

INTRODUCTION

Caddo Lake, located in northwestern Louisiana and northeastern Texas, is a popular recreational lake used for water-based activities such as fishing, boating, and swimming. Caddo Lake is a source of drinking water for several small Louisiana communities surrounding the lake. The latest (1994) available estimates of water withdrawn from the lake by public suppliers are as follows: the Blanchard Water System, 0.695 Mgal/d (million gallons per day); the Vivian Water System, 0.413 Mgal/d; Caddo Water District 1, 0.222 Mgal/d; the Mooringsport Water System, 0.113 Mgal/d; the East Mooringsport Water System, 0.17 Mgal/d; and the East Cove Utility Water System, 0.042 Mgal/d (P.M. Johnson-Thibaut, U.S. Geological Survey, written commun., 1998). An understanding of current hydrologic conditions of Caddo Lake and other lakes and reservoirs in Louisiana is essential to the management and protection of these valuable natural resources. Water quality and quantity are important concerns to those who use these lakes and reservoirs for municipal, recreational, agricultural, or industrial purposes. Current and accurate information regarding the physical and chemical-related properties and conditions of freshwater lakes and reservoirs in Louisiana is fundamental to planners and managers for evaluating these resources. In October 1996, the U.S. Geological Survey, in cooperation with the Louisiana Department of Transportation and Development, began a study to conduct a bathymetric survey and determine the physical and chemical-related properties of Caddo Lake.

The purpose of this report is to present the results of the bathymetric survey and the results of vertical profiles of physical and chemical-related properties, including depth, water temperature, dissolved oxygen (DO), specific conductance, and pH. Hydrographic surveying software was used for combining differential global positioning system (DGPS) information with digital survey fathometer data to accurately map the bathymetry of the lake. The bathymetric map was produced using geographic information systems (GIS), and lines of equal depth of water were reviewed and edited for accuracy and consistency. On-site physical and chemical-related properties were measured at three selected locations using a water-quality monitor. This report is one in a series of planned map reports describing current bathymetry and physical and chemical-related properties of lakes and reservoirs in Louisiana.

Description of Study Area

Caddo Lake (fig. 1), which is about 20 miles northwest of Shreveport, Louisiana, is located in northwestern Caddo Parish, Louisiana, and western Marion County, Texas. A 1997 census estimated a population of 200,827 for Shreveport, 244,943 for Caddo Parish (Northeast Louisiana University, Uniform Resource Locator accessed December 1, 1998), and 10,635 for Marion County, Texas (U.S. Bureau of the Census, URL accessed September 16, 1999). This area has a subtropical transitional climate with a mean annual rainfall of 46.1 inches and a mean annual temperature of 65.2°F (degrees Fahrenheit) (Jay Grymes, Louisiana Office of State Climatology, written commun., 1998).

Caddo Lake has a drainage area of 2,744 square miles. The lake receives inflow from Big Cypress Bayou in Texas and Hunts Creek in Louisiana, which enter at the western and northern ends, respectively, and numerous other smaller tributaries. Water level is controlled by a 3,725-foot-long spillway located at the eastern end of the lake in Louisiana. Water discharges into Willow Pass Twelve-mile Bayou. The spillway originally completed in 1914 was rebuilt in 1971; the crest elevation of the spillway is 168.00 feet above sea level. The maximum design discharge is 36,000 cubic feet per second (Ray Elifami, Louisiana Department of Transportation and Development, written commun., 1998).

Caddo Lake is a very wide shallow lake; shallower areas of the lake are densely vegetated and impassable to motorized boats. Active and abandoned oil well pumping station platforms and remnant pilings of decayed platforms are scattered throughout the lake. Well-demarcated channels allow boat traffic to avoid submerged obstacles and the densely vegetated areas.

Acknowledgments

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BATHYMETRY

Bathymetric data for Caddo Lake were collected during August 10-13 and September 1-2, 1998. Accurate position and

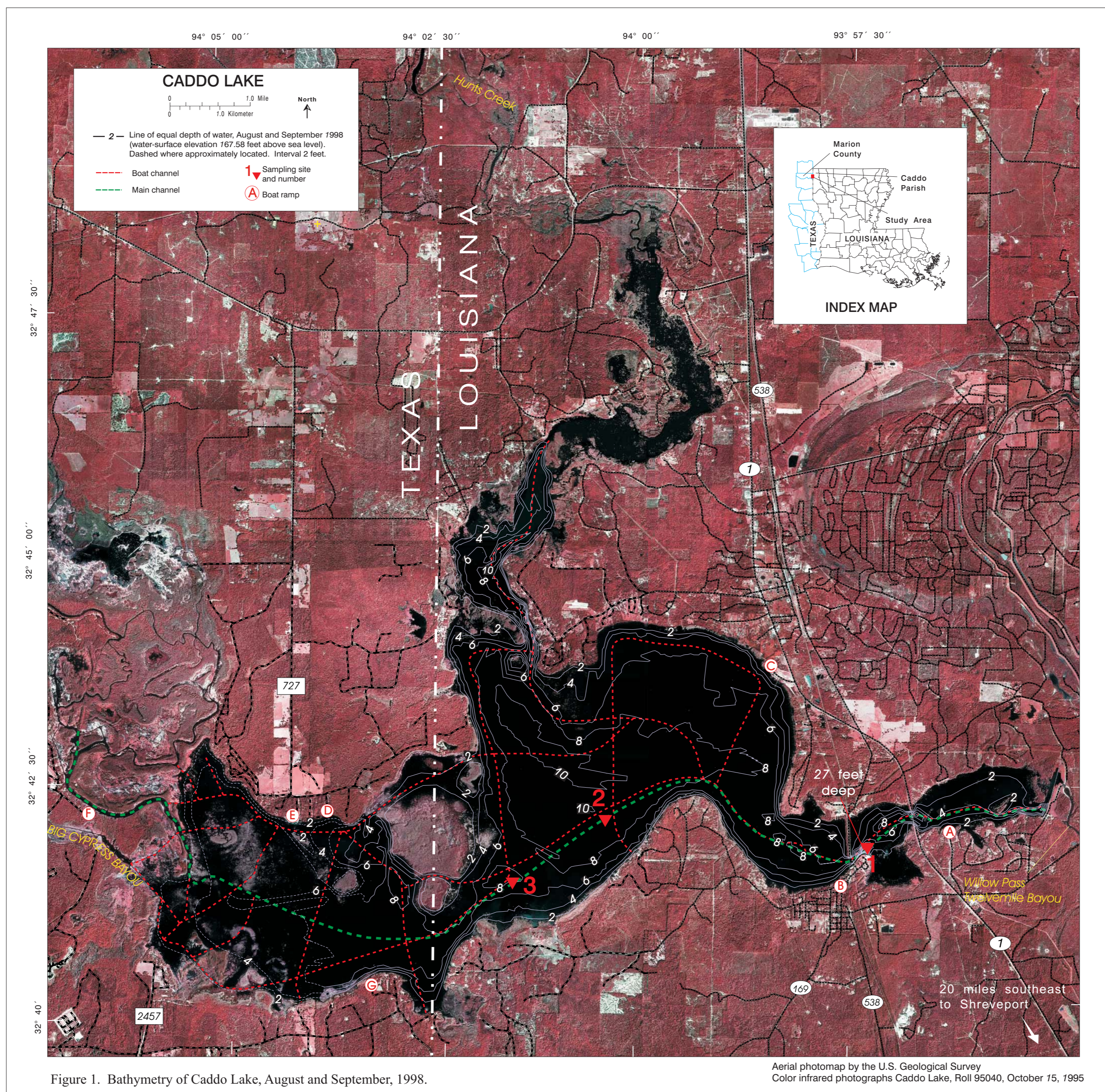


Figure 1. Bathymetry of Caddo Lake, August and September, 1998.

depth data were obtained to comprehensively describe the lake bathymetry; 154,959 data points of latitude, longitude, and depth were recorded. The bathymetry of Caddo Lake is shown in figure 1; all water depths are referenced to the August 10-13, 1998, water-surface elevation of 167.58 feet above sea level.

Equipment used during the bathymetric survey included a Starlink DNAV-212 DGPS, an Odom digital survey fathometer, and HYPACK software. The DGPS measured spatial position in latitude and longitude with routine accuracy of 5 feet; horizontal control points were established at the beginning and rechecked at the end of each survey day to maintain that accuracy. The survey fathometer measured the depth with routine accuracy of 0.1 foot; the fathometer was calibrated at the start and verified at the end of each survey day to maintain that accuracy. The HYPACK software was used for survey planning, survey execution, and storage and editing of data. Data were exported to ARC/INFO for drawing lines of equal depth of water and subsequent reviewing and editing of the results.

Surface area and volume spatial analyses also were performed within ARC/INFO. The water-surface area of Caddo Lake was 18,700 acres, and the water volume was 85,100 acre-feet. The depth-surface area and depth-volume relations are shown in figure 2. The

average depth of Caddo Lake was 4.6 feet, with depth of 4.6 feet or greater over more than 50 percent of the lake-surface area. Greatest depths are located in the eastern part of the lake east of the Highway 538 bridge, where the water depth is approximately 27 feet.

PHYSICAL AND CHEMICAL-RELATED PROPERTIES

Data on physical and chemical-related properties were collected on August 12, 1998, at selected sites in Caddo Lake. At these sites (1, 2, and 3 in fig. 1), multiple points along a vertical profile were sampled to establish the occurrence and depth of stratification. The HYDROLAB, a water-quality monitor, was calibrated at the beginning of the day prior to physical and chemical-related property data collection.

Data were collected along a vertical profile from above the lake bed to 1.6 feet below the water surface. Data were recorded at a maximum depth of 19.7 feet at site 1 and 7.2 feet at sites 2 and 3. Temperatures decreased from 88 to 85°F within 3 feet of the surface at site 1; however, water temperatures were uniform throughout the water column at sites 2 and 3. Shallow-water temperatures ranged from 88°F to approximately 83°F, and bottom-water temperatures

Aerial photomap by the U.S. Geological Survey
Color infrared photographs Caddo Lake, Roll 95040, October 15, 1995

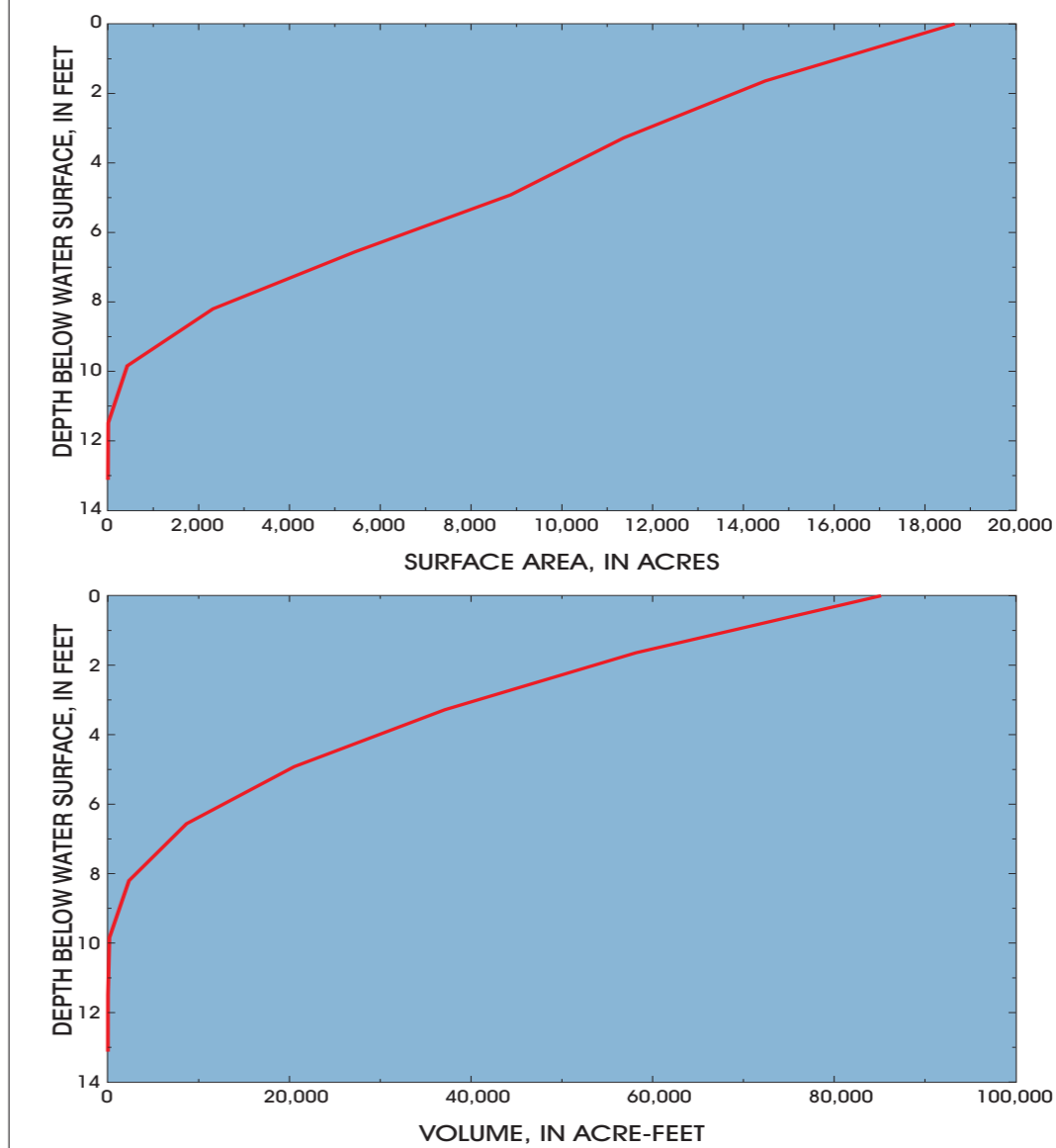


Figure 2. Depth-surface area and depth-volume relations for Caddo Lake. Water-surface elevation was 167.58 feet above sea level during the bathymetric survey of August and September 1998.

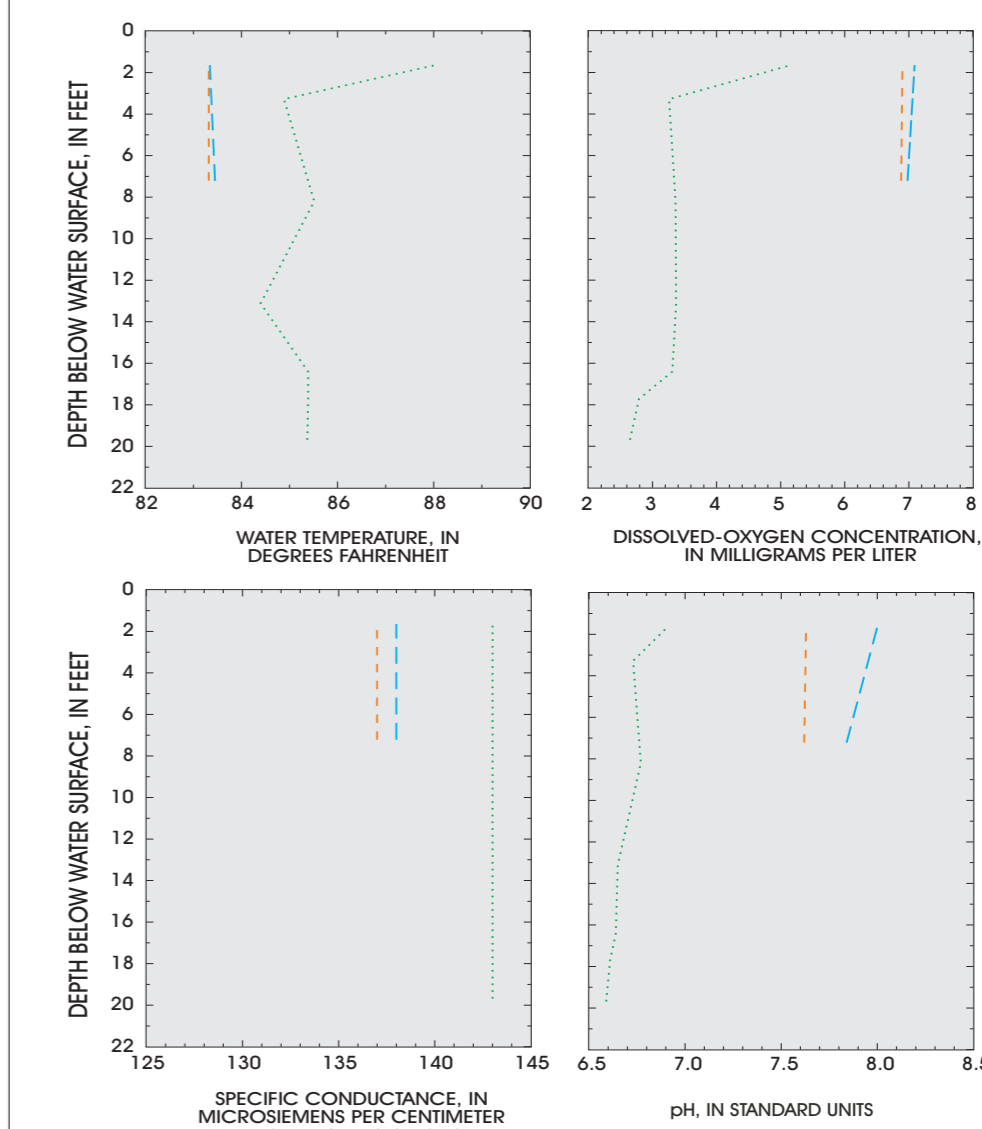


Figure 3. Variation of water temperature, dissolved-oxygen concentration, specific conductance, and pH in Caddo Lake, August 12, 1998.

ranged from approximately 85 to 83°F (fig. 3).

The DO concentration profiles were fairly uniform with depth, with only site 1 showing a slight decrease in concentration with depth. At site 1, DO concentrations decreased from 5.16 to 3.26 mg/L at approximately 3 feet, then varied slightly with depth. For sites 2 and 3, shallow-water DO concentrations ranged from 6.90 to 7.09 mg/L, and varied slightly with depth. Concentrations of DO vary considerably with depth, location, and season (Demas, 1985). The criterion for DO is 5 mg/L for freshwater aquatic life (Louisiana Department of Environmental Quality, 1998, p. 128; U.S. Environmental Protection Agency, 1976; 1986). Water visibility, measured with a Secchi disk, was 1.0 feet.

The specific conductance varied slightly; shallow-water concentrations ranged from 143 to 137 µS/cm (microsiemens per centimeter at 25 degrees Celsius). The pH ranged from 8.0 to 6.73 (standard units) near the surface, and varied only slightly with depth.

REFERENCES

Demas, C.R., 1985, A limnological study of Lake Bruin, Louisiana: Louisiana Department of Transportation and Development, Office of Public Works Water Resources Technical Report no. 38, 96 p.

Northeast Louisiana University, Center for Business and Economic Research, Louisiana parishes and municipalities July 1, 1997, population estimates published in January 1996; accessed December 1, 1998, at URL <http://leap.nlu.edu/POPHS/pop1997.txt>

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

-----1986, Quality criteria for water: Washington, D.C., U.S. Environmental Protection Agency [variously paged].

In this report, "sea level" refers to the National Geodetic Vertical Datum 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.

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