

Abstract

The U.S. Geological Survey, in cooperation with the Iowa Department of Natural Resources, conducted bathymetric surveys on two lakes in Iowa during 2006 (Little Storm Lake and Silver Lake). The surveys were conducted to provide the Iowa Department of Natural Resources with information for the development of total maximum daily load limits, particularly for estimating sediment load and deposition rates. The bathymetric surveys provide a baseline for future work on sediment loads and deposition rates for these lakes. Both of the lakes surveyed in 2006 are natural lakes.

Bathymetric data were collected at Silver Lake using boat-mounted, differential global positioning system, echo depth-sounding equipment, and computer software. At Little Storm Lake, because of its shallow nature, bathymetric data were collected using manual depth measurements. Data were processed with commercial hydrographic software and exported into a geographic information system for mapping and calculating area and volume. Lake volumes were estimated to be 7,547,000 cubic feet (173 acre-feet) at Little Storm Lake and 126,724,000 cubic feet (2,910 acre-feet) at Silver Lake. Surface areas were estimated to be 4,110,000 square feet (94 acres) at Little Storm Lake and 27,957,000 square feet (640 acres) at Silver Lake.

Introduction

Bathymetric mapping can provide useful information for water-quality managers to address a variety of issues on Iowa's lakes and reservoirs. The Iowa Water Science Center of the U.S. Geological Survey (USGS) began a lake bathymetric mapping program in June 2001 on Lake Delhi in east central Iowa, which resulted in a published bathymetric map and report (Schnoebelen and others, 2003). The USGS, in cooperation with the Iowa Department of Natural Resources (IDNR), conducted a bathymetric survey of Little Storm Lake in 2006 to provide the IDNR with information for the development of total maximum daily load limits (TMDLs), particularly for estimating sediment load and deposition rates. The bathymetric contours also can provide a baseline for future work on sediment load and deposition rates for Little Storm Lake.

Little Storm Lake is located in north-western Iowa just to the west of the city of Storm Lake in Buena Vista County, in the Little Storm Lake State Wildlife Management Area, and is used primarily for recreational activities. Little Storm Lake receives flow from Powell Creek from the west. Discharge from Little Storm Lake is through a culvert at the south end of the lake into Storm Lake.

Methods

Bathymetry data were collected on March 27, 28, and 29, 2006. Bathymetric mapping was accomplished using boat-mounted global positioning system (GPS), manual depth measurements, and computer software. The GPS allowed for accuracies of about 3.28 feet (ft) (approximately 1 meter) in the horizontal direction. Because of the shallow nature of Little Storm Lake, the extensive wetland surroundings with dense emergent vegetation, and the inability of the boat to penetrate these areas, only the open-water part of the lake was surveyed. Because of the depth limitations (less than 3.3 ft) of the available echo-sounding equipment (Specialty Devices, Inc., 2003), depths were obtained manually using a measuring device marked in 0.1-ft increments. The bathymetry data were collected along planned transect lines spaced approximately 75 ft apart (fig. 1). Individual data-collection locations along a transect line generally were 100 to 150 ft apart. The depth data were stored in hydrographic software (Coastal Oceanographics, Inc., 2002). The depth data later were converted to elevations by subtracting the depths at each location from the reference surface elevation of the lake. The reference surface elevation was determined at the beginning and end of each day of bathymetric data collection by measuring from a reference point of known elevation at the outlet. The elevation of the reference point was determined using a combination of GPS and standard surveying techniques. The bathymetry data then were entered into geographic information system (GIS) software to produce a three-dimensional surface of the lake-bottom elevations (Environmental Systems Research Institute, Inc., 1999–2006). The three-dimen-

sional surface was contoured, and the contours were adjusted manually to correct for interpretive errors. (See the Little Storm Lake metadata at <http://water.usgs.gov/lookup/getgislis> for a more detailed explanation of methods used to collect and process the bathymetric data.)

Quality Assurance

Independent control data sets previously have been used in bathymetric surveys to estimate the precision (repeatability) of sounding data collected with an echo sounder, to estimate the accuracy of the interpolation in three-dimensional surfaces, and to estimate the accuracy of the produced contours (Wilson and Richards, 2006). For Little Storm Lake, no independent control data set was collected because of the widely spaced data set collected with manual depth measurements, the shallow flat nature of the lake, and time constraints. Generally, for depths measured manually, and depending on the lake-bottom type, surface-water conditions, and boat movement, accuracy of these manual measurements can vary between 0.05 ft and 0.5 ft. Measurements collected in lakes with bottoms consisting of softer sediments, as is the case for much of Little Storm Lake, can be less accurate because of difficulty in determining the sediment/water interface. Under similar conditions, previous comparisons between manually measured depths and depths measured using echo depth-sounding equipment indicate that manually measured depths were over measured by an average of +0.3 ft (Wilson and Richards, 2006). In those comparisons, however, the range of measured depths were much greater (4 to 26 ft) than was present at Little Storm Lake (0.7 to 3.9 ft). An assumption could be made that, for a given lake-bottom type and surface-water condition, less error might be expected where the range of depths is less, as is the case for Little Storm Lake.

Bathymetric Contours

The water-surface elevation of Little Storm Lake was 1,398.8 ft above North American Vertical Datum of 1988 (NAVD88) on March 27, 28, and 29, 2006. Generally, the water depth increases toward the middle of the Lake (fig. 2). The deepest part of the lake is located in the outflow channel, and the lowest elevation measured was 1,394.9 ft (3.9 ft deep). The average elevation of the lake bottom, based on the three-dimensional surface, was 1,397.0 ft (1.8 ft deep). The slope of the lake bottom generally is greatest near the outlet. Data from this survey indicate that the total open-water surface area of Little Storm Lake, at a water-surface elevation of 1,398.8 ft, is approximately 4,110,000 square feet (ft²) (94 acres) and the total open-water volume of Little Storm Lake is approximately 7,547,000 cubic feet (ft³) (173 acre-ft).

References

- Coastal Oceanographics, Inc., 2002, HYPACK MAX®, hydrographic survey software user's manual: Middlefield, Connecticut, Coastal Oceanographics, Inc. [variously paged].
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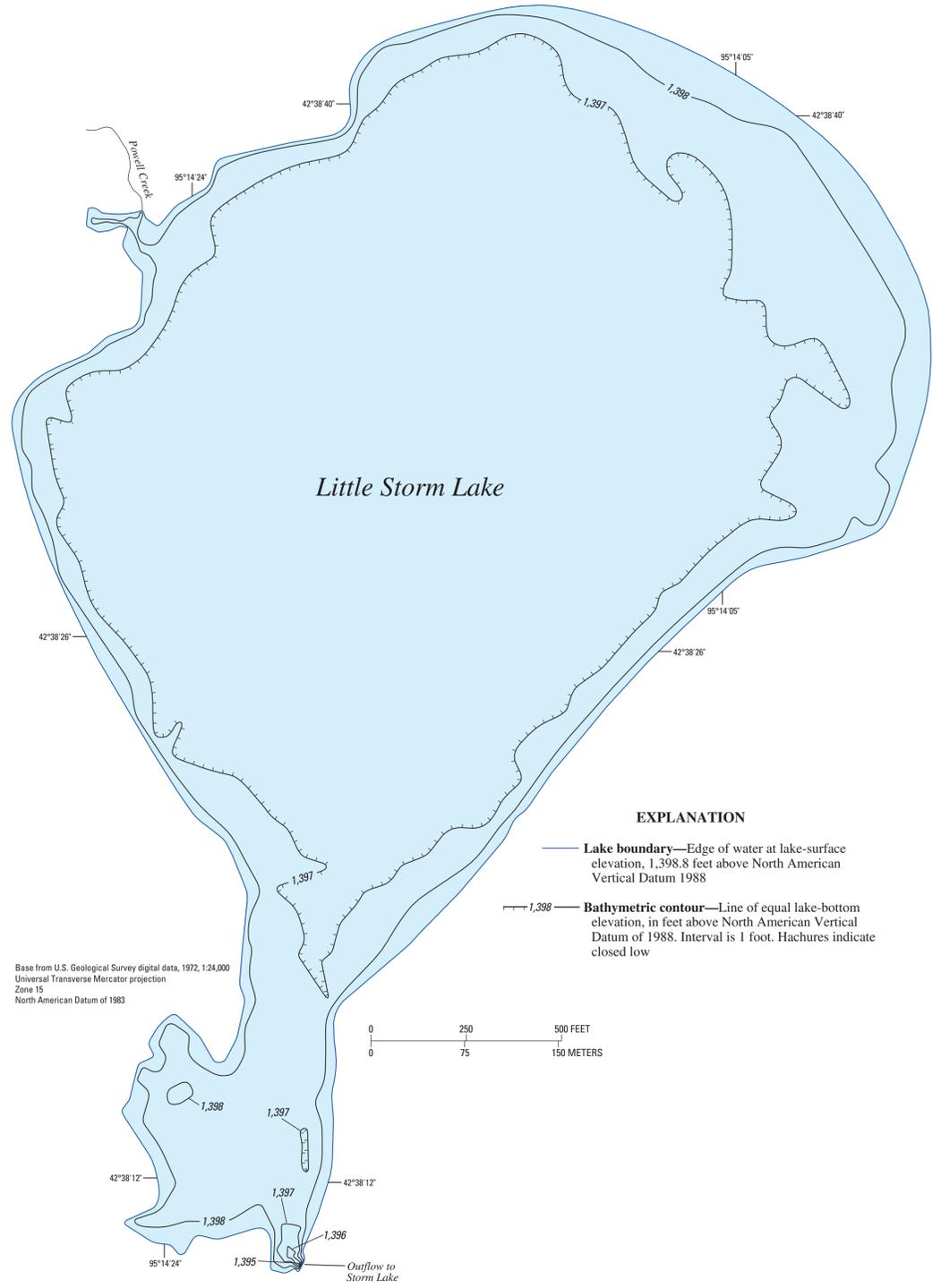


Figure 2. Bathymetric contours for Little Storm Lake, 2006 (not for navigational use).

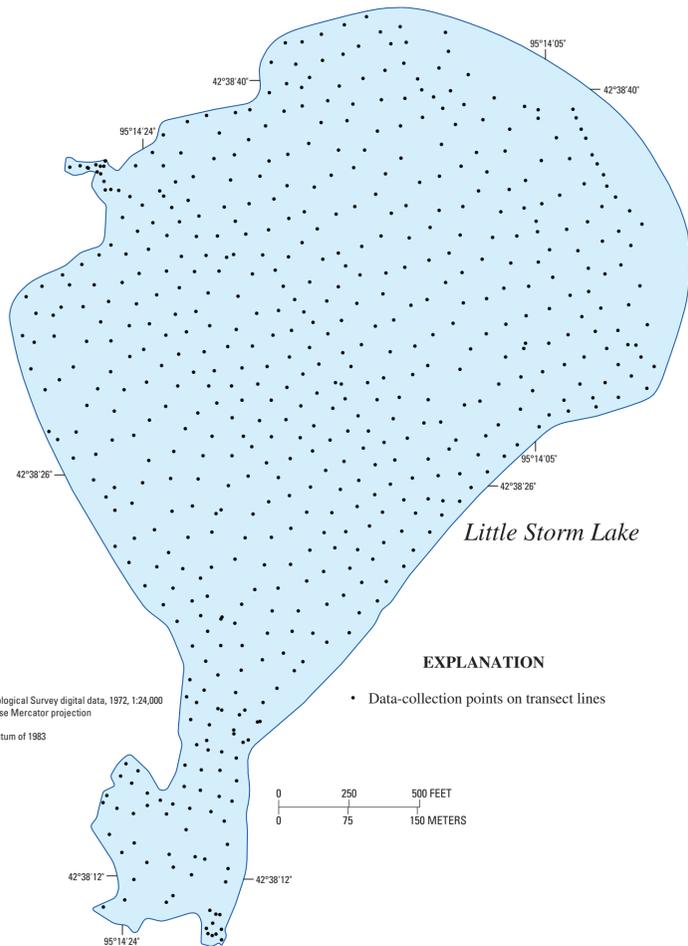


Figure 1. Data-collection points used to construct bathymetric contours.



Little Storm Lake in Buena Vista County, Iowa (photograph by Jason McVay, U.S. Geological Survey).



Location of Little Storm Lake in Buena Vista County, Iowa

Bathymetric Contours for Little Storm Lake, Buena Vista County, Iowa

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