CHAPTER 4

WATER QUALITY AND USE SUPPORT RATINGS IN THE CHOWAN RIVER BASIN

4.1 INTRODUCTION

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

Water Quality Monitoring and Assessment

- **Section 4.2** describes seven water quality monitoring programs conducted by the Environmental Sciences Branch of the Division of Water Quality's (DWQ's) Water Quality Section as well as other programs local to the basin (Section 4.2.2). Basinwide data summaries are presented for several of the DWQ programs.
- **Section 4.3** presents a summary of the ambient monitoring data for the basin.
- **Section 4.4** presents a more detailed investigation into flow, chlorohyll *a* and phytoplankton data for the Chowan River to assess the current status of nutrient enrichment.
- **Section 4.5** presents a narrative summary of water quality findings for each of the subbasins in the basin. This summary is based on the DWQ monitoring programs described in Section 4.2 Also included are watershed maps which show the locations of monitoring sites.

Use-Support Ratings

- **Section 4.6** 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 4.7** presents the use support ratings for many streams and estuaries in the Chowan basin through a series of tables and figures. Included is a color-coded use support map of the basin (Figure 4.20).

4.2 WATER QUALITY MONITORING PROGRAMS

4.2.1 DWQ Programs

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

- Benthic macroinvertebrate monitoring,
- Fish population and tissue monitoring,
- Lakes assessment (including phytoplankton monitoring),
- Aquatic toxicity monitoring,
- Special studies and chemical/physical water quality investigations, and
- Ambient water quality monitoring (covering the period 1991-1995).

Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom of rivers, streams and estuaries. The benthic organisms collected most often in freshwater monitoring are aquatic insect larvae. In estuarine (saltwater) systems the benthic organisms most often collected include molluscs (such as clams and snails), crustaceans (such as crabs and shrimp) and polychaetes (worms). The use of benthos data has proven to be a reliable water quality assessment tool (especially in freshwaters), 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.

For *freshwater* streams and rivers, criteria have been developed to assign five bioclassifications ranging from Poor to Excellent to each benthic sample. The bioclassifications include Excellent, Good, Good- Fair, Fair and Poor. The bioclassifications are based on the number of different kinds of species (taxa) present in three groups of pollution-intolerant insect larvae: 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 (i.e. a greater number of different kinds of species) are associated with better water quality. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is inadequately assessed by a taxa richness analysis alone. Different classification criteria have been developed for different ecoregions (mountains, piedmont and coastal plain) within North Carolina.

For *estuarine* waters the effort to develop a method to assess water quality based on macroinvertebrates started in North Carolina in late 1990. An Estuarine Biotic Index designed for Florida was modified to create the North Carolina Estuarine Biotic Index (EBI) which more closely reflects taxa and tolerences in North Carolina and can accurately rank sites of different water quality. Biocriteria based on these metrics are still being developed, so at the present time estuarine samples cannot be given a water quality rating.

Benthic Macroinvertebrate Sampling in the Chowan Basin

Benthic macroinvertebrate sampling has been conducted at ten sites throughout the Chowan basin with results ranging from poor to excellent. In some cases, the swampy nature of the sampling site prevented the assignment of a rating (however, an index is being developed for swamp streams). Based on benthic macroinvertebrate data from 1995, bioclassifications were Fair for the Wiccacon River and Ahoskie Creek and Good-Fair for the Chowan River at Riddicksville. General water quality in the Meherrin River is Good and Fair for Potecasi Creek. The results of benthic macroinvertebrate sampling for all sites in the Chowan River Basin are presented in the individual subbasin discussion in sections 4.5.1 - 4.5.4.

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. 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

As noted above, fish community structure involves assessing the overall health of the fish community as a means of assessing the quality of the ecosystem in which the fish reside. Fish community structure is assessed using a method called the North Carolina Index of Biotic Integrity (NCIBI). This method, which is a modification of Karr's IBI (1981), 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 in the Chowan Basin

Fish community structure (IBI) analyses were performed on data from 2 sites in the Chowan River Basin collected by DWQ. One site received a rating of Fair. The other site, although sampled, did not receive a rating because of its swampy nature. Table 4.1 presents this data.

Table 4.1. Fish Community Structure Collections in the Chowan River Basin, 1995.

Site	Index #	Drainage Area (mi^2)	Date	NCIBI Score	NCIBI Rating
Ahoskie Cr	25-14-1	63.3	02/28/95	44	Fair
Cutawhiskie Swamp	25-4-8-8	36.8	02/28/95	38	NR-Swamp

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. Therefore, results from fish tissue monitoring can serve as an important indicator of 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 action level 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 DWQ.

Fish Tissue Analyses in the Chowan Basin

Fish tissue samples were collected at 10 sites from 1983 to 1995 within the Chowan River Basin consisting of 226 observations. These obervations are summarized in Table 4.2. Samples were collected as part of the DWQ's ambient fish tissue monitoring program or as part of special mercury studies.

The Chowan River from the Virginia Border to the Albemarle Sound (at Highway 17 bridge) remains under a fish consumption advisory for all fish except herring, shellfish and shad (including roe). The advisory has been in place since August 1990 and currently recommends that the general population consume no more than two meals of any fish except those noted above in one month and that children and pregnant or nursing women consume no fish except those noted above. Yearly monitoring by Union Camp in North Carolina indicates that dioxin levels are gradually decreasing in fish from the Chowan and Meherrin Rivers since new bleaching technologies were instituted by the company to improve effluent quality. A map of the dioxin advisory area as well as further details on this subject are contained in Section 3.2.2 of Chapter 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.

One way to evaluate the health of a lake is to examine the growth of phytoplankton. Phytoplankton are microscopic algae found in the water column of lakes, rivers, streams, and estuaries. Phytoplankton populations respond to the availability of nutrients (phosphorus and nitrogen) 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 nutrient overenrichment (see following paragraph on trophic status) and are often collected with water quality samples from lakes. Prolific growths of phytoplankton 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. These blooms, which are often due to high concentrations of nutrients, may be unsightly and deleterious to water quality, causing fish kills, anoxia, or taste and odor problems. An 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 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

Table 4.2. **Fish Tissue Sampling Sites and Data Summary for the Chowan River Basin**

Location	Subbasin	Year(s) sampled	Total samples	Samples > EPA Criteria *	Samples > FDA Criteria *	Samples > NC Dioxin Crit. *
Chowan R. near Riddicksville	01	80-95	95	28 mercury	12 mercury	
Chowan R. near Winton	01	88-95	9			
Merchants Millpond	01	95	14	1 mercury		
Wiccacon R. at NC-45	01	94-95	43	20 mercury	4 mercury	
Chowan R. at Gatlington	01	90-95	17			5
Mehherin R. at Rt. 258	02	89-95	33	3 mercury		5
Chowan R. at Holiday Island	03	95	14	1 mercury		
Chowan R. at Colerain	03	80-94	28	1 mercury	1 mercury	
Chowan R. at Marker 16	03	89-95	29			10
Chowan R. at Marker 9	03	89-95	15			13
Chowan R. at Marker 5	03	89-95	26			10
Pembroke Creek at Edenton	04	95	18	2 mercury		
Salmon Creek	04	95	13	1 mercury	1 mercury	
Chowan R. at Edenhouse	04	80,81,90	63			27
Chowan R. at Marker 2	04	90-95	11			9

* Number of samples greater than listed criteria. For EPA and FDA criteria, the parameter violated is listed with the number of violations.

bloom. Bloom samples may be collected as a result of complaint investigations, fish kills, or during routine monitoring if a bloom is suspected.

Another measure of water quality in lakes is the North Carolina Trophic State Index (NCTSI). This is a numerical index that is used to evaluate the trophic status of lakes, and it can be used to determine whether the designated uses of a lake have been threatened or impaired by pollution. Trophic status is a relative measure of nutrient enrichment and productivity. The NCTSI index is based on total phosphorus, total organic nitrogen, secchi depth (water clarity indicator) and chlorophyll *a*. Based on this index, a lake is assigned one of five trophic status classifications: Oligotrophic, Mesotrophic, Eutrophic, Hypereutrophic and Dystrophic. Oligotrophic lakes are those that have the lowest levels of enrichment and generally have good clarity and no problems with algal blooms. At the other end of the spectrum are eutrophic and hypereutrophic lakes which have a lot of plant productivity which can cause nuisance problems and have little clarity in the water column. Dystrophic lakes are acidic blackwater lakes scattered throughout the coastal plain. Their NCTSI scores are highly skewed because of their natural discoloration. Further details of the NCTSI can be found in Appendix II.

Lakes Studies in the Chowan

Merchants Millpond is the only lake which has been monitored in the Chowan River Basin as part of the Lakes Assessment Program. Merchants Millpond was sampled most recently in 1995. The mean depth of the millpond is four feet (1.2 meters), the surface area is 450 acres (182 hectares) and the volume is 0.2 $x10^6m^3$. Land use is mostly forest or wetlands and agriculture with scattered residential areas. A heavy growth of aquatic macrophyte infestation throughout the lake along with elevated nutrient concentrations characterizes this impoundment.

In 1995, Merchant's Millpond had a NCTSI score of 2.5, indicating that the lake is eutrophic. The proliferation of aquatic macrophytes, which cover the lake's surface, is not uncommon in millponds. Both shallow depth and the long retention time of these ponds encourage the growth of aquatic macrophytes. This is the case with Merchants Millpond. The abundance of these plants in Merchants Millpond has been determined as a threat to designated uses (primarily canoeing and fishing). Low dissolved oxygen values also indicate that the uses of this lake are threatened. In 1995 the park had 85,000 visitors (Tingley, personal communication). During summers when macrophytes are abundant, park visitation could be affected due to the difficulty of maneuvering canoes through the vegetation.

Merchants Millpond was previously sampled by DWQ in 1981, 1983, 1984, 1985 and 1986. Total phosphorus and total kjeldahl nitrogen have been consistently elevated during these years. Since 1981, consistent concerns have been expressed for the heavy growth of aquatic macrophytes and the accumulation of sediment in the lake. Mean surface dissolved oxygen was consistently below the 5.0 mg/l level for each of these sampling years except for 1983 when the mean value was 6.1 mg/l (range = 5.2 to 7.0 mg/l).

Aquatic Toxicity Monitoring

Acute and/or chronic toxicity tests are used to determine toxicity of wastewater treatment 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. 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.

<u>Aquatic Toxicity Monitoring in the Chowan</u>
United Piece Dye Works is the only facility in the basin that is required to monitor whole effluent toxicity by their NPDES permit. Other facilities may be tested by DWQ's Aquatic Toxicology Laboratory.

Special Studies and Chemical/Physical Characterizations

Water quality simulation models are often used for the purpose of determining wasteload allocations. These models must accurately 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 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.

<u>Special Studies and Chemical/Physical Characterizations in the Chowan River Basin</u>
Over the years, the Chowan River has been the subject of several special studies. Most of these have been related to the problems with nutrient enrichment, although one was part of a study of selected marinas to investigate water quality, sediment quality and clam tissue. The nutrient section of Chapter 3 provides a thorough review of special nutrient studies conducted on the Chowan River.

Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake, and estuarine stations strategically located for the collection of physical and chemical water quality data or water quality parameters. Sampling stations are sited under one or more of the following monitoring designations:

<u>Fixed Monitoring Stations</u>
Point source
Nonpoint source
Baseline Water Supply

<u>Rotating Monitoring Stations</u>
Basinwide Information
HQW & ORW

Parametric coverage is tiered by the waterbody's assigned surface water quality classification and corresponding water quality standards. Under this arrangement, core parameters are based on Class C waters with additional parameters added based on other classifications. Table 4.3 presents the parameters monitored for the classifications assigned to waters in the Chowan River Basin. The next section (4.3) summarizes the results of ambient monitoring done in the Chowan basin.

Table 4.3. Ambient Monitoring System Freshwater Parametric Coverage.

Class C and Class B Waters (minimum monthly coverage for all stream stations)

***Field Parameters*:** dissolved oxygen, pH, conductivity, temperature, chlorine,
***Nutrients*:** total phosphorus, ammonia, total Kjeldahl nitrogen, nitrate+nitrite
Physical Measurements: total suspended solids, turbidity, hardness
Bacterial: fecal coliforms (Membrane Filter method)
Metals: aluminum (no present water quality standard), arsenic, cadmium, chromium, copper*, iron*, lead, mercury, nickel, silver*, zinc*

Nutrient Sensitive Waters
Chlorophyll *a* (where appropriate)

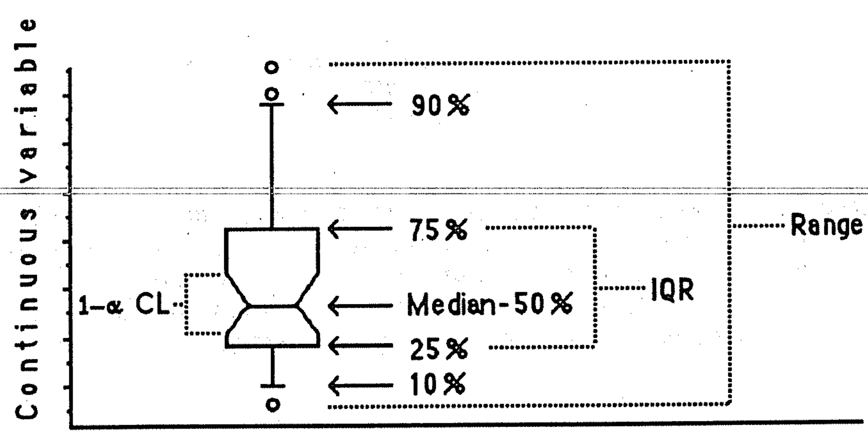
PLUS any additional parameters of concern for individual station locations.

*Action level water quality standard.

Ambient water quality data are often summarized using box and whisker plots (for example see Figure 4.8). Figure 4.1 provides an explanation of how to interpret the plots.

Figure 4.1 Box and Whisker Plots

Box and whisker plot are useful for the visual comparison of single variable data sets. 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. 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.

4.2.2 Local Water Quality Monitoring Programs

Citizen Monitoring Program

The Albemarle-Pamlico Citizen's Water Quality Monitoring Program (APMP) is a volunteer estuary monitoring program begun in 1987 with funding from the Albemarle-Pamlico Estuarine Study. Approximately 65 volunteers monitor water quality from over 100 monitoring sites in the Albemarle-Pamlico Estuary located in southeastern Virginia and northeastern North Carolina. Housed at East Carolina University (ECU), the program has two basic goals: to promote stewardship of the region's water resources by encouraging public participation in volunteer monitoring, and to collect high quality scientific data to provide a baseline characterizing the condition of the estuary's water quality.

The APMP is a perfect example of how everyone concerned with water quality can benefit from volunteer monitoring. The program director, Patrick Stanforth, works closely with the Department of Environment Health and Natural Resources regional office providing data to the Division of Water Quality. The program is actively involved in education involving school children, scouting clubs, and camps in monitoring efforts. The data are also used by graduate and undergraduate students at ECU in class projects and the program utilizes several work-study students. In addition, there is coordination with local nonprofit organizations including the Pamlico Tar River Foundation, Pungo River Fisherman Association, Carteret Crossroads, and the North Carolina Coastal Federation. These are just a few examples of the people the APMP is involved with.

Water quality samples are collected weekly during the summer and twice monthly during the winter. The samples are taken at the same site, at approximately the same time of day, and on the same day of the week. This ensures that the data are easily compared and any changes (at the site) are quickly made apparent. The parameters monitored are: Air and water temperature, turbidity, water depth, salinity, dissolved oxygen, pH, rainfall and other observations. These are tested from a bucket of surface water collected at the site. Figure 4.2 illustrates the location of sampling sites in the Chowan River Basin.

Data are received monthly by the director from the volunteers. The data are then verified and entered in to a database. The data are stored on the database and it is available to anyone caring to use it.

State of Virginia Water Quality Program

The Virginia Department of Environmental Quality has a surface water quality monitoring program that includes 896 monitoring locations (VDEQ, 1994). These stations are sampled for chemical and physical parameters on a variable basis to determine water quality conditions. In an average year, approximately 35,000 samples are collected to perform approximately 247,000 analyses. A subset of 51 of these stations form a portion of the Core Monitoring Program. These stations are sampled for pesticides, metals and organics in fish tissue and sediment on a three year cycle. Approximately 150 biological monitoring stations were sampled to determine the health of the bottom dwelling invertebrate population and ability of the stream to support a balanced aquatic community. In the Chowan-Dismal Swamp Basin of Virginia, there are 64 ambient monitoring stations and 8 biological monitoring stations.

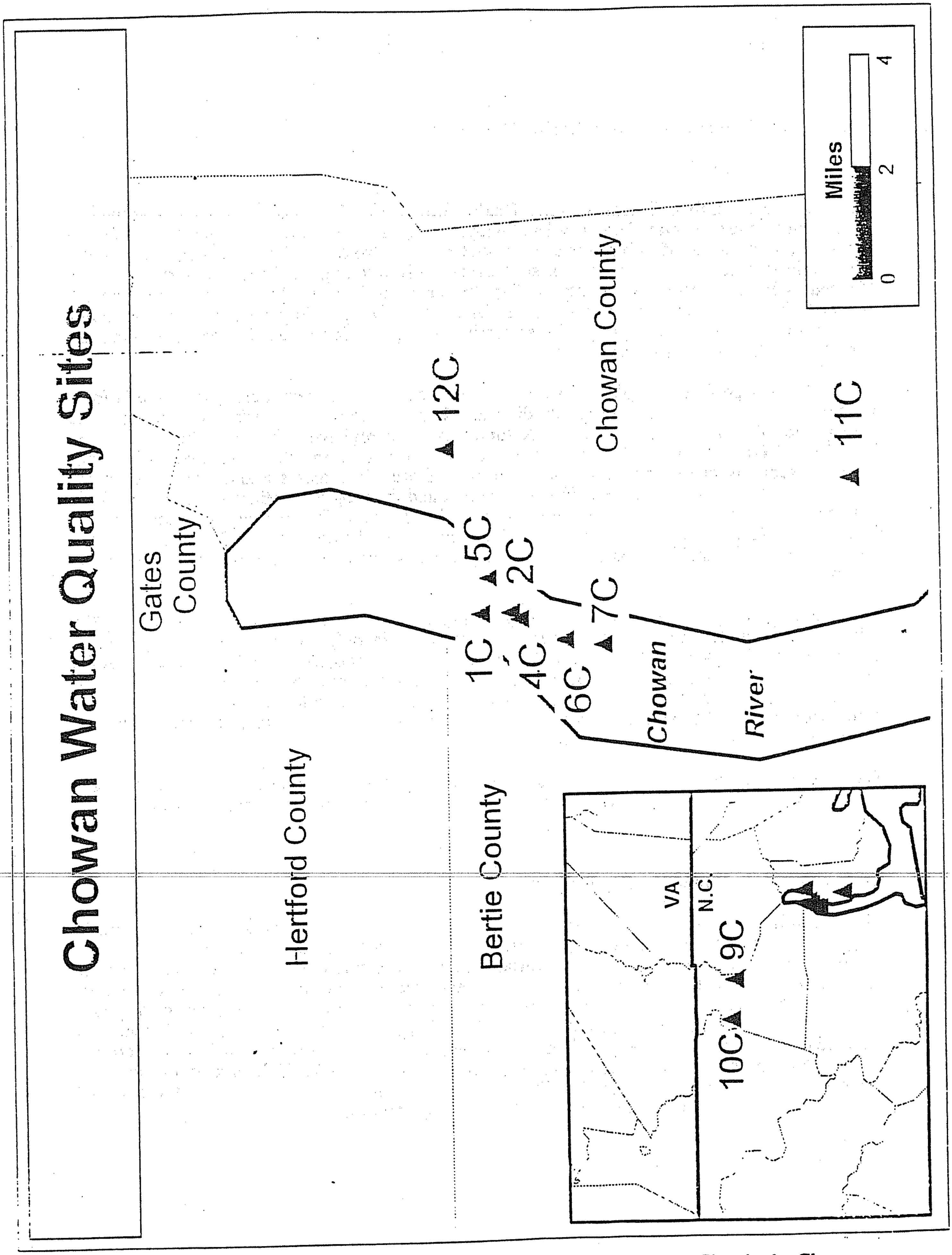


Figure 4.2. Location of Citizen Monitoring Program Sampling Sites in the Chowan River Basin

4.3 SUMMARY OF AMBIENT MONITORING DATA FOR THE CHOWAN RIVER BASIN

AMS stations for the basin are listed in Table 4.4 below. North Carolina has 12 stations in the Chowan River Basin. Seven stations are located on the mainstem of the Chowan River (one of these being at the mouth of the river in the Albemarle Sound) and three stations located on the Blackwater and Nottaway Rivers which form the Chowan. Also, there is one station at the mouth of the Meherrin River, a major tributary and one on Potecasi Creek. The locations of these stations are illustrated in the map on the next page (Figure 4.3).

Table 4.4. Ambient Monitoring System Stations Within the Chowan Basin.

Primary No	STORETNo	Station Name	Subbasin
Chowan River Drainage			
02047370	D0000050	NOTTAWAY RIVER AT US 258 NEAR RIVERDALE VA	030101
02050065	D0001200	BLACKWATER RIVER AT HORSESHOE BEND AT CHERRY GROVE VA	030101
0205007750	D0001800	BLACKWATER RIVER 150 YARDS ABOVE MOUTH NEAR WYANOKE NC	030101
02050079	D0010000	CHOWAN RIVER NEAR RIDDICKSVILLE NC	030101
02053200	D4150000	POTECASI CREEK NEAR UNION NC	030102
0205321790	D5000000	MEHERRIN RIVER AT SR 1175 PARKERS FERRY NR COMO NC	030102
02053244	D6250000	CHOWAN RIVER AT US 13 AT WINTON NC	030101
02053574	D8356200	CHOWAN RIVER AT MARKER 16 NEAR GATESVILLE NC	030101
0205360615	D8430000	CHOWAN RIVER 200 YARDS BELOW HOLIDAY ISLAND	030103
02053632	D8950000	CHOWAN RIVER AT MARKER 17 AT COLERAIN NC	030103
02053652	D9490000	CHOWAN RIVER AT US 17 AT EDENHOUSE NC	030105
02081145	D9995000	ALBEMARLE SOUND NEAR EDENTON NC	030104

Table 4.5 summarizes by parameter data collected at ambient stations in the Chowan Basin where there are one or more excursions (or deviation) from the numerical water quality criteria. Each station includes the following information:

- parameter that exceeds the criterion
- total number of samples
- number of samples with less than the detection level recorded
- the number of samples for that paramter that represented an excursion from a water quality criterion

It should be noted that there are limitations to ambient water quality data. Because of the limited sampling frequency, the water quality sample may not be taken during a significant water quality event. It also should be noted that the criteria are presented as numerical and represent instantaneous measurements. The actual standard may include a narrative, such as turbidity, and, as in some metals criteria, may be based on extended exposure at or above the criteria to expect chronic toxicity of the most sensitive species of organism. Therefore the table is useful for relative comparisons between locations and screening areas where frequent excursions of individual or multiple parameters suggest waters that might be targeted for more detailed evaluations and/or specific management strategies. A more thorough evaluation can include review of temporal and spatial trends, association of concentrations to flow, degree of excursion from the criterion, or use of other analytical methods. Table 4.6 shows totals from Table 4.5 as total samples, total excursions and percent excursions of total samples for each ambient station.

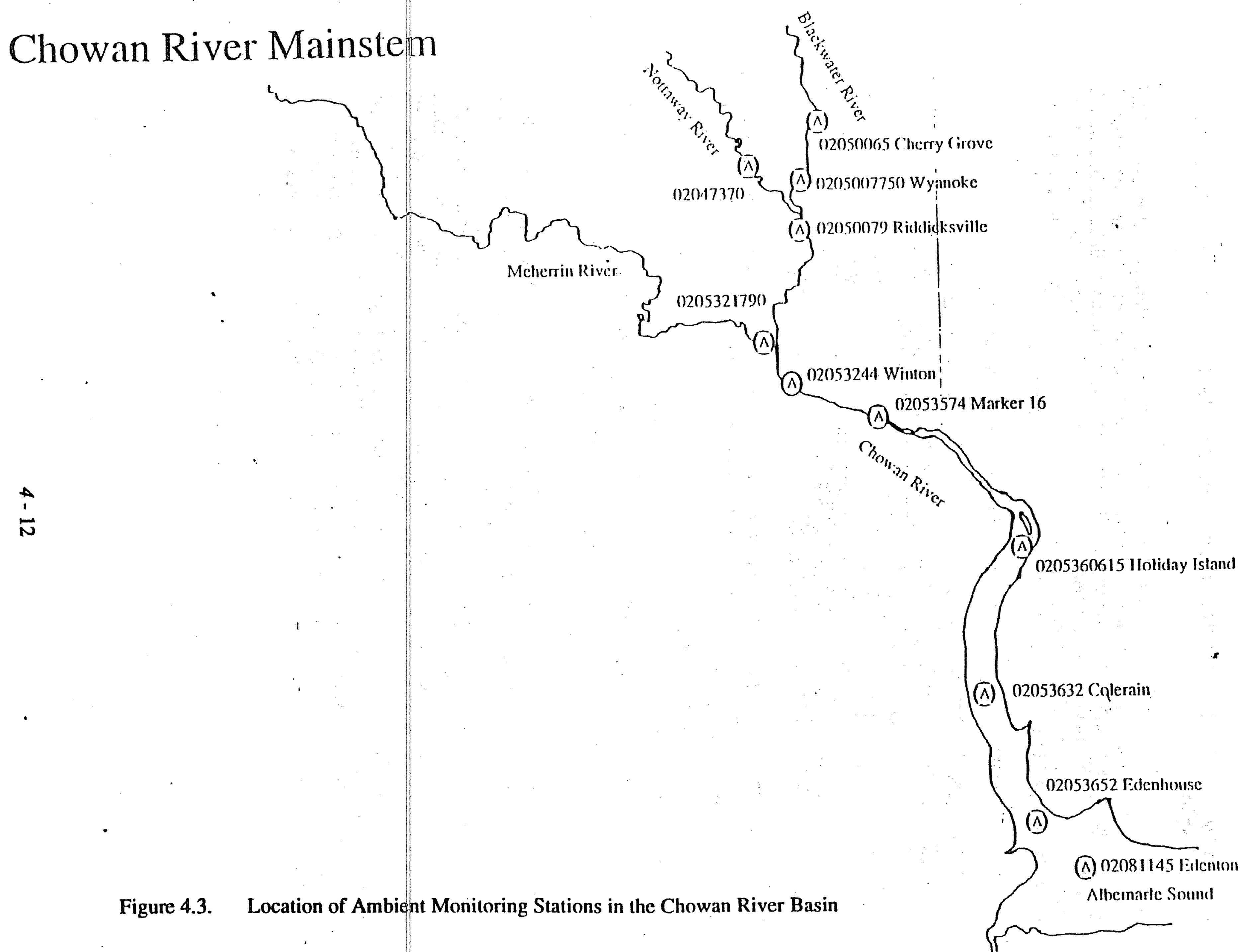


Figure 4.3. Location of Ambient Monitoring Stations in the Chowan River Basin

Table 4.5. Summary of Ambient Monitoring System Station Data Excursions from the NC Water Quality Criteria by Parameter. January 1990 to December 1994.

Station Number	Station Name	Parameter/Criterion	Samples All	Samples <Det	Samples Excur
0205360615	CHOWAN RIVER 200 YDS BELOW HOLIDAY ISLAND	Chlorophyll a (Corr)(µg/l)(40)	60	25	1
020253632	CHOWAN RIVER AT MARKER 17 AT COLERAIN NC	Chlorophyll a (Corr)(µg/l)(40)	62	23	3
020247370	NOTTAWAY RIVER AT US 258 NEAR RIVERDALE VA	Dissolved Oxygen (mg/l)(4)	64	0	3
020250065	BLACKWATER RIVER AT HORSESHOE BEND AT CHERRY GR	Dissolved Oxygen (mg/l)(4)	64	0	23
0205007750	BLACKWATER RIVER 150 YDS AB MTH NEAR WYANOKE NC	Dissolved Oxygen (mg/l)(4)	59	0	11
020250079	CHOWAN RIVER NEAR RIDDICKSVILLE NC	Dissolved Oxygen (mg/l)(4)	65	0	11
020253200	POTECASI CREEK NEAR UNION NC	Dissolved Oxygen (mg/l)(4)	67	0	29
0205321790	MEHERRIN RIVER AT SR 1175 PARKERS FERRY NR COMO NC	Dissolved Oxygen (mg/l)(4)	64	0	4
020253244	CHOWAN RIVER AT US 13 AT WINTON NC	Dissolved Oxygen (mg/l)(4)	64	0	2
020253574	CHOWAN RIVER AT MARKER 16 NEAR GATESVILLE NC	Dissolved Oxygen (mg/l)(4)	64	0	2
02050065	BLACKWATER RIVER AT HORSESHOE BEND AT CHERRY GR	Fecal Coliform (#/100ml)(200)	62	18	1
0205007750	BLACKWATER RIVER 150 YARDS ABMTH NEAR WYANOKE NC	Fecal Coliform (#/100ml)(200)	59	17	1
02053200	POTECASI CREEK NEAR UNION NC	Fecal Coliform (#/100ml)(200)	6	1	1
0205321790	MEHERRIN RIVER AT SR 1175 PARKERS FERRY NR COMO NC	Fecal Coliform (#/100ml)(200)	63	32	1
02053574	CHOWAN RIVER AT MARKER 16 NEAR GATESVILLE NC	Fecal Coliform (#/100ml)(200)	57	41	1
0205360615	CHOWAN RIVER 200 YARDS BELOW HOLIDAY ISLAND	Fecal Coliform (#/100ml)(200)	58	36	1
020253652	CHOWAN RIVER AT US 17 AT EDENHOUSE NC	Lead (µg/l)(25)	23	22	1
020247370	NOTTAWAY RIVER AT US 258 NEAR RIVERDALE VA	pH (SU)(6.0-9.0)	63	0	5
020250065	BLACKWATER RIVER AT HORSESHOE BEND AT CHERRY GR	pH (SU)(6.0-9.0)	63	0	6
0205007750	BLACKWATER RIVER 150 YDS AB MTH NEAR WYANOKE NC	pH (SU)(6.0-9.0)	59	0	4
020250079	CHOWAN RIVER NEAR RIDDICKSVILLE NC	pH (SU)(6.0-9.0)	65	0	5
020253200	POTECASI CREEK NEAR UNION NC	pH (SU)(6.0-9.0)	67	0	12
0205321790	MEHERRIN RIVER AT SR 1175 PARKERS FERRY NR COMO NC	pH (SU)(6.0-9.0)	63	0	5
020253244	CHOWAN RIVER AT US 13 AT WINTON NC	pH (SU)(6.0-9.0)	63	0	7
020253574	CHOWAN RIVER AT MARKER 16 NEAR GATESVILLE NC	pH (SU)(6.0-9.0)	64	0	4
0205360615	CHOWAN RIVER 200 YDS BELOW HOLIDAY ISLAND	pH (SU)(6.0-9.0)	67	0	5
020253632	CHOWAN RIVER AT MARKER 17 AT COLERAIN NC	pH (SU)(6.0-9.0)	68	0	8
020253652	CHOWAN RIVER AT US 17 AT EDENHOUSE NC	pH (SU)(6.0-9.0)	67	0	1
020281145	ALBEMARLE SOUND NEAR EDENTON NC	pH (SU)(6.8-8.5)	123	0	11
020253200	POTECASI CREEK NEAR UNION NC	Turbidity (NTU)(50)	66	0	2

Table 4.6. Summary of Ambient Monitoring System Station Data Excursions from the NC Water Quality Criteria by Total Samples. January 1990 to December 1994.

Station Number	Station Name	Samples Total	Samples <Det	Samples Excursions	Samples %Excursions
02047370	NOTTAWAY RIVER AT US 258 NEAR RIVERDALE VA	279	49	8	2.9
02050065	BLACKWATER RIVER AT HORSESHOE BEND AT CHERRY GR	335	81	30	9.0
0205007750	BLACKWATER RIVER 150 YARDS AB MTH NEAR WYANOKE NC	315	77	16	5.1
02050079	CHOWAN RIVER NEAR RIDDICKSVILLE NC	311	83	16	5.1
02053200	POTECASI CREEK NEAR UNION NC	295	68	44	14.9
0205321790	MEHERRIN RIVER AT SR 1175 PARKERS FERRY NR COMO NC	634	411	10	1.6
02053244	CHOWAN RIVER AT US 13 AT WINTON NC	335	82	9	2.7
02053574	CHOWAN RIVER AT MARKER 16 NEAR GATESVILLE NC	330	92	7	2.1
0205360615	CHOWAN RIVER 200 YARDS BELOW HOLIDAY ISLAND	342	85	7	2.0
02053632	CHOWAN RIVER AT MARKER 17 AT COLERAIN NC	315	90	11	3.5
02053652	CHOWAN RIVER AT US 17 AT EDENHOUSE NC	453	192	2	0.4
02081145	ALBEMARLE SOUND NEAR EDENTON NC	618	169	11	1.8
	Grand total	4562	1479	171	3.7

As the data from Tables 4.5 and 4.6 show, within the Chowan drainage there have been some excursions from the water quality criterion. The parameters with the majority of the excursions are dissolved oxygen and pH. The dissolved oxygen excursions occurred on the Blackwater River and in the upper Chowan River, and pH excursions occurred on Potecasi Creek and in the Albemarle Sound at the mouth of the Chowan River. In addition to Potecasi Creek and Albemarle Sound there are a number of low pH excursions distributed more or less equally throughout the drainage. Due to the swampy nature of this basin, these acidic conditions are likely natural. Discussion of fecal coliform excursions and conditions will take place in the last part of this section.

Examining the dissolved oxygen data over the past five years for the mainstem of the Chowan River, several excursions below the criterion were recorded at the upper sites at Riddicksville, Winton and Marker 16. However, as Figure 4.4 illustrates, many of the low dissolved oxygen readings occurred seasonally during the warmer months and these dips are natural for slow-moving, swampy, black-water systems such as the Chowan. The same seasonal fluctuation is evident when dissolved oxygen levels for the Chowan River are viewed for data going back to 1980 (Figure 4.5).

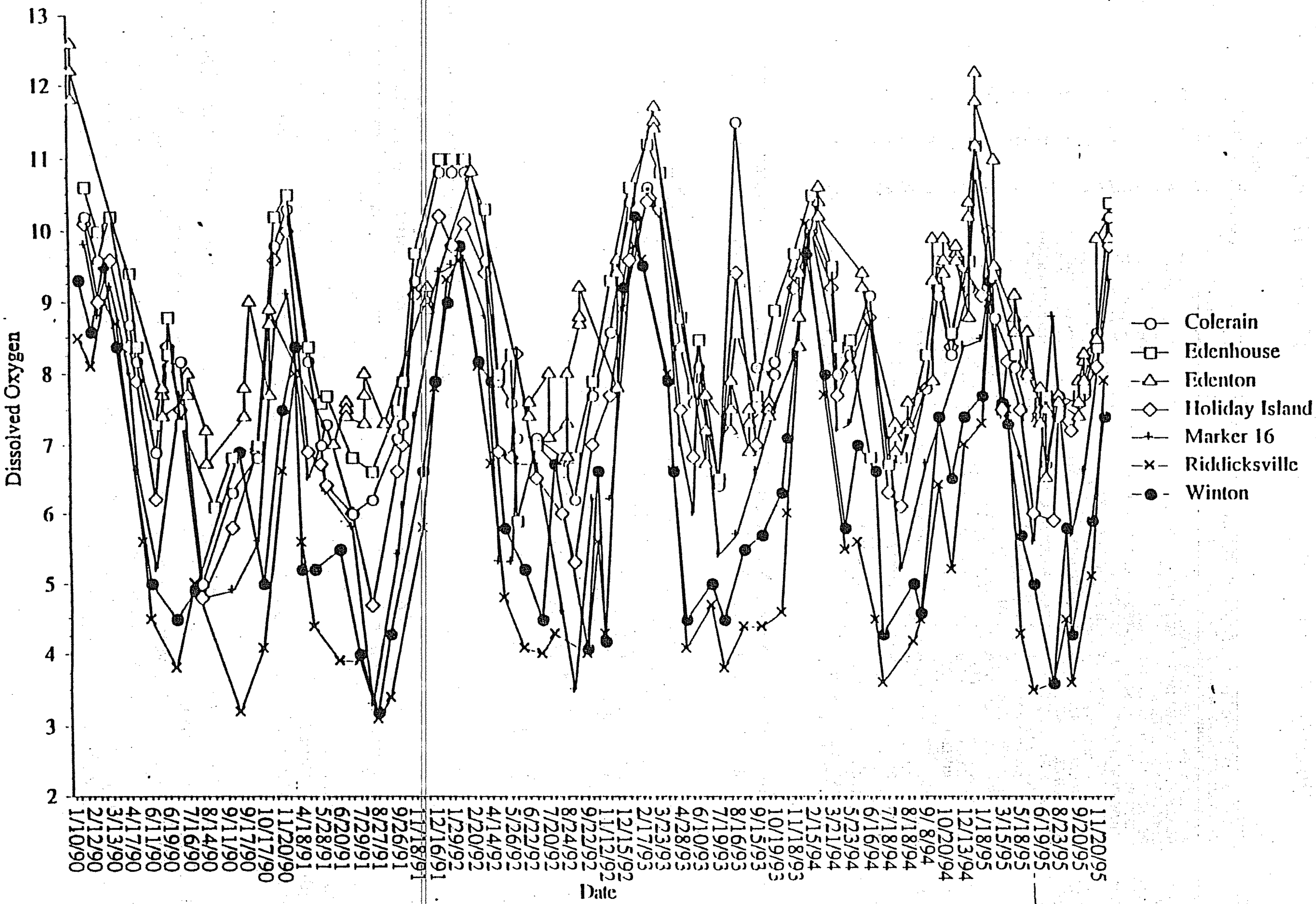


Figure 4.4. Chowan River Basin Mainstem Ambient Monitoring Sites. Dissolved Oxygen (mg/l) data - 1990 to 1995.

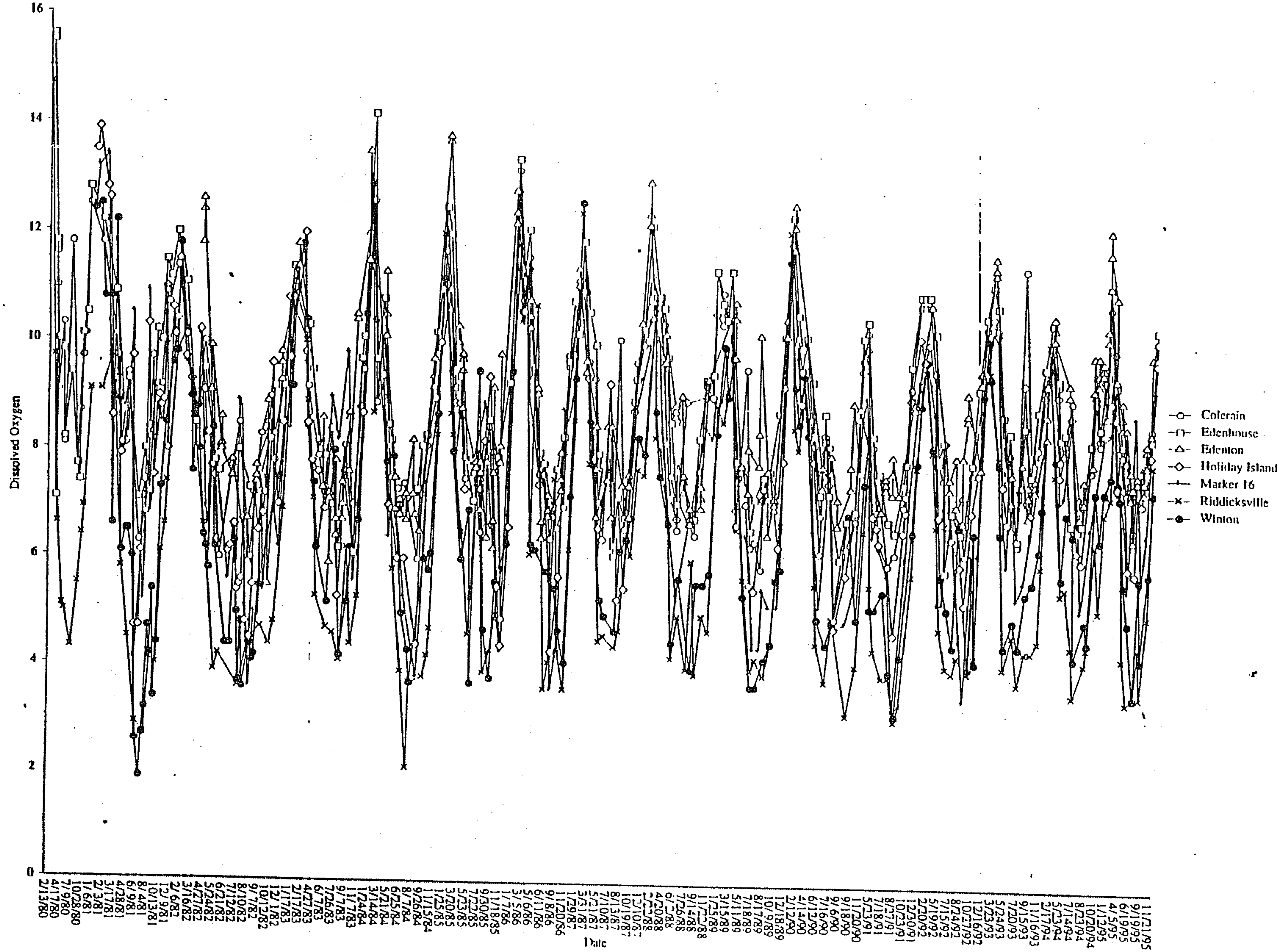


Figure 4.5. Chowan River Basin Mainstem Ambient Monitoring Sites. Dissolved Oxygen (mg/l) data - 1980 to 1995.

Chlorophyll *a* also fluctuates seasonally. Chlorophyll *a* is a measure of plant productivity or algal growth in surface waters. Figure 4.6 presents a graphic summarization of monthly chlorophyll *a* data from the Chowan River between the years of of 1980 and 1995. A steady increase in concentrations as the summer approaches, peaking in August and then tapering off in the fall is an evident pattern. When the same data is viewed by site (Figure 4.7), it is illustrated that the pattern remains the same at all sites, with varying degrees of magnitude. For example, the site at Riddicksville shows that there is an increase in chlorophyll *a* concentrations during the summer, but at the Marker 16 site, the increase is much greater.

Union Camp Corporation has a major discharge from a paper mill into the Blackwater River just north of the North Carolina-Virginia border. Union Camp's 13 billion gallon effluent treatment system is designed to store effluent during periods of low river flow, typically April through October, when conditions are poor for discharge due to low dissolved oxygen levels. The treated effluent is then released during the months of November through March. In the past, due to the volume of the release, the effluent was visible with the river system. Recent process improvements have reduced the effluent color to the point that, for the past 2 to 3 years, the effluent has not been visible in the Chowan River past the confluence with the Meherrin River. Union Camp conducts frequent monitoring during their discharge period to ensure adequate river flow is available for assimilative capacity. There are two ambient sites on the Blackwater River. One above the discharge (Cherry Grove) and one below (Wyanoke). When the data are viewed in the context of the discharge period, several parameters show an effect from the effluent. These are conductivity, total phosphorus, phosphate-phosphorus, total ammonia-nitrogen and total Kjeldahl nitrogen. Using conductivity as an example, a plot of the monthly distribution of the data illustrates the increasing levels during the period of discharge for the site downstream of the facility (Figure 4.8). Three-dimensional graphs show how the effects of the discharge resonate downstream. Conductivity (Figure 4.9) concentrations are elevated during the discharge months downstream to the Colerain site where the salinity begins to mask it. There are also high concentrations of total phosphorus (Figure 4.10) to the Colerain site. These high concentrations appear around November or December and begin to disappear by March or April.

<u>Fecal Coliform Bacteria</u>

Fecal coliform bacteria behave differently than most other water quality parameters, and these differences must be considered when using them to evaluate water quality. Available information was reviewed to identify potentially impaired waters and locate potential sources of pollutants in order to target efforts and develop appropriate management strategies. As sampled in the ambient monitoring system, fecal coliform bacteria are most useful as a screening tool to estimate the cumulative inputs from multiple sources, but in some instances can be used to locate a single large source of bacteria. Therefore, the data presented here are useful in identifying areas that may require some management action or further investigation.

Summary fecal coliform information is listed in Table 4.7. The primary screening tool used in establishing priority is the geometric mean. Sites with 10 or more fecal coliform samples within the last 5 years, that have a geometric mean exceeding 200/100ml, are considered highest priority. This information will be reflected in the use support designation for that stream or river (see sections 4.6 and 4.7 at the end of this chapter).

Data from the Chowan River Basin show only a few high bacterial concentrations through the five year period. There were no stations with a geometric mean greater than 200/100ml and only one with over two percent total samples over the 200/100ml criterion (Potecasi Creek). However, the geometric mean at this site is well below 200 and there are only eight samples that have been collected there thus far. Any conclusion about bacterial problems in this area should be withheld pending the collection of more samples. Sampling of fecal coliform bacteria from this site was added in the spring of 1995 and will continue. As more data is collected, a better assessment of bacterial conditions can and will be made.

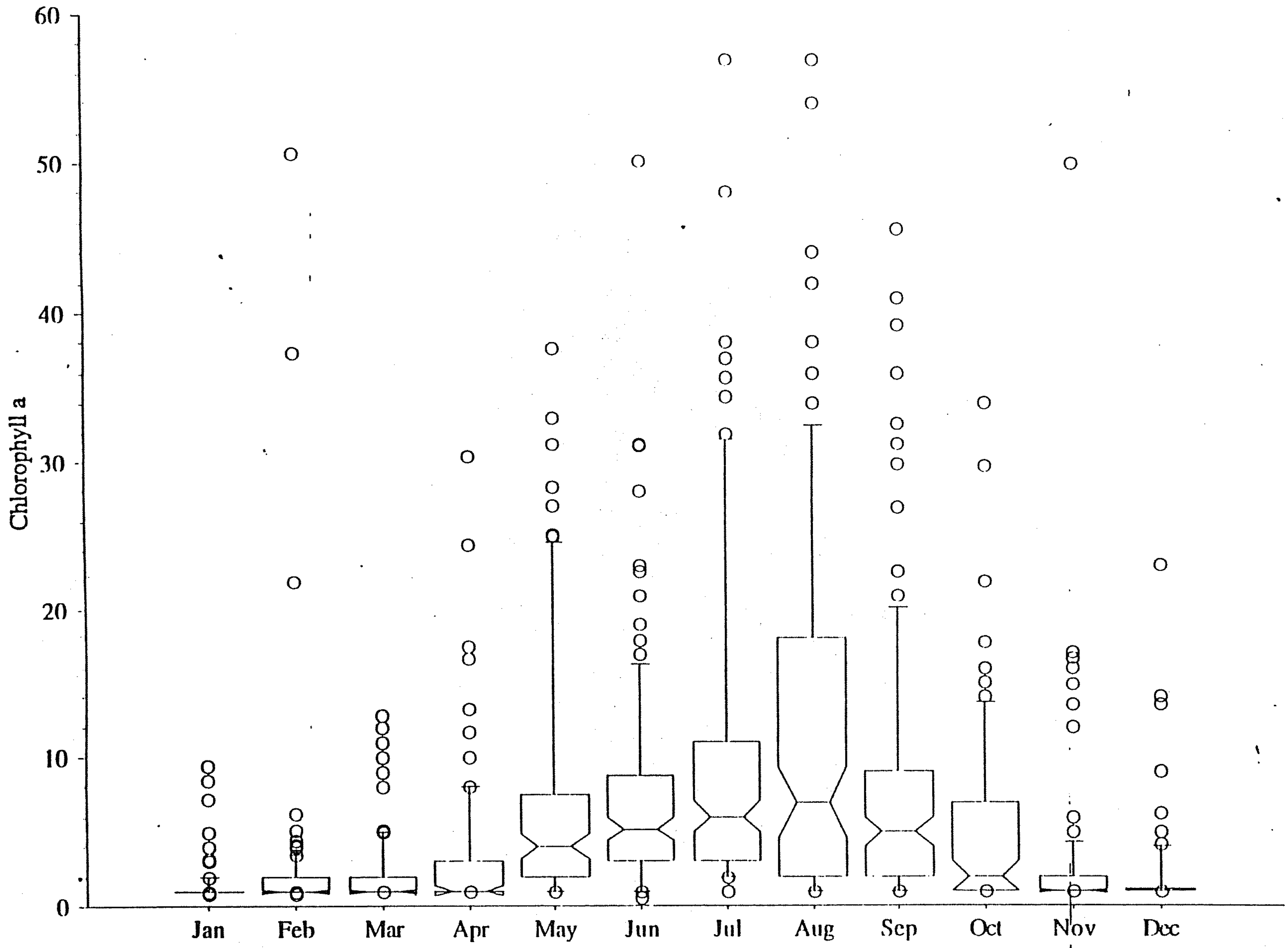


Figure 4.6. Chowan River Basin Mainstem Ambient Monitoring Sites. Chlorophyll *a* (µg/l) data distribution - 1980 to 1995.

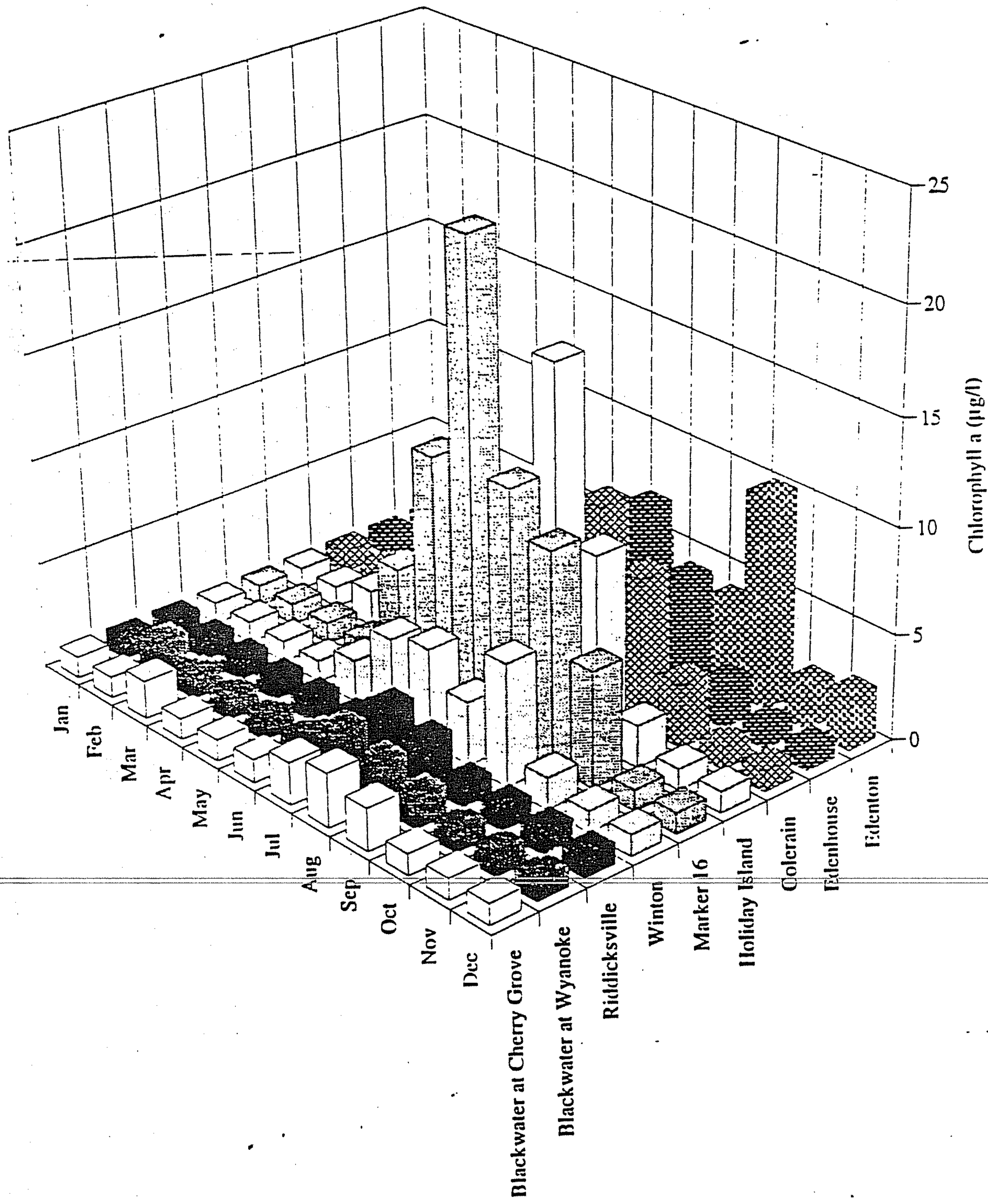


Figure 4.7. Chowan River Basin mainstem Ambient Monitoring Sites. Monthly Median Chlorophyll *a* (μg/l) - 1980 to 1996.

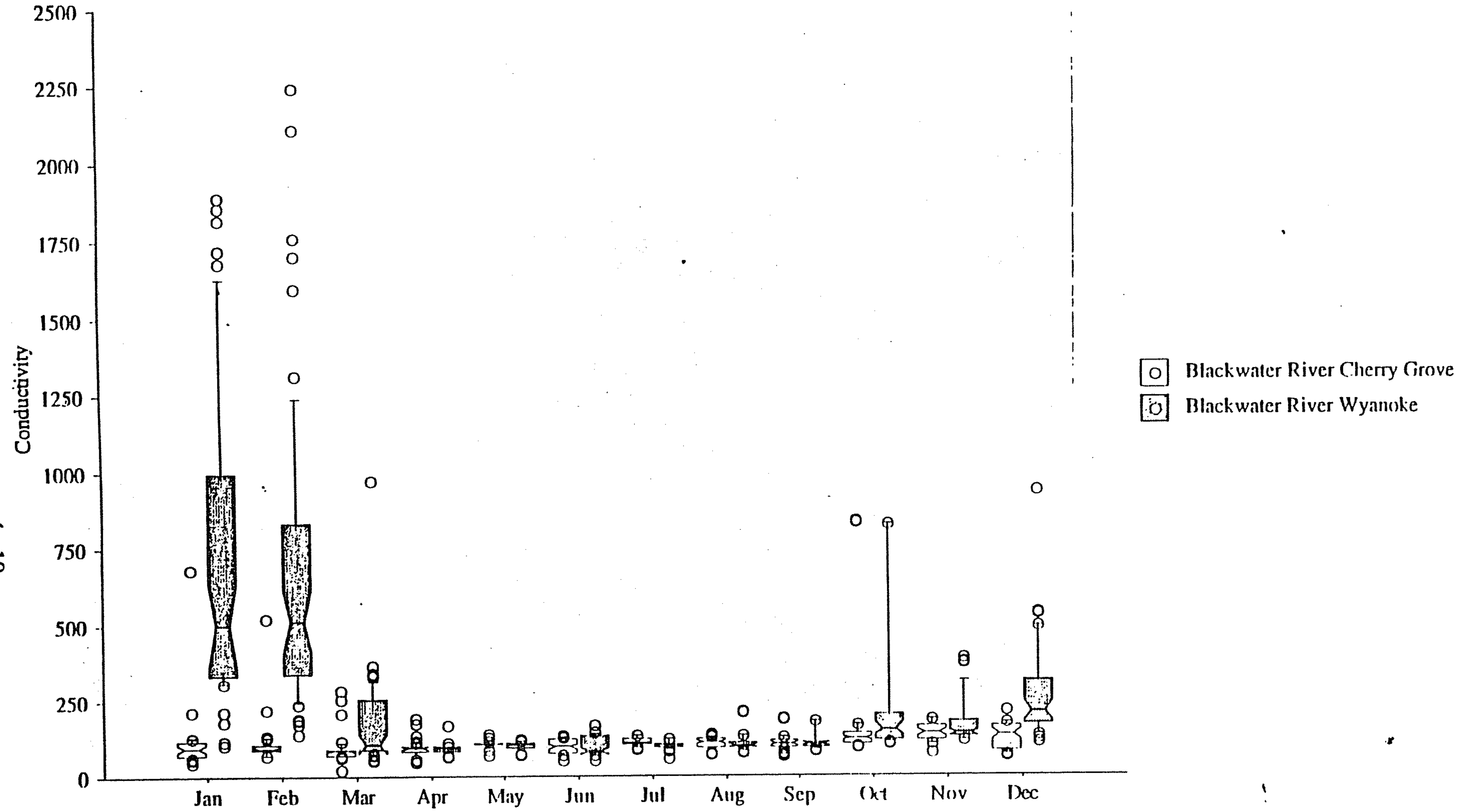


Figure 4.8. Blackwater River Ambient Monitoring Sites. Conductivity (µMhos) data distribution - 1980 to 1995.

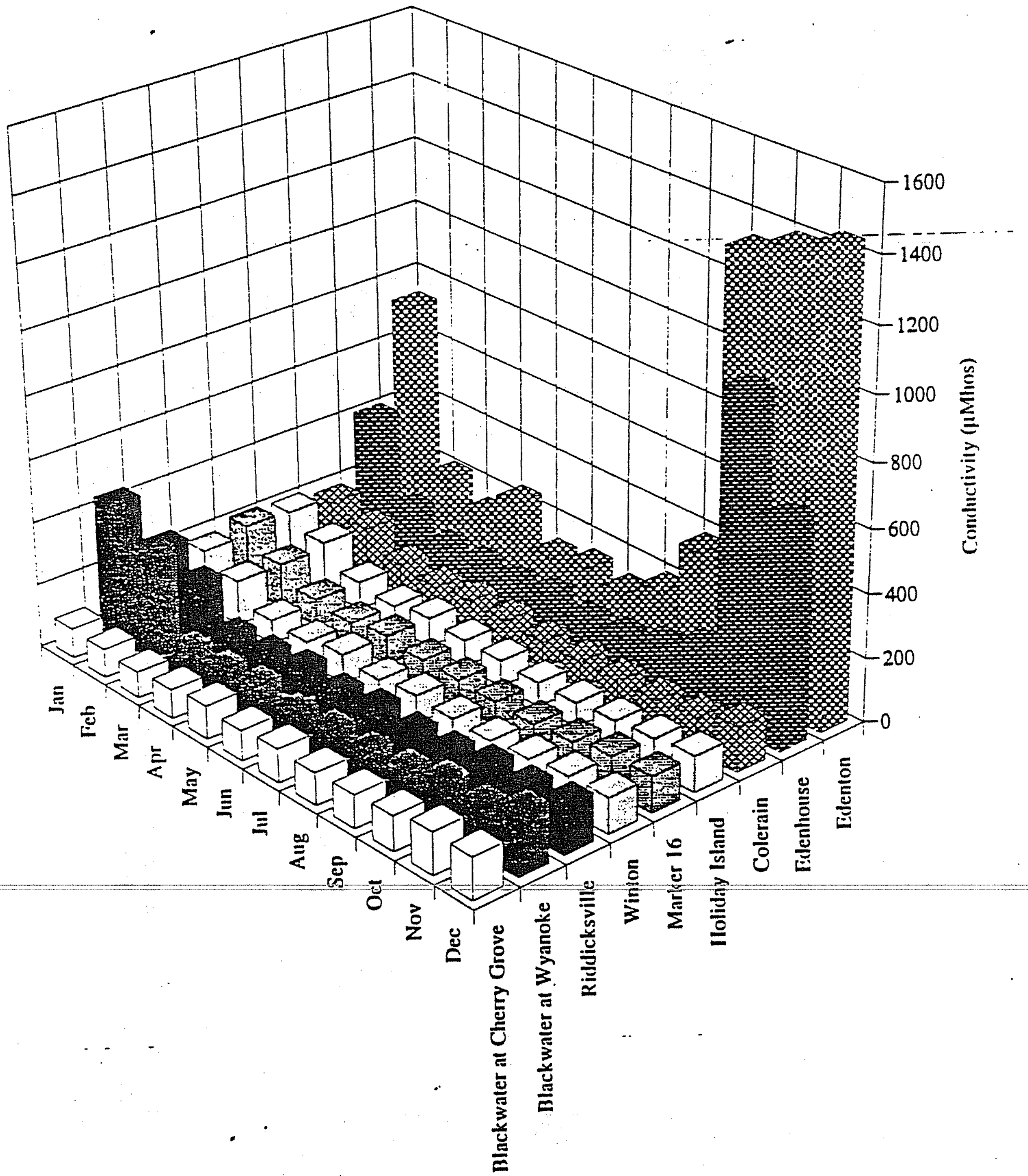


Figure 4.9. Chowan Basin Mainstem Monitoring Sites. Monthly Median Conductivity (µMhos) - 1980 to 1996.

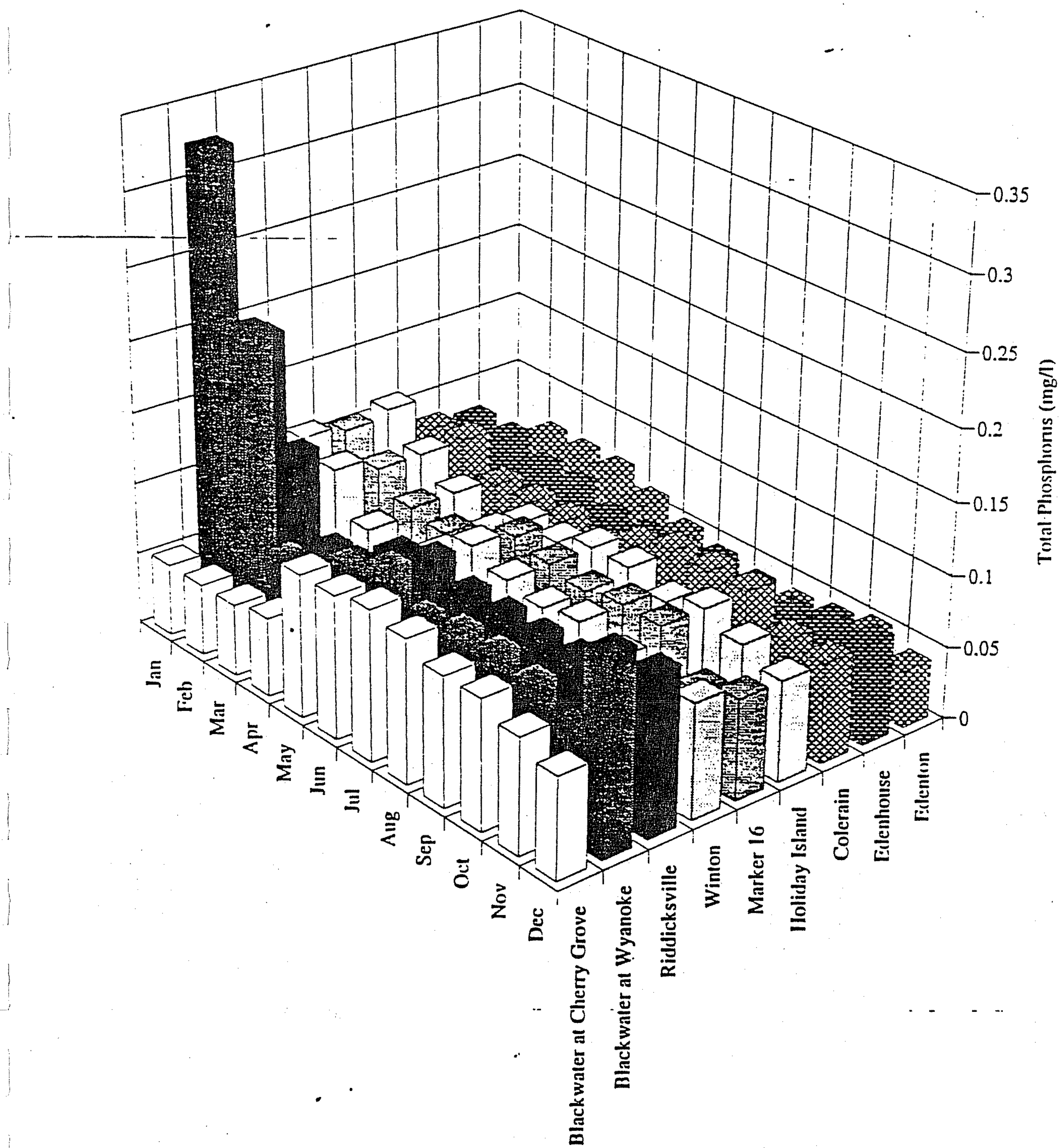


Figure 4.10. Chowan Basin Mainstem Monitoring Sites. Monthly Median Total Phosphorus (mg/l) - 1980 to 1995.

Table 4.7. Fecal Coliform summary data for the Chowan River Basin. 1990 to 1995.

Site	Total Samples	Geometric Mean	Samples > 200/100ml	Percent >200/100ml	First Sample	Last Sample
Nottaway River	66	16.38	0	0.0	1/24/90	5/14/96
Balckwater at Cherry Gr	65	24.20	1	1.5	1/24/90	5/14/96
Blackwater at Wyanoke	62	20.71	1	1.6	1/24/90	5/14/96
Chowan at Riddicksville	62	16.12	0	0.0	1/24/90	5/14/96
Potecasi Creek	8	36.68	2	25.0	5/24/95	5/28/96
Meherrin River	66	16.30	1	1.5	1/24/90	5/14/96
Chowan at Winton	62	13.49	0	0.0	1/24/90	5/14/96
Chowan at Marker 16	60	11.63	1	1.7	1/25/90	5/13/96
Chowan at Holiday Is	61	13.53	1	1.6	1/25/90	5/13/96
Chowan at Colerain	60	11.56	0	0.0	1/25/90	5/13/96
Chowan at Edenhouse	60	12.26	0	0.0	1/25/90	5/13/96
Chowan at Edenton	106	10.83	0	0.0	1/10/90	5/13/96

4.4 REVIEW OF FLOW, CHLOROPHYLL A AND PHYTOPLANKTON DATA FOR SELECTED STATIONS ON THE CHOWAN RIVER

This section discusses flow data from the US Geological Survey (USGS) and chlorophyll *a* and phytoplankton data obtained through the ambient water quality network. Although there are many monitoring stations within the basin, only data from the lower mainstem stations are evaluated here in order to look into the current status of nutrient enrichment in the Chowan River.

4.4.1 Regional Flow Patterns

In interpreting water quality data, some consideration needs to be given to flow or variations in flow among years. Since flow measurements are not available for the Chowan River, flow records for two tributary stations were used to determine temporal flow patterns (Figure 4.11) for the region. Flow data for Potecasi and Ahoskie Creeks (1980-1995) were obtained from the US Geological Survey (USGS). Similar temporal patterns existed for these two stations. Figure 4.11A groups monthly flow totals by year for Potecasi Creek. The curved line reveals yearly deviations from the average flow (horizontal line) for the period 1980-1995. In general low flows occurred during 1981, 1986, 1988 and 1990-1991. High flow occurred during 1982-1985, 1987 and 1989.

Monthly flow data from both creeks were used to develop an index showing flow variations within and among years (Figure 4.11B). The index represents the average of the standardized (z-) scores for each creek. (Standardized scores have a mean of zero and a standard deviation of one.) Standardization provides a common scale for data with different means and variation. In Figure 4.11B, the curved line reveals the variation in flow within each year. Note, for example, that during 1981, 1988 and 1991 high flows for the years were close to or below normal for the period 1980-1995. Also note that extreme variations in flow (high winter, low summer) occur within some years, for example 1983, 1984, 1987 and 1989.

4.4.2 Chlorophyll *a*

Chlorophyll *a* is a plant pigment that is used for assessing phytoplankton biomass. It has been measured in the Chowan River since the 1970's, however before 1980 there are many years without records. A more consistent data collection program began in 1980. Although sample size varies among stations and years, the data provide a good base upon which observations can be made.

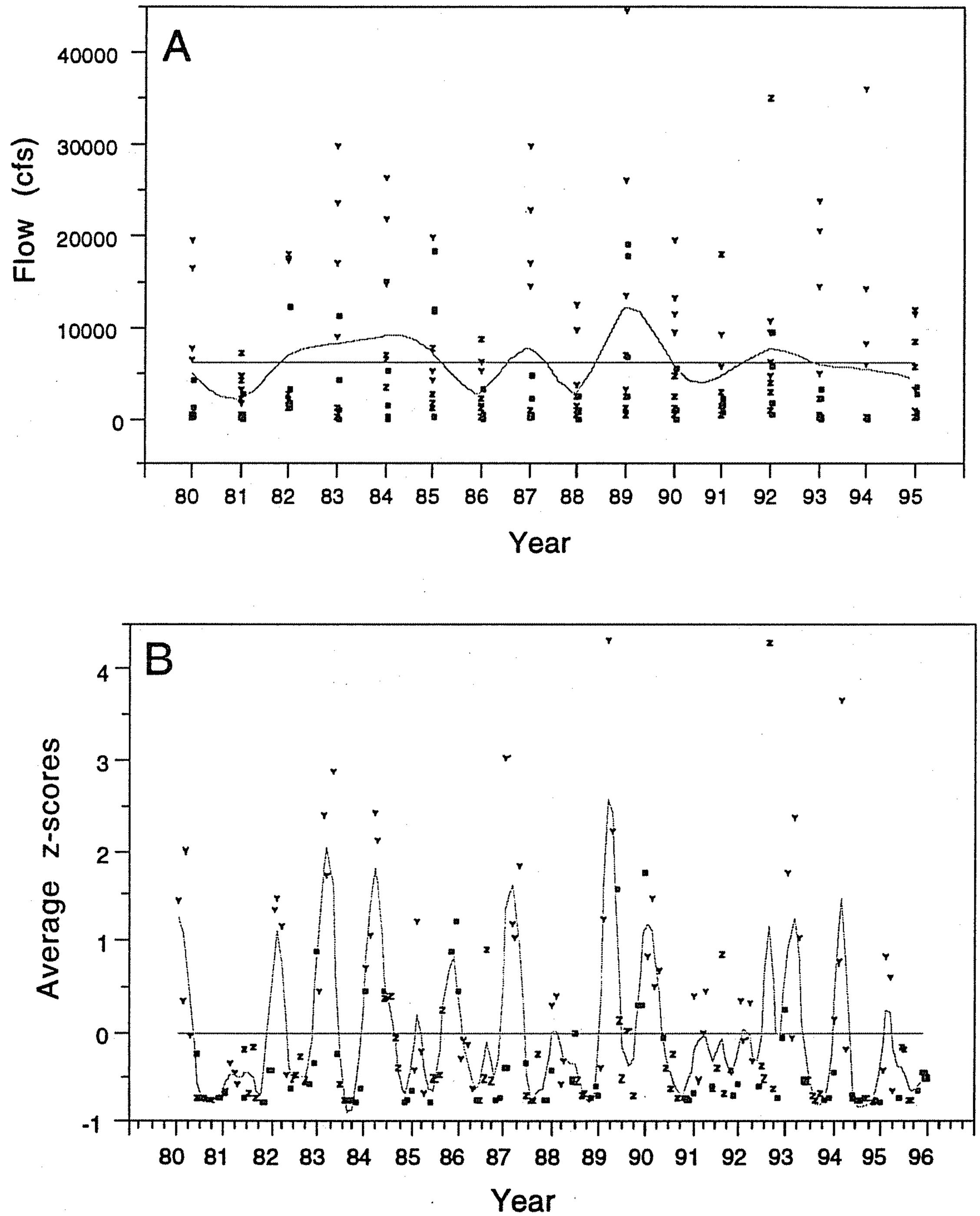


Figure 4.11. Flow patterns in the Chowan River basin from 1980-1995. Figure A depicts flow (cfs) from Potecasi Creek using data grouped by calendar year. Figure B depicts seasonal variations using the average of the standardized (z-) scores for Potecasi Creek and Ahoskie Creek (text provides details). The horizontal lines represent the mean for the period 1980-1995. The curved lines were fit using a smoothing spline (lambda=0.001). In Figure A the curved line accentuates yearly patterns, whereas in Figure B the seasonal patterns are highlighted. (Symbols Y=months Jan., Feb., Mar., Apr.; Z=Jun., Jul., Aug., Sep.)

The 1982 Chowan River Water Quality Management Plan (NC DNRCD 1982) states that chlorophyll *a* is a parameter to use for the assessment of eutrophication in the river. Specific goals include that peak chlorophyll *a* levels not exceed 40 µg/l and that average summer chlorophyll *a* concentrations not exceed 25 to 30 µg/l. Yearly concentrations of chlorophyll *a* at four mainstem ambient water quality stations are shown in Figure 4.12. Note that very few measurements are above 40 µg/l (the state's water quality standard) and all are below 45 µg/l. In general, the highest concentrations of chlorophyll *a* occurred during the mid 1980's. This pattern is seen by observing either the scatter of the data points, or the curved line. (The curved line was fit by a smoothing algorithm and is presented solely to elicit any temporal patterns.) Linear patterns, fitted by standard linear regression techniques, show a slight decrease in chlorophyll *a* concentrations over time. The largest decrease was only 0.57 µg/l per year and occurred at Winton, NC, but this represents a 7.4 µg/l decrease since 1983.

The scatter graph of summer chlorophyll *a* (June, July and August) concentrations is depicted in Figure 4.13. The ambient data show no concentrations exceeding 25 µg/l which was one of the target levels specified in the 1982 Chowan River Water Quality Management Plan (NC DNRCD 1982). Temporal patterns of chlorophyll *a* can be detected among the four ambient water quality stations (Figures 4.12 and 4.13). Most of the highest concentrations of chlorophyll *a* occurred during 1984 with significant decreases occurring by 1986. After 1986, chlorophyll *a* concentrations increased again and peaked during 1989 and 1990.

The temporal patterns of concentrations of chlorophyll *a* concentrations (Figure 4.12) are similar to the patterns of high and low flows (Figure 4.11). Relationships between flow and chlorophyll *a* concentrations indicate that years of high flows, particularly high spring flows, are the same years of high chlorophyll *a* concentrations. Flow and chlorophyll *a* concentrations were low during 1981, 1986, and 1991 (Figures 4.11 and 4.12).

One limitation of the trend analysis presented above is that it does not take into account the seasonal variation of chlorophyll a data. In an effort to address the seasonal nature of the data, a Seasonal Kendall Test was performed on chlorophyll a data from the four ambient monitoring stations presented in Figures 4.12 and 4.13 for the period of 1982-1996. The Seasonal Kendall Test is a statistical analysis designed to determine if a trend (upward or downward) is present over time in data subject to seasonal variation (Gilbert, 1987). The test determined that a slight, but statistically significant downward trend had occurred at the Gatesville station, but that no trend could be detected at the other stations.

One of the chief constraints of either of these analyses is the high degree of variability in the chlorophyll a data due to variability in flow and tidal fluctuation. If a more rigorous effort could be made to factor out the variability caused by flow, tests such as the Seasonal Kendall may be able to detect a more substantial trend over the 15 year period. It should be noted that the reported incidence of algal blooms in the Chowan River over the past 5-6 years presents a more encouraging outlook than the results of this statistical test. In recent years reported algal blooms have declined in both frequency and duration, with significant blooms occurring only twice in the past 5 years. A more detailed account of algal blooms in the Chowan River basin is presented in Section 4.4.4 of this chapter.

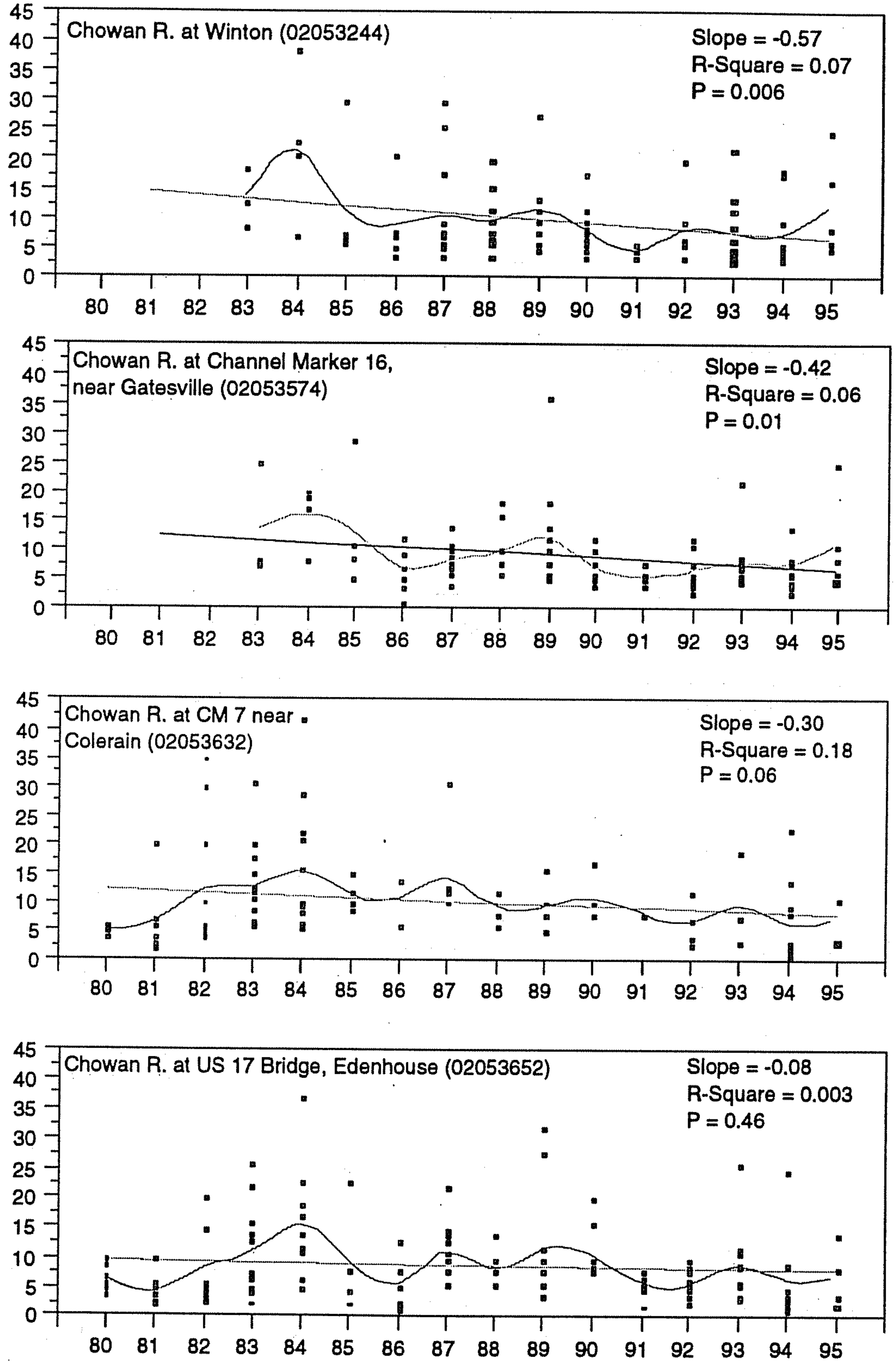


Figure 4.12. Patterns of the concentrations of chlorophyll-a (Y-axis, µg/l; X-axis = Year) at four ambient stations on the Chowan River. Curved line represents a smoothing spline fit (lambda=0.1). Slopes, R-squared values, and P-values for the linear fits are within each chart.

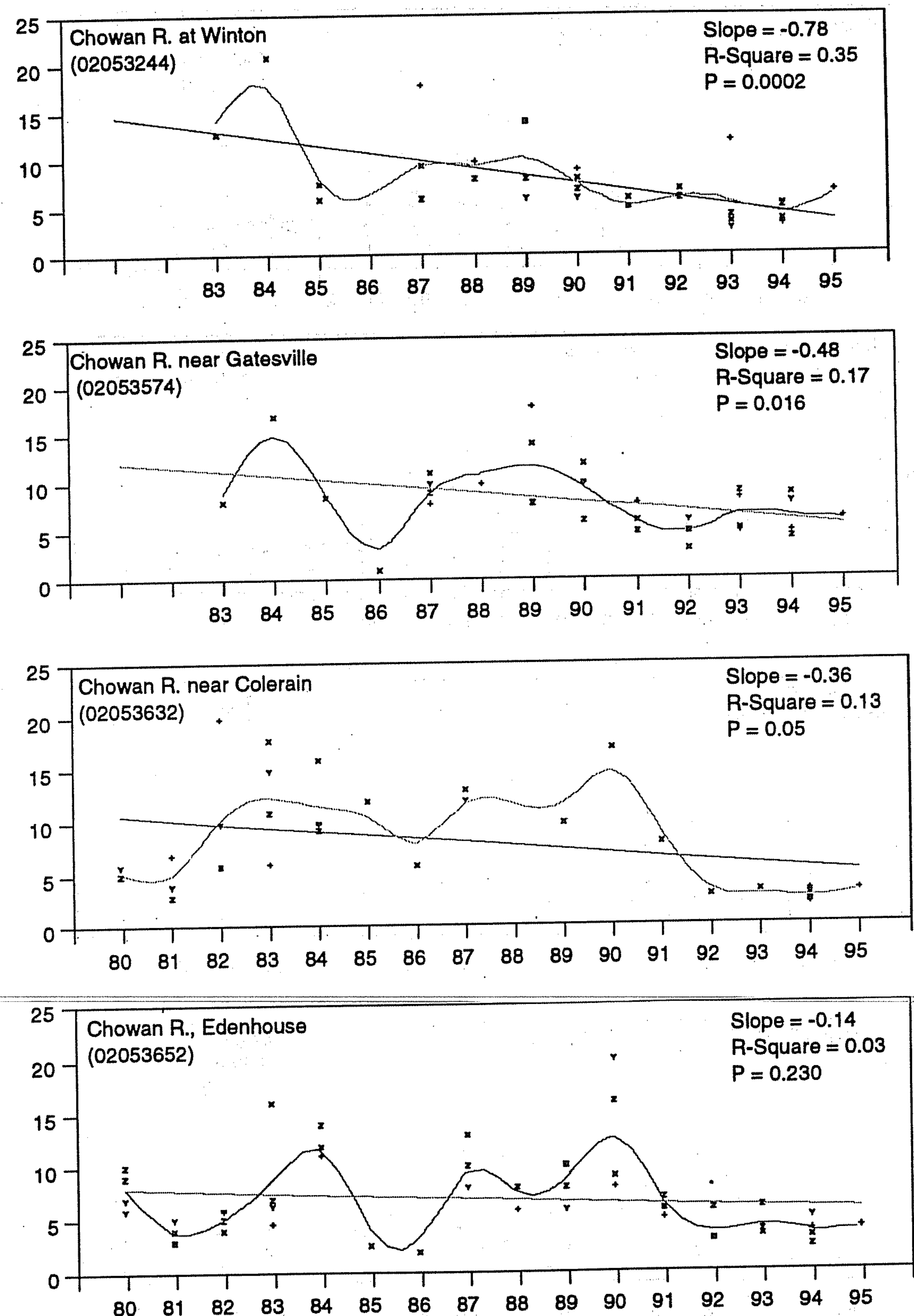


Figure 4.13. Patterns of summer (June +, July x, Aug. Y Sept. z) concentrations of chlorophyll a (Y-axis, µg/l; X-axis = Year) at four ambient stations on the Chowan R. Statistics for the linear fit are within each chart. Curved line represents a smoothing spline fit (lambda=0.1)

4.4.3 Phytoplankton

DWQ has collected and analyzed phytoplankton samples from the Chowan River since 1983. Samples include those collected in conjunction with ambient water quality samples and those associated with algal blooms. Sample analyses include identification of species at the lowest taxonomic level and an estimate of species density and biovolume. How often species occur (i.e. frequency), and a comparison of densities (cells or individuals per unit volume) and biovolume (size per unit volume) among species is how phytoplankton communities and monitoring stations can be compared. Changes in community structure can often be related to year, season, climate, and other environmental factors such as nutrient levels.

This section provides a summary of the phytoplankton samples collected as part of the ambient monitoring system. A description of the phytoplankton communities is presented first. The description focuses on the relative contribution a species provides to the phytoplankton community. An index that integrates measures of species frequency, density and biovolume is used to describe the communities and rank species. Secondly a summary of the sample parameters (total densities and total biovolume) is presented.

Phytoplankton communities and species composition

The phytoplankton sampling effort has varied over the years. That is, not all ambient stations have been sampled at the same time. Therefore, the following summary is based only on samples collected within the same time period for three stations on the Chowan River (Winton (02053244), Colerain (02053632) and Edenhouse (02053652)). By selecting a subset of samples in this manner, biases are not introduced into the analyses based upon unequal sample sizes. Since communities change as a result of seasons, samples were grouped by months into seasonal categories. Sampling did not occur every month and the greatest sampling effort was during the summer. Thus, there are differences in the number of months combined into the seasonal categories. The summer season represents a composite of samples collected from June through September (4 months). Likewise, the winter season included November , December, and February (3 months) and the spring season included April and May (2 months).

A species ranking index (Importance Value; IV) was developed based on the information provided by the number of samples in which a species occurred, the sum of the biovolume (mm^3/m^3) and density (individuals/ml; Table 4.8) for the species and the total sum of these parameters for all species. Further explanation of the information in Table 4.8 is provided by using *Anabaena portoricensis* as an example. A total of 87 samples were included in the summer seasonal category. *Anabaena portoricensis* occurred in 18 (21%) samples. Its total biovolume and density were 150, 871 (mm^3/m^3) and 23,429 (individuals/ml) respectively. Thus, it contributed 65% (0.65) and 13% (0.13) of the total biovolume and density respectively.

The relative frequency of a species represents the probability of selecting that species from a pool of all species sampled, weighted by the number of samples in which that species occurred. For example, *Anabaena portoricensis* occurred in 18 samples, however there was a total of 1429 species occurrences. Thus, the probability of selecting *Anabaena portoricensis* from the pool of all species occurrences is 0.01 (18/1429). All relative values are scaled from 0 to 1. A species ranking index (often called a species importance value, IV) was developed by averaging the three relative values. Table 4.8 presents the ten species with the highest importance value for each seasonal category.

The data (Table 4.8) show seasonal differences based on the biovolume provided by one species, *Anabaena portoricensis*. It is clear that when *Anabaena portoricensis* is present it dominates the community. This species was present in only 21% (n=18) of the summer samples and 4% (n=1)

Table 4.8. Phytoplankton species composition of the Chowan R. (Summer = Jun.- Sep., Winter = Nov., Dec., Feb., Spring = Apr. & May; Absolute biovolume (Bvol) in mm^3/m^3; absolute density (Den) in units/ml; Freq=frequency; see text for details).

		Absolute			Relative[2]			
SUMMER (n=87)[1] Species	N[4]	Freq (%)	Bvol	Density	Freq	Bvol	Den	IV[3]
Anabaena portoricensis	18	21	150,871	23,429	0.01	0.65	0.13	0.27
Chroomonas minuta	83	95	1,396	37,147	0.06	0.01	0.21	0.09
Ochromonas species 3	43	49	622	23,025	0.03	0.00	0.13	0.05
Cryptomonas erosa	78	90	6,129	9,890	0.06	0.03	0.06	0.05
Chroomonas caudata	71	82	2,079	11,908	0.05	0.01	0.07	0.04
Vacuolaria virescens	21	24	16,186	2,225	0.02	0.07	0.01	0.03
Skelotonema potamos	43	49	2,745	8,955	0.03	0.01	0.05	0.03
Chlorella vulgaris	16	18	2,599	9,390	0.01	0.01	0.05	0.03
Mallomonas akrokomos	58	67	229	3,929	0.04	0.00	0.02	0.02
Cryptomonas ovata	35	40	4,115	2,165	0.02	0.02	0.01	0.02
Others (n=200)[5]	963	1,102	45,335	44,197	0.67	0.20	0.25	0.37
TOTAL	1,429	1,637	232,306	176,260	1.00	1.00	1.00	1.00
WINTER (n=27)[1]								
Ochromonas species 3	11	41	86	3,184	0.04	0.02	0.26	0.11
Chroomonas minuta	25	93	77	2,044	0.09	0.02	0.17	0.09
Chroomonas caudata	21	78	226	1,326	0.07	0.05	0.11	0.08
Anabaena portoricensis	1	4	1,044	23	0.00	0.22	0.00	0.08
Cryptomonas ovata	12	44	623	327	0.04	0.13	0.03	0.07
Cryptomonas erosa	17	63	266	431	0.06	0.06	0.04	0.05
Ochromonas species	10	37	62	554	0.04	0.01	0.05	0.03
Chlorella vulgaris	5	19	116	419	0.02	0.03	0.04	0.03
Rhizosolenia species 2	1	4	72	680	0.00	0.02	0.06	0.03
Vacuolaria virescens	2	7	267	38	0.01	0.06	0.00	0.02
Others (n=79)[4]	182	1,248	1,825	3,031	0.64	0.39	0.25	0.41
TOTAL	287	1,637	4,663	12,057	1.00	1.00	1.00	1.00
SPRING (n=18)[1]								
Chroomonas minuta	17	94	281	7,596	0.09	0.03	0.32	0.14
Chlamydomonas species	1	6	1,642	2,746	0.01	0.16	0.11	0.09
Chroomonas caudata	12	67	580	3,412	0.06	0.06	0.14	0.09
Cryptomonas erosa	15	83	874	1,418	0.08	0.08	0.06	0.07
Peridinium cinctum	3	17	2,003	243	0.02	0.19	0.01	0.07
Cryptomonas ovata	15	83	756	386	0.08	0.07	0.02	0.05
Mallomonas majorensis	3	17	645	1,202	0.02	0.06	0.05	0.04
Ochromonas species 3	8	44	44	1,619	0.04	0.00	0.07	0.04
Skelotonema costatum	2	11	705	673	0.01	0.07	0.03	0.04
Cryptomonas erosa reflexa	6	33	272	219	0.03	0.03	0.01	0.02
Others (n=63)[4]	115	639	2,785	4,559	0.59	0.26	0.19	0.35
TOTAL	197	1,094	10,586	24,072	1.00	1.00	1.00	1.00

[1]Total number of samples; [2]Number represents the absolute value divided by total (scaling from 0 to 1); [3]Importance value (IV) is the average of relative values; [4]Number of samples in which the species occurred; [5]Total number of the remaining species (add 10 to obtain total number of species sampled.)

of the winter samples, but contributed 65% and 22% of the total species biovolume during these seasons, respectively. Apparently, it is extremely unlikely to occur during the winter or spring.

When *Anabaena portoricensis* is absent, the phytoplankton communities are dominated by the chrysophytes *Chroomonas minuta*, *C. caudata*, *Cryptomonas erosa* and *C. ovata*. During the winter a few dinoflagellates may occur (*Gymnodinium sp.* and *Peridinium cinctum*) along with the diatoms *Skelotonema potamos* and *S. costatum*.

Summary of Phytoplankton Samples

In the previous section, a subset of the total number of phytoplankton samples was used. However, here all the ambient phytoplankton samples are used except the five collected from the station near Gatesville (Station #02053574). Table 4.9 provides quantile measures and the means and standard errors of phytoplankton density and biovolume for three ambient water quality stations.

A quantile summary provides information on the percentage of values that are less or equal to that value. For example, the biovolume data for the station at Winton (02053244) show that 50% of the samples had biovolumes less than or equal to 200 mm^3/m^3 (Table 4.9). The summary shows clearly that the station at Colerain (02053632) has elevated biovolumes. In general a biovolume greater than 5000 mm^3/m^3 or a density greater than 10,000 individuals/ml reflects algal bloom conditions. Elevated biovolumes and densities almost always occur between April and September; the highest values occur between June and September.

Table 4.9. Summary of phytoplankton samples at three ambient stations in the Chowan River.

	Station		
	02053244	02053632	02053652
Sample size (n)	134	144	64
Biovolume (mm^3/m^3)			
maximum 100%	9,450	63,030	11,570
90%	1,740	5,020	3,050
75%	670	1,840	1,210
median 50%	200	420	340
25%	90	140	110
10%	50	70	60
minimum 0%	2	15	36
Mean:	700	2,820	1,070
Std Err Mean:	120	690	240
Density (units/ml)			
maximum 100%	18,440	13,810	8,560
90%	3,260	4,550	3,270
75%	1,140	2,610	1,920
median 50%	430	860	810
25%	210	330	300
10%	110	150	190
minimum 0%	29	35	111
Mean:	1,180	1,820	1,410
Std Err Mean:	190	190	190

4.4.4 Algal Blooms

Blue green algae blooms in the Chowan River are more severe, cover wider areas, and last longer during years with heavy winter and spring rains and dry summers. As discussed earlier, over the last 15 years there is a slight but statistically significant downward trend in chlorophyll *a* and nutrients. In addition, the frequency and duration of reported surface blooms has declined in recent years. Blooms do continue to occur, however, and the annual meteorological patterns remain important.

Flow data is not available from the Chowan River. Therefore, flow measurements from Ahoskie Creek were examined in comparing flow to algal response. During the past 5 years, significant blue green algal blooms occurred only in 1990 and 1993. Figures 4.14 and 4.15 depict flow measurements from Ahoskie Creek in those years. Both years recorded significant flow in the winter and late spring providing nutrient delivery, followed by low flow periods, enabling bloom development.

In 1990, "green flecks" were first noted in June, and extended from Holiday Island to the US 17 bridge near Edenton. The bloom was heaviest in mid July with chorophyll *a* values from surface grab samples as high as 350µg/L. The bloom persisted throughout August and into September, however it was confined to the lower river downstream of Colerain due to rainfall in late August. Anabaena portoricensis and to a lesser extent Anacystis cyanea were dominant phytoplankton species throughout the summer.

Blooms in 1993 were less severe, and not as long lived as in 1990, but affected the same area. Bloom conditions were not present until August and September. Associated chlorophyll *a* measurements were relatively low with the exception of a sample near Colerain on September 15 which contained 110 ug/L. One fish kill was associated with a blue green bloom in Deep Swamp Branch on September 5. Anabaena portoricensis comprised 97% of total phytoplankton biovolume.

One important concern associated with blue green algal blooms appears to be disruption of the food chain. Evidence suggests that blue green algae, which are not a suitable food source for small aquatic animals, can disrupt the food chain by replacing normal algal populations. Small aquatic animals are the basic food item for important fish species in the Chowan River. Therefore, blue green algae blooms can have a negative impact on fishery populations by affecting the food source of the small aquatic animals upon which fish feed.

Although the Chowan River has demonstrated measurable improvements in water quality, it remains sensitive to nutrients and supports blue green algal blooms on certain years. As in the past, when heavy spring rains are followed by dry summers, blooms are most prevalent. This suggests that continued implementation of Best Management Practices to further reduce nonpoint inputs during periods of heavy rain is an important strategy in minimizing the severity, extent, and duration of blooms in the lower Chowan River.

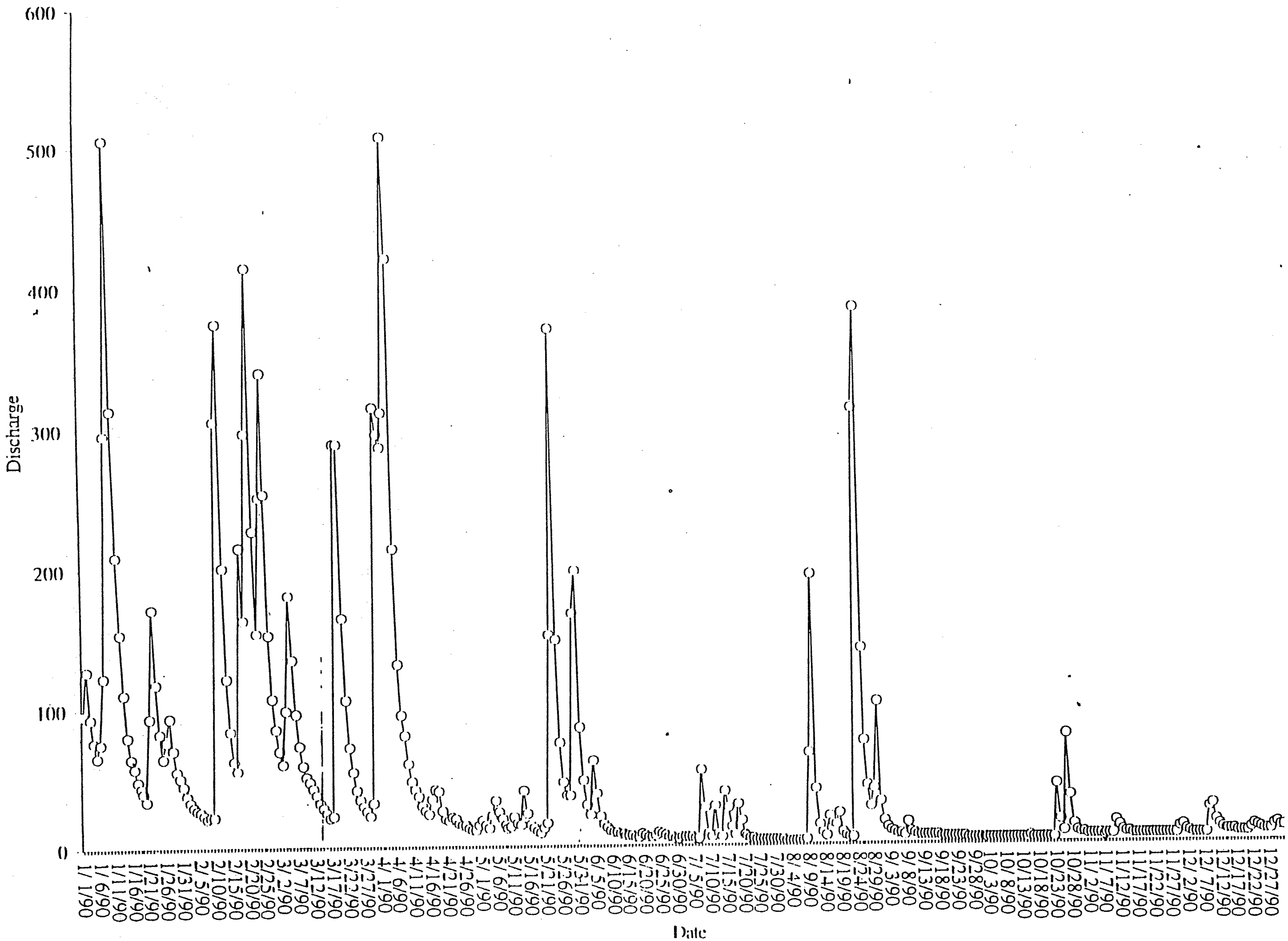


Figure 4.14. Mean Daily Discharge from USGS Flow Station 02053500, Ahoskie Creek at Ahoskie, NC, 1990.

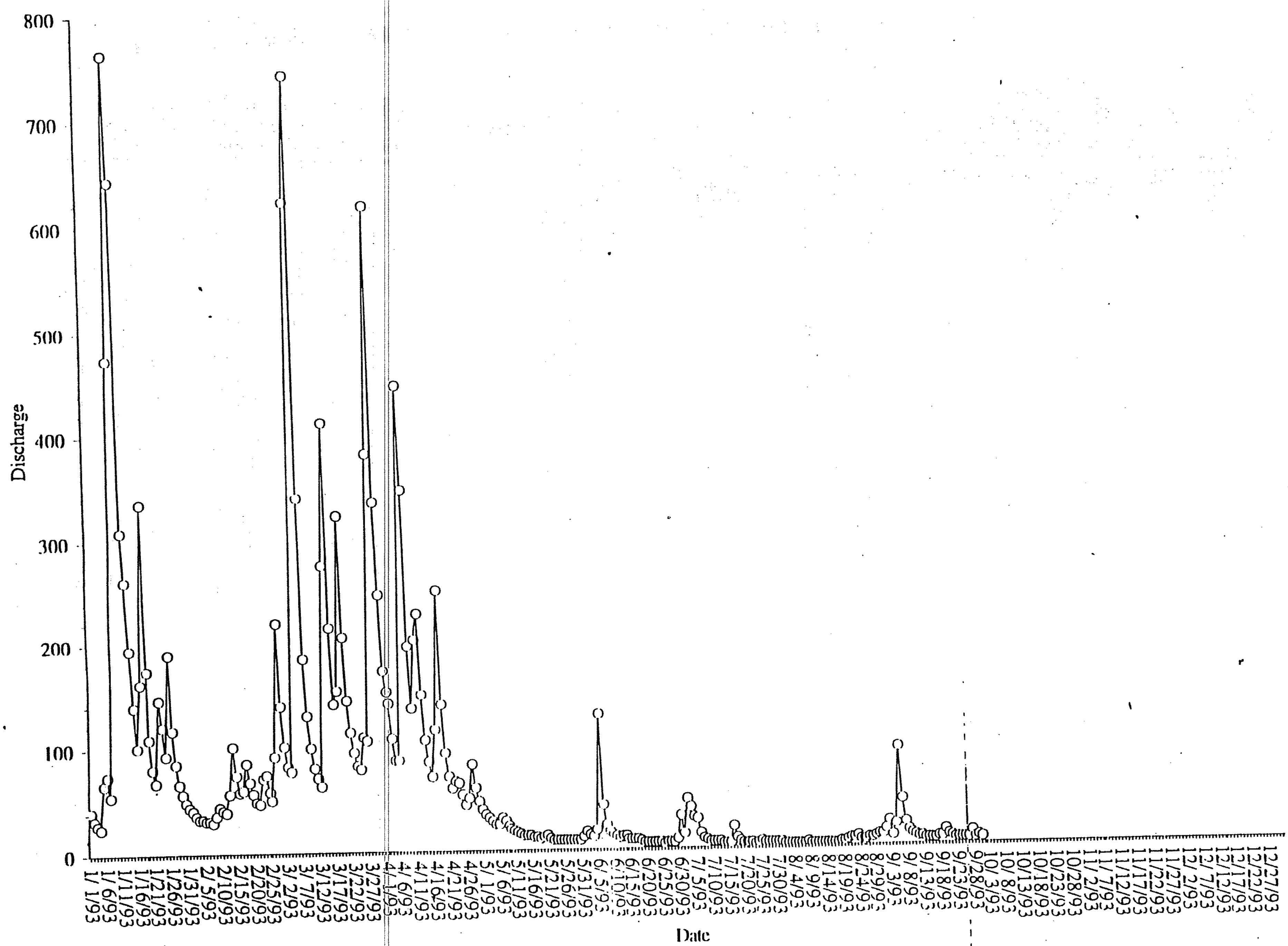


Figure 4.15. Mean Daily Discharge from USGS Flow Station 02053500, Ahoskie Creek at Ahoskie, NC, 1993.

4.5 NARRATIVE WATER QUALITY SUMMARIES BY SUBBASIN

4.5.1 Subbasin 01 - Upper Chowan River in North Carolina, Wiccacon River and Ahoskie Creek

Description

Chowan subbasin 01 is located in the northeastern coastal plain of North Carolina. The Chowan River originates in Virginia and its streams flow southeastward toward Albemarle Sound. The Chowan River is formed at the border of Virginia and North Carolina by the confluence of the Nottoway and Blackwater Rivers. The Chowan basin includes 1315 square miles in North Carolina, but the largest part of the drainage basin (3575 square miles) lies in Virginia. Major tributaries to the Chowan River in subbasin 01 include the Wiccacon River and Ahoskie Creek. The largest urban area in this subbasin is Ahoskie. Land use within this subbasin is mainly wetlands and agriculture. Figure 4.16 provides a map showing major streams and the location of DWQ's sampling locations in this subbasin.

Overview of Water Quality

There are 10 permitted dischargers in subbasin 01, all with a flow of ≤ 0.05 MGD. Bioclassifications of sites in this subbasin were Fair for the Wiccacon River and Ahoskie Creek and Good-Fair for the Chowan River at Riddicksville based on benthic macroinvertebrate data from 1995 (Table 4.10 presents all benthic macroinvertebrate sampling results for this subbasin). Fish community structure data was also collected from Ahoskie Creek, resulting in a NCIBI rating of Fair. The water quality problems encountered in this subbasin are thought to be due to nonpoint source runoff. From 1990-1995, 50% of the samples taken from the Wiccacon River had DO values above the minimum requirement of 4 mg/l. Only 14% of samples collected from the Chowan River at Riddicksville were above this minimum.

Table 4.10. Benthic Macroinvertebrate Data, Chowan Subbasin 01, 1983 through 1995.

Site	Map #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Chowan R, SR 1319, Hertford	B-1	25	08/95	53/8	7.81/4.17	Good-Fair
			07/90	58/14	7.46/5.39	Excellent
			07/88	66/10	7.31/6.15	Good
			07/86	63/10	7.62/6.27	Good
			07/84	65/9	6.88/5.37	Good
Wiccacon R, NC 45, SR 1433, Hertford	B-2	25-14	08/95	56/5	7.59/7.44	Fair
			02/95	27/2	8.60/6.82	Poor
			07/89	48/2	8.12/7.34	Poor
			07/87	60/3	8.07/7.95	Fair
			07/85	59/5	7.96/7.18	Fair
			07/83	56/4	7.93/6.72	Fair
Ahoskie Cr, NC 42, Hertford	B-3	25-14-1	08/95	61/7	7.67/6.19	Fair
			02/95	59/8	6.95/5.66	Swamp NR
UT Chinkapin Cr, SR 1432, Hertford	B-4	25-14-3-1	04/86	36/1	8.34/5.78	Swamp NR

Note: Map # refers to number on subbasin map; Index # refers to number in Schedule of Classifications for the Chowan River Basin; the ratings are described in section 4.2.1 of this chapter and Appendix II.

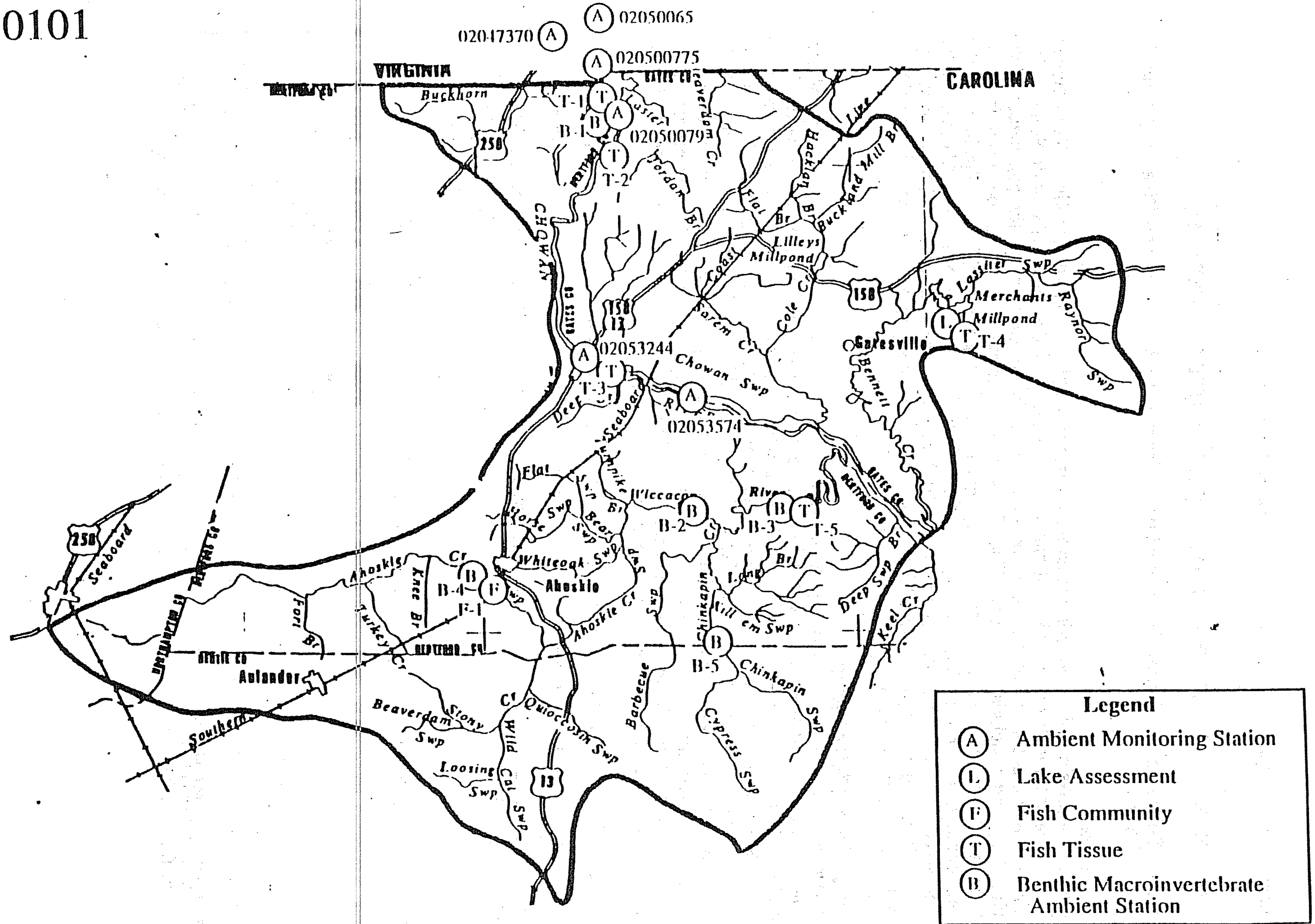


Figure 4.16. Locations of Sampling Stations for Subbasin 01

Fish tissue samples were collected at 5 sites within the Chowan 01 subbasin. The Chowan River from the Virginia Border to the Albemarle Sound (at Highway 17 bridge) remains under a fish consumption advisory for all fish except herring, shellfish and shad (including roe). The advisory has been in place since August 1990 and currently recommends that the general population consume no more than two meals of any fish except those noted above in one month and that children and pregnant or nursing women consume no fish except those noted above. The Union Camp Fine Paper mill in Franklin, Virginia is believed to contribute to the dioxin contamination of fish in the Chowan River. Yearly voluntary monitoring conducted by Union Camp shows that dioxin levels (as TEQ) in gamefish species collected at Gatlington and Winton in Chowan subbasin 01 and from Virginia locations on the Backwater and Nottoway Rivers have been below the 3 ppt (as TEQ) NC action level since monitoring was begun there in 1989. Channel catfish dioxin levels (as TEQ) from those same locations have been below the action level since 1994. Mercury contamination in the Chowan 01 subbasin is most prevalent near Riddicksville and the Wiccacon River near NC 45, with levels exceeding FDA and/or EPA criteria in 48 of 132 samples. Other metals results throughout the subbasin were non detectable or at levels below those of human health or ecological concern.

Merchants Millpond (the only significant lake in the Chowan Basin), located in Gates County was originally called Norfleets Millpond when it was constructed in 1811 and contained a grist mill, a wheat mill and a saw mill. Currently, the millpond is part of the Merchants Millpond State Park. The proliferation of aquatic macrophytes, which cover the lake's surface, is not uncommon in millponds. Both shallow depth and the long retention time of these ponds encourage the growth of aquatic macrophytes. This is the case with Merchants Millpond. The over abundance of these plants in Merchants Millpond has been determined as a threat to designated uses (primarily canoeing and fishing). Low dissolved oxygen values also indicate that the uses of this lake are threatened.

This subbasin contains the location of an abandoned fertilizer plant that historically contributed significant amounts of nutrient to the Chowan River. Sometime subsequent to the abandonment of the site, it was found that old holding ponds that had been capped with clay were leaking. Chromium was found in sufficient quantities to trigger the Resource Conservation and Recovery Act (RCRA), but with respect to water quality, the nutrients contained in the waste presented a continued concern. The details of a non-discharge permit to begin remediation are still being worked out among involved agencies, including DWQ.

4.5.2 Subbasin 02 - Meherrin River and Potecasi Creek

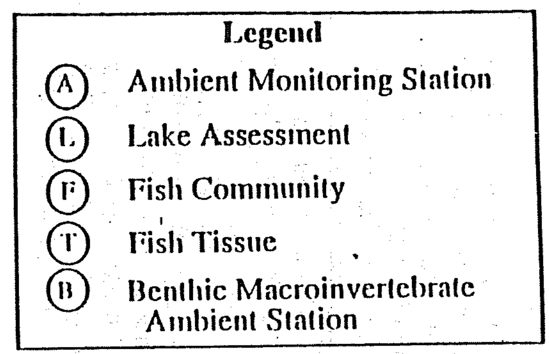
<u>Description</u>

This Chowan subbasin includes the Meherrin River and its tributary streams. The largest of these tributaries is Potecasi Creek. Murfreesboro is the largest urban area in this subbasin. Land use within the subbasin is mainly forest and agriculture. The Meherrin River flows into North Carolina from Greensville County, Virginia. Figure 4.17 provides a map showing the major hydrological features and the location of DWQ's sampling sites in this subbasin.

<u>Overview of Water Quality</u>

There are 5 permitted dischargers in subbasin 02, the largest of which is Resinall Corporation (0.325 MGD) which discharges into an unnamed tributary to Kirby's Creek in Northhampton County. General water quality in the Meherrin River is Good based on benthic macroinvertebrate data and Fair for Potecasi Creek (see Table 4.11 for complete list of benthic macroinvertebrate sampling results). From 1990-1995, 42% of the samples taken from Potecasi Creek violated the minimum DO requirement of 4 mg/l.

Chowan River Basin
030102



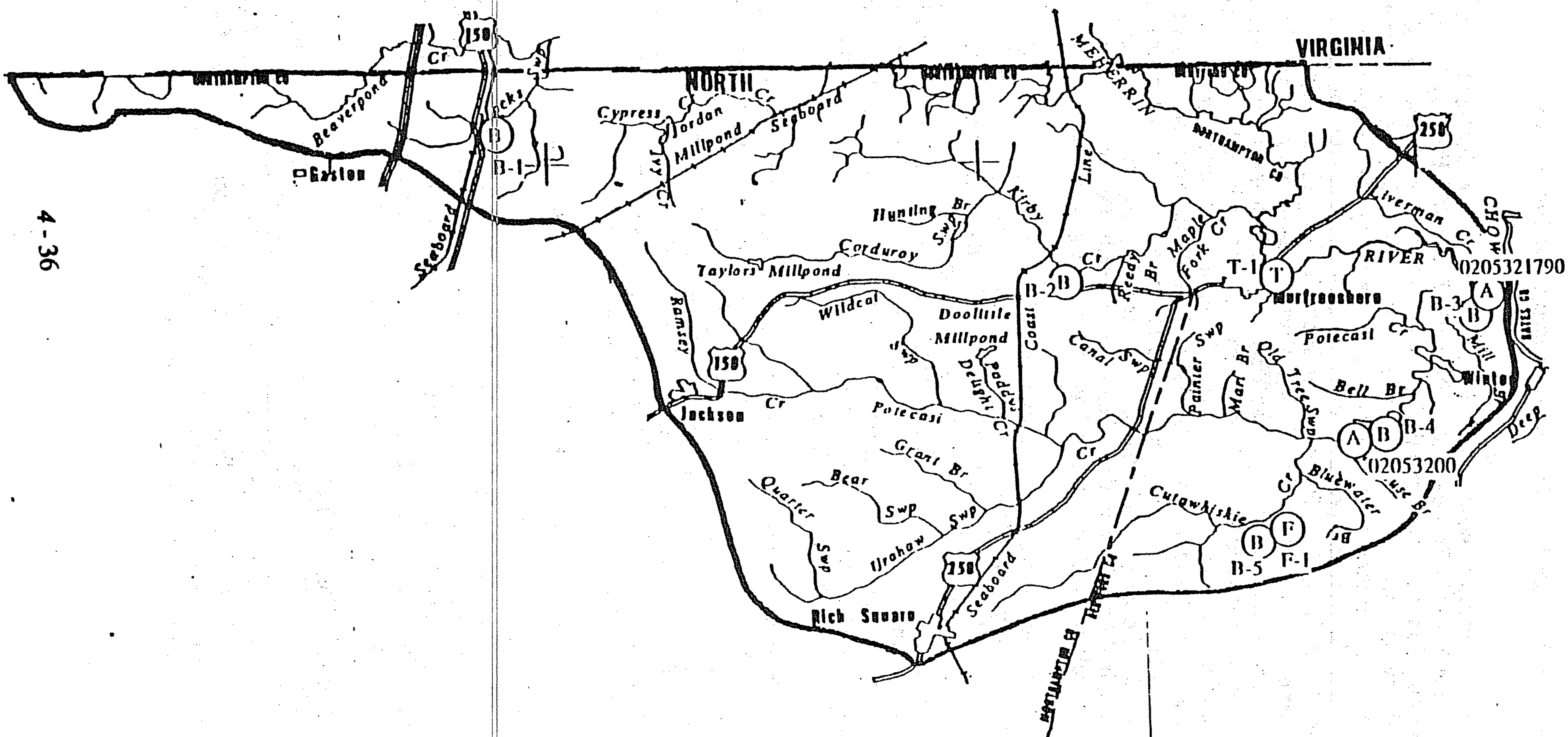


Figure 4.17. DWQ Sampling Sites in Subbasin 02.

Table 4.11. Benthic Macroinvertebrate Data, Chowan Subbasin 02, 1983 through 1995.

Site	Map #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Jacks Swp, SR 1301, Northampton	B-1	25-4-2-3	11/84	45/10	7.11/3.03	Good-Fair
Kirby's Cr, SR 1362, Northampton	B-2	25-4-4	02/95	62/11	6.52/5.86	Swamp NR
Meherrin R, SR 1175, Hertford	B-3	25-4-(5)	08/95	48/9	7.10/3.90	Good
			02/95	49/9	7.25/5.46	Good
			07/89	61/9	7.30/6.15	Good
			07/87	73/10	7.41/5.85	Good
			07/85	74/12	7.77/6.32	Excellent
			07/83	60/9	7.39/6.32	Good
Potecasi Cr, NC 11, Hertford	B-4	25-4-8	07/89	66/11	7.28/6.07	Fair
			07/86	53/6	7.39/5.95	Fair
			07/84	53/7	6.87/5.05	Fair
			07/83	60/9	7.39/6.32	Good
Cutawhiskie Cr, SR 1141, Hertford	B-5	25-4-8-7	08/95	49/4	6.80/6.13	Fair
			02/95	46/3	7.24/5.70	Swamp NR

Note: Map # refers to number on subbasin map; Index # refers to number in Schedule of Classifications for the Chowan River Basin; the ratings are described in section 4.2.1 of this chapter and Appendix II.

Fish community structure data were collected from Cutawhiskie Creek. The low NCIBI score (36) was attributed to a combination of only one sunfish species collected and an absence of piscivorous species. Both of these metrics are sensitive to degradation of pool habitats and quality of instream cover. No rating was given to this swamp stream.

Fish tissue samples were collected only from the Meherrin River at NC 258. The Meherrin River and Potecasi Creek are not under a fish consumption advisory due to dioxin contamination. Yearly voluntary monitoring conducted by Union Camp on channel catfish from the Meherrin River at NC 258 shows that dioxin levels (as TEQ) have been below the 3 ppt NC action level since 1991. Mercury contamination in samples collected from the Meherrin River was minimal, with only 3 samples exceeding the EPA screening value. Other metals results were non detectable or at levels below those of human health or ecological concern.

4.5.3 Subbasin 03 - Chowan River from Catherine Creek to Rockyhock Creek

<u>Description</u>

Chowan subbasin 03 contains the middle section of the Chowan River, above Rockyhock Creek and below Bennett Creek, including the tributaries Indian Creek and Catharine Creek. Land use is mainly forested wetlands. Figure 4.18 provides a visual description of the area and shows where DWQ's sampling sites in the subbasin are located.

<u>Overview of Water Quality</u>

Most of the information about water quality in this subbasin comes from water chemistry and phytoplankton sampling and is summarized previously in this chapter. No benthos or fish community structure collections have been made in this subbasin.

The Chowan River from the Virginia Border to the Albemarle Sound (at Highway 17 bridge) remains under a fish consumption advisory for all fish except herring, shellfish and shad (including roe). The advisory has been in place since August 1990 and currently recommends that the general population consume no more than two meals of any fish except those noted above in one month and that children and pregnant or nursing women consume no fish except those noted above. Further discussion of this is in Section 3.2.2 in Chapter 3.

Chowan River Basin
030103

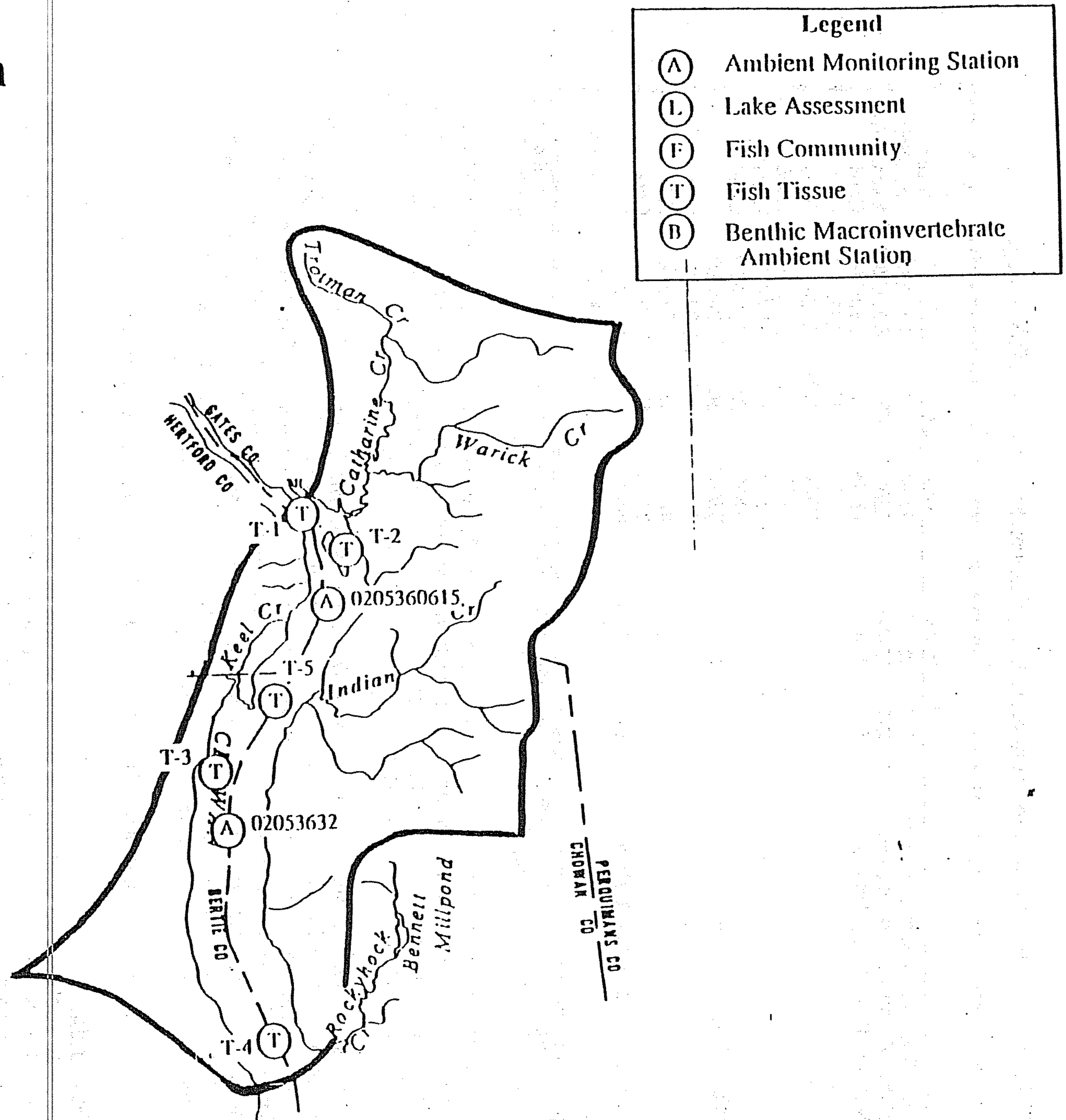


Figure 4.18. DWQ Sampling Sites in Subbasin 03.

Yearly voluntary gamefish monitoring conducted by Union Camp at Marker 16 and Marker 5 in subbasin 03 shows that largemouth bass and bluegill sunfish dioxin levels (as TEQ) have been below the 3 ppt NC action level since monitoring was begun there in 1990. Union Camp's monitoring further shows that channel catfish dioxin levels (as TEQ) have been below the NC action level at Marker 16 since 1994, and have been below the NC action level at Marker 5 since 1993. Marker 9 channel catfish levels were below the action level during 1995 and 1996, but have increased to slightly above the action level for 1997. It should be noted that the Albemarle Sound and the lower portion of the Chowan River experience tidal action and that the fish in this area may be impacted by other discharges of dioxin into waters that flow into the sound.

4.5.4 Subbasin 04 - Chowan River from Rockyhock Creek to Albemarle Sound

Description

Chowan subbasin 04 includes a small northwest portion of the Albemarle Sound, including Salmon Creek, Edenton Bay and Pembroke Creek, and the west side of the mouth of the Chowan River, below US 17. There are no large urban areas in this subbasin. Land use is mainly forested wetlands. Figure 4.19 shows the location of DWQ's sampling sites in the subbasin.

Overview of Water Quality

The only permitted discharger in subbasin 04 is the R. J. Reynolds Tobacco Company with a flow of 0.25 MGD. The only benthos site sampled in this subbasin is the Chowan River at US 17, where water quality has generally remained Good-Fair, based on benthic macroinvertebrate data, since 1983. Table 4.12 the results of all benthic samples taken at this location.

Table 4.12. Benthic Macroinvertebrate Data, Chowan Subbasin 04, 1983 through 1995.

Site	Map #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Chowan R, US 17, Hertford	B-1	25	08/95	34/8	6.50/5.40	Good-Fair
			06/90	41/11	6.32/4.87	Good
			07/88	45/7	6.72/5.55	Good-Fair
			07/86	38/6	6.81/5.55	Good-Fair
			07/85	37/5	7.04/4.91	Fair
			07/84	41/8	6.61/4.91	Good-Fair
			07/83	42/8	7.07/5.06	Good-Fair

Note: Map # refers to number on subbasin map; Index # refers to number in Schedule of Classifications for the Chowan River Basin; the ratings are described in section 4.2.1 of this chapter and Appendix II.

Fish tissue samples were collected at four sites within this subbasin. Mercury contamination was minimal in these fish with only 3 of 47 samples containing mercury above human health criteria. Other metals and organics results were non-detectable or at levels below those of human health or ecological concern.

The Chowan River from the Virginia Border to the Albemarle Sound (at Highway 17 bridge) remains under a fish consumption advisory for all fish except herring, shellfish and shad (including roe). The advisory has been in place since August 1990 and currently recommends that the general population consume no more than two meals of any fish except those noted above in one month and that children and pregnant or nursing women consume no fish except those noted above. Further discussion of this is in Section 3.2.2 in Chapter 3.

Union Camp has conducted voluntary fish tissue monitoring for channel catfish at the Highway 17 bridge since 1989 and at marker 2 (within the Albemarle Sound advisory area) since 1990. Union Camp performed no gamefish monitoring n Chowan subbasin 04 until 1997. 1997 data

Chowan River Basin
030104

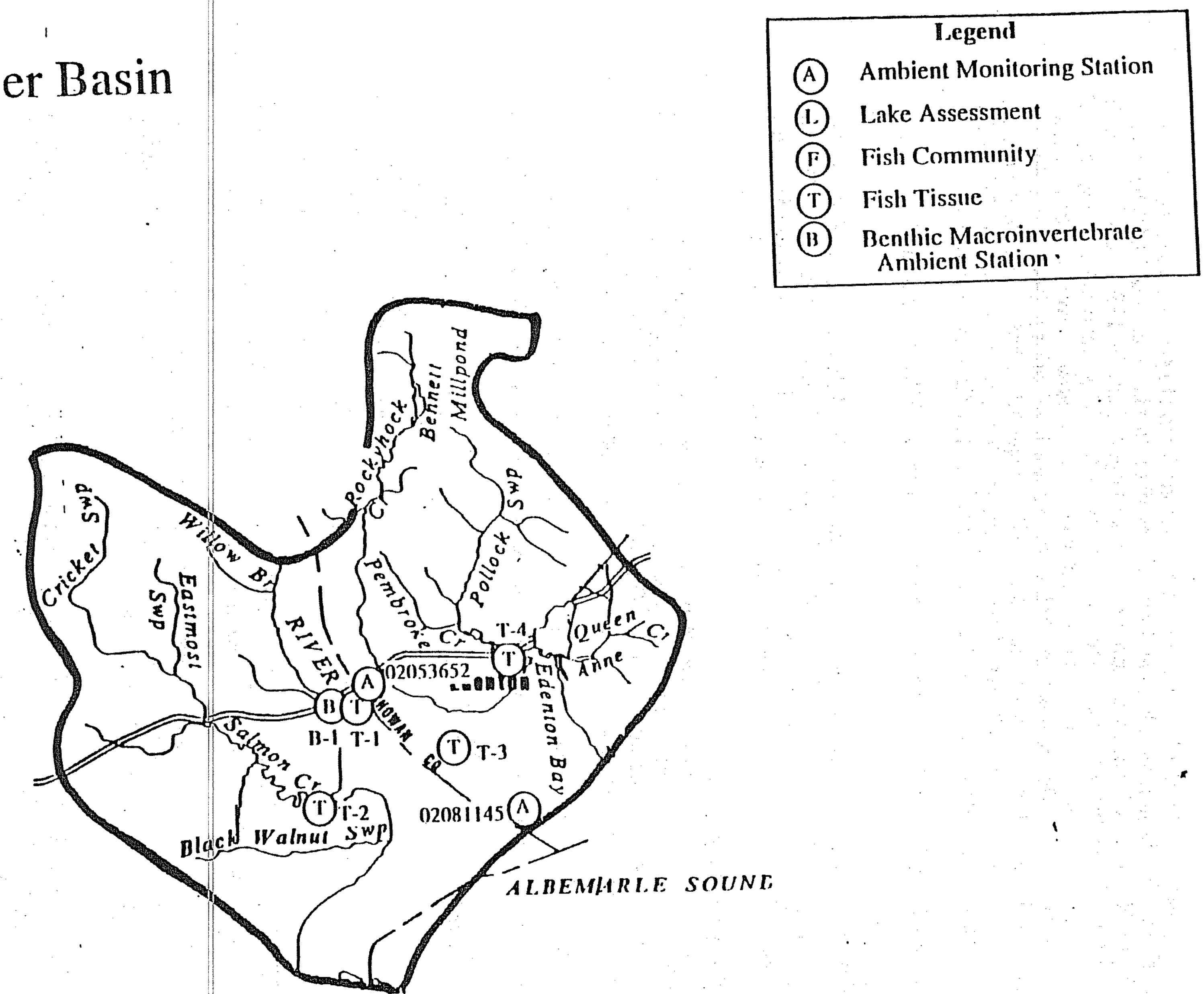


Figure 4.19. DWQ Sampling Sites in Subbasin 04.

for fish collected at the Highway 17 bridge shows that largemouth bass and bluegill sunfish dioxin levels (as TEQ) are below the 3 ppt NC action level. The channel catfish dioxin levels in Chowan subbasin 04 were below the action level during 1996, but have increased slightly above the action level for 1997. It should be noted that the Albemarle Sound and lower portion of the Chowan River experience tidal action and the fish in this area may be impacted by other discharges of dioxin into waters that flow into the sound.

4.6 USE-SUPPORT: DEFINITIONS AND METHODOLOGY

4.6.1 Introduction to Use Support

Waters are classified according to their best intended uses. Determining how well a waterbody supports its designated uses (*use support* status) is another important method of interpreting water quality data and assessing water quality. Use support assessments for the Chowan River basin are presented in Section 4.5.

Surface waters (streams, lakes or estuaries) are rated as either *fully supporting* (S), *support-threatened* (ST), *partially supporting* (PS), or *not supporting* (NS). The terms refer to whether the classified uses of the water (such as water supply, aquatic life protection and swimming) are fully supported, partially supported or are not supported. For instance, waters classified for fishing and water contact recreation (class C) are rated as fully supporting if data used to determine use support (such as chemical/physical data collected at ambient sites or benthic macroinvertebrate bioclassifications) did not exceed specific criteria. However, if these criteria were exceeded, then the waters would be rated as ST, PS or NS, depending on the degree of exceedence.

Streams rated as either partially supporting or nonsupporting are considered *impaired*. A waterbody is fully supporting but threatened (ST) for a particular designated use when it fully supports that use now, but may not in the future unless pollution prevention or control action is taken. Although threatened waters are currently supporting uses, they are treated as a separate category from waters fully supporting uses. 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.

4.6.2 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 impaired waters. Data used in the use support assessments include biological data, chemical physical data, lakes assessment data, DEH shellfish sanitation surveys, and monitoring data. Although there is a general procedure for analyzing the data and determining a waterbody's use support rating, each stream segment is reviewed individually, and best professional judgment is applied during these determinations.

Interpretation of the use support ratings compiled by DEM should be done with caution. The methodology used to determine the ratings must be understood, as should the purpose for which the ratings were generated. The intent of this use-support assessment was to gain an overall picture of the water quality, how well these waters support the uses for which they were classified, and the relative contribution made by different categories of pollution within the basin. In order to comply with guidance received from EPA to identify likely sources of pollution for all impaired stream mileage, DEM 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 not to manipulate the data to support policy decisions beyond the accuracy of these data. For example, according to this report, nonpoint source pollution is the greatest source of water quality degradation. However, this does not mean that there should be no point source control measures. 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.

The threat to water quality from all types of activities heightens the need for point and nonpoint source pollution control. It is important to consider any source (or potential source) of pollution in developing appropriate management and control strategies. 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.

4.6.3 Assessment Methodology - Freshwater Bodies

Many types of information were used to determine use support assessments and to determine causes and sources of use support impairment. A use support data file is maintained for each of the 17 river basins. In these files stream segments are listed as individual records. All existing data pertaining to a stream segment (from the above list) is entered into its record. In determining the use support rating for a stream segment, corresponding ratings are assigned to data values where this is appropriate. The following data and the corresponding use support ratings are used in the process: (note: The general methodology for using this data and translating the values to use support ratings corresponds closely to the 305(b) guidelines with some minor modifications.)

Biological Data

Benthic Macroinvertebrate Bioclassification
Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups Ephemeroptera, Plecoptera and Trichoptera (EPT S) and the Biotic Index which summarizes tolerence data for all taxa in each collection. The bioclassifications are translated to use support ratings as follows:

Bioclassification	Rating
Excellent	Supporting
Good	Supporting
Good-Fair	Support Threatened
Fair	Partially Supporting
Poor	Not Supporting

Fish Community Structure

The North Carolina Index of Biotic Integrity (NCIBI) is a method for assessing a streams biological integrity by examining the structure and health of its fish community. The index incorporates information about species richness and composition, trophic composition, fish abundance and fish condition. The index is translated to use support ratings as follows:

NCIBI	Rating
Excellent	Supporting
Good-Excellent	Supporting
Good	Supporting
Fair-Good	Support Threatened
Fair	Partially Supporting
Poor-Fair	Partially Supporting
Poor	Not Supporting
Very Poor - Poor	Not Supporting
Very Poor	Not Supporting

Phytoplankton and Algal Bloom Data

Prolific growths of phytoplankton, often due to high concentrations of nutrients, sometimes result in "blooms" in which one or more species of alga 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. An algal sample with a biovolume larger than 5,000 mm3/m3, density greater than 10,000 units/ml, or chlorophyll *a* concentration approaching or exceeding 40 micrograms per liter (the NC state standard) constitutes a bloom. A waterbody is rated ST if the biovolume, density and chlorophyll a concentrations are approaching bloom concentrations. If an algal bloom occurs, the waterbody is rated PS.

Chemical/Physical Data

Chemical/physical water quality data is collected through the Ambient Monitoring System as discussed in section 4.2.7. This data is downloaded from STORET to a desktop computer for analysis. Total number of samples and percent exceedences of the NC state standards are used for use support ratings. Percent exceedences correspond to use support ratings as follows:

Standards Violation	Rating
Criteria exceeded < 10%	Fully Supporting
Criteria exceeded 11-25%	Partially Supporting
Criteria exceeded >25%	Not Supporting

It is important to note that some waters may exhibit characteristics outside the appropriate standards due to natural conditions. These natural conditions do not constitute a violation of water quality standards.

Lakes Program Data

As discussed in section 4.2.3, assessments have been made for all publicly accessible lakes, lakes which supply domestic drinking water, and lakes where water quality problems have been observed.

Sources and Cause Data

In addition to the above data, existing information was entered for potential sources of pollution (point and nonpoint). It is important to note that not all impaired streams will have a potential source and/or cause listed for them. Staff and resources do not currently exist to collect this level of information. Much of this information is obtained through the cooperation of other agencies (federal, state and local), organizations, and citizens.

Point Source Data

__Whole Effluent Toxicity Data__
Many facilities are required to monitor whole effluent toxicity by their NPDES permit or by administrative letter. Streams that receive a discharge from a facility that have failed its whole effluent toxicity test may be rated ST (unless water quality data indicated otherwise), and have that facility listed as a potential source of impairment.

__Daily Monitoring Reports__
Streams which received a discharge from a facility significantly out of compliance with permit limits may be rated ST (unless water quality data indicated otherwise), and have that facility listed as a Point Source potential source of impairment.

Nonpoint Source Data

Information related to nonpoint source pollution (i.e., agricultural, urban and construction) was obtained from monitoring staff, other agencies (federal, state and local), 1988 nonpoint source workshops, land-use reviews, and workshops held at the beginning of each basin cycle.

Problem Parameters

Causes of use support impairment (problem parameters) 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 listed as a problem parameter. For segments without ambient stations, information from reports, other agencies, and monitoring staff were used if it was available.

Monitored vs. Evaluated

Assessments were made on either monitored (M) or evaluated (E) basis depending on the level of information that was used. Streams are rated on a monitored basis if the data is less than five years old. Streams are rated on an evaluated basis under the following conditions:

> If the only existing data for a stream is more than five years old, this data is used to rate the stream on an evaluated basis.
>
> If a stream is a tributary to a monitored (segment of a) stream rated fully supporting (S) or support threatened (ST), the tributary will receive the same rating on an evaluated basis. If a stream is a tributary to a monitored (segment of a) stream rated partially supporting (PS) or not supporting (NS), the stream is considered not evaluated (NE).

4.6.4 Assigning Use Support Ratings

At the beginning of each assessment, all data is reviewed by subbasin with the monitoring staff, and data is adjusted where necessary based on best professional judgment. Discrepancies between data sources are resolved during this phase of the process. For example, a stream may be sampled for both benthos and fish community structure, and the bioclassification may differ from the NCIBI (i.e. the bioclassification may be S while the NCIBI may be PS). To resolve this, the final rating may defer to one of the samples (resulting in S or PS), or, it may be a compromise between both of the samples (resulting in ST).

After reviewing the existing data, ratings are assigned to the streams. If one data source exists for the stream, the rating is assigned based on the translation of the data value as discussed above. If more than one source of data exists for a stream, the rating is assigned according to the following hierarchy:

Benthic Bioclassification / Fish Community Structure
Chemical/Physical Data
Monitored Data > 5 years old
Compliance / Toxicity Data

This is only a general guideline for assigning use support ratings and not meant to be restrictive. Each segment is reviewed individually and the resulting rating may vary from this process based on best professional judgment which takes into consideration site specific conditions.

After assigning ratings to streams with existing data, streams with no existing data were assessed. Streams that were direct or indirect tributaries to streams rated S or ST received the same rating (with an evaluated basis) if they had no known significant impacts, based on a review of the watershed characteristics and discharge information. Streams that were direct or indirect tributaries to streams rated PS or NS, or that had no data were assigned a Not Evaluated (NE) rating.

4.6.5 Revisions to Methodology Since 1992 - 93 305(b) Report

Methodology for determining use support has been revised. In the 1992-1993 305(b) Report, evaluated information from older reports and workshops were included in the use support process. Streams rated using this information were considered to be rated on an evaluated basis. In the current use support process, this older, evaluated information has been discarded, and streams are now rated using only monitored information (including current and older monitoring data). Streams are rated on a monitored basis if the data is less than five years old. Streams are rated on an evaluated basis under the following conditions:

If the only existing data for a stream is more than five years old, this data is used to rate the stream on an evaluated basis.

> If a stream is a tributary to a monitored segment of a stream rated fully supporting (S) or support threatened (ST), the tributary will receive the same rating on an evaluated basis. If a stream is a tributary to a monitored segment rated partially supporting (PS) or not supporting (NS), the stream is considered not evaluated (NE).

These changes resulted in a reduction in streams rated on an evaluated basis.

The basinwide process allows for concentrating more resources on individual basins during the monitoring phase. Therefore, more streams were monitored, and more information was available to use in the use support process.

Fish consumption advisories are no longer used in determining the use support rating. They are now shown on a separate map, and discussed in Chapter 3. This will more clearly show what types of advisories are in effect, and where they are occurring.

4.7 USE SUPPORT RATINGS FOR THE CHOWAN RIVER BASIN

Use Support ratings for all monitored and evaluated surface waters in the basin are presented on color-coded maps in Figure 4.20. The following sections describe the assignment of ratings to both the fresh and salt waters in the basin.

4.7.1 Freshwater Streams and Rivers

Of the 788 miles of freshwater streams and rivers in the Chowan basin, use support ratings were determined for 64% or 507 miles of water. The relative breakdown of percentages for the use support categories is as follows:

SUPPORTING 42%
- Fully supporting (17%)
- Support-threatened (25%)

IMPAIRED.................................... 22%
- Partially supporting (22%)
- Not supporting (0%)

NOT EVALUATED: 36%

These use support values are different from the values in the 1992-1993 305(b) Report. The total waters supporting their uses appear to have increased, while those that are impaired appear to have decreased. While the water quality may have improved since the 1992-1993 305(b) report, the changes in values may also be due to revisions in the methodology for assigning use support (discussed earlier in section 4.4.5).

Table 4.13 provides information on streams and stream segments that were monitored. Streams with data that was collected during the time period of 1991 through 1995 are considered to be monitored. This includes bioclassification and collection date for macrobenthic invertebrate samples, fish community structure samples, ambient monitoring station information, problem parameters such as sediment, potential sources of pollution (point or nonpoint), and the overall use support rating. All remaining streams in the basin were rated on an evaluated basis, or, if no data exists, were considered not evaluated. Table 4.14 presents the overall use support determinations by subbasin.

Impaired Freshwater Streams

In determining sources of pollution for impaired waters, observation from field staff, information from the 1988 nonpoint source workshops, and discharger daily monitoring reports were used. This does not provide a complete explanation for all potential sources of pollution in the basin. Recently, multi-agency teams have been assigned to address nonpoint source pollution in each of the river basins. As the different agencies work together within these teams, they will eventually provide more complete information on the nonpoint sources affecting the impaired waters.

In subbasin 030101, 64 stream miles were rated partially supporting. Approximately 44 miles (the Ahoskie Creek and several tributaries) is thought to be impaired from agriculture and channelization, while the source was unknown for the remaining 20 miles (the Wiccacon River).

In subbasin 030102, 66 stream miles were rated partially supporting. Potecasi Creek, Cutawhiskie Swamp, and Chapel Branch are all thought to be impaired due to agriculture and channelization.

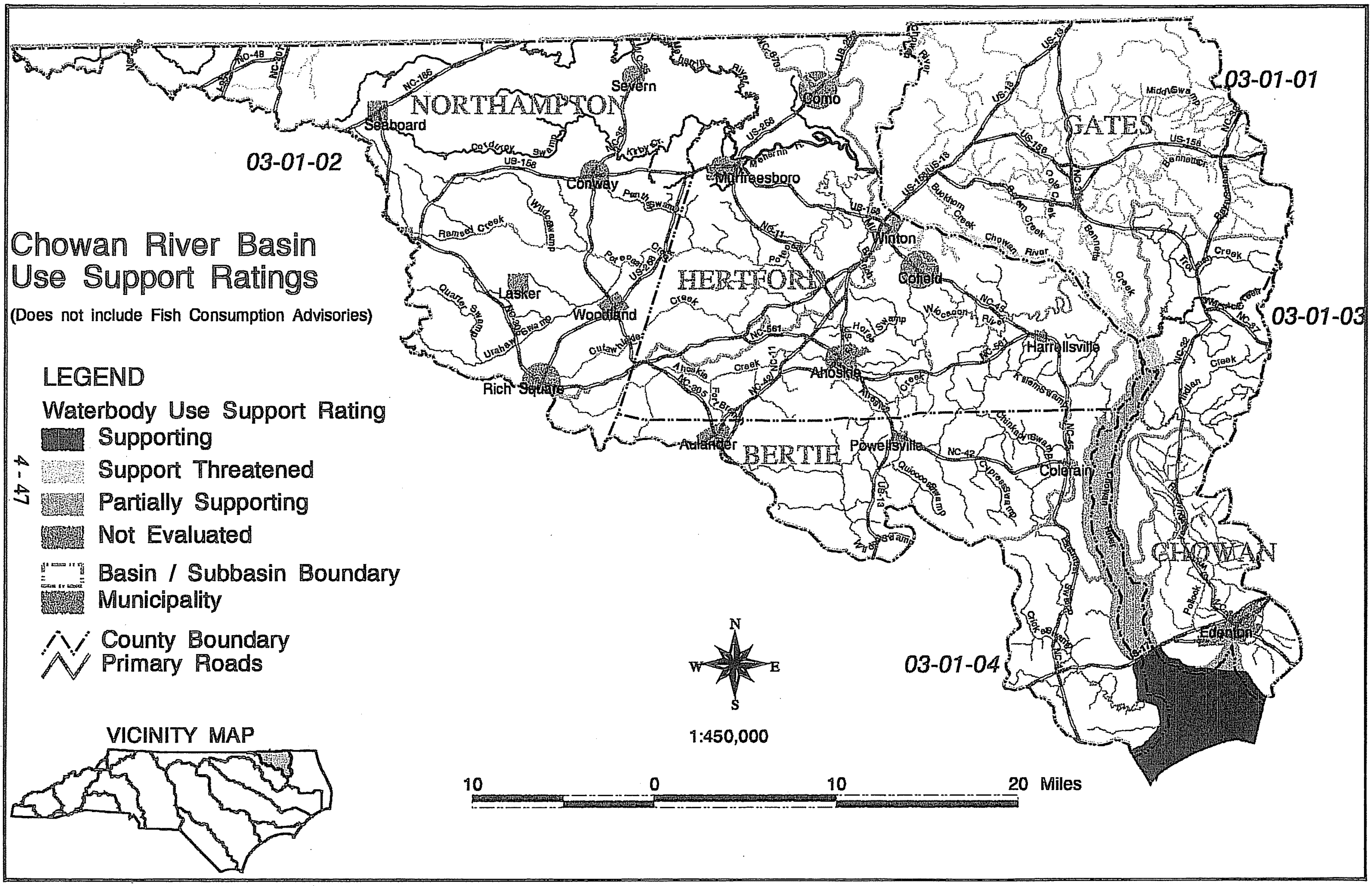


Figure 4.20. Use Support Map of the Chowan River Basin

Table 4.13. Use Support Status for Freshwater Streams in the Chowan River Basin

Station Number	Station Location	Classification	Index Number	Miles	Chem. Rating 90-94	<---Biological Rating---> 1991	1992	1993	1994	1995	Fish	OVERALL RATING Prob. Param.	Use Support	Major Source
30101														
2050079	Chowan River at Riddicksville, bugs at SR 1319, Hertford	B NSW	25a	1.8	PS					Good-Fair		DO	ST	NP
2053244	Chowan River at Hwy 13, Winston, NC	B NSW	25b	10.1	S								ST	NP
2053574	Chowan River at channel marker #16 near Gatesville, NC	B NSW	25c	14.5	S								ST	NP
	Wiccacon River NC 45, SR 1433, Hertford	C NSW	25-14	20.8						Fair			PS	NP
	Ahoskie Creek at NC 42, Hertford	C NSW	25-14-1	27.8						Fair	Fair		PS	NP
30102														
0205321790	Meherrin River near Como, SR-1175	B NSW	25-4-(5)	13.2	S					Good			S	
2053200	Potecasi Creek NC 11 near Union	C NSW	25-4-8	45.6	NS	Fair('89)						DO,pH	PS	NP
	Cutawhiskie Swamp, SR 1141, Hertford	C NSW	25-4-8-8	17.8						Fair	NR-Swamp		PS	NP
30103														
205360615	Chowan River 200 yards below Holiday Island	B NSW	25d	4.5	S								ST	NP
2053632	Chowan R. at marker 17 at Collerain	B NSW	25e	5.5	PS							Nutr,pH	PS	P
30104														
2053652	Chowan River at Edenhouse, U.S. Hwy. 17	B NSW	25f	14.5	S					Good-Fair		Nutr	PS	NP

Table 4.14. Overall Use Support Determinations by Subbasin.

USE SUPPORT STATUS FOR FRESHWATER STREAMS (MILES) (1990-1994)						
Subbasin	S	ST	PS	NS	NE	Total Miles
30101	0	180.1	64	0	104.6	348.7
30102	132.5	10.9	66.3	0	109.5	319.2
30103	0	4.5	9.6	0	35.7	49.8
30104	4.3	0	34.8	0	31.3	70.4
TOTAL	136.8	195.5	174.7	0	281.1	788.1
PERCENTAGE	17	25	22	0	36	

In subbasin 030104, 39 stream miles were rated partially supporting, including the lower part of the Chowan which is discussed below. Sources of impairment are thought to be agriculture and channelization. Edenton Bay, like the lower portion of the Chowan River, is rated PS due to the nuisance algal blooms.

The Chowan River (particularly the portion downstream of Holiday Island) has historically had problems with eutrophication. Nuisance algal blooms have been documented as far back as the early 1970s. Although the NSW strategy has been in place since 1982 and reductions in phosphorus and nitrogen have been documented, this portion of the river is still susceptible to blooms. The blooms almost always occur during warm, dry summers preceded by high spring river flows. Significant blooms were documented in 1990 and 1993. This portion of the Chowan River was rated partially supporting due to these blooms and the continued sensitivity to nutrients. This impairment is attributed to both point (Colerain WWTP and United Piece Dye Works) and nonpoint (agriculture) sources.

4.7.2 Lakes

Subbasin 030501

Merchants Millpond, located in Gates County, is the only significant lake in the Chowan basin. It is currently classified as C NSW and has a surface area of 450 acres. It was sampled in August 1995 and the proliferation of aquatic macrophytes resulted in a support threatened rating.

4.7.3 Use Support Ratings for Waters in Virginia

The State of Virginia has assigned use support ratings for the Chowan River-Dismal Swamp Basin in their state. The area is made up primarily of the Chowan drainage, but includes a small area that drains into what NC DWQ defines as the Pasquotank basin. Table 4.15 presents the results of their use support assessment for rivers in the Chowan-Dismal Swamp River Basin.

Table 4.15. Use Support Ratings for the Rivers of the Chowan River-Dismal Swamp Basin - Presented in Terms of Percent of Waters Representing Support Category (Source: Virginia DEQ, 1994)

Use	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Assessed
Aquatic Life	99%	<1%	<1%	<1%	0%
Fish Consumption	99%	0%	<1%	0%	0%
Swimming	100%	0%	0%	0%	0%
Drinking Water	78%	0%	0%	0%	21%

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