Impairments

Silver Lake was listed on the Iowa Section 303(d) Impaired Waters List as being impaired by algae and turbidity. The Silver Lake Total Maximum Daily Load (TMDL) is scheduled to be completed in 2008. The purpose of the TMDL is to calculate the maximum allowable nutrient loading (phosphorus) for the lake associated with algae and turbidity levels that will meet water quality standards. Data collected by CLAMP has been used in creating other TMDLs and also plays an important role in determining if the goals of TMDLs are being met. More information on TMDLs can be found at http://www.iowadnr.com/water/watershed/tmdl/index.html.

Other Monitoring

Iowa DNR - Ambient Lake Monitoring Program. Along with the volunteer monitoring that occurs through the CLAMP program, the lakes are routinely monitored throughout the summer by the Iowa State University Limnology Laboratory (2000-2006) and the University of Iowa Hygienic Laboratory (2005-2006). Through this program, the lakes are monitored for a number of parameters including nutrients, solids, common field parameters, phytoplankton, zooplankton, and microcystin. Results can be found at http://limnology.eeob.iastate.edu/lakereport/ and http://wqm.igsb.uiowa.edu/iastoret/.

Iowa DNR – Beach Sampling Program. Six state-owned beaches (Emerson Bay, Gull Point, Triboji, Pikes Point, Marble, and Sandy) and one county beach (Orleans) are monitored weekly during the outdoor recreation season for bacteria and microcystin. Results of beach monitoring can be found on the DNR website http://wqm.igsb.uiowa.edu/activities/beach/beach.htm.

References

Carlson, Robert E. (1977) A Trophic State Index for Lakes. Limnology and Oceanography, Vol. 22, No. 2 (Mar., 1977), p. 361-369.

Acknowledgements

CLAMP is coordinated by the Iowa Lakeside Laboratory and supported by Friends of Lakeside Lab, the Okoboji Protective Association, the Spirit Lake Protective Association, the Dickinson County Water Quality Commission, and the East Okoboji Improvement Corporation. Data used in this factsheet were provided by Iowa Lakeside Laboratory, Iowa State University Limnology Laboratory, and the University of Iowa Hygienic Laboratory.

The CLAMP program would not be possible without the hard work of volunteers. Volunteers on Silver Lake include: Don Goodell, Leon Goodell, Bob Herbert, Bob Worrick, and Wesley and Vivianne Lynn. Thanks also to CLAMP interns: Tasida Barfoot, Ted Klein, Emily Greives, and Laura Guderyahn.

Photo on page 1 from Iowa State University Limnology Laboratory.

Iowa Watershed Monitoring and Assessment Program Web Site – wqm.igsb.uiowa.edu

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IOWA'S WATER
Ambient Monitoring Program

Cooperative Lakes Area Monitoring Project
Silver Lake

Silver Lake in Dickinson County.

The Cooperative Lakes Area Monitoring Project (CLAMP) began in 1999 as a joint partnership between Iowa Lakeside Laboratory and Friends of Lakeside Laboratory to take advantage of a rich tradition of volunteer involvement in the Iowa Great Lakes region. CLAMP combines efforts of multiple organizations into a long-term, unified program for assessing the quality of the lakes in the region. A group of volunteers was organized and trained to monitor water quality on 10 lakes in northwest Iowa. CLAMP focuses on monitoring nutrient levels (nitrogen and phosphorus) as well as chlorophyll *a* (an index of algal abundance) and Secchi depth (an index of water clarity). By monitoring these parameters, CLAMP volunteers provide an integrated measure of each lake's water quality. To address concerns of excessive algae growth, phytoplankton and microcystin were recently added to the program. Phytoplankton are microscopic plants, mainly algae, that live in water. Microcystin is a toxin produced by cyanobacteria, a type of algae.

Since its inception in 1999, over 100 volunteers have participated in CLAMP. These volunteers have taken over 3500 samples on 10 lakes in Dickinson County: Big Spirit, Center, East Okoboji, Little Spirit, Lower Gar, Minnewashta, Silver, Trumbull, Upper Gar, and West Okoboji. By volunteering their time, CLAMP participants are providing a long-term data set that will be useful in protecting these prized resources while learning more about water quality issues and the ecology of the lakes.

CLAMP Data

Secchi depth in Silver Lake ranged from 0.1 meters (m) to 1.7 m, with the deepest Secchi depths occurring in the spring, when algal productivity is lowest, and the shallowest in late summer, when algal productivity is greatest. Overall, Secchi depths in Silver Lake were shallower than most other CLAMP

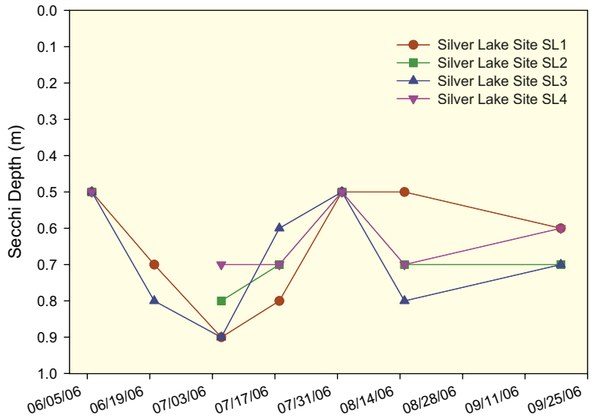
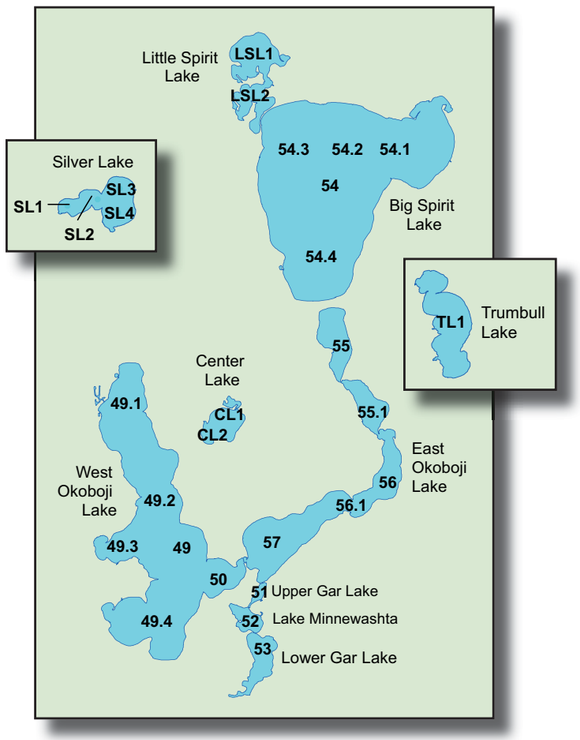


Figure 1. *Seasonal and site variation of Secchi depth in 2006 for Silver Lake.*



CLAMP *sampling locations*. NOTE: *data used for this fact sheet were from the deepest spot in each lake (for comparison).*

lakes and similar to the median for other glacial lakes in Iowa (Insert 1).

Total phosphorus concentrations ranged from 0.03 milligrams per liter (mg/L) to 0.8 mg/L. The median total phosphorus concentration for Silver Lake was higher than all other CLAMP lakes with the exception of Trumbull and Little Spirit and higher than the median for other glacial lakes in Iowa (Insert 1). Total nitrogen concentrations in Silver Lake were also higher than most other CLAMP lakes and the median for other glacial lakes in Iowa (Insert 1).

Chlorophyll *a* concentrations ranged from 3 micrograms per liter (μg/L) to 753 μg/L (not shown). The median chlorophyll *a* concentration for Silver Lake was similar to Upper Gar, Minnewashta, and Lower Gar as well as the median for other glacial lakes in Iowa (Insert 1).

Microcystin concentrations in Silver Lake ranged from 0.6 nanograms per liter (ng/L) to 9.3 ng/L. Silver Lake's maximum concentration of 9.3 ng/L is below the 20 ng/L threshold used by the Iowa DNR to post warnings at swimming beaches. Overall, microcystin concentrations were similar to other CLAMP lakes and slightly lower than the median for other glacial lakes in Iowa.

Figure 1 shows the seasonal and site variation of Secchi depth for Silver Lake in 2006. Secchi depths were deepest in early July and shallowest in late July and August. Site 1 had the shallowest Secchi depths with the exception of 7/18/2006 when Site 1 had the deepest Secchi depth. Site 2 generally had the deepest Secchi depth with the exception of 7/18/2006 when it had the shallowest Secchi depth.

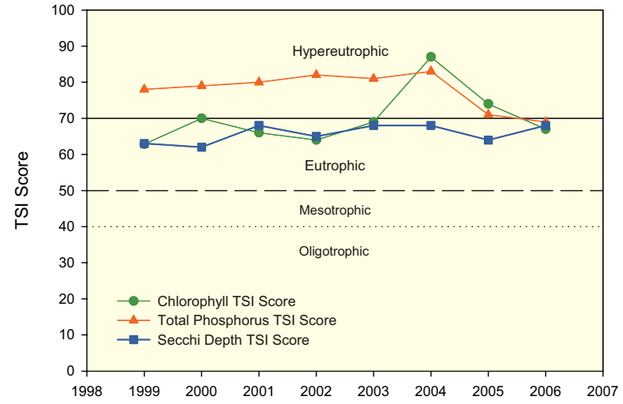


Figure 2. *Average Carlson Trophic State Index (TSI) scores by year for Silver Lake.*

Carlson's Trophic State Index

The large amount of water quality data collected by CLAMP can be confusing and difficult to evaluate. In order to analyze all of the data collected it is helpful to use a trophic state index (TSI). A TSI condenses large amounts of water quality data into a single, numerical index. Different values of the index are assigned to different concentrations or values of water quality parameters.

The most widely used and accepted TSI, called the Carlson TSI, was developed by Bob Carlson (1977). Carlson TSI values range from 0 to 100. Each increase of 10 TSI points (10, 20, 30, etc.) represents a doubling in algal biomass. The Carlson TSI is divided into four main lake productivity categories: *oligotrophic* (least productive), *mesotrophic* (moderately productive), *eutrophic* (very productive), and *hypereutrophic* (extremely productive). The productivity of a lake can therefore be assessed with ease using the TSI score for one or more parameters. Mesotrophic lakes, for example, generally have a good balance between water quality and algae/fish production. Eutrophic lakes have less desirable water quality and an overabundance of algae or fish. Hypereutrophic lakes have poor water quality and experience frequent algal blooms and a lack of oxygen in deep water.

Insert 2 shows the TSI scores for Secchi depth, chlorophyll *a*, and total phosphorus for all CLAMP lakes. The median TSI scores for Silver Lake based on Secchi depth and chlorophyll *a* are in the *eutrophic* category, while the score based on total phosphorus is in the *hypereutrophic* category. This indicates that phosphorus is not limiting algae growth. Possible other factors that could limit algae include: light limitation due to excessive algal or non-algal turbidity, nitrogen limitation, zooplankton grazing or toxin production.

Figure 2 shows the mean or average TSI scores for Silver Lake by year. Total phosphorus scores remained steady from 1999-2004 before dropping in 2005. Secchi depth scores have remained similar and in the *eutrophic* range throughout the CLAMP program. Chlorophyll *a* scores were most variable increasing in 2004 before decreasing in 2005 and 2006. Possible explanations for this variation include: yearly climatic variability and changes in the watershed.