National Oceanic and Atmospheric Administration Great Lakes Environmental Research Laboratory (NOAA-GLERL)

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State of Michigan GIS Users
May Meeting, Lansing, Michigan
May 3, 2018

GLERL

Lake Michigan Field Station

Vessels

- NOAA GLERL Vessels work in support of NOAA in the Great Lakes
- Ranges of size classes give flexibility to work in both nearshore and offshore environments
- GLERL operates and maintains 13 vessels.




OBSERVING SYSTEMS & ADVANCED TECHNOLOGY

Developing and deploying advanced technology to collect data year round across the Great Lakes using buoys, satellites, and research vessels.

GLERL's observing systems are providing real-time data on lake conditions to help users make informed decisions.

GLERL




ECOSYSTEM DYNAMICS

Gathering long-term observations of biological, chemical, and physical variables in the Great Lakes ecosystem.

Conducting targeted monitoring and fundamental research on ecosystem processes, including impacts of invasive species.

GLERL



INTEGRATED Physical & Ecological MODELING & FORECASTING

Developing evaluative and predictive models to forecast physical variables such as ice cover and water levels, and help understand how such factors impact the entire ecosystem.

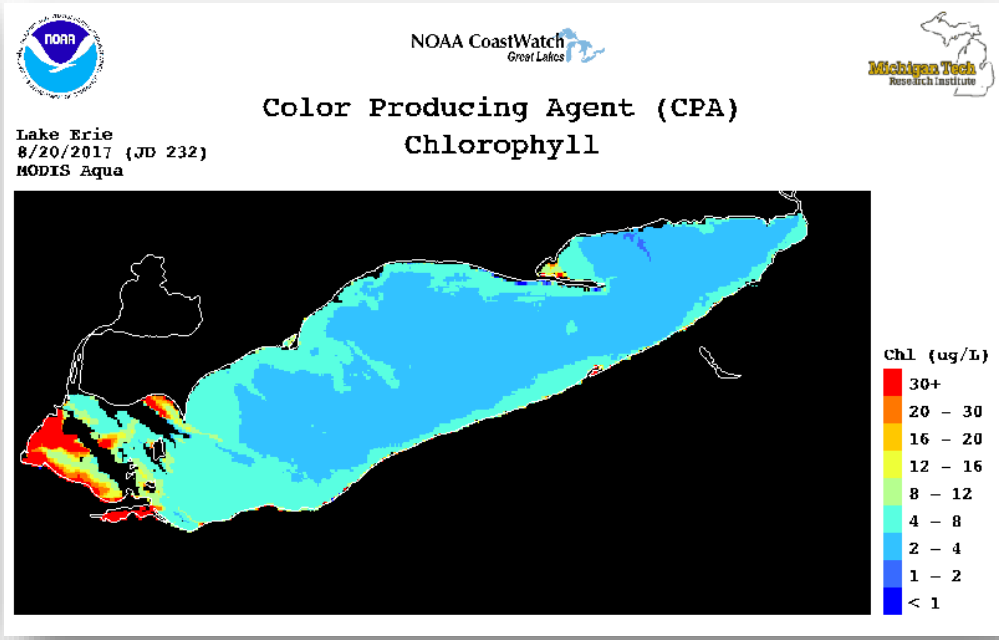
Delivering timely information on harmful algal blooms to beachgoers, recreational anglers, water utility managers, and other users and decision-makers.

GLERL

Observing Systems and Advanced Technology

NOAA Great Lakes Coastwatch

MODIS Satellite Imagery



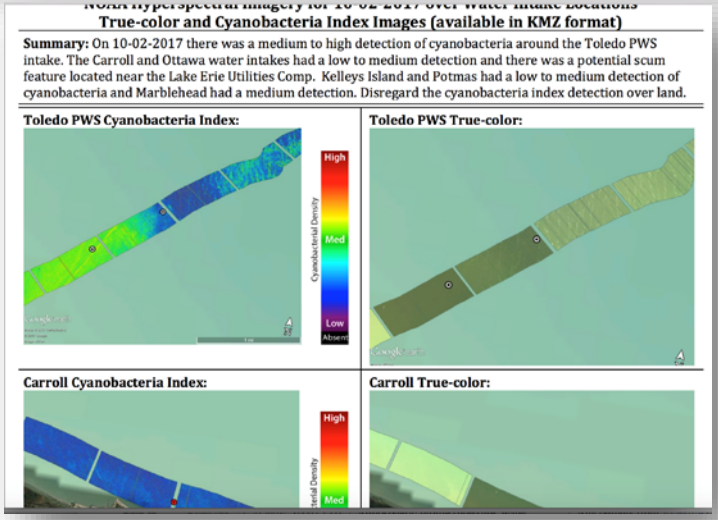
CPA (Color Producing Agent)

Key Scientific Drivers:

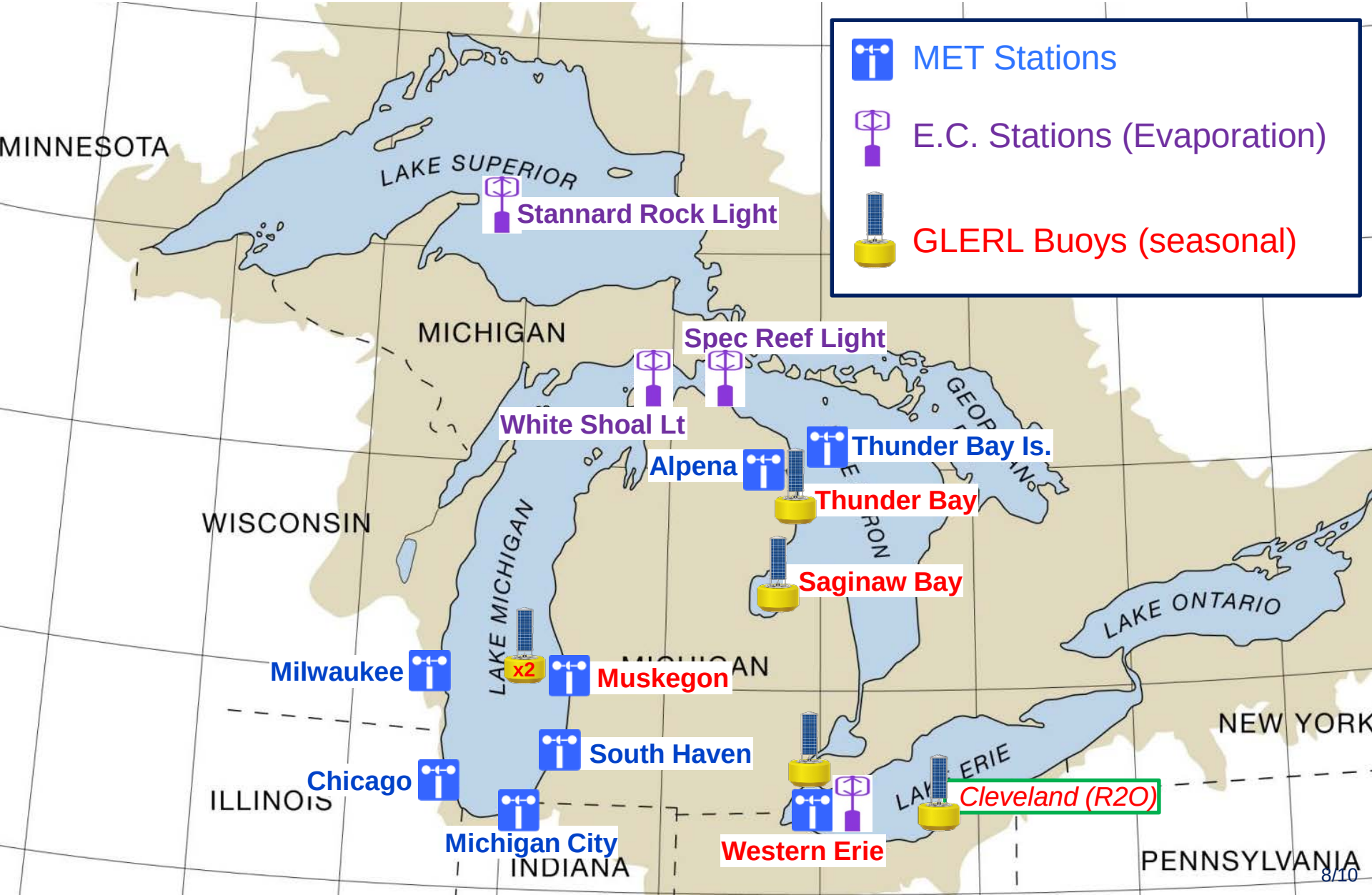
Can satellite and airborne remotely sensed data provide accurate, synoptic retrievals of key Great Lakes parameters?

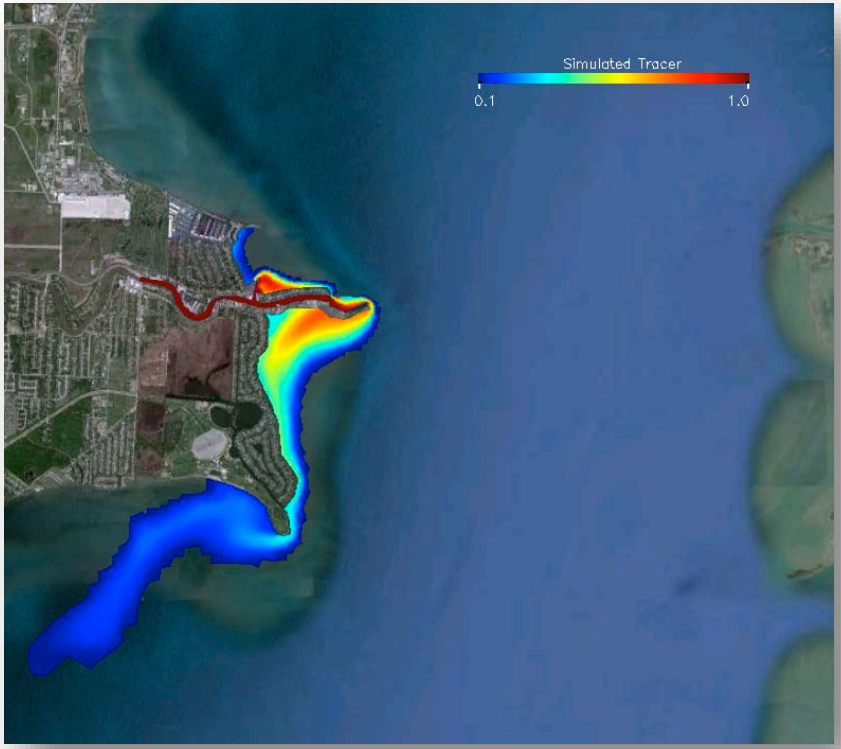
Hyperspectral Imaging

- HABs are detectable from hyperspectral sensors mounted to small airplanes.
- Because the flyovers are done at low altitude, cloud cover interference, as often seen in satellite images, is minimized.
- Information is distributed to water intake managers in the Western Basin of Lake Erie.



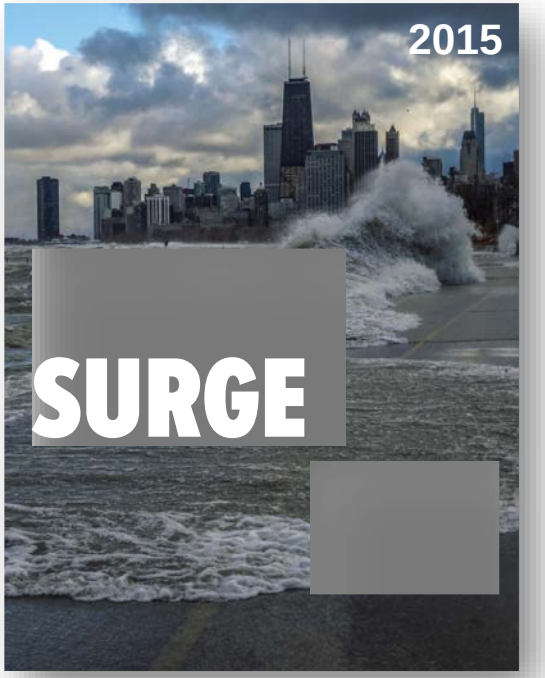
Real-time Coastal Observation Network (ReCON)

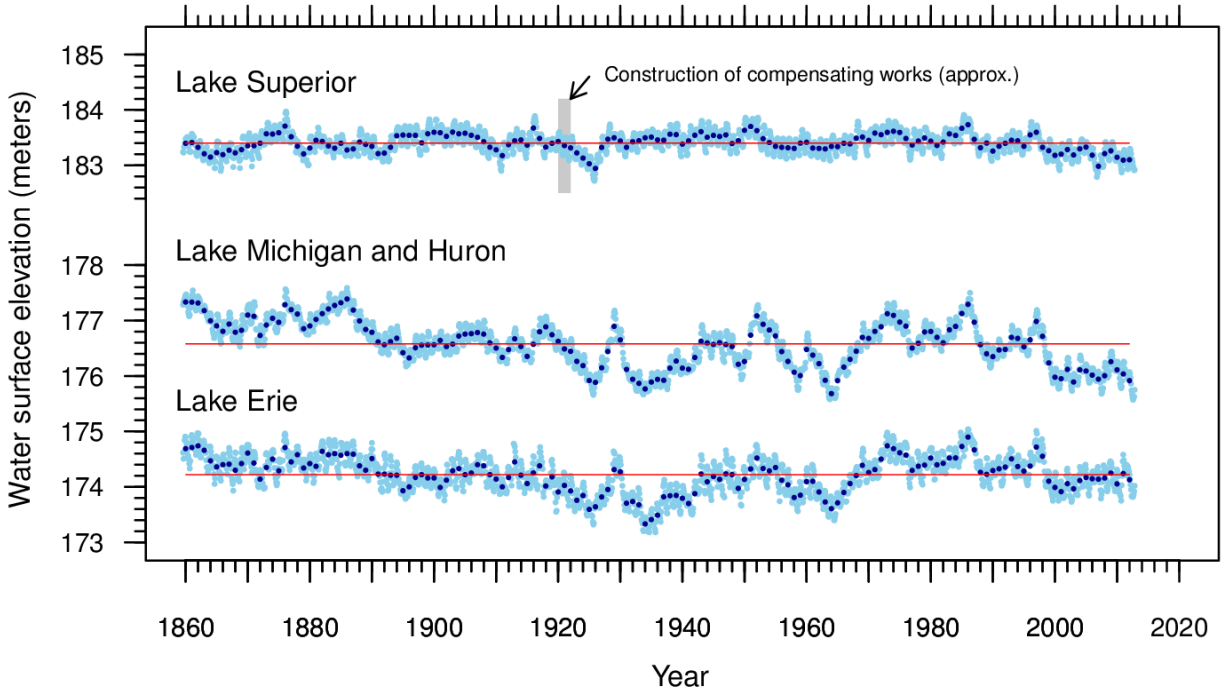




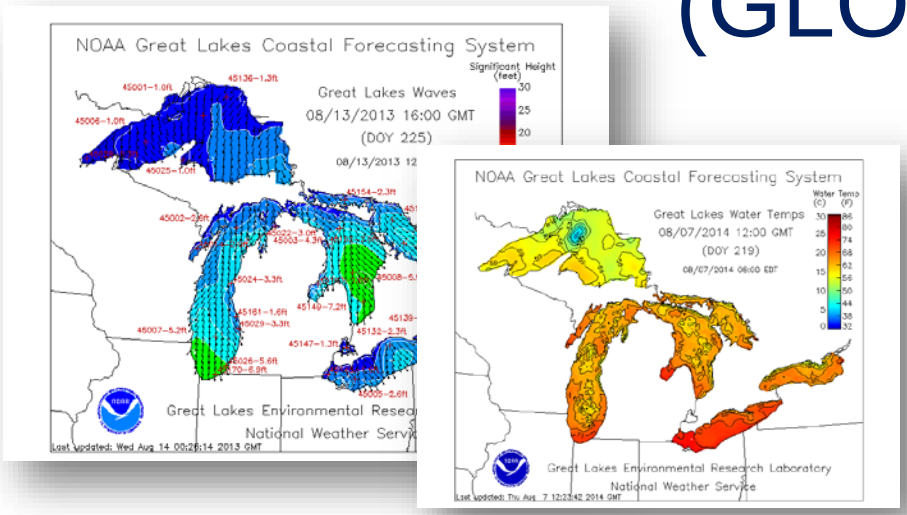
Integrated Physical and Ecological Modeling and Forecasting

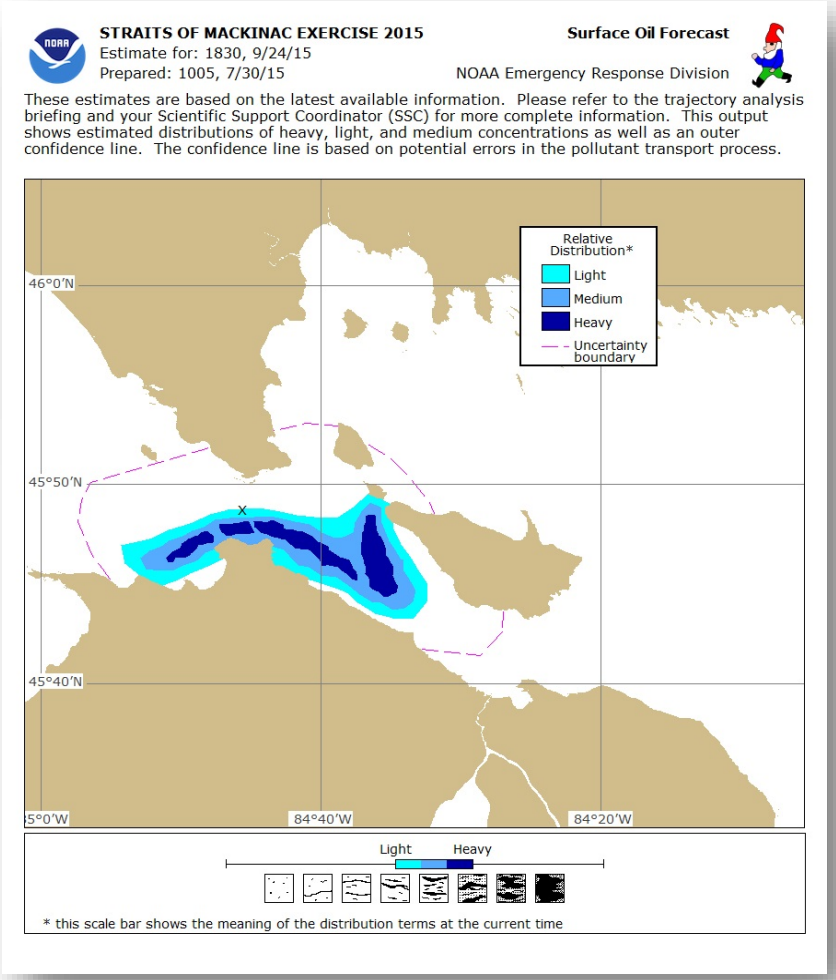
Great Lakes water levels: Long, continuous record; High variability; Ideal research platform





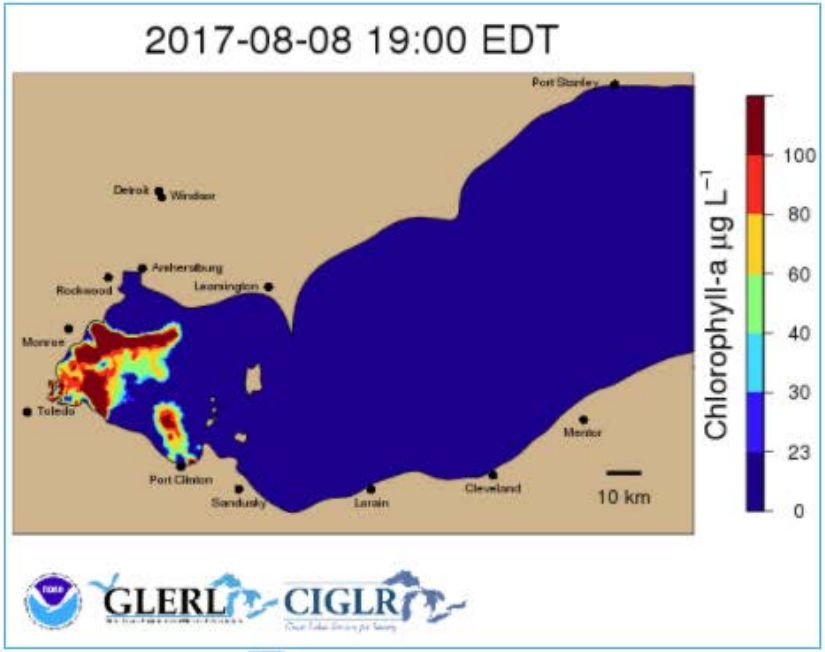
Great Lakes Operational Forecast System (GLOFS)



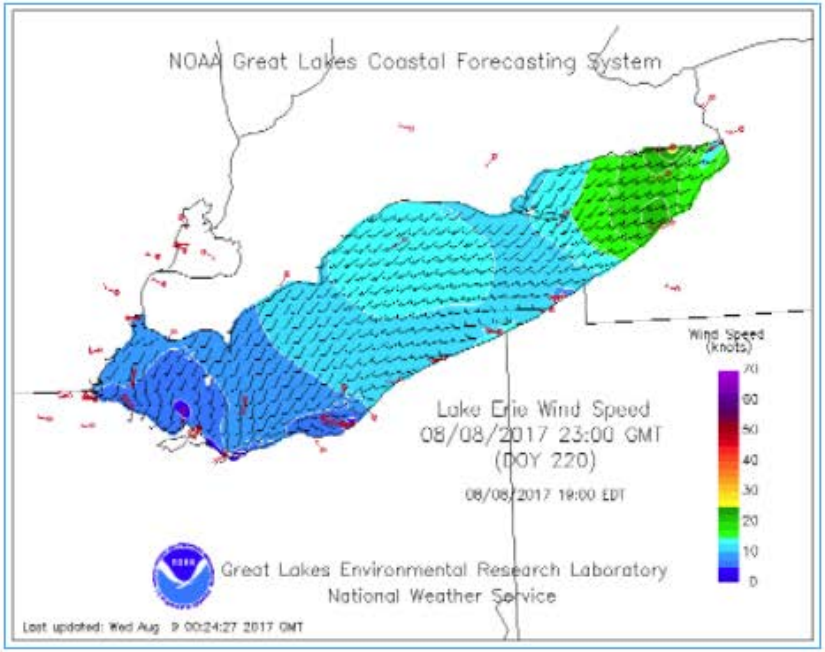


Experimental Lake Erie HAB Tracker

HAB Tracker forecast



GLCFS nowcast & 5-day wind speed forecast



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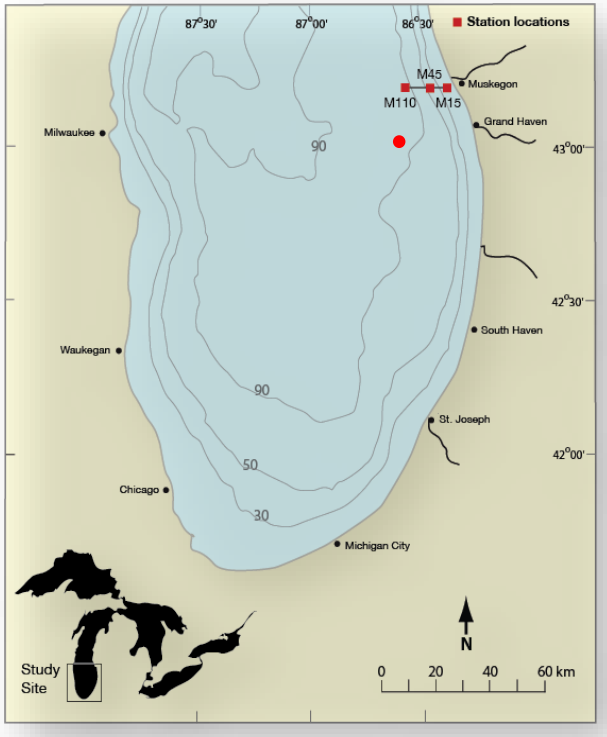
https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html

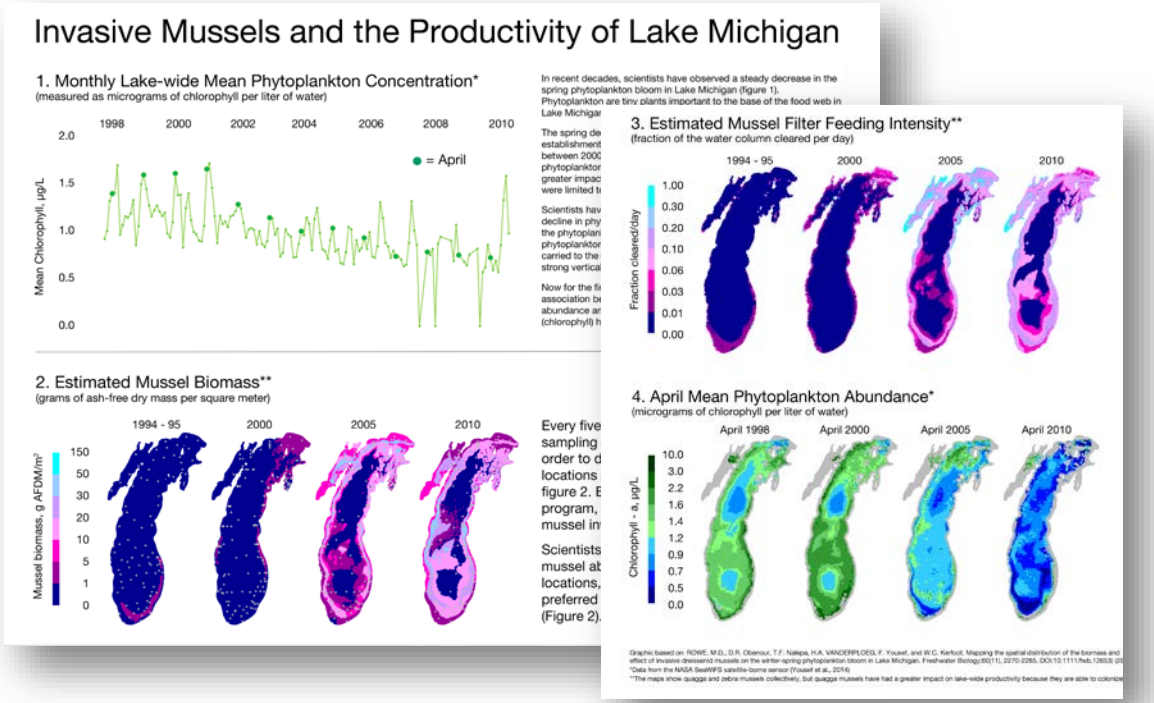
Ecosystem Dynamics

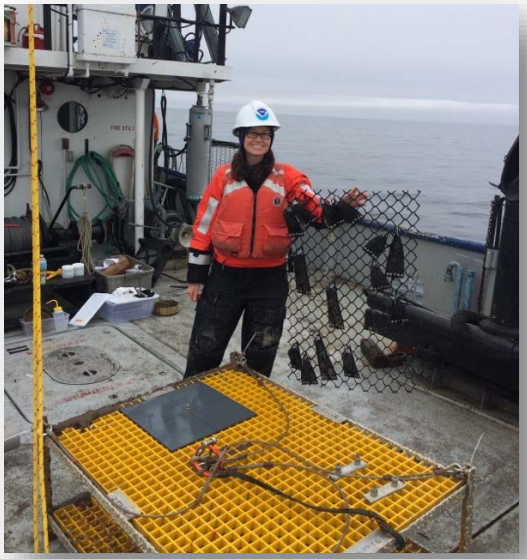
Long-term research

- **Lower Food Web Collections**
- **Moorings (year-round)**
- **Nearshore Transect**
- **Fish Ecology**
- **Lake Whitefish Recruitment**



Understand invasive mussel ecology and impacts to the lower food web



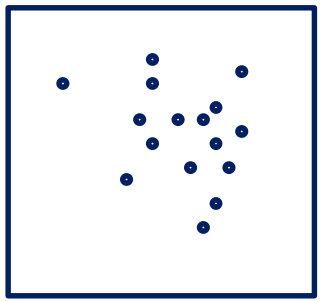


Predict Invasive Species Establishment, Distribution and Impacts in the Great Lakes

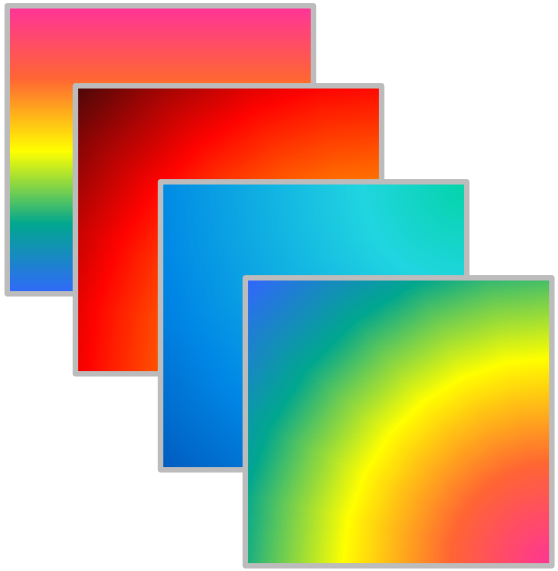
National Centers for
Coastal Ocean Science
Center for Sponsored
Coastal Ocean Research

Forecasting Invasive Species Habitat Suitability

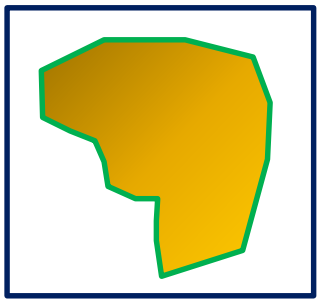
Envt'l Niche Model Algorithm/Approach



Occurrence Records



Environmental Layers



Estimate

(Diagram From A. Kramer and J. Drake, Univ. Georgia)

GLAHF

Great Lakes Aquatic Habitat Framework

GLAHF COMPREHENSIVE DATABASE

http://glahf.org/explorer/

Administrative Boundaries - 16
Lake & land units, Political boundaries
Management Units

Biological – 61+
Aquatic invasive species, Benthos, Fish

Environmental/Chemical - 37
Water chemistry

Geomorphology/Topobathymerty - 28
Hydrogeoforms
Substrate, Elevation, Relief, Slope

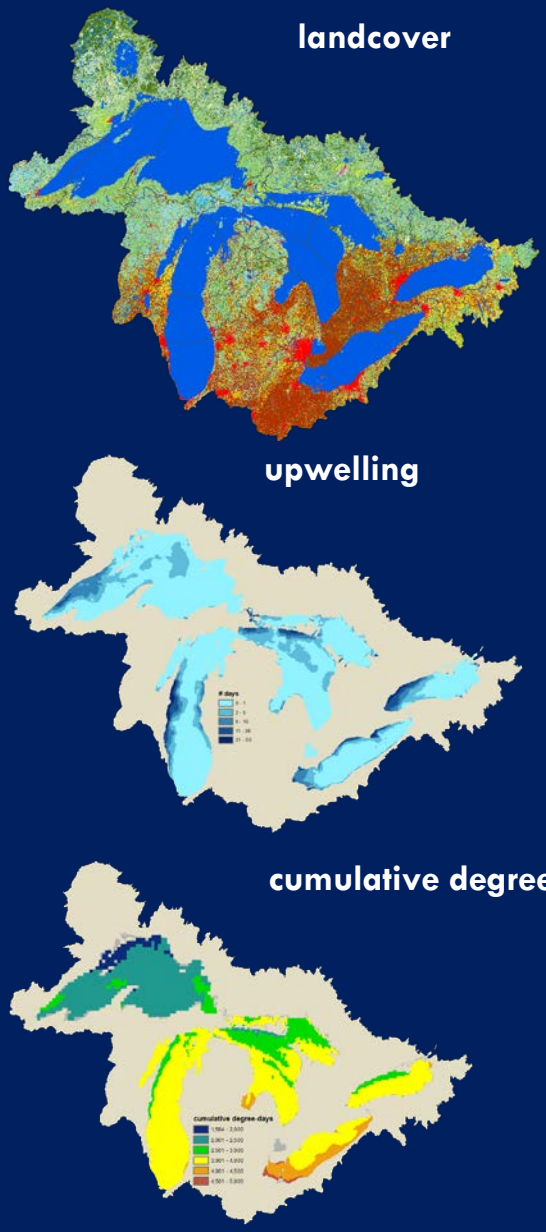
Landscape - 132
Land use/cover, Geology, Soils

Mechanical Energy - 19
Circulation, Upwelling, Waves

Rivers/Hydrology - 14
Flowlines, Watersheds, Dams & barriers

Temperature Energy - 19
Upwelling, Water temperature at depth, Growing Degree Days

Other Stressors - 4



Example: Grass carp and Hydrilla

Grass carp - *Ctenopharyngodon idella*

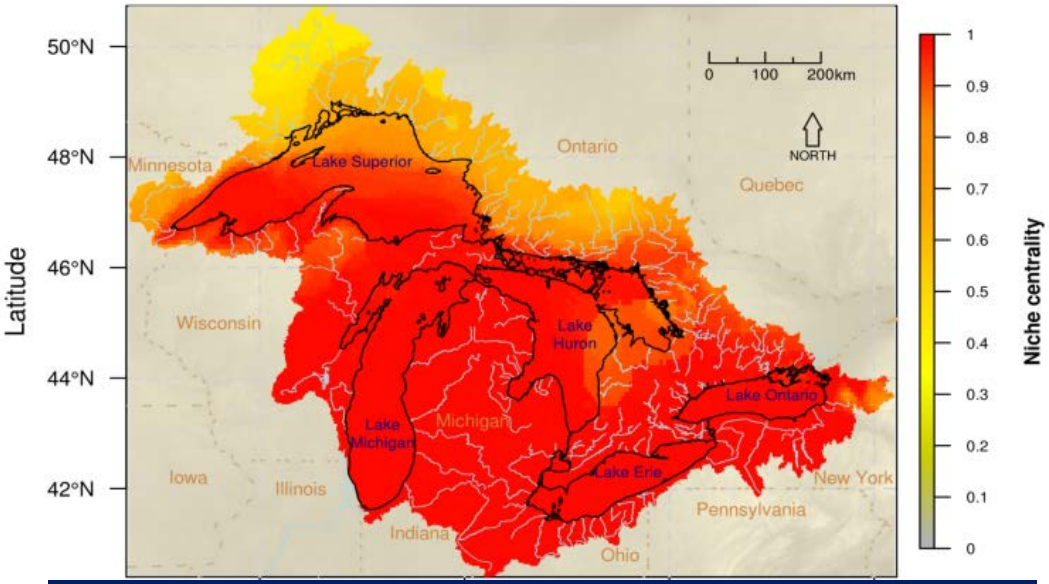
(Established and reproducing naturally)

Hydrilla - *H. verticillata*

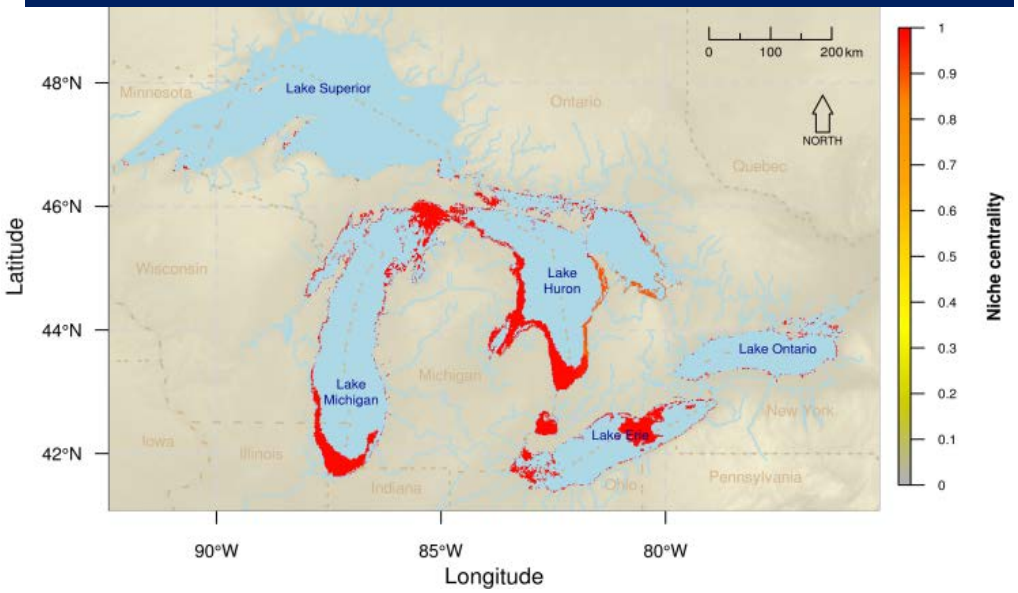
(Not yet established in Great Lakes)

Grass Carp – Niche Centrality

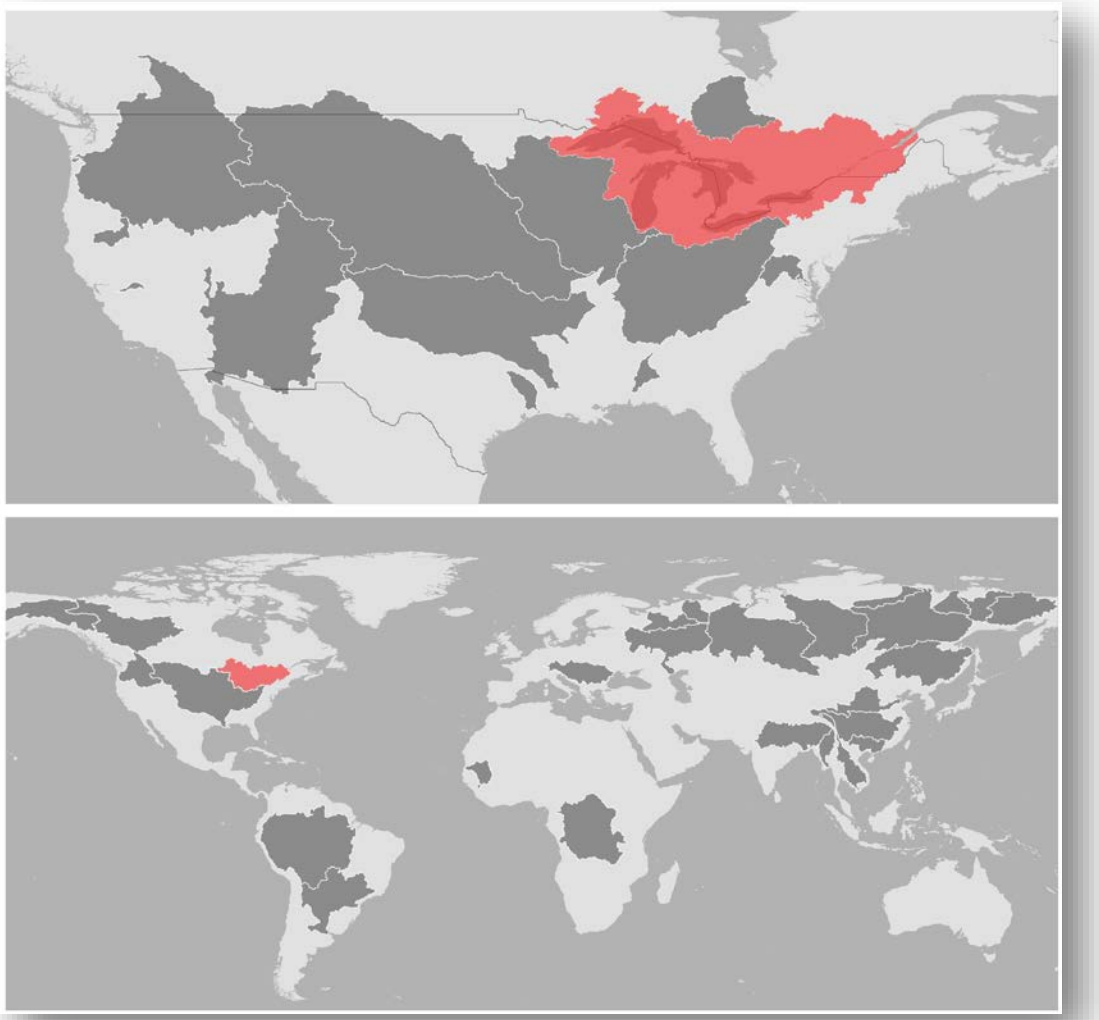
Grass carp niche – modeled using GL climate data and Climate data where carp occur outside GL basin



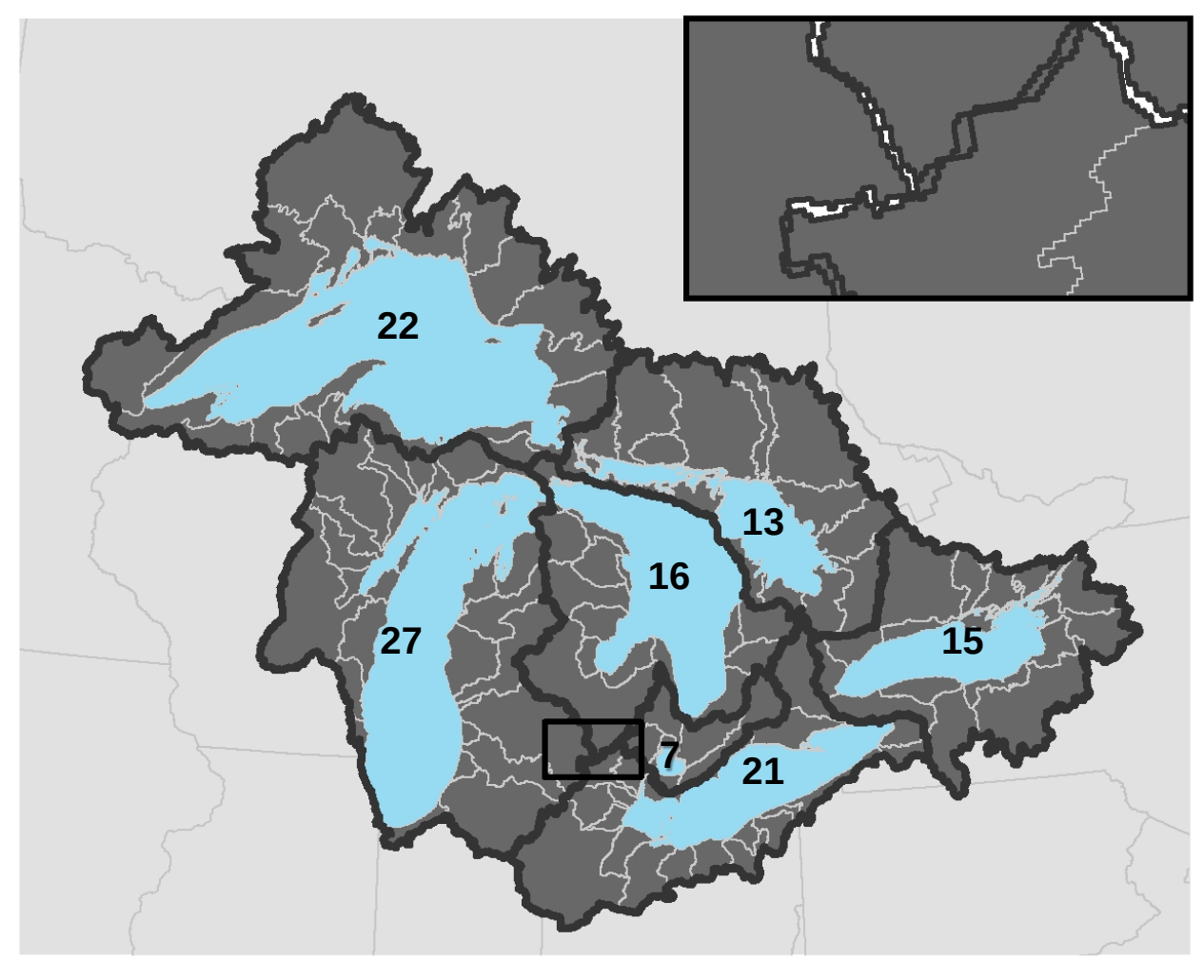
Above clipped using GL SAV, wetlands data + Hydrilla niche



Hydrologic Modeling in the Great Lakes Basin



Hydrologic Modeling at GLERL

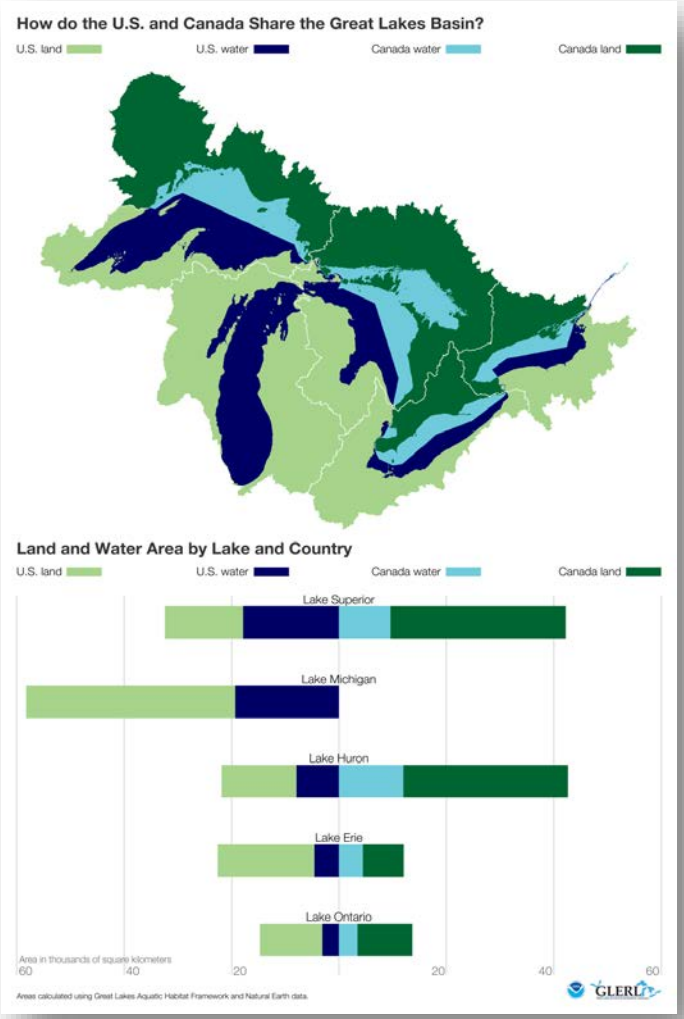


Why is it so difficult to model the Great Lakes basin?

Complex lake-atmosphere interactions

Data set consistency &reconciliation across international border

Encoding regulatory guidelines for controlling outflows



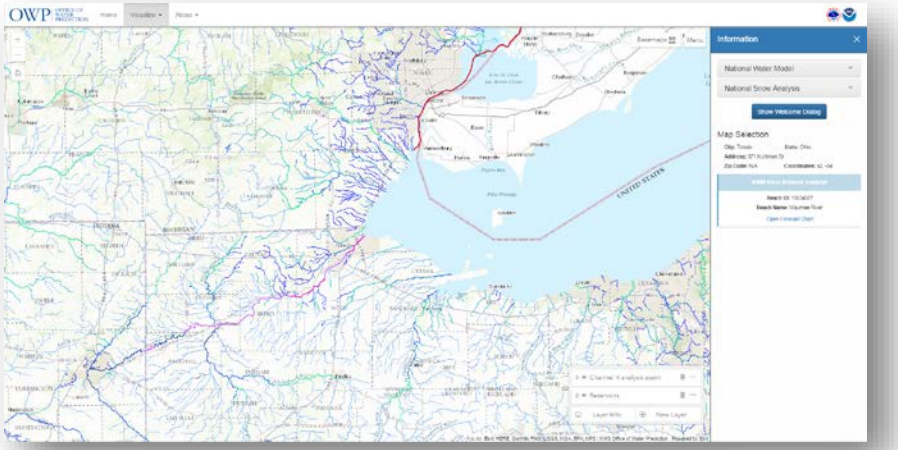
How do we further hydrologic modeling in the Great Lakes basin?

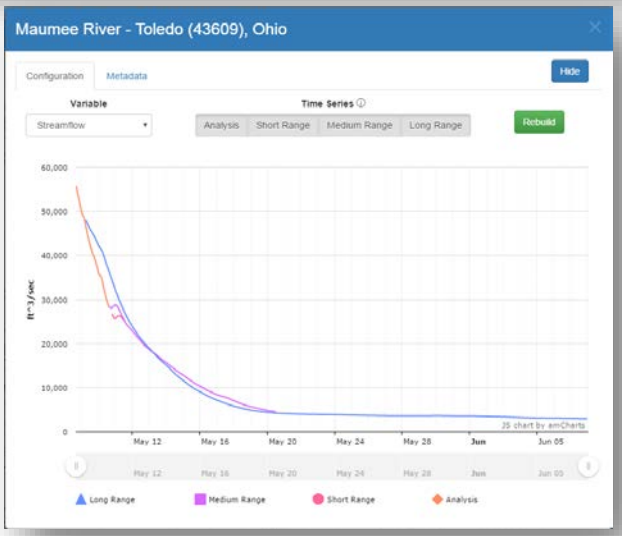
National Water Model
http://water.noaa.gov/about/nwm

Supported by the National Water Center (NOAA NWS + USGS, FEMA, visiting scientists & contractors).

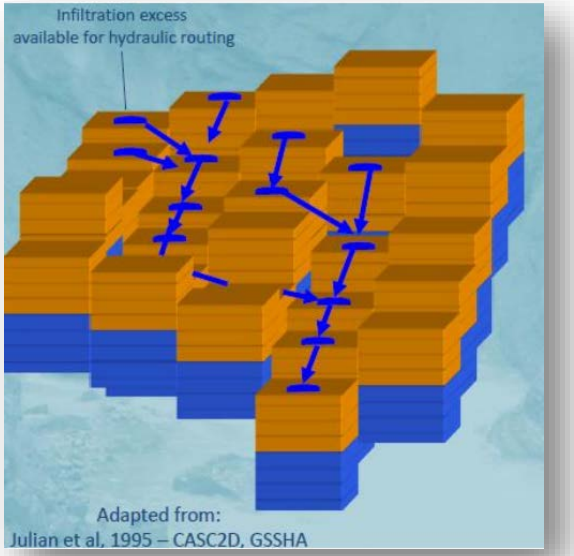
Modeled using the WRF-Hydro package, part of the Weather Research and Forecasting (WRF) system for CONUS

Version 1: Operational September 2016

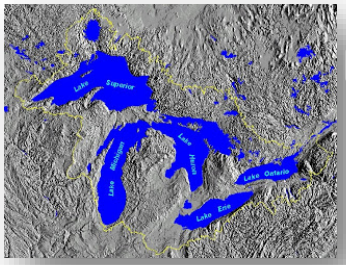




What's so unique about the National Water Model?



DEM



Flow Direction

78	72	69	71	58	49
74	67	56	49	46	50
69	53	44	37	38	48
64	58	55	22	31	24
68	61	47	21	16	19
74	53	34	12	11	12

Elevation surface

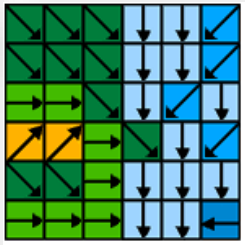
2	2	2	4	4	8
2	2	2	4	4	8
1	1	2	4	8	4
128	128	1	2	4	8
2	2	1	4	4	4
1	1	1	1	4	16

Flow direction

32	64	128
16		1
8	4	2

Direction coding

Flow Accumulation

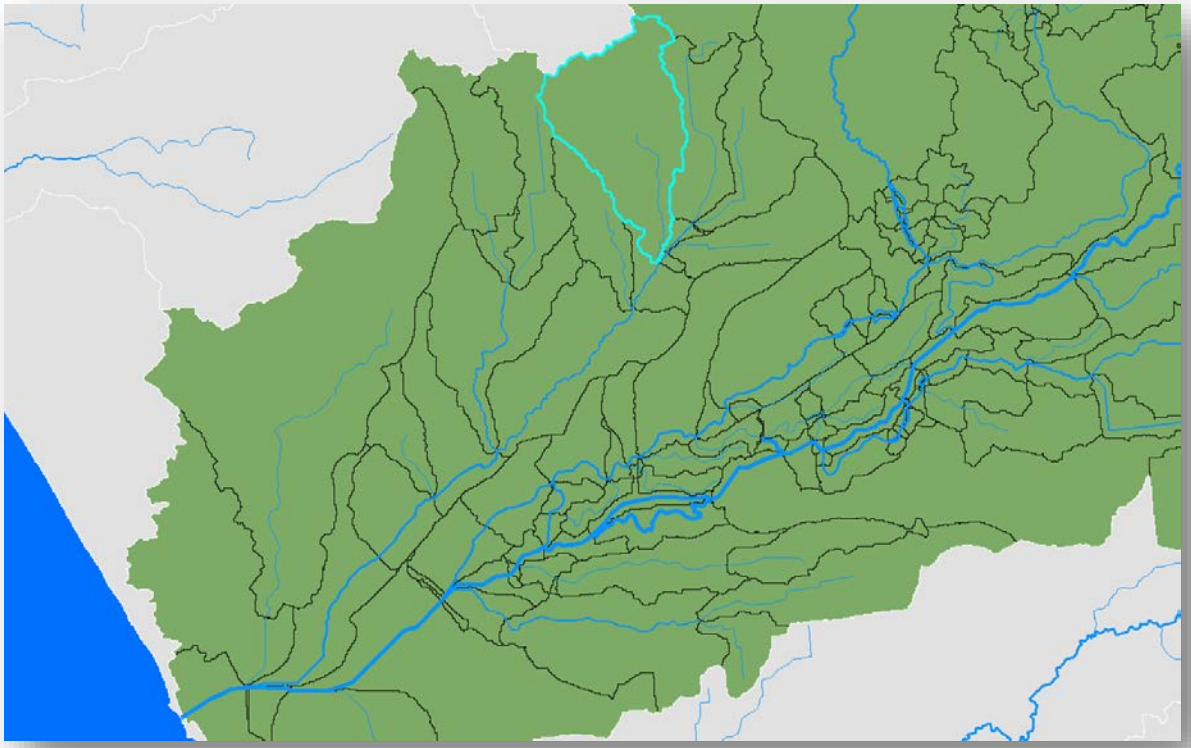


0	0	0	0	0	0
0	1	1	2	2	0
0	3	7	5	4	0
0	0	0	20	0	1
0	0	0	1	24	0
0	2	4	7	35	2

Flow direction

Flow accumulation

What's so unique about the National Water Model?



Muskegon River, Michigan

Stream segments & catchments with land surface attributes

↓

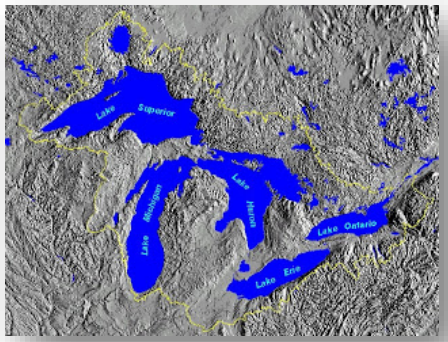
Water routing through stream network (slope & From-To Nodes)

↓

Report stream flow at stream segment scale

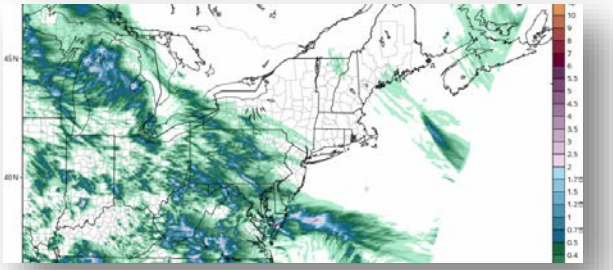
WRF-Hydro Inputs

Digital elevation model (DEM) OR hydrofabric representing the channel, lake & water management parameters

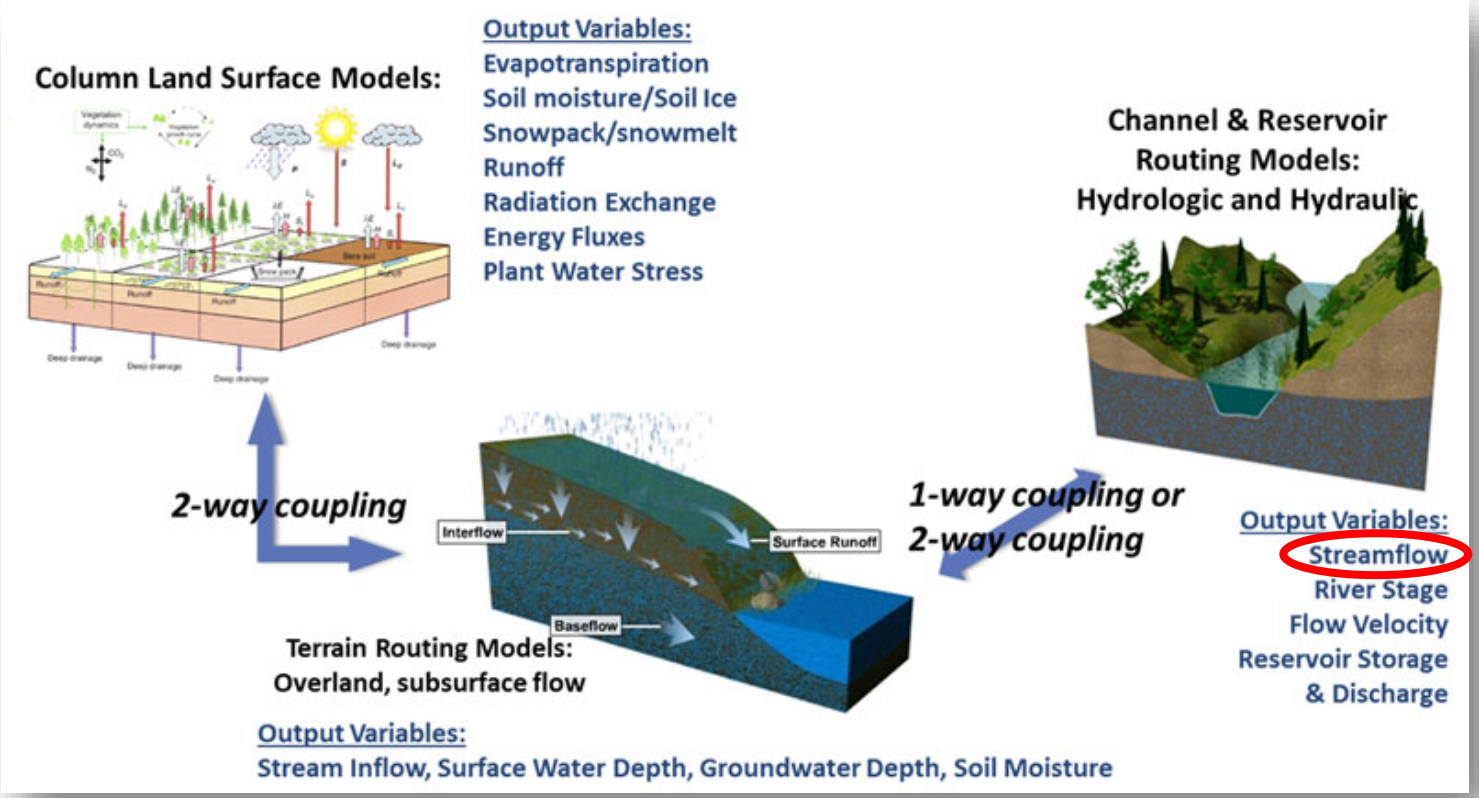


Geofabric representing land use & land cover, soil types, & greenness fraction

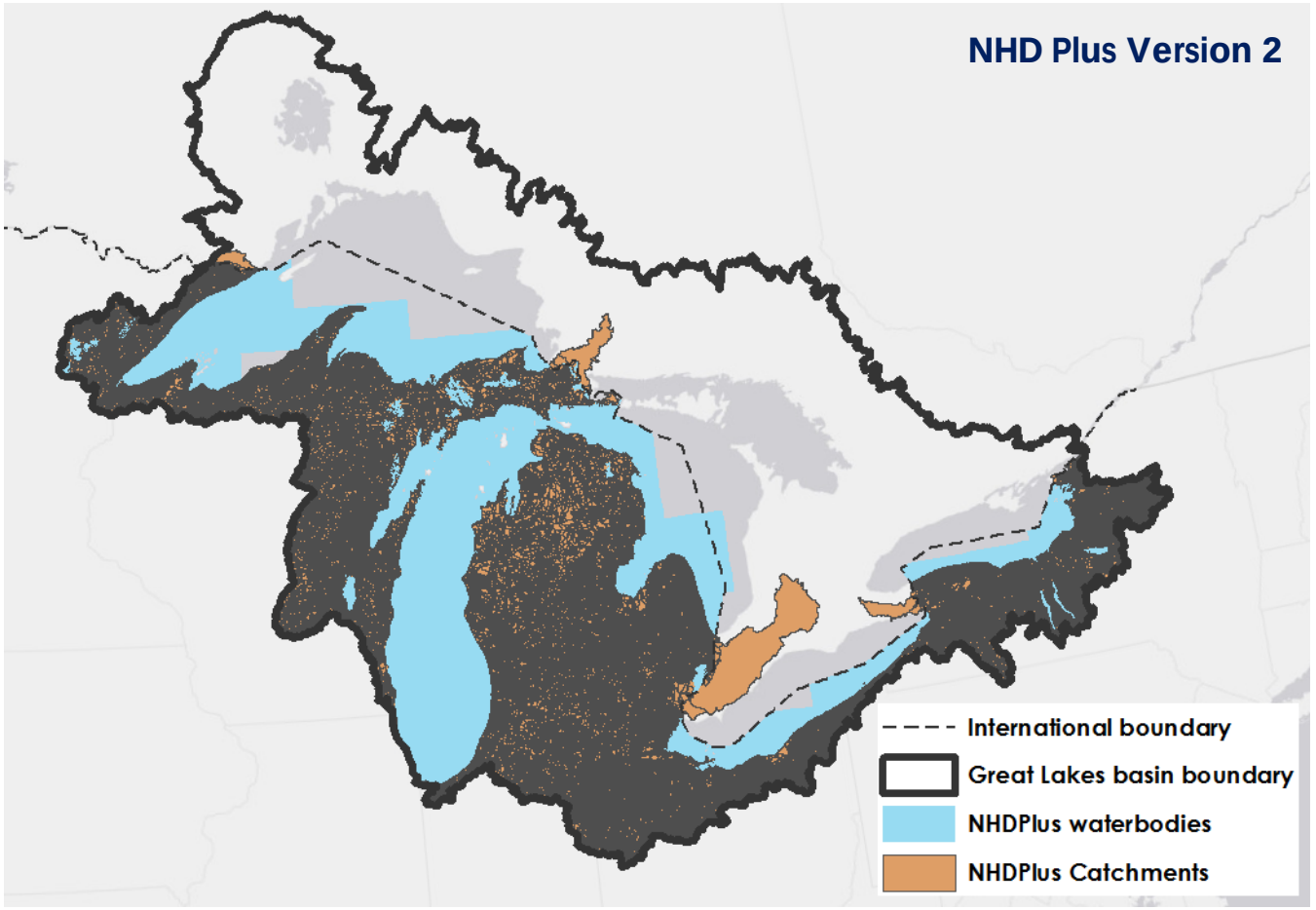
Meteorological Forcings



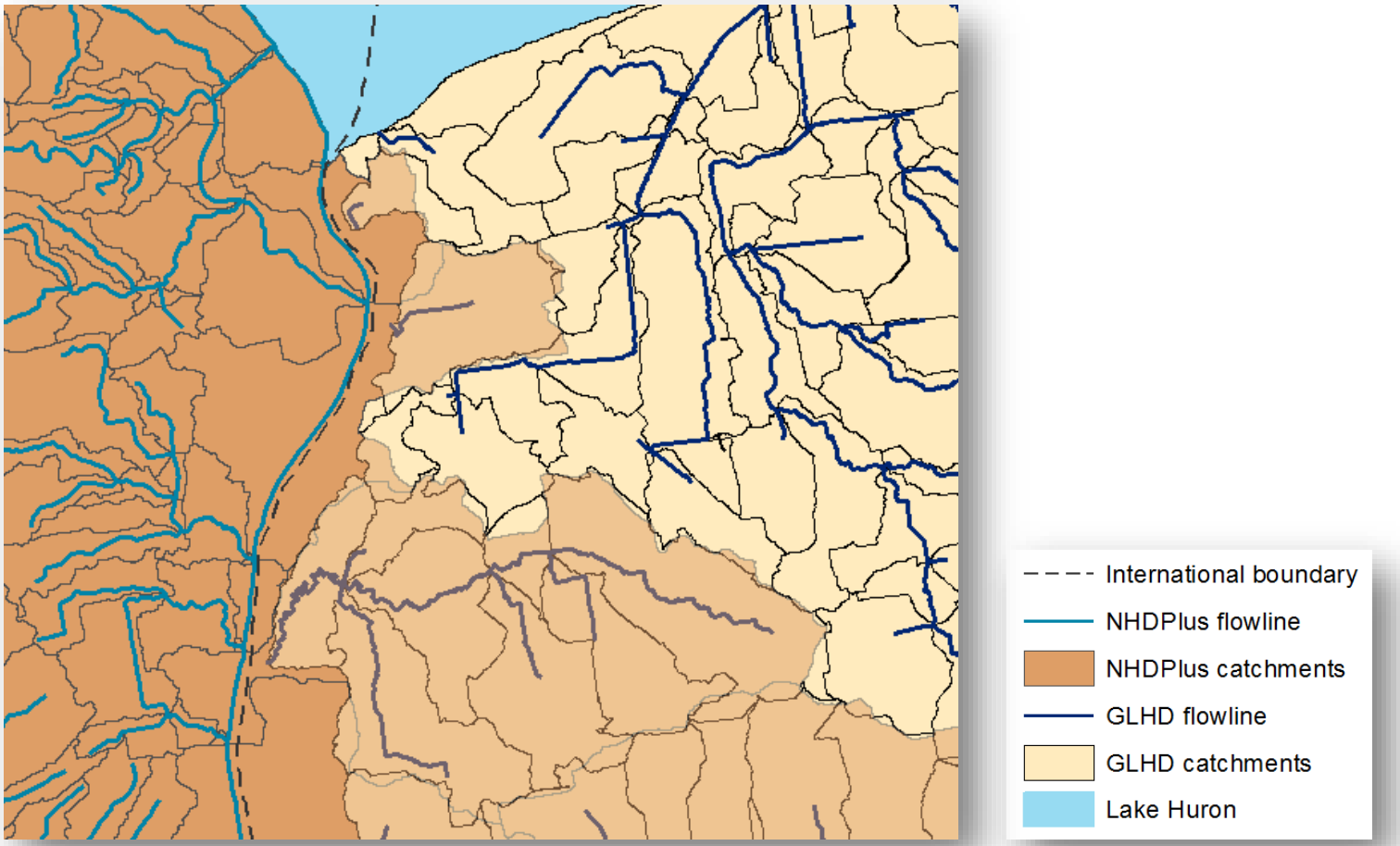
WRF-Hydro Outputs



Developing a Hydrofabric

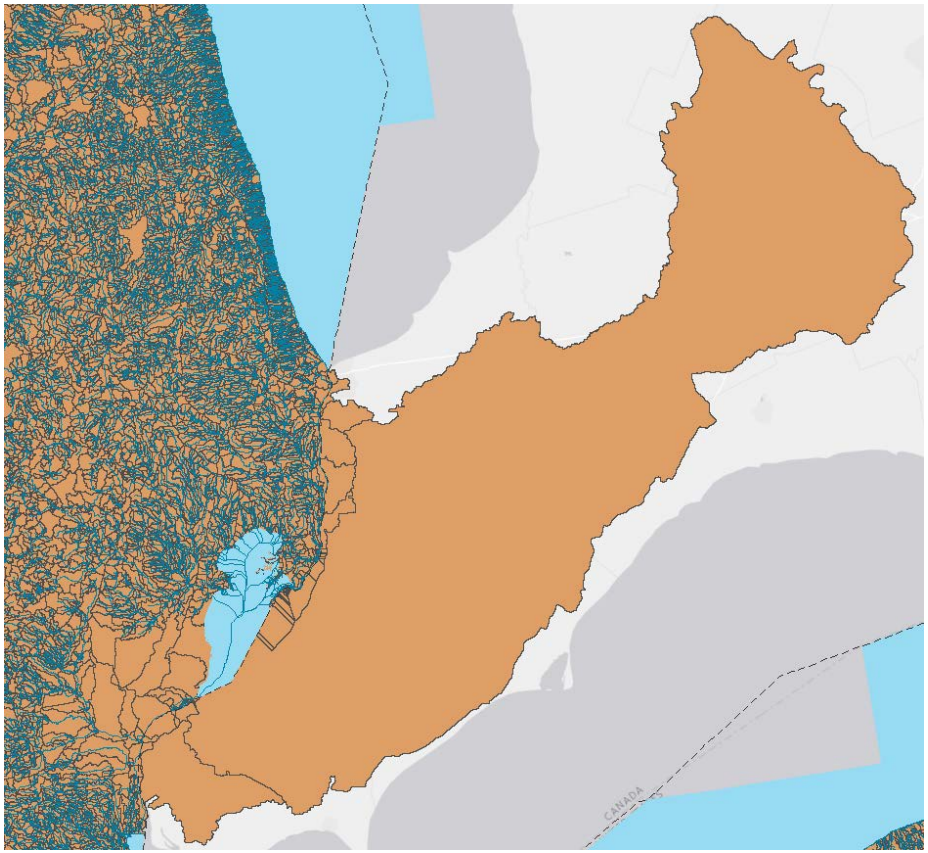


Developing a Hydrofabric

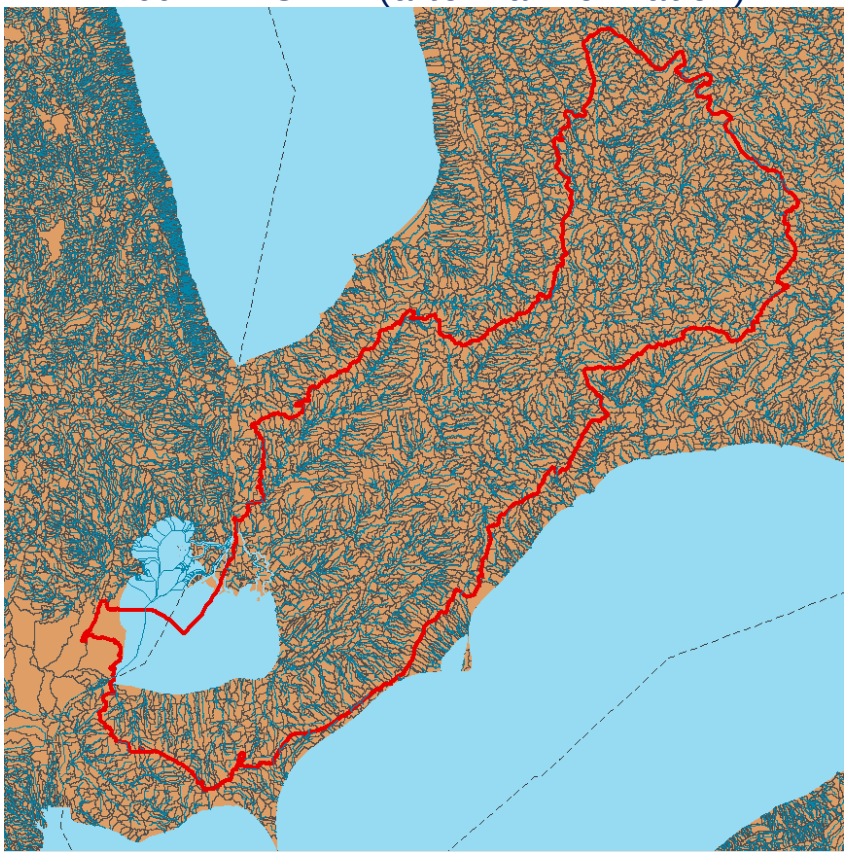


Developing a Hydrofabric

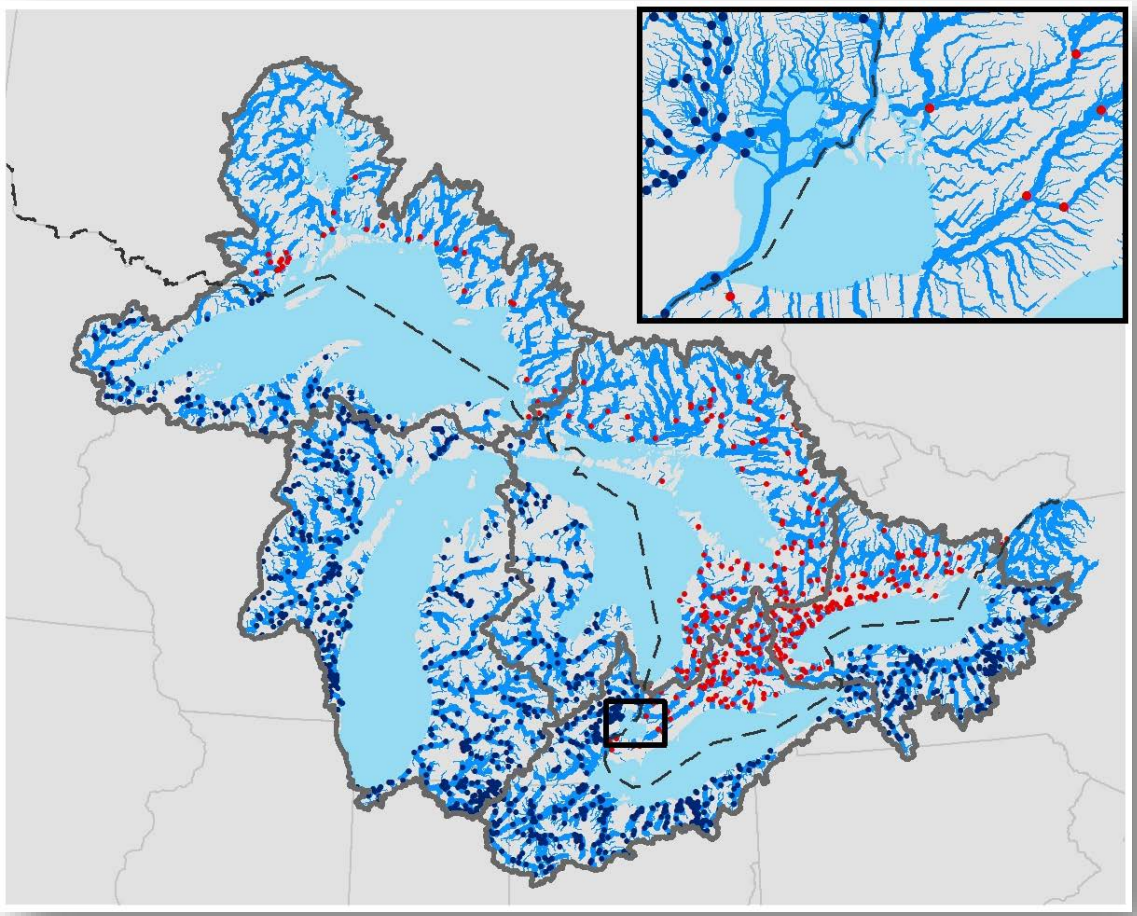
NHD Plus Version 2



NHD Plus V2 + GLHD (after harmonization)



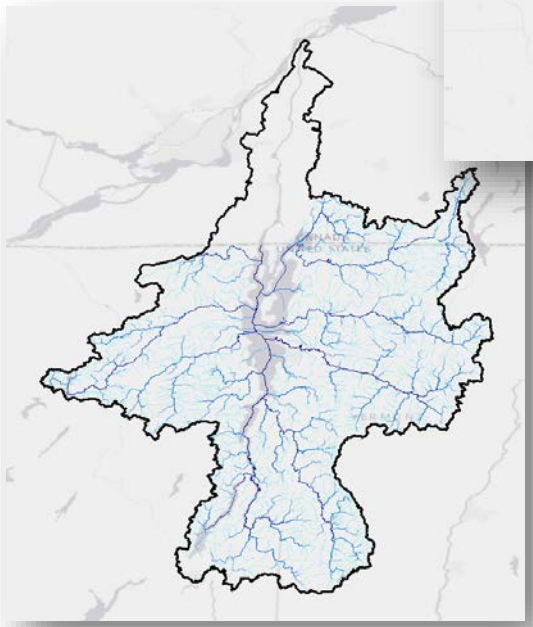
Developing a Hydrofabric



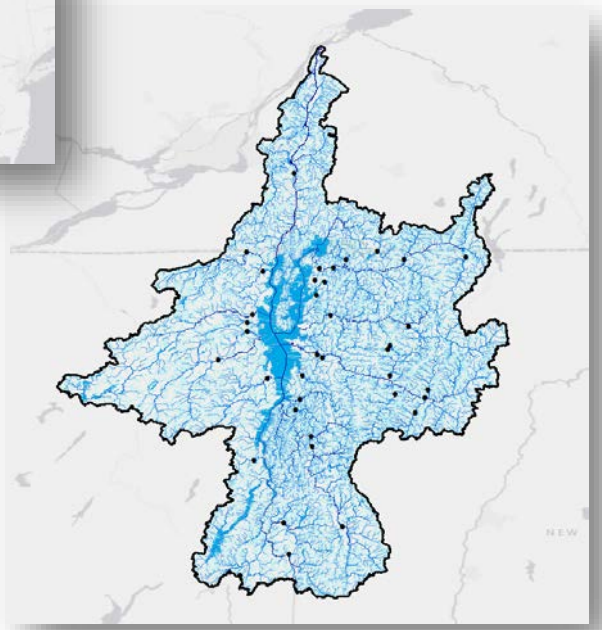
- Lake water body features: 7
- Stream segments: 151,641
- Land catchments: 154,475
- Stream-to-lake connections: 3,807
- USGS stream gages: 392
- ECCC stream gages: 348
- Grid-to-basin correspondence
  - 1km grid weights: 1,425,269
  - 250m grid weights: 11,602,357

National Water Model features:
2.7 million

Extending the domain: Lake Champlain



NHDPlus V2
1:100,000
Current NWM operational extent



NHDPlus HR (beta)
1:24,000

Partnerships

Michigan DNR
Institute for Fisheries Research

Great Lakes Aquatic Habitat Framework
https://www.glahf.org/

U.S. Environmental Protection Agency

U.S. Geological Survey

Further Information

NOAA-GLERL	https://www.glerl.noaa.gov/
Newsletter	https://www.glerl.noaa.gov/education/newsletter.html
Infographics	https://www.glerl.noaa.gov/pubs/brochures/infographics.html
Data	https://www.glerl.noaa.gov/data/
Blog	https://noaaglerl.blog/

Great Lakes Aquatic Habitat Framework
https://www.glahf.org/

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