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SCIENTIFIC INVESTIGATIONS MAP 2949
Bathymetric contours of Upper Gar Lake,
Dickinson County, Iowa—PLATE F
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 Upper Gar 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 Upper Gar Lake.

Upper Gar Lake is located in northwest Iowa near the city of Arnolds Park in Dickinson County and is used primarily for recreational activities. Upper Gar Lake is fed by East Okoboji Lake from the northeast. Discharge from Upper Gar Lake flows into Lake Minnewashta to the southwest.

Methods

Bathymetry data were collected on June 8, 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 on the concrete outflow structure of Lower Gar Lake. The elevation of the reference point was determined by using standard surveying techniques. The bathymetry data 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 Upper Gar 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 Upper Gar 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 13 paired data and control points for a calculated root mean square error (RMSE) of 0.47 ft. Within 0.5 ft of each other were 10 paired contours and control points with a calculated RMSE of 0.43 ft.

Bathymetric Contours

The water-surface elevation of Upper Gar Lake was 1,394.7 ft above National Geodetic Vertical Datum of 1929 (NGVD 29) on June 8, 2004. In general, the depth of water in the lake increases toward the northeastern end of the lake (fig. 2). The deepest part of the lake is in the center of the channel that connects Upper Gar Lake with East Okoboji Lake, and the lowest elevation measured was 1,386.6 ft (8.1 ft deep). The average elevation of the lake bottom, based on the three-dimensional surface, is 1,390.9 ft (3.8 ft deep). The slope of the lake bottom is greatest in the inflow channel. The slope of the lake bottom is more gradual in the southwestern end of the lake. Data from this survey indicate that the total surface area of Upper Gar Lake, at a water-surface elevation of 1,394.7 ft, is approximately 1,557,000 square feet (36 acres), and the total water volume of Upper Gar Lake is approximately 5,967,000 cubic feet (140 acre-feet).

References

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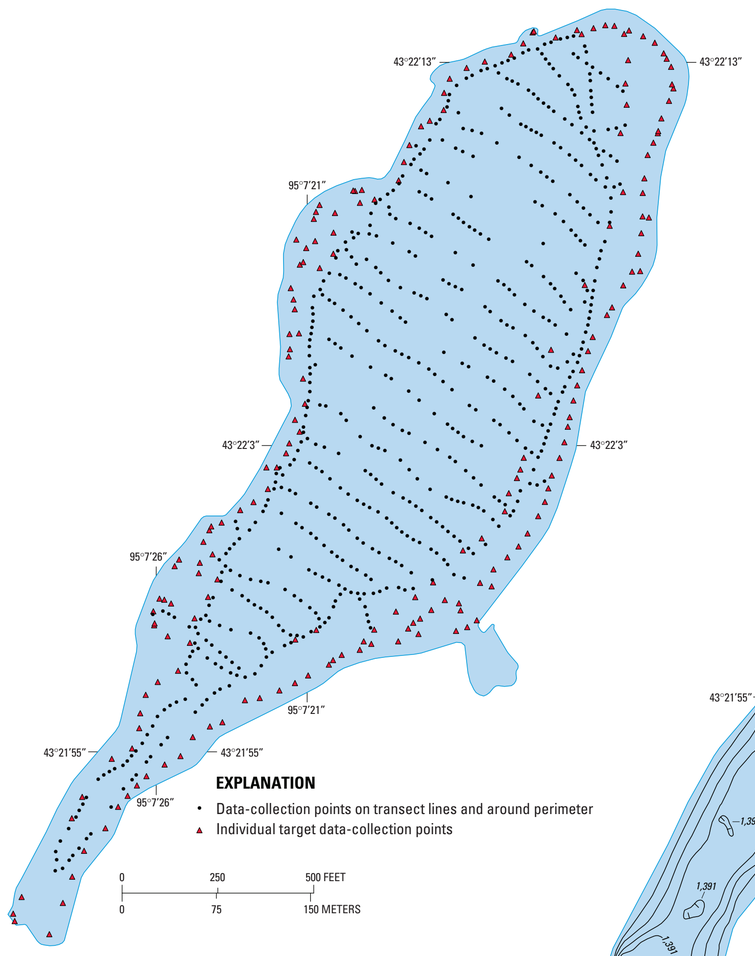
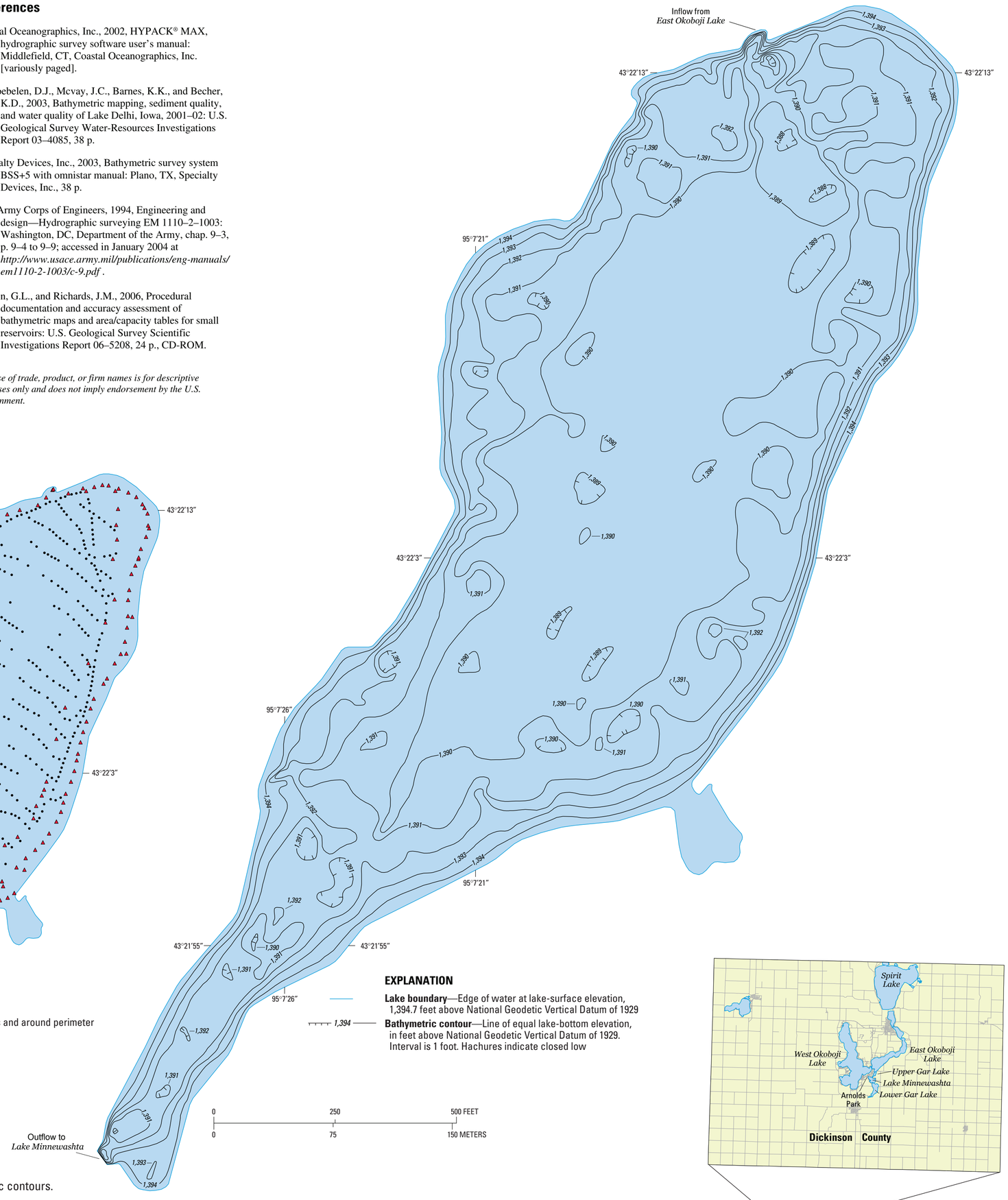


Base from U.S. Geological Survey digital data, 1 : 24,000, 1972, Universal Transverse Mercator projection, Zone 15, North American Datum of 1983

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



Base from U.S. Geological Survey digital data, 1 : 24,000, 1972, Universal Transverse Mercator projection, Zone 15, North American Datum of 1983

Figure 2. Bathymetric contours of Upper Gar Lake, 2004 (not for navigational use).

Location of Upper Gar Lake in Dickinson County, Iowa

Bathymetric Contours of Upper Gar Lake, Dickinson County, Iowa

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