NOAA GREAT LAKES

Improving NOAA's service to the Nation through collaboration

NOAA and the GLRI:
Summary Presentations of all current NOAA projects

January 22, 2020

Great Lakes RESTORATION

Focus Area 5: Foundations for Future Restoration Actions

- 2 Objectives:
  - Educate the next generation about the Great Lakes ecosystem (NOAA)
  - Conduct comprehensive science programs and projects (NOAA)

Objective 5.2 – Conduct comprehensive science programs and projects

Objective	Commitment
5.2. Conduct comprehensive science programs and projects.	• Assess overall health of the Great Lakes ecosystem and identify the most significant remaining problems. • Identify cross-cutting science priorities and implement projects to address those priorities.

Measures of Progress

- 5.2.1. Annual Great Lakes monitoring conducted and used to prioritize GLRI funding decisions.
- 5.2.2. Identify and address cross-Focus Area science priorities to support implementation of GLRI and the Great Lakes Water Quality Agreement.

Science Objective Projects

Project	Presenter
State, Tribal and Federal Capacity to coordinate and implement LAMP programs	Jennifer Day, OAR GLERL
Hardened Shoreline Ecological Indicator GIS	Brandon Krumwiede, NOS OCM
Updating vertical datums at local ports and harbors of refuge through seasonal water level measurements	Adam Grodsky, NOS CO-OPS
Long-term data assimilative, temperature and currents database for Lake Michigan, Lake Erie and Saginaw Bay	Philip Chu, OAR GLERL
SOAR - Under Ice	Steve Ruberg, OAR GLERL
Great Lakes Synthesis, Observations and Response (SOAR) System	Steve Ruberg, OAR GLERL and Andrea VanderWoude, OAR GLERL
Evaluating water clarity, turbidity, and eutrophication status of the Great Lakes with satellite radiometric data	Paul DiGiacomo, NESDIS STAR
NOAA Support Cooperative Science and Monitoring Initiative (CSMI)	Ashley Elgin, OAR GLERL and Hank Vanderploeg, OAR GLERL
Next Gen Tools to Sample Dreissena	Ashley Elgin, OAR GLERL

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LAMP Capacity

Jennifer Day

NOAA GLRI Webinar

January 22, 2020

Great Lakes RESTORATION

Project Introduction

- Project Lead: Jennifer Day
- Funding: $20k per year to support capacity to engage in each of the five Lakewide Action and Management Plans (LAMP)
- Funding comes from Focus Area 5.2.2. which supports work under the Great Lakes Water Quality Agreement

Project Description

- NOAA has several staff with geographic and issue expertise who can be engaged in the LAMPs
- Each lake is different from both a staffing and action need
- GLRI provides for a contractor to track actions from every meeting across five lake processes and keep track with actions and follow up
- GLRI provides funding for some travel to in-person meetings that otherwise would not be possible

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Hardened Shorelines Ecological Indicator GIS

Brandon Krumwiede

NOAA GLRI Webinar

January 22, 2020

Great Lakes RESTORATION

Project Introduction

Project Lead: Heather Stirratt (NOAA OCM)

Co-PIs: Brandon Krumwiede

Funding Amount: $400,000 (FY18-FY20)

GLRI Focus Area: 5 – Foundations for Future Restoration Actions

GLRI Objective: Implement a science based adaptive management approach for GLRI

Measures of Progress: Project evaluations completed and used to prioritize GLRI funding decisions each year

Partners: U.S. Army Corps of Engineers, Tetra Tech

Project Description

For many years the need for tracking changes in hardened shoreline has been recognized as a priority in the Great Lakes and it is one of many GLWQA ecological indictors. Understanding where hardened shoreline plays a role in identifying opportunities for littoral system restoration is a critical aspect of prioritizing work in an anthropomorphic system.

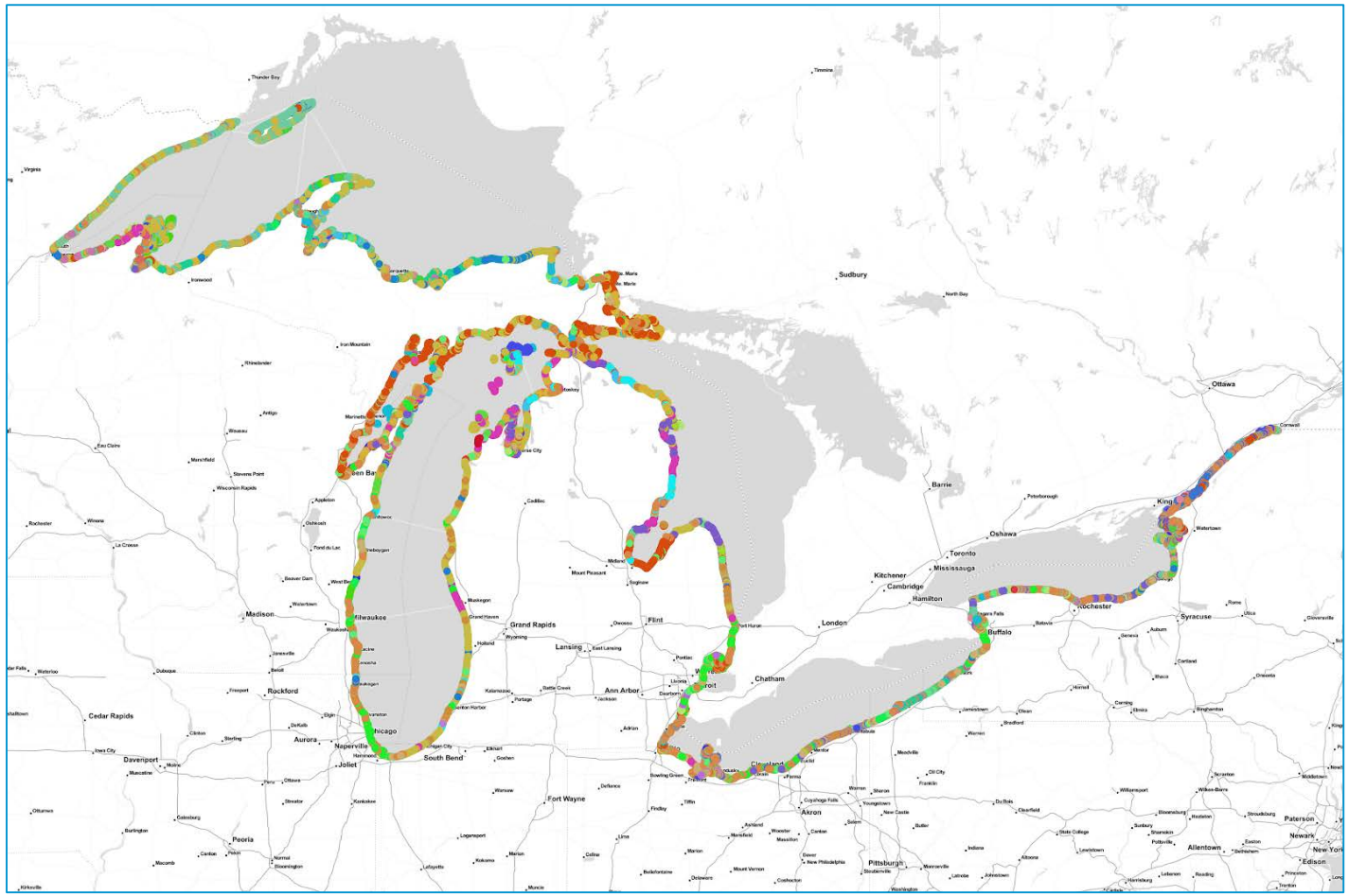
NOAA used existing aerial imagery and ancillary data to develop a baseline hardened shoreline classification using the best available imagery to date. The following products were created:

- Data sources list
- Uniform methodology for classification
- Geospatial data product (US side)
- Final report providing summary statistics from the basin level to state level

This effort provides a Great Lakes (US side) baseline for this long ignored ecological indicator.

The unintended consequences of hardened shoreline have long been recognized, but to date are not comprehensibly collected to recognize potential systemic issues in Focus Area 4.

Project Description



New Hardened Shoreline Classification for the Great Lakes showing shoreline type. Other attributes include: primary structure type and condition; secondary structure type and condition; town; county; state; image source vintage; and length. Final products will be publicly available February 2020.

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Updating Vertical Datums at Small Ports and Harbors of Refuge through Seasonal Water Level Measurements

Adam Grodsky

NOAA GLRI Webinar

January 22, 2020

Great Lakes RESTORATION

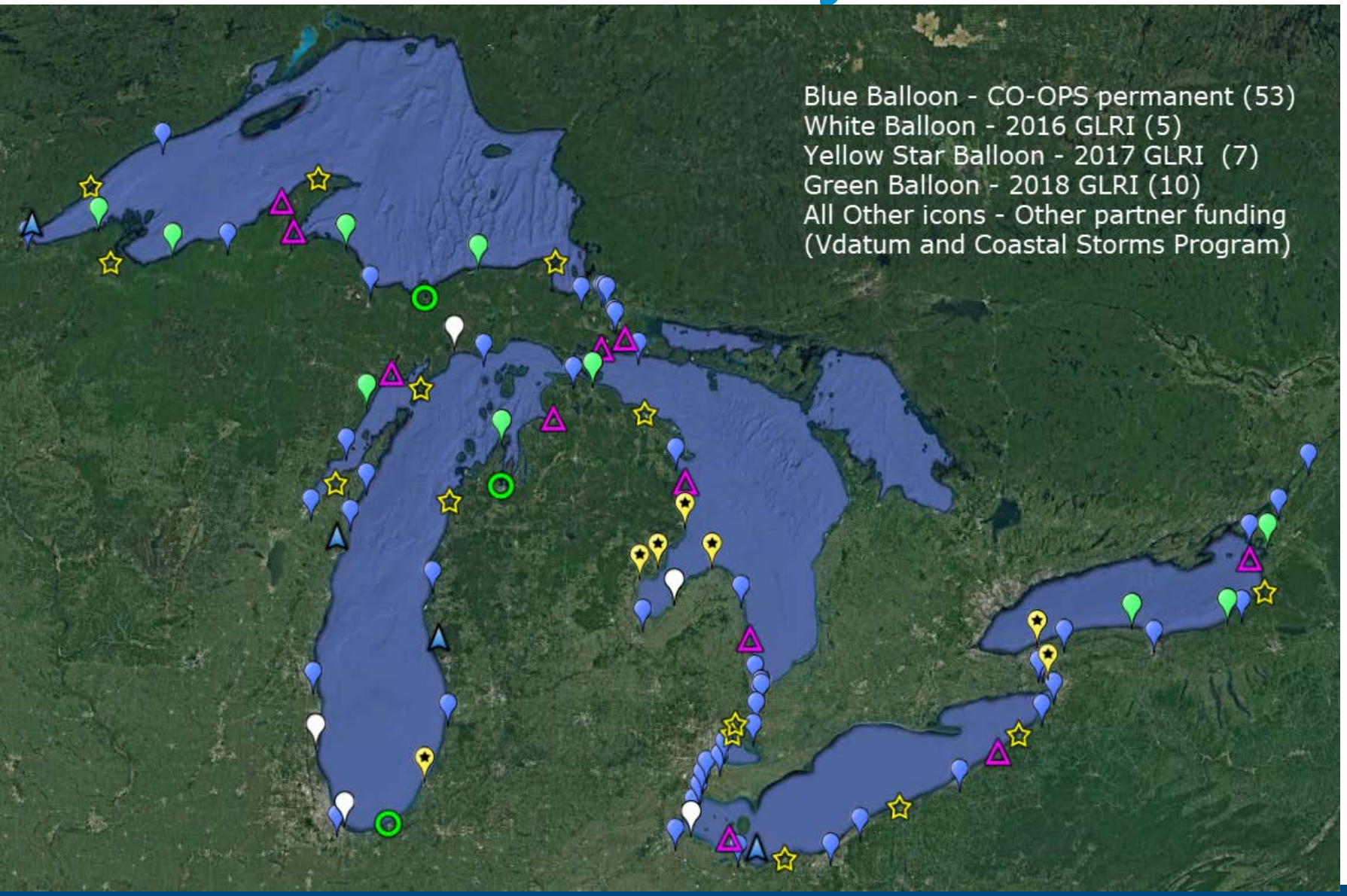
Project Introduction

- Project Lead: Laura Rear McLaughlin (NOS/CO-OPS)
- Co-lead: Adam Grodsky (NOS/CO-OPS)
- FY18 Funding: $310,000
- Focus Area 5 Objective 2: Conduct comprehensive science programs and projects
- Measure of Progress: Annual Great Lakes monitoring conducted and used to prioritize GLRI funding decisions
- Partner: NOS/NGS

Project Description

- Collect water level data at 10 small ports and harbors locations during June-September of 2020.
- This project will support the installation of those gauges at the most significant locations in the Great Lakes as determined by a prioritization that incorporates rates of vertical motion, input from the U.S. Army Corps of Engineers, and the EPA AOC program.
- Water level data will support the update of the International Great Lakes Datum and a modeling tool (VDatum) that will allow users to vertically transform geospatial data among IGLD and orthometric and ellipsoidal vertical datums.

Project Area



Project Outcomes

- Four months of water level will be collected (June through September)
- CO-OPS will calculate International Great Lakes Datum (IGLD) 1985 heights once all data has been collected
- Data will be available after IGLD 85 heights are calculated and data is placed on 85 elevation
- The 1985 heights will be converted to IGLD 2020 heights when the new datum is released in late 2025/early 2026.

	June 2018	July 2018	Aug 2018	Sept 2018	Summer Mean	Calculated HC	Model HC	Difference
Lake Superior								
9099018 Marquette	183.586	183.674	183.678	183.713	183.6628			
9099007 Whitefish Point	183.487	183.577	183.585	183.611	183.5650	-0.098	-0.072	-0.026
9099039 Eagle Harbor	183.526	183.617	183.611	183.655	183.6022	-0.061	0.022	-0.083
9099050 Ashland	183.709	187.775	183.782	183.835	183.7752	0.112	0.054	0.058
9099075 Beaver Bay	183.690	183.764	183.774	183.838	183.766	0.103	0.066	0.037
Lake Michigan								
9075014 Harbor Beach	176.990	177.001	176.966	176.945	176.976			
9087018 Frankfort	177.069	177.059	177.020	177.016	177.041	0.065	0.077	-0.012
9087036 St. Joseph	177.149	177.121	177.065	177.072	177.102	0.126	0.093	0.033
9087091 Anderson Point	177.130	177.120	177.078	177.090	177.105	0.128	0.075	0.053
9087175 Fish Creek Harbor	177.174	177.147	177.095	177.104	177.130	0.154	0.112	0.042
Lake Huron								
9075014 Harbor Beach	176.990	177.001	176.966	176.945	176.976			
9075024 Port Austin	176.985	176.999	176.960	176.939	176.971	-0.005	-.002	-0.003
9075045 Point Lookout	177.027	177.029	176.981	176.971	177.002	0.026	-0.001	0.027
9075056 Oscoda	176.979	176.993	176.950	176.932	176.964	-0.012	-0.002	-0.010
Lake St. Clair								
9034052 St Clair Shores	175.721	175.709	175.640	175.62	175.672			
9034055 Point Huron	175.739	175.733	175.672	175.638	175.696	0.024	0.001	0.023
9034057 New Baltimore	175.739	175.736	175.680	175.638	175.698	0.026	0.002	0.024
Lake Erie								
9063053 Fairport	174.877	174.815	174.714	174.650	174.764			
9063029 Dunkirk	174.822	174.772	174.697	174.581	174.718	-0.046	-0.025	-0.021
9063048 Ashtabula	174.849	174.788	174.694	174.614	174.736	-0.028	-0.010	-0.018
9063069 Lorain	174.942	174.872	174.750	174.714	174.820	0.056	0.003	0.053
Niagara River								
9063015 Beaver Island State Park	172.490	172.465	172.453	172.378	172.446			
Lake Ontario								
9052030 Oswego	75.204	75.049	74.906	74.712	74.968			
9052025 Port Ontario	75.225	75.070	74.925	74.727	74.987	0.019	0.001	0.018
9052090 Fort Niagara	75.253	75.104	74.941	74.782	75.020	0.052	0.029	0.023

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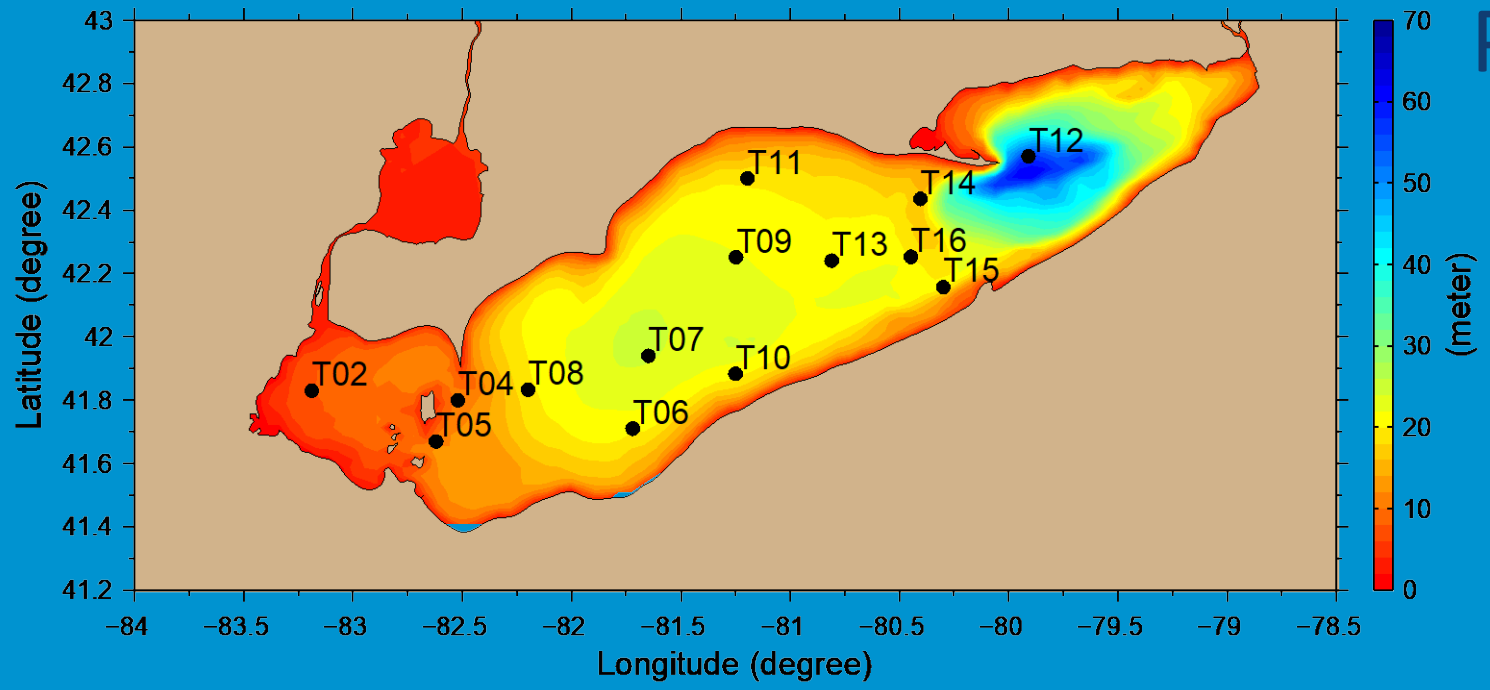
Long-term data assimilative, temperature and currents database for Lake Erie and Lake Michigan



Philip Chu, NOAA/GLERL

NOAA GLRI Webinar

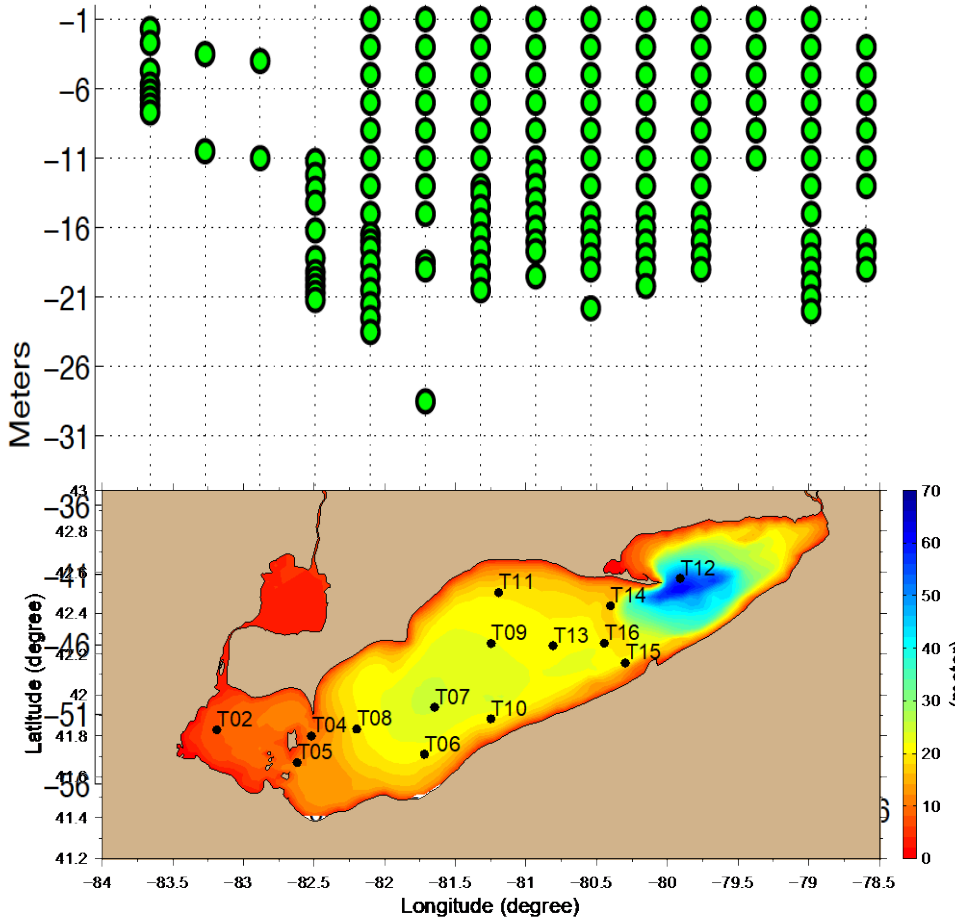
January 22, 2020

Project Introduction

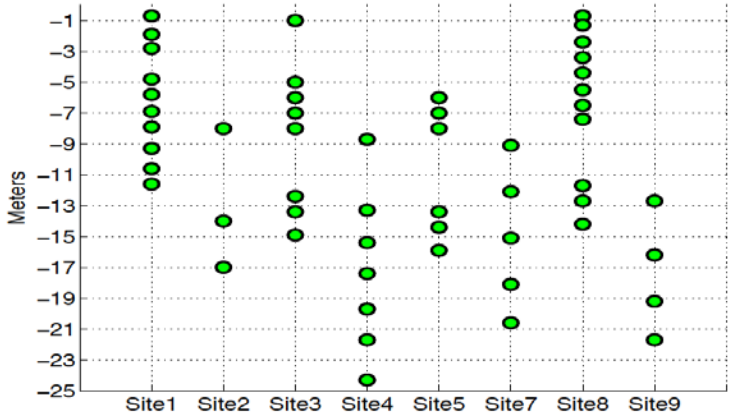
- Project Lead and Co-PIs: Philip Chu, NOAA/GLERL
  Professor Pengfei Xue, Michigan Technological University (MTU)
- GLRI Funding amounts: FY18 $250K, FY19 $250K
- GLRI Focus Area 5: Foundation for Future Restoration Actions
- Objective: 5.2 Conduct comprehensive science programs & projects
- Measurement of Progress: 5.2.1 Annual Great Lakes monitoring conducted and used to prioritize GLRI funding decisions
- Partners: Eric Anderson, Greg Lang, Lacey Mason - NOAA/GLERL
  Xinyu Ye, Chenfu Huang - MTU

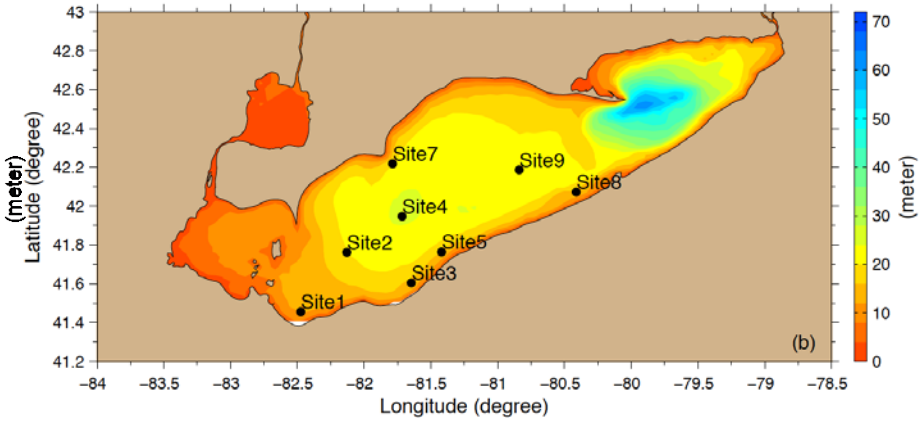
2005 (high vertical resolution) vs 2017 (lower vertical resolution, fewer sampling sites)

International Field Years on Lake Erie



Coastal Hypoxia Research Program



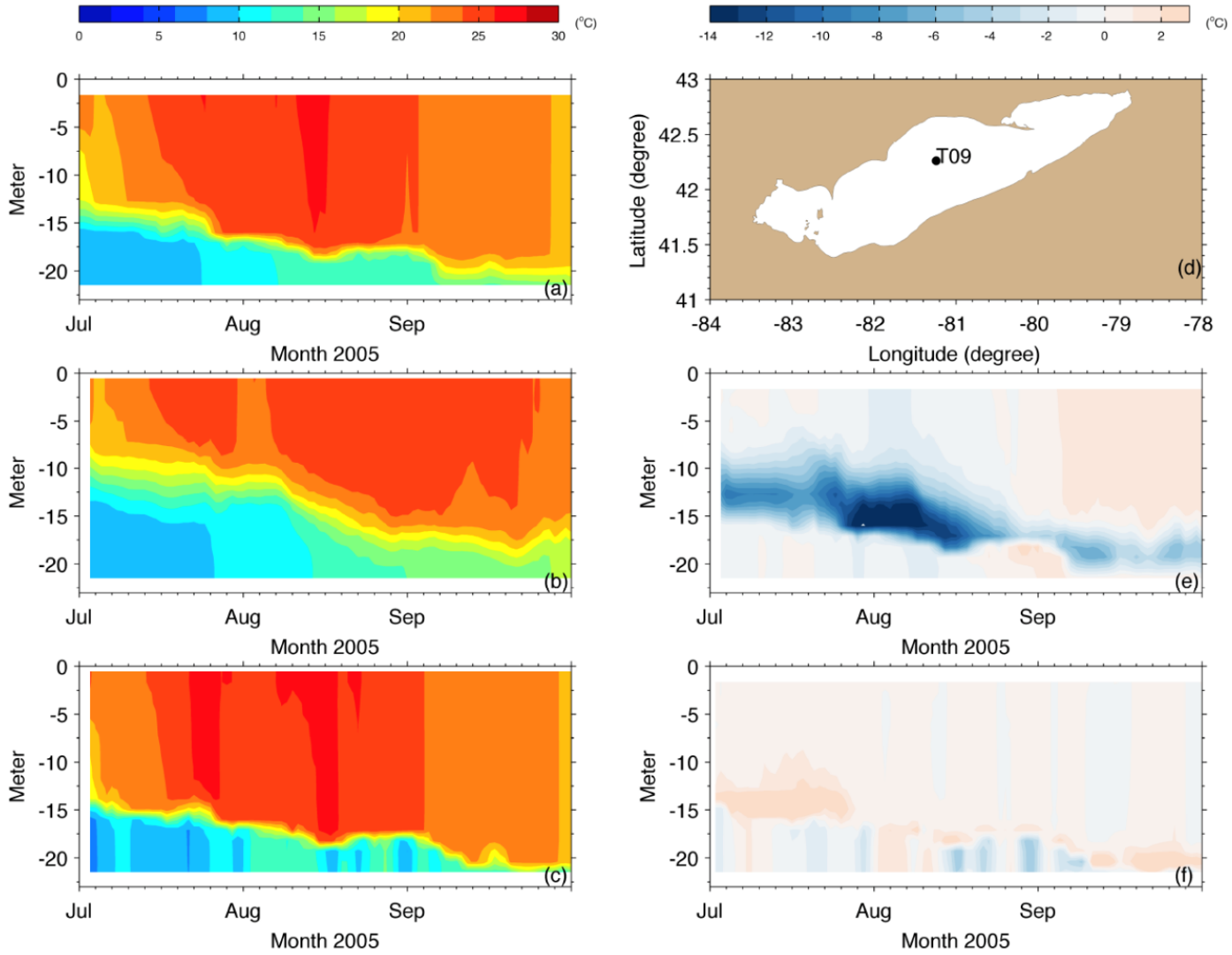


Improvement in vertical temperature profile

OBS

Control Run

DA#1

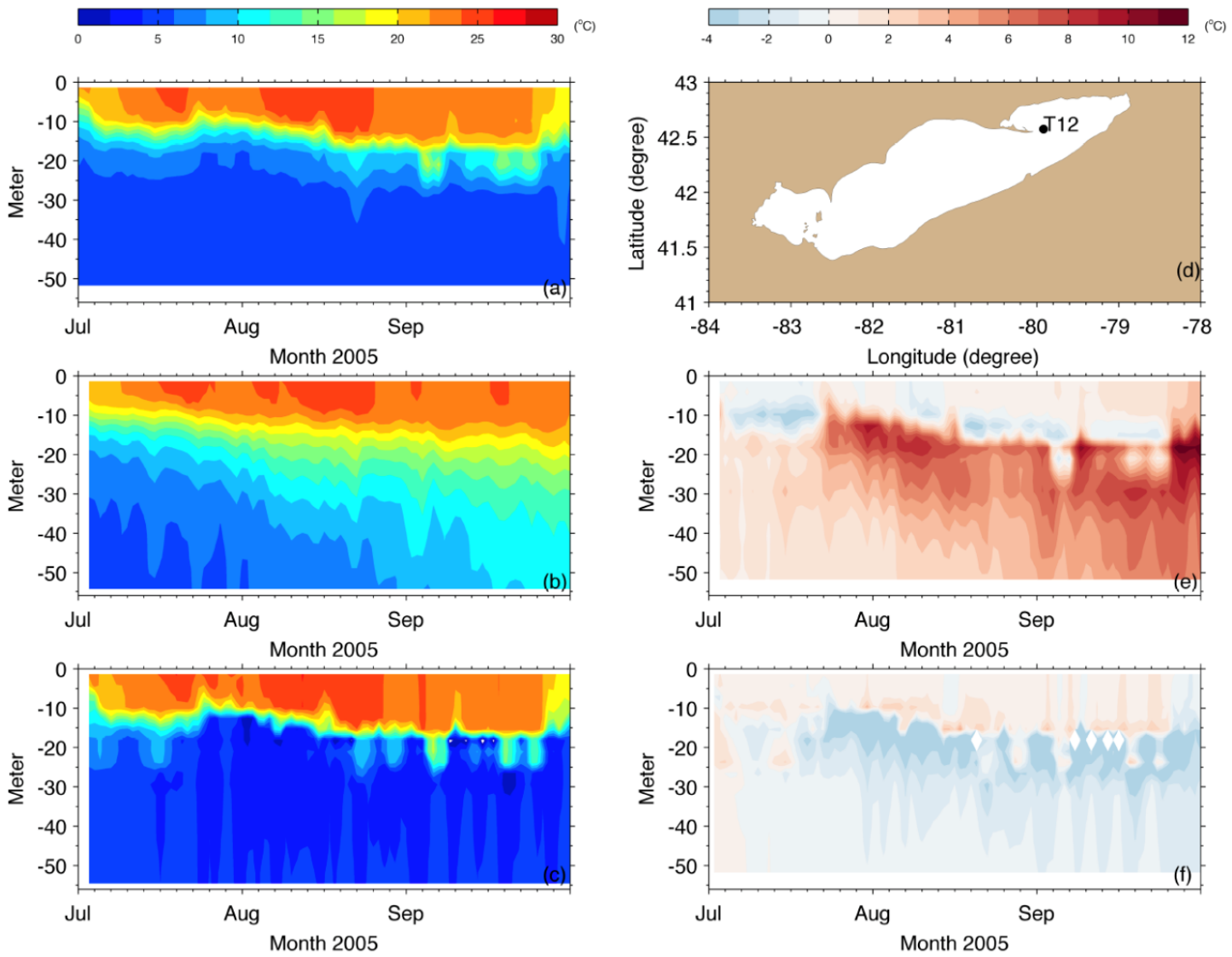


Improvement in vertical temperature profile

OBS

Control Run

DA#1

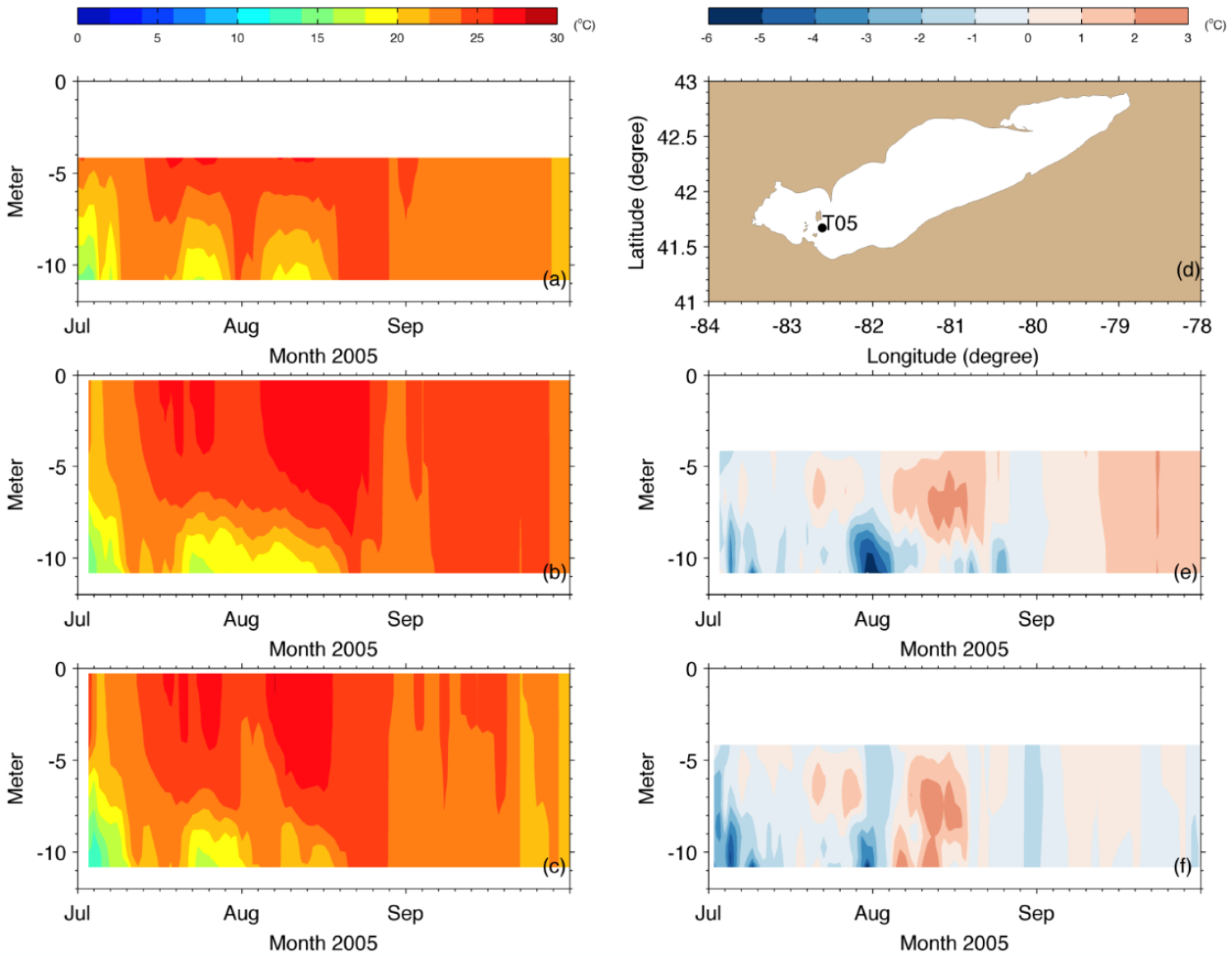


Improvement in vertical temperature profile

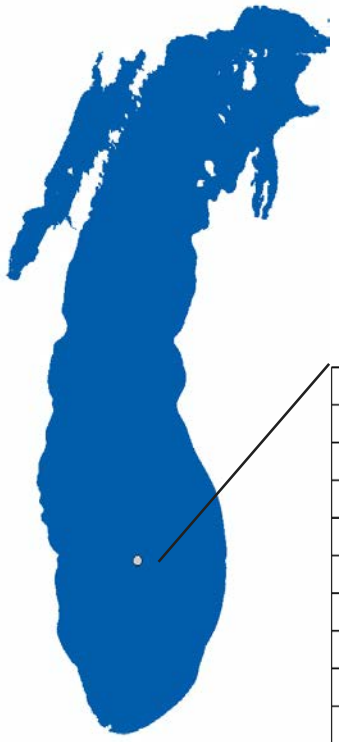
OBS

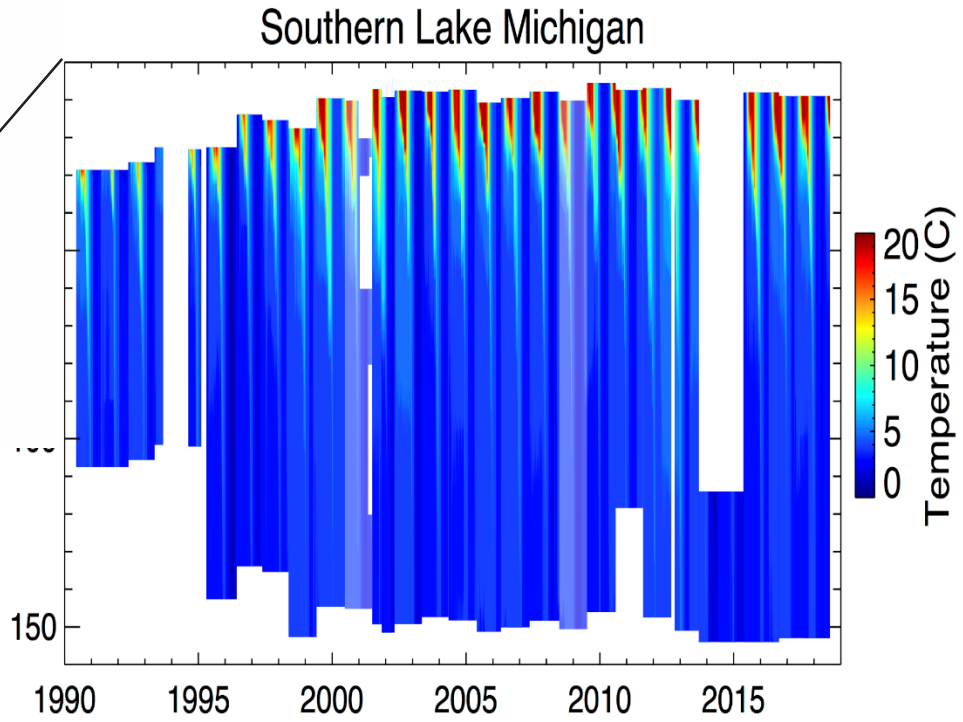
Control Run

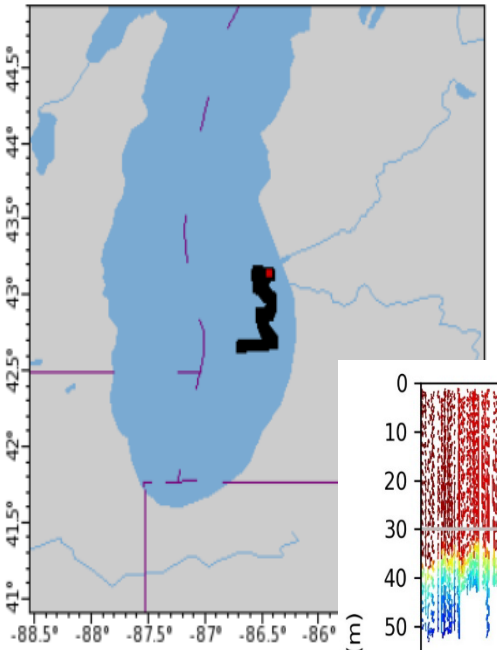
DA#1

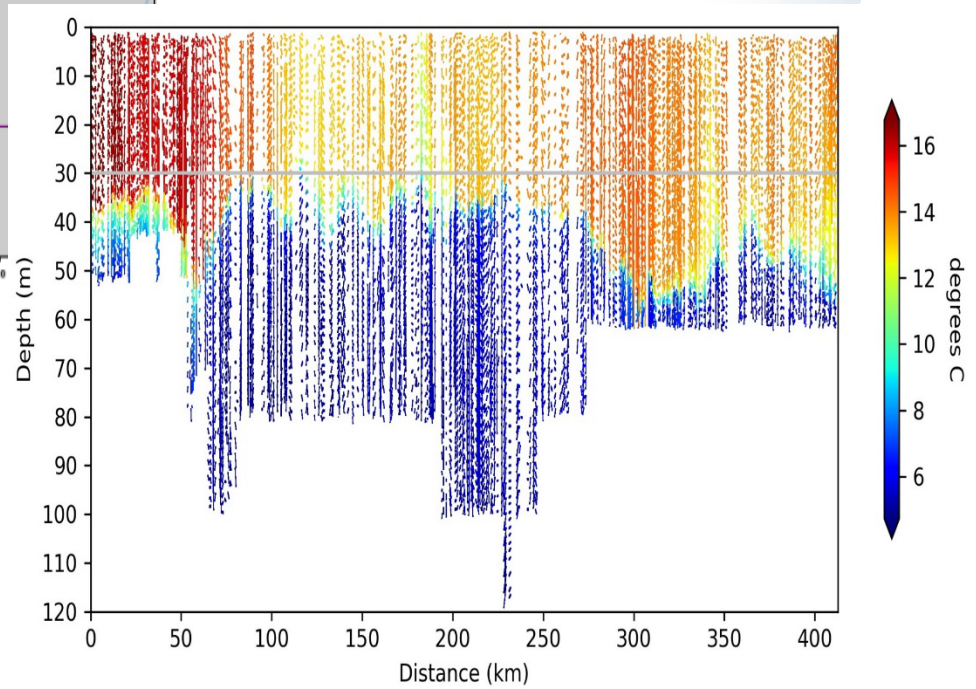


Lake Michigan temperature mooring and glider data









Project Summary

- Data Assimilation (DA) techniques improve Lake Erie thermal structure simulation and reanalysis using 2005 IFYLE and 2017 CHRP buoy and mooring data
- Working on completing data assimilative Lake Erie temperature database
- Work started on Lake Michigan with EEGLE, mooring, glider and PSS data
- Data assimilation offer additional insight to optimized sampling strategy for future fieldwork and cruise planning
- Process additional datasets from CSMI, EPA, USGS, CCIW and UMD-LLO for data assimilation
- Need funding to complete Lake Superior and Lake Ontario database

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Improved thermal structure simulation and optimized sampling strategy for Lake Erie using a data assimilative model

Xinyu Ye [a], Philip Y. Chu [c], Eric J. Anderson [c], Chenfu Huang [a], Gregory A. Lang [c], Pengfei Xue [a,b,*]

[a] Department of Civil and Environmental Engineering, Michigan Technological University, Houghton, MI, United States
[b] Great Lakes Research Center, Michigan Technological University, Houghton, MI, United States
[c] NOAA – Great Lakes Environmental Research Laboratory, Ann Arbor, MI, United States

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ABSTRACT

Lake Erie has experienced substantial environmental issues (e.g., hypoxia, harmful algal blooms) for decades, which are closely related to the lake's thermal characteristics. While three-dimensional (3D) hydrodynamic models have been widely applied to Lake Erie, challenges remain due to model representation of physical processes, errors and uncertainty in boundary conditions and forcing terms. The Great Lakes region has a relatively dense and long-term observational record, and these observational data have been used for model initialization and verification, but have not been incorporated into 3D model simulations through data assimilation (DA) to create reanalysis products or improve short-term forecasts. In this work, we developed and evaluated DA to improve thermal structure simulation of Lake Erie. Moored instrument data and satellite data are incorporated into a data-assimilative hydrodynamic model for analysis and evaluation. Results show that DA can effectively improve the model performance to create reanalysis fields when the DA formulation is appropriately developed in recognition of the dynamic com-

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Synthesis, Observations, and Response (SOAR)*

Steve Ruberg
Andrea Vander Woude

NOAA GLRI Webinar

January 22, 2020

*** Project integrated with Decision Support Tools, Vanderploeg**

Great Lakes RESTORATION

SOAR: Project Introduction

Project Lead and Co-PIs: Steve Ruberg, Andrea Vander Woude, Reagan Errera, Mike Sayers, Bob Shuchman, Russ Miller, Tom Johengen, Henry Vanderploeg

Funding Amounts: FY16($1,095K), FY17($900K), FY18($990K), FY19($1,080K), FY20($1,100K)

Focus Area 5: Adaptive management 5.3; Annual Great Lakes monitoring conducted and used to prioritize GLRI funding decisions each year 5.3.2

SOAR: Project Introduction

Partners and Collaborators:

Tom Johengen[2]
Danna Palladino[1]
Ashley Burtner[2]
Michele Wensman[2]
Russ Miller[2]
Joeseph Smith[2]
Heidi Purcell[2]
Dack Stuart[2]
Mike Sayers[2]
Bob Shuchman[2]

Mark Rowe[1]
Rick Stumpf[1]
Jim Birch[4]
Chris Preston[4]
Bill Ussler[4]
Brian Kieft[4]
Ben Yair Raanan[4]
Erik Traushke[4]
Paul DenUyl[2]
Zachary Haslick[5]

Eric Anderson[1]
Steve Constant[1]
Greg Doucette[1]
Kyle Beadle[1]
Karl Bosse[2]
Ron Muzzi[1]
Reagan Errera[1]
Andrea Vander Woude[3]

1 2 3 4 5

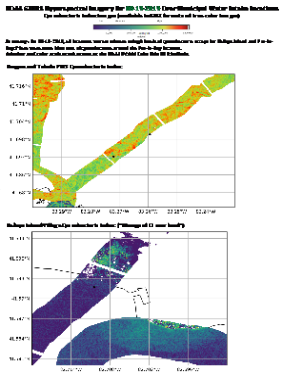
SOAR: Project Description

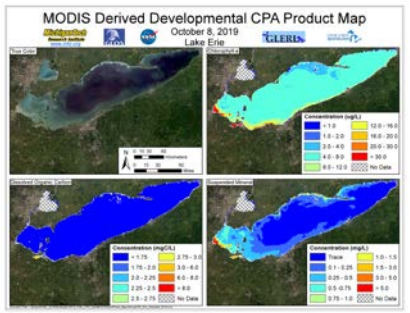
The SOAR project provides environmental information about coastal conditions to researchers and regional managers on Lakes Michigan, Huron and Erie. The implementation of the project includes the deployment and support of on-water and remote sensing platforms where observations from these systems are used to develop ecosystem models and forecasts, report on restoration progress, and aid in decision support for regional managers.

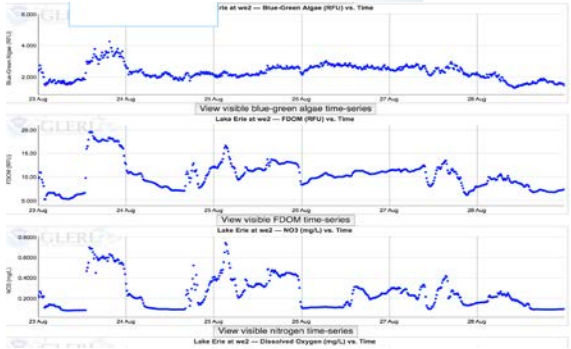
The project monitors and reports on ecosystem state, hypoxic conditions, harmful algal blooms (HABs), and nutrients using real-time sensor networks, hyperspectral flyovers, and satellite remote sensing. Decision support information products include a seasonal forecast, real-time data from buoys, a hyperspectral report of HABs around water intakes, and HAB areal extent for feedback on adaptive management success.

SOAR Products & End Users

Data / Instruments	Products	End Users
Airborne Hyperspectral Camera	Raw Radiance Data, Cyanobacteria Levels and Phytoplankton Groups	Municipal Drinking Water Managers, Academic Researchers and Federal Agencies
Optical Properties	Improves Remote Sensing-based Water Quality Products (i.e. Color-Producing Agent Algorithm)	NESDIS, Academic Researchers, EPA GLNPO
Spaceborne MODIS Satellite	HAB Areal Extent	EPA GLNPO, NOAA GLERL, Academic Researchers
Real-time Nutrient Buoys (Lake Erie)	Chlorophyll, Winds, Temperature, Turbidity, Nitrogen, Phosphorous, Dissolved Oxygen, Blue-Green Algae	Municipal Drinking Water Managers, Recreation, Academic Researchers (Models), Federal Agencies (Forecasts)
Real-time Ecosystem Buoys (Lake Michigan, Saginaw Bay)	Chlorophyll, Winds, Waves, Currents, Temperature, Turbidity, Dissolved Oxygen, Blue-Green Algae	Academic Researchers (Models), Federal Agencies (Forecasts), NWS (Validation), Coast Guard, Recreation
SOAR Under Ice	Ice Thickness, Ice Type, and Ecosystem Buoy Products	Ice-Modelers and Ecosystem Buoy Users







Hyperspectral Cameras

Western Lake Erie, weekly & Saginaw Bay, biweekly

Flights
2015: 8
2016: 28
2017: 30
2018: 22
2019: 21

Parameters	Resonon Pika II II	Resonon Pika L
Spectral range	400-900 nm	400-1000 nm
Bands/Channels	240	281
Field of View	17.6 degrees	24.8 degrees

Hyperspectral Product

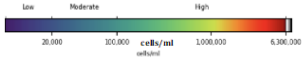
Cyanobacteria Levels

24 to 48-hours after flight ->
Hyperspectral Cyanobacteria Levels Report

- **Ohio EPA**
- **Ohio Municipal Drinking Water Managers**
- **Michigan Drinking Water Managers**
- **Michigan DNR**

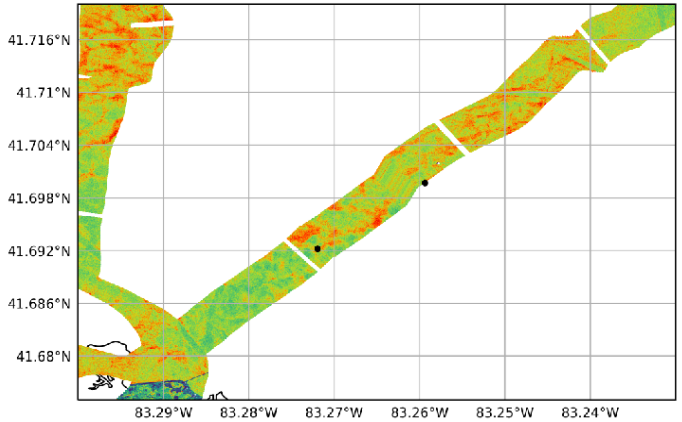
NOAA GLERL Hyperspectral Imagery for 08-19-2019 Over Municipal Water Intake Locations

Cyanobacteria Index Images (available in KMZ format and true-color images)

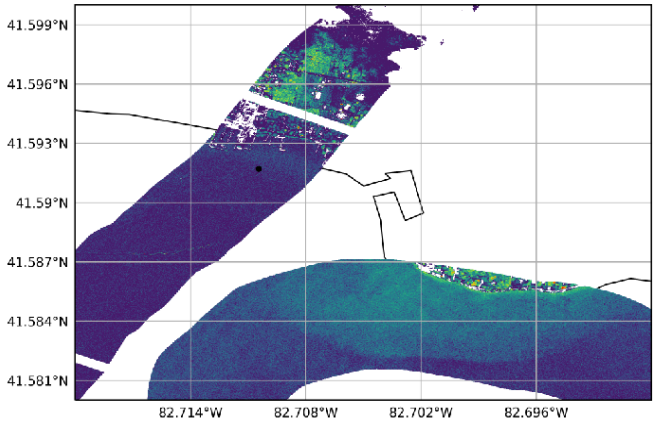


Summary: On 08-19-2019, all locations were moderate to high levels of cyanobacteria except for Kelleys Island and Put-In-Bay. There were some filaments of cyanobacteria around the Put-In-Bay location.
Colorbar and color scale are the same as the NOAA NCOSS Lake Erie HAB bulletin.

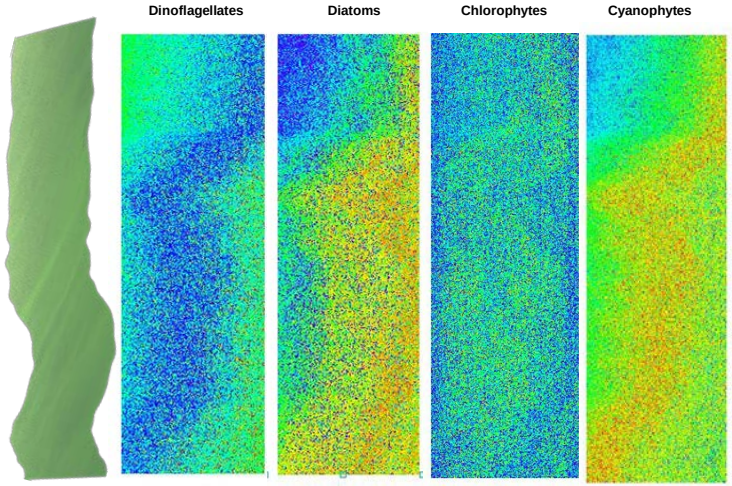
Oregon and Toledo PWS Cyanobacteria Index:



Kelleys Island Village Cyanobacteria Index: (*Disregard CI over land*)



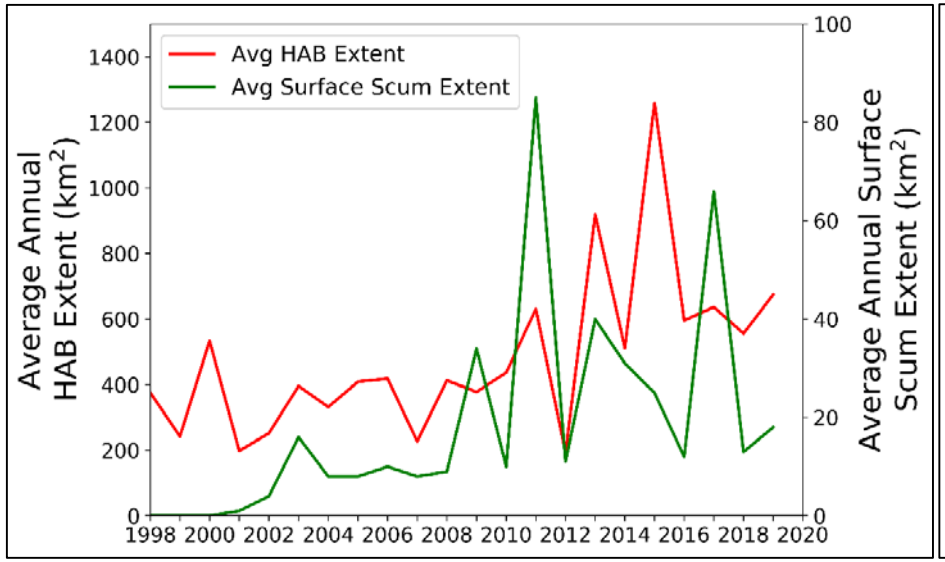
Hyperspectral Phytoplankton Groups Including Cyanobacteria

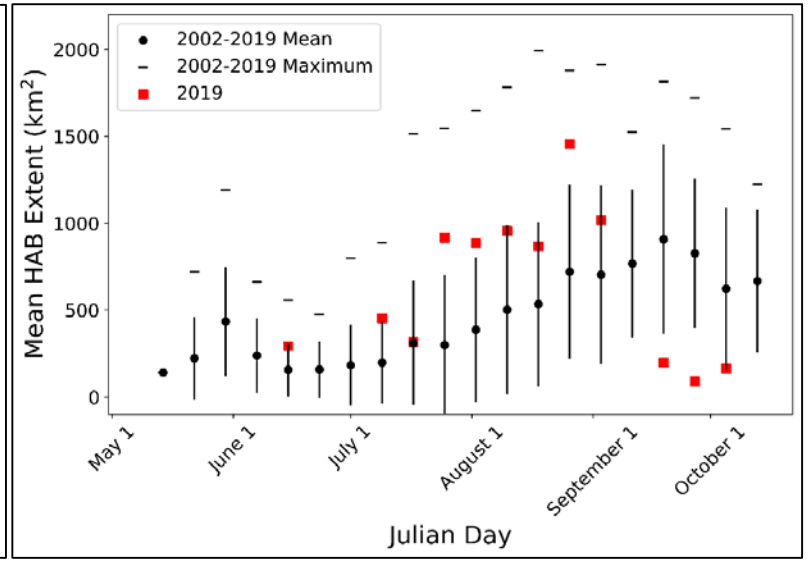


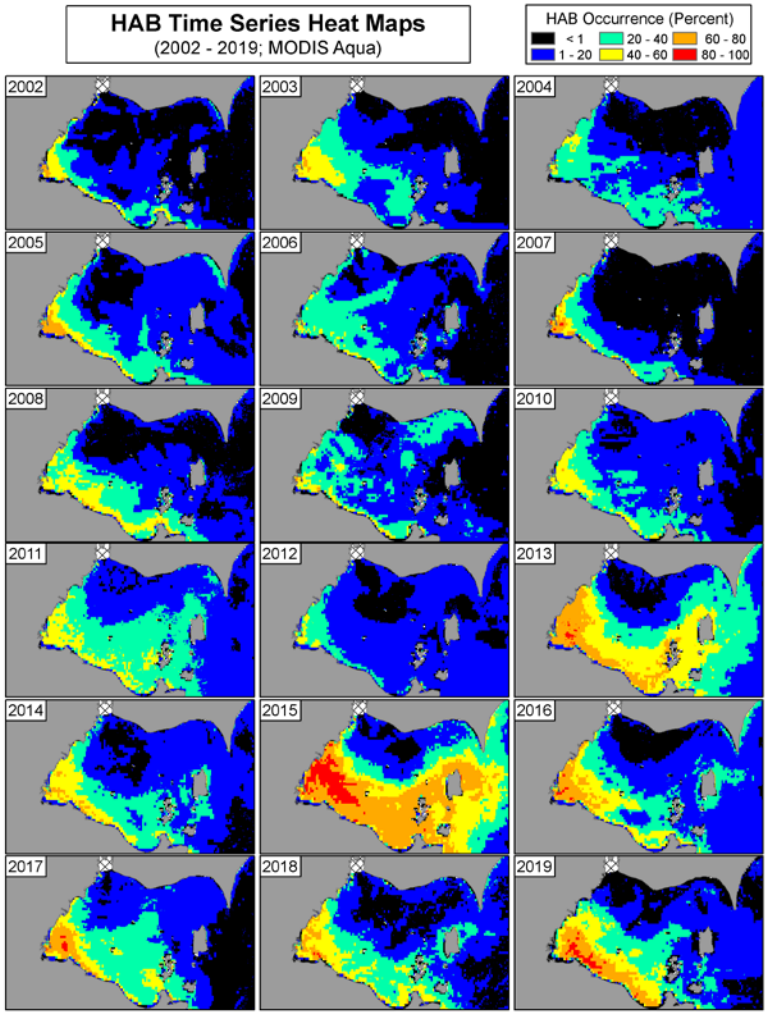
Satellite Product

Western Lake Erie HAB Areal Extent

- On average, the 2019 HAB in western Lake Erie covered approximately 700 sq km, up from 2018
- The bloom extent peaked in August and declined quickly due to persistent September winds
- End users: EPA GLNPO, NOAA GLERL, Academic Researchers



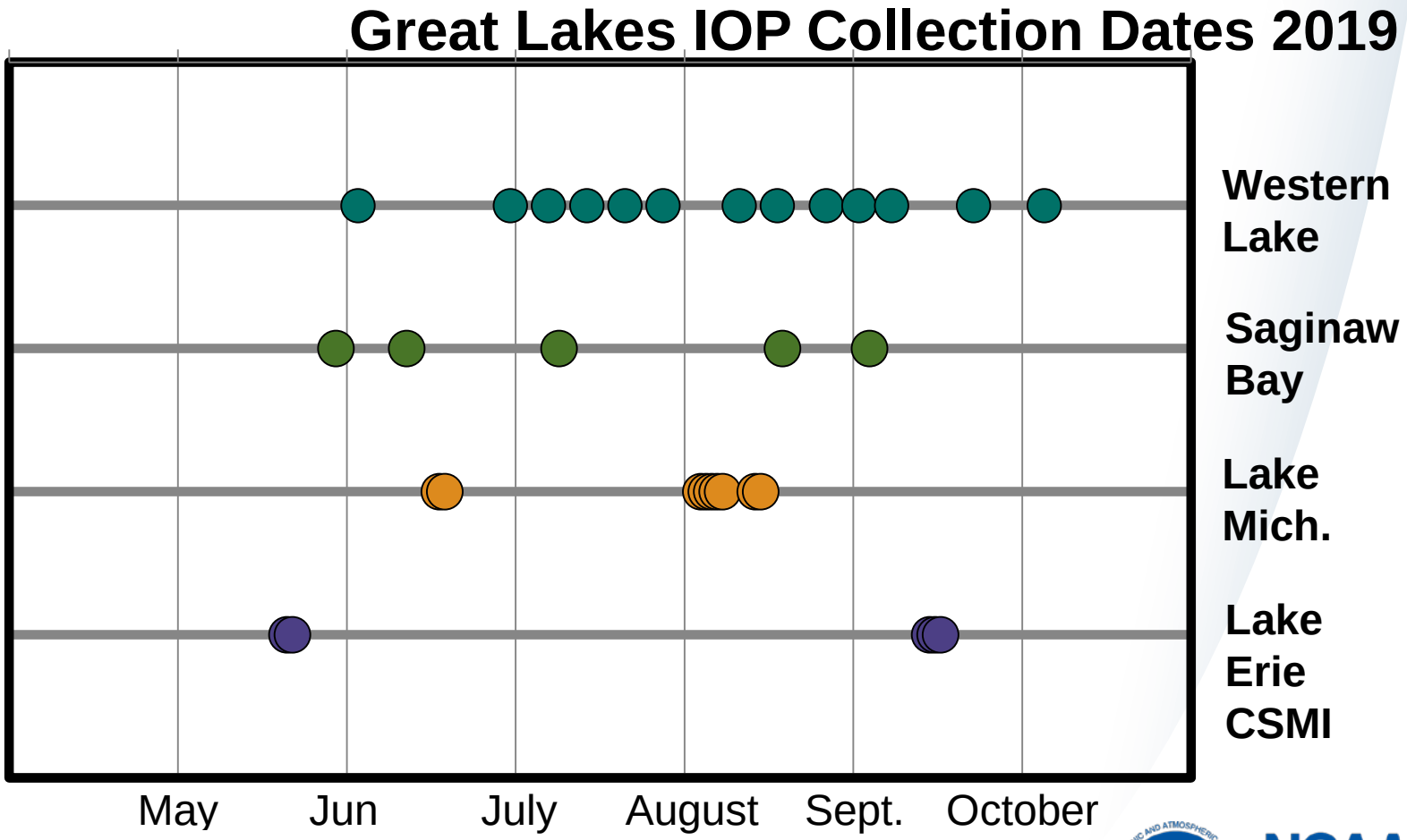




Optical Properties Product

Great Lakes, including Western Lake Erie

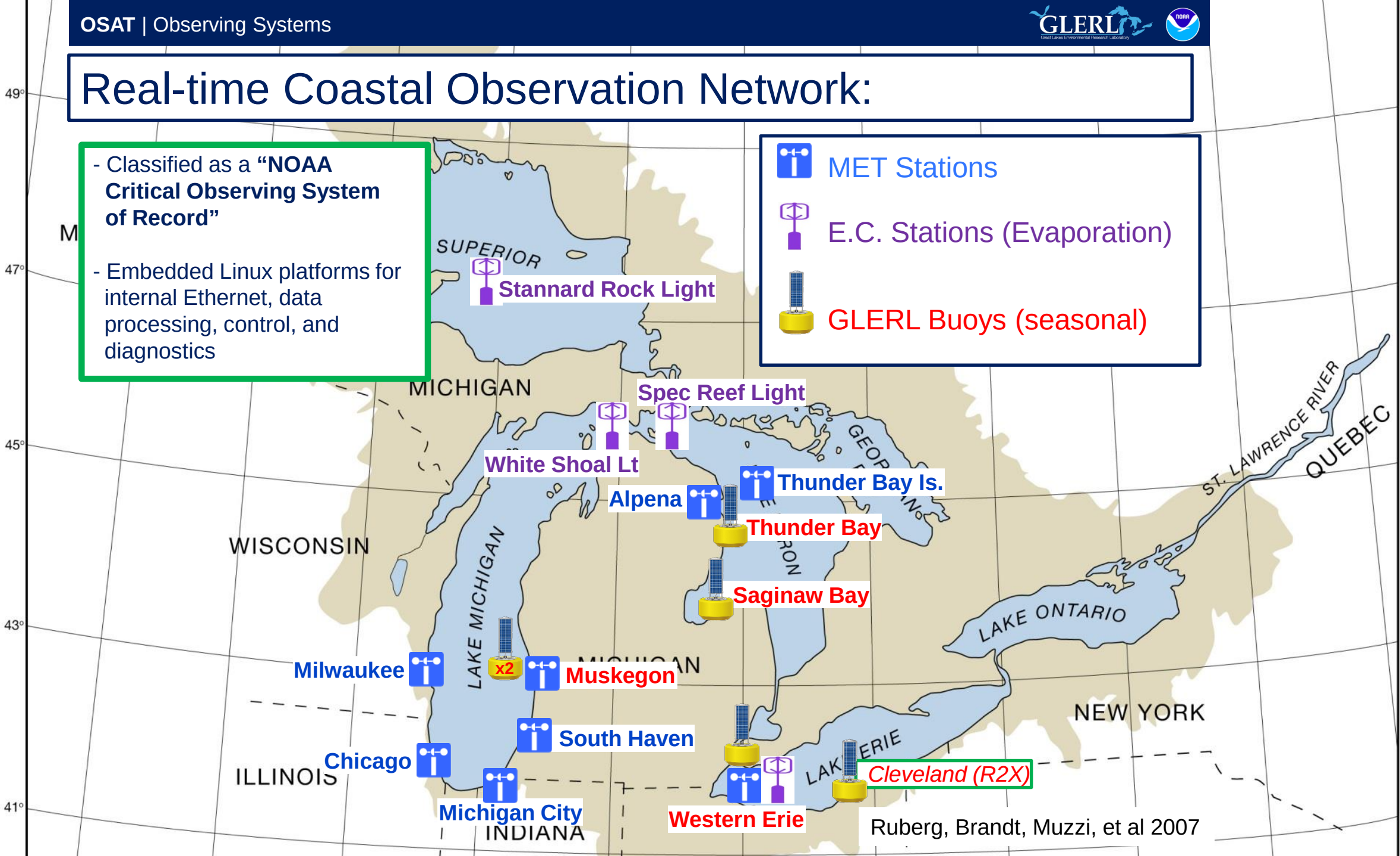
- Continued routine sampling of Inherent Optical Properties (IOP) and Apparent Optical Properties (AOP) in western Lake Erie and Saginaw Bay and opportunistic sampling in Lake Michigan and Lake Huron
- Sampled aboard the Lake Guardian for two Lake Erie CSMI cruises in May and September
- IOP/AOP sampling is allowing us to better understand the optical properties of the Great Lakes in order to improve our remote sensing-based water quality products
- End Users: NOAA (GLERL, NESDIS), Academic researchers, EPA GLNPO



Real-time Coastal Observation Network:

- Classified as a **"NOAA Critical Observing System of Record"**

- Embedded Linux platforms for internal Ethernet, data processing, control, and diagnostics

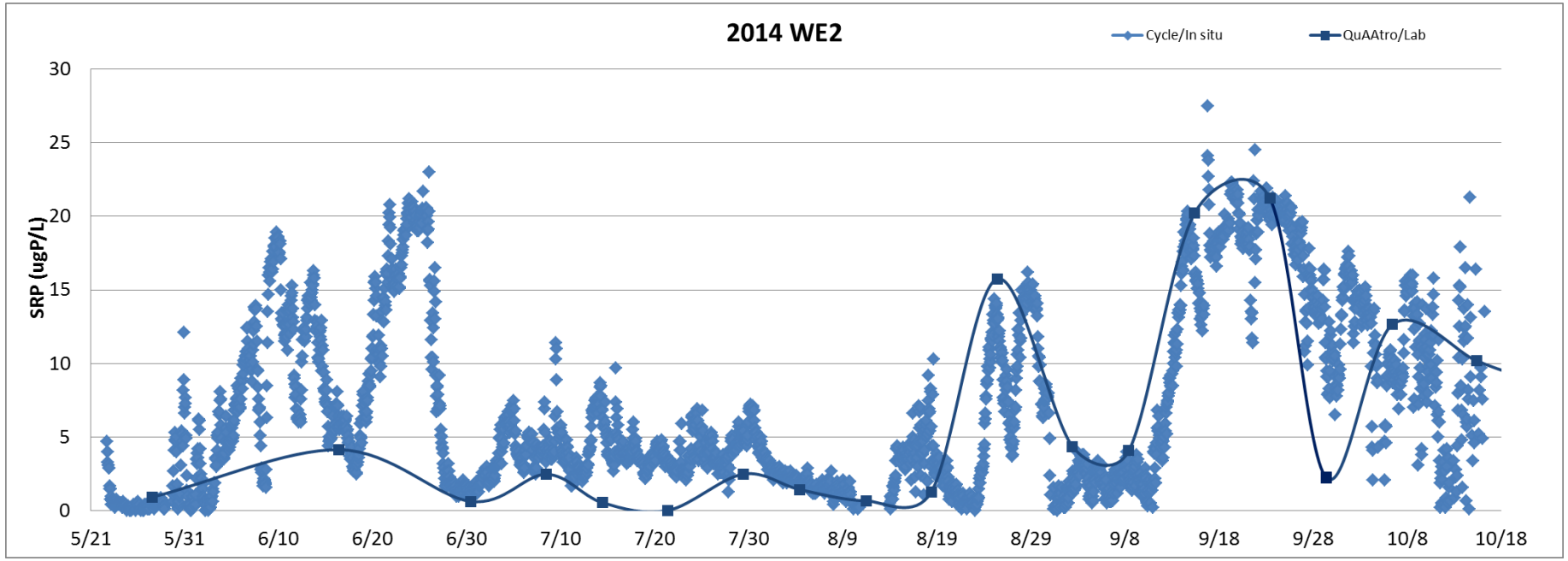


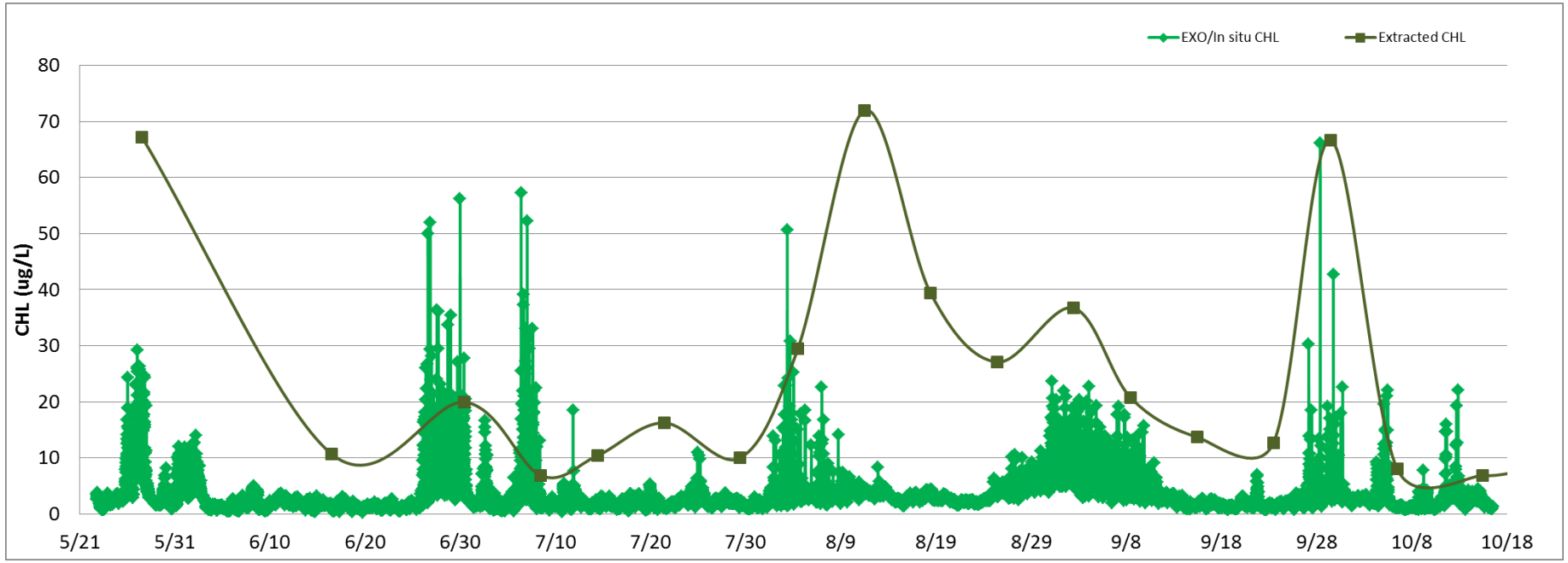
Ruberg, Brandt, Muzzi, et al 2007

WLE Continuous Real-time Monitoring Network

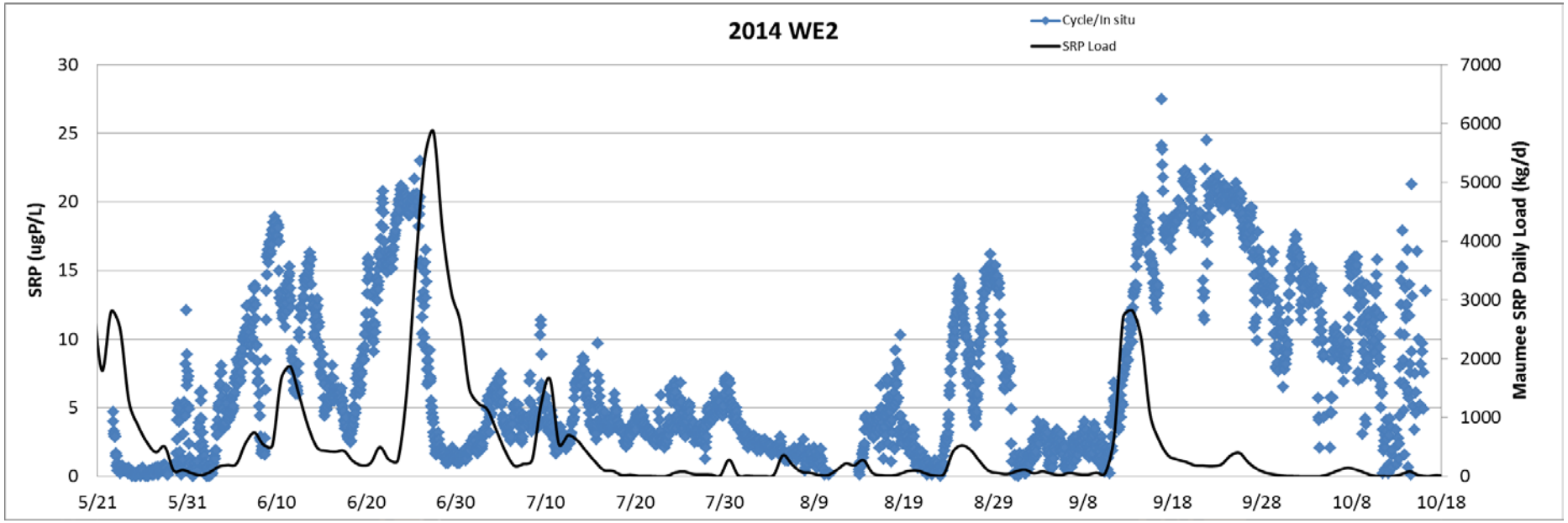
- Provide real-time water quality obs every 15 min
- Evaluate lake response to Nutrient Loads (and proposed mitigation)
- Evaluate internal nutrient dynamics
- Provide finer temporal resolution of bloom dynamics for biophysical model
- Examine relationships between nutrient availability and toxicity

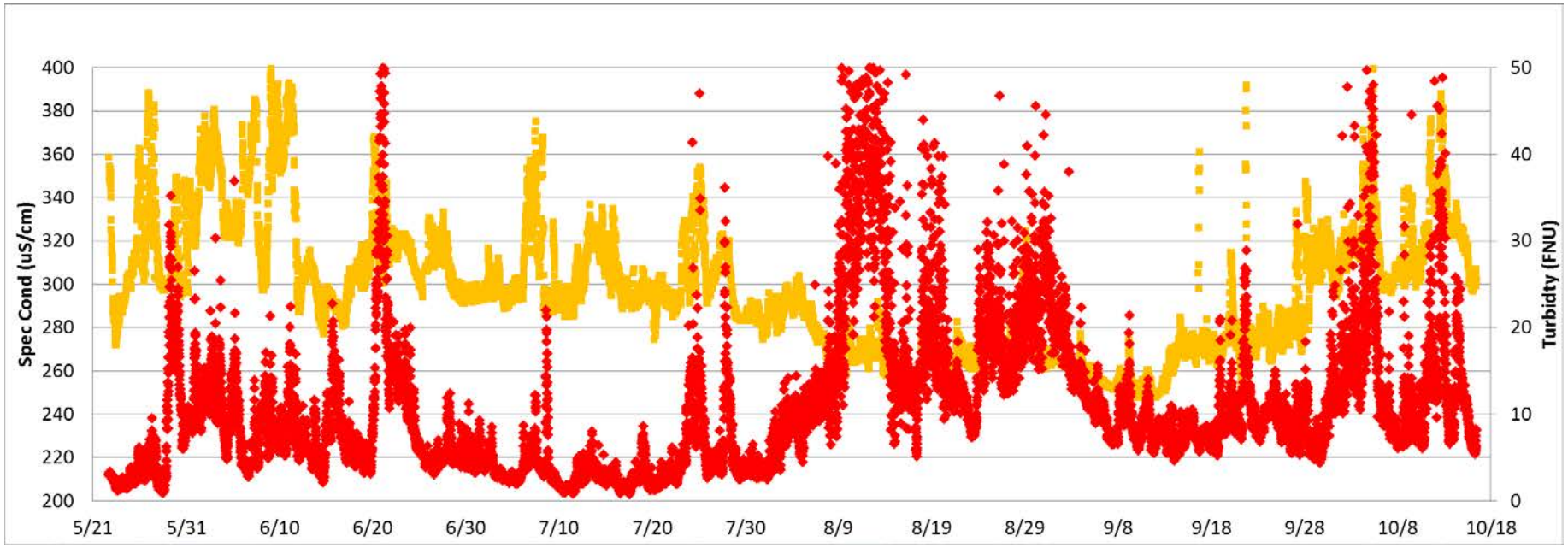
2014 Continuous Time Series: WE2





2014 Continuous Time Series: WE2





NOAA GREAT LAKES

Improving NOAA's service to the Nation through collaboration

SOAR Under Ice

Steve Ruberg

NOAA GLRI Webinar

January 22, 2020

Great Lakes RESTORATION

Project Introduction

Project Lead and Co-PIs: Steve Ruberg, Ron Muzzi, Andrea Vander Woude, Reagan Errera, Henry Vanderploeg

Funding Amounts: FY20 ($350K)

Focus Area 5: Adaptive management 5.3; Annual Great Lakes monitoring conducted and used to prioritize GLRI funding decisions each year 5.3.2

Partners and Collaborators: Ron Muzzi, Andrea Vander Woude, Reagan Errera, Henry Vanderploeg, Kyle Beadle, Steve Constant

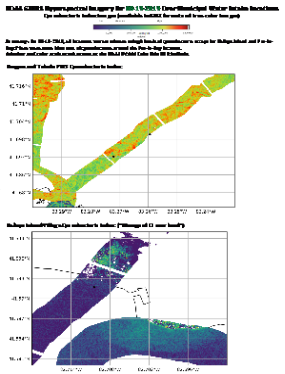
Project Description

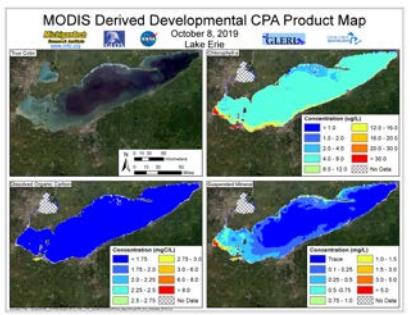
Observations of winter ecology have been neglected as ecologically unimportant relative to the summer open-water period, when most limnological field work has occurred. Recent indications are that some Great Lakes biological processes actually accelerate during the winter months (Elgin, unpublished data). Physical modeling and forecasting research and development efforts currently lack the observational and validation data required during the critical, annual thermal cycle transition times when conventional data collection platforms are precluded from safe or efficient operation.

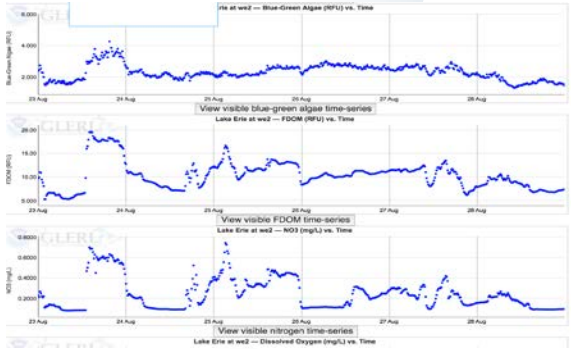
This project will provide high temporal resolution, real-time physical, chemical, and biological observations to improve our understanding of winter ecosystems and provide model and forecast validations. The project will deploy a short cabled system providing observations of relevant year-round water quality parameters through the winter ice season. Acoustic sensors will measure waves, currents, and ice-thickness for use in ice characterization and forecasting.

SOAR Products & End Users

Data / Instruments	Products	End Users
Airborne Hyperspectral Camera	Raw Radiance Data, Cyanobacteria Levels and Phytoplankton Groups	Municipal Drinking Water Managers, Academic Researchers and Federal Agencies
Optical Properties	Improves Remote Sensing-based Water Quality Products (i.e. Color-Producing Agent Algorithm)	NESDIS, Academic Researchers, EPA GLNPO
Spaceborne MODIS Satellite	HAB Areal Extent	EPA GLNPO, NOAA GLERL, Academic Researchers
Real-time Nutrient Buoys (Lake Erie)	Chlorophyll, Winds, Temperature, Turbidity, Nitrogen, Phosphorous, Dissolved Oxygen, Blue-Green Algae	Municipal Drinking Water Managers, Recreation, Academic Researchers (Models), Federal Agencies (Forecasts)
Real-time Ecosystem Buoys (Lake Michigan, Saginaw Bay)	Chlorophyll, Winds, Waves, Currents, Temperature, Turbidity, Dissolved Oxygen, Blue-Green Algae	Academic Researchers (Models), Federal Agencies (Forecasts), NWS (Validation), Coast Guard, Recreation
SOAR Under Ice	Ice Thickness, Ice Type, and Ecosystem Buoy Products	Ice-Modelers and Ecosystem Buoy Users







NOAA GREAT LAKES

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Evaluating water clarity, turbidity, and eutrophication status of the Great Lakes with satellite radiometric data

Paul M. DiGiacomo & Guangming Zheng

NESDIS/Center for Satellite Applications and Research

NOAA GLRI Webinar

January 22, 2020

Great Lakes RESTORATION

Project Introduction

- Paul DiGiacomo (Project Lead), Guangming Zheng (co-PI)

- GLRI Funding Amounts by Fiscal Year:
  - FY19 - $190,000
  - FY21 - $54,000 (Anticipated)

- GLRI Action Plan Focus Area, Objective and Measure of Progress
  - Focus Area: 5, Foundations for Future Restoration Actions
  - Objective: Implement a science-based adaptive management approach for GLRI
  - Measure of Progress: Reports on decadal changes in overall water quality and eutrophication in the Great Lakes as indicated by satellite-derived water clarity, turbidity, and phytoplankton data.

- Partners/Collaborators: Steve Ruberg, Andrea Vanderwoude (GLERL)

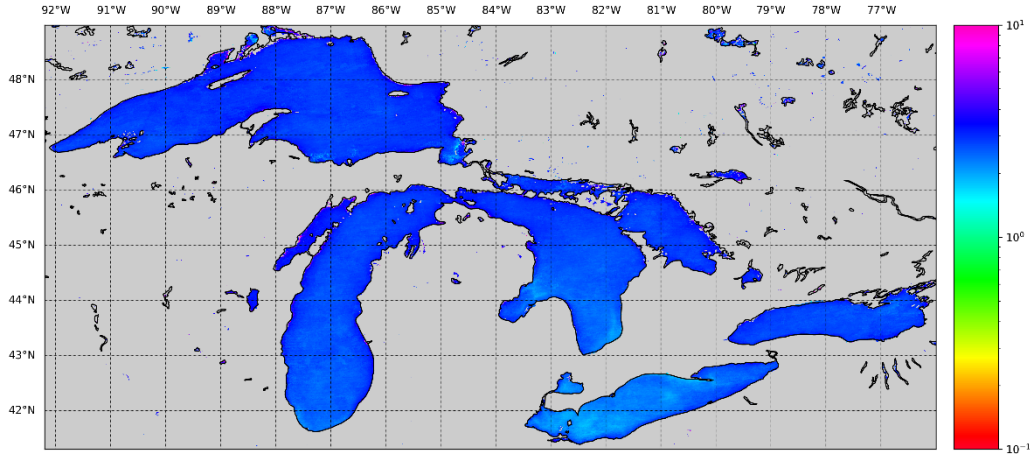
Project Description

- ## Project Summary
  We investigate the water quality in the Great Lakes from two perspectives using satellite data: 1) Overall quality and 2) Eutrophication status. Satellite-derived Secchi disk depth and nephelometric turbidity will be used as proxies of overall water quality. The degree of eutrophication will be evaluated with chlorophyll-*a* concentration ([Chl-*a*]) and the red-to-blue phytoplankton absorption band ratio.

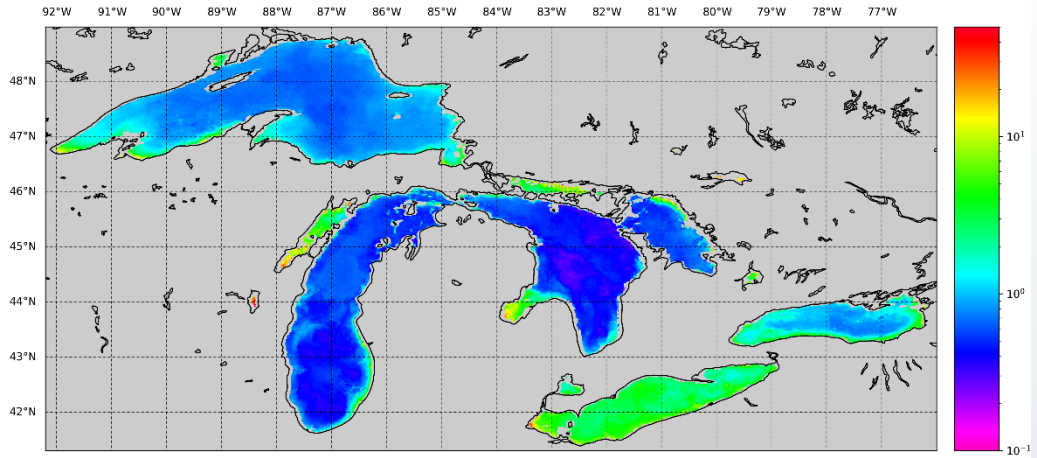
- ## Activities
  Satellite data processing
  Algorithm development and application
  Water quality trends reporting

- ## Notable outcomes / deliverables (anticipated or already realized)
  VIIRS water clarity and turbidity monthly product, 2012-2019

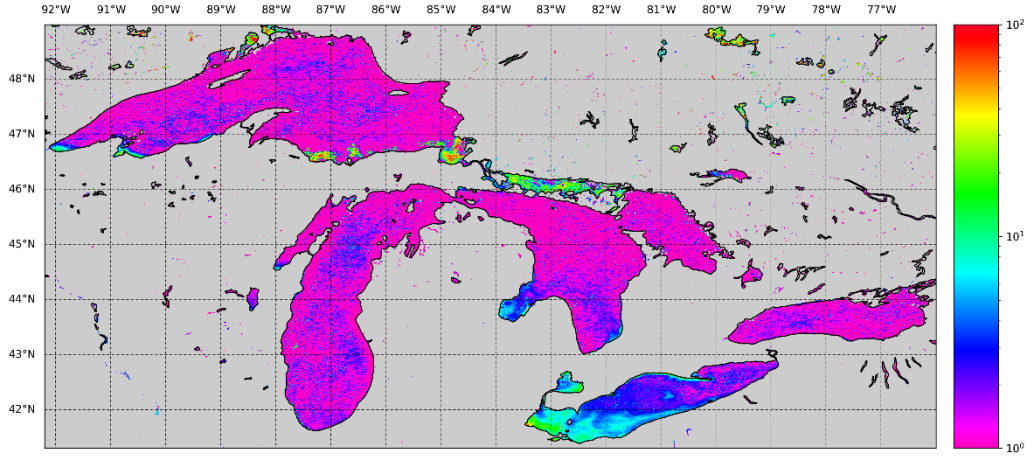
Water quality products



Secchi Disk Depth [m]



Standard Chl-a product [mg m^{-3}]



Turbidity [NTU]

- Water clarity - Secchi Disk Depth
- Water turbidity – NTU
- Eutrophication – chlorophyll-a

Future Work

Application of deep learning techniques in:

- Harmful Algal Bloom detection and forecasting
- Non-point source pollution monitoring
- Invasive species study

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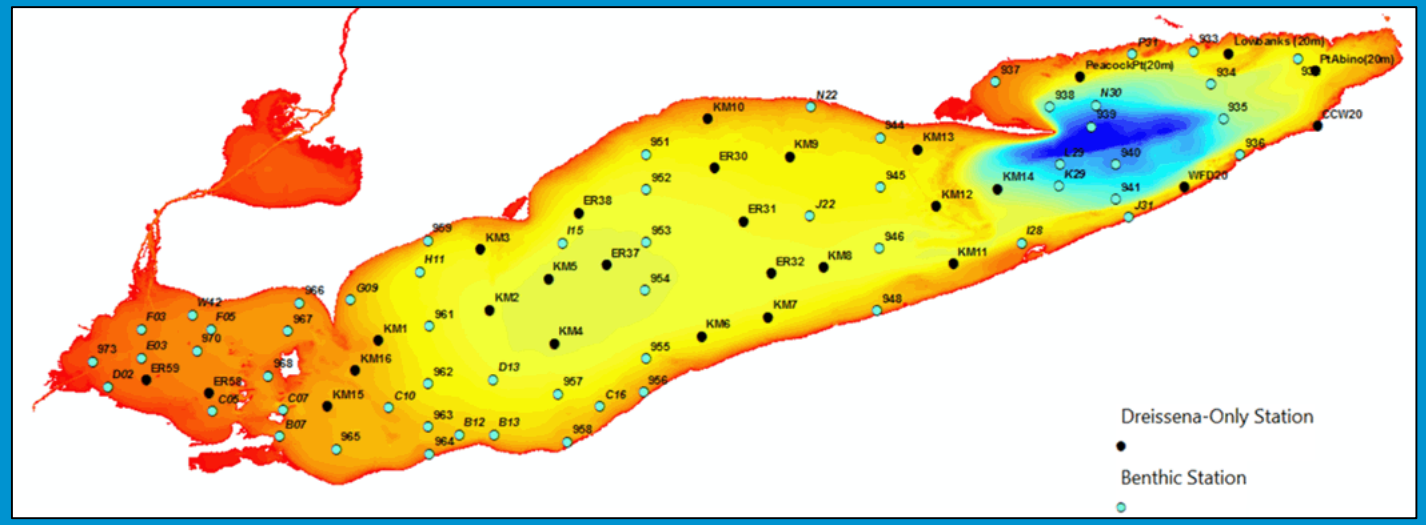
NOAA Support of CSMI



Ashley Elgin

NOAA GLRI Webinar

January 22, 2020

Great Lakes RESTORATION

CSMI Project Introduction

- **NOAA Project Leads:** Henry Vanderploeg and Ashley Elgin
- **NOAA co-PIs:** Reagan Errera, Doran Mason, Steve Pothoven, Mark Rowe, Steve Ruberg, Ed Rutherford, and Craig Stow
- **GLRI Funding Amounts:**
  - FY16: Lake Huron 2017 = $318,400
  - FY17: Lake Ontario 2018 = $73,000
  - FY18: Lake Erie 2019 = $500,000
  - FY19: Lake Michigan 2020 = $610,000
- **GLRI APIII Objective 5.3:** Implement a science-based adaptive management approach for GLRI
- **Measure 5.3.2:** Annual Great Lakes monitoring conducted and used to prioritize GLRI funding decisions each year
- **Partners/Collaborators**: Godwin, Johengen (Cooperative Institute for Great Lakes Research); Karatayev, Burlakova (Buffalo State College Great Lakes Center); Carrick (Central Michigan Univ); Bunnell, Kennedy, Schaefer, Weidel (US Geological Survey); Hinchey-Malloy, Nettesheim (US EPA); Biddanda, Steinman (Grand Valley State Univ); Denef (Univ of Michigan); Kashian (Wayne State Univ)

NOAA and CSMI

Field Year → Data Analysis → Report Out → Priority Setting → Planning

2017: Lake Huron
- Spatial Surveys, Pelagic and Benthic Monitoring, Mussel Growth Expt

2018: Lake Ontario
- Benthic Monitoring, Mussel Growth Expt

2019: Lake Erie
- Benthic Monitoring, Mussel Feeding Expts, HABs, Hypoxia, Primary Production

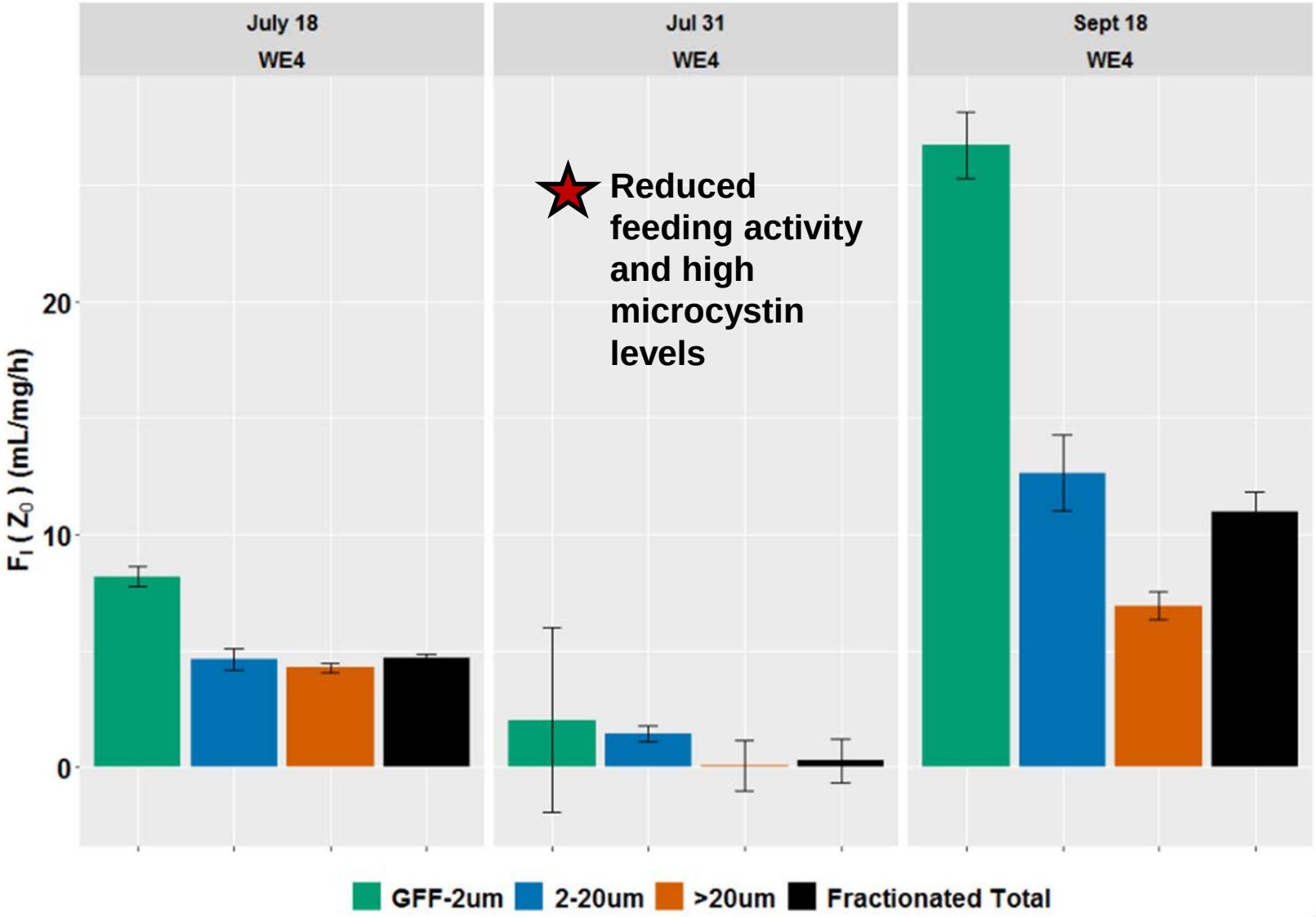
2020: Lake Michigan
- Spatial Surveys, Pelagic and Benthic Monitoring, Mussel Growth Expt, Observing Systems; Biophysical Modeling

Erie 2019: Benthic Monitoring

- Western Lake Erie Mayfly and Mussel Survey- collected by USGS and processed by NOAA
- Whole-lake mussel length-weight relationship and reproductive status led by NOAA
- Whole-lake benthic survey led by Buffalo State

Erie 2019: Mussel Feeding Experiments

- Feeding experiments using Lake Erie water reveal mussel and *Microcystis* interactions
- Mussels preferred smaller algae over larger size fractions
- ★ Feeding rates were very low when microcystin levels were >5µg/L
- **Preference for non-*Microcystis* is important for restructuring the algal community**

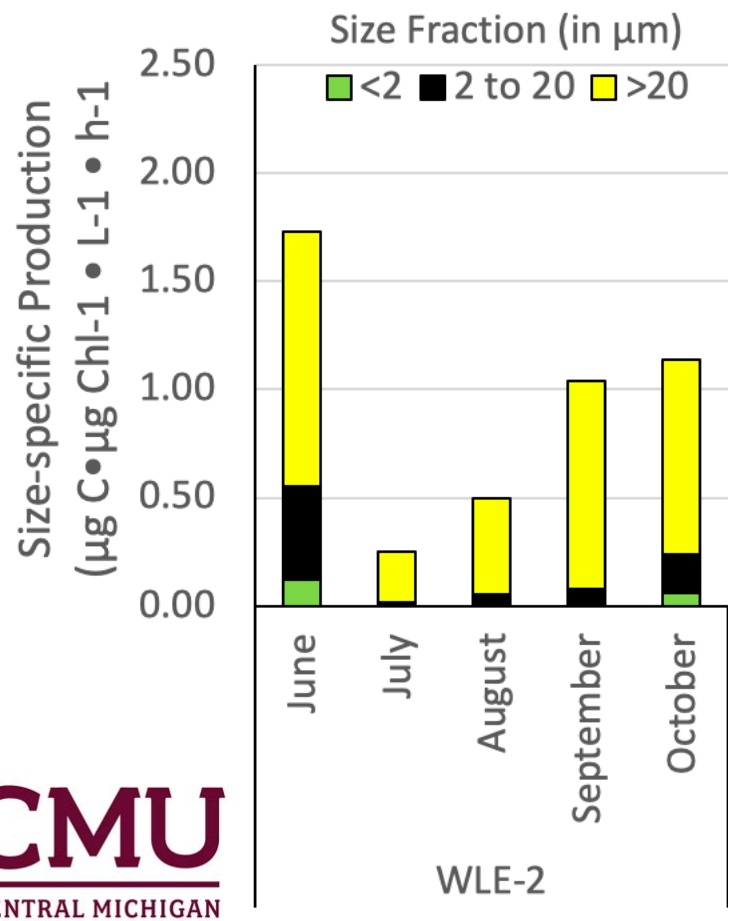


Erie 2019: *Microcystis* Growth and Toxicity

Lab experiments to quantify the relative contribution of increased light and nutrient excretion on HABs

- Nutrient addition alone explained a majority of *Microcystis* growth
- Nutrient addition *plus* increased light explained almost all of *Microcystis* growth
- **Selective feeding is not the only mechanism by which mussels promote HABs**

Erie 2019: Primary Production and HABs



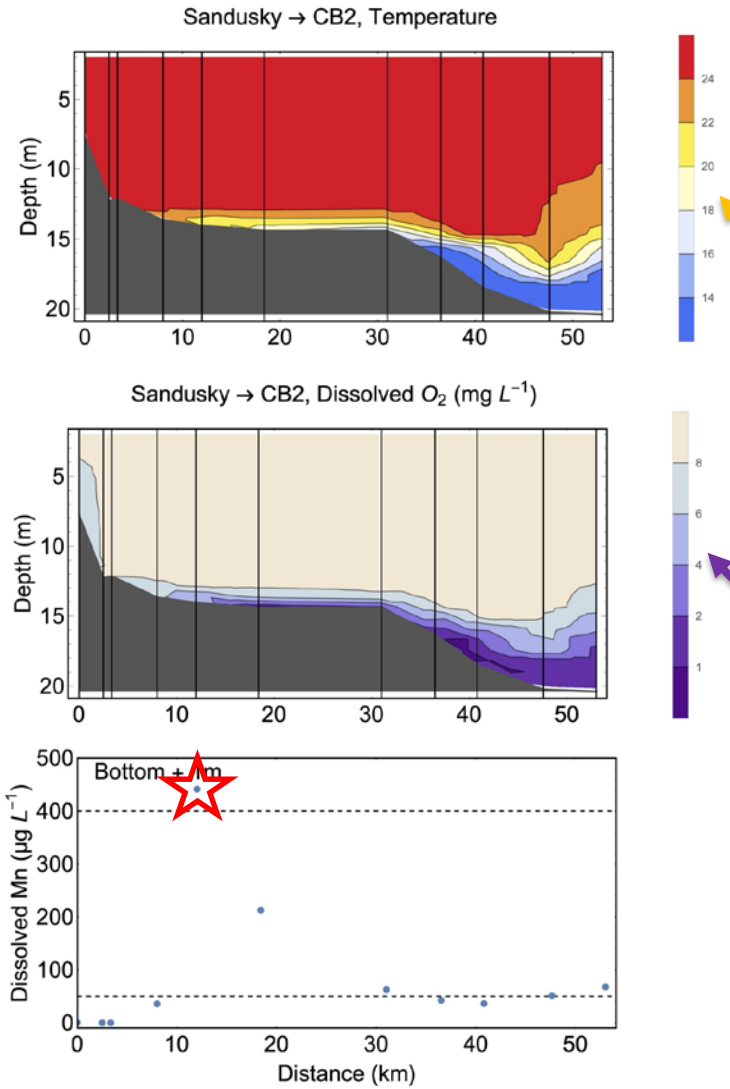
Monthly primary production estimates (PPr) were made at four Lake Erie monitoring stations (June-October) to study if *Microcystis* blooms in W Lake Erie are facilitated by low PPr

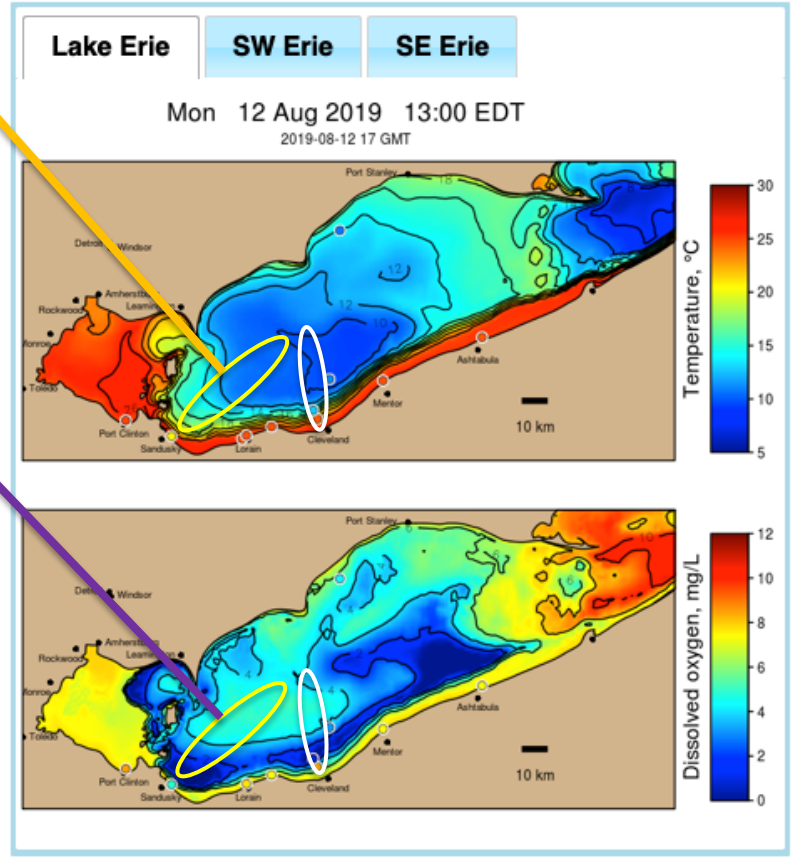
- PPr rates were highest in June, quickly declined, then increased over the season
- PPr was dominated by larger species: diatoms then *Microcystis*
- Picoplankton was a minor component of the assemblage

- **Despite high biomass, rates of PPr were not much different than in other, more nutrient poor locations in the Great Lakes**

Erie 2019: Hypoxia and Manganese

- Transect surveys with high vertical resolution were conducted to study the fate and distribution of Mn in relation to nearshore hypoxia
- ☆ Hypoxic sediments release Mn, which reduces drinking water quality
- Mn accumulates quickly in the hypolimnion close to shore, making it more likely to move ashore during upwelling events

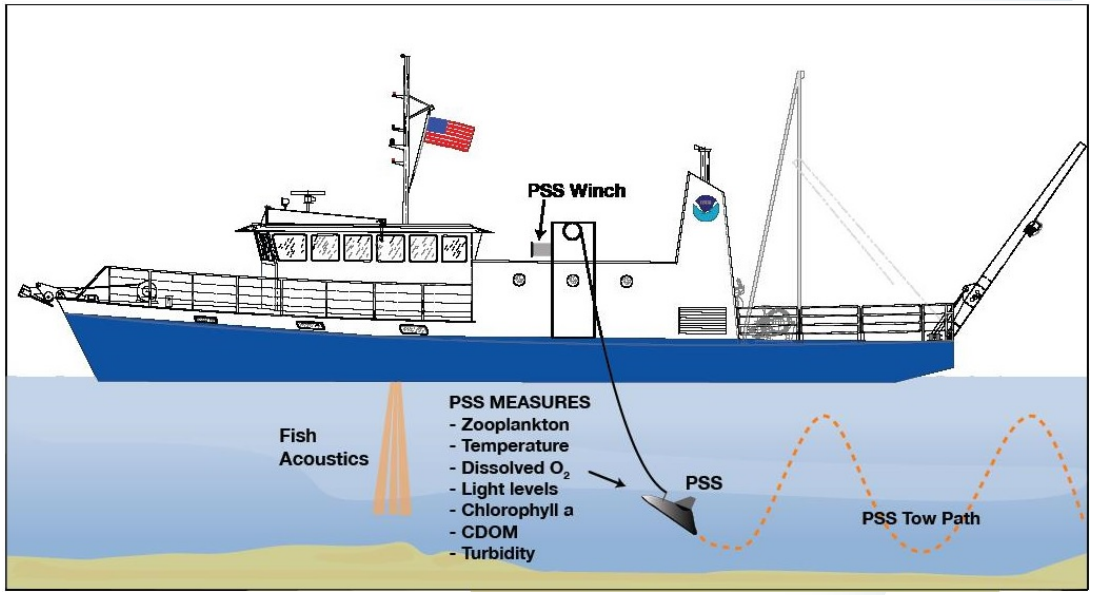




Michigan 2020 CSMI Plans

A suite of complementary empirical and modeling projects to study Lake Michigan from “phosphorus to fish”

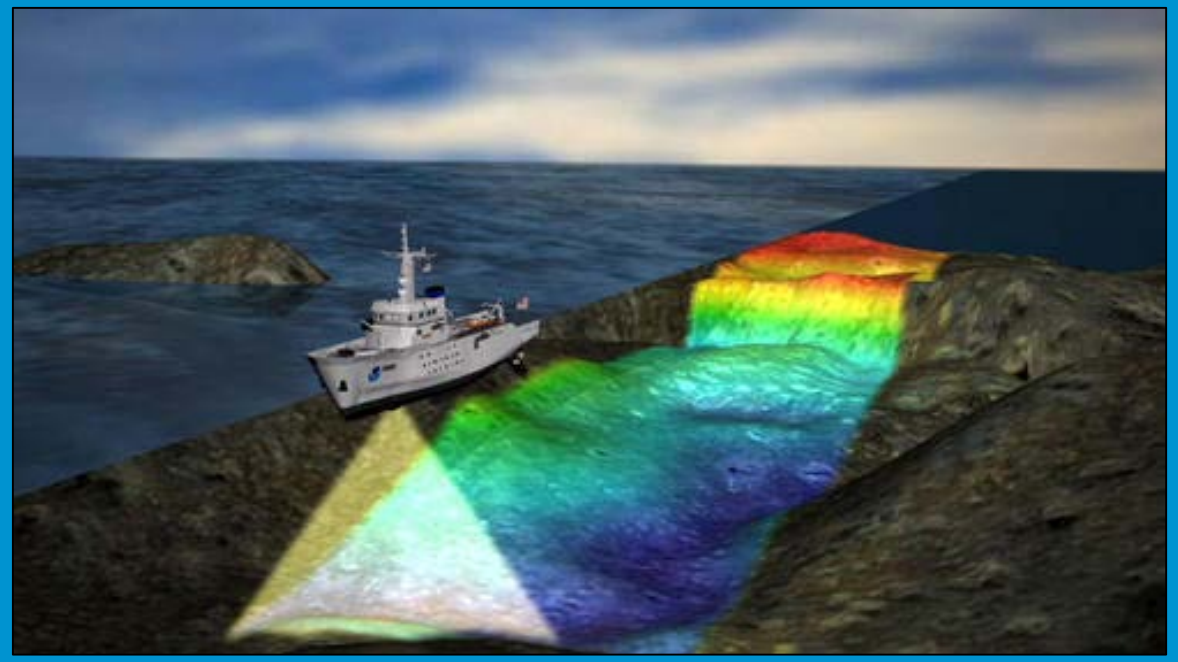
- Fish recruitment bottlenecks
- Dreissenid mussels (veliger focus)
- Lower food web from nearshore to offshore
- Productivity ‘hot spots’



NOAA GREAT LAKES

Improving NOAA's service to the Nation through collaboration

Next Generation Tools to Sample Dreissena



Ashley Elgin

NOAA GLRI Webinar

January 22, 2020

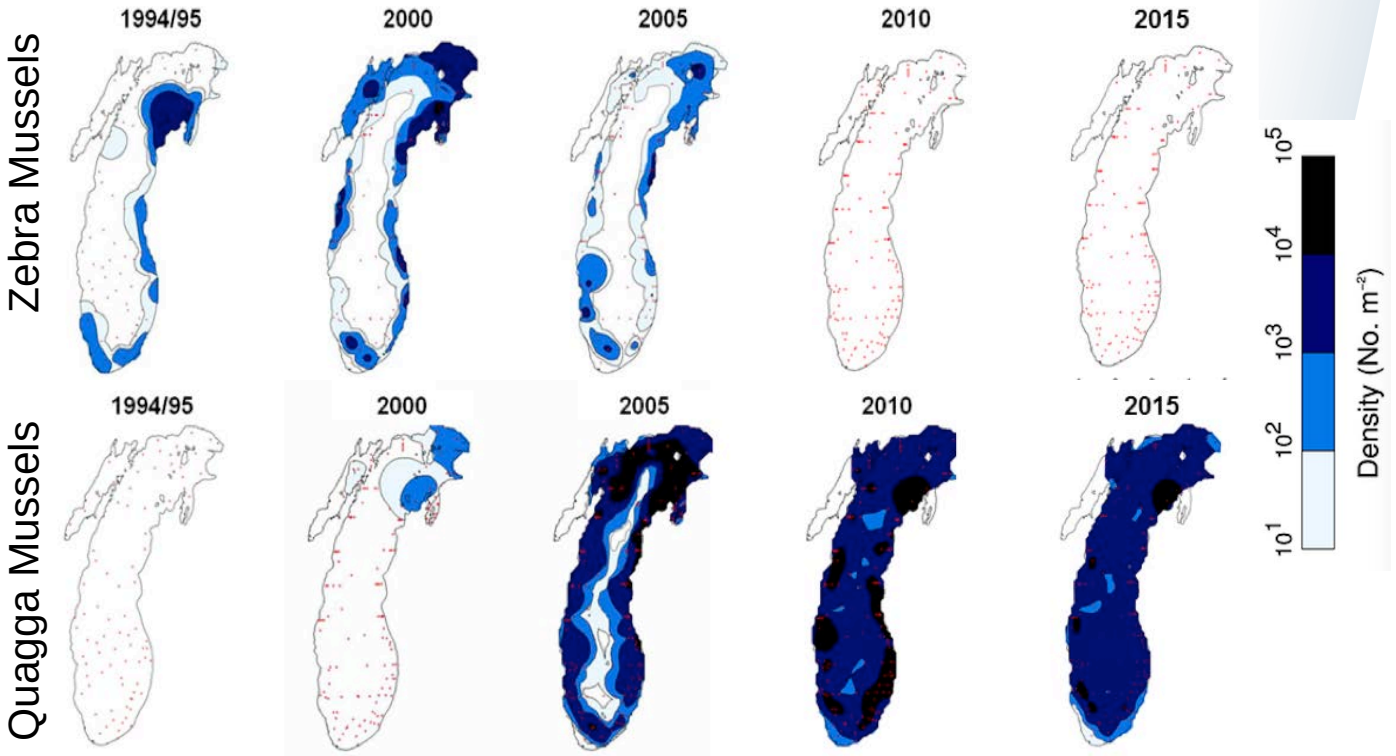
Great Lakes RESTORATION

Next Gen Tools Project Introduction

- **NOAA Project Lead:** Ashley Elgin
- **Partners/Collaborators:** Peter Esselman, Project Lead (USGS); Daniel Buscombe (Northern Arizona Univ); Al Steinman (Grand Valley State Univ)
- **GLRI Funding Amounts: FY19 $59,700 to NOAA ($240,300 to USGS)**
- **GLRI Action Plan III Objective 5.2:** Conduct comprehensive science programs and projects
- **Measure 5.2.1:** Annual Great Lakes monitoring conducted and used to prioritize GLRI funding decisions

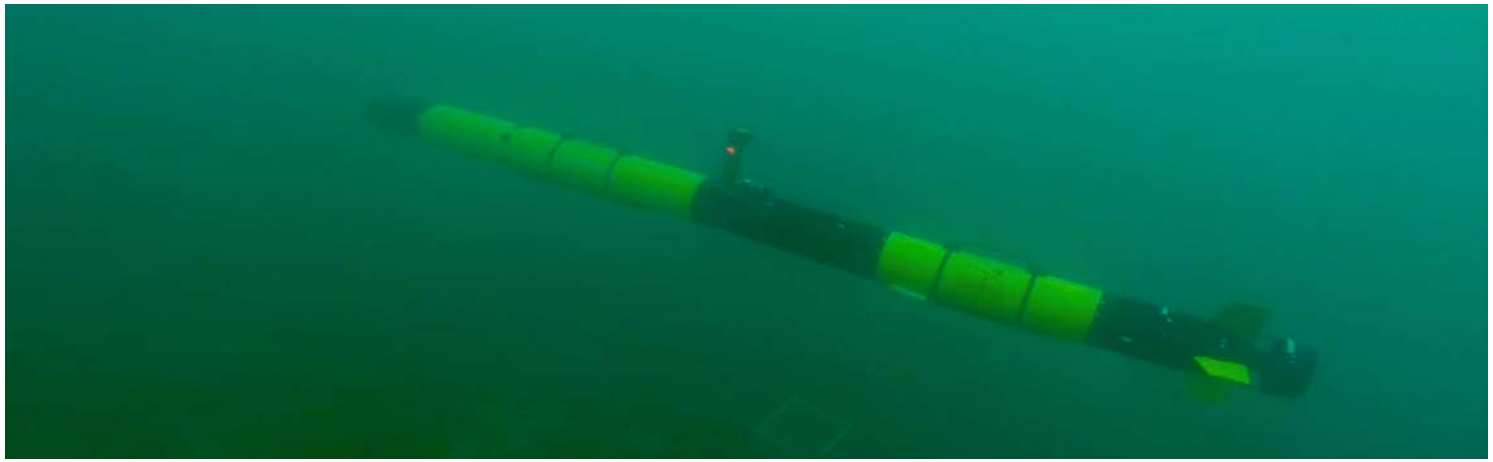
Project Motivation and Goals

- Nearshore and hard substrate zones are underrepresented by current sampling programs
- New technologies can improve our ability to map dreissenid populations
- Enhanced survey coverage will allow for better estimates of impacts (e.g., on HABs, *Cladophora,* production)



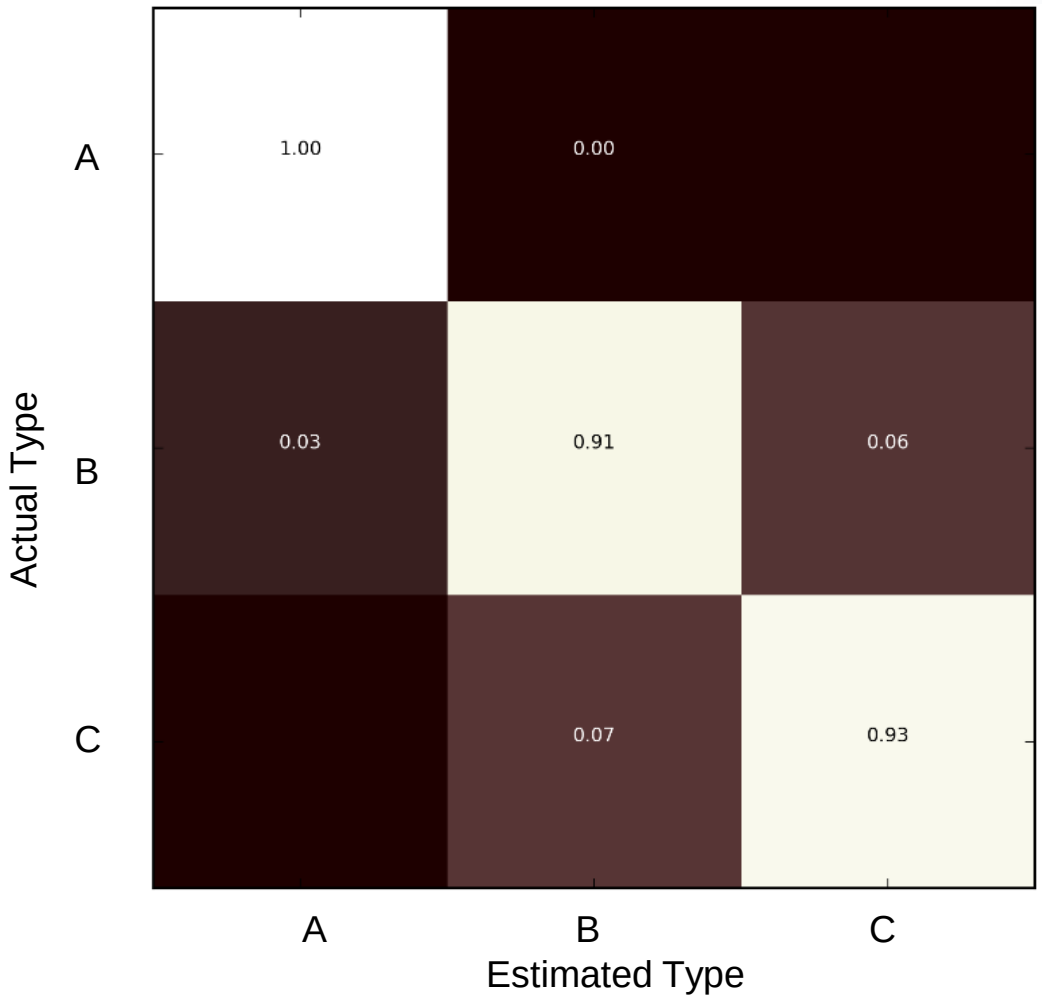
Approach and Deliverables

- Develop protocols to use high-resolution multi-beam echosounders (MBES), autonomous underwater vehicles (AUVs), and Ponar samples to sample dreissenid populations.
- Produce estimates of dreissenid presence, density, biomass, and size structure in multiple test geographies



Data Analysis

- The size and shape of sediment grains and organisms create unique acoustic backscatter signals (as collected by multi-beam echosounder)
- Use machine learning to distinguish mussels from different background substrate types
- Incorporate images collected by AUV and physical Ponar samples



Science Objective Q&A

Project	Presenter
State, Tribal and Federal Capacity to coordinate and implement LAMP programs	Jennifer Day, OAR GLERL
Hardened Shoreline Ecological Indicator GIS	Brandon Krumwiede, NOS OCM
Updating vertical datums at local ports and harbors of refuge through seasonal water level measurements	Adam Grodsky, NOS CO-OPS
Long-term data assimilative, temperature and currents database for Lake Michigan, Lake Erie and Saginaw Bay	Philip Chu, OAR GLERL
SOAR - Under Ice	Steve Ruberg, OAR GLERL
Great Lakes Synthesis, Observations and Response (SOAR) System	Steve Ruberg, OAR GLERL and Andrea VanderWoude, OAR GLERL
Evaluating water clarity, turbidity, and eutrophication status of the Great Lakes with satellite radiometric data	Paul DiGiacomo, NESDIS STAR
NOAA Support Cooperative Science and Monitoring Initiative (CSMI)	Ashley Elgin, OAR GLERL and Hank Vanderploeg, OAR GLERL
Next Gen Tools to Sample Dreissena	Ashley Elgin, OAR GLERL