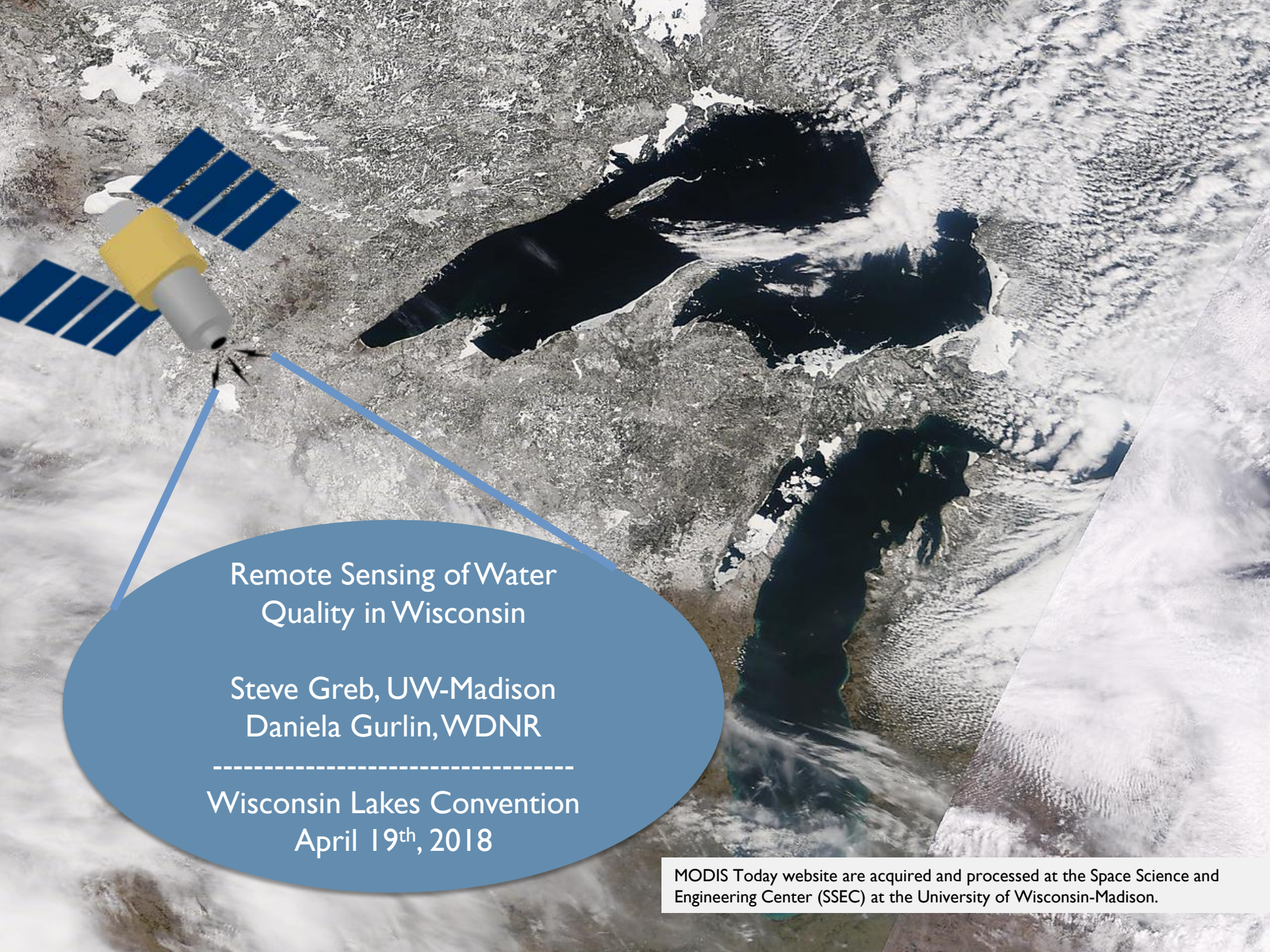


Remote Sensing of Water Quality in Wisconsin

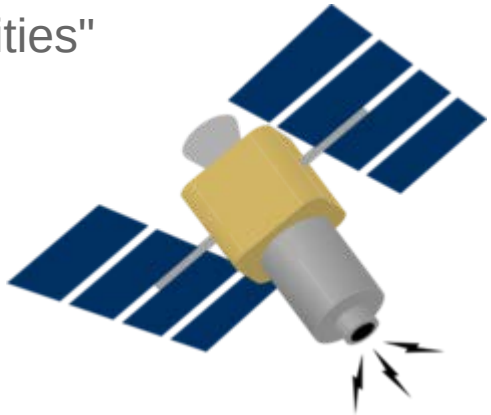
Steve Greb, UW-Madison
Daniela Gurlin, WDNR

Wisconsin Lakes Convention
April 19th, 2018

MODIS Today website are acquired and processed at the Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison.

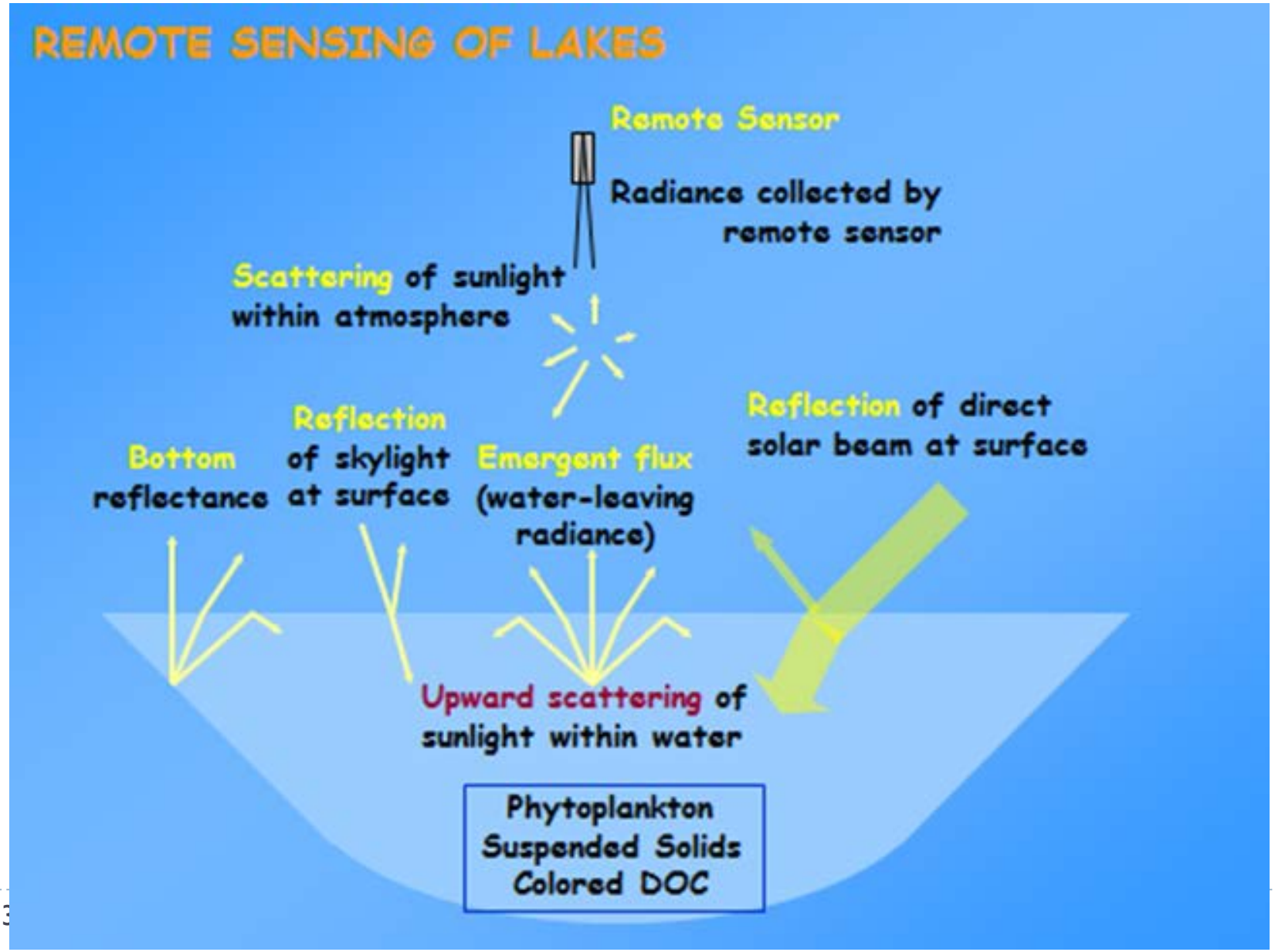
THE WISCONSIN IDEA

"to the government in the forms of serving in office, offering advice about public policy, providing information and exercising technical skill, and to the citizens in the forms of doing research directed at solving problems that are important to the state and conducting outreach activities"

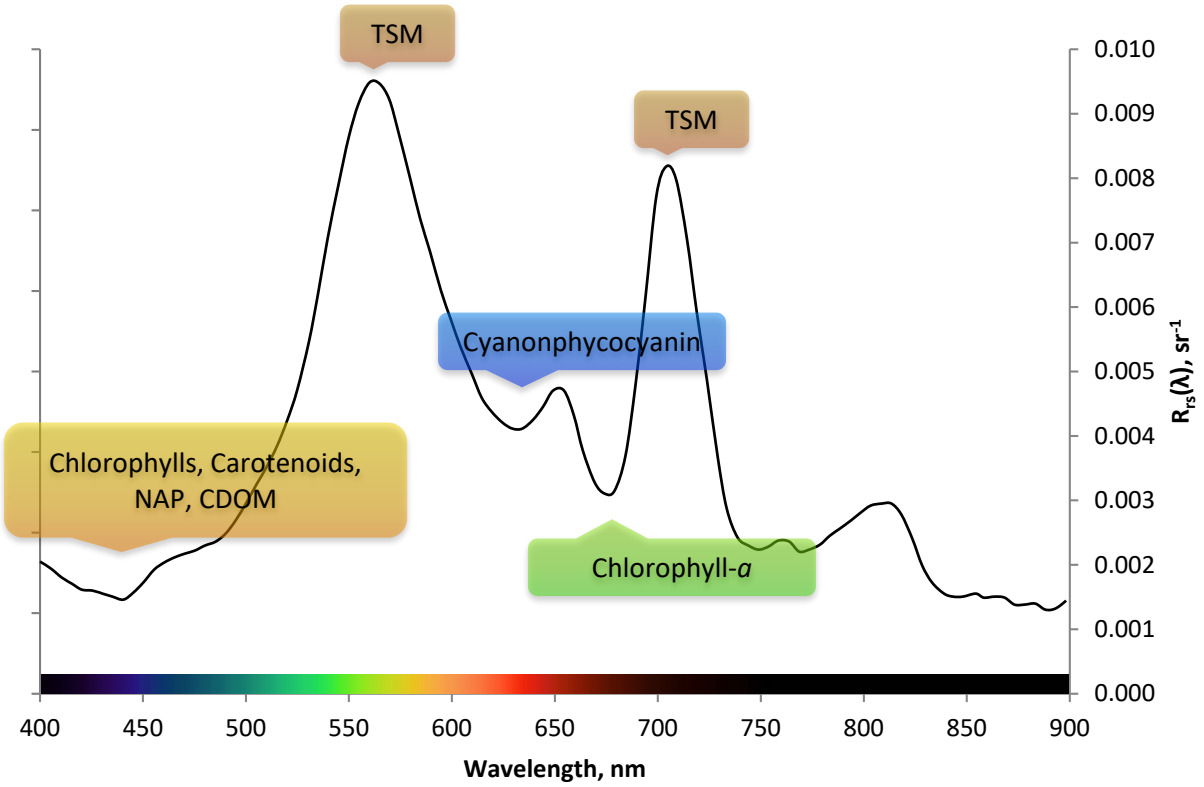


LakeSat.org

Primer on remote sensing

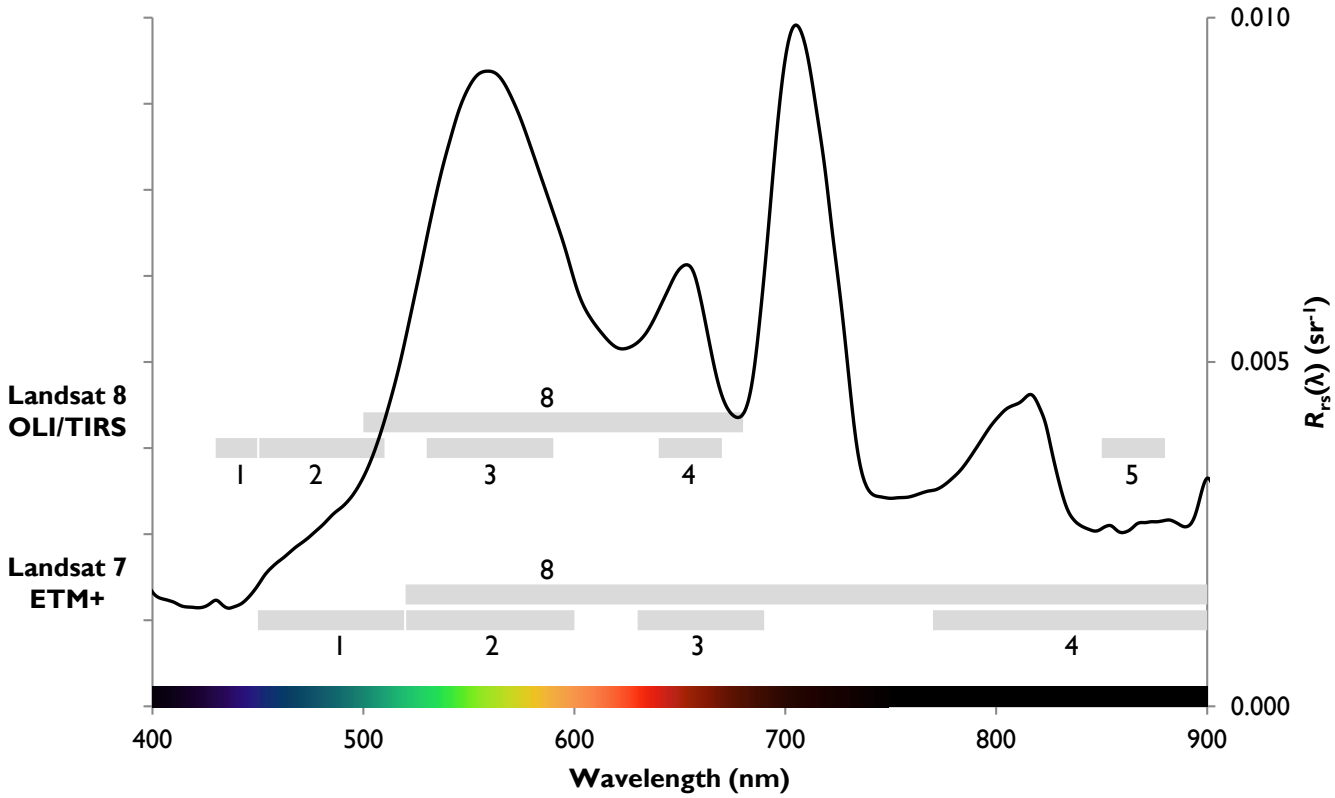


Primer on remote sensing



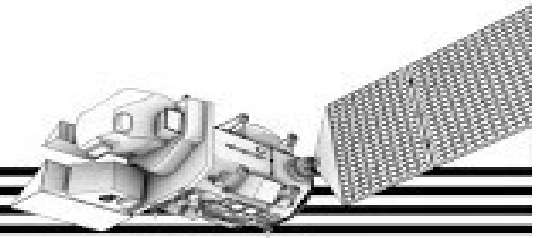
Comparison of Earth observation sensor bands

Comparison of Earth observation sensors suitable for water quality assessment with public access data policy



LANDSAT 8

NASA • USGS



Advantages and disadvantages

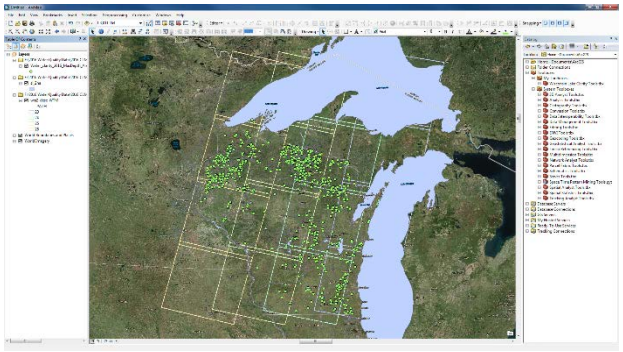
Advantages of the remote sensing of water quality

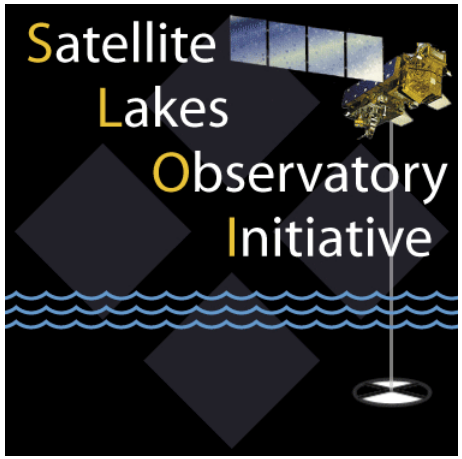
- Water quality data with a high spatial and temporal resolution for thousands of lakes at a time
- Evaluation of environmental problems and potential health risks
- Historical data for studies of trends in water quality
- Real time data for integration into early warning systems to protect the public from harmful algal blooms

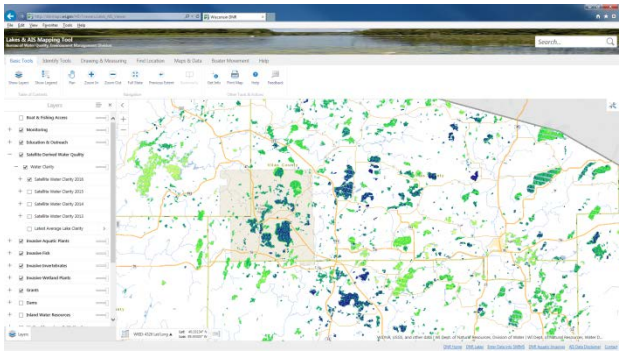
Disadvantages of the remote sensing of water quality

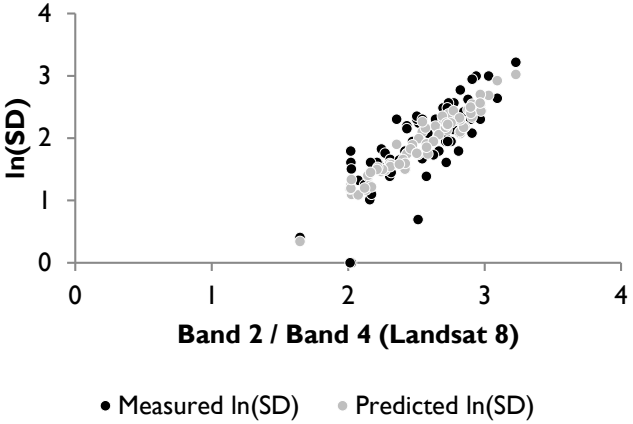
- Optically complex conditions found in lakes
- Potential interference from the lake bottom in shallow lakes
- Dynamic changes in water quality
- Limited number of water quality parameters
- Calibration and validation of models typically requires the collection of ground truth data

Systematic processing of satellite data





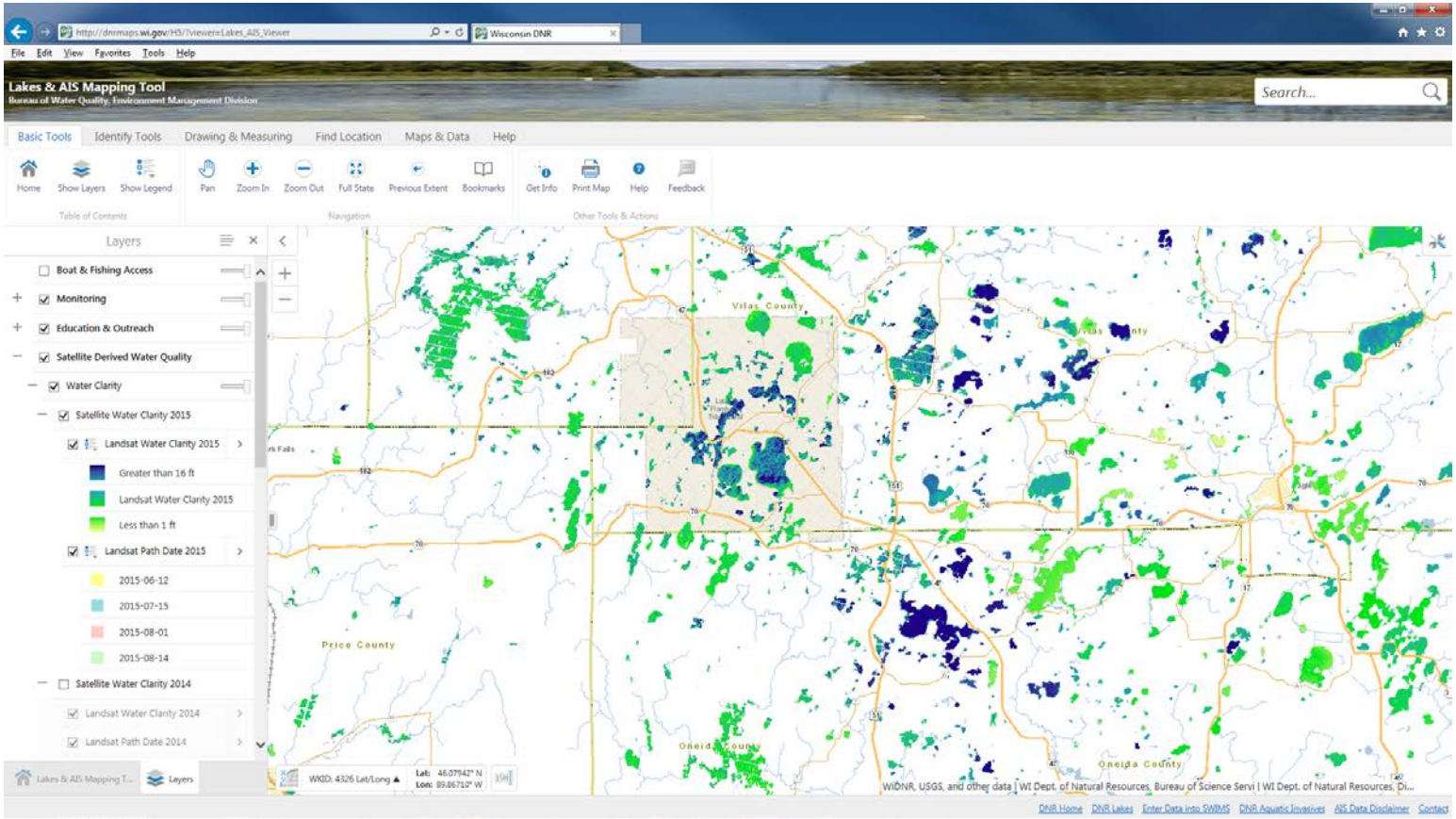




Systematic processing of satellite data

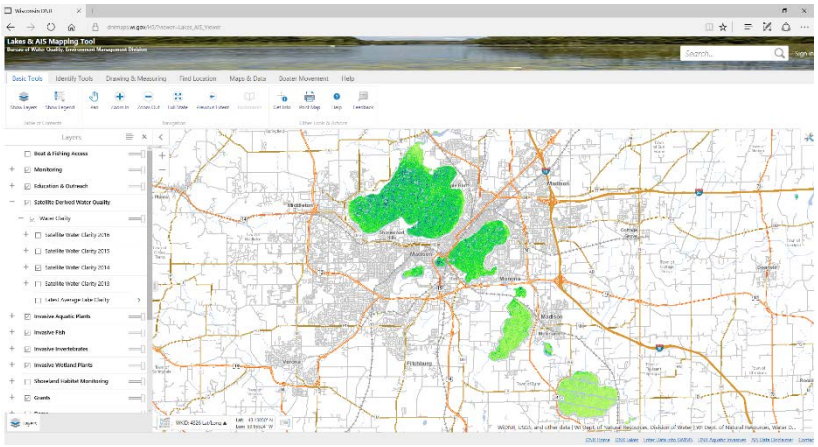
http://dnr.wi.gov/lakes/viewer/

Link to web site

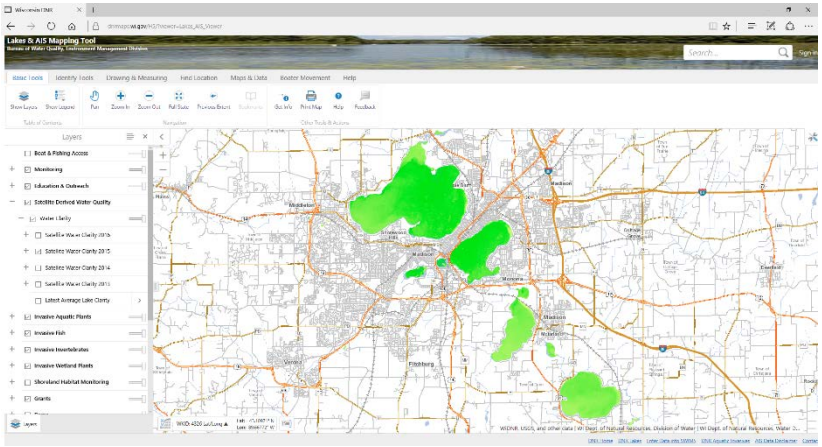


Effects of the signal-to-noise ratio on the satellite retrieval of the water clarity

Landsat 7 ETM+ (2014/09/06)



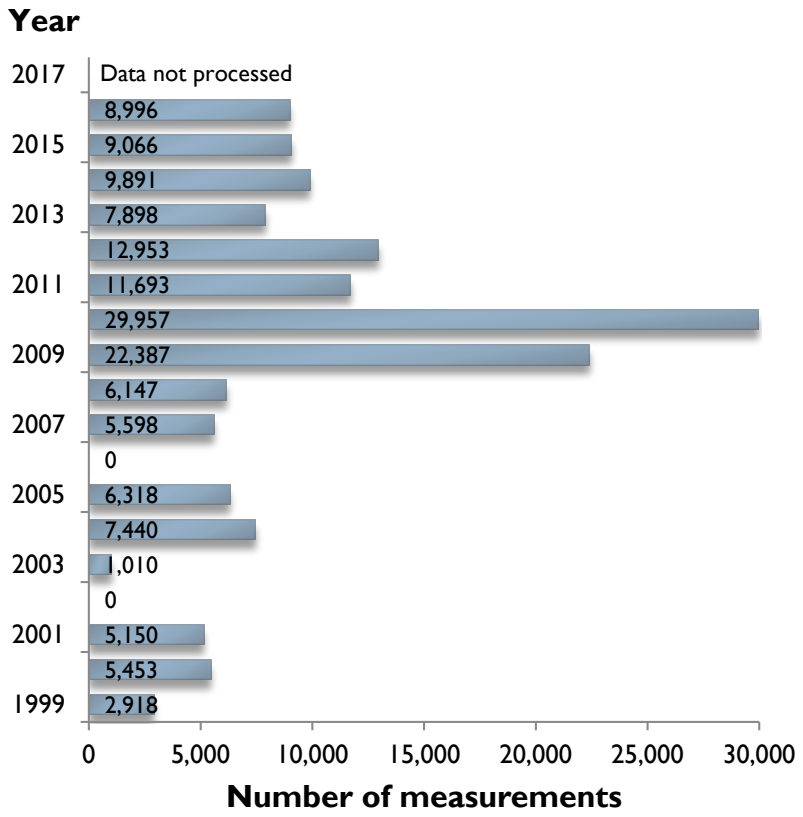
Landsat 8 OLI-TIRS (2015-07-15)



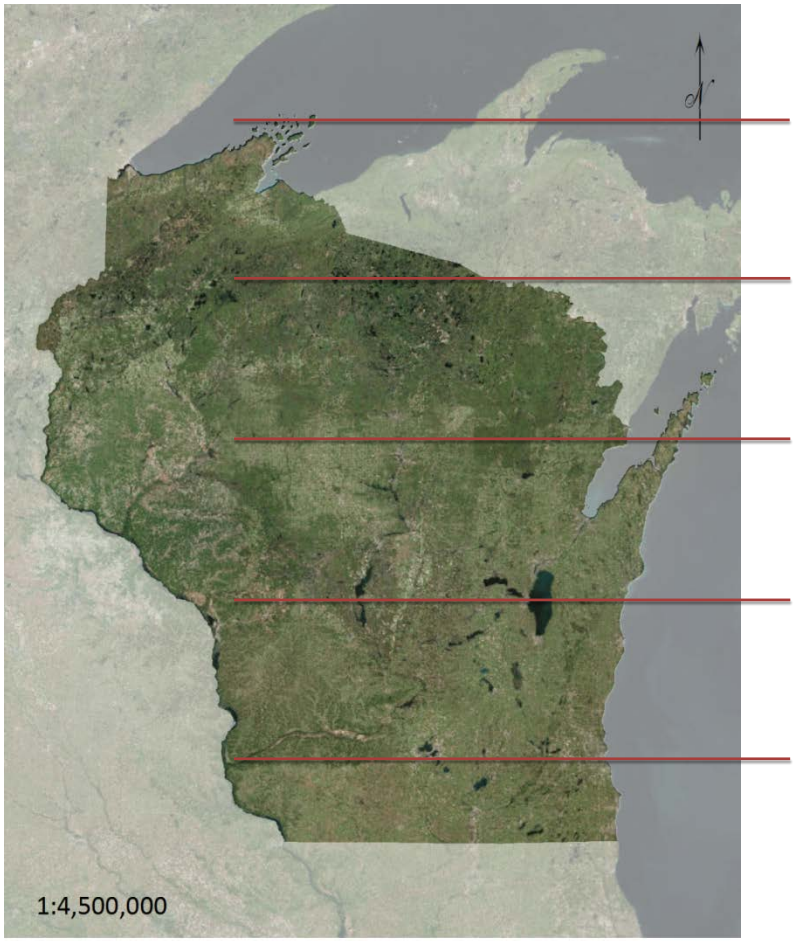
Systematic processing of satellite data

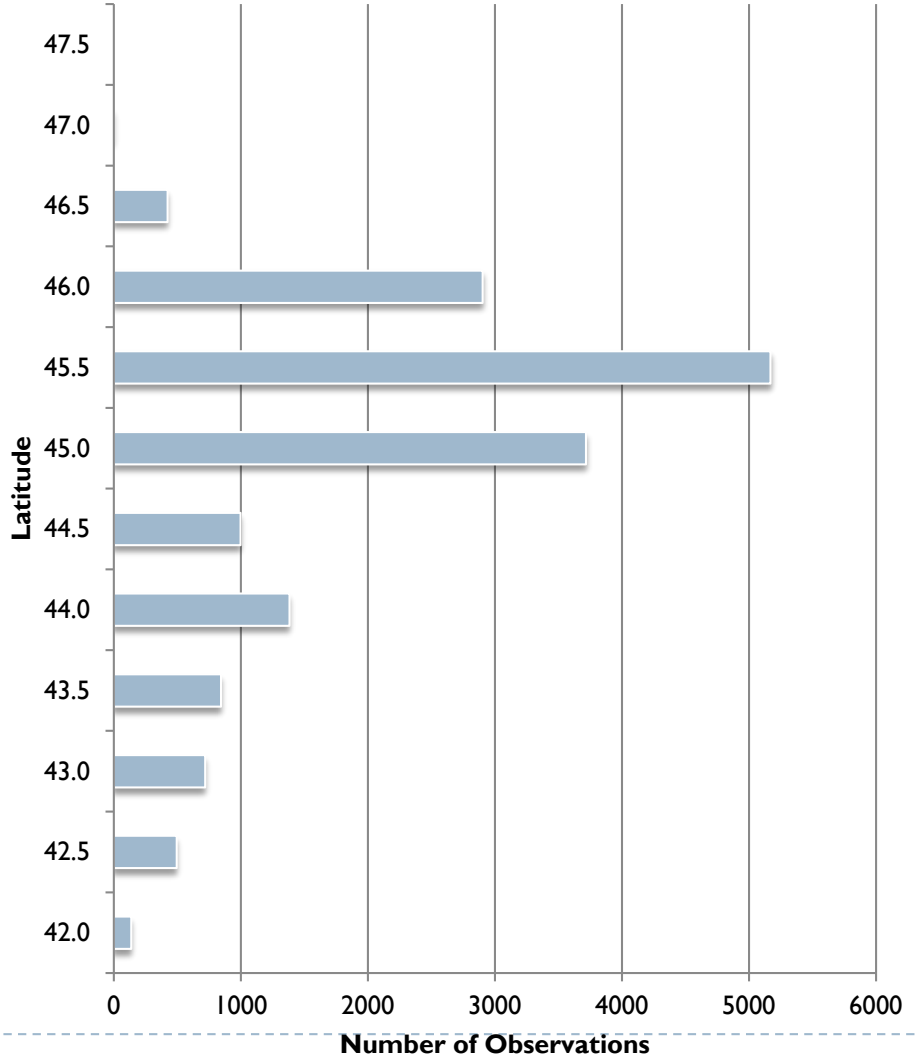
2016 water clarity estimation

- 40 Landsat 7 ETM+ and 36 Landsat 8 OLI-TIRS images downloaded from USGS Earth Explorer
- 30 images from 11 different dates and 608 ground-truth measurements collected by CLMN volunteers within 7 days from each image acquisition date used for algorithm development
- 9750 water clarity measurements for 4500 different waterbodies retrieved from the satellite data
- Mean absolute errors from 0.44 ft (8.9 %) to 2.78 ft (32.9 %) calculated for the calibration datasets



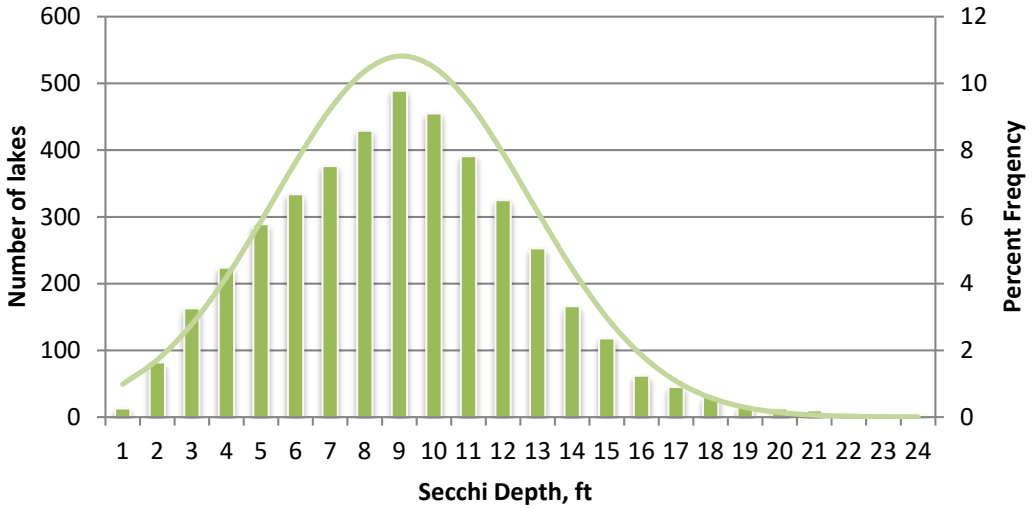
Distribution of lakes across the state for the 2014 water clarity dataset



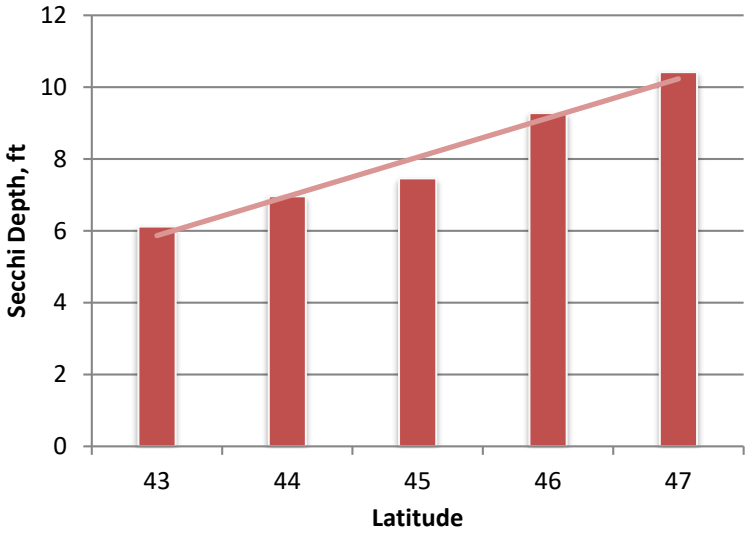


Source of basemap: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

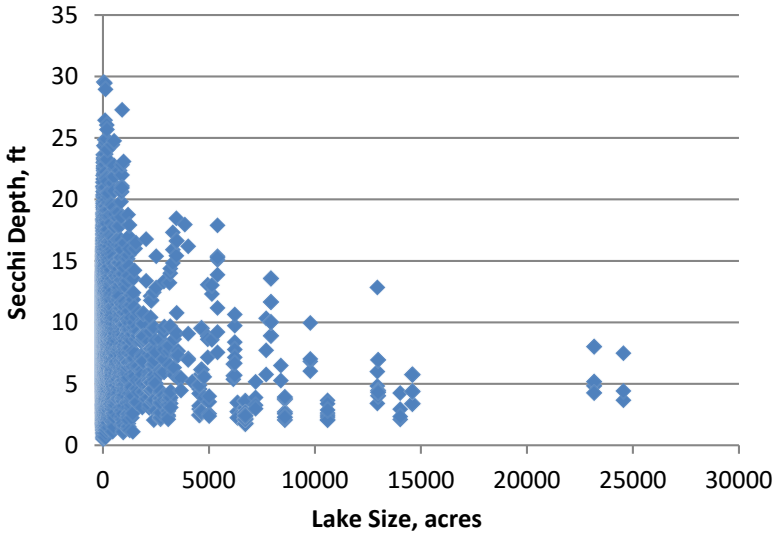
Number of lakes by Secchi depth intervals (2014 water clarity dataset)



Secchi depth from South to North



Relationship of Secchi to lake depth



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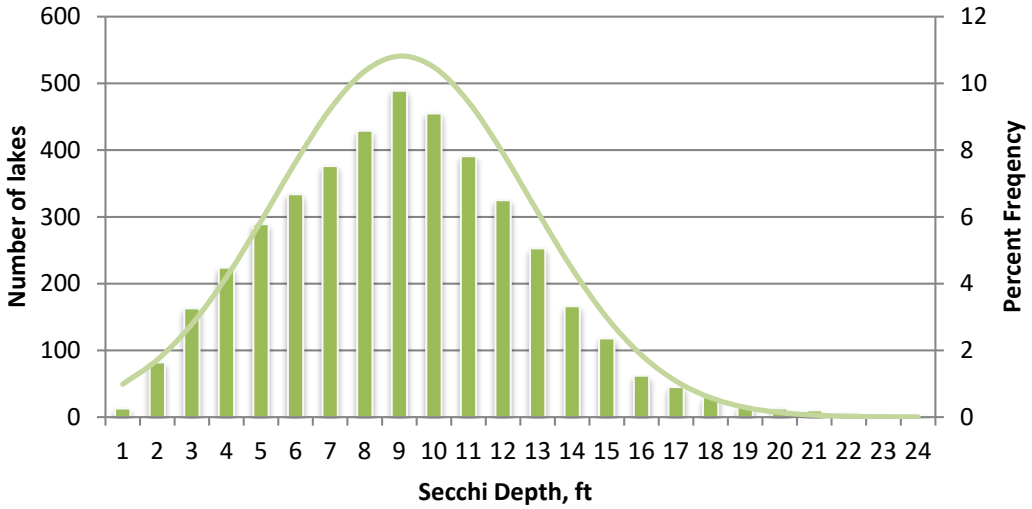
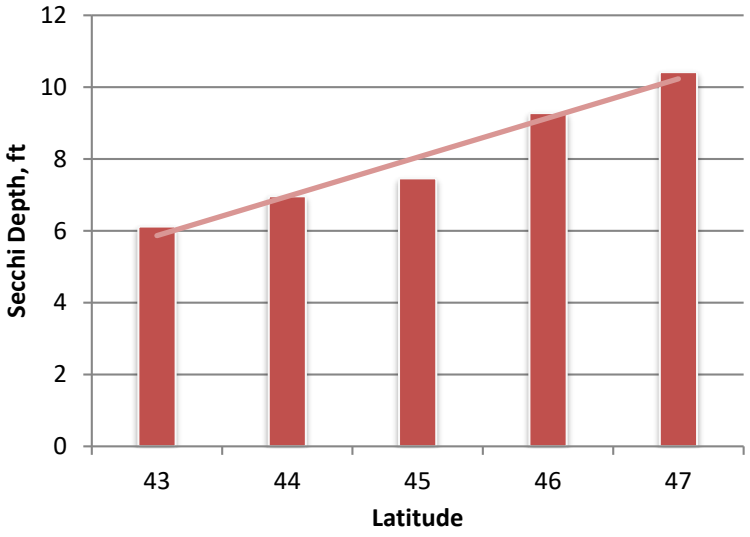


Secchi depth from South to North



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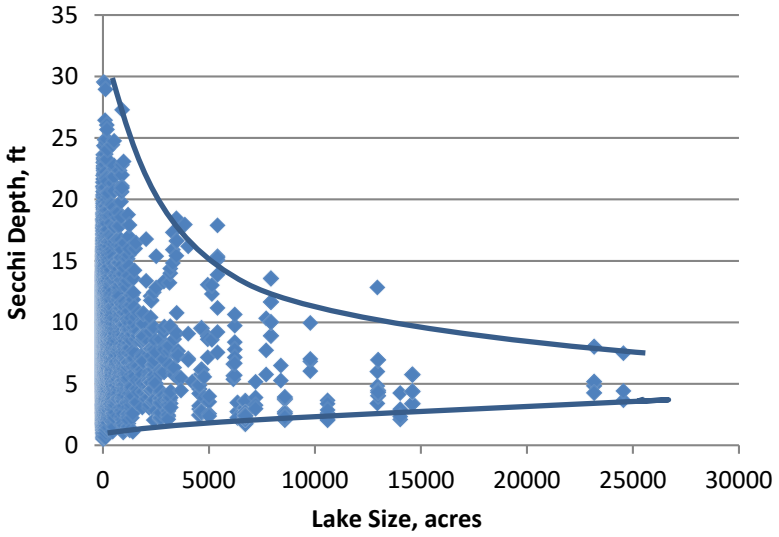


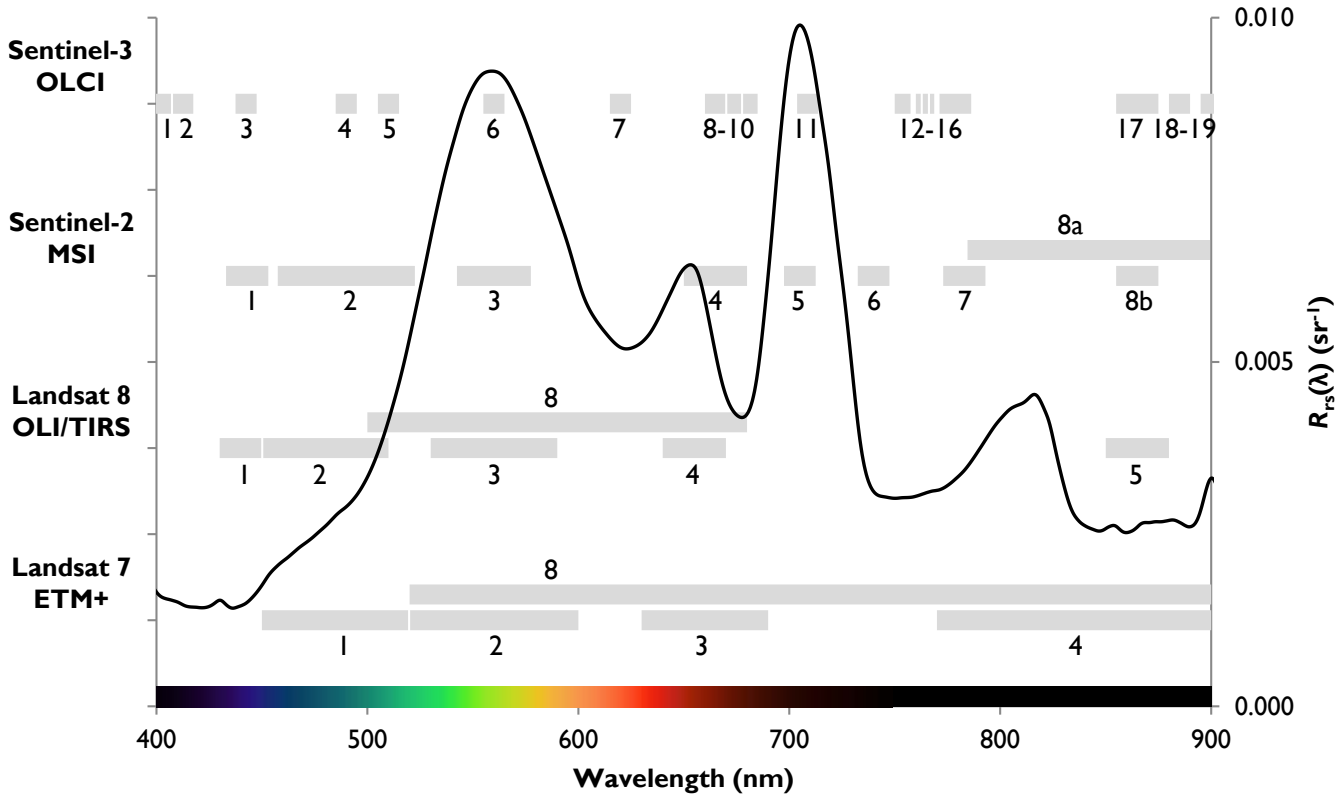
Current remote sensing activities

Current remote sensing activities at the Wisconsin DNR

- Systematic processing of satellite data for the retrieval of water clarity
- Use of satellite retrieved water clarity data for the assessment of trends in water quality
- Development of new interactive ways to present the satellite retrieved water clarity data for public use through the Lakes and Aquatic Invasive Species (AIS) Mapping Tool
- Increase in the effectiveness of the systematic processing of satellite data for the retrieval of water clarity
- Increase in Earth observation capabilities through the collection of field and satellite match-up data

Comparison of Earth observation sensors

Comparison of Earth observation sensors suitable for water quality assessment with public access data policy



Comparison of Earth observation sensors

Comparison of Earth observation sensors suitable for water quality assessment with public access data policy

	Landsat-7	Landsat-8	Sentinel-2	Sentinel-3
Satellite and sensor details				
Satellite sensor system	ETM+	OLI/TIRS	MSI	OLCI
Spatial resolution (m)	15, 30, 60	15, 30, 100	10, 20, 60	300
Spectral Bands	8	11	12	21
Revisit cycle (days)	16	16	5	2
Swath width (km)	185	185	290	1270
Launch date	April 1999	February 2013	June 2015	Feb 2016
Years in orbit/minimum design life (years)	18/5	4/5	2/7	1/7
Suitability for water quality assessment	●-Highly Suited; ●-Suitable; ●-Potential			
CHL	●	●	●	●
CYP	●	●	●	●
TSM	●	●	●	●
CDOM	●	●	●	●
SD	●	●	●	●
K_d	●	●	●	●

CHL – Chlorophyll, **CYP** – Cyanophycocyanin, **TSM** – Total Suspended Matter, **CDOM** – Colored Dissolved Organic Matter, **SD** – Secchi Disk Transparency, **K_d** – Vertical Attenuation of Light

Suitability for water quality assessment from Dekker, A.G. & Hestir, E. L. (2012) *Evaluating the Feasibility of Systematic Inland Water Quality Monitoring with Satellite Remote Sensing*. CSIRO: Water for a Healthy Country National Research Flagship


Thank you!