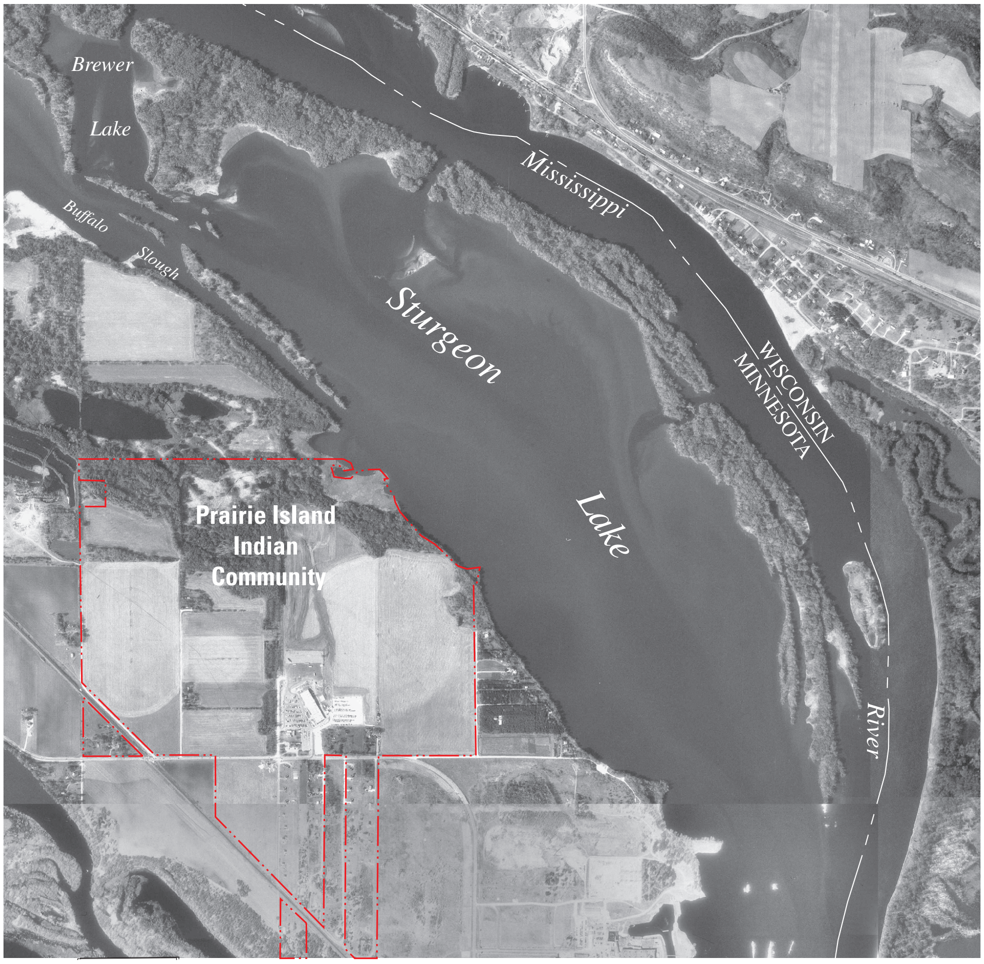
Physical, Chemical, and Biological Characteristics of Sturgeon Lake, Goodhue County, Minnesota, 2003-04



Scientific Investigations Report 2005-5182

Prepared in cooperation with the Prairie Island Indian Community and
Minnesota Department of Natural Resources

U.S. Department of the Interior
U.S. Geological Survey

Cover: Aerial photograph of Sturgeon Lake and Prairie Island Indian Community (USGS digital orthophoto, 1991).

Physical, Chemical, and Biological Characteristics of Sturgeon Lake, Goodhue County, Minnesota, 2003-04

By Kathy E. Lee[1], Christopher A. Sanocki[1], and Gary R. Montz[2]

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[1] **U.S. Geological Survey, Mounds View, Minnesota**

[2] **Minnesota Department of Natural Resources, St. Paul, Minnesota**

U.S. Department of the Interior
Gale A. Norton, Secretary

U.S. Geological Survey
P. Patrick Leahy, Acting Director

Mounds View, Minnesota, 2005

For additional information write to:
U.S. Geological Survey
Director, USGS Water Science Center of Minnesota
2280 Woodale Drive
Mounds View, MN 55112
http://mn.water.usgs.gov/

For more information about the USGS and its products:
Telephone: 1-888-ASK-USGS
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Conversion Factors, Datums, and Abbreviated Water-Quality Units

Multiply	By	To obtain
centimeter (cm)	0.39	inch (in.)
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound, avoirdupois (lb)
kilometer (km)	0.6214	mile (mi)
liter (L)	33.82	ounce, fluid (fl. oz)
liter (L)	61.02	cubic inch (in^3)
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)
micrometer (µm)	0.0000394	inch (in.)
square meter (m^2)	10.76	square foot (ft^2)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8\times°C)+32.$$

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88); horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Chemical concentrations are reported in metric units. Chemical concentrations of substances in water are reported in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams or micrograms per liter is a unit expressing the concentration of chemical constituents in solution as mass (milligrams or micrograms) of solute per unit volume (liter) of water. Chemical concentrations of substances in bottom sediment are reported in micrograms per kilogram (µg/kg), a unit expressing chemical constituents as a mass (micrograms) per unit mass (kilograms) of bottom sediment. One thousand micrograms per liter is equivalent to one milligram per liter.

Acknowledgments

Technical Reviewers

Robert C. Buchmiller, Hydrologist, U.S. Geological Survey, Iowa
Victoria Christensen, Hydrologist, U.S. Geological Survey, Minnesota

Local Project Coordination

Mr. Craig Wills, proposal development, study design, study review, and funding coordination on behalf of the Prairie Island Indian Community

Editing and Graphics

Ellen E. Hardy, Technical Publications Editor, U.S. Geological Survey, Utah
Robert Borgstede, Illustrator, U.S. Geological Survey, Minnesota
Charles E. Turner, Visual Information Specialist, U.S. Geological Survey, Utah
Stefanie L. Dragos, Computer Assistant, U.S. Geological Survey, Utah

Approving Official

Keith Lucey, Regional Reports Specialist, U.S. Geological Survey, Colorado

Physical, Chemical, and Biological Characteristics of Sturgeon Lake, Goodhue County, Minnesota, 2003-04

By Kathy E. Lee, Christopher A. Sanocki, and Gary R. Montz

ABSTRACT

The U.S. Geological Survey, in cooperation with the Prairie Island Indian Community and the Minnesota Department of Natural Resources, conducted a study of Sturgeon Lake (a backwater lake in Navigation Pool 3 of the Mississippi River) during 2003-04 to describe the physical, chemical, and biological characteristics of the lake. Riparian and shoreline areas surrounding Sturgeon Lake consist primarily of deciduous tree and shrub cover with minimal amounts of commercial or residential land use. Woody debris and aquatic vegetation are the major types of physical habitat suitable for fish and invertebrates. Among 10 bottom-sediment sampling sites, 24 organic wastewater compounds, 1 organochlorine pesticide metabolite (p,p'DDE), and total polychlorinated biphenyls (PCBs) were detected in the bottom sediments of Sturgeon Lake. The most prevalent class of compounds detected were polyaromatic hydrocarbons. Other classes of compounds detected include sterols, disinfectants, plastic components, alkylphenols, and fragrances. Three compounds detected (bisphenol A, benzo[a]pyrene, and triclosan) are considered endocrine disrupting compounds. Twenty-one and 49 invertebrate taxa were identified from 10 bottom-sediment and 6 woody-debris/vegetation samples, respectively. Most of the taxa were Diptera in the family Chironomidae. The most common invertebrate in terms of density in bottom-sediment samples was the burrowing mayfly (*Hexagenia sp.*). Trichoptera in the families Hydropsychidae or Polycentropodidae were common in most of the woody-debris samples. The presence of the *Hexagenia* larvae in samples indicates that the bottom sediments are stable and that dissolved oxygen concentrations in the lake do not drop to acute or sub-lethal anoxic conditions. Backwater lakes such as Sturgeon Lake are important areas of habitat for aquatic organisms along the Mississippi River, and this report provides baseline physical, chemical, and biological information that resource managers can compare with future investigations.

INTRODUCTION

The Prairie Island Indian Community is located in Goodhue County within the Mississippi River Valley between the cities of Hastings and Red Wing, on the eastern border of Minnesota (fig. 1). In the vicinity of Sturgeon Lake, the Mississippi Valley is 1.6 to 4.8 kilometers wide and bounded on each side by 100-meter-high bluffs. The Mississippi River flows northwest to southeast just north of Prairie Island and Sturgeon Lake. Just downstream from Sturgeon Lake is the U.S. Army Corps of Engineers Lock and Dam No. 3 about 1 kilometer upstream from the confluence of the Mississippi and Vermillion Rivers.

The surficial aquifer underlying Sturgeon Lake is 40-60 meters thick, extends to bedrock (the Franconia Formation, which also is an aquifer), and is composed primarily of sand and gravel but also contains thin, isolated lenses of finer-grained material (Cowdery, 1999). Flow in the surficial aquifer is normally from the Mississippi River to the Vermillion River (southwest). During spring snowmelt or heavy rains, ground water flows toward the surrounding surface waters, including Sturgeon Lake.

Backwater lakes such as Sturgeon Lake provide important areas of aquatic habitat along the Mississippi River. These backwater lakes are typically shallow, have warmer temperatures, increased residence times, and have higher biological productivity relative to the main channel (Eckblad and others, 1984; Junk and others, 1989). Organisms can take refuge in these lakes during extreme low or high flow events in the river and use the lakes for seasonal spawning and nursery habitat (Junk and others, 1989; Scott and Nielson, 1989). The U.S. Geological Survey (USGS), in cooperation with the Prairie Island Indian Community and the Minnesota Department of Natural Resources, conducted a study to measure and describe the physical, chemical, and biological characteristics of Sturgeon Lake during 2003-04.

Purpose and Scope

The purpose of this report is to present the physical, chemical, and biological characteristics of Sturgeon Lake during 2003-04. These characteristics include (1) lake bathymetry, (2) bottom-sediment composition, (3) physical habitat, (4) concentrations of selected contaminants in bottom sediments, and (5) invertebrate-community composition.

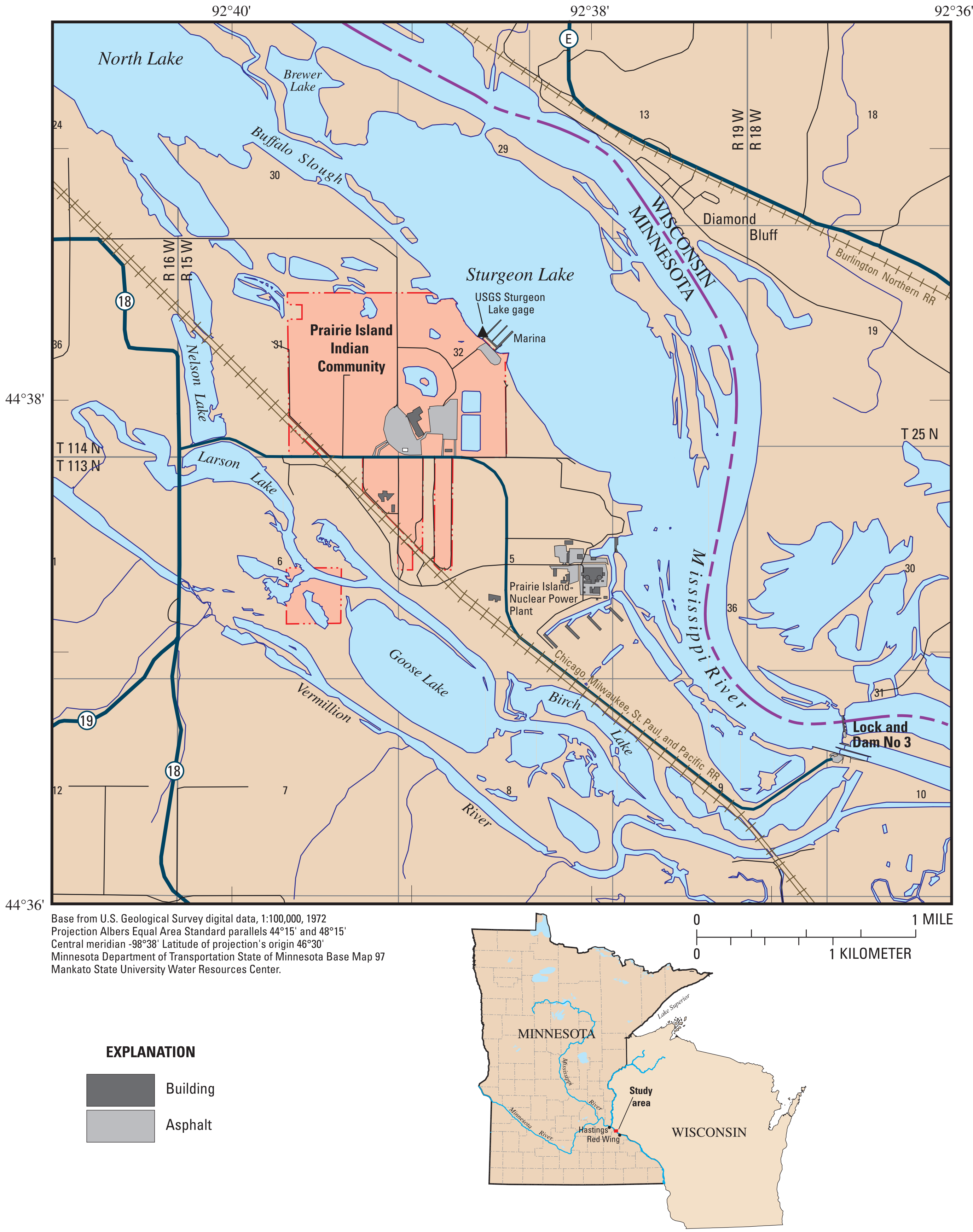


Figure 1. Location of Prairie Island Indian Community and Sturgeon Lake study area, Goodhue County, Minnesota.

Methods

Bathymetric data were collected, bottom-sediment composition was characterized at 63 sites (appendix 1), physical habitat was characterized at 30 sites (table 1, appendix 2), selected contaminants were measured in bottom sediments at 10 sites (table 1), and invertebrates were collected at 16 sites during 2003-04 (table 1).

Bathymetry—Data collection and processing

A bow-mounted, 1,200 kilohertz acoustic doppler current profiler (ADCP) deployed from a boat was used to gather lake depth data during April 24-25, 2003. The ADCP is a four-transducer beam instrument designed to collect streamflow information (discharge measurements, velocity vectors, and depths) and also can be used as a depth sounder. Approximately 50,000 lake-depth data points were collected with the ADCP along 20 transects in the lake to ensure a relatively uniform coverage of Sturgeon Lake. The depth of the ADCP below the water surface was checked at the beginning of each day. The four beams are projected at a 20-degree angle from the transducer head and each beam collects depth data. Lake depth was calculated by averaging the depths from each of the four beams and as such the footprint for the average depth is large enough to obscure some bottom features. Differentially corrected global positioning system (GPS) data were collected concurrently with ADCP data in National Marine Electronics Association data string (GGA) format.

WinRiver software (version 10.903.48, RD Instruments of San Diego, Calif., 2001) was used for data processing. Latitude, longitude, and the average value of the four individual beam depth readings and GPS coordinates were used for bathymetric map preparation. Lake elevation, recorded at the USGS lake gage (Sturgeon Lake, west side at Prairie Island, MN; station identification number 05344850), was used to adjust data to a known lake elevation (205.75 meters above NAVD 88).

Data files were processed with a geographic information system to prepare bathymetric contours of lake depth (fig. 2). Lake boundary lines were obtained from Minnesota Department of Natural Resources 1:24,000 lake data and modified to fit the study area (Minnesota Department of Natural Resources, 2003). The lake boundary was assigned a zero depth and used as input in the generation of lake bathymetric contours. The bathymetric map produced as part of this project is not intended for and is not sufficient for navigational purposes.

Bottom-sediment composition—Collection and processing

Bottom-sediment composition was characterized at 63 sites throughout the lake during August 11-13, 2003. A stainless-steel Eckman grab sampler was used to collect bottom-sediment samples from the top 25 centimeters of bottom sediment with minimal disturbance at the sediment-water interface. Bottom-sediment samples were characterized (table 2) on-site and archived at the USGS Minnesota Water Science Center. Latitude and longitude, lake depth, time, and sediment composition were recorded at each location. Basic water-quality field measurements (pH, dissolved oxygen, water temperature, and specific conductance) also were recorded at each sample location (appendix 1).

Physical habitat—Field characterization

Lake physical-habitat characterization followed U.S. Environmental Protection Agency (1997) protocols and was conducted during July 8-9, 2004. The following is a brief description of the procedures. Physical-habitat characterization at Sturgeon Lake included (1) temperature and dissolved oxygen profiles at one index location in the deepest part of the lake, and (2) measures or observations of riparian, shoreline, and littoral characteristics at 30 sites around the perimeter of the lake (fig. 3, table 1, appendix 2). Riparian observations at each site pertain to the adjacent land or wetland area that is 15 meters wide and extends 15 meters back onto land. Shoreline measurements pertain to the area 15 meters along the shore and 1 meter back onto land. Littoral measurements pertain to the water and lake bottom in the 10-meter distance between the boat and the shoreline and extending 15 meters along the shore.

Riparian area measures included characterization of vegetation type (appendix 2). Shoreline measures included characterization of shoreline substrate, bank features, and human influences (buildings, commercial sites, parks, docks, walls, dikes, revetments, dumps, roads, row crops, pasture, orchards, or lawns). Littoral area measures included determination of water depth, presence of surface films, bottom-substrate coverage, aquatic macrophyte coverage, and aquatic organism habitat coverage.

Contaminants in bottom sediment—Sample collection and processing techniques

Bottom-sediment contaminant samples were collected according to established protocols (Shelton and Capel, 1994). Twelve samples were collected from the lake (10 environmental samples and 2 quality-assurance samples) with a stainless steel Eckman grab sampler on September 4, 2003 (table 1, appendixes 3 and 4). The bottom-sediment sample was discarded if it contained a large amount of vegetation or appeared to be disturbed. Bottom-sediment samples were transferred to a glass container and homogenized for 5 minutes, and 100-200 grams of unsieved wet material were placed in wide-mouth, glass containers, chilled, and sent to the USGS National Water Quality Laboratory in Denver, Colorado.

All collection and processing equipment was cleaned between samples with a succession of native water, soapy tap

Table 1. Location and type of samples collected in Sturgeon Lake, Goodhue County, Minnesota 2003-04

[d, degrees; m, minutes; s, seconds; Y, sample collected; a, site where U.S. Geological Survey laboratory research method 8050 was used to analyze bottom-sediment samples; b, site where U.S. Geological Survey laboratory schedules 2503 and 1325 were used to analyze bottom-sediment samples; bt, invertebrate samples collected from bottom sediment; wd, invertebrate samples collected from woody debris; vg, invertebrate samples collected from aquatic vegetation; —, no data]

Site identifier (shown on fig. 3)	Lattitude (d,m,s)	Longitude (d,m,s)	Physical habit characterized	Bottom-sediment contaminant sample collected	Invertebrate sample collected
1	443813	0923832	Y	Y (a,b)	—
2	443815	0923833	—	—	—
3	443816	0923835	Y	Y (a,b)	Y (bt)
4	443818	0923805	—	Y (a,b)	Y (bt)
5	443830	0923813	—	—	—
6	443834	0923824	—	Y (a,b)	—
7	443841	0923835	—	—	—
8	443850	0923853	—	Y (a,b)	—
9	443853	0923935	Y	Y (a)	—
10	443826	0923852	Y	Y (a)	Y (bt)
11	443853	0923826	Y	Y (a)	Y (bt)
12	443751	0923812	Y	Y (a)	Y (bt)
13	443800	0923735	Y	Y (a)	Y (bt)
14	443839	0923907	Y	—	Y (b,t)
15	443828	0923755	Y	—	Y (bt)
16	443902	0923911	Y	—	Y (vg)
17	443754	0923755	—	—	Y (bt)
18	443737	0923738	—	—	Y (bt)
19	443849	0923923	Y	—	Y (wd)
20	443843	0923803	Y	—	Y (wd)
21	443812	0923738	Y	—	Y (wd)
22	443823	0923748	Y	—	Y (wd)
23	443836	0923816	—	—	Y (wd)
24	443807	0923827	Y	—	—
25	443759	0923821	Y	—	—
26	443744	0923800	Y	—	—
27	443738	0923754	Y	—	—
28	443735	0923743	Y	—	—
29	443745	0923728	Y	—	—
30	443852	0923818	Y	—	—
31	443902	0923844	Y	—	—
32	443904	0923857	Y	—	—
33	443906	0923904	Y	—	—
34	443859	0923924	Y	—	—
35	443848	0923912	Y	—	—
36	443842	0923902	Y	—	—
37	443832	0923856	Y	—	—
38	443818	0923841	Y	—	—
39	443835	0923902	Y	—	—

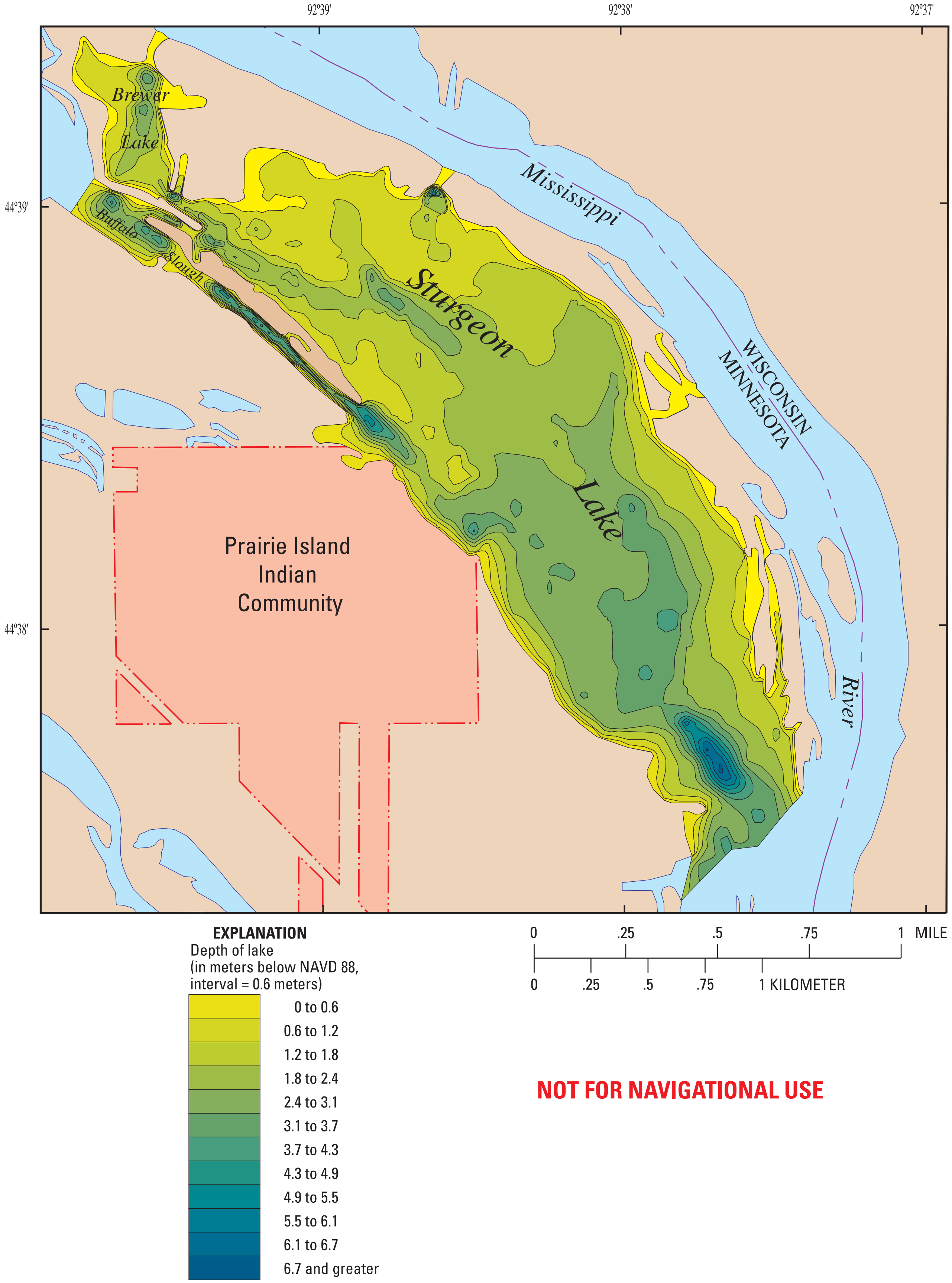


Figure 2. Bathymetry of Sturgeon Lake, Goodhue County, Minnesota.

[A reference elevation of 205.75 meters, from U.S. Geological Survey Sturgeon Lake gage, was applied to the lake-level data that were collected April 24-25, 2003.]

Table 2. Composition categories used for bottom-sediment characterization of Sturgeon Lake, Goodhue County, Minnesota, 2003-04

[mm, millimeter; 254 millimeters are equivalent to 1 inch]

Category	Description
Boulder	Stones greater than 256 mm in diameter
Cobble	Stones from 64 to 256 mm in diameter
Gravel	Stones from 2 to 64 mm in diameter
Sand	Material from 0.06 to 2 mm in diameter
Silt	Fine material from 0.004 to 0.06 mm in diameter
Clay	Fine material less than 0.004 mm in diameter
Detritus	Unconsolidated organic material including sticks, wood, and other partially or non-decayed coarse plant material

water, tap water, deionized water, methanol, and organic-free water rinses. To avoid contamination of samples, use of personal care items (such as insect repellent, sunscreen, cologne, aftershave, and perfume) was avoided for personnel collecting and processing samples. Caffeinated products and tobacco products were not consumed during (or immediately prior to) collection or processing of samples. Powderless, disposable gloves were worn during bottom-sediment sample collection to avoid contamination of samples. Standard labeling and packing techniques (double foam sleeves placed around bottles) were used to ensure sample integrity. When not in use, sample processing equipment was covered.

A submersible data sonde was used for profile measurements of pH, dissolved oxygen, water temperature, and specific conductance at the index location (site 53 on fig. 4), and at sites where bottom-sediment composition was characterized (appendix 1). The data sonde was calibrated according to manufacturer's specifications before and following sampling to assure proper operation. Measurements were made at multiple locations in the water column based on total lake depth. Measurements at sites with a total depth less than 1 meter were made in the middle of the water column. Sites with depths greater than 1 meter but less than 3 meters were measured at the top and bottom of the water column; and those sites with total depths greater than 3 meters were measured at multiple intervals. Top measurements were made at 0.1 meter below the lake surface and bottom measurements were made 0.1 meter above the lake bottom.

Contaminants in bottom sediment—Laboratory analyses

USGS production methods (laboratory schedules 1325 and 2503) and a research method (laboratory code 8050) were used to analyze compounds in bottom-sediment samples (appendixes 3 and 4). All analyses were completed at the USGS National Water Quality Laboratory in Denver, Colorado. Method 8050 was used to analyze 62 household, industrial, and agricultural-use compounds, and sterols (organic wastewater compounds (OWC)). Method 1325 was used to measure polychlorinated biphenyls and organochlorine pesticides according to Wershaw and others (1987). Twelve samples (10 environmental and 2 quality assurance) were collected throughout the lake (fig. 3 and table 1) and analyzed using lab code 8050. A subset of five samples (sites 1, 3, 4, 6, and 8) also was analyzed for laboratory schedules 1325 and 2503. Research methods, in contrast to production methods, are not conducted in a routine laboratory production capacity. Protocols are in development and extensive quality-control databases have not yet been developed or archived; therefore, there is greater uncertainty related to the constituent concentrations for research methods.

Subcritical water modified with 50-percent isopropanol was used to extract organic compounds from environmental sediment samples for research method 8050 at two temperatures (120ºC and 200ºC) at 2,000 pounds per square inch (40 minutes at each temperature) using a commercially available instrument (ASE 200, Dionex Corp.). Solid-phase extraction cartridges (polystyrene divinylbenzene and fluorosil) are used in tandem for extract clean up, and analysis is by full-scan capillary-column gas chromatography/mass spectrometry. At least one spike and one blank were analyzed for every set of 10 samples, and 3 surrogate compounds were added to each sample.

Invertebrates—Sample collection and processing techniques

Aquatic invertebrates were collected from woody debris, aquatic vegetation, and bottom sediments at 16 sites throughout Sturgeon Lake on September 9, 2004 (fig. 3 and table 1). Woody debris and vegetation samples were collected along the shoreline and within the lake by brushing the surface of wood or vegetation and collecting the debris in a D-framed-net with a 500-µm-size mesh. Bottom-sediment samples were collected with an Eckman grab sampler. Material in the grab was transferred to a sieve (500 µm) and rinsed until the fine sediments were removed. The remaining residue in the sieve was transferred into a 500-mL wide-mouth bottle. Invertebrate samples were preserved in the field in ethanol and sent to the Minnesota Department of Natural Resources Ecological Services Aquatic Invertebrate Biology Office in St. Paul for identification and enumeration.

Samples were sorted under a dissecting microscope and specimens were identified to the lowest practical taxon, typically at the genus level. Chironomidae were mounted in CMC-10 media on slides, allowed to clear for 1 week, and identified by using a compound microscope. Chironomidae were quantified when abundances were less than 500 individuals per sample. Those samples with greater than 500 Chironomidae per sample were subjectively assessed as "abundant," "common," or "present." Abundant indicates a taxa with the greatest number of individuals, followed by common, and

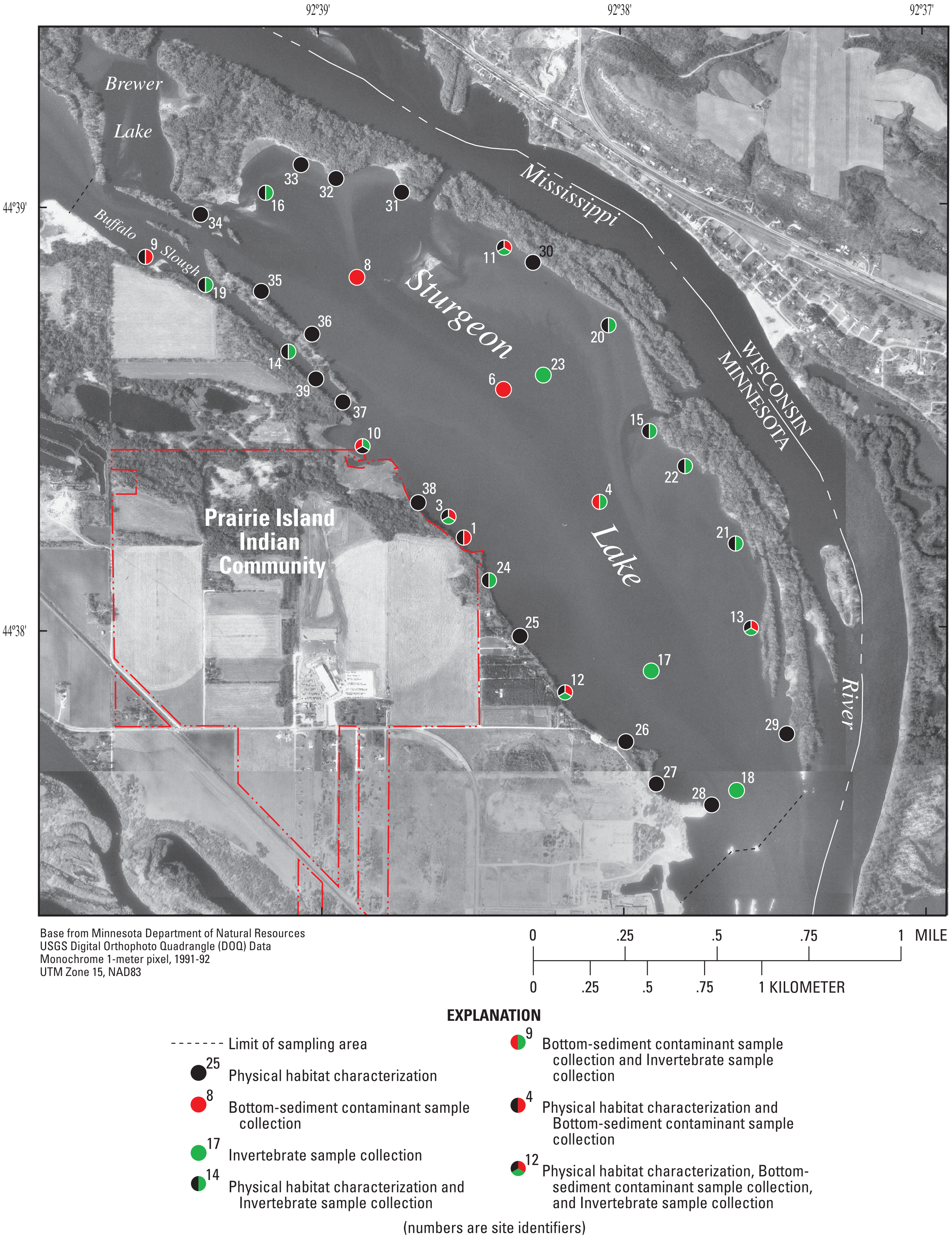


Figure 3. Location of physical habitat characterization, bottom-sediment contamination sample, and invertebrate sample collection sites, Sturgeon Lake, Goodhue County, Minnesota.
[See table 1 for site description.]

present, which has the fewest individuals. Invertebrate density (number of organisms per square meter) was quantified for the Ekman grab samples. Density of invertebrates was not quantified for samples collected from woody debris or vegetation, as the area of the sample was not known.

Quality Assurance

All field personnel were familiarized with study design and sampling protocols prior to field sampling or data processing to assure sample integrity. One laboratory blank and one laboratory spike sample were analyzed with environmental samples to assess laboratory procedures with respect to the 62 OWCs analyzed using USGS research method 8050. Two OWCs were detected in laboratory blank samples. Phenol and diethylhexyl phthalate were detected in both environmental and laboratory blank samples. Detection of either of these two compounds in environmental samples may be reflective of laboratory contamination. Laboratory spike samples provide information about how well a compound is recovered through laboratory analyses. Spike recoveries ranging from 60 to 120 percent are generally in the acceptable range for routine analyses. The spike recoveries among all OWCs ranged from 4 to 146 percent, but most were in the acceptable range (appendix 3). Those compounds with high or low recoveries may have environmental concentrations that are either biased high or low.

Replicate samples were collected at two bottom-sediment contaminant sites to determine variability of detection and concentration that result from sample processing techniques (sample splitting, filtration, and transport). Replicate samples consist of a split of the field sample so the field and replicate samples should be nearly equal in composition. Concentrations of detected compounds in replicate samples were compared by calculating a relative standard deviation (RSD) for each compound. The RSD is calculated by dividing the standard deviation of the samples by the mean of the samples, and then multiplying by 100. There was a wide range of RSDs for the compounds analyzed, ranging from 0 to 76.1 (table 3). The average RSD for detected compounds in the sample from sites 9 and 12, respectively, was 31 and 9 percent. Although RSDs for some OWCs are greater than 10 percent, the concentrations of OWCs in the field and replicate samples were in the same order of magnitude. The greater RSDs in the sample from site 9 may be the result of incomplete sample homogenization in the field or laboratory analytical error.

PHYSICAL CHARACTERISTICS

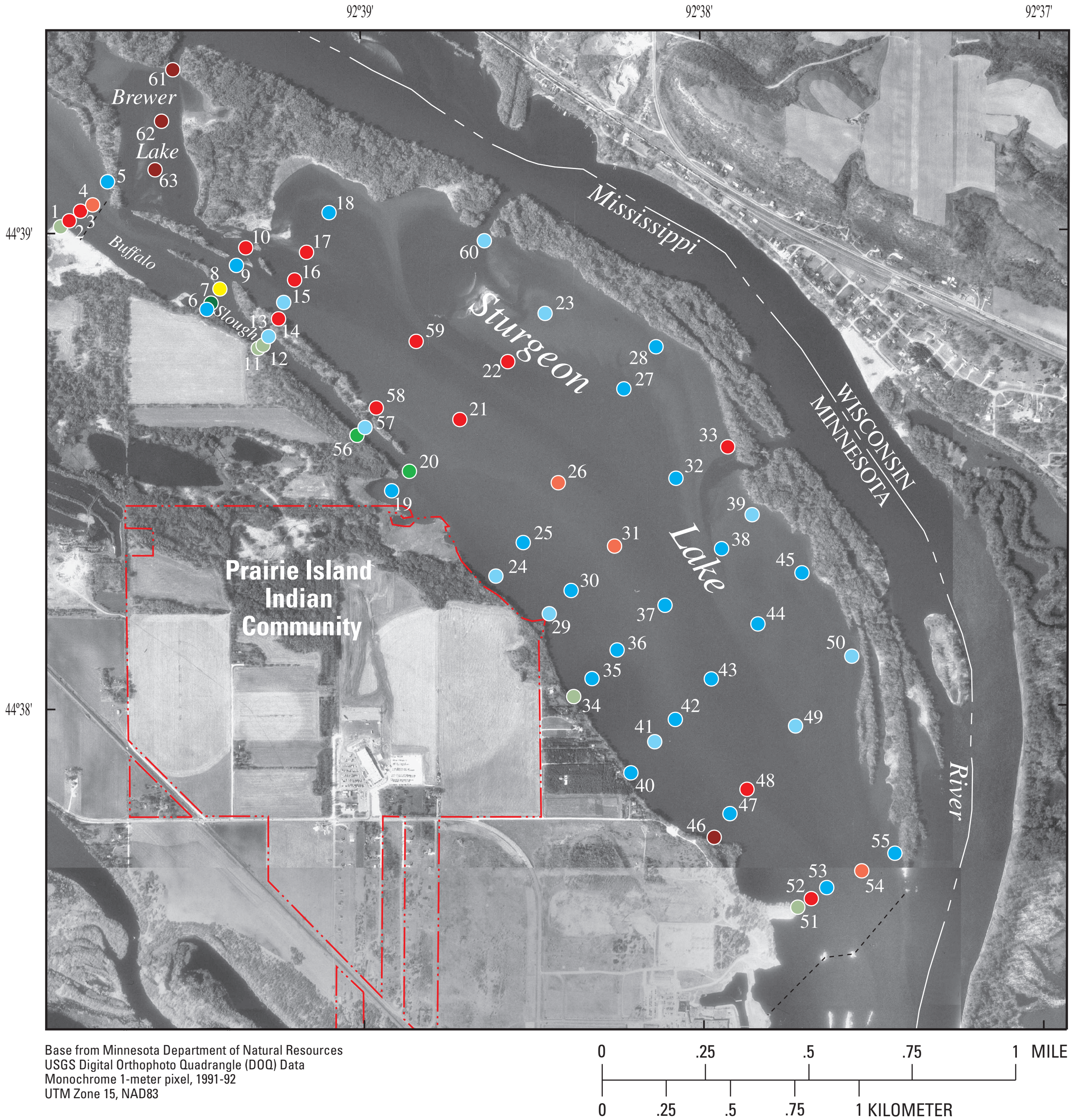
Sturgeon Lake is a backwater lake in Navigation Pool 3 of the Mississippi River that is essentially an impoundment behind Lock and Dam No. 3. Lake levels depend on river stage changes and Lock and Dam No. 3 operation. Sturgeon Lake lies just south of the Mississippi River along a length of approximately 3 kilometers and receives incoming Mississippi River water directly through two channels in the northern and eastern parts of the lake (fig. 1). In addition, it is also connected to North Lake through Buffalo Slough and to Brewer Lake by one channel. Both Brewer and North Lakes are connected to the Mississippi River.

Depths throughout the lake ranged from less than 1 to about 7 meters (fig. 2). Most of Sturgeon Lake is shallow (less than 3 meters) at a lake stage of 205.75 meters reported at the USGS gage located on the west side of Sturgeon Lake. Exceptions include deeper areas near an inlet from the Mississippi River on the north and west side of the lake (Stefan and Anderson, 1980), in Buffalo Slough, and near the outlet into the Mississippi River in the southeastern part of the lake. The lake bottom is periodically dredged to facilitate navigation from the lake marina to the outlet in the southeastern part of the lake.

Bottom-sediment composition is variable throughout the lake, likely depending on hydrologic conditions (fig. 4). The bottom substrate is a mixture of sand and silt in many areas within the lake. Bottom material in Buffalo Slough is composed primarily of coarse substrate such as boulders and gravel overlying coarse sand. Other areas in the lake near the inlets to the Mississippi River have bottom substrate that is composed of coarse sand. In the numerous areas downstream from islands and in small coves, the bottom material is primarily composed of silt, fine sand, and clay.

The riparian area surrounding Sturgeon Lake consists primarily of deciduous tree and shrub cover (fig. 5, appendix 2). Most of the cover consists of trees less than 0.3 meter in diameter, and herbs, forbes, and shrubs. There are few commercial or residential buildings in the riparian or shoreline areas surrounding the lake with the exception of the area near sites 1 and 3 (at the marina) and near sites 12, 24, and 25 where there is some residential land use. Human influences in the shoreline area consist of boat docks, walls, dikes and revetments, roads, and residential areas or parks. Shoreline substrate is composed mainly of loose sand and other fine sediment and is generally vegetated (appendix 2). Bank conditions are generally stable but vary around the lake from near vertical and undercut to more gently sloping banks with less than 30-percent slope.

Physical habitat for aquatic organisms includes overhanging vegetation, macrophytes, and woody debris along the shoreline of the lake, and coarse substrate such as boulders and gravel in Buffalo Slough. Although generally characterized by sparse or moderate cover, woody debris and aquatic macrophytes are the major types of physical habitat available for fish and invertebrates. There is little physical habitat in the open water areas of the lake, but the bottom substrate in these areas of the lake (sand and silt) is appropriate for invertebrate taxa, such as midges and burrowing mayflies, that serve as food sources for fish.



EXPLANATION

- - - - - - Limit of sampling area

8	Clay / Gravel	22	Sand / Silt
23	Clay / Silt	61	Sand / Sand
37	Silt / Clay	34	Sand / Gravel
26	Silt / Sand	20	Gravel / Sand
		7	Sand / Boulder

(numbers are site identifiers)

Figure 4. Bottom-sediment composition of Sturgeon Lake, Goodhue County, Minnesota.

[See table 2 for description of bottom-sediment composition categories; the first substrate listed is the dominant substrate, and the second one is the sub-dominant substrate.]

Table 3. Quality-assurance sample summary for detected organic wastewater compounds analyzed in bottom sediments collected from Sturgeon Lake, Goodhue County, Minnesota, September 4, 2003.

[Concentrations are reported in micrograms per kilogram (µg/kg) of sediment; —, not detected; relative standard deviation (standard deviation divided by the mean concentration of the two samples x 100)]

Compound	Site 9	Site 9 (Replicate sample)	Relative standard deviation	Site 12	Site 12 (Replicate sample)	Relative standard deviation
1-methylnapthalene	—	2.7	—	6.9	7.6	6.8
2,6-dimethylnapthalene	15	19	16.6	34	36	4.0
2-methylnapthalene	—	4.7	—	9.4	10	4.4
3-beta-coprostanol	150	—	—	210	250	12.3
anthracene	6.6	6.4	2.2	15	14	4.9
anthraquinone	10	16	32.6	24	23	3.0
benzo[a]pyrene	12	13	5.7	34	35	2.1
beta-sitosterol	1,700	2,900	36.9	1,600	2,200	22.3
bisphenol A	—	—	—	7.6	9.1	12.7
cholesterol	970	1,600	34.7	1,500	1,700	8.8
diethylhexyl phthalate	62	—	—	56	—	—
fluoranthene	38	49	17.9	96	96	.0
indole	120	67	40.1	210	220	3.3
naphthalene	10	10	.0	17	19	7.9
para-cresol	160	380	57.6	110	130	11.8
phenanthrene	11	15	21.8	39	40	1.8
phenol	190	57	76.2	110	120	6.1
pyrene	37	48	18.3	94	96	1.5
skatol	80	240	70.7	70	91	18.4
stigmastanol	490	850	38.0	570	790	22.9
triclosan	8.4	12	25.0	11	8	22.3
Average relative standard deviation			31			9

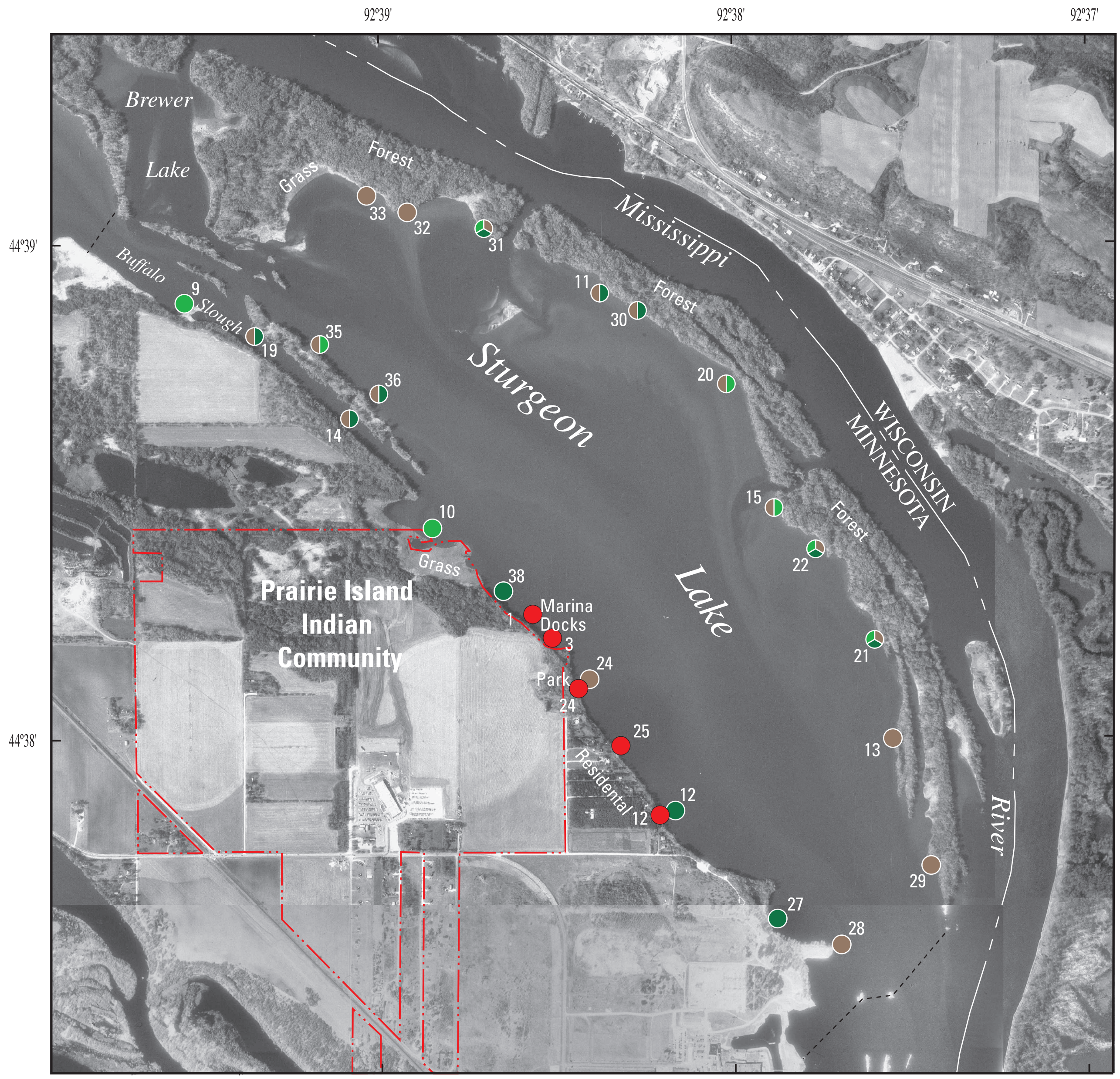
CHEMICAL CHARACTERISTICS

Water temperature, dissolved oxygen, specific conductance, and pH were relatively uniform throughout the lake (table 4, appendix 1) and followed an apparent pattern related to depth (appendix 1). Water temperature, dissolved oxygen concentrations, and pH were greater at the lake surface than at the bottom. These patterns are likely the result of greater phytoplankton photosynthesis in the relatively warmer water at the top of the lake that has greater sunlight penetration. During photosynthesis, algae utilize energy from incoming sunlight and take in nutrients and carbon to produce carbohydrates and produce oxygen (Stumm and Morgan, 1996). The pH increases at the same time the carbon dioxide, nitrate, and phosphate are utilized by phytoplankton, resulting in a greater number of relative hydroxyl ions in the water column.

Table 4. Summary of water-quality field measurements for Sturgeon Lake, Goodhue County, Minnesota, measured August 11-13, 2004

[Measurements were taken at multiple locations in the water column at 63 sites within Sturgeon Lake; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius]

Water-quality field measurement	Minimum	Average	Maximum
Water temperature (°C)	24.6	26.3	28.9
Dissolved oxygen (mg/L)	5.5	9.1	12.7
Dissolved oxygen saturation (percent)	78	114	163
Specific conductance (µS/cm)	442	463	479
pH (standard units)	8.0	8.5	8.8



Base from Minnesota Department of Natural Resources
USGS Digital Orthophoto Quadrangle (DOQ) Data
Monochrome 1-meter pixel, 1991-92
UTM Zone 15, NAD83

EXPLANATION

- Limit of sampling area
- Human influence in shoreline areas including one or more of the following: buildings, docks, park, roads, railroads, walks, orchard, and lawns

Aquatic habitat

- 10 Aquatic macrophytes
- 27 Overhanging vegetation
- 24 Woody debris
- 14 Woody debris / Overhanging vegetation
- 35 Woody debris / Aquatic macrophytes
- 22 Aquatic macrophytes / Woody debris / Overhanging vegetation

(numbers are site identifiers)

Figure 5. Aquatic habitat of Sturgeon Lake, Goodhue County, Minnesota. [See appendix 2 for aquatic habitat data.]

Twenty-four OWCs were detected in the bottom sediments of Sturgeon Lake that represent a wide variety of uses and sources (table 5, appendix 3). The number of OWCs detected ranged from 17 to 22 per site. The most prevalent category of compounds detected were polyaromatic hydrocarbons (PAHs). The sources of PAHs are complex, but typically they are byproducts of organic matter combustion and are components in fossil fuels. Atmospheric deposition, urban runoff, municipal wastewater-treatment-plant discharges, wood-treatment facilities, petroleum-development and processing facilities, coal-storage facilities, and transportation networks (both land and river) contribute PAHs to the Mississippi River (Rostad and others, 1995). Concentrations of PAHs in Sturgeon Lake bottom sediments were greatest at sites 10 and 11 near an inlet from the Mississippi River, and at site 12 (table 5; appendix 3). Rostad and others (1995) attributed the elevated concentrations of PAHs in the bed sediments of the Mississippi River near Minneapolis and St. Paul (in Navigation Pools 1 and 2 upstream from Sturgeon Lake) to municipal sources including wastewater discharge and urban runoff.

Other categories of chemicals detected include sterols, disinfectants, plastic components, alkylphenols, and fragrances (table 5, appendix 3). The sterol, 3-beta-coprostanol, is a fecal sterol that is present in human and livestock wastes. Although wastewater treatment generally removes 95-99 percent of the incoming 3-beta-coprostanol (Walker and others, 1982), the remaining amount can enter the environment and adsorb to sediments. Rostad and others (1995) attribute wastewater sources for the presence of 3-beta-coprostanol in the bottom sediments of Mississippi River pools near Minneapolis and St. Paul, Minn. The 3-beta-coprostanol concentrations in Sturgeon Lake bottom-sediment samples ranged from 40 to 210 µg/kg (appendix 3). Concentrations greater than 100 µg/kg indicate wastewater contamination (Hatcher and McGillivary, 1979; Venkatesan and Kaplan, 1990); therefore, the presence and concentration of 3-beta-coprostanol at sites 9-12 may indicate local or upstream wastewater sources.

Three OWCs (bisphenol A, benzo[a]pyrene, and triclosan) are considered endocrine-disrupting compounds (Nagel and others, 1997; Foran and others, 2000; Kolpin and others, 2002). Bisphenol A is used in the manufacture of polycarbonate resins. Benzo[a]pyrene is a PAH that is moderately persistent in the environment, binds to soils, and is expected to bioconcentrate in some aquatic organisms (U.S. Environmental Protection Agency, 2005). Triclosan is an antimicrobial disinfectant used in personal-care items such as hand soaps and toothpaste. The presence of triclosan in the bottom sediments of Sturgeon Lake indicates a local or upstream wastewater source.

Two of 10 organochlorine pesticide or polychlorinated biphenyl compounds analyzed for (p,p'DDE, and total polychlorinated biphenyls (PCBs)) were detected in the 5 bottom-sediment samples that were analyzed for those compounds (table 5, appendix 4). The DDT metabolite (p,p'DDE) concentrations ranged from 0.32 to 0.82 µg/kg, and PCB concentrations ranged from 9.4 to 37.4 µg/kg. The spatial distribution of the two compounds was similar. Concentrations of both compounds were lowest at the two sites sampled near the marina. Concentrations increased in an upstream (north and west) direction and were greatest near the Mississippi River inlet at site 8. Total PCB concentrations (0.90-370 µg/kg) were observed by McNellis and others (2001) in Mississippi River bed sediments upstream of Sturgeon Lake (near Anoka and Nininger, Minn.). Neither of the compounds is currently in use, and their detections within the lake-bottom sediments emphasize the ubiquitous nature and slow degradation of these compounds.

Sources of compounds (analyzed in this study) detected in Sturgeon Lake are unknown but may include incoming Mississippi River water or suspended sediments, as many of these compounds also were detected in the Mississippi River and in wastewaters upstream from Sturgeon Lake (Lee and others, 2004). Additional sources may include atmospheric deposition, surface runoff in the Sturgeon Lake watershed, or point sources into the lake.

BIOLOGICAL CHARACTERISTICS

Twenty-one invertebrate taxa (both insect and non-insect taxa) were identified from bottom-sediment samples collected from 10 sites in Sturgeon Lake (table 6). The number of taxa varied from 2 to 13 per site. Most of the taxa (12 of 21) were Diptera, and most of these were in the family Chironomidae. Chironomidae are commonly present in bottom sediments and other habitats as they are tolerant of a wide variety of conditions (Merritt and Cummins, 1996). The most common invertebrate in terms of density (individuals per square meter) was the burrowing mayfly (*Hexagenia sp*.). *Hexagenia* was a substantial part of many samples making up as much as 50 percent of the density of the invertebrates in some samples (sites 3, 4, 11, 17, and 18). *Hexagenia* density ranged from 43 per square meter at site 14 to 3,869 per square meter at site 11. Three sites (10, 13, and 14) had either no or very few *Hexagenia*.

Hexagenia larvae require soft and stable sediments to create burrows in the bottoms of shallow, slow-moving rivers or lakes (Merritt and Cummins, 1996) and are unable to withstand dissolved oxygen levels below 1 mg/L (Hunt, 1953; Eriksen, 1963). Persistent oxygen concentrations of less than 7 mg/L also can reduce both survival and size of *Hexegenia* nymphs (Winter and others, 1996). *Hexagenia* presence provides fish food and also reflects environmental health (Fremling 1968; Reynoldson and others, 1989). During 1957-69, *Hexagenia* were rare in the 48-kilometer Mississippi River reach near Sturgeon Lake downstream from Minneapolis and St. Paul, Minn., likely as a result of low dissolved oxygen concentrations on the river bottom (Fremling, 1973). More recently the abundance of *Hexagenia* has increased in this reach of the Mississippi River (Fremling and Johnson, 1990). The presence of the *Hexagenia* larvae in samples throughout

Table 5. Summary statistics for organic wastewater compounds, organochlorine pesticides, polychlorinated biphenyls, and carbon measured in bottom sediments of Sturgeon Lake, Goodhue County, Minnesota, collected September 4, 2003.

[MRL, method reporting level; µg/kg, micrograms per kilogram; APE, alkylphenol; EDC, endocrine disruptor; DIS, disinfectant; FIRE, fire retardant; FRAG, fragrance; PAH, polyaromatic hydrocarbon; OC-PEST, organochlorine pesticide; OWC, organic wastewater compound; PAH, polyaromatic hydrocarbon; PCB, polychlorinated biphenyls; PEST, pesticide; PLAST, plastic component; SOLV, solvent; STEROL, plant or animal sterol; TEXTILES, product used in textile manufacturing; Compound names in bold are those with detections]

Compound	General use category	MRL (µg/kg)	Minimum (µg/kg)	Maximum (µg/kg)	Number of sites where detected	Frequency of detection (percent)
Organic wastewater compounds[1]						
1,4-dichlorobenzene	PEST	50			0	0
1-methylnapthalene	PAH	50	0.9	6.9	8	80
2,6-dimethylnapthalene	PAH	50	4.2	34	9	90
2-methylnapthalene	PAH	50	1.6	9.4	8	80
3,4-dichlorophenyl isocyanate	OTHER	50			0	0
3-beta-coprostanol	STEROL	100	40	210	8	80
4-cumylphenol	NID	50			0	0
4-n-octylphenol	NID	50			0	0
4-tert-octylphenol	NID	50			0	0
acetophenone	FRAG	50	11	11	1	10
anthracene	PAH	50	2.7	51	9	90
anthraquinone	TEXTILES	50	3.5	24	9	90
atrazine	PEST	50			0	0
benzo(a)pyrene	PAH/EDC	50	6.7	82	9	90
benzophenone	OTHER	50			0	0
beta-sitosterol	STEROL	100	320	1,700	9	90
bisphenol A	PLAST/EDC	100	1.4	7.6	4	40
bromacil	PEST	100			0	0
bromoform	DIS	50			0	0
camphor	FLAVOR	50			0	0
carbazole	PEST	50			0	0
chlorpyrifos	PEST	50			0	0
cholesterol	STEROL	100	300	1,500	9	90
cumene	SOLVENT	50			0	0
diazinon	PEST	50			0	0
diethyl phthalate	PLAST/EDC	50			0	0
diethylhexyl phthalate	PLAST/EDC	50	32	98	5	50
d-limonene	FRAG	50	2.8	2.8	1	10
ethanol,2-butoxy-,phosphate	PLAST/FIRE	100	20	20	1	10
fluoranthene	PAH	50	14	130	9	90
galaxolide (HHCB)	FRAG	50			0	0
indole	FRAG	50	3.6	210	9	90
isoborneol	FLAVOR	50			0	0
isophorone	SOLV	50			0	0
isoquinoline	FLAVOR	50			0	0
menthol	FLAVOR	50			0	0

Table 5. Summary statistics for organic wastewater compounds, organochlorine pesticides, polychlorinated biphenyls, and carbon measured in bottom sediments of Sturgeon Lake, Goodhue County, Minnesota, collected September 4, 2003—Continued

[MRL, method reporting level; µg/kg, micrograms per kilogram; APE, alkylphenol; EDC, endocrine disruptor; DIS, disinfectant; FIRE, fire retardant; FRAG, fragrance; PAH, polyaromatic hydrocarbon; OC-PEST, organochlorine pesticide; OWC, organic wastewater compound; PAH, polyaromatic hydrocarbon; PCB, polychlorinated biphenyls; PEST, pesticide; PLAST, plastic component; SOLV, solvent; STEROL, plant or animal sterol; TEXTILES, product used in textile manufacturing; Compound names in bold are those with detections]

Compound	General use category	MRL (µg/kg)	Minimum (µg/kg)	Maximum (µg/kg)	Number of sites where detected	Frequency of detection (percent)
	Organic wastewater compounds[1]—Continued					
metalaxyl	PEST	100			0	0
methyl salicylate	OTHER	100			0	0
metolachlor	PEST	50			0	0
N,N-diethyltoluamide (DEET)	PEST	100			0	0
naphthalene	PAH	50	3.2	17	9	90
nonylphenol monoethoxylate (NP1EO)	NID	500			0	0
nonylphenol diethoxylate (NP2EO)	NID	500			0	0
octylphenol monoethoxylate (OP1EO)	NID	100			0	0
octylphenol diethoxylate (OP2EO)	NID	100	2	2	1	10
para-cresol	PAH	50	15	160	9	90
para-nonylphenol (NP)	NID	500			0	0
pentachlorophenol	PEST	200			0	0
phenanthrene	PAH	50	6	85	9	90
phenol	DIS	50	19	190	9	90
prometon	PEST	50			0	0
pyrene	PAH	50	16	180	9	90
skatol	FRAG	50	14	80	9	90
stigmastanol	STEROL	50	100	620	9	90
tetrabromodiphenyl ether	FIRE	50			0	0
tetrachloroethylene	SOLV	50			0	0
tonalide (AHTN)	FRAG	50			0	0
tri(2-chloroethyl)phosphate	PLAST/FIRE	100			0	0
tri(dichlorisopropyl)phosphate	PLAST/FIRE	100			0	0
tributylphosphate	PLAST	50			0	0
triclosan	DIS	50	3.1	39	7	70
triphenyl phosphate	PLAST/FIRE	100			0	0
	Organochlorine pesticides and polychlorinated biphenyls [2]					
aldrin	OC-PEST	.2			0	0
lindane	OC-PEST	.2			0	0
chlordane, technical mix	OC-PEST	3			0	0
p,p’-DDD	OC-PEST	.5			0	0
p,p’-DDE	OC-PEST	.2	.3	.8	5	100
p,p’-DDT	OC-PEST	.5			0	0
dieldrin	OC-PEST	.2			0	0
alpha-endosulfan	OC-PEST	.2			0	0
endrin	OC-PEST	.2			0	0

Table 5. Summary statistics for organic wastewater compounds, organochlorine pesticides, polychlorinated biphenyls, and carbon measured in bottom sediments of Sturgeon Lake, Goodhue County, Minnesota, collected September 4, 2003—Continued

[MRL, method reporting level; µg/kg, micrograms per kilogram; APE, alkylphenol; EDC, endocrine disruptor; DIS, disinfectant; FIRE, fire retardant; FRAG, fragrance; PAH, polyaromatic hydrocarbon; OC-PEST, organochlorine pesticide; OWC, organic wastewater compound; PAH, polyaromatic hydrocarbon; PCB, polychlorinated biphenyls; PEST, pesticide; PLAST, plastic component; SOLV, solvent; STEROL, plant or animal sterol; TEXTILES, product used in textile manufacturing; Compound names in bold are those with detections]

Compound	General use category	MRL (µg/kg)	Minimum (µg/kg)	Maximum (µg/kg)	Number of sites where detected	Frequency of detection (percent)
Organochlorine pesticides and polychlorinated biphenyls [2]—Continued						
toxaphene	OC-PEST	50			0	0
heptachlor	OC-PEST	.2			0	0
heptachlor epoxide	OC-PEST	.2			0	0
p,p'-methoxychlor	OC-PEST	2.5			0	0
polychlorinated biphenyls	PCB	5	9.4	37.4	5	100
mirex	OC-PEST	.2			0	0
Carbon[2]						
inorganic carbon	CARBON	.2	5.8	8	5	100
organic carbon	CARBON	.2	6	12	5	100

[1]Samples collected from 10 sites (see table 1).
[2]Samples collected from 5 sites (see table 1).

much of Sturgeon Lake indicates that the bottom sediments are stable and that dissolved oxygen concentrations in the lake do not drop to acute or sub-lethal anoxic conditions for extended periods.

A greater number of taxa (49 invertebrates) were present in woody-debris and vegetation samples than in bottom-sediment samples (table 7). As with the bottom-sediment samples, most of the taxa were Diptera, in the family Chironomidae. The number of invertebrate taxa ranged from 10 to 22 per site. Mayflies (Ephemeroptera) and caddisfly larvae (Trichoptera) also were more prevalent in the woody-debris samples. Trichoptera in the families Hydropsychidae or Polycentropodidae were common in most of the samples. Invertebrates in both of these families spin capture nets that filter particles and other food from the water. Hydropsychidae were more common on woody debris obtained out in the main body of the lake (site 23), and the Polycentropodidae were more commonly obtained on woody debris near the shoreline margins (sites 20 and 22). The distribution of these taxa is logical as the Hydropsychidae capture nets are coarser and withstand more current, while the Polycentropodidae capture nets have a finer mesh and generally are used in areas of slower currents. No burrowing mayflies were collected from these samples because these organisms would not inhabit solid substrates such as woody debris (Merritt and Cummins, 1996).

As part of ongoing monitoring, the Wisconsin Department of Natural Resources (WDNR) (in cooperation with the U.S. Fish and Wildlife Service) collected benthic invertebrates at a number of locations on the Mississippi River, including Sturgeon Lake. WDNR collections were processed with a coarser sieve than what was used during this study and sorted without preservation in the field. Although there were differences between the WDNR sampling and sorting procedures than those used in this study, a comparison of the two data sets (data provided by John Sullivan, WDNR) reveal that the dominant invertebrate groups follow similar patterns between the two studies. The most abundant invertebrates in both studies were the mayflies (*Hexagenia sp.*) followed by the midges (Chironomidae). Average densities for the major groups are greater for this study than for the WDNR study; however, the coarser-mesh sieve used by the WDNR and the laboratory processing likely explain these differences.

SUMMARY

The U.S. Geological Survey (USGS), in cooperation with the Prairie Island Indian Community and the Minnesota Department of Natural Resources, conducted a study of Sturgeon Lake (a backwater lake in Navigation Pool 3 of the Mississippi River) during 2003-04 to determine the physical, chemical, and biological characteristics of the lake. Bathymetric data were collected and a map prepared, bottom sediment was characterized at 63 sites and a map prepared, selected contaminants were measured in bottom sediments at 10 sites, physical habitat was characterized at 30 sites, and invertebrates were collected from woody debris and bottom sediment at 16 sites during 2003-04.

Most of the lake is shallow (less than 3 meters) except for a few areas in the lake primarily near the inlets from, and outlet to, the Mississippi River. Bottom-sediment composition

Table 6. Invertebrate abundance in samples collected from bottom sediments in Sturgeon Lake, Goodhue County, Minnesota, September 9, 2003

[?, taxa identification uncertain due to immature or damaged organism; invertebrate density in square meters can be obtained by dividing the abundance values by 0.023].

	Site identifier (Shown on fig. 3)									
	3	**4**	**10**	**11**	**12**	**13**	**14**	**15**	**17**	**18**
					Insect taxa					
EPHEMEROPTERA										
Ephemeridae										
Hexagenia sp.	19	35		89	21		1	12	49	75
Caenidae										
?Caenis sp.							1			
TRICHOPTERA										
Leptoceridae										
Oecetis sp.		1					1			
HETEROPTERA										
Corixidae (immat)					1					
DIPTERA										
Ceratopogonidae										
?Probezzia sp.	3	5	2	6	4		2	6		
Chaoboridae										
Chaoborus punctipennis	1	4								5
Chironomidae				1	2	1	1	1	1	1
Tanypodinae										
Coelotanypus sp.	4	2	7	22	16			2	2	5
Ablabesmyia ?annulata	3	2	1	2	8					
Procladius sp.	2			2			1	2		
Chironominae										
Chironomus sp.	1	3	8	34	4			1	2	4
Cryptochironomus sp.	1	1	1	4			2			
Polypedilum sp.				1				1		
?Harnischia sp.				1				2		
?Cladotanytarsus								1		
Orthocladiinae										
Epoicocladius sp.				1						
Total number of insect taxa	8	8	5	11	7	1	7	9	4	5
					Non-insect taxa					
Oligochaeta	2							6		1
Hydrachnidia			1	1	1					
MOLLUSCA										
Sphaeriidae	1			9		1	5	1	6	
Gastropoda							2			
Amnicola sp.							2			
Total number of non-insect taxa	2	0	1	2	1	1	3	2	1	1

Table 7. Invertebrate abundance in samples collected from woody debris and aquatic vegetation in Sturgeon Lake, Goodhue County, Minnesota, September 9, 2003

[?, taxa identification uncertain due to immature or damaged organism; taxa with abundances greater than 500 were classified into one of three categories: pres, present; abun, abundant, and comm, common]

	Site identifier (Shown on fig. 3)					
	16	19	20	21	22	23
Habitat sampled	Aquatic vegetation	Woody debris	Woody debris	Woody debris	Woody debris	Woody debris
			Insect taxa			
EPHEMEROPTERA						
Heptageniidae						
Stenonema integrum		4				12
S. exiguum		1	1			1
S. ?femoratum		1				
Caenidae						
Caenis sp.	1	3	1		1	
Baetidae						
Labiobaetis sp.						5
Leptohyphidae						
Tricorythodes sp.		1				
TRICHOPTERA						
Polycentropodidae				1		3
Cyrnellus ?fraternus			10		72	
Neureclipsis sp.						1
Hydropsychidae						
Hydropsyche orris		2	1			116
H. bidens						5
Potamyia sp.		1				4
Hydroptilidae						
Hydroptila sp.	2	1	7		1	1
Leptoceridae						
Oecetis sp.			1			
Triaenodes sp.			1			
MEGALOPTERA						
Sialidae						
Sialis sp.			1			
COLEOPTERA						
Elmidae						
Stenelmis sp.						1
Macronychus sp.			1			
Hydrophilidae						
Tropisternus sp.	1					
HETEROPTERA						
Pleidae						

Table 7. Invertebrate abundance in samples collected from woody debris and aquatic vegetation in Sturgeon Lake, Goodhue County, Minnesota, September 9, 2003—Continued

[?, taxa identification uncertain due to immature or damaged organism; taxa with abundances greater than 500 were classified into one of three categories: pres, present; abun, abundant, and comm, common]

Habitat sampled	Site identifier (Shown on fig. 3)					
	16	19	20	21	22	23
	Aquatic vegetation	Woody debris	Woody debris	Woody debris	Woody debris	Woody debris
Insect taxa—Continued						
Neoplea sp.		1				
Corixidae	abun		15			
Trichocorixa sp.	12		4	5		
Palmacorixa sp.	2		6			
ODONATA						
Coenagrionidae	3	5		1		2
?Argia sp.			1		3	
DIPTERA						
Ceratopogonidae						
Atrichopogon sp.		1		9	1	
Tipulidae						
Limonia sp.			2	5	2	6
Empididae						
Hemerodromia sp.		1	2	4	2	1
Chironomidae						
Tanypodinae						
Thienemannimyia grp.						pres
Ablabesmyia sp.			pres			pres
Chironominae						
Glyptotendipes sp.	abun	abun	comm	abund	abun	comm
Chironomus sp.	pres			pres		
Polypedilum sp.	comm	abun				comm
Dicrotendipes sp.	pres					comm
?Phaenopsectra sp.					pres	pres
Parachironomus sp.	pres		pres			pres
P. ?freqens			pres			
Endochironomus sp.	comm					
Cryptochironomus sp.	pres					
Orthocladiinae						
Cricotopus sp.	comm	comm	comm	abund	pres	abun
Nanocladius sp.						pres
Total number of insect taxa	15	15	20	9	10	22

Table 7. Invertebrate abundance in samples collected from woody debris and aquatic vegetation in Sturgeon Lake, Goodhue County, Minnesota, September 9, 2003—Continued

[?, taxa identification uncertain due to immature or damaged organism; taxa with abundances greater than 500 were classified into one of three categories: pres, present; abun, abundant, and comm, common]

Habitat sampled	Site identifier (Shown on fig. 3)					
	16	19	20	21	22	23
	Aquatic vegetation	Woody debris	Woody debris	Woody debris	Woody debris	Woody debris
Non-insect taxa						
CRUSTACEA						
Gammarus ?fasciatus	1		9	18	71	
HYDRACHNIDIA	2	2	3			
MOLLUSCA						
Dreissena polymorpha			1		1	
Sphaeriidae			1			
GASTROPODA		8				
?Amnicola sp.			2			
Feressia sp.		1				
?Physella sp.	4					
Total number of non-insect taxa	3	3	5	1	2	0

is variable throughout the lake, likely depending upon hydrologic conditions.

The riparian area surrounding Sturgeon Lake consists primarily of deciduous tree and shrub cover and a minimal amount of commercial or residential land use with the exception of the marina and a few residential areas. Although generally characterized by sparse or moderate cover, woody debris and aquatic vegetation in the littoral area are the major types of physical habitat suitable for fish and invertebrate habitat cover. There is little physical habitat structure in the open water areas of the lake, but the bottom substrate in these areas of the lake (sand and silt) is appropriate for invertebrate taxa such as midges and burrowing mayflies that serve as food sources for fish.

Contaminants measured within Sturgeon Lake bottom sediments include a variety of compounds from diverse sources including incoming Mississippi River water, atmospheric deposition, surface runoff in the Sturgeon Lake watershed, or point sources into the lake. There were 24 organic wastewater compounds (OWCs) detected in the bottom sediments of Sturgeon Lake (17 to 22 detected per site). Polyaromatic hydrocarbons (PAHs) were the most prevalent category of chemicals detected. Other categories of chemicals detected include sterols, disinfectants, plastic components, alkylphenols, and fragrances. The presence of the sterol 3-beta-coprostanol (a fecal sterol) and triclosan (a disinfectant) indicates a wastewater source that may originate from local or upstream areas. Three OWCs (bisphenol A, benzo[a]pyrene, and triclosan) are considered endocrine disrupting compounds. One organochlorine pesticide metabolite (p,p'DDE) and total polychlorinated biphenyls (PCBs) were detected in a subset of 5 of the 10 bottom-sediment sites that were sampled. The presence of compounds such as p,p'DDE and PCBs that are not currently in use emphasize the ubiquitous nature and slow degradation of these compounds once they are deposited in backwater areas such as Sturgeon Lake.

Twenty-one invertebrate taxa were identified from bottom-sediment samples collected from Sturgeon Lake. A greater number of taxa (49 taxa) were present in woody-debris/vegetation samples than in bottom-sediment samples. Most of the taxa in both sample types were Diptera in the family Chironomidae. Chironomidae are commonly present in bottom sediments and other habitats as they are tolerant of a wide variety of conditions. The most common invertebrate in the bottom sediments in terms of density was the burrowing mayfly (*Hexagenia sp.*). The presence of the *Hexagenia* larvae in samples throughout much of the lake indicates that the bottom sediments are stable and that dissolved oxygen concentrations in the lake do not drop to anoxic conditions for extended periods.

This report provides baseline information of physical, chemical, and biological characteristics for Sturgeon Lake, which is a backwater lake on the Mississippi River. This information will provide managers with information to manage the lake and a baseline with which to compare future investigations. Routine monitoring of aquatic invertebrate, fish, and aquatic plant characteristics in conjunction with water and sediment chemistry monitoring at established sites throughout the lake would provide insight into the relation among physical, chemical, and biological characteristics within the lake.

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