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NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Spatial and Seasonal Variability of Nutrients, Pesticides, Bacteria, and Suspended Sediment in the Santee River Basin and Coastal Drainages, North and South Carolina, 1995-97

U.S. Geological Survey
Water-Resources Investigations Report 00–4076

U.S. Department of the Interior
U.S. Geological Survey

CONVERSION FACTORS, TEMPERATURE, ABBREVIATED WATER-QUALITY UNITS, AND ACRONYMS:

Multiply	By	To obtain
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilogram (kg)	2.205	pound (lb)
cubic meter per second (m^3/s)	35.31	cubic feet per second (ft^3/s)
kilometer (km)	0.6214	mile (mi)
square kilometer (km^2)	0.3861	square mile (mi^2)

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit as follows:

$$^{o}F = (^{o}C \times 1.8) + 32$$

Abbreviated water-quality units:

mg/L	milligram per liter
µg/L	microgram per liter
mm	millimeter
mL	milliliter
col/100 mL	colonies per 100 milliliters

Acronyms:

HAL	health advisory level
MCL	maximum contaminant level
MRL	minimum reporting level
NAWQA	National Water-Quality Assessment Program
NWQL	National Water Quality Laboratory
SANT	Santee River Basin and coastal drainages
U.S. EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

Cover photograph: Congaree River near Columbia, S.C.

Spatial and Seasonal Variability of Nutrients, Pesticides, Bacteria, and Suspended Sediment in the Santee River Basin and Coastal Drainages, North and South Carolina, 1995–97

By Terry L. Maluk

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 00–4076

Prepared as part of the
NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Columbia, South Carolina
2000

U.S. DEPARTMENT OF THE INTERIOR
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FOREWORD

The mission of the U.S. Geological Survey (USGS) is to assess the quantity and quality of the earth resources of the Nation and to provide information that will assist resource managers and policymakers at Federal, State, and local levels in making sound decisions. Assessment of water-quality conditions and trends is an important part of this overall mission.

One of the greatest challenges faced by water-resources scientists is acquiring reliable information that will guide the use and protection of the Nation's water resources. That challenge is being addressed by Federal, State, interstate, and local water-resource agencies and by many academic institutions. These organizations are collecting water-quality data for a host of purposes that include: compliance with permits and water-supply standards; development of remediation plans for a specific contamination problem; operational decisions on industrial, wastewater, or water-supply facilities; and research on factors that affect water quality. An additional need for water-quality information is to provide a basis on which regional and national-level policy decisions can be based. Wise decisions must be based on sound information. As a society we need to know whether certain types of water-quality problems are isolated or ubiquitous, whether there are significant differences in conditions among regions, whether the conditions are changing over time, and why these conditions change from place to place and over time. The information can be used to help determine the efficacy of existing water-quality policies and to help analysts determine the need for and likely consequences of new policies.

To address these needs, the Congress appropriated funds in 1986 for the USGS to begin a pilot program in seven project areas to develop and refine the National Water-Quality Assessment (NAWQA) Program. In 1991, the USGS began full implementation of the program. The NAWQA Program builds upon an existing base of water-quality studies of the USGS, as well as those of other Federal, State, and local agencies. The objectives of the NAWQA Program are to:

- Describe current water-quality conditions for a large part of the Nation's freshwater streams, rivers, and aquifers.
- Describe how water quality is changing over time.
- Improve understanding of the primary natural and human factors that affect water-quality conditions.

This information will help support the development and evaluation of management, regulatory, and monitoring decisions by other Federal, State, and local agencies to protect, use, and enhance water resources.

The goals of the NAWQA Program are being achieved through ongoing and proposed investigations of 60 of the Nation's most important river basins and aquifer systems, which are referred to as study units. These study units are distributed throughout the Nation and cover a diversity of hydrogeologic settings. More than two-thirds of the Nation's freshwater use occurs within the 60 study units and more than two-thirds of the people served by public water-supply systems live within their boundaries.

National synthesis of data analysis, based on aggregation of comparable information obtained from the study units, is a major component of the program. This effort focuses on selected water-quality topics using nationally consistent information. Comparative studies will explain differences and similarities in observed water-quality conditions among study areas and will identify changes and trends and their causes. The first topics addressed by the national synthesis are pesticides, nutrients, volatile organic compounds, and aquatic biology. Discussions on these and other water-quality topics will be published in periodic summaries of the quality of the Nation's ground and surface water as the information becomes available.

This report is an element of the comprehensive body of information developed as part of the NAWQA Program. The program depends heavily on the advice, cooperation, and information from many Federal, State, interstate, Tribal, and local agencies and the public. The assistance and suggestions of all are greatly appreciated.

Robert M. Hirsch

Robert M. Hirsch
Chief Hydrologist

CONTENTS

FIGURES

TABLES

APPENDIX TABLES

Spatial and Seasonal Variability of Nutrients, Pesticides, Bacteria, and Suspended Sediment in the Santee River Basin and Coastal Drainages, North and South Carolina, 1995–97

By Terry L. Maluk

ABSTRACT

Results of a water-quality study conducted during 1995–97 in the Santee River Basin and coastal drainages of North and South Carolina indicate that nutrient, pesticide, and suspended sediment concentrations generally are low. Some concentrations of total phosphorus in the study area exceeded the U.S. Environmental Protection Agency recommended maximum of 0.10 milligrams per liter. Median total phosphorus concentrations were highest in the South Fork Catawba River, N.C. (0.14 milligram per liter). Insecticides such as diazinon, malathion, and parathion were detected primarily at urban sites. Some pesticides were detected at levels above published guidelines for the protection of aquatic life, including aldicarb sulfoxide, chlorpyrifos, diazinon, malathion, and parathion. None of the pesticide concentrations exceeded the maximum contaminant level or lifetime health advisory level for the protection of drinking-water quality and human health. Median suspended sediment concentrations were highest in the South Fork Catawba River (17 milligrams per liter). Urban sites had significantly higher suspended sediment concentrations than other sites that were sampled.

Fecal coliform and fecal streptococcus concentrations were variable. Nine of 13 sites had fecal coliform concentrations greater than 400 colonies per 100 milliliters of stream water. Concentrations ranged from less than 1 to almost 22,000 colonies per 100 milliliters, and individual concentrations were highest at agricultural sites. Fecal streptococcus concentrations ranged from 2 to more than 20,000 colonies per 100 milliliters, and medians were highest at agricultural sites.

Synoptic studies were conducted in two basins—Gills Creek Basin was sampled in September 1996, and the South Fork Catawba River Basin was sampled in October 1997. Nutrient concentrations generally were low in both basins. Phosphorus concentrations were higher in the South Fork Catawba River Basin than in the Gills Creek Basin. In the Gills Creek Basin, 10 different pesticides were detected above an adjusted minimum reporting level of 0.01 microgram per liter, and one pesticide, diazinon, was detected at a concentration above the aquatic life standard. Fecal coliform concentrations were greater than 400 colonies per 100 milliliters in about half of the sites in each synoptic study basin. Suspended sediment concentrations generally were low in both basins, except where samples were collected directly downstream of turbulent water.

INTRODUCTION

The U.S. Geological Survey (USGS) is conducting an assessment of surface- and ground-water quality in the Santee River Basin and coastal drainages (SANT), North and South Carolina, as part of the National Water-Quality Assessment (NAWQA) Program. NAWQA assesses watersheds as integrated systems, taking into consideration the physical and chemical aspects of surface and ground water, as well as the biological status of the aquatic community (U.S. Geological Survey, 1999a). The long-term goals of the NAWQA Program are to describe the status of and trends in the quality of a large representative part of the Nation's surface- and ground-water resources and to identify major factors that affect the quality of these resources (Hirsch and others, 1988; Leahy and others, 1990; Leahy and Thompson, 1994). More than 50 hydrologic systems, known as study units, are being assessed; these study units include parts of most major river basins and aquifer systems in the Nation. The assessment activities in the SANT study unit began in 1994.

Purpose and Scope

The purpose of this report is to describe spatial and seasonal variability in nutrient, pesticide, bacteria, and suspended sediment concentrations in streams, and to relate the concentrations to land cover in the SANT study area, 1995–97. Thirteen sites in the basin were selected, based on land cover, for sampling between October 1995 and September 1997. Samples generally were collected monthly, but as often as weekly at selected sites. Two surface-water synoptic studies also were conducted, during which a one-time water-quality sample was collected at numerous sites. One synoptic study was conducted in the Gills Creek Basin in Columbia, S.C., in September 1996, and the other was conducted in the South Fork Catawba River Basin, N.C., in October 1997.

Study Area Setting

The SANT study area, located in the southeastern United States in central South Carolina and western North Carolina, has a drainage area of about 23,600 square miles (mi^2) (fig. 1). The Santee River Basin makes up about 65 percent of the study area. Streams in the Santee River Basin flow about 415 miles (mi) from the mountains of North Carolina to the Atlantic Ocean. Several coastal drainages, primarily the Cooper, Edisto, Salkehatchie, and Coosawhatchie Rivers, make up the remaining 35 percent of the study area (fig. 1). These rivers range in length from less than 10 mi to 150 mi. The lower reaches of the rivers are brackish and affected by tides. Large surface-water impoundments in the study area include Lake Norman (32,510 acres) in North Carolina, and Lakes Murray (51,000 acres), Moultrie (60,400 acres), and Marion (110,600 acres) in South Carolina (fig. 1).

The climate in the study area is characterized by short, wet winters and long, hot summers. The annual mean precipitation in the study area during 1961–90 was about 48 inches per year (South Carolina Department of Natural Resources, 1999). During the sampling period, streamflow generally was average in the upper part of the study area, and slightly below average in the middle and lower parts of the study area. Monthly streamflows in the Edisto River ranged from about 35 percent of average to over 180 percent of average from October 1995 through September 1997 (fig. 2).

The study area contains four major metropolitan areas—Greenville-Spartanburg, Columbia, and Charleston in South Carolina and Gastonia-Charlotte in North Carolina (fig. 1). Forested lands make up about 66 percent of the SANT study area (fig. 3), and include hardwood-dominated forests, forested wetlands, pine and mixed hardwood forests, and intensively managed pine forests. Urban areas and water each account for about 5 percent of the study area. Croplands represent about 19 percent of the study area; the most common crops planted in 1997 were soybeans, wheat, corn, hay, cotton, and tobacco (U. S. Department of Agriculture, 1999).

Study Design

The SANT study was designed to compare water quality between basins with differing land covers in differing physiographic settings. Indicator sites, which indicate the water quality in basins influenced by one land cover, were chosen to characterize urban, agricultural, and forested land covers. Sites also were chosen to characterize a mixture of land covers; these sites are referred to as integrator sites because they represent an integration of multiple land covers. When possible, the sampling network design included nested indicator sites located upstream from an integrator site.

In the SANT study area, 13 fixed sites were chosen for study (table 1; fig. 1). Ten of the fixed sites are referred to as "basic" fixed sites (five indicator sites and five integrator sites), where sampling was conducted monthly and during storms between October 1995 and September 1997. The remaining three fixed sites are referred to as "intensive" fixed sites (two indicator sites and one integrator site), where sampling was intensified from monthly to weekly from February through October 1996. The three intensive fixed sites

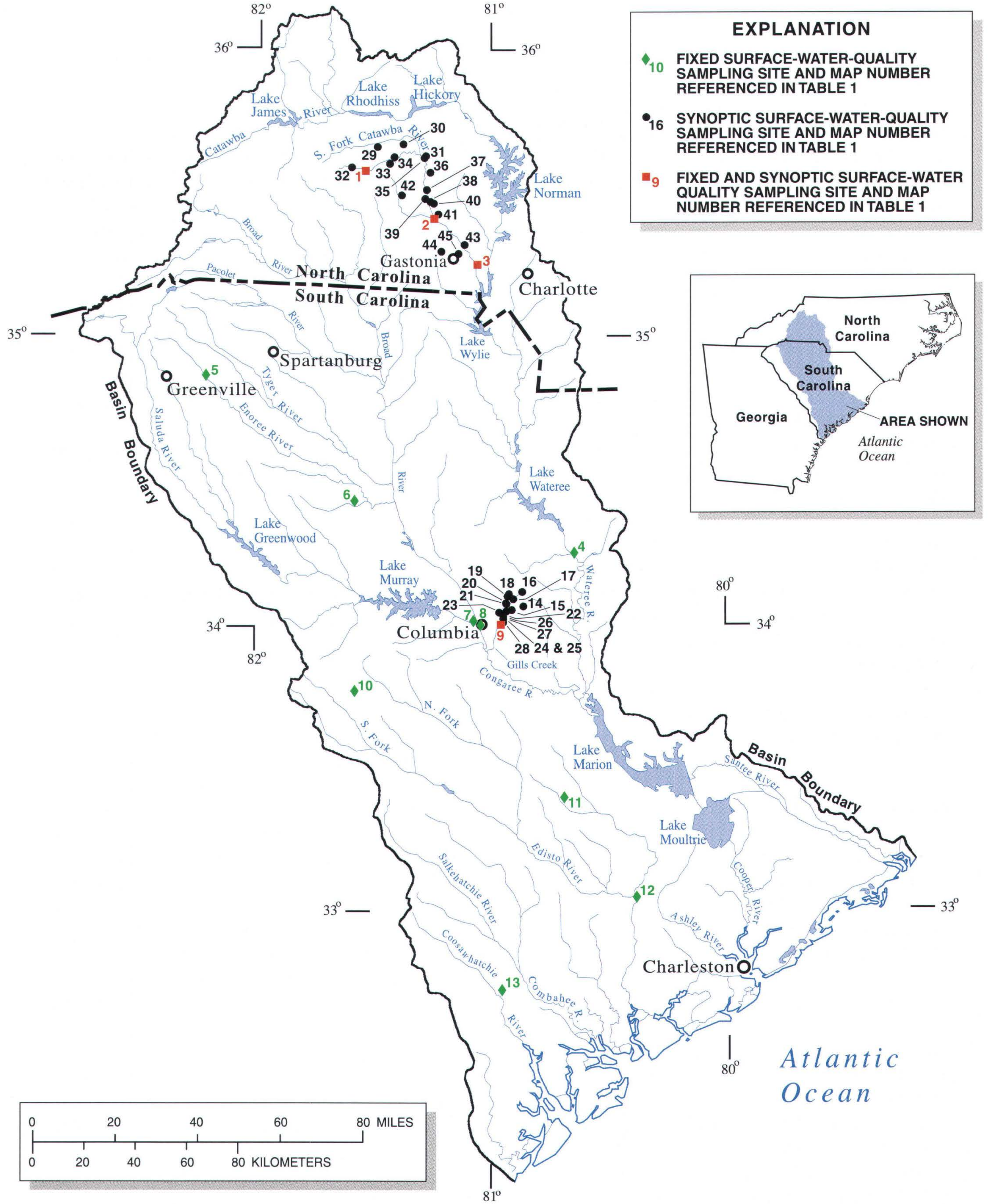

Figure 1. Locations of the Santee River Basin and coastal drainages study area, North and South Carolina, and surface-water-quality sampling sites.

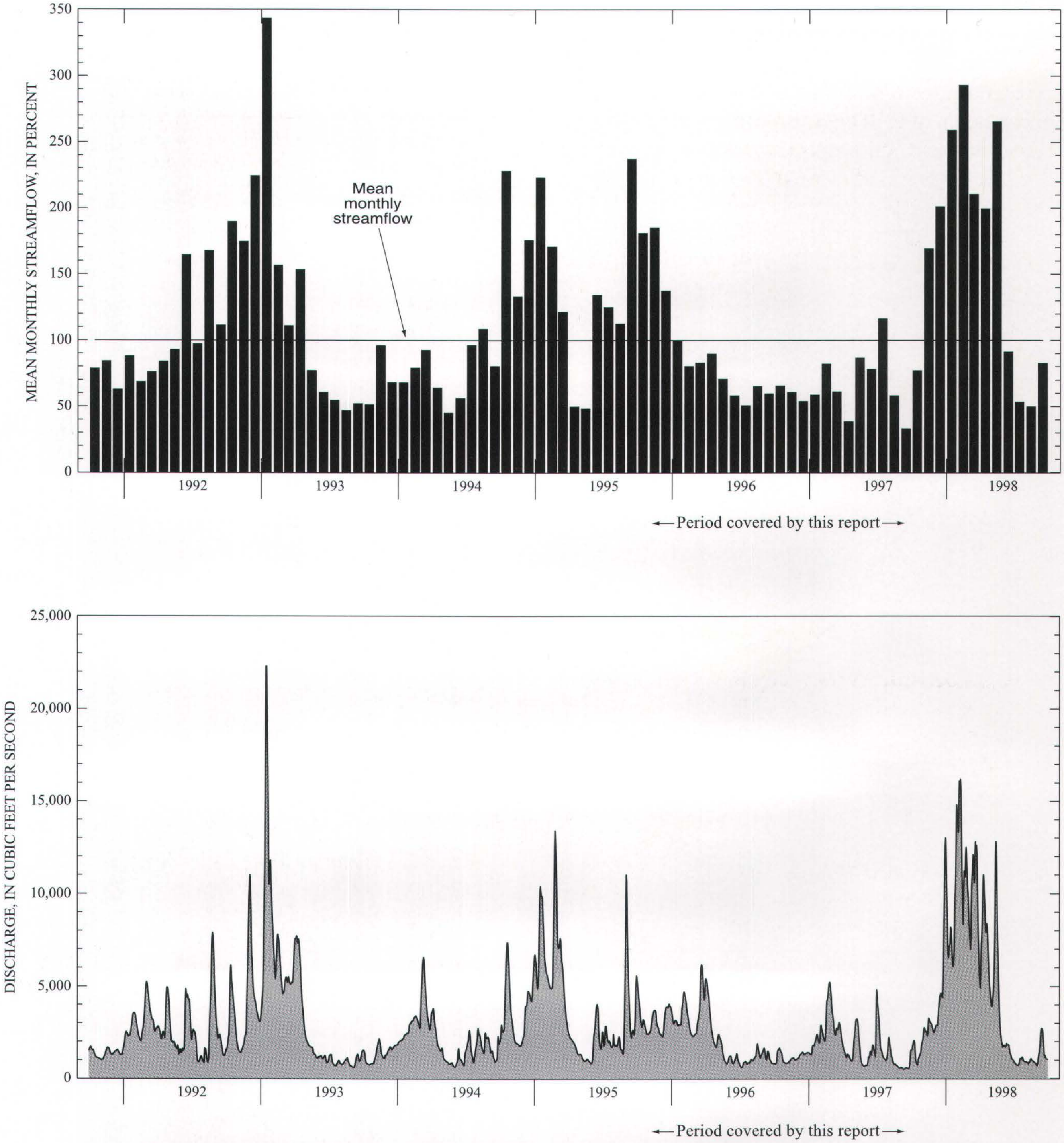

Figure 2. Distribution of streamflow in the Edisto River, S.C., 1991–98.

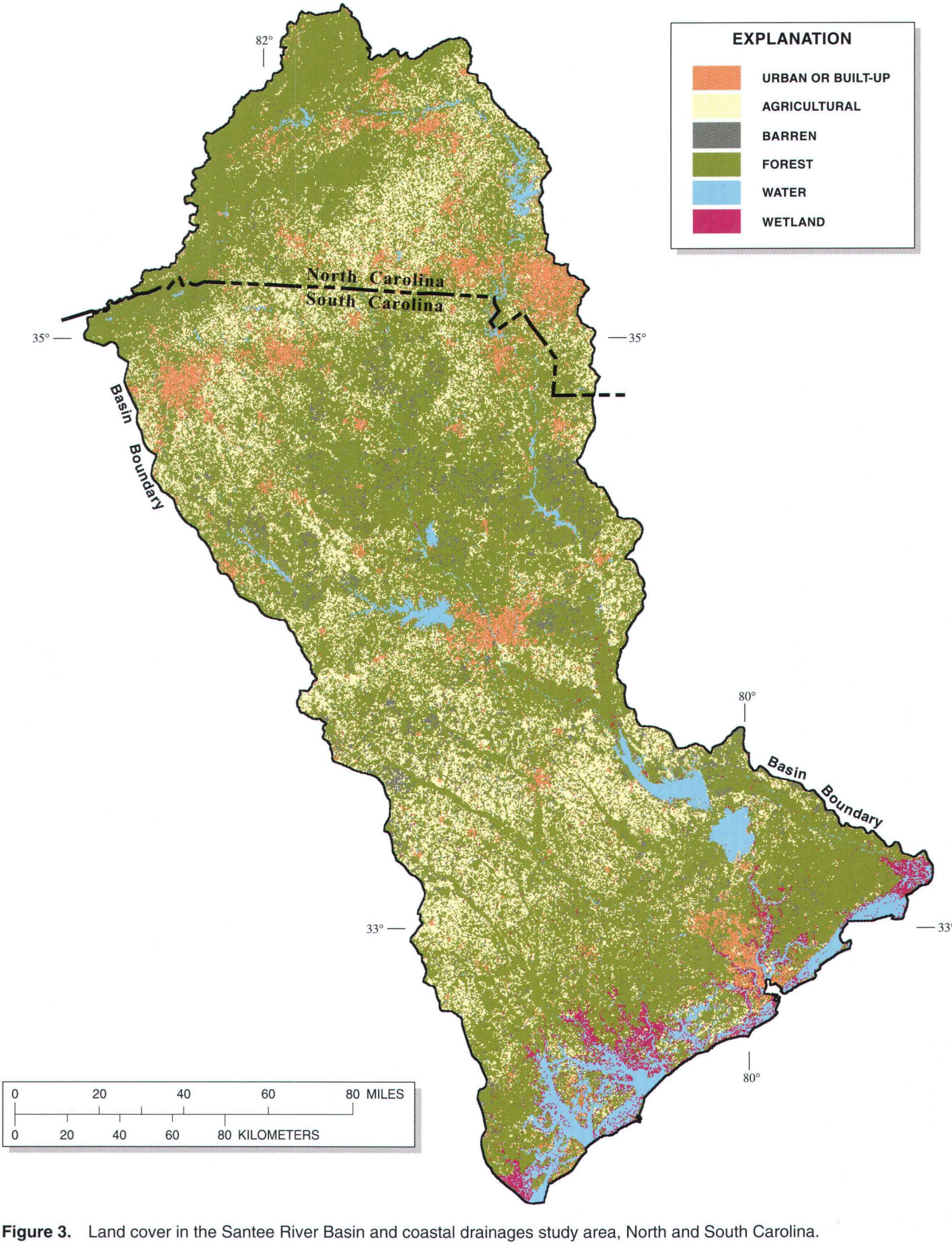

Figure 3. Land cover in the Santee River Basin and coastal drainages study area, North and South Carolina.

Table 1. Sampling sites; sampling frequencies for nutrients, pesticides, bacteria, and suspended sediment; and land cover in the Santee River Basin and coastal drainages study area, 1995–97

[mi^2, square miles; indicator, water quality influenced by one land cover; integrator, water quality influenced by a mixture of land covers; land covers may not add up to 100 percent]

Site number (fig. 1)	USGS station number	Site name	Site type	Type and number of samples collected				Land cover (percent)			Drainage area (mi^2)
				Nutrients	Pesticides	Bacteria	Suspended sediments	Agriculture	Forest	Urban	
Fixed sites											
1	02143040[a]	Jacob Fork at Ramsey, N.C.	Indicator	26	3	8	26	1.9	96	0.3	26
2	02143500[a]	Indian Creek near Laboratory, N.C.	Indicator	33	14	9	33	50	47	3	70
3	02145112[a]	South Fork Catawba River at McAdenville, N.C.	Integrator	27	3	8	27	30	60	8.8	630
4	02148000	Wateree River near Camden, S.C.	Integrator	8	3	3	8	17	70	8.4	5,060
5	021603257	Brushy Creek near Pelham, S.C.	Indicator	27	3	10	27	9.7	24	65	14
6	021607224	Indian Creek above Newberry, S.C.	Indicator	30	3	12	30	7.5	86	1.1	63
7	02169000	Saluda River near Columbia, S.C.	Integrator	23	3	10	23	21	66	6.1	2,500
8	02169500	Congaree River at Columbia, S.C.	Integrator	25	3	11	25	20	71	5.1	7,800
9	02169570[b]	Gills Creek at Columbia, S.C.	Indicator	60	43	13	61	7.2	49	38	59
10	02172300	McTier Creek near Monetta, S.C.	Indicator	29	4	12	29	20	77	.2	16
11	02174250	Cow Castle Creek near Bowman, S.C.	Indicator	62	38	13	62	46	48	.9	24
12	02175000	Edisto River near Givhans, S.C.	Integrator	38	17	12	38	32	60	1.5	2,700
13	02176517	Coosawhatchie River near Early Branch, S.C.	Integrator	48	3	9	48	32	62	1.4	380
Synoptic sites											
Gills Creek Basin, S.C.											
14	02169559	Rowell Creek at Dixie Road	Synoptic	1	1	1	1	0.6	71	0	2.5
15	02169560	Gills Creek at Boyden Arbor Road	Synoptic	1	1	1	1	4.2	76	8.8	19
16	021695601	Jackson Creek at Leaning Tree Road	Synoptic	1	1	1	1	14	27	46	.5
17	021695610	Jackson Creek at Alpine Road	Synoptic	1	1	1	1	16	56	20	5.2
18	021695614	Tributary to Little Jackson Creek at Rabon Road	Synoptic	1	1	1	1	7.9	30	57	2.5

Table 1. Sampling sites; sampling frequencies for nutrients, pesticides, bacteria, and suspended sediment; and land cover in the Santee River Basin and coastal drainages study area, 1995–97—Continued

[mi^2, square miles; indicator, water quality influenced by one land cover; integrator, water quality influenced by a mixture of land covers; land covers may not add up to 100 percent]

Site number (fig. 1)	USGS station number	Site name	Site type	Type and number of samples collected				Land cover (percent)			Drainage area (mi^2)
				Nutrients	Pesticides	Bacteria	Suspended sediments	Agriculture	Forest	Urban	
		Gills Creek Basin, S.C. (Continued)									
19	021695617	Little Jackson Creek at Legrande Road	Synoptic	1	1	1	1	5.8	33	58	3.7
20	021695626	Little Jackson Creek at Trenholm Road Extension	Synoptic	1	1	1	1	7.9	35	54	7.0
21	021695628	Jackson Creek above Decker Boulevard	Synoptic	1	1	1	1	10	42	42	16
22	021695639	Gills Creek above Forest Lake	Synoptic	1	1	1	1	5.3	72	14	22
23	021695658	Eightmile Branch at Covenant Road	Synoptic	1	1	1	1	3.2	25	71	2.4
24	021695666	Eightmile Branch below Trenholm Road	Synoptic	1	1	1	1	2.3	24	73	3.9
25	021695667	Gills Creek below Eightmile Branch	Synoptic	1	1	1	1	6.7	52	34	48
26	021695684	Penn Branch	Synoptic	1	1	1	1	1.8	29	68	2.9
27	021695689	Gills Creek below Lake Katherine	Synoptic	1	1	1	1	6.4	50	37	53
28	021695697	Wildcat Creek at Shady Lane	Synoptic	1	1	1	1	16	42	40	5.3
		South Fork Catawba River Basin, N.C.									
29	0214299430	Henry Fork near Valdese	Synoptic	1	0	1	1	3.9	96	0.2	55
30	02143000	Henry Fork near Henry River	Synoptic	1	0	1	1	8.2	90	1.2	82
31	0214302790	Henry Fork near Startown	Synoptic	1	0	1	1	11	82	6.9	110
32	0214303390	Jacob Fork near Chestnut Knob	Synoptic	1	0	1	1	0	100	0	8.6
33	0214304580	Jacob Fork near Cooksville	Synoptic	1	0	1	1	13	86	.3	55
34	0214305145	Camp Creek near Advent Crossroads	Synoptic	1	0	1	1	27	72	1.1	6.7
35	0214306800	Jacob Fork near Startown	Synoptic	1	0	1	1	18	79	1.6	96
36	0214307100	South Fork Catawba River near Plateau	Synoptic	1	0	1	1	17	78	4.3	220
37	0214307600	Pott Creek near Lincolnton	Synoptic	1	0	1	1	46	52	.9	26
38	0214308400	South Fork Catawba River near Lincolnton	Synoptic	1	0	1	1	22	74	3.8	260
39	0214309015	Howards Creek near Lincolnton	Synoptic	1	0	1	1	55	44	.2	28

Table 1. Sampling sites; sampling frequencies for nutrients, pesticides, bacteria, and suspended sediment; and land cover in the Santee River Basin and coastal drainages study area, 1995–97—Continued

[mi^2, square miles; indicator, water quality influenced by one land cover; integrator, water quality influenced by a mixture of land covers; land covers may not add up to 100 percent]

Site number (fig. 1)	USGS station number	Site name	Site type	Type and number of samples collected				Land cover (percent)			Drainage area (mi^2)
				Nutrients	Pesticides	Bacteria	Suspended sediments	Agriculture	Forest	Urban	
South Fork Catawba River Basin, N.C. (Continued)											
40	0214326000	Clark Creek at Lincolnton	Synoptic	1	0	1	1	36	46	17	91
41	0214334110	South Fork Catawba River near Long Shoals	Synoptic	1	0	1	1	28	64	7.6	400
42	0214342305	Indian Creek near Hulls Crossroads	Synoptic	1	0	1	1	53	46	.2	18
43	0214390800	South Fork Catawba River near Stanley	Synoptic	1	0	1	1	31	61	7.3	560
44	02144000	Long Creek near Bessemer City	Synoptic	1	0	1	1	40	50	7.4	31
45	0214463600	Long Creek near Dallas	Synoptic	1	0	1	1	32	47	19	48

[a]These sites were included in the synoptic study of the South Fork Catawba River Basin, N.C.

[b]This site was included in the synoptic study of the Gills Creek Basin, S.C.

are Gills Creek (site 9), Cow Castle Creek (site 11), and the Edisto River (site 12) (table 1; fig. 1).

In addition to the fixed site network, synoptic studies were conducted in two basins within the SANT study area (table 1). In September 1996, a study of the Gills Creek Basin in Columbia, S.C., was conducted. Sixteen sites were chosen to characterize the water quality in the tributaries upstream from the intensive fixed site on Gills Creek. In October 1997, a similar study was conducted at 20 sites in the South Fork Catawba River Basin upstream from the basic fixed site at McAdenville, N.C.

Methods

Data were collected for this study in accordance with methods used for the NAWQA Program. Surface-water samples were collected and processed according to the guidelines specified by Shelton (1994). Multiple depth-integrated samples were collected across the width of each stream. Samples were analyzed for nutrients and pesticides at the USGS National Water Quality Laboratory (NWQL). Suspended sediment samples were analyzed in the USGS Kentucky District sediment laboratory. Bacteria samples were processed in the USGS South Carolina District office.

Teflon sampling equipment was used. A Teflon cone splitter was used to composite and split the water samples into separate sample bottles for various analyses. Suspended sediment sample bottles were filled directly from the cone splitter. After splitting, water samples for dissolved nutrients were filtered immediately using a 0.45-micrometer (µm) pore size filter that was pre-rinsed with deionized water and native stream water. Samples for dissolved pesticides analyses were filtered immediately using a 0.7-µm pore size glass-fiber filter. Nutrient and pesticide samples were preserved and chilled immediately after filtration and then shipped overnight to the NWQL in Denver, Colo. Samples were analyzed using methods for NAWQA described in Patton and Truitt (1992), Fishman (1993), Zaugg and others (1995), or Werner and others (1996).

Statistically significant differences in constituent concentrations between sampling sites, land covers, and seasons were tested using the Tukey's test on the rank-transformed data. An acceptable error rate (α) of 0.05 was applied. Boxplots are presented using letters to denote sampling sites or categories with statistically significant differences. Sampling sites were grouped into four land-cover categories—agriculture (Indian Creek, N.C., and Cow Castle Creek); forested (Jacob Fork, McTier Creek, and Indian Creek, S.C.); integrator (or mixed land cover) (South Fork Catawba, Wateree, Saluda, Congaree, Edisto, and Coosawhatchie Rivers); and urban (Brushy and Gills Creeks) (table 1). Previous studies have shown that nutrient and herbicide concentrations generally are higher in agricultural basins than in other land-use settings. Insecticide detections in urban basins often are more frequent than in basins with other land cover (U.S. Geological Survey, 1999b). The lowest concentrations, detection frequencies, and variability of the various constituents sampled generally occur at forested sites.

Data were grouped for seasonal trend analysis in the following manner: winter (December, January, and February); spring (March, April, and May); summer (June, July, and August); and fall (September, October, and November). In order to compare the SANT study area sites with the other NAWQA study units which began in 1994, flow-weighted mean concentrations of five nutrients were used.

A common "adjusted" minimum reporting level (MRL) of 0.01 microgram per liter (µg/L) was used to compare the detection frequencies of pesticides having different MRL's. Detections below 0.01 µg/L were not counted as detections for frequency comparison. Using an adjusted MRL results in a loss of detection information; however, it allows a uniform comparison of the pesticide detection frequencies. Adjusted data were used to compare detection frequencies, while nonadjusted pesticide data were used in statistical analyses, comparisons with aquatic life and human health criteria, and the creation of boxplots.

Streamflow was determined from continuous-measurement gages located at each of the fixed sites. For synoptic studies, where no continuous-measurement gages were located, streamflow measurements were made at the time of sampling in accordance with standard USGS procedures (Rantz and others, 1982).

Quality-Control Methods and Results

Quality-control samples were collected throughout the study following NAWQA protocols (Shelton, 1994). Field blanks were collected using water certified to contain undetectable concentrations of constituents to be analyzed. The blank water was processed in the field through the collection and processing equipment to determine if any contamination of samples occurred during sample collection, processing, shipment, or analysis. A total of 69 blank samples were analyzed for nutrients (appendix 1). Detections of nutrients in the blank samples were uncommon, and concentrations generally were near the MRL. Ammonia nitrogen was the constituent most commonly detected in blank samples (19 of 69 blank samples), with a median blank concentration of 0.020 milligram per liter (mg/L). Ammonia nitrogen concentrations in environmental samples associated with blank samples ranged from the MRL of 0.015 mg/L to 0.316 mg/L (table 2). Of 22 blank samples analyzed for pesticides, none had detectable concentrations.

Sample replicates were collected to quantify the reproducibility of the results. Results from nutrient replicates indicated good reproducibility of data (appendix 2). Pesticide replicate results also indicated agreement between the sample concentrations (appendix 3).

NUTRIENTS

Nutrients, including various forms of nitrogen and phosphorus, are essential to the growth and development of aquatic biota. Nutrients occur naturally in streams from mineral weathering and from biological activity in the streambed sediment. Additional sources of nutrients to streams include runoff from agricultural land, atmospheric deposition, and wastewater discharge. When present in high concentrations, nutrients can cause excessive growth of plants, leading to decreased light penetration and fluctuations in concentrations of dissolved oxygen. Compared with national flow-weighted means from the 1994 study units, the SANT study area had low nutrient concentrations (table 2).

Nitrogen species that were studied include ammonia nitrogen, nitrite nitrogen, nitrite-plus-nitrate nitrogen, dissolved ammonia-plus-organic nitrogen, and total ammonia-plus-organic nitrogen. Nitrogen levels in the SANT study area generally were low (table 2).

Ammonia nitrogen concentrations were below 0.320 mg/L, and most sites had median concentrations below 0.050 mg/L. The South Fork Catawba River had the highest median concentration (0.068 mg/L), and Jacob Fork and McTier Creek had the lowest (0.015 g/L) median ammonia nitrogen concentrations (fig. 4). Jacob Fork, a forested site, had the least variability.

When grouped by land cover, urban sites had the highest (0.039 mg/L) median concentration of ammonia nitrogen, and forested sites had the lowest (0.015 mg/L) median concentrations. Ammonia nitrogen concentrations were statistically significantly higher in the summer than during the rest of the year. At sites influenced by point-source discharges, lower streamflow conditions may result in higher ammonia nitrogen concentrations. At agricultural sites, summer typically is a time of increased fertilization and irrigation, resulting in increased amounts of ammonia

Table 2. Summary of nutrient data, Santee River Basin and coastal drainages study area, 1995–97

[<, less than; concentrations in milligrams per liter; national flow-weighted means from 1994 NAWQA study units (Dave Mueller, written commun., 1999); —, no data available]

Constituent	Number of samples	Minimum	25th percentile	50th percentile (median)	75th percentile	Maximum	Median of national flow-weighted means
Ammonia nitrogen	438	<0.002	0.015	0.030	0.050	0.316	0.056
Nitrite-plus-nitrate nitrogen	438	<.005	.090	.290	.790	3.40	.630
Nitrite nitrogen	438	<.001	.010	.010	.010	.10	—
Dissolved ammonia-plus-organic nitrogen	438	<.20	.20	.20	.30	.98	—
Total ammonia-plus-organic nitrogen	438	<.20	.20	.30	.60	2.8	—
Total phosphorus	438	<.010	.020	.040	.080	1.10	.198
Dissolved phosphorus	439	<.010	.010	.018	.034	.250	—
Ortho-phosphorus	439	<.010	.010	.013	.030	.240	.043

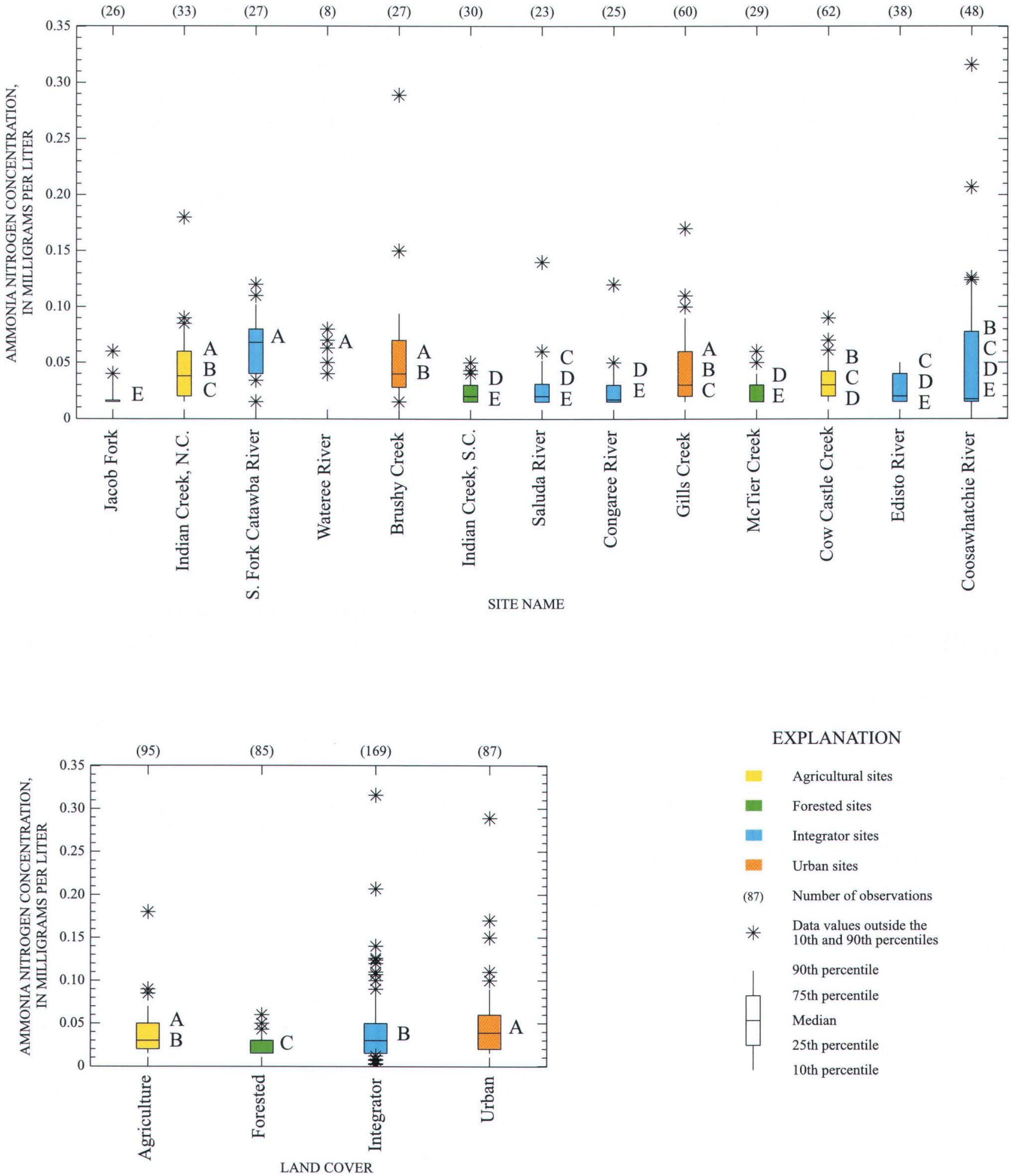

Figure 4. Distribution of ammonia nitrogen in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

nitrogen in irrigation runoff. In national studies, high concentrations of nitrogen at agricultural sites were correlated with fertilizer application to crops or with manure from livestock operations (U.S. Geological Survey, 1999b).

Nitrite-plus-nitrate nitrogen concentrations were below 3.50 mg/L, and most sites had median concentrations below 1.00 mg/L (fig. 5). Cow Castle Creek, an agricultural site, had a median concentration of 1.70 mg/L, significantly higher than any of the other sites (fig. 5). This may be a result of the application of fertilizers containing nitrogen to agricultural land. Two sites in North Carolina—Indian Creek and the South Fork Catawba River—also had elevated median nitrite-plus-nitrate concentrations (fig. 5). Indian Creek is an agricultural site, and the South Fork Catawba River is an integrator site below Indian Creek. No water-quality samples collected in the study area had nitrite-plus-nitrate nitrogen concentrations above 10.0 mg/L, the maximum contaminant level (MCL) set forth by the U.S. Environmental Protection Agency (U.S. EPA) for safe drinking water (U.S. Environmental Protection Agency, 1996). Indian Creek, S.C., the Coosawhatchie River, and Jacob Fork had the lowest median concentrations of nitrite-plus-nitrate nitrogen (fig. 5).

When grouped by land cover, agricultural sites had the highest (1.20 mg/L) and forested sites had the lowest (0.110 mg/L) median nitrite-plus-nitrate nitrogen concentration. Nitrite-plus-nitrate concentrations varied seasonally at several sites (fig. 6). Seasonal trends varied between sites, and high seasonal concentrations varied between summer, fall, and winter at different sites. These trends could be the result of seasonal increases in ground-water discharge, decreases in uptake by aquatic organisms, or a combination of factors. Compared with nitrite-plus-nitrate nitrogen concentrations, nitrite nitrogen concentrations were very low (median 0.010 mg/L), indicating that the majority of nitrite-plus-nitrate nitrogen was in the form of nitrate (table 2). This is typical because the conversion of nitrite to nitrate occurs rapidly in an aerobic environment.

Dissolved ammonia-plus-organic nitrogen concentrations were highest at the Coosawhatchie River, a blackwater, forested wetland site (fig. 7). Concentrations at all sites were below 1.0 mg/L, and medians ranged from 0.20 mg/L to 0.60 mg/L (fig. 7). When grouped by land cover, forested sites had significantly lower concentrations and integrator sites had significantly higher concentrations of dissolved ammonia-plus-organic nitrogen compared to urban or agricultural sites. Two of the integrator sites in the SANT study area are blackwater streams (Coosawhatchie and Edisto Rivers), which typically have high organic nitrogen concentrations. The South Fork Catawba River has high concentrations of dissolved ammonia-plus-organic nitrogen, which may be the result of point- and nonpoint-source influences. No seasonal trends were observed in dissolved ammonia-plus-organic nitrogen concentrations.

Total ammonia-plus-organic nitrogen concentrations ranged from 0.20 mg/L to 2.8 mg/L (table 2; fig. 8). The highest single concentrations were observed at Indian Creek, N.C., and the South Fork Catawba River (fig. 8). The highest medians were observed at the Coosawhatchie River and Gills Creek, and the lowest median was observed at Jacob Fork, a forested stream. Forested sites had significantly lower total ammonia-plus-organic nitrogen concentrations than sites with other types of land covers (fig. 8). The Coosawhatchie River exhibited a seasonal trend in concentrations with significantly lower concentrations in the winter and significantly higher concentrations in the summer (fig. 9). This may be due to a lower amount of total organic nitrogen present in the form of detritus during the winter than during the summer.

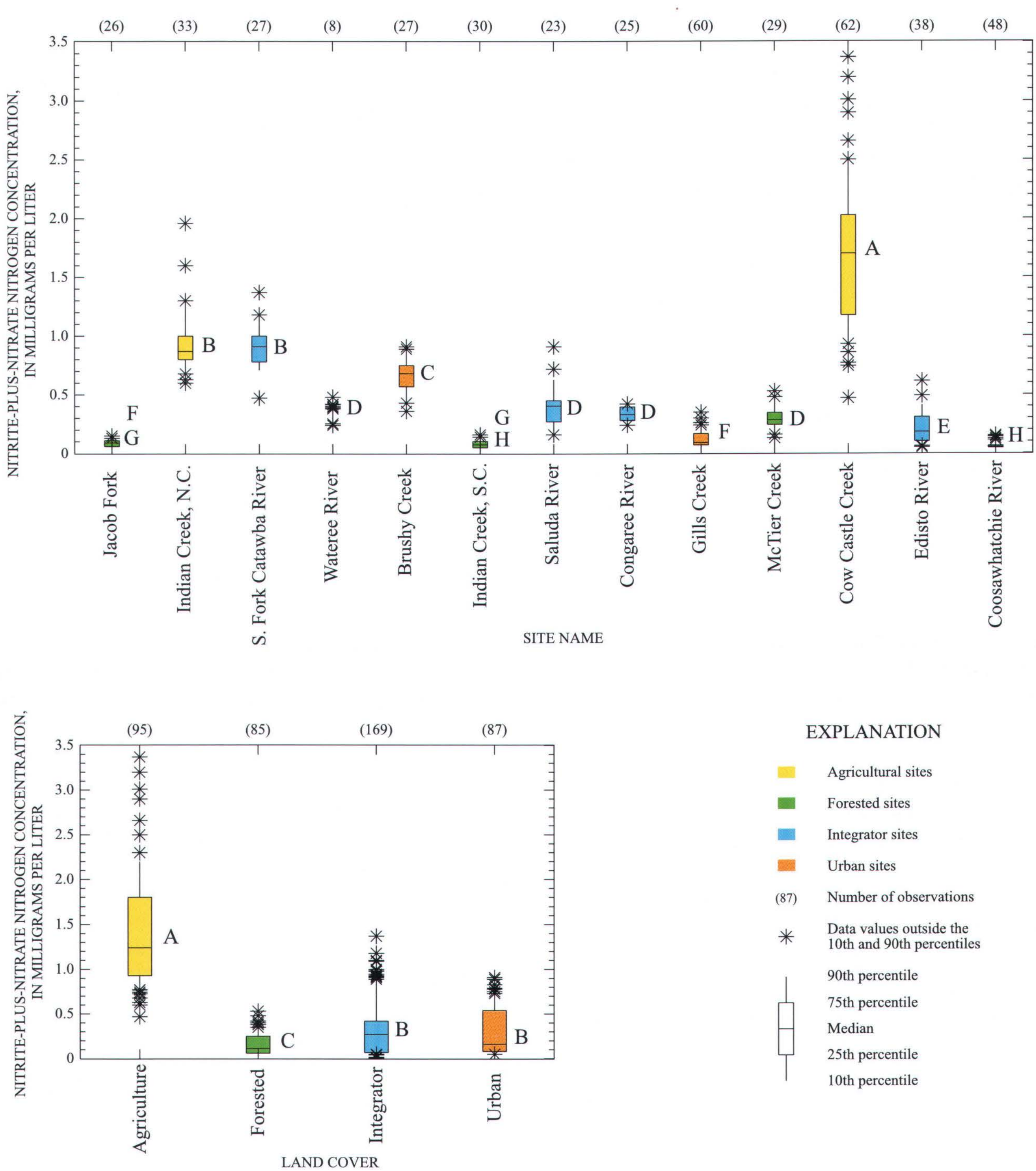

Figure 5. Distribution of nitrite-plus-nitrate nitrogen in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

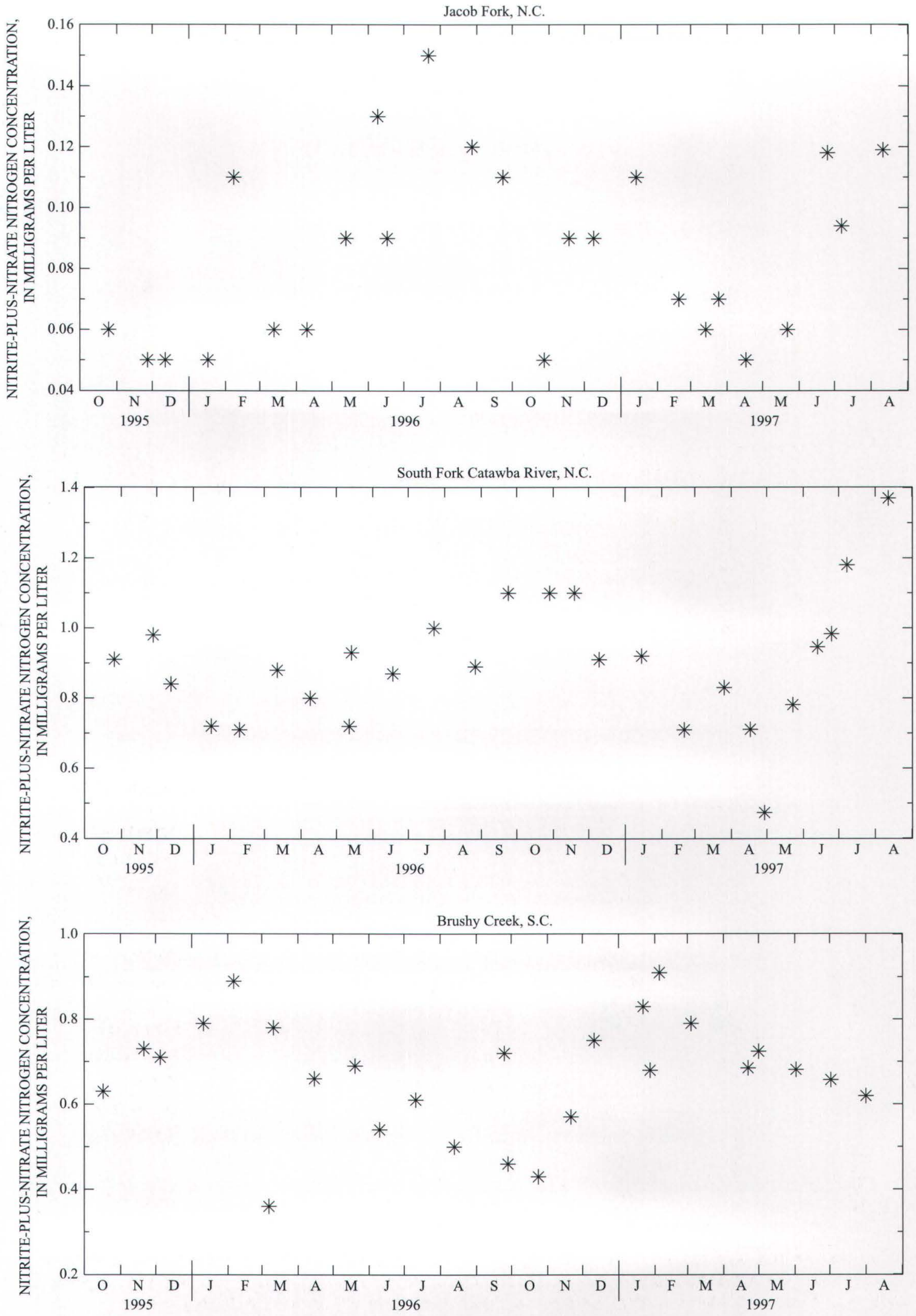

Figure 6. Seasonal variability of nitrite-plus-nitrate nitrogen in Jacob Fork and the South Fork Catawba River, N.C., and Brushy Creek, S.C., 1995–97.

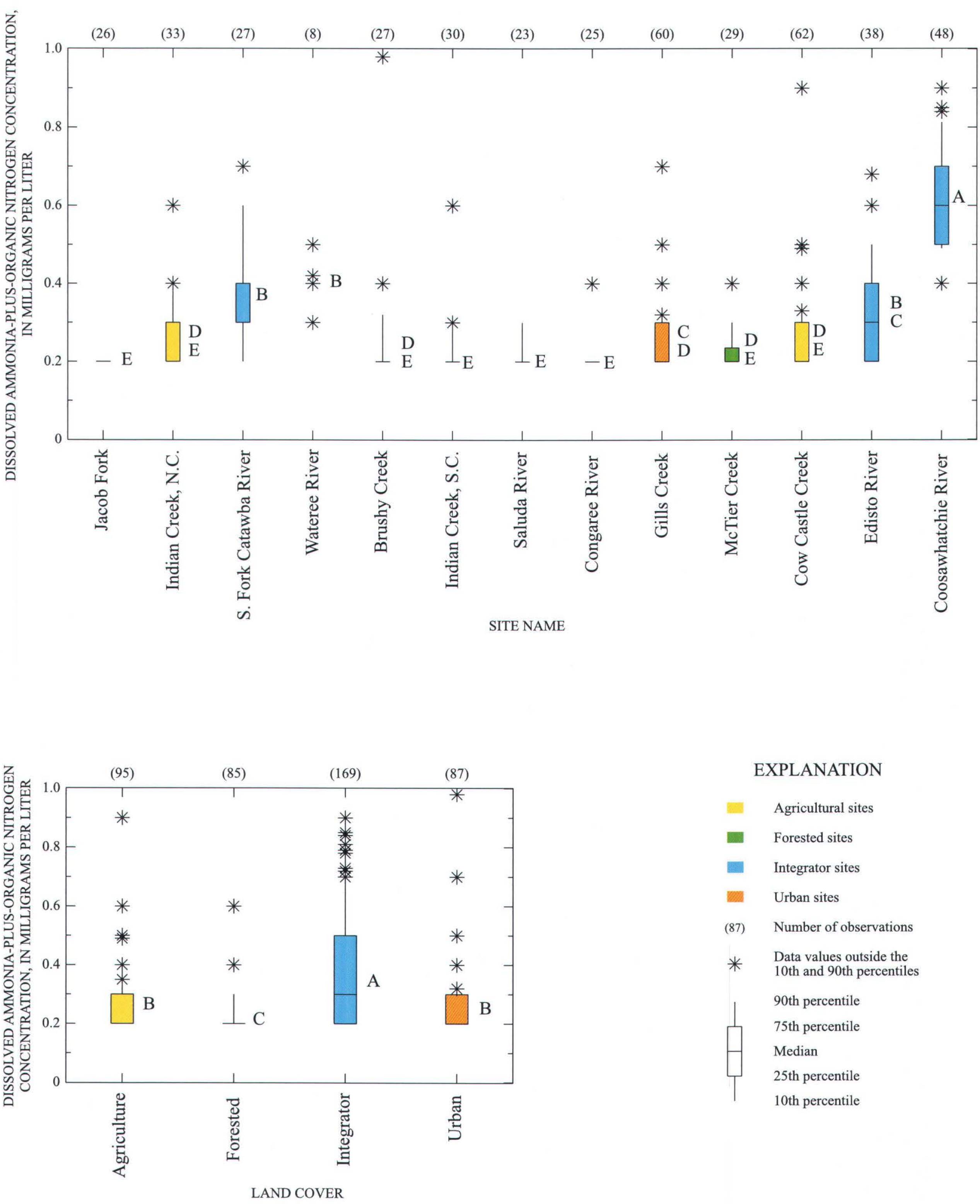

Figure 7. Distribution of dissolved ammonia-plus-organic nitrogen in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

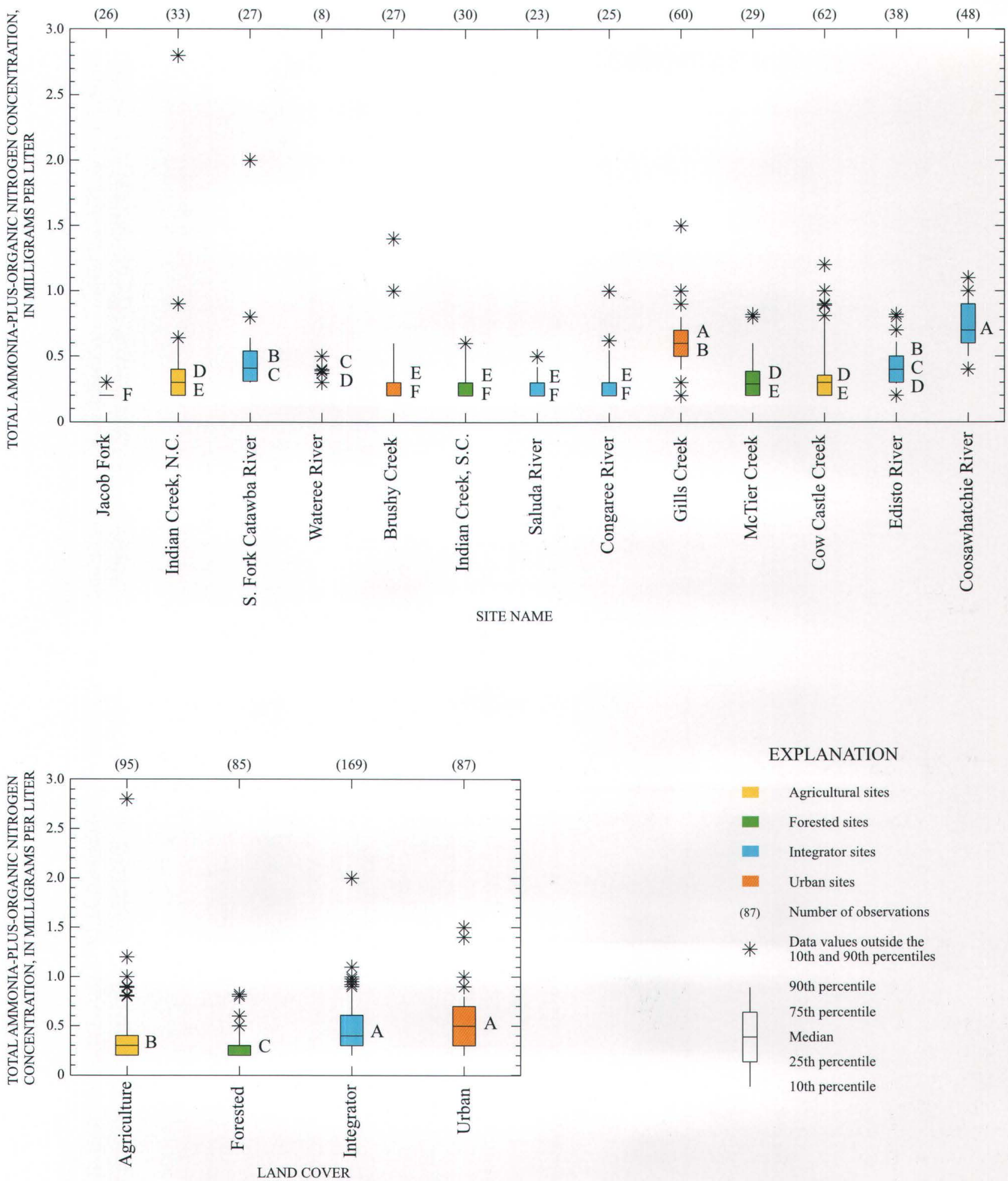

Figure 8. Distribution of total ammonia-plus-organic nitrogen in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

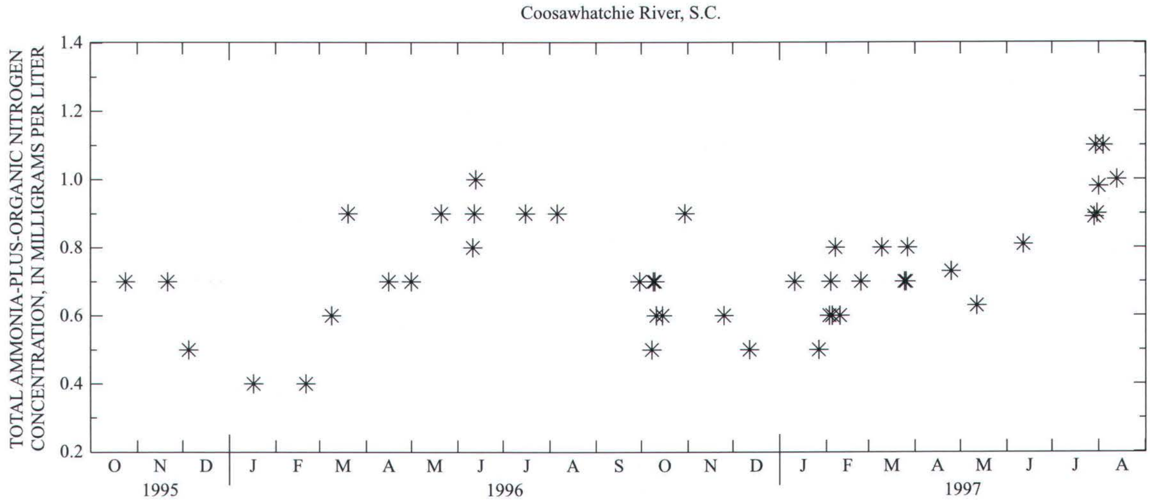

Figure 9. Seasonal variability of total ammonia-plus-organic nitrogen in the Coosawhatchie River, S.C., 1995–97.

Phosphorus species studied included total phosphorus, dissolved phosphorus, and ortho-phosphorus. The U.S. EPA has recommended that total phosphorus concentrations not exceed 0.10 mg/L in streams not entering lakes or impoundments (U.S. Environmental Protection Agency, 1986).

Phosphorus levels in the SANT study area generally were low compared to other 1994 NAWQA study units (table 2). Total phosphorus concentrations ranged from <0.010 to 1.10 mg/L (table 2; fig. 10). Median total phosphorus concentrations were highest in the South Fork Catawba River (0.14 mg/L) and in Indian Creek, N.C. (0.090 mg/L) (fig. 10). The South Fork Catawba River is influenced by industrial wastewater discharge and agricultural practices in upstream basins, including Indian Creek. The lowest median concentrations were observed at Jacob Fork, McTier Creek, Saluda River, and Brushy Creek (fig. 10). Although the median total phosphorus concentration at Brushy Creek was low, several high individual concentrations of total phosphorus were obtained during storms. The sampling site at Brushy Creek is directly downstream from a golf course and active urban development, which may account for total phosphorus runoff during rainfall. When grouped by land cover, forested sites had a significantly lower median total phosphorus concentration than sites with other types of land cover (fig. 10). No seasonal trends were observed in total phosphorus concentrations.

Dissolved phosphorus concentrations ranged from <0.010 to 0.250 mg/L in the SANT study area (table 2; fig. 11). The highest median concentration was observed at the South Fork Catawba River followed by Indian Creek, N.C., and the Coosawhatchie River (fig. 11). Compared with total phosphorus concentrations, dissolved phosphorus concentrations generally were low, indicating that most of the total phosphorus was in the suspended phase. Most sites had concentrations at or just above the MRL of 0.010 mg/L. Concentrations of dissolved phosphorus were significantly higher at integrator and agricultural sites compared to forested or urban sites (fig. 11). Seasonal trends in dissolved phosphorus concentrations were observed at some sites, such as the South Fork Catawba River (fig. 12), where concentrations generally were lowest in the winter.

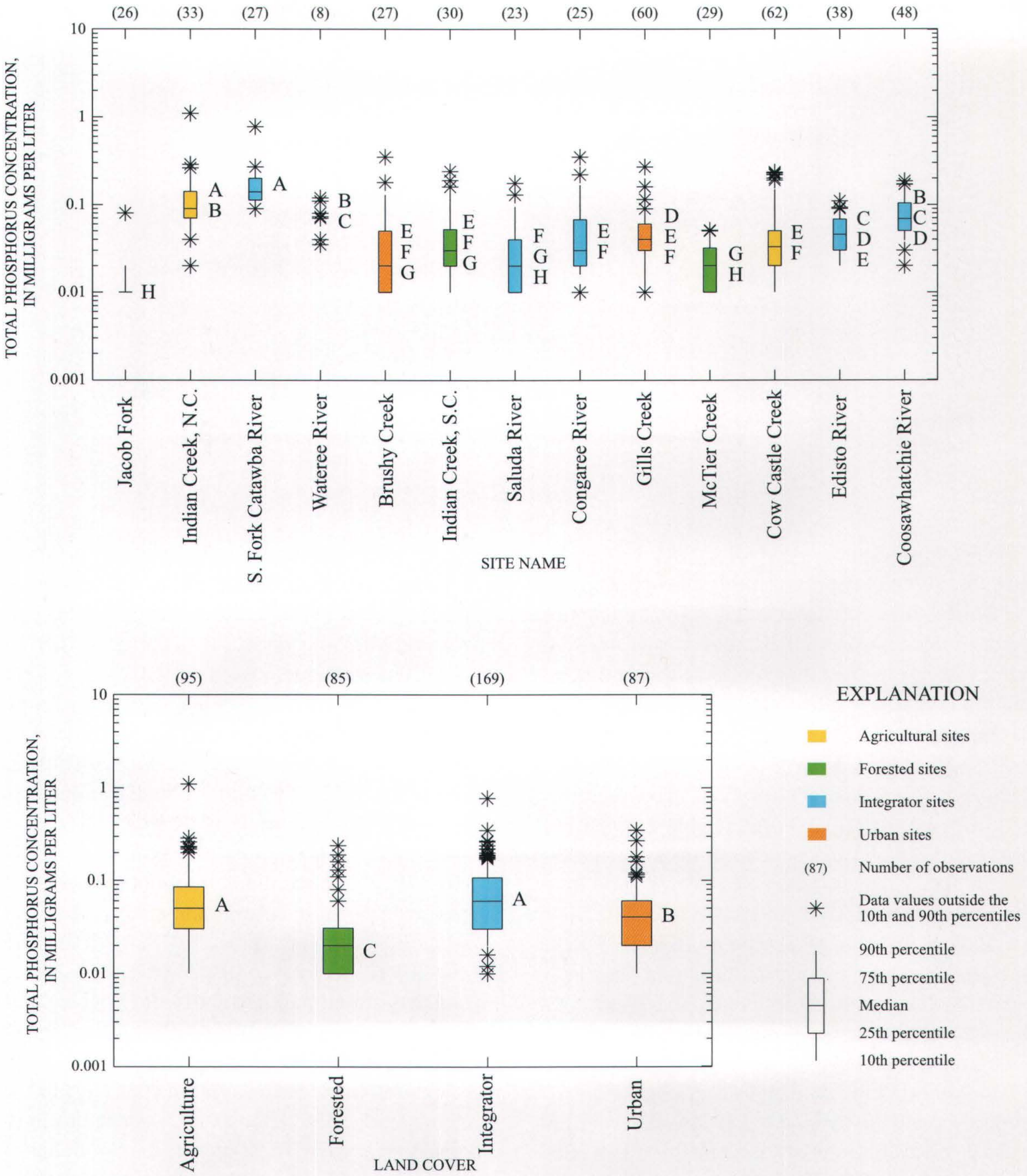

Figure 10. Distribution of total phosphorus in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

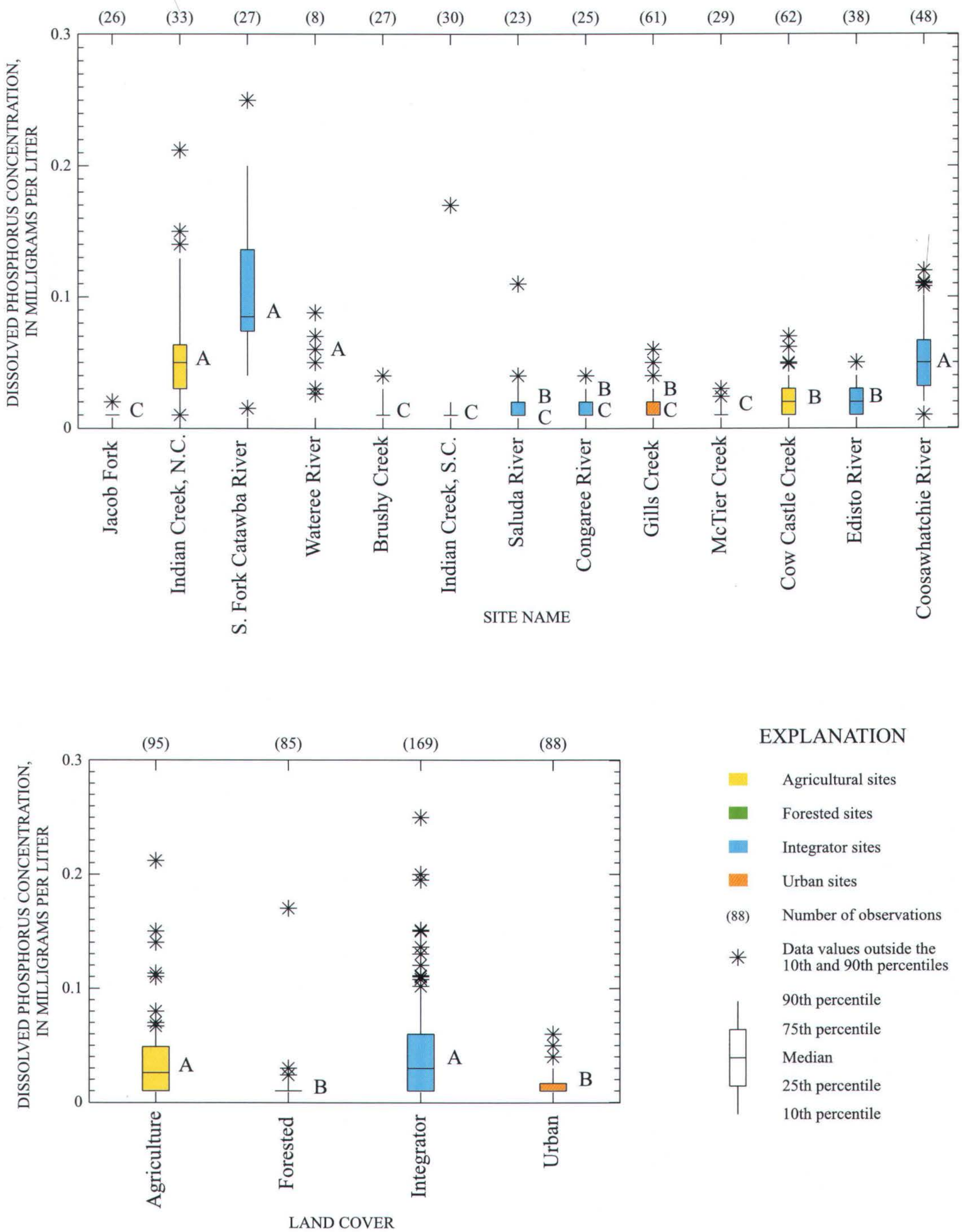

Figure 11. Distribution of dissolved phosphorus in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

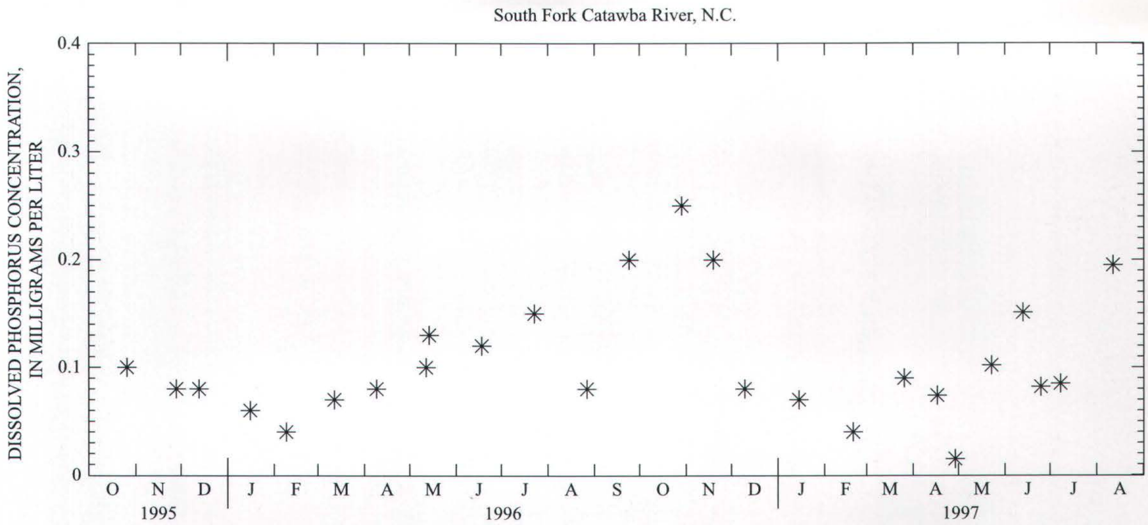

Figure 12. Seasonal variability of dissolved phosphorus in the South Fork Catawba River, N.C., 1995–97.

Median ortho-phosphorus concentrations were highest in the South Fork Catawba River (0.078 mg/L) and Indian Creek, N.C. (0.040 mg/L) (fig. 13). Ortho-phosphorus concentrations ranged from <0.010 mg/L to 0.240 mg/L (table 2). Median concentrations were significantly lower at forested and urban sites compared to agricultural and integrator sites (fig. 13). Concentrations were significantly lower in winter compared to concentrations in summer or fall.

PESTICIDES

Pesticides are used on a regular basis for agricultural, commercial, and domestic protection of plants, woods, soil, and other products from harmful organisms, and for control of the growth of certain vegetation. Pesticide use has increased as more chemicals have been developed to combat nuisance plants and pests. Although most pesticides target specific organisms, they also can have negative effects on non-target species. Due to their widespread use, pesticides commonly are detected in streams and lakes (Larson and others, 1997). Many pesticides degrade slowly in the environment; therefore, pesticide residuals or breakdown products frequently are found in streams. Chronic concentrations can increase to the point where aquatic biota are at risk. The U.S. EPA has established and continues to develop criteria for the protection of aquatic life. Although these criteria are for single compounds, studies indicate that multiple pesticides often are detected in a single sample. The effects of simultaneous exposure to multiple pesticides is currently being studied (U.S. Geological Survey, 1999b).

Pesticides detected in the SANT study area include herbicides and insecticides. Herbicides are used to control weeds and undesirable plants in agricultural and urban settings. Insecticides are used widely to control pests in and around homes, offices, and warehouses.

Of the 85 pesticides analyzed, 22 herbicides and 8 insecticides were detected at or above the adjusted MRL of 0.01 µg/L at the fixed sites (table 3). Numbers of detections varied from one each at the Coosawhatchie River, McTier Creek, and Indian Creek, S.C., to 263 at Gills Creek (table 4). Atrazine was detected at the most sites, occurring at all but two of the 13 fixed sites. Other pesticides occurring at 7 or more sites included simazine, tebuthiuron, and prometon (table 3). Simazine was detected most often (92 detections), and occurred at the highest concentrations, up to 1.6 µg/L (table 3).

Pesticide samples were collected weekly at Gills Creek and Cow Castle Creek during February through October 1996 and biweekly at the Edisto River during April through October 1996. Collection of monthly pesticide samples continued through February 1997 at Gills Creek. Insecticides, such as diazinon, malathion, and parathion, were detected almost exclusively at Gills Creek, the urban site. Atrazine and tebuthiuron concentrations were significantly higher at Gills Creek

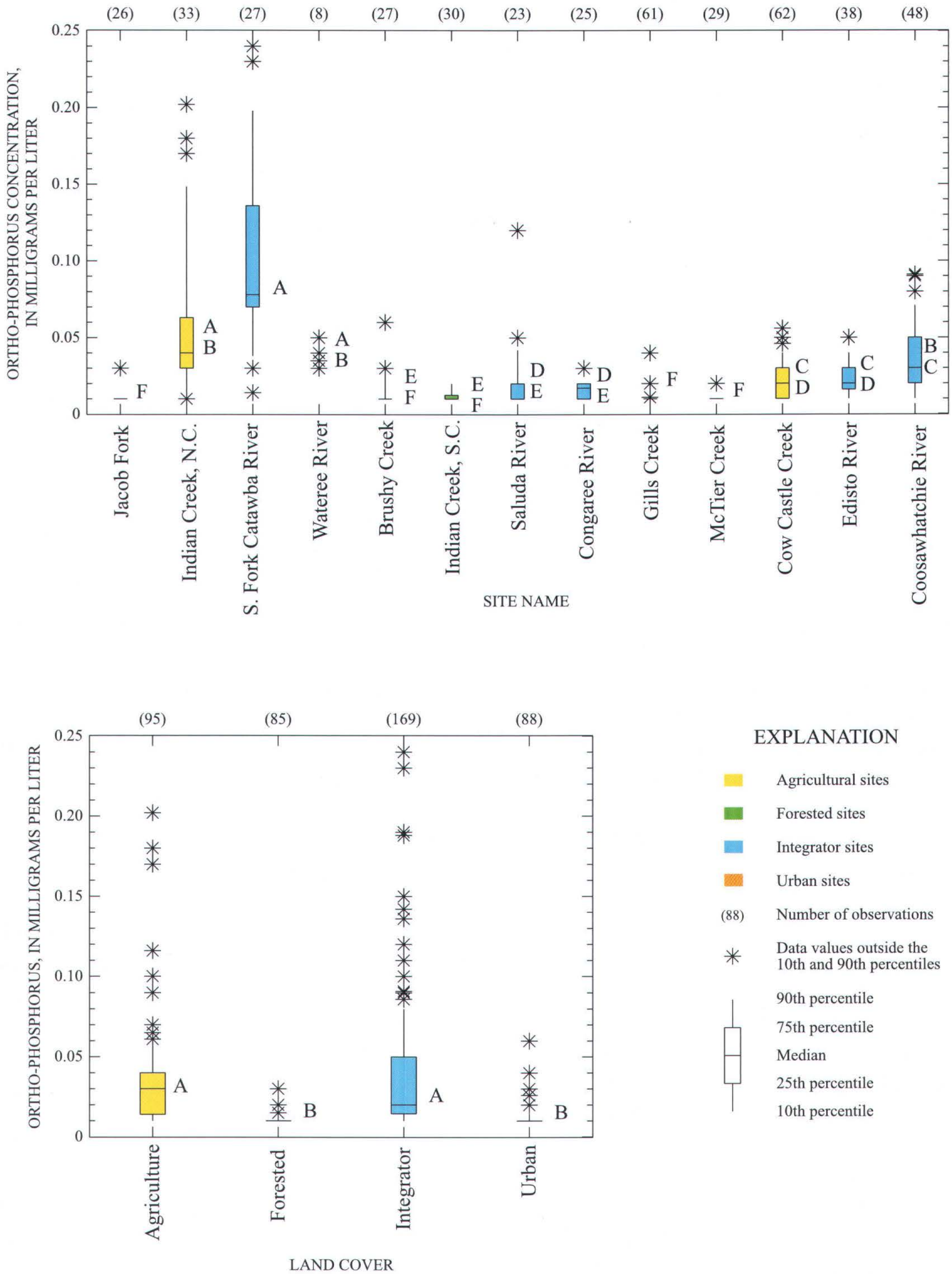

Figure 13. Distribution of ortho-phosphorus in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

Table 3. Summary of pesticide detections and aquatic life guidelines and criteria

[concentrations in micrograms per liter (µg/L); MRL, minimum reporting level; —, not established]

Pesticide	MRL	Number of detections above adjusted MRL of 0.01 µg/L	Number of sites with detections above adjusted MRL of 0.01 µg/L	Median concen-tration	Maximum concentra-tion	Aquatic criteria (µg/L)	Type of pesticide
2,4-D	0.035	4	2	0.195	0.820	4[a]	Herbicide
Alachlor	.002	22	1	.010	.045	—	Herbicide
Aldicarb sulfoxide	.021	1	1	1.20	1.20	1[a]	Metabolite
Aldicarb	.016	1	1	.480	.480	1[a]	Insecticide
Atrazine	.001	83	11	.019	1.10	1.8[a]	Herbicide
Bentazon	.014	9	1	.250	.660	—	Herbicide
Butylate	.002	1	1	.008	.073	—	Herbicide
Carbaryl	.003	19	3	.018	.160	.2[a]	Insecticide
Carbofuran	.003	5	2	.026	.310	1.8[a]	Insecticide
Chlorpyrifos	.004	28	3	.007	.095	.041[b]	Insecticide
Cyanazine	.004	3	1	.013	.058	2.0[a]	Herbicide
Deethylatrazine	.002	9	3	.005	.033	—	Metabolite
Diazinon	.002	35	4	.019	.130	.08[c]	Insecticide
Diuron	.020	11	2	.030	.120	—	Herbicide
Fenuron	.013	2	1	.015	.020	—	Herbicide
Fluometuron	.035	8	1	.020	.630	—	Herbicide
Linuron	.002	1	1	.011	.011	7[a]	Herbicide
Malathion	.005	24	5	.018	.216	.1[b]	Insecticide
Metolachlor	.002	45	6	.010	1.08	7.8[a]	Herbicide
Metribuzin	.004	1	1	.019	.019	1[a]	Herbicide
Molinate	.004	1	1	.011	.011	—	Herbicide
Oryzalin	.019	1	1	.130	.130	—	Herbicide
Parathion	.004	3	2	.011	.052	.013[b]	Insecticide
Pendimethalin	.004	4	1	.013	.034	—	Herbicide
Prometon	.018	41	7	.009	.055	—	Herbicide
Pronamide	.003	3	2	.007	.017	—	Herbicide
Simazine	.005	92	10	.044	1.60	10[a]	Herbicide
Tebuthiuron	.010	89	9	.017	.074	1.6[a]	Herbicide
Terbacil	.007	2	1	.014	.015	—	Herbicide
Trifluralin	.002	1	1	.005	.010	.2[a]	Herbicide

[a]Environment Canada, 1999.
[b]U.S. Environmental Protection Agency, 1999.
[c]International Joint Commission, 1999.

Table 4. Summary of pesticide detections at fixed sites, Santee River Basin and coastal drainages study area, 1995–97

[MRL, minimum reporting level; µg/L, micrograms per liter]

Site	Site type	Number of pesticide samples collected*	Number of pesticide detections above adjusted MRL of 0.01 µg/L	Number of different pesticides detected
Jacob Fork at Ramsey, N.C.	Forested indicator	3	6	6
Indian Creek near Laboratory, N.C.	Agricultural indicator	14	12	7
South Fork Catawba River at McAdenville, N.C.	Integrator	3	4	2
Wateree River near Camden, S.C.	Integrator	3	14	6
Brushy Creek near Pelham, S.C.	Urban indicator	3	11	8
Indian Creek above Newberry, S.C.	Forested indicator	3	1	1
Saluda River near Columbia, S.C.	Integrator	3	7	3
Congaree River at Columbia, S.C.	Integrator	3	9	4
Gills Creek at Columbia, S.C.	Urban indicator	43	263	18
McTier Creek near Monetta, S.C.	Forested indicator	4	1	1
Cow Castle Creek near Bowman, S.C.	Agricultural indicator	38	186	22
Edisto River near Givhans, S.C.	Integrator	17	34	7
Coosawhatchie River near Early Branch, S.C.	Integrator	3	1	1

*Eighty-five different pesticides or metabolites analyzed from each sample.

than at Cow Castle Creek or at the Edisto River (fig. 14). Gills Creek flows directly through residential and industrial development areas, where direct runoff can occur. Concentrations of pesticides generally were lower at the Edisto River compared to the other two intensive fixed sites.

Seasonal patterns in pesticide concentrations were observed at Cow Castle Creek and Gills Creek. Cow Castle Creek, an agricultural site, had the highest concentrations of the herbicide tebuthiuron during the spring (fig. 15). Atrazine and simazine concentrations at Cow Castle Creek also were highest in the spring and had a secondary increase in early fall. Metolachlor concentrations were highest in early fall with a secondary increase in the spring. Seasonal patterns at Gills Creek differed from those at Cow Castle Creek. Some herbicide concentrations at Gills Creek, such as atrazine, metolachlor, and simazine, were highest in early spring and decreased throughout the year, whereas deethylatrazine, prometon, and tebuthiuron

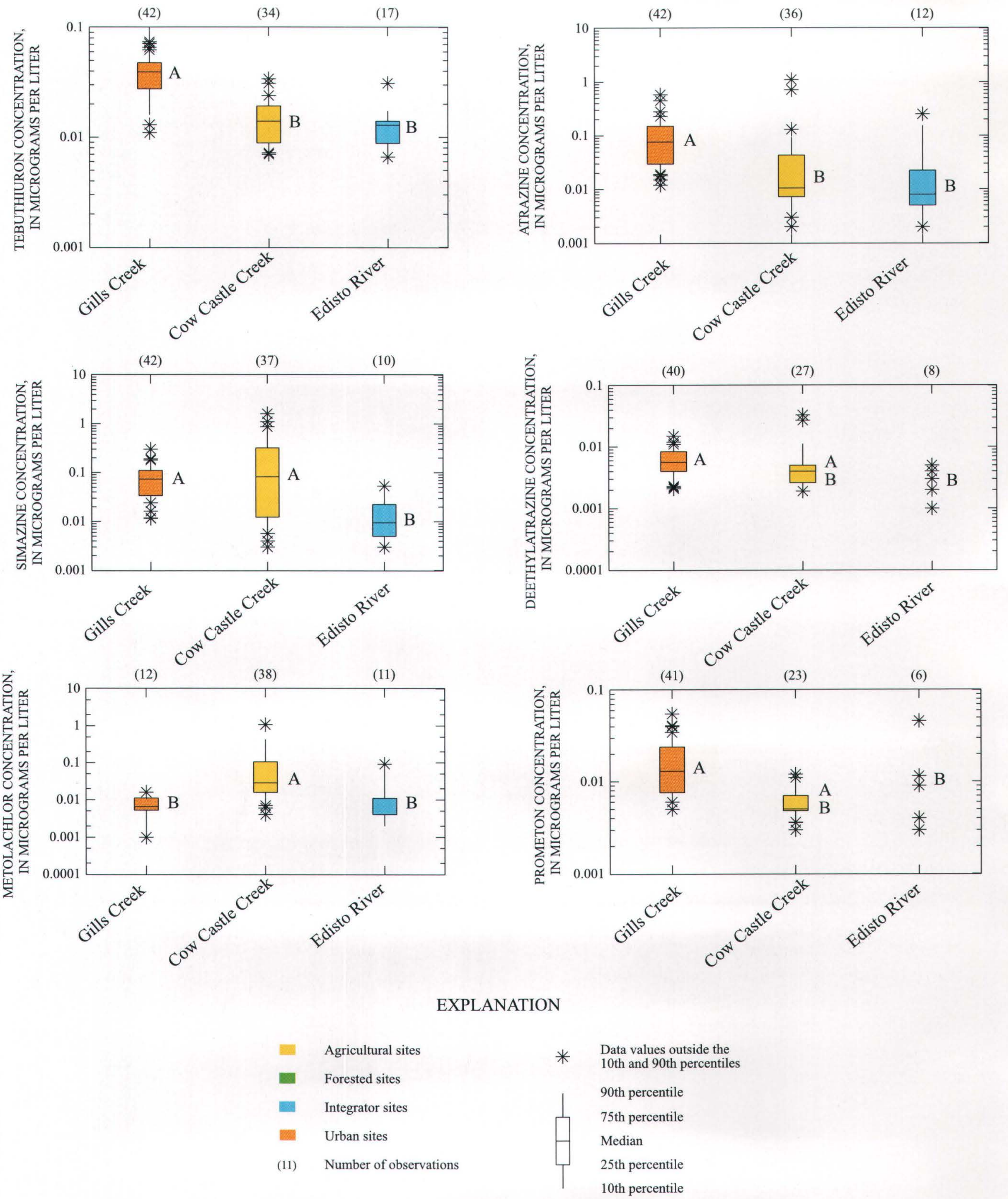

Figure 14. Distribution of selected pesticides in Gills Creek, Cow Castle Creek, and the Edisto River, S.C., 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

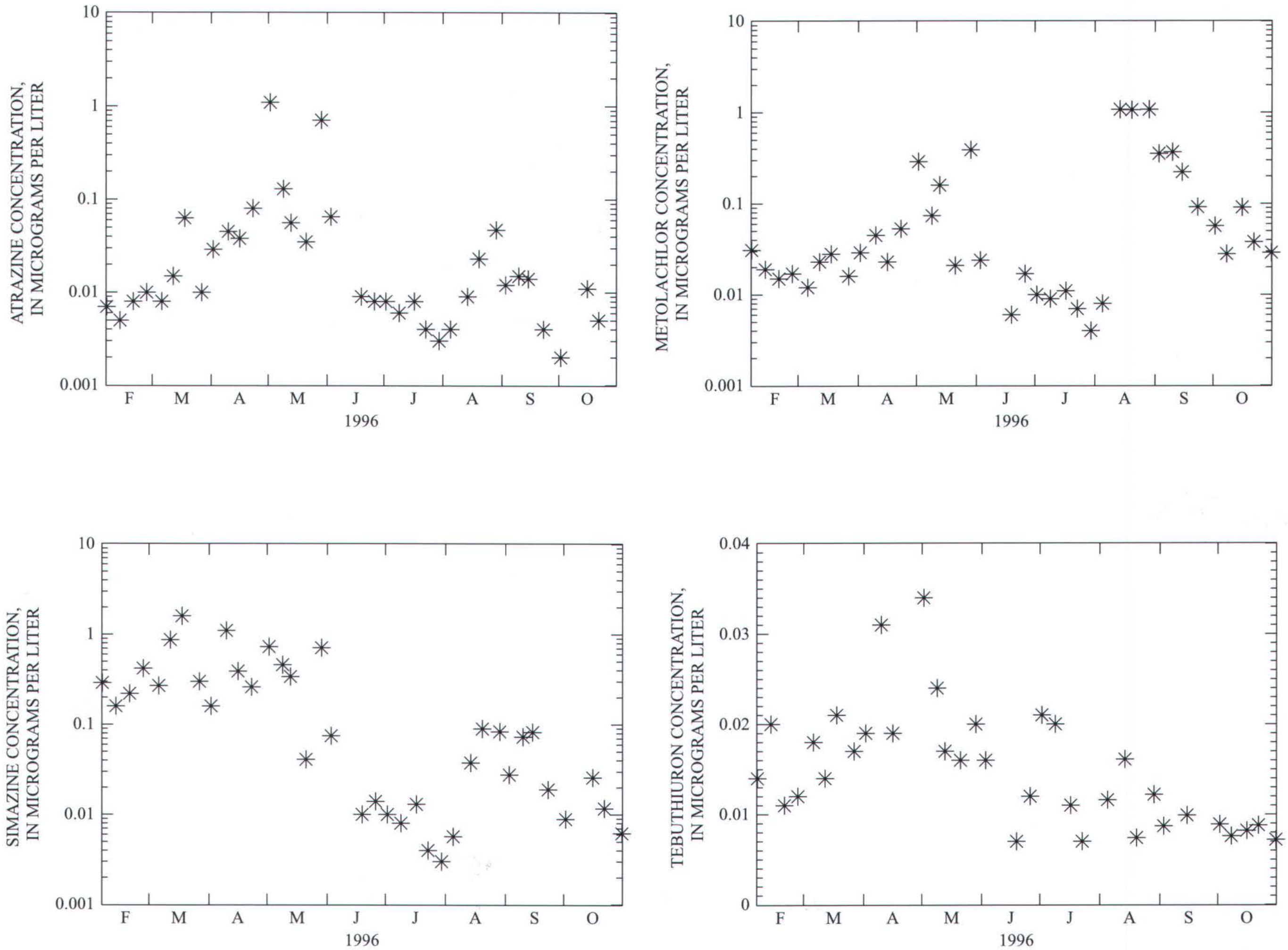

Figure 15. Seasonal variability of selected pesticides in Cow Castle Creek, S.C., 1995–97.

concentrations were low in early spring, increased during spring and early summer, and then decreased in the fall (fig. 16). Observed seasonal concentrations are likely a result of seasonal application and weather patterns. Spring applications of preemergent herbicides result in higher concentrations in early spring that decrease through summer. Concentrations of deethylatrazine, a metabolite of atrazine, increased during the summer as atrazine concentrations decreased.

Some pesticide concentrations were detected in excess of the guidelines established by the Environment Canada (1999) and the International Joint Commission (1999), or the U.S. EPA (1999) chronic aquatic life criteria: aldicarb sulfoxide (1 of 1 detection), chlorpyrifos (4 of 28 detections), diazinon (2 of 35 detections), malathion (3 of 24 detections), and parathion (1 of 3 detections). No concentration exceeded the U.S. EPA MCL or lifetime health advisory level (HAL) for the protection of drinking-water quality and human health (U.S. Environmental Protection Agency, 1996). Of the 30 pesticides detected, 13 do not have established criteria for the protection of aquatic life, and 7 do not have established MCL's or HAL's.

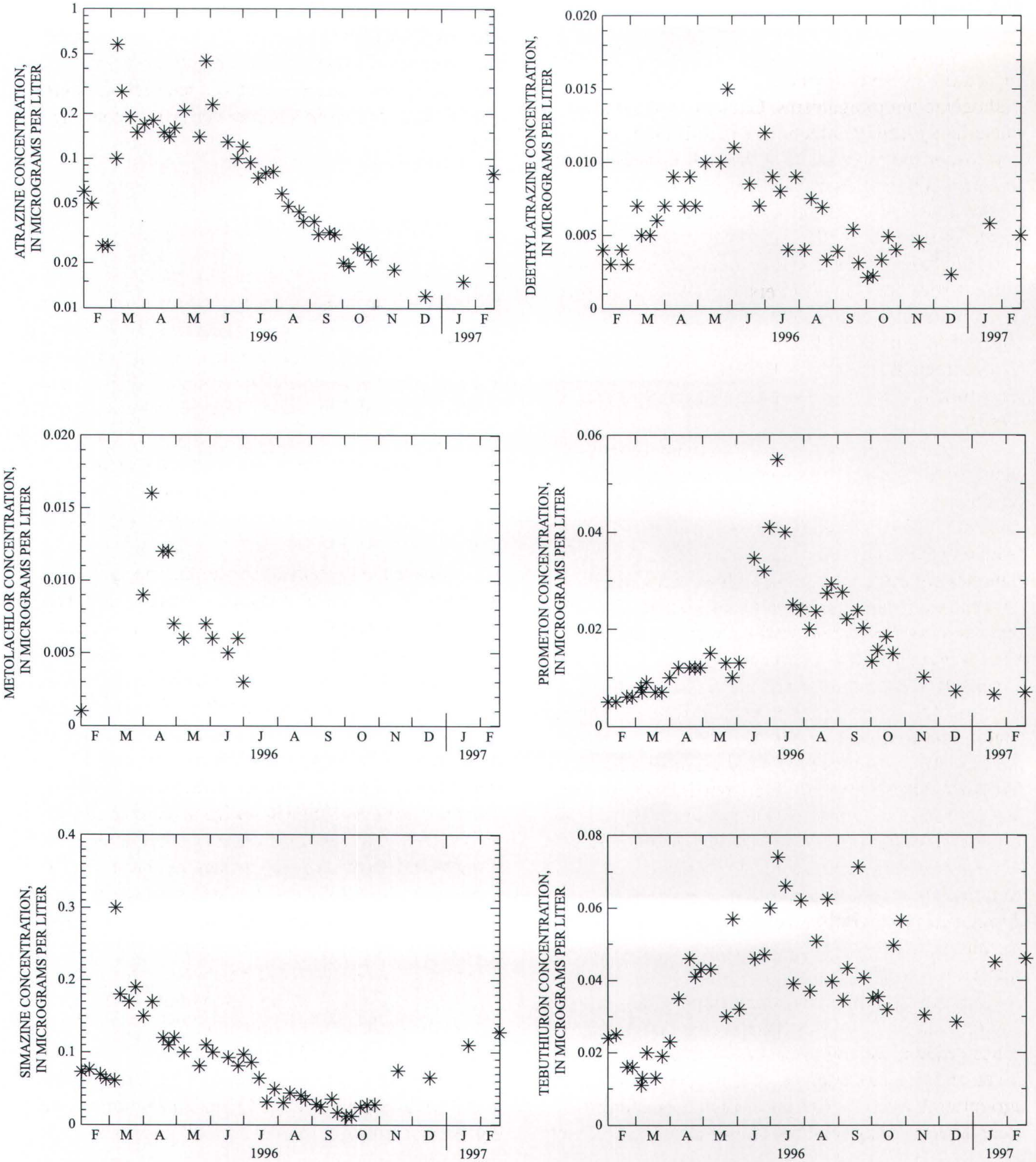

Figure 16. Seasonal variability of selected pesticides in Gills Creek, S.C., 1995–97.

BACTERIA

High concentrations of fecal-indicator bacteria in streams can indicate the possible presence of pathogenic microorganisms. Cholera, typhoid fever, bacterial dysentery, infectious hepatitis, and cryptosporidiosis are some of the well-known diseases that spread through water contaminated with fecal matter. Eye, ear, nose, and throat infections also can result from contact with contaminated water (Wilhelm and Maluk, 1998). Fecal coliform concentrations above 400 colonies per 100 milliliters (col/100 mL) of stream water are considered unsuitable for primary contact (South Carolina Department of Health and Environmental Control, 1992; North Carolina Department of Environment and Natural Resources, 1997).

Stream samples were collected and analyzed monthly for fecal coliform and fecal streptococcus bacteria at all fixed sites from October 1995 through September 1996. Fecal coliform concentrations ranged from less than 1 to almost 22,000 col/100 mL (fig. 17). Samples collected at 9 of the 13 fixed sites had concentrations greater than 400 col/100 mL. The highest individual concentrations were observed at agricultural sites (Indian Creek, N.C., and Cow Castle Creek). Agricultural sites are subject to high fecal coliform concentrations as a result of livestock waste runoff during periods of rainfall. The highest median concentration was observed at an urban site, Brushy Creek (480 col/100 mL), which may be the result of leaking septic systems, golf-course ponds supporting waterfowl, or pet waste from residential areas. When data from all sites were grouped by season, significantly higher concentrations were observed during summer months than during winter or spring months, possibly because bacterial growth increases in warmer temperatures.

Fecal streptococcus concentrations ranged from 2 to more than 20,000 col/100 mL (fig. 18). Individual concentrations were highest at the South Fork Catawba River, an integrator site, and at Cow Castle Creek, an agricultural site. The highest median concentrations were detected at agricultural sites—Cow Castle Creek and Indian Creek, N.C. Fecal streptococcus concentrations were significantly lower at integrator sites compared to agricultural and urban sites (fig. 18). Seasonally, fecal streptococcus concentrations were significantly higher in summer compared to spring or winter.

SUSPENDED SEDIMENT

Sediment suspended, resulting from streambed resuspension, rock weathering, and soil erosion from streambanks into the stream, is carried in the water column. High suspended sediment concentrations can limit light penetration into the stream. Contaminants may sorb onto the surface of suspended sediments and be transported downstream. As stream velocities decrease, such as in lakes and reservoirs, larger sediment particles may settle out, creating a sink for sediment and sorbed contaminants, and reducing lake holding capacity.

Suspended sediment concentrations generally were low in the SANT study area, ranging from less than 1 to 1,240 mg/L (fig. 19). Jacob Fork had the lowest median suspended sediment concentration (3 mg/L), and the South Fork Catawba River had the highest median concentration (17 mg/L). Suspended sediment concentrations were significantly correlated with streamflows at all sites. Urban sites had significantly higher suspended sediment concentrations than did sites with other land covers. This may be due to construction or other land-disturbing activities as well as increased runoff as a result of increased impervious land surface. Forested sites had the lowest suspended sediment concentrations (fig. 19). Seasonal patterns in concentrations were observed at some sites. The Edisto River had higher suspended sediment concentrations during summer and lower concentrations during winter (fig. 20). This may be a result of increased logging activities during summer in the Edisto River Basin. Combining data from all sites, suspended sediment concentrations were highest in spring.

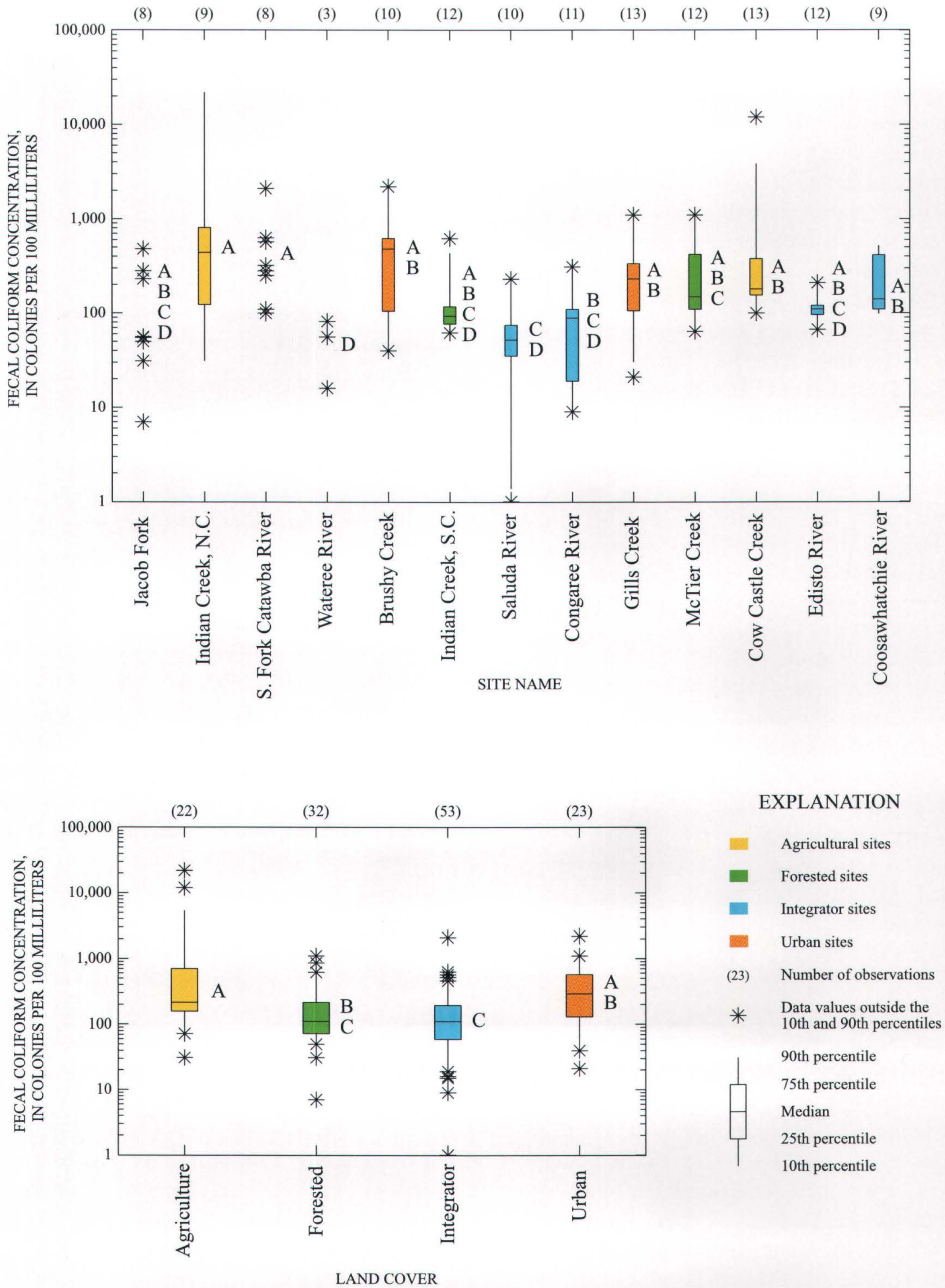

Figure 17. Distribution of fecal coliform bacteria in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

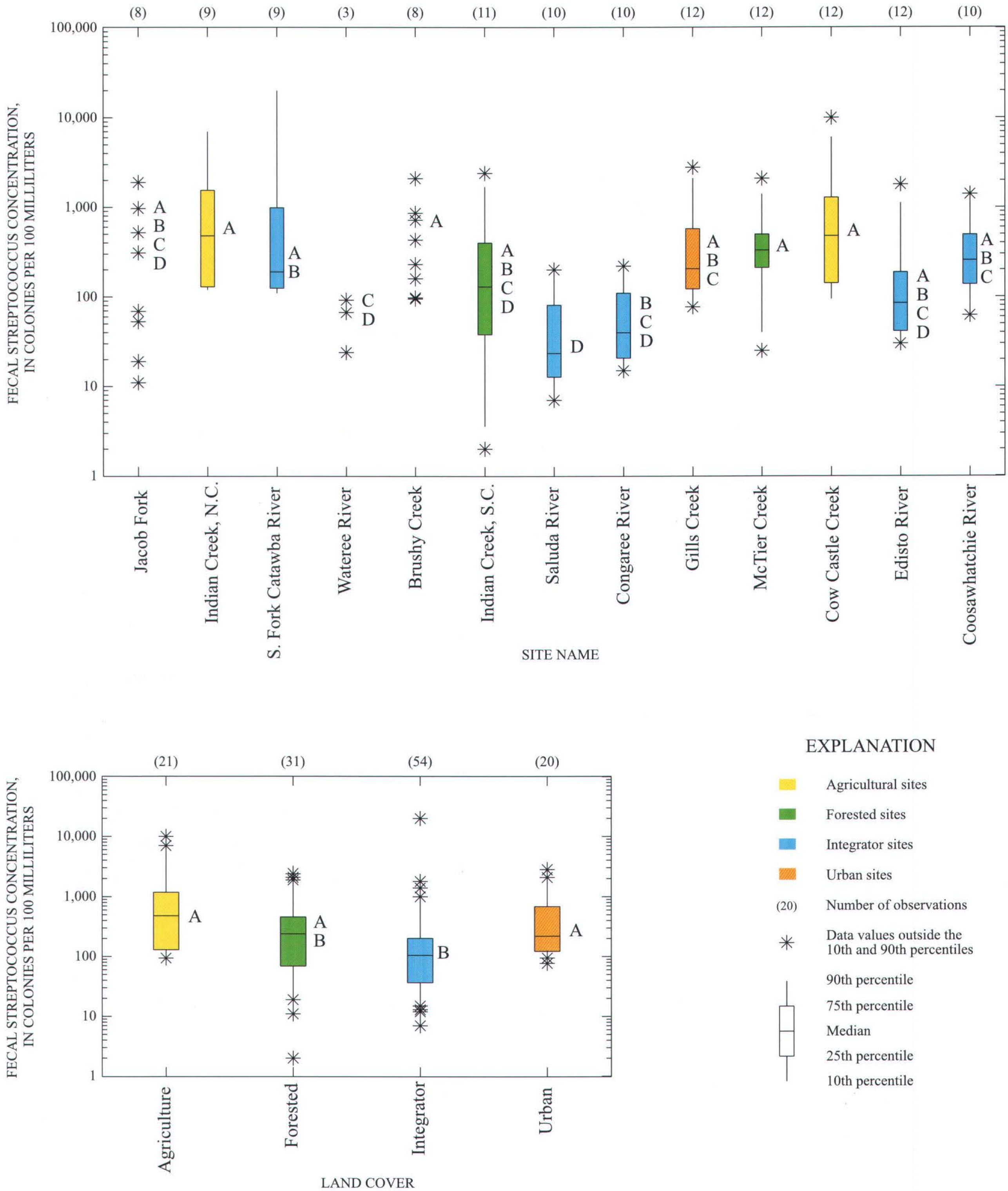

Figure 18. Distribution of fecal streptococcus bacteria in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

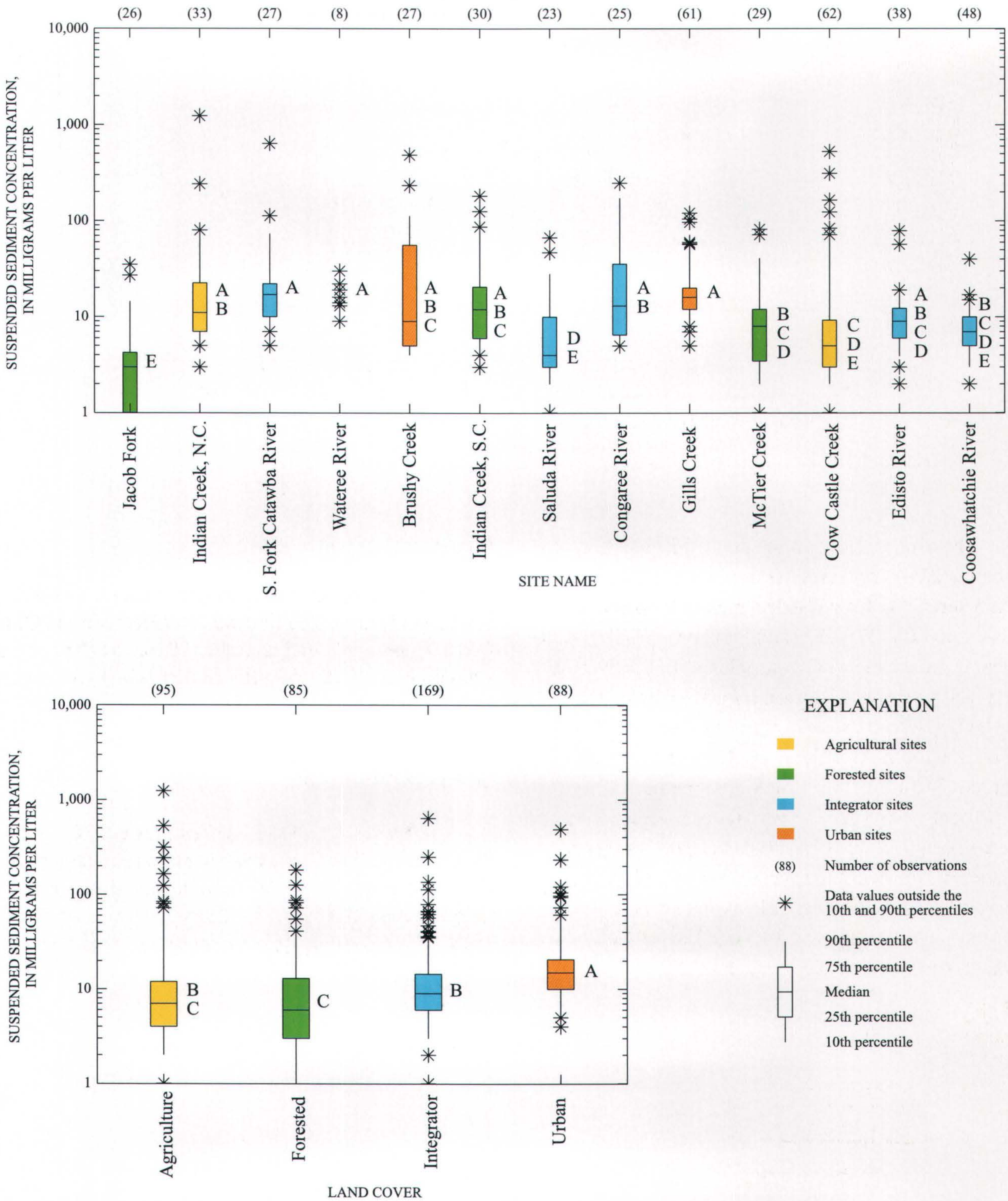

Figure 19. Distribution of suspended sediment in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

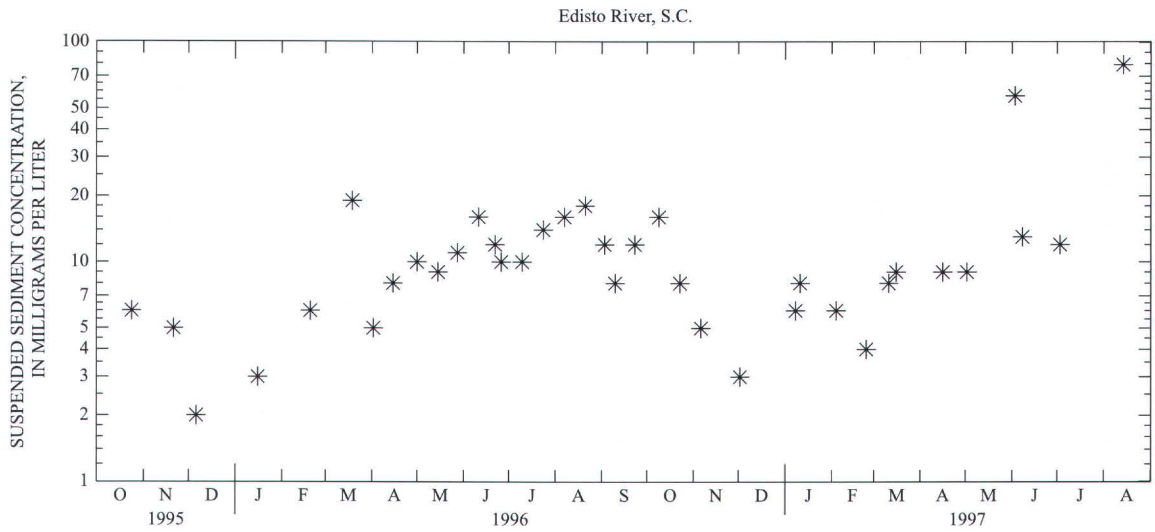

Figure 20. Seasonal variability of suspended sediment in the Edisto River, S.C., 1995–97.

The distribution of suspended sediment that was finer than 0.062 millimeter (mm) in diameter ranged from 5 percent at Cow Castle Creek to 99 percent at Gills Creek (fig. 21). The sampling site on Gills Creek is below a reservoir where particles of larger diameter likely will settle out. The South Fork Catawba River had the highest median (91 percent). The sampling site on the South Fork Catawba River also is below a reservoir. Jacob Fork had the lowest median (64 percent). Compared to integrator or urban sites, forested sites had significantly lower percentages of suspended sediment finer than 0.062 mm (fig. 21). Seasonally, the percentages of suspended sediment finer than 0.062 mm generally were lowest during summer, such as in Gills Creek (fig. 22).

SYNOPTIC STUDIES

Two synoptic studies were completed in the SANT study area. The first was conducted in the Gills Creek Basin, S.C., in September 1996, and the second was conducted in the South Fork Catawba River Basin, N.C., in October 1997.

Gills Creek Basin

In September 1996, 16 sites upstream from the fixed site on Gills Creek were sampled to characterize the water quality in the headwaters and tributaries to Gills Creek (table 1; fig. 1). The study was conducted when streamflows were in the lower 30 percent of the 1996 flows (Maluk, 1999).

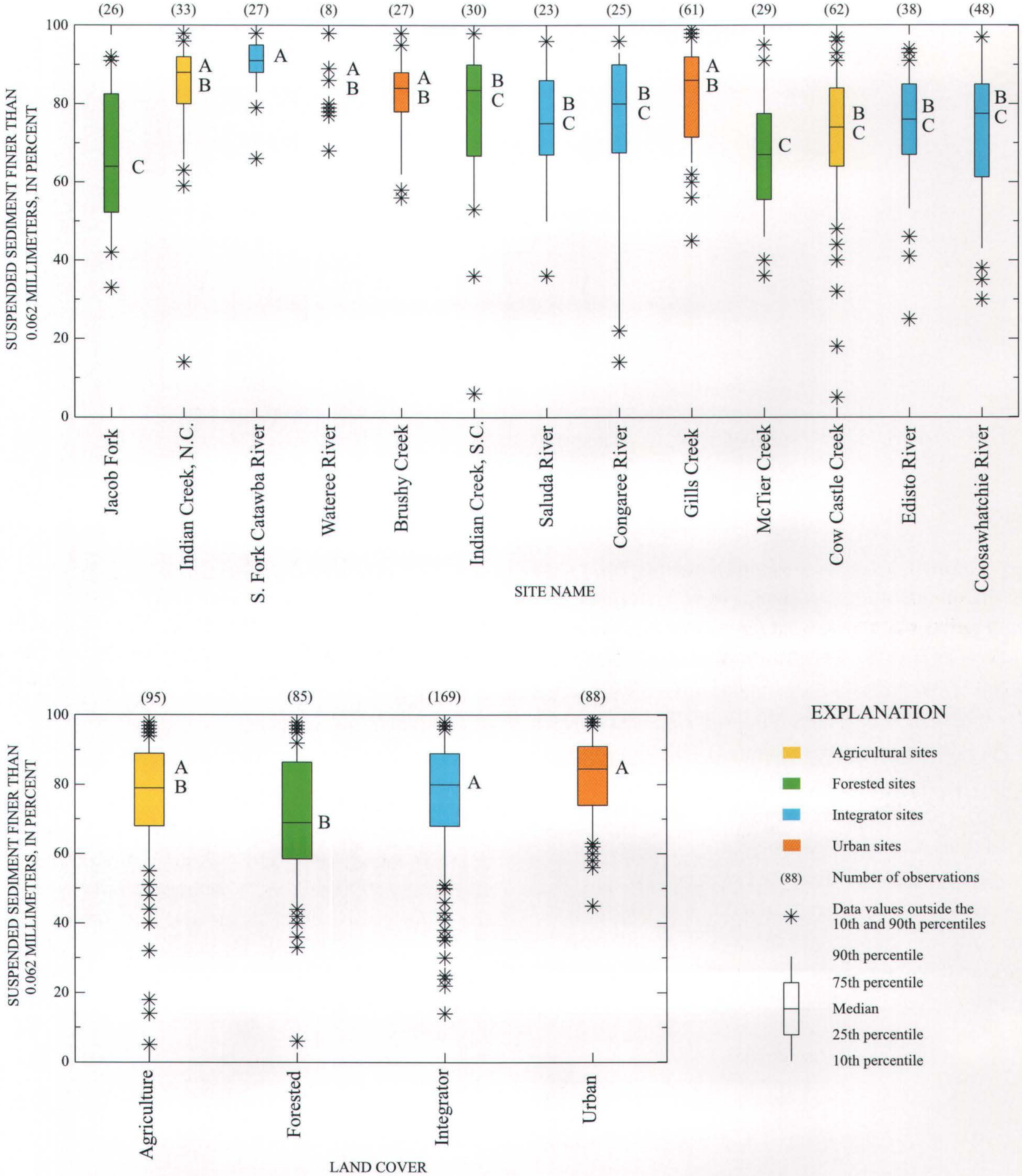

Figure 21. Distribution of percentages of suspended sediment finer than 0.062 millimeter in the Santee River Basin and coastal drainages study area, 1995–97. (Letters denote significantly different mean concentration ranks, with A being the highest, B being the next lower, etc. Sites with letters in common are not significantly different from each other.)

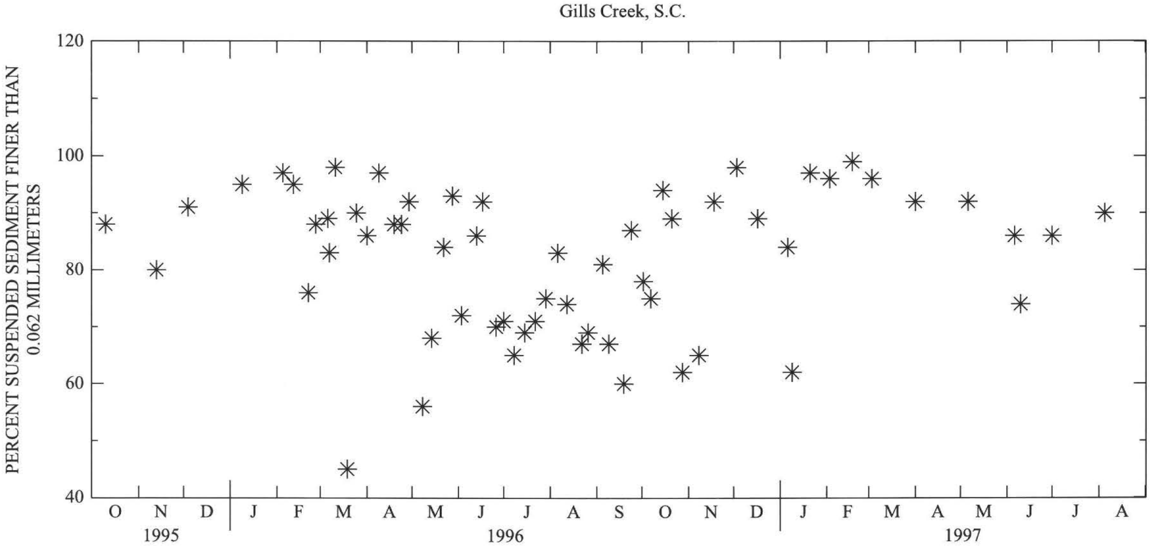

Figure 22. Seasonal variability of percentages of suspended sediment finer than 0.062 millimeter in Gills Creek, S.C., 1995–97.

Ammonia nitrogen concentrations ranged from the MRL of 0.015 to 0.110 mg/L (table 5). The highest concentration was detected at Penn Branch. Nitrite-plus-nitrate nitrogen concentrations were less than or equal to 0.720 mg/L in the Gills Creek Basin. The highest concentration was found at a highly urbanized site (Eightmile Branch at Covenant Road) and at the spring-fed headwaters of Jackson Creek at Leaning Tree Road. Dissolved ammonia-plus-organic nitrogen concentrations were low (less than or equal to 0.30 mg/L) and only five sites had detectable concentrations. Total ammonia-plus-organic nitrogen concentrations were below 1.0 mg/L. The highest concentrations were detected in Gills Creek and increased downstream to the fixed site at Columbia; total ammonia-plus-organic nitrogen concentrations possibly were associated with the increased suspended sediment concentrations.

Phosphorus concentrations, where detected, were low. Total phosphorus concentrations were below the MRL of 0.010 mg/L at 8 of the 16 sites. The highest total phosphorus concentration (0.080 mg/L) was detected at Gills Creek below Lake Katherine. This site also had the highest suspended sediment concentration.

Table 5. Summary of water-quality data from the Gills Creek Basin, September 1996

[mg/L, milligrams per liter; <, less than; col/100 mL, colonies per 100 milliliters; mm, millimeters]

Constituent	Number of samples	Minimum	Median	Maximum
Ammonia nitrogen (mg/L)	16	<0.015	0.030	0.110
Nitrite-plus-nitrate nitrogen (mg/L)	16	<.050	.155	.710
Nitrite nitrogen (mg/L)	16	<.010	.010	.020
Dissolved ammonia-plus-organic nitrogen (mg/L)	16	<.20	.20	.30
Total ammonia-plus-organic nitrogen (mg/L)	16	<.20	.30	.90
Total phosphorus (mg/L)	16	<.010	.015	.080
Dissolved phosphorus (mg/L)	16	<.010	.010	.020
Ortho-phosphorus (mg/L)	16	<.010	.010	.020
Fecal coliform (col/100 mL)	15	37	510	1,700
Fecal streptococcus (col/100 mL)	16	100	695	18,000
Suspended sediment (mg/L)	16	3	5	17
Sediment finer than 0.062 mm (percent)	16	48	74	91

Suspended sediments provide sorption sites for phosphorus, which may be why the total phosphorus concentration was highest at this site. Dissolved phosphorus concentrations were below the MRL of 0.010 mg/L at 15 of the 16 sites, and ortho-phosphorus was detected at only four sites. The highest concentrations both of dissolved phosphorus and ortho-phosphorus were 0.020 mg/L (table 5).

Pesticides are used in the Gills Creek Basin for residential and industrial pest control, roadside weed control, and other uses. A total of 10 different pesticides were detected in the Gills Creek Basin above the adjusted MRL of 0.01 µg/L (table 6). Samples from 14 of the 16 sites had detectable concentrations of at least one pesticide, and samples from 12 sites had detectable concentrations of at least five different pesticides. Tebuthiuron, a herbicide used for highway right-of-way weed control, was the most commonly detected pesticide (14 sites). Diazinon, an insecticide commonly used in residential areas, was detected at 13 of the 16 sites. Atrazine, a herbicide used on a wide variety of land covers, was detected at 12 of the sites. The number of pesticides detected at a site increased as the percentage of urban land cover increased.

Concentrations of only one insecticide, diazinon, exceeded the chronic criteria to protect aquatic life. Diazinon exceeded the criterion set forth by the Great Lakes Objective (0.08 µg/L) in 2 of the 13 detections (International Joint Commission, 1999). None of the pesticides detected exceeded the respective U.S. EPA MCL or health advisory level. Of the 10 pesticides detected, two do not have established criteria for the protection of aquatic life, and one does not have an established MCL or HAL.

Fecal coliform concentrations ranged from 37 to 1,700 col/100 mL (table 5); 8 of the 16 sites had concentrations above 400 col/100 mL. Concentrations were highest at the highly urbanized sites. Fecal streptococcus concentrations ranged from 100 to 18,000 col/100 mL (table 5). Concentrations were highest in Little Jackson Creek at Trenholm Road Extension. This site is influenced by wildlife and runoff from commercial shopping areas.

Suspended sediment concentrations were below 18 mg/L (table 5). The highest concentrations were found in Gills Creek below Lake Katherine and at the fixed site at Columbia. Turbulence caused by the spillway below Lake Katherine resuspends bed sediment, carrying it downstream. The three most downstream sites on Gills Creek had the highest percentages of suspended sediment finer than 0.062 mm.

Table 6. Summary of pesticide detections in the Gills Creek Basin, September 1996, and aquatic life guidelines and criteria

[concentrations in micrograms per liter (µg/L);MRL, minimum reporting level; —, not established]

Pesticide	MRL	Number of detections above adjusted MRL of 0.01 µg/L	Median	Maximum	Aquatic criteria (µg/L)	Type of pesticide
Atrazine	0.001	12	0.020	0.107	1.8[a]	Herbicide
Carbaryl	.003	10	.023	.139	.2[a]	Insecticide
Chlorpyrifos	.004	3	.008	.032	.041[b]	Insecticide
Diazinon	.002	13	.020	.323	.08[c]	Insecticide
Dieldrin	.001	2	.010	.011	.056[b]	Insecticide
Malathion	.005	5	.020	.032	.1[b]	Insecticide
Methyl parathion	.006	1	.012	.012	—	Insecticide
Prometon	.018	9	.022	.178	—	Herbicide
Simazine	.005	11	.021	.105	10[a]	Herbicide
Tebuthiuron	.010	14	.052	.177	1.6[a]	Herbicide

[a]Environment Canada, 1999.
[b]U.S. Environmental Protection Agency, 1999.
[c]International Joint Commission, 1999.

South Fork Catawba River Basin

In October 1997, 20 sites in the basin upstream from the South Fork Catawba River fixed site were sampled (table 1; fig. 1). Also included in this basin are two other fixed sites—Jacob Fork and Indian Creek, N.C.

Ammonia nitrogen concentrations were below 0.19 mg/L (table 7). Camp Creek and the South Fork Catawba River near Stanley, respectively, had the highest concentrations (0.181 and 0.152 mg/L). Nitrite-plus-nitrate nitrogen concentrations were highest in Clark Creek (2.61 mg/L), a small creek affected by industrial wastewater inputs, and in Long Creek near Dallas (1.51 mg/L), a creek affected by agricultural runoff. Nitrite nitrogen generally was at or below the MRL, except at Clark Creek and at three sites on the South Fork Catawba River near Long Shoals, near Stanley, and at McAdenville. Detectable concentrations of nitrite nitrogen may indicate a nearby source because nitrite nitrogen is quickly converted to nitrate nitrogen under aerobic conditions.

Phosphorus concentrations were variable. Total phosphorus concentrations ranged from the MRL (0.010 mg/L) to 0.377 mg/L (table 7) and were highest in Clark Creek. Ten of the 20 sites had total phosphorus concentrations greater than the U.S. EPA recommended maximum concentration of 0.10 mg/L for streams not flowing to reservoirs (U.S. Environmental Protection Agency, 1986). Dissolved phosphorus concentrations were similar to but slightly below total phosphorus concentrations, except at Jacob Fork near Startown, where the concentration of total phosphorus was much greater than dissolved phosphorus. High suspended sediment concentrations at this site may explain the difference. Clark Creek had the highest ortho-phosphorus concentration, 0.318 mg/L.

Fecal coliform concentrations ranged from 22 col/100 mL at Jacob Fork near Chestnut Knob to greater than 20,000 col/100 mL at Jacob Fork near Cooksville, where sampling occurred just after a rain storm. Concentrations were greater than 400 col/100 mL at 10 of the 20 sites. Samples also were analyzed for *Escherichia coli* (*E. coli*), and concentrations ranged from 19 to >20,000 col/100 mL (table 7).

Suspended sediment concentrations ranged from 1 to 466 mg/L (table 7), and generally were below 20 mg/L, except at Jacob Fork near Startown. The water flows over a dam from a drinking-water supply pond onto sand and rocks, resulting in an elevated suspended sediment concentration at this site. Suspended sediment finer than 0.062 mm ranged from 29 to 93 percent and was lowest at Jacob Fork near Chestnut Knob, a pristine forested site at the headwaters of Jacob Fork. Suspended sediment finer than 0.062 mm was 50 percent or greater at the remaining 19 sites.

Table 7. Summary of water-quality data from the South Fork Catawba River Basin, October 1997

[<, less than; mg/L, milligrams per liter; col/100 mL, colonies per 100 milliliters; >, greater than; mm, millimeters]

Constituent	Number of samples	Minimum	Median	Maximum
Ammonia nitrogen (mg/L)	20	<0.015	0.017	0.181
Nitrite-plus-nitrate nitrogen (mg/L)	20	<.050	.362	2.61
Nitrite nitrogen (mg/L)	20	<.010	.010	.039
Dissolved ammonia-plus-organic nitrogen (mg/L)	20	<.20	.20	.56
Total ammonia-plus-organic nitrogen (mg/L)	20	<.20	.21	1.0
Total phosphorus (mg/L)	20	<.010	.090	.377
Dissolved phosphorus (mg/L)	20	<.010	.014	.353
Ortho-phosphorus (mg/L)	20	<.010	.013	.318
Fecal coliform (col/100 mL)	19	22	350	>20,000
E. coli (col/100 mL)	20	19	340	>20,000
Suspended sediment (mg/L)	20	1	7	466
Sediment finer than 0.062 mm (percent)	20	29	81	93

SUMMARY

A study of surface-water quality was conducted in the Santee River Basin and coastal drainages study area as part of the U.S. Geological Survey National Water-Quality Assessment Program. Surface-water samples were collected at 13 fixed sites in North and South Carolina. Indicator sites were chosen to characterize water quality in basins with agricultural, urban, and forested land covers. Large rivers were sampled as integrator sites to characterize water quality in streams with mixed land covers. Additionally, synoptic studies were conducted in two of the fixed-site basins. Water-quality samples were collected during 1995–97.

Nutrient concentrations generally were low in the SANT study area. Ammonia nitrogen concentrations were below 0.320 mg/L in the study area; urban sites had the highest median concentrations, and forested sites had the lowest median ammonia nitrogen concentrations. Nitrite-plus-nitrate concentrations were below 3.50 mg/L, which was lower than the U.S. Environmental Protection Agency maximum contaminant level of 10.0 mg/L. Agricultural sites had the highest median concentrations and forested sites had the lowest median concentrations of nitrite-plus-nitrate nitrogen. Dissolved ammonia-plus-organic nitrogen concentrations were below 1.00 mg/L with the highest concentration detected at the Coosawhatchie River, a blackwater stream. Total ammonia-plus-organic nitrogen concentrations ranged from <0.20 to 2.8 mg/L; concentrations at forested sites were significantly lower compared to sites with other types of land covers.

Median total phosphorus, dissolved phosphorus, and ortho-phosphorus concentrations were highest in the South Fork Catawba River. Some concentrations of total phosphorus exceeded the U.S. Environmental Protection Agency recommended maximum concentration of 0.10 mg/L. Total phosphorus concentrations were significantly lower at forested sites than at sites with other types of land covers. Dissolved phosphorus concentrations were low, indicating that most of the phosphorus was associated with suspended sediment.

Of the 85 pesticides analyzed, 30 were detected at the 13 fixed sites—22 herbicides and 8 insecticides. Three of the fixed sites had only one detection, and Gills Creek, an urban stream, had the most detections (263). The most frequently detected pesticides included simazine, tebuthiuron, atrazine, metolachlor, prometon, diazinon, chlorpyrifos, and malathion. Insecticides such as diazinon, malathion, and parathion were detected almost exclusively at urban sites (Gills Creek and Brushy Creek).

Gills Creek, an urban stream, and Cow Castle Creek, an agricultural stream, were sampled weekly for pesticides, and the Edisto River, an integrator site, was sampled biweekly. Atrazine and tebuthiuron concentrations were significantly higher at Gills Creek than at Cow Castle Creek or the Edisto River. Concentrations of tebuthiuron, atrazine, and simazine were highest in the spring.

Stream samples were analyzed for fecal-indicator bacteria. Nine of 13 fixed sites had fecal coliform concentrations greater than 400 col/100 mL. Concentrations ranged from less than 1 to almost 22,000 col/100 mL and were highest at agricultural sites. Fecal streptococcus concentrations ranged from 2 to over 20,000 col/100 mL and were highest at agricultural sites. Concentrations of fecal coliform and fecal streptococcus were significantly higher during summer than during other seasons.

Suspended sediment concentrations generally were low in the study area. Median concentrations ranged from 3 to 17 mg/L. Concentrations of suspended sediment were significantly higher at urban sites than at sites with other types of land cover. Sites below reservoirs had the highest percentages of sediment finer than 0.062 millimeter.

Two synoptic studies were conducted—the Gills Creek Basin was sampled in September 1996 and the South Fork Catawba River Basin was sampled in October 1997. Nutrients in the Gills Creek Basin generally were low. Ammonia nitrogen concentrations were below the criterion for the protection of aquatic life, and nitrate nitrogen was well below the drinking-water standard. Ten different pesticides were detected above the adjusted minimum reporting level of 0.01 µg/L; one pesticide, diazinon, was detected at concentrations above an aquatic life standard. Fecal coliform concentrations were greater than 400 col/100 mL at 8 of the 16 sites, and concentrations ranged from 37 to 1,700 col/100 mL. Suspended sediment concentrations were low in the Gills Creek Basin ranging from 3 to 17 mg/L.

Nutrient concentrations were slightly higher at sites in the South Fork Catawba River Basin than at sites in the Gills Creek Basin. Ammonia nitrogen concentrations ranged from 0.015 to 0.181 mg/L. Nitrite-plus-nitrate nitrogen concentrations ranged from 0.050 to 2.61 mg/L. Ten of the 20 sites in the South Fork Catawba River Basin had total phosphorus concentrations greater than the U.S. Environmental Protection Agency recommended maximum concentration of 0.10 mg/L for streams not flowing to reservoirs. Fecal coliform concentrations ranged from 22 to greater than 20,000 col/100 mL in the South Fork Catawba River Basin. The highest fecal coliform concentration was found in a sample collected after a rain storm. Suspended sediment concentrations generally were low in the South Fork Catawba River Basin (less than 20 mg/L) except at one site directly below the falls at Jacob Fork near Startown.

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APPENDIX TABLES

Table A-1. Concentrations of nutrients in blank samples, Santee River Basin and coastal drainages study area, 1995–97

[<, less than; concentrations in milligrams per liter]

Date	Ammonia nitrogen	Dissolved ammonia-plus-organic nitrogen	Total ammonia-plus-organic nitrogen	Nitrite nitrogen	Nitrite-plus-nitrate nitrogen	Ortho-phosphorus	Dissolved phosphorus	Total phosphorus
11/30/95	<0.015	<0.20	<0.20	<0.010	<0.050	<0.010	<0.010	<0.010
12/04/95	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
12/05/95	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
02/05/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
02/21/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
02/28/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
03/11/96	.030	<.20	<.20	<.010	<.050	<.010	<.010	<.010
03/20/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
04/15/96	<.015	<.20	<.20	<.010	.080	.010	<.010	<.010
04/23/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
04/24/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
05/02/96	.030	<.20	<.20	<.010	<.050	<.010	<.010	<.010
05/06/96	.020	<.20	<.20	<.010	<.050	<.010	<.010	<.010
05/15/96	.110	<.20	<.20	<.010	.120	<.010	<.010	<.010
06/04/96	.020	<.20	<.20	<.010	.100	<.010	.010	<.010
06/18/96	.020	<.20	<.20	<.010	<.050	<.010	<.010	<.010
07/22/96	.030	<.20	<.20	<.010	.090	<.010	<.010	<.010
07/29/96	<.020	<.20	<.20	<.010	.050	.010	<.010	<.010
08/05/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	.010
08/12/96	<.020	<.20	<.20	<.010	.060	<.010	<.010	<.010
08/12/96	<.020	<.20	<.20	.060	.060	<.010	<.010	<.010
08/19/96	.020	<.20	<.20	.010	<.050	.010	<.010	<.010
08/29/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
09/03/96	<.015	<.20	<.20	<.010	.050	<.010	.020	.020
09/11/96	<.015	<.20	<.20	<.010	.060	<.010	.020	<.010
09/17/96	<.015	<.20	<.20	.020	.060	<.010	<.010	<.010
09/18/96	<.015	<.20	<.20	<.010	.050	<.010	.020	<.010
09/19/96	<.015	<.20	<.20	.010	.070	.010	.020	.020
09/25/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
10/24/96	.020	<.20	<.20	<.010	<.050	<.010	<.010	<.010
10/24/96	.020	<.20	<.20	<.010	<.050	<.010	<.010	<.010
10/24/96	.020	<.20	<.20	<.010	<.050	<.010	<.010	<.010
10/29/96	<.015	<.20	<.20	.010	<.050	<.010	<.010	<.010
10/30/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
11/06/96	<.015	<.20	<.20	.010	<.050	<.010	<.010	<.010

Table A-1. Concentrations of nutrients in blank samples, Santee River Basin and coastal drainages study area, 1995–97—Continued

[<, less than; concentrations in milligrams per liter]

Date	Ammonia nitrogen	Dissolved ammonia-plus-organic nitrogen	Total ammonia-plus-organic nitrogen	Nitrite nitrogen	Nitrite-plus-nitrate nitrogen	Ortho-phosphorus	Dissolved phosphorus	Total phosphorus
11/19/96	<0.015	<0.20	<0.20	<0.010	<0.050	<0.010	<0.010	0.020
11/20/96	.020	<.20	<.20	<.010	<.050	<.010	<.010	<.010
12/04/96	.020	<.20	<.20	<.010	<.050	.010	<.010	<.010
12/10/96	.020	<.20	<.20	<.010	<.050	<.010	<.010	<.010
12/16/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	.020
12/16/96	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
01/07/97	.020	<.20	<.20	.020	<.050	<.010	<.010	<.010
01/13/97	<.015	<.20	<.20	.010	<.050	<.010	<.010	.010
01/27/97	<.015	<.20	<.20	<.010	.060	<.010	<.010	<.010
02/03/97	<.015	<.20	<.20	.010	<.050	<.010	<.010	<.010
02/03/97	<.002	<.20	<.20	<.001	<.005	<.001	<.001	<.001
02/19/97	<.015	<.20	<.20	.020	<.050	<.010	<.010	<.010
03/10/97	<.015	<.20	<.20	<.010	.070	<.010	.020	.050
03/17/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
03/25/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	.010
03/26/97	<.002	<.20	<.20	<.001	<.005	<.001	<.001	<.001
04/22/97	.080	<.20	<.20	<.010	<.050	<.010	<.010	<.010
04/25/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	.012
05/01/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
05/05/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
05/12/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
06/02/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
06/09/97	.018	<.20	<.20	<.010	<.050	<.010	<.010	<.010
06/30/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
06/30/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
07/02/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
07/08/97	<.015	<.20	<.20	<.010	<.050	.010	<.010	.053
07/30/97	.003	<.20	<.20	.003	.008	.001	<.001	<.001
08/13/97	<.015	<.20	.29	<.010	<.050	<.010	<.010	.017
08/14/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
08/15/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
09/03/97	<.002	<.20	<.20	<.001	<.005	.001	<.001	<.001
09/29/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.010
10/06/97	<.015	<.20	<.20	<.010	<.050	<.010	<.010	<.001

Table A-2. Concentrations of nutrients in replicate samples, Santee River Basin and coastal drainages study area, 1995–97

[<, less than; concentrations in milligrams per liter]

Parameter	2/13/96		3/27/96		6/12/96	
	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
Ammonia nitrogen	<0.015	0.020	0.020	0.020	0.070	0.030
Nitrite-plus-nitrate nitrogen	2.20	2.20	2.00	2.00	1.70	1.60
Nitrite nitrogen	<.010	<.010	<.010	<.010	.020	.030
Dissolved ammonia-plus-organic nitrogen	<.20	<.20	<.20	<.20	<.20	<.20
Total ammonia-plus-organic nitrogen	.30	.30	<.20	<.20	.30	.30
Total phosphorus	.020	.040	<.010	<.010	.010	.020
Dissolved phosphorus	.010	.020	.010	.020	.010	.020
Ortho-phosphorus	<.010	<.010	.020	.020	.020	<.010

Table A-3. Concentrations of pesticides in replicate samples, Santee River Basin and coastal drainages study area, 1995–97

[<, less than; concentrations in micrograms per liter; E, estimated]

Parameter	6/17/96		1/21/96		2/13/96		3/27/96		5/17/96	
	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
Acetochlor	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Alachlor	E.003	E.002	<.002	<.002	.017	.017	.013	.012	.007	.008
Deethylatrazine	E.0085	E.0095	E.0058	E.0060	E.0020	<.0020	E.0030	E.0040	E.0060	E.0073
Atrazine	.129	.127	.015	.016	.005	.005	.010	.010	.031	.033
Methylazinphos	<.0010	<.0010	<.0010	<.0010	<.0010	<.0010	<.0010	<.0010	<.0010	<.0010
Benfluralin	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020
Butylate	<.0030	<.0030	<.0020	<.0020	<.0020	<.0020	.0080	.0070	<.0020	<.0020
Carbaryl	<.0030	<.0030	E.0181	E.0189	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030
Carbofuran	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030
Chlorpyrifos	.0098	.0107	.0063	.0066	.0250	.0280	.0110	.0100	.0083	.0082
Cyanazine	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040
DCPA	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020
p,p'-DDE	<.0060	<.0060	<.0060	<.0060	<.0060	<.0060	<.0060	<.0060	E.0014	<.0060
Diazinon	.025	.032	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
Dieldrin	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
2,6-Diethylaniline	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030
Disulfoton	<.0170	<.0170	<.0170	<.0170	<.0170	<.0170	<.0170	<.0170	<.0170	<.0170
EPTC	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	E.0030	E.0020	<.0020	<.0020
Ethalfluralin	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040
Ethoprop	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030
Fonofos	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030
α-BHC	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020
Lindane	<.004	<.004	<.004	<.004	<.004	<.004	<.004	<.004	<.004	<.004
Linuron	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020
Malathion	.012	.029	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Methyl parathion	<.0060	<.0060	<.0060	<.0060	<.0060	<.0060	<.0060	<.0060	<.0060	<.0060
Metolachlor	.005	.005	<.002	<.002	.019	.018	.016	.015	.447	.446
Metribuzin	<.004	<.004	<.004	<.004	<.004	<.004	<.004	<.004	<.004	<.004
Molinate	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040
Napropamide	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030
Parathion	<.004	<.004	<.004	<.004	<.004	<.004	<.004	<.004	<.004	<.004
Pebulate	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040
Pendimethalin	.0343	.0394	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040

Table A-3. Concentrations of pesticides in replicate samples, Santee River Basin and coastal drainages study area, 1995–97—Continued

[<, less than; concentrations in micrograms per liter; E, estimated]

Parameter	6/17/96		1/21/96		2/13/96		3/27/96		5/17/96	
	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
cis-Permethrin	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Phorate	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020
Pronamide	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030	<.0030
Prometon	.0346	.0347	E.0065	E.0088	E.0040	E.0040	E.0060	E.0040	E.0066	E.0081
Propchlor	<.0070	<.0070	<.0070	<.0070	<.0070	<.0070	<.0070	<.0070	<.0070	<.0070
Propanil	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040	<.0040
Propargite	<.0130	<.0130	<.0130	<.0130	<.0130	<.0130	<.0130	<.0130	<.0130	<.0130
Simazine	.0923	.0939	.110	.22	.160	.150	.300	.270	.192	.194
Thiobencarb	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020
Tebuthiuron	.0459	.0502	E.0450	E.0494	.0200	.0180	.0170	.0140	.0192	.0211
Terbacil	<.0260	<.0240	<.0070	<.0070	<.0070	<.0070	<.0070	<.0070	<.0070	<.0070
Terbofos	<.0130	<.0130	<.0130	<.0130	<.0130	<.0130	<.0130	<.0130	<.0130	<.0130
Triallate	<.0010	<.0010	<.0010	<.0010	<.0010	<.0010	<.0010	<.0010	<.0010	<.0010
Trifluralin	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020	<.0020

Table A-4. Parameter codes and minimum reporting levels for Schedule 2001 pesticides

[units in micrograms per liter]

Constituent	Mimimun reporting level
2,6-Diethylaniline	0.003
Acetochlor	.002
Alachlor	.002
Atrazine	.001
Azinphos-methyl	.001
Benfluralin	.002
Butylate	.002
Carbaryl	.003
Carbofuran	.003
Chlorpyrifos	.004
Cyanazine	.004
DCPA	.002
Deethylatrazine	.002
Diazinon	.002
Dieldrin	.001
Disulfoton	.017
EPTC	.002
Ethalfluralin	.004
Ethoprophos	.003
Fonofos	.003
Lindane	.004
Linuron	.002
Malathion	.005
Methyl parathion	.006
Metolachlor	.002
Metribuzin	.004
Molinate	.004
Napropamide	.003
Parathion	.004
Pebulate	.004
Pendimethalin	.004
Phorate	.002
Prometon	.018
Propachlor	.007
Propanil	.004
Propargite	.013
Pronamide	.003
Simazine	.005
Tebuthiuron	.010
Terbacil	.007
Terbufos	.013
Thiobencarb	.002
Tri-allate	.001
Trifluralin	.002
alpha-HCH	.002
cis-Permethrin	.005
p,p'-DDE	.006

Table A-5. Parameter codes and minimum reporting levels for Schedule 2050 pesticides

[units in micrograms per liter]

Constituent	Minimum reporting level
2,4,5-T	0.035
2,4-D	.035
2,4-DB	.035
Acifluoren	.035
Aldicarb	.016
Aldicarb sulfoxide	.021
Aldicarb sulfone	.016
Bentazon	.014
Bromacil	.035
Bromoxynil	.035
Carbaryl	.008
Carbofuran	.028
Chlorpyralid	.050
Chloramben	.011
Chlorothalonil	.035
Dacthal monacid	.017
Dicamba	.035
Dichlobenil	.020
Dichlorprop	.032
Dinoseb	.035
Diuron	.020
DNOC	.035
Esfenvalerate	.019
Fenuron	.013
Fluometuron	.035
3-Hydroxycarbofuran	.014
Linuron	.018
MCPA	.050
MCPB	.035
Methiocarb	.026
Methomyl	.017
1-Naphthol	.007
Neburon	.015
Norflurazon	.024
Oryzalin	.019
Oxamyl	.018
Picloram	.050
Propoxur	.035
Propham	.035
Silvex	.021
Triclopyr	.050

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