CHAPTER 4

WATER QUALITY AND USE SUPPORT RATINGS IN THE CAPE FEAR RIVER BASIN

4.1 INTRODUCTION

This chapter provides a detailed overview of water quality and use support ratings in the Cape Fear River Basin. It is divided into two major parts and four sections.

Water Quality Monitoring and Assessment

- **Section 4.2** presents a summary of water quality monitoring programs conducted by the Environmental Sciences Branch of the Division of Water Quality's (DWQ's) Water Quality Section including consideration of information reported by researchers and other agencies within the Cape Fear River Basin. Seven monitoring programs are described. Basinwide data summaries are presented for several of the programs.
- **Section 4.3** presents a narrative summary of water quality findings for each of the six major watershed areas (and 24 subbasins) in the basin. This summary is based on the monitoring programs described in Section 4.2 Also included are watershed maps, which show the locations of monitoring sites, and tables summarizing benthic macroinvertebrate sampling efforts.

Use-Support Ratings

- **Section 4.4** introduces the concept of use-support ratings and describes how they are derived. Using this approach, water quality for specific surface waters in the basin is assigned one of the following four use-support ratings: fully supporting uses, fully supporting but threatened, partially supporting or not supporting uses.
- **Section 4.5** presents the use support ratings for many streams and lakes in the Cape Fear basin through a series of tables and figures. Included is a color-coded 3-page use support map of the basin (Figure 4.19).

4.2 WATER QUALITY MONITORING PROGRAMS

DWQ's monitoring program integrates biological, chemical, and physical data assessment to provide information for basinwide planning. Below is a list of the seven major monitoring programs, each of which is briefly described in the following text.

- Benthic macroinvertebrate monitoring (Section 4.2.1 and Appendix II),
- Fish population and tissue monitoring(Section 4.2.2 and Appendix II),
- Lakes assessment (including phytoplankton monitoring) (Section 4.2.3 and Appendix II),
- Aquatic toxicity monitoring (Section 4.2.4),
- Special chemical/physical water quality investigations (Section 4.2.5),
- Sediment oxygen demand monitoring (Section 4.2.6), and
- Ambient water quality monitoring (covering the period 1988-1992) (Section 4.2.7).

4.2.1 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom of rivers and streams. These organisms are primarily aquatic insect larvae. The use of benthos data has proven to be a reliable water quality indicator, as these organisms are relatively immobile and sensitive to subtle changes in water quality. Since many organisms in a community have life cycles of six months to one year, the effects of short term pollution (such as an oil or chemical spill) will generally not be overcome until the following generation appears. The benthic community also responds to and shows the effects of a wide array of potential pollutant mixtures.

Criteria have been developed to assign five bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the pollution-intolerant groups Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). These three groups are used to develop EPT ratings. Likewise, ratings can be assigned with a Biotic Index (Appendix II). This index summarizes tolerance data for all taxa in each collection. The two rankings are given equal weight in final site classification. Higher taxa richness values are associated with better water quality. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is poorly assessed by a taxa richness analysis. Different criteria have been developed for different ecoregions (mountains, piedmont and coastal plain) within North Carolina.

In the Cape Fear River Basin, A total of 517 benthic macroinvertebrate samples have been collected from 295 monitoring locations from 1983 through 1993. The majority of these samples exhibited either Good/Fair (24%) or Fair (27%) bioclassifications, while only 8% of these samples noted Excellent bioclassifications. Bioclassifications were not given for 46 benthic macroinvertebrate samples collected from swamp-stream or euryhaline ecosystems within the Cape Fear River basin (this number also includes 4 very small streams). This is because bioclassification criteria have not been established for swamp-stream and euryhaline (brackish) ecosystems.

Ninety-four of the total monitoring locations have had data collected on two or more occasions, allowing for long-term data comparisons. Of these 94 monitoring locations, 58 (62%) had no long-term changes in bioclassification, 26 (28%) showed some improvement, and 10 (10%) noted a decline in bioclassification. Many of the improvements noted in bioclassifications were from monitoring sites in the Deep River watershed.

Locations of and summary information for all the benthic macroinvertebrate collections in the Cape Fear River basin are presented in maps and tables in sections 4.3.1 through 4.3.6. Summary information includes the site location, DWQ classification schedule Index Number, collection date, taxa richness and biotic index values and bioclassifications.

4.2.2 Fisheries Monitoring

To the public, the condition of the fishery is one of the most meaningful indicators of ecological integrity. Fish occupy the upper levels of the aquatic food web and are both directly and indirectly affected by chemical and physical changes in the environment. Water quality conditions that significantly affect lower levels of the food web will affect the abundance, species composition, and condition of the fish population. Two types of fisheries monitoring are conducted by DWQ and described briefly below. The first, called Fish Community Structure, involves assessing the overall health of the fish community. This information can be used as an indicator of the quality of the ecosystem the fish inhabit. The second, called Fish Tissue Analysis, involves analyzing fish tissues to determine whether they are accumulating metals or organic chemicals. This information is useful as an indicator of water quality and is also used to determine whether human consumption of these fish poses a potential health risk.

Fish Community Structure

The North Carolina Index of Biotic Integrity (NCIBI) is a modification of Karr's IBI (1981) which was developed as a method for assessing a stream's biological integrity by examining the structure and health of its fish community. The index, which is described in more detail in Appendix II), incorporates information about species richness and composition, trophic composition, fish abundance and fish condition. At this time there is no Index of Biotic Integrity calculated for fish populations in lakes.

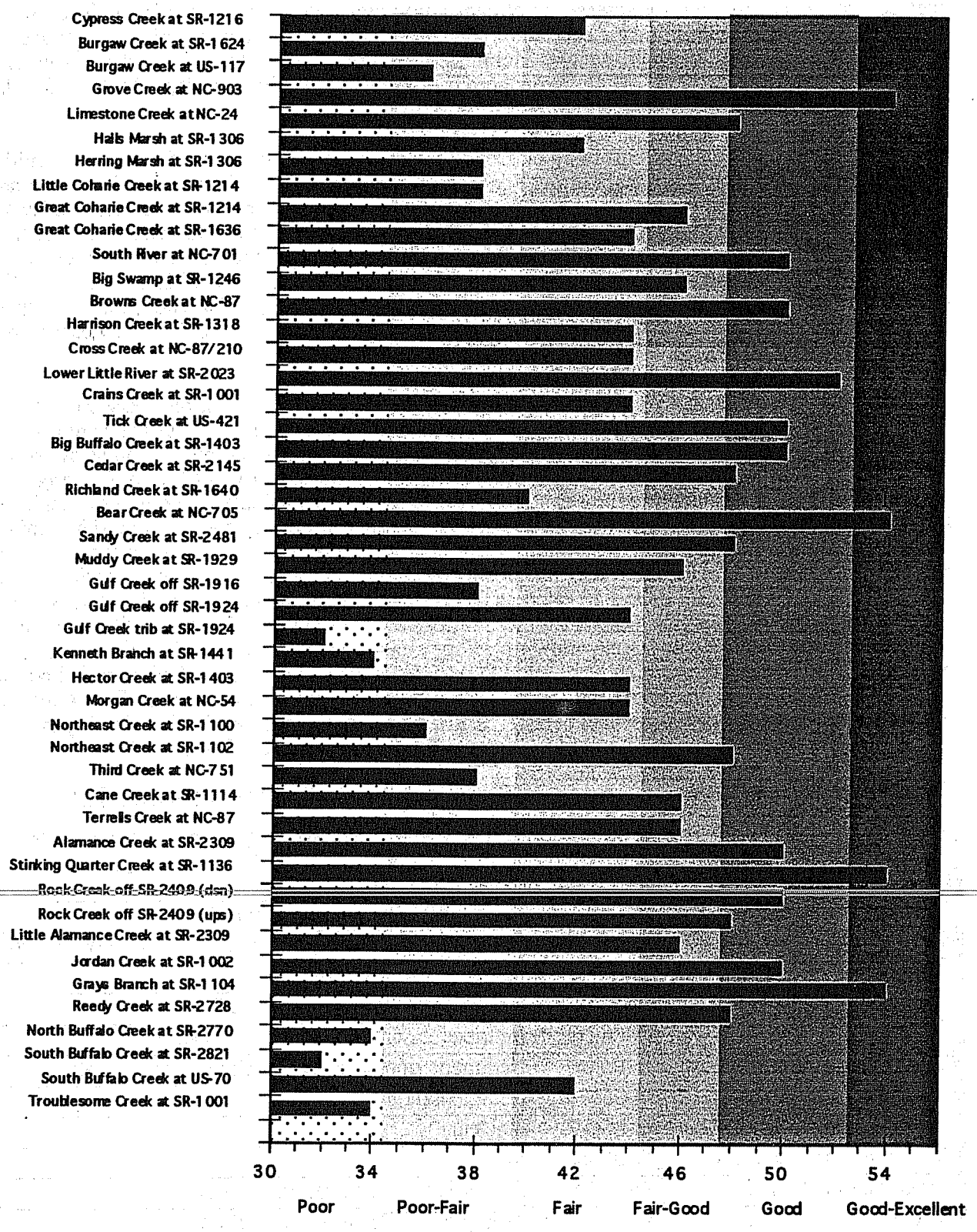
The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more 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 indicates 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 community structure analyses were performed at forty-seven sites in the Cape Fear River Basin. These individual site assessments should not be interpreted as representative samplings of either the entire basin or an entire subbasin. Many of the stations sampled were in areas of known impact. Constraints in both sampling methodology and resources prevent the monitoring of a sufficient number of fish community structure locations to clearly evaluate the ecological health of the entire basin. Therefore evaluations of the fish community structure analysis should be limited to a site specific interpretation. A summary graph of the individual station location results is presented in Figure 4.1. Of the fourty-seven sites sampled, 12 were rated as Poor or Poor-Fair, 17 rated as Fair or Fair-Good, and 18 rated as Good or Good-Excellent. Those sites which were rated as Poor or Poor-Fair and reasons for these ratings are presented in Table 4.1. Grays Branch, Stinking Quarter Creek, Bear Creek, and Grove Creek each received rating in the Good-Excellent category. Some of the sites which were rated Poor or Poor-Fair have already had remedial action taken or planned. The Cherokee Brick Quarry which drains into a tributary of Gulf Creek is currently applying for a stormwater permit, BMP's are being initiated in the Herring Marsh drainage, and the Burgaw WWTP has been upgraded since our sampling date in 1985.

Table 4.1 Cape Fear Basin Fish Community Structure Sites which rated Poor or Poor-Fair

SITE	SUBBASIN	REASONS FOR RATINGS
Troublesome Cr at SR-1001	03-06-01	nutrient enrichment
South Buffalo Cr at SR-2821	03-06-02	below WWTP and urban runoff
North Buffalo Cr at SR-2770	03-06-02	below two WWTP's, urban runoff, and poor habitat
Third Cr at NC-751	03-06-05	urban runoff and low flows
Northeast Cr at SR-1100	03-06-05	below WWTP and urban runoff
Kenneth Branch at SR-1441	03-06-07	nutrient enrichment and sedimentation
Gulf Cr trib at SR-1924	03-06-07	sedimentation, nutrient enrichment and low flow
Gulf Cr off SR-1916	03-06-07	sedimentation
Little Coharie Cr at SR-1214	03-06-19	unclear
Herring Marsh at SR-1306	03-06-22	unclear
Burgaw Cr at US-117	03-06-23	below WWTP and sedimentation
Burgaw Cr at SR-1216	03-06-23	below WWTP and sedimentation

Figure 4.1 Site Specific Summary of Fish Community Structure Evaluations



* Scale ranges from 0-60 (no values were found in the very poor or excellent range).

Fish Tissue Analysis

Since fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Therefore, by analyzing fish tissue, determinations about what chemicals are in the water can be made. Contamination of aquatic resources, including freshwater, estuarine, and marine fish and shellfish species has been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation either directly or through aquatic food webs and may accumulate in fish and shellfish tissues. Thus results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water. Fish tissue analysis results are also used as indicators for human health concerns, fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem.

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 and U.S. Environmental Protection Agency (EPA) recommended screening values for contaminants.

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. A list of fish tissue parameters accompanied by their FDA criteria are presented in Appendix II. At present, the FDA has only developed metals criteria for mercury (1.0 ppm). Individual parameters which appear to be of potential human health concern are evaluated by the N.C. Division of Epidemiology by request of the Water Quality Section.

In the Cape Fear Basin, 618 fish tissue samples from 51 locations have been analyzed from 1980 through 1994. EPA screening criteria for organics and metals (mercury) were equalled or exceeded in 52 samples at 16 sites. The FDA limit of 1.0 ppm for mercury was exceeded in ten samples at seven sites. Sampling locations are presented in Table 4.2. The term organics in the table includes the following substances: Dieldrin, DDT, Chlordane, Heptachlor epoxide, Heptachlor, Endrin and Lindane. None of these organic substances was found to exceed its FDA limit.

4.2.3 Lakes Assessment Program (including Phytoplankton)

Lakes are valued for the multiple benefits they provide to the public, including recreational boating, fishing, drinking water, and aesthetic enjoyment. The North Carolina Lakes Assessment Program seeks to protect these waters through monitoring, pollution prevention and control, and restoration activities. Assessments have been made at all publicly accessible lakes, at lakes which supply domestic drinking water, and lakes (public or private) where water quality problems have been observed. Data are used to determine the trophic state of each lake; a relative measure of nutrient enrichment and productivity, and whether the designated uses of the lake have been threatened or impaired by pollution.

Phytoplankton are microscopic algae found in the water column of lakes, rivers, streams, and estuaries. Phytoplankton populations respond to nutrient availability and other environmental factors such as light, temperature, pH, salinity, water velocity, and grazing by organisms in higher trophic levels. Phytoplankton may be useful as indicators of eutrophication and are often collected with ambient water quality samples from lakes. Prolific growths of phytoplankton, often due to high concentrations of nutrients, sometimes result in "blooms" in which one or more species of algae may discolor the water or form visible mats on top of the water. Blooms may be unsightly and deleterious to water quality, causing fish kills, anoxia, or taste and odor problems. The Algal Bloom Program was initiated in 1984 to document suspected algal blooms with species identification, quantitative biovolume, and density estimates. Usually, an algal sample with a

Table 4.2 Fish Tissue Sampling Sites and Partial Data Summary in the Cape Fear River Basin

LOCATION	SUB-BASIN	YEAR	TOTAL SAMPLES	> EPA SCREENING CRITERIA (*Organics or Metals)	> FDA LIMIT
Reedy Fork at NC-87 at Ossipee	02	85	15		
Lake Burlington	"	82	7		
Haw River at US 70, Haw River	"	85	8		
Haw River at Saxapahaw	"	80-89	47	5 organics, 2 mercury	
Alamance Creek at SR2116	"	85	4		
Cane Creek at SR 1100	04	84	9		
Haw River at Bynum	"	85-86	17	1 organics, 1 mercury	1 mercury
Jordan Reservoir above Stinking Creek	"	82-90	35		
Third Fork Creek Near Blands	05	85	8		
Northeast Creek at SR 1100	"	85	11		
Jordan Reservoir at mouth of New Hope Cr	"	82-83	20	1 - mercury	1 mercury
Jordan Reservoir at Farrington Point	"	82 & 90	16	1 - mercury	1 mercury
New Hope River Tributary at SR 1716	"	86	4		
Jordan Reservoir near mouth of Beaver Cr	"	82-83	21		
Jordan Reservoir at Folkner Creek	"	83	12	1 - mercury	1 mercury
Morgan Creek at SR 1726	06	85	12		
Jordan Reservoir at mouth of Morgan Cr	"	82-83	24		
Cape Fear River at Moncure	07	87	5	1 = mercury screeing level	
Cape Fear River at Lillington	"	80,87,90	9	2 organics	
Deep River at US 85	08	89	4		
Copper Branch	"	89	2		
Reddicks Creek at SR 1113	"	89	5		
Deep River at SR 1113	"	89	2		
Muddy Creek near Glenola	"	94	4		
Deep River at Randleman	"	85	10		
Deep River at Worthville	09	83-84	25		
Deep River at Main St in Ramseur	"	87	4		
Cabin Creek at SR 1275	10	88	10		
Bear Creek at NC 705	"	88	10		
Suck Creek Trib near Zion Grove	"	87	2		
Flat Creek near Iverness	14	84	3		
Reese Creek at SR 1728	15	88	2	1 organics	
Cape Fear River at Fayetteville	"	87	5		
Upchurch Pond	"	93	17	2 mercury	
Cape Fear River Near Tar Heel	16	92	4		
Cape Fear River at Elizabethtown	"	84-94	51	2 organics, 7 mercury (PCB > EPA limit)	2 mercury
Cape Fear River at Elwells Ferry	"	90-91	10		
~~Cape Fear River at Lock & Dam #1~~	"	~~80-92~~	~~7~~	~~1 organics (PCB)~~	
Northeast Cape Fear nr Castle Hayne	17	80-81	5		
Sutton Lake	"	88	15		
Sturgeon Creek at SR 1427	"	86	6		
Cape Fear River at Wilmington	"	85-90	13		
Boilings Springs Lake	"	93	11	5 mercury	2 mercury
Snows Cut near Wilmington	"	84	7		
South R nr SR 1503 nr Parkersburg	18	84-87	22	2 mercury	
Black River off SR 1133	20	86	5	2 mercury	2 mercury
Limestone Creek at NC 24	22	87	2		
Northeast Cape Fear River at NC 24	"	87-94	35		
Northeast Cape Fear River at US 117	23	92	25	10 mercury	
ICW at Spicers Bay nr Stump Sound	24	84	11		

* Organics include Dieldrin, Chlordane, Endrin, Lindane, DDT, PCB, Heptachlor and Heptachlor epoxide

biovolume larger than 5000 mm^3/m^3, density greater than 10,000 units/ml, or chlorophyll *a* concentration approaching or exceeding 40 µg/l (the North Carolina state standard) constitutes a bloom. Bloom samples may be collected as a result of complaint investigations, fish kills, or during routine monitoring if a bloom is suspected. There were thirty-six lakes in the Cape Fear River Basin sampled as part of the Lakes Assessment Program.

Each lake is individually discussed in the appropriate subbasin section with a focus on the most recent available data. Figure 4.2 shows the most recent NCTSI scores for the 36 lakes of the Cape Fear River basin. NCTSI scores are described in Appendix II. All of the lakes, with the exception of Hope Mills Lake, were sampled most recently in 1993. Thirty-four of the thirty-six lakes were fully supporting their designated uses. Sixteen of those lakes are listed as Threatened which identifies some cause for concern if precautions are not taken. One lake is designated as Not Supporting (Greenfield Lake) and one as partially supporting (Bay Tree Lake). The threatened and impaired lakes are presented Table 4.3.

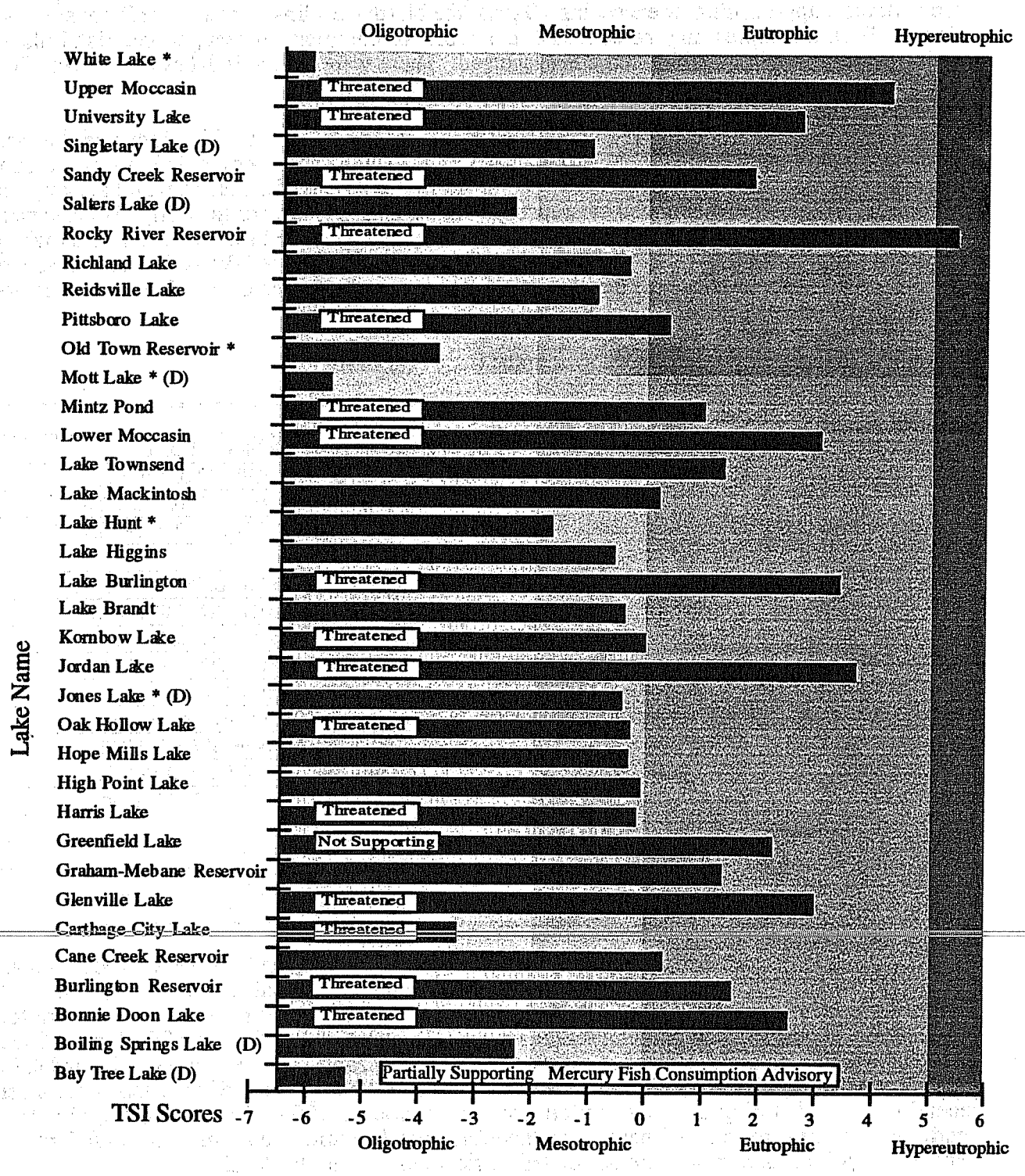
Table 4.3 Threatened and Impaired Lakes in the Cape Fear River Basin

LAKE	STATUS	CAUSES
Pittsboro Lake	Support-threatened	Algal blooms, Aquatic weeds,Elevated D.O.
Jordan Reservoir	Support-threatened	Elevated nutrients (TP 0.07MG/L,TN 0.58MG/L)
Upper Moccasin Lake	Support-threatened	Elevated nutrients (TP 0.12 MG/L,TN 0.92 MG/L)
Sandy Creek Res.	Support-threatened	Elevated nutrients (TP 0.07 MG/L,TN 0.77 MG/L)
Carthage City Lake	Support-threatened	Aquatic Weeds
Rocky River Res.	Support-threatened	Elevated nutrients (TP 0.095 MG/L,TN 1.01 MG/L)
Bonnie Doone Lake	Support-threatened	Elevated nutrients (TP 0.12 MG/L,TN 1.07 MG/L)
Mintz Pond	Support-threatened	Elevated nutrients (TP 0.08 MG/L,TN 0.58 MG/L)
Glenville Lake	Support-threatened	Elevated nutrients (TP 0.07 MG/L,TN 0.67 MG/L)
Greenfield Lake	Not Supporting	Algal blooms, Fish kills, Aquatic Weeds
University Lake	Support-threatened	Elevated nutrients (TP 0.065 MG/L,TN 0.66 MG/L)
Lower Moccasin Lake	Support-threatened	Elevated nutrients (TP 0.06 MG/L,TN 0.61 MG/L)
Lake Burlington	Support-threatened	Elevated nutrients (TP 0.065 MG/L,TN 0.56 MG/L)
Kornbow Lake	Support-threatened	Elevated nutrients (TP 0.05 MG/L,TN 0.78 MG/L)
Oak Hollow Lake	Support-threatened	Algal blooms
Harris Lake	Support-threatened	Elevated nutrients (TN 0.61 MG/L)
Burlington Lake	Support-threatened	Elevated nutrients (TN 1.51 MG/L)
Bay Tree Lake	Partially Supporting	Mercury fish consumption advisory

Precipitation during the 1993 growing season (i.e., May through September) was very low. Mean rainfall for the Cape Fear section of the state (northern piedmont, central piedmont, central coastal plain, and southern coastal plain) was 3.33 inches. This was the lowest mean rainfall amount for the time period covering the growing seasons of 1990 through 1993. Mean rainfalls for the Cape Fear River region during the growing seasons of 1990, 1991, and 1992 were 4.03, 4.65, and 4.76 inches, respectively (NOAA, 1993). Many of the lakes in the Cape Fear River Basin were most recently sampled during the low rainfall growing period of 1993. Improving trophic state conditions observed in some of these lakes, therefore, may be indicative of this low rainfall which reduced nonpoint source runoff and associated nutrient loading into the lakes.

Seven lakes have been sampled for the potential of supporting algal growth with the Algal Growth Potential Test (AGPT) in the Cape Fear River Basin. These are Jordan Reservoir, Harris Lake, White Lake, Lake Hunt, Mott Lake, Old Town Reservoir and Jones Lake. The results of the Algal Growth Potential Test are mentioned in each of the appropriate subbasin discussions. The

Figure 4.2 Lake Assessment Data for Cape Fear Basin: Trophic Status Index (TSI) Scores



Notes: All lakes sampled in 1993. Exception: Hope Mills Lake (1988). See Appendix II for explanationof trophic status and TSI calculations.

* Reference Lake

(D) Dystrophic Lake

objective of the Algal Growth Potential Test is to assess a waterbody's potential for supporting algal biomass and to determine whether algal growth is limited by nitrogen, by phosphorus, or co-limited by both nutrients. When a waterbody supports algal growth at bloom levels without additional increases in nitrogen and/or phosphorus, the system may be subject to frequent nuisance algal blooms. The test exposes a standard alga, Selenastrum capricornutum, to the test water (this constitutes the control). Additional test samples are enriched with nitrogen or phosphorus. When one of these nutrients is added to a water sample which is growth limiting to that nutrient, the resulting mean standing crop (MSC) will generally reflect the level of added nutrient. In some cases, the bioavailable nitrogen and phosphorus in a sample may approach their optimum ratio for growth of the test alga and the addition of nutrients may not clearly identify the limiting nutrient. A waterbody may be protected from nuisance algal blooms if an AGPT value is consistently less than or equal to 5 mg/l.

4.2.4 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. In the Cape Fear River basin their are 119 facilities that are required to monitor whole effluent toxicity by their NPDES permit or by administrative letter. Other facilities may be tested by DWQ's Aquatic Toxicology Laboratory. The Aquatic Survey and 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 DWQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

4.2.5 Chemical/Physical Characterizations

Water quality simulation models are often used for the purpose of constructing wasteload allocations. These models must adequately predict water body responses to different waste loads so that appropriate effluent limits can be included as requirements in National Pollutant Discharge Elimination System (NPDES) permits. Where large financial expenditures or the protection of water quality is at risk, models should be calibrated and verified with actual in-stream field data. Because sufficient historical data are often lacking, intensive water quality surveys are required to provide the field data necessary to accomplish model calibration and verification. Intensive water quality surveys are performed on water bodies below existing or proposed wastewater dischargers and usually consist of a time-of-travel dye study, flow measurements, physical and chemical samples, long-term biochemical oxygen demand (BOD_{lt}) analysis, water body channel geometry, and effluent characterization analysis.

4.2.6 Sediment Oxygen Demand

If oxygen depletion is suspected due to the characteristics of benthic sediments then sediment oxygen demand (SOD) studies may be performed. Each stream reach is divided into a series of model segments. The number of stream segments that must be evaluated with an intensive survey depends on the individual study and the spatial resolution desired. Intensive surveys and SOD evaluations are reported as a series of field data tables and summaries of laboratory analysis reports. For the purposes of this report, intensive surveys and SOD studies that have been performed within each subbasin will be listed in table format accompanied by a brief summary of surveys that have been performed within the last five years. Raw data from these studies are available on request.

There have been thirty-five Sediment Oxygen Demand (SOD) studies conducted in the Cape Fear River Basin between August 1988 and June 1994. Twelve of those studies were conducted at a

control site in the headwaters of Jordan Reservoir in Chatham County and were designed to confirm reproducibility of SOD test data and the ability to correct SOD rates for a range of ambient temperatures. Average SOD rates for the first 8 SOD tests (September 1989 to June 1991) were relatively consistent over a range of ambient temperatures. Morgan Creek SOD tests conducted after March 1992, however, resulted in a noticeably higher trend in SOD rates indicating physical changes occurring at the site and probable water quality changes occurring in the upstream drainage area. (See: Morgan Creek/Chatham County 03-06-06)

A general observation in average SOD rates for the Cape Fear Basin is an apparent trend of higher values measured in the upper to mid reaches of the basin and progressively decreasing rates at stations downstream in the basin. This may be due to the concentration of inputs from urbanized areas in the upper reaches and changes in hydrology and increased dilution in the lower reaches of the Cape Fear system. An exception to this observation is the SOD test conducted in the Tangle Oaks marina which resulted in a very high average rate. The marina site, although located in the Cape Fear Basin, may reflect rates resulting from a isolated concentration of organic inputs associated with activities occurring in and around the marina site.

4.2.7 Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake and estuarine (saltwater) water quality monitoring stations (about 380 statewide) strategically located for the collection of physical and chemical water quality data. The type of water quality data, or parameters, that are collected is determined by the waterbody's freshwater or saltwater classification and corresponding water quality standards. Table 4.4 summarizes the types of water quality data collection conducted at ambient stations. AMS data for the Cape Fear Basin are summarized Section 4.3.

Table 4.4 Ambient Monitoring System Parameters

C and SC WATERS (minimum monthly coverage for all stream stations)
- dissolved oxygen,
- pH,
- conductivity,
- temperature,
- salinity (SC),
- secchi disk (where appropriate),
- nutrients: total phosphorus, ammonia, total Kjeldahl nitrogen, nitrate+nitrite
- total suspended solids,
- turbidity,
- hardness,
- chlorides (SC),
- fecal coliforms,
- metals: aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, silver, zinc

NUTRIENT-SENSITIVE WATERS: Chlorophyll *a* (where appropriate)

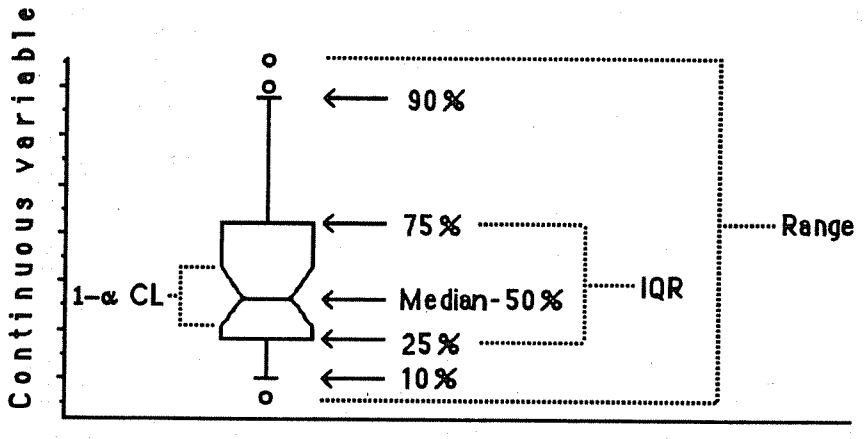
WATER SUPPLY
- chlorides,
- total coliforms,
- manganese,
- total dissolved solids

SA WATERS: Fecal coliforms (tube method where appropriate)

Ambient water quality data are often summarized using box and whisker plots (for examples see Figures 4.17 and 4.18). Figure 4.3 provides an explanation of how to interpret the plots.

Figure 4.3 Box and Whisker Plots

Box and whisker plot are useful for comparing sets of data comprised of a single variable by the visualization of selected order statistics. After the data have been ordered from low to high, the 10th, 25th, 50th, 75th, and 90th percentiles are calculated for plot construction. Box and whisker plots display the following important information: 1) the interquartile range (IQR) which measures the distribution and variability of the bulk of the data (located between the 25th and 75th percentiles), 2) the desired confidence interval (1- CL) for measuring the statistical significance of the median (50th percentile), 3) indication of skew from comparing the symmetry of the box above and below the median, 4) the range of the data from the lowest to highest values, and 5) the extreme values below the 10th percentile and above the 90th percentile (depicted as dots).



Visual comparison of confidence level notches about the medians of two or more box plots can be used to roughly perform hypothesis testing (Figure 4.1). If the box plots represent data from samples assumed to be independent, then overlapping notches indicate no significant difference in the samples at a prescribed level of confidence. Formal tests should subsequently be performed to verify preliminary conclusions based on visual inspection of the plots.

AMS stations for the basin are listed in Table 4.5 below. North Carolina has 69 stations within the Cape Fear River Basin. For the purpose of this summary, the basin has been divided into six major watershed areas (Haw River, Deep River, Upper Cape Fear, Black River, Northeast Cape Fear and lower Cape Fear and coastal areas. All ambient monitoring sites are shown in the figures accompanying the water quality summaries in Section 4.3.1 through 4.3.6 for each of the major watershed areas. A schematic map of the basin showing ambient monitoring stations on the mainstems of the Haw, Deep, Cape Fear and Northeast Cape Fear Rivers is presented in Figure 4.4.

Table 4.5 Ambient Monitoring System Stations Within the Cape Fear Basin.

	STORET No	Primary No	Station Name	County	Subbasin
Haw River Mainstem					
	B0040000	02093250	Haw River At SR 2109 Near Oak Ridge, NC	Guilford	030601
	B0050000	0209331280	Haw River At US 29a Near Benaja, NC	Rockingham	030601
	B0210000	02093599	Haw River At SR 1561 Near Altamahaw, NC	Alamance	030601
	B1140000	02096500	Haw River At Haw River, NC	Alamance	030602
	B2000000	02096879	Haw River At SR 1005 Near Saxapahaw, NC	Alamance	030602
	B2100000	02096960	Haw River At US Hwy 15-501 Near Bynum, NC	Chatham	030604
	B4050000	02098198	Haw River Below B. Everette Jordan Dam Nr Moncure, NC	Chatham	030604
Haw River Tributaries					
	B0160000	02093423	Little Troublesome Creek At SR 2600 Near Reidsville, NC	Rockingham	030601
	B0540000	02095500	North Buffalo Creek At SR 2832 Near Greensboro, NC	Guilford	030602
	B0750000	02095091	South Buffalo Creek At SR 2821 At Mcleansville, NC	Guilford	030602
	B0840000	02095681	Reedy Fork At NC Hwy 87 At Ossipee, NC	Alamance	030602
	B1090000	0209622751	Jordan Creek At SR 1002 Near Union Ridge, NC	Alamance	030602
	B1260000	0209651840	Town Branch At SR 2109 Near Graham, NC	Alamance	030602
	B1960000	02096813	Alamance Creek At SR 2116 At Swepsonville, NC	Alamance	030602
	B1670000	0209666850	Little Alamance Creek At NC Hwy 61 Near Whitsett, NC	Guilford	030603
	B2450000	02097189	Robeson Creek At SR 1939 Near Seaforth, NC	Chatham	030604
	B3040000	02097314	New Hope Creek At SR 1107 Near Blands, NC	Durham	030605
	B3660000	0209741955	Northeast Creek At SR 1100 Near Nelson, NC	Durham	030605
	B3900000	02097521	Morgan Creek At SR 1726 Near Farrington, NC	Chatham	030606
Deep River Mainstem					
	B4240000	02099000	East Fork Deep River At SR 1541 Near High Point NC	Guilford	030608
	B4615000	02099500	Deep River At SR 1921 Near Randleman, NC	Randolph	030608
	B4800000	02100219	Deep River At SR 2128 At Worthville, NC	Randolph	030609
	B5070000	02100500	Deep River At Main St At Ramseur, NC	Randolph	030609
	B5190000	02100747	Deep River At SR 1456 Near High Falls, NC	Moore	030609
	B5520000	0210102530	Deep River At NC Hwy 22 At High Falls, NC	Moore	030610
	B5575000	02101402	Deep River At NC Hwy 42 At Carbonton, NC	Chatham	030611
	B5820000	02101577	Deep River At US Hwys 15-501 Near Sanford, NC	Lee	030611
	B6050000	02102049	Deep River At CSX Railroad Bridge At Moncure, NC	Chatham	030611
Deep River Tributaries					
	B4410000	02099484	Richland Creek @ SR 1145 Nr High Point, NC	Guilford	030608
	B4890000	0210029550	Hasketts Creek At SR 2128 Near Central Falls, NC	Randolph	030609
	B5480000	02101001	Bear Creek At NC Hwy 705 At Robbins, NC	Moore	030610
	B6010000	02101946	Rocky River At US Hwys 15-501 Near Center Grove, NC	Chatham	030612
Cape Fear Mainstem					
	B6160000	02102178	Cape Fear River At NC Hwy 42 Near Corinth, NC	Chatham	030607
	B6370000	02102500	Cape Fear River At US Hwy 401 At Lillington, NC	Harnett	030607
	B6840000	02102696	Cape Fear River At NC Hwy 217 Near Erwin, NC	Harnett	030613
	B7600000	02104000	Cape Fear River At NC Hwy 24 At Fayetteville, NC	Cumberland	030615
	B8300000	02105500	Cape Fear River @ William O. Huske Lock Nr Tar Heel, NC	Bladen	030616
	B8305000	02105512	Cape Fear River At SR 1316 Near Tarheel, NC	Bladen	030616
	B8340000	02105544	Cape Fear River At Lock And Dam #2 Near Elizabethtown, NC	Bladen	030616
	B8350000	02105769	Cape Fear River At Lock #1 Near Kelly, NC	Bladen	030616
	B8360000	02105771	Cape Fear River At NC Hwy 11 Near Kelly, NC	Bladen	030616
	B8450000	02105825	Cape Fear River Above Neils Eddy Landing Near Acme, NC	Columbus	030617
	B9020000	02107570	Cape Fear River Below Hale Point Landing Nr Phoenix, NC	Brunswick	030617
	B9050000	02107576	Cape Fear River At Navassa NC	Brunswick	030617
	B9800000	02108736	Cape Fear River @ Channel Marker #55 @ Wilmington, NC	New Hanover	030617
	B9820000	02108757	Cape Fear River @ Channel Marker #50 Near Wilmington NC	New Hanover	030617
Cape Fear Tributaries					
	B6830000	02102634	Upper Little River At SR 2021 Near Erwin, NC	Harnett	030613
	B7280000	02103000	Little River[Lower] At NC Hwys 87&24 At Manchaster, NC	Cumberland	030614
	B7245000	02102897	Lower Little River At SR 2023 Near Lobelia, NC	Moore	030614
	B7700000	0210426450	Rockfish Creek At SR 1432 Near Raeford, NC	Hoke	030615
	B8220000	02104500	Rockfish Creek At US Hwy 301 Near Hope Mills, NC	Cumberland	030615
	B8445000	02105814	Livingston Creek At Mouth Near Riegelwood, NC	Columbus	030617
Black River Mainstem					
	B8750000	02106500	Black River At NC Hwy 411 Near Tomahawk, NC	Sampson	030619
	B9013000	0210756250	Black River Ds Raccoon Island Near Huggins, NC	Pender	030620
Black River Tributaries					
	B8919000	02107000	South River At SR 1503 Near Parkersburg, NC	Bladen	030618
	B8540000	02106000	Little Coharie Creek At NC Hwy 24 Near Roseboro, NC	Sampson	030619
	B8725000	0210643010	Six Runs At SR 1960 Near Taylors Bridge, NC	Sampson	030619
Northeast Cape Fear River Mainstem					
	B9080000	02107586	Northeast Cape Fear River At SR 1937 Near Mt Olive, NC	Wayne	030621
	B9290000	02108000	Northeast Cape Fear River @ NC Hwy 41 Nr Chinquapin, NC	Duplin	030622
	B9580000	02108619	Northeast Cape Fear River @ US Hwy117 @ Castle Hayne NC	New Hanover	030623
	B9740000	0210869230	Northeast Cape Fear River @ US Hwy 421 @ Wilmington, NC	New Hanover	030617
Northeast Cape Fear River Tributary					
	B9470000	02108563	Rockfish Creek At I-40 Near Wallace, NC	Duplin	030622
Coastal Area					
	B9879000	CPF213M4	Carolina Beach Harbor Near Icw & Below Snow's Cut	New Hanover	030624
	B9874000	0209321820	ICW At US Hwys 74 & 76 At Wrightsville Beach, NC	New Hanover	030624
	B9860000	0209320420	Intra-Coastal Waterway At NC Hwy 210 At Goose Bay, NC	Onslow	030624
	B9876000	0209323270	Intra-Coastal Waterway Near Everett Creek	New Hanover	030624
	B9872500	CPF213K4	Intra-Coastal Waterway Near Howe Point	New Hanover	030624
	B9872000	CPF213K	Intra-Coastal Waterway Near Long Point	Pender	030624
	B9865000	CPF213F	Intra-Coastal Waterway Near Morris Landing	Onslow	030624

Note: Locations of all of these stations are shown on the major river watershed maps in Section 4.3. Locations of stations on the mainstems of the Cape Fear, Northeast Cape Fear, Deep and Haw Rivers are shown on the schematic map in Figure 4.4

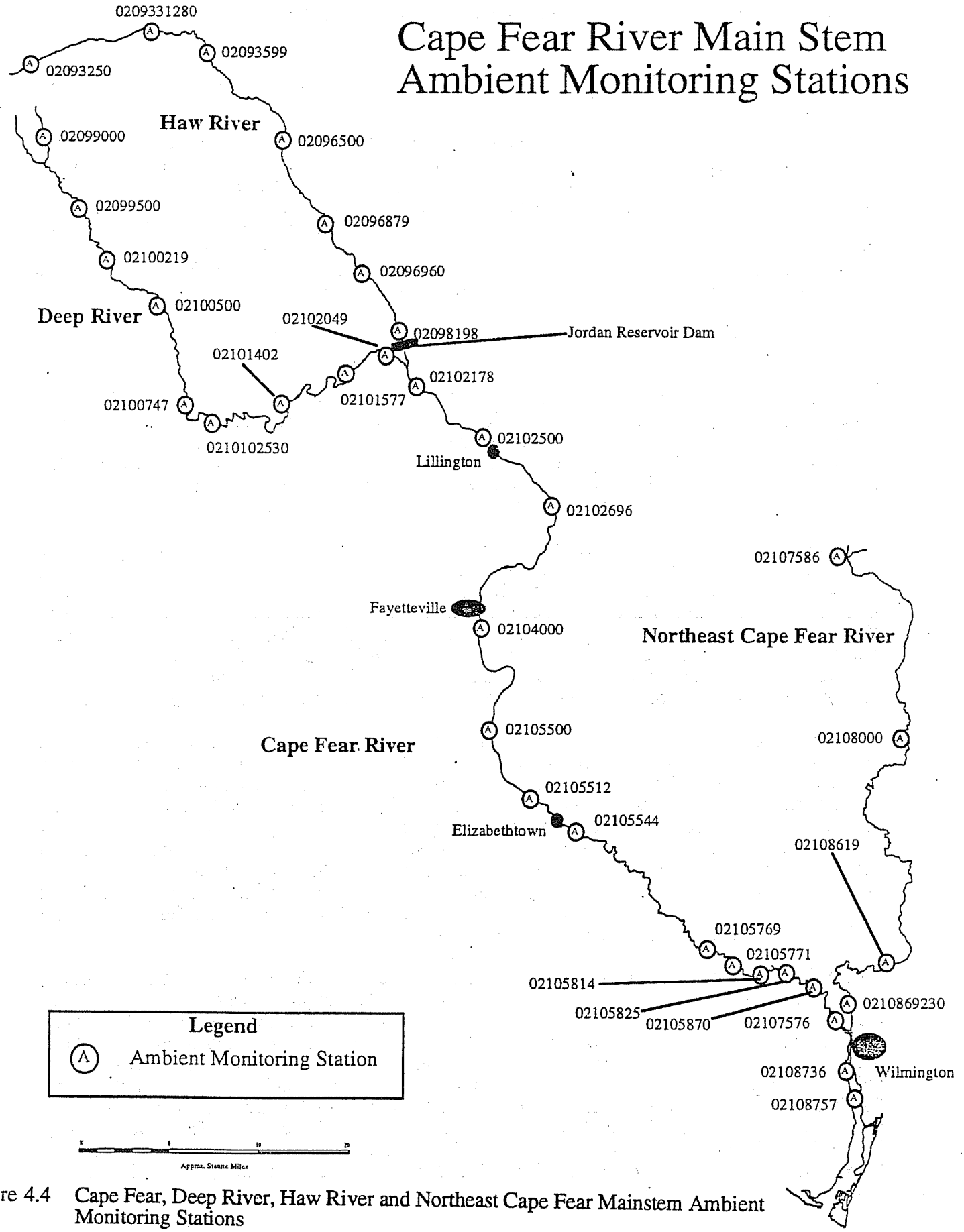


Figure 4.4 Cape Fear, Deep River, Haw River and Northeast Cape Fear Mainstem Ambient Monitoring Stations

4.3 NARRATIVE WATER QUALITY SUMMARIES BY MAJOR WATERSHED AREAS AND SUBBASINS

Water quality is summarized below for each of the six major watersheds in the Cape Fear River Basin. Each watershed is composed of 3 to 6 subbasins. The summaries are based on monitoring data collected by DWQ. Locations of the monitoring sites are presented in the accompanying watershed maps. There are 2 maps for each watershed area. The first of each set shows the benthic macroinvertebrate sites. The second shows ambient monitoring, lakes, fish community and fish tissue sampling sites. Table 1 in Appendix II contains more detailed information for all of the benthic monitoring sites in the basin. Data upon which these summaries are based are compiled in the draft basinwide assessment document for the Cape Fear River Basin (NC DEHNR, 1993).

4.3.1 Haw River/Jordan Reservoir Watershed (Subbasins 01 through 06)

Haw River Drainage

The Haw River originates in the Piedmont near Oak Ridge in Guilford County and drains 1,526 square miles. The river falls from about 1,000 feet above sea level to an elevation of 158 feet at its confluence with the Deep River. The upper two-thirds has an average fall of 6.5 feet per mile. The fall in this lower third varies considerably from 18 feet to 0.5 feet per mile. The watershed topography is generally rolling hills. The textile industry has historically been a principal industry in the area, but the industrial base has expanded, and agriculture is also important in the watershed.

The most upstream tributaries of the Haw River are Troublesome and Little Troublesome Creeks. The combination of agricultural land use and highly erodable soils produces widespread nonpoint source problems in both the upper Haw River and Troublesome Creek watersheds. Benthic macroinvertebrate surveys in 1993 produced Fair and Good-Fair bioclassifications at two upstream Haw River sites. Some recent improvement in the invertebrate bioclassification was observed for the Haw River near Altamahaw in 1993, improving from Fair or Good-Fair (1985-1990) to Good in 1993. Troublesome Creek received a Good-Fair bioclassification, although a single fish survey in Troublesome Creek produced a Poor ecological health rating (discussed in next paragraph).

Benthic macroinvertebrate surveys have assigned a Fair rating to Little Troublesome Creek just below the Reidsville WWTP discharge in 1987 and 1992, with a Poor rating further downstream in 1993. Troublesome Creek received a Poor ecological health rating based on a fish community assessment in 1993. This site had no sucker species and only limited numbers of darter, sunfish, and intolerant species thus indicating habitat degradation. Trophic composition was out of proportion with an increase in the percentage of omnivores, indicating nutrient enrichment. Urban runoff has also contributed to this problem, with a Fair rating in 1992 for Little Troublesome Creek above the discharge. Water chemistry from the ambient site on Little Troublesome Creek consistently had high copper concentrations. Lake Hunt and Reidsville Lake fully support all designated uses and usually have been evaluated as mesotrophic.

As the Haw River continues downstream, it is joined by Reedy Fork and its two major tributaries, North and South Buffalo Creeks. There are several major dischargers in the Greensboro area, but the largest of these are the Greensboro T.Z. Osborne South Buffalo Creek WWTP (20 MGD) and the Greensboro North Buffalo Creek WWTP (16 MGD). The Greensboro wastewater plants have been monitored by water chemistry samples at ambient sites, self-monitoring toxicity data, and collections of both benthic macroinvertebrates and fish. Water chemistry from both North and South Buffalo Creeks is characterized by high conductivities, high nutrient concentrations, and high total residue. Both fish and macroinvertebrate sampling have shown Poor water quality below these discharges. Upstream biological collections have also shown Poor water quality in North Buffalo Creek (urban runoff and Cone Mills discharge), but Fair water quality in South

(continued at bottom of page 4 - 19)

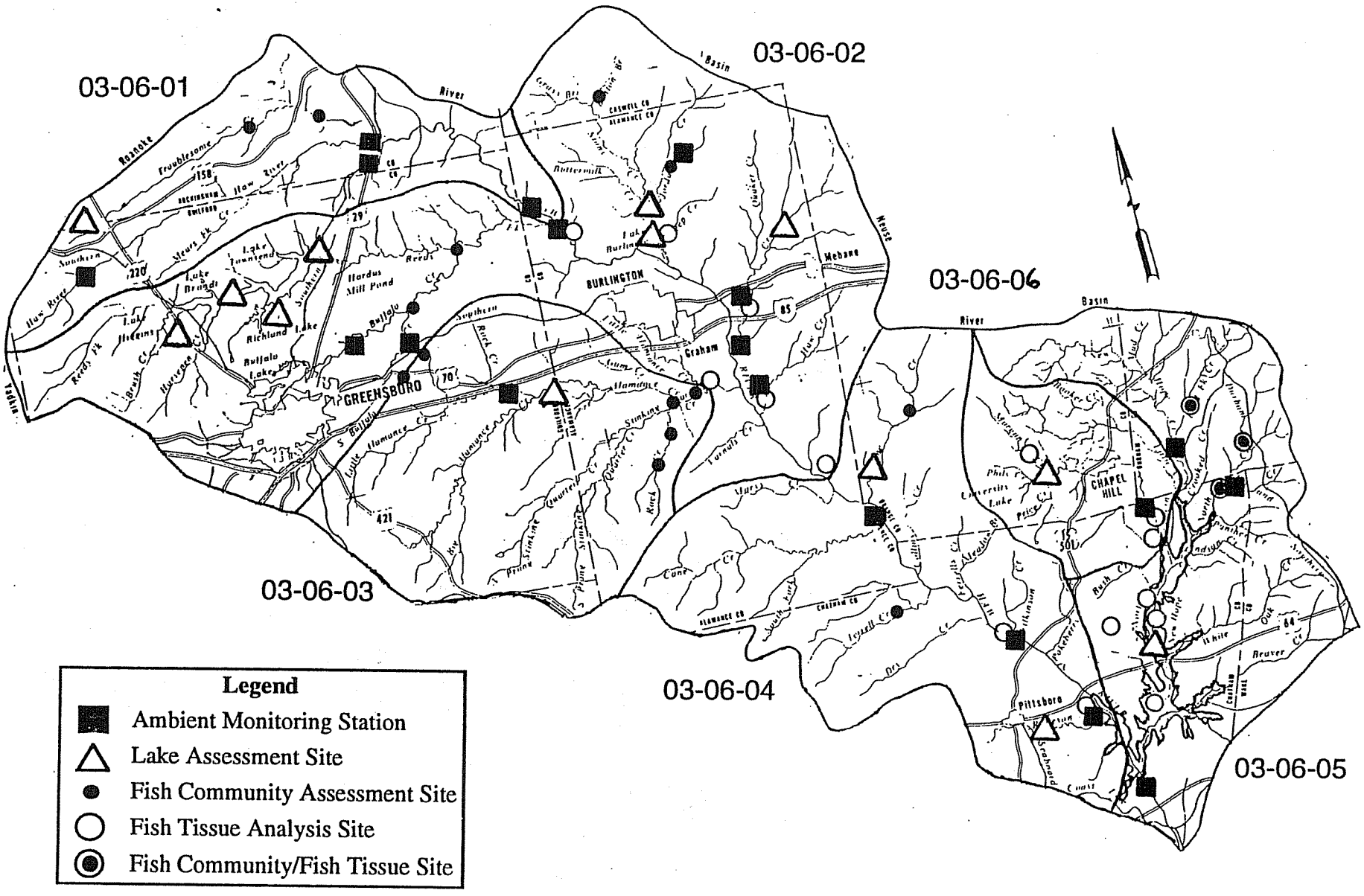


Figure 4.5 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sampling Sites in the Haw River/Jordan Lake Watershed (Subbasins 01 to 06)

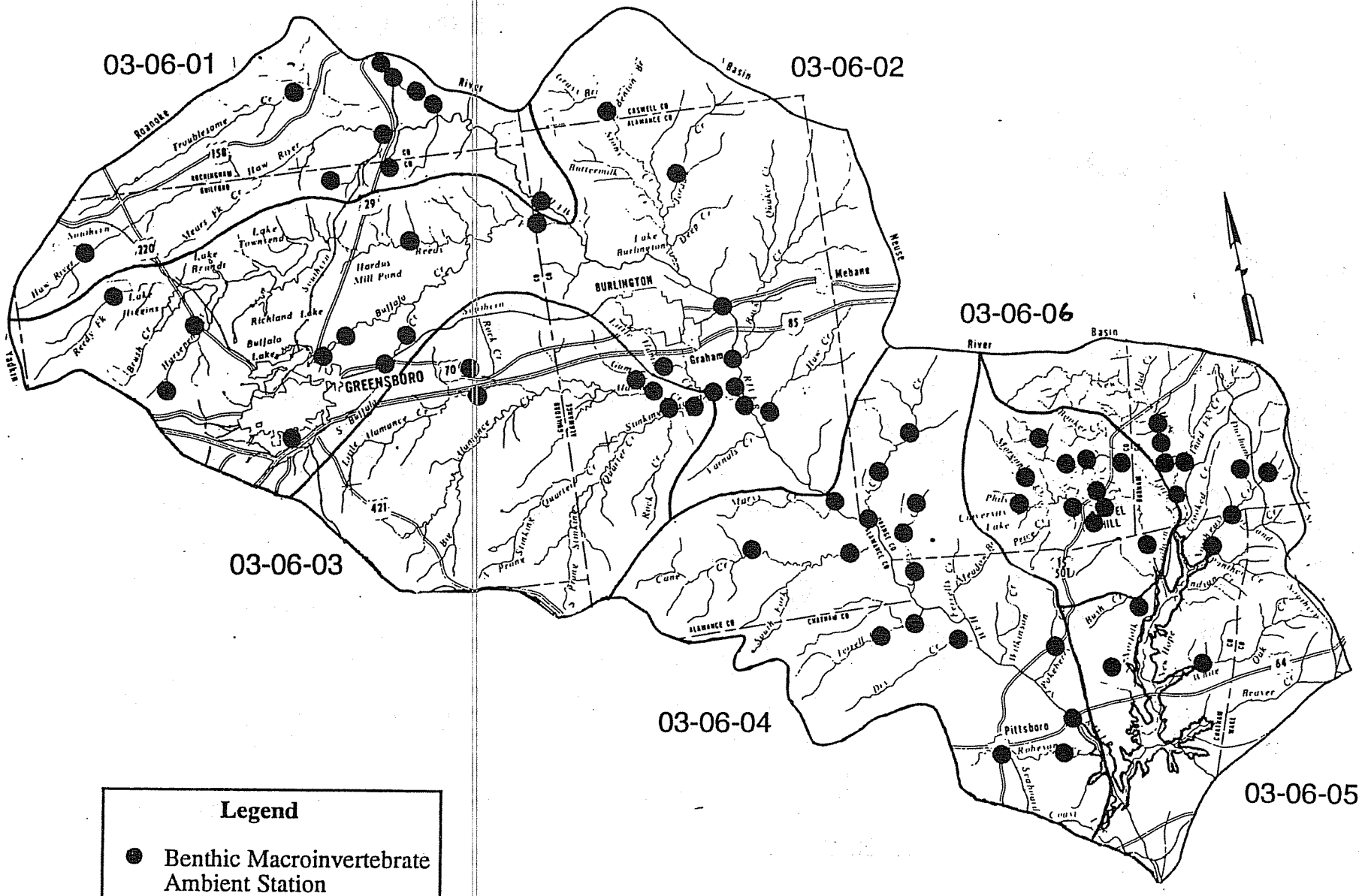


Figure 4.6 Benthic Macroinvertebrate Monitoring Stations in the Haw River/Jordan Lake Watershed (Subbasins 01 to 06)

Table 4.6 Benthic Macroinvertebrate Sampling Sites Data Summary for the Haw River/Jordan Lake Watershed (83-93)

Subbasin 01

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Haw R at Oak Ridge, SR 2109, Guilford	-/B-1	16-(1)	07/93	-/9	-/5.67	Fair
			05/85	59/11	6.50/4.73	Fair
Haw R, US 29 Bus, Rockingham	-/B-2	16-(1)	07/93	56/20	5.76/4.91	Good-Fair
Haw R nr Altamahaw, NC 87, Alamance	P/B-3	16-(1)	07/93	69/22	5.77/4.95	Good
			07/90	63/12	7.10/5.48	Fair
			07/87	65/14	6.33/5.65	Good/Fair
			05/85	65/23	6.50/4.91	Good/Fair
Brooks Lake Trib, Scout Camp, Guilford	114/B-4	16-4-1-(1)	06/90	53/15	4.21/2.44	Excellent*
			06/85	79/20	4.95/2.55	Excellent*
Candy Cr, SR 2700, Guilford	115/B-5	16-5	06/90	59/10	6.56/5.72	Fair
			06/85	69/11	6.96/6.16	Fair
Troublesome Cr, SR 2422, Rockingham	-/B-6	16-6-(0.7)	07/93	-/18	-/5.21	Good-Fair
L Troublesome Cr, ab Reidsville WWTP, Guilford	89/B-7	16-7	01/92	42/8	6.74/5.63	Fair
			12/87	68/18	6.68/5.21	Good/Fair
L Troublesome Cr, be Reidsville WWTP, Guilford	90/B-8	16-7	01/92	33/7	6.83/5.15	Fair
			12/87	37/11	7.26/4.33	Fair
L Troublesome Cr, SR 2598, Rockingham	1/B-9	16-7	05/85	36/3	7.72/7.22	Poor
L Troublesome Cr, SR 2600, Rockingham	-/B-10	16-7	07/93	42/3	7.22/7.50	Poor

Subbasin 02

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Haw R at Haw R, NC 49, Alamance	10/B-1	16-(1)	05/85	58/10	6.82/5.53	Fair
			08/84	36/12	6.53/5.58	Fair
Haw R nr Graham, NC 54, Alamance	A /B-2	16-(1)	07/93	64/19	6.04/5.20	Good-Fair
			08/89	58/14	6.03/5.29	Good/Fair
			08/87	-/13	-/5.34	Fair
			07/87	74/20	6.23/5.33	Good/Fair
			09/85	60/14	6.40/5.20	Good-Fair
			05/84	66/16	7.21/5.67	Fair
			08/83	73/15	7.00/5.26	Fair
Haw R ab Alamance Cr, Alamance	11/B-3	16-(1)	05/84	64/16	6.96/5.44	Fair
Haw R be Alamance Cr, Alamance	12/B-4	16-(1)	05/84	68/20	7.12/4.56	Fair
Reedy Fk nr Oak Ridge, SR 2128, Guilford	U,4/B-5	16-11-(1)	07/93	-/19	-/4.79	Good-Fair
			07/88	69/22	5.52/4.36	Good
			04/86	77/24	5.44/4.34	Good
Horsepen Cr, US 220, Guilford	5/B-6	16-11-5-(0.5)	07/93	-/9	-/5.93	Fair
			04/86	82/22	6.46/5.06	Good/Fair
UT Horsepen Cr, Friendly Rd, Guilford	-/B-7	16-11-5-1-(2)	09/92	43/4	7.46/6.97	Poor
Reedy Fk, SR 2728, Guilford	-/B-8	16-11-(9)	07/93	-/16	-/5.94	Good-Fair
Reedy Fk nr Ossippee, NC 87, Alamance	B/B-9	16-11-(9)	07/93	68/20	6.34/5.39	Good-Fair
			08/89	67/14	6.80/5.72	Fair
			07/86	59/10	6.67/5.79	Fair
			05/85	49/12	7.66/5.85	Fair
			08/83	52/13	7.55/6.30	Fair
N Buffalo Cr, ab WWTP, Guilford	80/B-10	16-11-14-1	11/88	37/3	7.84/7.42	Poor
N Buffalo Cr, be WWTP, SR 2832, Guilf.	81/B-11	16-11-14-1	07/93	40/4	8.09/6.49	Poor
			11/88	32/1	8.51/7.78	Poor
			05/85	28/2	8.66/6.05	Poor
S Buffalo Cr, US 70 ab WWTP, Guilford	78/B-12	16-11-14-2	07/93	59/8	7.41/6.02	Fair
			08/88	63/9	7.87/6.48	Poor
S Buffalo Cr, SR 2821 be WWTP, Guilford	7/B-13	16-11-14-2	07/93	50/2	8.35/6.22	Poor
			08/88	34/1	7.79/7.78	Poor
			05/85	36/2	8.41/6.50	Poor
Mile Run Cr, SR 1400, Guilford	8/B-14	16-11-14-2-4	04/86	25/1	8.69/6.58	Poor
Stony Cr, SR 1100, Caswell	-/B-15	16-14-(1)	07/93	-/21	-/4.67	Good
			02/93	-/27	-/4.03	Good
Jordan Cr, SR 1002, Alamance	-/B-16	16-14-6-(0.5)	02/93	-/23	-/4.78	Good-Fair
Little Alamance Cr, SR 2309, Alamance	9/B-18	16-19-11	07/85	45/8	7.30/6.52	Fair
Haw Cr, SR 2158, Alamance	-/B-19	16-20-(1)	02/93	-/19	-/4.76	Good-Fair

Subbasin 03

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
L Alamance Cr, SR 3056, Guilford	-/B-1	16-19-3-(4.5)	02/93	69/24	5.36/4.70	Good
UT Rock Cr, SR 2808, Guilford	82/B-2	16-19-8-3.5-(1)	11/88	-/20	-/4.52	Good/Fair
Big Alamance Cr, NC 49, Alamance	-/B-3	16-19-(4.5)	7/93	-/19	-/5.20	Good-Fair
			2/93	-/20	-/4.27	Good-Fair
Big Alamance Cr nr Bellemont, SR 2309, Alamance	O/B-4	16-19-(4.5)	10/89	95/31	5.79/4.93	Good
			08/89	79/22	6.02/5.25	Good/Fair
			04/89	79/26	5.70/4.53	Good/Fair
			02/89	65/22	5.70/4.53	Good/Fair
			07/86	80/22	6.00/5.00	Good/Fair
Gum Cr, SR 1148, Alamance	13/B-5	16-19-7	4/86	67/14	7.51/5.92	Fair
Stinking Quarter Cr, SR 1136, Alamance	14/B-6	16-19-8	7/93	-/16	-/5.01	Good-Fair
			2/93	-/25	-/4.01	Good-Fair
			4/86	91/30	6.00/4.95	Good

Subbasin 04

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Haw R nr Saxapahaw, SR 2158, Alamance	15/B-1	16-(1)	8/83	54/7	6.89/5.63	Fair
Haw R nr Saxapahaw, SR 1005, Alamance	C/B-2	16-(1)	7/93	60/18	5.81/5.04	Good-Fair
			7/90	71/20	6.03/4.83	Good-Fair
			8/89	60/18	6.14/5.20	Good-Fair
			7/88	74/21	6.18/4.90	Good-Fair
			7/87	71/21	5.84/4.99	Good-Fair
			7/87	-/21	-/5.04	Good
			7/86	67/19	6.10/4.89	Good-Fair
			9/85	64/23	5.54/5.03	Good
			5/85	73/24	6.24/4.84	Good-Fair
			9/84	61/13	6.44/4.90	Fair
			5/84	85/27	6.01/4.76	Good-Fair
Cane Cr, SR1114, Orange	16/B-3	16-27-(1)	7/93	-/20	-/4.05	Good-Fair
			2/93	-/28	-/3.56	Good
			4/86	110/33	5.62/4.52	Good
Cane Cr, SR 1100, Orange	-/B-4	16-27-(1)	11/84	88/27	5.90/4.88	Good-Fair
Cane Cr (West), SR 2351, Alamance	-/B-5	16-28	12/86	-/12	-/5.75	Fair
Cane Cr (West), NC 87, Alamance	-/B-6	16-28	2/93	-/20	-/4.36	Good-Fair
			12/86	-/5	-/4.85	Poor
Collins Cr, SR 1539, Chatham	-/B-7	16-30	12/86	44/4	7.02/4.12	Poor
UT Collins Cr, ab WWTP, Orange	-/B-8	16-30-(1)	8/91	52/17	5.72/4.75	Good-Fair
UT Collins Cr, be WWTP, Orange	-/B-9	16-30-(1)	8/91	63/15	5.82/5.03	Good-Fair
Terrells Cr, NC 87, Chatham	-/B-10	16-31-(2.5)	2/93	-/30	-/3.32	Good
Terrells Cr, SR 1520, Chatham	-/B-11	16-31-(2.5)	12/86	-/13	-/5.07	Fair
Dry Cr, SR 1520, Chatham	-/B-12	16-34	2/93	-/31	-/4.63	Good
			12/86	-/5	-/6.01	Poor
Haw R nr Pittsboro, US 64, Chatham	D/B-13	16-(36.7)	7/93	63/24	5.06/4.30	Good
			7/90	60/24	5.38/4.12	Good
			7/88	81/28	5.91/4.57	Good
			7/86	69/24	5.65/4.26	Good
			5/85	84/27	5.68/4.19	Good
			9/84	56/20	5.70/4.52	Good
			6/83	48/14	5.49/4.43	Good-Fair
			6/83	51/19	5.38/4.30	Good
			6/83	61/19	5.54/4.35	Good
Pokeberry Cr, SR 1711, Chatham	18/B-14	16-37	2/93	-/23	-/4.67	Good-Fair
			12/86	94/26	5.81/4.23	Good
			10/85	86/21	6.04/4.68	Good-Fair
Robeson Cr, ab Pittsboro WWTP, Chath.	116/B-15	16-38-(3)	9/90	67/7	7.61/7.00	Poor
Robeson Cr, be Pittsboro WWTP, Chath.	17/B-16	16-38-(3)	9/90	54/7	7.09/5.89	Fair
			4/86	82/11	7.25/5.89	Fair

Table 4.6 Continued

Subbasin 05

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
New Hope Cr, SR 1734, Orange	-/B-1	16-41-1-(0.5)	3/93	94/29	4.94/3.84	Good
New Hope Cr, SR 2220, Durham	66/B-2	16-41-1-(11.5)	3/87	53/14	6.70/5.71	Fair
New Hope Cr, I-40, Durham	20/B-3	16-41-1-(11.5)	10/85	49/10	7.56/6.07	Fair
New Hope Cr, SR 1107, Durham	21/B-4	16-41-1-(11.5)	10/85	32/5	7.56/6.65	Poor
UT New Hope Cr, SR 1716, Chatham	25/B-5	16-41-(3.5)	7/93	-/10	-/6.30	NR
			2/93	-/21	-/3.91	Good-Fair
			4/86	79/29	4.94/4.05	Good
Third Fork Cr, NC 751, Durham	22/B-6	16-41-1-12-(2)	2/93	39/8	7.78/6.64	Poor
			4/85	40/3	8.10.6.83	Poor
Northeast Cr, SR 1102, Durham	64/B-7	16-41-1-17-(0.7)	2/93	58/9	6.91/6.04	Fair
			3/87	29/3	7.71/6.50	Poor
Northeast Cr, SR 1100, Durham	24,65/B-8	16-41-1-17-(0.7)	2/93	35/7	6.99/5.83	Fair
			3/87	27/0	7.96/-	Poor
			12/86	-/4	-/6.39	Poor
			4/85	62/7	7.38/6.08	Fair
Northeast Cr, SR 1731, Chatham	-/B-9	16-41-1-17-(0.7)	7/93	46/8	7.10/6.30	Fair
			12/86	-/8	-/5.94	Fair
Burdens Cr, SR 1945, Durham	23/B-10	16-41-1-17-1-(0.7)	4/86	60/10	6.96/5.41	Fair
Cub Cr, SR 1008, Chatham	-/B-11	16-41-2-10-(0.5)	12/86	-/14	-/5.44	Fair
White Oak Cr, NC 751, Chatham	-/B-12	16-41-6-3.5)	2/93	-/13	-/4.82	Fair

Subbasin 06

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Little Cr, Pinehurst Dr, Orange	-/B-1	16-41-1-15-(0.5)	2/93	37/7	7.12/4.69	Fair
Bolin Cr, SR 1777, Orange	-/B-2	16-41-1-15-1-(0.5)	4/93	-/24	-/4.46	Good
Bolin Cr, Village Rd, Orange	-/B-3	16-41-1-15-1-(0.5)	4/93	-/24	-/3.89	Good
Bolin Cr, E Franklin St, Orange	27/B-4	16-41-1-15-1-(4)	2/93	32/8	6.50/5.34	Fair
			4/86	89/28	6.08/4.27	Good-Fair
Morgan Cr, NC 54, Orange	26/B-5	16-41-2-(1)	7/93	61/21	4.91/3.47	Good**
			2/93	91/36	4.44/3.23	Excell
			4/85	109/32	5.70/4.65	Good
Morgan Cr, Botanical Trail, Orange	-/B-6	16-41-2-(5.5)	4/93	-/16	-/4.94	Fair
			2/93	71/26	6.00/4.63	Good-Fair
Morgan Cr, ab OWASA, Orange	83/B-7	16-41-2-(5.5)	9/90	63/8	7.15/6.35	Fair
			7/88	82/13	6.91/6.29	Fair
Morgan Cr, be OWASA, Orange	84/B-8	16-41-2-(5.5)	2/93	42/7	7.08/4.93	Fair
			9/90	66/8	7.46/5.85	Fair
			7/88	52/4	7.80/7.11	Poor
Morgan Cr, SR 1726, Chatham	I/B-9	16-41-2-(5.5)	7/93	38/7	6.88/6.53	Fair
			7/90	54/8	7.16/6.47	Fair
			7/87	35/6	6.81/6.29	Fair
			4/85	40/4	7.71/5.67	Poor
			8/84	50/10	7.06/5.88	Fair
Pritchards Mill Cr, Damascus Rd, Orange	-/B-10	16-41-2-3-(2)	4/93	-/22	-/4.30	Good-Fair
Meeting of Waters Cr, Laurel Hill Rd, Orange	-/B-11	16-41-2-7	4/93	-/2	-/7.28	Poor

* Small Stream Criteria

** rating affected by very low flow

Buffalo Creek. Areas of higher water quality (Good macroinvertebrate bioclassification, Good or Good-Excellent fish IBI) include the headwaters of Reedy Fork and Stony Creek. Lake Higgins, Lake Brandt, Lake Townsend, and Richland Lake are in the upstream section of Reedy Fork and are evaluated as eutrophic (except Richland Lake is mesotrophic). Water chemistry shows some downstream recovery in Reedy Fork, and recent macroinvertebrate samples have shown improvement from Fair (1985-1989) to Good-Fair in 1993. These changes probably reflect improved waste treatment at the Greensboro facilities. The 1993 bioclassifications change from Good at the Haw River Altamahaw site to Good-Fair at the Haw River near Graham.

In the Burlington-Graham area, the Haw River collects the Alamance Creek watershed. All major streams (Big Alamance Creek, Little Alamance Creek and Stinking Quarter Creek) received Good-Fair or Good macroinvertebrate bioclassifications. Fish NCIBI ratings also indicated few problems in this watershed, with Good or Good-Excellent ratings at Rock Creek, Stinking Quarter Creek and Alamance Creek. Gum Creek is affected by a small discharger and urban runoff; it received a Fair macroinvertebrate bioclassification in 1986. The Burlington South WWTP (12 MGD) also may affect the Haw River below the confluence of Alamance Creek. Burlington Reservoir, Lake Burlington, Lake Macintosh and Graham-Mebane Reservoir in this area are eutrophic, though Lake Macintosh is a new reservoir and may not yet have stabilized.

The lower reach of the Haw River, above its confluence with B. Everett Jordan Reservoir, is approximately 25 river miles in length and contains many small to medium tributaries. Many of these tributary streams are located within the Carolina Slate Belt ecoregion and are prone to extreme low flow conditions during the summer.

Ambient water quality data have generally indicated good water quality in this section of river, with few violations in water quality criteria. Water quality data from the two lowermost Haw River locations indicate an improvement compared to data collected from upstream locations. The same is true for bioclassifications of the Haw River in this reach (Good and Good-Fair) when compared to upstream reaches near Burlington and Graham (Good-Fair and Fair). Apparently, the river has assimilated wastes generated by numerous point source dischargers near Burlington. Biological recovery is noted by consistent Good bioclassifications at the most downstream monitoring location near Pittsboro prior to the confluence with B. Everett Jordan Reservoir.

An ambient water quality location on Robeson Creek is located near the confluence with Haw River below the Pittsboro WWTP. A Fair bioclassification was assigned to this section of Robeson Creek during a biological investigation of the Pittsboro WWTP in 1990. However, the biological investigation noted that upstream water quality problems may have masked the effects of the Pittsboro WWTP. Trends in water quality data from the ambient location note significantly lower conductivity, total phosphorus, and ammonia-nitrogen in 1993 compared to values collected in 1988, suggesting an improvement in water quality.

Good and Good-Fair bioclassifications based on benthic macroinvertebrate samples were assigned to several tributary locations during 1993 surveys: both Cane Creeks, Terrells Creek, Dry Creek and Pokeberry Creek. Nonpoint source runoff from agricultural land or other nonpoint sources of pollution may account for the water quality deterioration and habitat loss in some tributaries. Fish community structure samples were collected from Terrells Creek and Cane Creek. These data indicated Fair-Good ecological health ratings and noted evidence of some nutrient enrichment based on the percentage of omnivore fish species present. Cane Creek Reservoir and Pittsboro Lake are currently classified as eutrophic. Cane Creek Reservoir is currently fully supporting its designated uses, whereas Pittsboro Lake is listed as threatened due to the occurrence of algal blooms and presence of nuisance aquatic weeds.

B. Everett Jordan Reservoir and Tributaries

Intensive monitoring and research of the 14,300 acre B. Everett Jordan Reservoir (Jordan Reservoir) has been performed by State and university personnel since the lake was filled in 1981 and DWQ investigations have been conducted since 1983. The lake was created for flood control, fish and wildlife habitat, recreation, and water supply. It is now used for water supply by the towns of Cary and Apex. The Haw River makes up 70-90% of the annual flow of Jordan Reservoir with an average retention time of five days. The New Hope arm of the lake has an average retention time of 418 days. Jordan Reservoir is about 5 miles in length on the Haw River arm and 17 miles long on the New Hope Creek arm.

Elevated nutrient and chlorophyll *a* levels have frequently been found in the lake along with periodic blooms of blue-green algae. Very high NCTSI values have been recorded from Jordan Reservoir making it one of the most eutrophic lakes in North Carolina. Historic monitoring data indicates that the lake has remained eutrophic since 1982, with little change in trophic index parameters. The highest algal growth and chlrophyll *a* values have been found in the shallow, upper reaches of the New Hope arm of the lake. The lake is currently considered Threatened.

Sediment oxygen demand (SOD) evaluations were conducted on Morgan Creek near the headwaters of the New Hope arm of the reservoir. A total of eleven SOD tests were conducted to evaluate testing procedures and provide quality assurance (QA) data. Results of these investigations noted negative SOD rates ranging from -1.0 gr/m^2/day to -2.3 gr/m^2/day. These results suggest that upstream sources are causing oxygen depletion of sediments within this arm of Jordan Reservoir. In addition, more negative SOD rates were noted during the most recent investigations (1992 and 1994) when compared to earlier investigations (1989 and 1990), suggesting that water quality conditions are deteriorating in the catchment.

Major tributaries to Jordan Reservoir, besides the Haw River, include Northeast, New Hope and Morgan Creeks. Both point and nonpoint sources of pollution have affected streams in this highly urbanized Chapel Hill and Durham area. Ambient water quality stations are located below Durham's two WWTPs, which discharge to Northeast Creek and New Hope Creek and have instream waste concentrations of 100% and 99.5%, respectively under 7Q10 low flow conditions. Elevated median summer concentrations of nitrate/nitrite-nitrogen and conductivity have been noted from both monitoring locations. On Morgan Creek below the OWASA/Mason Farm WWTP, A noticeable decrease in total phosphorus concentrations has been noted during the period from 1988 to 1993. This facility has an instream waste concentration of 93% under 7Q10 flow conditions. Fecal coliform excesses have consistently been found at all three of the above ambient sites.

Several benthic macroinvertebrate investigations have been conducted to determine the impacts of the Durham Triangle WWTP to Northeast Creek. These investigations have found Fair or Poor bioclassifications at both the upstream and downstream sampling locations. It appears that upstream water quality is being impacted to some degree by urban runoff and by summer low-flow conditions exacerbated by beaver dam impoundments. Good bioclassifications based on benthos data were assigned to an upstream site on New Hope Creek and one very small tributary catchment of B. Everett Jordan Reservoir (UT New Hope Creek). Fish community structure analyses have found Poor/Fair ecological health ratings at lower reaches of Third and Northeast Creeks. A Good ecological health rating was given to an upstream location on Northeast Creek.

The upstream reaches of Morgan and Bolin Creeks have Good to Excellent bioclassifications based on benthic macroinvertebrate data. Land use patterns within these headwater catchments appear to be agricultural with dairy operations and row crops. Water quality conditions degrade as streams flow through the suburban and urban sections of Chapel Hill. A benthic macroinvertebrate site on Bolin Creek at East Franklin Street declined from Good-Fair in 1986 to Fair in 1993. Nonpoint runoff from these areas may have impacted water quality conditions in these streams. A benthos site on Morgan Creek below OWASA improved from Poor in 1988 to Fair in 1990 and 1993.

A fish community structure sample was collected from Morgan Creek at NC 54. This site is used as a reference monitoring location by Triangle J Council of Governments and was assigned an Excellent bioclassification based on benthic macroinvertebrate data. However, the fish sample gave this stream reach a Fair ecological health rating and suggested the potential effects of nutrient enrichment. University Lake on Morgan Creek is eutrophic, but is currently supporting its uses.

4.3.2 Deep River Watershed (Subbasins 08 through 12)

Deep River Drainage Mainstem

The Deep River originates in eastern Forsyth County and flows about 116 miles, draining about 1,442 square miles, to its confluence with the Haw River. The fall line, separating the Piedmont from the Coastal Plain ecoregions, lies at this confluence. The Deep River flows over 16 small dams between High Point and it's confluence with the Haw River, which slow the river's velocity and limit the system's assimilative capacity. The average slope along the entire river from the High Point dam to its mouth is about 5 feet per mile. The fall is rapid down to the mouth of McLendons Creek, where it begins to flatten out. The watershed terrain changes from hilly and rolling in Randloph and Guilford Counties to flat or gently rolling in Moore and Lee Counties with some swampy areas. The river generally has high banks and few large flood plains.

Its headwaters, the East and West Forks of the Deep River, are both affected by nonpoint source runoff, small dischargers, and by low summer flows. Both streams are within largely agricultural catchments, but have urbanized segments near their headwaters. Macroinvertebrate samples during 1993 indicated Fair water quality in the East Fork, but Good-Fair water quality in the West Fork. The East Fork catchment has more development, including a large oil storage area.

Urban areas in the Deep River watershed include Kernersville, High Point, Randleman, Ramseur, Asheboro, and Sanford. Municipal wastewater treatment plants in these cities discharge either directly or indirectly to the Deep River, and their effluents may make up the majority of the flow during low flow periods. As a result, severe water quality problems have been observed throughout the upper portion of the Deep River. The river has been intensively sampled since 1983. Some improvements have been observed during this time period based on examination of benthos data, although as discussed below on pages 4-27 and 4-28, water quality in the Deep River continues to be stressed, and further improvements in quality may be limited by increasing urbanization. The observed improvements have been related to upgrades at several wastewater treatment plants. Using benthos data, an upstream site on the Deep River improved from Poor to Fair after the Jamestown WWTP ceased discharge in 1984. A site further downstream near the Guilford/Randolph County line improved from Poor in 1983 to Fair in 1984-1986. This site showed some further improvement in 1987-1990, but achieved a Good-Fair rating only in July 1988. Copper concentrations at this site are still sometimes above NC Action Levels. The Randleman WWTP is permitted to discharge 1.75 MGD directly to the Deep River. A Deep River site at Randleman improved from Poor in 1985 to Fair in 1986-1988, and to Good-Fair in 1993.

In the 25 river miles from Randleman to the Randolph/Moore County line there are three ambient locations at Worthville, Ramseur and Central Falls. Ambient water chemistry suggests a general trend of more water quality standard/action level exceedances or higher concentrations of nutrient parameters at the upstream location near Worthville and better water quality at downstream locations. This trend indicates that instream assimilative capacity of the Deep River and dilution are improving water quality at downstream reaches. Some excesses were noted for mercury at the Worthville and Central Falls locations. Benthos data from the Deep River at Ramseur have shown improvement from Fair in 1983 and 1985 to Good-Fair through 1993. The Ramseur WWTP has passed all of their recent chronic tests and are in compliance with their NPDES permit.

Benthos data from a location in Moore County have consistently indicated an Excellent bioclassification. Most of the Deep River in Moore County (from Grassy Creek to NC 42 near Carbonton) is classified as HQW. Ambient water quality samples are collected from the Deep River at High Falls and the Deep River at Carbonton. Copper and iron levels exceeded action levels for 33% and 29%, respectively, of the samples collected from the Deep River at High Falls. The excess percentages for these metals for the Deep River at Carbonton increased to 38% for copper and 56% for iron. Fecal coliform counts also exceeded state standards for 38% of the samples from the Carbonton site.

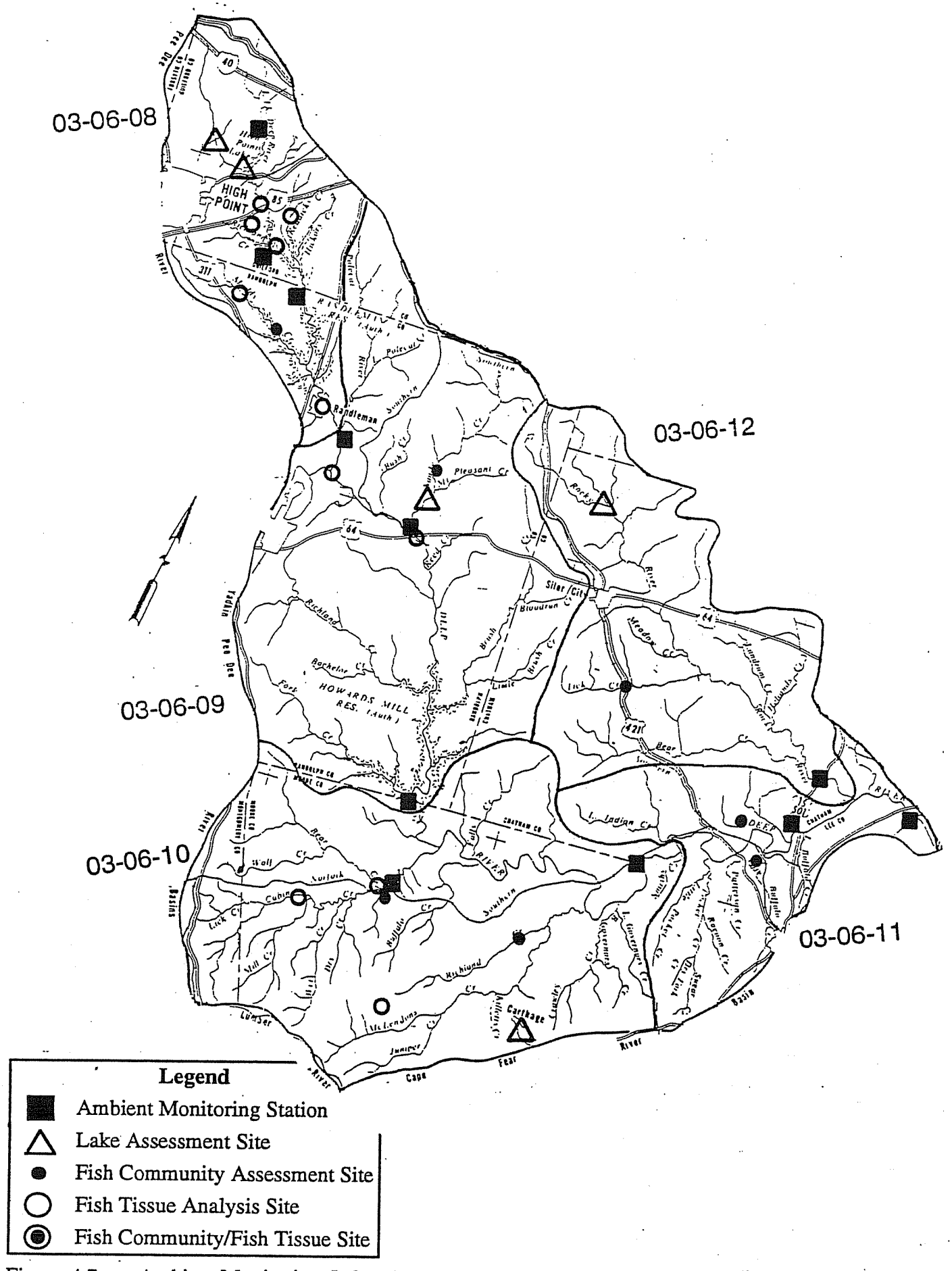


Figure 4.7 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sampling Sites in the Deep River Watershed (Subbasins 08 to 12)

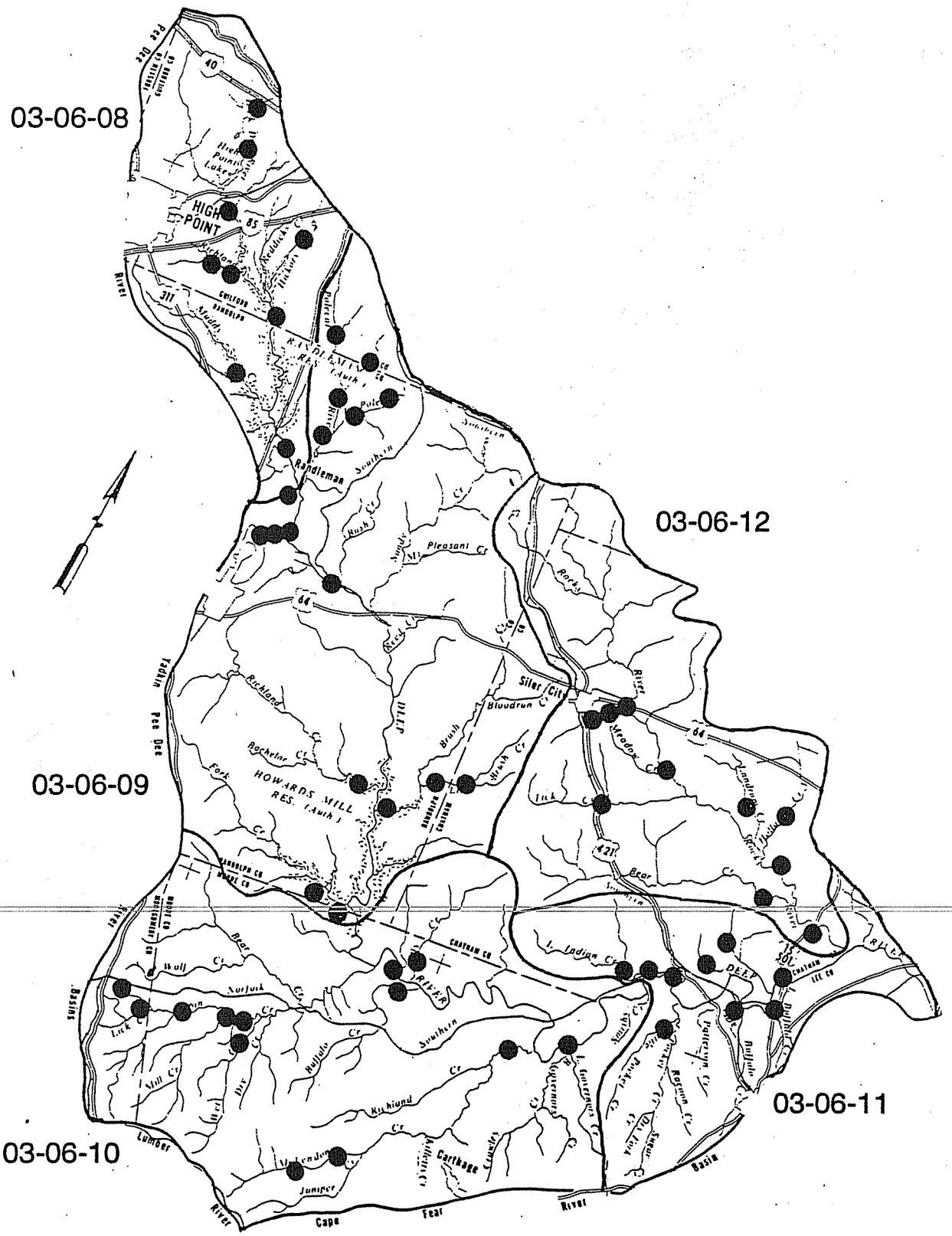


Figure 4.8 Benthic Macroinvertebrate Monitoring Stations in the Deep River Watershed (Subbasins 08 to 12)

Table 4.7 Benthic Macroinvertebrate Sampling Sites and Data Summary for the Deep River Watershed (83-93)

Subbasin 08

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
E Fk Deep R, SR 1541, Guilford	-/B-1	17-2-(0.3)	02/93	-/12	-/5.86	Fair
UT E Fk Deep R, I-40, Guilford	-/B-2	17-2-(0.3)	09/92	38/5	6.85/5.05	Fair
W Fk Deep R, SR 1850, Guilford	-/B-3	17-3-(0.3)	07/93	-/15	-/4.66	Good-Fair
			02/93	-/27	-/4.61	Good-Fair
W Fk Deep R, SR 1818, Guilford	30/B-4	17-3-(0.7)	08/83	71/12	-/-	Fair
UT W Fk Deep R, ab LCP, Guilford	85/B-5	17-3-(0.3)	10/88	35/8	5.97/5.31	Fair
UT W Fk Deep R, be LCP, Guilford	86/B-6	17-3-(0.3)	10/88	6/0	8.41/-	Poor
Deep R, SR 1113, Guilford	31/B-7	17-(4)	08/88	81/8	7.25/6.41	Fair
			08/87	90/17	7.00/5.96	Fair
			08/86	87/13	7.07/6.26	Fair
			07/85	67/14	6.61/6.15	Fair
			08/83	11/0	8.42/-	Poor
Deep R nr Randleman, SR 1921, Guilford	G/B-8	17-(4)	07/90	73/12	7.20/6.36	Fair
			07/89	66/16	6.94/5.99	Fair
			08/88	78/11	7.29/6.17	Fair
			07/88	80/18	6.95/6.15	Good-Fair
			08/87	78/16	6.92/6.32	Fair
			07/87	-/8	-/6.57	Fair
			08/86	56/10	7.67/6.70	Fair
			08/85	64/11	7.68/6.51	Fair
			08/84	39/7	7.36/6.46	Fair
			08/83	56/9	7.86/6.39	Poor
Deep R, Randleman, US 220 Bus, Randolph	32/B-9	17-(4)	07/93	74/20	6.01/5.24	Good-Fair
			08/88	63/12	6.57/6.06	Fair
			08/87	81/17	6.60/5.91	Fair
			08/86	74/10	7.08/5.93	Fair
			08/85	56/9	7.68/6.29	Poor
			08/83	60/9	7.14/6.15	Fair
Richland Cr, ab WWTP, Guilford	-/B-10	17-7	08/88	56/10	7.30/6.41	Fair
Richland Cr, SR 1145,be WWTP, Guilford	33/B-11	17-7	07/93	53/13	7.02/6.35	Fair
			08/88	62/9	7.62/6.47	Poor
			08/87	61/9	7.70/6.49	Poor
			08/86	40/2	8.19/6.58	Poor
			07/85	30/5	8.37/6.71	Poor
			08/83	47/9	7.50/6.63	Fair
Hickory Cr, SR 1131, Guilford	-/B-12	17-8-3	02/93	-/18	-/3.30	Fair
Muddy Cr, SR 1929, Randolph	-/B-13	17-9	02/93	-/22	-/4.71	Good-Fair

CPF 09

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Deep R, SR 2122, at Worthville, Randolph	34/B-1	17-(4)	8/88	74/10	7.22/5.93	Fair
			8/87	57/9	7.14/5.82	Fair
			8/86	66/10	7.92/6.40	Fair
			7/85	47/5	8.21/6.80	Poor
			8/83	46/3	8.20/6.72	Poor
Deep R, SR 2226, at Cedar Falls, Randolph	35/B-2	17-(4)	8/88	61/16	6.25/5.10	Good-Fair
			8/87	70/17	6.82/5.69	Fair
			8/86	61/12	6.82/5.95	Fair
			7/85	65/9	7.68/6.19	Poor
			8/83	50/5	7.83/6.77	Poor
Deep R, SR 2615, at Ramseur, Randolph	H/B-3	17-(4)	7/93	67/17	6.14/5.13	Good-Fair
			7/89	73/18	5.96/5.24	Good-Fair
			8/87	78/23	6.16/4.81	Good-Fair
			8/86	75/21	6.40/5.06	Good-Fair
			7/85	74/13	6.85/5.71	Fair
			8/83	62/15	7.08/5.64	Fair
Deep R, SR 2628, at Coleridge, Randolph	36/B-4	17-(4)	8/86	89/26	6.68/5.28	Good-Fair
			8/85	104/35	5.68/4.38	Excellent
			8/83	71/19	6.87/5.60	Good-Fair

Table 4.7 Continued

Subbasin 09 (continued)

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Deep R, SR 1456, nr Jugtown, Moore	37/B-5	17-(4)	7/93	80/32	4.94/4.07	Excellent
			8/88	96/34	4.98/3.97	Excellent
			8/87	111/38	5.02/4.13	Excellent
			8/86	87/32	4.90/3.70	Excellent
			8/85	99/33	5.13/4.11	Excellent
			8/83	94/33	5.14/4.05	Excellent
Polecat Cr, NC 220 Bus, Guilford	123/B-6	17-11-(1)	7/90	78/21	5.73/5.27	Good
Polecat Cr, SR 2113, Randolph	38/B-7	17-11-(1)	2/93	-/32	-/4.31	Good
Polecat Cr, SR 2116, Randolph	38/B-8	17-11-(1)	7/93	-/9	-/4.94	NR
			8/83	77/22	6.17/5.46	Good-Fair
UT Polecat Cr, nr SR 3430, Guilford	122/B-9	17-11-2-(2)	7/90	33/1	8.91/7.41	Poor
L Polecat Cr, SR 2108, Randolph	39/B-10	17-11-3	2/93	83/32	4.56/3.43	Excellent
L Polecat Cr, SR 2113, Randolph	39/B-11	17-11-3	8/86	91/20	5.14/4.21	Good
Hasketts Cr, SR 2149, Randolph	67/B-12	17-12	2/87	56/12	7.02/5.45	Fair
Hasketts Cr, be SR 2149, Randolph	88/B-13	17-12	2/90	58/10	7.20/6.55	Fair
			8/88	66/12	7.73/6.60	Fair
Hasketts Cr, SR 2128, Randolph	68/B-14	17-12	2/90	42/9	7.48/5.47	Fair
			8/88	35/4	7.90/6.84	Poor
			8/87	33/3	7.91/5.84	Poor
			2/87	29/3	8.36/5.81	Poor
Sandy Cr, SR 2261, Randolph	91/B-15	17-16-(1)	5/89	81/19	6.45/4.38	Good-Fair
			5/88	69/15	6.10/5.24	Good-Fair
Sandy Cr, SR 2481, Randolph	92/B-16	17-16-(1)	7/93	-/22	-/4.06	Good
			2/93	-/27	-/3.28	Good
			5/89	83/25	5.32/4.39	Good
			5/88	94/32	5.36/3.98	Good
UT Sandy Cr, SR 2261, Randolph	93/B-17	17-16-(1)	5/89	80/22	5.53/4.31	Good
			5/88	76/17	6.16/4.83	Good-Fair
Mount Pleasant Cr, SR 2442, Randolph	94/B-18	17-16-3	5/89	80/22	4.91/4.03	Good
			5/88	81/27	5.28/3.90	Good
Brush Cr, SR 1102, Chatham	119/B-19	17-23	5/90	-/26	-/4.89	Good
Brush Cr, NC 22, Randolph	42/B-20	17-23	2/93	-/23	-/3.58	Good-Fair
			5/90	-/28	-/4.24	Excellent
			8/83	95/26	6.00/4.32	Good
UT Little Brush Cr, SR 1100, Chatham	118/B-21	17-23-2	5/90	-/23	-/5.01	Good
UT Little Brush Cr, SR 1005, Randolph	117/B-22	17-23-2	5/90	-/17	-/4.15	Good-Fair
Richland Cr, SR 2873, Randolph	-/B-23	17-22	7/93	-/26	-/3.88	Good
			2/93	-/23	-/3.60	Good/Fair
Flat Cr, SR 2886, Randolph	-/B-24	17-24	2/93	-/17	-/5.07	Fair
Fork Cr, SR 2873, Randolph	-/B-25	17-25	2/93	-/22	-/3.37	Good/Fair

CPF 10

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Deep R, NC 22, Moore	-/B-1	17-(25.7)	07/89	69/24	5.45/4.68	Good
Wolf Cr, SR 1403, Moore	45/B-2	17-26-4	07/88	-/17	-/5.55	Good-Fair
			02/84	91/30	5.37/3.77	Good
Cabin Cr, SR 1400, Moore	-/B-3	17-26-5-(1)	02/93	-/27	-/3.62	Good
			09/92	-/14	-/4.50	NR
Cabin Cr, private rd off SR 1002, Moore	-/B-4	17-26-5-(1)	09/92	61/11	6.37/3.72	Good-Fair
Cabin Cr, SR 1275, Moore	-/B-5	17-26-5-(1)	09/92	91/27	5.49/3.74	Good
Cotton Cr, SR 1372, Montgomery	43/B-6	17-26-5-3	09/92	35/4	6.03/4.19	Fair
			07/88	-/0	-/0	Poor
			02/84	18/2	8.79/6.53	Poor
Cotton Cr, SR 1370, Montgomery	44/B-7	17-26-5-3	09/92	42/7	6.59/5.32	Fair
			02/84	33/10	7.16/4.87	Fair
Mill Cr, nr SR 1275, Moore	-/B-8	17-26-5-4	08/93	69/22	5.19/3.68	Good
			02/93	97/39	4.10/2.90	Excellent
Wet Cr, NC 24, Moore	-/B-9	17-26-5-5	02/93	-/34	-/3.95	Good
Bear Cr, NC 705, Moore	-/B-10	17-26-(6)	08/93	73/22	6.27/4.98	Good-Fair

Table 4.7 Continued

CPF 10 (continued)

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Falls Cr, SR 1606, Moore	-/B-11	17-27	02/93	-/18	-/4.61	Fair
Buffalo Cr, NC 22, Moore	-/B-12	17-28	02/93	-/20	-/3.51	Good-Fair
McLendon Cr, SR 1210, Moore	46/B-13	17-30-(0.5)	11/84	84/28	5.33/4.27	Good
UT Suck Cr, off SR 1261, Moore	95/B-14	17-30-1-(1)	03/86	63/21	4.86/2.72	Good
			02/84	65/25	4.20/2.60	Good
McLendon Cr, SR 1628, Moore	-/B-15	17-30-(6)	08/93	61/8	6.74/5.15	Fair
			02/93	-/13	-/5.59	Fair
Big Governors Cr, SR 1625, Moore	-/B-16	17-32-(0.7)	02/93	40/10	6.13/4.48	Poor

CPF 11

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
UT Deep R, nr SR 2140, Chatham	71/B-1	17-(33.5)	09/87	64/13	6.52/5.27	Good-Fair
Indian Cr, SR 2306, Chatham	-/B-2	17-35	03/93	-/10	-/5.17	Poor
Deep R, SR 1007, Lee	69/B-3	17-(36.5)	08/93	74/25	5.69/4.84	Good
			09/87	99/32	5.67/4.23	Good
Little Pocket Cr, NC 42, Lee	-/B-4	11-37-4	02/93	-/16	-/5.04	Fair
Cedar Cr, SR 2142, Chatham	-/B-5	17-39	02/93	-/13	-/5.28	Fair
Big Buffalo Cr, SR 1403, Lee	-/B-6	17-40	08/93	-/4	-/6.19	Poor
			02/93	-/12	-/5.12	Fair
Georges Cr, SR 2142, Chatham	-/B-7	17-41	02/93	-/15	-/4.83	Fair
Deep R, US 15/501-NC 87, Lee	70/B-8	17-(41.5)	08/93	77/27	5.96/4.69	Good
			09/87	88/25	6.09/4.62	Good-Fair
Little Buffalo Cr, SR 1420, Lee	-/B-9	17-42	02/93	-/5	-/7.08	Poor

CPF 12

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Rocky R, US 64, Chatham	104/B-1	17-43-8	7/93	69/12	6.90/5.72	Fair
			8/89	57/16	6.62/5.60	Fair
Rocky R, SR 2170, Chatham	103/B-2	17-43-8	7/93	66/19	6.50/5.27	Good-Fair
			8/89	56/11	6.66/6.02	Fair
Rocky R, NC 902, Chatham	102/B-3	17-43-8	8/89	73/24	5.76/4.55	Good
Rocky R, US15/501, Chatham	124/B-4	17-43-8	7/93	85/30	5.34/4.06	Good
			7/90	98/30	5.43/4.37	Good
Loves Cr, ab WWTP nr SR 2203, Chath.	100/B-5	17-43-10	8/89	52/7	7.39/6.83	Fair
Loves Cr, be WWTP nr SR 2203, Chath.	101/B-6	17-43-10	8/89	27/2	8.32/6.61	Poor
Tick Cr, US 421, Chatham	47/B-7	17-43-13	7/93	-/5	-/6.57	NR
			8/85	80/19	6.53/5.39	Good-Fair
Landrum Cr, NC 902, Chatham	-/B-8	17-43-14	7/90	-/19	-/3.53	Good-Fair
Harlands Cr, NC 902, Chatham	-/B-9	17-43-15	7/90	-/16	-/3.78	Good-Fair
Bear Cr, SR 2333, Chatham	-/B-10	17-43-16	8/91	73/16	6.77/5.79	Fair
Bear Cr, SR 2189, Chatham	-/B-11	17-43-16	8/91	69/15	6.50/5.57	Fair
Bear Cr, SR 2155, Chatham	-/B-12	17-43-16	7/90	-/15	-/4.83	Good-Fair

Monitoring to measure improvements in water quality associated with management efforts in the Deep River has been ongoing. A review of chemical and biological information from 1983 to 1987 was included in the *Chemical and Biological Assessment of the Deep River 1983-1987 (DWQ report no. 88-01)*. Improvements in biological integrity noted at that time have remained fairly stable. Water quality of the upper Deep River area has become of particular interest to the public since local governments formed the Piedmont Triad Regional Water Authority (PTRWA) in 1986 with plans to construct Randleman Lake for a drinking water supply. Because of the intense interest in this area, two separate studies, one of the upper section of the Deep River[1], and one of the lower[2] were undertaken to measure existing water quality in the river and its tributaries.

[1]NCDEM. September, 1994. Water Quality Monitoring Data for Waters in the Upper Deep River Area:July 28, 1992-October 7, 1993.

[2]NCDEM. September, 1994. Review of Deep River/Carbonton Water Quality Investigations: 1992/1993.

As part of the study of the upper Deep River, fourteen monthly sampling events were conducted at nine different locations from July, 1992 to October, 1993. Five coliform only sampling collections were conducted at eleven locations during the month of June, 1993.

Individual fecal coliform concentrations exceeding 200/100 ml were found at all stations during this evaluation. Five sampling runs for fecal coliform were performed with in a 30 day period of time during June of 1993. The fecal coliform water quality standard of 200/100ml was violated at four of eleven locations, Muddy Creek at SR 1936 (224/100 ml), the Deep River at Highway 220 Bypass (229/100 ml), Muddy Creek at SR1922 (288/100 ml), and at Muddy Creek at SR 1941 (851/100 ml). A suspected source of these high bacteria levels was a dairy located upstream on Muddy Creek. However, additional sampling performed on Muddy Creek upstream of the dairy at SR 1922 and at SR 1941 failed to confirm it as the primary cause of the high bacteria levels.

Metals concentrations higher than action levels for copper, zinc, and iron were found in the Upper Deep River. The High Point Eastside WWTP appears to be a contributing source of copper since all samples but one with concentrations greater than 7 µg/l were found downstream of the High Point Eastside WWTP (31 observations of Copper exceeded 7µg/l) though the county landfill and Seaboard Chemical company are also in this area and drainage. Significant color concerns have been reported and observed downstream of the High Point Eastside WWTP.

Three dissolved oxygen observations less than or equal to the water quality standard of 4.0 mg/l were found in the data collected. Two of these low dissolved oxygen values were found on the Deep River above the confluence of Richland Creek at I-85 upstream from the potential influence of the High Point Eastside WWTP.

Phenols values above laboratory detection levels were found at all stations in the upper Deep River study area. Pesticides and organics were found in the data collected from the Upper Deep River study area. Violations of the water quality standard for lindane and dieldrin were found. The source of the Lindane appears to be the High Point Eastside WWTP as most of the violations were found immediately downstream. The City of High Point suspects the residential use of flea dip and shampoo containing lindane as the source of these elevated lindane levels. Numerous unidentified peaks suggested the presence of many organic chemicals. Unidentified peaks are indications of organic compounds but chemical specific confirmation and identification was not possible. During this entire study 87 samples were collected for pesticides and organics analyses. Laboratory analysis of these samples indicated as many as 1,376 unidentified peaks. Richland Creek below the High Point WWTP discharge (14 samples) had as many as 643 unidentified peaks. While Richland Creek above the Highpoint WWTP discharge (14 samples) had 41 unidentified peaks.

Elevated nutrient levels were measured throughout the study area. The lowest concentrations of nutrients were observed on Richland Creek upstream of the waste water discharge from the High Point Eastside facility. The High Point Eastside WWTP is a significant contributing source of the observed elevated nutrient levels as all nutrient parameters were generally found in higher amounts at stations downstream of the WWTP. Algal growth potential tests performed on samples collected in Muddy Creek and in the Deep River indicated that these waters have the potential for significant problems from algal response to nutrients if sufficient retention time and sunlight were available.

Studies during 1993 on the lower section of the Deep River were designed to characterize water quality in the Carbonton impoundment and to determine the relationship between the impoundment and low dissolved oxygen (D.O.) levels that have been detected downstream in the Sanford area. Low D.O. levels have been reported annually during summer months by the City of Sanford's wastewater treatment facility, located 14.7 miles downstream from the impoundment. Self-monitoring data, provided by the Sanford wastewater treatment facility, has indicated frequently occurring low D.O. values in the Deep River at their upstream monitoring station, SR 1400 near Cumnock. The reported low D.O. levels are often below the water quality standards established

for instantaneous surface readings for class "C" surface waters (< 4.0 mg/l). Water quality conditions, as indicated by low background D.O. levels in the receiving waters, makes it difficult for the Sanford facility to maintain acceptable water quality downstream from their wastewater discharge.

Results from the lower Deep River studies indicate that water quality in the study reach, including the Carbonton impoundment, is severely impacted by nutrient loading from upstream sources (EHNR, 1994a). Although non-point source input and an array of NPDES point-source dischargers contribute to nutrient loading in the Deep River, data from the 1993 sampling implicate Richland Creek, receiving waters for High Point Eastside WWTP, as a significant contributor of point-source nutrients to the Deep River . The elevated nutrient levels in the upper Deep River originate from the High Point Eastside facility and these concentrations tended to decrease moving downstream to the lower portions of the River . A small increase in nutrient levels was detected in the area between Hwy 64 (station 13) and Hwy 22 (station DR1) during the 9/93 Deep River/Carbonton sampling event, and to a lesser extent, this observation was also detected in ambient monitoring data. The nutrient concentration increase noted in this area was the subject of a special intensive monitoring effort conducted during September 1994. This additional monitoring was used to assist in determining the quantitative importance of the Highpoint WWTP discharge to the total nutrient load of the Deep River and was used in recommending the nutrient waste limits for dischargers in the upper Deep River in Chapter 6.

The water quality issues in the Deep River are further complicated by a series of dams (impoundments) which reduce velocity (time-of-travel) by pooling water upstream from each dam, especially during low-flow conditions when in-stream waste concentrations are at the highest percentage and warm temperatures contribute to biological productivity (See Figure 6.5 in Chapter 6). The increased retention time provided by these dams allow utilization of nutrients by aquatic plants (algae) resulting in excessive chlorophyll *a* and major changes in D.O. There are approximately thirteen dams in the Deep River downstream from Richland Creek, prior to the confluence with the Haw River. Time-of-travel (dye) studies conducted by DWQ in the mid 1980's indicate that during low-flow (summer) conditions, time-of-travel for the slow-moving nutrient enriched waters to move from the upper Deep River (High Point area) downstream to the Cape Fear River would be measured in months.

Water quality in the Carbonton impoundment, and possibly in other Deep River impoundments, is further compromised by stratification periodically occurring with hypoxic conditions existing in the bottom waters. Carbonton impoundment data from 1993 also suggest that during the summer, periodic flushing of hypoxic waters from the stratified impoundment occurs during occasional high flow (storm) events. When this stratification is broken, nutrient rich bottom waters are released back into the system.

In addition to the 1993 Deep River/Carbonton evaluation, ambient monitoring data (DWQ) and data from an extensive water quality study conducted on the upper Deep River (DWQ) also implicate Richland Creek and the High Point Eastside WWTP as a major source of nutrients entering the Deep River (EHNR, 1994b). Data collected during a 1992/93 upper Deep River study confirm the elevated nutrient problems detected during the Deep River/Carbonton studies.

Results from the 1992/93 Deep River/Carbonton water quality investigations clearly indicate a need for the reduction in current point source nutrient inputs, especially from the High Point Eastside wastewater treatment facility. Although water quality modeling of the Deep River is complicated due to the series of dams that influence the hydrology of the system, DWQ is recommending that appropriate nutrient limitations be placed on High Point Eastside wastewater treatment facility and other upstream dischargers as noted in Section 6.4.3 in Chapter 6.

Deep River Tributaries

Major tributary streams in the upper Deep River watershed have received either a Good-Fair rating from both macroinvertebrate and fish samples (Muddy Creek), or were rated Fair using benthos data (Richland Creek and Hickory Creek). High Point Eastside WWTP is permitted to discharge 16 MGD to Richland Creek, just above its confluence with the Deep River. The Richland Creek site improved from Poor in 1985-1988 to Fair in 1993. Further improvement will be limited by upstream problems. Chemical monitoring has shown high conductivity, high nutrients and frequent records for copper and zinc above NC Action Levels. Much of this area lies within the Carolina Slate Belt ecoregion and small tributary catchments have a tendency to go dry, or pool up, during summer low flow conditions. Polecat Creek and Little Polecat are tributaries near Randleman and the most recent benthos data has shown Good or Excellent water quality. Little Polecat Creek has been reclassified an HQW. Hasketts Creek is the next major downstream tributary. An ambient site below the Asheboro WWTP has shown very high summer median nutrient concentrations and conductivity values. Toxicity compliance records indicate that while the Asheboro facility is passing most of their chronic tests, exceptions have been noted during the first quarter of 1994.

Benthos surveys conducted in tributary catchments from Ramseur to Moore County have found Good bioclassifications at Sandy and Richland Creek, Good-Fair ratings for Brush Creek and Fork Creek and Fair water quality at Flat Creek. A fish community structure sample from Sandy Creek also gave a Good ecological health rating.

Water quality in upper Cotton Creek is impacted by the discharge from the Star WWTP (0.6 MGD). While there is still a clear impact to Cotton Creek below the Star WWTP discharge (at SR 1372), the bioclassification has improved from Poor to Fair according to the most recent macroinvertebrate data. The effects of the WWTP discharge extend the length of Cotton Creek and are evident in Cabin Creek below the Cotton Creek confluence. The bioclassification in Cabin Creek improves to Good at the Mill Creek confluence. Many of the small streams in this area have Good-Fair or better bioclassifications, including Wolf Creek, Mill Creek, Wet Creek, Bear Creek, and an unnamed tributary to Suck Creek. Big Governors Creek, Falls Creek, and portions of McLendon Creek, have Poor to Fair bioclassifications.

Fish community structure analyses have been conducted on Bear Creek, Richland Creek (the most downstream of three Richland Creeks on the Deep River), Cedar Creek and Big Buffalo Creek. Bear Creek was rated as having Good-Excellent ecological health. Cedar Creek and Big Buffalo Creek had Good ecological health ratings, while Richland Creek had a Fair ecological health rating. The Cedar Creek rating may be inflated because of the site's proximity to the Deep River. Big Buffalo and Little Buffalo Creeks receive urban runoff from the Sanford area and both were assigned Poor benthos bioclassifications. Cedar Creek, Georges Creek, Indian Creek, and Little Pocket Creek drain agricultural areas and all were assigned Fair or Poor benthos bioclassifications.

Two impoundments, High Point Lake and Oak Hollow Lake in the upper watershed, have been evaluated as eutrophic or mesotrophic. Algal blooms have been reported from both lakes, principally due to small cyanophytes. Further down, Sandy Creek Reservoir is currently considered as threatened due to elevated nutrients and elevated dissolved oxygen. Carthage City Lake is oligotrophic, but is considered as support threatened due to aquatic weed infestation.

Rocky River

The Rocky River, a major tributary of the Deep River, is approximately 35 river miles in length. It is located mainly within Chatham County. Land use within its watershed is primarily agriculture and dairy production. This watershed is also in the Carolina Slate Belt ecoregion. Such streams are more resistant to land disturbing activities because erosion from slate belt soils put less sediment into streams than other piedmont areas. Siler City is the only urban area.

Bioclassifications from monitoring locations on the mainstem of the Rocky River have indicated that upstream reaches are generally Fair (Rocky River at US 64) or Good-Fair (Rocky River at SR 2170) and that bioclassifications improve downstream. Data from the most downstream monitoring location at US 15-501, near the confluence with the Deep River, have consistently indicated Good bioclassifications. All the benthic macroinvertebrate information collected from the Rocky River has been collected during summer, low-flow conditions. The downstream improvement in bioclassification is a likely response to increased flow and habitat diversity, rather than to any improvements in water quality although the site at SR 2170 improved from a Fair rating in 1989, to Good-Fair in 1993. It is located several miles below Loves Creek and the Siler City WWTP discharge. Ambient water quality data from the Rocky River at US 15-501 indicate good water quality with very few excesses of North Carolina water quality criteria.

Several freshwater mussel species have been collected from the Rocky River, which are proposed for state protection and Threatened North Carolina protection status. In addition, the Cape Fear Shiner (Notropus mekistocholas), a federally listed endangered fish species, has been reported from several sites in the Rocky River drainage. A reach of several miles of the lower Rocky River has been designated Critical Habitat for the Cape Fear Shiner by the US Fish and Wildlife Service.

Surveys on tributaries of the Rocky River have been conducted to assess the effects of the Siler City WWTP (Loves Creek), and Hill Forest Rest Home (Bear Creek). Poor water quality was assigned to Loves Creek in 1989 below the Siler City WWTP and, in addition, the effects of the discharge were noted in the Rocky River approximately 3 miles below the confluence with Loves Creek. The wastewater treatment plant has been upgraded since that time. No effects of the Hill Forest Rest Home were noted on the benthos of Bear Creek. Several tributaries were sampled as part of an ORW investigation of the lower Rocky River (Landrum, Harlands, and Bear Creek). Data collected during this latter investigation failed to determine Excellent water quality, therefore, a reclassification was not conducted. A single fish community structure sample was collected from Tick Creek. This site was given a Good ecological health rating.

Rocky River Reservoir is currently considered as hypereutrophic and threatened due to elevated nutrients.

4.3.3 Upper Cape Fear Watershed (Subbasins 07, 13, 14 and 15)

Cape Fear River Drainage - Mainstem and Minor Tributaries

The mainstem Cape Fear River originates near the fall line and then flows 170 miles through the Coastal Plain to Wilmington, with an average fall of 0.94 feet per mile. Stream gradient is higher down to Fayetteville, where it begins to flatten out. The flat terrain of the coastal plain results in many swamp systems, but the main river is not a typical swamp stream. The drainage area of the mainstem Cape Fear River is about 6,065 square miles. At its mouth the Cape Fear empties directly into the Atlantic Ocean and much of this estuarine area has salinities high enough for the waters to be classified as shellfish waters (SA).

The Cape Fear River mainstem is a complex system which can be divided into three distinct segments: from the confluence of the Haw and Deep Rivers to Lock & Dam 3 (subbasins 07 and 15); from Lock & Dam 3 to Lock & Dam 1 (subbasin 16); and from Lock & Dam 1 to the ocean (subbasin 17). From the Deep River to Erwin, there is significant slope to the river and the dissolved oxygen standard for fresh water is met. Below Erwin, the river becomes flat and there is limited reaeration. In addition, the river receives significant point and nonpoint source loading with cumulative impacts to the river. Special studies and facility self-monitoring data have shown low DO concentrations upstream of Lock & Dam 3 with violations of the DO standard occurring under summer conditions.

Water quality and biological monitoring locations for these subbasins are shown in Figure 4.9 Benthos ratings for the Cape Fear River at Lillington have been consistently Good since 1983. Other streams in the upper Cape Fear watershed have been rated Good (UT Kenneth Creek) or Fair (Neills Creek and Kenneth Creek). Parkers Creek, Avent Creek, and Hector Creek, in the Raven Rock State Park area are currently classified as HQW. The only Poor water quality indicated by macroinvertebrates in this area was for Kenneth Creek at a location below the Fuquay-Varina WWTP (1.2 MGD) in 1990.

Fish community structure analyses have been conducted for four streams in this area: Hector Creek, Kenneth Creek, unnamed tributary to Gulf Creek, and two locations on Gulf Creek. The fish community data indicated Poor to Fair ecological health ratings for these streams. These ratings were generally lower than those suggested by the macroinvertebrate data for the same locations.

Upper Moccasin Lake, outside Sanford, has a high NCTSI score and is considered highly eutrophic and is listed as support threatened. Lower Moccasin Lake, directly below Upper Moccasin Lake, is also eutrophic but supports its designated use. Harris Lake, a 4,150 acre impoundment owned by Carolina Power and Light, has a lower NCTSI score than the other lakes and is considered mesotrophic. Harris Lake fully supports its designated uses. In addition, it contains an extremely diverse array of aquatic macrophytes, with 58 species of aquatic plants identified from it.

An Excellent bioclassification was assigned to the section of the Cape Fear River near Erwin in 1993. At the Cape Fear River at NC 24 in Fayetteville, fecal coliforms were above the state criteria 4 times from 1992-1993. Iron levels at this site were above the action level 9 of 16 times during this same time period; although, iron is frequently found in excess of action level criteria due to their association with clay soils. Benthos data from the Cape Fear River near Fayetteville have generally indicated Good water quality. Cross Creek was given a Fair bioclassification.

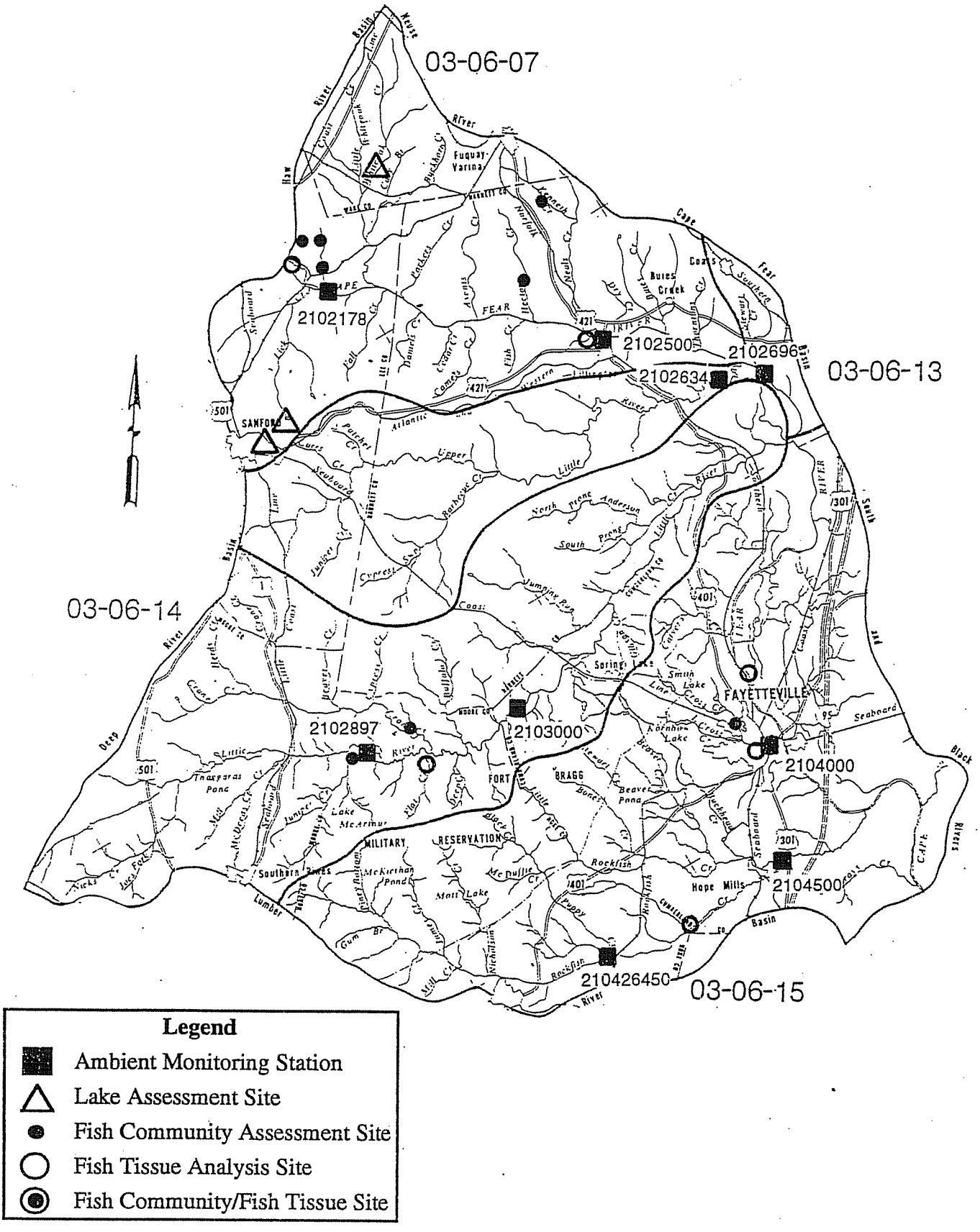


Figure 4.9 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sampling Stations in the Upper Cape Fear River Watershed Area (Subbasins 07, 13, 14 and 15)

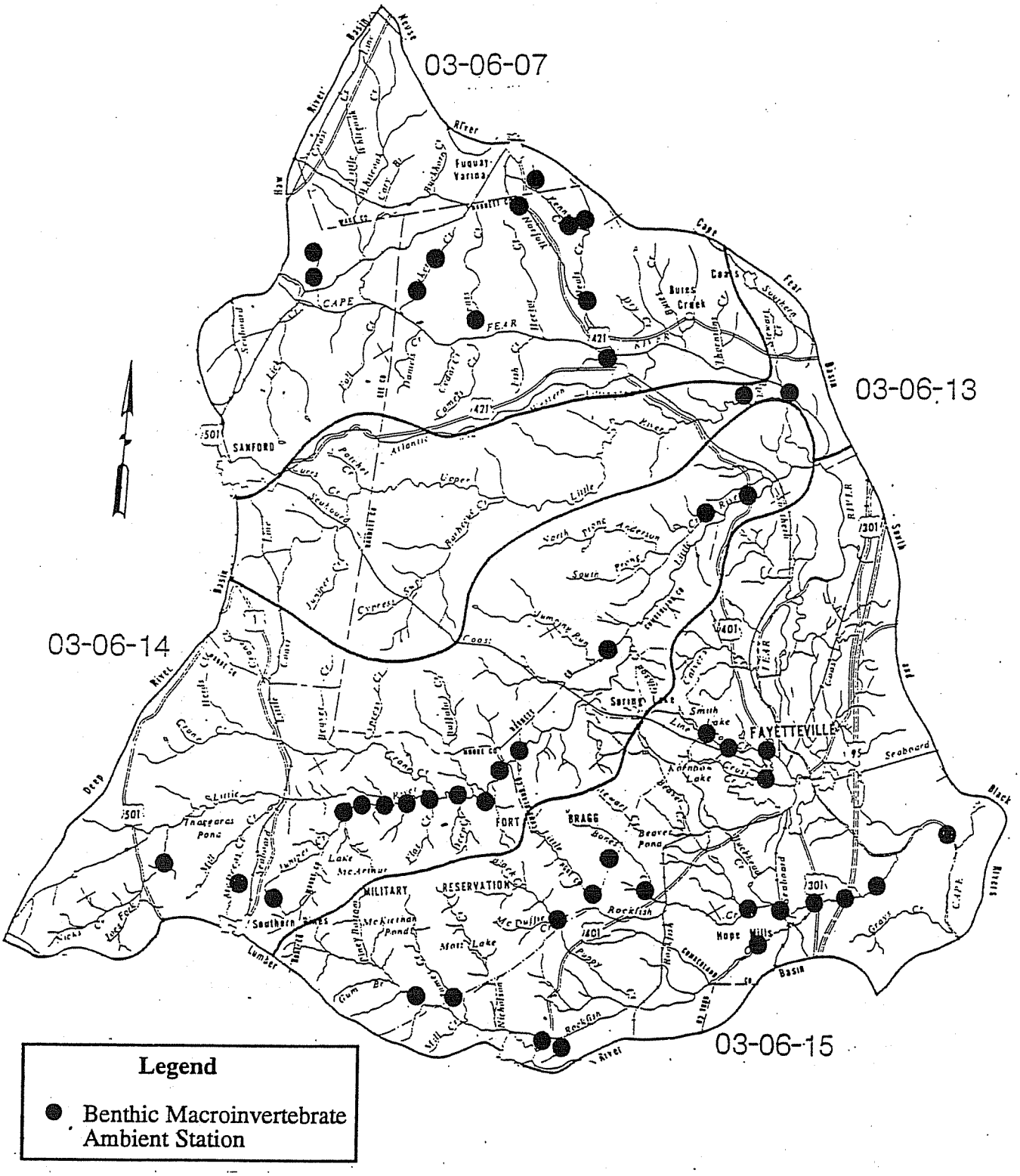


Figure 4. 10 Benthic Macroinvertebrate Monitoring Stations in the Upper Cape Fear River Watershed Area (Subbasins 07, 13, 14 and 15)

Table 4.8 Benthic Macroinvertebrate Sampling Sites and Data Summary for the Upper Cape River Watershed (83-93)

Subbasin 07

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Gulf Cr, nr SR 1924, Chatham	-/B-1	18-5-(1)	04/93	34/6	6.64-5.38	NR
UT Gulf Cr, nr SR 1924, Chatham	-/B-2	18-5-(1)	04/93	19/4	6.62-4.49	NR
Parkers Cr, SR 1450, Harnett	-/B-3	18-9	08/93	83/25	5.35-4.30	Good
			03/93	-/27	-/4.03	Good
Parkers Cr, off SR 1418, Harnett	96/B-4	18-9	11/88	-/28	-/3.42	Excellent
Avent Cr, SR 1418, Harnett	97/B-5	18-13	11/88	-/25	-/3.92	Excellent
Hector Cr, SR 1412, Harnett	98/B-6	18-15	11/88	100/29	5.19/3.90	Excellent
Neills (Neals) Cr, SR 1441, Harnett	-/B-7	18-16-(0.7)	03/93	-/18	-/4.65	Fair
Neills (Neals) Cr, SR 1403, Harnett	99/B-8	18-16-(0.7)	11/88	-/16	-/4.25	Good-Fair
Kenneth Cr, nr SR 2772, be F-V, Wake	120/B-9	18-16-1-(2)	09/90	47/3	7.53/6.50	Poor
Kenneth Cr, SR 1441,Harnett	-/B-10	18-16-1-(2)	03/93	43/7	6.18/5.29	Fair
UT Kenneth Cr, off SR 1447, Harnett	-/B-11	18-16-1-(2)	08/81	50/15	4.10/2.69	Good
Cape Fear R, Lillington, NC 401, Harnett	F/B-12	18-(16.7)	07/93	78/30	5.76/4.72	Good
			09/90	107/36	6.05/4.65	Good
			07/88	93/30	5.88/4.63	Good
			07/86	89/29	6.07/4.78	Good
			08/85	91/29	6.14/4.88	Good
			09/84	94/25	5.95/4.81	Good-Fair
			07/83	72/30	5.18/4.37	Good

CPF 13

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Juniper Cr, SR 1144, Lee	142/B-1	18-20-6-(1)	11/88	-/9	-/4.19	Fair
Upper Little R, SR 1222, Harnett	141/B-2	18-20-(8)	08/93	56/13	6.17/4.83	Good-Fair
			12/88	77/19	6.02/4.16	Good-Fair
Upper Little R, NC 27, Harnett	-/B-3	18-20-(8)	08/93	81/26	5.51/3.95	Good
Barbeque Swp, SR 1209, Harnett	143/B-4	18-20-13	08/93	-/14	-/3.61	Good-Fair
			11/88	-/19	-/4.09	Good-Fair
Upper Little R, nr SR 2016 ab Becker, Harn.	-/B-5	18-20-(23.5)	07/91	-/23	-/3.89	Good
Upper Little R, nr SR 2016 be Becker, Harn.	-/B-6	18-20-(23.5)	07/91	-/17	-/3.00	Good-Fair
Upper Little R nr Erwin, SR 2021, Harnett	R/B-7	18-20-(23.5)	08/93	67/25	5.33/3.90	Good
			07/91	-/25	-/3.44	Good
			07/88	83/27	5.22/3.72	Good
Cape Fear R, NC 217, Harnett	-/B-8	18-(20.7)	08/93	70/31	4.97/4.27	Excellent

Subbasin 14

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Nicks Cr, NC22, Moore	144/B-1	18-23-3-(3)	8/93	-/20	-/3.22	Good-Fair
			11/88	-/22	-/2.99	Good
Lower Little R, SR 2023, Moore	133/B-2	18-23-(10.7)	8/93	70/33	4.46/3.33	Excellent
			4/90	-/35	-/3.94	Excellent
			12/88	85/35	4.60/2.63	Excellent
UT Mill Cr, nr Weymouth Springs, Moore	/B-3	18-23-11-(5)	3/86	49/11	5.31/2.99	Good
			2/84	55/16	4.66/2.67	Good
UT McDeeds Cr, bel HB/PS, Moore	B-4	18-23-11-4-1	7/93	15/0	8.46/0.00	NR
James Cr, nr SR 2023, Hoke	132/B-5	18-23-13	4/90	-/24	-/3.93	Good
James Cr, at Little River, Moore	132/B-6	18-23-13	11/88	-/22	-/2.75	Good
Horse Cr, Manchester Rd, Hoke	130/B-7	18-23-14	4/90	-/18	-/3.41	Good-Fair
Flat Cr, Manchester Rd, Hoke	48/B-8	18-23-15	4/90	-/21	-/3.52	Good
			12/84	74/24	5.18/4.05	Good
Mills Cr, Manchester Rd, Hoke	129/B-9	18-23-17-1	4/90	-/13	-/3.65	Good-Fair
UT in Sicily Drop Zone, Man. Rd, Hoke	128/B-10	18-23-17-(2)	4/90	-/2	-/2.37	Poor
Jumping Run Cr, Manchester Rd, Hoke	127/B-11	18-23-20	4/90	-/13	-/4.37	Good-Fair
McPherson Cr, Manchester Rd, Cumber.	126/B-12	18-23-23.7	4/90	-/12	-/4.70	Good-Fair

Table 4.8 Continued

CPF 14 (continued)

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Lower Little R, at Manchester, NC 87/24, Cumberland	I/B-13	18-23-(24)	8/93	64/18	5.49/4.48	Good
			7/90	73/19	6.04/4.57	Good-Fair
			7/88	50/7	7.22/5.23	Fair
			6/86	57/8	6.74/3.03	Fair
			9/84	81/25	5.34/3.73	Excellent
Lower Little R, US 401, Cumberland	-/B-14	18-23-(24)	8/93	70/26	4.93/3.58	Excellent
Jumping Run Cr, NC 210, Cumber	-/B-15	18-23-29	8/93	-/16	-/3.24	Good-Fair
Anderson Cr, SR 2031, Harnett	-/B-16	18-23-32	8/93	-/13	-/2.97	Fair

CPF 15

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Cape Fear R, ab Cross Cr, Cumberland	50/B-1	18-(26)	1/86	77/31	5.62/4.23	Good
Cape Fear R, be Cross Cr WWTP, Cumber.	51/B-2	18-(26)	1/86	84/25	6.12/3.94	Good-Fair
Cape Fear R, Person St, Cumberland	-/B-3	18-(26)	8/93	48/19	5.37/4.55	Good
Cape Fear R, be Monsanto, Cumberland	52/B-4	18-(26)	1/86	78/28	5.88/4.46	Good
Cross Cr, ab UT, Cumberland	134/B-5	18-27-(1)	4/90	-/7	-/5.04	Fair
Cross Cr, be UT, Cumberland	135/B-6	18-27-(1)	4/90	-/10	-/5.12	Fair
Cross Cr, NC 87/210, Cumberland	-/B-7	18-27-(3)	8/93	-/10	-/6.01	Fair
Little Cross Cr, ab lake, Cumberland	136/B-8	18-27-4-(1)	4/90	-/2	-/2.52	Poor
Rockfish Cr, Plank Rd, Hoke	140/B-9	18-31-(1)	4/90	-/16	-/3.78	Good-Fair
Juniper Cr, Plank Rd, Hoke	139/B-10	18-31-10	4/90	-/19	-/3.85	Good
Peddlars Br, NC 20, Hoke	148/B-11	18-31-16	2/90	36/2	8.51/-	Poor
Peddlars Br, US 401, Hoke	149/B-12	18-31-16	2/90	16/0	8.66/-	Poor
Puppy Cr, Plank Rd, Hoke	138/B-13	18-31-19	4/90	-/15	-/4.35	Good-Fair
Rockfish Cr, SR 1432, Hoke	145/B-14	18-31-(23)	8/93	61/25	4.71/3.48	Excellent
			6/90	-/16	-/4.24	Good-Fair
Rockfish Cr, SR 1115, Cumberland	146/B-15	18-31-(23)	6/90	-/17	-/4.53	Good-Fair
Rockfish Cr, US 301 Bus, Cumberland	49/B-16	18-31-(23)	7/83	60/25	5.01/4.06	Excellent
Rockfish Cr, I-95, Cumberland	S/B-17	18-31-(23)	6/90	-/24	-/4.16	Excellent
			7/88	77/31	5.17/4.13	Excellent
Rockfish Cr, NC 87, Cumberland	-/B-18	18-31-(23)	8/93	60/23	4.93/3.74	Excellent
Little Rockfish Cr, Plank Rd, Hoke	137/B-19	18-31-24-(1)	4/90	-/12	-/3.50	Good-Fair
Bones Cr Trib, nr SR 1400, Cumberland	106/B-20	18-31-24-2	1/89	44/17	6.95/5.23	Good-Fair
UT Bones Cr, be Sunset MHP, Cumberld	105/B-21	18-31-24-2	1/89	6/0	9.49/-	Poor
Little Rockfish Cr, NC 59, Cumberland	-/B-22	18-31-24-(4)	8/93	-/23	-/3.70	Good
Little Rockfish Cr, be lake, Cumberland	147/B-23	18-31-24-(7)	6/90	-/13	-/4.78	Good-Fair

Three lakes have been monitored in Bladen County: Salters Lake, Jones Lake, and White Lake. All of these are natural "Carolina Bay" lakes. Salters Lake and Jones Lake are located within state park or state forest lands and they are dystrophic systems characterized by naturally low pH (<4) and humic water. White Lake is more developed, but has been consistently classified as oligotrophic.

Both Jones Lake and White Lake have been extensively monitored as part of a study of minimally impacted lakes in North Carolina. Closer to the coast, Greenfield Lake and Boiling Springs Lake were sampled by DWQ in 1993. Greenfield Lake, near Wilmington, is classified as C SW and considered Not Supporting because of algal blooms, sedimentation and fish kills that have occurred in the lake. Boiling Springs Lake, near the Town of Boiling Springs, is classified as B SW and is considered supporting of all uses. Fish tissue samples from Boiling Springs Lake, however, detected mercury levels in bass that were close to the EPA screening limits.

Sandhills

The first major watershed in the sandhills is the Upper Little River. It has a drainage area of 220 square miles and enters the Cape Fear River below Lillington. Bioclassifications in this subbasin are generally Good-Fair or better based on macroinvertebrate data. The only exception to this

pattern is Juniper Creek, which was rated Fair. Another tributary to the Upper Little River, Barbeque Swamp, has a Good-Fair bioclassification. The bioclassification for the upper Upper Little River is Good-Fair just below the Lee/Harnett County line, but improves to Good at the NC 27 road crossing. Further downstream, the Upper Little River bioclassification recovers to Good before the stream's confluence with the Cape Fear River. There is one ambient water quality site on the Upper Little River near Erwin. Iron has been frequently measured here over the action level.

The Lower Little River watershed is much larger (500 square miles) and is largely rural, but lower reaches flow through or near Spring Lake and Fayetteville. Water quality in this watershed based on benthos data, ranges from Poor, for a small stream within the Fort Bragg Military Reservation, to Excellent in the upper portion of the Lower Little River. The Lower Little River from the headwaters to Crane Creek has been designated as High Quality Waters. The Lower Little River in this section received an Excellent benthos rating and a Good NCIBI (fish) rating. The remaining watershed has mostly Good-Fair or Good bioclassifications (Nicks Creek, James Creek, Horse Creek, Flat Creek, Mills Creek and Jumping Run Creek). The Lower Little River at Manchester has shown improvement from Fair in 1986 and 1988 to Good in 1993, though it was Excellent in 1984. The Fort Bragg WWTP, the largest discharger in this watershed (8MGD), completed a major upgrade in 1991, and discharges to the river above the Manchester site.

Ambient monitoring system data from two locations on the Lower Little River indicate generally high nutrient values and fecal coliform counts. Fecal coliform bacteria exceeded the NC criterion seven times (44%) at the Lower Little River at Manchester site. Additional study will be needed to identify the sources.

Old Town Reservoir was classified as an oligotrophic lake, all uses are being supported, and no violations of water quality were found. The lake currently has a surface water classification of WS-II NSW and is one of sixteen lakes, statewide, selected as representative of a minimally impacted lake by which other lakes in the same region can be compared.

Most benthos samples in the Rockfish Creek (confluence with the Cape Fear is below Fayetteville) and Little Rockfish Creek watersheds were assigned a bioclassification of Good or Good-Fair. Rockfish Creek below the Raeford WWTP improved from Good-Fair in 1990 to Excellent in 1993 after upgrades were made at the plant. Further downstream near Hope Mills, Rockfish Creek has been rated Excellent. (However, a 1994 special study that was conducted to assess Rockfish Creek for a potential reclassification to High Quality Waters did not find consistent Excellent ratings. Based on this work, the stream was not recommended for HQW reclassification.) Nonpoint problems are considered to be larger problems in this watershed than point sources. Causes of nonpoint pollution include urban runoff (Cross Creek) and sediment from Fort Bragg (Gum Branch, Puppy Creek). Point source discharges are mostly located in or near the Cape Fear River. Ambient water quality samples analyzed from Rockfish Creek indicate low pH distributions, high nutrient values and high coliform counts.

Bonnie Doone, Kornbow, Mintz Pond, and Glenville Lake are a series of impoundments of Little Cross Creek and serve as backup water supply sources for the City of Fayetteville. All are restricted to the public. Mott Lake and Hope Mills lake have also been monitored. Activities at Fort Bragg and the general soil type of the area have contributed to extreme sedimentation problems at Bonnie Doone Lake. Trophic states of these six lakes range from eutrophic (Bonnie Doone, Mintz Pond, Glenville Lake and Hope Mills Lake) to mesotrophic (Kornbow Lake) to dystrophic (Mott Lake). Glenville Lake and Hope Mills Lake are designated as Threatened due to the elevated nutrients found. Mintz Pond was designated Threatened due to the elevated nutrient and turbidity levels and low dissolved oxygen levels.

4.3.4 Black River Watershed (Subbasins 18, 19 and 20)

South and Black Rivers

Naming of the Black and South Rivers can cause confusion when discussing sampling sites and water quality information. The South River actually is called the Black River in its headwaters near Dunn, then becomes the South River until its confluence with the Black River, where the combined flow is named the Black River to its confluence with the Cape Fear River. These rivers have been described as among the most beautiful and least disturbed of North Carolina's coastal plain rivers. Both are slow moving, meandering, sandy bottomed, blackwater rivers, with extensive swampy floodplains dominated by bald cypress and gum trees. The South River has a drainage area of about 500 square miles, while the Black River drainage is much larger (1,560 square miles). The South River from Bladen County SR 1503 (approximately 2 miles downstream of the ambient location) to the Black River was designated High Quality Waters in 1990. The South River below Big Swamp was designated ORW in 1994.

Nonpoint runoff and/or channelization contribute to the Fair bioclassifications for the upper portions of the South (Black) River near Dunn. Much further downstream, an ambient site on the South River near Parkersburg has consistently been assigned an Excellent bioclassification since 1985, reflecting the sparsely settled catchment with very few point source dischargers. The median value for pH at this site from 1988 to 1993 was below the state standard of 6, a reflection of humic acid input from swamps. Fish tissue samples from two largemouth bass, collected in 1984 and 1987 from the ambient station, contained mercury levels slightly exceeding the EPA recommended screening value of 0.6 ppm. Tributary streams are often swampy and difficult to sample and evaluate. However, the fish community was sampled at Big Swamp and given a Good-Fair rating, which is typical for swamp systems with no flow during periods of the year. A South River fish community sample had excellent species diversity and received a rating of Good.

Bay Tree Lake, a Carolina Bay, is owned by the State of North Carolina. The lake is classified C-SW, is dystrophic, and fully supported all of its designated uses in 1993. In 1994, a fish consumption advisory was issued indicating that largemouth bass and bowfin taken from this lake should not be eaten. The advisory was issued after finding high mercury levels in fish tissue for those two fish species.

Great Coharie Creek and Six Runs Creek merge to form the Black River. Land adjacent to the Black River is primarily undisturbed forest and swamp and Clinton is the largest town in the watershed. The Black River from its source to the Cape Fear River, and Six Runs Creek below Cuwhiffle Swamp, were reclassified as ORW in 1994. The Black River from NC 411 to the South River had previously been designated HQW. These reclassifications were based on Excellent biological and physical/chemical data, as well as the river's recreational and ecological significance. An ambient site on the Black River (near Tomahawk) has consistently received an Excellent bioclassification, though high nutrient values have been found. Some small streams in this area have been affected by WWTPs, including Stewart's Creek below the Warsaw WWTP (Good-Fair). Most of the streams sampled in the watershed (Black River, Six Runs Creek, Great Coharie Creek and upstream sections of Little Coharie Creek) have received ratings of Excellent or Good. A downstream site on Little Coharie Creek declined from Good in 1989 to Good-Fair in 1993, based on benthos data. The fish communities sampled ranged from Poor-Fair ecological health ratings at the downstream Little Coharie site to Fair and Fair-Good on Great Coharie Creek. Other tributaries to the Black River have not been sampled because of their still, swamp-like nature. Singletary Lake, classified as B-SW, is used for swimming, boating, and fishing, and fully supports its designated uses.

Low dissolved oxygen levels during summer months are the only consistent water quality violation detected at another ambient monitoring station on the Black River near Huggins. Low dissolved

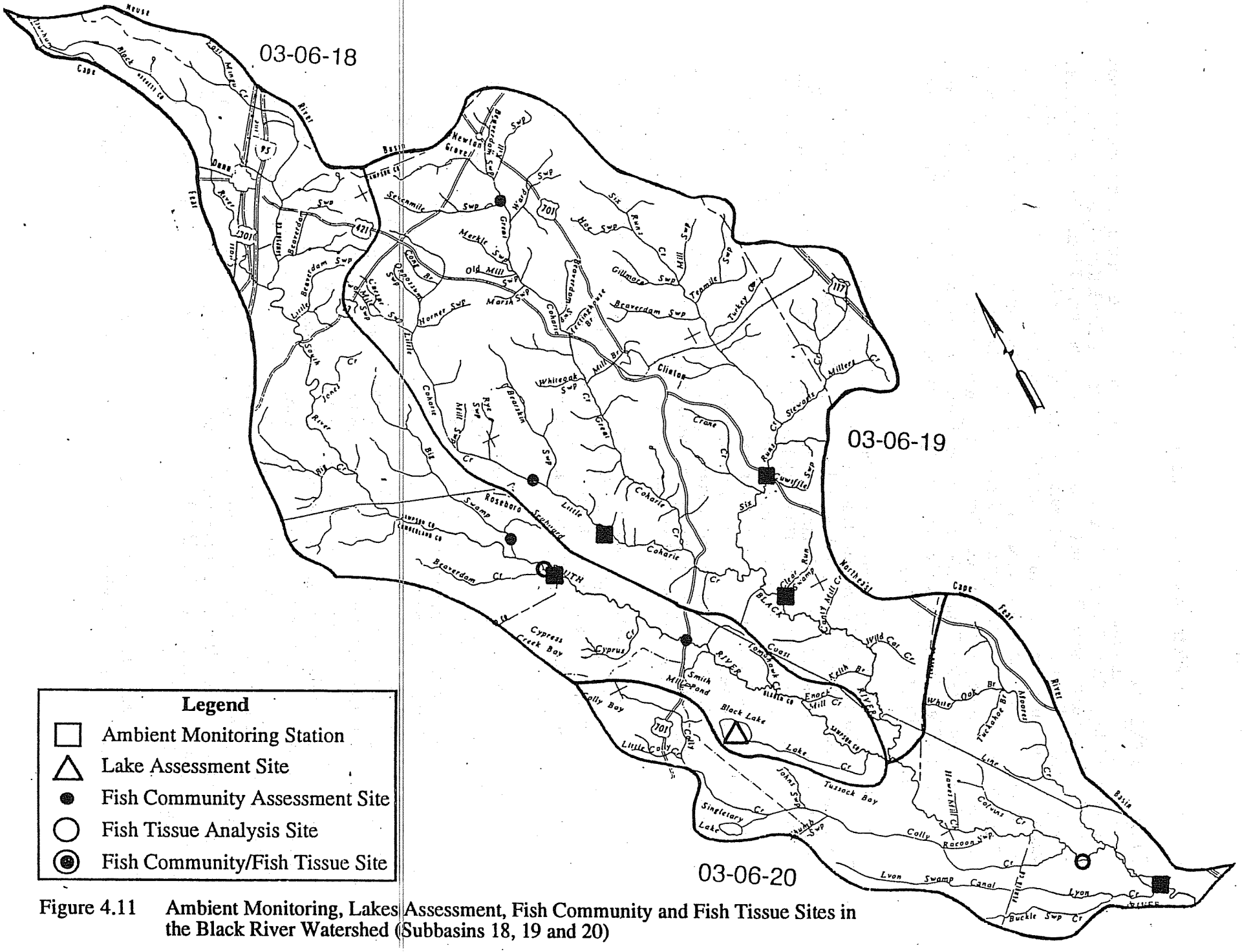


Figure 4.11 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sites in the Black River Watershed (Subbasins 18, 19 and 20)

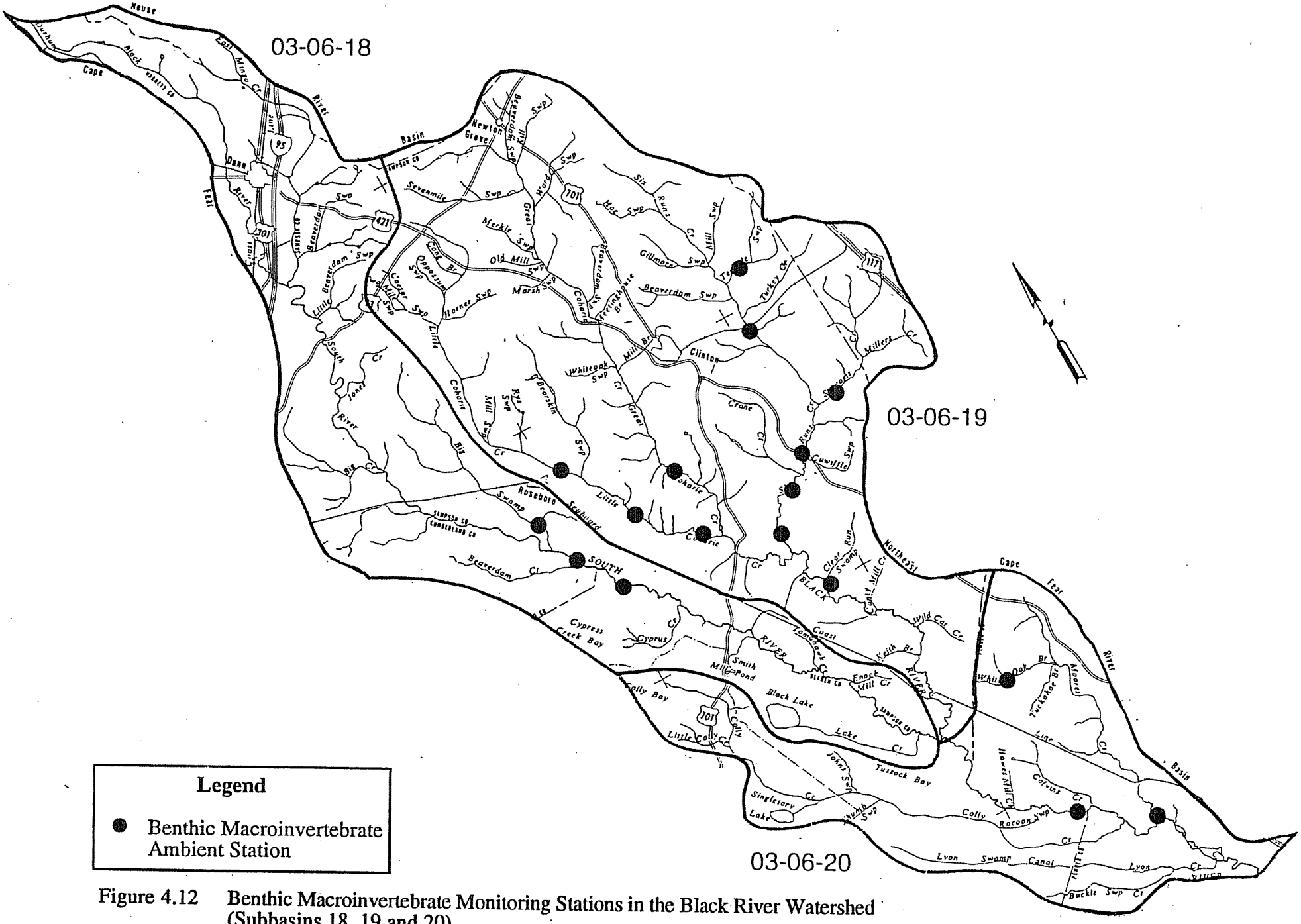


Figure 4.12 Benthic Macroinvertebrate Monitoring Stations in the Black River Watershed (Subbasins 18, 19 and 20)

Table 4.9 Benthic Macroinvertebrate Sampling Sites and Data Summary for the Black River Watershed (83-93)

Subbasin 18

Site	Old/New DWQ#	Index#	Date	S/EPTS	BI/BIEPT	Bioclass
South R, NC 13, Sampson	108/B-1	18-68-12(0.5)	10/89	-/5	-/5.78	Fair
South R, nr Parkersburg, NC 242, Sampson	-/B-2	18-68-12(0.5)	10/89	-/26	-/3.91	Excellent
South R, SR 1502, Bladen	K/B-3	18-68-12(0.5)	8/93	75/25	5.29/3.75	Excellent
			6/87	84/29	5.44/3.85	Excellent
			9/85	94/30	5.43/3.90	Excellent
			7/83	76/25	5.49/4.12	Good
Black R, NC 421, Harnett	107/B-4	18-68-12-1	10/89	-/11	-/5.47	Fair
Black R, nr Dunn, SR1780, Harnett	53/B-5	18-68-12-1	7/84	53/13	6.79/5.93	Fair
Big Swamp, SR1246, Sampson	109/B-6	18-68-12-8	12/89	-/14	-/5.38	Good-Fair

Subbasin 19

Site	Old/New DWQ#	Index#	Date	S/EPTS	BI/BIEPT	Bioclass
Great Coharie Cr, SR 1214, Sampson	55/B-1	18-68-1	8/93	77/26	5.49/4.35	Good
			10/89	-/19	-/4.53	Good
			9/88	69/20	5.89/4.47	Good
			7/83	62/19	5.53/3.66	Good
Little Coharie Cr, NC 24, Sampson	-/B-2	18-68-1-17	8/93	-/20	-/4.69	Good
Little Coharie Cr, SR 1214, Sampson	110/B-3	18-68-1-17	8/93	-/17	-/4.08	Good-Fair
			10/89	-/23	-/3.86	Good
Little Coharie Cr, SR 1207, Sampson	110/B-4	18-68-1-17	9/88	-/17	-/3.94	Good-Fair
Six Runs Cr, SR 1004, Sampson	112/B-5	18-68-2	12/89	-/21	-/3.78	Good
Six Runs Cr, SR 1960, Sampson	-/B-6	18-68-2	8/93	-/28	-/3.54	Excellent
Six Runs Cr, SR 1130, Sampson	111/B-7	18-68-2	10/89	-/26	-/3.39	Excellent
Six Runs Cr, SR 1003, Sampson	-/B-8	18-68-2	9/88	-/25	-/4.07	Excellent
Tenmile Swamp, SR 1740, Sampson	54/B-9	18-68-2-4	12/86	58/6	7.65/5.92	Fair
Stewarts Cr, SR 1943, Sampson	113/B-10	18-68-2-10	12/89	-/17	-/4.73	Good/Fair
Black R, nr Tomahawk, NC 411, Sampson	L/B-11	18-68(3.5)	8/93	96/31	5.47/3.90	Excellent
			10/89	-/31	-/3.67	Excellent
			7/88	107/37	5.51/4.25	Excellent
		9/85	94/30	5.33/4.01	Excellent	

Subbasin 20

Site	Old/New DWQ#	Index#	Date	S/EPTS	BI/BIEPT	Bioclass
Black R, 3 Sisters Area nr NC 11, Bladen	-/B-1	18-68-(11.5)	9/88	72/22	5.60/4.07	Good
Black R, nr Atkinson, NC 11, Bladen	M/B-2	18-68-(11.5)	8/93	73/28	5.47/4.15	Excellent
			9/91	100/28	5.76/4.16	Good
			8/90	48/18	6.19/4.67	Good-Fair
			10/89	-/28	-/3.89	Excellent
			6/86	78/23	6.18/4.71	Good
White Oak Br, SR 1209, Pender	77/B-3	18-68-18-5	12/87	-/7	-/5.01	Fair

oxygen during the summer is not unusual in a slow moving system such as this one. Though the Black River does continue to flow throughout the year, other large tributaries such as Colly Creek and Moores Creek have periods of no flow. Fish tissue samples from the Black River in 1986 did indicate elevated levels of mercury in some pickerel and bowfin.

4.3.5 Northeast Cape Fear Watershed (Subbasins 21, 22 and 23)

Northeast Cape Fear River

The last downstream major tributary of the Cape Fear River is the Northeast Cape Fear River, which originates near Mt. Olive in southern Wayne County and Duplin County. Its drainage area is about 1,750 square miles. Chemical monitoring of the Northeast Cape Fear below Mt. Olive shows a stream undergoing stress. Brine discharges from Mt. Olive Pickle Company elevate conductivity values. Nutrients also tended to be high at the ambient site. Median Total Phosphorus was almost 0.3 mg/l with several values in the 1.0 - 1.5 mg/l range. Since 1988, however, phosphorus levels each year have declined from the previous year. Metals were also higher here than anywhere else on the Northeast Cape Fear River.

Benthos data indicate Good-Fair water quality in Buck Marsh Branch, which may be typical of many tributaries to the Northeast Cape Fear River. Many of the streams in this watershed stop flowing during parts of the year so bioclassifications may indicate more impact than expected by the severity of anthropogenic disturbance. Poor water quality was found in Barlow Branch and upper portions of the Northeast Cape Fear River. This Poor water quality is due to brine discharges from Mt. Olive Pickle Company, although recent upgrades at Mt. Olive have significantly reduced both the severity and extent of the impacts. Recovery from the discharge now appears to be complete four miles downstream of Barlow Branch. Mt. Olive Pickle has been under an SOC since 1992.

Benthos data indicates Good to Excellent water quality in the middle portion of the Northeast Cape Fear River with the section of the river between Muddy Creek and Rockfish Creek classified as High Quality Waters. Most of the tributaries, Goshen Swamp, Stockinghead Creek and Rockfish Creek, are rated Fair or Good-Fair, usually due to nonpoint sources of pollution. In addition to nonpoint sources, water quality in Panther Branch and part of Goshen Swamp appears to be degraded by Charles F. Cates and Sons, though not nearly as badly as before upgrades, and Persimmon Branch appears to be impacted by the Beulaville WWTP. Cabin Creek was impacted by he House of Raeford chicken processing plant in 1987, and Rockfish Creek was shown to be impacted by Wallace WWTP and also possibly Stevecoknit Fabrics in 1993. Charles F. Cates and Sons and Stevecoknit are under SOCs.

Grove Creek was rated Good-Excellent, Limestone Creek was rated Good, Halls Marsh Run was rated Fair, and Herrings Marsh Run was rated Poor-Fair based on fish community samples.

Data from the most downstream ambient site, the Northeast Cape Fear River at US 117 at Castle Hayne, indicates all parameters fall within normal ranges of a tidally influenced freshwater system. Benthos data indicate Good-Fair water quality at this site. Many tributaries draining the Holly Shelter Game Refuge appear to be unimpacted, however, most of the streams outside the wildlife refuge are subject to nonpoint sources of pollution. Many of these streams stop flowing during parts of the year. Water quality in Burgaw Creek was reported to be degraded by the Burgaw WWTP discharge in 1987. Cypress Creek, a low diversity swamp stream, was given a Fair NCIBI rating and Burgaw Creek was given a Poor-Fair rating at two sites below the WWTP in 1985.

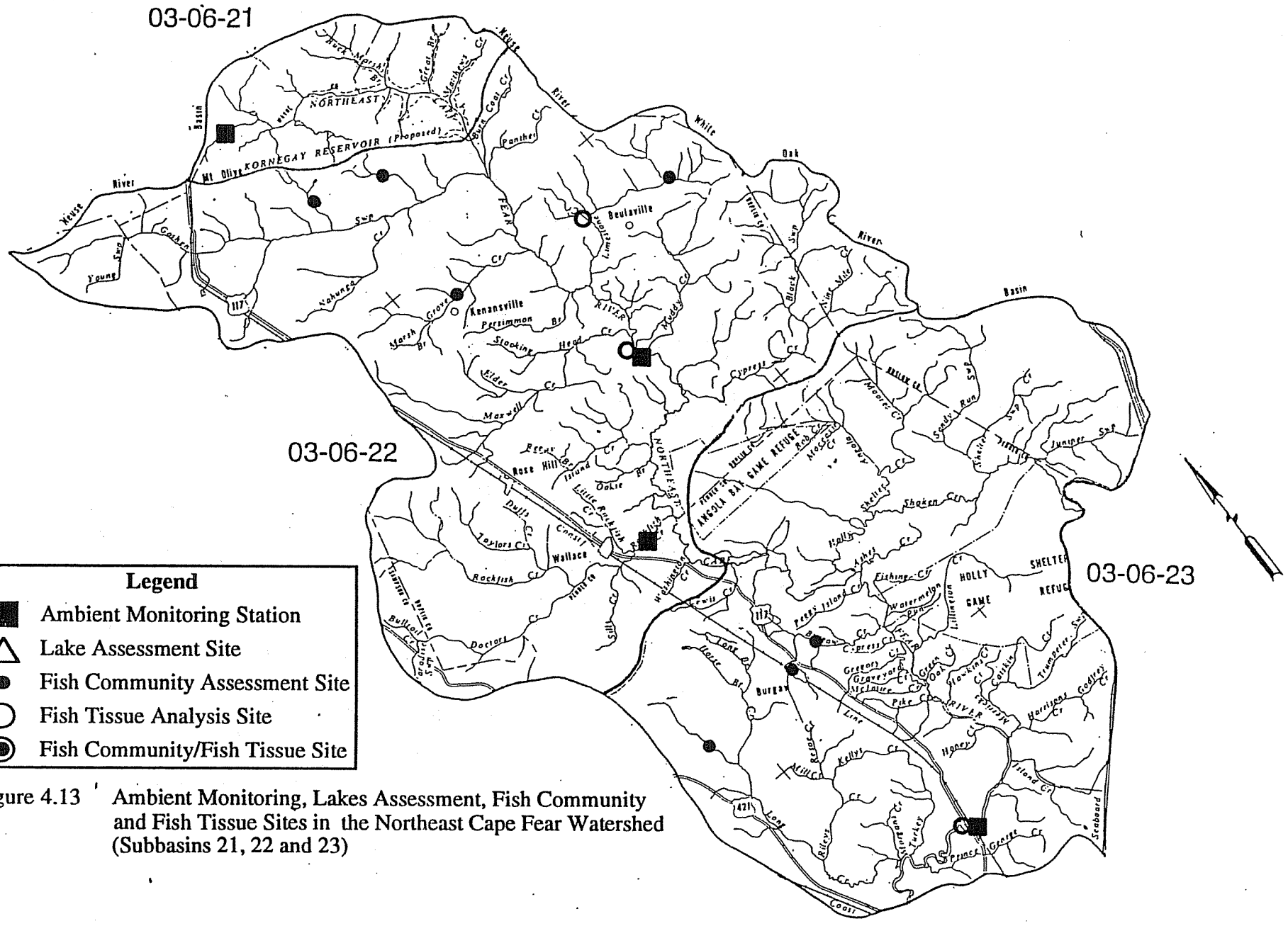


Figure 4.13 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sites in the Northeast Cape Fear Watershed (Subbasins 21, 22 and 23)

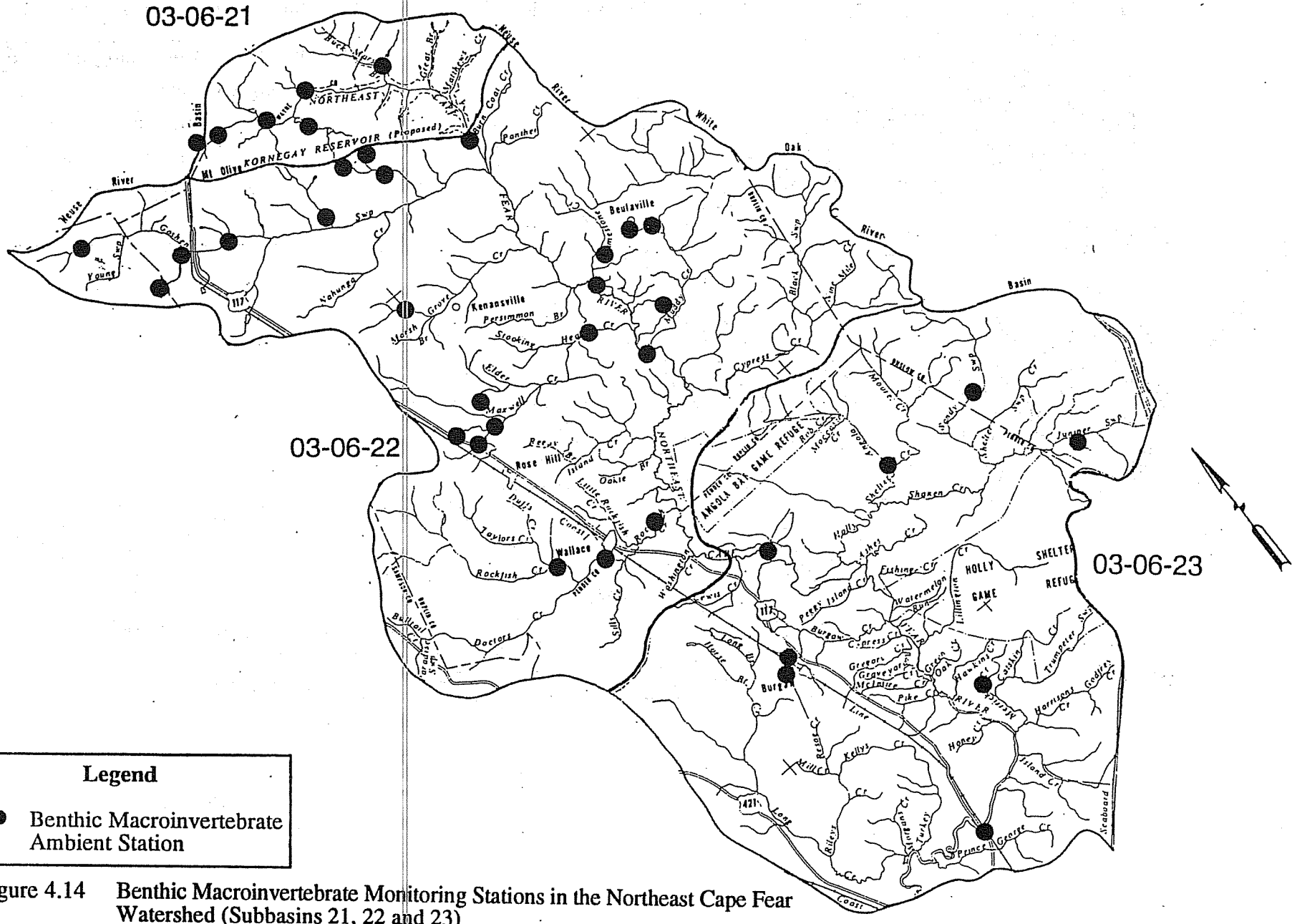


Figure 4.14 Benthic Macroinvertebrate Monitoring Stations in the Northeast Cape Fear Watershed (Subbasins 21, 22 and 23)

Table 4.10 Benthic Macroinvertebrate Sampling Sites and Data Summary for the Northeast Cape Fear River Watershed (83-93)

Subbasin 21

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
NE Cape Fear R, SR 1558, Duplin	61/B-1	18-74-(1)	5/93	54/4	8.15/6.87	Poor
			6/86	13/0	8.08/ -	Poor
NE Cape Fear R, NC 403, Duplin	-/B-2	18-74-(1)	5/93	68/13	7.26/5.27	Fair
NE Cape Fear R, SR 1948, Duplin	-/B-3	18-74-(1)	5/93	67/15	6.46/4.88	Good-Fair
Barlow Br, Bell St in Faison, Duplin	63/B-4	18-74-2	5/93	26/0	9.18/ -	Poor
			6/86	8/0	9.63/ -	Poor
Polly Run Cr, SR 1501, Duplin	60/B-5	18-74-5	7/86	67/11	6.71/5.52	Fair
Buck Marsh Br, NC 111, Duplin	-/B-6	18-74-8	8/93	-/16	-/3.84	Good-Fair

CPF 22

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
NE Cape Fear R, NC 11/903, Duplin	62/B-1	18-74-(1)	8/93	78/23	5.33/3.89	Excellent
			6/86	32/8	5.47/4.34	Good-Fair
NE Cape Fear R, NC 41 nr Chinquapin, Dup.	N/B-2	18-74-(25.5)	8/93	82/22	5.41/4.52	Excellent
			10/89	85/28	5.89/4.06	Good
			8/89	83/30	5.37/4.13	Excellent
			9/85	89/31	5.65/4.00	Excellent
Goshen Swp, SR 1302, Wayne	-/B-3	18-74-19	5/93	62/8	6.98/5.30	Fair
Goshen Swp, NC 117, Duplin	-/B-4	18-74-19	5/93	51/11	6.98/5.44	Fair
Goshen Swp, NC 403, Duplin	-/B-5	18-74-19	5/93	56/10	7.00/5.57	Fair
Panther Br, NC 50, Duplin	-/B-6	18-74-19-3	12/86	64/11	6.79/5.10	Fair
Panther Br, be Faison UT, Duplin	57/B-7	18-74-19-3	5/93	35/1	8.51/6.22	Poor
			12/86	10/0	8.25/ -	Poor
Halls Marsh Run, SR 1306, Duplin	151/B-8	18-74-19-11	9/93	68/12	6.53/5.27	Good-Fair
			9/92	69/9	6.30/4.98	Good-Fair
			9/91	53/7	6.48/4.80	Fair
			9/90	68/11	6.51/4.92	Good-Fair
UT Herrings Marsh Run, SR 1508, Duplin	-/B-9	18-74-19-16	9/93	-/0	- / -	Poor
			9/92	-/7	- /5.22	Fair
			9/91	-/2	- /5.68	Poor
Herrings Marsh Run, SR 1508, Duplin	-/B-10	18-74-19-16	9/93	-/8	- /4.89	Fair
			9/92	-/8	- /4.94	Fair
			9/91	-/14	- /4.43	Good-Fair
Herrings Marsh Run, SR 1306, Duplin	150/B-11	18-74-19-16	9/93	71/15	6.94/5.45	Good-Fair
			9/92	72/13	6.60/5.13	Good-Fair
			9/91	67/11	6.20/4.87	Good-Fair
			9/90	74/10	6.77/5.63	Fair
			1/90	-/13	-/5.08	Fair
UT Grove (Maple) Cr , SR 1376, Duplin	152/B-12	18-74-21	9/90	62/15	6.29/4.61	Good-Fair
Limestone Cr, NC 24, Duplin	-/B-13	18-74-23	4/86	35/1	7.47/6.23	Poor
Limestone Cr, SR 1702, Duplin	-/B-14	18-74-23	8/93	-/25	-/4.52	Excellent
Stockinghead Cr, SR 1956, Duplin	-/B-15	18-74-24	8/93	-/13	-/4.59	Good-Fair
Maxwell Cr, SR 1921, Duplin	59/B-16	18-74-24-1	6/85	55/5	6.93/5.52	Fair
UT Beaverdam Cr, SR 1916, Duplin	74/B-17	18-74-24-1-1	4/87	49/4	7.35/5.05	Fair
Cabin Br, SR 1911, Duplin	72/B-18	18-74-24-1-1-1	4/87	37/0	8.46/ -	Poor
			6/85	48/2	8.74/8.94	Poor
Cabin Br, SR 1915, Duplin	73/B-19	18-74-24-1-1-1	4/87	20/0	9.41/ -	Poor
			6/85	38/0	8.93/ -	Poor
Muddy Cr, NC 41, Duplin	-/B-20	18-74-25	8/93	-/4	- /5.59	Good-Fair
Persimmon Br, ab Beulaville, Duplin	-/B-21	18-74-25-1	9/90	45/4	6.98/6.62	Fair
Persimmon Br, be Beulaville, Duplin	-/B-22	18-74-25-1	9/90	31/0	7.53/ -	Poor
Rockfish Cr, NC 41 at Wallace, Duplin	T/B-23	18-74-29	7/88	79/17	6.46/4.84	Good-Fair
Rockfish Cr, SR 1165, Duplin	-/B-24	18-74-29	8/93	81/14	6.38/4.79	Good-Fair
Rockfish Cr, I-40, Duplin	-/B-25	18-74-29	8/93	64/12	6.84/5.26	Fair

CPF 23

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
NE Cape Fear R, nr Watha, Pender	-/B-1	18-74-(1)	7/83	44/5	7.29/4.81	Fair
NE Cape Fear R, US 117, New Hanover	-/B-2	18-74-(1)	8/93	38/7	6.93/4.84	NR
			6/90	45/7	6.51/5.26	NR
			6/87	41/6	7.32/5.34	NR
			8/85	42/5	7.05/4.46	NR
Sandy Run Swp, NC 50, Onslow	-/B-3	18-74-33-2	8/93	31/0	7.51/ -	NR
			5/93	42/5	6.78/4.89	NR
			3/93	39/8	6.63/4.86	NR
Angola Cr, NC 53, Pender	-/B-4	18-74-33-3	8/93	52/11	6.01/4.42	NR
			5/93	68/17	6.23/4.93	NR
			2/93	61/18	6.13/5.18	NR
Juniper Swp, NC 50, Onslow	-/B-5	18-74-33-4-1	8/93	25/1	7.68/4.46	NR
			5/93	34/2	7.17/5.90	NR
			2/93	44/5	7.19/5.85	NR
Burgaw Cr, at old RR track, Pender	75/B-6	18-74-39	12/87	37/0	8.93/ -	NR
Burgaw Cr, US 117, Pender	76/B-7	18-74-39	12/87	14/0	9.44/ -	NR
Merrick's Cr, NC 210, Pender	-/B-8	18-74-49-2	5/93	51/13	6.23/4.42	NR
			2/93	52/15	6.39/5.23	NR

4.3.6 Lower Cape Fear River and Coastal Waters Watershed (Subbasins 16, 17 and 24)

This watershed area includes the mainstem of the Cape Fear River from the confluence with Grays Creek in Cumberland County (several miles upstream from the Bladen County line and Lock and Dam #3) down to mouth. It also includes the Intracoastal Waterway and its tributaries. The drainage area of the mainstem Cape Fear River is about 6,605 square miles. At its mouth, the river empties directly into the Atlantic Ocean, and much of this estuarine area has salinities high enough for the waters to be classified as shellfish waters (SA). Ambient and biological monitoring sites are presented in Figures 4.15 and 4.16.

Cape Fear Mainstem (Grays Creek to Livingstone Creek - subbasins 16 and 17)
As the Cape Fear River flows into the inner coastal plain it carries a large silt load, and much silt settles out in this portion of the river. The 1993 benthos data indicated a Good-Fair rating for the Cape Fear River near Duarte, below Lock and Dam #2 and at SR 1730 in Bladen County, although prior data (1984-1987) had assigned Fair ratings to this segment of the river. This improvement in bioclassification may be partly related to increased flow and better collecting techniques. Biological data from above and below Federal Paperboard Company on the Cape Fear River found low taxa richness at both sites which may have been influenced by sampling conditions, poor habitat, the influence of tides, and/or point source discharges. Some degradation below this facility was noted in the macroinvertebrate community, with bioclassification changing from Good-Fair above to Fair below. Currently Federal Paperboard Company is operating under a Special Order by Consent.

In subbasin 16, the Cape Fear River becomes flat and there is limited reaeration. The series of Lock & Dams slow the river down and create lake-like conditions under prolonged low flow events. In addition, the river receives significant point and nonpoint source loading with cumulative impacts to the river. In examining the ambient water quality data for the mainstem, concentrations of dissolved oxygen gradually drop from upstream to downstream as depicted in Figure 4.17 (see Figure 4.3 for interpretation of box and whisker plots). Though the monthly ambient data indicate no dissolved oxygen standard violations upstream of Hale Point Landing near Phoenix, special studies indicate that there are pronounced DO sags upstream of each dam. While usually meeting the 4.0 mg/l instantaneous dissolved oxygen standard, it is important to note that the ambient data are collected monthly at fixed stations and are best used for screening and long-term trend analysis. Intensive water quality characterizations and subsequent predictive modeling may suggest other critical locations and time periods that dissolved oxygen might be reduced to problematic levels. For example, self-monitoring data provided by dischargers show a number of locations where dissolved oxygen concentrations have dipped below the instantaneous standard of 4.0 mg/l (Figure 4.18). In subbasin 17, below Lock and Dam 1, dissolved oxygen becomes influenced by additional point source loads, swamp water from the Black River and tidal action. As a result, there are occurrences of dissolved oxygen concentrations falling below the 4 mg/l instantaneous standard above Wilmington during summer conditions.

Harrison Creek was assigned a Fair rating by both fish and benthic macroinvertebrates, but this rating may have been affected by very low pH (4.5). Other tributaries had better water quality ratings, including Ellis Creek (Good-Fair, benthos) and Browns Creek (Good, fish).

Estuarine Area
Large portions of this area have been classified as Outstanding Resource Waters, including Turkey Creek, Howard Channel, Long Point Channel, Green Channel, Cedar Snag Creek, Butler Creek, Nixon Channel and Howe Creek. ORW areas also include portions of Stump Sound, Everett Bay, Middle Sound, Masonboro Sound and the Intracoastal Waterway. Two High Quality Waters areas

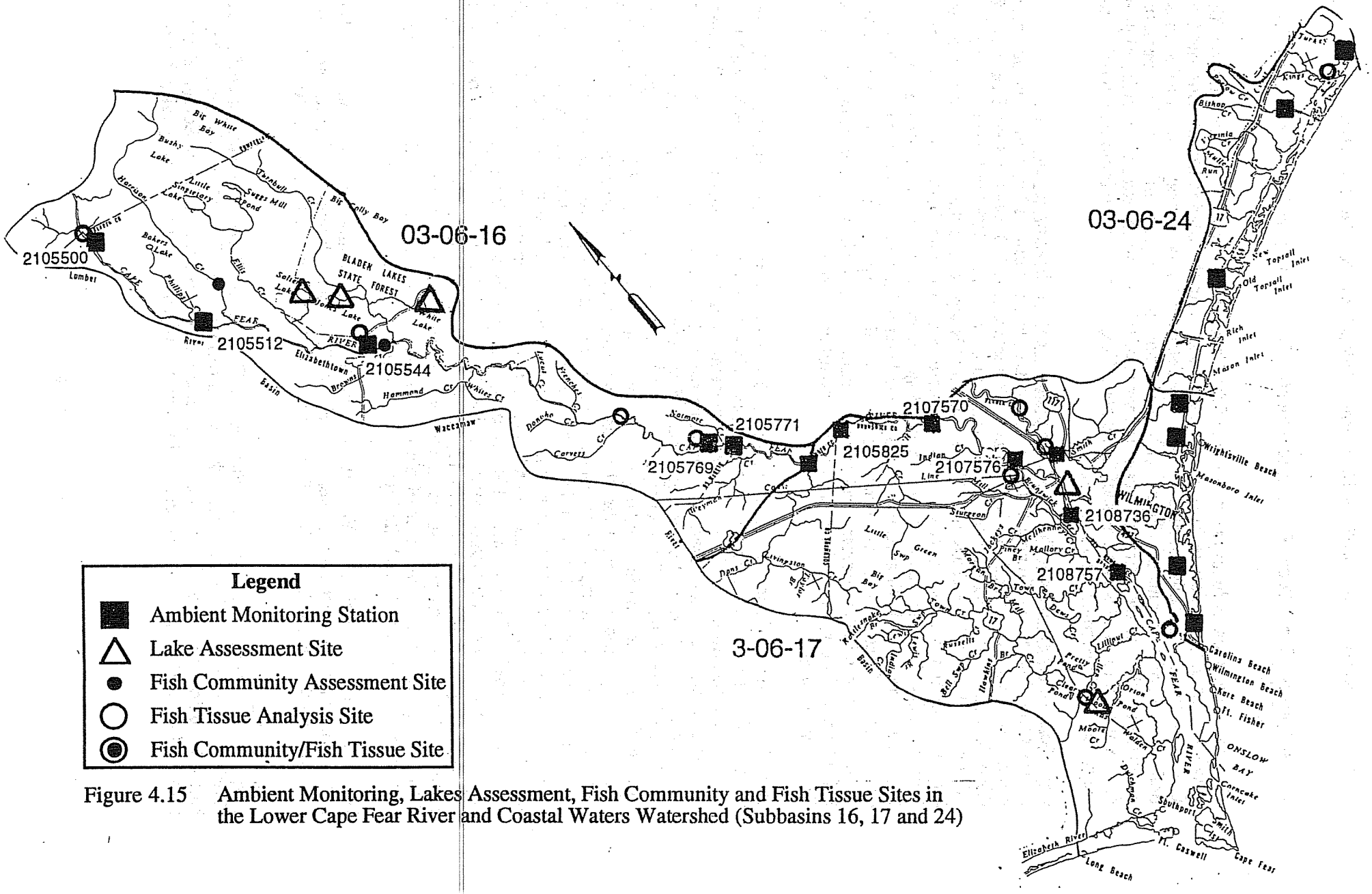


Figure 4.15 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sites in the Lower Cape Fear River and Coastal Waters Watershed (Subbasins 16, 17 and 24)

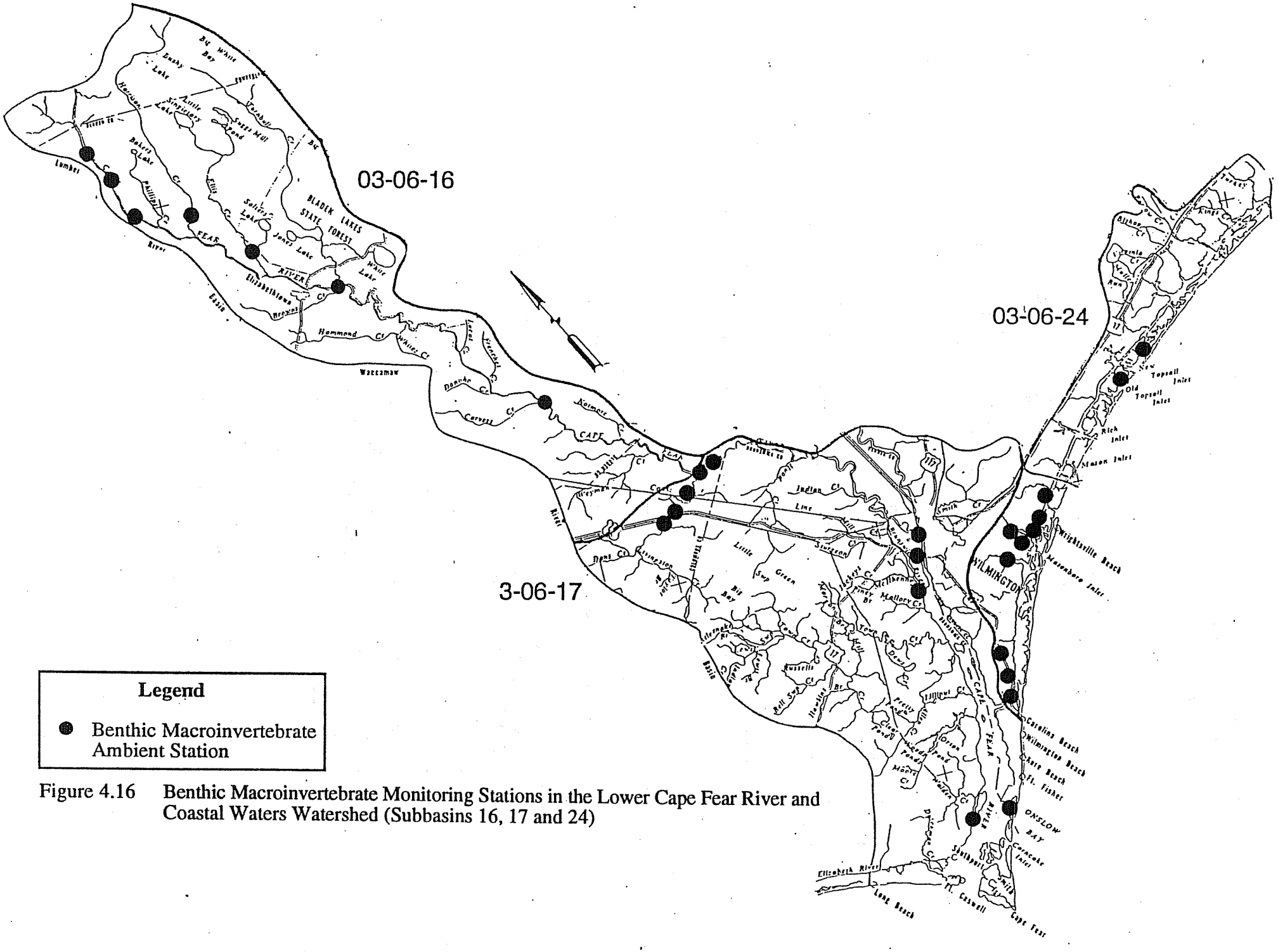


Figure 4.16 Benthic Macroinvertebrate Monitoring Stations in the Lower Cape Fear River and Coastal Waters Watershed (Subbasins 16, 17 and 24)

Figure 4.17 Box Plots of Dissolved Oxygen Concentrations at Ambient Monitoring Stations on the Cape Fear River Mainstem (1988 to 1993)

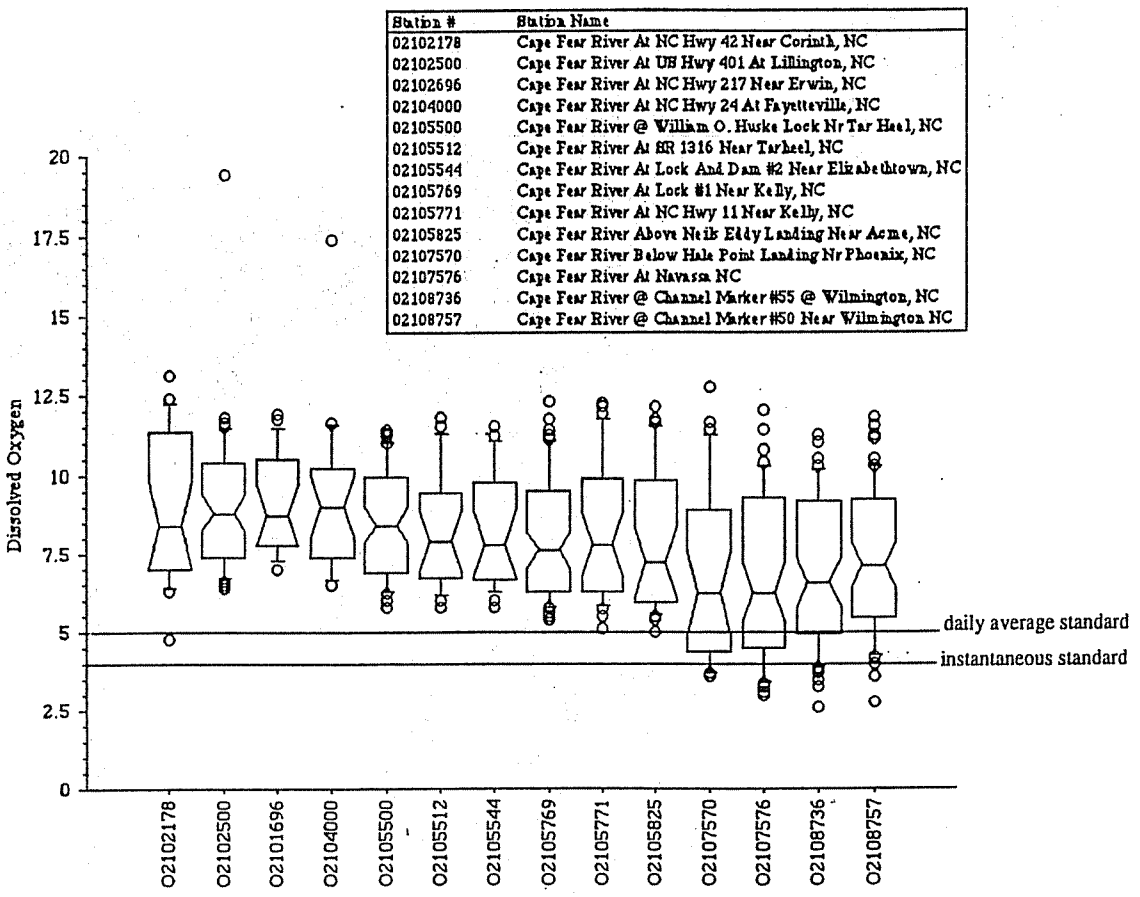


Figure 4.18 Dissolved Oxygen Concentrations for the Cape Fear River from Discharger Self-monitoring data (April - October, 1993 & 1994) Buckhorn Dam to Wilmington (160 miles)

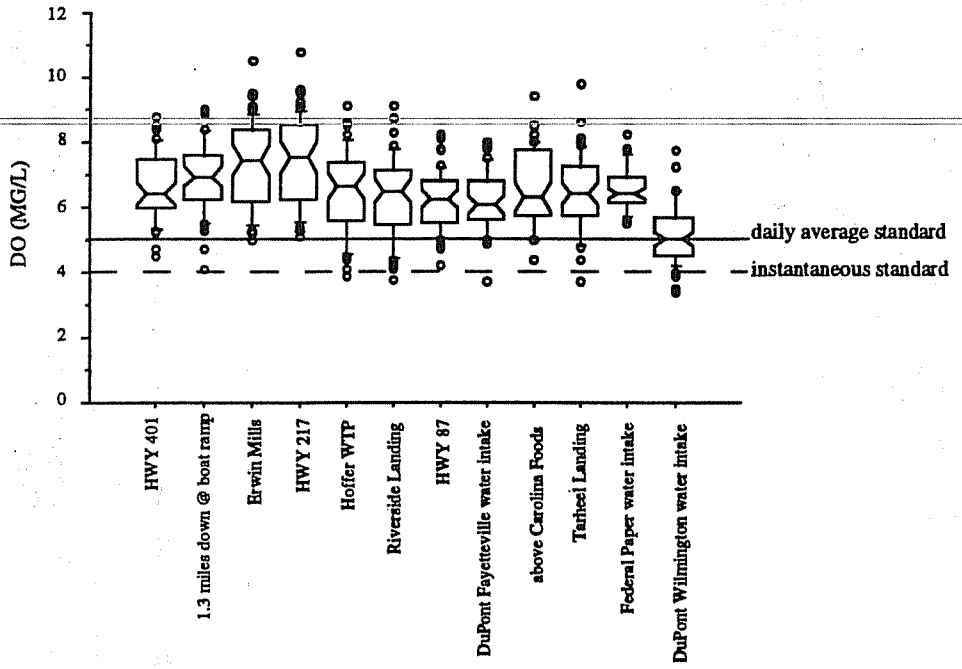


Table 4.11 Benthic Macroinvertebrate Sampling Sites and Data Summary for the Lower Cape Fear River and Coastal Waters Watershed (83-93)

Subbasin 16

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Cape Fear R, nr Duarte, Bladen	-/B-1	18-(26)	08/93	50/10	6.37/4.69	Good-Fair
Cape Fear R, ab Carolina Foods, Bladen	-/B-2	18-(26)	09/92	47/15	6.18/4.70	Good-Fair
Cape Fear R, be Carolina Foods, SR 1316, Cumberland	Q/B-3	18-(26)	09/92	45/11	6.56/4.88	Good-Fair
			06/87	41/7	7.24/5.22	Fair
Cape Fear R, below Lock 2, Bladen	-/B-4	18-(26)	08/93	53/15	6.74/5.24	Good-Fair
Ellis Cr, NC 53, Bladen	-/B-5	18-44	08/93	-/16	-/3.88	Good-Fair
Harrison Cr, SR 1318, Bladen	-/B-6	18-42	08/93	-/11	-/3.61	Fair
Cape Fear R, at Kelly, SR 1730, Bladen	J/B-7	18-(53.5)	08/93	48/11	6.51/4.74	Good-Fair
			08/90	44/12	7.42/4.28	Fair
			07/88	69/12	7.14/6.35	Fair
			06/86	51/6	7.25/6.83	Fair
			06/84	52/7	7.20/5.66	Fair

Subbasin 17

Site	Old/New DWQ#	Index#	Date	S/EPTS	BI/BIEPT	Bioclass
Cape Fear R, ab Federal Paper, Columbus	-/B-1	18-(59)	8/93	45/8	6.61/5.31	Good-Fair
Cape Fear R, be Federal Paper, Columbus	-/B-2	18-(63)	8/93	32/5	7.21/5.34	Fair
Livingston Cr, NC 74, Columbus	-/B-3	18-64	8/93	68/9	7.32/5.50	Fair
Livingston Cr, off SR 1878, Columbus	-/B-4	18-64	8/90	39/4	7.65/4.22	NR
Livingston Cr, off SR 1878, Columbus	-/B-5	18-64	8/90	24/0	8.73/-	NR
Cape Fear R, at Wilm. Docks, New Han.	-/B-6	18-(71)	6/93	9/0	1.0*	NR
Cape Fear R, at Wilm. Southside WWTP	-/B-7	18-(71)	6/93	20/0	1.5*	NR
Brunswick R, nr mouth, New Hanover	-/B-8	18-77	6/93	26/0	1.8*	NR
Cape Fear R, at Snow's Marsh, Brunswick	-/B-9	18-(87.5)	6/93	63/0	2.0*	NR
			6/93	17/0	2.0*	NR
			7/85	38/0	2.1*	NR
The Basin, at Zeke's Island, New Hanover	-/B-10	18-88-8-1	7/85	61/0		NR

Subbasin 24

Site	Old/New DWQ #	Index #	Date	Total S	Biotic Index*	Bioclass
Topsail Sound, nr Marker 5, Onslow	-/B-1	18-87-10	6/93	46	2.0	NR
Black Mud Channel, Onslow	-/B-2	18-87-13.5	6/93	24	2.8	NR
Howe Cr, New Hanover	-/B-3	18-87-23	2/93	28	2.7	NR
			5/93	14	2.1	NR
ICWW, N of US 74, New Hanover	-/B-4	18-87-24	6/93	5	1.9	NR
ICWW, Bridgetender Marina, New Hanover	-/B-5	18-87-24	6/93	17	1.2	NR
Bradley Cr, Bradley Cr Marina, New Hanover	-/B-6	18-87-24-4-(2)	2/93	37	1.7	NR
			5/93	30	1.9	NR
Bradley Cr, nr No Wake Sign, New Hanover	-/B-7	18-87-24-4-(2)	2/93	35	1.9	NR
Hewletts Cr, New Hanover	-/B-8	18-87-26	2/93	42	2.0	NR
			5/93	17	1.6	NR
Carolina Inlet Marina, New Hanover	-/B-9	18-87-(30.5)	6/93	27	1.5	NR
ICWW, Marker 156, New Hanover	-/B-10	18-87-(30.5)	6/93	21	1.9	NR
ICWW Spur, S of Snows Cut, New Hanover	-/B-11	18-87-31.2	6/93	11	1.2	NR

* The estuarine Biotic Index is a 1-5 scale (freshwater BI is 0-10) and higher values indicate more intolerant taxa.

NR=Not Rated

have also been designated in this subbasin based on their use as primary nursery areas: King Creek and Bradley Creek above US 17/74/76. Because of the large number of ORW areas in this subbasin, water quality can be inferred to be generally Good to Excellent due largely to good tidal flushing. Most water quality problems in this subbasin are related to urban nonpoint runoff and large marinas.

Seven ambient sites are located along the Intracoastal Waterway in this subbasin. It appears that water quality is generally good in this estuarine area, with most water quality problems coming

from outside the subbasin. To the south, Snow's Cut brings in lower salinity, nutrient enriched (high Total Phosphorus and Nitrate/Nitrite-Nitrogen) water from the Cape Fear River. This mostly affects Carolina Beach Harbor, but some effects can also be seen at Everetts Creek. In the north, water from the New River (NSW) is sometimes blown southwest to the Goose Bay station and occasionally as far as Morris Landing, bringing with it elevated levels of Total Phosphorus and Total Kjeldahl Nitrogen.

Much of the benthos data in collected in 1993 was aimed at the lower sections of the Brunswick River and Cape Fear River near, and south of Wilmington (Table 4.11). Only one benthos site has prior data which indicates there has been little degradation in the water quality in the lower Cape Fear River since 1985.

4.4 USE-SUPPORT: DEFINITIONS AND METHODOLOGY

4.4.1 Introduction to Use Support

Determining the *use support* status of a waterbody, that is how well a waterbody supports its designated uses, is another important method of interpreting water quality data and assessing water quality. Use support assessments are presented in Section 4.5 using figures, tables and maps for freshwater streams, lakes and estuaries within the Cape Fear River Basin.

Surface waters (streams, lakes or estuaries) are rated as either *fully supporting* (S), *support-threatened* (ST), *partially supporting* (PS), or *nonsupporting* (NS). The terms refer to whether the classified uses of the water (such as water supply, aquatic life protection and swimming) are being fully supported, partially supported or are not supported. For instance, saltwaters classified for commercial shellfish harvesting (SA) would be rated as fully supporting if bacterial levels in the water were low enough to allow harvesting (<14 MPN). However, if fecal coliform bacteria levels were too high to allow shellfish to be harvested (>14 MPN), but not too high to prevent swimming (<200 MPN), then the waters would be rated as partially supporting since they only support the swimming. If the waters were impacted to the point that even swimming was disallowed, the waters would be rated as nonsupporting. Streams rated as either partially supporting or nonsupporting are considered *impaired.* The support-threatened category for freshwater rivers and streams refers to those waters classified as good-fair based on water quality data, in contrast to excellent or good which are considered fully supporting. An overall fully supporting rating, however, does include both fully supporting and support-threatened waters. Streams which had no data to determine their use support were listed as non-evaluated (NE).

For the purposes of this document, the term *impaired* refers to waters that are rated either partially supporting or not supporting their uses based on specific criteria discussed more fully below. There must be a specified degree of degradation before a stream is considered impaired. This differs from the word impacted, which can refer to any noticeable or measurable change in water quality, good or bad.

4.4.2 Interpretation of Data

The assessment of water quality presented below involved evaluation of available water quality data to determine a water body's use support rating. In addition, an effort was made to determine likely causes (e.g., sediment or nutrients) and sources (e.g., agriculture, urban runoff, point sources) of pollution for waters that did not support their designated uses (i.e., those found to be either partially or nonsupporting). These data consisted of biological and chemical ratings, reports of citizen complaints, responses to mailings requesting water quality information, land-use reviews of topographic maps, and best professional judgment (see Data Analysis Methodology section for more details). By including best professional judgments (i.e., perceived water quality problems) in deciding the overall water quality ratings and the potential sources of pollution, a much broader, but less precise, picture of water quality conditions in the basin was developed.

Interpretation of these data compiled by DWQ should be done cautiously. The methodology used to acquire the numbers must be understood, as should the purpose for which the numbers were generated. The intent of this use-support assessment was to gain an overall picture of the relative contribution made by different categories of pollution within the Cape Fear basin. In order to comply with guidance received from EPA to identify likely sources of pollution for all impaired stream mileage, DWQ used the data mentioned above.

The data are not intended to provide precise conclusions about pollutant budgets for specific watersheds. Since the assessment methodology is geared toward general conclusions, it is important to not manipulate the data to support policy decisions beyond the accuracy of these data.

For example, according to this report, nonpoint source pollution is thought to be the most widespread source of the impairment of water quality. However, this does not mean that there should be no point source control measures. As discussed in previous sections of this chapter, and in Chapter 6, many stream miles in the basin are impacted by point source discharges, but the degree of impact has not resulted in a partial or nonsupport rating. What is clear from the plan is that all categories of point and nonpoint source pollution have the potential to cause significant water quality degradation if proper controls and practices are not utilized.

This threat to water quality from all types of activities heightens the need for point and nonpoint source pollution control. It is important to not neglect any source (or potential source) of pollution in developing appropriate management and control strategies. Data exist which document water quality problems from every major pollution category that has been considered in this report. Certainly, the potential for further problems remains high as long as the activity in question continues carelessly. Because of this potential, neglecting one pollution source in an overall control strategy can mask the benefits achieved from controlling all other sources.

4.4.3 Assessment Methodology - Freshwater Bodies

Many types of information were used to make use support assessments and to determine causes and sources of use support impairment. Chemical, physical and biological data as well as wastewater treatment plant self-monitoring data and toxicity data were the primary sources of information used to make use support assessments. Information was also obtained from other agencies, workshops, and pertinent reports.

The most recent water quality chemical data (January 1988 through August 1993) were interpreted for use support utilizing the STAND(ards) program available through the STORET system. The program determines water quality standard violations and computes percentages of the values in violation based on applicable North Carolina water quality standards. According to EPA guidance, use support determinations based on chemical data are to be made as follows:

Fully Supporting - for any one pollutant, criteria exceeded in $\leq$ 10% of the measurements,
Partially Supporting - for any one pollutant, criteria exceeded in 11- 25% of the measurements, and
Not Supporting - for any one pollutant, criteria exceeded in > 25% of the measurements.

The following parameters were evaluated in the STAND(ards) program: dissolved oxygen (surface values), temperature, pH, turbidity, fecal coliform bacteria (exceedance of 200 MF/100 ml geometric mean), chlorophyll *a*, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, mercury, zinc, chloride, fluoride and selenium.

Another valuable source of data used for the report was biological rankings from 1983 through 1992 as determined from benthic macroinvertebrate surveys discussed in section 4.2. The most recent report on these surveys (NCDEHNR, DWQ 1994) is available from DWQ's Environmental Sciences Branch. Data from North Carolina's Biological Monitoring Ambient Network (BMAN), in addition to special macrobenthic studies were ranked on a five point scale. This scale is based on taxa richness for the three pollution intolerant groups of Ephemeroptera, Plecoptera and Trichoptera (EPT).

Collected specimens are identified to the lowest possible taxonomic level. Total species (or taxa) richness values for the EPT groups are calculated and biological classifications assigned to each station (Excellent, Good, Good-fair, Fair or Poor). Higher species richness values are associated with better water quality. For ranking purposes, stations classified as "Poor" with regard to biological data are rated not supporting (NS) and stations classified as "Fair" are rated partially

supporting (PS). Stations classified as "Good-Fair" are rated as support-threatened (ST) and those having a Good to Excellent bioclassification are rated as supporting (S) their designated uses.

Other types of DWQ-collected data used to make use support assessments were toxicity data related to discharging facilities, fish tissue and fish community structure data and phytoplankton bloom information. In addition, fish consumption advisories and information from other agencies, workshops held in 1987 and pertinent reports were utilized. In general, stream segments which received a discharge from a facility significantly out of compliance with permit limits or failing their whole effluent toxicity test were rated as support-threatened, unless water quality data indicated otherwise. Streams which had a fish consumption advisory in place were rated as partially supporting. Assessments were made on either a monitored (M) or evaluated (E) basis. A *monitored* basis represents data which are less than five years old. An *evaluated* basis refers to the use of best professional judgment or data older than five years old. Overall ratings were determined for stream segments as follows:

1. *Biological ratings* generally were preferred over any other source of information since they are a direct measurement of aquatic life support.
2. *Chemical ratings* (when biological ratings were unavailable) were preferred over information from older reports or information from workshops.
3. *Workshop "evaluations"* or best professional judgments were preferred over information from older reports.
4. Information from older reports was used when no other information was available.

After overall ratings were assigned, probable sources of pollution (point or nonpoint) for partially supporting and nonsupporting streams were sought. Information on point sources, such as permit compliance records, was reviewed in order to identify major and minor discharges potentially affecting streams. The Aquatic Survey and Toxicology Unit was also consulted to identify facilities known to have toxic effects based on chronic and acute toxicity tests. Information related to nonpoint source pollution (e.g., agricultural, urban and construction) was obtained from other agencies (federal, state and local), citizens, land-use reviews and best professional judgment.

Causes of use support impairment, such as sedimentation and low dissolved oxygen, were also identified for specific stream segments. For ambient water quality stations, those parameters which exceeded the water quality standard >10% of the time for the review period were included as probable causes. For segments without ambient stations, information from reports, other agencies and best professional judgment were used. In general, facility self-monitoring data and facility aquatic toxicity data were not included in the cause or overall problem parameter column since these data may not reflect instream conditions occurring during the reporting period because they are based on 7Q10 conditions.

Once all monitored and evaluated information was located on water basin maps, remaining "unassessed" streams and segments were evaluated to have the same use-support if they were a direct or indirect tributary to monitored or evaluated segments rated supporting and support-threatened. Partially and nonsupporting segments were not extended. US Geological Survey (USGS) 7.5 minute topographic maps (1:26,000 scale) and orthophotoquads were used to determine probable sources for all impaired streams when other sources, such as WWTP compliance data, were insufficient.

4.4.4 Assessment Methodology - Saltwater Bodies

Saltwater Classifications

All tidal saltwaters are classified for their best usage with the following class descriptions:

Class SC - Secondary Recreation and Aquatic Life
Class SB - Primary Recreation plus SC uses
Class SA - Shellfishing for Market Purposes plus SC/SB uses

Supplemental classifications, such as swamp water (Sw), high quality waters (HQW), outstanding resource waters (ORW), or nutrient sensitive waters (NSW) may also be applied. Water quality standards for saltwater bodies were developed to protect these best uses.

Data Sources

When determining the Use Support Ratings for estuarine waters, (depending on the availability of the data,) all or a combination of the following sources of data are used: ambient monitoring data (physical/chemical data), NCDEHNR Division of Environmental Health's Shellfish Sanitation s Unit's sanitary surveys, and phytoplankton data.

Ambient monitoring data for saltwater bodies is interpreted using a program in 4thDimension. This program compares the ambient data to the appropriate numerical standards and determines the percent of violations. This information is used in the use support process as follows:

Fully Supporting - for any one pollutant, criteria exceeded in $\leq$ 10% of the measurements
Partially Supporting - for any one pollutant, criteria exceeded in 11-25% of the measurements, and
Not Supporting - for any one pollutant, criteria exceeded in > 25% of the measurements.

Within the NCDEHNR Division of Environmental Health, the Shellfish Sanitation Unit is responsible for determining the status of the shellfishing waters and maintaining a historical record of the opening and closing of designated shellfishing waters. The Shellfish Sanitation Unit has divided the saltwater bodies by area, and sanitary surveys are conducted on these areas every three years to evaluate factors that affect the sanitary quality of a shellfish growing area.

Prolific growths of phytoplankton may result in blooms which are deleterious to water quality, causing fish kills, anoxia, taste and odor problems. Criteria used to determine blooms are as follows: an algae sample with a biovolume larger than 5,000 mm3/m3, density greater than 10,000 units/ml or chlorophyll-a concentration approaching the 40 microgram/l standard. The magnitude and duration of bloom are also considered when using this information in the use support process. No coastal waters in the Cape Fear River Basin have been found to be impaired based on the above bloom criteria.

Assigning Use Support Ratings

When assessing estuarine or saltwater bodies, they are divided by the Shellfish Sanitation unit areas. All available data is reviewed for each area, and each area is assigned a rating. The use classification is also considered for each area, and data is reviewed according to the appropriate standards. If an area has sections that have different use classifications, the use support ratings assigned to that area may differ according to the classification. For example, if an area is divided into two sections, with one section classified as SC and the other is SA, and the only available data is the sanitation survey which indicates that the entire area is closed to shellfishing, the area classified as SA would be rated as PS and the area classified as SC would be rated as S. The entire

area is not rated PS because only the commercial shellfishing harvest use (as defined with the SA classification) is impaired. All of the uses associated with the SC classification are still fully supporting. If several sources of data are available in an area, all of the data are reviewed, and the rating is based on the combination of these data sources.

4.5 USE SUPPORT RATINGS FOR THE CAPE FEAR RIVER BASIN

Use Support ratings for all monitored and evaluated surface waters in the basin are presented on color coded maps in Figure 4.19 (3 pages). Use support ratings and background information for all monitored stream segments are presented in Table 4.12 (five pages).

4.5.1 Freshwater Streams and Rivers

Freshwater Streams and Rivers

Of the 6204 miles of freshwater streams and rivers in the Cape Fear basin, use support ratings were determined for 90% or 5601 miles with the following breakdown:

SUPPORTING 72%
- Fully supporting (38%)
- Support-threatened (34%)

IMPAIRED 18%
- Partially supporting (15%)
- Not supporting (3%)

NOT EVALUATED: 10%

Table 4.13 and Figure 4.20 summarize the use support determinations for freshwater streams for 23 of the basin's 24 subbasins. In subbasins 01 through 04, 06, 07, 09, 10 and 12 through 23, the total of the miles rated supporting and support-threatened accounted for more than 50% of the stream mileage for each basin. Subbasins 05, 08 and 11 had a larger percentage of streams which were rated as impaired (ie., partially supporting or not supporting).

Probable causes and sources of impairment were determined for about 76% of the impaired streams with the information summarized in Tables 4.14 (sources of impairment) and 4.15 (causes of impairment). When a stream segment had more than one cause or source listed, the total stream segment information was added to each cause or source. This means that the miles of stream impaired by the combination of all sources or all causes may be more than the total miles of partially and not supporting streams presented in Table 4.13. As an example, if a 10-mile long stream segment was determined to be impaired as a result of both point sources and urban development, then 10 miles would be entered under both the urban column and point source column in Table 4.14. Where the sources of impairment could not be identified, no mileage for that segment was entered into Table 4.14. Sediment was the most widespread cause of impairment throughout the basin, followed by turbidity, pH, metals, fecal coliform bacteria and ammonia.

Information on sources of impairment for stream miles rated partially or not supporting indicated that 870 stream miles were impaired by nonpoint sources, and 181 stream miles were impaired by point sources. Agriculture was the most widespread nonpoint source, followed by urban runoff and construction. Subbasins 03, 11, 18 and 22 each had more than 40 miles of streams impaired by agricultural sources. Subbasins 02, 05, 15 and 17 had the highest number of stream miles impaired by urban runoff while subbasins 05, 08, 15 and 17 had the highest number of stream miles impaired by construction.

4.5.2 Salt (Estuarine) Waters

Use support determinations were made for all of the 39,200 acres of saltwater in the Cape Fear Basin. Approximately 73 percent of the saltwaters were rated as fully supporting and the remaining 27 percent were rated partially supporting. Table 4.16 presents the use support determinations by Division of Environmental Health (DEH) area. It also includes probable causes and sources of use support impairment. A map of DEH areas is shown in Figure 4.21.

Fecal coliform bacteria was the most widespread probable cause of impairment followed by low dissolved oxygen. Elevated levels of fecal coliform bacteria are an indicator of water quality degradation that requires the closure of shellfishing areas. Approximately 18,732 acres of open waters in the basin have been closed to shellfish harvesting by the DEH Shellfish Sanitation Branch. Of this total, however, approximately 4,800 acres are classified as SA (shellfish) waters by DWQ. This smaller figure is the number used by DWQ for determining the acreage of impaired coastal waters based on fecal coliforms/closed shellfish waters. DEH has also indicated that all of the remaining 18,732 acres of open waters not permanently closed to shellfish harvesting may at time be closed on a temporary basis. The 3505 acres of open waters in areas B1 and B9 are conditionally open and they regularly close after a 1-1/2 inch rain. Other waters have closed after extraordinarily heavy rains or high river flows. Closures may run from several days to several weeks. DEH staff regularly monitor fecal coliform levels in the waters and when the levels are considered safe the waters are reopened.

Nonpoint source pollution is estimated to be the primary pollution source in 77% of the impaired waters, with the remaining 23% impaired due to point sources. Waters were impacted primarily by multiple nonpoint sources including agriculture, urban runoff, septic tanks and marinas.

4.5.3 Lakes

Thirty-six lakes in the Cape Fear basin totaling 32,475 acres were monitored and assigned use support ratings (Table 4.17). Ratings were determined based on criteria presented in Table 4.18. The number of lakes falling into each use support category are presented below:

SUPPORTING 34
Fully supporting: 18%
Fully supporting but threatened: 16%

IMPAIRED 2
Partially supporting: 1%
Not supporting: 1%

The majority of the lakes rated as support-threatened were given this rating due to elevated nutrients, although several also had problems with aquatic weeds. Of the impaired lakes, Black lake was rated partially supporting because a fish consumption advisory was issued due to certain fish containing mercury at levels of concern. Greenfield lake was rated not supporting due to ongoing problems with nuisance filamentous algal blooms, fish kills and aquatic macrophytes.

Table 4.12 Use Support Information for Monitored Freshwater Stream Segments in the Cape Fear Basin (Sheet 1 of 5)

Station Number	Station Location	Classification	Index Number	Miles	Chemical Rating	<------ Biological Ratings------>						Problem Parameters	Overall Use Support	Date Rated	Major Source
						Benthic Macroinvertebrates					Fish				
					89-93	1989	1990	1991	1992	1993	1993				
SUBBASIN 01															
02093250	Haw River near Oak Ridge, SR-2109	C NSW	16-(1)a	7.2	S					F			PS	Jul-92	NP,P
0209331280	Haw R at US 29A near Benaja, Rockingham Co	C NSW	16-(1)b	20.0	S					G- F		Sed	ST	Jul-92	NP
02093599	Haw River near Altamahaw, NC 87, Ambient at SR1561	C NSW	16-(1)c	15.8	PS		F			G		Turb(14)	S	Jul-92	NP,P
	Brooks Lake Trib, Scout Camp, Guilford	B NSW	16-4-1-(1)	1.2			Ex						S	Jul-92	NP
	Candy Cr, SR 2700, Guilford Co.	C NSW	16-5	3.6			F						PS	Jul-92	NP
	Troublesome Cr, SR 2422, Rockingham	WS-III NSW CA	16-6-(0.7)	5.8						G- F	Pr	Sed	PS	Jul-92	NP
	Little Troublesome Cr, Reidsv. WWTP	C NSW	16-7a	2.9					F				PS	Mar-90	NP
02093423	Little Troublesome Cr, incl SR 2598 station & SR 2600.	C NSW	16-7b	6.5	PS					Pr		Turb(13)	NS	Mar-90	P
SUBBASIN 02															
02096500	Haw River at Haw River, NC 49	C NSW	16-(1)d	13.9	PS							Turb(20),Cd(16),Fecal	PS	Jul-92	NP,P
	Haw River at NC 54 at Graham	C NSW	16-(1)e	3.1		G-F				G- F			ST	Jul-92	
02093800	Reedy Fork near Oak Ridge, SR-2128	WS-III NSW	16-11-(1)	12.4	S					G- F		Sed	ST	Mar-90	P
	Horsepen Cr at US 220, Guilford Co.	WS-III NSW	16-11-5-(0.5)	6.9						F			PS	Jul-92	NP
	UT Horsepen Cr, Friendly Rd, Guilford	WS-III NSW CA	16-11-5-1-(2)	2.9					Pr				NS	Jan-88	
02095681	Reedy Fork benthic: SR 2728 Guilford, fish: SR2719	C NSW	16-11-(9)a	11.5						G- F	G		S	Jan-88	NP
02095681	Reedy Fork at Ossippee, NC 87 Alamance	C NSW	16-11-(9)b	9.8	S	F				G- F			ST	Jan-88	NP,P
02095500	N. Buffalo Cr nr Greensboro, SR 2832; below WWTP	C NSW	16-11-14-1a	8.5	NS					Pr		NH3(47),Fecal	NS	Jul-92	NP, P
	S. Buffalo Cr at McLeansville; at US 70	C NSW	16-11-14-2a	18.6						F		Sed	PS	Jul-92	NP
02095091	South Buffalo Cr at SR 2821	C NSW	16-11-14-2b	4.3	NS					Pr		NH3(20),Cd(32)	NS	Jul-92	
	Stony Cr, SR 1100, Caswell	WS-II NSW	16-14-(1)	12.1						G			S	Jan-88	
0209622751	Jordan Cr at SR 1002, Near Union Ridge, Alamance Co.	WS-II NSW	16-14-6-(0.5)	10.9	S					G- F	G		S	Jan-88	NP
0209651840	Town Cr. SR 2109, near Graham, Alamance Co	C NSW	16-17	4.0	PS							Turb(13),Fecal	PS	Mar-90	
	Little Alamance Cr, SR 2309, Alamance	C NSW	16-19-11	12.3							F- G	Sed	ST	Jan-88	NP
	Haw Cr SR 2158	C NSW	16-20-(4)	3.6						G- F			ST	Jan-88	
SUBBASIN 03															
0209666850	Little Alamance Cr ambient: NC HWY 61 nr Whitsett, ben	WS-IV NSW CA	16-19-3-(4.5)	0.5	S					G		Sed	S	Jul-92	NP
	Big Alamance Cr, NC 49, Alamance	C NSW	16-19-(4.5)a	4.5						G- F			ST	Jan-88	P
02096813	Big Alamance Cr near Bellemont, SR-2309, ambient at 211	C NSW	16-19-(4.5)b	6.5	S	G/F							ST	Jan-88	P
	Stinking Quarter Cr at SR 1136, Alamance Co.	C NSW	16-19-8	5.1						G- F	G- Ex		S	Jul-92	
SUBBASIN 04															
0209666850	Haw River near Saxapahaw, SR-1005	C NSW	16-(1)i	6.9	PS	G/F	G- F			G- F		Turb(14)	ST	Jul-92	
	Cane Cr at SR 1114 & SR 1100, Orange Co	WS-II NSW CA	16-27-(2.5)	4.7						G- F			ST	Jan-88	
	Cane Cr NC 87 Alamance	C NSW	16-28b	15.2						G- F			ST	Jan-88	
	Collins Cr ab & be WWTP, Orange	C NSW	16-30-(1)	8.1				G- F				Sed	ST	Jan-88	NP,P
	Terrels Cr, NC 87 Chatham	WS-IV NSW	16-31-(2.5)a	4.0						G	F- G		S	Jul-92	
	Dry Cr, SR 1520 Chatham	WS-IV NSW	16-34-(0.7)	9.6						G			S	Jul-92	NP
02096960	Haw River near Pittsboro, US Hwy 64 and at 15/501	WS-IV NSW	16-(36.7)	3.4	PS		G			G		Turb(18)	S	Jul-92	
	Pokeberry Cr, SR 1711 Chatham	WS-IV NSW	16-37	8.1						G- F			ST	Jul-92	P
	Robeson Cr ab WWTP	WS-IV NSW	16-38-(3)a	0.9			Pr						NS	Jul-92	NP
02097189	Robeson Cr near Seaforth (also be WWTP)	WS-IV NSW	16-38-(3)b	4.7	PS		F					pH(12),Chla(20)	PS	Jul-92	NP
SUBBASIN 05															
	New Hope Cr, SR 1734, Orange	C NSW	16-41-1-(.5)	21.0						G			S	Mar-90	NP,P
02097299	Third Fork Cr near Blands, NC 751	WS-IV NSW	16-41-1-12-(2)	4.5	PS					Pr		Turb(18)	NS	Jul-92	NP
	Bolin Cr. SR 1777 and Village Rd, Orange (B2&B3)	C NSW	16-41-1-15-1-(.5)	9.0						G			S	Jan-88	
02097360	Bolin Cr at Chapel Hill, E. Franklin St. (benthci)	WS-IV NSW	16-41-1-15-1-(4)	1.0	S					F			PS	Jan-88	
	Northeast Cr at 1102, Durham	WS-IV NSW	16-41-1-17-(7)a	2.2						F	G		PS	Jan-88	NP
0209741955	Northeast Cr near Nelson/benthic at SR 1100 Durham	WS-IV NSW	16-41-1-17-(7)b	1.8	PS					F		Turb(14),Cu(14),Sed	PS	Mar-90	NP, P
	Northeast Cr at SR 1731, Chatham	WS-IV NSW	16-41-1-17-(7)c	4.4						F	Pr- F	Sed	PS	Jan-88	NP
	White Oak Cr. NC 751, Chatham	WS-IV NSW CA	16-41-6-(3.5)	0.5						F		Sed	PS	Jul-92	NP,P
02098198	Haw River below Jordan Dam near Moncure, NC	WS-IV	16-(42)	4.2	S								S	Jul-92	NP

Table 4.12 Use Support Information for Monitored Freshwater Stream Segments in the Cape Fear Basin (Sheet 2 of 5)

Station Number	Station Location	Classification	Index Number	Miles	Chemical Rating 89-93	<------ Biological Ratings------> Benthic Macroinvertebrates 1989	1990	1991	1992	1993	Fish 1993	Problem Parameters	Overall Use Support	Date Rated	Major Source
SUBBASIN 06															
	Morgan Cr at NC 54, Orange Co.	WS-II NSW	16-41-2-(1)	6.7						Ex	F		S	Jul-92	
	Pritchards Mill Cr, Damascus Rd, Orange	WS-II NSW CA	16-41-2-3-(2)	0.5						G- F			ST	Jan-88	
	Morgan Cr Botanical Trail, ab and below OWASA Dischar	WS-IV NSW	16-41-2-(5.5)	8.0			F			F		Sed	PS	Jul-92	NP,P
	Meeting of the Waters Cr, Laurel Hill Rd, Orange	WS-IV NSW	16-41-2-7	1.6						Pr			NS	Jan-88	NP
02097521	Morgan Cr near Farrington, SR 1726, Chatham	WS-IV NSW CA	16-41-2-(9.5)	0.6	S		F			F			PS	Jul-92	
SUBBASIN 07															
02102178	Cape Fear River at NC 42, Chatham Co.	WS-IV CA	18-(4.5)	0.5	S								S	Jul-92	NP
	Gulf Cr off SR 1916	WS-IV	18-5-(1)	5.1							Pr- F	Sed	NS		NP
02102192	Buckhorn Cr. near Corinth	C	18-7-(3)	9.4	S							Sed	S	Jul-92	
	Parkers Cr, SR 1450 Harnett, SR 1418, Harnett	C HQW	18-9	8.4						G			S	Mar-90	
	Hector Cr. SR 1412, Harnett Co.	WS-IV HQW	18-15	9.7							F		ST	Mar-90	
	Neills Cr. SR 1441, Harnett	WS-IV	18-16-(.7)	2.4						F		Sed	PS	Mar-90	
	Kenneth Cr. SR 2772, Be F-V Wake Co	WS-IV	18-16-1-(2)a	1.0			Pr						NS	Jul-92	NP,P
	Kenneth Cr SR1441 Harnett	WS-IV	18-16-1-(2)b	5.5						F	Pr		PS	Jul-92	NP
	UT to Kenneth Cr at SR 1447, Harnett Co.	C	18-16-1-1	0.8				G					S	Jul-92	P
02102500	Cape Fear River at NC 401, Harnett Co.	WS-IV	18-(16.7)	8.9	S		G			G			S	Jul-92	NP
SUBBASIN 08															
02099000	UT E Fork Deep R, I-40 Guilford, and SR 1541	WS-IV	17-2-(.3)	6.5	PS				F			Turb(11)	PS	Jul-92	NP,P
	W Fk Deep R, SR 1850, Guilford	WS-IV	17-3-(.3)	5.2						G- F			ST	Mar-90	
	W Fk Deep R, SR 1818, Guilford	WS-IV CA	17-3-(.7)	3.1									ST	Mar-90	
	Deep River at SR-1113, Guilford Co.	C	17-(4)a	2.0									PS	Jul-92	NP
02099500	Deep River near Randleman, SR-1921	C	17-(4)b	6.8	PS	F	F					Turb(14)	PS	Mar-90	NP
	Deep R, Randeleman, NC 220 Bus, Randolph	C	17-(4)c	9.0						G- F			ST	Jan-88	NP
02100219	Deep R, SR 2122, Randolph	C	17-(4)d	2.3	PS							Turb(13),Cu(13), Hg(13),Fecal	PS	Mar-90	NP
02099484	Richland Cr at SR 1145 near High Point, NC	C	17-7	9.1	PS					F		Turb(11),Cu(16)	PS	Jul-92	NP,P
	Hickory Cr, SR 1131, Guilford	C	17-8-3	6.5						F			ST	Mar-90	
	Muddy Cr at SR 1929, Randolph Co.	C	17-9	10.9						G- F	G- F		ST	Jul-92	NP
SUBBASIN 09															
02100500	Deep River at Ramseur, NC	C	17-(4)f	5.3	PS	G- F				G- F		Turb(25)	ST	Jul-92	P
02100747	Deep River at SR-1461, Moore Co. (also = 1456)	C HQW	17-(4)h	16.6	S					Ex			S	Mar-90	NP
	Polecat Cr at NC 220 Bus.	WS-III	17-11-(1)a	0.7			G						S	Jul-92	
	Polecat Cr at SR 2113, Randolph Co.	WS-III	17-11-(1)b	13.0						G			S	Jul-92	P
	UT Polecat Cr, nr SR 3430, Guilford	WS-III	17-11-2-(2)	1.4			Pr						NS	Jan-88	
	Little Polecat Cr at SR 2108 & SR 2113,Randolph Co	WS-III CA	17-11-3	6.3						Ex			S	Jan-88	NP
	Hasketts Cr, SR 2149, and be SR 2149	C	17-12a	5.5			F						PS	Jul-92	
0210029550	Hasketts Cr at SR-2128, Randolph Co	C	17-12b	2.3	NS		F					Cu(33)	PS	Jul-92	NP
	Sandy Cr. SR 2261 Randolph	WS-III	17-16-(1)a	12.1		G/F						Sed	ST	Jul-92	NP
	Sandy Cr. at SR 2481, Randolph	WS-III	17-16-(1)b	10.2		G				G	G		S	Jul-92	
	Mt Pleasant Cr, SR 2442, Randolph	WS-III	17-16-3	7.0		G							S	Mar-90	
	Richland Cr SR 2873, Randolph	C	17-22	15.8						G			S	Jul-92	NP
	Brush Cr at SR 1102 Chatham	C	17-23a	11.0			G						S	Jan-88	NP
	Brush Cr at NC 22, Randolph Co.	C	17-23b	13.3			Ex			G- F			ST	Jan-88	NP
	UT to Little Brush Cr SR 1100, Chatham Co.	C	17-23-2a	6.6			G						S	Jul-92	NP
	UT to Little Brush Cr at SR 1005, Randolph Co.	C	17-23-2b	5.2			G- F						ST	Jul-92	NP
	Flat Cr. SR 2886 Randolph	C	17-24	9.5						F			PS	Jul-92	NP
	Fork Cr. SR 2873 Randolph	C	17-25	15.7						G- F			ST	Mar-90	NP
SUBBASIN 10															
021012530	Deep River at NC 22, Moore Co.	C HQW	17-(25.7)	12.8	S	G							S	Mar-90	NP,P
	Cabin Cr SR 1400 Moore Co	WS-III	17-26-5-(1)a	7.1						G			S	Jan-88	NP

Table 4.12 Use Support Information for Monitored Freshwater Stream Segments in the Cape Fear Basin (Sheet 3 of 5)

Station Number	Station Location	Classification	Index Number	Miles	Chemical Rating	<------ Biological Ratings------>						Problem Parameters	Overall Use Support	Date Rated	Major Source
						Benthic Macroinvertebrates					Fish				
					89-93	1989	1990	1991	1992	1993	1993				
	Cabin Cr SR 1281	WS-III	17-26-5-(1)b	2.6					G- F			Sed	ST	Feb-88	NP
	Cabin Cr SR 1275 Moore	WS-III	17-26-5-(1)c	12.2					G				S	Jan-88	NP
	Cotton Cr. at SR 1372	WS-III	17-26-5-3-(1)a	0.3					F				PS	Mar-90	NP,P
	Cotton Cr. at SR 1370	WS-III	17-26-5-3-(1)b	6.5					F				PS	Jul-92	NP
	Mill Cr nr SR 1275	WS-III	17-26-5-4	10.5						G			S	Jan-88	
	Wet Cr NC 24, Moore	WS-III	17-26-5-5	10.6						G			S	Jan-88	
02101001	Bear Cr at Robbins, NC Hwy 705	C	17-26-(6)	6.3	S					G- F	G- Ex		S	Jul-92	
	Falls Cr SR 1606 Moore	C	17-27	11.6						F		Sed	PS	Jan-88	NP
	Buffalo Cr NC 22 Moore	C	17-28	16.4						G- F		Sed	ST	Feb-88	NP
02101402	Deep River NC 42, Chatham	WS-IV HQW	17-(28.5)	14.4	S								ST	Jan-88	NP
	Mclendons Cr. at SR 1628 Moore Co	C	17-30b	20.1						F			PS	Jul-92	
	Richland Cr, SR 1640 Moore County	C	17-30-5-(2)	12.8							F		PS	Jan-88	
	Big Gov Cr. SR 1625 Moore Co	WS-IV	17-32-(.7)	9.5						Pr			NS	Jan-88	
SUBBASIN 11															
	Indian Cr SR 2306, Chatham	WS-IV	17-35	8.2						Pr		Sed	NS	Jan-88	NP
	Deep River at SR 1007, Lee Co.	WS-IV	17-(36.5)	11.2						G			ST	Jul-92	
	Little Pocket Cr, NC 42, Lee	C	17-37-4	12.4						F			PS	Jan-88	NP
	Cedar Cr. SR 2142, Chatham	C	17-39	7.9						F		Sed	PS	Mar-90	NP
	Big Buffalo Cr. SR 1403, Lee	C	17-40	8.3						Pr	G	Sed	S	Jan-88	NP
	Georges Cr. SR 2142	C	17-41	8.7						F			PS	Mar-90	
02101577	Deep River at NC 87, Lee Co. (15/501)	WS-IV	17-(41.5)a	1.1	PS					G		Turb(13)	ST	Jul-92	P
02102049	Deep R. CSX RR bridge at Moncure, Chatham	WS-IV	17-(41.5)b	10.8	S								S	Jul-92	
	Little Buffalo Cr SR 1420, Lee	WS-IV	17-42	9.8						Pr		Sed	NS	Feb-88	NP
SUBBASIN 12															
	Rocky River at NC 64 Chatham	C	17-43-(8)a	4.2		F				F			PS	Mar-90	
	Rocky River at SR 2170	C	17-43-(8)b	4.8		F				G- F			ST	Mar-90	
	Rocky River at NC 902	C	17-43-(8)c	6.8		G							S	Mar-90	
02101946	Rocky River at NC 15-501	C	17-43-(8)d	9.5	S		G			G			S	Mar-90	
	Loves Cr. above WWTP nr SR 2203, Chatham Co.	C	17-43-10a	5.5		F							PS	Mar-90	NP
	Loves Cr. below WWTP nr SR 2203, Chatham Co.	C	17-43-10b	0.9		Pr							NS	Mar-90	NP,P
	Tick Cr at NC-421	C	17-43-13	15.6							G		S	Jul-92	
	Landrum Cr. NC 902, Chatham	C	17-43-14	10.0			G/F						ST	Jan-88	
	Harlands Cr, NC 902, Chatham	C	17-43-15	10.2			G/F						ST	Mar-90	NP
	Bear Cr. at SR 2333, SR 2189, Chatham Co.	C	17-43-16a	14.9				F				Sed	PS	Jul-92	
	Bear Cr. at SR 2155, Chatham	C	17-43-16b	9.8			G- F					Sed	ST	Jul-92	
SUBBASIN 13															
	Upper Little River at SR-1222, Harnett Co.	C	18-20-(8)a	2.4						G- F			ST	Jul-92	
	Upper Little River at NC 27, Harnett Co.	C	18-20-(8)b	22.0						G			S	Jul-92	
	Barbeque Cr SR 1209	C	18-20-13	11.6						G- F			ST	Mar-90	NP
	Upper Little River SR-2016, ab Becker, Harnett Co.	WS-IV	18-20-(23.5)a	15.6				G					S	Jul-92	
	Upper Little River SR-2016, be Becker, Harnett Co.	WS-IV	18-20-(23.5)b	0.5				G- F					ST	Jul-92	
02102634	Upper Little River near Erwin, SR-2021, Harnett Co.	WS-IV	18-20-(23.5)c	5.3	PS			G		G		pH(11)	S	Jul-92	
02102696	Cape Fear River, NC 217 near Erwin, Harnett Co.	WS-V	18-(20.7)	12.2	S					Ex			S	Jul-92	NP,P
SUBBASIN 14															
	Nicks Cr, NC 22, Moore Co.	WS-III	18-23-3-(3)	2.3						G- F			ST	Mar-90	NP
02102897	Little River (Lower) at SR 2023, Moore Co.	WS-III HQW	18-23-(10.7)	12.8	NS		Ex			Ex		pH(64)	S	Jul-92	
	James Cr Near SR 2023, Hoke Co.	WS-III	18-23-13a	0.7			G						S	Jul-92	
	Horse Cr, Manchester Rd. , Hoke Co.	WS-III	18-23-14	3.4			G- F						ST	Jul-92	
02102980	Flat Cr, Manchester Rd. , Hoke Co.	WS-III	18-23-15	6.3	NS		G					pH(94)	S	Jul-92	
	Mill Cr, Manchester Rd., Hoke Co.	WS-III	18-23-17-1	3.2			G- F						ST	Jul-92	NP
	Jumping Run Cr, Manchester Rd., Hoke Co.	WS-III	18-23-20	4.0			G- F					Sed	ST	Jul-92	NP

Table 4.12 Use Support Information for Monitored Freshwater Stream Segments in the Cape Fear Basin (Sheet 4 of 5)

Station Number	Station Location	Classification	Index Number	Miles	Chemical Rating	<------ Biological Ratings------>						Problem Parameters	Overall Use Support	Date Rated	Major Source
						Benthic Macroinvertebrates					Fish				
					89-93	1989	1990	1991	1992	1993	1993				
	McPherson Cr at Manchester Rd., Cumberland Co.	WS-III	18-23-25	4.8			G- F						ST	Jul-92	
02103000	Little River (Lower) Manchester Rd, NC - NC 87/24	C	18-23-(24)a	3.0	PS		G- F			G		pH(12)	S	Jul-92	NP
	Little River (Lower), NC 401 Cumberland	C	18-23-(24)b	25.3						Ex			S	Jul-92	NP
	Jumping Run Cr, NC 210 Cumberland	C	18-23-29	8.5						G- F			ST	Mar-90	NP
	Anderson Cr SR 2031, Harnett	C	18-23-32	5.5						F		Sed	PS	Mar-90	NP
SUBBASIN 15															
02104000	Cape Fear R. at NC HWY 24 Fayetteville, Cumberland	C	18-(26)b	2.0	S					G			S	Jul-92	
	Cross Cr ab & be UT, Cumberland Co.	WS-IV	18-27-(1)	9.0			F					Sed	PS	Jul-92	
02103997	Cross Cr at Fayetteville, NC Hwy 301, & 87/210, Cumberla	C	18-27-(3)	3.6	PS					F		Pb(13)	PS	Jan-88	NP
	Little Cross Cr above Bonnie Doone, Cumberland Co.	WS-IV	18-27-4-(1)	7.0			Pr						NS	Mar-90	
	Rockfish Cr at Plank Rd, Hoke	C	18-31-(1)	14.8			G- F						ST	Jan-88	NP
	Juniper Cr at Plank Rd., Hoke Co.	C	18-31-10	8.2			G						S	Jul-92	
	Pedler Branch at NC 20, NC401, Hoke Co.	C	18-31-16	2.6			Pr						NS	Jul-92	NP
02104380	Beaver Cr at Cumberland, SR-1141	C	18-31-17	7.9	S								S	Jan-88	NP
0210426450	Rockfish Cr SR 1432 near Raeford, Hoke Co.	B	18-31-(18)a	0.3	NS		G- F			Ex		pH(51)	S	Jul-92	NP
	Rockfish Cr at SR 1115, Cumberland Co.	B	18-31-(18)b	14.3			G- F						ST	Jul-92	
	Puppy Cr at Plank Rd., Hoke Co.	C	18-31-19	10.7			G- F					Sed	ST	Jul-92	NP
02104500	Rockfish Cr US 301, I-95, NC 87, Ambient at I-95.	C	18-31-(23)	9.1	PS		Ex			Ex		pH(14)	S	Jul-92	NP
	Little Rockfish Cr, Plank Rd, Hode	C	18-31-24-(1)	12.0			G/F						ST	Feb-88	NP
	UT#1 to Bones Cr below Sunset MHP, Cumberland Co.	C	18-31-24-2a	0.0			Pr						NS	Jul-92	
	UT#2 to Bones Cr at SR-1400, Cumberland Co.	C	18-31-24-2b	0.0			G- F						ST	Jul-92	
	Little Rockfish Cr NC 59 Cumberland	C	18-31-24-(4)	3.6						G			S	Feb-88	NP
	Little Rockfish Cr at SR 1131 be lake, Cumberland Co.	C	18-31-24-(7)	2.2			G- F						ST	Jul-92	NP
SUBBASIN 16															
02105500	Cape Fear River ab Carolina Foods, (Huske Lock, SR 1355	C	18-(26)d	11.0	S				G- F	G- F			ST	Jul-92	P
02105512	Cape Fear be Carolina Foods, SR 1316, Bladen	C	18-(26)e	7.6	S				G- F				ST	Jan-88	
02105544	Cape Fear at Lock & dam #2 near Elizabethtown, Bladen	C	18-(26)f	27.4	S					G- F			ST	Jan-88	P
02105520	Harrisons Cr at White Oak, SR-1320	C	18-42	20.5	NS					F		pH(100), Sed	PS	Jul-92	NP
	Ellis Cr, NC 53, Bladen	C	18-44	13.7						G- F			ST	Jan-88	
	Browns Cr, NC 87, Bladen Co.	C	18-45	9.0							G	Sed	S	Jan-88	NP
0210563128	Turnbull Cr near Elizabethtown, NC Hwys 41/53	C	18-46	27.2	NS							pH(100), Sed	PS	Jul-92	NP
	Cape Fear at Kelly, SR 1730, Bladen	WS-IV	18-(53.5)	13.4			F			G- F			ST	Jul-92	NP
	Cape Fear ab Federal Paper	WS-IV Sw CA	18-(62.5)	0.5						G- F			ST	Jul-92	NP
SUBBASIN 17															
02105825	Cape Fear R Above Neils Eddy Landing near Acme, Colum	C Sw	18-(63)a	2.1	S					F			PS	Mar-90	P
02107570	Cape Fear R. below Hale Point Landing near Phoenix, Brun	C Sw	18-(63)b	23.5	S								S	Mar-90	
	Livingston Cr, NC 74, Columbus	C Sw	18-64a	14.5						F			PS	Mar-90	
02105814	Livingston Cr, SR 1878, Columbus	C Sw	18-64b	7.7	PS		Pr					NH3(13)	NS	Mar-90	
SUBBASIN 18															
	South River at NC-13, Sampson Co.	C Sw	18-68-12a	7.2		F							PS	Jul-92	
	South River at NC 242, Sampson Co.	C Sw	18-68-12b	29.5		Ex							S	Jul-92	
	Black river at NC 421, Harnett	C Sw	18-68-12-1a	20.0		F						Sed	PS	Jul-92	NP
02107000	South River nr Parkersburg, SR-1502 Bladen & NC 701, Sa	C Sw ORW +	18-68-12-(8.5)	42.0	S					Ex	G		S	Jul-92	
	Big Swamp, SR 1246, Sampson	C Sw	18-68-12-8	9.0		G- F							ST	Jan-88	
SUBBASIN 19															
02106500	Black River near Tomahawk, NC Hwy 411	C Sw ORW +	18-68-(0.5)	5.0	S	Ex				Ex			S	Jul-92	NP
	Great Coharie Swamp at SR-1214, Sampson Co.	C Sw	18-68-1b	45.2		G				G	F- G		S	Jul-92	P
	Great Coharie Swamp at SR-1636, Sampson Co.	C Sw	18-68-1a	0.9							F		ST	Jul-92	P
02106000	Little Coharie Cr at SR 24 near Roseboro, Sampson	C Sw	18-68-1-17a	25.0	S					G			S	Jul-92	
	Little Coharie Cr at SR 1214 and 1207, Sampson Co.	C Sw	18-68-1-17b	13.7		G				G- F	Pr- F		ST	Jul-92	
	Six Runs Cr at SR 1004, Sampson Co.	C Sw	18-68-2a	19.7		G							S	Jul-92	

Table 4.12 Use Support Information for Monitored Freshwater Stream Segments in the Cape Fear Basin (Sheet 5 of 5)

Station Number	Station Location	Classification	Index Number	Miles	Chemical Rating	<------ Biological Ratings------>						Problem Parameters	Overall Use Support	Date Rated	Major Source
						Benthic Macroinvertebrates					Fish				
					89-93	1989	1990	1991	1992	1993	1993				
0210643010	Six Runs Cr at SR 1960, Sampson Co.	C Sw	18-68-2b	6.3	S					Ex			S	Jul-92	
	Six Runs Cr at SR 1130 and 1003, Sampson Co.	C Sw	18-68-2c	10.3		Ex							S	Jul-92	
	Stewarts Cr at SR 1943, Sampson Co.	C Sw	18-68-2-10	13.7		G/F						Sed	ST	Jul-92	
SUBBASIN 20															
	Black River at Turlingtons, Pender	C Sw ORW +	18-68-(11.5)a	10.1									S	Jul-92	
02017229	Black River near Atkinson, NC 11	C Sw ORW +	18-68-(11.5)b	3.7	S	Ex	G/F	G		Ex			S	Jul-92	
0210756250	Black R. downstream Raccoon Is. near Huggins, NC	C Sw ORW +	18-68-(11.5)c	20.6	S								S	Jul-92	
SUBBASIN 21															
02107586	NE Cape Fear River near Mount Olive, SR-1937(Wayne Co	C Sw	18-74-(1)a	3.3	NS					Pr		DO(39),NH3(15),Cl(20)	NS	Mar-90	
	NE Cape Fear R, NC 403, Duplin	C Sw	18-74-(1)b	2.6						F		Sed	PS	Jan-88	NP
	NE Cape Fear R, SR 1948, Duplin	C Sw	18-74-(1)c	3.5						G- F		Sed	ST	Jan-88	NP
	NE Cape Fear at NC-11, Duplin Co.	C Sw	18-74-(1)d	12.3						Ex			S	Jan-88	NP
	Barlow Br at Faison, Duplin	C Sw	18-74-2	1.1						Pr			NS	Jan-88	NP,P
	Buck Marsh Br, NC 111, Duplin Co	C Sw	18-74-8	5.1						G- F		Sed	ST	Jan-88	NP
SUBBASIN 22															
02108000	NE Cape Fear River near Chinquapin, NC Hwy 41	C Sw	18-74-(1)e	22.6	S	Ex				Ex			S	Jan-88	P
	Goshen Swamp at SR 1302 Wayne, NC 117 and NC 403 D	C Sw	18-74-19	32.6						F		Sed	PS	Jul-92	NP
	Panther Cr Below Faison Ut, Duplin Co.	C Sw	18-74-19-3b	3.0						Pr			NS	Mar-90	P
	Halls Marsh at SR 1306, Duplin Co.	C Sw	18-74-19-11	4.1			G- F	F	G- F	G- F	F		ST	Jul-92	
	Herrings Marsh Run at SR 1508, Duplin Co.	C Sw	18-74-19-16	1.8				G- F	F	F			PS	Jul-92	
	Herrings Marsh Run at SR 1306 , Duplin Co.	C Sw	18-74-19-16b	3.9			F	G- F	G- F	G- F	Pr- F		ST	Jul-92	
	UT to Grove Cr at SR 1376, Duplin Co.	C Sw	18-74-21a	0.0			G- F				G- Ex		S	Jul-92	
	Limestone Cr nr Hadley, nr NC Hwy 24	C Sw	18-74-23	7.5							G	Sed	PS	Feb-88	NP
	Limestone Cr SR 1702, Duplin	C Sw	18-74-23	3.0						Ex		Sed	S	Feb-88	NP
02107985	Stockinghead Cr, SR 1956, Duplin	C Sw	18-74-24	9.5	S					G- F			ST	Jul-92	
	Muddy Cr, NC 41, Duplin	C Sw	18-74-25	10.5						G- F		Sed	ST	Mar-90	NP
	Persimon Br ab WWTP	C Sw	18-74-25-1a	1.5			F						PS		
	Persimon Br be WWTP	C Sw	18-74-25-1b	0.8			Pr						NS		
	Rock Fish Cr, SR 1165, Duplin	C Sw	18-74-29b	4.9						G- F		Sed	ST	Mar-90	NP
01208563	Rock Fish Cr, I-40 near Wallace	C Sw	18-74-29c	7.2	PS					F		Cu(16),Sed	PS	Mar-90	NP,P
SUBBASIN 23															
02108585	Angola Cr near Maple Hill, NC Hwy 53	C Sw	18-74-33-3	8.9	S								S	Mar-90	NP
	Burgaw Cr at US 117 and SR 1624 Pender Co	C Sw	18-74-39b	10.7							Pr- F	Sed	NS	Mar-90	NP
02108619	Northeast Cape Fear R, US Hwy 117 at Castle Hayne, New	B Sw	18-74-(47.5)	15.8	S		G- F			G- F			ST		
	Cypress Cr SR 1216 Pender Co	C Sw	18-74-55-2	8.0							F		PS	Jan-88	NP

EXPLANATION OF COLUMN HEADINGS

Station Number - Ambient water quality monitoring station location number (see Section 4.2.7)

Station Location - Narrative site locations for all ambient, benthic macroinvertebrate and fish community sites (see Figures 4.5 to 4.16 for locations by subbasins)

Stream Classifications - See Section 2.6 and Appendix I for explanations

Index Number - Identification number used by DEM to identify specific stream segments

Miles - Length of stream segment being rated

Chemical Rating - Use support ratings based on water quality data collected at ambient monitoring sites Ratings based on parameters shown in Table 4.1. See Section 4.4 for rating methodology.

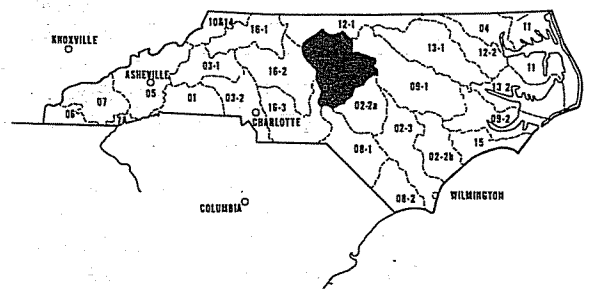
Biological Ratings - Water quality ratings based on benthic macroinvertebrate (aquatic insect larvae) sampling (see Section 4.2.1) and fish community assessments (Section 4.2.2).

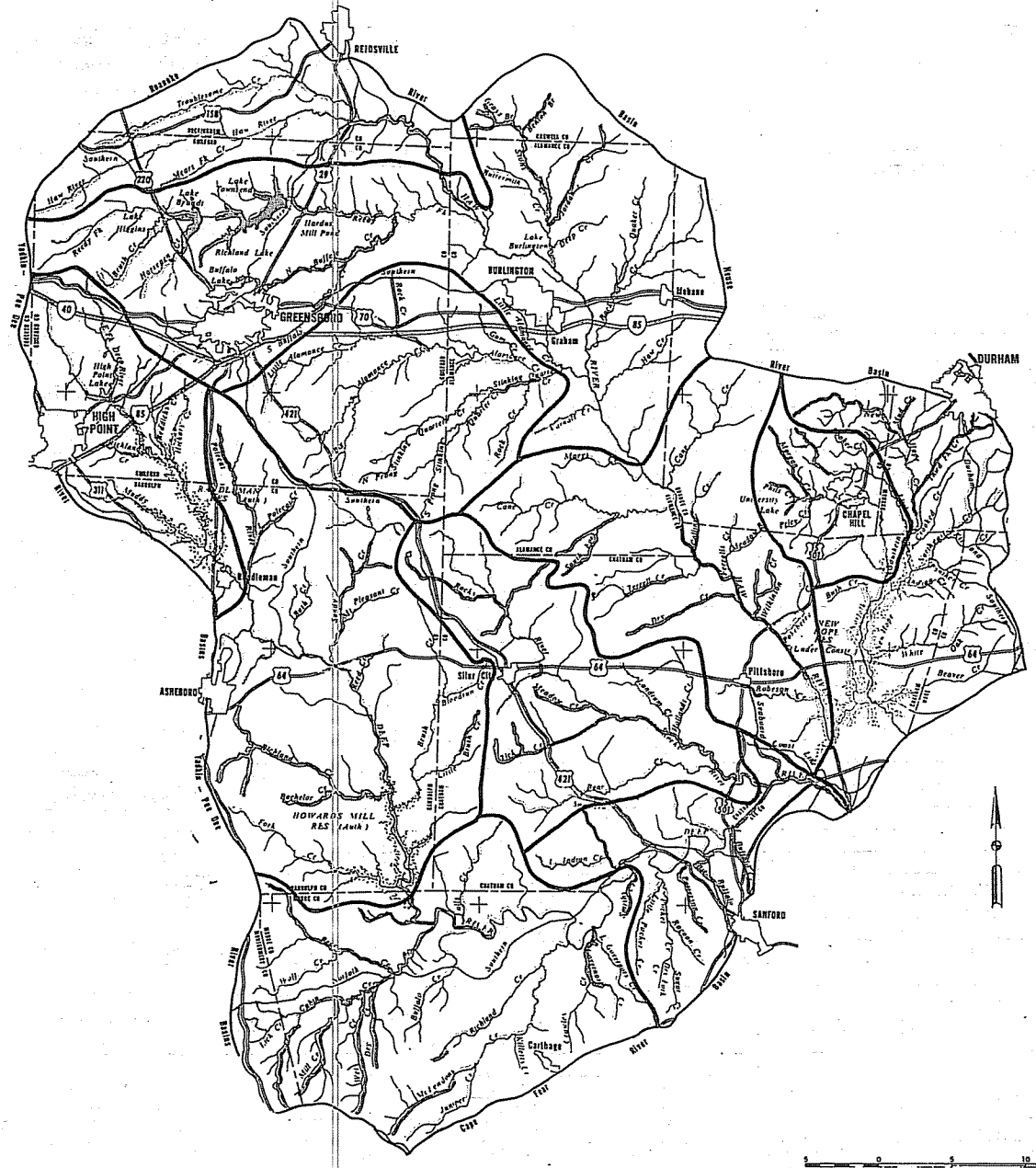
Overall Use Support - Use support rating based on both chemical and biological water quality data. (Section 4.4)

ABBREVIATIONS

Cd	Cadmium
Chla	Chlorophyll-a
Cu	Copper
Do	Dissolved oxygen
Ex	Excellent biologcial rating
Fecal	Fecal coliform bacteria
G	Good biological rating
G-F	Good-Fair biological rating
Hg	Mercury
NH3	Mercu.mmonia
NP	Nonpoint sources of pollution (e.g., pollution from stormwater runoff)
P	Point source pollution (e.g., from wastewater treatment plant discharges)
Pb	Lead
pH	Indicates that waters are sometimes found to be too acidic (<6 pH)
Pr	Poor biological rating
Sed	Sedimentation
Turb	Turbidity

Cape Fear River Basin #1





- Supporting
- Supporting - threatened
- Partially Supporting
- Not Supporting

Cape Fear River Basin #1

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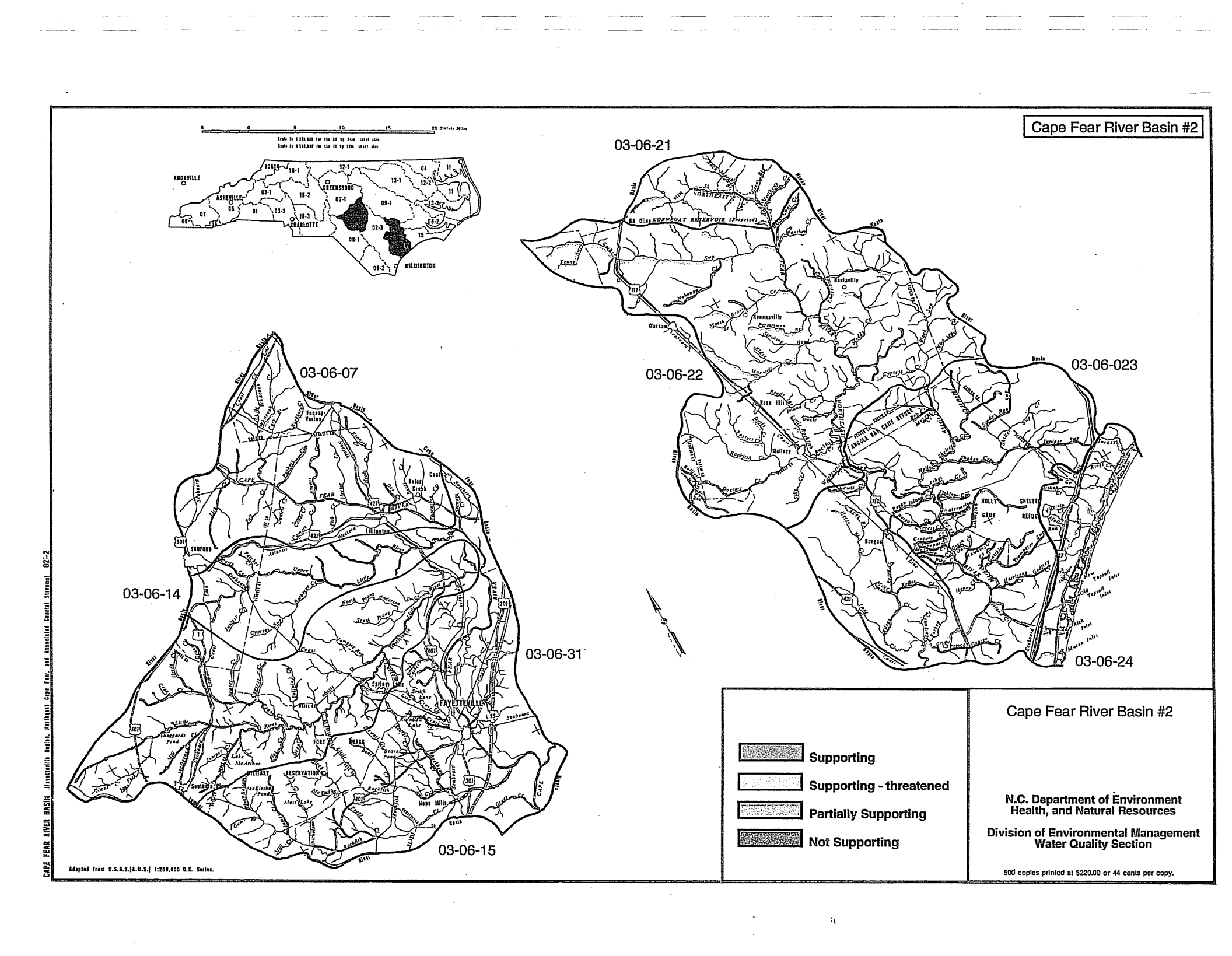
Cape Fear River Basin #2
03-06-21
03-06-22
03-06-023
03-06-24
03-06-07
03-06-14
03-06-31
03-06-15
Supporting
Supporting - threatened
Partially Supporting
Not Supporting
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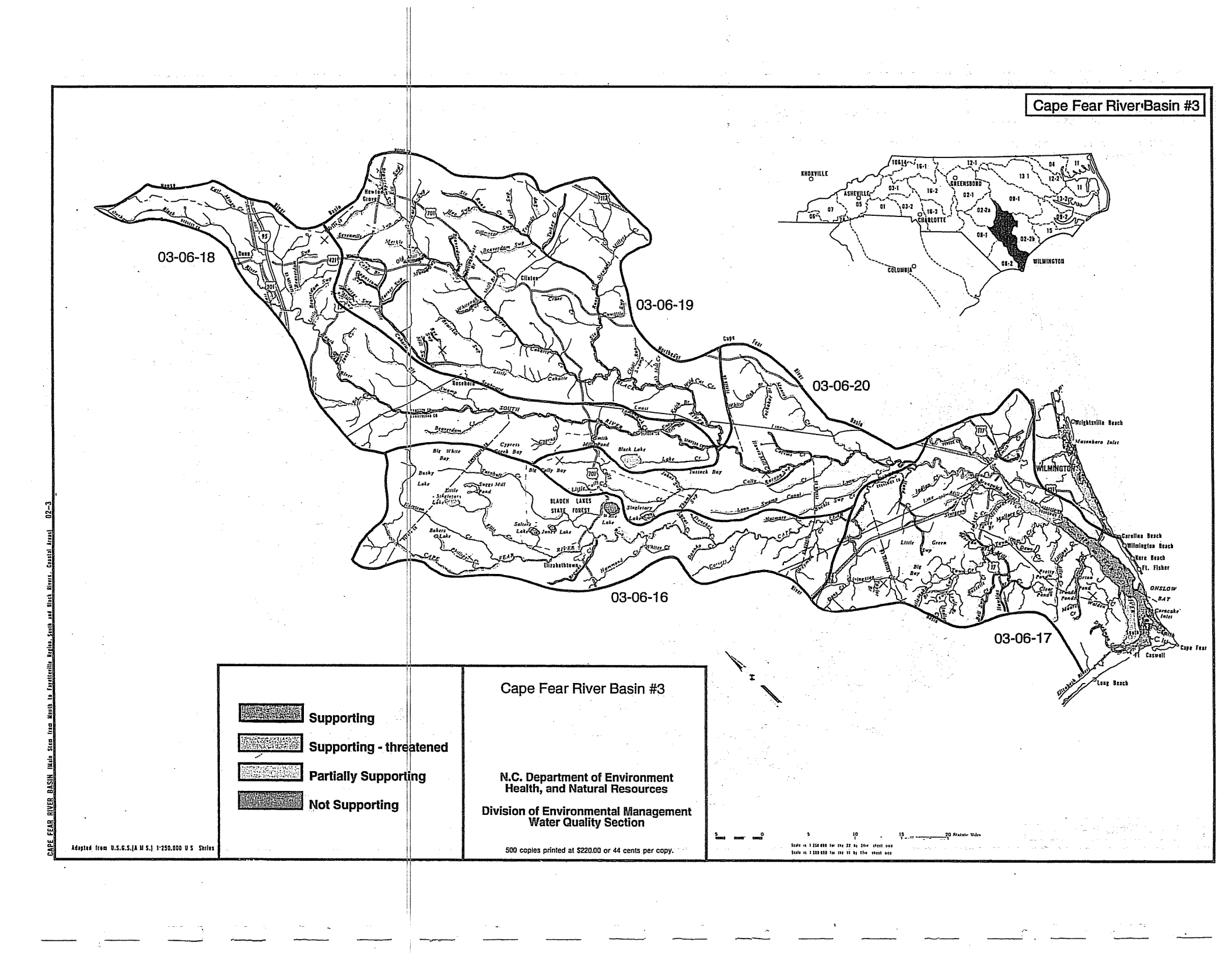
Cape Fear River Basin #3
03-06-18
03-06-19
03-06-20
03-06-16
03-06-17
KNOXVILLE
ASHEVILLE
GREENSBORO
CHARLOTTE
COLUMBIA
WILMINGTON
Cape Fear River Basin #3
Supporting
Supporting - threatened
Partially Supporting
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CAPE FEAR RIVER BASIN (Main Stem from Mouth to Fayetteville, Haw, South and Black Rivers, Coastal Areas) 02-3

Table 4.13 Use Support Ratings for Freshwater Streams by Subbasin

USE SUPPORT STATUS FOR FRESHWATER STREAMS (MILES) (1989-1993)						
Subbasin	S	ST	PS	NS	NE	Total Miles
30601	24.4	34.5	39.4	6.5	12.5	117.3
30602	89.5	223.2	63.3	37.2	40.7	453.9
30603	19.1	107.4	43.6	0	17.2	187.3
30604	70.1	103.8	36.1	4.8	36.3	251.1
30605	65.4	48.1	57.4	29.7	50.3	250.9
30606	17.2	11.4	11	3.2	11.5	54.3
30607	120.9	80.3	44.4	8.1	22.7	276.4
30608	2.7	55.3	39.5	3.3	22.4	123.2
30609	146.2	137.8	23.5	1.4	1.8	310.7
30610	151.1	78.8	56.5	9.5	19.9	315.8
30611	40.2	17.8	60.7	18	10.5	147.2
30612	70.8	67.6	24.6	0.9	11.2	175.1
30613	151.7	64.2	16.4	0	7.8	240.1
30614	294.4	70.2	17.8	0	34.6	417
30615	149.1	119.9	45.5	31.9	21.1	367.5
30616	20.9	211.1	54.2	0	39.1	325.3
30617	120.6	100.2	56.4	25.5	80	382.7
30618	94.6	70.1	51.3	0	42.5	258.5
30619	249.2	147.9	33.9	0	14	445
30620	65.5	131.1	19.8	0	6.3	222.7
30621	37.7	34.4	6.5	4.4	3.3	86.3
30622	135.1	75.8	103.8	6.6	81.9	403.2
30623	217	116.3	24.4	19.1	15.7	392.5
TOTAL	2353.4	2107.2	930	210.1	603.3	6204
PERCENTAGE	38	34	15	3	10	

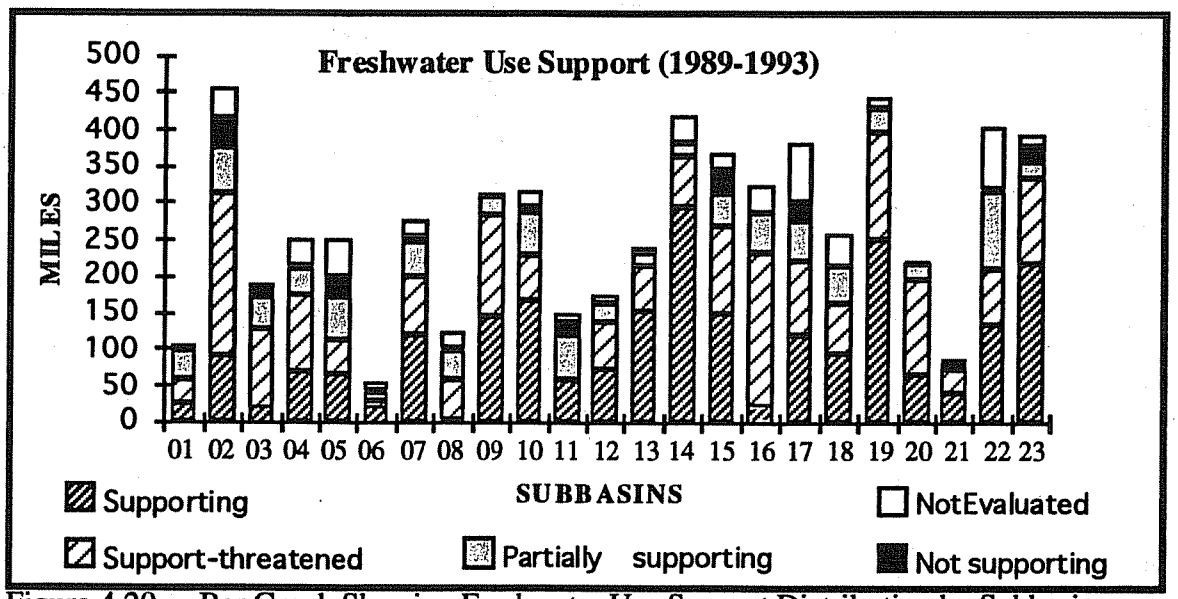

Figure 4.20 Bar Graph Showing Freshwater Use Support Distribution by Subbasin

Table 4.14 Sources of Use Support Impairment in Freshwaters of the Cape Fear River Basin

Subbasin	Nonpoint Source	Point Source	Agric	Forestry	Const	Urban Runoff	Mining	Land Disposal	Hydro-mod	Not known	Other
03-06-01	39.4	33.6	30.7	0	0	0	0	0	0	0	0
03-06-02	67.2	34.7	19.9	0	0	43.8	8.5	0	0	0	8.5
03-06-03	43.6	36.7	43.6	0	6.9	0	0	0	0	0	0
03-06-04	21.1	0	17.2	0	0	5.6	0	0	0	0	0
03-06-05	72.3	5.8	11.9	0	35.9	29.8	0	8.9	0	0	0
03-06-06	11.2	8.6	0	0	0	9.6	0	0	0	0	0
03-06-07	48.4	5.2	20.1	0	8.5	0	5.3	0	0	14.9	0
03-06-08	39.2	25.7	15.6	2.3	16.9	6.8	10.1	9.1	0	0	0
03-06-09	18	0	9.5	9.5	6.2	6.2	0	0	0	0	0
03-06-10	20.7	0.3	18.1	0	0	6.5	0	0	0	2.3	0
03-06-11	64.8	0	47.1	0	0	9.8	9.8	0	0	0	0
03-06-12	6.4	0.9	0.9	0	0	0	0	0	0	0	0
03-06-13	16.4	0	14.4	0	0	0	0	0	0	2	0
03-06-14	17.8	0	10.1	0	0	0	0	0	0	7.7	0
03-06-15	44.1	0	5.9	0	18.1	40.8	0	16.5	0	0	13.9
03-06-16	54.2	0	32.2	0	0	0	0	0	0	22	0
03-06-17	57.6	18.6	3.4	11.7	48.7	13	0	16.5	3.4	4.2	11.7
03-06-18	44.1	0	44.1	0	0	0	0	0	0	0	0
03-06-19	33.9	0	21.2	0	0	0	0	0	0	12.7	0
03-06-20	14.3	0	14.3	0	0	0	0	0	14.3	0	0
03-06-21	3.7	1.1	0	0	0	1.1	0	0	0	0	2.6
03-06-22	87.6	10.2	73	0	0	7.7	0	14.6	7.5	0	0
03-06-23	43.5	0	8.4	0	8.4	19.1	0	27.1	8.4	16.4	0
Total Miles	869.5	181.4	461.6	23.5	149.6	199.8	33.7	92.7	33.6	82.2	36.7
% PS & NS	76	16	40	2	13	18	3	8	3	7	3

Table 4.15 Major Causes of Use Support Impairment in Freshwaters in the Cape Fear River Basin

SUBBASIN	NH3	Sediment	pH	Turbidity	Metals	Fecal Coliform
01	0	25.7	0	6.5	0	0
02	12.8	30.9	0	17.9	18.2	26.4
03	0	23.5	0	0	0	0
04	0	3.9	4.7	0	0	0
05	0	37.9	0	6.3	1.8	0
06	0	9.6	0	0	0	0
07	0	44	0	0	0	0
08	0	0	0	24.7	11.4	0
09	0	0	0	0	2.3	0
10	0	13.9	0	0	0	0
11	0	57.6	0	0	0	0
12	0	14.9	0	0	0	0
13	0	6.4	0	0	0	0
14	0	10.1	0	0	0	0
15	0	49.5	0	0	3.6	0
16	0	54.2	47.7	0	0	0
17	7.7	52.1	0	0	0	0
18	0	31	0	0	0	0
19	0	27.1	0	0	0	0
20	0	14.3	0	0	0	0
21	3.3	2.6	0	0	0	0
22	0	68.4	0	0	7.2	0
23	0	35.5	0	0	0	0
Total Miles	23.8	613.1	52.4	55.4	44.5	26.4
% of PS & NS	2	54	5	5	4	2

Table 4.16 Estuarine Use Support Status for Division of Environmental Health (DEH) Shellfish Growing *Areas (acres)

	Total	DEH	Overall Use Support				Major Causes			Major Sources		
Area Name	Acres	*Area	S	ST	PS	NS	Fecal	DO	Chl-a	Point	NPS	Sources of impairment
Southport	1,325	B1	695	0	630	0	630			290	340	WWTP, ag, septic tanks, urban runoff
Buzzard Bay	2,850	B2	2,735	0	5	0	115				115	marina
The Basin	275	B3	274	0	1	0	1				1	marina
Cape Fear	20,000	B4	12,500	0	7,500	0	2,500	5,000		1,939	5,561	WWTP, ag, urban runoff, industry
Myrtle Sound	2,300	B5	2,075	0	225	0	225				225	urban runoff, septic tanks, marinas
Masonboro Snd	1,600	B6	1,318	0	282	0	282			80	202	WWTP, urban runoff, septic tanks, marinas
Wrightsville Bch	2,150	B7	1,563	0	5872	0	587				587	urban runoff, septic tanks, marinas
Topsail Sound	5,700	B8	5,290	0	410	0	410				410	ag, urban runoff, septic tanks, marinas
Stump Sound	3,000	B9	2,800	0	200	0	190	10		50	150	WWTP, ag, urban runoff, septic tanks
Acres	39,200		29,251	0	9,804	0	4,939	5,010	0	2,118	7,590	
Percent (%)	100.0		74.6	0.0	25.9	0.0	49.6	51.1	0.0	23.7	76.3	

Key to Abbreviations

S	Supporting uses	Fecal	Fecal coliform bacteria
ST	Support-threatened	DO	Dissolved Oxygen
PS	Partially supporting uses	Chl-a	Chlorophyll *a*
NS	Not supporting uses	ag	Agriculture

* Shellfish growing areas for the Cape Fear River Basin are shown in figure 4.21

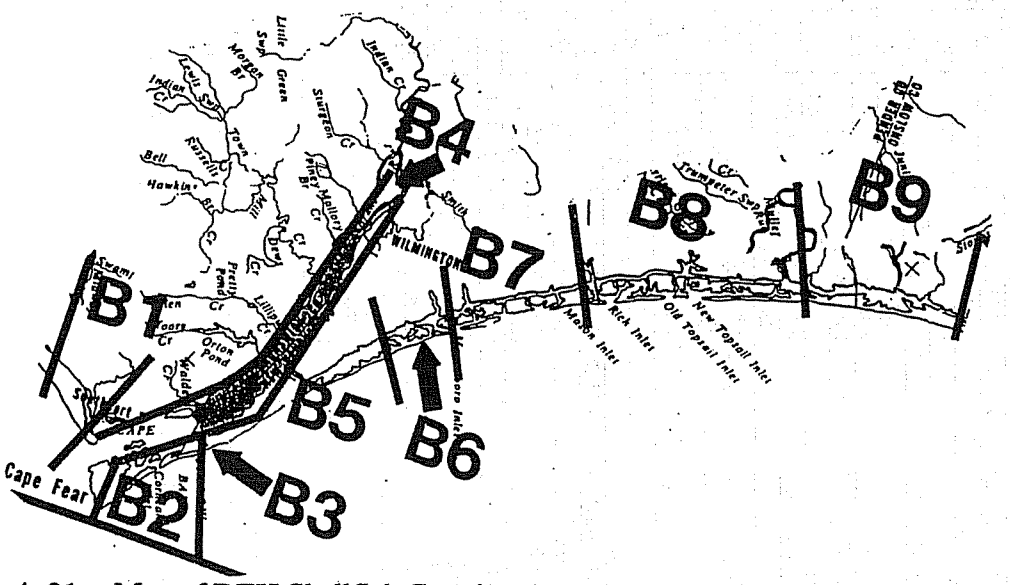

Figure 4. 21 Map of DEH Shellfish Growing Areas in the Cape Fear River Basin

Table 4.17 Use Support Ratings for Lakes in the Cape Fear River Basin

LAKE NAME	COUNTY NAME	SUBBASIN	SIZE (acres)	CLASS	OVERALL USE	FISH CONSUMP.	AQ. LIFE & SECONDARY CONTACT	SWIMMING	DRINKING WATER	TROPHIC STATUS	PROBLEM PARAMETERS
LAKE HUNT	ROCKINGHAM	03-06-01	180	WS,B-NSW	S	S	S	S	S	Mesotrophic	
REIDSVILLE LAKE	ROCKINGHAM	"	700	WS-NSW	S	S	S	n/a	S	Mesotrophic	
BURLINGTON RES. (LAKE CAMMACK)	ALAMANCE	03-06-02	750	WS-NSW	ST	S	ST	n/a	S	Eutrophic	Elevated TN (1.51 mg/l)
GRAHAM-MEBANE RESERVOIR	ALAMANCE	"	650	WS-NSW	S	S	S	n/a	S	Mesotrophic	
LAKE BRANDT	GUILFORD	"	710	WS-NSW	S	S	S	n/a	S	Mesotrophic	
LAKE BURLINGTON (STONY CREEK RES.)	ALAMANCE	"	137	WS-NSW	ST	S	ST	n/a	S	Eutrophic	Elevated TP, TN
LAKE HIGGINS	GUILFORD	"	287	WS-NSW	S	S	S	n/a	S	Mesotrophic	
LAKE TOWNSEND	GUILFORD	"	1610	WS-NSW	S	S	S	n/a	S	Eutrophic	
RICHLAND LAKE (LAKE JEANETTE)	GUILFORD	"	260	WS-NSW	S	S	S	n/a	S	Mesotrophic	
LAKE MACKINTOSH	ALAMANCE	03-06-03	1150	WS-NSW	S	S	S	n/a	S	Eutrophic	
CANE CREEK RESERVOIR	ORANGE	03-06-04	700	WS-NSW	S	S	S	n/a	S	Mesotrophic	
JORDAN LAKE	CHATHAM	"	14300	WS,B-NSW	ST	S	ST	S	S	Eutrophic	Elev. TP, TN
PITTSBORO LAKE	CHATHAM	"	38	C-NSW	ST	S	ST	n/a	n/a	Eutrophic	Algal Blooms, Aquat. weeds
UNIVERSITY LAKE	ORANGE	03-06-06	213	WS-NSW	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
HARRIS LAKE	CHATHAM	03-06-07	4150	B	ST	S	ST	S	n/a	Mesotrophic	Elev. TN
LOWER MOCCASIN LAKE	LEE	"	19	B	ST	S	ST	S	n/a	Eutrophic	Elev. TP, TN
UPPER MOCCASIN	LEE	"	34	B	ST	S	ST	S	n/a	Eutrophic	Elev. TP, TN
HIGH POINT LAKE	GUILFORD	03-06-08	300	WS	S	S	S	n/a	S	Eutrophic	
HIGH POINT RES. (OAK HOLLOW LAKE)	GUILFORD	"	720	WS	ST	S	ST	n/a	S	Mesotrophic	Algal Blooms
SANDY CREEK RESERVOIR	RANDOLPH	03-06-09	125	WS	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
CARTHAGE CITY LAKE	MOORE	03-06-10	8	WS	ST	S	ST	n/a	S	Oligotrophic	Aquatic Weeds
ROCKY RIVER RESERVOIR	CHATHAM	03-06-12	190	WS	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
OLD TOWN RESERVOIR	MOORE	03-06-14	60	WS	S	S	S	n/a	S	Oligotrophic	
BONNIE DOON LAKE	CUMBERLAND	03-06-15	27	WS	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
GLENVILLE LAKE	CUMBERLAND	"	26	WS	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
HOPE MILLS NUMBER FOUR LAKE	CUMBERLAND	"	110	WS,B	S	S	S	S	S	Eutrophic	
KORNBOW LAKE	CUMBERLAND	"	57	WS	ST	S	ST	n/a	S	Mesotrophic	Elev. TN, TP
MINTZ POND	CUMBERLAND	"	17	WS	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
MOTT LAKE	HOKE	"	150	C	S	S	S	n/a	n/a	Dystrophic	
JONES LAKE	BLADEN	03-06-16	225	B	S	S	S	S	n/a	Dystrophic	
SALTERS LAKE	BLADEN	"	315	C	S	S	S	n/a	n/a	Dystrophic	
WHITE LAKE	BLADEN	"	1050	B	S	S	S	S	n/a	Oligotrophic	
BOILING SPRINGS LAKE	BRUNSWICK	03-06-17	1120	B-SW	S	S	S	S	n/a	Dystrophic	
GREENFIELD LAKE	NEW HANOVER	"	115	C-SW	NS	S	NS	n/a	n/a	Hyper-Eutrophic	Nutrients, Nox. Aq. weeds, Urban runoff/Storm sewers
BAY TREE LAKE (BLACK LAKE)	BLADEN	03-06-18	1400	C-SW	PS	PS	S	n/a	n/a	Dystrophic	Mercury Fish Consump. Adv.
SINGLETARY LAKE	BLADEN	03-06-20	572	B-SW	S	S	S	S	n/a	Dystrophic	

Table 4.18 Criteria for Determining Lake Use Support Ratings.

USE	ASSESSMENT TYPE	FULLY SUPPORTING	THREATENED	PARTIALLY SUPPORTING	NOT SUPPORTING
Aquatic Life Support	Biological Community	No evidence of modification to aquatic life	(no criteria)	Some modification (including exotics)	Definite modification (including exotics)
	Chemical Standards (includes turbidity)	Any criterion exceeded in ≤10% of measurements	(no criteria)	Any criterion exceeded in 11-25% of measurements	Any criterion exceeded in >25% of measurements
	Trophic parameters*				
	Chl a	<40 ug/l	≥40 ug/l	≥40 ug/l	≥40 ug/l
	Total P	<0.05 mg/l	≥0.05 mg/l	≥0.05 mg/l	≥0.05 mg/l
	Total N	≤0.55 mg/l	>0.55 mg/l	>0.55 mg/l	>0.55 mg/l
	Secchi	>0.5 meters	≤0.5 meters	≤0.5 meters	≤0.5 meters
	DO	Meets standard as specified in state regulations	(no criteria)	(no criteria)	Does not meet standard as specified in state regulations
	Fish Consumption	No advisories or bans	(no criteria)	"Restricted consumption" advisory	"No consumption" advisory or ban on fishing
	Field Observations	(no criteria)	High algae, macrophytes, or siltation	High algae, macrophytes, or siltation	Severely high algae or dense macrophytes or severe siltation
Recreational Use: Swimming and Secondary Contact	Fecal coliform: geom. ≤200; single ≤ 400	Criterion exceeded in ≤10% of measurements	(no criteria)	Criterion exceeded in 11-25% of measurements	Criterion exceeded in >25% of measurements
	Field Observations	Beautiful or very minor aesthetic problems	Swimming and aesthetics slightly impaired	Swimming and enjoyment reduced	Swimming impossible
Drinking Water Supply	Chemical Standards	Mean or median of measurements < criterion	(no criteria)	(no criteria)	Mean or median of measurements > criterion

* For dystrophic lakes characterized by low pH and tannic colored waters, criteria may not apply

THREATENED waters are those that fully support their designated uses but that may not fully support uses in the future (unless pollution control action is taken) because of anticipated sources or adverse pollution trends.

LAKES WITH MULTIPLE USES:

Fully Supporting = All uses are fully supported.
Threatened = One or more uses are threatened and remaining uses are fully supported.
Partially Supporting = One or more uses are partially supported and remaining uses are fully supported.
Not Supporting = One or more uses are not supported.

1/14/94

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