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SCIENTIFIC INVESTIGATIONS MAP 2949
Bathymetric contours of Nine Eagles Lake,
Decatur County, Iowa—PLATE D
Linhart, S.M., and Lund, K.D., 2006, Bathymetric Contour
Maps of Lakes Surveyed in Iowa in 2004

Abstract

The U.S. Geological Survey, in cooperation with the Iowa Department of Natural Resources, conducted bathymetric surveys on six lakes in Iowa during 2004 (Lake Darling, Littlefield Lake, Lake Minnewashta, Nine Eagles Lake, Prairie Rose Lake, and Upper Gar 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 can provide a baseline for future work on sediment loads and deposition rates for these lakes. Two of the lakes surveyed in 2004, Lake Minnewashta and Upper Gar Lake, are natural lakes. The other four lakes are manmade lakes with fixed spillways.

Bathymetric data were collected using a boat-mounted, differential global positioning system, echo depth-sounding equipment, and computer software. Data were processed with commercial hydrographic software and exported into a geographic information system for mapping and calculating area and volume. Lake volume estimates ranged from 83,924,000 cubic feet (1,930 acre-feet) at Lake Darling to 5,967,000 cubic feet (140 acre-feet) at Upper Gar Lake. Surface area estimates ranged from 10,660,000 square feet (240 acres) at Lake Darling to 1,557,000 square feet (36 acres) at Upper Gar Lake.

Introduction

Bathymetric mapping can provide useful information for water-quality managers to address a variety of issues pertaining to 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 Nine Eagles Lake in 2004. The bathymetric survey was conducted 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 Nine Eagles Lake.

Nine Eagles Lake was constructed in 1952 and is located in south-central Iowa about 3.5 miles southeast of Davis City in Decatur County. Nine Eagles Lake is located in Nine Eagles State Park and is used primarily for recreational activities. Nine Eagles Lake is fed by unnamed creeks from the north, northeast, east, and southeast. Discharge from Nine Eagles Lake is over a fixed spillway at the dam on the western end of the lake into an unnamed tributary of Thompson River.

Methods

Bathymetry data were collected on July 26, 2004. Bathymetric mapping was accomplished using a boat-mounted global positioning system (GPS), echo depth-sounding equipment, and computer software. The GPS allowed for accuracies of about 3.28 feet (ft; approximately 1 meter) in the horizontal direction. The echo sounder emits pulses of sound that are reflected off the lake bottom and received by a transducer. The echo sounder transmitted at a frequency of 200 kilohertz, and water depths were determined by the echo sounder based on the speed of sound in water compensated for temperature (Specialty Devices, Inc., 2003). In some areas of the lake, the depth limitations (less than 3.3 ft) of the echo-sounding equipment necessitated determining the depths manually at target points using a measuring device marked in 0.10-ft increments. Using the echo sounder, the bathymetry data were collected along planned transect lines spaced 75 ft apart. Individual data-collection locations along a transect line generally were 5 to 10 ft apart. The depth data were later converted to elevation in the post-processing software (Coastal Oceanographics, Inc., 2002) by subtracting the depths at each location from the reference surface elevation of the lake. The reference surface elevation was determined on the day of bathymetric data collection by measuring from a reference point of known elevation at the dam. The elevation of the reference point was determined by using a combination of GPS and standard surveying techniques. The bathymetry data then were filtered (fig. 1) to reduce the density of data points and entered into geographic information system (GIS) software to produce a three-dimensional surface of the lake-bottom elevations. The three-dimensional surface was contoured, and the contours were adjusted manually to correct for interpretive errors. (See the Nine Eagles Lake metadata at *http://water.usgs.gov/lookup/getgislist* for a more detailed explanation of methods used to collect and process the bathymetric data.)

Quality Assurance

A bar check on the echo sounder was performed at the beginning of the day of data collection following established protocols (U.S. Army Corps of Engineers, 1994). This was done to ensure that the echo sounder was calibrated correctly. The bar check involved suspending a 2-ft diameter flat aluminum plate directly below the echo sounder. The suspension line was marked in 5-ft increments. An initial calibration was made at 5 ft by entering the speed of sound in the water and then adjusting the offset of the transducer in the computer software. The offset is the draft of the transducer below the lake surface. The aluminum plate was then lowered in 5-ft increments, depending on the range of depths expected to be encountered, and adjustments in the speed of sound were made until depth readings and the depth of the aluminum plate agreed to within approximately 0.1 ft.

A second independent bathymetry dataset was collected over a smaller area of Nine Eagles Lake. The control dataset was used to estimate the precision (repeatability) of the sounding data collected with the echo sounder and to estimate the accuracy of the contours (Wilson and Richards, 2006). Within 1.5 ft of each other were 35 paired data and control points for a calculated root mean square error (RMSE) of 0.89 ft. Within 0.5 ft of each other were 55 paired contours and control points with a calculated RMSE of 1.02 ft.

Bathymetric Contours

The water-surface elevation of Nine Eagles Lake was 937.0 ft above North American Vertical Datum of 1988 (NAVD 88) on July 26, 2004. In general, the depth of water in the lake increases toward the dam (fig. 2). The deepest part of the lake is approximately 180 ft east of the dam in the southwestern end of the lake, and the lowest elevation measured was 904.6 ft (32.4 ft deep). The average elevation of the lake bottom, based on the three-dimensional surface, is 924.9 ft (12.1 ft deep). The slope of the lake bottom is greatest in the area near the dam, along the shoreline between the two southernmost arms, and along the north shoreline just east of the small narrow arm. In general, the slope of the lake bottom is more gradual in the eastern part of the lake. Data from this survey indicate that the total surface area of Nine Eagles Lake, at a water-surface elevation of 937.0 ft, is approximately 2,603,000 square feet (60 acres), and the total water volume of Nine Eagles Lake is approximately 31,682,000 cubic feet (730 acre-feet).

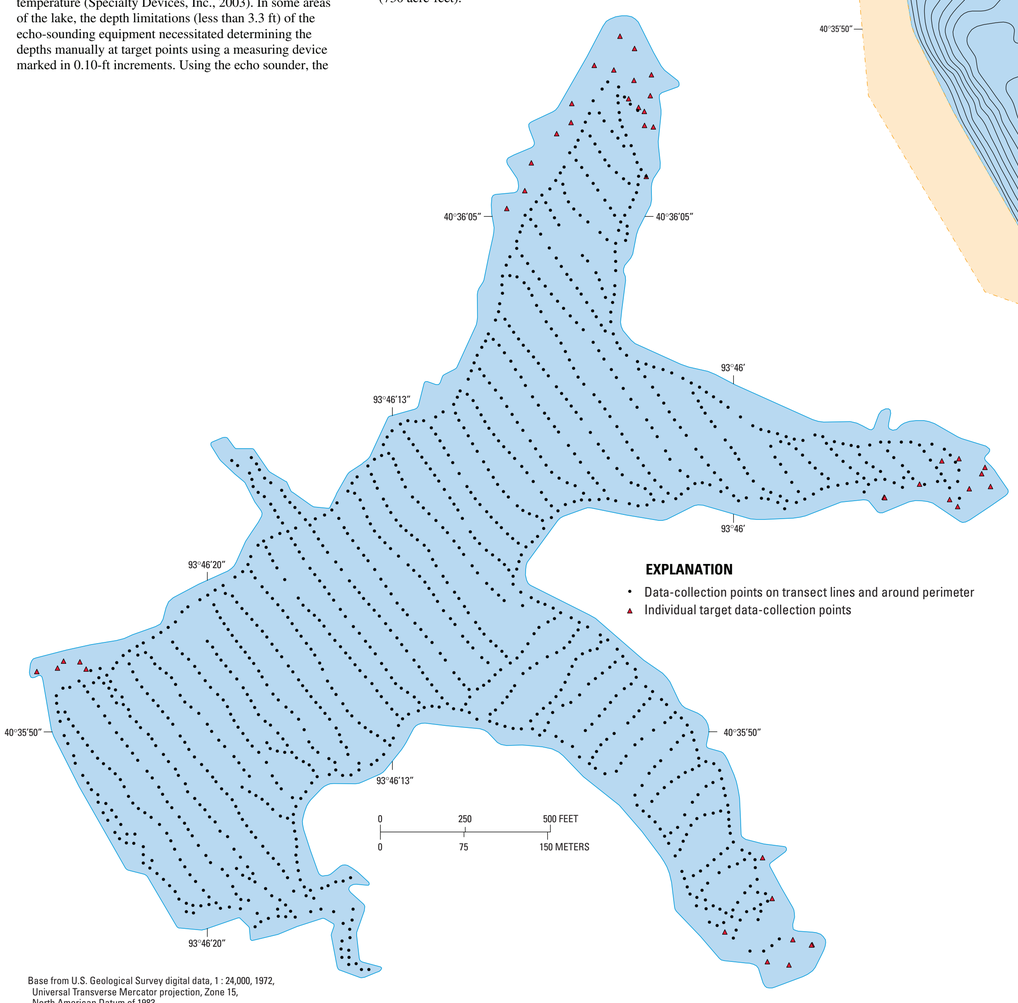


Figure 1. Data-collection points used to construct bathymetric contours.

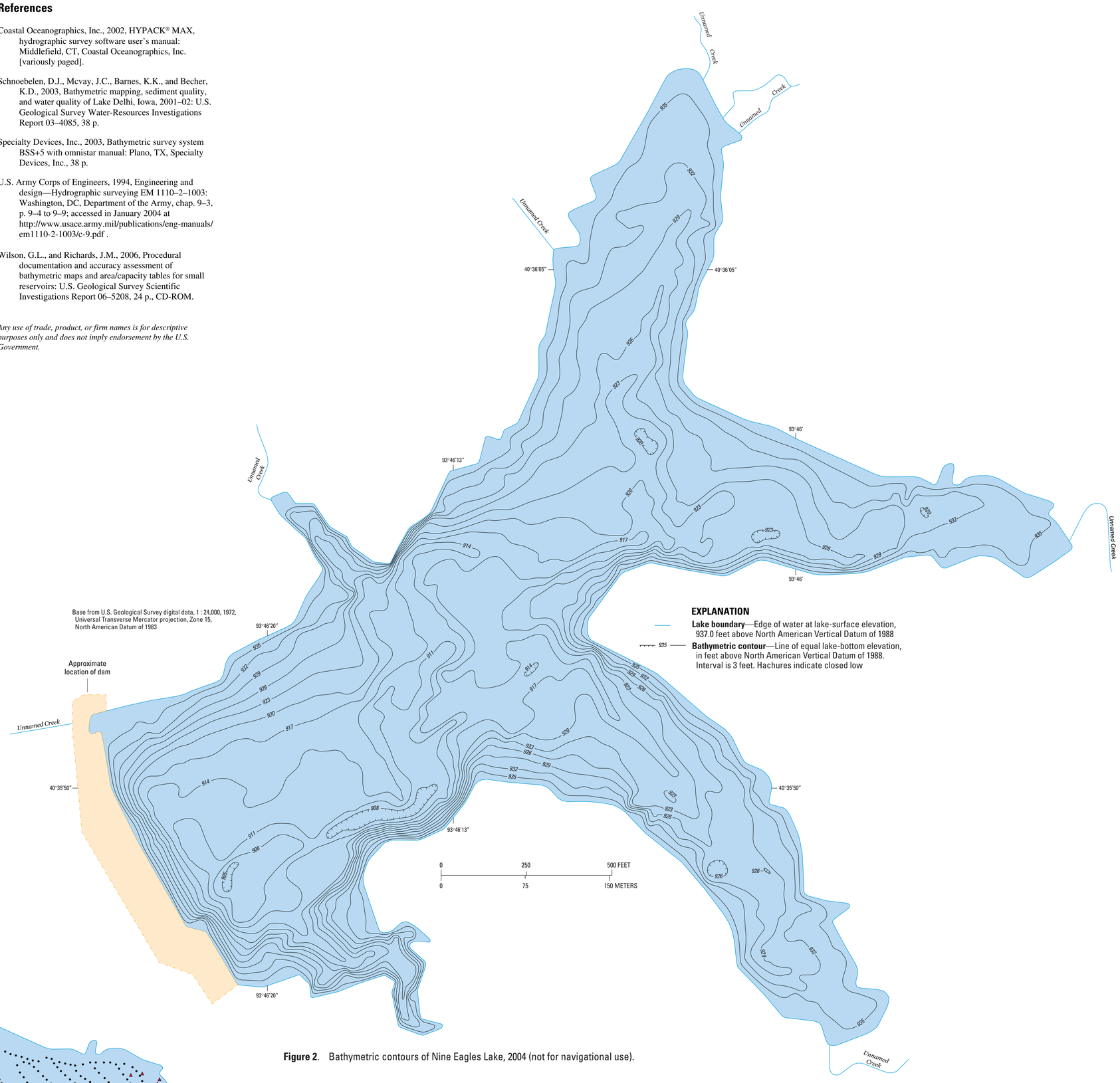
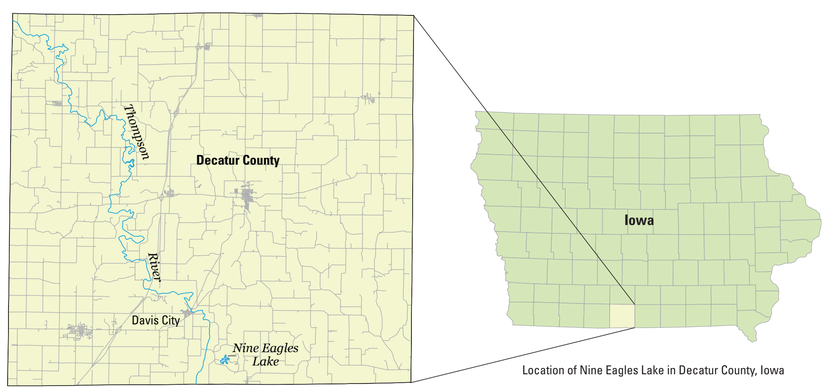


Figure 2. Bathymetric contours of Nine Eagles Lake, 2004 (not for navigational use).



Location of Nine Eagles Lake in Decatur County, Iowa

References

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

Schnoebelen, D.J., Mcvay, J.C., Barnes, K.K., and Becher, K.D., 2003, Bathymetric mapping, sediment quality, and water quality of Lake Delhi, Iowa, 2001–02: U.S. Geological Survey Water-Resources Investigations Report 03–4085, 38 p.

Specialty Devices, Inc., 2003, Bathymetric survey system BSS+5 with omnistar manual: Plano, TX, Specialty Devices, Inc., 38 p.

U.S. Army Corps of Engineers, 1994, Engineering and design—Hydrographic surveying EM 1110–2–1003: Washington, DC, Department of the Army, chap. 9–3, p. 9–4 to 9–9; accessed in January 2004 at http://www.usace.army.mil/publications/eng-manuals/em1110-2-1003/c-9.pdf .

Wilson, G.L., and Richards, J.M., 2006, Procedural documentation and accuracy assessment of bathymetric maps and area/capacity tables for small reservoirs: U.S. Geological Survey Scientific Investigations Report 06–5208, 24 p., CD-ROM.

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Bathymetric Contours of Nine Eagles Lake, Decatur County, Iowa

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2006