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SCIENTIFIC INVESTIGATIONS MAP 3037
Bathymetric contours of Yellow Smoke Lake,
Crawford County, Iowa—SHEET 7 of 7
Linhart, S.M., and Lund, K.D., 2008, Bathymetric Contour Maps of Lakes Surveyed in Iowa in 2005

Abstract

The U.S. Geological Survey, in cooperation with the Iowa Department of Natural Resources, conducted bathymetric surveys on seven lakes in Iowa during 2005 (Arrowhead Pond, Central Park Lake, Lake Keomah, Manteno Park Pond, Lake Miami, Springbrook Lake, and Yellow Smoke 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. All of the lakes surveyed in 2005 are man-made lakes with fixed spillways.

Bathymetric data were collected using 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 47,784,000 cubic feet (1,100 acre-feet) at Lake Miami to 2,595,000 cubic feet (60 acre-feet) at Manteno Park Pond. Surface area estimates ranged from 5,454,000 square feet (125 acres) at Lake Miami to 558,000 square feet (13 acres) at Springbrook 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 United States Geological Survey (USGS) began a lake bathymetric mapping program in June 2001 on Lake Delhi in east central Iowa resulting 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 Yellow Smoke Lake in 2005 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 Yellow Smoke Lake.

Yellow Smoke Lake was constructed in 1980 and is located in western Iowa about 1 mile (mi) northeast of Denison in Crawford County located in Yellow Smoke Park, and is owned by the Crawford County Conservation Board. Yellow Smoke Lake is used primarily for recreational activities. Yellow Smoke Lake receives flow from two unnamed creeks from the north. Discharge from Yellow Smoke Lake is through a bottom outlet at the dam into an unnamed tributary of the East Boyer River.

Methods

Bathymetry data were collected on May 23 and 24, 2005. Bathymetric mapping was accomplished using 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 sound pulses that are reflected off the lake bottom and received by a transducer. The echo sounder transmitted at a frequency of 200 kilohertz; water depths were determined by the echo sounder based on 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 later were 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 days of bathymetric data collection by measuring from a reference point of known elevation on the boat dock structure. The elevation of the reference point was determined using 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 Yellow Smoke 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, Chapter 9). 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 water, and 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 data set was collected for a smaller area of Yellow Smoke Lake. The control data set was used to estimate the precision (repeatability) of the sounding data collected with the echo sounder, to estimate the accuracy of the interpolation in the three-dimensional surface, and to estimate the accuracy of the contours (Wilson and Richards, 2006). Within 1.5 ft of each other there were 18 paired data and control points with a calculated Root Mean Square Error (RMSE) of 0.27 ft. At corresponding locations were 1,294 paired three-dimensional surface elevations and control points with a calculated RMSE of 1.60 ft, and within 0.25 ft of each other there were 23 paired contours and control points with a calculated RMSE of 0.84 ft.

Bathymetric Contours

The water-surface elevation of Yellow Smoke Lake was 1,247.3 ft above North American Vertical Datum of 1988 (NAVD88) on May 23 and 24, 2005. Generally, the water depth increases toward the dam (fig. 2). The deepest part of the lake is located approximately 180 ft north-northeast of the outflow at the dam, and the lowest elevation measured was 1,219.4 ft (27.9 ft deep). The average elevation of the lake bottom based on the three-dimensional surface was 1,236.2 ft (11.1 ft deep). The slope of the lake bottom is generally greatest along parts of the eastern shoreline. Data from this survey indicate that the surface area of Yellow Smoke Lake, at a water-surface elevation of 1,247.3 ft, is approximately 1,641,000 square feet (ft^2) (38 acres) and the total water volume of Yellow Smoke Lake is approximately 18,253,000 cubic feet (ft^3) (420 acre-feet).

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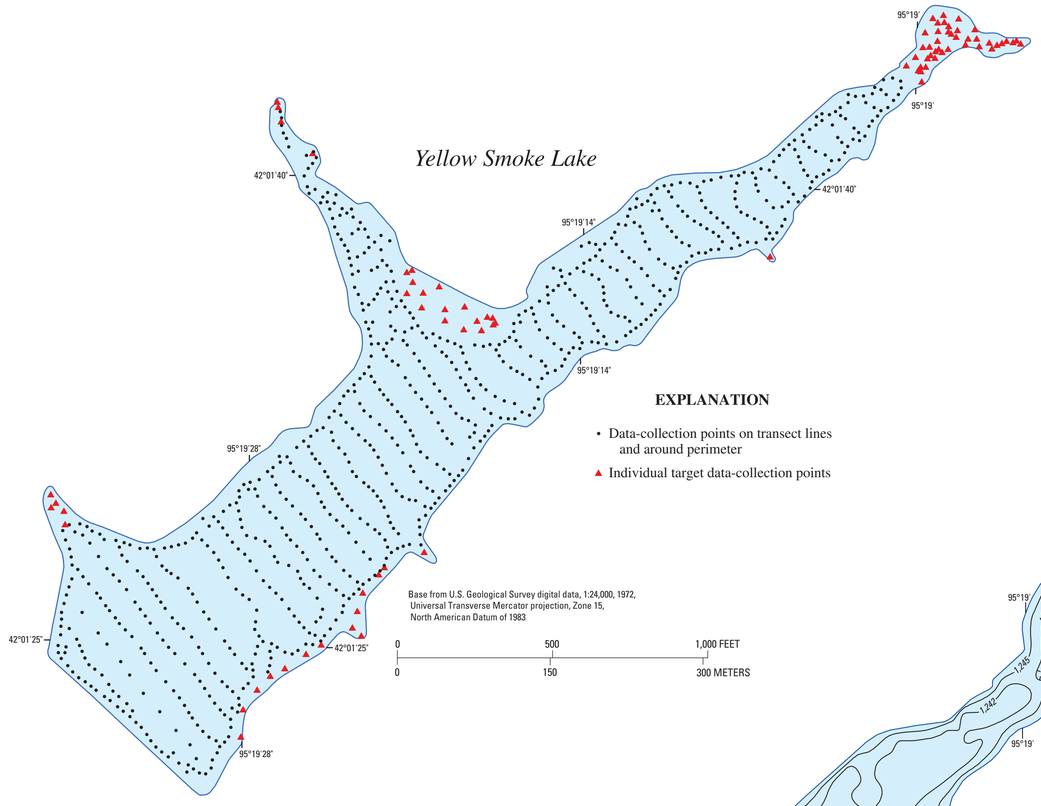

Figure 1. Data-collection points used to construct bathymetric contours.

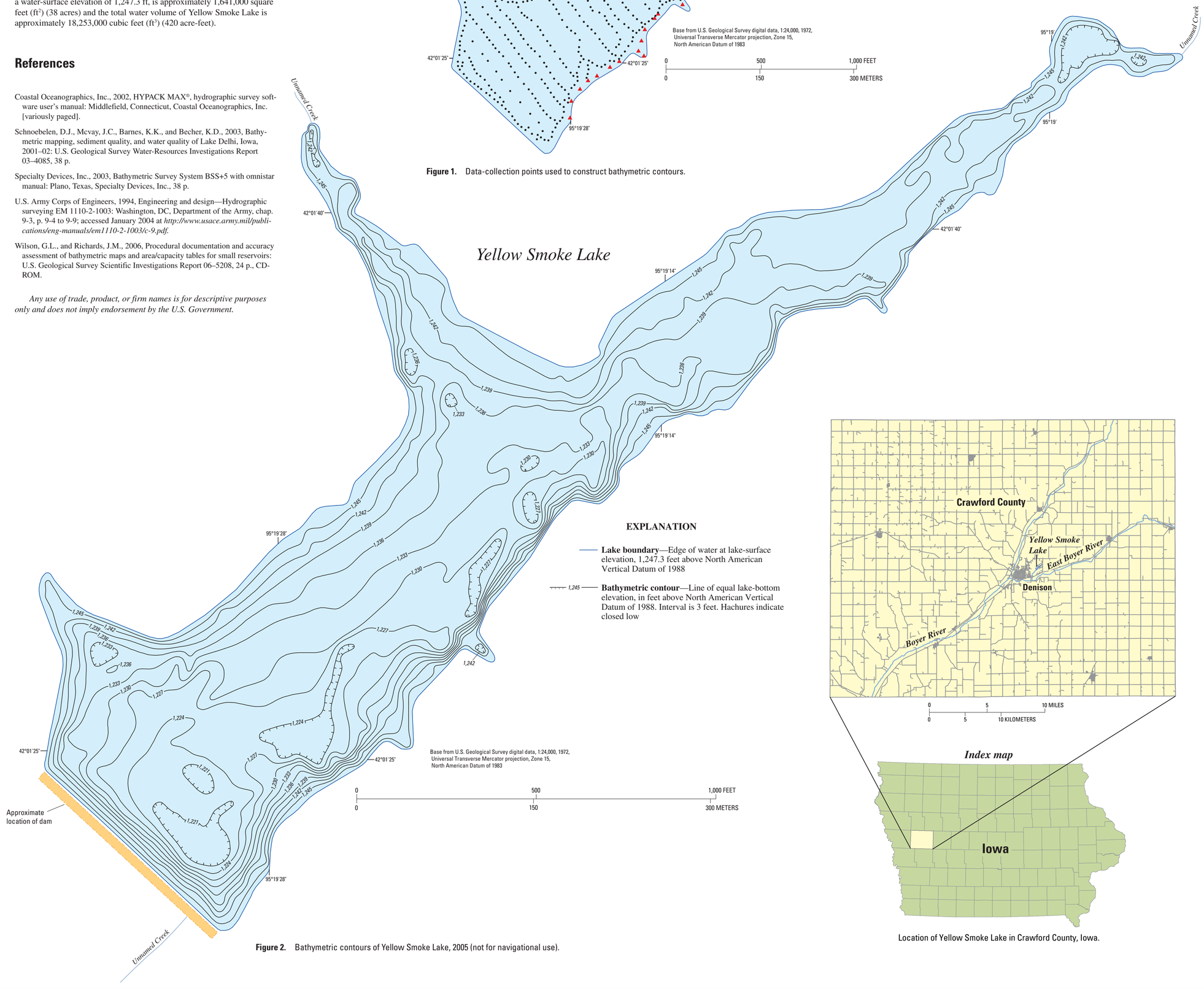

Figure 2. Bathymetric contours of Yellow Smoke Lake, 2005 (not for navigational use).

Location of Yellow Smoke Lake in Crawford County, Iowa.

Yellow Smoke Lake in Crawford County, Iowa (photograph by Aimee Donnelly, U.S. Geological Survey).

Bathymetric Contours for Yellow Smoke Lake, Crawford County, Iowa

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