

Remote Sensing for Great Lakes Mapping and Monitoring

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15th Annual Great Lakes Beach Association Joint Conference
Acme, MI*

October 29, 2015



Remote Sensing for Great Lakes Mapping and Monitoring

- **Remote sensing:** *the collection of data about an object, area, or phenomenon from a distance with a device that is not in contact with the object.*
- Includes both passive imagery and active radar/lidar
- Spaceborne, airborne, underwater and ground-based platforms
 - Satellite remote sensing provides Earth observations at repetitive intervals with the same geometry, allowing large-scale feature mapping and monitoring of changes over time
 - Manned/unmanned aircraft platforms can be more flexible, data is higher-resolution but less standardized
 - Ground-based and underwater platforms can get to areas not visible from above (deep water, under forest canopies)



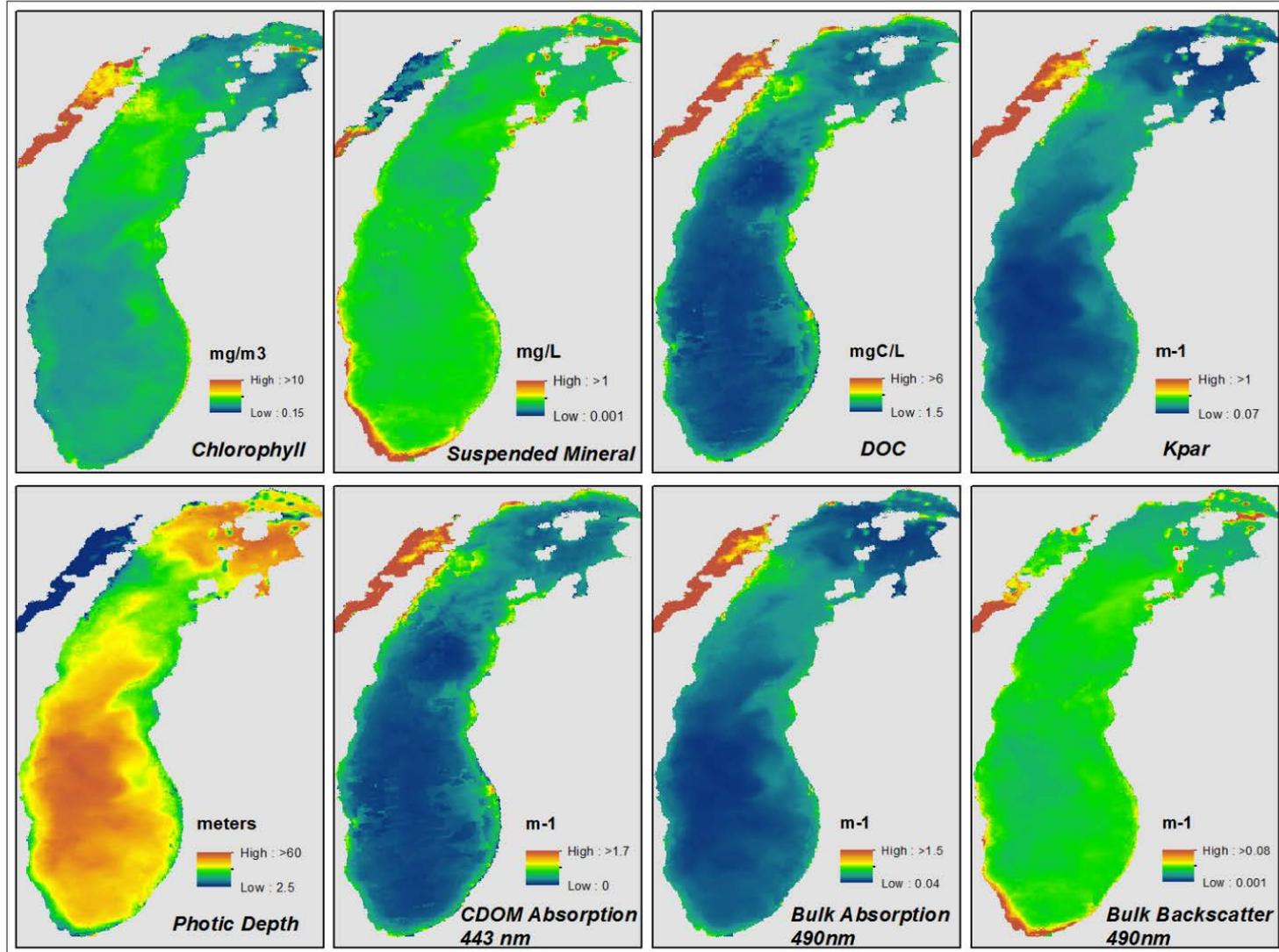
Remote Sensing for Great Lakes Mapping and Monitoring

Outline

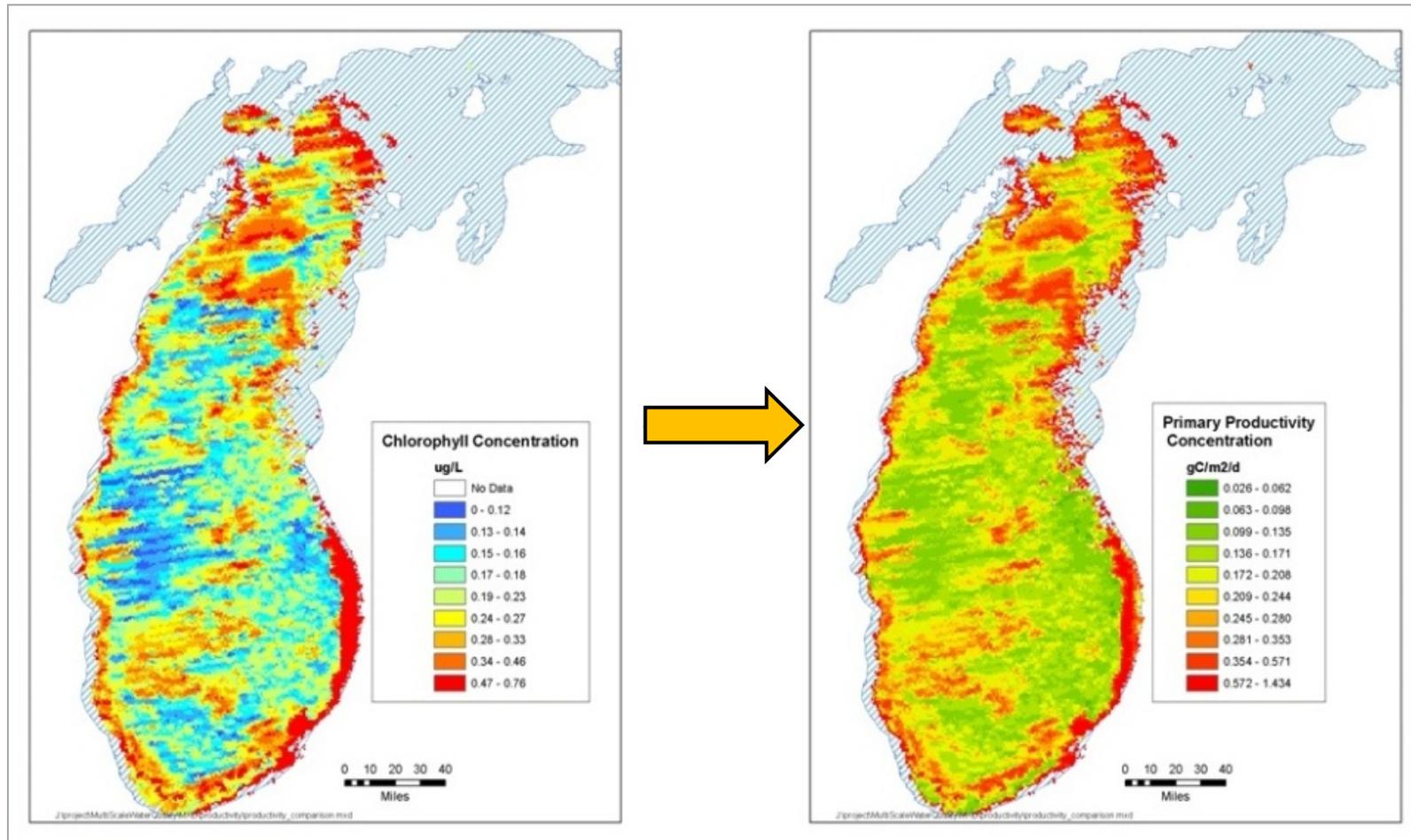
- Two major categories of Great Lakes remote sensing projects:
 - **Open water sensing** (water quality, harmful algae blooms, water temperature, ice cover)
 - **Coastal monitoring** (wetland classification, mapping invasive species and nuisance algae, monitoring rip currents and coastal erosion)
- Data are only useful if they're accessible; **data sharing and web portals** are an important part of the equation

Open Water Sensing for the Great Lakes: Water Quality Constituents

July 2013 Monthly Average Products for Lake Michigan

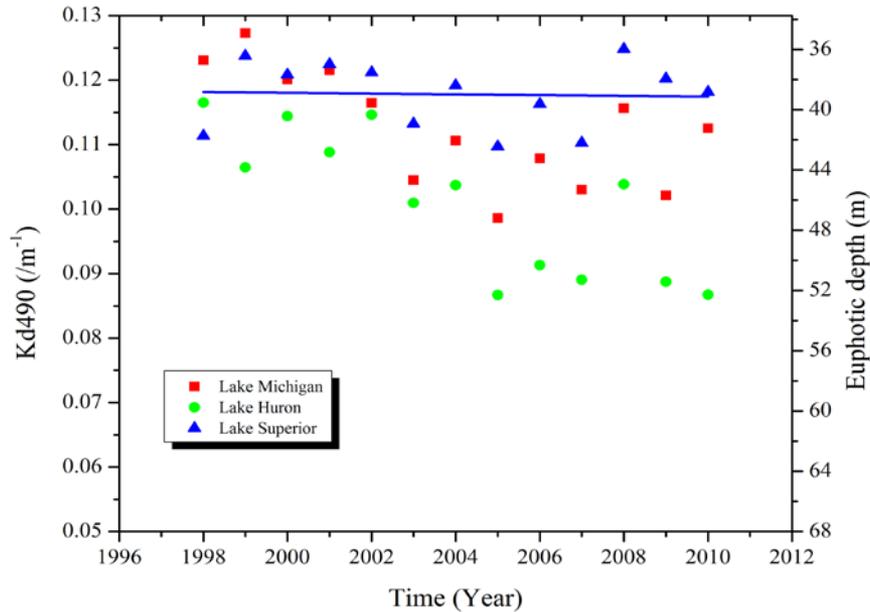


Open Water Sensing for the Great Lakes: Primary Production Estimates



Lake Michigan chlorophyll concentration and primary productivity estimates for March 20, 2008. Warmer colors (red, yellow) indicate higher values. Hatched areas indicate no retrieval due to clouds or lake bottom reflectance.

Open Water Sensing for the Great Lakes: Tracking the Post-Mussel Change in Water Clarity



> 900 Trillion
Dreissenid
Mussels in Lake
Michigan

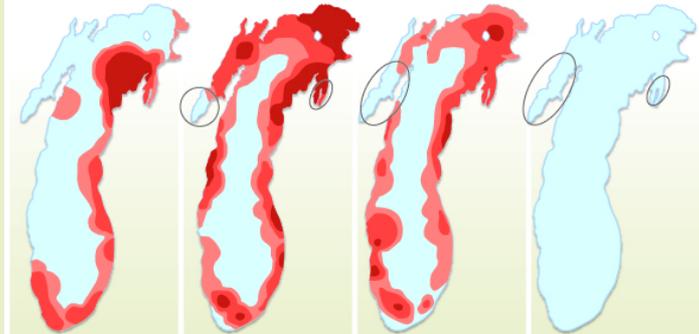
Changing mussel density in Lake Michigan

DENSITY PER SQUARE METER: ■ 10-100 ■ 100-1,000 ■ 1,000-10,000 ■ 10,000-100,000

○ AREA NOT SAMPLED

Zebras

The first of two species of invasive mussels to be discovered in the lake, zebra mussels have done what biologists thought was impossible: They've all but disappeared from Lake Michigan.



1994-'95

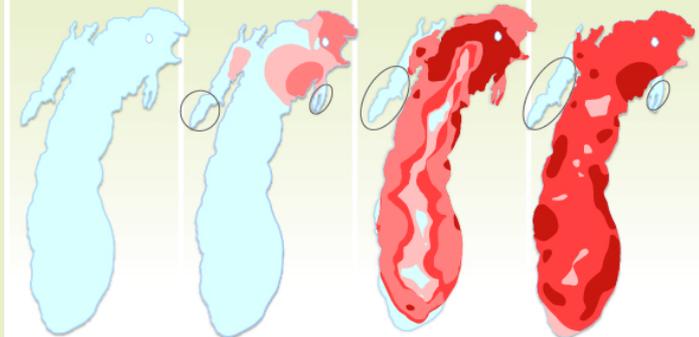
2000

2005

2010

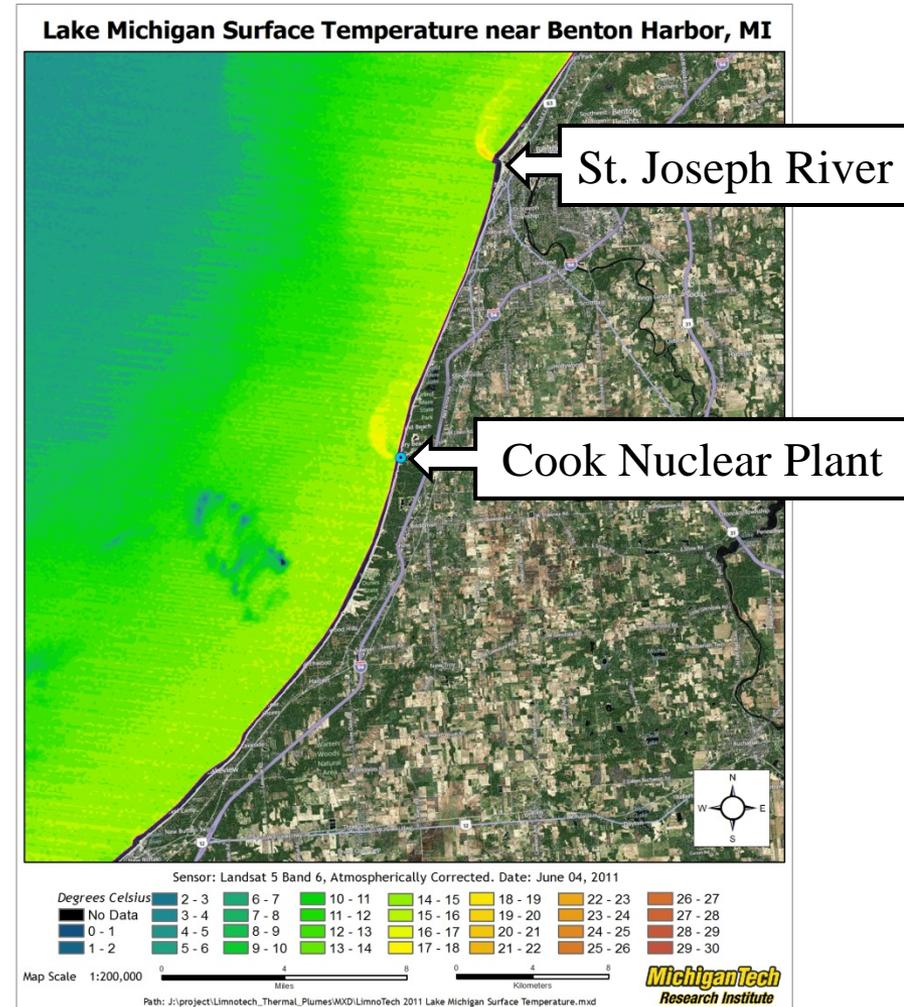
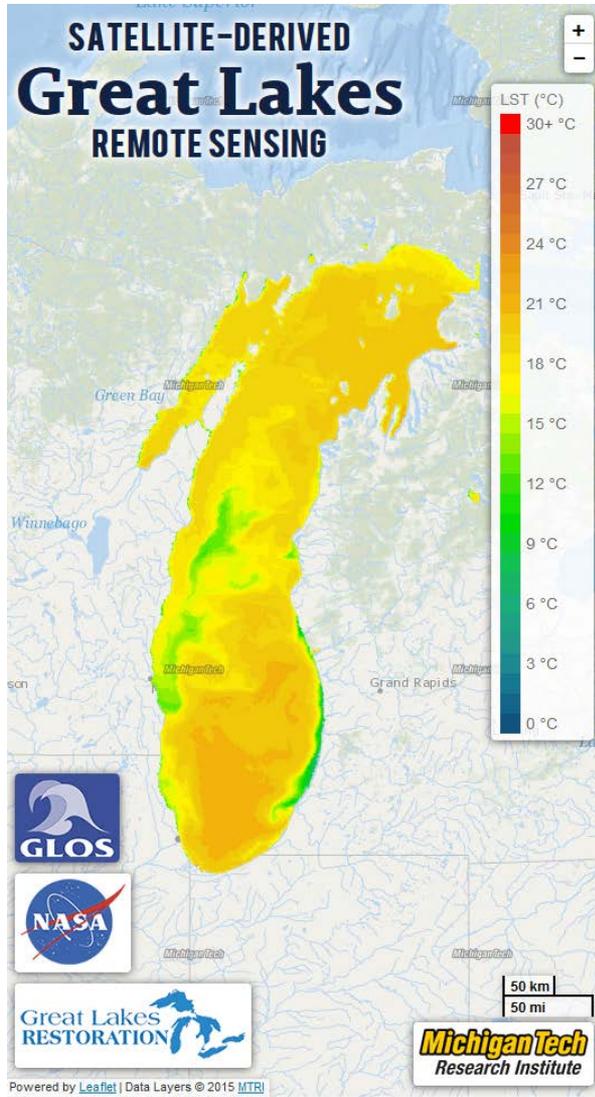
Quaggas

A close relative to zebra mussels, quagga mussels brought a second wave of ecological chaos to the lake by stripping out much of the plankton upon which native species depend.



Tom Nalepa, NOAA GLERL

Open Water Sensing for the Great Lakes: Water Temperature



Open Water Sensing for the Great Lakes: Ice Cover Mapping

GREAT LAKES SURFACE ENVIRONMENTAL ANALYSIS (GLSEA)

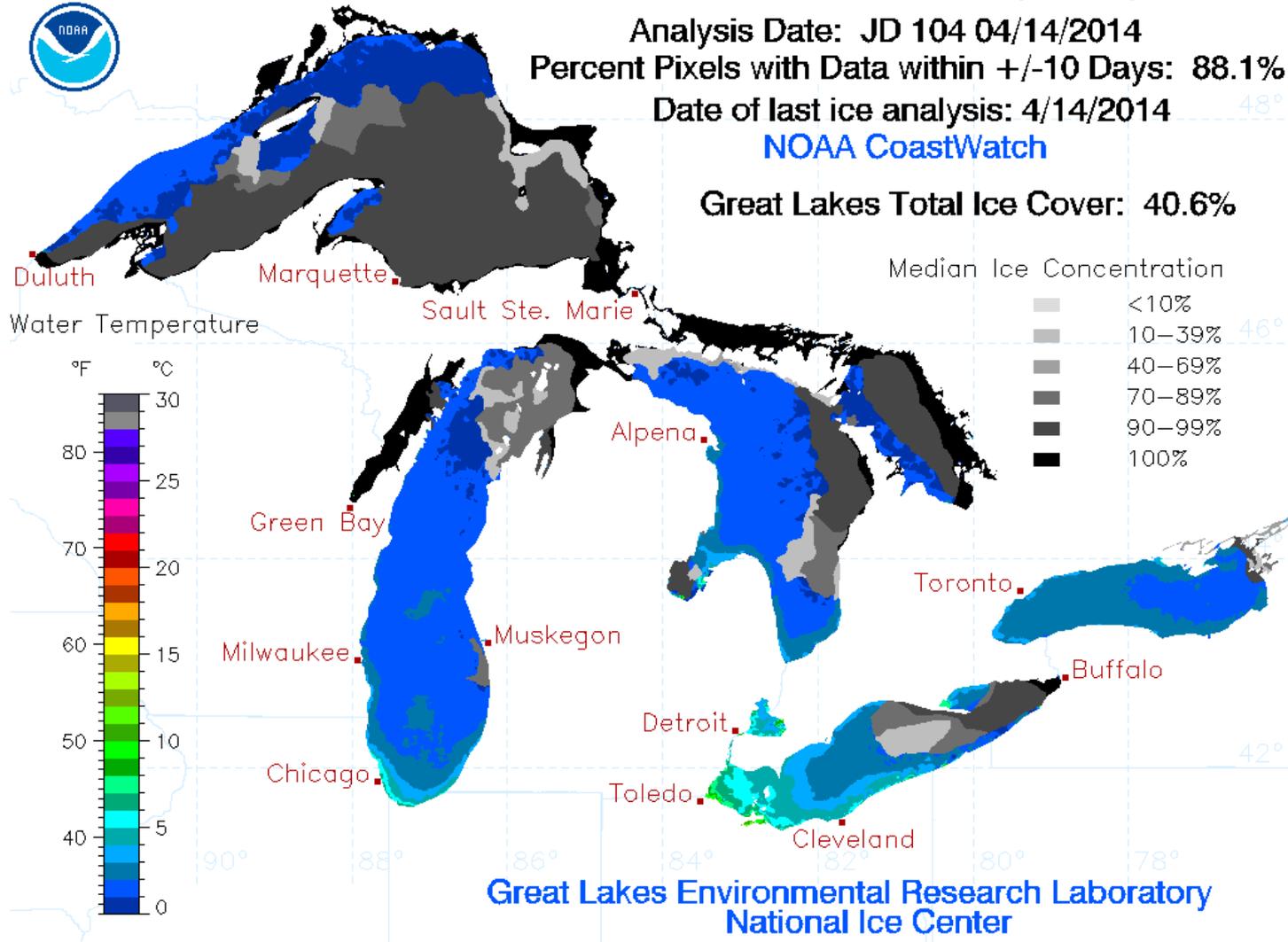


Analysis Date: JD 104 04/14/2014
Percent Pixels with Data within +/-10 Days: 88.1%

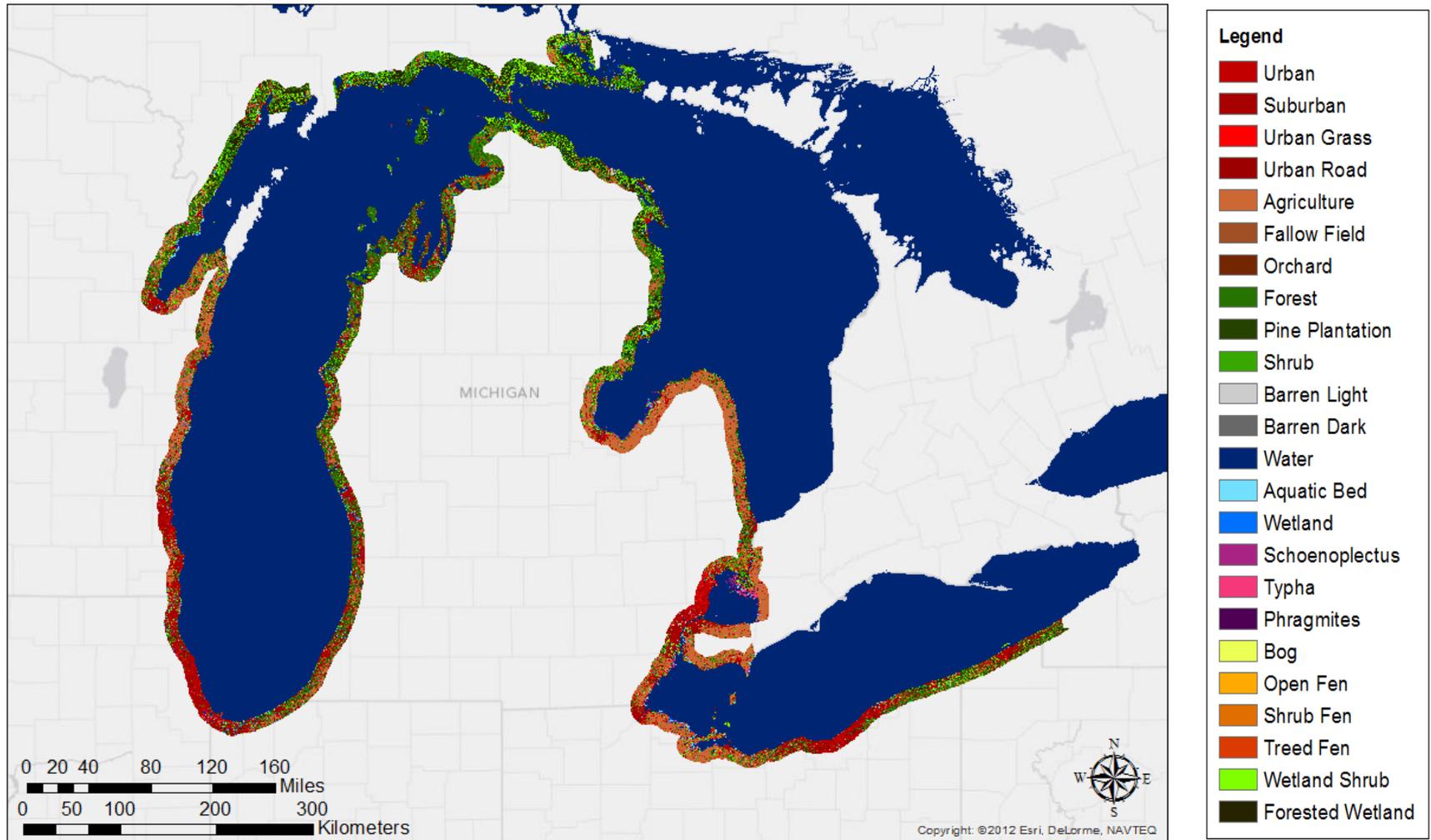
Date of last ice analysis: 4/14/2014 48°

NOAA CoastWatch

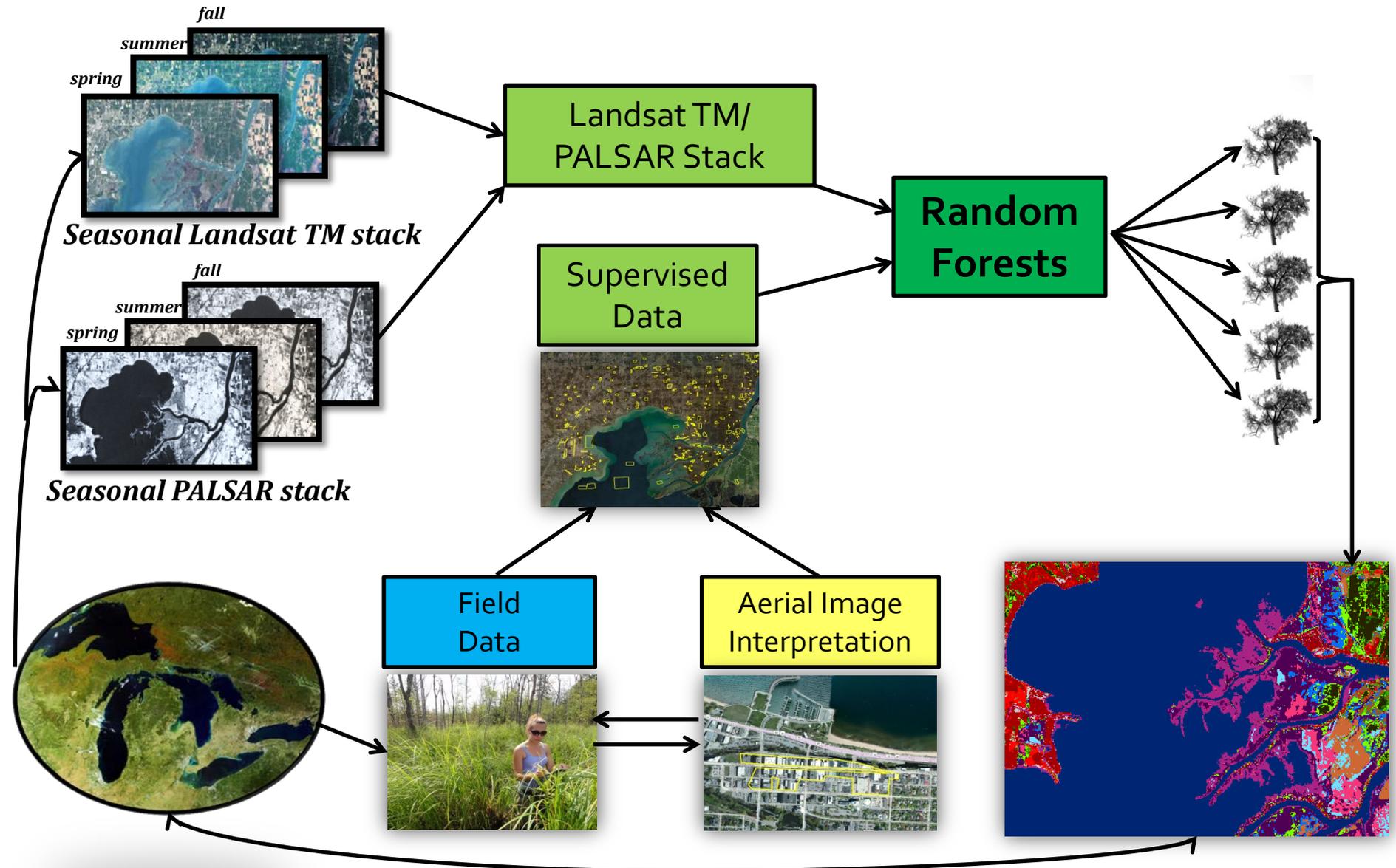
Great Lakes Total Ice Cover: 40.6%



Coastal Monitoring for the Great Lakes: Mapping Coastal Wetlands



Classification Schematic



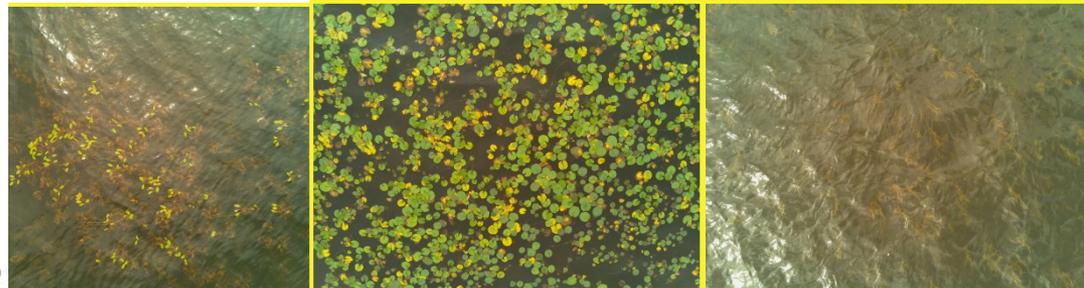
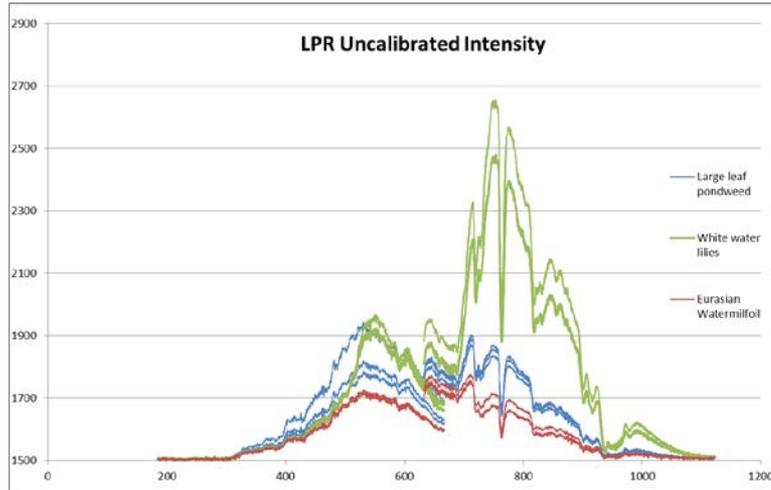
Coastal Monitoring for the Great Lakes: Invasive *Phragmites* Mapping

Lake Michigan *Phragmites* Distribution

- Classifier based on Landsat imagery combined with radar data
- MTRI project website:
<http://mtri.org/phragmites.html>
 - JPEGs of the 3-season radar image mosaics used to map *Phragmites*
 - 2010-2011 field data in Google Earth KML format
- GLRI *Phragmites* Decision Support Tool Mapper:
<http://cida.usgs.gov/glri/phragmites/>
 - Distribution map of coastal *Phragmites* stands > 0.2 ha
 - Map of estimated *Phragmites* habitat suitability based on current environmental conditions

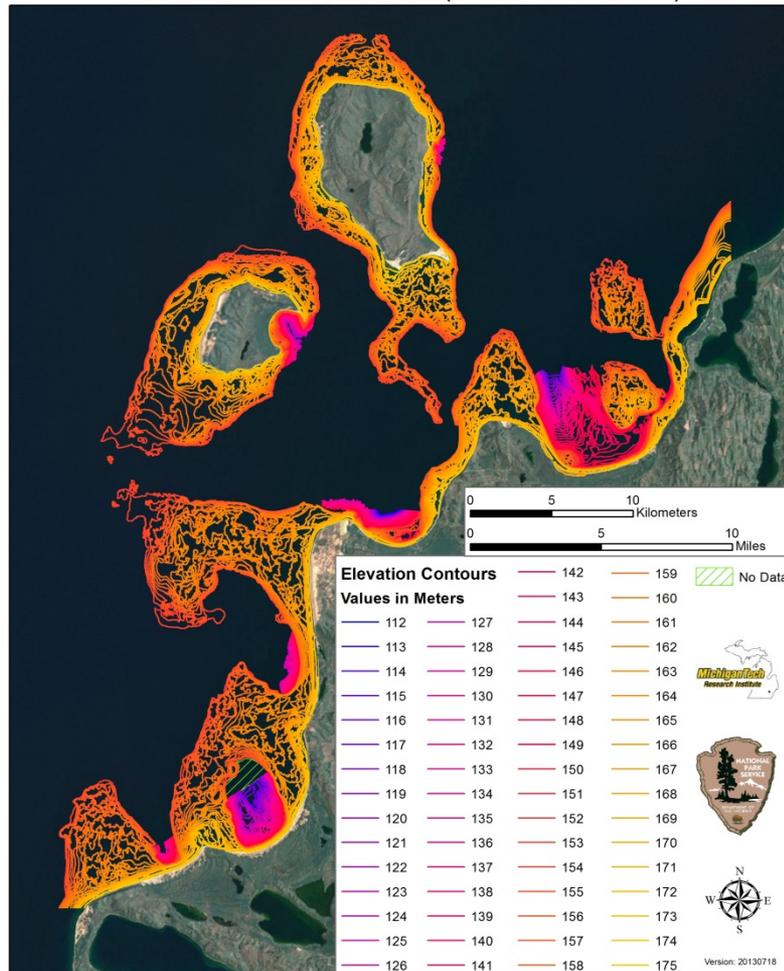


Coastal Monitoring for the Great Lakes: Eurasian Watermilfoil Mapping



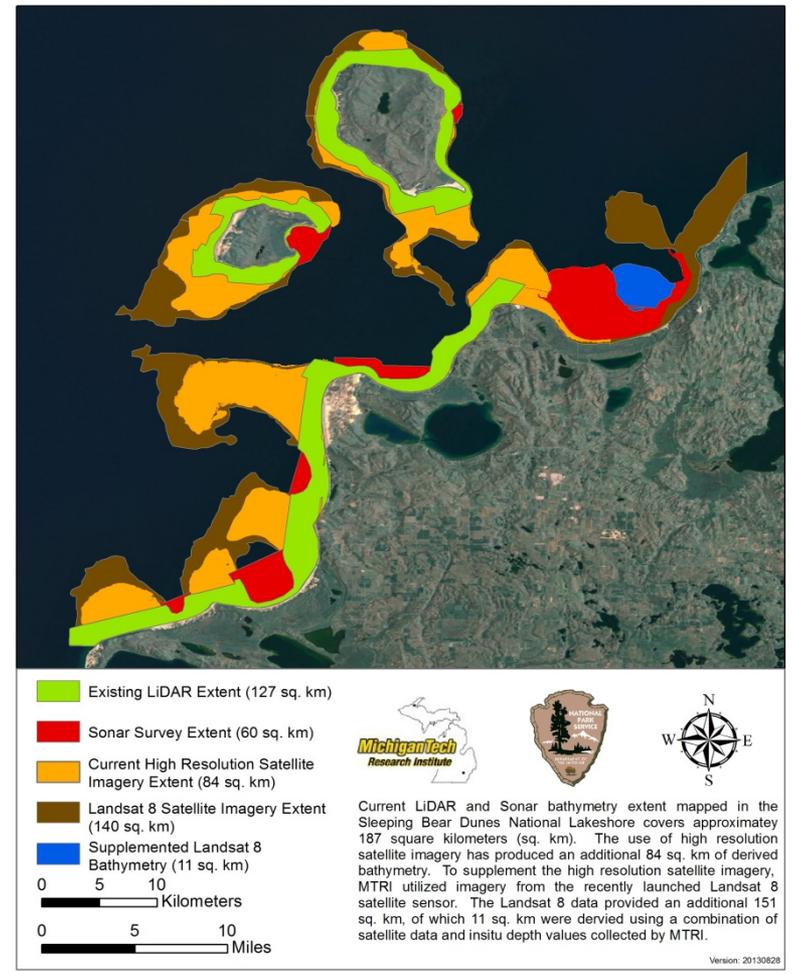
Coastal Monitoring for the Great Lakes: Nearshore Bathymetry

Multi-Source Derived Bathymetry at the Sleeping Bear Dunes National Lakeshore:
Elevation Contours Derived from LiDAR, Sonar, High Resolution and
Moderate Resolution Satellite Data (Elevation Datum: IGLD85)



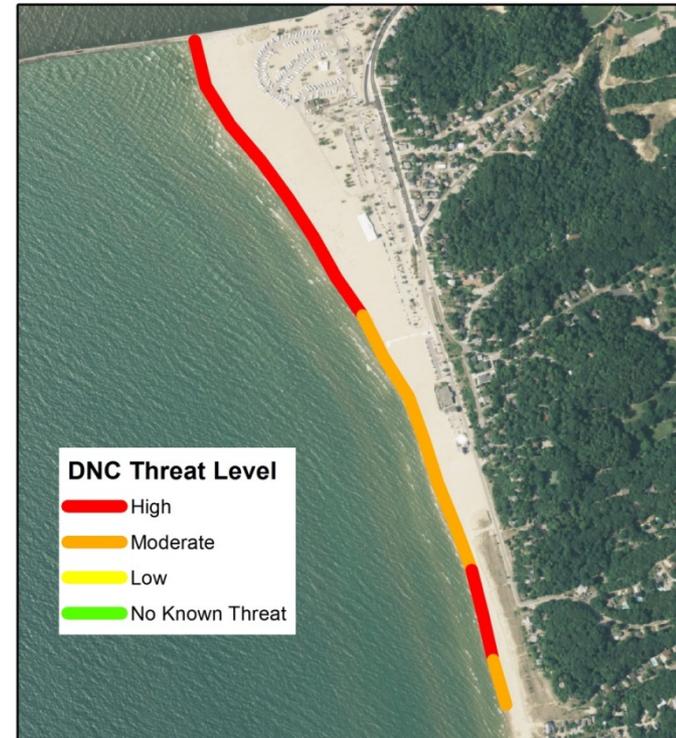
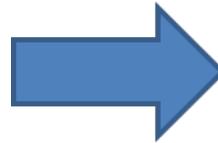
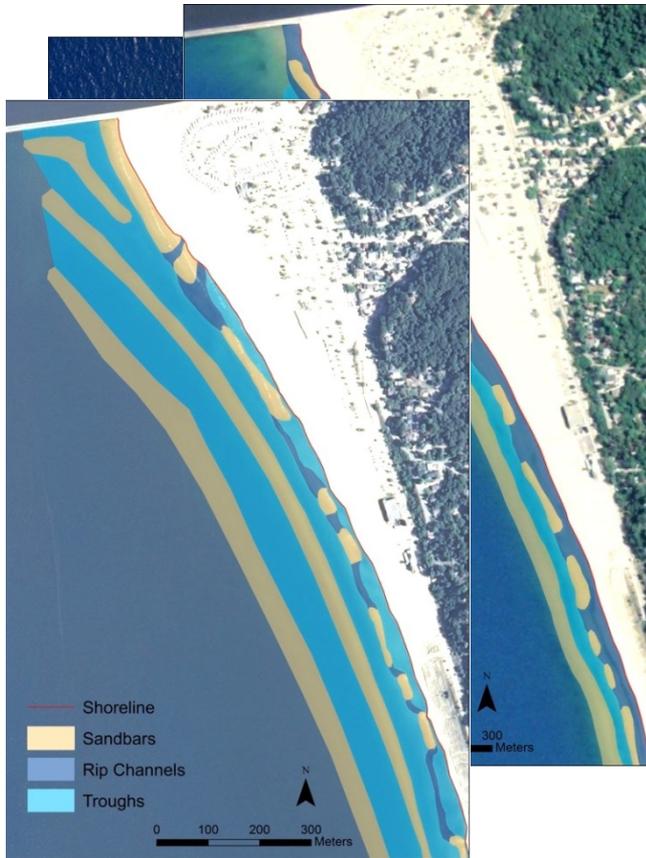
Document Path: J:\project\NPS_Bathymetry\MXD\All_Sources_Elevation.mxd

Current Extent of High Resolution Bathymetry Produced using LiDAR,
Sonar, High Resolution and Moderate Resolution Satellite Imagery



Document Path: J:\project\NPS_Bathymetry\MXD\All_Sources_Graphic_With_InSitu_20130828.mxd

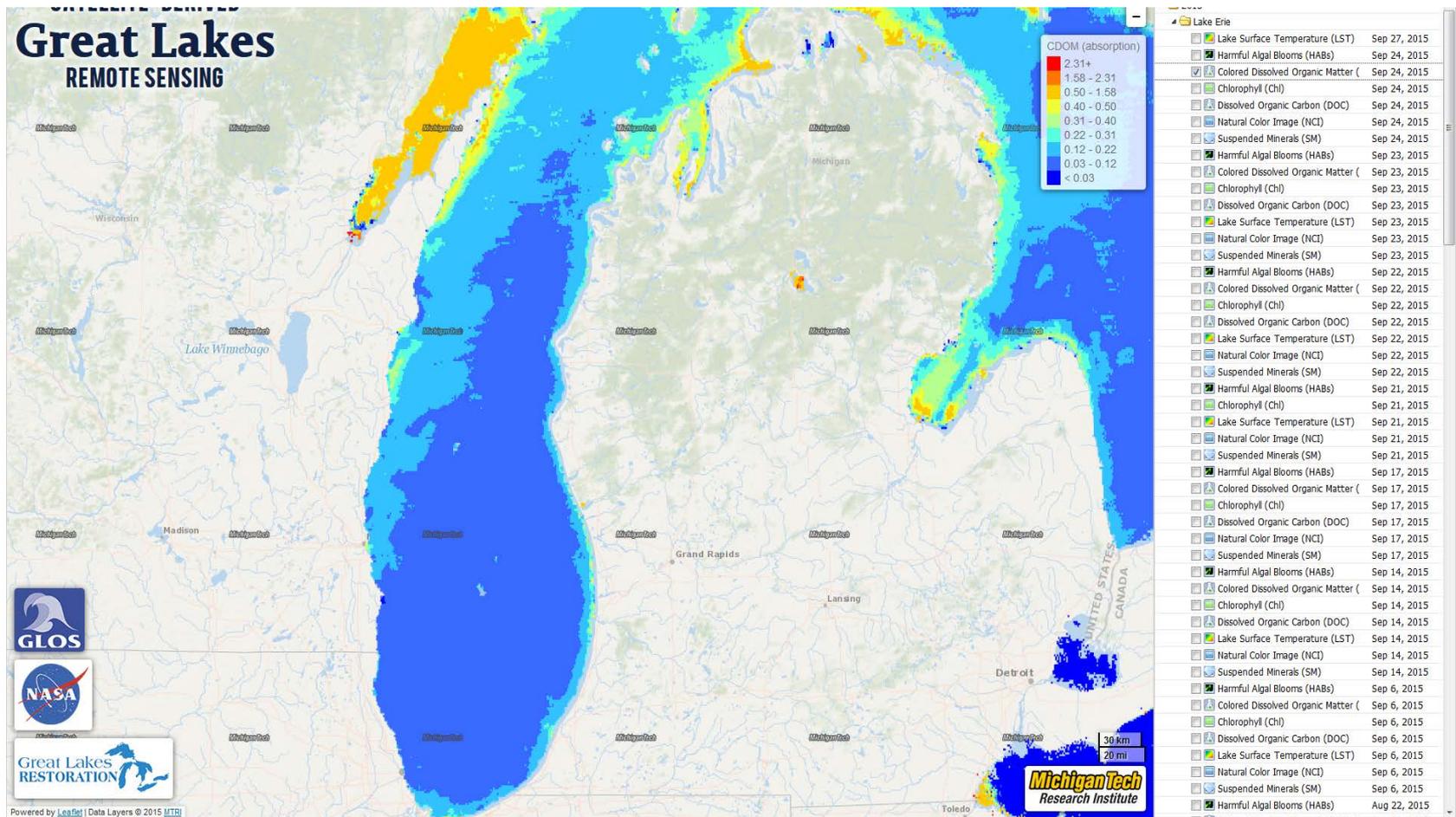
Coastal Monitoring for the Great Lakes: Mapping Dangerous Rip Currents



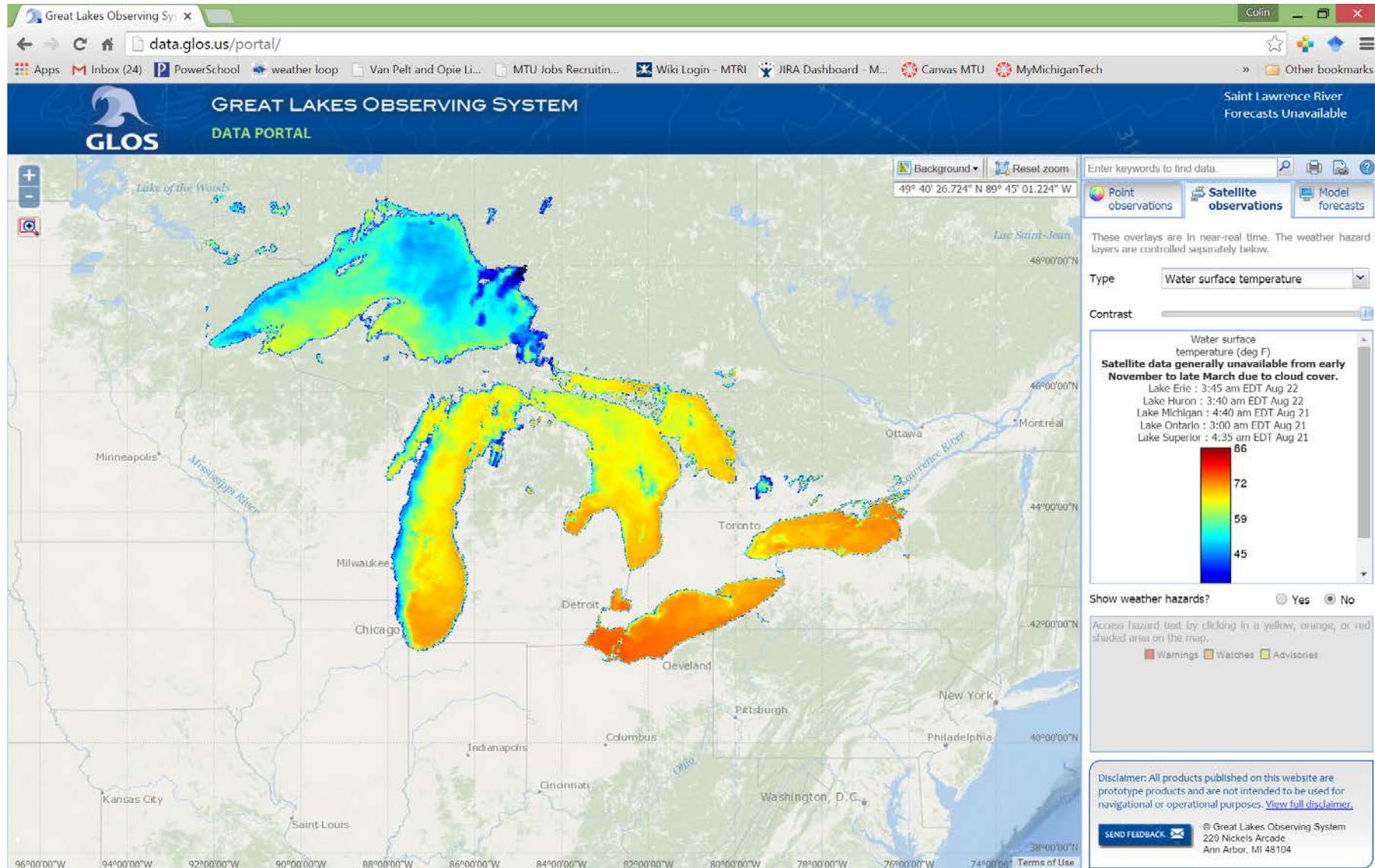
Frequency of rip feature presence	Threat level
> 50%	High
25 – 50%	Medium
< 25 %	Low
No rip features observed in any image	No Threat

PI: Dr. Guy Meadows

Data Sharing and Web Portals: GreatLakesRemoteSensing.org



Data Sharing and Web Portals: GLOS Data Portal



Great Lakes Observing System

data.glos.us/portal/

GLOS GREAT LAKES OBSERVING SYSTEM
DATA PORTAL

Saint Lawrence River Forecasts Unavailable

Background Resel zoom
49° 40' 26.724" N 89° 45' 01.224" W

Enter keywords to find data

Point observations Satellite observations Model forecasts

These overlays are in near-real time. The weather hazard layers are controlled separately below.

Type: Water surface temperature

Contrast

Water surface temperature (deg F)

Satellite data generally unavailable from early November to late March due to cloud cover.

Lake Erie : 3:45 am EDT Aug 22
 Lake Huron : 3:40 am EDT Aug 22
 Lake Michigan : 4:40 am EDT Aug 21
 Lake Ontario : 3:00 am EDT Aug 21
 Lake Superior : 4:35 am EDT Aug 21

86
72
59
45

Show weather hazards? Yes No

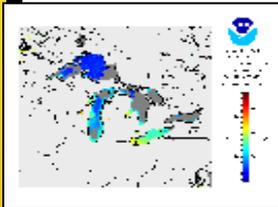
Access hazard text by clicking in a yellow, orange, or red shaded area on the map.

Warnings Watches Advisories

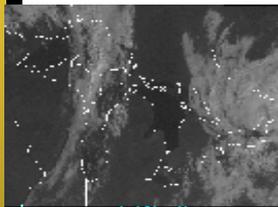
Disclaimer: All products published on this website are prototype products and are not intended to be used for navigational or operational purposes. [View full disclaimer.](#)

SEND FEEDBACK  © Great Lakes Observing System
229 Nickels Arcade
Ann Arbor, MI 48104

Data Sharing and Web Portals: NOAA CoastWatch Great Lakes Node



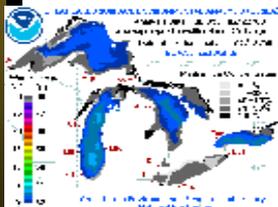
Goes SST



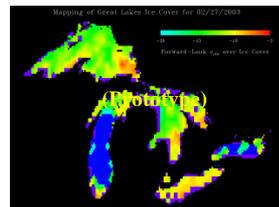
Goes VIS/IR



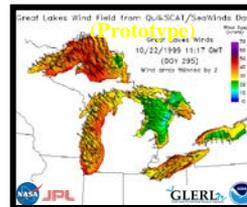
MODIS True Color



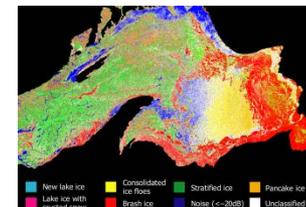
GLSEA



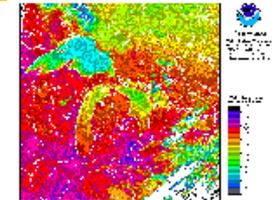
Scatterometer Ice
(prototype)



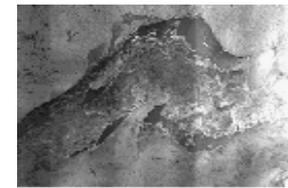
Scatterometer Winds
(prototype)



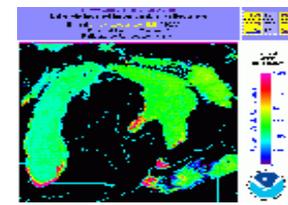
SAR Ice
(prototype)



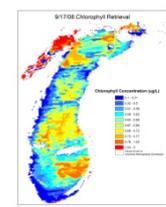
AVHRR SST



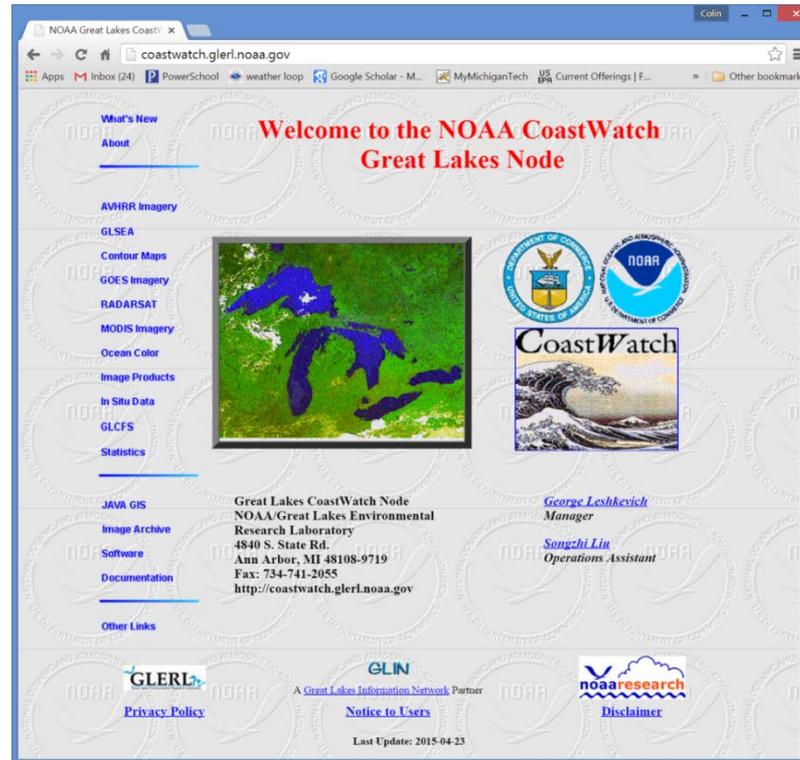
RADARSAT



Turbidity



Chl, CDOM, Mineral
(prototype)



NOAA Great Lakes CoastWatch

coastwatch.glerl.noaa.gov

Welcome to the NOAA CoastWatch Great Lakes Node

What's New

About

AVHRR Imagery

GLSEA

Contour Maps

GOES Imagery

RADARSAT

MODIS Imagery

Ocean Color

Image Products

In Situ Data

GLCFS

Statistics

JAVA GIS

Image Archive

Software

Documentation

Other Links

Great Lakes CoastWatch Node
NOAA/Great Lakes Environmental
Research Laboratory
4840 S. State Rd.
Ann Arbor, MI 48108-9719
Fax: 734-741-2055
http://coastwatch.glerl.noaa.gov

George Leshkevich
Manager

Songchi Lin
Operations Assistant

GLERL
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GLIN
A Great Lakes Information Network Partner
Notice to Users

noaa research
Disclaimer

Last Update: 2015-04-23



Data Sharing and Web Portals:

www.greatlakesbuoys.org

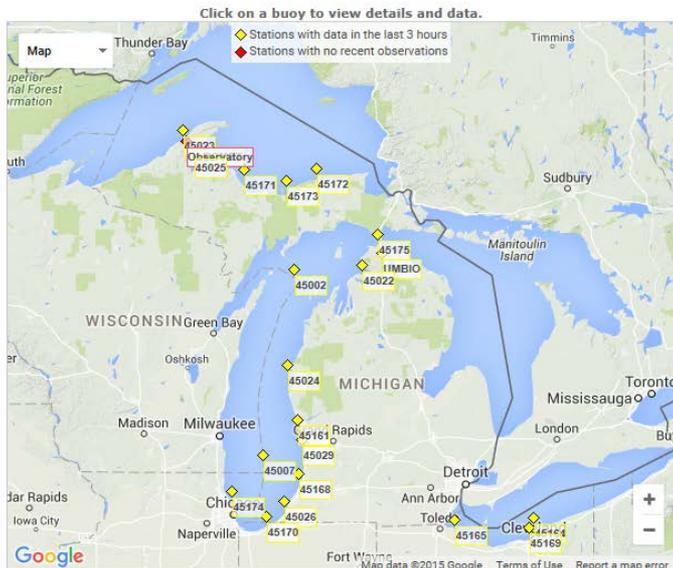
- Quick, easy access to Great Lakes buoy data, building from years of development of the Michigan Tech UGLOS site

Great Lakes Buoys



Great Lakes Nearshore Buoy Network

Access real-time observations from buoys and monitoring stations in the Great Lakes regions



Most Recent Observations

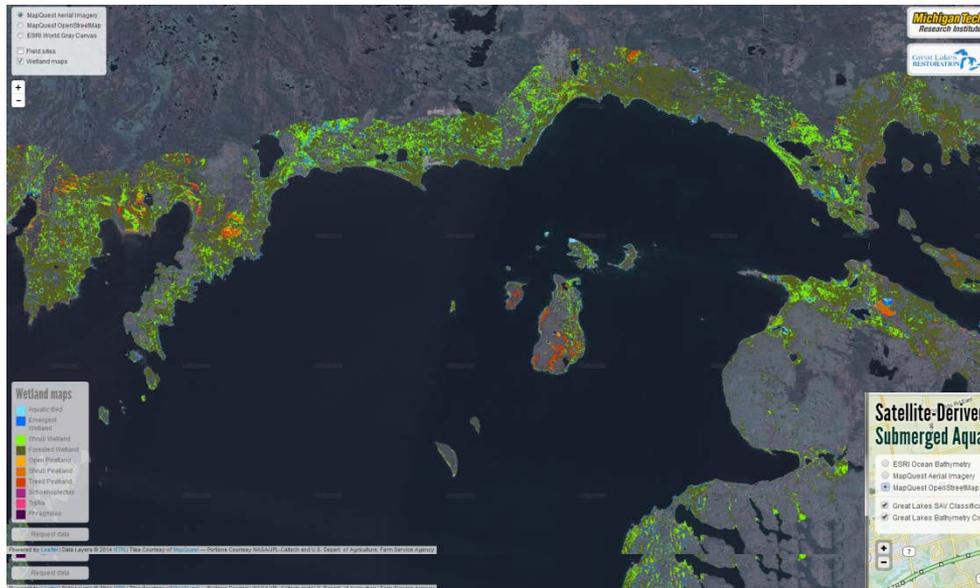
Station ID	Title	Location	Owner	Timestamp	Wind speed (m/s)	Wind gust (m/s)	Wind direction	Air temperature (°F)	Relative humidity (%)	Water temp. (°F)	Wave height (ft.)	Wave period (sec.)	Status
Erie													
45165	Toledo Water Intake	Oregon	LimnoTech	09/30/2015 14:20	9.2	9.9	NE	61.8	70	67.9	3.3	4.0	Up
45169	Cleveland Wind Buoy	Cleveland	LimnoTech	09/30/2015 14:30	8.6	11.4	NNE	61.7	75	69.4	5.2	2.1	Up
45164	Cleveland DO Buoy	Cleveland	LimnoTech	09/30/2015 14:00	9.1	0.0	ENE	58.8	0	0.0	0.0	0.0	Up
Inland													
GLRCMET	GLRC Meteorological Station	Houghton	MTU-GLRC	09/30/2015 14:20	3.5	3.8	WNW	57.6	44	0.0	0.0	0.0	Up
UMBIO	University of Michigan Biological Station	Douglas Lake	UM-CILER	09/30/2015 14:30	6.0	10.5	ENE	52.8	51	65.6	0.0	0.0	Up
Michigan													
45161	Muskegon Buoy	Muskegon	GLERL	09/30/2015 13:40	6.0	7.0	NE	56.5	0	50.9	1.0	3.0	Up
45170	Illinois-Indiana Sea Grant Buoy	Michigan City	IISG	09/30/2015 14:30	7.9	10.0	NNE	56.4	73	60.6	6.3	2.5	Up
45174	Wilmette Weather Buoy	Wilmette	IISG	09/30/2015 14:30	8.3	11.6	NNE	56.8	63	59.3	6.9	6.6	Up
45026	Cook Nuclear Plant Buoy	Bridgman	LimnoTech	09/30/2015 14:30	5.9	6.5	NE	53.4	75	51.3	4.3	6.6	Up
45029	LimnoTech Holland Buoy	Port Sheldon	LimnoTech	09/30/2015 14:30	4.4	6.1	NNE	54.1	59	48.5	1.7	4.0	Up
45168	South Haven Buoy	South Haven	LimnoTech	09/30/2015 14:30	4.7	6.1	NNW	50.2	71	45.1	3.1	5.6	Up
45022	Little Traverse Bay Buoy	Little Traverse Bay	Local	09/30/2015 14:30	5.9	9.3	ENE	53.6	59	65.8	1.5	2.2	Up
45175	Mackinac Straits West	Mackinaw City, MI	MTU-GLRC	09/30/2015 14:30	5.0	7.4	E	53.7	51	60.7	1.2	2.5	Up
45007	South Michigan Buoy	South Michigan	NOAA-NDBC	09/30/2015 13:50	9.0	11.0	NNE	56.1	0	66.4	5.2	6.0	Up
45002	North Michigan Buoy	North Michigan	NOAA-NDBC	09/30/2015 13:50	9.0	11.0	ENE	54.1	0	63.1	3.6	5.0	Up
45024	Ludington Buoy	Ludington	UM-CILER	09/30/2015 14:20	6.2	7.8	N	51.2	100	56.7	2.9	5.4	Up
Superior													
45023	North Entry Buoy	North Keweenaw Peninsula	MTU-GLRC	09/30/2015 14:30	4.5	6.1	NNE	55.9	67	60.4	1.2	3.2	Up
45025	South Entry Buoy	South Keweenaw Peninsula	MTU-GLRC	09/30/2015 14:30	2.8	3.6	ESE	55.7	58	—	0.6	1.7	Up
45173	Munising Buoy	Munising	NMU	09/30/2015 14:30	5.3	7.4	NE	54.4	50	0.0	1.4	3.0	Up
45171	Granite Island Buoy	Granite Island	NMU	09/30/2015 14:30	2.8	0.0	NNE	53.0	0	60.6	1.0	9.0	Up
45172	Grand Marais Buoy	Grand Marais	NMU	09/30/2015 14:30	5.6	0.0	NNE	51.3	0	61.1	1.6	4.0	Up

Rapid one-click access to buoy sites with current status

User-friendly overview of primary data on front page

Data Sharing and Web Portals: MTRI Interactive Maps

Great Lakes Coastal Wetlands



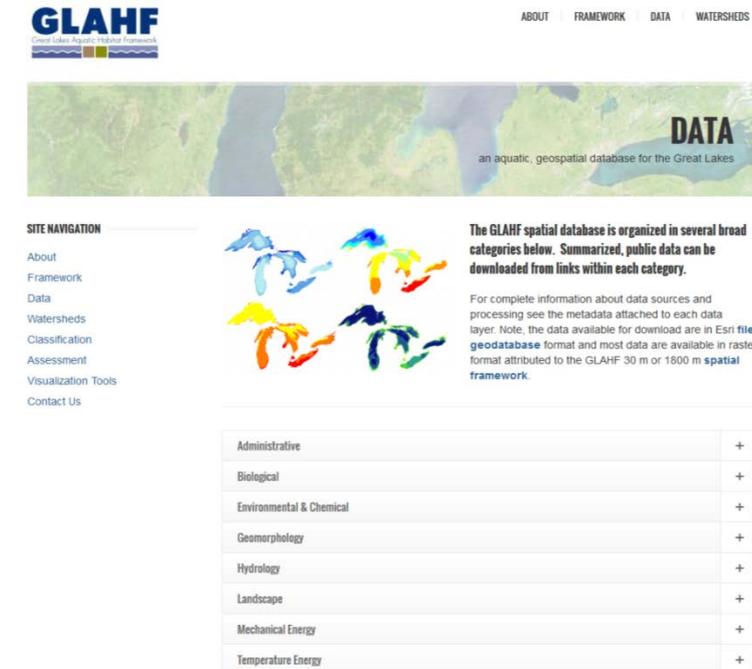
<http://geodjango.mtri.org/coastal-wetlands/>

Nearshore SAV Distribution



<http://geodjango.mtri.org/static/sav>

Data Sharing and Web Portals: Great Lakes Aquatic Habitat Framework



GLAHF
Great Lakes Aquatic Habitat Framework

ABOUT | FRAMEWORK | DATA | WATERSHEDS

DATA
an aquatic, geospatial database for the Great Lakes

SITE NAVIGATION

- About
- Framework
- Data
- Watersheds
- Classification
- Assessment
- Visualization Tools
- Contact Us

The GLAHF spatial database is organized in several broad categories below. Summarized, public data can be downloaded from links within each category.

For complete information about data sources and processing see the metadata attached to each data layer. Note, the data available for download are in Esri file geodatabase format and most data are available in raster format attributed to the GLAHF 30 m or 1800 m spatial framework.

Administrative	+
Biological	+
Environmental & Chemical	+
Geomorphology	+
Hydrology	+
Landscape	+
Mechanical Energy	+
Temperature Energy	+

- Under construction
- Spatial database combining remote-sensing-derived products and other types of data, including some MTRI products
- <http://ifr.snre.umich.edu/glahf/>

Thank you!

- More information on many of MTRI's current project areas can be found at mtri.org/environmental
- MTRI Portal for water products: greatlakesremotesensing.org
- Great Lakes Observing System: data.glos.us
- NOAA CoastWatch Great Lakes: coastwatch.glerl.noaa.gov
- Great Lakes Buoys: www.greatlakesbuoys.org

