

In cooperation with the U.S. Geological Survey and the Michigan Lake and Stream Associations, Inc.

Cooperative Lakes Monitoring Program Newsletter 2018

CLMP Measurements Support Satellite Remote Sensing Project

Thank you for your participation in the voluntary Cooperative Lakes Monitoring Program (CLMP) supported by the Michigan Department of Environmental Quality (MDEQ) and the Michigan Lake and Stream Associations, Inc. The CLMP is a core program of the Michigan Clean Water Corps (MiCorps), Michigan's volunteer water-quality monitoring network (www.micorps.net). This newsletter will introduce the remote sensing program to new volunteers and update the preferred sampling dates for 2018 on the reverse side of this newsletter.

The CLMP volunteers now sample approximately 250 inland lakes each year. However, there are more than 11,000 inland lakes in Michigan. In 2000, a remote sensing project was developed between the MDEQ and the U.S. Geological Survey that uses the volunteer Secchi disk transparency measurements, and relates them to Landsat satellite remote sensing imagery. A regression model was developed to predict water clarity, specifically for unsampled Michigan inland lakes. In figure 1, you will find a map of the Landsat satellite scenes for Michigan.

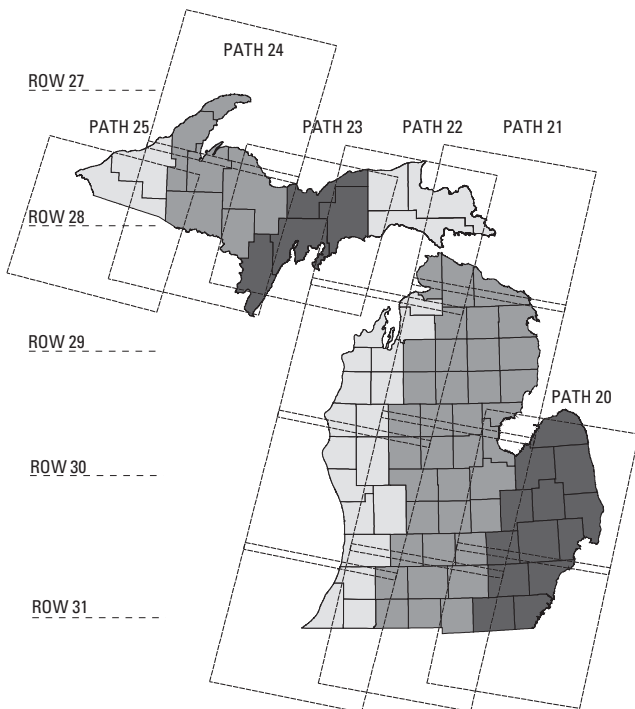


Figure 1. Landsat satellite scenes covering Michigan.

There are 8 satellite scenes that cover the majority of the Lower Peninsula of Michigan, and 6 that cover the Upper Peninsula of Michigan (the satellite scenes overlap one another). Landsat satellite scenes are located by a Path number and a Row number. Path numbers for Michigan range from Path 20 (over)

New Scientific Investigations Report 2016-5023:

Estimation of a Trophic State Index for Selected Inland Lakes in Michigan, 1999–2013 By: Lori M. Fuller and Richard S. Jodoin

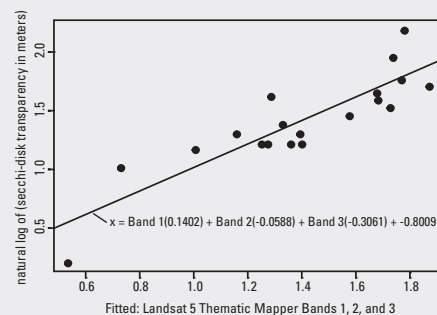
Prepared in cooperation with the Michigan Department of Environmental Quality

"A 15-year estimated Trophic State Index (eTSI) for Michigan inland lakes is available, and it spans seven datasets...from 1999 to 2013."

<https://pubs.er.usgs.gov/publication/sir20165023>

How the Remote Sensing Project works:

- 1) Approximately 20-25 Secchi disk measurements are needed for each satellite scene.
- 2) Those measurements are then related to the satellite scene to determine a regression equation specific to that scene. Each year the model is recalibrated with that year's measurements and Landsat satellite imagery. The regression equation can then be used to predict water clarity for unsampled inland lakes for Michigan.



A graph of the relationship between Secchi disk measurements and a 2002 Landsat 5 TM satellite scene Path 21 Row 29 (northern Lower Michigan).

How the Satellite Scenes are chosen:

- A model is produced for each satellite scene when the lakes are at their maximum biological productivity from July to September. This time period is shown to produce the best predictive models.
- Landsat satellite scenes are chosen between July and September based on the amount of cloud cover. If the cloud cover is greater than 10 percent, then the image is not chosen.
- For each satellite scene in Michigan, only 1 date is chosen between July - September to be representative of late summer sampling for that year.

How the Secchi disk measurements are chosen:

- For a good predictive model the measurements should be within at +/- 7 days of when the Landsat satellite scenes were taken, and preferably within +/- 3 days.
- Measurements should be in the deepest basin of the inland lake, and are preferable for this project when accurate latitude and longitude values are included, or the location of the measurement is marked on the volunteer map.
- Measurements for this project are used to produce the regression equation when they are no more than 2/3rds the total depth at the measurement site.

on the east side of the State, to Path 25 on the west side of the State. Row numbers for Michigan range from Row 27 in the north to Row 31 in the south.

With your help, we could improve the remote sensing model by asking volunteers to take Secchi disk measurements on the day the satellite is passing overhead or within plus or minus (+/-) 3 days. Landsat has a schedule for when the satellite will be passing over your area, and using the two tables below, you can find the preferable dates to sample.

Table 1 below will help you determine which Path (20-25) includes your inland lake(s). Once you know your Path, table 2 below lists (by Path) the month and day in 2018 when the satellite will pass over and take an image of your lake. Notice that the satellite passes over and records images within each Path every 16 days. For example, if I sample Higgins Lake in Roscommon County, my Path number is 21, and the days the satellite is overhead for May, 2018 would be the 15th and 31st. I can then plan to take my weekly Secchi disk transparency measurement within +/- 3 days of those dates (May 12-May 18, and May 28-June 3). For the other weeks in the month when there is no satellite passing, plan for your transparency measurements to be consistent with normal CLMP procedures.

We understand that there are many circumstances that might not allow you to take your measurements on these dates. If you are unable to take measurements corresponding to the Landsat satellite, then take them when you are able because they are still valuable measurements and are important to the CLMP. Thank you for your time and participation in this program. Your work is very valuable to our efforts to monitor and predict water clarity for Michigan's inland lakes. (Note: At this time we are focused on relating Secchi disk transparency measurements from the deepest basin for inland lakes to satellite imagery overpass dates. For chlorophyll *a*, continue to sample on your current schedule).

For more information on the remote sensing portion of the project, refer to the project website at:

<http://mi.water.usgs.gov/projects/RemoteSensing/index.html>

A report describing the process is available at:

<https://pubs.er.usgs.gov/publication/sir20165023>

Additional information on the MDEQ and USGS inland lake water-quality sampling program can be found at:

<http://pubs.usgs.gov/fs/2004/3048/>

For further questions specific to the remote sensing program contact:

Lori Fuller at (517) 887-8911 or lmfuller@usgs.gov

Table 1. Michigan counties listed by Landsat satellite Path.

Path 20	Path 21			Path 22		Path 23	Path 24	Path 25
Genesee	Alcona	Gladwin	Montcalm	Allegan	Manistee	Alger	Baraga	Gogebic
Huron	Alpena	Gratiot	Montmorency	Antrim	Mason	Delta	Dickinson	Ontonagon
Lapeer	Arenac	Hillsdale	Ogemaw	Benzie	Muskegon	Menominee	Houghton	
Lenawee	Barry	Ingham	Osceola	Berrien	Newaygo	Schoolcraft	Iron	
Livingston	Bay	Ionia	Oscoda	Cass	Oceana		Keweenaw	
Macomb	Branch	Iosco	Otsego	Charlevoix	Ottawa		Marquette	
Monroe	Calhoun	Isabella	Presque Isle	Chippewa	Van Buren			
Oakland	Cheboygan	Jackson	Roscommon	Grand Traverse	Wexford			
Sanilac	Clare	Kalamazoo	Saginaw	Kent				
St. Clair	Clinton	Kalkaska	Shiawassee	Lake				
Tuscola	Crawford	Mecosta	St. Joseph	Leelanau				
Washtenaw	Eaton	Midland		Luce				
Wayne	Emmet	Missaukee		Mackinac				

Table 2. Dates by month when the Landsat 8 satellite will be passing over Michigan Paths in 2018.

Month	Path 20	Path 21	Path 22	Path 23	Path 24	Path 25
April	6, 22	13, 29	4, 20	11, 27	2, 18	9, 25
May	8, 24	15, 31	6, 22	13, 29	4, 20	11, 27
June	9, 25	16	7, 23	14, 30	5, 21	12, 28
July	11, 27	2, 18	9, 25	16	7, 23	14, 30
August	12, 28	3, 19	10, 26	1, 17	8, 24	15, 31
September	13, 29	4, 20	11, 27	2, 18	9, 25	16
October	15, 31	6, 22	13, 29	4, 20	11, 27	2, 18