WATER QUALITY OF SELECTED STREAMS IN BALDWIN COUNTY, ALABAMA, SEPTEMBER 1994-APRIL 1996

By Will S. Mooty, J.L. Pearman, Richard S. Moreland, and Amy E. Clark

---

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 96-4136

Prepared in cooperation with the
BALDWIN COUNTY COMMISSION

Montgomery, Alabama
1996

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

For additional information write to:

District Chief
U.S. Geological Survey
2350 Fairlane Dr., Suite 120
Montgomery, AL 36116

Copies of this report may be purchased from:

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver, CO 80225-0286

CONTENTS

Abstract 1
Introduction 2
    Purpose and scope 2
    Climate and precipitation 2
    Physical features 2
Data collection 5
    Synoptic survey 5
    Fixed-station sampling sites 6
Water quality 13
    Physical and chemical properties 14
    Nutrients 21
    Minor constituents 24
    Pesticides 29
    Fecal coliform bacteria 32
Summary 32
References 34

FIGURES

1-6. Map showing:

1. Locations of synoptic survey water-quality sampling sites and wastewater treatment plant discharges in Baldwin County, Alabama 3
2. Land uses in Baldwin County.. 4
3. Specific conductance and pH measurements at synoptic sampling sites in Baldwin County, Alabama, September 1994........................... 7
4. Total phosphorus and total nitrate (as N) concentrations at synoptic sampling sites in Baldwin County, Alabama, September 1994 8
5. Biochemical oxygen demand and alkalinity concentrations at synoptic sampling sites in Baldwin County, Alabama, September 1994............. 9
6. Fecal coliform and fecal streptococci counts at synoptic sampling sites in Baldwin County, Alabama, September 1994........................... 10

7-17. Boxplot showing:

7. Distribution of water-temperature measurements at fixed-station sampling sites in Baldwin County, September 1994-April 1996 16
8. Distribution of pH measurements at fixed-station sampling sites in Baldwin County, September 1994-April 1996.................................... 17
9. Distrbution of specific conductance measurements at fixed-station sampling sites in Baldwin County, September 1994-April 1996 19
10. Distribution of dissolved oxygen concentrations at fixed-station sampling sites in Baldwin County, September 1994-April 1996 20
11. Distribution of instantaneous yields for ammonia and organic nitrogen at fixed-station sampling sites in Baldwin County, September 1994-April 1996. 22
12. Distribution of instantaneous yields for nitrite and nitrate nitrogen at fixed-station sampling sites in Baldwin County, September 1994-April 1996...... 23
13. Distribution of instantaneous yields for phosphorus at fixed-station sampling sites in Baldwin County, September 1994-April 1996 25
14. Measurements of dissolved barium concentrations at fixed-station sampling sites in Baldwin County, September 1994-April 1996 26
15. Measurements of dissolved copper concentrations at fixed-station sampling siites in Baldwin County, September 1994-April 1996.................. 27
16. Measurements of dissolved iron concentrations at fixed-station sampling sites in Baldwin County, September 1994-1996 28
17. Measurements of dissolved zinc concentrations at fixed-station sampling sites in Baldwin County, September 1994-April 1996 30
18. Distribution of fecal coliform and fecal streptococci concentrations at fixed-station sampling sites in Baldwin County, September 1994-April 1996...... 31

TABLES

1. Monthly and annual mean rainfall at stations in Baldwin County, Alabama, 1961-90 5
2. Synoptic and fixed-station water-quality sampling sites in Baldwin County, Alabama, 1994-96 11
3. Field measurements at synoptic sampling sites in Baldwin County, Alabama .... in back
4. Laboratory analyses of water samples from synoptic-sampling sites in Baldwin County, Alabama .... in back
5. Water-quality constituents and physical properties sampled at fixed-station sampling sites in Baldwin County, Alabama 12
6. Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 .... in back
7. Water-quality criteria for Alabama waters 15

***Sea level:** In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order nets of both the United States and Canada, formerly called Sea Level Datum of 1929.*

WATER-QUALITY OF SELECTED STREAMS IN BALDWIN COUNTY, ALABAMA, SEPTEMBER 1994 - APRIL 1996

By Will S. Mooty, J.L. Pearman, Richard S. Moreland, and Amy E. Clark

ABSTRACT

Point and non-point sources of pollution were evaluated during 1994 and 1996 for their affects on streams in Baldwin County. A synoptic water-quality survey of 32 stream sites was conducted first followed by periodic sampling at 8 of these sites. The synoptic survey indicated no significant point sources of pollution at the time of sampling. Analysis of the synoptic and periodic (fixed-stations) sampling site data shows marked difference in some constituents between northern and southern parts of the county. There is significantly more urban growth and agricultural activity in the southern part of the county than in the northern part.

The streams that were sampled in Baldwin County were poorly buffered and slightly acidic. Measurements of pH at the fixed-station sites ranged from a high of 6.9 at Blackwater River to a low of 4.4 at Majors Creek. The generally low pH values are the result of the poor buffering capacity of the soils and water in Baldwin County and also due to the presence of natural organic acids such as tannin.

One sample from the Blackwater River contained a dissolved-oxygen concentration of 5.0 milligrams per liter. This was the only measurement for dissolved oxygen of all of the fixed-station sites that was below the minimum concentration set by the Alabama Department of Environmental Management for public-water supply, swimming, and fish and wildlife uses of water.

All dissolved-solids concentrations were well below the recommended maximum concentration of 500 milligrams per liter for drinking water. The maximum measurement for dissolved solids was 58 milligrams per liter at Magnolia River.

Ammonia and organic nitrogen yields seem to be consistent across the county indicating that the ammonia and organic nitrogen that is being released into the streams is near equilibrium with the processes converting this form of nitrogen into other forms such as nitrite and nitrate. Measurements of nitrate nitrogen show increased levels in basins with higher percentages of agricultural activity and urban areas. Majors Creek, the basin with the least agricultural activity and urban area had levels of nitrate nitrogen ranging from 0.01 to 0.06 milligrams per liter. Magnolia River, a basin with a higher percentage of agricultural activity and urban area had levels of nitrate nitrogen ranging from 1.79 to 3.1 milligrams per liter.

One sample for pesticides was collected at each of three sites; Sandy Creek, Magnolia River, and Blackwater River. The only detections were for atrazine at all three sites and simazine at Sandy Creek and Blackwater River. The sites sampled for pesticides were chosen because of the relatively high degree of agricultural activity in the basin.

Of the eight fixed-station sites, only Sandy Creek had median concentrations of fecal coliform bacteria greater than 200 colonies per 100 milliliters, the maximum allowable level for swimming and whole-body contact waters as set by Alabama Department of Environmental Management. All eight sites have some measurements above 200 colonies per 100 milliliters but none above the drinking-water limit of 2,000 colonies per 100 milliliters.

INTRODUCTION

Baldwin County is one of two Alabama counties that lie on the Gulf of Mexico (fig. 1). It is the largest county in Alabama in terms of land area at 1,613 square miles. Mobile Bay borders the western side of the county and Florida borders much of the eastern side. The proximity of Baldwin County to the Gulf of Mexico and Mobile Bay has made tourism a large and growing industry in the county. Readily available ground water for irrigation and relatively flat land have also made agriculture a large industry in the county. Tourism, with its associated urban development, and agriculture demand large quantities of water. Baldwin County has extensive aquifer systems capable of producing the water necessary for the growing county's needs at the present time (James Robinson, oral commun., 1996).

In 1994, county managers began an evaluation of the ground-water and surface-water resources within Baldwin County. As land uses change with urban development and agriculture, these changes can sometimes be significant to the water resources. County managers needed information on the current condition of the water resources in the county to determine whether or not the waters of the county had been affected and to assist in water-resources management planning

In September 1994, the U.S. Geological Survey (USGS) entered a cooperative agreement with the Baldwin County Commission to determine if the water quality of selected streams had been affected by agricultural activities or by the growth of urbanization in the county.

Purpose and Scope

This report describes the quality of water in freshwater streams in Baldwin County. The water-quality data collected can serve as a baseline of data to help evaluate changes occurring to the quality of water in the streams. Date were collected from 1994 to 1996.

The investigation consisted of (1) a synoptic survey of water quality at 32 surface-water sites in Baldwin County, and (2) periodic sampling at 8 of the 32 synoptic sites for a period of about 1 year. The eight sites represent the major land uses within the county.

Climate and Precipitation

Baldwin County has a subtropical climate characterized by warm, humid summers and mild winters. Precipitation usually occurs in the form of rainfall. The average annual precipitation is about 66 inches with July and August being the wettest months and October and November the driest months. Table 1 lists monthly mean rainfall and annual mean rainfall at three rainfall stations in Baldwin County. The values in the table are based on National Weather Service data for the standard 30-year reference period of 1961-90 (U.S. Department of Commerce, 1961-90).

Physical Features

Topography and land use change from northern to southern parts of the county. Elevations in the northern part of the county are nearly 300 feet above sea level. This area is characterized by rolling hills, moderately incised streams, and sediments consisting of clay, sand, and sandy clay. The southern part of the county is relatively flat and lower in elevation and has sediments consisting of gravelly sand, clay, and sandy clay (Reed, 1971). Pine and hardwood forests dominate the northern part of the county, and cropland, pastures, and urban and residential development are prevalent in the southern part (fig. 2).

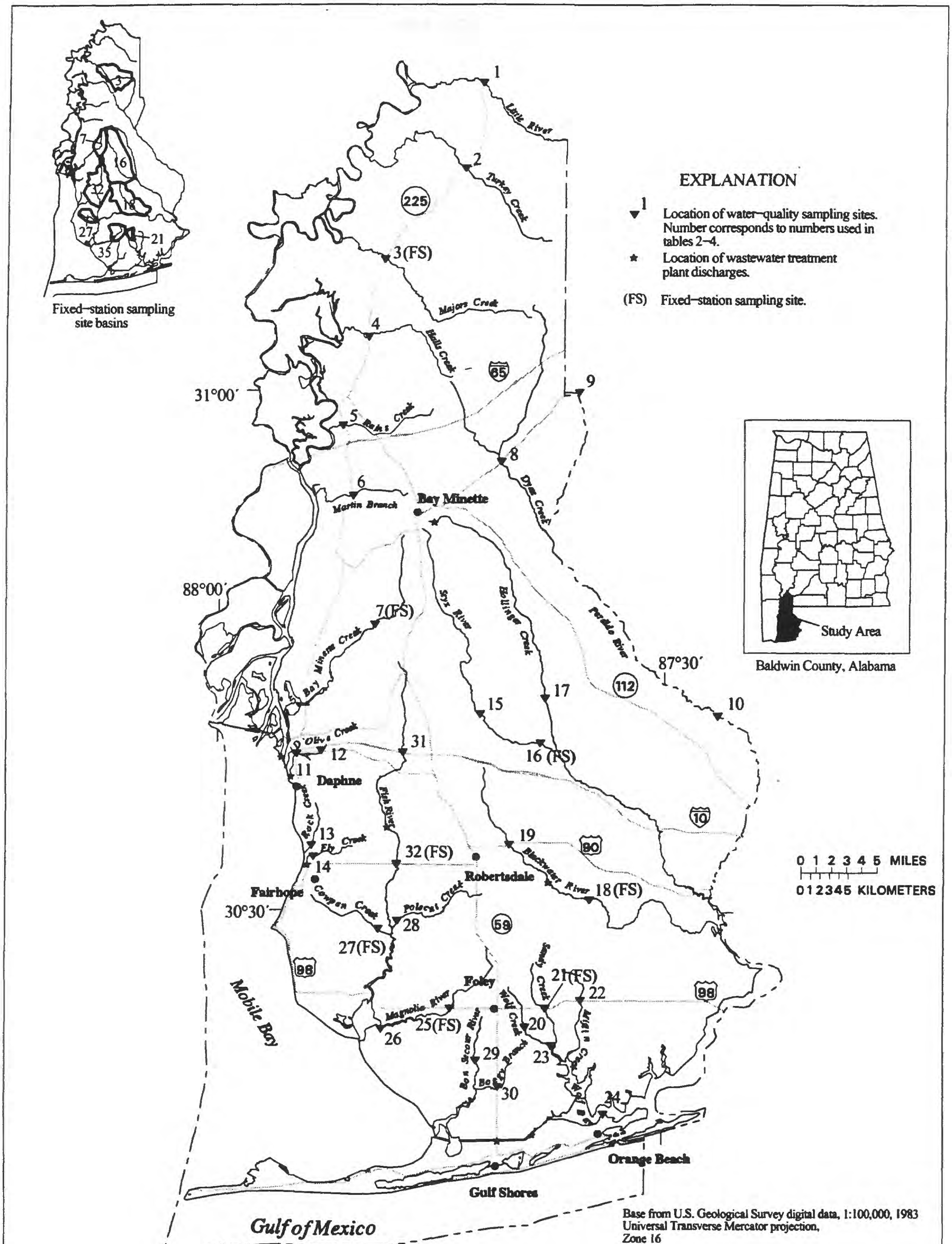

Figure 1.—Locations of synoptic survey water-quality sampling sites and wastewater treatment plant discharges in Baldwin County, Alabama.

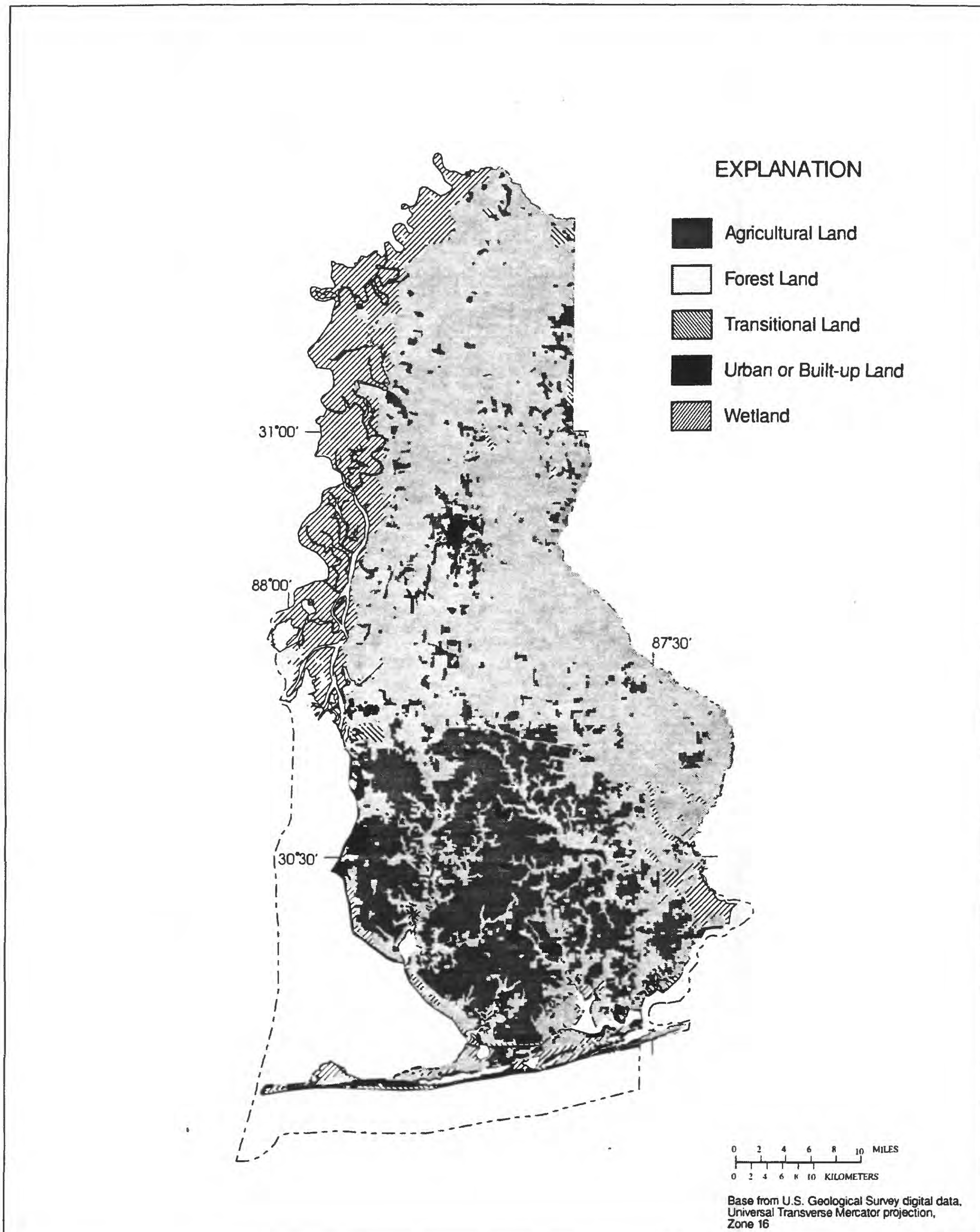

Figure 2. Land uses in Baldwin County.

Table 1.--Monthly and annual mean rainfall at stations in Baldwin County, Alabama, 1961-90 (U.S. Department of Commerce, 1961-90)

	Bay Minette (inches)	Robertsdale (inches)	Fairhope (inches)
January	5.37	5.23	5.01
February	5.72	5.86	6.06
March	6.62	6.12	6.08
April	4.52	4.48	4.13
May	5.44	4.98	5.36
June	5.79	5.98	6.56
July	7.75	7.39	7.29
August	6.56	7.50	6.66
September	5.40	5.86	5.65
October	3.08	3.58	3.18
November	4.40	4.57	4.30

Streams in Baldwin County vary from sand and gravel bottoms in swifter flowing streams in northern parts of the county to sluggish tidal streams with silty bottoms along the coast. The largest stream is the Perdido River (fig. 1) along the eastern border with a drainage area of 394 square miles and an average discharge of 771 cubic feet per second (Pearman and others, 1995). The largest stream with its drainage basin completely within the county is Styx River. Styx River has a drainage area of 192 square miles and an average discharge of 460 cubic feet per second near its mouth.

DATA COLLECTION

Sampling trips were made for the measure-ment of field water-quality characteristics and for the collection of water samples to be sent to USGS laboratories for further analysis. Field measurements included stream discharge, water temperature, dissolved oxygen, pH, specific conductance, bio-chemical oxygen demand (BOD), alkalinity, fecal coliform and fecal streptococci bacteria. Samples sent to the USGS Water Quality Service Unit in Ocala, Florida were analyzed for nutrients, chemical oxygen demand (COD), total organic carbon (TOC), turbidity, and total suspended solids. Additional samples were collected to analyze for minor constituents and total dissolved solids. A single sample was collected at three of the sites for analysis of a wide range of pesticides. All data collection procedures conformed to standard USGS protocol which included depth and width integrated sampling as well as using techniques to minimize contamination of water samples (Shelton, 1994).

Synoptic Survey

In Baldwin County, there are no permitted major industrial discharges of wastewater to streams. The permitted large discharges from wastewater treatment plants (WWTP) in Baldwin County are to Mobile Bay, the Intercoastal Canal, and Perdido Bay (fig. 1). Discharges to freshwater streams from WWTPs in Baldwin County are relatively small. To determine whether or not these discharges or other point sources of pollution were significantly affecting streams in the county, a synoptic sampling survey was conducted. Water samples from 32 sites were collected and analyzed for turbidity, nutrients, BOD, and total organic carbon. Field measurements collected at the time of sampling included stream discharge, water temperature, specific conductance, dissolved oxygen, pH, alkalinity, fecal coliform bacteria, and fecal streptococci bacteria. Sampling sites and data from this survey are shown in figures 1, 3-6 and listed in tables 2-4. Water samples were collected above and below WWTP discharge points, where possible, in addition to numerous other sites around the county. The sites represent drainage contribution from the major types of land use in the county.

Streamflow conditions at the time of the synoptic sampling, September 1994, were at medium baseflow. Baseflow occurs when there is no surface runoff and the flow in the streams is from ground water discharge. Rainfall was above average during the summer months of June, July, and August. Three-month rainfall totals at Bay Minette, Robertsdale, and Fairhope were 18.58, 27.26, and 24.75 inches, respectively. Therefore, streamflow during September was at medium baseflow instead of more typical low baseflow conditions as reflected by long-term gaging station records from Styx and Perdido Rivers. Discharge measurements were made at the time of water-quality sampling at all sites except 11, 23, 24, and 26 which are tidally influenced.

Fixed-Station Sampling Sites

Based on data from the synoptic survey, fixed-station sampling sites were selected for monthly, quarterly, and annual sampling. Nearly 60 constituents and physical properties were analyzed for each sample (table 5) and include physical and chemical properties, nutrients, minor constituents, pesticides, and bacteria. Initially, six fixed-station sites were chosen for monthly sampling (fig. 1). These sites represented the major land uses within Baldwin County. Later in the project, two additional sampling sites were established on Fish River and Cowpen Creek to expand the documentation of water quality in the county.

Site 3, Majors Creek, has a drainage area of approximately 44.4 square miles. The basin represents an area that has had relatively little development. Much of the basin is forested. Water-quality data from this site should represent nearly pristine streamwater in conditions Baldwin County.

Site 7, Bay Minette Creek, has a drainage area of approximately 19.5 square miles. The basin has a slight degree, less than 10 percent, of urbanization and agriculture but the majority is forested.

Site 16, Styx River, has a drainage area of approximately 92.2 square miles, making it the largest basin of the fixed-station sampling sites. The basin has a small percentage of agricultural activity. The remainder of the basin is forested.

Site 18, Blackwater River, has a drainage area of approximately 56.6 square miles. The basin has a small percentage of urbanization. About 75 percent of the basin is used for agriculture.

Site 21, Sandy Creek, has a drainage area of approximately 5.70 square miles, the smallest of the fixed-station sampling sites. Agricultural practices cover about 50 percent of the basin. Sampling at Sandy Creek was discontinued when sampling began at Fish River.

Site 25, Magnolia River, has a drainage area of approximately 16.6 square miles. Land use in the basin is approximately 5 percent urban, 85 percent agriculture, and 10 percent forested.

Site 27, Cowpen Creek, has a drainage area of approximately 12.0 square miles. About 10 percent of the basin is urban and this percentage is increasing. Cowpen Creek was not one of the original fixed-station sampling sites, but sampling was begun at the site in late 1995 to document streamwater quality in this rapidly changing basin.

Site 32, Fish River, has a drainage area of approximately 55.3 square miles. Land use in the basin is approximately 5 percent urban, 25 percent agriculture, and 70 percent forested. Fish River was not chosen as one of the original fixed-station sampling sites because it

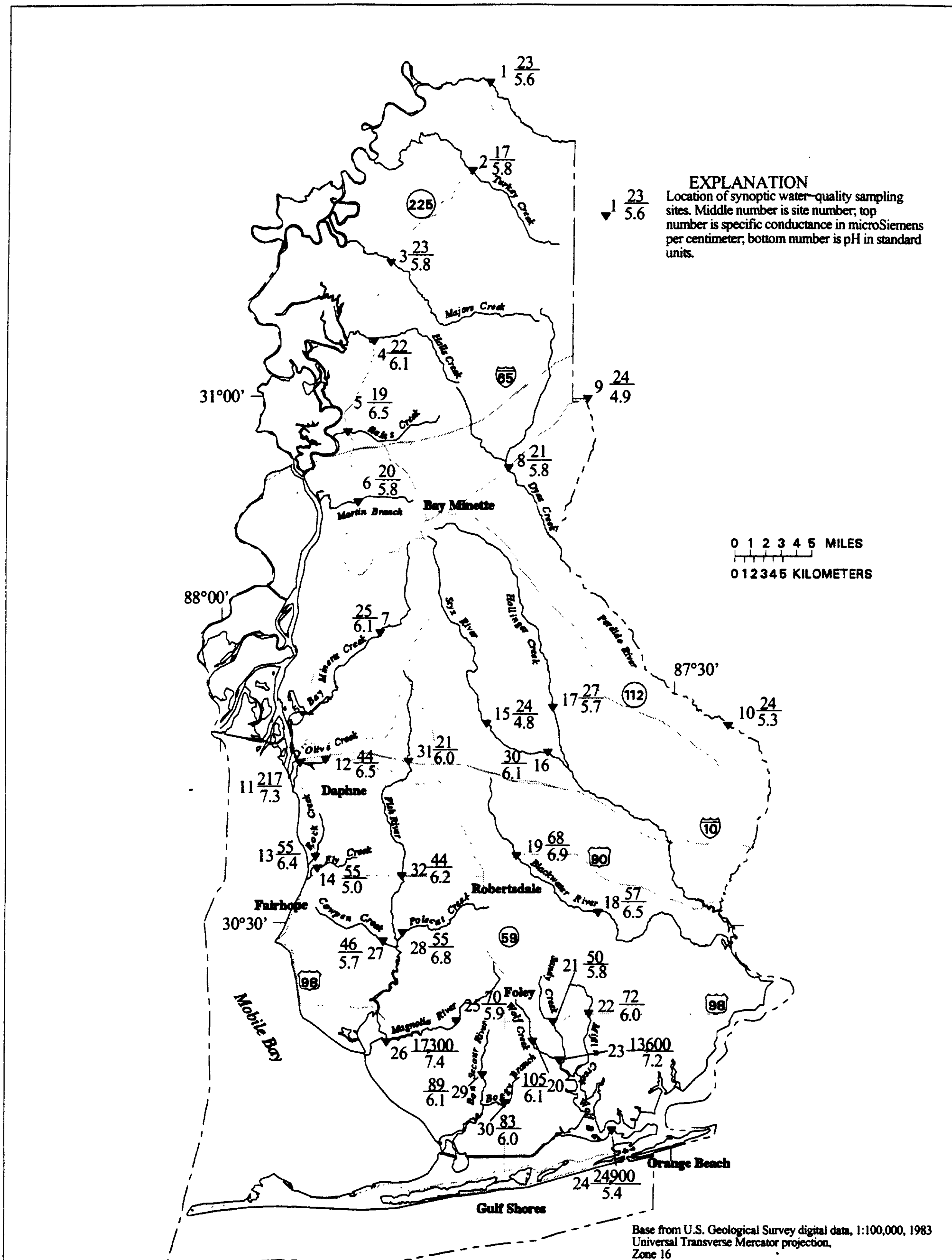

Figure 3.—Specific conductance and pH measurements at synoptic sampling sites in Baldwin County, Alabama, September 1994.

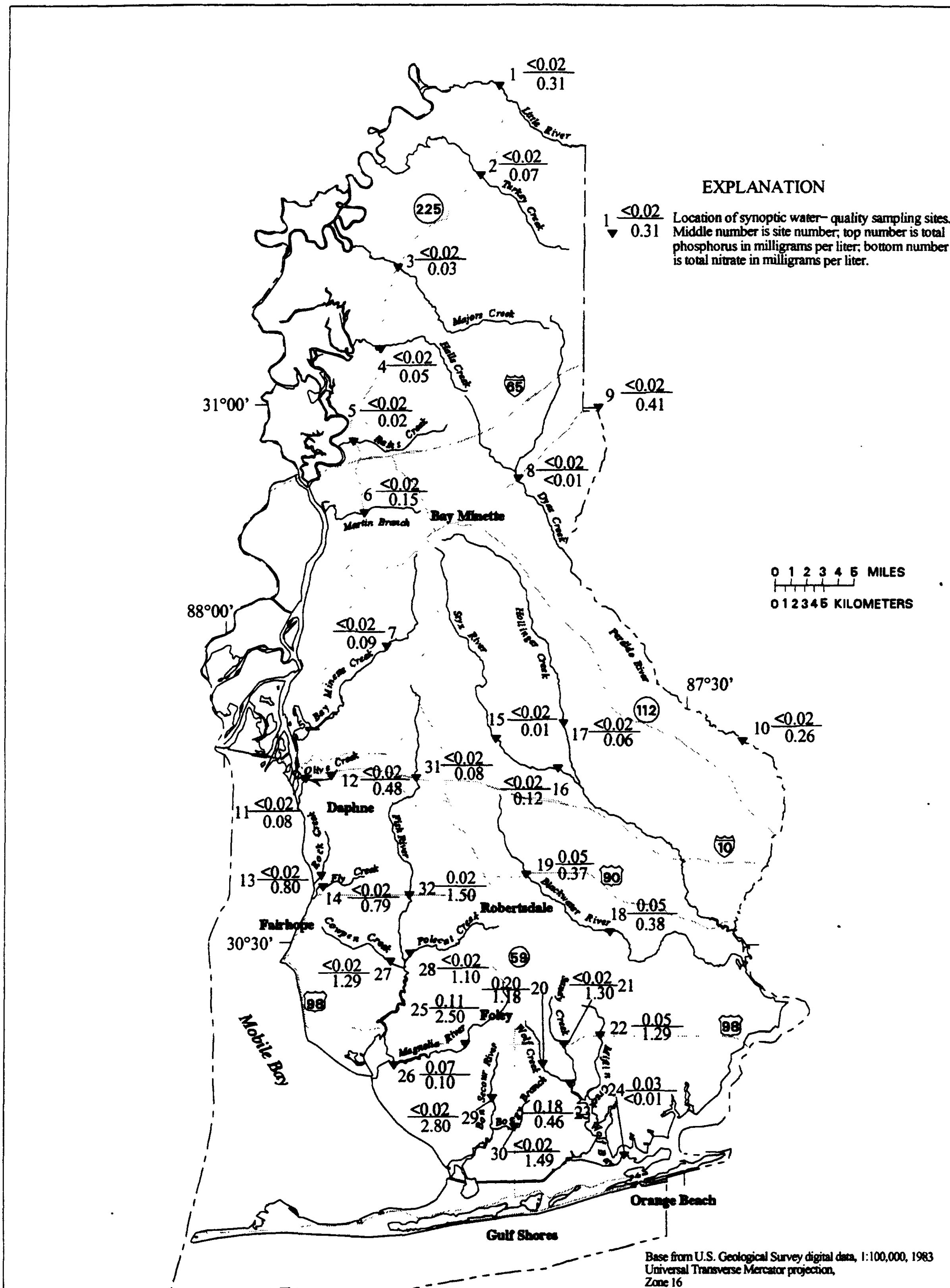

Figure 4.—Total phosphorus and total nitrate (as N) concentrations at synoptic sampling sites in Baldwin County, Alabama, September 1994

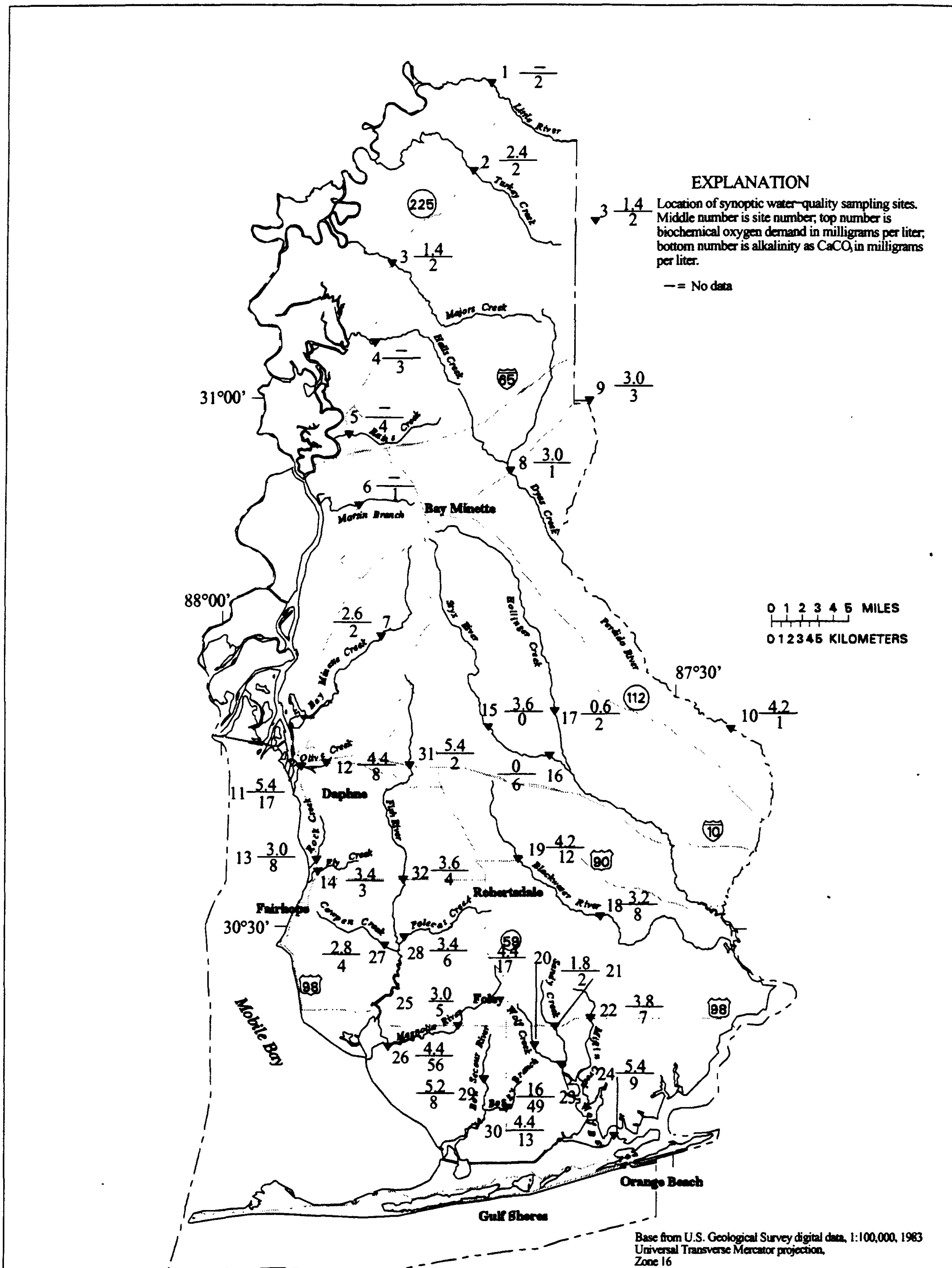

Figure 5.—Biochemical oxygen demand and alkalinity concentrations at synoptic sampling sites in Baldwin County, Alabama, September 1994.

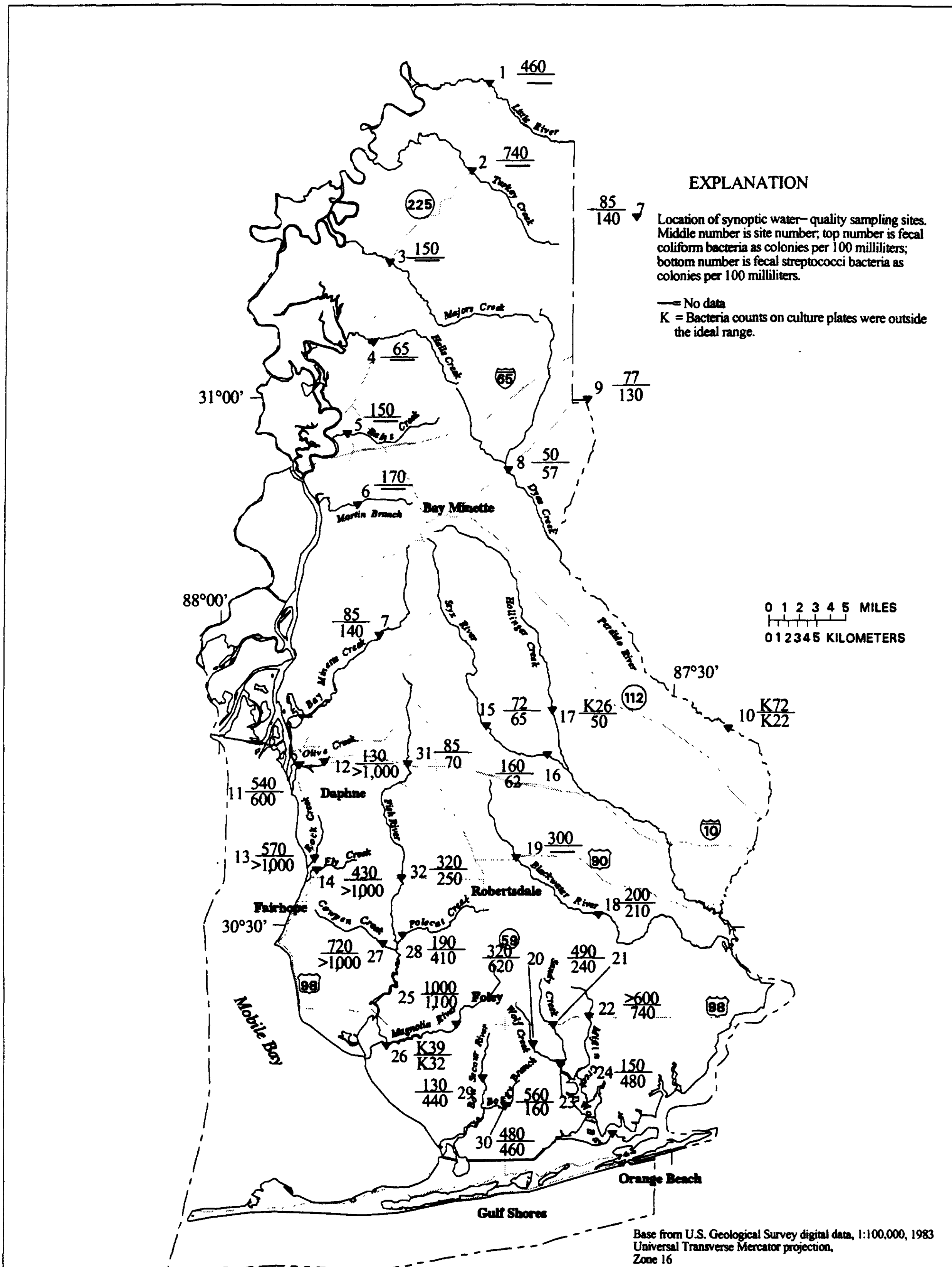

Figure 6.—Fecal coliform and fecal streptococci counts at synoptic sampling sites in Baldwin County, Alabama, September 1994.

Table 2.--Synoptic and fixed-station water-quality sampling sites in Baldwin County, Alabama, 1994-96
[FS, fixed-station site; A, agriculture; F, forest; U, urban; W, wetland; T, transmitional (logging or clearing for construction)]

Site number (figure 1)	Station number	Station name	Drainage area (square miles)	Dominate land-use type
1	02429605	Little River at State Highway 59 near Little River	137	F
2	02429628	Turkey Creek at State Highway 59 near Blacksher	19.5	F
3 (FS)	02429650	Majors Creek at State Highway 59 near Tensaw	44.4	F
4	02471025	Halls Creek at State Highway 59 near Latham	19.6	F
5	0247102810	Rains Creek at State Highway 59 near Stockton	18.0	F
6	02471030	Martin Branch at State Highway 225 below Stockton	6.23	F,A,U
7 (FS)	02471035	Bay Minette Creek at County Road 39 near Stapleton	19.5	F,U
8	02376240	Dyas Creek at US 31 near Dyas	57.5	F
9	02376220	Perdido River at US 31 near Atmore	44.9	F,T,A
10	02376500	Perdido River near Barrineau Park, Fla.	394	F
11	02378800	D'Olive Creek at US 98 near Daphne	13.3	F,T,U
12	02378770	D'Olive Creek at US 90 near Bridgehead	2.37	F,U
13	02378600	Rock Creek at US 98 near Fairhope	4.07	F,A,U
14	02378590	Fly Creek at US 98 near Fairhope	6.83	A,U
15	02377300	Styx River at Brady Road below Stapleton	49.7	F
16 (FS)	02377500	Styx River near Loxley	92.2	F
17	02377540	Hollinger Creek at county road near Stapleton	44.7	F
18 (FS)	02377960	Blackwater River at County Road 87 near Elsanor	56.6	A
19	02377920	Blackwater River at US 90 ner Robertsdale	23.1	A
20	02378160	Wolf Creek near Elberta	4.98	A,U
21 (FS)	02378150	Sandy Creek at US 98 near Elberta	5.70	F,A,U
22	02378177	Miflin Creek at US 98 at Elberta	3.99	A
23	02378176	Wolf Creek near Miflin	10.3	F,A,U
24	0237817725	Wolf Bay at Orange Beach	--	W
25 (FS)	02378300	Magnolia River at US 98 near Magnolia Springs	16.6	A,U
26	02378330	Magnolia River near mouth at Weeks Bay	--	A,U
27 (FS)	02378540	Cowpen Creek near Clay City	12.0	A,U
28	02378530	Polecat Creek at County Road near Marlow	29.3	F,A,U
29	02378195	Bon Secour River at County Road 12 near Foley	9.78	A
30	0237819550	Boggy Branch at State Highway 59 near Gulf Shores	3.44	A,U
31	02378375	Fish River at I-10 near Loxley	10.6	F
32 (FS)	02378500	Fish River at State Highway 104 near Silverhill	55.3	F,A

Table 5.--Water-quality constituents and physical properties sampled at fixed-station sampling sites in Baldwin County, Alabama

[M, sampled monthly; Q, sampled quarterly; A, sampled annually]

Water temperature (M)
Stream discharge (M)
Turbidity (M)
Specific conductance (M)
Dissolved oxygen (M)
Biochemical oxygen demand (M)
Chemical oxygen demand (M)
pH (M)
Alkalinity (M)
Total suspended solids (M)
Total dissolved solids (M)
Nutrients (nitrogen and phosphorus) (M)
Total organic carbon (M)
Minor constituents (Q)
- Cyanide
- Arsenic
- Barium
- Cadmium
- Chromium
- Copper
- Iron
- Lead
- Mercury
- Nickel
- Selenium
- Zinc

Pesticides (A)

Triazine herbicides	Carbamothiate herbicides	Miscellaneous pesticides
Propazine	Butylate	Bromacil
Simetryne	Cycloate	Butachlor
Simazine	Vernolate	Carboxin
Prometone	**Carbamate insecticides**	Diphenamide
Prometryne	Methiocarb	Hexazinone
Atrazine	Carbofuran	Propachlor
De-isopropylatrazine	Aldicarb	Propoxur
De-ethylatrazine		Terbacil
Cyanazine		Trifluralin
Ametryne		Methomyl
Metribuzine		Propham
		Alachlor
		Metolachlor

Bacteria
- Fecal coliform
- Fecal streptococci

has been extensively sampled by other agencies. It was later added due to the high degree of public interest in the basin.

The goal was to collect 12 monthly samples at each site. Ideally, the samples would cover a wide range of flow regimes during the sampling period from baseflow to storm-runoff conditions. Once per quarter additional samples were collected for the minor constituents listed in table 5. However, only one sample was collected during the year for pesticides because of the high cost of pesticide analysis. New analytical techniques are now available for specific pesticides that are more accurate and relatively inexpensive. Based on the findings of this study, sampling for those pesticides detected could be carried out throughout the year at a relatively low cost to document the probable seasonality of pesticide contamination.

WATER QUALITY

Various methods of analysis were used to evaluate water-quality data to obtain values for comparisons. Various statistical analyses were conducted on data collected within the study area by USGS personnel during the study period. The results are presented in tabular and graphical formats (table 6, figures 7-18). Normalizing the data is probably the most useful step in comparing water-quality data from various basins. Normalizing is the process of converting a concentration for a particular water-quality constituent into some type of yield. In this report, the yields are expressed in terms of tons per year per square mile.

A stream flows past a point (or through a cross-section) carrying an unknown load L of some compound, and we want to estimate the integral L over some time interval. The average constituent concentration in the cross-section, C, varies as a function of discharge, time (seasons, year-to-year variations), and other explanatory variables, and subject also to unexplained or random variability. It is assumed that the discharge, Q, is measured continuously and that errors in its measurement are negligible (Cohen and others, 1992a). The load of a compound can, therefore, be computed by the equation:

$$L = KQC$$

where K is a units conversion factor for milligrams per liter to tons per day equal to 0.002698. The yield is then computed by dividing the load by a unit of area which is square miles in this report.

Due to limitations in laboratory analytical techniques and equipment, a lower detection limit exists, below which the concentration of a constituent or compound cannot be accurately determined. It can only be stated, in such a case, that the concentration is less than the detection limit. Such data are referred to as censored. As techniques differ among laboratories and over time, data for a given constituent may contain censored values having different detection limits (Smoot and others, 1995).

Observations that were censored because concentrations were less than the lower limit of the analytical method were set equal to the detection limit. These statistics were used to report the range of constituent concentrations in the study area and to show spatial distribution of median constituent concentrations. Statistical summaries of the data at the fixed-station sites are listed in table 6 (located in back of report).

Boxplots (Tukey, 1977) were constructed to graphically display the median, interquartile range, quartile skew, and extreme data values from the study sites for selected constituents and physical properties. Boxplots consist of a box drawn from the 25th percentile to the 75th percentile, which constitutes the interquartile range. A horizontal line is drawn across the box at the median, and the two box portions depict the quartile skew. A vertical line (whisker) is drawn from the quartile to the largest data value less than or equal to the upper quartile (75th percentile) plus 1.5 times the interquartile range (upper adjacent value). Another whisker is drawn from the lower quartile (25th percentile) to the smallest data value greater than or equal to the lower quartile to the smallest data value greater than or equal to the lower quartile minus 1.5 times the interquartile range (lower adjacent value). Values less than or greater than 1.5 times the interquartile are plotted individually. Values from 1.5 to 3.0 times the interquartile range (outside values) are plotted with an asterisk. Data more than 3.0 times the interquartile range (far outside values) are plotted with a circle.

Physical and Chemical Properties

Several general physical and chemical measures are important because they indicate and influence water quality. Some of these measures are streamflow, water temperature, pH, alkalinity, specific conductance, dissolved solids, and dissolved oxygen.

The Alabama Department of Environmental Management (ADEM) (1991) states the maximum allowable streamwater temperature for all water-use classifications as 32.2 degrees Celsius (°C) (table 7). There is little spatial variability in temperature between the sites, as shown in figure 7. Streamwater temperatures generally reflect daily mean air temperatures, and because little spatial variability occurs in daily mean air temperature, little variability occurs in water temperatures.

The pH of a natural water is a measure of the acid-base equilibrium achieved by various dissolved salts and gasses. The principal system regulating pH in natural water is the carbonate system, and the bicarbonate and carbonate ions. A departure from mean-neutral pH may be caused by the influx of acidic or alkaline wastes, or for poorly buffered water, fluctuations in algal photosynthesis. Water with a pH ranging from 6.5 to 9.0 units generally provides adequate protection for freshwater fish and bottom-dwelling invertebrates (U.S. Environmental Protection Agency, 1986a).

Streams in Baldwin County generally are poorly buffered and slightly acidic (fig. 8; table 6). The median values for pH at all fixed-station sampling sites ranged from 5.45 to 6.40. The maximum value measured was 6.9 at Blackwater River and the minimum was 4.4 at Majors Creek. These generally low pH values are a result not only of the poor buffering capacity of the soils and water in Baldwin County, but also a result of natural organic acids such as tannin, which gives water a characteristic dark brown color when present. This coloring is a naturally occurring condition, particularly in coastal areas and not necessarily a result of pollution.

A noticeable increase in the median pH values occur between sites in the northern half of Baldwin County and the southern sites (fig. 1). Sites 3 and 7 are drained by relatively undisturbed basins whereas the other site basins have significant amounts of agricultural activities and urban growth (fig. 2). This may be the result of the agricultural activities causing increased nutrient loads to the streams. Increased nutrient loads can cause an increase in algal productivity which can, in turn, increase pH values. Another cause for increasing pH values could be lime application to farmland, which would buffer rainfall runoff to some degree.

Alkalinity is a measure of the capacity of water to neutralize a strong acid. The Federal criterion for alkalinity is set at a level of not less than 20 mg/L as calcium carbonate ($CaCO_3$) for protection of aquatic life (chronic) (U.S. Environmental Protection Agency, 1986a). The median values for alkalinity at all sites were between 2 and

WATER-QUALITY CRITERIA
ADEM Administrative Code R. 335-6-10-.09, 1994

SPECIFIC WATER-QUALITY CRITERIA	WATER-USE CLASSIFICAITON (ADEM Administrative Code R. 335-6-10-.0; R. 335-6-11-.02, 1994)				
	[1]Public Water Supply	Swimming/ Whole Body Contact	[1]Fish and Wildlife	Outstanding Alabama Water	Agricultural and Industrial
1. Waste Effleunt (R. 335-6-10-.08)	Treated Effluent in accordance to R. 335-6-10-.08: BOD5 below 4.5 mg/L; TSS below 4.5 mg/L				
2. pH Range (S.U.)	Between 6.0 to 8.5				
3.Max. Water Temperature (degrees Celsius)	Below 32.2				
4. Dissolved Oxygen (milligrams/liter)	Above 5.0			Above 5.5	Above 4.0
5. Toxic Substances (R. 335-6-10-.07)	Below acute or chronic toxicity levels determined from numeric criteria in R. 335-6-10-.07 or from effluent toxicity testing				Below levels that are unsuitable for livestock, irrigation, and industrial processes
6.Taste and odor producing substances	Same as 5 or affect aesthetic value of water: Iron < 0.3 mg/L; Manganese < 0.05 mg/L; TDS < 500 mg/L; Chloride < 250 mg/L; Nutrient loading below eutrophic levels				
7. Bacteria (geometric mean, colonies/100 mL)	[1]2,000 (Max. = 4,000)	200 (Coastal = 100)	[1]1,000 (Max. = 2,000)	200 Coastal = 100)	N/A
8. Radioactivity	State Department of Public Health standards				
9. Turbidity (nephelometric turbidity units)	Less than 50 above background				

[1] Bacteria levels are reduced to 200 col/100 mL for incidental water contact and recreation during June to September

Table 7.--Water-quality criteria for Alabama waters (Alabama Department of Environmental Management, 1991).

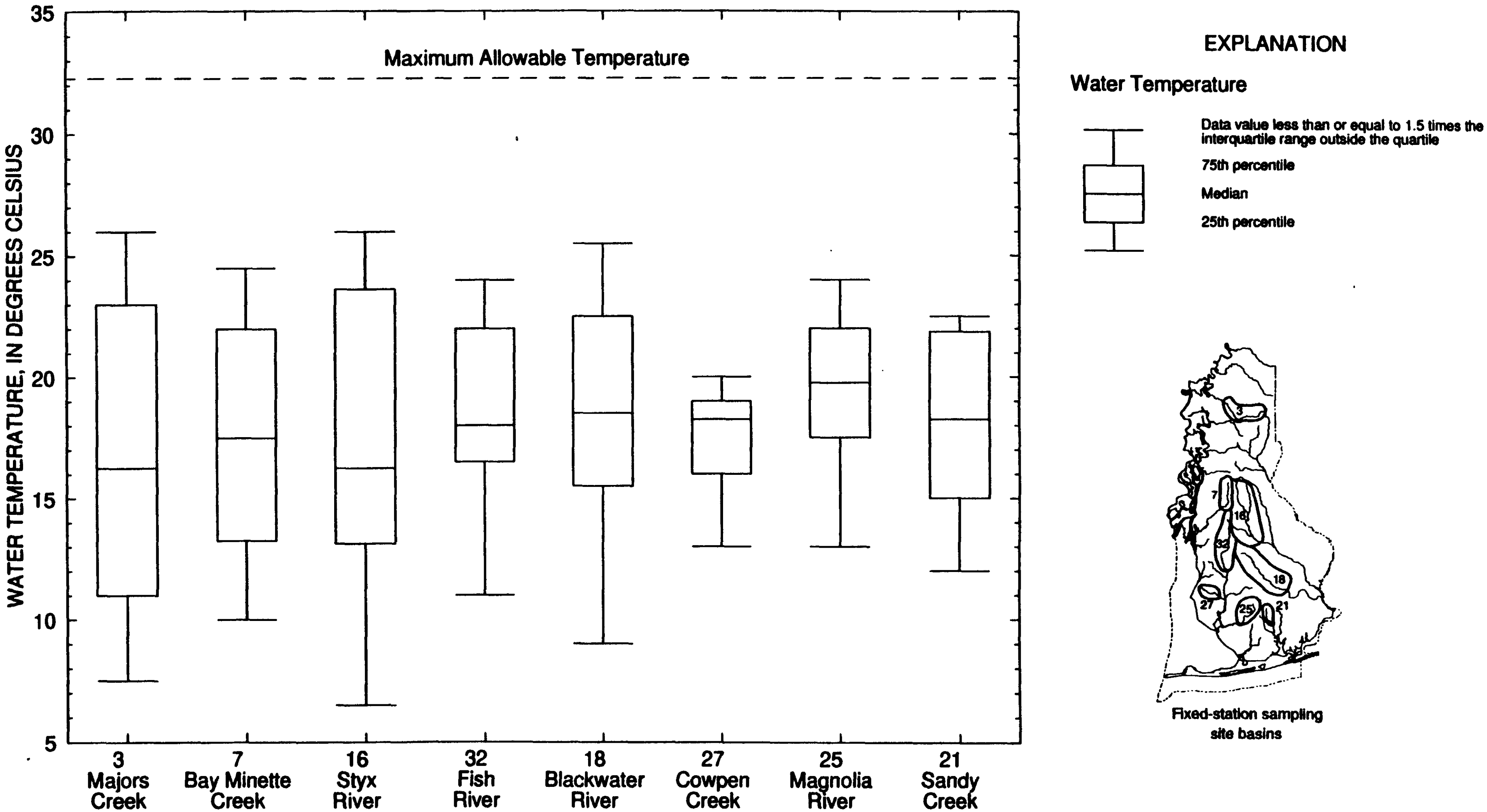

Figure 7. Distribution of water-temperature measurements at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

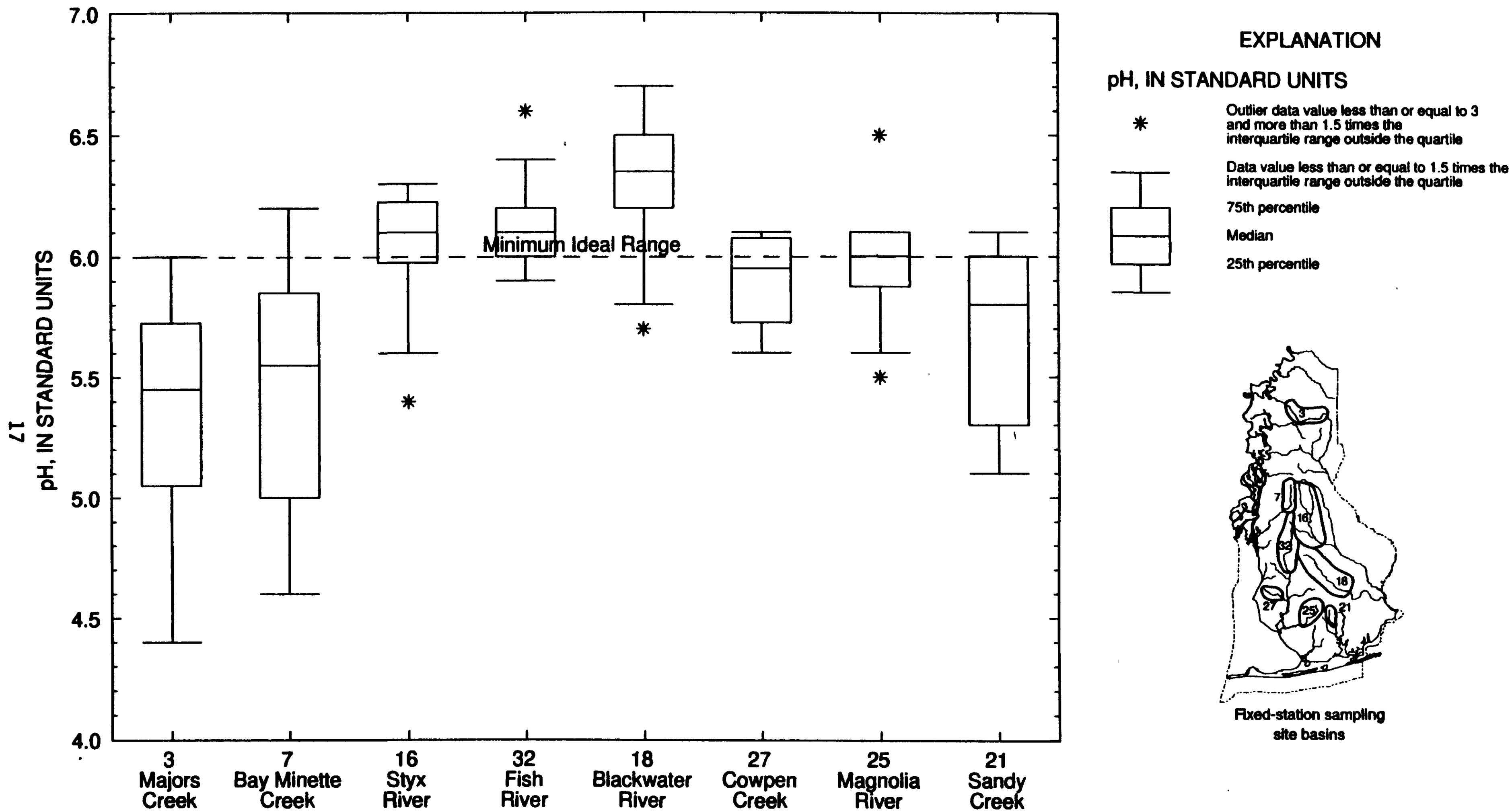

Figure 8. Distribution of pH measurements at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

8 mg/L with the maximum value measured being 11 mg/L at Blackwater River, site 18 (table 6). Even though these values are low, it is a naturally occurring condition as with pH. Normally, these low pH and alkalinity values would be stressful to aquatic life, but because these are the natural conditions of the streams, the aquatic life that are present are probably adapted to these conditions. However, as the pH and alkalinity values for the streams are near or at the lower range of tolerable limits for many types of aquatic life, this could make the aquatic life less tolerant of pH and alkalinity changes than aquatic life in streams with more neutral pH and higher alkalinity values.

Specific conductance is a measure of the ability of water to conduct an electrical current and is related to the quantity and types of ionized substances in water. Specific conductance is usually measured in the field whereas dissolved solids is a laboratory measurement. Dissolved-solids concentrations can usually be estimated accurately by multiplying the specific conductance by a factor. Specific conductance values at the fixed-station sampling sites ranged from 74 μS/cm at Magnolia River to 18 μS/cm at Majors Creek.

Specific conductance values across the county, as shown by the synoptic survey (fig. 3) and the fixed-station sampling sites (fig. 9), increase in areas of higher agricultural activity. The land-use maps (fig. 2) show a noticeable increase in urban development and agricultural activity south of a line generally represented by where I-10 crosses the county. This indicates that land use could have some effect on the water quality of streams. Other factors that may also effect specific conductance are geology, domestic waste, and tidal influences.

Dissolved solids consist of inorganic salts, small amounts of organic matter, and dissolved materials. For a number of reasons, high dissolved-solids concentrations (greater than 500 milligrams per liter [mg/L]) are undesirable, particularly in drinking water. The maximum value for dissolved solids was 58 at Magnolia River, which was well within acceptable limits (table 7).

Fish and other water organisms require dissolved oxygen to survive and propagate. ADEM requires a minimum dissolved-oxygen concentration of 5.0 mg/L (table 7) to ensure a healthy aquatic community (Alabama Department of Environmental Management, 1991).

Dissolved-oxygen concentrations can vary greatly throughout the day and year as well as spatially in response to various environmental processes. Oxygen solubility in water is a function of temperature and atmospheric pressure. The warmer the water temperature, the less the saturated dissolved oxygen level will be. Thus, dissolved-oxygen concentrations in streams are typically lower in the summer than during the winter. Oxygen in streams is consumed during bacterial decomposition of organic matter, oxidation of ammonia and nitrite by nitrifying bacteria (nitrification), and respiration of aquatic organisms. Oxygen is replenished in natural water primarily by diffusion of oxygen into the water from the atmosphere and by photosynthesis in aquatic plants. During summer months, when streamflows are low and water temperatures are high, the dissolved-oxygen concentration of streams can be depleted by high organic loads.

Dissolved-oxygen concentrations in streams also may vary significantly during a 24-hour period in response to algal and macrophyte photosynthesis and respiration. During the day algae and green plants consume carbon dioxide and produce oxygen. In some cases, this can lead to dissolved-oxygen concentrations that are higher than the saturated concentration. At times, algae can be a larger contributor of oxygen to the river than atmospheric diffusion. At night, oxygen is consumed by the decay of dead organisms.

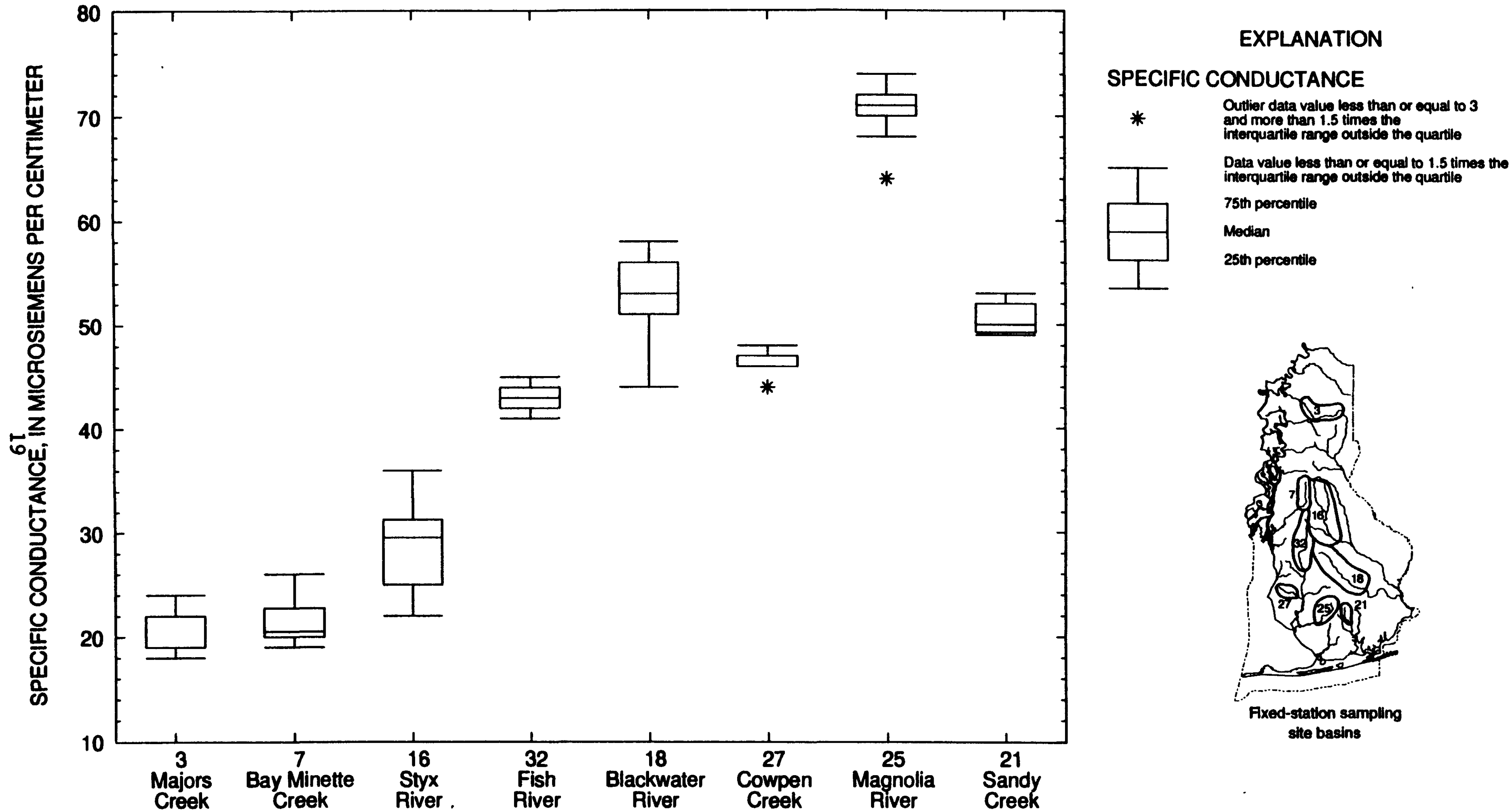

Figure 9. Distribution of specific conductance measurements at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

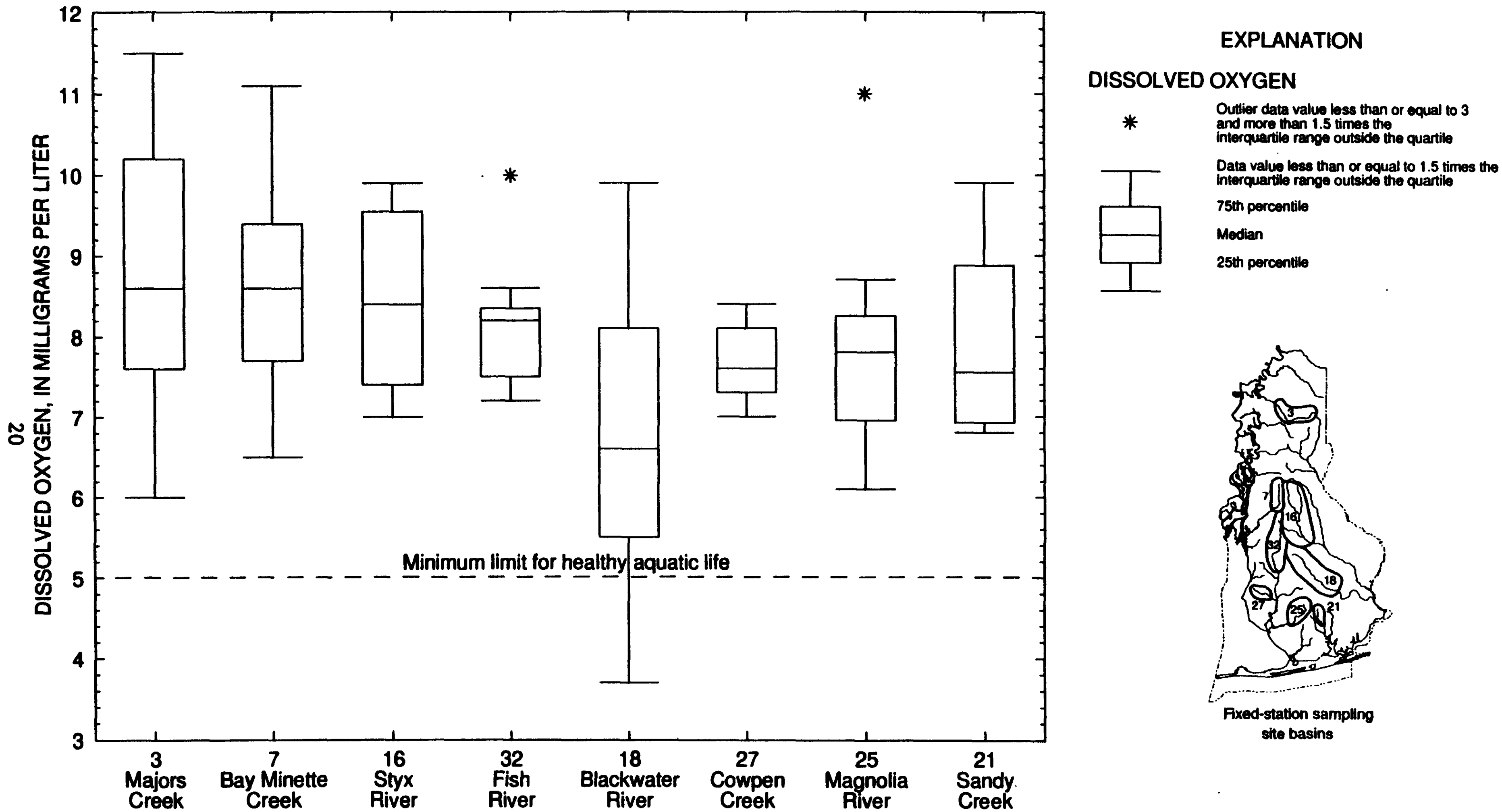

Figure 10. Distribution of dissolved-oxygen concentrations at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

Only one site, Blackwater River (site 18), had a dissolved-oxygen concentration less than the recommended minimum of 5.0 for public water supply and wildlife. All other minimum dissolved-oxygen concentrations were 6.0 mg/L or higher (fig. 10). It should be noted that all field measurements of dissolved oxygen occurred during daylight hours when values are typically higher. Given the diel variability of dissolved-oxygen concentration because of algal photosynthesis and respiration by the aquatic biota, an accurate assessment of dissolved-oxygen conditions would require measurements throughout the 24-hour day.

Nutrients

The major nutritive species of nitrogen and phosphorus are commonly found in all waters at low concentrations (Britton and others, 1983). Plants, including algae, require nitrogen, phosphorus, and potassium as well as trace amounts of other elements to grow. For purposes of this report, nitrogen and phosphorus are the primary nutrients discussed. Nitrogen species in water include nitrogen, ammonia, nitrite, and nitrate. Of these species, nitrate is usually predominant and most readily available for plant growth. Phosphorus species in water include the simple ionic orthophosphate and bound phosphate in soluble and particulate form. Dissolved species of nitrate and phosphate are more readily available to plants. Consequently, their concentrations in natural water are usually relatively low (Smoot and others, 1995).

Nutrient enrichment may encourage blooms of algae. Such phytoplankton blooms are common in lakes but are seldom seen in free-flowing streams. The effects of nutrient enrichment from agricultural practices and wastewater effluent seem to be reduced by increased stream turbidity from erosion and effluents (Wetzel, 1975).

Some major point-source discharges of nitrogen into natural water are municipal and industrial wastewater and feedlot runoff. Nonpoint sources of nitrogen include fertilizer application, leachate from waste in dumps or landfills, atmospheric deposition, and natural sources such as mineralization of soil organic matter. Septic tanks are another significant diffuse source of nitrogen (U.S. Environmental Protection Agency, 1976).

Farm animals produce considerable amounts of nitrogenous organic waste that tends to concentrate in places where large numbers of animals are confined. The amount of nitrogen fertilizers used in agricultural activities has increased greatly in recent decades.

Ammonia and organic nitrogen yields seem to be consistent across the county (fig. 11). This indicates that the ammonia and organic nitrogen being introduced into the streams are at near equilibrium with the processes converting these forms of nitrogen into other forms such as nitrite and nitrate.

Concentrations of nitrate nitrogen (fig. 12; table 6) increase in basins with more agricultural activity. Of the fixed-station sampling sites, Majors Creek, was the basin least affected by agricultural development in the study, and had nitrate levels ranging from 0.01 to 0.06 mg/L. Magnolia River, one of the more agriculturally developed basins, had nitrate values ranging from 1.79 to 3.1 mg/L. Yields of nitrite plus nitrate nitrogen show similar increases in basins with more agriculture and urban growth.

High intake of nitrates can pose a health hazard to warm-blooded animals. The Federal maximum concentration limit (MCL) for domestic water supply is 10 mg/L (U.S. Environmental Protection Agency, 1986). This concentration of nitrate is rarely reached in surface waters where algae and other aquatic plants take up the nitrate. Problems with nitrate usually occur in ground water and in receiving waters of streams such as bays, lakes, and reservoirs. Eutrophication usually

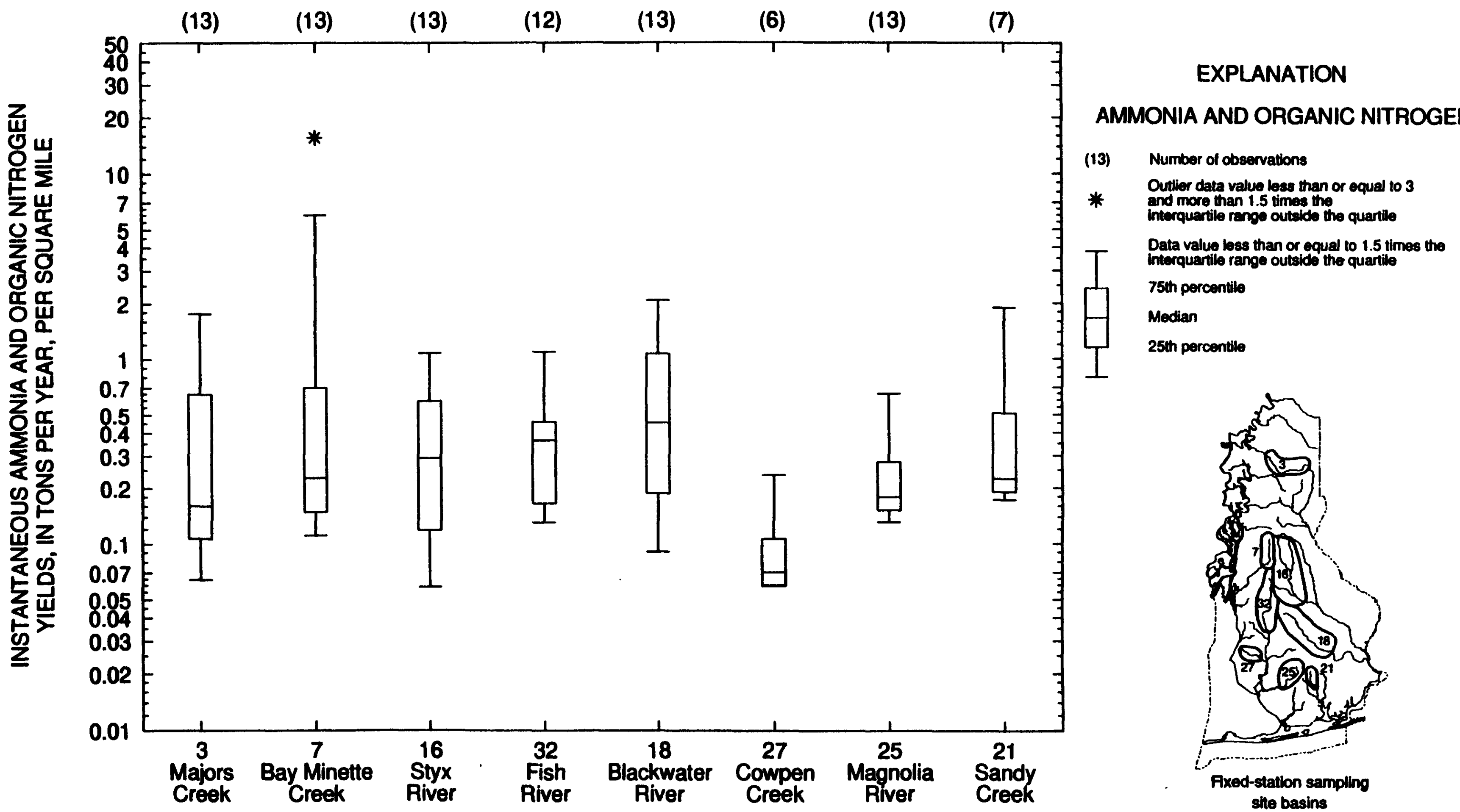

Figure 11. Distribution of instantaneous yields for ammonia and organic nitrogen at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

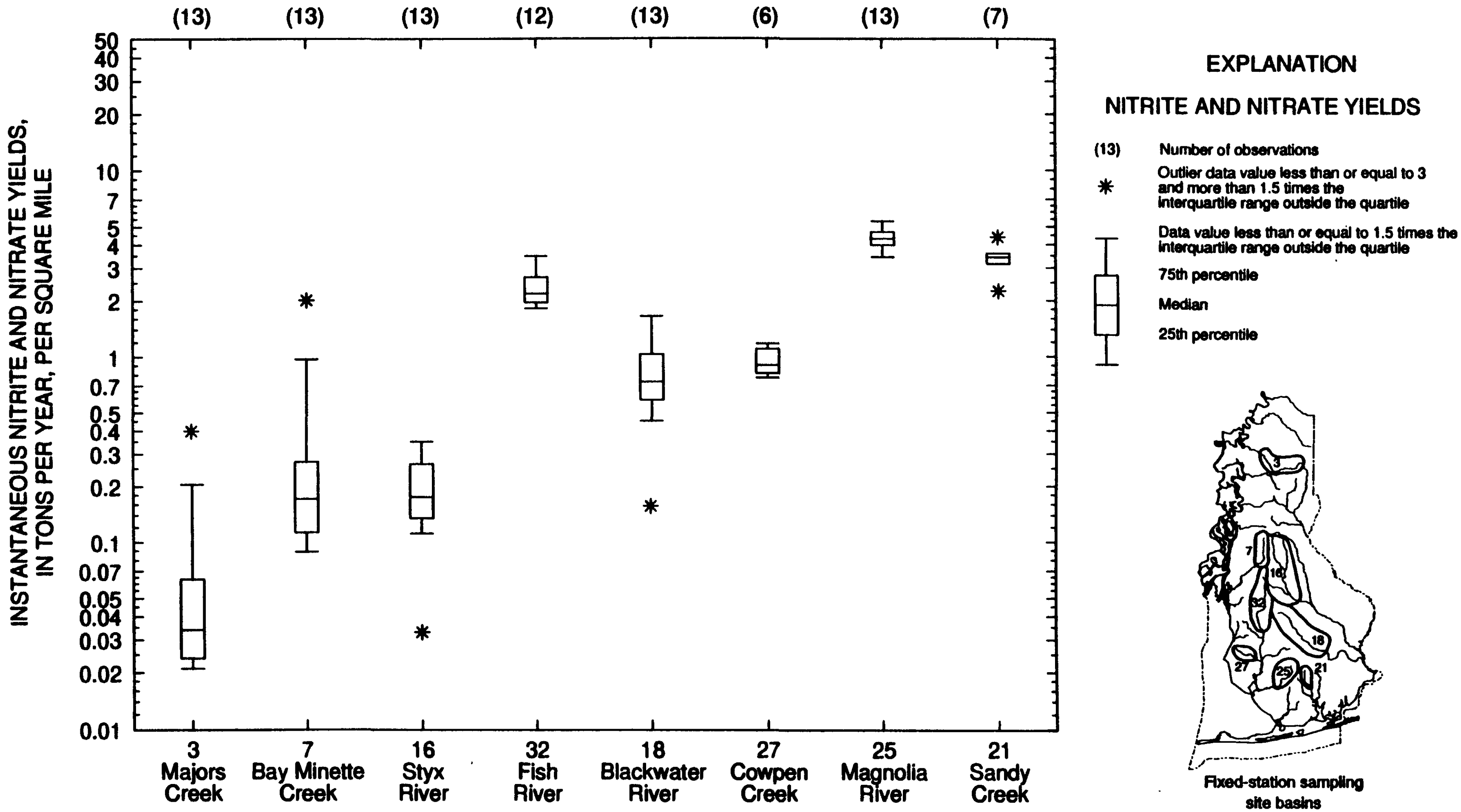

Figure 12. Distribution of instantaneous yields for nitrite and nitrate nitrogen at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

becomes a problem in receiving waters with high levels of nitrates. No long-term trend data are available in Baldwin County to determine if nitrogen concentrations are increasing, decreasing or remaining constant.

Phosphorus in streams is contributed from a number of natural and human-induced sources. Some of the more important of these are breakdown and erosion of phosphorus-bearing minerals in the soil, decaying plant and animal material, agricultural and domestic fertilizers, synthetic detergents, sewage effluents, and septic tank leachates. Elevated concentrations of phosphorus are of concern because of the role this nutrient often plays in nuisance algae blooms. Of the major nutrients, phosphorus is most frequently determined to be limiting to plant growth.

Concentrations of naturally occurring dissolved phosphorus in streams are normally no more than a few tenths of a milligram per liter (Hem, 1985). The Magnolia River and Blackwater River had maximum total phosphorus concentrations of 0.11 mg/L at the fixed-station sampling sites. Generally, concentrations of phosphorus were below the analytical detection limit. Yields of phosphorus shown on figure 13 are fairly evenly distributed among all sites indicating no significant contributions of phosphorus to streams from agricultural practices and urbanization in the southern half of the county.

Minor Constituents

Concern about the contamination of receiving water by minor constituents has increased substantially during recent years. Many constituents, such as cadmium, copper, lead, and mercury are toxic to aquatic organisms when present in high concentrations. These constituents are nondegradable and may persist in the environment for a long time.

Urban stormwater runoff has been shown to contain substantial concentrations of lead, zinc, and other metals (Martin and Smoot, 1986). Sources of these metals include automobile exhaust and various commercial and industrial activities. Other human-induced sources include domestic and industrial wastewater, paints, biocides, and fertilizers. Selected minor constituents discussed here include barium, copper, iron, lead, zinc, and nickel.

Barium is an alkaline-earth metal, which occurs in low concentrations in most surface waters. It occurs in igneous and carbonate sedimentary rocks, drilling mud, and hospital wastes. ADEM (1991) criterion for barium in drinking water supplies is 1,000 µg/L. Maximum values for barium in the study area ranged from 15 µg/L at Bay Minette Creek (site 7) to 75 µg/L at Magnolia River (site 25), all well below the maximum allowable limit (fig. 14).

Copper is a native metal that occurs in various mineral forms such as cuprite and chalcopyrite. Copper is used in a variety of products such as bactericides and can be used to eliminate algae. It is essential for plants because it is involved in the synthesis of chlorophyll. The ADEM secondary drinking water limit for copper is 1,000 µg/L. Maximum values for copper ranged from 2 µg/L at Sandy Creek to 28 µg/L at Bay Minette Creek, well below ADEM limits (fig. 15).

ADEM secondary drinking water regulations set the maximum allowable level of iron at 300 µg/L. Levels above 300 µg/L create taste and fixture-staining problems in drinking water. Higher levels in natural waters can be detrimental to some aquatic life, particularly fish eggs and bottom-dwelling organisms. Measurements of iron ranged from a high of 1,000 µg/L at Blackwater River to a low of 32 µg/L at Sandy Creek (fig. 16). The occurrence of iron did not seem to be associated with any particular type of land use.

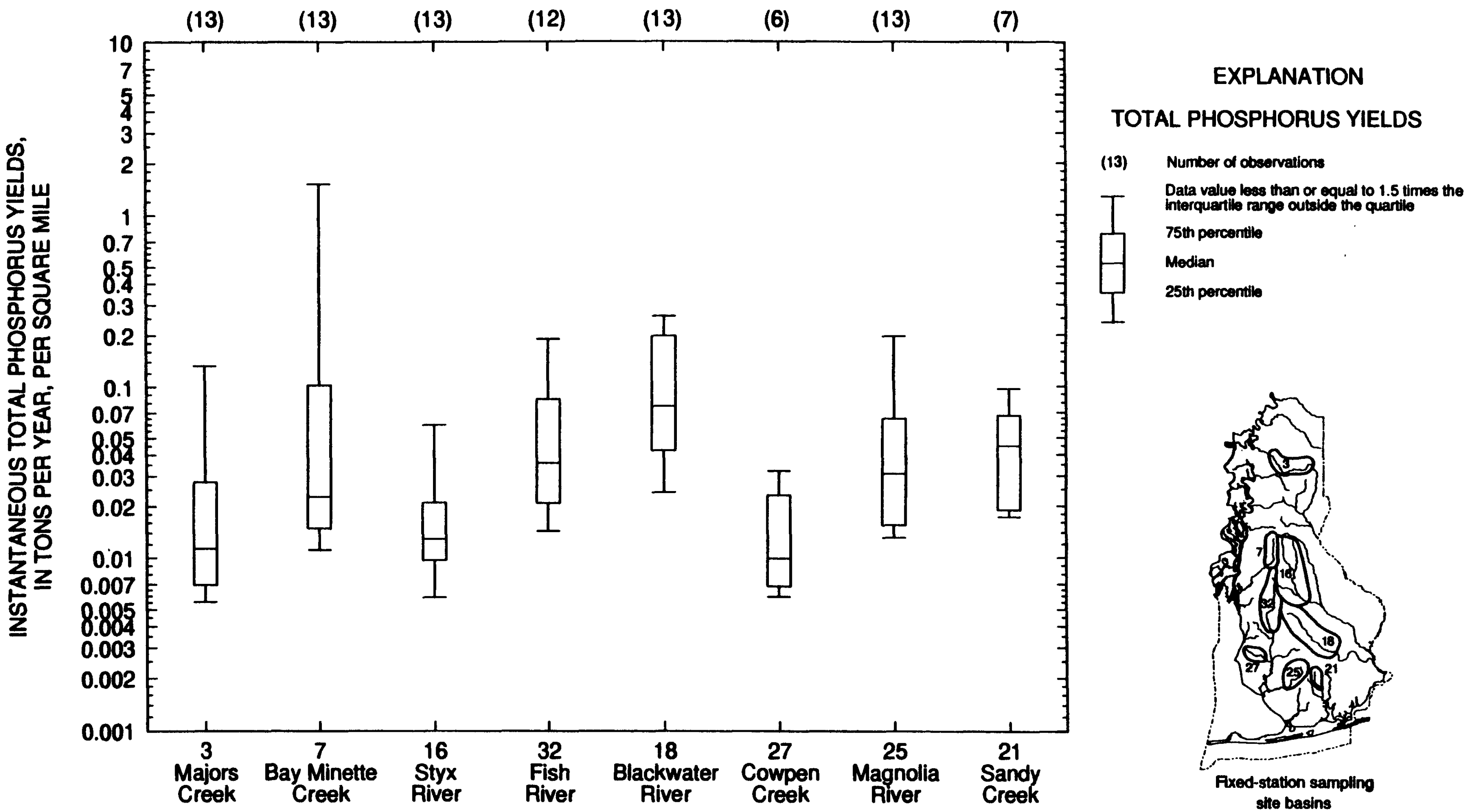

Figure 13. Distribution of instantaneous yields for phosphorus at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

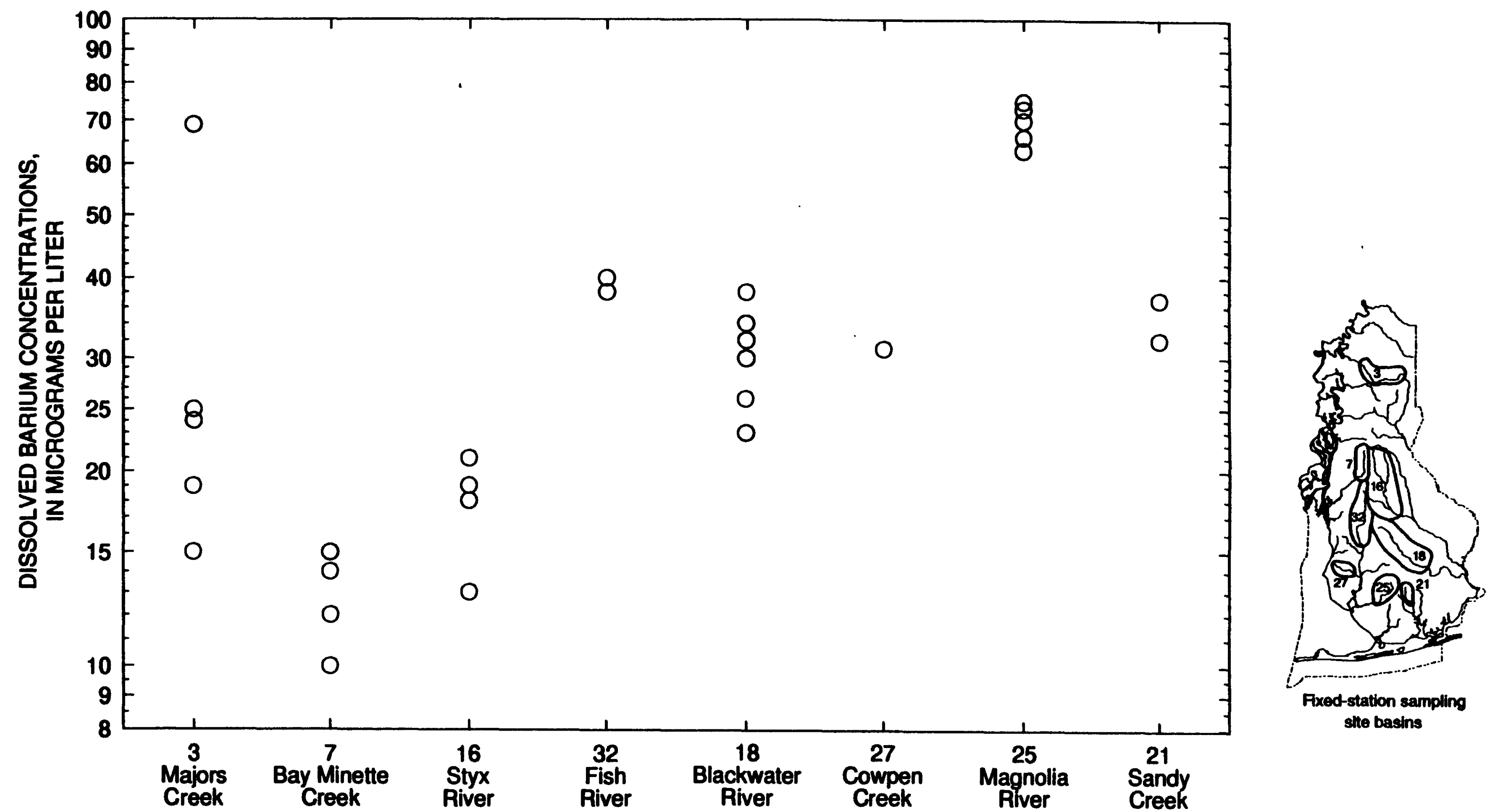

Figure 14. Measurements of dissolved barium concentrations at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

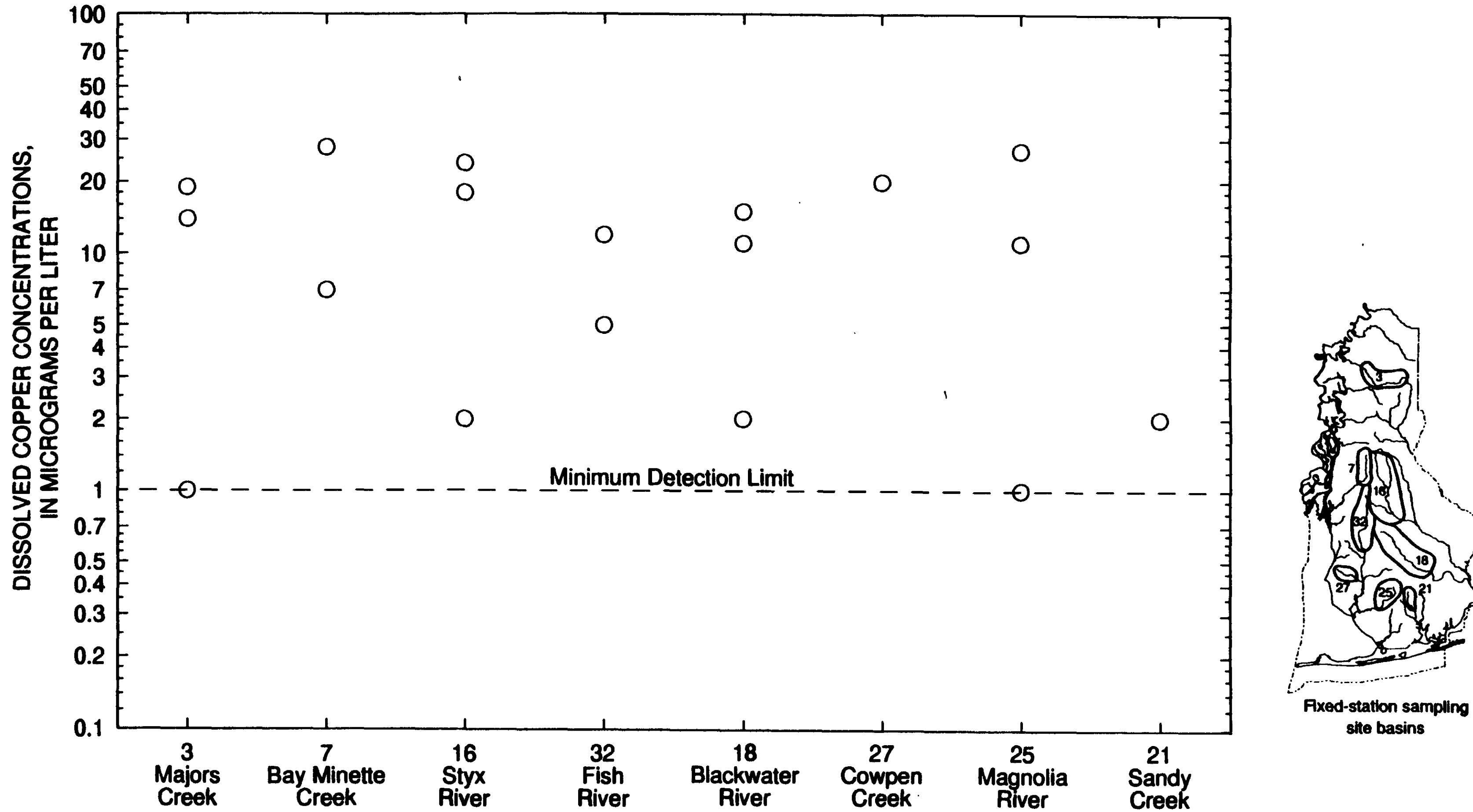

Figure 15. Measurements of dissolved copper concentrations at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

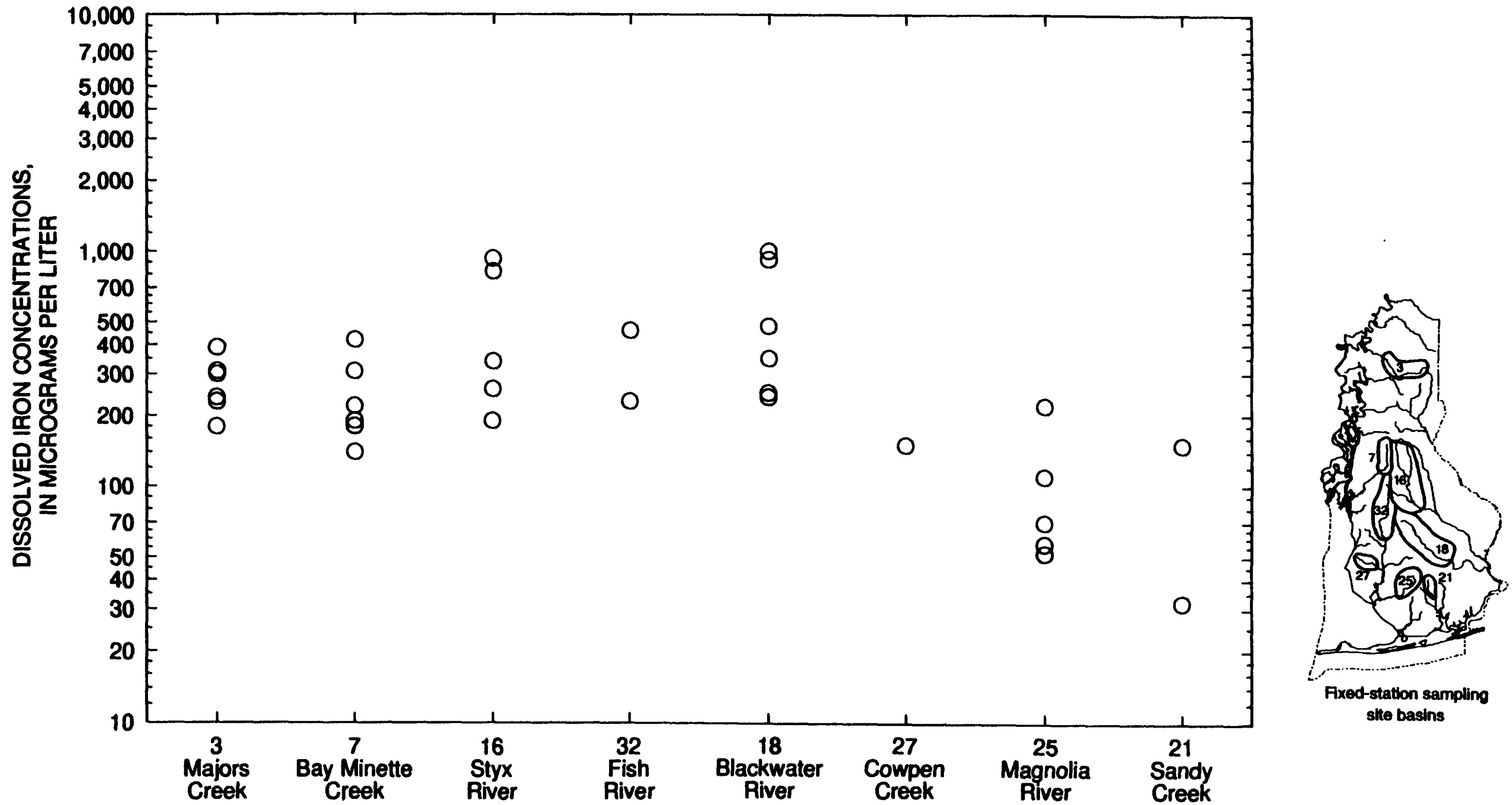

Figure 16. Measurements of dissolved iron concentrations at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

Lead is common in sedimentary rocks, but because of the low solubility of lead hydroxyl carbonates, its natural mobility is low (Hem, 1985). Lead has been dispersed widely through the environment mainly from the combustion of leaded gasoline. Large amounts of lead also can be released in the burning of coal. ADEM (1991) sets the maximum allowable limit for lead in drinking water at 20 µg/L. Most samples collected during the study did not detect measurable levels of lead. Measurable levels of lead were detected at Magnolia River (4 µg/L), Blackwater River (2 µg/L), Styx River (4 µg/L), Bay Minette Creek (4 µg/L), and Majors Creek (2 µg/L), well below maximum allowable limits. There seemed to be no pattern to the occurrences of lead in Baldwin County.

Zinc is a fairly common element often associated with lead in sedimentary rocks such as limestones. Zinc tends to be substantially more soluble in natural water than copper and nickel (Hem, 1985). High concentrations of zinc in surface water may indicate the presence of industrial and urban wastes. Streams draining areas with mining activities and other land disturbances may also contain zinc (U.S. Environmental Protection Agency, 1979).

ADEM lists the secondary drinking water limits for zinc as 5,000 µg/L. Measurable amounts of zinc were detected in all sites except Sandy Creek. The highest level measured was 49 µg/L at Bay Minette Creek, well within acceptable limits (fig. 17).

Nickel is present as a constituent in various ores, minerals, and soils. It is comparatively inert and is used in corrosion-resistant materials, long-lived batteries, electrical contacts, spark plugs, and electrodes. Nickel enters water predominantly from mine wastes, electroplating wastes, and atmospheric emissions (Hem, 1985). Measureable levels of nickel occurred at Bay Minette Creek, Magnolia River, Sandy Creek, Majors Creek, and Fish River, all with concentrations of 2 µg/L. Nickel has been shown to be toxic to plants at concentrations of 730 µg/L (U.S. Environmental Protection Agency, 1976). For water with hardness of 100 µg/L as $CaCO_3$, the Federal aquatic life criteria for acute and chronic considerations are 1,800 and 96 µg/L, respectively. Concentrations of nickel measured in Baldwin County are well below these levels.

Pesticides

Pesticides are chemicals designed to control various pests that damage agricultural and horticultural crops. These compounds are typically classified by the types of pests that are to be controlled and include insecticides, herbicides, fungicides, and rodenticides. Pesticides enter ground water and surface water through many routes, including runoff, direct application, spills, and faulty waste disposal techniques. Movement by erosion of soil particles with adsorbed pesticides is one of the principal means of entry into surface water (U.S. Environmental Protection Agency, 1972).

One sample for pesticide analysis was collected at Sandy Creek, Magnolia River, and Blackwater River. Atrazine was detected at all three sites at 0.1 µg/L, 0.1 µg/L, and 0.2 µg/L, respectively. Simazine was detected at Sandy Creek (0.2 µg/L) and Blackwater River (0.2 µg/L). U.S. Environmental Protection Agency (1993) primary drinking water regulations set the maximum contamination level for atrazine and simazine at 3 µg/L and 4 µg/L, respectively. Atrazine, the most widely used herbicide, and simazine are triazine herbicides that are highly soluble in water. Once into the water table, however, atrazine degrades at a much slower rate (McMahon and others, 1992). In surface waters, they degrade rapidly with half-lives of about 3 to 12 days. The levels detected in these three streams were barely above detection limits. The three sites

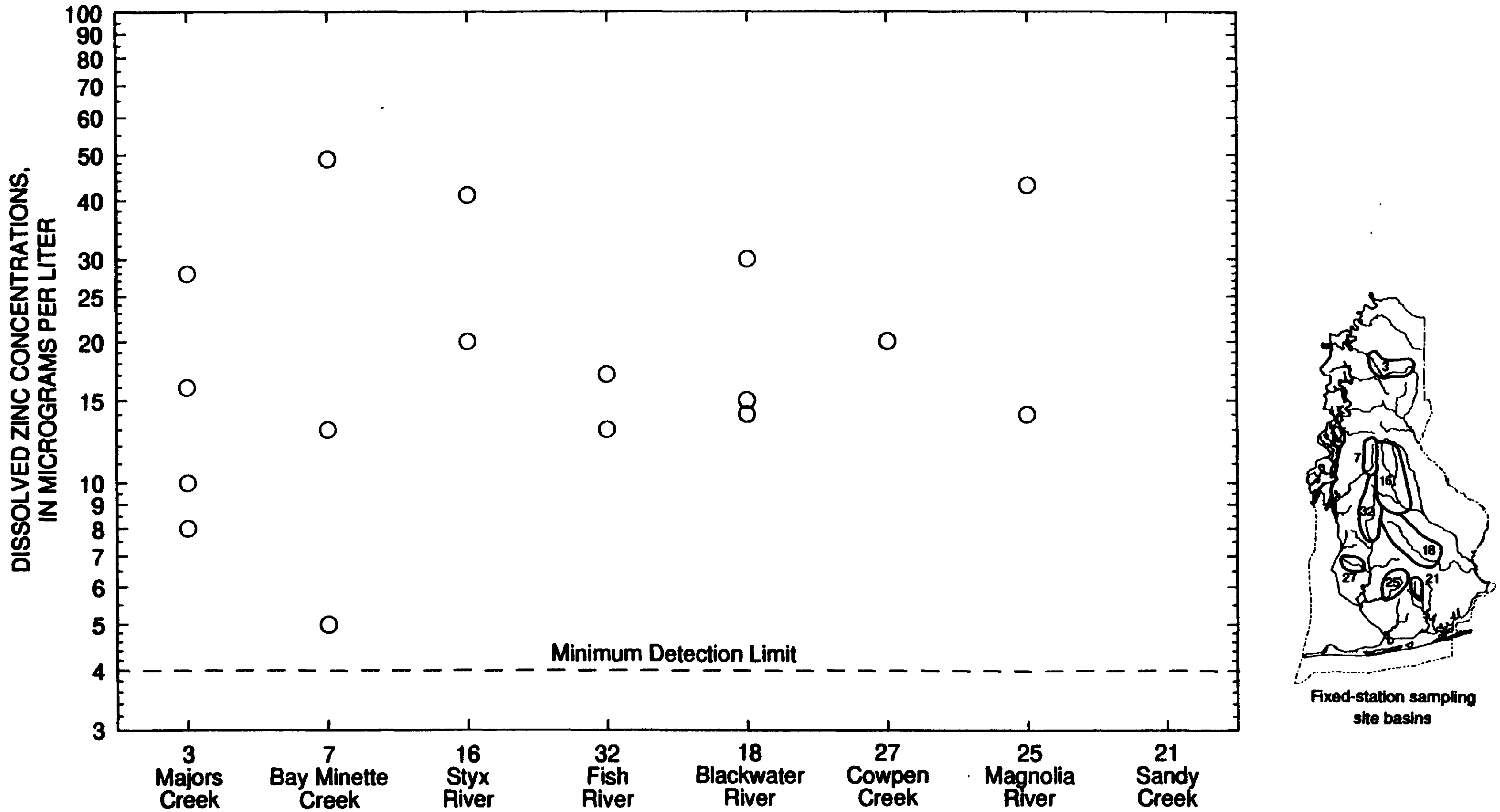

Figure 17. Measurements of dissolved zinc concentrations at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

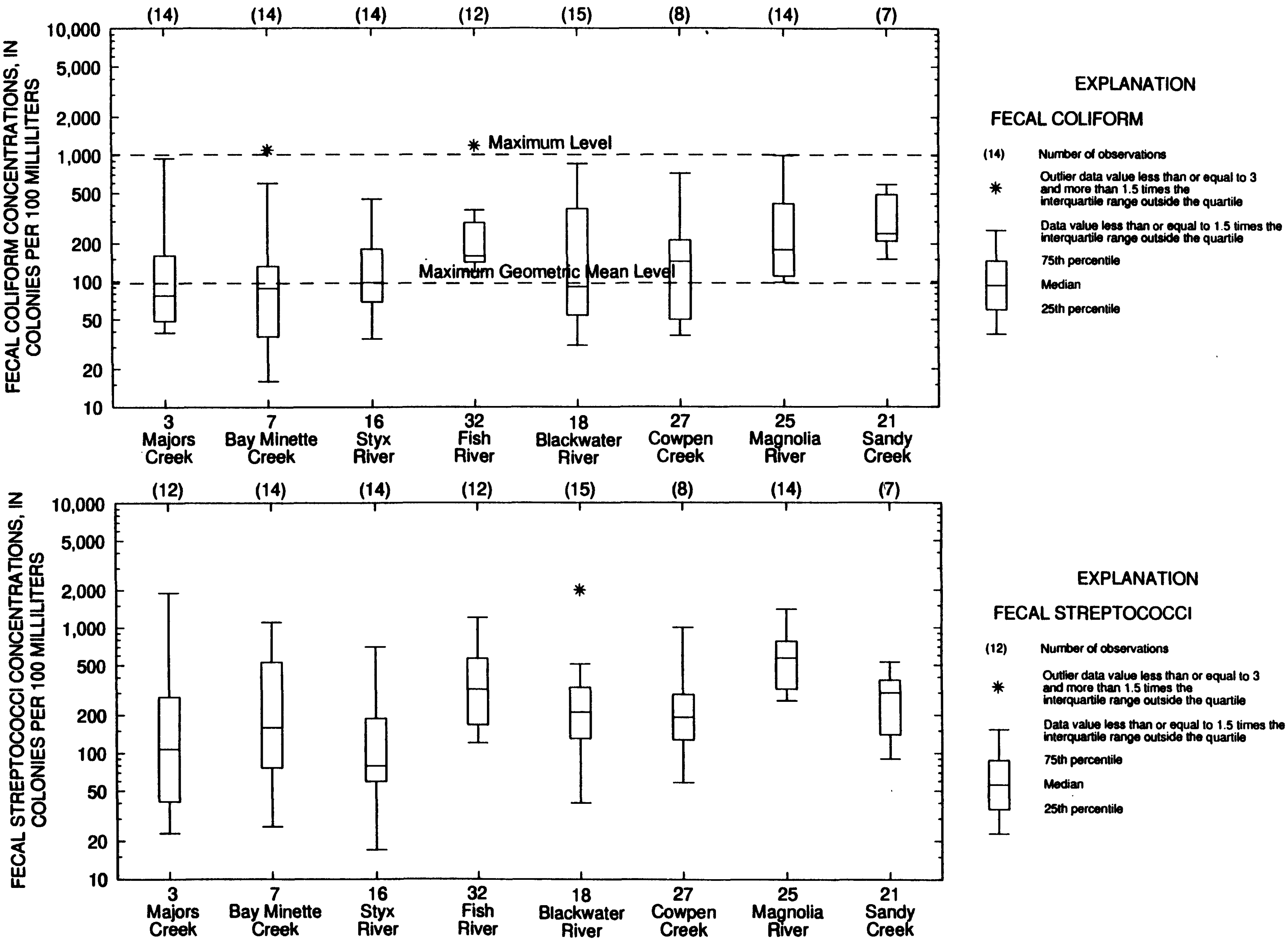

Figure 18. Distribution of fecal coliform and fecal streptococci concentrations at fixed-station sampling sites in Baldwin County, September 1994 - April 1996.

sampled were chosen because of the high degree of agricultural activity in these basins.

Fecal Coliform Bacteria

Fecal coliform bacteria are present in the intestinal tract of warm-blooded animals and are commonly used as indicators of fecal contamination in water. Pollution of aquatic systems by the excreta of warm-blooded animals may result in health problems for man and animals and potential disease problems for aquatic life. ADEM limits for drinking water supplies is a geometric mean of 2,000 colonies per 100 millimeters (cols/100 mL) of water and no more than 4,000 cols/100 mL (table 7). For swimming and other whole body contact waters, the limit is a geometric mean of 200 cols/100 mL and a maximum of 1,000 cols/100 mL.

Of the eight sites, only Sandy Creek had median concentrations of fecal coliform greater than 200 cols/100 mL (fig. 18). All sites had concentrations greater than 200 cols/100 mL, but none above the drinking water supply limit.

SUMMARY

Baldwin County is the largest county in Alabama in terms of land area and one of the fastest growing in populations. The proximity of the county to Mobile Bay and the Gulf of Mexico has made tourism a large industry within the county. Agriculture is also a large industry in the county. Tourism, with its associated urban growth, and agriculture both demand large quantities of water. At the present time, the county has sufficient water resources to meet its needs.

In 1994, Baldwin County managers began an evaluation of the total water resources in the county. Changes is land-use practices can sometimes cause significant changes to the water resources. County managers needed information on the quality of the surface-water resources in the county to determine whether or not the waters had already been affected and to assist in water-resources management planning. In September 1994 the USGS entered a cooperative agreement with the Baldwin County Commission to study the quality of water in streams of Baldwin County.

Point sources of pollution were the first concern for stream-water quality. A synoptic water-quality sampling survey was conducted to evaluate whether discharges from WWTPs or some other point source of pollution were significantly affecting streams in the county.

The synoptic data from sites above and below WWTP discharge points show no significant changes in water quality from the discharges. Non-point sources of pollution such as urban and agricultural runoff were then evaluated. Analysis of the synoptic water-quality data shows a marked difference in some constituents, particularly specific conductance, total phosphorus, and total nitrate, between sites in the northern part of the county and those in the southern part.

Eight of the synoptic-sampling sites were selected to be fixed-station sites for periodic sampling. The sites were chosen to represent the major land uses within Baldwin County. Samples were analyzed for physical and chemical properties, nutrients, minor constituents, pesticides, and bacteria.

Streams sampled in Baldwin County were generally poorly buffered and slightly acidic. The maximum pH measurement was 6.9 at Blackwater River and the minimum was 4.4 at Majors Creek. The generally low pH values are the result of the poor buffering capacity of the soils and water in Baldwin County and also to the presence of natural organic acids such as tannin. The pH of streams south of Interstate Highway 10 are generally higher than those to the north.

The median values for alkalinity at all sites were between 2 and 8 mg/L as CaCO3. The maximum value measured was 11 mg/L at Blackwater River. The minimum criterion for alkalinity set by ADEM for healthy aquatic life is 20 mg/L.

Only Blackwater River had a dissolved-oxygen concentration less than the recommended minimum of 5.0 mg/L for public-water supply, swimming, and fish and wildlife uses of water. All other fixed-station sites had minimum concentrations that were 6.0 mg/L or higher.

High dissolved-solids concentrations are undesirable for a number of reasons. The maximum value for dissolved solids at fixed-station sampling sites was 58 mg/L at Magnolia River, well below the recommended maximum of 500 mg/L for drinking water.

Ammonia and organic nitrogen yields seem to be consistent across the county indicating that the ammonia and organic nitrogen that is being released into the streams is near equilibrium with the processes converting this form of nitrogen into other forms such as nitrite and nitrate. Measurements of nitrate nitrogen show increased levels in basins with higher percentages of agricultural activity and urban areas. Majors Creek, the basin with the least agricultural activity and urban area of the fixed-station sites, had nitrate levels ranging from 0.01 to 0.06 mg/L. Magnolia River, a basin with significantly more agricultural activity and urban area, had nitrate values ranging from1.79 to 3.1 mg/L.

Concentrations of naturally occurring dissolved phosphorus in streams are usually no more than a few tenths of milligrams per liter. Measurements for phosphorus in Baldwin County streams were often below the analytical detection limit. Magnolia and Blackwater Rivers had maximum total phosphorus concentrations of 0.11 mg/L.

Selected minor constituents discussed in this report include barium, copper, iron, lead, zinc, and nickel. Maximum values for barium in the study area ranged from 15 μg/L at Bay Minette Creek to 75 μg/L at Magnolia River, all well below the maximum allowable level of 1,000 μg/L for drinking-water supplies as set by ADEM.

Maximum values for copper ranged from 2 μg/L at Sandy Creek to 28 μg/L at Bay Minette Creek. These are well below the ADEM secondary drinking water limit of 1,000 μg/L.

Measurements of iron ranged from a low of 32 μg/L at Sandy Creek to a high of 1,000 μg/L at Blackwater River. ADEM sets the secondary drinking water limit for iron at 300 μg/L. Levels above 300 μg/L create taste and fixture staining problems and can be detrimental to some aquatic life.

Most samples analyzed for lead during the study did not have detectable levels. Measurable levels of lead were detected at Magnolia River, Blackwater River, Styx River, Bay Minette Creek, and Majors Creek. The highest concentration measured was 4 μg/L at Magnolia River, Styx River, and Bay Minette Creek, well below the ADEM maximum allowable limit for drinking water of 20 μg/L.

Measurable concentrations of zinc were detected at all sites except Sandy Creek. The highest concentration measured was 49 μg/L at Bay Minette Creek, well below the ADEM limit of 5,000 μg/L.

Measurable concentrations of nickel occurred at Sandy Creek, Majors Creek, Bay Minette Creek, Magnolia River, and Fish River, all with concentrations of 2 μg/L. Federal aquatic life criteria for acute and chronic considerations are 1,800 and 96 μg/L, respectively.

REFERENCES

Alabama Department of Economic and Community Affairs, 1992-93, Alabama County Data Book, March 1993, 96 p.

Alabama Department of Environmental Management, 1991, Water quality criteria: Alabama Department of Environmental Management Administrative Code, Chapter 335-6-10.

Britton, L.J., Goddard, K.E., and Briggs, J.C., 1993, Quality of rivers of the United States, 1976 water year--based on the National Stream Quality Accounting Network (NASQAN): U.S. Geological Survey Open-File Report 80-594, 423 p.

Carmichael, J.K., and Bennett, M.W., 1993, Reconnaissance of quality of water from farmland wells in Tennessee, 1989-90: U.S. Geological Survey Water-Resources Investigations Report 92-4186.

Cohn, T.A., Caulder, D.L., Gilroy, E.J., Zynjuk, L.D., and Summers, R.M., 1992, The validity of a simple log-linear model for estimating fluvial constituent loads: an empirical study involving nutrient loads entering Chesapeake Bay, Water Resources Research, p. 2353-2363.

Geldreich, E.E., and Kenner, H.L., 1969, Concepts of fecal streptococci in stream pollution: Journal of the Water Pollution Control Federation, v. 41, part 2, p. A336-352.

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water:
U.S. Geological Survey Water-Supply Paper 2254.

Martin, E.H., and Smoot, J.L., 1986, Constituent-load changes in urban storm-water runoff routed through a detention pond-wetlands system in central Florida: U.S. Geological Survey Water-Resources Investigations Report 85-4310, 74 p.

McMahon, P.B., Chapelle, F.H., and Jagucki, M.L., 1992, Atrazine mineralization potential of alluvial-aquifer sediments under aerobic conditions: Journal of Environmental Science and Technology, p. 1556-1559.

Millipore Corporation, 1975, Field procedures in water microbiology: Bedford, Massachusetts, Millipore Corporation, Catalog no. LAB3140/U, 15 p.

Pearman, J.L., Stricklin, V.E., and Cole, P.W., 1995, Water resources data, Alabama, water year 1994: U.S. Geological Survey Water-Data Report AL-94-1, 538 p.

Reed, P.C., 1971, Geology of Baldwin County, Alabama: Geological Survey of Alabama Map 94, 5 p.

Shelton, L.R., 1994, Field guide for collecting and processing stream-water samples for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 94-455, 42 p.

Smoot, J.L., Liebermann, T.D., Evaldi, R.D., White, K.D., and Bradfield, A.D., 1995, Water-quality assessment of the Kentucky River Basin, Kentucky--Analysis of available water-quality data through 1986: U.S. Geological Survey Water-Supply Paper 2351, 194 p.

Tukey, J.W., 1977, Exploratory data analysis: Addison-Wesley, Reading, Massachusetts.

U.S. Department of Commerce, 1961-90, Climatological data for Alabama: National Oceanic and Atmospheric Climatological Data Reports (published monthly).

U.S. Environmental Protection Agency, 1972, A report of the committee on water quality criteria: U.S. Environmental Protection Agency R3.73.033, Washington, D.C., 594 p.

U.S. Environmental Protection Agency, 1976, Quality criteria for water: U.S. Environmental Protection Agency, Washington, D.C., 256 p.

____1979, Zinc: National Research Council, Division of Medical Sciences Assembly of Life Science, Committee on Medical and Biological Effects on Environmental Pollutants, Subcommittee on Zinc.

____1986a, Quality criteria for water: U.S. Environmental Protection Agency 440/5-86-001, Washington, D.C., 475 p.

____1986b, Maximum contaminant levels (subpart B of part 141, National interim primary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised as of July 1, 1986, p. 524-528.

____1986c, Secondary maximum contaminant levels (section 143.3 of part 143, National secondary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised as of July 1, 1986, p. 587-590.

____1987, Final rule, National primary drinking water regulations, maximum contaminant levels for organic contaminants (section 141.60 of part 141) and maximum contaminant level goals for organic contaminants (section 141.50 of part 141): U.S. Federal Register, v. 52, no. 130, July 8, 1987, p. 25,690-25,717.

____1993, Ground-water information exchange and technology support, v. II, no. I, January 1993, 54 p.

Wetzel, R.G., 1975, Limnology: Philadelphia, Pennsylvania, W.B., Saunders, 743 p.

Table 3.--Field measurements at synoptic sampling sites in Baldwin County, Alabama

(°C, degrees Celsius; µS/cm, microSiemens per centimeter at 25 °C; mg/L, milligrams per liter; --, missing values)

Site number	Date	Time	Temperature water (°C)	Temperature air (°C)	Discharge, (cubic feet per second)	Specific conductance (µS/cm)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)	pH water field (standard units)	Oxygen demand, biochemical, (5-day mg/L)
1	09-12-94	1315	24.0	30.0	168	23	8.7	103	5.6	--
2	09-12-94	1430	22.0	30.0	15	17	8.7	99	5.8	2.4
3	09-12-94	1330	23.0	29.0	27	23	7.6	89	5.8	1.4
4	09-12-94	1445	23.5	32.5	14	22	7.8	92	6.1	--
5	09-12-94	1300	23.0	30.0	21	19	7.4	86	6.5	--
	09-13-94	0940	23.5	--	--	18	8.3	98	--	--
6	09-12-94	1400	26.0	--	9.6	20	6.3	78	5.8	--
	09-13-94	0935	22.0	--	--	26	7.3	84	--	--
7	09-14-94	1100	20.5	--	35	25	7.9	88	6.1	2.6
8	09-13-94	1200	23.5	--	9.7	21	7.5	88	5.8	3.0
9	09-13-94	1115	21.0	25.0	42	24	8.5	95	4.9	3.0
10	09-13-94	1700	24.5	--	383	24	8.3	99	5.3	4.2
11	09-13-94	1000	26.5	--	--	53	5.3	66	--	--
	09-14-94	1540	26.5	--	--	58	5.4	67	--	--
	09-15-94	0900	24.5	21.5	--	217	5.4	65	7.3	5.4
12	09-13-94	1030	22.5	--	--	47	6.9	80	--	--
	09-14-94	1535	22.0	--	--	49	7.3	84	--	--
	09-15-94	1045	20.5	22.5	2.3	44	7.8	87	6.5	4.4

Table 3.--Field measurements at synoptic sampling sites in Baldwin County, Alabama--Continued

Site number	Date	Time	Temperature water (°C)	Temperature air (°C)	Discharge, (cubic feet per second)	Specific conductance (uS/cm)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)	pH water field (standard units)	Oxygen demand, biochemical, (5-day mg/L)
13	09-13-94	0930	22.0	--	--	53	6.8	78	--	--
	09-14-94	1600	22.5	--	--	51	7.2	84	--	--
	09-15-94	0830	22.5	--	6.1	55	6.7	78	6.4	3.0
14	09-15-94	0930	23.0	--	7.9	55	7.1	83	5.0	3.4
15	09-13-94	1200	22.5	32.0	39	24	6.6	77	4.8	3.6
16	09-13-94	1300	25.0	32.0	105	30	7.9	96	6.1	0
17	09-13-94	1400	23.0	32.0	40	27	8.4	99	5.7	0.6
18	09-13-94	0825	22.5	--	--	53	6.2	72	--	--
	09-14-94	1400	21.0	23.5	68	57	5.8	65	6.5	3.2
19	09-13-94	0800	23.0	--	--	61	4.9	57	--	--
	09-14-94	0900	23.0	--	--	66	4.3	50	--	--
	09-14-94	1200	21.5	25.5	20	68	4.9	55	6.9	4.2
	09-15-94	1310	23.5	--	--	66	4.0	47	--	--
20	09-13-94	1430	24.0	29.5	7.8	105	4.4	52	6.1	4.4
	09-14-94	0840	23.0	--	--	113	3.7	43	--	--
	09-14-94	1800	24.0	--	--	114	4.2	50	--	--
21	09-13-94	1045	22.0	30.5	14	50	7.5	86	5.8	1.8
	09-14-94	0800	19.5	21.0	--	49	7.3	80	--	--
22	09-13-94	0930	23.0	26.0	5.2	72	5.9	69	6.0	3.8
	09-14-94	0820	20.5	--	--	85	5.1	56	--	--
23	09-13-94	1545	27.0	30.0	--	13,600	12.4	163	7.2	16
	09-14-94	0900	26.0	27.0	--	8,400	3.8	48	--	--

Table 3.--Field measurements at synoptic sampling sites in Baldwin County, Alabama--Continued

Site number	Date	Time	Temperature water (°C)	Temperature air (°C)	Discharge, (cubic feet per second)	Specific conductance (uS/cm)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)	pH water field (standard units)	Oxygen demand, biochemical, (5-day mg/L)
23	09-14-94	1740	28.5	--	--	16,500	12.0	164	--	--
	09-15-94	1245	29.5	--	--	15,200	7.6	105	--	--
24	09-14-94	1300	28.0	--	--	24,900	7.0	97	5.4	5.4
25	09-13-94	0835	22.0	29.0	--	70	7.2	82	--	--
	09-14-94	0845	19.5	--	--	74	6.3	69	--	--
	09-15-94	0800	22.0	23.0	30	70	6.9	79	5.9	3.0
26	09-14-94	0745	27.5	22.0	--	15,900	8.0	106	--	--
	09-15-94	0915	27.0	23.5	--	17,300	7.1	95	7.4	4.4
27	09-14-94	0920	19.5	--	--	48	6.0	66	--	--
	09-15-94	1145	20.0	23.0	7.2	46	7.0	78	5.7	2.8
28	09-14-94	1040	20.5	24.5	42	55	5.9	65	6.8	3.4
	09-15-94	1205	21.0	--	--	53	7.4	83	--	--
29	09-13-94	0820	22.0	27.0	--	82	6.1	70	--	--
	09-14-94	0930	22.0	--	9.1	89	6.0	68	6.1	5.2
	09-14-94	1710	22.5	--	--	89	6.4	74	--	--
30	09-13-94	0800	25.0	25.0	--	79	3.3	40	--	--
	09-14-94	1055	22.5	--	2.2	83	3.7	43	6.0	4.4
	09-14-94	1725	23.5	--	--	83	4.9	58	--	--
31	09-14-94	1000	20.5	23.0	8.6	21	7.3	82	6.0	5.4
32	09-13-94	0820	21.5	--	86	45	7.2	82	--	--
	09-14-94	1200	22.0	28.0	81	44	7.6	87	6.2	3.6

Table 4.--Laboratory analyses of water samples from synoptic sampling sites in Baldwin County, Alabama

(mg/L; milligrams per liter; cols/100 ml, colonies per 100 milliliters; NTU, Nephelometric turbidity units; K, non-ideal colony count; >, actual value is know to be greater than value shown; <, actual value is known to be less than the value shown)

Site number	Date	Time	Carbon, organic total (mg/L as C)	Alkalinity total (mg/L as $CaCO_3$)	Carbonate dissolved (mg/L as CO_3)	Bicar-bonate dissolved (mg/L as HCO_3)	Alkalinity dissolved (mg/L as $CaCO_3$)	Coliform fecal (cols/ 100 ml)	Strep-tococci (cols/ 100 ml)	Turbidity (NTU)
1	09-12-94	1315	3.8	3	0	3	2	460	--	5.5
2	09-12-94	1430	5.2	3	0	3	2	740	--	9.8
3	09-12-94	1330	4.2	3	0	2	2	150	--	4.0
4	09-12-94	1445	3.5	4	0	3	3	65	--	2.2
5	09-12-94	1300	4.8	5	0	5	4	150	--	3.4
6	09-12-94	1400	3.3	2	0	1	1	170	--	2.8
7	09-14-94	1100	--	3	0	2	2	85	140	2.1
8	09-13-94	1200	6.6	2	0	1	1	50	57	2.3
9	09-13-94	1115	2.0	4	0	4	3	77	130	1.8
10	09-13-94	1700	3.2	1	0	1	1	K72	K22	3.8
11	09-15-94	0900	4.7	17	0	21	17	540	600	9.6
12	09-15-94	1045	3.5	9	0	9	8	130	>1,000	13
13	09-15-94	0830	2.8	9	0	10	8	570	>1,000	7.7
14	09-15-94	0930	2.5	4	0	4	3	430	>1,000	2.4
15	09-13-94	1200	7.5	1	0	0	0	72	65	2.6
16	09-13-94	1300	6.4	6	0	7	6	160	62	4.3
17	09-13-94	1400	4.9	2	0	3	2	K26	50	3.7
18	09-14-94	1400	7.9	9	0	10	8	200	210	6.3
19	09-14-94	1200	7.2	13	0	14	12	300	--	4.6
20	09-13-94	1430	4.9	16	0	21	17	320	620	1.4

Table 4.--Laboratory analyses of s water amples from synoptic sampling sites in Baldwin County, Alabama--Continued

Site number	Date	Time	Carbon, organic total (mg/L as C)	Alkalinity total (mg/L as $CaCO_3$)	Carbonate dissolved (mg/L as CO_3)	Bicar-bonate dissolved (mg/L as HCO_3)	Alkalinity dissolved (mg/L as $CaCO_3$)	Coliform fecal (cols/ 100 ml)	Strep-tococci (cols/ 100 ml)	Turbidity (NTU)
21	09-13-94	1045	4.6	3	0	3	2	490	240	1.2
22	09-13-94	0930	9.4	7	0	8	7	>600	740	4.4
23	09-13-94	1545	8.7	50	0	60	49	560	160	3.5
24	09-14-94	1300	11	10	0	11	9	150	480	9.5
25	09-15-94	0800	2.3	5	0	6	5	1,000	1,100	2.7
26	09-15-94	0915	11	56	0	68	56	K39	K32	9.9
27	09-15-94	1145	8.2	3	0	4	4	720	>1000	3.0
28	09-14-94	1040	3.1	7	0	8	6	190	410	2.6
29	09-14-94	0930	2.5	9	0	9	8	130	440	2.3
30	09-14-94	1055	2.3	14	0	16	13	480	460	1.7
31	09-14-94	1000	2.1	3	0	2	2	85	70	1.4
32	09-14-94	1200	2.7	5	0	5	4	320	250	3.5

Table 4.--Laboratory analyses of water samples from synoptic sampling sites in Baldwin County, Alabama--Continued

Site number	Nitrogen, total (mg/L as N)	Nitrogen, organic total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, nitrate total (mg/L as N)	Nitrogen, ammonia + organic total (mg/L as N)	Nitrogen NO_2+NO_3 total (mg/L as N)	Nitrogen, NO_2+NO_3 dissolved (mg/L (as N)
1	0.53	0.20	0.02	0.02	<.01	<.01	0.31	0.22	0.32	0.32
2	.31	.22	.02	.02	<.01	<.01	.07	.24	.07	.07
3	.25	.19	.03	.02	<.01	<.01	.04	.21	.05	.05
4	--	--	.03	.02	<.01	<.01	.05	<.20	.06	.06
5	.28	.24	.05	.02	<.01	<.01	.02	.26	.04	.04
6	.36	.20	.03	.01	<.01	<.01	.15	.21	.16	.16
7	--	--	.03	.01	<.01	<.01	.09	<.20	.12	.12
8	.26	.25	.02	.01	<.01	<.01	--	.26	<.02	<.02
9	--	--	.02	.03	<.01	<.01	.41	<.20	.41	.41
10	.54	.25	.02	.03	<.01	<.01	.26	.28	.26	.26
11	.52	.37	.06	.06	<.01	.01	.08	.43	.09	.09
12	--	--	.02	.02	<.01	<.01	.48	<.20	.48	.48
13	1.1	.22	.13	.12	.01	.01	.80	.34	.81	.81
14	--	--	.03	.02	<.01	<.01	.79	<.20	.80	.80
15	.39	.34	.03	.03	<.01	.01	.01	.37	.02	.02
16	.38	.24	.03	.02	<.01	<.01	.12	.26	.13	.13
17	.34	.26	.03	.02	<.01	<.01	.06	.28	.06	.06
18	.76	.35	.03	.03	<.01	<.01	.38	.38	.38	.38
19	.81	.36	.08	.08	<.01	<.01	.37	.44	.37	.37
20	1.6	.31	.08	.08	.02	.02	1.18	.39	1.20	1.20

Table 4.--Laboratory analyses of water samples from synoptic sampling sites in Baldwin County, Alabama--Continued

Site number	Nitrogen, total (mg/L as N)	Nitrogen, organic total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, nitrate total (mg/L as N)	Nitrogen, ammonia + organic total (mg/L as N)	Nitrogen NO_2+NO_3 total (mg/L as N)	Nitrogen, NO_2+NO_3 dissolved (mg/L (as N)
21	1.5	0.19	0.03	0.02	<.01	<.01	1.30	0.21	1.30	1.30
22	2.1	.53	.29	.29	<.01	.01	1.29	.82	1.20	1.20
23	2.3	1.5	.30	.31	<.01	.01	.46	1.8	.47	.47
24	.71	.69	.02	.02	<.01	<.01	--	.71	<.02	<.02
25	--	--	.02	.01	<.01	<.01	2.50	<.20	2.50	2.50
26	1.0	.91	.02	.02	<.01	<.01	.10	.93	.10	.10
27	--	--	.04	.02	<.01	.01	1.29	<.20	1.30	1.30
28	--	--	.02	.01	<.01	<.01	1.10	<.20	1.10	1.10
29	--	--	.05	.03	<.01	<.01	2.80	<.20	2.80	2.80
30	--	--	.03	.02	.01	.01	1.49	<.20	1.50	1.50
31	--	--	.02	.02	<.01	<.01	.08	<.20	.11	.11
32	1.7	.20	.03	.02	<.01	<.01	1.50	.22	1.50	1.50

Table 4.--Laboratory analyses of water samples from synoptic sampling sites in Baldwin County, Alabama--Continued

Site number	Nitrogen, ammonia total (mg/L as NH4)	Nitrogen, ammonia dissolved (mg/L as NH4)	Nitrogen, total (mg/L as N03)	Phosphate, total (mg/L as PO4)	Phosphate, ortho, dissolved (mg/L as PO4)	Phosphorus total (mg/L as P)	Phosphorus dissolved (mg/L as P)	Phosphorus organic total (mg/L as P)	Phosphorus ortho, dissolved (mg/L as P)	Phosphorus ortho total (mg/L (as P)
1	0.03	0.03	2.3	0.03	--	<.02	<.02	--	<.01	0.01
2	.03	.03	1.4	.03	--	<.02	<.02	--	<.01	.01
3	.03	.04	1.1	.03	--	<.02	<.02	--	<.01	.01
4	.03	.04	--	--	--	<.02	<.02	--	<.01	<.01
5	.03	.06	1.2	--	--	<.02	<.02	--	<.01	<.01
6	.01	.04	1.6	--	--	<.02	<.02	--	<.01	<.01
7	.01	.04	--	--	--	<.02	<.02	--	<.01	<.01
8	.01	.03	--	--	--	<.02	<.02	--	<.01	<.01
9	.04	.03	--	--	--	<.02	<.02	--	<.01	<.01
10	.04	.03	2.4	.03	--	<.02	<.02	--	<.01	.01
11	.08	.08	2.3	.03	--	<.02	<.02	--	<.01	.01
12	.03	.03	--	.03	--	<.02	<.02	--	<.01	.01
13	.15	.17	5.1	.03	--	<.02	<.02	--	<.01	.01
14	.03	.04	--	.03	.03	<.02	<.02	--	.01	.01
15	.04	.04	1.7	--	--	<.02	<.02	--	<.01	<.01
16	.03	.04	1.7	.03	.03	<.02	<.02	--	.01	.01
17	.03	.04	1.5	.03	--	<.02	<.02	--	<.01	.01
18	.04	.04	3.4	.15	.12	.05	.04	.0	.04	.05
19	.10	.10	3.6	.15	.12	.05	.05	.0	.04	.05
20	.10	.10	7.0	.61	.49	.20	.15	.0	.16	.20

Table 4.--Laboratory analyses of water samples from synoptic sampling sites in Baldwin County, Alabama--Continued

Site number	Nitrogen, ammonia total (mg/L as NH4)	Nitrogen, ammonia dissolved (mg/L as NH4)	Nitrogen, total (mg/L as N03)	Phosphate, total (mg/L as PO4)	Phosphate, ortho, dissolved (mg/L as PO4)	Phosphorus total (mg/L as P)	Phosphorus dissolved (mg/L as P)	Phosphorus organic total (mg/L as P)	Phosphorus ortho, dissolved (mg/L as P)	Phosphorus ortho total (mg/L (as P)
21	0.03	0.04	6.7	0.03	0.03	<.02	<.02	--	0.01	0.01
22	.37	.37	9.4	.15	.09	.05	<.02	.0	.03	.05
23	.40	.39	10	.28	.03	.18	.03	.09	.01	.09
24	.03	.03	--	.06	.03	.03	<.02	.01	.01	.02
25	.01	.03	--	.03	--	.11	.02	.10	<.01	.01
26	.03	.03	4.6	.12	--	.07	<.02	.03	<.01	.04
27	.03	.05	--	--	--	<.02	<.02	--	<.01	<.01
28	.01	.03	--	.03	--	<.02	<.02	--	<.01	.01
29	.04	.06	--	.03	.03	<.02	<.02	--	.01	.01
30	.03	.04	--	.03	.03	<.02	<.02	--	.01	.01
31	.03	.03	--	--	--	<.02	<.02	--	<.01	<.01
32	.03	.04	7.6	.09	.06	.02	<.02	.0	.02	.03

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996

ft^3/s, cubic foot per second; µS/cm, microSiemens per centimeter; mg/L milligrams per liter; µg/L, micrograms per liter; cols/100 mL, colonies per 100 milliliters; --, not available; <, less than. Locations of sites shown in fig. 1.]

Water-quality constituent or property	Number of samples	Concentration or measurement: Maximum	Minimum	Mean	Median
Site 3, Majors Creek near Tensaw					
PHYSICAL-CHEMICAL PROPERTIES					
Water temperature, in degree Celsius	16	26.0	7.5	17.9	19
Discharge, instantaneous, in ft^3/s	16	600	25	104	52
Specific conductance, instantaneous in µS/cm	16	24	18	21	20
Dissolved oxygen, in mg/L	13	11.5	6.0	8.8	8.6
Dissolved oxygen, in percent saturation	13	101	61	91	94
Biochemical oxygen demand, 5 day at 20 °C in mg/L	9	1.5	.4	.9	.9
Chemical oxygen demand, in mg/L	12	18	<10	--	--
pH, field value in standard units	16	6.1	4.4	--	5.4
Alkalinity, in mg/L as CaCO3	14	4.0	.0	1.9	2.0
Dissolved solids, total residue at 180 °C	6	51	18	30	27

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 3, Majors Creek near Tensaw					
NUTRIENTS					
Nitrate, total as N in mg/L	12	0.06	0.01	0.04	0.04
Nitrite, total as N in mg/L	13	.02	<.01	--	--
Nitrate plus nitrite, total as N in mg/L	13	.05	<.02	.04*	.04*
Nitrate plus nitrite, dissolved as N in mg/L	13	.05	<.02	.04*	.04*
Ammonia, total as N in mg/L	13	.03	<.01	.02*	.01*
Ammonia, dissolved as N in mg/L	13	.03	<.01	.02*	.01*
Ammonia, total as NH4 in mg/L	10	.04	.01	.02	.02
Ammonia, dissolved as NH4 in mg/L	12	.04	.01	.02	.01
Nitrogen, organic, total as N in mg/L	6	.42	.19	.27	.28
Nitrogen, ammonia plus organic, total as N in mg/L	13	.43	<.2	.20*	.18*
Nitrogen, total as N in mg/L	6	.48	.24	.32	.31
Phosphorus, total as P in mg/L	13	<.02	--	--	--
Phosphorus, dissolved as P in mg/L	13	<.02	--	--	--
Orthophosphorus, total as P in mg/L	13	.07	<.01	.02*	.01*
Orthophosphorus, dissolved as P in mg/L	13	.01	<.01	--	--
Phosphate, total as PO4 in mg/L	11	.21	.03	.05	.03
Orthophosphate, dissolved as PO4 in mg/L	3	.03	.03	--	--
Total organic carbon, in mg/L	13	9.4	2.9	5.0	4.2
MINOR CONSTITUENTS					
Cyanide, dissolved in mg/L	6	.02	<.02	--	--
Arsenic, dissolved, in µg/L	6	<1	--	--	--
Barium, dissolved in µg/L	6	69	15	29	24
Cadmium, dissolved, in µg/L	6	<1	--	--	--
Chromium, dissolved, in µg/L	6	<1	--	--	--
Copper, dissolved, in µg/L	6	19	<1	--	--
Iron, dissolved, in µg/L	6	390	230	290	280
Lead, dissolved, in µg/L	6	2	<1	--	--
Nickel, dissolved, in µg/L	6	2	<1	--	--
BACTERIA					
Fecal coliform, in cols/100 mL	14	940	39	160	78
Fecal streptococci, in cols/100 mL	12	1,900	23	300	100

* value is estimated by using a log-probability regression to predict the values of data below the detection limit.

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 7, Bay Minette Creek near Stapleton					
PHYSICAL-CHEMICAL PROPERTIES					
Water temperature, in degree Celsius	16	24.5	10.0	18.1	19.5
Discharge, instantaneous, in ft^3/s	16	1,000	22	100	50
Specific conductance, instantaneous in µS/cm	16	26	19	21	20
Dissolved oxygen, in mg/L	14	11.1	6.5	8.5	8.6
Dissolved oxygen, in percent saturation	14	104	77	90	90
Biochemical oxygen demand, 5 day at 20 °C in mg/L	8	2.6	.0	1.2	.90
Chemical oxygen demand, in mg/L	12	15	<10	--	--
pH, field value in standard units	16	6.2	4.6	--	5.6
Alkalinity, in mg/L as CaCO3	14	4.0	0.0	2.1	2.0
Dissolved solids, total residue at 180 °C	6	.30	10	22	23

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement Maximum	Minimum	Mean	Median
Site 7, Bay Minette Creek near Stapleton					
NUTRIENTS					
Nitrate, total as N in mg/L	13	0.11	0.03	0.07	0.08
Nitrite, total as N in mg/L	13	.01	<.01	--	--
Nitrate plus nitrite, total as N in mg/L	13	.12	.04	.07	.08
Nitrate plus nitrite, dissolved as N in mg/L	12	.12	.04	.08	.08
Ammonia, total as N in mg/L	13	.03	<.01	.01*	.01*
Ammonia, dissolved as N in mg/L	12	.03	<.01	.01*	.01*
Ammonia, total as NH4 in mg/L	10	.04	.01	.02	.01
Ammonia, dissolved as NH4 in mg/L	11	.04	.01	.02	.01
Nitrogen, organic, total as N in mg/L	4	.36	.21	--	--
Nitrogen, ammonia plus organic, total as N in mg/L	13	.37	<.20	--	--
Nitrogen, total as N in mg/L	4	.43	.27	--	--
Phosphorus, total as P in mg/L	13	.09	<.02	--	--
Phosphorus, dissolved as P in mg/L	12	.02	<.02	--	--
Orthophosphorus, total as P in mg/L	13	.03	<.01	.01*	.01*
Orthophosphorus, dissolved as P in mg/L	12	.02	<.01	.01*	.01*
Phosphate, total as PO4 in mg/L	10	.09	.03	.04	.03
Orthophosphate, dissolved as PO4 in mg/L	5	.06	.03	--	--
Total organic carbon, in mg/L	11	12	.10	4.29	2.90
MINOR CONSTITUENTS					
Cyanide, dissolved in mg/L	6	<.02	--	--	--
Arsenic, dissolved, in µg/L	6	<1	--	--	--
Barium, dissolved in µg/L	6	15	10	13	14
Cadmium, dissolved, in µg/L	6	<1.0	--	--	--
Chromium, dissolved, in µg/L	6	<1	--	--	--
Copper, dissolved, in µg/L	6	28	<1	--	--
Iron, dissolved, in µg/L	6	420	140	240	200
Lead, dissolved, in µg/L	6	4	<1	--	--
Nickel, dissolved, in µg/L	6	2	<1	--	--
BACTERIA					
Fecal coliform, in cols/100 mL	14	1,100	16	200	88
Fecal streptococci, in cols/100 mL	14	1,100	26	300	160

* value is estimated by using a log-probability regression to predict the values of data below the detection limit.

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 16, Styx River near Loxley					
PHYSICAL-CHEMICAL PROPERTIES					
Water temperature, in degree Celsius	16	26.0	6.5	18.5	19.5
Discharge, instantaneous, in ft^3/s	16	790	55	180	120
Specific conductance, instantaneous in µS/cm	16	36	22	29	30
Dissolved oxygen, in mg/L	14	9.9	7.0	8.4	8.2
Dissolved oxygen, in percent saturation	14	101	70	89	90
Biochemical oxygen demand, 5 day at 20 °C in mg/L	9	1.8	.0	.9	.9
Chemical oxygen demand, in mg/L	12	18	<10	--	--
pH, field value in standard units	16	6.3	5.2	--	6.1
Alkalinity, in mg/L as CaCO3	14	8.0	2.0	4.9	5.0
Dissolved solids, total residue at 180 °C	6	48	24	34	29

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 16, Styx River near Loxley					
NUTRIENTS					
Nitrate, total as N in mg/L	13	0.47	0.03	0.16	0.12
Nitrite, total as N in mg/L	13	.01	--	.01*	.01*
Nitrate plus nitrite, total as N in mg/L	13	.44	.04	.16	.14
Nitrate plus nitrite, dissolved as N in mg/L	13	.44	.04	.16	.14
Ammonia, total as N in mg/L	13	.03	<.01	.01*	.01*
Ammonia, dissolved as N in mg/L	13	.03	<.01	.01*	.01*
Ammonia, total as NH4 in mg/L	11	.04	.01	.02	.03
Ammonia, dissolved as NH4 in mg/L	12	.04	.01	.01	.01
Nitrogen, organic, total as N in mg/L	8	.57	.20	.35	.34
Nitrogen, ammonia plus organic, total as N in mg/L	13	.59	<.2	.28*	.26*
Nitrogen, total as N in mg/L	8	.78	.32	.54	.52
Phosphorus, total as P in mg/L	13	.05	<.02	--	--
Phosphorus, dissolved as P in mg/L	13	.03	<.02	--	--
Orthophosphorus, total as P in mg/L	13	.04	<.01	.01*	.01*
Orthophosphorus, dissolved as P in mg/L	13	.02	<.01	.01*	.01*
Phosphate, total as PO4 in mg/L	12	.12	.03	.05	.03
Orthophosphate, dissolved as PO4 in mg/L	10	.06	.03	.03	.03
Total organic carbon, in mg/L	13	15	2	7.0	5.4
MINOR CONSTITUENTS					
Cyanide, dissolved in mg/L	6	.02	<.02	--	--
Barium, dissolved in µg/L	6	21	13	17	18.5
Cadmium, dissolved, in µg/L	6	<1.0	--	--	--
Chromium, dissolved, in µg/L	6	<1	--	--	--
Copper, dissolved, in µg/L	6	24	<1	--	--
Iron, dissolved, in µg/L	6	930	190	460	300
Lead, dissolved, in µg/L	6	4	<1	--	--
Nickel, dissolved, in µg/L	6	<1	--	--	--
BACTERIA					
Fecal coliform, in cols/100 mL	14	450	35	140	--
Fecal streptococci, in cols/100 mL	14	700	17	160	79

* value is estimated by using a log-probability regression to predict the values of data below the detection limit.

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 18, Blackwater River near Elsanor					
PHYSICAL-CHEMICAL PROPERTIES					
Water temperature, in degree Celsius	16	25.5	9.0	18.7	20.0
Discharge, instantaneous, in ft^3/s	14	225	46	100	74
Specific conductance, instantaneous in µS/cm	16	58	44	53	53
Dissolved oxygen, in mg/L	15	9.9	3.7	6.6	6.6
Dissolved oxygen, in percent saturation	15	100	38	70	72.0
Biochemical oxygen demand, 5 day at 20 °C in mg/L	8	3.2	.7	1.5	1.3
Chemical oxygen demand, in mg/L	12	15	<10	--	--
pH, field value in standard units	15	6.9	5.7	--	6.4
Alkalinity, in mg/L as CaCO3	14	11.0	5.0	8.1	8.0
Dissolved solids, total residue at 180 °C	6	56	36	44	44

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 18, Blackwater River near Elsanor					
NUTRIENTS					
Nitrate, total as N in mg/L	13	0.99	0.03	0.56	0.52
Nitrite, total as N in mg/L	13	.01	<.01	.01*	.01*
Nitrate plus nitrite, total as N in mg/L	13	1.00	.04	.56	.52
Nitrate plus nitrite, dissolved as N in mg/L	13	1.00	.04	.56	.52
Ammonia, total as N in mg/L	13	.10	<.01	.03*	.02*
Ammonia, dissolved as N in mg/L	13	.04	.01	.02	.02
Ammonia, total as NH4 in mg/L	11	.13	.01	.04	.04
Ammonia, dissolved as NH4 in mg/L	13	.05	.01	.03	.03
Nitrogen, organic, total as N in mg/L	11	.52	.19	.32	.33
Nitrogen, ammonia plus organic, total as N in mg/L	13	.53	<.20	.32*	.31*
Nitrogen, total as N in mg/L	11	.99	.57	.86	.87
Phosphorus, total as P in mg/L	13	.11	.02	.06	.05
Phosphorus, dissolved as P in mg/L	13	.08	<.02	.03*	.03*
Orthophosphorus, total as P in mg/L	13	.08	.02	.04	.04
Orthophosphorus, dissolved as P in mg/L	13	.05	.02	.04	.04
Phosphate, total as PO4 in mg/L	13	.25	.06	.14	.12
Orthophosphate, dissolved as PO4 in mg/L	13	.15	.06	.11	.12
Total organic carbon, in mg/L	13	12	3.0	6.1	4.7
MINOR CONSTITUENTS					
Cyanide, dissolved in mg/L	6	.02	<.02	--	--
Arsenic, dissolved, in µg/L	6	<1	--	--	--
Barium, dissolved in µg/L	6	38	23	30	31
Cadmium, dissolved, in µg/L	6	<1.0	--	--	--
Chromium, dissolved, in µg/L	6	<1	--	--	--
Copper, dissolved, in µg/L	6	15	<1	--	--
Iron, dissolved, in µg/L	6	1,000	240	540	410
Lead, dissolved, in µg/L	6	2	<1	--	--
Nickel, dissolved, in µg/L	6	1	<1	--	--
BACTERIA					
Fecal coliform, in cols/100 mL	14	860	31	1,200	80
Fecal streptococci, in cols/100 mL	14	2,000	40	340	310

* value is estimated by using a log-probability regression to predict the values of data below the detection limit.

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 21, Sandy Creek near Elberta					
PHYSICAL-CHEMICAL PROPERTIES					
Water temperature, in degree Celsius	8	22.5	12.0	18.2	18.0
Discharge, instantaneous, in ft^3/s	7	28	10	15	13
Specific conductance, instantaneous in µS/cm	8	53	49	51	50
Dissolved oxygen, in mg/L	8	9.9	6.8	8.0	7.6
Dissolved oxygen, in percent saturation	8	92	71	84	86
Biochemical oxygen demand, 5 day at 20 °C in mg/L	5	1.8	.2	--	--
Chemical oxygen demand, in mg/L	6	10	<10	--	--
pH, field value in standard units	7	6.1	5.1	--	5.8
Alkalinity, in mg/L as CaCO3	7	7.0	1.0	3.4	3.0
Dissolved solids, total residue at 180 °C	2	42	36	--	--

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 21, Sandy Creek near Elberta					
NUTRIENTS					
Nitrate, total as N in mg/L	7	2.00	0.93	1.55	1.60
Nitrite, total as N in mg/L	7	.01	<.01	--	--
Nitrate plus nitrite, total as N in mg/L	7	2.00	.91	1.44	1.5
Nitrate plus nitrite, dissolved as N in mg/L	7	2.00	.91	1.44	1.5
Ammonia, total as N in mg/L	7	.09	<.01	.02*	.01*
Ammonia, dissolved as N in mg/L	7	.09	.01	.03	.02
Ammonia, total as NH4 in mg/L	6	.12	.01	.04	.02
Ammonia, dissolved as NH4 in mg/L	7	.12	.01	.04	.03
Nitrogen, organic, total as N in mg/L	3	.30	.19	--	--
Nitrogen, ammonia plus organic, total as N in mg/L	7	.39	<.20	--	--
Nitrogen, total as N in mg/L	3	1.7	1.3	--	--
Phosphorus, total as P in mg/L	7	.03	<.02	--	--
Phosphorus, dissolved as P in mg/L	7	.02	<.02	--	--
Orthophosphorus, total as P in mg/L	7	.02	<.01	.01*	.01*
Orthophosphorus, dissolved as P in mg/L	6	.06	.03	.03	.03
Phosphate, total as PO4 in mg/L	3	.06	.03	--	--
Orthophosphate, dissolved as PO4 in mg/L	7	9.0	1.6	3.4	2.2
Total organic carbon, in mg/L					
MINOR CONSTITUENTS					
Cyanide, dissolved in mg/L	2	<.02	--	--	--
Barium, dissolved in µg/L	2	37	32	--	--
Cadmium, dissolved, in µg/L	2	<1.0	--	--	--
Chromium, dissolved, in µg/L	2	<1	--	--	--
Copper, dissolved, in µg/L	2	2	<1	--	--
Iron, dissolved, in µg/L	2	150	32	--	--
Lead, dissolved, in µg/L	2	<1	--	--	--
Nickel, dissolved, in µg/L	2	2	<1	--	--
BACTERIA					
Fecal coliform, in cols/100 mL	7	590	150	310	240
Fecal streptococci, in cols/100 mL	7	530	90	290	300

* value is estimated by using a log-probability regression to predict the values of data below the detection limit.

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 25, Magnolia River near Magnolia Springs					
PHYSICAL-CHEMICAL PROPERTIES					
Water temperature, in degree Celsius	17	24.0	13.0	19.7	20
Discharge, instantaneous, in ft^3/s	15	34	22	30	30
Specific conductance, instantaneous in µS/cm	17	74	64	70	71
Dissolved oxygen, in mg/L	16	11	6.1	7.7	7.8
Dissolved oxygen, in percent saturation	16	103	66	84	83
Biochemical oxygen demand, 5 day at 20 °C in mg/L	9	3.0	.0	1.1	1.2
Chemical oxygen demand, in mg/L	12	11	<10	--	--
pH, field value in standard units	15	6.5	5.5	--	6.0
Alkalinity, in mg/L as CaCO3	14	8.0	3.0	5.3	5.0
Dissolved solids, total residue at 180 °C	6	58	40	50.8	53.5

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 25, Magnolia River near Magnolia Springs					
NUTRIENTS					
Nitrate, total as N in mg/L	13	3.10	1.79	2.63	2.69
Nitrite, total as N in mg/L	13	.01	<.01	--	--
Nitrate plus nitrite, total as N in mg/L	13	3.0	1.7	2.5	2.5
Nitrate plus nitrite, dissolved as N in mg/L	13	3.0	1.7	2.5	2.5
Ammonia, total as N in mg/L	13	.06	<.01	.02*	.01*
Ammonia, dissolved as N in mg/L	13	.03	<.01	.02*	.01*
Ammonia, total as NH4 in mg/L	11	.08	.01	.02	.01
Ammonia, dissolved as NH4 in mg/L	12	.04	.01	.02	.02
Nitrogen, organic, total as N in mg/L	3	.29	.19	--	--
Nitrogen, ammonia plus organic, total as N in mg/L	13	.32	<.20	--	--
Nitrogen, total as N in mg/L	3	2.8	2.1	--	--
Nitrogen, total in mg/L as NO3	3	12.0	9.4	--	--
Phosphorus, total as P in mg/L	13	.11	<.02	.03*	.02*
Phosphorus, dissolved as P in mg/L	13	.03	<.02	--	--
Orthophosphorus, total as P in mg/L	13	.04	<.01	.01*	.01*
Orthophosphorus, dissolved as P in mg/L	13	.03	<.01	.01*	.01*
Phosphate, total as PO4 in mg/L	10	.12	.03	.05	.03
Orthophosphate, dissolved as PO4 in mg/L	7	.09	.03	.05	.03
Total organic carbon, in mg/L	13	5.0	<.10	2*	1.6*
MINOR CONSTITUENTS					
Cyanide, dissolved in mg/L	6	.02	<.02	--	--
Arsenic, dissolved, in µg/L	6	<1	--	--	--
Barium, dissolved in µg/L	6	75	63	68	68
Cadmium, dissolved, in µg/L	6	<1.0	--	--	--
Chromium, dissolved, in µg/L	6	<1	--	--	--
Copper, dissolved, in µg/L	6	27	<1	--	--
Iron, dissolved, in µg/L	6	220	52	94.3	63.5
Lead, dissolved, in µg/L	6	4	<1	--	--
Nickel, dissolved, in µg/L	6	2	<1	--	--
BACTERIA					
Fecal coliform, in cols/100 mL	14	1,000	98	290	180
Fecal streptococci, in cols/100 mL	14	1,400	260	620	570

* value is estimated by using a log-probability regression to predict the values of data below the detection limit.

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 27, Cowpen Creek near Clay City					
PHYSICAL-CHEMICAL PROPERTIES					
Water temperature, in degree Celsius	9	20	13	17.8	18.5
Discharge, instantaneous, in ft^3/s	8	13	7.2	9.4	9.3
Specific conductance, instantaneous in µS/cm	9	48	44	46	47
Dissolved oxygen, in mg/L	9	8.4	6	7.5	7.6
Dissolved oxygen, in percent saturation	9	84	66	79	79
Biochemical oxygen demand, 5 day at 20 °C in mg/L	1	2.80	--	--	--
Chemical oxygen demand, in mg/L	6	<10	--	--	--
pH, field value in standard units	8	6.1	5.6	--	6.0
Alkalinity, in mg/L as CaCO3	8	5	3	4.6	5.0
Dissolved solids, total residue at 180 °C	1	32	--	--	--

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 27, Cowpen Creek near Clay City					
NUTRIENTS					
Nitrate, total as N in mg/L	7	1.60	1.09	1.35	1.30
Nitrite, total as N in mg/L	7	.01	<.01	--	--
Nitrate plus nitrite, total as N in mg/L	7	1.50	1.10	1.26	1.20
Nitrate plus nitrite, dissolved as N in mg/L	7	1.50	1.10	1.26	1.20
Ammonia, total as N in mg/L	7	.04	<.01	.02*	.02*
Ammonia, dissolved as N in mg/L	7	.04	<.01	.02*	.02*
Ammonia, total as NH4 in mg/L	6	.05	.01	.03	.03
Ammonia, dissolved as NH4 in mg/L	6	.05	.01	.03	.03
Nitrogen, organic, total as N in mg/L	1	.20	--	--	--
Nitrogen, ammonia plus organic, total as N in mg/L	7	.22	<.20	--	--
Nitrogen, total as N in mg/L	1	1.50	--	--	--
Phosphorus, total as P in mg/L	7	.03	<.02	--	--
Phosphorus, dissolved as P in mg/L	7	.03	<.02	--	--
Orthophosphorus, total as P in mg/L	7	.02	<.01	--	--
Orthophosphorus, dissolved as P in mg/L	7	.02	<.01	--	--
Phosphate, total as PO4 in mg/L	4	.06	.03	--	--
Orthophosphate, dissolved as PO4 in mg/L	3	.06	.03	--	--
Total organic carbon, in mg/L	7	8.20	<.10	2.16*	1.40*
MINOR CONSTITUENTS					
Cyanide, dissolved in mg/L	1	.02	--	--	--
Arsenic, dissolved, in µg/L	1	<1	--	--	--
Barium, dissolved in µg/L	1	31	--	--	--
Cadmium, dissolved, in µg/L	1	<1.0	--	--	--
Chromium, dissolved, in µg/L	1	<1	--	--	--
Copper, dissolved, in µg/L	1	20	--	--	--
Iron, dissolved, in µg/L	1	150	--	--	--
Lead, dissolved, in µg/L	1	<1	--	--	--
Nickel, dissolved, in µg/L	1	<1	--	--	--
BACTERIA					
Fecal coliform, in cols/100 mL	8	720	37	190	140
Fecal streptococci, in cols/100 mL	8	1,000	58	280	200

* value is estimated by using a log-probability regression to predict the values of data below the detection limit.

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 32, Fish River near Silverhill					
PHYSICAL-CHEMICAL PROPERTIES					
Water temperature, in degree Celsius	18	24	11	19.2	19.0
Discharge, instantaneous, in ft^3/s	16	150	66	93	84
Specific conductance, instantaneous in µS/cm	17	46	41	43	43
Dissolved oxygen, in mg/L	13	10	7.2	8.0	8.1
Dissolved oxygen, in percent saturation	13	90	82	86	86
Biochemical oxygen demand, 5 day at 20 °C in mg/L	5	3.6	.30	--	--
Chemical oxygen demand, in mg/L	10	36	<10	--	--
pH, field value in standard units	12	6.6	5.9	--	6.1
Alkalinity, in mg/L as CaCO3	12	8	4	5.1	5.0
Dissolved solids, total residue at 180 °C	3	40	30	--	--

Table 6.--Statistical summaries for water-quality data at fixed-station sampling sites in Baldwin County, Alabama, September 1994-April 1996 --Continued

Water-quality constituent or property	Number of samples	Concentration or measurement			
		Maximum	Minimum	Mean	Median
Site 32, Fish River near Silverhill					
NUTRIENTS					
Nitrate, total as N in mg/L	11	1.50	0.92	1.30	1.29
Nitrite, total as N in mg/L	11	.01	<.01	.01*	.01*
Nitrate plus nitrite, total as N in mg/L	11	1.50	.93	1.28	1.30
Nitrate plus nitrite, dissolved as N in mg/L	11	1.50	.93	1.28	1.30
Ammonia, total as N in mg/L	11	.06	<.01	.02*	.02*
Ammonia, dissolved as N in mg/L	11	.04	.01	.02	.02
Ammonia, total as NH4 in mg/L	10	.08	.01	.03	.03
Ammonia, dissolved as NH4 in mg/L	11	.05	.01	.03	.03
Nitrogen, organic, total as N in mg/L	6	.40	.16	.25	.24
Nitrogen, ammonia plus organic, total as N in mg/L	11	.46	<.20	.20*	.20*
Nitrogen, total as N in mg/L	6	1.7	1.3	1.5	1.6
Phosphorus, total as P in mg/L	11	.08	<.02	.03*	.03*
Phosphorus, dissolved as P in mg/L	11	.04	<.02	.02*	.02*
Orthophosphorus, dissolved as P in mg/L	11	.04	.02	.01*	.01*
Phosphate, total as PO4 in mg/L	11	.21	.03	.06	.03
Orthophosphate, dissolved as PO4 in mg/L	8	.12	.03	.06	.06
Total organic carbon, in mg/L	11	6.3	.09	2.3*	2.1*
MINOR CONSTITUENTS					
Cyanide, dissolved in mg/L	3	.02	<.02	--	--
Arsenic, dissolved, in µg/L	3	<1	--	--	--
Barium, dissolved in µg/L	3	40	32	--	--
Cadmium, dissolved, in µg/L	3	<1.0	--	--	--
Chromium, dissolved, in µg/L	3	<1	--	--	--
Copper, dissolved, in µg/L	3	12	<1	--	--
Iron, dissolved, in µg/L	3	460	210	--	--
Lead, dissolved, in µg/L	3	<1	--	--	--
Nickel, dissolved, in µg/L	3	2	<1	--	--
--					
BACTERIA					
Fecal coliform, in cols/100 mL	12	1,200	120	280	160
Fecal streptococci, in cols/100 mL	12	1,200	120	400	320

* value is estimated by using a log-probability regression to predict the values of data below the detection limit.