. This area continues to practice no till farming; all cattle (> 2,000 head) have been removed; and over 90 flashboard risers have been installed to control drainage (NCDEH 2000).

More natural lands include a portion of the Croatan National Forest (south of New Bern) and the Light Ground Pocosin (north of Oriental). Greens Creek from Kershaw Creek to the Neuse River (except lower Smith Creek) has been classified as High Quality Waters based on its designation as a Primary Nursery Area. Much of the area, inaccessible by roads, supports abundant wildlife and waterfowl.

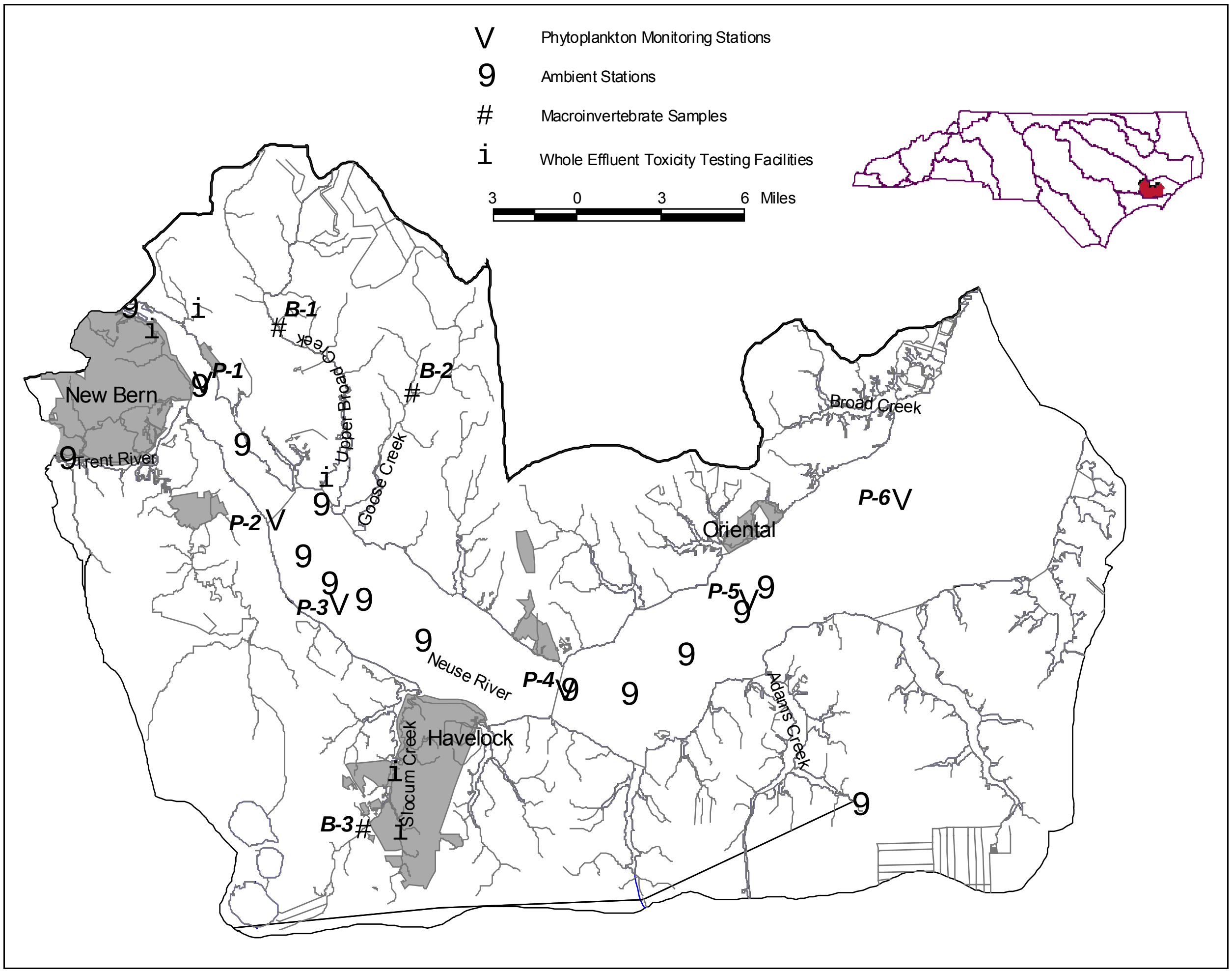


Figure 85. **Sampling sites in Subbasin 10 in the Neuse River basin.**

Moderate residential growth continues throughout this subbasin, although poorly drained soils limit the amount of development in some areas. The largest cities in this subbasin are New Bern, Havelock, and Oriental.

There are four major dischargers in the subbasin: New Bern (4.7 MGD) and NE Craven Utilities (0.6 MGD) which discharge into the Neuse River; USMC Cherry Point (3.5 MGD) which discharges into Slocum Creek; and Havelock WWTP (1.9 MGD) which discharges into East Prong Slocum Creek.

This entire subbasin was severely affected by Hurricanes Dennis and Floyd in 1999. These storms caused widespread flooding and produced large amounts of nonpoint source runoff.

Overview of Water Quality

Many organizations conduct investigations of water quality in the lower Neuse River. Data cited herein are primarily from the NCDWQ studies, but other data are also included (see “Other Studies”). All studies are in agreement that the fauna of the lower Neuse River is controlled by periods of very low dissolved oxygen (hypoxia) during summer months. Hackney, *et al.* (1998) looked at EMAP sediment data from the Neuse River, and suggested that high contaminant levels also may influence the benthic fauna at specific locations.

Water chemistry information through 1995 suggested that many of the contributing sources of nutrients to the estuary originate from upstream. Phosphorus concentrations were greatest near New Bern (median = 0.15 mg/L), gradually declining to a median concentration less than 0.05 mg/L near Oriental. Nitrate+nitrite concentrations showed very sharp fall-winter peaks, due to phytoplankton uptake during the growing season. These concentrations were the greatest at the head of the estuary near New Bern, but can be quite variable between stations and between years. The effect of hurricanes could be observed by the high concentrations of nitrate+nitrite in the fall and winter of 1999-2000.

A number of reported algae blooms in this part of the river are often accompanied by extreme swings in dissolved oxygen concentrations and pH values greater than 9.0 s.u. Mean pH values greater than 8.0 s.u. were found in the middle portion of Neuse River from Broad Creek to the mouth, but the lowest dissolved oxygen concentrations were recorded from New Bern to Riverdale.

Phytoplankton blooms can occur throughout the year, but the greatest problems were associated with summer blooms. Most blooms occurred in the Neuse River between Broad Creek and Oriental, with few blooms occurring near the mouth of the river. The mesohaline section of the river becomes strongly stratified in summer, leading to oxygen depletion of bottom waters. Summer algae blooms (especially dinoflagellates) have been commonly observed in this subbasin for many years. During the prior basin cycle, the most severe algal blooms occurred during 1990 and 1995. Both years were periods of high flow in spring and early summer, followed by a period of prolonged summer low flow. Blooms during the current basin cycle were less dependent on spring flows, partially due to repeated hurricane inputs during the preceding fall and winter and partially due to recycling of nutrients from the sediments. Almost all summer low-flow periods during 1997-2000 produced high algal biovolumes and algal blooms. The lowest summer algal populations were found during 1996 – a year with both normal spring and summer flows.

The NCDWQ's Neuse River Rapid Response Team, located in New Bern, is responsible for monitoring water quality conditions in the lower Neuse River watershed below Kinston. The team's primary charge is rapid evaluation of acute water quality-related events like fish kills and algal blooms. During routine operations, the team performs regular monitoring duties along the river, collecting monthly ambient water quality samples, and working collaboratively with other research agencies in monitoring field water quality parameters (e.g. dissolved oxygen, pH, temperature, and salinity). The Team, which began operations in June, 1997, has been involved with field aspects of *Pfiesteria* research. Team members frequently interact with the public in an educational capacity to pass along a better understanding of water quality issues.

The NCDWQ began tracking fish kill activity closely in North Carolina’s river basins in 1996. Field reports since 1996 have shown frequent fish kill activity in the Neuse River, especially in shallow and poorly flushed sections of the lower Neuse. These sections often experience eutrophication, stratification, and associated dissolved oxygen depletion that lead to numerous kill events during the warm months of the year.

Since 1995, several large storm events in North Carolina have resulted in widespread flooding, depletion of dissolved oxygen, and subsequent fish kills throughout many river basins, including the Neuse River basin. Field investigators reported 31 fish kill events in this subbasin from 1996 to 2000. Most events occurred in the mainstem of the Neuse River from Flanner's Beach to Minnesott Beach. These kills often involved large schools of menhaden and were associated with advanced lesions on the species.

Macroinvertebrate samples have been collected primarily from tributaries to the Neuse River, with only four samples collected from the Neuse River proper (Table 38 and Appendix B2). All Neuse River invertebrate collections were from the estuarine portion of the river and this area has not been sampled since 1998. Sampling of estuarine invertebrates has shown some water quality problems in Oriental Harbor (Eaton 2001).

None of the freshwater streams in this area are expected to have flowing water in the summer. Therefore, the NCDWQ conducted swamp sampling at three sites during February 1999 and 2000. Due to differences in geology and soil type, swamp stream in this subbasin cannot be easily compared with reference swamp streams in other portions of the coastal plain. Streams on the northern side of the Neuse River (Goose Creek and Broad Creek) are subjected to low pH, which limits the diversity of the fauna. Streams on the southern side (e.g., South West Prong Slocum Creek) have higher pH, and appeared most similar to streams in the White Oak River basin.
Based on benthic data, South West Prong Slocum Creek had good water quality. Broad Creek and Goose Creek were harder to evaluate, but did not show any major water quality problems.

Fish tissue samples have been collected from Dawson Creek and Slocum Creek and analyzed for metals. Only Slocum Creek was monitored during 1995-2000. No metals were found in concentrations greater than either US FDA or US EPA criteria.

Five dischargers conduct toxicity tests in this subbasin: Cherry Point USMC, New Bern WWTP, Havelock WWTP Fairfield Harbor, and Phillips Plating. The facility at New Bern has experienced problems in meeting their toxicity limits since 1994, but is working on improving their wastewater treatment operation.

There are two natural lakes in this subbasin: Long Lake and Lake Ellis. Both are typical dystrophic Carolina Bay lakes with shallow depth, tannic waters, and low nutrients. Both lakes were unimpaired during the last basin cycle, but were not sampled during 1996 - 2000.

The North Carolina Division of Environmental Health's Shellfish Sanitation Branch evaluates the shellfishing resource in this subbasin, but it does not monitor any part of the subbasin upstream of Minnesott Beach. The latter area has no commercially important shellfish. Of the 71,700 acres remaining in this subbasin with a potential shellfish resource, 4,036 acres (all within tributaries of the Neuse River) are closed to shellfishing (NCDEH 1998, 1999, 2000).

Table 38. Waterbodies monitored in Subbasin 10 in the Neuse River basin for basinwide assessment, 1995 - 2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Upper Broad Cr	Craven	SR 1612/NC 55	---	Not Rated
B-2	Goose Cr	Pamlico	SR 1100	Not Rated	Not Rated
B-3	SW Prong Slocum Cr	Craven	SR 1746	---	Not Rated
P-1	Neuse R	Craven	US 17	---	---
P-2	Neuse R	Craven	Broad Creek	---	---
P-3	Neuse R	Pamlico	Flanners Beach	---	---
P-4	Neuse R	Pamlico	Minnesott Beach	---	---
P-5	Neuse R	Pamlico	Oriental	---	---
P-6	Neuse R	Pamlico	Mouth of Neuse	---	---

[1]B = freshwater benthic macroinvertebrate monitoring sites; P = phytoplankton monitoring sites.

The amount of water chemistry data collected in this subbasin greatly expanded in the last five years, and now includes information from the lower Trent River, Back Creek, and 17 sites on the Neuse River. The Neuse River sites extend from the freshwater segment at New Bern through the estuarine section in Pamlico Sound. Sites in the lower Neuse River have problems with low dissolved oxygen concentrations in bottom waters. Detailed information is presented in the Ambient Monitoring section of this report.

At the Mouth of the Narrows, nitrate+nitrite concentration, though experiencing annual oscillation, remains available in the water column for most of the year. Further downstream at stations near the mouth of Broad Creek and Minnesott point, nitrate+nitrite concentration is practically depleted in the water column during warmer growing season months, even as Total Kjeldahl Nitrogen and total phosphorus remain available. It is therefore possible that inorganic nitrogen remains one of the limiting factors to algal growth in the estuarine portion of the Neuse River.

River and Stream Assessment

Freshwater streams on the northern side of the Neuse River are subject to low pH, which limits the diversity of the fauna. For example, the lack of mollusks and the scarcity of mayflies in these streams suggested a limitation by highly acidic conditions. Upper Broad Creek in February 1995 had a pH of 4.8, while Goose Creek had pH values of 4.3-4.6 in winter samples from 1995-1998. Conditions changed in 1999- 2000, with both sites having a pH > 5.0 during the February benthos collections. The increase in pH suggested greater disturbance in the later samples.

Upper Broad Creek, NC 55

Upper Broad Creek at NC 55 had a channel width of 8-10 meters in February 2000, although this stream flows through an extensive floodplain forest at higher flows. The substrate was mostly silt and detritus at an upstream site (SR 1612), but it changed to more sand at the NC 55 site.

Upper Broad Creek at NC 55, Craven County.

This site had good instream habitat, although there were relatively few pools. The highest current speed was observed at the bridge, and this was the only area where any baetid mayflies (*Baetis frondalis)* were collected. Total taxa richness was fairly low (35), although there was a good diversity of crustaceans (11). The large numbers of isopods (*Lirceus*, *Asellus racovitzai*, and *Asellus obtusus*) indicated the importance of the adjacent swamp forest. Orthoclad midges (*Orthocladius*, *Hydrobaenus*, and *Tvetenia bavarica* group) were abundant, but the dominant chironomid (*Dicrotendipes simpsoni*) indicated nutrient enrichment.

Goose Creek (Black Creek), SR 1100

Goose Creek has a channel width of 7 -10 meters at the road crossing, but it forms a very braided channel away from the bridge. The substrate is largely silt and organic debris with small sand patches. This stream had been sampled four times to establish conditions for reference swamps, but it was deleted from the reference data base due to continuing development and problems caused by hurricane damage.

Three caddisfly taxa were abundant in the first collection (March 1995), but were absent or sparse in the 1997 and 1999 collections. The fauna was dominated by isopods (especially *Lirceus*) in all collections, although Simuliidae and Orthocladiinae also were abundant. No enrichment indicators were collected in Goose Creek.

Southwest Prong Slocum Creek, SR 1746

Most of the freshwater streams on the south side of the Neuse River did not have sufficient flow to allow the collection of swamp samples. The notable exception to this was the South West Prong of Slocum Creek. This stream has a large

drainage area, being connected to Lake Ellis Simon by a canal system.
This portion of the stream had a distinct channel, with a mean width of seven meters. There was sufficient flow to maintain a sand substrate, but good snag and root habitats also were found. The hurricane damage observed for streams on the north side of the Neuse River was not observed at this site. There were few habitat problems aside from a scarcity of pools and a rather straight channel.

Southwest Prong Slocum Creek at SR 1746, Craven County.

The low biotic index (6.6) and high EPT taxa richness (13) indicated good water quality in this stream. Unusual taxa for this area included three caddisflies (*Hydropsyche decalda*, *Chimarra*, and *Triaenodes ochraeceus*) and one mayfly (*Eurylophella prudentalis*). This site was more similar to swamp streams in the White Oak River basin (e.g., Holston Creek and Hunters Creek) than to swamp streams on the north side of the Neuse River.

SPECIAL STUDIES

Estuarine Method Testing

Numerous estuarine sites were sampled in Oriental Harbor and Greens Creek to test an estuarine sampling technique (Eaton 2001). These samples showed water quality problems in the more developed portions of Oriental Harbor.

Boat IBI

A site on Brice Creek just above canoe mile marker 3 has been sampled in 1998 and 2000 as part of an ongoing project to develop a method to assess fish communities in small nonwadeable streams using an electrofishing boat. Brice Creek is a slow-flowing coastal plain blackwater stream. It is approximately 20 meters wide and had a habitat score of 75.

The 1998 sample indicated a typical fish community for a lower coastal plain blackwater stream. The 13 species collected included bluespotted sunfish, pirate perch, warmouth, and chain pickerel. However, in 2000, the stream was more brackish than before with over 1 ppt salinity. Only six fish representing four species were collected during an abbreviated sampling effort in 2000.

OTHER DATA

Shellfish Resources

The North Carolina Division of Environmental Health's Shellfish Sanitation Branch evaluates the shellfishing resource in this subbasin, but it does not monitor any part of the subbasin upstream of Minnesott Beach. The latter area has no commercially important shellfish. Of the 71,700 acres remaining in this subbasin with a potential shellfish resource, 4,036 acres (all within tributaries of the Neuse River) are closed to shellfishing (NCDEH 1998, 1999, 2000).

There were few recent changes in shellfish closures, the exception being the opening of Big Creek, a tributary of the South River. Both Whittaker Creek and Greens Creek are closed due to development and marinas. Most of the other closed areas in this subbasin receive unacceptable levels of coliform bacteria from freshwater runoff: Clubfoot Creek, Dawson Creek, Pierce Creek, upper Adams Creek, Back Creek and tributaries to the South River. Oysters are the only commercial species in this subbasin, with significant populations in Turnagain Bay and Point of Marsh.

Neuse River Estuary

Intensive monitoring of the Neuse River Estuary is conducted by three other groups:

- the Albemarle-Pamlico National Estuary Program;
- the Neuse River Estuarine Modeling and Monitoring Project and
- US EPA’s Environmental Monitoring and Assessment Program (EMAP). This project is conducted in conjunction with the National Oceanic and Atmospheric Administration with the most recent Neuse River data listed (but not analyzed) by Balthis, *et al.* (2000).

All studies are in agreement that the fauna of the lower Neuse River is controlled by periods of very low dissolved oxygen (hypoxia) during summer months. Hackney, *et al.* (1998) looked at EMAP sediment data from the Neuse River, and suggested that high contaminant levels also may influence the benthic fauna in this area. Sediment contaminants found in Neuse River samples included DDT, arsenic, PCBs, nickel and chromium.

Stow, *et al.* (2000) and Qian, *et al.* (2000) have evaluated spatial and temporal trends in nutrients in the Neuse River. They documented that declines in phosphorus coincided with a phosphate ban in 1988. Other changes in nutrient loading and wastewater treatment have not caused any significant changes in nitrogen and phosphorus concentrations in the lower Neuse River. This may be causing a shift from nitrogen to phosphorus limited phytoplankton. The resultant shift in the biotic community may be perceived as a decline in water quality, despite any change in nutrient concentration. There seemed to have been a chronic overload of nutrients to the lower Neuse River, and internal nutrient recycling may cause a significant delay between nutrient reduction and any biological response.

Fish Tissue

OTHER DATA

Fish samples were collected from Slocum Creek (within the US Marine Corps Aviation Station at Cherry Point property) in October 1998 and analyzed for select pesticides, PCBs, and metals. The purpose of the investigation was to evaluate potential impacts of the restoration sites on human health through fish consumption. Forty-five composite samples consisting of 1 to 5 fish of the same species (largemouth bass, sunfish, catfish, and pickerel) were analyzed. DDE, dieldrin, Aroclor-1260, arsenic, mercury, and zinc were the most frequently detected contaminants. However, all concentrations were less than current state and federal criteria (TTNUS 1999).

Phytoplankton Monitoring

Neuse River

Phytoplankton and nutrients were analyzed on an upstream - downstream transect of the Neuse River from New Bern to the mouth (Figure 85). The stations were:

- P-1--Highway 17 Bridge (Station J8570000)
- P-2--Mouth of Broad Creek near Thurman (Station J8902500)
- P-3--Flanners Beach near Riverdale (Station J8910000)
- P-4--Minnesott Beach (Station J9530000)
- P-5--Oriental (Station J9810000)
- P-6--Mouth of the Neuse River at Pamlico (Station J9930000).

Overview of Phytoplankton Biovolume, Taxa, and Nutrient Levels

Assemblage biovolumes were often high (> 5,000 mm^3/m^3) and ranged from 43 to 58,240 mm^3/m^3 for all ambient stations with the exception of the most upstream site (Highway 17 bridge) and the most downstream site (mouth of the Neuse River) (Figures 86-97). Concentrations at the downstream site were less than 5,000 mm^3/m^3 for all samples with the exception of November 2000 (Figures 91 and 97).

Cryptomonads and dinoflagellates were often dominant during February. From June through September, cryptomonads, dinoflagellates, diatoms, and small chrysophytes were common. During November, dinoflagellates and diatoms were prevalent at the downstream stations (Station J9530000 and below).

Nutrients fluctuated amongst stations, with higher inorganic nitrogen (NO_2+NO_3-N) concentrations often peaking during early winter (Figures 98-109). Total Kjeldahl Nitrogen (TKN) and total phosphorus (TP) concentrations often peaked during late summer. NO_2+NO_3-N ranged from 0.01 to 0.74 mg/L at the more upstream stations. The maximum concentration recorded at the mouth of the river was 0.14 mg/L. TKN ranged from 0.1 to 1.1 mg/L at all but three stations. At Flanners Beach, maximum TKN concentrations reached 2.0 mg/L, and at Minnesott Beach, TKN was recorded at 2.8 mg/L. The highest TKN concentrations at the mouth of the river were 0.7 mg/L.

A similar pattern in TP concentrations was also evident. At the Highway 17 Bridge, TP ranged from 0.06 to 0.39 mg/L, but at the mouth of the river, TP ranged from 0.01 to 0.12 mg/L). Patterns in nutrient fluctuations did not seem to coincide with phytoplankton biovolume fluctuations during the study period.

Phytoplankton Assemblages
1996
Biovolume concentrations were often low (< 5,000 mm^3/m^3) and ranged from 43 to 5,200 mm^3/m^3. An exception occurred when a bloom of the dinoflagellate *Gyrodinium uncatenum* contributed to the August biovolume at Broad Creek of 34,280 mm^3/m^3. Taxa assemblages were often dominated by this species and other dinoflagellates (*Gymnodinium, Gyrodinium, Glenodinium,* and *Peridinium*), cryptomonads, and small centric diatoms. Other taxa found during the summer included *Euglena* near Minnesott Beach and the silicoflagellate chrysophyte *Dictyocha* at Oriental.

1997
Biovolume concentrations ranged from 130 to 24,960 mm^3/m^3. An exception occurred at the Highway 17 Bridge, when a September bloom of *Gyrodinium* contributed to a five-year biovolume peak (47,760 mm^3/m^3) for this station. Biovolume concentrations at the mouth of the river never exceeded 680 mm^3/m^3. Dominant taxa along the river included centric and chain-forming diatoms (*Skeletonema*), cryptomonads (*Chroomonas* and *Cryptomonas*), dinoflagellates (*Gyrodinium* and *Prorocentrum*), and green algae (*Kirchneriella, Synura,* and *Tetrahedron*) during June through September. During November, dinoflagellates (*Gymnodinium* and *Polykrikos*) and diatoms (*Ceratulina* and *Nitzschia*) were common.

1998
Biovolumes ranged from 210 to 27,300 mm^3/m^3. During February, dinoflagellates (*Gymnodinium*) and cryptomonads (*Chroomonas*) were common at many stations. Winter dinoflagellates *Prorocentrum minimum* and *Heterocapsa triquetra* were predominant at Oriental that month. Assemblages along the river from June through September included chrysophytes (*Mallomonas, Dictyocha,* and *Ebria*) and the cryptomonad *Chroomonas*. Chain-forming diatoms (*Skeletonema* and *Melosira*) were more common at the Highway 17 Bridge, and large dinoflagellates (*Polykrikos* and *Peridinium*) were prevalent at Broad Creek, Minnesott Beach, and Oriental. Blue green algae (*Anabaena, Lyngbya, Merismopedia,* and *Oscillatoria*) were common from Minnesott Beach to the mouth. During November, cryptomonads (*Chroomonas*) and dinoflagellates (*Gymnodinium, Gyrodinium,* and *Peridinium*) were prevalent at many stations. Diatoms (*Skeletonema* and *Synedra*) were common at the mouth.

1999
Biovolumes ranged from 240 to 40,460 mm^3/m^3. During February, *Prorocentrum* and *Heterocapsa* were predominant from Minnesott Beach to the mouth. Diatoms (*Ceratulina* and *Rhizosolenia*) were also common at the mouth. From June through September, chrysophytes (*Calycomonas* and *Mallomonas*), cryptomonads (*Cryptomonas*), and dinoflagellates (*Gymnodinium, Gyrodinium, Glenodinium,* and *Peridinium*) were prevalent. High concentrations of the dinoflagellate *Polykrikos* at Oriental contributed to the 1999 biovolume peak. Diatoms (*Leptocylindrus, Nitzschia, Rhizosolenia,* and *Skeletonema*) were common at a few stations along the river. During November, cryptomonads (*Chroomonas,* and *Cryptomonas*) were common along the entire river, and *Skeletonema* was prevalent at Minnesott Beach and Oriental.

2000
Biovolumes ranged from 200 to 58,240 mm^3/m^3. During February, cryptomonads (*Chroomonas,* and *Cryptomonas*) were prevalent at the most upstream and downstream stations. *Melosira* diatoms were common at the Highway 17 Bridge and Flanners Beach. Green algae (*Chlamydomonas* and *Synura*) were predominant at Broad Creek and Flanners Beach. Dinoflagellates (*Heterocapsa* and *Katodinium*) were common from Minnesott Beach to the mouth. During June through September, small chrysophytes, cryptomonads (*Chroomonas, Cryptomonas* and *Rhodomonas*), diatoms (*Leptocylindrus, Melosira, Nitzschia,* and *Rhizosolenia*), and dinoflagellates (*Gyrodinium, Oxyrrhis, Polykrikos, Peridinium,* and *Prorocentrum*) were prevalent. Several dinoflagellate taxa at Broad Creek contributed to the highest biovolume concentration found for all stations during the regular sampling period of the five-year study. The chrysophyte *Chattonella* was prevalent at Minnesott Beach during September and at Flanners Beach during November. During November, the chrysophyte *Calycomonas*, cryptomonads, and dinoflagellates were common.

Algal Blooms
1996
A bloom of the winter dinoflagellate *Prorocentrum minimum* was discovered in Back Creek in early

spring. During July, blooms of diatoms and large dinoflagellates (*Gymnodinium nelsonii* and *Polykrikos*) were recorded in the lower Neuse River. A surface film and odor complaint at Beard Creek later that month revealed a bloom of the coccoid blue green alga *Synechococcus*.

1997

Bloom reports increased in the lower Neuse River with the formation of the Neuse River Rapid Response Team (NRRT). A report of brown water in July at Slocum Creek revealed a bloom of the chloromonad *Heterosigma* and the euglenoid *Trachelomonas*. Blooms of diatoms and the dinoflagellate *Polykrikos* were found during mid-July. A surface bloom of the filamentous blue green *Anabaena* also occurred later that month. In August, an oily foamy surface bloom near Bridgeton was caused by the flagellated green alga *Chlamydomonas*. A bloom of *Anabaena* at Broad Creek was also documented during August. From September through December, several dinoflagellate blooms (including *Gyrodinium aureolum* and *Gyrodinium uncatenum*) were documented.

1998

Blooms of diatoms (including *Cyclotella* and *Skeletonema*) were common during the winter and spring. In June, a dense bloom of the euglenoid *Eutreptia* was discovered in Hancock Creek. In July, another bloom at the site was dominated by filamentous blue greens (*Lyngbya* and *Anabaena*) with only a small amount of *Eutreptia*. During late July, several samples from the lower Neuse River were collected by the NRRT during a fish kill. Cell densities ranged from 0-326 cells/ml of *Pfiesteria*-like dinoflagellates. High densities of blue-green, green, and chrysophyte algae were also present in these samples. The presence of *P. piscicida* at this event was later confirmed by the NCSU Center for Applied Aquatic Ecology. A cryptomonad bloom was documented during September at Flanners Beach.

1999

Blooms of centric diatoms and dinoflagellates (including *Prorocentrum, Heterocapsa*, and *Katodinium*) were common from January through March. From June through mid-August, blooms of large dinoflagellates (including *Gymnodinium, Gyrodinium, Peridinium,* and *Polykrikos,*) were recorded. After the flushing events associated with Hurricanes Dennis and Floyd, no blooms were recorded after mid-August. All samples collected by the NRRT during May and July fish health events were negative for *Pfiesteria*, as confirmed by researchers at NCSU and UNC-Greensboro.

2000

Algal blooms in the lower Neuse River during July through September were often dominated by dinoflagellates (*Peridinium, Gyrodinium,* and *Prorocentrum*). Blooms on the Trent River near the Town of Rhems during June and August were dominated by cryptomonads, diatoms, and dinoflagellates. From October through December, all blooms along the Neuse River were dominated by cryptomonads, chain-forming diatoms (*Leptocylindrus,* and *Skeletonema*) and dinoflagellates.

Of the events investigated, one tested positive for *Pfiesteria*. A fish kill in Greens Creek during late September was positive for *Pfiesteria shumwayae* by researchers at UNC Greensboro, but researchers at NCSU found that it was not toxic.

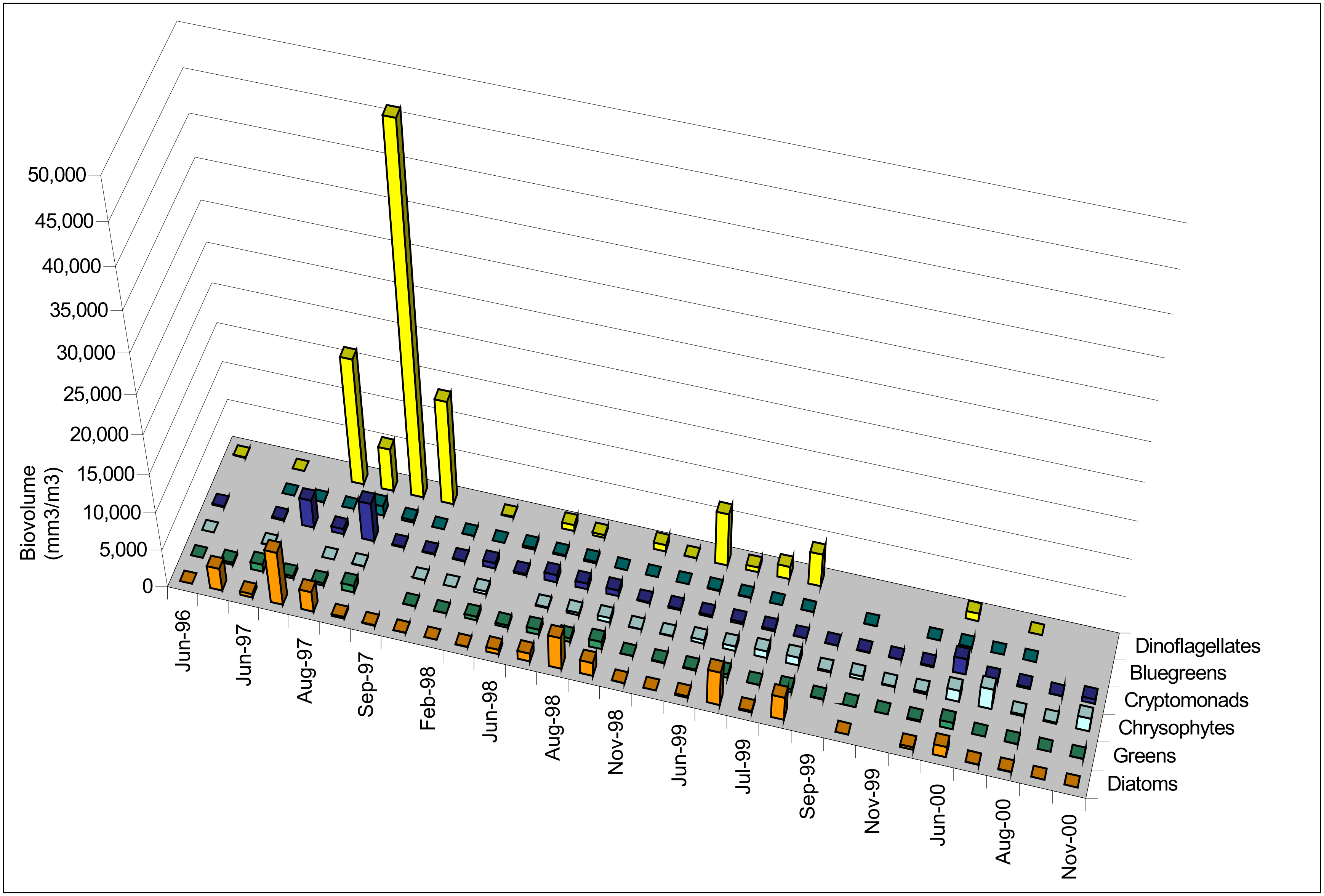


Figure 86. **Biovolumes of phytoplankton divisions from the Neuse River at US 17, Craven County, 1996 - 2000.**

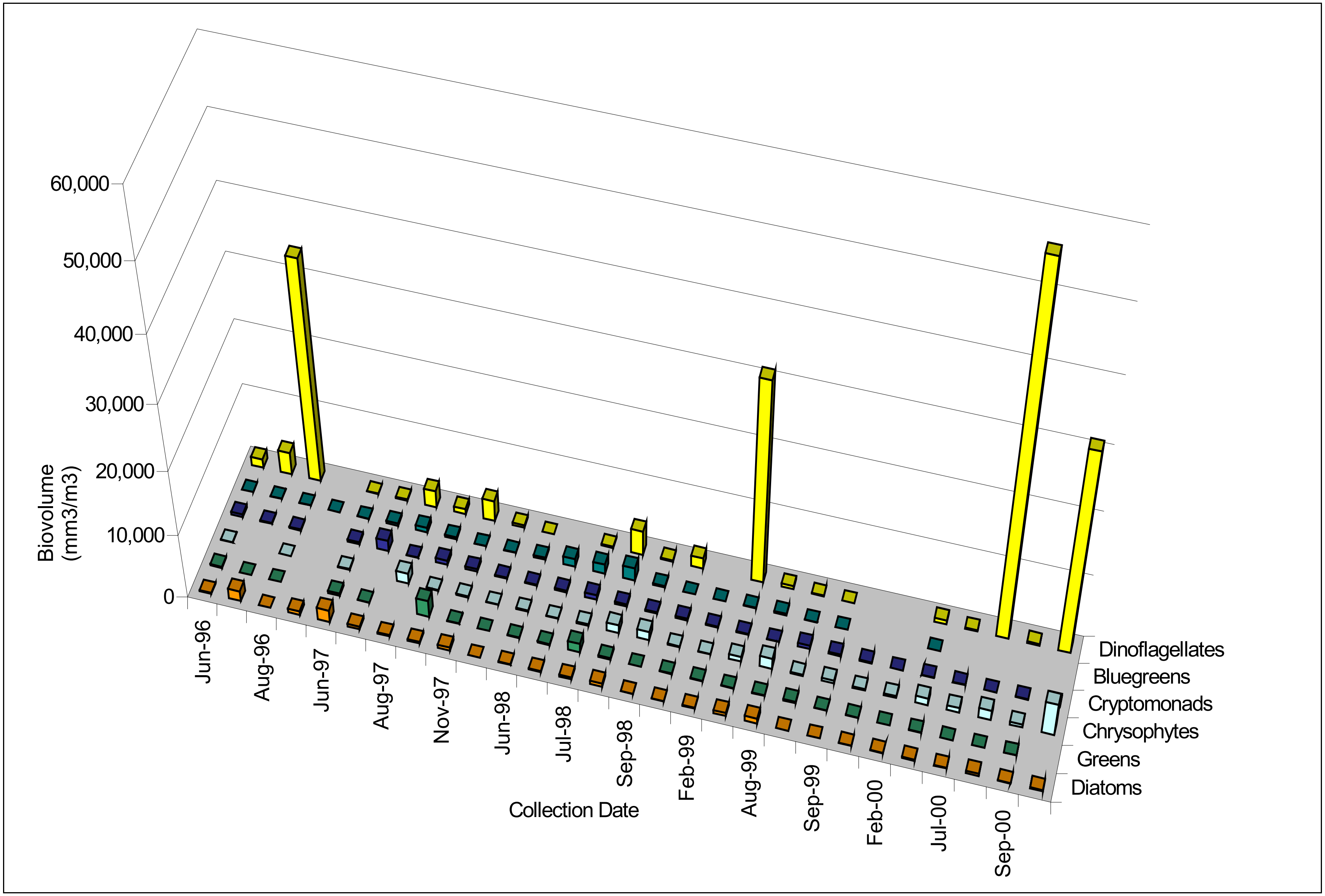


Figure 87. Biovolumes of phytoplankton divisions from the Neuse River at Broad Creek, Craven County, 1996 - 2000.

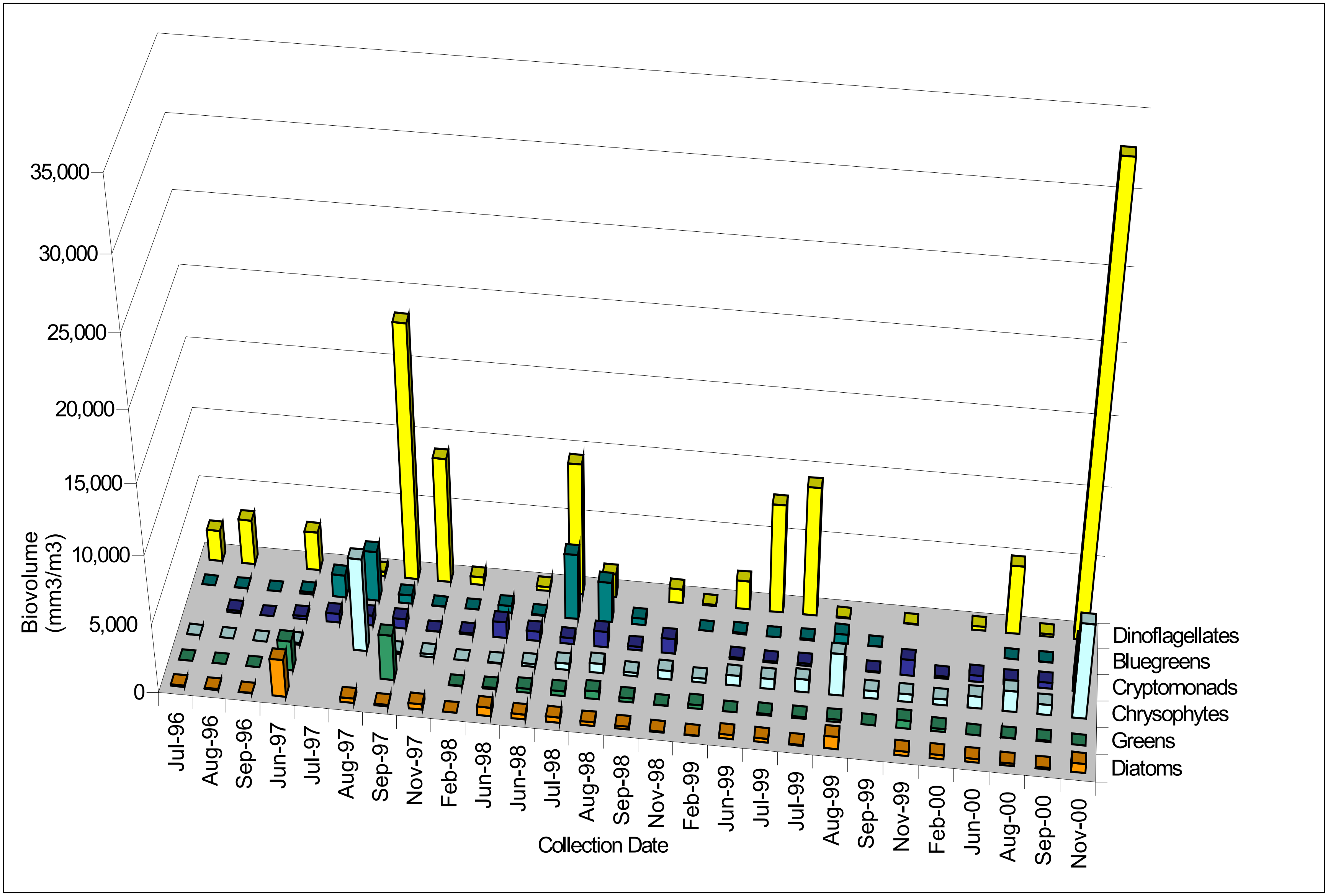


Figure 88. **Biovolumes of phytoplankton divisions from the Neuse River at Flanners Beach, Pamlico County, 1996 - 2000.**

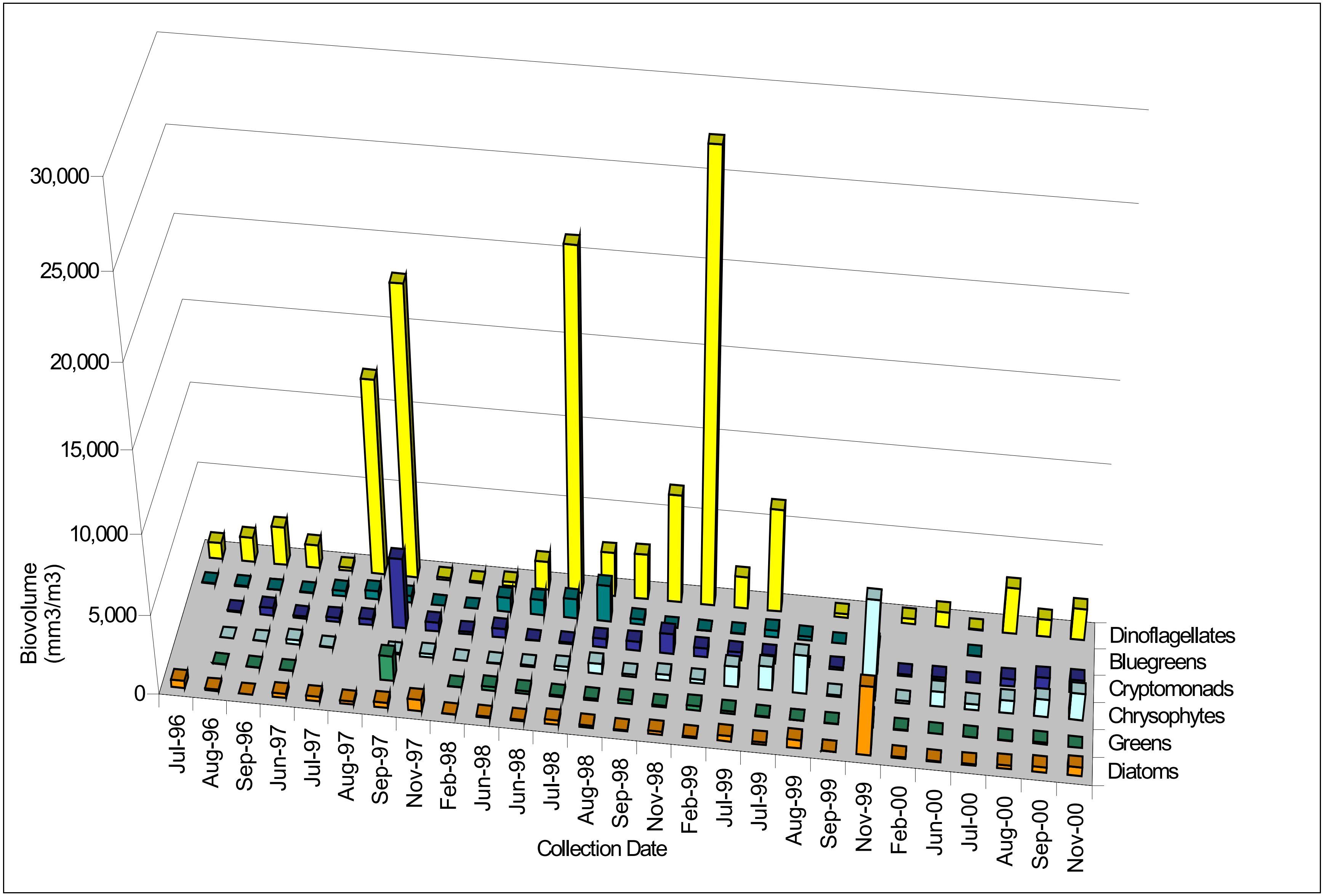


Figure 89. **Biovolumes of phytoplankton divisions from the Neuse River at Minnesott Beach, Pamlico County, 1996 - 2000.**

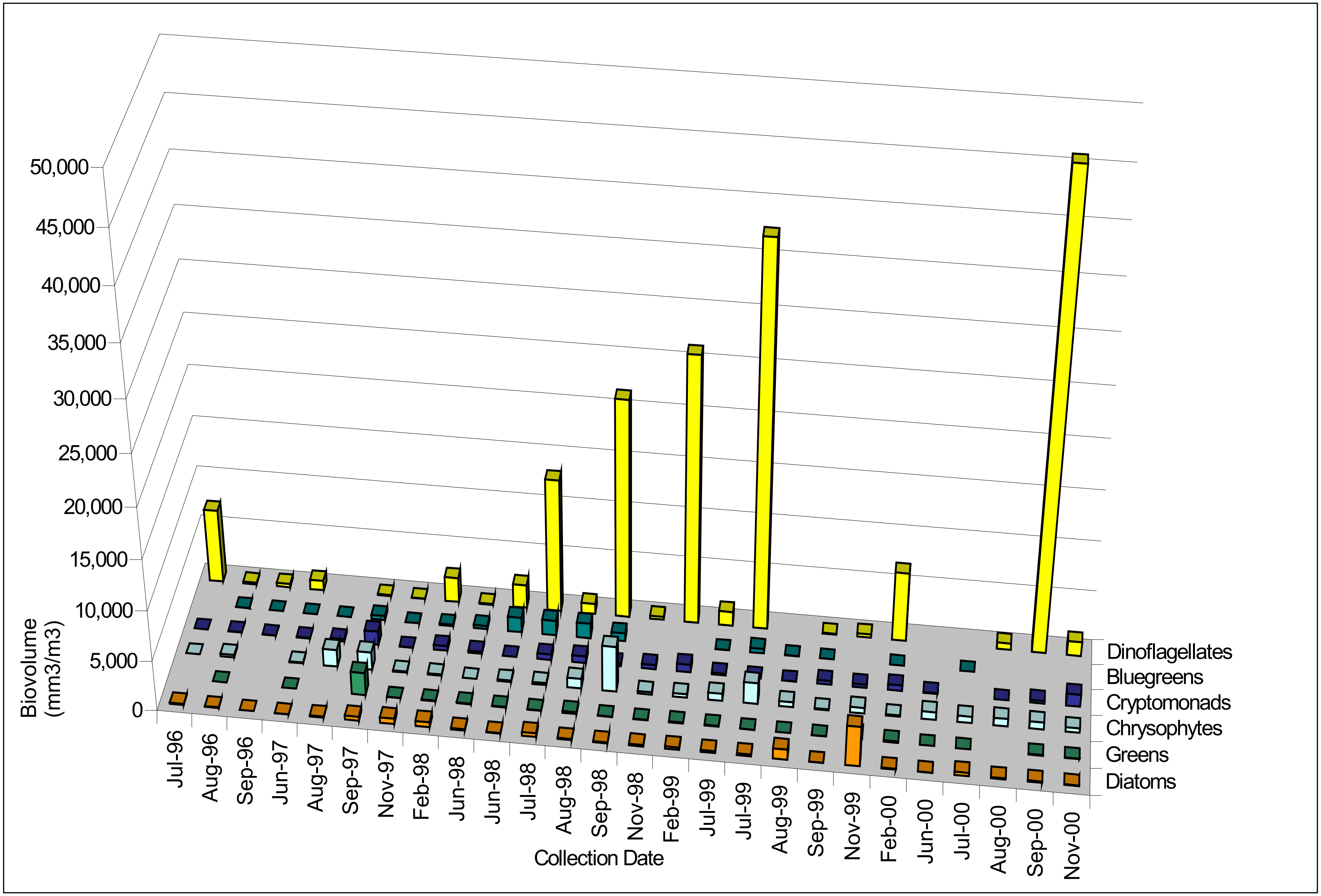


Figure 90. **Biovolumes of phytoplankton divisions from the Neuse River at Oriental, Pamlico County, 1996 - 2000.**

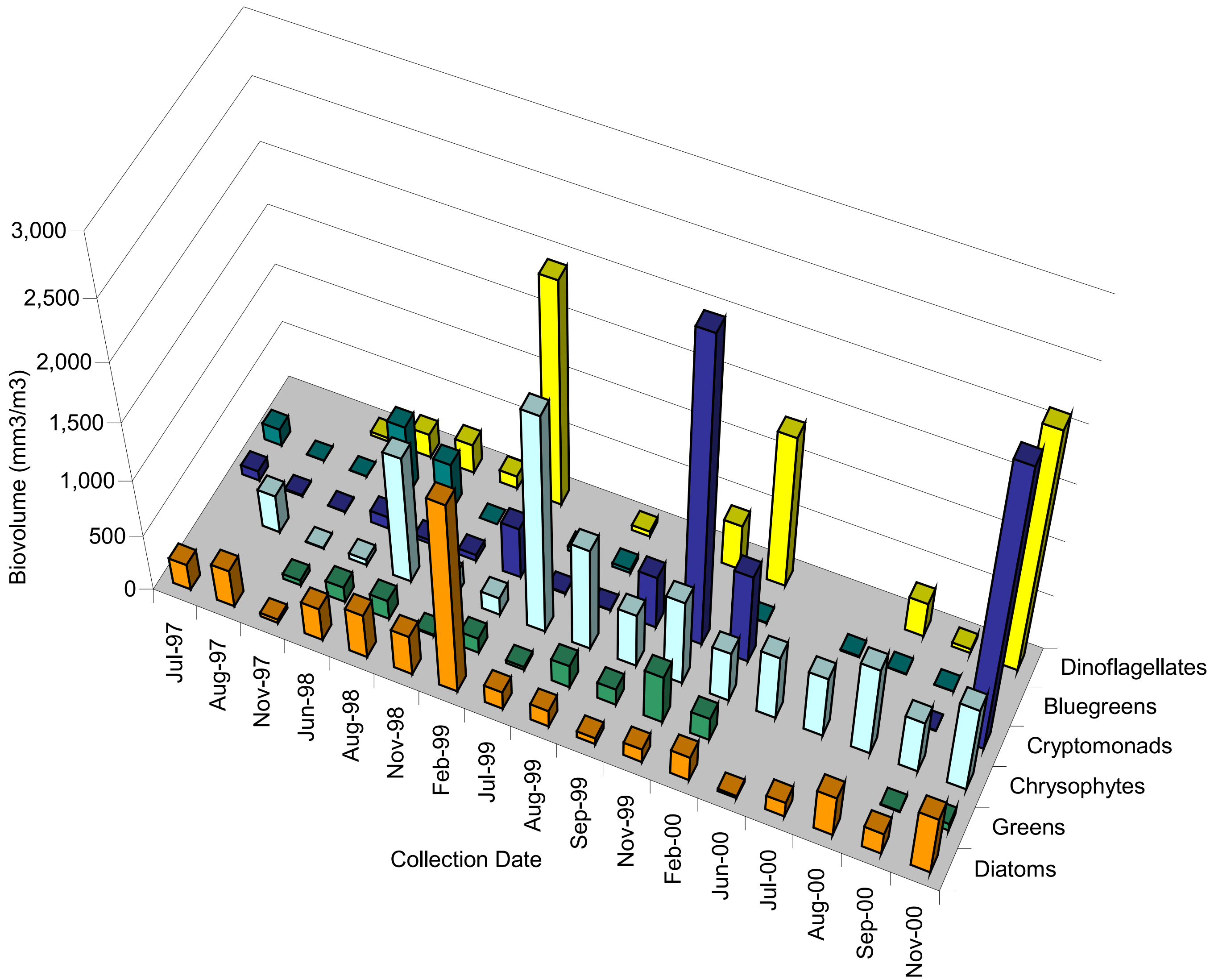


Figure 91. **Biovolumes of phytoplankton divisions from the mouth of the Neuse River, Pamlico County, 1996 - 2000.**

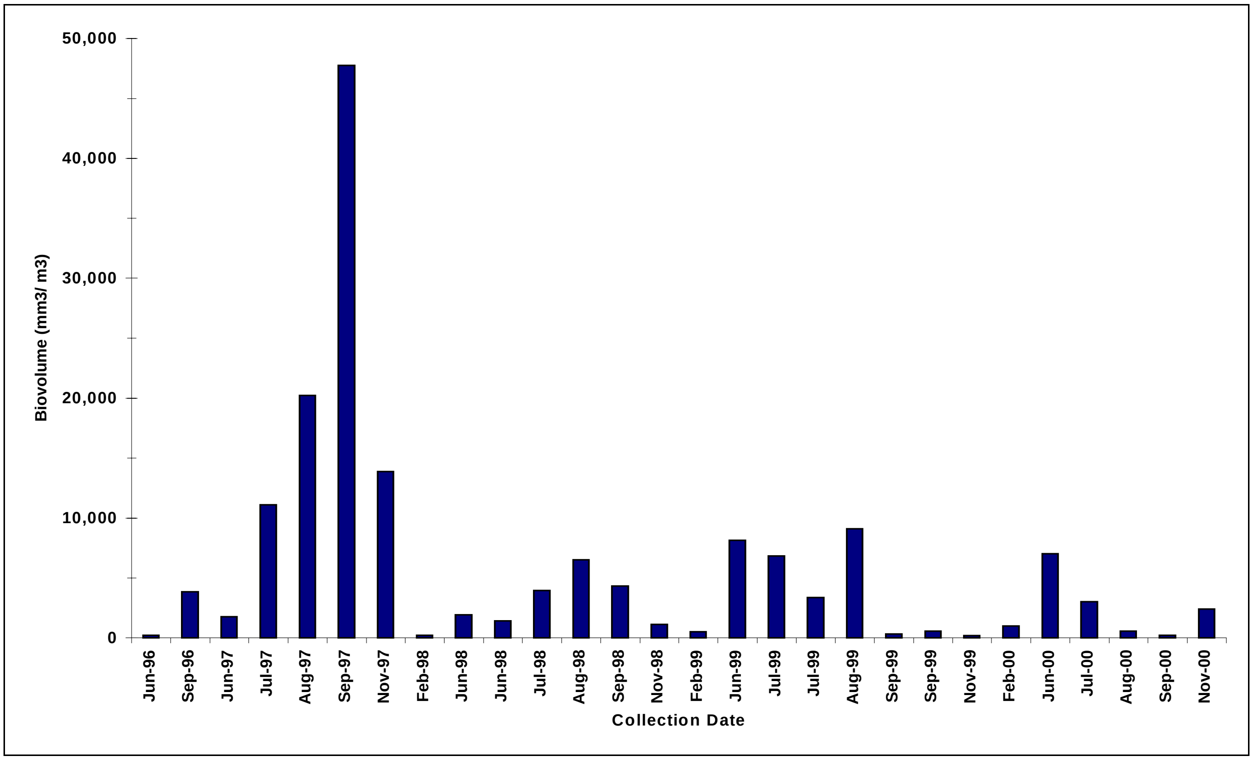


Figure 92. **Phytoplankton biovolume from the Neuse River at US 17, Craven County, 1996 - 2000.**

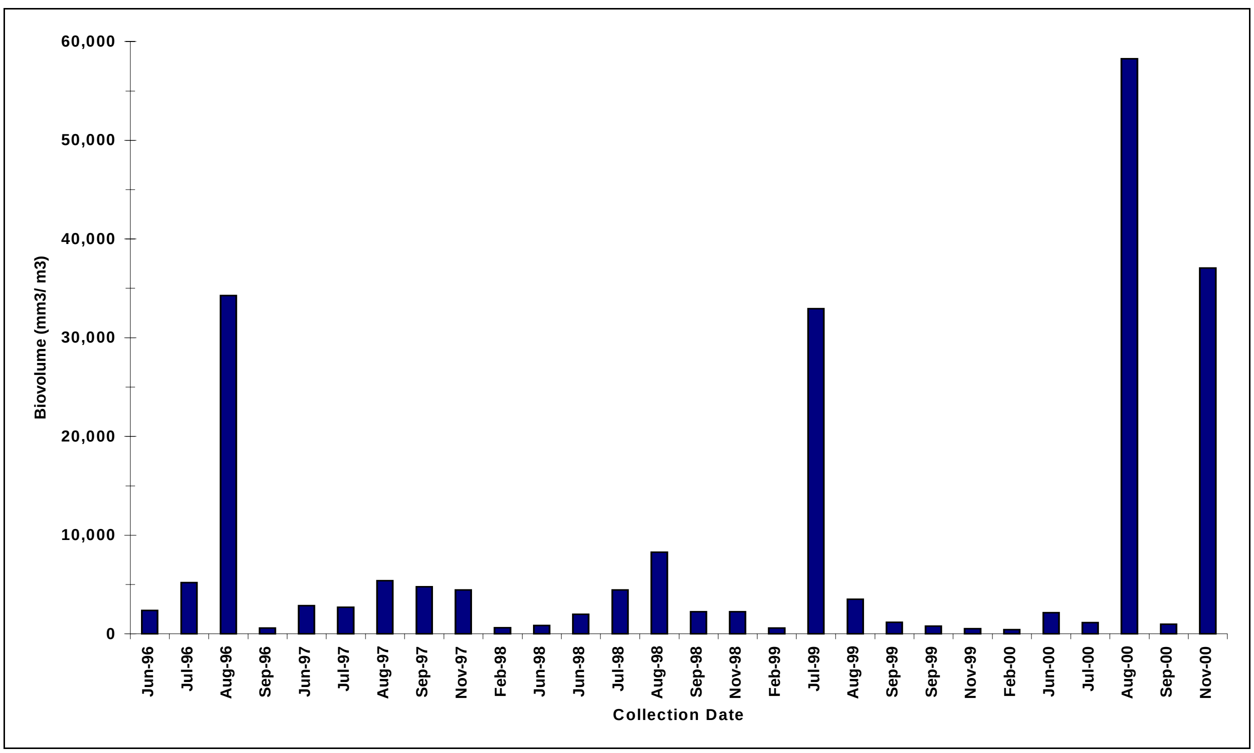


Figure 93. **Phytoplankton biovolume from the Neuse River at Broad Creek, Craven County, 1996 - 2000.**

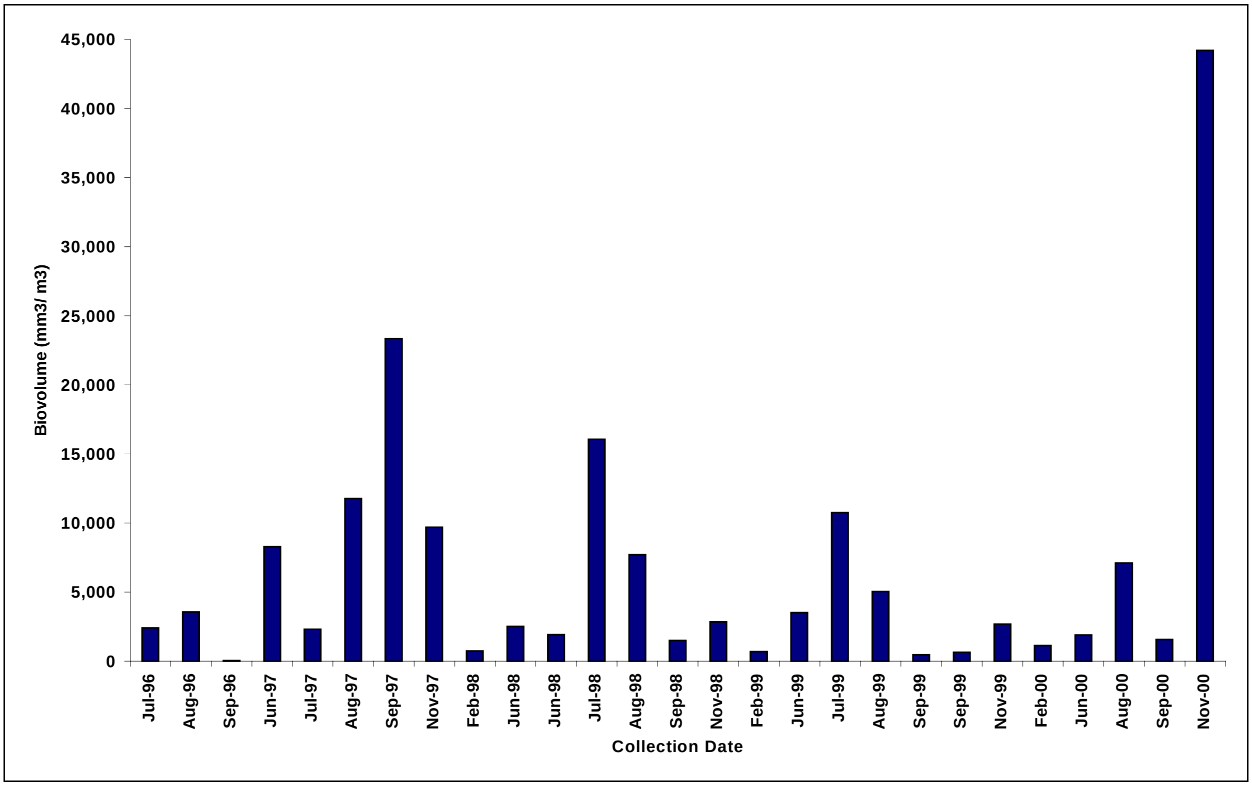


Figure 94. **Phytoplankton biovolume from the Neuse River at Flanners Beach, Pamlico County, 1996 - 2000.**

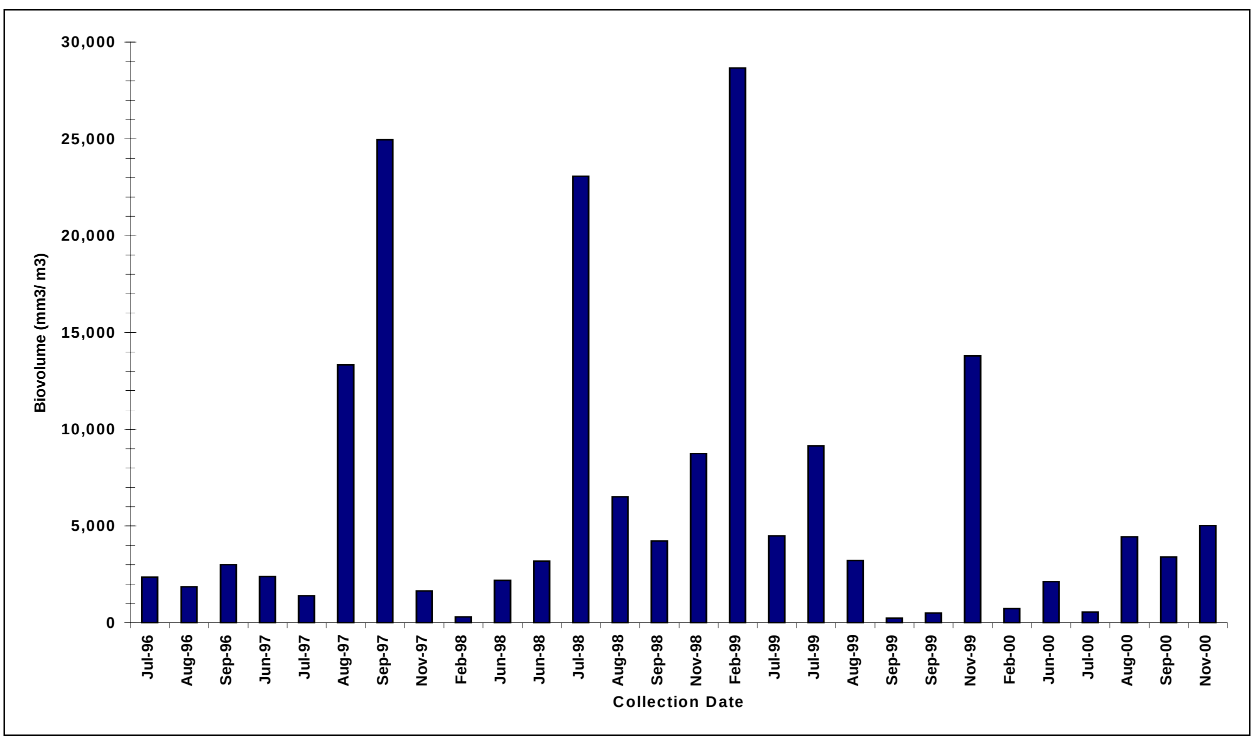


Figure 95. **Phytoplankton biovolume from the Neuse River at Minnesott Beach, Pamlico County, 1996 - 2000.**

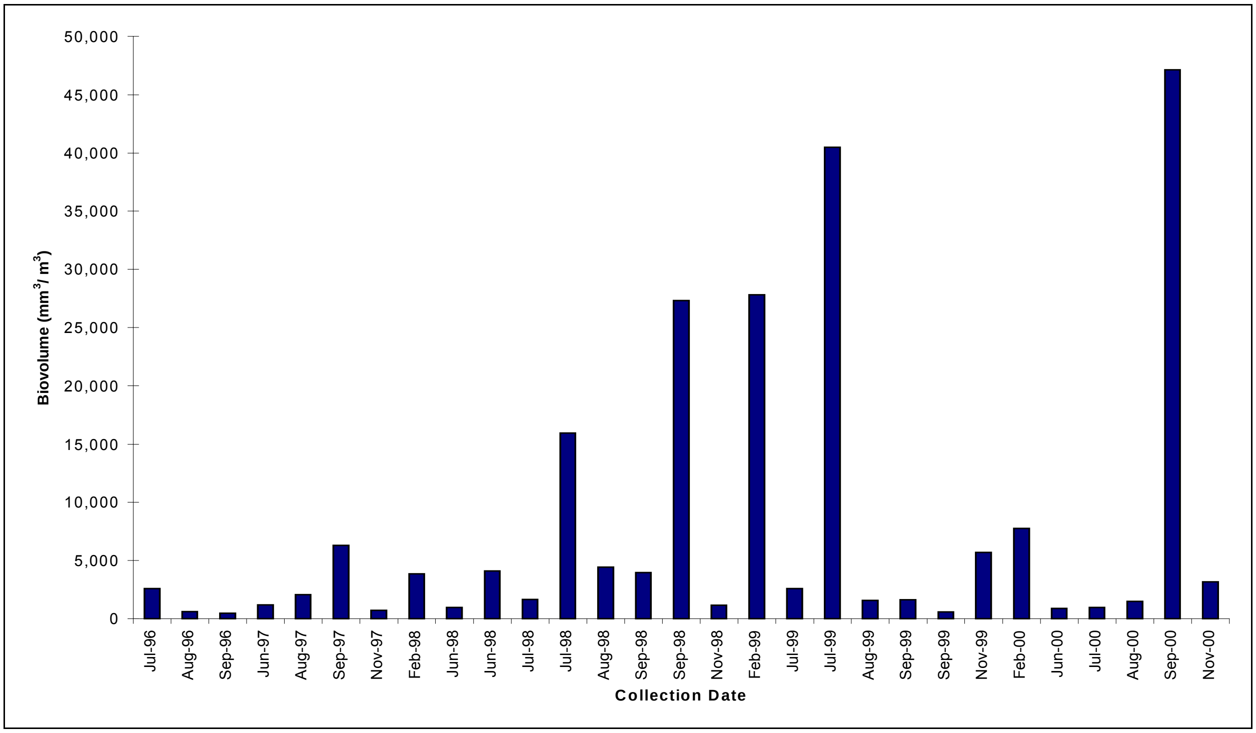


Figure 96. **Phytoplankton biovolume from the Neuse River at Oriental, Pamlico County, 1996 - 2000.**

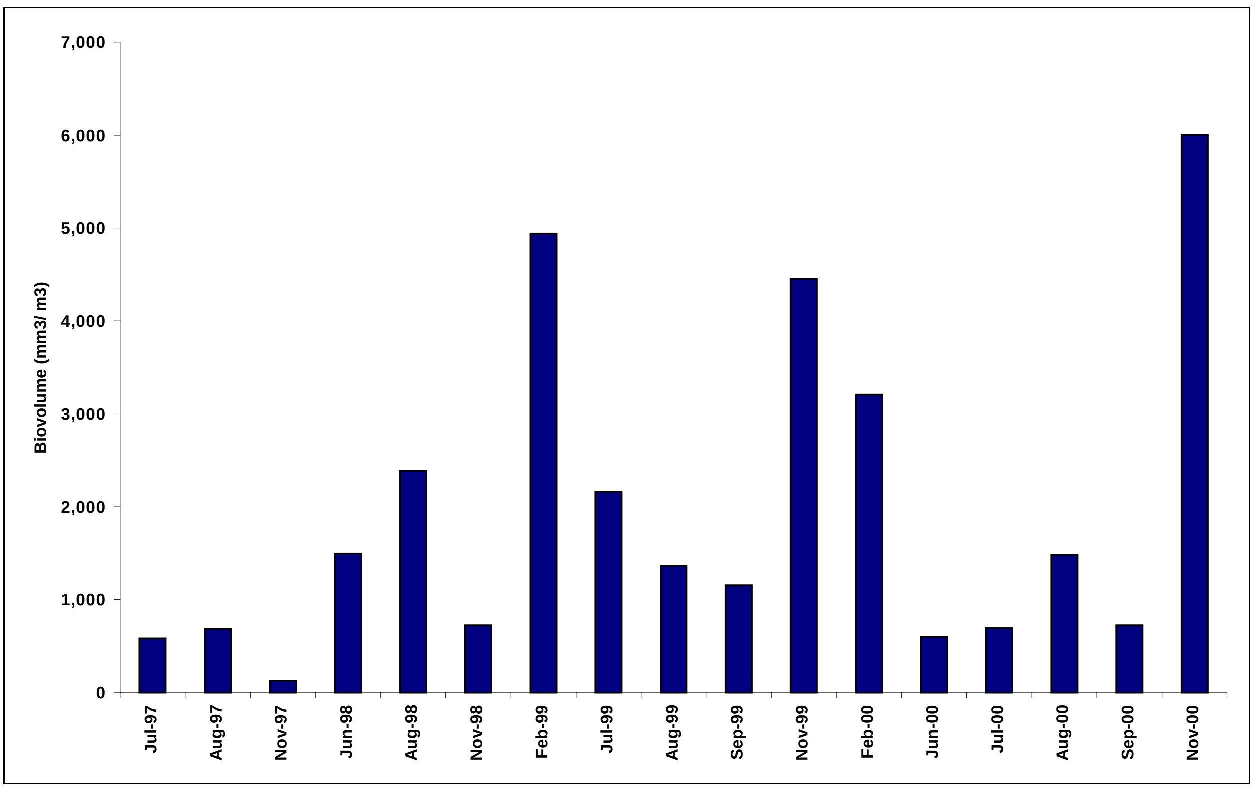


Figure 97. **Phytoplankton biovolume from the mouth of the Neuse River, Pamlico County, 1996 - 2000.**

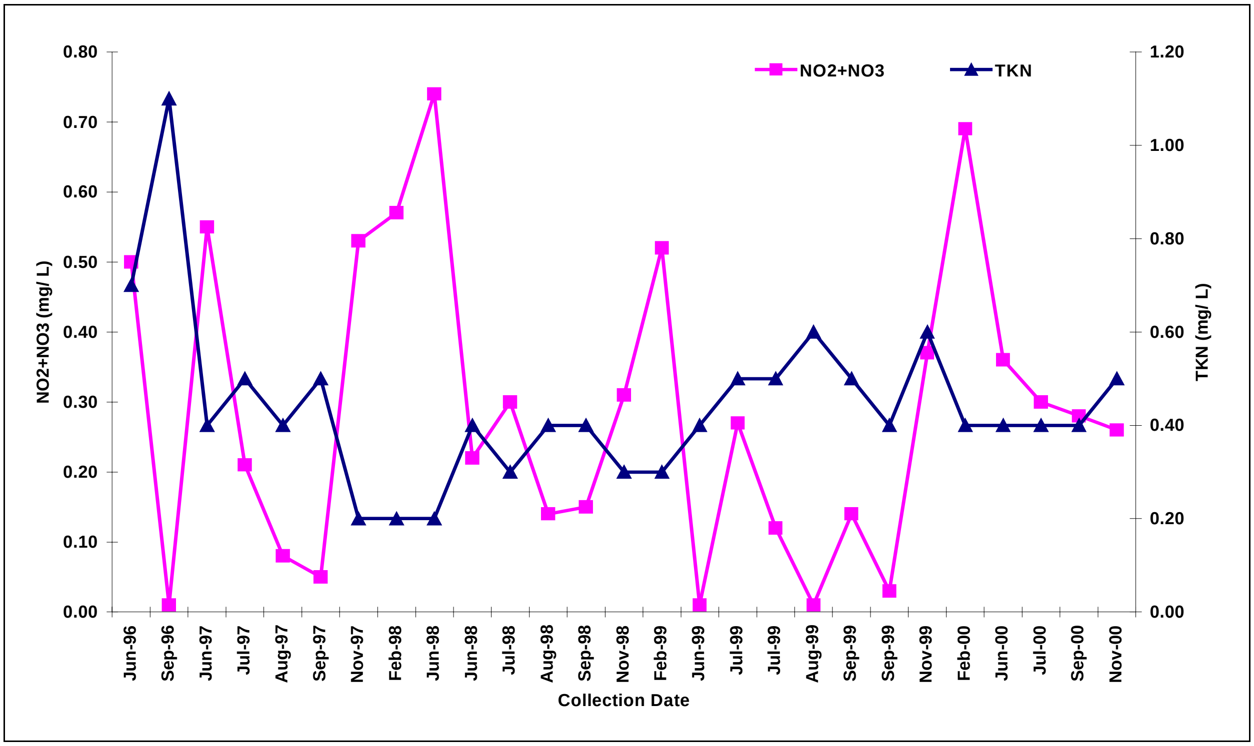


Figure 98. **Nitrite+nitrate and total Kjeldahl nitrogen from the Neuse River at US 17, Craven County, 1996 - 2000.**

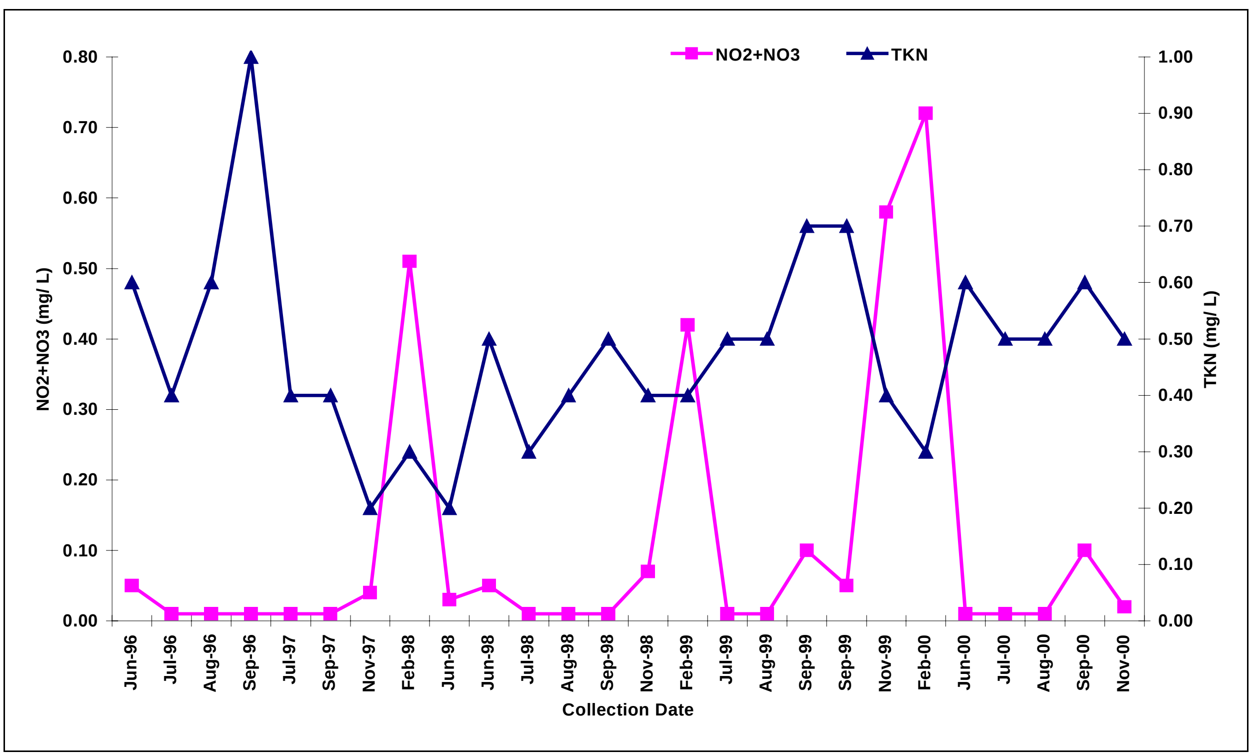


Figure 99. **Nitrite+nitrate and total Kjeldahl nitrogen from the Neuse River at Broad Creek, Craven County, 1996 - 2000.**

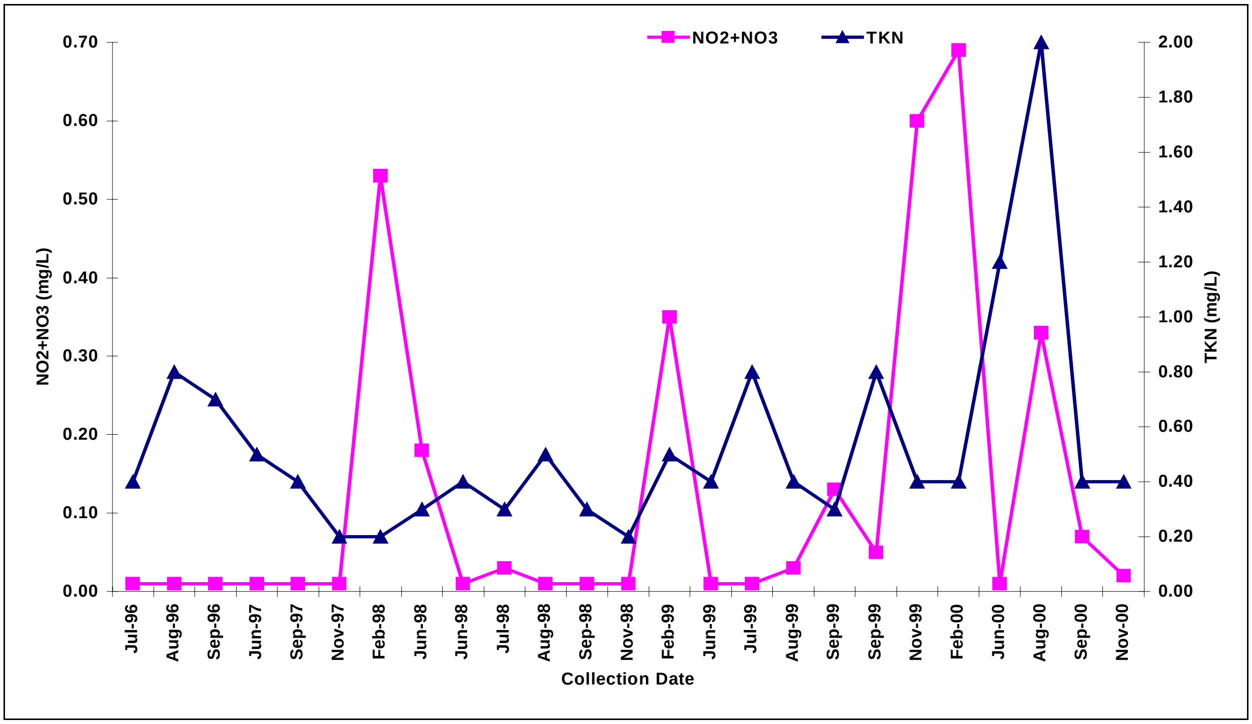


Figure 100. **Nitrite+nitrate and total Kjeldahl nitrogen from Flanners Beach, Pamlico County, 1996 - 2000.**

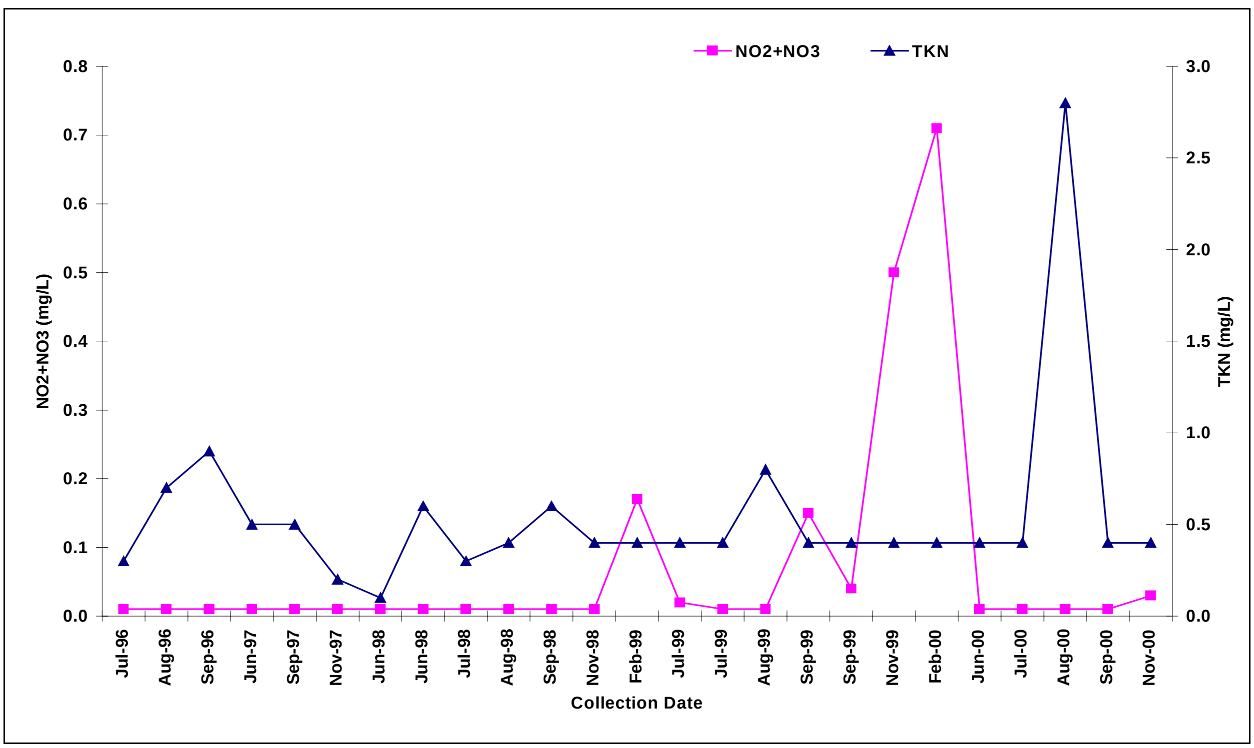


Figure 101. **Nitrite+nitrate and total Kjeldahl nitrogen from Minnesott Beach, Pamlico County, 1996 - 2000.**

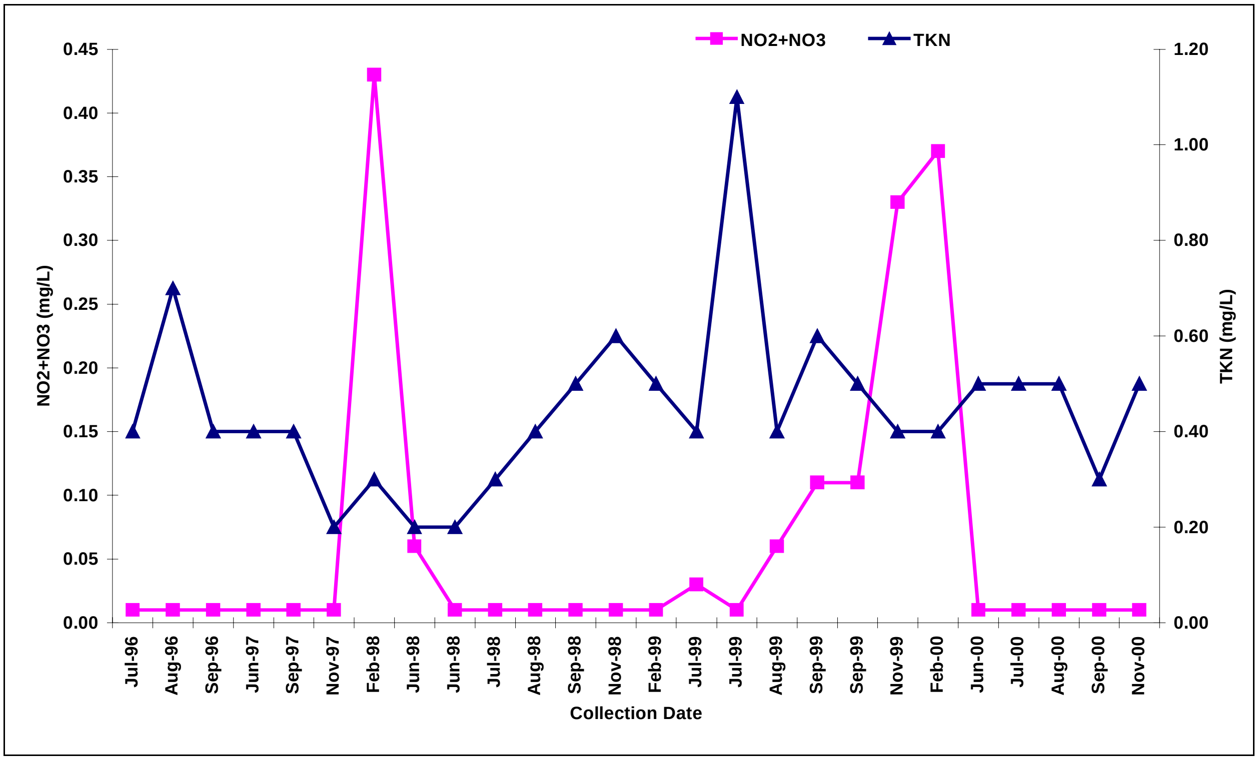


Figure 102. Nitrite+nitrate and total Kjeldahl nitrogen from the Neuse River at Oriental, Pamlico County, 1996 - 2000.

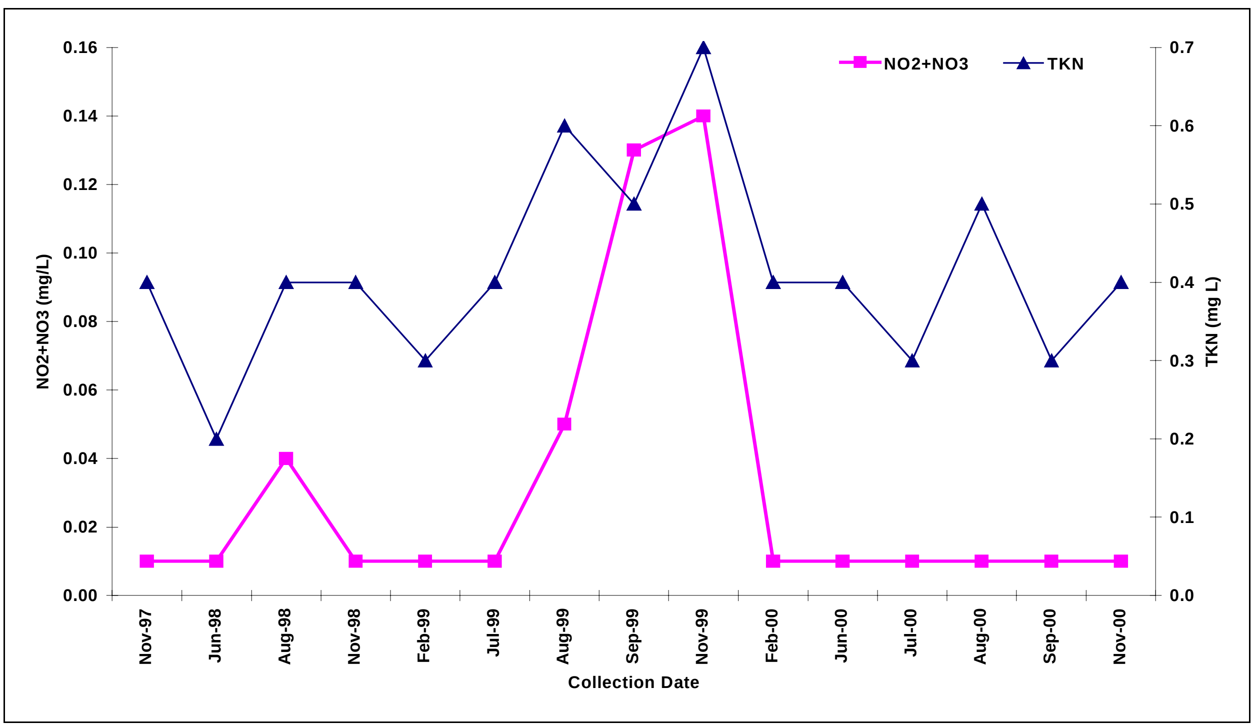


Figure 103. Nitrite+nitrate and total Kjeldahl nitrogen from the mouth of the Neuse River, Pamlico County, 1996 - 2000.

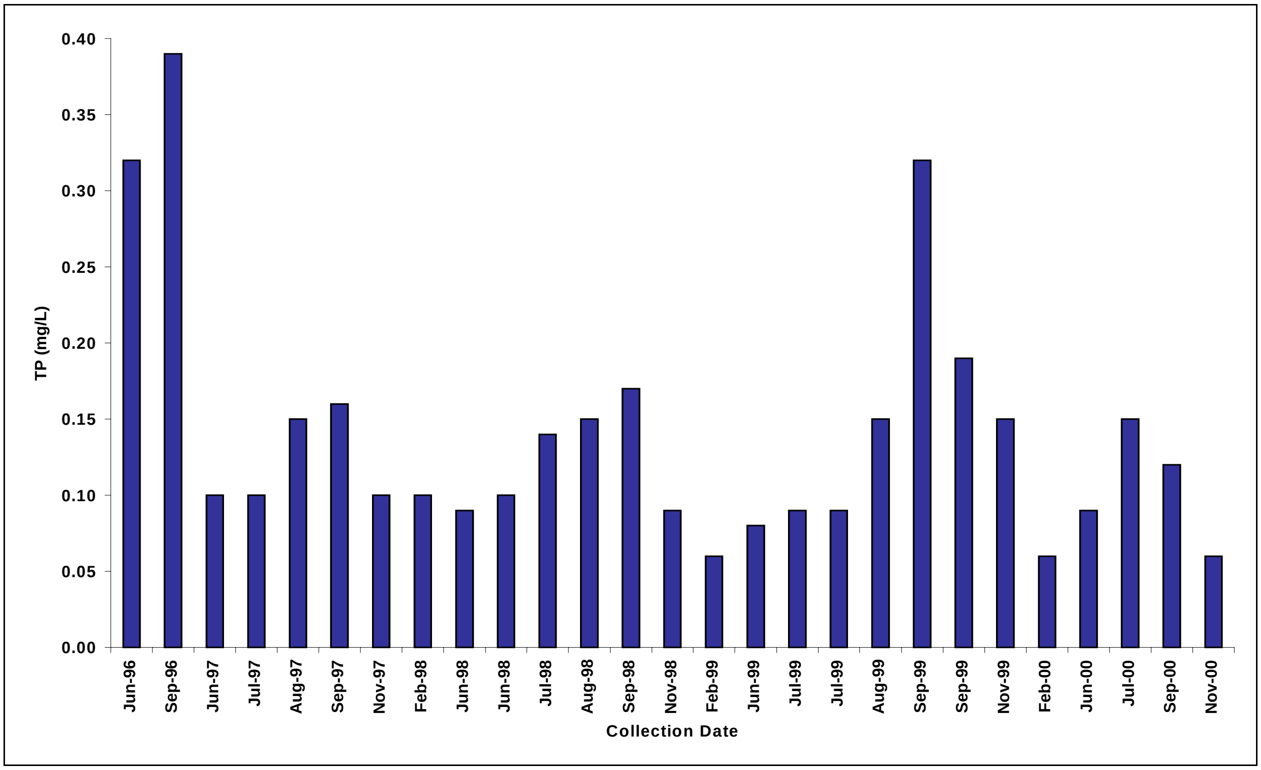


Figure 104. **Total phosphorus from the Neuse River at US 17, Craven County, 1996 - 2000.**

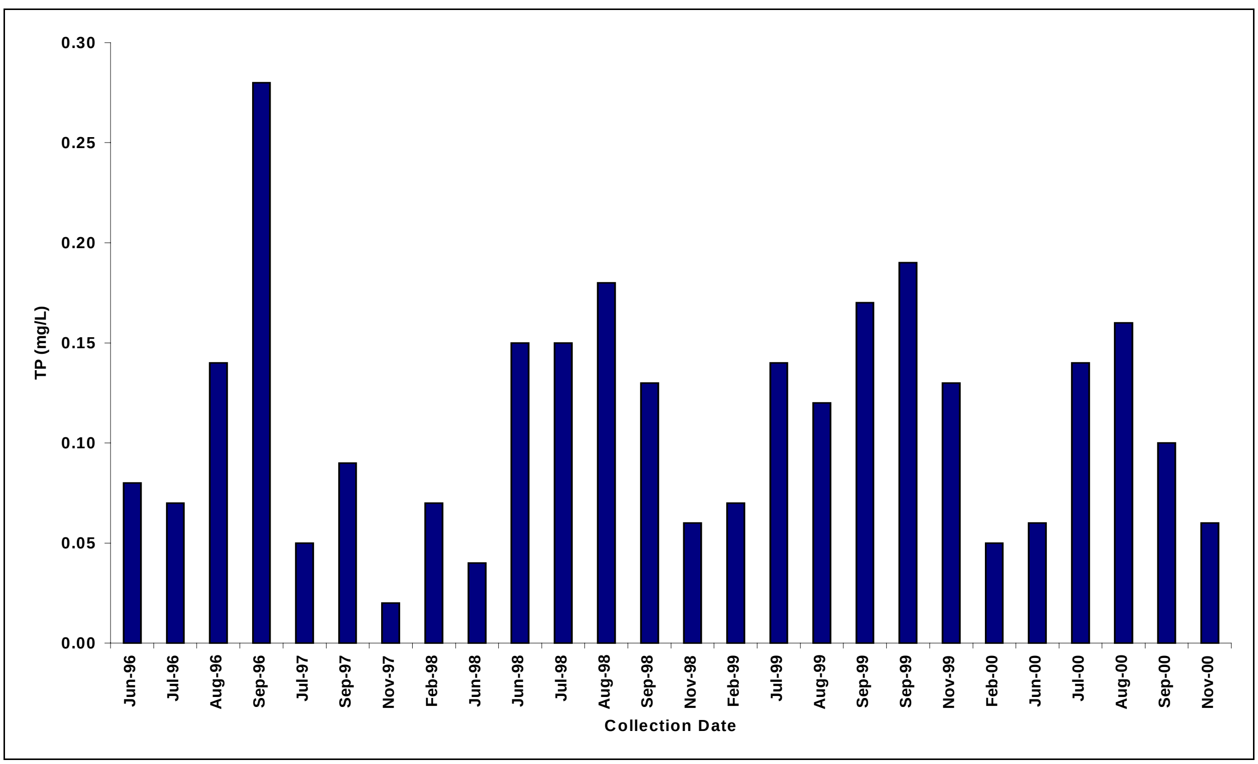


Figure 105. **Total phosphorus from the Neuse River at Broad Creek, Craven County, 1996 - 2000.**

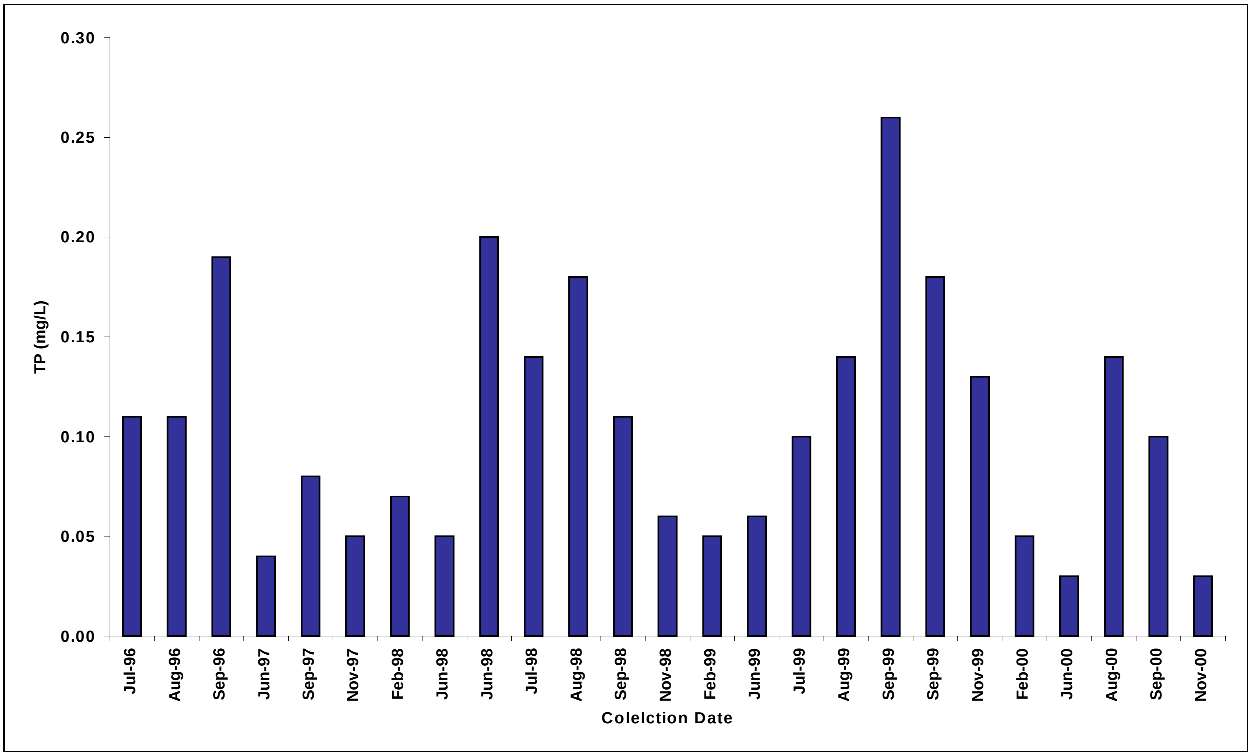


Figure 106. **Total phosphorus from the Neuse River at Flanners Beach, Craven County, 1996 - 2000.**

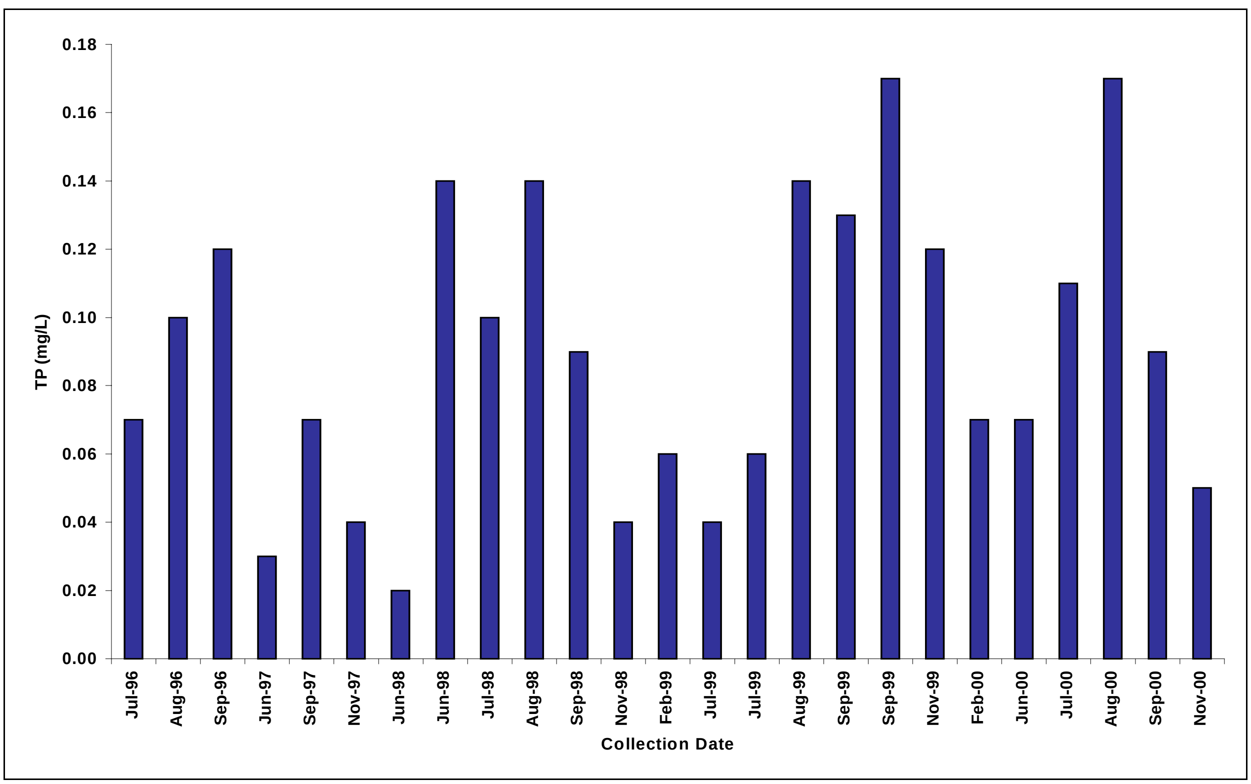


Figure 107. **Total phosphorus from Minnesott Beach, Pamlico County, 1996 - 2000.**

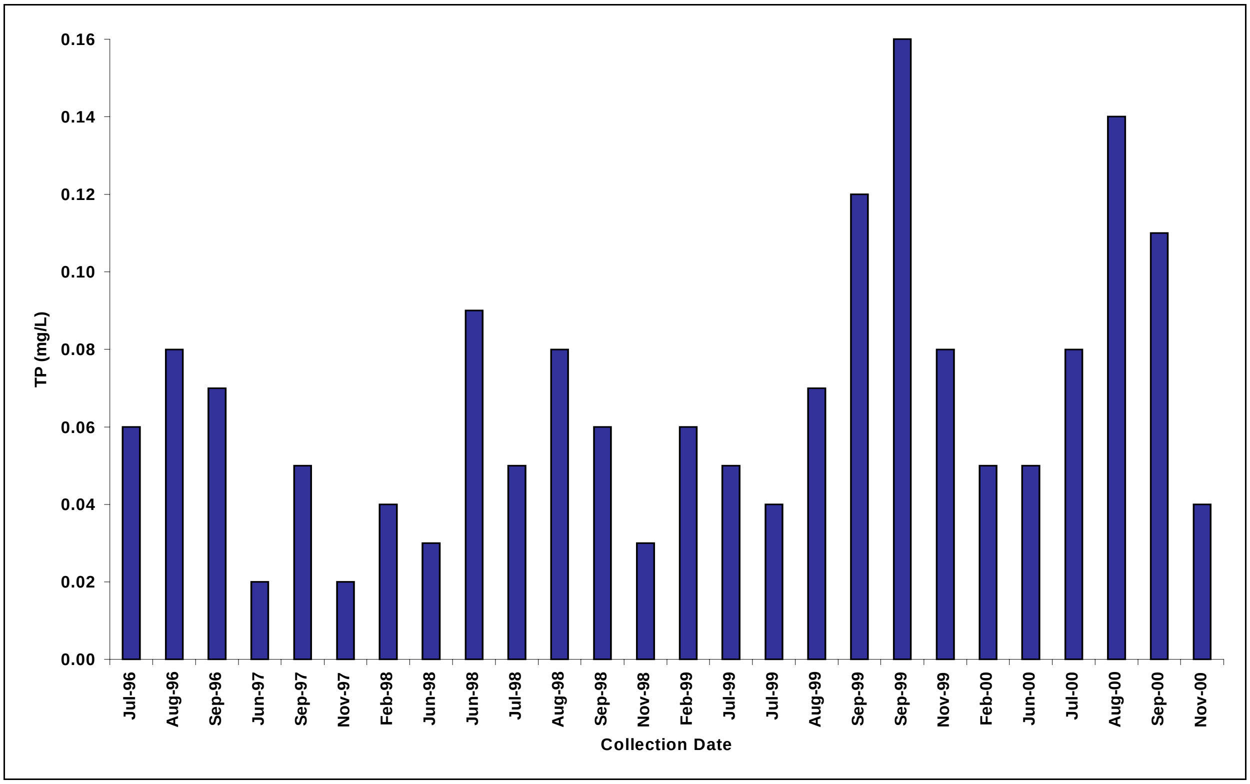


Figure 108. **Total phosphorus from the Neuse River at Oriental, Pamlico County, 1996 - 2000.**

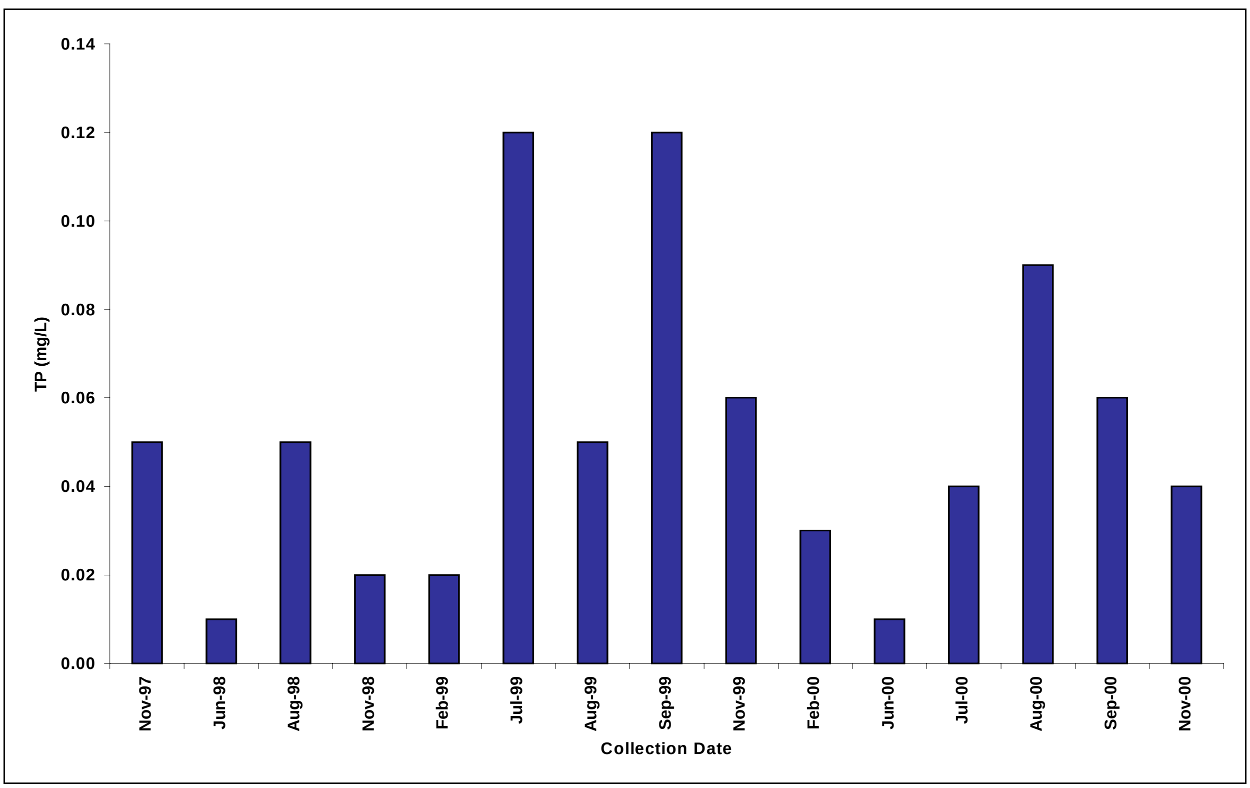


Figure 109. **Total phosphorus from the mouth of the Neuse River, Pamlico County, 1996 - 2000.**

NEUSE RIVER SUBBASIN 11

Description

The primary land use in this coastal plain subbasin (Figure 110) is agriculture and forest with a small urban area around Trenton. There are no major permitted discharges in the subbasin. The number of hog operations, however, has been increasing in the Trent River catchment, especially in the headwater area near the Jones/Lenoir county boundary. The eastern half of the subbasin contains over 50 registered hog farms, including 14 with over 25,000 hogs each (from GIS information).

Streams within this subbasin are usually humic-colored ("blackwater"), with a substrate composed of sand, silt and organic debris. Most streams are confined to a distinct channel, although a few more natural streams may flow through adjacent wetlands at higher flows. Recent hurricanes had a severe effect on the riparian zones of most streams with many trees knocked down by the high winds.

Because of the limestone bedrock throughout this area, many streams do not have the low pH values that are usually associated with swamp waters. However, streams draining the Hoffman State Forest (south of the Trent River) may have pH as low as 3.6 (e.g., Crooked Run). A portion of the Croatan National Forest, east of US 17 and south of the Trent River, also is located within this subbasin.

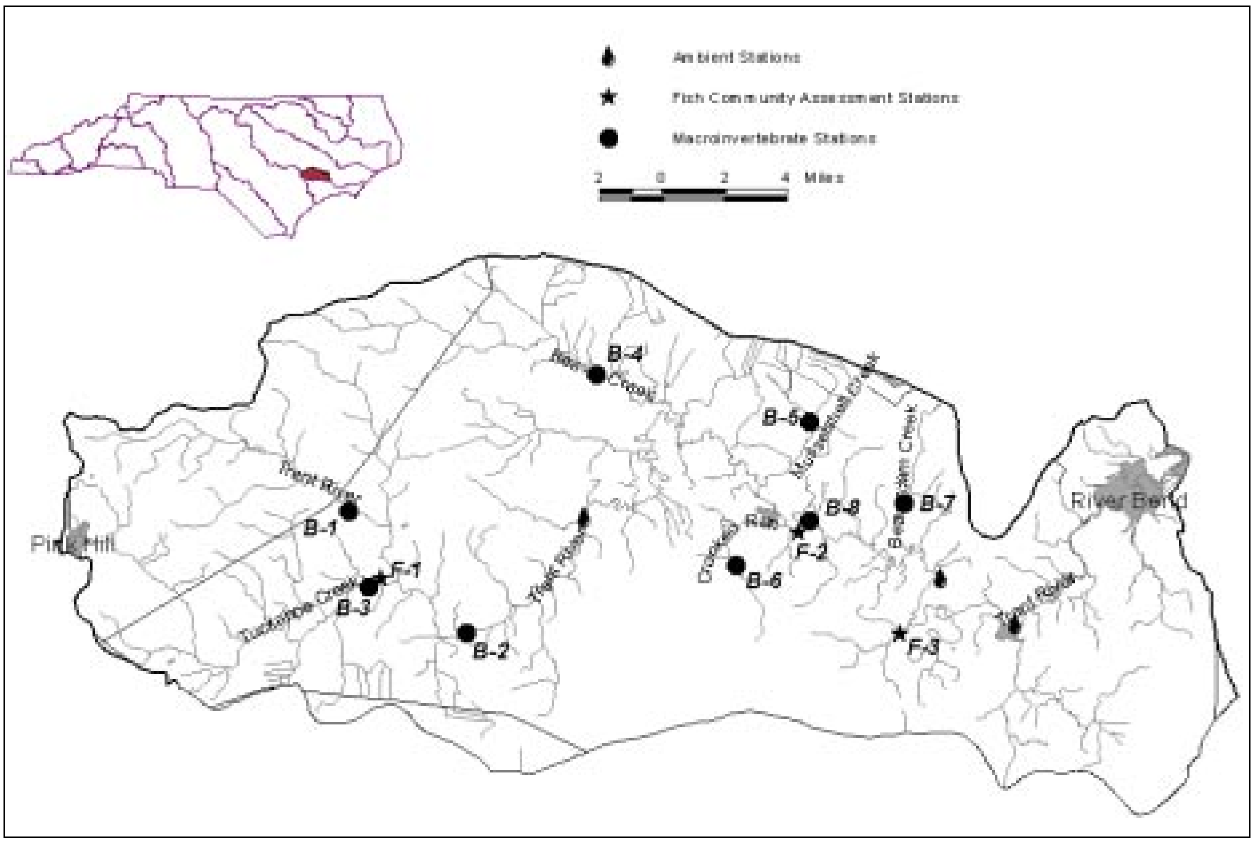


Figure 110. Sampling sites in Subbasin 11 in the Neuse River basin.

Overview of Water Quality

Natural stresses are intensified during summer low-flow periods, when many streams in this subbasin may stop flowing. At this time of the year, dissolved oxygen concentrations may be low, even in the least-impacted streams. Some of the smallest streams may dry up completely or become a series of pools separated by dry land. Water withdrawals for irrigation also may affect summer low flows and there is some evidence that the severity of low flows has been increasing for the Trent River at NC 58 (NCDEHNR 1996a).

Nonpoint source impacts were evident in many of the streams in this subbasin. Agricultural land use can lead to input of sediment, nutrients, and pesticides, as well as removing riparian buffer areas. Many streams surveyed during the 2000 benthic invertebrate collections had excessive periphyton growths, often in areas with many hog farms.

During the 2000 basinwide benthos collections, the NCDWQ biologists expanded the number of streams sampled in the Trent River watershed by switching from summer Coastal A collections to winter swamp collections (Table 39). While these swamp streams are not ratable using current NCDWQ criteria, this information indicated water quality problems in the upper Trent River, Beaver Creek, and Musselshell Creek. The best water quality was found in Beaverdam Creek, Mill Run, and Island Creek. Crooked Creek (flowing out of the Hoffman State Forest) seemed to have good water quality, but the fauna was limited by very low pH (3.6).

Phytoplankton blooms were reported in the lower Trent River in 1986, 1988, and 1993 - 1995. During the last basin cycle, however, summer blooms were observed only in 1998.

Monthly water chemistry data are collected from three sites on the Trent River in this subbasin: near Trenton, near Oak Grove, and near Pollocksville. These sites can experience very low dissolved oxygen concentrations during summer months. Detailed information is presented in the Ambient Monitoring section of this report.

Table 39. Waterbodies monitored in Subbasin 11 in the Neuse River basin for basinwide assessment, 1995 - 2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Trent R	Jones	SR 1153	---	Not Rated
B-2	Trent R	Jones	Becks Bank, near Comfort	---	Fair
B-3	Tuckahoe Cr	Jones	SR 1142	---	Not Rated
B-4	Beaver Cr	Jones	SR 1315	Fair (1991)	Not Rated
B-5	Musselshell Cr	Jones	SR 1320	Not Rated	Not Rated
B-6	Crooked Run	Jones	SR 1123	---	Not Rated
B-7	Beaverdam Cr	Jones	SR 1002	Not Rated	Not Rated
B-8	Island Cr[2]	Jones	SR 1004	Not Rated	Not Rated
F-1	Tuckahoe Cr	Jones	SR 1142	---	Not Rated
F-2	Mill Run	Jones	NC 58	---	Not Rated
F-3	Island Cr[2]	Jones	SR 1004	Not Rated	Not Rated

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available before 1995, refer to Appendix B2 or F3.

River and Stream Assessment

Two sites on the upper Trent River in Jones County were evaluated, but not sampled, as wadeable fish community sites. The Trent River at SR 1130 was too wide and too deep; and the Trent River at SR 1153 was not as wide, but was too deep and stagnant for adequate fish collections.

Winter flows were high in this subbasin; no summer collections were made for benthos.

Trent River, SR 1153
This part of the Trent River was about seven meters wide, and was mostly confined to a distinct channel. The bottom was primarily sand with some soft silty areas. This headwater segment of the Trent River drains an area with many hog farms. In addition, this part of North Carolina had much hurricane damage and many trees were knocked down in the riparian zone.

Upstream view of the Trent River at SR 1153, Jones County.

Habitat problems at this site included breaks in the riparian zone, no pools, and a relatively uniform instream habitat. Even during the winter benthos sampling, this site had heavy growths of filamentous algae, especially in backwater areas.

Filamentous algae along the lateral areas of the Trent River at SR 1153, Jones County.

The macroinvertebrate data indicated moderate to severe stress in comparison with reference data collected from Tuckahoe Swamp (Figure 111).

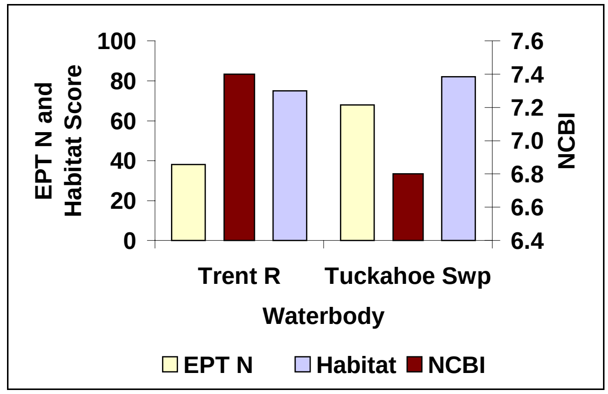


Figure 111. Comparisons of biological data collected from the Trent River and Tuckahoe Swamp, Jones County.

Many highly tolerant Chironomidae were abundant in the upper Trent river, including *Cricotopus bicinctus*, *Dicrotendipes simpsoni*, *Polypedilum illinoense*, *Rheotanytarsus*, and *Conchapelopia*.

Trent River, near Comfort

This part of the Trent River is still confined to a distinct channel, but the width has increased slightly from seven to nine meters. This site was sampled in May 2000, in an attempt to find a portion of the Trent River with high water quality.

The substrate is largely sand, but this area also had very good snag habitat. Macrophytes were abundant, but not as prolific as the growths of algae which were seen upstream at SR 1153 earlier in the year. It is not clear if seasonal differences in periphytic growth affected the comparison of these two stations. Dissolved oxygen was low in May 2000 (4.5 mg/L), and it is likely to have been much lower in the summer.

This part of the Trent River is locally known as Beck's Bank. It was sampled by the NCDWQ in 1979 to help evaluate a de-snagging project. Although the fauna was dominated by facultative macroinvertebrates in May 1979, some intolerant taxa had been collected from this area, especially the caddisfly *Brachycentrus numerosus*. No intolerant taxa were collected in May 2000, suggesting a long-term decline in water quality. In 2000, the site was rated Fair.

Tuckahoe Creek, SR 1142

Tuckahoe Creek was sampled in 2000 for macroinvertebrates (winter) and fish (spring). This site had a diverse substrate that included sand, detritus, and some limestone outcrops. There was a diverse assemblage of aquatic plants, but very little of the periphyton growths as seen in the upper Trent River. This portion of the stream was 7-10 meters wide, with a forested riparian zone. Reconnaissance of upstream areas, however, showed a more open canopy. And although the water was slightly stained, the pH was neutral.

Tuckahoe Creek at SR 1142, Jones County.

The macroinvertebrate samples from this site suggested good water quality for a swamp stream: low biotic index (6.8) and the highest EPT taxa richness (10) and total taxa richness (69) in this part of the Trent River catchment.

The invertebrate collections inadvertently collected two species of salamanders, including the Neuse River waterdog (*Necturus lewisi*). This species may be favored by the limestone ledges that occur in the upper part of the swamp (Alvin Braswell, North Carolina State Museum of Natural History, pers. comm.).

The fish community sampling effort indicated a trophicly balanced and diverse (19 species) community. The four most commonly collected species were the dusky shiner, redbreast sunfish, American eel, and pirate perch. Three species of darters, including the intolerant sawcheek darter, were also collected at this site.

Beaver Creek, SR 1315

Beaver Creek was similar to the upper Trent River in terms of size and in having an abundant growth of periphyton. Recent hurricanes had knocked down many trees in the riparian zone, producing a fairly open canopy. Macrophytes were very abundant along the banks, and the bottom was very silty. Portions of the creek upstream of SR 1315 had been channelized. This site had an unusually high specific conductance (218 µmhos/cm) and was the most disturbed site in the upper Trent River area.

Beaver Creek at SR 1315, Jones County.

Benthic macroinvertebrates also indicated that this was the most disturbed site in the upper Trent River area. The high biotic index (7.7) suggested severe stress relative to swamp reference sites. The abundance of many tolerant taxa such as *Cricotopus bicinctus*, *Dicrotendipes simpsoni*, *Polypedilum illinoense*, *Conchapelopia*, *Physella*, and *Dugesia tigrina,* indicated both enrichment and low dissolved oxygen. Many of these taxa were also abundant in the upper Trent River.

Musselshell Creek, SR 1320

Musselshell Creek is about four meters wide and runs though an area of intensive cotton farming. This stream had a very poor habitat score (23), reflecting severe channelization, a lack of instream habitat, homogeneous substrate, no pools, eroding banks, open canopy, and a poor riparian zone.

Musselshell Creek at SR 1320, Jones County.

All invertebrate taxa were sparse at this site; there were no dominants. Severe stress in Musselshell Creek can be seen by comparing this site with nearby Beaverdam Creek (Figure 112). Similar results were obtained from two samples in 1995.

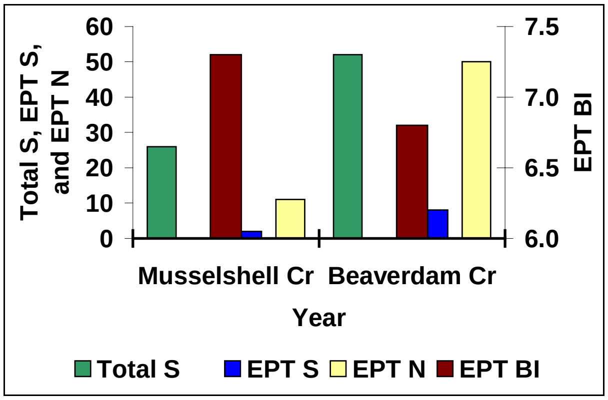


Figure 112. Comparisons of biological data collected from Musselshell Creek and Beaverdam Creek, Jones County.

Crooked Run, SR 1123

Crooked Run was eight meters wide with excellent instream habitat. The substrate was largely sand, but both snags and macrophytes (*Vallisneria*) were abundant. This stream drains the Hoffman State Forest and is naturally very acidic. A pH of 3.6 was recorded in March 2000, the lowest reading ever measured by the NCDWQ biologists. Streams with pH < 4.0 are very difficult to evaluate, as this amount of natural stress excludes most invertebrate taxa.

Upstream view of Crooked Run at SR 1123, Jones County.

Total taxa richness (29) was similar to other swamp streams with pH < 4, and the low biotic index (6.6) also suggested good water quality. The dominant species was a midge, *Unniella multivirga,* not found at other nearby sites.

Beaverdam Creek, SR 1002

Beaverdam Creek was originally selected as a control site for Musselshell Creek, and there are two prior winter collections from this site in 1995 and 1997. Like Musselshell Creek, Beaverdam Creek is about four meters wide, with a sand/silt substrate. This stream, however, has good instream habitat, including snags, aquatic plants and roots. Beaverdam Creek runs through a farming area at this site, but it has a good riparian buffer zone. Although the upper part of the catchment drains the Great Dover Swamp, this site has always had a pH > 6.3.

There has been considerable hurricane damage in this region, with many trees knocked down by high winds. The 1997 collection was intended to evaluate hurricane damage to the aquatic fauna of the Trent River area.
The low NC Biotic Index for this site (all collections < 6.8) indicated good water quality, although total taxa richness and EPT abundance were slightly below the expectations from similar reference swamp sites. There has been considerable change in the invertebrate fauna at this site since 1995, with a loss of Plecoptera and a reduction in some intolerant Trichoptera (especially *Rhyacophila ledra* and *Heteroplectron americanum*). This was partially offset by greater numbers of mayflies after 1995. Unusual taxa collected in 2000 included the mayfly *Eurylophella prudentalis* and the midge *Eukiefferiella devonica* group.

The post-hurricane samples seemed to show a slight decline in water quality with lower EPT taxa richness and a higher biotic index than pre-hurricane samples.

Mill Run, NC 58

Similar to the Tuckahoe Creek site, Mill Run at NC 58 had a neutral pH reading when the fish community sample was collected. However, unlike Tuckahoe Creek and many other coastal plain streams, Mill Run had very clear water with no tannin color. The average width at the site was six meters and the stream had a sand bottom with a few gravel areas. The habitat score for the site was 97.

The fish community was diverse with 19 species collected. The most abundant species was the American eel accounting for 30 percent of the fauna. The next three most abundant species; redbreast sunfish, dusky shiner, and tessellated darter, combined to make up 49 percent of the total population.

Island Creek, SR 1004

Island Creek has been sampled 10 times: 7 times for benthic macroinvertebrates and 3 times for fish. These collections include basinwide sampling, swamp reference site sampling, and hurricane recovery evaluation.

At this site, Island Creek has a width of 4 to 7 meters with a sand and silt substrate. All samples indicate a high quality habitat with habitat scores greater than 80. The greatest habitat problem was a lack of good pools. The water is stained, but all pH readings have been > 6.3. Island Creek will stop flowing during dry years, but may have year-round flow during wetter years.

Island Creek at SR 1004, Jones County.

The macroinvertebrate data had the highest EPT taxa richness and abundance in the first sample (December 1984). Three stonefly taxa were abundant at this time, but none of these species was abundant in subsequent collections. A sharp decline was noted in 1995 and significant recovery in 1999. More than 35 EPT taxa have been collected from this stream, making this an area of exceptional insect diversity in the subbasin.

This site was sampled as part of a fish community special study in March and August 1995 in addition to the 2000 basinwide monitoring. Although more individuals were collected during the 2000 than in August 1995, 15 species of fish were collected during both years. The March 1995 sampling effort documented only eight species. Regardless of the differences in the number of species and the number of individuals collected, the most abundant species for all three events were the American eel and the pumpkinseed.

SPECIAL STUDY
Boat IBI

A site on the Trent River just below Trenton was sampled in 2000 as part of an ongoing project to develop a method to assess fish communities in small nonwadeable streams using an electrofishing boat. In addition to the mostly sand substrate, limestone outcrops were present in the sampling reach. The site was assigned a habitat score of 80.

A diverse (23 species) and trophicly balanced fish community was present. The most commonly collected species were the redbreast sunfish, American eel, and bluegill. The intolerant chainback darter was also collected at this site.

NEUSE RIVER SUBBASIN 12

Description

This subbasin is located in the coastal plain (Figure 113). The primary land use is agriculture including confined animal operations, but there are also more developed areas around the City of Goldsboro.

Goldsboro's WWTP (6.7 MGD) discharges just downstream of this subbasin in Subbasin 05. Major tributaries to the Neuse River in this subbasin include Beaverdam Creek and Thoroughfare Swamp.

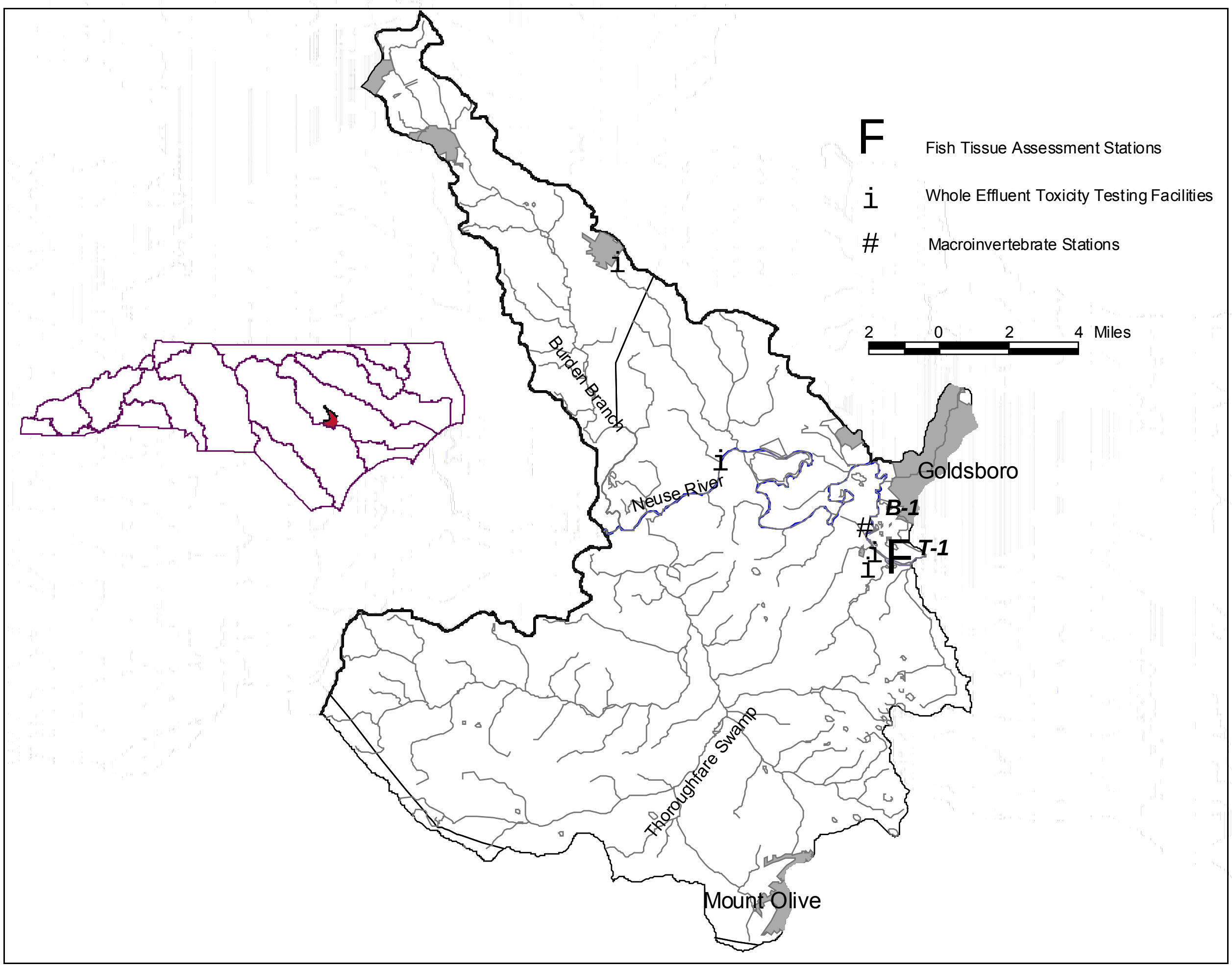


Figure 113. Sampling sites in Subbasin 12 in the Neuse River basin.

Overview of Water Quality

Benthos samples have resulted in ratings of Good-Fair or Good for the Neuse River at US 117 (Table 40). No other streams had sufficient continuous flow to sample and rate with current biological criteria. Most of this subbasin has a high nonpoint source pollution potential, including runoff from cropland, pastureland, and animal operations (NRCS 1995).

All fish tissue samples collected from the Neuse River at US 117 indicated that metal concentrations were less than laboratory detection levels or were below current state or federal regulatory criteria.

Toxicity monitoring was confined to two CP&L Lee Plant discharges. Combined, these discharges had 43 pre 2000 passes and only two failures. All toxicity tests in 2000 yielded passing results.

Table 40. Waterbodies monitored in Subbasin 12 in the Neuse River basin for basinwide assessment, 1995-2000.

Map #[1]	Waterbody	County	Location	1995	2000
B-1	Neuse R[2]	Wayne	US 117	Good-Fair	Good-Fair
T-1	Neuse R	Wayne	at Goldsboro	---	---

[1]B = benthic macroinvertebrate monitoring sites; T = fish tissue monitoring sites.
[2]Data are available before 1995, refer to Appendix B2.

River and Stream Assessment

Flows in Subbasin 12 for the 2000 spring through summer (March-August) sampling period were lower than historic monthly means for the same period except August 2000 when the monthly flow exceeded the historic August monthly flow mean (Figure 114). This same trend was observed in Subbasin 03 (Figure 54).

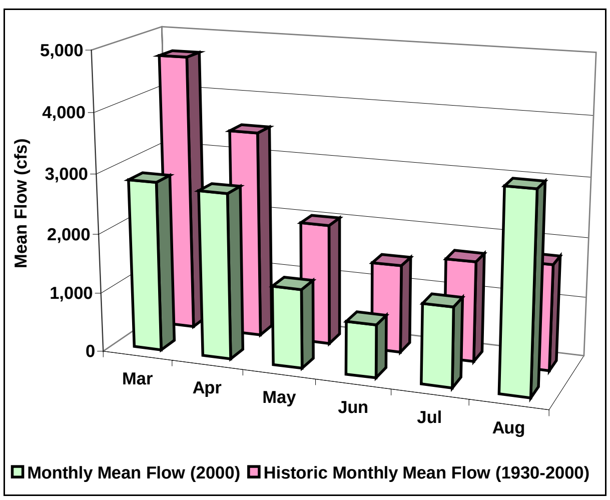


Figure 114. Spring and summer monthly mean flow and historic monthly mean flow at the Neuse River at Goldsboro, Wayne County.

A number of streams in this subbasin have been severely affected by hurricanes since 1996. In Wayne County, two such sites on Falling Creek, at SR 1006 and SR 1105, could not be sampled as fish community sites due to the large numbers of downed trees acting to dam the stream and locally increase water depth.

Neuse River at US 117

The Neuse River had been sampled at SR 1915 near Goldsboro four times for benthos between 1984 and 1990. The monitoring site was above the Goldsboro WWTP outfall and received Good ratings from 1986 to 1990. In 1988, the facility outfall was relocated. After this change, the monitoring site was moved to the US 117 bridge to stay above the discharge.

The Neuse River at this site is very wide with little instream habitat. The majority of the habitat, restricted to the river's banks, is almost exclusively snags and root mats. The substrate was a homogeneous mix of sand and silt; there was massive bank erosion; and bank vegetation was sparse. However, the riparian zone was still intact.

Neuse River at US 117, Wayne County.

In 1991 and 2000, the EPT taxa richness at this site was 29 and 23, respectively (Figure 115). In between 1991 and 2000, the EPT taxa richness had decreased to 16 and the bioclassification had decreased from Good to Good-Fair. Although the EPT taxa richness strongly increased between 1995 and 2000, the rating did not change.

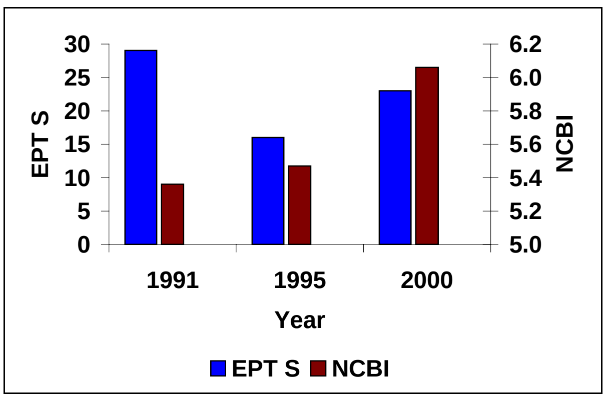


Figure 115. EPT taxa richness (EPT S) and biotic index (NCBI) at the Neuse River at US 17, Wayne County, 1991 - 2000.

This was because the NCBI continued to increase (Figure ---). During high flow periods (e.g., 1995), midges (Chironomidae) are often scoured and removed from the system.. This decreases the NCBI. This is the apparent trend between 1995 and 2000. In 1995, 10 taxa of midges were collected while in 2000, 16 taxa were collected.

This trend is further strengthened by the increase in EPT taxa richness between 1995 and 2000. In addition, the presence of the rare and intolerant mayfly *Leptohyphes dolani* (found only in 1991 at this site) may indicate that the water quality at this site is stable. The species subsequent absence may further suggest that *L. dolani* is susceptible to scour.

Fish Tissue

Neuse River at Goldsboro

Twenty-one samples from the Neuse River near Goldsboro were collected during May 2000 and analyzed for metals contaminants. The samples were collected as part of the NCDWQ efforts to monitor pollutants introduced into the Neuse basin following Hurricane Floyd. Likely sinks of many of the pollutants introduced by Hurricane Floyd (organics, pesticides, petroleum products, and nutrients) included bottom sediments and tissues of fish and shellfish. The Goldsboro site included areas where significant spills occurred, urban areas, and areas of hydrologic deposition.

Concentrations of metals in the fish tissue were less than laboratory detection levels or were below current USEPA, USFDA, and North Carolina criteria. (Appendices FT1 and FT2).

NEUSE RIVER SUBBASIN 13

Description

This subbasin consists of Pamlico Sound and its tributaries Broad Creek, Bay River and Jones Bay in Pamlico County (Figure 116). Land use in the subbasin is mostly agriculture and most of the waters are estuarine. Freshwater is confined to the upper reaches of the many tributary streams, which are swamp-like in nature with ephemeral flow. Upper Chapel Creek and its tributaries, upper Swindell Creek and its tributaries, Smith Creek and the tributaries to Vandemere Creek have been classified High Quality Waters in this subbasin because of their designation as Primary Nursery Areas. There is one discharger in this subbasin (Bay River MSD WWTP, 0.3 MGD).

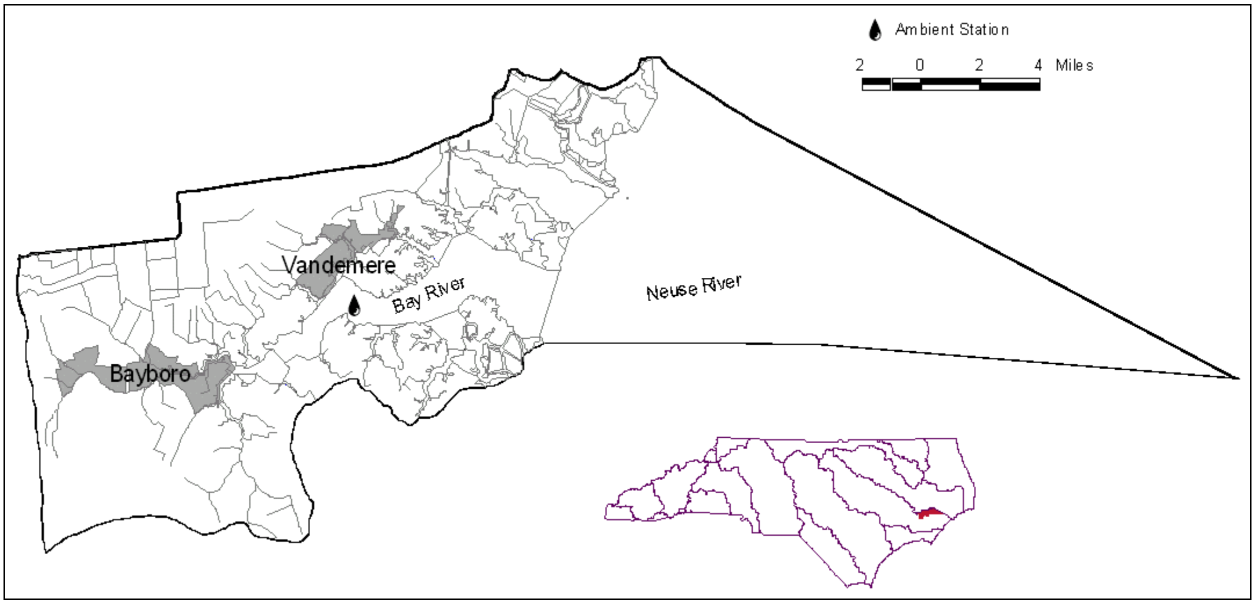


Figure 116. Sampling sites in Subbasin 13 in the Neuse River basin.

Overview of Water Quality

The Division of Environmental Health's Shellfish Sanitation Branch has reported DMF closure to shellfishing of 2850 acres of the 28,000 acres of waters in this subbasin. This is 525 acres fewer than in 1995. With the exception of Point Marina on Broad Creek, all closed areas are due to elevated levels of coliform bacteria in freshwater runoff. These areas include Bay River above Flea Point, Smith Creek, Vandemere Creek, upper Bear Creek, upper Gale Creek, Bills Creek and Doll Creek. Oysters are the primary shellfish resource in this subbasin and production is rated Fair to Poor generally with Fair to Good production at clutch plantings in Broad Creek.

Monthly water chemistry data are collected from one site in this subbasin -- the Bay River near Vandemere. Detailed information is presented in the Ambient Monitoring section of this report.

NEUSE RIVER SUBBASIN 14

Description

This estuarine subbasin consists of Pamlico Sound, upper Core Sound and West Bay, and their embayments and tributaries in Carteret County (Figure 117). Core and Pamlico Sounds, Thorofare Bay, Barry Bay, Rumley Bay, Lewis Creek, SW Prong Lewis Creek, Cedar Island Bay, Back Bay and Goose Bay have been classified as Outstanding Resource Waters because of their high fisheries value. Land use in the area is mostly agriculture (including a portion of Open Grounds Farm) or undeveloped. These undeveloped areas include a military bombing range and the Cedar Island National Wildlife Refuge. There are no large dischargers in this subbasin.

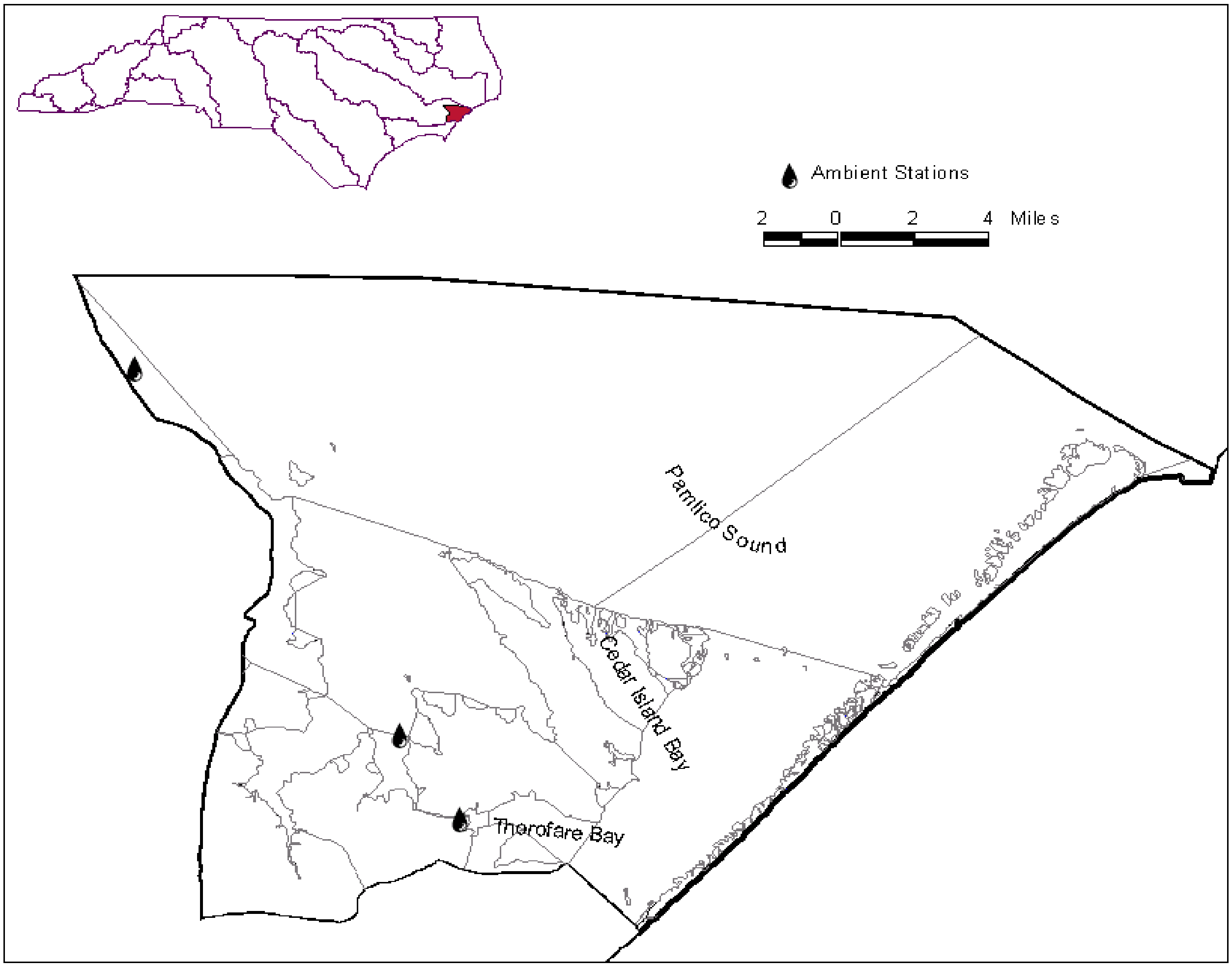


Figure 117. Sampling sites in Subbasin 14 in the Neuse River basin.

Overview of Water Quality

The Division of Environmental Health's Shellfish sanitation branch has reported DMF closure to shellfishing of The Thorofare, Salters Creek Canal, and Cedar Island Harbor, an area of 25 acres in the 85,000 acres of waters in this subbasin. Oyster and clam production are rated Good in this subbasin with Fair commercial value. Ambient chemistry data are collected monthly from the Neuse River at Mouth near Pamlico, West Thorofare Bay and Thorofare Canal. Detailed information is presented in the Ambient Monitoring section of this report.

AMBIENT MONITORING SYSTEM

INTRODUCTION

The NCDWQ collects ambient water quality information from approximately 400 monitoring stations statewide. In the Neuse River basin, 59 stations were monitored during this basinwide assessment cycle (Figure 118 and Tables 41 and 42).

Water quality concerns in this basin are similar to those in other North Carolina basins. Erosional sediment deposition and subsequent habitat modification is a significant issue in most surface water bodies in which urbanization and other land-disturbing activities are taking place. Eutrophication of the estuary, particularly nitrogen loading, has been the most widely publicized concern for the basin. Ultimate effects of eutrophication, and those of most immediate concern, are algal blooms, potential effect of harmful algal species, and increased spatial and temporal occurrence of hypoxia with resulting effects on fish and shellfish populations.

Recent publications (Qian, *et al.* 2000, Stow, *et al.* 2000) have indicated that while nutrient loading to the basin has risen substantially, particularly in the past 10 years, the observed increases in nitrogen were not being observed in the estuary. This would imply that nitrogen has some other fate in the riverine portion of the basin (e.g. dentrification, sediment sinks, or loss to groundwater) than transport to the estuary. Both Qian and Stow utilized the same NCDWQ data that has been used for later analysis in this report and should be interpreted with the same caveats (see later discussion). If substantial storage of nitrogen is occurring in the river, reductions in loading from terrestrial sources may not be immediately recognizable in measured concentrations of waterborne nitrogen.

Cooper (2000) found that the stratigraphic record of Neuse River estuarine sediments records a change in algal population structure in the last 30 - 50 years. Algal taxa richness has decreased. An observed shift from benthic diatom species to planktonic species could indicate the combined effects of eutrophication and a decline in light penetration from increasingly turbid waters.

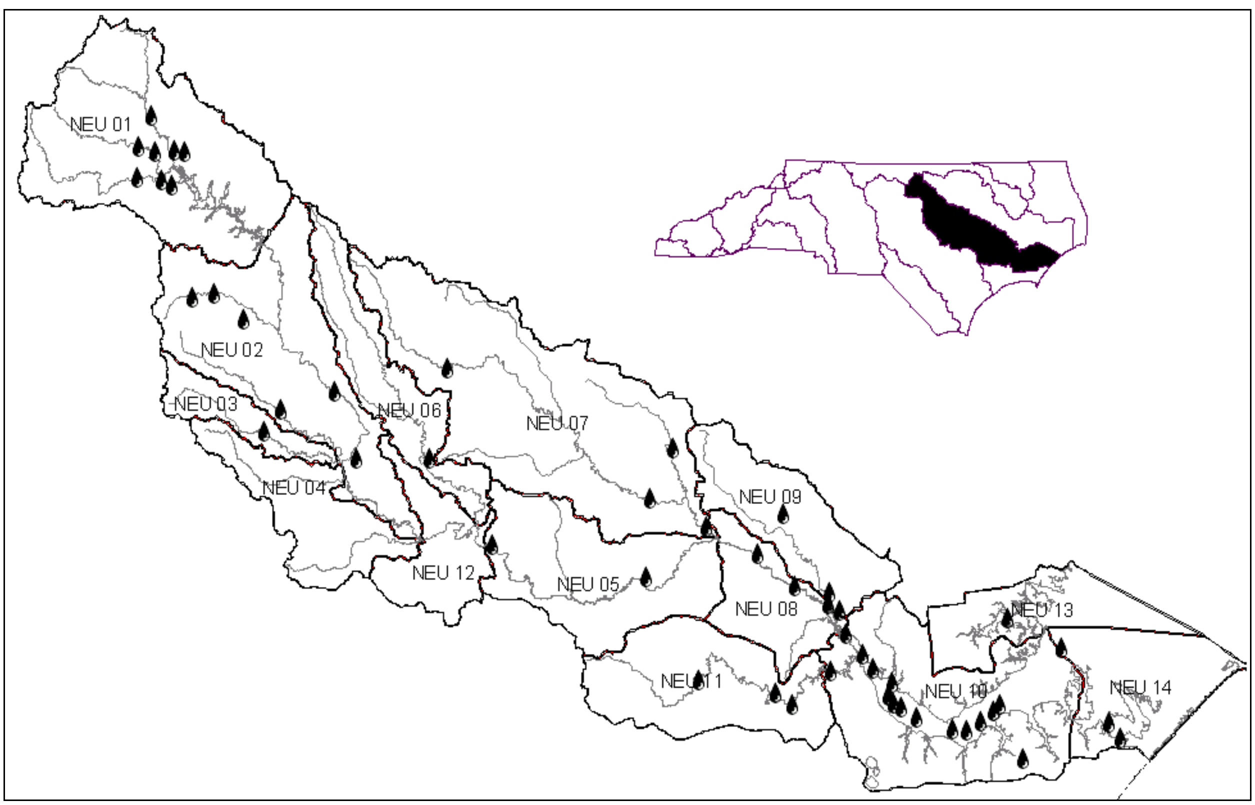


Figure 118. Ambient monitoring system sites within the Neuse River basin.

Table 41. Ambient monitoring system sites on the mainstem of the Neuse River.

Subbasin/ Station No.	Station Name	County	Class[1]
01			
J0770000	Eno River near Durham	Durham	WS-IV NSW
J0810000	Eno River at SR 1004 near Durham	Durham	WS-IV NSW
J0820000	Little River at SR 1461 near Orange Factory	Durham	WS-II NSW CA
J0840000	Little River Reservoir at SR 1628 at Orange Factory	Durham	WS-II NSW CA
J1070000	Flat River near Quail Roost	Durham	WS-III NSW
J1100000	Flat River at SR 1004 near Willardsville	Durham	WS-IV NSW
02			
J1890000	Neuse River near Falls	Wake	C NSW
J4170000	Neuse River at NC 42 near Clayton	Johnston	WS-IV NSW
J4370000	Neuse River at Smithfield	Johnston	WS-V NSW
05			
J5970000	Neuse River at SR 1915 near Goldsboro	Wayne	C NSW
J6150000	Neuse River at NC 11B at Kinston	Lenoir	C NSW
08			
J7850000	Neuse River at SR 1470 near Fort Barnwell	Craven	C Sw NSW
J7860000	Neuse River at Lane Landing near Perfection	Craven	C Sw NSW
J7930000	Neuse River at SR 1400 at Streets Ferry	Craven	C Sw NSW
J8250000	Neuse River downstream of Swift Creek near Askin	Craven	SC Sw NSW
J8270000	Neuse River at Channel Marker 64 near Bellair	Craven	SC Sw NSW
J8290000	Neuse River at Mouth of Narrows near Washington Forks	Craven	SC Sw NSW
10			
J8570000	Neuse River at US 17 at New Bern	Craven	SC Sw NSW
J8900800	Neuse River at Channel Marker 22 near Fairfield Harbor	Craven	SC Sw NSW
J8902500	Neuse River at mouth of Broad Creek near Thurman	Craven	SB Sw NSW
J8903500	Neuse River at Channel Marker 17 near Thurman	Craven	SB Sw NSW
J8903600	Neuse River at Channel Marker 15 near Riverdale	Craven	SB Sw NSW
J8910000	Neuse River at Channel Marker 11 near Riverdale	Craven	SB Sw NSW
J8920000	Neuse River near Kennel Beach	Craven	SB Sw NSW
J8925000	Neuse River near Arapahoe	Craven	SB Sw NSW
J9431500	Neuse River near Cherry Point USMC Air Station	Craven	SB Sw NSW
J9530000	Neuse River at Channel Marker 9 near Minnesott Beach	Pamlico	SA NSW
J9540000	Neuse River near Pierce	Craven	SA NSW
J9590000	Neuse River near Janeiro	Craven	SA NSW
J9685000	Neuse River near Merrimon	Carteret	SA NSW
J9810000	Neuse River at mile 12 near Oriental	Pamlico	SA NSW
J9860000	Neuse River near Cockle Point	Carteret	SA NSW
J9900000	Neuse River near Piney Point	Carteret	SA NSW
14			
J9930000	Neuse River at Mouth near Pamlico	Pamlico	SA NSW

[1]Class abbreviations: B = Class B freshwaters; C = Class C freshwaters; NSW = Nutrient Sensitive Waters; Sw = Saltwaters; SB = Class B saltwaters; SA = Class A saltwaters; WS I = Water Supply I; WS II = Water Supply II; WS III = Water Supply III; WS IV = Water Supply IV; WS V = Water Supply V.

Table 42. Ambient monitoring system sites on tributaries of the Neuse River.

Subbasin/ Station No.	Station Name	County	Class[1]
	Neuse River Tributaries		
01			
J1210000	Knap Of Reeds Creek near Butner	Granville	WS-IV NSW CA
J1330000	Ellerbe Creek at SR 1636 near Durham	Durham	WS-IV NSW
02			
J2850000	Crabtree Creek at SR 1795 near Umstead State Park	Wake	B NSW
J3000000	Crabtree Creek at SR 1649 near Raleigh	Wake	B NSW
J3251000	Crabtree Creek at SR 2000 Old Wake Forest Road	Wake	C NSW
J3290000	Crabtree Creek at US Hwy 1 at Raleigh	Wake	C NSW
J3300000	Pigeon House Creek at Dortch Street at Raleigh	Wake	C NSW
J4510000	Swift Creek at NC 42 near Clayton	Johnston	C NSW
03			
J5000000	Middle Creek at NC 50 near Clayton	Johnston	C NSW
06			
J5850000	Little River near Princeton	Johnston	WS-V NSW
07			
J6740000	Contentnea Creek near Lucama	Wilson	WS-V NSW
J7450000	Contentnea Creek at NC 123 at Hookerton	Greene	C Sw NSW
J7739550	Little Contentnea Creek at SR 1125 near Farmville	Pitt	C Sw NSW
J7810000	Contentnea Creek near SR 1800 at Grifton	Pitt	C Sw NSW
09			
J8150000	Creeping Swamp at NC 43 near Vanceboro	Craven	C Sw NSW
J8210000	Swift Creek at mouth near Askin	Craven	SC Sw NSW
J8230000	Swift Creek at NC 43 near Streets Ferry	Craven	SC Sw NSW
10			
J9690000	Back Creek at SR 1300 near Merrimon	Carteret	SA NSW
11			
J8690000	Trent River near Trenton	Jones	C Sw NSW
J8720000	Trent River at SR 1121 near Oak Grove	Jones	C Sw NSW
J8730000	Trent River at Pollocksville	Jones	C Sw NSW
J8770000	Trent River upstream Reedy Branch near Rhems	Craven	SB Sw NSW
13			
J9950000	Bay River at Channel Marker 5 near Vandemere	Pamlico	SA NSW
14			
J9938000	West Thorofare Bay at Channel Marker 10 near Atlantic	Carteret	SA NSW
J9940000	Thorofare Canal at NC 12 near Atlantic	Carteret	SA NSW

[1]Class abbreviations: B = Class B freshwaters; C = Class C freshwaters; NSW = Nutrient Sensitive Waters; Sw = Saltwaters; SB = Class B saltwaters; SA = Class A saltwaters; WS I = Water Supply I; WS II = Water Supply II; WS III = Water Supply III; WS IV = Water Supply IV; WS V = Water Supply V.

DATA ASSESSMENT AND INTERPRETATION

Before discussing data, it is important to understand the scope of the data utilized in this report and some necessary assumptions applied in summarizing the information.

Stations selected for assessment are those currently routinely monitored by the NCDWQ as part of its ambient monitoring network. Generally, samples or measurements represent monthly sampling trips. These trips are intentionally random events in time (within a 30 day window) and may represent a range of climatic conditions. To the extent that field staff are not subjected to hazardous conditions, sampling may occur over a full range of climatic events. While a full range of sample and measurement parameters are taken at most sites, some sites may have specific parameters (e.g., field measurements) only. Three sites in the basin were sampled on a daily basis during this review period using automated samplers for nutrient parameters.

Monitoring and sampling results considered in this report represent samples collected or measurements taken at less than one meter in depth to establish a consistent comparison across the basin. Because a significant purpose of this report is to provide a summary of data for use support determination, current procedures dictate this type of summary. Estuarine stations may have additional subsurface profiles of field parameters such as dissolved oxygen, specific conductance, temperature, pH, Secchi depth, and salinity that are available upon request.

Median and percentile statistics (Tables 43 to 66) are calculated from all data, assuming that values reported below the minimum reporting level equal that level. This would affect the data by overestimating actual percentiles. In instances where matrix effects caused a higher than routine minimum reporting level, that new reporting level is assumed as the value for the purpose of percentile calculation. Minimum and maximum values are actual reported values. Calculations were performed using Microsoft® Excel 2000.

Use Support Assessment Considerations

- The daily average dissolved oxygen standard of 5.0 mg/L is presented as the standard against which excesses are judged. Instantaneous values as low as 4.0 mg/L are actually acceptable and even lower values may be acceptable if due to natural conditions.
- Action level standards (copper, iron, and zinc) are used only as comparators. Follow-up toxicological work will need to be conducted before use support determination can be made for these parameters.
- The geometric mean was calculated for fecal coliform results for each station. This value was compared to 200 colonies/100 mL as an indicator of status *vs.* the fecal coliform standard. For an understanding of the fecal coliform standard and appropriate interpretation of results one should refer to the NC Administrative Code Section 15A NCAC 2B.0211(3)(e).

Analytical Considerations

- Chlorophyll data are not presented or discussed in this report due to analytical problems discovered in early 2001 that severely affected the accuracy and confidence of reportable data.
- Contamination of zinc samples (producing a high bias) was likely between April 1995 and March 1999.
- Due to quality assurance problems with nitrogen and phosphorus parameters discovered in early 2001, ammonia (NH_3), nitrate+nitrite nitrogen (NO_2+NO_3-N) and total phosphorus results less than 0.05 mg/L and total Kjeldahl nitrogen results less than 1.0 mg/L., did not meet desired quality assurance measures. Neither the accuracy nor bias of those results is known. The results therefore are presented as reported but should be considered with a great deal of uncertainty.

DISCUSSION

Flow -- Water Volume and Velocity

Flow can influence many water quality parameters. Terrestrial runoff can carry significant amounts of sediment and various other pollutants in areas where land disturbing practices occur. The US Geological Survey (USGS) routinely measures flow using both automated gage sites and manual measurements funded by the NCDWQ and others.

Nonpoint source runoff is generally assumed to be greatest following rainfall events and thus, higher flows as well as after these events. Point source discharges tend to have their greatest relative influence during low stream flows where the "instream waste concentration" of the discharge is relatively greater. Periods of low flow, which frequently occur during summer months and hot weather, also reduce physical re-aeration of the water column. This factor, coupled with the reduced capacity for water to hold oxygen at higher temperatures, can result in conditions increasingly stressful to aquatic life.

Figure 119 displays a time series graph of flow from the USGS gage sites in the Neuse River at Clayton and at Kinston. Data were obtained from the USGS website. Readily discernible in these graphs are the flow peaks following a series of hurricanes in 1996 (Bertha and Fran) and 1999 (Dennis, Floyd, and Irene).

Turbidity and Total Suspended Solids

Turbidity is a laboratory measurement of the ability of light to pass through a sample. It is an indicator for dissolved, colored materials, colloids, and suspended materials that inhibit light penetration. Depending on the cause(s) of increased turbidity, assumptions can be made about potential effects on benthic or planktonic algal communities by reduction of available light, and potential for sediment deposition in a water body.

Water quality effects of the highly urbanized area surrounding the City of Raleigh and the influence of the clay soils predominant in the piedmont are demonstrated in the turbidity results reported for all the Crabtree Creek stations (Figure 120). This stream, which bisects Raleigh, displays some of the highest trends of turbidity of all stations sampled in the basin. At Crabtree Creek at Umstead State Park, more than 25 percent of values exceeded the standard. Crabtree Creek near Raleigh and at Old Wake Forest Road had at least 10 percent of the values exceeding the standard.

Along the mainstem of the Neuse River, including the Flat and Eno Rivers, no stations had the 10th percentiles exceeding 50 NTU. Most of the piedmont stations had maximum values several times greater than the standard. Once exiting the piedmont and flowing into the sandier soils of the coastal plain, the river's turbidity ranges (interquartile range), medians, and maximum values decreased sharply in both tributary and mainstem stations.

Total suspended solids (TSS) is a gravimetric measurement of particles suspended in a sample. Elevated concentrations of suspended solids can mean an increased probability of sedimentation and benthic habitat disruption. In the piedmont, TSS is frequently dominated by clay soil runoff but in some situations can also result from poorly clarified wastewater discharges. Many clay soils, though, can introduce particles or colloids smaller than those able to be accurately measured.

Comparison of turbidity and TSS plots (Figures 120 and 121) showed similar trends among most stations. Interestingly, all four Crabtree Creek stations displayed relatively greater turbidity than all other stations, but did not have corresponding elevated TSS concentrations. This may be the effect of the small particle or colloidal clays as previously discussed.

Metals

Similar to, and related to trends in turbidity, aluminum and iron values ranged widely across the basin and were influenced in large part by the clay soils of the piedmont. These metals are good indicators of the influence of land disturbing activities. Thirty-two of 33 freshwater stations in the basin had greater than 10 percent of iron values exceeding the action level of 1000 µg/L.

No positive values of arsenic or cadmium were reported in the basin during this period. One positive value was reported for mercury at the Neuse River at Kinston. One positive value was reported for total chromium at the Neuse River at Channel Marker 11 near Riverdale.

Though positive values were more frequent for nickel and lead, no station had greater than 10 percent of values exceeding water quality standards. One notably high lead value of 6,500 µg/L was reported at the Flat River near Willardsville. Manganese values exceeded water supply standards in greater than 10 percent of samples at the Flat River at Willardsville, Knap of Reeds Creek, and Contentnea Creek near Lucama.

Copper and zinc are relatively ubiquitous metals in many watersheds, particularly watersheds influenced by urban or development activities. Like iron, the toxicity of these metals is significantly dependent on the bioavailability of the free metal ion to aquatic organisms. This relationship is influenced by adsorption to inorganic particulates and most significantly by ligation of binding sites by organic ligands (e.g. humic acids in the water column). Because of these potential variables, copper and zinc (and several other state water quality standards) are established as action level standards to recognize these matrix effects.

Thirty of 47 monitoring sites in the basin had greater than 10 percent of reported values of copper exceeding the action level. Zinc values exceeded the action level in greater than 10 percent of the samples at 10 of 47 stations. Follow-up toxicity monitoring to assess observable toxicity is warranted at those stations (Tables 61 and 66).

A possible large-scale contamination of zinc samples was identified for the period April 1995 though March 1999. During this period, a review of statewide zinc data demonstrated a sudden rise in values unexplainable in terms of water quality trends. The purchase and installation of additional automated sample handling apparatus by the NCDWQ's Laboratory Section corresponded with a statewide decrease in reported values. This series of events could be interpreted to mean that values following installation of the new equipment may more accurately reflect actual water column concentrations. Indeed, time series of data (not presented in this report) do visually lead to the conclusion that most excesses of action level standards occurred during the early part of this five-year period.

Coliform Bacteria

Concentrations of coliform bacteria are used as an indicator of the possible presence of pathogenic microorganisms in the water column. A water quality standard (50 colonies/100 mL) is in place for total coliform bacteria in WS-I classified water bodies used as unfiltered water supplies. A fecal coliform bacteria standard (200 colonies/100 mL) is also in place for all surface waters with the exception of salt water bodies suitable for shellfish harvest (classified SA) that have a more stringent standard (14 colonies/100 mL).

No ambient monitoring sites in the basin are located in WS-I waters. Because of specific sampling restrictions contained in the water quality standards pertinent to these parameters and classifications, summary statistics and threshold values are discussed here as geometric means of reported results.

Fecal coliform bacteria exceeded a geometric mean of 200 colonies/100 mL at only two (Crabtree Creek at US 1 and Pigeon House Creek) of 41 stations (fresh and salt water stations not classified SA). Only one SA classified salt-water station (Back Creek near Merrimon) had a geometric mean that exceeded 14 colonies/100 mL.

Dissolved Oxygen

Stations with greater than 10 percent of values less than 5.0 mg/L included Contentnea Creek near Lucama and Back Creek near Merrimon (tributaries) and the Flat River near Willardsville, Neuse River at Goldsboro, and Neuse River at Kinston (mainstem) (Figure 122). Because the summary statistics presented in this report assess only those measurements taken at a depth of less than one meter, these results will likely underestimate hypoxic and even anoxic events known to occur in the estuary.

Better quantitation of dissolved oxygen status and trends in the estuary may come from three automated data collection platforms operated jointly by the NCDWQ and the USGS. These three sites, located at US Highway 17, Channel Marker 11, and Channel Marker 9, provide surface and bottom measurements of dissolved oxygen, pH, temperature, and salinity. A review of daily mean surface dissolved oxygen concentrations at the three sites for the period of approximately July 1996 - September 2000 showed 2% - 5% of the values were less than 5.0 mg/L (Figures 123 - 125). Daily average bottom concentrations were less than 5.0 mg/L on 41%, 33%, and 22% of days at the same three sites, respectively.

The location of these continuous monitoring sites bracket the area of the estuary most susceptible to hypoxia. This area is where the river widens and slows greatly; where saltwater begins to mix with the freshwater portions of the river creating stratified layers; and where available wind fetch and rearation possibilities are much more limited than below the river's northeast turn at Minnesott Point.

Records of observed fish kills over the past five years unsurprisingly also suggest that this area is the most probable location for kills to occur in the basin. The occurrence of these kills depends on the magnitude, duration, and frequency of hypoxic events. Anecdotal evidence from watermen and ongoing research (e.g. ModMon, discussed later) indicated that the occurrence of fish kills was also highly dependent on whether refuge from hypoxic conditions was available to fish populations. As the estuary stratifies, wind, tide and currents can oscillate stratified layers vertically in the water column as well as horizontally (north to south) across the river. These oscillations can cut off fish populations from rapid escape from hypoxic conditions and cause immediate or delayed mortality.

pH

The only two sites in the basin with greater than 10 percent of pH values outside the 6.8 - 8.5 range are the stations on Back Creek near Merrimon and the Neuse River station at Channel Marker 9 near Minnesott Point. Both these sites are in waters currently classified SA. Both sites' excursions outside of standards were also predominately acidic, possibly implying a swamp water influence or characteristic. Coincidentally, both sites also had lower specific conductance tendencies than surrounding sites which may support the influence of more fresh acidic water from nearby lowlands. The Neuse River at Channel Marker 9 is bordered to the southeast by the drainage of Clubfoot Creek and to the southwest by both Hancock and Slocum Creeks.

Specific Conductance

In freshwater portions of the basin, specific conductance (the ability of water to conduct an electrical current proportional to the total dissolved solids presents) provides an indicator of the relative anthropogenic influence on a water body. Sites with specific conductance above background levels and those with widely varying values demonstrated this influence.

As the river enters estuarine and salt water segments of its course, specific conductance was dominated by the dissolved solids (i.e. salts) of seawater. Thus, the segment of the river most greatly influenced by wind, flow, and lunar tides becomes well defined by specific conductance measurements, as do the estuarine tributaries

(Figure 126). Not surprisingly, the same segment from New Bern downstream to Channel Marker 11, is the same segment discussed earlier that experiences low dissolved oxygen and resulting fish kills due to frequent stratification.

Nutrients

In considering the interpretation and data described for nutrients, the reader should review the qualifications discussed previously in the "Data Assessment and Interpretation" section.

The algal growing stimulating nutrients, nitrogen and phosphorus, remained among the chief parameters of concern in the basin. Nitrogen is measured as three components: ammonia, total Kjeldahl nitrogen, and nitrate+nitrite-nitrogen. Nitrogen discharged as biological wastes generally is nitrified from organic to inorganic forms and ultimately is denitrified or lost as gaseous nitrogen to the atmosphere. Nitrate and, to a lesser extent in surface waters, nitrite are considered the most available forms of nitrogen for most algal species. Nitrogen is also considered the primary limiting nutrient to algal growth in the estuarine portions of the basin while phosphorus may have a more important role than nitrogen in the freshwater portion of the basin. Figures 127 through 135 depict descriptive statistics for the three nitrogen parameters and phosphorus at the ambient monitoring sites.

Among tributary stations, Knap of Reeds Creek, Ellerbe Creek, Middle Creek, and Pigeon House Creek had median NO_2+NO_3-N concentrations greater than 1 mg/L. The primary influences on concentrations in these stations were likely the John Umstead Hospital WWTP (Butner), the Durham North Water Reclamation Facility, and the Clayton WWTP. The site on Pigeon House Branch is influenced by urban runoff as the stream bisects the City of Raleigh. The next lower medians among tributaries were noted at Contentnea Creek at Hookerton and Contentnea Creek at Grifton, with 0.68 and 0.66 mg/L, respectively. These stations were probably influenced by several small municipal sewage treatment systems and concentrated agricultural operations in the watershed.

The mainstem stations, beginning with the Neuse River at Clayton, showed the influence of major nutrient inputs as the river passes though or near the urban areas of Raleigh, Clayton, Smithfield, Goldsboro, Kinston, and New Bern. Median NO_2+NO_3-N concentrations were 1.1 mg/L at Clayton, 0.71 m/L at Goldsboro, and varied between 0.6 and 0.8mg/L until the river reached the Mouth of the Narrows above New Bern. When the river enters the estuarine section near New Bern, median NO_2+NO_3-N concentrations decreased rapidly.

The graphs of daily concentrations at three stations depict a cyclical nature of NO_2+NO_3-N concentrations (Figures 131). Total nitrogen load was apparently greatly increased during periods of higher flow, indicating that nonpoint sources of nitrogen (i.e. those delivered in response to rainfall events) were significant events in the nitrogen budget of the system.

Figures 132 through 135 demonstrate what may be the biological (i.e. phytoplanktonic) response to available nutrients as the Neuse River enters the estuarine zone. At the Mouth of the Narrows, NO_2+NO_3-N concentrations, though experiencing annual oscillations, remained available in the water column for most of the year. Further downstream at stations near the mouth of Broad Creek and at Minnesott Point, concentrations were practically depleted in the water column during warmer growing season months, even as TKN and total phosphorus remained available. It is therefore possible that inorganic nitrogen remains one of the limiting factors to algal growth in the estuary.

Four Years of Hurricanes

During the period 1996 - 1999, North Carolina experienced an unusual number of major hurricanes. In late summer of 1996, Hurricane Bertha was followed by Hurricane Fran, causing an extended period of rainfall across the piedmont and coastal plain. Though diminished to tropical depression/tropical storm wind velocities, Hurricane Danny made an inland traverse of the state in 1997. In 1998, Hurricane Bonnie brought coastal rainfall as great as 11 inches (NOAA National Hurricane Center, http://www.nhc.noaa.gov). In September and October of 1999, three hurricanes affected North Carolina. Two, Hurricanes Dennis and Floyd, made landfall. Hurricane Irene passed off the coast in mid October and possibly improved re-aeration of Pamlico Sound waters heavily laden with organic matter flushed from the eastern half of the state by the previous two storms.

Significant effects of these storms on water quality included widespread depression of dissolved oxygen concentrations after Hurricane Fran and immense nutrient and biochemical oxygen demand (BOD) loading by both the 1996 and 1999 storm clusters. The tremendous volume of water entering coastal rivers from the 1999 storms evidently tended to dilute BOD and potentially acute toxic concentrations of pollutants. Very few fish mortality events were noted. Unlike 1996 conditions, cooler weather following the 1999 storms probably also helped keep dissolved oxygen concentrations above critical levels.

Following Hurricane Floyd, the North Carolina Legislature appropriated funds to study water quality effects of this flooding. From these funds, studies were initiated by:

- North Carolina State University - Dr. D. Shea to study potential bioaccumulative pollutants in the water column by deployment of semipermeable membrane devices;
- University of North Carolina and Duke University - Drs. H Paerl and J. Ramus to establish mobile water quality monitoring devices on ferries traversing Pamlico Sound;
- Duke University - Dr. L. Crowder to study flood effects on fish populations and habitat in Pamlico Sound;
- Oak Ridge National Laboratory - Dr. M. Adams to study physiological effects on fish populations by use of biomarker chemicals;
- USGS - Dr. J. Bales to deploy fixed nutrient monitoring devices at the mouths of the Neuse and Pamlico Rivers to assess long term water column nutrient flux; and
- NCDWQ - to study sediment and fish tissue chemical contaminants in flood affected areas.

Currently, all these studies are ongoing and conclusions have not yet been reached. Summary papers by several agencies and researchers chronicled effects of both the 1996 and 1999 hurricanes on water quality and quantity (Bales and Childress, 1996, NCDWQ 1997, Bales, *et al.*, 2000, Paerl, *et al.*, 2000).

Other Continuing Research

A great deal of other research on chemical and physical aspects of water quality is also being conducted in the basin:

- One of the most significant research efforts has been the ModMon (modeling and monitoring) project that has involved several universities, the NCDWQ, and Weyerhaeuser Corporation to develop an understanding of the estuarine portions of the basin. This has been a multidisciplinary project involving water quality, geology, fisheries, modeling, geochemistry, benthic ecology, hydrography, and hydrodynamics.
- The NC Water Quality Workgroup (North Carolina State University and the NCDWQ) operates Rivernet, a project to deploy automated nutrient and physical parameter monitors in the basin (all riverine stations to date) and uplink data to the Internet (http://rivernet.ncsu.edu).
- The North Carolina State University Center for Applied Aquatic Ecology (http://www.pfiesteria.org) maintains significant sampling programs and automated monitoring platforms in the Neuse River estuary and focuses predominantly on *Pfiesteria* research, nutrients, and dynamics of the estuary. Burkholder, *et al.* (1996), also reported results of a three year biomonitoring study on the area around the new discharge location for the US Marine Corps Air Station at Cherry Point.
- With funding supplemented by the NCDWQ, the USGS maintains three automated data platforms in the estuary that upload data *via* satellite and make this information available on the Internet (http://water.usgs.gov). This area of the Neuse River generally brackets the area most significantly affected by vertical stratification of fresh and saline waters and subsequent hypoxic events.
- The USGS is the primary research agency for the Triangle Water Supply Monitoring Project (http://nc.water.usgs.gov). This is a study of water quality in several water supply reservoirs and rivers in the Triangle Area. In addition, the agency is also conducting a study on the fate and transport of organic contaminants in the basin. The agency also performs water quality monitoring for a variety of projects around the state and maintains a large number of stream flow gages from which the NCDWQ derives the majority of its flow data.
- The NCDWQ has recently set up a public access web site that allows individual researchers or agencies to provide, electronically, abstracts for any water quality research ongoing in the state. This database can be user-sorted to the Neuse River basin to view any research information that has been submitted (http://www.esb.enr.state.nc.us).

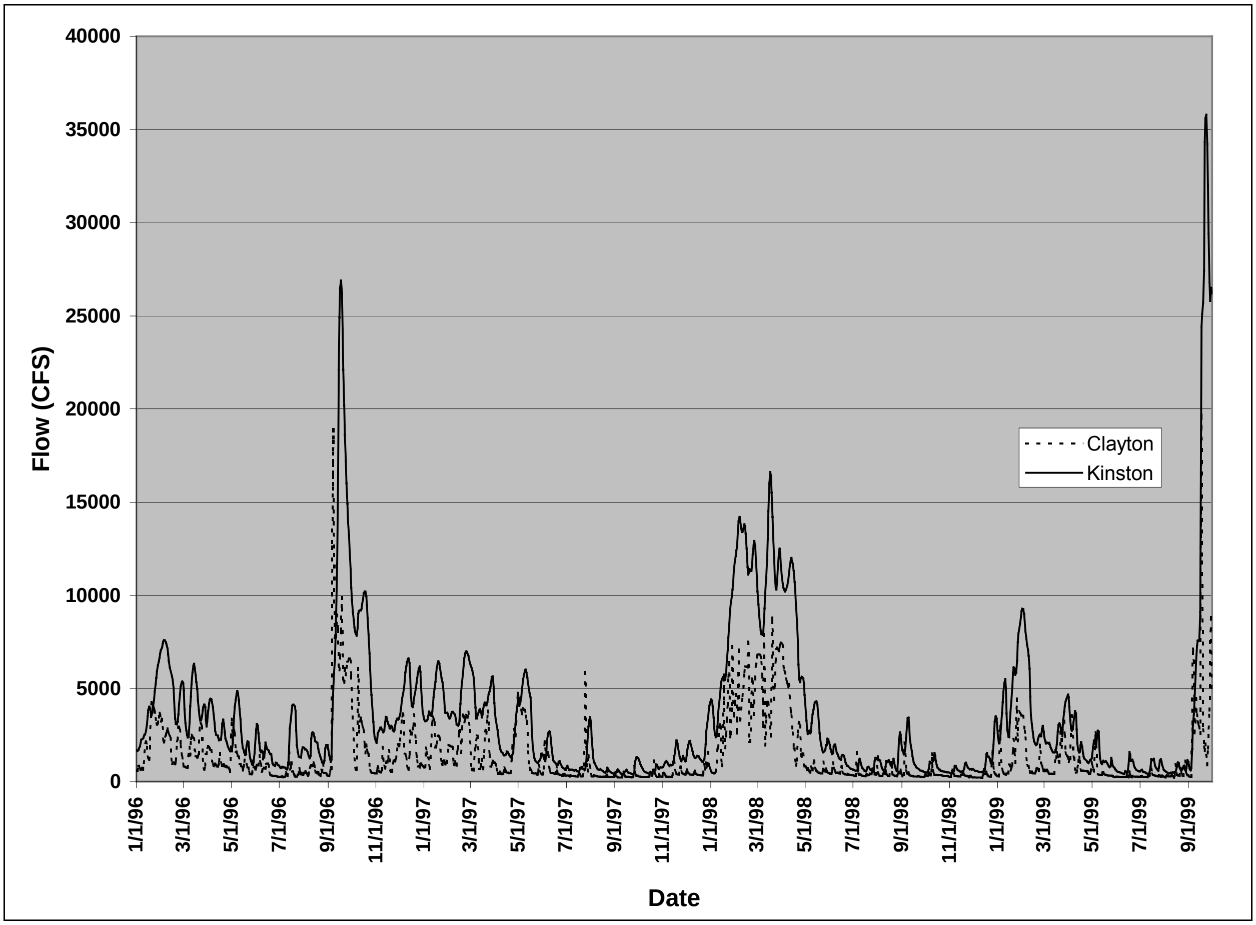
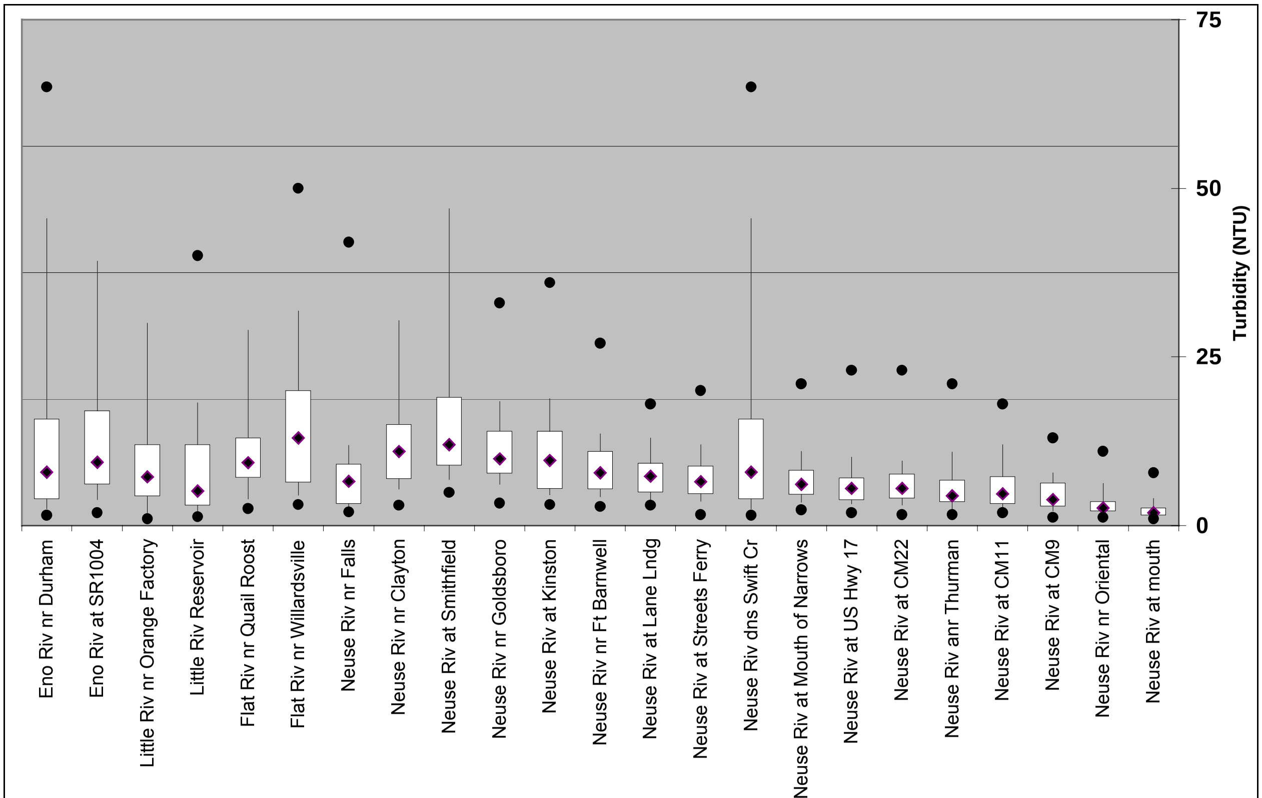


Figure 119. **Mean daily flow (cfs) of the Neuse River at Clayton and Kinston, 1996 - 1999.**



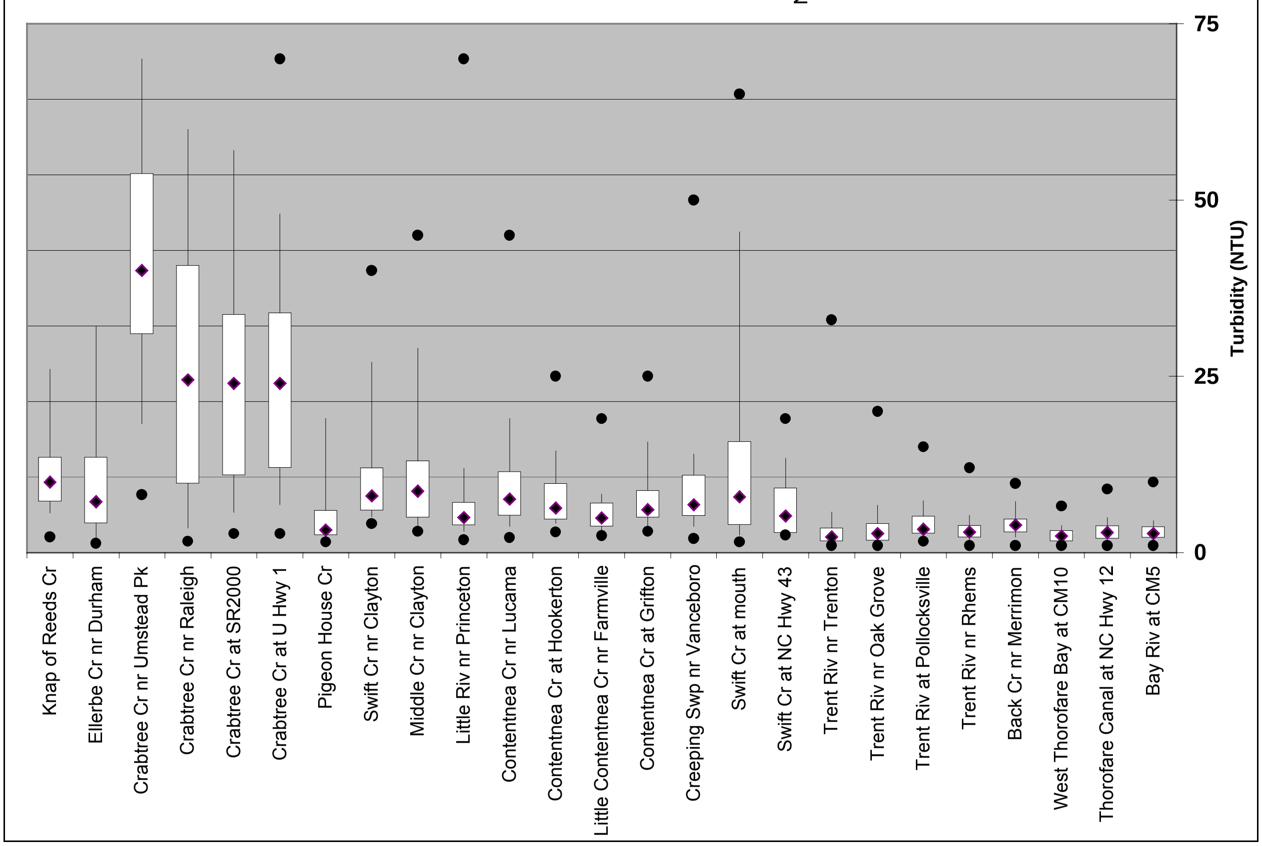


Figure 120. Turbidity (NTU) of Neuse River mainstem (top) and tributary (bottom) stations, 1996 - 2000.

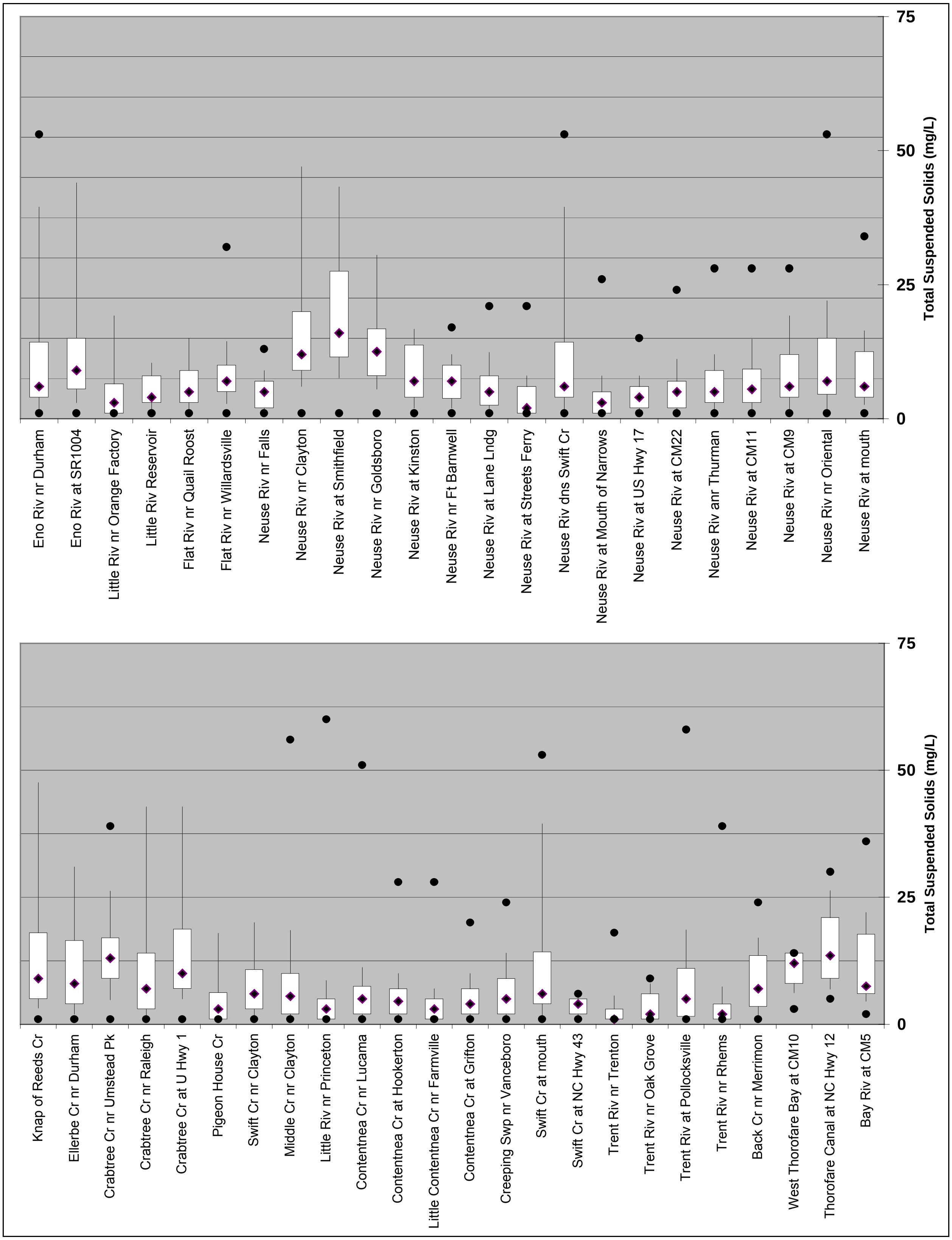


Figure 121. **Total suspended solid concentrations (mg/L) of Neuse River mainstem (top) and tributary (bottom) stations, 1996 - 2000.**

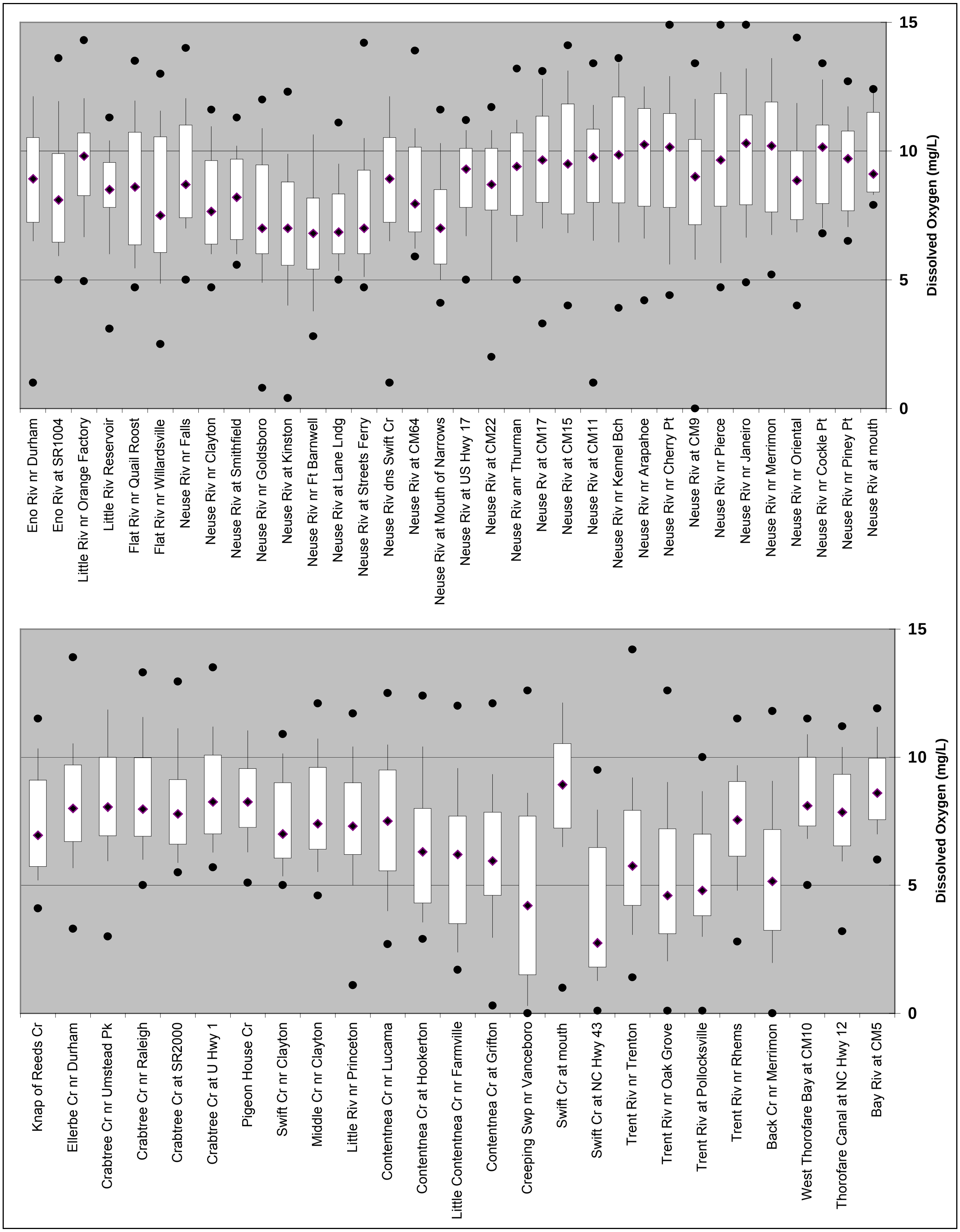


Figure 122. **Dissolved oxygen concentrations (mg/L) of Neuse River mainstem (top) and tributary (bottom) stations, 1996 - 2000.**

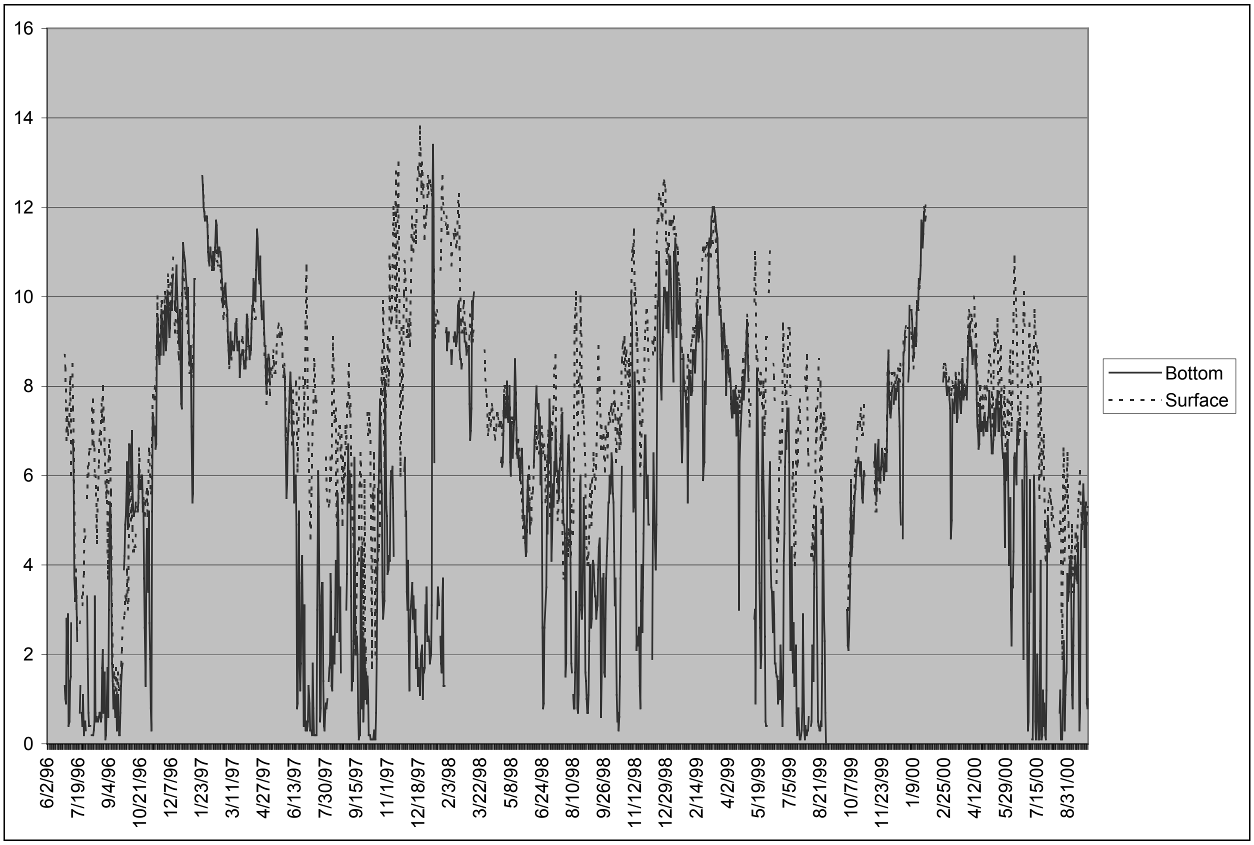


Figure 123. **Daily surface and bottom dissolved oxygen concentrations (mg/L) in the Neuse River, US 17 at New Bern, 1996 - 2000.**

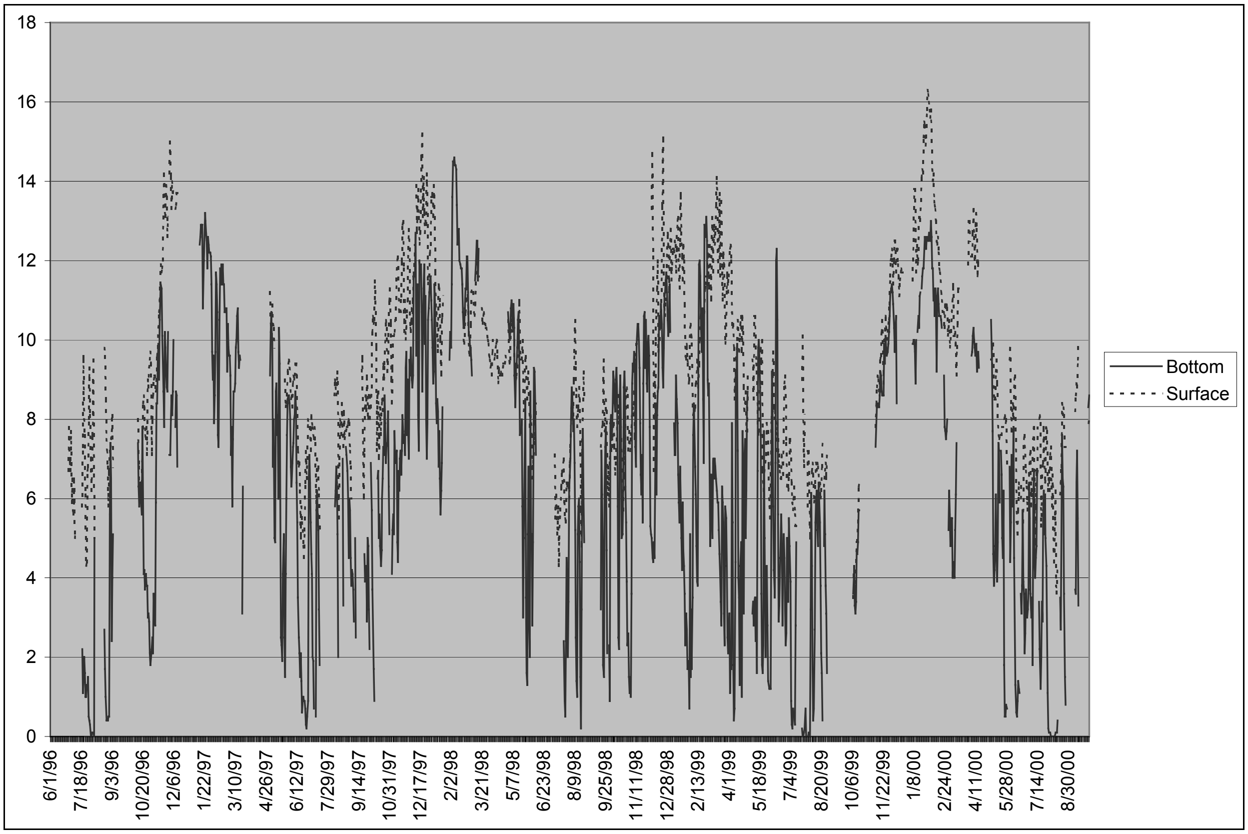


Figure 124. **Daily surface and bottom dissolved oxygen concentrations (mg/L) in the Neuse River, Channel Marker 11 at Riverdale, 1996 - 2000.**

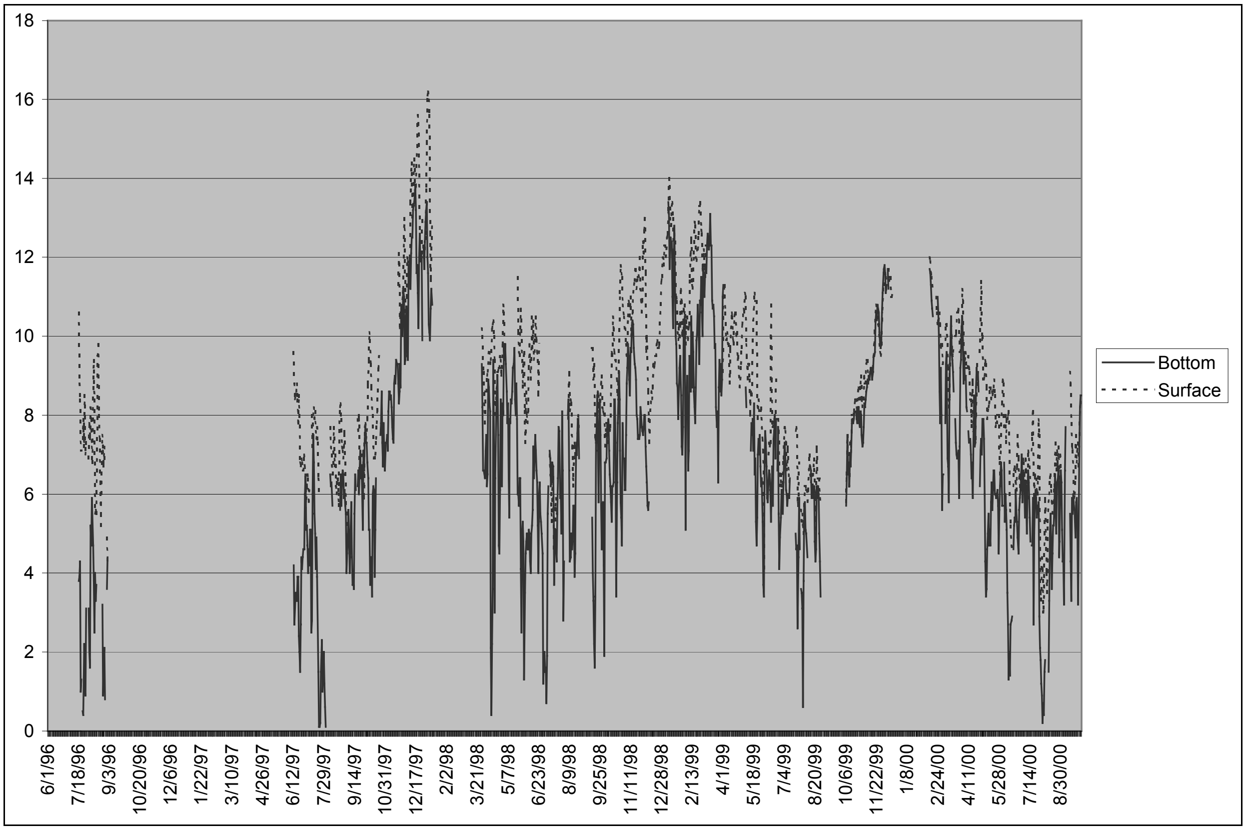
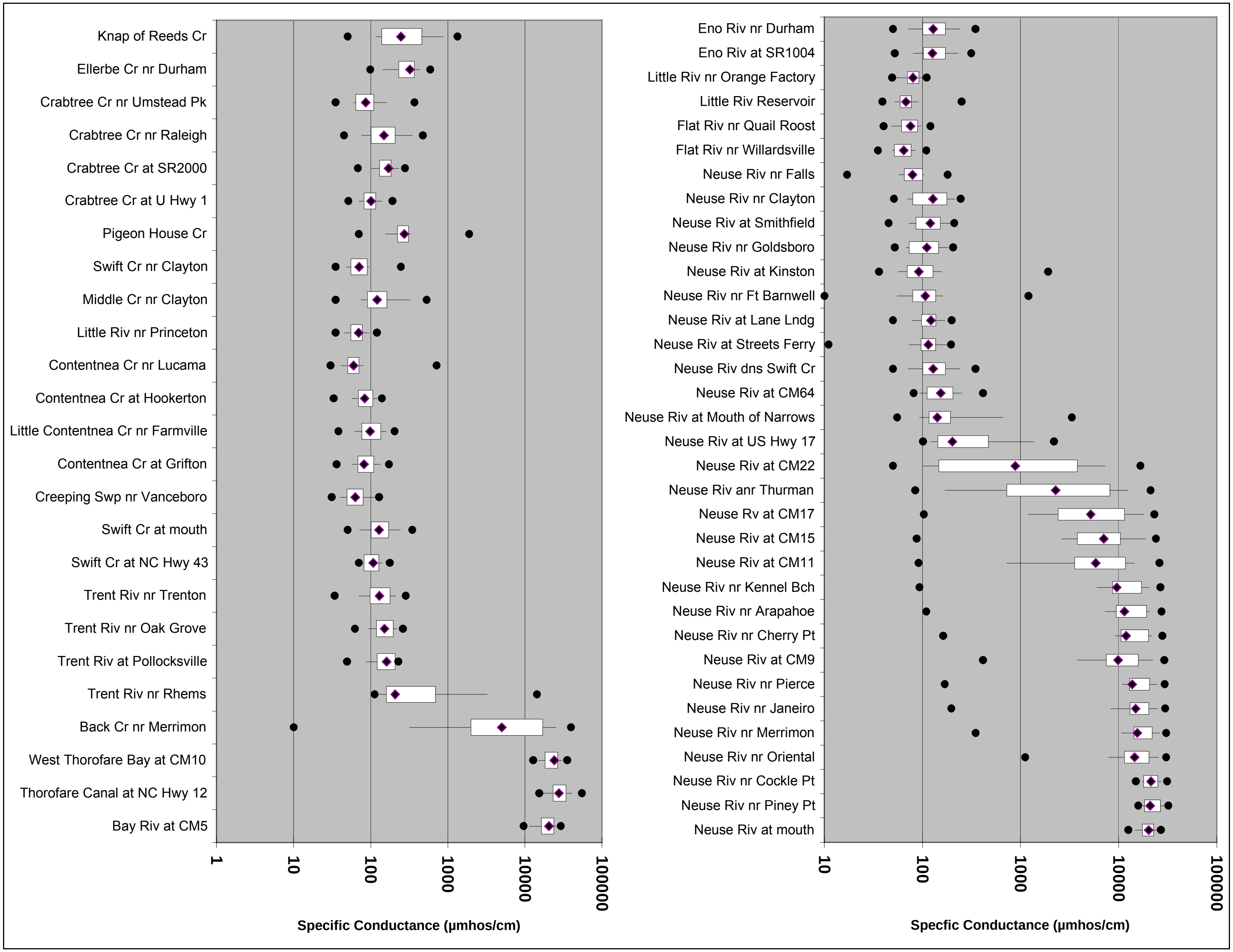


Figure 125. **Daily surface and bottom dissolved oxygen concentrations (mg/L) in the Neuse River at Channel Marker 9 near Minnesott Beach, 1996 - 2000.**

Figure 126. Specific conductance (µmhos/cm) of Neuse River mainstem (top) and tributary (bottom) stations, 1996 - 2000.



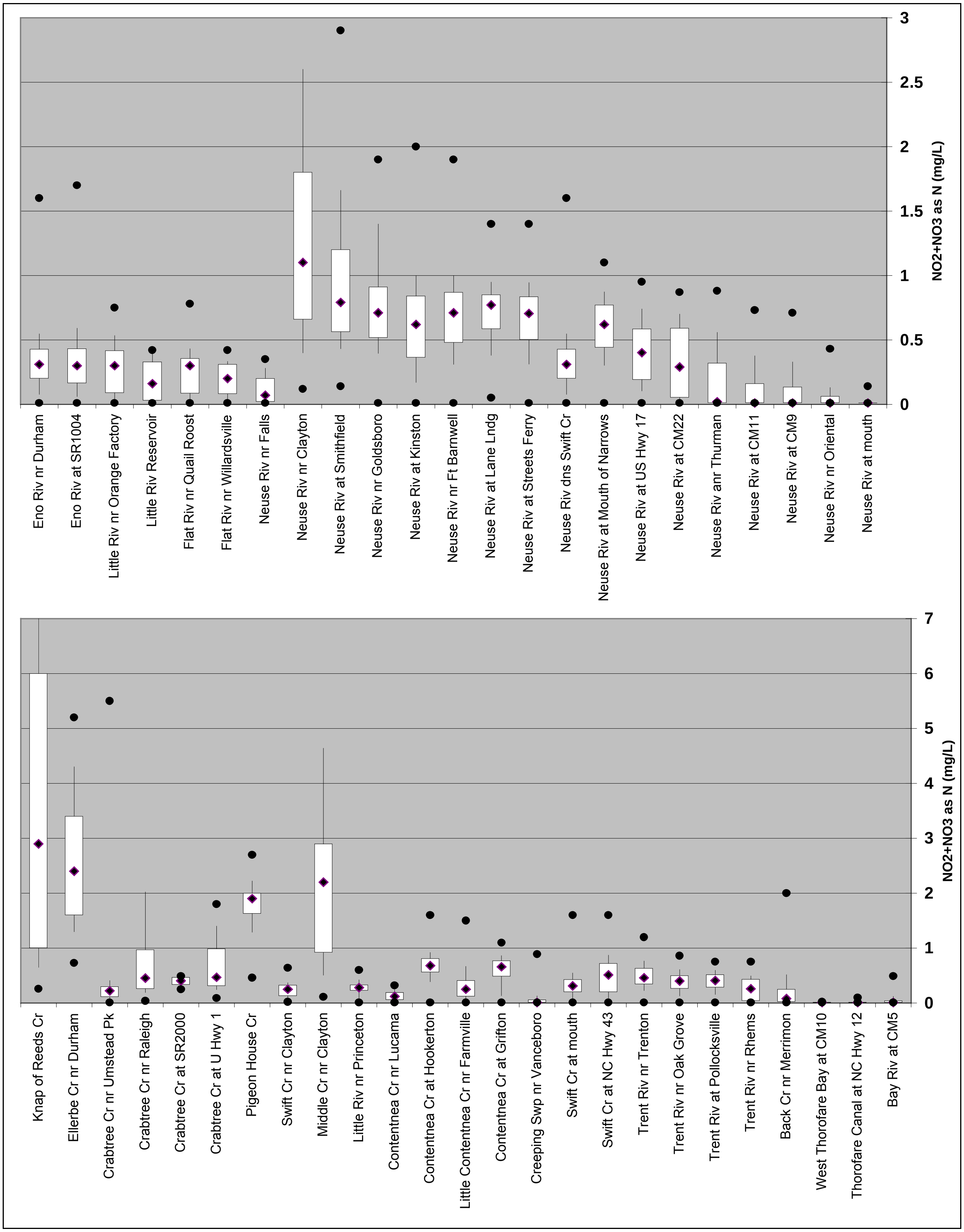


Figure 127. Nitrate+nitrite nitrogen (NO_3+NO_2-N, mg/L) of Neuse River mainstem (top) and tributary (bottom) stations, 1996 - 2000.

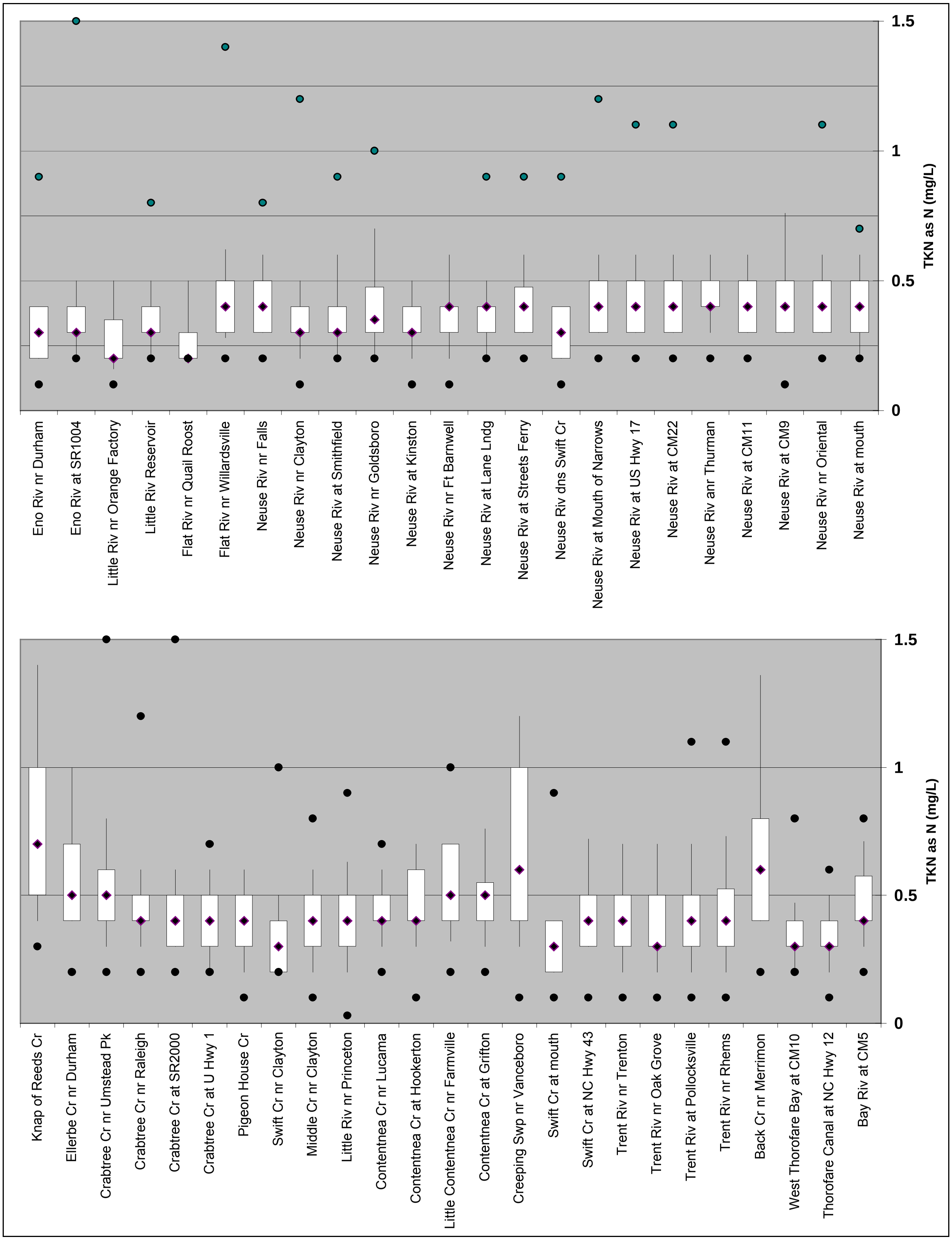


Figure 128. **Total Kjeldahl nitrogen concentrations (mg/L) of Neuse River mainstem (top) and tributary (bottom) stations, 1996 - 2000.**

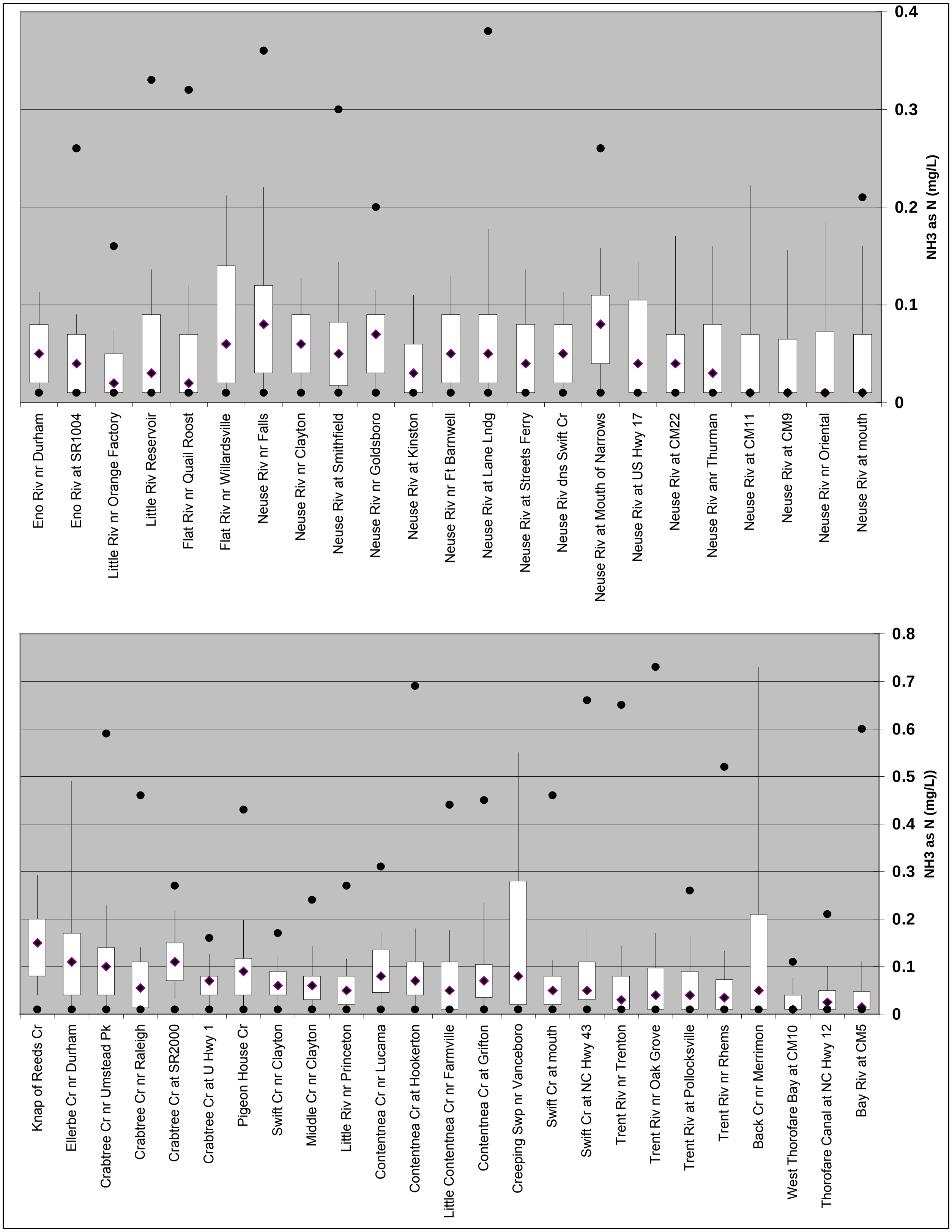
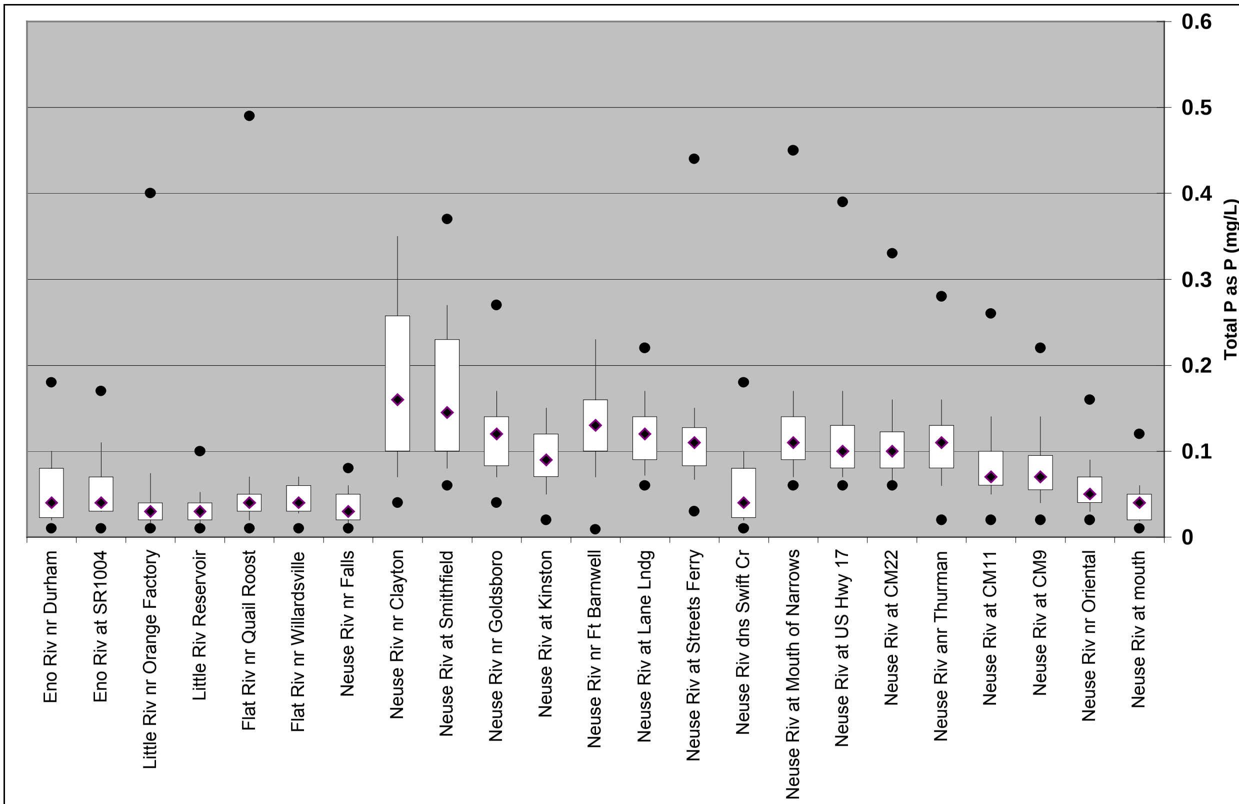


Figure 129. Ammonia nitrogen concentrations (NH_4^+-N, mg/L) of Neuse River mainstem (top) and tributary (bottom) stations, 1996 - 2000.



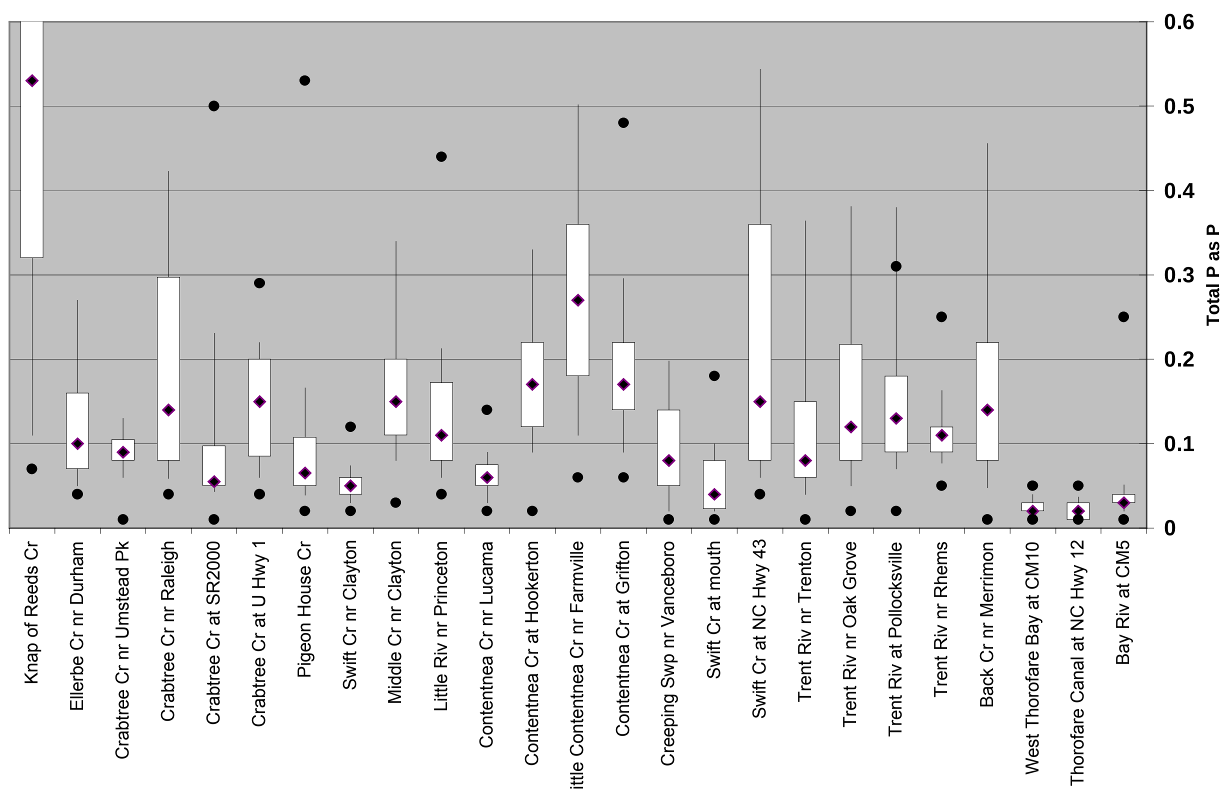


Figure 130. **Total phosphorus concentrations (mg/L) of Neuse River mainstem (top) and tributary (bottom) stations, 1996 - 2000.**

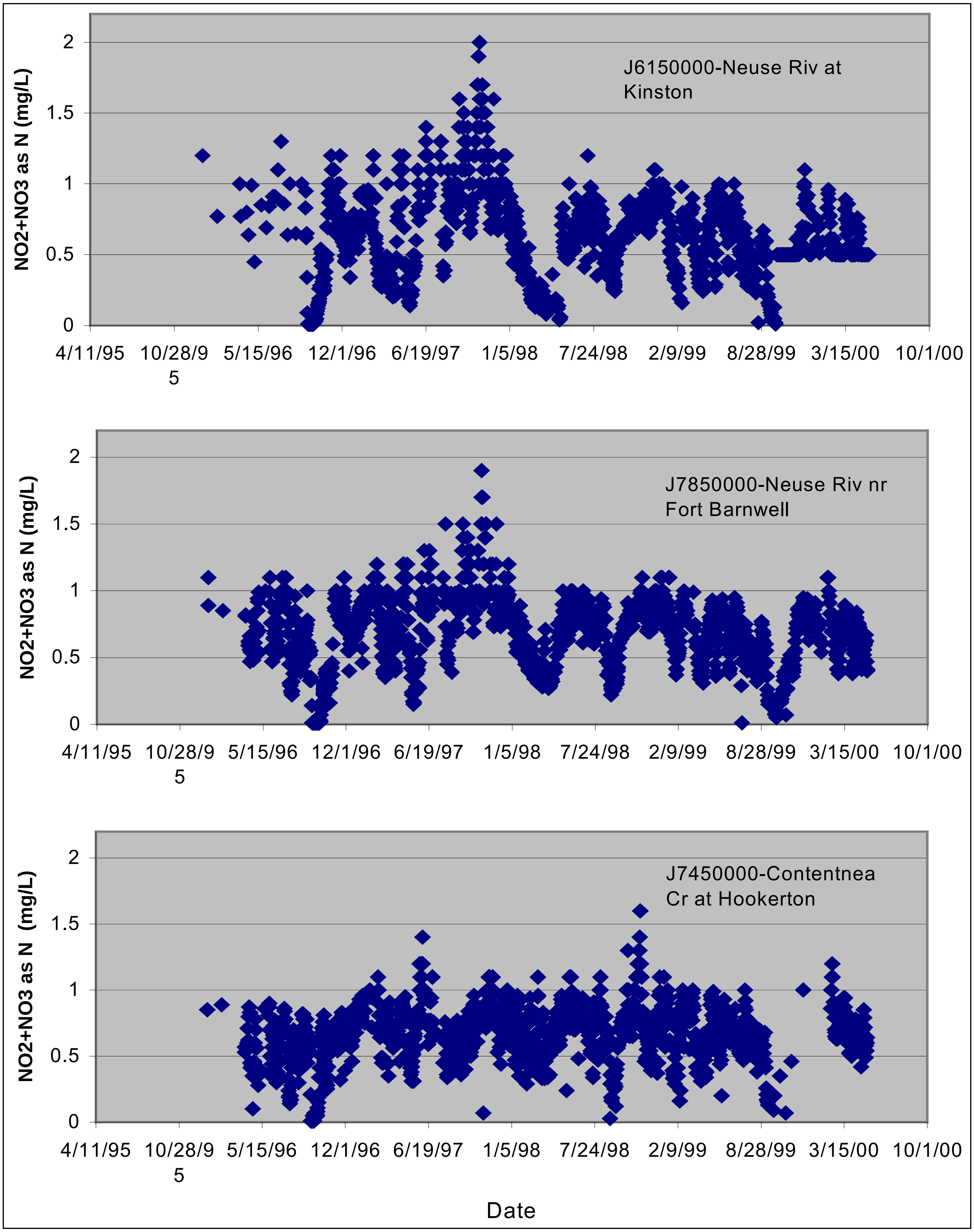


Figure 131. **Daily nitrate+nitrite nitrogen (NO_3+NO_2-N, mg/L) concentrations at two sites on the Neuse River and at Contentnea Creek, 1996 - 2000.**

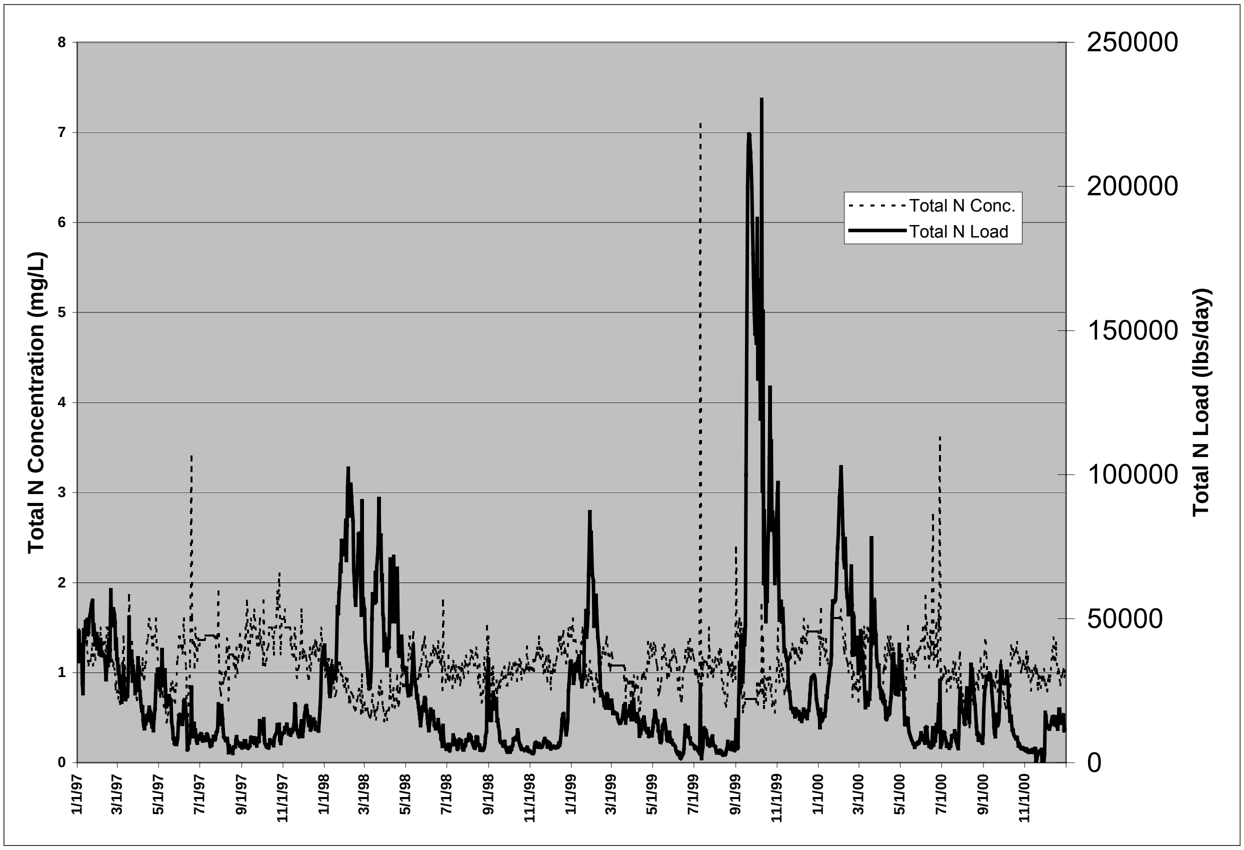


Figure 132. Daily total nitrogen concentrations (mg/L) and load (pounds/day) in the Neuse River at Fort Barnwell, 1997 - 2000.

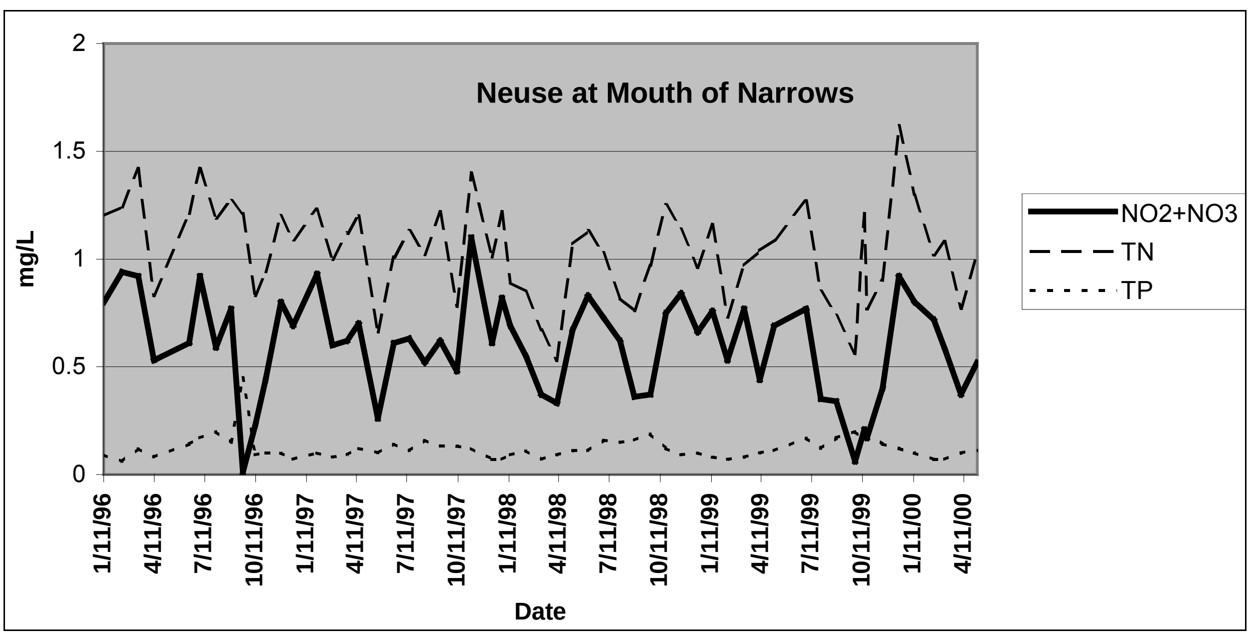


Figure 133. Nitrate+nitrite, total nitrogen, and total phosphorus concentrations (mg/L) in the Neuse River at Mouth of Narrows near Washington Forks.

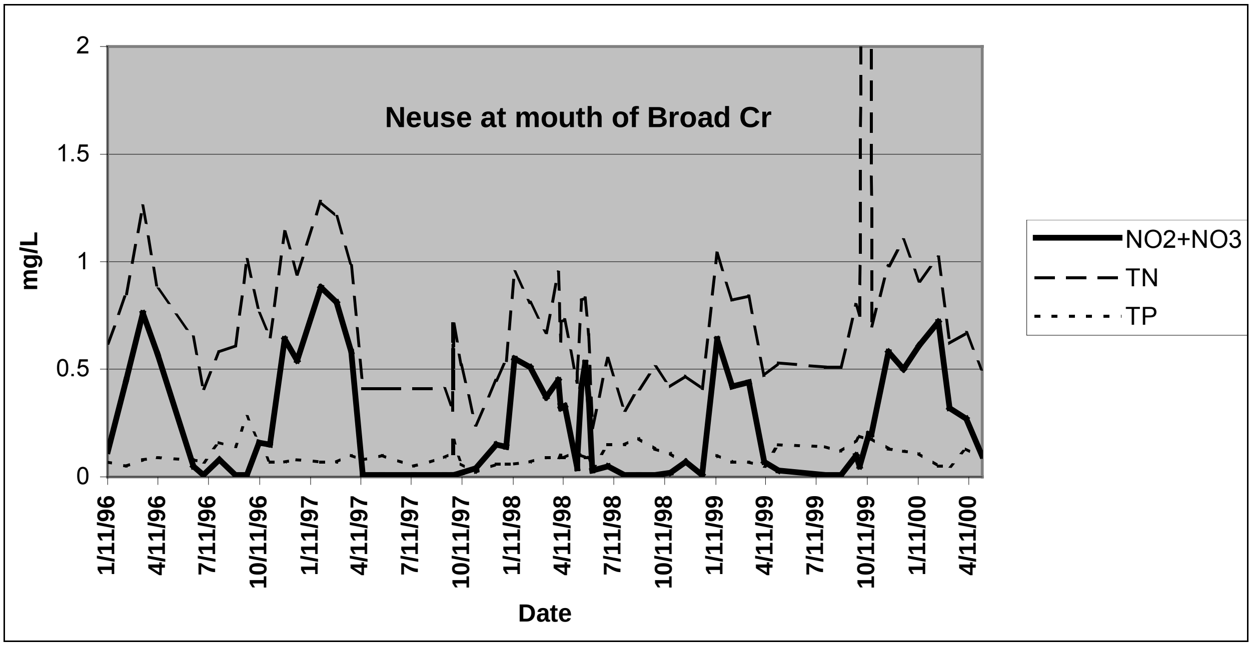


Figure 134. **Nitrate+nitrite, total nitrogen, and total phosphorus concentrations (mg/L) in the Neuse River at the mouth of Broad Creek near Thurman, 1996 - 2000.**

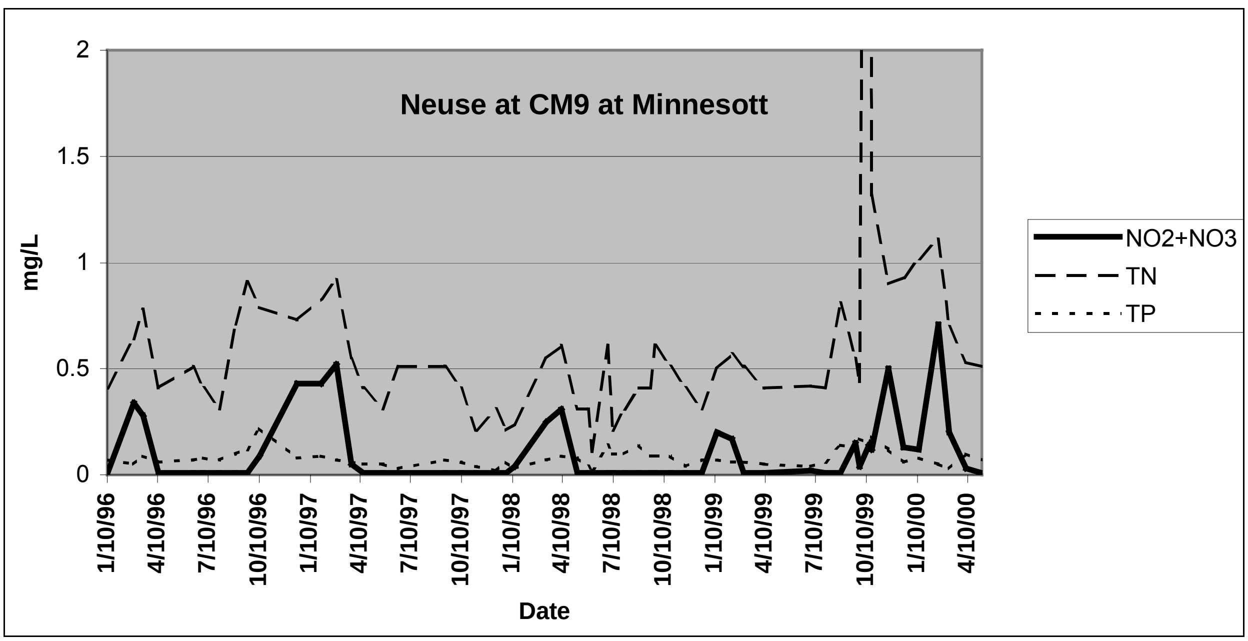


Figure 135. **Nitrate+nitrite, total nitrogen, and total phosphorus concentrations (mg/L) in the Neuse River at Channel Marker 9 near Minnesott Beach, 1996 - 2000.**

For Tables 43 to 66 station number and current stream classification on the left. Mainstem Neuse River stations are shaded. Column headers are:

- Min = Minimum,
- $10^{th\%}$-90^{th}% are percentiles of the data,
- Med = Median,
- Max = Maximum,
- Count = Number of values,
- # > D = Number greater than the minimum analytical reporting level,
- C = criterion (See 15A 2B.0200 Rules for complete interpretation),
- % > C is the percent of values greater than the stated criterion (values>10% are shaded),
- Geo. Mean = geometric mean of coliform values.

Table 43. Summary statistics for dissolved oxygen (mg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	1	6.5	7.225	8.92	10.525	12.12	15.1	48	48	5	2.1
J0810000-WSIV-NSW	Eno Riv at SR1004	5	5.928	6.45	8.1	9.9025	11.93	13.6	48	48	5	0
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	4.94	6.66	8.25	9.8	10.7	12.04	14.3	47	47	5	2.1
J0840000-WSII-NSW CA	Little Riv Reservoir	3.1	6	7.8	8.5	9.55	10.4	11.3	75	75	5	9.3
J1070000-WSII-NSW	Flat Riv nr Quail Roost	4.7	5.45	6.345	8.6	10.725	11.95	13.5	46	46	4.3	3.9
J1100000-WSIV-NSW	Flat Riv nr Willardsville	2.5	4.856	6.05	7.5	10.55	11.56	13	47	47	5	12.8
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	4.1	5.2	5.7225	6.95	9.1	10.33	11.5	48	48	5	6.2
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	3.3	5.676	6.7	8	9.7	10.52	13.9	49	49	5	4.1
J1890000-C-NSW	Neuse Riv nr Falls	5	7	7.4	8.7	11	12.04	14	49	49	5	0
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	3	5.95	6.925	8.05	10	11.85	17.4	46	46	5	2.2
J3000000-B-NSW	Crabtree Cr nr Raleigh	5	6	6.9	7.975	9.975	11.56	13.3	46	46	5	0
J3251000-C-NSW	Crabtree Cr at SR2000	5.5	5.882	6.6	7.78	9.12	11.12	12.95	17	17	5	0
J3290000-C-NSW	Crabtree Cr at U Hwy 1	5.7	6.28	7	8.25	10.075	11.18	13.5	28	28	5	0
J3300000-C-NSW	Pigeon House Cr	5.1	6.296	7.25	8.25	9.55	11.03	16.2	48	48	5	0
J4170000-WSIV-NSW	Neuse Riv nr Clayton	4.7	6	6.375	7.65	9.625	10.95	11.6	56	56	5	1.8
J4370000-WSIV-NSW	Neuse Riv at Smithfield	5.58	6	6.55	8.2	9.68	10.2	11.3	41	41	5	0
J4510000-C-NSW	Swift Cr nr Clayton	5	5.36	6.05	7	9	10.136	10.9	45	45	5	0
J5000000-C-NSW	Middle Cr nr Clayton	4.6	5.53	6.4	7.4	9.6	10.712	12.1	45	45	5	4.4
J5850000-WSV-NSW	Little Riv nr Princeton	1.1	5	6.185	7.3	9	10.408	11.7	43	43	5	9.3
J5970000-C-NSW	Neuse Riv nr Goldsboro	0.8	4.89	6	7	9.4625	10.88	12	40	40	5	12.5
J6150000-C-NSW	Neuse Riv at Kinston	0.4	4.01	5.55	7	8.8	9.88	12.3	52	52	5	17.3
J6740000-WSV-NSW	Contentnea Cr nr Lucama	2.7	4.003	5.55	7.5	9.5	10.482	12.5	52	52	5	19.2
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	2.9	3.56	4.3	6.3	8	10.4	12.4	49	49	NA	NA
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	1.7	2.38	3.5	6.2	7.7	9.56	12	49	49	NA	NA
J7810000-C Sw -NSW	Contentnea Cr at Grifton	0.3	2.96	4.6	5.95	7.85	9.33	12.1	48	48	NA	NA
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	2.8	3.78	5.4	6.8	8.175	10.64	15.2	42	42	NA	NA
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	5	5.35	6	6.85	8.325	9.5	11.1	36	36	NA	NA
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	4.7	5.12	6	7	9.25	10.49	14.2	42	42	NA	NA
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	0	0.3	1.5	4.2	7.7	8.6	12.6	51	51	NA	NA
J8210000-SC Sw -NSW	Swift Cr at mouth	2	3.42	4.85	6.75	8	10.89	11.9	38	38	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	0.1	1.27	1.8	2.75	6.475	7.94	9.5	20	20	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	3.6	4.8	5	8.3	10.1	11.1	13.5	21	21	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64	5.9	6.21	6.85	7.95	10.15	10.88	13.9	22	22	NA	NA
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	4.1	5	5.6	7	8.5	10.3	11.6	41	41	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	5	6.7	7.8	9.3	10.1	10.8	11.2	21	21	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	1.4	3.067	4.2	5.75	7.925	9.2	14.2	144	144	NA	NA
J8720000-C Sw -NSW	Trent Riv nr Oak Grove	0.1	2.04	3.1	4.6	7.2	9.02	12.6	125	125	NA	NA
J8730000-C Sw -NSW	Trent Riv at Pollocksville	0.1	3	3.8	4.8	7	8.66	10	135	135	NA	NA
J8770000-C Sw -NSW	Trent Riv nr Rhems	2.8	4.79	6.125	7.55	9.05	9.67	11.5	34	34	NA	NA
J8900800-C Sw -NSW	Neuse Riv at CM22	2	5	7.7	8.7	10.1	10.8	11.7	41	41	NA	NA
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	5	6.48	7.5	9.4	10.7	11.2	13.2	37	37	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17	3.3	7	8	9.65	11.35	12.8	13.1	22	22	NA	NA
J8903600-SB Sw -NSW	Neuse Riv at CM15	4	6.82	7.55	9.5	11.825	13.11	14.1	24	24	NA	NA
J8910000-SB Sw -NSW	Neuse Riv at CM11	1	6.53	8	9.75	10.85	11.78	13.4	44	44	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch	3.9	6.46	7.975	9.85	12.1	13.4	13.6	24	24	NA	NA
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe	4.2	6.6	7.85	10.25	11.65	12.5	15.4	26	26	NA	NA
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt	4.4	5.6	7.8	10.15	11.45	12.9	14.9	26	26	NA	NA
J9530000-SA -NSW	Neuse Riv at CM9	0	5.789	7.125	9	10.448	12.01	13.4	50	50	5	10
J9540000-SA -NSW	Neuse Riv nr Pierce	4.7	5.66	7.85	9.65	12.225	13.06	14.9	24	24	5	4.3
J9590000-SA -NSW	Neuse Riv nr Janeiro	4.9	6.65	7.9	10.3	11.4	13.2	14.9	26	26	5	3.8
J9685000-SA-NSW	Neuse Riv nr Merrimon	5.2	6.75	7.625	10.2	11.9	13.6	18.1	26	26	5	0
J9690000-SA -NSW	Back Cr nr Merrimon	0	1.98	3.225	5.15	7.175	9.07	11.8	40	40	5	47.5
J9810000-SA -NSW	Neuse Riv nr Oriental	4	6.85	7.325	8.85	10	11.85	14.4	36	36	5	2.8
J9860000-SA -NSW	Neuse Riv nr Cockle Pt	6.8	7.01	7.95	10.15	11	12.77	13.4	22	22	5	0
J9900000-SA-NSW	Neuse Riv nr Piney Pt	6.5	7.05	7.675	9.7	10.775	11.72	12.7	20	20	5	0
J9930000-SA -NSW	Neuse Riv at mouth	7.9	8.3	8.4	9.1	11.5	12.3	12.4	11	11	5	0
J9938000-SA -NSW	West Thorofare Bay at CM10	5	6.82	7.3	8.1	10	10.88	11.5	33	33	5	0
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	3.2	5.94	6.525	7.85	9.325	10.39	11.2	38	38	5	5.3
J9950000-SA -NSW	Bay Riv at CM5	6	7	7.55	8.6	9.95	11.17	11.9	24	24	5	0

Table 44. Summary statistics for pH (s.u.) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	85th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	6	6.52	7	7.2	7.4	7.5	8	47	47	6-9	0
J0810000-WSIV-NSW	Eno Riv at SR1004	6	6.2	7	7.2	7.4	7.5	7.9	45	45	6-9	0
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	6	6.7	7	7.3	7.5	7.7	8	45	45	6-9	0
J0840000-WSII-NSW CA	Little Riv Reservoir	5.5	6.19	6.84	7.1	7.4	7.8	8.9	74	74	6-9	2.7
J1070000-WSII-NSW	Flat Riv nr Quail Roost	5.5	6.44	6.9	7	7.2	7.3	7.3	45	45	6-9	2.2
J1100000-WSIV-NSW	Flat Riv nr Willardsville	6	6.05	6.605	6.93	7.1	7.2	7.4	46	46	6-9	0
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	6	6	6.56	6.94	7.09	7.2	7.6	45	45	6-9	0
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	6	6.9	7	7.3	7.5	7.7	8.2	47	47	6-9	0
J1890000-C-NSW	Neuse Riv nr Falls	6	6.6	6.8675	7	7.2	7.293	7.7	48	48	6-9	0
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	6	6.19	6.615	7	7.0975	7.2	8.08	46	46	6-9	0
J3000000-B-NSW	Crabtree Cr nr Raleigh	6	6.25	6.8	7	7.3	7.5	8	46	46	6-9	0
J3251000-C-NSW	Crabtree Cr at SR2000	6.7	6.768	6.9	7.1	7.16	7.216	7.3	17	17	6-9	0
J3290000-C-NSW	Crabtree Cr at U Hwy 1	6	6.42	6.95	7	7.2	7.34	7.4	27	27	6-9	0
J3300000-C-NSW	Pigeon House Cr	6	6.8	7	7.22	7.4	7.5	8.8	47	47	6-9	0
J4170000-WSIV-NSW	Neuse Riv nr Clayton	5	6.5	6.7	7	7.1	7.2	7.3	53	53	6-9	0
J4370000-WSIV-NSW	Neuse Riv at Smithfield	6	6.1	6.8	7.05	7.2	7.3	7.33	41	41	6-9	0
J4510000-C-NSW	Swift Cr nr Clayton	6	6.34	6.8	7	7.02	7.2	7.6	45	45	6-9	0
J5000000-C-NSW	Middle Cr nr Clayton	6	6.28	6.8	7	7.2	7.3	7.43	45	45	6-9	0
J5850000-WSV-NSW	Little Riv nr Princeton	6	6	6.55	6.9	7	7.1	7.4	43	43	6-9	0
J5970000-C-NSW	Neuse Riv nr Goldsboro	6	6.49	6.775	6.9	7	7.101	7.43	40	40	6-9	0
J6150000-C-NSW	Neuse Riv at Kinston	5	6	6.375	6.7	7	7.1	7.5	52	52	6-9	9.6
J6740000-WSV-NSW	Contentnea Cr nr Lucama	6	6	6.6	6.9	7	7.056	7.3	53	53	6-9	0
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	5	5.2	5.975	6.3	6.7	6.93	7.2	48	48	NA	NA
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	5	5.94	6.2	6.5	6.7	6.92	8.8	49	49	NA	NA
J7810000-C Sw -NSW	Contentnea Cr at Grifton	4	5.26	5.9	6.3	6.6	6.8	7.1	47	47	NA	NA
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	5	6	6.1	6.5	6.8	6.9	7.1	41	41	NA	NA
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	6	6	6.9	7.1	7.625	8	8.3	36	36	NA	NA
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	6	6	6.65	6.9	7.35	7.94	8.5	44	44	NA	NA
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	4	5.2	5.6	6	6.35	6.6	8.9	51	51	NA	NA
J8210000-SC Sw -NSW	Swift Cr at mouth	6	6	6.625	6.9	7.375	7.73	8.2	38	38	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	5.8	6.09	6.1	6.6	6.925	7.1	7.7	20	20	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	6.6	6.8	6.9	7	7.1	7.2	7.7	21	21	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64	6.7	6.81	6.9	7.15	7.4	7.69	8.1	22	22	NA	NA
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	6	6	6.6	7	7.3	7.5	8.2	41	41	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	6.6	6.7	6.8	7.1	7.4	7.6	8.6	21	21	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	4.61	6	6	6.6	7	7.2	7.6	142	142	NA	NA
J8720000-C Sw -NSW	Trent Riv nr Oak Grove	5.4	6	6.2	6.7	7.1	7.2	7.6	127	127	NA	NA
J8730000-C Sw -NSW	Trent Riv at Pollocksville	5.4	6	6.15	6.7	7.1	7.3	7.3	135	135	NA	NA
J8770000-C Sw -NSW	Trent Riv nr Rhems	5.9	6.15	6.825	7.05	7.5	7.91	8.7	34	34	NA	NA
J8900800-C Sw -NSW	Neuse Riv at CM22	6	6.16	7	7.5	8	8.3	9.3	41	41	NA	NA
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	5.9	6	7	7.6	8	8.54	9	37	37	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17	7.5	7.9	8	8.2	8.6	8.79	9.2	22	22	NA	NA
J8903600-SB Sw -NSW	Neuse Riv at CM15	7.3	7.6	7.9	8.1	8.6	8.74	9.2	24	24	NA	NA
J8910000-SB Sw -NSW	Neuse Riv at CM11	6	6.9	7.2	7.9	8.2	8.5	9.3	44	44	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch	7.3	7.9	7.9	8.2	8.6	8.6	9.6	24	24	NA	NA
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe	7.3	7.45	7.825	8	8.3	8.6	9.4	26	26	NA	NA
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt	7.3	7.5	7.825	8	8.5	8.65	9.3	26	26	NA	NA
J9530000-SA -NSW	Neuse Riv at CM9	5	6.7	7.3	7.8	8.2	8.4	9.3	48	48	6.8-8.5	12.5
J9540000-SA -NSW	Neuse Riv nr Pierce	7.3	7.8	7.9	8	8.4	8.5	9.6	24	24	6.8-8.5	8.3
J9590000-SA -NSW	Neuse Riv nr Janeiro	7.2	7.9	7.925	8	8.2	8.5	9.4	26	26	6.8-8.5	7.7
J9685000-SA-NSW	Neuse Riv nr Merrimon	7.1	7.55	7.9	8	8.275	8.5	8.9	26	26	6.8-8.5	3.8
J9690000-SA -NSW	Back Cr nr Merrimon	6	6	6.7	7	7.1	7.3	7.7	41	41	6.8-8.5	36.6
J9810000-SA -NSW	Neuse Riv nr Oriental	6.7	7	7	7.75	8	8.35	9.2	36	36	6.8-8.5	5.5
J9860000-SA -NSW	Neuse Riv nr Cockle Pt	7.6	7.61	7.7	7.8	7.9	7.99	8.3	22	22	6.8-8.5	0
J9900000-SA-NSW	Neuse Riv nr Piney Pt	7.1	7.3	7.6	7.8	7.925	8.1	8.1	20	20	6.8-8.5	0
J9930000-SA -NSW	Neuse Riv at mouth	7.8	7.8	7.9	8.1	8.15	8.2	8.5	11	11	6.8-8.5	0
J9938000-SA -NSW	West Thorofare Bay at CM10	7	7	7.45	7.7	7.825	8	8	32	32	6.8-8.5	0
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	6.3	7	7.4	7.7	7.7	7.9	8.1	37	37	6.8-8.5	5.4
J9950000-SA -NSW	Bay Riv at CM5	7	7.06	7.6	7.85	8.025	8.1	8.3	24	24	6.8-8.5	0

Table 45. Summary statistics for specific conductance (µmhos/cm) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	50	72.1	100	128.5	170.75	241.7	346	48	48	NA	NA
J0810000-WSIV-NSW	Eno Riv at SR1004	52	80	101.75	126.5	170.5	230.3	313	48	48	NA	NA
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	49	53.8	70	80	92	100.6	110	45	45	NA	NA
J0840000-WSII-NSW CA	Little Riv Reservoir	39	52	59	68	77	90.2	250	75	75	NA	NA
J1070000-WSII-NSW	Flat Riv nr Quail Roost	40	48.5	61	75.5	89.5	96	120	46	46	NA	NA
J1100000-WSIV-NSW	Flat Riv nr Willardsville	35	49.5	51.25	64.5	76.5	84	109	46	46	NA	NA
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	50	116.3	138.5	247	462	872.8	1330	48	48	NA	NA
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	98	144.4	230	322	369	428.4	590	49	49	NA	NA
J1890000-C-NSW	Neuse Riv nr Falls	17	57.4	65	79	100	103.4	180	49	49	NA	NA
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	35	60	63.5	86	109.5	160.8	368	47	47	NA	NA
J3000000-B-NSW	Crabtree Cr nr Raleigh	45	76	100	148	207	347	473	47	47	NA	NA
J3251000-C-NSW	Crabtree Cr at SR2000	68	101.6	129	170	183	231.4	277	17	17	NA	NA
J3290000-C-NSW	Crabtree Cr at U Hwy 1	51	70.7	81.5	101	116	140.3	191	28	28	NA	NA
J3300000-C-NSW	Pigeon House Cr	70	154.9	221.5	274	310.5	331.3	1880	48	48	NA	NA
J4170000-WSIV-NSW	Neuse Riv nr Clayton	51	70.5	79	127.5	177	212.5	244	56	56	NA	NA
J4370000-WSIV-NSW	Neuse Riv at Smithfield	45	73	85	120	152	198	210	41	41	NA	NA
J4510000-C-NSW	Swift Cr nr Clayton	35	48.4	55	71	90	95.6	245	45	45	NA	NA
J5000000-C-NSW	Middle Cr nr Clayton	35	75.4	90	121	162	326.2	530	45	45	NA	NA
J5850000-WSV-NSW	Little Riv nr Princeton	35	45.2	55	70	78	95	120	43	43	NA	NA
J5970000-C-NSW	Neuse Riv nr Goldsboro	52	67.9	72.75	110.5	145.5	181.4	205	40	40	NA	NA
J6150000-C-NSW	Neuse Riv at Kinston	36	57	69.5	92	127.5	156	1903	51	51	NA	NA
J6740000-WSV-NSW	Contentnea Cr nr Lucama	30	41.1	50	60	70.25	80	710	52	52	NA	NA
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	33	56.8	69	83.5	106	121.1	139	50	50	NA	NA
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	38	61.4	76	98	135	159	203	49	49	NA	NA
J7810000-C Sw -NSW	Contentnea Cr at Grifton	36	57.4	67.75	82	109.25	132.8	172	48	48	NA	NA
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	10	55.2	79.5	107	136	161	1200	43	43	NA	NA
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	50	79.5	97.5	122	136.75	169.5	198	36	36	NA	NA
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	11	73.1	96.25	114.5	135.75	182.1	195	40	40	NA	NA
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	31	40	49	63	80	111	128	51	51	NA	NA
J8210000-SC Sw -NSW	Swift Cr at mouth	11	76.7	110	140	173.75	201	1115	38	38	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	70	71.8	81.5	108	127.5	141.5	176	20	20	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	11	113	119	132	156	159	169	21	21	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64	81	94.1	111.25	154	204	251.9	414	22	22	NA	NA
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	55	93.2	116	142	192	660.4	3317	37	37	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	101	122	143	202	470	1357	2190	21	21	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	34	70.2	97	130	177.5	211.6	284	143	143	NA	NA
J8720000-C Sw -NSW	Trent Riv nr Oak Grove	62	94.4	118	151	195	214	261	125	125	NA	NA
J8730000-C Sw -NSW	Trent Riv at Pollocksville	49	87.2	120.75	161	206.75	226.7	227	134	134	NA	NA
J8770000-C Sw -NSW	Trent Riv nr Rhems	112	128.5	158.25	208	694.25	3244.4	14306	34	34	NA	NA
J8900800-C Sw -NSW	Neuse Riv at CM22	50	102.4	146	887	3780	7256.2	16585	37	37	NA	NA
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	84	169.6	720	2280	8130	12480	21052	37	37	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17	103	1197.2	2397.5	5201	11486	17963	23066	22	22	NA	NA
J8903600-SB Sw -NSW	Neuse Riv at CM15	87	2622.4	3773	7060.5	10394	18728	23967	24	24	NA	NA
J8910000-SB Sw -NSW	Neuse Riv at CM11	91	719.3	3526.5	5837.5	11700	14498	25997	44	44	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch	93	5986.9	8602.5	9560	17087	20524	26578	24	24	NA	NA
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe	109	7251	9373.5	11480	19261	20641	27297	26	26	NA	NA
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt	162	9225.5	10507	11917	20092	21706	27824	26	26	NA	NA
J9530000-SA -NSW	Neuse Riv at CM9	413	3770.5	7423.8	9870.5	15800	22242	29118	46	46	NA	NA
J9540000-SA -NSW	Neuse Riv nr Pierce	168	10959	12826	13785	20576	24782	29369	24	24	NA	NA
J9590000-SA -NSW	Neuse Riv nr Janeiro	196	8265	12980	14934	20267	24981	29732	26	26	NA	NA
J9685000-SA-NSW	Neuse Riv nr Merrimon	348	10684	14278	15523	21928	26323	30371	26	26	NA	NA
J9690000-SA -NSW	Back Cr nr Merrimon	10	319.3	1975	5035	17043	25352	39420	42	42	NA	NA
J9810000-SA -NSW	Neuse Riv nr Oriental	1112	7915.4	11400	14545	20350	25216	30362	33	33	NA	NA
J9860000-SA -NSW	Neuse Riv nr Cockle Pt	14944	17345	17897	21406	25106	26993	31065	22	22	NA	NA
J9900000-SA-NSW	Neuse Riv nr Piney Pt	15740	17494	18355	20980	26632	29916	31991	20	20	NA	NA
J9930000-SA -NSW	Neuse Riv at mouth	12510	14720	17350	20290	22715	24320	26850	11	11	NA	NA
J9938000-SA -NSW	West Thorofare Bay at CM10	12720	14998	18190	24042	26700	30080	35252	33	33	NA	NA
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	15300	17330	23000	27700	34000	40860	54520	37	37	NA	NA
J9950000-SA -NSW	Bay Riv at CM5	9594	11328	16333	20586	23795	25333	29128	24	24	NA	NA

Table 46. Summary statistics for temperature (⁰C)from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	2	5.56	10.8	16.05	23.375	26.96	28.5	48	48	NA	NA
J0810000-WSIV-NSW	Eno Riv at SR1004	3.1	8	10.8	16.25	25	27.06	28.9	48	48	NA	NA
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	2.9	6.05	9.05	15.4	22.975	26.35	29	46	46	NA	NA
J0840000-WSII-NSW CA	Little Riv Reservoir	3	7	11.5	20.1	27	28.6	29.8	75	75	NA	NA
J1070000-WSII-NSW	Flat Riv nr Quail Roost	2.6	6.5	10.425	15	23	26.5	28	46	46	NA	NA
J1100000-WSIV-NSW	Flat Riv nr Willardsville	4.5	6.68	10.4	16.1	23	26.46	29	47	47	NA	NA
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	4.1	8.85	11.925	18.95	25	26.96	29.5	48	48	NA	NA
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	7.1	9.98	11.8	18	25	26.2	28.4	49	49	NA	NA
J1890000-C-NSW	Neuse Riv nr Falls	3.8	7.18	11	21	25	28.2	119	49	49	NA	NA
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	4.8	6	13.2	20	24.1	28	29.5	47	47	NA	NA
J3000000-B-NSW	Crabtree Cr nr Raleigh	5.9	7.12	12.85	19	23.8	26	28	47	47	NA	NA
J3251000-C-NSW	Crabtree Cr at SR2000	11.3	13.42	16.7	21.2	23.1	25.24	26	17	17	NA	NA
J3290000-C-NSW	Crabtree Cr at U Hwy 1	5.1	6.56	11.9	18.1	22.075	26	27.9	28	28	NA	NA
J3300000-C-NSW	Pigeon House Cr	8	10	13.725	18.5	23.025	27.03	28.7	48	48	NA	NA
J4170000-WSIV-NSW	Neuse Riv nr Clayton	5	8	11.825	18.65	24.25	27	28	56	56	NA	NA
J4370000-WSIV-NSW	Neuse Riv at Smithfield	5.2	8.1	12.3	18	25	26.1	29.5	41	41	NA	NA
J4510000-C-NSW	Swift Cr nr Clayton	4	7.72	12	18	24	27	28	45	45	NA	NA
J5000000-C-NSW	Middle Cr nr Clayton	3.1	7.46	11	19.6	23.7	25	27	45	45	NA	NA
J5850000-WSV-NSW	Little Riv nr Princeton	2.3	8	11.9	19.5	25	27.8	29.1	43	43	NA	NA
J5970000-C-NSW	Neuse Riv nr Goldsboro	2	7.92	11.3	22	25.4	28	29.4	39	39	NA	NA
J6150000-C-NSW	Neuse Riv at Kinston	2	9.84	13.5	18	25	28	30.7	53	53	NA	NA
J6740000-WSV-NSW	Contentnea Cr nr Lucama	3	7.76	13	19	25.2	28.26	30	53	53	NA	NA
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	1	8.9	11.025	17	24.775	26.19	28.3	50	50	NA	NA
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	0	9	12.6	18	23	26.12	27.1	49	49	NA	NA
J7810000-C Sw -NSW	Contentnea Cr at Grifton	2	9	11.9	18.5	25	27.06	28.8	48	48	NA	NA
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	3	10.06	11.5	17	26	27.94	70	43	43	NA	NA
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	8.4	11.85	15.7	21.95	26.85	27.95	31	36	36	NA	NA
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	2.8	7.32	11.75	18.65	25.7	28.04	30.8	44	44	NA	NA
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	3	8.5	12.1	17	22.85	25.6	27	51	51	NA	NA
J8210000-SC Sw -NSW	Swift Cr at mouth	5	9	13.25	19.35	25	28.9	31	38	38	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	9	9	14.75	18.5	25.425	26.46	27	20	20	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	4	7.3	9.7	19.6	25.1	27.6	27.7	21	21	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64	5.9	8.9	11.05	14.6	25.35	28.36	30.7	22	22	NA	NA
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	4	8.1	13	19	26	28.6	30.5	41	41	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	3	7.7	10.8	17.3	24.2	28.1	28.6	21	21	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	3	9	12.75	19	23.15	25	27.5	143	143	NA	NA
J8720000-C Sw -NSW	Trent Riv nr Oak Grove	4	10	14	20.7	25	27	29.2	125	125	NA	NA
J8730000-C Sw -NSW	Trent Riv at Pollocksville	4	10.76	14.3	21	25.75	28	90	135	135	NA	NA
J8770000-C Sw -NSW	Trent Riv nr Rhems	5	11.45	14.15	21.3	26.875	29.7	30.5	34	34	NA	NA
J8900800-C Sw -NSW	Neuse Riv at CM22	3	9.2	13	20	26	28.2	31.7	41	41	NA	NA
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	3	9.42	13	21.4	25.7	28.58	30	37	37	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17	7.9	8.5	9.25	16.45	26.05	27.99	30.5	22	22	NA	NA
J8903600-SB Sw -NSW	Neuse Riv at CM15	7.1	8.6	10.925	18.55	27.325	28.4	32	24	24	NA	NA
J8910000-SB Sw -NSW	Neuse Riv at CM11	3	10.3	15.525	23	26.925	28.41	30.7	44	44	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch	7.6	8.6	11	18.7	27.025	28.27	30.5	24	24	NA	NA
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe	7.8	8.9	11.9	15.95	26.3	28.25	31.5	26	26	NA	NA
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt	7.7	8.7	11.925	15.95	26.2	28.4	30.6	26	26	NA	NA
J9530000-SA -NSW	Neuse Riv at CM9	4	9.92	15	18.3	25.75	27.91	30.1	50	50	NA	NA
J9540000-SA -NSW	Neuse Riv nr Pierce	7.9	8.6	11.075	18.2	26.925	28	29.7	24	24	NA	NA
J9590000-SA -NSW	Neuse Riv nr Janeiro	7.5	8.4	11.9	15.8	26.6	28.1	29.5	26	26	NA	NA
J9685000-SA-NSW	Neuse Riv nr Merrimon	7.6	8.5	11.9	15.35	26.5	28	30	26	26	NA	NA
J9690000-SA -NSW	Back Cr nr Merrimon	8	11.1	15.85	21.95	28.15	29.92	32.9	42	42	NA	NA
J9810000-SA -NSW	Neuse Riv nr Oriental	2	8.4	11.75	20.95	26.125	27.9	29.9	36	36	NA	NA
J9860000-SA -NSW	Neuse Riv nr Cockle Pt	7.2	7.8	8.975	14.05	25.125	28.1	29.5	22	22	NA	NA
J9900000-SA-NSW	Neuse Riv nr Piney Pt	7.3	11.41	12.45	16.4	27.2	27.89	29.6	20	20	NA	NA
J9930000-SA -NSW	Neuse Riv at mouth	4	8.4	10.6	21.9	26.65	27.5	28.5	11	11	NA	NA
J9938000-SA -NSW	West Thorofare Bay at CM10	5.9	9.54	12.3	19.9	27	28.44	29.5	33	33	NA	NA
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	5.4	10.87	13.025	20.45	26	28.15	29.7	38	38	NA	NA
J9950000-SA -NSW	Bay Riv at CM5	4	12.04	16.375	26.5	27.5	27.84	31.5	24	24	NA	NA

Table 47. Summary statistics for total suspended solids (mg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<1	1	4	6	14.25	39.5	53	50	48	NA	NA
J0810000-WSIV-NSW	Eno Riv at SR1004	<1	3	5.5	9	15	44	130	51	49	NA	NA
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<1	1	1	3	6.5	19.2	370	47	37	NA	NA
J0840000-WSII-NSW CA	Little Riv Reservoir	<1	1	3	4	8	10.4	100	69	63	NA	NA
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<1	1	3	5	9	15	460	51	49	NA	NA
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<1	2.8	5	7	10	14.4	32	49	48	NA	NA
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<1	3.2	5	9	18	47.6	190	53	52	NA	NA
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	1	2	4	8	16.5	31	500	51	51	NA	NA
J1890000-C-NSW	Neuse Riv nr Falls	<1	1.6	2	5	7	9	13	47	45	NA	NA
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<1	4.8	9	13	17	26.2	39	50	49	NA	NA
J3000000-B-NSW	Crabtree Cr nr Raleigh	<1	1	3	7	14	42.8	96	49	44	NA	NA
J3290000-C-NSW	Crabtree Cr at U Hwy 1	1	5	7	10	18.75	42.8	100	34	34	NA	NA
J3300000-C-NSW	Pigeon House Cr	<1	1	1	3	6.25	17.9	430	52	38	NA	NA
J4170000-WSIV-NSW	Neuse Riv nr Clayton	1	6	9	12	20	47	100	58	58	NA	NA
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<1	7.6	11.5	16	27.5	43.2	150	47	45	NA	NA
J4510000-C-NSW	Swift Cr nr Clayton	<1	1.5	3	6	10.75	20	230	46	44	NA	NA
J5000000-C-NSW	Middle Cr nr Clayton	<1	1	2	5.5	10	18.5	56	48	45	NA	NA
J5850000-WSV-NSW	Little Riv nr Princeton	<1	1	1	3	5	8.6	60	48	40	NA	NA
J5970000-C-NSW	Neuse Riv nr Goldsboro	1	5.5	8	12.5	16.75	30.5	97	46	46	NA	NA
J6150000-C-NSW	Neuse Riv at Kinston	<1	2	4	7	13.75	16.7	120	54	52	NA	NA
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<1	1	2	5	7.5	11.2	51	59	55	NA	NA
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<1	1	2	4.5	7	10	28	48	47	NA	NA
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<1	1	1	3	5	7	28	51	44	NA	NA
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<1	1	2	4	7	10	20	53	49	NA	NA
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	1	2	3.75	7	10	12	17	48	48	NA	NA
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<1	1	2.5	5	8	12.4	21	43	41	NA	NA
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<1	1	1	2	6	8	21	57	48	NA	NA
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<1	1	2	5	9	14	24	51	46	NA	NA
J8210000-SC Sw -NSW	Swift Cr at mouth	<1	1	1	2	4	7.6	26	55	49	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<1	1	2	4	5	5.8	6	13	12	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<1	1	1	3	5	7	15	50	41	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64											
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<1	1	1	3	5	8	26	56	52	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<1	1	2	4	6	8	15	53	49	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	<1	1	1	1	3	5.6	18	65	45	NA	NA
J8720000-C Sw -NSW	Trent Riv nr Oak Grove	<1	1	1	2	6	8	9	22	16	NA	NA
J8730000-C Sw -NSW	Trent Riv at Pollocksville	1	1	1.5	5	11	18.6	58	15	15	NA	NA
J8770000-C Sw -NSW	Trent Riv nr Rhems	<1	1	1	2	4	7.4	39	47	42	NA	NA
J8900800-C Sw -NSW	Neuse Riv at CM22	<1	1	2	5	7	11.1	24	50	46	NA	NA
J8902500-SB Sw -NSW	Neuse Riv at Thurman	<1	1	3	5	9	12	28	54	51	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17											
J8903600-SB Sw -NSW	Neuse Riv at CM15											
J8910000-SB Sw -NSW	Neuse Riv at CM11	<1	1	3	5.5	9.25	14.9	28	52	51	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch											
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe											
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt											
J9530000-SA -NSW	Neuse Riv at CM9	<1	1.8	4	6	12	19.2	28	49	48	NA	NA
J9540000-SA -NSW	Neuse Riv nr Pierce											
J9590000-SA -NSW	Neuse Riv nr Janeiro											
J9685000-SA-NSW	Neuse Riv nr Merrimon											
J9690000-SA -NSW	Back Cr nr Merrimon	<1	1	3.5	7	13.5	17	24	19	16	NA	NA
J9810000-SA -NSW	Neuse Riv nr Oriental	<1	1	4.5	7	15	22	53	51	48	NA	NA
J9860000-SA -NSW	Neuse Riv nr Cockle Pt											
J9900000-SA-NSW	Neuse Riv nr Piney Pt											
J9930000-SA -NSW	Neuse Riv at mouth	1	2.6	4	6	12.5	16.4	34	39	39	NA	NA
J9938000-SA -NSW	West Thorofare Bay at CM10	3	6.2	8	12	14	14	14	13	13	NA	NA
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	5	6.9	9	13.5	21	26.3	30	20	20	NA	NA
J9950000-SA -NSW	Bay Riv at CM5	2	4.5	6	7.5	17.75	22	36	26	26	NA	NA

Table 48. Summary statistics for fecal coliform bacteria (No. colonies/100 ml) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C	Geo. Mean
J0770000-WSIV-NSW	Eno Riv nr Durham	<10	10	10	44	160	627	5700	50	37	200	22	59
J0810000-WSIV-NSW	Eno Riv at SR1004	<10	10	20.25	68.5	185	885	4200	50	44	200	20	81
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<10	10	10	29	100	520	80000	47	31	200	14.9	45
J0840000-WSII-NSW CA	Little Riv Reservoir	<10	10	10	10	10	61.4	1000	69	21	200	25	16
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<10	10	27	45	82	290	3500	51	46	200	11.8	12
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<10	10	10	18	45	230	550	49	27	200	12.2	26
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<10	10.8	54	170	327.5	915	24000	52	47	200	42.3	151
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	<10	27	58.5	140	680	2900	30000	51	47	200	43	198
J1890000-C-NSW	Neuse Riv nr Falls	<10	10	10	10	18.5	38.7	180	48	20	200	0	15
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	9	10	10	27.5	70	309	770	50	50	200	16	37
J3000000-B-NSW	Crabtree Cr nr Raleigh	<10	10	10	45	120	308	600	49	38	200	16.3	45
J3251000-C-NSW	Crabtree Cr at SR2000	33	89.2	120	170	270	516	920	14	14	200	42.9	184
J3290000-C-NSW	Crabtree Cr at U Hwy 1	10	45	120	270	685	2800	5600	35	35	200	62.9	285
J3300000-C-NSW	Pigeon House Cr	9	140	330	810	2750	6900	14000	51	51	200	86.3	916
J4170000-WSIV-NSW	Neuse Riv nr Clayton	<10	18	27	68.5	122.5	353	1400	60	56	200	15	71
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<10	19.6	62	100	210	482	2000	49	47	200	26.5	110
J4510000-C-NSW	Swift Cr nr Clayton	<10	15.6	36	59.5	112.5	268	1100	48	45	200	14.6	64
J5000000-C-NSW	Middle Cr nr Clayton	<10	17.2	36	81.5	137.5	292	2000	50	46	200	16	75
J5850000-WSV-NSW	Little Riv nr Princeton	<10	10	18	45	91	398	2400	47	39	200	17	51
J5970000-C-NSW	Neuse Riv nr Goldsboro	<10	10	18.5	27	71	180	790	46	37	200	8.7	37
J6150000-C-NSW	Neuse Riv at Kinston	<10	10	18	36	102.5	265	1600	56	46	200	14.3	45
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<10	10	10	10	19.5	45	610	59	30	200	5.1	17
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<10	10	20	67	185	337	1700	52	47	200	23	65
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<10	10	27	70	110	208	3900	53	44	200	13.6	60
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<10	10	27	91	230	632	2500	55	50	200	28.6	93
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<10	10	10	27	54	155	2600	50	38	200	8	33
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<10	10	10	14	36	128	340	43	26	200	9..3	23
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<10	10	10	18	62	110	310	55	41	200	5.4	27
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<10	10	27	76.5	160	425	4300	54	47	200	24.1	78
J8210000-SC Sw -NSW	Swift Cr at mouth	<10	10	10	27	72.25	90.7	3700	54	40	200	9.2	34
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<10	23.5	27	45	64.25	82	220	20	18	200	5	42
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<10	10	10	19	36	83.8	1300	50	33	200	2	23
J8270000-SC Sw -NSW	Neuse Riv at CM64												
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<10	10	10	18	45	77.2	770	55	40	200	1.8	23
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<10	10	10	28.5	110	210	430	56	40	200	12.5	35
J8690000-C Sw -NSW	Trent Riv nr Trenton	<10	27	41.25	66.5	100	155	300	66	64	200	6.1	64
J8720000-C Sw -NSW	Trent Riv nr Oak Grove	9	15	18	36	91	160	880	21	21	200	4.8	46
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<10	33.3	41.25	54	177.5	269	800	18	17	200	22.2	77
J8770000-C Sw -NSW	Trent Riv nr Rhems	<10	10	10	10	30	114	900	47	24	200	4.2	19
J8900800-C Sw -NSW	Neuse Riv at CM22	<10	10	10	27	73	114	220	49	32	200	2	29
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	<10	10	10	10	19.5	59.1	110	54	22	200	0	15
J8903500-SB Sw -NSW	Neuse Rv at CM17												
J8903600-SB Sw -NSW	Neuse Riv at CM15												
J8910000-SB Sw -NSW	Neuse Riv at CM11	<10	10	10	10	10	19.8	100	52	13	200	0	12
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch												
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe												
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt												
J9530000-SA -NSW	Neuse Riv at CM9	<10	10	10	10	10	10	23	48	3	14	4.2	10
J9540000-SA -NSW	Neuse Riv nr Pierce												
J9590000-SA -NSW	Neuse Riv nr Janeiro												
J9685000-SA-NSW	Neuse Riv nr Merrimon												
J9690000-SA -NSW	Back Cr nr Merrimon	<10	18	38	80	195	382	3800	43	40	14	93	91
J9810000-SA -NSW	Neuse Riv nr Oriental	<10	10	10	10	10	10	100	50	1	14	0	10
J9860000-SA -NSW	Neuse Riv nr Cockle Pt												
J9900000-SA-NSW	Neuse Riv nr Piney Pt												
J9930000-SA -NSW	Neuse Riv at mouth	<10	10	10	10	10	10	10	39	0	14	0	10
J9938000-SA -NSW	West Thorofare Bay at CM10	<10	10	10	10	10	18	20	34	5	14	14.7	11
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<10	10	10	10	10	19.4	220	44	10	14	15.9	13
J9950000-SA -NSW	Bay Riv at CM5	<10	10	10	10	10	18	200	28	7	14	10.7	12

Table 49. Summary statistics for chloride (mg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	3	5	6.5275	8	9	11.1	25	50	50	250	0
J0810000-WSIV-NSW	Eno Riv at SR1004	4	5.351	7	8	9.795	12.2	22	50	50	250	0
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<1	4	4.745	5	6	6.048	8.67	47	45	250	0
J0840000-WSII-NSW CA	Little Riv Reservoir	2.85	3.301	4	5	6	7	8	68	68	250	0
J1070000-WSII-NSW	Flat Riv nr Quail Roost	3	4.41	5	6	7	7	10	51	51	250	0
J1100000-WSIV-NSW	Flat Riv nr Willardsville	1.96	4	4	5	6	6.12	84	48	48	250	0
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	3.92	12.442	24	42	120	178	320	53	53	250	0
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	3.92	16	23	32.64	42	51.5	60	50	50	250	0
J4170000-WSIV-NSW	Neuse Riv nr Clayton	3.43	6	10	14.28	19	21.6	26	45	45	250	0
J4370000-WSIV-NSW	Neuse Riv at Smithfield	3.92	6	9.5175	12	16	20	22	48	48	250	0
J5850000-WSV-NSW	Little Riv nr Princeton	4	4.287	5.88	7	8	10	56	48	48	250	0
J6740000-WSV-NSW	Contentnea Cr nr Lucama	3	4.8	5	6	7	8	8	19	19	250	0

Table 50. Summary statistics for manganese (mg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	15	26.7	35	50	78	94.5	240	50	50	200	2
J0810000-WSIV-NSW	Eno Riv at SR1004	31	43	51	71	120	172	270	49	49	200	6
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<10	11.5	19	25	36	55	850	46	44	200	2.3
J0840000-WSII-NSW CA	Little Riv Reservoir	23	32.4	44	70	90	180	400	69	69	200	7.2
J1070000-WSII-NSW	Flat Riv nr Quail Roost	18	24	32.5	44	91	150	600	51	51	200	5.9
J1100000-WSIV-NSW	Flat Riv nr Willardsville	16	54.4	66	110	200	330	1000	49	49	200	22.4
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	40	64	110	130	205	350	1700	51	51	200	23.5
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	24	42.6	60.5	82.5	99.75	150	560	50	50	200	4
J4170000-WSIV-NSW	Neuse Riv nr Clayton	30	52.8	68.5	110	115	152	200	7	7	200	0
J4370000-WSIV-NSW	Neuse Riv at Smithfield	62	75	84	95	140	160	340	47	47	200	6.4
J5850000-WSV-NSW	Little Riv nr Princeton	26	32	42	55	97	150	350	31	31	200	6.4
J6740000-WSV-NSW	Contentnea Cr nr Lucama	16	28.6	33.5	43	125.5	262	500	19	19	200	21

Table 51. Summary statistics for total residue (mg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	13	90.4	100	120	170	222	420	49	49	500	0
J0810000-WSIV-NSW	Eno Riv at SR1004	87	94	110	130	185	250	450	51	51	500	0
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	47	67.6	73.5	80	91	100	500	47	47	500	0
J0840000-WSII-NSW CA	Little Riv Reservoir	47	59	66	74	82.25	89.6	100	68	68	500	0
J1070000-WSII-NSW	Flat Riv nr Quail Roost	54	64	74	82	88	110	600	51	51	500	2
J1100000-WSIV-NSW	Flat Riv nr Willardsville	60	67.1	73	79	89	98	110	48	48	500	0
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	13	102	140	220	440	530	730	53	53	500	17
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	160	190	210	240	280	300	670	51	51	500	2
J3251000-C-NSW	Crabtree Cr at SR2000	110	123	130	145	160	170	750	14	14	NA	NA
J4170000-WSIV-NSW	Neuse Riv nr Clayton	85	100	120	140	157.5	160	240	46	46	500	0
J4370000-WSIV-NSW	Neuse Riv at Smithfield	90	98	110	130	140	160	270	49	49	500	0
J5850000-WSV-NSW	Little Riv nr Princeton	54	65.8	70	79	88	95.4	180	49	49	500	0
J6740000-WSV-NSW	Contentnea Cr nr Lucama	53	71.8	76.25	79.5	84	90.2	110	18	18	500	0
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	72	77.3	84.25	96.5	110	120	130	34	34	NA	NA

Table 52. Summary statistics for total coliform bacteria (No. colonies/100 ml) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C	Geo. Mean
J0810000-WSIV-NSW	Eno Riv at SR1004	<10	120	215	570	2400	8400	56000	47	46	NA	NA	757
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<10	52.2	105	200	505	2340	1E+05	47	45	NA	NA	278
J0840000-WSII-NSW CA	Little Riv Reservoir	9	10	10	25.5	132.5	386	3200	68	NA	NA	33.8	39
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<10	80.1	130	290	537.5	1350	11000	50	48	NA	NA	298
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<10	36	58.5	140	375	696	4100	47	44	NA	NA	143
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	66	550	840	2150	7450	22400	65000	50	50	NA	NA	2562
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	<10	384	790	2700	6400	40600	94000	49	48	NA	NA	2869
J4170000-WSIV-NSW	Neuse Riv nr Clayton	80	223	280	475	1325	6180	36000	44	44	NA	NA	717
J4370000-WSIV-NSW	Neuse Riv at Smithfield	56	320	400	700	2850	6660	27000	47	47	NA	NA	1143
J5850000-WSV-NSW	Little Riv nr Princeton	<10	110	222.5	335	695	4250	22000	46	45	NA	NA	471
J6740000-WSV-NSW	Contentnea Cr nr Lucama	27	36	45	95	185	276	2400	15	15	NA	NA	104

Table 53. Summary statistics for ammonia (mg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<0.01	0.01	0.02	0.05	0.08	0.113	0.46	50	40	NA	NA
J0810000-WSIV-NSW	Eno Riv at SR1004	<0.01	0.01	0.01	0.04	0.07	0.09	0.26	51	37	NA	NA
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<0.01	0.01	0.01	0.02	0.05	0.074	0.16	47	28	NA	NA
J0840000-WSII-NSW CA	Little Riv Reservoir	<0.01	0.01	0.01	0.03	0.09	0.136	0.33	69	58	NA	NA
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<0.01	0.01	0.01	0.02	0.07	0.12	0.32	51	34	NA	NA
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<0.01	0.01	0.02	0.06	0.14	0.212	0.73	49	42	NA	NA
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<0.01	0.04	0.08	0.15	0.2	0.292	0.93	53	52	NA	NA
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	<0.01	0.01	0.04	0.11	0.17	0.49	1.6	51	48	NA	NA
J1890000-C-NSW	Neuse Riv nr Falls	<0.01	0.01	0.03	0.08	0.12	0.22	0.36	49	41	NA	NA
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<0.01	0.01	0.04	0.1	0.14	0.23	0.59	51	44	NA	NA
J3000000-B-NSW	Crabtree Cr nr Raleigh	<0.01	0.01	0.0125	0.055	0.11	0.14	0.46	50	42	NA	NA
J3251000-C-NSW	Crabtree Cr at SR2000	<0.01	0.033	0.07	0.11	0.15	0.219	0.27	14	13	NA	NA
J3290000-C-NSW	Crabtree Cr at U Hwy 1	<0.01	0.01	0.04	0.07	0.08	0.126	0.16	35	32	NA	NA
J3300000-C-NSW	Pigeon House Cr	<0.01	0.01	0.04	0.09	0.1175	0.198	0.43	50	44	NA	NA
J4170000-WSIV-NSW	Neuse Riv nr Clayton	<0.01	0.01	0.03	0.06	0.09	0.127	0.61	154	141	NA	NA
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<0.01	0.01	0.0175	0.05	0.0825	0.144	0.3	48	41	NA	NA
J4510000-C-NSW	Swift Cr nr Clayton	<0.01	0.01	0.04	0.06	0.09	0.12	0.17	47	43	NA	NA
J5000000-C-NSW	Middle Cr nr Clayton	<0.01	0.01	0.03	0.06	0.08	0.142	0.24	49	45	NA	NA
J5850000-WSV-NSW	Little Riv nr Princeton	<0.01	0.01	0.02	0.05	0.08	0.116	0.27	48	39	NA	NA
J5970000-C-NSW	Neuse Riv nr Goldsboro	<0.01	0.01	0.03	0.07	0.09	0.115	0.2	46	40	NA	NA
J6150000-C-NSW	Neuse Riv at Kinston	<0.01	0.01	0.01	0.03	0.06	0.11	1.3	1318	1032	NA	NA
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<0.01	0.02	0.045	0.08	0.135	0.172	0.31	59	57	NA	NA
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<0.01	0.02	0.04	0.07	0.11	0.18	0.69	1176	1115	NA	NA
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<0.01	0.01	0.01	0.05	0.11	0.176	0.44	53	44	NA	NA
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<0.01	0.01	0.035	0.07	0.105	0.234	0.45	55	49	NA	NA
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<0.01	0.01	0.02	0.05	0.09	0.13	0.71	1387	1197	NA	NA
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<0.01	0.01	0.02	0.05	0.09	0.178	0.38	43	35	NA	NA
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<0.01	0.01	0.01	0.04	0.08	0.136	0.46	58	46	NA	NA
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<0.01	0.01	0.02	0.08	0.28	0.55	1.1	53	42	NA	NA
J8210000-SC Sw -NSW	Swift Cr at mouth	<0.01	0.01	0.02	0.055	0.0825	0.145	0.94	56	47	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<0.01	0.01	0.03	0.05	0.11	0.18	0.66	189	166	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<0.01	0.019	0.03	0.065	0.13	0.15	0.21	50	46	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64											
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<0.01	0.01	0.04	0.08	0.11	0.158	0.26	57	51	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<0.01	0.01	0.01	0.04	0.105	0.144	0.43	59	44	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	<0.01	0.01	0.01	0.03	0.08	0.144	0.65	237	172	NA	NA
J8720000-C Sw -NSW	Trent Riv nr Oak Grove	<0.01	0.01	0.01	0.04	0.0975	0.17	0.73	150	115	NA	NA
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<0.01	0.01	0.01	0.04	0.09	0.165	0.26	206	165	NA	NA
J8770000-C Sw -NSW	Trent Riv nr Rhems	<0.01	0.01	0.01	0.035	0.0725	0.133	0.52	48	36	NA	NA
J8900800-C Sw -NSW	Neuse Riv at CM22	<0.01	0.01	0.01	0.04	0.07	0.17	0.48	52	35	NA	NA
J8902500-SB Sw -NSW	Neuse Riv at Thurman	<0.01	0.01	0.01	0.03	0.08	0.16	0.55	97	61	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17											
J8903600-SB Sw -NSW	Neuse Riv at CM15											
J8910000-SB Sw -NSW	Neuse Riv at CM11	<0.01	0.01	0.01	0.01	0.07	0.222	0.75	105	56	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch											
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe											
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt											
J9530000-SA -NSW	Neuse Riv at CM9	<0.01	0.01	0.01	0.01	0.065	0.156	1.3	55	30	NA	NA
J9540000-SA -NSW	Neuse Riv nr Pierce											
J9590000-SA -NSW	Neuse Riv nr Janeiro											
J9685000-SA-NSW	Neuse Riv nr Merrimon											
J9690000-SA -NSW	Back Cr nr Merrimon	<0.01	0.01	0.01	0.05	0.21	0.73	1.2	45	33	NA	NA
J9810000-SA -NSW	Neuse Riv nr Oriental	<0.01	0.01	0.01	0.01	0.0725	0.184	0.56	52	29	NA	NA
J9860000-SA -NSW	Neuse Riv nr Cockle Pt											
J9900000-SA-NSW	Neuse Riv nr Piney Pt											
J9930000-SA -NSW	Neuse Riv at mouth	<0.01	0.01	0.01	0.01	0.07	0.16	0.21	40	23	NA	NA
J9938000-SA -NSW	West Thorofare Bay at CM10	<0.01	0.01	0.01	0.01	0.04	0.077	0.11	34	15	NA	NA
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<0.01	0.01	0.01	0.025	0.05	0.1	0.21	44	25	NA	NA
J9950000-SA -NSW	Bay Riv at CM5	<0.01	0.01	0.01	0.015	0.0475	0.111	0.6	30	18	NA	NA

Table 54. Summary statistics for nitrate+nitrite-nitrogen (mg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<0.1	0.078	0.2	0.31	0.4275	0.546	1.6	50	48	NA	NA
J0810000-WSIV-NSW	Eno Riv at SR1004	<0.1	0.06	0.165	0.3	0.43	0.59	1.7	51	50	NA	NA
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<0.1	0.01	0.09	0.3	0.415	0.534	0.75	47	43	NA	NA
J0840000-WSII-NSW CA	Little Riv Reservoir	<0.1	0.01	0.03	0.16	0.33	0.394	0.42	69	60	NA	NA
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<0.1	0.02	0.085	0.3	0.355	0.43	0.78	51	48	NA	NA
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<0.1	0.038	0.08	0.2	0.31	0.334	0.42	49	46	NA	NA
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	0.26	0.648	1	2.9	6	8.76	11	53	53	NA	NA
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	0.73	1.3	1.6	2.4	3.4	4.3	5.2	51	51	NA	NA
J1890000-C-NSW	Neuse Riv nr Falls	<0.1	0.01	0.02	0.07	0.2	0.28	0.35	49	42	NA	NA
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<0.1	0.06	0.11	0.22	0.3	0.41	5.5	51	49	NA	NA
J3000000-B-NSW	Crabtree Cr nr Raleigh	0.04	0.19	0.26	0.455	0.9675	2.02	7.5	50	50	NA	NA
J3251000-C-NSW	Crabtree Cr at SR2000	0.25	0.26	0.335	0.405	0.465	0.477	0.49	14	14	NA	NA
J3290000-C-NSW	Crabtree Cr at U Hwy 1	0.09	0.246	0.315	0.47	0.985	1.4	1.8	35	35	NA	NA
J3300000-C-NSW	Pigeon House Cr	0.46	1.29	1.625	1.9	2	2.22	2.7	50	50	NA	NA
J4170000-WSIV-NSW	Neuse Riv nr Clayton	0.12	0.399	0.66	1.1	1.8	2.6	3.6	154	154	NA	NA
J4370000-WSIV-NSW	Neuse Riv at Smithfield	0.14	0.43	0.5625	0.79	1.2	1.66	2.9	48	48	NA	NA
J4510000-C-NSW	Swift Cr nr Clayton	0.02	0.09	0.13	0.25	0.325	0.37	0.64	47	47	NA	NA
J5000000-C-NSW	Middle Cr nr Clayton	0.11	0.504	0.92	2.2	2.9	4.64	12	49	49	NA	NA
J5850000-WSV-NSW	Little Riv nr Princeton	<0.1	0.054	0.2275	0.28	0.3325	0.422	0.6	48	46	NA	NA
J5970000-C-NSW	Neuse Riv nr Goldsboro	<0.1	0.395	0.5175	0.71	0.91	1.4	1.9	46	45	NA	NA
J6150000-C-NSW	Neuse Riv at Kinston	<0.1	0.17	0.3625	0.62	0.84	1	2	1318	1294	NA	NA
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<0.1	0.02	0.06	0.12	0.19	0.244	0.32	59	57	NA	NA
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<0.1	0.39	0.56	0.68	0.81	0.92	1.6	1176	1172	NA	NA
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	0.01	0.03	0.12	0.25	0.41	0.666	1.5	53	53	NA	NA
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<0.1	0.134	0.485	0.66	0.77	0.864	1.1	55	54	NA	NA
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<0.1	0.31	0.48	0.71	0.87	1	1.9	1387	1369	NA	NA
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	0.05	0.38	0.585	0.77	0.85	0.948	1.4	43	43	NA	NA
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<0.1	0.312	0.5025	0.705	0.835	0.946	1.4	58	57	NA	NA
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<0.1	0.01	0.01	0.01	0.06	0.128	0.89	53	32	NA	NA
J8210000-SC Sw -NSW	Swift Cr at mouth	<0.1	0.125	0.38	0.53	0.685	0.805	1.4	56	55	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<0.1	0.09	0.2	0.51	0.72	0.872	1.6	189	184	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<0.1	0.265	0.465	0.68	0.795	0.93	1.3	50	49	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64											
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<0.1	0.302	0.44	0.62	0.77	0.872	1.1	57	56	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<0.1	0.104	0.19	0.4	0.585	0.74	0.95	59	57	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	<0.1	0.226	0.34	0.46	0.63	0.764	1.2	237	235	NA	NA
J8720000-C Sw -NSW	Trent Riv nr Oak Grove	<0.1	0.129	0.2625	0.4	0.5	0.61	0.86	150	147	NA	NA
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<0.1	0.155	0.2825	0.41	0.5175	0.595	0.75	206	204	NA	NA
J8770000-C Sw -NSW	Trent Riv nr Rhems	<0.1	0.01	0.0375	0.26	0.43	0.496	0.75	48	42	NA	NA
J8900800-C Sw -NSW	Neuse Riv at CM22	<0.1	0.01	0.0525	0.29	0.59	0.7	0.87	52	42	NA	NA
J8902500-SB Sw -NSW	Neuse Riv at Thurman	<0.1	0.01	0.01	0.02	0.32	0.558	0.88	97	52	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17											
J8903600-SB Sw -NSW	Neuse Riv at CM15											
J8910000-SB Sw -NSW	Neuse Riv at CM11	<0.1	0.01	0.01	0.01	0.16	0.376	0.73	105	47	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch											
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe											
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt											
J9530000-SA -NSW	Neuse Riv at CM9	<0.1	0.01	0.01	0.01	0.135	0.328	0.71	55	25	NA	NA
J9540000-SA -NSW	Neuse Riv nr Pierce											
J9590000-SA -NSW	Neuse Riv nr Janeiro											
J9685000-SA-NSW	Neuse Riv nr Merrimon											
J9690000-SA -NSW	Back Cr nr Merrimon	<0.1	0.01	0.02	0.08	0.25	0.514	2	45	36	NA	NA
J9810000-SA -NSW	Neuse Riv nr Oriental	<0.1	0.01	0.01	0.01	0.0625	0.13	0.43	52	22	NA	NA
J9860000-SA -NSW	Neuse Riv nr Cockle Pt											
J9900000-SA-NSW	Neuse Riv nr Piney Pt											
J9930000-SA -NSW	Neuse Riv at mouth	<0.1	0.01	0.01	0.01	0.01	0.041	0.14	40	9	NA	NA
J9938000-SA -NSW	West Thorofare Bay at CM10	<0.1	0.01	0.01	0.01	0.01	0.01	0.02	34	3	NA	NA
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<0.1	0.01	0.01	0.01	0.01	0.01	0.1	44	11	NA	NA
J9950000-SA -NSW	Bay Riv at CM5	<0.1	0.01	0.01	0.01	0.04	0.121	0.49	30	13	NA	NA

Table 55. Summary statistics for total Kjeldahl nitrogen (mg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	0.1	0.2	0.2	0.3	0.4	0.4	0.9	50	50	NA	NA
J0810000-WSIV-NSW	Eno Riv at SR1004	0.2	0.2	0.3	0.3	0.4	0.5	1.5	51	51	NA	NA
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	0.1	0.16	0.2	0.2	0.35	0.5	1.7	47	47	NA	NA
J0840000-WSII-NSW CA	Little Riv Reservoir	0.2	0.2	0.3	0.3	0.4	0.5	0.8	69	69	NA	NA
J1070000-WSII-NSW	Flat Riv nr Quail Roost	0.2	0.2	0.2	0.2	0.3	0.5	1.7	51	51	NA	NA
J1100000-WSIV-NSW	Flat Riv nr Willardsville	0.2	0.28	0.3	0.4	0.5	0.62	1.4	49	49	NA	NA
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	0.3	0.4	0.5	0.7	1	1.4	2.8	53	53	NA	NA
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	0.2	0.4	0.4	0.5	0.7	1	2.1	51	51	NA	NA
J1890000-C-NSW	Neuse Riv nr Falls	0.2	0.3	0.3	0.4	0.5	0.6	0.8	49	49	NA	NA
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	0.2	0.3	0.4	0.5	0.6	0.8	1.5	51	51	NA	NA
J3000000-B-NSW	Crabtree Cr nr Raleigh	0.2	0.3	0.4	0.4	0.5	0.6	1.2	50	50	NA	NA
J3251000-C-NSW	Crabtree Cr at SR2000	0.2	0.3	0.3	0.4	0.5	0.6	1.5	14	14	NA	NA
J3290000-C-NSW	Crabtree Cr at U Hwy 1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	35	35	NA	NA
J3300000-C-NSW	Pigeon House Cr	0.1	0.2	0.3	0.4	0.5	0.6	1.6	50	50	NA	NA
J4170000-WSIV-NSW	Neuse Riv nr Clayton	0.1	0.2	0.3	0.3	0.4	0.5	1.2	154	154	NA	NA
J4370000-WSIV-NSW	Neuse Riv at Smithfield	0.2	0.2	0.3	0.3	0.4	0.6	0.9	48	48	NA	NA
J4510000-C-NSW	Swift Cr nr Clayton	0.2	0.2	0.2	0.3	0.4	0.5	1	47	47	NA	NA
J5000000-C-NSW	Middle Cr nr Clayton	0.1	0.2	0.3	0.4	0.5	0.6	0.8	49	49	NA	NA
J5850000-WSV-NSW	Little Riv nr Princeton	0.03	0.2	0.3	0.4	0.5	0.63	0.9	48	48	NA	NA
J5970000-C-NSW	Neuse Riv nr Goldsboro	0.2	0.2	0.3	0.35	0.475	0.7	1	46	46	NA	NA
J6150000-C-NSW	Neuse Riv at Kinston	0.1	0.2	0.3	0.3	0.4	0.5	6.1	1318	1318	NA	NA
J6740000-WSV-NSW	Contentnea Cr nr Lucama	0.2	0.3	0.4	0.4	0.5	0.6	0.7	59	59	NA	NA
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	0.1	0.3	0.4	0.4	0.6	0.7	7	1176	1176	NA	NA
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	0.2	0.32	0.4	0.5	0.7	0.7	1	53	53	NA	NA
J7810000-C Sw -NSW	Contentnea Cr at Grifton	0.2	0.3	0.4	0.5	0.55	0.76	1.7	55	55	NA	NA
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<0.1	0.2	0.3	0.4	0.4	0.6	6.8	1387	1386	NA	NA
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	0.2	0.2	0.3	0.4	0.4	0.5	0.9	43	43	NA	NA
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	0.2	0.3	0.3	0.4	0.475	0.6	0.9	58	58	NA	NA
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	0.1	0.3	0.4	0.6	1	1.2	3.6	53	53	NA	NA
J8210000-SC Sw -NSW	Swift Cr at mouth	0.2	0.3	0.3	0.4	0.5	0.6	2.6	56	56	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	0.1	0.3	0.3	0.4	0.5	0.72	70	189	189	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	0.2	0.3	0.3	0.4	0.5	0.6	12	50	50	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64											
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	0.2	0.3	0.3	0.4	0.5	0.6	1.2	57	57	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	0.2	0.3	0.3	0.4	0.5	0.6	1.1	59	59	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	0.1	0.2	0.3	0.4	0.5	0.7	5.1	237	237	NA	NA
J8720000-C Sw -NSW	Trent Riv nr Oak Grove	0.1	0.2	0.3	0.3	0.5	0.7	1.7	150	150	NA	NA
J8730000-C Sw -NSW	Trent Riv at Pollocksville	0.1	0.2	0.3	0.4	0.5	0.7	1.1	206	206	NA	NA
J8770000-C Sw -NSW	Trent Riv nr Rhems	0.1	0.2	0.3	0.4	0.525	0.73	1.1	48	48	NA	NA
J8900800-C Sw -NSW	Neuse Riv at CM22	0.2	0.3	0.3	0.4	0.5	0.6	1.1	52	52	NA	NA
J8902500-SB Sw -NSW	Neuse Riv at Thurman	0.2	0.3	0.4	0.4	0.5	0.6	10	97	97	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17											
J8903600-SB Sw -NSW	Neuse Riv at CM15											
J8910000-SB Sw -NSW	Neuse Riv at CM11	0.2	0.3	0.3	0.4	0.5	0.6	2.9	105	105	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch											
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe											
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt											
J9530000-SA -NSW	Neuse Riv at CM9	0.1	0.3	0.3	0.4	0.5	0.76	7.9	55	55	NA	NA
J9540000-SA -NSW	Neuse Riv nr Pierce											
J9590000-SA -NSW	Neuse Riv nr Janeiro											
J9685000-SA-NSW	Neuse Riv nr Merrimon											
J9690000-SA -NSW	Back Cr nr Merrimon	0.2	0.4	0.4	0.6	0.8	1.36	3	45	45	NA	NA
J9810000-SA -NSW	Neuse Riv nr Oriental	0.2	0.3	0.3	0.4	0.5	0.6	1.1	52	52	NA	NA
J9860000-SA -NSW	Neuse Riv nr Cockle Pt											
J9900000-SA-NSW	Neuse Riv nr Piney Pt											
J9930000-SA -NSW	Neuse Riv at mouth	0.2	0.2	0.3	0.4	0.5	0.6	0.7	40	40	NA	NA
J9938000-SA -NSW	West Thorofare Bay at CM10	0.2	0.2	0.3	0.3	0.4	0.47	0.8	34	34	NA	NA
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	0.1	0.2	0.3	0.3	0.4	0.5	0.6	44	44	NA	NA
J9950000-SA -NSW	Bay Riv at CM5	0.2	0.3	0.4	0.4	0.575	0.71	0.8	30	30	NA	NA

Table 56. Summary statistics for total phosphorus (mg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<0.01	0.02	0.0225	0.04	0.08	0.1	0.18	50	0	NA	0
J0810000-WSIV-NSW	Eno Riv at SR1004	0.01	0.03	0.03	0.04	0.07	0.11	0.17	51	51	NA	NA
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<0.01	0.01	0.02	0.03	0.04	0.074	0.4	47	45	NA	NA
J0840000-WSII-NSW CA	Little Riv Reservoir	<0.01	0.01	0.02	0.03	0.04	0.052	0.1	69	68	NA	NA
J1070000-WSII-NSW	Flat Riv nr Quail Roost	0.01	0.02	0.03	0.04	0.05	0.07	0.49	51	51	NA	NA
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<0.01	0.028	0.03	0.04	0.06	0.07	0.67	49	48	NA	NA
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	0.07	0.11	0.32	0.53	1.3	2.02	4.6	53	53	NA	NA
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	0.04	0.05	0.07	0.1	0.16	0.27	0.92	51	51	NA	NA
J1890000-C-NSW	Neuse Riv nr Falls	<0.01	0.01	0.02	0.03	0.05	0.06	0.08	49	48	NA	NA
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	0.01	0.06	0.08	0.09	0.105	0.13	1.2	51	51	NA	NA
J3000000-B-NSW	Crabtree Cr nr Raleigh	0.04	0.059	0.08	0.14	0.2975	0.423	1.7	50	50	NA	NA
J3251000-C-NSW	Crabtree Cr at SR2000	<0.01	0.043	0.05	0.055	0.0975	0.231	0.5	14	13	NA	NA
J3290000-C-NSW	Crabtree Cr at U Hwy 1	0.04	0.06	0.085	0.15	0.2	0.22	0.29	35	35	NA	NA
J3300000-C-NSW	Pigeon House Cr	0.02	0.039	0.05	0.065	0.1075	0.166	0.53	50	50	NA	NA
J4170000-WSIV-NSW	Neuse Riv nr Clayton	0.04	0.07	0.1	0.16	0.2575	0.35	1.2	154	154	NA	NA
J4370000-WSIV-NSW	Neuse Riv at Smithfield	0.06	0.08	0.1	0.145	0.23	0.27	0.37	48	48	NA	NA
J4510000-C-NSW	Swift Cr nr Clayton	0.02	0.03	0.04	0.05	0.06	0.074	0.12	47	47	NA	NA
J5000000-C-NSW	Middle Cr nr Clayton	0.03	0.08	0.11	0.15	0.2	0.34	0.7	49	49	NA	NA
J5850000-WSV-NSW	Little Riv nr Princeton	0.04	0.06	0.08	0.11	0.1725	0.213	0.44	48	48	NA	NA
J5970000-C-NSW	Neuse Riv nr Goldsboro	0.04	0.07	0.0825	0.12	0.14	0.17	0.27	46	46	NA	NA
J6150000-C-NSW	Neuse Riv at Kinston	0.02	0.05	0.07	0.09	0.12	0.15	1.7	1315	1315	NA	NA
J6740000-WSV-NSW	Contentnea Cr nr Lucama	0.02	0.03	0.05	0.06	0.075	0.09	0.14	59	59	NA	NA
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	0.02	0.09	0.12	0.17	0.22	0.33	7.4	1176	1176	NA	NA
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	0.06	0.11	0.18	0.27	0.36	0.502	0.79	53	53	NA	NA
J7810000-C Sw -NSW	Contentnea Cr at Grifton	0.06	0.09	0.14	0.17	0.22	0.296	0.48	55	55	NA	NA
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	0.009	0.07	0.1	0.13	0.16	0.23	2.4	1387	1387	NA	NA
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	0.06	0.072	0.09	0.12	0.14	0.17	0.22	43	43	NA	NA
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	0.03	0.067	0.0825	0.11	0.1275	0.15	0.44	58	58	NA	NA
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<0.01	0.02	0.05	0.08	0.14	0.198	0.99	53	51	NA	NA
J8210000-SC Sw -NSW	Swift Cr at mouth	0.03	0.055	0.0675	0.09	0.13	0.165	0.26	56	56	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	0.04	0.06	0.08	0.15	0.36	0.544	1.3	189	189	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	0.05	0.069	0.09	0.11	0.14	0.19	0.38	50	50	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64											
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	0.06	0.07	0.09	0.11	0.14	0.17	0.45	57	57	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	0.06	0.07	0.08	0.1	0.13	0.17	0.39	59	59	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	0.01	0.04	0.06	0.08	0.15	0.364	0.83	237	237	NA	NA
J8720000-C Sw -NSW	Trent Riv nr Oak Grove	0.02	0.05	0.08	0.12	0.2175	0.381	0.86	150	150	NA	NA
J8730000-C Sw -NSW	Trent Riv at Pollocksville	0.02	0.07	0.09	0.13	0.18	0.38	0.31	206	206	NA	NA
J8770000-C Sw -NSW	Trent Riv nr Rhems	0.05	0.077	0.09	0.11	0.12	0.163	0.25	48	48	NA	NA
J8900800-C Sw -NSW	Neuse Riv at CM22	0.06	0.061	0.08	0.1	0.1225	0.16	0.33	52	52	NA	NA
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	0.02	0.06	0.08	0.11	0.13	0.16	0.28	97	97	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17											
J8903600-SB Sw -NSW	Neuse Riv at CM15											
J8910000-SB Sw -NSW	Neuse Riv at CM11	0.02	0.05	0.06	0.07	0.1	0.14	0.26	105	105	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch											
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe											
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt											
J9530000-SA -NSW	Neuse Riv at CM9	0.02	0.04	0.055	0.07	0.095	0.14	0.22	55	55	NA	NA
J9540000-SA -NSW	Neuse Riv nr Pierce											
J9590000-SA -NSW	Neuse Riv nr Janeiro											
J9685000-SA-NSW	Neuse Riv nr Merrimon											
J9690000-SA -NSW	Back Cr nr Merrimon	0.01	0.048	0.08	0.14	0.22	0.456	1	45	45	NA	NA
J9810000-SA -NSW	Neuse Riv nr Oriental	0.02	0.03	0.04	0.05	0.07	0.09	0.16	52	52	NA	NA
J9860000-SA -NSW	Neuse Riv nr Cockle Pt											
J9900000-SA-NSW	Neuse Riv nr Piney Pt											
J9930000-SA -NSW	Neuse Riv at mouth	<0.01	0.019	0.02	0.04	0.05	0.06	0.12	40	39	NA	NA
J9938000-SA -NSW	West Thorofare Bay at CM10	0.01	0.01	0.02	0.02	0.03	0.04	0.05	34	34	NA	NA
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<0.01	0.01	0.01	0.02	0.03	0.037	0.05	44	41	NA	NA
J9950000-SA -NSW	Bay Riv at CM5	<0.01	0.02	0.03	0.03	0.04	0.051	0.25	30	29	NA	NA

Table 57. Summary statistics for aluminum (µg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	65	93.7	162.5	245	540	1460	6800	50	50	NA	NA
J0810000-WSIV-NSW	Eno Riv at SR1004	70	128	220	390	680	1120	8100	49	49	NA	NA
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	32	70.5	120	230	490	1135	9700	46	46	NA	NA
J0840000-WSII-NSW CA	Little Riv Reservoir	<50	63.2	100	200	370	840	2400	69	67	NA	NA
J1070000-WSII-NSW	Flat Riv nr Quail Roost	81	150	240	430	650	1700	39000	51	51	NA	NA
J1100000-WSIV-NSW	Flat Riv nr Willardsville	110	150	260	440	990	1700	3400	49	49	NA	NA
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	86	180	247.5	540	785	1670	7100	52	52	NA	NA
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	96	130	232.5	435	1067.5	1720	13000	50	50	NA	NA
J1890000-C-NSW	Neuse Riv nr Falls	10	110	147.5	265	400	576	2200	48	48	NA	NA
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<50	480	1300	2400	3900	5200	9700	51	50	NA	NA
J3000000-B-NSW	Crabtree Cr nr Raleigh	10	170	335	990	2550	4110	5700	50	50	NA	NA
J3251000-C-NSW	Crabtree Cr at SR2000	10	258	665	1650	3050	3540	44000	14	14	NA	NA
J3290000-C-NSW	Crabtree Cr at U Hwy 1	10	208	450	1000	2700	3120	4600	35	35	NA	NA
J3300000-C-NSW	Pigeon House Cr	<50	50	80.25	120	180	982	1500	50	44	NA	NA
J4170000-WSIV-NSW	Neuse Riv nr Clayton	10	157	320	545	940	1730	9300	58	58	NA	NA
J4370000-WSIV-NSW	Neuse Riv at Smithfield	130	266	420	700	1200	1800	9400	49	49	NA	NA
J4510000-C-NSW	Swift Cr nr Clayton	10	110	160	270	405	1240	2300	47	47	NA	NA
J5000000-C-NSW	Middle Cr nr Clayton	10	120	162.5	300	440	1160	3400	50	50	NA	NA
J5850000-WSV-NSW	Little Riv nr Princeton	<50	94.8	120	210	350	730	3900	49	48	NA	NA
J5970000-C-NSW	Neuse Riv nr Goldsboro	10	230	312.5	520	797.5	1200	1500	46	46	NA	NA
J6150000-C-NSW	Neuse Riv at Kinston	10	202	260	530	810	1280	2700	53	53	NA	NA
J6740000-WSV-NSW	Contentnea Cr nr Lucama	57	120	160	300	475	960	3300	59	59	NA	NA
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	10	192	265	390	615	1380	2100	47	47	NA	NA
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	10	113	180	285	387.5	626	2400	54	54	NA	NA
J7810000-C Sw -NSW	Contentnea Cr at Grifton	10	180	250	370	540	1260	1700	53	53	NA	NA
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	10	170	225	390	670	980	2300	47	47	NA	NA
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	10	172	240	400	595	758	1100	43	43	NA	NA
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	10	168	225	310	480	612	1600	55	55	NA	NA
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	10	300	345	480	770	1300	2600	51	51	NA	NA
J8210000-SC Sw -NSW	Swift Cr at mouth	10	134	220	380	540	790	2200	55	55	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	10	160	190	330	557.5	658	700	14	14	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	10	160	250	320	602.5	732	1200	50	50	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64											
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	10	170	250	285	492.5	765	1300	56	56	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	10	140	212.5	305	437.5	606	1500	58	58	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	<50	61.6	125	270	405	450	1200	55	52	NA	NA
J8720000-C Sw -NSW	Trent Riv nr Oak Grove											
J8730000-C Sw -NSW	Trent Riv at Pollocksville	10	140	140	240	510	578	630	15	15	NA	NA
J8770000-C Sw -NSW	Trent Riv nr Rhems	10	112	180	260	355	514	740	47	47	NA	NA
J8900800-C Sw -NSW	Neuse Riv at CM22	<50	110	187.5	265	412.5	679	1300	52	51	NA	NA
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	<50	84.2	142.5	245	435	611	1100	54	53	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17											
J8903600-SB Sw -NSW	Neuse Riv at CM15											
J8910000-SB Sw -NSW	Neuse Riv at CM11	<50	73.9	122.5	250	417.5	701	1100	54	53	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch											
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe											
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt											
J9530000-SA -NSW	Neuse Riv at CM9	10	88.8	132.5	265	440	704	880	50	50	NA	NA
J9540000-SA -NSW	Neuse Riv nr Pierce											
J9590000-SA -NSW	Neuse Riv nr Janeiro											
J9685000-SA-NSW	Neuse Riv nr Merrimon											
J9690000-SA -NSW	Back Cr nr Merrimon	10	152	215	260	435	638	1700	43	43	NA	NA
J9810000-SA -NSW	Neuse Riv nr Oriental	<50	99.1	120	220	347.5	450	1400	52	50	NA	NA
J9860000-SA -NSW	Neuse Riv nr Cockle Pt											
J9900000-SA-NSW	Neuse Riv nr Piney Pt											
J9930000-SA -NSW	Neuse Riv at mouth	<50	69.6	110	175	295	421	760	40	38	NA	NA
J9938000-SA -NSW	West Thorofare Bay at CM10	10	109	152.5	210	347.5	430	620	34	34	NA	NA
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<50	136	180	300	410	512	930	44	43	NA	NA
J9950000-SA -NSW	Bay Riv at CM5	<50	122	185	270	355	412	1100	27	25	NA	NA

Table 58. Summary statistics for arsenic (µg/L) from the Neuse River basin, 1996 - 2000.

		Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<10	10	10	10	10	10	10	50	0	50	0
J0810000-WSIV-NSW	Eno Riv at SR1004	<10	10	10	10	10	10	10	49	0	50	0
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<10	10	10	10	10	10	10	46	0	50	0
J0840000-WSII-NSW CA	Little Riv Reservoir	<10	10	10	10	10	10	10	69	0	50	0
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<10	10	10	10	10	10	10	51	0	50	0
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<10	10	10	10	10	10	46	49	1	50	0
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<10	10	10	10	10	10	13	52	2	50	0
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	<10	10	10	10	10	10	10	50	0	50	0
J1890000-C-NSW	Neuse Riv nr Falls	<10	10	10	10	10	10	10	49	0	50	0
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<10	10	10	10	10	10	10	51	0	50	0
J3000000-B-NSW	Crabtree Cr nr Raleigh	<10	10	10	10	10	10	10	50	0	50	0
J3251000-C-NSW	Crabtree Cr at SR2000	<10	10	10	10	10	10	10	14	1	50	0
J3290000-C-NSW	Crabtree Cr at U Hwy 1	<10	10	10	10	10	10	10	35	0	50	0
J3300000-C-NSW	Pigeon House Cr	<10	10	10	10	10	10	10	50	0	50	0
J4170000-WSIV-NSW	Neuse Riv nr Clayton	<10	10	10	10	10	10	14	58	1	50	0
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<10	10	10	10	10	10	10	49	0	50	0
J4510000-C-NSW	Swift Cr nr Clayton	<10	10	10	10	10	10	10	48	0	50	0
J5000000-C-NSW	Middle Cr nr Clayton	<10	10	10	10	10	10	10	50	0	50	0
J5850000-WSV-NSW	Little Riv nr Princeton	<10	10	10	10	10	10	10	49	0	50	0
J5970000-C-NSW	Neuse Riv nr Goldsboro	<10	10	10	10	10	10	10	46	0	50	0
J6150000-C-NSW	Neuse Riv at Kinston	<10	10	10	10	10	10	10	53	0	50	0
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<10	10	10	10	10	10	10	59	0	50	0
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<10	10	10	10	10	10	10	48	0	50	0
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<10	10	10	10	10	10	10	54	0	50	0
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<10	10	10	10	10	10	10	53	0	50	0
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<10	10	10	10	10	10	10	47	0	50	0
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<10	10	10	10	10	10	10	43	0	50	0
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<10	10	10	10	10	10	10	55	0	50	0
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<10	10	10	10	10	10	10	51	0	50	0
J8210000-SC Sw -NSW	Swift Cr at mouth	<10	10	10	10	10	10	10	55	0	50	0
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<10	10	10	10	10	10	10	14	0	50	0
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<10	10	10	10	10	10	10	50	0	50	0
J8270000-SC Sw -NSW	Neuse Riv at CM64											
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<10	10	10	10	10	10	10	56	1	50	0
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<10	10	10	10	10	10	50	58	1	50	0
J8690000-C Sw -NSW	Trent Riv nr Trenton	<10	10	10	10	10	10	10	56	0	50	0
J8720000-C Sw -NSW	Trent Riv nr Oak Grove											
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<10	10	10	10	10	10	10	15	0	50	0
J8770000-C Sw -NSW	Trent Riv nr Rhems	<10	10	10	10	10	10	50	47	0	50	0
J8900800-C Sw -NSW	Neuse Riv at CM22	<10	10	10	10	10	10	50	52	1	50	0
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	<10	10	10	10	10	10	50	54	0	50	0
J8903500-SB Sw -NSW	Neuse Rv at CM17											
J8903600-SB Sw -NSW	Neuse Riv at CM15											
J8910000-SB Sw -NSW	Neuse Riv at CM11	<10	10	10	10	10	50	50	54	0	50	0
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch											
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe											
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt											
J9530000-SA -NSW	Neuse Riv at CM9	<10	10	10	10	10	50	50	50	1	50	0
J9540000-SA -NSW	Neuse Riv nr Pierce											
J9590000-SA -NSW	Neuse Riv nr Janeiro											
J9685000-SA-NSW	Neuse Riv nr Merrimon											
J9690000-SA -NSW	Back Cr nr Merrimon	<10	10	10	10	10	50	50	42	1	50	0
J9810000-SA -NSW	Neuse Riv nr Oriental	<10	10	10	10	10	50	50	52	1	50	0
J9860000-SA -NSW	Neuse Riv nr Cockle Pt											
J9900000-SA-NSW	Neuse Riv nr Piney Pt											
J9930000-SA -NSW	Neuse Riv at mouth	<10	10	10	10	12.25	50	50	40	2	50	0
J9938000-SA -NSW	West Thorofare Bay at CM10	<10	10	10	10	10	47	50	34	2	50	0
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<10	10	10	10	10	48	50	43	2	50	0
J9950000-SA -NSW	Bay Riv at CM5	<10	10	10	10	10	50	50	27	1	50	0

Table 59. Summary statistics for cadmium (µg/L) from the Neuse River basin, 1996 - 2000.

		Min	Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<2	2	2	2	2	2	2	10	50	0	2	0
J0810000-WSIV-NSW	Eno Riv at SR1004	<2	2	2	2	2	2	2	8	51	0	2	0
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<2	2	2	2	2	2	2	10	46	0	2	0
J0840000-WSII-NSW CA	Little Riv Reservoir	<2	2	2	2	2	2	2	10	69	0	2	0
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<2	2	2	2	2	2	2	10	51	0	2	0
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<2	2	2	2	2	2	2	5.9	49	1	2	2
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<2	2	2	2	2	2	2	2	53	0	2	0
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	<2	2	2	2	2	2	2	2	51	0	2	0
J1890000-C-NSW	Neuse Riv nr Falls	<2	2	2	2	2	2	2	2	49	0	2	0
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<2	2	2	2	2	2	2	2	51	0	2	0
J3000000-B-NSW	Crabtree Cr nr Raleigh	<2	2	2	2	2	2	2	2	50	0	2	0
J3251000-C-NSW	Crabtree Cr at SR2000	<2	2	2	2	2	2	2	2	14	0	2	0
J3290000-C-NSW	Crabtree Cr at U Hwy 1	<2	2	2	2	2	2	2	2	35	0	2	0
J3300000-C-NSW	Pigeon House Cr	<2	2	2	2	2	2	2	2	50	0	2	0
J4170000-WSIV-NSW	Neuse Riv nr Clayton	<2	2	2	2	2	2	2	2	58	0	2	0
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<2	2	2	2	2	2	2	2	49	0	2	0
J4510000-C-NSW	Swift Cr nr Clayton	<2	2	2	2	2	2	2	2	47	0	2	0
J5000000-C-NSW	Middle Cr nr Clayton	<2	2	2	2	2	2	2	2	50	0	2	0
J5850000-WSV-NSW	Little Riv nr Princeton	<2	2	2	2	2	2	2	2	49	0	2	0
J5970000-C-NSW	Neuse Riv nr Goldsboro	<2	2	2	2	2	2	2	2	46	0	2	0
J6150000-C-NSW	Neuse Riv at Kinston	<2	2	2	2	2	2	2	2	53	0	2	0
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<2	2	2	2	2	2	2	2	59	0	2	0
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<2	2	2	2	2	2	2	2	48	0	2	0
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<2	2	2	2	2	2	2	2	54	0	2	0
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<2	2	2	2	2	2	2	2	53	0	2	0
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<2	2	2	2	2	2	2	2	47	0	2	0
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<2	2	2	2	2	2	2	2	43	0	2	0
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<2	2	2	2	2	2	2	2	55	0	2	0
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<2	2	2	2	2	2	2	2	51	0	2	0
J8210000-SC Sw -NSW	Swift Cr at mouth	<2	2	2	2	2	2	2	2	55	0	5	0
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<2	2	2	2	2	2	2	2	14	0	2	0
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<2	2	2	2	2	2	2	2	50	0	5	0
J8270000-SC Sw -NSW	Neuse Riv at CM64												
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<2	2	2	2	2	2	2	2	56	0	5	0
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<2	2	2	2	2	2	2	5	58	1	5	0
J8690000-C Sw -NSW	Trent Riv nr Trenton	<2	2	2	2	2	2	2	2	56	0	2	0
J8720000-C Sw -NSW	Trent Riv nr Oak Grove												
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<2	2	2	2	2	2	2	2	15	0	2	0
J8770000-C Sw -NSW	Trent Riv nr Rhems	<2	2	2	2	2	2	2	2	47	0	2	0
J8900800-C Sw -NSW	Neuse Riv at CM22	<2	2	2	2	2	2	2	10	52	0	2	0
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	<2	2	2	2	2	2	2	10	54	0	5	0
J8903500-SB Sw -NSW	Neuse Rv at CM17												
J8903600-SB Sw -NSW	Neuse Riv at CM15												
J8910000-SB Sw -NSW	Neuse Riv at CM11	<2	2	2	2	2	2	2	10	54	0	5	0
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch												
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe												
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt												
J9530000-SA -NSW	Neuse Riv at CM9	<2	2	2	2	2	2	2	10	49	0	5	0
J9540000-SA -NSW	Neuse Riv nr Pierce												
J9590000-SA -NSW	Neuse Riv nr Janeiro												
J9685000-SA-NSW	Neuse Riv nr Merrimon												
J9690000-SA -NSW	Back Cr nr Merrimon	<2	2	2	2	2	2	10	10	43	0	5	0
J9810000-SA -NSW	Neuse Riv nr Oriental	<2	2	2	2	2	2	2	10	52	0	5	0
J9860000-SA -NSW	Neuse Riv nr Cockle Pt												
J9900000-SA-NSW	Neuse Riv nr Piney Pt												
J9930000-SA -NSW	Neuse Riv at mouth	<2	2	2	2	2	2	2.6	10	40	0	5	0
J9938000-SA -NSW	West Thorofare Bay at CM10	<2	2	2	2	2	2	10	10	34	0	5	0
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<2	2	2	2	2	10	10	10	44	0	5	0
J9950000-SA -NSW	Bay Riv at CM5	<2	2	2	2	2	2	10	10	27	0	5	0

Table 60. Summary statistics for total chromium (µg/L) from the Neuse River basin, 1996 - 2000.

		Min	Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<25	25	25	25	25	25	25	25	50	0	50	0
J0810000-WSIV-NSW	Eno Riv at SR1004	<25	25	25	25	25	25	25	25	51	0	50	0
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<25	25	25	25	25	25	25	25	46	0	50	0
J0840000-WSII-NSW CA	Little Riv Reservoir	<25	25	25	25	25	25	25	25	69	0	50	0
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<25	25	25	25	25	25	25	25	51	0	50	0
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<25	25	25	25	25	25	25	25	49	0	50	0
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<25	25	25	25	25	25	25	25	53	0	50	0
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	<25	25	25	25	25	25	25	25	51	0	50	0
J1890000-C-NSW	Neuse Riv nr Falls	<25	25	25	25	25	25	25	25	49	0	50	0
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<25	25	25	25	25	25	25	25	51	0	50	0
J3000000-B-NSW	Crabtree Cr nr Raleigh	<25	25	25	25	25	25	25	25	50	0	50	0
J3251000-C-NSW	Crabtree Cr at SR2000	<25	25	25	25	25	25	25	25	14	0	50	0
J3290000-C-NSW	Crabtree Cr at U Hwy 1	<25	25	25	25	25	25	25	25	35	0	50	0
J3300000-C-NSW	Pigeon House Cr	<25	25	25	25	25	25	25	25	50	0	50	0
J4170000-WSIV-NSW	Neuse Riv nr Clayton	<25	25	25	25	25	25	25	25	58	0	50	0
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<25	25	25	25	25	25	25	25	49	0	50	0
J4510000-C-NSW	Swift Cr nr Clayton	<25	25	25	25	25	25	25	25	47	0	50	0
J5000000-C-NSW	Middle Cr nr Clayton	<25	25	25	25	25	25	25	25	50	0	50	0
J5850000-WSV-NSW	Little Riv nr Princeton	<25	25	25	25	25	25	25	25	49	0	50	0
J5970000-C-NSW	Neuse Riv nr Goldsboro	<25	25	25	25	25	25	25	25	46	0	50	0
J6150000-C-NSW	Neuse Riv at Kinston	<25	25	25	25	25	25	25	25	53	0	50	0
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<25	25	25	25	25	25	25	25	59	0	50	0
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<25	25	25	25	25	25	25	25	48	0	50	0
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<25	25	25	25	25	25	25	25	54	0	50	0
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<25	25	25	25	25	25	25	25	53	0	50	0
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<25	25	25	25	25	25	25	125	47	0	50	0
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<25	25	25	25	25	25	25	25	42	0	50	0
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<25	25	25	25	25	25	25	25	55	0	50	0
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<25	25	25	25	25	25	25	25	51	0	50	0
J8210000-SC Sw -NSW	Swift Cr at mouth	<25	25	25	25	25	25	25	25	55	0	20	0
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<25	25	25	25	25	25	25	25	14	0	20	0
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<25	25	25	25	25	25	25	25	50	0	20	0
J8270000-SC Sw -NSW	Neuse Riv at CM64												
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<25	25	25	25	25	25	25	25	56	0	20	0
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<25	25	25	25	25	25	25	25	58	0	20	0
J8690000-C Sw -NSW	Trent Riv nr Trenton	<25	25	25	25	25	25	25	25	56	0	50	0
J8720000-C Sw -NSW	Trent Riv nr Oak Grove												
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<25	25	25	25	25	25	25	25	15	0	50	0
J8770000-C Sw -NSW	Trent Riv nr Rhems	<25	25	25	25	25	25	25	25	47	0	50	0
J8900800-C Sw -NSW	Neuse Riv at CM22	<25	25	25	25	25	25	25	25	52	0	50	0
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	<25	25	25	25	25	25	25	25	54	0	20	0
J8903500-SB Sw -NSW	Neuse Rv at CM17												
J8903600-SB Sw -NSW	Neuse Riv at CM15												
J8910000-SB Sw -NSW	Neuse Riv at CM11	<25	25	25	25	25	25	25	255	54	1	20	1.8
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch												
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe												
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt												
J9530000-SA -NSW	Neuse Riv at CM9	<25	25	25	25	25	25	25	25	49	0	20	0
J9540000-SA -NSW	Neuse Riv nr Pierce												
J9590000-SA -NSW	Neuse Riv nr Janeiro												
J9685000-SA-NSW	Neuse Riv nr Merrimon												
J9690000-SA -NSW	Back Cr nr Merrimon	<25	25	25	25	25	25	25	125	43	0	20	0
J9810000-SA -NSW	Neuse Riv nr Oriental	<25	25	25	25	25	25	25	125	52	0	20	0
J9860000-SA -NSW	Neuse Riv nr Cockle Pt												
J9900000-SA-NSW	Neuse Riv nr Piney Pt												
J9930000-SA -NSW	Neuse Riv at mouth	<25	25	25	25	25	25	25	125	40	0	20	0
J9938000-SA -NSW	West Thorofare Bay at CM10	<25	25	25	25	25	25	25	25	34	0	20	0
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<25	25	25	25	25	25	25	100	44	0	20	0
J9950000-SA -NSW	Bay Riv at CM5	<25	25	25	25	25	25	25	125	27	0	20	0

Table 61. Summary statistics for copper (µg/L) from the Neuse River basin, 1996 - 2000.

		Min	Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<2	2	2	2	3	6.3	10.2	25	50	34	7(AL)	14
J0810000-WSIV-NSW	Eno Riv at SR1004	<2	2	2	2.15	3.1	6.2	10	23	51	44	7(AL)	22
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<2	2	2	2	2	3.5	6.8	19	46	21	7(AL)	10.8
J0840000-WSII-NSW CA	Little Riv Reservoir	<2	2	2	2	3	4	8	14	69	44	7(AL)	10.1
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<2	2	2	2	2.5	3.8	13	140	51	30	7(AL)	13.7
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<2	2	2	2.6	3.2	4	7.2	16	49	41	7(AL)	10.2
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<2	2	2.3	3.4	6	9.6	13	33	53	48	7(AL)	37.7
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	<2	2	2.2	3.15	4.3	7	8.2	23	51	48	7(AL)	21.6
J1890000-C-NSW	Neuse Riv nr Falls	<2	2	2	2	3	3.6	7.02	27	49	33	7(AL)	10.2
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<2	2	2.5	4	4.9	6.55	8	18	51	49	7(AL)	17.6
J3000000-B-NSW	Crabtree Cr nr Raleigh	<2	2	2	3	4.4	6.875	10.1	48	50	44	7(AL)	22
J3251000-C-NSW	Crabtree Cr at SR2000	<2	2	2.18	2.975	3.85	4.95	5.61	20	14	12	7(AL)	7.1
J3290000-C-NSW	Crabtree Cr at U Hwy 1	<2	2	2.56	3	4	6	7.92	19	35	34	7(AL)	17.1
J3300000-C-NSW	Pigeon House Cr	<2	2	3.98	5.775	12	18.5	24.4	41	50	48	7(AL)	66
J4170000-WSIV-NSW	Neuse Riv nr Clayton	<2	2	2	2.575	3.65	6	7.93	11	58	50	7(AL)	12.1
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<2	2	2	3	3.9	5.6	7.64	32	49	43	7(AL)	12.2
J4510000-C-NSW	Swift Cr nr Clayton	<2	2	2	2	2.2	3.1	6.56	32	47	30	7(AL)	10.6
J5000000-C-NSW	Middle Cr nr Clayton	<2	2	2	2	2.5	4	7.02	42	50	35	7(AL)	8
J5850000-WSV-NSW	Little Riv nr Princeton	<2	2	2	2	2	4	6.2	27	49	23	7(AL)	6.1
J5970000-C-NSW	Neuse Riv nr Goldsboro	<2	2	2	2.025	3	3.7	5.7	12	46	35	7(AL)	2.2
J6150000-C-NSW	Neuse Riv at Kinston	<2	2	2	2	3	5	10	19	53	39	7(AL)	15.1
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<2	2	2	2	2.9	4.35	7.16	16	59	38	7(AL)	10.2
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<2	2	2	2	2.15	3.5	6.39	19	48	28	7(AL)	6.25
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<2	2	2	2	2	3.25	5.72	25	54	27	7(AL)	5.5
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<2	2	2	2	2	3	4.36	12	53	27	7(AL)	1.9
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<2	2	2	2	2.3	3.45	5.3	14	47	32	7(AL)	8.5
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<2	2	2	2	3	4.6	6.34	50	43	26	7(AL)	9.3
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<2	2	2	2	2.4	3.45	7.06	15	55	33	7(AL)	10.9
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<2	2	2	2	2	3	4	17	51	22	7(AL)	3.9
J8210000-SC Sw -NSW	Swift Cr at mouth	<2	2	2	2	2	3	5.54	38	55	28	3(AL)	21.8
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<2	2	2	2	2	2.6	3	11	14	7	3(AL)	7.1
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<2	2	2	2	2.05	4	5.31	10	50	28	3(AL)	32
J8270000-SC Sw -NSW	Neuse Riv at CM64												
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<2	2	2	2	2.45	4	6.85	19	56	34	3(AL)	30.3
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<2	2	2	2	2.4	3.7	5.42	15	58	36	3(AL)	34.5
J8690000-C Sw -NSW	Trent Riv nr Trenton	<2	2	2	2	2	3	6.5	22	56	18	7(AL)	8.9
J8720000-C Sw -NSW	Trent Riv nr Oak Grove												
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<2	2	2	2	2	2	3.6	6	15	6	7(AL)	0
J8770000-C Sw -NSW	Trent Riv nr Rhems	<2	2	2	2	2	2.6	4.38	40	47	17	7(AL)	4.2
J8900800-C Sw -NSW	Neuse Riv at CM22	<2	2	2	2	2.35	4.025	6.49	13	52	29	7(AL)	9.6
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	<2	2	2	2	2.15	3.975	6.63	19	54	31	3(AL)	31.5
J8903500-SB Sw -NSW	Neuse Rv at CM17												
J8903600-SB Sw -NSW	Neuse Riv at CM15												
J8910000-SB Sw -NSW	Neuse Riv at CM11	<2	2	2	2	2	2.775	5.61	17	54	21	3(AL)	16.7
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch												
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe												
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt												
J9530000-SA -NSW	Neuse Riv at CM9	<2	2	2	2	2	3	5.34	11	49	20	3(AL)	24.5
J9540000-SA -NSW	Neuse Riv nr Pierce												
J9590000-SA -NSW	Neuse Riv nr Janeiro												
J9685000-SA-NSW	Neuse Riv nr Merrimon												
J9690000-SA -NSW	Back Cr nr Merrimon	<2	2	2	2	2	2.2	3.4	11	43	14	3(AL)	11.6
J9810000-SA -NSW	Neuse Riv nr Oriental	<2	2	2	2	2	2.9	4	180	52	18	3(AL)	19.2
J9860000-SA -NSW	Neuse Riv nr Cockle Pt												
J9900000-SA-NSW	Neuse Riv nr Piney Pt												
J9930000-SA -NSW	Neuse Riv at mouth	<2	2	2	2	2	2.125	3.55	7.1	40	12	3(AL)	10
J9938000-SA -NSW	West Thorofare Bay at CM10	<2	2	2	2	2	2.525	4	7.9	34	10	3(AL)	20.6
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<2	2	2	2	2	2	2.6	7	44	9	3(AL)	6.8
J9950000-SA -NSW	Bay Riv at CM5	<2	2	2	2	2	2.65	5.2	9.3	27	10	3(AL)	18.5

Table 62. Summary statistics for iron (µg/L) from the Neuse River basin, 1996 - 2000.

		Min	Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	250	250	290	452.5	715	927.5	1820	4300	50	50	000(AL)	24
J0810000-WSIV-NSW	Eno Riv at SR1004	260	260	414	560	800	1100	1840	8500	49	49	000(AL)	29
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	110	110	320	487.5	745	987.5	1500	17000	46	46	000(AL)	23.9
J0840000-WSII-NSW CA	Little Riv Reservoir	80	80	150	280	500	690	1120	1900	69	69	000(AL)	11.6
J1070000-WSII-NSW	Flat Riv nr Quail Roost	290	290	580	695	920	1100	1700	20000	51	51	000(AL)	41.2
J1100000-WSIV-NSW	Flat Riv nr Willardsville	250	250	458	650	830	1300	1640	2400	49	49	000(AL)	40.9
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	230	230	460	740	1100	1425	3460	12000	52	52	000(AL)	55.8
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	150	150	257	432.5	680	1100	1630	14000	50	50	000(AL)	32
J1890000-C-NSW	Neuse Riv nr Falls	120	120	166	310	540	790	1060	1500	49	49	000(AL)	14.3
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	180	180	710	1550	2400	3000	3800	8500	51	51	000(AL)	84.3
J3000000-B-NSW	Crabtree Cr nr Raleigh	240	240	339	652.5	1350	2375	3530	9000	50	50	000(AL)	66
J3251000-C-NSW	Crabtree Cr at SR2000	810	810	916	1425	2150	2550	2970	32000	14	14	000(AL)	85.7
J3290000-C-NSW	Crabtree Cr at U Hwy 1	670	670	820	1050	1600	2300	2720	3800	35	35	000(AL)	77.1
J3300000-C-NSW	Pigeon House Cr	<50	50	469	515	625	770	1110	2200	50	49	000(AL)	14
J4170000-WSIV-NSW	Neuse Riv nr Clayton	390	390	527	662.5	955	1300	2000	9000	58	58	000(AL)	41.4
J4370000-WSIV-NSW	Neuse Riv at Smithfield	600	600	620	830	1100	1600	2300	9000	49	49	000(AL)	57.1
J4510000-C-NSW	Swift Cr nr Clayton	690	690	818	995	1300	1500	1800	2300	47	47	000(AL)	74.5
J5000000-C-NSW	Middle Cr nr Clayton	350	350	591	800	1300	1800	2110	3800	50	50	000(AL)	64
J5850000-WSV-NSW	Little Riv nr Princeton	610	610	914	1200	1500	2000	2820	3800	49	49	000(AL)	85.7
J5970000-C-NSW	Neuse Riv nr Goldsboro	160	160	700	992.5	1250	1700	2050	2300	46	46	000(AL)	73.9
J6150000-C-NSW	Neuse Riv at Kinston	580	580	644	900	1200	1500	1880	2500	53	53	7(AL)	66
J6740000-WSV-NSW	Contentnea Cr nr Lucama	170	170	576	875	1600	2000	2700	4300	59	59	000(AL)	71.2
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	320	320	1000	1275	1600	1825	2100	2900	48	48	000(AL)	87.5
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	320	320	714	1200	1600	2400	2800	3200	35	35	000(AL)	85.7
J7810000-C Sw -NSW	Contentnea Cr at Grifton	700	700	1200	1300	1900	2050	2300	2700	31	31	000(AL)	93.5
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	610	610	672	920	1100	1500	1640	2300	47	47	000(AL)	61.7
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	560	560	688	900	1100	1400	1600	2000	43	43	000(AL)	55.8
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	380	380	640	795	980	1250	1660	3700	55	55	000(AL)	47.3
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<50	340	355	680	1400	2675	3200	6600	54	49	000(AL)	61.1
J8210000-SC Sw -NSW	Swift Cr at mouth	350	350	532	620	880	1100	1400	2200	55	55	NA	NA
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	440	440	503	620	695	905	977	1000	14	14	NA	NA
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	530	530	648	785	925	1200	1700	3200	50	50	NA	NA
J8270000-SC Sw -NSW	Neuse Riv at CM64												
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	460	460	620	722.5	985	1225	1600	3900	56	56	NA	NA
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	81	81	422	552.5	840	1175	1530	3200	58	58	NA	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	<50	50	278	390	590	935	1160	1500	55	53	000(AL)	14.5
J8720000-C Sw -NSW	Trent Riv nr Oak Grove												
J8730000-C Sw -NSW	Trent Riv at Pollocksville	360	360	400	500	590	825	1168	1500	15	15	000(AL)	13
J8770000-C Sw -NSW	Trent Riv nr Rhems	<50	50	118	310	430	635	898	1200	47	45	000(AL)	0
J8900800-C Sw -NSW	Neuse Riv at CM22	50	50	231	377.5	770	1100	1490	2800	52	52	000(AL)	27
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	63	63	96.9	192.5	545	890	1400	2200	54	54	NA	NA
J8903500-SB Sw -NSW	Neuse Rv at CM17												
J8903600-SB Sw -NSW	Neuse Riv at CM15												
J8910000-SB Sw -NSW	Neuse Riv at CM11	<50	50	83.3	240	450	860	1270	1600	54	53	NA	NA
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch												
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe												
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt												
J9530000-SA -NSW	Neuse Riv at CM9	<50	50	62.9	110	250	575	937	1500	50	46	NA	NA
J9540000-SA -NSW	Neuse Riv nr Pierce												
J9590000-SA -NSW	Neuse Riv nr Janeiro												
J9685000-SA-NSW	Neuse Riv nr Merrimon												
J9690000-SA -NSW	Back Cr nr Merrimon	<50	50	142	260	350	685	862	1300	43	42	NA	NA
J9810000-SA -NSW	Neuse Riv nr Oriental	<50	50	57.3	87.75	170	312.5	650	740	52	46	NA	NA
J9860000-SA -NSW	Neuse Riv nr Cockle Pt												
J9900000-SA-NSW	Neuse Riv nr Piney Pt												
J9930000-SA -NSW	Neuse Riv at mouth	<50	50	50	61	84	157.5	280	690	40	30	NA	NA
J9938000-SA -NSW	West Thorofare Bay at CM10	<50	50	50	50.75	80	135	187	1000	34	25	NA	NA
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<50	50	56.3	81.5	115	185	285	400	44	41	NA	NA
J9950000-SA -NSW	Bay Riv at CM5	<50	50	50	54.5	89	140	204	450	27	20	NA	NA

Table 63. Summary statistics for lead (µg/L) from the Neuse River basin, 1996 - 2000.

		Min	Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<10	10	10	10	10	10	10	10	50	0	25	0
J0810000-WSIV-NSW	Eno Riv at SR1004	<10	10	10	10	10	10	10	40	51	0	25	0
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<10	10	10	10	10	10	10	10	46	0	25	0
J0840000-WSII-NSW CA	Little Riv Reservoir	<10	10	10	10	10	10	10	10	69	0	25	0
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<10	10	10	10	10	10	10	12	51	1	25	0
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<10	10	10	10	10	10	21.8	6500	49	9	25	8.16
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<10	10	10	10	10	10	10.8	27	53	6	25	1.9
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	<10	10	10	10	10	10	10	65	51	4	25	2
J1890000-C-NSW	Neuse Riv nr Falls	<10	10	10	10	10	10	10	10	49	0	25	0
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<10	10	10	10	10	10	10	16	51	1	25	0
J3000000-B-NSW	Crabtree Cr nr Raleigh	<10	10	10	10	10	10	10	450	50	4	25	2
J3251000-C-NSW	Crabtree Cr at SR2000	<10	10	10	10	10	10	10	29	14	1	25	7.1
J3290000-C-NSW	Crabtree Cr at U Hwy 1	<10	10	10	10	10	10	10	10	35	0	25	0
J3300000-C-NSW	Pigeon House Cr	<10	10	10	10	10	10	10	36	50	4	25	2
J4170000-WSIV-NSW	Neuse Riv nr Clayton	<10	10	10	10	10	10	10	10	58	0	25	0
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<10	10	10	10	10	10	10	10	49	0	25	0
J4510000-C-NSW	Swift Cr nr Clayton	<10	10	10	10	10	10	10	10	47	0	25	0
J5000000-C-NSW	Middle Cr nr Clayton	<10	10	10	10	10	10	10	10	50	0	25	0
J5850000-WSV-NSW	Little Riv nr Princeton	<10	10	10	10	10	10	10	10	49	0	25	0
J5970000-C-NSW	Neuse Riv nr Goldsboro	<10	10	10	10	10	10	10	10	46	0	25	0
J6150000-C-NSW	Neuse Riv at Kinston	<10	10	10	10	10	10	10	22	53	1	25	0
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<10	10	10	10	10	10	10	10	59	0	25	0
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<10	10	10	10	10	10	10	10	48	0	25	0
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<10	10	10	10	10	10	10	10	54	0	25	0
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<10	10	10	10	10	10	10	15	53	2	25	0
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<10	10	10	10	10	10	10	10	47	0	25	0
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<10	10	10	10	10	10	10	10	43	0	25	0
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<10	10	10	10	10	10	10	10	55	0	25	0
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<10	10	10	10	10	10	10	10	51	0	25	0
J8210000-SC Sw -NSW	Swift Cr at mouth	<10	10	10	10	10	10	10	10	55	0	25	0
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<10	10	10	10	10	10	10	10	14	0	25	0
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<10	10	10	10	10	10	10	10	50	0	25	0
J8270000-SC Sw -NSW	Neuse Riv at CM64												
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<10	10	10	10	10	10	10	10	56	0	25	0
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<10	10	10	10	10	10	10	50	58	0	25	0
J8690000-C Sw -NSW	Trent Riv nr Trenton	<10	10	10	10	10	10	10	84	56	1	25	1.8
J8720000-C Sw -NSW	Trent Riv nr Oak Grove												
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<10	10	10	10	10	10	10	10	15	0	25	0
J8770000-C Sw -NSW	Trent Riv nr Rhems	<10	10	10	10	10	10	10	50	47	0	25	0
J8900800-C Sw -NSW	Neuse Riv at CM22	<10	10	10	10	10	10	10	50	52	0	25	0
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	<10	10	10	10	10	10	10	50	54	0	25	0
J8903500-SB Sw -NSW	Neuse Rv at CM17												
J8903600-SB Sw -NSW	Neuse Riv at CM15												
J8910000-SB Sw -NSW	Neuse Riv at CM11	<10	10	10	10	10	10	10	50	54	0	25	0
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch												
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe												
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt												
J9530000-SA -NSW	Neuse Riv at CM9	<10	10	10	10	10	10	10	50	49	0	25	0
J9540000-SA -NSW	Neuse Riv nr Pierce												
J9590000-SA -NSW	Neuse Riv nr Janeiro												
J9685000-SA-NSW	Neuse Riv nr Merrimon												
J9690000-SA -NSW	Back Cr nr Merrimon	<10	10	10	10	10	25	50	50	43	0	25	0
J9810000-SA -NSW	Neuse Riv nr Oriental	<10	10	10	10	10	10	50	50	52	0	25	0
J9860000-SA -NSW	Neuse Riv nr Cockle Pt												
J9900000-SA-NSW	Neuse Riv nr Piney Pt												
J9930000-SA -NSW	Neuse Riv at mouth	<10	10	10	10	10	10	50	50	40	0	25	0
J9938000-SA -NSW	West Thorofare Bay at CM10	<10	10	10	10	10	10	50	50	34	1	25	0
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<10	10	10	10	10	50	50	50	44	0	25	0
J9950000-SA -NSW	Bay Riv at CM5	<10	10	10	10	10	10	50	50	27	0	25	0

Table 64. Summary statistics for mercury (µg/L) from the Neuse River basin, 1996 - 2000.

		Min	Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	50	0	0.012	0
J0810000-WSIV-NSW	Eno Riv at SR1004	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	50	0	0.012	0
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	46	0	0.12	0
J0840000-WSII-NSW CA	Little Riv Reservoir	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	69	0	0.012	0
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	51	0	0.012	0
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	49	0	0.012	0
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	52	0	0.012	0
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	50	0	0.012	0
J1890000-C-NSW	Neuse Riv nr Falls	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	49	0	0.012	0
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	51	0	0.012	0
J3000000-B-NSW	Crabtree Cr nr Raleigh	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	50	0	0.012	0
J3251000-C-NSW	Crabtree Cr at SR2000	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	14	0	0.012	0
J3290000-C-NSW	Crabtree Cr at U Hwy 1	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	35	0	0.012	0
J3300000-C-NSW	Pigeon House Cr	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	50	50	0.012	0
J4170000-WSIV-NSW	Neuse Riv nr Clayton	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	58	0	0.012	0
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	49	0	0.012	0
J4510000-C-NSW	Swift Cr nr Clayton	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	48	0	0.012	0
J5000000-C-NSW	Middle Cr nr Clayton	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	50	0	0.012	0
J5850000-WSV-NSW	Little Riv nr Princeton	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	49	0	0.012	0
J5970000-C-NSW	Neuse Riv nr Goldsboro	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	46	0	0.012	0
J6150000-C-NSW	Neuse Riv at Kinston	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.2	52	1	0.012	1.9
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	59	0	0.012	0
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	48	0	0.012	0
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	54	0	0.012	0
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	53	0	0.012	0
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	47	0	0.012	0
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	43	0	0.012	0
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	55	0	0.012	5.4
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	51	0	0.012	0
J8210000-SC Sw -NSW	Swift Cr at mouth	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	55	0	0.025	0
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	14	0	0.025	0
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	50	0	0.025	0
J8270000-SC Sw -NSW	Neuse Riv at CM64												
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	56	0	0.025	0
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	58	0	0.025	NA
J8690000-C Sw -NSW	Trent Riv nr Trenton	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	56	0	0.012	0
J8720000-C Sw -NSW	Trent Riv nr Oak Grove												
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	15	0	0.012	0
J8770000-C Sw -NSW	Trent Riv nr Rhems	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	47	0	0.012	0
J8900800-C Sw -NSW	Neuse Riv at CM22	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	52	0	0.012	0
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	54	0	0.025	0
J8903500-SB Sw -NSW	Neuse Rv at CM17												
J8903600-SB Sw -NSW	Neuse Riv at CM15												
J8910000-SB Sw -NSW	Neuse Riv at CM11	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	54	0	0.025	0
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch												
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe												
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt												
J9530000-SA -NSW	Neuse Riv at CM9	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	50	0	0.025	0
J9540000-SA -NSW	Neuse Riv nr Pierce												
J9590000-SA -NSW	Neuse Riv nr Janeiro												
J9685000-SA-NSW	Neuse Riv nr Merrimon												
J9690000-SA -NSW	Back Cr nr Merrimon	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	42	0	0.025	0
J9810000-SA -NSW	Neuse Riv nr Oriental	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	52	0	0.025	0
J9860000-SA -NSW	Neuse Riv nr Cockle Pt												
J9900000-SA-NSW	Neuse Riv nr Piney Pt												
J9930000-SA -NSW	Neuse Riv at mouth	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	40	0	0.025	0
J9938000-SA -NSW	West Thorofare Bay at CM10	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	34	0	0.025	0
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	44	0	0.025	0
J9950000-SA -NSW	Bay Riv at CM5	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	26	0	0.025	0

Table 65. Summary statistics for nickel (µg/L) from the Neuse River basin, 1996 - 2000.

		Min	Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<10	10	10	10	10	10	10	10	50	0	25	0
J0810000-WSIV-NSW	Eno Riv at SR1004	<10	10	10	10	10	10	10	10	51	0	25	0
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<10	10	10	10	10	10	10	10	46	0	25	0
J0840000-WSII-NSW CA	Little Riv Reservoir	<10	10	10	10	10	10	10	10	69	0	25	0
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<10	10	10	10	10	10	10	10	51	0	25	0
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<10	10	10	10	10	10	10	10	49	0	25	0
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<10	10	10	10	10	10	10	14	53	2	88	0
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	<10	10	10	10	10	10	10	10	51	0	25	0
J1890000-C-NSW	Neuse Riv nr Falls	<10	10	10	10	10	10	10	10	49	0	88	0
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<10	10	10	10	10	10	10	10	51	0	88	0
J3000000-B-NSW	Crabtree Cr nr Raleigh	<10	10	10	10	10	10	10	10	50	0	88	0
J3251000-C-NSW	Crabtree Cr at SR2000	<10	10	10	10	10	10	10	10	14	0	88	0
J3290000-C-NSW	Crabtree Cr at U Hwy 1	<10	10	10	10	10	10	10	10	35	0	88	0
J3300000-C-NSW	Pigeon House Cr	<10	10	10	10	10	10	10	13	50	2	88	0
J4170000-WSIV-NSW	Neuse Riv nr Clayton	<10	10	10	10	10	10	10	10	58	0	25	0
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<10	10	10	10	10	10	10	10	49	0	25	0
J4510000-C-NSW	Swift Cr nr Clayton	<10	10	10	10	10	10	10	10	47	0	88	0
J5000000-C-NSW	Middle Cr nr Clayton	<10	10	10	10	10	10	10	10	50	0	88	0
J5850000-WSV-NSW	Little Riv nr Princeton	<10	10	10	10	10	10	10	10	49	0	25	0
J5970000-C-NSW	Neuse Riv nr Goldsboro	<10	10	10	10	10	10	10	10	46	0	88	0
J6150000-C-NSW	Neuse Riv at Kinston	<10	10	10	10	10	10	10	10	53	0	88	0
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<10	10	10	10	10	10	10	10	59	0	25	0
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<10	10	10	10	10	10	10	10	48	0	88	0
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<10	10	10	10	10	10	10	10	54	0	88	0
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<10	10	10	10	10	10	10	10	53	0	88	0
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<10	10	10	10	10	10	10	10	47	0	88	0
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<10	10	10	10	10	10	10	10	43	0	88	0
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<10	10	10	10	10	10	10	10	55	0	88	0
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<10	10	10	10	10	10	10	10	51	0	88	0
J8210000-SC Sw -NSW	Swift Cr at mouth	<10	10	10	10	10	10	10	10	55	0	8.3	0
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<10	10	10	10	10	10	10	10	14	0	8.3	0
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<10	10	10	10	10	10	10	10	50	0	8.3	0
J8270000-SC Sw -NSW	Neuse Riv at CM64												
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<10	10	10	10	10	10	10	10	56	0	8.3	0
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<10	10	10	10	10	10	10	50	58	1	8.3	1.7
J8690000-C Sw -NSW	Trent Riv nr Trenton	<10	10	10	10	10	10	10	10	56	0	88	0
J8720000-C Sw -NSW	Trent Riv nr Oak Grove												
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<10	10	10	10	10	10	10	10	15	0	88	0
J8770000-C Sw -NSW	Trent Riv nr Rhems	<10	10	10	10	10	10	10	10	47	0	88	0
J8900800-C Sw -NSW	Neuse Riv at CM22	<10	10	10	10	10	10	10	50	52	0	88	0
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	<10	10	10	10	10	10	10	50	54	1	8.3	1.8
J8903500-SB Sw -NSW	Neuse Rv at CM17												
J8903600-SB Sw -NSW	Neuse Riv at CM15												
J8910000-SB Sw -NSW	Neuse Riv at CM11	<10	10	10	10	10	10	10	50	54	0	8.3	0
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch												
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe												
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt												
J9530000-SA -NSW	Neuse Riv at CM9	<10	10	10	10	10	10	10	50	49	0	8.3	0
J9540000-SA -NSW	Neuse Riv nr Pierce												
J9590000-SA -NSW	Neuse Riv nr Janeiro												
J9685000-SA-NSW	Neuse Riv nr Merrimon												
J9690000-SA -NSW	Back Cr nr Merrimon	<10	10	10	10	10	10	10	50	43	0	8.3	0
J9810000-SA -NSW	Neuse Riv nr Oriental	<10	10	10	10	10	10	10	50	52	0	8.3	0
J9860000-SA -NSW	Neuse Riv nr Cockle Pt												
J9900000-SA-NSW	Neuse Riv nr Piney Pt												
J9930000-SA -NSW	Neuse Riv at mouth	<10	10	10	10	10	10	10	50	40	0	8.3	0
J9938000-SA -NSW	West Thorofare Bay at CM10	<10	10	10	10	10	10	10	50	34	0	8.3	0
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<10	10	10	10	10	10	10	55	44	1	8.3	2.3
J9950000-SA -NSW	Bay Riv at CM5	<10	10	10	10	10	10	10.4	50	27	1	8.3	3.7

Table 66. Summary statistics for zinc (µg/L) from the Neuse River basin, 1996 - 2000.

		Min	Min	10th%	25th%	Med	75th%	90th%	Max	Count	#>D	C	%>C
J0770000-WSIV-NSW	Eno Riv nr Durham	<10	10	10	10	13	22.75	38.7	100	50	30	50(AL)	6
J0810000-WSIV-NSW	Eno Riv at SR1004	<10	10	10	10	15	23.5	50	160	51	34	50(AL)	10
J0820000-WSII-NSW CA	Little Riv nr Orange Factory	<10	10	10	10	11.5	24.5	42.5	66	46	25	50(AL)	4.3
J0840000-WSII-NSW CA	Little Riv Reservoir	<10	10	10	10	12	30	40	74	69	45	50 (AL)	4.3
J1070000-WSII-NSW	Flat Riv nr Quail Roost	<10	10	10	10	11	21	42	89	51	27	50(AL)	5.9
J1100000-WSIV-NSW	Flat Riv nr Willardsville	<10	10	10	10	14	26	47.6	530	49	31	50(AL)	8.2
J1210000-WSIV-NSW-CA	Knap of Reeds Cr	<10	10	10.2	17	29	39	89.2	590	53	47	50(AL)	18.9
J1330000-WSIV-NSW	Ellerbe Cr nr Durham	14	14	30	37.5	44	61.5	80	150	51	51	50(AL)	37.2
J1890000-C-NSW	Neuse Riv nr Falls	<10	10	10	10	13	23	41.4	81	49	29	50(AL)	6.12
J2850000-B-NSW	Crabtree Cr nr Umstead Pk	<10	10	10	10	17	31	66	140	51	38	50(AL)	9.3
J3000000-B-NSW	Crabtree Cr nr Raleigh	<10	10	12.9	18	26.5	40.5	64.3	130	50	47	50(AL)	16
J3251000-C-NSW	Crabtree Cr at SR2000	<10	10	10	11.25	14.5	26	31.1	69	14	11	50(AL)	7.1
J3290000-C-NSW	Crabtree Cr at U Hwy 1	<10	10	13	17	25	41.5	56.2	120	35	34	50(AL)	14.3
J3300000-C-NSW	Pigeon House Cr	15	15	20.9	26.75	42.5	72.75	120	500	50	50	50(AL)	44
J4170000-WSIV-NSW	Neuse Riv nr Clayton	<10	10	10	14	20	32	45.1	130	58	52	50(AL)	8.6
J4370000-WSIV-NSW	Neuse Riv at Smithfield	<10	10	10	11	16	28	38.6	240	49	40	50(AL)	8.2
J4510000-C-NSW	Swift Cr nr Clayton	<10	10	10	10	11	19.5	38.8	89	47	27	50(AL)	8.5
J5000000-C-NSW	Middle Cr nr Clayton	<10	10	10	10	14	21.5	34.1	70	50	35	50(AL)	6
J5850000-WSV-NSW	Little Riv nr Princeton	<10	10	10	10	14	19	35.4	77	49	31	50(AL)	6.1
J5970000-C-NSW	Neuse Riv nr Goldsboro	<10	10	10	10	18	33	50.5	120	46	34	50(AL)	10.9
J6150000-C-NSW	Neuse Riv at Kinston	<10	10	10	10	13.5	24.5	44.7	140	52	37	50(AL)	7.7
J6740000-WSV-NSW	Contentnea Cr nr Lucama	<10	10	10	10	12	24	52	79	59	41	50(AL)	11.8
J7450000-C Sw -NSW	Contentnea Cr at Hookerton	<10	10	10	11	16	27.25	40.6	61	48	40	50(AL)	2.1
J7739500-C Sw -NSW	Little Contentnea Cr nr Farmville	<10	10	10	12.5	16.5	24.5	41	100	54	47	50(AL)	5.5
J7810000-C Sw -NSW	Contentnea Cr at Grifton	<10	10	10	11	19	28	52.8	110	53	43	50(AL)	11.3
J7850000-C Sw -NSW	Neuse Riv nr Ft Barnwell	<10	10	10	10	14	25	56.8	150	47	29	50(AL)	12.8
J7860000-C Sw -NSW	Neuse Riv at Lane Lndg	<10	10	10	10	13	21	38.6	88	43	25	50(AL)	4.6
J7930000-C Sw -NSW	Neuse Riv at Streets Ferry	<10	10	10	10	14	23	36	99	55	35	50(AL)	3.6
J8150000-C Sw -NSW	Creeping Swp nr Vanceboro	<10	10	10	10	14	24.5	45	87	51	36	50(AL)	5.9
J8210000-SC Sw -NSW	Swift Cr at mouth	<10	10	10	10	11	24.5	32.6	350	55	29	86(AL)	3.6
J8230000-SC Sw -NSW	Swift Cr at NC Hwy 43	<10	10	12.6	15	19	36.5	44	61	14	13	86(AL)	0
J8250000-SC Sw -NSW	Neuse Riv dns Swift Cr	<10	10	10	10	12.5	21.25	36.7	140	50	30	86(AL)	2
J8270000-SC Sw -NSW	Neuse Riv at CM64												
J8290000-SC Sw -NSW	Neuse Riv at Mouth of Narrows	<10	10	10	10	13	20.75	34	110	56	35	86(AL)	1.8
J8570000-SC Sw -NSW	Neuse Riv at US Hwy 17	<10	10	10	10	11.5	26	45.1	140	58	33	86(AL)	3.5
J8690000-C Sw -NSW	Trent Riv nr Trenton	<10	10	10	10	16	27	48.5	110	56	42	50(AL)	8.9
J8720000-C Sw -NSW	Trent Riv nr Oak Grove												
J8730000-C Sw -NSW	Trent Riv at Pollocksville	<10	10	10	11	21	35.5	55.6	59	15	13	50(AL)	20
J8770000-C Sw -NSW	Trent Riv nr Rhems	<10	10	10	10	11	25	33.2	73	47	25	50(AL)	6.4
J8900800-C Sw -NSW	Neuse Riv at CM22	<10	10	10	10	12.5	28.25	39.9	390	52	32	50(AL)	7.7
J8902500-SB Sw -NSW	Neuse Riv anr Thurman	<10	10	10	10	14	27	39.7	140	54	37	86(AL)	3.6
J8903500-SB Sw -NSW	Neuse Rv at CM17												
J8903600-SB Sw -NSW	Neuse Riv at CM15												
J8910000-SB Sw -NSW	Neuse Riv at CM11	<10	10	10	10	12	17.75	32	77	54	33	86(AL)	0
J8920000-SB Sw -NSW	Neuse Riv nr Kennel Bch												
J8925000-SB Sw -NSW	Neuse Riv nr Arapahoe												
J9431500-SB Sw -NSW	Neuse Riv nr Cherry Pt												
J9530000-SA -NSW	Neuse Riv at CM9	<10	10	10	10	16	22	37	70	49	33	86 (AL)	0
J9540000-SA -NSW	Neuse Riv nr Pierce												
J9590000-SA -NSW	Neuse Riv nr Janeiro												
J9685000-SA-NSW	Neuse Riv nr Merrimon												
J9690000-SA -NSW	Back Cr nr Merrimon	<10	10	10	10	13	24.5	36.8	79	43	30	86(AL)	0
J9810000-SA -NSW	Neuse Riv nr Oriental	<10	10	10	10.75	15	24	33.9	180	52	39	86(AL)	1.9
J9860000-SA -NSW	Neuse Riv nr Cockle Pt												
J9900000-SA-NSW	Neuse Riv nr Piney Pt												
J9930000-SA -NSW	Neuse Riv at mouth	<10	10	10	10	15	21	30.7	340	40	28	86(AL)	2.5
J9938000-SA -NSW	West Thorofare Bay at CM10	<10	10	10	10	14.5	29.5	54.8	150	34	22	86(AL)	2.9
J9940000-SA -NSW	Thorofare Canal at NC Hwy 12	<10	10	10	11	14.5	30	43.7	60	44	34	86(AL)	0
J9950000-SA -NSW	Bay Riv at CM5	<10	10	10	10	13	20.5	31.6	110	27	18	86(AL)	3.7

LOWER NEUSE RIVER BASIN COALITION MONITORING

INTRODUCTION

The Lower Neuse Basin Association (LNBA) of NPDES dischargers voluntarily formed in 1994. Data collected from this coalition complements the NCDWQ's basinwide ambient monitoring. The concept of the coalition is to integrate instream sampling requirements as set forth in the NPDES permits with the NCDWQ's basinwide management strategy. Monitoring sites and parameters are located and strategically established such that instream monitoring is more efficient, cost-effective, basin-oriented, and potentially yields better quality and more usable data.

The LNBA is comprised of 25 NPDES dischargers who began sampling in December 1994. The LNBA currently collects water quality data at 50 sites covering the entire lower basin area below the Falls of the Neuse Reservoir. This watershed is approximately 6,200 mi^2 over 19 counties (Figure 136 and Table 67). Field parameters (temperature, dissolved oxygen, conductivity, and pH) were collected 17 times per year; nutrients (total phosphorus, ammonia-nitrogen, nitrate+nitrite nitrogen, and total Kjeldahl nitrogen) were collected monthly; and total suspended solids, turbidity, and fecal coliform bacteria were collected monthly.

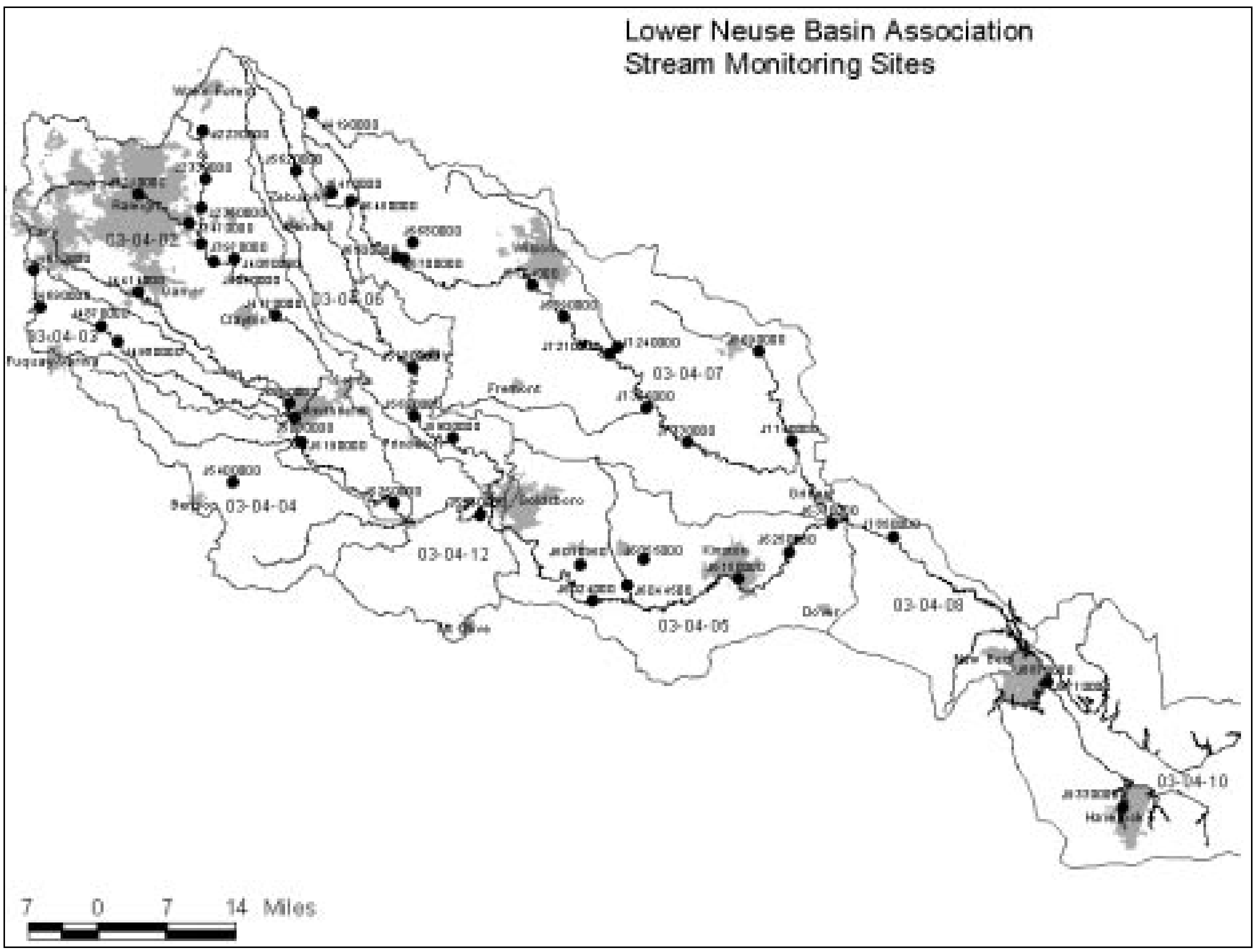


Figure 136. Lower Neuse River Basin Association stream monitoring sites.

Table 67. Lower Neuse River Basin Association monitoring station locations.

Subbasin/ Station No.	County	Station and Location
02		
J2230000	Wake	Smith Cr at SR 2045 near Wake Forest
J2330000	Wake	Neuse R at SR 2215 near Neuse
J2360000	Wake	Neuse R at Milburnie Dam near Raleigh
J3210000	Wake	Crabtree Cr at Lassister Mill Dam at Raleigh
J3470000	Wake	Crabtree Cr at New Hope Rd near Wilders Grove
J3970000	Wake	Walnut Cr at SR 2551 near Raleigh
J4050000	Wake	Neuse R at SR 2555 near Raleigh
J4080000	Wake	Poplar Cr at SR 2049 near Knightdale
J4130000	Johnston	Neuse R at SR 1700 near Archers Lodge
J4170000	Johnston	Neuse R at Hwy 42 near Clayton
J4190000	Johnston	Neuse R at SR 1908 near Wilson Mills
J4414000	Wake	Swift Cr at SR 1152 near Macedonia
J5250000	Johnston	Neuse R at SR 1201 near Cox Mill
03		
J4590000	Johnston	Swift Cr at NC 210 near Smithfield
J4610000	Wake	Middle Cr near Apex
J4690000	Wake	Middle Cr upstream Sunset Lake near Holly Springs
J4870000	Wake	Middle Cr at upstream Hwy 401 near Banks
J4980000	Wake	Middle Cr at SR 1006 near Willow Springs
J5030000	Johnston	Middle Cr at mouth near Smithfield
04		
J5190000	Johnston	Black Cr at mouth near Smithfield
J5400000	Johnston	Hannah Cr at I-95 near Benson
05		
J6010950	Wayne	Walnut Cr at SR 1730 near Elroy
J6024000	Wayne	Neuse R at SR 1731 near Seven Springs
J6044500	Lenoir	Bear Cr at SR 1311 near Kinston
J6055000	Lenoir	Moseley Cr tributary at SR 1327 near Kinston
J6150000	Lenoir	Neuse R at Hwy 11 Bypass at Kinston
J6250000	Lenoir	Neuse R at Hwy 55 near Grainger
J6370000	Lenoir	Neuse R near SR 1803 near Tick Bite[4]
06		
J5620000	Wake	Little R at SR 2333 near Zebulon
J5690000	Johnston	Little R at upstream Hwy 301 near Kenly
J5730000	Johnston	Little R at I-95 near Lowell Mill
J5900000	Wayne	Little R at SR 1234 near Crossroads
07		
J6410000	Wake	Little Cr at Hwy 97 at Zebulon
J6450000	Wake	Little Cr at Hwy 39 at Zebulon
J6500000	Wilson	Moccasin Cr at SR 1131 near Conner
J6700000	Wilson	Turkey Cr at SR 1128 near Conner
J6764000	Wilson	Contentnea Cr at upstream Hwy 301 near Dixie
J6890000	Wilson	Contentnea Cr at SR 1622 near Wilson
J7210000	Wilson	Contentnea Cr at Hwy 58 near Stantonsburg
J7240000	Wilson	Toisnot Swp at SR 1539 near Stantonsburg
J7325000	Greene	Nahunta Swp at Hwy 58 near Contentnea
J7330000	Greene	Contentnea Cr at upstream Hwy 13 at Snow Hill
J7690000	Pitt	Little Contentnea Cr at SR 1218 near Farmville
J7740000	Pitt	Little Contentnea Cr at SR 1110 at Scuffleton
08		
J7850000	Craven	Neuse R at SR 1470 near Fort Barnwell
10		
J8870000	Craven	Trent R at RR Bridge near New Bern
J9330000	Craven	Slocum Cr at Slocum Rd at Cherry Point
J9770000	Pamlico	Smith Cr at Blackwell Point
12		
J5950000	Wayne	Little R at mouth near Asylum

DATA ASSESSMENT AND INTERPRETATION

Selected water quality parameters are summarized in box and whisker plots (Figures 137 to 140), which were used to depict differences in the concentrations of various parameters. These plots readily provide visual differences among stations and identify sites were water quality problems (e.g. low dissolved oxygen or high nutrients) may be present. Figure 137 illustrates how box and whisker plots may be interpreted, however, Figures 138 to 144 do not depict maximum and minimum values.

The parameters depicted in Figures 138 to 144 are limited to dissolved oxygen, turbidity and nutrients. The figures are grouped by mainstem stations, and tributary stations, with the tributary stations are divided into northern and southern components, based upon their position (north or south) relative to the Neuse River.

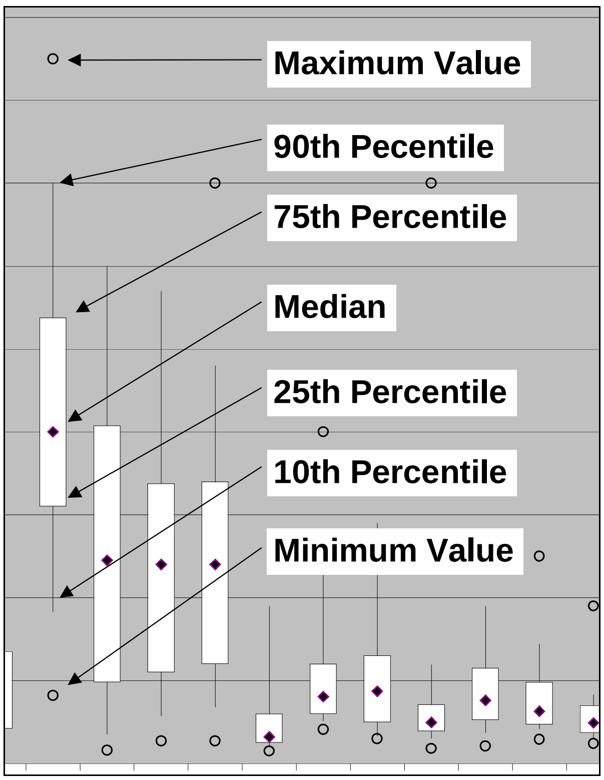


Figure 137. Explanation of box and whisker charts.

Discussion
Turbidity
Box and whisker plots showed elevated turbidity values for one mainstem station (Neuse River at Cox Mill) and seven tributary stations (Little River at Zebulon, Bear Creek near Kinston, Little Creek at Zebulon, Crabtree Creek at Lassiter Mill Dam, Crabtree Creek near Wilders Grove, Swift Creek near Macedonia, and Hannah Creek near Benson (Figures 139, 141, and 143). Although the graphs for these stations depict high turbidity values relative to the other stations on the figures, all stations are freshwater and have a turbidity standard of 50 NTU. The 90th percentile for all these stations was less than 50 NTU, thus fewer than 10 percent of the measurements exceeded the turbidity standard.

High turbidity was previously noted for stations along Crabtree Creek in Raleigh (refer to Ambient Monitoring System section). Similar patterns are found in the turbidity data collected by the LNBA at stations Crabtree Creek at Lassister Mill Dam and Crabtree Creek near Wilders Grove (Figure 143). Although these two stations depict high turbidities, median values were less than 10 NTU.

Dissolved Oxygen
Dissolved oxygen (DO) is an extremely important water quality parameter. Low concentrations directly affect aquatic life and have been responsible for some fish kills, particularly in the estuarine portions of the watershed. Concentrations less than 5.0 mg/L are considered low. A notable exception are streams with a “Swamp waters” (Sw) supplemental water quality classifications. Streams classified as Sw are generally slow moving or stagnant during the summer and commonly have low oxygen concentrations due to natural conditions.

Standards for dissolved oxygen depend on the classification of the body of water. For freshwaters that do not support trout, dissolved oxygen concentrations should be “. . . *not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l; swamp waters, lake coves or backwaters, and lake bottom waters may have lower values if caused by natural conditions*” (NCAC 2001). For salt waters, dissolved oxygen concentrations should be “. . . *not less than 5.0 mg/l, except that swamp waters, poorly flushed tidally influenced streams or embayments, or estuarine bottom waters may have lower values if caused by natural conditions*” (NCAC 2001).

The NCDWQ typically evaluates the proportion of samples with DO concentrations less than 5.0 mg/L. Figures 138, 141, and 143 show that 32 of the 50 stations had greater than 10 percent of the samples less than 5.0 mg/L.. Table 68 identifies many possible causes of the high proportion of samples with DO concentrations less than 5.0 mg/L. Many streams have as Sw (Swamp water) classification or are located near wastewater treatment facilities.

Table 68. Stations with low dissolved oxygen concentrations.

Station No.	Location	% DO samples < 5.0 mg/L	Possible causes, notes
	Mainstem		
J2330000	Neuse R at SR 2215	> 10%	Mainstream dissolved oxygen sag
J2360000	Neuse R at Milburnie Dam	> 10%	Assess dam impact
J4130000	Neuse R at SR 1700	> 10%	unknown
J8870000	Trent R at RR Bridge	> 25%	Sw; Neuse R. Water and Sewer District
J9330000	Slocum Cr at Slocum Rd	> 25%	Sw; Downstream of Havelock WWTP
J9770000	Smith Cr at Blackwell Point	> 10%	Downstream of Oriental WWTP
	Northern Tributaries		
J5620000	Little R at SR 2333	~ 50%	Reference site, (mussels)
J5690000	Little R at upstream Hwy 301	> 25%	Upstream Kenly, endangered species
J5730000	Little R at I-95	> 25%	Kenly
J5900000	Little R at SR 1234	~ 25%	Princeton
J5950000	Little R mouth near Asylum	> 10%	Significant tributary
J6010950	Walnut Cr at SR 1730	~ 50%	Significant tributary
J6450000	Little Cr at Hwy 39	~ 50%	
J6500000	Moccasin Cr at SR 1131	~ 25%	
J6680000	Turkey Creek at SR1101	~ 100%	
J6700000	Turkey Cr at SR 1128	> 25%	Middlesex, Load to Buckhorn 303 (d)
J6764000	Contentnea Cr at Hwy 301	> 10%	Sw; Background from Wiggins Mill
J6890000	Contentnea Cr at SR 1622	> 25%	Sw; Wilson RTI Model sag
J7210000	Contentnea Cr at Hwy 58	> 25%	Sw
J7240000	Toisnot Swp at SR 1539	> 25%	Sw
J7325000	Nahunta Swp at Hwy 58	> 10%	Sw
J7330000	Contentnea Cr at NC 13	~ 25%	Sw
J7690000	Little Contentnea Cr at SR 1218	> 50%	Sw; Farmville, Walstonburg, 303 (d)
J7740000	Little Contentnea Cr at SR 1110	> 25%	Sw; Mouth, load to Contentnea Creek
	Southern Tributaries		
J3210000	Crabtree Cr at Lassister Mill Dam	> 10%	Urban, dissolved oxygen sag Cary, targeted stream
J4414000	Swift Cr at SR 1152	> 10%	NPS concerns
J4610000	Middle Cr near Apex	> 25%	
J4870000	Middle Cr at upstream Hwy 401	> 10%	Dissolved oxygen sag from Cary, 303 (d)
J4980000	Middle Cr at SR 1006	> 10%	Dissolved oxygen sag when Fuquay online 303 (d)
J5030000	Middle Cr at mouth	> 10%	Load to Swift Creek 303(d)
J5190000	Black Cr at mouth	> 25%	Low dissolved oxygen observed 303 (d)
J5400000	Hannah Cr at I-95	> 50%	Low flow stream with major facility 303 (d)

Sw = Stations with Swamp Waters classification.
303 (d) = streams on impaired stream list.

Nutrients

Nutrients include nitrogen and phosphorus and both can contribute to algal growth. Three forms of nitrogen are generally measured. These include ammonia-nitrogen (NH3-N), nitrite and nitrate (NO2+NO3-N) and total Kjeldahl nitrogen (TKN). Figures 140, 142, and 144 depict results for total phosphorus and TKN. Both these nutrients can increase in concentration as a result of wastewater treatment plant discharges and significant nonpoint source loading. The box and whisker plots for total phosphorus measured at stations along the Neuse River showed an increase beginning with the Neuse River near Clayton which is downstream from the Raleigh wastewater treatment facility (Figure 140).

Nutrient samples collected from stations on the northern tributaries to the Neuse River (Figure 142) showed relatively high total phosphorus concentrations for Little Creek downstream of the Zebulon WWTP, Little Contentnea Creek near Farmville, and Little Contentnea Creek at Scuffleton. The site on Little Contentnea Creek at Farmville is downstream of the town's wastewater treatment plant and is on the impaired streams 303 (d) list.

Relatively high TKN concentrations were noted for Turkey Creek below Bailey (Figure 142). Very low dissolved oxygen concentrations were also measured here. Field recognizance in September, 2001 confirmed low oxygen concentrations at this site, perhaps due to swampy conditions. Other stations with elevated TKN concentrations include Contentnea Creek downstream of the Wilson WWTP and Little Contentnea Creek, downstream of the Farmville WWTP.

Wastewater treatment facilities also influenced phosphorus and total Kjeldahl nitrogen concentrations for southern tributaries (Figure 144). [Note the increase for both nutrients beginning with the station at Middle Creek near

Apex, downstream of the Apex WWTP.] Two other sites on Middle Creek -- near Holly Springs and near Willow Springs-- are also near WWTPs, and segments of the creek are also listed on the 303 (d) list. Hannah Creek near Benson and Mosley Creek tributary also showed slight increases for total phosphorus. Both these stations are near dischargers.

Because the Lower Neuse Basin Association member facilities represent approximately 80 percent of all permitted wastewater discharges in the lower basin, nitrogen reduction performance is periodically reviewed. According to the Association, the total pounds of nitrogen discharged into the Neuse River by the Association member facilities between 1995 and 2000 was reduced by 46 percent at the point of discharge and 40 percent at the estuary. During the same period, Association facilities experienced an increase in wastewater flow of 11 percent.

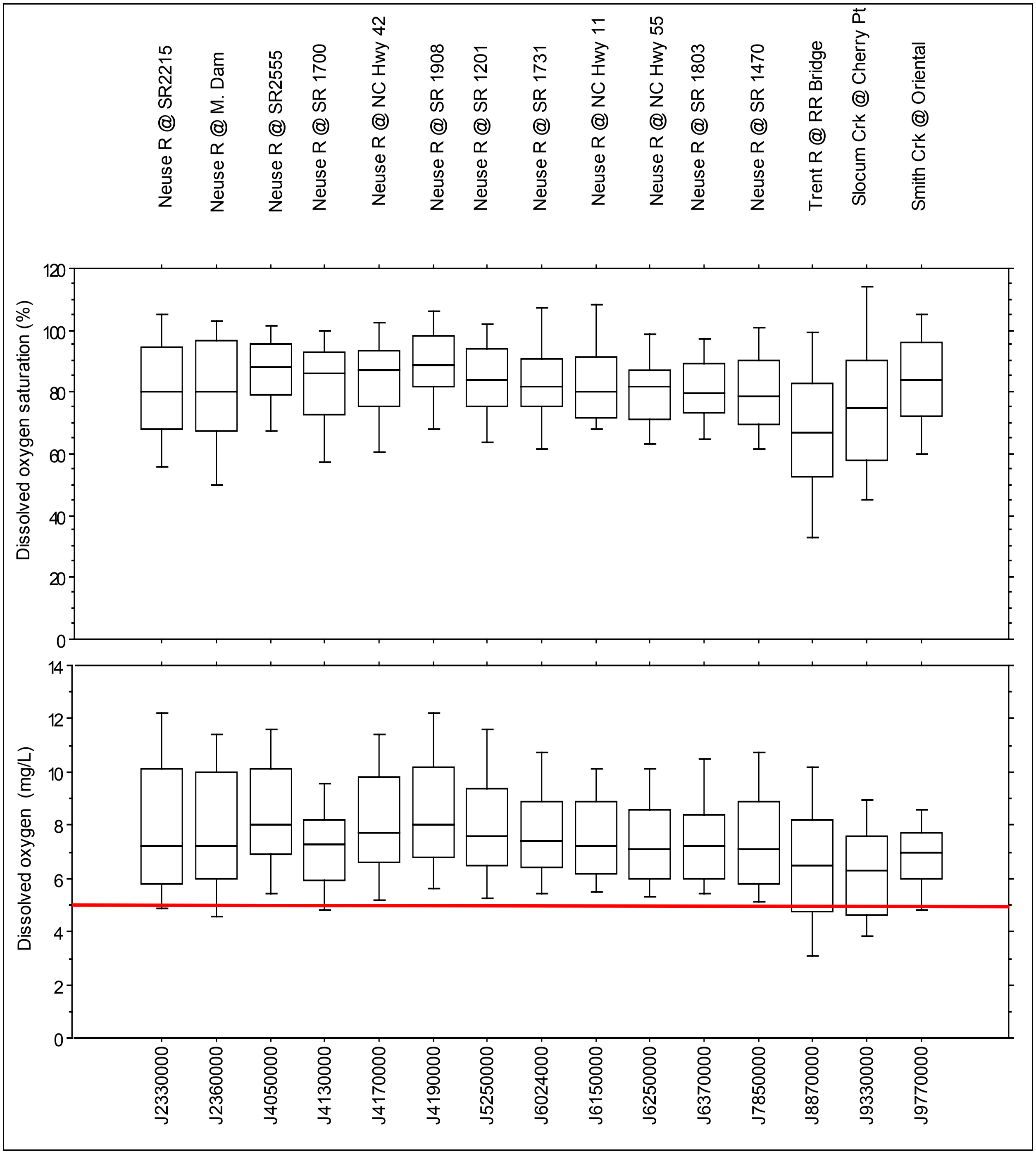


Figure 138. **Box plots for dissolved oxygen and percent saturation for the mainstem Neuse River monitoring stations.**

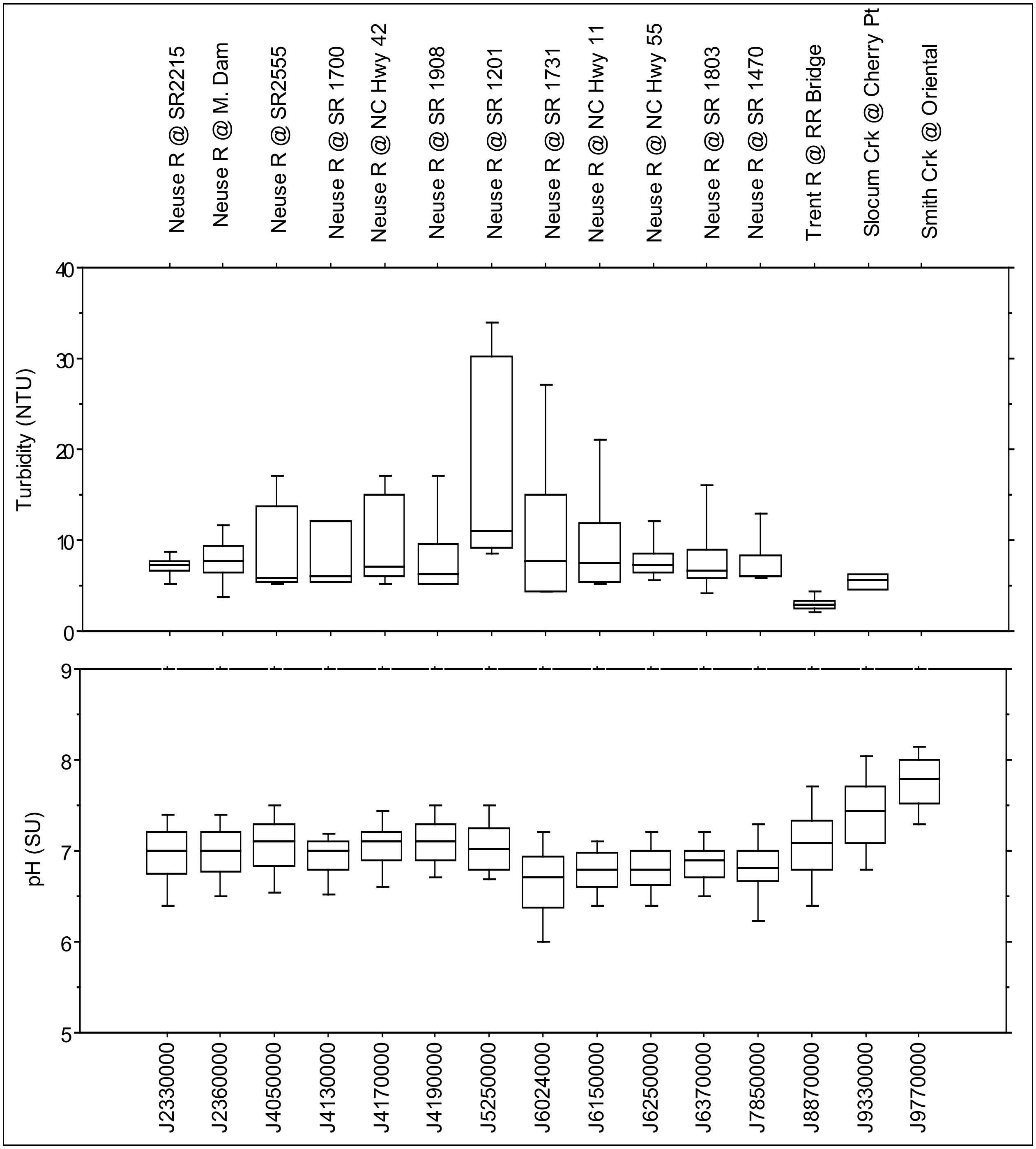


Figure 139. **Box plots for turbidity and pH for the mainstem Neuse River monitoring stations.**

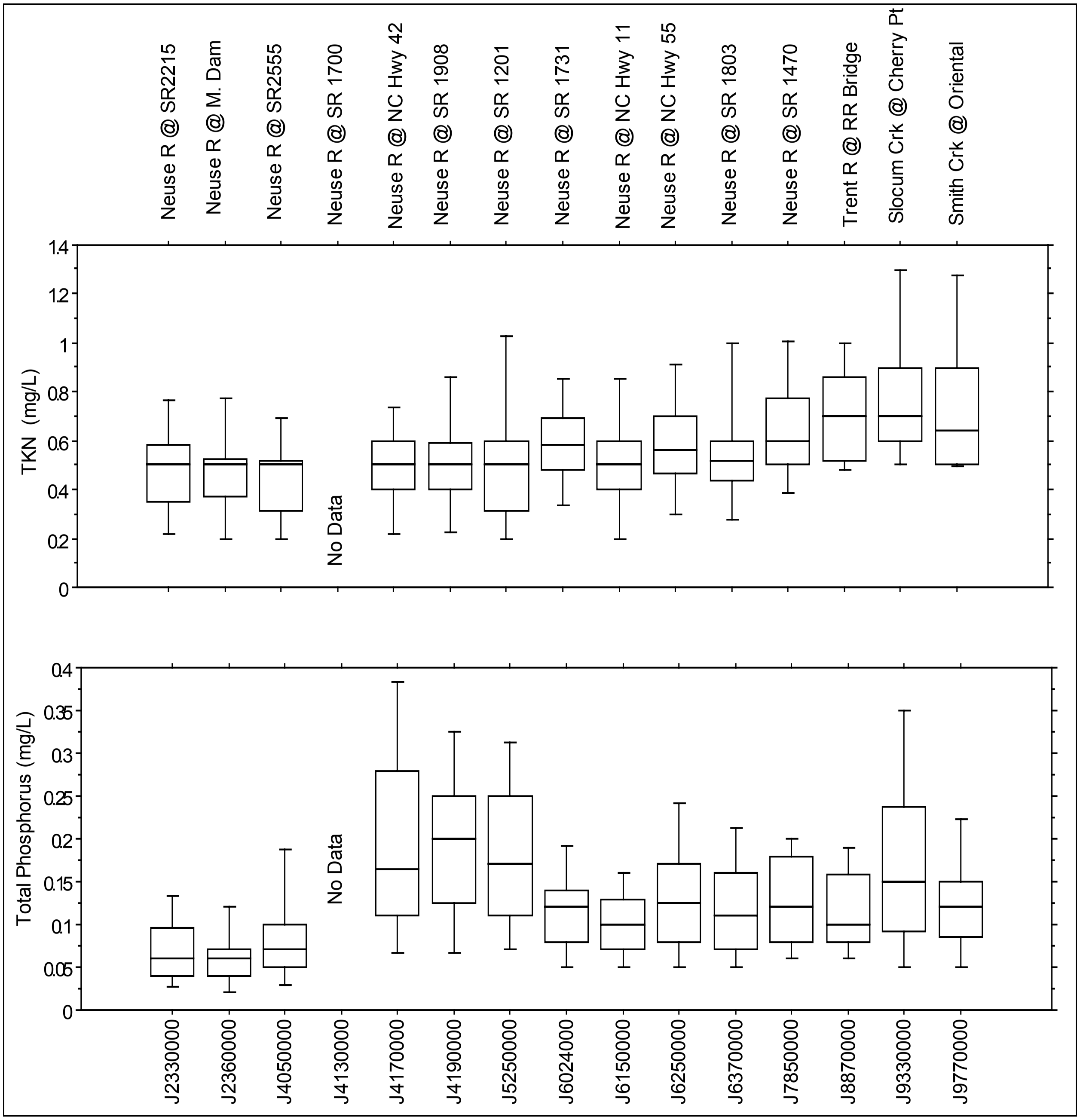


Figure 140. **Box plots for total phosphorus and total Kjeldahl nitrogen for the mainstem Neuse River monitoring stations.**

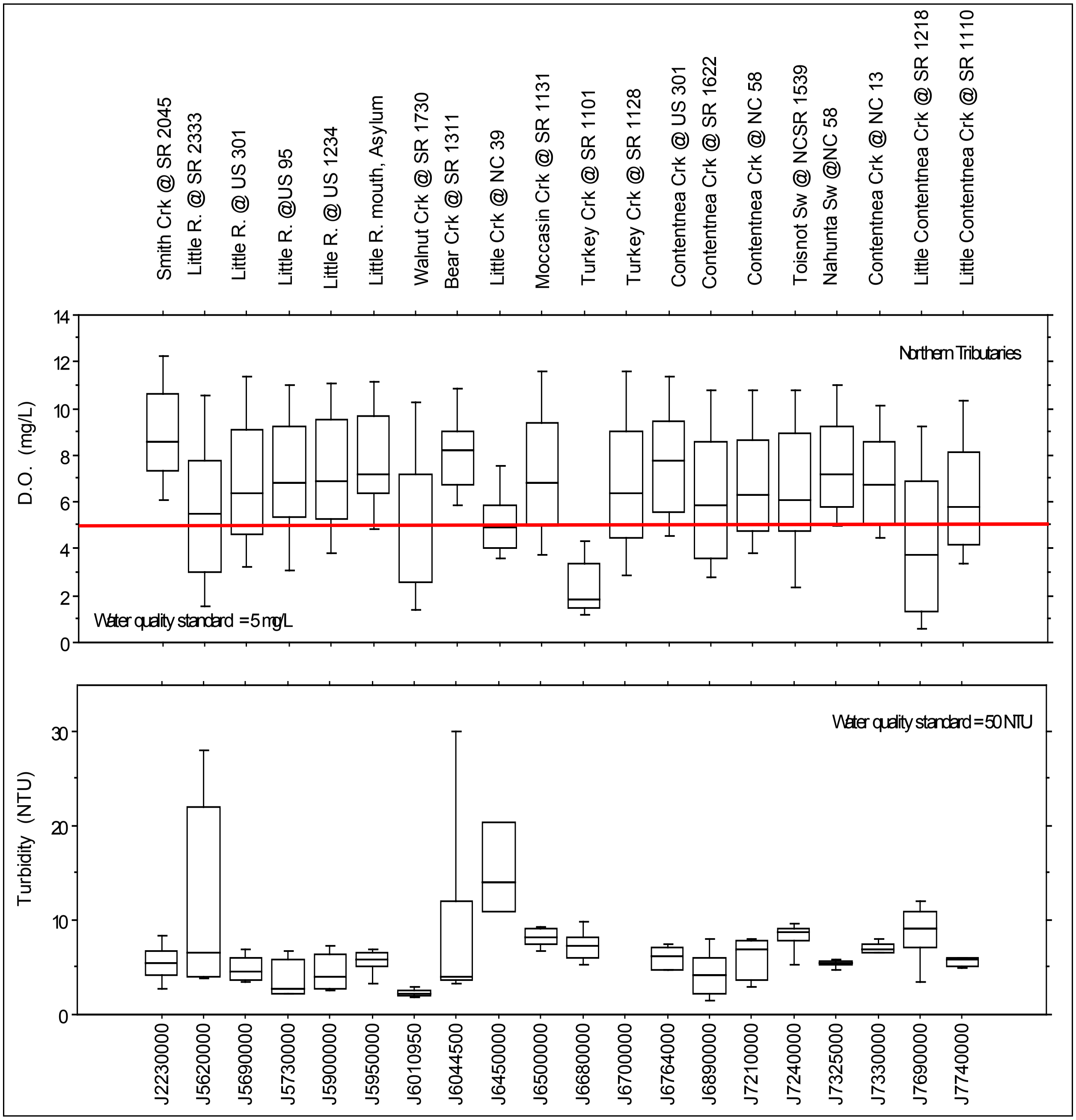


Figure 141. **Box plots for dissolved oxygen and turbidity for the northern tributaries to the Neuse River.**

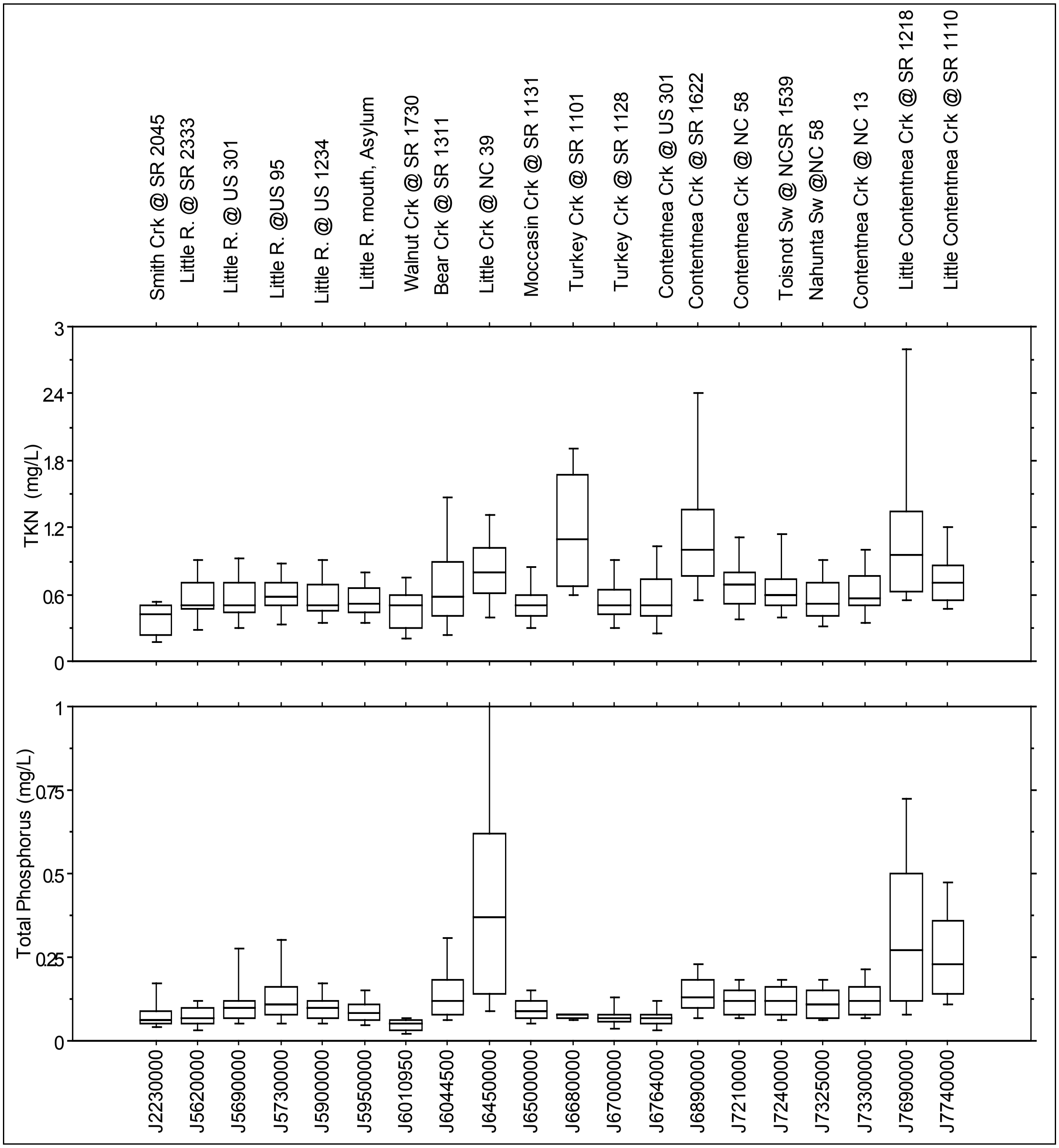


Figure 142. **Box plots for total Kjeldahl nitrogen and total phosphorus for the northern tributaries to the Neuse River.**

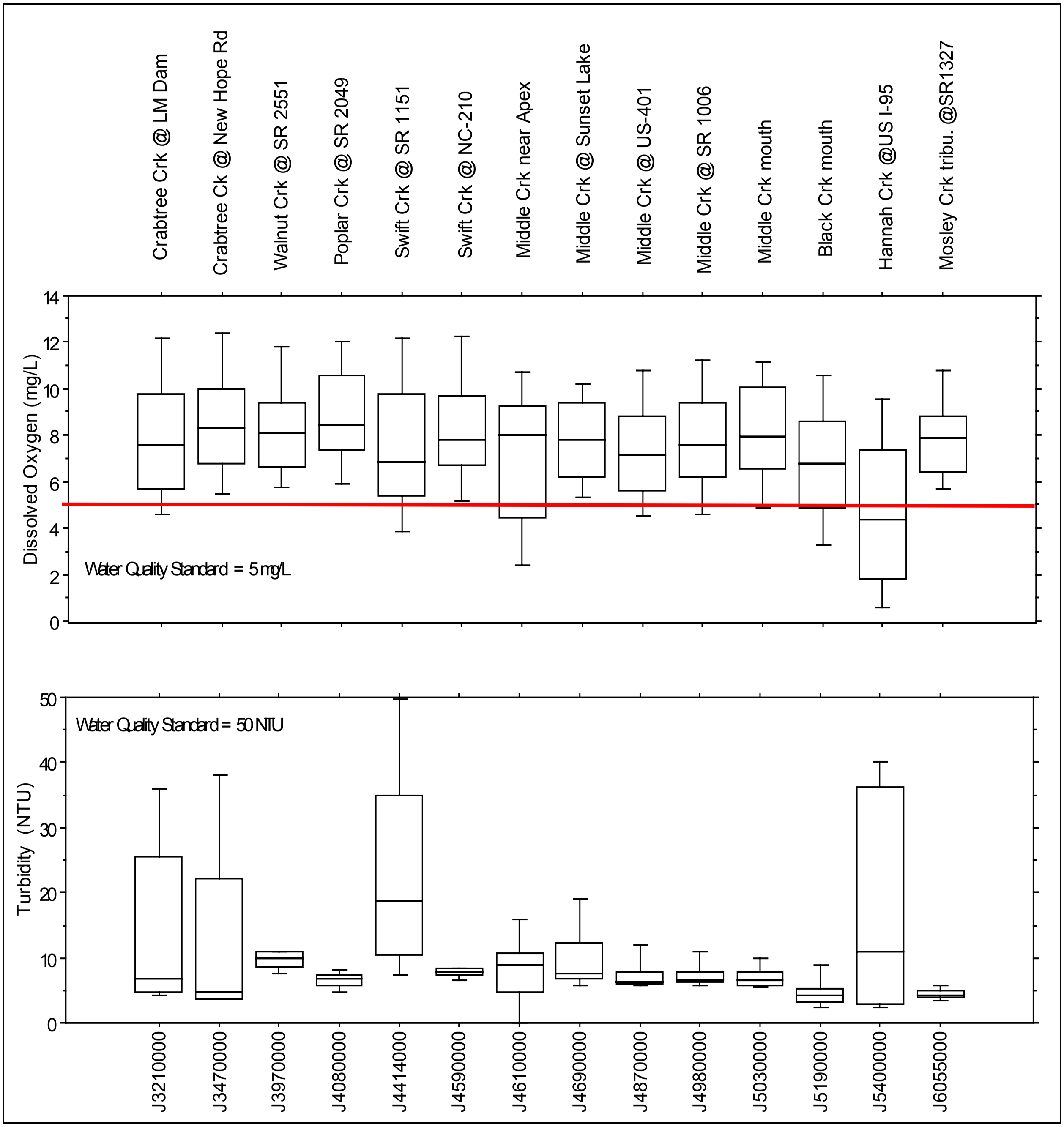


Figure 143. **Box plots for dissolved oxygen and turbidity for the southern tributaries to the Neuse River.**

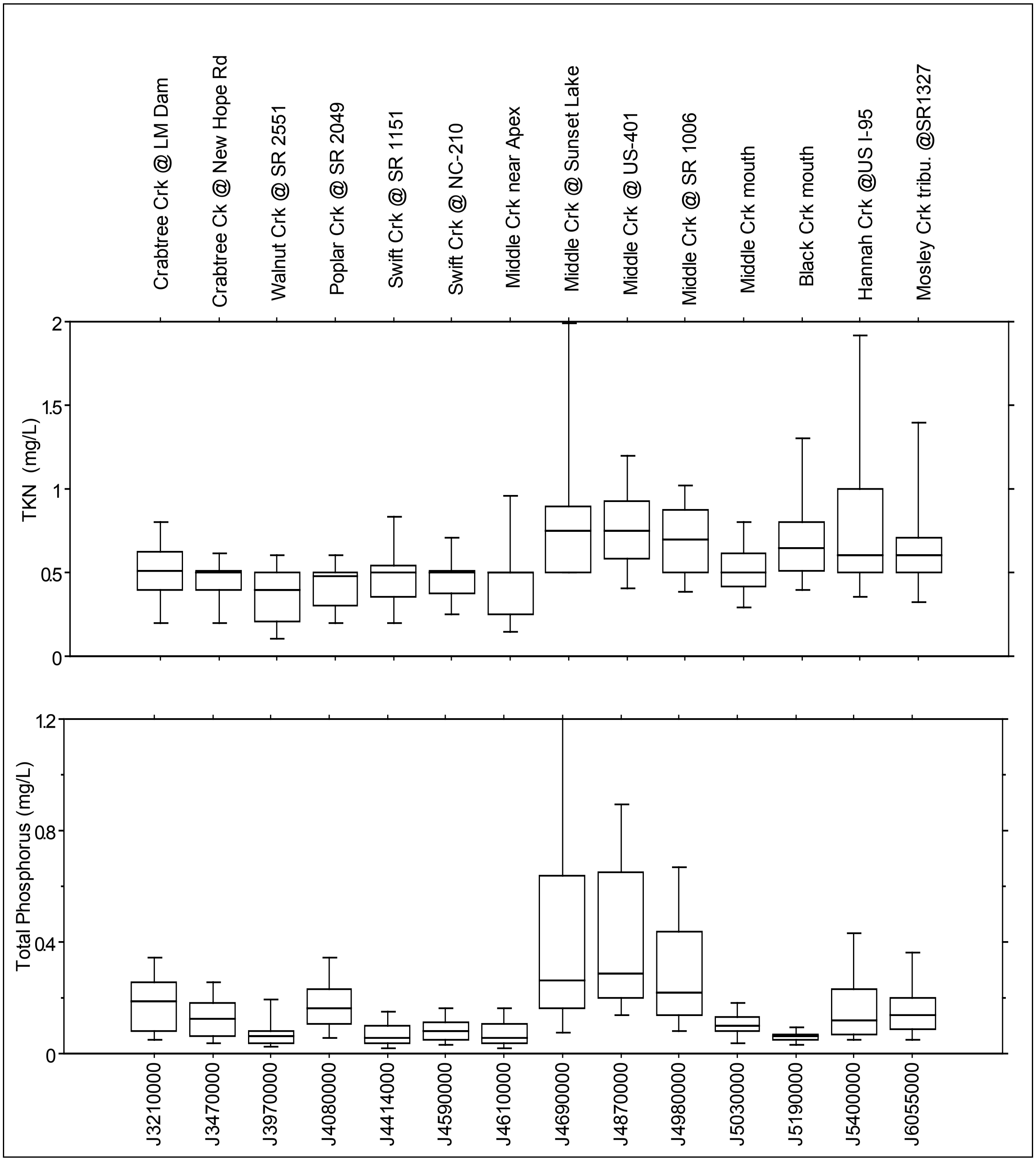


Figure 144. **Box plots for total Kjeldahl nitrogen and total phosphorus for the southern tributaries to the Neuse River.**

AQUATIC TOXICITY MONITORING

Seventy-two facility permits in the Neuse River basin currently require whole effluent toxicity (WET) monitoring (Figure 145 and Table 69).

Forty-five facility permits have a WET limit; the majority of the other facilities have episodic discharges and their permits specify monitoring but with no limit.

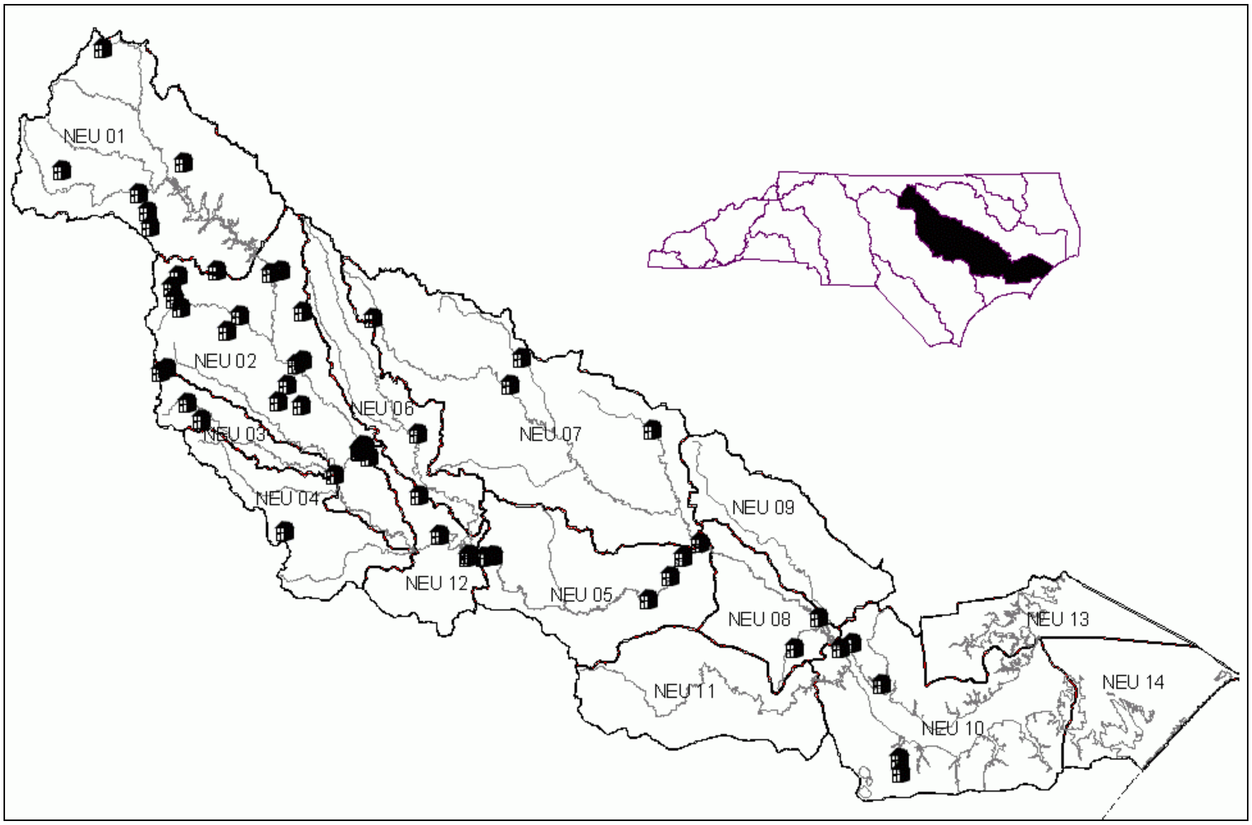


Figure 145. Facilities required to perform toxicity testing in the Neuse River basin.

The number of facilities in this basin monitoring for whole effluent toxicity has increased steadily since 1986, the first year that monitoring was required (Figure 146). Whole effluent toxicity limits were written into permits in North Carolina beginning in 1987. The compliance rate of those facilities has risen since the inception of the program. Since 1991, the compliance rate has also stabilized at approximately 90-95% (Figure 146 and Table 70).

The City of New Bern WWTP (Subbasin 10) has experienced problems consistently meeting its whole effluent toxicity limit since 1994. The City has speculated that the failures are associated with ammonia. The plant currently uses trickling filters for its secondary treatment. This technology is deficient for ammonia removal. The City is in the process of negotiating a special order by consent with the Washington Regional Office to upgrade treatment works for advanced nitrogen and phosphorus removal using a Bardenpho process.

The Town of Cary's North WWTP (Subbasin 02) has experienced recent problems with whole effluent toxicity. The Town is currently undertaking a toxicity reduction evaluation and believes the failures may be related to a toxic fungus or algae.

Table 69. Facilities in the Neuse River basin required to perform whole effluent toxicity testing.

Subbasin/Facility	NPDES Permit No.	Receiving Stream	County	Flow (MGD)	IWC (%)	7Q10
01						
Durham-Northside WWTP	NC0023841/001	Ellerbe Cr.	Durham	20.0	99.5	0.075
Eaton Corp/001	NC0003379/001	UT North Flat R.	Person		100	0.0
Hillsborough WWTP	NC0026433/001	Eno R.	Orange	3.0	96	0.18
John Umstead Hospital	NC0026824/001	Knap Of Reeds Cr.	Granville	3.5	98.4	0.09
Nello L. Teer Company	NC0085243/001	UT Eno R.	Durham	0.108	100	0.0
W. P. Ballard and Company-Durham	NC0086720/001	UT Ellerbe Cr	Durham	0.014	100	0.0
Wildwood Green	NC0063614/001	UT Lower Barton Cr.	Wake	0.1	72	0.06
02						
Alcatel Network Systems Inc.	NC0086126/001	Crabtree Cr.	Wake	0.08	6.1	1.9
BP Oil Co - Gulf Prods Div/002	NC0036145/002	UT Neuse R.	Johnston	VAR	100	0.0
BP Oil Co. - Gulf Prods. Div/001	NC0036145/001	UT Mill Cr.	Johnston	VAR	100	0.0
Carolina Water Service-Kings Grant	NC0062219/001	UT Poplar Cr.	Wake	0.07	100	0.0
Carolina Water Service-White Oak	NC0060330/001	UT White Oak Cr.	Johnston	0.05	100	0.0
Carolina Water Service-Willowbrook	NC0064378/001	UT Beddingfield Cr.	Wake	0.030	100	0.0
Cary North WWTP	NC0048879/001	Crabtree Cr.	Wake	12.0	95.8	0.30
Central Johnston County WWTP	NC0030716/001	Neuse R.	Johnston	4.5	3.6	184
Citgo Petroleum #001	NC0021954/001	UT Mill Cr.	Johnston	VAR	100	0.0
Citgo Petroleum #002	NC0021954/002	UT Mill Cr.	Johnston	VAR	100	0.0
Clayton WWTP	NC0025453/001	Neuse R.	Johnston	1.9	1.6	186
Colonial Pipeline- RDU/001	NC0081469/001	UT Crabtree Cr.	Wake	N/A	100	NA
Colonial Pipeline- RDU/002	NC0081469/002	UT Crabtree Cr.	Wake	VAR	100	0.0
Colonial Pipeline -Selma	NC0031011/001	UT Mill Cr.	Johnston	VAR	100	0.0
Crown Central Petroleum	NC0027227/001	UT Mill Cr.	Johnston	VAR	100	0.0
Exxon Co. - Selma	NC0027006/001	UT Mill Cr.	Johnston	VAR	100	0
Ira D Lee/ Deerchase	NC0063746/001	Toms Cr.	Wake	0.05	90	0.0
Phillips Pipe Line Co.	NC0032875/002	UT Mill Cr.	Johnston	VAR	90	0.0
Phillips Pipeline Co.	NC0032875/001	UT Mill Cr.	Johnston	N/A	100	0.0
Raleigh-Neuse WWTP	NC0029033/001	Neuse R.	Wake	60.0	49.0	98.7
RDU Airport Authority-001	NC0084514/001	UT to Brier Cr.	Wake	N/A	100	0
RDU Airport Authority-002	NC0084514/002	Brier Cr.	Wake	N/A	100	0
RDU Airport Authority-003	NC0084514/003	Brier Cr.	Wake	N/A	100	0
RDU Airport Authority-004	NC0084514/004	UT Sycamore Cr.	Wake	N/A	100	0
Square D-Phase I	NC0081540/001	Marks Cr.	Wake	0.021	14	0.20
TransMontaigne Terminaling/Selma	NC0003549/002	UT Mill Cr.	Johnston	VAR	100	0.0
TransMontaigne Terminaling/Selma	NC0003549/001	UT Mill Cr.	Johnston	VAR	100	0.0
TransMontaigne Terminaling/Selma	NC0003549/003	UT Mill Cr.	Johnston	VAR	100	0.0
Triad Terminal Co./001	NC0049204/001	UT Mill Cr.	Johnston	N/A	100	0.0
Valero Marketing and Supply Co.	NC0076457/001	UT Mill Cr.	Johnston	VAR	100	0.0
Wake Forest WWTP	NC0030759/001	Neuse R.	Wake	6.0	12	67
Ward Transformer Co, Inc.	NC0045608/001	UT Little Brier Cr.	Wake	0.05	100	0.0
William Energy Ventures-Selma	NC0052311/001	UT Mill Cr.	Johnston	---	100	0.0
York Properties	NC0084174/001	UT Pigeon House Br.	Wake	0.0029	100	0.0
03						
Apex WWTP	NC0064050/001	UT Middle Cr.	Wake	3.6	100	0.0
Cary South WWTP	NC0065102/001	Middle Cr.	Wake	12.8	90	0.3
Fuquay-Varina WWTP	NC0066516/001	Terrible Cr.	Wake	0.5	100	0.0
Star Enterprise	NC0022217/001	Middle Cr.	Wake	N/A	100	0.0
04						
Benson WWTP	NC0020389/001	Hannah Cr.	Johnston	1.5	100	0.0
05						
E. I. Dupont De Nemours	NC0003760/001	Neuse R.	Lenoir	3.6	1.9	283.1
GAF Materials Corp.	NC0050695/001	UT Neuse R.	Wayne	0.003	100	0.0
Genoa Ind. WWTP	NC0030392/001	Neuse R.	Wayne	0.40	0.23	270
Goldsboro WWTP	NC0023949/001	Neuse R.	Wayne	10.10	6.0	271.1
Kinston Northside WWTP	NC0024236/001	Neuse R.	Lenoir	4.5	2.4	283.1
Kinston-Peachtree WWTP	NC0020541/001	Neuse R.	Lenoir	6.75	3.5	282.8
USAFB-Seymour Johnson/001	NC0063177/001	UT Stoney Cr.	Wayne	1.0	100	0.0
USAFB-Seymour Johnson/002	NC0063177/002	Neuse R.	Wayne	2.25	1.3	271.1

Table 69 (continued).

Subbasin/Facility	NPDES Permit No.	Receiving Stream	County	Flow (MGD)	IWC (%)	7Q10
06						
Kenly WWTP	NC0064891/001	Little R.	Johnston	0.52	15	4.4
Princeton WWTP	NC0026662/001	Little R.	Johnston	0.275	7.19	5.50
07						
Contentnea MSD	NC0032077/001	Contentnea Cr.	Pitt	2.85	11	36.0
Farmville WWTP	NC0029572/001	L Contentnea Cr.	Pitt	3.5	98.7	0.07
Wilson Technical Community College	NC0084581/001	UT Toisnot Swp.	Wilson	0.0144	100	0.0
Wilson WWTP	NC0023906/001	Contentnea Cr.	Wilson	12.0	97.37	0.5
Zebulon WWTP	NC0079316/001	Little Cr.	Wake	1.85	100	0.0
08						
Craven Co. Wood Energy-001	NC0075281/001	Bachelor Cr.	Craven	0.20	68.89	0.14
Weyerhaeuser-New Bern	NC0003191/001	Neuse R.	Craven	32.0	13	329
10						
Fairfield Harbor Subdivision	NC0033111/001	Neuse R.	Craven	1.00	NA	TIDAL
Havelock WWTP	NC0021253/001	E. Prong Slocum Cr.	Craven	1.9	100	0
New Bern WWTP	NC0025348/001	Neuse R.	Craven	4.7	NA	TIDAL
Phillips Plating Co.	NC0001881/001	Neuse R.	Craven	0.10	100	TIDAL
USMC Cherry Point	NC0003816/001	Neuse R.	Craven	3.5	14.0	TIDAL
USMC Cherry Point #114	NC0003816/114	UT Hancock Cr.	Craven	VAR	100	0.0
USMC Cherry Point 136	NC0003816/136	UT Slocum Cr.	Craven	VAR	100	0.0
12						
CP&L-Lee/001 Ash Pond	NC0003417/001	Neuse R.	Wayne	VAR	0.47	263.0
CP&L-Lee/002	NC0003417/002	Neuse R.	Wayne	VAR	NA	263.0

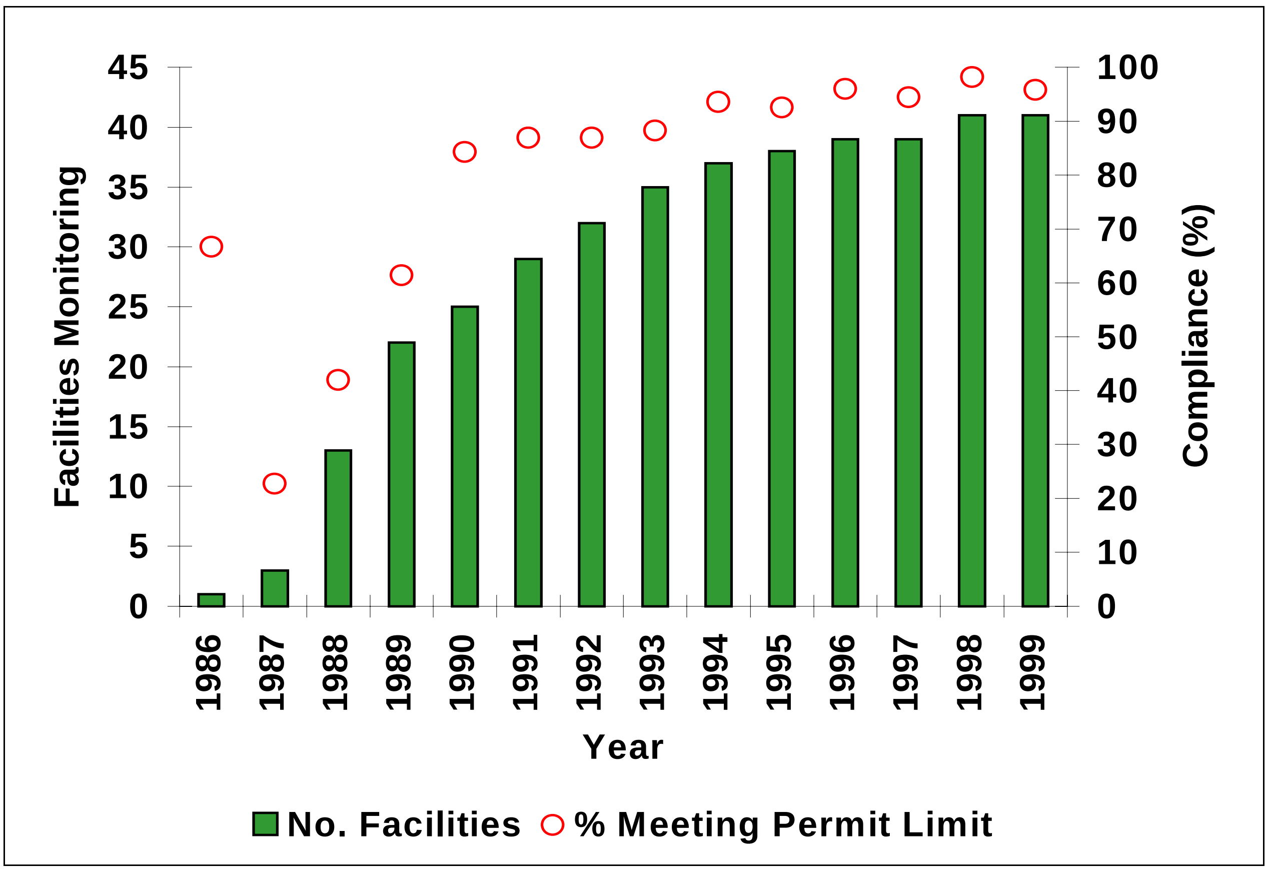


Figure 146. **Whole effluent toxicity monitoring in the Neuse River basin, 1987 - 1999. The compliance values were calculated by determining whether a facility was meeting its ultimate permit limit during the given time period, regardless of any SOCs in force.**

Table 70. Compliance record of facilities performing whole effluent toxicity testing in the Neuse River basin.

Subbasin/Facility	NPDES Permit No.	Pre 2000 Passes[1]	Pre 2000 Fails	2000 Passes	2000 Fails
01					
Durham-Northside WWTP	NC0023841/001	74	23	4	0
Eaton Corp/001	NC0003379/001	0	0	0	0
Hillsborough WWTP	NC0026433/001	44	24	6	2
John Umstead Hospital	NC0026824/001	60	25	5	1
Nello L. Teer Company	NC0085243/001	5	1	3	0
W. P. Ballard and Company-Durham	NC0086720/001	0	0	0	0
Wildwood Green	NC0063614/001	33	9	5	0
02					
Alcatel Network Systems Inc.	NC0086126/001	8	0	4	0
BP Oil Co - Gulf Prods Div/002	NC0036145/002	4	7	1	0
BP Oil Co. - Gulf Prods. Div/001	NC0036145/001	4	15	1	0
Carolina Water Service-Kings Grant	NC0062219/001	33	7	3	0
Carolina Water Service-White Oak	NC0060330/001	19	4	5	1
Carolina Water Service-Willowbrook	NC0064378/001	21	17	4	0
Cary North WWTP	NC0048879/001	48	14	5	0
Central Johnston County WWTP	NC0030716/001	37	2	4	1
Citgo Petroleum #001	NC0021954/001	11	11	1	0
Citgo Petroleum #002	NC0021954/002	6	0	2	0
Clayton WWTP	NC0025453/001	39	17	4	1
Colonial Pipeline - RDU/001	NC0081469/001	9	0	1	0
Colonial Pipeline - RDU/002	NC0081469/002	0	0	0	0
Colonial Pipeline - Selma	NC0031011/001	9	0	1	0
Crown Central Petroleum	NC0027227/001	1	0	0	0
Exxon Co. - Selma	NC0027006/001	11	0	1	0
Ira D Lee/Deerchase	NC0063746/001	35	18	4	0
Phillips Pipe Line Co.	NC0032875/002	0	0	0	0
Phillips Pipeline Co.	NC0032875/001	1	3	0	1
Raleigh-Neuse WWTP	NC0029033/001	47	2	6	1
RDU Airport Authority-001	NC0084514/001	2	6	0	0
RDU Airport Authority-002	NC0084514/002	8	1	0	2
RDU Airport Authority-003	NC0084514/003	16	2	0	0
RDU Airport Authority-004	NC0084514/004	0	0	0	0
Square D-Phase I	NC0081540/001	25	0	4	0
TransMontaigne Terminaling/Selma	NC0003549/002	0	0	2	0
TransMontaigne Terminaling/Selma	NC0003549/001	14	5	1	0
TransMontaigne Terminaling/Selma	NC0003549/003	12	1	1	0
Triad Terminal Co./001	NC0049204/001	15	8	2	0
Valero Marketing and Supply Co.	NC0076457/001	8	3	0	0
Wake Forest WWTP	NC0030759/001	45	3	4	0
Ward Transformer Co, Inc.	NC0045608/001	46	22	4	0
William Energy Ventures-Selma	NC0052311/001	9	0	1	0
York Properties	NC0084174/001	0	0	0	0
03					
Apex WWTP	NC0064050/001	36	8	4	0
Cary South WWTP	NC0065102/001	38	8	6	2
Fuquay-Varina WWTP	NC0066516/001	13	4	4	0
Star Enterprise	NC0022217/001	10	0	1	0
04					
Benson WWTP	NC0020389/001	38	12	4	0
05					
E. I. Dupont De Nemours	NC0003760/001	22	0	4	0
GAF Materials Corp.	NC0050695/001	14	34	3	1
Genoa Ind. WWTP	NC0030392/001	25	2	4	0
Goldsboro WWTP	NC0023949/001	42	0	4	0
Kinston Northside WWTP	NC0024236/001	45	4	4	0
Kinston-Peachtree WWTP	NC0020541/001	44	4	4	0
USAFB-Seymour Johnson/001	NC0063177/001	29	3	3	0
USAFB-Seymour Johnson/002	NC0063177/002	30	1	3	0
06					
Kenly WWTP	NC0064891/001	38	3	5	0
Princeton WWTP	NC0026662/001	44	12	4	0

Table 70 (continued).

Subbasin/Facility	NPDES Permit No.	Pre 2000 Passes[1]	Pre 2000 Fails	2000 Passes	2000 Fails
07					
Contentnea MSD	NC0032077/001	47	2	4	0
Farmville WWTP	NC0029572/001	56	30	4	0
Wilson Technical Community College	NC0084581/001	3	0	4	0
Wilson WWTP	NC0023906/001	40	12	4	0
Zebulon WWTP	NC0079316/001	35	5	4	0
08					
Craven Co. Wood Energy-001	NC0075281/001	39	42	3	0
Weyerhaeuser-New Bern	NC0003191/001	28	1	4	0
10					
Fairfield Harbor Subdivision	NC0033111/001	0	0	0	0
Havelock WWTP	NC0021253/001	42	16	4	0
New Bern WWTP	NC0025348/001	51	20	2	5
Phillips Plating Co.	NC0001881/001	44	3	3	1
USMC Cherry Point	NC0003816/001	45	1	3	0
USMC Cherry Point #114	NC0003816/114	0	4	0	0
USMC Cherry Point 136	NC0003816/136	41	0	3	0
12					
CP&L-Lee/001 Ash Pond	NC0003417/001	41	2	3	0
CP&L-Lee/002	NC0003417/002	2	0	0	0

[1]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.

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GLOSSARY

7Q10	A value which represents the lowest average flow for a seven day period that will recur on a ten year frequency. This value is applicable at any point on a stream. 7Q10 flow (in cfs) is used to allocate the discharge of toxic substances to streams.
Bioclass or Bioclassification	Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each standard qualitative benthic sample based on the number of taxa present in the intolerant insect orders (EPT) and the Biotic Index value.
cfs	Cubic feet per second, generally the unit in which stream flow is measured.
CHL *a*	Chlorophyll *a*.
Class C Waters	Freshwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. All freshwaters shall be classified to protect these uses at a minimum.
Conductivity	In this report, synonymous with specific conductance and reported in the units of µmhos/cm at 25 ^{o}C. Conductivity is a measure of the resistance of a solution to electrical flow. Resistance is reduced with increasing content of ionized salts.
Division	The North Carolina Division of Water Quality.
D.O.	Dissolved Oxygen.
Ecoregion	An area of relatively homogeneous environmental conditions, usually defined by elevation, geology, vegetation, and soil type. Examples include mountains, piedmont, coastal plain, 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.
IWC	Instream Waste Concentration. The percentage of a stream comprised of an effluent calculated using permitted flow of the effluent and 7Q10 of the receiving stream.
Major Discharger	Greater than or equal to one million gallons per day discharge (≥ 1 MGD).
MGD	Million Gallons per Day, generally the unit in which effluent discharge flow is measured.

Minor Discharger	Less than one million gallons per day discharge (< 1 MGD).
NPDES	National Pollutant Discharge Elimination System.
NCBI (EPT BI)	North Carolina Biotic Index, EPT Biotic Index. A summary measure of the tolerance values of organisms found in the sample, relative to their abundance. Sometimes noted as the NCBI or EPT BI.
NCIBI	North Carolina Index of Biotic Integrity (NCIBI); a summary measure of the effects of factors influencing the fish community.
NSW	Nutrient Sensitive Waters. Waters subject to growths of microscopic or macroscopic vegetation requiring limitations on nutrient inputs.
NTU	Nephelometric Turbidity Unit.
ORW	Outstanding Resource Waters. Unique and special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses.
Parametric Coverage	A listing of parameters measured and reported.
SA Waters	Suitable for commercial shellfishing and all other tidal saltwaters uses.
SB Waters	Saltwaters protected for primary recreation which includes swimming on a frequent or organized basis and all Class SC waters.
SC Waters	Saltwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. All saltwaters shall be classified to protect these uses at a minimum.
SOC	A consent order between an NPDES permittee and the Environmental Management Commission that specifically modifies compliance responsibility of the permittee, requiring that specified actions are taken to resolve non-compliance with permit limits.
Total S (or S)	The number of different taxa present in a benthic macroinvertebrate sample.
WWTP	Wastewater treatment plant.

Appendix B1. Benthic macroinvertebrate sampling methods and criteria.

Freshwater wadeable and flowing waters

Benthic macroinvertebrates can be collected from wadeable, freshwater, flowing waters using two sampling procedures. The Biological Assessment Unit's standard qualitative 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 (NCDEHNR 1997). 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).

Benthic macroinvertebrates can also be collected using an EPT sampling procedure. [Note: "EPT" is an abbreviation for Ephemeroptera + Plecoptera + Trichoptera, insect groups that are generally intolerant of many kinds of pollution.] Four rather than 10 composite qualitative samples are taken at each site: 1 kick, 1 sweep, 1 leafpack and visual collections. Only EPT groups are collected and identified, and only EPT criteria are used to assign a bioclassification.

Several data-analysis summaries (metrics) can be produced from standard qualitative and EPT samples to detect water quality problems (Tables B1 and B2). These metrics are based on the idea that unstressed streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted streams have fewer numbers of invertebrate taxa and are dominated by tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts; the tolerance of the stream community is evaluated using a biotic index.

Table B1. Benthos classification criteria for flowing water systems in the piedmont ecoregion.

Metric	Sample type	Bioclass	Score
EPT S	10-sample Qualitative	Excellent	> 31
		Good	24 – 31
		Good-Fair	16 - 23
		Fair	8 – 15
		Poor	0 - 7
	4-sample EPT	Excellent	> 27
		Good	21 - 27
		Good-Fair	14 - 20
		Fair	7 - 13
		Poor	0 - 6
Biotic Index (range 0 – 10)	10-sample Qualitative	Excellent	< 5.19
		Good	5.19 - 5.78
		Good-Fair	5.79 - 6.48
		Fair	6.49 - 7.48
		Poor	> 7.48

Table B2. Benthos classification criteria for freshwater wadeable and flowing water systems in the coastal plain ecoregion.

Metric	Sample type	Bioclass	Score
EPT S	10-sample Qualitative	Excellent	> 27
		Good	21 - 27
		Good-Fair	14 - 20
		Fair	7 - 13
		Poor	0 - 6
	4-sample EPT	Excellent	> 23
		Good	18 - 23
		Good-Fair	12 - 17
		Fair	6 –11
		Poor	0 - 5
Biotic Index (range 0 – 10)	10-sample Qualitative	Excellent	< 5.47
		Good	5.47 - 6.05
		Good-Fair	6.06 - 6.72
		Fair	6.73 - 7.73
		Poor	> 7.73

For standard qualitative samples, EPT taxa richness (EPT S) is used with the NCDWQ criteria to assign water quality scores. Higher EPT taxa richness values usually indicate better water quality. Water quality ratings also are based on the relative tolerance of the macroinvertebrate community as summarized by the North Carolina Biotic Index (NCBI).

Both tolerance values for individual species and the final biotic index values have a range of 0-10, with higher numbers indicating more tolerant species or more polluted conditions. Water quality scores assigned with the biotic index numbers are combined with EPT taxa richness scores to produce a final bioclassification, using criteria for coastal plain streams. EPT abundance (EPT N) and total taxa richness calculations also are used to help examine between-site differences in water quality. If the EPT taxa richness score and the biotic index differ by one, the EPT abundance value is used to determine the final site rating.

Both EPT taxa richness and biotic index values also can be affected by seasonal changes. The NCDWQ criteria for assigning bioclassification are based on summer sampling: June - September. For samples collected outside summer, EPT taxa richness can be adjusted by subtracting out winter/spring Plecoptera or other adjustment based on resampling of summer site. The biotic index values also are seasonally adjusted for samples outside the summer season.

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is not assessed as well by a taxa richness analysis.

Boat Sampling and Coastal B Criteria

Coastal B rivers are defined as waters in the coastal plain that are deep (nonwadeable) with little or no visible current under normal or low flow conditions and that have freshwater. Other characteristics may include open canopy, low pH, and low dissolved oxygen. These waters require a boat for sampling. These are usually large coastal plain rivers, including the lower sections of the Alligator, Chowan, Meherrin, Neuse, Pasquotank, Perquimans, Roanoke, Tar, South, Black, Waccamaw, Wiccacon, Northeast Cape Fear and Cape Fear rivers. In such habitats, petite Ponar dredge sampling replaces kick-net samples, but all other standard qualitative collections techniques are still useable.

The standard boat method still aims at a total of 10 composite samples per site: three samples using a petite Ponar; three bank sweeps, one leafpack sample, two epifaunal collections of macrophytes and well-colonized logs, and visual collections from macrophytes, logs along the shore, and logs in the current.

The Biological Assessment Unit has limited data on Coastal B rivers and has had a difficult time gathering more data. Criteria have been developed based only on EPT taxa richness (Table B2), although using biotic index values and total taxa richness values were also evaluated. 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 B2. Benthos classification criteria for freshwater nonwadeable, Coastal B systems in the coastal plain ecoregion.

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

Swamp streams

Swamp streams are located in the coastal plain area and cease flowing during summer low-flow periods. This seasonal interruption in flow limits the diversity of the fauna, requiring special criteria to properly rate such streams. The swamp stream sampling method utilizes a variety of collection techniques to inventory the macroinvertebrate fauna at a site. A total of nine sweep samples (one series of three by each field team member) are collected from each of the following habitat types: 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 should be substituted. A sweep for the swamp method is defined as the area that can be reached from a given standing location. Three log/debris washes also are 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, or Abundant) for each taxon. Sampling during winter flow periods provides the best opportunity for detecting impacts, and only winter benthos (February and March) data can be used to evaluate swamp streams.

A draft multi-metric system is being developed to evaluate swamp streams, using the NC Biotic Index (BI), habitat score, total taxa richness (S) and EPT abundance (EPT N). The system uses data from the Lumber, White Oak, Cape Fear, Neuse and Tar River basins. Other basins will need different criteria. Swamp streams are divided into two broad types: streams with a distinct channel and streams with a braided channel. Both EPT abundance and total taxa richness are expected to be lower in braided swamp streams. Stream pH also affects these metrics, and scoring criteria will likely be adjusted for all sites with pH < 5.5.

Estuaries

Shallow (< 1.5 m) estuarine waters are sampled using a D-frame dip net with a 600 - 700 µm mesh bag. All available subtidal benthic habitats were swept for a total of ten minutes. Some elutriation of the sample usually took place in the field to reduce sample volume, then the sample was preserved in 10% formalin with rose bengal added as a tissue stain.

At the laboratory, macroinvertebrates were separated from the sediment by visual examination. Macroinvertebrates were identified to the lowest practical taxonomic level, usually species. Abundance was recorded semi-quantitatively, with only a general indication of a taxon's abundance: Rare = 1 - 2; Common = 3 - 9; Abundant = 10 – 29; Very Abundant = 30 – 99; and Dominant > 100. No more than 100 individuals of any taxon were counted since the presence of a greater number of individuals of a particular taxa at a site was no more informative, but much more costly to enumerate.

A biotic index is calculated from the individual taxon's sensitivity values (ranging from 1 to 5) and weighted for abundance using a formula commonly used in calculating freshwater biotic indices (Chutter 1972, Hilsenhoff 1977, Lenat 1993):

$$NCBI = (\sum SV_i * N_i)/\text{Total N}$$

where SV_i is the sensitivity value of the i^{th} taxa, N_i is the abundance of the i^{th} taxa and Total N is the number of individuals in the sample. A high Estuarine Biotic Index (E NCBI) value indicates many intolerant taxa and good water quality at a location, while a low EBI is indicative of stressed conditions.

Amphipoda and Caridean shrimp taxa richness, as well as Total taxa richness, also are used to assess between-site differences. Many species at a location, particularly pollution intolerant taxa, indicate healthy conditions, while few species at a site indicate stressed conditions (Eaton 2001).

A total score is assigned to a body of water based on the values of these three metrics. The score is derived by following these four steps:

1. Assign points for each of three metrics from a sweep sample (Table B2).

2. Sum points. This will yield a number between 3 and 15 with 15 suggesting the least stressed community.

3. Check for Bonus Point conditions. Add 2 points to score if one or more of the conditions occurred:
   - homogeneous habitat,
   - consistently high wave action, or
   - very high (> 26 ppt/yr) salinity fluctuations.

4. Comparisons between sites are made based on the value of the final score.

Table B2. Scoring of estuarine metric criteria.

Salinity[1]	Points	Estuarine BI	Total S	Total S amphipods & caridean shrimp
Polyhaline	1	> 2.6	≥ 95	≥ 21
	2	2.5 - 2.59	86 - 94	18 - 20
	3	2.01 - 2.49	69 - 85	13 - 17
	4	1.91 - 2.0	60 - 68	10 - 12
	5	≤ 1.9	< 60	< 9
Mesohaline	1	> 2.2	≥ 38	≥ 8
	2	2 - 2.16	32 – 37	7
	3	1.96 - 2.15	24 – 31	6
	4	1.9 - 1.95	18 – 23	4 or 5
	5	< 1.9	< 17	< 3

[1]Polyhaline = 21 ppt to seawater, mesohaline = 10 – 20 ppt.

References

Chutter, F. M. 1972. An empirical biotic index of the quality of water in South African streams and rivers. Water Research. 6: 19-30.

Eaton, L. E. 2001. Development and validation of biocriteria using benthic macroinverte-brates for North Carolina estuarine waters. Marine Pollution Bulletin. 42: 23-30.

Hilsenhoff, W. L. 1977. Use of arthropods to evaluate water quality in streams. Wisconsin Department of Natural Resources, Technical Bulletin No. 100.

Lenat, D. L. 1993. A biotic index for the south-eastern United States: derivation and list of tolerance values, with criteria for assigning water-quality ratings. J. North American Benthological Society. 12: 279-290.

Flow Measurement

Changes in the benthic macroinvertebrate community are often used to help assess between-year changes in water quality. Some between-year changes in the macroinvertebrates, however, may be due largely to changes in flow. High flow years magnify the potential effects of nonpoint source runoff, leading to scour, substrate instability, and reduced periphyton. Low flow years may accentuate the effect of point source dischargers by providing less dilution of wastes.

For these reasons, all between-year changes in the biological communities are considered in light of flow conditions (high, low, or normal) for one month before the sampling date. Daily flow information is obtained from the closest available USGS monitoring site and compared to the long-term mean flows. High flow is defined as a mean flow > 140% of the long-term mean for that time period, usually July or August. Low flow is defined as a mean flow < 60% of the long-term mean, while normal flow is 60-140% of the mean. While broad scale regional patterns are often observed, there may be large geographical variation within the state, and large variation within a single summer period.

Habitat Evaluation

The NCDWQ has developed a habitat assessment form to better evaluate the physical habitat of a stream. The habitat score has a potential range of 1 - 100, based on 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.

Appendix B2. Benthic macroinvertebrate data, Neuse River Basin, 1983 - 2000. Basin sites are in bold.

Subbasin/Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPT NCBI	BioClass
1									
Sevenmile Cr	SR 1120	Orange	27-2-6-(0.5)	8/7/00	---	18	---	5.00	Good-Fair
				8/1/95	---	21	---	5.10	Good
				7/8/91	---	20	---	5.28	Good-Fair
Eno R	SR 1336	Orange	27-2-(1)	8/7/00	---	21	---	4.95	Good
				7/24/95	---	20	---	5.30	Good-Fair
				7/8/91	---	20	---	4.45	Good-Fair
Eno R	NC 70 Bypass	Orange	27-2-(7)	8/17/89	75	17	6.16	5.22	Good-Fair
Eno R	NC 86, above WWTP	Orange	27-2-(7)	8/17/89	89	24	6.29	5.51	Good-Fair
Eno R	Above Hillsborough WWTP	Orange	27-2-(7)	9/20/94	72	15	6.05	4.69	Good-Fair
Eno R	Below Hillsborough WWTP	Orange	27-2-(7)	9/20/94	71	13	6.09	4.54	Fair
Eno R	2nd NC 70 Bypass	Orange	27-2-(7)	8/17/89	90	26	6.00	5.19	Good
				6/21/88	73	20	6.06	4.83	Good-Fair
Eno R	SR 1569, Cabes Ford	Orange	27-2-(10)	8/7/00	75	26	4.75	4.24	Excellent
				10/14/96	88	28	5.38	4.52	Good
				7/28/95	85	27	5.09	4.19	Excellent
				7/9/91	97	33	4.89	4.21	Excellent
				6/21/88	92	30	5.66	4.22	Good
Eno R	US 15/501	Durham	27-2-(10)	8/8/00	83	36	5.49	5.00	Excellent
				7/28/95	70	23	5.47	4.63	Good
				7/11/90	87	30	5.65	4.64	Good
				7/14/88	90	27	6.14	5.18	Good
				7/7/86	82	28	5.58	4.46	Good
				8/6/84	87	31	5.43	4.69	Good
Eno R	SR 1004	Durham	27-2-(19.5)	8/9/00	62	24	5.57	4.75	Good
				7/28/95	71	27	5.52	4.94	Good
				7/9/91	88	31	5.35	4.51	Good
				6/10/85	91	32	5.85	4.45	Good
Little R	SR 1461	Durham	27-2-21-(3.5)	8/8/00	88	34	5.27	4.39	Excellent
				7/28/95	81	28	5.72	4.67	Good
				7/8/91	82	31	4.89	3.98	Excellent
				10/22/90	79	25	5.76	4.18	Good
				9/11/90	100	36	5.16	3.92	Excellent
				4/5/90	96	37	4.84	3.88	Excellent
				1/11/90	86	31	5.10	4.17	Excellent
				10/12/89	93	34	4.99	3.61	Excellent
				7/27/89	82	30	5.38	4.79	Good
				4/20/89	78	30	4.58	3.84	Excellent
				2/15/89	102	33	5.79	3.93	Excellent
Little R	US 501	Durham	27-2-21-(3.5)	7/6/87	113	38	5.57	4.46	Excellent
				7/29/85	90	31	5.19	3.90	Good
Little R	SR 1004	Durham	27-2-21-(6)	6/12/85	76	25	5.89	4.70	Good-Fair
S Fk Little R	SR 1538	Orange	27-2-21-2	8/4/00	23	23	4.50	4.50	Good
				8/1/95	---	19	---	4.45	Fair
N Fk Little R	SR 1519	Orange	27-2-21-3	8/04/00	---	17	---	5.09	Good-Fair
				7/24/95	---	11	---	6.16	Fair
N Fk Little R	SR 1538	Orange	27-2-21-3	8/8/00	---	20	---	4.34	Good-Fair
				7/24/95	99	29	5.70	4.63	Good
N Fk Little R	SR 1461	Durham	27-2-21-3	7/8/91	103	33	5.58	4.44	Good
Mountain Cr	Above SR 1464	Durham	27-2-21-4-(1)	3/15/94	44	15	5.86	3.75	Good-Fair
Mountain Cr	Below SR 1464	Durham	27-2-21-4-(1)	3/15/94	50	16	5.68	4.29	Good-Fair
Mountain Cr	SR 1466	Durham	27-2-21-4-(1)	3/15/94	45	17	5.05	3.52	Good-Fair
Flat R	SR 1737	Person	27-3-(1)	6/9/93	81	27	5.37	4.71	Good
				5/8/90	29	29	4.12	4.12	Good

Appendix B2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPT NCBI	BioClass
Flat R	SR 1614	Durham	27-3-(1)	8/3/00	90	30	5.46	4.84	Good
				10/14/96	75	28	5.67	4.66	Good
				3/13/95	102	42	5.00	4.00	Excellent
				7/24/95	86	27	5.80	4.97	Good
				7/8/93	98	32	5.22	4.12	Excellent
				2/8/93	92	33	5.11	3.72	Excellent
				7/8/91	98	36	5.24	4.47	Excellent
				7/11/90	107	37	5.82	4.73	Good
				7/14/88	91	26	5.53	4.43	Good
				7/7/86	92	28	5.55	4.76	Good
				8/9/84	82	25	5.02	4.46	Good
				8/6/84	68	23	5.35	4.43	Good
Flat R	SR 1004	Durham	27-3-(9)	8/9/00	48	13	6.85	5.95	Fair
				8/1/95	62	12	7.06	5.35	Fair
				6/12/85	61	10	7.03	6.56	Fair
N Flat R	SR 1144	Person	27-3-2	6/9/93	65	12	5.93	5.54	Good-Fair
N Flat R	SR 1715	Person	27-3-2	7/8/93	77	24	5.00	4.22	Good
				2/9/93	80	29	4.83	3.60	Excellent
				7/8/91	---	21	---	4.66	Good
S Flat R	SR 1009	Person	27-3-3	5/8/90	---	11	---	5.56	Fair
S Flat R	NC 157	Person	27-3-3	6/9/93	90	24	5.86	4.99	Good-Fair
				5/8/90	29	29	4.73	4.69	Good
S Flat R	SR 1125	Person	27-3-3	7/8/93	75	23	5.25	4.04	Good
				2/9/93	76	28	4.55	3.42	Good
Brushy Fk	SR 1108	Person	27-3-3-1	5/8/90	---	23	---	4.17	Good
Deep Cr	SR 1717	Person	27-3-4	2/9/93	67	20	6.02	4.42	Good
Deep Cr	SR 1715	Person	27-3-4	8/4/00	---	21	---	4.70	Good
				7/24/95	---	23	---	4.88	Good
				3/13/95	113	41	5.08	4.30	Excellent
				2/8/93	80	31	5.25	4.07	Good
				5/8/90	---	32	---	3.85	Excellent
Deep Cr	SR 1734	Person	27-3-4	11/6/84	78	24	5.50	3.52	Good
Knap of Reeds Cr	SR 1104	Granville	27-4-(6)	6/12/85	65	15	6.72	6.31	Fair
Knap of Reeds Cr	Above WWTP	Granville	27-4-(6)	9/19/94	78	12	6.84	5.79	Fair
				8/7/91	58	12	6.64	5.97	Fair
				2/5/87	62	14	6.92	5.00	Fair
				6/12/85	70	10	7.08	6.42	Fair
				5/26/82	61	11	7.09	6.45	Fair
Knap of Reeds Cr	Below WWTP	Granville	27-4-(6)	8/9/00	51	8	7.10	6.55	Fair
				9/19/94	66	7	7.39	5.88	Fair
				8/7/91	46	8	7.08	5.88	Fair
				2/5/87	32	3	8.12	6.23	Poor
				6/12/85	19	0	7.92	0.00	Poor
				5/26/82	30	4	8.05	6.55	Poor
Knap of Reeds Cr	above 1st tributary	Granville	27-4-(6)	2/5/87	39	3	8.32	6.66	Poor
				6/13/85	40	2	7.92	7.30	Poor
Ellerbe Cr	SR 1709	Durham	27-5-(0.7)	3/13/95	32	4	7.88	5.97	Poor
				8/7/91	41	0	8.42	0.00	Poor
Ellerbe Cr	SR 1636	Durham	27-5-(2)	8/23/00	41	6	7.28	6.72	Fair
				3/29/95	38	3	7.74	6.11	Poor
				8/7/91	36	3	7.84	7.42	Poor
				6/10/85	35	2	8.74	7.51	Poor
L Lick Cr	SR 1815	Durham	27-9-(0.5)	2/14/95	27	1	7.95	5.81	Poor
				8/7/91	56	7	7.79	6.25	Poor
				2/15/88	---	5	---	5.80	Poor
L Lick Cr	SR 1814	Durham	27-9-(0.5)	3/6/00	26	2	7.07	7.22	Poor
				2/14/95	34	6	7.89	6.22	Poor
				8/7/91	59	7	7.21	6.34	Fair
				2/15/88	---	4	---	5.99	Poor
				6/13/85	77	11	7.09	5.87	Fair
Lick Cr	SR 1905	Durham	27-11-(0.5)	3/6/00	26	12	6.69	5.69	Fair
				2/14/95	---			5.77	Fair
				2/15/88	---	5	---	4.31	Fair

Appendix B2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPT NCBI	BioClass
Smith Cr	SR 1710	Granville	27-12-2-(1)	8/10/00	---	21	---	5.18	Good
				7/25/95	85	24	5.92	5.37	Good-Fair
				3/2/95	90	31	5.13	4.26	Good
				4/24/92	84	30	5.14	4.44	Good
				8/6/91	---	17	---	4.73	Good-Fair
				11/16/84	84	29	5.41	4.62	Good
				6/20/84	87	23	5.38	4.97	Good
				4/2/84	100	32	5.45	4.44	Good
				1/25/84	79	29	5.01	4.14	Good
New Light Cr	SR 1912	Wake	27-13-(0.1)	8/10/00	---	23	---	5.20	Good
				3/2/95	---	24	---	4.24	Good-Fair
Upper Barton Cr	NC 50	Wake	27-15-(1)	8/10/00	---	14	---	5.44	Good-Fair
				12/9/96	---	13	---	4.58	Fair
				7/25/95	---	16	---	4.49	Good-Fair
				2/23/95	---	32	---	3.93	Good
				2/14/95	---	29	---	3.71	Good
				7/9/91	---	21	---	4.34	Good
Lower Barton Cr	SR 1844	Wake	27-16-(1)	2/14/95	---	31	---	3.82	Good-Fair
		Wake		6/13/85	83	19	6.12	5.34	Good-Fair
Horse Cr	SR 1923	Wake	27-17-(0.7)	9/12/96	---	12	---	4.48	Fair
2									
Neuse R	US 401	Wake	27-(20.7)	7/6/00	63	21	5.76	4.99	Good-Fair
				7/25/95	56	22	5.89	5.01	Good-Fair
				7/9/91	70	20	5.91	5.18	Good-Fair
				8/18/89	53	15	6.27	5.55	Good-Fair
				7/10/87	---	19	---	5.01	Good-Fair
				6/30/87	74	21	6.15	4.83	Good-Fair
				12/4/86	---	12	---	4.97	Fair
				7/26/85	71	20	6.66	5.60	Good-Fair
				11/22/83	58	12	6.33	5.25	Fair
				10/14/83	70	19	6.53	5.56	Good-Fair
				9/16/83	68	13	6.64	5.64	Fair
				7/13/83	58	17	6.14	5.38	Good-Fair
Neuse R	US 1	Wake	27-(20.7)	12/4/86	---	12	---	5.36	Fair
				11/6/85	48	10	7.25	5.56	Fair
Neuse R	US 64	Wake	27-(20.7)	9/11/00	45	16	5.86	5.17	Good-Fair
				10/24/96	48	17	5.61	4.64	Good-Fair
				7/26/95	62	22	5.59	4.79	Good
				7/10/91	69	22	6.00	4.81	Good-Fair
				12/4/86	---	13	---	5.23	Fair
Neuse R	SR 2555	Wake	27-(20.7)	6/30/87	74	22	6.17	5.14	Good-Fair
Neuse R	SR 2509	Wake	27-(20.7)	6/30/87	71	22	6.01	4.98	Good-Fair
UT Neuse R	ab N Wake fill	Wake	27-(20.7)	5/18/92	73	24	5.40	4.01	Good
UT Neuse R	be N Wake fill	Wake	27-(20.7)	5/19/92	50	17	4.77	3.77	Good
UT Neuse R	Mallinkrodt M1	Wake	27-(20.7)	5/18/92	54	5	6.96	4.48	Fair
UT Neuse R	Mallinkrodt M3	Wake	27-(20.7)	5/18/92	49	2	7.61	6.05	Poor
Richland Cr	SR 1931	Wake	27-21	5/20/97	---	17	---	4.08	Good-Fair
Richland Cr	US 1	Wake	27-21	3/17/00	---	18	---	4.90	Good-Fair
				12/10/96	---	13	---	5.08	Fair
				3/10/95	---	20	---	4.41	Good-Fair
				3/24/94	60	22	5.09	4.30	Good-Fair
				8/20/91	---	17	---	4.58	Good-Fair
Smith Cr	be WF Res.	Wake	27-23-(2)	3/25/87	---	2	---	4.95	Poor
Smith Cr	SR 2049	Wake	27-23-(2)	12/2/86	---	12	---	5.45	Fair
Smith Cr	SR 2044	Wake	27-23-(2)	12/2/86	---	2	---	6.58	Poor
Smith Cr	SR 2045	Wake	27-23-(2)	7/6/00	---	12	---	5.10	Fair
				7/25/95	---	15	---	5.38	Good-Fair
				12/2/86	---	4	---	6.07	Poor
Austin Cr	SR 2053	Wake	27-23-3	3/25/87	---	12	---	3.41	Fair
Sanford Br	SR 2049	Wake	27-23-5	12/2/86	---	9	---	5.99	Fair
UT Toms Cr	SR 2044	Wake	27-24	5/12/00	59	20	5.49	4.30	NR
Toms Cr	off powerline	Wake	27-24	5/11/00	45	14	4.98	3.54	NR
Toms Cr	Ab Deerchase	Wake	27-24	8/21/00	36	6	6.79	6.27	NR

Appendix B2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPT NCBI	BioClass
Toms Cr	SR 2044	Wake	27-24	7/6/00	---	11	---	5.40	Fair
				5/11/00	45	8	6.21	5.58	NR
				7/25/95	---	10	---	5.35	Fair
				8/21/91	61	17	5.70	4.23	Good
Perry Cr	SR 2006	Wake	27-25-(2)	7/6/00	---	8	---	5.23	Fair
				12/9/96	---	11	---	5.56	Fair
				7/25/95	---	8	---	5.87	Fair
Mango Cr	ab WWTP	Wake	27-32	3/24/87	---	6	---	4.57	Poor
Mango Cr	be WWTP	Wake	27-32	3/24/87	---	3	---	5.97	Poor
Crabtree Cr	NC 54	Wake	27-33-(1)	7/5/00	70	8	7.55	7.07	Poor
				7/24/95	---	6	---	6.68	Poor
				7/9/91	---	8	---	6.61	Fair
				8/3/88	---	5	---	6.38	Poor
				3/22/88	65	15	7.25	6.24	Fair
Crabtree Cr	SR 1002	Wake	27-33-(1)	8/3/88	---	9	---	6.36	Fair
				3/22/88	66	12	7.25	6.18	Fair
Crabtree Cr	SR 1795	Wake	27-33-(1)	4/19/94	51	6	7.69	7.17	Poor
				6/23/87	---	6	---	6.65	Poor
				10/26/84	73	11	6.59	5.91	Fair
				4/19/84	61	14	6.03	5.16	Good-Fair
Crabtree Cr	I-40	Wake	27-33-(3.5)	4/19/94	55	11	7.18	5.56	Fair
				6/23/87	---	7	---	6.27	Fair
				10/26/84	56	8	7.20	6.60	Fair
				4/12/84	68	16	5.32	4.59	Fair
Crabtree Cr	Umstead Park	Wake	27-33-(3.5)	7/5/00	55	13	6.19	5.99	Good-Fair
				7/24/95	54	13	6.37	5.98	Good-Fair
				4/19/94	54	10	6.56	6.40	Fair
				7/2/87	55	9	6.54	6.69	Fair
				6/23/87	---	9	---	6.09	Fair
				4/15/86	80	20	6.31	5.30	Good-Fair
				10/26/84	65	14	6.18	5.67	Good-Fair
Black Cr	Weston Pkwy	Wake	27-33-5	7/27/00	---	8	---	6.33	Fair
				5/17/94	---	11	---	5.56	Fair
Reedy Cr	Umstead Park	Wake	27-33-8	5/19/00	31	7	6.76	6.16	NR
Sycamore Cr	SR 1649	Wake	27-33-9	8/20/91	---	15	---	5.79	Good-fair
UT Turkey Cr	ab Delta Rdg	Wake	27-33-9-2	7/26/00	26	6	5.25	5.14	NR
UT Turkey Cr	be Delta Rdg	Wake	27-33-9-2	7/26/00	15	3	6.21	3.69	NR
Crabtree Cr	SR 1649	Wake	27-33-(10)	4/19/94	---	9	---	5.62	Fair
				7/9/91	---	9	---	6.30	Fair
				6/22/87	---	15	---	5.63	Good-Fair
Crabtree Cr	US 1	Wake	27-33-(10)	8/30/00	54	13	6.55	5.89	Fair
				10/15/96	41	11	6.64	6.14	Fair
				7/24/95	54	16	6.55	6.09	Fair
				10/12/89	45	12	6.70	6.14	Fair
				7/27/89	54	12	6.62	6.16	Fair
				4/21/89	63	14	6.47	5.31	Fair
				2/15/89	46	9	7.14	6.29	Fair
				9/6/84	56	10	6.85	5.97	Fair
Richlands Cr	SR 1775	Wake	27-33-11	8/15/96	---	7	---	7.04	Fair
Richlands Cr	SR 1649	Wake	27-33-11	8/15/96	---	12	---	6.21	Fair
				7/9/91	---	10	---	6.27	Fair
Hare Snipe Cr	US 70	Wake	27-33-12-(2)	3/17/00	---	5	---	5.53	Poor
				2/23/95	---	10	---	5.17	Fair
Mine Cr	above lake	Wake	27-33-14	9/26/95	---	7	---	5.71	Fair
Mine Cr	below lake	Wake	27-33-14	3/17/00	---	3	---	6.93	Poor
				2/23/95	---	4	---	6.05	Poor
Pigeon House Cr	Dortch St	Wake	27-33-18	7/25/95	31	1	8.85	7.00	Poor
Pigeon House Cr	Fenton St	Wake	27-33-18	2/27/00	33	2	8.13	7.60	Poor
Marsh Cr	near US 1	Wake	27-33-20	7/27/00	40	3	7.43	6.61	Poor
				7/26/95	44	6	6.85	6.47	Fair
				11/16/84	39	4	7.59	6.83	Poor
				4/2/84	39	3	7.88	5.82	Poor
				1/25/84	20	4	7.59	5.57	Poor
				6/4/83	48	6	7.55	6.62	Poor

Appendix B2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPT NCBI	BioClass
Walnut Cr	SR 1700	Wake	27-34-(4)	11/6/85	49	3	7.61	6.84	Poor
Walnut Cr	Hammond Rd	Wake	27-34-(4)	11/6/85	36	5	8.27	7.01	Poor
Walnut Cr	SR 1004	Wake	27-34-(4)	3/24/94	47	7	7.68	5.22	Poor
				11/6/85	36	2	8.26	7.69	Poor
Walnut Cr	State St	Wake	27-34-(4)	3/24/94	45	4	7.28	6.01	Poor
Walnut Cr	SR 2554	Wake	27-34-(4)	3/24/94	44	5	7.33	6.11	Poor
Walnut Cr	SR 1730	Wake	27-34-(4)	7/16/91	---	9	---	6.04	Fair
Walnut Cr	SR 2551	Wake	27-34-(4)	7/27/00	61	15	6.37	5.57	Good-Fair
				7/26/95	51	10	7.03	5.59	Fair
				3/24/94	49	12	6.10	4.60	Fair
				11/8/85	42	13	6.45	5.93	Fair
UT Big Br	ab Goodmark	Wake	27-34-11	4/20/89	47	6	7.03	4.91	NR
UT Big Br	be Goodmark	Wake	27-34-11	4/20/89	31	1	8.11	5.50	NR
UT Poplar Cr	ab WWTP	Wake	27-35	11/10/98	24	5	5.70	3.89	NR
UT Poplar Cr	ab SR 2509	Wake	27-35	11/10/98	17	1	7.80	2.21	NR
Neuse R	NC 42	Johnston	27-(36)	10/12/00	63	25	5.45	4.63	Good
				9/11/00	60	24	5.59	4.73	Good
				10/25/96	49	20	5.32	4.53	Good
				7/27/95	67	21	5.78	4.90	Good-Fair
				7/10/91	70	25	5.82	4.81	Good
				8/6/90	72	23	5.94	4.73	Good-Fair
				7/13/88	79	21	6.08	5.19	Good-Fair
				7/11/88	---	14	---	5.39	Good-Fair
				7/11/86	81	20	6.39	5.09	Good-Fair
				7/11/86	65	18	6.40	5.19	Good-Fair
				7/22/85	63	18	6.26	5.24	Good-Fair
				9/19/84	60	21	5.90	5.08	Good-Fair
				7/14/83	58	13	6.24	5.02	Good-Fair
Neuse R	SR 1201	Johnston	27-(36)	10/13/00	61	23	5.56	4.25	Good
				8/3/95	60	25	4.99	4.00	Good
				7/10/91	64	24	5.61	4.53	Good
UT Neuse R	SR 1903	Johnston	27-(36)	9/15/92	65	18	5.23	4.73	Good
Marks Cr	SR 1714	Johnston	27-38	9/8/00	---	19	---	5.12	Good-Fair
				7/27/95	---	18	---	5.01	Good-Fair
				7/15/91	---	17	---	4.47	Good-Fair
Mill Cr	NC 70A	Johnston	27-40	9/15/92	46	7	7.31	6.58	NR
Swift Cr	Old Raleigh Rd	Wake	27-43-(1)	3/16/89	---	1	---	7.78	NR
Swift Cr	ab Williams Cr	Wake	27-43-(1)	5/19/00	43	7	6.61	6.59	NR
Swift Cr	ab US 1	Wake	27-43-(1)	7/5/00	---	5	---	6.72	Poor
				5/10/00	32	8	6.99	6.78	NR
				7/24/95	---	4	---	7.41	Poor
				7/9/91	---	10	---	6.27	Fair
				3/2/89	---	9	---	6.34	Fair
Swift Cr	SR 1300	Wake	27-43-(1)	5/3/00	63	9	7.36	6.33	Poor
				3/2/89	---	14	---	6.18	Fair
Swift Cr	SR 1152	Wake	27-43-(1)	7/5/00	---	9	---	6.80	Fair
				4/24/00	56	12	6.84	6.41	Fair
				7/24/95	---	7	---	6.34	Fair
				3/6/89	---	9	---	6.17	Fair
UT Swift Cr B	Radio Tower	Wake	27-43-(1)	3/6/89	---	13	---	2.77	NR
UT Swift Cr	nr Swift Cr	Wake	27-43-(1)	3/6/89	---	5	---	4.67	NR
UT Swift Cr A	T4	Wake	27-43-(1)	3/2/89	---	13	---	3.07	NR
UT Swift Cr	Hemlock Bluff	Wake	27-43-(1)	3/2/89	---	23	---	2.91	NR
UT Swift Cr	Old Stage cont	Wake	27-43-(1)	6/13/97	---	16	---	4.12	NR
UT Swift Cr	Old Stage Dev	Wake	27-43-(1)	6/13/97	---	6	---	5.94	NR
Williams Cr	ab US 64	Wake	27-43-2	5/19/00	39	6	7.29	6.69	NR
Williams Cr	Old Raleigh	Wake	27-43-2	3/6/89	---	4	---	6.75	NR
Speight Cr	SR 1345	Wake	27-43-3.5	5/2/00	55	6	6.75	5.51	NR
Swift Cr	NC 42	Johnston	27-43-(8)	7/12/91	---	8	---	5.61	Fair
				7/11/86	53	8	6.75	5.36	Fair
Swift Cr	SR 1525	Johnston	27-43-(8)	7/27/95	---	14	---	5.55	Good-Fair
Swift Cr	SR 1555	Johnston	27-43-(8)	10/2/00	---	16	---	5.76	Good-Fair

Appendix B2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPT NCBI	BioClass
Swift Cr	SR 1501	Johnston	27-43-(8)	10/2/00	67	21	5.52	4.83	Good
				7/27/95	58	18	5.60	5.08	Good
				8/19/91	76	19	5.74	5.00	Good-Fair
UT Swift Cr	ab MHP	Johnston	27-43-(8)	3/24/87	---	15	---	4.09	Good-Fair
UT Swift Cr	be MHP	Johnston	27-43-(8)	3/24/87	---	16	---	4.06	Good-Fair
Little Cr	SR 1562	Johnston	27-43-12	9/8/00	---	11	---	6.20	Fair
				7/27/95	---	10	---	5.59	Fair
				8/19/91	---	13	---	5.48	Fair
Moccasin/Racoon Swp	SR 1007	Johnston	27-51	7/11/91	---	7	---	5.96	Fair
3									
UT Middle Cr	Lufkin Rd.	Wake	27-43-15-(1)	2/6/87	29	2	8.09	2.66	Poor
				2/6/87	27	1	8.90	7.78	Poor
Middle Cr	SR 2739	Wake	27-43-15-(1)	6/2/86	82	12	6.51	5.05	Fair
	Tallicud Rd	Wake	27-43-15-(1)	5/30/86	72	10	6.93	5.89	Fair
Middle Cr	SR 1301	Wake	27-43-15-(1)	9/5/90	81	16	6.26	4.46	Good-Fair
				5/29/86	65	9	7.07	5.70	Fair
Basal Cr	NC 55	Wake	27-43-15-3	5/29/86	95	16	6.08	4.65	Good-Fair
Middle Cr	SR 1375	Wake	27-43-15-(4)	8/21/00	42	13	6.01	5.78	Good-Fair
				8/11/95	39	10	6.01	5.94	Fair
				7/25/91	55	11	6.25	5.77	Good-Fair
				5/30/86	67	14	6.82	4.95	Fair
Middle Cr	US 401	Wake	27-43-15-(4)	6/2/86	96	26	6.22	4.91	Good
Middle Cr	NC 50	Johnston	27-43-15-(4)	8/21/00	49	18	5.49	4.88	Good-Fair
				8/9/95	46	14	5.78	4.68	Good-Fair
				7/24/91	82	17	5.99	4.95	Good-Fair
				7/13/90	84	18	6.16	4.72	Good-Fair
				7/10/87	---	14	---	5.06	Good-Fair
				7/7/87	80	17	6.61	4.83	Fair
Terrible Cr	SR 1507	Johnston	27-43-15-8-(2)	6/3/86	73	13	6.58	5.26	Fair
4									
Black Cr	SR 1330	Johnston	27-45-(2)	8/9/95	47	7	6.56	5.47	Fair
				7/24/91	62	10	7.11	5.86	Fair
Mill Cr	SR 1662	Johnston	27-52	7/11/83	50	19	6.30	4.93	Good-Fair
Mill Cr	SR 1009	Johnston	27-52	8/24/00	---	12	---	5.29	Good-Fair
				8/8/95	---	12	---	4.82	Good-Fair
				8/19/91	---	13	---	5.07	Good-Fair
Hannah Cr	SR 1200	Johnston	27-52-6	7/11/83	58	11	7.55	5.72	Fair
Hannah Cr	SR 1009	Johnston	27-52-6	8/15/00	---	11	---	5.68	Fair
				8/8/95	---	13	---	5.33	Good-Fair
				8/19/91	---	8	---	5.27	Fair
Stone Cr	SR 1138	Johnston	27-52-5	8/9/95	---	8	---	5.46	Good-Fair
5									
Neuse R	NC 58	Lenoir	27-(56)	10/17/00	62	22	5.42	4.17	Good
				8/7/95	58	20	5.08	4.18	Good
				7/19/91	60	21	5.21	4.75	Good
				7/10/90	70	24	5.38	4.51	Good
				7/11/88	71	24	5.66	4.97	Good
				7/7/87	76	23	5.85	4.84	Good-Fair
				6/26/86	74	23	6.28	5.17	Good-Fair
				9/3/85	74	22	5.83	4.73	Good-Fair
				9/4/84	63	20	5.57	4.46	Good
				7/25/83	60	18	5.65	4.90	Good
Stoney Cr	Ashe St park	Wayne	27-62	6/15/00	52	5	7.19	6	Fair
Stoney Cr	SR 1920	Wayne	27-62	8/22/00	---	8	---	5.60	Fair
				6/15/00	50	5	6.98	5.73	Fair
				8/8/95	---	4	---	5.96	Poor
Bear Cr	SR 1731	Wayne	27-572	10/13/00	63	21	5.25	4.24	Good
Bear Cr	SR 1311	Lenoir	27-72	8/22/00	---	13	---	5.24	Good-Fair
				8/7/95	---	7	---	5.40	Fair
				7/10/91	---	14	---	4.92	Good-Fair
Falling Cr	SR 1546	Lenoir	27-77	1/7/97	---	8	---	5.31	Poor
Falling Cr	SR 1519	Lenoir	27-77	10/5/00	---	11	---	5.44	Fair
Falling Cr	SR 1001	Lenoir	27-77	11/18/99	---	13	---	5.61	Good-Fair

Appendix B2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPT NCBI	BioClass
Falling Cr	SR 1340	Lenoir	27-77	7/10/91	---	14	---	4.55	Good-Fair
				8/7/95	---	12	---	5.45	Good-Fair
Southwest Cr	SR 1804	Lenoir	27-80	8/7/95	---	6	---	6.03	Not Rated
Briery Run	SR 1732	Lenoir	27-81-8	7/10/91	---	6	---	6.03	Not Rated
				11/2/93	23	1	8.82	6.37	Not Rated
Stonyton Cr	SR 1742	Lenoir	27-81-8	11/2/93	25	1	7.52	5.50	Not Rated
6									
Little R	NC 96	Wake	27-57-(1)	08/15/00	---	20	---	5.09	Good-Fair
				08/24/95	94	21	6.48	4.94	Good-Fair
				01/27/95	70	20	6.45	4.84	Good-Fair
				08/14/91	81	21	6.35	5.13	Good-Fair
				11/06/84	98	25	6.12	4.64	Good-Fair
				09/21/84	92	21	5.98	4.94	Good-Fair
				08/02/84	96	18	5.87	4.62	Good-Fair
				06/22/84	101	23	6.00	4.77	Good-Fair
				05/15/84	107	26	5.91	4.49	Good
				04/13/84	104	32	5.62	4.31	Good
				03/14/84	102	30	5.74	4.42	Good
				02/10/84	89	24	5.65	4.67	Good
				01/23/84	80	28	5.74	5.03	Good
				12/16/83	107	28	6.19	5.40	Good-Fair
				11/22/83	100	25	6.33	5.15	Good-Fair
				10/14/83	96	21	6.10	4.89	Good-Fair
				09/07/83	89	19	6.43	4.94	Good-Fair
Little R	SR 2224	Wake	27-57-(1)	01/27/95	75	15	6.19	5.01	Good-Fair
Little R	SR 1722	Johnston	27-57-(8.5)	07/23/91	77	19	6.14	4.72	Good-Fair
Little R	SR 2130	Johnston	27-57-(8.5)	08/15/00	66	19	5.51	4.68	Good
				08/24/95	75	16	5.98	4.85	Good-Fair
				07/23/91	75	24	5.39	4.73	Good
				03/24/88	---	37	---	3.55	Excellent
Little R	SR 2335	Johnston	27-57-(8.5)	03/23/88	---	16	---	5.17	Good-Fair
Little R	SR 2320	Johnston	27-57-(8.5)	07/11/89	64	17	5.73	5.13	Good-Fair
				07/08/87	83	23	5.77	5.01	Good-Fair
				09/03/85	78	13	6.51	5.35	Fair
				07/11/83	63	22	5.31	4.09	Good
Buffalo Cr	SR 1007	Wake	27-57-16-(2)	08/06/91	---	2	---	7.63	Poor
Buffalo Cr	SR 1941	Johnston	27-57-16-(3)	08/15/00	73	15	6.27	5.47	Good-Fair
				07/25/91	---	9	---	4.62	Fair
Mill Cr	above Kenly WWTP	Johnston	27-57-18	03/23/88	41	8	6.89	4.67	Not Rated
Mill Cr	below Kenly WWTP	Johnston	27-57-18	03/23/88	23	1	8.60	5.81	Not Rated
				07/23/91	56	5	7.30	6.90	Not Rated
Little R	NC 581	Wayne	27-57-(20.2)	08/24/00	60	17	5.56	4.48	Good-Fair
				08/24/95	69	17	6.11	4.33	Good-Fair
				07/24/91	78	25	5.51	4.58	Good
Little R	off SR 1326	Wayne	27-57-(21.1)	07/06/94	84	20	6.49	4.93	Good-Fair
Little R	above US 70	Wayne	27-57-(21.2)	07/xx/94	69	21	---	---	Good
Little R	US 70	Wayne	27-57-(21.2)	07/06/94	---	14	---	4.81	Good-Fair
7									
Moccasin Cr	NC 231	Nash	27-86-2	09/22/00	---	17	---	5.37	Good-Fair
				08/15/00	---	14	---	6.04	Good-Fair
				09/20/96	---	13	---	5.21	Fair
				08/23/95	---	16	---	5.38	Good-Fair
				07/25/91	---	17	---	4.97	Good-Fair
Moccasin Cr	SR 1131	Nash	27-86-2	05/29/91	64	16	6.01	5.32	Good-Fair
				05/10/88	79	25	5.81	5.15	Good
Little Cr	NC 39	Wake	27-86-2-4	07/23/91	46	2	7.92	7.64	Poor
Bull Br	above SR 2110	Johnston	27-86-2-6.5	10/03/00	43	17	4.96	4.21	Not Rated
Turkey Cr	SR 1109	Nash	27-86-3-(1)	08/15/00	---	11	---	6.26	Fair
Turkey Cr	SR 1101	Nash	27-86-3-(1)	05/29/91	74	14	6.67	6.10	Fair
				05/10/88	81	15	6.38	5.65	Good-Fair
Turkey Cr	SR 1128	Wilson	27-86-3-(1)	08/23/95	---	18	---	4.84	Good-Fair
				07/25/91	13	13	5.13	5.13	Good-Fair

Appendix B2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPT NCBI	BioClass
Beaverdam Cr	SR 1111	Nash	27-86-3-8	10/03/00	56	8	6.52	6.60	Fair
				07/22/91	84	18	6.00	5.00	Good-Fair
Beaverdam Cr	SR 1112	Nash	27-86-3-8	05/29/91	75	11	6.54	5.66	Fair
				05/10/88	76	17	6.27	5.14	Good-Fair
Bloomery Swp	NC 42	Wilson	27-86-6-(3)	09/20/96	---	4	---	5.95	Poor
		Wilson		08/28/96	60	8	6.40	5.87	Good-Fair
Contentnea Cr	NC 42	Wilson	27-86-(1)	08/29/96	67	15	6	5.65	Good-Fair
Contentnea Cr	SR 1606	Wilson	27-86-(7)	08/28/96	62	9	6.96	6.07	Fair
Contentnea Cr	NC 222	Wilson	27-86-(7)	08/29/00	78	20	6.39	5.65	Good-Fair
Contentnea Cr	NC 58	Wilson	27-86-(7)	08/23/95	64	11	7.07	6.36	Fair
				07/22/91	78	19	6.28	5.38	Good-Fair
				07/09/90	54	13	6.95	5.43	Fair
				07/11/88	60	7	7.09	6.14	Fair
				07/10/86	79	15	6.56	5.27	Good-Fair
Contentnea Cr	SR 1800	Pitt	27-86-(7)	10/17/00	75	19	6.35	5.19	Good-Fair
				08/22/95	69	16	6.51	5.06	Good-Fair
				07/22/91	77	25	5.69	4.75	Good
				07/07/87	89	24	6.37	5.11	Good
				07/22/85	86	20	6.54	5.14	Good-Fair
				07/26/83	70	20	6.13	5.02	Good-Fair
Great Swp	SR 1634	Wilson	27-86-9-3	08/28/96	60	4	7.23	6.01	Poor
Toisnot Swp	US 264	Wilson	27-86-11-(5)	10/05/00	---	9	---	5.80	Fair
Toisnot Swp	NC 222	Wilson	27-86-11-(5)	08/29/96	68	5	6.71	6.77	Fair
				07/24/91	---	11	---	5.82	Fair
Nahunta Swp	SR 1058	Greene	27-86-14	08/16/00	72	9	6.54	5.43	Fair
				11/18/99	---	6	---	5.83	Fair
				08/22/95	57	6	6.40	5.76	Fair
				07/09/90	68	16	6.54	5.24	Good-Fair
				05/02/90	66	13	6.34	5.13	Good-Fair
				07/11/88	65	10	6.70	4.99	Fair
Wheat Swp Cr	NC 58	Lenoir	27-86-24	02/22/00	48	6	7.54	6.03	Not Rated
	SR 1091	Greene	27-86-24	02/25/92	82	7	7.35	6.58	Not Rated
				07/24/91	---	2	---	6.28	Not Rated
L Contentnea Cr	NC 264A	Pitt	27-86-26	10/05/00	---	6	---	6.08	Fair
8									
Neuse R	SR 1423	Craven	27-(85)	07/21/95	68	10	6.98	5.86	Good-Fair
				07/14/89	73	18	6.64	5.51	Good-Fair
				07/07/87	66	15	7.16	5.81	Good-Fair
				07/23/85	64	12	7.50	6.73	Fair
				07/12/83	52	9	7.19	5.48	Good-Fair
Core Cr	NC 55	Craven	27-90	08/16/00	61	10	6.92	6.47	Fair
				08/21/95	44	3	7.52	7.53	Poor
				07/23/91	---	8	---	6.26	Fair
Flat Swp	NC 55	Craven	27-90-3	02/23/00	55	8	7.85	6.91	Not Rated
Rollover Cr	SR 1224	Craven	27-98-2	05/25/89	49	5	6.94	5.48	Not Rated
				05/03/88	29	9	6.40	5.36	Not Rated
Beaverdam Br	SR 1244	Craven	27-98-2.2	05/25/89	59	4	7.22	5.18	Not Rated
				05/03/88	36	6	7.09	6.06	Not Rated
Caswell Br	off SR 1243	Craven	27-98-2.6	05/25/89	52	10	6.32	4.58	Not Rated
				05/03/88	35	11	6.34	5.35	Not Rated
9									
Swift Cr	NC 102	Pitt	27-97-(0.5)	08/22/95	---	5	---	5.88	Poor
				07/24/91	---	8	---	6.04	Fair
Swift Cr	NC 118	Craven	27-97-(0.5)	10/12/00	78	13	6.82	6.19	Fair
				08/21/95	59	6	7.04	6.01	Fair
				07/23/91	---	12	---	5.95	Good-Fair
Swift Cr	SR 1478	Craven	27-97-(0.5)	07/07/87	65	11	7.29	5.78	Not Rated
				07/22/85	55	2	7.88	6.18	Not Rated
				07/12/83	45	2	7.99	6.03	Not Rated
Fork Swp	SR 1711	Pitt	27-97-4	08/14/95	46	2	7.39	5.99	Not Rated
				03/14/95	42	2	7.53	7	Not Rated
Clayroot Swp	SR 1941	Pitt	27-97-5	08/16/00	---	3	---	5.89	Poor
				02/24/00	56	8	7.03	5.45	Fair
				08/21/95	---	3	---	5.88	Poor
				07/23/91	---	9	---	5.57	Fair

Appendix B2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPT NCBI	BioClass
Creeping Swp	NC 102	Pitt	27-97-5-3	02/24/00	30	2	6.87	7.39	Not Rated
Palmetto Swp	NC 43	Craven	27-97-5.3	02/24/00	60	8	7.09	6.44	Not Rated
L Swift Cr	SR 1623	Craven	27-97-8	03/14/95	25	2	7.66	7.07	Not Rated
Fisher Swp	SR 1621	Craven	27-97-8-3	02/25/97	44	4	7.14	7.27	Not Rated
				03/14/95	48	4	6.97	6.24	Not Rated
				08/14/95	35	2	7.25	6.82	Not Rated
10									
Freshwater									
Mill Br	nr Mouth	Craven	27-99.5	08/22/95	35	5	8.30	---	Not Rated
W Pr Brices Cr	SR 1101	Craven	27-101-40-(1)	04/22/86	53	13	6.12	4.47	Not Rated
Upper Broad Cr	SR 1612	Craven	27-106-(1)	03/15/95	34	3	6.89	6.72	Not Rated
Upper Broad Cr	NC 55	Craven	27-106-(1)	02/25/00	35	4	7.19	7.33	Not Rated
Deep Run	NC 55	Pamlico	27-106-6	04/28/95	29	5	7.06	6.54	Not Rated
				03/14/95	24	5	6.14	5.78	Not Rated
Goose Cr (Black Cr)	SR 1100	Pamlico	27-107-(1)	02/23/99	30	3	6.75	6.57	Not Rated
		Pamlico		03/06/98	21	2	5.98	4.95	Not Rated
		Pamlico		02/25/97	27	0	7.26	---	Not Rated
		Pamlico		03/21/95	27	4	6.41	5.89	Not Rated
SW Pr Slocum Cr	SR 1746	Craven	27-112-1	02/25/00	48	13	6.50	4.95	Not Rated
Fork Run	SR 1005	Pamlico	27-125-2	03/21/95	26	1	8.06	---	Not Rated
Estuarine									
Neuse R	New Bern	Craven	27-96	08/22/95	25	1	2.2	---	Not Rated
Lawson Cr	at Mouth	Craven	27-101-42	08/22/95	10*	---	1.4	---	Not Rated
Upper Slocum Cr	at Turkey Gut	Craven	27-112	02/09/92	10*	---	1.2*	---	Not Rated
Slocum Cr	at Mouth	Craven	27-112	08/23/95	14	---	2.4	---	Not Rated
E Pr Slocum Cr	below Havelock WWTP	Craven	27-112-2	02/09/92	3*	---	1.3*	---	Not Rated
Neuse R	at Hancock Cr	Craven	27-(115)	08/23/95	19	---	2.3	---	Not Rated
Hancock Cr	E of Cherry Pt	Craven	27-115	02/09/92	12*	---	1.5*	---	Not Rated
Clubfoot Cr	nr Mouth	Craven	27-123	08/23/95	18	---	2.1	---	Not Rated
Neuse R	Pierson Pt	Pamlico	27-(129)	06/03/98	31	---	2.4	---	Not Rated
Neuse R	NC 55 Bridge	Pamlico	27-(129)	07/12/84	29	---	1.8	---	Not Rated
Neuse R	Windmill Pt	Pamlico	27-(129)	06/03/98	27	---	2.4	---	Not Rated
Greens Cr	above Kershaw Cr	Pamlico	27-129-(1)	02/09/92	16*	---	1.3*	---	Not Rated
Greens Cr	at Kershaw Cr	Pamlico	27-129-(2)	06/03/98	42	---	2.0	---	Not Rated
			27-129-(2)	08/22/95	10*	---	1.9*	---	Not Rated
Greens Cr	NC 55	Pamlico	27-129-(2)	06/03/98	37	---	2.0	---	Not Rated
Greens Cr	nr Yacht Club	Pamlico	27-129-(2)	02/09/92	10*	---	1.3*	---	Not Rated
				06/03/98	32	---	1.9		Not Rated
Oriental Harbor	at Docks	Pamlico	27-129-8	02/09/92	7	---	1.2	---	Not Rated
Oriental Harbor	at Fulcher's Seafood	Pamlico	27-129-8	08/22/95	9	---	1.3	---	Not Rated
Oriental Harbor	Boathouse	Pamlico	27-129-8	06/03/98	25	---	1.4	---	Not Rated
South R	at mouth	Carteret	27-135	06/02/94	31	---	2.0	---	Not Rated
W Fk South R	Open Ground Farms	Carteret	27-135-1	06/02/94	33	---	2.0	---	Not Rated
Southwest Cr	Open Ground Farms	Carteret	27-135-9	06/02/94	34	---	2.0	---	Not Rated
Eastman Cr	at WIRO site 15	Carteret	27-135-10	06/02/94	19	---	1.5	---	Not Rated
Eastman Cr	nr headwaters	Carteret	27-135-10	06/02/94	31	---	1.9	---	Not Rated
Mulberry Cr	at Island	Carteret	27-135-16	06/02/94	31	---	2.0	---	Not Rated
Hardy Cr	Upstream	Carteret	27-135-18	06/02/94	31	---	1.6	---	Not Rated
Hardy Cr	at Mouth	Carteret	27-135-18	06/02/94	31	---	2.3	---	Not Rated
11									
Trent R	SR 1153	Jones	27-101-(1)	02/25/00	57	7	7.36	5.89	Not Rated
Trent R	near Comfort	Jones	27-101-(1)	05/09/00	50	7	6.82	5.97	Fair

Appendix B2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPT NCBI	BioClass
Trent R	NC 58	Jones	27-101-(1)	08/21/95	71	12	6.38	5.15	Good-Fair
				11/01/90	61	13	6.29	3.50	Good-Fair
				06/27/90	69	12	6.80	5.28	Fair
				05/02/90	70	19	5.94	4.41	Good-Fair
				06/26/89	72	19	6.48	4.58	Good-Fair
				06/23/87	86	22	6.48	4.50	Good-Fair
				06/25/86	79	20	6.46	4.96	Good-Fair
				09/03/85	76	13	6.07	4.66	Good-Fair
				07/11/83	64	12	6.29	5.17	Good-Fair
				08/11/82	77	19	5.37	3.95	Good
Trent R	NC 17, Pollocksville	Jones	27-101-(1)	03/20/95	63	5	7.26	5.28	Not Rated
Beaverdam Swp	NC 258	Lenoir	27-101-3	07/22/91	---	6	---	5.68	Not Rated
Tuckahoe Swp	SR 1142	Jones	27-101-5-1	02/23/00	69	10	6.76	5.81	Not Rated
Tuckahoe Swp	SR 1105	Lenoir	27-101-5-1	08/12/92	23	2	7.07	5.88	Not Rated
				05/13/92	45	7	6.90	5.36	Not Rated
				02/24/92	61	10	6.57	5.18	Not Rated
Reedy Br	NC 41	Jones	27-101-7	07/22/91	---	6	---	5.02	Good-Fair
Cypress Cr	SR 1134	Jones	27-101-8	08/11/92	29	0	8.49	---	Not Rated
				05/15/92	51	3	7.26	5.37	Not Rated
				02/24/92	49	6	6.96	6.48	Not Rated
L Chinquapin Cr	SR 1131	Jones	27-101-11	07/22/91	---	7	---	5.79	Not Rated
Beaver Cr	SR 1315 or 1316	Jones	27-101-15	03/02/00	49	8	7.65	6.33	Not Rated
				07/23/91	---	9	---	5.48	Fair
Musselshell Cr	SR 1320	Jones	27-101-17	02/24/00	26	2	7.31	6.05	Not Rated
				08/15/95	19	1	8.32	6.22	Not Rated
				03/15/95	15	1	7.64	7.41	Not Rated
Crooked Run	SR 1123	Jones	27-101-18	03/02/00	29	1	6.59	6.37	Not Rated
Beaverdam Cr	SR 1002	Jones	27-101-21	02/24/00	52	8	6.77	5.38	Not Rated
				02/25/97	43	7	6.39	5.49	Not Rated
				03/20/95	44	11	6.02	4.50	Not Rated
Mill Run	NC 58	Jones	27-101-23	07/22/91	---	19	---	4.12	Good
UT Mill Run	SR 1119	Jones	27-101-23	07/22/91	---	13	---	4.60	Good
Island Cr	SR 1004	Jones	27-101-33	11/17/99	20	20	4.92	4.92	Not Rated
				02/22/99	67	20	5.76	4.41	Not Rated
				08/15/95	63	22	6.04	4.46	Not Rated
				03/15/95	60	18	6.47	5.70	Not Rated
				07/22/91	---	15	---	4.15	Good
				12/13/84	82	25	5.83	4.13	Good
Wilson Cr	US 17	Craven	27-101-37	04/28/95	45	4	7.55	7.04	Not Rated
12									
Thoroughfare Swp	SR 1120	Wayne	27-54-5-(1.5)	2/25/92	72	9	7.60	7.07	
				7/11/91	1	1	7.41	7.41	Not Rated
Neuse R	SR 1915	Wayne	27-(56)	7/9/90	71	22	5.48	4.54	Good
				7/11/88	73	23	5.91	4.90	Good-Fair
				7/10/86	81	26	6.03	4.79	Good
				9/4/84	57	17	6.31	5.22	Good-Fair
Neuse R	US 117	Wayne	27-(56)	8/29/00	66	23	6.06	4.85	Good-Fair
				8/8/95	53	16	5.47	4.64	Good-Fair
				7/19/91	77	29	5.36	4.57	Good

*From dredge samples only, not directly comparable to sweeps used for later estuarine collections.
[1]For estuarine waters, the Estuarine Biotic Index (EBI) is applied.

Appendix F1. Fish community sampling methods and criteria.

Wadeable Stream Sampling Methods

At each sample site, a 600 ft. section of stream was selected and measured. The fish in the delineated stretch of stream were then collected using two backpack electrofishing units and two persons netting the stunned fish. After collection, all readily identifiable fish were examined for sores, lesions, fin damage, or skeletal anomalies, measured (total length to the nearest 1 mm), and then released. Those fish not readily identifiable were preserved and returned to the laboratory for identification, examination, and total length measurement. Detailed descriptions of the sampling methods may be found in NCDENR (2001) or electronically at: http://www.esb.enr.state.nc.us/BAU.

Nonwadeable Small Boat Sampling Methods

At each site, a 400 m section of stream is measured off into 100 m segments. There are four segments along each shore line and two segments down the center of the stream, for a total of 10 segments. For each of the 100 m segments, fish are collected and processed the same as those collected using the wadeable stream method. The last collection technique used at each location, is a timed catfish collection effort outside the measured stream reach. Data from each of the 100 meter segments and the catfish sampling are currently treated as a separate subsample.

NCIBI Analysis

The assessment of biological integrity using the North Carolina Index of Biotic Integrity (NCIBI) is provided by the cumulative assessment of 12 parameters or metrics. The values provided by the metrics are converted into scores on a 1, 3, or 5 scale. A score of 5 represents conditions which would be expected for undisturbed reference streams in the specific river basin or ecoregion, while a score of 1 indicates that the conditions deviate greatly from those expected in undisturbed streams of the region. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score. Finally, the score (an even number between 12 and 60) is then used to determine the ecological integrity class, as proposed by Karr (1981), of the stream from which the sample was collected (Table F1).

The NCIBI has recently been revised (NCDENR 2001). Since the mid- to late 1990s, the focus of using and applying the NCIBI has been restricted to wadeable streams that can be sampled by a crew of four persons. The bioclassifications and criteria have also be recalibrated against regional reference site data (Biological Assessment Unit Memorandum 20001017) (Tables F2 and F3).

Table F1. Original scores, integrity classes, and class attributes for evaluating fish communities using Karr's 1981 Index of Biotic Integrity.

NCIBI Scores	Integrity Classes	Class Attributes[1]
> 58	Excellent	Comparable to the best situations without human disturbance. All regionally expected species for the habitat and stream size, including the most intolerant forms are present, along with a full array of size classes and a balanced trophic structure.
48-52	Good	Species richness somewhat below expectation, especially due to the loss of the most intolerant species; some species are present with less than optimal abundances or size distributions; and the trophic structure shows some signs of stress.
40-44	Fair	Signs of additional deterioration include the loss of intolerant species, fewer species, and a highly skewed trophic structure.
28-34	Poor	Dominated by omnivores, tolerant species, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; and diseased fish often present.
< 22	Very Poor	Few fish present, mostly introduced or tolerant species; and disease fin damage and other anomalies are regular.
-----	No fish	Repeated sampling finds no fish.

[1] Over-lapping classes share attributes with classes greater than and less than the respective IBI score.

Table F2. Revised scores and classes for evaluating the fish community of a wadeable stream using the North Carolina Index of Biotic Integrity in the piedmont portion of the Cape Fear, Neuse, Roanoke, and Tar River basins.

NCIBI Scores	NCIBI Classes
> 54	Excellent
46 -52	Good
40-44	Good-Fair
34-38	Fair
≤ 32	Poor

Criteria and ratings applicable only to wadeable streams in the piedmont region of the Neuse River basin are the same as those for the Cape Fear, Roanoke, and Tar River basins. The definition of the piedmont for these four river basins is based map of North Carolina watersheds by Fels (1997). Specifically for the Neuse River basin, the piedmont encompasses the entire basin above Smithfield and Wilson, NC, except for the south and southwest portions of Johnston County and the eastern two-thirds of Wilson County.

Metrics and ratings should not be applied to non-wadeable streams and all streams in the coastal plain region of each of these basins. These streams are currently not rated.

References

Fels, J. 1997. North Carolina watersheds map. North Carolina State University Cooperative Extension Service. Raleigh, NC.

Karr, J. R. 1981. Assessment of biotic integrity using fish communities. Fisheries. 6: 21-27.

NCDENR. 2001. Stream fish community assessment and fish tissue. Standard operating procedure biological monitoring. Biological Assessment Unit. Environmental Sciences Branch. Water Quality Section. Division of Water Quality. North Carolina department of Environment and Natural Resources. Raleigh, NC.

Table F3. Scoring criteria for the NCIBI for wadeable streams in the Outer Piedmont of the Cape Fear, Neuse, Roanoke, and Tar River basins ranging between 3.1 and 328 mi^2.

No.	Metric		Score
1	**No. of species**		
	≥ 16 species		5
	10-15 species		3
	< 10 species		1
2	**No. of fish**		
	≥ 225 fish		5
	150-224 fish		3
	< 150 fish		1
3	**No. of species of darters**		
	Cape Fear	Neuse, Roanoke, and Tar	
	≥ 2 species	≥ 3 species	5
	1 species	1 or 2 species	3
	0 species	0 species	1
4	**No. of species of sunfish**		
	≥ 4 species		5
	3 species		3
	0, 1, or 2 species		1
5	**No. of species of suckers**		
	Cape Fear	Neuse, Roanoke, and Tar	
	≥ 2 species	≥ 3 species	5
	1 species	1 or 2 species	3
	0 species	0 species	1
6	**No. of intolerant species**		
	Cape Fear	Neuse, Roanoke, and Tar	
	≥ 1 species	≥ 3 species	5
	no middle score	1 or 2 species	3
	0 species	0 species	1
7	**Percentage of tolerant individuals**		
	≤ 35%		5
	36-50%		3
	> 50%		1
8	**Percentage of omnivorous and herbivorous individuals**		
	10-35%		5
	36-50%		3
	> 50%		1
	< 10%		1
9	**Percentage of insectivorous individuals**		
	65-90%		5
	45-64%		3
	< 45%		1
	> 90%		1
10	**Percentage of piscivorous individuals**		
	≥ 1.4-15%		5
	0.4-1.3%		3
	< 0.4%		1
	> 15%		1
11	**Percentage of diseased fish (DELT = diseased, fin erosion, lesions, and tumors)**		
	≤ 1.75%		5
	1.76-2.75%		3
	> 2.75%		1
12	**Percentage of species with multiple age groups**		
	≥ 50% of all species have multiple age groups		5
	35-49% all species have multiple age groups		3
	< 35% all species have multiple age groups		1

Appendix F2. Fish community structure data collected in the Neuse River basin, 1990 - 2000. Current basinwide sites are bolded.

Subbasin/Waterbody	Location	County	Index No.	Date	NCIBI Score	NCIBI Rating
01						
Eno R	**SR 1336**	**Orange**	27-2-1	04/04/00	54	Excellent
Eno R	SR 1569	Orange	27-2-(10)	08/03/98	60	Excellent
Eno R	SR 1003	Durham	27-2-(10)	08/03/98	60	Excellent
S Fk Little R	**SR 1461**	**Durham**	27-2-21-2	04/07/00	60	Excellent
N Fk Little R	**SR 1461**	**Durham**	27-2-21-3	04/07/00	48	Good
N Flat R	**SR 1715**	**Person**	27-3-2	04/06/00	56	Excellent
				06/10/99	50	Good
S Flat R	**NC 157**	**Person**	27-3-3	04/06/00	48	Good
Deep Cr	**SR 1734**	**Person**	27-3-4	04/06/00	56	Excellent
				05/16/95	56	Excellent
				07/19/90	60	Excellent
Ellerbe Cr	SR 1709	Durham	27-5-(0.7)	04/11/95	26	Poor
Ellerbe Cr	SR 1636	Durham	27-5-(2)	04/11/95	28	Poor
Smith Cr	**SR 1710**	**Granville**	27-12-2-(2)	04/04/00	44	Good-Fair
				04/11/95	48	Good
Newlight Cr	SR 1911	Wake	27-13-2	05/16/95	42	Good-Fair
Upper Barton Cr	**NC 50**	**Wake**	27-15-(2)	04/03/00	52	Good
				05/18/95	48	Good
02						
Richland Cr	US 1	Wake	27-21	04/12/95	52	Good
Smith Cr	**SR 2045**	**Wake**	27-23-(2)	04/03/00	56	Excellent
				05/18/95	42	Good-Fair
Crabtree Cr	**SR 1664**	**Wake**	27-33-10	06/22/00	54	Excellent
Crabtree Cr	US 1/401	Wake	27-33-10	04/12/95	52	Good
Walnut Cr	SR 1348	Wake	27-34-(1.7)	04/03/95	32	Poor
				06/25/91	44	Good-Fair
Walnut Cr	SR 1564	Wake	27-34-(4)	06/25/91	48	Good
Walnut Cr	SR 2542	Wake	27-34-(4)	04/04/95	32	Poor
Walnut Cr	**SR 2544**	**Wake**	27-34-(4)	04/11/00	44	Good-Fair
				04/04/95	34	Fair
				06/25/91	48	Good
Marks Cr	**SR 1714**	**Johnston**	27-38	04/05/00	54	Excellent
				05/18/95	50	Good
				09/23/91	46	Good
Swift Cr	**SR 1152**	**Wake**	27-43-(1)	04/24/00	34	Fair
				04/24/00	40	Good-Fair
				10/15/99	34	Fair
				10/15/99	40	Good-Fair
				08/20/99	38	Fair
				08/20/99	38	Fair
				06/25/99	38	Fair
				06/25/99	40	Good-Fair
				04/28/99	38	Fair
				04/28/99	42	Good-Fair
				04/27/95	28	Poor
Swift Cr	SR 1525	Johnston	27-43-(8)	04/27/95	34	Fair
				10/02/91	50	Good
03						
Middle Cr	SR 1404	Wake	27-43-15-(4)	04/27/95	52	Good
				06/04/91	48	Good
Middle Cr	SR 1531	Johnston	27-43-15-(4)	06/04/91	34	Fair
Middle Cr	NC 50	Johnston	27-43-15-(4)	06/01/95	52	Good
Middle Cr	SR 1504	Johnston	27-43-15-(4)	06/01/95	54	Excellent
				06/04/91	48	Good
04						
Black Cr	SR 1330	Johnston	27-45-(2)	05/25/95	---	Not rated
Stone Cr	SR 1138	Johnston	27-52-5	05/25/95	---	Not rated
				10/02/91	---	Not rated
Hannah Cr	SR 1162	Johnston	27-52-6	05/25/95	---	Not rated
				10/02/91	---	Not rated
05						
Stoney Cr	**SR 1920**	**Wayne**	27-62	04/17/00	---	Not rated
				07/20/95	---	Not rated

Appendix F2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	NCIBI Score	NCIBI Rating
05 (continued)						
Bear Cr	**SR 1311**	**Lenoir**	27-72	06/14/00	---	Not rated
				10/28/96	---	Not rated
				05/22/95	---	Not rated
Falling Cr	off SR 1546	Lenoir	27-77	10/28/96	---	Not rated
Falling Cr	**SR 1340**	**Lenoir**	27-77	06/14/00	---	Not rated
				05/22/95	---	Not rated
Moseley Cr	**SR 1475**	**Craven**	27-77-2	06/13/00	---	Not rated
				10/29/96	---	Not rated
				04/19/95	---	Not rated
				06/27/91	---	Not rated
Southwest Cr	SR 1804	Lenoir	27-80	05/22/95	---	Not rated
Briery Run	SR 1732	Lenoir	27-81-1	11/02/93	---	Not rated
Stonyton Cr	SR 1742	Lenoir	27-81	11/02/93	---	Not rated
06						
Little R	**NC 96**	**Wake**	27-57-(1)	04/04/00	40	Good-Fair
				07/19/95	50	Good
Little R	SR 2130	Johnston	27-57-(8.5)	08/01/95	54	Excellent
Buffalo Cr	**SR 1941**	**Johnston**	27-57-16-(3)	04/05/00	44	Good-Fair
				07/19/95	54	Excellent
07						
Moccasin Cr	SR 1001	Wake	27-86-2	06/06/91	42	Good-Fair
Moccasin Cr	**NC 231**	**Johnston**	27-86-2	06/22/00	58	Excellent
				10/31/96	54	Excellent
				07/21/95	56	Excellent
				06/06/91	54	Excellent
Turkey Cr	**SR 1131**	**Nash**	27-86-3-(1)	04/05/00	---	Not rated
Hominy Swp	SR 1606	Wilson	27-86-8	08/03/95	---	Not rated
Toisnot Swp	SR 1945	Nash	27-86-11-(1)	06/05/91	---	Not rated
Toisnot Swp	NC 42	Wilson	27-86-11-(5)	06/05/91	---	Not rated
Toisnot Swp	US 264	Wilson	27-86-11-(5)	06/05/91	---	Not rated
Toisnot Swp	**NC 222**	**Wilson**	27-86-11-(5)	05/25/00	---	Not rated
				08/01/95	---	Not rated
The Slough	**SR 1535**	**Wayne**	27-86-14-1	05/25/00	---	Not rated
				08/03/95	---	Not rated
Tyson Marsh	US 13/NC 58	Greene	27-86-17	05/23/95	---	Not rated
Little Contentnea Cr	SR 1228	Pitt	27-86-26	05/23/95	---	Not rated
Sandy Run	US 258/13	Greene	27-86-26-5-1	05/23/95	---	Not rated
08						
Core Cr	SR 1001	Craven	27-90	10/28/96	---	Not rated
				04/19/95	---	Not rated
09						
Swift Cr	NC 102	Pitt	27-97-(0.5)	05/22/95	---	Not rated
Fork Swp	SR 1711	Pitt	27-97-4	08/14/95	---	Not rated
				03/22/95	---	Not rated
Clayroot Swp	**SR 1941**	**Pitt**	27-97-5	06/13/00	---	Not rated
				05/22/95	---	Not rated
				06/26/91	---	Not rated
Creeping Swp	SR 1800	Pitt	27-97-5-3	08/30/91	---	Not rated
	NC 43	Pitt	27-97-5-3	08/30/91	---	Not rated
Little Swift Cr	SR 1623	Craven	27-97-8	03/22/95	---	Not rated
Fisher Swp	SR 1621	Craven	27-97-8-3	08/14/95	---	Not rated
				03/22/95	---	Not rated
10						
Deep Run	NC 55	Pamlico	27-106-6	03/22/95	---	Not rated
11						
Trent R	SR 1130	Jones	27-101-(1)	11/05/91	---	Not rated
Tuckahoe Cr	**SR 1142**	**Jones**	27-101-5	06/12/00	---	Not rated
Little Chinquapin Br	SR 1131	Jones	27-101-11	07/16/91	---	Not rated
Musselshell Cr	SR 1320	Jones	27-101-17	08/15/95	---	Not rated
				03/23/95	---	Not rated

Appendix F2 (continued).

Subbasin/Waterbody	Location	County	Index No.	Date	NCIBI Score	NCIBI Rating
11 (continued)						
Mill Run	**NC 58**	**Jones**	27-101-23	06/12/00	---	Not rated
Island Cr	**SR 1004**	**Jones**	27-101-33	06/12/00	---	Not rated
				08/15/95	---	Not rated
				03/23/95	---	Not rated
12						
Thoroughfare Swp	SR 1120	Wayne	27-101-5-(1.5)	07/20/95	---	Not rated

Appendix F3. Fish community metric values from wadeable streams in the 2000 Neuse River basinwide monitoring program. Ratable streams are only those in the piedmont ecoregion.

Subbasin Waterbody	Location	County	Eco-region	d. a. (mi2)	Date	No. Species	No. Fish	No. Sp. Darters	No. Sp. Sunfish	No. Sp. Suckers	No. Intol. Sp.	% Tolerant	% Omni. + Herb.	% Insect.	% Pisc.	% DELT	% MA
01																	
Deep Cr	SR 1734	Person	P	32.5	04/06/00	22	411	4	4	4	3	13	29	71	0.2	0.0	50
Eno R	SR 1336	Orange	P	26.7	04/04/00	18	169	3	5	2	2	5	14	82	4.7	0.0	61
N Fk Little R	SR 1461	Durham	P	29.7	04/07/00	14	418	2	4	1	3	12	51	46	2.9	0.0	57
N Flat R	SR 1715	Person	P	33.0	04/06/00	21	581	4	5	4	3	8	27	73	0.2	0.0	62
S Fk Little R	SR 1461	Durham	P	39.0	04/07/00	24	361	3	6	4	3	33	12	79	9.0	0.0	50
S Flat R	NC 157	Person	P	17.3	04/06/00	17	451	2	4	2	2	13	42	58	0.4	0.0	65
Smith Cr	SR 1710	Granville	P	6.2	04/04/00	15	366	2	5	0	0	17	33	67	0.0	0.0	53
Upper Barton Cr	NC 50	Wake	P	5.8	04/03/00	21	795	2	4	3	0	10	28	71	0.4	0.0	52
02																	
Crabtree Cr	SR 1664	Wake	P	84.0	06/22/00	19	240	3	3	2	1	25	15	81	3.3	0.0	63
Marks Cr	SR 1714	Johnston	P	25.2	04/05/00	18	366	3	3	2	2	23	11	80	8.0	0.0	56
Smith Cr	SR 2045	Wake	P	22.6	04/03/00	17	494	3	5	1	1	25	15	79	6.0	0.0	53
Swift Cr	SR 1152	Wake	P	21.0	04/24/00	18	389	1	6	2	0	19	7	92	0.8	0.8	39
Swift Cr	SR 1152	Wake	P	21.0	04/24/00	13	369	1	6	1	0	24	0	99	0.5	3.0	46
Walnut Cr	SR 2544	Wake	P	29.4	04/11/00	18	400	3	3	0	2	22	1	92	7.0	0.0	56
05																	
Bear Cr	SR 1311	Lenoir	CA	61.7	06/14/00	22	387	4	8	0	2	45	0	69	25.0	0.0	41
Falling Cr	SR 1340	Lenoir	CA	46.9	06/14/00	25	661	3	8	1	1	30	3	59	38.0	0.0	68
Moseley Cr	SR 1475	Craven	CA	45.7	06/13/00	25	436	2	7	1	1	42	3	73	10.0	0.0	56
Stoney Cr	SR 1920	Wayne	CA	25.4	04/17/00	15	259	1	4	0	0	30	0	69	31.0	0.0	60
06																	
Buffalo Cr	SR 1941	Johnston	P	41.2	04/05/00	15	139	3	3	0	3	28	3	86	12.0	0.0	60
Little R	NC 96	Wake	P	21.2	04/04/00	11	263	1	3	0	0	47	5	89	6.0	0.4	55
07																	
Moccasin Cr	NC 231	Johnston	P	59.0	06/22/00	26	524	4	7	1	3	7	10	86	3.6	0.0	50
The Slough	SR 1535	Wayne	CA	15.9	05/25/00	26	321	3	6	1	2	25	2	87	11.0	0.0	35
Toisnot Swp	NC 222	Wilson	CA	114.7	05/25/00	24	421	5	4	1	3	37	1	81	13.0	0.2	29
Turkey Cr	SR 1131	Nash	CA	29.7	04/05/00	13	77	2	3	1	0	4	8	84	8.0	0.0	23
09																	
Clayroot Swp	SR 1941	Pitt	CA	12.0	06/13/00	23	815	2	5	1	1	22	1	52	40.0	0.0	61
11																	
Island Cr	SR 1004	Jones	CA	5.7	06/12/00	15	206	1	6	1	0	4	2	50	48.0	0.0	73
Mill Run	NC 58	Jones	CA	21.0	06/12/00	19	345	2	6	1	1	24	3	62	35.0	0.0	58
Tuckahoe Swp	SR 1142	Jones	CA	49.7	06/12/00	19	424	3	4	1	1	24	4	78	19.0	0.0	74

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

Appendix FT1. Fish tissue criteria.

In evaluating fish tissue analysis results, several different types of criteria are used. Human health concerns related to fish consumption are screened by comparing results with federal Food and Drug Administration (FDA) action levels (USFDA 1980), Environmental Protection Agency (USEPA) recommended screening values, and criteria adopted by the North Carolina State Health Director (Table FT1). Parameter results which are of potential human health concern are evaluated by the NC Division of Occupational and Environmental Epidemiology by request from the NCDWQ.

The FDA levels were developed to protect humans from the chronic effects of toxic substances consumed in foodstuffs and thus employ a "safe level" approach to fish tissue consumption. Presently, the FDA has only developed metals criteria for mercury.

The US EPA has recommended screening values for target analytes which are formulated from a risk assessment procedure (USEPA 1995). These are the concentrations of analytes in edible fish tissue that are of potential public health concern. The NCDWQ compares fish tissue results with US EPA screening values to evaluate the need for further intensive site specific monitoring.

The North Carolina State Health Director has adopted a selenium limit of 5 µg/g for issuing an advisory. Although the USEPA has suggested a screening value of 0.7 ppt (pg/g) for dioxins, the State of North Carolina currently uses a value of 3.0 ppt in issuing an advisory.

Table FT1. Fish tissue criteria. All wet weight concentrations are reported in parts per million (ppm, µg/g), except for dioxin which is in parts per trillion (ppt, pg/g).

Contaminant	FDA Action Levels	US EPA Screening Values	NC Health Director
Metals			
Cadmium		10.0	
Mercury	1.0	0.6	1.0
Selenium		50.0	5.0
Organics			
Aldrin	0.3		
Chlorpyrifos		30	
Total chlordane		0.08	
Cis-chlordane	0.3		
Trans-chlordane	0.3		
Total DDT[1]		0.3	
o,p DDD	5.0		
p, p DDD	5.0		
o,p DDE	5.0		
p,p DDE	5.0		
o,p DDT	5.0		
p,p DDT	5.0		
Dieldrin		0.007	
Dioxins (total)		0.7	3.0
Endosulfan (I and II)		60.0	
Endrin	0.3	3.0	
Heptachlorepoxide		0.01	
Hexachlorobenzene		0.07	
Lindane		0.08	
Mirex		2.0	
Total PCBs		0.01	
PCB-1254	2.0		
Toxaphene		0.1	

[1] Total DDT includes the sum of all its isomers and metabolites (i.e. p,p DDT, o,p DDT, DDE, and DDD).
[2]Total chlordane includes the sum of cis-and trans- isomers as well as nonachlor and oxychlordane.

Appendix FT2. Wet weight concentrations of mercury (Hg), arsenic (As), total chromium (Crt), cadmium (Cd)*, copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn) in fish tissue from the Neuse River at Goldsboro (Wayne County) and at Kinston (Lenoir County), May 02, 2000.[1]

Location/Species	Length (cm)	Weight (g)	Hg (µg/g)	As (µg/g)	Crt (µg/g)	Cu (µg/g)	Ni (µg/g)	Pb (µg/g)	Zn (µg/g)
Neuse River at Goldsboro									
Micropterus salmoides	24.2	209	0.39	ND	0.19	0.13	ND	ND	4.5
Micropterus salmoides	30	373	0.40	ND	0.10	ND	ND	ND	3.4
Micropterus salmoides	31.1	454	0.47	ND	0.16	0.36	ND	ND	4.3
Micropterus salmoides	31.8	469	0.48	ND	0.16	0.25	ND	ND	4.8
Micropterus salmoides	30.5	475	0.52	ND	0.15	0.17	ND	ND	4.1
Morone saxatilis	41.1	753	0.50	3.3	0.51	0.31	ND	0.33	3.3
Morone saxatilis	41.5	764	0.22	0.30	0.11	0.29	ND	ND	3.1
Morone saxatilis	46	1055	0.21	0.52	0.23	0.35	ND	ND	4.7
Lepomis macrochirus	17.8	130.6	0.20	ND	0.17	0.45	0.10	ND	7.0
Lepomis macrochirus	19.2	161.5	0.21	ND	0.19	4.9	ND	ND	6.3
Lepomis macrochirus	20.6	217.5	0.25	ND	0.20	2.1	ND	ND	6.9
Lepomis microlophus	19.5	161.3	0.16	ND	0.14	0.31	ND	ND	6.4
Lepomis microlophus	22.1	224	0.15	ND	0.19	0.78	0.13	ND	6.3
Lepomis microlophus	22.7	259.5	0.23	ND	0.18	0.38	ND	ND	5.8
Lepomis microlophus	24.25	337.5	0.27	0.12	0.14	0.26	ND	ND	5.1
Ictalurus punctatus	43.5	831	0.10	ND	0.13	0.13	ND	ND	2.3
Ictalurus punctatus	42	782	0.11	ND	0.36	0.42	0.12	ND	10.0
Ictalurus furcatus	44.3	814	0.14	0.11	0.15	0.13	ND	ND	3.2
Ictalurus furcatus	44.5	979	0.14	ND	0.14	0.49	ND	ND	3.0
Ictalurus furcatus	34	1517	0.23	ND	0.12	0.44	ND	ND	3.3
Ictalurus furcatus	55	1953	0.28	ND	0.12	0.19	ND	ND	4.5
Neuse River at Kinston									
Micropterus salmoides	26	273	0.48	ND	0.18	0.26	ND	ND	5.4
Micropterus salmoides	31.1	448	0.47	ND	0.14	0.16	ND	ND	4.8
Micropterus salmoides	33.8	619	0.63	ND	0.19	0.20	ND	ND	5.3
Micropterus salmoides	37	745	0.55	ND	0.17	0.30	0.11	ND	14.0
Micropterus salmoides	37.1	752	0.62	ND	0.15	0.13	ND	ND	3.9
Micropterus salmoides	41.5	1108	1.4	ND	0.35	0.17	0.14	ND	4.2
Micropterus salmoides	48.1	1720	0.71	ND	0.14	0.14	ND	ND	5.0
Morone saxatilis	56	1849	0.31	0.38	0.14	0.41	ND	ND	3.3
Lepomis auritus	18.8	164	0.22	ND	0.16	0.41	0.33	ND	6.6
Lepomis auritus	19.5	185.5	0.20	ND	0.12	0.23	0.12	ND	5.4
Lepomis macrochirus	18.5	135	0.21	ND	0.17	0.23	ND	ND	9.0
Lepomis macrochirus	19.2	158.5	0.39	ND	0.16	0.25	ND	ND	9.9
Lepomis macrochirus	21.5	263.5	0.26	ND	0.17	0.23	ND	ND	6.6
Lepomis macrochirus	22.5	310	0.23	0.11	0.23	0.24	ND	ND	6.0
Lepomis microlophus	22.3	267.5	0.29	ND	0.17	0.18	ND	ND	7.1
Lepomis microlophus	26.5	481	0.37	ND	0.21	0.20	ND	ND	7.1
Lepomis microlophus	26.2	406	0.27	ND	0.17	0.56	ND	ND	5.1
Lepomis microlophus	26.2	485	0.38	0.52	0.48	0.58	0.56	ND	5.4
Ictalurus punctatus	60	2698	0.29	ND	0.16	0.18	ND	ND	6.7
Ictalurus punctatus	60	2698	0.11	0.13	0.30	0.60	0.37	0.19	22.0

[1]Cadmium was non-detectable in all samples.

ND = non detect; detection level for arsenic = 1.0 µg/g, nickel = 0.5µg/g, and lead = 0.5 µg/g.

Appendix L1. Lake assessment program.

Collection Methods

Physical field measurements (dissolved oxygen, pH, water temperature, and conductivity) are made with a calibrated Hydrolab™. Readings are taken at the surface of the lake (0.15 meters) and at 1 m increments to the bottom of the lake. Secchi depths are measured at each sampling station with a weighted Secchi disk attached to a rope marked off in centimeters. Surface water samples are collected for chloride, hardness, fecal coliform bacteria, and metals. A Labline™ sampler is used to composite water samples within the photic zone (a depth equal to twice the Secchi depth). Nutrients, chlorophyll *a*, solids, turbidity and phytoplankton are typically collected at this depth. Nutrients and chlorophyll *a* from the photic zone are used to calculate the North Carolina Trophic State Index score. The Labline™ sampler is also used to collect a grab water samples near the bottom of the lake for nutrients. Water samples are collected and preserved in accordance with protocols specified in (NCDEHNR 1996b).

Data Interpretation

Numerical indices are often used to evaluate the trophic state of lakes. An index was developed specifically for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NCDNRCD 1982). The North Carolina Trophic State Index (NCTSI) is based on total phosphorus (TP in mg/L), total organic nitrogen (TON in mg/L), Secchi depth (SD in inches), and chlorophyll *a* (CHL in µg/L). Lakewide means for these parameters are used to produce a NCTSI score for each lake, using the equations:

$$TON_{Score} = ((\text{Log}(TON) + 0.45)/0.24)*0.90$$

$$TP_{Score} = ((\text{Log}(TP) + 1.55)/0.35)*0.92$$

$$SD_{Score} = ((\text{Log}(SD) - 1.73)/0.35)*-0.82$$

$$CHL_{Score} = ((\text{Log}(CHL) - 1.00)/0.48)*0.83$$

$$NCTSI = TON_{Score} + TP_{Score} + SD_{Score} + CHL_{Score}$$

In general, NCTSI scores relate to trophic classifications (Table L1). When scores border between classes, best professional judgment is used to assign an appropriate classification. NCTSI scores may be skewed by highly colored water typical of dystrophic lakes. Some variation in the trophic state of a lake between years is not unusual because of the potential variability of data collections which usually involve sampling a limited number of times during the growing season.

Table L1. Lakes classification criteria.

NCTSI Score	Trophic classification
< -2.0	Oligotrophic
-2.0 – 0.0	Mesotrophic
0.0 – 5.0	Eutrophic
> 5.0	Hypereutrophic

Lakes are classified for their “best usage” and are subject to the state’s water quality standards. Primary classifications are C (suited for aquatic life propagation /protection and secondary recreation such as wading), B (primary recreation, such as swimming, and all class C uses), and WS-I through WS-V(water supply source ranging from highest watershed protection level I to lowest watershed protection V, and all class C uses).

Lakes with a CA designation represent water supplies with watersheds that are considered Critical Areas (i.e., an area within 0.5 mile and draining to water supplies from the normal pool elevation of reservoirs, or within 0.5 mile and draining to a river intake).

Supplemental classifications may include SW (slow moving Swamp Waters where certain water quality standards may not be applicable), NSW (Nutrient Sensitive Waters subject to excessive algal or other plant growth where nutrient controls are required), HQW (High Quality Waters which are rated excellent based on biological and physical/chemical characteristics), and ORW (Outstanding Resource Waters which are unique and special waters of exceptional state or national recreational or ecological value). A complete listing of these water classifications and standards can be found in Title 15 North Carolina Administrative Code, Chapter 2B, Section .0100 and .0200.

Appendix L2. Surface waters data collected from the lakes in the Neuse River basin, 1995 - 2000.

Subbasin/Lake	Date	Station	Dissolved oxygen (mg/L)	Temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)
01							
Lake Orange	07/18/00	NEU00B	8.6	29.6	8.3	79	1.1
	07/18/00	NEU00B2	8.4	29.8	8.3	79	1.1
	07/18/00	NEU00B4	8.4	29.2	8.4	79	1.2
	06/13/00	NEU00B	7.9	29.1	7.3	75	0.9
	06/13/00	NEU00B2	7.8	29.9	7.4	77	0.8
	06/13/00	NEU00B4	7.6	28.6	7.7	74	1.3
	08/14/95	NEU00B	7.7	29.9	7.4	49	1.4
	08/14/95	NEU00B2	7.7	29.6	7.2	49	1.5
	08/14/95	NEU00B4	7.6	29.4	7.4	49	1.7
Corporation Lake	08/09/00	NEU00C	8.5	26.9	7.3	78	0.6
	08/09/00	NEU00C1	9.5	26.8	7.9	76	0.5
	07/18/00	NEU00C	6.6	24.0	7.1	81	0.6
	07/18/00	NEU00C1	6.6	24.9	7.2	84	0.6
	06/26/00	NEU00C	8.4	26.9	6.9	78	0.5
	06/26/00	NEU00C1	7.8	26.7	6.8	7.9	0.4
	08/14/95	NEU00C	7.3	27.8	7.1	80	0.6
	08/14/95	NEU00C1	7.1	27.9	7.0	83	0.9
Lake Ben Johnson	08/09/00	NEU00D	6.3	27.3	6.8	75	0.6
	07/18/00	NEU00D	5.6	25.2	7.2	90	0.9
	06/26/00	NEU00D	6.8	27.5	6.7	77	0.6
	08/14/95	NEU00D	8.3	28.2	5.8	82	1.1
Little River Reservoir	08/14/00	NEU006S	7.1	28.0	7.0	75	0.9
	08/14/00	NEU006T	6.4	27.3	6.9	74	1.2
	08/14/00	NEU006U	6.0	27.1	6.8	74	1.0
	06/14/00	NEU006S	11.2	28.5	8.9	74	1.0
	06/14/00	NEU006T	9.9	28.3	8.8	72	1.1
	06/14/00	NEU006U	9.4	27.2	8.4	70	1.1
	09/17/97	NEU006S	5.5	25.2	6.6	78	0.7
	09/17/97	NEU006T	3.8	24.9	6.8	79	1.0
	09/17/97	NEU006U	6.4	25.3	7.2	79	0.9
	07/15/97	NEU006S	9.9	27.5	8.7	73	1.3
	07/15/97	NEU006T	9.8	28.1	8.9	74	1.1
	07/15/97	NEU006U	8.6	27.5	7.4	72	0.9
	06/12/97	NEU006S	9.9	23.2	7.2	68	1.1
	06/12/97	NEU006T	9.6	22.8	6.8	67	1.0
	06/12/97	NEU006U	8.4	20.4	6.2	70	0.9
	08/16/96	NEU006S	10.3	26.9	8.1	73	1.0
	08/16/96	NEU006T	9.1	26.1	7.4	70	1.1
	08/16/96	NEU006U	8.5	26.4	7.1	70	1.4
	07/18/96	NEU006S	8.5	28.5	7.2	78	1.1
	07/18/96	NEU006T	8.2	28.4	7.2	77	1.0
	07/18/96	NEU006U	7.8	28.6	7.2	77	1.3
	06/20/96	NEU006S	8.6	29.1	7.8	77	1.5
	06/20/96	NEU006T	8.5	28.9	7.8	77	1.3
	06/20/96	NEU006U	9.0	28.4	8.1	75	1.0
	08/21/95	NEU006S	4.5	28.2	6.2	63	0.7
	08/21/95	NEU006T	4.3	27.8	6.3	63	0.9
	08/21/95	NEU006U	3.5	27.5	6.8	65	0.7
Falls of the Neuse Res.	09/28/00	NEU010	7.3	20.0	6.8	177	0.3
	09/28/00	NEU013	8.5	20.2	7.1	164	0.3
	09/28/00	NEU018E	8.3	21.8	7.3	99	0.7
	09/28/00	NEU019E	5.9	22.0	6.7	94	0.6
	09/28/00	NEU019P	4.6	22.5	6.6	96	0.9
	09/28/00	NEU020D	4.1	22.5	6.6	94	1.1
	08/23/00	NEU010	7.4	26.0	6.9	120	0.3
	08/23/00	NEU013	8.4	26.0	7.5	131	0.3
	08/23/00	NEU018E	6.7	26.6	7.2	98	0.6
	08/23/00	NEU019E	7.1	27.1	7.1	93	0.7
	08/23/00	NEU019P	7.1	27.8	7.2	92	0.9
	08/23/00	NEU020D	6.7	28.0	7.1	88	1.0
	06/07/00	NEU010	8.6	22.7	7.5	121	0.2

Appendix L2 (continued).

Subbasin/Lake	Date	Station	Dissolved oxygen (mg/L)	Temperature (^{o}C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)
01							
Falls of the Neuse Res.	06/07/00	NEU013	8.2	22.3	7.5	122	0.2
	06/07/00	NEU018E	7.3	23.0	7.3	85	0.3
	06/07/00	NEU019E	6.9	23.1	7.3	83	0.6
	06/07/00	NEU019P	7.6	23.8	7.3	82	0.8
	06/07/00	NEU020D	8.4	24.0	7.7	82	1.2
	09/16/97	NEU010	6.5	23.8	7.1	280	0.2
	09/16/97	NEU013	6.5	23.6	7.0	268	0.2
	09/16/97	NEU013B	5.6	24.9	6.9	235	0.3
	09/16/97	NEU0171B	7.3	25.0	7.0	131	0.6
	09/16/97	NEU018E	6.1	25.0	6.9	118	0.6
	09/16/97	NEU019E	5.6	25.0	6.8	111	0.8
	09/16/97	NEU019L	7.1	25.4	6.9	100	1.2
	09/16/97	NEU019P	7.1	25.8	6.8	91	1.2
	09/16/97	NEU020D	7.1	25.8	6.9	77	1.4
	08/25/97	NEU010	5.4	25.5	7.1	209	0.2
	08/25/97	NEU013	7.4	25.6	7.3	203	0.2
	08/25/97	NEU013B	8.0	26.0	7.5	158	0.2
	08/25/97	NEU0171B	7.0	26.2	7.1	119	0.3
	08/25/97	NEU018E	5.6	26.6	6.9	105	0.6
	08/25/97	NEU019E	7.1	27.6	7.3	94	0.8
	08/25/97	NEU019L	6.2	28.0	7.0	86	1.0
	08/25/97	NEU019P	6.6	28.4	6.8	79	1.2
	08/25/97	NEU020D	6.8	28.3	6.8	70	1.4
	07/14/97	NEU010	6.2	28.4	7.2	167	0.2
	07/14/97	NEU013	7.6	28.5	7.5	168	0.2
	07/14/97	NEU013B	7.4	29.0	7.5	133	0.3
	07/14/97	NEU0171B	7.2	28.1	7.3	104	0.5
	07/14/97	NEU018E	7.3	28.2	7.3	92	0.7
	07/14/97	NEU019E	8.1	29.8	7.8	85	0.9
	07/14/97	NEU019L	7.8	29.9	7.5	79	1.0
	07/14/97	NEU019P	8.0	29.6	7.7	77	1.0
	07/14/97	NEU020D	7.9	30.5	7.8	79	1.2
	06/26/97	NEU010	5.3	29.7	6.8	134	0.2
	06/26/97	NEU013	6.1	30.2	7.1	154	0.2
	06/26/97	NEU013B	6.4	29.4	7.2	127	0.4
	06/26/97	NEU0171B	7.2	28.9	7.1	104	0.6
	06/26/97	NEU018E	8.0	29.3	7.7	96	1.0
	06/26/97	NEU019E	8.4	30.2	8.0	86	1.0
	06/26/97	NEU019L	8.2	30.6	7.8	83	1.2
	06/26/97	NEU019P	8.4	30.6	8.0	82	1.2
	06/26/97	NEU020D	8.5	30.9	7.9	84	1.4
	05/22/97	NEU010	7.2	21.4	6.9	106	0.3
	05/22/97	NEU013	7.2	21.3	7.0	123	0.2
	05/22/97	NEU013B	7.3	21.4	7.0	96	0.3
	05/22/97	NEU0171B	9.3	21.5	7.2	79	0.5
	05/22/97	NEU018E	8.9	21.8	7.5	80	0.6
	05/22/97	NEU019E	9.5	22.3	7.5	78	0.7
	05/22/97	NEU019L	9.6	23.4	7.5	79	0.8
	05/22/97	NEU019P	9.4	22.8	7.3	79	0.8
	05/22/97	NEU020D	9.8	23.3	7.7	84	0.9
	07/10/96	NEU010	6.7	28.6	7.0	167	0.2
	07/10/96	NEU013	7.1	28.7	6.8	187	0.2
	07/10/96	NEU013B	6.5	28.6	6.6	128	0.3
	07/10/96	NEU0171B	7.3	28.4	6.9	112	0.6
	07/10/96	NEU018E	7.0	28.5	6.8	107	0.7
	07/10/96	NEU019E	8.3	29.5	8.0	98	1.0
	07/10/96	NEU019L	8.2	30.0	7.7	95	1.8
	07/10/96	NEU019P	8.3	29.6	7.8	94	1.8
	07/10/96	NEU020D	8.1	29.9	8.2	91	1.8
	06/25/96	NEU010	6.6	30.5	6.8	123	0.2
	06/25/96	NEU013	7.0	30.4	7.1	153	0.2
	06/25/96	NEU013B	5.3	30.1	7.0	129	0.4

Appendix L2 (continued).

Subbasin/Lake	Date	Station	Dissolved oxygen (mg/L)	Temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)
01							
Falls of the Neuse Res.	06/25/96	NEU0171B	6.4	30.1	6.9	114	0.6
	06/25/96	NEU018E	6.8	30.2	6.6	107	0.9
	06/25/96	NEU019E	7.3	31.6	7.2	96	1.0
	06/25/96	NEU019L	7.3	32.7	7.1	32	1.1
	06/25/96	NEU019P	7.2	31.2	7.2	92	1.2
	06/25/96	NEU020D	7.3	31.5		68	1.6
	09/25/95	NEU010	5.5	19.6	6.3	112	0.2
	09/25/95	NEU013	8.2	18.1	6.8	167	0.2
	09/25/95	NEU013B	7.4	19.1	6.6	155	0.3
	09/25/95	NEU0171B	7.0	20.5	6.5	108	0.4
	09/25/95	NEU018E	7.4	21.2	7.0	91	0.4
	09/25/95	NEU019E	5.3	21.7	6.2	89	0.6
	09/25/95	NEU019L	3.2	22.6	6.0	87	0.7
	09/25/95	NEU019P	1.6	22.7	6.0	88	0.8
	09/25/95	NEU020D	2.1	22.8	6.0	89	0.8
	08/31/95	NEU010	9.0	27.4	6.6	152	0.3
	08/31/95	NEU013	8.6	27.7	6.9	157	0.2
	08/31/95	NEU013B	10.5	27.9	8.2	122	0.3
	08/31/95	NEU0171B	9.7	27.0	8.0	89	0.4
	08/31/95	NEU018E	9.0	27.1	7.6	82	0.4
	08/31/95	NEU019E	9.2	28.8	7.5	77	0.5
	08/31/95	NEU019L	8.4	29.4	7.0	75	0.7
	08/31/95	NEU019P	7.9	28.8	6.8	78	0.8
	08/31/95	NEU020D	7.7	29.4	6.7	81	0.8
	07/31/95	NEU010	10.5	30.4	7.6	158	0.2
	07/31/95	NEU013	8.5	31.6	6.8	131	0.2
	07/31/95	NEU013B	8.6	32.6	7.1	102	0.3
	07/31/95	NEU0171B	8.2	32.9	6.9	96	0.3
	07/31/95	NEU018E	8.1	31.9	6.7	84	0.7
	07/31/95	NEU019E	7.7	31.6	6.7	83	0.8
	07/31/95	NEU019L	6.4	31.2	6.4	86	0.8
	07/31/95	NEU019P	6.9	31.0	6.4	88	1.0
	07/31/95	NEU020D	6.5	30.5	6.7	96	1.0
	06/28/95	NEU010	4.1	24.4	6.0	77	0.2
	06/28/95	NEU013	5.1	24.3	6.2	79	0.2
	06/28/95	NEU013B	6.4	25.0	6.4	94	0.3
	06/28/95	NEU0171B	5.7	25.9	6.7	136	0.5
	06/28/95	NEU018E	8.8	25.9	7.8	134	0.8
	06/28/95	NEU019E	8.7	26.8	7.3	124	0.8
	06/28/95	NEU019L	8.0	26.6	6.9	117	0.8
	06/28/95	NEU019P	8.7	27.6	7.3	107	0.9
	06/28/95	NEU020D	8.7	27.1	7.3	91	1.2
Lake Michie	08/14/00	NEU0061G	7.6	27.8	6.9	74	0.5
	08/14/00	NEU0061J	7.1	28.4	7.0	67	0.7
	08/14/00	NEU0061L	7.6	28.0	7.1	66	0.8
	06/14/00	NEU0061G	9.7	29.2	8.2	69	1.3
	06/14/00	NEU0061J	8.4	29.7	7.7	67	1.6
	06/14/00	NEU0061L	8.4	29.9	7.3	68	2.0
	08/06/95	NEU0061J	8.4	30.0	7.3	67	0.6
	08/06/95	NEU0061L	7.7	29.7	6.7	66	0.7
Lake Butner	08/14/00	NEU007	6.6	27.2	6.9	52	1.6
	08/14/00	NEU007B	6.9	27.4	7.1	52	2.2
	07/20/00	NEU007	7.3	29.1	7.0	53	2.0
	07/20/00	NEU007B	6.4	28.4	7.0	54	1.8
	08/17/95	NEU007	7.8	29.1	6.6	45	1.2
	08/17/95	NEU007B	8.0	29.7	6.6	44	1.3
Lake Rogers	08/14/00	NEU017A	5.4	27.0	7.1	69	0.5
	07/20/00	NEU017A	28.9	5.7	6.8	83	0.2
	08/17/95	NEU017A	29.7	4.9	6.1	80	0.3

Appendix L2 (continued).

Subbasin/Lake	Date	Station	Dissolved oxygen (mg/L)	Temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)
02							
Lake Crabtree	08/24/00	NEUCL1	6.1	25.4	7.0	9	0.2
	08/24/00	NEUCL2	5.7	26.3	7.0	96	0.2
	08/24/00	NEUCL3	6.4	26.4	7.0	91	0.2
	08/07/00	NEUCL1	5.1	27.4	6.7	91	0.2
	08/07/00	NEUCL2	3.8	26.9	6.5	92	0.2
	08/07/00	NEUCL3	6.7	28.2	7.2	83	0.2
	07/12/00	NEUCL1	6.9	28.3	7.3	131	0.3
	07/12/00	NEUCL2	5.5	29.0	7.1	132	0.3
	07/12/00	NEUCL3	6.6	29.3	7.3	130	0.5
	08/21/96	NEUCL1	7.7	27.1	7.4	74	0.2
	08/21/96	NEUCL2	7.1	26.1	7.5	92	0.2
	08/21/96	NEUCL3	5.7	26.3	6.2	74	0.2
	08/17/95	NEUCL1	6.9	28.8	7.7	96	0.2
	08/17/95	NEUCL2	6.1	28.7	7.8	127	0.2
	08/17/95	NEUCL3	6.8	29.5	7.6	95	0.2
Reedy Creek Lake	08/07/00	NEU035A7	10.4	29.8	8.2	61	0.2
	07/12/00	NEU035A7	7.3	29.7	7.4	119	0.8
	06/25/00	NEU035A7	7.6	29.4	7.7	109	1.2
	08/10/95	NEU035A7	7.3	26.6	6.6	70	0.7
Big Lake	08/07/00	NEU035G	10.9	31.3	8.5	86	0.3
	08/07/00	NEU035H	10.1	30.4	7.8	91	0.3
	07/12/00	NEU035G	7.4	29.5	7.6	132	0.7
	07/12/00	NEU035H	8.2	29.7	8.2	132	1.3
	06/27/00	NEU035G	6.1	29.5	7.3	127	0.3
	06/27/00	NEU035H	7.3	29.4	7.7	125	1.0
	08/21/96	NEU035G	8.7	27.8	8.5	101	0.7
	08/21/96	NEU035H	9.1	27.7	8.2	99	0.7
	07/03/95	NEU035G	5.3	26.1	6.2	83	0.8
	07/03/95	NEU035H	4.9	25.9	6.4	84	0.8
Sycamore Lake	08/07/00	NEU035J	9.6	28.9	7.8	76	0.2
	07/12/00	NEU035J	8.7	29.4	7.9	127	1.4
	06/27/00	NEU035J	6.5	28.9	7.4	121	1.3
	08/10/95	NEU035J	5.7	26.0	6.2	68	1.0
Apex Reservoir	07/12/00	NEU055A	7.9	29.1	8.5	122	0.3
	07/27/95	NEU055A	7.9	30.5	7.3	74	0.9
Lake Wheeler	08/09/00	NEU055A01	8.0	31.5	7.7	80	0.8
	08/09/00	NEU055A02	7.8	31.8	8.0	84	1.0
	07/18/00	NEU055A01	7.5	29.6	7.3	97	0.7
	07/18/00	NEU055A02	8.0	29.2	7.8	99	1.1
	06/07/00	NEU055A01	5.8	23.4	6.5	102	0.8
	06/07/00	NEU055A02	7.3	24.1	7.1	102	0.9
	08/08/95	NEU055A01	6.1	28.2	7.1	56	0.8
	08/08/95	NEU055A02	5.7	28.5	6.8	57	0.9
Lake Benson	08/09/00	NEU055A3	8.0	30.7	7.6	81	0.7
	08/09/00	NEU055A4	8.3	31.4	8.3	81	0.8
	07/18/00	NEU055A3	7.8	29.3	7.7	100	0.4
	07/18/00	NEU055A4	8.3	29.5	8.2	102	0.6
	06/07/00	NEU055A3	8.5	24.5	7.2	96	0.5
	06/07/00	NEU055A4	8.1	25.0	7.8	97	0.6
	08/30/96	NEU055A3	8.3	27.6	7.4	79	0.4
	08/30/96	NEU055A4	8.4	28.1	7.3	78	0.4
	09/01/95	NEU055A3	6.7	26.5	7.2	53	0.4
	09/01/95	NEU055A4	9.2	27.3	7.1	50	0.5
05							
Cliffs of The Neuse Lk.	08/16/00	NEUO7113A	8.4	28.8	4.4	65	2.4
	07/28/00	NEUO7113A	8.7	27.8	4.4	65	2.4
	07/11/00	NEUO7113A	8.9	29.5	4.3	66	3.1
	07/25/95	NEUO7113A	8.1	31.2	4.1	62	2.5

Appendix L2 (continued).

Subbasin/Lake	Date	Station	Dissolved oxygen (mg/L)	Temperature (^oC)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)
07							
Lake Wilson	07/11/00	NEU096B4	8.2	29.4	7.2	70	0.6
	06/28/00	NEU096B4	7.9	30.0	7.3	79	0.6
	07/25/95	NEU096B4	7.4	31.2	6.4	64	0.8
Toisnot Reservoir	08/16/00	NEU096E	3.1	26.8	6.4	75	0.6
	07/11/00	NEU096E	3.4	28.7	6.5	79	0.6
	06/28/00	NEU096C	1.4	28.1	6.5	89	0.6
	06/28/00	NEU096E	5.1	28.6	6.9	87	0.7
	08/07/95	NEU096C	4.9	28.7	5.9	71	0.4
	08/07/95	NEU096E	5.8	28.6	6.2	61	0.4
Wiggins Mill Reservoir	08/16/00	NEU084D	6.1	26.6	6.4	65	0.7
	08/16/00	NEU084F	6.2	26.6	6.7	66	0.7
	07/11/00	NEU084D	7.1	28.7	6.9	78	0.9
	07/11/00	NEU084F	7.1	28.2	7.0	78	0.8
	06/28/00	NEU084D	6.6	28.4	7.0	82	0.8
	06/28/00	NEU084F	6.3	28.4	7.1	82	0.8
	07/25/95	NEU084D	5.9	29.6	5.8	58	0.5
	07/25/95	NEU084F	5.4	28.9	6.3	58	0.5

Appendix L3. Photic zone data collected from lakes in the Neuse River basin, 1995 - 2000.[1]

Subbasin/Lake	Date	Station	TP	TKN	NH_3	NO_x	TN	TON	TIN	Chl a	Total Solids	Susp. Solids	Turbidity
01													
Lake Orange	07/18/00	NEU00B	0.02	0.4	0.03	< 0.01	0.41	0.37	0.04		56	3	2.8
	07/18/00	NEU00B2	0.02	0.5	0.01	< 0.01	0.51	0.49	0.02		56	4	2.9
	07/18/00	NEU00B4	0.02	0.3	0.10	< 0.01	0.31	0.20	0.11		57	5	2.5
	06/13/00	NEU00B	0.04	0.3	< 0.01	< 0.01	0.31	0.30	0.01		77	4	4.2
	06/13/00	NEU00B2	0.04	0.4	0.01	< 0.01	0.41	0.39	0.02				4.4
	06/13/00	NEU00B4	0.06	0.4	0.03	< 0.01	0.41	0.37	0.04				4.1
	08/14/95	NEU00B	0.04	0.3	0.01	< 0.01	0.31	0.29	0.02	91	72	5	3.8
	08/14/95	NEU00B2	0.05	0.4	0.02	< 0.01	0.41	0.38	0.03	68	64	4	3.3
	08/14/95	NEU00B4	0.02	0.4	0.03	< 0.01	0.41	0.37	0.04	8	61	4	2.0
Corporation Lake	08/09/00	NEU00C	0.05	0.5	0.02	0.24	0.74	0.48	0.26	69	100	8	9.4
	08/09/00	NEU00C1	0.06	0.4	0.03	0.18	0.58	0.37	0.21		94	8	14.0
	07/18/00	NEU00C	0.04	0.4	0.04	0.24	0.64	0.36	0.28		46	6	14.0
	07/18/00	NEU00C1	0.05	0.3	0.04	0.23	0.53	0.26	0.27		66	13	16.0
	06/26/00	NEU00C	0.06	0.4	0.13	0.29	0.69	0.27	0.42		92	8	11.0
	06/26/00	NEU00C1	0.12	0.6	0.32	0.33	0.93	0.28	0.65		180	91	40.0
	08/14/95	NEU00C	0.04	0.2	0.04	0.27	0.47	0.16	0.31	4	92	11	16.0
	08/14/95	NEU00C1	0.05	0.2	0.07	0.28	0.48	0.13	0.35	13	98	15	14.0
Lake Ben Johnson	08/09/00	NEU00D	0.12	0.3	0.02	0.16	0.46	0.28	0.18		*	*	11.0
	07/18/00	NEU00D	*	*	*	*	*	*	*		63	3	6.8
	06/26/00	NEU00D	0.04	0.4	< 0.01	0.30	0.70	0.40	0.31				10.0
	08/14/95	NEU00D	0.05	0.6	0.04	0.14	0.74	0.56	0.18	17	93	12	11.0
Little River Res.	08/14/00	NEU006S	0.03	0.4	0.01	< 0.01	0.41	0.39	0.02	22	57	1	3.1
	08/14/00	NEU006T	0.01	0.3	0.01	< 0.01	0.31	0.29	0.02		56	1	2.7
	08/14/00	NEU006U	0.02	0.5	0.01	< 0.01	0.51	0.49	0.02		55	1	3.6
	06/14/00	NEU006S	0.03	0.4	0.08	< 0.01	0.41	0.32	0.09		89	3	3.2
	06/14/00	NEU006T	0.02	0.8	0.03	0.04	0.84	0.77	0.07		94	2	3.4
	06/14/00	NEU006U	0.02	0.4	0.01	0.06	0.46	0.39	0.07		83	4	5.5
	09/17/97	NEU006S	0.03	0.4	< 0.01	< 0.01	0.41	0.40	0.01		66	8	4.3
	09/17/97	NEU006T	0.01	0.3	0.06	< 0.01	0.31	0.24	0.07		59	5	2.6
	09/17/97	NEU006U	0.04	0.4	0.03	< 0.01	0.41	0.37	0.04		66	7	2.6
	07/15/97	NEU006S	0.03	0.3	< 0.01	< 0.01	0.31	0.30	0.01		75	11	7.6
	07/15/97	NEU006T	0.04	0.4	< 0.01	< 0.01	0.41	0.40	0.01		75	16	9.0
	07/15/97	NEU006U	0.03	0.3	0.01	< 0.01	0.31	0.29	0.02		70	5	2.6
	06/12/97	NEU006S	0.07	0.2	< 0.01	0.10	0.30	0.20	0.11		60	2	5.4
	06/12/97	NEU006T	0.05	0.3	< 0.01	0.15	0.45	0.30	0.16		63	1	5.6
	06/12/97	NEU006U	0.05	0.4	< 0.01	0.19	0.59	0.40	0.20		64	2	6.5
	08/16/96	NEU006S	<0.01	0.3	< 0.01	< 0.01	0.31	0.30	0.01		74	1	4.0
	08/16/96	NEU006T	0.01	0.3	< 0.01	< 0.01	0.31	0.30	0.01		63	<1	3.8
	08/16/96	NEU006U	<0.01	0.8	< 0.01	< 0.01	0.81	0.80	0.01		66	1	3.0
	07/18/96	NEU006S	0.02	0.2	0.01	< 0.01	0.21	0.19	0.02		68	4	2.4
	07/18/96	NEU006T	<0.01	0.3	< 0.01	< 0.01	0.31	0.30	0.01		69	4	2.0
	07/18/96	NEU006U	<0.01	0.3	0.01	< 0.01	0.31	0.29	0.02		75	4	2.1
	06/20/96	NEU006S	0.03	0.4	0.01	0.05	0.45	0.39	0.06		75	1	3.1
	06/20/96	NEU006T	0.04	0.3	< 0.01	0.02	0.32	0.30	0.03		71	<1	2.3
	06/20/96	NEU006U	0.03	0.3	< 0.01	0.11	0.41	0.30	0.12		73	<1	2.1
	08/21/95	NEU006S	0.04	0.6	0.04	< 0.01	0.61	0.56	0.05	9	74	4	3.5
	08/21/95	NEU006T	0.03	0.4	0.08	< 0.01	0.41	0.32	0.09	7	78	4	3.4
	08/21/95	NEU006U	0.04	0.5	0.08	< 0.01	0.51	0.42	0.09	5	77	4	4.0
Falls of the Neuse Res.	09/28/00	NEU010	0.07	0.5	0.01	0.38	0.88	0.49	0.39		150	21	
	09/28/00	NEU013	0.09	0.4	< 0.01	0.29	0.69	0.40	0.30				
	09/28/00	NEU018E	0.03	0.4	< 0.01	< 0.01	0.41	0.40	0.01		79	8	
	09/28/00	NEU019E	0.03	0.5	0.07	0.01	0.51	0.43	0.08		80	2	
	09/28/00	NEU019P	0.01	0.4	0.16	< 0.01	0.41	0.24	0.17		70	2	
	09/28/00	NEU020D	0.01	0.4	0.09	< 0.01	0.41	0.31	0.10		64	6	
	08/23/00	NEU010	0.11	0.5	< 0.01	< 0.01	0.51	0.50	0.01		130	27	24.0
	08/23/00	NEU018E	0.04	1.0	< 0.01	< 0.01	1.01	1.00	0.01		90	8	6.6
	08/23/00	NEU019E	0.03	0.6	0.36	< 0.01	0.61	0.24	0.37		83	5	4.1

Appendix L3 (continued).

Subbasin/Lake	Date	Station	TP	TKN	NH_3	NO_x	TN	TON	TIN	Chl a	Total Solids	Susp. Solids	Turbidity
01													
Falls of the Neuse Res.	08/23/00	NEU019P	0.03	0.5	< 0.01	0.03	0.53	0.50	0.04		82	4	3.1
	08/23/00	NEU020D	0.02	0.5	0.03	< 0.01	0.51	0.47	0.04		75	4	2.6
	06/07/00	NEU010	0.06	0.3	0.09	< 0.01	0.31	0.21	0.10		170	74	45.0
	06/07/00	NEU013	0.03	1.7	0.06	< 0.01	1.71	1.64	0.07		150	63	40.0
	06/07/00	NEU018E	0.01	0.4	0.26	< 0.01	0.41	0.14	0.27				10.0
	06/07/00	NEU019E	0.01	0.4	0.17	< 0.01	0.41	0.23	0.18		73	6	4.9
	06/07/00	NEU019P	<0.01	0.4	0.26	< 0.01	0.41	0.14	0.27		74	6	4.0
	06/07/00	NEU020D	<0.01	0.2	0.05	< 0.01	0.21	0.15	0.06		69	4	3.7
	09/16/97	NEU010	0.07	0.4	0.01	0.13	0.53	0.39	0.14				
	09/16/97	NEU013	0.08	0.7	0.01	0.03	0.73	0.69	0.04				
	09/16/97	NEU013B	0.04	0.6	0.06	0.01	0.61	0.54	0.07				
	09/16/97	NEU0171B	0.02	0.6	0.15	0.03	0.63	0.45	0.18				
	09/16/97	NEU018E	0.01	0.8	0.26	0.02	0.82	0.54	0.28				
	09/16/97	NEU019E	0.01	0.5	0.18	0.02	0.52	0.32	0.20				
	09/16/97	NEU019L	0.01	0.4	0.05	0.01	0.41	0.35	0.06				
	09/16/97	NEU019P	0.01	0.2	0.01	0.01	0.21	0.19	0.02				
	09/16/97	NEU020D	0.01	0.1	0.01	0.01	0.11	0.09	0.02				
	08/25/97	NEU010	0.11	0.9	0.01	0.01	0.91	0.89	0.02				
	08/25/97	NEU013	0.15	0.8	0.01	0.01	0.81	0.79	0.02				
	08/25/97	NEU013B	0.10	0.7	0.01	0.01	0.71	0.69	0.02				
	08/25/97	NEU0171B	0.06	0.3	0.01	0.01	0.31	0.29	0.02				
	08/25/97	NEU018E	0.04	0.2	0.01	0.01	0.21	0.19	0.02				
	08/25/97	NEU019E	0.03	0.2	0.01	0.01	0.21	0.19	0.02				
	08/25/97	NEU019L	0.02	0.4	0.01	0.01	0.41	0.39	0.02				
	08/25/97	NEU019P	0.02	0.4	0.01	0.01	0.41	0.39	0.02				
	08/25/97	NEU020D	0.02	0.3	0.01	0.01	0.31	0.29	0.02				
	07/14/97	NEU010	0.12	0.4	0.01	0.01	0.41	0.39	0.02				
	07/14/97	NEU013	0.11	0.8	0.01	0.01	0.81	0.79	0.02				
	07/14/97	NEU013B	0.08	0.4	0.01	0.01	0.41	0.39	0.02				
	07/14/97	NEU0171B	0.05	0.4	0.01	0.01	0.41	0.39	0.02				
	07/14/97	NEU018E	0.05	0.4	0.01	0.01	0.41	0.39	0.02				
	07/14/97	NEU019E	0.04	0.4	0.01	0.01	0.41	0.39	0.02				
	07/14/97	NEU019L	0.01	0.4	0.01	0.01	0.41	0.39	0.02				
	07/14/97	NEU019P	0.03	0.3	0.01	0.01	0.31	0.29	0.02				
	07/14/97	NEU020D	0.03	0.3	0.01	0.01	0.31	0.29	0.02				
	06/26/97	NEU010	0.13	0.4	< 0.01	< 0.01	0.41	0.40	0.01		150	29	
	06/26/97	NEU013	0.14	0.4	< 0.01	< 0.01	0.41	0.40	0.01		160	44	
	06/26/97	NEU013B	0.07	0.2	< 0.01	< 0.01	0.21	0.20	0.01		110	19	
	06/26/97	NEU0171B	<0.01	0.2	< 0.01	< 0.01	0.21	0.20	0.01		100	9	
	06/26/97	NEU018E	0.04	0.3	< 0.01	< 0.01	0.31	0.30	0.01		87	6	
	06/26/97	NEU019E	0.03	0.3	< 0.01	< 0.01	0.31	0.30	0.01		66	5	
	06/26/97	NEU019L	0.02	0.3	< 0.01	< 0.01	0.31	0.30	0.01		62	4	
	06/26/97	NEU019P	0.02	0.2	< 0.01	< 0.01	0.21	0.20	0.01		63	3	
	06/26/97	NEU020D	<0.01	0.2	< 0.01	< 0.01	0.21	0.20	0.01		65	4	
	05/22/97	NEU010	0.11	0.3	0.01	0.06	0.36	0.29	0.07				
	05/22/97	NEU013	0.14	0.5	0.01	0.01	0.51	0.49	0.02				
	05/22/97	NEU013B	0.10	0.5	0.01	0.01	0.51	0.49	0.02				
	05/22/97	NEU0171B	0.07	0.2	0.01	0.04	0.24	0.19	0.05				
	05/22/97	NEU018E	0.06	0.4	0.02	0.03	0.43	0.38	0.05				
	05/22/97	NEU019E	0.05	0.3	0.01	0.02	0.32	0.29	0.03				
	05/22/97	NEU019L	0.05	0.4	0.01	0.01	0.41	0.39	0.02				
	05/22/97	NEU019P	0.05	0.3	0.01	0.01	0.31	0.29	0.02				
	05/22/97	NEU020D	0.04	0.4	0.01	0.01	0.41	0.39	0.02				
	07/10/96	NEU010	0.13	0.6	0.07	< 0.01	0.61	0.53	0.08		170	38	
	07/10/96	NEU013	0.20	0.6	0.05	< 0.01	0.61	0.55	0.06		180	60	
	07/10/96	NEU013B	0.09	0.4	0.05	< 0.01	0.41	0.35	0.06		130	18	
	07/10/96	NEU0171B	0.04	0.3	0.05	< 0.01	0.31	0.25	0.06		97	9	
	07/10/96	NEU018E	0.03	0.2	0.06	< 0.01	0.21	0.14	0.07		95	3	
	07/10/96	NEU019E	0.02	0.4	0.05	< 0.01	0.41	0.35	0.06		84	2	
	07/10/96	NEU019L	0.02	0.2	0.04	< 0.01	0.21	0.16	0.05		80	4	
	07/10/96	NEU019P	0.02	0.2	0.06	< 0.01	0.21	0.14	0.07		79	<1	

Appendix L3 (continued).

Subbasin/Lake	Date	Station	TP	TKN	NH_3	NO_x	TN	TON	TIN	Chl a	Total Solids	Susp. Solids	Turbidity
01													
Falls of the Neuse Res.	07/10/96	NEU020D	0.01	0.2	0.04	< 0.01	0.21	0.16	0.05	20	78	<1	
	06/25/96	NEU010	0.13	0.5	0.07	< 0.01	0.51	0.43	0.08		130	34	
	06/25/96	NEU013	0.13	0.6	0.07	< 0.01	0.61	0.53	0.08		150	34	
	06/25/96	NEU013B	0.08	0.5	0.08	< 0.01	0.51	0.42	0.09		120	17	
	06/25/96	NEU0171B	0.03	0.4	0.08	< 0.01	0.41	0.32	0.09		86	3	
	06/25/96	NEU018E	0.02	0.4	0.06	< 0.01	0.41	0.34	0.07		80	3	
	06/25/96	NEU019E					0.00	0.00	0.00				
	06/25/96	NEU019L	0.01	0.4	0.06	< 0.01	0.41	0.34	0.07		79	5	
	06/25/96	NEU019P	0.01	0.3	0.04	< 0.01	0.31	0.26	0.05		79	3	
	06/25/96	NEU020D	<0.01	0.3	0.05	< 0.01	0.31	0.25	0.06		78	2	
	09/25/95	NEU010	0.04	1.0	0.10	0.05	1.05	0.90	0.15	6	140	29	
	09/25/95	NEU013	0.12	0.5	0.05	< 0.01	0.51	0.45	0.06	20	190	67	
	09/25/95	NEU013B	0.10	0.7	0.07	< 0.01	0.71	0.63	0.08	12	160	46	
	09/25/95	NEU0171B	0.03	0.7	0.13	< 0.01	0.71	0.57	0.14	8	120	23	
	09/25/95	NEU018E	0.05	0.6	0.08	0.03	0.63	0.52	0.11	10	110	17	
	09/25/95	NEU019E	0.06	0.2	0.60	< 0.01	0.18	-0.43	0.61	5	88	6	
	09/25/95	NEU019L	0.03	0.6	0.22	< 0.01	0.61	0.38	0.23	4	83	15	
	09/25/95	NEU019P	0.02	0.6	0.25	< 0.01	0.61	0.35	0.26	7	84	8	
	09/25/95	NEU020D	0.01	0.5	0.11	< 0.01	0.51	0.39	0.12	6	83	6	
	08/31/95	NEU010	0.07	0.7	0.06	0.02	0.72	0.64	0.08	14	140	28	
	08/31/95	NEU013	0.13	0.8	0.06	0.01	0.81	0.74	0.07	20	150	32	
	08/31/95	NEU013B	0.08	0.7	0.06	< 0.01	0.71	0.64	0.07	5	120	20	
	08/31/95	NEU0171B	0.06	0.8	0.06	< 0.01	0.81	0.74	0.07	10	83	13	
	08/31/95	NEU018E	0.04	0.7	0.05	< 0.01	0.71	0.65	0.06	14	96	10	
	08/31/95	NEU019E	0.02	0.6	0.05	< 0.01	0.61	0.55	0.06	13	76	9	
	08/31/95	NEU019L	0.03	0.6	0.06	< 0.01	0.61	0.54	0.07	6	69	5	
	08/31/95	NEU019P	0.03	0.5	0.05	< 0.01	0.51	0.45	0.06	6	70	3	
	08/31/95	NEU020D	0.03	0.6	0.04	< 0.01	0.61	0.56	0.05	5	74	5	
	07/31/95	NEU010	0.14	0.8	0.07	0.80	1.60	0.73	0.87	12	170	28	
	07/31/95	NEU013	0.11	0.5	0.06	< 0.01	0.51	0.44	0.07	11	150	28	
	07/31/95	NEU013B	0.07	0.5	0.08	< 0.01	0.51	0.42	0.09	8	130	13	
	07/31/95	NEU0171B	0.07	0.6	0.07	< 0.01	0.61	0.53	0.08	8	110	15	
	07/31/95	NEU018E	0.04	0.4	0.07	< 0.01	0.41	0.33	0.08	9	94	8	
	07/31/95	NEU019E	0.03	0.4	0.07	< 0.01	0.41	0.33	0.08	5	86	8	
	07/31/95	NEU019L	0.04	0.5	0.06	< 0.01	0.51	0.44	0.07	5	88	4	
	07/31/95	NEU019P	0.03	0.4	0.07	< 0.01	0.41	0.33	0.08	5	75	11	
	07/31/95	NEU020D	0.02	0.4	0.07	< 0.01	0.41	0.33	0.08	4	90	5	
	06/28/95	NEU010	0.10	0.5	0.01	0.10	0.60	0.49	0.11	16	120	31	
	06/28/95	NEU013	0.11	0.6	0.08	0.11	0.71	0.52	0.19	12	130	34	
	06/28/95	NEU013B	0.09	0.6	0.07	0.05	0.65	0.53	0.12	11	120	32	
	06/28/95	NEU0171B	0.06	0.5	0.06	< 0.01	0.51	0.44	0.07	9	100	15	
	06/28/95	NEU018E	0.05	0.5	0.06	< 0.01	0.51	0.44	0.07	10	105	12	
	06/28/95	NEU019E	0.04	0.4	0.06	< 0.01	0.41	0.34	0.07	10	97	14	
	06/28/95	NEU019L	0.02	0.3	0.07	< 0.01	0.31	0.23	0.08	9	90	7	
	06/28/95	NEU019P	0.03	0.3	0.06	< 0.01	0.31	0.24	0.07	7	77	3	
	06/28/95	NEU020D	0.02	0.3	0.06	< 0.01	0.31	0.24	0.07	6	68	4	
Lake Michie	08/14/00	NEU0061G	0.04	0.5	< 0.01	< 0.01	0.00	0.00	0.00		79	8	8.1
	08/14/00	NEU0061J	0.02	0.5	0.01	0.01	0.00	0.00	0.00		61	2	4.8
	08/14/00	NEU0061L	0.01	0.4	0.01	< 0.01	0.00	0.00	0.00		60	5	2.9
	06/14/00	NEU0061G	0.03	0.4	0.03	0.03	0.43	0.37	0.06		93	3	7.0
	06/14/00	NEU0061J	0.02	0.4	0.12	0.03	0.43	0.28	0.15		87	4	4.2
	06/14/00	NEU0061L	0.02	0.4	0.02	0.03	0.43	0.38	0.05		87	4	4.4
	08/06/95	NEU0061J	0.04	0.5	0.05	< 0.01	0.51	0.45	0.06	6	83	9	5.3
	08/06/95	NEU0061L	0.03	0.5	0.04	< 0.01	0.51	0.46	0.05	5	76	6	4.9
Lake Butner	08/14/00	NEU007	0.01	0.3	0.03	< 0.01	0.31	0.27	0.04		43	5	2.5
	08/14/00	NEU007B	0.01	0.4	< 0.01	< 0.01	0.41	0.40	0.01		46	13	1.6
	07/20/00	NEU007	0.02	0.4	0.03	< 0.01	0.41	0.37	0.04		57	1	1.8
	07/20/00	NEU007B	0.02	0.4	0.11	< 0.01	0.41	0.29	0.12		54	1	1.6
	08/17/95	NEU007	0.02	0.5	< 0.01	< 0.01	0.51	0.50	0.01	7	63	6	2.8
	08/17/95	NEU007B	0.01	0.5	< 0.01	< 0.01	0.51	0.50	0.01	4	68	2	2.3

Appendix L3 (continued).

Subbasin/Lake	Date	Station	TP	TKN	NH_3	NO_x	TN	TON	TIN	Chl a	Total Solids	Susp. Solids	Turbidity
01													
Lake Rogers	08/14/00	NEU017A	0.05	0.6	0.08	< 0.01	0.61	0.52	0.09		82	14	6.3
	07/20/00	NEU017A	0.08	0.9	0.19	< 0.01	0.91	0.71	0.20				7.1
	08/17/95	NEU017A	0.10	0.9	0.05	< 0.01	0.91	0.85	0.06	14	110	13	14.0
02													
Lake Crabtree	08/24/00	NEUCL1	0.14	0.6	0.35	0.06	0.66	0.25	0.41		150	41	60.0
	08/24/00	NEUCL2	0.14	0.5	0.09	< 0.01	0.51	0.41	0.10		39	41	45.0
	08/24/00	NEUCL3	0.11	0.8	0.33	0.06	0.86	0.47	0.39		130	11	50.0
	08/07/00	NEUCL1	0.13	1.0	0.39	0.06	1.06	0.61	0.45		150	44	90.0
	08/07/00	NEUCL2	0.10	0.6	0.07	0.10	0.70	0.53	0.17		140	29	75.0
	08/07/00	NEUCL3	0.09	0.6	0.02	0.06	0.66	0.58	0.08		110		55.0
	07/12/00	NEUCL1	0.09	0.5	0.03	0.01	0.51	0.47	0.04		110	49	28.0
	07/12/00	NEUCL2	0.10	0.7	< 0.01	0.01	0.71	0.70	0.02		150	29	17.0
	07/12/00	NEUCL3	0.05	0.4	0.06	< 0.01	0.41	0.34	0.07		120	12	12.0
	08/21/96	NEUCL1	0.07	0.4	< 0.01	< 0.01	0.41	0.40	0.01		120	39	36.0
	08/21/96	NEUCL2	0.10	0.6	0.06	0.23	0.83	0.54	0.29		130	44	35.0
	08/21/96	NEUCL3	0.05	0.6	0.14	0.02	0.62	0.46	0.16		100	18	26.0
	08/17/95	NEUCL1	0.08	0.7	0.02	0.01	0.71	0.68	0.03	13	170	55	55.0
	08/17/95	NEUCL2	0.19	0.9	0.10	0.16	1.06	0.80	0.26	13	200	70	65.0
	08/17/95	NEUCL3	0.10	0.6	0.05	0.03	0.63	0.55	0.08	8	130	25	36.0
Reedy Creek Lake	08/07/00	NEU035A7	0.08	0.6	0.05	< 0.01	0.61	0.55	0.06		150	18	50.0
	07/12/00	NEU035A7	0.04	0.3	0.16	0.01	0.31	0.14	0.17		99	11	5.3
	06/25/00	NEU035A7	0.01	0.4	0.08	< 0.01	0.41	0.32	0.09		76	2	2.7
	08/10/95	NEU035A7	0.04	0.4	< 0.01	< 0.01	0.41	0.40	0.01	6	68	5	7.8
Big Lake	08/07/00	NEU035G	0.08	0.7	0.20	0.07	0.77	0.50	0.27		100	22	45.0
	08/07/00	NEU035H	0.07	0.6	0.12	0.15	0.75	0.48	0.27		100	15	40.0
	07/12/00	NEU035G	0.05	0.4	0.01	0.01	0.41	0.39	0.02		110	11	7.4
	07/12/00	NEU035H	0.03	0.5	< 0.01	< 0.01	0.51	0.50	0.01		100	20	3.9
	06/27/00	NEU035G	0.03	0.9	0.03	< 0.01	0.91	0.87	0.04		95	20	11.0
	06/27/00	NEU035H	<0.01	0.7	0.02	< 0.01	0.71	0.68	0.03		70	12	2.9
	08/21/96	NEU035G	0.01	0.4	< 0.01	< 0.01	0.41	0.40	0.01		100	13	
	08/21/96	NEU035H	0.03	0.5	0.01	< 0.01	0.51	0.49	0.02		94	10	5.6
	07/03/95	NEU035G	0.03	0.4	0.01	< 0.01	0.41	0.39	0.02	9	80	2	6.4
	07/03/95	NEU035H	0.03	0.4	0.01	< 0.01	0.41	0.39	0.02	10	82	2	5.0
Sycamore Lake	08/07/00	NEU035J	0.07	0.5	< 0.01	0.06	0.56	0.50	0.07		100	14	40.0
	07/12/00	NEU035J	0.02	0.4	0.19	0.01	0.41	0.21	0.20		100	7	4.6
	06/27/00	NEU035J	<0.01	0.9	0.32	< 0.01	0.91	0.58	0.33	22	91	3	3.4
	08/10/95	NEU035J	0.02	0.4	< 0.01	< 0.01	0.41	0.40	0.01	11	68	3	4.8
Apex Reservoir	07/12/00	NEU055A	0.06	1.0	0.01	< 0.01	1.01	0.99	0.02		400	12	9.1
	07/27/95	NEU055A	0.07	0.7	0.08	< 0.01	0.71	0.62	0.09	7	84	10	6.3
Lake Wheeler	08/09/00	NEU055A01	0.04	0.4	0.01	< 0.01	0.41	0.39	0.02		92	9	8.0
	08/09/00	NEU055A02	0.02	0.5	0.13	< 0.01	0.51	0.37	0.14		78	4	4.0
	07/18/00	NEU055A01	0.03	0.4	0.01	< 0.01	0.41	0.39	0.02		62	4	5.1
	07/18/00	NEU055A02	0.01	0.5	0.02	< 0.01	0.51	0.48	0.03		52	2	2.2
	06/07/00	NEU055A01	0.02	0.2	< 0.01	< 0.01	0.21	0.20	0.01		81	8	5.4
	06/07/00	NEU055A02	0.02	0.3	< 0.01	< 0.01	0.31	0.30	0.01		83	8	4.3
	08/08/95	NEU055A01	0.03	0.3	0.04	< 0.01	0.31	0.26	0.05	13	75	7	5.2
	08/08/95	NEU055A02	0.02	0.3	0.04	< 0.01	0.31	0.26	0.05	14	71	4	3.1
Lake Benson	08/09/00	NEU055A3	0.03	0.5	0.01	< 0.01	0.51	0.49	0.02		85	9	8.4
	08/09/00	NEU055A4	0.03	0.4	0.04	< 0.01	0.41	0.36	0.05		80	7	6.5
	07/18/00	NEU055A3	0.04	0.4	< 0.01	< 0.01	0.41	0.40	0.01		68	6	8.4
	07/18/00	NEU055A4	0.03	0.4	< 0.01	< 0.01	0.41	0.40	0.01		69	6	5.1
	06/07/00	NEU055A3	0.06	0.5	< 0.01	< 0.01	0.51	0.50	0.01		93	22	13.0
	06/07/00	NEU055A4	0.03	0.4	< 0.01	< 0.01	0.41	0.40	0.01		87	11	8.5
	08/30/96	NEU055A3	0.03	0.4	0.03	< 0.01	0.41	0.37	0.04		72	8	8.3
	08/30/96	NEU055A4	0.03	0.5	0.03	< 0.01	0.51	0.47	0.04		71	4	7.1
	09/01/95	NEU055A3	0.08	0.5	0.02	0.01	0.51	0.48	0.03	9	80	16	17.0
	09/01/95	NEU055A4	0.06	0.4	0.02	< 0.01	0.41	0.38	0.03	10	73	11	17.0
05													
Cliffs of the Neuse Lake	08/16/00	NEU07113A	0.01	0.2	< 0.01	0.01	0.21	0.20	0.02		55	2	1.3
	07/28/00	NEU07113A	0.01	0.4	0.02	< 0.01	0.41	0.38	0.03		53	3	1.1
	07/11/00	NEU07113A	<0.01	0.1	< 0.01	0.08	0.18	0.10	0.09		51	1	1.1
	07/25/95	NEU07113A	0.01	0.2	0.04	0.01	0.21	0.16	0.05	9	50	5	1.7

Appendix L3 (continued).

Subbasin/Lake	Date	Station	TP	TKN	NH_3	NO_x	TN	TON	TIN	Chl a	Total Solids	Susp. Solids	Turbidity
07													
Lake Wilson	07/11/00	NEU096B4	0.09	0.7	0.14	0.08	0.78	0.56	0.22		89	9	5.5
	06/28/00	NEU096B4	0.04	0.6	< 0.01	< 0.01	0.61	0.60	0.01		69	8	4.9
	07/25/95	NEU096B4	0.12	0.6	0.01	< 0.01	0.61	0.59	0.02	10	99	7	3.6
Toisnot Res.	08/16/00	NEU096E	0.11	0.6	0.24	0.02	0.62	0.36	0.26		130	37	9.4
	07/11/00	NEU096E	0.13	0.8	0.03	0.11	0.91	0.77	0.14		99	9	6.8
	06/28/00	NEU096C	0.08	0.7	0.05	< 0.01	0.71	0.65	0.06		80	5	6.7
	06/28/00	NEU096E	0.06	0.4	< 0.01	< 0.01	0.41	0.40	0.01		81	10	7.2
	08/07/95	NEU096C	0.23	0.8	0.24	< 0.01	0.81	0.56	0.25	21	110	22	12.0
	08/07/95	NEU096E	0.22	0.6	0.01	< 0.01	0.61	0.59	0.02	8	170	63	11.0
Wiggins Mill Res.	08/16/00	NEU084D	0.06	0.5	0.18	0.04	0.54	0.32	0.22		73	2	4.7
	08/16/00	NEU084F	0.06	0.5	0.45	0.03	0.53	0.05	0.48		77	7	4.9
	07/11/00	NEU084D	0.05	0.4	< 0.01	0.07	0.47	0.40	0.08		86	8	5.0
	07/11/00	NEU084F	0.04	0.3	0.09	0.06	0.36	0.21	0.15		83	3	3.9
	06/28/00	NEU084D	0.02	0.5	< 0.01	< 0.01	0.51	0.50	0.01		61	11	5.7
	06/28/00	NEU084F	<0.01	0.3	< 0.01	< 0.01	0.31	0.30	0.01		54	4	3.7
	07/25/95	NEU084D	0.13	0.6	0.04	0.12	0.72	0.56	0.16	6	100	9	9.8
	07/25/95	NEU084F	0.13	0.8	0.02	0.12	0.92	0.78	0.14	9	92	10	9.9

[1]Abbreviations are TP = total phosphorus, TKN = total Kjeldahl nitrogen, NH_3 = ammonia nitrogen, No_x = nitrate + nitrite nitrogen, TON = total organic nitrogen, TIN = total inorganic nitrogen, and Chl *a* = chlorophyll *a*. Units of measure are mg/L, except for chlorophyll *a* which is µg/l and turbidity which is NTU.

Appendix P1. Summary of samples collected in the Neuse River basin during 1996 - 2000 and suspected as algal blooms.

Subbasin/ Waterbody/Station	Date	Biovolume (mm^3/m^3)	Density (cells/ ml)	Dominant Algae[1]	Reason Sampled	Pfiesteria-likes? (cells/ml)
1						
Corporation Lake						
NEU00C1	08/09/00	NQ	NQ	CHL	Bloom	
NEU00C	08/09/00	13,640	2,280	CHL	Bloom	
Eno River						
ENO-16	07/14/97	NQ	NQ	EUG	Surface film	
Ellerbe Creek	07/14/97	NQ	NQ	CYA,BAC,CHL,EUG	Bloom	
Falls Reservoir						
J1370000	06/25/96	7,420	81,430	CHL,CYA	Special study	
J1727000	06/25/96	3,680	20,550	PRY	Special study	
J1370000	07/10/96	14,977	97,859	CHL,CYA	Special study	
J1727000	07/10/96	1,130	17,125	CYA,PRY	Special study	
J1370000	05/22/97	3,790	43,163	CHL	Special study	
J1727000	05/22/97	3,601	45,749	CYA,PRY	Special study	
J1370000	06/26/97	3,570	39,144	CHL,CYA	Special study	
J1727000	06/26/97	4,929	47,182	BAC,PRY	Special study	
J1370000	07/14/97	6,017	59,589	CHL,CYA	Special study	
J1727000	07/14/97	2,667	38,882	CYA	Special study	
NEU010	07/14/97	3,086	14,417	CYA	Special study	
J1370000	08/25/97	6,768	74,181	CHL,CYA	Special study	
J1727000	08/25/97	5,149	45,085	BAC,CYA	Special study	
J1370000	09/16/97	7,914	81,084	CHL,CYA	Special study	
J1727000	09/16/97	3,933	33,028	BAC,CYA	Special study	
Lake Michie						
NEU0061J	06/14/00	3,000	7,940	PRY	Bloom	
NEU0061L	08/14/00	6,500	43,670	CHL,CYA	Bloom	
NEU0061G	08/14/00	9,450	40,380	BAC,CYA	Bloom	
Lake Rogers						
NEU017A	07/20/00	36,400	12,110	CHL	Bloom	
NEU017A	08/14/00	13,140	6,730	CHL,CHM	Bloom	
Little River Reservoir						
NEU006S	08/16/96	5,820	35,990	DIN,EUG	Bloom	
NEU006T	06/14/00	5,200	2,500	BAC	Bloom	
Reeds Creek						
Knap of Creek	09/03/98	NQ	NQ	EUG	Surface film	
2						
Big Lake						
NEU035H	08/07/00	5,760	11,740	CHL	Bloom	
Crabtree Creek						
J2850000	08/11/99	155,747	266,493	CHL	Bloom	
Hayes Farm Pond						
no site #	03/01/00	1,136,970	3,383,810	CHL	Dead fish	
Lake Apex						
NEU055A	07/12/00	62,760	1,015,860	CYA	Bloom	
Lake Benson						
NR NEU055A3	08/30/96	NQ	NQ	CHL,CYA	Bloom	
Vandora-1	05/22/98	NQ	NQ		Lesions	
NEU055A4	06/07/00	4,510	28,330	CYA,PRY	Bloom	
Swift Creek	06/30/00	12,348	43,810	CYA	Bloom	
NEU055A3	07/18/00	13,000	39,750	CHL,CYA	Bloom	
NEU055A3	08/09/00	14,590	24,490	CHL,CYA	Bloom	
Lake Crabtree						
NEUCL1	08/21/96	805	11,463	CYA	Bloom	
NEUCL3	08/07/00	NQ	NQ	BAC,CRY	Bloom	
Lake Wheeler						
Wheeler-1	06/05/96	1,310	7,570	BAC	Dead clams	
NEU055A01	07/18/00	8,770	27,392	CHL,CYA	Bloom	
NEU055A01	08/09/00	13,550	34,430	CHL,CYA,EUG	Bloom	
NEU055A02	08/09/00	27,390	11,280	CHL,CYA	Bloom	
Pigeonhouse Creek						
208732544	07/01/96	462	4,334	BAC	Surface film	
Reedy Creek Lake						
NEU035A7	08/07/00	37,330	5,910	CHL	Bloom	
Swift Creek (UT)	03/10/99	NQ	NQ	BAC,CHL,CRY	Surface film	

Appendix P1 (continued).

Subbasin/ Waterbody/Station	Date	Biovolume (mm^3/m^3)	Density (cells/ ml)	Dominant Algae[1]	Reason Sampled	Pfiesteria-likes? (cells/ml)
5						
Cliffs of Neuse Lake						
NEU07113A	07/11/00	4,470	3,840	CHL,PRY	Bloom	
Hog Lagoon						
Hog Lagoon	07/12/00	NQ	NQ	CHL,EUG	Bloom	
Kinston WWTP						
Peachtree	01/28/99	NQ	NQ	CHR,BAC,CHL	Foam	
Peachtree	02/26/99	41,238	232,766	CHL,CHR	Dead fish	
Kinston Private Pond						
no site #	07/05/00	24,740	29,110	CHL	Dead fish	
Lake Wilson						
NEU096B4	07/11/00	24,040	7,530	CHL,CHM,CYA	Bloom	
Lake Toisnot						
NEU096E	06/28/00	8,940	2,590	CHL,CHM,CYA	Bloom	
Wiggins Mill Reservoir						
NEU084D	06/28/00	7,240	3,920	BAC,CHL,CHM	Bloom	
NEU084F	08/16/00	7,630	14,970	CHL,PRY	Bloom	
6						
Driver Ponds						
Driver-1	10/13/98	56,050	421,495	CHL	Bloom	
Control-1	10/15/98	1,680	11,851	CHR,CRY,CHL	Reference	
Girl Scout Camp Pond						
no site #	06/21/00	NQ	NQ	CYA	Floating mat	
7						
Contentnea Creek						
J7810000	07/13/98	NQ	NQ		Surface film	
Hood Swamp Drainage Pond						
Hood Swamp-A	05/14/98	NQ	NQ	EUG	Dead fish	
Little Contentnea Creek						
J7739550	06/30/97	NQ	NQ		Surface film	
8						
Neuse River						
J7930000	08/12/97	2,561	37,571	CHR	Bloom	
New Bern-Sandy Pt	10/10/97	NQ	NQ	onlyPf-likecounted	Lesions	58
Canal-C	10/20/97	1,750	10,974	CYA	Bloom	
Swift Creek						
J8210000	07/15/97	2,711	8,155	BAC	Bloom	
J8210000	06/30/98	777	10,077	BAC,CHR	Bloom	
9						
Canal at Riverbend						
Canal-C	06/29/98	NQ	NQ	CHL,CYA	Floating mat	
Neuse River						
Neuse River	08/12/97	2,148	14,213	CHR,CRY	Bloom	
10						
Adams Creek						
Adams-A	07/22/97	NQ	NQ	DIN,CYA,EUG	Dead fish	111
Back Creek						
Back Creek	04/17/96	10,257	16,426	DIN	Bloom	
J9690000	08/05/97	5,847	15,640	BAC,DIN	Dead fish	699
J9690000	04/20/99	15,312	133,858	CRY,CHR	Bloom	
J9690000	10/03/00	70,254	69,346	CRY,CHR	Bloom	
Bay River						
J9950000	07/30/98	3,011	52,308	CYA,CHR	Bloom	
J9950000	01/14/99	16,345	43,687	CHL,DIN	Bloom	
Beard Creek						
Beard-1	07/09/96	349	18,523	CYA	Film, odor	
Beard-2	07/09/96	6,287	246,047	CYA	Film, odor	
Beard-3	07/09/96	1,443	91,743	CYA	Film, odor	
Bogue Sound						
Fort Macon	09/17/97	NQ	NQ	onlyPf-likecounted	Lesions	47
Briggand Bay Canal						
Briggand Bay	05/01/96	NQ	NQ	CHL	Floating mat	
Bryces Creek						
Bryce-B	09/18/97	NQ	NQ	onlyPf-likecounted	Dead fish	12

Appendix P1 (continued).

Subbasin/ Waterbody/Station	Date	Biovolume (mm^3/m^3)	Density (cells/ ml)	Dominant Algae[1]	Reason Sampled	Pfiesteria-likes? (cells/ml)
10						
Cypress Lake						
Cypress-1	06/06/97	13,970	5,312	CYA	Bloom	
Duck Creek Marina						
Duck-A	08/09/97	3,435	29,707	DIN,BAC	Dead fish	
Goose Creek						
Goose-1	07/18/97	NQ	NQ		Dead fish	250
Hancock Creek						
H	06/26/98	121,866	205,505	EUG,CHL,DIN	Bloom	
Hancock-A	07/09/98	12,516	76,191	CYA	Bloom	
Hancock-1	06/09/99	NQ	NQ		Lesions	
Lake Clermont						
no site #	06/12/00	2,480	10,830	CYA	Dead fish	
no site #	07/28/00	NQ	NQ	CHL,CYA	Surface film	
no site #	09/14/00	5,530	6,260	CYA	Bloom	
Lochbridge Pond						
Riverbend	08/03/99	114,450	425,881	CHL	Bloom	
Mills Branch						
Mills-1	07/17/97	1,023	13,368	BAC	Dead fish	
Neuse River						
J8902500	07/01/96	5,204	24,203	BAC	Bloom	
J9810000	07/01/96	7,394	880	DIN	Bloom	
South-Turn	06/11/97	736	8,388		Porpoise kill	
Greens Creek	06/20/97	NQ	NQ	Only Pf-like counted	Lesions	606
Headwaters Hog Pen	06/23/97	NQ	NQ	Only Pf-like counted	Lesions	384
Hog Pen Gut-1	06/23/97	NQ	NQ	Only Pf-like counted	Lesions	617
Oriental-1	06/25/97	NQ	NQ	Only Pf-like counted	Lesions	443
Oriental-1	06/27/97	NQ	NQ	Only Pf-like counted	Lesions	425
Clubfoot Creek	07/02/97	NQ	NQ	Only Pf-like counted	Background	146
Beard Creek	07/03/97	NQ	NQ	Only Pf-like counted	Background	157
Dawson Creek	07/03/97	NQ	NQ	Only Pf-like counted	Background	99
Hancock Creek	07/03/97	NQ	NQ	Only Pf-like counted	Background	99
Upper Broad Creek	07/03/97	NQ	NQ	Only Pf-like counted	Background	70
Gatlin	07/07/97	NQ	NQ	Only Pf-like counted	Background	0
Neuse-MR-8	07/07/97	NQ	NQ	Only Pf-like counted	Background	70
Pierson Point	07/07/97	NQ	NQ	Only Pf-like counted	Background	70
SE Seafarer	07/07/97	NQ	NQ	Only Pf-like counted	Background	98
South Seafarer	07/07/97	NQ	NQ	Only Pf-like counted	Background	140
SW Seafarer	07/07/97	NQ	NQ	Only Pf-like counted	Background	35
Neuse-170	07/15/97	13,630	27,645	DIN,CYA	Bloom	
Carolina-B	07/22/97	NQ	NQ	DIN,BAC	Dead fish	320
Neuse-A	07/26/97	NQ	NQ	CYA	Surface film	
Bridgeton	08/04/97	10,279	21,844	CHL	Surface film	
Neuse-MR-9	08/04/97	3,656	35,416	CYA,DIN	Dead fish	116
Neuse-H68E	08/05/97	4,519	14,417	BAC,CYA,DIN	Dead fish	306
Neuse-17B	08/09/97	2,597	11,533	DIN,CYA,BAC	Bloom	
Sandy Point-C	08/09/97	2,317	49,978	CYA,CRY	Bloom	
J8570000	08/12/97	20,236	28,834	DIN,BAC,CYA	Bloom	
J8770000	08/12/97	NQ	NQ		Bloom	
J8902500	08/12/97	5,410	16,147	DIN,CHR,CYA	Bloom	
J8910000	08/12/97	31,629	11,798	CYA,CHR	Bloom	
J9810000	08/12/97	2,061	11,184	CHR,CRY	Bloom	
J8570000	09/09/97	47,848	49,978	DIN,CYA	Bloom	
Dove's Dock	09/12/97	NQ	NQ	Only Pf-like counted	Stressed	1479
J8910000	10/06/97	3,913	111,257	CHL,CRY,CHR,CYA	Bloom	
J9530000	10/06/97	3,102	135,081	CHL,CRY,CHR,CYA	Bloom	
J8570000	10/09/97	6,804	29,782	DIN	Bloom	
New 17 Bridge	10/09/97	74,274	55,246	DIN	Dead fish	225
J8903060	10/06/97	23,390	193,709	DIN	Bloom	
J8900800	11/04/97	57,655	61,656	DIN	Bloom	
Broad-A	11/10/97	13,924	50,378	DIN,BAC	Bloom	
Goose-A	11/21/97	6,937	114,927	DIN	Bloom	

Appendix P1 (continued).

Subbasin/ Waterbody/Station	Date	Biovolume (mm^3/m^3)	Density (cells/ ml)	Dominant Algae[1]	Reason Sampled	Pfiesteria-likes? (cells/ml)
Slocum-A	12/02/97	16,027	66,987	BAC,CHL,CRY,CYA	Bloom	
J8900800	12/29/97	38,135	99,537	BAC,DIN	Bloom	
J9530000	12/29/97	8,192	43,058	BAC,DIN	Bloom	
Neuse-Mill	01/02/98	NQ	NQ	BAC	Foam	
J9540000	01/13/98	15,028	9,855	DIN,BAC	Bloom	
J8925000	05/06/98	30,726	60,813	BAC	Bloom	
J9540000	05/06/98	26,003	105,548	BAC	Bloom	
J8902500	05/06/98	59,216	74,094	BAC	Bloom	
J9810000	05/06/98	3,679	38,270	BAC	Bloom	
J9530000	05/26/98	1,366	31,979	BAC	Bloom	
J8910000	05/27/98	7,087	90,869	BAC	Bloom	
J8910000	06/03/98	41,390	76,540	CHL	Bloom	
CM 22	06/30/98	4,563	47,182	BAC,CYA	Bloom	
J8910000	07/09/98	1,416	13,980	CYA,CHR	Bloom	
J8910000	07/14/98	3,776	33,552	CYA,CHR	Lesions	122
Camp Seafarer	07/21/98	NQ	NQ	only Pf-like counted	Dead fish	58
J9810000	07/28/98	2,370	26,999	CYA,CHR	Dead fish	367
25% CM 13	07/28/98	NQ	NQ	only Pf-like counted	Dead fish	0
50% CM 13	07/28/98	NQ	NQ	only Pf-like counted	Dead fish	52
25% Slocum	07/28/98	NQ	NQ	only Pf-like counted	Dead fish	367; Pf found
50% Slocum	07/28/98	4,460	59,415	BAC,CHR	Dead fish	326; Pf found
75% Slocum	07/28/98	NQ	NQ	only Pf-like counted	Dead fish	181; Pf found
J9530000	09/15/98	8,201	124,072	CYA	Bloom	
Slocum/Hancock	09/15/98	6,176	77,763	CYA,CHR,CRY	Dead eels	
J8910000	09/15/98	20,059	114,985	CRY,CYA,BAC	Bloom	
J8920000	09/23/98	3,545	39,610	CHR,CYA	Bloom	
J8910000	11/17/98	2,834	16,676	CHR,CHL	Bloom	
J9530000	01/13/99	9,805	31,315	DIN,BAC	Bloom	
J9685000	01/13/99	7,181	38,095	DIN,CHL	Bloom	
J9810000	02/09/99	27,819	36,697	DIN,CHR	Bloom	
J8902500	03/11/99	16,050	53,124	BAC,CHR	Bloom	
J8910000	03/11/99	31,908	61,861	BAC,DIN,CHR	Bloom	
J9530000	03/11/99	10,852	40,192	BAC,CHR	Bloom	
J8902500	04/08/99	6,343	60,451	BAC,CHR	Bloom	
J8910000	04/26/99	6,957	38,667	BAC,CHR	Bloom	
Broad Creek-A	05/23/99	NQ	NQ		Dead fish	227
Broad Creek-B	05/23/99	NQ	NQ		Dead fish	198
Broad Creek-C	05/23/99	NQ	NQ		Dead fish	373
J8570000	06/14/99	8,122	28,985	DIN,CHR,BAC,CRY	Bloom	
CM 15	07/20/99	NQ	NQ		Lesions	670 (auto)
CM 17	07/20/99	NQ	NQ		Lesions	233 (auto)
CM 19	07/20/99	NQ	NQ		Lesions	408 (auto)
Green Spring	07/22/99	4,654	42,116	BAC,CHR,CYA	Foam	
Station 150	07/27/99	19,136	15,915	DIN,CHR	Bloom	
CM 38	08/05/99	53,770	10,438	DIN,CHR	Dead fish	873 (auto)
Hancock Creek	08/13/99	NQ	NQ	CHR,BAC	Dead fish	245 (auto)
Long Creek-A	08/15/99	NQ	NQ	DIN	Dead fish	1898 (auto)
Long Creek-B	08/15/99	NQ	NQ	DIN	Dead fish	1793 (auto)
Long Creek-C	08/15/99	NQ	NQ	DIN	Dead fish	75 (auto)
J8910000	03/07/00	3,171	45,142	BAC,CHL	Bloom	
J8920000	05/04/00	9,526	90,586	BAC,CHR	Bloom	
Clubfoot Creek	06/16/00	NQ	NQ	only Pf-like counted	Dead fish	41 (no fluor)
J8910000	06/21/00	NQ	NQ	only Pf-like counted	Dead fish	169 (both)
Carolina Pines	06/21/00	NQ	NQ	only Pf-like counted	Dead fish	233 (auto)
J8903500	07/25/00	38,966	100,933	DIN,CHR,CRY	Bloom	
J8925000	08/22/00	3,443	33,947	DIN,CHR	Bloom	
Slocum Creek	09/12/00	NQ	NQ	CHR,CRY,BAC	Dead fish	
Kennel Beach	09/13/00	NQ	NQ		Dead fish	181 (auto)
Beard Creek	09/13/00	8,395	46,110	DIN,CHR	Dead fish	23 (auto)
Carolina Pines	09/14/00	2,882	55,550	CHR,CHL	Dead fish	47 (auto)
J8910000	09/24/00	NQ	NQ		Dead fish	12 (auto)
Transect 15	09/24/00	NQ	NQ		Dead fish	47 (auto)
J8910000	09/25/00	NQ	NQ		Dead fish	6 (auto)
Beard Creek	09/25/00	NQ	NQ		Dead fish	41 (auto)
Carolina Pines	09/25/00	NQ	NQ		Dead fish	58 (auto)

Appendix P1 (continued).

Subbasin/ Waterbody/Station	Date	Biovolume (mm^3/m^3)	Density (cells/ ml)	Dominant Algae[1]	Reason Sampled	Pfiesteria-likes? (cells/ml)
Carolina Pines	09/27/00	NQ	NQ		Dead fish	6 (auto)
Beard Creek	09/27/00	NQ	NQ		Dead fish	140 (auto)
J8910000	09/27/00	NQ	NQ		Dead fish	12 (auto)
Hancock Creek	09/27/00	NQ	NQ		Dead fish	12 (auto)
Kennel Beach	09/27/00	NQ	NQ		Dead fish	140 (auto)
Greens Creek	09/28/00	NQ	NQ		Dead fish	116 (auto); Pf found
Spice Creek	09/29/00	NQ	NQ		Dead fish	23 (fluor not used)
Goose Creek	10/04/00	NQ	NQ		Dead fish	12 (fluor not used)
J8925000	10/19/00	17,098	37,759	DIN,CHR,BAC	Bloom	
J9590000	10/19/00	13,690	35,399	DIN,CHR	Bloom	
J8910000	10/25/00	NQ	NQ		Dead fish	140 (auto)
J8903600	11/14/00	44,002	110,329	DIN,CRY,CHR,BAC	Bloom	
J9810000	11/14/00	3,152	14,160	DIN,CRY	Bloom	
Union Point	11/16/00	NQ	NQ	CHL	Surface film	
J8570000	12/13/00	2,052	5,228	DIN,BAC	Bloom	
J8902500	12/13/00	9,241	7,189	DIN,BAC	Bloom	
J9590000	12/13/00	11,407	18,880	BAC	Bloom	
Northwest Creek						
Northwest Creek	07/03/97	8,035	23,678	CHM,BAC, CYA	Bloom	
Northwest-1	09/01/00	101,788	56,639	DIN,EUG,CHR	Dead fish	5590 (fluor not used)
River Bend Pond						
River Bend	08/24/97	12,221	29,358	BAC,CHL	Dead fish	
Site A	01/19/99	3,976	109,043	CYA	Surface film	
Site B	01/19/99	3,657	118,829	BAC	Dead duck	
Site C	01/20/99	3,367	97,510	CYA,EUG	Surface film	
Slocum Creek						
Slocum-SW	07/07/97	5,586	5,941	CHM,EUG	Brown water	
Spice Creek						
Spice-A	12/10/97	4,591	9,436	CHR, CRY, DIN	Dead fish	
Swift Creek						
Swift Creek	06/29/98	2,347	10,893	PRY,CRY,CHR	Bloom	
Swift Creek	03/10/99	NQ	NQ	CHL,BAC,CRY	Floating mat	
Trent River						
J8770000	06/27/00	7,008	104,564	CRY,BAC	Bloom	
J8770000	08/22/00	2,301	27,049	BAC,DIN,CHR	Bloom	
Tucker Creek						
Tucker-1	08/04/97	5,027	58,890	BAC,CYA,DIN	Lesions	524
Whitaker Creek						
Whitaker-1	07/18/00	11,972	55,368	DIN,CHR,BAC	Bloom	
11						
Trent River						
Trent-P	10/13/97	NQ	NQ	CHL	Floating mat	
J8730000	06/25/98	NQ	NQ	CHL	Bloom	
J8690000	07/13/98	NQ	NQ	CHL	Bloom	
B	08/13/98	NQ	NQ	CHL	Bloom	
12						
Neuse River						
Neuse-Little	04/28/98	NQ	NQ	CHL,BAC	Dried algae	
13						
Alligator Creek						
Alligator-G	10/15/97	NQ	NQ	only Pf-like counted	Dead fish	12
14						
W. Thorofare Bay						
J9938000	04/24/00	6,456	26,020	BAC,DIN	Bloom	

[1]Abbreviations
- BAC - Bacillariophyceae (diatom)
- CHL - Chlorophyceae (green algae)
- CHR - Chrysophyceae (golden brown algae)
- CRY - Cryptophyceae (cryptomonads)
- CYA - Cyanophyceae (blue green algae)
- DIN - Dinophyceae (dinoflagellates)
- EUG - Euglenophyceae (euglenoids)
- Pf-like - Pfiesteria-like dinoflagellates
- NS - not sampled
- NQ - not quantified