BASINWIDE ASSESSMENT REPORT

YADKIN 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

The water quality and biological communities of the Yadkin River basin were most recently evaluated in 2001. The previous assessment was conducted in 1996. The 2001 water quality assessment conducted by the North Carolina Division of Water Quality included 106 monitoring locations for benthic macroinvertebrates, 56 fish community assessments, 46 ambient chemistry locations, 26 reservoirs, and 2 fish tissue evaluations. These monitoring efforts were supplemented with effluent toxicity testing at 80 NPDES facilities and the investigation of 19 fish kill incidents. The Yadkin-Pee Dee River Basin Association also conducted ambient chemistry monitoring at an additional 71 locations.

2001 was representative of a drought year with the potential to reduce impacts from nonpoint sources and magnify the impacts from point source discharges. This flow regime must be kept in mind when looking at temporal and spatial changes in water quality.

Observed water quality concerns in the basin included increasing nutrient enrichment, increasing urbanization and suburbanization of once rural landscapes, instream sedimentation from nonpoint sources, and instream impacts from permitted municipal and industrial dischargers. Most of the monitored reservoirs, including municipal drinking water supplies, were observed to have excessive algal growth and associated concerns with dissolved oxygen and pH. These problems were caused by low flow, sedimentation, nutrients, and toxicants.

Despite these water quality concerns, there are still many streams with very good water quality characteristics and that have not changed since the 1996 evaluation. These streams tend to drain forested catchments such as those found in Wilkes and Surry counties and in the Uwharrie National Forest. Excellent or Good biological ratings were documented at 36 percent of the benthic macroinvertebrate and 57 percent of the fish community sites. Many of these sites are currently rated as Outstanding Resource and High Quality Waters.

Approximately three-fourths of the benthic macroinvertebrate and fish community sites did not change between the 1996 and 2001 assessments. Improvements in water quality ratings were related to wastewater treatment plant upgrades or the closing of industries.

In 2001, 19 percent of the benthic macroinvertebrate and 14 percent of the fish community evaluations suggested impaired conditions (rated either Fair or Poor). The most degraded water quality was found in Forsyth, Rowan, Iredell, Cabarrus, and Davidson counties. Measured declines in water quality since 1996 were attributed to increasing nutrient enrichment, land-use changes, low flow conditions, and habitat degradation.

Fish kills and fish mortality were relatively low in the basin. Elevated mercury levels have been measured in largemouth bass and bowfin collected throughout the basin. This condition has also been observed throughout coastal river basins in the southeastern United States. Atmospheric mercury deposition and bioaccumulation have been shown to provide a significant influence on these observed levels. A mercury fish consumption advisory is in place for largemouth bass in Ledbetter Lake and there is a statewide fish consumption advisory for bowfin.

No temporal patterns in dissolved oxygen were observed using all historical data. Turbidity standards were exceeded throughout the basin. Exceedances of the action level for copper were measured at 35 of the 46 sites. Thirteen sites had fecal coliform bacteria levels greater than a geometric mean of 200 colonies/100ml. Monitoring locations with elevated nutrient concentrations were all located below permitted wastewater treatment facilities.

Since 1996, municipal and industrial facilities have been in compliance with toxicity limits in more than 90 percent of the evaluations. Only 10 of the 80 facilities with toxicity requirements have had difficulty meeting the permitted levels.

OVERVIEW OF THE WATER QUALITY OF THE YADKIN RIVER BASIN

The Yadkin River basin is the second largest basin in North Carolina, covering 7,213 square miles within twenty-one counties (Figure 1). The basin drains many subecoregions. The mountain ecoregion includes the Southern Crystalline Ridges and Mountains, and the Eastern Blue Ridge Foothills; the piedmont is broken up into the Northern Inner Piedmont, the Triassic Uplands, the Sauratown Mountains, the Southern Outer Piedmont, and the Carolina Slate Belt. The lower part of the basin lies within a small section of the Sandhills. Streams within each are affected by the soils, geology, vegetation, and topography that are characteristic of the ecoregion.

Originating on the eastern slopes of the Blue Ridge Mountains in Caldwell and Wilkes counties, the Yadkin River flows northeasterly for about 100 miles, then flows to the southeast until it joins the Uwharrie River to form the Pee Dee River. The Pee Dee River continues flowing southeasterly to the North Carolina-South Carolina state line and then through South Carolina to Winyah Bay.

All 2001 samples were collected during a drought year that had the potential to reduce the impacts from nonpoint sources and magnify the impacts from point source discharges. This below average flow regime must be considered when looking at changes in water quality.

UPPER YADKIN RIVER (SUBBASINS 01 - 07)
The Yadkin River and its tributaries originate in the mountain ecoregion (Figure 2). Many of the mountain streams are classified as trout streams, and, in terms of fish communities, are considered mountain cold water and foothills cool water types. Stone Mountain State Park and Doughton Park (part of the Blue Ridge Parkway Recreational Area) contain some of the best water quality streams in the upper basin.

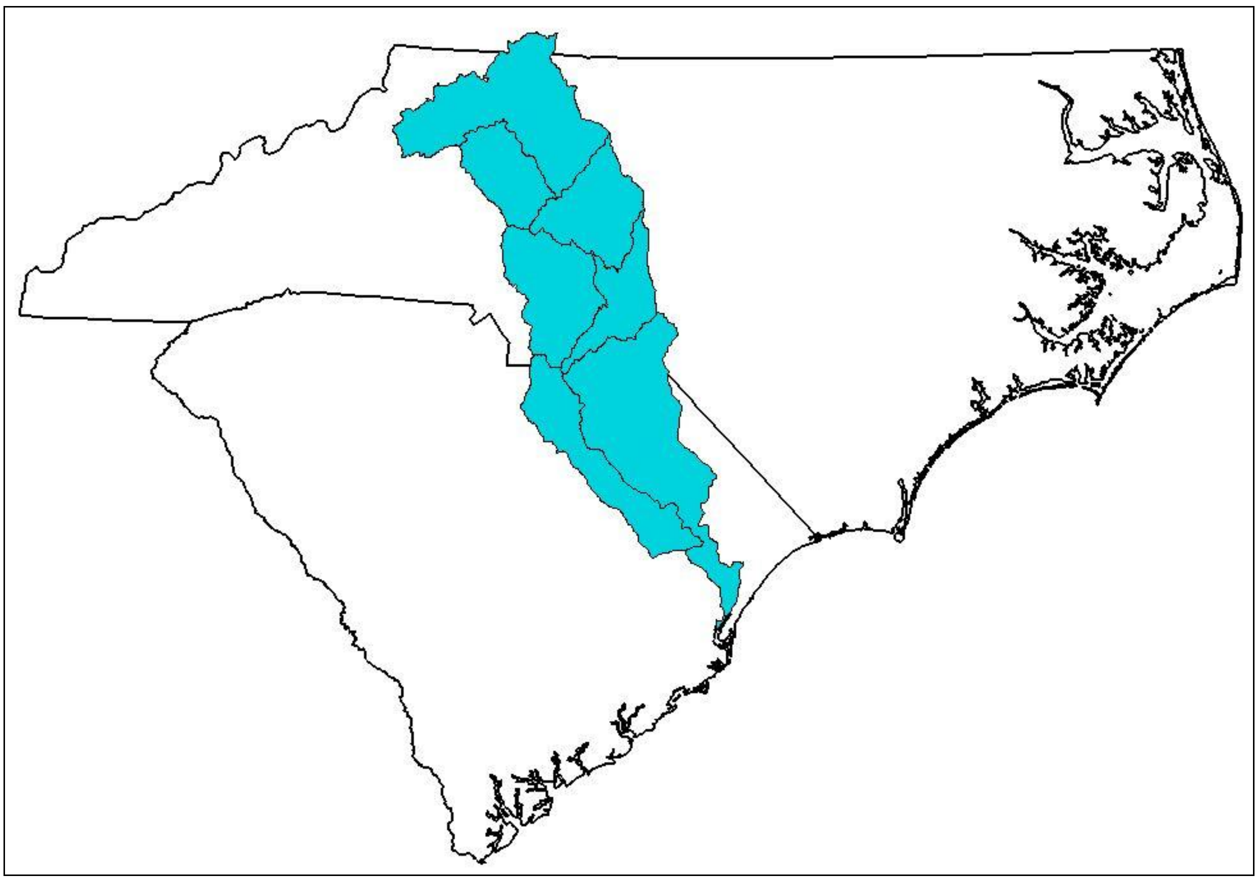


Figure 1. Geographical relationships of the Yadkin River basin in Virginia, North Carolina, and South Carolina.

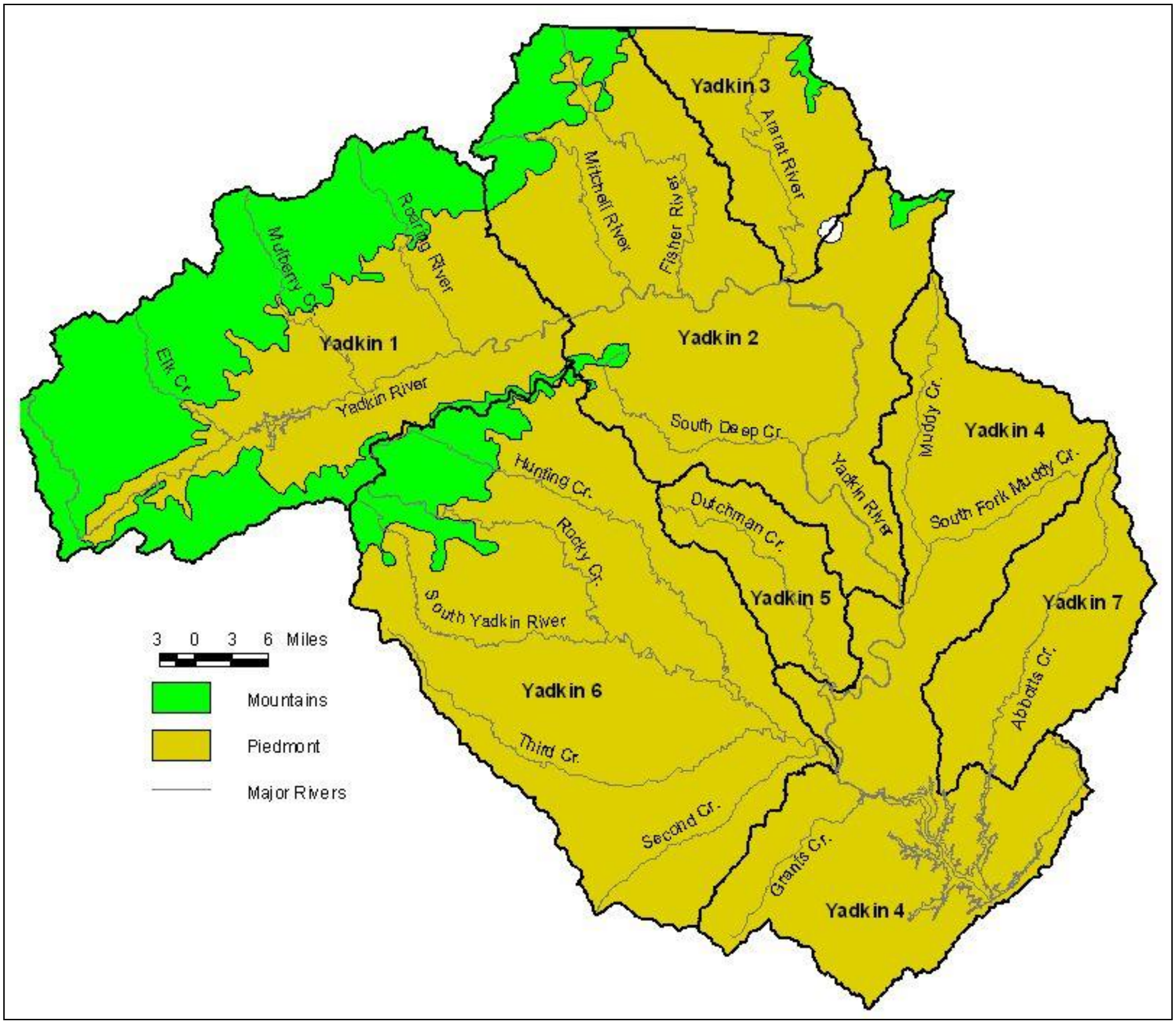


Figure 2. Geographical relationships of the upper Yadkin River basin in North Carolina.

The cities of Wilkesboro and North Wilkesboro both have wastewater treatment plants that discharge to the Yadkin River. Sampling in the upper Yadkin River in 2001 near Patterson and North Wilkesboro found a noticeable degradation of water quality, with reduced benthic ratings and evidence of nutrient enrichment and severe sedimentation impacts to instream habitat. W. Kerr Scott Reservoir, located upstream of Wilkesboro, is the first of the Yadkin River Chain-of-Lakes. This 1,450 acre reservoir also had indications that nutrients are beginning to seriously impact the reservoir. Additional sampling is planned to further address this issue.

The Yadkin River next encounters the Winston-Salem metropolitan area. Winston-Salem is one of the largest urban areas in the state, with many streams potentially affected by urban runoff and/or permitted dischargers. There are many permitted dischargers in this urban area, but the largest are the Winston-Salem Archie Elledge WWTP and Muddy Creek WWTP. Urban streams in the area (Muddy and Salem Creeks) usually had poor habitat, but the invertebrate communities also suggested toxic conditions. Smaller tributaries outside Winston-Salem in agricultural areas usually had Good-Fair water quality, though some areas had Fair bioclassifications perhaps due to the extreme drought and very low flows. Lakes surveyed in this area often exhibited symptoms of excessive nutrient loading with documented algal blooms.

In addition, the Roaring River dropped in bioclassification to Good, with indications of nutrient enrichment, perhaps due to increased numbers of animal operations in this watershed. Smaller streams in this headwater area still have water quality ranging from Excellent in undeveloped areas to Good-Fair in areas of development such as Moravian Creek.

As the Yadkin River flows through the town of Elkin and on through Surry County water quality improved to Good, perhaps as a result of reduced nonpoint impacts in a drought year. Major tributaries that originate in the mountain ecoregion include Elkin Creek and the Mitchell, Fisher, Little Fisher, and Little Yadkin Rivers. Biological data showed no major changes in water quality for these waters during basinwide surveys, with Excellent, Good and Good-Fair bioclassifications.

The Ararat River and its tributaries originate in Virginia and flow generally south into North Carolina and into the Yadkin River, just before the Yadkin River begins its turn to the south. Land use in the area is mostly agriculture and suspended sediments are a problem. Water quality in the Ararat River downstream of the Town of Mt. Airy 's WWTP improved to Good-Fair and Good in 2001. This was most likely due to industries closing in Mt. Airy which caused a decrease in effluent volume. Tributary streams ranged from Fair to Good for benthos, but fish community data indicated Excellent water quality.

Below the confluence with the Little Yadkin River, the Yadkin River begins flowing almost due south, then slightly southwest in the piedmont ecoregion. Tributary streams such as North Deep, South Deep, Forbush, and Logan Creeks reflected this change from mountain to piedmont topography and have slower flows and sandier substrates, and primarily Good-Fair bioclassifications.

The South Yadkin River originates in the Brushy Mountains and is a major tributary that enters the Yadkin River north of Salisbury in Rowan County. The river and its tributary streams comprise large watersheds in Iredell, Davie, and Rowan counties. The largest metropolitan area is Statesville. Land use within this subbasin is mainly forest and pasture. The two largest dischargers in the watershed are the Statesville WWTPs to Fourth and Third Creeks. Water quality in the upper part of the watershed is Good or Excellent. Benthos (Good) and fisheries (Poor) data gave contrasting pictures of Third and Fourth Creeks, both sandy channelized streams with little instream habitat.

Grants and Town Creeks flow through the urban areas of Salisbury, China Grove, Spencer, and East Spencer. Then, Grants Creek flows into the Yadkin River and Town Creek flows into the Crane Creek arm of High Rock Lake. These streams suffer from urban runoff, poor instream habitat, and effluent from many dischargers.

High Rock Lake is the largest impoundment of the Yadkin River and is located in Davidson and Rowan counties. Its surface area is 15,750 acres and it has a drainage area of nearly 4,000 square miles. The lake is eutrophic, and has had problems with excessive algal growth, elevated pH, dissolved oxygen, chlorophyll *a*, and nutrients.

The cities of Lexington, Thomasville, and parts of High Point are located in the Abbotts Creek watershed. Land use is still mainly forest and pasture but there is a greater percentage of urban areas in this subbasin than in any other subbasin. The large number of dischargers, sedimentation effects, and nonpoint runoff in this watershed were reflected in the degraded water quality.

LOWER YADKIN RIVER (SUBBASINS 08 - 17)

Below High Rock Lake dam, the Yadkin River is composed of a chain of impoundments -- Tuckertown, Badin, Falls, Tillery, and Blewett Falls Lakes (Figure 3). Eutrophication affects all these lakes, with nutrients coming from developed areas upstream, agriculture, and shoreline development.

The Uwharrie River joins the Yadkin River at Lake Tillery. The Yadkin River now becomes known as the Pee Dee River. Headwater streams in the Uwharrie River subbasin drain portions of the cities of Thomasville, Randleman, and Asheboro, but the southern half of the watershed is within the Uwharrie National Forest. Streams affected by nonpoint source runoff include the upper part of the Uwharrie and Little Uwharrie Rivers and Jackson, Caraway, and Back Creeks. Minimally disturbed streams in the national forest (Barnes and Dutchmans Creeks) received an Excellent rating. Barnes Creek is classified as ORW.

The middle and lower portion of the Uwharrie River have very high water quality, but there were extensive growths of aquatic plants. Increasing eutrophication was noted for Asheboro's water supply lakes -- McCrary, Bunch, Back Creek, and Reese.

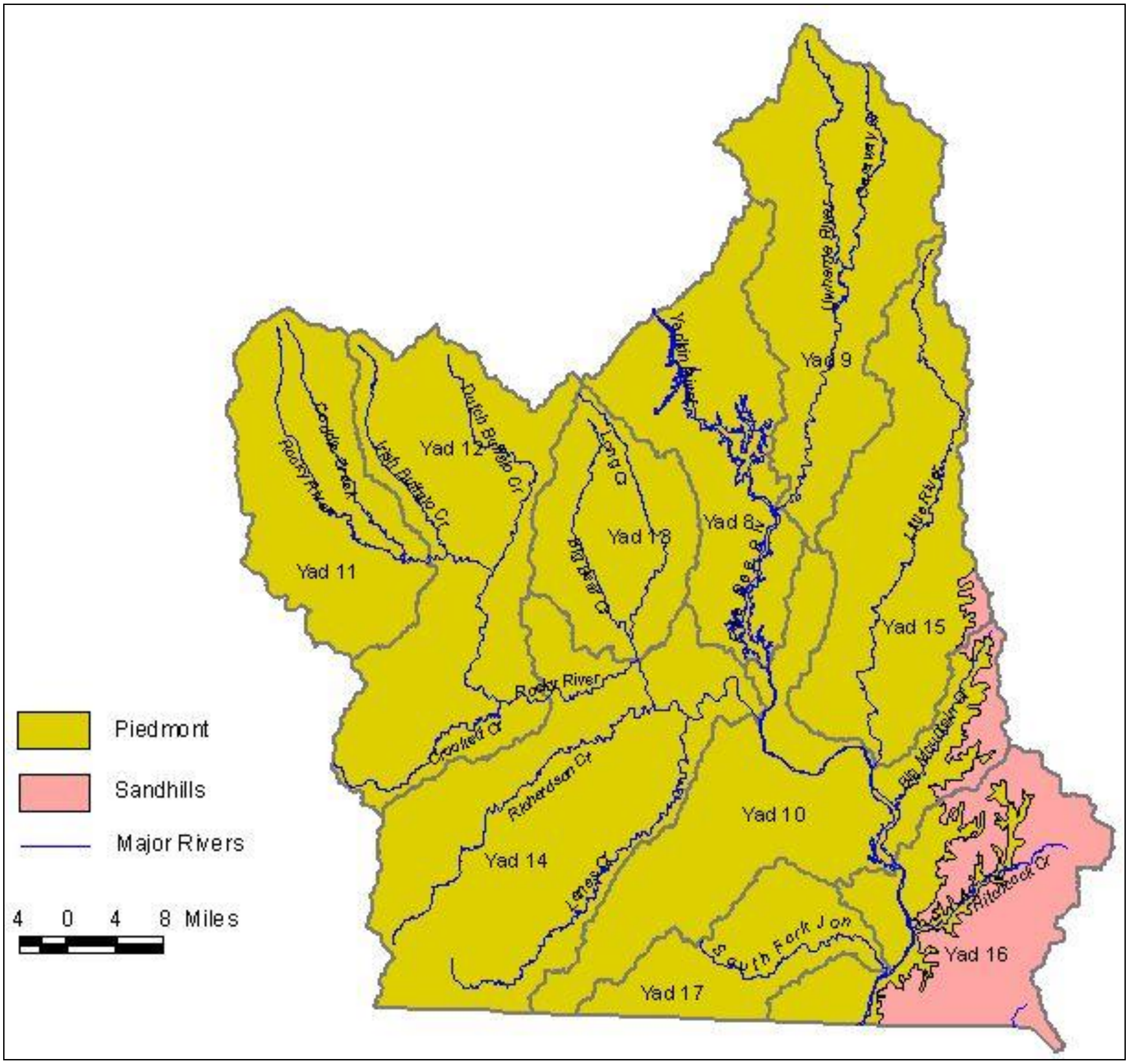


Figure 3. Geographical relationships of the lower Yadkin River basin in North Carolina.

Below Lake Tillery, the next major tributary to enter the Pee Dee River is the Rocky River. This river has a very large watershed reaching from its headwaters in Iredell County near Mooresville through Mecklenburg, Cabarrus, Union, Stanly, and Anson counties. The headwaters contain the urban areas of Mooresville and Concord. In many streams, during low and normal flow conditions, flow is reduced to small meanders within a very sandy channel. Substrates are typically very unstable and the water becomes extremely turbid during high flows.

The Rocky River below the Mooresville WWTP (5.2 MGD to Dye Branch) has severe water quality problems based on biological and chemical data. A Fair bioclassification was assigned in 1996 to Coddle Creek which drains much of the suburban area of Concord. Mallard Creek above the CMUD/Mallard Creek WWTP had an Excellent fish rating. This Slate Belt stream has maintained good instream and riparian habitat, even in a developed watershed.

Below the upper reaches of the Rocky River, there is a "Z" shaped section of the river and four large tributaries: Irish Buffalo, Dutch Buffalo, Goose, and Crooked Creeks. This middle reach of the Rocky River is approximately 20 river miles long, and is affected by the discharge from the Rocky

River Regional WWTP (24 MGD). Benthos data in 2001 indicated further degradation and resampling will occur to determine if the river should go on the impaired streams list. Tributaries found in the northern half of the subbasin (Irish Buffalo and Dutch Buffalo Creeks) are typical piedmont streams dominated by sandy substrates. However, streams found within the southern half (Goose and Crooked Creeks) are typical Slate Belt streams. Benthos data from these streams suggested worse problems than did fisheries data. Goose Creek is in the worst condition in this subbasin and still rated Poor. Lakes in this area also are eutrophic.

The lowermost reach of the Rocky River is a 25 mile reach bordering Stanly, Union and Anson counties. In Stanly County, Big Bear Creek is the only major tributary and Albemarle is the only major developed area. While ambient monitoring locations on the Rocky River near Norwood and Long Creek noted some water chemistry problems, benthos data gave a Good rating for the Rocky River and a Good-Fair rating for Long Creek. Biological data indicated Good water quality in Big Bear Creek.

Two other large tributaries to the lower Rocky River are Richardson and Lanes Creeks. These streams are also in the Slate Belt where small streams tend to dry up under low flow conditions. No flow was found in the Lanes Creek watershed during the summer of 2001. The Town of Monroe is in this watershed, and its WWTP discharges to Richardson Creek, where problems are noted below the discharge with recovery occurring downstream. Numerous confined animal operations are also found in these two catchments. The occurrence of prolific growths of algae during basinwide sampling indicated that these streams are receiving massive inputs of nutrients. Fisheries data from the Richardson Creek watershed ranged from Excellent at Island Creek, to Fair at Lanes Creek. Surveys at Lakes Lee, Monroe, and Twitty indicated that all three reservoirs are eutrophic.

On the east side of the Pee Dee River is the Little River and its tributaries. This is another large watershed with headwaters in Randolph County. A large portion of the watershed is located within the Uwharrie National Forest. The land is mostly forested, with some areas utilized for agriculture and silviculture. The Town of Troy is located in this watershed. Most biological data produced Good or Excellent ratings in this watershed. Exceptions were Cheek and Hamer Creeks, which were Fair, but these ratings may be related to low flows due to the drought or location in the Triassic basin.

Mountain Creek flows into Blewett Falls Lake downstream of the Little River. Its tributaries have good flow during the summer as they are located in typical hilly piedmont topography. Dischargers affected Little Mountain Creek (ALCOA and Greater Badin WWTP) and Lick Creek (Denton WWTP). Though enrichment was evident in Mountain Creek, it had high water quality, as did Clarks and Brown Creeks.

Below Blewett Falls Lake, the Pee Dee River flows west of Rockingham to the state line. Much of the land use is forest or agriculture. Headwater streams of Hitchcock Creek drain the Sandhills Game Land and serve as a good regional reference sites.

The Jones Creek catchment is the most downstream watershed on the west side of the Pee Dee River. The upper portions of the North Fork and South Fork Jones Creeks are also in the Slate Belt section, but have very sandy substrates. Land use is primarily forest. Water quality problems based on benthos data may result from lack of flow, as fish communities (that can move to avoid areas of no flow) were diverse and indicated high water quality, despite poor instream habitat.

In conclusion, in 2001, 32 fish community and 42 benthic macroinvertebrate sites were rated either Good or Excellent (Figure 4). Conversely, 8 fish community sites and 20 benthic macroinvertebrate sites were rated either Fair or Poor (Figure 5).

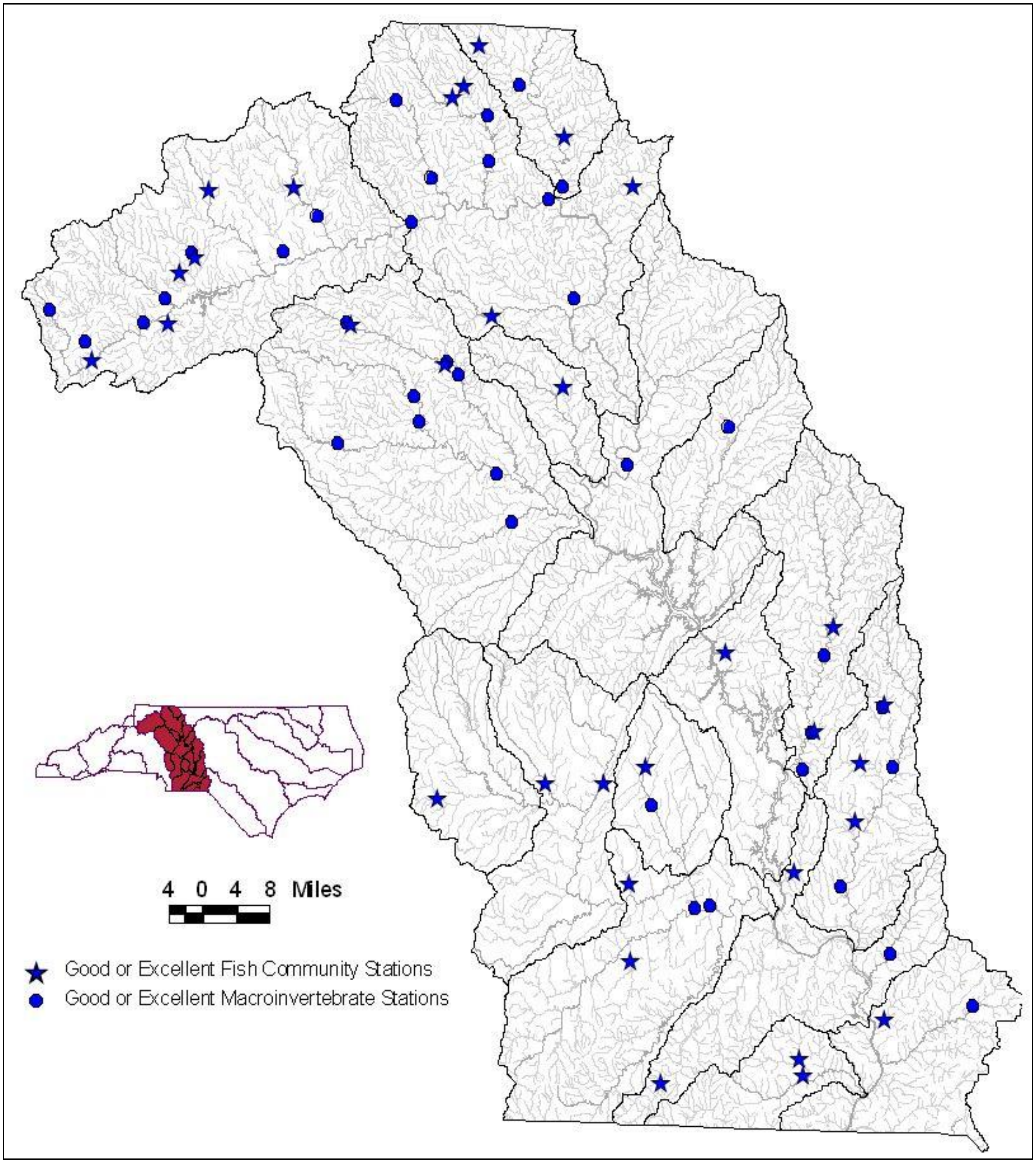


Figure 4. Streams in the Yadkin River basin rated Excellent or Good based upon benthic macroinvertebrate or fish community ratings, 2001.

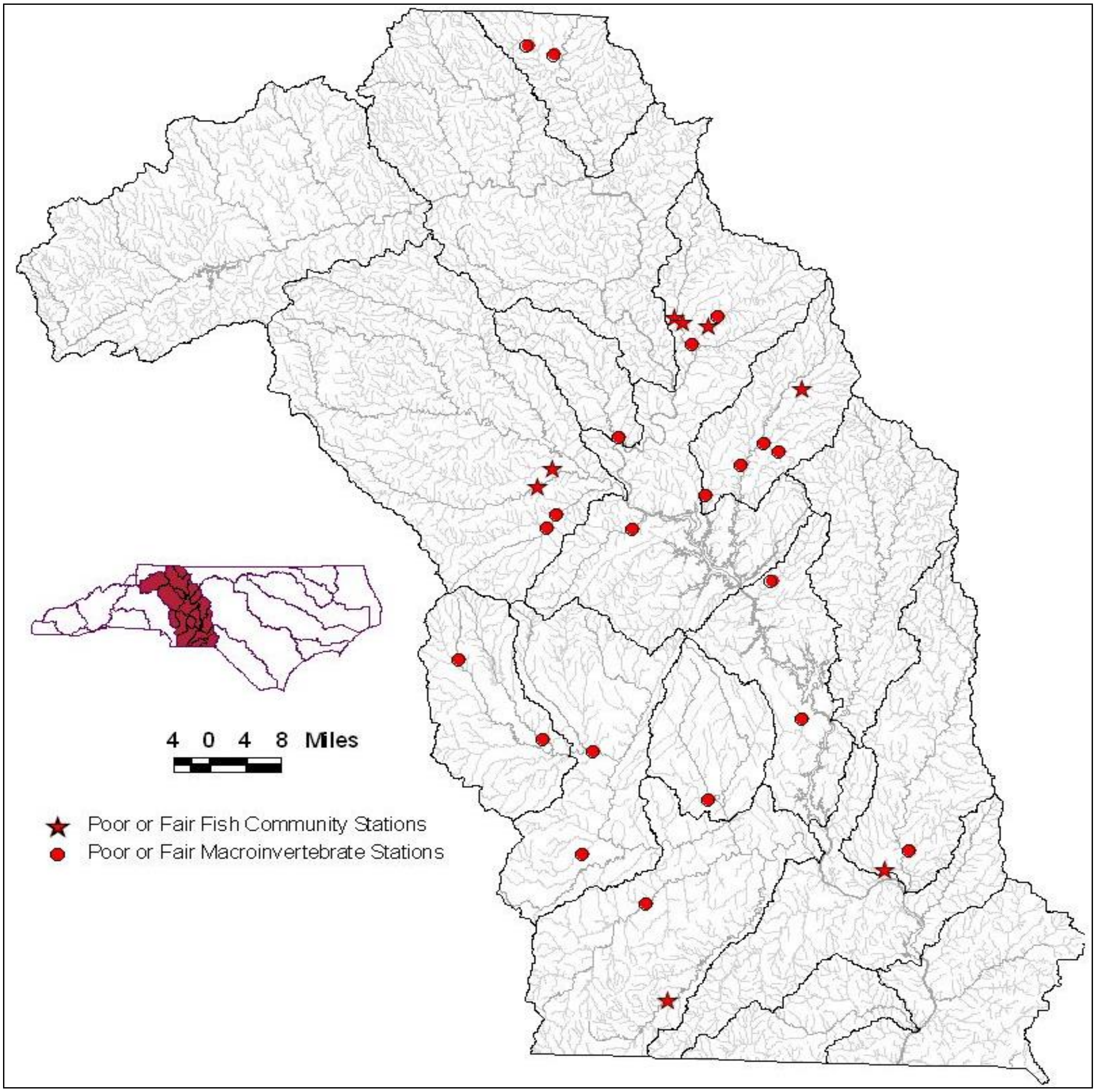


Figure 5. **Streams in the Yadkin River basin rated Fair or Poor based upon benthic macroinvertebrate or fish community ratings, 2001.**

PROGRAM AREA OVERVIEWS

BENTHIC MACROINVERTEBRATES

Bioclassifications and Water Quality Changes

Benthic macroinvertebrates have been collected at over 300 rated sites in the basin since 1983. For the 2001 collections, the greatest number of the samples received a Good-Fair rating, although there were also high numbers of both Good and Fair ratings (Figure 6). The distribution of the 2001 ratings was similar to the distribution of ratings for all sites sampled since 1983 (Table 1).

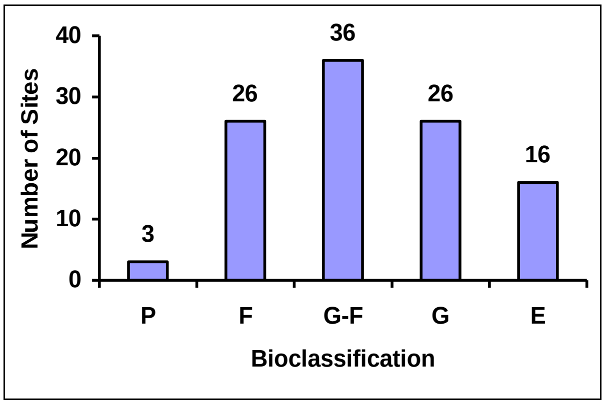


Figure 6. Distribution of bioclassifications for 107 benthic invertebrate samples collected in the Yadkin River basin in 2001.

Table 1. Most recent ratings for all rateable benthic macroinvertebrate sites in the Yadkin River basin sampled since 1983.[1]

	Bioclass				
Subbasin	**P**	**F**	**G-F**	**G**	**E**
01	---	---	7	21	12
02	---	2	21	18	7
03	---	4	10	3	---
04	5	9	16	2	---
05	---	3	3	1	
06		4	8	7	11
07	3	12	8	1	---
08	---	2	3	---	---
09	---	---	8	2	6
10	---	1	2	2	---
11	1	5	6	---	---
12	3	10	8	2	---
13	---	4	2	2	---
14	2	6	3	3	---
15	---	1	5	5	9
16	---	2	5	2	2
17	---	1	5	---	---
Total (#)	**14**	**66**	**120**	**71**	**47**
Total (%)	**4**	**21**	**38**	**22**	**15**

[1]Some older ratings were not included (especially in Subbasins 04, 07, and 16) if there was an indication from other sites, or other data sources, that water quality had improved.

Excellent ratings were found in only 6 of the 17 subbasins with the greatest number of high quality sites in the headwaters (Subbasins 01 and 02), in the South Yadkin River, and in the Little River - Uwharrie River areas. Each of these three areas contains some unique taxa (Appendix 9). Poor ratings usually were found in the subbasins with the greatest amount of urban landuse (Subbasins 04, 07, 11, and 12), reflecting both urban runoff and many point-source dischargers.

Between-year changes in water quality were evaluated at over 100 sites in the basin, although some of these sites could only be evaluated for short-term changes over the last five years. The greatest number of sites (87) had no change in water quality since the 1997 basinwide survey, other than flow-related changes in bioclassification. Improving water quality, due in large part to wastewater treatment plant closures, facility upgrades, or less nonpoint source runoff during a low-rainfall year, was documented at 11 sites (Table 2). The Upper Yadkin River at SR 1372 (Subbasin 01) and the Yadkin River at Elkin (Subbasin 02) also showed improving water quality but for unknown reasons or multiple causes. Declining water quality was documented at 10 sites (Table 2). Nonpoint source problems were associated with most of these declines, including nutrient enrichment, sedimentation, and residential development.

Table 2. Sites with improving or declining water quality in the Yadkin River basin.

Subbasin	Waterbody
Improving	
01	UT Mulberry Creek, Wilkes County
02	Yadkin River, SR 1003, Surry County
03	Ararat River, SR 2026, Surry County
	Heatherly Creek, Surry County
04	Salem Creek/Muddy Creek, Forsyth County
	UT Grants Creek, SR 1500, Rowan County
	Lower Town Creek, Rowan County
07	Hamby Creek, Davidson County
	Hunts Fork, Davidson County
12	Crooked Creek, Union County
16	Hitchcock Creek, Richmond County
Declining	
01	Upper Yadkin River, NC 268, Caldwell County
	Roaring River, SR 1990, Wilkes County
02	Little Fisher River, Surry County
03	Stewarts Creek, NC 89, Surry County
04	Upper Reynolds Creek, Forsyth County
	Lower Grants Creek, Rowan County
05	Dutchmans Creek, Davie County
06	South Yadkin River SR 1561, Iredell County
	North Second Creek, Rowan County
07	Swearing Creek, NC 47, Davidson County

FISHERIES

Fish Community Assessment

In 2001, 56 sites were sampled from early April through late June (Figures 7 and 8). One special study (Cub Creek, Subbasin 01) was conducted at the request of the regional office. All streams, except for those in the Sandhills ecoregion, were evaluated using the North Carolina Index of Biotic Integrity (Appendices 10 - 12). The ratings ranged from Poor to Excellent (Figure 9) with the scores ranging from 28 to 60. Sandhills streams were not rated.

Of the sites sampled in 1996 and 2001, 7 sites had scores that did not change, 18 sites had scores that increased, and 10 sites had scores that decreased between 1996 and 2001. The range in the difference in the scores between 2001 and 1996 was from -8 to +12 units (Figure 10). A majority (69 percent) of the sites in 2001 had scores that were different by ± 4 units from the scores receive in 1996. The ratings did not change at 17 sites, increased 1 or 2 classifications at 13 sites, and decreased 1 classification at 5 sites (Figure 11).

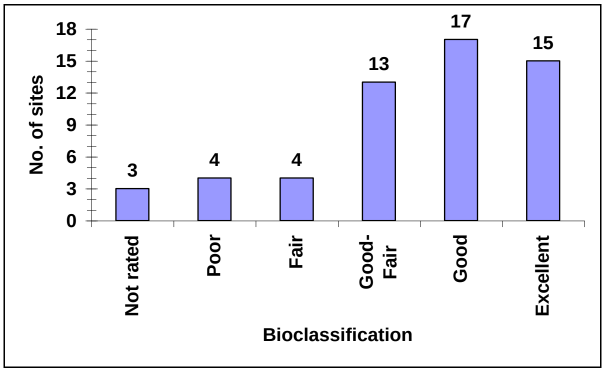


Figure 9. Bioclassifications of fish community basinwide sites in the Yadkin River basin, 2001.

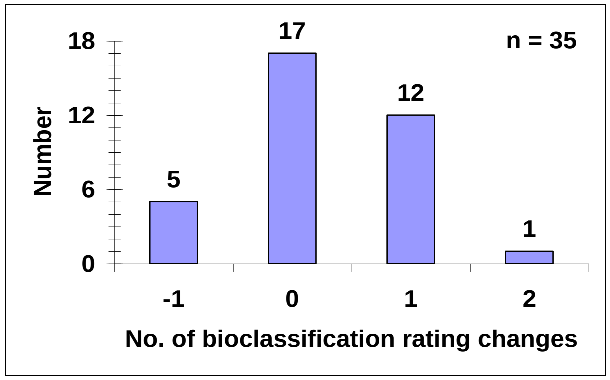


Figure 11. Bioclassification rating changes between 1996 and 2001 at fish community sites in the Yadkin River basin.

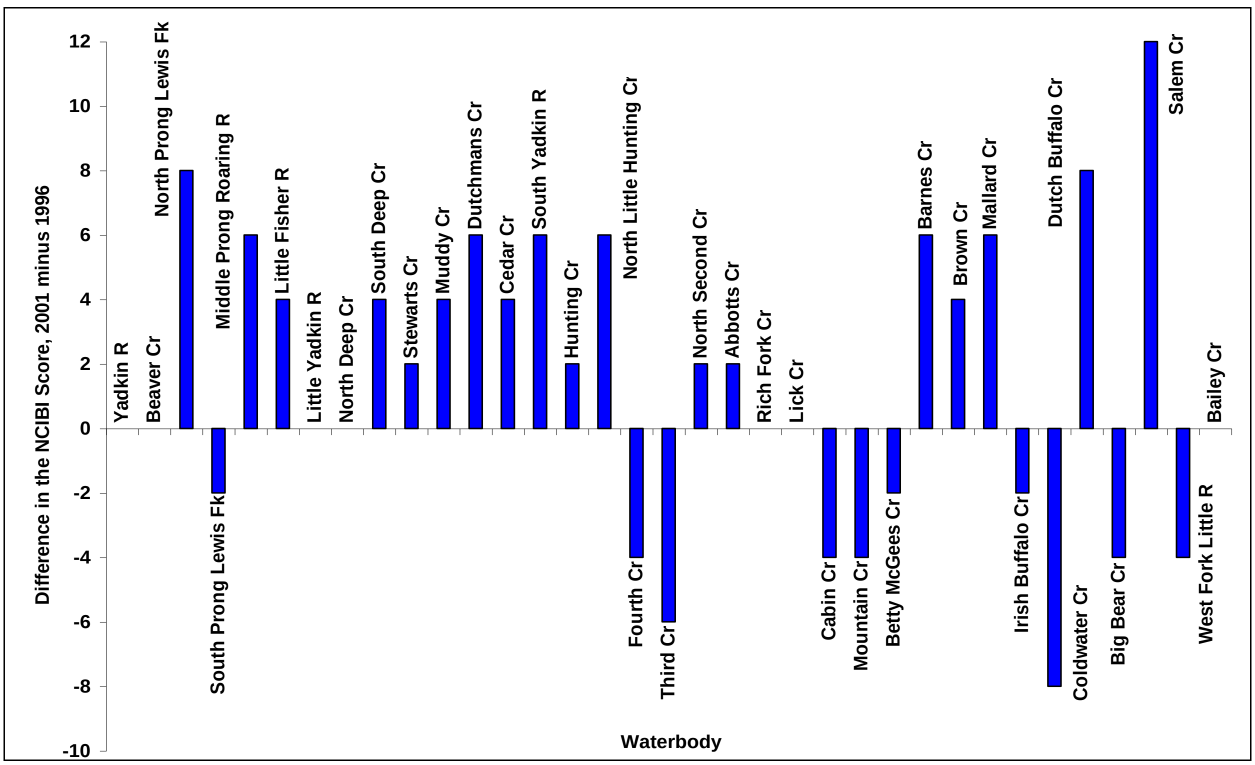


Figure 10. A comparison of the NCIBI score at 35 rateable fish community sites in the Yadkin River basin between 2001 and 1996.

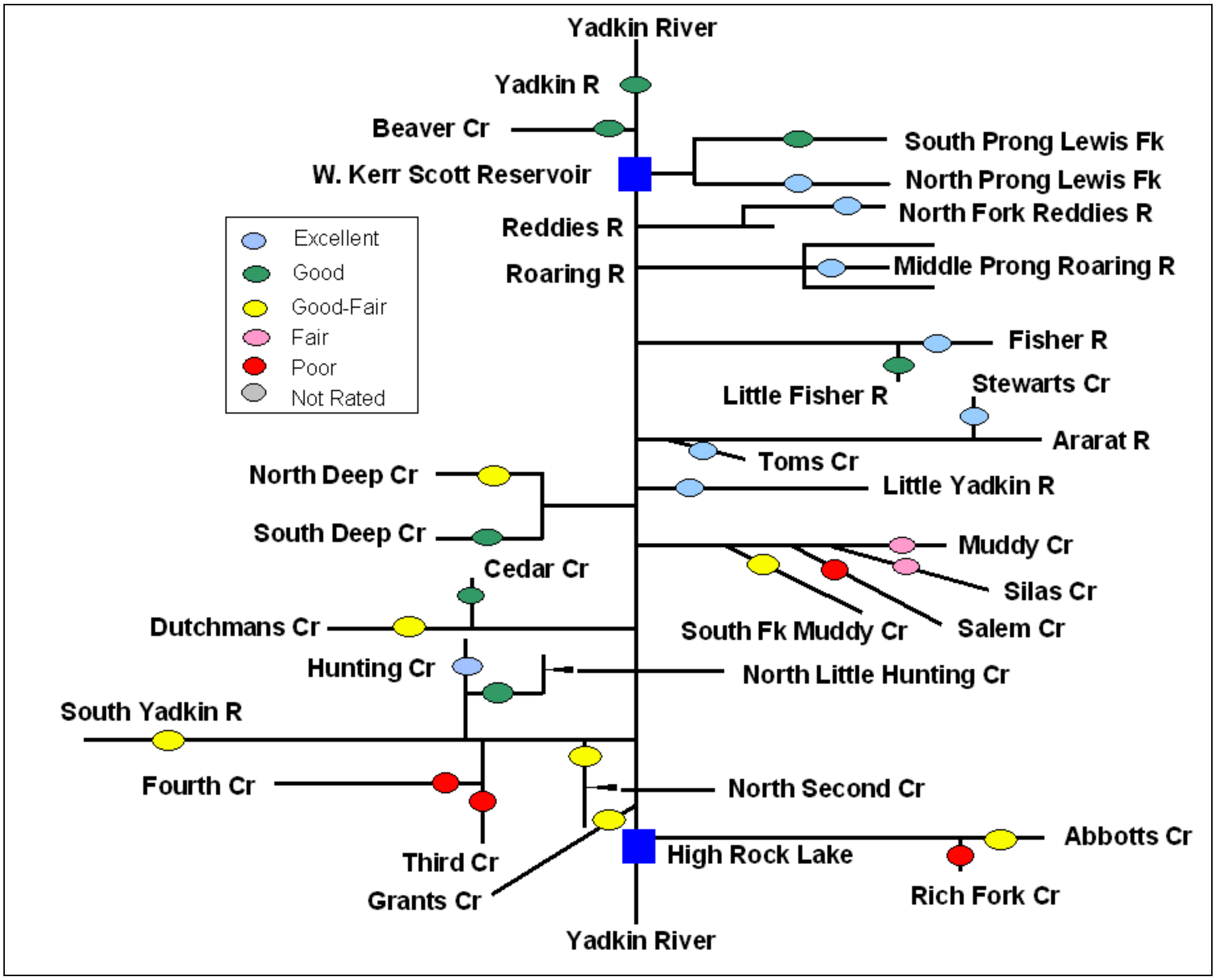


Figure 7. **Fish community assessment sites in the upper Yadkin River basin, 2001.**

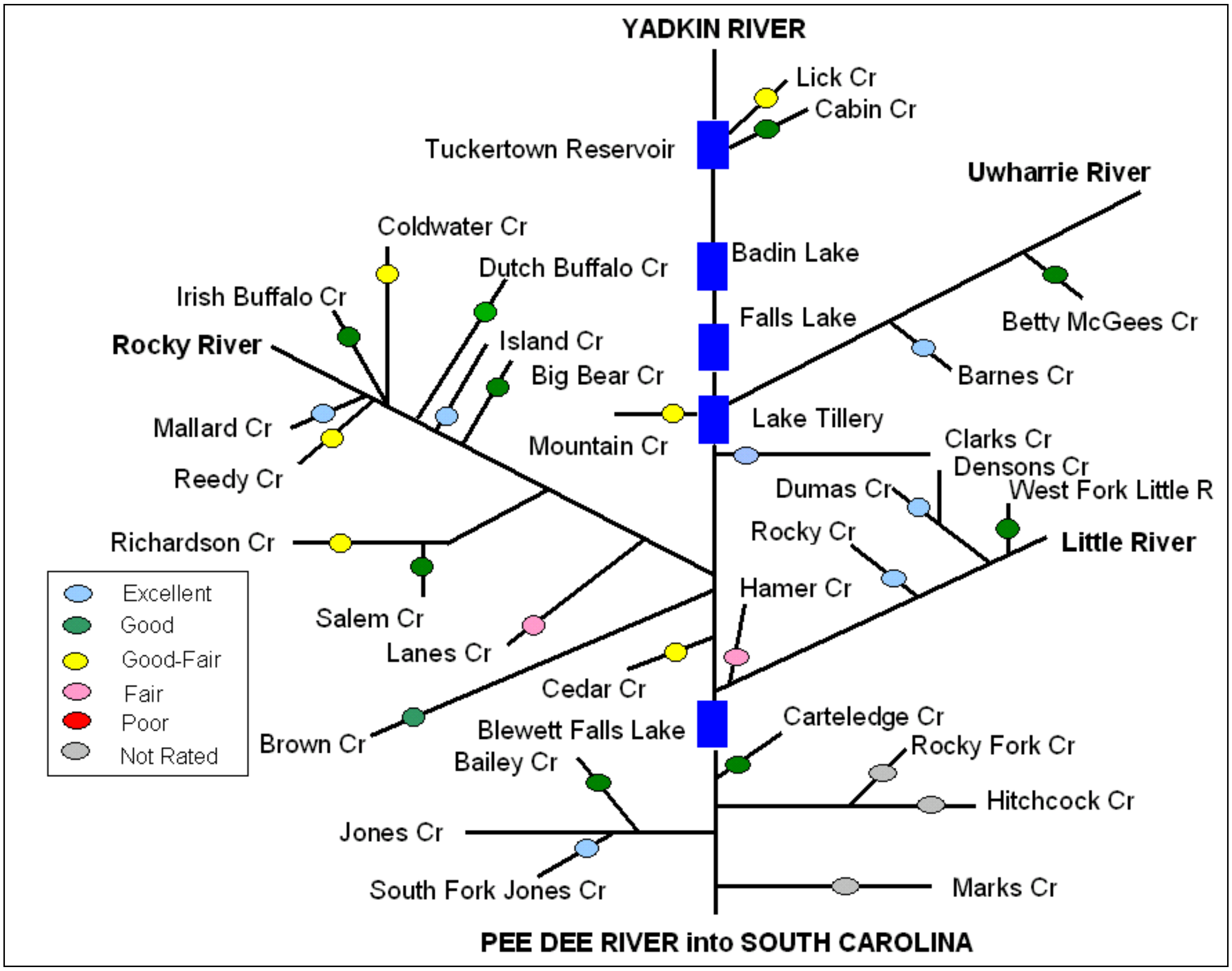


Figure 8. **Fish community assessment sites in the lower Yadkin River basin, 2001.**

Fish Tissue Contaminants
Since 1997, the NC DWQ has conducted two fish tissue surveys in the basin. Fish samples were collected from the Pee Dee River at US 74 during 1999 and from the Pee Dee River immediately below Blewett Falls Dam during 2000. All metal contaminants were non-detectable or at levels below current USEPA, USFDA, and North Carolina criteria.

Significant mercury levels were discovered in fish from Ledbetter Lake (Subbasin 16) in 1993 (NCDEHNR 1994). The State Health Director issued a fish consumption advisory for largemouth bass from the lake that still remains in effect:

- "*Largemouth bass in Ledbetter Lake contain higher than normal levels of mercury. Consumption of largemouth bass should be limited to no more than two meals per person per month. Women of childbearing age and children should eat no largemouth bass taken from this area until further notice*".

In June 1997, the State Health Director issued a statewide fish consumption advisory for bowfin due to elevated mercury. The advisory states:

- *"Some bowfin (or blackfish) sampled across the state have been found to contain potentially unsafe levels of mercury. Based on these findings, consumption of bowfin caught in North Carolina should be limited to no more than two meals per person per month. Children, pregnant women and women of childbearing age should not eat bowfin collected in North Carolina".*

Additional information on consumption advisories in North Carolina may be found at: http://www.schs.state.nc.us/epi/fish/current.html.

Fish Kills
The NC DWQ has systematically monitored and reported on fish kill events across the state since 1996. Field investigators reported 19 fish kill events in the basin from 1996 to 2000. Kill activity and fish mortality were the highest in 1997 (10 kills affecting 11,500 fish), but the levels have generally remained relatively low through the years compared to the coastal river basins. Causes listed on kill reports from included spills, algal blooms, and low dissolved oxygen levels. Fish species most often affected included largemouth bass, sunfishes, and catfishes (NCDENR 2001).

LAKE ASSESSMENT
Twenty-six lakes in the basin were monitored as part of the Lakes Assessment program (Appendix 17). Between 1999 and 2001, each lake was sampled one to three times during the summer months. There were a variety of water quality concerns documented during this time period. Surface physical data and photic zone chemistry data collected from 1994 through 2001 are presented in Appendix 18.

Sixteen lakes in the basin exhibited symptoms of excessive nutrient loading, including elevated dissolved oxygen and pH values, documented algae blooms, and green or brownish-green colored water. Most nutrient inputs appeared to be from nonpoint sources (*i.e*., storm runoff from agricultural lands and urban areas). Elevated nutrient inputs increase the likelihood of blooms of nuisance blue-green algae that, in turn, reduce the aesthetic appearance of the lake, cause taste and odor problems in drinking water, and diminish the appeal of recreational activities such as swimming. Nutrient management strategies for point sources are being implemented in the High Rock Lake watershed to address some of these concerns.

Sediment loading is also a problem in this river basin. It reduces the holding capacities of lakes over time, introduces nutrients, and reduces their aesthetic appeal by giving the water a muddy appearance. Soils of the basin are highly erodible. The most notable example of this problem can be seen in the upper end of High Rock Lake. Winston Lake and Lake Concord also show signs of accelerated sedimentation.

A few of the lakes had one-time exceedances of manganese, iron, or zinc surface water quality standards. All of these metals are naturally occurring in piedmont soils and do not represent significant threats to the use of these lakes. Eight lakes sampled had copper concentrations above the state standard (7 µg/L). Five of the lakes, Wright, Corriher, Twitty, Water and Wadesboro City Pond, had been treated for algal blooms using copper sulfate prior to or during the summer sampling events. The other three lakes (High Rock, Thom-A-Lex and Kannapolis) only had one low exceedance of the standard. These exceedances are not considered to represent significant threats to the uses of these lakes.

Several lakes have warranted or do warrant additional sampling:

- Rockingham City Lake, sampled in 2000, continued to support nuisance levels of aquatic macrophytes to the extent that it is designated as partially supporting for aquatic life and secondary recreation (NCDENR 2000a). The lake is on the 303(d) list of impaired surface waters and does require TMDL development.
- Hamlet City Lake is also on the 303 (d) list as partially supporting its designated uses because it had been drained in 1998 when the list was being prepared. Since the listing was based on not being able to sample the lake, no TMDL is being developed. Hamlet City Lake has since been refilled and sampling in 2000 indicates that the lake is still experiencing problems due to aquatic macrophytes and possibly increased sedimentation.
- Badin Lake experienced fish kills and poor water quality conditions in 2000 and 2001. Fish kills primarily involved stripped bass, bream and catfish. Some of these fish had small sores and appeared to be emaciated. In response to these concerns, NC DWQ is planning to conduct a special water quality study on this lake in the summer of 2002.

The final thing to note regarding this assessment is that due to quality assurance issues with chlorophyll *a* laboratory analyses from 1996 through February 2001, only a few of the lakes have 2001 NCTSI scores. No NCTSI scores were calculated for 1996 - 2000.

AMBIENT MONITORING SYSTEM
The NC DWQ collected physical and chemical measurements from 46 monitoring stations between September 01, 1996 and August 31, 2001. The Yadkin Pee Dee River Basin

Association (YPDRBA) monitored an additional 71 stations, however sampling was initiated in June 1998. Interpretation focused on the NC DWQ data because the YPDRBA data only represented a portion of the period from which the NC DWQ data were collected.

Significant findings at NC DWQ sites during the assessment period included:

- eight stations had more than 10 percent of the measurements for dissolved oxygen less than 5.0 mg/L. No temporal patterns were evident at these stations using all available data, thus patterns observed during this basin assessment period have been present historically;
- three stations had more than 10 percent of the pH measurements less than 6.0 s.u. and one station exceeded a pH of 9.0 for about 16 percent of the samples;
- exceedances for turbidity occurred in 22 percent of the samples from the Yadkin River at NC 268 - waters classified as Trout Waters. Seven stations with a turbidity standard of 50 NTU exceeded the standard, but for not more than 13 percent of the samples. Three reservoir stations exceeded the turbidity standard (25 NTU) for about 27 percent of the samples.
- exceedances for copper were common. Thirty-five stations exceeded the standard (7.0 µg/L). Approximately 73 percent of the samples collected from Hambys Creek exceeded the standard;
- thirteen sites had geometric means for fecal coliform bacteria exceeding 200 colonies/100ml; and
- stations with high concentrations of nutrients were all located below wastewater treatment facilities.

Data collected by the YPDRBA showed 10 of the 71 stations with more than 10 percent of the samples less than the standard for dissolved oxygen (5.0 mg/L). Many stations (n = 36) had geometric means for fecal coliform bacteria exceeding 200 colonies/100ml. However many of the stations monitored by the YPDRBA are located downstream of wastewater treatment facilities.

AQUATIC TOXICTY MONITORING

Eighty facility permits in the basin currently require whole effluent toxicity (WET) monitoring. Seventy-seven facility permits have a WET limit; the other three facility permits specify monitoring with no limit. Since 1996 the compliance rate for those facilities with a limit has stabilized at approximately 90 - 95%. Ten facilities have had difficulty meeting their toxicity limits (Table 3).

Table 3. Facilities that have had difficulty meeting toxicity limits in the Yadkin River basin.

Subbasin	Facility
02	Town of Boonville's WWTP
03	Proctor Silex
	Flat Rock Elementary School's WWTP
04	Lucent Technologies
	Salisbury's-Sowers Rd WWTP
	Scarlett Acres Mobile Home Park
06	Mocksville's Bear Creek WWTP
	NC DOT I-77 Rest Stop
07	Centerclair Nursing Home's WWTP
14	R. P. Scherer/Chelsea Laboratories

INTRODUCTION TO PROGRAM METHODS

The NCDWQ uses a basinwide approach to water quality management. Activities within the 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 Yadkin River basin was sampled by the Environmental Sciences Branch in 2001.

The Environmental Sciences Branch 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 Yadkin River basin include benthic macroinvertebrates, fish community, lake assessment, 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 NC DWQ'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. 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 has proven to be a reliable monitoring tool, as 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 6) 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) and the value of the North Carolina Biotic Index (NCBI or 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 7) 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 and EPT taxa richness criteria are used for flowing freshwater sites. Refinements of the criteria continue to occur as more data are gathered.

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 10). 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, in many instances, 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. When 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, the Environmental Sciences Branch (ESB) has performed fish tissue surveys as part of the Basinwide Assessment Program. As part of the 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 North Carolina 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 the DWQ'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 15).

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. Additional information on fish kills may be found at: http://www.esb.enr.state.nc.us.

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 at 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 17 and 18).

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. 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 4).

Table 4. 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 (s)	✔	✔
Arsenic (s)	✔	✔
Cadmium (s)	✔	✔
Chromium, total (s)	✔	✔
Copper, total (s)	✔	✔
Iron (s)	✔	✔
Lead (s)	✔	✔
Mercury	✔	✔
Nickel (s)	✔	✔
Silver (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).

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 11). The parameters presented in this report were also presented in the previous basin assessment report (NCDEHNR 1997).

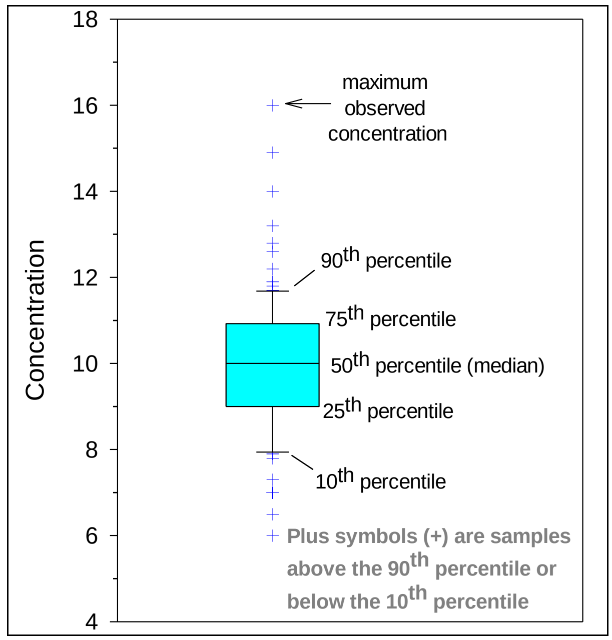


Figure 12. Explanation of box and whisker charts.

The water quality reference value may be an ecological evaluation level, a narrative or numeric standard, or an action level as specified in the North Carolina Administrative Code 15A NCAC 2B .0200 (Table 5). Zinc is included in the summaries for metals but 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.

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 NC DWQ's Aquatic Toxicology Laboratory. If toxicity is detected, NCDWQ may include aquatic toxicity testing upon permit renewal.

The NC DWQ's Aquatic Toxicology Unit maintains a compliance summary for all facilities required to perform tests and provides a monthly update of this information to regional offices and 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 5. Selected water quality standards for parameters sampled as part of the ambient monitoring system.[1]

	Standards for All Freshwater			Standards to Support Additional Uses		
Parameter (µg/L, unless noted)	Aquatic Life	Human Health	Water Supply Classifications	Trout Water	HQW	Swamp Waters
Arsenic	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).

YADKIN RIVER SUBBASIN 01

Description

This subbasin is located within the mountain ecoregion (Figure 13). Major tributaries to the Yadkin River in this subbasin include the Roaring River and Buffalo, Elk, Stoney Fork, Moravian, and Mulberry Creeks. Landuse is predominately forest (Table 6).

Subbasin 01 contains the cities of Wilkesboro and North Wilkesboro whose wastewater treatment plants discharge to the Yadkin River (4.9 MGD and 2.0 MGD, respectively). The other major discharger is ABTCO Inc (1.0 MGD) which also discharges to the Yadkin River.

Table 6. Landuse in Subbasin 01. Based upon CGIA coverage 1993 - 1995 (total area = 531,153 Ac).

Landuse	Percent
Water	0.5
Cultivated crop	1.1
Pasture	16.8
Urban	0.6
Forest	81.1

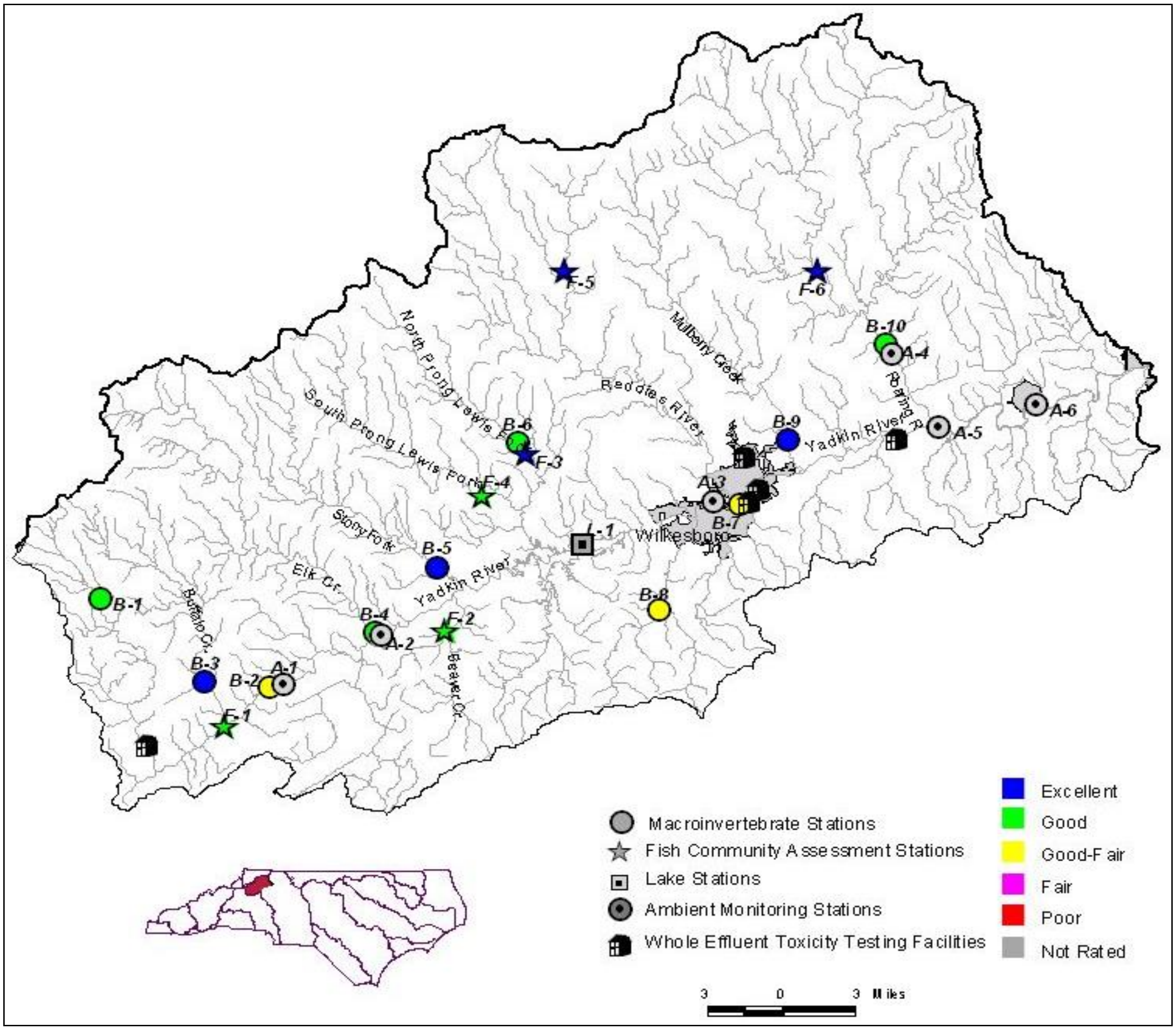


Figure 13. Sampling sites in Subbasin 01 in the Yadkin River basin.

Overview of Water Quality

The Yadkin River had Good bioclassifications for benthos in 1996 at the Patterson and North Wilkesboro sites. For 2001, both of these sites declined to Good-Fair (Table 7). Most notably, the Yadkin River site in downtown Wilkesboro had obvious signs of enrichment (e.g., thick filamentous algal growth) and had severe interstitial sedimentation.

The only other site in this subbasin that had changed in bioclassification for benthos from 1996 was the Roaring River at SR 1990 which declined from Excellent in 1996 to Good in 2001. After discussion with staff of the Winston-Salem Regional Office, it was apparent that this site has had increased numbers of newly opened animal operations within its catchment since the last sampling period in 1996. This site is also an ambient monitoring station and has shown statistically significant increases in nitrate + nitrite - nitrogen concentrations - consistent with runoff associated with animal operations.

Smaller streams in the subbasin generally had Good or Excellent water quality, based on benthos data, although Good-Fair ratings are found in areas of development such as Moravian Creek.

Fish data in this subbasin indicated a general pattern of Good and Excellent water quality. All sites previously sampled in 1996 either improved in bioclassification from Good to Excellent (e.g., North Prong Lewis Fork and Middle Prong roaring River) or maintained a Good bioclassification (e.g., Yadkin River, Beaver Cr, and South Prong Lewis Fork). One new site, the North Fork Reddies River, received an Excellent bioclassification.

The only lake assessed in this subbasin was W. Kerr Scott Reservoir. Based on summer sampling from 2000 and 2001, this waterbody was determined to be oligotrophic. However, the trophic status of this reservoir has fluctuated between oligotrophic and mesotrophic from 1981 to present. As a result, increased sampling frequency during the summer of 2002 is scheduled to more accurately determine the trophic status of this reservoir.

There are six ambient monitoring stations located in this subbasin (four on the Yadkin River at Patterson, Wilkesboro, Roaring River, and at Ronda; Elk Creek, and Roaring River). Of these, only the Roaring River showed statistically significant changes in any of the monitored parameters.

There are four active dischargers in this subbasin that are required to perform whole effluent toxicity testing. ABTCO, Inc. has a 1.0 MGD discharge to the Yadkin River below Wilkesboro and is a large contributor of biochemical oxygen demand and total suspended solids to the river. This facility had 18 pre-2001 fails but 0 fails in 2001.

Carolina Mirror was the subject of a special benthos study in 1993 which indicated that the discharge was having an adverse impact to the river. EPT taxa richness on the receiving stream (UT Mulberry Creek) increased from 3 in 1990 to 13 in 2001 after the facility was taken off-line. Continuing problems at this site may be due to most of the stream's catchment being occupied by commercial and industrial areas of Wilkesboro.

The three remaining active dischargers are the North Wilkesboro WWTP (1 pre-2001 fail, 0 fails in 2001), the Wilkesboro WWTP (14 pre-2001 fails, 0 fails for 2001), and Omni Supply Inc. (4 pre--2001 fails, 0 fails for 2001).

Table 7. Waterbodies monitored in Subbasin 01 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Yadkin R	Caldwell	SR 1372	Good	Good
B-2	Yadkin R[2]	Caldwell	NC 268	Good	Good-Fair
B-3	Buffalo Cr[2]	Caldwell	SR 1504	Excellent	Excellent
B-4	Elk Cr[2]	Wilkes	SR 1175	Good	Good
B-5	Stoney Fk	Wilkes	SR 1135	Excellent	Excellent
B-6	N Pr Lewis Fk	Wilkes	SR 1304	Good	Good
B-7	Yadkin R[2]	Wilkes	NC 18/268	Good	Good-Fair
B-8	Moravian Cr	Wilkes	NC 18	Good-Fair	Good-Fair
B-9	Mulberry Cr	Wilkes	NC 268	Excellent	Excellent
B-10	Roaring R[2]	Wilkes	SR 1990	Excellent	Good
F-1	Yadkin R	Caldwell	NC 268	Good	Good
F-2	Beaver Cr	Wilkes	SR 1131	Good	Good
F-3	N Pr Lewis Fk	Wilkes	SR 1304	Good	Excellent
F-4	S Pr Lewis Fk	Wilkes	SR 1154	Good	Good
F-5	N Fk Reddies R	Wilkes	SR 1567	---	Excellent
F-6	M Pr Roaring R	Wilkes	SR 1002	Good	Excellent
L-1	W. Kerr Scott Res.	Wilkes		---	Oligotrophic

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix B2.

River and Stream Assessment

Laurel, Basin, and Garden Creeks were not sampled for fish community assessment in 2000. Data had been collected from Laurel Creek as recently as 1999 and no changes were expected to have occurred within the forested watersheds of Basin and Garden Creeks.

Mean monthly flows in this subbasin were low during the summer of 2001. An extreme rainfall event occurred in portions of Caldwell and Wilkes counties during July 31, to August 2, 2001. This event prevented benthos sampling in Elk Creek at SR 1175 and the Yadkin River at NC 268 due to extremely high flows. These sites were resampled approximately 27 days later on August 28.

Yadkin River, SR 1372

In 1988 and 1996, Dennis Creek at SR 1372 was sampled. In 2001, this site was discontinued and a sample from the Yadkin River just downstream from Dennis Creek was taken to better assess more of the catchment.

This new site, which is downstream of the confluence of Dennis Creek and an unnamed tributary, forms the headwaters of the Yadkin River. Here, the river is high gradient and, like Dennis Creek, flows through intermittent pasture. Despite the pasture, the riparian zone was good at this five meter-wide site and the predominately rubble/boulder substrate was only slightly embedded. Typical of high gradient, rock-dominated mountain streams, root mats and undercut banks were sparse. There were few pools but the banks were stable.

Yadkin River at SR 1372, Caldwell County.

Water quality improved at Dennis Creek between 1988 (when it rated Good-Fair) and 1996 when it rated Good. For 2001, this site rated Good and the trend of improving water quality in this catchment from 1988 to present seemed to continue.

Common or abundant EPT at this site included the mayflies *Epeorus dispar*, *Paraleptophlebia*, and *Ephemerella catawba,* the stoneflies *Tallaperla*, *Pteronarcys*, *Paragnetina immarginata*, *Leuctra*, and *Isoperla* near *holochlora*, and the caddisflies *Ceratopsyche sparna*, *C. bronta*, and *Neophylax oligius*. The rare and intolerant mayflies *Rhithrogena exilis* and *Neoephemera purpurea* were also found.

Yadkin River, NC 268 (near Patterson)
The substrate at this 12 meter wide site was mostly boulder and sand with some sticks and leaf packs. Root mats were sparse.

Yadkin River at NC 268, Caldwell County.

Water quality at this site has shown continuous improvement since 1985, receiving Good bioclassifications in 1987, 1990, and 1996. However, in 2001, this site declined to Good-Fair. EPT taxa richness had been as high as 41 in 1996 with BI's as low as 4.32, also in 1996 (Figure 14). The lowest EPT taxa richness was observed in 1985 with 24 species, a BI of 5.90, and a Good-Fair bioclassification. Sampling in 2001 matched the all time low EPT richness and the second highest BI (5.52).

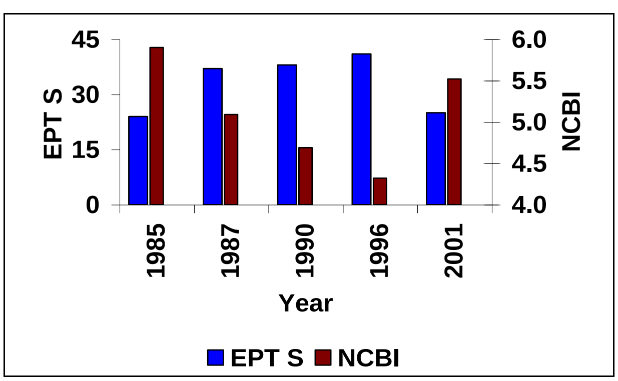


Figure 14. EPT taxa richness (EPT S) and biotic index (NCBI) for the Yadkin River at NC 268, Caldwell County.

In 1996, the stoneflies *Leuctra*, *Perlesta*, and *Tallaperla* were common. All of these stoneflies were absent from the 2001 sample. Other abundant taxa that disappeared were hydropsychid caddisflies including *Ceratopsyche bronta*, *C. morosa*, *C. sparna* and the edge dwelling leptocerid *Triaenodes ignitus*. Low flows for 2001 may account for the lack of the flow-dependent hydropsychid caddisflies as well as the absence of the root-mat dependent *Triaenodes ignitus* (due to most roots being above the water line). However, the low flows do not necessarily explain the loss of stoneflies from 1996 to 2001.

Given the long-term drought conditions and the prevalence of nonpoint pollution in the catchment, it would have been anticipated that a Good bioclassification would have been maintained, or even increased for 2001. The fact that this did not happened may indicate increased declining water quality.

An alternate hypothesis is that the drought reduced flow enough to deleteriously affect the benthic community. However, if this drought explanation were the case at least some other similarly sized sites in this subbasin should exhibit the same pattern. This was not the case as shown by improvement or maintenance of bioclassification in Buffalo, Elk Creek, Stoney Fork, Moravian, and Mulberry Creeks and North Prong Lewis Fork.

Another possible explanation for the lowered bioclassification may be due to the brief but acute exceedance of historic median daily flow in early August (Appendix 1). However, as was the case with several sites sampled in this subbasin after the spate, there seemed to be no affect on scour-sensitive species. Many baetid mayflies (*Baetis anoka*, *B. intercalaris*, *B. pluto*, *B. propinquus*, *B. punctiventris*, and *Centroptilum*) were collected in abundance after the spate. It is unclear why the benthic community at this site has declined from previous sample periods.

Yadkin River, NC 268 (near Legerwood)
The watershed of the upper Yadkin River drains the northeast corner of Caldwell County. At NC 268 near Legerwood, the river flows through the broad Yadkin River valley below the community of Patterson. At this site, the river is approximately 10 meters wide. It is approximately 4.5 miles below the benthic invertebrate monitoring site at NC 268 near Patterson.

Upstream view of the Yadkin River at NC 268, Caldwell County.

The fish community was rated Good (NCIBI = 48) in 2001 and 1996. Between 1996 and 2001, there was a shift in the trophic structure of the community. The percentage of omnivores + herbivores increased (20% to 45%) and the percentage of insectivores decreased (80% to 55%). In 1996, the bluehead chub and the exotic central stoneroller constituted 19 percent of all the fish collected. In 2001, they represented 44 percent of all the fish. This shift may indicate that more nutrient enrichment of the river is occurring from within the valley.

The trophic shift in 2001 was off-set by a greater abundance of fish and by more species being represented by multiple age classes than in 1996. The fish community at this site was also represented by one species of sunfish + bass + trout - the redbreast sunfish. This low diversity was unusual within the basin. This species was also rare at this site; it accounted for only 0.5 percent of all the fish collected.

Buffalo Creek, SR 1504

This 12 meter wide site is located about 200 meters downstream of a dam and was nearly all bedrock with only sparse boulder riffles. Roots, snags, and undercut banks in this high gradient stream were also rare. Banks were stable, leafpacks were common, and the overall riparian zone was good.

Buffalo Creek at SR 1504, Caldwell County.

Bioclassifications at this site have improved from 1988 (when it rated Good) to Excellent in 1996 with 40 EPT species. For 2001, this site was again Excellent with a total of 43 EPT taxa -- the highest EPT richness to date. Notable taxa included the mayflies *Epeorus dispar*, *E. rubidus*, and the very intolerant *Drunella allegheniensis;* the caddisflies *Ceratopsyche bronta*, *C. sparna*, *C. morosa*, *Nyctiophylax*, *Psychomyia nomada*, and the very intolerant *Micrasema rickeri*, *M. wataga*, and *M. benetti;* and the stoneflies *Tallaperla* and *Acroneuria lycorias*. The increase in EPT richness was consistent with a decrease in nonpoint pollution inputs during a drought year.

Elk Creek at SR 1175

This 12 meter wide site had a very good mix of boulder, rubble, and cobble substrates. Pool habitat was good, as were root mat, undercut banks, and leaf pack habitats. Banks were stable and the riparian zone was largely intact.

Elk Creek at SR 1175, Wilkes County.

The bioclassification declined at this site from Excellent in 1987 and 1988 to Good in 1996, and 2001. The benthic community at this site appeared stable between the 1996 and 2001 sampling periods.

Beaver Creek, SR 1131
The watershed of Beaver Creek drains the extreme southwest corner of Wilkes County and northeast Caldwell County. There are no NPDES facilities in the rural watershed. At SR 1131, the stream has a sand and gravel substrate and is approximately seven meters wide.

Upstream view of Beaver Creek at SR 1131, Wilkes County.

The fish community was rated Good (NCIBI = 50) in 2001 and 1996. Like the Yadkin River at NC 268, between 1996 and 2001, there was a shift in the trophic structure of the community. The percentage of omnivores + herbivores increased (32% to 73%) and the percentage of insectivores decreased (68% to 27%). A greater percentage of omnivores + herbivores were collected at this site than at any other sites within the basin in 2001.

In 1996, the bluehead chub constituted 26 percent of all the fish collected. In 2001, it represented 55 percent of all the fish. This shift may indicate that more nutrient enrichment of the creek is occurring from within the rural, agricultural valley.

The trophic shift in 2001 was off-set by a greater diversity of sunfish + bass + trout, the presence of a small population of intolerant highback chubs, and a slight increase in the percentage of piscivores.

Stoney Fork Creek, SR 1135
Most of the substrate at this high gradient 13 meter wide site was embedded bedrock although there were a few boulder/rubble riffles present. The riparian zone was intact, leaf packs were abundant, and root mat and undercut bank habitat was good.

Stoney Fork Creek at SR 1135, Wilkes County.

This site received an Excellent bioclassification in 1996 with a total of 38 EPT taxa. For 2001, this site kept the Excellent rating while the EPT taxa richness increased to 45. Notable EPT taxa included the mayflies *Paraleptophlebia*, *Epeorus dispar*, *E. rubidus,* and the very intolerant *Drunella allegheniensis* and *Anthopotamus distinctus,* the caddisflies *Neophylax fuscus*, *Ceratopsyche morosa*, *C. sparna*, *C. bronta*, *Lype diversa*, *Rhyacophila fuscula*, and the intolerant *Chimarra* and *Micrasema wataga*, and the stoneflies *Leuctra*, *Paragnetina immarginata*, and *P. ichusa*. The increase in EPT taxa is consistent with reduced nonpoint pollution inputs due to drought.

North Prong Lewis Fork, SR 1304
The watershed of the North Prong Lewis Fork drains the northwest region of Wilkes County. There are no NPDES facilities in this rural watershed. The stream is a fish community regional reference site.

This high gradient, five meter-wide (in July 2001), scenic mountain stream flows through a small gorge section over a predominately bedrock substrate. In addition to the prevalence of bedrock, there was some boulder riffles present. Leafpacks were abundant, the riparian zone was largely intact, but root mats, undercut banks, leafpacks, and stick habitats were rare.

North Prong Lewis Fork at SR 1304, Wilkes County.

This site had 33 EPT taxa in 1996 and received a Good bioclassification. For 2001, this site also received a Good bioclassification and the EPT taxa increased to 35. Notable EPT taxa present included the mayflies *Stenonema ithaca*, *Brachycercus*, *Paraleptophlebia*, *Epeorus dispar*, and *E. rubidus*, the caddisflies, *Ceratopsyche bronta*, *C. sparna*, *Rhyacophila fuscula*, and the intolerant *Chimarra*, and *Dolophilodes*, and the stoneflies *Leuctra*, and *Paragnetina immarginata*.

In 2001, the fish community was rated Excellent; in 1996 it was rated Good (NCIBI = 56 and 48, respectively). Metrics that contributed to the increase in score in 2001 were the number of individuals; the number of intolerant species and species of sunfish + bass + trout, and in the percentage of piscivores. Only 1percent of all the fish were tolerant species - the lowest percentage of any community in the basin in 2001.

South Prong Lewis Fork, SR 1154

The watershed of the South Prong Lewis Fork drains the northwest region of Wilkes County. There are no NPDES facilities in this rural watershed. The stream, a fish community regional reference site, parallels US 421. Widening of the highway during the past couple years has increased the amount of suspended sediment and turbidity in the stream.

Upstream view of the South Prong Lewis Fork at SR 1154, Wilkes County.

The fish community was rated Good (NCIBI = 50) in 2001 and 1996 (NCIBI = 48 and 50, respectively). Like the Yadkin River at NC 268 and Beaver Creek sites, there was a shift in the trophic structure of the community between 1996 and 2001. The percentage of omnivores + herbivores increased (21% to 49%) and the percentage of insectivores decreased (79% to 51%).

In 1996, the bluehead chub constituted 21 percent of all the fish collected. In 2001, it represented 46 percent of all the fish. This shift may indicate that more nutrient enrichment of the stream is occurring from construction activities associated with the widening of US 421. The trophic shift in may also be responsible for the four-fold increase in the number of fish collected between 1996 and 2001 (252 vs. 1,009, respectively).

Also like the Yadkin River site, the fish community at this site was also represented by only one species of sunfish + bass + trout - the redbreast sunfish. In 1996, no species of this group were collected. This low diversity was unusual within the basin. This species was also rare at this site; it accounted for only 0.8 percent of all the fish collected.

Yadkin River, NC 18/268

This 35 meter-wide site is located in the heart of downtown North Wilkesboro and had little intact riparian zone. The substrate was primarily embedded rubble although root mats and snags provided additional habitat.

Yadkin River at NC 18/268, Wilkes County.

However, staff noticed an increase in the quantity of instream sedimentation and a drastic increase in the amount of filamentous algae and macrophytes from previous sampling years. In fact, the filamentous algal growth was so dense that at every step a large plume of sediment was released downstream.

Turbidity plume in the Yadkin River at NC 18/268, Wilkes County.

Throughout most of the 1980s water quality had remained Good-Fair (Figure 15). Since 1989, however, there appeared a slight but noticeable improvement to a low Good bioclassification. This trend of improvement has, at least for now, reversed with the 2001 rating of Good-Fair.

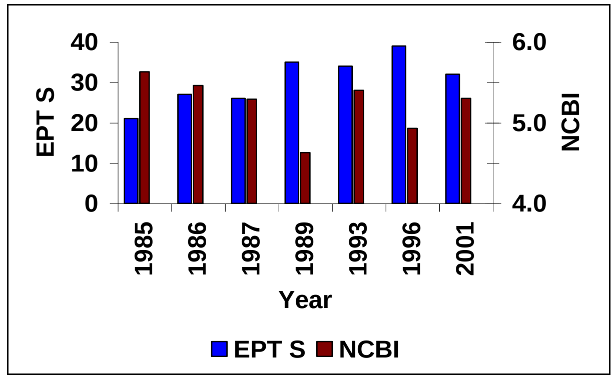


Figure 15. EPT taxa richness (EPT S) and biotic index (NCBI) for the Yadkin River at NC 18/268, Wilkes County.

In 1996, EPT taxa that were common or abundant included the mayflies *Serratella deficiens*, and *S. serratoides*, the stonefly *Pteronarcys*, and the caddisfly *Psychomyia nomada*. All of these EPT taxa were absent from the 2001 sample.

The quantity of filamentous algae, typically indicative of enrichment, may indicate increasing nutrient inputs. The increased and massive sedimentation may be exacerbating the already enriched conditions and may also be acting to decrease habitat availability in and under rocks through embedding. This site is downstream of Wilkesboro's WWTP and seemed to be feeling the effect of intensified point source pollution associated with the lowered drought flows. This site was sampled prior to the severe rains and flooding which occurred in this subbasin in early August. As a result, scour was not the reason for lowered bioclassification at this site.

Moravian Creek, NC 18
This seven meter-wide site seemed to have been historically channelized. The substrate was comprised of a homogeneous material of mostly gravel and sand and there was little sinuosity. In addition to the lack of good substrate habitat, there were few root mats, few undercut banks, and very little stick and log habitat. However, leaf packs were abundant.

Moravian Creek at NC 18, Wilkes County

This site received a Good-Fair bioclassification in 1996 and had 27 EPT taxa. For 2001, this site also rated Good-Fair but EPT declined to 25.

North Fork Reddies River, SR 1567

This location on the North Fork Reddies River was sampled in 1999 as part of a fish community regional reference site survey (Biological Assessment Unit Memoranda 09182000 and 09222000). The fish community basinwide monitoring site was changed from the 1996 monitoring site at SR 1501 to this site because it would assess a slightly larger drainage area than its upstream counterpart.

The watershed of the North Fork Reddies River drains a part of the northwest region of Wilkes County. There are no NPDES facilities in this rural watershed. The stream is a fish community regional reference site.

Upstream view of the North Fork Reddies River at SR 1567, Wilkes County.

In 2001, the fish community was rated Excellent (NCIBI = 56). The redlip shiner and the bluehead chub were the co-dominant species.

Mulberry Creek, NC 268

This 11 meter-wide site is located just east of North Wilkesboro and is under a power line easement. As a result, the riparian zone was generally devoid of trees and was largely comprised of low shrubs and herbaceous growth. The substrate had a good mix of boulder, rubble, and gravel habitat although it was embedded. Pools were rare, but riffles were abundant. Root mats, undercut banks, snags and leaf packs were also rare.

Mulberry Creek at NC 268, Wilkes County.

Despite these shortcomings, this site received an Excellent bioclassification in 1996 with 36 EPT species. For 2001, this site was Excellent. In addition, the EPT diversity increased to 41 species and included the mayflies *Drunella allegheniensis*, and *Serratella serratoides*, the stoneflies *Pteronarcys*, *Leuctra*, and *Eccoptura xanthenes*, and the caddisflies *Ceratopsyche sparna*, *C. bronta*, *Chimarra*, *Psychomyia flavida*, *Brachycentrus spinae, B. nigrosoma*, and *Micrasema bennetti*. The slightly increased EPT diversity at this site may be due to reduced impacts from nonpoint pollution due to the drought especially in a watershed where some tributaries drain urban areas.

Roaring River, SR 1990

The substrate at this 25 meter-wide site was a good mix of embedded boulder and gravel. Leaf packs, root mats, undercut banks, snags, and macrophytes were also abundant.

Roaring River at SR 1990, Wilkes County.

Water quality in the Roaring River had demonstrated continuous improvement since it was first sampled in 1983 until 1996 (Figure 16). Total taxa richness and EPT taxa richness increased with each sample reflecting an increasingly diverse community. This site received an Excellent bioclassification in 1996 with a total of 48 EPT species.

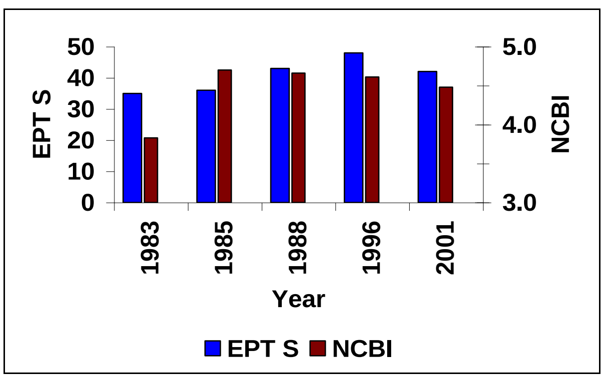


Figure 16. EPT taxa richness (EPT S) and biotic index (NCBI) for the Roaring River at SR 1990, Wilkes County.

The intolerant EPT taxa *Tallaperla*, *Neoperla*, *Pteronarcys*, *Ephemerella septentrionalis*, *Dolophilodes*, *Goera*, and *Micrasema charonis*, which had not been previously recorded from this site, were all collected in 1996. However, for 2001 the bioclassification declined to Good with 42 EPT species present. In addition, all aforementioned intolerant EPT species (with the exception of *Dolophilodes*) were not collected from the 2001 sample.

Although the 2001 sample was collected soon after a very mild rainfall the day before, the decline in EPT diversity and lowered bioclassification is likely not the result of scour. This conclusion is further strengthened by the presence of numerous scour-sensitive taxa (e.g., *Baetis intercalaris*, *B. flavistriga*, *B. pluto*, and *Stenonema modestum*). As a result, it seems likely that increased adverse activities are probably occurring in this catchment and is the most likely explanation for the lowered bioclassification.

This hypothesis is further supported by the increases in nitrate+nitrite-nitrogen from 1996 to 2001 (Figure 17). After discussions with Winston-Salem Regional Office staff, increased nitrate+nitrite-nitrogen at this site may be the result of increased numbers of animal operations (most notably poultry, cattle, and dairy) in this catchment since the mid-1990s.

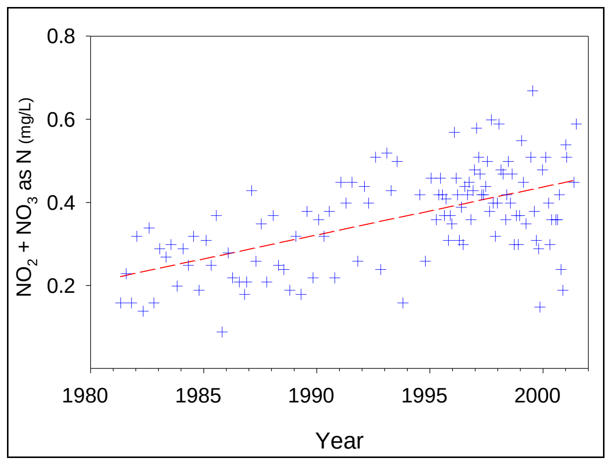


Figure 17. Nitrate+nitrite concentrations in the Roaring River at SR 1990, Wilkes County, 1980 - 2001. Dashed red line denotes a significant trend.

Middle Prong Roaring River, SR 1002

The watershed of the Middle Prong Roaring River is rural and drains the northern portion of Wilkes County including the Doughton Park area along the Blue Ridge Parkway. There are no NPDES facilities in this watershed. The stream is a fish community regional reference site.

Upstream view of the Middle Prong Roaring River at SR 1002, Wilkes County.

The fish community was rated Excellent in 2001 and Good in 1996 (NCIBI = 56 and 50, respectively). Like several other fish community sites in this subbasin, there was a shift in the trophic structure of the community between 1996 and 2001. The percentage of omnivores + herbivores increased (24% to 48%) and the percentage of insectivores decreased (76% to 48%). There was also an increase in the percentage of piscivores form 0.25% in 1996 to 4.51% in 2001.

In 1996, the bluehead chub constituted 24 percent of all the fish collected. In 2001, it represented 47 percent of all the fish. By comparison, the dominant species in 1996 was the redlip shiner (49% of all fish). In 2001, it represented only 22% of all the fish collected. This trophic shift may indicate that more nutrient enrichment of the river is occurring.

The trophic shift in 2001 was compensated by an increase in the total diversity of the community, an increase in the number of species of sunfish + bass + trout, an increase in the percentage of piscivores, and by more species being represented by multiple age classes than in 1996.

More species of suckers (n = 5) and intolerant species (n = 6) were collected at this site than at any other site in 2001. The suckers were represented by white sucker, notchlip redhorse, V lip redhorse, striped jumprock, and brassy jumprock. The intolerant species were represented by thicklip chub, fieryblack shiner, highback chub, rock bass, smallmouth bass and piedmont darter.

SPECIAL STUDIES
Benthos Assessment of the Reddies River Headwaters

North Fork Reddies River, SR 1575
This five meter-wide site was selected to complement fish data and to compile benthos information. There have been no samples on the Reddies River prior to this study.

This site had a good mix of boulder, rubble, and gravel substrates with plentiful riffles and pools. Snags were rare but root mats, undercut banks, and leafpacks were common. Although this site was adjacent to a pasture, the riparian zone was good and it appeared that the cattle did not have access to the stream.

North Fork Reddies River at SR 1575, Wilkes County.

This site had 34 EPT species and received a Good bioclassification. Notable EPT species present included the mayflies *Paraleptophlebia*, *Epeorus rubidus*, *E. dispar*, and *Neoephemera purpurea*, the stoneflies *Leuctra*, *Pteronarcys*, and *Paragnetina immarginata*, and the caddisflies *Ceratopsyche bronta*, *C. sparna*, *Chimarra*, *Dolophilodes*, and *Lype diversa*.

Middle Fork Reddies River, SR 1559
This site had less boulder habitat than did the North Fork Reddies River, but still had a very good mix of substrate types and included boulder, rubble, gravel and sand. With the slightly increased level of sand, this site was more embedded than the North Fork site and also had fewer pools.

Middle Fork Reddies River at SR 1559, Wilkes County.

Despite these shortcomings, this site had 42 EPT species and a subsequently higher bioclassification of Excellent. Notable EPT species present included the mayflies *Eurylophella doris*, *Serratella serrata*, *Anthopotamus distinctus*, *Operas dispar*, and *E. rubidus*, the stoneflies *Leuctra* and *Paragnetina immarginata*, and the caddisflies *Ceratopsyche bronta*, *C. sparna*, *C. morosa*, *Culoptila*, *Lype diversa*, *Dolophilodes*, *Psychomyia nomada*, *P. flavida*, and *Nyctiophylax celta*.

South Fork Reddies River, SR 1355

Of all the Reddies River sites, the South Fork was the smallest (four meters) and had the highest gradient. It also had more bedrock than either the North Fork or the Middle Fork sites. Root mats, undercut banks, and snags were also rare.

South Fork Reddies River at SR 1355, Wilkes County.

However, this site, like all of the other Forks of the Reddies River, had a diverse community of EPT species (33) and received a Good bioclassification. Notable EPT species present included the mayflies *Eurylophella doris*, *Epeorus dispar*, *E. rubidus*, *Paraleptophlebia*, and *Neoephemera purpurea*, the stoneflies *Pteronarcys*, *Paragnetina immarginata*, and *Tallaperla*, and the caddisflies *Dolophilodes*, *Ceratopsyche bronta*, *C. sparna*, and *Rhyacophila fuscula*. Of note were the presence of the small stream mayfly *Stenonema meririvulanum* and the small stream stonefly *Isoperla* near *holochlora*.

All three forks of the Reddies River sampled in this special study indicated no obvious problems in their respective catchments. In addition, with an Excellent bioclassification, the Middle Fork Reddies River at SR 1559 may be a candidate for HQW designation.

303 (d) Stream - UT Mulberry Creek, Flint Hill Road

This three meter-wide stream had a good mix of substrate types but was highly embedded. Riffles were plentiful, pools and leafpacks common, but root mats and undercut banks were rare.

UT Mulberry Creek at Flint Hill Road, Wilkes County.

This site was originally assessed in 1990 to determine effects of the Gardner Mirror WWTP discharge. That study was initiated in response to the facility failing several toxicity tests. In 1990, this site had only three EPT species (*Ephemera blanda*, *Eurylophella doris*, and *Allocapnia*) and a BI of 7.78 (Figure 18).

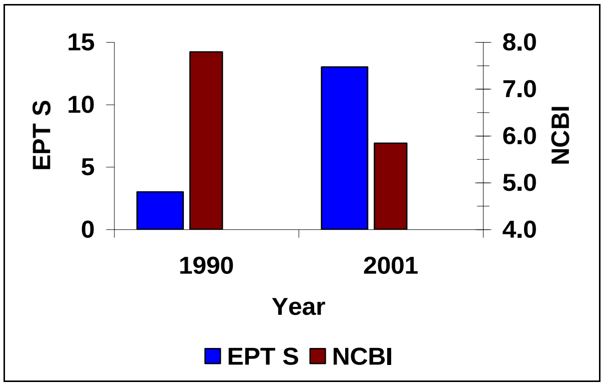


Figure 18. **EPT taxa richness (EPT S) and biotic index (NCBI) for UT Mulberry Creek at Flint Hill Road, Wilkes County.**

In 2001, this site was reassessed to determine if the removal of the discharge had any effects on the receiving stream. Indeed, the most recent sample yielded 13 EPT species, a lowered BI of 5.84, and dominance by the intolerant caddisfly *Chimarra*.

This site has several other industries and commercial enterprises in its catchment. It is likely that these activities continue to adversely impact conditions in this stream.

Purlear Creek and Little Fork, Rendezvous Mountain State Forest

Purlear Creek and Little Fork were sampled in 2001 to determine the effects of past logging practices on instream habitat and benthic macroinvertebrates (Biological Assessment Unit Memorandum 07022000). The upstream site was a small one to two meter wide headwater stream. Substrate was an embedded mix of boulder, rubble, gravel, and sand. The substrate was evaluated as 40% to 80% embedded and was comprised of 40 percent sand. The riparian zone was intact. Root mat, leaf pack, snag, and riffle habitats were good. Pool habitat, however, was rare. The overall habitat score was 72. The site was rated Excellent with 50 taxa, 31 EPT taxa, and an EPT abundance of 212.

Purlear Creek, upstream site, Wilkes County.

The downstream segment was slightly larger (two to three meters wide) than the upstream segment and the riparian zone was intact. Root mat, leaf pack, snag, and riffles were common but pools were again rare. Substrate here was also an embedded mix of boulder, rubble, gravel, and sand. Substrate embeddedness was also evaluated at 40% to 80% with 30% of the substrate comprised of sand. This site received a habitat score of 77. Like the upstream site, the downstream site received an Excellent bioclassification with 59 total taxa, 35 EPT taxa, and an EPT abundance of 222.

Purlear Creek, Downstream. Wilkes County.

Little Fork was sampled in a portion of the state forest that had been logged further in the past than either of the two Purlear Creek sites. As a result, this stream served as a control to the two Purlear Creek sites. Because the catchment of Little Fork has had longer to recover from logging impacts, it was predicted that the habitat here would be better than habitat found at either of the Purlear Creek sites. In fact, this was the case. Pools were more frequent and the substrate was much less embedded (20% to 40% versus 40% to 80% at Purlear Creek). The riparian zone was intact; root mat, leaf pack, snag, and riffle habitats were all common. The total habitat score was 85.

Little Fork, Wilkes County.

This site received an Excellent bioclassification. While all sites evaluate for this study were rated Excellent, Little Fork, with its superior habitat had more overall taxa (69), higher EPT richness (41) and a higher abundance of EPT (329) than the other two sites.

Cub Creek, SR 1001

Cub Creek was sampled in June 2001 at the request of the NC DWQ's Winston-Salem Regional Office. The beliefs were that the stream was "*not in good shape*" and "*had been impacted one too many times*". Threats to stream water quality included occasional spills, small dairy and poultry operations, and urban runoff. The watershed of Cub Creek includes the City of Wilkesboro and the Town of Moravian Falls.

Downstream view of Cub Creek at SR 1001, Wilkes County.

The stream was observed to have degraded riparian and instream habitats (i.e., sandy substrate, infrequent and shallow riffles, easily erodible banks, and a narrow riparian zone). However, the diverse and abundant fish community was rated Good (NCIBI = 50). There was an absence of piscivores and the percentage of diseased fish was slightly elevated (0.93%).

Like the Yadkin River and the South Prong Lewis Fork, the fish community was represented by only one species of sunfish + bass + trout - the redbreast sunfish. However, the species was not rare; it accounted for seven percent of all the fish collected.

Fish Community Reference Streams

Fish community samples were collected from Buffalo Creek, Laurel Creek, Middle Fork Reddies River, and North Fork Reddies River (two sites) during 1998 and 1999 as part of regional reference stream surveys (Biological Assessment Unit Memorandum 09182000). The data were used to calibrate NCIBI metrics and scoring criteria. All sites were rated as either Excellent or Good (Biological Assessment Unit Memorandum 09222000).

East Prong Roaring River - Stone Mountain State Park

Benthic macroinvertebrate and fish community samples were collected from three locations on the East Prong Roaring River in October 1998. The purpose of this study was to establish baseline and reference conditions on various reaches of the East Prong Roaring River prior to the initiation of a stream restoration project.

All three sites had good habitat although the most downstream location had severe bank erosion and moderate substrate embeddedness. All three sites received Good bioclassifications with EPT species richness values as high as 43 at the upstream site (above confluence with Widows Creek), 41 at the middle reach (one mile below Widows Creek), and 39 EPT at SR 1737 (Biological Assessment Unit Memorandum 12141998). The fish communities were rated Good and Excellent (Biological Assessment Unit Memorandum 09222000).

Lake Assessment

W. Kerr Scott Reservoir

W. Kerr Scott Reservoir (Figure 19) was most recently sampled in during the summers of 2000 and 2001. Prior to 2000, this reservoir had been sampled 11 times.

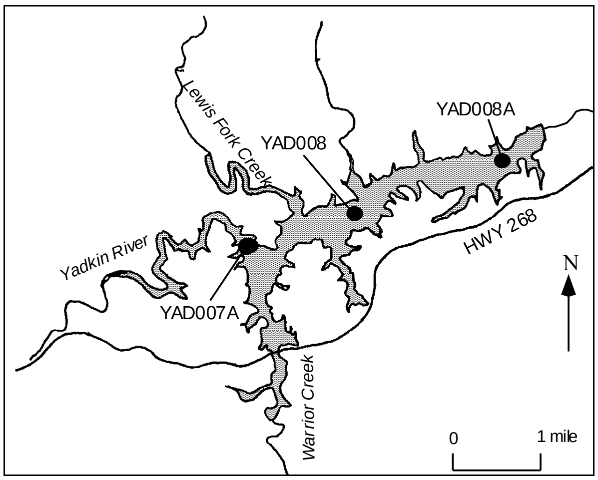


Figure 19. Sampling sites at W. Kerr Scott Reservoir, Wilkes County.

Secchi depths for 2000 - 2001 ranged from 1.3 to 2.8 meters. These depths were indicative of good light availability within the water column. Between 1981 and 1999, mean Secchi depths were similar to those observed in 2000 and 2001.

During the summers of 2000 and 2001, the lake was stratified with hypoxic conditions present near the dam at a depth of six to seven meters (depth to bottom near the dam approximately 16 meters). Surface dissolved oxygen was elevated in 2000 and 2001 with percent oxygen saturation values greater than the state water quality standard of 110% for a dissolved gas at all three sites. Surface pH values were also moderately elevated in both years.

Elevated surface dissolved oxygen and pH values are usually indicative of increased algal photosynthetic activity. Concentrations of nutrients, which ranged from low to elevated in 2000 and 2001, were at levels sufficient to support this increased algal productivity. Chlorophyll *a* values during 2001 ranged from low to moderate (7 - 13 µg/L).

The trophic status of this reservoir has fluctuated slightly between oligotrophic and mesotrophic (Figure 20). However, elevated surface dissolved oxygen and pH values during 2000 and 2001 raised concerns that the current sampling regime is insufficient to determine if nutrients are beginning to seriously impact the lake. Therefore, additional sampling is planned for the summer of 2002.

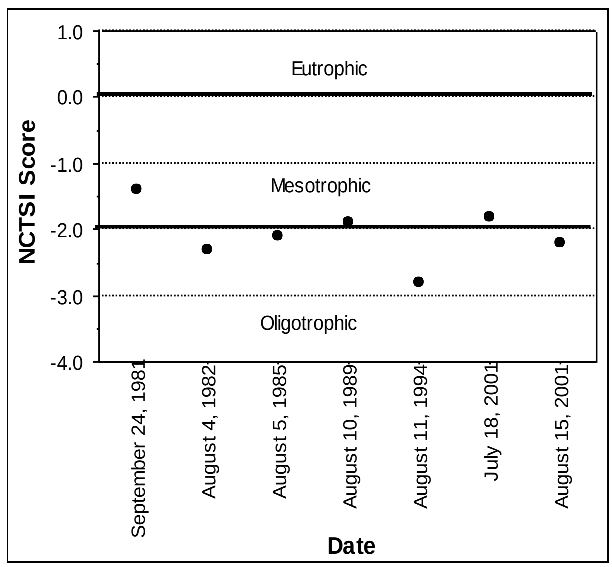


Figure 20. Historic NCTSI Scores for W. Kerr Scott Reservoir (the bold lines indicate divisions between trophic states).

YADKIN RIVER SUBBASIN 02

Description

The Yadkin River continues its flow northeast from the town of Elkin in Surry County, before making a large curve to the south and west at the juncture of Surry, Stokes, and Forsyth counties (Figure 21). The river continues south in this subbasin to just below I-40 in Davie County. The major tributaries include the Mitchell, Fisher, and Little Yadkin Rivers and Deep, Forbush, and Logan Creeks. The Mitchell River flows from the top of the Blue Ridge escarpment, and the section of the river above the confluence with the South Fork Mitchell River is classified as ORW.

This subbasin is primarily in the Northern Inner Piedmont ecoregion of the state (more montane characteristics), while the southern area is in the Southern Outer Piedmont, where streams are characterized by slower flows and sandy substrates.

The land is largely forested or used for pasture, with only small residential communities (Table 8). Elkin is the largest town in the subbasin, followed in size by Yadkinville and Dobson. The three largest dischargers are Elkin WWTP (1.8 MGD into the Yadkin River), Chatham Manufacturing (4.0 MGD into the Yadkin River at Elkin), and Yadkinville WWTP (1.0 MGD into North Deep Creek).

Table 8. Landuse in Subbasin 02. Based upon CGIA coverage 1993 - 1995 (total area = 526,218 Ac).

Landuse	Percent
Water	0.7
Cultivated crop	6.5
Pasture	32.2
Urban	1.2
Forest	59.4

Overview of Water Quality

Biological sampling in this subbasin, both benthos and fish community, showed a distinct change in water quality from primarily Good or Excellent in the part of the subbasin with more montane characteristics, to Good-Fair water quality in the southern area with more piedmont topography (Table 9). It is possible, with the benthos data especially, that a true mountain stream fauna cannot develop in the Southern Outer Piedmont subecoregion and that the lower ratings are a result of using mountain criteria. However, there were definite habitat problems and high conductivities found in the Good-Fair streams. Bluehead chub were dominant at all fish sites in this subbasin.

Two large Yadkin River benthos sites at Elkin and at Siloam are about 23 river miles apart. Both improved from Good-Fair in 1996 to Good in 2001 during the drought, perhaps due to reduced nonpoint source impacts. Elkin Creek, a tributary of the Yadkin River that flows through Yadkin Valley and Elkin, is impacted by agriculture and urban runoff, and was rated Good-Fair for benthos in 1996 and 2001.

In the Mitchell River watershed, the Excellent water quality found before its ORW designation, is now Good at an upper site near Devotion, while a site in the lower watershed at Surry County SR 1001 improved from Good to Excellent in 2001. The lower watershed contains residential and agricultural areas and continued development along I-77 northeast of Elkin, and there may have been less nonpoint impacts during the 2001 drought. Snow Creek, a tributary of the Mitchell River, declined from Good in 1996 to Good-Fair in 2001. There may be problems other than nonpoint runoff in this watershed, as it was one of the few streams that did not improve during low flows.

The Fisher River was sampled for benthos and fish with similar bioclassifications showing high water quality: two Good benthos sites and one Excellent fish community site. The downstream site was below possible impacts from Dobson, including its WWTP. A site on the Little Fisher River was Good-Fair for benthos in 2001 and fish in 1996, but Good for fish in 2001 and benthos in 1996. This rural watershed had organic enrichment indicators in both trophic levels.

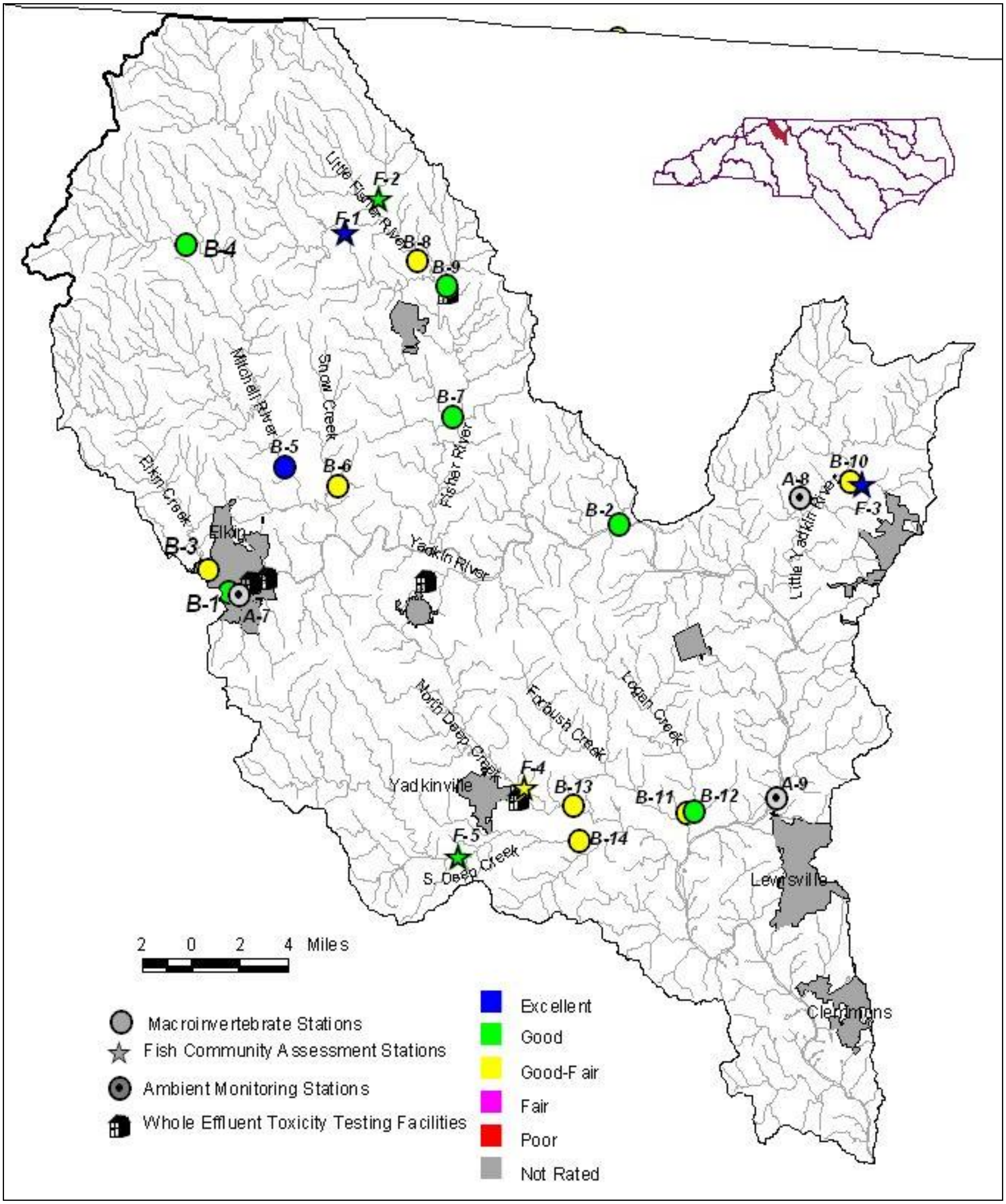


Figure 21. Sampling sites in Subbasin 02 in the Yadkin River basin.

Finally, Forbush, Logan, and North and South Deep Creeks, all streams in the Southern Outer Piedmont, had Good-Fair water quality based on benthos (though Logan Creek edged into the Good rating in 2001) for both basinwide surveys. These are largely forest and agriculture watersheds, though North Deep Creek has the discharge from the Yadkinville WWTP. A fish community site on South Deep Creek had a Good bioclassification.

Ambient chemistry data was collected by NC DWQ or by YPDRBA from 10 stations in this subbasin: four on the Yadkin River, two on North Deep Creek, and one each on South Deep Creek and the Mitchell, Little Yadkin, and Fisher Rivers. The Yadkin River at Enon had about 10% of the samples exceeding the turbidity standard, but no other obvious water quality problems were noted.

Table 9. Waterbodies monitored in Subbasin 02 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Yadkin R[2]	Yadkin	US 21	Good-Fair	Good
B-2	Yadkin R[2]	Surry	SR 1003	Good-Fair	Good
B-3	Elkin Cr	Surry	NC 268	Good-Fair	Good-Fair
B-4	Mitchell R[2]	Surry	SR 1330	Good	Good
B-5	Mitchell R[2]	Surry	SR 1001	Good	Excellent
B-6	Snow Cr[2]	Surry	SR 1121	Good	Good-Fair
B-7	Fisher R	Surry	US 601	Good	Good
B-8	Fisher R	Surry	NC 268	Good	Good
B-9	L Fisher R	Surry	SR 1480	Good	Good-Fair
B-10	L Yadkin R	Stokes	SR 1236	Good-Fair	Good-Fair
B-11	Forbush Cr	Yadkin	SR 1570	Good-Fair	Good-Fair
B-12	Logan Cr	Yadkin	SR 1571	Good-Fair	Good
B-13	N Deep Cr[2]	Yadkin	SR 1510	Good-Fair	Good-Fair
B-14	S Deep Cr	Yadkin	SR 1710	Good-Fair	Good-Fair
F-1	Fisher R	Surry	SR 1331	---	Excellent
F-2	L Fisher R	Surry	SR 1480	Good-Fair	Good
F-3	L Yadkin R	Stokes	SR 1236	Excellent	Excellent
F-4	N Deep Cr	Yadkin	SR 1236	Good-Fair	Good-Fair
F-5	S Deep Cr	Yadkin	SR 1152	Good	Good

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

River and Stream Assessment

The Mitchell River and Cody Creek were not sampled for fish community assessment in 2000. Data had been collected from the Mitchell River as recently as 1999 and no changes were expected to have occurred within the Cody Creek watershed.

Yadkin River, US 21

This site near Elkin is about 22 river miles downstream of the North Wilkesboro benthos site in Subbasin 01, and assesses water quality of the river leaving that subbasin. Here, the river separates Elkin and Jonesville and is in an urban setting, though most of the watershed between North Wilkesboro and Elkin is rural. In 2001, benthos ratings improved from Good-Fair to Good between these two sites. The width of the river here is greater than 50 meters with a substrate of rubble and boulder. The 2001 drought confined the fast flow to narrow areas and reduced edge habitat.

Yadkin River at US 21 near Elkin, Yadkin County.

This site has improved from Fair in 1989 (though high flows that year may have hampered sampling efforts or reduced the abundance of some taxa because of scour), to Good-Fair in 1996 and Good in 2001. EPT taxa richness increased from 23 in 1996 to 30 in 2001, with a dramatic increase in the caddisfly taxa richness. In 1996, all five caddisfly taxa were hydropsychids. In 2001, hydropsychids were still dominant (eight taxa), but eight other taxa were present. No chironomids were abundant in 2001, perhaps as a result of the appearance and abundance of the snails *Elimia* and *Amnicola*. There was also a decrease in the BI from 5.43 to 4.72, which along with the increase in EPT richness, suggested a real change in water quality, perhaps due to reduced nonpoint source impacts.

Yadkin River, SR 1003

This Yadkin River site near Siloam is about 23 river miles below Elkin. It is below the confluence with the Fisher River, and upstream of the confluence with the Ararat River. It is a very large river benthos site, located in an area of forest and agriculture. The only riffle was extremely difficult to reach in 2001, due to the buildup of silt along the shore during the reduced flows of the drought, and the site should be moved. The width was estimated to be 80 meters, with a mainly rubble and gravel substrate, compared to a primarily sand substrate in 1996.

Yadkin River at SR 1003 near Siloam, Surry County.

This site had the same total and EPT taxa richness as the Elkin site and was given a Good bioclassification in 2001. This site also improved from Good-Fair in 1996, but this was due only to a decrease in the BI (from 5.40 to 4.54), as EPT richness was 30 in both years. Chironomids were greatly reduced and molluscs were abundant. Other changes from 1996 to 2001 included increases in stonefly taxa from 1 to 3, beetle taxa from 2 to 7, and odonate taxa from 3 to 6. Though dominant taxa (hydropsychids) were similar both years, there was a subtle replacement of other taxa with those that are more intolerant.

Elkin Creek, NC 268

Elkin Creek begins in an agricultural area, then flows through a more urban watershed of Elkin Valley and Elkin before flowing into the Yadkin River. This downstream benthos site was in an urban setting. It was about 12 meters wide, with a substrate composed mainly of sand and silt, but with some larger cobble and boulder.

Elkin Creek at NC 268, Surry County.

Though the EPT sample in 2001 resulted in four fewer taxa than in 1996 (20), the Good-Fair bioclassification did not change. EPT abundance was similar both years. Only facultative taxa were abundant both years: *Isonychia*, *Stenonema modestum*, *Cheumatopsyche,* and *Symphitopsyche sparna*. The Good-Fair rating reflects nonpoint source impacts and habitat degradation (thick layer of silt, high embeddedness, and minimal riparian zone).

Mitchell River, SR 1330
This site is located about three miles below Devotion and the largely undeveloped Reynolds Estate. The river is about eight meters wide and has a heterogenous substrate composed of boulder/cobble and gravel/sand.

This upper section of the Mitchell River has prior data from special benthic studies. The Mitchell River was classified ORW after a benthos study in 1987 assigned an Excellent bioclassification. Shortly after that, a residential area and golf course named Olde Beau, constructed in the headwaters off US 21 in Roaring Gap, caused sedimentation in the Mitchell River. Increasing amounts of sand and silt have been noted at this present site during recent sampling.

Mitchell River at SR 1330, Surry County.

Benthos data from 1991, 1996, and 2001 all have resulted in a Good bioclassification. With its headwaters coming off the Blue Ridge escarpment, the Mitchell River has a diverse EPT fauna (38 - 40 taxa), and the benthos community is dominated by intolerant taxa (BI values of 4.02 and 4.22 during basinwide sampling). The most recent Excellent bioclassification in the upper ORW section of the river was in 1991.

A watershed protection plan has been prepared by the Piedmont Land Conservancy for the Mitchell River watershed (PLC 2001). This plan noted that 2,800 acres of land have been protected and 6,900 feet of stream bank have been restored by the Mitchell River Watershed Coalition.

Mitchell River, SR 1001
This downstream benthos site at the gaging station is larger (16 meters), but has a similar substrate to the upstream site.

Mitchell River at SR 1001, Surry County.

In 1996, the site was rated Good, but an Excellent rating was given in 2001. This resulted from a slight improvement in EPT taxa richness (43 to 45) and the BI (4.54 to 4.29).

The lower Mitchell River watershed contains residential areas, agricultural areas, and continued development along I-77, northeast of Elkin, and there may have been less nonpoint impacts to the benthic community during the 2001 drought. The only major change in the benthos was the appearance (and abundance) of the snails *Elimia* and *Leptoxis* in 2001. The mayfly, *Heptagenia marginalis*, and the caddisfly, *Symphitopsyche sparna*, were the numerically dominant EPT taxa.

Snow Creek, SR 1121
This large (8 - 11 meters wide) tributary of the Mitchell River has a largely gravel, sand, and silt substrate, with some boulder and rubble. Its confluence with the Mitchell River is below the Mitchell River at SR 1001 site, so the Good-Fair water quality does not affect the river. Land use in the Snow Creek watershed is forest and agriculture. This site had straight, steep banks, and a habitat score of 79.

Snow Creek at SR 1121, Surry County.

This was one the few benthos sites that declined in 2001, from Good in 1996 using mountain criteria. EPT taxa richness decreased from 31 to 24. EPT abundance was low in 1996 (98), but decreased further in 2001 to 77.

Changes in abundant taxa included: loss of ubiquitous mayfly *Isonychia; Heptagenia* decreased to common; *Leucrocuta* and *Symphitopsyche sparna* became rare; while increases to abundant were seen for *Acroneuria abnormis*, *Cheumatopsyche*, and *Stenacron pallidum*. Such changes are difficult to interpret, but may indicate a shift to taxa that are more adapted to slower flows and warmer temperature (though the mountain mayfly *Epeorus* did appear in 2001).

Fisher River, SR 1331

The Fisher River was sampled for the first time for fish community assessment in 2001. At this crossing, the instream, riparian, and watershed characteristics qualified the site as a new regional reference site. Its rural watershed drains the northwest corner of Surry County.

Upstream view of the Fisher River at SR 1331, Surry County.

The fish community received a perfect NCIBI score (60) and an Excellent rating. Among the 18 species collected were five intolerant species: thicklip chub, fieryblack shiner, highback chub, smallmouth bass, and piedmont darter.

Fisher River, US 601

The Fisher River was sampled for benthos at US 601 and at NC 268 in the middle of the watershed. The more upstream EPT sample at US 601 resulted in a Good bioclassification with 30 taxa in 1996 and in 2001. The river was about 15 meters wide with a good mix of substrate sizes, though pools were filled with sediment. EPT abundance increased during the 2001 low flows, but the dominant taxa were the same, with the exception of the appearance (abundant) of *Brachycentrus nigrosoma*. This filter feeder would increase under less turbid conditions.

Fisher River at US 601, Surry County.

Fisher River, NC 268

A Good bioclassification also was assigned to the river at this site, as it was in 1996. This full scale benthos sample was collected to evaluate all upstream inputs in the Fisher River watershed, which includes the Dobson WWTP (0.35 MGD into Cody Creek) and agricultural runoff. The habitat at this site was better (habitat score of 76 compared to 65 upstream), and there was less sediment in the pools and riffles. EPT abundance also increased at this site from 153 to 201 under low flows. Chironomids, beetles, and odonates were similar between years, but more molluscs were collected in 2001.

Fisher River at NC 268, Surry County.

Little Fisher River, SR 1480

The rural watershed of the Little Fisher River drains north-central Surry County up to the VA-NC state line. The Little Fisher River is a large tributary to the Fisher River above the US 601 site. At this location, the stream is eight meters wide with a mixed sand, gravel, and cobble substrate. The substrate was dominated by gravel and sand in 1996, but was more heterogeneous in 2001. During the fish community assessment period, the habitat was scored 66, but the site was scored 85 during benthic invertebrate monitoring. Land use in the surrounding areas were planted in corn.

Upstream view of the Little Fisher River at SR 1480, Surry County during June 2001.

Downstream view (looking upstream) of the Little Fisher River at SR 1480, Surry County during July 2001.

The 29 EPT taxa collected in 1996 (Good bioclassification) decreased to 22 in 2001 (Good-Fair bioclassification). EPT abundance was similar in both years, 112 and 94, respectively with baetids, heptageniids, and hydropsychids dominant. Even under low flow conditions, water quality declined slightly in this agricultural watershed. Field notes from 2001 suggest organic enrichment was a problem here.

The fish community was rated Good in 2001 and Good-Fair in 1996 (NCIBI = 46 and 50, respectively). The number of species of darters metric contributed the most to the increase in score in 2001with the addition of the fantail darter and piedmont darter. The tessellated darter was collected in 1996 and 2001.

The trophic structure was not as skewed in 2001 as it was in 1996 because the bluehead chub, though still abundant, was not as dominant in 2001 as it was in 1996. The percentage of omnivores + herbivores decreased (54% to 40%) and the percentage of insectivores increased (45% to 60%). However, there was also a decrease in the percentage of piscivores form 0.93% in 1996 to 0.13% in 2001.

Little Yadkin River, SR 1236

The rural watershed of the Little Yadkin River drains the southwest corner of Stokes County. There are no NPDES facilities in its watershed. This site is approximately one mile below the confluence of the West Prong and East Prong Little Yadkin Rivers, which join to become the Little Yadkin River. Each of these headwater streams has considerable agricultural land in their watersheds.

At this site, The substrate was mostly sand or embedded gravel, with a layer of silt covering the substrate in the slower moving areas. The stream was approximately 10 meters wide and shallow.

Downstream view of the Little Yadkin River at SR 1236, Stokes County, August 2001.

Upstream view (from the bridge) of the Little Yadkin River at SR 1236, Stokes County, June 2001.

Agricultural activities in the watershed were probably the cause of the Little Yadkin River receiving only a Good-Fair benthos rating in 1996 and 2001, using mountain criteria. While EPT taxa richness (24 - 25) and the BI were similar both years, total taxa increased from 54 in 1996 to 89 in 2001. This increase was primarily in chironomids (11 to 25 taxa) which thrived under low flow conditions and nutrient enrichment, but all other non-EPT groups also increased in richness.

By contrast, in 2001 and 1996, the fish community was rated Excellent (NCIBI = 54). More fish (1,058) were collected at this site than at any other site in 2001. Also, the second highest diversity of fish (n = 22) was found at this site. The bluehead chub was the dominant species in 2001 as it was in 1996.

Forbush Creek, SR 1570

Forbush Creek is the first of the streams located in the Southern Outer Piedmont in this subbasin, but has been rated for benthos using mountain criteria due to the presence of the mayfly *Epeorus*. It flows southeast into the Yadkin River just west of Winston-Salem and east of Yadkinville. Its watershed is forest and agriculture.

Forbush Creek at SR 1570, Yadkin County.

Good-Fair ratings were found in 1996 and 2001 based on EPT values of 23 and 22. A habitat score of 75 was given to this seven meter wide stream. However, field notes indicate excessive algal growth and steep, eroding stream banks. Only *Isonychia*, *Stenonema modestum*, and *Cheumatopsyche* were abundant in 2001, but the benthic community was very similar both years.

Logan Creek, SR 1571
The watershed of Logan Creek lies adjacent to Forbush Creek's watershed and has a similar land use. A lower habitat score (63) indicates more habitat degradation. As with Forbush Creek, this stream is about seven meters wide, but has a much sandier substrate.

Good-Fair (almost Good) water quality was found in 1996 based on an EPT value of 27, using mountain criteria. The bioclassification changed to Good in 2001, when 31 EPT taxa were collected. EPT abundance also increased from 98 to 135, perhaps due to less scour. The similarities between the faunas both years, however, suggested no change in water quality.

North Deep Creek, SR 1605
The central region of Yadkin County, including the eastern part of the Town of Yadkinville, drain into North Deep Creek. There are no NPDES facilities upstream of the fish community monitoring site. At the SR 1605 crossing, the stream has a sand bottom and is seven meters wide.

Upstream view of North Deep Creek at SR 1605, Yadkin County.

The NCIBI metric values and scores were nearly identical in 2001 and 1996. Both times, the community was rated Good-Fair. There was no change in the fish community. The community was 1 of 4 communities in the basin where darters were absent. The bluehead chub remained dominant; approximately 50 percent of all fish collected in 2001 and 1996 were this species.

North Deep Creek, SR 1510
The site is located below the Yadkinville WWTP. It is located on a scenic stretch of rocky stream below a waterfall, and had a habitat score of 93. Bioclassifications have been Good-Fair since 1993, based on benthic data. Conductivity was elevated at 140 µmhos/cm, and the rocks were covered with benthic algae.

This was another site in this subbasin where EPT taxa richness (24 and 26) and the BI (5.39 and 5.44) was very similar between basin years, yet total taxa richness increased from 57 to 76. In this case, though, the chironomids changed only in abundance, not in taxa richness, and other groups of the benthic community all had a more diverse fauna. It would be expected that low flows would increase discharger impacts, especially where a strong chlorine odor was detected, but this was not the case.

South Deep Creek, SR 1152
The southwest quadrant of Yadkin County, west of the Town of Yadkinville, drain into South Deep Creek. There is one minor NPDES facility (0.01 MGD) located in the upper headwaters of the watershed. At this site, the stream is seven

meters wide and has a shifting sand substrate with occasional bedrock outcroppings and slopes.

Upstream view of South Deep Creek at SR 1152, Yadkin County.

In 2001 and 1996, the fish community was rated Good (NCIBI = 52 and 48, respectively). The greater NCIBI score in 2001 was due to a slight increase in the number of species, an approximately three-fold increase in the number of individuals collected, and a decrease in the percentage of tolerants as compared with 1996. The bluehead chub remained dominant; 36 percent of all fish collected in 2001 and 1996 were this species.

South Deep Creek, SR 1710

South Deep Creek (10 meters wide, drainage area = 63 mi^2) originates in the Brushy Mountains and joins North Deep Creek (drainage area = 40 mi^2) to form Deep Creek just downstream of SR 1710 in Yadkin County. As was found at Logan Creek and Forbush Creek in this area, the stream was very sandy and bank erosion was severe. The habitat score of 77 reflected this and a lack of riffles. Good-Fair ratings were found both basin years using benthos data. EPT taxa richness dropped from 26 in 1996 to 19 in 2001, but total taxa richness increased. No Diptera, other than chironomids, were found in 1996, but six taxa were collected in 2001, along with small increases in other groups.

SPECIAL STUDIES

South Fork Mitchell River

Three sites on the South Fork Mitchell River were sampled for benthos in 1998 prior to a stream restoration project funded by the Clean Water Management Trust Fund. Samples above and below the proposed restoration area resulted in Good-Fair bioclassifications, while a site further downstream was Good.

Little Beaver Creek

This small stream was sampled just upstream of its confluence with the Fisher River near NC 268. It was a scenic, well shaded, stream with a very good mix of boulder, rubble, gravel, and sand habitats. Although there was an upstream hillside pasture with streamside cattle access, there were minimal impacts on stream habitat.

Little Beaver Creek at mouth off NC 268, Surry County.

In 1989, a tire disposal area upstream of the site had a tire fire, which resulted in a Poor rating with two EPT species and a BI of 6.76. In 2001, dramatic improvement was found -- the bioclassification increased to Good with 27 EPT species present and there was a much lower BI of 3.95 than in 1989.

Fish Community Reference Streams

A fish community sample was collected from the Mitchell River during 1999 as part of regional reference stream survey (Biological Assessment Unit Memorandum 09182000). The data were used to calibrate NCIBI metrics and scoring criteria. The community was rated Good (Biological Assessment Unit Memorandum 09222000).

YADKIN RIVER SUBBASIN 03

Description

This subbasin, which contains the Ararat River and its tributaries, originates in the mountains of Virginia. Small western and northwestern sections of the subbasin fall within the mountain ecoregion. However, the vast majority of this subbasin is in the piedmont ecoregion. The major tributaries to the Ararat River include Stewarts, Lovills, and Flat Shoals Creeks (Figure 22). The Ararat River flows generally south and empties into the Yadkin River east of Elkin. Land use in the area is mostly forest and pasture (Table 10).

Table 10. Landuse in Subbasin 03. Based upon CGIA coverage 1993 - 1995 (total area = 126,866 Ac).

Landuse	Percent
Water	0.2
Cultivated crop	4.9
Pasture	32.7
Urban	3.0
Forest	59.1

The Ararat River and its tributaries have moderate to swift flow throughout the year and turbidity can become a problem after rainfall. This subbasin contains the cities of Mt Airy and Pilot Mountain, which both have wastewater treatment plants that discharge to the Ararat River at 7 MGD and 1.5 MGD, respectively.

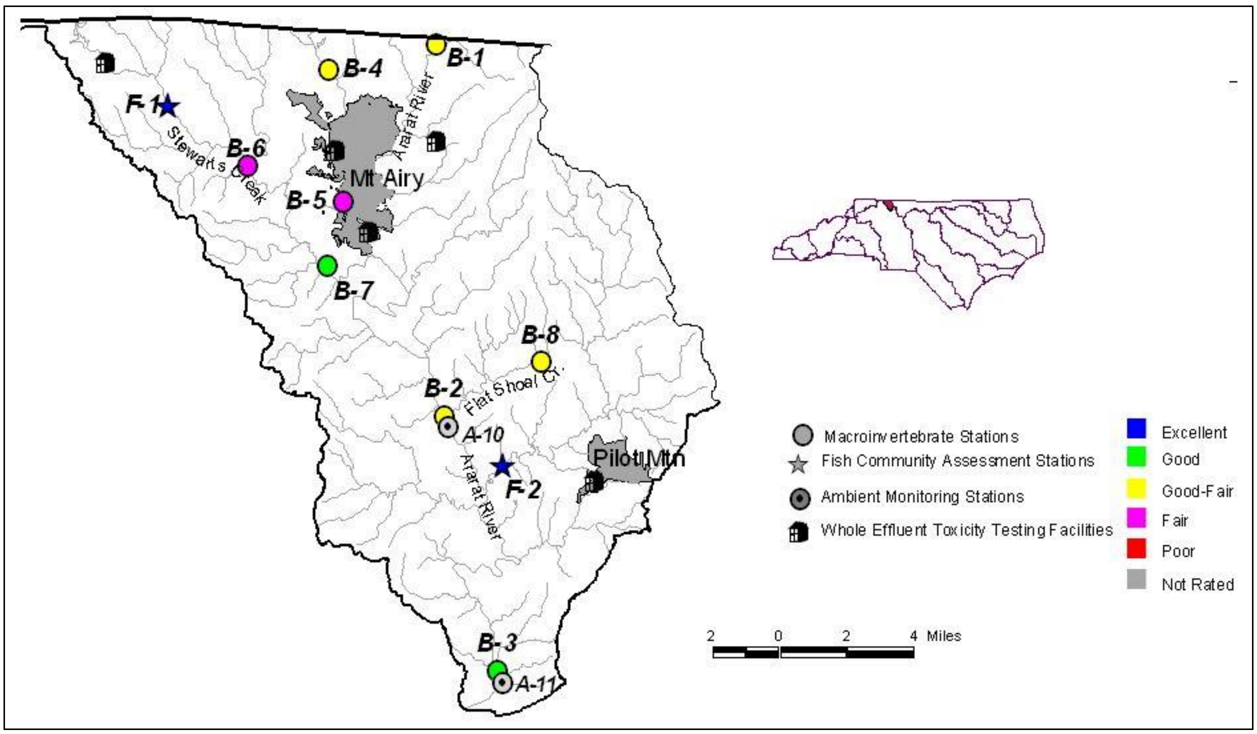


Figure 22. Sampling sites in Subbasin 03 in the Yadkin River basin.

Overview of Water Quality

Three sites on the Ararat River were monitored in 2001 (Table 11). An upstream site (at NC 104) was Good-Fair in 1996 and 2001; a middle watershed site (at SR 2026) was Fair in 1996 but improved to Good-Fair in 2001, and the furthest downstream site (at SR 2080) was Fair in 1996 but improved dramatically to Good in 2001. The site at SR 2080 is downstream of the Town of Mt. Airy's WWTP. In a low flow year, one would expect this site to show adverse effects from the facility due to less dilution of the discharge. However, just the opposite effect was observed (i.e., improved bioclassification with low flow). Consequently, the Operator in Responsible Charge (ORC) of the plant was contacted to see if a change in treatment process or a facility upgrade had occurred since 1996. The ORC noted that the likely reason for the improved bioclassification was due to a reduction in the volume discharged (from 3.0 MGD to 1.5 MGD) because many local industries closed down and thereby ceased inputs to the plant.

The Town of Pilot Mountain's WWTP no longer discharges to Heatherly Creek; the discharge was relocated to the Ararat River in 1996. Prior to 2001, repeated sampling of Heatherly Creek had documented impacts from the discharge. After removal, the downstream reach improved from Poor in 1987 and 1994 to Fair in 2001. The section of the creek upstream from the discharge also increased from Fair in 1987 and 1994 to Good-Fair in 2001.

Other benthos sites included the uppermost site of Stewart's Creek (at NC 89) which declined to Fair in 2001 from Good-Fair in 1996. Conversely, the downstream site of Stewart's Creek (at SR 2258) improved in bioclassification from Good-Fair in 1996 to Good in 2001. Lovills Creek at an upstream benthos site (at SR 1700) was Good-Fair in 1996 and 2001, while the downstream site (at SR 1371) was Fair in 1996 and 2001. Flat Shoals Creek (at SR 1827) was also Good-Fair in 1996 and 2001.

In terms of fisheries data, Stewarts Creek (at SR 1622) was Excellent in 1996 and 2001, while Toms Creek (at SR 2034) received an Excellent bioclassification in 2001. Toms Creek (SR 2034) is a new site with no previous fishery data.

There are two ambient monitoring stations located in this subbasin. The Ararat River at SR 2080 and at SR 2026 showed no statistically significant change in monitored parameters since 1996.

There are five dischargers in this subbasin which are required to conduct whole effluent toxicity testing. The Proctor Silex facility (25 pre-2001 fails, zero 2001 fails) has gone offline and has not had a discharge to Lovills Creek since January 2001. The remaining four active dischargers include: Flat Rock Elementary School (2 pre-2001 fails, 3 2001 fails), NCDOT (4 pre-2001 fails, 1 2001 fail), the Town of Mt. Airy's WWTP (42 pre-2001 fails, 2 fails for 2001), and the Town of Pilot Mountain's WWTP (57 pre-2001 fails, zero fails for 2001). Only the Flat Rock Elementary is having acute difficulty meeting their toxicity limits, most notably limits for ammonia and surfactants.

Table 11. Waterbodies monitored in Subbasin 03 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Ararat R[2]	Surry	NC 104	Good-Fair	Good-Fair
B-2	Ararat R[2]	Surry	SR 2026	Fair	Good-Fair
B-3	Ararat R[2]	Surry	SR 2080	Good-Fair	Good
B-4	Lovills Cr[2]	Surry	SR 1700	Good-Fair	Good-Fair
B-5	Lovills Cr[2]	Surry	SR 1371	Fair	Fair
B-6	Stewarts Cr	Surry	NC 89	Good-Fair	Fair
B-7	Stewarts Cr	Surry	SR 2258	Good-Fair	Good
B-8	Flat Shoals Cr[2]	Surry	SR 1827	Good-Fair	Good-Fair
F-1	Stewarts Cr	Surry	SR 1622	Excellent	Excellent
F-2	Toms Cr	Surry	SR 2034	---	Excellent

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

Ararat River at NC 104

The substrate of this eight meter wide site was a good mix of boulder, rubble, and gravel although it was highly embedded. Root mats and undercut banks were common, but snags and leafpacks were sparse. This site is upstream of the Town of Mt. Airy's WWTP.

Ararat River at NC 104, Surry County.

This site has rated Good-Fair in 1986, 1996, and 2001. While the bioclassification has not changed at this site, the number of EPT species have increased from 18 in 1986 to 26 in 1996 and 25 in 2001. Notable EPT species present included the mayflies *Serratella serratoides*, *S. serrata*, and *Epeorus rubidus*, the stonefly *Leuctra*, and the caddisfly *Ceratopsyche sparna*.

Ararat River, SR 2026

Substrate at this 25 meter wide site was a moderately embedded mix of boulder, rubble and gravel. Root mats, snags, and leafpacks were all common, although pools were rare. This site is below the town of Mt Airy and its WWTP.

Ararat River at SR 2026, Surry County.

Water quality was stable between 1984 - 1996 with consistent Fair bioclassifications. However, in 2001, this site improved to Good-Fair. A likely explanation for this trend is a result of the Town of Mt Airy WWTP reducing its discharge from 4.5 MGD during the middle and late 1990s to the present day 3.0 MGD. This reduction in effluent volume corresponded to the closure of several industries in the town. In addition to the lower volume, additional reductions in toxicity due to lessened industrial inputs are also likely causes for an improved bioclassification.

Notable EPT taxa present in 2001 included the mayflies *Epeorus rubidus* and *Leucrocuta*, the stonefly *Leuctra*, and the caddisflies *Ceratopsyche bronta*, *C. sparna*, *C. morosa*, and *Psychomyia flavida*.

Ararat River, SR 2080

This 35-meter wide site had a good combination of boulder, rubble and gravel. Snags, leafpacks, root mats and undercut banks were common although pools were rare.

Ararat River at SR 2080, Surry County.

This site received a Fair bioclassification in 1986, improved to Good-Fair in 1996, and has improved again in 2001 to Good. Most significantly, this site has gone from 17 and 19 EPT taxa in 1986 and 1996, respectively, to 35 EPT taxa in 2001 (Figure 23). Furthermore, the BI decreased from between 5.84 in 1986 to 4.94 in 2001.

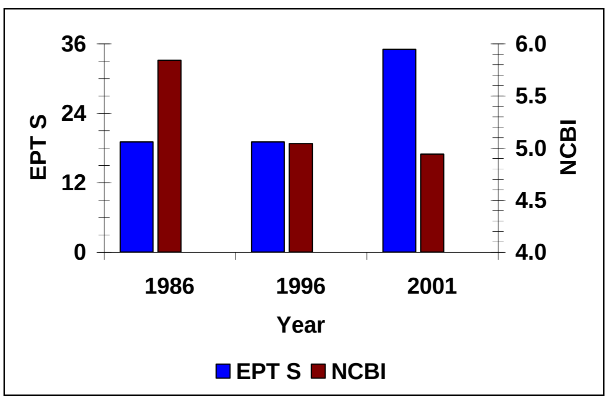


Figure 23. EPT taxa richness (EPT S) and biotic index (NCBI) for Ararat River at SR 2080, Surry County.

Notable common or abundant EPT taxa not previously collected include the mayflies *Stenacron interpunctatum*, *Leucrocuta*, and *Centroptilum*, and the caddisflies *Nyctiophylax celta*, *Protoptila*, *Nectopsyche exquisita*, *Neophylax oligius*, and *Polycentropus*.

Lovills Creek, SR 1700

Water quality appears to be stable at this site since 1986 despite the relatively new golf course and subdivision in the watershed. The substrate of this eight meter wide stream was a good mix of boulder and rubble, but the lack of any trees at the site reduced shading, edge habitat and leaf packs.

Lovills Creek at SR 1700, Surry County

Bioclassifications were Good-Fair for 1986, 1996, and 2001. Notable EPT taxa included the mayflies *Serratella serratoides* and *Heptagenia marginalis*, the stonefly *Tallaperla*, and the caddisflies *Micrasema wataga*, *Neophylax oligius*, and *Ceratopsyche sparna*.

Lovills Creek, SR 1371

The substrate of this six meter stream was primarily bedrock and sand with most surfaces supporting a luxuriant periphyton growth. Root mats, undercut banks and snags were non-existent, consistent findings of a stream with no riparian zone and artificially hardened banks.

Lovills Creek at SR 1371, Surry County.

Water quality at this downtown Mt. Airy stream appears to have remained stable between 1986 and 1996 with Fair bioclassifications. For 2001, this site again received a Fair bioclassification.

During the 2001 benthos sampling, a fish kill of approximately 1,000 fish (catfish, sunfish, and suckers) was observed. The cause of the kill was not determined.

Instream trash and dead fish in Lovills Creek at SR 1371, Surry County.

Dead fish in stream and along the shoreline at Lovills Creek at SR 1371, Surry County.

In addition to habitat problems, there are several industrial and commercial facilities (including a concrete plant) upstream as well as at least one storm sewer outfall directly discharging to the stream. Even if the armored stream banks were removed and the riparian zone replanted, it is unlikely this stream will demonstrate any significant improvement until point and nonpoint discharges in the catchment are adequately addressed.

Stewarts Creek, SR 1622

The watershed of Stewarts Creek drains the extreme upper north-central region of Surry County and a small southern portion of Carroll County, Virginia. Two NPDES dischargers (total flow = 0.05 MGD) associated with an I-77 rest area are located approximately 3.5 miles upstream on Naked Creek, a tributary of Stewarts Creek. At the SR 1622 bridge, the stream is eight meters wide with a substrate of largely cobble and gravel and some bedrock shelves.

The NCIBI metric values and scores were nearly identical in 2001 and 1996. Both times, the community was rated Excellent. The dominant species during both collection periods was the redlip shiner.

Upstream view of Stewarts Creek at SR 1622, Surry County.

Stewarts Creek NC 89

This 11 meter wide stream was a fairly uniform run with a mostly homogeneous sand and gravel bed, no boulder and only a trace of rubble substrate. Riffles were rare, as were snags, leafpacks, root mats, and undercut banks.

Stewarts Creek at NC 89, Surry County

This site was sampled in 1996 and received a Good-Fair bioclassification with 23 EPT species (Figure 24), including four stoneflies. For 2001, this site declined to Fair with a corresponding decrease of EPT species to 18 with no stoneflies collected.

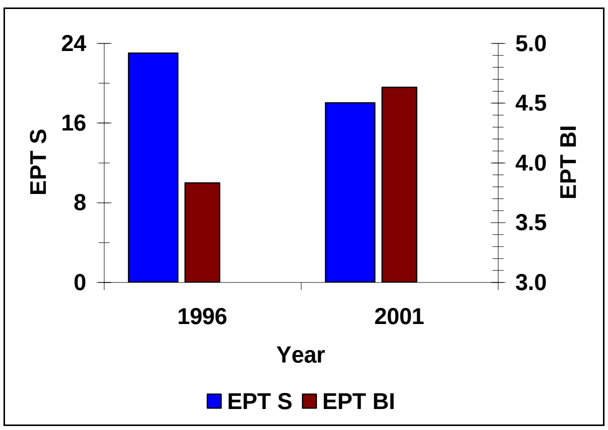


Figure 24. EPT taxa richness (EPT S) and biotic index (NCBI) for Stewarts Creek at NC 89, Surry County.

Notably intolerant EPT taxa collected in 1996 but absent for 2001 include the mayflies *Isonychia*, *Leucrocuta*, *Epeorus*, and *Serratella serrata*, the stoneflies *Acroneuria abnormis*, *Pteronarcys*, *Leuctra*, and *Perlesta*, and the caddisfly *Psychomyia nomada*.

This site was originally sampled in 1996 to serve as an upstream reference site for the Stewarts Creek at SR 2258 site which is downstream of Mt. Airy. Given that the downstream site actually improved from Good-Fair in 1996 to Good in 2001, it is apparent there were adverse anthropogenic activities occurring upstream of this NC 89 reach.

Stewarts Creek, SR 2258

This 12 meter wide stream had a heterogeneous mix of boulder, rubble, and gravel substrates. Snags, root mats and undercut banks were rare, although leafpacks were common. The riparian zone was not intact and the flow was swift despite the prolonged lack of precipitation.

Stewarts Creek at SR 2258, Surry County.

This site was selected in 1996 to determine potential deleterious impacts of nonpoint pollution from Mt. Airy. In 1996 this site received a Good-Fair bioclassification with 27 EPT species (Figure 25). In 2001, the bioclassification at this site improved to Good with 34 EPT taxa

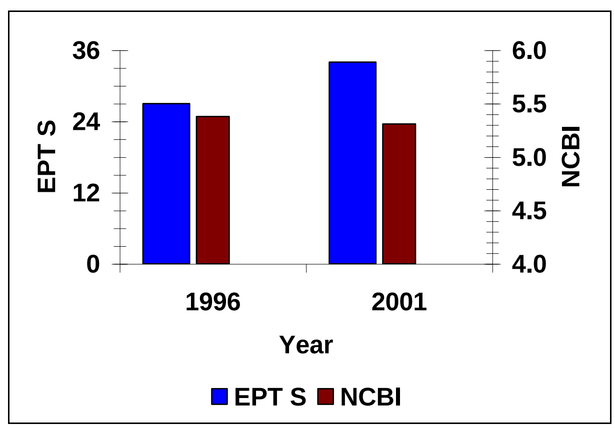


Figure 25. EPT taxa richness (EPT S) and biotic index (NCBI) for Stewarts Creek at SR 2258, Surry County.

The improvement in bioclassification for 2001 is likely the result of the prolonged drought which acted to lessen the impacts of nonpoint pollution. Notable EPT additions for 2001 include the mayflies *Epeorus rubidus*, *Heptagenia marginalis*, *Leucrocuta*, and *Tricorythodes*, and the caddisflies *Chimarra*, *Glossosoma*, *Nyctiophylax*, and *Ceratopsyche morosa*.

Flat Shoals Creek, SR 1827
This small, four meter wide stream is in a largely agricultural watershed. The substrate was a good mix of boulder, rubble and gravel with good leaf pack and edge habitat. While the stream received good shading, the riparian buffer was not fully intact.

Flat Shoals Creek at SR 1827, Surry County.

In 1987 this site received a Good bioclassification but was collected in January. Samples from 1996 and 2001 were taken in summer and received Good-Fair bioclassifications. The minor shift may be the result of less stressful physical conditions in January.

Toms Creek, SR 2024
At the request of the NC DWQ's Winston-Salem Regional Office, a fish community sample was scheduled for Toms Creek to assess the stream following the relocation of the Town of Pilot Mountain's WWTP discharge from Heatherly Creek to Toms Creek to the Ararat River. The stream's watershed drains southeast Surry County including the Town of Pilot Mountain. Following relocation of the discharge, there remains only one small WTP discharge (on Heatherly Creek, a tributary to Toms Creek) upstream from the monitoring site.

At the SR 2024 crossing, Toms Creek is 10 meters wide with a mixed substrate of cobble, bedrock, gravel, sand, and silt. The substrate did not have any excessive growths of periphyton which are often seen in an nutrient enriched environments such as those below WWTP facilities. After evaluating the physical characteristics of the site (instream and riparian habitats of moderately high quality)and its location within the watershed, the site was added to the list of fish community basinwide monitoring sites.

Upstream view of Toms Creek at SR 2024, Surry County.

The fish community was rated Excellent (NCIBI = 56). More species (n = 23) were collected at this site than at any other site in the basin in 2001. The bluehead chub and the redlip shiner were the co-dominant species.

SPECIAL STUDIES
303 (d) Streams
Heatherly Creek, NC 268 (above Pilot Mountain WWTP)
This three meter wide stream is located above what once was the discharge from the Town of Pilot Mountain's WWTP. The substrate was predominately sand with only small amounts of rubble and gravel. Snags were rare but root mats, undercut banks and leaf packs were common.

Heatherly Creek at NC 268, Surry County.

This site was sampled in 1987 and 1994 and had 14 and 17 EPT species, respectively and with BI scores of 6.41 and 6.05, respectively (Figure 26). For 2001, EPT richness stayed static at 17 but the BI dramatically decreased to 5.03.

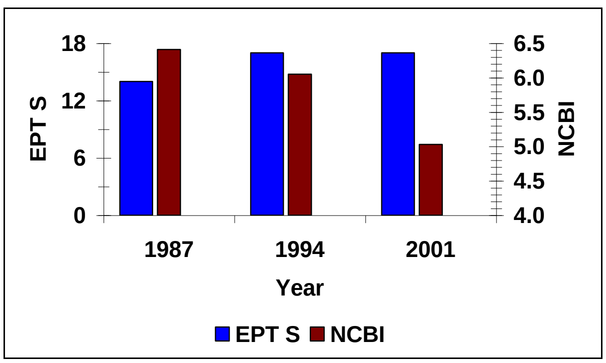


Figure 26. EPT taxa richness (EPT S) and biotic index (NCBI) for Heatherly Creek at NC 268, Surry County.

The intolerant caddisfly *Chimarra* was abundant and the stonefly *Eccoptura xanthenes* was common. Other EPT species not previously collected include the stonefly *Leuctra*, and the mayflies *Stenacron pallidum*, *S. interpunctatum*, and *Epeorus rubidus*. The lowered BI and improved bioclassification were likely due to lessened nonpoint source pollution as a result of the drought.

Heatherly Creek, US 52 (below Pilot Mountain WWTP)

Prior to 2001, the effluent from the Town of Pilot Mountain's WWTP was discharged into Heatherly Creek. At this site below the discharge, the site was rated Poor in 1987 with only two EPT species and a BI of 8.50 (Figure 27). By 2001, the discharge was routed to the Ararat River. In 2001, the site received a Fair bioclassification with 11 EPT taxa present and a BI of 5.80.

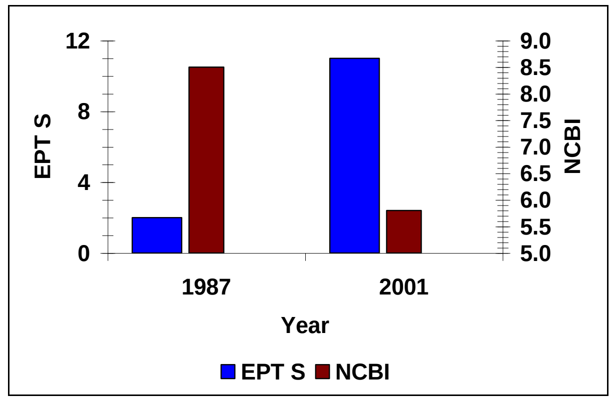


Figure 27. EPT taxa richness (EPT S) and biotic index (NCBI) for Heatherly Creek at US 52, Surry County.

Notable EPT taxa present at this site not previously collected include the caddisflies *Chimarra*, and *Diplectrona modesta*, and the mayflies *Eurylophella bicolor* and *Baetisca berneri*. The improvement at this site is most likely the result of the removal of Pilot Mountain's WWTP. However, as was the case in the upstream segment of Heatherly Creek at NC 268, additional improvement may also be the result of lessened nonpoint source pollution related to the prolonged drought.

YADKIN RIVER SUBBASIN 04

Description

This area is located in the piedmont ecoregion and includes the cities of Winston-Salem, Salisbury and Spencer (Figure 28). Muddy Creek is the largest stream in this subbasin, with one of its tributaries (Salem Creek) draining a heavily urbanized portion of Winston-Salem. Grants Creek, in the southwest part of the subbasin, runs through Salisbury, Spencer, and East Spencer. This subbasin also includes High Rock Lake.

Winston-Salem is one of the largest urban areas in North Carolina, with many streams potentially affected by urban runoff and/or permitted dischargers. There are many permitted dischargers in this subbasin, although many of these are small residential dischargers. Dischargers with a permitted flow >0.5 MGD in the Muddy Creek drainage include Winston-Salem Archie Elledge WWTP (Salem Creek, 30 MGD), Winston Salem Muddy Creek WWTP (Yadkin River, 21 MGD), and RJ Reynolds (UT Silas Creek, 0.8 MGD). Dischargers with a permitted flow >0.5 MGD in the Salisbury/Spencer area include PPG Industries (N Potts Creek, 0.6 MGD), and Spencer WWTP (Grants Creek, 0.8 MGD).

Agricultural land use affects most other streams outside of the urban areas.

Subbasin 04 is located in an area of easily eroded soils. Consequently, streams in areas of urban or agricultural land use are affected by sediment inputs, and have large amounts of coarse sand.

Although there are many urban areas, landuse in the subbasin is still primarily forest and pasture (Table 12). Agricultural land use affects most other streams outside of the urban areas. This subbasin is located in an area of easily eroded soils. Consequently, streams in areas of urban or agricultural land use are affected by sediment inputs, and have large amounts of coarse sand.

Table 12. Landuse in Subbasin 04. Based upon CGIA coverage 1993 - 1995, total area = 467,740 Ac).

Landuse	Percent
Water	3.6
Cultivated crop	2.8
Pasture	31.7
Urban	6.0
Forest	55.9

Overview of Water Quality

Numerous NC DWQ special benthos studies have examined the effects of permitted dischargers on stream biota in Subbasin 04. Upstream - downstream studies in the 1980s and 1990s had demonstrated problems in the headwaters of Muddy, Salem, Grants, town, and Reynolds Creeks. The 2001 basinwide benthos investigations demonstrated that water quality problems still exist in parts of Muddy Creek (Good-Fair at two sites) and Salem Creek (Good-Fair at an upstream site and Fair at two downstream sites) (Table 13), although improvements in wastewater treatment had reduced the severity of these problems prior to 1996. These improvements were apparent in water chemistry, effluent toxicity, and stream biota. Improvement also was seen in Town Creek (from Poor to Fair) after the removal of the Town of Salisbury's WWTP discharge and a similar improvement is expected in Reynolds Creek when the Sequoia WWTP discharge is removed. An improvement also was recorded for the invertebrate community in UT Grants Creek after better management of a small discharge from Fieldcrest Mills.

The severe effects of urban runoff were demonstrated by the Fair or Poor bioclassifications assigned to Silas, Salem, Grants, and Town Creeks. Fish and benthos samples produced very similar ratings for these streams. These urban streams have very poor habitat, as a heavy sediment load eliminates all pools and the stream bed is changed into a uniform sandy run. A stream in an area of light residential land use (e.g., upper Salem Creek) may attain a Good-Fair bioclassification, but most streams with substantial suburban or urban land use were found to have Fair benthos or fish ratings. One fish sample from Salem Creek (above the WWTP) produced a Poor rating. Many small dischargers also potentially contribute to the problems associated with urban runoff. Although urban streams always had poor habitat, the invertebrate communities also suggested toxic conditions.

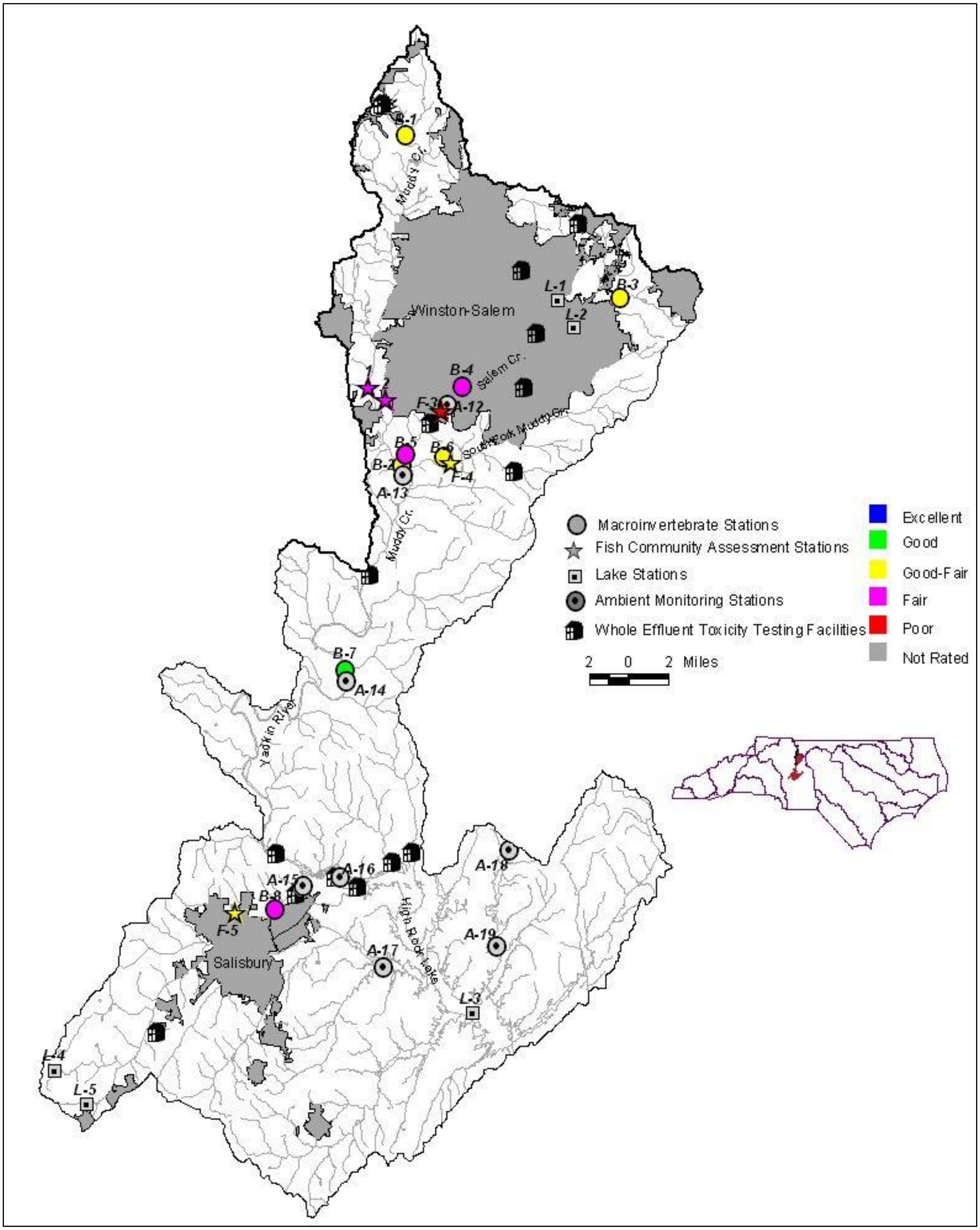


Figure 28.Sampling sites in Subbasin 04 in the Yadkin River basin.

In agricultural areas, the normal rocky riffle areas were reduced or entirely eliminated by massive inputs of coarse sand, reducing the available habitat for benthic macroinvertebrates and fish. Typical agricultural streams with a Good-Fair bioclassification included South Fork Muddy, upper Muddy, and Second Creeks.

The highest bioclassification in this subbasin was given to the Yadkin River near Yadkin College, which has consistently received a Good rating.

Monthly ambient chemistry samples were collected by NC DWQ at eight sites in this subbasin: Salem Creek above the WWTP, lower Muddy Creek, two sites on the Yadkin River (at Yadkin College and Spencer), lower Grants Creek, Town Creek, and two sites on Abbotts Creek. These last three sites are located on arms of High Rock Lake and may be influenced by lake conditions and algal growth. The Yadkin Pee Dee River Basin Association collects samples at an additional six sites, as well as duplicating NC DWQ samples at four sites.

Ambient water chemistry data demonstrated high nutrients (especially phosphorus) and high turbidity throughout the subbasin. There were no sites, however, that had low dissolved oxygen, reflecting decades of management of point-source dischargers. Conductivity can be used to track the potential effect of point source dischargers, with maximum levels in lower Salem and Muddy Creeks. The latter stream also had elevated levels of fecal coliform bacteria, copper, and zinc.

Five lakes were monitored in this subbasin during this cycle: Winston, Salem, Wright, Corriher, and High Rock. High Rock Lake has received the greatest amount of study over the past two decades. All of these lakes were found to be eutrophic in 2000 and 2001, with occasional algal blooms. Long-term data suggested a decline in water quality for Lake Wright with increasing nutrient values and more severe algal blooms. Both Lake Wright and Lake Corriher are treated with copper sulfate to control algal growths, leading to occasional high levels of copper.

Fifteen facilities currently monitor effluent toxicity as a permit requirement. Existing (2001) toxicity problems were recorded only for Scarlet Acres Mobile Home Park (UT Mill Creek). Significant improvements over the last five years were observed for Lucent Technologies groundwater remediation facility (UT Salem creek) and Salisbury's Sowers Road WWTP (Grants Creek). Many other dischargers were found to be toxic when the toxicity program was initiated, but have since shown large improvements. These improvements often were reflected by an improvement in downstream bioclassifications.

Table 13. Waterbodies monitored in Subbasin 04 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Muddy Cr[2]	Forsyth	SR 1898	Good-Fair	Good-Fair
B-2	Muddy Cr[2]	Forsyth	SR 2995	Good-Fair	Good-Fair
B-3	Salem Cr	Forsyth	SR 2657	Good-Fair	Not Rated
B-4	Salem Cr[2]	Forsyth	SR 2902	Fair	Fair
B-5	Salem Cr[2]	Forsyth	SR 2991	Fair	Fair
B-6	S Fork Muddy Cr	Forsyth	SR 2902	Good-Fair	Good-Fair
B-7	Yadkin River[2]	Davidson	SR 1147	Good (1990)	Good
B-8	Grants Cr	Rowan	SR 1910	Good-Fair	Fair
F-1	Muddy Cr	Forsyth	SR 1891	Poor	Fair
F-2	Silas Cr	Forsyth	SR 1137	---	Fair
F-3	Salem Cr	Forsyth	off SR 1120	---	Poor
F-4	South Fork Muddy Cr	Forsyth	SR 2902	---	Good-Fair
F-5	Grants Cr	Forsyth	SR 2200	---	Good-Fair
L-1	Winston Lake	Forsyth			Eutrophic
L-2	Salem Lake	Forsyth			Eutrophic
L-3	High Rock Lake	Davidson, Rowan			
L-4	Lake Wright	Rowan			
L-5	Lake Corriher	Rowan			

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

Town Creek at SR 1526, Rowan County, was not sampled for fish community assessment due to the lack of flow and the hydrology of the stream which had been altered by previous and on-going beaver activity.

Muddy Creek, SR 1898

Muddy Creek at SR 1898 is a rocky stream about 4 to 5 meters wide. This site is located upstream of Winston-Salem. The overall habitat was good, although the substrate was slightly embedded (20 - 40%) and pools were infrequent. Land use in the watershed is mainly agricultural.

Muddy Creek at SR 1898, Forsyth County.

This area was affected by a Westinghouse Corporation facility discharge in the late 1980s, when it received a Fair bioclassification. The facility went offline in 1987, and samples collected in 1996 and 2001 produced a Good-Fair bioclassification, with similar benthic communities in both years.

Muddy Creek, SR 1891

Muddy Creek is a suburban stream draining the southwestern region of metropolitan Winston-Salem.

Upstream view of Muddy Creek at SR 1891, Forsyth County.

The fish community was rated Fair in 2001 and Poor in 1996. The difference was due, in part, to better sampling conditions in 2001 than in 1996 when the water was deeper and more turbid. In 2001, the percentage of tolerant fish decreased, and more fish and an additional species of darter were collected. The community was dominated by bluehead chub, the trophic structure was skewed towards omnivores and herbivores, and there was an absence of intolerant species. Three rosefin shiners, a new exotic species in the basin, were also collected.

Muddy Creek, SR 2995

The lower site on Muddy Creek is downstream of the confluence with Salem Creek, hence it drains most of the Winston-Salem area (drainage area = 186 mi^2). This large stream (10 - 13 meters wide) has some good riffles, but the predominant substrate is sand. The water had a slightly reddish tinge and elevated conductivity (663 µmhos/cm) during benthos collections in August 2001. This was due to the discharge from the Archie Elledge WWTP into Salem Creek.

Muddy Creek at SR 2995, Forsyth County, illustrating the riffle at the bridge.

This site received a Fair rating in 1983 and 1985, but improved to Good-Fair in 1996 and 2001. Given the high waste concentration for this site, it was surprising to find two species of stonefly present. Toxic and organic indicator species were abundant in lower Muddy Creek in the 1980s, but these species were no longer abundant in 2001.

Silas Creek, SR 1137
At this location, Silas Creek is a suburban stream; however, its watershed drains the western region of metropolitan Winston-Salem.

Upstream view of Silas Creek at SR 1137, Forsyth County.

As a new fish community basinwide monitoring site, Silas Creek was rated Fair in 2001. The bluehead chub was the most abundant species and no darters, suckers, intolerant, or piscivorous species were collected. Silas Creek and Salem Creek were the only sites monitored in the basin in 2001 where darters, suckers, and intolerant species were all absent. Twelve rosefin shiners were also collected at this site.

Salem Creek (Kerners Mill Creek), SR 2657
The site is located in the headwaters of Salem Creek, upstream of Salem Lake. The land use is mostly residential. Salem Creek at SR 2657 is small, with a width of only three meters under the low-flow conditions of August 2001. The stream width in 1996, however, was six meters. A consistently low habitat score has been given to this site (44 and 54), based on the amount of sand/silt and the lack of riffles or pools.

There appear to be few significant changes in the benthic community in 2001, relative to the Good-Fair bioclassification recorded in 1996. According to current procedures, this site would be given a "Not Impaired" classification, because it meets the criteria for a Good-Fair rating for piedmont streams greater than four meters in width. A number of moderately intolerant mayflies were common or abundant in both collections: *Baetis pluto*, *Hexagenia*, *Serratella deficiens* and *Isonychia*.

Salem Creek, SR 2902
The middle portion of Salem Creek drains much of downtown Winston-Salem, and the catchment upstream of Ebert Road included many small dischargers. The low habitat score for this site (39 in 2001) reflected bank erosion, a uniform sand substrate, and many breaks in the riparian zone.

Salem Creek at SR 2902, Forsyth County. Note tires in stream.

Relative to the site at SR 2657, width increased at this site to 8 to 11 meters. Bank erosion may have contributed to this stream widening. Conductivity also doubled relative to the headwater site in 2001 (from 90 to 186 µmhos/cm).

Abundant periphyton (mostly on tires) suggested enrichment in Salem Creek, but the benthic fauna was sparse. This site was rated as Poor when it was first sampled in 1982, but it had a stable Fair bioclassification in 1996 and 2001. None of the invertebrate samples from this site has indicated low dissolved oxygen, but toxic indicators were abundant in 1981 and 1996. Intolerant and facultative species are absent in this portion of Salem Creek, but some fairly tolerant mayflies were abundant, including *Baetis* (*B. flavistriga* in 1982 and 1996, *B. propinquus* in 2001) and *Stenonema modestum*.

Salem Creek, off SR 1120
Salem Creek (also known as Middle Fork Muddy Creek) drains the south central portion of Winston-Salem. This new fish community basinwide monitoring site was sampled above the discharge but on the property of the Archie Elledge WWTP. At this site, the stream is shallow, very clear, and unlike other streams in the subbasin, the water did not become turbid when walking through the stream bed. Urban debris, including abandoned tires, was abundant along the shoreline and in the stream (Appendix 2).

The fish community was rated Poor with only eight species collected - the fewest of any site monitored in 2001. Like Silas Creek, the bluehead chub was the most abundant species and no darters, suckers, intolerant, or piscivorous species were collected. In addition to the bluehead chub, the tolerant redbreast sunfish and exotic, red shiner were also abundant.

Salem Creek, SR 2991
The high flow and high specific conductivity at this site (835 µmhos/cm in 2001) were due to the discharge from Winston Salem's Archie Elledge WWTP. Effluent from this 30 MGD plant may comprise 76% percent of stream flow under $7Q_{10}$ conditions. The water had a reddish tinge when the invertebrate samples were collected in August 2001. Unlike other sites on Salem Creek, the SR 2991 site had rubble riffles. Although these riffles were infrequent, they resulted from bridge construction and occasional bedrock outcroppings. In between riffles, the substrate was composed of the same sand/silt observed in other portions of Salem Creek.

Salem Creek at SR 2991, Forsyth County. Bedrock area in foreground.

The site was rated as Poor in 1982, but improved to Fair in 1996 and 2001. Overall community characteristics in 2001 were very similar to those of the upstream site on Salem Creek (at SR 2902), with almost identical EPT taxa richness (9 and 10), EPT abundance (51 and 52) and Biotic index (6.9 and 7.1). This pattern suggested that the discharge from the Archie Elledge WWTP did not further degrade water quality in Salem Creek.

There were, however, a few changes in the invertebrate community that may indicate some toxicity problems. Of particular concern was the absence of heptageniid mayflies (*Stenonema* and *Stenacron*) at this site, in spite of favorable habitat.

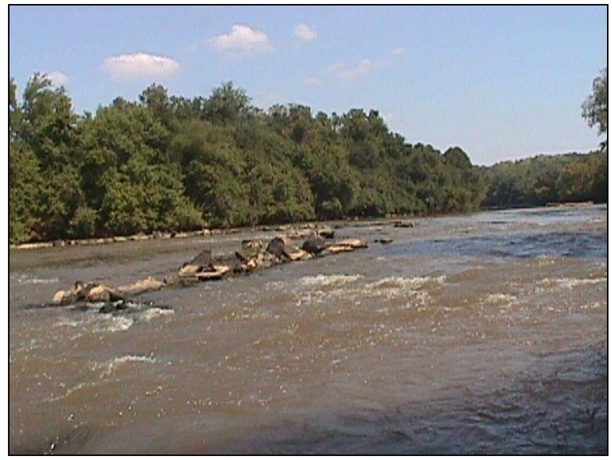
South Fork Muddy Creek, SR 2902
This stream drains the southern portion of the City of Winston-Salem and the northern portion of Davidson County. This shallow site was above a sand-dipping operation. At this site, the stream is deeply entrenched with a width of six to nine meters. The habitat scores were consistently low (39 - 46).

Upstream view of South Fork Muddy Creek at SR 2902, Forsyth County.

The site is located in an agricultural area and it had EPT taxa richness values (14 and 17, Good-Fair) much greater than those observed for the urban segment of nearby Salem Creek (8 - 11, Fair). This rating reflected the more benign impacts of agricultural runoff compared to urban runoff, even though both streams are very sandy and have poor instream habitat. Some moderately intolerant taxa were present at this site, although none were abundant. For example, three stonefly taxa were collected in 2001. No significant changes were observed between 1996 and 2001.

This new fish community site was rated Good-Fair. The coarse woody debris and sticks in the current provided marginal habitat for the two species of darters collected at this site. Like other streams in the subbasin, no species of suckers or piscivores were collected and there was a high percentage of tolerant fish present. The most abundant species was the tolerant, whitefin shiner.

Yadkin River, at the end of SR 1147
This portion of the Yadkin River is large (about 75 meters wide) and it is potentially affected by many upstream point and nonpoint source problems. Other areas of the Yadkin River are quite sandy, but the site near Yadkin College has good boulder/rubble substrate.



Yadkin River at the end of SR 1147, Davidson County.

This site received a Good bioclassification in four samples since 1985. No sample was collected from this site in 1996 due to high flows, so the latest sample available for comparison to the 2001 collections was from 1990. There were few significant changes in the invertebrate community since 1986, with relatively stable EPT taxa richness (26 - 29) and Biotic index (5.5 - 5.9). Stoneflies were abundant in 1990, but were rare in 2001. This change may reflect the greater concentration of wastes at low flow.

Some unusual species were collected at this site in 2001 including *Ceraclea cf ophioderus* (Rare) and *Stactobiella* (Common).

Grants Creek, SR 2200
The watershed of Grants Creek includes the urban areas of China Grove and Salisbury.

Upstream view of Grants Creek (from the bridge) at SR 2200, Rowan County.

This new fish community monitoring site received a Good-Fair rating in 2001. No intolerant species or piscivores were collected; the bluehead chub was the dominant species, and there was evidence of slight organic enrichment because of the elevated percentage of omnivores and herbivores. Five of the 12 species were represented by only one individual per species.

Grants Creek, SR 1910
Grants Creek is a medium-sized stream (six to nine meters wide) that drains much of the Salisbury area. This site is downstream of six permitted dischargers, including the Salisbury WWTP. Low flow in 2001 would be expected to result in higher instream waste concentrations for these dischargers.

Grants Creek was a deeply entrenched stream with poor habitat, having habitat scores of only 33 and 46 in 1996 and 2001, respectively. It had a uniform sand substrate, no pools or riffles, severely eroding banks and many breaks in the riparian zone.

Grants Creek at SR 1910, Rowan County.

Samples further upstream in the 1980s produced Fair and Poor ratings, but Grants Creek recovered to a Good-Fair at the SR 1910 site based on surveys in 1989 and 1996. In 2001, however, this site declined to a Fair bioclassification (Figure 29).

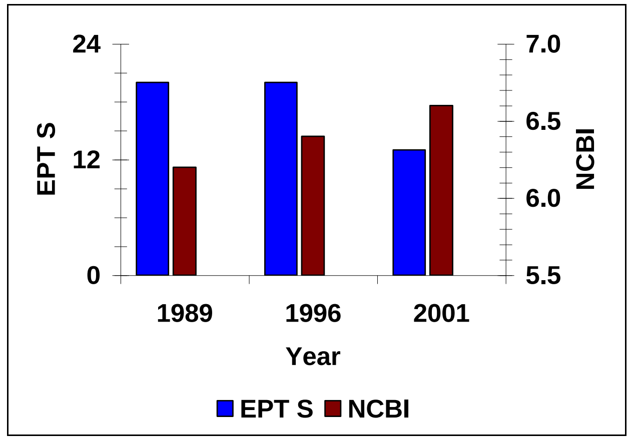


Figure 29. EPT taxa richness (EPT S) and biotic index (NCBI) for Grants Creek, SR 1910, Rowan County.

Although there was no change in bioclassification until 2001, some substantial changes in the community were observed between 1989 and 1996. In particular there was a sharp decline in the abundance of *Isonychia*, *Baetis flavistriga*, *Hexagenia*, *Lype diversa*, and *Polycentropus*.

The between-year comparison is complicated by differences in flow – normal flow in 1989 and 1996, but very low flow in 2001. Further collections will be needed to determine if this is a true long-term decline in water quality. For this reason, Grants Creek will be resampled in 2002.

SPECIAL STUDIES
303 (d) Streams
Town Creek, I-85
Town Creek at I-85 is located downstream of the old Salisbury WWTP, as well as draining much of the Town of Salisbury. A survey in 1990 indicated Poor water quality above and below this facility. EPT taxa richness declined from nine taxa above the discharge to 0 taxa at I-85. As of September 2000, the facility no longer discharges to Town Creek. This downstream site was resampled for benthos in August 2001 to look for recovery.

This portion of Town Creek had an average width of six meters, although it was only one to two meters wide in riffle areas. There was fairly good habitat for invertebrates, although collectors noted severely eroding banks and many breaks in the riparian zone. A high conductivity (270 µmhos/cm) reflected the effects of upstream urban development.

Town Creek, above I-85, Rowan County. Riffle in background just above bridge.

Removal of the discharge resulted in a significant improvement in the stream. EPT taxa richness improved from 0 in 1990 to 8 in 2001, with a corresponding change in bioclassification from Poor to Fair (Figure 30). The extent of the improvement may be limited by the upstream water quality.

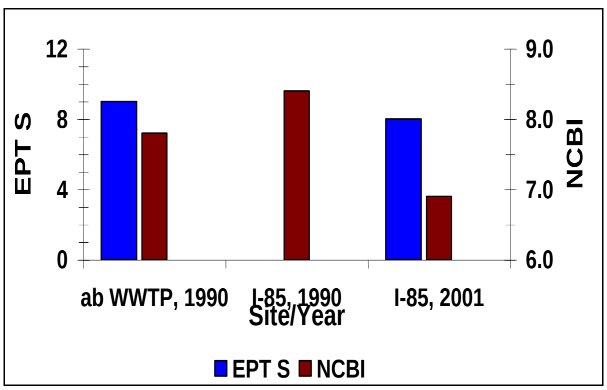


Figure 30. EPT taxa richness (EPT S) and biotic index (NCBI) for Town Creek, near Salisbury, Rowan County.

UT Grants Creek, SR 1500

UT Grants Creek was first sampled in September 1989 to evaluate the impact of the Fieldcrest Mills discharge. Although *Ceriodaphnia* chronic toxicity tests predicted that this discharge would not affect stream biotic, no EPT taxa were collected from this small stream. Comparison with a nearby stream of similar size (Little Creek) clearly indicated that Fieldcrest Mills was having a substantial impact on stream biota. This site was again sampled in August 2001 to look for recovery.

UT Grants Creek was only one meter wide, but it seemed to have permanent flow. This stream had a rocky substrate, but it had a relatively uniform habitat with few pools.

UT Grants Creek, SR 1500, Rowan County. Note "step-across" size.

EPT taxa richness increased from 0 in 1989 to 14 in 2001, indicating a large increase in water quality (Figure 31). EPT taxa collected in 2001 included several intolerant taxa: *Diplectrona modesta* (common), *Chimarra* (abundant), and *Neophylax oligius* (abundant). If UT Grants Creek was rated using piedmont stream criteria and if it was of sufficient size, it would be rated at least Good-Fair. Therefore, because of its small size, it was rated "Not Impaired".

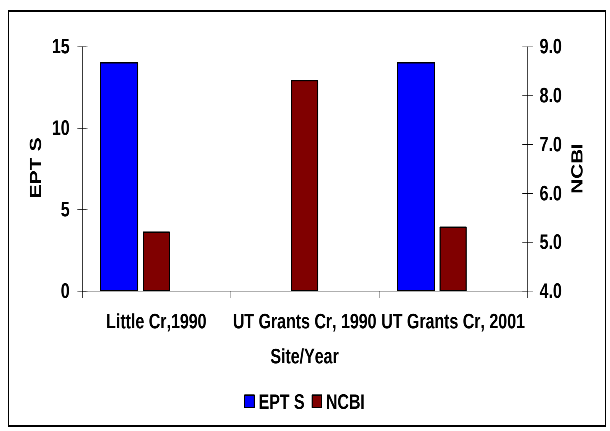


Figure 31. EPT taxa richness (EPT S) and biotic index (NCBI) for UT Grants Creek *vs.* Little Creek, Rowan County. All sites are one meter wide.

Reynolds Creek - Sequoia WWTP Study

The Sequoia residential area in Forsyth County was served by a small package wastewater treatment plant (NPDES Permit No. NC 0057509) that discharged to Reynolds Creek. The Bioassessment Assessment Unit first sampled this stream in 1994, at the request of the Winston-Salem Regional Office. This study indicated Good water quality in the upper part of Reynolds Creek, but only a Fair water quality downstream of the discharge. The upstream area was dominated by intolerant and facultative macroinvertebrate species, while the downstream area was dominated by highly tolerant species. The macroinvertebrate community at the downstream site indicated organic loading and periodic low dissolved oxygen concentrations. In 2000, the stream was resampled to determine if there had been any improvement during the past six years (Biological Assessment Unit Memorandum 10252000).

Reynolds Creek is a small stream (two to four meters wide), but appears to have flow throughout the year.

Reynolds Creek, above WWTP, Forsyth County.

Reynolds Creek, below WWTP, Forsyth County.

In 2000, significant problems below this discharge were still detected, although increasing residential development also caused a slight decline in the water quality at the upstream site. An area of sludge deposition just downstream of the discharge was linked to this facility by the presence of a massive number of sludge worms, *Tubifex tubifex*. Because of these continuing problems, the facility will be shut down, and this neighborhood will tie into the local sewage lines.

Winston Lake

Winston Lake (Figure 32) was most recently monitored during the summers of 2000 and 2001. Prior to 2000, this lake had been sampled five times (once in 1981 and 1990 and three times in 1999). The lake was dredged in 1986 due to sedimentation (accumulated sediment was estimated to range from two feet to almost 13 feet).

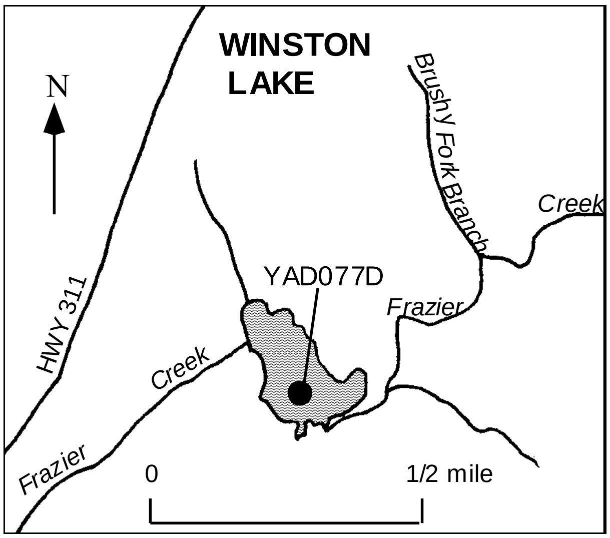


Figure 32. Sampling site at Winston Lake, Forsyth County.

In June 2000, turbidity was 40 NTU compared to the state water quality standard of 25 NTU. Total solids and suspended solids were also greater than during other sampling occasions. Field notes indicated that no rain had fallen within the watershed during the previous 48 hours. Subsequent turbidity samples were below the standard. It is possible that the elevated turbidity and solids measurements were due to algal activity.

Nutrient concentrations in 1981 through 1999 fluctuated between low to elevated, indicating a large degree of variability. In 2000 and 2001, field notes described the water as appearing colored from algae. Analysis of a phytoplankton sample collected on August 2000 indicated a bloom of large colonial chrysophytes (golden-brown algae).

As with most piedmont lakes, iron concentrations in the surface waters were occasionally elevated (in 1999 and 2000). Iron occurs naturally in the soils of the state; therefore, these concentrations are not considered to be problematic. All other parameters were within applicable state water quality standards.

Winston Lake was determined to be mesotrophic in 1990 and eutrophic in 2001. Due to its shallow depth (mean of eight feet), the lake is vulnerable to increased nutrients and sediment inputs.

Salem Lake

Salem Lake is a water supply reservoir providing drinking water for the City of Winston-Salem and Forsyth County (Figure 33). This lake has a maximum depth of 36 feet (11 meters), well defined north and south arms and 14 miles of shoreline. The watershed includes portions of the Towns of Kernersville and Walkertown.

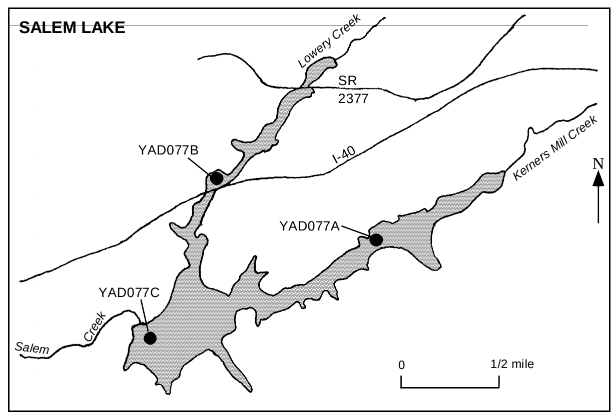


Figure 33. Sampling sites at Salem Lake, Forsyth County.

Salem Lake has been monitored since 1994, with the most recent samples taken in 2000 and 2001. Overall, the lake is showing some signs of nutrient over-enrichment, based on nutrient concentrations and NCTSI scores.

Surface dissolved oxygen at Station YAD077B on June 12, 2000 was 3.4 mg/L, which was less than the state water quality standard of 4.0 mg/L for an instantaneous reading. A review of the data indicated that the sample was taken at 9:15 AM and that previous samples taken at the station that early also exhibited low dissolved oxygen compared to the other stations.

In keeping with the moderate to elevated nutrient concentrations found over the years, chlorophyll *a* values for 2001 were in the moderate range (12 - 20 µg/L). Phytoplankton samples collected in 1999 indicated that the lake contained a diverse assemblage of algae ranging from blue-green and green algae in the Kerners Mill Creek arm to diatoms near the dam.

In September, 2000, the US Environmental Protection Agency investigated lead contaminated soil at a battery manufacturing plant in Walkertown and at an unnamed tributary to Lowery Creek (AP 2000). Lead levels of 320 µg/L were found in the creek. The NC DWQ's sampling during 2000 and 2001 found lead levels less than the water quality laboratory detection level of 10 µg/L.

All other parameters were below state standards with the exception of manganese in 2000 at one station in July. Manganese concentrations above the state water quality standard of 200 µg/L for water supply sources are common in the state. The concentration of 340 µg/L did not present a potential problem for the drinking water intakes.

Based on the calculated NCTSI score, Salem Lake was determined to be eutrophic in 1994. Data collected in 2001 were consistent with previous years resulting in a eutrophic rating.

High Rock Lake

High Rock Lake is an impoundment of the Yadkin River (Figure 34). The maximum depth is 62 feet (19 meters). Because water from the lake is used to generate hydroelectric power, the reservoir's discharge rate remains fairly constant although the inflow varies. This variation causes considerable fluctuations in lake level and affects the hydraulic retention time. Residence times can range from as few as 3 days to as many as 50 days depending on inflow.

The immediate drainage area includes several major urban areas of the Central Piedmont including the cities of Winston-Salem, Salisbury, Lexington, and High Point. The lake is classified WS-V from its headwaters to and including Crane and Swearing Creeks. From this point to 0.6 mile upstream of the dam, the lake is classified WS-IV and B. From a point 0.6 mile upstream of the dam to Badin Dam, the lake is classified WS-IV CA and B. The Abbotts Creek Arm of High Rock Lake is classified WS-V and B.

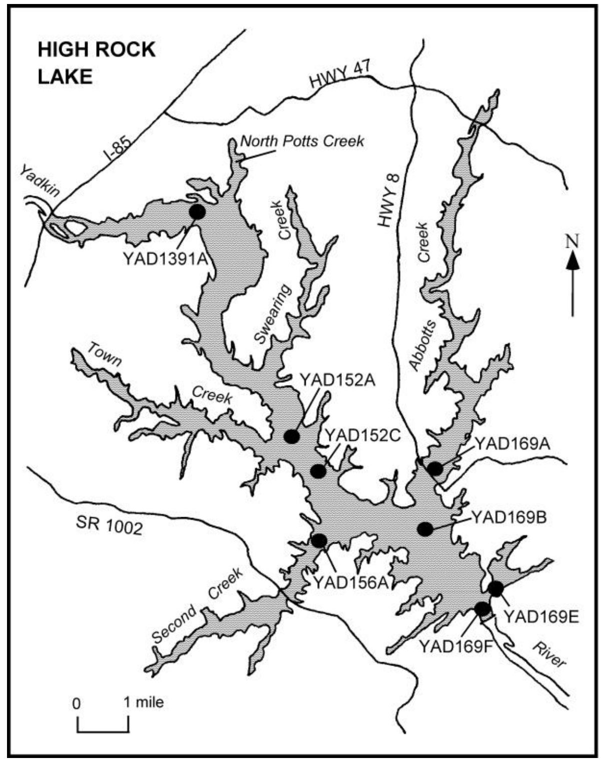


Figure 34. **Sampling sites at High Rock Lake, Davidson and Rowan counties.**

High Rock Lake was most recently monitored in 2000 and 2001. The lake has been monitored regularly since 1981.

Concentrations of surface metals were within applicable state water quality standards with the exception of copper in July 1999 (11.0 µg/L), which was greater than the state water quality action level of 7.0 µg/L. Zinc in August 1997 (55 µg/L) was greater than the state water quality action level of 50 µg/L. These concentrations do not represent concentrations of concern based on a one-time exceedance.

As has been seen during previous sampling efforts, Secchi depths were at or less than one meter in 2000 and 2001. Surface dissolved oxygen concentrations were also elevated at most of the sampling sites (range = 8.2 to 12.1 mg/L). Associated percent dissolved oxygen saturation ranged from 148% to 157%, which was greater than the state water quality standard of 110% for dissolved gases. Along with the elevated dissolved oxygen values, surface pH values were elevated suggesting increased algal productivity. As might be expected from the dissolved oxygen and pH levels, total phosphorus and total organic nitrogen concentrations were also elevated in 2000, 2001 and previous years. These elevated nutrient concentrations continued to support increased algae productivity as evidenced by chlorophyll *a* values greater than the state water quality standard of 40 µg/L (range = 40 µg/L – 52 µg/L) in 2001.

Blue-green algae species, commonly found in eutrophic waters and often associated with taste and odor problems, were present in 1994. They also dominated samples collected in July and August 1999. Based on the NCTSI scores for July and August, High Rock Lake was determined to be eutrophic. This lake has been consistently eutrophic since monitoring began in 1981.

At High Rock Lake, symptoms of eutrophication (i.e., elevated pH values and dissolved oxygen, chlorophyll *a,* and nutrient concentrations, and algal blooms) have been documented since 1981. Decreased Secchi depths due to suspended sediments in the water column have also been common.

The highly erodible soils of the stream and creek channels in this basin are subjected to sudden changes in water volume and force (flashing) due to stormwater discharge from urban areas within the watershed. These soils contribute to the red or brown colors observed in the river and streams following storm events. Transported sediment has reduced the depth of the upper end of the lake such that at low flow periods, the uppermost sampling site can no longer be reached by boat. In addition to reducing the clarity of the lake water, these sediments also contribute nutrients.

Another source of nutrients to High Rock Lake is municipal wastewater treatment facilities. The NC DWQ has initiated a variety of actions to address over-enrichment in the High Rock Lake watershed and continues to monitor and reassess needed actions. Wastewater facilities are relocating discharges and improving their nutrient control processes. Nonpoint sources are being investigated. More information on these actions is available in the 1998 Yadkin - Pee Dee River Basinwide Water Quality Management Plan (NCDENR 1998).

In addition to the Division's activities, Yadkin, Inc., the hydroelectric company that manages High Rock Lake has developed a Shoreline Management Plan to encourage responsible development around the reservoir. As a planning guide to future development, the Plan also identifies important natural resources and designates portions of the shoreline where these are found as "Conservation Zones". The Plan also contains a Shoreline Stewardship Policy, which contains specifications for private recreation facilities, subdivision access approval, multi-use facility permitting and industrial approval procedures. The plan was approved by the Federal Energy Regulatory Commission (FERC) in 2000.

Lake Wright

Lake Wright is located north of the Town of Landis in Rowan County. The town owns the lake, which is used as a back-up water supply during times of low flow. The watershed, which had consisted of areas of forest and row crops, was converted to a private golf course (Warrior Golf Club) in 1999. Grants Creek is the major inflow to Lake Wright (Figure 35). Access to Lake Wright is controlled and no recreation is allowed.

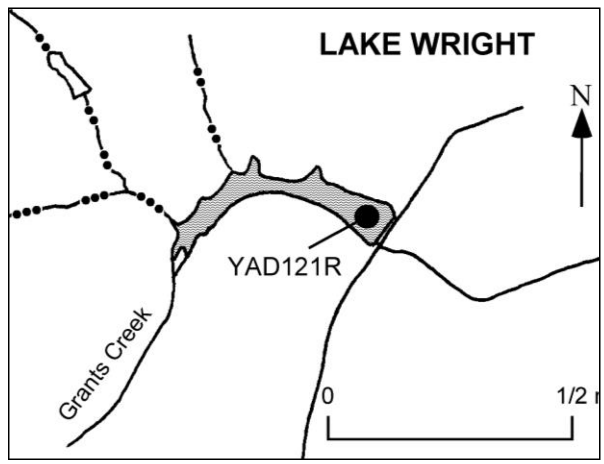


Figure 35. Sampling site at Lake Wright, Rowan County.

Lake Wright was most recently monitored in 1999. Previous monitoring took place in 1994 and indicated that the lake was very eutrophic.

Sampling in 1999 seemed to continue to support that eutrophic evaluation, although a NCTSI score could not be calculated without a chlorophyll *a* reading. Secchi depths in 1999 ranged from 0.7 meter to 1.5 meters, consistent with previous readings. Surface dissolved oxygen and pH were elevated as was percent oxygen saturation.

Field notes indicated that the color of the water was brownish-green. Photic zone algae samples collected during a bloom in June1999 were dominated by green algae; a bloom in July was dominated by blue-green algae. Blue-green algae species identified in the July sample are known to cause taste and odor problems in drinking water. In keeping with the presence of algal blooms, nutrient concentrations were also elevated.

Surface metals were within state water quality standards for a drinking water supply source with the exception of copper (33 µg/L) and iron (2,500 µg/L). The value for copper was greater than the state water quality action level of 7.0 µg/L and the value for iron was greater than the action level of 1,000 µg/L. The lake had been treated earlier in the growing season with a copper-based algaecide to control the growth of algae. As noted earlier, elevated iron concentrations are common in piedmont reservoirs.

Lake Wright was determined to be very eutrophic in 1994 based on the calculated NCTSI score of 4.1. In 1989, when the lake was first sampled, it was determined to be mesotrophic. Since 1989, nutrient concentrations, elevated dissolved oxygen levels and chlorophyll *a* values have suggested that the lake is experiencing increasing eutrophication. Prior to 1999, the upper end of the watershed consisted of row crops and runoff from this area may have contributed nutrients to the lake. The watershed is now dominated by the golf course. Additional sampling would be useful in determining if the change in land use and associated land management practices will improve or continue to degrade water quality conditions in Lake Wright.

Lake Corriher

Lake Corriher is located downstream of Lake Wright on Grants Creek and is a water supply source for the Town of Landis (Figure 36). This lake was most recently monitored in 1999. Previous monitoring took place in 1994.

A drought during the summer of 1999 significantly lowered the water level in this small reservoir. The depth near the dam decreased from 3 meters in June to 2.1 meters in August. Sediment had filled in the upper end of the lake to the extent that access to the historic location for Station YAD122B was not possible. Data reported for YAD122B in 1999 were taken approximately 600 feet downstream from the original sampling site.

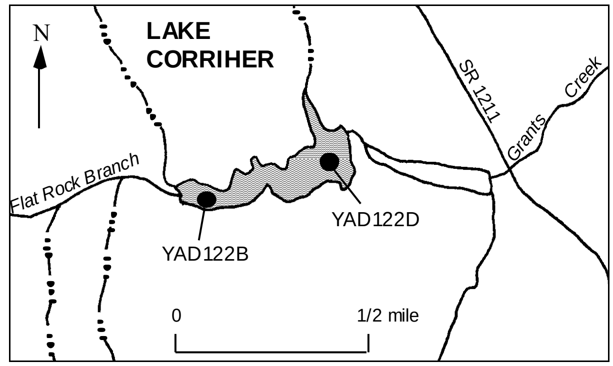


Figure 36. Sampling sites at Lake Corriher, Rowan County.

The lower end of Lake Corriher was strongly stratified in 1999. As in previous years, dissolved oxygen concentrations and percent oxygen saturation were elevated. Percent oxygen saturation was greater than the state water quality standard of 110% for dissolved gases (1994 = 111% and 1999 = 116%).

As in previous years, the levels of nutrients in 1999 were sufficient to support excess algal productivity. Copper sulfate was used by the Town staff to control algal blooms. Use of copper sulfate resulted in-lake copper concentrations exceeding the state water quality action level of 7.0 µg/L in 1994 and 1999.

As documented in other piedmont reservoirs, iron and manganese were slightly elevated in 1999, exceeding the state water quality action level standard and by approximately 2%. Due to their ubiquitous nature in the piedmont and the capabilities of the water treatment facility, these concentrations were not considered to be problematic.

Lake Corriher continues to be eutrophic possibly due to nonpoint source impacts from agriculture in the watershed.

YADKIN RIVER SUBBASIN 05

Description

This small subbasin is comprised of Dutchmans Creek and it tributaries (Figure 37). These streams are all in Davie County, which is in the Piedmont ecoregion of the state. Mocksville's WWTP (0.68 MGD into Dutchmans Creek) is the largest permitted discharge. Most of this small watershed is rural with forest and pasture the dominant land use.

Table 14. Landuse in Subbasin 05. Based upon CGIA coverage 1993 - 1995. Total acreage = 82,903 Ac.

Landuse	Percent
Water	0.6
Cultivated crop	5.5
Pasture	35.1
Urban	1.9
Forest	56.8

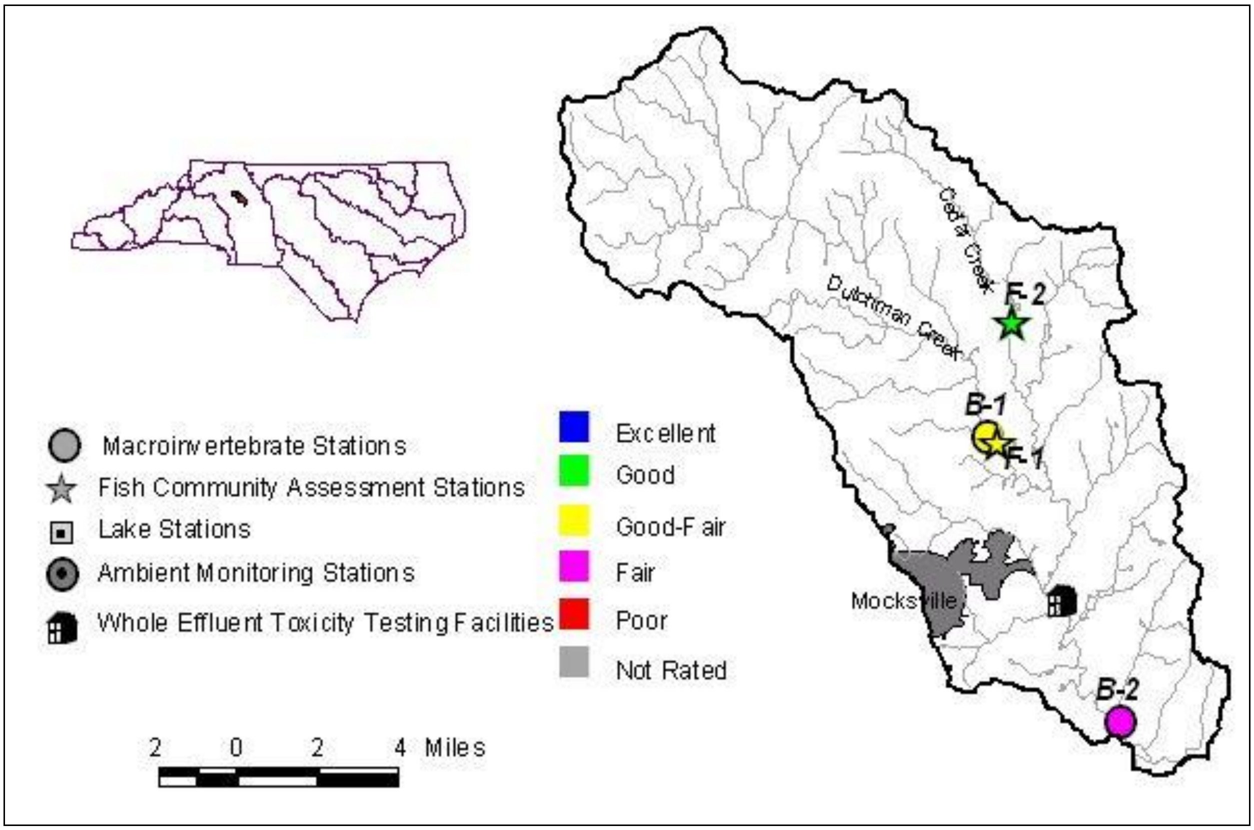


Figure 37. Sampling sites in Subbasin 05 in the Yadkin River basin.

Overview of Water Quality

Benthos samples from two sites on Dutchman's Creek that bracket the Town of Mocksville both dropped one bioclassification from the 1996 basinwide survey (Table 15). This decline was most likely due to the extremely low flows during the summer 2001 sampling. A Good-Fair rating was found at the upstream site, while a Fair rating was found downstream.

In contrast, fish community samples showed an increase from Fair to Good-Fair at the upstream site. Under lower flow sampling conditions and less non point sediment impacts, more fish, species of darters, intolerant species, piscivores, and a lower percentage of tolerant species were collected in 2001 than in 1996.

An ambient chemistry monitoring station on Dutchman's Creek at US 64, downstream of

Mocksville's WWTP, had 55 percent of the samples exceeding the standard for fecal coliform bacteria. Low dissolved oxygen levels were also found at this station.

Cedar Creek had no flow in the summer of 2001 and could not be sampled for benthos, but fish collections were made in the spring. In 1996, the fish community was rated Good-Fair, but in 2001, it was rated Good (NCIBI = 46 and 50, respectively). More than 75% of all the fish collected in 2001 were the redbreast sunfish.

Table 15. Waterbodies monitored in Subbasin 05 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Dutchmans Cr[2]	Davie	US 158	Good	Good-Fair
B-2	Dutchmans Cr	Davie	NC 801	Good	Fair
F-1	Dutchmans Cr	Davie	US 158	Fair	Good-Fair
F-2	Cedar Cr	Davie	SR 1437	Good-Fair	Good

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

River and Stream Assessment

Cedar Creek is the largest tributary to Dutchmans Creek, but was not flowing in August 2001. Therefore, this basinwide benthos site could not be sampled.

Dutchmans Creek, US 158
Dutchmans Creek's watershed encompasses the rural, agricultural areas of the northern portion of the county. This turbid stream has a primarily sandy substrate, infrequent, short riffles, easily erodible banks with breaks in the riparian zone but good canopy shading. The habitat scores during fish community and benthos sampling were 44 and 49, respectively. By August 2001, the drought had reduced the stream width to only four meters.

Downstream view of Dutchmans Creek at US 158, Davie County, May 2001.

Dutchmans Creek (downstream of US 158, Davie County, looking upstream), August 2001.

Benthos samples were originally collected at US 158 to determine water quality above the confluence with Cedar Creek. There was very little flow at the time of benthos sampling and this most likely influenced the drop in bioclassification to Good-Fair in 2001 from the Good rating found in 1996. EPT taxa richness dropped only by 4 to 20, but the BI rose from 5.63 to 6.34. EPT abundance dropped considerably from 146 to 85. Caddisflies were especially sparse - only *Cheumatopsyche* was abundant. Conductivity was high (142 µmhos/cm) even though this site is above the WWTP discharge.

In 2001, the fish community was rated Good-Fair; in 1996, it was rated Fair (NCIBI = 44 and 38, respectively). Under lower flow sampling conditions and less non point sediment impacts, more fish, species of darters, intolerant species, piscivores, and a lower percentage of tolerant species were collected in 2001 than in 1996. However, more omnivores and herbivores and fewer insectivores were collected in 2001 than in 1996. Forty percent of the fish collected in 2001 were bluehead chub; in 1996, this species represented only 12 percent of the total fauna. This trophic shift may indicate an increase in nutrient enrichment within the watershed.

Dutchmans Creek, NC 801

The lower site on Dutchmans Creek, at NC 801, was sampled to determine water quality below the confluence with all major tributaries and below the Town of Mocksville. A habitat score of 48 reflects the same habitat problems here as at the upstream site.

Dutchmans Creek at NC 801, Davie County.

During the drought of 2001, the water was flowing in only one spot, but a benthos sampled was collected nonetheless. It resulted in a decrease in bioclassification from Good in 1996 to Fair in 2001.

The EPT fauna was nearly reduced by one-half from 30 to 17, but the BI rose only slightly from 6.24 to 6.54. Conductivity at this site below the WWTP was only slightly higher (183 µmhos/cm) than the upstream site; dissolved oxygen concentrations decreased from 8.7 to 5.3 mg/L, most likely as a result of the very low flow. This site will be resampled in 2002 if normal flows have returned.

Cedar Creek, SR 1437

Cedar Creek is a small tributary to Dutchmans Creek and like Dutchmans Creek, it also drains rural agricultural areas in the north-central region of the county. At this crossing, the canopy and riparian zone are lacking near the bridge but improve upstream.

Upstream view of Cedar Creek (from the bridge) at SR 1437, Davie County.

Unexpectedly when sampled, the conductivity was elevated (222 µmhos/cm) and the dissolved oxygen was low (5.8 mg/L, 60% of saturation). There were no known causes for these unusual readings. There are no poultry or large animal operations in the area, only several small (< 100 cattle) dairy farms (pers. comm., M. Rosebrock, Winston Salem Regional Office, NCDWQ).

In 1996, the fish community was rated Good-Fair; in 2001, it was rated Good (NCIBI = 46 and 50, respectively). More than 75% of all the fish collected were the redbreast sunfish. The high percentage of this species also resulted in the highest percentage of tolerant fish collected in 2001. The slight change in score and rating in 2001 was due to the collection of three highback chubs, an intolerant species. This species was absent in 1996. There still was some degradation at this site as evident from the lower overall diversity and the diversity of darters and suckers and in the high percentage of tolerant fish which are present.

YADKIN RIVER SUBBASIN 06

Description

This subbasin consists of the South Yadkin River watershed and its major tributaries: Hunting, Rocky, Fourth, Third, and Second Creeks (Figure 38). The tributary streams constitute large watersheds in Iredell, Davie, and Rowan counties. Except for a very small portion of the headwater sections of Hunting and North Hunting Creeks (in Wilkes and Yadkin counties) which are located in the mountain ecoregion, the majority of the subbasin is located in the piedmont ecoregion. The watershed includes the I-40 and US 70 corridors from Salisbury westward. The largest metropolitan area in this subbasin is Statesville. Land use is mainly forest and pasture (Table 16).

Table 16. Landuse in Subbasin 06. Based upon CGIA coverage 1993 - 1995 (total area = 467,740 Ac).

Landuse	Percent
Water	0.3
Cultivated crop	6.2
Pasture	38.0
Urban	1.5
Forest	54.0

Five of the dischargers in this subbasin have permitted flows > 1 MGD. The facilities discharge to the South Yadkin River and Hunting, Second, Third, and Fourth Creeks.

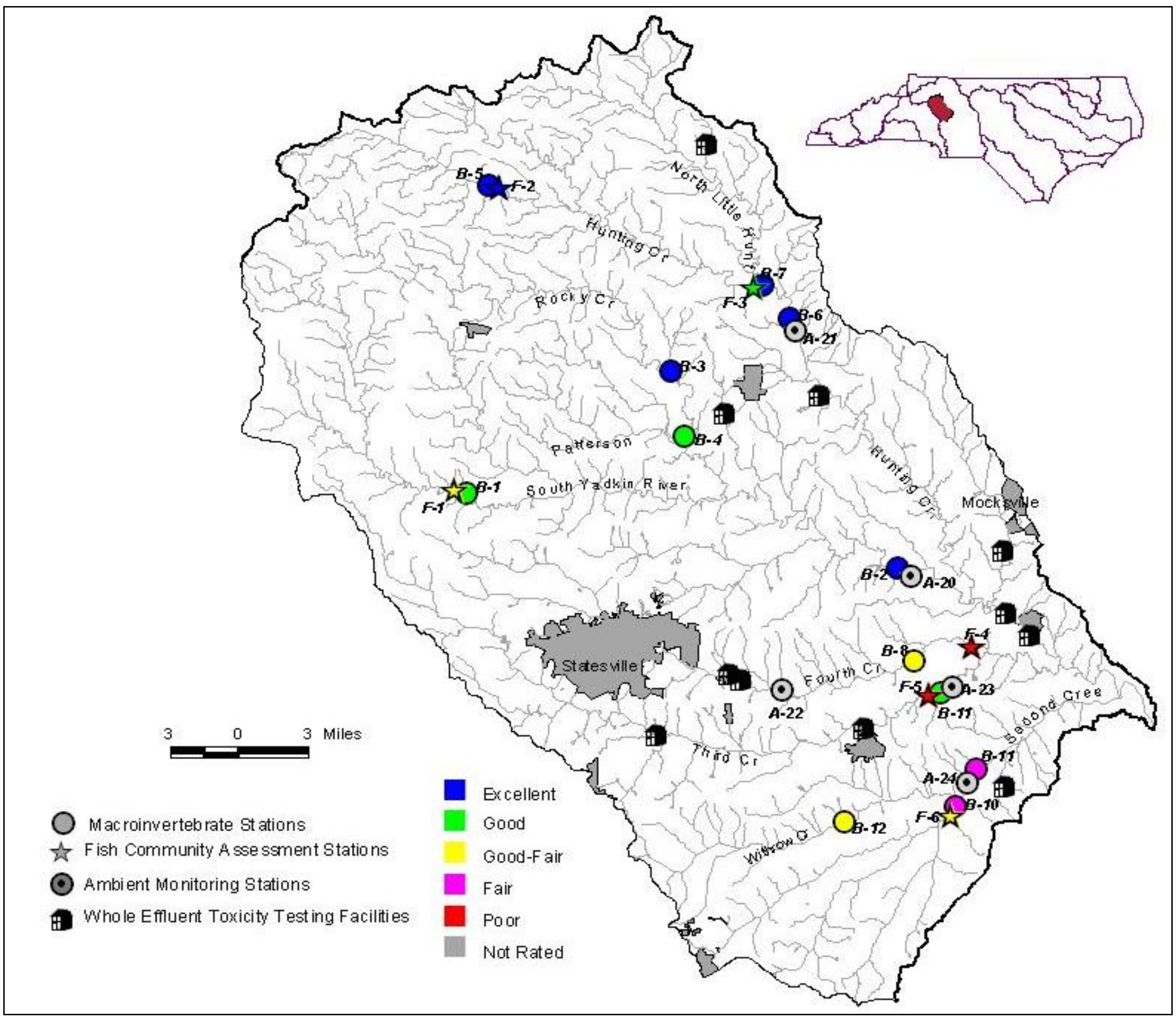


Figure 38. Sampling sites in Subbasin 06 in the Yadkin River basin.

Overview of Water Quality

All streams in this subbasin were turbid during benthos sampling (not just after rainfall events) and suffering from sedimentation. According to past field notes, habitat data, and past basin assessment reports, each round of basinwide sampling finds most of these streams more and more filled in with sediment. The macroinvertebrate fauna in the headwater, undisturbed areas that have always rated Good or Excellent take more time to show any ill effects from this sedimentation. However, the benthic fauna at the borderline (Good-Fair) sites reflect the degradation more severely (Table 17).

All the streams sampled for benthos were classified using Piedmont criteria, except for Hunting Creek at NC 115 (Mountain ecoregion). The South Yadkin River, Hunting Creek, and the Rocky Creek watersheds all have Good or Excellent water quality based on the diversity of intolerant taxa that were abundant.

The South Yadkin River, the main tributary to the Yadkin River, has been sampled five times since 1984. It was always rated Good or Excellent based on benthic macroinvertebrates. The fish communities in this upper portion of the subbasin generally supported the benthos findings. However, there was an increase of intolerant fish species and a decrease in tolerant and diseased fish in the South Yadkin River at SR 1561 where the benthos suggested a decline.

The Fourth, Third, and North Second Creeks watersheds, including Withrow Creek, are located in Rowan County. Fourth and Third Creeks drain the City of Statesville. All of these watersheds support a more tolerant benthic community as compared to the upper South Yadkin River watershed. Some intolerant species which decreased in abundance or were not collected in these watersheds as opposed to the upper South Yadkin watershed included: *Heptagenia*, *Homoeoneuria cahabensis*, *Stenacron pallidum*, and two species of *Brachycentrus*.

The fish community reflected less species diversity than the benthos, especially in Fourth and Third Creeks which were rated Poor by the fish but Good by the benthos. This may be explained by the lack of good instream habitats (fish refugia) in these very sandy streams.

The Town of Mocksville's WWTP, which discharges to Bear Creek, had noncompliances beginning in August 2001 associated with high levels of nickel and zinc. The facility is required to either accept a permit limit for zinc or conduct studies to rule out zinc as the cause of toxicity.

Table 17. Waterbodies monitored in Subbasin 06 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	South Yadkin R	Iredell	SR 1561	Excellent	Good
B-2	South Yadkin R[2]	Davie	SR 1159	Good	Excellent
B-3	Rocky Cr	Iredell	SR 1884	Good	Excellent
B-4	Patterson Cr	Iredell	SR 1890 (SR 1892 in 1996)	Good	Good
B-5	Hunting Cr	Wilkes	NC 115	Excellent (1992)	Excellent
B-6	Hunting Cr[2]	Iredell	SR 2115	Excellent	Excellent
B-7	North Little Hunting Cr	Iredell	SR 1829	Excellent	Excellent
B-8	Fourth Cr	Rowan	SR 1003	Good	Good
B-9	Third Cr[2]	Rowan	SR 1970	Good	Good
B-10	North Second Cr	Rowan	SR 1526	Good-Fair	Fair
B-11	North Second Cr	Rowan	US 70	Good-Fair	Fair
B-12	Withrow Cr	Rowan	SR 1547	Good-Fair	Good-Fair
F-1	South Yadkin R	Iredell	SR 1561	Fair	Good-Fair
F-2	Hunting Cr[2]	Wilkes	NC 115	Excellent	Excellent
F-3	North Little Hunting Cr	Iredell	SR 1829	Good-Fair	Good
F-4	Fourth Cr	Rowan	SR 1985	Poor	Poor
F-5	Third Cr	Rowan	SR 1970	Fair	Poor
F-6	North Second Cr	Rowan	SR 1526	Fair	Good-Fair

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

Olin Creek at SR 1892, Iredell County, was not sampled for fish community assessment in 2001 because no changes were expected to have occurred within the watershed.

South Yadkin River, SR 1561
The northeast quadrant of Alexander County, including the Town of Taylorsville, constitutes the upper watershed of the South Yadkin River. This site is in the upper portion of the watershed before the stream receives any influence from major tributaries. At this site, the shallow stream is a good example of a stream having areas of bar exposure and sand deposition.

Upstream view of South Yadkin River at SR 1561, Iredell County.

In 1996, this site was rated Excellent based upon benthic macroinvertebrates. Since then, the EPT taxa richness has decreased (from 30 to 21) and the BI has increased (from 5.0 to 5.8). This site was rated Good in July 2001.

A second sample collected two months later by another field crew (a Quality Assurance sample) resulted in a bioclassification of Good-Fair. The July sample was a borderline Good: the EPT abundance value rounded up to Good instead of down to Good-Fair, so this is not a real change in water quality. However, there has been a definite decline in the diversity and tolerance of the macroinvertebrate community since 1996, suggesting a decline in water quality. This was most evident in the loss of the stonefly community between sampling periods. There was very little change in habitat scores between 1996 and 2001 (from 58 to 52), indicating that this change in bioclass is definitely a water quality problem that should be further investigated.

In 2001, the fish community was rated Good-Fair; in 1996, it was rated Fair (NCIBI = 46 and 40, respectively). A 6-fold increase in the number of fish were collected in 2001 compared with 1996 along with an increase in the number of species of darters, sunfish, suckers, and intolerant species, and decreases in the percentage of tolerant fish and diseased fish. The bluehead chub represented 45% of all the fish collected in 2001.

Although low flow conditions may have ameliorated non point source impacts and aided in the collection of more fish, several species which were absent or rare in 1996 were common or abundant in 2001: rosyside dace, highback chub, bluehead chub, redlip shiner, striped jumprock, fantail darter, and piedmont darter. Some degradation is still noted in the overall diversity and in the trophic balance of the community.

South Yadkin River, SR 1159
The South Yadkin River is a major tributary (25 meters wide), entering the Yadkin River north of Salisbury in Rowan County. Its tributaries drain most of Iredell County. The lower portion of the South Yadkin River forms the boundary between Davie and Rowan counties.

South Yadkin River at SR 1159, Davie County.

This site has consistently been rated Good or Excellent and continues to support a diverse and intolerant benthic macroinvertebrate community. However, the habitat score of 58 at this site reflected the instream sedimentation and the unstable, steep banks.

Rocky Creek, SR 1884

Rocky Creek is nine meters wide at SR 1884, located approximately two miles upstream of its confluence with Patterson Creek. The habitat score of 64 reflects a sandy, silty substrate, few riffles, and limited amount of instream habitat available for colonization.

Rocky Creek at SR 1884, Iredell County.

In 1996, this site missed an Excellent bioclassification by two taxa (26 EPT taxa found). This site received an Excellent bioclassification based on benthos data in 2001 (38 EPT). Dominant taxa here included *Serratella deficiens*, *Paragnetina fumosa*, and *Triaenodes ignitus*.

Patterson Creek, SR 1890

Patterson Creek is a small tributary (eight meters wide) to Rocky Creek. Patterson Creek and Rocky Creek were sampled for benthos in 1990 to assess the water quality condition of the streams prior to BMP implementation in this agricultural watershed. Patterson Creek at SR 1890 has good instream habitat, a good rocky riffle area provided by an old mill site, and extensive riparian zone.

Patterson Creek at SR 1890, Rowan County

This site received a rating of Good in 2001, based on an EPT taxa richness of 25. In 1996, this stream was sampled one bridge upstream and also was rated Good.

Hunting Creek, NC 115

The watershed of Hunting Creek drains the southeast corner of Wilkes County. The stream flows parallel to NC 115 upstream of the sampling site. During fish community sampling, habitat scores were 68 in 1996 but only 49 in 2001. Despite the sandy substrate, a paucity of riffles, some breaks in the riparian zone, and the stream draining an agricultural watershed, Hunting Creek is a "least impacted" stream in this area of the basin. The conductivity is also low, 48 µmhos/cm, for a stream in the piedmont. It, however, is not a fish community regional reference site.

Upstream view of Hunting Creek at NC 115, Wilkes County, July 2001.

Benthic macroinvertebrates were last sampled in 1992. That sample and the recent 2001 sample resulted in a bioclassification of Excellent based on EPT values of 43 and 37, respectively. This most upstream site on Hunting Creek drains the Brushy Mountains and it was rated using Mountain criteria. It was added to basin assessment in 2001 to have an upstream undisturbed reference site on Hunting Creek. Dominant taxa included *Neophylax oligius* and *Serratella deficiens*.

The fish community was rated Excellent in 1996 and in 2001 (NCIBI = 56 and 58, respectively). The only metric not scoring a "5" was the number of sunfish+bass+trout metric. Only two species--redbreast sunfish and smallmouth bass--were collected.

Hunting Creek, SR 2115

This site is located about midway between the headwaters of Hunting Creek and its confluence with the South Yadkin River. The Hunting Creek watershed, including North Hunting Creek and Little Hunting Creek, is the largest tributary to the South Yadkin River. Water quality at this site has remained relatively consistent since 1983. This site was rated Excellent using Piedmont criteria in 1996 and 2001.

North Little Hunting Creek, SR 1829

The watershed of North Little Hunting Creek includes primarily the southwest corner of Yadkin County south of US 421 and bisected by I-77. Most of the catchment is located in the Brushy Mountains of Wilkes County. The sampling site at SR 1829 (Iredell County) is the most downstream bridge crossing before North Little Hunting Creek's confluence with Hunting Creek. North Little Hunting Creek is another good example of a stream having areas of severe bank erosion and sand deposition.

Bank erosion in North Little Hunting Creek, SR 1829, Iredell County.

This stream was Excellent in 1996 and 2001 based on benthos data. However, the habitat score of 68 and the sandy, embedded habitat reflect the sedimentation that is occurring here. If this site continues to fill in with sand the diversity of the benthic fauna may decline.

The fish community was rated Good in 2001 (NCIBI = 50), a slight improvement from Good-Fair in 1996 (NCIBI = 44). Bluehead chubs, the dominant species and indicative of some nutrient enrichment, represented approximately 50% of all the fish collected. Overall, there was a high diversity of all species, including darters, suckers, and intolerant species, and a low percentage of tolerant fish.

Fourth Creek, SR 1003

The headwaters of Fourth Creek are near the county line between Iredell and Alexander County. This stream flows southeastward draining the north side of Statesville and then flows into the South Yadkin River in Rowan County. The largest discharge into Fourth Creek is the Statesville WWTP, with a permitted flow of 4 MGD. This site is about 10 miles below the town of Statesville. The habitat here is good, with a score of 83.

Fourth Creek at SR 1003, Rowan County.

Previous data collected in 1989 at sites above the WWTP indicated Good-Fair water quality. A site just below the WWTP indicated Fair water quality in 1989. This most downstream site (SR 1003) sampled in 2001, as well as in 1996, received a bioclassification of Good in both years. This indicated that the stream had recovered from some of the adverse effects of the WWTP before it reaches the South Yadkin River. This recovery is supported by the common occurrence downstream of such intolerant species as *Heterocloeon* and *Symphitopsyche sparna*.

A Quality Assurance sample at this location was taken in September 2001. This resulted in a bioclassification of Good-Fair. It missed receiving a rating of Good by one EPT taxa.

Fourth Creek, SR 1985

The watershed of Fourth Creek includes the northern and eastern portions of the City of Statesville and the rural areas of eastern Iredell and northwestern Rowan counties. Approximately 15 miles upstream from the monitoring site is the City of Statesville's Fourth Creek and Southern States Cooperative WWTPs (combined discharge = 4.1 MGD).

Upstream view of Fourth Creek, SR 1895, Rowan County.

The fish community was rated Poor in 1996 and in 2001. Only 93 fish were collected at this site in 2001 - the second fewest fish from any site, except for at Third Creek. In 1996, only 75 fish were collected. Seven of the 12 metrics deviated greatly (scoring a 1) from the reference condition. Only 4 of the 12 species were represented by multiple age classes and 6 of the 12 species were represented by only one fish per species.

Third Creek, SR 1970

This tributary to Fourth Creek originates in Alexander County, a few miles southeast of Taylorsville. From there, the stream flows southeasterly through Iredell County, along the southern edge of Statesville, into Rowan County to Fourth Creek. This site is located in the lower reach of the watershed, thus providing an overall watershed assessment. It is also approximately five miles below the Town of Cleveland's and the 15 miles below the City of Statesville's WWTPs (0.3 and 4 MGD, respectively).

Third Creek at this site is eight meters wide, suffering from massive sedimentation with large sandbars and undercut banks. The low habitat scores reflected a stream with a uniform sand substrate and very limited instream habitats. The banks are unstable and erosion is severe.

At the time of fish community sampling in spring, the water was plum colored and the conductivity was elevated at 262 µmhos/cm. During benthos sampling in July 2001, the water was again plum colored and the conductivity was 287 µmhos/cm. In 1996, it was 140 µmhos/cm.

Downstream view of Third Creek, SR 1970, Rowan County.

Upstream view of Third Creek at SR 1970, Rowan County.

Although this stream receives effluent from seven dischargers, most of which are above this site, this site has consistently received a bioclassification of Good since 1987. This seems remarkable in light of the habitat problems and so many dischargers. This site continued to support an abundant community of *Homoeoneuria cahabensis*. This is a rare, intolerant mayfly that has only been collected in the South Fork Catawba River and the Second Broad River (Broad River basin).

Contrary to the rating based upon the benthic macroinvertebrates, in 1996, the fish community was rated Fair. In 2001, it was rated Poor (NCIBI = 40 and 34, respectively). In 1996, only 40 fish were collected from this site; in 2001, only 49 fish were collected - the fewest fish collected at any of the sites in 2001. No suckers were collected and the dominant species was the bluehead chub (n = 24).

North Second Creek, SR 1526

This site had the poorest habitats of any of the sites monitored for fish community assessment in the basin in 2001 (Appendix 3). The habitat score was 22. The stream has a straight channel, is deeply entrenched with no riffles, unstable banks, and the riparian zone is very narrow with breaks common. Along both shorelines and immediately upstream, is the property of the NC Department of Agriculture dairy research station. Small tributaries and channelized ditches on the property are without riparian buffers or canopy.

During the summer, the stream has a wide channel, but the wetted width of the stream at this site was only four meters at low flow in 2001. In 1996, the width was recorded as 10 - 12 meters. Below the bridge, the channel here has been artificially widened by a sand-dipping operation. The banks suffered from severe erosion and the habitat score was only 37 (52 in 1996).

Upstream view of North Second Creek at SR 1526, Rowan County.

In 2001, the benthic fauna reflect this habitat degradation with a decrease in EPT taxa (from 16 to 10) and an increase in the EPT Biotic Index over that recorded from 1996 (from 4.75 to 5.95). This site dropped from a rating of Good-Fair in 1996 to Fair in 2001.

As at other deficient instream habitat sites, fish were found in the small side pools or near the sticks and snags in the current which provide some structure and instream habitat.

Instream habitat in North Second Creek, SR 1526, Rowan County.

In 1996, the fish community was rated Fair; in 2001, it was rated Good-Fair (NCIBI = 40 and 42, respectively). In 2001, fewer total species, fewer species of sunfish, and fewer species of suckers were collected compared with 1996. In addition, a greater percentage of omnivores and herbivores and a lower percentage of insectivores were present in 2001 than in 1996.

The bluehead chub increased from 11 percent in 1996 to 44 percent of all the fish collected in 2001. The two unit increase in the NCIBI in 2001 resulted from an increase in the number of fish collected, the presence of an intolerant species, a decrease in the percentage of tolerant fish, and an increase in the percentage of species with multiple age classes.

North Second Creek, US 70

North Second Creek at US 70 is the most downstream site for overall assessment of water quality. It is also an ambient chemistry monitoring site. This watershed is located in the southern part of the subbasin west of Salisbury. The stream at this site is 12 to 13 meters wide with one single riffle at the bridge. The remainder of the site is sandy and slow-flowing, with few pools and a narrow, riparian zone with some breaks allowing nonpoint source runoff to enter the creek. The habitat score was 48 in 2001 and 54 in 1996.

North Second Creek at US 70 at bridge, Rowan County.

North Second Creek at US 70, downstream, Rowan County.

The bioclassification based on benthic macroinvertebrates decreased from Good-Fair in 1996 to Fair in 2001. EPT taxa decreased slightly (from 17 to 16) and the Biotic Index increased (from 6.20 to 6.83). The most notable differences in community were the lack of stoneflies in the 2001 sample and an increase in toxic indicator species *Conchapelopia* and *Polypedilum illinoense*. Organic/enrichment indicator species such as *Limnodrilus* spp and Lumbriculidae also increased in abundance.

Withrow Creek, SR 1547

Withrow Creek, a tributary to North Second Creek, was sampled at SR 1547, to assess the overall water quality of this section of the North Second Creek catchment. This stream was five meters wide (down from 10 meters in 1996), with a predominately sand substrate. Instream habitat was rare, riffles and pools were absent and the banks were severely eroded (habitat score = 43). Conditions were much the same in 1996, with a score of 52.

Withrow Creek at SR 1547, Rowan County.

This site received a bioclassification of Good-Fair in 1996 and 2001 based on the benthos data. The macroinvertebrate fauna here was a bit more diverse and intolerant than that found in North Second Creek. The biggest difference was seen in the EPT BI. EPT BI at North Second Creek was 6.07 and 4.77 at Withrow Creek in 2001. This difference comes from the absence of stonefly taxa in North Second Creek. North Second Creek at US 70 had a conductivity of 270 µmhos/cm while the conductivity in Withrow Creek measured 95 µmhos/cm in July 2001. This clearly indicated the presence of a major discharge to North Second Creek (Arteva Specialties at 2.3 MGD).

SPECIAL STUDIES

303(d) Stream - Fourth Creek, SR 2308

This seven meter wide site had a good mix of boulder, rubble, gravel, and sand substrates. Pools, riffles, snags, and root mats were common and the riparian zone was generally intact.

This site was rated Fair in 1989 based upon 63 taxa collected including 17 EPT taxa, and a BI of 6.99. In 2001, this site also was rated Fair with a nearly identical BI of 6.9 and similar levels of EPT diversity (12) and total taxa (57). As a result, Fourth Creek should remain on the 303 (d) list.

YADKIN RIVER SUBBASIN 07

Description

This subbasin contains primarily the Abbotts Creek watershed (Figure 39). Abbotts Creek starts just south of Kernersville, flows south through Lexington, and empties into High Rock Lake. Smaller streams in the watershed are Rich and Hunts Forks and Swearing and Hamby Creeks, which drain High Point, Thomasville, and the west side of Lexington.

The subbasin is located primarily in Davidson County and is dissected by the industrial and commercial US 64 and I-85 corridors. The largest municipalities in the subbasin are the cities of Lexington, Thomasville, and Highpoint. The largest discharger is the City of High Point's WWTP with a permitted flow of 6.2 MGD into Rich Fork. Other large municipal WWTP dischargers are Thomasville (4 MGD to Hamby Creek) and Lexington (5.5 MGD to Abbotts Creek).

Land use is primarily forest and pasture (Table 18). However, this subbasin contains the greatest percentage of urban areas than any other subbasin in the entire basin.

Table 18. Landuse in Subbasin 07. Based upon CGIA coverage 1993 - 1995 (total area = 151,888 Ac).

Landuse	Percent
Water	0.8
Cultivated crop	3.0
Pasture	31.8
Urban	7.8
Forest	56.5

Overview of Water Quality

Bioclassifications in 2001 based upon benthic macroinvertebrates, ranged from Good at Brushy Fork to Poor at North Hamby Creek. Although flow was very low in 2001, all the streams were turbid at the time of benthos sampling even though there had been no recent rainfall event. The many large WWTP dischargers in this subbasin are reflected in widespread water quality problems. These problems are compounded by nonpoint source pollutant and sediment inputs.

The fish communities sampled also reflected the troubled water quality.

Ambient monitoring data indicated high nutrient levels in Rich Fork and Hamby's Creek. Copper exceeded its standard in 73 percent of the samples collected form Hamby's Creek.

Lake Tom-A-Lex has been consistently eutrophic since first monitored in 1981. Secchi depths were typical of piedmont reservoirs (<1 m).

Table 19. Waterbodies monitored in Subbasin 07 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Swearing Cr	Davidson	NC 47	Good-Fair	Fair
B-2	Abbotts Cr	Davidson	SR 1755	Good-Fair	Good-Fair
B-3	Brushy Fork	Davidson	SR 1810	Fair	Good
B-4	Abbotts Cr[2]	Davidson	SR 1243	Fair	Fair
B-5	Rich Fork[2]	Davidson	SR 2005	---	Fair
B-6	Hamby Cr[2]	Davidson	SR 2017[3]	Poor	Fair
B-7	Leonards Cr	Davidson	SR 1844[4]	Good-Fair	Good-Fair
F-1	Abbotts Cr	Davidson	SR 1800	Good-Fair	Good-Fair
F-2	Rich Fork Cr	Davidson	NC 109	Poor	Poor
L-1	Lake Thom-A-Lex	Davidson		---	Eutrophic

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites; and L = lake assessment sites.
[2]Data are available prior to 1996, refer to Appendix 7.
[3]Sampled two bridges upstream at SR 2025 in 1996.
[4]Sampled at Leonard Creek Farm Road in 2001.

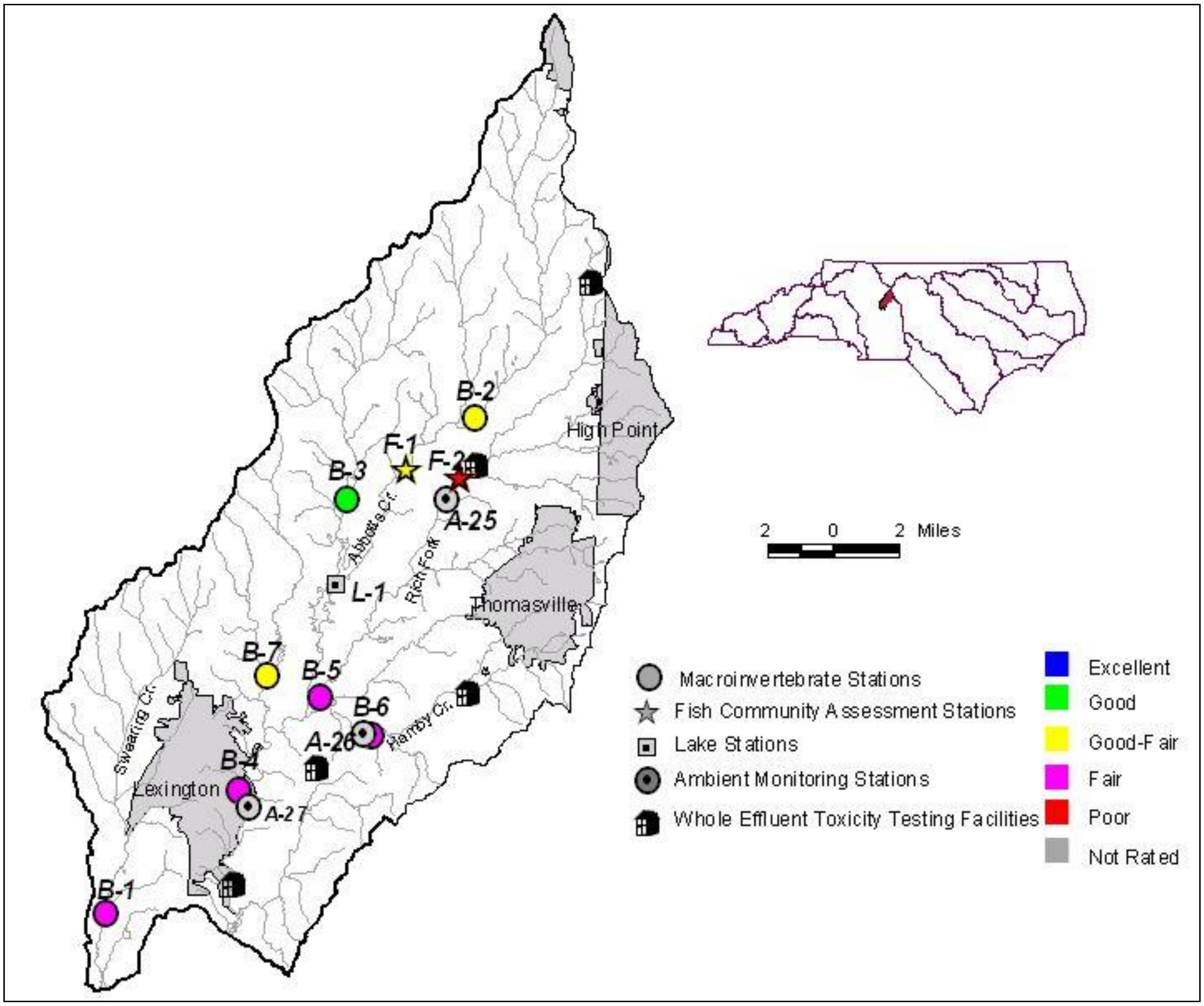


Figure 39. Sampling sites in Subbasin 07 in the Yadkin River basin.

River and Stream Assessment

Swearing Creek, NC 47

Swearing Creek at NC 47 was shallow and five meters wide (wetted width) at the time of sampling. This stream was estimated to be 12 meters wide in 1996 under higher flow conditions. Since 1996, the amount of available instream habitat has decreased (from abundant to limited), riffle areas have disappeared, and bank erosion has increased. The substrate is predominately sand with infrequent riffle areas. The banks were stable with plenty of vegetative cover in 1996, but now have sparse vegetation with poor soil binding capabilities. The riparian zone is still intact. The habitat score in 1996 was 82, but only 49 in 2001.

Swearing Creek at NC 47 Davidson County

This site decreased from a Good-Fair rating in 1996 (16 EPT) to a Fair (13 EPT) in 2001. The latest sample missed receiving a Good-Fair rating by one EPT taxa. Stoneflies were not collected in the 2001 survey.

Abbotts Creek, SR 1755

Abbotts Creek at SR 1755 is north of Highway 109. This upstream site is small (six meters wide). The substrate contains some gravel and rubble, but is mostly sand. Habitat here is generally good (score of 74) and the site received a bioclassification of Good-Fair (15 EPT) based on the macroinvertebrate fauna. This site also was Good-Fair (16 EPT) in 1996.

Abbotts Creek at SR 1755, Davidson County

Abbotts Creek, SR 1800

The upper Abbotts Creek watershed includes the extreme southeastern corner of Forsyth and the northeastern corner of Davidson counties.

Upstream view of Abbotts Creek at SR 1800, Davidson County.

The fish community in 2001 was rated Good-Fair, the same rating it received in 1996. In both years, the bluehead chub was the dominant species representing 42% of all the fish collected. The only difference between sampling periods was in 2001 when two additional species of suckers were collected.

Brushy Fork, SR 1810

Brushy Fork, located north of Lexington, is a tributary to Tom-a-Lex Lake (water supply for the cities of Lexington and Thomasville). This is a small, shallow stream, about five meters width. Instream habitat was very limited, the substrate was nearly all sand, and riffle areas and pools were absent. The riparian zone was large and intact, filtering some of the effects of nonpoint runoff.

Brushy Fork at SR 1810, Davidson County.

This site received a bioclassification of Good in 2001, based on a full scale benthos sample (this was a borderline Good/ Good-Fair). This was up from a Fair rating (based on an EPT sample) in 1996, although the habitat here was actually a bit better in 1996 (there were still some riffle areas). There was an increase in EPT taxa collected (from 13 to 20). Many intolerant taxa increased in abundance: *Hexagenia, Serratella deficiens, Pteronarcys,* and *Oecetis persimillis*. These factors suggest that this stream fairs better in a low flow year when nonpoint source impacts are limited.

Abbotts Creek, SR 1243

Prior collections from this section of Abbots Creek have been at I-85, but for reasons concerning safety, accessibility, and wadeable flow, the site was moved about one mile upstream to the gauging station at Center Street in Lexington (SR 1243) in 1996.

Abbotts Creek at this site was approximately 20 meters wide. It was shallow and turbid at the time of sampling. Instream habitat is fairly abundant and the substrate consists of gravel and sand. Riffle areas are infrequent, but extensive, and the banks are unstable. The riparian zone is wide but breaks are common, allowing potential nonpoint runoff into the stream.

Abbotts Creek at SR 1243, Davidson County.

This downstream stretch has consistently been rated Fair since 1985. The City of Lexington WWTP is permitted to discharge 5.5 MGD to Abbotts Creek. Several taxa known to be tolerant of toxic conditions have been found in abundance here over the years: *Cricotopus bicinctus*, *Dicrotendipes neomodestus*, *Polypedilum convictum*, and *Limnodrilus hoffmeisteri*.

Rich Fork Creek, NC 109

The upper reaches of Rich Fork Creek drain the western and southwestern urban areas of the City of High Point. In 2001, as in 1996, the stream was sampled upstream from a sand dipping operation and downstream from the City of High Point's West Side WWTP (6.2 MGD). The stream had the highest conductivity (433 µmhos/cm) of any site fish community site monitored in 2001.

Rich Fork Creek at NC 109, Davidson County.

The fish community was rated Poor in 1996 and 2001 (NCIBI = 34). In 2001, the bluehead chub, redbreast sunfish, and the spottail shiner were the dominant species. In 1996, the dominant species was the redbreast sunfish. Rich Fork Creek was one of the few waterbodies monitored in 2001 where darters were absent. No intolerant species were collected and the trophic structure was skewed towards omnivores and herbivores.

Rich Fork, SR 2005

This site is the most downstream bridge crossing before Rich Fork enters Abbotts Creek. The substrate at this seven meter wide site was predominately sand with a small amount of gravel. The water had a slight reddish tinge, instream habitat was limited, but the riparian zone was intact and extensive.

Rich Fork at SR 2005, Davidson County.

This site has consistently been rated Fair based on benthic macroinvertebrate data since 1985.

However, EPT taxa richness increased slightly in 2001 (from 13 to 15). Organic/ enrichment and toxic indicator taxa found in abundance here include: *Conchapelopia*, *Polypedilum illinoense*, and Lumbriculidae.

Hamby Creek, SR 2017
Hamby Creek flows from Thomasville into Abbotts Creek north of Lexington. This creek receives effluent from the City of Thomasville's WWTP (4 MGD).

This stream was sampled at SR 2025 in 1996, resulting in a bioclassification of Poor based on an EPT sample (EPT = 6). For reasons concerning flow and accessibility, in 2001, the stream was sampled two bridges further downstream at SR 2017. At this site, the stream was rated Fair (EPT = 12). The EPT abundance also increased from 14 in 1996 to 56 in 2001.

The water at this site was clear with a reddish tinge and a distinct effluent odor was prominent. Instream habitat was good, riffle areas were frequent, and the banks were stable with a wide intact riparian zone. These favorable habitat conditions support the assumption that the discharger is adversely impacting the stream.

Hamby Creek at SR 2017, Davidson County.

Leonards Creek, Leonard Creek Farm Road
In 2001, due to size and accessibility concerns, this site was moved from the 1996 location to a site one-half mile upstream, off Leonard Creek Farm Road. This stream is a small (three meter wide) tributary to Abbotts Creek. Its headwaters are north of the Town of Welcome and the stream flows southeasterly to Abbotts Creek just above Lexington.

Leonards Creek, off Leonard Creek Farm Road, Davidson County.

This site received a Good-Fair bioclassification at SR 1844 in 1996 and Good-Fair at the alternate site in 2001. Instream habitat at both sites was abundant and riffles were infrequent, but wide.

There are only two access points to this stream below City Lake. One is at SR 1844 and the other is off Leonard Creek Farm Road on private property. Because of its size and accessibility problems, this stream should be dropped from the basinwide monitoring list.

SPECIAL STUDIES
303 (d) Streams
Hunts Fork, above SR 1787
This stream was sampled to determine if it should remain on the impaired streams list. The site was three meters wide with a substrate composed primarily of sand and silt. Root mats were rare; macrophytes, leaf packs, and snags were common; and the riparian zone was not intact.

Hunts Fork at SR 1787, Davidson County.

In 1983, this site had 40 taxa, 4 EPT taxa, and the BI was 8.49. In 2001, this site was not rated due to its small size, but it has improved with 66 taxa, 9 EPT taxa, and a BI of 7.21. EPT taxa not previously collected included *Baetis flavistriga*, *Caenis, Paracloeodes*, and *Lype diversa.*

This site has exhibited some improvements over conditions found in 1983, but is still exhibiting signs of deleterious activities in the catchment.

North Hamby Creek, SR 2031

This five meter wide stream had very good flow and a heterogeneous substrate comprised of boulder, rubble, gravel, sand, and silt. Leaf packs and root mats were abundant, although snags, macrophytes and pools were rare and the riparian zone was not intact. There was a reddish tinge to the water at the time of sampling.

North Hamby Creek at SR 2031, Davidson County.

North Hamby Creek SR 2031, Davidson County showing colored water.

This site was originally sampled in 1987, and has since received a rating of Poor. Overall habitat and flow do not seem to be limiting factors at this site, rather it seems evident that there is some input having an adverse impact on this reach of North Hamby Creek. This site received a Poor bioclassification in 2001 with 41 total taxa, 3 EPT taxa, and a BI of 7.09. There are currently no permitted dischargers on North Hamby Creek.

Lake Assessment

Lake Thom-A-Lex

Lake Tom-A-Lex is a water supply reservoir for the cities of Thomasville and Lexington. The major tributary is Abbotts Creek (Figure 40).

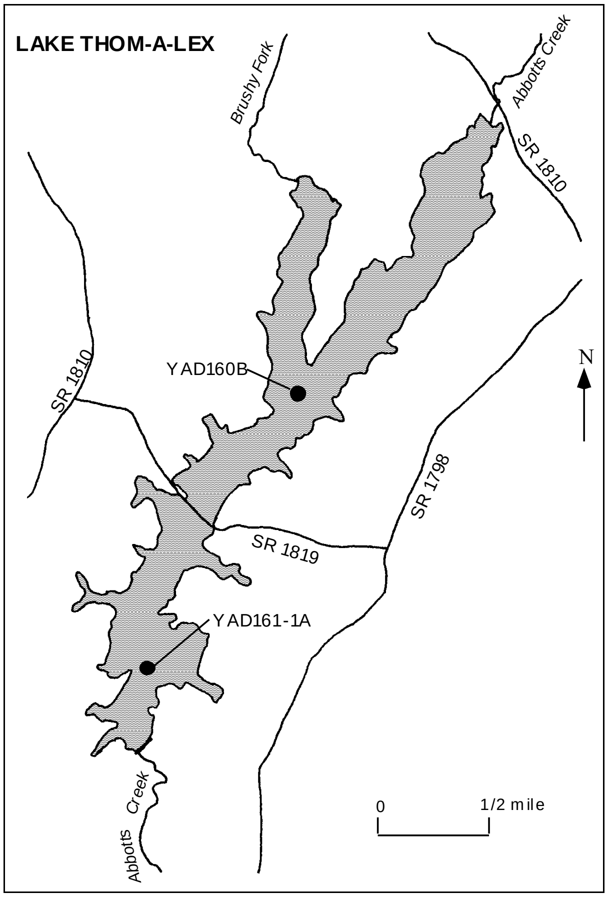


Figure 40. Sampling sites at Lake Thom-A-Lex, Davidson County.

This lake was monitored in 1999, 2000 and 2001. Sampling was previously conducted in 1994 at which time the lake was determined to be eutrophic. This lake has been consistently eutrophic since it was first monitored in 1981.

Secchi depths in 1999 through 2001 were typical of a piedmont reservoir with readings usually less than one meter. As in previous years, surface dissolved oxygen was elevated with percent dissolved oxygen values ranging from 110% to 133%. These values were greater than the state water quality standard of 110% for dissolved gases.

In general, nutrient concentrations were elevated in 1999 through 2001. The availability of nutrients supported increased algae productivity in all years. In 2001, chlorophyll *a* values ranged from 24 to 31 µg/L. Lake Thom-A-Lex was determined to be eutrophic in 2001 based on the calculated NCTSI scores.

As has been seen in other piedmont lakes, the state water quality standards were exceeded once in the 1999 - 2001 period for copper and manganese.

YADKIN RIVER SUBBASIN 08

Description

This subbasin includes a portion of the Yadkin River Chain-of-Lakes (Tuckertown, Badin, Falls, and Tillery) and their tributaries (excluding the Uwharrie River watershed) (Figure 41). Approximately two-thirds of the subbasin is forested (Table 20).

Table 20. Landuse in Subbasin 08. Based upon CGIA coverage 1993 - 1995 (total area = 188,258 Ac).

Landuse	Percent
Water	8.0
Cultivated crop	2.5
Pasture	20.9
Urban	0.8
Forest	67.9

This subbasin includes the small towns of Denton, Badin, Norwood, and Mount Gilead. During the years between 1997 and 2001, the Town of Denton expanded their WWTP from 0.3 to 0.8 MGD, upgraded the facility to tertiary treatment, and relocated the discharge from the no-flow UT Lick Creek to Lick Creek. The only other large discharger is the Greater Badin WWTP which discharges 0.7 MGD to Little Mountain Creek.

All streams are located in the slate belt portion of the piedmont ecoregion. These stream usually have a rocky substrate, but may have very low flow during drought conditions.

Overview of Water Quality

Dischargers were found to affect two streams in this subbasin: Little Mountain Creek (Alcoa and Greater Badin WWTPs) and Lick Creek (Denton WWTP). Both streams have consistently received a Fair bioclassification using benthic macroinvertebrate data, although fish collections assigned a Good-Fair rating to Lick Creek (Table 21). Toxicity self-monitoring data prior to 2001 had shown occasional failures for Alcoa and Denton (especially the latter), but the number of failures has been much reduced in recent years. The low flow encountered during 1996 and 2001 benthos surveys would not have provided much dilution for these dischargers. Therefore, samples were collected during a period of maximum potential impact to the stream fauna.

Most streams in this subbasin have a rocky substrate due to the Slate Belt geology of this area. Enrichment was evident in Mountain Creek, but this stream received a Good-Fair bioclassifications in 2001 for both fish and benthos collections. The highest rating was given to Cabin Creek (Good) based on fish community data.

Monthly ambient chemistry samples were collected by NC DWQ at only one site in this subbasin: the Yadkin River below High Rock Lake. The Yadkin Pee Dee River Basin Association collects samples at an additional five sites, including the Yadkin River near Richfield, the Pee Dee River near Albemarle, and Little Mountain and Mountain Creeks.

The NC DWQ ambient monitoring data showed that low dissolved oxygen concentrations occurred in the Yadkin River below High Rock Lake (25 percent of the values were less than 5 mg/L) due to the release of hypolimnetic water from the hydroelectric plant. This water quality problem should be addressed in more detail when the Alcoa facility comes up for relicensing.

Three lakes were monitored in this subbasin: Tuckertown Reservoir, Badin Lake, and Lake Tillery. These lakes are all mainstem impoundments of the Pee Dee River, with Tuckertown being the most upstream lake and Lake Tillery being the furthest downstream. The relatively short retention time of these impoundments may help to control phytoplankton blooms, even when nutrient levels are high. Most of the nutrients come from developed areas upstream of this subbasin. Nutrient levels and phytoplankton standing crop declined from Tuckertown to Tillery. Only Tuckertown Reservoir is still classified as eutrophic; the other lakes are classified as mesotrophic. Long-term data (1981 - 2001) also suggested improvements in water quality in these lakes, although some of these changes may have been affected by changes in rainfall and flow. Small mats of a nuisance algae (*Lyngbya woolei*) were observed in Badin Lake during the spring of 2001.

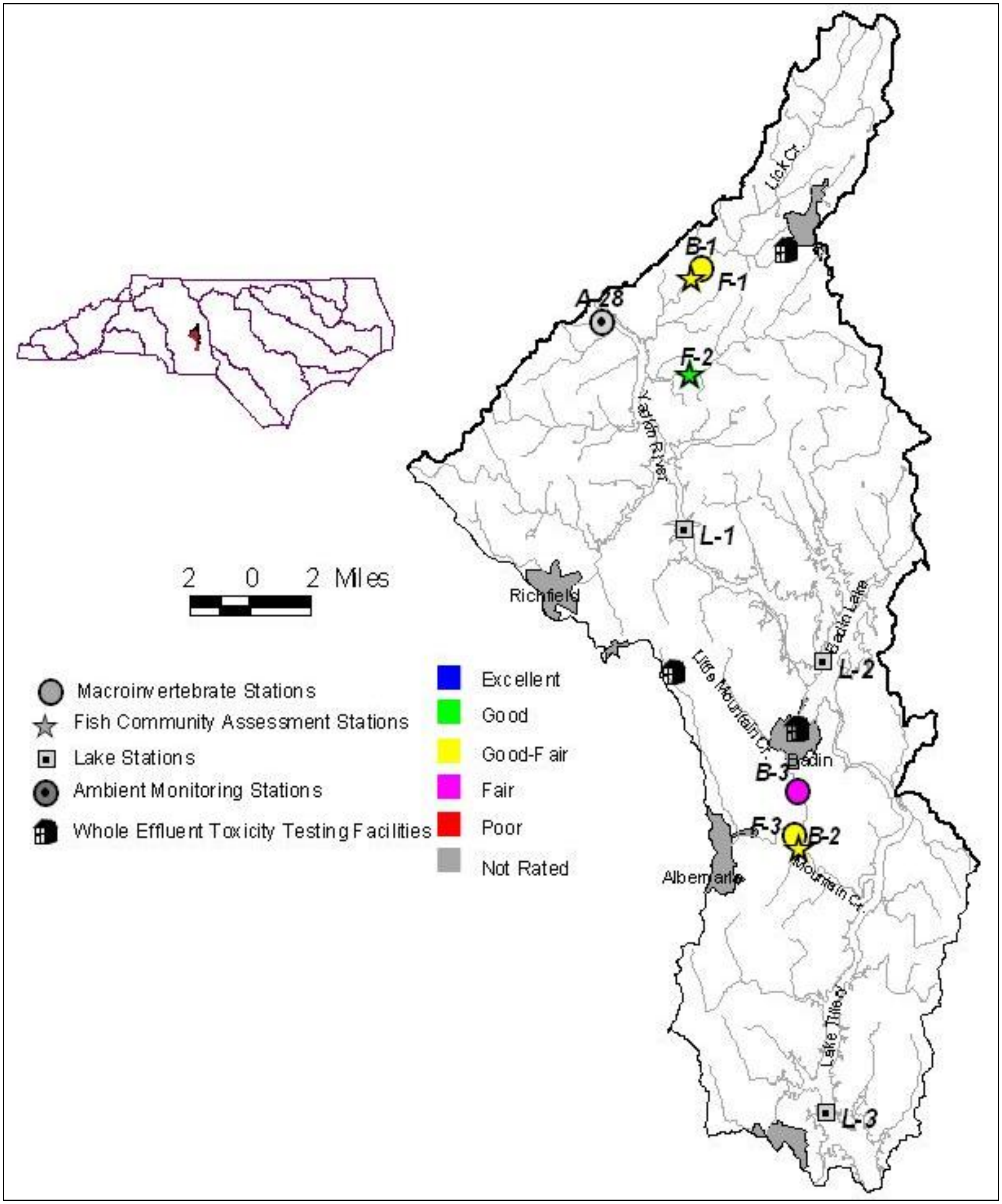


Figure 41. Sampling sites in Subbasin 08 in the Yadkin River basin.

Table 21. Waterbodies monitored in Subbasin 08 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Lick Cr[2]	Davidson	NC 8	Fair	Fair
B-2	Mountain Cr	Stanly	SR 1720	Good	Good-Fair
B-3	Little Mountain Cr	Stanly	SR 1720	Fair	Fair
F-1	Lick Cr	Davidson	NC 8	Good-Fair	Good-Fair
F-2	Cabin Cr	Davidson	SR 2536	Good	Good
F-3	Mountain Cr	Stanly	SR 1720	Good	Good-Fair
L-1	Tuckertown Lake	Davidson		---	---
L-2	Badin Lake	Montgomery		---	---
L-3	Lake Tillery	Montgomery		---	---

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

River and Stream Assessment

Lick Creek, NC 8
The watershed of Lick Creek includes the Town of Denton in the southeastern corner of Davidson County. The benthos and fish community site was approximately three miles below the Town of Denton's WWTP outfall. The outfall was relocated from UT Lick Creek to Lick Creek in 2000. During benthos sampling, this portion of Lick Creek was eight to ten meters wide, with a boulder-rubble substrate. There were no leafpacks, but there were good riffle and root habitats.

Downstream view of Lick Creek at NC 8, Davidson County, April 2001.

Lick Creek at NC 8, Davidson County, August 2001.

There were no significant habitat problems, but the very high conductivity recorded in August 2001 (382 µmhos/cm) reflected the influence of the Denton WWTP effluent. The conductivity in 2001 was approximately three times greater than the value recorded in 1996 (120 µmhos/cm). This increase reflected the change in location for the discharge and low dilution during extremely low flow. Much of the stream flow during the August 2001 collection may have been treated effluent.

A Fair bioclassification was assigned in 1996 and 2001 and EPT taxa richness and abundance were similar for both years. A few changes in the EPT fauna between 1996 and 2001 suggested a slight between sampling period decline in water quality, probably due to the extreme low flow observed in 2001. A decline in abundance was noted for the principal pool species (*Stenacron*), and there was a loss of the most intolerant taxon (*Isonychia*). Tolerant filter-feeders (*Cheumatopsyche*, and *Hydropsyche betteni*) were dominant in 2001.

The true impact of this discharger may best be evaluated by a winter or spring sampling above and below the discharge point. No upstream flow for Lick Creek was observed in August 2001.

Despite the relocation of the outfall, there was no appreciable change in the fish community between 1996 and 2001. During both monitoring cycles, the community was rated Good-Fair (NCIBI = 44). The community continued to be dominated by the tolerant redbreast sunfish and the omnivorous bluehead chub -- 68 percent of all fish collected were these two species. Indicators of degradation such as the absence of intolerant species and piscivores, the high percentage of tolerant fish, and a moderate percentage of omnivores and herbivores still existed.

Cabin Creek, SR 2536
Cabin Creek has a small watershed in the extreme southeastern corner of Davidson County. Thee are no NPDES facilities in this small watershed. During this drought, stream flow was low, the water was clear, and there were prolific growths of the filamentous green algae, *Spirogyra*, on the bottom. Dissolved oxygen was supersaturated at 119 percent a the time of fish sampling in May.

Filamentous algae (*Spirogyra*) at Cabin Creek at SR 2536, Davidson County.

During 1996 and 2001, the fish community was rated Good (NCIBI = 52 and 48). In 2001, three more species, including an additional species of sucker, were collected. However, other changes were also observed in 2001:

- the number of fish collected decreased by 45 percent;
- the percentage of tolerant fish increased from 23% to 31%;
- the number of species of darters decreased from 2 to 1 (the fantail darter which was common in 1996 was not collected in 2001); and
- the number of species with multiple age classes decreased from 75% to 47% (7 out of the 12 species were represented by only 1 or 2 fish per species).

These changes may be due to prolonged low flow effects such as crowding and diurnal fluctuations in dissolved oxygen.

Mountain Creek, SR 1720
Mountain Creek is another small watershed-size stream in northeastern Stanly County. The stream is a rocky Slate Belt type stream with a mean width of five to eight; there were extensive areas of bedrock covered with periphyton. As in 1996, cattle continued to have direct access to the stream.

Upstream view of Mountain Creek at SR 1720, Stanly County, April 2001.

Upstream view of Mountain Creek in August 2001. Structure in the back ground is intended to exclude cattle from the stream near the bridge.

Due to the lack of habitat at low flow in 2001, this site was switched from a Full Scale benthos sample in 1996 to an EPT sample in 2001. The 18 EPT taxa in 2001 were equivalent to about 21 taxa with a Full Scale sample. This was only four taxa less than the 25 EPT taxa collected in 1996.

Based on the macroinvertebrate collections, the site switched from a low Good bioclass in 1996 to a Good-Fair in 2001. However, this shift can be attributed to the extremely low flow conditions in 2001. Equivalent EPT N values were observed in both years (96 and 105), as well as equivalent EPT BI values (5.1 and 5.2). Some intolerant taxa remained very abundant in 2001 (*Leucrocuta*, *Isonychia*, and *Chimarra*), although stoneflies were sparse.

In 1996 the fish community was rated Good; in 2001, it was rated Good-Fair (NCIBI = 50 and 46, respectively). Slight changes noted in 2001 were: an increase in the percentage of omnivores + herbivores (from 33% to 42%) and a decrease in the percentage of insectivores (67% to 58%). During both monitoring periods, the bluehead chub was the most abundant species. Two other species, the redbreast sunfish and the redlip shiner, also were abundant during both cycles. Collectively, these three species represented 85% of all the fish collected in 2001.

Little Mountain Creek, SR 1720

Little Mountain Creek is a rocky Slate-Belt stream, five to six meters wide. This site is downstream of the Greater Badin WWTP, and the greater conductivity in 2001 than in 1996 (240 µmhos/cm *vs*. 140 µmhos/cm, respectively) reflected low dilution of the effluent under drought conditions.

Little Mountain Creek at SR 1720, Stanley County (low light level).

This site was rated as Fair in 1996 and 2001, with only 11 and 12 EPT taxa collected. One intolerant mayfly was abundant in riffles (*Leucrocuta*), but other dominants were highly tolerant taxa (*Baetis flavistriga* and *Cheumatopsyche*). There may have been a slight improvement in 2001, with an increase in EPT abundance from 36 (1996) to 70 (2001). Heptageniidae and Hydropsychidae increased in abundance over this time period.

Other Data

Relicensing Activities at the Tillery and Blewett Falls Hydroelectric Plants

Carolina Power and Light Company (CP&L) has been conducting environmental studies in Subbasins 08, 10, and 16 of the Yadkin-Pee Dee River system since 1998 as part of its effort to prepare for relicensing of its Blewett and Tillery hydroelectric plants. These studies have encompassed various environmental aspects including migratory fish presence and timing of spawning movements, resident fish and benthic invertebrate community assessments, water quality evaluations, and terrestrial and wildlife studies. The studies have focused on the receiving tailwaters of the Pee Dee River below each facility as well as the power plant reservoirs (Lake Tillery and Blewett Falls Lake). Studies have been conducted in alternating years at the two facilities.

CP&L has also coordinated multi-agency efforts to search for the robust redhorse and the Carolina redhorse, two rare species of native suckers below the power plants in 2000 and 2001. These efforts have documented the robust redhorse in the Pee Dee River below the Blewett Hydroelectric Plant (Subbasin 16) during both years. The Carolina redhorse was documented in Blewett Falls Lake and the tailwaters of the plant during 2001 (Subbasin 10 and 16).

CP&L intends to file its environmental data with the U. S. Federal Energy Regulatory Commission and other regulatory resource agencies during 2003 when it begins its formal hydro relicensing process. Relicensing of both plants is expected to be completed by 2008.

The Pee Dee River from Norwood Dam (the dam at Lake Tillery) to the mouth of Turkey Top Creek (Subbasins 08 and 10) is on the 303 (d) impaired streams list because of low dissolved oxygen (NCDENR 2000). Low dissolved oxygen levels in this portion of the river seem to be related to hypolimnetic discharges from CP&L's Tillery Hydroelectric Plant. In coordination with the NC Division of Water Resources, the NC DWQ will explore mitigative actions to be taken to correct this problem when the facility comes up for relicensing (NCDENR 2000).

Lake Assessment

Tuckertown Reservoir

Located between High Rock and Badin Lakes on the Yadkin River, Tuckertown Reservoir is a run-of-the-river reservoir (Figure 42). This water body was most recently monitored in 1999. Previous monitoring was done in 1994, with ambient monitoring beginning in 1981.

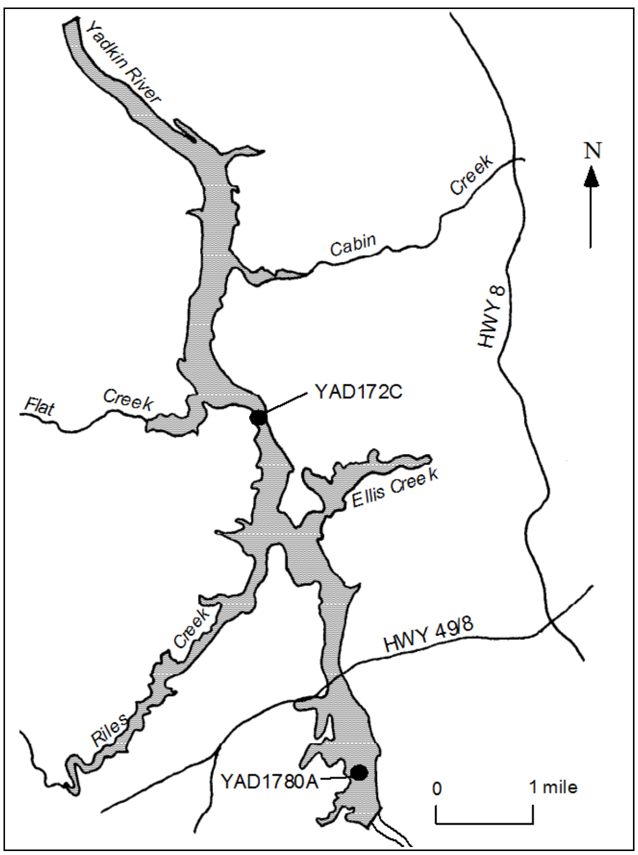


Figure 42. Sampling sites at Tuckertown Reservoir, Davidson and Montgomery Counties.

Tuckertown Reservoir is another typical piedmont reservoir, suffering from eutrophication. Secchi depths are generally less than one meter. Surface dissolved oxygen values and surface pH values near the dam are usually above 9.0 mg/L and 8.0 s.u., respectively. These elevated physical parameters suggest increased algal productivity.

Nutrient concentrations have been elevated over the years. Phytoplankton samples collected at the sampling site near the dam were dominated by green algae in July and by euglenoids in August of 1999. This shift in species is indicative of an increase in nutrient availability in the reservoir.

This lake has been consistently eutrophic since it was first sampled in 1981 but is still considered to be supporting its designated uses.

In 2000, the Federal Energy Regulatory Commission (FERC) approved the Shoreline Management Plan developed by Yadkin, Inc., the company that manages Tuckertown and three other hydropower reservoirs in the basin. The Plan contains a Shoreline Stewardship Policy, which includes specifications for private recreation facilities, subdivision access approval, multi-use facility permitting, and industrial approval procedures.

Badin Lake

Badin Lake is a chain lake on the Yadkin River, located just downstream from Tuckertown Reservoir (Figure 43). It has a maximum depth of 174 feet (53 meters) and an average hydraulic retention time of 28 days. Badin Lake receives the majority of its inflow from the discharge of Tuckertown Reservoir.

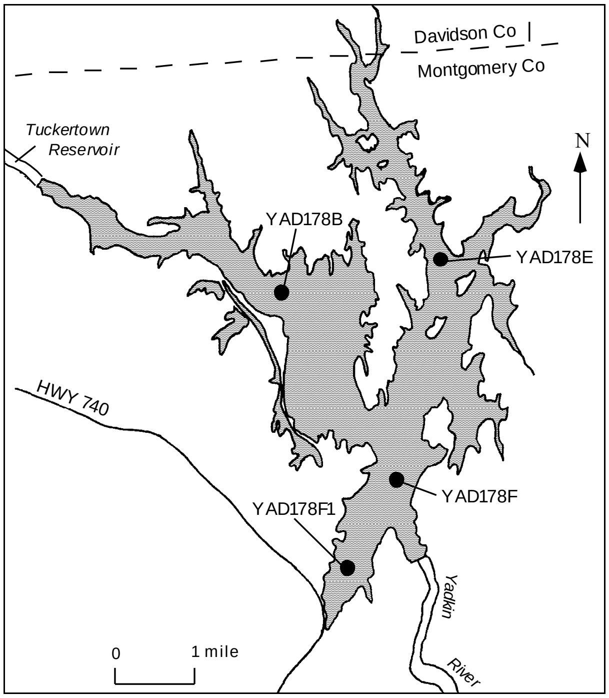


Figure 43. **Sampling sites at Badin Lake, Davidson and Montgomery counties.**

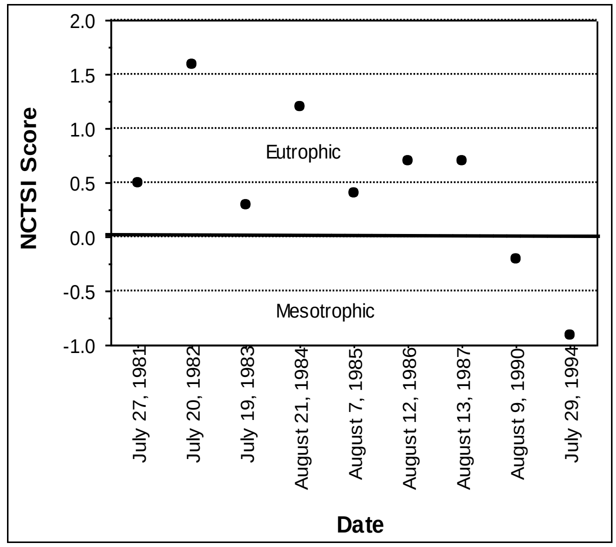


Figure 44. **NCTSI Scores for Badin Lake, 1981 - 1994 (the bold lines indicate divisions between trophic states).**

Badin Lake has been monitored 13 times since 1981, most recently in 1999. Nutrient enrichment, particularly in the arms, has been an ongoing concern.

This reservoir had been eutrophic from 1981 through 1987 and mesotrophic in 1990 and 1994 (Figure 44). This shift in trophic status from highly productive to moderately productive may have been influenced by increased precipitation and flow in 1989 compared with previous years. Lower chlorophyll *a* values (7 µg/L) in 1994 seemed to have had the most significant impact on the trophic status for that year.

Potential sources of nutrient loading to Badin Lake include inflow of nutrient-rich water from Tuckertown Reservoir and development in the immediate watershed. A residential development and golf course went in between the mainstem and Beaverdam Creek Arm of the reservoir in 1991.

As with Tuckertown, Badin is a hydropower reservoir, controlled by Yadkin, Inc. As part of their FERC relicensing, Yadkin, Inc. prepared and will implement a Shoreline Management Plan to guide development around the reservoir.

The Fayetteville Regional Office of the NC DWQ received public complaints regarding fish kills and poor water quality conditions in Badin Lake in 2000 and 2001. Fish kills have involved striped bass, sunfish, and catfish.

In May and June 2001, small mats of *Lyngbya woolei* were observed near Site YAD178F (around Palmer Island). *Lyngbya woolei* is a nuisance blue-green algae, which forms thick fibrous mats and is generally an indicator of nutrient-rich water. This algae is already a problem in South Carolina waters and appears to be expanding its range in North Carolina, taking advantage of lower water levels and high nutrient concentrations.

The Intensive Survey Unit and Fayetteville Regional Office are planning an intensive water quality survey of Badin Lake in 2002 to better document water quality.

Lake Tillery

Lake Tillery is one of the lower lakes of the Yadkin Chain of Lakes system, located between Falls Lake and Blewett Falls Lake (Figure 45). The lake is owned by Carolina Power and Light Company and has an average hydraulic retention time of 15 days. This fairly short retention time probably contributes to the mesotrophic status this lake by reducing the residence time of nutrients for algal uptake. The reservoir has been rated mesotrophic since it was first sampled in 1981.

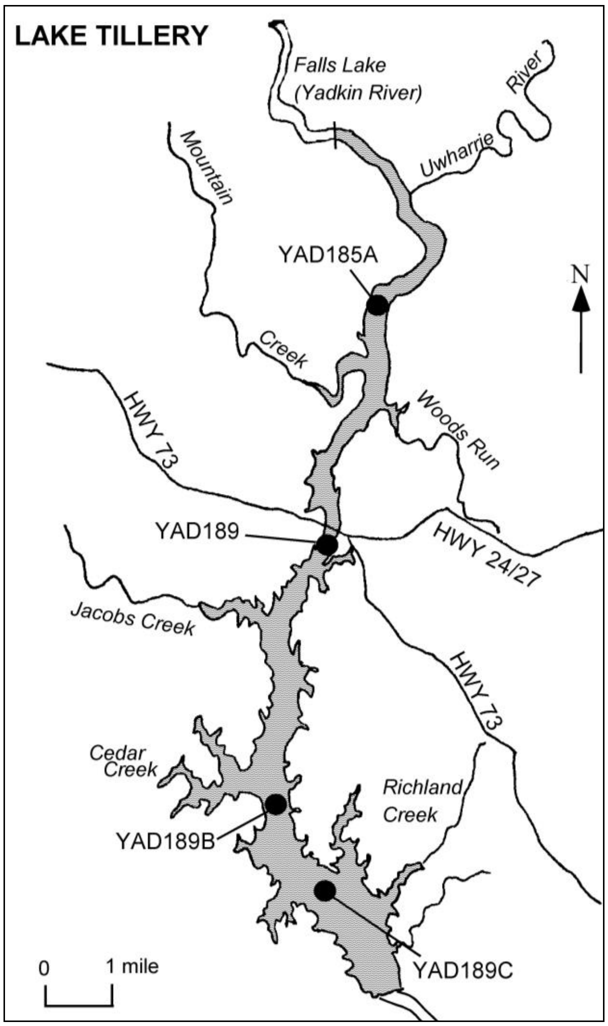


Figure 45. Sampling sites at Lake Tillery, Montgomery County.

Lake Tillery was most recently sampled in 1999. Surface dissolved oxygen and the percent dissolved oxygen saturation were elevated with the exception of one location in August. Surface dissolved oxygen concentration at the most upstream lake sampling site was low (4.8 mg/L) in August and may have been due to the hypolimnetic release from Falls Lake, upstream of Lake Tillery. Secchi depths were greater than one meter (range = 1.1 to 2.0 meters). Nutrient concentrations ranged from low to moderate. Overall, the lake seems to be supporting its designated uses.

YADKIN RIVER SUBBASIN 09

Description

This subbasin encompasses the entire Uwharrie River watershed (Figure 46). The upper watershed, primarily in Randolph County, includes portions of the municipalities of High Point, Thomasville, Archdale, Randleman, and Asheboro. The lower portion of the watershed in southern Randolph and northwestern Montgomery counties, are within the Uwharrie National Forest. Seventy-five percent of the subbasin is forested (Table 22). There are no major permitted dischargers in this subbasin, therefore, most problems can be attributed to nonpoint source runoff.

Table 22. Landuse in Subbasin 09. Based upon CGIA coverage 1993 - 1995 (total area = 248,188 Ac).

Landuse	Percent
Water	0.7
Cultivated crop	1.5
Pasture	20.8
Urban	1.1
Forest	75.9

The Uwharrie River is within the piedmont Carolina Slate Belt ecoregion, but some tributaries draining the Uwharrie Mountains have montane characteristics. Certain geological subdivisions of the Carolina Slate Belt appear to have ecological significance. The sandiest streams were observed in the northern portion of the subbasin, where the underlying rocks are metamudstone and metaargillite. More rocky streams were observed in the southern portion of the subbasin where the underlying rocks are metavolcanic.

Overview of Water Quality

There have been no significant long-term changes in water quality in this subbasin (Table 23). Based on observations by NC DWQ, nonpoint source runoff results in turbid water, bank erosion, and high nutrient levels in many streams outside of the Uwharrie National Forest. Many streams that are affected by nonpoint source runoff have received a Good-Fair rating, based upon benthic macroinvertebrate data, in 1996 or 2001 or both. These streams include the upper part of the Uwharrie River, Little Uwharrie River, and Jackson, Caraway, and Back Creeks. Back and Jackson Creeks could not be sampled in August 2001 due to low-flow conditions. Minimally disturbed streams in the Uwharrie National Forest (e.g., Barnes, Dutchmans, and Betty McGees Creeks) received Excellent benthos or fish ratings. Barnes Creek has been classified as an Outstanding Resource Water based on earlier NC DWQ surveys. The middle and lower portion of the Uwharrie River usually receive a Good rating based on macroinvertebrate data, although the lower site edged into the Excellent range in 2001.

Monthly ambient chemistry samples were collected by NC DWQ at the Uwharrie River at NC 109 and Dutchmans Creek. The Uwharrie River site monitors water quality in the entire subbasin, while the Dutchmans Creek site is intended to serve as a small-stream reference site. The Yadkin Pee Dee River Basin Association also collects samples from the Uwharrie River at NC 49.

The ambient monitoring data from the Uwharrie River indicated high turbidity (after rainfall) and high phosphorus concentrations. This contrasted sharply with reference data from Dutchmans Creek. From 1996 to 2001 on five occasions, low dissolved oxygen concentrations (less than 5 mg/L) were measured in the Uwharrie River. In the preceding five years, 1991 - 1996, no values were recorded less than 6.9 mg/L.

Four lakes were monitored in this subbasin: McCrary, Bunch, Back Creek, and Reese. McCrary and Bunch Lakes were mesotrophic, while Back Creek Lake and Lake Reese were eutrophic. Lake Bunch and Lake Reese showed symptoms of increasing eutrophication (i.e., increasing productivity over time). Two algal blooms were also documented in Back Creek Lake in 1999.

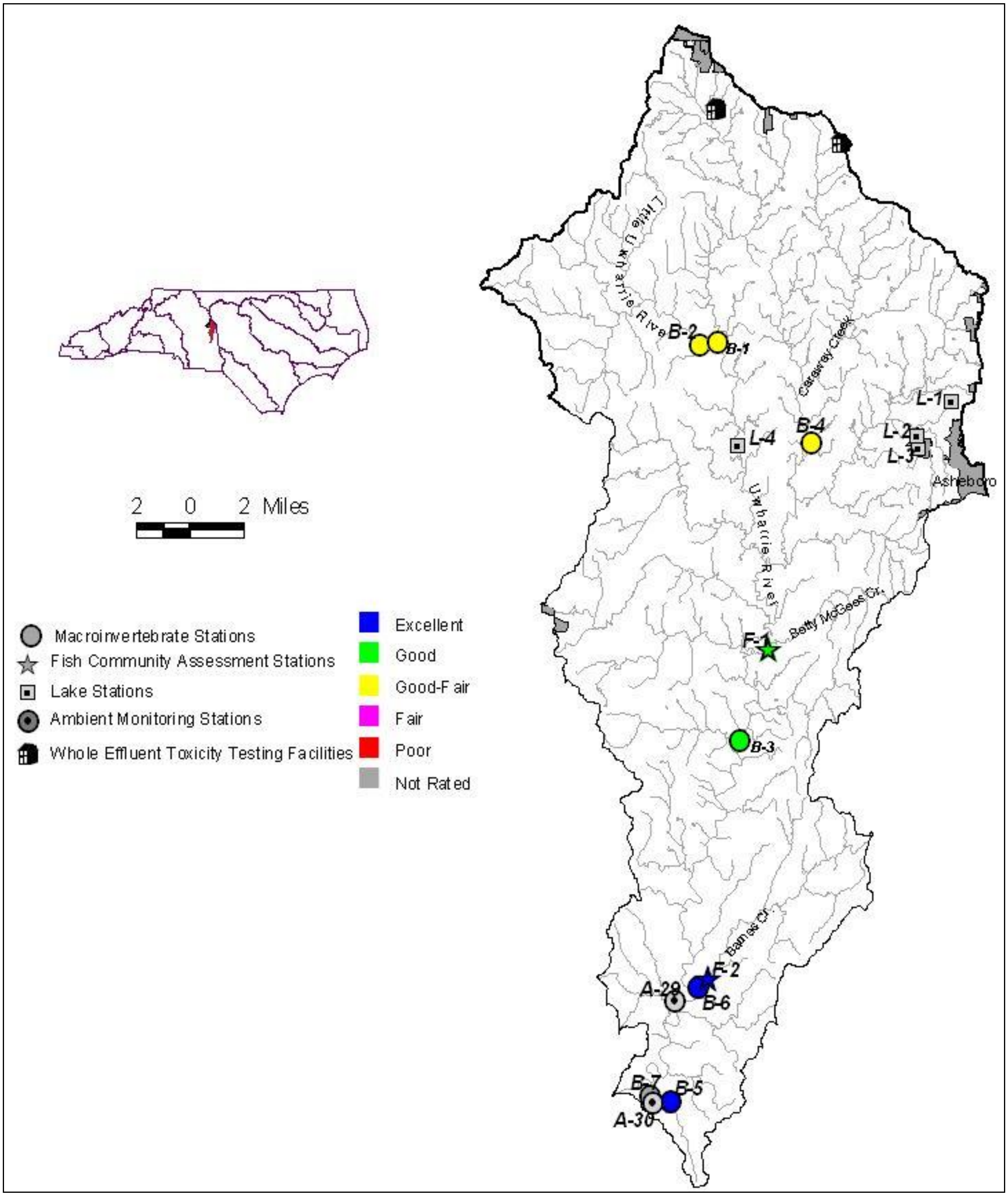


Figure 46. **Sampling sites in Subbasin 09 in the Yadkin River basin.**

Table 23. Waterbodies monitored in Subbasin 09 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Uwharrie R	Randolph	SR 1406	Good	Good-Fair
B-2	Little Uwharrie Cr	Randolph	SR 1405	Good-Fair	Good-Fair
B-3	Uwharrie R	Randolph	SR 1143	Good	Good
B-4	Caraway Cr	Randolph	SR 1331	Good-Fair	Good-Fair
B-5	Uwharrie R[2]	Montgomery	NC 109	Good	Excellent
B-6	Barnes Cr[2]	Montgomery	SR 1303	Excellent	Excellent
B-7	Dutchmans Cr[2]	Montgomery	SR 1150	Excellent	Not rated
F-1	Betty McGees Cr	Randolph	SR 1107	Excellent	Good
F-2	Barnes Cr	Montgomery	SR 1303	Good	Excellent
L-1	McCrary Lake	Randolph			Mesotrophic
L-2	Lake Bunch	Randolph			Eutrophic
L-3	Back Creek	Randolph			Eutrophic
L-4	Lake Reese	Randolph			Eutrophic

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

River and Stream Assessment

Mean monthly flows in this subbasin were extremely low during the summer of 2001 with insufficient flows for collection at Jackson and Back Creeks. Because this subbasin is primarily influenced by nonpoint source runoff, some sites had an increase in taxa richness at these low flow levels. Also due to the drought, streams channels during benthos collections were usually three to five meters narrower than in 1996. Mean stream widths given for each site included this between sampling period variation.

Conductivity measurements during the benthos collections were usually slightly higher in 2001 than 1996, especially in the smaller streams. No change, however, was observed at the largest site on the Uwharrie River. All headwater sites (Uwharrie River, Little Uwharrie River, and Caraway Creek) had elevated conductivity values in 2001 (131 - 146 μmhos/cm), reflecting either greater development and/or different geology.

The Uwharrie River at SR 1406, Randolph County, was not sampled for fish community assessment because sufficient data to evaluate the stream had been collected from this site as recently as 1999.

Uwharrie River, SR 1406

The headwaters of the Uwharrie River include some developed areas in the southern portions of High Point and Archdale, although most of the land use is agriculture and forest. The upper part of the catchment drains an area outside of the Slate Belt, and contributes large amounts of sediment.

There were two very different kinds of habitat at this site. The portion closest to the road was very sandy (Segment 1) with only one riffle near the bridge. There was severe bank erosion, although this process resulted in good root habitat. No mussels were observed, although the habitat seemed favorable for many species. Water filled only 25 percent of the channel under the extremely low flow conditions observed in 2001.

Segment 1, Uwharrie River at SR 1406, Randolph County.

About 200 meters further downstream (Segment 2), the stream bottom abruptly changes to a boulder-rubble substrate, with large amounts of bedrock. Many of the rocks in this segment had heavy growths of sponge, suggesting occasional periods of low dissolved oxygen. Segment 2 was included in the 2001 sample, but it was not sampled in 1996.

Segment 2, Uwharrie River at SR 1406, Randolph County.

This stream was given a Good-Fair rating in 1996 and 2001, but had low EPT abundance (61 and 64) for a stream in the subbasin. Most of the intolerant taxa collected in 2001 were found only in Segment 2.

Little Uwharrie River, SR 1405
The Little Uwharrie River is a rocky Slate Belt stream, with a mean width of 11 meters. There was only one good riffle area in this segment of the river with most of the segment composed of slow-moving runs or pools.

Little Uwharrie River at SR 1405, Randolph County.

This site was rated Good-Fair in 1996 and 2001, but EPT taxa richness was greater in 2001 than in 1996 (18 and 14 taxa, respectively). There was a large increase in the abundance of Baetidae (thee species) between 1996 and 2001, suggesting the effects of scour at the higher flows in 1996.

Of the three headwater streams sampled in the subbasin during 2001, the Little Uwharrie River had the best water quality. Several intolerant EPT taxa were abundant at this site, including *Leucrocuta*, *Neoperla*, and *Ceraclea ancylus*.

Uwharrie River, SR 1143
The Uwharrie River at SR 1143 is a rocky stream about 25 to 30 meters in width. Riffles are infrequent, separated by long pool/run areas with slow-flowing water. The surrounding land use is agricultural (largely row crops) and the riparian zone was only 12 to 18 meters wide. Most of the rocks were covered with a layer of silt and periphyton.

Uwharrie River at SR 1143, Randolph County.

Mussels were abundant in this part of the river. These were mostly *Elliptio complanata* group, but also collected was one specimen of *Villosa delumbis*. Other mollusc taxa were the dominant invertebrates at this site, especially *Corbicula fluminea* (the Asiatic clam) and the snail *Somatogyrus*.

This site received a Good bioclassification in 1996 and 2000, although there was an increase in EPT taxa richness from 19 to 27 under the low-flow conditions of August 2001. This increase in EPT taxa richness reflected the addition of rare species, with very little change in EPT abundance: (118 in 1996 and 111 in 2001). Water quality seemed to be stable in this portion of the Uwharrie River.

Caraway Creek, SR 1331
Caraway Creek had the worst habitat of any benthos sites in this subbasin. In contrast to most other streams in the subbasin, the substrate was mostly gravel (45%) and sand/silt (35%). Riffles were infrequent, stream banks were severely eroded, and there were frequent breaks in the riparian zone. This site also had the lowest dissolved oxygen concentration of any site in the subbasin during the 1996 and 2001 benthos surveys (5.4 and 5.8 mg/L, respectively). Conductivity increased sharply under low flow conditions, going from 56 µmhos/cm in 1996 to 131 µmhos/cm in 2001.

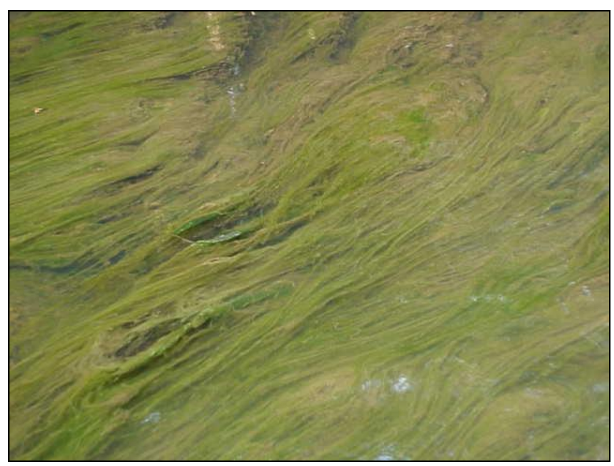
Caraway Creek at SR 1331, Randolph County.

This site received a Good-Fair rating in 1996 and 2001, with little change in EPT taxa richness (17 and 18) and EPT Abundance (65 and 79). Some intolerant taxa which were abundant in 2001, included *Chimarra* and *Isonychia*.

Betty McGees Creek, SR 1107
This stream is a fish community regional reference site. In 2001, the fish community was rated Good; in 1996 it was rated Excellent (NCIBI = 52 and 54, respectively). The only appreciable change in 2001 was an increase in the abundance and dominance of the redbreast sunfish from 7% to 31% of all the fish collected. This shift increased the percentage of tolerant fish from 17% to 35%.

Downstream view of Betty McGees Creek at SR 1107, Randolph County.

Uwharrie River, NC 109
The Uwharrie River at NC 109 integrates water quality from most of the upper subbasin. This is a large (27 to 33 meters wide) rocky river, with signs of nutrient enrichment. Much of the rocky substrate was covered with heavy growths of filamentous algae during summer samples. Abundant growth of river weed (*Potamogeton*) occurred in areas of faster current and large beds of water willow (*Justicia americana*) were found near the bridge.



Filamentous algae growing over rocky substrate, Uwharrie River at NC 109, Montgomery County.

Uwharrie River at NC 109, Montgomery County (water willow in background near bridge; riffle in foreground).

As observed at the SR 1143 site on the Uwharrie River, riffles were infrequent and separated by long stretches of slow-moving water. There was, however, good habitat diversity at this site since areas with more shade were not as choked by algal growths.

The Uwharrie River at NC 109 has been sampled six times between 1984 and 2001. Most of these collections produced a Good bioclassification, but this site edged into the Excellent category in 2001. This small change did not appear to indicate any long-term change in water quality, but reflected the low flow (and low scour) during the summer of 2001. This portion of the river is primarily affected by nonpoint source runoff, so that the level of stress should be proportional to either flow or rainfall.

Many rare taxa have been collected at this site; many of which are expected to be confined to large river sites. These taxa include *Leptohyphes robacki*, *Acroneuria arenosa*, *Psychomyia flavida* (1988 only), *Helicopsyche borealis* (2001 only), and *Villosa constricta* (1988).

Barnes Creek, SR 1303

Barnes Creek is a rocky Slate Belt stream with excellent habitat. The width is highly variable with a mean of 12 meters. About 100 meters upstream of the SR 1303 bridge, the stream is constricted to a width of only four meters, forming a long and fast-flowing riffle.

Barnes Creek above SR 1303, Montgomery County, at head of riffle.

Barnes Creek is classified as Outstanding Resource Water (ORW), and has consistently received an Excellent bioclassification. This site has seven summer collections since 1985, as well as spring (May 1985) and fall (October 1984) samples. This site is characterized by very high EPT taxa richness, with a maximum of 40 EPT collected in August 2001. Intolerant species are dominant, producing extremely low biotic index values (4.2 - 4.9) for a piedmont stream.

Barnes Creek was resampled in late September 2001 as part of the Biological Assessment Unit's Quality Assurance Program. In spite of some seasonal changes in the benthic macroinvertebrate community, EPT taxa richness (38) and the biotic index (4.2) were virtually identical to those from the August 2001 collection.

Barnes Creek (and Dutchmans Creek) drain the Uwharrie Mountains, and some highly disjunct mountain taxa are found in these streams: *Epeorus rubidus*, *Dolophilodes*, *Rhyacophila vuphipes* (single larvae in 2001), and *Symphitopsyche sparna*. Other unusual taxa include *Stenonema vicarium*, *Helicopsyche borealis*, *Micrasema bennetti*, and *Psilotreta.*

Like Betty McGees Creek, Barnes Creek is a fish community regional reference site. The conductivity was 45 µmhos/cm - the lowest of any stream in the piedmont portion of the basin which was monitored in 2001.

The fish community has been sampled in 1996, 1997, and 2001. In 1996 the community was rated Good. In 1997 the monitoring site was moved upstream away from the bridge pool to an area more characteristic of the stream. However, the community was not rated in 1997 due to high flow impacts from Hurricane Fran in 1996, other high flow events in 1996 and 1997 followed by extremely low flows in 1997 prior to sampling in October 1997.

In 2001, the community was rated Excellent. The diverse community was represented by three species of suckers, darters, and intolerant species, including an introduced, but reproducing population of smallmouth bass.

Dutchmans Creek, SR 1150

Dutchman's Creek was established as a small-stream reference site, and shares many of the same species recorded at Barnes Creek. This stream was too small to rate under low-flow conditions in 1995 and 2001, but this site received an Excellent rating in 1996 when the mean width was four meters. All three collections suggested excellent water quality based on the assemblage of highly intolerant invertebrate species. There was no significant difference in biotic index and EPT taxa richness in 2001 compared to data from 1996. The low water level in 2001 resulted in poor leafpack and root habitats.

Dutchmans Creek at SR 1150, Montgomery County, under low-flow conditions.

SPECIAL STUDIES

Fish Community Temporal Variability

The fish community in the Uwharrie River at SR 1406, Randolph County, was sampled in April, June, and October 1999 to determine the temporal variability of the NCIBI during NC DWQ's traditional monitoring period. The community was rated Excellent in April and June, but only Good-Fair in October. The decline in October followed a prolonged summer drought and extremely high flows from Hurricane Floyd. Except for detectable impacts from summer-long droughts and late summer hurricanes, it was determined that seasonality was not an important factor to consider when using the NCIBI to assess the fish community of a stream (Biological Assessment Unit Memorandum 09222000).

Lake Assessment

McCrary Lake
McCrary Lake is primarily used to regulate flow upstream of Lake Bunch, which is a water supply source for the City of Asheboro (Figure 47). A landfill is located on the west side of McCrary Lake and Lake Bunch.

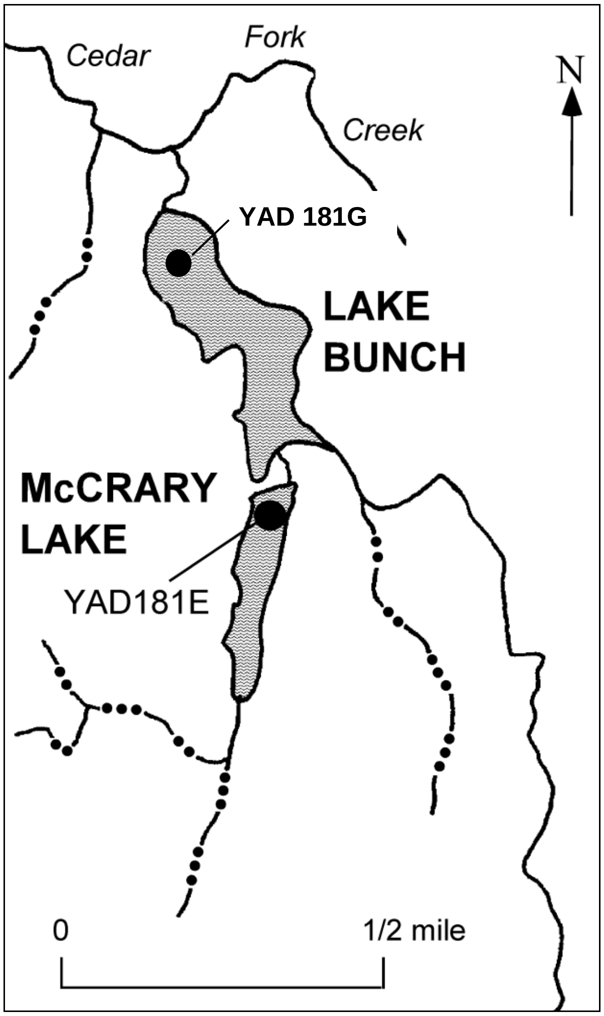


Figure 47. Sampling sites at McCrary Lake and Lake Bunch, Randolph County.

McCrary Lake was monitored in 1999, 2000, and 2001. Surface dissolved oxygen concentrations were elevated as was percent dissolved oxygen and pH. Elevated dissolved oxygen and pH values suggested increased algal productivity. Secchi depths were greater than two meters, indicating good light availability in the photic zone. Total phosphorus concentrations have ranged from low to elevated and total organic nitrogen concentrations have ranged from moderate to elevated.

As in some of the other lakes in the basin, manganese was elevated in one sample (260 µg/L). Hypoxic conditions at a depth of three meters to the bottom of the lake (4.6 meters) may have resulted in release of manganese from the sediment. This exceedance does not represent a threat to the use of the water.

In 2001, McCrary Lake was mesotrophic based on the calculated NCTSI score. This is in keeping with previous trophic status determinations. The lake appears to be supporting its designated uses.

Lake Bunch
Lake Bunch was built by the City of Asheboro for use as a water supply reservoir in 1932. This lake is located on an unnamed tributary to Cedar Fork, which eventually flows into Back Creek Lake another water supply lake used by the City of Asheboro (Figure 47).

Lake Bunch was monitored in 1999, 2000, and 2001. Secchi depths ranged from 2.2 to 4.8 meters, indicating very good light availability within the photic zone. The lake was stratified and, according to the dissolved oxygen depth profile in 2000, there appeared to be increased photosynthetic activity along the thermocline (Figure 48).

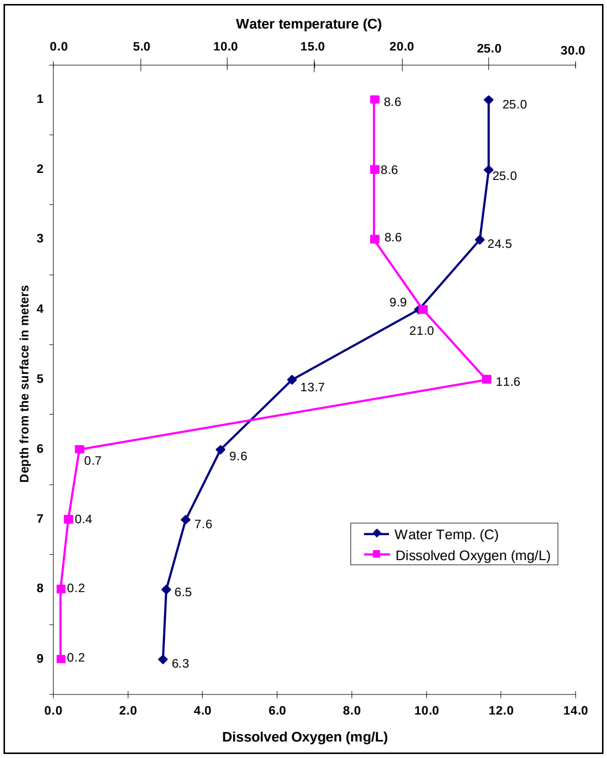


Figure 48. Dissolved oxygen and water temperature profiles for Lake Bunch, June 6, 2000.

Total phosphorus and total organic nitrogen concentrations ranged from low to moderate in 1999 through 2000, and elevated in 2001. Chlorophyll *a* in 2001 ranged from low (6 µg/L) to moderate (21 µg/L). Analysis of the phytoplankton sample collected in July 1999 indicated blue-green algae to be dominant.

Lake Bunch has a history of blue-green algae blooms occurring below the surface of the lake, which do not usually result in elevated chlorophyll *a* concentrations. The calculated trophic status of this lake has varied from oligotrophic to eutrophic since 1989 when it was first monitored. Although oligotrophic and mesotrophic conditions have been observed, symptoms of increased productivity (blue-green algae bloom along with elevated dissolved oxygen and pH within the photic zone) suggest that accelerated eutrophication is occurring. The presence of blue-green algae may be depressing the trophic status due to their low *chlorophyll a* concentrations and increasing uptake of nutrients. Additional sampling and watershed assessment would be useful in better managing this water body.

Based on the calculated NCTSI scores, Lake Bunch was mesotrophic in early August and eutrophic in late August 2001.

Back Creek Lake (Lake Lucas)

Back Creek Lake (also called Lake Lucas) is the primary water supply for the City of Asheboro (Figure 49). The reservoir is part of a public park where fishing, boating, and swimming are common. The maximum depth is eight meters and the maximum water extraction rate is 5 MGD. Hypolimnetic aerators have been installed near the water intake structure to improve the quality of the water before it is withdrawn for treatment. Back Creek and Greenes Branch drain the rolling terrain of the watershed. Approximately one-half of the drainage area is wooded and most of the remainder is cultivated. Dairy operations are located within the upper watershed.

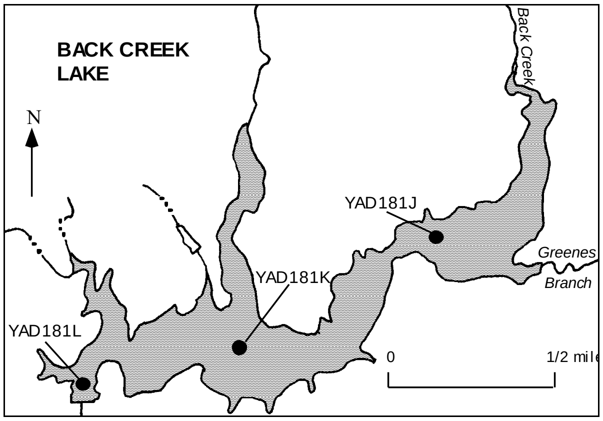


Figure 49. Sampling sites at Back Creek Lake, Randolph County.

Back Creek Lake was most recently monitored in 1999 and 2001. Secchi depths in 1999 were usually less than one meter and the water color was described in field notes as brownish-green. In 2001, Secchi depths were slightly better and averaged 1.1 meter. Field notes for August 2001 indicated that the water color was green. Surface dissolved oxygen was elevated at each sampling site. Percent dissolved oxygen values were usually greater than the state water quality standard of 110% for dissolved gasses (range = 112% - 130%). Surface pH values in 1999 were also elevated.

Total phosphorus was elevated in 1999 and 2001 while total organic nitrogen was moderate in 1999 and elevated in 2001. The availability of nutrients along with elevated dissolved oxygen and pH values indicated that this lake is very productive.

Algal bloom samples collected in June 1999 indicated that a bloom was indeed present and that the dominant algae was an unidentified golden-brown. A second algal bloom was confirmed in July when samples were dominated by filamentous blue-green and green algae. The blue-green algae found in the July samples, *Anabaena aphanizomenoides,* is a known contributor to taste and odor problems in drinking water. This finding agreed with the public complaints regarding the bad taste of the drinking water, which had been reported by the Director of Water Resources for the City of Asheboro (Allen, Melvin. 1999).

Based on the calculated NCTSI scores, Back Creek Lake has been eutrophic since first monitored 1989.

Lake Reese
In 1983, the City of Asheboro impounded the Uwharrie River to form Lake Reese, a water supply that is also used for recreation (Figure 50). This lake is only used after the primary water supply (Back Creek Lake) has a three-foot drop in level.

Lake Reese has been monitored since 1989, with the most recent sampling occurring in the summers of 1999 through 2001. Nutrient concentrations ranged from low to moderate and chlorophyll *a* values were also moderate. Field notes for August 2001 indicated that the water was yellow, which may have been associated with elevated levels of algae.

The lake was eutrophic in July and August 2001 based on the NCTSI scores. In 1994, the lake was borderline eutrophic/mesotrophic and in 1989, when this lake was first monitored, the lake was mesotrophic. The productivity in this lake seemed to be increasing.

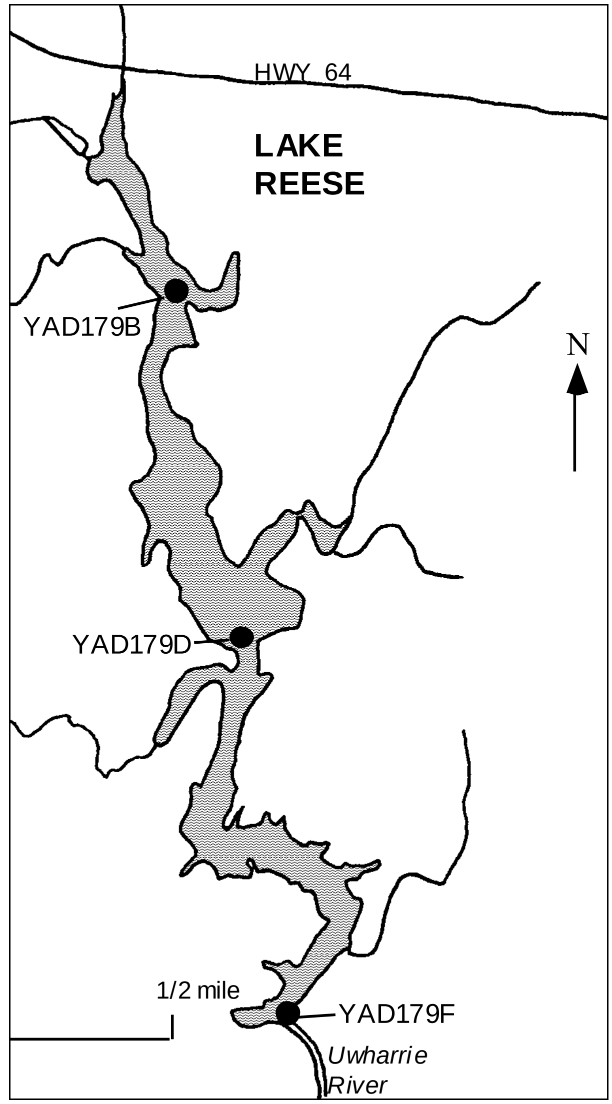


Figure 50. Sampling sites at Lake Reese, Randolph County.

YADKIN RIVER SUBBASIN 10

Description

This subbasin consists of the portion of the Pee Dee River and its tributaries from the Rocky River confluence to the dam at Blewett Falls Lake (Figure 51). Almost 80 percent of the landuse in the subbasin is forested (Table 24). Although the Town of Wadesboro is the largest urban area in the subbasin, only 0.4 percent of the subbasin is urban - the lowest percentage in the entire Yadkin River basin. There are no large (0.5 MGD or greater) dischargers in this subbasin.

Table 24. Landuse in Subbasin 10. Based upon CGIA coverage 1993 - 1995 (total area = 260,429 Ac).

Landuse	Percent
Water	1.7
Cultivated crop	11.9
Pasture	7.3
Urban	0.4
Forest	78.7

Although the subbasin is located entirely in the piedmont ecoregion of the state, Brown Creek (the largest tributary to the Pee Dee in this subbasin) and many of its tributaries are in the Triassic Uplands. Streams in the middle and lower part of the Brown Creek watershed have coastal plain characteristics and very little flow during the summer. In contrast, Clarks Creek, Mountain Creek and their tributaries are located in more hilly topography in the Carolina Slate Belt and have good flow during the summer. The Mountain Creek Corridor is a nearly continuous woodland corridor, more than 10 miles long. It includes the entire Richmond County portion of Big Mountain Creek. The corridor is a regionally significant site (Sorie 2001).

Overview of Water Quality

There are presently three ambient monitoring sites in this subbasin: one on Brown Creek and two on the Pee Dee River. Dissolved oxygen values recorded at Brown Creek were the lowest in the entire basin. Chemistry data also show moderately low nutrient levels.

Benthos samples were collected at Mountain and Clarks Creeks (Table 25). A decline in EPT taxa richness dropped the bioclassification of Mountain Creek from Excellent to Good, however abundance and biotic index values suggest no change in water quality. The decline was most likely related to the very low flows at the time of the summer sample. Clarks Creek maintained a Good-Fair rating despite the low flows.

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In contrast to the benthos data, fisheries data from Clarks Creek revealed a diverse and abundant community with 19 species including four species of suckers and two intolerant species. It was designated a regional reference site with a rating of Excellent. Cedar Creek, another fish reference site, was rated Good-Fair. No intolerant species were present possibly due to lack of year-round flow. With a rating of Good, Brown Creek had a diverse fish community including the Carolina darter, a state-listed species of “Special Concern,” and eight species of sunfish.

Blewett Falls Lake has shown predominantly eutrophic conditions since first monitored in 1981

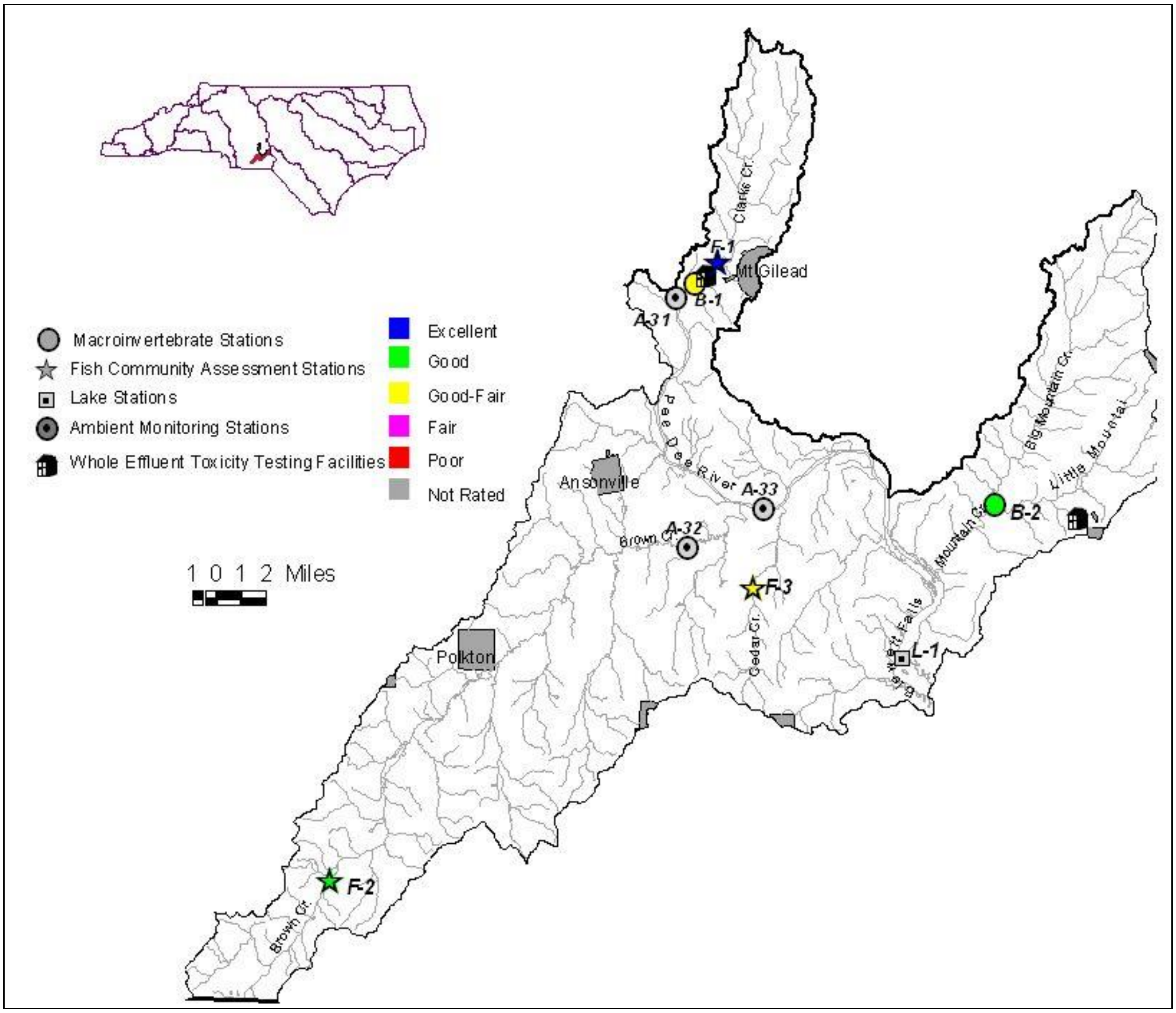


Figure 51. **Sampling sites in Subbasin 10 in the Yadkin River basin.**

Table 25. **Waterbodies monitored in Subbasin 10 in the Yadkin River basin for basinwide assessment, 1996 - 2001.**

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Mountain Cr	Richmond	SR 1150	Excellent	Good
B-2	Clarks Cr	Montgomery	SR 1110	Good-Fair	Good- Fair
F-1	Clarks Cr	Montgomery	SR 1188	---	Excellent
F-2	Brown Cr	Anson	SR 1230	Good	Good
F-3	Cedar Cr	Anson	SR 1709	Not rated	Good-Fair
L-1	Blewett Falls Lake	Anson		---	---

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

Due to extremely low flow conditions, Brown Creek at SR 1620 was not sampled in 2001. Low summer flow may help explain the Fair rating received in 1996.

The Mountain Creek watershed in Richmond County was not sampled for fish community assessment because sufficient data to evaluate the streams had been collected from several sites as recently as 1999.

Mountain Creek, SR 1150
Mountain Creek at SR 1550 is 8 - 10 meters wide with a bedrock and rubble substrate. This site had a low habitat score due to infrequent pools and riffles plus a riparian zone fragmented by the gravel road on one side.

Mountain Creek at SR 1150, Richmond County.

This site received a bioclassification of Excellent in 1996, but was rated Good in 2001 due to a decline in EPT taxa richness (from 30 to 25). EPT abundance, however, was similar for both years (135 and 136), suggesting no significant change in water quality. Taxa that were lost (such as *Baetis* spp.), were somewhat tolerant, while those that appeared (*Anisocentropus* and *Nyctiophylax*) were intolerant. This change in taxa resulted in an improved EPT biotic index for 2001.

Clarks Creek, SR 1188
Clarks Creek was sampled for the first time for fish community assessment in 2001. The site is above the Town of Mount Gilead's WWTP discharge and approximately three miles above its mouth at the Pee Dee River. At this crossing, the instream, riparian, and watershed characteristics qualified the site as a new regional reference site.

Downstream view of Clarks Creek at SR 1188, Montgomery County.

The community was rated Excellent. The diverse and abundant community was represented by 19 species including 4 species of suckers, 3 species of darters, and 2 intolerant species. The bluehead chub was the most abundant species collected.

Clarks Creek, SR 1110
Clarks Creek is a medium-sized stream, five to eight meters wide during the summer. This benthos site is located just upstream of the Town of Mt Gilead's WWTP. Flow in 2001 was confined to areas where the stream was only one to two meters wide. This stream had good habitat, but it was difficult to find leafpacks and root mats. There was some sand deposition in pools, but fish still appeared to be very abundant in the pools.

Clarks Creek at SR 1110, Montgomery County.

A pleurocerid snail (*Elimia*) was very abundant at this site, possibly competing with other grazing invertebrate species. A Full Scale sample was collected in 1996, but only an EPT sample was collected in 2001 due to extremely low flow conditions.

This site received a Good-Fair bioclassification in 1996 and 2001. A slight decline in EPT taxa richness was observed, similar to that observed at Mountain Creek, and this change is most likely related to the very low flow conditions in August 2001. The abundance of several intolerant taxa in 2001 (*Chimarra* and *Isonychia*) suggested only minor water quality problems in this stream.

Brown Creek, SR 1230

Brown Creek originates in Chesterfield County, South Carolina and flows through the southeastern corner of Union County before crossing into southwestern Anson County. The fish community monitoring site at SR 1230 is located in the upper part of the watershed. At this site, instream and riparian habitats show some signs of habitat alteration: an embedded sand and gravel substrate, easily erodible banks, and infrequent gravel riffles.

Downstream view of Brown Creek at SR 1230, Anson County.

In 1996 and 2001, the fish community was rated Good (NCIBI = 48 and 52, respectively). Slight improvements noted included a decrease in the percentage of tolerant fish from 30% to 20% and an increase in the percentage of piscivores from 0.65% to 7.1%.

With the stream having an abundance of undercut banks and root mats, the pirate perch was the most abundant species. The Carolina darter, a state-listed species of "Special Concern", was the second most abundant species; it was also present in 1996. The diverse community included eight species of sunfish. Two of these species, the flier and mud sunfish, are more characteristic of Coastal Plain rather than piedmont streams. The mud sunfish is rare in the Yadkin River basin. Brown Creek was 1 of 4 streams monitored in 2001 where the bluehead chub was not collected. It has yet to be collected in this watershed (Menhinick 1991).

Cedar Creek, SR 1709

This small stream, a tributary to the Pee Dee River, is a fish community regional reference site. The watershed is 8.6 square miles. Because of its size and location in the Triassic Uplands, the stream may go intermittent during low flow periods.

Upstream view of Cedar Creek at SR 1709, Anson County.

As a regional reference site, the sample collected in 1996 should have been rated Good or Excellent. However, the 1996 sample was not given a rating because it was considered as an outlier of the data set (Biological Assessment Unit Memorandum (09222000).

In 2001, the community was rated Good-Fair (NCIBI = 46). No intolerant species or piscivores were collected. The same species were dominant during both monitoring cycles: creek chub, redlip shiner, bluehead chub, rosyside dace, and redbreast sunfish.

The stream's lack of year-round, sustained flow may impact the fish community and cause the ratings to be lower than what they should be for a regional reference site.

SPECIAL STUDIES

Fish Community Reference Sites

In 1998, Big Mountain Creek at SR 1319, Richmond County, was evaluated as a regional fish community reference site. The fish community was rated Excellent (Biological Assessment Unit Memorandum 09222000). The stream will again become a basinwide monitoring site in 2006.

Fish Community Temporal Variability

The fish community in Big Mountain Creek at SR 1319, Richmond County, was sampled in April, June, and October 1999 to determine the temporal variability of the NCIBI during NC DWQ's traditional monitoring period. The community was rated Excellent in April, Good in June, and Good-Fair in October (NCIBI = 54, 52, and 46, respectively). The decline in October followed a prolonged summer drought and then extremely high flows from Hurricane Floyd. Except for detectable impacts from droughts and hurricanes, it was determined that seasonality was not an important factor to consider when using the NCIBI to assess the fish community of a stream (Biological Assessment Unit Memorandum 09222000).

Fish Community Spatial Variability

The fish communities in Big Mountain Creek at SR 1319, NC 73, and SR 1005, Richmond County, were sampled in April 1999 to determine the spatial variability of the NCIBI. The three sites were rated Excellent or Good (NCIBI = 54, 52, and 54, respectively). This indicated replicability of the NCIBI when water quality or land use did not change and when no major tributaries joined the stream (Biological Assessment Unit Memorandum 12101999 and 09222000).

Lake Assessment

Blewett Falls Lake

Blewett Falls Lake, a eutrophic, run-of-the-river impoundment, is the most downstream of the Yadkin River Chain Lakes in North Carolina (Figure 52). The reservoir is owned by Carolina Power and Light and has a mean hydraulic retention time of seven days. The reservoir receives the majority of its inflow from the discharge of the upstream reservoir, Lake Tillery.

The reservoir was most recently monitored in 1999. As was seen in previous years, surface dissolved oxygen, pH and percent oxygen saturation were all elevated. Secchi depths were within one meter and nutrient concentrations ranged from moderate to elevated. A phytoplankton sample collected in July from the sampling site near the dam was dominated by blue-green algae. Previous phytoplankton analysis also showed blue-green algae as the dominant species. The short retention time of this water body probably prevents blooms from occurring even in the presence of elevated nutrient concentrations.

This reservoir has demonstrated predominantly eutrophic conditions since 1981 when it was first monitored.

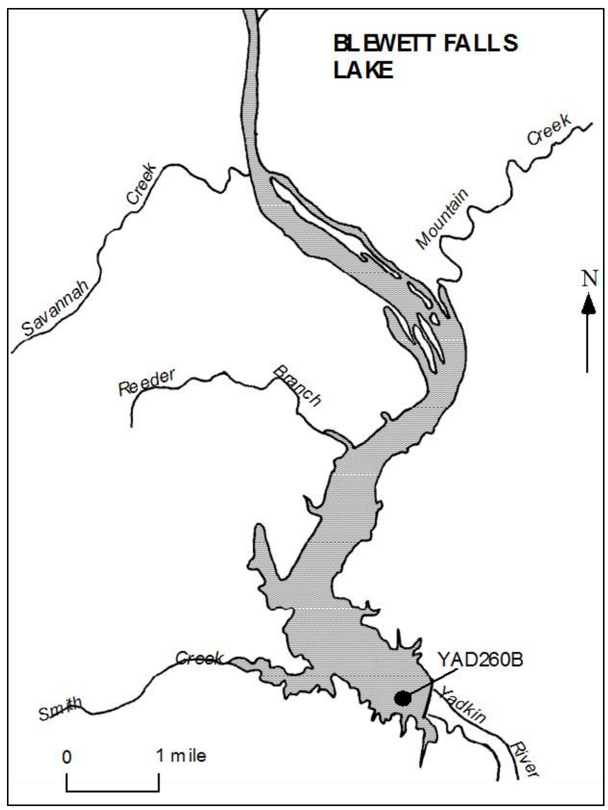


Figure 52. Sampling site at Blewett Falls Lake, Anson and Richmond counties.

YADKIN RIVER SUBBASIN 11

Description

This subbasin includes the uppermost reach of the Rocky River watershed, primarily in Cabarrus County (Figure 53). The Rocky River, the largest tributary of the Yadkin River, flows for approximately 25 river miles in this subbasin from its headwaters near Mooresville in Iredell County to its confluence with Irish Buffalo Creek.

This subbasin contains the urban areas of Mooresville, Concord, Cornelius, Davidson, Huntersville, the I-77 and I-85 corridors, and the populous area of eastern Mecklenburg County. Landuse is still predominantly forest (Table 26).

Table 26. Landuse in Subbasin 11. Based upon CGIA coverage 1993 - 1995 (total area = 177,207 Ac).

Landuse	Percent
Water	0.5
Cultivated crop	3.0
Pasture	29.4
Urban	6.1
Forest	60.9

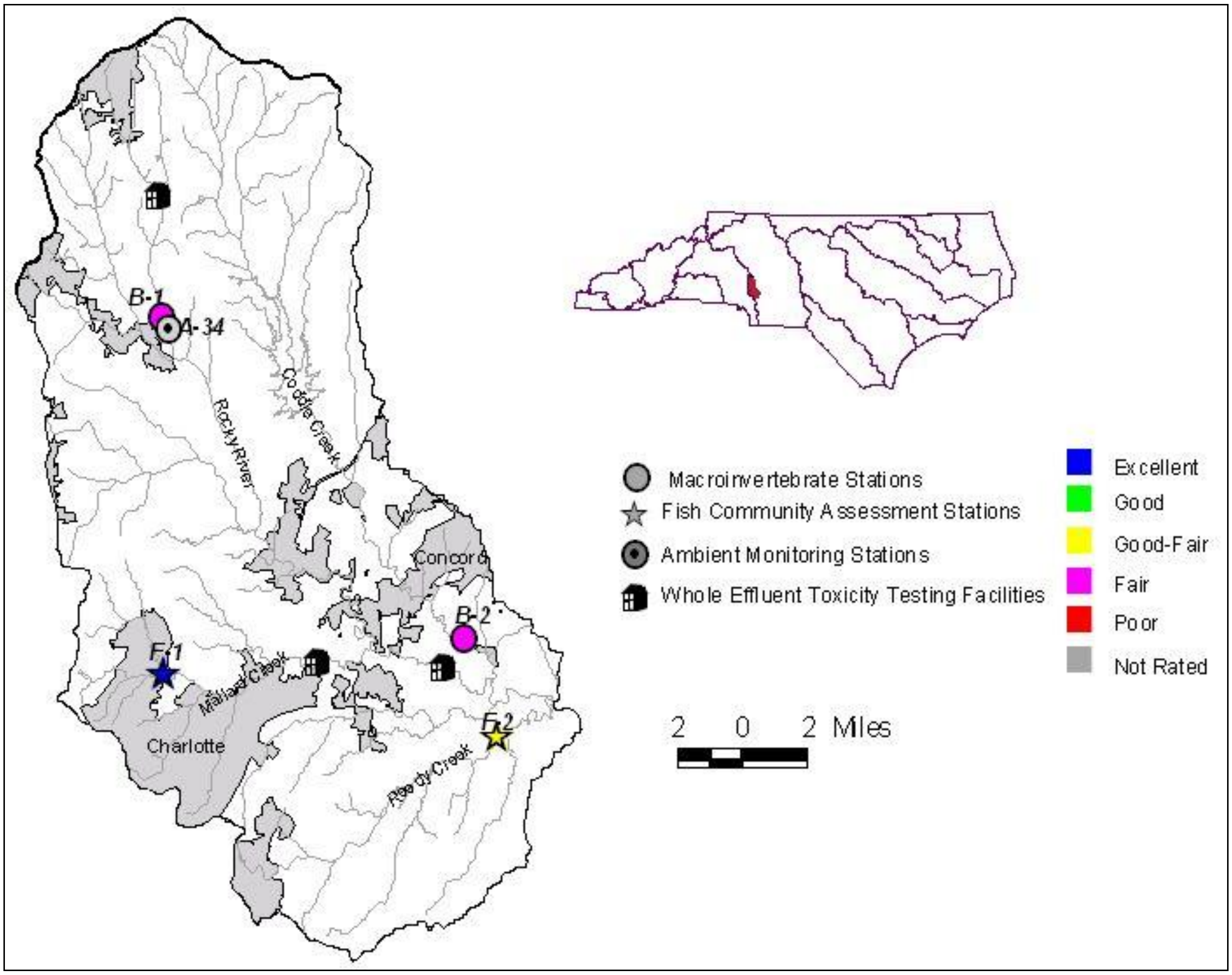


Figure 53. Sampling sites in Subbasin 11 in the Yadkin River basin.

Overview of Water Quality

Ambient monitoring data were collected from one location in this subbasin: the Rocky River near Davidson. This location is below the City of Mooresville's Rocky River WWTP (permitted flow = 5.2 MGD, instream waste concentration = 94 percent) which discharges to Dye Branch. Results of intensive investigations of this facility have indicated the waste is having a deleterious impact to Dye Branch and the Rocky River below the discharge point. High levels of nutrients and fecal coliform concentrations, as well as extremely high conductivities, have been documented in the Rocky River. In 21 percent of the samples, copper concentrations were greater than the action level and 70 percent of the samples exceeded turbidity standards.

Biological samples collected from the same site have indicated stressed conditions (Table 27). Fair and Poor bioclassifications were given to this site during benthic macroinvertebrate and fish community surveys conducted during 1999 and 2001. Good-Fair and Fair water quality conditions have been consistently recorded from most sites in this subbasin. These water quality conditions are the result of both nonpoint source runoff and point source discharges. A Fair bioclassification was assigned in 1996 and 2001 to Coddle Creek, which drains much of the suburban area of the Town of Concord.

Fish community sampling resulted in an Excellent rating in Mallard Creek due to very good instream habitat, and Good-Fair in Reedy Creek, a site with adequate woody debris instream habitat provided by the eroding banks.

Table 27. Waterbodies monitored in Subbasin 11 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Rocky R[2]	Mecklenburg	SR 2420	Fair	Fair
B-2	Coddle Cr	Cabarrus	NC 49	Fair	Fair
F-1	Mallard Cr	Mecklenburg	SR 2467	Good	Excellent
F-2	Reedy Cr	Cabarrus	SR 1136	---	Good-Fair

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

River and Stream Assessment

Rocky River at SR 1608, Cabarrus County, was not sampled for fish community assessment because sufficient data to evaluate the stream had been collected from this site as recently as 1999.

Rocky River, SR 2420
The Rocky River at SR 2420 in Mecklenburg was selected to represent water quality from an upstream reach of this river. This site is below the Mooresville/Rocky River WWTP (permitted flow of 5.2 MGD, IWC = 94%) which discharges to Dye Branch.

This reach of the Rocky River is very small (approximately four meters wide) and has a very sandy substrate. This location has consistently received a Fair bioclassification based on benthos data, since 1985. However, the BI has steadily increased and the Total Taxa and total EPT Taxa counts have decreased since 1985. The low taxa count and high BI in 2001 could be accounted for by the low flows which increase the concentration of any effluent to the stream. Only a single mayfly and stonefly specimen were collected from this location in 1996, and no stoneflies were collected in 2001, suggesting that the Mooresville/Rocky River WWTP and poor habitat characteristics are impacting stream quality.

The habitat score here dropped from 55 in 1996 to 43 in 2001. The one riffle found in 1996 has since become buried in sediment, and the banks have become more unstable with less plant cover.

Mallard Creek, SR 2467
Although the upper watershed of Mallard Creek is fairly developed, the instream habitats are still good. The stream is in the Carolina Slate Belt which accounts for the stream's extremely rocky and angular substrate. Unusual for a stream in a developed watershed, the stream is not

channelized, the embeddedness is low, riffles are frequent, and the banks are stable.

Upstream view of Mallard Creek at SR 2467, Mecklenburg County.

The fish community was rated Good in 1996 and Excellent in 2001 (NCIBI = 50 and 56, respectively). The community was diverse, abundant, and except for the lack of piscivores, it had a balanced trophic structure. The fish were free of disease and 75 percent of the species were represented by multiple age classes. The redlip shiner and the bluehead were the two most abundant species collected.

Coddle Creek, NC 49

A site on Coddle Creek was selected to assess the water quality of the catchment above the confluence with the Rocky River. Coddle Creek at this location is five meters wide and has a substrate dominated by sand and silt. Pools are filled in with sediment, instream substrate available for insect colonization is limited, and riffles are rare. This location is below the Concord metropolitan area and receives urban runoff.

Coddle Creek at NC 49, Cabarrus County.

A Fair bioclassification was given to this location in 1996 and 2001. The benthic fauna was dominated by tolerant taxa including *Tricorythodes*, *Baetis intercalaris*, and *Cheumatopsyche,* and *Rheotanytarsus.* The Asiatic clam, *Corbicula fluminea*, was also very abundant.

Reedy Creek, SR 1136

Reedy Creek was sampled for the first time for fish community assessment in 2001 because part of the watershed is in a growth area of eastern Mecklenburg County. The site is downstream from a cluster of package wastewater treatment plants which may have contributed to the elevated conductivity which was observed (211 µmhos/cm).

At this site, severe bank erosion is contributing large volumes of sand into the stream. Presently, the sloughing banks and bank failure also contribute large quantities of large, woody debris (tree trunks) which provides good instream habitats such as snags and side pools around the trunks. As prolonged erosion continues, the riparian zone will eventually become narrower with more breaks. As expected with such quantities of sand in the channel, riffles are absent.

Downstream view of Reedy Creek at SR 1136, Cabarrus County.

The fish community was rated Good-Fair (NCIBI = 46). No piscivores were collected and only one species of darter (and one individual) was present. The abundance of omnivores and the dominance by the bluehead chub were indicative of some nutrient enrichment.

SPECIAL STUDIES
303 (d) Streams
Dye Creek, SR 1147
This site is above the Mooresville/Rocky River WWTP which has a permit to discharge 5.2 MGD into Dye Creek. This three meter wide site had a sandy substrate with few riffles. Pools were absent, snags and root mats were rare, but sticks and leaf packs were common. It was obvious that this site was being filled in with large quantities of sand as evidenced by filled pools and thick deposits of instream sand.

Dye Creek at SR 1147, Iredell County.

Samples from 1985 and 1990 both resulted in Fair bioclassifications with 14 and 13 EPT species, respectively and BI's of 6.53 and 6.33, respectively. For 2001, this site was not rated, because it was less than 4 meters wide. Had it been larger, it would have received a Fair bioclassification with 9 EPT species and a BI of 6.35. It seemed that the Fair bioclassification at this site has been stable since 1985.

Dye Creek, SR 1142
This site was directly below the Mooresville /Rocky River WWTP. This four meter wide site had good mix of bedrock, boulder, gravel, and sand substrates. The flow was swift, sticks and leaf pack habitats common, but snag, bank, and root mat habitats were rare.

In 1985 and 1990, this site received Poor bioclassifications both times with 4 EPT species present in each sample, and with BI's of 8.15 and 7.95, respectively. For 2001, this site also received a Poor bioclassification with a BI of 7.75 and 2 EPT taxa present.

Dye Creek at SR 1142, Iredell County.

The instream waste concentration from the WWTP at the time of sampling was extremely high and the smell of residual chlorine was nearly overwhelming. It is clear that the WWTP is having an adverse impact on this reach of Dye Branch and conditions here, since 1985, have not improved.

Fish Community Repeatability at Impaired Sites
The Rocky River at SR 1608, Cabarrus County, was sampled in 1999 to determine the multi-year temporal repeatability of the NCIBI at sites with known poor water quality. Sampled downstream

from the Town of Mooresville's WWTP (5.2 MGD), the conductivity was approximately 400 - 500 µmhos/cm during 1996 and 1999.

In 1996 and 1999, the fish community was rated Poor (NCIBI = 34 and 32, respectively). The community is depauperate, the diversity is low, and the incidence of diseased fish is high (NCDWQ unpublished data). If improvements to the discharge occur, the site may once again become a basinwide monitoring site in 2006.

Other Data

Between 1997 and 1999, the Mecklenburg County Department of Environmental Protection monitored fish communities in Mecklenburg County and applied an earlier version of the NCIBI to determine the ecological health of several streams (MDEP 1998, 1999, 2000). The collection methods and rating system are not directly comparable to those currently used by the NC DWQ. These data are given for comparative purposes only (Table 28).

Table 28. Fish community data collected by the Mecklenburg County Department of Environmental Protection, 1997-1999.[1]

Waterbody	Location	Year	Score	Rating
Clarke Cr	SR 1449	1997	46	Fair-Good
N Pr Clarke Cr	SR 2442	1997	46	Fair-Good
S Pr Clarke Cr	SR 2442	1997	38	Poor-Fair
Ramah Cr	SR 2425	1997	38	Poor-Fair
Toby Cr	SR 2840	1999	36	Poor-Fair
		1998	40	Fair
	Knollwood Ct	1999	48	Good
		1998	40	Fair
		1997	44	Fair

[1]All data are from Mecklenburg County, except for Clarke Creek which was from Cabarrus County.

YADKIN RIVER SUBBASIN 12

Description

This subbasin contains the middle portion of the Rocky River watershed and four of its largest tributaries: Irish Buffalo, Dutch Buffalo, Goose, and Crooked Creeks (Figure 54). The middle reach of the river is approximately 20 miles long. Streams in this subbasin primarily drain the populous Kannapolis-Concord area of central Cabarrus County. Landuse is predominantly forest and pasture (Table 29).

Table 29. Landuse in Subbasin 12. Based upon CGIA coverage 1993 - 1995 (total area = 278,017 Ac).

Landuse	Percent
Water	0.6
Cultivated crop	8.8
Pasture	32.0
Urban	5.0
Forest	53.6

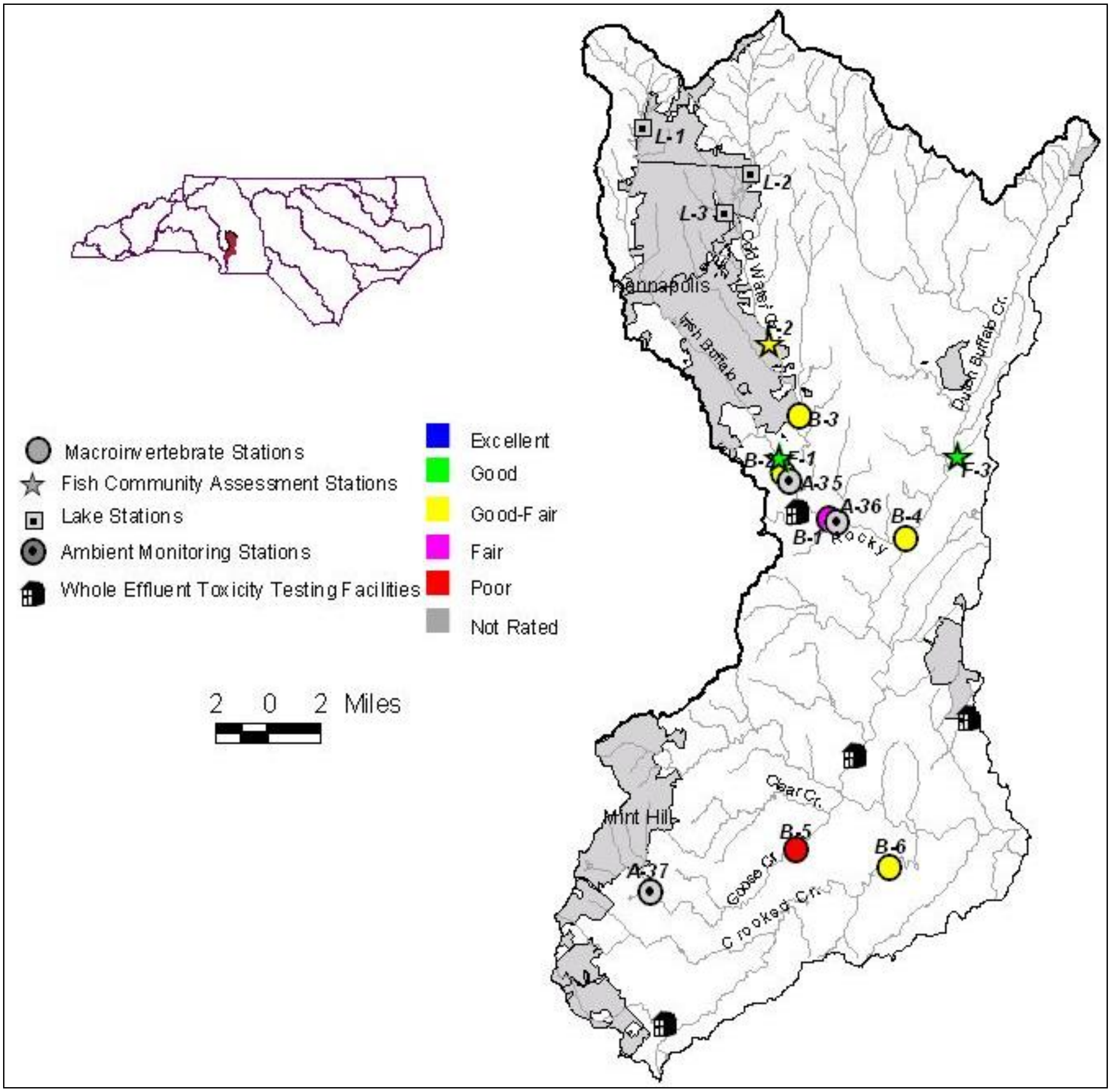


Figure 54. Sampling sites in Subbasin 12 in the Yadkin River basin.

Streams within this subbasin are contained within two distinct subecoregions. Tributaries in the subbasin's northern half (Irish Buffalo and Dutch Buffalo Creeks) are within the piedmont ecoregion and are dominated by sandy substrates and stable habitats are limited and scoured during spate events. However, streams in the southern half (Goose and Crooked Creeks) are typical Carolina Slate Belt streams. The instream habitats are stable, but the streams are susceptible to lack of flow during dry periods.

Most of the numerous dischargers in this subbasin are small (< 0.5 MGD). There are four facilities that discharge to Goose Creek with a total flow of 0.8 MGD.

Overview of Water Quality

There are three ambient monitoring locations in this subbasin: Irish Buffalo Creek near Faggarts, Rocky River near Concord, and Goose Creek near Mint Hill. The Rocky River location monitors water quality conditions of the middle reaches of this system, but, this site is approximately one mile below the Rocky River Regional WWTP (permitted flow = 24 MGD, instream waste concentration = 73 percent). Water quality reflected the effects of this facility. Extremely high conductivities were reported as well as high pH and nutrient and fecal coliform concentrations. Unusually high dissolved oxygen data indicated algal blooms in Irish Buffalo and Goose Creeks. Ten percent of the samples from these stations exceeded the turbidity standard. High nutrient values were also recorded from Goose Creek.

In 1996 and 1989, a Good-Fair bioclassification was given to this same site on the Rocky River based on benthic macroinvertebrate data (Table 30). The Fair rating in 2001 reflected the effects of the WWTP effluent on the stream during a drought year.

The other ambient monitoring locations are in urban/suburban (Irish Buffalo Creek) or agricultural (Goose Creek) catchments. Based upon benthic data , Irish Buffalo Creek was rated Good-Fair in 1996 and 2001. Goose Creek was rated Poor in both years based on data collected during the basinwide investigation.

Fish community data also indicated Good or Good-Fair ratings from this subbasin. Recent monitoring data from the three lakes is this subbasin classified them all as eutrophic.

Table 30. Waterbodies monitored in Subbasin 12 in the Yadkin River basin for basinwide assessment, 1995 - 2001.

Map #[1]	Waterbody	County	Location	1995/1996	2001
B-1	Rocky R[2]	Cabarrus	US 601	Good-Fair	Fair
B-2	Irish Buffalo Cr	Cabarrus	SR 1132	Good-Fair	Good-Fair
B-3	Coldwater Cr	Cabarrus	NC 49	Good-Fair	Good-Fair
B-4	Dutch Buffalo Cr[2]	Cabarrus	NC 200	Good-Fair	Good-Fair
B-5	Goose Cr	Union	US 601	Poor	Poor
B-6	Crooked Cr	Union	SR 1547	Fair	Good-Fair
F-1	Irish Buffalo Cr	Cabarrus	SR 1132	Good	Good
F-2	Coldwater Cr	Cabarrus	NC 73	Good	Good-Fair
F-3	Dutch Buffalo Cr	Cabarrus	SSR 2622	Good-Fair	Good
L-1	Kannnapolis Lake	Rowan		Eutrophic	---
L-2	Lake Fisher	Rowan and Cabarrus		Eutrophic	---
L-3	Lake Concord	Cabarrus		Eutrophic	---

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites; and L = lake assessment sites.
[2]Data are available prior to 1996, refer to Appendix 7.

Rocky River, US 601

This site is approximately one river mile downstream of the Rocky River Regional WWTP (permitted flow = 24 MGD, IWC = 73%). Conductivity at the time of sampling in 2001 was 743 μmhos/cm. The habitat at this site has changed very little since 1996. The predominately sand and gravel substrate provides frequent but narrow riffle areas. Instream habitat was fairly abundant and the banks were stable with a good, extensive riparian zone.

Rocky River at US 601, upstream, Cabarrus County.

Benthic macroinvertebrate samples have been collected from this location in 1989, 1996, and 2001. Very similar data were collected during 1989 and 1996 suggesting that there had been very little change in water quality between these two periods.

However, the 2001 benthic data reflected a decline in water quality. Total number of taxa and total number of EPT taxa have declined, while the Biotic Index has increased, which indicated a change to a more tolerant benthic community. This, plus the increase in abundance of toxic/enrichment indicator species such as: *Conchapelopia,* and *Polypedilum illinoense,* suggested that the WWTP effluent during a drought year is having a more severe effect on the stream than during normal flow years. In addition, some intolerant EPT taxa collected in previous years were not collected in 2001 such as *Stenacron interpunctatum,* stoneflies, *Leucotrichia pictipes,* and *Triaenodes ignitus*.

Irish Buffalo Creek, SR 1132

Irish Buffalo Creek originates in southwestern Rowan County where it is impounded to form Kannapolis Lake. Draining western Kannapolis and Concord, the creek joins Coldwater Creek and then the Rocky River southeast of Concord. The benthic macroinvertebrate and fish community monitoring site is below the Town of Concord and receives urban runoff, but no large point source discharges.

The stream at this site is approximately 8 to 10 meters wide and has a relatively diverse habitat. The substrate has a good mix of gravel, rubble, and boulders. This is somewhat unusual for many streams in this area, which normally have a shifting sandy substrate.

Irish Buffalo Creek at SR 1132, Cabarrus County.

Based upon the benthos, a Good-Fair bioclassification was given to this location in 1996 and 2001. The benthic fauna was dominated by facultative to tolerant taxa including *Tricorythodes* and *Stenonema modestum*.

The fish community was rated Good in 1996 and in 2001 (NCIBI = 52 and 50, respectively). The community, represented by 22 species, was one of the most diverse in the basin. Slight enrichment was evident by the abundance of the bluehead chub and the spottail shiner. There was no change in the two dominant species between 1996 and 2001. In both periods, the bluehead chub and the redlip shiner represented approximately 57% of the fish collected.

Coldwater Creek, NC 73
Geographically, this stream is the mirror image of Irish Buffalo Creek. Coldwater Creek originates in southwestern Rowan County where it is impounded to from Lake Fisher. Draining eastern Kannapolis and Concord, the creek joins Irish Buffalo Creek and then the Rocky River southeast of Concord.

Upstream view of Coldwater Creek (from the bridge) at NC 73, Cabarrus County.

The fish community declined from Good in 1996 to Good-Fair in 2001 (NCIBI = 52 and 44, respectively). Although the community remained diverse and abundant, it did not have a balanced trophic structure. Except for three fish communities in the Sandhills (Subbasin 16), the community in Coldwater Creek was the only site monitored in 2001 where there was too high a percentage of insectivores and too low a percentage of omnivores. These trophic characteristics has been observed in some degraded, urban streams where the redbreast sunfish dominates the community.

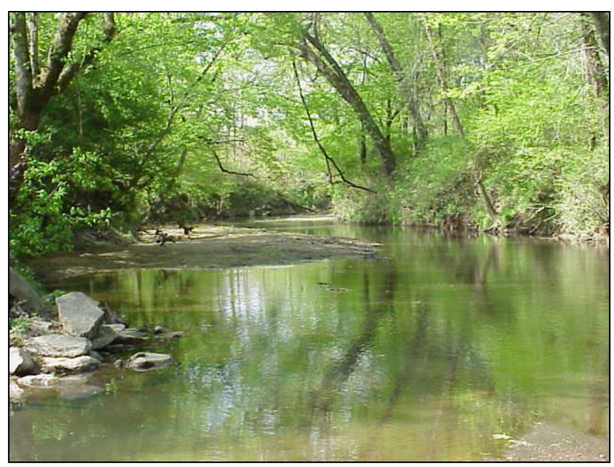
However, in Coldwater Creek, the spotted killifish, a species typically found in shallow, sandy-bottom streams, was the dominant species in 2001. With extremely low flow conditions occurring in this stream for a long period of time and shallow, sandy bottom habitats, this species seemed to have displaced the redbreast sunfish and shifted the trophic structure. Whether this displacement continues upon return of normal flow conditions in the future is not known.

Coldwater Creek, NC 49
Coldwater Creek at NC 49 is a very sandy, five meter wide, tributary of Irish Buffalo Creek. Instream habitat here is limited, pools are rare and there were no riffle areas.

Coldwater Creek at NC 49, Cabarrus County.

A Good-Fair bioclassification was given to this location (EPT taxa richness = 14) in 1996 and in 2001 (EPT = 15). The benthic fauna was dominated by facultative to tolerant taxa including *Tricorythodes, Stenonema modestum,* and *Baetis propinquis*.

Dutch Buffalo Creek, SR 2622
The Dutch Buffalo Creek watershed is on the extreme southeastern border between the piedmont and the Carolina Slate Belt. The stream originates in southern Rowan County and drains northeastern Cabarrus County. Mount Pleasant is the only municipality within its watershed. During the 2001 fish community monitoring period, abundant periphyton grew atop the sand in the very shallow water areas (Appendix 2).



Downstream view of Dutch Buffalo Creek at SR 2622, Cabarrus County.

In 1996 the fish community was rated Good-Fair; in 2001, it was rated Good (NCIBI = 44 and 52, respectively). Differences in the total score between the sampling periods resulted from an increase in darter and sucker diversity and a balanced trophic structure. The total diversity of the community and representation of multiple age classes by the species were slightly lower than expected. The bluehead chub was the dominant species in 2001, as it was in 1996.

Dutch Buffalo Creek, NC 200

Habitat here has changed very little since 1996. This seven meter wide stream had a sand substrate, very little instream habitat, no riffle areas, excessive bank erosion and a riparian zone with many breaks.

Dutch Buffalo Creek at NC 200 Cabarrus County.

Benthic macroinvertebrate samples have been collected from this site on four occasions since 1986. Good-Fair bioclassifications were assigned to this site in the last three surveys, while a Fair bioclassification was given to it in 1986. EPT taxa richness and abundance values were lower in 1996 and 2001 than they were in 1989. There are no large point source discharges in the catchment.

Goose Creek, US 601

Goose Creek is a small (approximately five meters wide) tributary of the Rocky River. The habitat score of 79 reflected extremely unstable stream banks and infrequent pool habitat. However, Goose Creek had good instream and riffle habitats and riparian zone.

Goose Creek at US 601, Union County.

EPT taxa richness was very low (EPT = 5) which suggested upstream water quality problems. This site was given a Poor bioclassification in 1996, 1998, and 2001. Flow was very low at the time of the 2001 survey and the conductivity was 262 μmhos/cm, indicative of a point source.

Only two hydropsychid caddisfly taxa were collected and only one was abundant (*Cheumatopsyche*). Only three mayflies were collected and the only abundant one was *Stenonema modestum*. Many organic/enrichment taxa were found in abundance in 2001 such as *Dicrotendipes neomodestus*, *Natarsia* sp., *Chironomus*, *Procladius,* and *Polypedilum illinoense*.

The Goose Creek catchment was intensely surveyed in 1998 due to the importance of this area as habitat for rare mussel species and the development occurring from the expanding Charlotte metropolitan area (see Special Studies).

Crooked Creek, SR 1547

A site was selected on Crooked Creek (SR 1547) near the confluence with the Rocky River to assess water quality in the entire catchment. Crooked Creek at this location is a small (seven meter wide) stream with a substrate dominated by boulder and rubble. A very stable, unperturbed habitat was noted at this location in 1996, as well as in 2001.

Crooked Creek at SR 1547, Union County.

However, this site is below the Union County/Grassy Branch WWTP. A Fair bioclassification was given to this site in 1996 based on an EPT sample (12 EPT). In 2001, the rating improved to Good-Fair (18 EPT). Many organic/enrichment taxa were found in abundance here in 2001: *Conchapelopia*, *Chironomus*, and *Polypedilum illinoense.* However some intolerant taxa (*Ceraclea ancylus, Leucrocuta, Neoperla,* and *Isonychia*) also were common or abundant.

SPECIAL STUDIES

North Fork Crooked Creek

The Modeling/TMDL Unit of NC DWQ requested that benthic macroinvertebrates be collected from this stream at SR 1520 and SR 1514 (Union County) in June 2000. The purpose of the collections were to identify impaired watersheds to be included in a watershed assessment and restoration study (Biological Assessment Unit, unpublished data).

Goose Creek Watershed

The Goose Creek watershed is receiving much attention due to the importance of the area as habitat for rare mussel species and the threat of development from the expanding Charlotte metropolitan area. The Biological Assessment Unit worked with several agencies to help provide information on the existing water quality of this watershed. Sites were chosen to bracket most of the developments and known dischargers. Water quality problems in the middle and lower segments of Goose Creek were more severe than problems observed in other streams in this subbasin (Biological Assessment Unit Memorandum 980814).

303 (d) Stream - Clear Creek, SR 3181

This site was turbid at the time of sampling and there were cows in the stream. Habitat below the bridge (above the bridge belonged to the cows) was pretty good with abundant instream habitat, a natural channel and an extensive, intact riparian zone. However, riffle areas were infrequent and the banks were severely eroded. Flow was very low at the time of sampling, so most root mat habitat was out of the water and unavailable to the benthic community.

Clear Creek at SR 3181, Mecklenburg County.

The stream at this site was rated Good-Fair based on benthic macroinvertebrates in 1998 and 2001> It should not be on the impaired streams list based on these data.

Other Data

In 1999, the Mecklenburg County Department of Environmental Protection monitored fish communities in Mecklenburg County and applied an earlier version of the NCIBI to determine the ecological health of several streams (MDEP 2000). The collection methods and rating system are not directly comparable to those currently used by the NC DWQ. These data are given for comparative purposes only (Table 31).

Table 31. Fish community data collected from Mecklenburg County by the Mecklenburg County Department of Environmental Protection, 1999.

Waterbody	Location	Year	Score	Rating
Stevens Cr	SR 3128	1999	42	Fair
	I-485	1999	38	Poor-Fair

Kannapolis Lake

The City of Kannapolis uses this lake as a water supply, although it is owned by Atlantic American Properties (Figure 55). Access to the lake is strictly controlled. Land uses in the watershed are residential, agriculture, and forest.

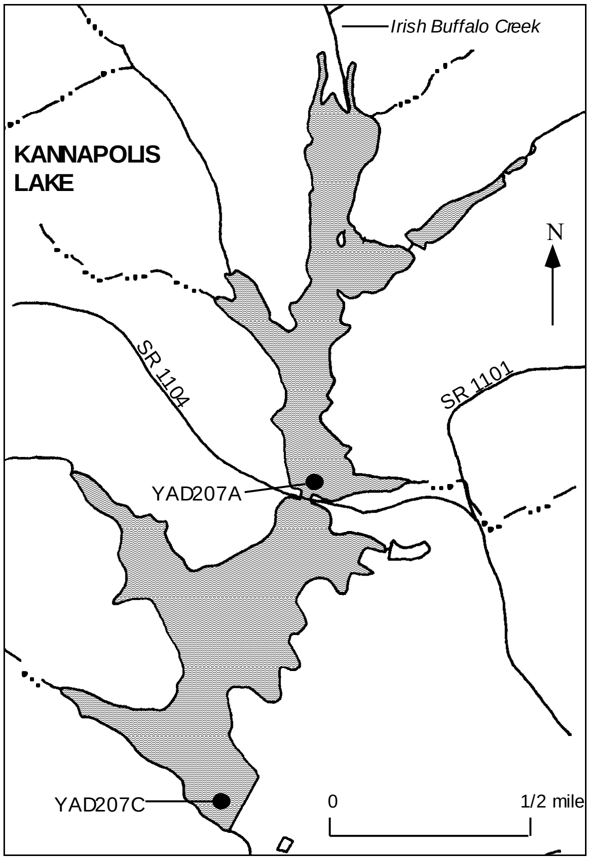


Figure 55. Sampling sites at Kannapolis Lake, Rowan County.

Kannapolis Lake has been monitored since 1989 and most recently it was monitored in 2000. As was seen in previous years, surface dissolved oxygen concentrations and pH were elevated at both locations. Dissolved oxygen was greatest at a depth of approximately one meter below the surface in June and July, suggesting that the greatest algal productivity was occurring at this depth instead of at the surface.

Nutrient concentrations in June were low to moderate and the mean Secchi depth was 1.2 meters. In July, Secchi depths were less than one meter at both sites and nutrient had increased to moderate and elevated concentrations. In August, Secchi depths improved to slightly greater than one meter at both sites. Nutrient concentrations decreased as compared with values observed in July. The decrease suggested increased uptake by algae.

Surface metals were within applicable water quality standards with the exception of copper. In August it was greater (11 µg/L) than the water quality action level (7.0 µg/L).

Kannapolis Lake was determined to be eutrophic in 1995 based on the calculated NCTSI score and has been consistently eutrophic since it was first monitored in 1989.

Lake Fisher

Lake Fisher is a water supply reservoir for the City of Concord and access to the lake is strictly controlled (Figure 56).

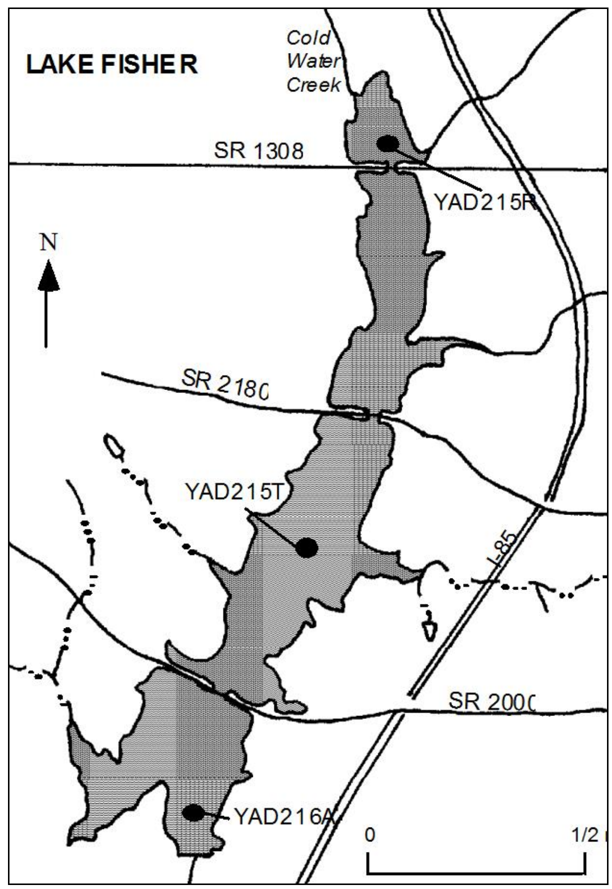


Figure 56. Sampling sites at Lake Fisher, Rowan and Cabarrus counties.

This lake was most recently monitored in 2000. Drought conditions lowered the lake level during the summer and the upper end of the lake could not be reached by boat. A substitute site located just upstream of SR 2180 was sampled instead. The depth of the lake near the dam decreased from eight meters in June to 4.9 meters in August. This site was also strongly stratified with hypoxic conditions observed at a depth of three meters. Secchi depths were less than one meter at all three sites in 2000. Nutrient concentrations, with the exception of nitrite plus nitrate, were elevated.

Surface metals were within applicable water quality standards with the exception of manganese (290 µg/L) in August. According to field notes, the water appeared brownish-green - a color most likely due to a combination of algae and suspended sediment. Manganese is naturally occurring in these waters and may be related to increased suspended sediment in the water column.

Based on the calculated NCTSI scores, Lake Fisher was been consistently eutrophic since it was first sampled in 1989.

Lake Concord

The lake is used as a back-up water supply for the City of Concord. The upstream watershed is primarily urban although there is a forested buffer around the lakeshore (Figure 57).

Lake Concord was most recently monitored in 2000. Station YAD126E could not be sampled at its original location due to insufficient depth. Samples were collected at a new location approximately 120 yards from the original site. Despite being further downstream, water depth at this new site was only 0.6 meter. In previous years, depths in this arm were between 1.5 and 2 meters. Drought conditions and sedimentation have contributed to the shallow depths observed in 2000.

The lake's upper watershed is undergoing a rapid transformation in landuse. New residential developments were observed with approximately 300 homes planned. Land clearing activities were contributing to the sediment load entering the upper end of the lake, decreasing light penetration and increasing conductivity. Secchi depths were less than one meter at each of the three sampling sites and surface conductivity ranged from 106 to 113 µmhos/cm.

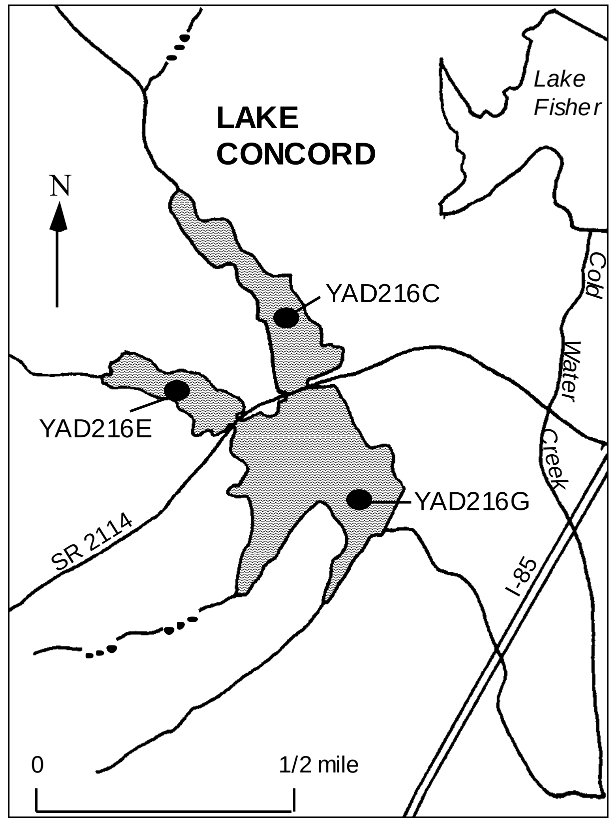


Figure 57. Sampling sites at Lake Concord, Cabarrus County.

Total phosphorus concentrations were elevated and nitrogen concentrations, with the exception of nitrite plus nitrate, were moderate to elevated. Field notes indicate that the water color was brownish-green.

In 1995, Lake Concord was determined to be eutrophic based on the calculated NCTSI score. This lake was also eutrophic in 1989 when it was first sampled.

YADKIN RIVER SUBBASIN 13

Description

This subbasin contains tributaries of the lowermost reach of the Rocky River from the mouth of Irish Buffalo Creek to the river's confluence with the Pee Dee River (Figure 58). However, it does not include the Rocky River *per se*. Big Bear and Long Creeks are the only major tributaries to the river and the entire subbasin is wholly within the Carolina Slate Belt. The predominant landuse is almost evenly divided between forest and pasture (Table 32). In addition, the percentage of land in cultivated crops and pasture exceeds the percentage of forested land within this subbasin.

Table 32. Landuse in Subbasin 13. Based upon CGIA coverage 1993 - 1995 (total area = 128,971 Ac).

Landuse	Percent
Water	0.3
Cultivated crop	13.4
Pasture	40.9
Urban	1.7
Forest	43.7

The Town of Albemarle is the only major metropolitan area in this area. Its WWTP (16.0 MGD) and the Town of Oakboro's WWTP (0.5 MGD) both discharge to Long Creek.

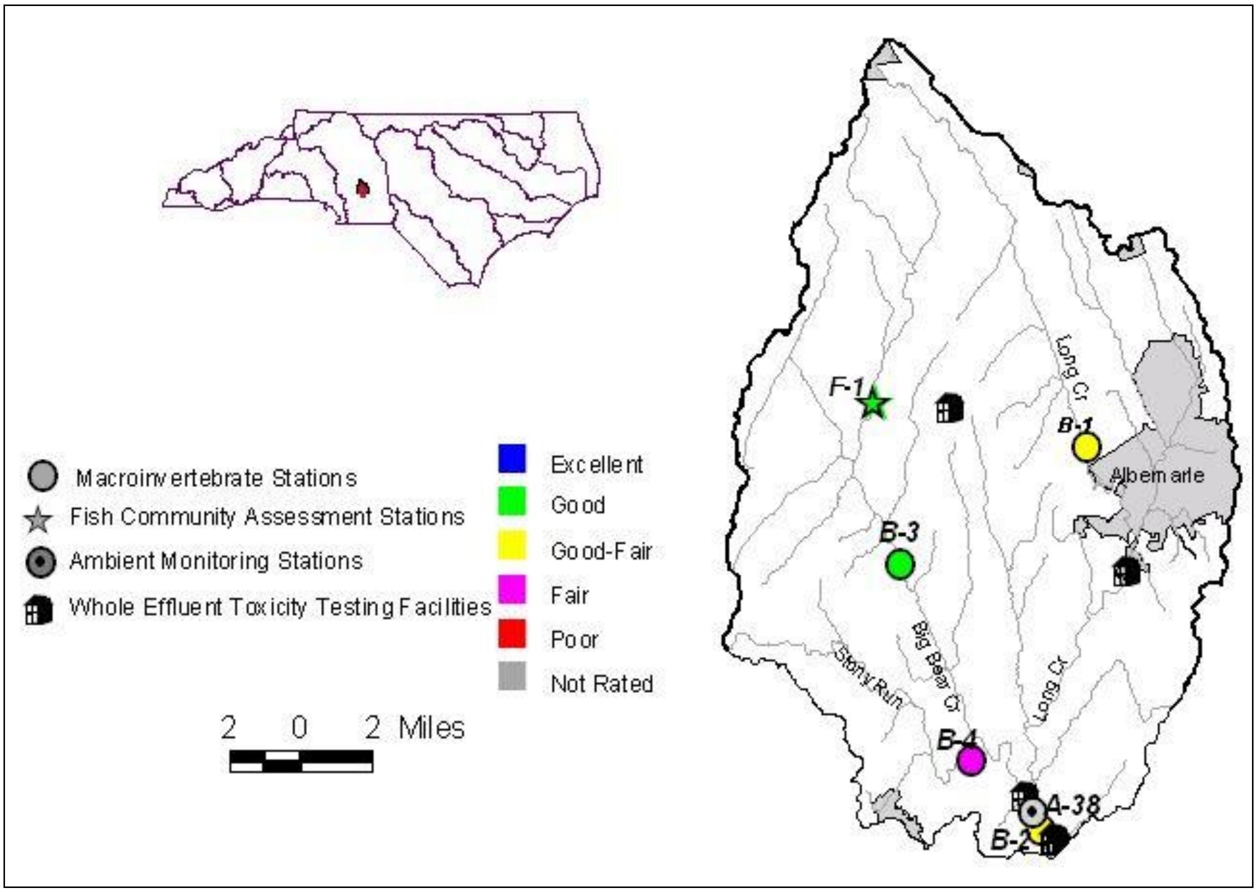


Figure 58. Sampling sites in Subbasin 13 in the Yadkin River basin.

Overview of Water Quality

Four locations were sampled for benthic macroinvertebrates in this subbasin in 2001 (Table 33). Long Creek at Rocky River Springs is downstream of the Towns of Albemarle's and Oakboro's WWTPs and also receives agricultural and urban nonpoint source runoff. The stream improved from Fair in 1983 - 1986 to Good-Fair in 1989 - 2001.

Good and Fair bioclassifications were given to Big Bear and Stoney Run Creeks, respectively, based on benthic data. Stoney Run Creek is a very small tributary of Big Bear Creek and flow was restricted to very small channels, possibly accounting for lower taxa richness values relative to the 1996 collections. This site, due to its size, should be dropped from the basinwide monitoring list.

Higher water quality in these catchments was due to a combination of Slate Belt geology and a general lack of disturbance. A fish community sample from Big Bear Creek also resulted in a Good NCIBI score. Ambient monitoring data from Long Creek at SR 1954 documented high conductivity values and copper concentrations.

Table 33. Waterbodies monitored in Subbasin 13 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Long Cr	Stanly	SR 1401	-	Good-Fair
B-2	Long Cr[2]	Stanly	SR 1917	Good-Fair	Good-Fair
B-3	Big Bear Cr*	Stanly	SR 1225	Good	Good
B-4	Stony Run Cr	Stanly	SR 1970	Good-Fair	Fair
F-1	Big Bear Cr	Stanly	NC 73	Good	Good

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

River and Stream Assessment

Long Creek, SR 1401
This new location, above the Town of Albemarle, was chosen as a reference site for Long Creek downstream of Albemarle and its WWTP. Here, the stream is seven meters wide with a mixed boulder, rubble and gravel substrate . Instream habitat is abundant, riffles are frequent, and the banks and riparian zone are in good shape (habitat score = 81).

Long Creek at SR 1401, Stanly County.

This section of Long Creek received a Good-Fair rating based on EPT criteria (EPT = 17). Several EPT taxa were collected here that have not been collected downstream (*Baetis flavistriga*, *Callibaetis*, and *Ceraclea ancylus*). However, the conductivity at the time of sampling was 342 μmhos. This high value suggested some input.

Long Creek, SR 1917
Benthic macroinvertebrate samples have been collected from this location during five summer surveys. The Town of Albemarle's WWTP discharges to Long Creek above this monitoring location (permitted flow = 16 MGD, instream waste concentration = 94 percent).

The habitat was very similar to the upstream site (habitat score = 85). However, despite the great habitat conditions, the fauna and high conductivity (248 μmhos/cm) suggested some point source affect. The water was tinged red at the time of sampling, and there was a distinctly caustic odor at this site.

Long Creek at SR 1917, Stanly County.

Data from the three most recent surveys (1989, 1996, and 2001) assigned Good-Fair bioclassifications while data from earlier surveys (1986 and 1983) gave Fair bioclassifications. A distinct improvement in the taxa richness and abundance values of many taxa were noted in 1989 versus those found in 1986 (Figure 59).

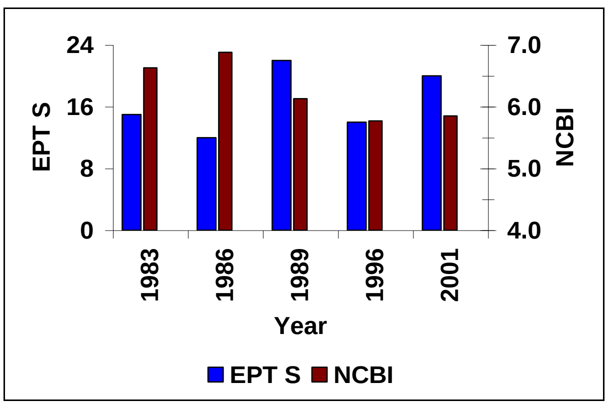


Figure 59. EPT taxa richness (EPT S) and biotic index (NCBI) for Long Creek at SR 1917, Stanly County, 1983 - 2001.

Several EPT taxa were abundant in later surveys that were not collected in 1986 or 1983: *Baetis intercalaris, Heptagenia, Isonychia, Leucrocuta,* and *Leucotrichia*, suggesting an improvement in water quality. EPT taxa richness and abundance values were lower during the 1996 basinwide survey. However, the biotic index value also was lower resulting in a Good-Fair bioclassification. EPT and Total Taxa richness increased in 2001, relative to 1996, but still resulted in a bioclassification of Good-Fair.

Big Bear Creek, NC 73

The upper watershed of Big Bear Creek drains the extreme northeastern corner of Cabarrus County and northwestern Stanly counties.

Downstream view of Big Bear Creek at NC 73, Stanly County.

In 2001, the community had several unique characteristics:

- The green sunfish was the dominant sunfish. This site was only 1 of 3 sites in the basin in 2001 where the exotic green sunfish has displaced the native redbreast sunfish as the dominant sunfish.
- No bluehead chubs were collected. This site was only 1 of 4 sites in the mountain and piedmont regions of the basin where the species was not collected in 2001. It was present in 1996.
- This was 1 of 4 sites where fewer fish were collected in 2001 than in 1996. The number of fish collected decreased by approximately 50percent. Populations of the fantail darter and the whitemouth shiner decreased by 96 percent and 80 percent, respectively.
- Nineteen species have been collected at this site, yet 10 of the 19 were present in only 1 of the 2 collection periods. And 4 of these 10 species are either species uncommon in this drainage or rare at this site.

With these community characteristics and with this Carolina Slate Belt stream having a watershed of only 19 square miles, it is likely that the stream, during prolonged periods of drought and low flow, becomes a series of shallow, isolated pools connected by subsurface flow. The characteristics observed in 2001 may be due to low flow effects (crowding and diurnal dissolved oxygen fluctuations in the pools) rather than any significant long-term water quality change.

The NCIBI scores did not change appreciably between sampling periods (NCIBI = 52 in 1996 and 48 in 2001) and the communities in both years were rated Good. The slight change in score between years was due to a decrease in the number of species (from 15 to 13) and a decrease in the percentage of species represented by multiple age groups (from 87% to 54%). The dominant species in 2001 was the highfin shiner. It was a co-dominant species with the whitemouth shiner in 1996.

Big Bear Creek, SR 1134/1225

Due to difficulty of access and low flow conditions, this site was moved to a location one bridge crossing downstream of the 1996 location at SR 1134. Big Bear Creek has a typical Carolina Slate Belt substrate dominated by boulder and rubble.

Big Bear Creek at SR 1225, Stanly County.

Data have been collected from four summer periods and all resulted in Good bioclassifications. Dominant taxa have remained similar between investigations and included several intolerant taxa: *Stenacron pallidum, Chimarra,* and *Ceraclea ancylus*. The habitat and macroinvertebrate fauna at the 2001 location was similar to the site sampled in previous years.

Stony Run Creek, SR 1970

Stony Run Creek is a very small (five meters wide) tributary of Big Bear Creek. Habitat here is good, with adequate instream habitat, good mixed substrate, frequent riffle areas, stable banks, and a good riparian zone. This typical Slate Belt stream is subject to very low flow conditions during the summer months.

Stony Run Creek at SR 1970, Stanly County.

A Good-Fair bioclassification was assigned to this site based on an EPT sample (19 EPT) in 1996, but this rating was reduced to Fair in 2001 (12 EPT). Baetid mayflies were not collected in 2001, but were common in 1996. Other taxa that were abundant or common in 1996, but rare or not collected in 2001 include: *Hexagenia*, *Isonychia*, and *Ceraclea ancylus*. The mayfly *Stenonema femoratum* is an indicator of low flow conditions and was common in 2001 but not collected in 1996. This could be an indication that flow may be the reason for this change in rating and not water quality. This site, due to its size, should be dropped from the basinwide list.

YADKIN RIVER SUBBASIN 14

Description

This subbasin includes Rocky River and the entire watersheds of Richardson and Lanes Creeks (Figure 60). These two streams are large tributaries of the middle reach of the Rocky River. The Towns of Marshville, Wingate, and Monroe (along US 74) are the only large metropolitan areas in this subbasin. The percentage of land in cultivated crops and pasture exceeds the percentage of forested land within this subbasin (Table 34). This subbasin contains a greater percentage of cultivated cropland than any other subbasin in the entire Yadkin River basin.

Table 34. Landuse in Subbasin 14. Based upon CGIA coverage 1993 - 1995 (total area = 339,115 Ac).

Landuse	Percent
Water	0.5
Cultivated crop	27.0
Pasture	29.4
Urban	1.1
Forest	42.0

The two largest permitted dischargers in the subbasin are the Town of Monroe's WWTP (permitted flow = 9.0 MGD with an instream waste concentration = 96 percent and Teledyne-Allvac (1.9 MGD).

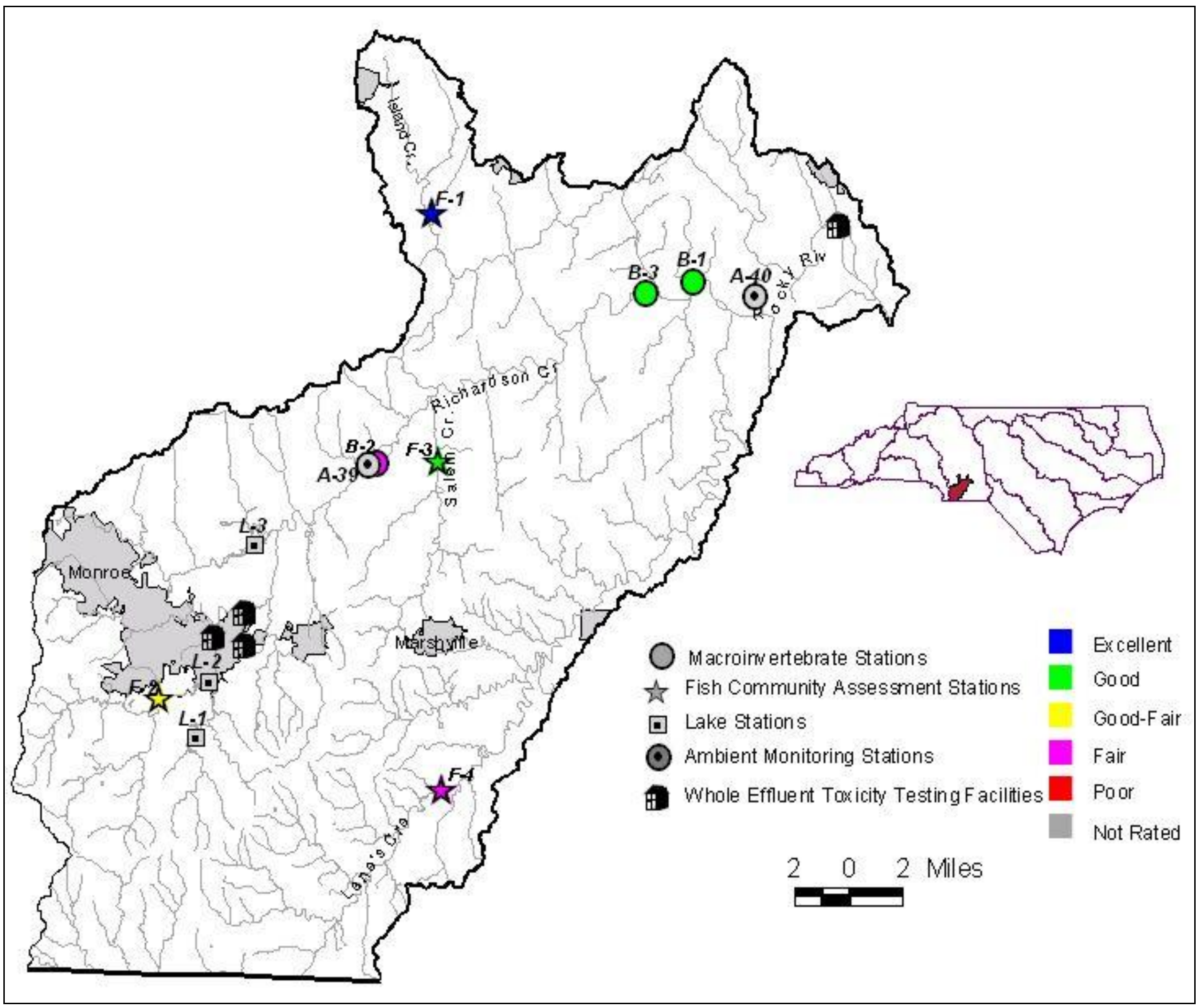


Figure 60. Sampling sites in Subbasin 14 in the Yadkin River basin.

Overview of Water Quality

In previous basinwide reports, the Rocky River near Norwood has been included in Subbasin 13. According to the latest stream classification schedule, that site is now in Subbasin 14.

There are more swine and poultry operations in this subbasin than in any other subbasin. Numerous confined animal operations (CAOs) are found in the Richardson and Lanes Creeks catchments. For example, in 1996 Union County (which is within this subbasin) had 66 CAOs compared to 30 in Anson, 16 in Cabarrus, and 23 in Stanly counties. As of May 1998, swine operations comprised 51 percent of all animal operations.

The Richardson Creek sites surveyed during the 1996 and 2001 benthic basinwide investigation had prolific growths of filamentous green algae, especially *Pithophora* (commonly called horse hair algae) and *Spirogyra*. These prolific growths of algae indicated the streams are receiving large inputs of nutrients.

There are two ambient monitoring sites in this subbasin: the Rocky River near Norwood and Richardson Creek near Fairfield. The Richardson Creek site is located below the Town of Monroe's WWTP. This facility was assessed a fee for toxicity test failures in June and August 2000. Unusually high nutrient concentrations have been documented from this location. Both ambient monitoring locations reported extremely high conductivity values as well as high copper concentrations.

Benthic macroinvertebrate samples from this location on Richardson Creek have consistently produced Fair bioclassifications (Table 35). A Good bioclassification was given to the most downstream location on Richardson Creek in 2001, suggesting that some recovery was taking place compared to data collected at the upstream ambient monitoring site. Fish community samples resulted in ratings ranging from Excellent at Island Creek to Fair at Lanes Creek.

The most recent data from the three monitored lakes in this subbasin classified them as eutrophic.

Table 35. Waterbodies monitored in Subbasin 14 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1995/1996	2001
B-1	Rocky R[2]	Stanly	SR 1943[3]	Good	Good
B-2	Richardson Cr[2]	Union	SR 1649	Fair	Fair
B-3	Richardson Cr[2]	Union	SR 1600	Good-Fair	Good
F-1	Island Cr	Stanly	SR 1118	---	Excellent
F-2	Richardson Cr	Union	NC 207	---	Good-Fair
F-3	Salem Cr	Union	SR 1006	Fair	Good
F-4	Lanes Cr	Union	SR 1929	---	Fair
L-1	Lake Monroe	Union		Eutrophic	---
L-2	Lake Lee	Union		Eutrophic	---
L-3	Lake Twitty	Union		Eutrophic	---

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites, L = lake assessment sites.
[2]Data are available prior to 1996, refer to Appendix 7.
[3]This site has previously been sampled at SR 1935 (moved one bridge crossing upstream)

River and Stream Assessment

Samples were not collected from the uppermost reaches of Lanes Creek or many of the tributaries of Lanes and Richardson Creeks during the 1996 basinwide investigation due to very low flow conditions. No samples could be collected from Lanes Creek during the 2001 survey.

Rocky River, SR 1935/1943
The Rocky River near Norwood is the most downstream monitoring location on the Rocky River. Data have been collected from this location nine times since 1983. The site was moved in 2001 one bridge crossing upstream of the site sampled previously.

The habitat score of 81 reflected a site with good instream habitat, a mixed substrate of gravel, cobble, and boulders, frequent riffle areas and a good riparian zone. This site had growths of *Pithophora* and *Spirogyra* in 2001.

Rocky River at SR 1943, Stanly County.

Bioclassifications have been fairly consistent for the period of record: high Good-Fair (borderline Good) or Good. EPT taxa richness values have ranged from a low of 22 in 1986 and 1996 to a high value of 28 in 1990. There were no striking differences in the macroinvertebrate community structure of the 2001 site sampled and the site sampled in previous years (SR 1935). Since 1988, this site has experienced a reduction in some low dissolved oxygen and enrichment indicator species such as *Cardiocladius, Chironomus*, *Dicrotendipes moestus*, and *Procladius.*

Island Creek, SR 1118

Island Creek was sampled for the first time for fish community assessment in 2001. The small, agricultural watershed is located in the southwest corner of Stanly County. There is one, minor (0.01MGD) NPDES facility located approximately seven miles upstream on an unnamed tributary to Island Creek. At the SR 1118 site, instream and riparian habitats were of high quality.

Upstream view of Island Creek at SR 1118, Stanly County.

An Excellent rating (NCIBI = 54) was given to the fish community. The abundant and diverse community was dominated by the bluehead chub and the tessellated darter.

Richardson Creek, NC 207

Richardson Creek was sampled for the first time for fish community assessment in 2001. The upper watershed of this stream is located in south-central Union County and includes a portion of the Town of Monroe. There are no NPDES facilities in the watershed upstream of the fish community monitoring site.

Upstream view of Richardson Creek at NC 207, Union County.

A Good-Fair rating was given to the fish community (NCIBI = 46). Intolerant species were absent and there was a high percentage of tolerant fish. The community was dominated by the tolerant, green sunfish. This site was only 1 of

3 sites in the basin in 2001 where the exotic green sunfish has displaced the native redbreast sunfish as the dominant sunfish. Also, no bluehead chubs were collected. This site was only 1 of 4 sites in the mountain and piedmont regions of the basin where this species was not collected in 2001.

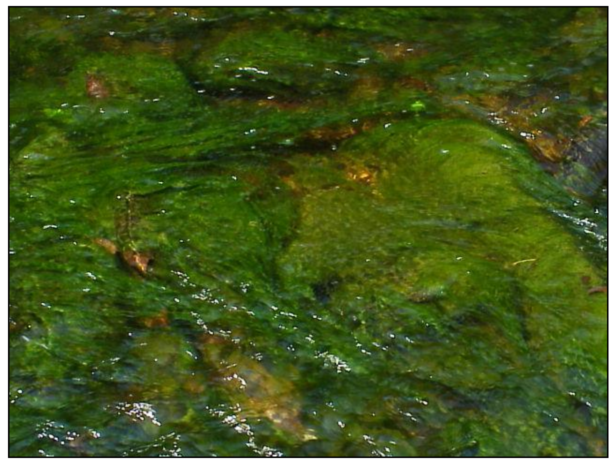
Richardson Creek, SR 1649
This stream is located midway in the watershed, below the Town of Monroe and its WWTP discharge. Richardson Creek at this point had flow and substrate characteristics typical of Slate Belt streams and had prolific growths of *Pithophora* and *Spirogyra* in 1996 and 2001.

Richardson Creek at SR 1649, Union County.

Benthic macroinvertebrates have been collected from this location four times since 1987. Taxa richness and BI values have remained fairly stable, always resulting in a bioclassification of Fair at this site. Very high conductivities have been recorded at this site in 1996 and 2001 (750 and 755 μmhos/cm, respectively).

Richardson Creek, SR 1600
Richardson Creek at SR 1600 in Anson County is located near the confluence with the Rocky River. The substrate here is very rocky, similar to the upstream site. Richardson Creek in 1996 and 2001 had low flow and prolific growths of *Pithophora* and *Spirogyra*.

Richardson Creek at SR 1600, Anson County.



Prolific growths of algae at Richardson Creek, SR 1600, Anson County.

Very few differences were noted between the 1983 and 1996 collections which both resulted in ratings of Good-Fair. However, this changed to Good in 2001. EPT taxa increased from 18 to 24 suggesting that some recovery is taking place prior to the confluence with the Rocky River.

This downstream site improved remarkably over the upstream site at SR 1649 (Fair to Good). There are four tributary streams that feed Richardson Creek between SR 1649 and SR 1600 adding some dilution to the effluent that dominates the flow at SR 1649. EPT taxa increased from 10 at SR 1649 to 24 at SR 1600. Some less tolerant taxa that were collected at this downstream site, but not upstream at SR 1649 included *Neoperla, Chimarra*, *Helicopsyche borealis*, and *Lepidostoma*. However, the stream at this site is still effluent dominated with conductivities of 600 and 694μmhos/cm in 1996 and 2001, respectively.

Salem Creek, SR 1006
The watershed of Salem Creek, in eastern Union County, includes the north side of the Town of Marshville. This stream is a tributary to lower Richardson Creek. Mid-afternoon readings of dissolved oxygen levels (11.9 mg/L, 136% of saturation) and pH (8.1 s.u.) resulted from the photosynthetic activity of the abundant periphyton.

Upstream view of Salem Creek at SR 1006, Union County.

This site received a Fair rating in 1996 and a Good rating in 2001 (NCIBI = 36 and 48, respectively). The improved scores were due to the collection of an additional species of darter (fantail darter), a decrease in the percentage of tolerant fish (from 44% to 15%), and a more balanced and slight shift in the trophic structure.

The fantail darter, with a restricted distribution in Union County streams, was common in the large riffle at the end of the 600 ft. reach. The percent insectivores decreased from 91% to 89% and the percentage of omnivores + herbivores increased from 8% to 11%. These slight shifts increased the NCIBI score by 8 units. In both monitoring periods, no intolerant species were collected. In 1996, the dominant species was the tolerant, redbreast sunfish. It constituted 31 percent of all the fish collected. In 2001, it had decreased to only 9 percent of all the fish collected. The highfin shiner was the dominant species in 2001.

Lanes Creek, SR 1929
Lanes Creek's watershed drains southeastern Union County and northwestern Anson County. There are no NPDES facilities in the watershed upstream of the fish community monitoring site. A new monitoring site was selected in 2001 because the site sampled in 1996 (downstream at SR 1415, Anson County) was too wide to sample following existing standard sampling procedures. Instream habitats and flow habits at the new site are typical of Carolina Slate Belt streams. At the time of fish community monitoring, dissolved oxygen concentrations were depressed (5.9 mg/L, 65% of saturation).

Lanes Creek at SR 1929, Union County.

The fish community was rated Fair (NCIBI = 40). There was a low diversity of darters, intolerant species were absent, and there was a high percentage of tolerant fish. The community was dominated by the tolerant, green sunfish. This site was only 1 of 3 sites in the basin which were monitored in 2001 where the exotic green sunfish has displaced the native redbreast sunfish as the dominant sunfish.

SPECIAL STUDIES
303 (d) Stream - Richardson Creek, SR 1006
This site in Union County was sampled to determine if this segment of Richardson Creek should remain on the 303 (d) impaired streams list. This site is downstream of the City of Monroe's WWTP discharge and the Teledyne Allvac discharge. The city's WWTP has undergone significant upgrades in the past few years including upgraded tertiary filters, increasing the size of the EQ basin, and adding additional sludge storage (pers. comm. Mooresville Regional Office).

The Biotic Index has consistently decreased in the three surveys since 1989 suggesting a more intolerant macroinvertebrate community structure; the EPT taxa richness increased from five in 1990 to eight in 2001. This resulted in a bioclass change from Poor to Fair. The increase in EPT abundance was more dramatic 16 to 46, suggesting a real change in the water quality.

Richardson Creek at SR 1006, Union County.

Lake Assessment

Lake Monroe

Lake Monroe is a secondary water supply for the City of Monroe in Union County and is also used for recreation (Figure 61).

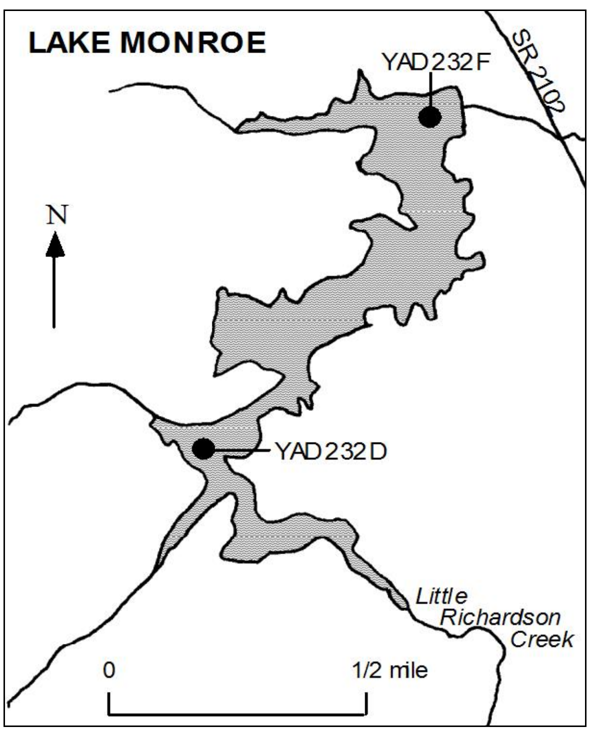


Figure 61. Sampling sites at Lake Monroe, Union County.

This lake was most recently sampled in 2000. While Lake Monroe was rated eutrophic in 1995, surface dissolved oxygen and pH values were even higher in 2000. Total phosphorus and total organic nitrogen were elevated in both years and the 2000 phytoplankton sample analysis confirmed the presence of algal blooms in June, July and August. Phytoplankton samples from July and August were dominated by filamentous blue-green algae (*Anabaena* sp. and *Anabaenopsis* sp.) commonly implicated in taste and odor problems in drinking water.

Water quality data from 2000 continue to support rating this water body eutrophic. This lake was also eutrophic was first monitored in 1989.

Lake Lee

Lake Lee is a secondary water supply for the City of Monroe. Water from Lake Monroe feeds into Lake Lee and water from Lake Lee is pumped into a tributary of Lake Twitty (Lake Stewart) during periods of low flow (Figure 62).

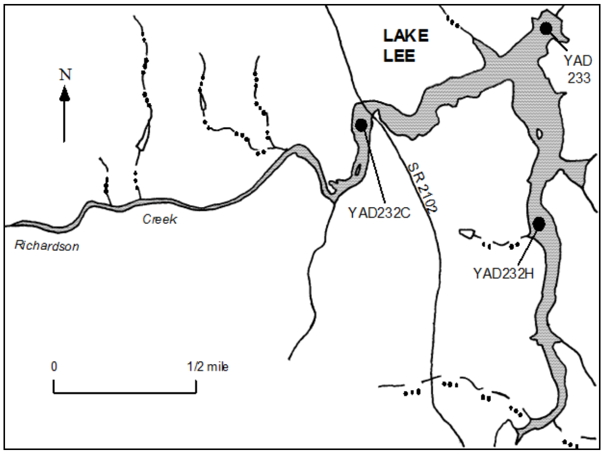


Figure 62. Sampling sites at Lake Lee, Union County.

Lake Lee was most recently monitored in 2000. In 1995, the lake was approximately three feet below normal due to construction on the dam. Consequently, water quality conditions of the lake may not have been truly represented. However, Lake Lee was determined to be eutrophic. In 1989, Lake Lee was found to be hypereutrophic. Although chlorophyll *a* concentrations are not available for 2000, the nutrient concentrations measured were more than sufficient to again classify this lake as eutrophic.

In keeping with the previous years findings, Secchi depths were less than one meter at each of the three sampling sites and surface dissolved oxygen and pH were elevated. Elevated dissolved oxygen and pH values suggest increased algae productivity was occurring in the lake despite the poor light availability. Total phosphorus and total organic nitrogen concentrations were elevated.

Surface algal mats and green-colored water were observed at Lake Lee in 2000. An analysis of phytoplankton samples confirmed the presence of algal blooms during each sampling event. Samples collected in June were dominated by green algae while samples collected in July and August were dominated by filamentous blue-green algae (*Anabaena* sp*.* and *Anabaenopsis* sp*.*) commonly associated with taste and odor problems in drinking water.

As with many other lakes in the basin, manganese was the only metal found to be above the applicable surface water quality standard. However, one exceedance does not indicate a need for concern over drinking water from this lake and while the lake is eutrophic, it seemed to be supporting its designated uses. The City of Monroe may want to review its water supply management strategy and provide more protection to the lake from nonpoint source nutrients.

Lake Twitty (Lake Stewart)

Lake Twitty (also called Lake Stewart) is owned by the City of Monroe and operated as a water supply reservoir and for recreation (Figure 63).

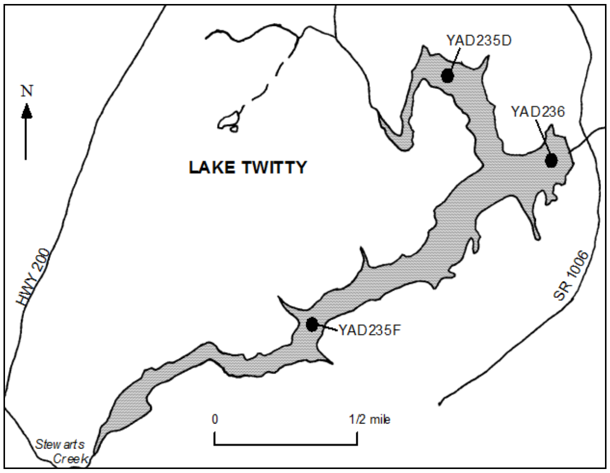


Figure 63. Sampling sites at Lake Twitty, Union County.

Lake Twitty was most recently monitored in 2000. The lake was strongly stratified near the dam with hypoxic conditions present at a depth of three meters from the surface (depth to bottom in June was 12 meters). Secchi depths were less than one meter at each of the sampling sites, indicating poor light availability within the water column. Surface dissolved oxygen and pH values were elevated. Elevated dissolved oxygen and pH values are symptoms of increased algal photosynthetic activity in the lake. Field notes indicated that the water color was green in color in 2000.

Nutrient concentrations were elevated. Analysis of phytoplankton samples confirmed the presence of algal blooms in June, July and August. Samples collected in June were dominated by green algae while samples collected in July and August were dominated by filamentous blue-green algae. The blue-green algae observed in the July and August samples (*Anabaena* sp., *Oscillatoria* sp., and *Anabaenopsis* sp.) are commonly associated with taste and odor problems in drinking water.

Surface metals were within applicable state water quality standards with the exception of copper.

Values in June, July and August (15.0, 9.8, and 76.0 µg/L, respectively) were greater than the state water quality action level of 7.0 µg/L. A conversation with Mr. Allan Kilogh, Water Treatment Plant Supervisor for the Town of Monroe revealed that Lake Stewart was treated with a copper based algaecide twice during the summer. One of these treatment occurred the first week of August. The product used remains in suspension, which explains the elevated copper values.

This lake was previously monitored in 1995. Conditions observed in 1995 were similar to those observed in 2000. Based on the calculated NCTSI score, the lake was determined to be eutrophic. It was also eutrophic in 1989 - the first year it was first sampled.

YADKIN RIVER SUBBASIN 15

Description

This subbasin contains the watershed of the Little River, a tributary to the Pee Dee River (Figure 64). Public lands in the subbasin are part of the Uwharrie National Forest. Eighty-five percent of the subbasin is forested - the highest percentage of any subbasin in the entire Yadkin River basin (Table 36).

Most of the region is in the Carolina Slate Belt although the southern portion lies within the Triassic Uplands. The southern portion of the City of Asheboro and the Town of Troy are the two larger urban areas in the subbasin.

Table 36. Landuse in Subbasin 15. Based upon CGIA coverage 1993 - 1995 (total area = 224,448 Ac).

Landuse	Percent
Water	0.4
Cultivated crop	3.3
Pasture	10.4
Urban	0.9
Forest	85.1

Overview of Water Quality

There is one ambient monitoring site in this subbasin located in the middle reach of the Little River. Data from this site indicated low levels of nutrients, low conductivity, and good concentrations of dissolved oxygen. Fecal coliform bacteria values were slightly elevated.

Benthos samples were collected at four sites including two with long-term data sets (Table 37). The Little River at SR 1340 has maintained an Excellent bioclassification since 1985. This location is within a section of the river between Suggs and Densons Creeks designated as HQW. The West Fork Little River at SR 1311, with high quality instream and riparian habitats, has been rated Good or Excellent since 1989. The Little River at NC 731 continued to have stable water quality with an intolerant macroinvertebrate fauna. Other HQW waters in this subbasin include Bridgers and Densons Creeks and the lower section of Rocky Creek. Cheek Creek was rated Fair due to poor habitat and impacts from nonpoint runoff.

Fisheries community samples were collected from the West Fork Little River and Dumas and Rocky Creeks. These locations, rated Good or Excellent, are regional reference sites with diverse and abundant communities. Fish were also sampled in Hamer Creek which was rated Fair. The typical Triassic Uplands fish assemblage included golden shiner, sunfish, and creek chubsucker.

Table 37. Waterbodies monitored in Subbasin 15 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Little R[2]	Montgomery	SR 1340	Excellent	Excellent
B-2	W Fk Little R[2]	Montgomery	SR 1311	Excellent	Excellent
B-3	Little R	Montgomery	NC 731	Good	Good
B-4	Cheek Cr	Montgomery	SR 1541	Good-Fair	Fair
F-1	West Fork Little R	Montgomery	SR 1311	Excellent	Good
F-2	Dumas Cr	Montgomery	SR 1310	---	Excellent
F-3	Rocky Cr	Montgomery	SR 1549	---	Excellent
F-4	Hamer Cr	Richmond	SR 1159	---	Fair

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

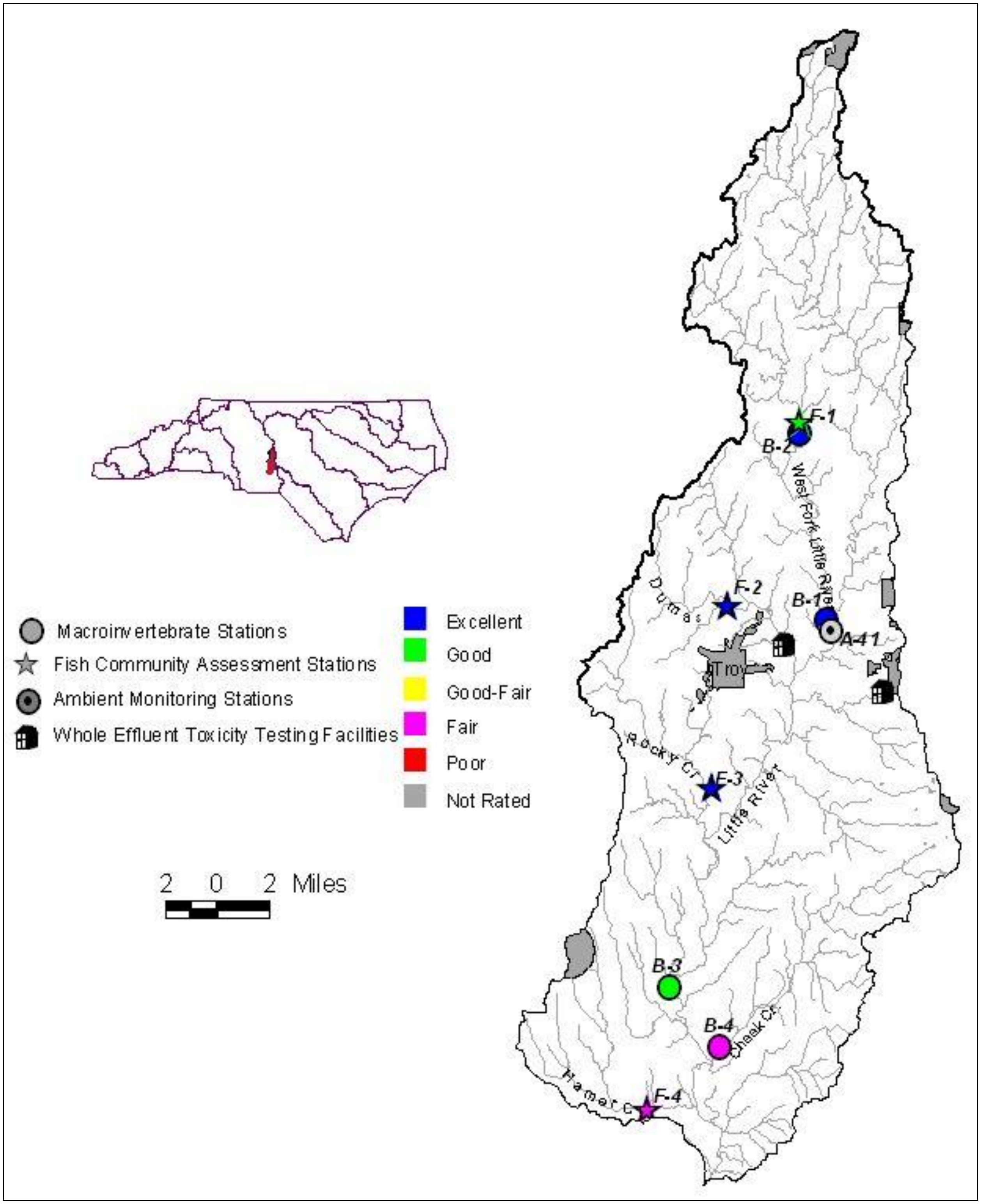


Figure 64. Sampling sites in Subbasin 15 in the Yadkin River basin.

Due to extreme low-flow conditions in 2001, Rocky Creek was reduced to less than one meter wide and it was not sampled for macroinvertebrates.

Cheek Creek at SR 1541 (Montgomery County) was not sampled for fish community assessment because sufficient data to evaluate Cheek Creek had been collected as recently as 1999. Bridgers Creek at SR 1519 (Montgomery County) also was not sampled for fish community assessment in 2001 because no changes were expected to have occurred within the watershed.

At Dumas and Rocky Creeks, the conductivity was the second lowest (47 and 48 mhos/cm) for any streams in the piedmont portion of the basin which were monitored for fish in 2001.

Little River, SR 1340
This site was about 20 meters wide with a mixed substrate of rubble, gravel and bedrock. Habitat was good with long runs separated by short riffles having swift current. Forested riparian zones here provide good shading and stable banks.

Little River at SR 1340, Montgomery County.

This location has been sampled five times in the summer since 1983, and has been rated Excellent since 1985. A comparison of the last four summer samples (1985,1988,1996,and 2001) shows a decline in EPT taxa richness in 2001 (from 39 and 40 to 30) and steady decline in EPT abundance over this time period (from 240 to 155). Biotic Index values have fluctuated, but continued to reflect an intolerant community (4.4 - 5.1). These changes may reflect nonpoint source runoff from agricultural areas higher up in the catchment, although some changes may reflect the unusually low flow in 2001. Even with these changes, the rating remained Excellent in 2001.

This site is the type locality for a new species of caddisfly in the genus *Ceraclea,* found only in the middle sections of the Little River. This species was abundant at this site in 2001.

West Fork Little River, SR 1311
This site on the West Fork Little River flows through a heavily forested area. The stream is also a fish community regional reference site. A typical Carolina Slate Belt stream, the instream and riparian habitats are of high quality.

Upstream view of the West Fork Little River at SR 1311, Montgomery County.

Based on benthic macroinvertebrates, this site was rated Excellent in 1996 and 2001 with few between-year changes. EPT taxa richness declined from 30 to 26 but EPT abundance increased from 113 to 143. EPT Biotic Index values were nearly identical for both years (4.05 and 4.06).

This site was rated Excellent in 1996 and Good in 2001 (NCIBI = 56 and 52, respectively). The slight decrease was due to an absence of piscivores and the low diversity of sunfish. The fish community continued to be diverse and abundant. It was represented by 4 species of suckers, 3 species of darters, and 2 intolerant species. Seventy-five percent of the species were represented by multiple age classes. Exotic species were absent and the redlip shiner was the numerically dominant species.

Little River, NC 731
The stream channel at this site was about 15 - 20 meters wide. The stream was braided with areas of higher flow about five meters wide. The flow was almost all run with few pools and riffles. The substrate was a mixture of embedded cobble and gravel with some sand. Above and below the braided area, the stream fills the entire channel and flow was much slower.

Little River at NC 731, Montgomery County.

This site was rated Good in 1996 and 2001; water quality was stable. EPT taxa richness was identical for both years and abundance improved slightly for 2001. The Biotic Index also improved due to the addition of a few intolerant taxa such as *Leucrocuta* and *Leptohyphes.*

Dumas Creek, SR 1310
Dumas Creek was sampled for the first time for fish community assessment in 2001. The stream, a tributary to Densons Creek, is classified as Class C HQW. At this crossing, the instream, riparian, and watershed characteristics qualified the site as a new regional reference site.

Upstream view of Dumas Creek at SR 1310, Montgomery County.

The fish community was rated Excellent (NCIBI = 54). The diverse and abundant community was represented by three species of darters, including the Carolina darter. Exotic species were absent and the redlip shiner was the numerically dominant species.

Rocky Creek, SR 1549
A new monitoring site was selected in 2001 because the site sampled in 1996 (upstream at NC 24/27) probably becomes intermittent during low flow periods and, therefore, was not rated (Biological Assessment Unit Memorandum 09222000). This lower site is larger and within the reach classified as Class C HQW. At this crossing, the instream, riparian, and watershed characteristics qualified the site as a new regional reference site.

Upstream view of Rocky Creek at SR 1549, Montgomery County.

The fish community was rated Excellent (NCIBI = 54). The diverse and abundant community was represented by three species of suckers and darter and two intolerant species. The redlip shiner was the numerically dominant species.

Cheek Creek, SR 1541
The upper sections of Cheek Creek drain areas of the Uwharrie National Forest, however the lower sections are mostly row-crop agriculture. During mid-summer, the stream was five meters wide with a narrow, fragmented riparian corridor separating the stream from a large cornfield. The stream had a sand and gravel bottom with short, infrequent riffles. Both banks were eroded.

This site was rated Good-Fair in 1996. A decrease in EPT taxa richness (from 15 to 9) and a higher BI (from 6.3 to 6.5) dropped the rating to Fair in 2001. This site will be resampled to evaluate the possible effect of low flows of 2001.

Hamer Creek, SR 1159
Hamer Creek was sampled for the first time for fish community assessment in 2001. Unlike other streams in this subbasin, streams in the southwest corner are in the Triassic Uplands. Streams such as Hamer Creek are typically slow moving and have a sand, detritus, and muck bottom. Its watershed includes the southwest corner of Montgomery County, south of Mount Gilead, and a small portion of northwestern Richmond County. And although its watershed is primarily forested, the stream was turbid following heavy rains the week prior to sampling.

Upstream view (looking downstream) of Hamer Creek at SR 1159, Richmond County.

The fish community was rated Fair (NCIBI = 36). Overall, the diversity of darters was low and intolerant species and piscivores were absent. The species were typical of those found in slow moving Triassic Upland streams in that portion of the Yadkin River basin: golden shiner, creek chubsucker (the dominant species), bluespotted sunfish, flier, warmouth, and Carolina darter. No exotic species were collected at this site.

SPECIAL STUDIES
Fish Community Reference Sites
In 1998, Cheek Creek at SR 1563, Montgomery County, was evaluated as a regional fish community reference site. The fish community was rated Excellent (NCIBI = 58) (Biological Assessment Unit Memorandum 09222000). The stream will again become a basinwide monitoring site in 2006.

Fish Community Temporal Variability
The fish community in Cheek Creek at SR 1563, Montgomery County, was sampled in April, June, and October 1999 to determine the temporal variability of the NCIBI during NC DWQ's traditional monitoring period. The community was rated Excellent during each month (NCIBI = 58, 56, and 56, respectively) despite a prolonged summer drought. Extremely high flows from Hurricane Floyd in September did not occur at this site as they had at Big Mountain Creek (Richmond County). It was determined that seasonality was not an important factor to consider when using the NCIBI to assess the fish community of a stream (Biological Assessment Unit Memorandum 09222000).

Fish Community Spatial Variability
The fish communities in the Little River at SR 1127, NC 134, and SR 1135, Randolph County, were sampled in April 1999 to determine the spatial variability of the NCIBI. The three sites were all rated Good (NCIBI = 52). This indicated replicability of the NCIBI when water quality or land use did not change and when no major tributaries joined the stream (Biological Assessment Unit Memoranda 12101999 and 09222000).

YADKIN RIVER SUBBASIN 16

Description

This subbasin consists of the segment of the Pee Dee River from the tailrace of Blewett Falls Lake to the state line (Figure 65). Rockingham and Hamlet are the largest urban areas in the subbasin. With the exception of these two towns, more than 80 percent of the land use is forested (Table 38). Most of the subbasin is located within the Sandhills ecoregion, except for a small northern portion in the Carolina Slate Belt.

Table 38. Landuse in Subbasin 16. Based upon CGIA coverage 1993 - 1995 (total area = 212,139 Ac).

Landuse	Percent
Water	2.2
Cultivated crop	8.0
Pasture	6.1
Urban	1.5
Forest	82.2

The Sandhills Game Land, through which Hitchcock and Rocky Fork Creeks flow, is a national significant natural landscape (Sorie 2001). The Marks Creek Corridor is a Natural Heritage Program macrosite. [Macrosites are natural areas that occur in clusters with strong geographical connections and ecological relationships.] For more than 15 miles, the main channel of Marks Creek lows through a high quality swamp forest (Sorie 2001).

Several large dischargers are located in this subbasin, including the Town of Rockingham's WWTP (6.0 MGD to Pee Dee River), Burlington Industries (1.2 MGD to Hitchcock Creek), and Anson County's Regional WWTP (3.5 MGD to Pee Dee River).

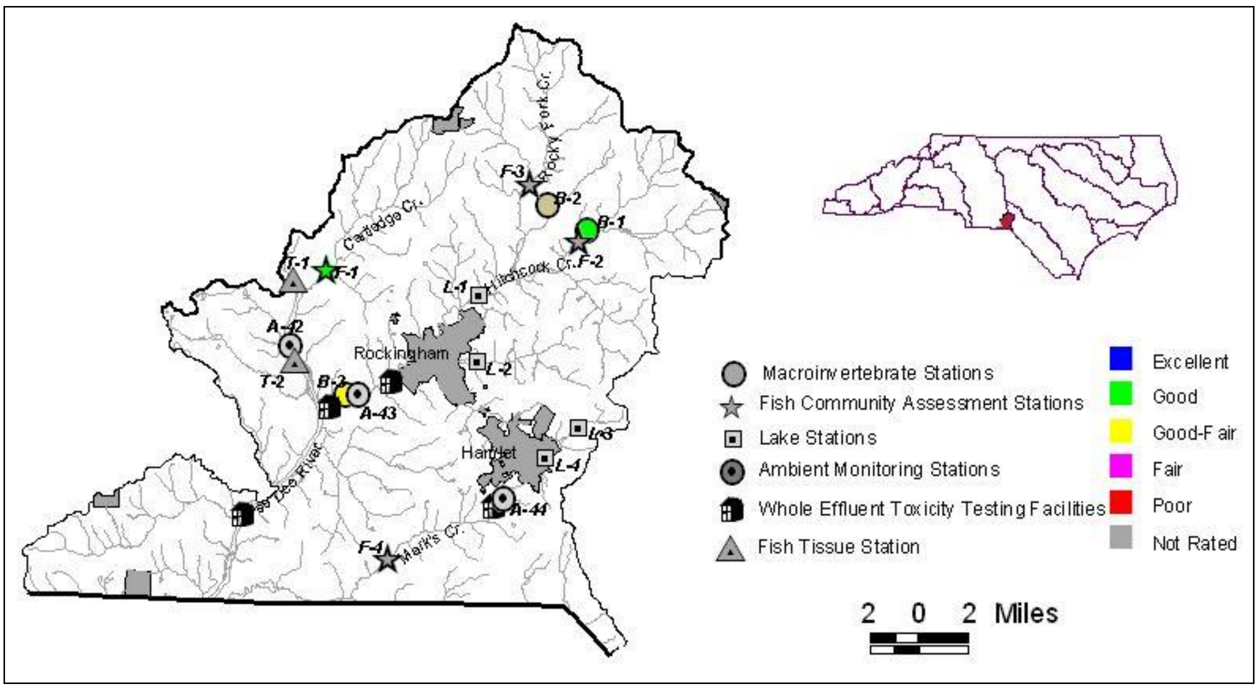


Figure 65. Sampling sites in Subbasin 16 in the Yadkin River basin.

Overview of Water Quality

Four ambient monitoring sites are in this subbasin: two on the Pee Dee River, and one each on Hitchcock and Marks Creeks. Along with higher conductivity, data from Hitchcock Creek showed elevated levels of ammonia and fecal coliform bacteria compared to the other sites. Marks and Hitchcock Creeks recorded the lowest average pH values in the basin. Marks Creek also had very low dissolved oxygen concentrations.

Benthos data from the upstream locations on Hitchcock and Beaverdam Creeks continued to show good water quality in this part of the catchment (Table 39). The downstream site on Hitchcock Creek has shown great improvement since 1996. EPT taxa richness increased from 5 to 21, raising the bioclassification from Poor to Good-Fair.

Sandhills streams are not yet rated using fish community data, but samples from Hitchcock and Rocky Fork Creeks reflected a limited but unique fauna. These locations will be used for reference sites in developing criteria. Cartledge Creek, a Slate Belt stream, was rated Good using fish data. Fish tissue sampling on the Pee Dee River yielded low or undetectable levels for all tested contaminants.

Lake assessments determined that Roberdel and Rockingham City Lakes had excessive macrophyte growths. Rockingham City Lake is on the 303 (d) list of impaired surface waters. Water and Hamlet City Lakes, both water supply lakes, have water quality problems but are supporting their designated uses.

Table 39. Waterbodies monitored in Subbasin 16 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1995/1996	2001
B-1	Hitchcock Cr	Richmond	SR 1486	Good	Good
B-2	Beaverdam Cr	Richmond	SR 1486	Excellent	Not Impaired
B-3	Hitchcock Cr	Richmond	SR 1109	Poor	Good-Fair
F-1	Cartledge Cr	Richmond	SR 1142	---	Good
F-2	Hitchcock Cr	Richmond	SR 1486	---	Not rated
F-3	Rocky Fork Cr	Richmond	SR 1424	---	Not rated
F-4	Marks Cr	Richmond	SR 1104	---	Not rated
T-1	Pee Dee R	Richmond	US 74	---	---
T-2	Pee Dee R	Richmond	Below Blewett Falls Dam	---	---
L-1	Roberdel Lake	Richmond		Dystrophic	---
L-2	Rockingham City Lake	Richmond		Dystrophic	---
L-3	Water Lake	Richmond		Mesotrophic	---
L-4	Hamlet City Lake	Richmond		Eutrophic	---

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

River and Stream Assessment

Due to low flow conditions, Cartledge Creek at SR 1142, and Marks Creek at SR 1812 were not sampled in 2001. Low flow may help explain the Fair rating Cartilage Creek received in 1996. Marks Creek has characteristics typical of a swamp stream and may be a candidate for winter sampling.

Cartledge, Hitchcock, and Marks Creeks were sampled for fish community assessment for the first time in 2001. Rocky Fork and Hitchcock Creeks drain the undeveloped NC WRC's Sandhills Gameland. Both these sites had the lowest conductivity and pH of any site monitored in the entire basin in 2001. The conductivities were 20 and 25 µmhos/cm and the pHs were 4.8 and 5.4 s.u.

The fish fauna is limited in numbers and diversity but is unique and adapted to Sandhill streams. The fauna includes chain and redfin pickerel, dusky shiner, creek chubsucker, spotted sucker, bluespotted sunfish, and dollar sunfish.

Criteria have not been developed for rating fish communities in the Sandhills. As criteria are developed, Hitchcock and Rocky Fork Creeks should serve as regional reference sites because of the high quality instream, riparian, and watershed characteristics these streams share.

Cartledge Creek, SR 1142

Cartledge Creek, a tributary to the Pee Dee River, was first evaluated and qualified as a regional reference site in August 1998. However, it was not sampled for fish community assessment until

April 2001. Habitat scores were 67 and 61 in 1998 and 2001, respectively.

Although in the Carolina Slate Belt, the stream is not a typical stream of this ecoregion. The stream has a sand and gravel bottom and large woody debris creating side pools and instream habitats. Also, flow may get very low during periods of prolonged drought.

Upstream view of Cartledge Creek at SR 11442, Richmond County.

The fish community was rated Good (NCIBI = 50). The overall diversity of the community was high, however, only one species of darter and sucker were collected. The favorable instream pool habitats did not produce the number and size of sunfish and suckers that was to be expected. Also, the species with multiple age classes metric was less than expectations. Ten of the 17 species were represented by only 1 or 2 fish per species. The redlip shiner and bluehead chub were the numerically dominant species.

Hitchcock Creek, SR 1486

The upper sections of Hitchcock Creek are located in the Sandhills ecoregion. During benthic macroinvertebrate sampling in August, the stream is five meters wide with a substrate of sand and gravel. Good instream habitat was present, although pools and riffles were infrequent. The riparian corridor was forested, but both banks were vertical and eroded.

This site was rated Good in 1996 and 2001 with consistent EPT taxa richness (21 and 23). The most abundant taxon was the caddisfly *Macrostemum*, although many other intolerant taxa were also collected at this site.

This fish community site is approximately two miles downstream from the NC WRC's McKinney Lake and fish hatchery. The stream is surrounded by a bay and holly forest. The fish community was reduced in numbers but dominated by the dusky shiner and spotted sucker.

Upstream of Hitchcock Creek (looking downstream) at SR 1486, Richmond County.

Rocky Fork Creek, SR 1424

Rocky Fork Creek was sampled once before - at SR 1487 in 1990. This site was immediately below Millstone Lake and the fish community was atypical of that found in an unimpacted Sandhills stream (i.e., it was diverse and abundant).

In 2001, the site was moved approximately two miles further downstream. This new site appeared to be near the Fall Line as there was evidence of a very old mill dam and there were large boulders and rock outcroppings. Fourteen species were collected of which nine were represented by only 1 or 2 fish per species. Of the 83 fish collected, 50 of them were the dusky shiner.

Rocky Fork Creek at SR 1424, Richmond County.

Beaverdam Creek, SR 1486
This stream originates in the Sandhills Game Lands and the catchment is largely forested. It has tannic water and a sandy bottom with large amounts of woody debris. The stream edge has numerous root mats and slightly eroded banks. The flow was nearly all run with almost no pools. Riffles were created as a result of wood stacking up. Beaverdam Creek was only three meters wide during low-flow conditions in 2001.

Beaverdam Creek at SR 1486, Richmond County.

In 1996, Beaverdam Creek was rated Excellent, but this site was given the designation of Not Impaired in 2001. EPT taxa richness was down slightly from 27 in 1996 to 24 in 2001, with Trichoptera (caddisflies) accounting for 17 of the 24 taxa. This decline may be due to lower flow conditions in 2001 rather than to any change in water quality.

Hitchcock Creek, SR 1109
This downstream site on Hitchcock Creek is just upstream of the confluence with the Pee Dee River. Heavy sediment deposition was apparent, with many sand bars under low flow conditions. Width was variable with areas of higher flow at constriction points. The water was turbid with a slight sewage smell. Both banks were vertical and undercut.

The substrate was all sand with silt deposits in areas of low flow. Riffles and pools were infrequent, however the riparian zone was forested below the bridge. Land use was mostly industrial upstream of the bridge. The sampling location was about 100 meters downstream from the old Laurel Hill Paper outfall.

Hitchcock Creek at SR 1109, Richmond County.

When this site was sampled in 1996, the macroinvertebrate community was dominated by pollution tolerant taxa. With only five EPT taxa, and high Biotic Index (7.9), it was rated as Poor.

Conditions improved dramatically in 2001. EPT taxa now totaled 21, with 17 Trichoptera taxa. The Biotic Index score dropped to 6.0 and the bioclassification improved to Good-Fair. A large part of this improvement maybe due to the fact that the Laurel Hill Paper quit discharging in February 1998.

Marks Creek, SR 1104
This site on Marks Creek was below the Town of Hamlet which may account for the stream's elevated conductivity and pH (43 µmhos/cm and 6.3 s.u., respectively) compared with the lower readings from Rocky Fork and Hitchcock Creeks. The bridge crossing and road right-of-way were also popular places for the disposal of household wastes. This site was also more Coastal Plain-like than Sandhills: more silt, detritus, and sand and less gravel. The fish community was dominated by the dusky shiner and the redbreast sunfish.

Upstream view of Marks Creek at SR 1104, Richmond County.

SPECIAL STUDIES

303 (d) Stream - Hitchcock Creek

Hitchcock Creek at US 74 was sampled in 2001 as a 303 (d) site. This location, upstream of the SR 1109 site, improved from Fair to Good. Some of the factors leading to the improvement of water quality at US 74 may also have influenced changes downstream at SR 1109.

Fish Tissue

Yadkin River at Rockingham and Immediately Below Blewett Falls Dam

Eighteen samples from the Pee Dee River near Rockingham (US 74) and nine samples from the Pee Dee River immediately below Blewett Falls Dam were collected during 1999 and 2000, respectively. The samples were analyzed for total mercury and other metals contaminants. All results were at non-detectable levels or below current USEPA, USFDA, and North Carolina criteria (Appendices FT1 and FT2).

Lake Assessment

Roberdel Lake

Roberdel Lake supplies approximately two-thirds of the drinking water to the City of Rockingham. This reservoir is located in the Sandhills and is dystrophic with characteristics of a blackwater/cypress swamp lake (Figure 66).

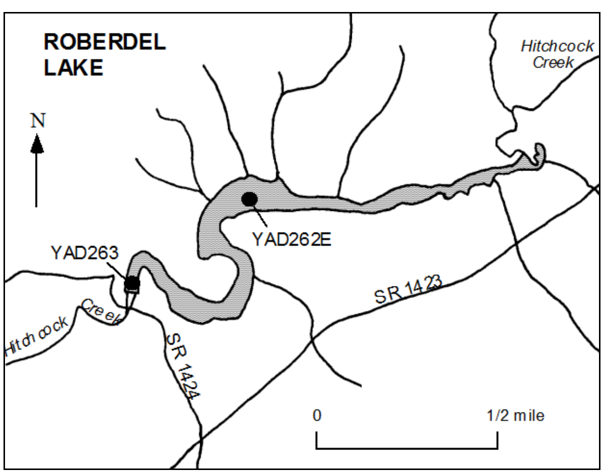


Figure 66. Sampling sites at Roberdel Lake, Richmond County.

Roberdel Lake was most recently monitored in 2000 and 1995. Due to the naturally dark color of the lake water, Secchi depths were less than a meter. Nutrient concentrations were generally low to moderate. All other parameters were within applicable state water quality standards.

Acidic, "blackwater" lakes, like Roberdel Lake, are rich in organic matter, mainly in the form of suspended plant colloids and larger plant fragments, but usually have low productivity and few water quality problems. Since the NCTSI was calibrated based on lakes that were not dystrophic, NCTSI scores are not considered meaningful in evaluating dystrophic lakes such as Roberdel.

Rockingham City Lake

Rockingham City Lake is a secondary water supply reservoir for the City of Rockingham (Figure 67).

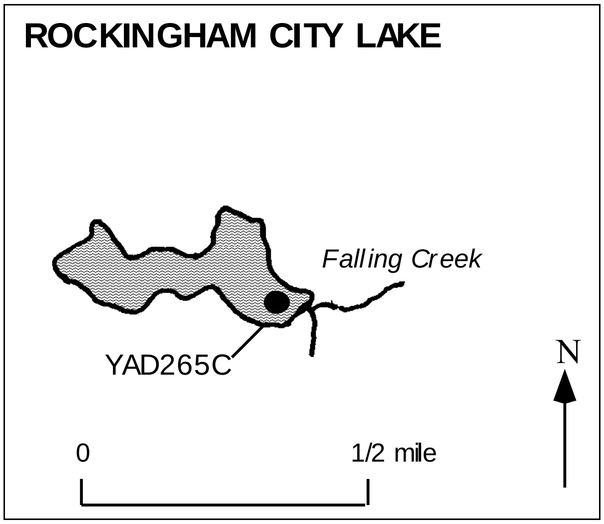


Figure 67. Sampling site at Rockingham City Lake, Richmond County.

Rockingham City Lake was most recently monitored in 2000. This lake is dystrophic with numerous aquatic macrophytes present. Plant samples collected from the lake consisted of spikerush (*Eleocharis* sp.), bog moss (*Mayaca fluviatilis*), variable-leaf watermilfoil (*Myriophyllum heterophyllum*), and fragrant or white water lily (*Nymphae odorata*).

Due to the naturally dark colored water, Secchi depths were less than a meter. Surface dissolved oxygen concentrations (3.9 mg/L in June and 3.2 mg/L in August) were less than the state water quality standard of 4.0 mg/L for an instantaneous reading. This low dissolved oxygen reading is not considered unusual in the presence of such thick stands of macrophytes. Nutrient concentrations ranged from low to moderate.

This lake has been listed as partially supporting its designated uses due to the excessive growth aquatic macrophytes. As a result of this rating, Rockingham City Lake is on the 303(d) list of impaired surface waters and is scheduled for TMDL development.

Water Lake

Water Lake, which is the water supply reservoir for the City of Hamlet, is located in the Sandhills region (Figure 68).

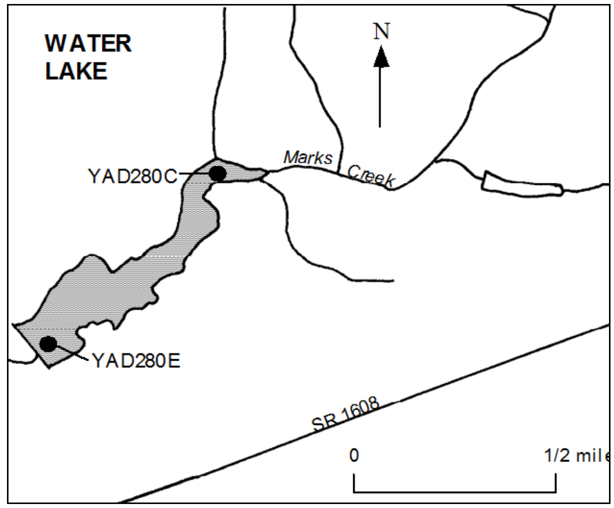


Figure 68. Sampling sites at Water Lake, Richmond County.

Water Lake was most recently monitored in 2000. The results were very similar to previous years. Secchi depth was less than one meter at the upstream sampling site and ranged from 1.1 to 1.8 meters near the dam. In August, surface dissolved oxygen near the dam was 8.5 mg/L and the percent dissolved oxygen saturation was 112%. This value was greater than the state water quality standard of 110% for dissolved gasses. Total phosphorus concentrations were low and total organic nitrogen ranged from moderate to elevated.

Surface metals were within applicable state water quality standards with the exception of copper in June (17.0 µg/L) and August (42 µg/L). These values were greater than the state water quality action level of 7.0 µg/L and were due to copper sulfate treatments to control algae growth.

Water Lake was previously monitored in 1995 and was determined to be mesotrophic. The trophic state of this lake has varied between mesotrophic and eutrophic with the exception of an oligotrophic NCTSI score in 1989 (Figure 69).

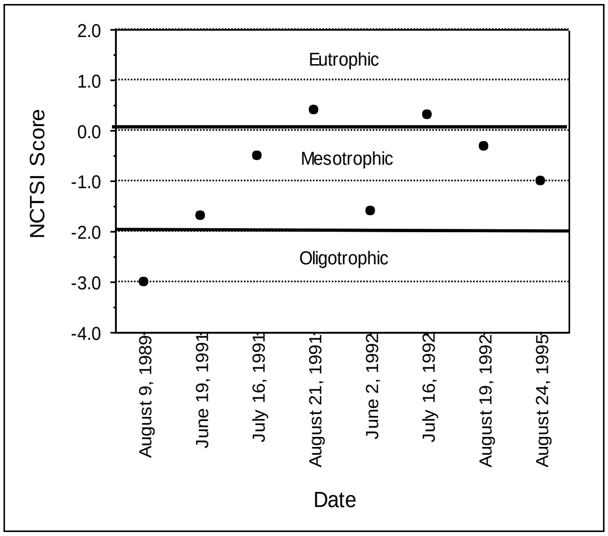


Figure 69. NCTSI scores for Water Lake, Richmond County (the bold lines indicate divisions between trophic states).

Hamlet City Lake

Hamlet City Lake is a small, shallow lake located in the Town of Hamlet (Figure 70). The lake has had on-going water quality problems related to aquatic macrophytes and sedimentation. Restoration work to alleviate these problems was competed by the US Army Corps of Engineers in 1998 and the lake was refilled by the summer of that year.

Sampling in the summer of 2000 indicated that aquatic macrophytes were again becoming a problem. In August, the surface dissolved oxygen value at the upper end of the lake (3.6 mg/L) was less than the state water quality standard of 4.0 mg/L for an instantaneous reading. In shallow waters, decomposition of macrophytes can result in severe oxygen depletion to the point of anoxia throughout the water column (Wetzel 1975). Since all other dissolved oxygen values were above the state standard and numerous aquatic macrophytes were noted in this location, decomposition seems to be the logical reason for the low dissolved oxygen concentrations.

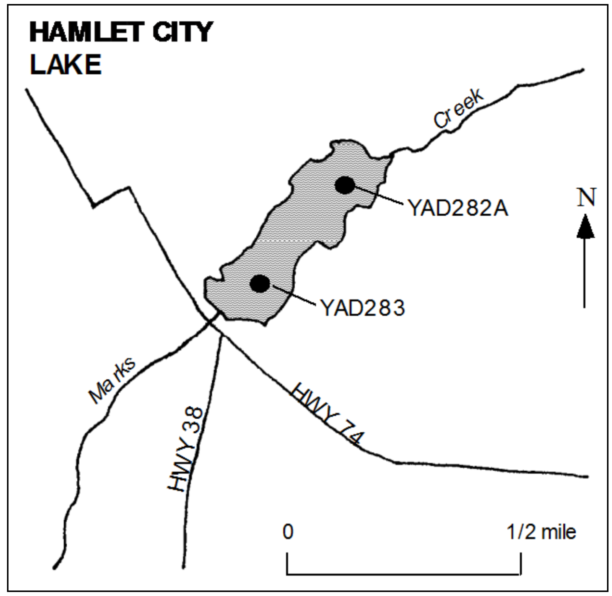


Figure 70. Sampling sites at Hamlet City Lake, Richmond County.

Concentrations of total phosphorus ranged from low to moderate and concentrations of total organic nitrogen ranged from low to elevated. The concentration of suspended solids was low (range = 2 to 5 mg/L).

Hamlet City Lake was previously monitored in 1995, prior to lake restoration. The lake was determined to be eutrophic based on the calculated NCTSI score.

YADKIN RIVER SUBBASIN 17

Description

This subbasin contains the watersheds of Jones and Deadfall Creeks in southern Anson County (Figure 71). Most of the subbasin is in the Carolina Slate Belt. The southern and eastern portions of the Town of Wadesboro drain into the Bailey Creek and North Fork Jones Creek watersheds. There are no NPDES permitted dischargers in the subbasin. Almost 80 percent of the landuse in the subbasin is forested (Table 40).

Table 40. Landuse in Subbasin 17. Based upon CGIA coverage 1993 - 1995 (total area = 97,547 Ac).

Landuse	Percent
Water	0.6
Cultivated crop	8.4
Pasture	10.8
Urban	0.9
Forest	79.2

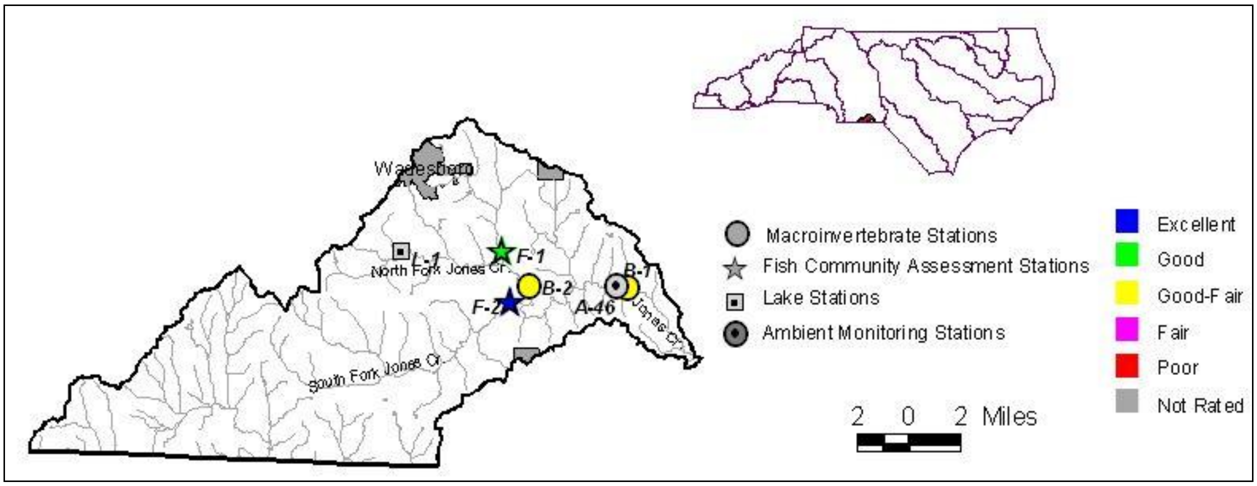


Figure 71. Sampling sites in Subbasin 17 in the Yadkin River basin.

Overview of Water Quality

Jones Creek is the only ambient monitoring site in this subbasin. Here, fecal coliform bacteria levels have been recorded slightly above the reference level of 200 colonies/100ml.

Benthos data from North Fork Jones Creek indicated some improvements in water quality (Table 41). EPT taxa richness increased from 11 in 1996 to 16 in 2001, and abundance doubled. These changes raised the bioclassification to Good-Fair. Jones Creek has been rated Good-Fair since 1987.

Fish community monitoring on Bailey Creek rated it Good, with continued signs of some nutrient enrichment. South Fork Jones Creek was rated Excellent, with a diverse fish community dominated by bluehead chub and redlip shiner.

Wadesboro City Pond was found to have elevated nutrient concentrations and increased algae activity in 2001.

Table 41. Waterbodies monitored in Subbasin 17 in the Yadkin River basin for basinwide assessment, 1996 - 2001.

Map #[1]	Waterbody	County	Location	1996	2001
B-1	Jones Cr[2]	Anson	NC 145	Good-Fair	Good-Fair
B-2	North Fork Jones Cr[2]	Anson	SR 1121	Fair	Good-Fair
F-1	Bailey Cr	Anson	SR 1811	Good	Good
F-2	South Fork Jones Cr	Anson	SR 1821	---	Excellent
L-1	Wadesboro City Pond	Anson		---	---

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]Data are available prior to 1996, refer to Appendix 7.

River and Stream Assessment

Due to low flow conditions, South Fork Jones Creek at SR 1821 was not sampled in 2001.

Jones Creek, NC 145
The stream channel of Jones Creek at NC 145 is about 20 meters wide. There is a mixed substrate of boulder, rubble and gravel with some sand and silt in areas of lower flow. Pools and riffles were infrequent and flow was observed only in areas where stream width was less than eight meters. The riparian zone was forested and banks were only moderately eroded. The water was slightly turbid at the time of sampling.

Jones Creek at NC 145, Anson County.

This site has been sampled for benthos four times since 1987 and has consistently been rated Good-Fair. EPT taxa richness (16 - 18) and the Biotic Index (5.8 - 6.0) have been stable over the last three samples. Baetid mayflies were absent in 2001, while flatworms and mites were abundant in the leafpacks. This may be a result of low flow conditions. The overall assessment indicated no significant changes in water quality.

North Fork Jones Creek, SR 1121
The stream channel at this site is about 15 meters wide, but during low-flow conditions in 2001 the stream width was only about five meters. The current was very slow and only one area suitable for a kick sample was located. The substrate was nearly all sand with a few scattered rocks. The banks were undercut and sandbars were well developed on the inside of bends.

North Fork Jones Creek at SR 1121, Anson County.

This location was sampled in 1996 under normal flow conditions and was given a Fair bioclassification. During low flow in 2001, however, there was some improvement. EPT taxa richness increased from 11 in 1996 to 16 in 2001, and abundance doubled from 35 to 70. These changes brought the rating up to Good-Fair. This pattern suggested that North Fork Jones Creek is affected by nonpoint source runoff and will continue to vary between a Fair and Good-Fair rating depending on the flow conditions.

Bailey Creek, SR 1811
The watershed of Bailey Creek includes the eastern half of the Town of Wadesboro. Although in the Carolina Slate Belt, the stream is not a typical stream of this ecoregion. The stream has a very sandy bottom and instream and riparian habitats show some signs of habitat alteration: an embedded sand and gravel substrate, easily erodible and vertical banks, and infrequent gravel riffles.

Upstream view of Bailey Creek at SR 1811, Anson County.

This site was rated Good in 1996 and in 2001 (NCIBI = 52). Metric values and scores were almost identical for both years. For a stream of its size, the community was abundant and diverse. A skewed trophic structure continued to show evidence of some nutrient enrichment. The bluehead chub was again the dominant species. As in 1996, sea lampreys were collected at this site. But this time, the species was represented by 16 ammocoetes rather than two adults.

South Fork Jones Creek, SR 1821
A new fish community monitoring site was selected in 2001 because the site sampled in 1996 (Jones Creek at SR 1812) was too wide to sample following existing standard sampling procedures.

The watershed of South Fork Jones Creek drains the extreme rural, southern area of Anson County. There are no NPDES facilities in the watershed upstream of the monitoring site. Although in the Carolina Slate Belt, the stream is not a typical stream of this ecoregion. The stream has a sand and gravel bottom with a few bedrock boulders. The stream also showed some signs of habitat alteration with easily erodible and vertical banks. The conductivity, however, was relatively low for a piedmont stream (59 µmhos/cm).

Upstream view (looking downstream) South Fork Jones Creek at SR 1821, Anson County.

The fish community was rated Excellent (NCIBI = 54). Exotic species were absent and the bluehead chub and the redlip shiner were the numerically dominant species. One ammocoete sea lamprey was also collected.

Wadesboro City Pond

Wadesboro City Pond serves as the water supply for the City of Wadesboro. Located in the Triassic Uplands, the pond has a flat drainage area that consists of forested and agricultural areas (Figure 72).

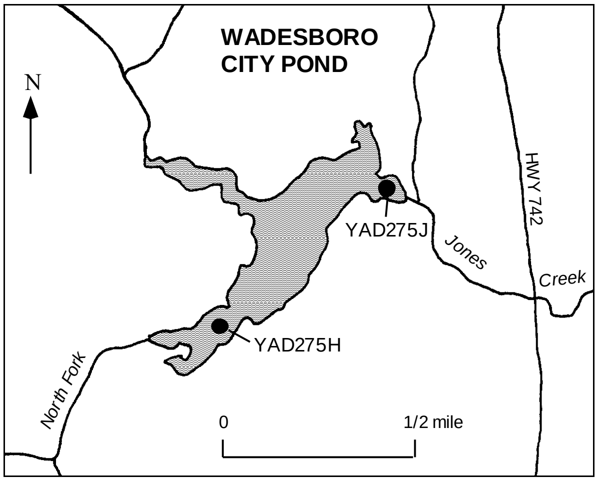


Figure 72. Sampling sites at Wadesboro City Pond, Anson County.

Wadesboro City Pond was first sampled in 1989 with the most recent sampling event occurring in 2000. Secchi depths at both sampling sites in June and August were less than one meter indicating poor light availability in the water column. In July, the Secchi depth near the dam was 2.2 meters and 0.8 meters at the upper end of the pond, indicating adequate light availability at the lower end of the pond to support algae growth within the water column as opposed to the upper end of the pond. Surface dissolved oxygen was elevated in 2000. Nutrient concentrations ranged from low to moderate in June and increased to more elevated concentrations in July and August. The availability of light at the lower end of the pond along with nutrients at concentrations suitable to support algae growth may have contributed to an increase in algae productivity.

Surface metals, with the exception of copper in June (25.0 µg/L) and August (22.0 µg/L), were within the applicable state water quality standards. The values for copper in June and August were greater than the state water quality action level of 7.0 µg/L. Copper sulfate had been applied to the pond to control algal growth.

Based on the calculated NCTSI score, this pond determined to be eutrophic in 1995 and 1989.

AMBIENT MONITORING SYSTEM

A general understanding of human activities and natural forces that affect pollution loads and their potential impacts on water quality can be obtained through routine sampling from fixed water quality monitoring stations. Routine (i.e. monthly) sampling is referred to as ambient monitoring and during this assessment period (September 01, 1996 - August 31, 2001), 46 stations were monitored within the basin (Figure 73 and Table 42).

Data collected by the Yadkin Pee Dee River Basin Association (YPDRBA) complemented the data collected by the NC DWQ. The YPDRBA began monitoring in June 1998; therefore, their data represent only a portion of the assessment period. A brief discussion of these complementary data is provided at the end of the discussion of the NC DWQ ambient data.

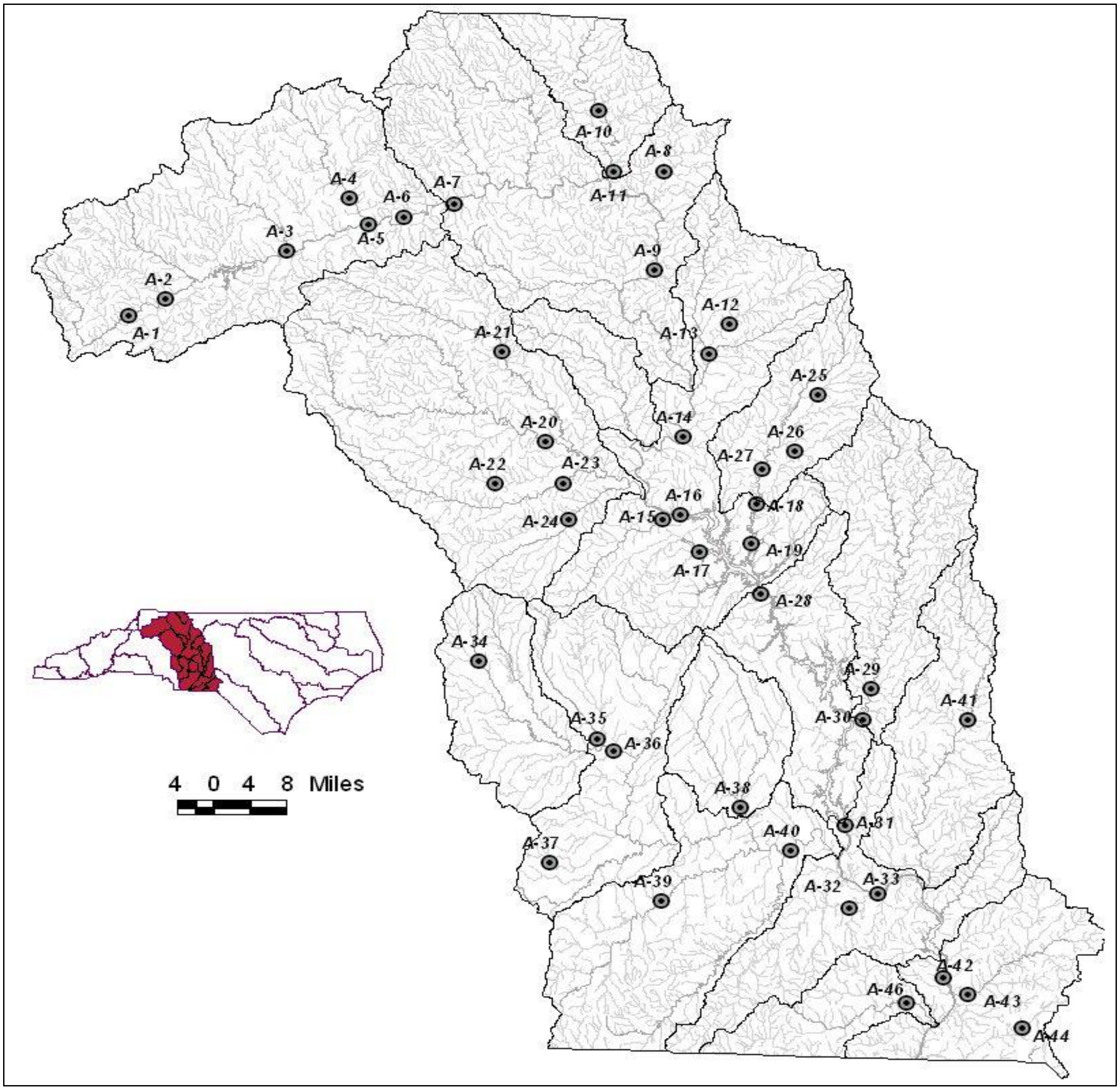


Figure 73. Ambient monitoring system sites within the Yadkin River basin. Site A-45 is not shown.

Table 42. Ambient monitoring system sites within the Yadkin River basin (sorted by subbasin and station).

Subbasin/ Map Code	Station	Location[1]	Class
01			
A-1	Q0060000	Yadkin River at NC 268 at Patterson	C Tr
A-2	Q0220000	Elk Creek at NC 268 at Elkville	B ORW
A-3	Q0390000	Yadkin River at Wilkesboro	C
A-4	Q0660000	Roaring River at SR 1990 near Roaring River	B
A-5	Q0690000	Yadkin River at SR 2327 at Roaring River	WS-V
A-6	Q0720000	Yadkin River at SR 2303 at Ronda	WS-IV
02			
A-7	Q0810000	Yadkin River at US 21 Bus at Elkin	C
A-8	Q2020000	Little Yadkin River at US52 at Dalton	WS-IV
A-9	Q2040000	Yadkin River at SR 1605 at Enon	WS-IV
03			
A-10	Q1780000	Ararat River at SR 2019 at Ararat	C
A-11	Q1950000	Ararat River at SR 2080 near Siloam	WS-IV
04			
A-12	Q2510000	Salem Creek at Elledge WWTP at Winston Salem	C
A-13	Q2600000	Muddy Creek at SR 2995 near Muddy Creek	C
A-14	Q2810000	Yadkin River at US 64 at Yadkin College	WS-IV CA
A-15	Q4600000	Grants Creek Below Salisbury and Spencer WWTP	C
A-16	Q4660000	Yadkin River at NC 150 near Spencer	WS-V
A-17	Q5360000	Town Creek at SR 2168 near Duke	WS-V
A-18	Q5970000	Abbotts Creek at NC 47 near Cotton Grove	WS-V & B
A-19	Q5990000	Abbotts Creek at SR 2294 near Southmont Duracell	WS-IV & B
06			
A-20	Q3460000	S Yadkin River at SR 1159 near Mocksville	WS-IV
A-21	Q3484000	Hunting Creek at SR 2115 near Harmony	WS-III
A-22	Q3735000	Fourth Creek at SR 2308 near Elmwood	C
A-23	Q3934500	Third Creek at SR 1970 near Woodleaf	WS-IV
A-24	Q4120000	Second Creek at US 70 near Barber	WS-IV
07			
A-25	Q5780000	Rich Fork at SR 1800 near Thomasville	C
A-26	Q5906000	Hamby Creek at SR 2790 near Holly Grove	C
A-27	Q5930000	Abbotts Creek at SR 1243 at Lexington	C
08			
A-28	Q6120000	Yadkin River at SR 1002 at High Rock	WS-IV & B CA
09			
A-29	Q6810000	Uwharrie River at NC 109 near Uwharrie	WS-IV
A-30	Q6820000	Dutchmans Creek at SR1150 near Uwharrie	WS-IV CA
10			
A-31	Q7150000	Pee Dee River at NC 731 near Shankle	WS-V & B
A-32	Q9155000	Brown Creek at SR 1627 near Pinkston	C
A-33	Q9160000	Pee Dee River at NC 109 near Mangum	WS-V & B
11			
A-34	Q7330000	Rocky River at SR 2420 near Davidson	C
12			
A-35	Q8090000	Irish Buffalo Creek at SR 1132 near Faggarts	C
A-36	Q8210000	Rocky River at US 601 near Concord	C
A-37	Q8360000	Goose Creek at SR 1524 near Mint Hill	C
13			
A-38	Q8720000	Long Creek at SR 1954 near Rocky River Springs	C
14			
A-39	Q8917000	Richardson Creek at SR 1649 near Fairfield	C
A-40	Q9120000	Rocky River at SR 1935 near Norwood	C
15			
A-41	Q9200000	Little River at SR 1340 near Star	C HQW
16			
A-42	Q9400000	Pee Dee River at US 74 near Rockingham	C
A-43	Q9660000	Hitchcock Creek at SR 1109 at Cordova	C
A-44	Q9940000	Marks Creek at SR 1812 near Hamlet	C
A-45	Q9980000	Pee Dee River at SC Hwy 9 at Cheraw SC	C
17			
A-46	Q9777000	Jones Creek at NC 145 near Pee Dee	C

Data Assessment and Interpretation
Monitoring and sampling results considered in this report represent samples collected or measurements taken at less than one meter in depth in order to establish a consistent comparison among the monitoring stations throughout the basin.

Median and percentile statistics are calculated for most of the data. These statistics were not calculated for the metals arsenic, cadmium, chromium, lead, mercury and nickel because samples frequently had concentrations less than the reporting level. Percentiles were calculated using Microsoft® Excel 2000; values less than the minimum reporting level were evaluated as equal to the reporting level. Box and whisker plots (constructed using SigmaPlot® version 6) are presented only for those water quality characteristics that showed significant variation among the monitoring stations.

Analytical Considerations
During this assessment period two issues were noted as part of the analytical laboratory process:
1. laboratory or sampling related contamination may have produced higher than expected values of zinc between April 1995 and March 1999; and
2. nitrogen and 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 precision of those results is known.

Use Support Assessment Considerations
- The daily average dissolved freshwater oxygen standard of 5.0 mg/L is presented as an evaluation level. Instantaneous values of 4.0 mg/L or less can occur and may be acceptable if caused by natural (e.g. swampy) conditions.
- Action level standards (copper, iron, and zinc) are used primarily as evaluation guidelines because results include fractions that may have little effect on aquatic life. Where appropriate, follow-up toxicological work will need to be conducted before use support determination can be made for these parameters.
- The geometric mean and median statistics were calculated for fecal coliform results for each station. These values were compared to the appropriate standards for tidal and nontidal waters. Details are discussed in the section presenting the results for fecal coliform bacteria.

Dissolved Oxygen
During this assessment period, eight stations had more than 10 percent of the measurements less than 5.0 mg/L (Figure 74 and Table 43). The three stations on the Pee Dee River are below hydroelectric plants.

Table 43. Stations with more than 10 percent of the dissolved oxygen concentrations less than 5.0 mg/L, September 1996 - August 2001.

Station	Location	N	% < 4.0	% < 5.0
Q5780000	Rich Fork	47	0.0	12.8
Q5990000	Abbotts Cr	43	7.0	11.6
Q6120000	Yakin R, SR 1002	48	10.4	25.0
Q7150000	Pee Dee R, NC 731	57	3.5	10.5
Q9155000	Brown Cr	54	27.8	37.0
Q9160000	Pee Dee R, NC 109	53	1.9	11.3
Q9400000	Pee Dee R, US 74	55	9.1	18.2
Q9940000	Marks Cr	54	20.4	25.9

To determine if concentrations were increasing or decreasing over time, all measurements since 1980 were graphed (Figure 75). Overall no significant trends (increases or decreases) were observed. It seemed that concentrations at these eight stations have remained constant over the last 21 years. However, the Pee Dee River at US 74 has recently begun to show an increasing frequency of measurements less than 5.0 mg/L (Figures 74 and 75). Measurements at this site warrant further observation as additional data are collected.

Data collected since 1980 from those stations that did not have had more than 10 percent of the samples less than 5.0 mg/L were examined to ascertain whether any temporal patterns were present. This examination focused on identifying stations that may have a pattern of decreasing concentrations, but with values greater than 5.0 mg/L. No stations depicted a pattern of decreasing concentrations. Overall, many stations showed improvements in concentrations early in their monitoring period (late 1970s to early 1980s). These improvements were likely due to improvements in wastewater treatment. Concentrations have remained fairly constant after these improvements were implemented.

Dissolved oxygen concentrations along the mainstem portion of the Yadkin - Pee Dee River showed more concentrations less than the water quality standard in the lower part than in the upper part of the basin (Figure 76). The 25th percentile was at or less than the standard at four of these sites. As mentioned previously in Subbasin 08, the Pee Dee River from Norwood Dam (the dam at Lake Tillery) to the mouth of Turkey Top Creek (Subbasins 08 and 10) is on the 303 (d) impaired streams list because of low dissolved oxygen (NCDENR 2000). Low dissolved oxygen levels in this portion of the river seem to be related to hypolimnetic discharges from CP&L's Tillery Hydroelectric Plant. In coordination with the NC Division of Water Resources, the NCDWQ will explore mitigative actions to be taken to correct this problem when the facility comes up for relicensing (NCDENR 2000).

Although the station along the Uwharrie River at NC 109 (Station Q6810000) showed no long term patterns, it is within this assessment period that the first and only measurements less than 5.0 mg/L were observed. This resulted in four of the 55 measurements (7.3%) taken during this assessment period less than 5.0 mg/L. During the previous assessment period (January 30, 1992 to November 07, 1996) the minimum concentration observed was 6.9 mg/L.

Seventeen stations showed 27 abnormally elevated (> 15.0 mg/L) concentrations in the data collected since 1997. Most (n = 25) elevated measurements occurred during the months of December through April; 14 occurred during December 2000 and January 2001, and 2 occurred during the summer. These high values are seen in Appendices 19 - 64. For example, a maximum Dissolved oxygen of 18.6 mg/L was measured from Elk Creek at NC 268 (Station Q0220000; Appendix 20).

The values were compared to dissolved oxygen saturation tables that provide estimates of the solubility of oxygen at given temperatures at standard atmospheric pressure (Wetzel and Likens 1991). The saturation tables showed that a maximum solubility of 14.6 mg/L occurs in pure water at 0º C at standard pressure. Although field measurements greater than 14.6 mg/L can occur naturally during high rates of photosynthesis, no explanation can be provided for these elevated values.

pH

The pH of natural waters can vary. Low values (<< 7.0 s.u.) can be found in waters rich in dissolved organic matter, whereas high values (>> 7.0 s.u.) in North Carolina are found during algal blooms. Point source dischargers can also influence the pH of a stream. The measurement of pH is relatively easy, however extremely accurate measurements are difficult to make under field conditions. This is due, in part, because the scale for measuring pH is logarithmic (i.e. a pH of 8 is ten times more concentrated than a pH of 7).

The water quality standards for pH in freshwaters consider values less than 6.0 s.u. or greater than 9.0 s.u. as extreme and warrant attention. Only four stations had more than 10 percent of samples exceeding these standards (Table 44 and Figure 78).

Table 44. Stations with more than 10 percent of the samples exceeding water quality standards for pH.

Station	Location	N	% < 6.0 s.u.	% > 9.0 s.u.
Q0220000	Elk Cr	51	13.7	0.0
Q5360000	Town Cr	55	0.0	16.4
Q9660000	Hitchcock Cr	55	14.5	0.0
Q9940000	Marks Cr	54	22.2	0.0

Three stations had pH concentrations less than 6.0 s.u. and Town Creek had pH concentrations greater than 9.0 s.u. Water quality in Town Creek is influenced by discharges from the Town of Salisbury's wastewater treatment facility.

Historically, Elk Creek had few observations below 6.0 s.u. (Figure 77). Values apparently decreased between 1996 and 1999 and then increased. No explanation has been found for the greater frequency of observations less than 6.0 s.u. between 1998 and 2001.

The historical record for Hitchcock Creek and Marks Creek showed observations less than 6.0 s.u. These exceedances were not uncommon between 1979 and 1987. Some of the lowest values occurred between 1995 and 1996 (Figure 77).

Long-term data from stations that did not have more than 10 percent exceedances were also examined to ascertain any patterns or changes. Because outliers are common in pH data, linear regression techniques were not used. Instead, data were divided into two groups: 1) all data before September 01, 1996 (i.e. “before” the current assessment period); and 2) all data collected since September 01, 1996 (i.e., “during” the current assessment period). The difference in the median concentration for both periods was calculated for each station.

Abbotts Creek at SR 2294 (Station Q5990000) depicted the greatest change. Median pH for the “Before” group was 8.00 s.u. and 7.2 s.u. for the “During” group (a decrease of 0.8 s.u.). This Abbotts Creek site can be considered part of High Rock Lake and thus, has lentic water (non-flowing) characteristics. Photosynthesis by algae can increase the pH of natural waters. Perhaps fewer algal blooms or a decrease in algal production was a factor in the decrease in the median pH. However, no definitive explanatory factor has been found to explain the difference.

Conductivity

Conductivity is a measure of the ability of water to conduct an electric current. The presence of ions, their total concentration and valence, and temperature are major factors in the ability of water to conduct a current. Clean, fresh water has a low conductivity, whereas high conductivities may indicate polluted water. Measurements reported are corrected for temperature, thus the range of values reported over a period of time indicate the relative presence of ions in water.

The conductivity of freshwaters in the United States can vary, with values between 50 to 1,500 µmhos/cm commonly reported (APHA 1998). However 95 percent of the values observed from the Yadkin River (using all available data) lie between 29 and 612 µmhos/cm.

Conductivity is used to evaluate variations in dissolved mineral concentrations (ions) among sites with varying degree of impact resulting from point source dischargers. Generally, impacted sites show elevated and widely ranging values for conductivity (Figure 79). Many stations showed widely varying values which were the result of point source dischargers located upstream of the sample site.

Turbidity

Turbidity data may denote episodic high values on particular dates or within narrow time periods (Figure 80). These were often the result of intense or sustained rainfall events; however large values for turbidity can occur at other times. Flow data (1980 - 2000) from the South Yadkin River near Mocksville (USGS Station 02118000) were used to determine when high flows occurred within this assessment period and if high flows coincided with high turbidity values (Figure 81).

Eleven stations within this assessment period had more than 10 percent of the observations greater than the water quality standard (Table 45).

Table 45. Stations with more than 10 percent of the samples exceeding the turbidity standard.[1]

Station	Location	Class	N	N > STD	% > STD
Q0060000	Yadkin R, NC 268	TR	44	10	22.7
Q1950000	Ararat R, SR 2080	WS-IV	56	7	12.5
Q2040000	Yadkin R, SR 1605	WS-IV	58	6	10.3
Q3460000	S Yadkin R, SR 1159	WS-IV	55	6	10.9
Q4600000	Grants Cr below WWTP	C	56	6	10.7
Q4660000	Yadkin R, NC 150	WS-V	55	6	10.9
Q5360000	Town Cr, SR 2168 (res.)	WS-V	55	15	27.3
Q5970000	Abbotts Cr, NC 47 (res.)	WS-V & B	56	15	26.8
Q5999000	Abbotts Cr, SR 2295 (res.)	WS-V & B	45	12	26.7
Q7330000	Rocky R, SR 2420	C	56	6	10.7
Q8090000	Irish Buffalo Cr	C	57	6	10.5

[1]Turbidity standard = 10 NTU for trout waters; 25 NTU for reservoirs; and 50 NTU for all other stations.

Stations situated in the arms of reservoirs had the greatest proportion of samples exceeding the turbidity standard (Table 45). Only the Yadkin River at NC 268 is classified as trout water and turbidity here exceeded the standard for 23 percent of the samples. The frequency of exceedance increased at this station during this assessment period (Figure 81). For all other stations, exceedances ranged from 10% to 13%.

Turbidity data collected since 1980 were examined for long term patterns. Decreases in the long term data were noted for a few stations; and increases noted for the Yadkin River at NC 268 (Station Q0060000) (Figure 82).

Metals

For most stations, arsenic, cadmium, chromium, lead, mercury and nickel rarely exceeded the analytical reporting level. Samples that had concentrations greater than the reporting level were generally too few to interpret statistically. A total of 12,984 results for these six metals were reported during this assessment period and only 90 results (< 1%) were observed greater than the reporting level (Table 46). This considers that about six metals per site-visit were analyzed for all monitoring stations (n = 46) over this assessment period (60 months). Only one result greater than the reporting level was recorded for cadmium and mercury.

Nickel and lead exceeded reporting limits at many stations (Table 46), but no station showed more than 10 percent of the samples greater than the appropriate action level. Nickel concentrations, from bodies of water classified as water supplies, exceeded the action level of 25 µg/L only once on August 27, 2000 from the Yadkin River at Yadkin College (Station Q2810000; 34 µg/L).

Metals that typically had a sufficient number of values that exceeded reporting levels included aluminum, copper, iron, manganese and zinc. Aluminum and iron are elements commonly observed to exceed their action levels but these elements are found naturally in the clay based soils in the piedmont. Concentrations of zinc were generally low and no station had more than 10 percent of the samples exceeding action levels.

Overall, 35 stations had more than 10 percent of the samples greater than the action level (7.0 µg/L) for copper (Table 47). However, the median concentration exceeded 7.0 µg/L only at the Ararat River at Ararat, Long Creek near Rocky River Springs, and Hambys Creek (Table 47).

Zinc was observed to exceed its Action Level (50 µg/L) at many stations. However laboratory or sampling related contamination may have produced higher than expected values of zinc between April 1995 and March 1999. Median values for all stations were less than 50 µg/L except from Muddy Creek (Station Q2600000; median = 61 µg /L).

Protocols for the Ambient Monitoring System have been reviewed and require the measurement of manganese from all waterbodies with water supply (WS -) classifications. However, not all stations with this classification have a sufficient number of samples to provide any confidence in a statistical summary. Nineteen stations in the basin have water supply classification, but seven of these have a maximum of four samples; all others have at least 40 samples. Only Abbotts Creek at NC 47 exceeded the action level of 200 µg/L. The 75th percentile showed a concentration of 168 µg /L.

Fecal Coliform Bacteria

Concentrations of fecal coliform bacteria can vary greatly. The descriptive statistics used to gage concentrations of fecal coliform bacteria include the geometric mean or the median and these depend on the classification of the body of water. Basically for all freshwater bodies of water the standard specified in Administrative Code 15A NCAC 02B .0211 (3)(e) is applicable. This standard (effective April 1, 2001) states:

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

The strict application of this standard is often hindered because the monthly (*circa* 30 day) sampling frequency employed for water quality monitoring usually does not provide more than one sample per 30 - day period. However water quality problems can be discerned using monthly sampling (Table 48 and Figure 83). Thirteen stations exceeded the geometric mean of 200 colonies/100 ml reference level (standard). None of these were Class B stations.

Stations with geometric means exceeding 200 colonies/100 ml were compared to results reported in the previous assessment period (1992 - 1996) (NCDEHNR 1997a). During the previous assessment period, 18 sites had geometric means greater that 200 colonies/100 ml. Thirteen sites exceeded this concentration during the current assessment period, and these 13 sites were also listed during the previous assessment period.

Data collected since 1970 were graphed for all 18 stations to determine if any temporal patterns were present (Figure 84). The beginning point of this period was chosen because a large number of fecal coliform samples were collected during the 1970s, and the high values present during the 1970s help illustrate improvements in water quality. These temporal graphs also show periods of time from which no data were collected.

Although substantial decreases in fecal coliform bacteria can be noted for some stations during the 1970s and 1980s (e.g. Station Q7330000) concentrations currently remain high. Various linear regression models were fitted to the data collected from each of these 18 stations since 1990, but no station exhibited a statistically significant decrease even though many plots show a pattern of decreasing concentrations.

Nutrients
The ranges of concentrations for nutrients among all sites are depicted in Figure 85. Clearly, elevated median and large interquartile (difference between the 75th and 25th percentiles) ranges of concentrations were present at a variety of tributary stations. Overall, this pattern is likely due to the effects of point source discharges.

[Note: nitrogen and phosphorus concentrations less than 0.05 mg/L and total Kjeldahl nitrogen concentrations less than 1.0 mg/L did not meet desired quality assurance measures. Neither the accuracy nor precision of those results is known.]

Few statistically significant long term patterns were evident when all available data were examined. The Roaring River (Station Q0600000) and the Yakin River near Elkin (Station Q0810000) showed increasing concentrations for nitrite+nitrate nitrogen; but most values were less than 0.75 mg/L (Figure 86).

Many stations depicted a dramatic decrease in concentration for nutrients during the 1970's – 1980's. Jones Creek showed a significant decrease in nitrite+nitrate nitrogen beginning in late 1992 (Figure 85).

Nutrient Patterns along the Yadkin River
Data were regrouped and summarized to show the spatial patterns along the mainstem of the Yadkin - Pee Dee River. For many stations, there was a high correlation between conductivity and nitrogen, and to simplify comparisons, only total nitrogen, total phosphorus and conductivity were portrayed (Figure 87).

Nutrient patterns along the river remained relatively the same as described in the previous basin assessment report (NCDEHNR 1997a) Generally, these patterns depicted relatively stable concentrations (most medians < 0.70 mg/L) of ammonia-nitrogen among the monitoring stations. One exception was the station at High Rock (Station Q6120000) with a median concentration of 0.14 mg/L.

Concentrations of total nitrogen increased from Patterson (Station Q0060000; median = 0.38 mg/L) to Ronda (Station Q0720000; median = 0.99 mg/L) and concentrations fluctuated between 0.71 and 1.04 mg/L. Conductivities were low and medians ranged from 37 to 68 µmhos/cm between the six upstream sites. Thereafter, conductivities increased and medians ranged from 99 to 132 µmhos/cm. Phosphorus concentrations showed cyclical increases and decreases that may be due to the influences of many of the reservoirs along the Yadkin - Pee Dee River system.

Complementary Programs and Data
In addition to the NC DWQ ambient water quality monitoring activities, the Yadkin Pee Dee River Basin Association (hereafter abbreviated as YPDRBA) conducts additional monitoring activities at 71 locations (Figure 87 and Table 49). The YPDRBA formed to integrate and consolidate instream sampling requirements as set forth in individual NPDES permits. A Memorandum of Agreement (MOA) with the NC DWQ specified that the YPDRBA conduct all instream sampling and perform all required analyses instead of each discharger conducting individual sampling. Thus, monitoring sites and parameters are strategically located and established such that instream monitoring is more efficient and effective.

The YPDRBA was formed in 1998 and is comprised of 36 members. Approximately 71 sites have been sampled on a monthly basis since June 1998. All sites have monthly measurements of field parameters (temperature, pH, dissolved oxygen, and conductivity), turbidity and fecal coliform bacteria. Fewer stations were sampled for nutrients and metals.

The data collected by the YPDRBA were obtained only during a portion (June 1, 1998 through August 31, 2001) of the NC DWQ basin assessment period (September 01, 1996 through August 31, 2001). Therefore, the period from which the YPDBRA data were collected was not subject to the same spectrum of environmental factors as the data collected by the NC DWQ. These factors include, but are not limited to temperature extremes and stream flow.

Overall stream flow has decreased since 1998 (Figure 80) due to drought conditions and low flows can greatly influence the results. In addition, some YPDRBA stations were located downstream of wastewater treatment plants and in dissolved oxygen sag zones. Caution should be used in making comparisons between data collected by the NC DWQ and the YPDRBA. Because the YPDRBA data did not cover the same time frame as the NC DWQ data, statistical comparisons were not attempted.

The YPDRBA data were compared to NC water quality standards and action levels (Tables 50 and 51). Parameters not listed indicated that no stations had 10 percent of samples exceeding water quality criteria. Ten stations had more than 10 percent of the measurements for dissolved oxygen less than 5.0 mg/L; six of these stations were located downstream of wastewater treatment plants. Two stations had more than 10 percent of the measurements for dissolved oxygen less than 4.0 mg/L.

Many (n = 36) stations had geometric means for fecal coliform bacteria exceeding 200 colonies/100ml, and 17 of these stations were located downstream of wastewater treatment plants.

Box and whisker plots were made for dissolved oxygen, pH, conductivity, turbidity, fecal coliform bacteria, and nutrients (Figures 89 to 95). In addition, a comparison of nutrient data are provided for four sites where sampling between NC DWQ and the YPDRBA overlaps (Figure 96). Overall, data appeared comparable, but the data collected by the NC DWQ were from a longer monitoring period.

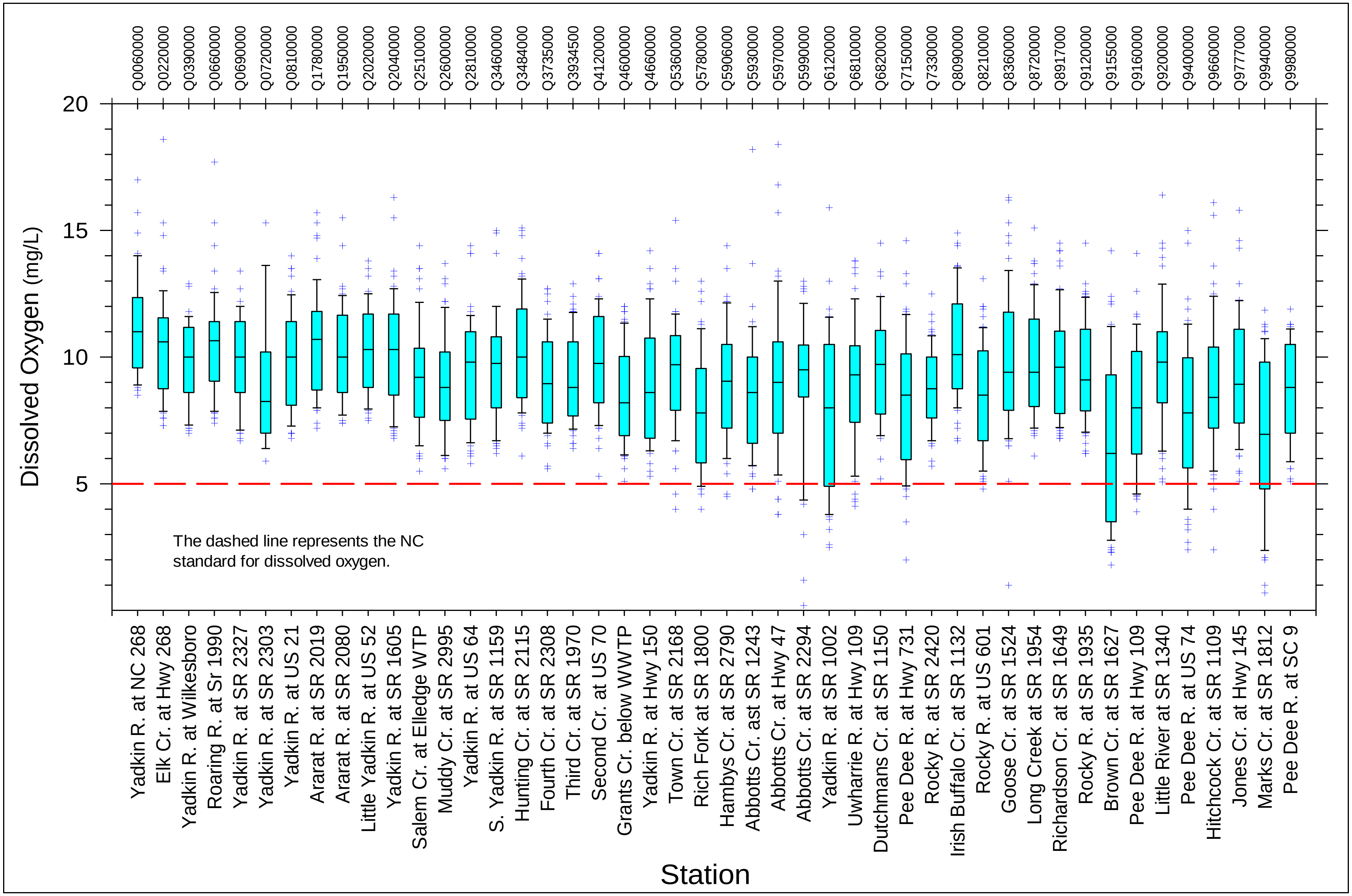


Figure 74. **Dissolved oxygen concentrations by station from NC DWQ monitoring sites in the Yadkin River basin, September 1996 - August 2001.**

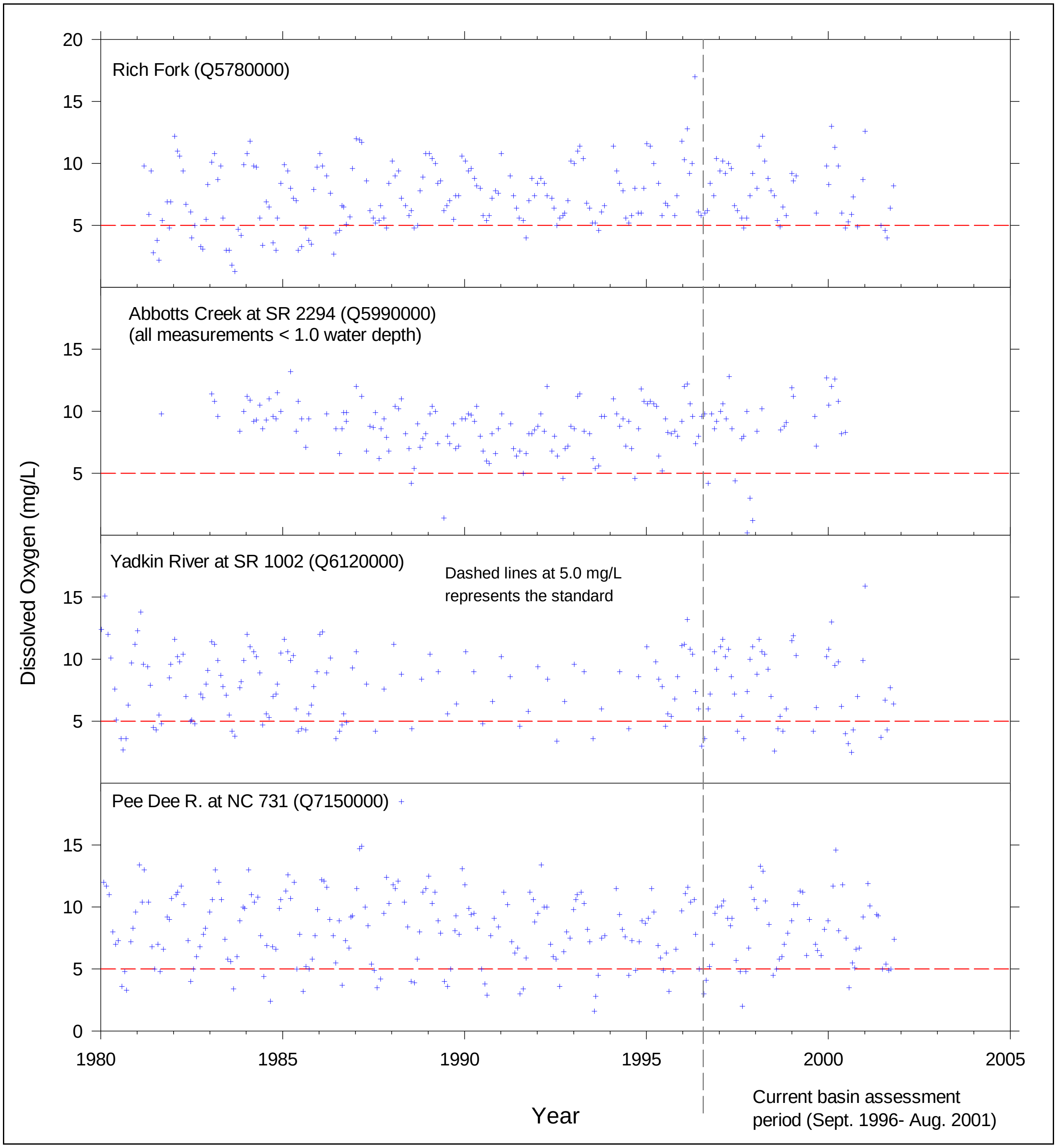


Figure 75. Long term dissolved oxygen concentrations for stations that showed more than 10 percent of the measurements less than 5.0 mg/L during the current assessment period.

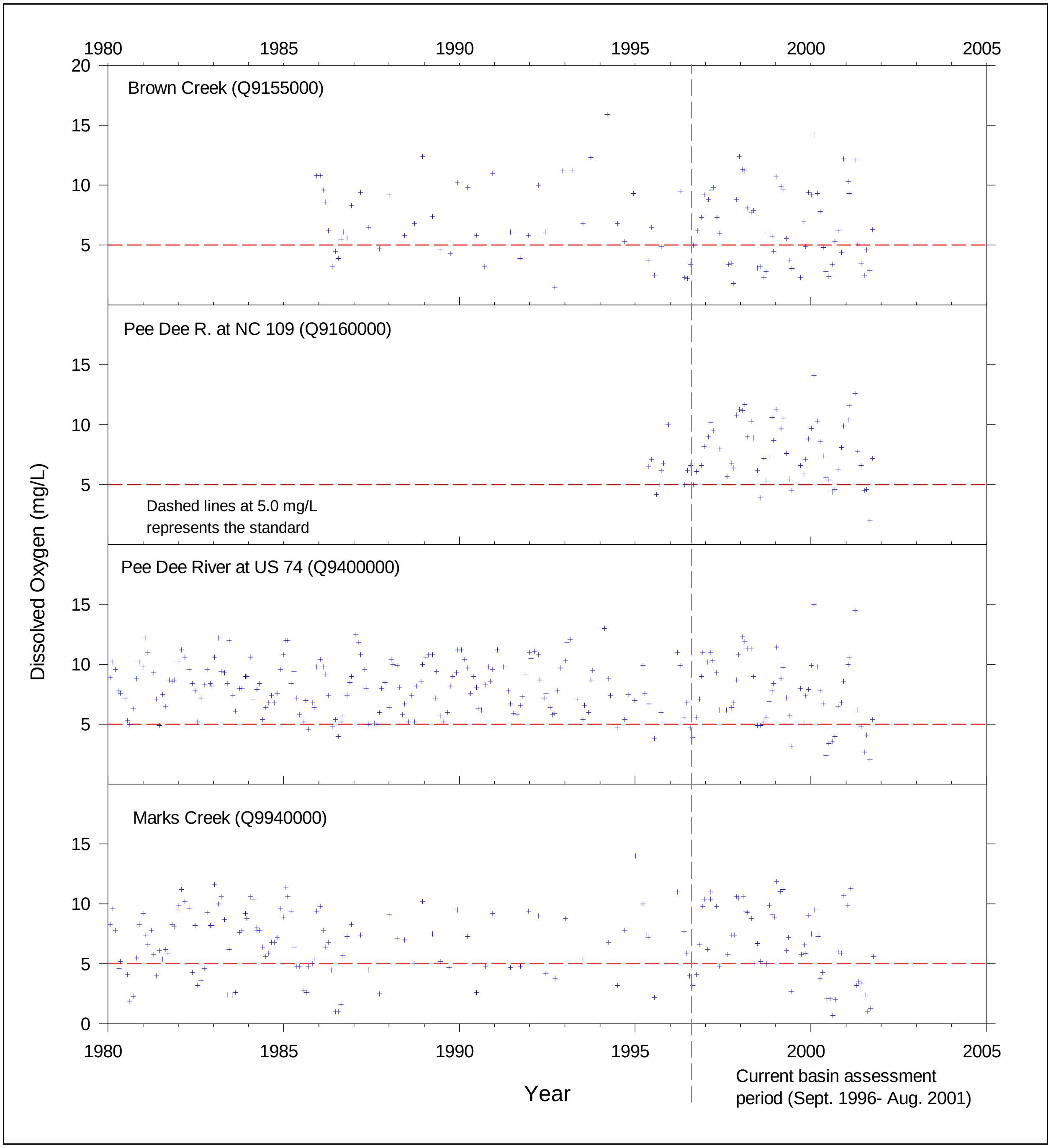


Figure 75 (continued).

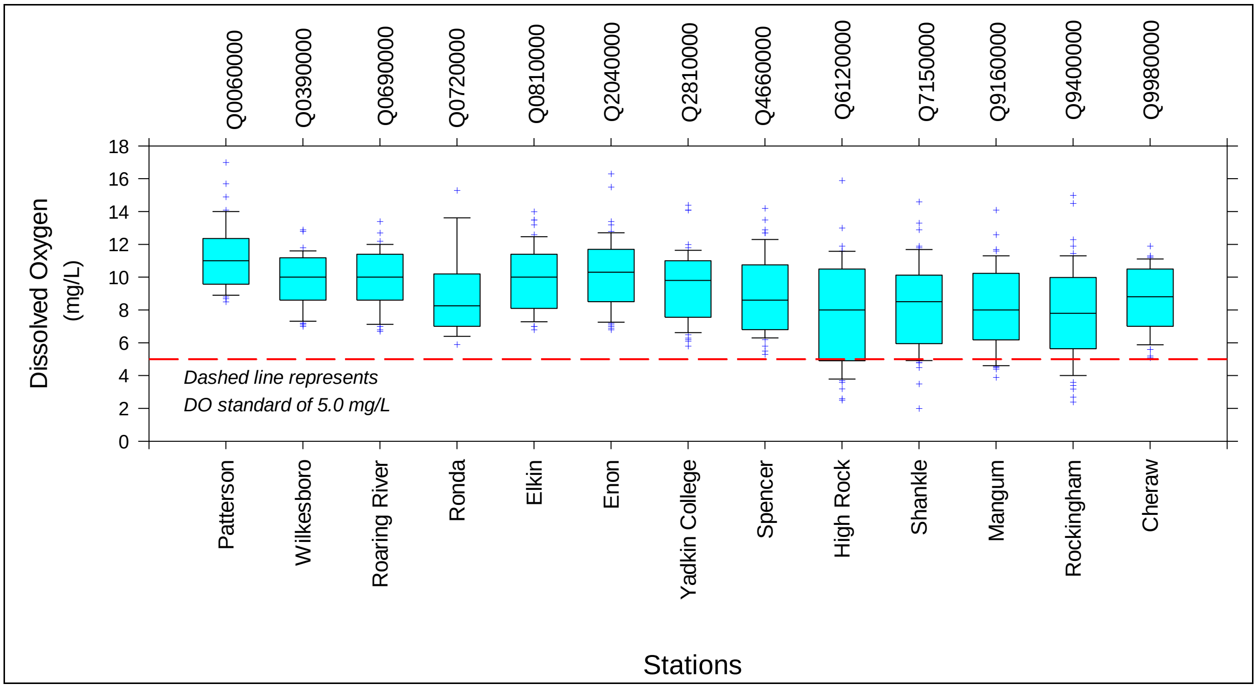


Figure 76. **Dissolved oxygen concentrations along the mainstem portion of the Yadkin - Pee Dee River.**

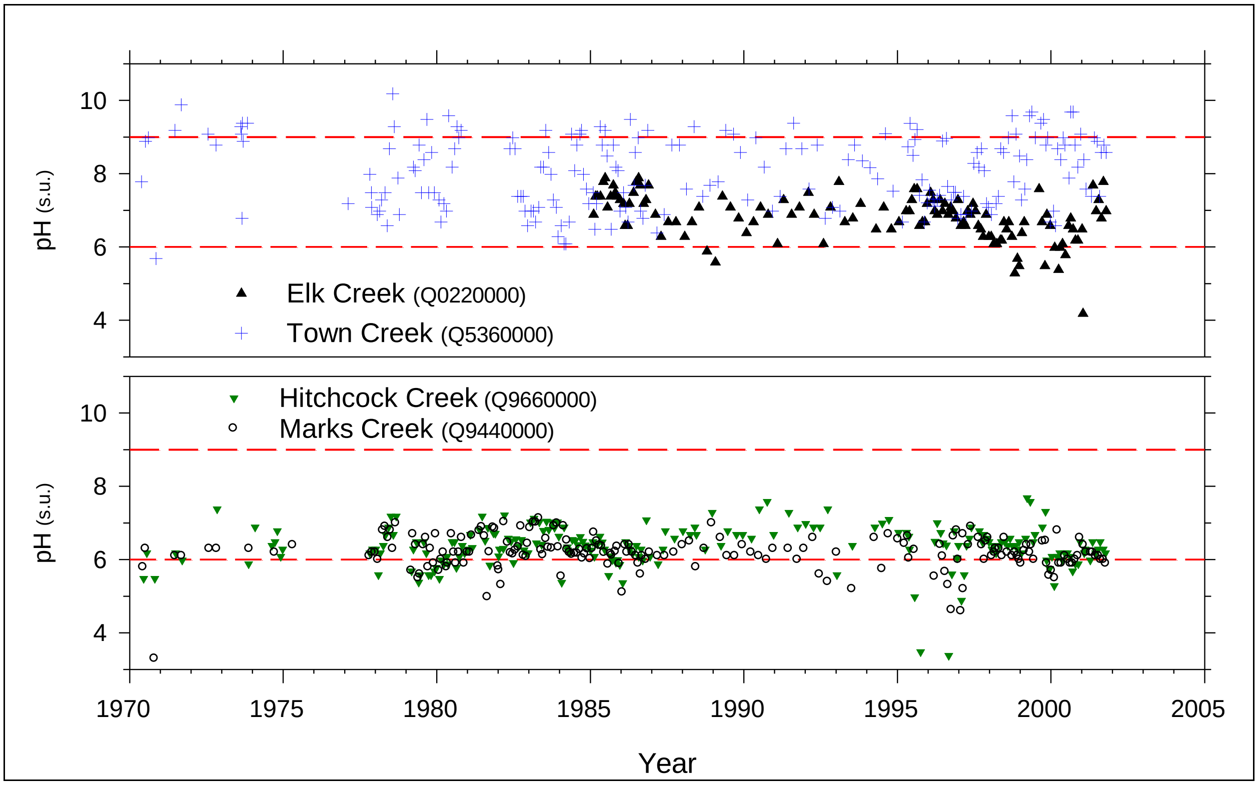


Figure 77. **Long term patterns of pH concentrations for the stations having more than 10 percent of the samples exceeding the water quality standard, 1996 - 2001.**

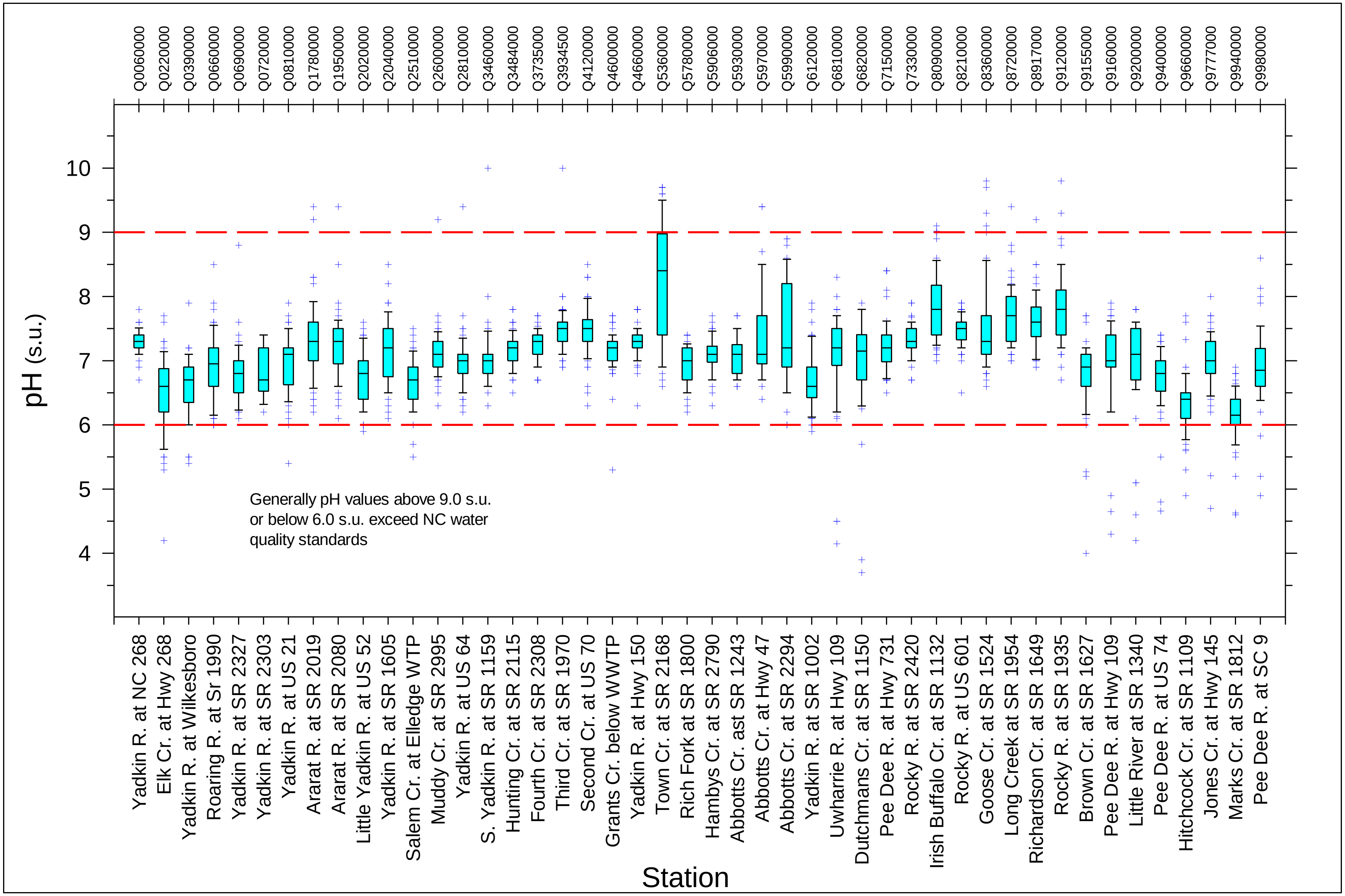


Figure 78. **pH by station from NC DWQ monitoring sites in the Yadkin River basin, September 1996 - August 2001.**

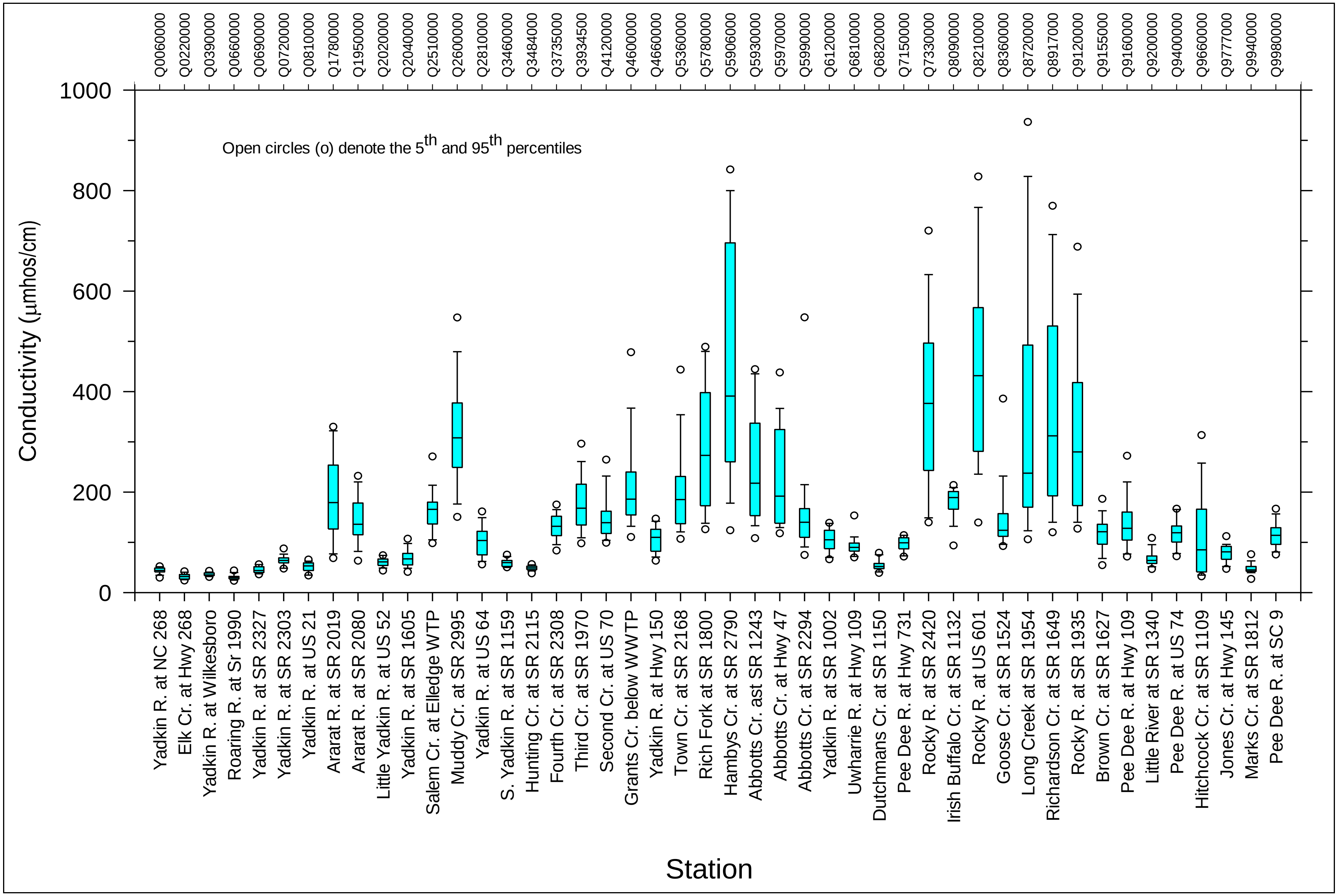


Figure 79. **Conductivity by station from NC DWQ monitoring sites in the Yadkin River basin, September 1996 - August 2001.**

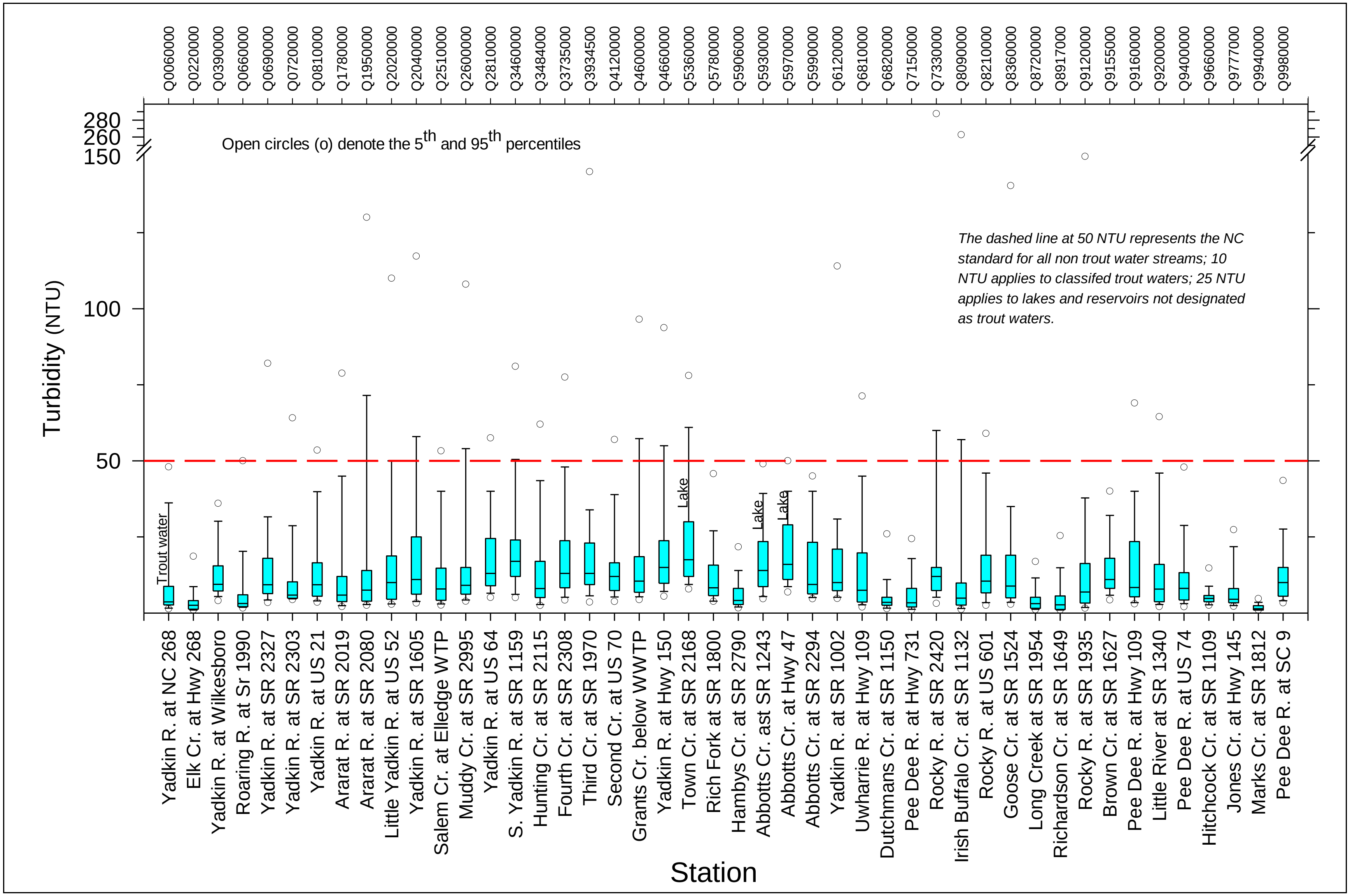


Figure 80. **Turbidity by station from NC DWQ monitoring sites in the Yadkin River basin, September 1996 - August 2001.**

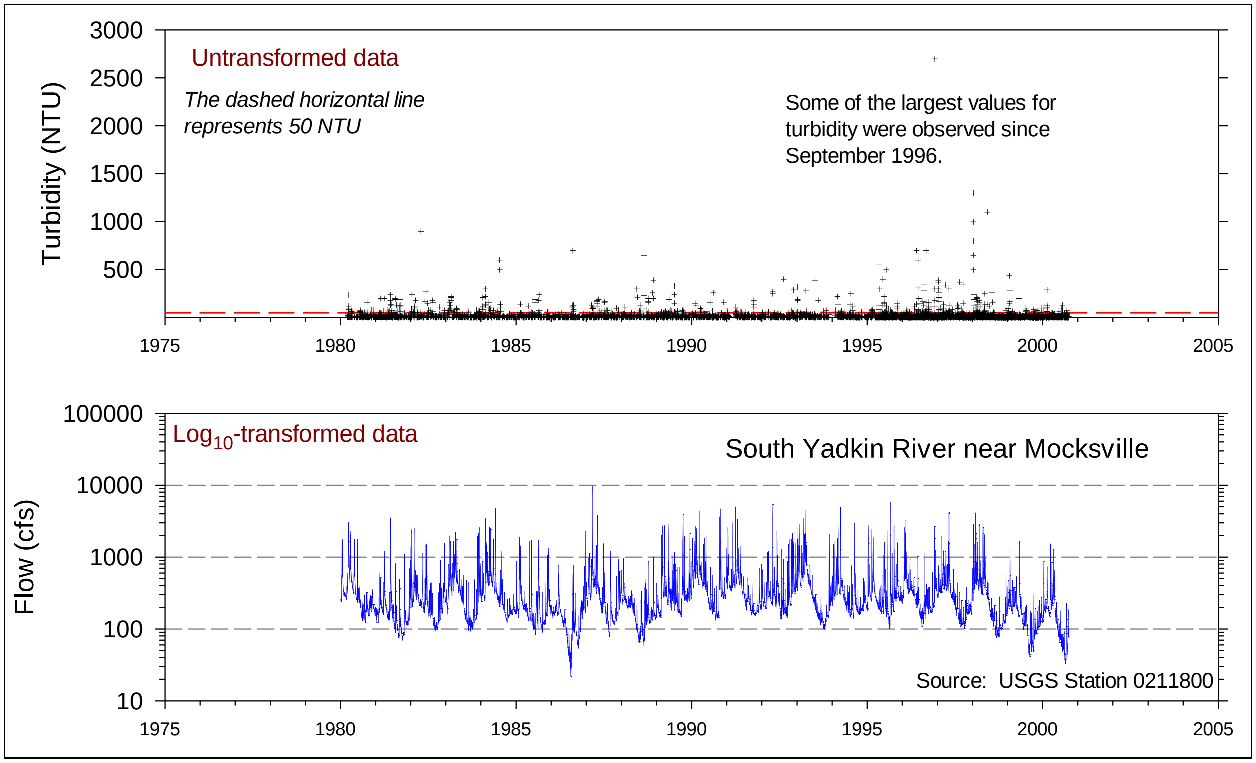


Figure 81. **Turbidity values from all ambient monitoring sites in the basin and stream flow at the South Yadkin River near Mocksville since 1980**

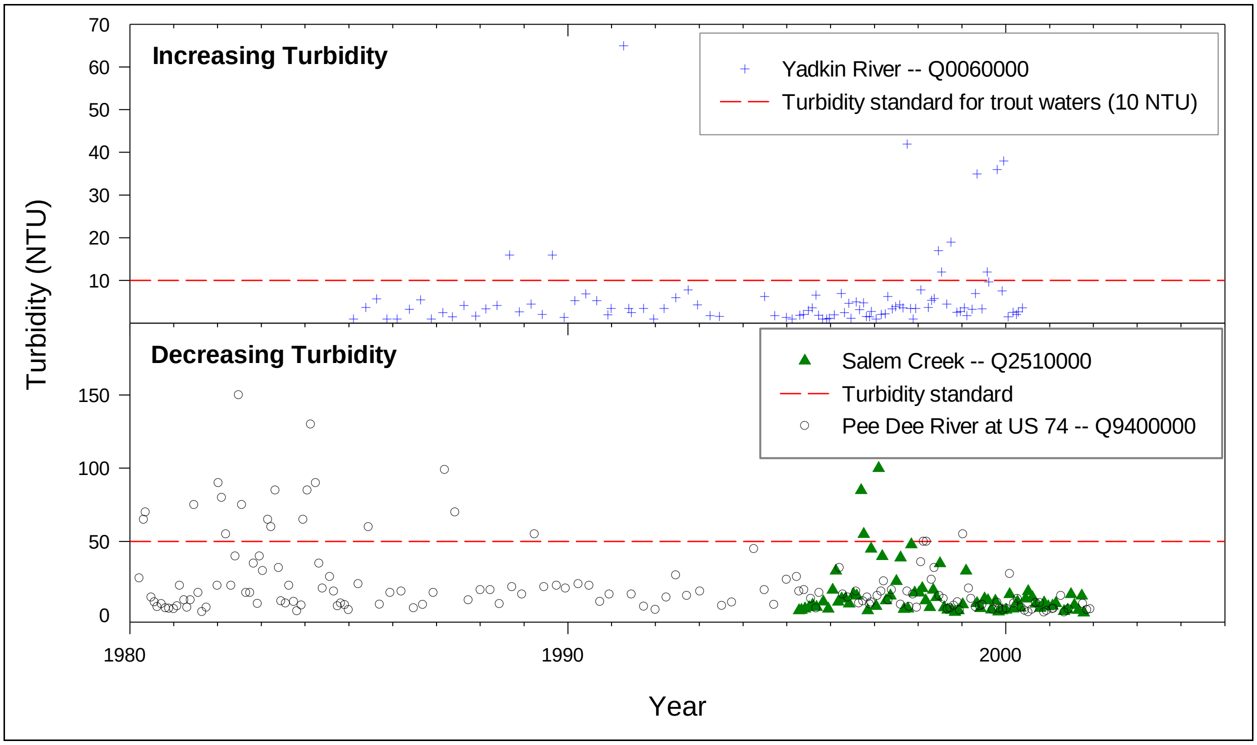


Figure 82. **Stations in the Yadkin River basin with increasing or decreasing turbidity values using all available data.**

Table 46. Concentrations of arsenic, cadmium, chromium, mercury, nickel and lead above the reporting level of 1 µg/L.

Station	Location	Date	Metal (µg/L)[1]					
			As	Cd	Cr	Hg	Ni	Pb
Q0060000	Yadkin River at NC 268 at Patterson	01/19/1999	.	.	.	.	.	**41**
		03/24/1999	.	.	.	.	.	13
		04/21/1999	.	.	.	.	.	15
		05/05/1999	.	.	.	.	.	**37**
		01/08/1998	.	.	.	.	.	14
		05/07/1998	.	.	.	.	22	11
Q1780000	Ararat River at SR 2019 at Ararat	01/08/1998	.	.	36	.	21	40
		06/04/1998	.	.	.	.	.	**37**
		06/07/1999	.	.	.	.	22	.
Q1950000	Ararat River at SR 2080 near Siloam	01/08/1998	.	.	36	.	25	**48**
Q2020000	Little Yadkin River at US52 at Dalton	01/08/1998	.	.	28	.	.	19
		07/09/1998	.	**2.2**	.	.	.	.
Q2040000	Yadkin River at SR 1605 at Enon	01/08/1998	.	.	30	.	.	22
Q2510000	Salem Creek at Elledge WTP at Winston Salem	09/11/1996	.	.	.	.	.	14
		10/02/1996	.	.	.	.	.	15
		02/03/1997	.	.	.	.	.	**25**
		11/03/1997	.	.	.	.	.	19
Q2600000	Muddy Creek at SR 2995 near Muddy Creek	09/04/1996	.	.	.	.	11	**53**
		10/02/1996	.	.	.	.	.	12
		08/05/1997	.	.	.	.	.	13
		05/04/1998	.	.	.	.	10	13
		12/01/1999	.	.	.	.	10	.
		08/27/2001	.	.	.	.	.	**25**
Q2810000	Yadkin River at US 64 at Yadkin College	12/02/1996	.	.	.	.	.	13
		11/27/2000	.	.	.	.	.	**46**
		02/20/2001	.	.	.	.	.	13
		08/27/2001	.	.	**72**	.	**34**	.
Q3735000	Fourth Creek at SR 2308 near Elmwood	09/10/1997	.	.	.	.	.	13
		01/15/1998	.	.	.	.	.	17
		02/23/1998	.	.	.	.	13	17
		02/14/2000	.	.	43	.	15	13
Q3934500	Third Creek at SR 1970 near Woodleaf	02/12/1998	.	.	.	.	.	16
Q4120000	Second Creek at US 70 near Barber	01/16/1997	.	.	.	.	.	11
Q4600000	Grants Creek Below Salisbury and Spencer WWTP	08/15/2000	.	.	.	**0.59**	.	.
Q5780000	Rich Fork at SR 1800 near Thomasville	10/01/1996	.	.	.	.	.	15
		04/10/2000	.	.	**61**	.	.	.

Table 46 (continued).

Station	Location	Date	Metal (µg/L)[1]					
			As	Cd	Cr	Hg	Ni	Pb
Q5906000	Hambys Creek at SR 2790 near Holly Grove	09/03/1996	.	.	.	.	13	.
		10/01/1996	.	.	.	.	12	20
		07/01/1997	.	.	.	.	32	.
		08/13/1997	.	.	.	.	11	.
		09/03/1997	.	.	.	.	13	.
		10/02/1997	.	.	.	.	20	.
		06/03/1998	.	.	.	.	13	.
		07/07/1998	.	.	.	.	18	.
		08/06/1998	.	.	.	.	16	.
		09/03/1998	.	.	.	.	22	.
		10/01/1998	.	.	.	.	21	.
		11/03/1998	.	.	.	.	34	.
		12/30/1998	.	.	.	.	13	.
		01/14/1999	.	.	.	.	21	.
		02/11/1999	15	.	.	.	20	.
		06/01/1999	.	.	.	.	14	.
		07/06/1999	.	.	.	.	14	.
		08/03/1999	.	.	.	.	33	.
		09/01/1999	.	.	.	.	19	.
		11/02/1999	.	.	.	.	12	.
		05/13/2000	.	.	.	.	37	.
		06/19/2000	.	.	.	.	23	.
		12/13/2000	24	.	.	.	24	.
		04/24/2001	.	.	.	.	19	.
Q5930000	Abbotts Creek at SR 1243 at Lexington	07/10/1997	.	.	.	.	.	14
Q7150000	Pee Dee River at Hwy 731 near Shankle	04/13/2000	**240**	.	.	.	.	.
Q7330000	Rocky River at SR 2420 near Davidson	01/09/1997	.	.	.	.	11	18
Q7330000		05/07/1998	.	.	.	.	21	11
Q8090000	Irish Buffalo Creek at SR 1132 near Faggarts	09/04/1996	.	.	.	.	.	**64**
		01/09/1997	.	.	.	.	20	**62**
		09/24/1997	.	.	28	.	17	**51**
		05/07/1998	.	.	.	.	.	17
		04/04/2000	**310**	.	.	.	.	.
Q8210000	Rocky River at US 601 near Concord	01/09/1997	.	.	.	.	16	34
Q8720000	Long Creek at SR 1954 near Rocky River Springs	06/26/2000	15	.	.	.	.	.
Q8917000	Richardson Creek at SR 1649 near Fairfield	05/22/2000	13	.	.	.	.	.
		06/26/2000	15	.	.	.	.	.
Q9120000	Rocky River at SR 1935 near Norwood	09/25/1997	.	.	.	.	.	14
Q9200000	Little River at SR 1340 near Star	01/05/1999	.	.	.	.	.	10
Q9980000	Pee Dee River at SC Hwy 9 at Cheraw SC	05/11/1999	.	.	.	.	.	**36**

[1]Reporting levels: arsenic, nickel, and lead = 10 µg/L; cadmium and mercury = 2 µg/L; and chromium = 25 µg/L. Numbers in bold font were greater than the Action Level.

Table 47. **Copper concentrations in the Yadkin River basin. Stations are listed in ascending order in the proportion (%) of samples greater than 7.0 µg/L.**

Station	Location	N	% > 7	50%[1]	90%[1]	100%[1]
Stations with less than a 10 percent exceedance						
Q0720000	Yadkin River at SR 2303 at Ronda	6	0.0	2.00	2.00	2
Q3484000	Hunting Creek at SR 2115 near Harmony	52	3.8	2.00	5.00	20
Q7150000	Pee Dee River at NC 731 near Shankle	50	6.0	2.00	5.20	13
Q9940000	Marks Creek at SR 1812 near Hamlet	48	6.3	2.00	6.07	21
Q6820000	Dutchmans Creek at SR1150 near Uwharrie	44	6.8	2.00	6.50	78
Q9980000	Pee Dee River at SC 9 at Cheraw SC	44	6.8	2.65	6.70	8.6
Q9155000	Brown Creek at SR 1627 near Pinkston	47	8.5	3.00	6.78	26
Q9400000	Pee Dee River at US 74 near Rockingham	47	8.5	2.90	5.82	31
Q0660000	Roaring River at SR 1990 near Roaring River	46	8.7	2.55	7.54	40
Q9200000	Little River at SR 1340 near Star	46	8.7	2.35	5.98	15
Q9160000	Pee Dee River at NC 109 near Mangum	45	8.9	3.80	7.24	15
Stations with a greater than 10 percent exceedance						
Q0810000	Yadkin River at US 21 Bus at Elkin	48	10.4	2.85	8.66	47
Q0060000	Yadkin River at NC 268 at Patterson	45	11.1	2.00	9.00	17
Q2020000	Little Yadkin River at US52 at Dalton	45	11.1	2.60	7.14	15
Q5990000	Abbotts Creek at SR 2294 near	45	11.1	3.30	8.18	25
Q4660000	Yadkin River at NC 150 near Spencer	52	11.5	2.60	8.66	14
Q2040000	Yadkin River at SR 1605 at Enon	51	11.8	3.60	9.58	38
Q6120000	Yadkin River at SR 1002 at High Rock	49	12.2	2.90	7.80	21
Q4600000	Grants Creek Below Salisbury/Spencer WWTP	51	13.7	3.20	11.80	27
Q9777000	Jones Creek at NC 145 near Pee Dee	43	14.0	2.10	8.88	39
Q0690000	Yadkin River at SR 2327 at Roaring River	42	14.3	2.95	9.40	36
Q5780000	Rich Fork at SR 1800 near Thomasville	49	14.3	4.00	8.00	22
Q9660000	Hitchcock Creek at SR 1109 at Cordova	48	14.6	2.40	8.38	42
Q0220000	Elk Creek at NC 268 at Elkville	47	14.9	2.00	9.12	16
Q6810000	Uwharrie River at NC 109 near Uwharrie	47	14.9	2.80	8.58	89
Q0390000	Yadkin River at Wilkesboro	44	15.9	2.65	8.60	23
Q8360000	Goose Creek at SR 1524 near Mint Hill	51	19.6	3.90	9.62	26
Q7330000	Rocky River at SR 2420 near Davidson	51	21.6	4.50	9.64	23
Q8090000	Irish Buffalo Creek at SR 1132 near Faggarts	51	21.6	2.60	11.80	61
Q3934500	Third Creek at SR 1970 near Woodleaf	50	22.0	4.25	11.00	18
Q3460000	S Yadkin River at SR 1159 near Mocksville	47	23.4	3.10	10.16	40
Q5360000	Town Creek at SR 2168 near Duke	51	23.5	4.00	11.80	37
Q3735000	Fourth Creek at SR 2308 near Elmwood	50	24.0	4.00	10.00	31
Q2510000	Salem Creek at Elledge WWTP at Winston Salem	47	25.5	4.40	10.00	17
Q5930000	Abbotts Creek at SR 1243 at Lexington	47	25.5	5.00	11.00	33
Q5970000	Abbotts Creek at NC 47 near Cotton Grove	49	26.5	4.20	8.00	11
Q2810000	Yadkin River at US 64 at Yadkin College	48	27.1	3.65	9.58	22
Q9120000	Rocky River at SR 1935 near Norwood	50	28.0	5.35	13.00	22
Q4120000	Second Creek at US 70 near Barber	51	31.4	4.90	11.58	22
Q2600000	Muddy Creek at SR 2995 near Muddy Creek	47	31.9	5.90	15.20	24
Q8210000	Rocky River at US 601 near Concord	50	36.0	5.05	9.68	52
Q1950000	Ararat River at SR 2080 near Siloam	49	42.9	6.20	14.00	47
Q8917000	Richardson Creek at SR 1649 near Fairfield	48	45.8	6.95	12.20	23
Q1780000	Ararat River at SR 2019 at Ararat	50	52.0	7.30	16.00	110
Q8720000	Long Creek at SR 1954 near Rocky River Springs	49	57.1	7.60	20.00	27
Q5906000	Hambys Creek at SR 2790 near Holly Grove	48	72.9	9.90	19.20	36

[1]Percentiles: 50% = median; 100% = maximum.

Table 48. Summary for fecal coliform bacteria, Yadkin River basin.

Station[1]	Location	Class	N	N < RL[2]	Geometric Mean
Q0060000	Yadkin River at NC 268 at Patterson	C Tr	44	8	9
Q0220000	Elk Creek at NC 268 at Elkville	B ORW	56	11	75
Q0390000	Yadkin River at Wilkesboro	C	43	10	58
Q0660000	Roaring River at SR 1990 near Roaring River	B	54	16	55
Q0690000	Yadkin River at SR 2327 at Roaring River	WS-V	42	9	117
Q0720000	Yadkin River at SR 2303 at Ronda	WS-IV	12	.	161
Q0810000	Yadkin River at US 21 Bus at Elkin	C	56	6	127
Q1780000	Ararat River at SR 2019 at Ararat	C	54	5	92
Q1950000	Ararat River at SR 2080 near Siloam	WS-IV	52	9	83
Q2020000	Little Yadkin River at US52 at Dalton	WS-IV	44	6	91
Q2040000	Yadkin River at SR 1605 at Enon	WS-IV	57	22	45
Q2510000	**Salem Creek at Elledge WWTP at Winston Salem**	**C**	**56**	**.**	**773**
Q2600000	**Muddy Creek at SR 2995 near Muddy Creek**	**C**	**55**	**.**	**488**
Q2810000	Yadkin River at US 64 at Yadkin College	WS-IV CA	55	5	122
Q3460000	**S Yadkin River at SR 1159 near Mocksville**	**WS-IV**	**54**	**1**	**398**
Q3484000	**Hunting Creek at SR 2115 near Harmony**	**WS-III**	**56**	**1**	**234**
Q3735000	**Fourth Creek at SR 2308 near Elmwood**	**C**	**56**	**.**	**504**
Q3934500	**Third Creek at SR 1970 near Woodleaf**	**WS-IV**	**57**	**1**	**375**
Q4120000	**Second Creek at US 70 near Barber**	**WS-IV**	**57**	**1**	**309**
Q4600000	**Grants Creek Below Salisbury and Spencer WWTP**	**C**	**57**	**2**	**291**
Q4660000	Yadkin River at NC 150 near Spencer	WS-V	58	6	104
Q5360000	Town Creek at SR 2168 near Duke	WS-V	56	26	34
Q5780000	**Rich Fork at SR 1800 near Thomasville**	**C**	**52**	**2**	**254**
Q5906000	Hambys Creek at SR 2790 near Holly Grove	C	52	3	150
Q5930000	Abbotts Creek at SR 1243 at Lexington	C	50	.	149
Q5970000	Abbotts Creek at NC 47 near Cotton Grove	WS-V&B	55	14	50
Q5990000	Abbotts Creek at SR 2294 near Southmont Duracell	WS-IV & B	45	25	21
Q6120000	Yadkin River at SR 1002 at High Rock	WS-IV&B CA	54	17	38
Q6810000	Uwharrie River at NC 109 near Uwharrie	WS-IV	53	9	55
Q6820000	Dutchmans Creek at SR1150 near Uwharrie	WS-IV CA	43	21	24
Q7150000	Pee Dee River at NC 731 near Shankle	WS-V&B	57	32	14
Q7330000	**Rocky River at SR 2420 near Davidson**	**C**	**57**	**2**	**249**
Q8090000	**Irish Buffalo Creek at SR 1132 near Faggarts**	**C**	**56**	**1**	**234**
Q8210000	**Rocky River at US 601 near Concord**	**C**	**55**	**.**	**234**
Q8360000	**Goose Creek at SR 1524 near Mint Hill**	**C**	**57**	**2**	**241**
Q8720000	Long Creek at SR 1954 near Rocky River Springs	C	57	3	102
Q8917000	Richardson Creek at SR 1649 near Fairfield	C	56	3	79
Q9120000	Rocky River at SR 1935 near Norwood	C	55	3	66
Q9155000	Brown Creek at SR 1627 near Pinkston	C	53	5	85
Q9160000	Pee Dee River at NC 109 near Mangum	WS-V&B	51	6	85
Q9200000	Little River at SR 1340 near Star	C HQW	52	5	82
Q9400000	Pee Dee River at US 74 near Rockingham	C	53	10	29
Q9660000	Hitchcock Creek at SR 1109 at Cordova	C	53	9	61
Q9777000	Jones Creek at NC 145 near Pee Dee	C	49	2	107
Q9940000	Marks Creek at SR 1812 near Hamlet	C	54	10	47
Q9980000	Pee Dee River at SC 9 at Cheraw, SC	C	44	7	43

[1]Sites in bold font exceeded 200 colonies/ml.
[2]N = Number of samples; RL = Reporting Level.

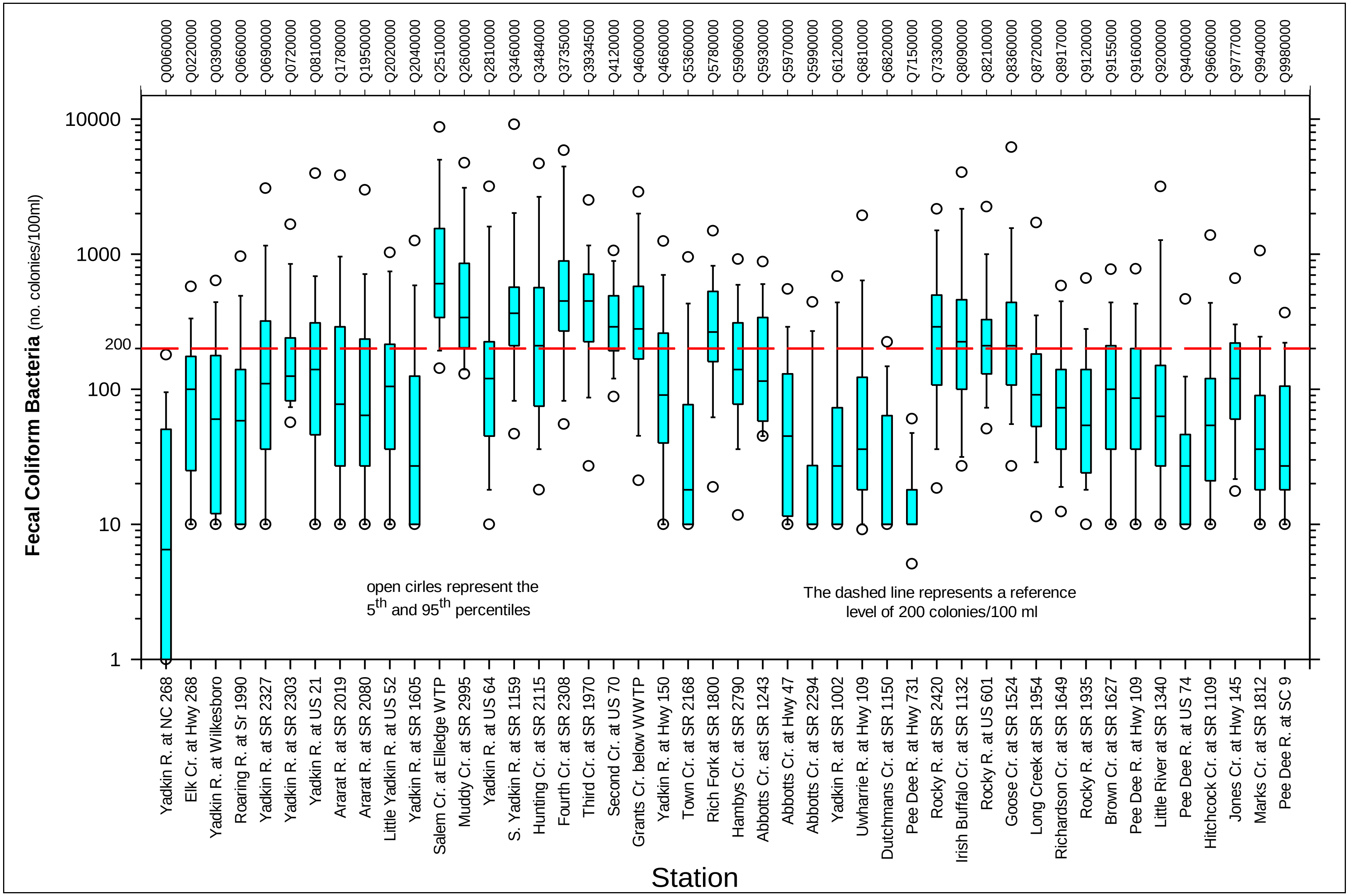


Figure 83. **Fecal coliform bacteria by station from NC DWQ monitoring sites in the Yadkin River basin.**

Figure 84. **Fecal coliform concentrations by time for stations that had geometric means exceeding 200 colonies/100ml during the previous assessment period (1992 - 1996) or during this assessment period (1996 - 2001).**

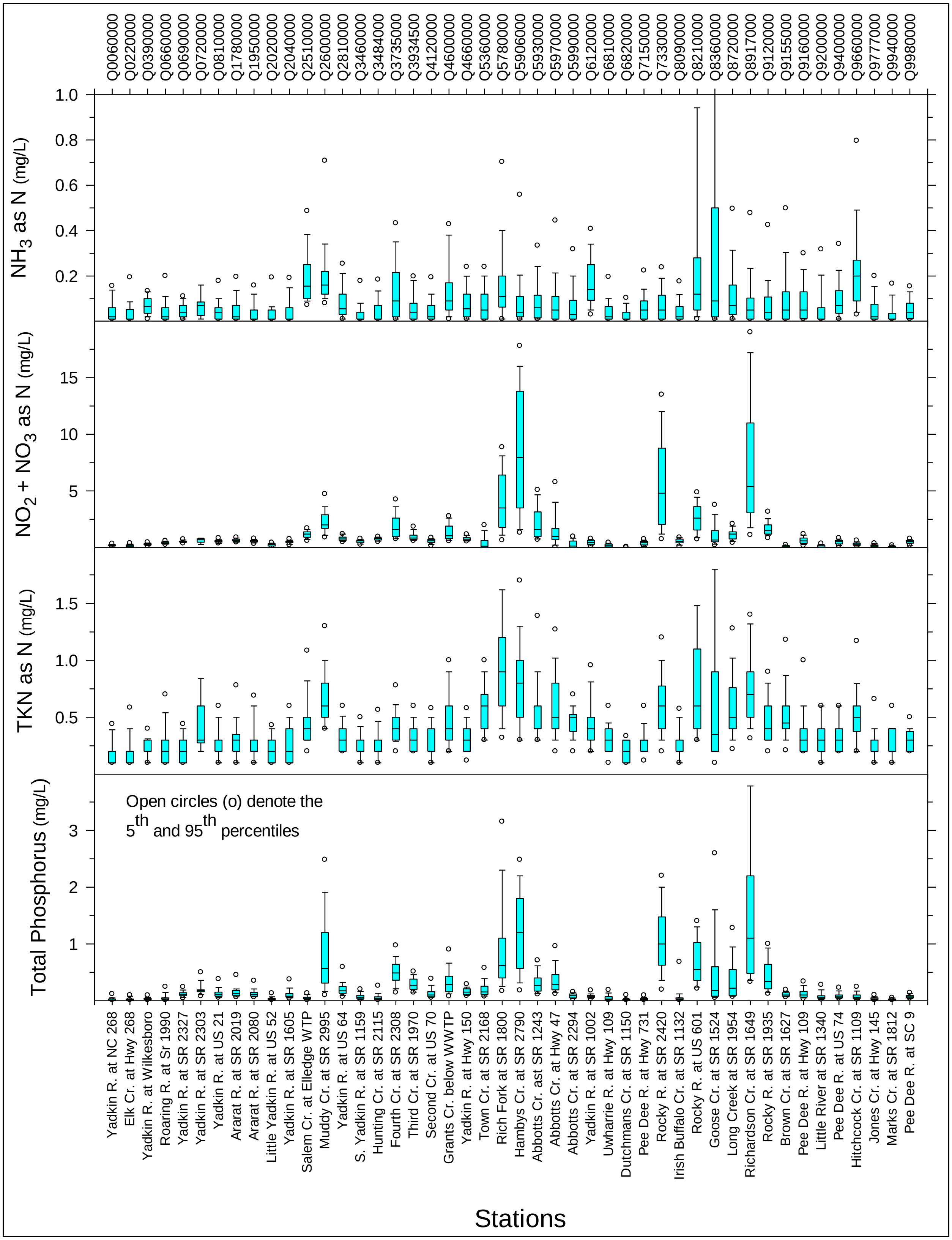


Figure 85. Nutrients by station from NC DWQ monitoring sites in the Yadkin River basin.

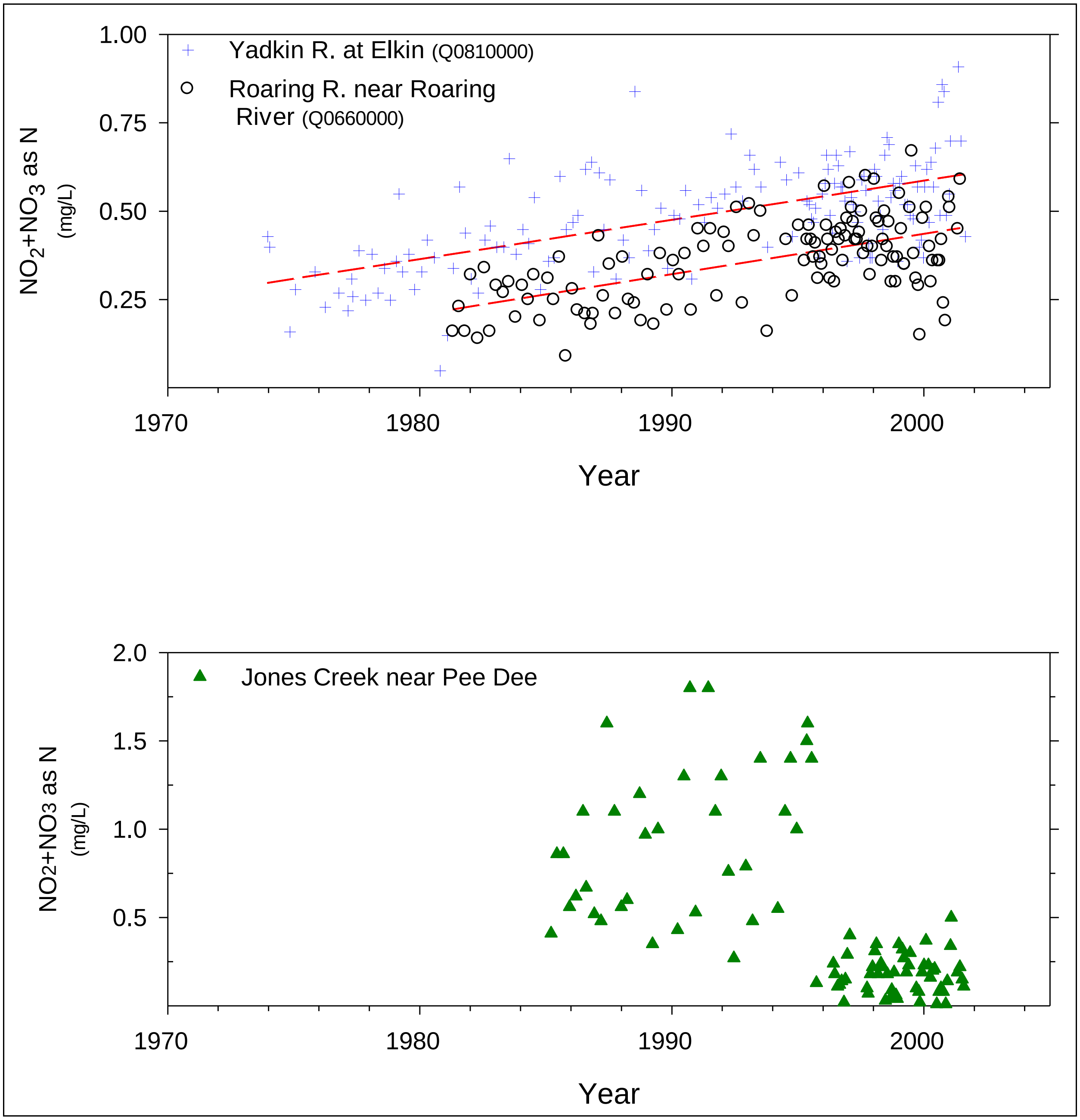


Figure 86. **Temporal patterns for nitrite+nitrate nitrogen from three stations in the Yadkin River basin. The dashed lines in the top graph represent statistically significant linear regressions.**

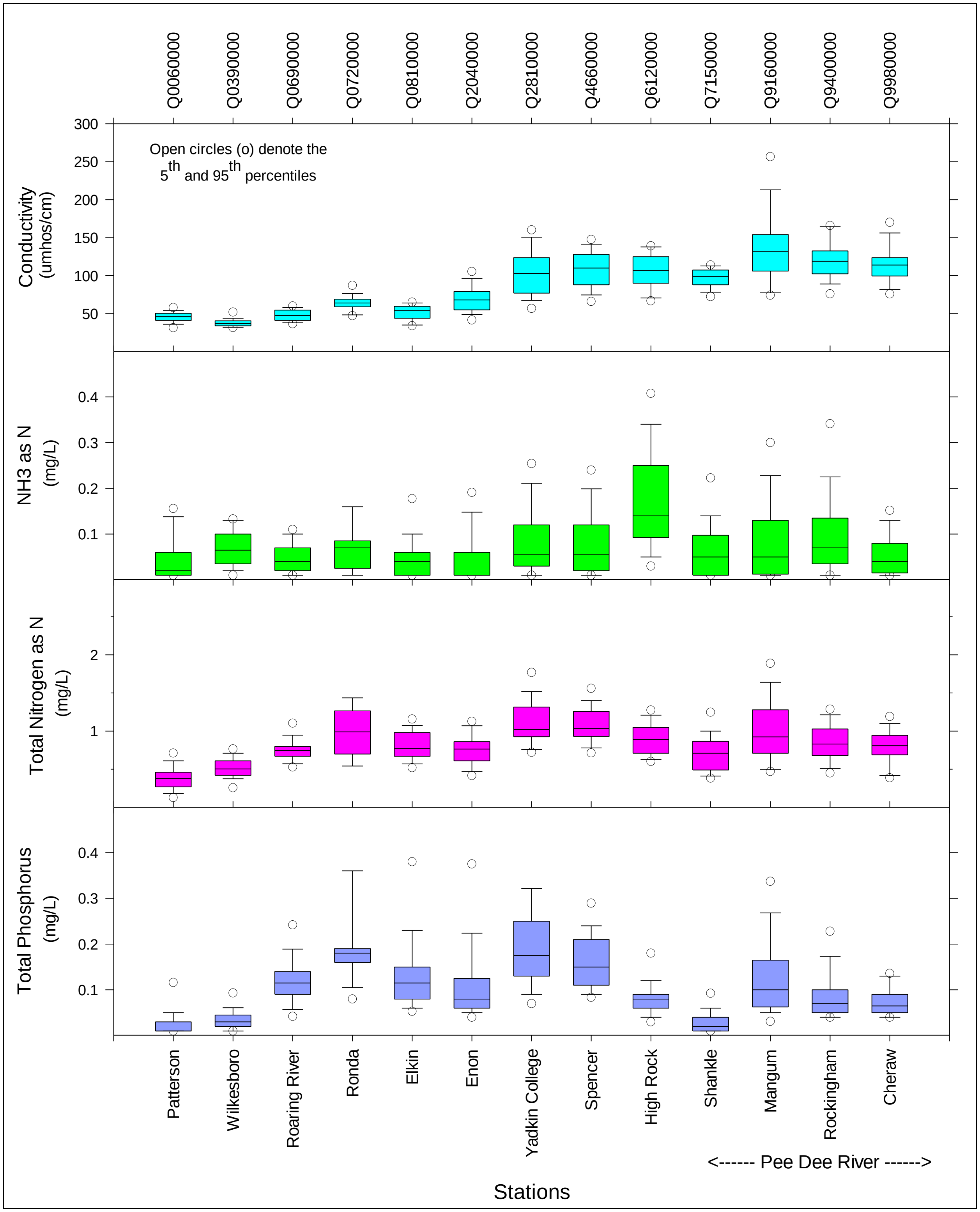


Figure 87. **Nutrients and conductivity along the mainstem portion of the Yadkin - Pee Dee River.**

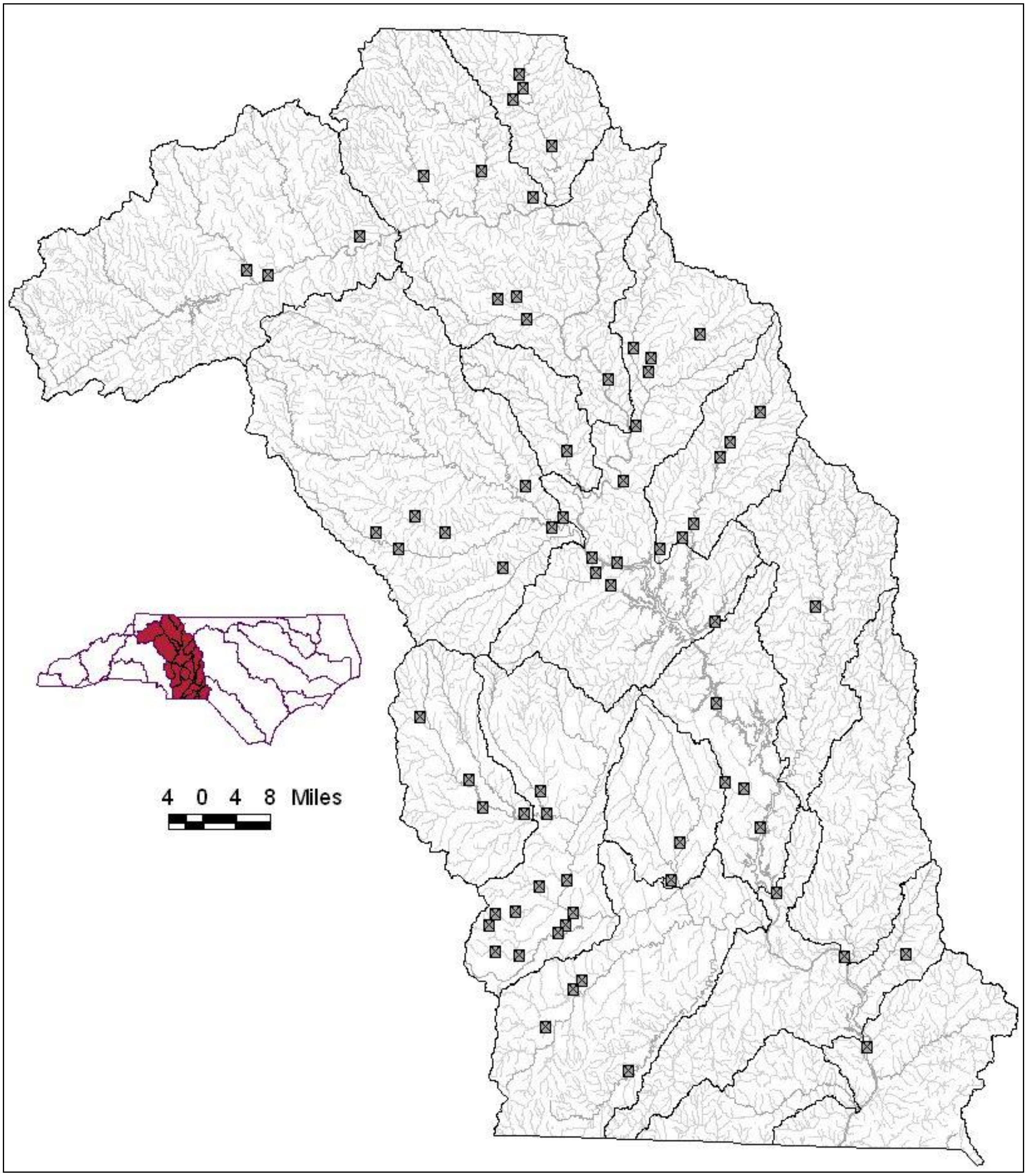


Figure 88. Yadkin-Pee Dee River Coalition monitoring sites within the Yadkin River basin.

Table 49. Yadkin Pee Dee River Basin Association monitoring stations within the Yadkin River basin, 1998 - 2001.

Subbasin	Station	Location	Notes[1]
1	Q0360000	Reddies River at SR 1517 at N Wilkesboro	Significant tributary to the Yadkin River, flow data for loading calculations
	Q0450000	Yadkin River at Business 421	Below N Wilkesboro's and Wilkesboro' s WWTPs, below urban areas
	Q0720000	Yadkin River at SR 2303 near Ronda	Downstream ABTCO, dissolved oxygen sag zone
2	Q1065000	Mitchell River at SR 1001	Significant tributary to Yadkin River, loading calculations, NRCS Request
	Q1215000	Fisher River at NC 268 near Fairview	Downstream of Wayne Poultry, flow data for loading calculations
	Q1350000	Yadkin River at SR 1003 near Siloam	Mainstem
	Q2090000	North Deep Creek at SR 1605 near Yadkinville	Upstream Yadkinville's WWTP, NRCS request
	Q2120000	North Deep Creek at SR 1510 near Yadkinville	Upstream Yadkinville's WWTP, NRCS request
	Q2135000	South Deep Creek at SR 1710 near Yadkinville	NRCS request
	Q2180000	Yadkin River at NC 158	Mainstem
3	Q1500000	Ararat River at US 52 near Mt. Airy	Upstream Mt. Airy's WWTP
	Q1710000	Ararat River 1 mi. below Mt. Airy's WWTP	Downstream Mt. Airy's WWTP, DWQ-BAU request
	Q1725000	Ararat River at SR 2119 near Mt. Airy	Downstream Mt. Airy's WWTP, dissolved oxygen sag zone, DWQ-BAU request
	Q1935000	Ararat River at SR 2044 near Mt. Airy	Downstream Pilot Mtn. 's WWTP
4	Q2291000	Muddy Creek at Interstate 40 near Jonesville	Significant tributary to the Yadkin River, urban
	Q2479455	Salem Creek at SR 2740 near Winston-Salem	Downstream Salem Lake, urban
	Q2540000	Salem Creek at SR 1120 in Winston-Salem	Downstream Salem Lake, urban
	Q2570000	Salem Creek at SR 2991 near Winston-Salem	Downstream Salem Lake, urban
	Q2720000	Muddy Creek at SR 1485 near Winston-Salem	Downstream Winston-Salem's WWTP, dissolved oxygen sag zone
	Q2810000	Yadkin River at US 64 or the Davidson County water intake	Downstream Winston-Salem's WWTP, duplicates ambient station, loading calculation
	Q4540000	Grants Creek at Third St. extension near Spencer	Upstream Salisbury's and Spencer's WWTP, urban
	Q4600000	Grants Creek below Salisbury & Spencer WWTP D6	Downstream Salisbury and Spencer WWTPs, urban, duplicates ambient station
	Q4660000	Yadkin River at US 150 near Spencer	Upstream Fieldcrest Cannon-NC Finishing, duplicates ambient station
	Q5240000	Town Creek at I- 85 near Spencer	Downstream Salisbury's WWTP, urban
	Q5980000	Abbotts Creek at NC 47 near Cotton Grove	Downstream Lexington's WWTP, duplicates ambient station, dissolved oxygen sag zone
5	Q3105000	Dutchman Creek at US 64 near Mocksville	Downstream Mocksville's Dutchman Creek WWTP, dissolved oxygen sag zone
6	Q3555000	Bear Creek at SR 1116 near Mocksville	Downstream Mocksville's Bear Creek WWTP
	Q3720000	Fourth Creek at SR 2316 near Statesville	0.3 mi. above Statesville's Fourth Creek WWTP
	Q3735000	Fourth Creek at SR 2308 near Elmwood	Downstream Statesville's Fourth Creek WWTP, duplicates ambient station
	Q3900000	Third Creek at SR 2342 near Statesville	Upstream Statesville's Third Creek WWTP
	Q3932000	Third Creek at SR 2359 near Statesville	Downstream Statesville's Third Creek WWTP
	Q3970000	South Yadkin River at US 601 near Salisbury	Significant tributary to the Yadkin River
	Q4030000	Second Creek at SR 1526 near Salisbury	Significant tributary, upstream N Second Creek's WWTP & Hoechst Celanese
	Q4165000	Second Creek at US 601 near Salisbury	Downstream N Second Creek's WWTP & Hoechst Celanese, dissolved oxygen sag zone
7	Q5135000	Swearing Creek at SR 1272 near Linwood	Significant tributary to the Yadkin River, urban drainage
	Q5750000	Rich Fork Creek at SR 1755 near High Point	Upstream High Point's West Side WWTP
	Q5785000	Rich Fork Creek at SR 1787 near High Point	Downstream High Point's West Side WWTP, dissolved oxygen sag zone
	Q5790000	Rich Fork Creek at SR 2123 near High Point	Downstream High Point's West Side WWTP, dissolved oxygen sag zone
	Q5940000	Abbotts Creek at I 85 near Lexington	Upstream Lexington's WWTP

Table 49 (continued).

Subbasin	Station	Location	Notes[1]
8	Q6360000	Yadkin River at NC 8/49 near Richfield	Mainstem, located in Tuckertown Reservoir
	Q6950000	Little Mountain Creek at SR 1798 near Badin	Upstream Greater Badin's WWTP
	Q6960000	Mountain Creek arm of Lake Tillery at boat ramp off SR 1730	Downstream Greater Badin's WWTP
	Q7030000	Pee Dee River at NC 24/27 near Albemarle	Mainstem Pee Dee River, upstream Lake Tillery
9	Q6180000	UT to Lick Creek at SR 2505 near Denton	Downstream Denton's WWTP
	Q6705000	Uwharrie River at NC 49 near Farmer	Significant tributary to the Yadkin River
10	Q7210000	Clarks Creek at SR 1187 near Mount Gilead	Downstream Mt. Gilead's WWTP
11	Q7330000	Rocky River at SR 2420 near Davidson	Downstream Mooresville's WWTP, dissolved oxygen sag zone
	Q7450000	Rocky River at NC 29 near Charlotte	At modeler's request
	Q7600000	Rocky River at SR 1304 near Charlotte	At modeler's request
	Q7780000	Rocky River at SR 1132 near Concord	At modeler's request
12	Q8200000	Coldwater Creek at SR 1132 near Concord	Significant tributary, downstream from Lakes Fisher and Concord, urban
	Q8210000	Rocky River at US 601 near Concord	At modeler's request
	Q8340000	UT tributary to Clear Creek at SR 3104	Upstream Tallwood Estates' WWTP
	Q8342000	Clear Creek at US 601 near Brief	Downstream Tallwood Estates' WWTP
	Q8355000	Rocky River at SR 1114 near Midland	At modeler's request
	Q8359000	Goose Creek at SR 4228 near Mint Hill	Upstream Huntley Branch's WWTP
	Q8360000	Goose Creek at SR 1524 near Mint Hill	Downstream Huntley Branch's WWTP, duplicates ambient station
	Q8385000	Rocky River at SR 1606 near Monroe	Below confluence of Goose Creek, DWQ-BAU request
	Q8386000	North Fork Crooked Creek at SR 1520 near Monroe	Upstream Union County's WWTP
	Q8386200	North Fork Crooked Creek at SR 1514 near Monroe	Downstream Union County's WWTP
	Q8388000	Crooked Creek at NC 218 near Monroe	DWQ-BAU request; significant tributary to Rocky River, downstream Grassy Branch's WWTP
	Q8388900	Crooked Creek at SR 1601	Upstream Grassy Branch's WWTP
13	Q8715000	Long Creek at SR 1968 near Oakboro	Upstream Oakboro's WWTP
	Q8720000	Long Creek at SR 1917 near Oakboro	Upstream Oakboro's WWTP
14	Q8800000	Richardson Creek at SR 1751 near Monroe	Urban, upstream Monroe's WWTP
	Q8820000	Richardson Creek at SR 1006 near Monroe	Downstream of Monroe's WWTP
	Q8850000	Richardson Creek at SR 1630 near Monroe	Downstream of Monroe's WWTP
	Q9021300	Lanes Creek at SR 1005 near Marshville	Significant watershed, DWQ-BAU request, concentration of animal operations
15	Q9320000	Little River at SR 1148 near Ellerbe	Significant tributary to the Pee Dee River
	Q9340000	Toms Branch at SR 1310 near Ellerbe	Downstream of Ellerbe's WWTP
16	Q9400000	Pee Dee River at US 74 near Rockingham	Mainstem, duplicates ambient station

[1]WWTP = wastewater treatment plant, sites recommended by DWQ-BAU = Division of Water Quality-Biological Assessment Unit, NRCS = Natural Resource Conservation Service

Table 50. Total number of Yadkin Pee Dee River Basin Association samples collected for parameters that had exceedances of water quality standards or action levels. (See Table 51 for the proportion (%) of samples exceeding standards or action levels.).

Station	Classification	DO	pH	Chl *a*	Turbidity	Cd	Cu	Fe	Hg	Mn	Pb	Zn	Fecal
Q0360000	WS-II	53	53	.	38	.	.	.	.	.	.	.	37
Q0450000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q0720000	WS-V	53	53	.	38	.	.	.	.	.	.	.	1
Q1065000	C	54	54	.	38	31	31	34	31	.	31	31	38
Q1215000	C	54	54	.	38	.	.	.	.	.	.	.	38
Q1350000	WS-IV	54	54	.	38	31	31	36	31	.	31	31	38
Q1500000	C	93	53	.	38	.	.	.	.	.	.	.	38
Q1710000	C	92	53	.	38	.	.	.	.	.	.	.	38
Q1725000	C	93	53	.	38	.	.	.	.	.	.	.	38
Q1935000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q2090000	C	54	54	.	38	.	.	.	.	.	.	.	38
Q2120000	C	50	50	.	36	.	.	.	.	.	.	.	36
Q2135000	WS-IV	54	54	.	38	.	.	.	.	.	.	.	38
Q2180000	WS-IV	54	54	.	38	31	31	36	31	.	31	31	38
Q2291000	C	52	52	.	38	31	31	38	31	.	31	31	38
Q2479455	C	52	52	.	38	31	31	38	31	.	31	31	38
Q2540000	C	94	52	.	38	.	.	.	.	.	.	.	38
Q2570000	C	94	52	.	38	.	.	.	.	.	.	.	38
Q2720000	WS-IV	94	52	.	38	.	.	.	.	.	.	.	38
Q2810000	WS-IV CA	52	52	.	38	31	31	37	31	34	31	31	38
Q3105000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q3555000	WS-V	53	53	.	38	.	.	.	.	.	.	.	38
Q3720000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q3735000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q3900000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q3932000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q3970000	C	53	53	.	38	31	31	38	31	.	31	31	38
Q4030000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q4165000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q4540000	C	52	52	.	38	.	.	.	.	.	.	.	38
Q4600000	C	51	51	15	37	.	.	.	.	.	.	.	37
Q4660000	WS-V	52	52	16	38	.	.	.	.	.	.	.	38
Q5135000	C	52	52	.	38	.	.	.	.	.	.	.	38
Q5240000	C	52	52	.	38	.	.	.	.	.	.	.	38
Q5750000	WS-III	93	52	.	38	.	.	.	.	.	.	.	38
Q5785000	WS-III CA	93	52	.	38	.	.	.	.	.	.	.	38
Q5790000	WS-III CA	94	52	.	38	.	.	.	.	.	.	.	38
Q5940000	C	93	52	.	38	.	.	.	.	.	.	.	38
Q5980000	WS-V	92	52	17	38	.	.	.	.	.	.	.	38
Q6180000	C	50	50	.	37	.	.	.	.	.	.	.	37
Q6360000	WS-IV CA	53	53	18	39	32	32	34	32	.	32	32	38
Q6705000	C	52	52	.	38	.	.	.	.	.	.	.	37
Q6950000	WS-IV	51	51	.	38	.	.	.	.	.	.	.	38
Q6960000	WS-IV	53	53	18	39	.	.	.	.	.	.	.	39
Q7030000	WS-IV & B CA	53	53	18	39	32	32	34	32	.	32	32	38
Q7210000	C	54	54	.	38	.	.	.	.	.	.	.	37
Q7330000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q7450000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q7600000	C	53	53	.	38	31	31	37	31	.	31	31	38
Q7780000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q8200000	C	53	52	.	38	.	.	.	.	.	.	.	38
Q8210000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q8340000	C	85	49	.	36	.	.	.	.	.	.	.	36
Q8342000	C	93	53	.	38	.	.	.	.	.	.	.	38
Q8355000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q8359000	C	93	53	.	38	.	.	.	.	.	.	.	38
Q8360000	C	93	53	.	38	.	.	.	.	.	.	.	38
Q8385000	C	53	53	.	38	.	.	.	.	.	.	.	38
Q8386000	C	85	47	.	33	.	.	.	.	.	.	.	33
Q8386200	C	93	53	.	38	.	.	.	.	.	.	.	38
Q8388000	C	93	53	.	38	.	.	.	.	.	.	.	38
Q8388900	C	93	53	.	38	.	.	.	.	.	.	.	38
Q8715000	C	54	54	.	38	.	.	.	.	.	.	.	38

Table 50 (continued).

Station	Classification	DO	pH	Chl *a*	Turbidity	Cd	Cu	Fe	Hg	Mn	Pb	Zn	Fecal
Q8720000	C	54	54	.	38	.	.	.	.	.	.	.	38
Q8800000	C	93	53	.	38	.	.	.	.	.	.	.	38
Q8820000	C	93	53	.	38	.	.	.	.	.	.	.	38
Q8850000	C	93	53	.	38	.	.	.	.	.	.	.	38
Q9021300	WS-V	53	53	.	38	31	31	38	31	.	31	31	38
Q9320000	WS-IV	54	54	.	38	.	.	.	.	.	.	.	38
Q9340000	C	51	51	.	36	.	.	.	.	.	.	.	36
Q9400000	C	61	54	.	38	31	31	37	31	37	31	31	38

DO = Dissolved oxygen; Chl *a* = chlorophyll *a*; Cd = cadmium; Cu = copper; Fe = iron, Hg = mercury, Pb = lead, Zn = Zinc, and Fecal = fecal coliform bacteria.

Table 51. Proportion (%) of Yadkin Pee Dee River Basin Association samples exceeding standards or action levels. (See Table 50 for total number of samples collected).

	Dissolved oxygen												
Station[1]	%<5	%<4	pH	Chl *a*	Turbidity	Cd	Cu	Fe	Mn	Pb	Zn	Fecal[2]	Fecal[3]
Q0360000	.	.	.	.	2.6	.	.	.	.	.	.	59	5.4
Q0450000	**1.9**	.	.	.	**2.6**	.	.	.	.	.	.	**323**	**44.7**
Q0720000[4]	.	.	.	.	**5.3**	.	.	.	.	.	.	**2**	.
Q1065000	.	.	1.9	.	2.6	6.5	12.9	20.6	.	.	.	79	13.2
Q1215000	.	.	.	.	7.9	.	.	.	.	.	.	90	10.5
Q1350000	.	.	.	.	15.8	3.2	6.5	38.9	.	.	.	58	13.2
Q1500000	.	.	.	.	7.9	.	.	.	.	.	.	131	18.4
Q1710000[4]	**1.1**	.	.	.	**5.3**	.	.	.	.	.	.	**180**	**34.2**
Q1725000[4]	.	.	.	.	**7.9**	.	.	.	.	.	.	**185**	**23.7**
Q1935000[4]	.	.	.	.	**10.5**	.	.	.	.	.	.	**166**	**31.6**
Q2090000	.	.	.	.	10.5	.	.	.	.	.	.	423	47.4
Q2120000	.	.	.	.	8.3	.	.	.	.	.	.	297	30.6
Q2135000	.	.	.	.	10.5	.	.	.	.	.	.	268	21.1
Q2180000	.	.	.	.	13.2	.	.	47.2	.	.	3.2	74	7.9
Q2291000	.	.	.	.	5.3	.	6.5	36.8	.	.	.	265	21.1
Q2479455	3.8	.	.	.	5.3	3.2	3.2	36.8	.	.	19.4	307	42.1
Q2540000	.	.	.	.	7.9	.	.	.	.	.	.	327	39.5
Q2570000	3.2	.	.	.	5.3	.	.	.	.	.	.	368	39.5
Q2720000[4]	.	.	.	.	**10.5**	.	.	.	.	.	.	**255**	**23.7**
Q2810000[4]	.	.	.	.	**21.1**	.	**3.2**	**51.4**	**2.9**	.	.	**118**	**23.7**
Q3105000[4]	**9.4**	**3.8**	.	.	**13.2**	.	.	.	.	.	.	**572**	**55.3**
Q3555000[4]	**5.7**	**1.9**	.	.	**5.3**	.	.	.	.	.	.	**382**	**39.5**
Q3720000	.	.	.	.	7.9	.	.	.	.	.	.	543	63.2
Q3735000[4]	.	.	.	.	**13.2**	.	.	.	.	.	.	**306**	**44.7**
Q3900000	.	.	.	.	7.9	.	.	.	.	.	.	314	50.0
Q3932000[4]	.	.	.	.	**10.5**	.	.	.	.	.	.	**294**	**28.9**
Q3970000	1.9	.	.	.	23.7	3.2	6.5	60.5	.	.	3.2	225	21.1
Q4030000	.	.	.	.	2.6	.	.	.	.	.	.	359	47.4
Q4165000[4]	.	.	.	.	**10.5**	.	.	.	.	.	.	**194**	**21.1**
Q4540000	.	.	.	.	10.5	.	.	.	.	.	.	282	34.2
Q4600000	.	.	.	.	**5.4**	.	.	.	.	.	.	**231**	**21.6**
Q4660000	.	.	.	.	18.4	.	.	.	.	.	.	105	15.8
Q5135000	3.8	1.9	.	.	7.9	.	.	.	.	.	.	295	31.6
Q5240000[4]	**3.8**	**1.9**	**1.9**	.	**7.9**	.	.	.	.	.	.	**85**	**18.4**
Q5750000	5.4	1.1	.	.	7.9	.	.	.	.	.	.	330	44.7
Q5785000[4]	**20.4**	**2.2**	.	.	10.5	.	.	.	.	.	.	**236**	**21.1**
Q5790000[4]	**14.9**	**2.1**	.	.	**7.9**	.	.	.	.	.	.	**169**	**21.1**
Q5940000	9.7	5.4	.	.	10.5	.	.	.	.	.	.	114	15.8
Q5980000	**6.5**	**1.1**	**7.7**	.	**2.6**	.	.	.	.	.	.	**45**	**15.8**
Q6180000	**42.0**	**30.0**	.	.	**5.4**	.	.	.	.	.	.	**291**	**29.7**
Q6360000	1.9	.	1.9	.	.	.	.	11.8	.	.	3.1	7	2.6
Q6705000	15.4	1.9	.	.	.	.	.	.	.	.	.	186	18.9
Q6950000	2.0	2.0	.	.	.	.	.	.	.	.	.	103	5.3
Q6960000	**3.8**	.	.	.	.	.	.	.	.	.	.	**40**	**5.1**
Q7030000	.	.	.	.	.	.	.	2.9	.	.	.	5	2.6
Q7210000	**3.7**	.	.	.	**10.5**	.	.	.	.	.	.	**136**	**21.6**
Q7330000[4]	**1.9**	.	.	.	**7.9**	.	.	.	.	.	.	**433**	**44.7**
Q7450000	1.9	1.9	.	.	7.9	.	.	.	.	.	.	243	23.7
Q7600000	1.9	1.9	.	.	13.2	.	9.7	48.6	.	.	6.5	300	21.1
Q7780000	.	.	.	.	7.9	.	.	.	.	.	.	171	18.4
Q8200000	7.5	3.8	.	.	7.9	.	.	.	.	.	.	290	28.9
Q8210000	7.5	3.8	.	.	10.5	.	.	.	.	.	.	175	18.4
Q8340000	**17.6**	**7.1**	.	.	.	.	.	.	.	.	.	**325**	**52.8**
Q8342000	**7.5**	**3.2**	.	.	**10.5**	.	.	.	.	.	.	**464**	**50.0**
Q8355000	3.8	1.9	.	.	10.5	.	.	.	.	.	.	124	21.1
Q8359000	1.1	.	.	.	2.6	.	.	.	.	.	.	988	84.2
Q8360000	**8.6**	**3.2**	**3.8**	.	**10.5**	.	.	.	.	.	.	**412**	**42.1**
Q8385000	1.9	1.9	1.9	.	13.2	.	.	.	.	.	.	86	10.5
Q8386000	**17.6**	**5.9**	.	.	**24.2**	.	.	.	.	.	.	**349**	**42.4**
Q8386200	**10.8**	**1.1**	.	.	**13.2**	.	.	.	.	.	.	**318**	**28.9**
Q8388000	3.2	.	.	.	15.8	.	.	.	.	.	.	210	28.9
Q8388900	3.2	.	.	.	21.1	.	.	.	.	.	.	290	34.2
Q8715000	.	.	.	.	5.3	.	.	.	.	.	.	79	7.9

Table 51 (continued).

Station[1]	Dissolved oxygen		pH	Chl *a*	Turbidity	Cd	Cu	Fe	Mn	Pb	Zn	Fecal[2]	Fecal[3]
	%<5	%<4											
Q8720000	.	.	.	.	2.6	.	.	.	.	.	.	105	21.1
Q8800000	15.1	1.1	.	.	.	.	.	.	.	.	.	69	5.3
Q8820000	**8.6**	**1.1**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**140**	**10.5**
Q8850000	**2.2**	**.**	**.**	**.**	**5.3**	**.**	**.**	**.**	**.**	**.**	**.**	**142**	**13.2**
Q9021300	54.7	43.4	1.9	.	2.6	.	16.1	36.8	.	.	.	171	13.2
Q9320000	5.6	.	.	.	10.5	.	.	.	.	.	.	115	15.8
Q9340000	**.**	**.**	**.**	**.**	**2.8**	**.**	**.**	**.**	**.**	**.**	**.**	**285**	**30.6**
Q9400000	16.4	4.9	.	.	2.6	.	.	10.8	2.7	3.2	3.2	23	.

DO = Dissolved oxygen; Chl *a* = chlorophyll *a*; Cd = cadmium; Cu = copper; Fe = iron, Pb = lead, Zn = Zinc, Fecal = fecal coliform bacteria. No exceedances for mercury (Hg) were observed.
[1]Stations in bold font are downstream from wastewater discharges.
[2]Geometric mean.
[3]Proportion of samples greater than 400 colonies/100 ml.
[4]Station in dissolved oxygen sag zone.

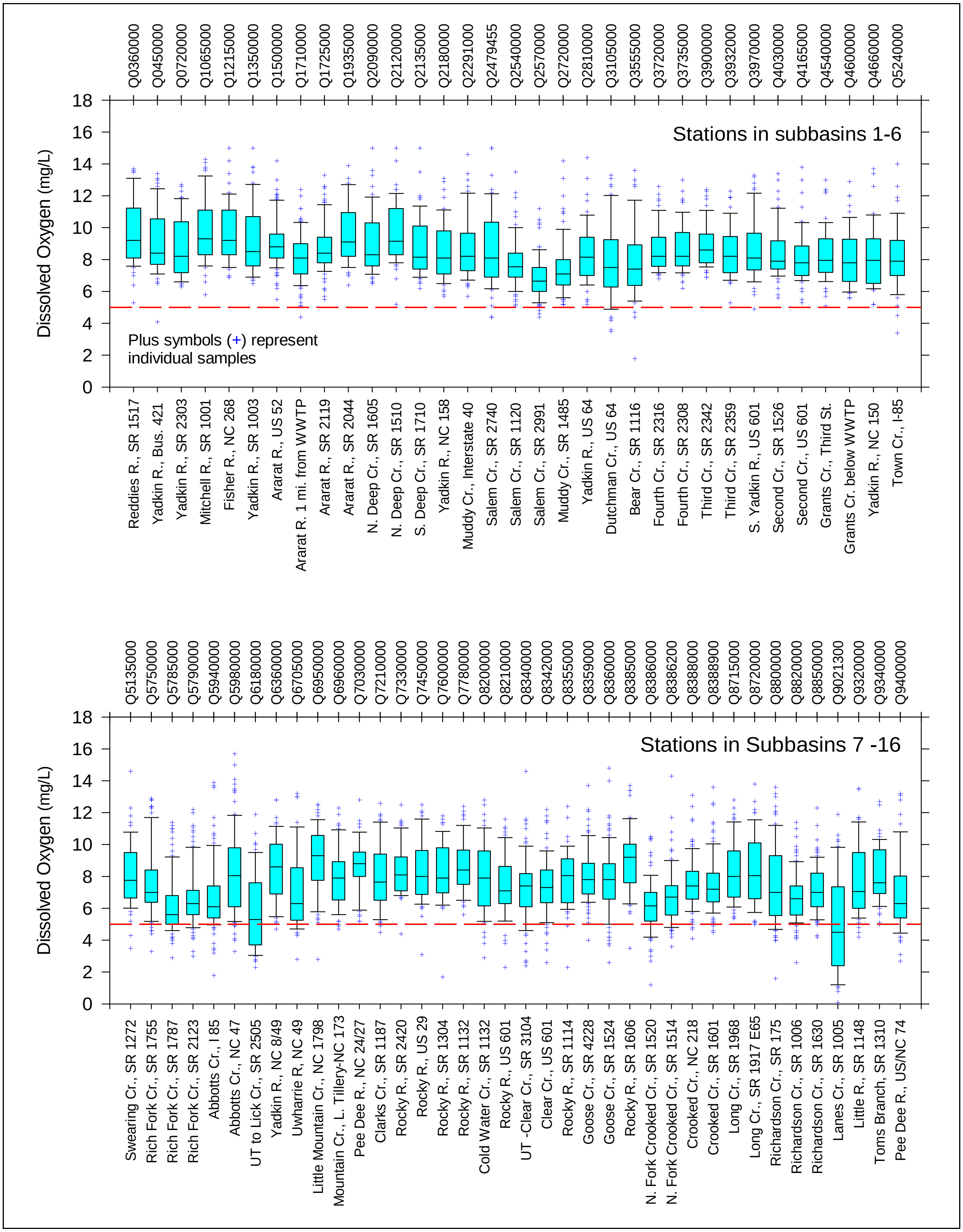


Figure 89. **Dissolved oxygen from YPDBA monitoring stations in the Yadkin River basin, 1998 - 2001.**

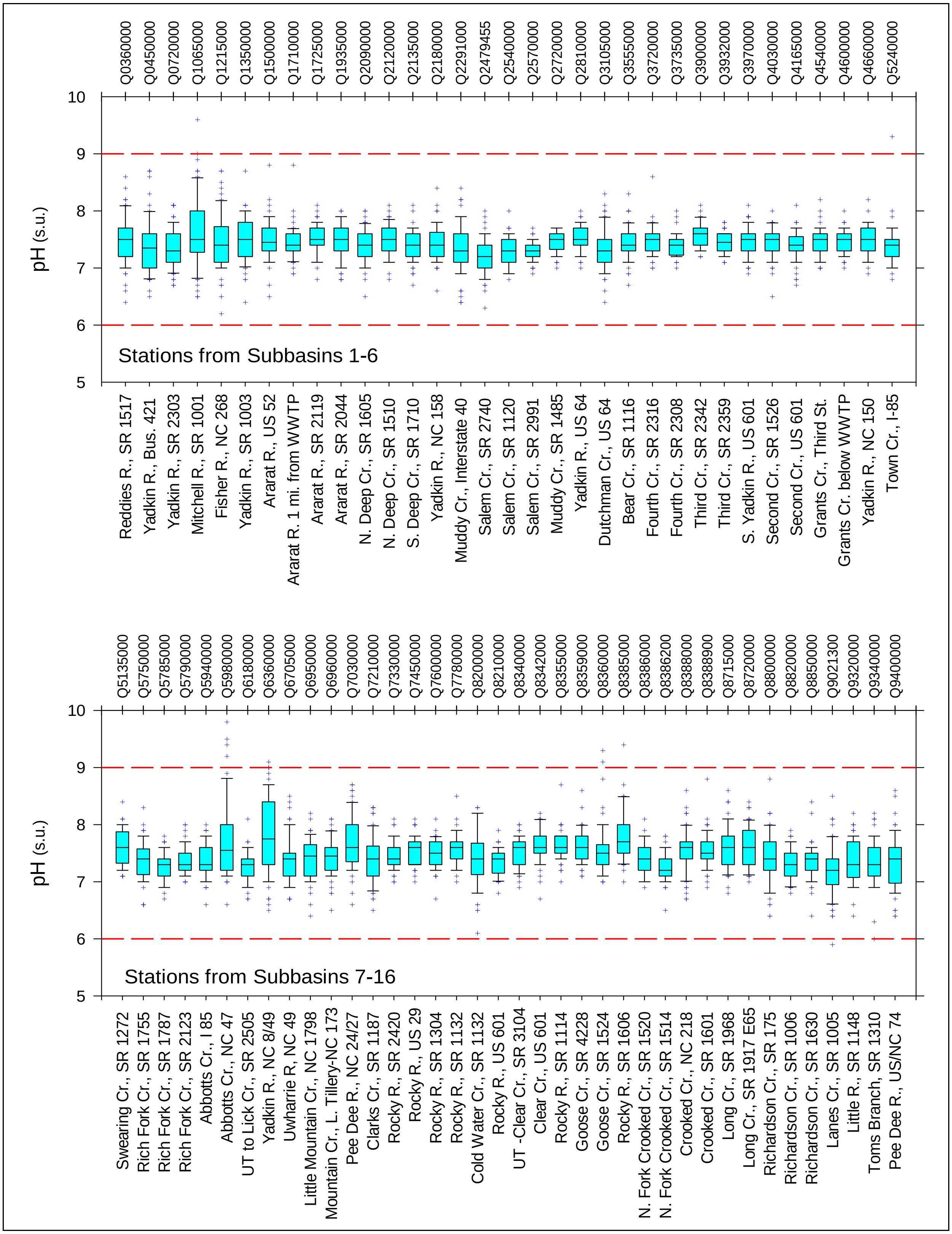


Figure 90. **pH from YPDBA monitoring stations in the Yadkin River basin, 1998 - 2001.**

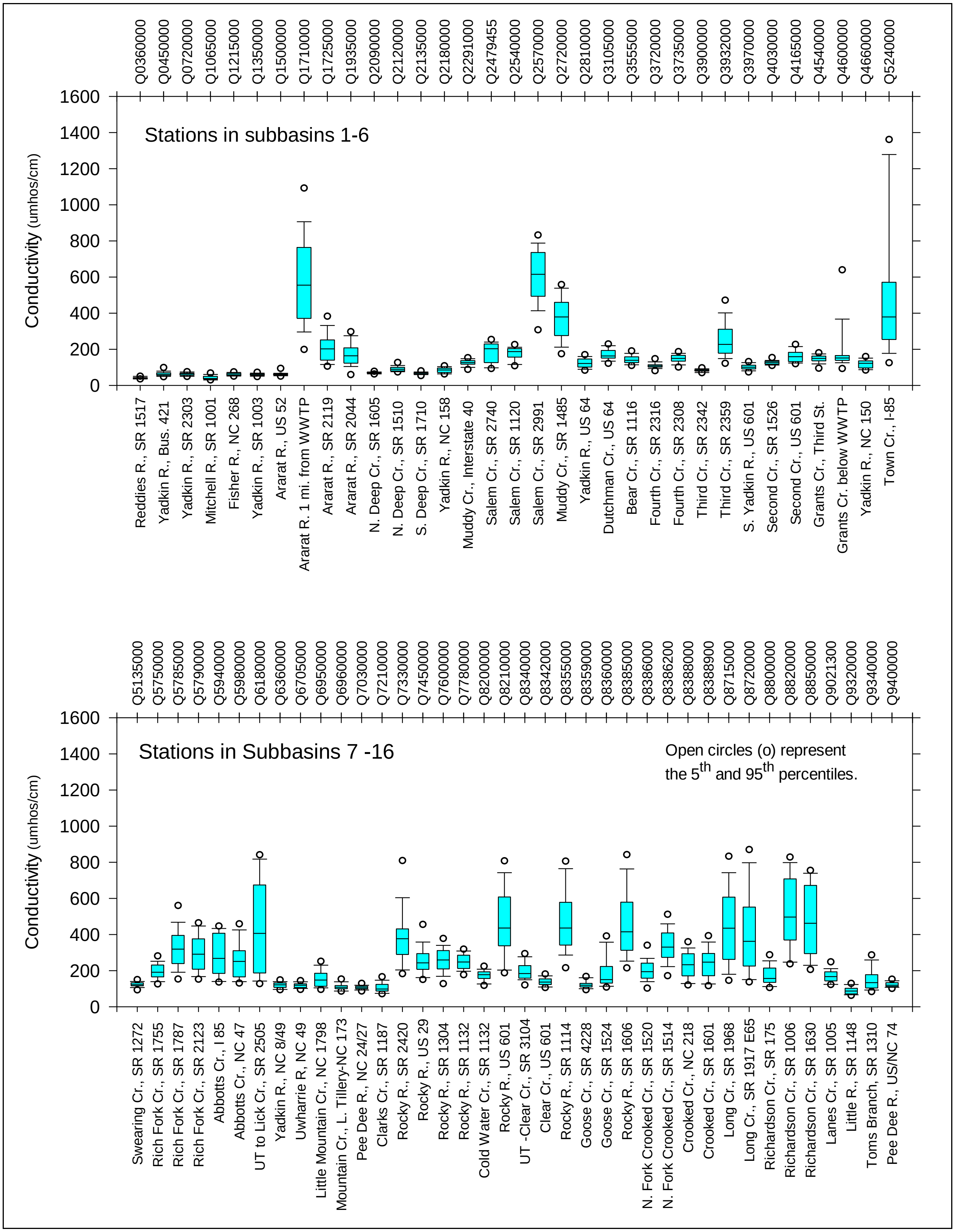


Figure 91. Conductivity from YPDBA monitoring stations in the Yadkin River basin, 1998 - 2001.

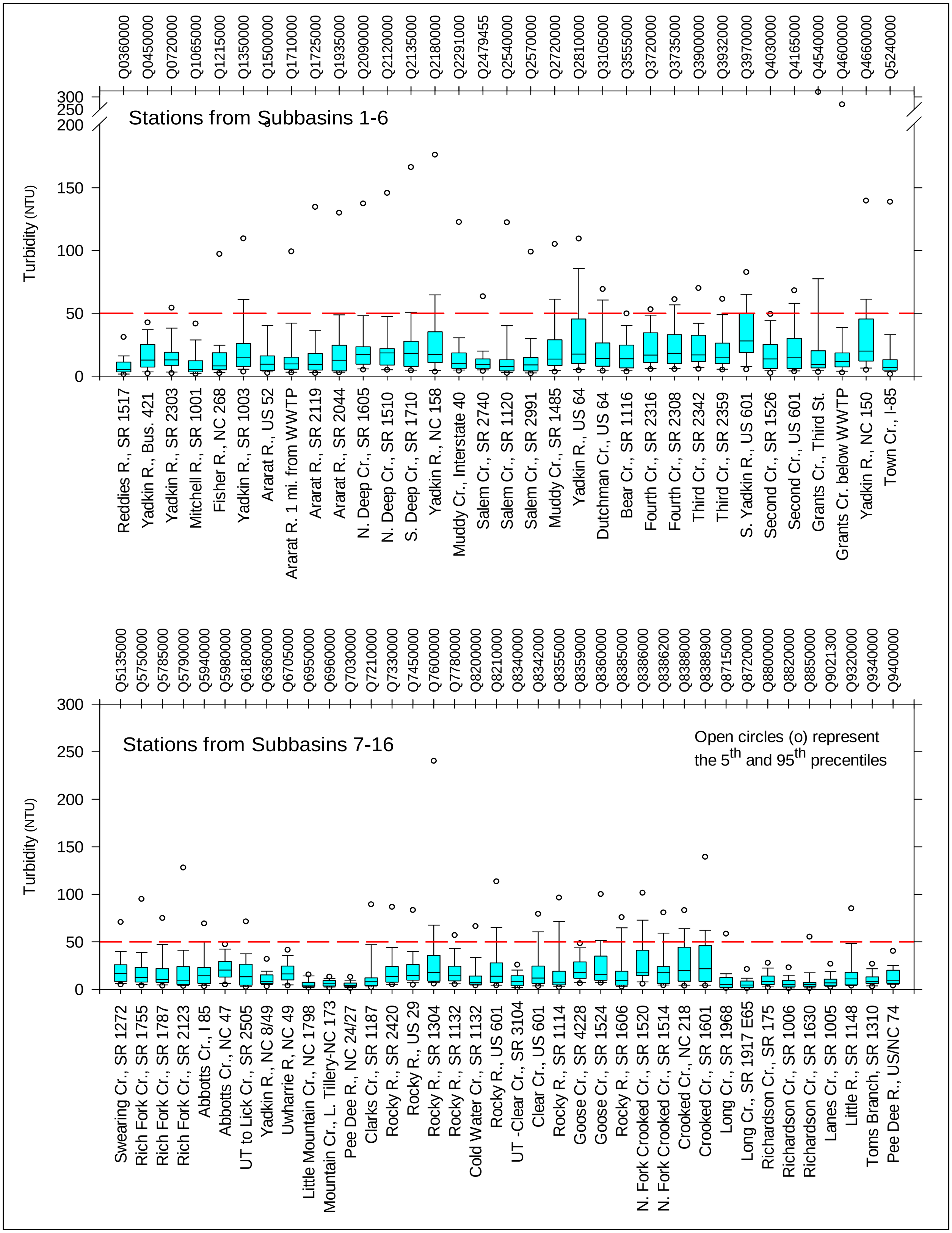


Figure 92. Turbidity from YPDBA monitoring stations in the Yadkin River basin, 1998 - 2001.

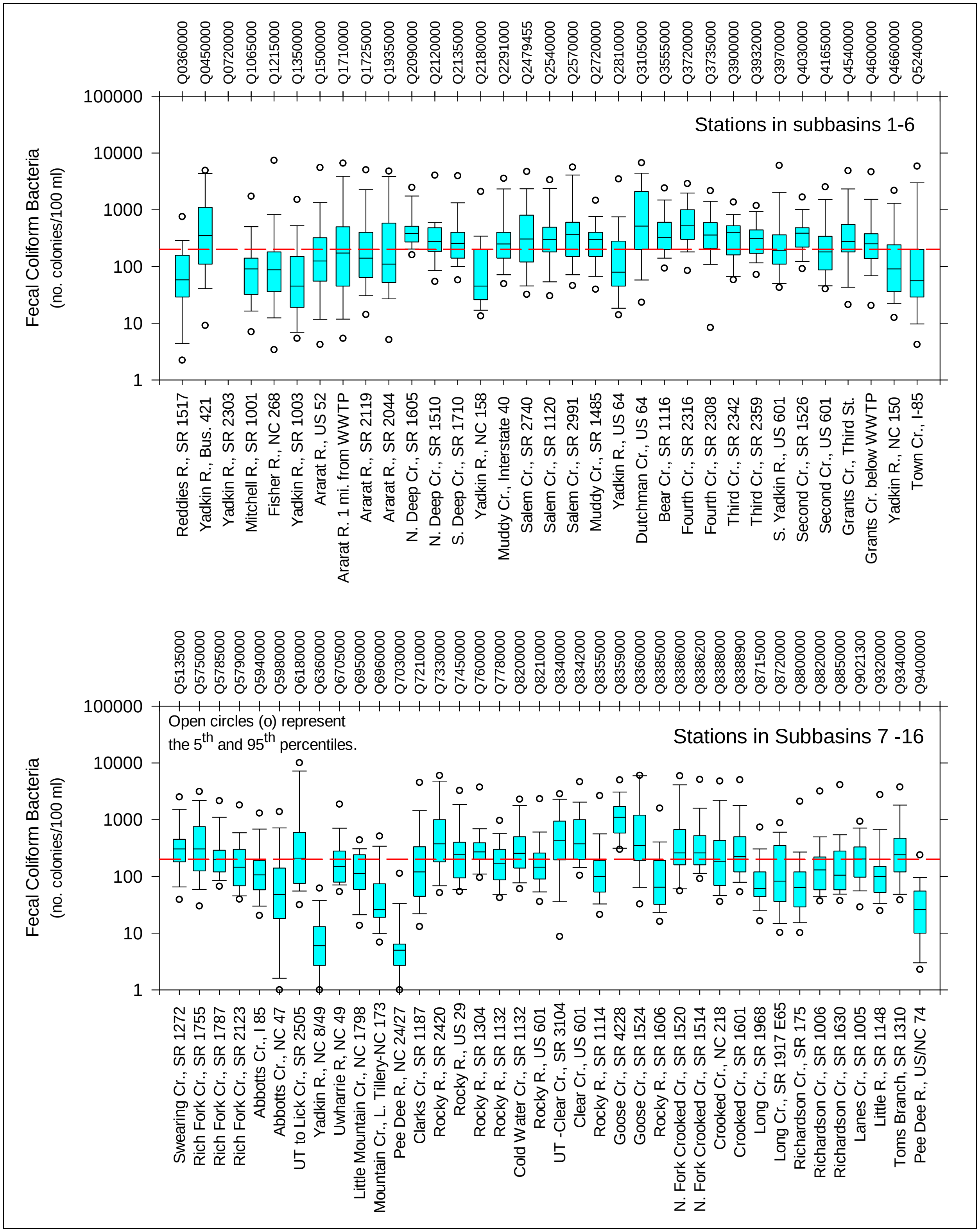


Figure 93. **Fecal coliform bacteria from YPDBA monitoring stations in the Yadkin River basin, 1998 - 2001.**

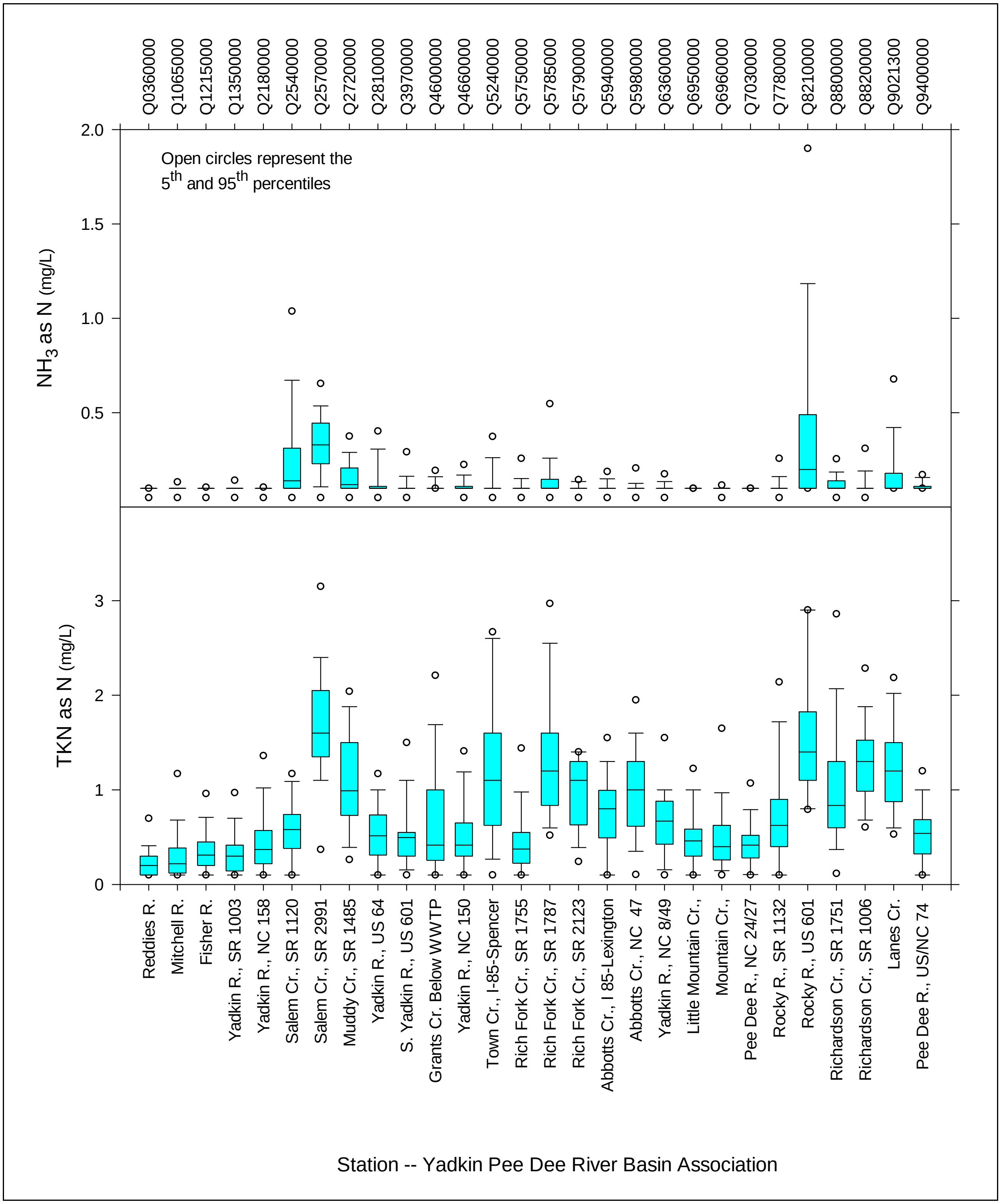


Figure 94. **Ammonia and total Kjeldahl nitrogen from YPDBA monitoring stations in the Yadkin River basin, 1998 - 2001.**

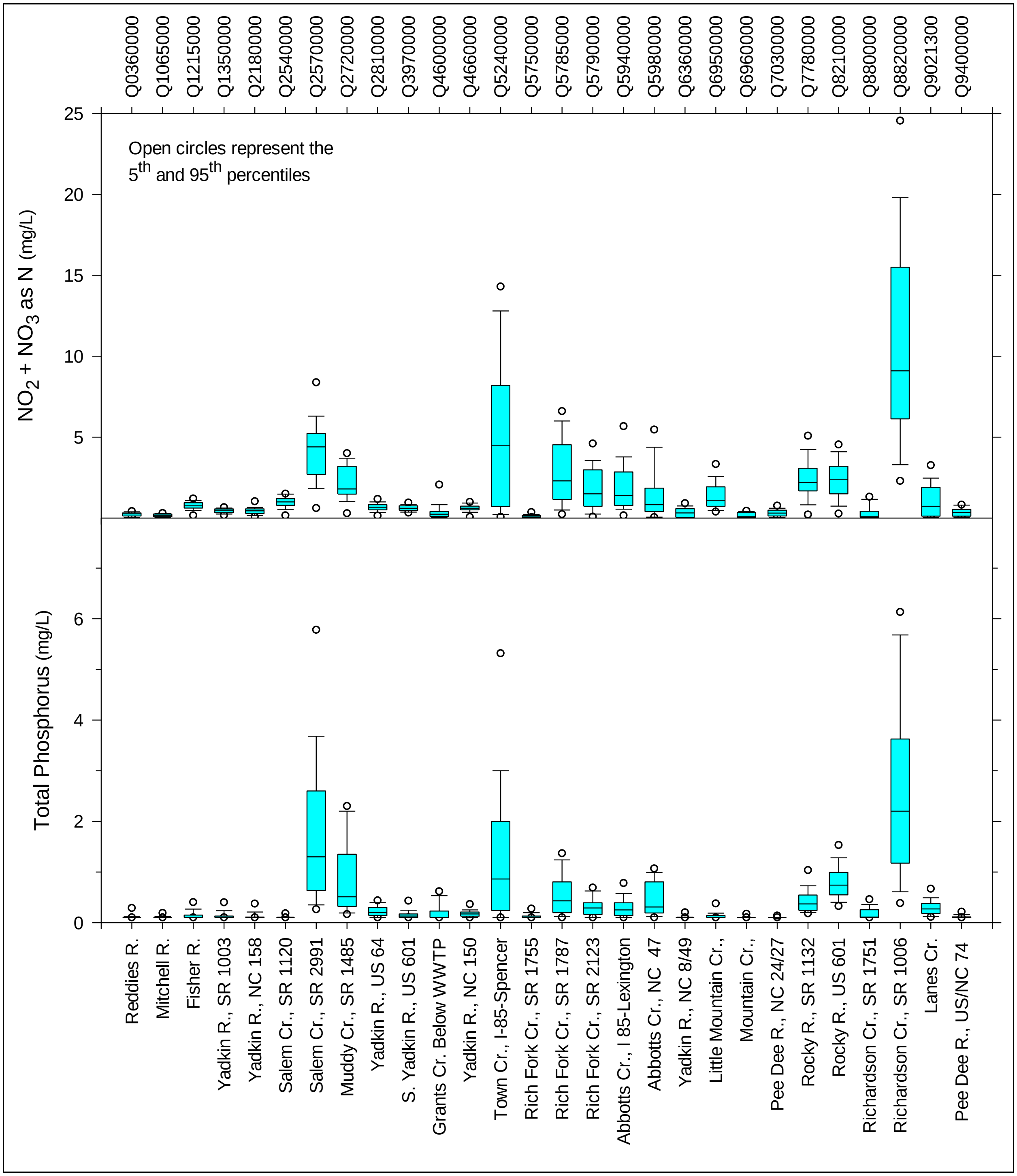


Figure 95. **Nitrite+nitrate and total phosphorus from YPDBA monitoring stations in the Yadkin River basin, 1998 - 2001.**

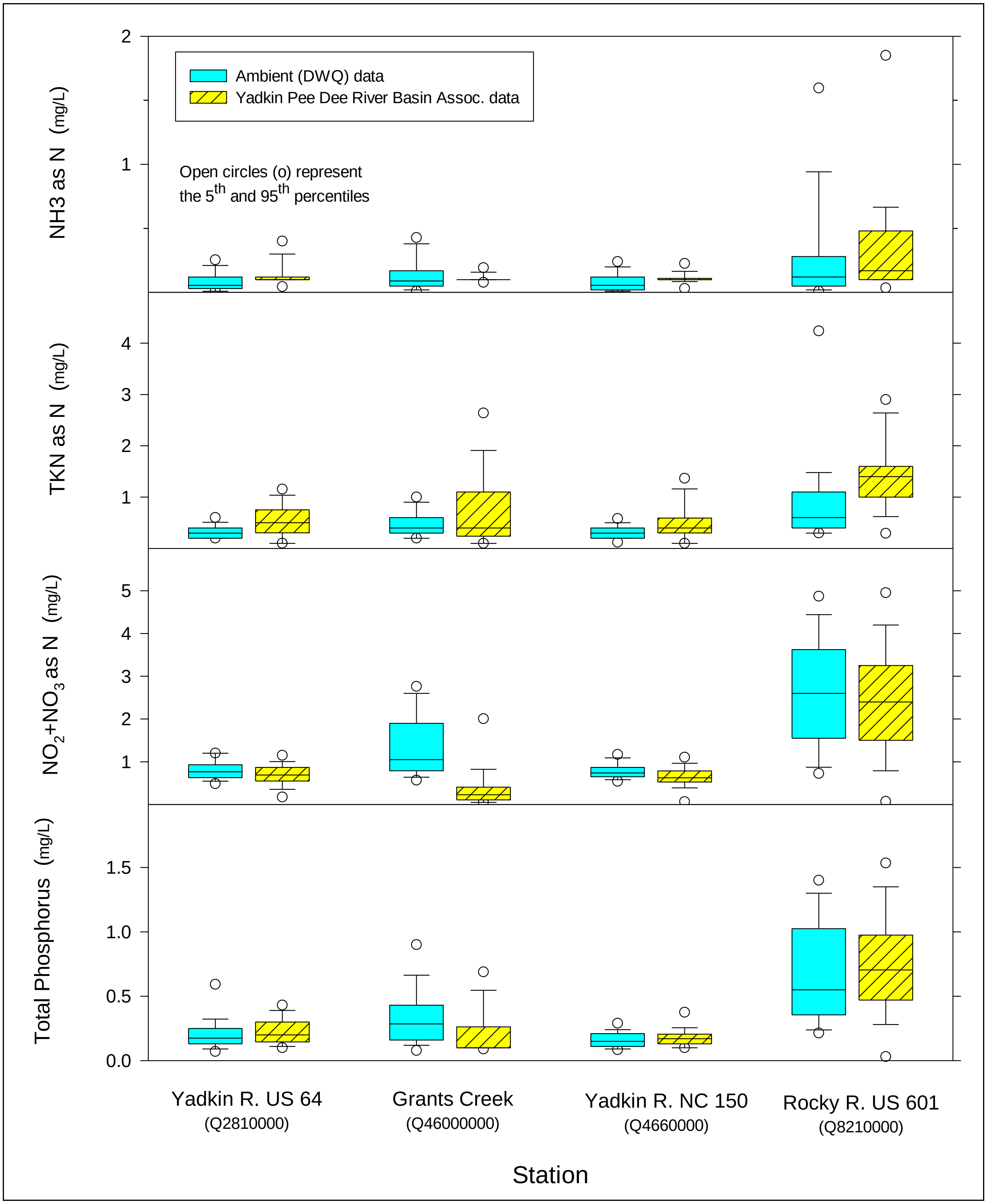


Figure 96. **A comparison of nutrient data collected by the NC DWQ and the YPDBA (1998 - 2001).**

AQUATIC TOXICITY MONITORING

Eighty facility NPDES permits in the basin currently require whole effluent toxicity (WET) monitoring (Figure 97 and Table 52). Seventy-seven facility permits have a WET limit; the other three facility permits specify monitoring with no limit.

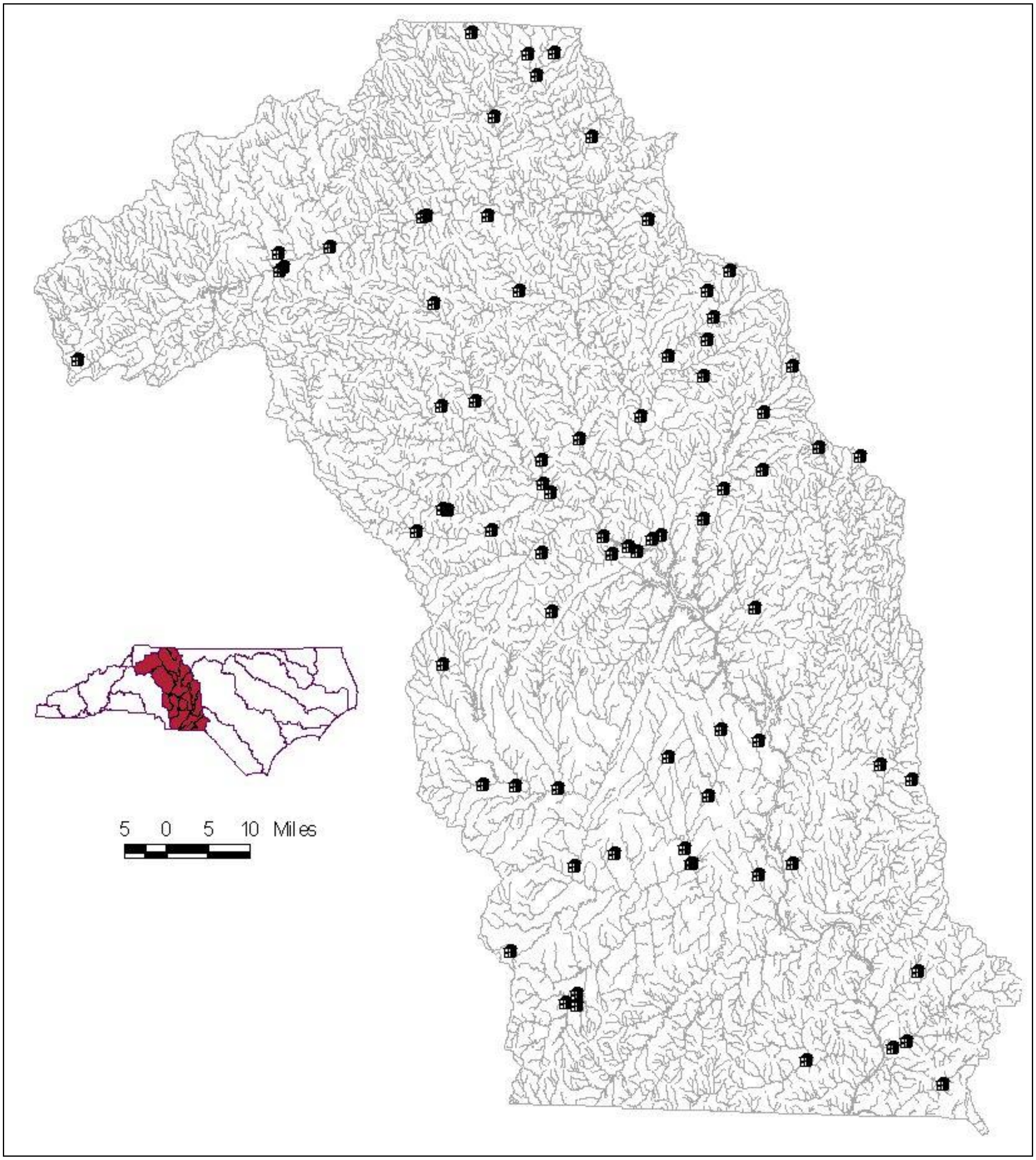


Figure 97. Facilities required to perform toxicity testing in the Yadkin River basin.

Table 52. **Facilities in the Yadkin River basin required to perform whole effluent toxicity testing.**

Subbasin/Facility	NPDES Permit No.	Receiving Stream	County	Flow (MGD)	IWC (%)	$7Q_{10}$ (cfs)
01						
ABTCO Inc.	NC0005266/001	Yadkin R	Wilkes	1.0	0.675	228.0
Carolina Mirror	NC0006696/001	UT Mulberry Cr	Wilkes	0.50	82	0.17
North Wilkesboro WWTP	NC0020761/001	Yadkin R	Wilkes	2.0	1.5	196.0
Omni Supply Inc.	NC0006254/001	Yadkin R	Caldwell	0.45	8.02	8.00
Wilkesboro WWTP	NC0021717/001	Yadkin R	Wilkes	4.9	3.72	196
02						
Boonville WWTP	NC0020931/001	Tanyard Cr	Yadkin	0.2	81.0	0.075
CMI Industries Inc.-Chatham Div.	NC0005312/001	Yadkin R	Surry	4.0	1.94	314
Elkin WWTP	NC0020567/001	Yadkin R	Surry	1.8	0.87	317.0
Wayne Farms-Dobson Plant	NC0006548/001	Fisher R	Surry	0.6	3.9	23
Yadkinville WWTP	NC0020338/001	North Deep Cr	Yadkin	2.5	50	3.9
03						
Mt. Airy WWTP	NC0021121/001	Ararat R	Surry	7.0	42.0	14.9
Pilot Mountain WWTP	NC0026646/001	Ararat R	Surry	1.5	2.75	82.2
Proctor Silex	NC0005703/001	Lovills Cr	Surry	0.085	1.7	7.6
Surry County-Flat Rock Elem. School	NC0041904/001	UT Champ Cr	Surry	0.0045	100	0
NC Department of Transportation	NC0029190/001	Naked Run	Surry	0.030	13	0.3
04						
Color-Tex Finishing Corp.	NC0005487/001	Yadkin R	Rowan	4.25	0.64	1030
Duke Power-Buck Steam Station	NC0004774/002	Yadkin R	Rowan	NA	0.598	1030
Fieldcrest Mills	NC0004286/001	UT Grants Cr	Rowan	0.05	100	0.0
Flakt Products, Inc.	NC0085871/001	Brushy Fork	Forsyth	0.0864	4.5	2.9
Lucent Technologies, Inc.	NC0080853/001	UT Salem Cr	Forsyth	0.302	90	0.05
Norfolk And Western Railway Co.	NC0046931/001	UT Brushy Fork	Forsyth	Var	100	0
Norfolk Southern Railway Co.	NC0029246/011	High Rock L	Davidson	0.317	29.0	1.2
PPG Industries	NC0004626/001	N Potts Cr	Davidson	0.6	48.19	1.0
Reynolds Tobacco-001	NC0055093/001	Barkers Cr	Forsyth	NA	100.0	0.0
Salisbury-Grants Creek WWTP	NC0023884/001	Yadkin R	Rowan	12.5	7.0	263.5
Salisbury-Sowers Ferry Road WWTP	NC0025593/001	Grants Cr	Rowan	0.75	17	5.8
Scarlett Acres	NC0061204/001	UT Mill Cr	Forsyth	0.02	100.0	0.0
Three R's MHP	NC0051489/001	Leak Cr	Forsyth	0.012	19.8	0.075
Winston-Salem A. Elledge WWTP	NC0037834/001	Salem Cr	Forsyth	30	75.6	15.0
Winston-Salem Lower Muddy Cr	NC0050342/001	Yadkin R	Forsyth	21.0	5.5	554.0
05						
Mocksville WWTP Dutchman's Cr	NC0021491/001	Dutchman's Cr	Davie	0.68	6.57	15.0
06						
Arteva Specialties-KOSA	NC0004944/001	N Second Cr	Rowan	2.305	34.08	6.9
Cleveland WWTP	NC0049867/001	Third Cr	Rowan	0.27	3.0	14.0
Cooleemee WWTP	NC0024872/001	South Yadkin R	Davie	1.5	2.1	106
Harmony WWTP	NC0087033/001	Dutchman Cr	Iredell	0.250	35	0.71
Hoechst Celanese/Needmore Rd	NC0079898/001	S Yadkin R	Rowan	0.288	0.42	106
Mocksville WWTP Bear Cr	NC0050903/001	Bear Cr	Davie	0.25	37	0.65
Southern States Coop./S.S. Fertilizer	NC0082821/001	Fourth Cr	Iredell	0.144	2.89	7.5
Statesville Fourth Cr WWTP	NC0031836/001	Fourth Cr	Iredell	4.0	36.0	11.0
Statesville Third Cr WWTP	NC0020591/001	Third Cr	Iredell	4.0	39	9.8
NC Department of Transportation	NC0028614/001	Rocky Branch	Yadkin	0.018	9.0	0.3
Tyson Foods Inc-Harmony Division	NC0005126/001	Hunting Cr	Iredell	0.5	1.8	43
07						
Centerclair Nursing Home	NC0036561/001	UT Pounder Fork Cr	Davidson	0.010	100	0.0
High Point Care Center	NC0046035/001	Rich Fork Cr	Forsyth	0.01	20.5	0.06
High Point Westside WWTP	NC0024228/001	Rich Fork Cr	Davidson	6.2	93.47	0.67
Lexington Regional WWTP	NC0055786/001	Abbott's Cr-H Rock	Davidson	5.5	56	6.7
Thomasville WWTP	NC0024112/001	Hamby Cr	Davidson	4.0	94	0.43
08						
Alcoa-002	NC0004308/002	Badin L (Yadkin R)	Stanly	NA	NA	NA
Alcoa-005	NC0004308/005	UT Little Mountain Cr	Stanly	NA	100	0.0
Alcoa-011	NC0004308/011	Badin L (Yadkin R)	Stanly	VAR	NA	NA
Alcoa-012	NC0004308/012	Badin L (Yadkin R)	Stanly	NA	NA	NA
Alcoa-013	NC0004308/013	Badin L (Yadkin R)	Stanly	NA	NA	NA
Denton WWTP	NC0026689/001	UT Lick Cr	Davidson	0.30	100	0.0
J.E. Morgan Knitting Mills	NC0086487/001	Poplin Branch	Stanly	0.03	100	0.0

Table 52 (continued).

Subbasin/Facility	NPDES Permit No.	Receiving Stream	County	Flow (MGD)	IWC (%)	$7Q_{10}$ (cfs)
09						
Furniture Illustrators Inc.	NC0084786/001	UT Uwharrie R	Randolph	0.001	100	0.0
Trinity American Corporation	NC0086029/001	Caraway Cr	Randolph	0.072	100	0
10						
Ellerbe WWTP	NC0021784/001	Tom's Branch	Richmond	0.18	61.0	0.18
Mt. Gilead WWTP	NC0021105/001	Pee Dee R	Montgomery	0.85	3.2	40
11						
Chemical Specialties, Inc.	NC0006351/001	Rocky R	Cabarrus	0.025	0.96	4.0
CMUD-Mallard Cr. WWTP	NC0030210/001	Mallard Cr	Mecklenburg	6.0	94.0	0.64
Mooresville WWTP	NC0046728/001	Dye Cr	Iredell	5.2	94.15	0.5
12						
Concord Rocky River WWTP	NC0036269/001	Rocky R	Cabarrus	20	69	14.0
Corning Inc.-Midland Fiber Facility	NC0086169/003	Rocky R	Cabarrus	0.107	1.0	30
Dixie Yarns Inc.	NC0083763/001	UT Rock Hole Branch	Stanly	0.072	100	0
Union County WWTP #2	NC0069841/001	N Fork Crooked Cr	Union	1.9	100	0.0
13						
Albemarle WWTP	NC0024244/001	Long Cr	Stanly	16.0	94	1.60
Oakboro WWTP	NC0043532/002	Rocky R	Stanly	0.9	4.6	29
Oakboro WWTP	NC0043532/001	Long Cr	Stanly	0.5	19	3.3
Solite Corp	NC0028169/002	Long Branch	Stanly	0.36	100.0	0.0
South Central Oil Company	NC0085758/001	UT to Little Cr	Stanly	0.0331	100	0.0
14						
Monroe WWTP	NC0024333/001	Richardson Cr	Union	9.0	96.18	0.43
Norwood WWTP	NC0021628/001	Rocky R	Stanly	0.75	2.68	42.0
R. P. Scherer/Chelsea Laboratories	NC0084344/001	UT Rays Fork	Union	0.05	100.0	0.0
Teledyne Allvac	NC0045993/001	Richardson Cr	Union	0.2	67.4	0.15
15						
Biscoe WWTP	NC0021504/001	Hickory Branch	Montgomery	0.6	100	0.0
Troy WWTP	NC0028916/001	Denson's Cr	Montgomery	0.84	79	0.35
16						
Anson County WWTP	NC0041408/001	Pee Dee R	Anson	3.5	2.99	175.5
Burlington Ind.-Richmond	NC0043320/001	Hitchcock Cr	Richmond	1.2	7.0	25.0
Hamlet WWTP	NC0047562/001	Marks Cr	Richmond	1.0	38.27	2.5
Rockingham WWTP	NC0020427/001	Pee Dee R	Richmond	9.0	8.0	153

The number of facilities in this basin monitoring whole effluent toxicity has increased steadily since 1986, the first year that monitoring was required (Figure 98). 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 1996, the compliance rate has stabilized at approximately 90 - 95 percent (Figure 98 and Table 53).

The Town of Boonville's WWTP (Subbasin 02) experienced problems meeting its whole effluent toxicity limit from the beginning of 1995 through the end of 1999. Many of the failures were associated with high residual chlorine levels in the effluent. The facility has had one failure since November 1999. The facility has since implemented ultraviolet light disinfection. However, improvements in levels of whole effluent toxicity pre-date installation of this system. The exact source of the toxicity is unclear at this point.

Proctor Silex (Subbasin 03) was sporadically noncompliant with its WET limit during the period September 1997 through October 2000, failing 6 of 18 chronic toxicity tests. Over time, the facility has reduced process wastes that include metal plating and painting. The facility has gone offline, not discharging since January 2001. Facility staff likely will request rescission of its NPDES permit in the near future.

The Surry County Flat Rock Elementary School WWTP (Subbasin 03) has been almost continuously noncompliant since it began operation in January 2000. The facility has had operational problems associated with a faulty sand filter liner that has since been replaced. However, whole effluent toxicity levels have not improved. Toxicants associated with sand filter facilities at schools include ammonia and surfactant and disinfectant constituents of cleaning chemicals.

The Lucent Technologies groundwater remediation facility (Subbasin 04) failed four consecutive chronic toxicity tests during the period

March - June 1999. Facility staff replaced the system’s carbon filter media and optimized application of treatment chemicals to address the problem. No failures have occurred since June 1999.

Noncompliances in 1999 and 2000 at the Town of Salisbury's Sowers Road WWTP (Subbasin 04) seemed to be associated with operational problems at the WWTP. There have been no failures since September 2000.

The wastewater treatment plant at the Scarlett Acres Mobile Home Park has produced sporadic failures since it began operation in 1990. Its most recent noncompliances in 2001 have been attributed to poor operation and numerous power outages.

Noncompliances beginning in August 2001 at the Town of Mocksville's Bear Creek WWTP (Subbasin 06) were associated with high levels of nickel and zinc that have been attributed to a particular industrial user. The levels of zinc detected in the effluent coupled with whole effluent toxicity failures have made the facility subject to the NC DWQ's Action Level Implementation Strategy. The facility is required to either accept a permit limit for zinc or conduct investigations that definitively rule out zinc as the cause of toxicity. The investigations must be completed by the end of September 2002.

The recent noncompliances at the NC Department of Transportation's I-77 rest stop facility (Subbasin 06) have been attributed to excessive chlorination. Facility staff members are investigating installation of a flow-paced chlorination system.

Centerclair Nursing Home WWTP (Subbasin 07) consistently failed to comply with its toxicity testing limit from the inception of its permit limit in July 1999 through June 2000. According to the plant’s operator, dechlorination was installed in October 1999 which mitigated some of the toxicity problems. However, a change in detergent used at the facility’s onsite laundry operation in the summer of 2000 seemed to have significantly reduced toxicity in the effluent. The facility has failed one toxicity test since July 2000.

The groundwater remediation discharge at R. P. Scherer/Chelsea Laboratories (Subbasin 14) has produced noncompliant test results in 9 of 17 monitoring events since May 1998. The facility’s contractor has made arrangements to connect the facility to the City of Monroe’s WWTP pending the attainment of an access easement. In the interim, the facility operators have reduced the treatment rate and utilized the facility’s infiltration gallery such that no discharge has occurred since October 2000.

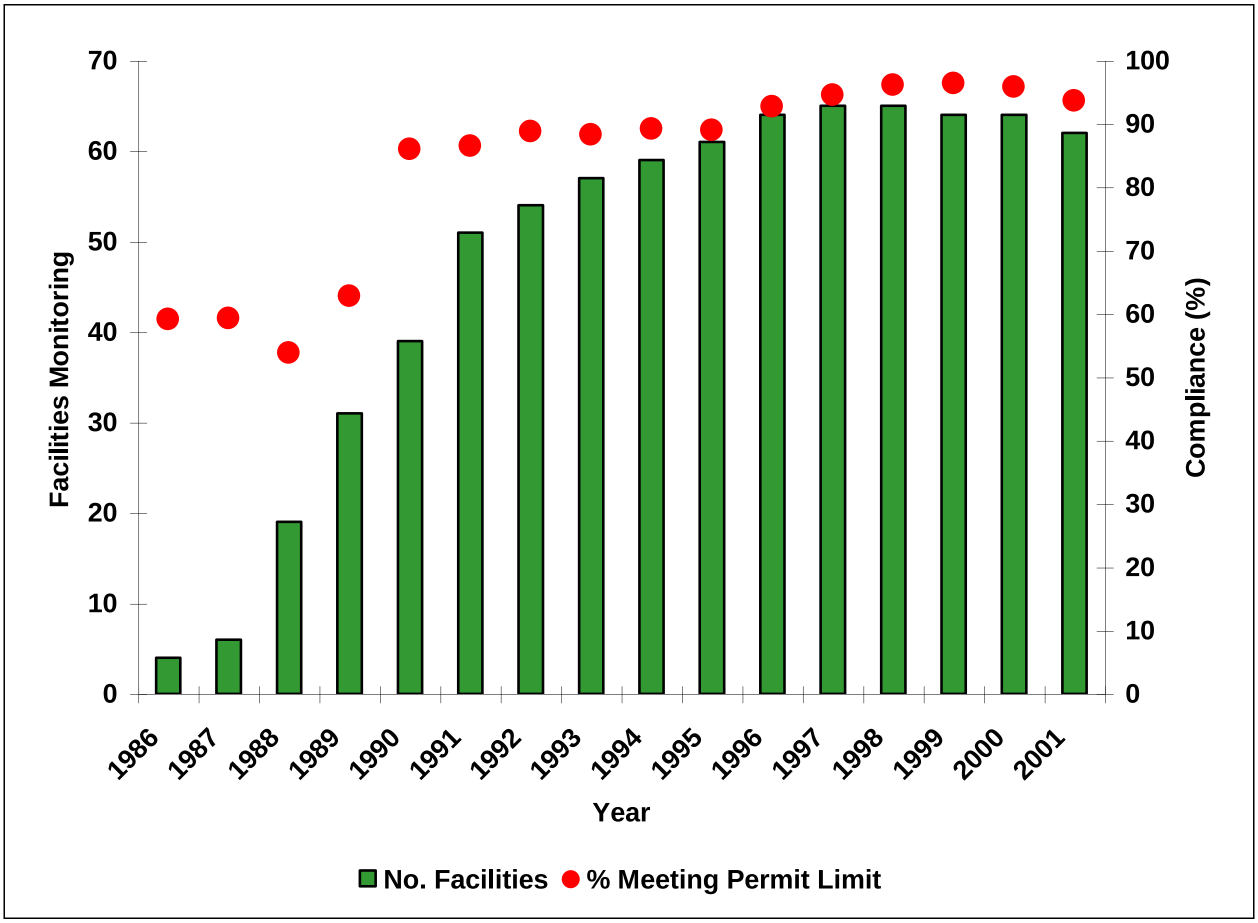


Figure 98. Whole effluent toxicity monitoring in the Yadkin River basin, 1986 - 2001. The compliance values were calculated by determining whether a facility was meeting its ultimate permit limit during the given time period, regardless of any SOCs in force.

Table 53. Compliance record of facilities performing whole effluent toxicity testing in the Yadkin River basin.

Subbasin	Subbasin/Facility	NPDES Permit No.	Pre 2001 Passes[1]	Pre 2001 Fails	2001 Passes	2001 Fails
01	ABTCO, Inc.	NC0005266/001	62	18	4	0
	Carolina Mirror	NC0006696/001	54	21	6	2
	North Wilkesboro WWTP	NC0020761/001	37	1	4	0
	Omni Supply Inc.	NC0006254/001	48	4	4	0
	Wilkesboro WWTP	NC0021717/001	45	14	3	0
02	Boonville WWTP	NC0020931/001	37	24	4	0
	CMI Industries, Inc.-Chatham Div.	NC0005312/001	50	1	4	0
	Elkin WWTP	NC0020567/001	43	0	4	0
	Wayne Farms-Dobson Plant	NC0006548/001	48	6	4	0
	Yadkinville WWTP	NC0020338/001	48	24	4	0
03	Mt. Airy WWTP	NC0021121/001	69	42	7	2
	Pilot Mountain WWTP	NC0026646/001	22	57	4	0
	Proctor Silex	NC0005703/001	50	25	0	0
	Surry County-Flat Rock Elem. School	NC0041904/001	1	2	0	3
	Transportation, NC Dept of	NC0029190/001	33	4	5	1
04	Color-Tex Finishing Corp.	NC0005487/001	56	14	0	0
	Duke Power-Buck Steam	NC0004774/002	44	0	4	0
	Fieldcrest Mills	NC0004286/001	28	4	3	0
	Flakt Products, Inc.	NC0085871/001	10	1	4	0

Table 53 (continued).

Subbasin	Subbasin/Facility	NPDES Permit No.	Pre 2001 Passes[1]	Pre 2001 Fails	2001 Passes	2001 Fails
	Lucent Technologies, Inc.	NC0080853/001	21	6	4	0
	Norfolk And Western Railway Co.	NC0046931/001	11	1	1	0
	Norfolk Southern Railway Co.	NC0029246/011	41	43	7	1
	PPG Industries	NC0004626/001	38	27	4	0
	Reynolds Tobacco-001	NC0055093/001	49	2	4	0
	Salisbury-Grants Creek WWTP	NC0023884/001	50	29	4	0
	Salisbury-Sowers Ferry Road WWTP	NC0025593/001	45	5	4	0
	Scarlett Acres	NC0061204/001	40	19	4	4
	Three R's MHP	NC0051489/001	4	0	4	0
	Winston-Salem A. Elledge WWTP	NC0037834/001	33	11	4	0
	Winston-Salem Lower Muddy Cr	NC0050342/001	41	0	4	0
05	Mocksville WWTP Dutchman's Cr	NC0021491/001	47	7	4	0
06	Arteva Specialties-KOSA	NC0004944/001	28	2	4	0
	Cleveland WWTP	NC0049867/001	21	1	3	0
	Cooleemee WWTP	NC0024872/001	51	1	4	0
	Harmony WWTP[2]	NC0087033/001	0	0	0	0
	Hoechst Celanese/Needmore Rd	NC0079898/001	31	1	3	0
	Mocksville WWTP Bear Creek	NC0050903/001	49	18	2	6
	Southern States Coop./S.S. Fertilizer	NC0082821/001	13	1	2	1
	Statesville Fourth Creek WWTP	NC0031836/001	52	26	5	1
	Statesville Third Creek WWTP	NC0020591/001	47	2	6	2
	NC Department of Transportation	NC0028614/001	33	13	5	2
	Tyson Foods Inc-Harmony Division	NC0005126/001	36	18	4	0
07	Centerclair Nursing Home	NC0036561/001	2	11	5	1
	High Point Care Center	NC0046035/001	41	6	4	0
	High Point Westside WWTP	NC0024228/001	93	25	5	1
	Lexington Regional WWTP	NC0055786/001	59	6	5	2
	Thomasville WWTP	NC0024112/001	52	21	4	1
08	Alcoa-002	NC0004308/002	44	8	4	0
	Alcoa-005	NC0004308/005	29	10	3	0
	Alcoa-011	NC0004308/011	9	0	1	0
	Alcoa-012	NC0004308/012	47	7	4	0
	Alcoa-013	NC0004308/013	19	0	4	0
	Denton WWTP	NC0026689/001	42	27	5	1
	J.E. Morgan Knitting Mills	NC0086487/001	4	6	1	0
09	Furniture Illustrators, Inc.[2]	NC0084786/001	0	0	0	0
	Trinity American Corporation	NC0086029/001	10	0	4	0
10	Ellerbe WWTP	NC0021784/001	46	18	4	0
	Mt. Gilead WWTP	NC0021105/001	30	9	4	0
11	Chemical Specialties, Inc.	NC0006351/001	46	22	0	0
	CMUD-Mallard Cr. WWTP	NC0030210/001	41	2	5	0
	Mooresville WWTP	NC0046728/001	49	19	4	0
12	Concord Rocky River WWTP	NC0036269/001	56	7	4	0
	Corning Inc.-Midland Fiber Facility	NC0086169/003	8	0	4	0
	Dixie Yarns, Inc.	NC0083763/001	24	5	4	2
	Union County WWTP #2	NC0069841/001	40	2	4	0
13	Albemarle WWTP	NC0024244/001	52	39	4	0
	Oakboro WWTP	NC0043532/002	0	0	2	0
	Oakboro WWTP	NC0043532/001	45	22	3	0
	Solite Corp	NC0028169/002	5	0	0	0
	South Central Oil Company	NC0085758/001	0	0	1	0
14	Monroe WWTP	NC0024333/001	56	9	4	2
	Norwood WWTP	NC0021628/001	44	5	4	0
	R. P. Scherer/Chelsea Laboratories	NC0084344/001	7	10	0	0
	Teledyne Allvac	NC0045993/001	42	4	6	2
15	Biscoe WWTP	NC0021504/001	28	4	5	1
	Troy WWTP	NC0028916/001	47	27	5	1
16	Anson Co. WWTP	NC0041408/001	73	9	4	0
	Burlington Ind.-Richmond	NC0043320/001	49	2	4	0
	Hamlet WWTP	NC0047562/001	39	3	4	0
	Rockingham WWTP	NC0020427/001	45	4	4	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 benthic sample based on the number of taxa present in the intolerant groups (EPT) and the Biotic Index value.
cfs	Cubic feet per second, generally the unit in which stream flow is measured.
CHL *a*	Chlorophyll *a*.
Class C Waters	Freshwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. All freshwaters shall be classified to protect these uses at a minimum.
Conductivity	In this report, synonymous with specific conductance and reported in the units of μmhos/cm at 25 ^{o}C. Conductivity is a measure of the resistance of a solution to electrical flow. Resistance is reduced with increasing content of ionized salts.
Division	The North Carolina Division of Water Quality.
D.O.	Dissolved Oxygen.
Ecoregion	An area of relatively homogeneous environmental conditions, usually defined by elevation, geology, vegetation, and soil type. Examples include mountains, piedmont, coastal plain, 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 Excellent based on biological and physical/chemical characteristics through Division monitoring or special studies, primary nursery areas designated by the Marine Fisheries Commission, and all Class SA waters.
Major Discharger	Greater than or equal to one million gallons per day discharge (≥ 1 MGD).
MGD	Million Gallons per Day, generally the unit in which effluent discharge flow is measured.
Minor Discharger	Less than one million gallons per day discharge (< 1 MGD).
NPDES	National Pollutant Discharge Elimination System.

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

Appendix 1. Flow measurement and flow conditions in the Yadkin River basin, 2001.

The Yadkin River basin experienced a prolonged drought throughout 2001 (Figures 1 - 3). During fish community sampling (April - June) daily flows at some sites were as low as 25% of the historical median flow. However, in Subbasin 11, flows in nearby streams were near normal levels. For example, daily flows of Mallard Creek below Stony Creek near Harrisburg were approximately 85 percent of the historical median flow. Also, in Subbasin 16, daily flows of Drowning Creek near Hoffman were approximately 100 percent of the historical median flow.

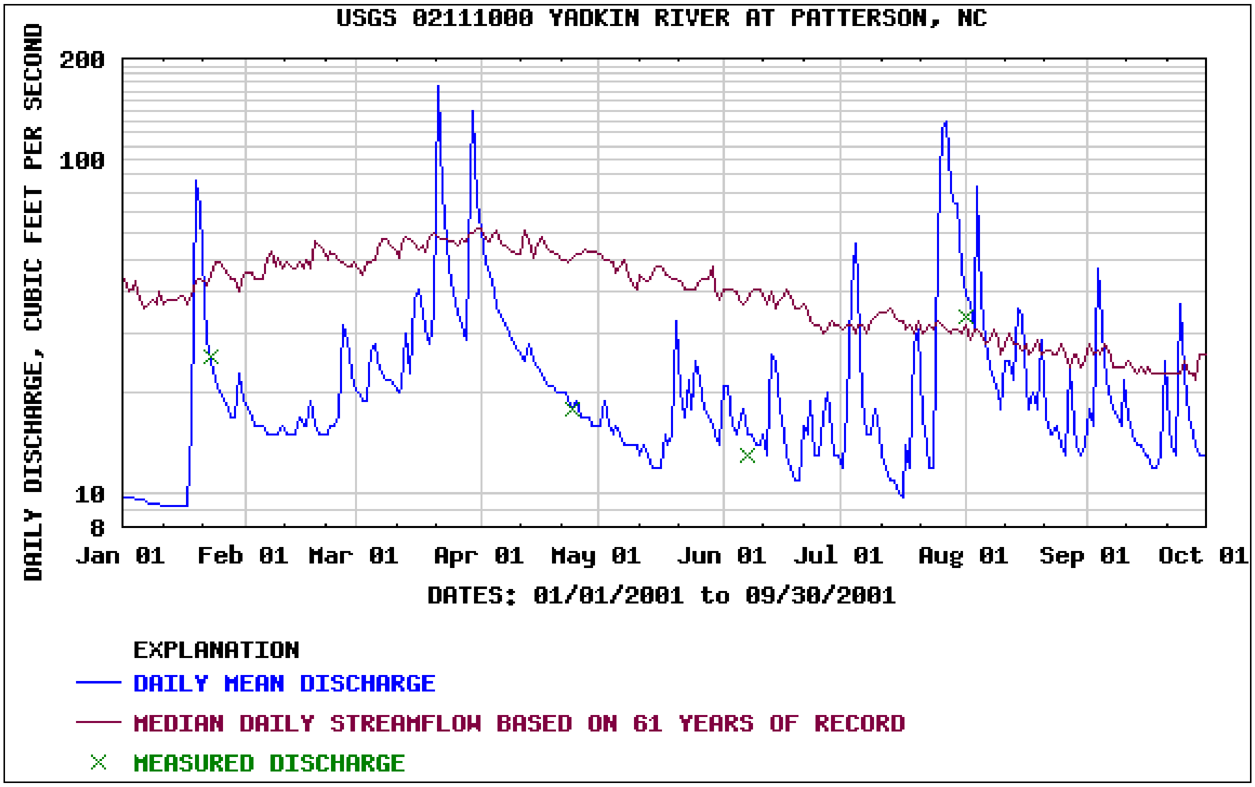
During benthic macroinvertebrate sampling (July - August), there were also two exceptions. An extreme rainfall event occurred in portions of Caldwell and Wilkes Counties from July 31 to August 2 (Figure 5). Extremely high flows prevented sampling in some of the larger catchments including Elk Creek at SR 1175 and the Yadkin River at NC 268. These sites were later resampled on August 28.

Changes in the benthic macroinvertebrate community are often used to help assess between-year changes in water quality. Some between-year changes in the communities, however, may be due largely to changes in flow. High flows magnify the potential effects of nonpoint source runoff, leading to scour, substrate instability, and reduced periphyton. Low flows may accentuate the effect of point source dischargers by providing less dilution of wastes.

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

- *Flow*. In the prior three months of collection, daily flow patterns are examined using the most comparable 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 affected primarily by point source dischargers may improve after high flow (with dilution of the effluent) and decline after low flows. These changes, however, 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.

Consequently, all between-year changes in the biological communities are considered in light of flow conditions for one month prior to the sampling date. Daily flow information is obtained from the closest available USGS monitoring site and compared to the long-term median flows. High flow is defined as a median flow greater than 140 percent of the long-term median for that time period, usually July or August. Low flow is defined as a median flow less than 60 percent of the long-term median, while normal flow is 60 - 140% of the median. Although broad scale regional patterns are often observed, there may be large geographical variation within the state, and large variation within a single summer period.



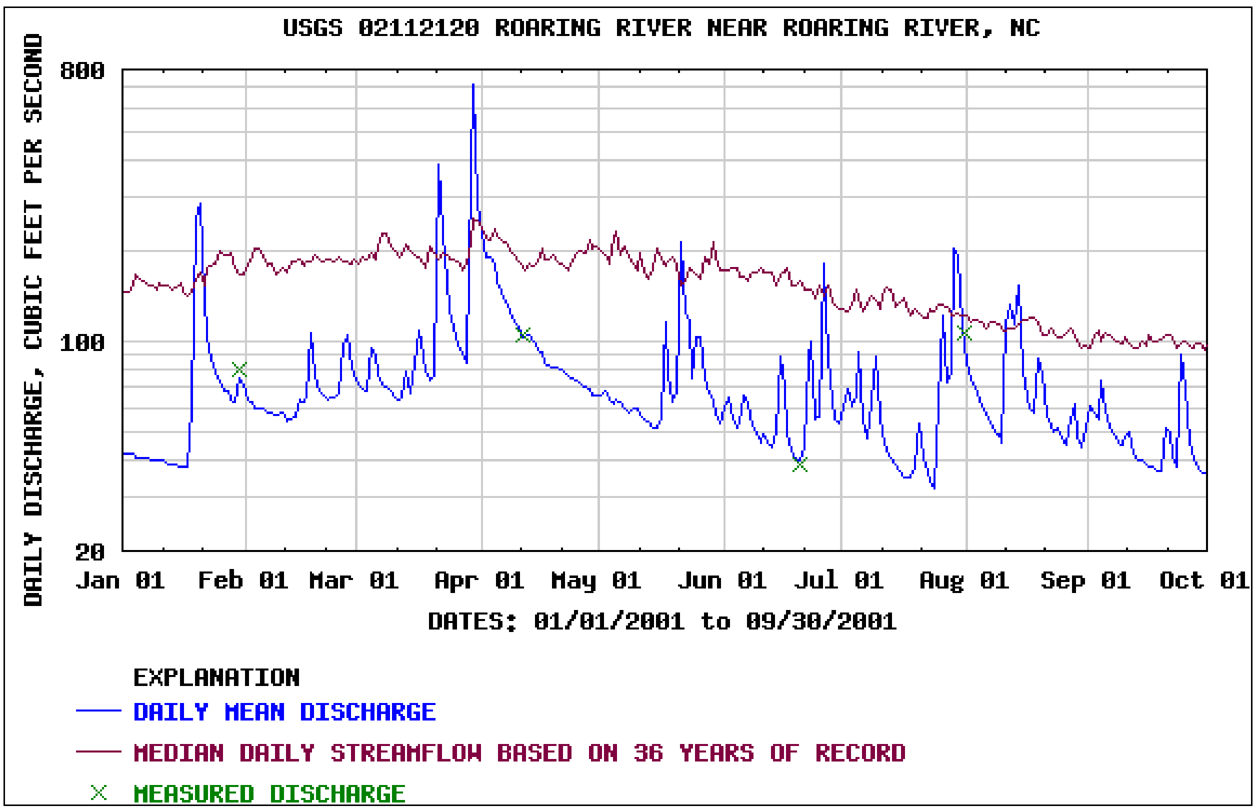
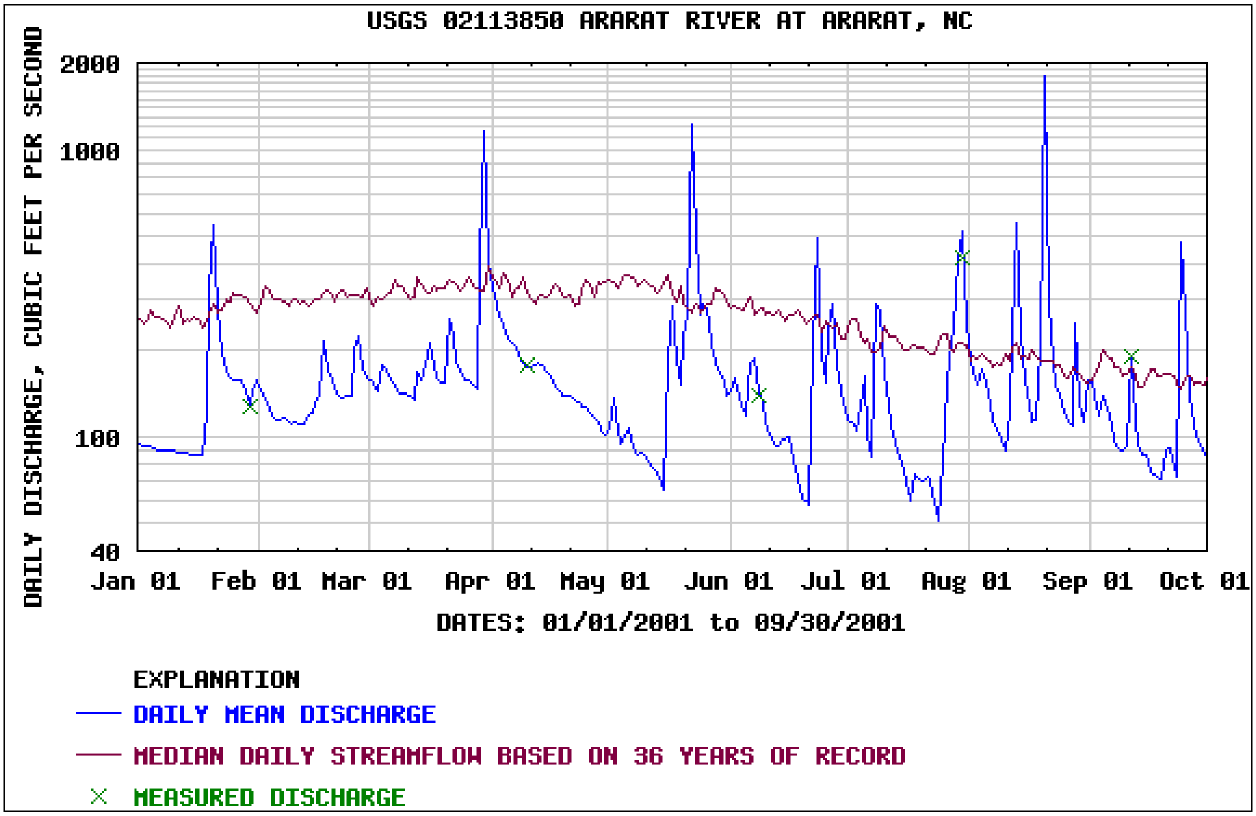


Figure 1. **Flows of the Yadkin River (top) and the Roaring River (bottom), January 01, 2001 - September 30, 2001.**



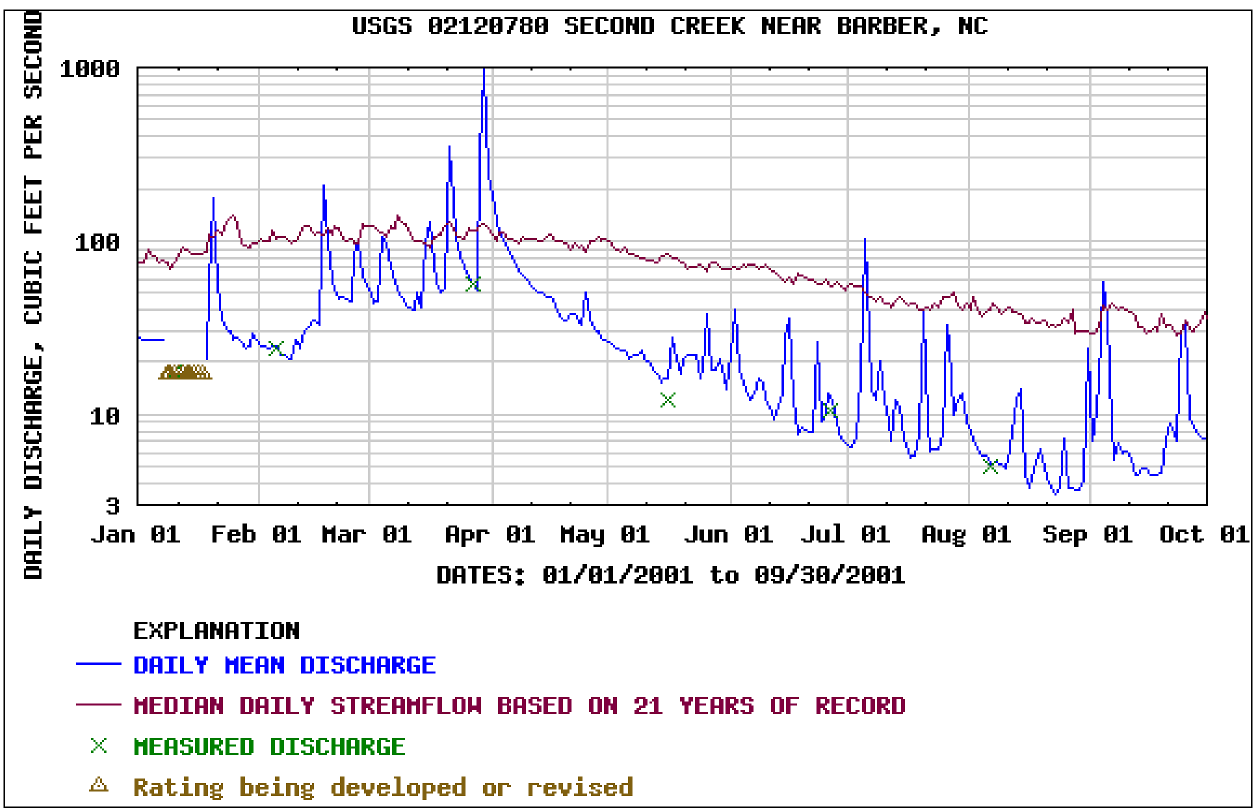
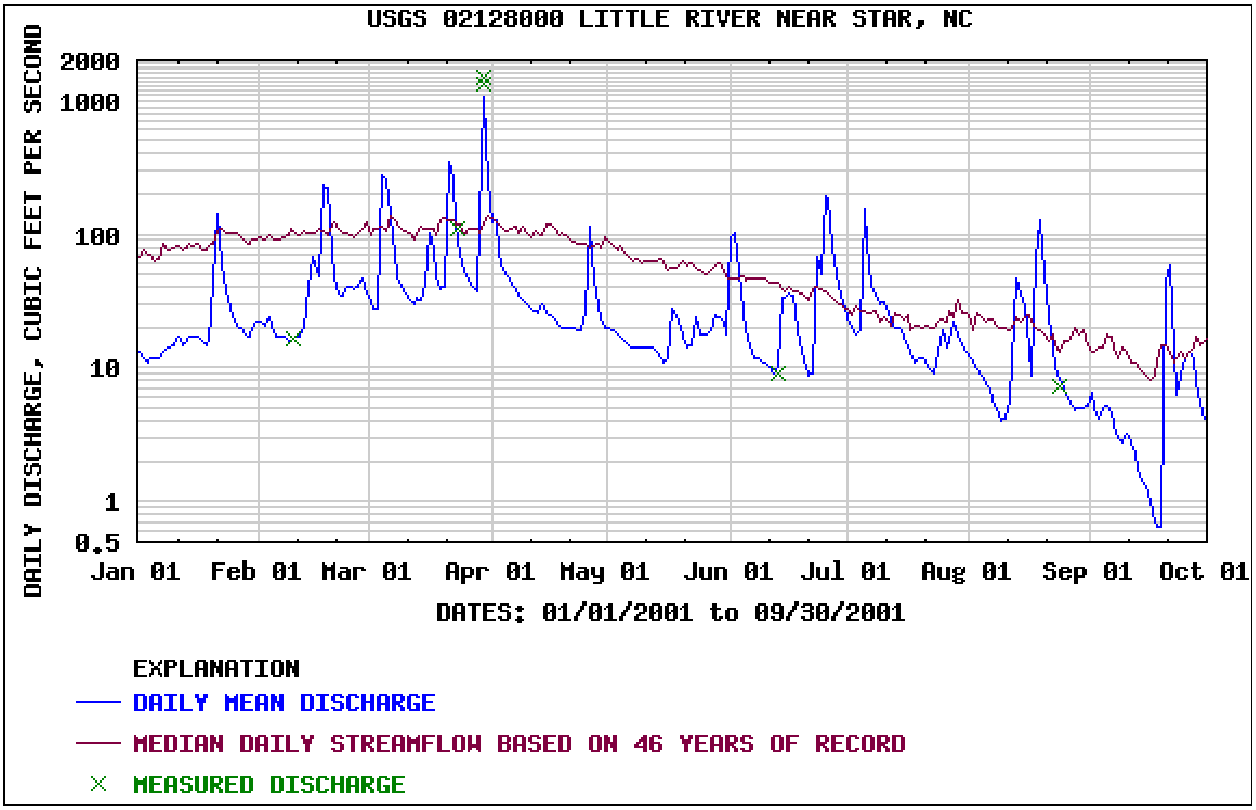


Figure 2. Flows of the Ararat River (top) and Second Creek (bottom), January 01, 2001 - September 30, 2001.



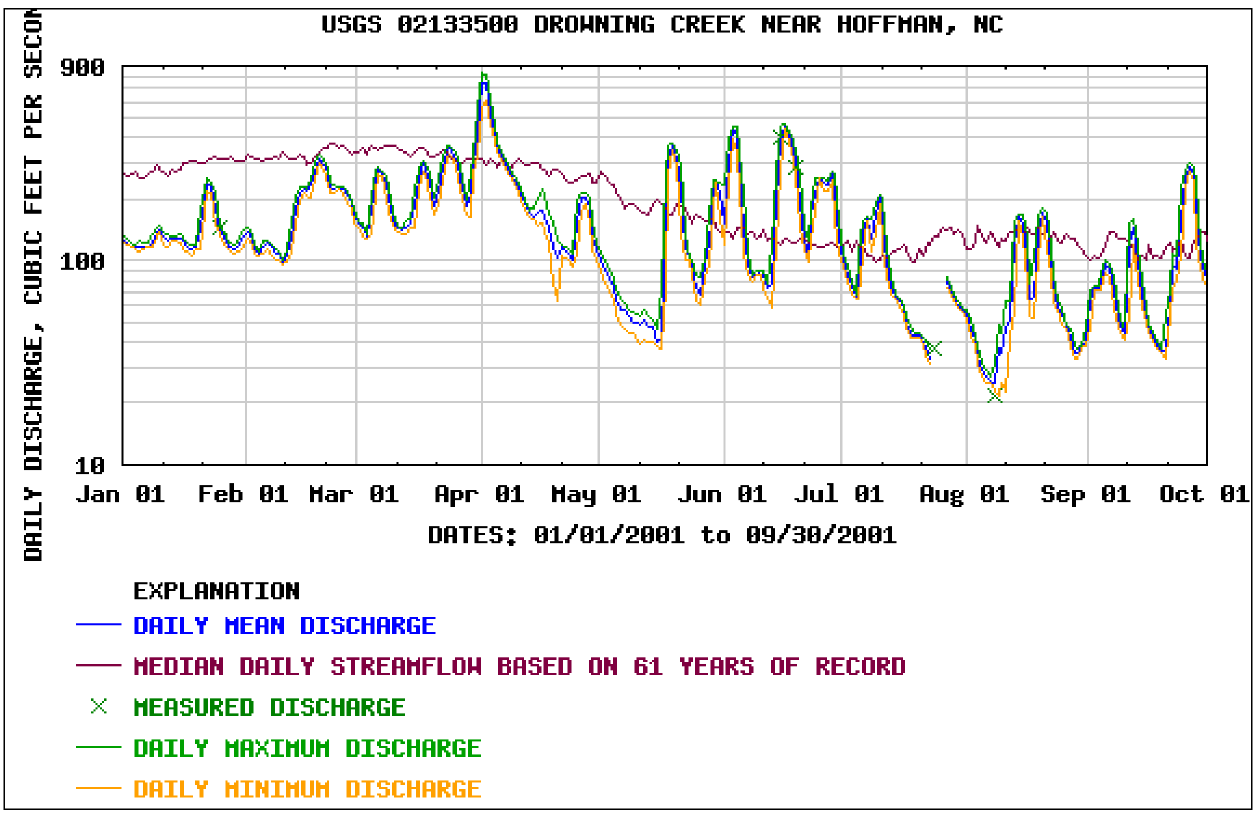


Figure 3. Flows of the Little River (top) and Drowning Creek (bottom), January 01, 2001 - September 30, 2001.

Appendix 2. Habitat evaluations and stream and riparian habitats at fish community monitoring sites.

A assessment form has been developed by the NC DWQ to better evaluate the physical habitat of a stream (NCDENR 2001a). The habitat score, which ranges between 1 and 100, is based on the evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration, and riparian zone width. Higher numbers suggest better habitat quality, but no criteria have been developed to assign impairment ratings. Habitat metric scores for all benthic macroinverte-brate and fish community sites in the Yadkin River basin which were evaluated in 2001 and 1996 are listed in Appendices 3 - 5.

In 2001, basinwide fish community sampling was conducted within all 17 subbasins in the basin. The instream and riparian habitats, as expected, considering the size of the basin, variedly widely among the subbasins (Appendix 3).

Generally, with a few exceptions, streams with high to moderately high instream and riparian habitats (habitat scores ≥ 65) are found in Subbasins 01, 02 (in part), 03, 08, 09, 10 (in part) 11 (in part), and 13 - 16. Characteristics of these streams are:

- instream habitats composed of rocks, sticks, leafpacks, snags and logs, and undercut banks and root mats (Figure 1);
- a substrate of gravel, cobble, and boulders with low embeddedness;
- frequent pools and riffles of varying depths and widths; and
- stable banks with a good tree canopy, and a wide riparian zone with no or rare breaks in the zone (Figure 2).

Figure 1. Instream habitats composed of rocks, sticks, leafpacks, snags and logs, and undercut banks and root mats (West Fork Little River at SR 1311, Montgomery County).

Figure 2. Stable banks with a good tree canopy and a wide riparian zone (Clarks Creek at SR 1188, Montgomery County).

Streams in Subbasins 08, 09, 10 (in part), and 11-15 are within the Carolina Slate Belt ecoregion. The streams generally have large bedrock ledges and boulder/rubble dominated substrates (Figure 3). Soil erosion can produce high turbidity from inputs of suspended clays, but little sandy material accumulates as bedload. Small streams in this subbasin tend to dry up or are reduced to a series of small pools during low flow periods.

Figure 3. **A Carolina Slate Belt stream, Barnes Creek at SR 1303, Montgomery County.**

Streams in the Sandhills (Subbasin 16) are clear, but the waters are lightly to darkly stained by tannins and humic acids (Figure 4). In contrast to the mountain and piedmont streams, streams in the Sandhills have a naturally sandy and gravelly substrate.

Figure 4. **A Sandhills stream, Rocky Fork Creek at SR 1424, Richmond County.**

In contrast, streams with low to poor quality instream and riparian habitats (habitat scores < 65) are found in Subbasins 02 (in part), 04, 06, 07, 11 (in part), 12, and 17 (Appendix 3). In these subbasins, the streams have a predominantly sandy substrate. Under normal hydrological conditions, and even more so during a drought, flow is reduced to small meanders within a very sandy channel. These substrates are typically very unstable and the water becomes extremely turbid during high flow conditions. Severe bank erosion contributes large woody debris to the systems. However, due to the extremely sandy substrates, permanent instream habitat is generally reduced. Other characteristics of these streams are:

- the channel and stream bottom is filled with shifting sand and bar development is evident (Figure 5);
- during low flow periods, the sandy substrate is covered with heavy periphytic growths (Figure 6);
- there are a lack of cobble riffles, if riffles are present, they are usually caused by embedded, coarse woody debris in the current;
- the streams are deeply entrenched with easily erodible and unstable banks (Figure 7); and
- the riparian zones are narrow. In the future as the few remaining trees fall into the stream, the canopy will become more open and stream temperatures will increase.

Figure 5. **Shifting sand and bar development, Salem Creek at SR 2902, Forsyth County.**

Figure 6. **Periphyton in Dutch Buffalo Creek at SR 2622, Cabarrus County.**

Figure 7. **Bank erosion and lack of riparian zone (North Little Hunting Creek, SR 1829, Iredell County).**

One hundred thirty-one fish community samples with associated habitat evaluations have been collected throughout the basin, primarily since 1996. This data set showed that as instream and riparian habitat deteriorated, so did the fish community ratings (Figure 8). Median habitat scores for Excellent and Good sites were 82 and 72, respectively. Good-Fair, Fair, and Poor sites had median habitat scores between 50 and 58.

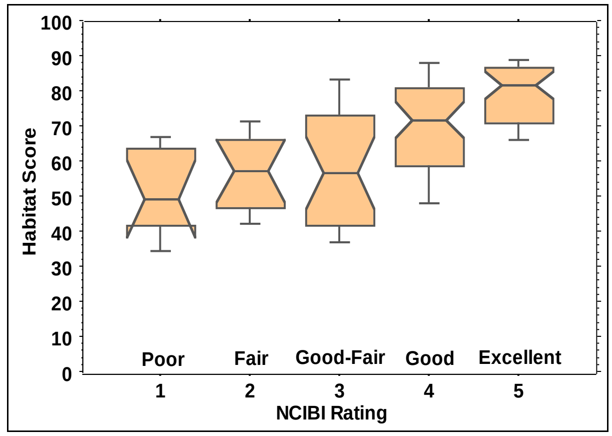


Figure 8. **Relationships between habitat scores and NCIBI ratings in the Yadkin River basin, 1996 - 2001.**

In 2001, with a few exceptions, fish communities rated Excellent were found in streams with moderate to high quality habitats (Table 1 and Appendices 3 and 4). Conversely, communities rated Good-Fair, Fair, or Poor were found in low to poor quality habitats.

Table 4. **NCIBI ratings and habitat quality in the Yadkin River basin, 2001.**

NCIBI Rating	Waterbodies with Moderate to High Quality Habitat (Score ≥ 65)	Waterbodies with Low to Poor Quality Habitat (Score < 65)
Excellent	N Pr Lewis, N Fk Reddies, M Pr Roaring, Fisher, L Yadkin, Stewarts, Toms, Barnes, Clarks, Mallard, Island, Dumas, Rocky	Hunting, S FK Jones
Good	S Pr Lewis, L Fisher, Cabin, Betty McGees, Big Bear, Salem (Union Co.), W Fk Little	Yadkin, Beaver, S Deep, Cedar (Davie Co.), N L Hunting, Brown, Irish Buffalo, Dutch Buffalo, Cartledge, Bailey
Good-Fair	Lick, Mountain, Richardson	N Deep, S Fk Muddy, Grants, Dutchmans, S Yadkin, N Second, Abbotts, Cedar (Anson Co.), Reedy, Coldwater
Fair	Lanes	Muddy, Silas, Salem, Hamer
Poor		Fourth, Third, Rich Fork

The streams rated Good or Good-Fair but with low to poor quality habitats had generally sand and gravel substrates and unstable banks. Good-Fair communities with moderate to high quality habitats may indicate that these sites could support a better fish community but water quality impacts (cattle access at Mountain Creek, a discharge at Lick Creek, or an unknown cause at Richardson Creek) are preventing them.

The two Excellent fish communities at sites where the habitat was of low to poor quality are existing perhaps because the overall water quality is still good. Hunting Creek is a "least impacted" stream in the upper basin with low conductivity. South Fork Jones Creek may also be a "least impacted" stream in the extreme lower basin. Its conductivity was relatively low, also.

Lanes Creek is rated Fair, but has a moderate quality habitat (score = 66). The fish community in this Carolina Slate Belt stream may be impacted more by lack of flow and periodic low dissolved oxygen concentrations than by habitat.

Appendix 3. Habitat evaluation at 57 fish community sites in the Yadkin River basin, 2001.

Subbasin/ Ecoregion	Stream	Location	County	Width (m)	Channel	Instream Habitat	Substrate	Pools	Riffles	Bank Stability-L	Bank Stability-R	Shade	Riparian Zone-L	Riparian Zone-R	Total Score
03-07-01															
MT	Yadkin R	NC 268	Caldwell	10	5	11	10	6	4	6	5	7	3	2	59
P	Beaver Cr	SR 1131	Wilkes	7	4	11	4	6	3	2	2	10	2	5	49
MT	N Pr Lewis Fk	SR 1304	Wilkes	10	4	15	8	6	7	6	6	10	3	5	70
MT	S Pr Lewis Fk	SR 1154	Wilkes	11	4	14	7	6	12	6	6	7	4	5	71
MT	N Fk Reddies R	SR 1567	Wilkes	6	4	20	12	6	14	7	7	9	3	5	87
P	Cub Cr	SR 1001	Wilkes	4	5	11	3	6	3	2	2	7	2	2	43
MT	M Pr Roaring R	SR 1002	Wilkes	12	4	18	10	6	14	6	7	9	4	5	83
03-07-02															
P	Fisher R	SR 1331	Surry	11	4	16	12	7	7	5	5	7	3	3	69
P	L Fisher R	SR 1480	Surry	8	4	16	11	7	7	5	5	7	2	2	66
P	L Yadkin R	SR 1236	Stokes	10	4	15	9	6	6	6	6	7	4	5	68
P	N Deep Cr	SR 1605	Yadkin	7	5	7	2	6	1	3	2	6	4	2	38
P	S Deep Cr	SR 1152	Yadkin	7	4	11	3	6	0	6	5	10	4	1	50
03-07-03															
P	Stewarts Cr	SR 1622	Surry	8	4	19	12	8	9	6	6	10	4	5	83
P	Toms Cr	SR 2024	Surry	10	4	16	11	7	7	6	6	8	3	5	73
03-07-04															
P	Muddy Cr	SR 1891	Forsyth	9	4	12	3	9	3	2	2	7	1	1	44
P	Silas Cr	SR 1137	Forsyth	7	3	7	3	6	3	2	2	10	2	2	40
P	Salem Cr	off SR 1120	Forsyth	10	3	6	3	6	0	2	2	4	2	2	30
P	S Fk Muddy Cr	SR 2902	Forsyth	8	3	11	3	6	0	2	2	10	1	1	39
P	Grants Cr	SR 2200	Rowan	12	4	14	5	6	5	2	3	10	2	3	54
03-07-05															
P	Dutchmans Cr	US 158	Davie	8	4	11	3	4	3	2	2	10	2	3	44
P	Cedar Cr	SR 1437	Davie	6	4	16	6	8	7	3	3	7	1	5	60
03-07-06															
P	S Yadkin R	SR 1561	Iredell	9	4	7	3	6	3	2	2	7	3	3	40
P	Hunting Cr	NC 115	Wilkes	10	4	14	5	6	3	3	3	7	2	2	49
P	N Little Hunting Cr	SR 1829	Iredell	10	4	7	3	6	3	0	2	4	0	3	32
P	Fourth Cr	SR 1985	Rowan	11	4	13	3	4	0	2	2	10	2	3	43
P	Third Cr	SR 1970	Rowan	11	4	9	3	4	3	2	2	9	3	3	42
P	N Second Cr	SR 1526	Rowan	11	2	6	3	2	0	0	2	7	0	0	22
03-07-07															
P	Abbotts Cr	SR 1800	Davidson	7	4	11	3	6	3	2	0	7	3	3	42
P	Rich Fork Cr	NC 109	Davidson	7	4	11	3	4	0	2	2	7	3	3	39
03-07-08															
P	Lick Cr	NC 8	Davidson	12	4	20	8	4	7	3	3	10	3	5	67
P	Cabin Cr	SR 2536	Davidson	8	4	20	12	8	3	3	3	9	5	5	72
P	Mountain Cr	SR 1720	Stanly	8	4	18	12	10	14	3	3	10	5	5	84
03-07-09															
P	Betty McGees Cr	SR 1107	Randolph	8	5	16	12	10	12	3	3	10	5	5	81
P	Barnes Cr	SR 1303	Montgomery	10	5	20	15	10	16	2	2	10	5	4	89

Appendix 3 (continued).

Subbasin/ Ecoregion	Stream	Location	County	Width (m)	Channel	Instream Habitat	Substrate	Pools	Riffles	Bank Stability-L	Bank Stability-R	Shade	Riparian Zone-L	Riparian Zone-R	Total Score
03-07-10															
P	Clarks Cr	SR 1188	Montgomery	10	4	14	14	7	11	6	5	7	5	5	78
P	Brown Cr	SR 1230	Anson	6	4	11	5	6	3	2	2	7	4	4	48
P	Cedar Cr	SR 1709	Anson	6	5	12	5	6	7	4	4	10	4	4	61
03-07-11															
P	Mallard Cr	SR 2467	Mecklenburg	8	4	18	10	4	14	5	5	4	1	5	70
P	Reedy Cr	SR 1136	Cabarrus	8	4	6	3	6	0	0	0	10	1	3	33
03-07-12															
P	Irish Buffalo Cr	SR 1132	Cabarrus	10	4	11	6	4	7	3	3	7	3	3	51
P	Coldwater Cr	NC 73	Cabarrus	6	4	7	3	4	0	3	3	9	4	5	42
P	Dutch Buffalo Cr	SR 2622	Cabarrus	15	4	7	3	4	0	3	3	7	5	5	41
03-07-13															
P	Big Bear Cr	NC 73	Stanly	7	4	16	12	8	10	5	5	7	5	3	75
03-07-14															
P	Island Cr	SR 1118	Stanly	8	4	12	13	6	14	3	6	10	5	5	78
P	Richardson Cr	NC 207	Union	9	4	16	10	7	5	3	3	10	5	5	68
P	Salem Cr	SR 1006	Union	10	4	16	12	6	12	5	3	10	5	5	78
P	Lanes Cr	SR 1929	Union	9	4	16	12	4	5	2	3	10	5	5	66
03-07-15															
P	W Fk Little R	SR 1311	Montgomery	11	4	18	12	6	14	7	7	10	5	5	88
P	Dumas Cr	SR 1310	Montgomery	8	5	20	12	6	12	6	6	7	5	5	84
P	Rocky Cr	SR 1549	Montgomery	8	4	16	12	10	7	5	5	7	5	3	74
P	Hamer Creek	SR 1159	Richmond	8	5	15	3	6	0	6	6	10	5	5	61
03-07-16															
P	Cartledge Cr	SR 1142	Richmond	9	5	11	4	6	7	4	4	10	5	5	61
SH	Hitchcock Cr	SR 1486	Richmond	6	15	15	13	6		9	9	10	5	5	87
SH	Rocky Fork Cr	SR 1424	Richmond	8	15	15	14	6		10	10	10	5	5	90
SH	Marks Cr	SR 1104	Richmond	6	15	15	6	6		10	10	10	5	5	82
03-07-17															
P	Bailey Cr	SR 1811	Anson	5	5	11	3	4	5	2	3	7	1	2	43
P	S Fk Jones Cr	SR 1821	Anson	8	4	11	3	6	3	3	2	10	4	4	50
	Maximum possible scores - Mountains and Piedmont				**5**	**20**	**15**	**10**	**16**	**7**	**7**	**10**	**5**	**5**	**100**
	Maximum possible scores - Sandhills				**15**	**20**	**15**	**10**	**---**	**10**	**10**	**10**	**5**	**5**	**100**

Appendix 4. Habitat evaluation at 54 fish community sites in the Yadkin River basin, 1996. Note: the metrics and the scores were changed between 1996 and 2001.

Subbasin/ Ecoregion	Stream	Location	County	Width (m)	Channel	Instream Habitat	Substrate	Pools	Riffles	Bank Stability	Bank Vegetation Left	Bank Vegetation Right	Shade	Riparian Zone Left	Riparian Zone Right	Total Score
03-07-01																
MT	Yadkin R	NC 268	Caldwell	12	7	16	3	6	5	6	4	4	8	3	3	65
MT	Laurel Cr	SR 1508	Watauga	8	8	12	8	10	10	9	5	4	9	5	4	87
P	Beaver Cr	SR 1131	Wilkes	7	8	6	3	6	3	4	3	4	6	3	4	50
MT	N Pr Lewis Fk	SR 1304	Wilkes	12	7	16	5	6	8	9	4	4	9	4	4	76
MT	S Pr Lewis Fk	SR 1154	Wilkes	12	10	18	7	10	9	9	5	5	9	5	5	92
MT	N Fk Reddies R	SR 1501	Wilkes	8	8	16	8	6	9	9	4	4	8	5	2	79
MT	M Pr Roaring R	SR 1002	Wilkes	12	8	14	6	8	10	6	3	3	4	4	5	71
MT	Basin Cr	SR 1730	Wilkes	8	8	16	8	10	10	6	5	5	9	5	4	86
MT	Garden Cr	SR 1739	Wilkes	4	10	16	10	10	10	10	5	5	10	5	5	96
03-07-02																
P	Mitchell R	SR 1330	Surry	15	8	14	10	8	8	10	5	5	9	3	5	85
P	L Fisher R	SR 1480	Surry	12	8	18	4	10	6	4	3	3	6	2	3	67
P	Cody Cr	US 268	Surry	8	8	13	3	4	8	6	4	4	9	3	3	65
P	L Yadkin R	SR 1236	Stokes	12	9	20	8	10	8	4	4	4	6	3	2	78
P	N Deep Cr	SR 1605	Yadkin	8	10	12	3	5	0	4	3	2	6	2	3	50
P	S Deep Cr	SR 1152	Yadkin	12	10	14	3	10	0	6	4	4	9	1	1	59
03-07-03																
P	Stewarts Cr	SR 1622	Surry	8		16	8	10	10	6	5	5	9	3	5	85
03-07-04																
P	Muddy Cr	SR 1891	Forsyth	12	8	12	3	8	3	4	3	4	9	1	3	58
P	Town Cr	SR 1526	Rowan	5	8	14	6	6	5	6	3	3	9	4	3	67
03-07-05																
P	Dutchmans Cr	US 158	Davie	11	9	12	3	10	5	4	3	2	6	3	3	60
P	Cedar Cr	SR 1437	Davie	7	8	14	4	10	8	6	4	5	9	2	5	75
03-07-06																
P	S Yadkin R	SR 1561	Iredell	12	8	12	3	0	1	2	2	2	5	4	4	43
P	Olin Cr	SR 1892	Iredell	4	8	10	3	6	6	2	4	3	8	1	0	51
P	Hunting Cr	NC 115	Wilkes	15	10	17	5	10	3	4	3	3	9	2	2	68
P	N Little Hunting Cr	SR 1829	Iredell	12	10	13	3	5	0	2	2	2	9	0	0	46
P	Fourth Cr	SR 1985	Rowan	12	8	16	3	6	0	6	4	4	9	4	4	64
P	Third Cr	SR 1970	Rowan	12	8	12	3	8	0	4	2	3	9	3	3	55
P	N Second Cr	SR 1526	Rowan	12	4	14	3	6	3	4	3	3	6	2	2	50
03-07-07																
P	Abbotts Cr	SR 1800	Davidson	7	8	16	3	8	6	4	3	3	6	3	3	63
P	Rich Fork Cr	NC 109	Davidson	10	10	16	3	6	6	4	3	3	9	3	3	66
03-07-08																
P	Lick Cr	NC 8	Davidson	12	10	16	8	6	8	9	5	5	9	3	4	83
P	Cabin Cr	SR 2536	Davidson	10	8	17	6	8	7	6	3	2	9	4	4	74
P	Mountain Cr	SR 1720	Stanly	12	9	16	10	10	8	9	5	5	8	5	3	88
03-07-09																
P	Uwharrie R	SR 1406	Randolph	12	8	14	4	7	6	6	4	4	9	5	3	70
P	Betty McGees Cr	SR 1107	Randolph	10	8	12	8	10	5	6	3	3	8	4	5	72

Appendix 4 (continued).

Subbasin/ Ecoregion	Stream	Location	County	Width (m)	Channel	Instream Habitat	Substrate	Pools	Riffles	Bank Stability	Bank Vegetation Left	Bank Vegetation Right	Shade	Riparian Zone Left	Riparian Zone Right	Total Score
P	Barnes Cr	SR 1303	Montgomery	11	9	12	10	10	8	10	5	5	8	3	5	85
P	Dutchmans Cr	SR 1150	Montgomery	4	10	16	10	6	10	9	5	5	10	5	5	91
03-07-10																
P	Mountain Cr	SR 1150	Montgomery	12	10	18	8	6	6	6	4	4	9	1	4	76
P	Brown Cr	SR 1230	Anson	6	8	14	4	7	5	4	2	2	8	1	4	59
P	Cedar Cr	SR 1709	Anson	3	10	16	6	9	7	6	3	3	10	5	5	80
03-07-11																
P	Mallard Cr	SR 2467	Mecklenburg	10	10	12	8	10	10	6	4	4	9	2	1	76
P	Rocky R	SR 1608	Cabarrus	7	8	6	3	4	0	4	3	3	9	5	4	49
03-07-12																
P	Irish Buffalo Cr	SR 1132	Cabarrus	10	8	12	8	9	8	9	5	5	6	1	1	72
P	Coldwater Cr	NC 73	Cabarrus	8	8	12	3	44	0	4	3	3	6	2	5	50
P	Dutch Buffalo Cr	SR 2622	Cabarrus	15	8	10	3	10	5	2	2	2	8	5	2	57
03-07-13																
P	Big Bear Cr	NC 73	Stanly	10	9	12	8	9	8	9	4	4	6	5	3	77
03-07-14																
P	Salem Cr	SR 1006	Union	10	8	15	7	10	5	7	4	4	9	4	4	77
P	Lanes Cr	SR 1415	Anson	15	8	12	3	4	5	9	5	4	9	5	5	69
03-07-15																
P	W Fk Little R	SR 1311	Montgomery	12	10	17	10	8	8	10	5	5	10	5	5	93
P	Bridgers Cr	SR 1519	Montgomery	5	9	16	10	9	8	9	5	5	9	4	4	88
P	Rocky Cr	NC 24/27	Montgomery	5	10	16	10	6	10	9	4	4	10	5	5	89
P	Cheek Cr	SR 1541	Montgomery	9	8	14	4	7	10	4	2	2	9	1	4	66
03-07-16																
SH	Beaverdam Cr	SR 1486	Richmond	1.5	10	20	6	9	6	10	5	5	10	5	5	91
03-07-17																
P	Bailey Cr	SR 1811	Anson	4.5	8	14	4	4	5	8	4	4	8	2	1	62
P	Jones Cr	SR 1812	Anson	15	8	12	3	4	2	10	5	5	9	5	5	68
	Maximum possible scores - Mountains, Piedmont, and Sandhills				**10**	**20**	**10**	**10**	**10**	**10**	**5**	**5**	**10**	**5**	**5**	**100**

Appendix 5. Habitat evaluation at 85 benthic macroinvertebrate sites in the Yadkin River basin, 1996 - 2001.[1]

Subbasin/ Stream/Location	County	Channel 1996	Channel 2001	I-Habitat 1996	I-Habitat 2001	Substrate 1996	Substrate 2001	Pool 1996	Pool 2001	Riffle 1996	Riffle 2001	B-S 1996	B-V 1996	B-S & V 2001	SH 1996	SH 2001	Rip 1996	Rip 2001	Score 1996	Score 2001
03-07-01																				
Buffalo Cr - SR 1505	Caldwell	8	4	10	8	3	12	10	9	10	13	10	10	14	2	5	3	7	66	72
Elk Cr - SR 1175	Wilkes	8	4	14	12	8	12	10	4	9	14	14	10	12	2	7	8	6	83	71
Moravian Cr - NC 18/268	Wilkes	7	3	10	8	4	6	6	2	5	10	6	6	14	2	5	6	5	52	53
Mulberry Cr - NC 268	Wilkes	8	4	16	12	8	9	3	3	5	14	10	9	10	3	2	4	8	66	62
N. Pr Lewis Fk - SR 1304	Wilkes	10	4	14	12	7	13	10	10	10	14	12	8	14	10	8	6	7	87	82
Roaring R - SR 1990	Wilkes	8	4	16	15	6	11	7	3	6	14	10	10	12	6	7	10	10	79	76
Stony Fk - Cr - SR 1135	Wilkes	8	4	14	12	5	11	10	8	8	10	14	8	14	7	7	8	8	82	74
Yadkin R - NC 18/268	Wilkes	8	4	16	14	4	7	10	0	6	14	12	8	10	2	4	2	5	68	58
03-07-02																				
Elkin Cr - NC 268	Surry	8	5	10	10	3	4	4	4	7	12	6	4	12	10	10	4	4	56	57
Fisher R - NC 268	Surry	10	5	16	16	6	8	8	6	8	16	14	10	14	4	2	7	9	83	76
Fisher R - US 601	Surry	7	5	16	14	6	5	4	4	5	7	6	6	14	5	7	6	9	61	65
Forbush Cr - SR 1570	Yadkin	10	5	14	16	5	8	6	6	8	14	3	4	6	10	10	9	10	69	75
L Fisher R - SR 1480	Surry	9	5	14	19	4	11	4	4	9	16	6	6	14	5	10	4	6	61	85
Logan Cr - SR 1571	Yadkin	9	5	8	16	4	3	4	6	4	3	3	4	10	10	10	3	10	49	63
Mitchell R - SR 1330	Surry	10	5	16	15	8	6	8	4	7	14	14	8	12	7	10	6	6	84	72
N Deep Cr - SR 1510	Yadkin	9	5	16	20	6	12	10	6	8	16	14	10	14	10	10	8	10	91	93
S Deep Cr - SR 1710	Yadkin	10	5	8	20	3	8	4	10	2	10	6	6	6	8	10	8	8	55	77
Snow Cr - SR 1121	Surry	10	5	16	16	6	6	10	4	8	14	4	6	14	10	10	6	10	76	78
Yadkin R - US 21	Yadkin	8	5	10	14	2	6	4	4	2	7	6	6	12	2	2	7	8	47	58
Yadkin R - SR 1003	Surry	8	4	14	12	3	12	4	10	5	7	4	4	6	2	2	6	6	50	59
03-07-03																				
Ararat R - NC 104	Surry	9	4	16	14	8	11	4	4	8	14	10	10	14	8	7	4	6	77	74
Ararat R - SR 2026	Surry	8	4	10	15	6	12	6	4	8	14	6	8	12	2	6	8	8	62	75
Flat Shoals Cr - SR 1827	Surry	10	4	15	11	9	12	10	8	10	16	6	8	12	10	8	4	9	82	80
Lovills Cr - SR 1371	Surry	1	3	6	9	6	3	3	3	3	10	14	6	4	0	0	3	2	42	34
Lovills Cr - SR 1700	Surry	8	4	14	14	8	11	2	5	8	14	8	8	10	2	2	2	2	60	62
Stewart's Cr - NC 89	Surry	10	4	10	12	6	7	10	4	5	4	6	6	8	7	6	4	6	64	51
Stewart's Cr - SR 2258	Surry	8	4	12	13	4	9	10	4	3	16	7	7	8	2	3	6	3	59	60
03-07-04																				
Grants Cr - SR 1910	Rowan	10	4	10	7	3	3	6	2	2	0	4	4	5	7	10	0	5	46	36
Muddy Cr - SR 1898	Forsyth	10	5	14	13	5	11	10	4	10	14	6	6	11	7	10	2	6	70	74
Muddy Cr - SR 2995	Forsyth	10	4	14	12	6	8	4	8	2	7	4	4	6	4	10	6	7	54	62
S Fk Muddy Cr - SR 2902	Forsyth	8	4	10	8	3	3	4	4	2	0	4	4	5	7	10	4	8	46	42
Salem Cr - SR 2657	Forsyth	10	5	3	7	3	3	4	0	3	0	6	8	12	7	8	10	9	54	44
Salem Cr - SR 2902	Forsyth	1	4	10	8	6	3	4	4	3	3	4	6	5	5	7	6	5	45	39
Salem Cr - SR 2991	Forsyth	1	4	6	12	3	5	0	4	1	3	4	4	5	5	7	1	5	25	45
03-07-05																				
Dutchmans Cr - NC 158	Davie	10	5	6	12	3	3	6	4	0	3	2	4	6	7	10	1	6	39	49
Dutchmans Cr - NC 801	Davie	2	5	6	10	3	3	2	4	0	0	3	6	6	7	10	6	10	35	48
03-07-06																				
Fourth Cr - SR 1003	Rowan	8	5	8	20	6	8	8	4	5	14	6	8	12	10	10	8	10	67	83
Hunting Cr - SR 2115	Iredell	8	5	6	10	3	5	0	4	3	3	4	6	12	7	7	8	6	45	52
Patterson Cr - SR 1890	Rowan	1	5	6	20	3	12	4	4	3	13	4	6	14	7	10	5	10	39	88
Rocky Cr - SR 1884	Iredell	8	5	10	15	4	5	3	4	3	3	10	10	12	7	10	9	10	64	64
S Yadkin R - SR 1159	Davie	8	5	16	16	8	8	0	8	8	7	6	6	6	7	2	7	6	66	58
S Yadkin R - SR 1561	Iredell	10	5	10	11	3	3	4	6	3	3	6	6	4	10	10	6	10	58	52
Third Cr - SR 1970	Rowan	8	5	10	11	3	3	4	4	0	0	6	8	6	10	10	9	10	58	49

Appendix 5 (continued).

Subbasin/ Stream/Location	County	Channel 1996	Channel 2001	I-Habitat 1996	I-Habitat 2001	Substrate 1996	Substrate 2001	Pool 1996	Pool 2001	Riffle 1996	Riffle 2001	B-S 1996	B-V 1996	B-S & V 2001	SH 1996	SH 2001	Rip 1996	Rip 2001	Score 1996	Score 2001
03-07-07																				
Withrow Cr - SR 1547	Rowan	8	5	3	9	3	3	0	0	3	0	10	8	6	10	10	7	10	52	43
Abbotts Cr - SR 1243	Davidson	10	4	10	16	6	8	8	8	8	12	10	8	5	10	5	8	6	78	64
Abbotts Cr - SR 1755	Davidson	10	5	10	17	6	5	6	4	5	7	6	8	12	7	10	6	6	64	66
Brushy Fk - SR 1810	Davidson	10	5	6	7	3	3	0	0	3	0	10	8	12	10	10	10	10	60	47
Hamby Cr - SR 2017	Davidson	10	5	10	16	8	8	8	8	8	16	10	8	10	10	10	10	8	82	81
Leonards Cr - Farm Rd	Davidson	10	5	15	11	8	3	6	0	5	0	6	8	10	10	10	6	6	74	45
N Second Cr - SR 1526	Rowan	8	3	10	7	3	3	0	0	3	0	4	6	4	10	10	8	10	52	37
N Second Cr - US 70	Rowan	8	3	6	11	3	3	0	4	5	3	6	8	10	10	10	8	4	54	48
Swearing Cr - NC 47	Davidson	9	5	15	11	3	3	10	4	5	0	10	10	6	10	10	10	10	82	49
03-07-08																				
Mountain Cr - SR 1720	Stanly	8	5	8	18	10	15	10	8	10	10	14	11	10	5	10	6	1	81	78
03-07-09																				
Barnes Cr - SR 1303	Montgomery	8	4	12	18	10	12	10	6	7	12	14	14	10	7	7	9	10	87	83
Caraway Cr - SR 1330	Randolph	8	5	8	12	6	8	10	4	3	3	6	6	6	10	10	7	6	64	54
Dutchmans Cr - SR 1150	Montgomery	10	5	14	17	10	15	10	10	10	16	12	12	10	10	10	10	10	96	95
L Uwharrie R - SR 1405	Randolph	8	4	3	16	6	10	8	8	5	7	8	11	9	7	7	6	7	60	70
Uwharrie R - SR 1406	Randolph	8	5	3	7	6	3	4	8	5	3	2	7	7	10	10	7	7	49	50
Uwharrie R - SR 1143	Randolph	8	5	10	16	8	12	8	8	5	7	10	10	8	2	7	7	6	66	71
Uwharrie R - NC 109	Montgomery	10	5	14	18	6	12	4	6	5	7	14	12	10	5	5	10	8	78	73
03-07-10																				
Clarks Cr - SR 1103	Montgomery	10	5	10	15	10	15	8	10	10	16	14	12	10	7	10	6	10	85	93
Mountain Cr - SR1150	Richmond	8	5	15	19	6	15	8	6	8	7	10	10	12	7	7	5	8	77	79
03-07-11																				
Coddle Cr - NC 49	Cabarrus	9	5	10	12	3	3	4	6	2	3	6	8	10	10	10	9	7	61	56
Rocky R - SR 2420	Mecklenburg	10	5	6	11	3	3	0	0	3	0	6	8	4	10	10	6	10	52	43
03-07-12																				
Coldwater Cr - NC 49	Cabarrus	8	5	10	11	3	3	0	4	2	0	6	8	6	10	10	10	9	57	48
Crooked Cr - SR 1547	Union	10	5	14	20	8	12	9	4	10	14	10	8	12	10	10	10	10	89	87
Dutch Buffalo Cr - NC 200	Cabarrus	10	5	5	11	3	3	0	4	3	0	5	6	4	10	10	2	5	44	42
Goose Cr - NC 601	Union	10	5	14	16	8	12	10	6	10	16	6	8	4	10	10	10	10	86	79
Irish Buffalo Cr - SR 1132	Cabarrus	10	5	16	16	8	8	10	4	6	14	10	8	12	10	10	6	6	84	75
Rocky R - NC 601	Cabarrus	8	5	10	10	6	6	6	6	5	12	10	8	14	4	10	9	10	66	73
03-07-13																				
Big Bear Cr - SR 1225	Stanley	10	5	10	16	10	12	10	0	6	16	12	9	14	10	8	9	10	86	81
Long Cr - SR 1917	Stanley	8	5	16	20	8	12	10	10	7	14	14	8	6	10	10	10	8	91	85
03-07-14																				
Rocky R - SR 1943	Stanley	8	5	16	16	8	10	4	6	7	14	10	8	10	2	10	10	10	73	81
Stoney Run Cr - SR 1970	Stanley	8	5	10	16	3	8	10	4	6	16	12	10	14	10	10	8	10	77	83
Richardson Cr - SR 1600	Anson	8	5	10	19	6	12	4	4	7	16	14	8	12	7	7	10	10	74	85
Richardson Cr - SR 1649	Union	8	5	12	15	10	12	10	10	10	14	14	10	10	10	7	10	10	94	83
03-07-15																				
Cheek Cr - SR1541	Montgomery	8	5	14	15	2	8	8	10	5	7	2	4	10	10	10	6	10	59	75
Little R - NC 731	Montgomery	10	4	16	12	2	10	8	4	8	7	6	8	14	6	10	9	10	73	71
Little R - SR1340	Montgomery	10	4	16	13	7	12	8	4	5	7	10	10	14	5	7	9	10	80	71
W Fk Little R - SR1311	Montgomery	10	5	14	15	8	15	10	10	10	16	12	10	14	10	10	8	10	92	95
03-07-16																				
Beaverdam Cr - SR1486	Richmond	10	5	16	16	5	3	4	6	5	7	14	10	12	8	10	10	10	82	69
Hitchcock Cr - SR1109	Richmond	10	5	11	11	3	3	10	4	3	3	10	10	12	10	10	10	10	77	58
Hitchcock Cr - SR1486	Richmond	10	5	16	16	5	11	4	6	5	7	14	10	12	9	10	8	10	81	77

Appendix 5 (continued).

Subbasin/ Stream/Location	County	Channel 1996	Channel 2001	I-Habitat 1996	I-Habitat 2001	Substrate 1996	Substrate 2001	Pool 1996	Pool 2001	Riffle 1996	Riffle 2001	B-S 1996	B-V 1996	B-S & V 2001	SH 1996	SH 2001	Rip 1996	Rip 2001	Score 1996	Score 2001
03-07-17																				
Jones Cr - NC 145	Anson	8	4	16	12	8	9	8	4	7	7	10	8	12	7	7	8	10	80	65
N Fk Jones Cr - SR1121	Anson	10	4	8	16	4	3	10	6	3	3	10	8	10	10	10	6	8	69	60

[1]Abbreviations are: I-Habitat = instream habitat, B-S = bank stability, B-V = bank vegetation, B-S & V = bank stability and vegetation, SH = shading, Rip = riparian.

Appendix 6. 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 (NCDENR 2001a). 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 1 and 2). 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 1. Benthos classification criteria for flowing water systems in the mountain ecoregion.

Metric	Sample type	Bioclass	Score
EPT S	10-sample Qualitative	Excellent	> 41
		Good	32 - 41
		Good-Fair	22 - 31
		Fair	12 - 21
		Poor	0 - 11
	4-sample EPT	Excellent	> 35
		Good	28 - 35
		Good-Fair	19 - 27
		Fair	11 - 18
		Poor	0 - 10
Biotic Index (range 0 – 10)	10-sample Qualitative	Excellent	< 4.05
		Good	4.06 - 4.88
		Good-Fair	4.89 - 5.74
		Fair	5.75 - 7.00
		Poor	> 7.00

Table 2. 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

For standard qualitative samples, EPT taxa richness (EPT S) is used with 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).

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.

EPT taxa richness and biotic index values also can be affected by seasonal changes. DWQ 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.

Small Streams

Benthic studies in unimpacted mountain ecoregion watersheds have shown naturally reduced EPT taxa richness in small streams (less than 4 meters width), but similar studies have not been done in piedmont small streams or small streams that have disturbance in the watershed. For this reason, samples taken from sites with a width less than 4 meters are currently being listed as Not Impaired for use support evaluations, if the bioclassification would be Good-Fair or better using standard EPT criteria. Because such ratings are minimum ratings (no stream size correction factor has yet been developed), small stream sites that would be at least Poor or Fair, are listed as Not Rated to reflect the possibility that such sites might have higher ratings if a size correction was used. In Appendix 7, this Not Impaired or Not Rated terminology is applied to data that will be used for use support (collected since September 1996), and has not been retrofitted to all of the older data from small streams.

Appendix 7. Benthic macroinvertebrate data, Yadkin River basin, 1983 - 2001. Current basinwide sites are in bold font.

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
03-07-01									
Yadkin R	US 321	Caldwell	12-(1)	9/19/88	95	35	4.49	3.66	Good
Yadkin R	NC 268	Caldwell	12-(1)	8/30/01	69	24	5.52	4.68	Good-Fair
				7/22/96	102	41	4.55	3.75	Good
				7/10/90	87	38	4.89	3.91	Good
				8/4/87	87	37	5.23	4.39	Good
				8/6/85	76	24	6.03	4.27	Good-Fair
Yadkin R	SR 1372	Caldwell	12-(1)	7/27/01	---	34	---	3.49	Good
				9/19/88	---	26	---	3.11	Good-Fair
Dennis Cr	SR 1372	Caldwell	12-7	7/22/96	---	32	---	2.71	Good
				9/19/88	---	21	---	2.99	Good-Fair
Jackson Camp Cr	SR 1372	Caldwell	12-10	9/19/88	---	23	---	3.14	Good-Fair
Preston Cr	US 321	Caldwell	12-12	9/19/88	---	29	---	3.45	Good
Buffalo Cr	be Buffalo Cove	Caldwell	12-19	9/29/88	---	31	---	3.25	Good
Buffalo Cr	SR 1504	Caldwell	12-19	8/30/01	---	43	---	3.87	Excellent
				7/22/96	---	40	---	3.65	Excellent
				9/20/88	83	32	4.63	3.46	Good
Old Field Br	SR 1502	Caldwell	12-19-9	9/20/88	---	26	---	3.24	Good-Fair
Joes Br	SR 1574	Caldwell	12-19-11	9/20/88	---	30	---	3.47	Good
Elk Cr	SR 1508	Wilkes	12-24-(1)	12/15/87	71	38	2.90	2.31	Good
				12/14/87	101	49	3.60	2.52	Excellent
Laurel Cr	SR 1508	Wilkes	12-24-8	12/14/87	---	45	---	2.20	Excellent
Elk Cr	SR 1175	Wilkes	12-24-(10)	8/29/01	100	43	4.60	3.66	Good
				7/22/96	85	42	4.68	3.90	Good
				7/29/88	96	47	4.52	3.51	Excellent
				12/14/87	100	49	3.51	2.21	Excellent
				8/6/85	107	44	4.72	3.73	Good
Dugger Cr	SR 1162	Wilkes	12-24-11	12/14/87	---	38	---	2.56	Excellent
UT Stoney Fk Cr	SR 1505	Watauga	12-26-(1)	7/23/96	---	29	---	2.31	Good
Stoney Fk Cr	SR 1500	Watauga	12-26-(1)	7/23/96	---	31	---	2.31	Good
Stoney Fk Cr	SR 1135	Wilkes	12-26-(7)	7/26/01	---	45	---	3.64	Excellent
				7/22/96	---	38	---	3.45	Excellent
Little Fk	Headwaters	Wilkes	12-31-1-2	6/13/01	69	41	2.54	1.90	Not Impaired
N Pr Lewis Fk	SR 1304	Wilkes	12-31-1-(7.5)	7/25/01	---	35	---	3.57	Good
				7/23/96	---	33	---	3.25	Good
Purlear Cr	above falls	Wilkes	12-31-8-(1)	6/12/01	50	31	2.41	1.95	Not Impaired
Purlear Cr	Headwaters	Wilkes	12-31-8-(1)	6/12/01	59	35	2.61	2.11	Not Impaired
S Pr Lewis Fk	off US 421	Wilkes	12-31-2-(1)	7/23/96	---	32	---	2.51	Good
Yadkin R	NC 18/268	Wilkes	12-(38)	7/25/01	94	32	5.30	4.41	Good-Fair
				7/24/96	72	39	5.03	4.01	Good
				6/7/93	73	34	5.50	4.47	Good-Fair
				8/10/89	75	35	4.75	4.21	Good
				8/6/87	67	26	5.41	4.60	Good-Fair
				7/12/87	---	20	---	4.70	Good-Fair
				8/5/86	67	27	5.49	4.25	Good-Fair
				9/9/85	66	21	5.69	4.87	Good-Fair
				8/28/84	58	29	4.78	4.36	Good-Fair
Yadkin R	above ABT	Wilkes	12-(38)	6/7/93	90	40	5.12	3.98	Good
Yadkin R	be ABT	Wilkes	12-(38)	6/7/93	70	26	5.59	4.63	Good-Fair
Moravian Cr	NC 18	Wilkes	12-39	7/26/01	---	25	---	4.96	Good-Fair
				7/23/96	---	27	---	4.25	Good-Fair
Middle Fk Reddies R	SR 1559	Wilkes	12-40-2	7/26/01	---	42	---	3.98	Excellent
S Fk Reddies R	SR 1355	Wilkes	12-40-3	7/26/01	---	33	---	2.86	Good
N Fk Reddies R	SR 1567	Wilkes	12-40-4	7/26/01	---	34	---	3.57	Good
Mulberry Cr	NC 268	Wilkes	12-42	7/25/01	---	41	---	4.11	Excellent
				7/24/96	---	37	---	3.06	Excellent
UT Mulberry Cr	AB Gardner Mirror	Wilkes	12-42-9	9/12/90	39	17	4.65	3.40	Good-Fair
UT Mulberry Cr	Flint Hill Rd	Wilkes	12-42-9	7/25/01	50	13	5.84	4.60	Not Rated
				9/12/90	22	3	7.79	3.03	Poor
Roaring R	SR 1990	Wilkes	12-46	7/25/01	89	42	4.48	3.44	Good
				7/24/96	98	48	4.68	3.43	Excellent
				7/29/88	92	43	4.77	3.53	Good
				8/8/85	88	36	4.80	3.29	Good
				8/10/83	66	35	3.94	3.35	Good

Appendix 7 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
Pike Cr	SR 1728	Wilkes	12-46-1-2	10/25/89	---	32	---	2.28	Excellent
Basin Cr	SR 1730	Wilkes	12-46-2-2	10/24/89	---	36	---	2.61	Excellent
E Pr Roaring R	SR 1739	Wilkes	12-46-4-(7)	10/20/98	75	41	3.56	2.64	Good
				10/20/98	66	39	3.97	3.06	Good
E Pr Roaring R	off SR 1739	Wilkes	12-46-4-(7)	10/20/98	73	43	3.64	2.70	Good
E Pr Roaring R	SR 1002	Wilkes	12-46-4-(7)	10/24/89	---	28	---	2.80	Good
Bullhead Cr	SR 1739	Wilkes	12-46-4-2	10/24/89	---	36	---	2.38	Excellent
Rich Mt Cr	ab Bullhead Cr	Wilkes	12-46-4-2-2	10/24/89	---	41	---	2.07	Excellent
Widows Cr	SR 1739	Wilkes	12-46-4-4	10/23/89	---	34	---	2.24	Excellent
Garden Cr	SR 1739	Wilkes	12-46-4-6	10/23/89	---	30	---	2.56	Good
				8/17/89	---	30	---	2.06	Good
				12/06/88	---	33	---	2.19	Good
Big Sandy Cr	SR 1737	Wilkes	12-46-4-8-(2)	10/23/89	---	29	---	2.83	Good
L Sandy Cr	SR 1943	Wilkes	12-46-4-10	10/24/89	---	30	---	3.42	Good
03-07-02									
Yadkin R	US 21, Elkin	Yadkin	12-(53)	8/6/01	65	30	4.72	3.81	Good
				7/23/96	56	23	5.43	4.43	Good-Fair
				8/7/89	50	17	5.75	5.19	Fair
				7/21/87	58	24	5.38	4.42	Good-Fair
Yadkin R	SR 1003	Surry	12-(53)	8/7/01	65	30	4.54	3.83	Good
				7/23/96	62	30	5.40	4.62	Good-Fair
				8/27/84	45	19	5.32	4.64	Fair
Elkin Cr	NC 268	Surry	12-54-(4.5)	8/6/01	---	20	---	3.74	Good-Fair
				7/22/96	---	24	---	3.56	Good-Fair
Mitchell R	ab Sam's Br	Alleghany	12-62-(1)	7/24/90	---	24	---	1.49	Good
				8/16/89	---	28	---	1.56	Good
				12/5/88	---	29	---	1.42	Excellent
				9/1/88	---	31	---	1.40	Excellent
Sam's Br	on Reynolds estate	Alleghany	12-62-(1)	7/24/90	---	15	---	1.22	Good-Fair
				8/16/89	---	17	---	1.86	Good-Fair
				12/5/88	---	20	---	1.29	Good
				9/1/88	---	23	---	1.65	Good
Mitchell R	be Sam's Br	Alleghany	12-62-(1)	7/24/90	---	20	---	1.23	Good
				8/16/89	---	22	---	1.38	Good
				12/5/88	---	28	---	1.35	Good
				9/1/88	---	30	---	1.46	Excellent
UT Mitchell R	on Reynolds estate	Surry	12-62-(1)	6/12/90	---	39	---	1.85	Excellent
Mitchell R	SR 1330, near Devotion	Surry	12-62-(1)	2/7/91	---	41	---	1.98	Excellent
				10/25/89	---	34	---	2.66	Good
				8/16/89	---	32	---	2.75	Good
				12/5/88	---	39	---	2.22	Excellent
				8/31/88	---	33	---	2.79	Good
				6/30/87	91	41	3.55	2.77	Excellent
Mitchell R	SR 1330	Surry	12-62-(1)	8/6/01	90	40	4.22	3.09	Good
				7/23/96	79	38	4.02	3.32	Good
				6/30/87	73	32	4.59	3.59	Good
Roaring Gap Br	on Reynold's estate	Alleghany	12-62-(1)	9/1/88	---	32	---	1.63	Excellent
Stewart Fk	on Reynold's estate	Surry	12-62-2	7/24/90	---	34	---	2.02	Excellent
				8/16/89	---	30	---	1.75	Excellent
				12/5/88	---	30	---	1.75	Excellent
				8/31/88	---	26	---	1.96	Good
Mitchell R	SR 1315	Surry	12-62-(7)	6/30/87	88	38	4.23	3.65	Good
				9/23/86	94	31	4.94	3.57	Good-Fair
				3/21/85	100	43	4.44	2.68	Excellent
Mitchell R	SR 1001	Surry	12-62-(12.5)	8/6/01	94	45	4.29	3.16	Excellent
				7/27/96	82	43	4.54	3.72	Good
				7/1/87	78	31	4.79	3.66	Good
S Fk Mitchell R	off SR 1316 upst	Surry	12-62-13	11/12/98	63	27	4.65	3.97	Good-Fair
S Fk Mitchell R	off SR 1316 dwst	Surry	12-62-13	11/13/98	61	30	4.47	3.85	Good-Fair
S Fk Mitchell R	SR 1307	Surry	12-62-13	7/1/87	74	29	4.52	4.00	Good
S Fk Mitchell R	SR 1301	Surry	12-62-13	11/13/98	66	36	4.34	3.69	Good

Appendix 7 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
Snow Cr	SR 1121	Surry	12-62-15	8/6/01	---	24	---	3.96	Good-Fair
				7/23/96	---	31	---	3.67	Good
				7/1/87	67	27	5.11	4.33	Good-Fair
Endicott Cr	off SR 1421	Surry	12-63-5-(1)	2/6/91	95	52	3.14	2.13	Excellent
L Endicott Cr	off SR 1421	Surry	12-63-5-2	2/6/91	86	48	3.13	1.91	Excellent
Endicott Cr	SR 1338	Surry	12-63-5-(3)	2/7/91	---	12	---	4.29	Fair
Fisher R	US 601	Surry	12-63-(9)	8/8/01	---	30	---	3.19	Good
				7/23/96	---	30	---	3.67	Good
Fisher R	NC 268	Surry	12-63-(9)	8/8/01	88	39	5.14	3.90	Good
				7/22/96	84	36	5.13	4.04	Good
L Fisher R	SR 1480	Surry	12-63-10-(2)	8/7/01	---	22	4.87	4.87	Good-Fair
				7/23/96	---	29	---	4.28	Good
L Beaver Cr	NC 268	Surry	12-63-13	7/6/89	63	20	5.32	4.62	Good-Fair
L Beaver Cr	off NC 268	Surry	12-63-13	7/24/01	67	27	3.95	3.05	Not Impaired
				7/6/89	23	2	6.76	4.21	Poor
N Pr S Fk Mitchell R	off SR 1515	Surry	12-62-13-1	6/12/90	32	32	3.18	3.18	Good
L Yadkin R	SR 1236	Stokes	12-77	8/8/01	89	25	5.29	4.41	Good-Fair
				7/22/96	54	24	5.05	4.64	Good-Fair
L Yadkin R	US 52	Stokes	12-77	7/26/88	---	16	---	4.91	Fair
L Yadkin R	SR 1104	Stokes	12-77	5/18/94	82	31	5.42	4.08	Good
				5/13/92	94	37	5.15	4.26	Good
				5/13/91	82	32	5.05	4.36	Good
				5/14/90	72	32	4.98	4.49	Good-Fair
				8/7/89	84	27	5.57	4.82	Good-Fair
				5/31/89	77	30	5.62	4.65	Good-Fair
				7/26/88	---	19	---	5.00	Good-Fair
				5/26/88	---	23	---	4.10	Good-Fair
				7/22/87	97	32	5.14	4.25	Good-Fair
				5/6/87	62	25	5.06	4.29	Good-Fair
L Yadkin R	SR 1604	Forsyth	12-77	5/26/88	---	28	---	3.68	Good-Fair
				5/5/87	61	26	4.75	4.21	Good-Fair
W Pr L Yadkin R	SR 1136	Stokes	12-77-1-(1)	5/14/90	69	35	4.18	3.31	Good
				5/30/89	85	35	4.94	3.62	Good
				5/25/88	---	37	---	3.60	Good
				5/6/87	83	39	4.13	3.29	Good
W Pr L Yadkin R	SR 1160	Stokes	12-77-1-(2)	5/14/91	72	27	4.70	3.84	Good-Fair
				5/25/88	---	26	---	4.22	Good-Fair
				6/6/87	70	30	4.77	3.99	Good
E Pr L Yadkin R	SR 1220	Stokes	12-77-2-(1)	5/17/94	60	25	5.38	4.10	Good-Fair
				5/12/92	72	28	5.16	3.99	Good-Fair
				5/14/91	72	28	4.79	4.19	Good
E Pr L Yadkin R	SR 1166	Stokes	12-77-2-(1)	5/13/91	60	25	5.27	4.56	Good-Fair
				5/13/90	59	27	5.34	4.97	Good-Fair
				5/30/89	68	21	5.28	4.51	Good-Fair
				5/25/88	66	25	4.81	4.06	Good-Fair
				5/6/87	57	28	4.40	3.53	Good-Fair
E Pr L Yadkin R	SR 1224	Stokes	12-77-2-(1)	5/17/94	66	30	5.28	4.54	Good-Fair
				5/13/91	81	30	5.01	4.48	Good-Fair
				5/13/90	62	26	5.27	4.35	Good-Fair
				5/31/89	84	29	5.35	4.15	Good-Fair
				5/25/88	88	29	5.41	4.31	Good-Fair
				5/6/87	60	29	4.49	4.03	Good
N UT E Pr L Yadkin R	NC 66	Stokes	12-77-2-(1)	5/17/94	72	36	3.89	2.98	Good
				5/12/92	72	35	3.66	3.02	Good
				5/14/91	70	30	4.08	3.09	Good
S UT E Pr L Yadkin R	NC 66	Stokes	12-77-2-(1)	5/17/94	60	27	4.37	3.71	Good
				5/12/92	70	27	4.70	3.82	Good-Fair
				5/14/91	64	24	4.98	3.80	Good-Fair
Crooked Run Cr	SR 1104	Stokes	12-77-4	5/25/88	---	21	---	4.80	Good-Fair
				5/6/87	60	25	4.43	3.91	Good-Fair
Yadkin R	SR 1605	Forsyth	12-(71)	7/21/87	65	23	4.79	3.84	Good
Justice Reynolds Cr	off SR 1561	Yadkin	12-(71)	6/29/93	61	28	4.79	4.15	Good-Fair
				7/5/89	69	25	5.24	4.25	Good-Fair
Justice Reynolds Cr	off SR 1562	Yadkin	12-(71)	6/29/93	70	30	4.29	3.61	Good
				7/5/89	65	27	4.65	4.14	Good-Fair

Appendix 7 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
Dill Cr	off SR 1563	Yadkin	12-(71)	6/29/93	71	26	5.19	4.95	Good-Fair
				7/5/89	78	25	5.37	4.61	Good-Fair
Forbush Cr	SR 1570	Yadkin	12-83-(1.5)	8/8/01	---	22	---	4.15	Good-Fair
				7/24/96	---	23	---	4.02	Good-Fair
Logan Cr	SR 1571	Yadkin	12-83-2-(0.7)	8/9/01	---	31	---	4.77	Good
				7/24/96	---	27	---	4.75	Good-Fair
N Deep Cr	SR 1503	Yadkin	12-84-1-(0.5)	4/12/93	62	26	5.21	4.67	Good-Fair
N Deep Cr	NC 601	Yadkin	12-84-1-(0.5)	4/12/93	58	27	5.10	4.38	Good-Fair
N Deep Cr	SR 1510	Yadkin	12-84-1-(0.5)	8/9/01	76	26	5.44	4.55	Good-Fair
				7/25/96	57	24	5.39	4.93	Good-Fair
				4/12/93	53	25	4.90	4.41	Good-Fair
S Deep Cr	SR 1710	Yadkin	12-84-2-(5)	8/9/01	65	19	5.31	4.43	Good-Fair
				7/26/96	56	26	4.88	4.41	Good-Fair
03-07-03									
Ararat R	NC 104	Surry	12-72-(1)	7/23/01	---	25	---	4.03	Good-Fair
				7/25/96	---	26	---	3.95	Good-Fair
				9/23/86	64	18	5.31	4.82	Good-Fair
Ararat R	US 52 Bus	Surry	12-72-(4.5)	9/23/86	63	20	5.70	4.52	Good-Fair
Ararat R	US 52,	Surry	12-72-(4.5)	11/15/94	72	27	5.21	3.90	Good-Fair
	above WWTP			3/20/85	82	24	5.55	4.38	Good-Fair
Ararat R	below WWTP	Surry	12-72-(4.5)	11/15/94	47	13	5.69	4.19	Fair
				9/23/86	32	1	7.56	4.28	Poor
				3/20/85	45	11	6.87	4.39	Poor
Ararat R	SR 2119	Surry	12-72-(4.5)	3/20/85	44	10	6.63	5.11	Poor
Ararat R	SR 2026	Surry	12-72-(4.5)	7/23/01	77	28	5.57	4.61	Good-Fair
				8/28/96	69	20	5.81	4.81	Fair
				7/12/90	59	17	6.16	5.43	Fair
				7/26/88	62	16	6.35	5.68	Fair
				9/24/86	50	11	6.55	5.45	Fair
				8/4/86	65	21	6.16	4.87	Fair
				8/15/84	66	24	5.94	4.68	Fair
Ararat R	SR 2080	Surry	12-72-(4.5)	7/12/01	82	35	4.94	3.85	Good
				8/28/96	42	19	5.27	4.67	Fair
				9/23/86	60	16	5.90	4.48	Fair
Lovills Cr	SR 1700	Surry	12-72-8-(1)	7/24/01	---	26	---	4.17	Good-Fair
				7/25/96	---	22	---	4.75	Good-Fair
				2/16/86	60	25	4.47	3.69	Good-Fair
Lovills Cr	SR 1371	Surry	12-72-8-(3)	7/24/01	67	14	6.38	4.70	Fair
				7/25/96	63	16	6.41	5.05	Fair
				2/19/86	39	12	5.55	4.12	Fair
Stewarts Cr	SR 1622	Surry	12-72-9-(1)	10/20/87	90	32	5.34	3.99	Good-Fair
				2/20/86	104	39	4.47	3.05	Good
Stewarts Cr	NC 89	Surry	12-72-9-(4)	7/24/01	---	18	---	4.63	Fair
				7/25/96	---	23	---	3.88	Good-Fair
Stewarts Cr	SR 2258	Surry	12-72-9-(8)	7/24/01	78	34	5.31	4.47	Good
				7/25/96	81	27	5.60	4.77	Good-Fair
Pauls Cr	SR 690 (Carroll, Va)		12-72-9-7	10/20/87	61	25	5.09	4.13	Good-Fair
Brushy Fk	SR 1625	Surry	12-72-9-7-1	10/20/87	---	17	---	4.30	Good-Fair
Flat Shoals Cr	SR 1827	Surry	12-72-13	7/23/01	---	20	---	3.46	Good-Fair
				8/28/96	---	27	---	3.54	Good-Fair
				1/22/87	86	37	4.40	3.52	Good
Toms Cr	NC 52	Surry	12-72-14-(3.5)	1/21/87	56	27	5.20	4.50	Good
Toms Cr	SR 1815	Surry	12-72-14-(4)	1/21/87	51	16	5.66	4.58	Fair
Heatherly Cr	above WWTP	Surry	12-72-14-5	11/15/94	48	18	6.12	4.98	Fair
				1/21/87	47	14	6.52	5.38	Fair
Heatherly Cr	NC 268	Surry	12-72-14-5	8/29/01	50	17	5.03	4.88	Good-Fair
Heatherly Cr	below WWTP	Surry	12-72-14-5	11/15/94	14	0	8.50	0.00	Poor
				1/21/87	25	2	8.44	7.00	Poor
Heatherly Cr	US 52	Surry	12-72-14-5	8/29/01	44	11	5.80	5.62	Not Rated
Heatherly Cr	below US 52	Surry	12-72-14-5	1/21/87	32	2	8.50	5.35	Poor
Subbasin 04									
Muddy Cr	SR 1620	Forsyth	12-94-(0.5)	1/14/85	90	29	5.40	4.64	Good
Muddy Cr	ab Westinghouse	Forsyth	12-94-(0.5)	1/24/89	-	22	-	4.49	Good-Fair
				10/13/88	-	18	-	5.46	Good-Fair
				1/15/85	75	22	5.73	4.99	Good-Fair

Appendix 7 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
Muddy Cr	be Westinghouse	Forsyth	12-94-(0.5)	1/24/89	-	15	-	4.77	Fair
				10/13/88	-	11	-	5.81	Fair
				1/15/85	51	19	6.04	5.07	Fair
Muddy Cr	SR 1898	Forsyth	12-94-(0.5)	8/6/01	-	19	-	5.11	Good-Fair
				8/5/96	-	18	-	5.02	Good-Fair
				3/19/87	-	15	-	5.61	Fair
Muddy Cr	off SR 1632	Forsyth	12-94-(0.5)	1/15/85	71	19	6.73	5.70	Fair
Muddy Cr	SR 2995	Forsyth	12-94-(0.5)	8/7/01	50	14	6.47	5.82	Good-Fair
				8/6/96	51	18	6.37	5.56	Good-Fair
				7/31/85	53	17	6.58	5.23	Fair
				8/09/83	54	8	7.38	6.05	Fair
Barkers Cr	SR 1620	Forsyth	12-94-1	3/19/87	6	5	6.42	6.47	Poor
Barkers Cr	ab Parkers Cr	Forsyth	12-94-1	3/19/87	-	18	-	4.68	Good-Fair
Barkers Cr	SR 1898	Forsyth	12-94-1	3/19/87	-	20	-	4.73	Good-Fair
Parkers Cr	SR 1620	Forsyth	12-94-1-1	1/24/89	-	21	-	4.07	Good
				3/19/87	22	18	3.53	3.50	Good-Fair
				1/14/85	78	33	5.07	4.61	Good
Grassy Cr	SR 1669	Forsyth	12-94-7-3	10/17/84	54	11	7.12	5.77	Fair
Grassy Cr	SR 1672	Forsyth	12-94-7-3	10/17/84	65	13	6.95	5.65	Fair
Reynolds Cr	above Sequoia	Forsyth	12-94-9	10/23/00	36	11	5.84	5.32	Not Rated
				8/0/94	44	17	4.70	4.21	Good
Reynolds Cr	below Sequoia	Forsyth	12-94-9	10/23/00	36	6	7.91	7	Not Rated
				8/3/94	41	9	6.51	5.04	Fair
Salem Cr	SR 2657	Forsyth	12-94-12-(1)	8/6/01	13	13	5.07	5.07	Not Impaired
				8/5/96	-	15	-	4.97	Good-Fair
Salem Cr	NC 52	Forsyth	12-94-12-(4)	9/16/83	36	4	8.23	6.88	Poor
Salem Cr	below Bath Br	Forsyth	12-94-12-(4)	9/16/83	29	0	8.87		Poor
Salem Cr	SR 2902	Forsyth	12-94-12-(4)	8/6/01	45	9	6.85	6.31	Fair
				8/5/96	53	11	7.21	5.96	Fair
				9/27/82	31	4	7.94	7.11	Poor
Salem Cr	SR 2991	Forsyth	12-94-12-(4)	8/6/01	39	10	7.10	6.36	Fair
				8/5/96	43	8	7.16	5.85	Fair
				9/27/82	22	0	8.38		Poor
Bath Br	Stadium Dr	Forsyth	-	9/15/83	11	1	9.39	6.22	Poor
S Fk Muddy Cr	SR 2902	Forsyth	12-94-13	8/6/01	-	17	-	5.54	Good-Fair
				8/5/96	-	14	-	4.83	Good-Fair
Fryes Cr	NC 150	Davidson	12-94-15-(1)	9/28/82	53	16	5.82	5.17	Good-Fair
Yadkin R	SR 1447	Davidson	12-(97.5)	9/12/01	67	29	5.46	4.57	Good
				7/9/90	64	27	5.50	4.59	Good
				8/5/86	67	26	5.84	4.83	Good
				9/9/85	60	23	5.68	4.50	Good
				8/9/83	53	19	5.26	4.38	Good-Fair
Second Cr	SR 2335	Rowan	12-108-21	6/14/88	-	18	-	4.91	Good-Fair
				2/10/87	64	25	5.47	4.00	Good
				10/12/84	91	25	5.60	5.07	Good
Second Cr	SR 2337	Rowan	12-108-21	6/14/88	-	18	-	4.86	Good-Fair
				2/10/87	82	25	6.17	4.11	Good
				10/12/84	78	17	6.47	5.20	Good-Fair
Second Cr	SR 2338	Rowan	12-108-21	10/12/84	93	22	6.34	5.45	Good-Fair
UT Second Cr	SR 2235, ab WWTP	Rowan	12-108-21	6/14/88	-	18	-	5.29	Good-Fair
				2/10/87	-	17	-	4.75	Good-Fair
UT Second Cr	location unclear	Rowan	12-108-21	6/14/88	14	14	4.69	4.69	Good-Fair
Grants Cr	SR 1197	Rowan	12-110	7/1/83	20	3	7.57	5.67	Poor
Grants Cr	Patterson St	Rowan	12-110	7/1/83	24	1	8.52	6.22	Poor
Grants Cr	SR 1506	Rowan	12-110	7/1/83	51	10	6.42	5.34	Fair
Grants Cr	SR 1910	Rowan	12-110	8/7/01	72	13	6.57	6.26	Fair
				8/6/96	74	20	6.41	5.48	Good-Fair
				7/13/89	67	20	6.23	5.45	Good-Fair
UT Grants Cr	SR 1500	Rowan	12-110	8/28/01	34	14	5.33	4.63	Not Impaired
				9/10/90	26	0	8.33	-	Poor
Little Cr	SR 1535	Rowan	12-110-3	9/10/90	46	14	5.23	4.20	Good-Fair
N Potts Cr	ab UT	Davidson	12-112	10/20/88	-	14	-	5.26	Good-Fair
N Potts Cr	be UT	Davidson	12-112	10/20/88	-	18	-	4.54	Good-Fair
UT N Potts Cr	ab WWTP	Davidson	12-112	10/20/88	34	11	6.10	4.62	Fair
UT N Potts Cr	be WWTP	Davidson	12-112	10/20/88	26	6	6.57	4.60	Fair

Appendix 7 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
Town Cr	above WWTP	Rowan	12-115-3	9/10/90	68	9	7.84	6.46	Poor
Town Cr	I-85	Rowan	12-115-3	8/7/01	50	8	6.93	6.76	Fair
				9/10/90	32	0	8.35	-	Poor
03-07-05									
Dutchmans Cr	US 158	Davie	12-102-(1)	8/7/01	72	20	6.34	5.46	Good-Fair
				7/24/96	69	24	5.63	4.80	Good
Dutchmans Cr	NC 801	Davie	12-102-(2)	8/7/01	77	17	6.54	5.20	Fair
				7/24/96	84	30	6.24	4.65	Good
Cedar Cr	NC 801	Davie	12-102-13-(1)	6/11/90	---	10	---	5.98	Fair
Cedar Cr	above quarry	Davie	12-102-13-(2)	6/13/90	63	13	6.62	6.22	Fair
Cedar Cr	I-40, be quarry	Davie	12-102-13-(2)	6/13/90	69	16	6.50	6.00	Good-Fair
Cedar Cr	US 158	Davie	12-102-13-(2)	7/24/96	---	15	---	6.00	Good-Fair
Elisha Cr	SR 1405	Davie	12-102-15	4/7/88	---	27	---	4.08	Good
03-07-06									
S Yadkin R	SR 1561	Iredell	12-108-(5.5)	9/11/01	68	21	5.80	4.92	Good-Fair
				7/24/01	77	25	5.83	5.07	Good
				8/5/96	70	30	4.97	4.25	Excellent
S Yadkin R	SR 1159	Davie	12-108-(14.5)	7/24/01	80	32	4.71	3.92	Excellent
				8/6/96	60	29	4.51	3.83	Good
				7/13/89	73	32	4.69	3.94	Excellent
				8/5/86	79	26	5.05	4.17	Good
				8/27/84	83	34	4.73	3.95	Excellent
Rocky Cr	SR 1862	Iredell	12-108-11	11/7/90	91	45	4.01	3.03	Excellent
Rocky Cr	SR 1884	Iredell	12-108-11	7/23/01	---	38	---	3.77	Excellent
				8/5/96	---	26	---	3.75	Good
Rocky Cr	SR 1890	Iredell	12-108-11	11/7/90	79	37	4.49	3.49	Excellent
Patterson Cr	SR 1892	Iredell	12-108-11-3	8/5/96	---	22	---	4.24	Good
Patterson Cr	SR 1890	Iredell	12-108-11-3	7/23/01	---	25	---	4.06	Good
				11/7/90	77	32	5.32	4.32	Excellent
Fifth Cr	SR 2158	Iredell	12-108-13	6/21/89	---	25	---	4.82	Good
Hunting Cr	SR 2428	Wilkes	12-108-16-(0.5)	4/13/93	89	46	3.57	2.62	Excellent
Hunting Cr	NC 115	Wilkes	12-108-16-(0.5)	7/30/01	---	37	---	3.67	Excellent
				6/16/92	84	43	3.96	3.51	Excellent
Hunting Cr	SR 2423	Wilkes	12-108-16-(0.5)	6/16/92	85	42	4.23	3.45	Good
Hunting Cr	SR 2115	Iredell	12-108-16-(0.5)	7/23/01	74	31	5.06	4.19	Excellent
				8/07/96	66	30	4.66	3.29	Excellent
				7/27/88	72	27	5.36	4.08	Good
				7/30/85	79	33	4.94	3.71	Excellent
				8/10/83	78	28	5.24	4.35	Good
Hunting Cr	SR 2120	Iredell	12-108-16-(0.5)	6/12/90	82	40	4.54	4.15	Excellent
Hunting Cr	SR 2127	Iredell	12-108-16-(0.5)	6/12/90	66	34	5.24	4.66	Excellent
Hunting Cr	US 64	Davie	12-108-16-(0.5)	6/12/90	---	28	---	3.79	Excellent
N Little Hunting Cr	SR 1829	Iredell	12-108-16-6	7/23/01	---	31	---	4.08	Excellent
				8/5/96	---	28	---	3.68	Excellent
Bear Cr	US 64	Davie	12-108-18-(1)	5/25/94	74	23	5.70	4.82	Good-Fair
Bear Cr	SR 1139	Davie	12-108-18-(3)	4/7/88	77	25	5.87	5.15	Good-Fair
Bear Cr	SR 1116	Davie	12-108-18-(3)	4/7/88	93	25	6.34	4.89	Good-Fair
Fourth Cr	SR 2321	Iredell	12-108-20	9/16/87	---	16	---	5.31	Good-Fair
Fourth Cr	SR 2322	Iredell	12-108-20	9/16/87	---	16	---	5.23	Good-Fair
Fourth Cr	SR 2316	Iredell	12-108-20	9/11/01	51	13	6.13	5.11	Fair
				6/22/89	59	18	5.96	5.62	Good-Fair
Fourth Cr	SR 2308	Iredell	12-108-20	9/12/01	57	12	6.89	6.00	Fair
				6/22/89	63	17	6.99	5.81	Fair
Fourth Cr	SR 1003	Rowan	12-108-20	7/24/01	---	20	---	5.30	Good-Fair
				9/11/01	---	23	---	5.21	Good
				8/6/96	---	23	---	5.00	Good
Third Cr	SR 2318	Iredell	12-108-20-4	9/11/90	69	22	5.69	5.17	Good
				6/2189	71	23	5.71	5.37	Good

Appendix 7 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
Third Cr	SR 2359	Iredell	12-108-20-4	9/11/90	72	21	5.96	5.13	Good-Fair
				6/21/89	69	17	6.09	5.24	Good-Fair
Third Cr	SR 1970	Rowan	12-108-20-4	7/24/01	52	22	5.23	4.40	Good
				8/6/96	56	23	4.93	4.36	Good
				7/9/90	62	23	5.62	4.18	Good
				7/20/87	68	26	5.69	4.10	Good
North Second Cr	SR 1526	Rowan	12-108-21	7/24/01	---	10	---	5.95	Fair
				8/6/86	---	16	---	4.75	Good-Fair
North Second Cr	US 70	Rowan	12-108-21	7/24/01	66	16	6.83	6.07	Fair
				8/7/96	54	17	6.20	5.81	Good-Fair
Withrow Cr	SR 1547	Rowan	12-108-21-3	7/25/01	---	18	---	4.77	Good-Fair
				8/7/96	---	14	---	4.64	Good-Fair
03-07-07									
Swearing Cr	SR 1147	Davidson	12-113	11/13/87	62	20	6.23	5.44	Good-Fair
Swearing Cr	SR 1104	Davidson	12-113	11/13/87	63	18	6.27	5.48	Good-Fair
				10/30/85	46	9	6.91	4.48	Fair
Swearing Cr	above WWTP	Davidson	12-113	10/30/85	72	21	6.29	4.99	Good-Fair
Swearing Cr	SR 1272	Davidson	12-113	10/30/85	42	7	7.50	5.88	Poor
Swearing Cr	NC 47	Davidson	12-113	7/25/01	---	13	---	5.75	Fair
				8/7/96	---	16	---	5.15	Good-Fair
Abbots Cr	SR 1755	Davidson	12-119-(1)	9/28/01	---	15	---	5.42	Good-Fair
				8/8/96	---	16	---	4.84	Good-Fair
Brushy Fk	SR 1810	Davidson	12-119-5-(1)	7/30/01	53	20	5.40	4.40	Good
				8/8/96	---	13	---	4.65	Fair
Abbotts Cr	SR 1243	Davidson	12-119-(6)	7/25/01	61	15	6.80	6.22	Fair
				8/9/96	62	17	6.54	6.15	Fair
				11/13/85	49	12	7.42	6.17	Fair
Abbotts Cr	below WWTP	Davidson	12-119-(6)	11/15/85	47	13	7.17	5.73	Fair
Abbotts Cr	I-85	Davidson	12-119-(6)	11/12/87	46	10	7.50	5.72	Fair
				8/4/86	46	10	7.5	6.48	Fair
				11/15/85	58	17	7.01	5.9	Fair
				9/24/84	55	8	7.22	5.86	Fair
Abbotts Cr	US 29/70	Davidson	12-119-(6)	11/14/85	49	12	7.28	5.79	Fair
Rich Fk	SR 1784	Davidson	12-119-7	11/13/87	60	14	6.75	5.27	Fair
				11/12/85	62	19	6.2	5.3	Good-Fair
Rich Fk	NC 109	Davidson	12-119-7	11/12/85	56	10	7.83	5.35	Fair
Rich Fk	SR 1792	Davidson	12-119-7	11/12/87	53	10	6.86	5.98	Fair
				11/14/85	34	2	8.13	6.81	Poor
				9/29/83	18	0	8.80	0	Poor
Rich Fk	SR 2123	Davidson	12-119-7	9/29/83	35	2	8.39	5.39	Poor
Rich Fk	SR 2022	Davidson	12-119-7	11/14/85	50	11	7.41	5.92	Fair
Rich Fk	SR 2005	Davidson	12-119-7	7/25/01	65	15	6.98	6.5	Fair
				11/9/87	57	13	7.03	5.81	Fair
				11/15/85	57	12	7.36	5.62	Fair
				9/29/83	34	3	7.89	6.63	Poor
Hunts Fk	SR 1792	Davidson	12-119-7-3	11/12/87	49	13	6.84	5.57	Fair
				11/13/85	69	15	6.84	5.63	Fair
Hunts Fk	above SR 1787	Davidson	12-119-7-3	8/28/01	66	9	7.21	6.46	NR
				9/29/83	40	4	8.49	2.17	Poor
Hunts Fk	SR 1787	Davidson	12-119-7-3	9/83	42	0	8.5	0	Poor
Hamby Cr	SR 2031	Davidson	12-119-7-4	11/9/87	44	3	7.92	5.73	Poor
				11/13/85	35	4	7.96	6.44	Poor
Hamby Cr	SR 2025	Davidson	12-119-7-4	8/8/96	---	6	---	6.36	Poor
Hamby Cr	SR 2005	Davidson	12-119-7-4	11/13/85	57	12	7.18	5.85	Fair
Hamby Cr	near SR 2005, above confluence	Davidson	12-119-7-4	9/29/83	34	4	7.42	6.11	Poor
Hamby Cr	SR 2017	Davidson	12-119-7-4	7/30/01	58	12	6.55	6.12	Fair
N Hamby Cr	SR 2085	Davidson	12-119-7-4-1	11/9/87	48	6	8.07	7.74	Poor
				11/13/85	41	7	7.52	6.7	Poor
N Hamby Cr	SR 2031	Davidson	12-119-7-4-1	8/28/01	41	3	7.09	7.0	Poor
Jimmy's Cr	above quarry	Davidson	12-119-7-4-2	6/14/90	58	15	6.35	6.04	Not Rated
Jimmy's Cr	SR 2020	Davidson	12-119-7-4-2	6/14/90	58	14	6.34	5.75	Not Rated
Leonards Cr	Leonard Cr Farm Rd	Davidson	12-119-8-(3)	7/25/01	---	17	---	5.18	Good-Fair
Leonards Cr	SR 1844	Davidson	12-119-8-(3)	8/8/96	---	18	---	5.14	Good-Fair

Appendix 7 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
03-07-08									
UT Lick Cr	NC 47	Davidson	12-126-(3)	5/14/86	53	4	8.24	6.39	Poor
				5/15/85	32	2	8.46	7.31	Poor
UT Lick Cr	SR 2505	Davidson	12-126-(3)	5/14/86	56	11	7.20	4.58	Fair
				5/15/85	23	1	8.90	4.72	Poor
Lick Cr	SR 2351	Davidson	12-126-(3)	5/15/85	84	18	6.22	5.46	Good-Fair
Lick Cr	NC 8	Davidson	12-126-(3)	8/7/01	-	11	-	6.52	Fair
				8/6/96	-	12	-	5.54	Fair
				5/20/85	76	22	6.16	4.97	Good-Fair
Cabin Cr	NC 8	Davidson	12-127-(2)	8/06/96	20	20	-	4.59	Good-Fair
				5/16/85	88	16	6.05	5.07	Good-Fair
Mountain Cr	SR 1720	Stanly	13-5-(0.7)	8/8/01	-	18	-	5.20	Good-Fair
				8/6/96	91	25	5.65	5.09	Good
L Mountain Cr	SR 1720	Stanly	13-5-1-(2)	8/8/01	54	12	5.92	5.82	Fair
				8/7/96	-	11	-	5.91	Fair
03-07-09									
Uwharrie R	SR 1406	Randolph	13-2-(0.5)	8/9/01	-	18	-	5.34	Good-Fair
				8/8/96		22	4.97	4.97	Good-Fair
L Uwharrie R	SR 1405	Randolph	13-2-1	8/9/01	-	18	-	4.72	Good-Fair
				8/8/96	-	14	4.37	4.37	Good-Fair
Uwharrie R	SR 1143	Randolph	13-2-1-(1.5)	8/9/01	84	27	5.67	4.90	Good
				8/8/96	72	19	5.22	4.67	Good
Jackson Cr	SR 1312	Randolph	13-2-2	8/8/96	-	19	-	4.00	Good-Fair
Caraway Cr	SR 1331	Randolph	13-2-3	8/9/01	-	18	-	4.39	Good-Fair
				8/8/96	-	17	-	4.73	Good-Fair
Back Cr	SR 1318	Randolph	13-2-3-3-(1.5)	8/8/96	-	15	-	4.44	Good-Fair
L Back Cr	SR 1327	Randolph	13-2-3-3-(1.5)	2/9/89	57	21	5.10	3.63	Good-Fair
UT Back Cr	off SR 1504	Randolph	13-2-3-3-(1.5)	2/21/90	82	21	5.60	4.74	Good-Fair
UT Back Cr	SR 1512	Randolph	13-2-3-3-(1.5)	2/21/90	61	17	6.53	5.24	Good-Fair
Betty McGees Cr	SR 1107	Randolph	13-2-5	10/25/89	-	27	-	3.31	Good
Uwharrie R	NC 109	Montgomery	13-2-(17.5)	8/8/01	89	33	4.97	3.85	Excellent
				8/8/96	80	27	5.27	4.12	Good
				7/23/90	81	30	5.22	4.23	Good
				7/15/88	101	30	5.29	3.90	Good
				7/25/86	100	27	5.48	3.98	Good
				8/14/84	84	29	5.27	4.37	Good
Barnes Cr	SR 1307	Montgomery	13-2-18-(0.5)	3/16/88	-	30	-	3.63	Excellent
UT Barnes Cr (Poison Br)	SR 1306	Montgomery	13-2-18-1	3/17/88	-	33	-	2.84	Excellent
Barnes Cr	SR 1303	Montgomery	13-2-18-(2.5)	9/28/01	79	38	4.16	3.02	Excellent
				8/9/01	108	40	4.21	3.54	Excellent
				8/7/96	99	36	4.46	3.40	Excellent
				7/11/89	83	24	4.88	3.79	Good
				7/20/87	-	28	-	4.04	Excellent
				7/8/87	90	27	4.92	3.78	Good
				8/1/85	87	29	4.85	4.01	Excellent
				5/20/85	100	36	4.88	3.99	Excellent
				10/31/84	97	37	4.57	3.49	Excellent
Cedar Cr	SR 1150	Montgomery	13-2-23	3/17/88	90	39	4.02	3.28	Excellent
Dutchmans Cr	SR 1150	Montgomery	13-2-24	8/8/01	-	26	-	3.04	Not Rated
				8/7/96	63	29	3.76	3.05	Excellent
				7/31/85	60	24	4.05	3.22	Not Rated
				8/20/96	59	18	6.24	5.46	Good-Fair
				7/12/89	74	23	5.95	5.17	Good-Fair
				7/24/86	78	12	6.68	5.29	Fair
03-07-10									
Clarks Cr	SR 1174	Montgomery	13-16	8/7/96	-	24	-	3.91	Good
Clarks Cr	SR 1110	Montgomery	13-16	8/8/01	-	18	-	4.95	Good-Fair
				8/7/96	82	26	5.89	5.20	Good-Fair
Brown Cr	SR 1627	Anson	13-20	8/21/96	70	8	7.04	6.07	Fair
Lick Cr	SR 1244	Anson	13-20-5	4/3/86	88	21	6.20	5.13	Good-Fair
Savannah Cr	SR 1742	Anson	13-26	9/22/83	33	4	6.87	5.96	Not Rated
Mountain Cr	SR 1150	Richmond	13-28-1-(0.5)	8/8/01	-	25	-	3.77	Good
				8/6/96	-	30	-	3.83	Excellent

Appendix 7 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
03-07-11									
Rocky R	SR 2420	Mecklenburg	13-17	8/21/01	41	8	6.73	6.32	Fair
				8/19/96	---	7	---	5.84	Fair
				3/26/85	64	13	6.41	4.92	Fair
Rocky R	SR 1142	Iredell	13-17	6/6/85	59	18	6.1	5.15	Good-Fair
Rocky R	SR 1608	Cabarrus	13-17	6/6/85	57	16	6.13	5.31	Good-Fair
Rocky R	NC 29	Cabarrus	13-17	3/26/85	70	19	6.15	5.16	Fair
Rocky R	SR 1132	Cabarrus	13-17	3/27/85	81	27	6.18	5.37	Good-Fair
Dye Br	SR 1147	Iredell	13-17-2	9/11/01	44	9	6.34	6.29	Not Rated
				9/11/90	52	13	6.33	5.70	Fair
				6/6/85	53	14	6.53	5.63	Fair
Dye Br	SR 1142	Iredell	13-17-2	9/11/01	25	2	7.75	6.25	Poor
				9/11/90	27	4	7.95	6.77	Poor
				6/6/85	30	4	8.15	5.88	Poor
Mallard Cr	SR 1300	Cabarrus	13-17-5	3/27/85	82	22	6.16	5.0	Good-Fair
Coddle Cr	SR 1612	Cabarrus	13-17-6-(0.5)	6/6/85	66	21	5.80	5.03	Good-Fair
Coddle Cr	NC 49	Cabarrus	13-17-6-(5.5)	8/21/01	67	14	6.59	5.74	Fair
				8/19/96	---	13	---	5.40	Fair
Back Cr	SR 2827	Mecklenburg	13-17-7	10/16/84	64	19	6.18	5.03	Good-Fair
Fuda Cr	SR 1158	Cabarrus	13-17-7-1	3/27/85	74	18	6.6	5.84	Fair
UT Reedy Cr	below landfill	Mecklenburg	13-17-8	10/16/84	44	11	7.09	5.69	Not Rated
03-07-12									
Rocky R	US 601	Cabarrus	13-17	8/22/01	48	15	6.55	5.79	Fair
				8/20/96	56	19	6.15	5.5	Good-Fair
				7/12/89	66	19	6.36	5.40	Good-Fair
Rocky R	NC 24/27	Cabarrus	13-17	3/28/85	86	30	6.22	4.91	Good-Fair
Irish Buffalo Cr	SR 1132	Cabarrus	13-17-9-(2)	8/21/01	56	15	6.37	5.62	Good-Fair
				8/19/96	58	15	6.01	5.36	Good-Fair
Coldwater Cr	NC 49	Cabarrus	13-17-9-4-(1.5)	8/21/01	---	15	---	5.16	Good-Fair
				8/19/96	---	14	---	5.15	Good-Fair
Dutch Buffalo Cr	SR 1006	Cabarrus	13-17-11-(4.5)	3/27/85	92	24	5.78	4.72	Good-Fair
Dutch Buffalo Cr	NC 200	Cabarrus	13-17-11-5	8/22/01	79	18	6.66	5.75	Good-Fair
				8/20/96	59	18	6.24	5.46	Good-Fair
				7/12/89	74	23	5.95	5.17	Good-Fair
				7/24/86	78	12	6.68	5.29	Fair
Clear Cr	SR 3181	Mecklenburg	13-17-17	8/22/01	57	15	5.96	5.16	Good-Fair
				5/1/98	---	19	---	4.77	Good-Fair
Goose Cr	SR 1004	Mecklenburg	13-17-18	4/21/98	80	18	5.92	5.34	Good-Fair
Goose Cr	below Fairfield Plantation	Union	13-17-18	4/22/98	---	12	---	5.43	Fair
Goose Cr	Glamorgan Rd	Union	13-17-18	4/22/98	---	22	---	4.62	Good
Goose Cr	SR 1524	Union	13-17-18	4/22/98	---	16	---	4.65	Good-Fair
Goose Cr	SR 1525	Union	13-17-18	4/21/98	35	4	6.93	6.96	Poor
Goose Cr	SR 1533	Union	13-17-18	4/21/98	---	9	---	5.5	Fair
Goose Cr	US 601	Union	13-17-18	8/22/01	48	5	7.16	5.98	Poor
				7/21/98	47	10	7.37	5.87	Poor
				8/20/96	---	2	---	6.09	Poor
Goose Cr	SR 1547	Union	13-17-18	5/1/98	---	11	---	6.01	Fair
Stephens Cr	off Maple Hollow Rd	Mecklenburg	13-17-18-1	4/21/98	87	26	5.29	4.09	Good
UT Stephens Cr	Thompson Rd	Mecklenburg	13-17-18-1	4/20/98	48	12	5.35	4.70	Not Impaired
Duck Cr	US 601	Union	13-17-18-3	4/21/98	65	14	6.43	5.41	Fair
Crooked Cr	SR 1547	Union	13-17-20	8/22/01	68	18	5.93	5.15	Good-Fair
				8/20/96	---	12	---	4.67	Fair
N Fk Crooked Cr	SR 1520	Union	13-17-20-1	6/27/00	57	6	7.23	6.50	Fair
				9/12/95	46	8	6.57	5.92	Fair
N Fk Crooked Cr	SR 1514	Union	13-17-20-1	6/27/00	53	7	6.98	6.79	Fair
				9/12/95	59	12	6.45	5.78	Good-Fair
N Fk Crooked Cr	SR 1004	Union	13-17-20-1	9/12/95	48	9	6.69	6.40	Fair
S Fk Crooked Cr	above SR 1515	Union	13-17-20-2	9/13/95	59	3	7.46	6.82	Poor
S Fk Crooked Cr	SR 1515	Union	13-17-20-2	9/13/95	54	5	6.89	6.83	Fair
S Fk Crooked Cr	SR 1367	Union	13-17-20-2	9/12/95	42	8	6.71	6.22	Fair
03-07-13									
Long Cr	SR 1401	Stanly	13-17-31	8/20/01	---	17	---	5.13	Good-Fair
Long Cr	above WWTP	Stanly	13-17-31	8/22/89	67	15	6.75	5.84	Fair

Appendix 7 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
Long Cr	SR 1967	Stanly	13-17-31	8/22/89	56	10	6.49	6.22	Fair
Long Cr	SR 1917	Stanly	13-17-31	8/23/01	70	20	5.85	4.87	Good-Fair
				8/22/96	64	14	5.77	5.32	Good-Fair
				7/12/89	76	22	6.13	5.28	Good-Fair
				7/24/86	88	12	6.88	5.64	Fair
				9/2/83	59	15	6.63	4.92	Fair
Lower(Little) Long Br	SR 2001	Stanly	13-17-31-4	6/3/91	47	7	6.63	4.7	NR
Lower(Little) Long Br	below NC 138	Stanly	13-17-31-4	6/3/91	54	15	6.91	6.26	NR
Big Bear Cr	SR 1434	Stanly	13-17-31-5	8/22/89	---	10	---	5.39	Fair
Big Bear Cr	SR 1134	Stanly	13-17-31-5	8/22/96	---	24	---	3.83	Good
				7/24/90	88	31	5.71	4.89	Good
				7/20/87	97	28	5.90	4.92	Good
Big Bear Cr	SR 1225	Stanly	13-17-31-5	8/20/01	---	22	---	4.53	Good
Stony Run Cr	SR 1970	Stanly	13-17-31-5-5	8/20/01	---	12	---	5.55	Fair
				8/22/96	---	19	---	4.22	Good-Fair
03-07-14									
Rocky R	SR 1970	Stanly	13-17	6/3/91	---	16	---	3.43	Good-Fair
Rocky R	above Carolina Solite	Stanly	13-17	6/3/91	---	14	---	4.38	Good-Fair
Rocky R	below Carolina Solite	Stanly	13-17	6/3/91	---	16	---	4.55	Good-Fair
Rocky R	SR 1943	Stanly	13-17	8/23/01	62	24	5.07	4.24	Good
Rocky R	SR 1935	Stanly	13-17	8/21/96	68	22	5.41	4.66	Good
				7/24/90	80	28	5.45	4.29	Good
				7/14/88	80	25	5.38	4.23	Good
				7/24/86	93	22	6.24	5.06	Good-Fair
				7/31/85	76	25	5.31	4.57	Good
				3/28/85	99	27	5.29	3.96	Good
				9/24/84	79	25	5.81	4.05	Good
				8/2/83	73	23	6.05	4.61	Good-Fair
Richardson Cr	SR 1751	Union	13-17-36-(5)	9/14/90	57	6	7.67	7.32	Poor
				3/13/89	62	12	7.5	5.7	Fair
Richardson Cr	SR 1006	Union	13-17-36-(5)	8/24/01	48	8	6.74	6.88	Fair
				9/14/90	55	5	7.35	6.62	Poor
				3/13/89	52	14	7.64	5.51	Fair
Richardson Cr	SR 1649	Union	13-17-36-(5)	8/23/01	46	10	6.38	6.17	Fair
				8/21/96	46	12	6.22	5.63	Fair
				7/24/90	57	10	6.95	6.12	Fair
				7/8/87	57	10	6.96	5.98	Fair
Richardson Cr	SR 1600	Anson	13-17-36-(5)	8/23/01	---	24	---	3.98	Good
				8/21/96	---	18	---	3.91	Good-Fair
				8/1/83	69	20	6.28	5.34	Good-Fair
Lanes Cr	SR 2111	Union	13-17-40-(1)	5/16/89	52	9	6.5	4.4	Fair
Lanes Cr	SR 1937	Union	13-17-40-(1)	5/16/89	59	15	6.20	5.03	Fair
				5/11/88	58	13	6.53	4.84	Fair
Lanes Cr	SR 1929	Union	13-17-40-(1)	5/17/89	72	13	6.30	5.16	Fair
Lanes Cr	SR 1901	Union	13-17-40-(12)	8/21/96	---	6	---	6.21	Poor
Lanes Cr	SR 1612	Anson	13-17-40-(12)	8/21/96	---	11	---	4.93	Fair
Wicker Br	SR 1940	Union	13-17-40-4	5/16/89	60	10	6.54	5.45	NR
				5/11/88	62	11	6.41	4.55	NR
Waxhaw Br	SR 1937	Union	13-17-40-6	5/16/89	38	8	6.06	4.6	NR
				5/11/88	56	12	6.93	5.09	NR
03-07-15									
Little R	SR 1127	Randolph	13-25-(11.5)	10/24/89	-	22	-	4.12	Good-Fair
Little R	SR 1349	Montgomery	13-25-(11.5)	10/24/89	-	36	-	3.65	Excellent
Little R	above SR 1340	Montgomery	13-25-(11.5)	11/28/95	89	36	4.36	3.26	Excellent
Little R	SR 1340	Montgomery	13-25-(11.5)	8/13/01	92	30	4.72	3.54	Excellent
				8/22/96	98	39	5.11	3.94	Excellent
				11/28/95	90	36	4.48	3.54	Excellent
				10/25/89	-	40	-	3.38	Excellent
				7/15/88	106	40	4.88	3.72	Excellent
				7/31/85	104	40	4.37	3.67	Excellent
				8/2/83	80	23	5.28	4.34	Good

Appendix 7 (continued).

Waterbody	Location	County	Index No.	Date	ST	EPT	NCBI	EPTBI	BioClass[1]
Little R	below SR 1340	Montgomery	13-25-(11.5)	11/28/95	93	34	4.68	3.52	Excellent
W Fk Little R	SR 1115	Randolph	13-25-15	2/22/94	88	30	4.85	3.51	Excellent
W Fk Little R	NC 134	Montgomery	13-25-15	2/22/94	93	32	5.15	3.50	Good
W Fk Little R	SR 1311	Montgomery	13-25-15	8/13/01	37	26	4.25	4.06	Excellent
				8/22/96	-	30	-	4.04	Excellent
				2/22/94	78	28	4.79	3.51	Good
				10/24/89	-	25	-	3.60	Good
Little R	SR 1565	Montgomery	13-25-(19)	10/25/89	-	21	-	3.52	Good-Fair
Little R	NC 731	Montgomery	13-25-(19)	8/15/01	72	29	5.01	4.33	Good
				8/21/96	76	29	5.37	4.22	Good
Densons Cr	NC 134	Montgomery	13-25-20-(1)	10/24/89	-	38	-	3.84	Excellent
Densons Cr	SR 1323	Montgomery	13-25-20-(9)	7/29/92	98	31	5.52	4.45	Good
Densons Cr	SR 1324	Montgomery	13-25-20-(9)	7/29/92	75	17	5.98	5.63	Good-Fair
Bridgers Cr	SR 1519	Montgomery	13-25-24	10/25/89	-	31	-	3.99	Excellent
Rocky Cr	SR 1134	Montgomery	13-25-30-(0.3)	3/16/88	-	21	-	4.46	Good-Fair
Rocky Cr	NC 24/27	Montgomery	13-25-30-(0.3)	8/22/96	-	19	-	3.25	Good-Fair
Rocky Cr	SR 1549	Montgomery	13-25-30-(0.5)	3/16/88	104	35	4.99	3.61	Excellent
Disons Cr	above SR 1543	Montgomery	13-25-32	6/6/97	59	20	5.67	4.78	Good
Disons Cr	SR 1543	Montgomery	13-25-32	6/6/97	73	26	5.31	4.82	Good
Cheek Cr	SR 1541	Montgomery	13-25-36	8/15/01	62	9	6.50	6.13	Fair
				8/21/96	66	15	6.33	5.20	Good-Fair
03-07-16									
Pee Dee R	US 74	Richmond	13-(34)	7/23/90	70	21	5.99	4.77	Good-Fair
				7/14/88	68	19	6.54	5.23	Good-Fair
				9/11/85	64	21	6.11	4.94	Good-Fair
				9/24/84	68	21	5.79	4.13	Good-Fair
				8/1/83	67	17	6.79	5.42	Fair
Cartledge Cr	SR 1142	Richmond	13-35	8/19/96	-	11	-	5.57	Fair
UT Hitchcock Cr	SR 1475	Richmond	13-39-(1)	10/24/90	61	20	5.39	3.39	Good-Fair
Hitchcock Cr	SR 1486	Richmond	13-39-(1)	8/15/01	-	23	-	3.24	Good
				8/19/96	-	21	-	21	Good
Bones Fork Cr	SR 1487	Richmond	13-39-5	11/7/84	72	27	4.67	2.82	Excellent
UT Bones Fork Cr	SR 1475	Richmond	13-39-5	10/24/90	76	25	5.87	3.74	Good
Beaverdam Cr	SR 1486	Richmond	13-39-8-7	8/14/01	-	24	-	2.39	Not Impaired
				8/19/96	-	27	-	3.21	Excellent
Hitchcock Cr	US 74	Richmond	13-39-(10)	8/14/01	72	21	5.67	4.53	Good
				10/18/88	-	11	-	4.72	Fair
Hitchcock Cr	above Fox Yarns	Richmond	13-39-(10)	10/18/88	-	12	-	4.38	Fair
Hitchcock Cr	below Fox Yarns	Richmond	13-39-(10)	10/18/88	-	10	-	4.69	Fair
Hitchcock Cr	SR 1109	Richmond	13-39-(10)	8/15/01	71	21	6.01	4.61	Good-Fair
				8/20/96	40	5	7.85	6.47	Poor
Marks Cr	SR 1812	Richmond	13-45-2	8/19/96	59	15	6.26	4.86	Good-Fair
				2/21/91	63	11	7.06	5.99	Fair
Marks Cr	NC 177	Richmond	13-45-2	2/21/91	59	22	6.96	4.82	Good Fair
Marks Cr	SR 1104	Richmond	13-45-2	2/21/91	-	12	-	5.70	Fair
03-07-17									
Jones Cr	SR 1812	Anson	13-42	12/8/92	55	17	6.02	5.25	Good-Fair
Jones Cr	NC 145, near Pee Dee	Anson	13-42	8/14/01	74	18	5.95	4.49	Good-Fair
				8/20/96	63	17	5.84	4.86	Good-Fair
				7/23/90	73	16	5.93	5.04	Good Fair
				7/7/87	70	24	5.94	4.65	Good-Fair
N Fk Jones Cr	SR 1121	Anson	13-42-1-(0.5)	8/13/01	63	16	6.14	5.42	Good-Fair
				8/20/96	-	11	-	5.18	Fair
				12/8/92	51	15	5.87	4.52	Fair
Moss Br	McLaurin Rd	Anson	13-42-1-3-1	9/22/83	23	0	8.03	-	Not Rated
Moss Br	US 74	Anson	13-42-1-3-1	9/22/83	28	2	8.32	6.50	Not Rated
S Fk Jones Cr	SR 1821, above WWTP	Anson	13-42-2	8/20/96	-	15	-	4.99	Good-Fair
				12/8/92	49	14	6.11	4.91	Good-Fair
S Fk Jones Cr	SR 1821, below WWTP	Anson	13-42-2	12/8/92	41	11	6.08	5.29	Fair
Shaw Cr	SR 1421	Anson	13-42-2-4	4/3/86	70	26	5.69	4.83	Good-Fair

[1]Bioclassifications that will be used for use support (1997 - 2001data) have been changed to Not Rated or Not Impaired for all streams less than four meters wide that are not considered high quality mountain streams. See Appendix 6.

Appendix 8. Water quality measurements at benthos sites in the Yadkin River basin, 1996 and 2001.

Subbasin/ Waterbody	Location	Date	Width (m)	Temperature (˚C)	Specific conductance (µmhos/cm)	Dissolved oxygen (mg/L)	pH (s.u.)
03-07-01							
Buffalo Cr	SR 1505	08/30/01	12	21	35	7.3	7.6
Elk Cr	SR 1175	07/22/96	18	25	31	7.1	7.3
		08/29/01	12	26	44	6.8	7.4
Moravian Cr	NC 18	07/23/96	8	25	45	7.8	6.9
		07/26/01	7	---	---	---	---
Mulberry Cr	NC 268	07/24/96	13	25	39	7.9	7.1
		07/25/01	11	23	35	7.5	6.5
N Pr Lewis Fk	SR 1304	07/25/01	5	21	31	8.3	6.0
		07/23/96	9	20	22	8.6	6.9
Roaring R	SR 1990	07/24/96	30	28	28	7.8	7.2
		07/25/01	25	23	41	7.6	6.5
Stoney Fk Cr	SR 1135	07/22/96	16	25	28	7.5	6.7
		07/26/01	13	---	---	---	---
Yadkin R	NC 18/268	07/24/96	44	24	42	7.8	6.7
		07/25/01	35	23	48	7.4	6.3
Yadkin R	NC 268	07/22/96	21	23	38	8.5	7.5
		08/30/01	12	22	69	7.6	7.3
Yadkin R	SR 1372	07/27/01	5	---	---	---	---
03-07-02							
Elkin Cr	NC 268	07/22/96	12	26	45	---	7.2
		08/06/01	12	20	56	4.0	6.9
Fisher R	NC 268	07/22/96	25	25	45	7.7	7.7
		08/08/01	20	25	66	7.8	7.7
Fisher R	US 601	07/23/96	22	23	43	7.8	7.4
		08/08/01	15	25	53	8.8	7.8
Forbush Cr	SR 1570	07/24/96	8	25	98	6.4	7.2
		08/08/01	7	25	68	6.7	7.5
L Fisher R	SR 1480	07/23/96	8	23	45	7.4	7.2
		08/07/01	7	24	55	---	7.1
L Yadkin R	SR 1236	07/22/96	8	22	60	6.6	7.1
		08/08/01	10	23	72	7.1	7.3
Logan Cr	SR 1571	07/24/96	10	26	70	6.4	7.0
		08/09/01	7	24	92	6.6	7.3
Mitchell R	SR 1001	07/27/96	16	23	30	7.6	7.1
		08/06/01	16	22	---	---	7.3
Mitchell R	SR 1330	07/23/96	14	21	22	7.6	7.1
		08/06/01	8	21	---	4.1	7.3
N Deep Cr	SR 1510	07/25/96	14	23	75	7.6	7.4
		08/09/01	11	24	140	8.0	7.7
S Deep Cr	SR 1710	07/26/96	9	24	65	6.5	7.0
		08/09/01	10	23	68	6.4	7.4
Snow Cr	SR 1121	07/23/96	11	26	49	7.2	7.3
		08/06/01	8	23	56	---	6.9
Yadkin R	SR 1003	07/23/96	80	25	55	6.5	7.2
		08/07/01	80	28	65	6.3	7.4
Yadkin R	US 21	07/23/96	55	26	58	7.9	7.4
		08/06/01	55	23	67	4.3	7.1
03-07-03							
Ararat R	NC 104	07/25/96	8	23	35	8.1	6.8
		07/23/01	8	24	52	8.1	7.0
Ararat R	SR 2026	07/23/01	25	25	172	10.0	8.8
		08/28/96	38	22	138	7.9	7.2
Ararat R	SR 2080	08/28/96	33	25	87	---	7.3
		07/23/01	30	22	248	9.0	7.6
Flat Shoals Cr	SR 1827	08/28/96	4	19	39	8.2	7.5
		07/23/01	4	19	42	8.5	7.4
Lovills Cr	SR 1371	07/24/01	6	24	81	8.0	6.7
		07/25/96	12	24	62	9.6	7.9
Lovills Cr	SR 1700	07/25/96	12	25	45	8.3	6.8
		07/24/01	8	23	54	8.4	7.1
Stewarts Cr	NC 89	07/25/96	12	22	36	8.0	6.7
		07/24/01	11	22	70	8.4	6.8

Appendix 8 (continued).

Subbasin/ Waterbody	Location	Date	Width (m)	Temperature (˚C)	Specific conductance (µmhos/cm)	Dissolved oxygen (mg/L)	pH (s.u.)
Stewarts Cr	SR 2258	07/25/96	14	24	57	8.1	6.7
		07/24/01	12	25	53	9.0	7.0
03-07-04							
Grants Cr	SR 1910	08/06/96	11	24	120	7.1	7.4
		08/07/01	7	23	164	9.5	---
Muddy Cr	SR 1898	08/05/96	5	22	75	8.0	6.9
		08/06/01	4	22	96	10.2	7.4
Muddy Cr	SR 2995	08/06/96	23	---	---	---	---
		08/07/01	13	25	663	7.8	7.0
S Fk Muddy Cr	SR 2902	08/05/96	9	24	95	7.1	7.3
		08/06/01	6	24	116	9.8	7.4
Salem Cr	SR 2657	08/05/96	6	22	80	8.6	6.9
		08/06/01	3	22	90	8.6	6.6
Salem Cr	SR 2902	08/05/96	11	26	140	6.6	7.0
		08/06/01	8	26	186	10.6	8.1
Salem Cr	SR 2991	08/05/96	18	27	600	6.5	7.1
		08/06/01	12	28	835	8.0	7.9
Yadkin R	SR 1447	09/12/01	75	25	190	7.1	7.3
03-07-05							
Dutchmans Cr	NC 801	07/24/96	14	24	110	5.2	7.1
		08/07/01	12	24	183	5.3	7.4
Dutchmans Cr	US 158	07/24/96	8	26	140	6.2	7.4
		08/07/01	5	26	142	8.7	6.9
03-07-06							
Fourth Cr	SR 1003	08/06/96	7	24	145	7.0	7.7
		07/24/01	10	23	200	11.0	7.8
		09/11/01	11	22	192	7.9	7.8
Fourth Cr	SR 2316	09/11/01	7	22	116	7.5	7.5
Hunting Cr	NC 115	07/30/01	11	21	47	8.0	7.6
Hunting Cr	SR 2115	08/07/96	17	23	50	7.2	7.1
		07/23/01	20	22	57	8.0	7.2
N Little Hunting Cr	SR 1829	08/05/96	10	22	45	7.2	7.4
		07/23/01	11	22	59	9.4	7.4
N Second Cr	SR 1526	08/06/96	4	24	120	6.4	7.6
		07/24/01	4	24	127	7.7	7.8
N Second Cr	US 70	08/07/96	12	24	145	7.0	7.7
		07/24/01	13	25	260	7.1	7.7
Patterson Cr	SR 1890	07/23/01	8	22	54	8.0	6.9
Patterson Cr	SR 1892	08/05/96	3	23	52	7.2	7.2
Rocky Cr	SR 1884	08/05/96	10	23	45	7.3	7.2
		07/23/01	9	23	47	9.0	7.0
S Yadkin R	SR 1159	08/06/96	25	23	60	6.6	7.3
		07/24/01	30	23	76	9.0	7.5
S Yadkin R	SR 1561	08/05/96	8	25	---	7.0	---
		07/24/01	8	22	60	9.0	7.4
S Yadkin R	SR 1561	09/11/01	8	20	58	8.3	7.1
Third Cr	SR 1970	08/06/96	9	23	140	6.4	7.4
		07/24/01	8	24	287	7.7	7.8
Withrow Cr	SR 1547	08/07/96	5	23	90	7.3	7.4
		07/25/01	5	22	95	7.6	7.7
03-07-07							
Abbotts Cr	SR 1243	08/09/96	20	24	175	5.3	7.3
		07/25/01	20	23	479	6.0	6.8
Abbotts Cr	SR 1755	08/08/96	4	23	90	7.2	7.5
		09/28/01	7	14	132	11.2	7.6
Brushy Fk	SR 1810	08/08/96	3	23	100	7.0	7.7
		07/30/01	5	20	115	5.7	7.3
Hamby Cr	SR 2017	07/30/01	9	22	417	6.6	7.3
Leonard Cr	off Leonard Cr Farm Rd	07/25/01	4	24	116	6.7	6.8
Leonard Cr	SR 1844	08/08/96	3	29	125	6.4	7.5
Rich Fk	SR 2005	07/25/01	7	23	300	6.6	6.8
Swearing Cr	NC 47	08/07/96	4	24	130	6.8	7.6
		07/25/01	5	23	139	6.7	7.5

Appendix 8 (continued).

Subbasin/ Waterbody	Location	Date	Width (m)	Temperature (˚C)	Specific conductance (µmhos/cm)	Dissolved oxygen (mg/L)	pH (s.u.)
03-07-08							
L Mountain Cr	SR 1720	08/07/96	6	23	140	7.1	7.1
		08/08/01	5	23	240	8.7	---
Lick Cr	NC 8	08/06/96	8	25	120	6.3	7.0
		08/07/01	6	27	382	6.3	7.0
Mountain Cr	SR 1720	08/06/96	7	24	90	7.4	7.1
		08/08/01	5	23	147	6.7	---
03-07-09							
Back Cr	SR 1318	08/08/96	10	24	93	6.6	7.1
Barnes Cr	SR 1303	08/07/96	16	25	40	7.6	7.2
		08/09/01	8	24	61	7.3	---
Caraway Cr	SR 1331	08/08/96	10	23	100	5.4	7.2
		08/09/01	7	25	131	5.8	---
Dutchmans Cr	SR 1150	08/07/96	4	23	50	8.0	7.3
		08/08/01	3	27	76	9.0	---
Jackson Cr	SR 1312	08/08/96	8	24	105	6.6	7.1
L Uwharrie R	SR 1405	08/08/96	13	25	85	7.3	6.9
		08/09/01	8	27	141	7.7	---
Uwharrie R	NC 109	08/08/96	33	25	90	7.4	7.2
		08/08/01	18	29	93	9.8	---
Uwharrie R	SR 1143	08/08/96	18	27	100	7.4	7.2
		08/09/01	15	26	117	8.8	---
Uwharrie R	SR 1406	08/08/96	11	25	110	7.8	7.8
		08/09/01	6	29	142	10.6	---
03-07-10							
Brown Cr	SR 1627	08/21/96	8	24	100	3.2	6.7
Clarks Cr	SR 1110	08/07/96	8	23	50	7.1	7.2
		08/08/01	5	27	83	9.1	---
Clarks Cr	SR 1174	08/07/96	4	23	55	7.8	7.2
Mountain Cr	SR 1150	08/21/96	10	23	52	7.8	7.1
		08/15/01	8	24	54	5.5	7.0
03-07-11							
Coddle Cr	NC 49	08/19/96	8	24	160	7.4	7.5
		08/21/01	5	25	186	9.0	7.2
Rocky R	SR 2420	08/19/96	4	22	680	7.5	7.5
		08/21/01	4	22	422	10.0	7.5
03-07-12							
Coldwater Cr	NC 49	08/19/96	7	25	155	7.1	7.6
		08/21/01	6	25	167	9.7	7.4
Crooked Cr	SR 1547	08/20/96	6	25	138	7.8	7.2
		08/22/01	7	25	405	9.0	7.6
Dutch Buffalo Cr	NC 200	08/20/96	9	24	132	6.5	7.2
		08/22/01	7	21	138	6.0	7.3
Goose Cr	US 601	08/20/96	5	25	143	6.9	7.2
		08/22/01	5	23	262	7.0	7.2
Irish Buffalo Cr	SR 1132	08/19/96	8	25	185	9.1	8.0
		08/21/01	8	25	196	11.0	8.1
Rocky R	US 601	08/22/01	20	23	743	8.0	7.4
		08/20/96	31	23	680	7.5	7.5
03-07-13							
Big Bear Cr	SR 1134	08/22/96	11	24	100	8.4	7.3
		08/20/01	7	---	---	---	---
Long Cr	SR 1401	08/20/01	8	24	342	6.2	7.0
Long Cr	SR 1917	08/22/96	11	24	485	6.0	7.4
		08/23/01	12	23	248	9.3	7.3
Stony Run Cr	SR 1970	08/22/96	5	23	97	9.6	---
		08/20/01	5	25	72	6.8	7.1
03-07-14							
Richardson Cr	SR 1600	08/21/96	16	27	600	12.2	9.0
		08/23/01	15	27	694	10.5	8.6
Richardson Cr	SR 1649	08/20/96	20	27	750	9.2	8.3
		08/23/01	19	25	755	9.5	8.0
Rocky R	SR 1935	08/21/96	63	29	415	10.2	8.6
Rocky R	SR 1943	08/23/01	40	26	296	8.0	7.5

Appendix 8 (continued).

Subbasin/ Waterbody	Location	Date	Width (m)	Temperature (˚C)	Specific conductance (µmhos/cm)	Dissolved oxygen (mg/L)	pH (s.u.)
03-07-15							
Cheek Cr	SR 1541	08/21/96	7	25	88	6.2	6.8
		08/15/01	5	25	108	7.1	7.0
Little R	NC 731	08/21/96	23	28	50	6.4	6.4
		08/15/01	6	28	85	8.6	7.4
Little R	SR 1340	08/22/96	20	26	60	8.0	7.3
		08/13/01	15	27	78	8.1	7.2
W Fk Little R	SR 1311	08/22/96	6	26	59	7.6	7.0
		08/13/01	6	24	68	7.5	7.0
03-07-16							
Beaverdam Cr	SR 1486	08/19/96	3	22	20	7.9	5.9
		08/14/01	3	25	14	7.5	5.6
Cartledge Cr	SR 1142	08/19/96	7	25	60	7.0	7.0
Hitchcock Cr	SR 1109	08/20/96	17	26	305	7.0	6.9
		08/15/01	7	25	74	9.3	6.7
Hitchcock Cr	SR 1486	08/19/96	3	22	20	6.0	6.3
		08/14/01	5	27	23	7.1	5.8
Marks Cr	SR 1812	08/19/96	5	30	39	6.4	6.0
03-07-17							
Jones Cr	NC 145	08/20/96	20	28	93	8.2	7.2
		08/14/01	8	26	110	5.9	7.0
N Fk Jones Cr	SR 1121	08/13/01	5	26	188	7.0	6.9
		08/20/96	6	28	120	7.8	6.8

Appendix 9. New species and distributional records for the benthic macroinvertebrate fauna of the Yadkin River basin.

Many of the rare species known to occur in the basin are limited to the headwater sections in Subbasins 01 and 02. This area includes the only coldwater streams in the basin, therefore mountain taxa will not usually occur in other subbasins. The exception to this pattern is a few sites in the Uwharrie Mountains (Barnes Creek and Dutchmans Creek, Subbasin 09). Some of the taxa limited to Subbasins 01 and 02 might be more common if the NC DWQ data base included more collections in smaller streams or collections in periods outside of the summer months. Rare taxa from the headwaters section include:

- *Diploperla morgani* -- January - May, Surry County, most recent records are from 1990.
- *Rhyacophila minor*. -- Dennis Creek, Caldwell County, 1988.
- *Agapetus* spp. -- one cluster of records (*A. iridus*?) limited to small mountain streams in the spring: Purlear Creek (Wilkes County), Endicott Creek (Surry County). A second cluster in Montgomery County probably represents a different species.
- *Setodes* spp. -- Roaring River, Wilkes County.
- *Culoptila* sp. --- Middle Fork Reddies River, Wilkes County. This species also occurs in the nearby New River basin (Allegheny County).
- *Micrasema sprulesi* -- Little Endicott Creek, Surry County, February 1991.
- *Micrasema rusticum* -- Elk Creek, Wilkes County, December 1987.
- *Micrasema charonis* -- Roaring River and Mulberry Creek, Wilkes County. Specimens also have been collected from the West Fork of the Little River, Montgomery County.
- *Micrasema rickeri* -- Elk Creek, Buffalo Creek, and Laurel Fork.
- *Cambarus (Puncticambarrus)* n sp. A distinctly striped species (being described by John Cooper, NC State Museum of Natural History), in high gradient streams in Wilkes County. Populations are also known from the upper Broad River basin. This species is rare even within the known range.

The South Fork Yadkin River catchment (Subbasin 06) includes some extremely rare species, in spite of widespread habitat problems. This pattern suggests that sandy streams may be natural in this geographic area.

- *Homoeoneuria cahabensis* -- This very rare mayfly is known only from limited areas in North Carolina and Alabama. The largest number of individuals have been collected from Third Creek with other records from several sites on Hunting Creek. Recent collections by CP&L also have recorded this species in the Pee Dee River near the NC/SC state line.
- *Macdunnoa brunnea* -- the greatest numbers in the basin were observed in Hunting Creek (June 1990), with another record from the Yadkin River, Wilkes County.
- *Pseudiron centralis* -- Fourth and Hunting Creeks, Iredell County.

The mainstem of the Pee Dee River near the NC/SC state line is a unique habitat that supports a variety of unusual fish and invertebrate species. Recent collection by CP&L biologists (Rick Smith, pers. comm.) have documented:

- *Hydroperla phomidia* (only NC record).
- *Homoeoneuria cahabensis*.

The Little River (Subbasin 15) and Barnes Creek (Subbasin 09) have remarkably high EPT taxa richness for piedmont sites. Values as great as 40 have been recorded. Both streams are within the Slate Belt ecoregion and drain portions of the Uwharrie Mountains. Barnes Creek (and nearby Dutchmans Creek) contain a number of disjunct mountain taxa: *Epeorus rubidus*, *Dolophilodes*, *Rhyacophila vuphipes* (single larvae in 2001), and *Symphitopsyche sparna*. Other unusual taxa include *Stenonema vicarium*, *Helicopsyche borealis*, *Micrasema bennetti*, and *Psilotreta.*

The Little River is notable for a diverse mussel assemblage, but the most notable record is for a new caddisfly species in the genus *Ceraclea*. This species is being described by John Morse of Clemson University, and will be considered as a candidate for the endangered species list. This species is of interest because of the following characteristics:

- Very limited distribution, found only in a few miles of the Little River and absent from tributaries and other nearby rivers. A single spill event could eliminate the entire population.
- Rare even within the known range.

- Taxonomically distinct, i.e., very different from other species in this genus.
- Ecologically distinct, acting as a predator on freshwater snails.

The most significant areas for rare mussel species include the Little and Uwharrie Rivers catchments in Montgomery and Randolph counties and Goose Creek in Union County. Survey work by the North Carolina Wildlife Resources Commission recently discovered specimens of *Valvata cf. sincera* in the Little River at SR 1148, Richmond County (Watson and Fullerton 2000). This is the first state record and a large range extension.

Freshwater mussels can be difficult to collect during routine water quality surveys. The most complete source of information is summarized by the North Carolina Nongame and Endangered Wildlife Program (http://www.ncwildlife.org). At least 11 species in need of protection occur in the basin (Table 1).

Table 1. Species of mussels listed as endangered, threatened, of special concern, or significantly rare in the Yadkin River basin.

Species	Common Name	Status[1]
Lasmigona decorata	Carolina heelsplitter	FE
Alasmidonta varicosa	Brook floater	SE
Villosa vaughaniana	Carolina creekshell	SE
Toxolasma pulla	Savannah lilliput	SE
Lampsilis cariosa	Yellow lampmussel	SE
Lampsilis radiata conspicua	Carolina fatmucket	ST
Stophitus undulatus	Creeper	ST
Elliptio roanokensis	Roanoke slabside	ST
Alasmidonta undulata	Triangle floater	ST
Villosa constricta	Notched rainbow	SC
Villosa delumbis	Eastern creekshell	SR

[1]FE = federally endangered; SE = state endangered; ST = state threatened; SC = special concern; and SR = significantly rare.

Appendix 10. Fish community sampling methods and criteria.

In 2001, 36 of the 56 Yadkin River basin sites which had been previously sampled in 1996 were sampled again, while the remaining 20 sites represented new monitoring sites. Some sites that were sampled during the initial cycle of basinwide monitoring in 1996 were not resampled in 2001 because of lack of flow or because there were already sufficient data collected since 1996 to assess the fish community in these streams. The new sites were selected:

- to represent possible regional reference sites;
- because the stream had been placed on the 303 (d) impaired stream list but from which fish community data were lacking (Table 1);
- to represent typical streams draining rural or urban watersheds and which may be impacted primarily by nonpoint source pollution; or
- because the site represented a more suitable location than the site which had been sampled in 1996.

Table 1. Fish community sites monitored in 2001 that are on the state's 303(d) list of impaired waters (NCDENR 2000).

Subbasin/ Waterbody	Reach Affected	Suspected Cause
04		
Salem Cr	Salem Lake to Muddy Cr	Turbidity and historical listing for "sediment" based on biological impairment
Grants Cr	Source to the Yadkin R	Fecal coliform bacteria, turbidity and historical listing for "sediment" based on biological impairment
07		
Rich Fork Cr	Source to Abbotts Cr	Fecal coliform bacteria from potential sources such as agriculture, construction, municipal point sources, urban runoff/storm sewers
14		
Lanes Cr	SR 1929 (Union County) to the Marshville Water Supply Dam	Historical listing for "sediment" based on biological impairment
16		
Cartledge Cr	Source to Pee Dee R	Unknown causes potentially due to agriculture
17		
S Fk Jones Cr	SR 1821 to Jones Cr	Historical listing for "sediment" based on biological impairment

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 that were 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 at: http://www.esb.enr.state.nc.us/BAU.html.

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 of the stream from which the sample was collected.

The NCIBI has recently been revised (NCDENR 2001b). Currently, 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 been recalibrated against regional reference site data (Biological Assessment Unit Memorandum 09222000) (Tables 2 - 3).

Table 2. Revised scores and classes for evaluating the fish community of a wadeable stream using the North Carolina Index of Biotic Integrity in the Broad, Catawba, Savannah, and Yadkin River basins.

NCIBI Scores	NCIBI Classes
> 54	Excellent
48 - 52	Good
42 - 46	Good-Fair
36 - 40	Fair
≤ 34	Poor

Criteria and ratings applicable only to wadeable streams in the mountain and piedmont regions of the Yadkin River basin are the same as those for the Broad, Catawba, and Savannah River basins. The definition of the mountain and piedmont for these four river basins is based on a map of North Carolina watersheds by Fels (1997). Metrics and ratings should not be applied to non-wadeable streams and trout streams in each of these basins. These streams, along with streams draining the Sandhills ecoregion in the southeast corner of the Yadkin River basin, are currently not rated.

Blackspot Disease

Black spot disease is a naturally occurring, common infection of fish by an immature stage of flukes. The life cycle involves fish, snails, and piscivorous birds or mammals. Although heavy, acute infections can be fatal, especially to small fish, fish can carry amazingly high worm burdens without any apparent ill effects (Noga 1996). The infections may often be disfiguring and render the fish unpalatable or aesthetically unpleasing (Figure 1).

Figure 1. Heavy infestation of blackspot disease on creek chub.

Although some researchers incorporate the incidence of black spot incidence into indices of biotic integrity (e.g., Steedman 1991), others, because of a lack of a consistent, inverse relationship to environmental quality, do not (e.g., Sanders et al. 1999). The disease is not considered in Metric 11 of the NCIBI because it is widespread, affecting fish in all types of streams ranging from Fair to Excellent.

In the Yadkin River basin, the incidence of blackspot disease seemed to be especially prevalent in some of the Carolina Slate Belt streams such as Lanes, Richardson, Salem, Island, Clarks, Betty McGees, Lick, and Mountain Creeks. The infestation was absent in the streams draining the urban Winston-Salem area and in sandy bottom streams in Rowan County. The disease was especially prevalent in bluehead chub, creek chub, redlip shiner, highback chub, and satinfin shiner.

Table 2. Scoring criteria for the NCIBI for wadeable streams in the mountain and piedmont ecoregions of the Broad, Catawba, Savannah, and Yadkin River basins with watershed drainage areas ranging between 2.8 and 245 mi^2.

No.	Metric		Score
1	**No. of species**		
	where Y is the number of species in the sample and X is the stream's drainage area in mi^2:		
	$Y \geq 9.5 * Log_{10}X + 1.6$		5
	$4.8 * Log_{10}X + 0.8 \leq Y < 9.5 * Log_{10}X + 1.6$		3
	$Y < 4.8 * Log_{10}X + 0.8$		1
2	**No. of fish**		
	Mountains	Piedmont	
	≥ 300 fish	≥ 150 fish	5
	200-299 fish	100-149 fish	3
	< 200 fish	< 100 fish	1
3	**No. of species of darters**		
	where Y is the number of species of darters in the sample and X is the stream's drainage area in mi^2.		
	$Y \geq 1.6 * Log_{10}X$		5
	$0.8 * Log_{10}X \leq Y < 1.6 * Log_{10}X$		3
	$Y < 0.8 * Log_{10}X$		1
	If the drainage area is > 70 mi^2, then ≥ 3 species = 5		
4	**No. of species of sunfish, bass, and trout**		
	≥ 3 species		5
	2 species		3
	0 or 1 species		1
5	**No. of species of suckers**		
	≥ 2 species		5
	1 species		3
	0 species		1
6	**No. of intolerant species**		
	Mountains	Piedmont	
	≥ 3 species	≥ 1 species	5
	1or 2 species	(no middle criteria or score)	3
	0 species	0 species	1
7	**Percentage of tolerant individuals**		
	Mountains	Piedmont	
	≤ 12%	≤ 25%	5
	13-25%	26-35%	3
	> 25%	> 35%	1
8	**Percentage of omnivorous and herbivorous individuals**		
	10-35%		5
	36-50%		3
	> 50%		1
	< 10%		1
9	**Percentage of insectivorous individuals**		
	60-90%		5
	45-59%		3
	< 45%		1
	> 90%		1
10	**Percentage of piscivorous individuals**		
	≥ 1.0%		5
	0.25-1.0%		3
	≤ 0.24%		1
11	**Percentage of diseased fish (DELT = diseased, fin erosion, lesions, and tumors)**		
	< 0.75%		5
	0.76-1.25%		3
	> 1.25%		1
12	**Percentage of species with multiple age groups**		
	Mountains	Piedmont	
	≥ 65% of all species have multiple age groups	≥ 55% of all species have multiple age groups	5
	45-64% all species have multiple age groups	35-54% all species have multiple age groups	3
	< 45% all species have multiple age groups	< 35% all species have multiple age groups	1

Table 3. Tolerance ratings and adult trophic guild assignments for fish in the Yadkin River basin.

Family/ Species	Common Name	Tolerance Rating	Trophic Guild of Adults
Petromyzontidae	**Lampreys**		
Petromyzon marinus	Sea lamprey	Intermediate	Parasitic
Acipenseridae	**Sturgeons**		
Acipenser brevirostrum	Shortnose sturgeon	Intermediate	Insectivore
A. oxyrinchus	Atlantic sturgeon	Intermediate	Insectivore
Lepisosteidae	**Gars**		
Lepisosteus osseus	Longnose gar	Tolerant	Piscivore
Amiidae	**Bowfins**		
Amia calva	Bowfin	Tolerant	Piscivore
Anguillidae	**Eels**		
Anguilla rostrata	American eel	Intermediate	Piscivore
Clupeidae	**Herrings and shads**		
Alosa aestivalis	Blueback herring	Intermediate	Insectivore
A. sapidissima	American shad	Intermediate	Insectivore
Dorosoma cepedianum	Gizzard shad	Intermediate	Omnivore
D. petenense	Threadfin shad	Intermediate	Omnivore
Salmonidae	**Trouts and Chars**		
Oncorhynchus mykiss	Rainbow trout	Intolerant	Insectivore
Salmo trutta	Brown trout	Intermediate	Piscivore
Salvelinus fontinalis	Brook trout	Intolerant	Insectivore
Esocidae	**Pikes**		
Esox americanus americanus	Redfin pickerel	Intermediate	Piscivore
E. niger	Chain pickerel	Intermediate	Piscivore
Cyprinidae	**Minnows**		
Campostoma anomalum	Stoneroller	Intermediate	Herbivore
Carassius auratus	Goldfish	Tolerant	Omnivore
Clinostomus funduloides	Rosyside dace	Intermediate	Insectivore
Ctenopharyngodon idella	Grass carp	Tolerant	Herbivore
Cyprinella analostana	Satinfin shiner	Tolerant	Insectivore
C. chloristia	Greenfin shiner	Intermediate	Insectivore
C. labrosa	Thicklip chub	Intolerant	Insectivore
C. lutrensis	Red shiner	Tolerant	Insectivore
C. nivea	Whitefin shiner	Intermediate	Insectivore
C. pyrrhomelas	Fieryblack shiner	Intolerant	Insectivore
C. zanema	Thinlip chub	Intolerant	Insectivore
Cyprinus carpio	Common carp	Tolerant	Omnivore
Hybognathus regius	Silvery minnow	Intermediate	Herbivore
Hybopsis hypsinotus	Highback chub	Intolerant	Insectivore
Luxilus coccogenis	Warpaint shiner	Intermediate	Insectivore
Lythrurus ardens	Rosefin shiner	Intermediate	Insectivore
Nocomis leptocephalus	Bluehead chub	Intermediate	Omnivore
Notemigonus crysoleucas	Golden shiner	Tolerant	Omnivore
Notropis alborus	Whitemouth shiner	Intermediate	Insectivore
N. altipinnis	Highfin shiner	Intermediate	Insectivore
N. amoenus	Comely shiner	Intermediate	Insectivore
N. chiliticus	Redlip shiner	Intermediate	Insectivore
N. cummingsae	Dusky shiner	Intermediate	Insectivore
N. hudsonius	Spottail shiner	Intermediate	Omnivore
N. maculatus	Taillight shiner	Intolerant	Insectivore
N. petersoni	Coastal shiner	Intermediate	Insectivore
N. procne	Swallowtail shiner	Intermediate	Insectivore
N. scepticus	Sandbar shiner	Intermediate	Insectivore
N. telescopus	Telescope shiner	Intolerant	Insectivore
Phoxinus oreas	Mountain redbelly dace	Intermediate	Herbivore
Pimephales promelas	Fathead minnow	Tolerant	Omnivore

Table 3 (continued).

Family/ Species	Common Name	Tolerance Rating	Trophic Guild of Adults
Rhinichthys atratulus	Blacknose dace	Intermediate	Insectivore
Semotilus atromaculatus	Creek chub	Tolerant	Insectivore
S. lumbee	Sandhills chub	Intolerant	Insectivore
Catostomidae	**Suckers**		
Carpiodes cyprinus	Quillback	Intermediate	Omnivore
C. velifer complex	Highfin carpsucker	Intermediate	Insectivore
Catostomus commersoni	White sucker	Tolerant	Omnivore
Erimyzon oblongus	Creek chubsucker	Intermediate	Omnivore
Hypentelium nigricans	Northern hogsucker	Intermediate	Insectivore
Ictiobus bubalus	Smallmouth buffalo	Intermediate	Omnivore
I. cyprinellus	Bigmouth buffalo	Intermediate	Insectivore
Minytrema melanops	Spotted sucker	Intermediate	Insectivore
Moxostoma collapsum	Notchlip redhorse	Intermediate	Insectivore
M. macrolepidotum	Shorthead redhorse	Intermediate	Insectivore
M. pappillosum	V-lip redhorse	Intermediate	Insectivore
M. robustum	Robust redhorse	Intolerant	Insectivore
M. sp. cf. *erythrurum*	Carolina redhorse	Intermediate	Insectivore
Scartomyzon rupiscartes	Striped jumprock	Intermediate	Insectivore
S. sp. cf. *lachneri*	Brassy jumprock	Intermediate	Insectivore
Ictaluridae	**Catfishes**		
Ameiurus brunneus	Snail bullhead	Intermediate	Insectivore
A. catus	White catfish	Tolerant	Omnivore
A. melas	Black bullhead	Tolerant	Insectivore
A. natalis	Yellow bullhead	Tolerant	Omnivore
A. nebulosus	Brown bullhead	Tolerant	Omnivore
A. platycephalus	Flat bullhead	Tolerant	Insectivore
Ictalurus furcatus	Blue catfish	Intermediate	Piscivore
I. punctatus	Channel catfish	Intermediate	Omnivore
Noturus gyrinus	Tadpole madtom	Intermediate	Insectivore
N. insignis	Margined madtom	Intermediate	Insectivore
Pylodictis olivaris	Flathead catfish	Intermediate	Piscivore
Aphredoderidae	**Pirate perches**		
Aphredoderus sayanus	Pirate perch	Intermediate	Insectivore
Fundulidae	**Topminnows**		
Fundulus lineolatus	Lined topminnow	Intermediate	Insectivore
F. rathbuni	Speckled killifish	Intermediate	Insectivore
Poeciliidae	**Livebearers**		
Gambusia holbrooki	Eastern mosquitofish	Tolerant	Insectivore
Atherinidae	**Silversides**		
Labidesthes sicculus	Brook silverside	Intermediate	Insectivore
Moronidae	**Temperate basses**		
Morone americana	White perch	Intermediate	Piscivore
M. chrysops	White bass	Intermediate	Piscivore
M. saxatilis	Striped bass	Intermediate	Piscivore
Centrarchidae	**Sunfishes and Black Basses**		
Acantharchus pomotis	Mud sunfish	Intermediate	Insectivore
Ambloplites rupestris	Rock bass	Intolerant	Piscivore
Centrarchus macropterus	Flier	Intermediate	Insectivore
Enneacanthus gloriosus	Bluespotted sunfish	Intermediate	Insectivore
Lepomis auritus	Redbreast sunfish	Tolerant	Insectivore
L. cyanellus	Green sunfish	Tolerant	Insectivore
L. gibbosus	Pumpkinseed	Intermediate	Insectivore
L. gulosus	Warmouth	Intermediate	Insectivore
L. macochirus	Bluegill	Intermediate	Insectivore
L. marginatus	Dollar sunfish	Intermediate	Insectivore
L. microlophus	Redear sunfish	Intermediate	Insectivore

Table 3 (continued).

Family/ Species	Common Name	Tolerance Rating	Trophic Guild of Adults
Lepomis sp.	Hybrid sunfish	Tolerant	Insectivore
Micropterus dolomieu	Smallmouth bass	Intolerant	Piscivore
M. punctulatus	Spotted bass	Intermediate	Piscivore
M. salmoides	Largemouth bass	Intermediate	Piscivore
Pomoxis annularis	White crappie	Intermediate	Piscivore
P. nigromaculatus	Black crappie	Intermediate	Piscivore
Percidae	**Darters and Perches**		
Etheostoma collis	Carolina darter	Intermediate	Insectivore
E. flabellare	Fantail darter	Intermediate	Insectivore
E. fusiforme	Swamp darter	Intermediate	Insectivore
E. olmstedi	Tessellated darter	Intermediate	Insectivore
E. serrifer	Sawcheek darter	Intolerant	Insectivore
Perca flavescens	Yellow perch	Intermediate	Piscivore
Percina crassa	Piedmont darter	Intolerant	Insectivore
Stizostedion vitreum	Walleye	Intermediate	Piscivore

Appendix 11. Fish community structure data collected in the Yadkin River basin, 1990 - 2001. Current basinwide sites are in bold font.

Subbasin/Waterbody	Station	County	Index No.	Date	NCIBI Score	NCIBI Rating
03-07-01						
Yadkin R	NC 268	Caldwell	12-1	06/18/01	48	Good
				05/23/96	48	Good
Buffalo Cr	SR 1594	Caldwell	12-19	06/08/99	56	Excellent
Laurel Cr	SR 1508	Watauga	12-24-8	05/05/99	52	Good
				10/01/98	54	Excellent
				05/23/96	54	Excellent
Beaver Cr	SR 1131	Wilkes	12-25	06/18/01	50	Good
				05/21/96	50	Good
North Prong Lewis Fk	SR 1304	Wilkes	12-31-1-(5.5)	06/19/01	56	Excellent
				05/21/96	48	Good
South Prong Lewis Fk	SR 1154	Wilkes	12-31-2-(7)	06/19/01	48	Good
				05/21/96	50	Good
Middle Fork Reddies R	SR 1562	Wilkes	12-40-2	05/06/99	58	Excellent
North Fork Reddies R	SR 1501	Wilkes	12-40-4	05/05/99	52	Good
				05/22/96	50	Good
North Fork Reddies R	SR 1567	Wilkes	12-40-4	06/19/01	56	Excellent
				05/05/99	58	Excellent
Cub Cr	SR 1001	Wilkes	12-41	06/18/01	50	Good
Middle Prong Roaring R	SR 1002	Wilkes	12-46-2-(6)	06/20/01	56	Excellent
				05/22/96	50	Good
Basin Cr	SR 1730	Wilkes	12-46-2-2	05/22/96	58	Excellent
East Prong Roaring R #1	SR 1739	Wilkes	12-46-4-(1)	10/21/98	52	Good
East Prong Roaring R #2	SR 1739	Wilkes	12-46-4-(5)	10/20/98	54	Excellent
East Prong Roaring R #3	SR 1739	Wilkes	12-46-4-(5)	10/20/98	58	Excellent
Garden Cr	SR 1739	Wilkes	12-46-4-6	05/22/96	54	Excellent
03-07-02						
Mitchell R	SR 1330	Surry	12-62-1	05/26/99	52	Good
				05/16/96	46	Good-Fair
Fisher R	SR 1331	Surry	12-63-(1)	06/20/01	60	Excellent
Little Fisher R	SR 1480	Surry	12-63-10-(2)	06/20/01	50	Good
				05/16/96	46	Good-Fair
Cody Cr	US 268	Surry	12-63-14	05/16/96	50	Good
Little Yadkin R	SR 1236	Stokes	12-77-(1)	06/21/01	54	Excellent
				05/17/96	54	Excellent
North Deep Cr	SR 1605	Yadkin	12-84-1	06/21/01	44	Good-Fair
				05/15/96	44	Good-Fair
South Deep Cr	SR 1152	Yadkin	12-84-2-(1)	06/22/01	52	Good
				05/15/96	48	Good
03-07-03						
Stewarts Cr	SR 1622	Surry	12-72-9-1	06/21/01	56	Excellent
				05/17/96	54	Excellent
Toms Cr	SR 2024	Surry	12-72-14-(4)	06/21/01	56	Excellent
03-07-04						
Muddy Cr	SR 1891	Forsyth	12-94-(0.5)	04/30/01	38	Fair
				05/14/96	34	Poor
Silas Cr	SR 1137	Forsyth	12-94-10	04/30/01	40	Fair
Salem Cr	off SR 1120	Forsyth	12-94-12-(4)	04/30/01	30	Poor
South Fork Muddy Cr	SR 2902	Forsyth	12-94-13	04/30/01	42	Good-Fair
Grants Cr	SR 2200	Rowan	12-110	05/02/01	42	Good-Fair
Town Cr	SR 1526	Rowan	12-115-3	04/25/96	40	Fair
03-07-05						
Dutchmans Cr	US 158	Davie	12-102-(2)	05/04/01	44	Good-Fair
				05/13/96	38	Fair
Cedar Cr	SR 1437	Davie	12-102-13-(2)	05/04/01	50	Good
				05/13/96	46	Good-Fair
03-07-06						
South Yadkin R	SR 1561	Iredell	12-108-(5.5)	05/03/01	46	Good-Fair
				05/14/96	40	Fair
Olin Cr	SR 1892	Iredell	12-108-11-3-3	05/14/96	36	Fair
Hunting Cr	NC 115	Wilkes	12-108-16-(0.5)	05/03/01	58	Excellent
				05/15/96	56	Excellent
				06/16/92	52	Good
Hunting Cr	SR 2423	Wilkes	12-108-16-(0.5)	06/16/92	46	Good-Fair

Appendix 11 (continued).

Subbasin/Waterbody	Station	County	Index No.	Date	NCIBI Score	NCIBI Rating
03-07-06						
North Little Hunting Cr	SR 1829	Iredell	12-108-16-6	05/03/01	50	Good
				05/14/96	44	Good-Fair
Fourth Cr	SR 1985	Rowan	12-108-20-(3.5)	05/02/01	28	Poor
				04/26/96	32	Poor
Third Cr	SR 1970	Rowan	12-108-20-4-(7)	05/02/01	34	Poor
				04/25/96	40	Fair
North Second Cr	SR 1526	Rowan	12-108-21	05/02/01	42	Good-Fair
				04/25/96	40	Fair
03-07-07						
Abbotts Cr	SR 1800	Davidson	12-119-(4.5)	05/01/01	46	Good-Fair
				04/24/96	44	Good-Fair
Rich Fork Cr	NC 109	Davidson	12-119-7	05/01/01	34	Poor
				04/25/96	34	Poor
03-07-08						
Lick Cr	NC 8	Davidson	12-126-(3)	04/19/01	44	Good-Fair
				04/23/96	44	Good-Fair
Cabin Cr	SR 2536	Davidson	12-127-(2)	05/01/01	48	Good
				04/24/96	52	Good
Mountain Cr	SR 1720	Stanly	13-5-(0.7)	04/17/01	46	Good-Fair
				04/18/96	50	Good
03-07-09						
Uwharrie R	SR 1406	Randolph	13-2-(0.5)	10/26/99	44	Good-Fair
				06/15/99	54	Excellent
				04/14/99	58	Excellent
				04/24/96	52	Good
Betty McGees Cr	SR 1107	Randolph	13-2-5	04/16/01	52	Good
				04/18/96	54	Excellent
Barnes Cr	SR 1303	Montgomery	13-2-18-(0.5)	04/16/01	54	Excellent
				10/17/97		Not rated
				04/22/96	48	Good
Dutchmans Cr	SR 1150	Montgomery	13-2-24	04/22/96		Not rated
03-07-10						
Clarks Cr	SR 1188	Montgomery	13-16	04/12/01	54	Excellent
Brown Cr	SR 1230	Anson	13-20	04/10/01	52	Good
				04/16/96	48	Good
Cedar Cr	SR 1709	Anson	13-21	04/10/01	46	Good-Fair
				06/10/96		Not rated
Mountain Cr	SR 1150	Richmond	13-28-(0.5)	04/15/96	52	Good
Big Mountain Cr	SR 1319	Richmond	13-28-1-(0.5)	10/27/99	46	Good-Fair
				06/15/99	52	Good
				04/12/99	54	Excellent
				09/22/98	56	Excellent
Big Mountain Cr	NC 73	Richmond	13-28-1-(0.5)	04/12/99	52	Good
Big Mountain Cr	SR 1005	Richmond	13-28-1-(0.5)	04/12/99	54	Excellent
03-07-11						
Rocky R	SR 1608	Cabarrus	13-17	04/14/99	32	Poor
				04/17/96	34	Poor
Mallard Cr	SR 2467	Mecklenburg	13-17-5	04/19/01	56	Excellent
				06/10/96	50	Good
Reedy Cr	SR 1136	Cabarrus	13-17-8	04/18/01	46	Good-Fair
03-07-12						
Irish Buffalo Cr	SR 1132	Cabarrus	13-17-9-(2)	04/19/01	50	Good
				04/17/96	52	Good
Coldwater Cr	NC 73	Cabarrus	13-17-9-4-(1.5)	04/18/01	44	Good-Fair
				04/17/96	52	Good
Dutch Buffalo Cr	SR 2622	Cabarrus	13-17-11-(5)	04/18/01	52	Good
				04/17/96	44	Good-Fair
North Fork Crooked Cr # 1	SR 1514	Union	13-17-20-1	10/03/95	46	Good-Fair
North Fork Crooked Cr # 2	SR 1514	Union	13-17-20-1	10/03/95	50	Good
South Fork Crooked Cr # 1	SR 1515	Union	13-17-20-2	10/03/95	42	Good-Fair
South Fork Crooked Cr # 2	SR 1515	Union	13-17-20-2	10/03/95	38	Fair
03-07-13						
Big Bear Cr	NC 73	Stanly	13-17-31-5	04/18/01	48	Good
				04/18/96	52	Good

Appendix 11 (continued).

Subbasin/Waterbody	Station	County	Index No.	Date	NCIBI Score	NCIBI Rating
03-07-14						
Island Cr	SR 1118	Stanly	13-17-26	04/11/01	54	Excellent
Richardson Cr	NC 207	Union	13-17-36-(3.5)	04/11/01	46	Good-Fair
Salem Cr	SR 1006	Union	13-17-36-15	04/11/01	48	Good
				06/10/96	36	Fair
Lanes Cr	SR 1929	Union	13-17-40-(1)	04/11/01	40	Fair
Lanes Cr	SR 1415	Anson	13-17-40-(12)	04/16/96	40	Fair
03-07-15						
Little R	SR 1127	Randolph	13-25-(1)	04/14/99	52	Good
Little R	NC 134	Randolph	13-25-(1)	04/13/99	52	Good
Little R	SR 1135	Randolph	13-25-(1)	04/13/99	52	Good
West Fork Little R	SR 1311	Montgomery	13-25-15	04/17/01	52	Good
				04/23/96	56	Excellent
Dumas Cr	SR 1310	Montgomery	13-25-20-8	04/16/01	54	Excellent
Bridgers Cr	SR 1519	Montgomery	13-25-24	04/22/96	52	Good
Rocky Cr	NC 24/27	Montgomery	13-25-30-(0.3)	04/23/96		Not rated
Rocky Cr	SR 1549	Montgomery	13-25-30-(0.5)	04/17/01	54	Excellent
Cheek Cr	SR 1563	Montgomery	13-25-36	10/26/99	56	Excellent
				06/15/99	56	Excellent
				04/13/99	58	Excellent
				09/21/98	58	Excellent
Cheek Cr	SR 1541	Montgomery	13-25-36	04/23/96	54	Excellent
Hamer Cr	SR 1159	Richmond	13-25-37	04/05/01	36	Fair
03-07-16						
Cartledge Cr	SR 1142	Richmond	13-35	04/06/01	50	Good
Hitchcock Cr	SR 1486	Richmond	13-39-(1)	04/05/01		Not rated
Rocky Fork Cr	SR 1424	Richmond	13-39-8	04/05/01		Not rated
Rocky Fork Cr	SR 1487	Richmond	13-39-8	08/21/90		Not rated
Beaverdam Cr	SR 1486	Richmond	13-39-8-7	04/15/96		Not rated
Marks Cr	SR 1104	Richmond	13-45-(2)	04/06/01		Not rated
03-07-17						
Jones Cr	SR 1812	Anson	13-42	04/16/96	34	Poor
Bailey Cr	SR 1811	Anson	13-42-1-3	04/06/01	52	Good
				04/15/96	52	Good
South Fork Jones Cr	SR 1821	Anson	13-42-2	04/10/01	54	Excellent

Appendix 12. Fish community metric values from wadeable streams in the 2001 Yadkin River basinwide monitoring program.[1]

Subbasin Waterbody	Location	County	Eco-region	d. a. (mi^2)	Date	No. Species	No. Fish	No. Sp. Darters	No. Sp. Sunfish + Bass + Trout	No. Sp. Suckers	No. Intol. Sp.	% Tolerant	% Omni. +Herb.	% Insect.	% Pisc.	% DELT	% MA
03-07-01																	
Yadkin R	NC 268	Caldwell	P	85.2	06/18/01	20	589	3	1	4	4	9	45	55	0.00	0.00	70
Beaver Cr	SR 1131	Wilkes	P	17.4	06/18/01	19	464	2	6	3	1	19	73	27	0.43	0.00	63
N Pr Lewis Fk	SR 1304	Wilkes	MT	23.7	06/19/01	17	681	3	3	4	3	1	35	64	0.44	0.00	59
S Pr Lewis Fk	SR 1154	Wilkes	MT	32.3	06/19/01	17	1009	3	1	3	4	3	49	51	0.00	0.00	100
N Fk Reddies R	SR 1567	Wilkes	MT	12.7	06/19/01	17	718	1	6	2	5	2	35	62	2.65	0.00	59
M Pr Roaring R	SR 1002	Wilkes	MT	57.3	06/20/01	20	599	3	3	5	6	2	48	48	4.51	0.00	65
03-07-02																	
Fisher R	SR 1331	Surry	P	51.2	06/20/01	18	441	3	4	2	5	7	35	63	2.27	0.00	83
L Fisher R	SR 1480	Surry	P	21.3	06/20/01	19	769	3	2	3	5	8	40	60	0.13	0.00	53
L Yadkin R	SR 1236	Stokes	P	42.8	06/21/01	22	1058	3	3	3	4	11	40	60	0.09	0.00	68
N Deep Cr	SR 1605	Yadkin	P	35.8	06/21/01	13	359	0	4	1	1	19	51	48	0.56	0.00	62
S Deep Cr	SR 1152	Yadkin	P	50.6	06/22/01	19	375	2	4	3	2	20	37	62	0.53	0.00	42
03-07-03																	
Stewarts Cr	SR 1622	Surry	P	24.2	06/21/01	17	570	3	2	3	4	6	29	71	0.18	0.00	65
Toms Cr	SR 2024	Surry	P	37.7	06/21/01	23	731	3	5	4	3	13	35	65	0.14	0.00	57
03-07-04																	
Muddy Cr	SR 1891	Forsyth	P	89.2	04/30/01	13	194	2	3	1	0	24	59	40	0.52	0.52	46
Silas Cr	SR 1137	Forsyth	P	11.9	04/30/01	12	252	0	5	0	0	16	38	62	0.00	1.19	67
Salem Cr	off SR 1120	Forsyth	P	65.6	04/30/01	8	176	0	4	0	0	51	43	57	0.00	0.00	38
S Fk Muddy Cr	SR 2902	Forsyth	P	42.9	04/30/01	13	215	2	2	0	1	47	22	78	0.00	0.00	77
Grants Cr	SR 2200	Rowan	P	55.1	05/02/01	12	376	2	3	1	0	15	37	63	0.00	0.27	50
03-07-05																	
Dutchmans Cr	US 158	Davie	P	57.6	05/04/01	17	303	2	4	3	1	21	60	40	0.66	0.33	53
Cedar Cr	SR 1437	Davie	P	10.9	05/04/01	11	437	1	4	1	1	84	12	86	1.37	0.23	64
03-07-06																	
South Yadkin R	SR 1561	Iredell	P	69.3	05/03/01	16	639	2	2	4	3	9	45	55	0.16	0.00	63
Hunting Cr	NC 115	Wilkes	P	29.8	05/03/01	17	625	3	2	4	4	6	30	69	1.28	0.00	76
N Little Hunting Cr	SR 1829	Iredell	P	54.5	05/03/01	21	422	3	3	3	3	17	54	46	0.24	0.00	71
Fourth Cr	SR 1985	Rowan	P	80.0	05/02/01	12	93	1	3	1	0	39	56	42	1.08	0.00	33
Third Cr	SR 1970	Rowan	P	96.6	05/02/01	11	49	1	2	0	1	16	61	35	4.08	0.00	45
N Second Cr	SR 1526	Rowan	P	63.3	05/02/01	9	248	2	2	1	1	13	44	56	0.00	0.00	56
03-07-07																	
Abbotts Cr	SR 1800	Davidson	P	37.1	05/01/01	15	505	2	4	3	0	17	42	57	0.40	0.20	60
Rich Fork Cr	NC 109	Davidson	P	25.6	05/01/01	12	241	0	5	1	0	30	63	37	0.41	0.00	50
03-07-08																	
Lick Cr	NC 8	Davidson	P	28.0	04/19/01	16	564	2	5	2	0	38	40	60	0.00	0.35	56
Cabin Cr	SR 2536	Davidson	P	18.7	05/01/01	15	142	1	6	2	0	31	33	63	3.52	0.70	47
Mountain Cr	SR 1720	Stanly	P	14.0	04/17/01	15	784	1	6	2	0	28	42	58	0.26	0.13	60
03-07-09																	
Betty McGees Cr	SR 1107	Randolph	P	8.0	04/16/01	15	307	2	4	1	1	35	30	69	0.33	0.00	53
Barnes Cr	SR 1303	Montgomery	P	22.4	04/16/01	16	499	3	2	3	3	28	25	74	1.20	0.00	44

Appendix 12 (continued).

Subbasin Waterbody	Location	County	Eco-region	d. a. (mi^2)	Date	No. Species	No. Fish	No. Sp. Darters	No. Sp. Sunfish + Bass + Trout	No. Sp. Suckers	No. Intol. Sp.	% Tolerant	% Omni. +Herb.	% Insect.	% Pisc.	% DELT	% MA
03-07-10																	
Clarks Cr	SR 1188	Montgomery	P	26.0	04/12/01	19	415	3	2	4	2	10	26	74	0.24	0.00	63
Brown Cr	SR 1230	Anson	P	25.2	04/10/01	20	211	2	8	1	0	20	12	81	7.11	0.00	80
Cedar Cr	SR 1709	Anson	P	8.6	04/10/01	12	484	1	2	1	0	20	30	70	0.00	0.00	83
03-07-11																	
Mallard Cr	SR 2467	Mecklenburg	P	11.9	04/19/01	20	867	2	3	3	1	9	25	75	0.00	0.00	75
Reedy Cr	SR 1136	Cabarrus	P	30.9	04/18/01	17	254	1	4	2	1	21	42	58	0.00	0.00	53
03-07-12																	
Irish Buffalo Cr	SR 1132	Cabarrus	P	45.4	04/19/01	22	560	3	6	2	2	12	43	57	0.18	0.00	50
Coldwater Cr	NC 73	Cabarrus	P	34.6	04/18/01	17	337	2	3	1	1	24	7	93	0.30	0.89	65
Dutch Buffalo Cr	SR 2622	Cabarrus	P	94.4	04/18/01	19	358	3	5	1	2	9	35	65	0.28	0.00	53
03-07-13																	
Big Bear Cr	NC 73	Stanly	P	19.1	04/18/01	13	256	3	3	2	0	9	22	78	0.00	0.00	54
03-07-14																	
Island Cr	SR 1118	Stanly	P	19.2	04/11/01	20	472	3	2	3	1	21	27	73	0.00	0.00	70
Richardson Cr	NC 207	Union	P	32.6	04/11/01	14	153	2	6	1	0	36	16	82	1.96	0.65	64
Salem Cr	SR 1006	Union	P	23.6	04/11/01	18	457	2	4	3	0	15	11	89	0.22	0.00	50
Lanes Cr	SR 1929	Union	P	47.8	04/11/01	14	135	1	3	2	0	40	27	73	0.00	0.00	64
03-07-15																	
W Fk Little R	SR 1311	Montgomery	P	19.0	04/17/01	16	774	3	1	4	2	6	31	69	0.00	0.00	75
Dumas Cr	SR 1310	Montgomery	P	13.6	04/16/01	16	461	3	3	1	1	10	12	87	0.22	0.22	69
Rocky Cr	SR 1549	Montgomery	P	24.6	04/17/01	18	530	3	2	3	2	4	25	75	0.00	0.00	56
Hamer Cr	SR 1159	Richmond	P	22.7	04/05/01	11	102	1	6	1	0	27	37	63	0.00	0.00	45
03-07-16																	
Cartledge Cr	SR 1142	Richmond	P	30.2	04/06/01	17	125	1	5	1	1	15	32	65	3.20	0.00	35
Hitchcock Cr	SR 1486	Richmond	SH	15.7	04/05/01	12	58	1	5	2	1	9	9	66	25.9	0.00	50
Rocky Fork Cr	SR 1424	Richmond	SH	29.7	04/05/01	14	83	1	3	2	0	6	4	83	13.3	0.00	21
Marks Cr	SR 1104	Richmond	SH	29.9	04/06/01	13	100	1	5	0	0	35	4	89	7.00	0.00	38
03-07-17																	
Bailey Cr	SR 1811	Anson	P	13.0	04/06/01	20	395	2	5	1	1	5	48	47	1.27	0.00	45
S Fk Jones Cr	SR 1821	Anson	P	34.6	04/10/01	18	195	2	5	1	1	8	35	62	2.56	0.51	39

[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 13. Fish distributional records for the Yadkin River basin.

In 2001, the most widely distributed species (collected at all 56 sites) was the redbreast sunfish. The bluehead chub was the most abundant species; representing 32% of all the fish collected. The dominance by this species also reflected that many of the sites had an elevated percentage of omnivores, indicative of an abundance of nutrients. Other abundant species included the redlip shiner and the redbreast sunfish. Collectively, these three species accounted for 59% of all the fish collected.

Based upon Menhinick (1991), NCDWQ data, and data from other researchers, 107 species of fish are known from the Yadkin River basin in North Carolina. Six of these species have been given special protection status by the U. S. Department of the Interior, the NC Wildlife Resources Commission, or the NC Natural Heritage Program under the NC State Endangered Species Act (G.S. 113-331 to 113-337) (LeGrand *et al*. 2001; Menhinick and Braswell 1997) (Table 1). The shortnose sturgeon is considered "Endangered" at the federal level. The other species are considered as "Special Concern" at the state level.

Table 1. Species of fish listed as endangered or of special concern in the Yadkin River basin.

Species	Common Name	State Rank
Acipenser brevirostrum	Shortnose sturgeon	S1
Acipenser oxyrhynchus	Atlantic sturgeon	S3
Carpiodes velifer	Highfin carpsucker	S2
Etheostoma collis pop. 1	Carolina darter	S3
Moxostoma robustum	Robust redhorse	S1
Semotilis lumbee	Sandhills chub	S3

[1]S1 = Critically imperiled in North Carolina because of extreme rarity or because of some factor (s) making it especially vulnerable to extirpation from North Carolina. S2 = Imperiled in North Carolina because of rarity or because of some factor(s) making it very vulnerable to extirpation from North Carolina. S3 = rare or uncommon in North Carolina (LeGrand *et al*. 2001).

In 2001, as part of the NC DWQ's fish community monitoring program, the Carolina darter was collected from Brown, Big Bear, Island, Richardson, Dumas, and Hamer Creeks. Other new distributional county records included:

- central stoneroller - Wilkes and Surry,
- goldfish - Surry,
- greenfin shiner - Stanly,
- rosefin shiner - Forsyth,
- fathead minnow - Montgomery,
- spotted sucker - Davie, Davidson, Montgomery, and Randolph,
- northern hogsucker - Wilkes and Surry,
- striped jumprock - multiple records from the upper and middle Yadkin River basin,
- mud sunfish - Anson, and
- bluespotted sunfish - Montgomery.

No exotic species were collected from North Deep, North Little Hunting, Abbotts, Coldwater, Dumas, Hamer, South Fork Jones, and Marks Creeks.

Appendix 14. Water quality at fish community sites in the Yadkin River basin, 2001.

Most stream flows during 2001 were very low. Under these conditions, the streams were shallow and generally clear with conductivity readings between 20 and 433 µmhos/cm (Table 1). Except for two sites, the conductivity was greater in 2001 than in 1996 (Figure 1).

At Salem Creek (Union County) and Bailey Creek, the flows were greater in 2001 than in 1996, diluting the dissolved ions and thus decreasing the conductivity in 2001. Conductivity was greater at Rich Fork and Third Creeks in 2001 than in 1996 because the streams, which received WWTP effluent, were probably not able to dilute the effluent as much in 2001 as they were in 1996.

Table 1. Water quality at 56 basinwide fish community sites in the Yadkin River basin, 2001.

Subbasin/ Waterbody	Station	County	Date	Temperature (˚C)	Specific conductance (µmhos/cm)	Dissolved oxygen (mg/L)	Saturation (%)	pH (s.u.)
03-07-01								
Yadkin R	NC 268	Caldwell	06/18/01	20.5	65	8.8	98	7.1
Beaver Cr	SR 1131	Wilkes	06/18/01	21.4	55	7.2	81	7.2
N Pr Lewis Fk	SR 1304	Wilkes	06/19/01	19.5	30	7.3	80	7.0
S Pr Lewis Fk	SR 1154	Wilkes	06/19/01	18.8	33	9.2	99	7.2
N Fk Reddies R	SR 1567	Wilkes	06/19/01	23.5	31	8.9	105	7.5
Middle Pr Roaring R	SR 1002	Wilkes	06/20/01	20.5	35	9.5	106	7.2
03-07-02								
Fisher R	SR 1331	Surry	06/20/01	24.3	37	9.6	115	7.2
L Fisher R	SR 1480	Surry	06/20/01	21.6	66	8.7	99	7.2
L Yadkin R	SR 1236	Stokes	06/21/01	24.6	64	10.7	129	7.5
N Deep Cr	SR 1605	Yadkin	06/21/01	23.3	68	8.6	101	7.3
S Deep Cr	SR 1152	Yadkin	06/22/01	21.3	64	6.0	68	7.0
03-07-03								
Stewarts Cr	SR 1622	Surry	06/21/01	20.2	42	9.9	109	7.0
Toms Cr	SR 2024	Surry	06/21/01	21.3	61	8.5	96	7.4
03-07-04								
Muddy Cr	SR 1891	Forsyth	04/30/01	14.6	116	8.3	82	7.2
Silas Cr	SR 1137	Forsyth	04/30/01	13.5	138	8.2	79	7.0
Salem Cr	off SR 1120	Forsyth	04/30/01	18.2	178	8.7	92	7.2
S Fk Muddy Cr	SR 2902	Forsyth	04/30/01	17.0	101	9.0	93	7.2
Grants Cr	SR 2200	Rowan	05/02/01	16.0	144	7.8	79	6.9
03-07-05								
Dutchmans Cr	US 158	Davie	05/04/01	17.6	126	7.7	81	6.4
Cedar Cr	SR 1437	Davie	05/04/01	16.8	222	5.8	60	6.9
03-07-06								
South Yadkin R	SR 1561	Iredell	05/03/01	15.0	53	8.6	85	6.3
Hunting Cr	NC 115	Wilkes	05/03/01	16.0	48	8.9	90	6.6
N Little Hunting Cr	SR 1829	Iredell	05/03/01	22.0	56	8.0	92	6.9
Fourth Cr	SR 1985	Rowan	05/02/01	20.0	149	8.2	90	7.3
Third Cr	SR 1970	Rowan	05/02/01	19.0	262	8.4	91	7.2
N Second Cr	SR 1526	Rowan	05/02/01	17.0	120	9.4	97	7.3
03-07-07								
Abbotts Cr	SR 1800	Davidson	05/01/01	16.0	121	7.9	80	7.0
Rich Fork Cr	NC 109	Davidson	05/01/01	18.0	433	8.2	87	7.0
03-07-08								
Lick Cr	NC 8	Davidson	04/19/01	14.7	159	10.7	105	7.3
Cabin Cr	SR 2536	Davidson	05/01/01	18.0	114	11.3	119	7.3
Mountain Cr	SR 1720	Stanly	04/17/01	13.5	109	9.6	92	7.2
03-07-09								
Betty McGees Cr	SR 1107	Randolph	04/16/01	15.0	107	8.3	82	7.0
Barnes Cr	SR 1303	Montgomery	04/16/01	15.8	45	10.0	101	7.3
03-07-10								
Clarks Cr	SR 1188	Montgomery	04/12/01	20.0	75	6.9	76	7.0
Brown Cr	SR 1230	Anson	04/10/01	22.0	102	8.3	95	6.9
Cedar Cr	SR 1709	Anson	04/10/01	19.0	107	7.9	85	7.0
03-07-11								
Mallard Cr	SR 2467	Mecklenburg	04/19/01	11.3	153	12.3	112	7.7
Reedy Cr	SR 1136	Cabarrus	04/18/01	12.9	211	11.4	108	7.5

Table 1 (continued).

Subbasin/ Waterbody	Station	County	Date	Temperature (˚C)	Specific conductance (µmhos/cm)	Dissolved oxygen (mg/L)	Saturation (%)	pH (s.u.)
03-07-12								
Irish Buffalo Cr	SR 1132	Cabarrus	04/19/01	8.5	200	11.6	99	7.3
Coldwater Cr	NC 73	Cabarrus	04/18/01	10.5	199	10.1	91	7.1
Dutch Buffalo Cr	SR 2622	Cabarrus	04/18/01	10.2	150	11.4	102	7.2
03-07-13								
Big Bear Cr	NC 73	Stanly	04/18/01	9.0	110	10.0	87	7.0
03-07-14								
Island Cr	SR 1118	Stanly	04/11/01	23.0	93	9.5	111	7.7
Richardson Cr	NC 207	Union	04/11/01	20.0	129	6.9	76	6.9
Salem Cr	SR 1006	Union	04/11/01	22.0	153	11.9	136	8.1
Lanes Cr	SR 1929	Union	04/11/01	20.0	128	5.9	65	6.7
03-07-15								
W Fk Little R	SR 1311	Montgomery	04/17/01	14.3	57	8.4	82	7.2
Dumas Cr	SR 1310	Montgomery	04/16/01	18.0	48	9.3	98	7.0
Rocky Cr	SR 1549	Montgomery	04/17/01	13.5	47	8.0	77	7.1
Hamer Cr	SR 1159	Richmond	04/05/01	15.0	72	10.4	103	6.5
03-07-16								
Cartledge Cr	SR 1142	Richmond	04/06/01	12.0	52	11.9	110	6.5
Hitchcock Cr	SR 1486	Richmond	04/05/01	11.0	20	11.3	103	5.4
Rocky Fork Cr	SR 1424	Richmond	04/05/01	12.0	25	12.2	113	4.8
Marks Cr	SR 1104	Richmond	04/06/01	13.0	43	9.8	93	6.3
03-07-17								
Bailey Cr	SR 1811	Anson	04/06/01	15.0	82	10.7	106	6.9
S Fk Jones Cr	SR 1821	Anson	04/10/01	20.0	59	8.1	89	6.8

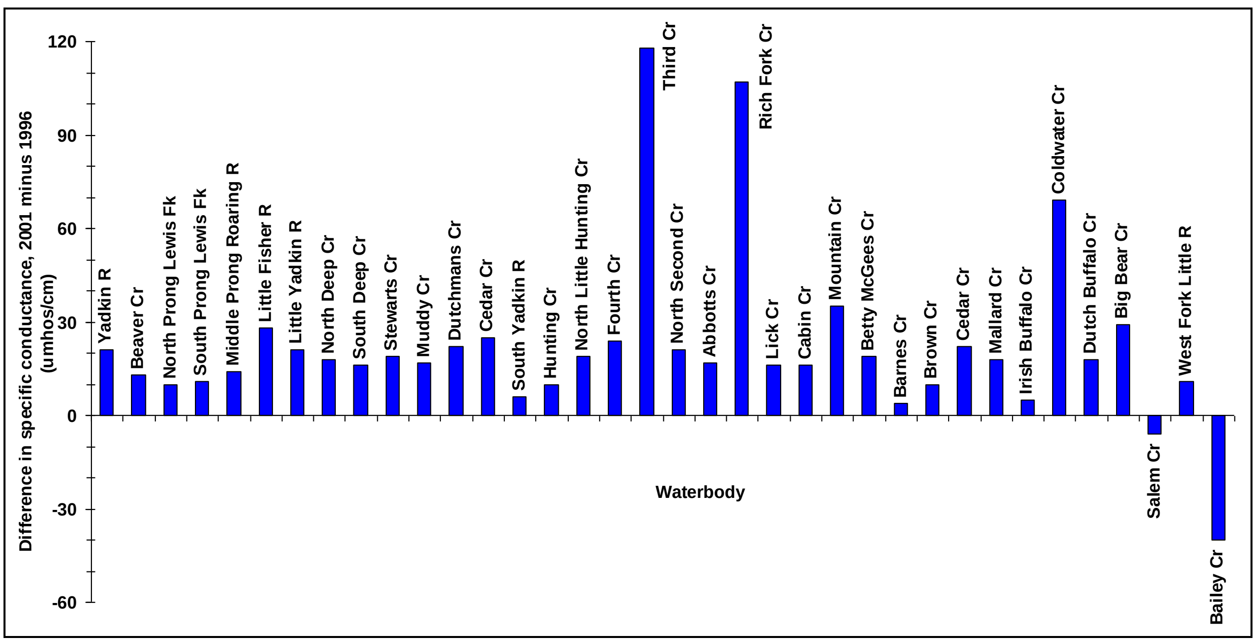


Figure 1. **A comparison of the specific conductance at 36 fish community sites in the Yadkin River basin, 1996 *vs*. 2001. A positive difference meant that conductivity was greater in 2001 than in 1996; a negative difference meant that conductivity was greater in 1996 than in 2001.**

Appendix 15. 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 1). Individual parameter results which seem to be of potential human health concern are evaluated by the N.C. Division of Occupational and Environmental Epidemiology by request from the Water Quality Section.

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 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 DWQ 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 1. 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 16. Wet weight concentrations of mercury (Hg), arsenic (As), copper (Cu), and zinc (Zn) in fish tissue from the Pee Dee River (Subbasin 16) near Rockingham and immediately Blewett Falls Dam, July 1999 and April 2000.

Station	Species	Length (mm)	Weight (g)	Hg (μg/g)	As (μg/g)	Cu (μg/g)	Zn (μg/g)
Pee Dee R at US 74	*Micropterus salmoides*	500	2286	0.53			
		415	1108	0.28	ND		
		403	907	0.31	ND		
		351	610	0.31	ND		
		372	644	0.29	ND		
		403	740	0.14	ND		
		366	535	0.16	ND		
	Lepomis macrochirus	177	125	0.09	ND		
		162	105	0.07	ND		
	Lepomis gulosus	167	105	0.12	ND		
	Ictalurus furcatus	560	2463	0.06	ND		
		597	2846	0.07	ND		
		530	1795	0.06	ND		
	Ictalurus punctatus	442	869	0.07	ND		
		425	940	0.06	ND		
		423	708	0.10	ND		
	Pylodictis olivaris	375	519	0.10	ND		
Pee Dee R below Blewett Falls Dam	*Micropterus salmoides*	361	666	0.14	0.13	0.29	4.7
		328	577	0.13	0.11	0.33	4.7
		370	740	0.23	ND	0.17	3.2
		482	2137	0.35	ND	0.20	3.7
	Ictalurus punctatus	531	1934	0.07	ND	0.29	4.9
		572	2138	0.11	ND	0.27	3.7
		461	1119	0.08	0.12	0.26	4.0
		457	1012	0.08	ND	0.21	3.7
		522	1481	0.12	ND	0.23	3.7

Cadmium, chromium, nickel and lead were non-detectable in all samples.
ND = non detect; detection level for arsenic = 1.0 μg/g.

Appendix 17. Lake assessment program.

Lakes Monitored

Twenty-six lakes in the Yadkin River basin were monitored as part of the Lakes Assessment program in 1999, 2000 and 2001. The morphological data related to these lakes is presented in Table 1. Surface physical data and photic zone chemistry data collected at these lakes from 1994 through 2001 are presented in Appendix 18.

Lake Sampling 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 one meter 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 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 specified protocols (NCDEHNR 1996).

Table 1. Lakes monitored in the Yadkin River basin during the 1999 – 2001 sampling effort.

Subbasin/ Lake	County	Classification	Surface Area (Ac)	Mean Depth (ft.)	Volume ($X10^6 m^3$)	Watershed (mi^2)	Retention Time (days)
03-07-01							
Kerr Scott Reservoir	Wilkes	WS-IV B Tr	1,450	39	189	348	
03-07-04							
Winston Salem Lake	Forsyth	C	25	8	0.03	7	
Salem Lake	Forsyth	WS-III CA	360	18	0.8	26	
High Rock Lake	Rowan	WS-IV CA B WS-V	15,750	16	314	3,929	27
Lake Wright	Rowan	WS-II HQW CA	29	10	0.3	2	
Lake Corriher	Rowan	WS-IV CA	17	8	0.2	2	
03-07-07							
Lake Thom-A-Lex	Davidson	WS-III CA	650	26	7.8	39	
03-07-08							
Tuckertown Reservoir	Davidson	WS-IV B CA	2,550	33	289	4,210	
Badin Lake	Montgomery	WS-IV B CA	5,350	46	344	4,116	28
Lake Tillery	Stanly	WS-IV B CA	5,263	23.6	165.6	4,834	9.3
03-07-09							
McCrary Lake	Randolph	WS-II HQW CA	15	10	0.9	1	
Lake Bunch	Randolph	WS-II HQW CA	30	10	0.04	2	
Back Creek Lake	Randolph	WS-II HQW CA	250	13	5	16	
Lake Reese	Randolph	WS-III CA	600	16	0.9	100	
03-07-10							
Blewett Falls Lake	Anson	WS-IV B CA	2,570	10.8	38.1	6,784	1.9
03-07-12							
Kannapolis Lake	Rowan	WS-III CA	289	16	5.2	11	
Lake Fisher	Cabarrus	WS-IV CA	277	15	0.01	78	
Lake Concord	Cabarrus	WS-IV CA	131	12	1.3	4	
03-07-14							
Lake Monroe	Union	WS-IV CA	140	18	1.8	9	
Lake Lee	Union	WS-IV CA	125	5	9.5	51	
Lake Twitty	Union	WS-III CA	82	18	7.6	36	
03-07-16							
Roberdel Lake	Richmond	WS-III CA	99	10	10	140	
Rockingham City Lake	Richmond	WS-III CA	27	2	0.02	20	
Water Lake	Richmond	WS-II HQW CA	47	10	0.06	20	
Hamlet City Lake	Richmond	C	100	3	0.04	10	
03-07-17							
Wadesboro City Pond	Anson	WS-II HQW CA	100	8	0.1	9	

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 2). 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 2. 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 18. Surface physical water data and photic zone chemistry data collected from lakes in the Yadkin River basin, 1994 – 2001.

Subbasin/ Waterbody/ Date	Station	Dissolved Oxygen (mg/L)	Water temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)	TP (mg/L)	TKN (mg/L)	NH_3 (mg/L)	NO_x (mg/L)	TN (mg/L)	TON (mg/L)	TIN (mg/L)	CHL *a* (µg/L)	Total Solids (mg/L)	Susp. Solids (mg/L)	Turbidity (NTU)
01-Kerr Scott Res.																	
08/10/2000	YAD007A	8.8	28.4	8.1	43	2.1	0.02	0.40	0.01	0.02	0.42	0.39	0.03		43	1	3.2
08/10/2000	YAD008	10.0	28.5	7.7	43	2.5	0.02	0.30	0.02	<0.01	0.31	0.28	0.03		38	3	2.6
08/10/2000	YAD008A	8.7	28.8	7.9	43	2.4	0.01	0.30	0.06	<0.01	0.31	0.24	0.07		42	1	2.2
07/19/2000	YAD007A	8.7	28.1	7.8	44	2.2	0.01	0.20	<0.01	<0.01	0.21	0.20	0.01		35	3	2.3
07/19/2000	YAD008	9.1	28.0	8.0	44	2.4	0.01	0.20	0.01	<0.01	0.21	0.19	0.02		37	4	2.1
07/19/2000	YAD008A	8.3	28.6	7.9	44	2.8	0.01	0.20	0.05	0.01	0.21	0.15	0.06		38	1	1.6
06/22/2000	YAD007A	8.7	27.0	8.3	45	1.8	0.01	0.30	<0.01	<0.01	0.31	0.30	0.01		34	4	3.3
06/22/2000	YAD008	8.6	27.5	8.2	45	2.0	<0.01	0.40	0.03	0.02	0.42	0.37	0.05		38	5	2.5
06/22/2000	YAD008A	8.3	27.9	8.2	43	2.4	0.01	0.20	<0.01	<0.01	0.21	0.20	0.01		38	2	1.6
08/12/1999	YAD007A	9.0	29.9	8.4	45	1.7	<0.01	0.30	<0.01	<0.01	0.31	0.30	0.01		58	2	3.4
08/12/1999	YAD008	8.4	29.4	8.3	45	1.6	<0.01	0.30	0.03	<0.01	0.31	0.27	0.04		43	1	2.6
08/12/1999	YAD008A	8.3	29.9	8.1	44	1.8	<0.01	0.40	0.33	<0.01	0.41	0.07	0.34		39	1	2.5
07/13/1999	YAD007A	7.5	24.9	7.8	42	1.0	0.02	0.20	0.08	0.08	0.28	0.12	0.16		58	5	8.2
07/13/1999	YAD008	7.8	24.7	6.9	41	1.2	0.02	0.20	0.01	0.06	0.26	0.19	0.07		54	5	6.0
07/13/1999	YAD008A	7.3	24.5	6.8	41	1.6	0.02	0.10	0.04	0.05	0.15	0.06	0.09		57	3	3.6
06/08/1999	YAD007A	8.5	27.5	8.0	49	1.3	0.04	0.40	<0.01	0.04	0.44	0.40	0.05		46	3	2.0
06/08/1999	YAD008	8.8	27.6	8.0	48	1.8	0.03	0.20	<0.01	0.04	0.24	0.20	0.05		41	2	3.0
06/08/1999	YAD008A	8.6	28.0	7.9	46	1.7	0.03	0.20	<0.01	0.06	0.26	0.20	0.07		34	21	3.4
08/11/1994	YAD007A	7.7	27.8	8.3	33	2.3	0.03	0.30	0.03	<0.01	0.31	0.27	0.04	3	53	4	1.8
08/11/1994	YAD008	7.6	28.5	8.1	33	2.3	0.02	0.20	0.04	0.01	0.21	0.16	0.05	6	49	3	2.0
08/11/1994	YAD008A	7.4	28.3	8.2	32	2.2	0.01	0.20	0.05	<0.01	0.21	0.15	0.06	1	55	1	1.6
04-Winston Lake																	
08/20/2001	YAD077D	8.5	28.6	7.9	94	1.6								10	110	6	6.3
07/12/2001	YAD077D	10.5	28.9	9.0	93	0.6	0.03	0.6	0.19	0.03	0.64	0.42	0.22	24	93	7	14.0
08/02/2000	YAD077D	8.3	26.4	7.5	98	1.4	0.04	0.5	0.14	0.24	0.74	0.36	0.38		74	8	16.0
07/24/2000	YAD077D	7.4	24.0	7.3	96	0.6	0.03	0.6	0.24	0.24	0.84	0.36	0.48		96	23	22.0
06/01/2000	YAD077D	8.1	22.9	7.3	103	1.0	0.07	0.4	0.24	0.31	0.71	0.16	0.55		140	54	40.0
08/04/1999	YAD077D	6.9	29.4	7.5	95	1.4	0.03	0.4	0.07	0.20	0.60	0.33	0.27		90	9	10.0
07/20/1999	YAD077D	8.3	26.6	7.3	91	0.8	0.04	0.3	0.15	0.30	0.60	0.15	0.45		74	9	19.0
06/23/1999	YAD077D	8.9	22.6	7.3	91	0.7	0.02	0.3	<0.01	0.32	0.62	0.30	0.33		84	7	16.0
Salem Lake																	
08/22/2001	YAD077A	7.4	27.4	7.4	95	0.7	0.03	0.4	<0.01	<0.01	0.40	0.39	0.01	15	72	8	7.1
08/22/2001	YAD077B	7.2	27.0	7.4	92	0.9	0.03	0.5	<0.01	<0.01	0.52	0.51	0.01	15	81	7	5.5
08/22/2001	YAD077C	8.0	27.6	7.8	95	1.3	0.02	0.5	<0.01	<0.01	0.47	0.46	0.01	14			2.4
07/16/2001	YAD077A	8.5	27.6	8.3	92	0.9	0.05	0.2	0.15	<0.01	0.23	0.07	0.16	20	97	18	15.0
07/16/2001	YAD077B	8.4	27.5	7.4	90	0.9	0.03	0.3	0.02	<0.01	0.32	0.29	0.03	19	77	6	6.9
07/16/2001	YAD077C	9.3	27.6	8.6	91	1.4	0.02	0.2	0.24	<0.01	0.25	0.00	0.25	12	75	3	2.8
08/02/2000	YAD077A	7.5	27.8	7.3	96	0.7	0.04	0.3	<0.01	<0.01	0.31	0.30	0.01		140	120	9.7
08/02/2000	YAD077B	5.5	27.7	7.2	93	0.6	0.04	0.4	0.10	0.01	0.41	0.30	0.11		68	13	8.7
08/02/2000	YAD077C	8.6	26.7	7.6	96	1.6	0.03	0.4	0.18	<0.01	0.41	0.22	0.19		60	13	2.8
07/24/2000	YAD077A	6.9	24.8	7.3	93	0.6	0.04	0.3	0.03	0.02	0.32	0.27	0.05		91	16	12.0
07/24/2000	YAD077B	8.1	20.0	6.5	100	0.7	0.07	0.6	0.17	0.08	0.68	0.43	0.25		110	32	18.0
07/24/2000	YAD077C	7.1	25.6	7.4	92	1.0	0.02	0.4	0.01	<0.01	0.41	0.39	0.02		82	5	3.5
06/12/2000	YAD077A	8.7	27.4	7.2	88	1.2	0.07	0.2	0.06	<0.01	0.21	0.14	0.07				8.9
06/12/2000	YAD077B	3.4	26.0	7.3	91	1.1	0.03	0.4	0.06	0.09	0.49	0.34	0.15		94	10	5.6
06/12/2000	YAD077C	8.4	27.0	7.2	86	1.8	0.02	0.3	0.07	<0.01	0.31	0.23	0.08		87	5	3.7
08/09/1999	YAD077A	7.3	29.8	8.1	91	0.6	0.04	0.6	<0.01	<0.01	0.61	0.60	0.01		85	16	13.0
08/09/1999	YAD077B	6.4	29.9	7.4	94	0.4	0.04	0.5	<0.01	<0.01	0.51	0.50	0.01		82	13	9.7
08/09/1999	YAD077C	8.1	29.2	7.8	88	1.5	0.01	0.5	<0.01	0.01	0.51	0.50	0.02		73	6	2.5
07/06/1999	YAD077A	9.4	31.5	8.4	84	1.2	0.03	0.3	<0.01	0.03	0.33	0.30	0.04		65	4	6.3
07/06/1999	YAD077B	8.6	31.8	8.3	83	1.1	0.03	0.4	<0.01	<0.01	0.41	0.40	0.01		73	7	5.6

Appendix 18 (continued).

Subbasin/ Waterbody/ Date	Station	Dissolved Oxygen (mg/L)	Water temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)	TP (mg/L)	TKN (mg/L)	NH_3 (mg/L)	NO_x (mg/L)	TN (mg/L)	TON (mg/L)	TIN (mg/L)	CHL *a* (µg/L)	Total Solids (mg/L)	Susp. Solids (mg/L)	Turbidity (NTU)
07/06/1999	YAD077C	8.3	32.0	8.2	84	1.8	0.02	0.4	<0.01	<0.01	0.41	0.40	0.01		60	4	3.6
06/23/1999	YAD077A	7.8	22.3	7.2	85	0.7	0.02	0.3	<0.01	<0.01	0.31	0.30	0.01		71	8	10.0
06/23/1999	YAD077B	7.7	22.5	7.3	85	0.9	0.02	0.3	<0.01	<0.01	0.31	0.30	0.01		77	8	8.3
06/23/1999	YAD077C	7.8	22.9	7.2	80	1.1	0.01	0.3	<0.01	<0.01	0.31	0.30	0.01		66	5	3.3
09/01/1994	YAD077A	8.2	27.0	7.7	79	0.9	0.03	0.5	0.01	0.02	0.52	0.49	0.03	14	81	6	4.5
09/01/1994	YAD077B	8.0	26.8	7.5	78	1.2	0.04	0.3	0.25	0.02	0.32	0.05	0.27	16	86	5	3.0
09/01/1994	YAD077C	7.3	26.6	7.8	78	1.1	0.03	0.4	<0.01	0.02	0.42	0.40	0.03	15	87	10	3.1
High Rock Lake																	
08/16/2001	YAD152A	8.0	29.2	7.8	122	0.4	0.14	0.6	0.02	0.44	1.06	0.60	0.46	15	110	17	14.0
08/16/2001	YAD152C	9.3	29.5	8.7	125	0.8	0.1	0.9	0.01	0.14	1.01	0.86	0.15	40	110	10	6.9
08/16/2001	YAD156A	9.6	29.2	8.8	120	0.7	0.09	0.9	<0.01	<0.01	0.90	0.89	0.01	52	94	9	6.0
08/16/2001	YAD169A	9.1	29.1	8.7	127	0.7	0.06	0.7	0.01	<0.01	0.75	0.73	0.02	39	91	11	5.0
08/16/2001	YAD169B	8.2	28.9	8.8	119	0.8	0.07	0.8	<0.01	0.03	0.78	0.75	0.04	46	97	9	4.9
08/16/2001	YAD169E	8.3	28.9	8.7	123	0.8	0.05	0.7	0.01	<0.01	0.72	0.70	0.02	34	94	9	5.2
08/16/2001	YAD169F	7.9	28.6	8.6	121	0.8	0.06	0.9	<0.01	<0.01	0.87	0.86	0.01	42	98	9	4.9
07/31/2001	YAD1391A	7.0	25.6	7.7	105	0.4	0.22	0.3	0.22	0.87	1.14	0.05	1.09	3	140	40	50.0
07/31/2001	YAD152A	6.6	26.7	7.5	98	0.3	0.2	0.5	0.32	0.83	1.33	0.18	1.15	4	120	24	50.0
07/31/2001	YAD152C	10.6	27.2	8.7	142	0.7	0.11	0.8	0.03	0.35	1.12	0.74	0.38	46	110	13	9.3
07/31/2001	YAD156A	8.1	27.1	8.1	135	0.7	0.1	0.9	0.1	0.24	1.09	0.75	0.34	38	120	12	8.2
07/31/2001	YAD169A	8.8	27.6	8.5	150	0.9	0.07	0.9	0.05	0.04	0.91	0.82	0.09	40	120	12	9.4
07/31/2001	YAD169B	7.4	28.1	8.0	129	0.9	0.09	0.6	0.04	0.21	0.77	0.52	0.25	27	120	26	13.0
07/31/2001	YAD169E	7.4	26.7	7.9	127	0.9	0.05	0.7	0.04	0.09	0.76	0.63	0.13	32	110	9	6.5
07/31/2001	YAD169F	7.0	26.7	7.8	128	1.1	0.06	0.6	0.03	0.21	0.80	0.56	0.24	22	110	25	5.6
08/01/2000	YAD152A	9.0	28.1	8.9	129	0.4	0.15	0.5	0.02	0.01	0.51	0.48	0.03		120	33	23.0
08/01/2000	YAD152C	9.5	28.2	8.9	133	0.4	0.13	0.6	0.02	0.13	0.73	0.58	0.15		100	19	14.0
08/01/2000	YAD156A	8.7	27.3	8.7	128	0.8	0.09	0.4	0.02	0.02	0.42	0.38	0.04		110	14	9.0
08/01/2000	YAD169A	7.8	27.5	8.6	132	0.6	0.07	0.5	<0.01	<0.01	0.51	0.50	0.01		110	11	8.3
08/01/2000	YAD169B	8.2	27.1	8.7	127	0.6	0.08	0.5	<0.01	<0.01	0.51	0.50	0.01		94	10	7.9
08/01/2000	YAD169E	6.8	26.2	7.8	125	0.8	0.06	0.5	0.01	0.16	0.66	0.49	0.17		90	8	5.4
08/01/2000	YAD169F	7.2	26.2	8.1	125	0.8	0.06	0.4	0.07	0.16	0.56	0.33	0.23		100	9	5.4
07/05/2000	YAD1391A	6.6	29.4	7.4	119	0.4	0.20	0.4	0.27	1.00	1.40	0.13	1.27		110	18	24.0
07/05/2000	YAD152A	11.4	28.7	8.9	115	0.6	0.12	0.7	0.01	0.44	1.14	0.69	0.45		87	12	14.0
07/05/2000	YAD152C	12.1	28.8	9.1	123	0.6	0.10	0.6	0.03	0.21	0.81	0.57	0.24		97	10	10.0
07/05/2000	YAD156A	11.8	29.0	9.1	129	0.6	0.09	0.7	0.01	0.15	0.85	0.69	0.16		93	10	8.1
07/05/2000	YAD169A	8.2	28.4	8.2	131	0.6	0.06	1.4	0.03	<0.01	1.41	1.37	0.04		110	12	8.8
07/05/2000	YAD169B	11.7	28.6	9.1	130	0.8	0.09	0.8	<0.01	0.02	0.82	0.80	0.03		110	7	7.3
07/05/2000	YAD169E	11.2	29.0	9.1	127	0.7	0.06	0.8	0.02	<0.01	0.81	0.78	0.03		84	10	6.3
07/05/2000	YAD169F	12.0	29.0	9.1	128	0.7	0.06	0.6	0.03	<0.01	0.61	0.57	0.04		100	9	9.7
06/20/2000	YAD1391A	6.2	29.3	7.6	149	0.5	0.22	0.3	0.11	1.20	1.50	0.19	1.31		120	18	18.0
06/20/2000	YAD152A	6.2	28.1	7.5	137	0.3	0.21	0.4	0.19	0.86	1.26	0.21	1.05		130	30	28.0
06/20/2000	YAD152C	6.4	27.7	7.7	133	0.6	0.11	0.7	0.15	0.51	1.21	0.55	0.66		89	12	11.0
06/20/2000	YAD156A	7.1	27.6	7.9	128	0.8	0.09	0.4	0.07	0.36	0.76	0.33	0.43		99	7	7.1
06/20/2000	YAD169A	7.6	27.3	7.9	133	0.8	0.05	0.4	0.06	<0.01	0.41	0.34	0.07		89	7	5.5
06/20/2000	YAD169B	7.9	27.5	8.4	123	1.0	0.07	0.4	0.06	0.07	0.47	0.34	0.13		91	5	8.0
06/20/2000	YAD169E	8.5	27.4	8.5	117	1.0	0.05	0.3	0.13	<0.01	0.31	0.17	0.14		80	10	5.8
06/20/2000	YAD169F	8.6	27.6	8.7	120	1.0	0.06	0.4	0.06	0.06	0.46	0.34	0.12		94	5	6.3
08/26/1999	YAD1391A	5.7	26.8	7.1	189	0.3	0.33	0.4	0.13	1.20	1.60	0.27	1.33		190	54	49.0
08/26/1999	YAD152A	8.2	27.6	8.4	149	0.7	0.10	0.6	0.07	0.20	0.80	0.53	0.27		120	7	9.1
08/26/1999	YAD152C	8.8	27.7	8.3	143	0.7	0.10	0.6	0.13	0.21	0.81	0.47	0.34		120	8	9.2
08/26/1999	YAD156A	6.7	27.8	7.5	135	0.7	0.07	0.5	0.10	0.12	0.62	0.40	0.22		110	17	6.6
08/26/1999	YAD169A	6.2	28.4	8.0	134	0.6	0.05	0.5	0.31	0.02	0.52	0.19	0.33		100	9	6.8
08/26/1999	YAD169B	6.8	28.4	7.8	133	0.7	0.06	0.5	0.14	0.11	0.61	0.36	0.25		100	7	7.2

Appendix 18 (continued).

Subbasin/ Waterbody/ Date	Station	Dissolved Oxygen (mg/L)	Water temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)	TP (mg/L)	TKN (mg/L)	NH_3 (mg/L)	NO_x (mg/L)	TN (mg/L)	TON (mg/L)	TIN (mg/L)	CHL *a* (µg/L)	Total Solids (mg/L)	Susp. Solids (mg/L)	Turbidity (NTU)
08/26/1999	YAD169E	5.6	28.3	7.2	126	0.9	0.04	0.4	0.06	0.17	0.57	0.34	0.23		99	6	4.8
08/26/1999	YAD169F	3.1	28.1	7.0	123	0.8	0.05	0.4	0.11	0.23	0.63	0.29	0.34		99	6	7.2
07/15/1999	YAD1391A	7.7	22.3	7.9	85	0.4	0.15	0.4	0.14	0.83	1.23	0.26	0.97		120	22	32.0
07/15/1999	YAD152A	9.5	22.1	6.3	103	0.7	0.09	0.4	0.27	0.46	0.86	0.13	0.73		100	7	12.0
07/15/1999	YAD152C	7.2	25.6	7.0	104	0.7	0.09	0.4	0.30	0.41	0.81	0.10	0.71		93	5	7.9
07/15/1999	YAD156A	7.0	25.8	7.1	110	0.8	0.06	0.4	0.30	0.26	0.66	0.10	0.56		99	4	7.6
07/15/1999	YAD169A	7.1	26.1	7.3	131	0.8	0.05	0.5	0.22	0.01	0.51	0.28	0.23		110	6	4.6
07/15/1999	YAD169B	7.3	25.9	7.0	119	0.9	0.05	0.5	0.32	0.15	0.65	0.18	0.47		100	1	5.2
07/15/1999	YAD169E	7.3	25.3	7.1	119	1.2	0.04	0.5	0.21	0.07	0.57	0.29	0.28		130	5	3.7
07/15/1999	YAD169F	5.7	25.6	7.3	116	1.0	0.05	0.4	0.29	0.11	0.51	0.11	0.40		110	<1	5.4
06/03/1999	YAD1391A	7.6	27.8	7.6	124	0.5	0.18	0.2	0.06	0.85	1.05	0.14	0.91		110	18	18.0
06/03/1999	YAD152A	10.3	27.1	8.6	109	0.6	0.09	0.4	0.03	0.34	0.74	0.37	0.37		98	9	9.2
06/03/1999	YAD152C	11.0	26.3	8.0	65	0.5	0.09	0.4	0.01	0.38	0.78	0.39	0.39		100	6	7.7
06/03/1999	YAD156A	10.5	26.7	8.5	109	0.7	0.07	0.4	0.04	0.36	0.76	0.36	0.40		88	4	8.4
06/03/1999	YAD169A	8.5	25.1	7.9	47	0.7	0.05	0.3	0.03	0.15	0.45	0.27	0.18		89	6	4.5
06/03/1999	YAD169B	9.1	24.9	8.1	107	0.9	0.04	0.3	0.01	0.35	0.65	0.29	0.36		79	7	4.7
06/03/1999	YAD169E	9.4	24.5	8.4	104	0.7	0.03	0.2	<0.01	0.27	0.47	0.20	0.28		74	3	4.1
06/03/1999	YAD169F	9.7	25.0	8.5	100	0.9	0.01	0.3	0.02	0.26	0.56	0.28	0.28		80	3	5.3
08/28/1997	YAD1391A	7.4	27.9	7.3	145	0.4	0.12	0.1	0.02	0.69	0.79	0.08	0.71	8	120	20	19.0
08/28/1997	YAD152A	11.1	28.0	8.8	123	0.5	0.04	0.3	<0.01	0.02	0.32	0.30	0.03	35	99	10	6.3
08/28/1997	YAD152C	11.0	28.1	8.8	123	0.5	0.05	0.4	0.01	0.02	0.42	0.39	0.03	49	99	11	6.8
08/28/1997	YAD156A	10.4	28.0	8.6	123	0.6	0.04	0.5	<0.01	0.03	0.53	0.50	0.04	36	99	8	5.9
08/28/1997	YAD169A	9.3	28.1	8.4	121	0.6	0.04	0.4	<0.01	0.02	0.42	0.40	0.03	31	97	9	5.5
08/28/1997	YAD169B	9.8	27.9	8.5	121	0.6	0.03	0.3	<0.01	0.02	0.32	0.30	0.03	33	97	9	5.7
08/28/1997	YAD169E	8.4	27.2	7.9	108	0.6	0.02	0.2	<0.01	0.02	0.22	0.20	0.03	18	82	8	5.6
08/28/1997	YAD169F	6.0	27.1	7.3	118	0.7	0.03	0.3	0.15	0.10	0.40	0.15	0.25	16	85	8	6.0
07/29/1997	YAD1391A	6.1	28.7	7.2	85	0.2	0.18	0.3	0.01	0.65	0.95	0.29	0.66	4	150	48	70.0
07/29/1997	YAD152A	8.0	29.5	7.5	91	0.2	0.13	0.6	<0.01	0.42	1.02	0.60	0.43	17	140	13	55.0
07/29/1997	YAD152C	9.3	30.0	8.3	99	0.4	0.11	0.4	<0.01	0.22	0.62	0.40	0.23	19	130	22	25.0
07/29/1997	YAD156A	10.8	30.5	8.8	102	0.5	0.11	0.4	<0.01	0.08	0.48	0.40	0.09	23	120	23	20.0
07/29/1997	YAD169A	8.1	30.2	8.5	114	0.6	0.06	0.4	<0.01	<0.01	0.41	0.40	0.01	14	100	6	5.4
07/29/1997	YAD169B	10.2	30.2	8.9	103	0.6	0.09	0.4	<0.01	<0.01	0.41	0.40	0.01	25	120	18	15.0
07/29/1997	YAD169E	10.9	30.9	9.0	103	0.6	0.08	0.4	<0.01	0.01	0.41	0.40	0.02	16	120	19	16.0
07/29/1997	YAD169F	11.3	31.1	9.1	106	0.6	0.07	0.4	<0.01	<0.01	0.41	0.40	0.01	22	110	12	8.7
06/25/1997	YAD1391A	6.7	28.1	7.6	94	0.2	0.15	0.3	0.04	0.84	1.14	0.26	0.88	2	100	29	50.0
06/25/1997	YAD152A	10.5	29.7	8.7	93	0.7	0.07	0.3	<0.01	0.36	0.66	0.30	0.37	14	75	6	11.0
06/25/1997	YAD152C	10.4	29.3	8.7	95	0.7	0.07	0.3	<0.01	0.39	0.69	0.30	0.40	14	75	5	9.6
06/25/1997	YAD156A	9.2	29.0	8.5	93	0.9	0.05	0.2	0.02	0.35	0.55	0.18	0.37	10	75	4	6.3
06/25/1997	YAD169A	9.4	30.2	8.8	95	1.0	0.04	0.3	<0.01	0.17	0.47	0.30	0.18	11	71	2	4.3
06/25/1997	YAD169B	10.1	29.8	8.9	93	1.1	0.05	0.3	<0.01	0.21	0.51	0.30	0.22	10	79	2	4.3
06/25/1997	YAD169E	10.1	28.3	8.9	90	0.8	0.05	0.2	<0.01	0.17	0.37	0.20	0.18	13	77	6	4.1
06/25/1997	YAD169F	10.0	28.6	8.9	93	0.9	0.05	0.2	<0.01	0.17	0.37	0.20	0.18	12	72	5	4.3
07/20/1994	YAD1391A	7.5	29.8	7.2	113	0.4	0.30	0.5	0.04	0.60	1.10	0.46	0.64	3	130	59	22.0
07/20/1994	YAD152A	10.7	29.8	9.0	106	0.7	0.14	0.3	0.04	0.17	0.47	0.26	0.21	17	86	12	7.6
07/20/1994	YAD152C	9.6	29.8	9.1	106	0.7	0.07	0.6	<0.01	<0.01	0.61	0.60	0.01	15	77	10	5.8
07/20/1994	YAD156A	8.1	29.2	8.6	103	0.7	0.10	0.4	0.02	0.88	1.28	0.38	0.90	16	75	10	6.0
07/20/1994	YAD169A	7.9	29.9	9.1	111	0.7	0.07	0.5	0.04	<0.01	0.51	0.46	0.05	13	75	10	5.1
07/20/1994	YAD169B	8.2	29.7	9.1	107	0.8	0.07	0.5	<0.01	<0.01	0.51	0.50	0.01	21	72	9	4.5
07/20/1994	YAD169E	8.2	29.9	9.2	108	0.7	0.05	0.5	0.01	<0.01	0.51	0.49	0.02	16	69	11	4.8
07/20/1994	YAD169F	8.1	29.7	9.2	108	0.8	0.05	0.6	0.02	<0.01	0.61	0.58	0.03	15	75	9	4.2

Appendix 18 (continued).

Subbasin/ Waterbody/ Date	Station	Dissolved Oxygen (mg/L)	Water temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)	TP (mg/L)	TKN (mg/L)	NH_3 (mg/L)	NO_x (mg/L)	TN (mg/L)	TON (mg/L)	TIN (mg/L)	CHL *a* (µg/L)	Total Solids (mg/L)	Susp. Solids (mg/L)	Turbidity (NTU)
Lake Wright																	
08/02/1999	YAD121R	8.0	31.2	7.3	78	1.5	0.02	0.5	0.09	0.05	0.55	0.41	0.14		83	5	2.9
07/20/1999	YAD121R	11.0	30.8	9.4	86	0.8	0.16	0.7	0.04	<0.01	0.71	0.66	0.05		77	6	6.4
06/03/1999	YAD121R	9.4	27.6	9.2	84	0.7	0.06	0.4	0.02	<0.01	0.41	0.38	0.03		110	8	5.4
08/25/1994	YAD121R	10.8	27.4	8.1	50	0.6	0.06	0.9	0.01	<0.01	0.91	0.89	0.02	28	71	11	15.0
08/08/1989	YAD121R	7.7	27.9	7.9	61	2.2	0.03	0.2	0.07	<0.01	0.21	0.13	0.08	40	60	5	5.4
Lake Corriher																	
08/02/1999	YAD122B	6.6	30.7	6.9	89	0.4	0.03	0.4	0.08	<0.01	0.41	0.32	0.09		83	5	
08/02/1999	YAD122D	7.0	30.8	7.0	88	1.1	0.03	0.4	0.14	<0.01	0.41	0.26	0.15		85	8	4.9
07/20/1999	YAD122B	8.8	29.6	7.2	87	0.7	0.09	0.6	0.04	<0.01	0.61	0.56	0.05		98	8	12.0
07/20/1999	YAD122D	8.8	29.8	7.7	85	1.3	0.10	0.6	0.11	<0.01	0.61	0.49	0.12		62	4	7.3
06/03/1999	YAD122B	7.4	26.0	7.0	86	1.0	0.08	0.4	<0.01	<0.01	0.41	0.40	0.01		110	11	10.0
06/03/1999	YAD122D	7.6	26.9	7.4	85	1.2	0.08	0.3	0.01	<0.01	0.31	0.29	0.02		84	9	9.9
08/24/1994	YAD122B	8.9	26.3	6.4	62	0.9	0.11	0.5	0.03	0.01	0.51	0.47	0.04	26	83	10	7.2
08/24/1994	YAD122D	9.0	26.2	7.2	62	0.8	0.09	0.6	0.02	<0.01	0.61	0.58	0.03	17	70	5	5.2
07- Lake Thom-A-Lex																	
08/22/2001	YAD160B	8.8	28.6	8.3	109	0.5	0.06	0.8	<0.01	<0.01	0.85	0.84	0.01	31	110	14	11.0
08/22/2001	YAD1611A	8.7	29.5	8.3	109	0.8	0.04	0.7	<0.01	<0.01	0.66	0.65	0.01	24	110	8	4.8
07/18/2001	YAD160B	8.5	28.5	8.3	104	0.7	0.05	0.8	0.03	<0.01	0.85	0.81	0.04	28	100	9	10.0
07/18/2001	YAD1611A	8.7	28.7	8.2	103	1.0	0.04	0.6	0.04	<0.01	0.62	0.57	0.05	28	83	5	4.0
08/02/2000	YAD160B	7.9	27.7	8.0	106	0.7	0.05	0.4	0.01	<0.01	0.41	0.39	0.02		99	10	11.0
08/02/2000	YAD1611A	8.2	26.8	7.9	101	1.0	0.04	0.3	<0.01	<0.01	0.31	0.30	0.01		92	10	6.1
07/24/2000	YAD160B	5.8	25.0	7.3	111	0.5	0.06	0.7	0.06	0.01	0.71	0.64	0.07		110	15	16.0
07/24/2000	YAD1611A	7.0	26.1	7.4	104	0.9	0.03	0.4	0.12	<0.01	0.41	0.28	0.13		90	5	4.2
06/01/2000	YAD160B	10.7	26.6	8.3	110	1.0	0.07	0.5	0.10	<0.01	0.51	0.40	0.11		130	34	29.0
06/01/2000	YAD1611A	8.5	26.1	7.9	108	1.4	0.18	0.5	0.13	<0.01	0.51	0.37	0.14		300	2	120.0
08/09/1999	YAD160B	8.0	29.2	7.8	96	0.9	0.04	0.5	<0.01	<0.01	0.51	0.50	0.01		81	4	7.2
08/09/1999	YAD1611A	8.1	29.2	8.3	85	1.1	0.02	0.5	<0.01	<0.01	0.51	0.50	0.01		82	3	3.1
07/07/1999	YAD160B	9.9	30.9	8.5	88	0.5	0.03	0.4	<0.01	<0.01	0.41	0.40	0.01		83	11	15.0
07/07/1999	YAD1611A	9.1	30.2	8.3	83	0.7	0.05	0.4	<0.01	<0.01	0.41	0.40	0.01		76	10	9.9
06/21/1999	YAD160B	6.4	21.5	7.1	95	0.4	0.06	0.5	0.12	<0.01	0.51	0.38	0.13		110	16	20.0
06/21/1999	YAD1611A	7.0	22.5	7.1	88	0.8	0.03	0.4	0.09	<0.01	0.41	0.31	0.10		90	4	7.6
07/19/1994	YAD160B	8.3	29.7	8.4	85	0.6	0.05	0.4	0.03	0.01	0.41	0.37	0.04	15	89	10	9.4
07/19/1994	YAD1611A	7.8	29.5	7.7	79	1.1	0.01	0.4	0.03	0.01	0.41	0.37	0.04	8	78	6	4.4
08-Tuckertown Res.																	
08/03/1999	YAD172C	7.7	30.0	8.2	116	0.5	0.09	0.5	<0.01	<0.01	0.51	0.50	0.01		75	4	6.4
08/03/1999	YAD1780A	9.5	30.5	8.9	113	0.6	0.05	0.8	0.07	<0.01	0.81	0.73	0.08		84	4	3.6
07/08/1999	YAD172C	7.4	29.0	7.8	120	0.8	0.04	0.5	0.01	0.03	0.53	0.49	0.04		81	8	4.5
07/08/1999	YAD1780A	9.2	30.0	8.1	119	1.0	0.04	0.5	<0.01	<0.01	0.51	0.50	0.01		87	6	2.5
06/03/1999	YAD172C	8.0	25.2	7.8	96	0.7	0.06	0.3	0.07	0.33	0.63	0.23	0.40		90	6	8.8
06/03/1999	YAD1780A	9.1	26.0	8.6	95	1.1	0.04	0.2	0.02	0.24	0.44	0.18	0.26		82	6	3.9
07/19/1994	YAD172C	4.7	29.1	7.8	110	0.6	0.07	0.7	0.25	0.05	0.75	0.45	0.30	21	110	9	8.1
07/19/1994	YAD1780A	8.6	29.6	8.7	107	0.7	0.05	0.5	0.03	<0.01	0.51	0.47	0.04	24	94	7	4.1
Badin Lake																	
08/03/1999	YAD178B	8.6	30.1	8.5	108	0.9	0.02	0.4	<0.01	0.02	0.42	0.40	0.03		69	5	3.7
08/03/1999	YAD178E	7.6	30.3	7.9	98	1.6	0.01	0.4	0.01	0.02	0.42	0.39	0.03		65	1	1.6
08/03/1999	YAD178F	8.1	30.6	8.7	107	1.5	0.02	0.4	<0.01	<0.01	0.41	0.40	0.01		70	3	1.9
08/03/1999	YAD178F1	8.2	30.9	8.8	109	1.5	0.02	0.5	<0.01	0.01	0.51	0.50	0.02		74	2	2.1
07/08/1999	YAD178B	9.0	30.4	8.3	104	1.2	0.02	0.3	<0.01	0.09	0.39	0.30	0.10		77	3	2.6
07/08/1999	YAD178E	8.7	30.2	7.9	93	1.2	0.01	0.4	<0.01	0.05	0.45	0.40	0.06		76	3	1.9
07/08/1999	YAD178F	9.0	29.2	8.1	100	1.3	0.02	0.3	<0.01	0.07	0.37	0.30	0.08		110	3	1.8
07/08/1999	YAD178F1	8.7	29.2	7.9	101	1.4	0.01	0.3	<0.01	0.10	0.40	0.30	0.11		69	3	1.8

Appendix 18 (continued).

Subbasin/ Waterbody/ Date	Station	Dissolved Oxygen (mg/L)	Water temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)	TP (mg/L)	TKN (mg/L)	NH_3 (mg/L)	NO_x (mg/L)	TN (mg/L)	TON (mg/L)	TIN (mg/L)	CHL *a* (µg/L)	Total Solids (mg/L)	Susp. Solids (mg/L)	Turbidity (NTU)
06/07/1999	YAD178B	10.3	27.4	8.9	97	1.0	0.04	0.3	0.03	0.15	0.45	0.27	0.18		81	9	3.5
06/07/1999	YAD178E	9.4	27.6	8.7	92	1.0	0.03	0.3	0.05	0.08	0.38	0.25	0.13		80	6	4.9
06/07/1999	YAD178F	10.4	26.7	9.1	96	1.0	0.03	0.3	0.04	0.10	0.40	0.26	0.14		86	6	3.8
06/07/1999	YAD178F1	8.7	26.7	8.6	94	0.8	0.03	0.3	0.04	0.17	0.47	0.26	0.21		87	18	4.8
07/28/1994	YAD178B	4.8	28.0	7.0	104	0.8	0.02	0.5	0.17	0.08	0.58	0.33	0.25	7	90	4	4.7
07/28/1994	YAD178E	6.4	28.2	7.2	94	1.4	0.01	0.3	0.07	0.07	0.37	0.23	0.14	6	72	1	2.0
07/28/1994	YAD178F	4.2	27.7	6.9	104	1.2	0.03	0.5	0.18	0.08	0.58	0.32	0.26	7	86	3	2.8
07/28/1994	YAD178F1	4.1	27.5	6.9	101	1.4	0.01	0.4	0.11	0.14	0.54	0.29	0.25	6	87	1	1.8
Lake Tillery																	
08/03/1999	YAD185A	4.8	27.6	6.8	104	1.1	0.02	0.3	0.01	0.20	0.50	0.29	0.21		81	2	2.4
08/03/1999	YAD189	6.2	28.4	7.1	102	1.5	0.01	0.3	<0.01	0.12	0.42	0.30	0.13		75	1	2.1
08/03/1999	YAD189B	8.0	29.7	8.2	97	1.4	0.01	0.3	<0.01	<0.01	0.31	0.30	0.01		82	2	3.1
08/03/1999	YAD189C	8.6	30.5	8.7	96	1.5	0.01	0.4	<0.01	<0.01	0.41	0.40	0.01		78	2	1.8
07/08/1999	YAD185A	9.5	30.9	8.4	94	1.5	<0.01	0.4	<0.01	0.10	0.50	0.40	0.11		74	3	2.6
07/08/1999	YAD189	9.2	31.0	8.7	93	1.5	0.01	0.3	<0.01	0.13	0.43	0.30	0.14		74	2	2.0
07/08/1999	YAD189B	9.2	31.4	8.6	94	1.5	<0.01	0.3	<0.01	0.14	0.44	0.30	0.15		75	2	1.8
07/08/1999	YAD189C	8.9	31.2	8.4	94	1.7	<0.01	0.4	<0.01	0.15	0.55	0.40	0.16		76	3	2.1
06/02/1999	YAD185A	9.8	25.1	7.8	93	1.5	0.02	0.2	<0.01	0.28	0.48	0.20	0.29		72	2	4.6
06/02/1999	YAD189	9.2	25.4	7.8	94	1.7	0.02	0.2	0.01	0.30	0.50	0.19	0.31		74	3	3.3
06/02/1999	YAD189B	9.5	24.9	7.6	92	1.6	0.02	0.2	<0.01	0.31	0.51	0.20	0.32		75	2	2.7
06/02/1999	YAD189C	9.1	24.5	6.9	91	2.0	0.01	0.3	<0.01	0.36	0.66	0.30	0.37		72	1	1.8
07/26/1994	YAD185A	7.0	28.3	7.4	88	1.4	0.02	0.4	0.02	0.21	0.61	0.38	0.23	7	67	2	2.0
07/26/1994	YAD189	8.1	29.6	7.9	80	1.4	0.02	0.4	0.03	0.11	0.51	0.37	0.14	3	65	3	2.4
07/26/1994	YAD189B	8.2	28.9	7.8	80	1.5	0.02	0.4	0.01	0.12	0.52	0.39	0.13	6	64	2	1.9
07/26/1994	YAD189C	8.4	29.1	7.9	80	1.5	0.02	0.3	0.01	0.12	0.42	0.29	0.13	4	70	1	2.0
McCrary Lake																	
08/29/2001	YAD181E	8.2	28.8	8.0	109	4.0	0.02	0.4	<0.01	0.01	0.43	0.42	0.02	15		2.5	<1
08/02/2001	YAD181E	7.0	25.7	7.7	103	2.6	0.02	0.3	0.09	<0.01	0.34	0.24	0.10	22	97	5	4.3
08/09/2000	YAD181E	8.8	30.5	8.4	105	3.5	0.03	0.5	0.03	<0.01	0.51	0.47	0.04		97	4	3.9
06/05/2000	YAD181E	8.7	24.7	7.8	108	2.8	0.02	0.6	0.03	<0.01	0.61	0.57	0.04		97	11	7.1
08/24/1999	YAD181E		27.4	7.6	101	2.6	0.06	0.5	0.16	0.03	0.53	0.34	0.19		110	7	5.7
07/21/1999	YAD181E	8.1	28.2	9.2	108	3.0	<0.01	0.4	0.03	<0.01	0.41	0.37	0.04		73	3	2.5
06/16/1999	YAD181E	8.3	25.4	7.6	101	2.0	0.01	0.4	<0.01	<0.01	0.41	0.40	0.01		75	3	2.8
08/23/1994	YAD181E	6.9	27.1	7.2	77	2.5	0.04	0.3	<0.01	0.01	0.31	0.30	0.02		93	4	2.4
07/27/1989	YAD181E	8.4	29.3	8.7	81	3.2	0.01	0.2	0.03	0.01	0.21	0.17	0.04		83	5	2.6
Bunch Lake																	
08/29/2001	YAD181G	8.2	29.1	8.0	82	4.1	0.04	0.7	0.1	<0.01	0.70	0.59	0.11	21		6	<1
08/02/2001	YAD181G	7.5	26.4	7.8	81	6.0	0.05	0.8	0.17	<0.01	0.82	0.64	0.18	6	75	6	4.8
08/09/2000	YAD181G	8.3	29.9	8.1	83	3.6	0.01	0.4	<0.01	0.04	0.44	0.40	0.05		72	1	2.9
07/06/2000	YAD181G	8.9	28.9	7.9	33	4.8	0.03	0.3	<0.01	0.01	0.31	0.30	0.02		68	4	2.8
06/05/2000	YAD181G	8.6	25.0	7.8	79	3.2	<0.01	0.3	0.01	<0.01	0.31	0.29	0.02		78	14	5.3
08/24/1999	YAD181G	3.1	27.7	7.7	78	2.5	0.03	0.4	0.01	<0.01	0.41	0.39	0.02		75	4	1.5
07/21/1999	YAD181G	7.9	28.9	7.8	29	3.4	<0.01	0.2	0.10	0.03	0.23	0.10	0.13		64	4	3.2
06/16/1999	YAD181G	8.0	25.9	7.5	81	3.0	0.03	0.3	<0.01	<0.01	0.31	0.30	0.01		65	2	2.8
08/23/1994	YAD181G	7.4	26.9	7.5	65	3.8	0.03	0.3	<0.01	<0.01	0.31	0.30	0.01	1	96	1	1.2
Back Creek Lake																	
08/29/2001	YAD181J	8.2	28.5	7.5	97	0.8	0.06	0.7	<0.01	<0.01	0.74	0.73	0.01	27	92	7	<1
08/29/2001	YAD181K	8.2	28.5	7.6	97	1.2	0.04	0.7	<0.01	<0.01	0.69	0.68	0.01	6	84	5	<1
08/29/2001	YAD181L	9.0	28.1	7.9	98	1.2	0.04	0.7	0.02	<0.01	0.67	0.64	0.03	19	87	5	<1
07/19/2001	YAD181J	8.0	28.1	7.6	94	1.0	0.05	0.8	0.04	<0.01	0.78	0.73	0.05	27	71	7	7.2
07/19/2001	YAD181K	8.7	28.0	8.0	93	1.1	0.04	0.7	0.03	<0.01	0.73	0.69	0.04	19	77	4	3.3
07/19/2001	YAD181L	8.4	27.6	7.9	92	1.2	0.03	0.9	0.21	<0.01	0.89	0.67	0.22	14	71	12	6.4

Appendix 18 (continued).

Subbasin/ Waterbody/ Date	Station	Dissolved Oxygen (mg/L)	Water temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)	TP (mg/L)	TKN (mg/L)	NH_3 (mg/L)	NO_x (mg/L)	TN (mg/L)	TON (mg/L)	TIN (mg/L)	CHL *a* (µg/L)	Total Solids (mg/L)	Susp. Solids (mg/L)	Turbidity (NTU)
07/07/1999	YAD181J	8.4	30.8	8.2	100	0.7	0.07	0.5	0.02	<0.01	0.51	0.48	0.03		71	12	6.4
07/07/1999	YAD181K	9.0	29.7	8.6	99	1.0	0.04	0.4	0.02	<0.01	0.41	0.38	0.03		80	9	3.8
07/07/1999	YAD181L	8.0	29.2	7.9	98	0.9	0.04	0.4	0.04	<0.01	0.41	0.36	0.05		70	8	4.5
06/03/1999	YAD181J	10.4	26.8	10.1	95	0.5	0.08	0.4	0.01	<0.01	0.41	0.39	0.02		110	11	8.1
06/03/1999	YAD181K	9.2	26.6	8.4	94	0.9	0.05	0.3	0.02	<0.01	0.31	0.28	0.03		100	6	5.2
06/03/1999	YAD181L	9.0	26.6	8.1	95	0.8	0.07	0.4	0.02	<0.01	0.41	0.38	0.03		120	9	6.6
08/23/1994	YAD181J	7.8	28.9	7.0	79	0.6	0.06	0.6	0.01	<0.01	0.61	0.59	0.02	6	110	8	6.6
08/23/1994	YAD181K	8.1	28.7	7.1	77	0.7	0.06	0.5	<0.01	<0.01	0.51	0.50	0.01	15	97	6	4.2
08/23/1994	YAD181L	6.7	28.1	7.1	78	0.7	0.08	0.5	0.01	<0.01	0.51	0.49	0.02	22	120	7	6.0
Lake Reese																	
08/29/2001	YAD179B	8.4	28.9	7.7	97	0.6	0.03	0.7	0.04	<0.01	0.68	0.63	0.05	20	90	7	1.1
08/29/2001	YAD179D	8.8	28.6	8.1	95	0.8	0.03	0.8	<0.01	<0.01	0.83	0.82	0.01	5	94	7	1.0
08/29/2001	YAD179F	9.3	28.1	8.3	93	0.8	0.02	0.7	0.01	<0.01	0.70	0.68	0.02	16	100	5	1.1
07/19/2001	YAD179B	7.8	29.6	7.8	99	0.8	0.05	0.6	0.11	<0.01	0.63	0.51	0.12	18	72	10	8.7
07/19/2001	YAD179D	8.9	28.9	8.4	96	1.1	0.04	0.6	0.34	<0.01	0.59	0.24	0.35	21	80	5	3.7
07/19/2001	YAD179F	8.4	28.3	8.1	96	1.2	0.02	0.6	0.03	<0.01	0.60	0.56	0.04	9	53	4	4.2
08/09/2000	YAD179B	8.6	29.5	7.9	112	1.2	0.02	0.4	0.05	0.05	0.45	0.35	0.10	29	90	5	5.5
08/09/2000	YAD179D	8.7	29.8	8.1	113	1.5	0.01	0.4	0.40	0.05	0.45	0.00	0.45	63	89	4	4.3
08/09/2000	YAD179F	8.5	30.4	8.1	110	2.3	0.01	0.4	<0.01	0.01	0.41	0.40	0.02		88	1	2.6
07/06/2000	YAD179B	8.3	28.2	7.5	110	1.1	0.02	0.5	0.03	<0.01	0.51	0.47	0.04		96	6	4.5
07/06/2000	YAD179D	8.2	28.6	8.1	118	1.4	0.02	0.3	0.08	<0.01	0.31	0.22	0.09		89	5	4.2
07/06/2000	YAD179F	8.1	28.9	8.0	116	2.0	0.01	0.4	0.13	<0.01	0.41	0.27	0.14			5	3.6
06/05/2000	YAD179B	7.4	25.4	7.7	115	1.0	0.03	0.4	0.03	<0.01	0.41	0.37	0.04		100	9	7.3
06/05/2000	YAD179D	7.8	25.4	7.6	109	1.4	0.02	0.3	0.02	<0.01	0.31	0.28	0.03		100	19	8.5
06/05/2000	YAD179F	7.5	25.8	7.6	107	1.6	0.04	0.3	0.03	<0.01	0.31	0.27	0.04		130	39	2.5
08/24/1999	YAD179B	6.0	27.9	7.1	117	0.8	0.03	0.5	0.04	<0.01	0.51	0.46	0.05		110	12	9.6
08/24/1999	YAD179D	7.6	26.6	7.4	117	1.1	0.01	0.4	0.05	0.03	0.43	0.35	0.08		95	4	4.8
08/24/1999	YAD179F	7.0	27.5	7.9	111	1.1	0.01	0.5	<0.01	0.01	0.51	0.50	0.02		100	4	3.8
07/21/1999	YAD179B	7.9	28.9	7.5	42	1.1	<0.01	0.4	0.01	0.01	0.41	0.39	0.02		95	6	4.9
07/21/1999	YAD179D	8.3	29.1	7.6	113	1.7	0.02	0.3	0.03	<0.01	0.31	0.27	0.04		93	1	3.5
07/21/1999	YAD179F	8.2	29.3	7.6	113	2.0	0.03	0.4	0.01	<0.01	0.41	0.39	0.02		89	4	2.9
06/16/1999	YAD179B	5.4	25.9	7.3	115	0.7	0.02	0.3	<0.01	<0.01	0.31	0.30	0.01		98	6	7.0
06/16/1999	YAD179D	7.3	25.8	7.3	115	0.9	0.01	0.2	<0.01	<0.01	0.21	0.20	0.01		99	2	4.5
06/16/1999	YAD179F	7.3	28.0	7.4	68	1.1	0.01	0.2	<0.01	<0.01	0.21	0.20	0.01		100	1	4.1
08/25/1994	YAD179B	8.6	26.8	7.8	87	1.1	0.04	0.4	<0.01	<0.01	0.41	0.40	0.01	3	74	6	5.6
08/25/1994	YAD179D	8.6	26.5	8.0	86	1.0	0.05	0.4	<0.01	<0.01	0.41	0.40	0.01	4	73	7	3.9
08/25/1994	YAD179F	8.2	26.2	7.9	85	1.2	0.04	0.4	<0.01	<0.01	0.41	0.40	0.01	5	67	4	3.1
10-Blewett Falls Res.																	
08/03/1999	YAD260B	7.6	30.1	8.4	128	1.1	0.04	0.8	<0.01	<0.01	0.81	0.80	0.01		76	6	3.4
07/08/1999	YAD260B	10.5	31.4	8.9	135	1.0	0.03	0.4	<0.01	0.08	0.48	0.40	0.09		97	4	2.6
06/02/1999	YAD260B	10.6	26.0	9.2	130	1.0	0.05	0.2	<0.01	0.17	0.37	0.20	0.18		85	5	4.9
07/26/1994	YAD260B	8.8	28.7	8.1	103	0.7	0.06	0.4	0.02	0.48	0.88	0.38	0.50	7	94	6	6.5
12-Kannapolis Lake																	
08/22/2000	YAD207A	6.7	27.9	7.8	106	1.1	0.04	0.2	0.03	<0.01	0.21	0.17	0.04		100	7	4.1
08/22/2000	YAD207C	7.4	28.3	8.0	106	1.3	0.03	0.3	0.05	<0.01	0.31	0.25	0.06		92	5	3.4
07/10/2000	YAD207A	8.5	30.3	8.8	109	0.7	0.04	0.4	0.05	0.02	0.42	0.35	0.07		120	11	4.6
07/10/2000	YAD207C	8.7	29.8	8.8	109	0.8	0.03	0.9	0.68	0.01	0.91	0.22	0.69		110	3	4.0
06/12/2000	YAD207A	10.5	29.2	9.4	94	1.1	0.03	0.2	<0.01	<0.01	0.21	0.20	0.01		84	7	7.5
06/12/2000	YAD207C	9.1	29.5	8.8	93	1.2	0.02	0.4	0.29	<0.01	0.41	0.11	0.30		100	7	3.0
08/02/1995	YAD207A	10.4	31.8	8.3	77	0.8	0.05	0.4	0.02	<0.01	0.41	0.38	0.03	7	76	14	6.1
08/02/1995	YAD207C	9.7	31.0	8.2	75	0.5	0.05	0.4	0.02	0.02	0.42	0.38	0.04	9	90	19	5.1

Appendix 18 (continued).

Subbasin/ Waterbody/ Date	Station	Dissolved Oxygen (mg/L)	Water temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)	TP (mg/L)	TKN (mg/L)	NH_3 (mg/L)	NO_x (mg/L)	TN (mg/L)	TON (mg/L)	TIN (mg/L)	CHL *a* (µg/L)	Total Solids (mg/L)	Susp. Solids (mg/L)	Turbidity (NTU)
Lake Fisher																	
08/22/2000	YAD215R	8.2	27.1	8.0	141	0.4	0.08	0.4	0.09	0.01	0.41	0.31	0.10		140	20	20.0
08/22/2000	YAD215T	5.8	27.4	7.5	140	0.7	0.05	0.5	0.06	<0.01	0.51	0.44	0.07		120	2	8.5
08/22/2000	YAD216A	7.0	27.0	8.0	139	0.9	0.04	0.4	0.03	<0.01	0.41	0.37	0.04		120	7	5.6
07/10/2000	YAD215R	8.4	30.5	8.2	146	0.3	0.16	0.4	0.06	0.02	0.42	0.34	0.08		270	83	40.0
07/10/2000	YAD215T	7.6	29.2	8.3	145	0.7	0.03	0.2	<0.01	0.01	0.21	0.20	0.02		140	7	5.8
07/10/2000	YAD216A	7.9	29.2	8.5	145	0.8	0.02	0.3	0.12	0.01	0.31	0.18	0.13		130	9	3.2
06/21/2000	YAD215R	8.4	28.5	8.2	140	0.6	0.03	0.3	0.12	<0.01	0.31	0.18	0.13		110	11	11.0
06/21/2000	YAD215T	8.7	28.3	8.5	139	0.8	0.04	0.3	0.01	<0.01	0.31	0.29	0.02		100	4	5.9
06/21/2000	YAD216A	8.5	28.1	8.5	139	0.8	0.02	0.4	<0.01	<0.01	0.41	0.40	0.01		100	5	9.2
08/02/1995	YAD215R	8.0	30.6	6.9	97	0.6	0.13	0.5	0.06	<0.01	0.51	0.44	0.07	<1	140	43	25.0
08/02/1995	YAD215T	9.2	30.5	8.1	90	1.0	0.06	0.4	0.02	<0.01	0.41	0.38	0.03	9	90	10	6.2
08/02/1995	YAD216A	8.9	30.5	8.1	87	0.8	0.06	0.4	0.02	<0.01	0.41	0.38	0.03	8	110	9	5.2
Lake Concord																	
07/10/2000	YAD216C	8.1	29.8	8.5	111	0.6	0.05	0.4	0.07	0.03	0.43	0.33	0.10		110	12	8.9
07/10/2000	YAD216E	7.3	29.3	7.8	113	0.3	0.08	0.6	0.25	<0.01	0.61	0.35	0.26		140	27	20.0
07/10/2000	YAD216G	8.0	29.0	8.4	112	0.6	0.04	0.4	0.02	0.01	0.41	0.38	0.03		120	9	6.4
06/21/2000	YAD216C	8.1	28.3	8.5	106	0.5	0.05	0.4	0.03	<0.01	0.41	0.37	0.04		83	9	7.4
06/21/2000	YAD216E	7.7	28.3	8.1	107	0.4	0.07	0.4	0.06	<0.01	0.41	0.34	0.07		100	23	15.0
06/21/2000	YAD216G	8.2	28.0	8.6	106	0.7	0.10	0.4	0.01	<0.01	0.41	0.39	0.02		85	7	8.2
08/02/1995	YAD216C	8.9	31.4	8.0	80	0.8	0.06	0.5	0.02	<0.01	0.51	0.48	0.03	5	98	15	8.4
08/02/1995	YAD216E	9.2	31.5	7.8	81	0.4	0.07	0.5	0.02	<0.01	0.51	0.48	0.03	6	100	20	17.0
08/02/1995	YAD216G	8.2	30.8	8.0	79	0.7	0.06	0.4	0.02	0.02	0.42	0.38	0.04	5	96	10	7.2
14-Lake Monroe																	
08/08/2000	YAD232D	10.1	32.8	9l.3	115	0.6	0.07	0.9	<0.01	<0.01	0.91	0.90	0.01		88	8	6.7
08/08/2000	YAD232F	10.1	31.6	9.4	117	0.5	0.08	0.9	0.15	0.03	0.93	0.75	0.18		110	7	5.4
07/17/2000	YAD232D	11.5	31.7	9.6	123	0.6	0.07	0.8	<0.01	<0.01	0.81	0.80	0.01		110	5	4.4
07/17/2000	YAD232F	10.3	31.9	9.4	118	0.7	0.11	0.5	0.06	<0.01	0.51	0.44	0.07		95	6	5.4
06/12/2000	YAD232D	9.1	29.9	9.2	105	0.8	0.06	0.6	0.01	<0.01	0.61	0.59	0.02		93	1	4.2
06/12/2000	YAD232F	8.5	30.9	8.8	107	0.8	0.16	0.7	0.03	<0.01	0.71	0.67	0.04	14	90	8	3.8
09/07/1995	YAD232D	7.7	25.6	6.8	82	0.5	0.07	0.6	0.02	<0.01	0.61	0.58	0.03	6	81	2	11.0
09/07/1995	YAD232F	6.2	25.4	6.6	77	0.8	0.05	0.9	0.13	0.32	1.22	0.77	0.45	35	110	10	6.9
Lake Lee																	
08/08/2000	YAD232C	11.7	32.8	9.1	122	0.3	0.17	1.5	0.02	0.01	1.51	1.48	0.03		100	20	14.0
08/08/2000	YAD232H	12.8	34.1	9.5	129	0.3	0.14	1.3	0.03	0.01	1.31	1.27	0.04		110	16	12.0
08/08/2000	YAD233	12.8	33.0	9.5	129	0.4	0.13	0.8	0.01	0.03	0.83	0.79	0.04		130	18	10.0
07/17/2000	YAD232C	11.0	29.8	8.7	127	0.4	0.19	0.8	0.01	0.03	0.83	0.79	0.04		240	130	3.3
07/17/2000	YAD232H	11.4	31.1	9.0	130	0.5	0.11	0.8	0.02	0.02	0.82	0.78	0.04		120	11	8.3
07/17/2000	YAD233	9.5	29.7	8.3	129	0.5	0.12	0.8	<0.01	<0.01	0.81	0.80	0.01		110	13	7.9
06/12/2000	YAD232C	8.4	28.3	8.7	115	0.6	0.08	0.8	0.03	<0.01	0.81	0.77	0.04		100	10	7.4
06/12/2000	YAD232H	9.1	20.2	9.0	113	0.7	0.07	0.4	<0.01	<0.01	0.41	0.40	0.01		92	3	3.7
06/12/2000	YAD233	8.6	29.4	8.6	115	0.8	0.14	0.8	0.02	<0.01	0.81	0.78	0.03	9	100	9	8.8
09/07/1995	YAD232C	11.1	24.9	7.3	94	0.5	0.12	0.7	0.02	<0.01	0.71	0.68	0.03	8	110	13	11.0
09/07/1995	YAD232H	8.4	25.0	6.9	88	0.4	0.19	0.7	0.03	<0.01	0.71	0.67	0.04	7	100	12	8.7
09/07/1995	YAD233	6.4	24.7	6.7	89	0.4	0.15	0.9	0.04	0.01	0.91	0.86	0.05	31	130	30	7.8
Lake Twitty																	
08/08/2000	YAD235D	9.8	31.7	9.2	132	0.8	0.06	0.6	0.11	<0.01	0.61	0.49	0.12		94	6	4.4
08/08/2000	YAD235F	8.5	31.9	8.8	130	0.8	0.06	0.5	0.02	<0.01	0.51	0.48	0.03		95	4	3.5
08/08/2000	YAD236	8.2	32.1	8.8	131	0.9	0.09	0.5	<0.01	0.04	0.54	0.50	0.05		120	6	5.4
07/17/2000	YAD235D	10.7	29.8	9.2	135	0.9	0.08	0.6	0.10	0.03	0.63	0.50	0.13		120	4	5.8
07/17/2000	YAD235F	10.8	29.8	9.3	135	0.8	0.08	0.6	0.09	0.02	0.62	0.51	0.11		110	6	5.0
07/17/2000	YAD236	11.0	29.3	9.3	135	0.9	0.13	0.5	0.11	<0.01	0.51	0.39	0.12		90	8	5.1

Appendix 18 (continued).

Subbasin/ Waterbody/ Date	Station	Dissolved Oxygen (mg/L)	Water temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm)	Secchi depth (m)	TP (mg/L)	TKN (mg/L)	NH_3 (mg/L)	NO_x (mg/L)	TN (mg/L)	TON (mg/L)	TIN (mg/L)	CHL *a* (µg/L)	Total Solids (mg/L)	Susp. Solids (mg/L)	Turbidity (NTU)
06/12/2000	YAD235D	13.8	29.9	10.2	134	0.8	0.15	1.0	<0.01	0.01	1.01	1.00	0.02		78	11	6.9
06/12/2000	YAD235F	11.3	27.9	9.8	120	0.7	0.13	1.7	0.26	<0.01	1.71	1.44	0.27		110	10	5.7
06/12/2000	YAD236	13.3	29.1	9.9	134	0.8	0.24	0.7	0.03	0.31	1.01	0.67	0.34	11	89	10	7.9
08/30/1995	YAD235D	11.4	27.5	7.7	110	0.6	0.19	0.6	0.02	0.15	0.75	0.58	0.17	10	91	10	8.8
08/30/1995	YAD235F	11.2	28.1	8.0	111	0.7	0.19	0.7	0.02	0.10	0.80	0.68	0.12	10			
08/30/1995	YAD236	11.4	27.4	8.4	111	0.7	0.06	0.7	0.03	0.01	0.71	0.67	0.04	35	100	8	5.2
16- Roberdel Lake																	
08/17/2000	YAD262E	5.9	28.1	5.6	24	0.8	0.02	0.4	0.27	0.01	0.41	0.13	0.28		15	5	4.5
08/17/2000	YAD263	7.2	27.7	6.2	24	0.9	0.02	0.4	0.11	<0.01	0.41	0.29	0.12		44	4	3.2
08/17/2000	YAD262E	6.5	24.2	5.9	25	0.8	0.01	0.5	0.05	0.12	0.62	0.45	0.17		31	5	3.2
06/08/2000	YAD263	6.7	23.2	6.7	26	0.9	0.01	0.4	0.30	0.13	0.53	0.10	0.43		36	2	4.0
08/24/1995	YAD262E	5.3	29.1	5.1	25	0.6	0.02	0.4	0.02	<0.01	0.41	0.38	0.03	3	34	5	4.5
08/24/1995	YAD263	6.5	28.8	5.5	25	0.5	0.02	0.4	0.03	<0.01	0.41	0.37	0.04	3	31	3	2.8
Rockingham City Lake																	
08/17/2000	YAD265C	3.2	26.8	5.3	28	0.7	0.03	0.5	0.11	0.01	0.51	0.39	0.12		65	10	2.0
06/08/2000	YAD265C	3.9	25.5	5.7	27	0.7	0.02	0.3	0.13	0.01	0.31	0.17	0.14		46	7	2.5
08/24/1995	YAD265C	3.0	28.6	5.1	32	0.5	0.03	0.5	0.03	<0.01	0.51	0.47	0.04	8	48	4	2.3
Water Lake																	
08/17/2000	YAD280C	6.8	29.2	6.1	55	0.9	0.01	0.6	0.09	0.09	0.69	0.51	0.18		59	4	1.4
08/17/2000	YAD280E	8.5	29.7	7.4	51	1.1	0.01	1.9	0.01	<0.01	1.91	1.89	0.02		55	4	3.1
06/08/2000	YAD280C	8.2	25.8	6.5	55	0.9	<0.01	0.4	<0.01	0.31	0.71	0.40	0.32		53	10	2.8
06/08/2000	YAD280E	8.0	25.8	6.8	53	1.8	<0.01	0.3	<0.01	0.16	0.46	0.30	0.17		42	2	1.2
08/24/1995	YAD280C	7.7	29.5	5.7	55	0.8								8	62	5	2.0
08/24/1995	YAD280E	8.6	29.9	6.7	51	0.8	<0.01	0.6	0.03	<0.01	0.61	0.57	0.04	7	59	5	2.1
Hamlet City Lake																	
08/17/2000	YAD282A	3.6	28.5	5.9	46	1.1	0.02	0.3	0.05	0.01	0.31	0.25	0.06		51	5	1.9
08/17/2000	YAD283	4.9	28.6	6.2	47	1.2	0.03	0.5	<0.01	0.02	0.52	0.50	0.03		54	2	1.3
06/08/2000	YAD282A	6.5	25.6	6.3	48	1.0	0.01	0.3	<0.01	<0.01	0.31	0.30	0.01		42	3	1.7
06/08/2000	YAD283	6.4	24.7	6.5	48	1.0	0.01	0.4	<0.01	0.01	0.41	0.40	0.02		45	5	2.0
08/24/1995	YAD282A	4.9	28.9	5.7	55	0.8	0.09	0.4	0.03	<0.01	0.41	0.37	0.04	6	51	7	1.7
08/24/1995	YAD283	5.4	29.0	5.6	54	0.7	0.02	0.3	0.02	<0.01	0.31	0.28	0.03	4	46	2	2.1
17-City Pond																	
08/08/2000	YAD275H	8.0	28.9	7.0	54	0.6	0.05	0.1	0.03	<0.01	0.11	0.07	0.04		69	18	10.0
08/08/2000	YAD275J	8.2	29.7	7.4	55	0.8	0.04	0.4	0.15	<0.01	0.41	0.25	0.16		51	7	7.8
07/17/2000	YAD275H	8.1	28.9	8.6	64	0.8	0.05	0.3	<0.01	0.04	0.34	0.30	0.05		110	52	12.0
07/17/2000	YAD275J	8.1	29.1	8.7	65	2.2	0.06	0.4	0.06	0.04	0.44	0.34	0.10		86	2	
06/08/2000	YAD275H	8.4	25.2	8.0	57	0.7	0.02	0.4	0.06	<0.01	0.41	0.34	0.07		56	6	5.5
06/08/2000	YAD275J	8.4	25.8	7.6	57	0.8	0.02	0.4	0.01	<0.01	0.41	0.39	0.02		54	4	5.0
08/30/1995	YAD275H	7.8	27.2	6.3	60	0.7	0.05	0.5	0.03	<0.01	0.51	0.47	0.04	9	95	40	14.0
08/30/1995	YAD275J	8.7	27.8	7.5	59	0.7	0.03	0.4	0.02	<0.01	0.41	0.38	0.03	11	57	5	7.2

[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*.

Appendix 19. Summary of the water quality parameters from the Yadkin River at NC 268 at Patterson (Q0060000; C Tr) collected between September 30, 1996 and June 28, 2000.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	45	NA	<5	0	0.0	8.5	8.9	9.6	11.0	12.3	14.0	17.0
(DO; mg/L)			<6	0	0.0	.	.	.	.	.	.	.
Conductivity	45	NA	.	.	.	25	38	41	46	50	54	62
Temperature (C)	45	NA	.	.	.	3	6	10	13	18	23	25
pH (s.u.)	44	NA	<6	0	0.0	6.7	7.1	7.2	7.3	7.4	7.5	7.8
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	1	0	.	.	.	21	21	21	21	21	21	21
TSS	43	2	>10	9	20.9	1	1	2	4	10	18	250
			>20	4	9.3							
Chloride	0	0.	.	.	.	.	.	.	.	.	.	
Turbidity (NTU)	44	2	>50	2	4.5	1	2	3	4	8	36	170
			>25	6	13.6	.	.	.	.	.	.	.
			>10	10	22.7	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	46	13	.	.	.	0.01	0.01	0.01	0.02	0.06	0.13	0.19
TKN as N	46	3	.	.	.	0.10	0.10	0.10	0.10	0.20	0.35	0.60
NO_2+NO_3 as N	46	1	>10	0	0.0	0.01	0.07	0.15	0.21	0.25	0.30	0.47
Total Phosphorus	46	11	0.05	4	8.7	0.01	0.01	0.01	0.01	0.03	0.05	0.24
Metals (µg/L)												
Aluminum (Al)	43	3	.	.	.	50	89	120	210	440	1580	9400
Copper (Cu)	45	24	>7	5	11.1	2	2	2	2	4	8	17
Iron (Fe)	42	0	>1000	8	19.0	130	171	243	350	708	1590	13000
Manganese (Mn)	0	0	>200	0	.	.	.	.	.	.	.	.
Zinc (Zn)	45	18	>50	3	6.7	10	10	10	11	18	32	150
Arsenic (As)	45	45	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	45	45	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	45	45	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	45	41	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	45	45	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	45	45	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 20 **Summary of the water quality parameters from Elk Creek at NC 268 at Elkville (Q0220000; B ORW) collected between September 17, 1996 and August 14, 2001.**

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	Percentiles 25	Percentiles 50	Percentiles 75	Percentiles 90	Max.
Field												
Dissolved Oxygen	51	NA	<4	0	0.0	7.3	7.9	8.9	10.6	11.5	12.1	18.6
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	52	NA	.	.	.	21	26	27	32	36	41	137
Temperature (C)	52	NA	.	.	.	1	5	10	15	21	23	26
pH (s.u.)	51	NA	<6	7	13.7	4.2	5.7	6.2	6.6	6.9	7.1	7.7
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	47	7	>10	12	25.5	1	1	1	3	11	26	91
			>20	6	12.8							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	56	1	>50	1	1.8	1	1	1	3	4	8	90
			>25	1	1.8	.	.	.	.	.	.	.
			>10	4	7.1	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	53	28	.	.	.	0.01	0.01	0.01	0.01	0.05	0.08	0.57
TKN as N	53	3	.	.	.	0.10	0.10	0.10	0.20	0.20	0.40	1.00
NO_2+NO_3 as N	53	1	>10	0	0.0	0.01	0.03	0.08	0.17	0.24	0.30	1.80
Total Phosphorus	54	11	0.05	7	13.0	0.01	0.01	0.01	0.02	0.03	0.07	20.00
Metals (µg/L)												
Aluminum (Al)	47	3	.	.	.	50	59	85	160	345	910	2400
Copper (Cu)	47	27	>7	7	14.9	2	2	2	2	3	9	16
Iron (Fe)	47	1	>1000	4	8.5	50	100	135	220	435	988	2200
Manganese (Mn)	1	0	>200	0	0.0	20	20	20	20	20	20	20
Zinc (Zn)	47	10	>50	4	8.5	10	10	11	16	30	46	85
Arsenic (As)	47	47	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	47	47	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	47	47	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	47	47	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	47	47	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	47	47	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 21. Summary of the water quality parameters from the Yadkin River at Wilkesboro (Q0390000; C) collected between September 17, 1996 and June 12, 2000.

				< or > Eval. Level			Percentiles					
Parameter	**N**	**Num. < R.L.**	**Eval. Level**	**n**	**%**	**Min.**	**10**	**25**	**50**	**75**	**90**	**Max.**
Field												
Dissolved Oxygen	39	NA	<4	0	0.0	7.0	7.4	8.6	10.0	11.2	11.6	12.9
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	40	NA	.	.	.	27	32	34	37	40	43	90
Temperature (C)	40	NA	.	.	.	4	8	10	14	20	23	25
pH (s.u.)	40	NA	<6	3	7.5	5.4	6.0	6.4	6.7	6.9	7.1	7.9
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	44	0	>10	20	45.5	2	5	8	10	18	39	88
			>20	8	18.2							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	44	0	>50	1	2.3	2	6	7	9	15	27	85
			>25	5	11.4	.	.	.	.	.	.	.
			>10	20	45.5	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	44	3	.	.	.	0.01	0.02	0.04	0.07	0.10	0.13	0.18
TKN as N	44	0	.	.	.	0.10	0.10	0.20	0.20	0.30	0.30	0.40
NO_2+NO_3 as N	44	0	>10	0	0.0	0.13	0.18	0.23	0.31	0.34	0.41	0.61
Total Phosphorus	44	2	0.05	7	15.9	0.01	0.01	0.02	0.03	0.04	0.06	0.28
Metals (µg/L)												
Aluminum (Al)	44	0	.	.	.	73	290	418	580	1300	2010	9500
Copper (Cu)	44	17	>7	7	15.9	2	2	2	3	4	8	23
Iron (Fe)	44	0	>1000	17	38.6	110	325	538	830	1425	2070	3100
Manganese (Mn)	1	0	>200	0	0.0	110	110	110	110	110	110	110
Zinc (Zn)	44	4	>50	3	6.8	10	10	14	23	35	46	85
Arsenic (As)	44	44	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	44	44	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	44	44	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	44	44	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	44	44	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	44	44	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 22. Summary of the water quality parameters from the Roaring River at SR 1990 near Roaring River (Q0660000; B) collected between September 17, 1996 and August 14, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	48	NA	<4	0	0.0	7.4	7.9	9.1	10.7	11.4	12.4	17.7
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	51	NA	.	.	.	21	25	27	29	32	39	57
Temperature (C)	51	NA	.	.	.	1	5	10	15	22	23	27
pH (s.u.)	50	NA	<6	0	0.0	6.0	6.2	6.6	7.0	7.2	7.5	8.5
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	1	0	.	.	.	11	11	11	11	11	11	11
TSS	49	8	>10	11	22.4	1	1	1	4	9	53	77
			>20	9	18.4							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	53	0	>50	2	3.8	1	2	2	3	6	14	90
			>25	5	9.4	.	.	.	.	.	.	.
			>10	8	15.1	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	52	18	.	.	.	0.01	0.01	0.01	0.03	0.06	0.11	0.96
TKN as N	52	2	.	.	.	0.10	0.10	0.10	0.20	0.30	0.50	1.30
NO_2+NO_3 as N	52	0	>10	0	0.0	0.15	0.30	0.36	0.42	0.49	0.55	0.67
Total Phosphorus	53	5	0.05	12	22.6	0.01	0.01	0.02	0.03	0.05	0.12	0.50
Metals (µg/L)												
Aluminum (Al)	46	1	.	.	.	50	95	130	210	373	2250	9600
Copper (Cu)	46	20	>7	4	8.7	2	2	2	3	4	7	40
Iron (Fe)	46	0	>1000	8	17.4	67	150	215	310	480	2150	3400
Manganese (Mn)	1	0	>200	0	0.0	14	14	14	14	14	14	14
Zinc (Zn)	46	11	>50	4	8.7	10	10	10	18	30	39	120
Arsenic (As)	46	46	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	46	46	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	46	46	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	46	46	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	46	46	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	46	46	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 23. Summary of the water quality parameters from the Yadkin River at SR 2327 at Roaring River (Q0690000; WS-V) collected between September 17, 1996 and June 12, 2000.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	38	NA	<4	0	0.0	6.7	7.3	8.7	10.0	11.4	12.0	13.4
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	40	NA	.	.	.	34	38	41	48	54	57	92
Temperature (C)	40	NA	.	.	.	4	7	10	15	20	24	29
pH (s.u.)	38	NA	<6	0	0.0	6.1	6.3	6.5	6.8	7.0	7.2	8.8
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	41	0	.	.	.	34	47	52	68	81	110	200
TSS	42	2	>10	21	50.0	1	3	7	11	19	41	140
			>20	10	23.8							
Chloride	42	0	.	.	.	2	2	2	3	4	4	8
Turbidity (NTU)	42	0	>50	3	7.1	3	4	6	9	18	31	120
			>25	6	14.3	.	.	.	.	.	.	.
			>10	17	40.5	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	42	5	.	.	.	0.01	0.01	0.02	0.04	0.07	0.10	0.14
TKN as N	42	0	.	.	.	0.10	0.10	0.10	0.20	0.30	0.39	0.60
NO_2+NO_3 as N	42	0	>10	0	0.0	0.31	0.44	0.47	0.52	0.57	0.67	0.79
Total Phosphorus	42	0	0.05	38	90.5	0.02	0.06	0.09	0.12	0.14	0.18	0.44
Metals (µg/L)												
Aluminum (Al)	42	2	.	.	.	50	240	343	540	998	2530	8700
Copper (Cu)	42	14	>7	6	14.3	2	2	2	3	4	8	36
Iron (Fe)	42	0	>1000	13	31.0	75	322	483	725	1175	2600	8200
Manganese (Mn)	42	1	>200	0	0.0	10	28	36	46	62	77	120
Zinc (Zn)	42	13	>50	4	9.5	10	10	10	15	26	41	84
Arsenic (As)	42	42	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	42	42	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	42	42	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	42	42	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	42	42	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	42	42	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 24. Summary of the water quality parameters from the Yadkin River at SR 2303 at Ronda (Q0720000; WS-IV) collected between July 19, 2000 and August 14, 2001.

				< or > Eval. Level			Percentiles					
Parameter	**N**	**Num. < R.L.**	**Eval. Level**	**n**	**%**	**Min.**	**10**	**25**	**50**	**75**	**90**	**Max.**
Field												
Dissolved Oxygen	12	NA	<4	0	0.0	5.9	6.6	7.0	8.3	9.7	12.7	15.3
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	12	NA	.	.	.	47	50	61	64	69	71	89
Temperature (C)	12	NA	.	.	.	3	3	11	21	24	25	26
pH (s.u.)	11	NA	<6	0	0.0	6.2	6.4	6.6	6.7	7.1	7.4	7.4
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	6	0	.	.	.	52	57	63	69	75	80	82
TSS	5	0	>10	3	60.0	6	7	8	14	15	16	17
			>20	0	0.0							
Chloride	1	0	.	.	.	5	5	5	5	5	5	5
Turbidity (NTU)	12	0	>50	1	8.3	4	5	5	6	10	11	70
			>25	1	8.3	.	.	.	.	.	.	.
			>10	3	25.0	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	9	1	.	.	.	0.01	0.01	0.03	0.07	0.08	0.12	0.20
TKN as N	9	1	.	.	.	0.20	0.20	0.30	0.30	0.60	0.68	1.00
NO_2+NO_3 as N	9	0	>10	0	0.0	0.18	0.36	0.49	0.70	0.76	0.83	0.84
Total Phosphorus	10	1	0.05	10	100.0	0.08	0.13	0.16	0.18	0.19	0.25	0.50
Metals (µg/L)												
Aluminum (Al)	6	0	.	.	.	170	280	428	540	585	720	840
Copper (Cu)	6	6	>7	0	0.0	2	2	2	2	2	2	2
Iron (Fe)	6	0	>1000	2	33.3	340	445	630	870	1043	1100	1100
Manganese (Mn)	2	0	>200	0	0.0	60	60	61	62	62	63	63
Zinc (Zn)	6	5	>50	0	0.0	10	10	10	10	10	11	11
Arsenic (As)	5	5	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	6	6	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	6	6	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	6	6	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	5	5	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	6	6	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 25. Summary of the water quality parameters from the Yadkin River at US 21 Bus at Elkin (Q0810000; C) collected between September 09, 1996 and August 16, 2001.

				< or > Eval. Level			Percentiles					
Parameter	N	Num. < R.L.	Eval. Level	n	%	Min.	10	25	50	75	90	Max.
Field												
Dissolved Oxygen	52	NA	<4	0	0.0	6.8	7.4	8.2	10.0	11.4	12.4	14.0
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	52	NA	.	.	.	31	35	44	54	59	64	88
Temperature (C)	52	NA	.	.	.	2	6	10	16	22	24	27
pH (s.u.)	51	NA	<6	1	2.0	5.4	6.4	6.7	7.1	7.2	7.5	7.9
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	46	1	>10	32	69.6	1	6	9	14	32	59	310
			>20	14	30.4							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	57	0	>50	3	5.3	3	4	6	9	17	39	650
			>25	8	14.0	.	.	.	.	.	.	.
			>10	24	42.1	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	55	12	.	.	.	0.01	0.01	0.01	0.04	0.06	0.10	0.21
TKN as N	54	0	.	.	.	0.10	0.10	0.20	0.20	0.30	0.47	0.80
NO_2+NO_3 as N	55	0	>10	0	0.0	0.36	0.38	0.49	0.56	0.62	0.70	0.91
Total Phosphorus	56	1	0.05	53	94.6	0.05	0.06	0.08	0.12	0.15	0.23	1.10
Metals (µg/L)												
Aluminum (Al)	48	1	.	.	.	50	207	320	620	1200	2190	42000
Copper (Cu)	48	16	>7	5	10.4	2	2	2	3	5	7	47
Iron (Fe)	48	1	>1000	19	39.6	50	392	508	905	1525	2660	36000
Manganese (Mn)	1	0	>200	0	0.0	42	42	42	42	42	42	42
Zinc (Zn)	48	18	>50	5	10.4	10	10	10	15	28	46	320
Arsenic (As)	48	48	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	48	48	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	48	48	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	48	46	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	48	48	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	48	47	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 26. Summary of the water quality parameters from the Ararat River at SR 2019 at Ararat (Q1780000; C) collected between September 09, 1996 and August 16, 2001.

				< or > Eval. Level			Percentiles					
Parameter	**N**	**Num. < R.L.**	**Eval. Level**	**n**	**%**	**Min.**	**10**	**25**	**50**	**75**	**90**	**Max.**
Field												
Dissolved Oxygen	52	NA	<4	0	0.0	7.2	8.0	8.8	10.7	11.8	12.7	15.7
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	52	NA	.	.	.	49	84	125	179	253	320	380
Temperature (C)	52	NA	.	.	.	0	5	9	15	21	23	27
pH (s.u.)	52	NA	<6	0	0.0	6.2	6.6	7.0	7.3	7.6	7.8	9.4
			>9	2	3.8	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	2	0	.	.	.	88	91	96	104	112	117	120
TSS	49	1	>10	22	44.9	1	2	4	7	15	55	1400
			>20	9	18.4							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	55	0	>50	4	7.3	2	3	4	6	12	43	1300
			>25	9	16.4	.	.	.	.	.	.	.
			>10	16	29.1	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	53	17	.	.	.	0.01	0.01	0.01	0.02	0.07	0.13	0.28
TKN as N	52	0	.	.	.	0.10	0.11	0.20	0.30	0.33	0.49	0.80
NO_2+NO_3 as N	53	0	>10	0	0.0	0.29	0.48	0.55	0.64	0.74	0.83	1.70
Total Phosphorus	54	1	0.05	52	96.3	0.04	0.07	0.09	0.13	0.18	0.20	1.90
Metals (µg/L)												
Aluminum (Al)	50	0	.	.	.	53	150	190	340	683	3280	63000
Copper (Cu)	50	2	>7	26	52.0	2	4	5	7	11	16	110
Iron (Fe)	50	0	>1000	11	22.0	120	340	440	680	983	3350	84000
Manganese (Mn)	1	0	>200	0	0.0	34	34	34	34	34	34	34
Zinc (Zn)	50	3	>50	7	14.0	10	12	17	27	44	57	140
Arsenic (As)	50	50	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	50	50	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	50	49	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	50	48	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	50	50	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	50	48	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 27. Summary of the water quality parameters from the Ararat River at SR 2080 near Siloam (Q1950000; WS-IV) collected between September 09, 1996 and August 16, 2001.

				< or > Eval. Level			Percentiles					
Parameter	N	Num. < R.L.	Eval. Level	n	%	Min.	10	25	50	75	90	Max.
Field												
Dissolved Oxygen	52	NA	<4	0	0.0	7.4	7.8	8.7	10.0	11.6	12.4	15.5
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	52	NA	.	.	.	59	88	114	145	195	235	264
Temperature (C)	52	NA	.	.	.	0	6	9	15	21	23	27
pH (s.u.)	52	NA	<6	0	0.0	6.1	6.6	7.0	7.3	7.5	7.6	9.4
			>9	1	1.9	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	3	0	.	.	.	81	87	96	110	140	158	170
TSS	48	2	>10	18	37.5	1	1	4	7	17	57	1400
			>20	10	20.8							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	56	0	>50	7	12.5	2	3	4	8	14	65	1000
			>25	9	16.1	.	.	.	.	.	.	.
			>10	21	37.5	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	52	19	.	.	.	0.01	0.01	0.01	0.01	0.05	0.12	0.20
TKN as N	52	0	.	.	.	0.10	0.11	0.20	0.20	0.30	0.59	1.00
NO_2+NO_3 as N	52	0	>10	0	0.0	0.29	0.41	0.50	0.59	0.65	0.71	0.85
Total Phosphorus	53	1	0.05	51	96.2	0.04	0.07	0.08	0.11	0.14	0.20	1.80
Metals (µg/L)												
Aluminum (Al)	49	0	.	.	.	69	156	230	430	800	2180	6200
Copper (Cu)	49	1	>7	21	42.9	2	3	4	6	9	12	47
Iron (Fe)	49	0	>1000	13	26.5	240	390	490	670	1100	2660	41000
Manganese (Mn)	2	0	>200	0	0.0	30	31	31	33	34	35	35
Zinc (Zn)	49	4	>50	7	14.3	10	11	15	28	37	60	150
Arsenic (As)	49	49	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	49	49	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	49	48	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	49	48	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	49	49	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	49	48	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 28. Summary of the water quality parameters from the Little Yadkin River at US 52 at Dalton (Q2020000; WS-IV) collected between September 09, 1996 and June 07, 2000.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	40	NA	<4	0	0.0	7.5	8.0	8.8	10.3	11.7	12.4	13.8
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	40	NA	.	.	.	41	50	54	63	68	74	81
Temperature (C)	40	NA	.	.	.	0	7	8	15	19	22	25
pH (s.u.)	40	NA	<6	1	2.5	5.9	6.2	6.4	6.8	7.0	7.3	7.6
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	43	0	.	.	.	42	55	64	74	91	134	1000
TSS	44	3	>10	14	31.8	1	1	2	6	15	55	560
			>20	10	22.7							
Chloride	42	0	.	.	.	2	3	3	4	4	4	7
Turbidity (NTU)	45	0	>50	4	8.9	3	3	5	10	18	48	500
			>25	9	20.0	.	.	.	.	.	.	.
			>10	22	48.9	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	44	18	.	.	.	0.01	0.01	0.01	0.01	0.05	0.06	0.35
TKN as N	44	1	.	.	.	0.10	0.10	0.10	0.20	0.30	0.40	0.80
NO_2+NO_3 as N	44	1	>10	0	0.0	0.01	0.03	0.15	0.28	0.33	0.38	0.49
Total Phosphorus	44	7	0.05	7	15.9	0.01	0.01	0.02	0.03	0.04	0.07	0.85
Metals (µg/L)												
Aluminum (Al)	45	0	.	.	.	86	120	170	580	1100	2080	32000
Copper (Cu)	45	19	>7	5	11.1	2	2	2	3	5	7	15
Iron (Fe)	45	0	>1000	18	40.0	330	454	530	930	1300	2440	37000
Manganese (Mn)	43	0	>200	1	2.3	12	15	21	27	41	50	790
Zinc (Zn)	45	4	>50	6	13.3	10	10	17	28	42	59	120
Arsenic (As)	45	45	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	45	44	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	45	44	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	45	44	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	45	45	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	45	45	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 29. Summary of the water quality parameters from the Yadkin River at SR 1605 at Enon (Q2040000; WS-IV) collected between September 17, 1996 and August 27, 2001.

				< or > Eval. Level			Percentiles					
Parameter	**N**	**Num. < R.L.**	**Eval. Level**	**n**	**%**	**Min.**	**10**	**25**	**50**	**75**	**90**	**Max.**
Field												
Dissolved Oxygen	50	NA	<4	0	0.0	6.8	7.3	8.5	10.3	11.7	12.6	16.3
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	52	NA	.	.	.	35	49	55	68	79	96	565
Temperature (C)	52	NA	.	.	.	1	6	10	16	23	26	29
pH (s.u.)	52	NA	<6	0	0.0	6.1	6.5	6.8	7.2	7.5	7.7	8.5
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	49	1	.	.	.	1	54	67	80	96	142	960
TSS	50	2	>10	26	52.0	1	3	5	12	26	70	560
			>20	19	38.0							
Chloride	46	0	.	.	.	3	4	4	5	7	7	10
Turbidity (NTU)	58	0	>50	6	10.3	3	4	6	11	23	53	800
			>25	14	24.1	.	.	.	.	.	.	.
			>10	30	51.7	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	56	24	.	.	.	0.01	0.01	0.01	0.01	0.06	0.14	0.50
TKN as N	54	2	.	.	.	0.10	0.10	0.13	0.20	0.40	0.50	1.00
NO_2+NO_3 as N	56	1	>10	0	0.0	0.08	0.28	0.44	0.52	0.57	0.65	0.86
Total Phosphorus	56	1	0.05	49	87.5	0.02	0.05	0.06	0.08	0.12	0.20	1.10
Metals (µg/L)												
Aluminum (Al)	51	0	.	.	.	64	200	330	690	1400	3000	44000
Copper (Cu)	51	8	>7	6	11.8	2	2	3	4	5	8	38
Iron (Fe)	51	0	>1000	23	45.1	210	420	535	950	1600	3000	49000
Manganese (Mn)	48	0	>200	1	2.1	11	15	17	32	44	73	380
Zinc (Zn)	51	9	>50	5	9.8	10	10	12	18	29	50	72
Arsenic (As)	50	50	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	51	51	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	51	50	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	51	50	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	50	50	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	51	51	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 30. Summary of the water quality parameters from Salem Creek at Elledge WWTP at Winston-Salem (Q2510000; C) collected between September 11, 1996 and August 27, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	51	NA	<4	0	0.0	5.5	6.5	7.7	9.2	10.3	11.8	14.4
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	51	NA	.	.	.	78	114	137	166	185	213	347
Temperature (C)	52	NA	.	.	.	0	3	10	14	23	24	25
pH (s.u.)	50	NA	<6	2	4.0	5.5	6.2	6.4	6.7	6.9	7.1	7.5
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	1	0	.	.	.	120	120	120	120	120	120	120
TSS	46	0	>10	22	47.8	1	2	3	10	22	66	190
			>20	13	28.3							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	56	0	>50	3	5.4	2	3	4	8	15	40	100
			>25	9	16.1	.	.	.	.	.	.	.
			>10	22	39.3	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	54	1	.	.	.	0.01	0.09	0.10	0.16	0.25	0.37	0.72
TKN as N	53	0	.	.	.	0.20	0.30	0.30	0.40	0.50	0.78	1.40
NO_2+NO_3 as N	54	0	>10	0	0.0	0.37	0.72	0.92	1.20	1.40	1.57	1.80
Total Phosphorus	54	2	0.05	19	35.2	0.01	0.02	0.03	0.04	0.06	0.11	0.20
Metals (µg/L)												
Aluminum (Al)	47	1	.	.	.	50	120	225	380	830	1980	7000
Copper (Cu)	47	5	>7	12	25.5	2	2	3	4	7	9	17
Iron (Fe)	47	0	>1000	17	36.2	520	572	690	870	1350	2480	8000
Manganese (Mn)	1	0	>200	0	0.0	99	99	99	99	99	99	99
Zinc (Zn)	47	0	>50	16	34.0	16	23	27	41	69	87	150
Arsenic (As)	47	47	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	47	47	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	47	47	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	47	43	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	47	47	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	47	47	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 31. Summary of the water quality parameters from Muddy Creek at SR 2995 near Muddy Creek (Q2600000; C) collected between September 4, 1996 and August 27, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	51	NA	<4	0	0.0	5.6	6.2	7.5	8.8	10.2	11.8	13.7
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	50	NA	.	.	.	98	177	247	310	402	522	594
Temperature (C)	52	NA	.	.	.	0	5	11	15	23	25	27
pH (s.u.)	50	NA	<6	0	0.0	6.3	6.8	6.9	7.1	7.3	7.4	9.2
			>9	1	2.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	1	0	.	.	.	220	220	220	220	220	220	220
TSS	46	0	>10	25	54.3	2	4	7	12	25	150	460
			>20	15	32.6							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	55	0	>50	5	9.1	3	4	6	9	16	46	180
			>25	9	16.4	.	.	.	.	.	.	.
			>10	23	41.8	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	54	2	.	.	.	0.01	0.10	0.12	0.16	0.22	0.33	1.30
TKN as N	53	0	.	.	.	0.30	0.40	0.50	0.60	0.80	0.98	1.60
NO_2+NO_3 as N	54	0	>10	0	0.0	0.78	1.16	1.70	2.00	2.90	3.48	5.60
Total Phosphorus	54	0	0.05	54	100.0	0.09	0.17	0.33	0.57	1.15	1.87	4.70
Metals (µg/L)												
Aluminum (Al)	47	1	.	.	.	50	168	355	590	1350	4560	24000
Copper (Cu)	47	3	>7	15	31.9	2	3	4	6	9	15	24
Iron (Fe)	47	0	>1000	23	48.9	340	578	795	1000	1700	4800	30000
Manganese (Mn)	1	0	>200	0	0.0	120	120	120	120	120	120	120
Zinc (Zn)	47	0	>50	28	59.6	27	35	41	61	78	107	150
Arsenic (As)	47	47	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	47	47	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	47	47	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	47	42	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	47	47	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	47	44	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 32. Summary of the water quality parameters from the Yadkin River at US 64 at Yadkin College (Q2810000; WS-IV CA) collected between September 4, 1996 and August 27, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	49	NA	<4	0	0.0	5.8	6.7	7.6	9.8	11.0	11.5	14.4
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	48	NA	.	.	.	39	70	78	103	123	149	180
Temperature (C)	51	NA	.	.	.	2	7	12	16	25	27	29
pH (s.u.)	50	NA	<6	0	0.0	6.2	6.5	6.8	7.0	7.1	7.3	9.4
			>9	1	2.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	40	0	.	.	.	60	80	90	100	120	140	290
TSS	47	1	>10	38	80.9	1	7	13	19	35	91	390
			>20	23	48.9							
Chloride	43	0	.	.	.	3	5	7	9	12	14	17
Turbidity (NTU)	56	0	>50	3	5.4	4	7	9	13	24	40	2700
			>25	13	23.2	.	.	.	.	.	.	.
			>10	34	60.7	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	54	7	.	.	.	0.01	0.01	0.03	0.06	0.12	0.21	0.47
TKN as N	53	0	.	.	.	0.10	0.20	0.20	0.30	0.40	0.50	0.70
NO_2+NO_3 as N	54	0	>10	0	0.0	0.32	0.55	0.63	0.77	0.93	1.20	1.40
Total Phosphorus	54	1	0.05	53	98.1	0.01	0.09	0.13	0.18	0.25	0.32	1.00
Metals (µg/L)												
Aluminum (Al)	48	0	.	.	.	140	290	465	845	1675	2820	20000
Copper (Cu)	48	9	>7	13	27.1	2	2	2	4	7	9	22
Iron (Fe)	48	0	>1000	24	50.0	380	511	790	1050	1800	3720	14000
Manganese (Mn)	43	0	>200	2	4.7	21	33	37	56	69	114	270
Zinc (Zn)	48	3	>50	6	12.5	10	11	14	22	30	59	130
Arsenic (As)	48	48	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	48	48	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	48	47	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	48	45	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	48	48	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	48	47	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 33. Summary of the water quality parameters from the South Yadkin River at SR 1159 near Mocksville (Q3460000; WS-IV) collected between September 4, 1996 and August 27, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	50	NA	<4	0	0.0	6.2	6.8	8.1	9.8	10.8	12.0	15.0
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	49	NA	.	.	.	49	50	53	60	64	73	117
Temperature (C)	51	NA	.	.	.	1	5	11	14	22	24	26
pH (s.u.)	49	NA	<6	0	0.0	6.3	6.6	6.8	7.0	7.1	7.4	10.0
			>9	1	2.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	43	0	.	.	.	58	69	74	90	120	168	430
TSS	46	0	>10	39	84.8	3	7	13	23	35	100	310
			>20	26	56.5							
Chloride	43	0	.	.	.	2	3	3	4	4	4	9
Turbidity (NTU)	55	0	>50	6	10.9	4	6	12	17	25	53	300
			>25	14	25.5	.	.	.	.	.	.	.
			>10	44	80.0	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	53	22	.	.	.	0.01	0.01	0.01	0.01	0.04	0.08	0.36
TKN as N	51	0	.	.	.	0.10	0.10	0.20	0.20	0.30	0.40	0.70
NO_2+NO_3 as N	52	0	>10	0	0.0	0.21	0.32	0.43	0.59	0.65	0.73	1.00
Total Phosphorus	52	1	0.05	27	51.9	0.01	0.02	0.04	0.06	0.09	0.15	0.62
Metals (µg/L)												
Aluminum (Al)	47	0	.	.	.	110	276	700	1200	2000	4680	20000
Copper (Cu)	47	14	>7	11	23.4	2	2	2	3	6	9	40
Iron (Fe)	47	0	>1000	40	85.1	610	848	1350	1700	2400	5280	13000
Manganese (Mn)	43	0	>200	1	2.3	34	47	61	81	120	148	430
Zinc (Zn)	47	15	>50	7	14.9	10	10	10	16	31	61	190
Arsenic (As)	47	47	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	47	47	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	47	47	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	47	47	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	47	47	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	47	47	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 34. Summary of the water quality parameters from Hunting Creek at SR 2115 near Harmony (Q3484000; WS-III) collected between September 5, 1996 and August 14, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	58	NA	<4	0	0.0	6.1	7.8	8.4	10.0	11.8	12.9	15.1
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	57	NA	.	.	.	38	44	47	50	53	55	478
Temperature (C)	58	NA	.	.	.	1	5	9	14	21	24	28
pH (s.u.)	58	NA	<6	0	0.0	6.5	6.8	7.0	7.2	7.3	7.4	7.8
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	46	0	.	.	.	42	49	54	64	87	140	3200
TSS	52	2	>10	22	42.3	1	2	5	9	26	50	260
			>20	15	28.8							
Chloride	47	0	.	.	.	2	2	3	3	4	4	7
Turbidity (NTU)	58	0	>50	3	5.2	1	3	5	8	17	42	130
			>25	10	17.2	.	.	.	.	.	.	.
			>10	20	34.5	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	58	26	.	.	.	0.01	0.01	0.01	0.01	0.07	0.13	0.50
TKN as N	57	3	.	.	.	0.10	0.10	0.20	0.20	0.30	0.43	1.00
NO_2+NO_3 as N	58	0	>10	0	0.0	0.47	0.57	0.68	0.79	0.86	0.92	1.10
Total Phosphorus	58	3	0.05	20	34.5	0.01	0.02	0.02	0.04	0.07	0.13	0.50
Metals (µg/L)												
Aluminum (Al)	52	0	.	.	.	73	140	218	495	1450	2400	14000
Copper (Cu)	52	26	>7	2	3.8	2	2	2	2	4	5	20
Iron (Fe)	52	0	>1000	16	30.8	180	280	448	670	1500	2290	8000
Manganese (Mn)	49	4	>200	0	0.0	10	12	14	25	36	54	150
Zinc (Zn)	52	25	>50	2	3.8	10	10	10	10	24	32	84
Arsenic (As)	52	52	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	52	52	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	52	52	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	52	52	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	52	52	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	52	52	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 35. Summary of the water quality parameters from Fourth Creek at SR 2308 near Elmwood (Q3735000; C) collected between September 25, 1996 and August 14, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	%	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	58	NA	<4	0	0.0	5.6	7.0	7.4	9.0	10.6	11.5	12.7
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	57	NA	.	.	.	75	101	116	132	151	165	216
Temperature (C)	58	NA	.	.	.	4	6	8	14	20	23	25
pH (s.u.)	58	NA	<6	0	0.0	6.7	6.9	7.1	7.3	7.4	7.5	7.7
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	49	0	>10	33	67.3	1	7	9	16	38	89	400
			>20	17	34.7							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	55	0	>50	4	7.3	4	6	8	13	24	44	290
			>25	13	23.6	.	.	.	.	.	.	.
			>10	33	60.0	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	55	11	.	.	.	0.01	0.01	0.02	0.09	0.21	0.35	0.50
TKN as N	54	2	.	.	.	0.20	0.30	0.30	0.40	0.50	0.60	1.00
NO_2+NO_3 as N	55	0	>10	0	0.0	0.65	0.81	0.97	1.60	2.60	3.48	5.60
Total Phosphorus	55	1	0.05	54	98.2	0.03	0.22	0.37	0.49	0.64	0.78	1.20
Metals (µg/L)												
Aluminum (Al)	50	0	.	.	.	83	279	385	840	1650	4060	32000
Copper (Cu)	50	5	>7	12	24.0	2	2	3	4	5	10	31
Iron (Fe)	50	0	>1000	31	62.0	400	648	823	1300	2250	5770	33000
Manganese (Mn)	1	0	>200	0	0.0	80	80	80	80	80	80	80
Zinc (Zn)	50	4	>50	5	10.0	10	11	15	25	36	51	95
Arsenic (As)	50	50	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	50	50	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	50	49	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	50	46	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	50	50	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	50	48	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 36. Summary of the water quality parameters from Third Creek at SR 1970 near Woodleaf (Q3934500; WS-IV) collected between September 25, 1996 and August 13, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	57	NA	<4	0	0.0	6.4	7.3	7.7	8.8	10.6	11.7	12.9
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	57	NA	.	.	.	67	119	141	172	216	289	416
Temperature (C)	57	NA	.	.	.	4	6	9	15	20	23	25
pH (s.u.)	57	NA	<6	0	0.0	6.9	7.1	7.3	7.5	7.6	7.7	10.0
			>9	1	1.8	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	46	0	.	.	.	120	130	140	160	205	230	360
TSS	49	0	>10	35	71.4	3	6	10	18	36	62	240
			>20	22	44.9							
Chloride	45	0	.	.	.	3	4	5	5	6	7	13
Turbidity (NTU)	56	0	>50	4	7.1	3	6	9	13	23	34	210
			>25	12	21.4	.	.	.	.	.	.	.
			>10	38	67.9	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	55	15	.	.	.	0.01	0.01	0.01	0.04	0.08	0.18	0.42
TKN as N	53	0	.	.	.	0.10	0.20	0.20	0.30	0.40	0.50	0.60
NO_2+NO_3 as N	55	0	>10	0	0.0	0.39	0.64	0.73	0.85	1.10	1.56	2.10
Total Phosphorus	56	1	0.05	56	100.0	0.13	0.16	0.20	0.27	0.38	0.46	0.59
Metals (µg/L)												
Aluminum (Al)	50	0	.	.	.	110	244	400	725	1300	2410	9200
Copper (Cu)	50	6	>7	11	22.0	2	2	3	4	6	11	18
Iron (Fe)	50	0	>1000	35	70.0	420	809	985	1300	2175	3420	16000
Manganese (Mn)	48	0	>200	4	8.3	47	76	94	120	140	163	360
Zinc (Zn)	50	16	>50	2	4.0	10	10	10	15	27	43	68
Arsenic (As)	50	50	>50	.	.	*Most all samples collected for these metals have*						
Cadmium (Cd)	50	50	>2	.	.	*concentrations below the reporting level.*						
Chromium (Cr)	50	50	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	50	49	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	50	50	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	50	50	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 37. Summary of the water quality parameters from Second Creek at US 70 near Barber (Q4120000; WS-IV) collected between September 25, 1996 and August 13, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	58	NA	<4	0	0.0	5.3	7.3	8.2	9.8	11.6	12.3	14.1
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	58	NA	.	.	.	88	103	120	139	155	224	277
Temperature (C)	58	NA	.	.	.	3	6	8	14	21	23	26
pH (s.u.)	58	NA	<6	0	0.0	6.3	7.1	7.3	7.5	7.6	7.9	8.5
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	45	0	.	.	.	88	110	120	130	140	168	450
TSS	48	1	>10	30	62.5	1	3	6	14	22	45	270
			>20	13	27.1							
Chloride	44	0	.	.	.	4	5	6	8	8	10	14
Turbidity (NTU)	56	0	>50	3	5.4	3	5	8	12	16	35	260
			>25	10	17.9	.	.	.	.	.	.	.
			>10	29	51.8	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	56	19	.	.	.	0.01	0.01	0.01	0.02	0.07	0.12	0.27
TKN as N	54	0	.	.	.	0.10	0.10	0.20	0.20	0.40	0.47	0.68
NO_2+NO_3 as N	56	0	>10	0	0.0	0.03	0.28	0.46	0.61	0.72	0.80	0.96
Total Phosphorus	57	1	0.05	54	94.7	0.04	0.06	0.07	0.10	0.16	0.26	0.61
Metals (µg/L)												
Aluminum (Al)	51	0	.	.	.	91	140	290	550	1020	1500	21000
Copper (Cu)	51	1	>7	16	31.4	2	3	4	5	8	10	22
Iron (Fe)	51	0	>1000	20	39.2	280	530	635	900	1200	1900	15000
Manganese (Mn)	48	0	>200	3	6.3	37	57	66	88	113	150	400
Zinc (Zn)	51	28	>50	2	3.9	10	10	10	10	15	40	91
Arsenic (As)	51	51	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	51	51	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	51	51	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	51	50	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	51	51	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	51	51	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 38. Summary of the water quality parameters from Grants Creek below Salisbury and Spencer WWTP (Q4600000; C) collected between September 25, 1996 and August 13, 2001.

				< or > Eval. Level			Percentiles					
Parameter	N	Num. < R.L.	Eval. Level	n	%	Min.	10	25	50	75	90	Max.
Field												
Dissolved Oxygen	57	NA	<4	0	0.0	5.1	6.2	6.9	8.2	10.0	11.2	12.0
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	57	NA	.	.	.	95	135	153	185	249	365	617
Temperature (C)	57	NA	.	.	.	4	5	8	15	21	23	26
pH (s.u.)	57	NA	<6	1	1.8	5.3	6.9	7.0	7.2	7.3	7.4	7.7
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	9	0	.	.	.	110	118	120	150	210	230	230
TSS	49	2	>10	14	28.6	1	3	4	8	13	25	250
			>20	6	12.2							
Chloride	8	0	.	.	.	5	5	7	9	11	14	15
Turbidity (NTU)	56	0	>50	6	10.7	2	5	7	11	18	47	210
			>25	9	16.1	.	.	.	.	.	.	.
			>10	28	50.0	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	54	3	.	.	.	0.01	0.02	0.05	0.09	0.17	0.37	0.92
TKN as N	51	0	.	.	.	0.20	0.20	0.30	0.40	0.60	0.90	2.80
NO_2+NO_3 as N	54	0	>10	0	0.0	0.19	0.65	0.80	1.05	1.90	2.57	4.50
Total Phosphorus	54	1	0.05	54	100.0	0.06	0.12	0.16	0.29	0.43	0.66	1.80
Metals (µg/L)												
Aluminum (Al)	50	0	.	.	.	66	190	270	405	745	1220	7700
Copper (Cu)	51	11	>7	7	13.7	2	2	2	3	5	11	27
Iron (Fe)	50	0	>1000	18	36.0	360	579	695	970	1200	1910	11000
Manganese (Mn)	4	0	>200	2	50.0	97	110	129	215	305	332	350
Zinc (Zn)	51	23	>50	6	11.8	10	10	10	11	26	55	71
Arsenic (As)	50	50	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	51	51	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	51	51	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	51	51	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	50	49	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	51	51	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 39. Summary of the water quality parameters from the Yadkin River at NC 150 near Spencer (Q4660000; WS-V) collected between September 25, 1996 and August 13, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	55	NA	<4	0	0.0	5.3	6.3	6.8	8.6	10.7	11.9	14.2
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	54	NA	.	.	.	59	75	88	110	128	140	159
Temperature (C)	55	NA	.	.	.	1	5	8	15	23	27	32
pH (s.u.)	55	NA	<6	0	0.0	6.3	7.0	7.2	7.3	7.4	7.5	7.8
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	47	0	.	.	.	79	84	92	110	120	148	280
TSS	50	0	>10	39	78.0	2	7	12	18	27	56	180
			>20	19	38.0							
Chloride	46	0	.	.	.	3	5	6	9	10	12	1700
Turbidity (NTU)	55	0	>50	6	10.9	5	7	10	15	24	53	180
			>25	10	18.2	.	.	.	.	.	.	.
			>10	40	72.7	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	56	9	.	.	.	0.01	0.01	0.02	0.06	0.12	0.20	0.38
TKN as N	54	0	.	.	.	0.10	0.20	0.20	0.30	0.40	0.50	1.30
NO_2+NO_3 as N	56	0	>10	0	0.0	0.47	0.59	0.66	0.74	0.87	1.05	1.20
Total Phosphorus	57	1	0.05	57	100.0	0.06	0.09	0.11	0.15	0.21	0.24	0.50
Metals (µg/L)												
Aluminum (Al)	52	0	.	.	.	69	333	520	865	1525	4730	21000
Copper (Cu)	52	14	>7	6	11.5	2	2	2	3	5	8	14
Iron (Fe)	52	0	>1000	28	53.8	270	623	785	1150	1725	4200	15000
Manganese (Mn)	48	0	>200	0	0.0	18	31	40	59	85	126	200
Zinc (Zn)	52	17	>50	2	3.8	10	10	10	13	22	36	54
Arsenic (As)	52	52	>50	.	.	*Most all samples collected for these metals have*						
Cadmium (Cd)	52	52	>2	.	.	*concentrations below the reporting level.*						
Chromium (Cr)	52	52	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	52	52	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	52	52	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	52	52	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 40. Summary of the water quality parameters from Town Creek at SR 2168 near Duke (Q5360000; WS-V) collected between September 25, 1996 and August 13, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	55	NA	<4	0	0.0	4.0	6.8	7.9	9.7	10.8	11.7	15.4
(DO; mg/L)			<5	2	3.6	.	.	.	.	.	.	.
Conductivity	55	NA	.	.	.	95	128	145	185	244	409	671
Temperature (C)	55	NA	.	.	.	2	7	10	18	26	29	32
pH (s.u.)	55	NA	<6	0	0.0	6.6	6.9	7.4	8.4	9.0	9.5	9.7
			>9	9	16.4	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	9	0	.	.	.	120	120	120	200	200	204	220
TSS	48	0	>10	37	77.1	1	5	13	22	31	43	63
			>20	27	56.3							
Chloride	9	0	.	.	.	8	9	9	14	21	23	25
Turbidity (NTU)	55	0	>50	6	10.9	7	10	13	18	30	52	110
			>25	15	27.3	.	.	.	.	.	.	.
			>10	47	85.5	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	55	17	.	.	.	0.01	0.01	0.01	0.05	0.12	0.19	0.65
TKN as N	53	0	.	.	.	0.20	0.30	0.40	0.60	0.70	0.90	1.50
NO_2+NO_3 as N	55	14	>10	0	0.0	0.01	0.01	0.01	0.13	0.63	1.42	3.00
Total Phosphorus	56	1	0.05	54	96.4	0.05	0.09	0.11	0.16	0.25	0.39	0.74
Metals (µg/L)												
Aluminum (Al)	50	0	.	.	.	150	310	570	860	1375	2710	13000
Copper (Cu)	51	9	>7	12	23.5	2	2	3	4	6	11	37
Iron (Fe)	50	0	>1000	25	50.0	310	501	795	1050	1475	2610	8900
Manganese (Mn)	4	0	>200	1	25.0	83	97	118	155	200	236	260
Zinc (Zn)	51	20	>50	3	5.9	10	10	10	14	24	38	69
Arsenic (As)	50	50	>50	.	.	*Most all samples collected for these metals have*						
Cadmium (Cd)	51	51	>2	.	.	*concentrations below the reporting level.*						
Chromium (Cr)	51	51	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	51	51	>25	.	.	*reporting and reference levels are too few in*						
						number to provide any confidence for						
Mercury (Hg)	50	50	>0.012	.	.	*interpretation.*						
Nickel (Ni)	51	51	>25	.	.							

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 41. Summary of the water quality parameters from Rich Fork at SR 1800 near Thomasville (Q5780000; C) collected between September 03, 1996 and August 13, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	47	NA	<4	0	0.0	4.0	4.9	5.9	7.8	9.5	10.8	13.0
(DO; mg/L)			<5	6	12.8	.	.	.	.	.	.	.
Conductivity	48	NA	.	.	.	82	157	223	299	452	481	528
Temperature (C)	49	NA	.	.	.	3	8	12	16	23	26	28
pH (s.u.)	49	NA	<6	0	0.0	6.2	6.5	6.7	7.0	7.2	7.2	7.4
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	1	0	.	.	.	330	330	330	330	330	330	330
TSS	47	0	>10	20	42.6	1	3	5	8	18	29	260
			>20	9	19.1							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	56	0	>50	2	3.6	2	4	6	8	15	25	120
			>25	6	10.7	.	.	.	.	.	.	.
			>10	20	35.7	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	55	3	.	.	.	0.01	0.02	0.07	0.11	0.20	0.36	2.30
TKN as N	54	0	.	.	.	0.20	0.40	0.63	0.90	1.20	1.60	5.40
NO_2+NO_3 as N	55	0	>10	1	1.8	0.37	1.10	1.85	3.50	6.40	8.10	12.00
Total Phosphorus	55	0	0.05	55	100.0	0.13	0.25	0.41	0.62	1.10	2.18	3.30
Metals (µg/L)												
Aluminum (Al)	49	1	.	.	.	50	180	300	470	920	2100	9200
Copper (Cu)	49	7	>7	7	14.3	2	2	3	4	6	7	22
Iron (Fe)	49	0	>1000	13	26.5	77	440	580	750	1100	1920	10000
Manganese (Mn)	0	0	>200	0	.	.	.	.	.	.	.	.
Zinc (Zn)	49	1	>50	17	34.7	10	16	29	42	57	66	4000
Arsenic (As)	49	49	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	49	49	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	49	48	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	49	48	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	48	48	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	49	49	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 42. **Summary of the water quality parameters from Hambys Creek at SR 2790 near Holly Grove (Q5906000; C) collected between September 03, 1996 and August 13, 2001.**

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	48	NA	<4	0	0.0	4.5	6.0	7.3	9.1	10.5	12.1	14.4
(DO; mg/L)			<5	2	4.2	.	.	.	.	.	.	.
Conductivity	48	NA	.	.	.	83	200	307	481	742	807	1200
Temperature (C)	49	NA	.	.	.	1	8	11	15	23	24	26
pH (s.u.)	49	NA	<6	0	0.0	6.3	6.7	7.0	7.1	7.2	7.4	7.7
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	1	0	.	.	.	480	480	480	480	480	480	480
TSS	46	3	>10	3	6.5	1	1	1	4	6	9	550
			>20	2	4.3							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	56	0	>50	1	1.8	1	2	3	4	8	14	160
			>25	2	3.6	.	.	.	.	.	.	.
			>10	11	19.6	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	54	9	.	.	.	0.01	0.01	0.02	0.04	0.11	0.20	1.40
TKN as N	54	1	.	.	.	0.20	0.30	0.50	0.80	1.00	1.30	3.20
NO_2+NO_3 as N	54	0	>10	20	37.0	0.60	1.63	3.73	7.95	13.60	16.00	22.00
Total Phosphorus	54	0	0.05	54	100.0	0.12	0.33	0.59	1.20	1.78	2.17	2.80
Metals (µg/L)												
Aluminum (Al)	48	2	.	.	.	50	92	163	225	423	781	15000
Copper (Cu)	48	0	>7	35	72.9	2	4	7	10	14	19	36
Iron (Fe)	48	0	>1000	3	6.3	57	167	230	335	483	880	19000
Manganese (Mn)	0	0	>200	0	.	.	.	.	.	.	.	.
Zinc (Zn)	48	2	>50	14	29.2	10	17	29	41	57	71	110
Arsenic (As)	48	46	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	48	48	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	48	48	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	48	47	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	48	48	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	48	24	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 43. Summary of the water quality parameters from Abbotts Creek at SR 1243 at Lexington (Q5930000; C) collected between September 30, 1996 and August 13, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	Percentiles 25	Percentiles 50	Percentiles 75	Percentiles 90	Max.
Field												
Dissolved Oxygen	47	NA	<4	0	0.0	4.8	5.8	6.6	8.6	10.0	11.2	18.2
(DO; mg/L)			<5	2	4.3	.	.	.	.	.	.	.
Conductivity	46	NA	.	.	.	98	135	155	219	342	436	508
Temperature (C)	48	NA	.	.	.	2	8	11	16	23	25	28
pH (s.u.)	48	NA	<6	0	0.0	6.6	6.7	6.8	7.1	7.2	7.5	7.7
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	1	0	.	.	.	260	260	260	260	260	260	260
TSS	46	1	>10	31	67.4	1	4	8	14	25	38	130
			>20	16	34.8							
Chloride	2	0	.	.	.	18	19	22	25	29	31	33
Turbidity (NTU)	53	0	>50	1	1.9	3	6	9	14	23	39	70
			>25	12	22.6	.	.	.	.	.	.	.
			>10	34	64.2	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	52	8	.	.	.	0.01	0.01	0.02	0.06	0.11	0.23	1.10
TKN as N	51	0	.	.	.	0.10	0.30	0.40	0.40	0.60	0.90	3.20
NO_2+NO_3 as N	52	0	>10	0	0.0	0.47	0.78	0.99	1.60	3.13	4.57	6.50
Total Phosphorus	52	0	0.05	52	100.0	0.11	0.13	0.17	0.27	0.40	0.59	0.82
Metals (µg/L)												
Aluminum (Al)	47	0	.	.	.	180	376	595	920	1800	3400	6600
Copper (Cu)	47	0	>7	12	25.5	2	3	4	5	7	11	33
Iron (Fe)	47	0	>1000	30	63.8	150	626	920	1200	1950	2580	3800
Manganese (Mn)	3	0	>200	1	33.3	100	118	145	190	280	334	370
Zinc (Zn)	47	5	>50	6	12.8	10	10	12	17	28	58	190
Arsenic (As)	47	47	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	47	47	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	47	47	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	47	46	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	46	46	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	47	47	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 44. Summary of the water quality parameters from Abbotts Creek at NC 47 near Cotton Grove (Q5970000; WS-V&B) collected between September 10, 1996 and August 13, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen (DO; mg/L)	50	NA	<4	2	4.0	3.8	5.6	7.0	9.0	10.5	12.8	18.4
			<5	4	8.0	.	.	.	.	.	.	.
Conductivity	50	NA	.	.	.	106	128	135	191	288	348	468
Temperature (C)	53	NA	.	.	.	2	6	11	16	25	27	30
pH (s.u.)	48	NA	<6	0	0.0	6.4	6.7	7.0	7.1	7.7	8.5	9.4
			>9	2	4.2	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	44	0	.	.	.	95	140	150	170	203	247	330
TSS	48	1	>10	33	68.8	1	5	9	16	25	36	74
			>20	18	37.5							
Chloride	45	1	.	.	.	1	8	9	16	21	35	62
Turbidity (NTU)	56	0	>50	1	1.8	5	9	12	17	26	40	65
			>25	15	26.8	.	.	.	.	.	.	.
			>10	45	80.4	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	54	14	.	.	.	0.01	0.01	0.01	0.05	0.11	0.20	0.67
TKN as N	53	0	.	.	.	0.20	0.30	0.40	0.50	0.80	1.00	1.70
NO_2+NO_3 as N	54	3	>10	0	0.0	0.01	0.28	0.71	0.99	1.70	3.81	7.80
Total Phosphorus	54	0	0.05	54	100.0	0.10	0.14	0.20	0.29	0.45	0.69	1.30
Metals (µg/L)												
Aluminum (Al)	49	0	.	.	.	52	366	640	950	1600	3240	7100
Copper (Cu)	49	4	>7	13	26.5	2	2	3	4	7	8	11
Iron (Fe)	49	0	>1000	30	61.2	89	736	890	1200	1700	2640	3700
Manganese (Mn)	46	0	>200	6	13.0	18	79	110	135	168	210	270
Zinc (Zn)	49	4	>50	4	8.2	10	11	16	23	36	47	190
Arsenic (As)	49	49	>50	.	.	*Most all samples collected for these metals have*						
Cadmium (Cd)	49	49	>2	.	.	*concentrations below the reporting level.*						
Chromium (Cr)	49	49	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	49	49	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	48	48	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	49	49	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 45. Summary of the water quality parameters from Abbotts Creek at SR 2294 near Southmont Duracell (Q5990000; WS-IV & B) collected between September 10, 1996 and June 19, 2000.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	43	NA	<4	3	7.0	0.2	5.0	8.5	9.5	10.5	12.0	13.0
(DO; mg/L)			<5	5	11.6	.	.	.	.	.	.	.
Conductivity	42	NA	.	.	.	69	96	110	140	158	206	1026
Temperature (C)	44	NA	.	.	.	3	8	11	17	22	28	29
pH (s.u.)	37	NA	<6	0	0.0	6.0	6.5	6.9	7.2	8.2	8.5	8.9
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	42	0	.	.	.	69	100	110	130	150	170	200
TSS	44	0	>10	26	59.1	1	5	8	13	17	23	44
			>20	5	11.4							
Chloride	41	0	.	.	.	4	7	9	12	14	16	28
Turbidity (NTU)	45	0	>50	1	2.2	5	6	7	11	26	43	55
			>25	12	26.7	.	.	.	.	.	.	.
			>10	23	51.1	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	45	17	.	.	.	0.01	0.01	0.01	0.03	0.09	0.18	0.49
TKN as N	45	0	.	.	.	0.20	0.30	0.40	0.50	0.50	0.60	0.90
NO_2+NO_3 as N	45	11	>10	0	0.0	0.01	0.01	0.01	0.14	0.58	0.83	1.40
Total Phosphorus	45	0	0.05	32	71.1	0.02	0.04	0.05	0.09	0.12	0.14	0.22
Metals (µg/L)												
Aluminum (Al)	45	1	.	.	.	50	160	260	490	960	2960	4400
Copper (Cu)	45	11	>7	5	11.1	2	2	2	3	5	7	25
Iron (Fe)	45	1	>1000	12	26.7	50	260	340	620	1100	2220	3700
Manganese (Mn)	43	1	>200	1	2.3	10	36	44	61	95	128	220
Zinc (Zn)	45	7	>50	4	8.9	10	10	12	23	32	49	250
Arsenic (As)	45	45	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	45	45	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	45	45	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	45	45	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	45	45	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	45	45	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 46. Summary of the water quality parameters from the Yadkin River at SR 1002 at High Rock (Q6120000; WS-IV&B CA) collected between September 10, 1996 and August 13, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	48	NA	<4	5	10.4	2.5	3.9	5.2	8.0	10.5	11.5	15.9
(DO; mg/L)			<5	12	25.0	.	.	.	.	.	.	.
Conductivity	48	NA	.	.	.	54	71	90	107	125	137	142
Temperature (C)	49	NA	.	.	.	3	7	11	17	26	27	29
pH (s.u.)	47	NA	<6	1	2.1	5.9	6.2	6.5	6.6	6.9	7.3	7.9
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	43	0	.	.	.	69	79	89	100	105	130	200
TSS	40	0	>10	25	62.5	1	6	8	11	15	37	92
			>20	6	15.0							
Chloride	43	0	.	.	.	4	5	6	8	9	11	12
Turbidity (NTU)	56	0	>50	4	7.1	3	5	7	10	20	31	190
			>25	12	21.4	.	.	.	.	.	.	.
			>10	26	46.4	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	55	0	.	.	.	0.02	0.05	0.10	0.14	0.25	0.34	0.41
TKN as N	54	0	.	.	.	0.10	0.20	0.30	0.40	0.50	0.77	1.20
NO_2+NO_3 as N	55	2	>10	0	0.0	0.01	0.16	0.29	0.45	0.65	0.74	0.81
Total Phosphorus	55	0	0.05	42	76.4	0.03	0.04	0.06	0.08	0.09	0.12	0.23
Metals (µg/L)												
Aluminum (Al)	49	0	.	.	.	150	238	320	590	1100	1820	4800
Copper (Cu)	49	10	>7	6	12.2	2	2	2	3	4	7	21
Iron (Fe)	49	0	>1000	17	34.7	100	386	520	840	1300	1800	4800
Manganese (Mn)	3	0	>200	1	33.3	57	57	58	59	220	316	380
Zinc (Zn)	49	20	>50	6	12.2	10	10	10	14	30	57	130
Arsenic (As)	49	49	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	49	49	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	49	49	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	49	49	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	48	48	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	49	49	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 47. Summary of the water quality parameters from the Uwharrie River at NC 109 near Uwharrie (Q6810000; WS-IV) collected between October 03, 1996 and August 07, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	55	NA	<4	0	0.0	4.1	5.3	7.5	9.3	10.4	12.3	13.8
(DO; mg/L)			<5	4	7.3	.	.	.	.	.	.	.
Conductivity	55	NA	.	.	.	65	72	84	91	98	107	164
Temperature (C)	55	NA	.	.	.	3	6	9	14	22	25	29
pH (s.u.)	55	NA	<6	3	5.5	4.2	6.3	7.0	7.2	7.5	7.7	8.3
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	42	0	.	.	.	62	71	79	86	100	130	290
TSS	46	4	>10	9	19.6	1	1	2	4	8	33	190
			>20	6	13.0							
Chloride	40	0	.	.	.	3	3	4	4	6	6	6
Turbidity (NTU)	53	0	>50	3	5.7	2	3	4	8	19	44	100
			>25	12	22.6	.	.	.	.	.	.	.
			>10	23	43.4	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	52	24	.	.	.	0.01	0.01	0.01	0.02	0.06	0.10	0.81
TKN as N	50	1	.	.	.	0.10	0.20	0.20	0.30	0.40	0.41	1.00
NO_2+NO_3 as N	51	9	>10	0	0.0	0.01	0.01	0.07	0.21	0.32	0.38	0.81
Total Phosphorus	53	3	0.05	18	34.0	0.01	0.01	0.02	0.03	0.07	0.13	0.50
Metals (µg/L)												
Aluminum (Al)	47	0	.	.	.	61	88	130	320	955	1940	6800
Copper (Cu)	47	16	>7	7	14.9	2	2	2	3	4	8	89
Iron (Fe)	47	0	>1000	15	31.9	230	310	400	740	1250	2780	9300
Manganese (Mn)	43	1	>200	1	2.3	10	11	16	26	45	83	450
Zinc (Zn)	47	22	>50	5	10.6	10	10	10	10	17	46	250
Arsenic (As)	47	47	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	47	47	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	47	47	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	47	47	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	47	47	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	47	47	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 48. Summary of the water quality parameters from Dutchmans Creek at SR1150 near Uwharrie (Q6820000; WS-IV CA) collected between October 03, 1996 and August 10, 2000.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	Percentiles 25	Percentiles 50	Percentiles 75	Percentiles 90	Max.
Field												
Dissolved Oxygen	44	NA	<4	0	0.0	5.2	7.0	7.8	9.7	11.0	12.3	14.5
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	44	NA	.	.	.	22	41	47	52	57	68	81
Temperature (C)	44	NA	.	.	.	2	6	9	13	20	24	27
pH (s.u.)	44	NA	<6	3	6.8	3.7	6.3	6.7	7.2	7.4	7.8	7.9
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	43	0	.	.	.	50	61	67	69	75	83	270
TSS	44	12	>10	2	4.5	1	1	1	1	2	6	190
			>20	2	4.5							
Chloride	42	0	.	.	.	1	2	3	3	3	4	7
Turbidity (NTU)	43	0	>50	1	2.3	1	2	3	4	5	11	85
			>25	2	4.7	.	.	.	.	.	.	.
			>10	5	11.6	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	44	21	.	.	.	0.01	0.01	0.01	0.01	0.04	0.08	0.12
TKN as N	43	2	.	.	.	0.10	0.10	0.10	0.20	0.30	0.30	0.50
NO_2+NO_3 as N	43	25	>10	0	0.0	0.01	0.01	0.01	0.01	0.03	0.05	0.11
Total Phosphorus	39	11	0.05	3	7.7	0.01	0.01	0.01	0.01	0.02	0.03	0.20
Metals (µg/L)												
Aluminum (Al)	44	3	.	.	.	50	67	92	145	233	417	2700
Copper (Cu)	44	28	>7	3	6.8	2	2	2	2	3	6	78
Iron (Fe)	44	0	>1000	2	4.5	130	223	260	330	420	644	2600
Manganese (Mn)	40	19	>200	0	0.0	10	10	10	10	14	21	160
Zinc (Zn)	44	26	>50	2	4.5	10	10	10	10	19	32	75
Arsenic (As)	44	44	>50	.	.							
Cadmium (Cd)	44	44	>2	.	.							
Chromium (Cr)	44	44	>50	.	.							
Lead (Pb)	44	44	>25	.	.							
Mercury (Hg)	44	44	>0.012	.	.							
Nickel (Ni)	44	44	>25	.	.							

Most all samples collected for these metals have concentrations below the reporting level. Samples that have concentrations above reporting and reference levels are too few in number to provide any confidence for interpretation.

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 49. Summary of the water quality parameters from the Pee Dee River at NC 731 near Shankle (Q7150000; WS-V&B) collected between September 24, 1996 and August 29, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	57	NA	<4	2	3.5	2.0	5.0	6.0	8.5	10.1	11.6	14.6
(DO; mg/L)			<5	6	10.5	.	.	.	.	.	.	.
Conductivity	57	NA	.	.	.	68	79	88	99	107	112	124
Temperature (C)	57	NA	.	.	.	6	9	11	18	24	27	29
pH (s.u.)	57	NA	<6	0	0.0	6.5	6.8	7.0	7.2	7.4	7.6	8.4
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	46	0	.	.	.	22	57	70	77	87	110	170
TSS	49	10	>10	1	2.0	1	1	1	2	4	8	18
			>20	0	0.0							
Chloride	45	0	.	.	.	4	5	6	8	9	10	11
Turbidity (NTU)	56	1	>50	1	1.8	1	1	2	3	8	18	437
			>25	2	3.6	.	.	.	.	.	.	.
			>10	10	17.9	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	54	15	.	.	.	0.01	0.01	0.01	0.05	0.09	0.14	0.50
TKN as N	54	2	.	.	.	0.10	0.20	0.20	0.30	0.30	0.43	3.40
NO_2+NO_3 as N	54	1	>10	0	0.0	0.08	0.12	0.23	0.44	0.56	0.66	0.80
Total Phosphorus	54	6	0.05	8	14.8	0.01	0.01	0.01	0.02	0.04	0.06	0.50
Metals (µg/L)												
Aluminum (Al)	50	6	.	.	.	50	50	91	160	248	631	2600
Copper (Cu)	50	29	>7	3	6.0	2	2	2	2	3	5	13
Iron (Fe)	50	2	>1000	3	6.0	50	99	140	200	318	862	3100
Manganese (Mn)	48	0	>200	5	10.4	11	17	22	36	70	163	480
Zinc (Zn)	50	25	>50	3	6.0	10	10	10	10	20	40	150
Arsenic (As)	50	49	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	50	50	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	50	50	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	50	50	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	50	50	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	50	50	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 50. Summary of the water quality parameters from the Rocky River at SR 2420 near Davidson (Q7330000; C) collected between September 16, 1996 and August 29, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	58	NA	<4	0	0.0	5.7	6.7	7.6	8.8	10.0	10.8	12.5
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	58	NA	.	.	.	113	153	247	341	435	625	804
Temperature (C)	58	NA	.	.	.	5	7	10	16	22	24	27
pH (s.u.)	58	NA	<6	0	0.0	6.7	7.0	7.2	7.3	7.5	7.6	7.9
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	49	0	>10	34	69.4	1	6	9	14	22	80	740
			>20	14	28.6							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	56	1	>50	6	10.7	1	5	8	12	15	44	390
			>25	7	12.5	.	.	.	.	.	.	.
			>10	32	57.1	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	55	15	.	.	.	0.01	0.01	0.01	0.05	0.11	0.19	0.32
TKN as N	55	1	.	.	.	0.20	0.30	0.40	0.60	0.75	0.92	1.50
NO_2+NO_3 as N	55	0	>10	7	12.7	0.30	1.28	2.10	4.80	8.75	11.60	15.00
Total Phosphorus	55	0	0.05	55	100.0	0.11	0.39	0.64	1.00	1.45	1.96	2.40
Metals (µg/L)												
Aluminum (Al)	51	0	.	.	.	61	190	395	620	970	2600	28000
Copper (Cu)	51	7	>7	11	21.6	2	2	2	5	6	8	23
Iron (Fe)	51	0	>1000	25	49.0	200	540	785	1000	1350	2600	26000
Manganese (Mn)	0	0	>200	0	.	.	.	.	.	.	.	.
Zinc (Zn)	51	3	>50	14	27.5	10	13	19	29	51	74	180
Arsenic (As)	51	51	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	51	51	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	51	51	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	51	49	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	51	51	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	51	49	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 51. Summary of the water quality parameters from Irish Buffalo Creek at SR 1132 near Faggarts (Q8090000; C) collected between September 4, 1996 and August 08, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	59	NA	<4	0	0.0	6.7	8.0	8.8	10.1	12.1	13.4	14.9
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	59	NA	.	.	.	73	131	166	188	200	208	270
Temperature (C)	59	NA	.	.	.	3	6	9	16	21	24	26
pH (s.u.)	59	NA	<6	0	0.0	7.0	7.3	7.4	7.8	8.2	8.5	9.1
			>9	2	3.4	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	49	7	>10	12	24.5	1	1	1	4	7	49	880
			>20	8	16.3							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	57	1	>50	6	10.5	1	2	3	5	10	41	700
			>25	6	10.5	.	.	.	.	.	.	.
			>10	13	22.8	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	56	18	.	.	.	0.01	0.01	0.01	0.02	0.06	0.11	0.43
TKN as N	55	2	.	.	.	0.10	0.10	0.20	0.20	0.30	0.50	0.70
NO_2+NO_3 as N	56	1	>10	0	0.0	0.01	0.24	0.44	0.56	0.75	0.88	1.40
Total Phosphorus	56	5	0.05	13	23.2	0.01	0.01	0.02	0.03	0.05	0.12	1.30
Metals (µg/L)												
Aluminum (Al)	51	1	.	.	.	50	62	120	220	615	3200	67000
Copper (Cu)	51	18	>7	11	21.6	2	2	2	3	6	11	61
Iron (Fe)	51	1	>1000	10	19.6	50	150	210	360	710	4400	49000
Manganese (Mn)	0	0	>200	0	.	.	.	.	.	.	.	.
Zinc (Zn)	51	22	>50	6	11.8	10	10	10	12	24	55	210
Arsenic (As)	51	50	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	51	51	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	51	50	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	51	47	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	51	51	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	51	49	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 52. Summary of the water quality parameters from the Rocky River at US 601 near Concord (Q8210000; C) collected between September 24, 1996 and August 08, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	59	NA	<4	0	0.0	4.8	5.5	6.7	8.5	10.2	11.1	13.1
(DO; mg/L)			<5	1	1.7	.	.	.	.	.	.	.
Conductivity	59	NA	.	.	.	94	237	316	441	580	752	880
Temperature (C)	59	NA	.	.	.	5	7	10	17	25	28	30
pH (s.u.)	59	NA	<6	0	0.0	6.5	7.2	7.4	7.5	7.6	7.7	7.9
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	49	4	>10	24	49.0	1	1	5	10	25	81	670
			>20	14	28.6							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	54	0	>50	5	9.3	2	4	7	11	19	43	300
			>25	9	16.7	.	.	.	.	.	.	.
			>10	27	50.0	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	53	2	.	.	.	0.01	0.02	0.05	0.12	0.28	0.94	3.50
TKN as N	53	0	.	.	.	0.20	0.32	0.40	0.60	1.10	1.40	5.40
NO_2+NO_3 as N	53	0	>10	0	0.0	0.41	0.92	1.60	2.60	3.60	4.38	5.70
Total Phosphorus	53	0	0.05	52	98.1	0.03	0.24	0.36	0.55	1.00	1.28	1.90
Metals (µg/L)												
Aluminum (Al)	50	1	.	.	.	50	120	270	530	1225	3310	8700
Copper (Cu)	50	3	>7	18	36.0	2	3	4	5	8	10	52
Iron (Fe)	50	0	>1000	17	34.0	64	318	490	880	1500	3530	14000
Manganese (Mn)	0	0	>200	0	.	.	.	.	.	.	.	.
Zinc (Zn)	50	3	>50	6	12.0	10	13	17	24	33	53	110
Arsenic (As)	50	50	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	50	50	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	50	50	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	50	49	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	50	50	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	50	49	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 53. Summary of the water quality parameters from Goose Creek at SR 1524 near Mint Hill (Q8360000; C) collected between September 4, 1996 and August 06, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	59	NA	<4	1	1.7	1.0	6.9	7.9	9.4	11.8	12.9	16.3
(DO; mg/L)			<5	1	1.7	.	.	.	.	.	.	.
Conductivity	59	NA	.	.	.	67	98	113	128	173	335	497
Temperature (C)	59	NA	.	.	.	5	9	11	17	23	25	28
pH (s.u.)	59	NA	<6	0	0.0	6.6	6.9	7.1	7.3	7.7	8.5	9.8
			>9	4	6.8	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	52	4	>10	18	34.6	1	1	2	4	12	39	400
			>20	7	13.5							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	58	0	>50	4	6.9	2	4	5	9	19	35	280
			>25	13	22.4	.	.	.	.	.	.	.
			>10	25	43.1	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	57	10	.	.	.	0.01	0.01	0.02	0.09	0.50	0.99	14.00
TKN as N	56	1	.	.	.	0.10	0.20	0.20	0.35	0.85	1.80	15.00
NO_2+NO_3 as N	57	0	>10	0	0.0	0.09	0.32	0.51	0.67	1.50	2.82	4.80
Total Phosphorus	57	1	0.05	53	93.0	0.03	0.06	0.08	0.18	0.57	1.60	3.70
Metals (µg/L)												
Aluminum (Al)	51	1	.	.	.	50	100	140	370	950	2000	21000
Copper (Cu)	51	6	>7	10	19.6	2	2	3	4	6	9	26
Iron (Fe)	51	0	>1000	14	27.5	160	300	385	610	1100	1900	23000
Manganese (Mn)	2	0	>200	0	0.0	48	51	56	64	71	76	79
Zinc (Zn)	51	17	>50	4	7.8	10	10	10	17	32	45	160
Arsenic (As)	52	52	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	51	51	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	51	51	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	51	51	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	52	52	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	51	51	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 54. Summary of the water quality parameters from Long Creek at SR 1954 near Rocky River Springs (Q8720000; C) collected between September 24, 1996 and August 29, 2001.

				< or > Eval. Level			Percentiles					
Parameter	**N**	**Num. < R.L.**	**Eval. Level**	**n**	**%**	**Min.**	**10**	**25**	**50**	**75**	**90**	**Max.**
Field												
Dissolved Oxygen	57	NA	<4	0	0.0	6.1	7.2	8.1	9.4	11.5	12.8	15.1
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	57	NA	.	.	.	52	129	168	240	469	780	1140
Temperature (C)	57	NA	.	.	.	4	8	10	16	23	27	28
pH (s.u.)	57	NA	<6	0	0.0	7.0	7.2	7.3	7.7	8.0	8.1	9.4
			>9	1	1.8	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	49	6	>10	4	8.2	1	1	1	2	6	9	220
			>20	4	8.2							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	57	2	>50	1	1.8	1	1	2	3	5	11	140
			>25	2	3.5	.	.	.	.	.	.	.
			>10	6	10.5	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	54	8	.	.	.	0.01	0.01	0.03	0.07	0.16	0.30	1.10
TKN as N	54	1	.	.	.	0.10	0.30	0.40	0.50	0.75	1.00	1.60
NO_2+NO_3 as N	54	0	>10	0	0.0	0.34	0.55	0.78	1.20	1.40	1.84	3.10
Total Phosphorus	54	1	0.05	52	96.3	0.03	0.08	0.09	0.22	0.54	0.93	1.30
Metals (µg/L)												
Aluminum (Al)	49	1	.	.	.	50	62	79	150	240	760	4500
Copper (Cu)	49	1	>7	28	57.1	2	3	5	8	14	19	27
Iron (Fe)	49	0	>1000	4	8.2	130	168	220	320	400	786	4900
Manganese (Mn)	1	0	>200	0	0.0	17	17	17	17	17	17	17
Zinc (Zn)	49	10	>50	8	16.3	10	10	11	22	42	57	220
Arsenic (As)	50	49	>50	.	.	*Most all samples collected for these metals have*						
Cadmium (Cd)	49	49	>2	.	.	*concentrations below the reporting level.*						
Chromium (Cr)	49	49	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	49	49	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	50	50	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	49	49	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 55. Summary of the water quality parameters from Richardson Creek at SR 1649 near Fairfield (Q8917000; C) collected between September 24, 1996 and August 29, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	57	NA	<4	0	0.0	6.8	7.3	7.8	9.6	11.0	12.6	14.5
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	57	NA	.	.	.	73	142	194	312	534	701	839
Temperature (C)	57	NA	.	.	.	5	9	11	16	22	26	28
pH (s.u.)	57	NA	<6	0	0.0	6.9	7.1	7.4	7.6	7.8	8.1	9.2
			>9	1	1.8	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	48	11	>10	5	10.4	1	1	1	2	5	12	230
			>20	4	8.3							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	56	7	>50	2	3.6	1	1	1	3	5	15	95
			>25	3	5.4	.	.	.	.	.	.	.
			>10	7	12.5	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	53	17	.	.	.	0.01	0.01	0.01	0.05	0.10	0.22	1.00
TKN as N	53	1	.	.	.	0.20	0.40	0.50	0.70	0.90	1.28	1.50
NO_2+NO_3 as N	53	0	>10	14	26.4	0.02	1.84	3.10	5.40	11.00	16.80	20.00
Total Phosphorus	53	0	0.05	53	100.0	0.15	0.36	0.48	1.10	2.10	3.68	6.30
Metals (µg/L)												
Aluminum (Al)	48	3	.	.	.	50	55	75	115	315	934	2300
Copper (Cu)	48	0	>7	22	45.8	3	4	5	7	10	12	23
Iron (Fe)	48	1	>1000	4	8.3	50	72	118	195	465	986	3500
Manganese (Mn)	0	0	>200	0	.	.	.	.	.	.	.	.
Zinc (Zn)	48	2	>50	21	43.8	10	14	20	39	62	95	160
Arsenic (As)	49	47	>50	.	.							
Cadmium (Cd)	48	48	>2	.	.							
Chromium (Cr)	48	48	>50	.	.							
Lead (Pb)	48	48	>25	.	.							
Mercury (Hg)	49	49	>0.012	.	.							
Nickel (Ni)	48	48	>88	.	.							

Most all samples collected for these metals have concentrations below the reporting level. Samples that have concentrations above reporting and reference levels are too few in number to provide any confidence for interpretation.

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 56. Summary of the water quality parameters from the Rocky River at SR 1935 near Norwood (Q9120000; C) collected between September 24, 1996 and August 29, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	57	NA	<4	0	0.0	6.2	7.1	7.9	9.1	11.1	12.3	14.5
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	57	NA	.	.	.	74	142	179	283	427	569	779
Temperature (C)	57	NA	.	.	.	4	7	10	18	24	28	31
pH (s.u.)	57	NA	<6	0	0.0	6.7	7.2	7.4	7.8	8.1	8.5	9.8
			>9	2	3.5	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	49	4	>10	15	30.6	1	1	2	5	15	69	420
			>20	9	18.4							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	57	1	>50	5	8.8	1	2	3	7	16	33	200
			>25	8	14.0	.	.	.	.	.	.	.
			>10	23	40.4	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	55	14	.	.	.	0.01	0.01	0.01	0.04	0.11	0.18	0.56
TKN as N	54	2	.	.	.	0.20	0.30	0.30	0.40	0.60	0.77	1.60
NO_2+NO_3 as N	54	0	>10	0	0.0	0.64	1.13	1.23	1.50	2.00	2.50	5.60
Total Phosphorus	54	1	0.05	54	100.0	0.09	0.14	0.21	0.34	0.64	0.91	1.30
Metals (µg/L)												
Aluminum (Al)	50	0	.	.	.	64	109	190	320	698	1410	21000
Copper (Cu)	50	2	>7	14	28.0	2	3	4	5	7	13	22
Iron (Fe)	49	0	>1000	11	22.4	94	236	320	500	920	1620	17000
Manganese (Mn)	4	0	>200	1	25.0	16	21	28	37	88	173	230
Zinc (Zn)	50	4	>50	4	8.0	10	11	12	18	26	46	370
Arsenic (As)	50	50	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	50	50	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	50	50	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	50	49	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	50	50	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	50	50	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 57. Summary of the water quality parameters from Brown Creek at SR 1627 near Pinkston (Q9155000; C) collected between October 07, 1996 and August 01, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	54	NA	<4	15	27.8	1.8	2.8	3.6	6.2	9.3	11.1	14.2
(DO; mg/L)			<5	20	37.0	.	.	.	.	.	.	.
Conductivity	54	NA	.	.	.	47	71	96	116	136	161	201
Temperature (C)	54	NA	.	.	.	2	6	9	15	21	24	27
pH (s.u.)	54	NA	<6	3	5.6	4.0	6.2	6.6	6.9	7.1	7.2	7.7
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	2	0	.	.	.	110	114	120	130	140	146	150
TSS	47	1	>10	11	23.4	1	1	2	4	7	26	37
			>20	7	14.9							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	54	0	>50	1	1.9	2	6	8	11	18	31	73
			>25	9	16.7	.	.	.	.	.	.	.
			>10	31	57.4	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	53	12	.	.	.	0.01	0.01	0.01	0.05	0.12	0.28	0.80
TKN as N	52	1	.	.	.	0.20	0.30	0.40	0.45	0.60	0.81	1.60
NO_2+NO_3 as N	53	8	>10	0	0.0	0.01	0.01	0.02	0.07	0.17	0.20	0.50
Total Phosphorus	53	3	0.05	52	98.1	0.05	0.07	0.08	0.10	0.14	0.16	0.50
Metals (µg/L)												
Aluminum (Al)	47	0	.	.	.	80	188	300	550	1400	2100	3600
Copper (Cu)	47	15	>7	4	8.5	2	2	2	3	5	6	26
Iron (Fe)	39	0	>1000	35	89.7	740	1060	1400	1700	2300	2700	3700
Manganese (Mn)	1	0	>200	0	0.0	150	150	150	150	150	150	150
Zinc (Zn)	47	23	>50	1	2.1	10	10	10	10	18	26	71
Arsenic (As)	47	47	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	47	47	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	47	47	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	47	47	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	47	47	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	47	47	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 58. Summary of the water quality parameters from the Pee Dee River at NC 109 near Mangum (Q9160000; WS-V&B) collected between October 01, 1996 and August 01, 2001.

		Num.	Eval.	< or > Eval. Level			Percentiles					
Parameter	**N**	**< R.L.**	**Level**	**n**	**%**	**Min.**	**10**	**25**	**50**	**75**	**90**	**Max.**
Field												
Dissolved Oxygen	53	NA	<4	1	1.9	3.9	4.7	6.2	8.0	10.2	11.3	14.1
(DO; mg/L)			<5	6	11.3	.	.	.	.	.	.	.
Conductivity	53	NA	.	.	.	65	79	106	132	153	208	454
Temperature (C)	53	NA	.	.	.	3	7	10	16	22	26	30
pH (s.u.)	53	NA	<6	3	5.7	4.3	6.2	6.9	7.0	7.4	7.6	7.9
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	39	0	.	.	.	65	79	92	110	120	164	310
TSS	45	0	>10	24	53.3	1	5	7	11	20	39	100
			>20	11	24.4							
Chloride	36	0	.	.	.	5	6	8	10	12	15	28
Turbidity (NTU)	52	0	>50	4	7.7	2	3	5	8	23	39	120
			>25	12	23.1	.	.	.	.	.	.	.
			>10	22	42.3	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	51	12	.	.	.	0.01	0.01	0.02	0.05	0.13	0.22	0.50
TKN as N	50	2	.	.	.	0.10	0.20	0.20	0.30	0.40	0.60	1.20
NO_2+NO_3 as N	51	0	>10	0	0.0	0.10	0.27	0.38	0.60	0.85	1.10	1.50
Total Phosphorus	51	1	0.05	43	84.3	0.02	0.05	0.07	0.10	0.16	0.26	0.50
Metals (µg/L)												
Aluminum (Al)	44	0	.	.	.	53	170	318	555	1125	2770	4400
Copper (Cu)	45	9	>7	4	8.9	2	2	2	4	5	7	15
Iron (Fe)	44	0	>1000	15	34.1	110	320	378	735	1300	2540	4500
Manganese (Mn)	37	0	>200	1	2.7	25	45	55	72	83	150	210
Zinc (Zn)	45	20	>50	1	2.2	10	10	10	12	19	28	52
Arsenic (As)	45	45	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	45	45	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	45	45	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	45	45	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	45	45	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	45	45	>25	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 59. Summary of the water quality parameters from the Little River at SR 1340 near Star (Q9200000; C HQW) collected between October 24, 1996 and August 07, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	54	NA	<4	0	0.0	5.1	6.4	8.3	9.8	11.0	12.7	16.4
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	54	NA	.	.	.	38	49	58	64	69	82	112
Temperature (C)	54	NA	.	.	.	2	6	8	13	20	24	27
pH (s.u.)	54	NA	<6	4	7.4	4.2	6.6	6.7	7.1	7.5	7.6	7.8
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	4	0	.	.	.	11	28	55	69	70	73	74
TSS	46	5	>10	8	17.4	1	1	2	3	6	33	170
			>20	7	15.2							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	52	0	>50	5	9.6	2	3	4	8	16	40	100
			>25	10	19.2	.	.	.	.	.	.	.
			>10	20	38.5	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	51	20	.	.	.	0.01	0.01	0.01	0.01	0.06	0.20	0.39
TKN as N	49	1	.	.	.	0.10	0.10	0.20	0.30	0.40	0.60	0.60
NO_2+NO_3 as N	50	11	>10	0	0.0	0.01	0.01	0.02	0.15	0.24	0.30	0.63
Total Phosphorus	51	2	0.05	30	58.8	0.01	0.02	0.04	0.06	0.09	0.19	0.50
Metals (µg/L)												
Aluminum (Al)	46	1	.	.	.	50	98	165	280	850	1950	4600
Copper (Cu)	46	20	>7	4	8.7	2	2	2	2	4	5	15
Iron (Fe)	40	0	>1000	9	22.5	330	410	518	625	948	2050	5400
Manganese (Mn)	1	0	>200	0	0.0	23	23	23	23	23	23	23
Zinc (Zn)	46	27	>50	3	6.5	10	10	10	10	15	27	120
Arsenic (As)	46	46	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	46	46	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	46	46	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	46	45	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	46	46	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	46	46	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 60. Summary of the water quality parameters from the Pee Dee River at US 74 near Rockingham (Q9400000; C) collected between September 26, 1996 and August 01, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	55	NA	<4	5	9.1	2.4	4.0	5.7	7.8	10.0	11.3	15.0
(DO; mg/L)			<5	10	18.2	.	.	.	.	.	.	.
Conductivity	55	NA	.	.	.	62	89	103	119	131	164	174
Temperature (C)	55	NA	.	.	.	3	8	11	17	23	27	30
pH (s.u.)	55	NA	<6	3	5.5	4.7	6.3	6.6	6.8	7.0	7.2	7.4
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	41	0	.	.	.	25	68	83	93	100	120	140
TSS	47	1	>10	18	38.3	1	1	4	9	14	21	44
			>20	5	10.6							
Chloride	31	0	.	.	.	4	6	7	8	10	12	13
Turbidity (NTU)	53	0	>50	1	1.9	2	3	4	8	13	27	55
			>25	6	11.3	.	.	.	.	.	.	.
			>10	20	37.7	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	52	7	.	.	.	0.01	0.01	0.04	0.07	0.13	0.21	0.91
TKN as N	51	2	.	.	.	0.20	0.20	0.20	0.30	0.40	0.60	1.40
NO_2+NO_3 as N	52	0	>10	0	0.0	0.14	0.19	0.33	0.53	0.64	0.73	0.91
Total Phosphorus	52	3	0.05	35	67.3	0.03	0.04	0.05	0.07	0.10	0.17	0.62
Metals (µg/L)												
Aluminum (Al)	47	0	.	.	.	61	176	230	320	705	1760	2900
Copper (Cu)	47	11	>7	4	8.5	2	2	2	3	4	5	31
Iron (Fe)	41	0	>1000	8	19.5	160	290	340	500	890	1800	2500
Manganese (Mn)	43	0	>200	0	0.0	32	44	54	62	96	110	150
Zinc (Zn)	47	27	>50	1	2.1	10	10	10	10	18	36	170
Arsenic (As)	47	47	>50	.	.	*Most all samples collected for these metals have*						
Cadmium (Cd)	47	47	>2	.	.	*concentrations below the reporting level.*						
Chromium (Cr)	47	47	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	47	47	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	47	47	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	47	47	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 61. Summary of the water quality parameters from Hitchcock Creek at SR 1109 at Cordova (Q9660000; C) collected between October 01, 1996 and August 01, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	55	NA	<4	1	1.8	2.4	5.5	7.2	8.4	10.4	12.4	16.1
(DO; mg/L)			<5	3	5.5	.	.	.	.	.	.	.
Conductivity	55	NA	.	.	.	30	37	44	132	170	211	423
Temperature (C)	54	NA	.	.	.	3	8	11	17	22	25	28
pH (s.u.)	55	NA	<6	8	14.5	4.9	5.8	6.1	6.4	6.5	6.8	7.7
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	2	0	.	.	.	140	144	150	160	170	176	180
TSS	48	3	>10	7	14.6	1	1	2	4	6	16	62
			>20	3	6.3							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	55	0	>50	0	0.0	2	3	4	5	6	9	18
			>25	0	0.0	.	.	.	.	.	.	.
			>10	4	7.3	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	54	3	.	.	.	0.01	0.04	0.10	0.20	0.27	0.49	1.20
TKN as N	53	2	.	.	.	0.10	0.20	0.40	0.50	0.60	0.76	1.60
NO_2+NO_3 as N	54	1	>10	0	0.0	0.08	0.14	0.21	0.28	0.40	0.49	0.86
Total Phosphorus	54	3	0.05	30	55.6	0.01	0.02	0.04	0.06	0.10	0.17	0.50
Metals (µg/L)												
Aluminum (Al)	48	0	.	.	.	120	227	268	295	403	630	1700
Copper (Cu)	48	21	>7	7	14.6	2	2	2	2	4	8	42
Iron (Fe)	48	0	>1000	21	43.8	370	517	680	970	1425	1830	3300
Manganese (Mn)	0	0	>200	0	.	.	.	.	.	.	.	.
Zinc (Zn)	48	9	>50	2	4.2	10	10	11	16	23	32	140
Arsenic (As)	48	48	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	48	48	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	48	48	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	48	48	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	48	48	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	48	48	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 62. Summary of the water quality parameters from Jones Creek at NC 145 near Pee Dee (Q9777000; C) collected between September 26, 1996 and August 01, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	50	NA	<4	0	0.0	5.1	6.6	7.5	8.9	11.1	12.2	15.8
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	50	NA	.	.	.	39	57	66	80	89	94	121
Temperature (C)	50	NA	.	.	.	3	6	9	14	20	23	27
pH (s.u.)	50	NA	<6	2	4.0	4.7	6.5	6.8	7.0	7.3	7.4	8.0
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	3	0	.	.	.	4	20	44	83	92	97	100
TSS	42	2	>10	7	16.7	1	1	1	4	7	24	42
			>20	5	11.9							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	49	0	>50	0	0.0	2	2	3	5	8	21	50
			>25	3	6.1	.	.	.	.	.	.	.
			>10	10	20.4	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	48	21	.	.	.	0.01	0.01	0.01	0.02	0.07	0.15	0.50
TKN as N	47	4	.	.	.	0.03	0.10	0.20	0.20	0.30	0.40	1.00
NO_2+NO_3 as N	48	1	>10	0	0.0	0.01	0.04	0.09	0.18	0.23	0.34	0.50
Total Phosphorus	48	5	0.05	9	18.8	0.01	0.01	0.02	0.03	0.05	0.07	0.50
Metals (µg/L)												
Aluminum (Al)	43	2	.	.	.	50	69	95	140	420	1224	4300
Copper (Cu)	43	21	>7	6	14.0	2	2	2	2	5	9	39
Iron (Fe)	43	0	>1000	24	55.8	580	652	810	1100	1350	1920	3500
Manganese (Mn)	0	0	>200	0	.	.	.	.	.	.	.	.
Zinc (Zn)	43	23	>50	0	0.0	10	10	10	10	18	25	35
Arsenic (As)	43	43	>50	.	.							
Cadmium (Cd)	43	43	>2	.	.							
Chromium (Cr)	43	43	>50	.	.							
Lead (Pb)	43	43	>25	.	.							
Mercury (Hg)	43	43	>0.012	.	.							
Nickel (Ni)	43	43	>88	.	.							

Most all samples collected for these metals have concentrations below the reporting level. Samples that have concentrations above reporting and reference levels are too few in number to provide any confidence for interpretation.

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 63. Summary of the water quality parameters from Marks Creek at SR 1812 near Hamlet (Q9940000; C) collected between October 01, 1996 and August 13, 2001.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	54	NA	<4	11	20.4	0.7	2.5	4.9	7.0	9.8	10.7	11.9
(DO; mg/L)			<5	14	25.9	.	.	.	.	.	.	.
Conductivity	54	NA	.	.	.	5	40	42	45	49	57	149
Temperature (C)	54	NA	.	.	.	4	8	10	16	22	25	31
pH (s.u.)	54	NA	<6	12	22.2	4.6	5.8	6.0	6.2	6.4	6.6	6.9
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	0	0	.	.	.	.	.	.	.	.	.	.
TSS	30	5	>10	0	0.0	1	1	1	1	3	5	7
			>20	0	0.0							
Chloride	0	0	.	.	.	.	.	.	.	.	.	.
Turbidity (NTU)	53	10	>50	0	0.0	1	1	1	1	2	3	7
			>25	0	0.0	.	.	.	.	.	.	.
			>10	0	0.0	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	52	25	.	.	.	0.01	0.01	0.01	0.01	0.03	0.11	0.44
TKN as N	51	1	.	.	.	0.10	0.10	0.20	0.20	0.40	0.40	0.72
NO_2+NO_3 as N	51	21	>10	0	0.0	0.01	0.01	0.01	0.01	0.09	0.15	0.29
Total Phosphorus	52	7	0.05	2	3.8	0.01	0.01	0.01	0.02	0.03	0.05	0.10
Metals (µg/L)												
Aluminum (Al)	48	2	.	.	.	50	57	71	88	133	173	270
Copper (Cu)	48	25	>7	3	6.3	2	2	2	2	4	5	21
Iron (Fe)	40	0	>1000	12	30.0	230	309	375	610	1200	1810	3200
Manganese (Mn)	1	1	>200	0	0.0	10	10	10	10	10	10	10
Zinc (Zn)	48	18	>50	2	4.2	10	10	10	11	18	28	110
Arsenic (As)	48	48	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	48	48	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	48	48	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	48	48	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	48	48	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	48	48	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.
Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.

Appendix 64. Summary of the water quality parameters from Pee Dee River at SC Hwy 9 at Cheraw, SC (Q9980000; C) collected between September 26, 1996 and August 16, 2000.

Parameter	N	Num. < R.L.	Eval. Level	< or > Eval. Level n	< or > Eval. Level %	Min.	Percentiles 10	25	50	75	90	Max.
Field												
Dissolved Oxygen	44	NA	<4	0	0.0	5.1	6.0	7.0	8.8	10.5	11.0	11.9
(DO; mg/L)			<5	0	0.0	.	.	.	.	.	.	.
Conductivity	44	NA	.	.	.	67	84	100	114	123	153	211
Temperature (C)	44	NA	.	.	.	6	9	11	16	23	28	30
pH (s.u.)	44	NA	<6	3	6.8	4.9	6.4	6.6	6.9	7.2	7.5	8.6
			>9	0	0.0	.	.	.	.	.	.	.
Other (mg/L)												
Total Residue	9	0	.	.	.	75	77	87	93	99	99	100
TSS	43	0	>10	14	32.6	1	2	4	7	15	24	52
			>20	6	14.0							
Chloride	8	0	.	.	.	7	7	7	8	8	8	8
Turbidity (NTU)	43	0	>50	1	2.3	2	4	6	10	14	25	60
			>25	5	11.6	.	.	.	.	.	.	.
			>10	19	44.2	.	.	.	.	.	.	.
Nutrients (mg/L)												
NH_3 as N	43	11	.	.	.	0.01	0.01	0.02	0.04	0.08	0.13	0.19
TKN as N	43	0	.	.	.	0.20	0.20	0.20	0.30	0.35	0.40	2.00
NO_2+NO_3 as N	43	0	>10	0	0.0	0.14	0.22	0.40	0.55	0.64	0.74	0.82
Total Phosphorus	43	0	0.05	25	58.1	0.02	0.04	0.05	0.07	0.09	0.13	0.23
Metals (µg/L)												
Aluminum (Al)	44	0	.	.	.	60	175	258	420	693	1540	2900
Copper (Cu)	44	10	>7	3	6.8	2	2	2	3	4	6	9
Iron (Fe)	44	0	>1000	9	20.5	220	275	430	605	960	1570	2600
Manganese (Mn)	0	0	>200	0	.	.	.	.	.	.	.	.
Zinc (Zn)	44	23	>50	1	2.3	10	10	10	10	17	28	79
Arsenic (As)	44	44	>50	.	.	*Most all samples collected for these metals*						
Cadmium (Cd)	44	44	>2	.	.	*have concentrations below the reporting level.*						
Chromium (Cr)	44	44	>50	.	.	*Samples that have concentrations above*						
Lead (Pb)	44	43	>25	.	.	*reporting and reference levels are too few in*						
Mercury (Hg)	44	44	>0.012	.	.	*number to provide any confidence for*						
Nickel (Ni)	44	44	>88	.	.	*interpretation.*						

Abbreviations: N or n = number; Num. < R.L. = number < Reporting Level; < or > refers to "less than or greater than"; TSS = Total Suspended Solids; Conductivity measured as µmhos/cm; NA = not applicable.

Evaluation Levels (Eval. Level or EL) are presented to facilitate review. Some levels refer to water quality standards; others may be used for ecological or Action Level review. Measurements should not exceed the range (< or >) indicated by the EL.