# STREAMFLOW IN AND WATER QUALITY AND BOTTOM MATERIAL ANALYSES OF THE J.B. CONVERSE LAKE BASIN, MOBILE COUNTY, ALABAMA, 1990-92

By Celeste A. Journey, William L. Psinakis, and J.B. Atkins

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 95-4106

Prepared in cooperation with the
BOARD OF WATER AND SEWER COMMISSIONERS,
CITY OF MOBILE, ALABAMA

Tuscaloosa, Alabama

1995

**U.S. DEPARTMENT OF THE INTERIOR**
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## CONVERSION FACTORS AND VERTICAL DATUM

| Multiply | By | To obtain |
|---|---|---|
| inch (in.) | 25.4 | millimeter |
| foot (ft) | 0.3048 | meter |
| square mile ($mi^2$) | 2.590 | square kilometer |
| acre | 4,047 | square meter |
| acre-foot (acre-ft) | 1,233 | cubic meter |
| gallon (gal) | 0.003785 | cubic meter |
| cubic foot per second ($ft^3/s$) | 0.02832 | cubic meter per second |
| cubic foot per second per square mile [$(ft^3/s)/mi^2$] | 0.01093 | cubic meter per second per square kilometer |
| acre-foot per year (acre-ft/yr) | 0.000039 | cubic meter per second |
| ton per day | 0.9072 | megagram per day |
| ton per year (ton/yr) | 0.9072 | megagram per year |
| ton per year per square mile [$(ton/yr)/mi^2$] | 0.3503 | megagram per year per square kilometer |
| degree Celsius ($^oC$) | $^oF = 1.8 \times {}^oC + 32$ | degree Fahrenheit |

<u>Sea level</u>: 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 level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

# STREAMFLOW IN AND WATER QUALITY AND BOTTOM MATERIAL ANALYSES OF THE J.B. CONVERSE LAKE BASIN, MOBILE COUNTY, ALABAMA, 1990-92

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## ABSTRACT

J.B. Converse Lake, a 3,600-acre reservoir in Mobile County, Alabama, is the primary source of water for the city of Mobile. This report describes hydrologic and water-quality data collected at seven major tributary sites and four lake sites in J.B. Converse Lake Basin from October 1990 to September 1992.

Big Creek and Hamilton Creek contributed approximately half of the J.B. Converse Lake inflow during low-flow periods and 60 percent of the baseflow to J.B. Converse Lake in 1991. Hamilton Creek had the highest low-flow yield among the tributaries; and Boggy Branch, the lowest. The time of travel for conservative substances in the lake was estimated on the basis of residence time of water within the reservoir and ranged from 7 to 10 days for normal lake volumes.

Only minor spatial and temporal variations in the physical and chemical properties of water were noted between tributary and lake sites. In the tributaries, the range in dissolved oxygen concentrations was 5.1 to 11 milligrams per liter; in specific conductance, 20 to 50 microsiemens per centimeter; in pH, 4.8 to 6.8; and in alkalinity, 1 to 12 milligrams per liter as calcium carbonate. Vertical profiles of dissolved oxygen concentrations, specific conductance, pH, and water temperature were obtained at four sites on the lake and demonstrated, to some degree, thermal stratification in August. The overall water chemistry of the J.B. Converse Lake Basin was classified as a sodium-calcium-chloride type. Long Branch and Boggy Creek had the maximum concentrations of iron and manganese. Mean concentrations of fecal coliform ranged from 124 to 670 colonies per 100 milliliters at the tributary sites; but was reduced to 16 colonies per 100 millimeter at the lake site near the pump station.

In 1991, the total nitrogen load and yield of the tributaries to J.B. Converse Lake were 138.69 tons per year and 1.94 tons per year per square mile. Big Creek contributed the maximum total nitrogen load of 64.41 tons per year. The total phosphorus load and yield for 1991 were 4.96 tons per year and 0.069 tons per year per square mile. Big Creek contributed the maximum total phosphorus load of 1.37 tons per year.

Water samples were collected quarterly at four lake locations, at the Myers Filtration Facility, and within the Mobile water system; and analyzed for the presence of *Giardia*. *Giardia* cysts were observed only in May 1991 at two lake sites: the mouth of Crooked Creek and at the pump station.

Bottom material was collected and analyzed for the presence of selected trace metals and pesticides at four lake sites. Manganese, lead, zinc, iron, chromium, copper, arsenic, and mercury, listed in order of decreasing concentrations, were detected. The detected pesticides were DDT, DDD, DDE, Chlordane, Dieldrin, and Heptachlor epoxide. No pesticide concentrations exceeded 11 micrograms per kilogram.

# INTRODUCTION

J.B. Converse Lake, a 3,600-acre reservoir in Mobile County, Alabama (fig. 1), is the primary source of freshwater for the city of Mobile, the second largest city in the State. According to the Mobile Chamber of Commerce (oral commun., 1993), the population of Mobile in 1990 was 196,278. The reservoir is also used for flood control, fish and wildlife, and recreational activities by residents and visitors to the area. The lake was created in 1952 by impounding Big Creek. The drainage area of J.B. Converse Lake at the dam is 103 $mi^2$ (square miles). At normal operational pool level, the lake holds approximately 17 billion gallons of water.

In July 1990, the U.S. Geological Survey, in cooperation with the Board of Water and Sewer Commissioners, city of Mobile, Alabama, began a study of the hydrologic and water-quality conditions of J.B. Converse Lake and selected tributaries to the lake. Municipal managers can use this data to assist in operating the present water system and in planning future development.

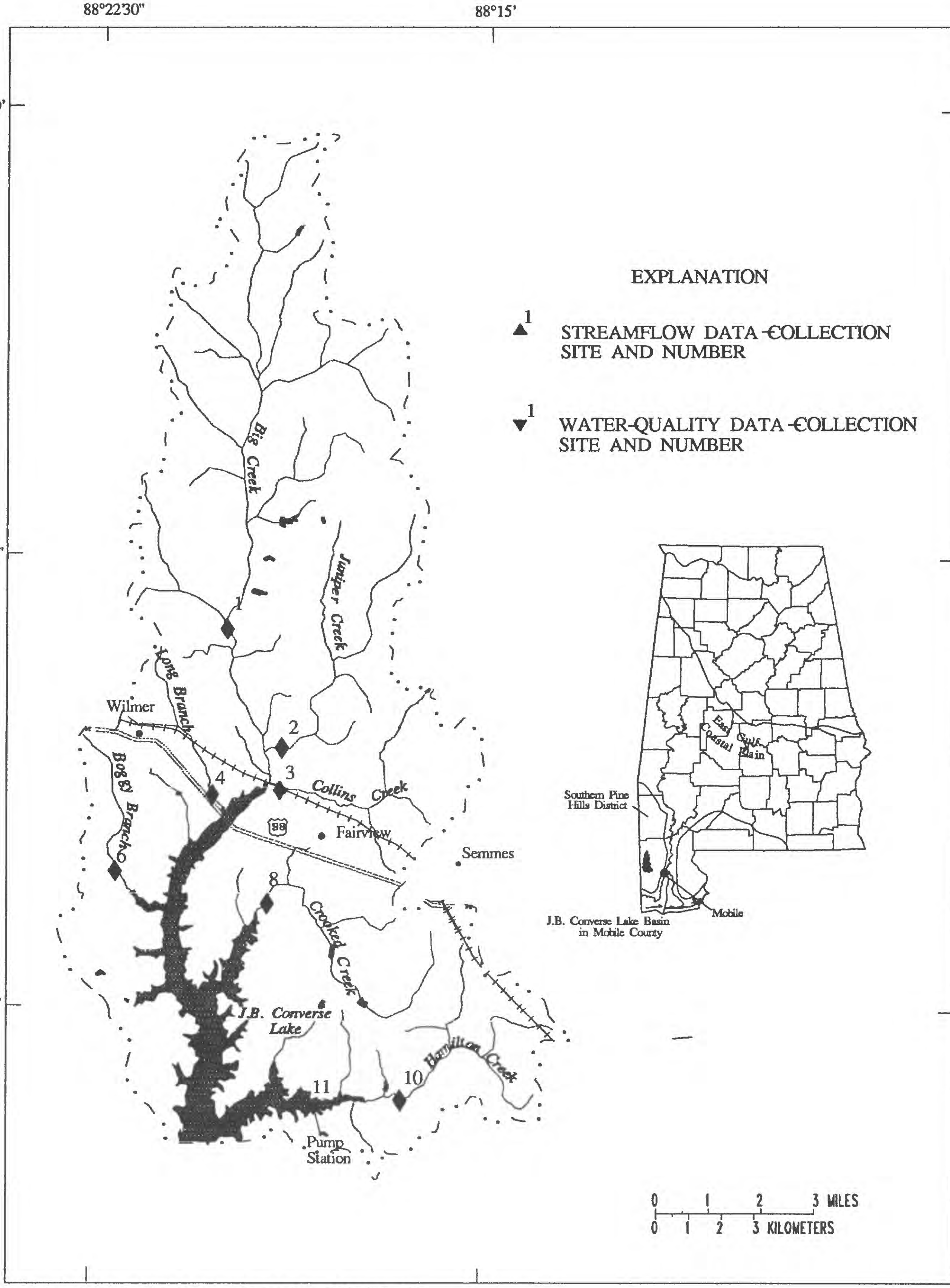
## Purpose and Scope

This report describes the results of a 2-year study on the streamflow and water-quality characteristics at seven tributary and four lake sites in J.B. Converse Lake Basin for the period of October 1990 to September 1992. The following hydrologic variables were measured and are summarized in this report: streamflow, water chemistry, bottom material chemistry, and biological properties. Spatial and temporal variations in the hydrologic properties at these sites serve as the basis for assessing the water-quality conditions in J.B. Converse Lake Basin. The report also contains estimates of the low-flow characteristics and annual nutrient loads of the tributaries and the time-of-travel of substances in the lake based on the residence time of water.

## Basin Description

The J.B. Converse Lake Basin is in the Southern Pine Hills District of the East Gulf Coastal Plain physiographic province (Sapp and Emplaincourt, 1975). The terrain in the basin is gently- to moderately-rolling. The land-surface elevation ranges from about 110 feet above sea level at the dam to about 300 feet above sea level at the headwaters of Big Creek. From the dam, Big Creek flows south-southwestward to the Escatawpa River in southeastern Mississippi.

Basin land was primarily forests, pastures, and farmlands at the time of impoundment. Gradually this land is being converted to residential, commercial, light industrial, and shrub nurseries. A railroad and a highway cross the lake near the mouth of Big Creek. The communities of Fairview and Wilmer are in the basin.




Base from U.S. Geological Survey digital data, 1:100,000, 1983
Universal Transverse Mercator projection,
Zone 16

Figure 1. --J.B. Converse Lake Basin, Mobile County, Alabama, and data-collection sites

## Climatological Information

The climate of the basin is temperate to subtropical. The summer months are warm and winter months are mild except for an occasional cold wave that generally lasts only a few days. The average annual temperature is about 20 °C. The monthly average temperatures range from about 11 °C in January to about 28 °C in July.

Average annual precipitation is about 65 inches. Precipitation in July, the wettest month, averages 7.74 inches. Precipitation in October, the driest month, averages 2.62 inches. The area is subject to tropical storms and hurricanes. Precipitation was about 6 inches above normal over the 2-year period of investigation (National Oceanic and Atmospheric Administration, 1991). In January 1991, precipitation was 16.07 inches at Bates Field near Mobile, which set a record for the wettest January on record. During the driest month, October 1991, precipitation was 0.86 inch.

## Data Collection and Analyses

Hydrologic and water-quality data were collected from seven major tributary sites and one site on the lake (fig. 1). Gaging stations constructed at these sites were equipped with stage recorders and water-quality minimonitors. The minimonitors provided continuous record of water temperature and specific conductance. Vertical water-profile data and bottom material were collected at four sites on the lake (fig. 2). The frequency of sampling and the types of constituents or properties obtained from the samples are listed in table 1.

Monthly water samples were collected from the seven major tributary sites (sites 1-4, 6, 8, 10) and from one lake site at the pump station (site 11). The monthly water samples were analyzed for major nutrient concentrations. Quarterly water samples were collected from the same sites and were analyzed for major dissolved constituents and minor elements. Field data--consisting of dissolved oxygen, specific conductance, pH, alkalinity, water temperature, and bacterial constituents (fecal coliform and fecal streptococcus)--were determined by field personnel during monthly sampling. Discharge measurements were made at the tributary sites.

The method for estimating mean annual nutrient load applied to major tributary sites (sites 1-4, 6, 8, 10) in the J.B. Converse Lake Basin incorporated the use of a logarithmic regression analysis between the nutrient load (dependent variable) and the instantaneous discharge (independent variable). The monthly nutrient load was computed at each site as a function of the concentration of the selected nutrient and a corresponding instantaneous discharge with the equation

$$\mathbf{L_i = 0.002697 C_i Q_i}, \qquad (1)$$

where $\mathbf{L_i}$ is the nutrient load in tons per day at the monthly sample period **i**,
$\mathbf{C_i}$ is the concentration of the nutrient in milligrams per liter at sample period **i**,
$\mathbf{Q_i}$ is the instantaneous discharge in cubic feet per second at sample period **i**,
and the coefficient is a conversion factor to tons per day. The regression equation developed was:

$$\mathbf{Ln\ (L) = b\ Ln\ (Q) + Ln\ a}, \qquad (2)$$

where **Ln** is the natural logarithm,

**L** is the daily nutrient load in tons per day,

**Q** is the daily mean discharge in cubic feet per second,

**a** is the intercept regression constant, and

**b** is the discharge regression coefficient (Garrett, 1990, p.10).

Ferguson (1986) noted that bias arises when the results of equation 2 are "retransformed into actual units. This bias can be reduced by adding an additional term to equation 2 to form:

$$Ln(L) = bLn(Q) + Ln(a) + \frac{s^2}{2}, \quad (3)$$

where **s** is the standard deviation of the residuals of the regression equation (equation 2). Before equation 3 was retransformed the last two terms of the equation were combined so that the retransformed equation was of the form:

$$\mathbf{L = c\,Q^{b}}, \quad (4)$$

where **c** represents the anti-log of the sum of the last two terms of equation 3.

Daily nutrient loads at each site were estimated from the regression equation by applying the daily discharge values for the study period. These daily load values are summed for the 1991 and 1992[1] water years to estimate the annual nutrient-load contribution of each tributary. The annual loads of each tributary were summed for the 1991 water year to obtain the total annual load to J.B. Converse Lake. The yield of each tributary can be calculated from the estimated annual nutrient load by dividing the annual load by the corresponding drainage area.

Vertical profiles of dissolved oxygen, specific conductance, pH, and water temperature were obtained at four sites on the lake (fig. 2). The profiles were at quarter points between the left and right banks (left one-quarter, center, and right one-quarter). Measurements were made from the surface to the bottom of the lake at 5-foot depth intervals. Water, collected from near the surface of the lake, was passed through a filter, and the filter was analyzed for Giardia. Treated water from within the city's water system was also filtered and analyzed for Giardia. Bottom material was collected from the center location of the lake profile and was analyzed for selected minor elements and pesticides.

## Acknowledgments

Appreciation is expressed to the management and staff at the Howard Johnsons Lodge[2] in Mobile for donating water from the Mobile Water System that was analyzed for the presence of Giardia. Appreciation is also extended to Kevin White of the University of South Alabama for his advice and guidance concerning sampling.

[1]Water year: in this report "water year" is the 12-month period, October 1 through Sept. 30. The water year is designated by the calendar year in which it ends. Thus, the year ending September 30, 1992 is called the 1992 water year.

[2]Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

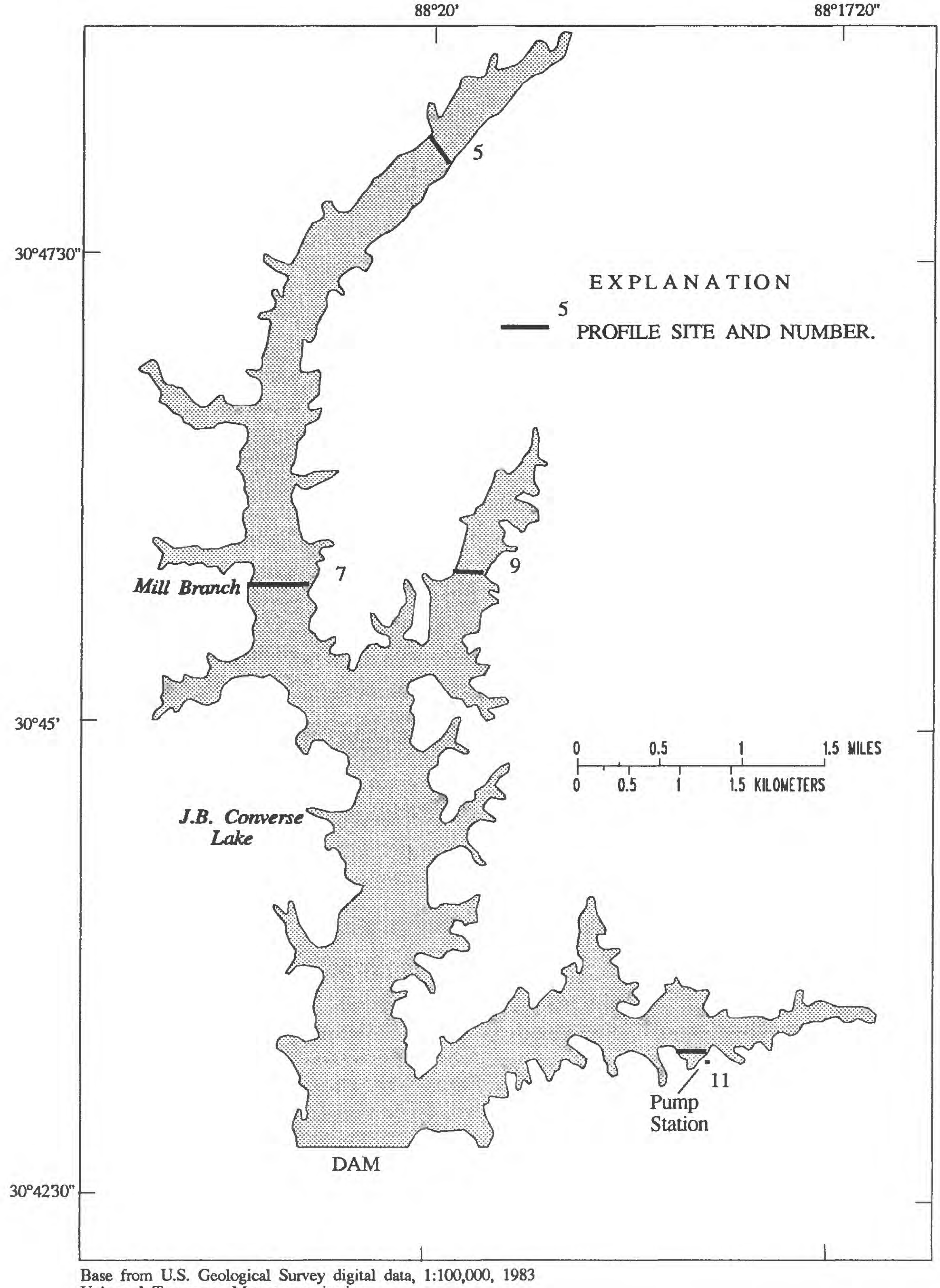
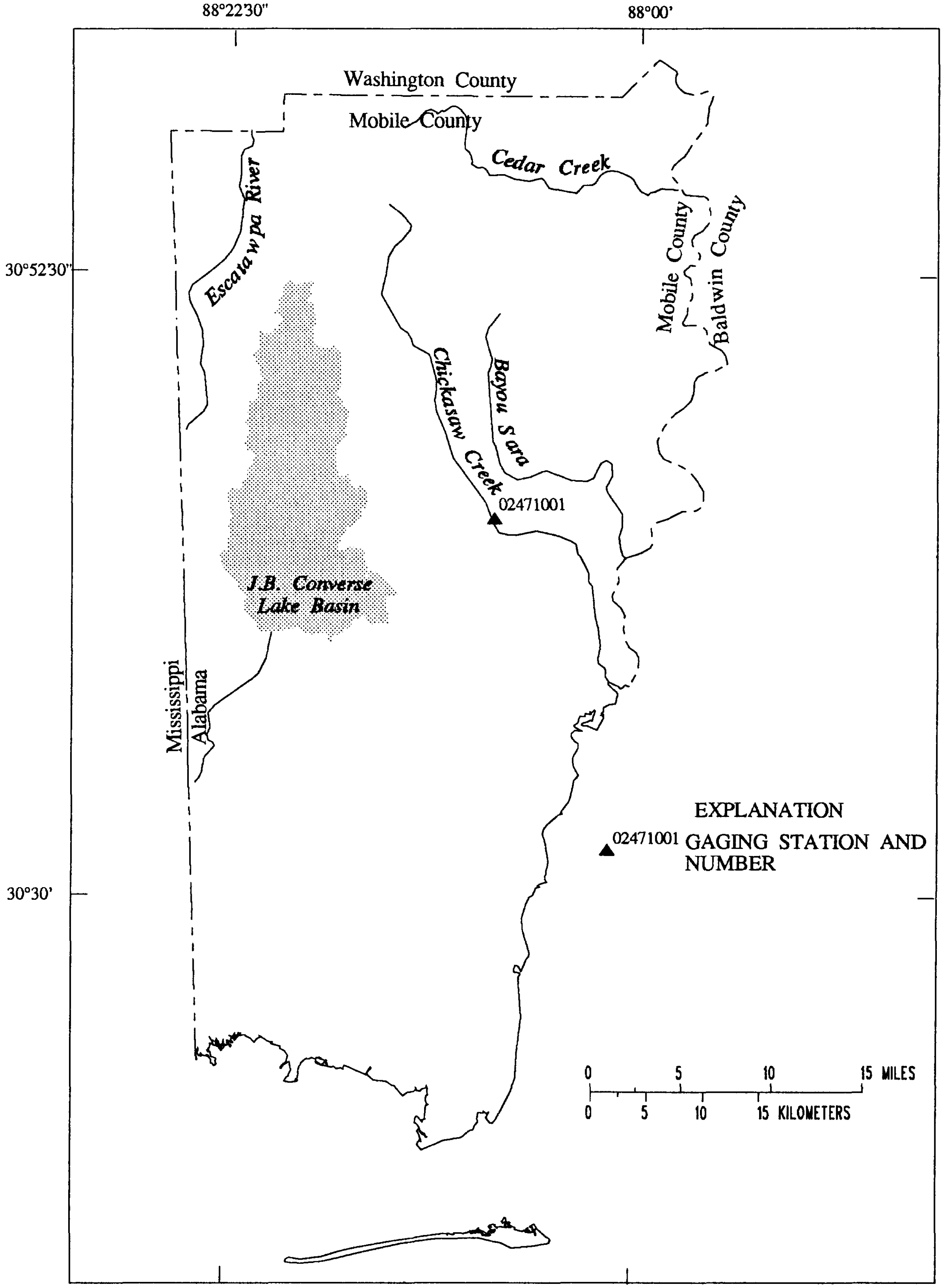



Figure 2.--Location of data-collection profile sites on J.B. Converse Lake




Base from U.S. Geological Survey digital data, 1:100,000, 1983
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Figure 3.— Location of gaging station on Chickasaw Creek

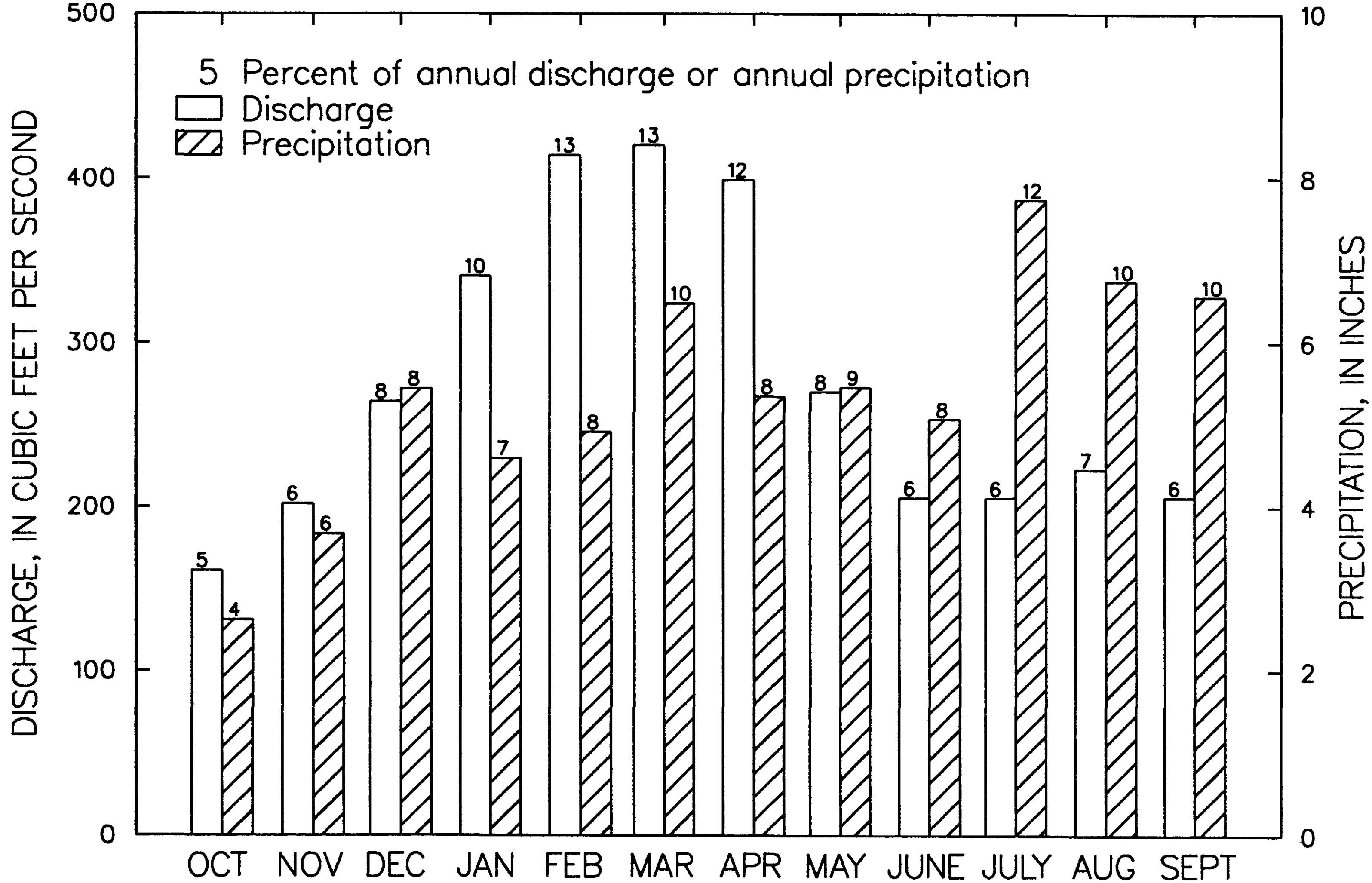


Figure 4.--Mean monthly discharge, precipitation, and percentage of annual discharge and precipitation, water years 1952-92, for Chickasaw Creek.

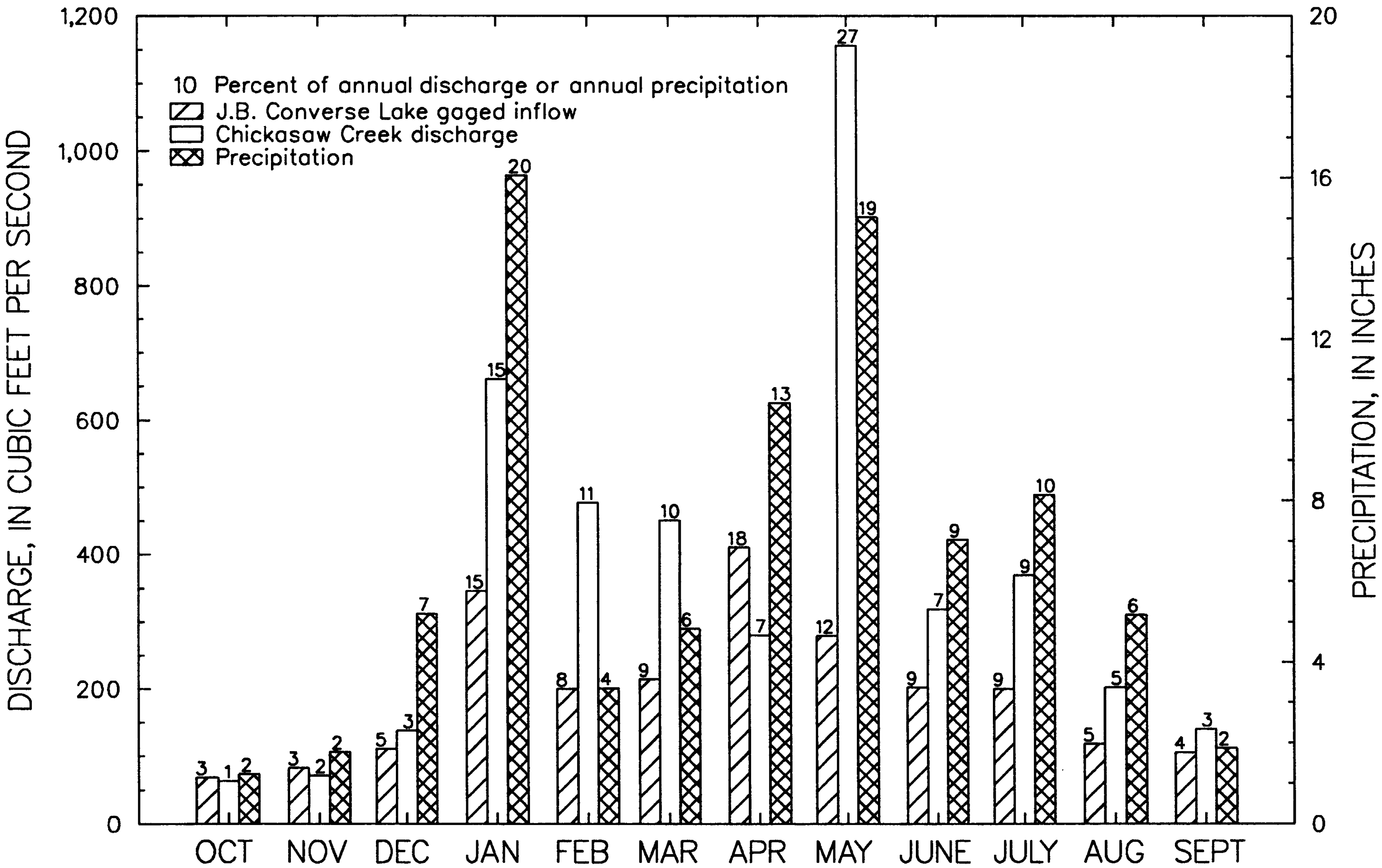


Figure 5.--Mean monthly discharge of gaged inflow for J.B. Converse Lake and Chickasaw Creek, monthly precipitation, and percentage of annual discharge and precipitation, water year 1991.

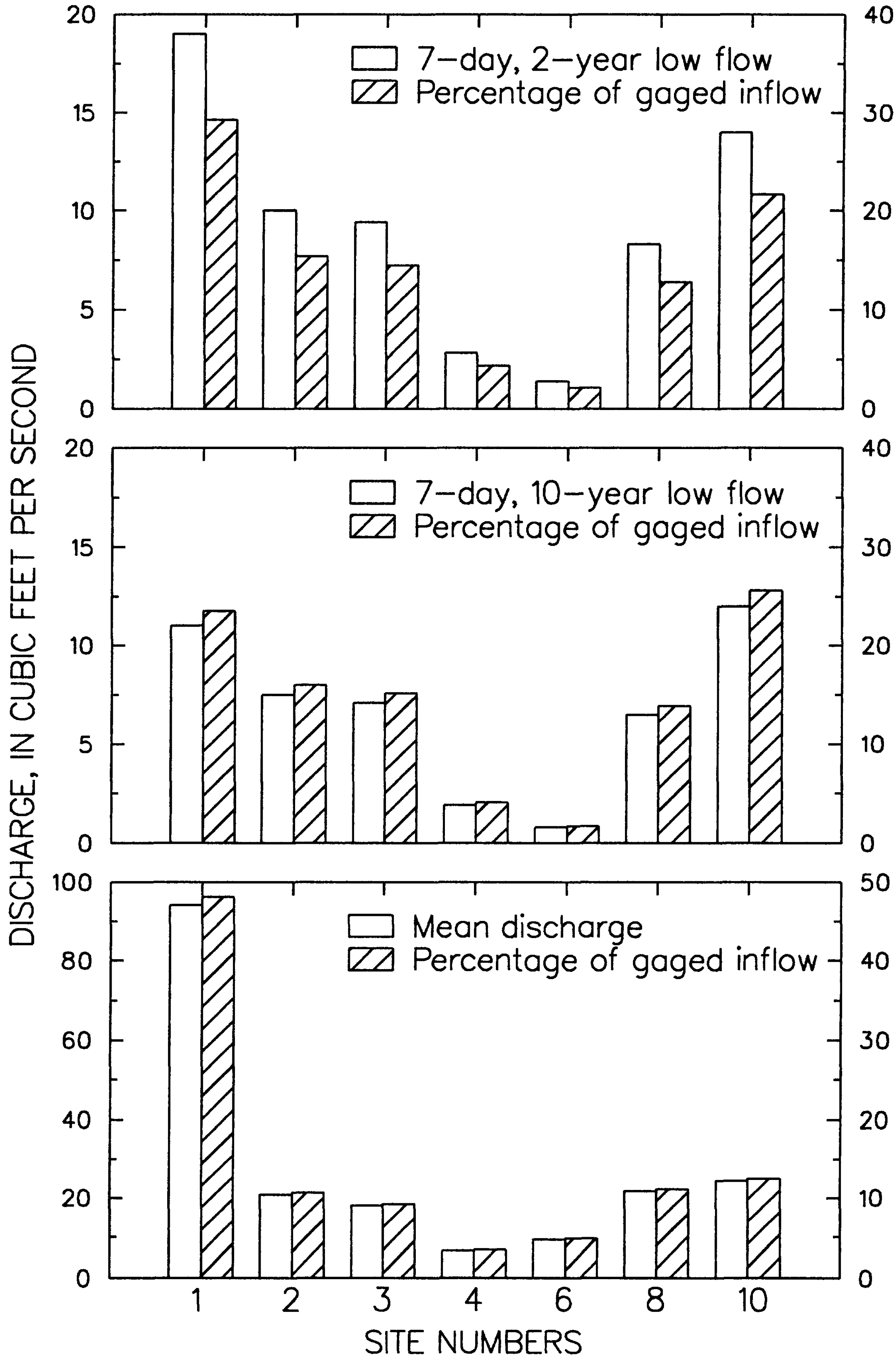


Figure 6.——Low–flow characteristics, 1991 water year mean discharges, and percentage of gaged inflow for the J.B. Converse Lake Basin gaging stations.

## STREAMFLOW

Streamflow in the Mobile County area generally is highest during December through May and lowest during June through November, on the basis of long-term (1952-92) streamflow data for Chickasaw Creek near Kushla (fig. 3). Although precipitation is higher during the summer than other periods of the year, streamflow generally is lower in the summer than other periods of the year as illustrated in figure 4. These lower streamflows are due to higher evapotranspiration rates which occur during late spring and summer.

During the 1991 water year, 67 percent of the gaged J.B. Converse Lake inflow occurred during December through May, and 69 percent of the total precipitation for the water year occurred during those months. Likewise, 73 percent of the annual discharge for Chickasaw Creek occurred during December through May (fig. 5).

### Low-Flow Characteristics

Low-flow characteristics were estimated to determine the contribution of each tributary to the reservoir during dry-weather baseflows. These low-flow characteristics, generally referred to as the 7-day, 2-year low flow ($7Q_2$) and the 7-day, 10-year low flow ($7Q_{10}$), are defined as the annual minimum flows for 7 consecutive days that have recurrence intervals of 2 and 10 years, respectively. Low-flow characteristics are estimated by fitting the annual 7-day low flows to a frequency curve, based on at least 10 years of continuous daily discharge data. However, because the periods of daily discharge data for the J.B. Converse Lake tributaries were 1 to 2 years in length, another method (Stedinger and Thomas, 1985) was used to estimate the $7Q_2$ and $7Q_{10}$, based on relations of the baseflows of each gaging station with the baseflows of Chickasaw Creek.

Estimates of low-flow characteristics are subject to uncertainty. The standard error of estimate of these low-flow characteristics was related to the accuracy of the correlations with the Chickasaw Creek gage. The standard errors were estimated using an equation developed by Stedinger and Thomas (1985, p. 8, equation 30) and converted to percentages. The standard errors for each site generally were less than 10 percent except for Boggy Branch (site 6) which had standard errors of 11 and 15 percent for the $7Q_2$ and the $7Q_{10}$, respectively, and Big Creek which had a standard error equal to 10 percent (table 2).

Low-flow characteristics of each site's drainage area (in cubic feet per second per square mile) provides a discharge yield which can be used as a means of comparison between each tributary in the J.B. Converse Lake Basin as listed in table 2. This comparison indicates that Hamilton Creek has the maximum low-flow yield among the seven gaged inflow sites and that Boggy Branch has the minimum low-flow yield. Although Big Creek (which drains 44 percent of the study area) contributed 48 percent of the mean 1991 water year inflow, the Big Creek base-flow contribution was 29 percent of the $7Q_2$ and 24 percent of the $7Q_{10}$, as indicated in figure 6. In contrast, Hamilton Creek (which drains 11 percent of the study area) contributed 13 percent of the mean 1991 water-year inflow, but its contribution during $7Q_2$ conditions was about 22 percent.

**Time-of-Travel**

An estimate of the time-of-travel of substances entering the J.B. Converse Lake at U.S. Highway 98 (site 5) near Wilmer and dispersing to the pump station (site 11) was determined by calculating the residence time of water within the lake. The accuracy of this estimate in simulating the actual time-of-travel for a substance within the lake depends upon several factors:

(1) behavior of the substance compared to water (such as, solubility, density, chemical and biological reactivity, sediment-water and air-water interactions);

(2) the rate, consistency, and distribution of water inflow from the tributaries, and outflow from the pump station, and spillage at the dam; and

(3) the mixing characteristics of the lake (such as, stratified versus unstratified, surface effects of wind and precipitation).

Therefore, three limiting assumptions for this estimate on the behavior of the substance are that the substance

(1) has the same density as water,

(2) instantaneously dissolves and evenly disperses within the lake, and

(3) is nonreactive, chemically and biologically.

Also, the outflow of the lake is assumed to be a regulated constant rate. The lake volume is continually renewed by the tributaries at a constant annual rate and is not affected by stratification.

Residence time of a material within a lake is the ratio of the total volume (in acre-feet) of the material in the lake to the flux (in acre-feet/year) of that material into or out of that lake. For this study, the overall flux of water into the lake was estimated from the total inflow of water from selected tributaries and precipitation during the 1991 water year (table 3). The overall flux of water out of the lake was estimated from the total outflow of water pumpage at the pump station, plus spillage at the dam, and estimated lake evaporation (table 3).

The total volume of water in the lake was divided by the flux of water into the lake and by the flux of water out of the lake to obtain two estimates of the residence time of water in years:

$$\textbf{1. Residence time (years)} = \frac{\textbf{Lake water volume}}{\textbf{Inflow + precipitation}}$$

and

$$\textbf{2. Residence time (years)} = \frac{\textbf{Lake water volume}}{\textbf{Outflow + evaporation}}$$

The normal lake volume is 52,000 acre-ft (Ricky White, City of Mobile Water and Sewer Board, oral commun., 1992). The area of interest from U.S. Highway 98 (site 5) to the pump station (site 11) virtually encompasses the entire lake; therefore, the assumption was made that the lake volume used in calculating the residence time was equal to the normal lake volume. The inflow to the lake from the tributaries combined with precipitation for the 1991 water year totalled 2,018,000 acre-ft/yr, producing a residence time of 0.026 year or about 9.5 days. The flux of water out of the lake (pumpage, spillage, and evaporation) for the same period totalled 2,625,000 acre-ft. A residence time of 0.020 year or about 7.3 days is estimated using outflow.

The residence time for water in the J.B. Converse Lake reservoir during the 1991 water year was estimated to fall between 7 to 10 days for normal lake volumes. In general, a 10-percent decrease in lake volume would decrease the residence time by 1 day, assuming constant rate of inflow and outflow. A 10-percent decrease in inflow and precipitation would increase the residence time by about 1 day, assuming a constant lake volume. Stratification in late summer would decrease the volume of water moving in the lake and, therefore, decrease the residence time.

Accurate measurements for time-of-travel of conservative substances would require the acquisition and numerical application of additional data. Use of conservative tracers, whether natural (alkalinity, lithium, sulfate) or introduced (dyes), could give a better understanding of the vertical and lateral dispersion of substances within the lake and provide a better estimate for the time required for water to reach the pump station from various locations. Special consideration would be required for modeling the behavior of nonconservative, particulate, or hydrophobic substances within the lake system.

## WATER QUALITY

The water quality of J.B. Converse Lake Basin (fig. 1), based on water samples collected from eight water-quality sites, is described for the period of October 1990 to September 1992. Seven major tributary sites (sites 1-4, 6, 8, 10) and one lake site, located at the pump station (site 11), comprised the water-quality sites. Sites 4 and 6 were not sampled from October 1991 to September 1992.

The water-quality data are presented in tabular (table 4) and graphical form. The degree of spatial and temporal variation of selected physical and chemical properties at the seven tributary sites (1-4, 6, 7, 10) and four lake sites (5, 7, 9, 11) are illustrated in box plots. Thermal stratification in late summer-early fall and overturn in late fall-early winter in J.B. Converse Lake are illustrated graphically by seasonal plots of the change in selected physical and chemical properties with depth at site 7. Areal variation of major dissolved constituents in J.B. Converse Lake Basin are illustrated by pie charts that represent the proportion of the average concentration of major ions at the eight water quality sites (1-4, 6, 8, 10, 11). Statistical analyses of major nutrient data were used to determine the nutrient loads and yields of the seven major tributaries (sites 1-4, 6, 8, 10) to J.B. Converse Lake and the results are presented in tabular and graphical form. Areal distribution of the minor elements in J.B. Converse Lake Basin are illustrated in bar graphs of total recoverable and dissolved concentrations of iron and manganese at the eight water-quality sites (1-4, 6, 8, 10, 11).

## Physical and Chemical Properties

The physical and chemical properties of dissolved oxygen, specific conductance, pH, alkalinity, and water temperature were determined instantaneously in the field at the eight water-quality sites (1-4, 6, 8, 10, 11) in J.B. Converse Lake Basin. Streamflow was monitored at the seven tributary sites (1-4, 6, 8, 10). Vertical profiles of dissolved oxygen, specific conductance, pH, and water temperature were determined at depth intervals of 5 feet at four sites (5, 7, 9, 11) in J.B. Converse Lake.

### Water-Quality Sites

The water in the tributary sites exhibited relatively low specific conductance, slightly acidic pH, and low alkalinity (table 4). Only minor areal variation was observed between tributary sites. The water at the four lake profile sites had specific conductance and pH ranges similar to the tributaries. Greater variation in the physical and chemical properties, especially dissolved oxygen, occurred at the lake profile sites due to changes in these properties with depth.

The optimum amount of oxygen that can be dissolved in water is a function of several factors, including the vapor pressure of oxygen, temperature of the water, and air pressure. Aquatic plant activity (photosynthesis) and streamflow can raise the dissolved oxygen in natural waters; however, biological and chemical processes in these waters generally dominate, reducing the dissolved oxygen below the optimum. Generally, the dissolved oxygen is presented as a concentration; but, it can be described as a saturation percentage, which is a ratio of the dissolved oxygen concentration measured in the water to the optimum dissolved-oxygen concentration based on oxygen solubility. The water quality of rivers is classified as fair for dissolved-oxygen greater than 40 percent saturation and good for greater than 60 percent (Ellis, 1989).

Dissolved-oxygen concentrations in the water at the seven tributary sites had a minimum of 5.1 mg/L (milligrams per liter) at Boggy Branch (site 6) and a maximum of 11 mg/L at Collins Creek (site 3). The mean dissolved-oxygen concentrations ranged from 6.7 mg/L at Boggy Branch (site 6) to 8.7 mg/L at Long Branch (site 4). The minimum percentage of dissolved oxygen saturation was 60 at Hamilton Creek (site 10) and the maximum was 97 at Collins Creek (site 3). The mean percentage of dissolved oxygen saturation ranged from 71 at Boggy Branch (site 6) to 92 at Long Branch (site 4).

The minimum specific conductance of the tributaries was 20 µS/cm (microsiemens per centimeter) at Collins Creek (site 3) and the maximum was 50 µS/cm at Long Branch (site 4). The mean specific conductance ranged from 22 µS/cm at Collins Creek (site 3)to 40 µS/cm at Long Branch (site 4). Published water-quality data for the adjacent basin of Chickasaw Creek (fig. 3) showed similar ranges in specific conductance (Pearman and others, 1990).

The minimum pH of the tributaries was 4.8 at Big Creek (site 1) and the maximum pH was 6.8 at Crooked Creek (site 8) and Long Branch (site 4). The water at the seven tributary sites had alkalinities that ranged from a minimum of 1 mg/L as CaCO3 at Big Creek (site 1) to a maximum of 12 mg/L as CaCO3 (calcium carbonate) at Crooked Creek (site 8). The mean values of alkalinity ranged from 2.9 mg/L as CaCO3 at Big Creek (site 1) to 7.0 mg/L as CaCO3 at Crooked Creek (site 8).

Dissolved oxygen, specific conductance, pH, and alkalinity are shown graphically by box plots (figs. 7, 8, 9, 10, respectively) to determine the degree of areal variation in these properties between tributary sites (1-4, 6, 8, 10) and the lake site at the pump station (site 11). The box graphically represents the position of the middle 50 percent of the data. The outline of the box is drawn from the 75th percentile (or third quartile) to the 25th percentile (or first quartile) with a solid line crossing the box at the median. The mean is represented by a dotted line. Those values above the third or upper quartile and those values below the first or lower quartile are shown as vertical lines, commonly called whiskers, that extend to the maximum and minimum value.

Only minor variation was observed in the box plots between the seven tributary sites and the lake site at the pump station in J.B. Converse Lake Basin. The tributaries located in the central and southern part of the basin (sites 6, 8, and 10; fig. 7) had lower dissolved-oxygen concentrations than the tributaries at the northern end (sites 1-4; fig. 7). These same sites (sites 6, 8, 10), with the addition of Long Branch (site 4), had higher specific conductance than Big Creek, Juniper Creek, and Collins Creek (sites 1-3, respectively; fig. 8), and the lake site (site 11). Big Creek (site 1) had the greatest range in pH compared to the other tributary sites (fig. 9). A general trend of increasing pH (fig. 9) was observed in the tributaries in J.B. Converse Lake Basin from north to south (sites 1-4, 8, 10). Long Branch (site 4) and Crooked Creek (site 8) had the greatest range in alkalinity and the highest values compared to the other sites (fig. 10). The alkalinity at site 11 ranged from a minimum of 2 mg/L as CaCO3 to a maximum of 7 mg/L as CaCO3 (table 4). The range was similar to the range of the mean alkalinity at the tributary sites (fig. 10).

**Lake Profile Sites**

The physical and chemical properties in J.B. Converse Lake are influenced by complex hydrodynamic processes in the lake due to factors such as the geometry of the lake (depth, width, length, surface area), hydrologic tributary effects, and climate. Relatively shallow lake regions near tributary mouths generally are dominated by riverine (stream-type) processes that actively mix the waters. In the deeper lake regions, the hydrodynamic mixing of the lake is dominated by lacustrine (lake-related) processes. The most important mixing process is dependent on the thermal properties of the lake. Thermal stratification of a lake occurs in the summer when the colder, deep waters (hypolimnion) are separated from the warmer surface waters (epilimnion) by a layer called the thermocline. The water in the hypolimnion no longer has a supply of oxygen from the surface and becomes depleted in dissolved oxygen due to the continued decay of the organic material in the bottom sediments. The depletion of oxygen and other oxidants in the hypolimnion creates a reducing environment that can affect the mobility of metals and degradation of pesticides in the bottom material of the lake. Thermal stratification can also affect the hydrodynamics of the lake by restricting the volume of water moving in the reservoir to the upper epilimniotic layer. The restricted movement of water decreases the hydraulic residence time of the lake.

Dissolved-oxygen concentrations, specific conductance, and pH are shown for the lake profile sites (5, 7, 9, 11) by box plots (figs. 11, 12, 13, respectively). Whiskers of the box plots at the profile sites are attributed to changes of the physical properties with depth, especially dissolved oxygen. Dissolved-oxygen concentrations and specific conductance at the lake sites (sites 5, 7, 9, 11) showed only slight areal variations (figs. 11, 12). The range in mean specific

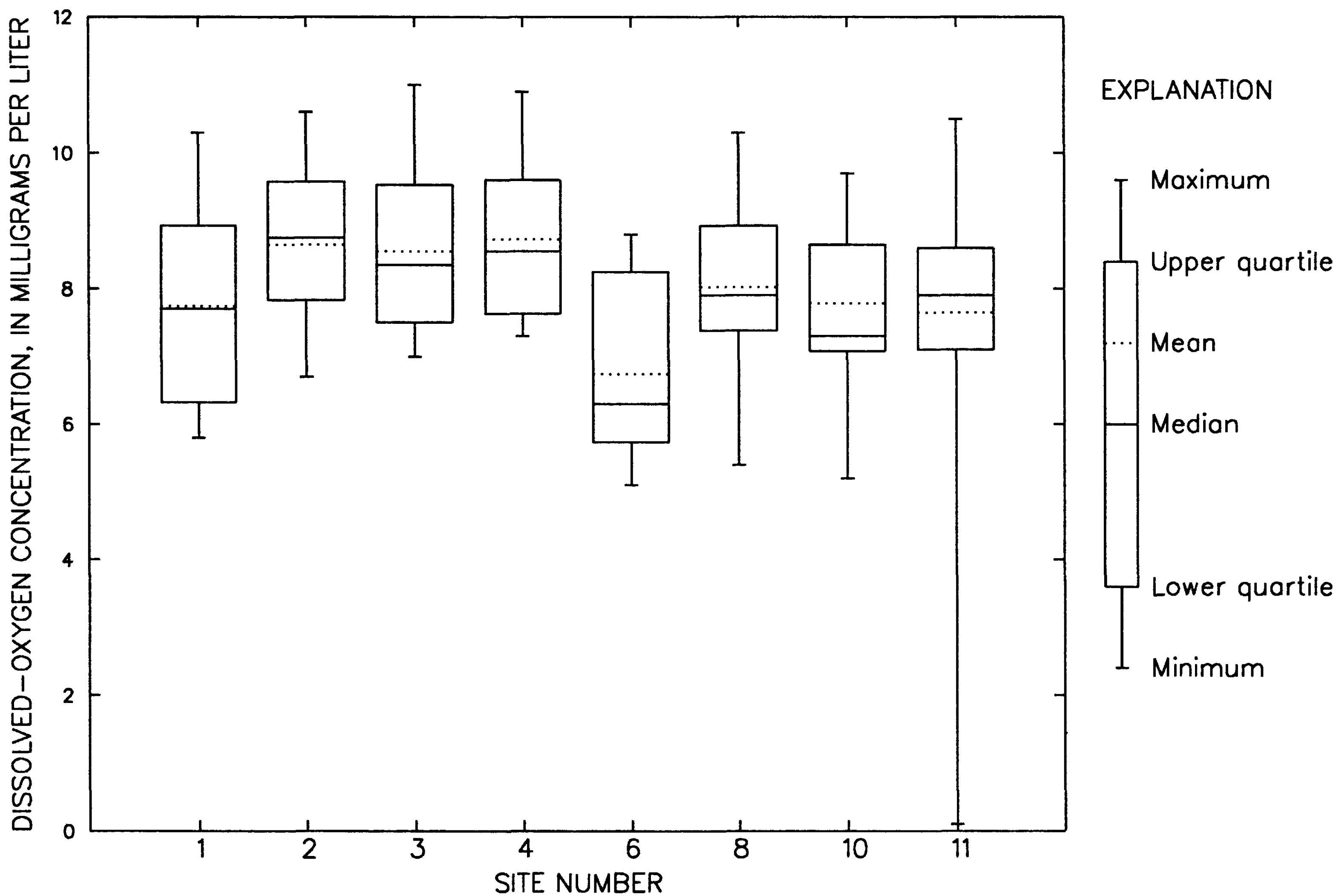


Figure 7.--Distribution of dissolved oxygen concentrations at the tributary sites and at one lake site (site 11) in J.B. Converse Lake Basin from October 1990 to September 1992.

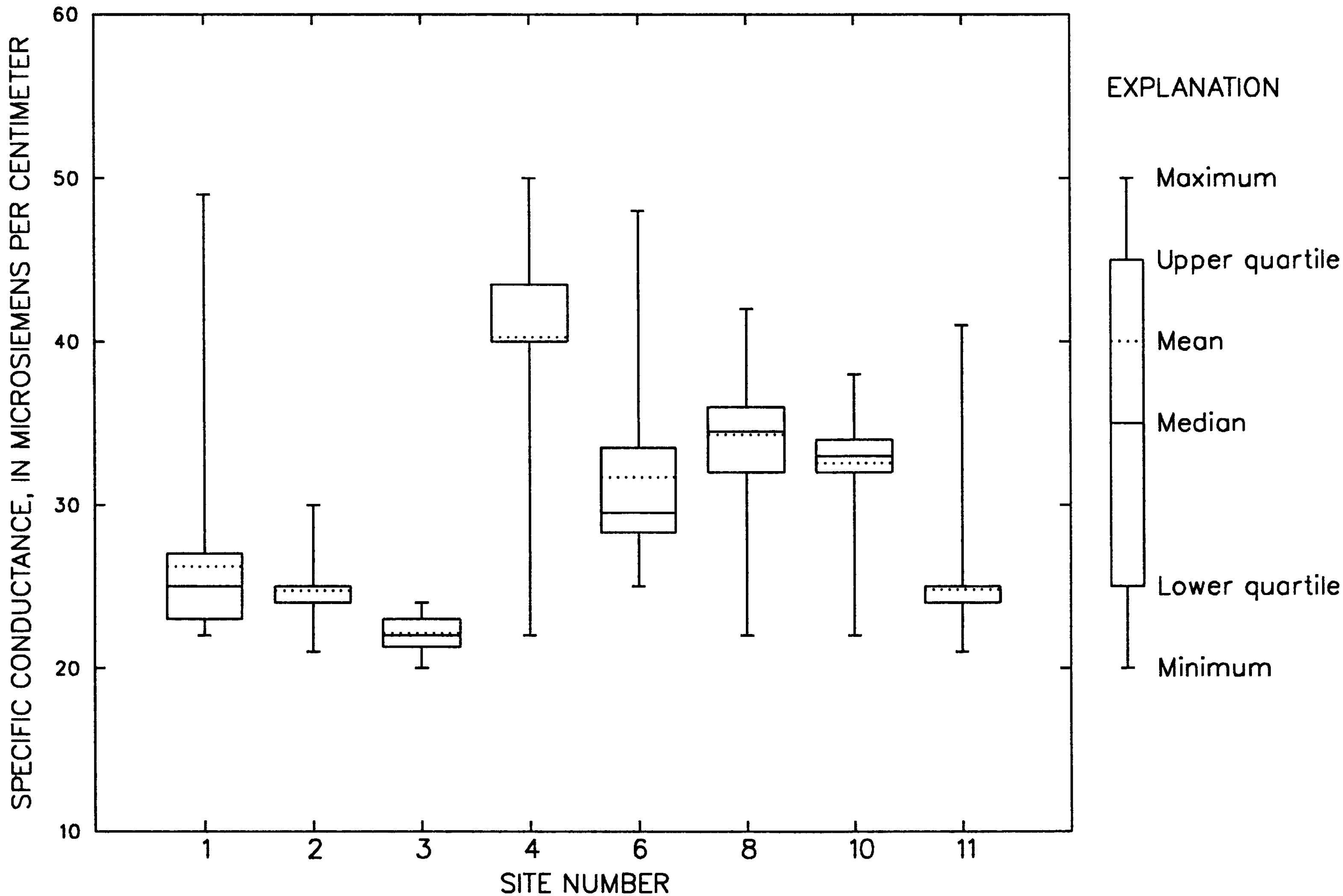


Figure 8.--Distribution of specific conductance at the tributary sites and at one lake site (site 11) in J.B. Converse Lake Basin from October 1990 to September 1992. The medians and lower quartiles are equal for sites 2, 4, and 11.

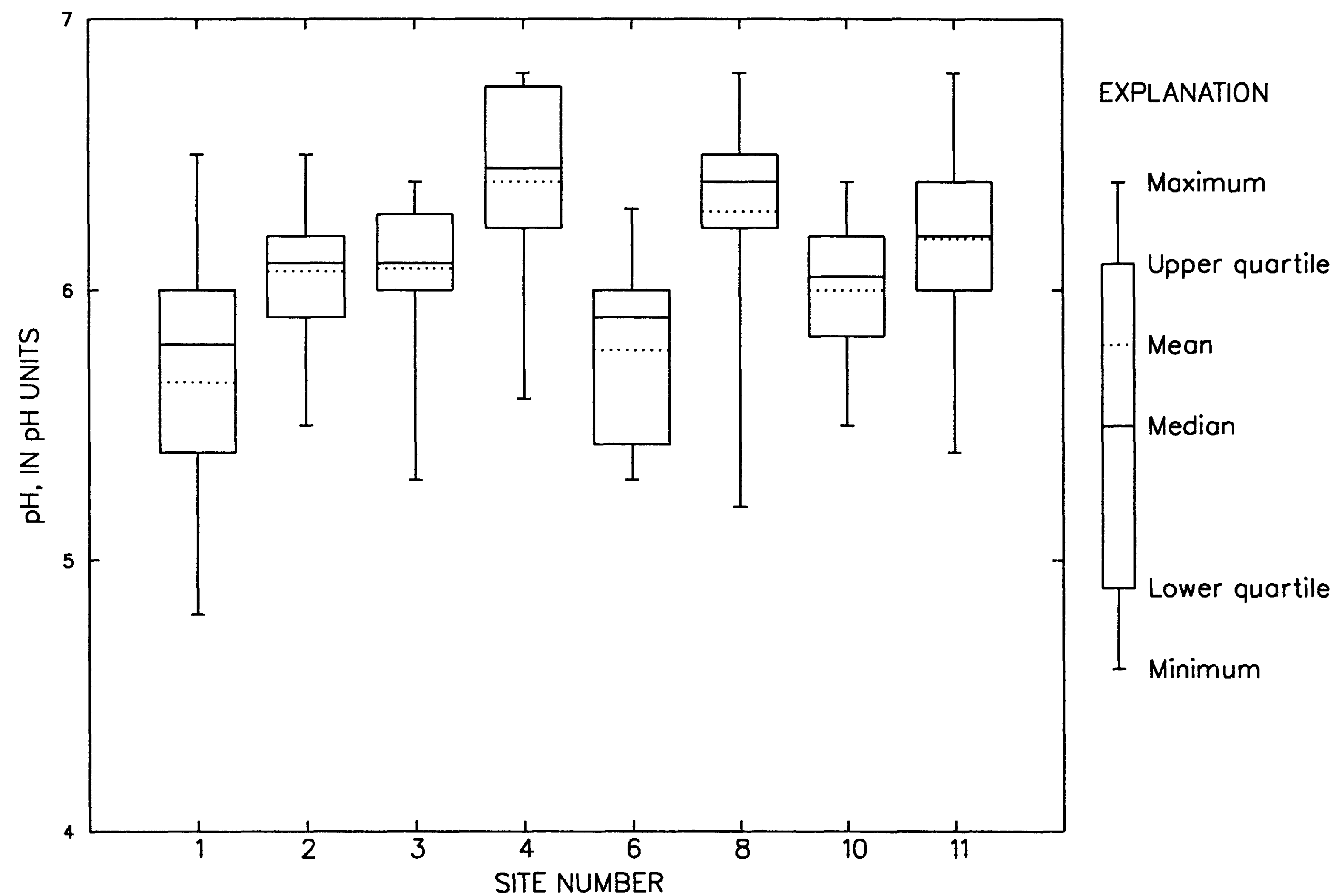


Figure 9.--Distribution of pH at the tributary sites and at one lake site (site 11) in J.B. Converse Lake Basin from October 1990 to September 1992.

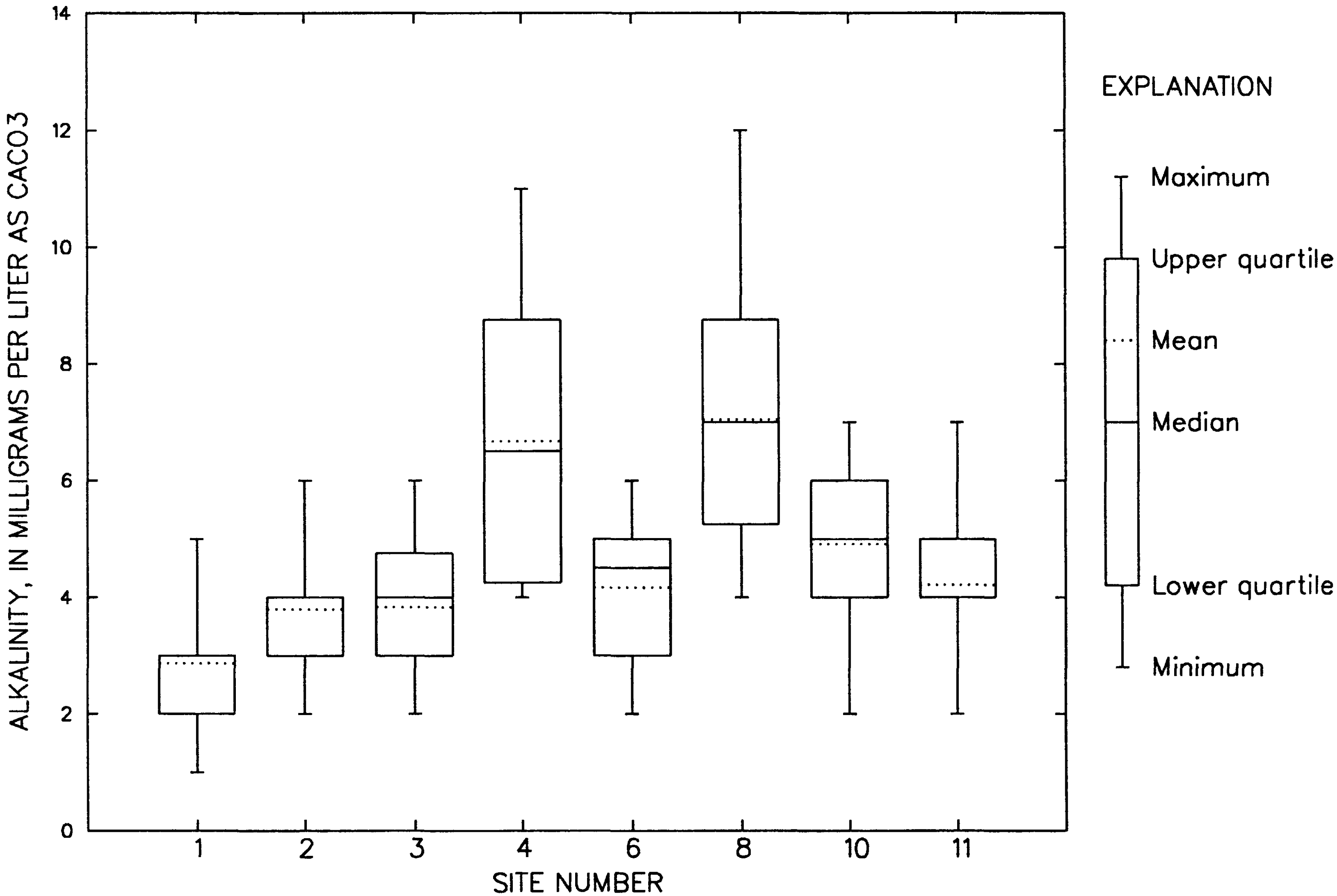


Figure 10.--Distribution of alkalinity at the tributary sites and at one lake site (site 11) in J.B. Converse Lake Basin from October 1990 to September 1992. The medians are equal to the upper quartiles for sites 1 and 2 and the lower quartile for site 11.

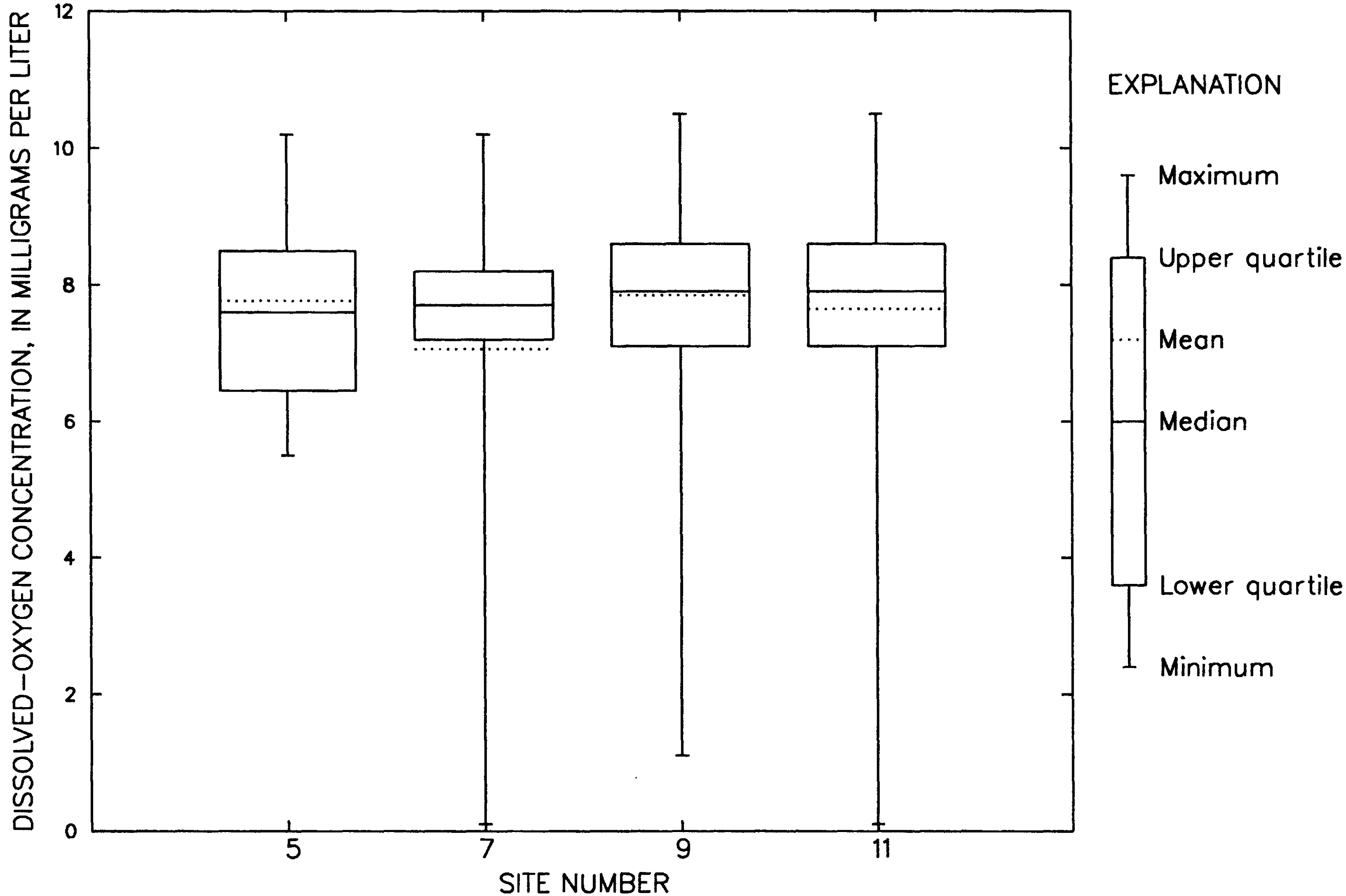


Figure 11.--Distribution of dissolved-oxygen concentrations at the lake profile sites in J.B. Converse Lake Basin from October 1990 to September 1992.

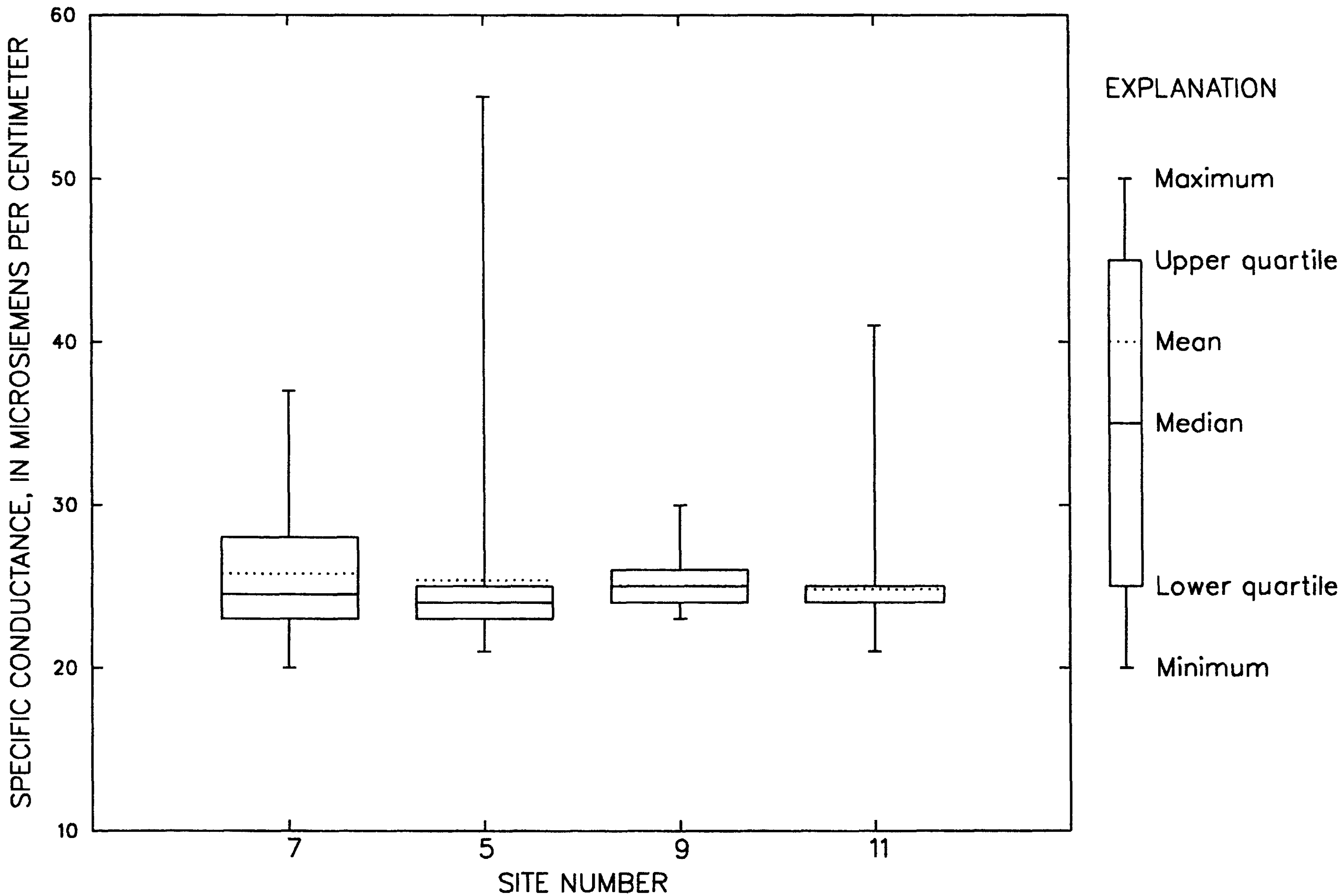


Figure 12.--Distribution of specific conductance at the lake profile sites in J.B. Converse Lake Basin from October 1990 to September 1992. The median and lower quartile are equal for site 11.

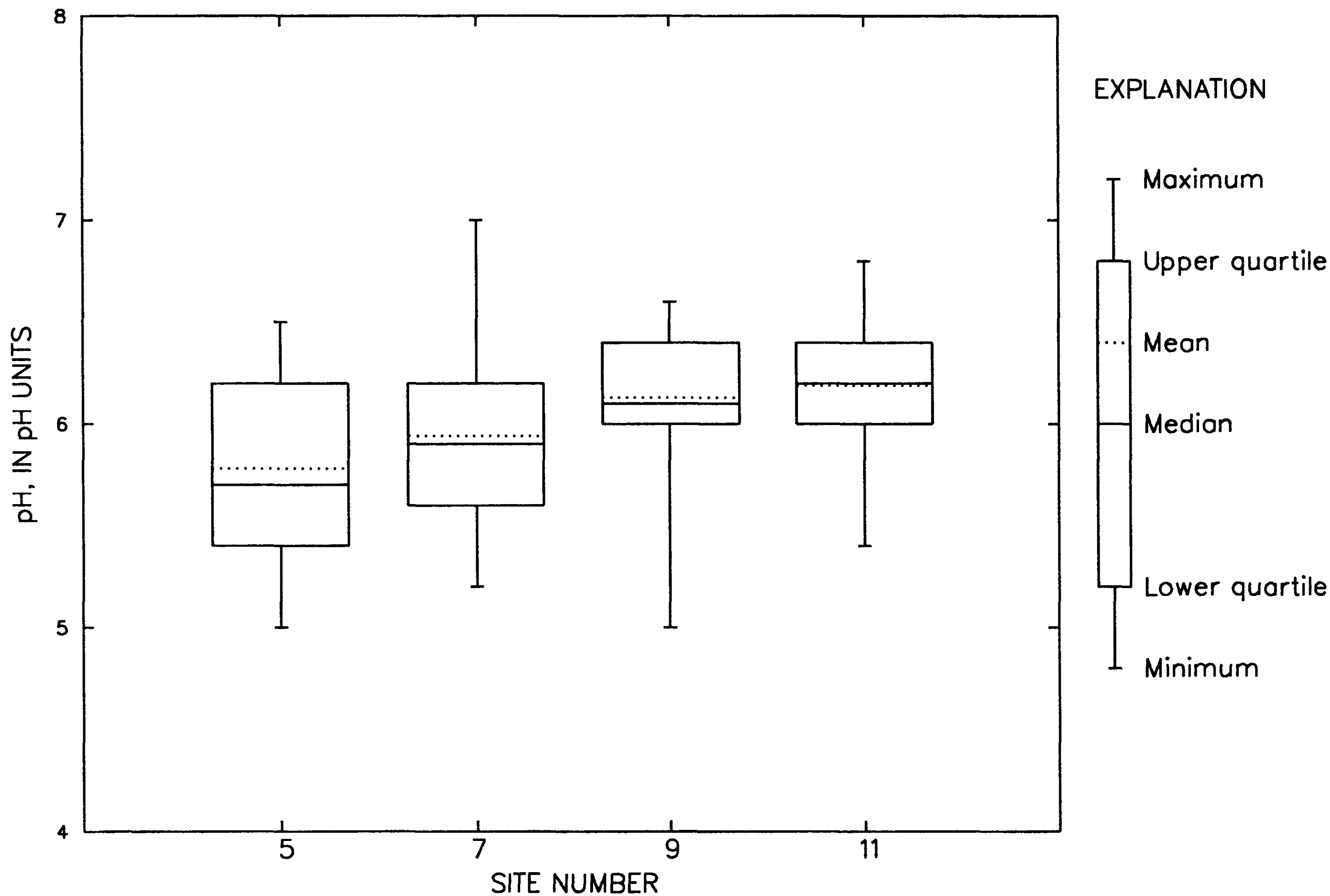


Figure 13.--Distribution of pH at the lake profile sites in J.B. Converse Lake Basin from October 1990 to September 1992.

conductance at lake sites 5, 7, 9 and 11 (25 to 26 µS/cm; see fig. 12) was similar to the range seen in the mean specific conductance of the tributary sites near the northern end of the lake (sites 1-3; see fig. 8). The pH at the lake sites ranged from a minimum value of 5.4 at site 11 to a maximum of 6.1 at site 9 (fig. 13).

The vertical profiles at the lake sites demonstrated, to varying degrees, thermal stratification during the month of August (table 5). The change in water temperature from the surface to the bottom of the lake showed the greatest decrease at these sites in August. The decrease in temperature ranged from 2.0 °C to 8.5 °C, depending on the depth. The thermal stratification resulted in the development of a thermocline at depths of 15 to 20 feet. The development of the stratified layer probably restricted the volume of water moving in the lake only to the upper 15 or 20 feet. Minimum dissolved-oxygen concentrations at sites 7 and 11 were near 0 mg/L at depths greater than 20 feet. Specific conductance increased significantly in the zone of near zero dissolved oxygen. Overturn appeared to occur between the months of August and November when the lake returned to the unstratified state.

Typical seasonal changes of dissolved oxygen, pH, temperature, and specific conductance with depth in J.B. Converse Lake are graphically represented by vertical profiles (fig. 14) for the second quarter of the lake profile at site 7 (fig. 2). The November 1990 profile shows only a slight decrease in dissolved oxygen and temperature with depth. A greater decrease in temperature at a depth of 15 feet is shown in the May 1991 profile. A corresponding increase in specific conductance was seen at this depth. The lake profile for August exhibits the greatest thermal stratification, having a 8 °C decrease in water temperature and a near zero dissolved-oxygen concentration in the lower hypolimniotic layer. The specific conductance increased at a depth of 20 feet to twice the value in the upper epilimniotic layer. This increase is attributed to reduction and remobilization of metals, such as iron and manganese, in the hypolimnion from the bottom sediments.

## Major Dissolved Constituents

Types and concentrations of major dissolved constituents, or ions, were determined from the chemical analyses of monthly water samples at eight water-quality sites (sites 1-4, 6, 8, 10, 11) (table 4). The major cations were sodium, calcium, magnesium, and potassium. The major anions were chloride, bicarbonate, sulfate, and nitrate. The areal variation in major ions, represented by the total dissolved solids (TDS), appeared to be similar to the specific conductance, with higher values in the tributaries located at the central and southern part of the basin. Long Branch (site 4), Boggy Branch (site 6), Crooked Creek (site 8), and Hamilton Creek (site 10) had mean TDS concentrations of 28 mg/L, 32 mg/L, 24 mg/L and 24 mg/L, respectively, compared with Big Creek (site 1), Juniper Creek (site 2), and Collins Creek (site 3) that had mean TDS concentrations of 19 mg/L, 18 mg/L, and 17 mg/L, respectively. The TDS concentrations ranged from a minimum of 16 mg/L at Big Creek (site 1) and Collins Creek (site 3) to a maximum of 59 mg/L at Boggy Branch (site 6).

The areal variation in the proportional distribution of major dissolved constituents in J.B. Converse Lake Basin is illustrated graphically for October 1990 to September 1992 by pie charts (fig. 15). The pie charts contain subdivisions that represent the proportion of the mean

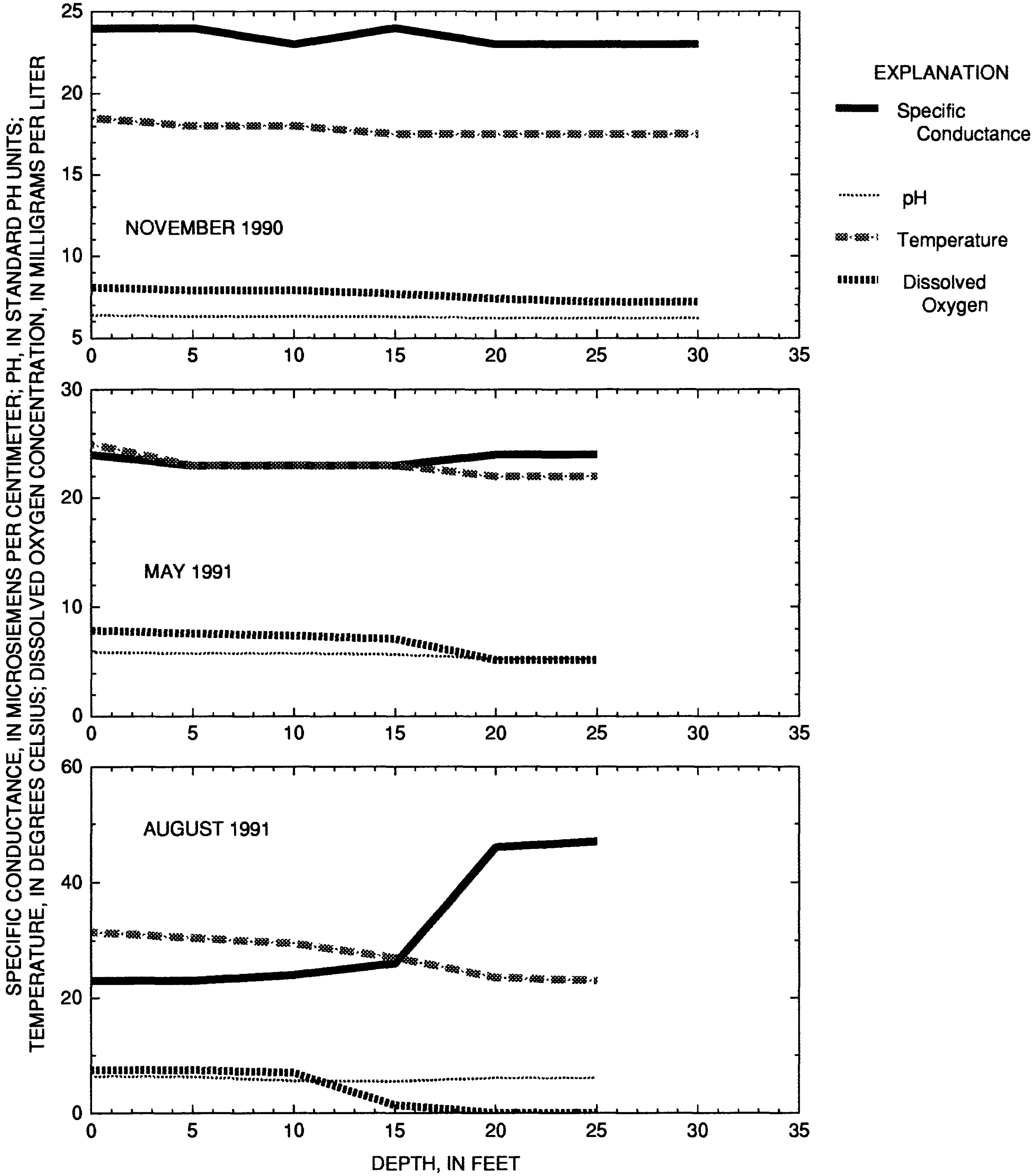


Figure 14.--Seasonal variation in the vertical profiles of selected physical and chemical properties at the second quarter location of the lake cross-section at site 7 in J. B. Converse Lake [Location of site 7 shown in fig. 2]. 24

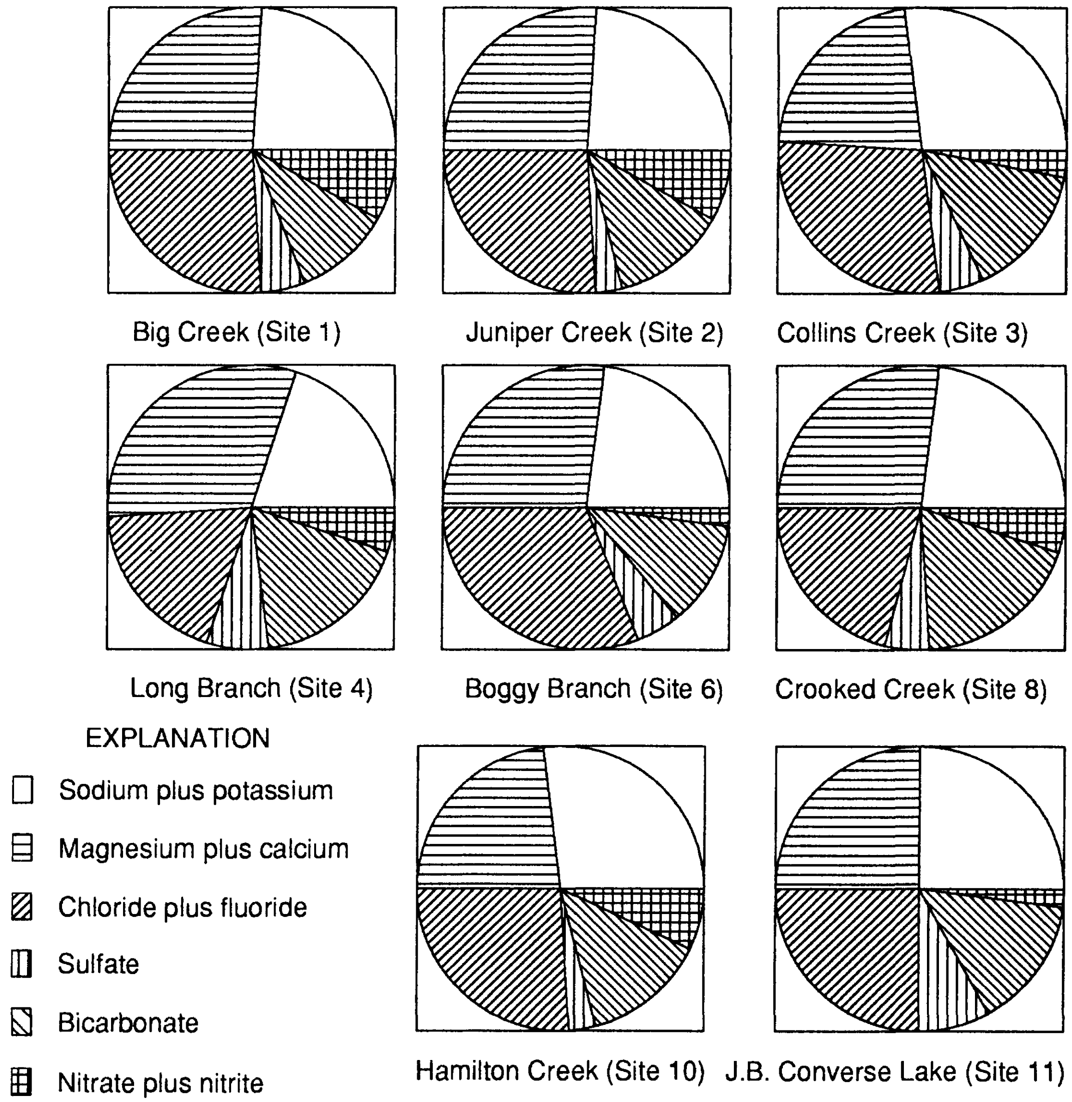


Figure 15.--Spatial variation in water chemistry for J.B. Converse Lake Basin for 1990-92. Ionic proportions based on mean concentrations in milliequivalents per liter.

concentration of major ions, in milliquivalents per liter, at each of the eight water-quality sites. Ions with the same valence and similar properties were combined. The overall water chemistry can be described as sodium-calcium-chloride type. The greater variation in proportionality between sites was exhibited by the anionic species, such as chloride, bicarbonate, nitrate and sulfate, but produced only minor overall areal variation.

**Major Bacterial Constituents**

Two major fecal bacteria in natural waters are fecal coliform and fecal streptococcus. The concentrations or densities of fecal coliform and fecal streptococci bacteria are used as an index of fecal pollution from humans and other warm-blooded animals. Although most fecal coliform bacteria are not directly harmful, their presence in significant numbers indicate the possible presence of other pathogenic species, such as *Escherichia coli, Salmonella* sp., and *Staphylococcus* sp. (Carmichael and Bennett, 1993; Geldreich, 1990; Hem, 1985).

Concentrations of major biological constituents of fecal coliform and fecal streptococcus were determined at the eight water-quality sites (table 4) and illustrated in box plots (figs. 16, 17). Fecal coliform concentrations in the tributaries to J.B. Converse Lake (fig. 16) had mean values that ranged from 124 cols/100 mL (colonies per 100 milliliters) at Long Branch (site 4) to 670 cols/100 mL at Boggy Branch (site 6). Fecal streptococcus concentrations in the tributaries (fig. 17) had mean values that ranged from 670 cols/100 mL at Crooked Creek (site 8) to 1,600 cols/100 mL at Juniper Creek (site 2); however, maximum and minimum values differed from the mean by an order of magnitude at most tributary sites. Big Creek (site 1), Juniper Creek (site 2), and Boggy Branch (site 6) had maximum fecal coliform concentrations of 6,000 cols/100 mL, that exceed the water-quality criteria mandated by Alabama Department of Environmental Management for a public-water supply (4,000 cols/100 mL) (ADEM, 1991). The mean values in the tributaries were more than an order of magnitude greater than the mean values in the lake at the pump station (site 11). The mean fecal coliform and fecal streptococcus concentrations at the lake site (site 11) were reduced to 16 cols/100 mL and 10 cols/100 mL, respectively. The reduction in the bacterial concentrations at site 11 generally were attributed to natural, self-purification processes within reservoirs. The self-purification process had been described as an ill-defined, complex mechanism that involves bacterial adsorption with sedimentation, predation, dilution, hydrologic tributary effects, water temperature, and solar radiation (Geldreich, 1990).

Studies of surface-water pollution have related the probable source of bacterial contamination (human versus other animals) to the density ratio of fecal coliform to fecal streptococcus in water (FC/FS ratio) (Millipore Corporation, 1975, p. 11; Geldreich and Kenner, 1969). A dominance in the ratio of fecal coliform to fecal streptococcus colonies in a water sample is strong evidence for contamination from a human source (Carmichael and Bennett, 1993). The predominant sources of contamination indicated by specific FC/FS ratios are

(1) human waste for ratios greater than 4,

(2) human waste in mixed pollution for ratios between 2.0 and 4.0, and

(3) livestock or poultry wastes for the ratios below 1.0.

The source of contamination for ratios that fall between 1.0 and 2.0 is uncertain, but is probably a mixed type.

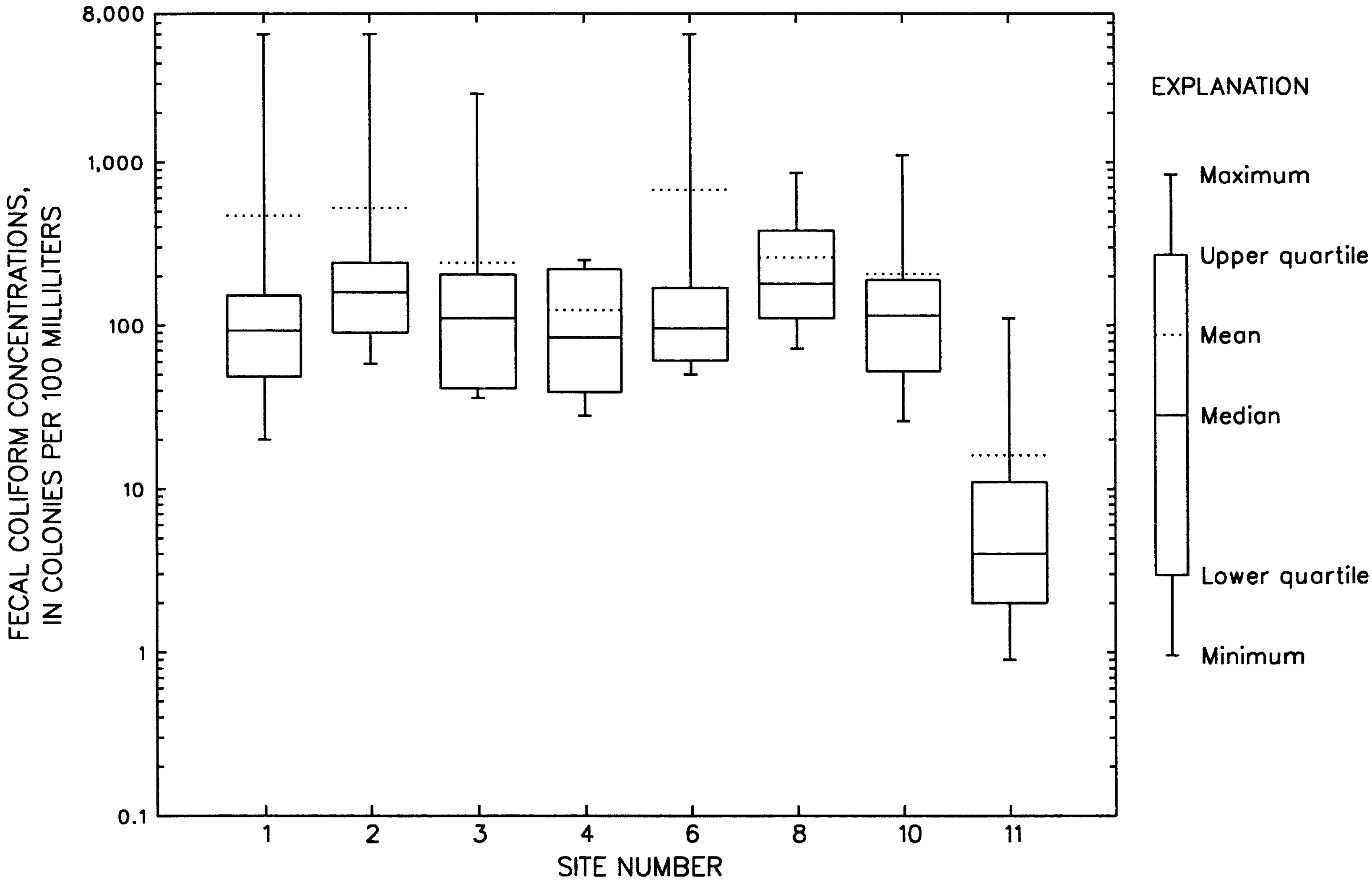


Figure 16.—Distribution of fecal coliform concentrations at the tributary sites and at one lake site (site 11) in J.B. Converse Lake Basin from October 1990 to September 1992.

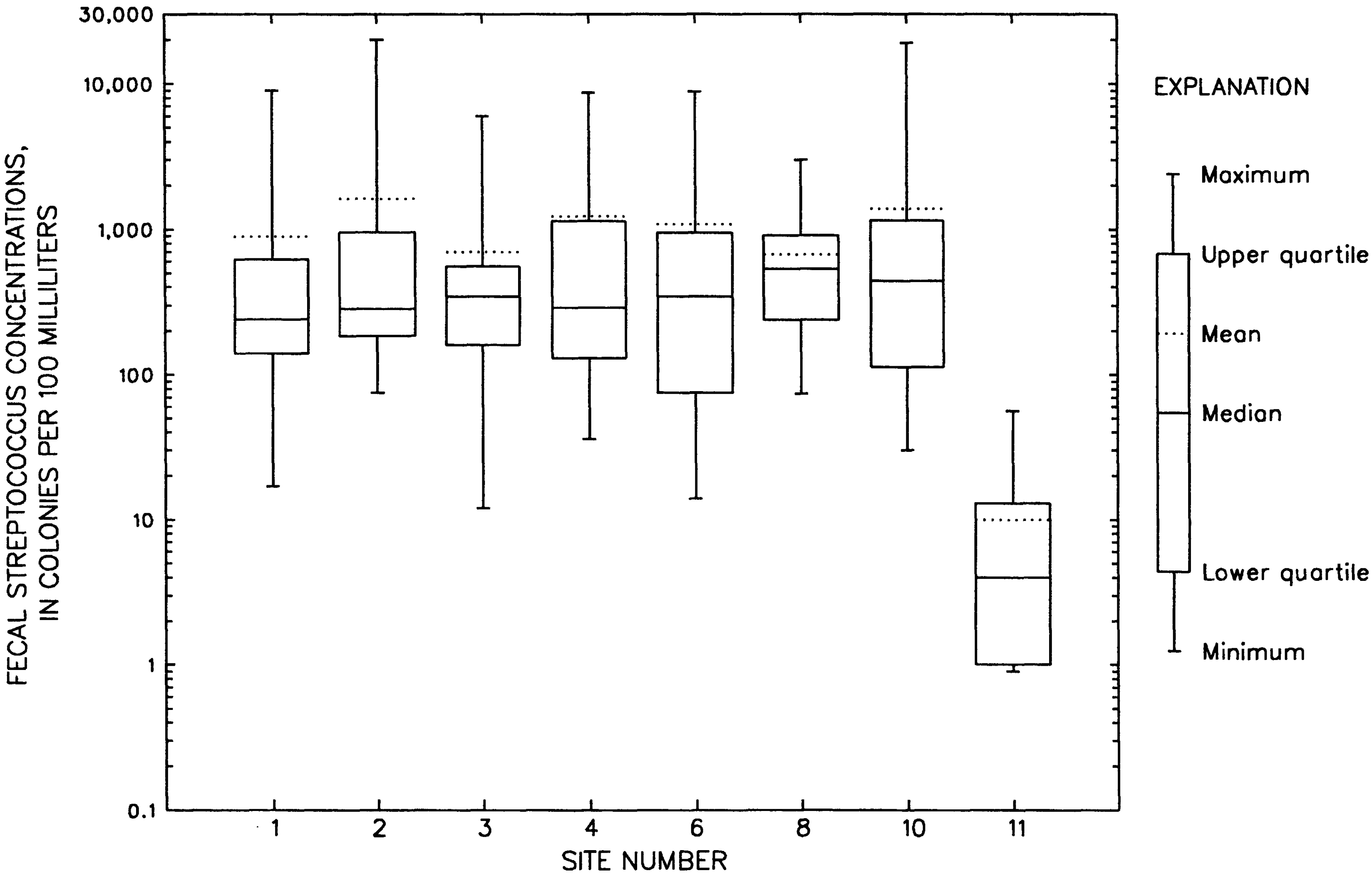


Figure 17.--Distribution of fecal streptococcus concentrations at the tributary sites and at one lake site (site 11) in J.B. Converse Lake Basin from October 1990 to September 1992.

The FC/FS ratios for five tributary sites (sites 1-3, 8, 10) and the lake site at the pump station (site 11) in J.B. Converse Lake Basin were shown on semi-logarithmic time plots for October 1990 to September 1992 (fig. 18). The FC/FS ratios at the tributary sites generally were less than 4:1, with the majority of the ratios less than or equal to 1:1. The lake site at the pump station (site 11) had FC/FS ratios that generally were greater than or equal to 2:1. Seasonal variations were noted in the FC/FS ratios, with the higher ratios being observed in the winter and spring months and the lower ratios in the summer months. FC/FS ratios around 1:10 were observed during the summer months at the tributary sites.

FC/FS ratios are not definitive. The predominant FC/FS ratios of below 1 at the tributary sites suggested the source of the fecal bacteria could be livestock or poultry wastes, whereas the predominant FC/FS ratio of greater than 2:1 at the lake site suggested the source could be either human or mixed wastes. Analyses of water samples for the presence of MBAS (methyl blue activated substances) or *Escherichia coli* concentrations could further identify if the source of the fecal contamination was raw sewage effluent from human sources. The detection of MBAS in water samples would indicate the presence of substances, such as detergents, that are associated with human sewage effluent.

## Nutrient Loads

Nitrogen and phosphorus are nutrients that are required by aquatic plants for growth. Eutrophication, a detrimental increase in aquatic plant growth, can result if nutrient loads are too high. Associated problems with eutrophication include algal blooms that produce discoloration and bad taste in drinking water, and that, ultimately, increase the cost of water treatment (Dunne and Leopold, 1978). The amount of algal plant material produced (primary production) can be limited by one of many factors, such as nutrients, water temperature, turbidity, and trace elements. The most common nutrient that limits algal production is phosphorus rather than nitrogen. Nutrient sources can be natural, such as atmospheric precipitation and weathering of rocks, and anthropogenic, such as agricultural runoff (fertilizers), sewage effluent, and waste effluent from livestock and poultry farms.

Nutrient loads for the major tributaries (sites 1-4, 6, 8, 10) to J.B. Converse Lake were determined for the 1991 and 1992 (October 1990 to September 1992) water years using logarithmic regression analysis. The regression equations for nitrogen and phosphorus loads were derived for each tributary site. The derived regression equations and their associated $r^2$ values are listed in table 6 (total nitrogen, total phosphorus) and in table7 (total nitrate plus nitrite, total organic nitrogen plus ammonia). The $r^2$ values indicate how well the dependent variable varied with respect to the independent variable ($r^2 = 1$ for perfect correlation), and were adjusted to reflect the sample size and number of independent variables in the regression equation.

Total nitrogen and total phosphorus loads, in tons per year, and yields, in tons per year per square mile, were determined for the 1991 and 1992 water years (table 8, 9, respectively; fig. 19) from the regression equations. No data were collected at Boggy Branch and Long Branch (sites 4, 6) in the 1992 water year, therefore, mean and total annual loads and yields to J.B. Converse Lake were not determined for the basin during that period.

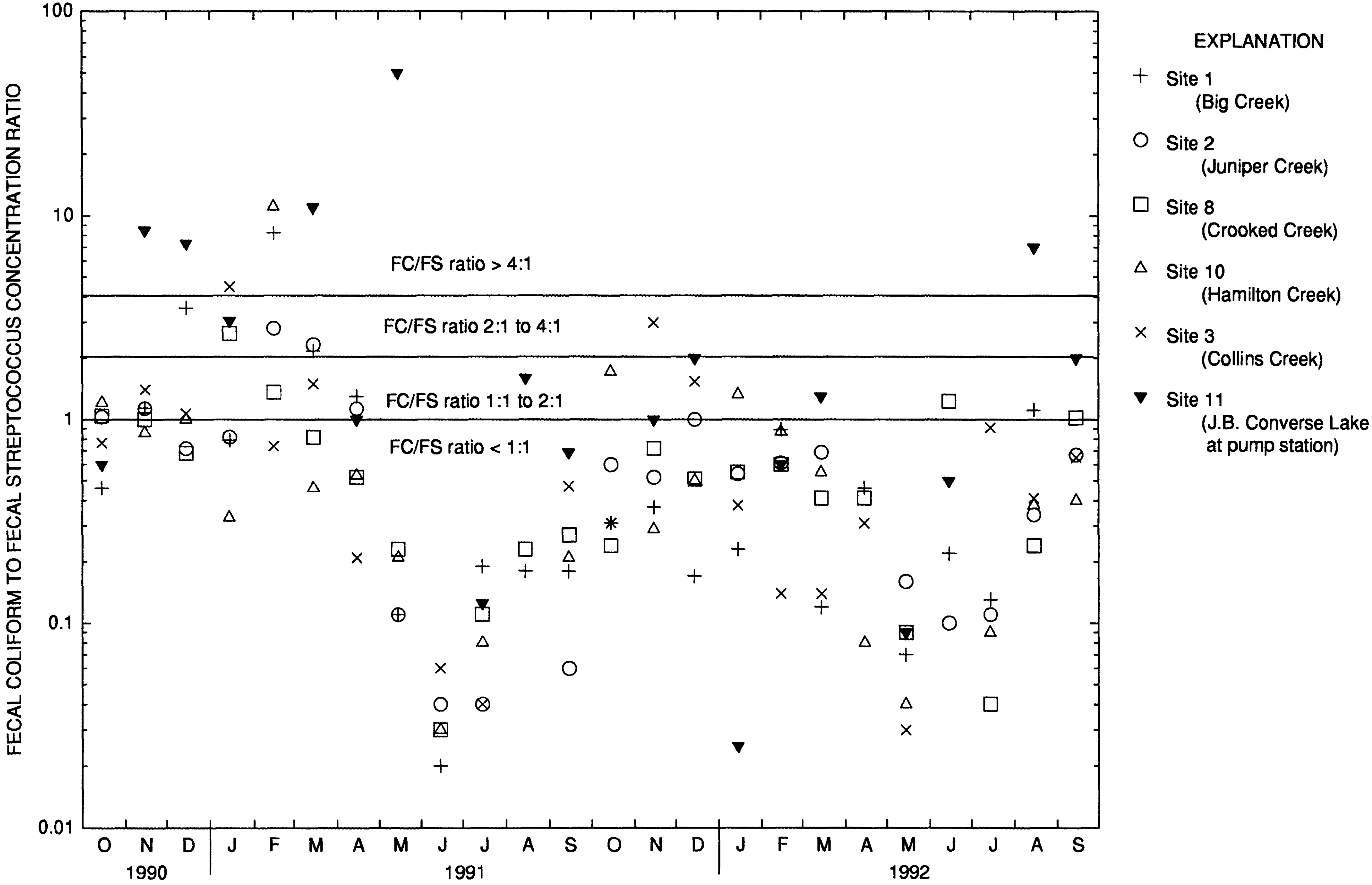


Figure 18.--Seasonal variation in the fecal coliform (FC) to fecal streptococcus (FS) ratio at representative tributary sites and one lake site (site 11) in J.B. Converse Lake Basin for October 1990 to September 1992. [Location of the sites are shown in fig. 1]

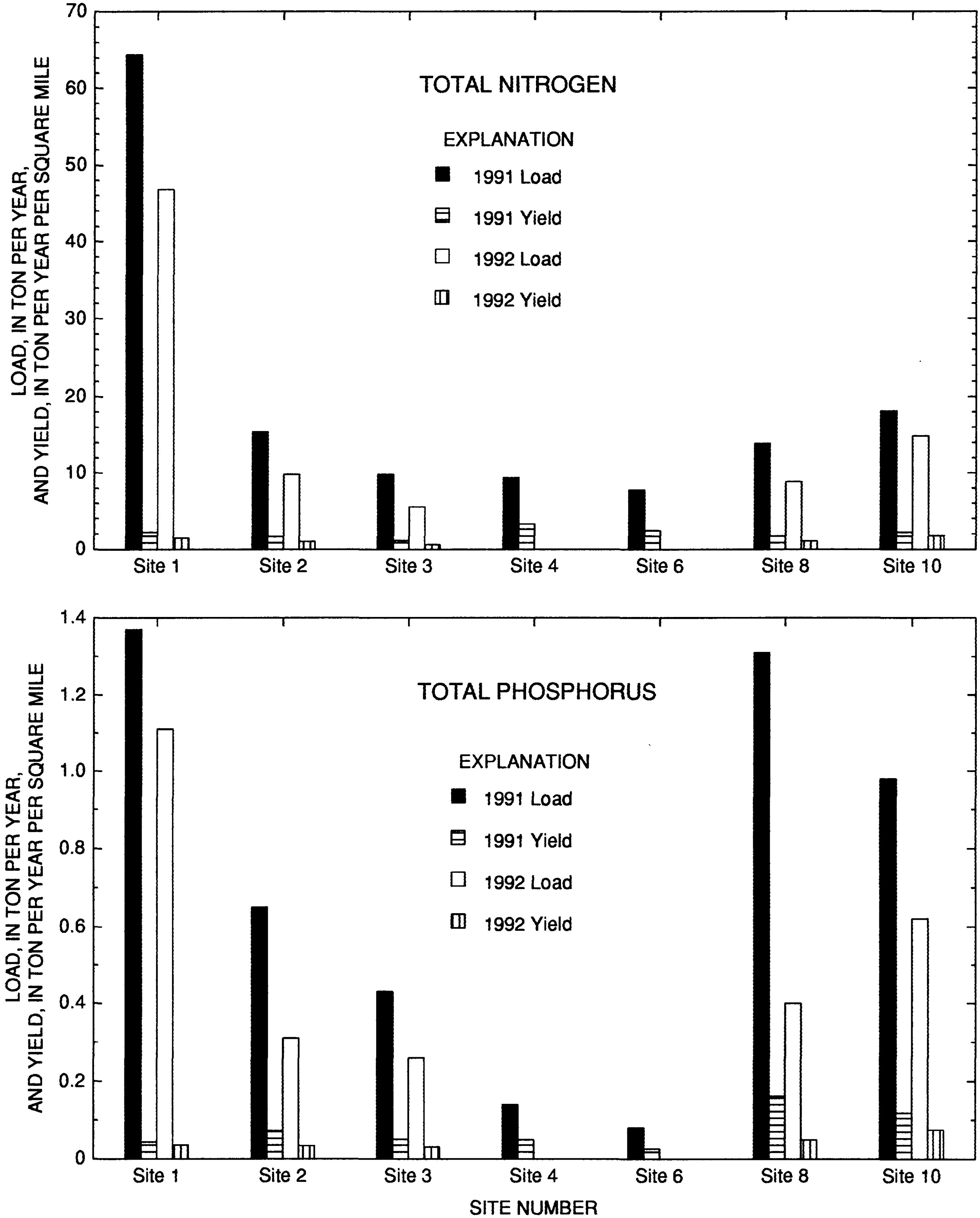


Figure 19.--Annual nutrient loads and yields for major tributary sites in the J.B. Converse Basin for the 1991 and 1992 water years.
[Locations of sites shown in fig. 1]

In the 1991 water year, the total nitrogen loads ranged from a minimum of 7.74 tons/yr (tons per year) at Boggy Branch (site 6) to a maximum of 64.41 tons/yr at Big Creek (site 1), and had a mean value for the basin of 19.81 tons/yr (table 8; fig. 19). The total annual nitrogen load to J.B. Converse Lake was 138.69 tons/yr. The annual yields for total nitrogen ranged from a minimum of 1.15 tons/yr/mi$^2$ (tons per year per square mile) at Collins Creek (site 3) to a maximum of 3.28 tons/yr/mi$^2$ at Long Branch (site 4), with a total yield for all the tributaries of 1.94 tons/yr/mi$^2$. Big Creek (site 1) contributed almost half (45 percent) of the total nitrogen load in 1991 (fig. 19). However, when the annual loads are normalized to drainage area to obtain yields, Long Branch (site 4) contributed nearly 22 percent of the total nitrogen yield, which is about 1.5 times the total nitrogen yield contributed by Big Creek (site 1) (fig. 20).

In the 1992 water year, the total nitrogen loads ranged from a minimum of 5.5 tons/yr at Collins Creek (site 3) to a maximum of 46.81 tons/yr at Big Creek (site 1) (table 9; fig. 19). The total nitrogen yields ranged from a minimum of 0.64 tons/yr/mi$^2$ at Collins Creek (site 3) to a maximum of 1.81 tons/yr/mi$^2$ at Hamilton Creek (site 10). In general, calculated loads and yields of total nitrogen decreased between 18 percent (site 10) and 44 percent (site 3) from the 1991 to the 1992 water year. These decreases were related, in part, to a corresponding decrease in mean annual discharge for the 1992 water year of 19 percent (site 10) to 44 percent (site 1) compared to the 1991 water year.

In the 1991 water year, total phosphorus loads ranged from a minimum of 0.08 tons/yr at Boggy Creek (site 6) to a maximum of 1.37 tons/yr at Big Creek (site 1) and had a basin mean of 0.71 tons/yr (table 9; fig. 19). The total annual phosphorus load to J.B. Converse Lake was 4.96 tons/yr in the 1991 water year. The total phosphorus yields ranged from a minimum of 0.025 tons/yr/mi$^2$ at Boggy Branch (site 6) to a maximum of 0.162 tons/yr/mi$^2$ at Crooked Creek (site 8). Crooked Creek and Big Creek had the largest phosphorus loads (54 percent). However, Crooked Creek contributed 31 percent of the total phosphorus yield in 1991 while Big Creek contributed 8.3 percent (fig. 21).

In the 1992 water year, the total phosphorus loads ranged from about 0.26 tons/yr at Collins Creek (site 3) to 1.11 tons/yr at Big Creek (site 1) (table 9). The yields ranged from 0.03 tons/yr/mi$^2$ at Big Creek (site 1) to 0.075 tons/yr/mi$^2$ at Hamilton Creek (site 10). The total annual phosphorus loads decreased between 19 percent (site 1) and 69 percent (site 8), but exhibited less areal variation in the 1992 water year compared to the 1991 water year. These decreases were related, in part, to the decrease in mean annual discharge in the 1992 water year compared to the 1991 water year.

### Minor Elements

Concentrations of dissolved boron, total recoverable and dissolved species of iron, and total recoverable and dissolved species of manganese are presented in table 4 for the eight water-quality sites in the J.B. Converse Lake Basin. Boron, an important trace element in agriculture, is used in fertilizers and as herbicides. Boron is also used as a cleaning aid (soap, detergents). Hence, boron is usually present in agricultural, sewage, or industrial wastes. National secondary drinking water standards (aesthetic levels) require that dissolved iron and manganese concentrations not exceed 300 μg/L (micrograms per liter) and 50 μg/L, respectively, in drinking

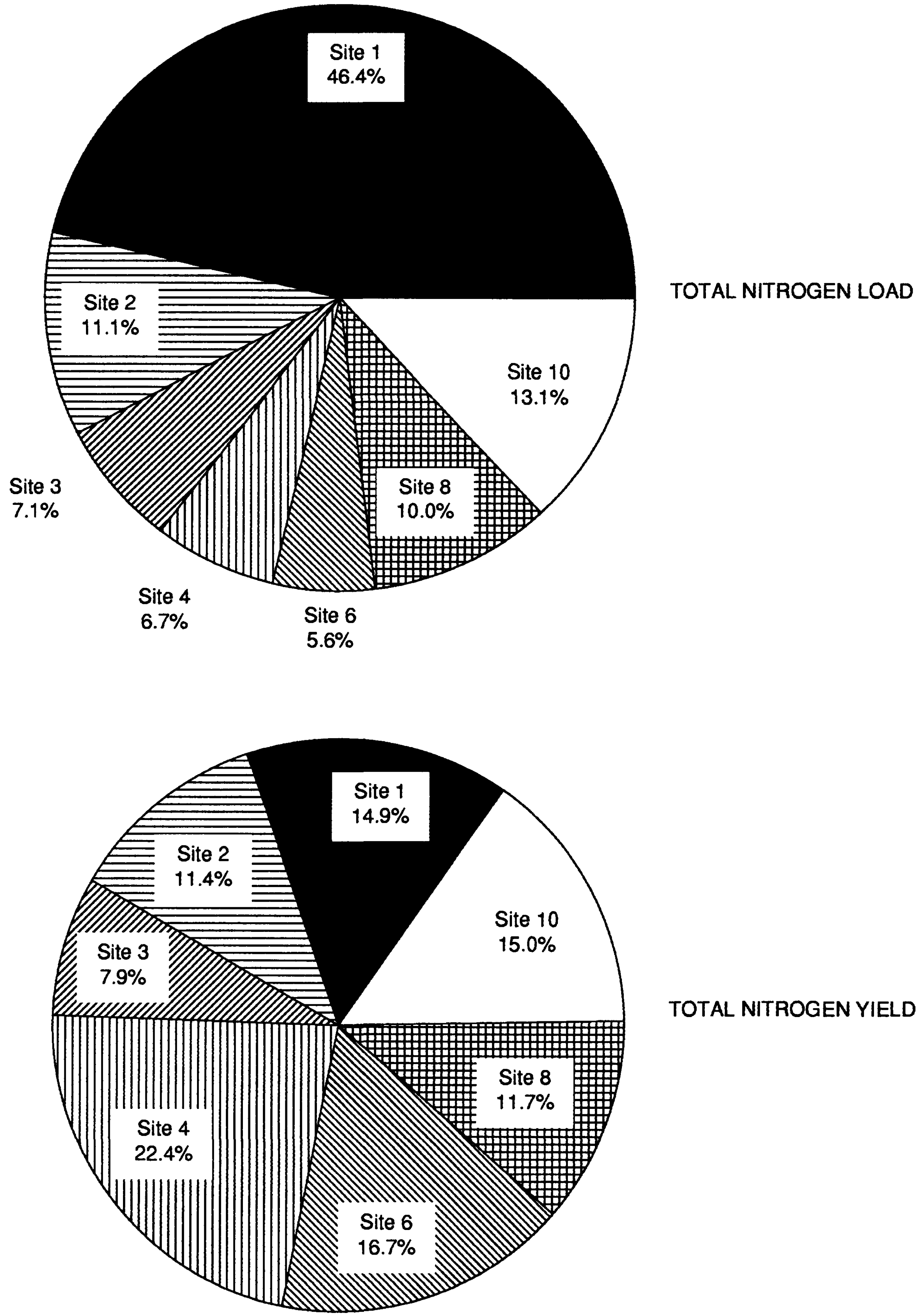


Figure 20.--Proportional distribution and percentages of total nitrogen loads and yields in major tributaries to J.B. Converse Lake during 1991 water year. [Location of sites shown in fig. 1]

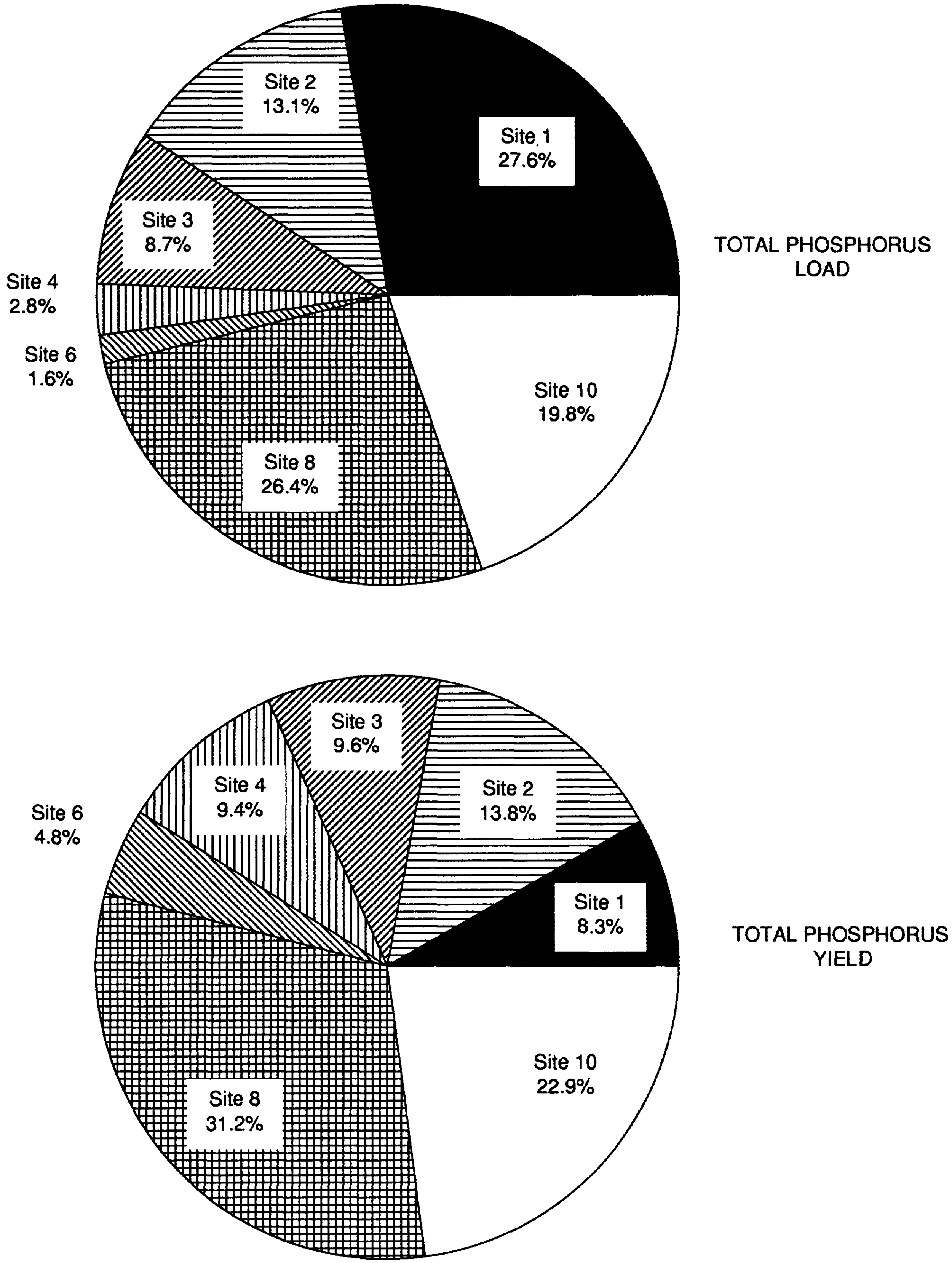


Figure 21.--Proportional distribution and percentages of total phosphorus loads and yields in major tributaries to J.B. Converse Lake during 1991 water year. [Location of sites shown in fig. 1]

water (USEPA, 1986). Elevated levels of iron and manganese in drinking water create color, odor, and taste problems that ultimately add to the cost of water treatment. Total recoverable iron and manganese concentrations reflect the particulate and dissolved species of the element.

Dissolved boron concentrations ranged from a minimum value of less than the detection limit (20 µg/L) to a maximum of 50 µg/L at Big Creek (site 1) and Collins Creek (site 3). The remaining water-quality sites had a maximum boron concentration of 30 µg/L.

The maximum concentrations of total recoverable and dissolved iron were 6,400 µg/L at Long Branch (site 4) and 730 µg/L at Boggy Branch (site 6), respectively. The minimum concentrations of total recoverable and dissolved iron were 60 µg/L at Big Creek (site 1) and 30 µg/L at Long Branch and Juniper Creek (sites 4 and 2, respectively). The mean concentrations of total recoverable iron ranged from 340 µg/L at Juniper Creek (site 2) to 2,080 µg/L at Long Branch (site 4) (fig. 22). The maximum concentrations of total recoverable and dissolved manganese were 280 µg/L (site 4) and 80 µg/L (sites 4, 6), respectively. The minimum concentrations of total recoverable and dissolved manganese were 9 µg/L at Big Creek (site 1) and 5 µg/L at Juniper Creek (site 2), respectively. The mean concentrations of total recoverable manganese ranged from 22 µg/L at Juniper Creek (site 2) to 113 µg/L at Long Branch (site 4) (fig. 22).

**Water-Quality Assessment**

A general assessment of the water quality of the seven major tributary sites (sites 1-4, 6, 8, 10) was made on the basis of the water-quality data of instantaneous dissolved oxygen, pH, specific conductance, alkalinity, fecal bacterial concentrations, nutrients yields and loads, and minor element concentrations from October 1990 to September 1992 (table 10). The overall water quality of J.B. Converse Lake and its tributaries can be described as good. Water-quality characteristics of the basin generally were within the State's public water-supply requirements. Long Branch (site 4) and Boggy Branch (site 6) had elevated levels of iron and manganese, and Big Creek (site 1), Juniper Creek (site 2), and Boggy Creek (site 6) had maximum fecal coliform concentrations that exceeded public water-supply requirements. Collins Creek (site 3) exhibited relatively better water quality than the other tributary sites, with the highest instantaneous dissolved-oxygen concentrations and pH, below average nutrient loads and yields, and relatively low fecal bacterial concentrations. Long Branch (site 4) exhibited relatively poorer water quality, having the highest iron and manganese concentrations, highest nitrogen yields, highest instantaneous specific conductance, and lowest instantaneous dissolved-oxygen concentrations of the tributary sites. However, Long Branch had relatively low fecal bacterial concentrations. Intermediate sites, in respect to water quality, include Crooked Creek (site 8) with the maximum phosphorus loads and yields; Boggy Creek (site 6) with relatively high fecal coliform concentrations, low instantaneous dissolved oxygen concentration, and elevated iron and manganese concentrations; and Juniper Creek (site 2) with high fecal bacterial concentrations, but low iron and manganese concentrations.

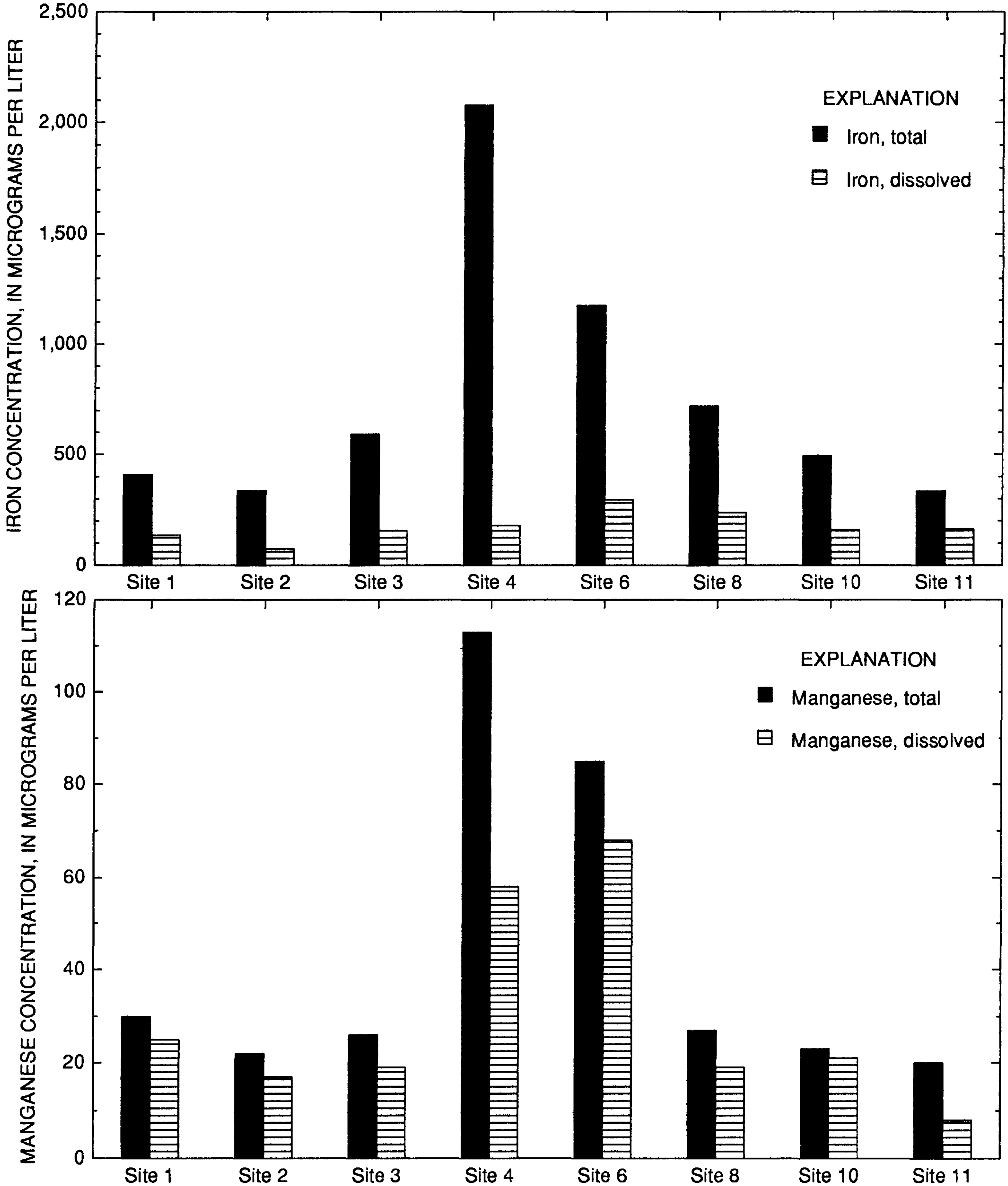


Figure 22.--Mean concentrations of iron and manganese in the seven major tributary sites and one lake site (site 11) in J.B. Converse Lake Basin from October 1990 to September 1992. [Locations of sites shown in fig. 1]

## GIARDIA SAMPLING AND ANALYSES

*Giardia lamblia* and *Giardia duodenalis* are two species of flagellate protozoans that infect the upper portion of the small intestine of humans, causing the disease Giardiasis. *Giardia duodenalis* infect many different species of mammals, whereas *Giardia lamblia* is generally considered host-specific to humans. Humans are infected by ingestion of a *Giardia* cyst. The cyst forms to protect *Giardia sp.* from the environment for a few hours to a few days on land and about 2 months in water (exposure limit is temperature dependent).

Currently, *Giardia sp.* is recognized as the most common cause of waterborne disease in humans. However, the least common mode of transmission of the parasite is waterborne; the most common mode is direct fecal-oral contact (daycare centers, nurseries). Forty-two waterborne outbreaks have been documented from 1965 to 1980. Consumption of untreated surface water or surface water with only disinfection treatment was the most common reason (67 percent) for the outbreaks (Hibler and Hancock, 1986). Ineffective filtration was the reason for 12 percent of the other outbreaks (Hibler and Hancock, 1986).

*Giardia* cysts are not evenly dispersed in water and few in number; hence, sampling procedures require the filtration of large volumes of water. Temporal variability in lake conditions, such as low turbidity and cold temperatures, can produce positive sampling results from once negative sources. Colder temperatures increase the exposure limit of the cyst and turbidity affects the sampling and analysis procedures. Overall, *Giardia* cysts are detected less often in lakes (reservoirs) than creeks, rivers, and open springs because of settling (Hibler and Hancock, 1986).

*Giardia* cysts were detected in J.B. Converse Lake in May 1991. Four cysts were detected at lake profile site 9 (mouth of Crooked Creek) and one cyst at lake profile site 11 (the pump station) (table 11). No *Giardia* cysts were observed in any other samples, including the water system samples.

## BOTTOM MATERIAL ANALYSES AND RESULTS

Samples of bottom material were collected in May 1991 from three lake profile sites on J.B. Converse Lake (sites 5, 7, 9). These samples were analyzed for 11 selected trace metals and more than 20 pesticides or their byproducts. In August 1992, bottom-material samples were collected at the three lake sites and an additional lake profile site near the pump station (site 11). These samples were analyzed for the presence of the selected pesticides. All samples were sent to the U.S. Geological Survey National Water-Quality Laboratory for analysis.

Sources for trace metals present in bottom material can be natural, such as weathering of rocks, or anthropogenic (Dojlido and Best, 1993). Arsenic is contained in pesticides, wood preservatives, feed additives, and veterinary chemicals. Chromium is used in many industries such as steel, dye, tanning, textile, and chemical. Copper is used in industrial (electrical, construction) and agricultural activities. Lead is used in acid storage batteries and formerly used in antiknock gasoline additives.

In natural aquatic systems, arsenic, chromium, copper, lead, zinc, and mercury tend to attach strongly to sediments and organic matter or to co-precipitate with hydrous iron and manganese oxides. Arsenic can be remobilized under sufficiently reducing conditions. Lead methylation, which makes lead more biologically available to organisms, has been demonstrated to occur in lakes in laboratory experiments (Dojlido and Best, 1993). Mercury can also undergo methylation in natural aquatic systems. Mercury generally is very soluble in oxidized natural waters when not strongly sorbed to sediments and organic compounds.

The results of the trace metal analyses indicate that 8 of the 11 trace metals selected were present in detectable amounts in the bottom material of the three lake profile sites (table 12). The detected metals include manganese, lead, zinc, iron, chromium, copper, arsenic, and mercury, listed in order of highest to lowest concentration. The bottom material from lake profile site 9, located at the mouth of Crooked Creek, generally had higher trace metal concentrations for all constituents than the other two lake sites.

Pesticides are economically significant tools in the management of weeds, insects, and fungi in agriculture. Most pesticides are applied directly to the soil. Runoff, spray drift, and wash-off transport some of these pesticides into streams, rivers, and lakes. The most persistent pesticides are the organochlorine insecticides which generally degrade very slowly and tend to attach to sediment and organic matter rather than dissolve in water. Because of their persistence in the environment and their toxicity to organisms, their use has been largely discontinued in the United States. Organochlorine insecticides include aldrin, DDT (dichlorodiphenyltrichloreoethane), chlordane, dieldrin, heptachlor, and lindane. DDT will sequentially degrade to DDD (dichlorodiphenyldichloroethane) then to DDE (dichlorodiphenyldichloroethylene) by reductive dechlorination, requiring highly reducing conditions. Further degradation of DDE is generally not observed. Heptachlor can be oxidized to heptachlor epoxide.

Results of the pesticide analyses on the bottom material samples indicated that six organochlorine pesticides or their degradation products were present: chlordane, DDT, DDD, DDE, Dieldrin, and heptachlor epoxide (table 13). DDT and its degradation products (DDD, DDE) were the most prevalent pesticides in the bottom material; however, pesticide concentrations did not exceed 11 μg/kg (micrograms per kilogram). Maximum levels of DDD and DDE were detected at the lake site near the pump station (site 11) and at the lake site at the mouth of Crooked Creek (site 9) (table 13).

## SUMMARY

J.B. Converse Lake, a 3,600-acre reservoir, is the primary source of water for the city of Mobile, Alabama. The J.B. Converse Lake Basin is in the Southern Pines Hill District of the East Gulf Coastal Plain physiographic province. The climate of the basin is temperate to subtropical.

A study of streamflow and water-quality conditions at seven tributary and four lake sites in J.B. Converse Lake Basin was conducted from October 1990 to September 1992. Hydrologic data, including selected biological, chemical, and physical properties of water, were collected at eight water-quality sites that include the seven tributary sites and one lake site at the pump station. Vertical profile data and bottom-material samples were collected at four sites on the lake.

Low-flow characteristics were estimated to determine the contribution of each tributary to the reservoir during dry-weather baseflows. Big Creek and Hamilton Creek contributed approximately half of the J.B. Converse Lake inflow during these low-flow periods. Hamilton Creek had the highest low-flow yield among the tributaries, and Boggy Branch, the lowest. Big Creek and Hamilton Creek contributed 60 percent of the baseflow to J.B. Converse Lake in 1991 water year.

An estimate of the time-of-travel of conservative substances in the lake was determined by calculating the residence time of water within the lake. Based on the ratios of total volume of the lake to total inflow and total volume of the lake to total outflow, the time of travel was estimated to be 7 to 10 days for normal lake volumes.

The spatial and temporal variations in dissolved oxygen, specific conductance, pH, alkalinity, and water temperature were determined at the eight water-quality sites. Only minor variations in these properties were observed between tributary and lake sites. In the tributaries, dissolved-oxygen concentrations ranged from 5.1 mg/L at Boggy Branch to 11 mg/L at Collins Creek. Specific conductance ranged from 20 μS/cm at Collins Creek to 50 μS/cm at Long Branch. The range in pH was 4.8 at Boggy Creek to 6.8 at Crooked Creek and Long Branch. Alkalinity ranged from 1 mg/L as CaCO3 at Big Creek to 12 mg/L as CaCO3 at Crooked Creek.

Vertical profiles of dissolved oxygen, specific conductance, pH, and water temperature were obtained at four sites on the lake. The lake profiles demonstrated some degree of thermal stratification in August. Minimum dissolved-oxygen concentrations of near 0 mg/L and maximum specific conductance values were observed at depths greater than 20 feet during stratification.

The types and concentrations of major dissolved constituents, or ions, were determined for the eight water-quality sites. The overall water chemistry in the basin can be described as a sodium-calcium-chloride type. The greater proportional variation between sites was exhibited by the anions, such as chloride, bicarbonate, nitrate, and sulfate; but, the degree of variation produced was minor.

Concentrations of fecal coliform and fecal streptococcus were determined at the eight water-quality sites. Mean concentrations of fecal coliform in the tributaries ranged from 124 cols/100 mL at Long Branch to 670 cols/100 mL at Boggy Branch. Mean concentrations of fecal streptococcus in the tributaries ranged from 670 cols/100 mL at Crooked Creek to 1,600 cols/100 mL at Juniper Creek. Mean concentrations of fecal coliform and fecal streptococcus at the pump station site were 16 cols/100 mL and 10 cols/100 mL.

Nutrient loads and yields for the tributaries to J.B. Converse Lake were determined for the 1991 and 1992 water years using logarithmic regression analysis. The total nitrogen load and yield of the tributaries in 1991 were 138.69 tons/yr and 1.94 tons/yr/mi$^2$. The maximum load was 64.41 tons/yr at Big Creek. The total phosphorus load and yield for the 1991 water year were 4.96 tons/yr and 0.069 tons/yr/mi$^2$. The maximum phosphorus load was 1.37 tons/yr at Big Creek. In 1992, the nutrient loads decreased due, in part, to a decrease in the mean annual discharge from the previous year.

Concentrations of dissolved boron, total recoverable and dissolved iron, and total recoverable and dissolved manganese were determined at the eight water-quality sites. Maximum concentrations of these constituents were in the tributaries. The maximum concentrations of boron was 50 µg/L at Big Creek and Collins Creek. Maximum concentrations of total recoverable and dissolved iron at Long Branch and Boggy Branch were 6,400 µg/L and 730 µg/L, respectively. Maximum concentrations of total recoverable and dissolved manganese were 280 µg/L at Long Branch and 80 µg/L at Long Branch and Boggy Branch.

A general assessment of the water quality of the tributaries was made on the basis of water-quality data collected from 1991 to 1992. The overall water quality of the tributaries can be described as good and generally within State requirements for public-water supplies. Long Branch and Boggy Branch had elevated levels of iron and manganese. Big Creek, Juniper Creek, and Boggy Branch had maximum fecal coliform levels that exceed public water-supply requirements.

During the 1991 water year, water samples were collected from four lake profile sites and from within the Mobile water system, and were analyzed for *Giardia*. In the 1992 water year, raw water from the reservoir at the Myers Filtration Facility was also sampled and analyzed for *Giardia*. In May 1991, five *Giardia* cysts were detected in water samples from two lake profile sites: near the mouth of Crooked Creek and at the pump station. No other *Giardia* cysts were detected during the period of study.

Bottom-material samples at lake profile sites were analyzed for selected trace metals and pesticides. The detected metals were manganese, lead, zinc, iron, chromium, copper, arsenic, and mercury, listed in order of highest to lowest concentrations. The detected pesticides were DDE, DDD, Chlordane, DDT, Dieldrin, and Heptachlor epoxide. No detected pesticide concentrations exceeded 11 µg/kg.

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**Table 1**.--Frequency of sampling at study sites in the J.B. Converse Lake Basin, Alabama
[A, annually; C, continuous; M, monthly; Q, quarterly; --, no data]

| | | Sample frequency | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site number | Station name | Major constituents, minor elements | Specific conductance | Water temperature | Dissolved oxygen | pH | Alkalinity, bacteria, nutrients | Vertical profiles | Giardia | Bottom material |
| 1 | Big Creek near Wilmer | Q | C | C | M | M | M | -- | -- | -- |
| 2 | Juniper Creek near Fairview | Q | C | C | M | M | M | -- | -- | -- |
| 3 | Collins Creek near Fairview | Q | C | C | M | M | M | -- | -- | -- |
| 4 | Long Branch near Wilmer[1] | Q | C | C | M | M | M | -- | -- | -- |
| 5 | J.B. Converse Lake at U.S. 98 Highway | -- | Q | Q | Q | Q | -- | Q | Q | A |
| 6 | Boggy Branch near Wilmer[1] | Q | C | C | M | M | M | -- | -- | -- |
| 7 | J.B. Converse Lake below Mill Branch | -- | Q | Q | Q | Q | -- | Q | Q | A |
| 8 | Crooked Creek near Fairview | Q | C | C | M | M | M | -- | -- | -- |
| 9 | J.B. Converse Lake below mouth of Crooked Creek | -- | Q | Q | Q | Q | -- | Q | Q | A |
| 10 | Hamilton Creek near Semmes | Q | C | C | M | M | M | -- | -- | -- |
| 11 | J.B. Converse Lake at pump station | Q | C | C | M | M | M | Q | Q | A |

[1] Station discontinued after first year of study.

**Table 2.** Summary of low-flow characteristics of selected streams in J.B. Converse Lake Basin
[$mi^2$, square miles; $ft^3/s$, cubic feet per second; $(ft^3/s)/mi^2$; cubic feet per second per square mile; $7Q_2$, 7-day, 2-year low flow; $7Q_{10}$, 7-day, 10-year low flow; --, not applicable]

| Site number | Station name | Drainage area ($mi^2$) | 7Q2 ($ft^3/s$) | $7Q_2$ [$(ft^3/s)/mi^2$] | Standard error (percent) | 7Q10 ($ft^3/s$) | $7Q_{10}$ [$(ft^3/s)/mi^2$] | Standard error (percent) |
|---|---|---|---|---|---|---|---|---|
| 1 | Big Creek | 31.5 | 19.0 | 0.60 | 8 | 11.0 | 0.35 | 10 |
| 2 | Juniper Creek | 9.22 | 10.0 | 1.08 | 5 | 7.5 | .81 | 6 |
| 3 | Collins Creek | 8.54 | 9.4 | 1.10 | 5 | 7.1 | .83 | 6 |
| 4 | Long Branch | 2.85 | 2.8 | .98 | 7 | 1.9 | .67 | 9 |
| 6 | Boggy Branch | 3.17 | 1.4 | .44 | 11 | .8 | .25 | 15 |
| 8 | Crooked Creek | 8.08 | 8.3 | 1.03 | 4 | 6.5 | .80 | 5 |
| 10 | Hamilton Creek | 8.22 | 14.0 | 1.70 | 3 | 12.0 | 1.46 | 4 |
| Total | | 71.58 | 64.9 | [a]0.91 | -- | 46.8 | [b]0.65 | -- |

[a] Quotient of the total $7Q_2$ discharge divided by the total drainage area.
[b] Quotient of the total $7Q_{10}$ discharge divided by the total drainage area.

**Table 3.** Water fluxes for the 1991 water year for J.B. Converse Lake at normal lake volume

| Process | Flux (acre-feet/year) |
|---|---|
| Inflow | 1,691,000 |
| Precipitation | 327,000 |
| **Total flux into lake** | **2,018,000** |
| Outflow | 2,355,000 |
| Evaporation | 270,000 |
| **Total flux out of lake** | **2,625,000** |

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992

[$ft^3/s$, 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 milliliter; --, 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 |
| **Site 1, Big Creek** | | | | |
| PHYSICAL PROPERTIES | | | | |
| Discharge, instantaneous, in $ft^3/s$ | 42 | 1,280 | 15 | -- |
| Dissolved oxygen, in mg/L | 20 | 10.3 | 5.8 | 7.7 |
| Dissolved oxygen, in percent saturation | 20 | 92 | 63 | 81 |
| Specific conductance, instantaneous in µS/cm | 23 | 49 | 22 | 26 |
| pH, field value in standard units | 23 | 6.5 | 4.8 | -- |
| Alkalinity, WHFe, in mg/L as CaCO3 | 23 | 5.0 | 1.0 | 2.9 |
| Water temperature, in degree Celsius | 23 | 24.5 | 9.5 | 18.2 |
| Hardness, total, in mg/L as CaCO3 | 7 | 7.0 | 4.0 | 5.4 |
| Hardness, noncarbonate dissolved as CaCO3 | 7 | 5.0 | 1.0 | 3.3 |
| Bicarbonate, dissolved, in mg/L as HCO3 | 23 | 5.0 | .0 | 2.3 |
| Carbonate, dissolved, in mg/L as CO3 | 23 | .0 | -- | -- |
| MAJOR CONSTITUENTS | | | | |
| Calcium, dissolved, in mg/L | 7 | 1.1 | .8 | .9 |
| Magnesium, in mg/L | 7 | 1.0 | .5 | .8 |
| Sodium, dissolved, in mg/L | 7 | 2.2 | 1.7 | 1.9 |
| Potassium, dissolved in mg/L | 7 | .9 | .5 | .7 |
| Chloride, dissolved in mg/L | 7 | 4.4 | 3.2 | 3.9 |
| Sulfate, dissolved in mg/L | 7 | 1.5 | .5 | .8 |
| Fluoride, dissolved in mg/L | 7 | <.1 | <.1 | -- |
| Silica, dissolved in mg/L | 7 | 7.0 | 4.7 | 6.1 |
| Dissolved solids, total in mg/L | 7 | 21 | 16.0 | 18.7 |
| Dissolved solids, total residue at 180 °C | 7 | 24 | 15.0 | 19.4 |
| Dissolved solids, total in tons/day | 7 | 6.1 | 1.1 | 2.2 |
| Fecal coliform, in cols/100 mL | 22 | 6,000 | 20 | 470 |
| Fecal streptococci, in cols/100 mL | 23 | 9,000 | 17 | 900 |

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 1, Big Creek** | | | | |
| MINOR ELEMENTS | | | | |
| Boron, dissolved in µg/L | 7 | 50 | <20 | -- |
| Iron, total recoverable in µg/L | 7 | 930 | 60 | 440 |
| Iron, dissolved in µg/L | 7 | 280 | 50 | 140 |
| Manganese, total recoverable in µg/L | 7 | 60 | 9 | 30 |
| Manganese, dissolved in µg/L | 7 | 50 | 6 | 24 |
| MAJOR NUTRIENTS | | | | |
| Nitrate, total as N in mg/L | 21 | .70 | .16 | .44 |
| Nitrite, total as N in mg/L | 22 | .01 | <.01 | .01* |
| Nitrate plus nitrite, total as N in mg/L | 22 | .70 | .17 | .45 |
| Nitrate plus nitrite, dissolved as N in mg/L | 22 | .70 | .17 | .45 |
| Ammonia, total as N in mg/L | 21 | .08 | .01 | .04 |
| Ammonia, dissolved as N in mg/L | 21 | .09 | .01 | .04 |
| Ammonia, total as NH4 in mg/L | 19 | .10 | .01 | .05 |
| Ammonia, dissolved as NH4 in mg/L | 18 | .12 | .01 | .05 |
| Nitrogen, organic, total as N in mg/L | 20 | .68 | .18 | .33 |
| Nitrogen, ammonia plus organic, total as N in mg/L | 20 | .68 | .21 | .36 |
| Nitrogen, total as N in mg/L | 20 | 1.10 | .45 | .79 |
| Nitrogen, total in mg/L as NO3 | 20 | 5.00 | 2.00 | 3.50 |
| Phosphorus, total as P in mg/L | 22 | .04 | <.01 | .02* |
| Phosphorus, dissolved as P in mg/L | 21 | .04 | <.01 | .01* |
| Orthophosphorus, total as P in mg/L | 22 | .02 | <.01 | .01* |
| Orthophosphorus, dissolved as P in mg/L | 21 | .01 | <.01 | .01* |
| Phosphate, total as PO4 in mg/L | 15 | .06 | .03 | .03 |
| Orthophosphate, dissolved as PO4 in mg/L | 6 | .03 | .03 | .03 |

* Value calculated by using a log-probability regression to estimate the values of data below the detection limits.

**Table 4**. Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 2, Juniper Creek** | | | | |
| PHYSICAL PROPERTIES | | | | |
| Discharge, instantaneous, in $ft^3/s$ | 41 | 82 | 7.0 | 16.5 |
| Dissolved oxygen, in mg/L | 20 | 10.6 | 6.7 | 8.6 |
| Dissolved oxygen, in percent saturation | 20 | 93 | 75 | 89 |
| Specific conductance, instantaneous in µS/cm | 23 | 30 | 21 | 25 |
| pH, field value in standard units | 24 | 6.5 | 5.5 | -- |
| Alkalinity, WHFe, in mg/L as CaCO3 | 24 | 6.0 | 2.0 | 3.8 |
| Water temperature, in degree Celsius | 24 | 23.5 | 10.0 | 17 |
| Hardness, total, in mg/L as CaCO3 | 8 | 6.0 | 5.0 | 5.5 |
| Hardness, noncarbonate dissolved as CaCO3 | 8 | 4.0 | .0 | 2.4 |
| Bicarbonate, dissolved, in mg/L as HCO3 | 24 | 6.0 | 2.0 | 3.6 |
| Carbonate, dissolved, in mg/L as CO3 | 24 | .0 | -- | -- |
| MAJOR CONSTITUENTS | | | | |
| Calcium, dissolved, in mg/L | 8 | 1.2 | .8 | 1.0 |
| Magnesium, in mg/L | 8 | .8 | .7 | .8 |
| Sodium, dissolved, in mg/L | 8 | 2.2 | 1.9 | 2.0 |
| Potassium, dissolved in mg/L | 8 | .8 | .5 | .6 |
| Chloride, dissolved in mg/L | 8 | 4.0 | 3.5 | 3.8 |
| Sulfate, dissolved in mg/L | 8 | .9 | .4 | .6 |
| Fluoride, dissolved in mg/L | 8 | <.1 | <.1 | -- |
| Silica, dissolved in mg/L | 8 | 7.1 | 5.8 | 6.4 |
| Dissolved solids, total in mg/L | 8 | 20 | 18.0 | 19 |
| Dissolved solids, total residue at 180 °C | 8 | 25 | 9.0 | 18 |
| Dissolved solids, total in tons/day | 8 | 4.6 | .3 | 1.1 |
| Fecal coliform, in cols/100 mL | 22 | 6,000 | 58 | 520 |
| Fecal streptococci, in cols/100 mL | 24 | 20,000 | 75 | 1,600 |

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 2, Juniper Creek** | | | | |
| MINOR ELEMENTS | | | | |
| Boron, dissolved in µg/L | 8 | 30.0 | <20.0 | -- |
| Iron, total recoverable in µg/L | 8 | 620 | 200 | 340 |
| Iron, dissolved in µg/L | 8 | 130 | 30 | 70 |
| Manganese, total recoverable in µg/L | 8 | 50 | 10 | 22 |
| Manganese, dissolved in µg/L | 8 | 40 | 5 | 17 |
| MAJOR NUTRIENTS | | | | |
| Nitrate, total as N in mg/L | 22 | .55 | .14 | .42 |
| Nitrite, total as N in mg/L | 23 | .04 | <.01 | .01* |
| Nitrate plus nitrite, total as N in mg/L | 23 | .54 | .13 | .42 |
| Nitrate plus nitrite, dissolved as N in mg/L | 23 | .54 | .13 | .42 |
| Ammonia, total as N in mg/L | 22 | .04 | .01 | .02 |
| Ammonia, dissolved as N in mg/L | 22 | .11 | .01 | .02 |
| Ammonia, total as NH4 in mg/L | 20 | .05 | .01 | .02 |
| Ammonia, dissolved as NH4 in mg/L | 19 | .14 | .01 | .03 |
| Nitrogen, organic, total as N in mg/L | 15 | .96 | .16 | .35 |
| Nitrogen, ammonia plus organic, total as N in mg/L | 23 | .99 | <.20 | .29* |
| Nitrogen, total as N in mg/L | 15 | 1.30 | .57 | .76 |
| Nitrogen, total in mg/L as NO3 | 15 | 5.90 | 2.50 | 3.40 |
| Phosphorus, total as P in mg/L | 23 | .85 | <.01 | .06* |
| Phosphorus, dissolved as P in mg/L | 22 | .05 | <.01 | .01* |
| Orthophosphorus, total as P in mg/L | 23 | .07 | <.01 | .01* |
| Orthophosphorus, dissolved as P in mg/L | 22 | .02 | <.01 | .01* |
| Phosphate, total as PO4 in mg/L | 19 | .21 | .03 | .05 |
| Orthophosphate, dissolved as PO4 in mg/L | 11 | .06 | .03 | .03 |

* Value calculated by using a log-probability regression to estimate the values of data below the detection limits.

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 3, Collins Creek** | | | | |
| PHYSICAL PROPERTIES | | | | |
| Discharge, instantaneous, in $ft^3/s$ | 42 | 36 | 7.8 | 12 |
| Dissolved oxygen, in mg/L | 22 | 11.0 | 7.0 | 8.6 |
| Dissolved oxygen, in percent saturation | 22 | 97 | 83 | 89 |
| Specific conductance, instantaneous in μS/cm | 24 | 24 | 20 | 22 |
| pH, field value in standard units | 24 | 6.4 | 5.3 | -- |
| Alkalinity, WHFe, in mg/L as CaCO3 | 24 | 6.0 | 2.0 | 3.8 |
| Water temperature, in degree Celsius | 24 | 25.5 | 10 | 17.6 |
| Hardness, total, in mg/L as CaCO3 | 8 | 5.0 | 3.0 | 4.4 |
| Hardness, noncarbonate dissolved as CaCO3 | 8 | 3.0 | 1.0 | 1.5 |
| Bicarbonate, dissolved, in mg/L as HCO3 | 24 | 6.0 | 2.0 | 3.7 |
| Carbonate, dissolved, in mg/L as CO3 | 24 | .0 | -- | -- |
| MAJOR CONSTITUENTS | | | | |
| Calcium, dissolved, in mg/L | 8 | 1.3 | .7 | .9 |
| Magnesium, in mg/L | 8 | .5 | .4 | .5 |
| Sodium, dissolved, in mg/L | 8 | 2.2 | 1.6 | 2.0 |
| Potassium, dissolved in mg/L | 8 | .7 | .6 | .6 |
| Chloride, dissolved in mg/L | 8 | 3.7 | 2.5 | 3.4 |
| Sulfate, dissolved in mg/L | 8 | 1.4 | .5 | .8 |
| Fluoride, dissolved in mg/L | 8 | <.10 | <.10 | -- |
| Silica, dissolved in mg/L | 8 | 6.7 | 4.5 | 6.0 |
| Dissolved solids, total in mg/L | 8 | 19 | 16 | 17 |
| Dissolved solids, total residue at 180 °C | 8 | 20 | 10 | 16 |
| Dissolved solids, total in tons/day | 8 | 1.8 | .3 | .6 |
| Fecal coliform, in cols/100 mL | 21 | 2,600 | 36 | 24 |
| Fecal streptococci, in cols/100 mL | 24 | 6,000 | 12 | 700 |

**Table 4**. Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 3, Collins Creek** | | | | |
| MINOR ELEMENTS | | | | |
| Boron, dissolved in µg/L | 8 | 50 | <20 | -- |
| Iron, total recoverable in µg/L | 8 | 900 | 360 | 590 |
| Iron, dissolved in µg/L | 8 | 480 | 60 | 160 |
| Manganese, total recoverable in µg/L | 8 | 50 | 20 | 26 |
| Manganese, dissolved in µg/L | 8 | 40 | 10 | 19 |
| MAJOR NUTRIENTS | | | | |
| Nitrate, total as N in mg/L | 23 | .28 | .07 | .15 |
| Nitrite, total as N in mg/L | 24 | .02 | <.01 | .01* |
| Nitrate plus nitrite, total as N in mg/L | 24 | .20 | .08 | .16 |
| Nitrate plus nitrite, dissolved as N in mg/L | 24 | .20 | .08 | .16 |
| Ammonia, total as N in mg/L | 23 | .05 | .01 | .02 |
| Ammonia, dissolved as N in mg/L | 23 | .07 | <.01 | .02* |
| Ammonia, total as NH4 in mg/L | 21 | .06 | .01 | .02 |
| Ammonia, dissolved as NH4 in mg/L | 19 | .09 | .01 | .03 |
| Nitrogen, organic, total as N in mg/L | 15 | .51 | .19 | .29 |
| Nitrogen, ammonia plus organic, total as N in mg/L | 24 | .53 | <.20 | .26* |
| Nitrogen, total as N in mg/L | 15 | .67 | .34 | .47 |
| Nitrogen, total in mg/L as NO3 | 15 | 3.00 | 1.50 | 2.08 |
| Phosphorus, total as P in mg/L | 24 | .04 | <.01 | .02* |
| Phosphorus, dissolved as P in mg/L | 23 | .04 | <.01 | .01* |
| Orthophosphorus, total as P in mg/L | 24 | .03 | <.01 | .01* |
| Orthophosphorus, dissolved as P in mg/L | 23 | .02 | <.01 | .01* |
| Phosphate, total as PO4 in mg/L | 16 | .09 | .03 | .04 |
| Orthophosphate, dissolved as PO4 in mg/L | 7 | .06 | .03 | .03 |

* Value calculated by using a log-probability regression to estimate the values of data below the detection limits.

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 4, Long Branch** | | | | |
| PHYSICAL PROPERTIES | | | | |
| Discharge, instantaneous, in $ft^3/s$ | 12 | 13.0 | 2.8 | 6.6 |
| Dissolved oxygen, in mg/L | 12 | 10.9 | 7.3 | 8.7 |
| Dissolved oxygen, in percent saturation | 12 | 96 | 88 | 92 |
| Specific conductance, instantaneous in μS/cm | 12 | 50 | 22 | 40 |
| pH, field value in standard units | 12 | 6.8 | 5.6 | -- |
| Alkalinity, WHFe, in mg/L as CaCO3 | 12 | 11.0 | 4.0 | 6.7 |
| Water temperature, in degree Celsius | 12 | 25.5 | 10.0 | 18.3 |
| Hardness, total, in mg/L as CaCO3 | 4 | 12.0 | 9.0 | 11 |
| Hardness, noncarbonate dissolved as CaCO3 | 4 | 8.00 | .0 | -- |
| Bicarbonate, dissolved, in mg/L as HCO3 | 12 | 13.0 | 4.0 | 7.2 |
| Carbonate, dissolved, in mg/L as CO3 | 12 | .0 | -- | -- |
| MAJOR CONSTITUENTS | | | | |
| Calcium, dissolved, in mg/L | 4 | 2.8 | 2.1 | 2.5 |
| Magnesium, in mg/L | 4 | 1.3 | 1.0 | 1.1 |
| Sodium, dissolved, in mg/L | 4 | 2.9 | 2.3 | 2.5 |
| Potassium, dissolved in mg/L | 4 | 1.2 | 1.0 | 1.1 |
| Chloride, dissolved in mg/L | 4 | 5.2 | 4.2 | 4.8 |
| Sulfate, dissolved in mg/L | 4 | 3.8 | 1.2 | 2.7 |
| Fluoride, dissolved in mg/L | 4 | <.10 | <.10 | -- |
| Silica, dissolved in mg/L | 4 | 6.4 | 5.9 | 6.2 |
| Dissolved solids, total in mg/L | 4 | 30 | 25 | 28 |
| Dissolved solids, total residue at 180 °C | 4 | 31 | 26 | 30 |
| Dissolved solids, total in tons/day | 4 | .88 | .27 | .69 |
| Fecal coliform, in cols/100 mL | 11 | 250 | 28 | 124 |
| Fecal streptococci, in cols/100 mL | 12 | 8,700 | 36 | 1,200 |

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 4, Long Branch** | | | | |
| MINOR ELEMENTS | | | | |
| Boron, dissolved in µg/L | 4 | 30.00 | <20.00 | -- |
| Iron, total recoverable in µg/L | 4 | 6,400.00 | 550.00 | 2,080 |
| Iron, dissolved in µg/L | 4 | 420.00 | 30.00 | 180 |
| Manganese, total recoverable in µg/L | 4 | 280.00 | 20.00 | 113 |
| Manganese, dissolved in µg/L | 4 | 80.00 | 20.00 | 58 |
| MAJOR NUTRIENTS | | | | |
| Nitrate, total as N in mg/L | 12 | .99 | .35 | .61 |
| Nitrite, total as N in mg/L | 12 | .01 | <.01 | .01* |
| Nitrate plus nitrite, total as N in mg/L | 12 | .99 | .35 | .61 |
| Nitrate plus nitrite, dissolved as N in mg/L | 12 | .99 | .35 | .61 |
| Ammonia, total as N in mg/L | 11 | .11 | .02 | .05 |
| Ammonia, dissolved as N in mg/L | 11 | .11 | .03 | .05 |
| Ammonia, total as NH4 in mg/L | 11 | .14 | .03 | .06 |
| Ammonia, dissolved as NH4 in mg/L | 11 | .14 | .04 | .07 |
| Nitrogen, organic, total as N in mg/L | 10 | 1.70 | .22 | .44 |
| Nitrogen, ammonia plus organic, total as N in mg/L | 12 | 1.70 | <.20 | .43* |
| Nitrogen, total as N in mg/L | 10 | 2.10 | .59 | 1.10 |
| Nitrogen, total in mg/L as NO3 | 10 | 9.30 | 2.60 | 4.86 |
| Phosphorus, total as P in mg/L | 12 | .08 | <.01 | .02* |
| Phosphorus, dissolved as P in mg/L | 11 | .04 | <.01 | .01* |
| Orthophosphorus, total as P in mg/L | 12 | .02 | .01 | .01 |
| Orthophosphorus, dissolved as P in mg/L | 11 | .01 | <.01 | -- |
| Phosphate, total as PO4 in mg/L | 12 | .06 | .03 | .03 |
| Orthophosphate, dissolved as PO4 in mg/L | 3 | .03 | .03 | -- |

* Value calculated by using a log-probability regression to estimate the values of data below the detection limits.

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 6, Boggy Branch** | | | | |
| PHYSICAL PROPERTIES | | | | |
| Discharge, instantaneous, in $ft^3/s$ | 12 | 12 | 1.3 | 6.0 |
| Dissolved oxygen, in mg/L | 12 | 8.8 | 5.1 | 6.7 |
| Dissolved oxygen, in percent saturation | 12 | 88 | 61 | 71 |
| Specific conductance, instantaneous in µS/cm | 12 | 48 | 25 | 32 |
| pH, field value in standard units | 12 | 6.3 | 5.3 | -- |
| Alkalinity, WHFe, in mg/L as CaCO3 | 12 | 6.0 | 2.0 | 4.2 |
| Water temperature, in degree Celsius | 12 | 25.5 | 9.0 | 18.4 |
| Hardness, total, in mg/L as CaCO3 | 4 | 8.0 | 6.0 | 7.2 |
| Hardness, noncarbonate dissolved as CaCO3 | 4 | 6.0 | .0 | -- |
| Bicarbonate, dissolved, in mg/L as HCO3 | 12 | 7.0 | 2.0 | 3.8 |
| Carbonate, dissolved, in mg/L as CO3 | 12 | .0 | -- | -- |
| MAJOR CONSTITUENTS | | | | |
| Calcium, dissolved, in mg/L | 4 | 1.4 | 1.1 | 1.3 |
| Magnesium, in mg/L | 4 | 1.2 | .8 | 1.0 |
| Sodium, dissolved, in mg/L | 4 | 3.0 | 2.0 | 2.5 |
| Potassium, dissolved in mg/L | 4 | .9 | .7 | .8 |
| Chloride, dissolved in mg/L | 4 | 41.0 | 4.8 | 15 |
| Sulfate, dissolved in mg/L | 4 | 1.9 | .7 | 1.3 |
| Fluoride, dissolved in mg/L | 4 | <.10 | <.10 | -- |
| Silica, dissolved in mg/L | 4 | 8.1 | 6.0 | 7.0 |
| Dissolved solids, total in mg/L | 4 | 59 | 21 | 32 |
| Dissolved solids, total residue at 180 °C | 4 | 25 | 19 | 23 |
| Dissolved solids, total in tons/day | 4 | .62 | .09 | .35 |
| Fecal coliform, in cols/100 mL | 11 | 6,000 | 50 | 670 |
| Fecal streptococci, in cols/100 mL | 12 | 8,800 | 14 | 1,100 |

**Table 4**. Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 6, Boggy Branch** | | | | |
| MINOR ELEMENTS | | | | |
| Boron, dissolved in µg/L | 4 | 30 | <20 | -- |
| Iron, total recoverable in µg/L | 4 | 1,700 | 610 | 1,180 |
| Iron, dissolved in µg/L | 4 | 730 | 90 | 215 |
| Manganese, total recoverable in µg/L | 4 | 100 | 60 | 85 |
| Manganese, dissolved in µg/L | 4 | 80 | 50 | 68 |
| MAJOR NUTRIENTS | | | | |
| Nitrate, total as N in mg/L | 12 | .30 | .09 | -- |
| Nitrite, total as N in mg/L | 12 | .01 | <.01 | -- |
| Nitrate plus nitrite, total as N in mg/L | 12 | .30 | .08 | .14 |
| Nitrate plus nitrite, dissolved as N in mg/L | 12 | .30 | .08 | .14 |
| Ammonia, total as N in mg/L | 11 | .04 | <.01 | .02* |
| Ammonia, dissolved as N in mg/L | 11 | .04 | .01 | .02 |
| Ammonia, total as NH4 in mg/L | 10 | .05 | .01 | .02 |
| Ammonia, dissolved as NH4 in mg/L | 11 | .05 | .01 | .02 |
| Nitrogen, organic, total as N in mg/L | 12 | 1.50 | .21 | .45 |
| Nitrogen, ammonia plus organic, total as N in mg/L | 12 | 1.50 | .22 | .47 |
| Nitrogen, total as N in mg/L | 12 | 1.60 | .40 | .61 |
| Nitrogen, total in mg/L as NO3 | 12 | 7.20 | 1.80 | 2.71 |
| Phosphorus, total as P in mg/L | 12 | .04 | <.01 | .02* |
| Phosphorus, dissolved as P in mg/L | 11 | .03 | <.01 | .01* |
| Orthophosphorus, total as P in mg/L | 12 | .03 | <.01 | .01* |
| Orthophosphorus, dissolved as P in mg/L | 11 | .02 | <.01 | .01* |
| Phosphate, total as PO4 in mg/L | 11 | .09 | .03 | .04 |
| Orthophosphate, dissolved as PO4 in mg/L | 5 | .06 | .03 | -- |

* Value calculated by using a log-probability regression to estimate the values of data below the detection limits.

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 8, Crooked Creek** | | | | |
| PHYSICAL PROPERTIES | | | | |
| Discharge, instantaneous, in $ft^3/s$ | 38 | 24 | 6.6 | 12 |
| Dissolved oxygen, in mg/L | 22 | 10.3 | 5.4 | 8.0 |
| Dissolved oxygen, in percent saturation | 22 | 93 | 61 | 83 |
| Specific conductance, instantaneous in µS/cm | 24 | 42 | 22 | 34 |
| pH, field value in standard units | 24 | 6.8 | 5.2 | -- |
| Alkalinity, WHFe, in mg/L as CaCO3 | 24 | 12 | 4.0 | 7.0 |
| Water temperature, in degree Celsius | 24 | 23.5 | 9.0 | 17.4 |
| Hardness, total, in mg/L as CaCO3 | 8 | 10.0 | 7.0 | 8.0 |
| Hardness, noncarbonate dissolved as CaCO3 | 7 | 4.0 | 1.0 | 2.3 |
| Bicarbonate, dissolved, in mg/L as HCO3 | 24 | 13.0 | 5.0 | 8.0 |
| Carbonate, dissolved, in mg/L as CO3 | 24 | .0 | -- | -- |
| MAJOR CONSTITUENTS | | | | |
| Calcium, dissolved, in mg/L | 8 | 2.6 | 1.4 | 1.9 |
| Magnesium, in mg/L | 8 | 1.0 | .8 | .9 |
| Sodium, dissolved, in mg/L | 8 | 2.9 | 2.3 | 2.6 |
| Potassium, dissolved in mg/L | 8 | 1.5 | .8 | 1.1 |
| Chloride, dissolved in mg/L | 8 | 4.9 | 4.0 | 4.5 |
| Sulfate, dissolved in mg/L | 8 | 2.2 | 1.0 | 1.5 |
| Fluoride, dissolved in mg/L | 8 | <.1 | <.1 | -- |
| Silica, dissolved in mg/L | 8 | 6.8 | 5.4 | 6.2 |
| Dissolved solids, total in mg/L | 8 | 28 | 22 | 24 |
| Dissolved solids, total residue at 180 °C | 8 | 31 | 17 | 25 |
| Dissolved solids, total in tons/day | 8 | 1.7 | .5 | .9 |
| Fecal coliform, in cols/100 mL | 23 | 860 | 72 | 260 |
| Fecal streptococci, in cols/100 mL | 24 | 3,000 | 74 | 670 |

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 8, Crooked Creek** | | | | |
| MINOR ELEMENTS | | | | |
| Boron, dissolved in µg/L | 8 | 30.0 | <20.0 | -- |
| Iron, total recoverable in µg/L | 8 | 1,100 | 420 | 720 |
| Iron, dissolved in µg/L | 8 | 500 | 65 | 240 |
| Manganese, total recoverable in µg/L | 8 | 50 | 20 | 27 |
| Manganese, dissolved in µg/L | 8 | 30 | 9 | 16 |
| MAJOR NUTRIENTS | | | | |
| Nitrate, total as N in mg/L | 22 | .52 | .27 | .38 |
| Nitrite, total as N in mg/L | 23 | .01 | <.01 | .01* |
| Nitrate plus nitrite, total as N in mg/L | 23 | .52 | .25 | .39 |
| Nitrate plus nitrite, dissolved as N in mg/L | 23 | .52 | .25 | .39 |
| Ammonia, total as N in mg/L | 22 | .05 | .01 | .02 |
| Ammonia, dissolved as N in mg/L | 22 | .07 | .01 | .02 |
| Ammonia, total as NH4 in mg/L | 20 | .06 | .01 | .02 |
| Ammonia, dissolved as NH4 in mg/L | 19 | .09 | .01 | .03 |
| Nitrogen, organic, total as N in mg/L | 19 | .49 | .18 | .31 |
| Nitrogen, ammonia plus organic, total as N in mg/L | 23 | .50 | <.20 | .30* |
| Nitrogen, total as N in mg/L | 19 | .89 | .23 | .69 |
| Nitrogen, total in mg/L as NO3 | 18 | 3.90 | 2.30 | 3.16 |
| Phosphorus, total as P in mg/L | 23 | .05 | <.01 | .02* |
| Phosphorus, dissolved as P in mg/L | 22 | .05 | <.01 | .01* |
| Orthophosphorus, total as P in mg/L | 23 | .03 | .01 | .02 |
| Orthophosphorus, dissolved as P in mg/L | 22 | .02 | <.01 | .01* |
| Phosphate, total as PO4 in mg/L | 22 | .09 | .03 | .04 |
| Orthophosphate, dissolved as PO4 in mg/L | 13 | .06 | .03 | .03 |

* Value calculated by using a log-probability regression to estimate the values of data below the detection limits.

**Table 4**. Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 10, Hamilton Creek** | | | | |
| PHYSICAL PROPERTIES | | | | |
| Discharge, instantaneous, in $ft^3/s$ | 41 | 171 | 11 | 22 |
| Dissolved oxygen, in mg/L | 22 | 9.7 | 5.2 | 7.8 |
| Dissolved oxygen, in percent saturation | 22 | 96 | 60 | 82 |
| Specific conductance, instantaneous in µS/cm | 24 | 38 | 22 | 33 |
| pH, field value in standard units | 24 | 6.4 | 5.5 | -- |
| Alkalinity, WHFe, in mg/L as CaCO3 | 23 | 7.0 | 2.0 | 5.0 |
| Water temperature, in degree Celsius | 24 | 23.5 | 10.5 | 18.1 |
| Hardness, total, in mg/L as CaCO3 | 8 | 7.0 | 6.0 | 6.6 |
| Hardness, noncarbonate dissolved as CaCO3 | 8 | 3.0 | 1.0 | 2.4 |
| Bicarbonate, dissolved, in mg/L as HCO3 | 24 | 6.0 | 1.0 | 4.8 |
| Carbonate, dissolved, in mg/L as CO3 | 24 | .0 | -- | -- |
| MAJOR CONSTITUENTS | | | | |
| Calcium, dissolved, in mg/L | 8 | 1.7 | 1.1 | 1.4 |
| Magnesium, in mg/L | 8 | .8 | .7 | .8 |
| Sodium, dissolved, in mg/L | 8 | 3.3 | 2.9 | 3.1 |
| Potassium, dissolved in mg/L | 8 | .8 | .5 | .7 |
| Chloride, dissolved in mg/L | 8 | 5.9 | 4.2 | 4.9 |
| Sulfate, dissolved in mg/L | 8 | 1.50 | .8 | 1.0 |
| Fluoride, dissolved in mg/L | 8 | <.10 | <.10 | -- |
| Silica, dissolved in mg/L | 8 | 7.3 | 6.1 | 6.8 |
| Dissolved solids, total in mg/L | 8 | 26 | 22 | 24 |
| Dissolved solids, total residue at 180 °C | 8 | 28 | 15 | 22 |
| Dissolved solids, total in tons/day | 8 | 1.49 | .53 | 1.02 |
| Fecal coliform, in cols/100 mL | 22 | 1,100 | 26 | 210 |
| Fecal streptococci, in cols/100 mL | 24 | 19,000 | 30 | 1,400 |

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 10, Hamilton Creek** | | | | |
| MINOR ELEMENTS | | | | |
| Boron, dissolved in µg/L | 8 | 30 | <20 | -- |
| Iron, total recoverable in µg/L | 8 | 810 | 310 | 490 |
| Iron, dissolved in µg/L | 8 | 300 | 70 | 160 |
| Manganese, total recoverable in µg/L | 8 | 33 | 10 | 23 |
| Manganese, dissolved in µg/L | 8 | 30 | 10 | 21 |
| MAJOR NUTRIENTS | | | | |
| Nitrate, total as N in mg/L | 22 | .64 | .07 | .50 |
| Nitrite, total as N in mg/L | 23 | .03 | <.01 | .01* |
| Nitrate plus nitrite, total as N in mg/L | 23 | .63 | .07 | .50 |
| Nitrate plus nitrite, dissolved as N in mg/L | 23 | .63 | .07 | .50 |
| Ammonia, total as N in mg/L | 22 | .04 | .01 | .02 |
| Ammonia, dissolved as N in mg/L | 22 | .06 | .01 | .02 |
| Ammonia, total as NH4 in mg/L | 21 | .05 | .01 | .03 |
| Ammonia, dissolved as NH4 in mg/L | 20 | .08 | .01 | .03 |
| Nitrogen, organic, total as N in mg/L | 16 | .59 | .18 | .33 |
| Nitrogen, ammonia plus organic, total as N in mg/L | 23 | .60 | <.02 | .30* |
| Nitrogen, total as N in mg/L | 16 | 1.20 | .66 | .82 |
| Nitrogen, total in mg/L as NO3 | 16 | 5.40 | 2.90 | 3.66 |
| Phosphorus, total as P in mg/L | 23 | .11 | <.01 | .03* |
| Phosphorus, dissolved as P in mg/L | 22 | .04 | <.01 | .01* |
| Orthophosphorus, total as P in mg/L | 23 | .09 | <.01 | .02* |
| Orthophosphorus, dissolved as P in mg/L | 22 | .02 | <.01 | .01* |
| Phosphate, total as PO4 in mg/L | 17 | .28 | .03 | .06 |
| Orthophosphate, dissolved as PO4 in mg/L | 12 | .06 | .03 | .03 |

* Value calculated by using a log-probability regression to estimate the values of data below the detection limits.

**Table 4**. Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 11, J.B. Converse Lake at pump station** | | | | |
| PHYSICAL PROPERTIES | | | | |
| Discharge, instantaneous, in $ft^3/s$ | -- | -- | -- | -- |
| Dissolved oxygen, in mg/L | 115 | 10.5 | 0.1 | 7.6 |
| Dissolved oxygen, in percent saturation | 32 | 104 | 71 | 91 |
| Specific conductance, instantaneous in µS/cm | 116 | 41 | 21 | 25 |
| pH, field value in standard units | 116 | 6.8 | 5.4 | -- |
| Alkalinity, WHFe, in mg/L as CaCO3 | 24 | 7.0 | 2.0 | 4.2 |
| Water temperature, in degree Celsius | 116 | 32.0 | 12.0 | 21.1 |
| Hardness, total, in mg/L as CaCO3 | 8 | 6.0 | 5.0 | 5.6 |
| Hardness, noncarbonate dissolved as CaCO3 | 8 | 4.0 | 1.0 | 2.4 |
| Bicarbonate, dissolved, in mg/L as HCO3 | 23 | 7.0 | 2.0 | 4.0 |
| Carbonate, dissolved, in mg/L as CO3 | 23 | .0 | -- | -- |
| MAJOR CONSTITUENTS | | | | |
| Calcium, dissolved, in mg/L | 8 | 1.4 | 1.0 | 1.2 |
| Magnesium, in mg/L | 8 | .7 | .6 | .7 |
| Sodium, dissolved, in mg/L | 8 | 2.3 | 1.9 | 2.1 |
| Potassium, dissolved in mg/L | 8 | .9 | .6 | .8 |
| Chloride, dissolved in mg/L | 8 | 4.0 | 3.4 | 3.6 |
| Sulfate, dissolved in mg/L | 8 | 2.0 | 1.3 | 1.6 |
| Fluoride, dissolved in mg/L | 8 | <.1 | <.1 | -- |
| Silica, dissolved in mg/L | 8 | 4.3 | 2.0 | 3.0 |
| Dissolved solids, total in mg/L | 8 | 17 | 14 | 16 |
| Dissolved solids, total residue at 180 °C | 8 | 21 | 10 | 16 |
| Dissolved solids, total in tons/day | -- | -- | -- | -- |
| Fecal coliform, in cols/100 mL | 21 | 110 | <1 | 16* |
| Fecal streptococci, in cols/100 mL | 23 | 56 | <1 | 10* |

**Table 4.** Statistical summary of physical properties and concentrations of major constituents, major nutrients, and minor elements in water from seven major tributary sites and one lake site in J.B. Converse Lake Basin, from October 1990 to September 1992--Continued

| Water-quality constituent or property | Number of samples | Concentration or measurement | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Mean |
| **Site 11, J.B. Converse Lake at pump station** | | | | |
| MINOR ELEMENTS | | | | |
| Boron, dissolved in µg/L | 8 | 30 | <200 | -- |
| Iron, total recoverable in µg/L | 8 | 530 | 190 | 340 |
| Iron, dissolved in µg/L | 8 | 330 | 40 | 160 |
| Manganese, total recoverable in µg/L | 8 | 33 | <10 | 20* |
| Manganese, dissolved in µg/L | 8 | 10 | <10 | 7.5* |
| MAJOR NUTRIENTS | | | | |
| Nitrate, total as N in mg/L | 19 | .19 | .02 | .10 |
| Nitrite, total as N in mg/L | 23 | .01 | <.01 | -- |
| Nitrate plus nitrite, total as N in mg/L | 23 | .18 | <.02 | .09* |
| Nitrate plus nitrite, dissolved as N in mg/L | 23 | .18 | <.02 | .09* |
| Ammonia, total as N in mg/L | 22 | .05 | .01 | .02 |
| Ammonia, dissolved as N in mg/L | 22 | .06 | .01 | .02 |
| Ammonia, total as NH4 in mg/L | 21 | .06 | .01 | .03 |
| Ammonia, dissolved as NH4 in mg/L | 20 | .06 | .01 | .02 |
| Nitrogen, organic, total as N in mg/L | 21 | .51 | .16 | .32 |
| Nitrogen, ammonia plus organic, total as N in mg/L | 23 | .53 | .20 | .34 |
| Nitrogen, total as N in mg/L | 21 | .65 | .31 | .44 |
| Nitrogen, total in mg/L as NO3 | 17 | 2.90 | 1.40 | 1.94 |
| Phosphorus, total as P in mg/L | 23 | .04 | <.01 | .02* |
| Phosphorus, dissolved as P in mg/L | 22 | .03 | <.01 | .01* |
| Orthophosphorus, total as P in mg/L | 23 | .02 | <.01 | .01* |
| Orthophosphorus, dissolved as P in mg/L | 22 | .02 | <.01 | .01* |
| Phosphate, total as PO4 in mg/L | 13 | .06 | .03 | .03 |
| Orthophosphate, dissolved as PO4 in mg/L | 8 | .06 | .03 | .03 |

* Value calculated by using a log-probability regression to estimate the values of data below the detection limits.

**Table 5**. Change in temperature and change in dissolved-oxgyen concentrations from the surface to the bottom of the lake at the center quarter of the four lake profile cross-sections in J. B. Converse Lake from November 1990 to August 1992

[Δ T, change in temperature;Δ D.O., change in dissolved-oxygen concentrations; Depth is total depth from surface to bottom of lake; °C, degrees Celsius; mg/L, milligrams per liter. Locations of the lake profile sites shown in fig. 2]

| Date | Change in property with depth | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Site 5 | | | Site 7 | | | Site 9 | | | Site 11 | | |
| | Depth (feet) | ΔT (°C) | Δ D.O. (mg/L) | Depth (feet) | ΔT (°C) | Δ D.O. (mg/L) | Depth (feet) | ΔT (°C) | Δ D.O. (mg/L) | Depth (feet) | ΔT (°C) | Δ D.O. (mg/L) |
| 11-15-90 | 15 | -1.0 | 0.0 | 28 | -1.0 | -0.9 | 12 | -2.5 | -0.3 | 14 | -0.5 | -0.3 |
| 02-06-91 | 8 | -3.0 | -0.9 | 34 | -2.5 | -1.0 | 13 | -4.0 | -1.8 | 16 | -2.5 | -0.2 |
| 05-09-91 | 10 | -2.5 | -0.4 | 23 | -3.0 | -2.7 | 15 | -4.0 | -1.7 | 18 | -1.0 | -1.6 |
| 08-06-91 | 15 | -5.0 | -1.4 | 23 | -8.0 | -7.3 | 13 | -2.5 | -6.1 | 23 | -8.5 | -7.3 |
| 11-05-91 | 10 | -2.0 | 0.0 | 23 | -1.0 | -0.2 | 14 | -2.0 | + 0.5 | 15 | -0.5 | -0.1 |
| 02-03-92 | 13 | -2.0 | -0.1 | 24 | -3.5 | -0.2 | 13 | -1.0 | -0.3 | 10 | 0.0 | -0.2 |
| 05-07-92 | 14 | -1.0 | -0.5 | 22 | -1.5 | -1.8 | 13 | -0.5 | -3.3 | 7 | 0.0 | 0.0 |
| 08-04-92 | 7 | -4.0 | -0.7 | 22 | -7.5 | -7.4 | 10 | -2.0 | -1.7 | 17 | -2.5 | -2.7 |
| MEAN | 12 | -- | -- | 22 | -- | -- | 13 | -- | -- | 15 | -- | -- |

**Table 6**. Statistical parameters and regression equations used to determine total nitrogen and total phosphorus loads for the major tributaries to J.B. Converse Lake, October 1990 to September 1992

[$r^2$, r-squared value adjusted for a sample size of the regression equation; Q, mean daily discharge, in cubic feet per second. Location of sites shown in fig. 1]

| Site number | Tributary name | Number of samples | Regression analysis for total nitrogen (Nt) load, in tons per day. | | | Regression analysis for total phosphorus (Pt) load, in tons per day | | |
|---|---|---|---|---|---|---|---|---|
| | | | Regression equation | $r^2$ | Standard error (percent) | Regression equation | $r^2$ | Standard error (percent) |
| 1 | Big Creek | 21 | $Nt = 0.0033\ Q^{0.887}$ | 0.91 | 20 | $Pt = 0.00064\ Q^{0.417}$ | 0.04 | 166 |
| 2 | Juniper Creek | [1]22 | $Nt = .001\ Q^{1.22}$ | .90 | 24 | $Pt = .000006\ Q^{1.80}$ | .67 | 97 |
| 3 | Collins Creek | 22 | $Nt = .00015\ Q^{1.72}$ | .69 | 48 | $Pt = .000014\ Q^{1.49}$ | .24 | 109 |
| 4 | Long Branch | 12 | $Nt = .0008\ Q^{1.43}$ | .93 | 23 | $Pt = .00002\ Q^{1.48}$ | .37 | 119 |
| 6 | Boggy Branch | 12 | $Nt = .0011\ Q^{1.24}$ | .86 | 38 | $Pt = .00014\ Q^{0.259}$ | .07 | 50 |
| 8 | Crooked Creek | 21 | $Nt = .00208\ Q^{0.949}$ | .73 | 21 | $Pt = .000008Q^{1.78}$ | .32 | 119 |
| 10 | Hamilton Creek | 21 | $Nt = .00242\ Q^{0.948}$ | .87 | 21 | $Pt = .000011\ Q^{1.62}$ | .45 | 156 |

[1] 21 samples were used to develop total phosphorus (Pt) load equations.

**Table 7**. Statistical parameters and regression equations used to determine nitrate plus nitrite loads and organic nitrogen plus ammonia loads for the major tributaries to J.B. Converse Lake, October 1990 to September 1992

[Q, mean daily discharge, in cubic feet per second; $r^2$, r-squared value adjusted for sample size of the regrssion equation; >, greater than. Locations of sites shown in fig. 1]

| Site number | Tributary name | Number of samples | Regression analysis for nitrate plus nitrite ($NO_3$+$NO_2$) load, in tons per day. | | | Regression analysis for organic nitrogen and ammonia (Ng) load, in tons per day | | |
|---|---|---|---|---|---|---|---|---|
| | | | Regression equation | $r^2$ | Standard error (percent) | Regression equation | $r^2$ | Standard error (percent) |
| 1 | Big Creek | 21 | $NO_3+NO_2 = 0.00718\ Q^{0.526}$ | 0.66 | 28 | $Ng = 0.00033\ Q^{1.27}$ | 0.92 | 27 |
| 2 | Juniper Creek. | 22 | $NO_3+NO_2 = .00289\ Q^{0.663}$ | .85 | 16 | $Ng = .000017\ Q^{2.4}$ | .51 | 225 |
| 3 | Collins Creek | 22 | $NO_3+NO_2 = .00102\ Q^{0.67}$ | .63 | 19 | $Ng = .000002\ Q^{3.25}$ | .34 | 343 |
| 4 | Long Branch | 12 | $NO_3+NO_2 = .00076Q^{1.43}$ | .84 | 31 | $Ng = .000245\ Q^{1.85}$ | .53 | 92 |
| 5 | Boggy Branch | 12 | $NO_3+NO_2 = .00036\ Q^{1.07}$ | .84 | 33 | $Ng = .000799\ Q^{1.26}$ | .78 | 50 |
| 6 | Crooked Creek | 21 | $NO_3+NO_2 = .00192\ Q^{0.763}$ | .75 | 15 | $Ng = .000581\ Q^{1.32}$ | .06 | 233 |
| 7 | Hamilton Creek | 21 | $NO_3+NO_2 = .01152\ Q^{0.264}$ | .64 | 11 | $Ng = .000071\ Q^{1.92}$ | .35 | 247 |

**Table 8.** Annual nutrient loads and yields, determined from regression analysis, for seven major tributary sites in the J.B. Converse Lake Basin for the 1991 water year

[$mi^2$, square miles; $ft^3/s$, cubic foot per second; ton/yr, tons per year; ton/yr/$mi^2$, tons per year per square mile; --, not applicable; N, nitrogen; P, phosphorus. Locations of sites shown in fig. 1. Regression equations used in the determination of loads listed in table 5]

| Site number | Tributary name | Drainage area ($mi^2$) | Total annual discharge (mean) ($ft^3/s$) | Total nitrogen, as N | | Total phosphorus, as P | |
|---|---|---|---|---|---|---|---|
| | | | | Annual load (ton/yr) | Annual yield (ton/yr/$mi^2$) | Annual load (ton/yr) | Annual yield (ton/yr/$mi^2$) |
| 1 | Big Creek | 31.50 | 34,337 (94.1) | 64.41 | 2.19 | 1.37 | 0.043 |
| 2 | Juniper Creek | 9.22 | 7,631 (20.9) | 15.41 | 1.67 | .65 | .072 |
| 3 | Collins Creek | 8.54 | 6,604 (18.1) | 9.79 | 1.15 | .43 | .050 |
| 4 | Long Branch | 2.85 | 2,468 (6.8) | 9.34 | 3.28 | .14 | .049 |
| 6 | Boggy Branch | 3.17 | 3,441 (9.4) | 7.74 | 2.44 | .08 | .025 |
| 8 | Crooked Creek | 8.08 | 7,946 (21.8) | 13.89 | 1.72 | 1.31 | .162 |
| 10 | Hamilton Creek | 8.22 | 8,926 (24.5) | 18.11 | 2.20 | .98 | .119 |
| BASIN TOTAL | | 71.58 | 71,353 | 138.69 | [1]1.94 | 4.96 | [2].069 |
| BASIN MEAN | | -- | -- | 19.81 | -- | .71 | -- |

[1] Total nitrogen yield of the basin calculated by dividing total annual nitrogen load by the total drainage area for the basin.

[2] Total phosphorus yield of the basin calculated by dividing total annual phosphorus load by the total drainage area for the basin.

**Table 9.** Annual nutrient loads and yields, determined from regression analysis, for five major tributary sites in the J.B. Converse Lake Basin for the 1992 water year

[$mi^2$, square miles; $ft^3/s$, cubic foot per second; ton/yr, tons per year; ton/yr/$mi^2$, tons per year per square mile; --, not applicable; N, nitrogen; P, phosphorus. Locations of sites shown in fig. 1. Regression equations used in the determination of loads listed in table 5]

| Site number | Tributary name | Drainage area, ($mi^2$) | Total annual discharge (mean) ($ft^3/s$) | Total nitrogen, as N | | Total phosphorus, as P | |
|---|---|---|---|---|---|---|---|
| | | | | Annual load (ton/yr) | Annual yield (ton/yr/$mi^2$) | Annual load (ton/yr) | Annual yield (ton/yr/$mi^2$) |
| 1 | Big Creek | 31.50 | 19,351 (52.9) | 46.81 | 1.49 | 1.11 | 0.035 |
| 2 | Juniper Creek | 9.22 | 5,337 (14.6) | 9.80 | 1.06 | .30 | .033 |
| 3 | Collins Creek | 8.54 | 4,879 (13.3) | 5.50 | .64 | .26 | .030 |
| 8 | Crooked Creek | 8.08 | 4,889 (13.4) | 8.83 | 1.09 | .40 | .049 |
| 10 | Hamilton Creek | 8.22 | 7,240 (19.8) | 14.88 | 1.81 | .62 | .075 |

**Table 10**. Characterization of water quality data for the major tributary sites in J.B. Converse Lake Basin, October 1990 to September 1992
[$\overline{X}_{min}$, minimum mean value; $\overline{X}_{max}$, maximum mean value; Max, maximum value; Min, minimum value; --, not applicable]

| Site number | Physcial and chemical properties | | | | | Fecal bacteria | | Nutrient yields [b,c] | | Nutrient loads [b,c] | | Minor elements [d] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Discharge, percent [a] | Dissolved oxygen | pH | Specific conductance | Alkalinity | Coliform | Streptococcus | Total nitrogen | Total phosphorus | Total nitrogen | Total phosphorus | Iron | Manganese |
| 1 | 48 | -- | Min | -- | $\overline{X}_{min}$; Min | Max; Min | -- | > | < | Max | > | Min | Min |
| 2 | 11 | -- | -- | -- | -- | Max | Max; $\overline{X}_{max}$ | Min | > | < | > | $\overline{X}_{min}$ | $\overline{X}_{min}$ |
| 3 | 9 | Max | Max | $\overline{X}_{min}$; Min | -- | -- | Min | < | < | < | < | -- | -- |
| 4 | 3.5 | $\overline{X}_{max}$ | -- | $\overline{X}_{max}$; Max | -- | $\overline{X}_{min}$ | -- | Max | < | < | < | $\overline{X}_{max}$; Max | $\overline{X}_{max}$; Max |
| 6 | 5 | $\overline{X}_{min}$; Min | -- | -- | -- | $\overline{X}_{max}$; Max | -- | > | Min | Min | Min | -- | -- |
| 8 | 11 | -- | -- | -- | $\overline{X}_{max}$; Max | -- | $\overline{X}_{min}$ | < | Max | < | Max | -- | -- |
| 10 | 12.5 | -- | -- | -- | -- | -- | Max | > | > | < | > | -- | $\overline{X}_{min}$ |

[a] Discharge as percent of total annual discharge of the seven major tributaries to J.B. Converse Lake for the 1991 water year (table 8)
[b] Maximum and minimum nutrient yields and loads determined from the 1991 water year results (fig.20, 21; table 8)
[c] Nutrient yields and loads of each site represented as equal to, greater than, or less than (=,>, or <, respectively) the mean nutrient yield or load of the basin for the 1991 water year (table 8)
[d] Maximum, minimum, and mean values for minor elements dervied from total recoverable concentrations (table 4)

**Table 11**.--Results of analyses for the presence of Giardia in water collected at four sites in J.B. Converse Lake and two sites in the water system of the city of Mobile

[0/380, number of cysts observed/liters of water filtered; --, no data; >, greater than. Locations of lake sites shown in fig. 1]

| Date of Sampling | Giardia cysts detected, in number of cysts observed per liters of water filtered | | | | | |
|---|---|---|---|---|---|---|
| | Site 5 | Site 7 | Site 9 | Site 11 | Myer's Water Plant | City's treated water |
| November 1990 | 0/>380 | 0/380 | 0/380 | 0/380 | -- | 0/570 |
| February 1991 | 0/380 | 0/380 | 0/380 | 0/495 | -- | 0/>380 |
| May 1991 | 0/570 | 0/570 | 4/570 | 1/530 | -- | 0/660 |
| August 1991 | 0/570 | 0/570 | 0/570 | 0/570 | -- | 0/760 |
| November 1991 | 0/570 | 0/570 | 0/570 | 0/760 | 0/765 | 0/970 |
| February 1992 | 0/570 | 0/570 | 0/570 | 0/760 | 0/760[a] | 0/760 |
| May 1992 | 0/570 | 0/570 | 0/570[a] | 0/760[b] | 0/760[a] | 0/570 |
| August 1992 | 0/570[a] | 0/680[a] | 0/570[a] | 0/760[a] | 0/570[a] | 0/605 |
| Totals | 0/4,180 | 0/4,290 | 4/4,290 | 1/5,015 | 0/2,855 | 0/5,275 |

[a] Due to heavy algae presence, results represent a 380-liter sample.

[b] Due to heavy algae presence, results represent a 530-liter sample.

**Table 12**. Results of analyses for the presence of selected trace metals in the bottom material at three sites in J.B. Converse Lake, May 1991
[<, less than]

| Site number | Trace metal concentrations recovered from bottom material, in micrograms per liter | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Arsenic | Cadmium | Chromium | Cobalt | Copper | Lead | Manganese | Zinc | Total Selenium | Iron | Mercury |
| 5 | 2 | <1 | 4 | <5 | 3 | 10 | 260 | 10 | <1 | 23 | 0.05 |
| 7 | 3 | <1 | 5 | <5 | 3 | 20 | 97 | 20 | <1 | 13 | .06 |
| 9 | 5 | <1 | 8 | <5 | 10 | 40 | 110 | 40 | <1 | <1 | .06 |

**Table 13.** Results of the pesticide analyses on bottom-material samples collected at four sites in J.B. Converse Lake in May 1991 and August 1992

[<, less than; --, no data. Location of the sites shown in fig. 1]

| Site Number | Sample date | Pesticide concentrations, in micrograms per liter | | | | | |
|---|---|---|---|---|---|---|---|
| | | ChlordanE | Dieldrin | Heptachlor epoxide | DDT | DDD | DDE |
| 5 | 5/09/91 | 2.0 | 0.1 | < 0.1 | 0.3 | 0.5 | 0.7 |
| | 8/04/92 | < 1.0 | < .1 | < .2 | .1 | 1.2 | 1.0 |
| 7 | 5/09/91 | < 1.0 | < .1 | < .1 | < .1 | .3 | .4 |
| | 8/04/92 | < 1.0 | .1 | .3 | .2 | 3.1 | 4.4 |
| 9 | 5/09/91 | 4.0 | .2 | < .1 | .2 | 2.2 | 6.7 |
| | 8/05/92 | < 1.0 | .5 | .1 | .5 | 5.5 | 11.0 |
| 11 | 5/09/91 | -- | -- | -- | -- | -- | -- |
| | 8/05/92 | < 1.0 | < .1 | < .1 | .2 | 8.3 | 8.4 |