Prepared in cooperation with the
SOUTH CAROLINA PUBLIC SERVICE AUTHORITY

ABSTRACT

Lakes Marion and Moultrie are two large, connected reservoirs in the Coastal Plain of South Carolina. Bathymetric surveys during 1984-85 determined that, for the full-pool water-surface elevation of 76.8 feet, the volume of Lake Marion is 1,425,000 acre-feet, and for the full-pool water-surface elevation of 75.0 feet, the volume of Lake Moultrie is 1,060,000 acre-feet. These volumes are considered accurate to within 5 percent. Comparison with volumes determined in 1941, when the reservoirs were filled, shows decreases in volume of 73,000 acre-feet in Lake Marion and 30,000 acre-feet in Lake Moultrie. These changes in volume, however, are subject to relatively large possible error because they represent relatively small differences between relatively large volumes, and because the accuracy of the 1941 volumes is not known. Measurements of sediment inflow and outflow and of deposition rate suggest the volume losses were more likely about 29,000 acre-feet in Lake Marion and about 1,600 acre-feet in Lake Moultrie. The discrepancy in the estimate of volume changes does not affect the accuracy of the volume computation or the maps.

INTRODUCTION

Lakes Marion and Moultrie are two large connected reservoirs in the Coastal Plain of South Carolina (fig. 1). The maps on this sheet represent the first complete survey of the bed topography of Lakes Marion and Moultrie since the reservoirs were formed in 1941. The mapping was conducted in 1984 and 1985 in cooperation with the South Carolina Public Service Authority (SCPSA) to provide information on changes in lake volume, on areas of rapid sediment deposition, and on present water depths.

The reservoirs were created as part of the Santee-Cooper Diversion Project by SCPSA in order to generate hydroelectric power at Pinopolis Dam on Lake Moultrie. A new outlet for Lake Moultrie was created by the completion of the Rediversion Canal in 1985 to alleviate a sedimentation problem in Charleston Harbor (Patterson, 1983).

The reservoirs have become famous among sport fishermen, but concern has recently been mounting over several environmental issues affecting the lakes. Recent studies have addressed growth of aquatic macrophytes (Harvey, Pickett, and Bates, 1987; Welch, Fung, and Remillard, 1985), reproduction of striped bass (Bulak, Crane, and Gates, 1985), water quality (Inabinet, 1985, Pickett, personal communication, 1987), flow patterns and retention times (Patterson and Harvey, 1985) and sediment inflow and outflow (Patterson and Cooney, 1986).

METHODS

A boat equipped with an automatic positioning system (Motorola Miniranger III)[1] and a depth sounder (Innerspace 423)[1] was driven along transects to collect the data for the map. The depth sounder was equipped with a 200 khz transducer. The positioning system used microwaves to measure the distances between the boat and two remote transponders at known locations. Coordinates for the transponders were determined from topographic maps. The boat had to be within sight of the transponders and within a nearly circular area of acceptable geometry within which the bearings to the transponders formed an angle between 30 and 150 degrees. These requirements necessitated moving the transponders many times, especially in the upper part of Lake Marion. Coordinates for the boat position were automatically triangulated by the positioning system. The coordinates, along with time and mean water depth, were recorded every 7 seconds on magnetic tape. The boat speed was such that depths were measured about every 120 feet along each transect. Depths were considered accurate within 0.2 foot. Horizontal position was considered accurate to within 30 feet. The combined margin of error for the depth contours is about 0.5 foot.

In open water the transects were generally 1000-1300 feet apart. Where open water was limited in extent, or where bed topography was complex, transects and depth measurements were spaced more closely.

Certain parts of the upper end of Lake Marion are densely wooded and virtually non-navigable except for isolated boat trails. Depth observations were made along these boat trails and in the immediately adjacent areas. Based on these observations an average depth of 4 feet was assumed for the densely wooded part of the lake upstream of Pack's Flat. The upper limit of the lake was approximated by a transverse line near the confluence of the Wateree and Congaree Rivers.

The water surface elevation of the lake was checked on each day of data collection at the closest gage to the area being mapped. Five gages on Lake Marion and one gage on Lake Moultrie were used. The depth data were adjusted so that all depths were relative to the full pool elevation (76.8 feet above sea level for Lake Marion, 75.0 feet above sea level for Lake Moultrie).

The adjusted depths were plotted on large-scale sectional maps of the lakes, and depth contours were drawn by hand. The contours for each section were digitized into a computer file, and files were combined and edge-matched to form a complete contour map for each lake. Volume tables were prepared by digitizing the area enclosed by each contour, and computing the volume of each 4-foot layer of each lake.

RESULTS

The pre-impoundment topography of both lakebeds is still plainly evident in the contour maps (plate 1 and 2). In Lake Marion the submerged channel of the Santee River, bounded by submerged natural levees; and numerous smaller, sinuous flood-plain channels are prominent features. It is difficult to depict, using contour lines, these steep-walled channels cut into a relatively flat flood-plain. To avoid the appearance of contour lines that converge, some of the contours that should appear between adjacent higher and lower contours in the narrow, steep slopes of the channels have been truncated.

Sedimentation has reduced water depths in parts of the lakes. The most notable reductions in depth have occurred where the incoming flow of the Santee River leaves the confines of the river channel near Brown's Cut and Low Falls Landing in upper Lake Marion. As much as 11 feet of sediment has accumulated in these areas during 43 years.

Sedimentation has also occurred in the deeper parts of both lakes. Samples from the deepest part of Lake Moultrie show that the bed material there is fine-grained and loosely packed. Bathymetric surveys on different days show that this fine-grained sediment seems to move in response to wind-generated currents. The contours for depths greater than 48 feet in Lake Moultrie represent average conditions, and may vary by several feet on occasion.

The volume of Lake Marion, for a level water surface of 76.8 feet above sea level, computed by adding the volume of each 4-foot layer of the lake, is 1,425,000 acre-feet. The volume of Lake Moultrie for a level water surface of 75.0 feet is 1,060,000 acre-feet. These volumes are considered accurate to within 5 percent, which allows for variation in depth between contours and between sounding transects.

Comparison of these volumes with volumes determined in 1939 during pre-impoundment engineering surveys (Harza Engineering Co., 1939) gives some idea of the loss of lake volume caused by sedimentation during the 43-year history of the lakes (figs. 2, 3). The decrease in volume estimated by this method for Lake Marion is 73,000 acre-feet, and for Lake Moultrie, 30,000 acre-feet. These estimates, however, are subject to a large potential error for two reasons: they represent a relatively small difference between relatively large numbers, and the accuracy of the original volume computations is not known.

A more reliable estimate of the decrease in volume of the lakes is provided by measurements of sediment inflow and outflow in the lakes, and by determinations of sediment deposition rate using ^{210}Pb dating. A study using these techniques, which will be described in greater detail in a forthcoming report, suggests that a more accurate estimate of the volume loss for Lake Marion is about 29,000 acre-feet, and for Lake Moultrie, 1,600 acre-feet. The discrepancy in the estimates of change in volume do not necessarily reflect inaccuracy in the estimates of lake volumes, or in the bathymetric maps.

Stage-area curves for the lakes are presented in figures 4 and 5.

[1] Use of brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

CONVERSION FACTORS AND ABBREVIATIONS OF UNITS

The inch-pound units used in this report may be converted to metric (International System) units by the following factors:

Multiply inch-pound unit	*By*	*To obtain metric unit*
feet (ft)	0.3048	meters (m)
acres	4.047	square meters (m^2)
acre-feet (acre-ft)	1,233	cubic meters (m^3)
acre-feet	0.5042	CFS-days

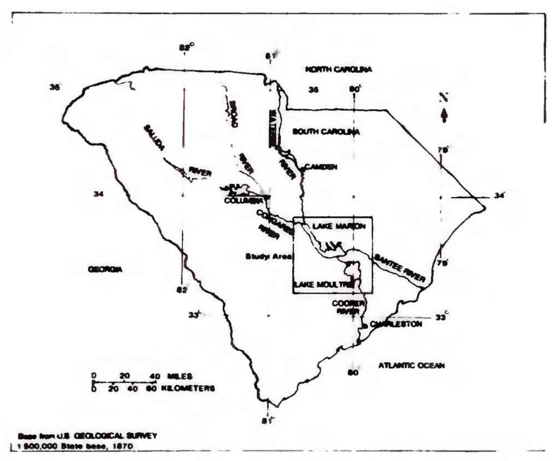


Figure 1.—Location of Lakes Marion and Moultrie.

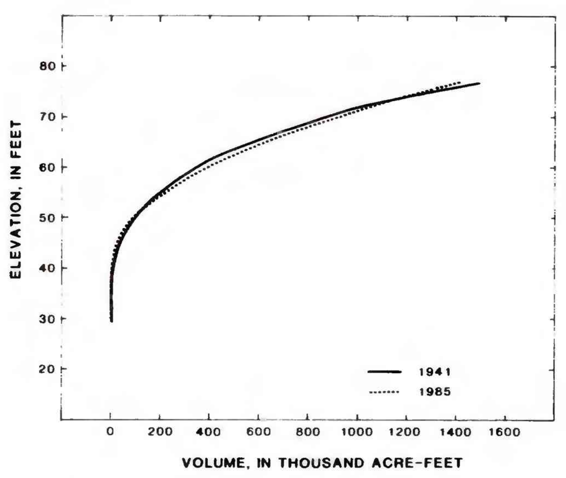


Figure 2.—Stage-volume relation for Lake Marion.

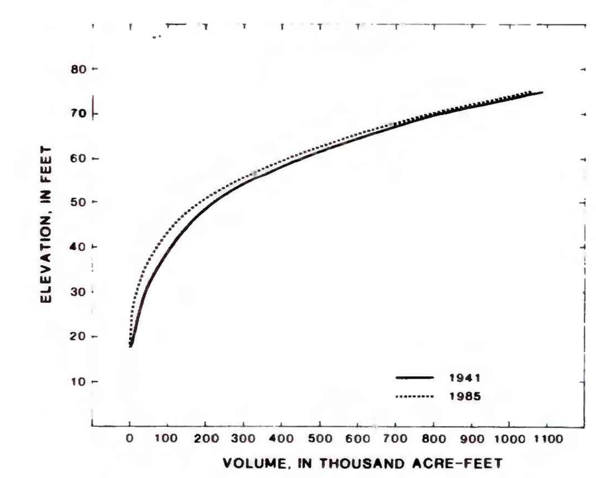


Figure 3.—Stage-volume relation for Lake Moultrie.

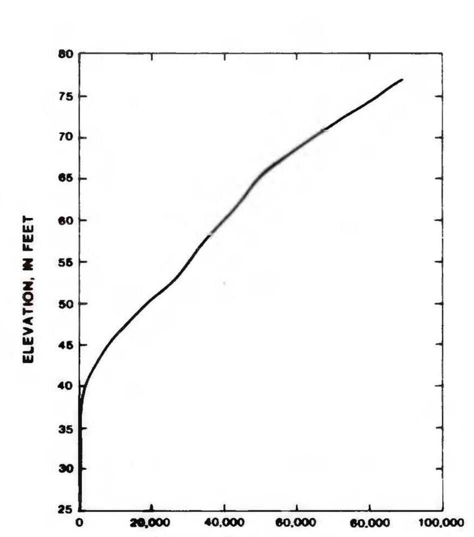


Figure 4.—Stage-area relation for Lake Marion.

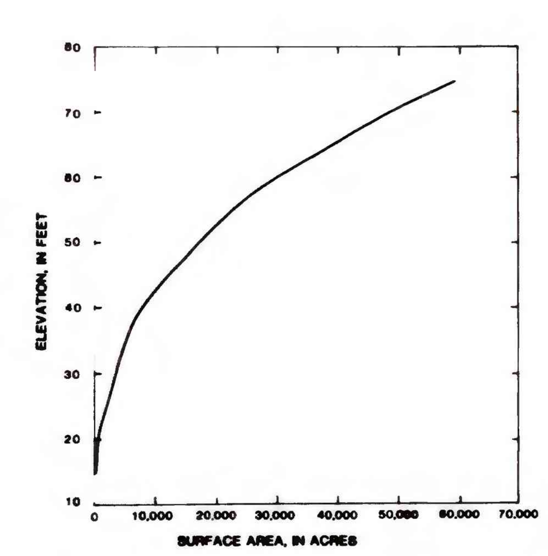
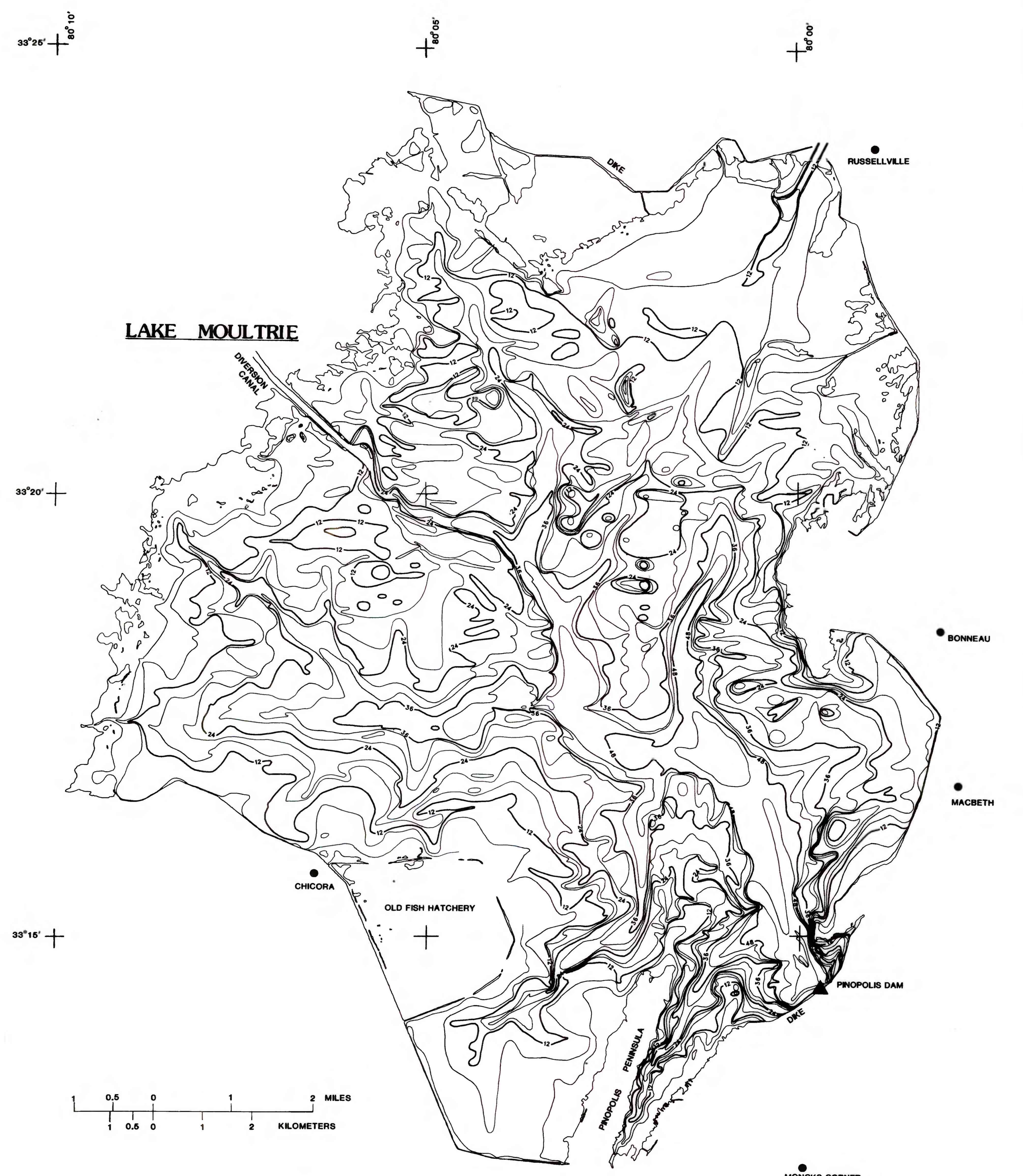


Figure 5.—Stage-area relation for Lake Moultrie.



EXPLANATION

—24— LINE OF EQUAL WATER DEPTH--Depths accurate within 0.5 foot. Zero contour line is 75 feet above National Geodetic Vertical Datum of 1929. Interval is 4 feet.

▲ LAKE LEVEL GAGE

Base map digitized from Santee Cooper, South Carolina Public Service Authority Maps. Scale 1" 400', March 1977

For additional information write to:
District Chief U.S. Geological Survey WRD
1835 Assembly Street, Suite 677A
Columbia, South Carolina 29201

BATHYMETRY OF LAKES MARION AND MOULTRIE, SOUTH CAROLINA, 1984-85

BY G. G. PATTERSON AND S. W. LOGAN

Black and white copies of the report can be purchased from:
Book and Open-File Reports Section, U.S. Geological Survey,
Federal Center, Box 25425, Denver Colorado 80225
(Telephone 303/236-7476)