

# Minnesota Lake Water Quality 2017–2024 Metadata

## Abstract

Recent advancements in satellite technology have significantly improved spatial, spectral, radiometric, and temporal resolution. Coupled with enhancements in satellite image collection processing, atmospheric correction, cloud detection, machine learning, and supercomputing, these innovations have transformed regional-scale water quality monitoring.

Researchers from the University of Minnesota's Department of Forest Resources and the Minnesota Supercomputing Institute have developed an automated image processing system (Olmanson & Porter, 2023) and established a comprehensive water quality database for over 10,500 lakes across Minnesota, covering the period from 2017 to 2024. This database comprises more than 1.55 million measurements of key water quality variables, including chlorophyll, clarity, and colored dissolved organic matter (CDOM), resulting in a total of over 4.65 million records.

The data is accessible through the Minnesota LakeBrowser (<https://lakes.rs.umn.edu/>), an online map viewer linked to a spatial database created by research staff at U-Spatial. This platform enables users to perform temporal analysis, generate statistical summaries, and create dynamic visualizations of lake water quality.

This research was supported by the University of Minnesota, the Minnesota Environment and Natural Resources Trust Fund (ENRTF), the Michigan Department of Environment, Great Lakes, and Energy (EGLE), and the U.S. Environmental Protection Agency (EPA). The Minnesota LakeBrowser was updated with funds from the Minnesota Department of Natural Resources.

This GIS dataset comprises water quality measurements derived from Sentinel-2 imagery, focusing on Minnesota lakes with a surface area of eight hectares or larger. It contains monthly and late summer (July 20 to September 20) averages of lake clarity, chlorophyll, and CDOM for over 10,500 lakes from 2017 to 2024, during the open water season (May through October). Additional background information and documentation for the Water quality data can be accessed at <https://water.rs.umn.edu/>.

The correlation between satellite data and field measurements was strong, with an  $R^2$  of 0.83 for training (75%) and validation (25%) data sets, covering clarity and chlorophyll, with sample sizes of  $N = 58,499$  and  $N = 17,512$ , respectively and  $R^2$  of 0.71 for training (75%) and validation (25%) data sets for CDOM, with sample sizes of  $N = 1,537$ .

## Purpose

The dataset was created to provide federal, state, and local agencies, as well as the public, access to comprehensive surface water monitoring data for over 10,500 Minnesota lakes.

## Attribute Field Detail

- MN\_LK\_NUM: unmlknum with MN before the lake ID to indicate Minnesota
- unmlknum: Updated 2010 UMN lake number and the only unique ID for all 12,193 polygons
- umnlknum\_o: The original UMN lake number from polygon layer created in 2000
- dowlknum\_1: umnlknum centerpoint linked to the dow lake number from December 2010 DNR lake polygons - this is the number to link to other DNR data - Note there may be multiple polygons with the same dowlknum since the umnlknum polygons are at a finer scale for some lakes
- RNAME\_1: Name of the water body associated with the lake polygon.
- PWI\_CLASS: Public Waters Inventory (PWI) class as defined by Bulletin No. 25 - An Inventory of Minnesota Lakes  
[http://www.dnr.state.mn.us/waters/watermgmt\\_section/pwi/bulletin25.html](http://www.dnr.state.mn.us/waters/watermgmt_section/pwi/bulletin25.html)
- AREA\_BASIN: Lake area in acres from Bulletin No. 25 - An Inventory of Minnesota Lakes
- WETTYPE: Public waters wetlands type 3, type 4, and type 5 wetlands (as defined in U.S. Fish and Wildlife Service Circular No. 39, 1971 edition)
- X\_UTM: Map coordinate from Bulletin No. 25 - An Inventory of Minnesota Lakes
- Y\_UTM: Map coordinate from Bulletin No. 25 - An Inventory of Minnesota Lakes
- PolyAcres: Polygon area in acres calculated from the lake polygon.
- SD\_201705: e.g., Mean water clarity in meters for year 2017 and month 5 (May).
- SD\_20170601\_0930: e.g., Mean summer water clarity in meters for the year 2017 and the summer period (June 1 through September 30)
- SD\_20170720\_0920: e.g., Mean late summer water clarity in meters for the year 2017 and the late summer period (July 20 through September 20)
- SD\_20170726\_0824: e.g., Mean water clarity in meters for the period of maximum oxythermal stress for fish (July 26 through August 24) for the year 2017
- CL\_201705: e.g. Mean chlorophyll a ( $\mu\text{g/L}$ ) for the year 2017 and month 5 (May).
- CL\_20170601\_0930: e.g., Mean summer chlorophyll a ( $\mu\text{g/L}$ ) for the year 2017 and the summer period (June 1 through September 30)
- CL\_20170720\_0920: e.g., Mean late summer chlorophyll a ( $\mu\text{g/L}$ ) for the year 2017 and the late summer period (July 20 through September 20)

- CL\_20170726\_0824: e.g., Mean chlorophyll a ( $\mu\text{g/L}$ ) for the period of maximum oxythermal stress for fish (July 26 through August 24) for the year 2017
- a440\_201705: e.g., Mean water clarity as measured at  $440\text{nm}$  ( $a_{440}\text{m}^{-1}$ ) for year 2017 and month 5 (May).
- a440\_20170601\_0930: e.g., Mean summer water clarity as measured at  $440\text{nm}$  ( $a_{440}\text{m}^{-1}$ ) for the year 2017 and the summer period (June 1 through September 30)
- a440\_20170720\_0920: e.g., Mean late summer water clarity as measured at  $440\text{nm}$  ( $a_{440}\text{m}^{-1}$ ) for the year 2017 and the late summer period (July 20 through September 20)
- a440\_20170726\_0824: e.g., Mean water clarity as measured at  $440\text{nm}$  ( $a_{440}\text{m}^{-1}$ ) for the period of maximum oxythermal stress for fish (July 26 through August 24) for the year 2017

## Citations

Olmanson, L., Porter, D. (2023). Advanced water quality monitoring of optically variable lake systems using Landsat 8 OLI and Sentinel 2 MSI imagery in an automated high-performance computing environment. Retrieved from the University Digital <https://conservancy.umn.edu/items/7a7e3fd5-d02e-4dbe-9455-662447854332>.

## Distribution Disclaimer

Researchers at the University of Minnesota have aspired to produce accurate maps and data of lake water quality. However, it makes no representations or warranties, either expressed or implied, regarding the accuracy, currency, suitability, or reliability of the data for any particular purpose. Although every effort has been made to ensure the accuracy of information, errors and conditions originating from the source data and processing may be present in the data supplied. Users are reminded that all geospatial maps and data are subject to errors in positional and thematic accuracy.

The user accepts the data as is and assumes all risks associated with its use. The data are the intellectual property of the University of Minnesota. They may be used for educational and non-commercial purposes, provided proper attribution is given. Secondary distribution of the data is permitted but not supported by the University of Minnesota. By accepting the data, the user agrees not to transmit, provide access to, or disclose any part of this data to another party unless the user includes with the data a copy of this disclaimer. The University of Minnesota disclaims any responsibility for actual or consequential damages incurred by any user as a result of relying on the data.

## Contact Information

**Contact Person:** Leif Olmanson

**Contact Organization:** University of Minnesota, Department of Forest Resources

**Contact Address:** 1530 Cleveland Avenue North, St. Paul, MN 55108-6112

**Contact Electronic Mail Address:** [olman002@umn.edu](mailto:olman002@umn.edu)

**Website:** <http://water.rs.umn.edu/>

**LakeBrowser:** <http://lakes.rs.umn.edu/>