Great Lakes Coastal Mapping Summit
Day 2 and additional presentations

Great Lakes Bottom Mapping Workgroup Discussion

Peter Esselman, USGS Great Lakes Science Center
Brandon Krumwiede, NOAA Office for Coastal Management
Hans Van Sumeren, Northwestern Michigan College

Great Lakes Coastal Mapping Summit Chicago, Illinois April 4-6, 2017

Great Lakes Bottom Mapping Workgroup

To harmonize collection, processing, and sharing of continuous high-resolution maps of Great Lakes bathymetry, sonar reflectance, bottom type classifications, and derived data products.

Ad hoc, organic, volunteer driven based on the needs of the Great Lakes community at large focused on mapping at or below the water.

Organization

Steering Committee

Sub-Groups:

Technology (Hans Van Sumeren and John Bright)

Data Holders (Brandon Krumwiede and Ethan Theuerkauf)

Data Users (Peter Esselman and TBD)

Identifying Regional Technology and Standards

Identifying Regional Data Holdings

Regional to Local

Example:
Need for current, high-resolution data

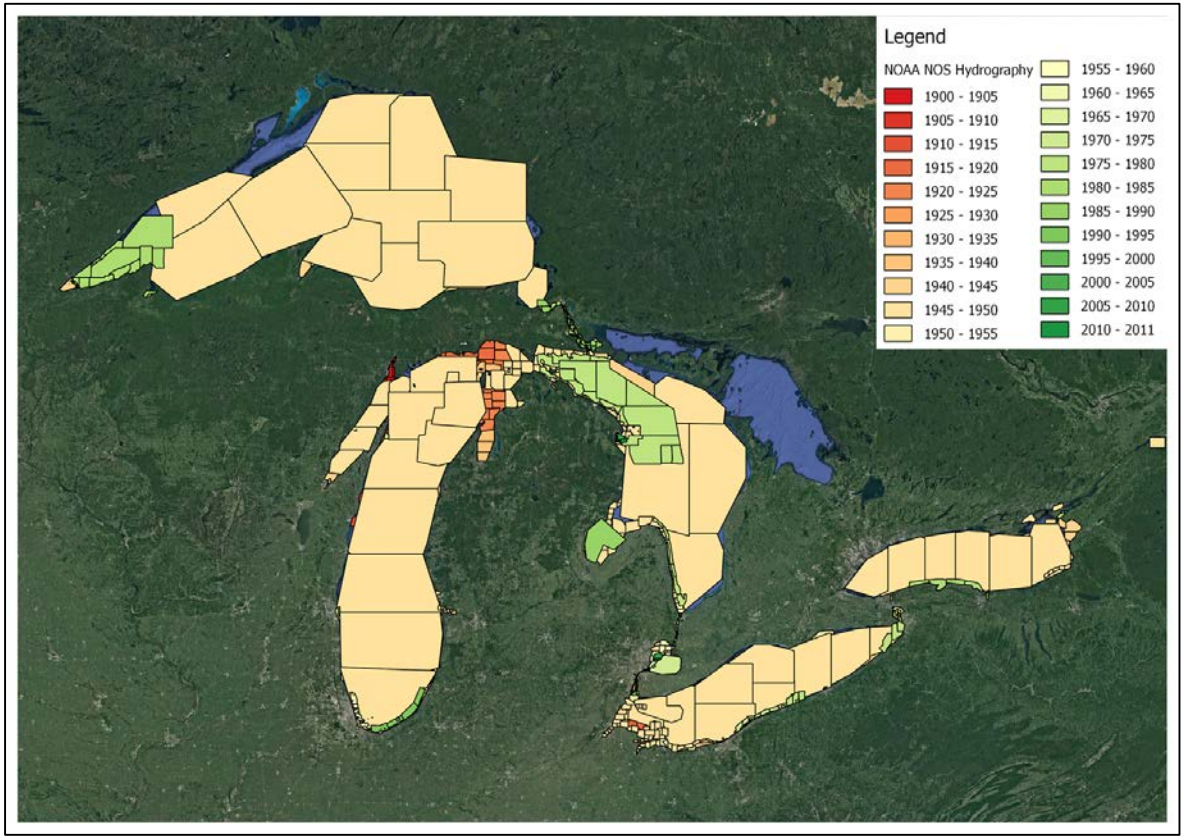
NOAA NOS Hydrography 1980-Present

Identifying Regional Data Holdings

Some parts of the Great Lakes have not been visited since the early 1900s.

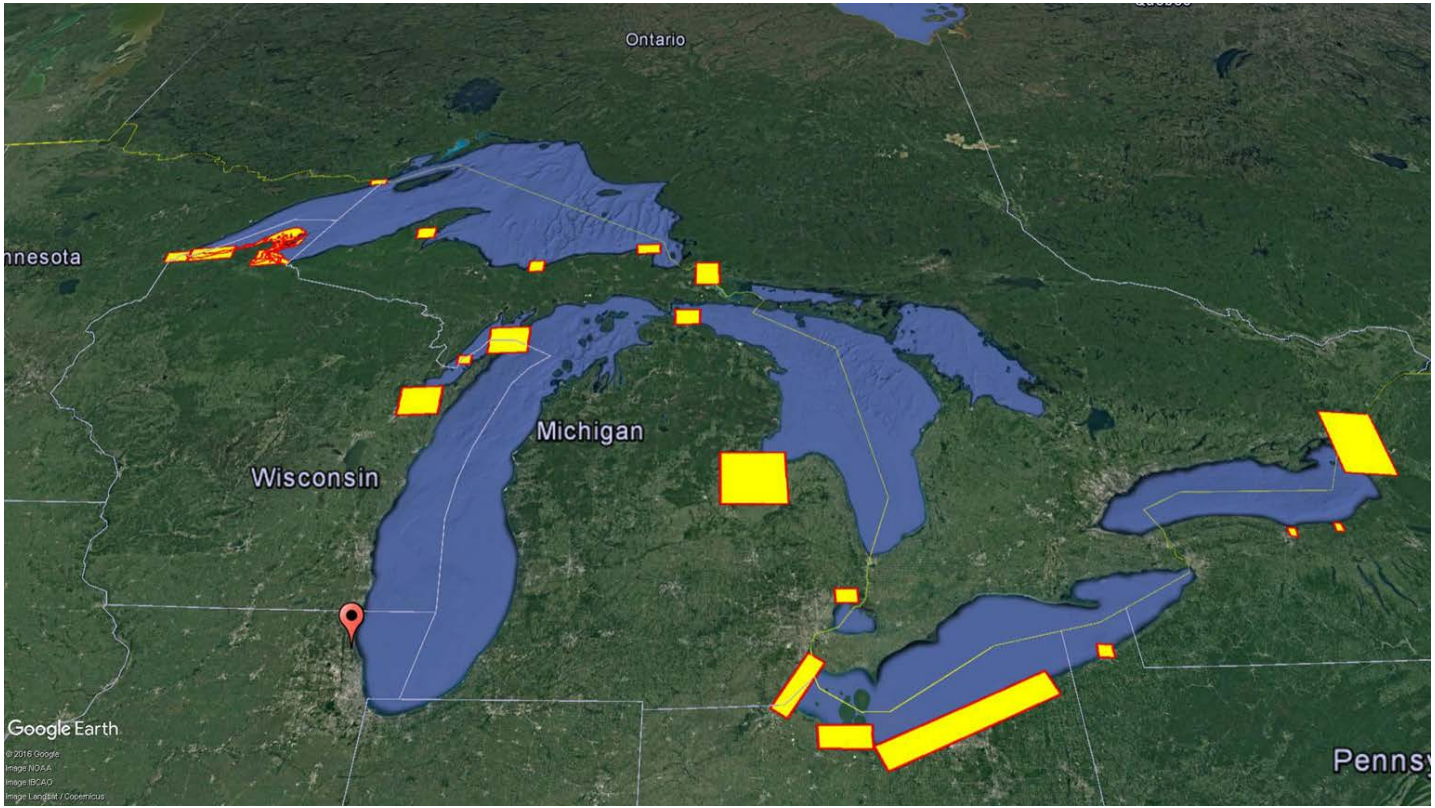
Open water areas surveyed in the mid-1900s.

This does not reflect recent JALBTCX coastal topo/bathy lidar collections.



Identifying Regional Data Needs

Bottom Mapping Workgroup User reported data needs



Breakout Group Time!

Group Brainstorming and Reflection:

Goal: Discuss, identify, and prioritize 3 key objectives for the 3 groups listed below as they relate to the Great Lakes region.

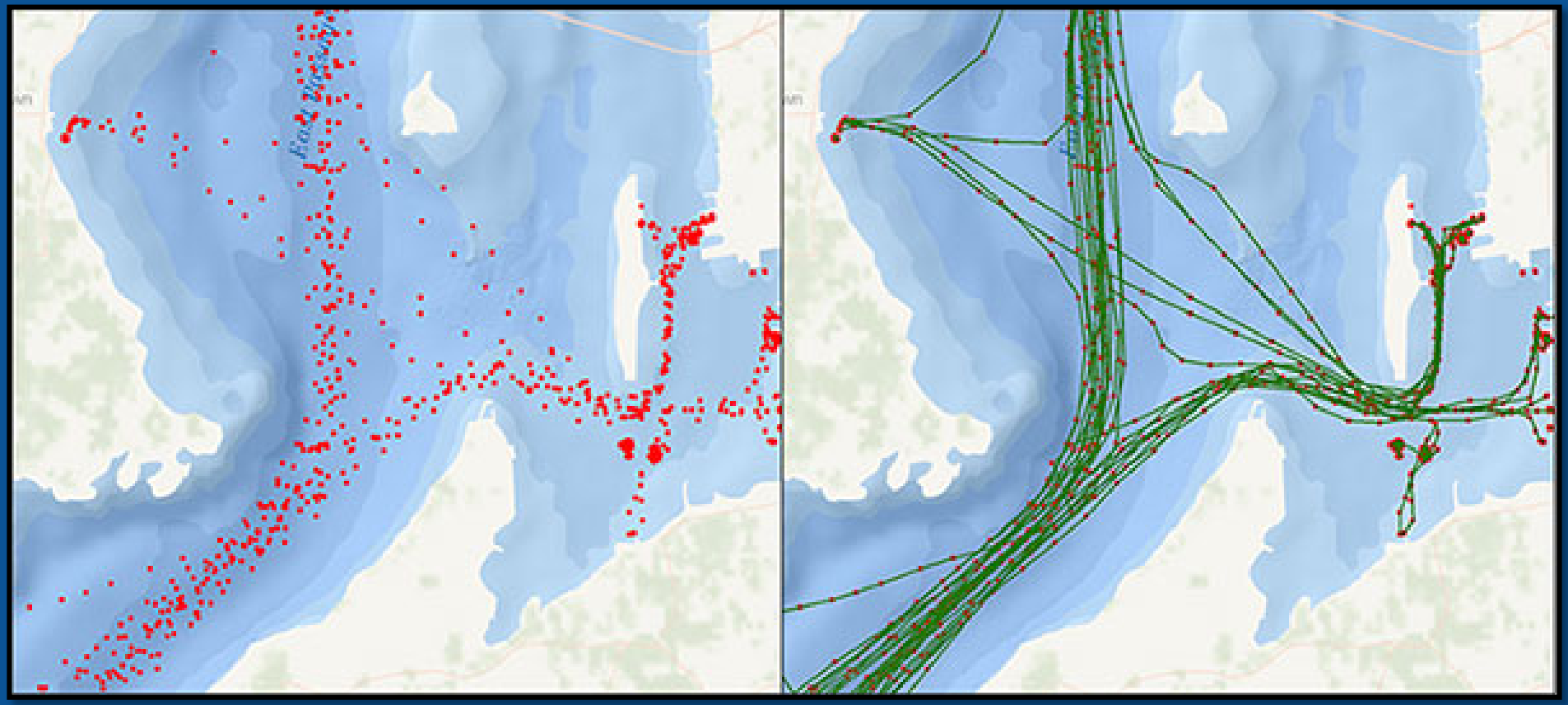
-Technology / Standards

-Data Management / Holders

-Data Applications / Users

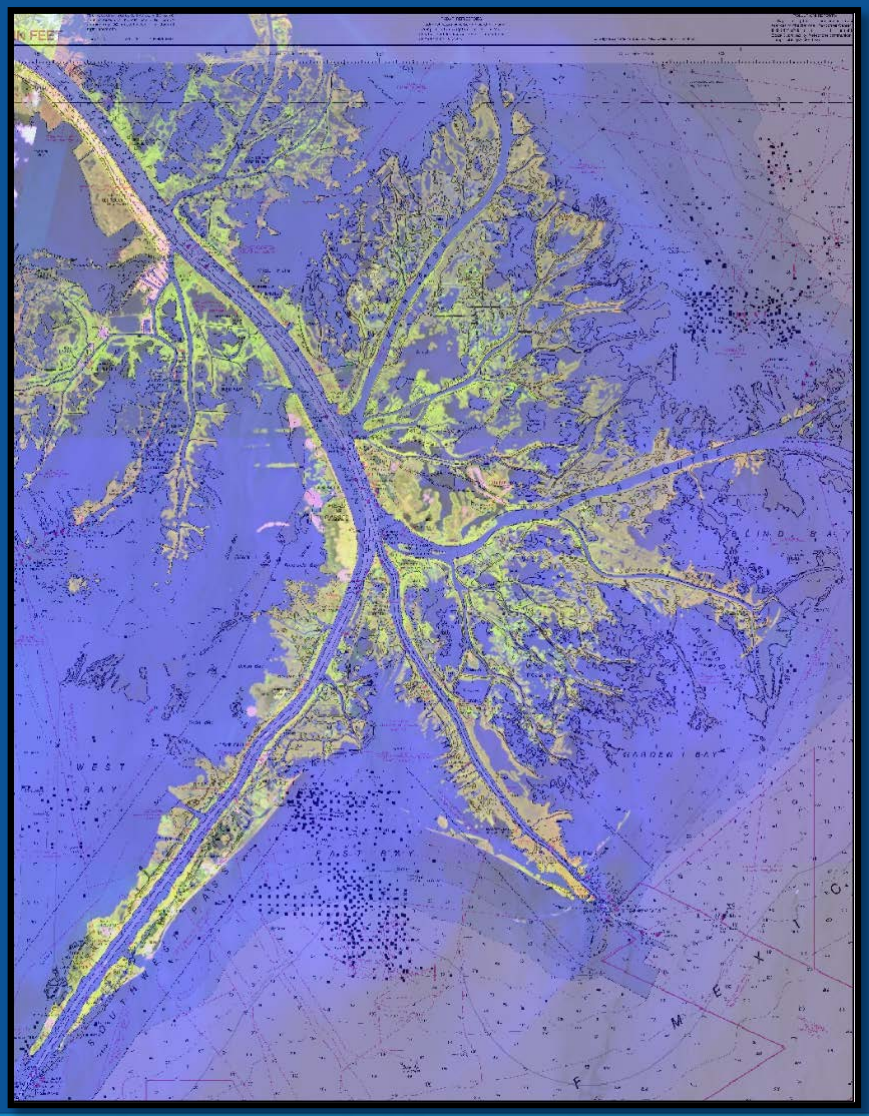
Great Lakes Coastal Mapping Summit
Additional Presentations

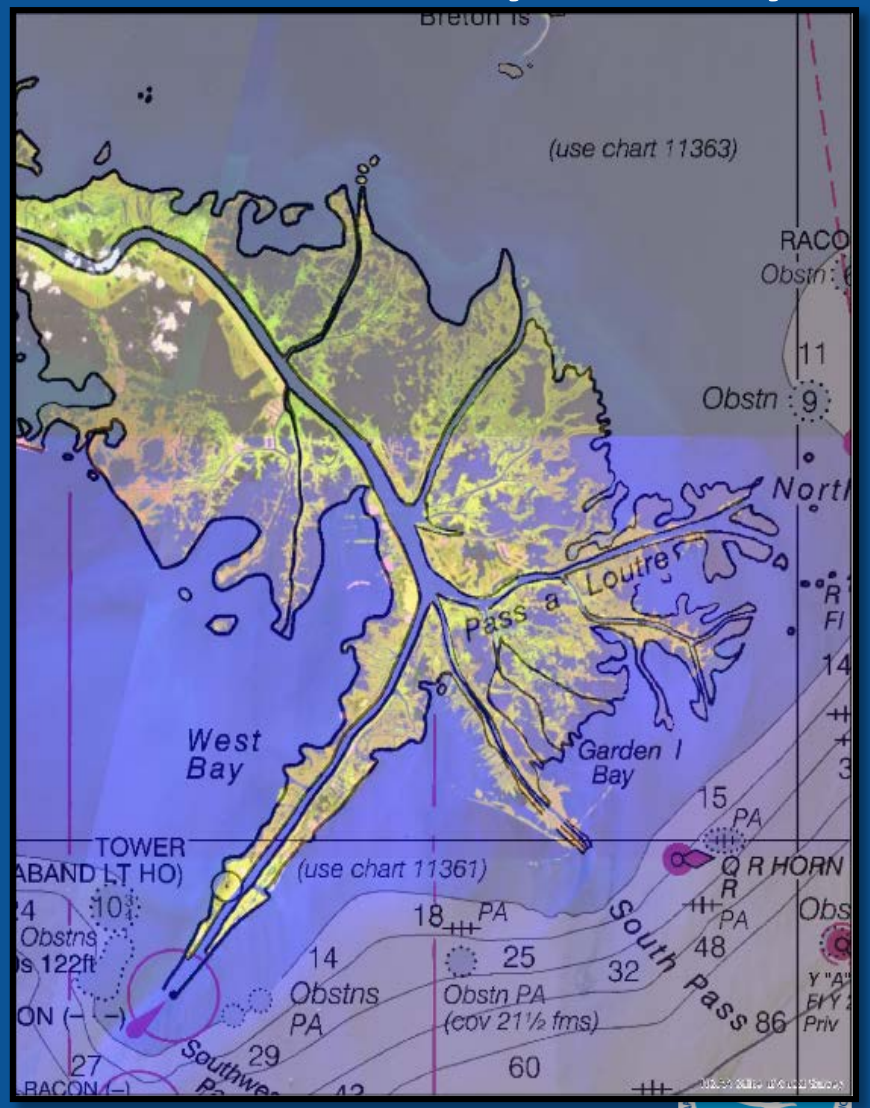
Crowdsourced Bathymetry



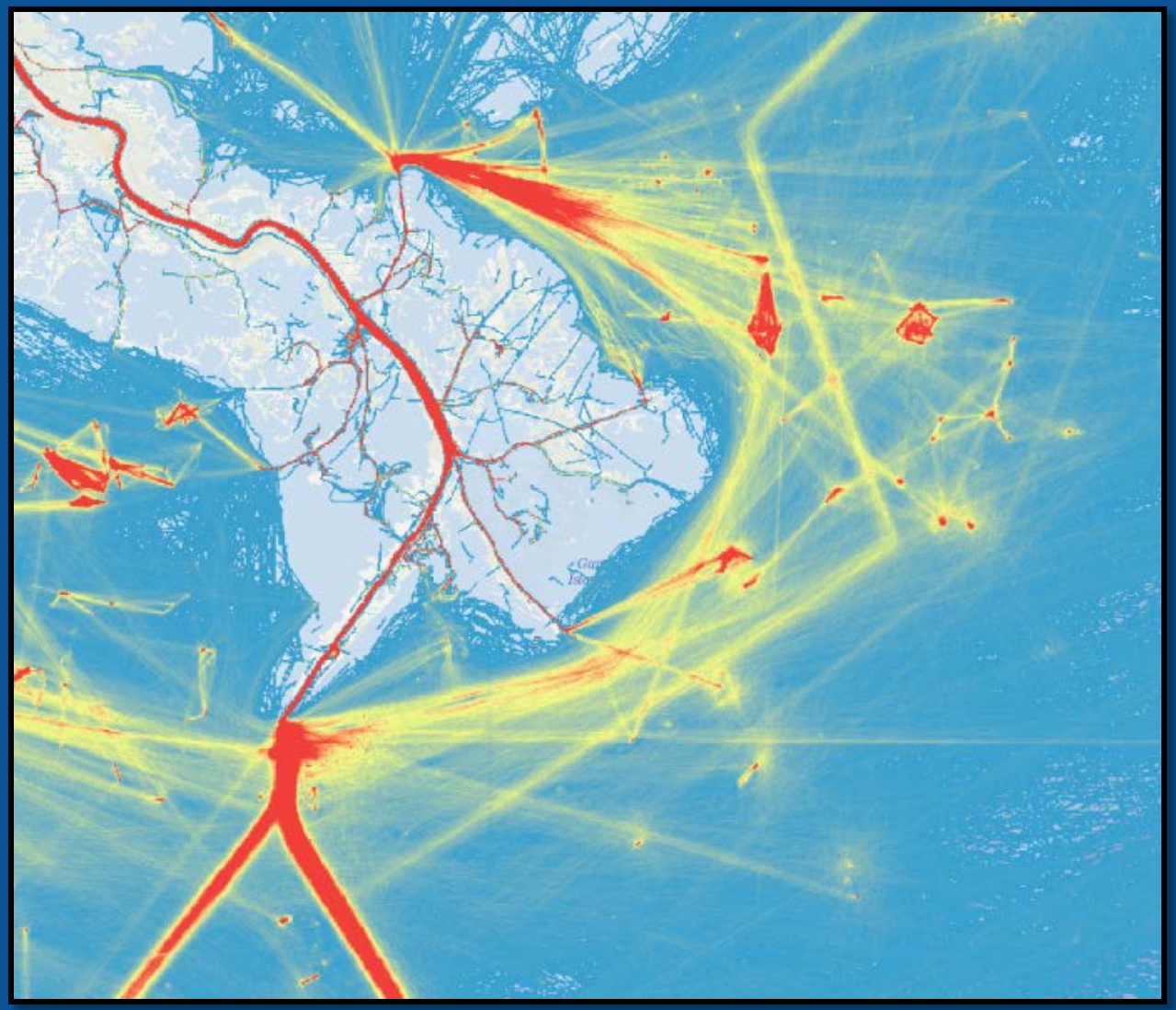
Adam Reed, LT/NOAA

Benefits of crowdsourced bathymetry

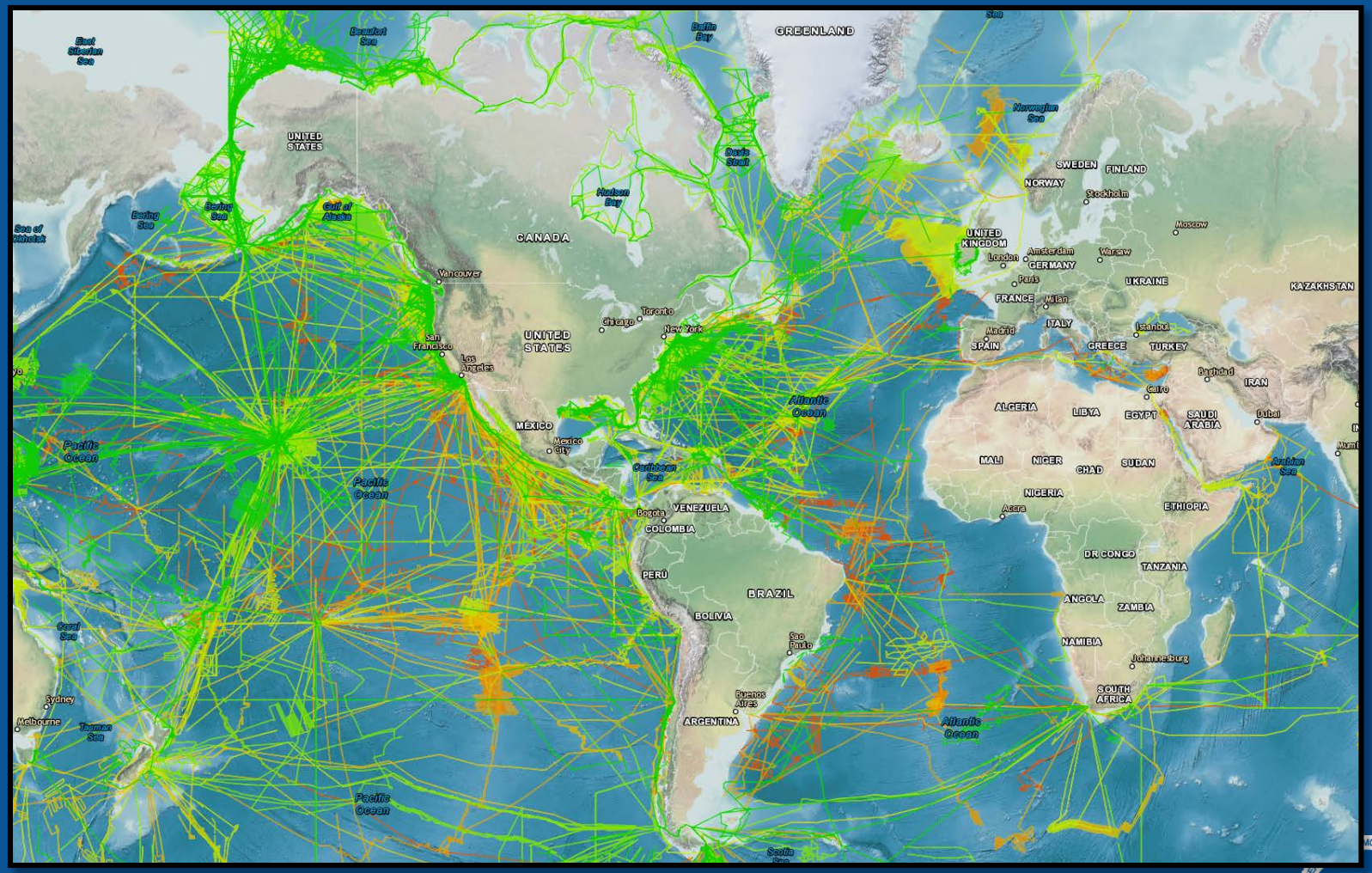




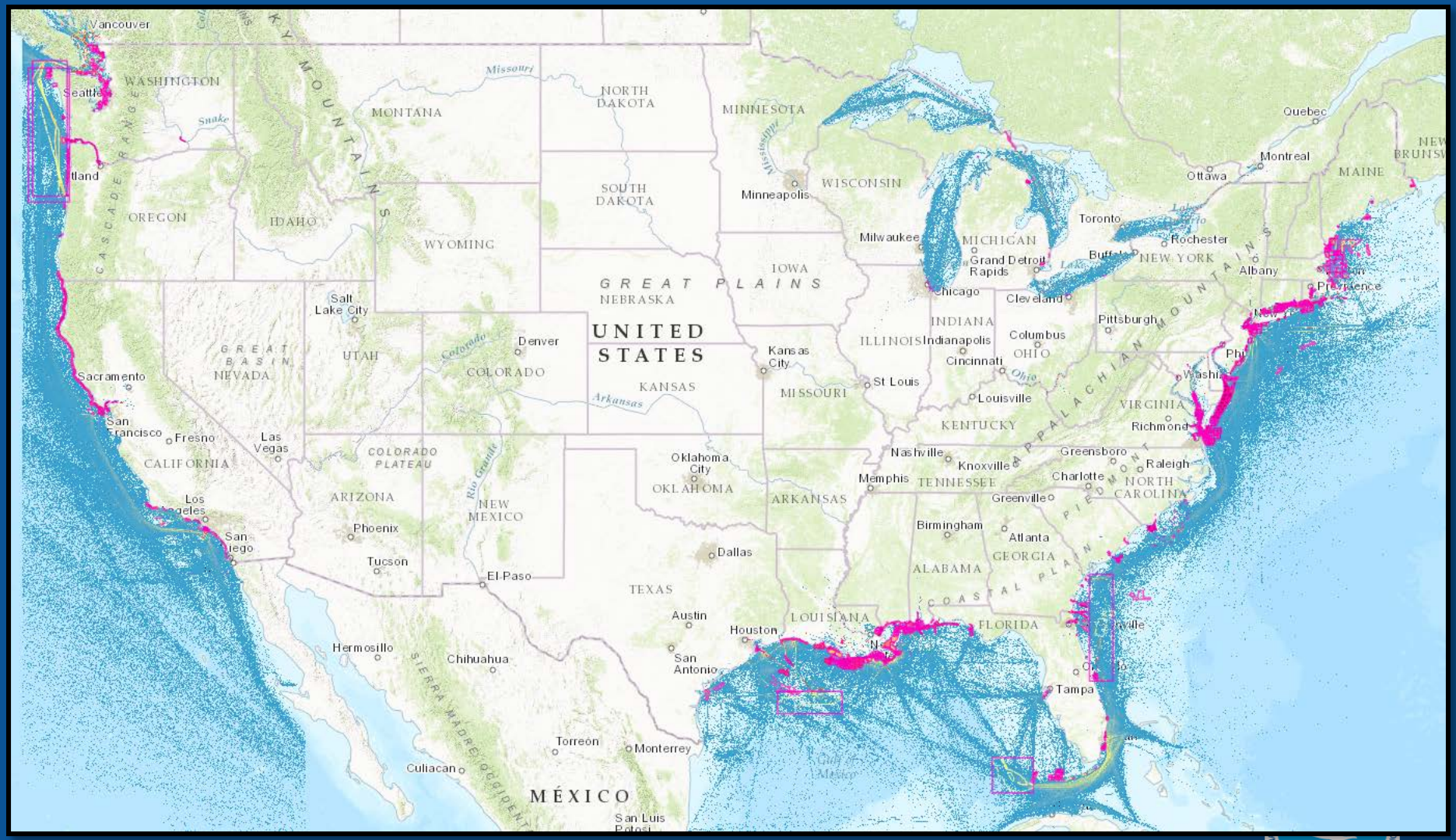
Benefits of crowdsourced bathymetry



Benefits of crowdsourced bathymetry



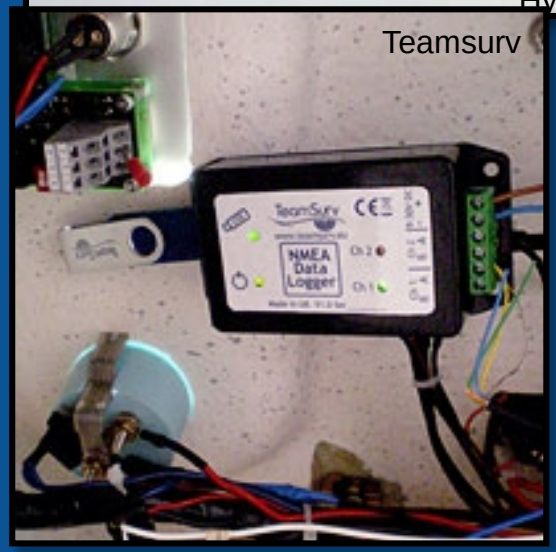
Benefits of crowdsourced bathymetry



Hardware Solutions

Hydro International

Olex



Teamsurv

Sea-ID

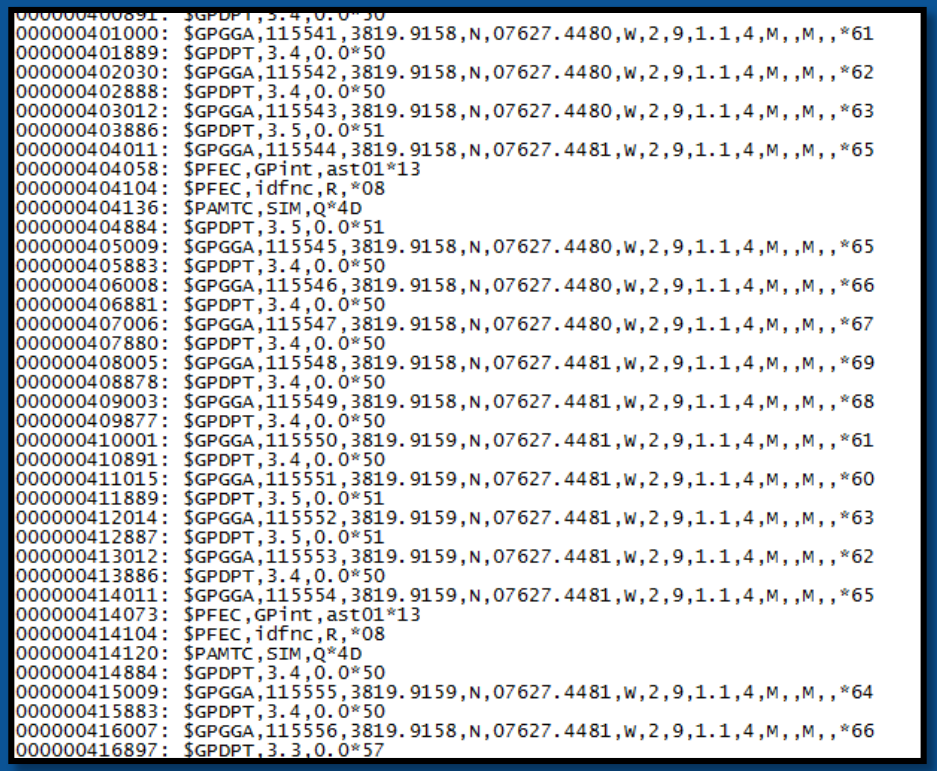
Software Solutions

- Electronic Charting Systems (ECS)
- Crowd size and diversity
- Minimize Barriers to entry

www.pcmaritime.com

Log files

- NMEA strings
  - GGA
  - DPT
- Automatically logged

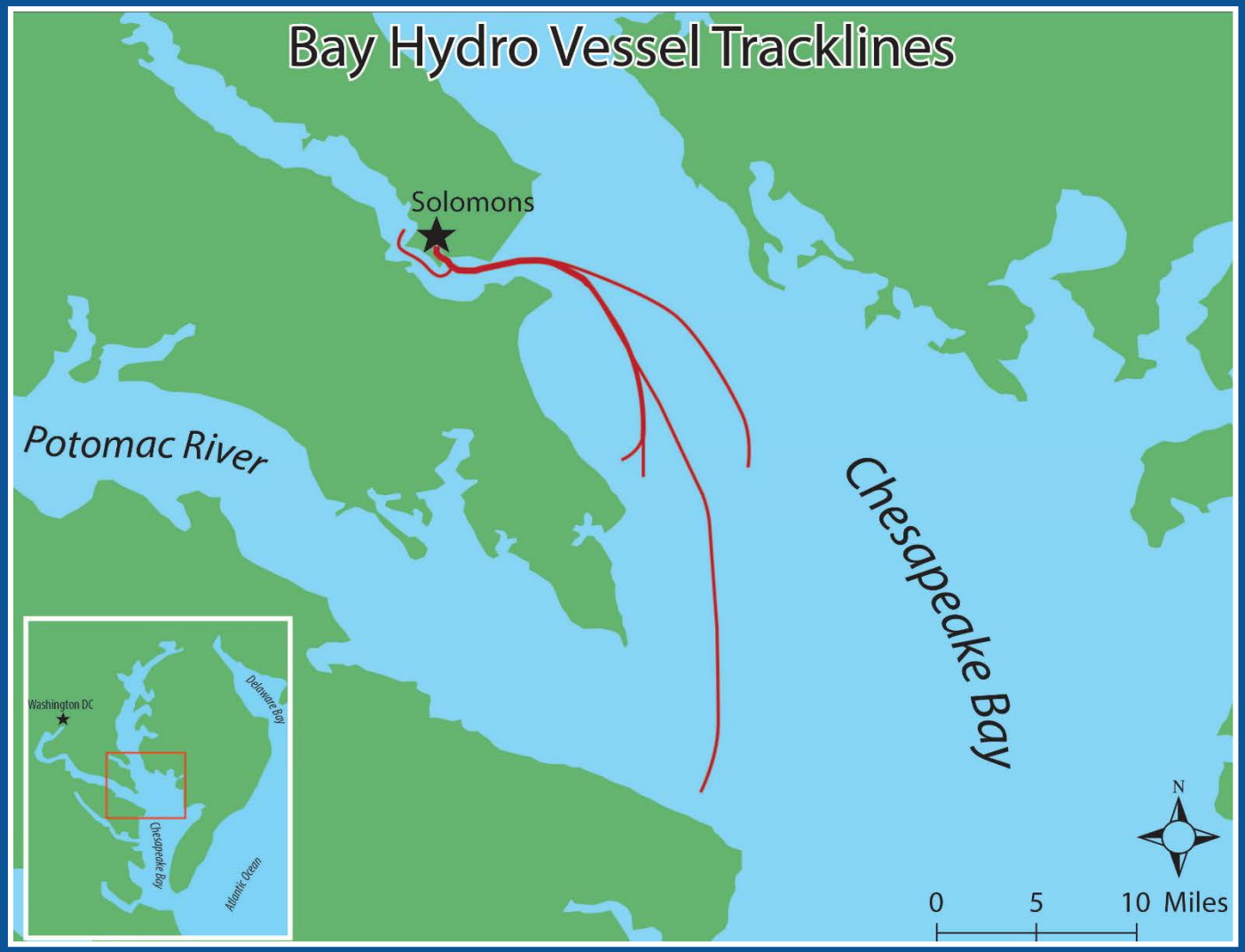


Testing the theory

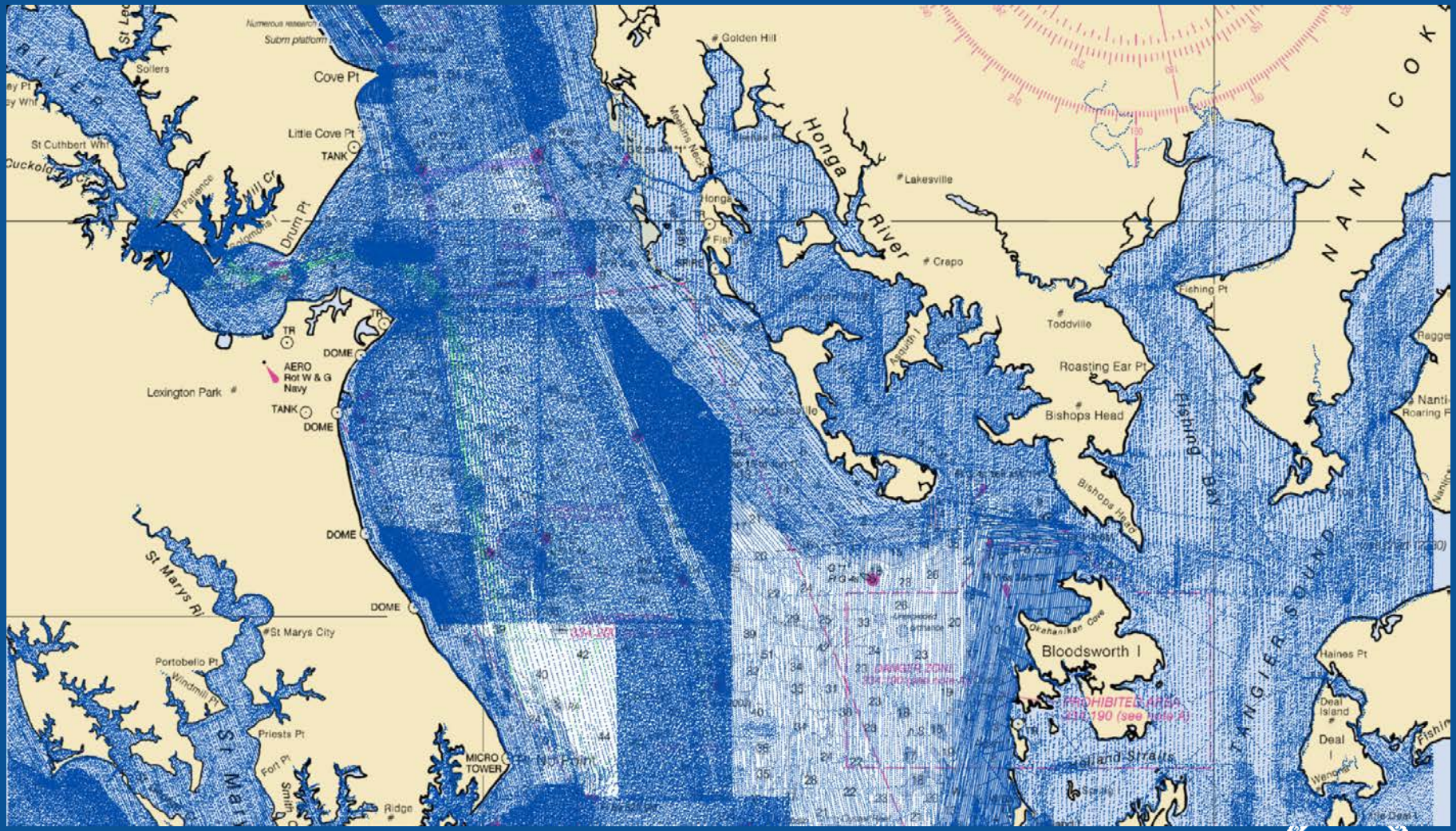
- NOAA R/V *Bay Hydro II*
- Coastal Explorer (Rose Point Navigation Systems)

www.rosepointnav.com

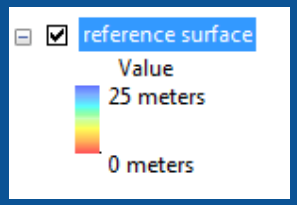
Project Area

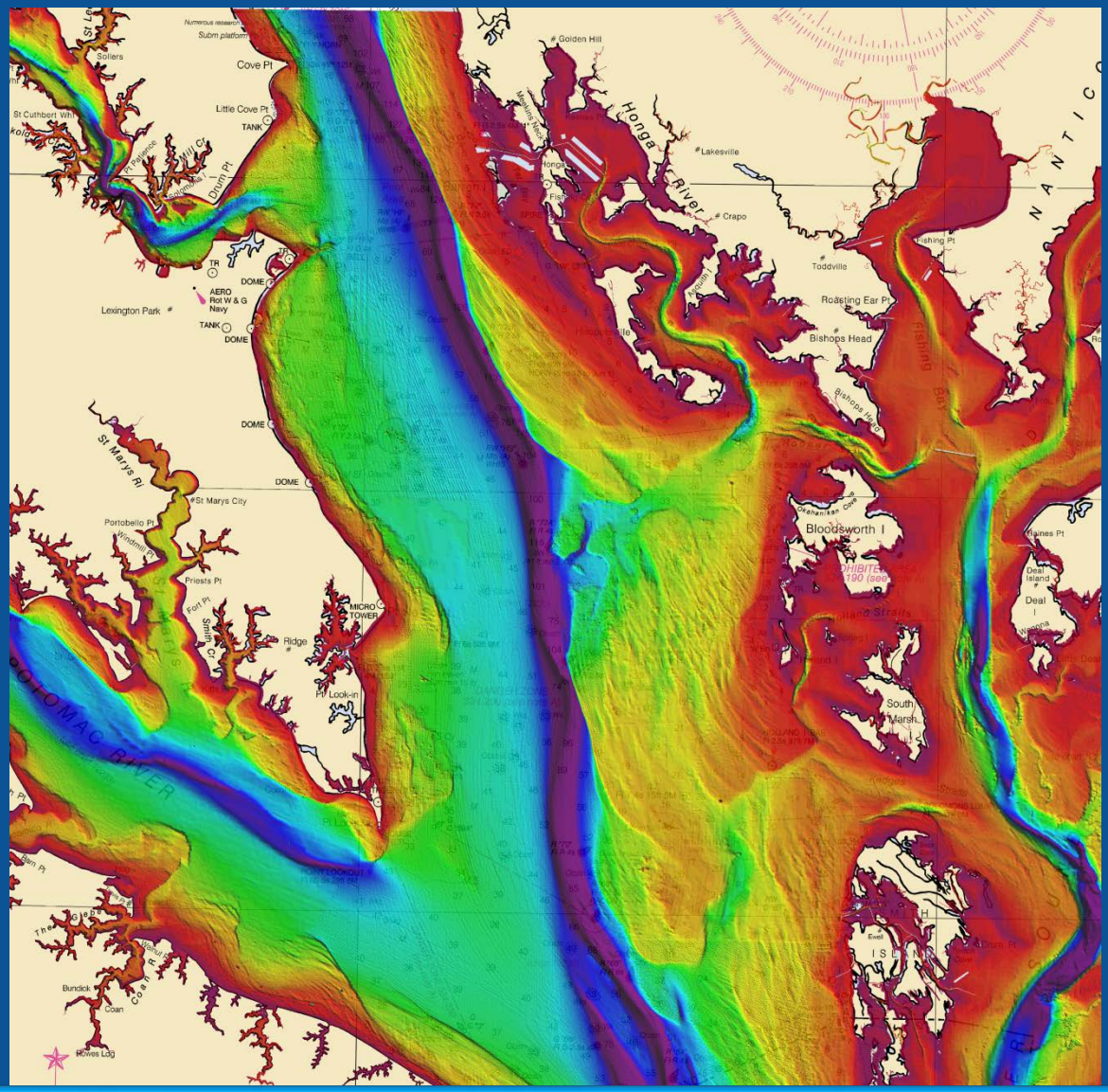


Survey Scale (Fair Sheet) Soundings



Reference Surface





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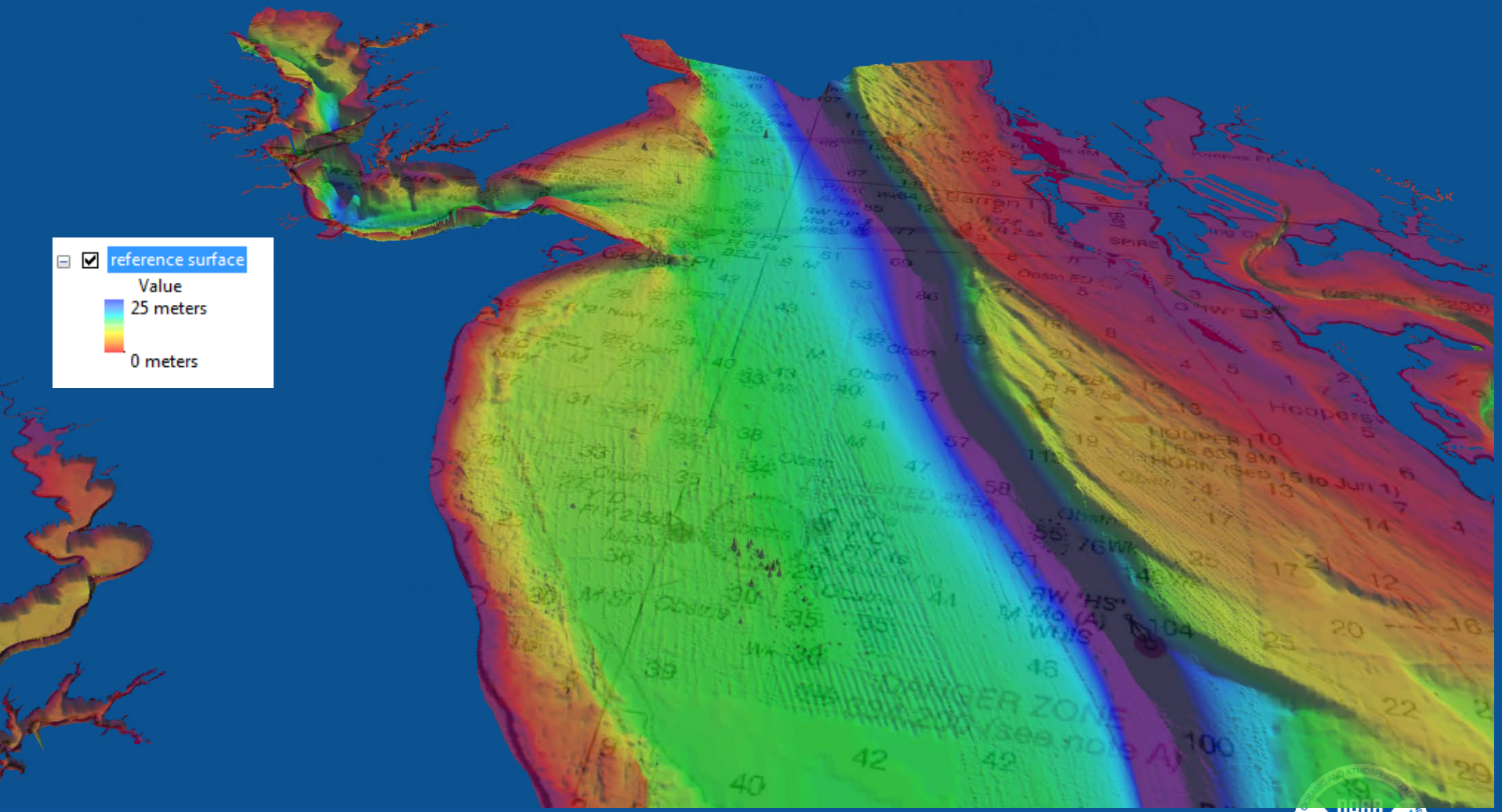
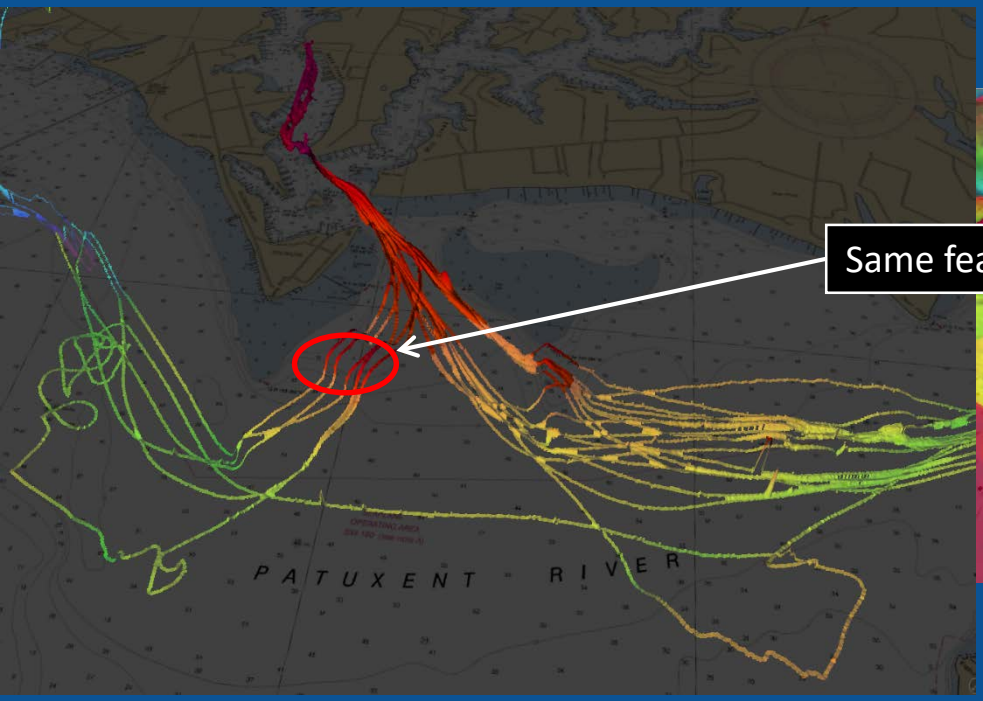


Comparison to Charted Depths

Crowdsourced Bathymetry



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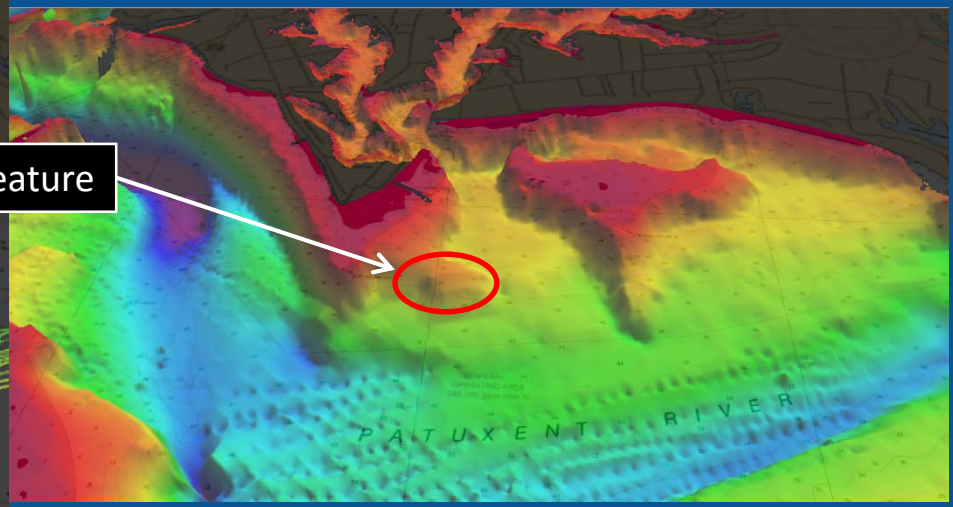
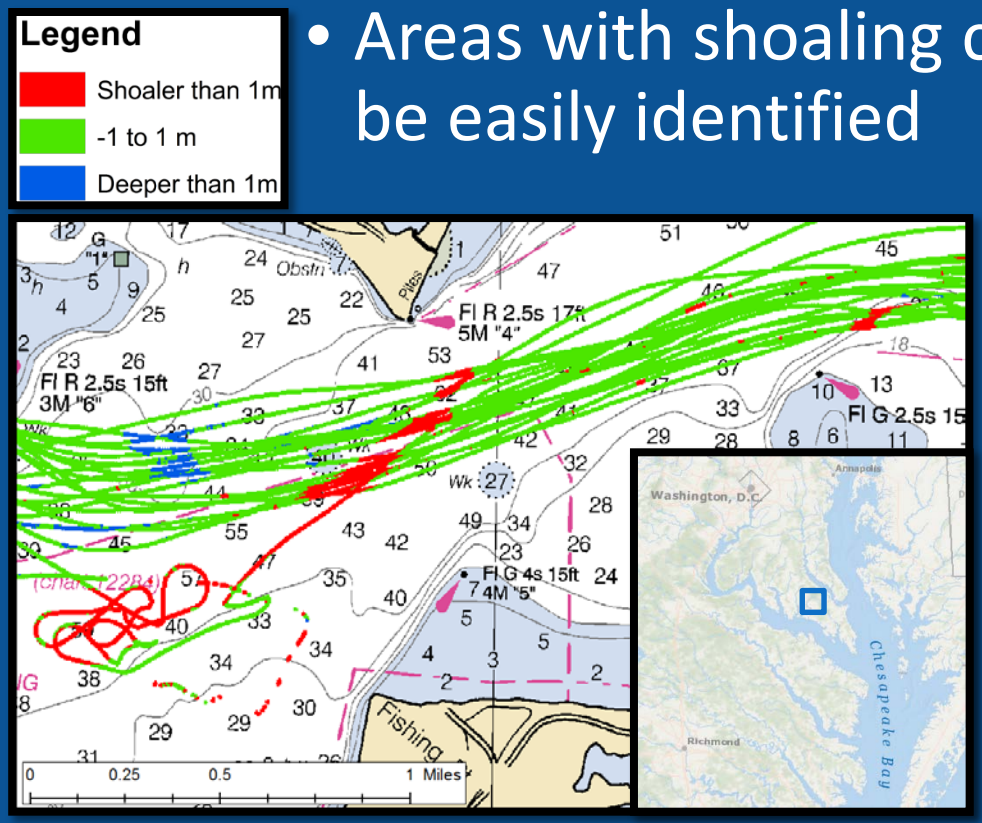
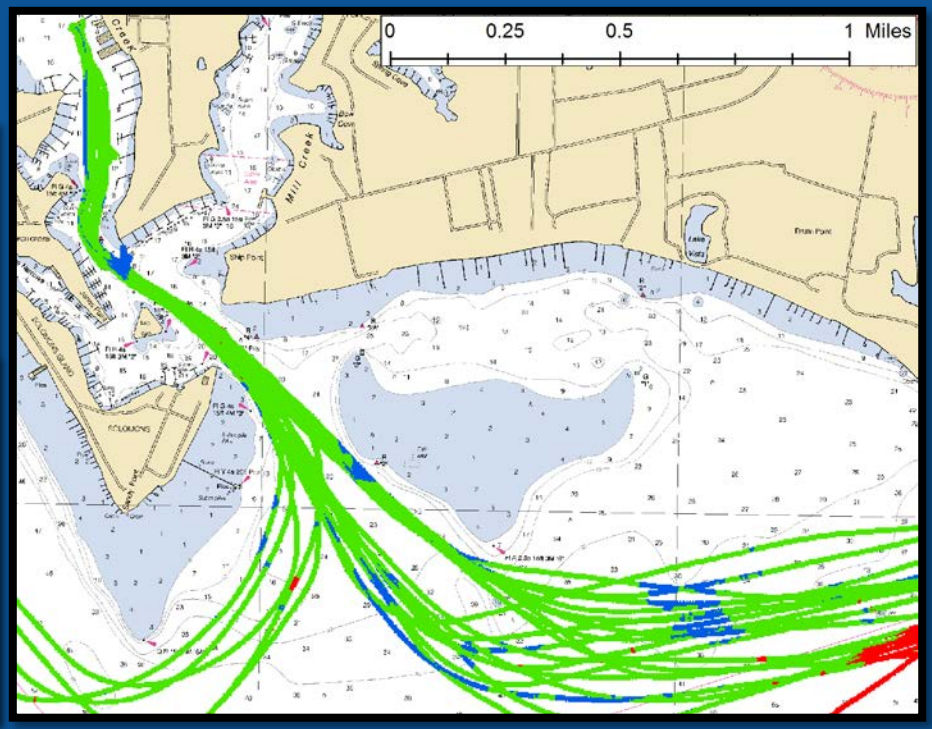


Internally Consistent Trends

- Areas with shoaling can be easily identified

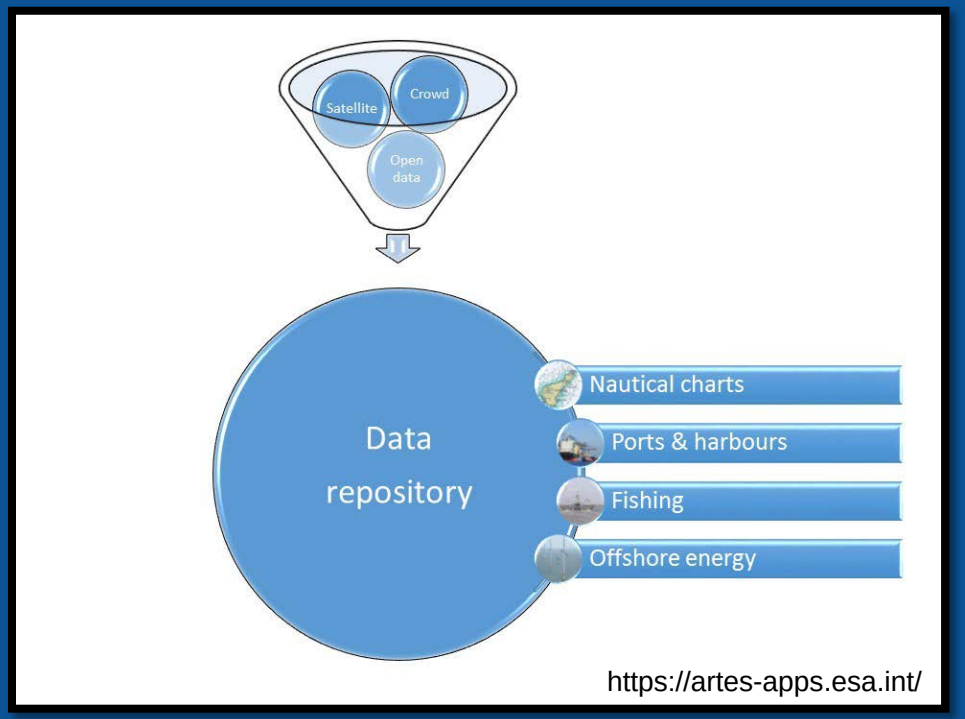




The Crowdsourced Model

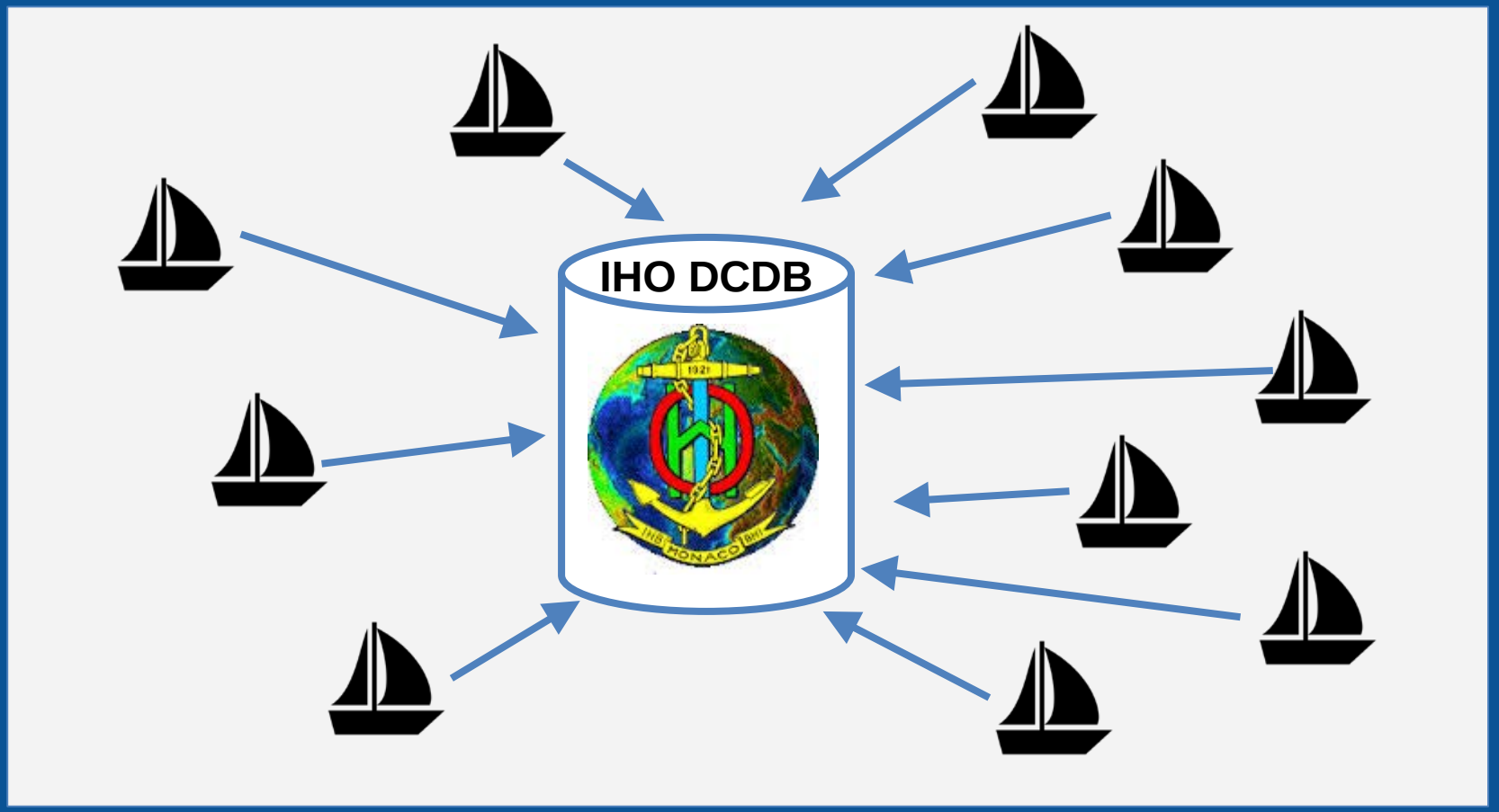
NOAA's Office of Coast Survey is using it for:

- Examining vessel traffic
- Determining Survey Priorities
- Determining Chart Adequacy

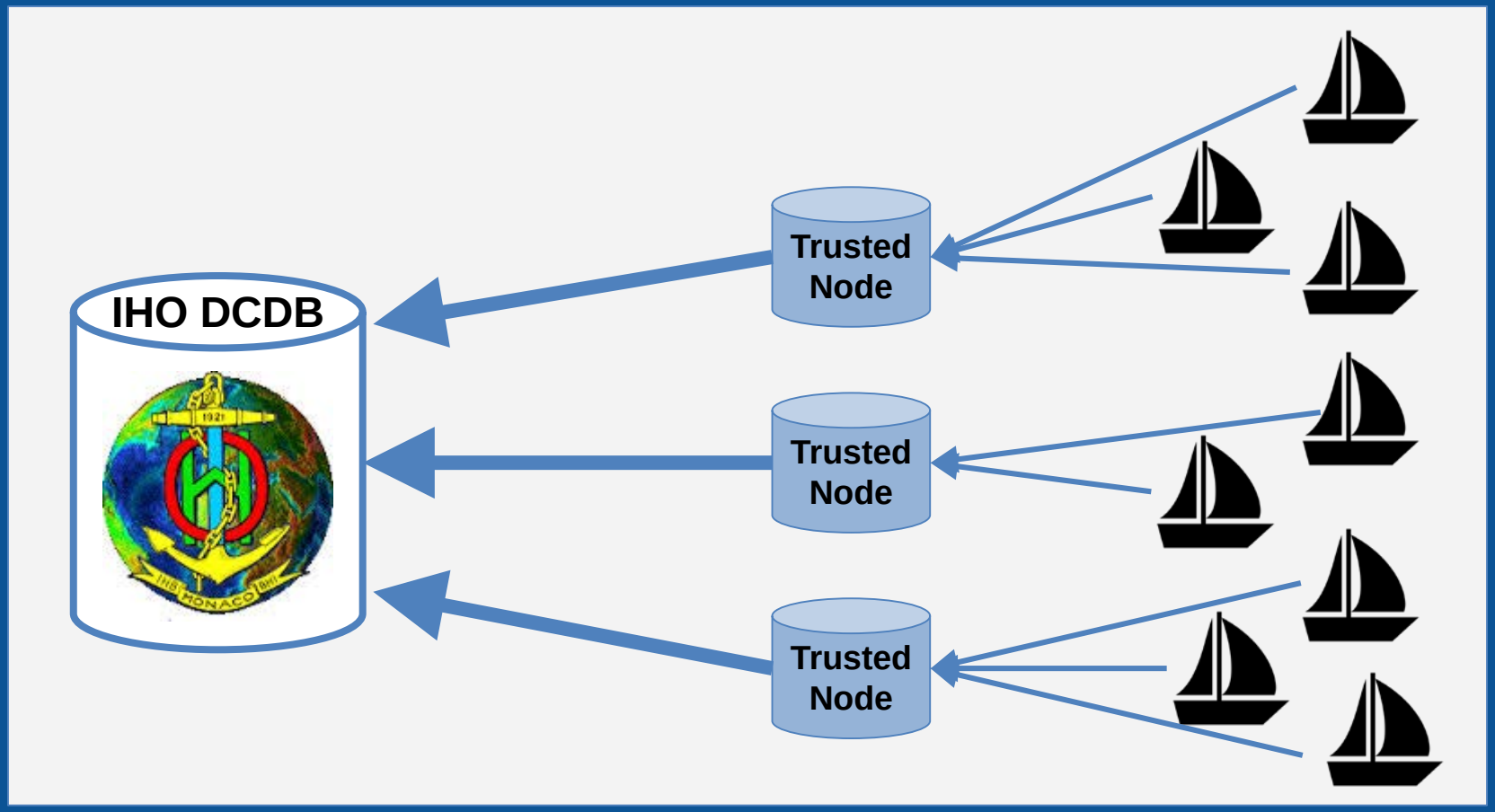


How would this data help you?

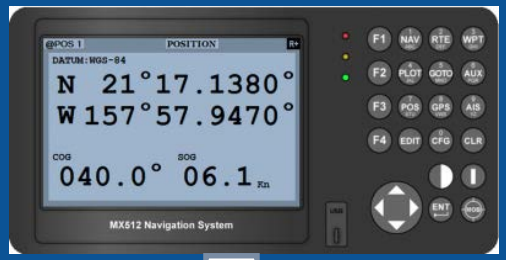
Individual Contributor Model



Trusted Node Model



Project Flow



X, Y, T

Z

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lat,lon,depth,time
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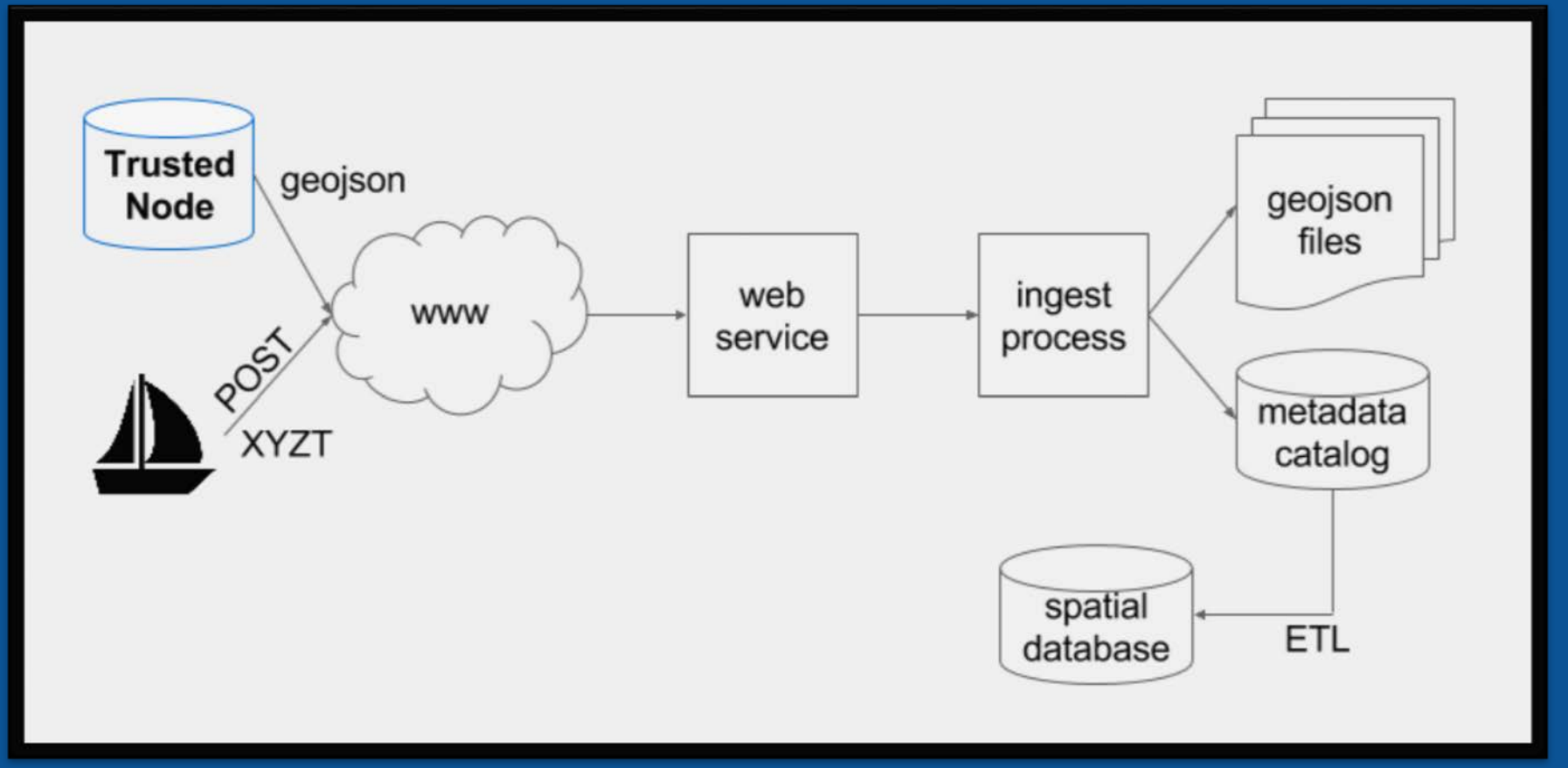
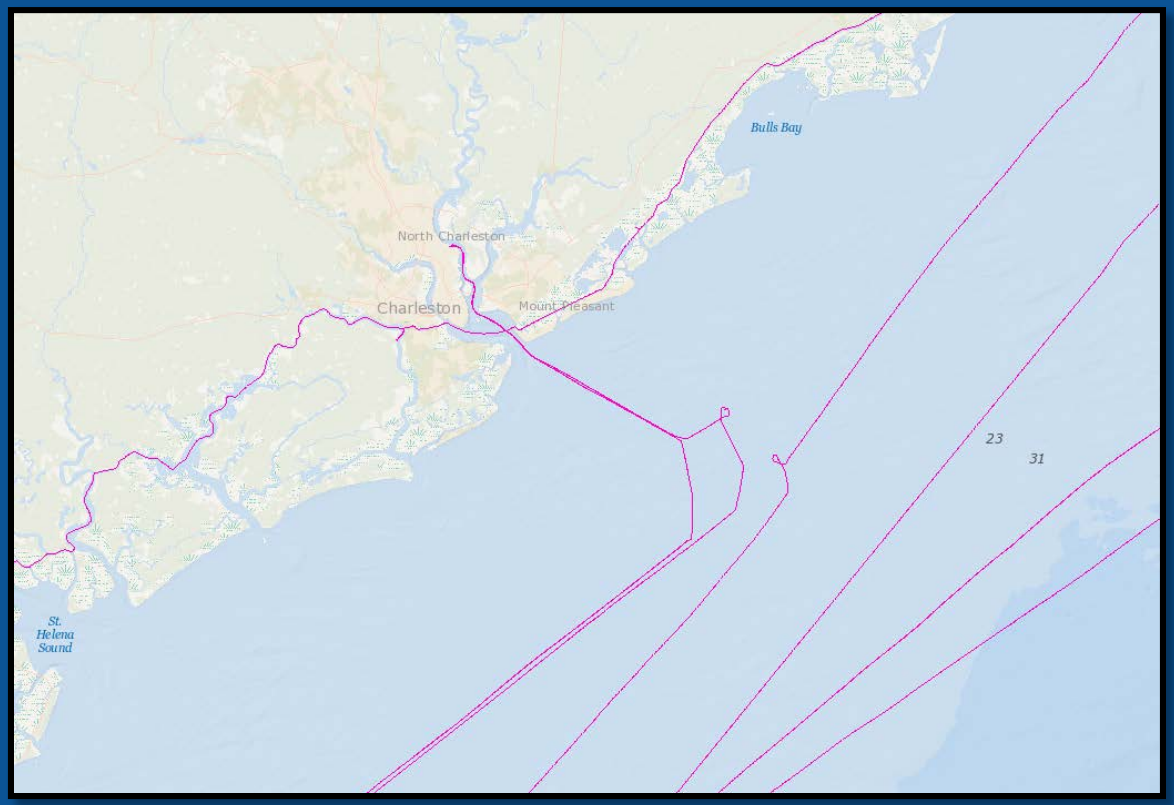
Project Flow

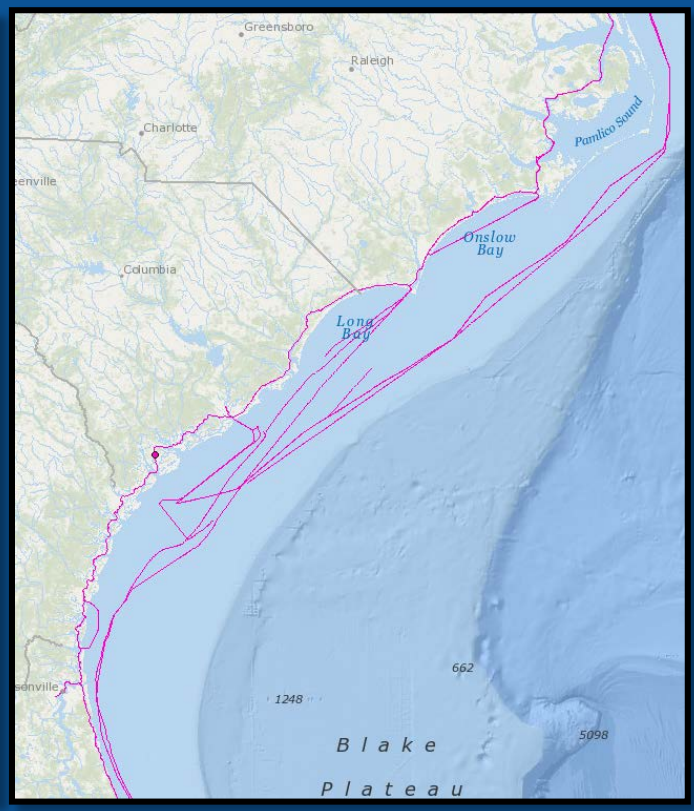


IHO DCDB Crowdsourced Viewer

maps.ngdc.noaa.gov/viewers/csb/

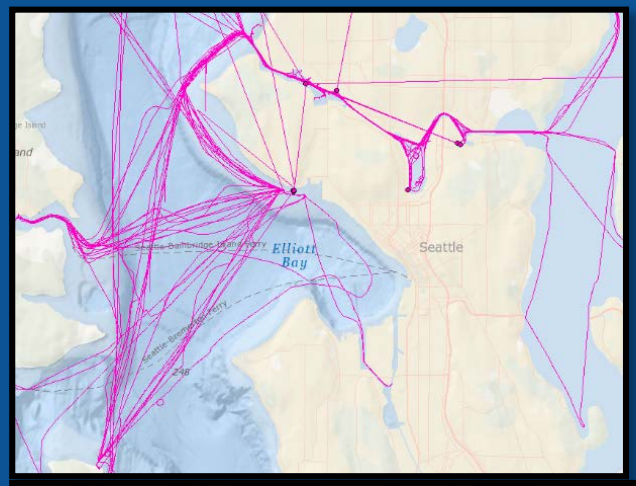
Current Data in DCDB near Charleston

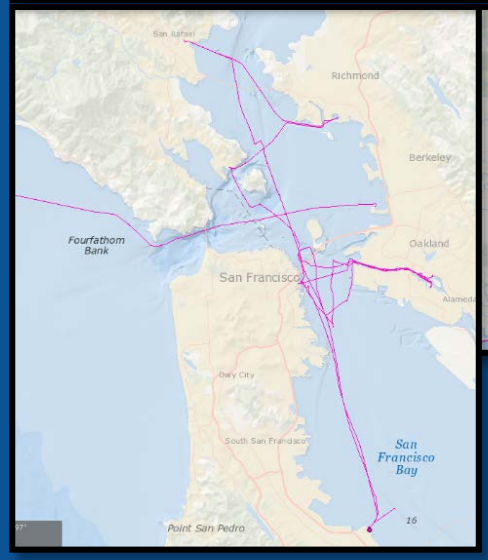


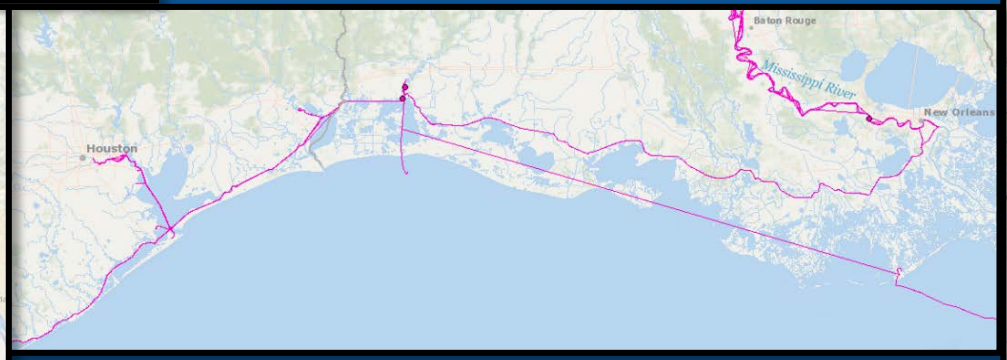


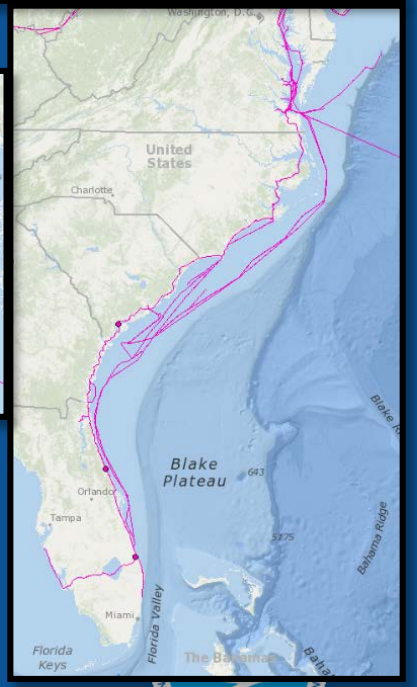
maps.ngdc.noaa.gov/viewers/csb/

Crowdsourced Bathymetry - Archive





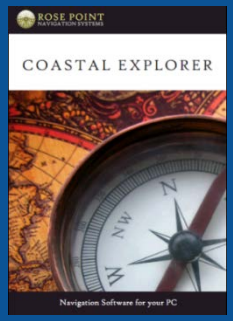




maps.ngdc.noaa.gov/viewers/csb/

Thank you

- LT Anthony Klemm & Evan Robertson
- Rose Point Navigation Systems
- NOAA R/V *Bay Hydro II*
- International Hydrographic Organization
- Crowdsourced Bathymetry Working Group
- National Centers for Environmental Information



Adam.Reed@noaa.gov
NOAA Integrated Oceans and Coastal Mapping

INDIANA GEOLOGICAL SURVEY
INDIANA UNIVERSITY

Geologic Mapping in the Great Lakes Coastal Zone

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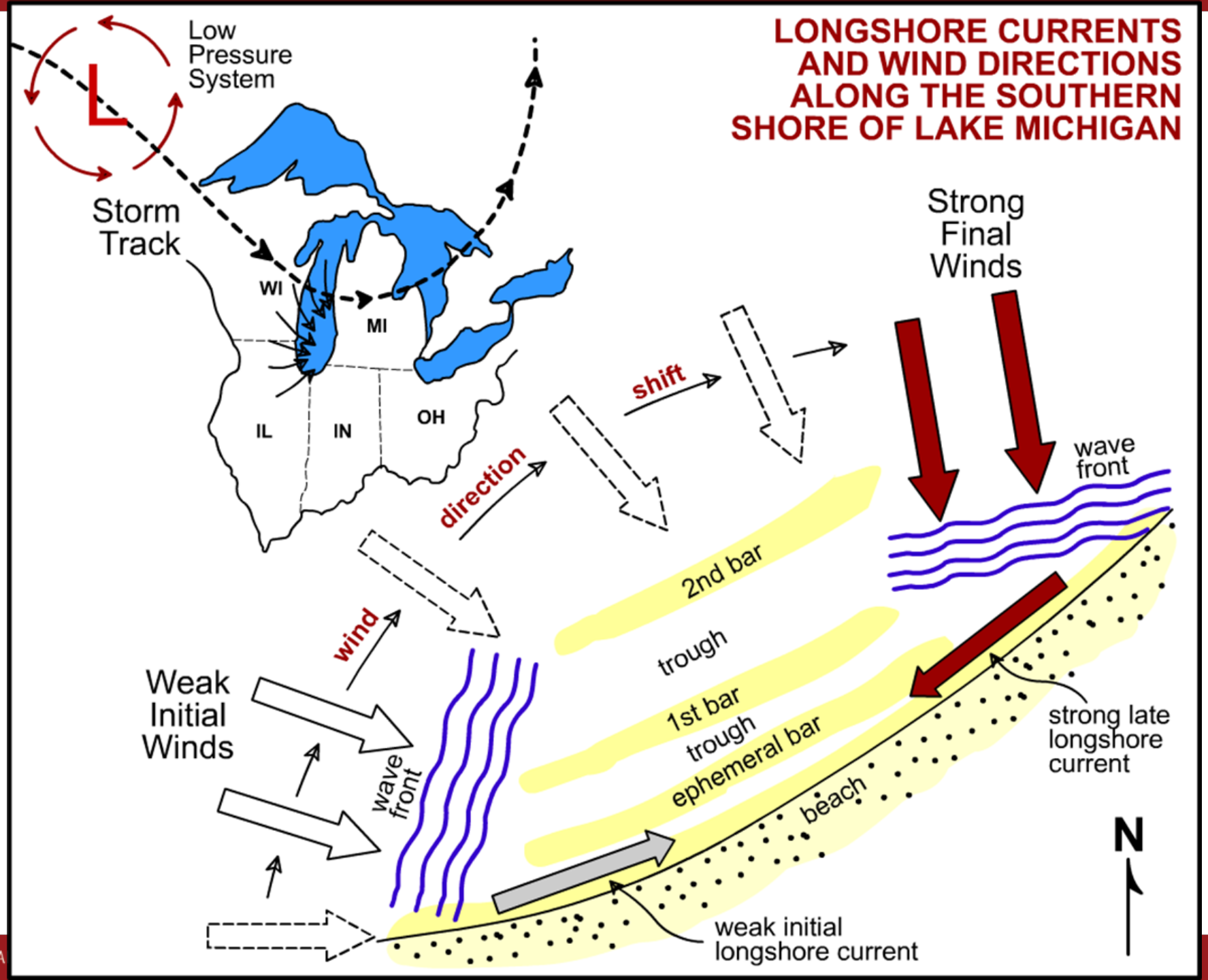
Bloomington, IN 47405-2208
tthomps@Indiana.edu
(812) 855-7428


LONGSHORE CURRENTS AND WIND DIRECTIONS ALONG THE SOUTHERN SHORE OF LAKE MICHIGAN
Low Pressure System
L
Storm Track
WI
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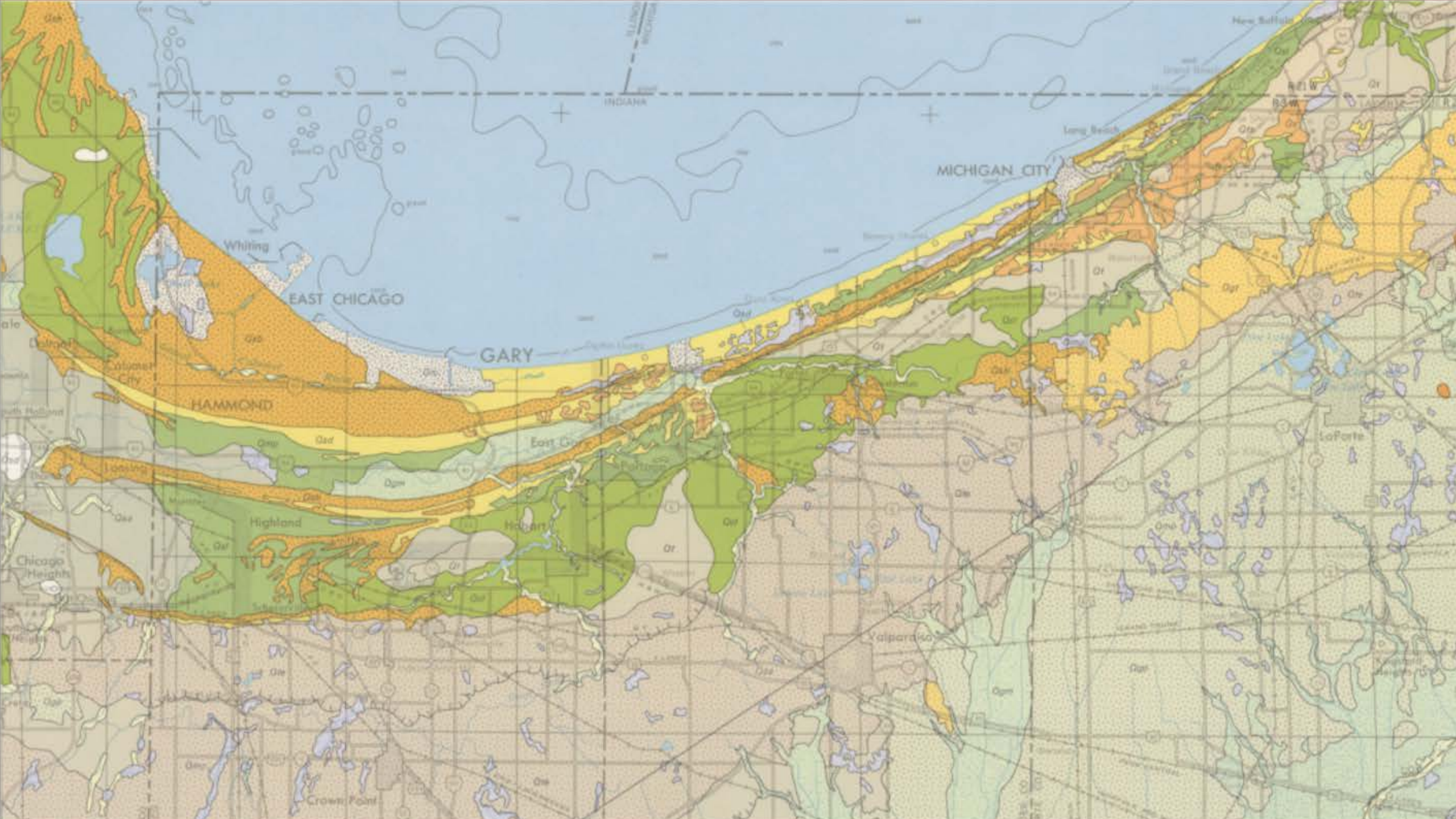
OH
shift
direction
Strong Final Winds
wave front
2nd bar
trough
1st bar
trough
ephemeral bar
beach
strong late longshore current
wind
Weak Initial Winds
wave front
weak initial longshore current
N


INDIANA
MICHIGAN CITY
Whiting
EAST CHICAGO
GARY
HAMMOND
Highland
Crown Point
LaPorte

Geologic Resources Inventory Scoping Summary
Indiana Dunes National Lakeshore, Indiana

Prepared by Katie KellerLynn
November 30, 2010

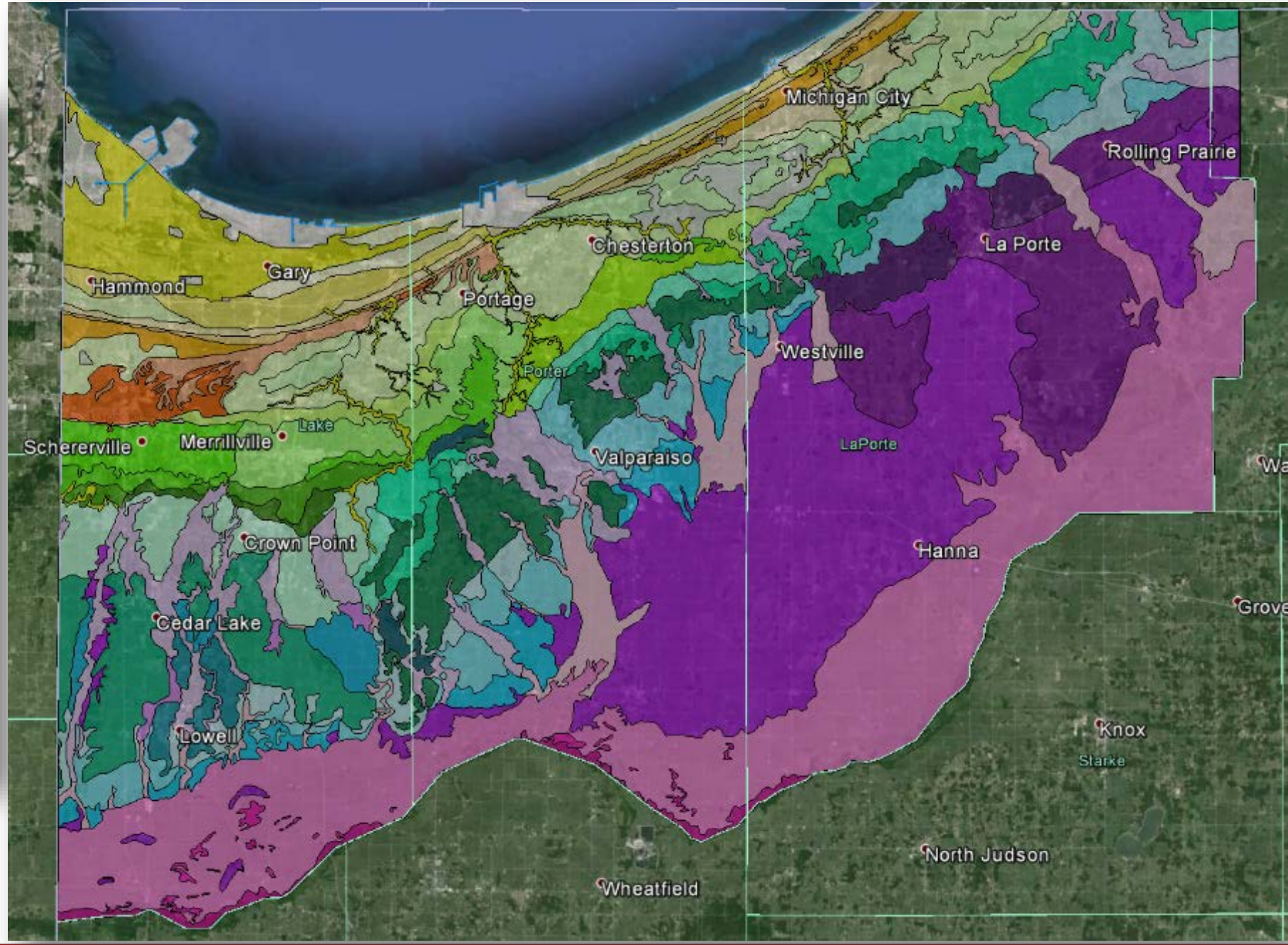
Geologic Resources Division
National Park Service
U.S. Department of the Interior

The Geologic Resources Inventory (GRI) Program provides each of the 270 identified natural area National Park System units with a geologic scoping meeting, a geologic scoping summary, a digital geologic map, and a geologic resources inventory report. Geologic scoping meetings generate an evaluation of the adequacy of existing geologic maps for resource management, provide an opportunity to discuss park-specific geologic management issues and, if possible, include a site visit with local experts. GRI products (maps, scoping summaries, and final reports) are available at http://www.nature.nps.gov/geology/inventory/gre_publications.cfm (accessed November 26, 2010).

On June 28–29, 2010, the Geologic Resources Division held a GRI scoping meeting for Indiana Dunes National Lakeshore at the Bailly Ranger Station, Porter, Indiana (fig 1). Participants at the meeting included NPS staff from the national lakeshore and Geologic Resources Division, and cooperators from Colorado State University, the Indiana Geological Survey, and the U.S. Geological Survey (table 3). Superintendent Constantine Dillon welcomed the group and expressed his interest and support of the geologic inventory by stating, "We don't have near the mapping I wish we had." He also highlighted some of the impacts that industry and development have had on the "much manipulated landscape" of Indiana Dunes National Lakeshore. He pointed out two topics that he hopes the inventory can help address: What are the sand sources and are they the same as during initial development of the shoreline? And, where are the "remnant dunes?"

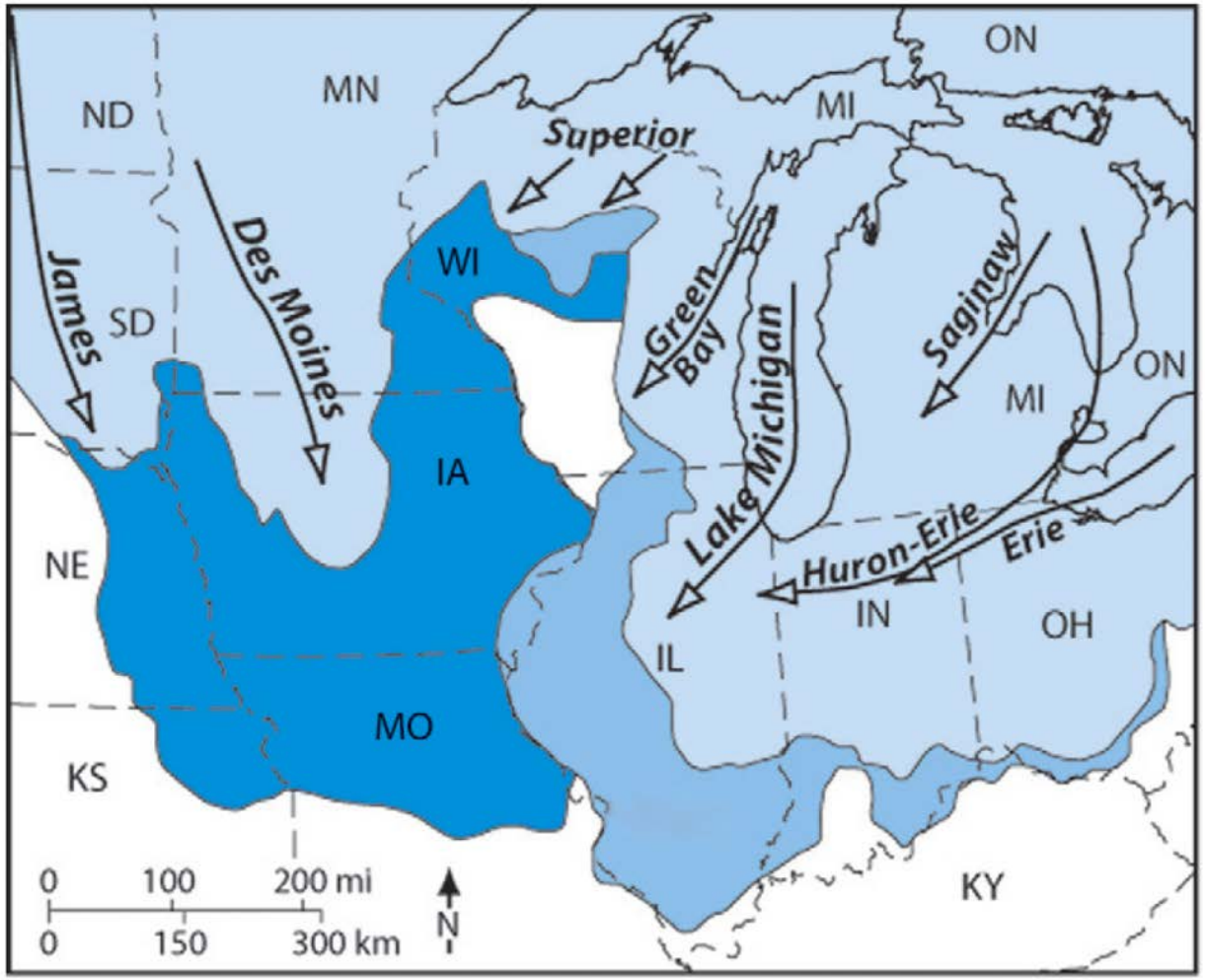
During the meeting, Georgia Hybels (Geologic Resources Division) facilitated the group's assessment of map coverage and needs, and Lisa Norby (Geologic Resources Division) led the discussion of geologic features, processes, and issues. Todd Thompson (Indiana Geological Survey) presented a geologic overview of Indiana with a focus on the shoreline evolution of Lake Michigan.

During the site visit on June 29, 2010, participants traveled via car to many of the sites discussed during the "features, processes, and issues" portion of the scoping meeting. They also visited selected sites that illustrated the geologic evolution of Lake Michigan. Todd Thompson and park staff led the tour to the following stops: (1) Miller Woods, showing past shorelines, parabolic dunes, the shifting mouth of the Grand Calumet River, and the reestablishment of native dune vegetation; (2) Douglas Environmental Education Center, explaining the wetland-dune systems and beach sediment (fig. 2); (3) West Beach, discussing blowout dunes, optically stimulated luminescence (OSL) as a dating method, ridge-crest association with groundwater highs, sedimentation from Burns Ditch, the geologic story of Tolleston Beach, and past mining/sand extraction from large parabolic dunes that are no longer in existence; (4) Inland Marsh, revealing an east-facing (now vegetated) parabolic dune that formed 3,800 years ago and an oak savanna that now covers the higher, drier parts of the dune; (5) Furnessville with its cemetery and schoolhouse (notably, the cemetery is on sand, which is easier to dig than clay); (6) Kemil Road where participants drove across the Glenwood and Calumet beach ridges (fig. 3); (7) Central Beach with a view of Mt. Baldy and the Northern Indiana Public Service Company (NIPSCO) coal-fired, power-generating station; and (8) extreme erosion at Mt. Baldy, a sand dune that is part of the Tolleston Beach system.



http://www.nature.nps.gov/geology/inventory/

SELECTED PHASES OF ANCESTRAL LAKE MICHIGAN

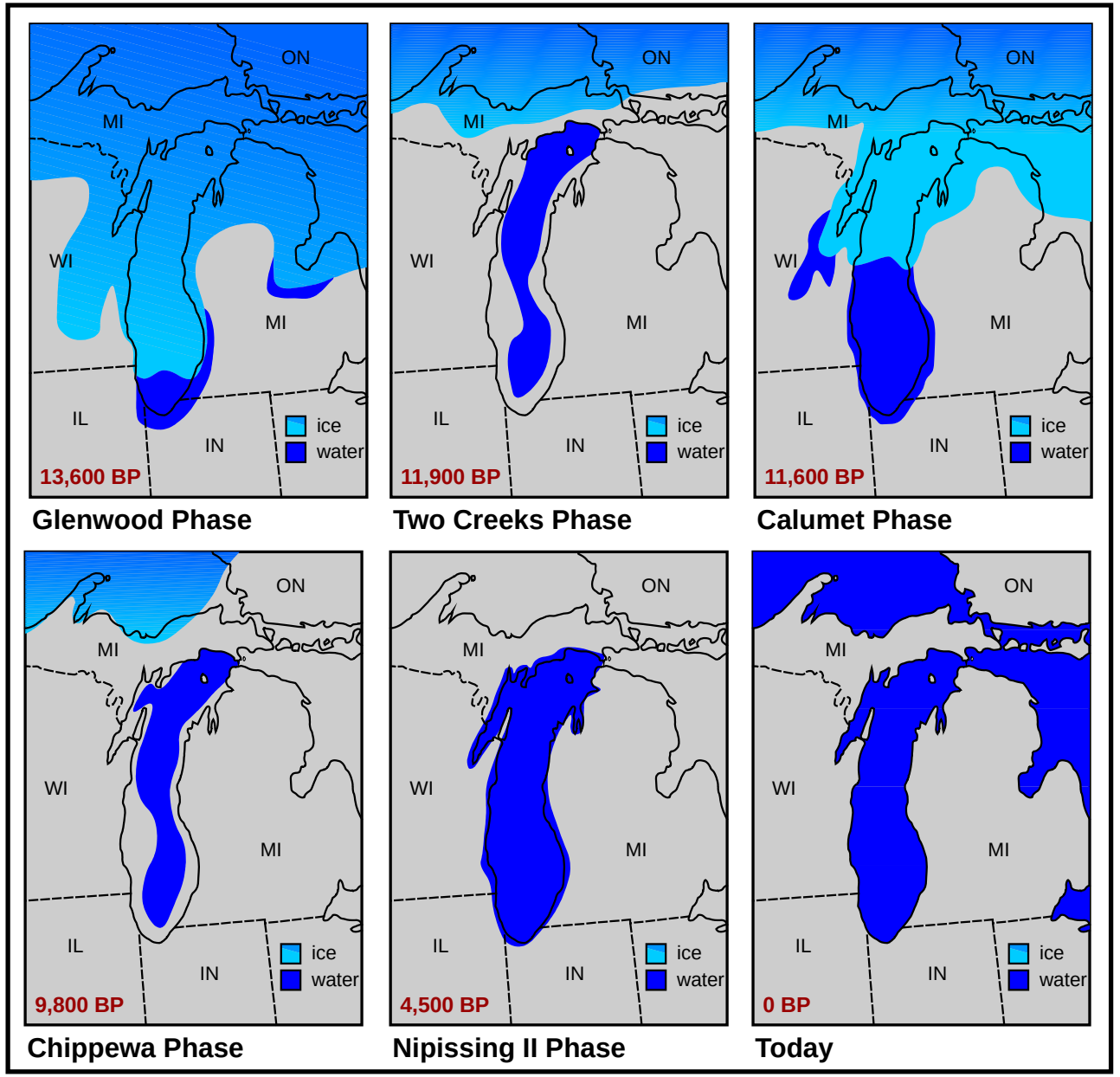


Wisconsin (60,000 – 12,500 years ago)

Pre-Illinois (1,800,000 – 190,000 years ago)

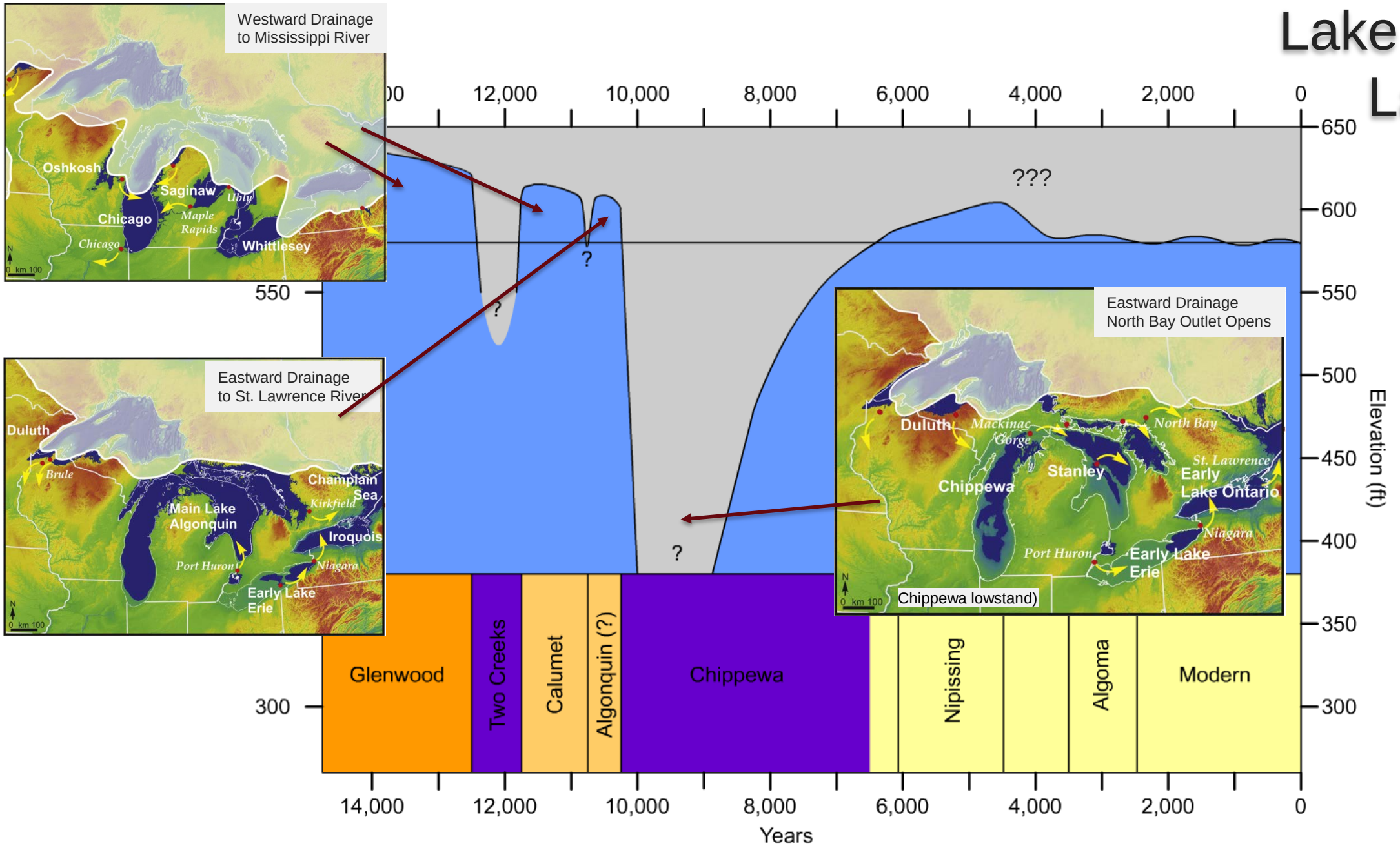
Illinois (190,000 – 130,000 years ago)

Prior (1991), Curry et al. (2011)

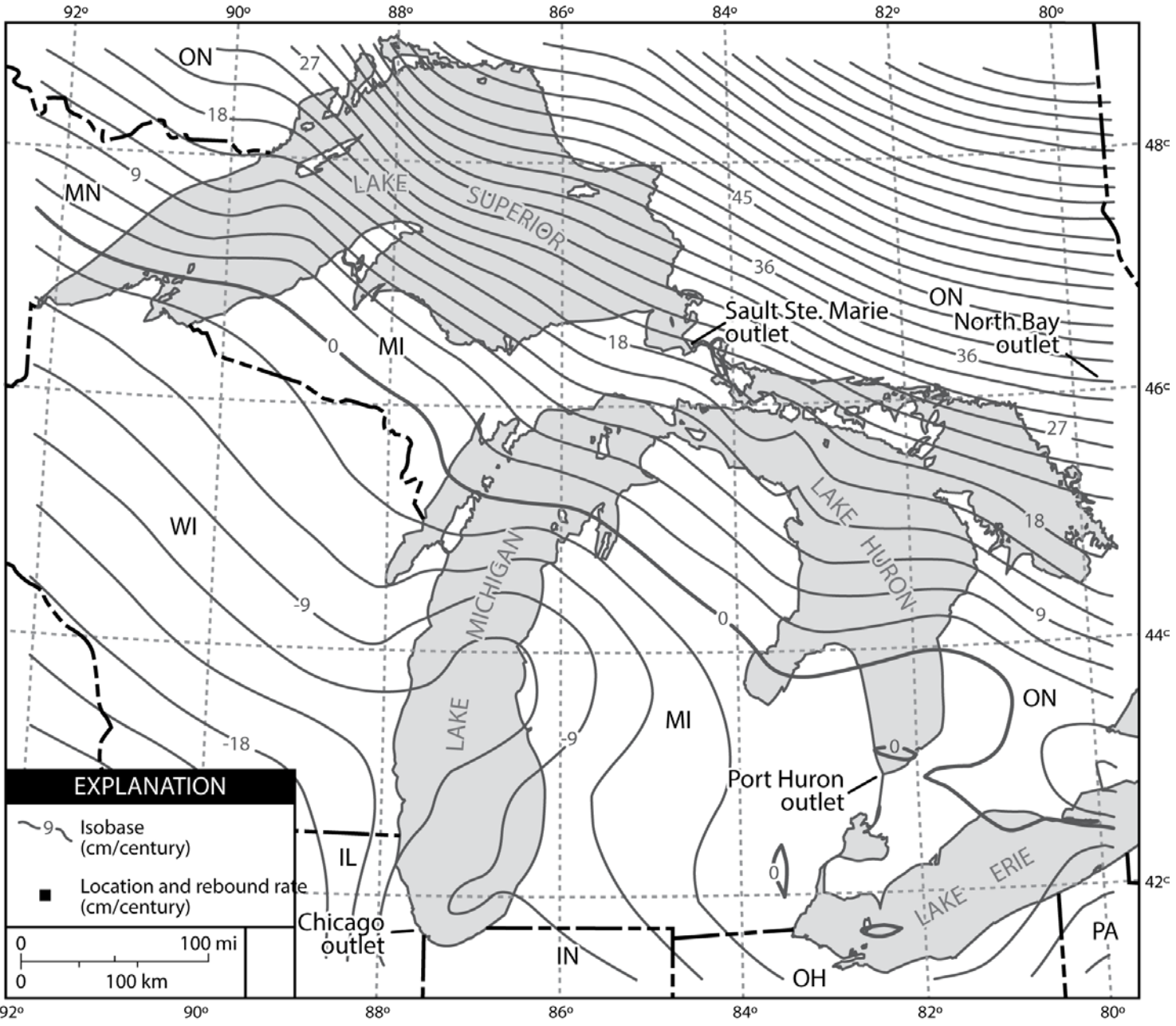


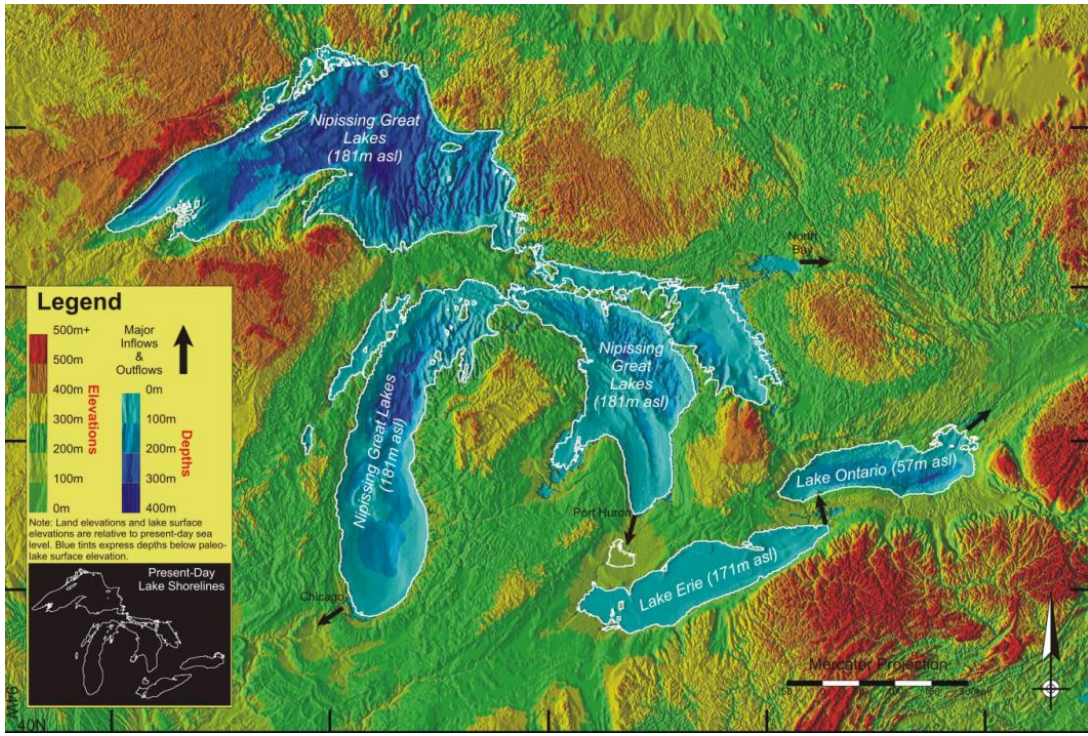
Modified from Hansel and others (1985).

Lake Michigan Lake Level



Isostatic rebound

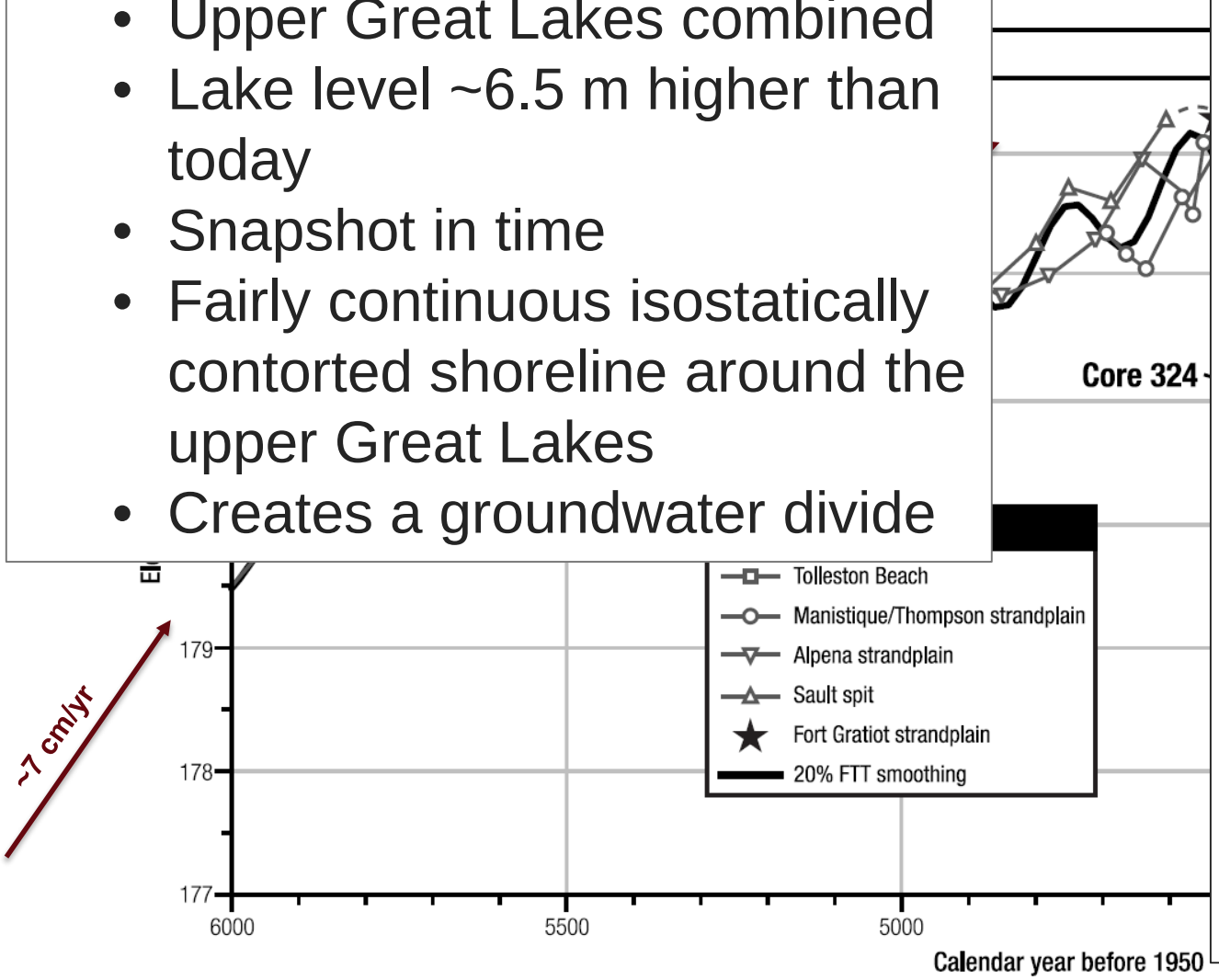




Nipissing Phase

Peak Nipissing

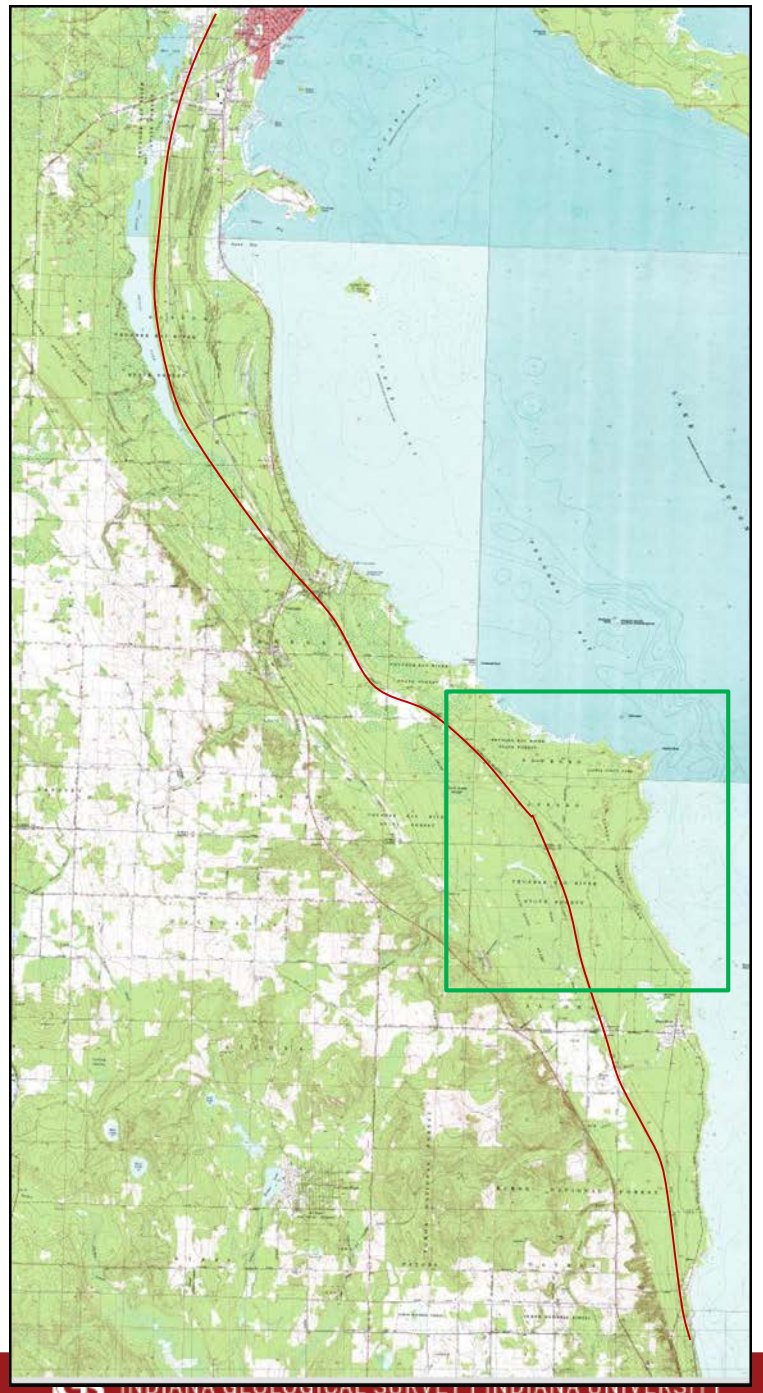
- The Last Great Lake™
- Upper Great Lakes combined
- Lake level ~6.5 m higher than today
- Snapshot in time
- Fairly continuous isostatically contorted shoreline around the upper Great Lakes
- Creates a groundwater divide



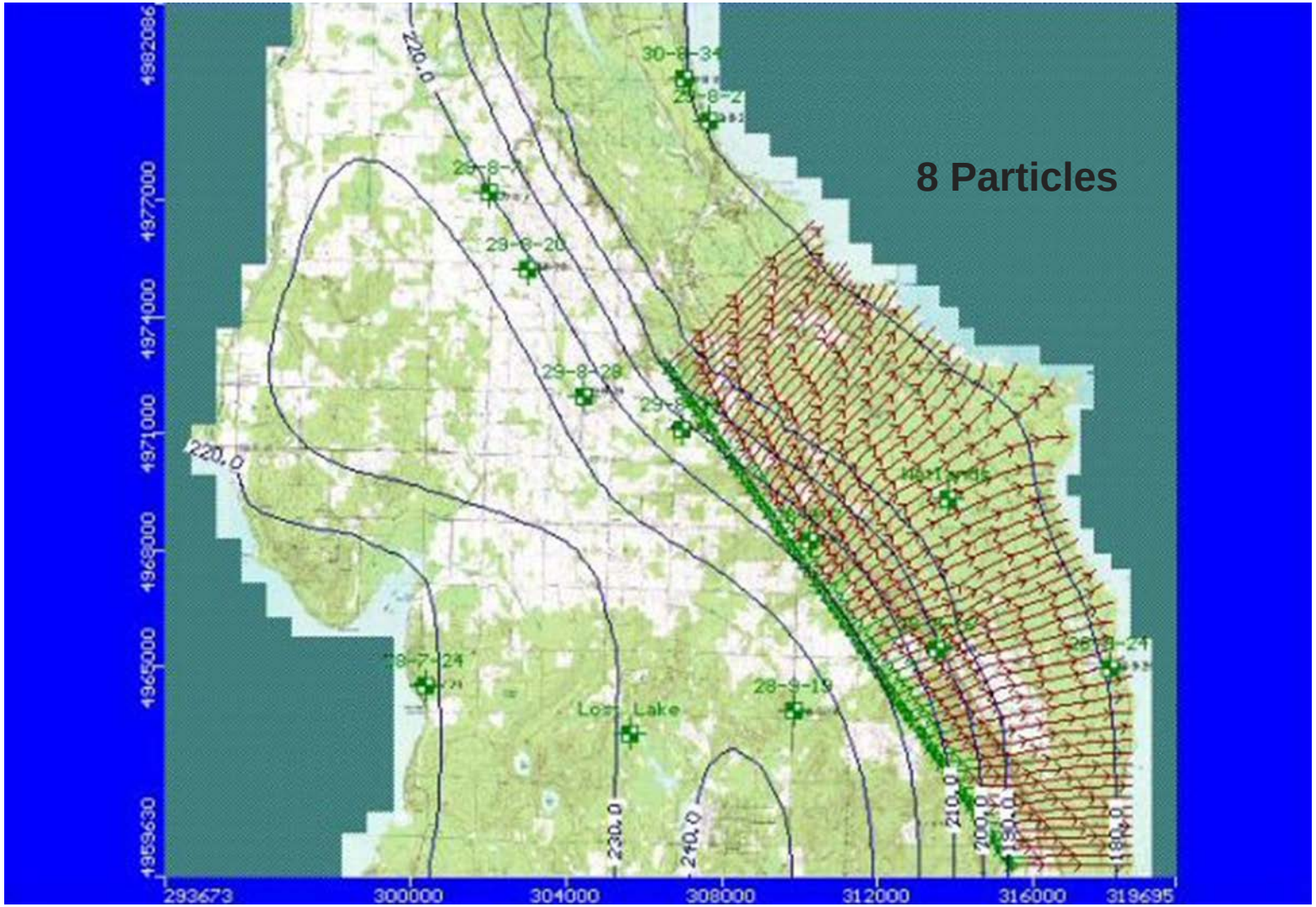
Fall from the Peak Nipissing

- Lake level fall of ~4.5 m
- Dune development everywhere you can blow sand onshore
- Established:
  - Outlet configurations (lose North Bay and Chicago outlets)
  - Shoreline configurations
  - Long-term patterns of littoral drift
  - Shoreline behavior
  - Groundwater flow patterns

Groundwater at Negwegon

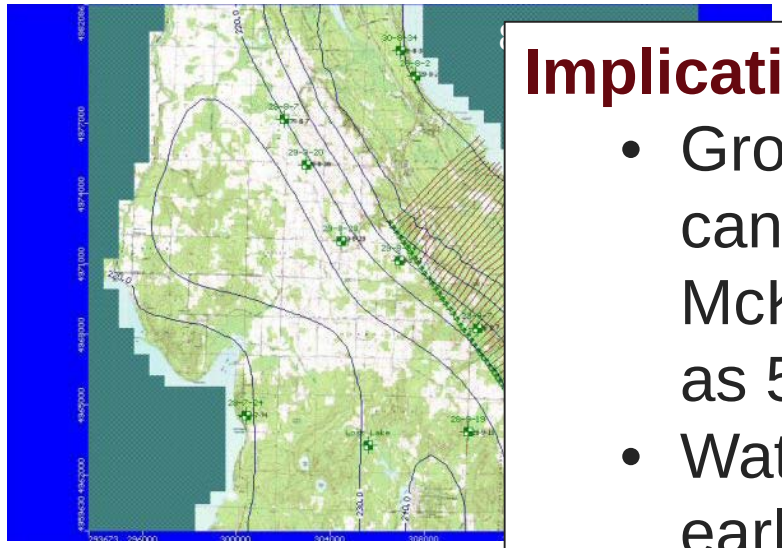


Current Potentiometric Surface

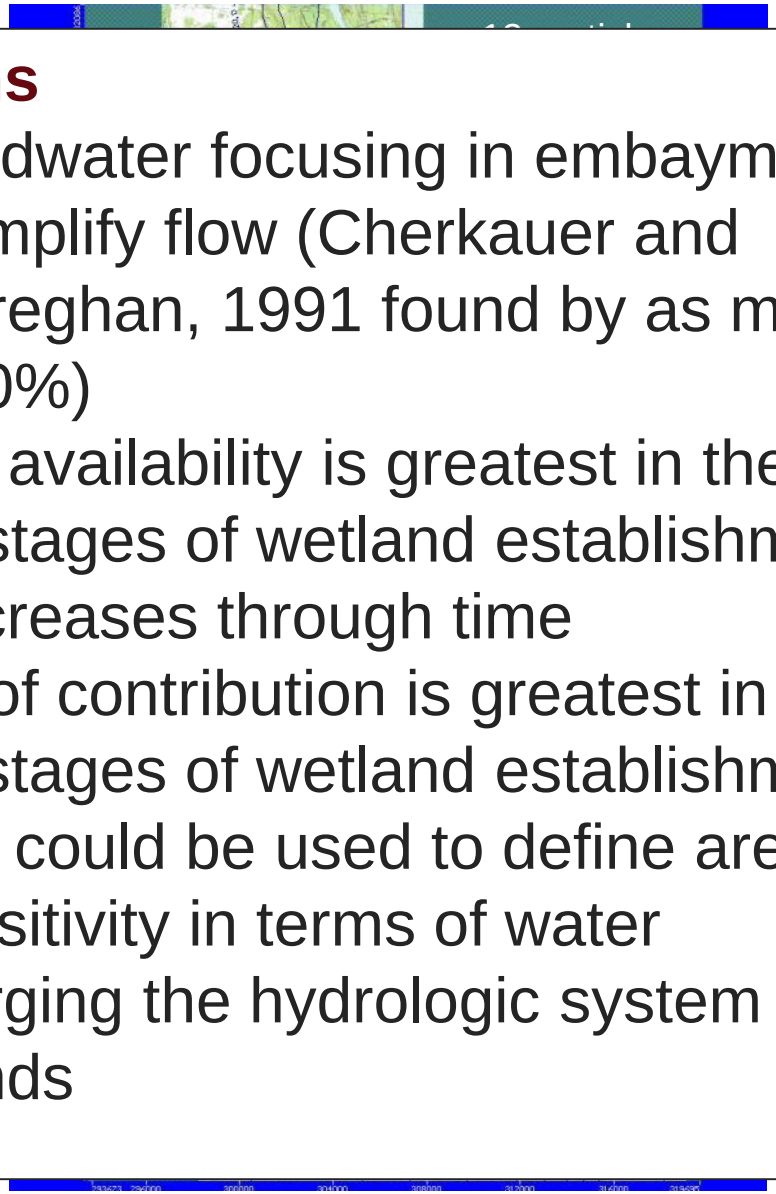


Groundwater Focusing and Negwegon

800 years ago



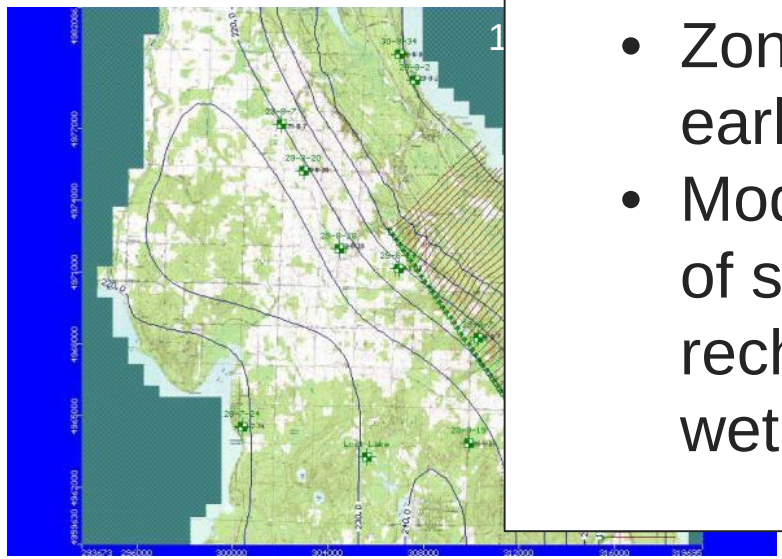
1400 years ago



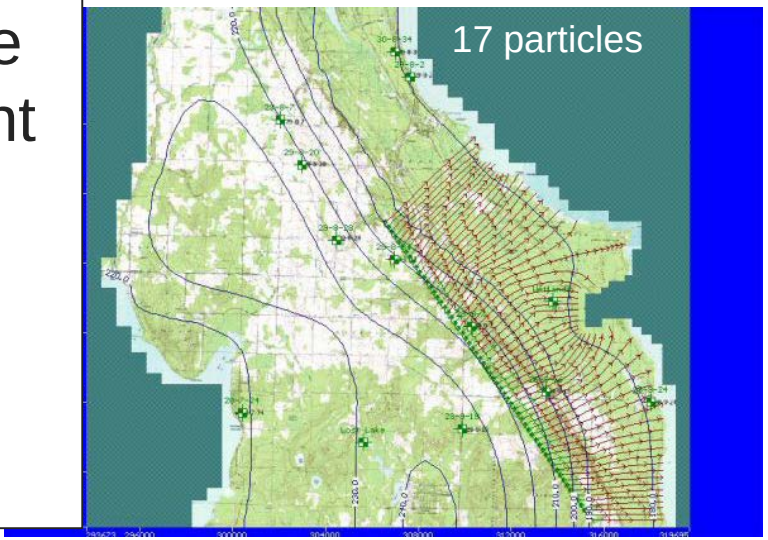
Implications

- Groundwater focusing in embayments can amplify flow (Cherkauer and McKereghan, 1991 found by as much as 500%)
- Water availability is greatest in the early stages of wetland establishment … decreases through time
- Zone of contribution is greatest in the early stages of wetland establishment
- Model could be used to define areas of sensitivity in terms of water recharging the hydrologic system of wetlands

1100 years ago



2000 years ago



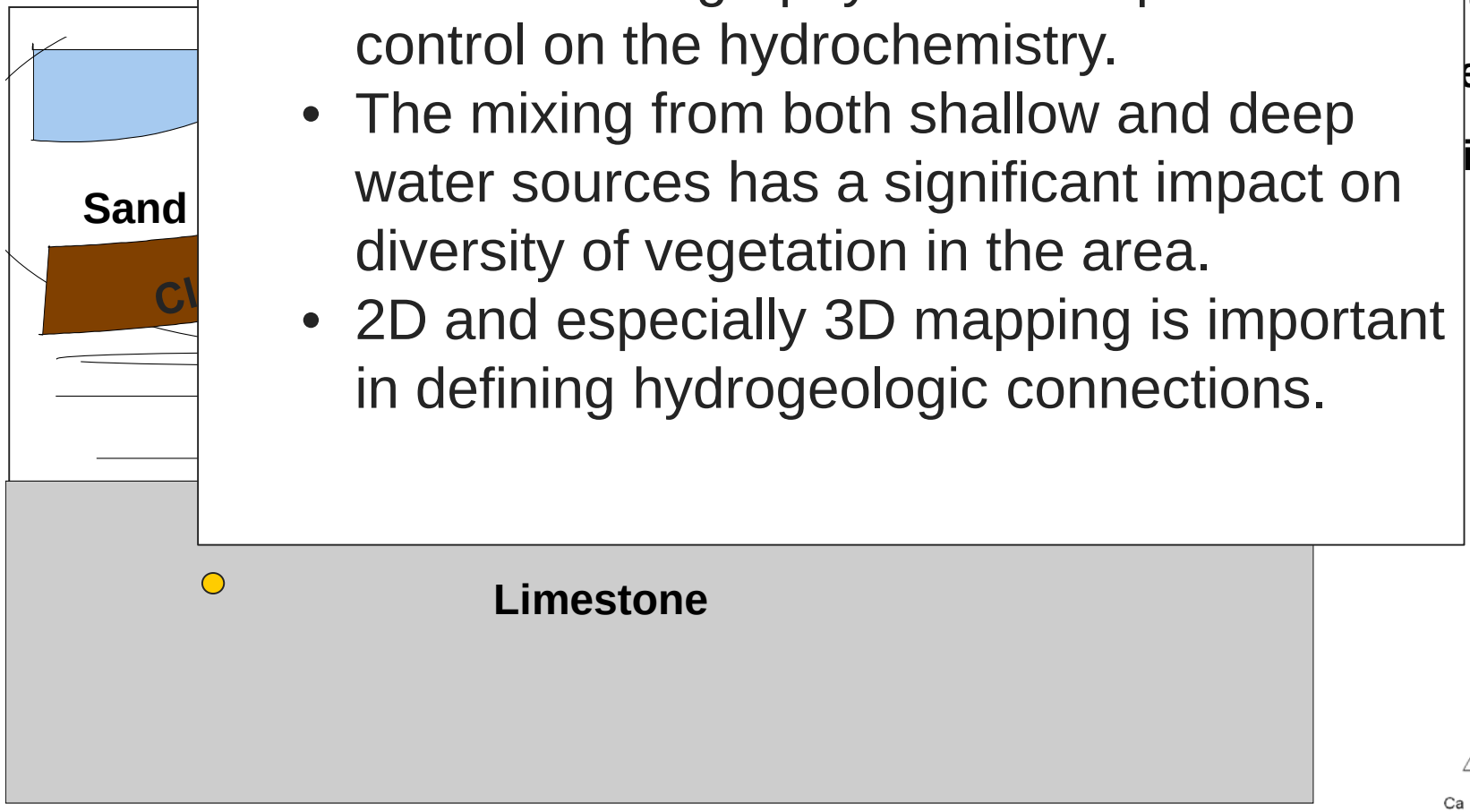
Groundwater at Manistique

- 95 well logs and a dozen cone-penetrometer were synthesized into a cross-section

Manistique conceptual model

Implications

- Shallow stratigraphy has an important control on the hydrochemistry.
- The mixing from both shallow and deep water sources has a significant impact on diversity of vegetation in the area.
- 2D and especially 3D mapping is important in defining hydrogeologic connections.

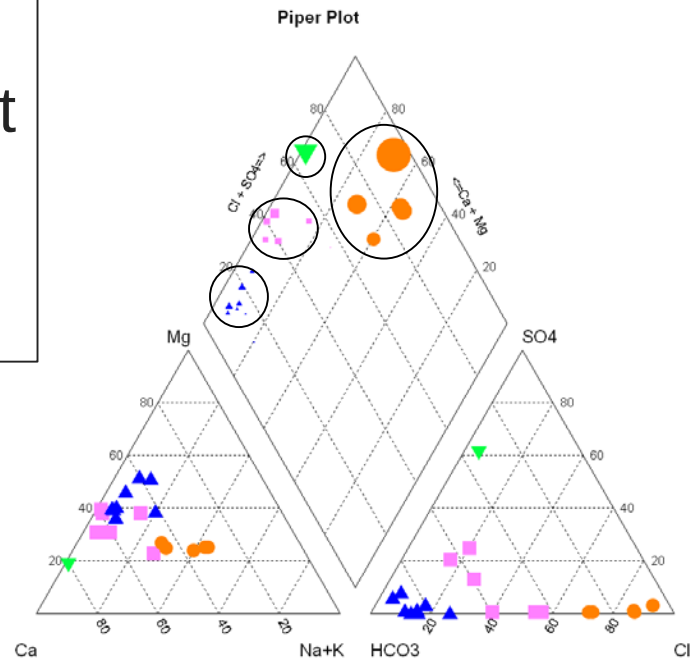


hallow

termediate

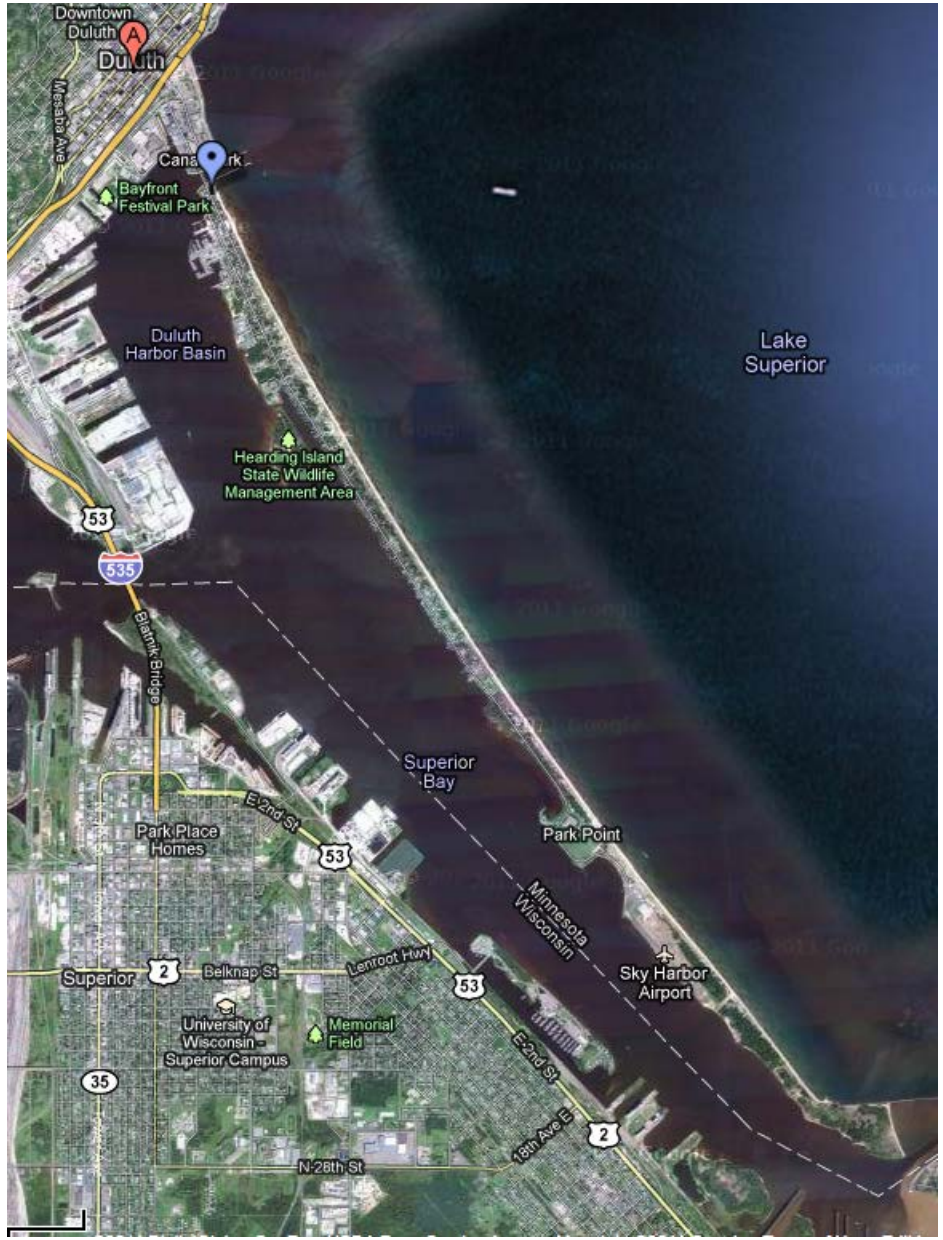
eep

ix



Shoreline Features – barrier beach

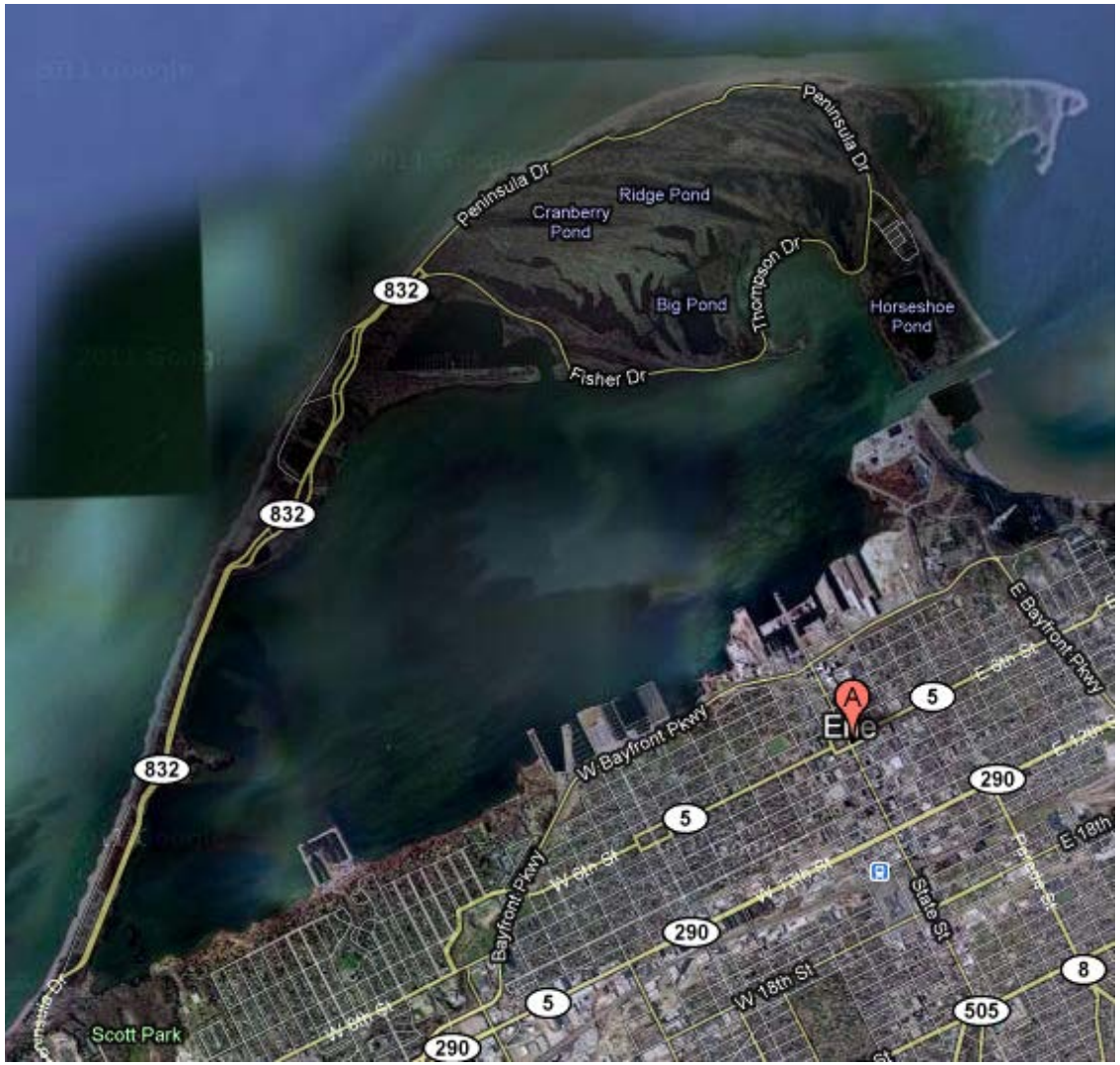
Duluth, Minnesota



Indiana Dunes National Lakeshore and State Park, Indiana

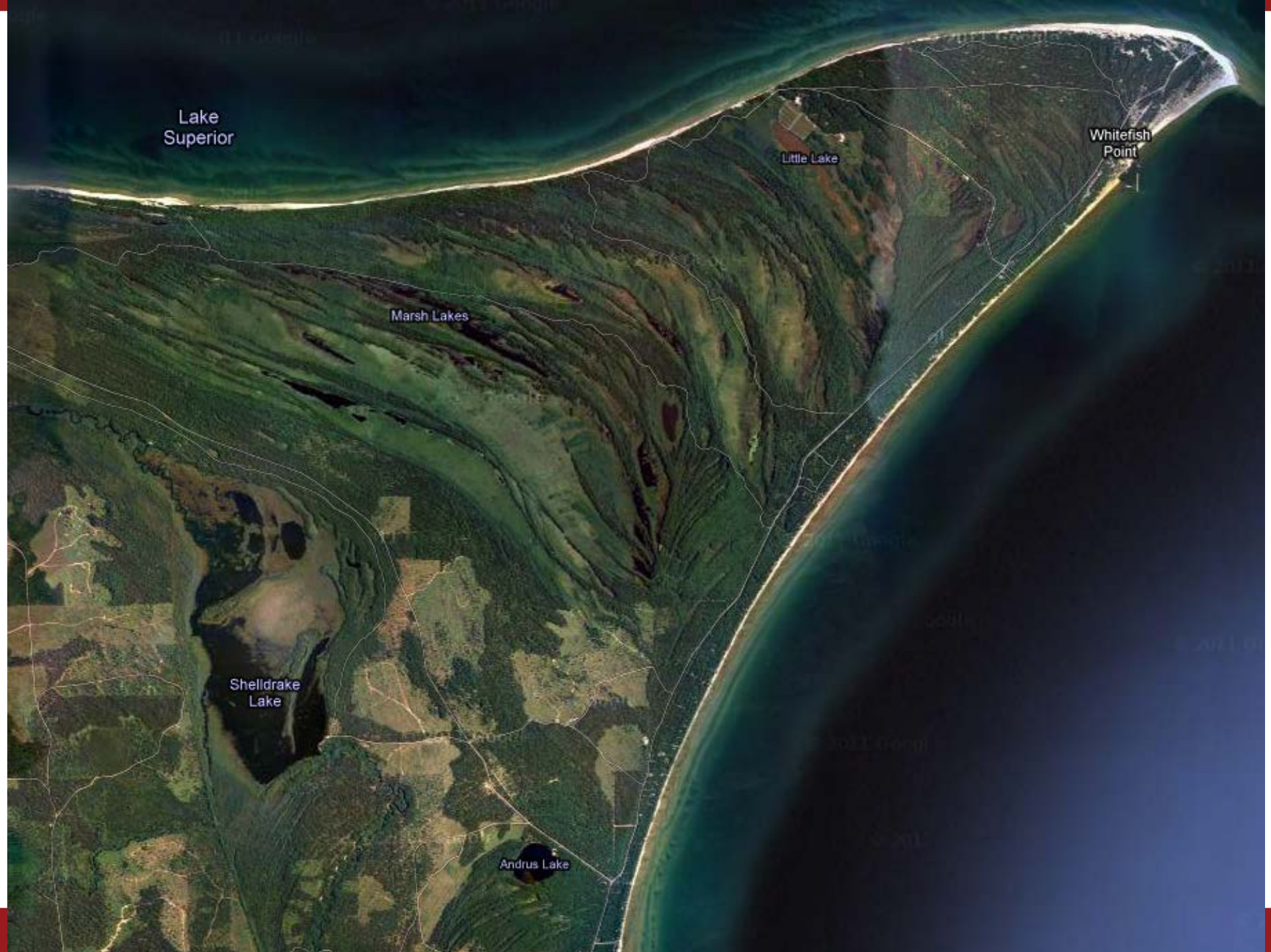
Shoreline Features – spit

Erie, Pennsylvania



Sault Ste. Marie, Michigan

Shoreline Features – spit



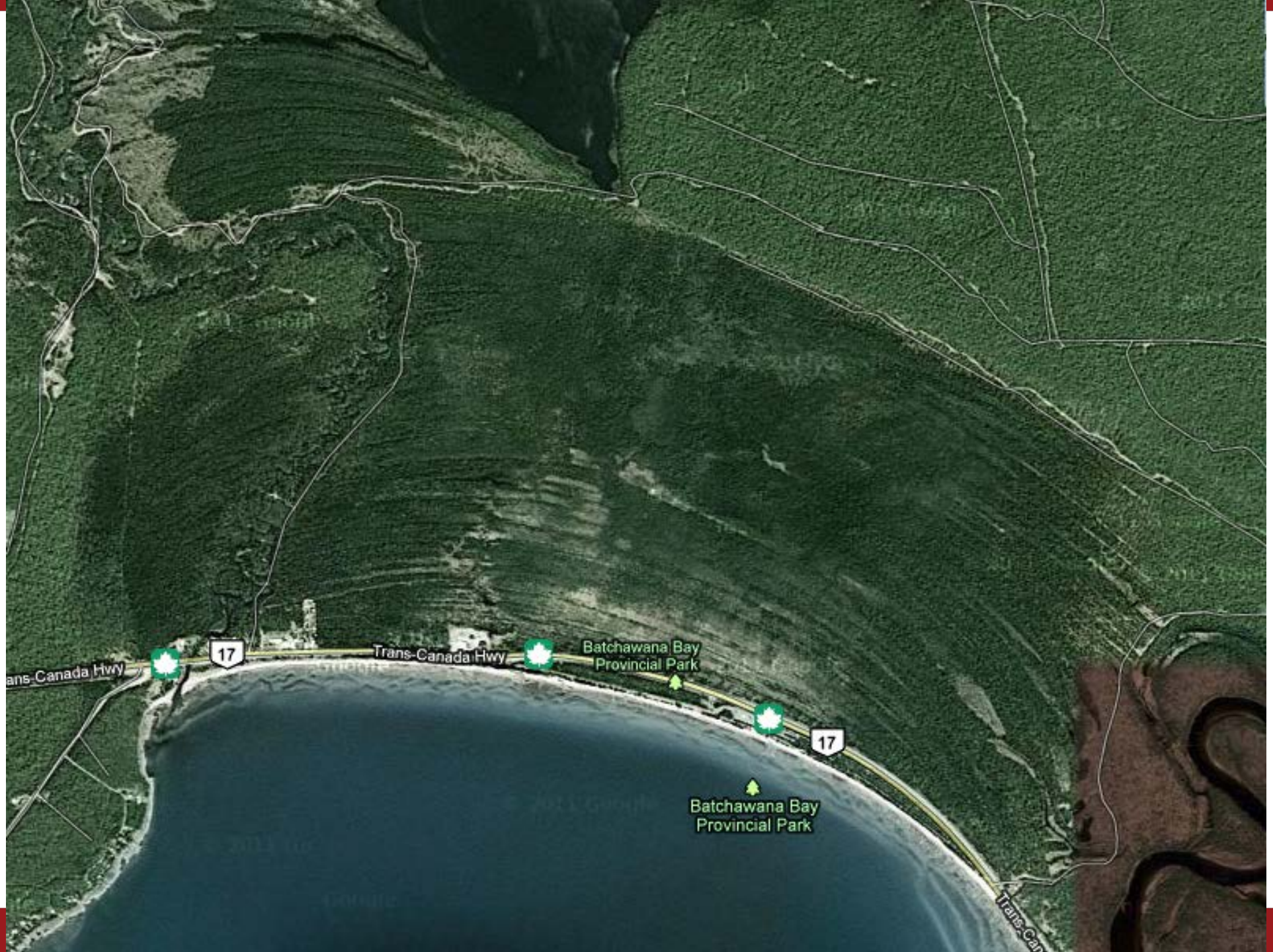
Whitefish Point, Michigan

Shoreline Features – strandplain

Illinois Beach State Park,
Zion, Illinois

Grand Traverse Bay,
Michigan

Shoreline Features – strandplain



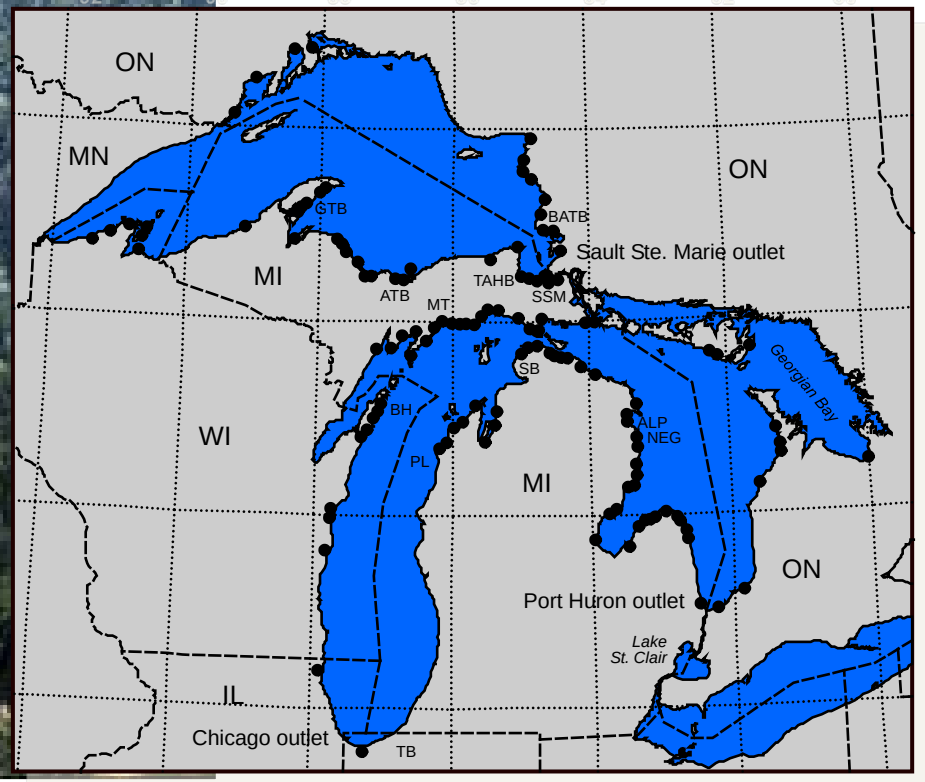
Batchawana Bay, Ontario

Manistique, MI

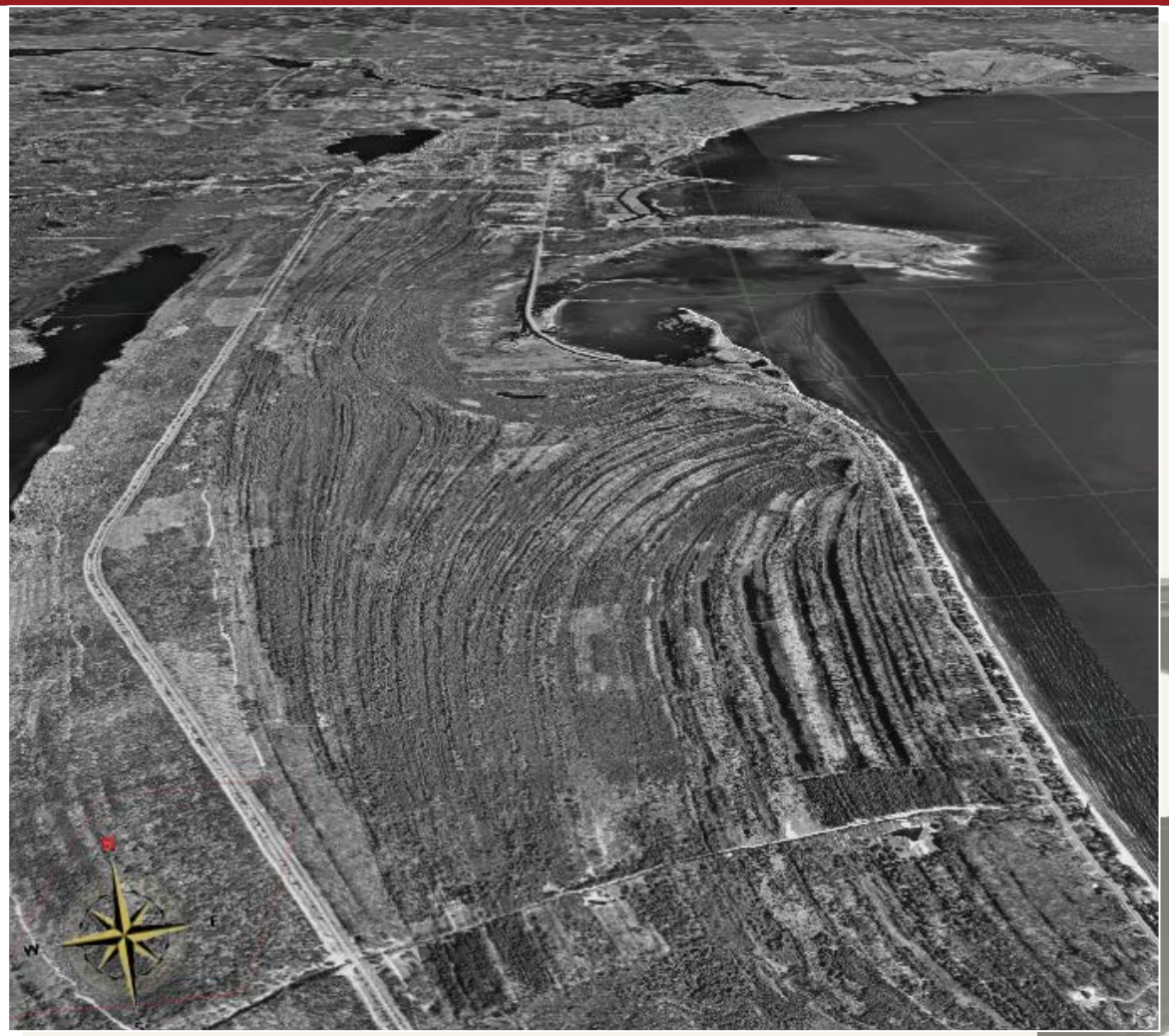
Bathtub Rings

Beach Ridges

Strandplains

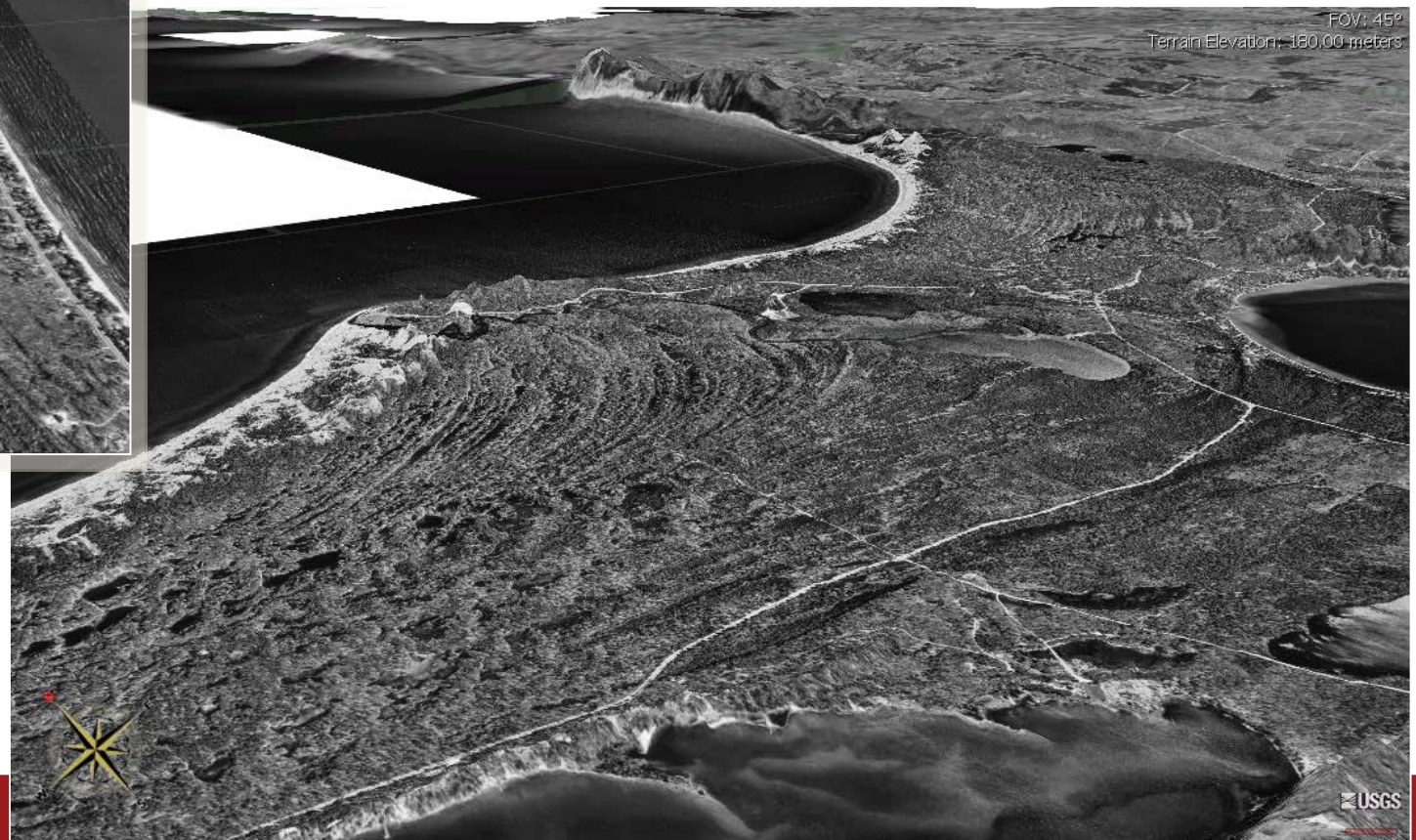


Upper Great Lakes Strandplains

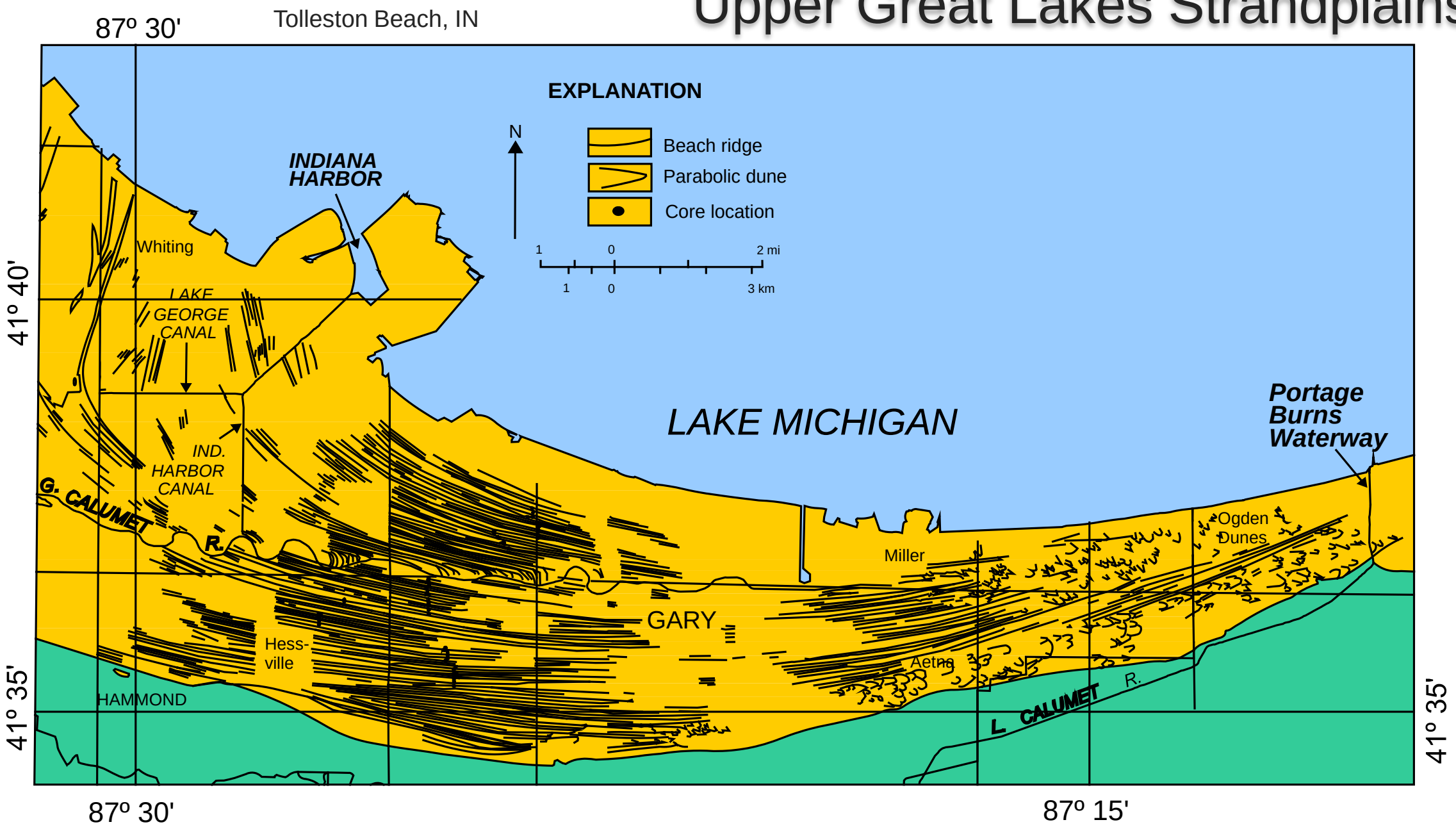


Alpena, MI

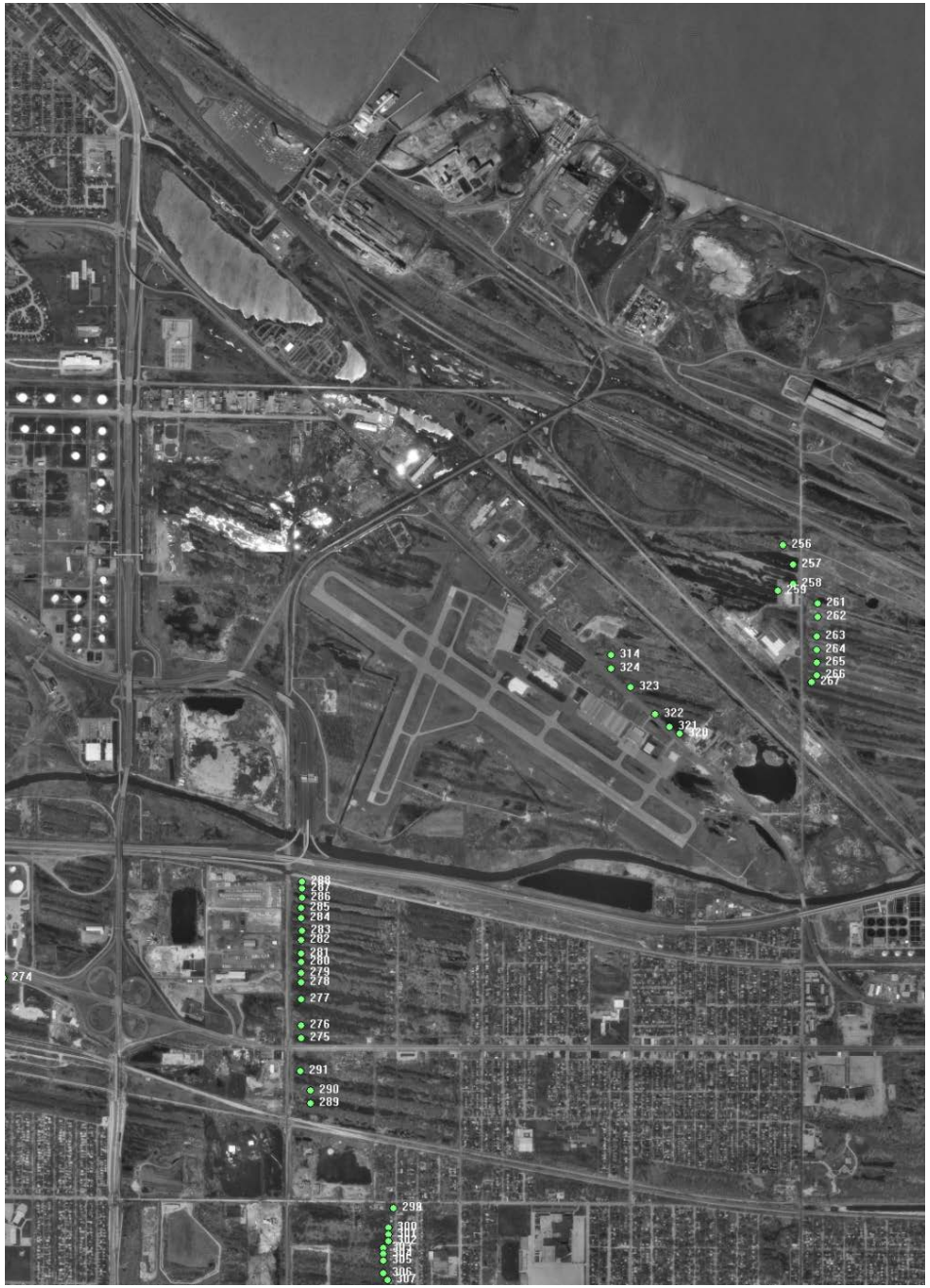
SBDNL, MI



Upper Great Lakes Strandplains



Tolleston Beach 1938 vs. 1998



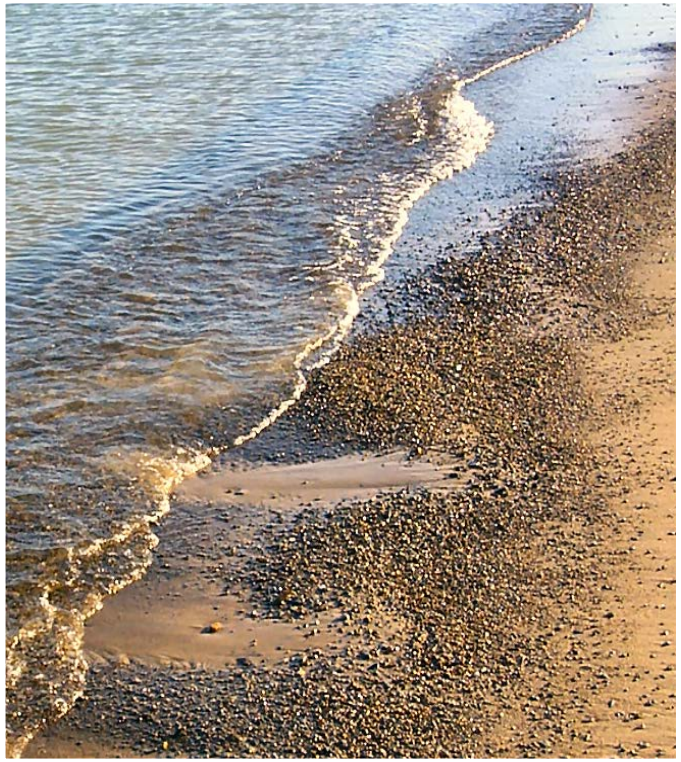
Tahquamenon Bay, MI

Grand Traverse
Bay, MI

Vibracoring

Tahquamenon Bay, MI

Tahquamenon
Bay, MI



Gary, IN

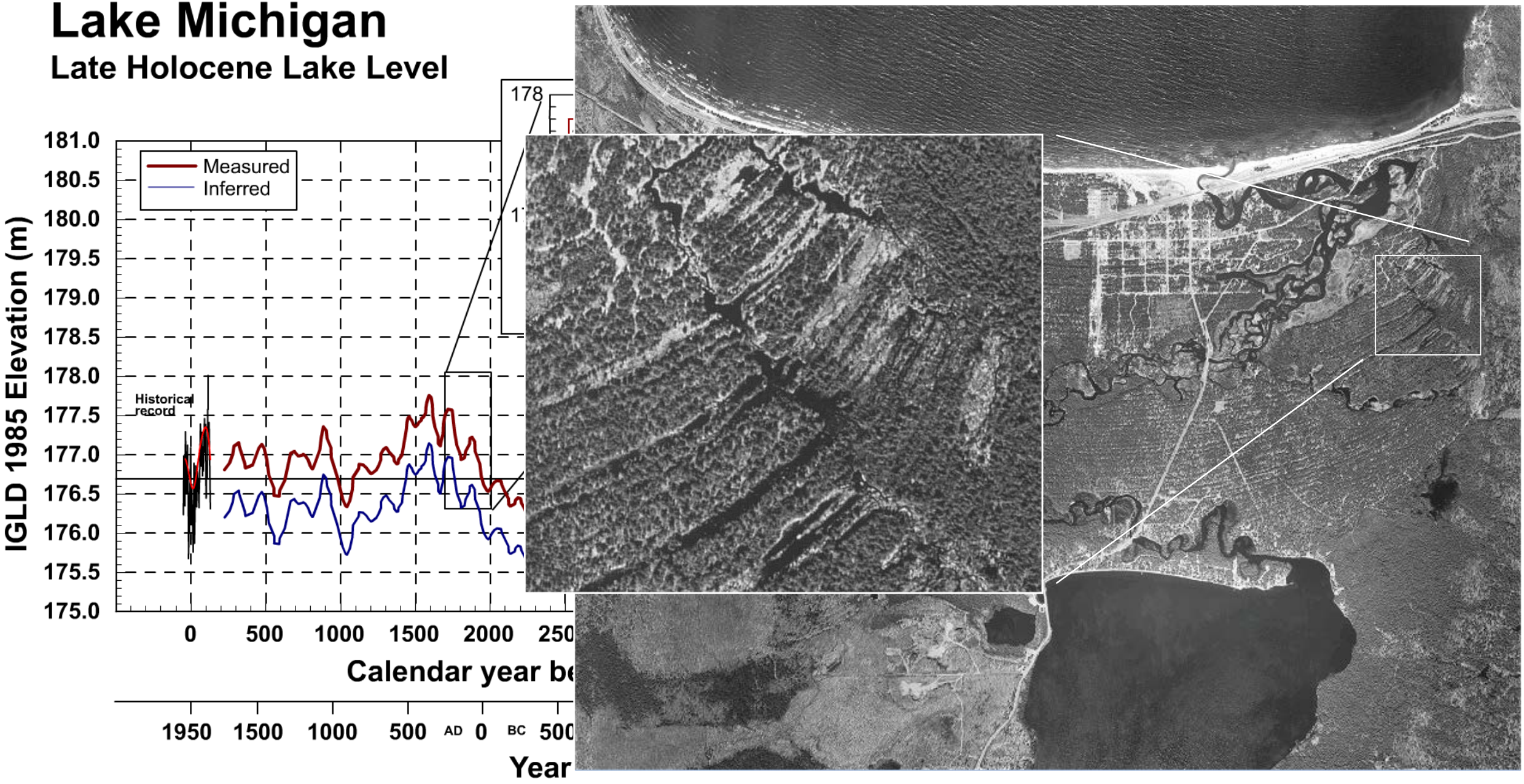
Peat Coring And OSLing

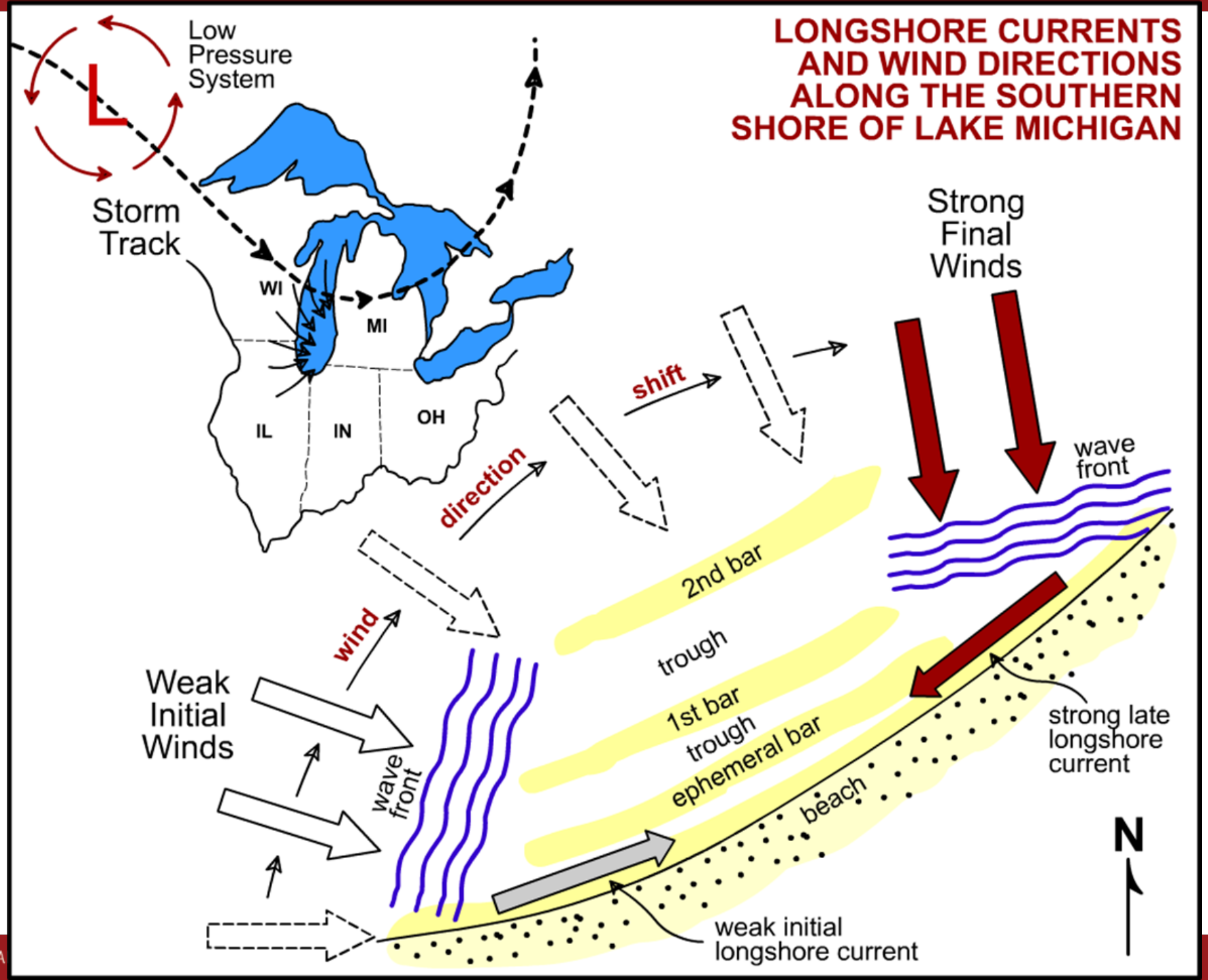
Tahquamenon Bay, MI

Au Train Bay, MI

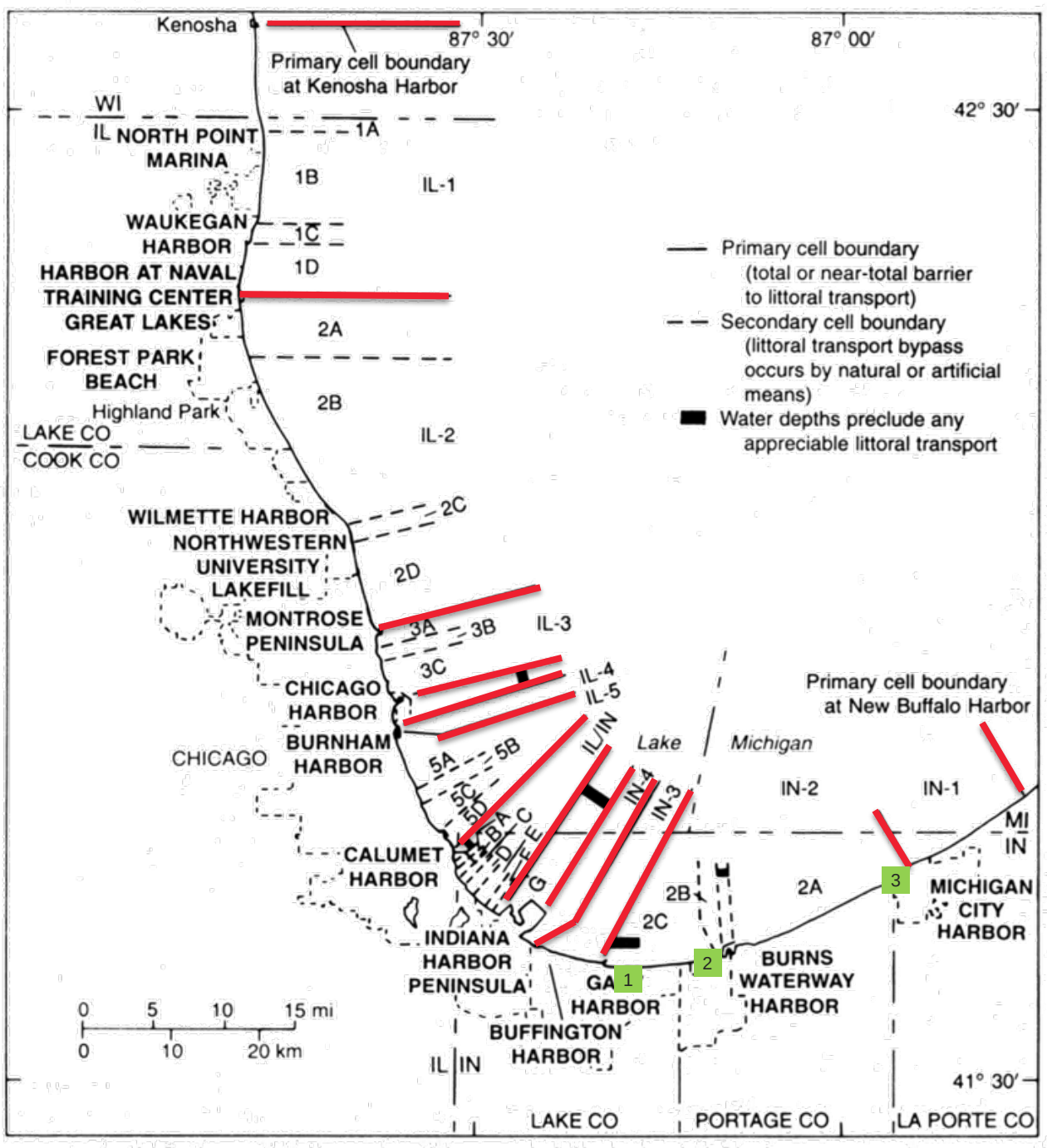
Lake Michigan

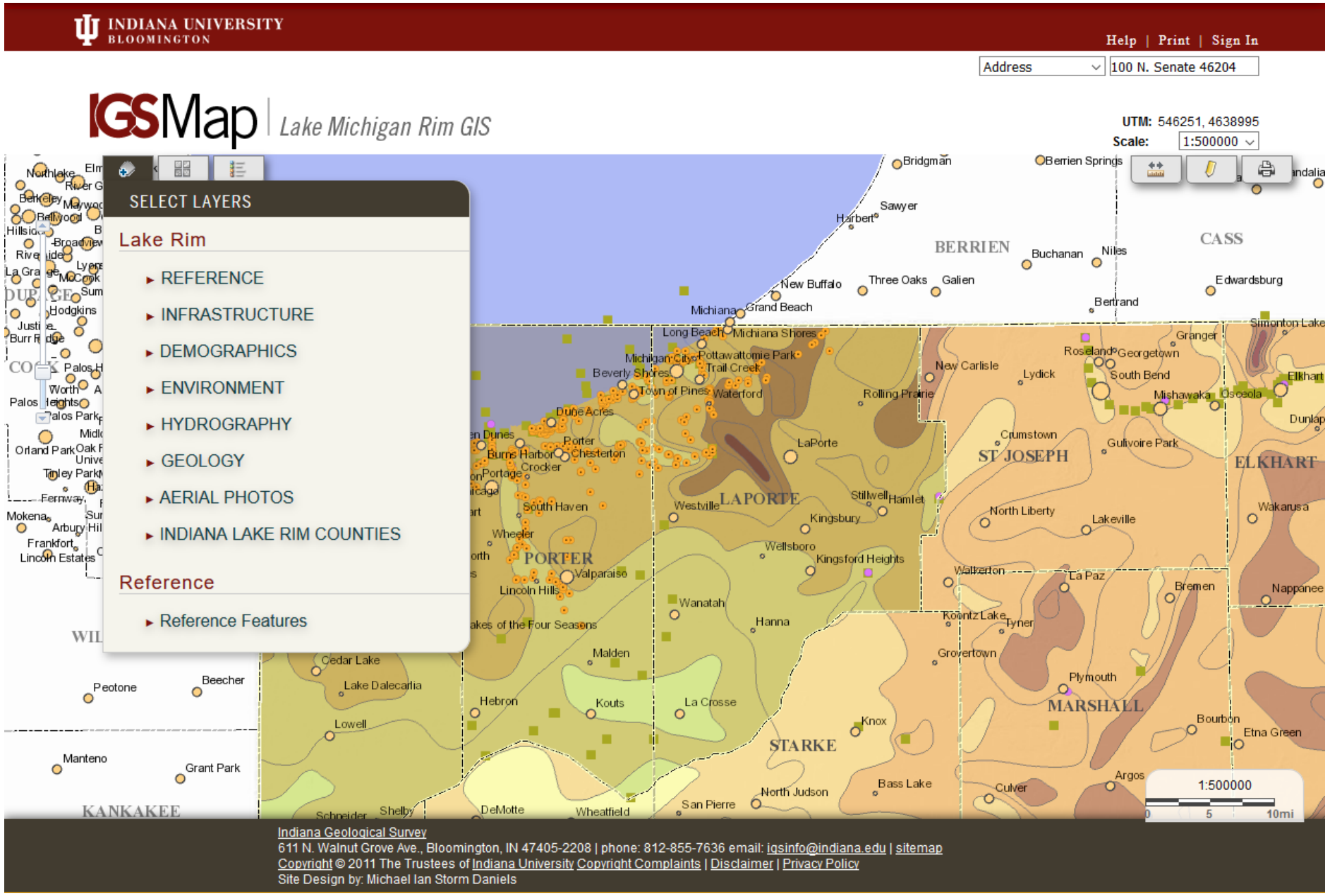
Late Holocene Lake Level




LONGSHORE CURRENTS AND WIND DIRECTIONS ALONG THE SOUTHERN SHORE OF LAKE MICHIGAN
Low Pressure System
L
Storm Track
WI
MI
IL
IN
OH
shift
direction
Strong Final Winds
wave front
2nd bar
trough
1st bar
trough
ephemeral bar
beach
strong late longshore current
wind
Weak Initial Winds
wave front
weak initial longshore current
N

SLM
Sediment Cells




INDIANA UNIVERSITY
BLOOMINGTON
Help | Print | Sign In
Address
100 N. Senate 46204
IGSMap | Lake Michigan Rim GIS
UTM: 546251, 4638995
Scale: 1:500000
SELECT LAYERS
Lake Rim
REFERENCE
INFRASTRUCTURE
DEMOGRAPHICS
ENVIRONMENT
HYDROGRAPHY
GEOLOGY
AERIAL PHOTOS
INDIANA LAKE RIM COUNTIES
Reference
Reference Features
BERRIEN
CASS
ST JOSEPH
ELKHART
LAPORTE
PORTER
STARKE
MARSHALL
KANKAKEE
Bridgman
Berrien Springs
Sawyer
Harbert
Buchanan
Niles
Edwardsburg
Bertrand
New Buffalo
Three Oaks
Galien
Michiana
Grand Beach
Long Beach
Michiana Shores
Michigan City
Pottawattomie Park
Trail Creek
Beverly Shores
Town of Pines
Waterford
Rolling Prairie
New Carlisle
Lydick
Roseland
Georgetown
South Bend
Granger
Mishawaka
Osceola
Elkhart
Simonton Lake
Dunlap
Crumstown
Gulivoire Park
LaPorte
Dune Acres
Porter
Chesterton
Burns Harbor
Crocker
Portage
Westville
Stillwell
Hamlet
Kingsbury
North Liberty
Lakeville
Wakarusa
Wellsboro
Kingsford Heights
Valparaiso
Lincoln Hills
South Haven
Wheeler
Walkerton
La Paz
Bremen
Nappanee
Koontz Lake
Tyner
Grovertown
Wanatah
Hanna
Malden
Cedar Lake
Lake Dalecarlia
Hebron
Kouts
La Crosse
Lowell
Knox
Plymouth
Bourbon
Etna Green
Argos
Culver
Bass Lake
North Judson
San Pierre
Wheatfield
DeMotte
Shelby
Schneider
Peotone
Beecher
Manteno
Grant Park
1:500000
0 5 10mi
Indiana Geological Survey
611 N. Walnut Grove Ave., Bloomington, IN 47405-2208 | phone: 812-855-7636 email: igsinfo@indiana.edu | sitemap
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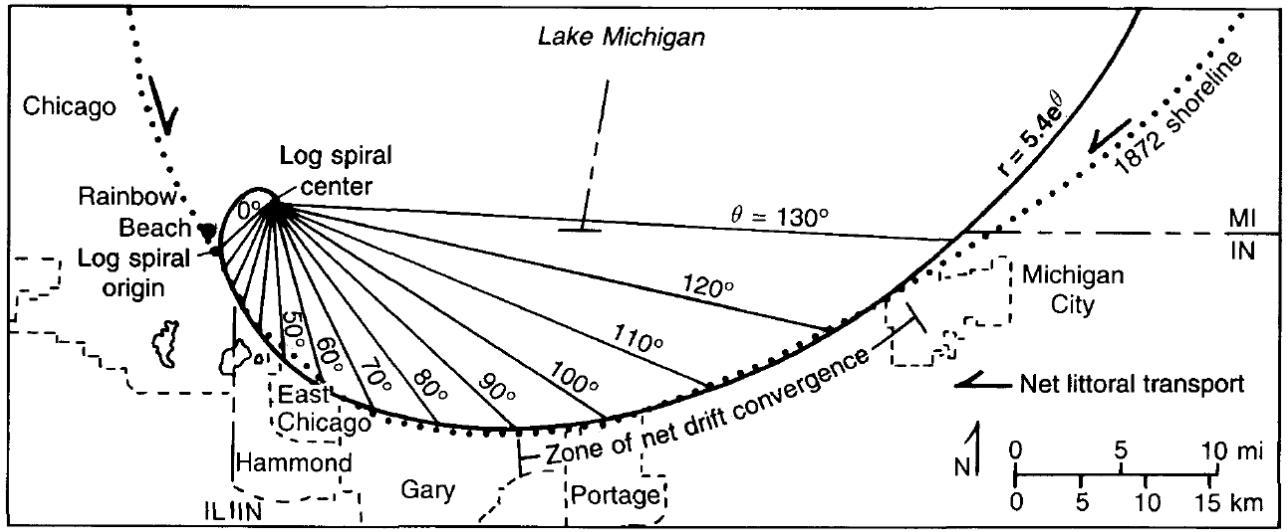
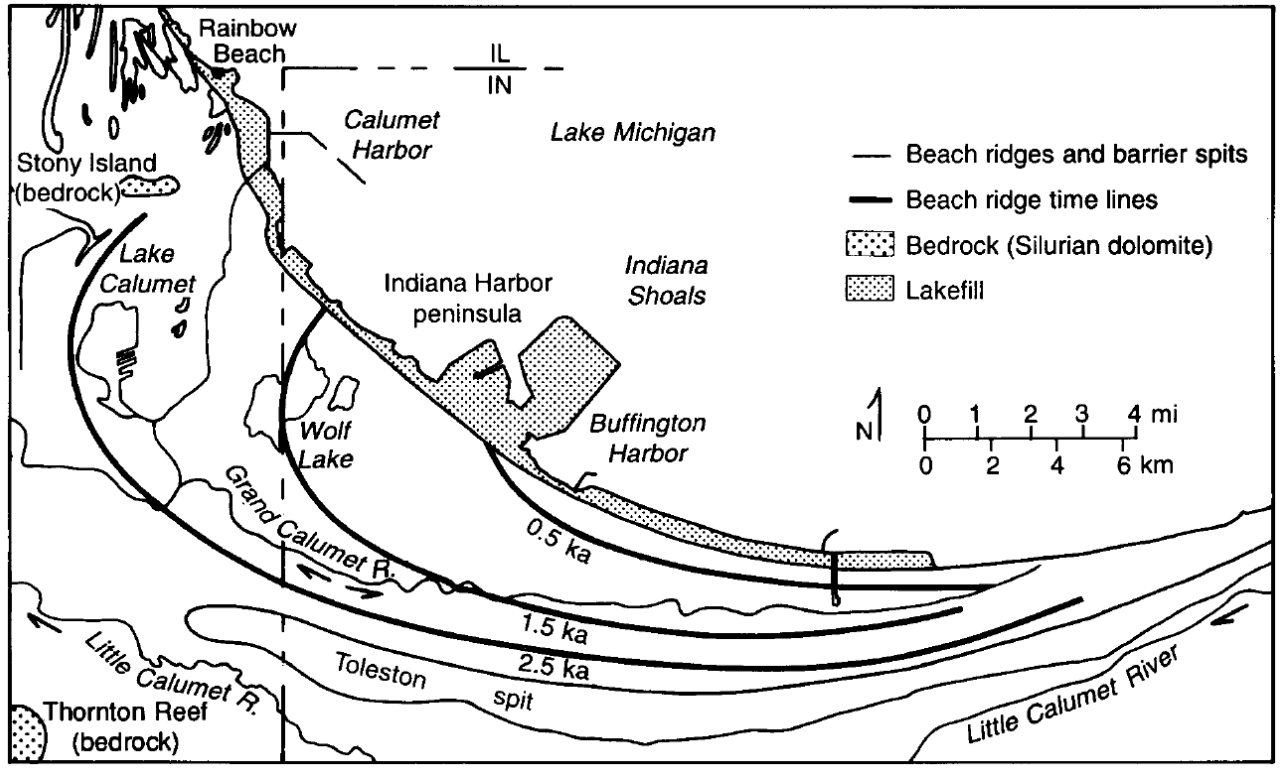
Harry Jol and many more….


Lake Michigan
Chicago
Log spiral center
Rainbow Beach
Log spiral origin
0°
θ = 130°
r = 5.4e^θ
1872 shoreline
MI
IN
120°
110°
100°
90°
80°
70°
60°
50°
Michigan City
East Chicago
Hammond
Gary
Portage
IL IN
Zone of net drift convergence
Net littoral transport
N
0 5 10 mi
0 5 10 15 km


Rainbow Beach
IL
IN
Calumet Harbor
Lake Michigan
Stony Island (bedrock)
Lake Calumet
Indiana Harbor peninsula
Indiana Shoals
Beach ridges and barrier spits
Beach ridge time lines
Bedrock (Silurian dolomite)
Lakefill
Wolf Lake
Buffington Harbor
N
0 1 2 3 4 mi
0 2 4 6 km
Grand Calumet R.
0.5 ka
1.5 ka
2.5 ka
Little Calumet R.
Toleston spit
Thornton Reef (bedrock)
Little Calumet River

Great Lakes Coastal Flood Study

Report to State Partners

March 28, 2017

Source: http://www.weather.com/news/science/impressive-waves-crash-lake-michigan-20141027

Great Lakes Coastal Flood Study

Report to State Partners

Discussion Outline >>>

- Program Status
- Schedule for Workmap roll-out and community Outreach
- High-level Review of methods and key technical considerations
- Outreach and Communication Best Practices
  - Strategy for workmap review and comment intake
  - Provide tools to enable local focus
  - Evaluation of high-impact communities
  - Fact sheet development
- NFIP Issues and Next steps

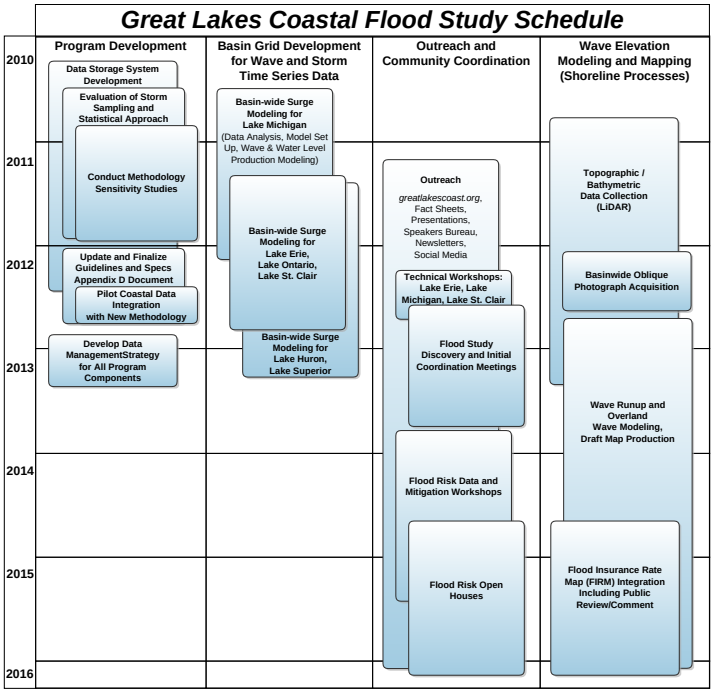
FEMA

Great Lakes Coastal Flood Study

Looking back to our start

FEMA

- 2010 Started ADCIRC runs for all lakes
- 2011 Funded outreach for 3 lakes (MI, StC, and ER). Started Bathy-LiDAR. Conducted pilot studies to test "D.3" standards document with focus on wave runup
- 2012 Funded major shoreline analysis (MI, StC and ER), plus more bathy-LiDAR
- 2013 Funded major analysis (SU and HU). Inland rivers and lakes started for 12 counties.
- 2014 Rolled out workmap for first 13 counties. Worked with independent study group at UNC.
- FY15 Modify near-shore wave methods based on indep. study, running contract mods where necessary
- 2016 Run 2-d SWAN+paired ADIRC for upper lakes; Release workmaps for Lake Erie shoreline in OH and MI

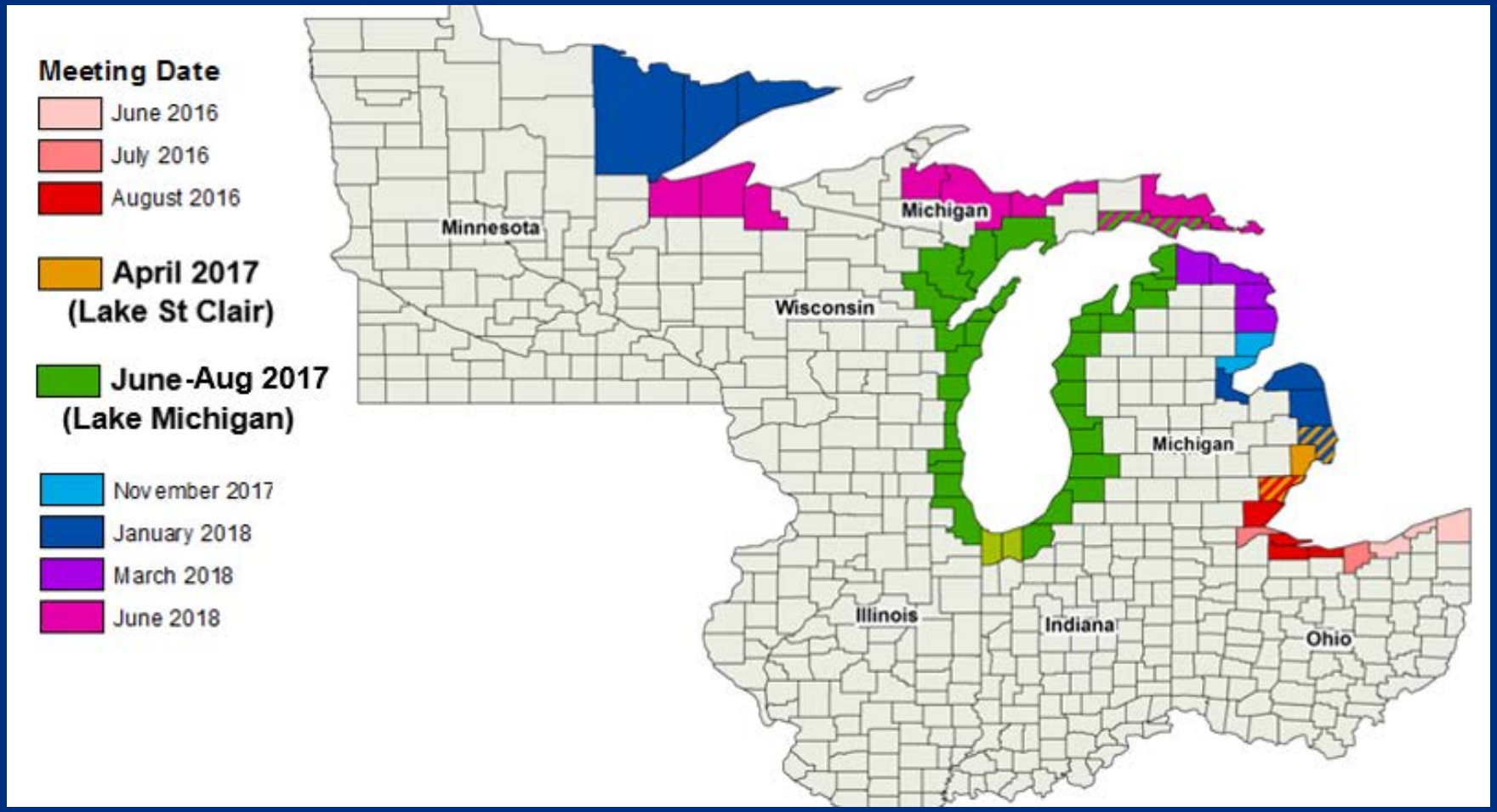


RiskMAP
Increasing Resilience Together

Great Lakes Coastal Flood Study

Great Lakes Coastal Flood Study

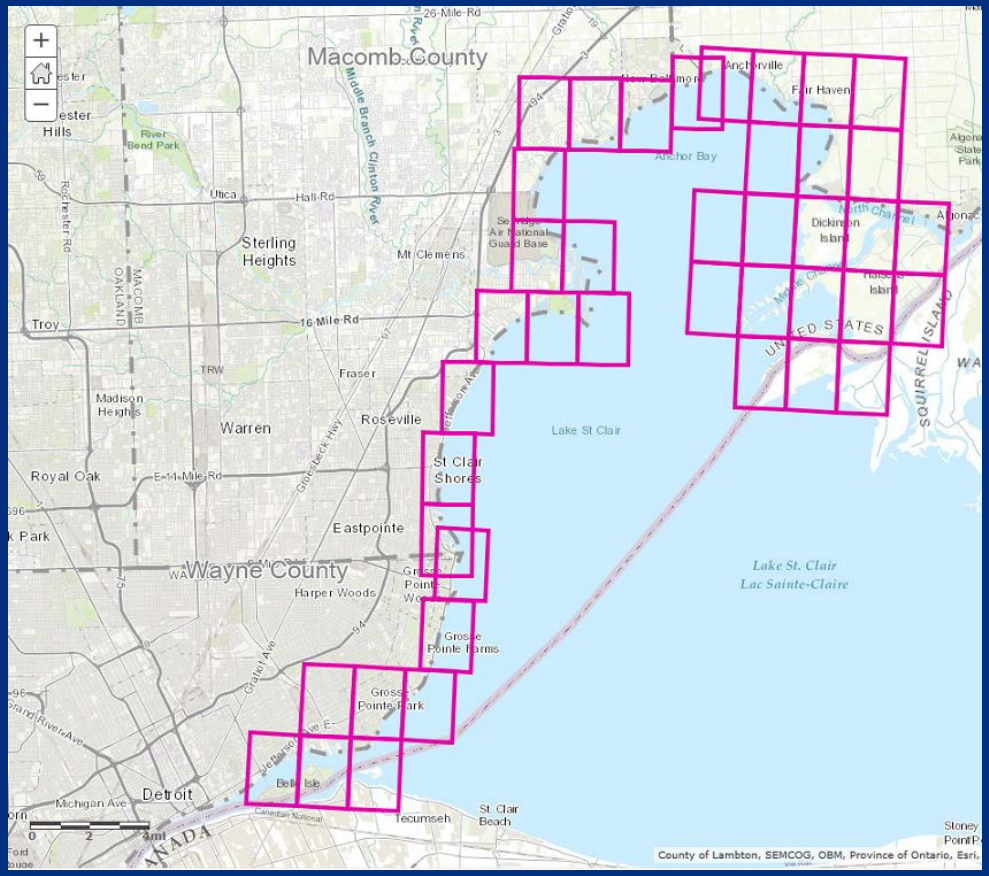
Workmap release and Meeting Schedule



FEMA

Great Lakes Coastal Flood Study

Workmap release and Meeting Schedule

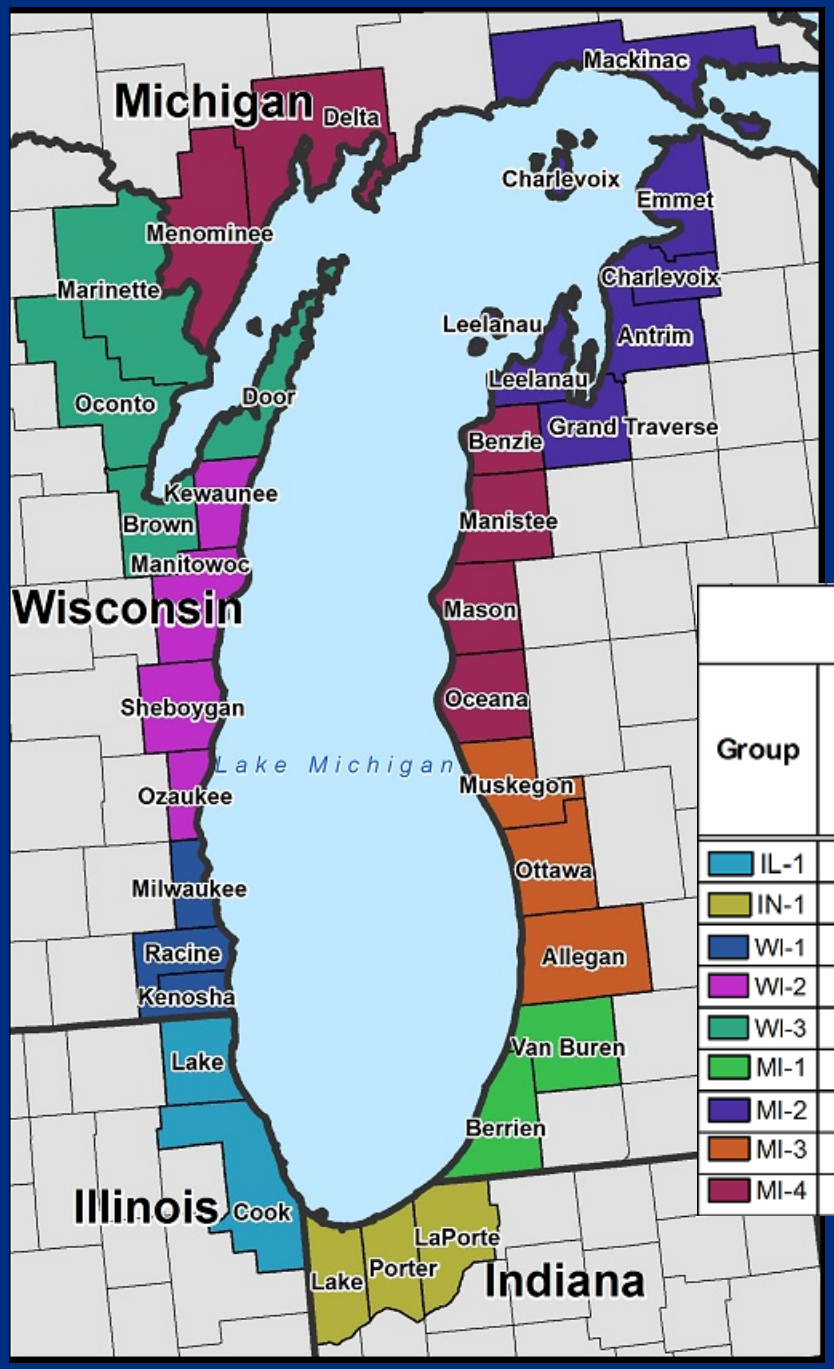


Macomb County
Weds, April 12, 2-4 pm
Macomb Intermed. School
District Building
Clinton Township, MI

St. Clair County
Thurs, April 13, 8:30-10:30 am
Ira Township Hall
Fair Haven, MI

Wayne County
Thurs, April 13, 2 - 4 pm
Grosse Pointe Public Library
Grosse Pointe Park, MI

FEMA



Great Lakes Coastal Flood Study

Workmap release and and Meeting Schedule

2017 Outreach --- Target Schedule

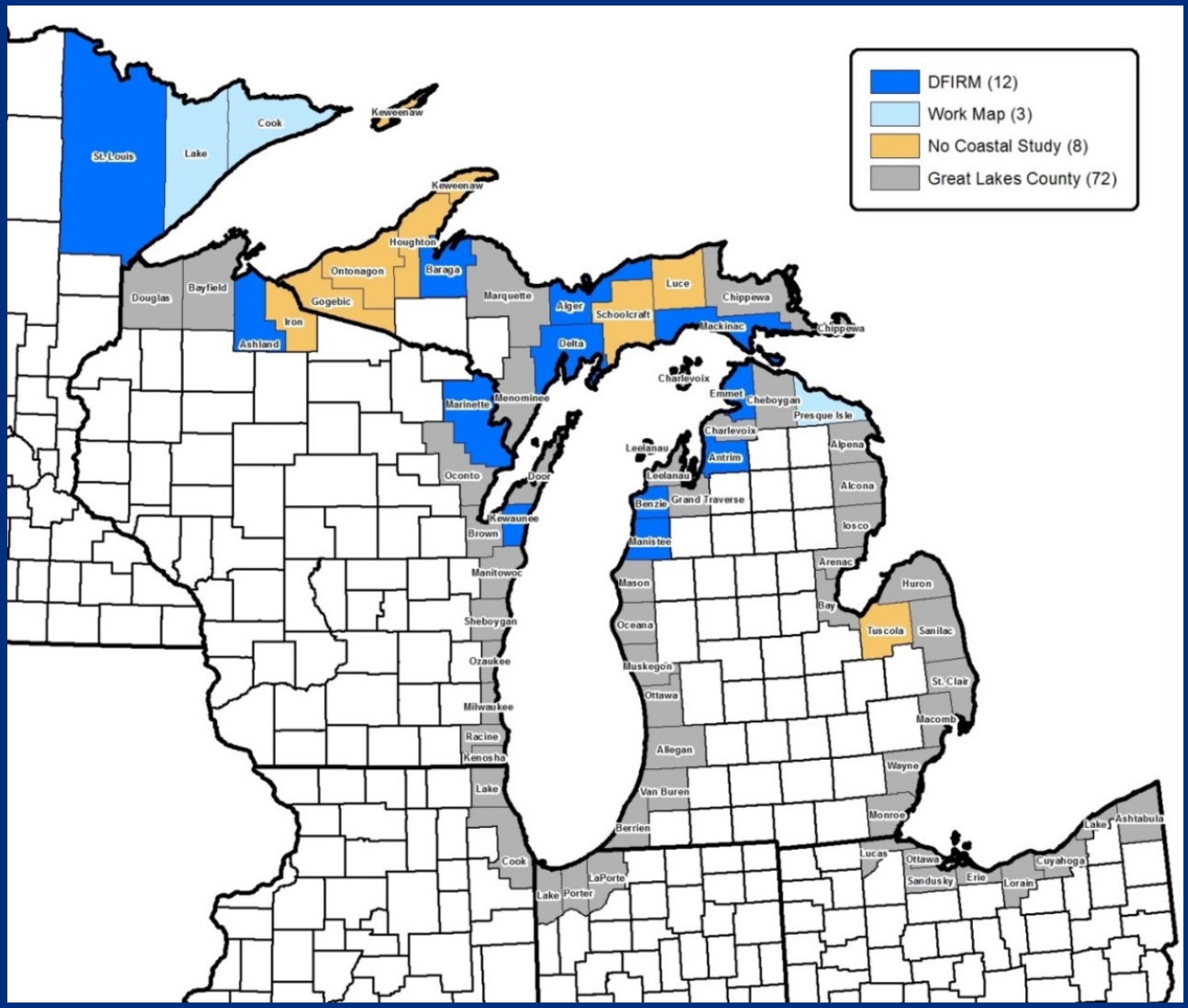
Group	Upload to GeoPortal	State Briefing	Hold FRR Meeting	Comment Response and map edits where applicable	Contract Outreach Lead
IL-1	4/27/17	5/11/17	6/1/17	7/28/17	Errol Dufour
IN-1	5/22/17	6/5/17	7/13/17	9/7/17	
WI-1	6/9/17	6/23/17	7/23/17	8/29/17	Jordan Williams
WI-2	6/23/17	7/7/17	8/6/17	9/12/17	
WI-3	7/7/17	7/21/17	8/19/17	9/26/17	
MI-1	6/14/17	6/28/17	7/13/17	9/7/17	Brett Holthaus
MI-2	6/26/17	7/7/17	8/8/17	9/22/17	
MI-3	8/1/17	8/9/17	8/28/17	10/26/17	
MI-4	8/15/17	8/29/17	9/18/17	11/5/17	

Great Lakes Program Goals

- Latest models, data, and technology
  - Provide for statistical (or response-based) methods, including basin-wide water surface grids and storm sampling built from continuous record of meteorological, water level and ice field data (1960 - 2009).
  - Comprehensive bathy-LiDAR collection with some hydrography survey
  - Incorporate modern run-up computations
  - ***Incorporate VE velocity mapping designation as appropriate***
- Deliver updated flood maps for 64 of the 72 counties located along Great Lakes shoreline in FEMA Region V states
- Provide new study for inland rivers and lakes for 12 Great Lakes counties
- Survey possible applications for enabling local and regional efforts in risk assessment and planning

FEMA

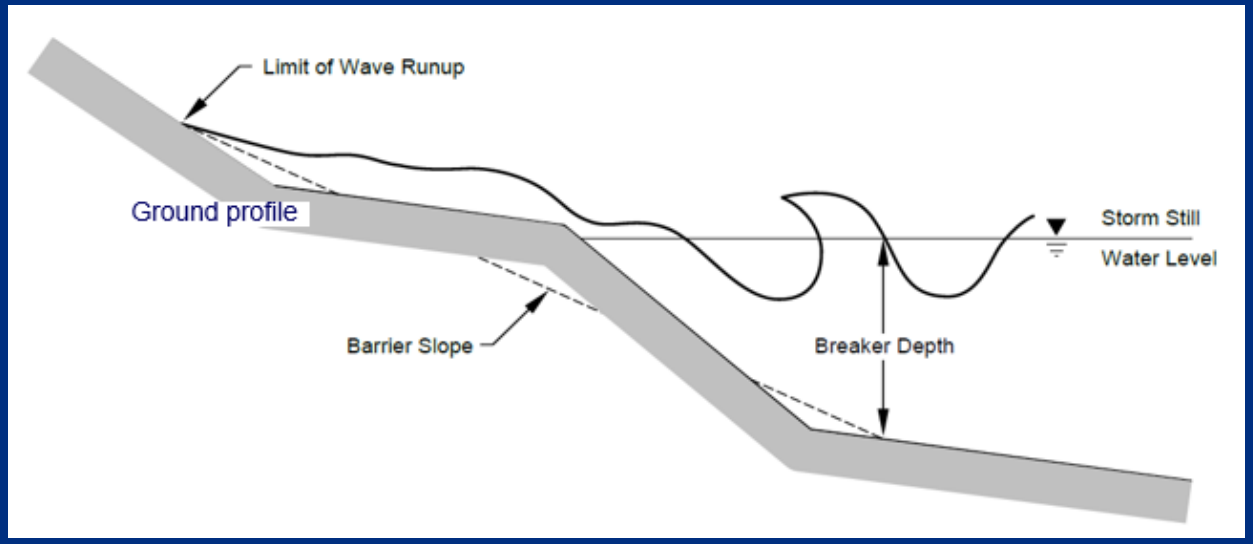
Great Lakes Program Goals



FEMA

Response-Based Wave Runup

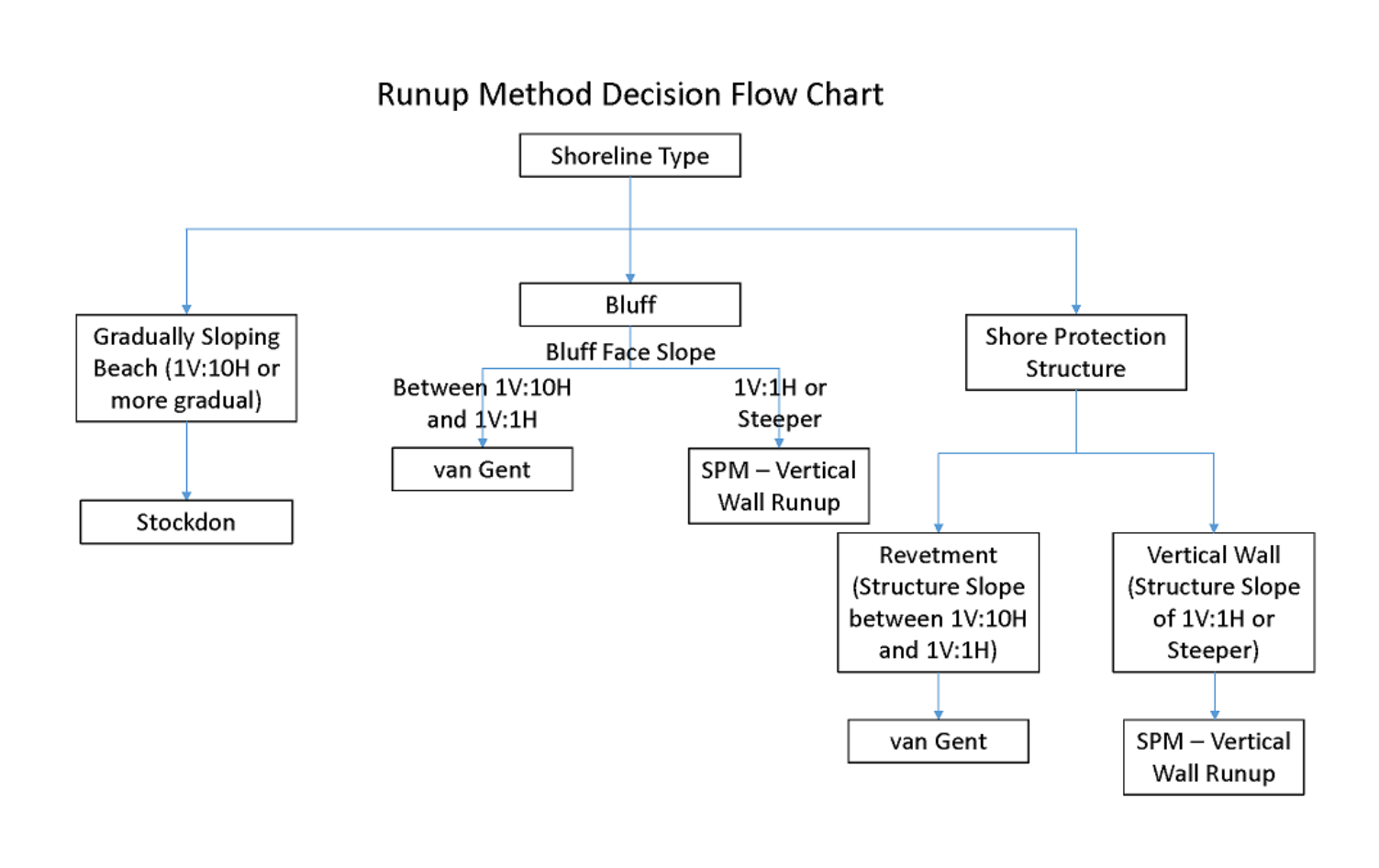
- Wave runup is the uprush of water from wave action on a beach, steep bluff or coastal structure.
- It is calculated at each transect using appropriate hydrodynamic equations, simulating an event for every time step captured for select storms using the ADCIRC-SWAN record, and run through all historic storm samples identified as having lake-wide (“regional”) impact.
- A statistical analysis is performed on the maximum runup results at each transect to obtain the 1-percent-annual-chance runup elevation.



FEMA

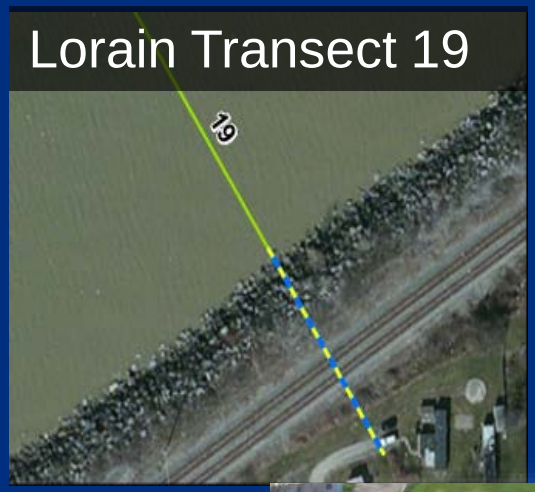
Run-up Methods

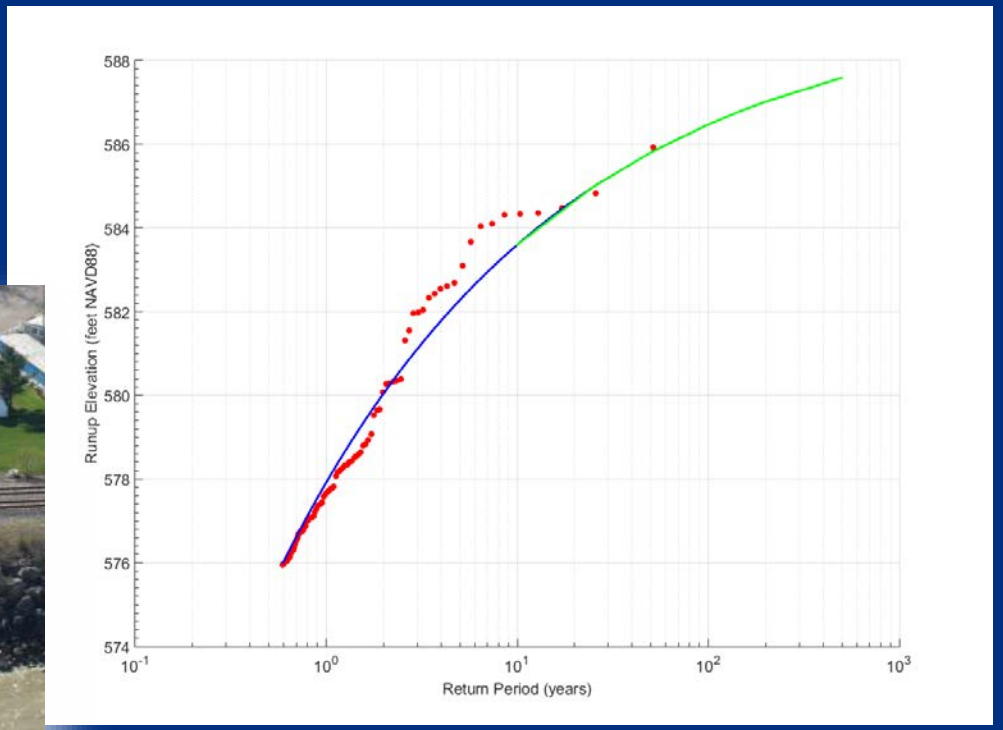
Approach for Upper Lakes numerical modeling



FEMA

Response-Based Wave Runup





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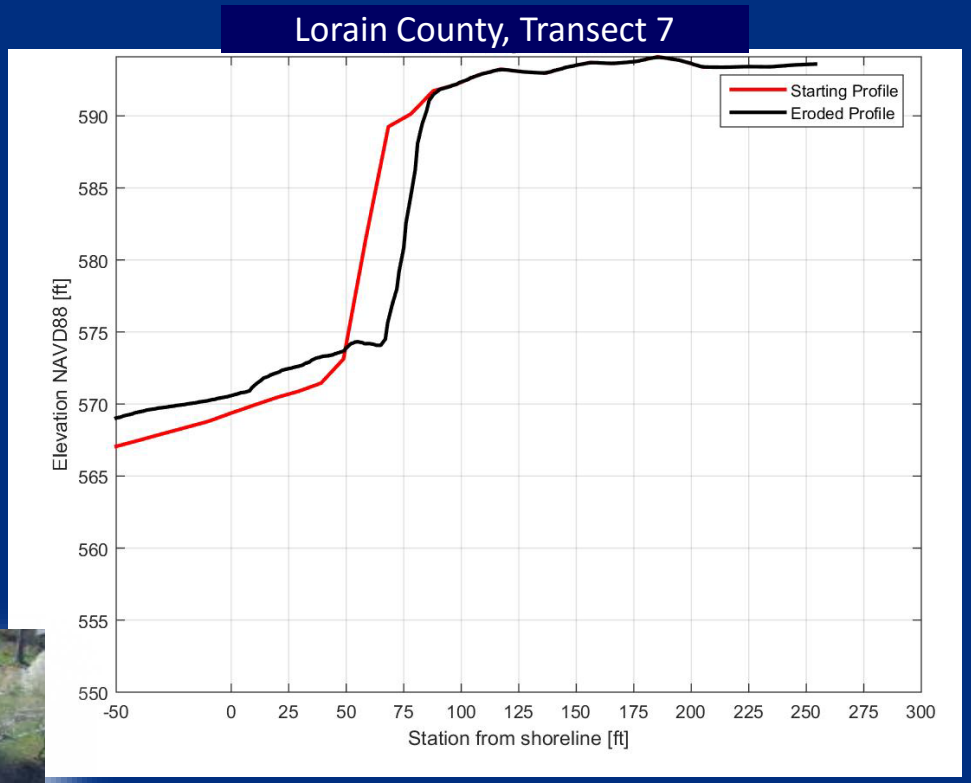
Erosion

USACE CSHORE model:

- Applies real physics
- Near-shore wave processes
- Cross-shore sediment transport



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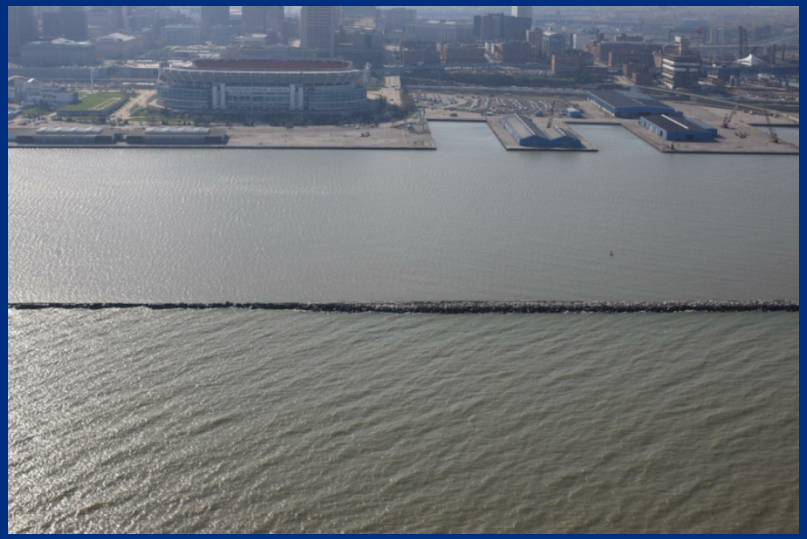
Shoreline Structures

- Major Structures
  - Typically extending into surf zone
  - Designed for storm protection
  - Continuous along shoreline



- Minor Structures
  - Located at shoreline and intended to limit erosion
  - Treatment in mapping based on assumed eroded profile
  - Categorized by reach

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Great Lakes Coastal Flood Study

Rules for Transect-based Computations

- Transects are placed to define representative profiles for a shoreline reach
- Transect spacing depends on scalable engineering alternatives
  - High Density – 1 transect per 0.5 to 1.5 coastal mile
  - Commercial/Industrial/Moderate Residential – 1 transect per 1.5 to 3 coastal miles
  - Low Density Residential – 1 transect per 3 to 6 coastal miles
  - Parkland/Forested/Farmland – 1 transect per 6 to 20 coastal miles
- Results of transect computation may be inserted at a discontiguous shoreline reach where appropriate; this “Mapping transect” will be subject to representative morphology and wave climate.

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Wave Overtopping

- Overtopping rate considerations for establishing Flood Insurance Rate Zones
- Magnitude of overtopping rates was calculated by applying formulas of the EurOTop Manual
- Overtopping rate determines AO Zone (sheet flow) depth

Wave overtopping on the coast of Lake Ontario during a 1973 Storm, Edgemere Drive, Monroe County, NY.

— Photo Courtesy of Dr. Martin

FEMA

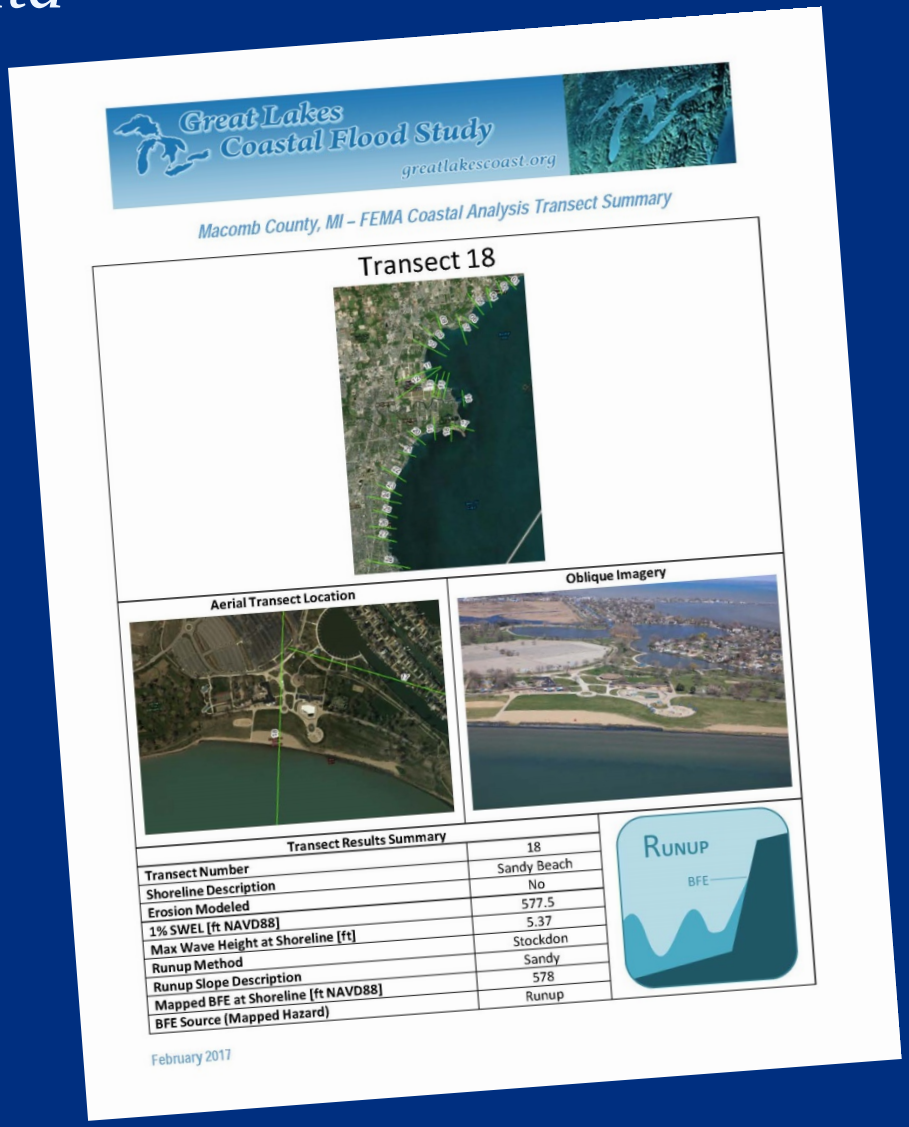
Enabling local focus

An evolution of tools and data

- Leveraging Oblique photos collected in 2011 and 2012 can build immediate connections with beach morphology and land use.
- Recognition of key terms requires an organized and common English presentation

High-res oblique aerial images are available here:

http://greatlakes.erdc.dren.mil/



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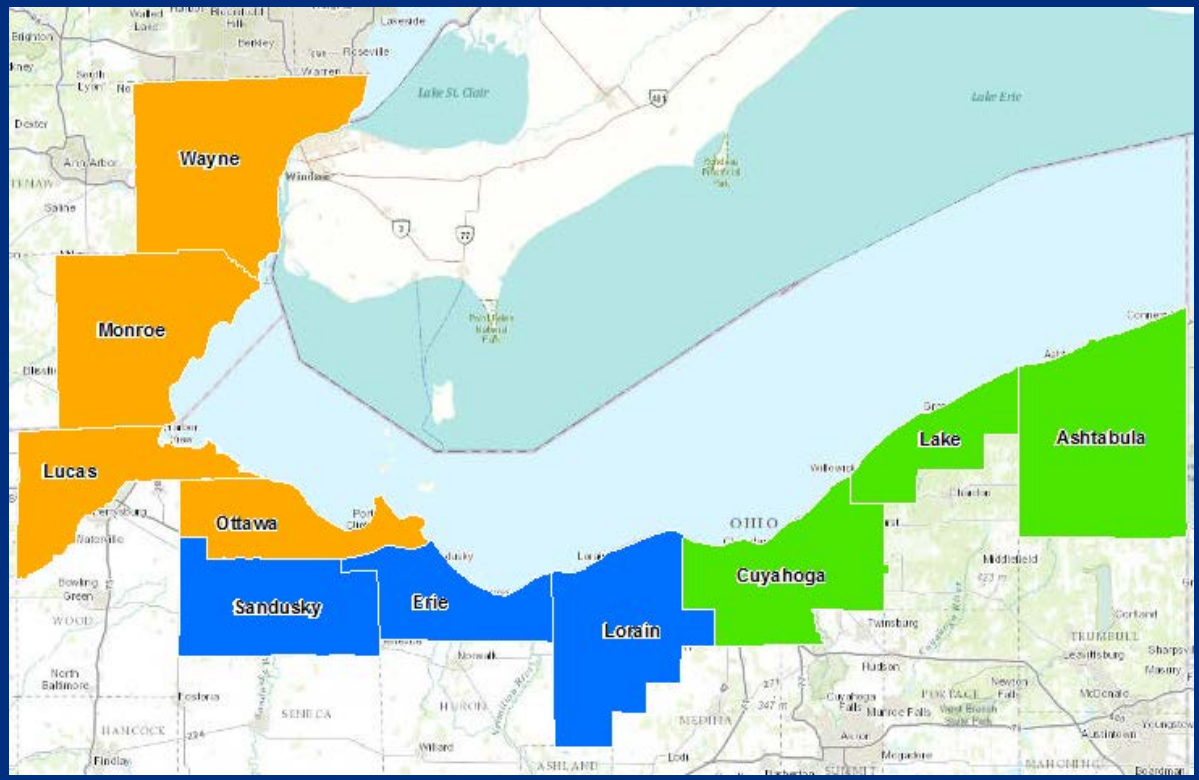
Enabling local focus

An evolution of tools and data

- County production inside FEMA contracts were executed by groups, allowing a sub-regional level
- FRR Meetings are placed in similar group execution
- Workmap display via FEMA's "Geoportal" will show same sub-regional focus



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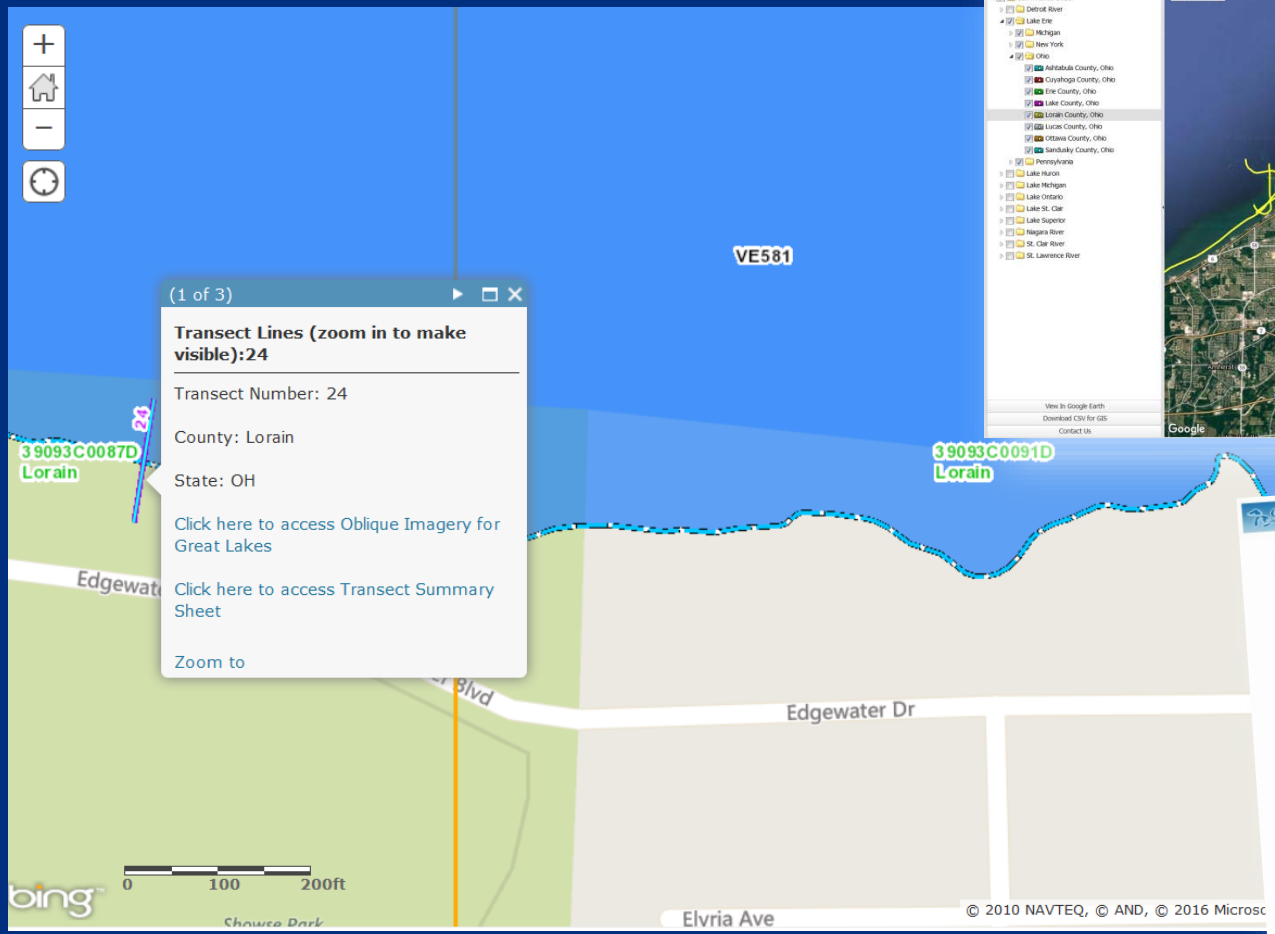
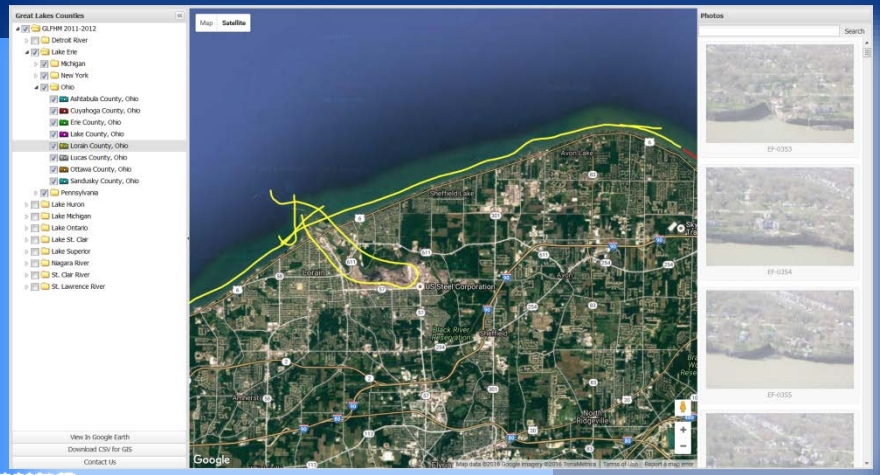
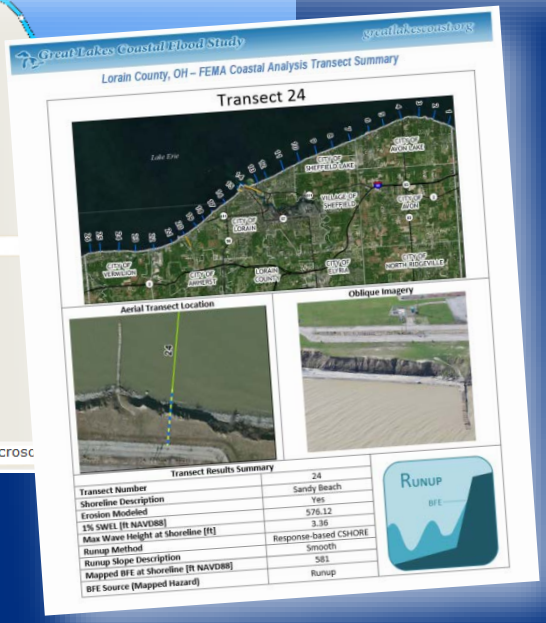
Enabling local focus

An evolution of tools and data







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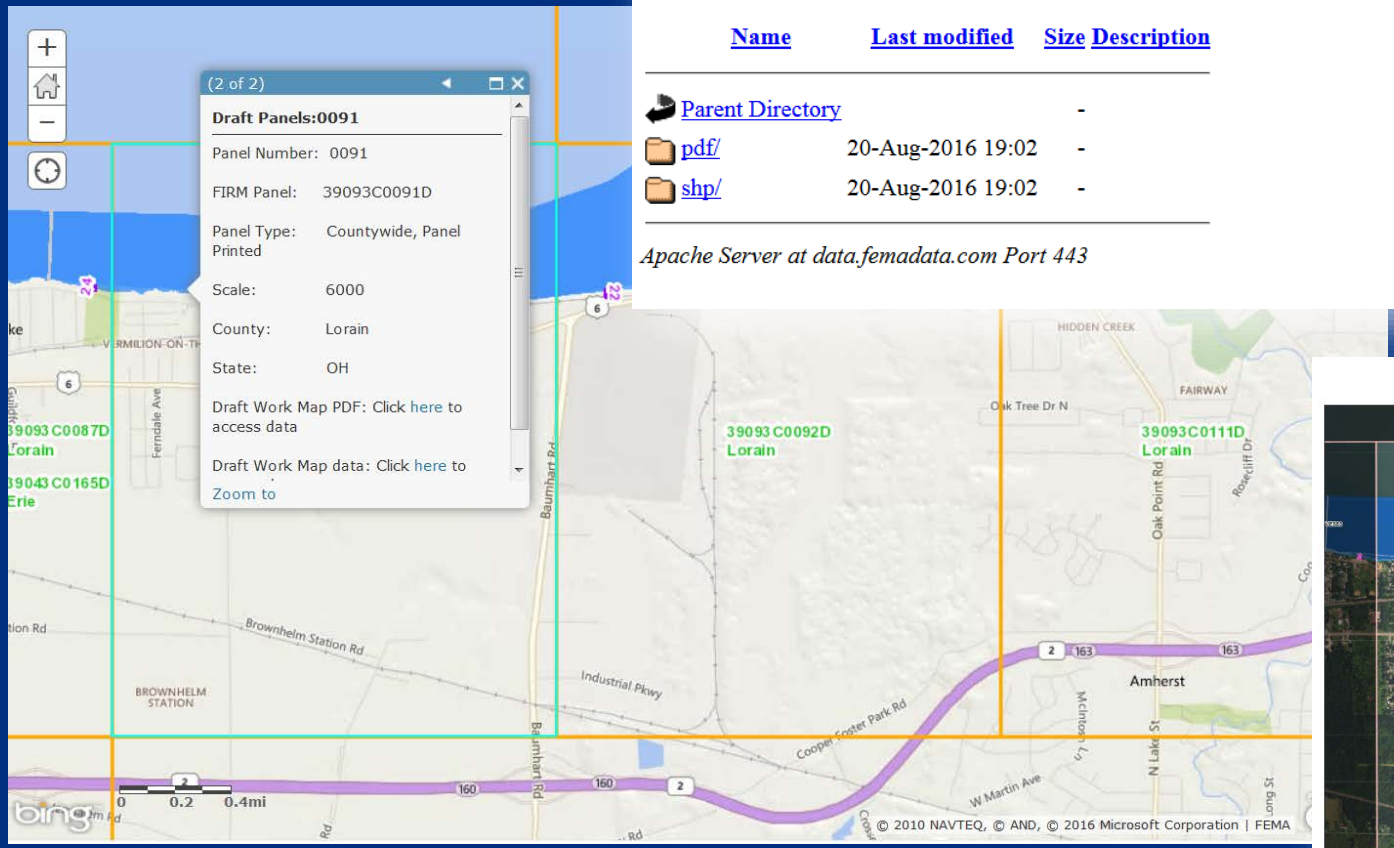
Enabling local focus

An evolution of tools and data



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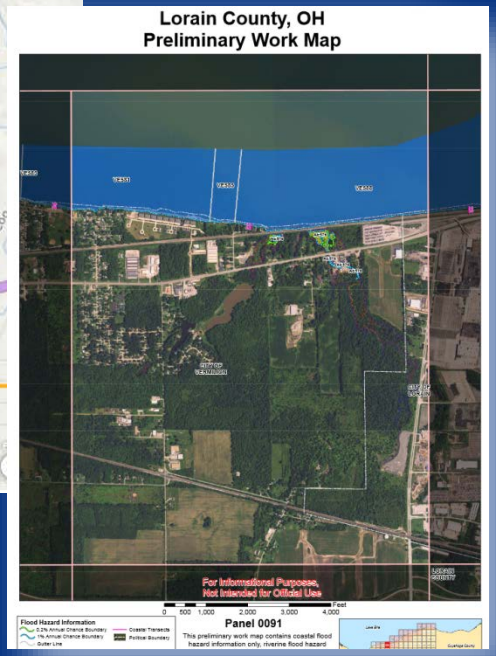

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VE Zones, AE Zones, AO Zones

Zone VE:

- Represents areas where wave action and/or high-velocity water can cause structural damage, with wave heights > 3ft
- Subdivided into elevation zones, and BFEs are assigned

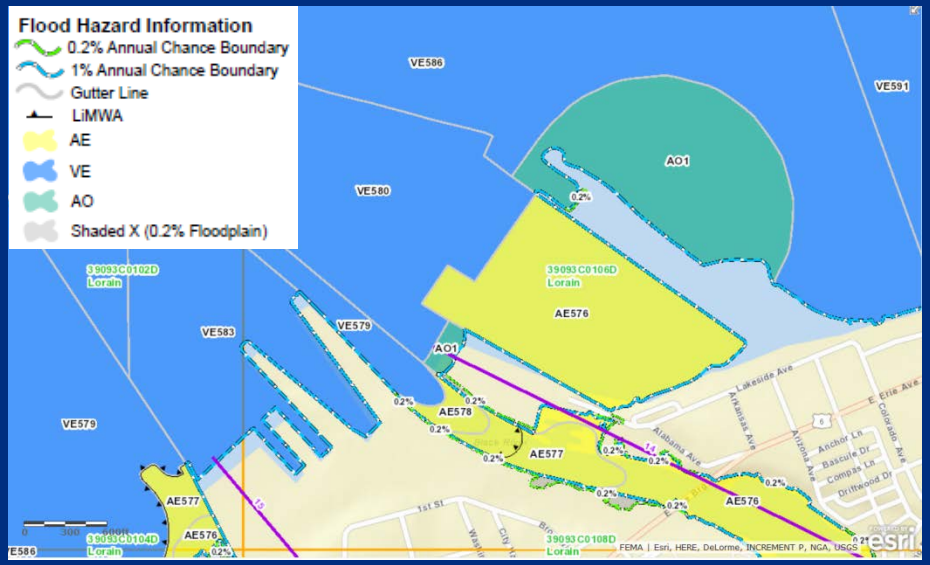
Zone AE:

- Areas subject to inundation by the 1-percent-annual-chance flood, wave heights < 3ft.
- Subdivided into elevation zones, and BFEs are assigned

Zones AO:

- Applied in areas of sheet-flow shallow flooding
- Designated with 1-, 2-, or 3-foot depths of flooding

Overtopping (AO Zone)



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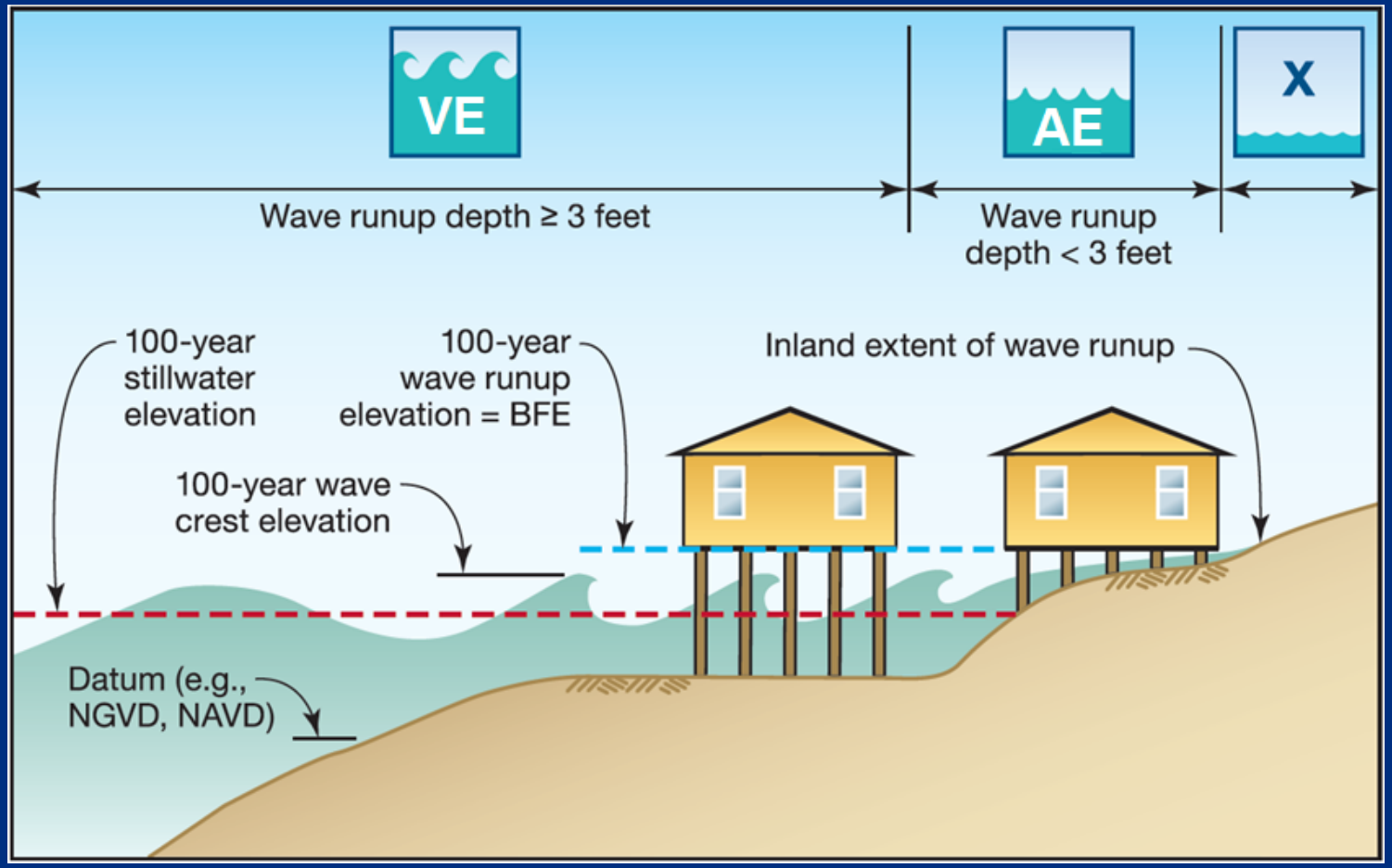
VE Zones, AE Zones, AO Zones



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V-zone Floodplain management : 44 CFR 60.3(e)

The community must require that all new construction and substantial improvements have the lowest horizontal structural member of the lowest floor elevated to or above the base flood level,

… with the space below the lowest floor either free of obstruction or constructed with non-supporting breakaway walls …

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Another view of Zone VE Floodplain Management

- NO USE OF FILL as structural support
- Elevated portion of the building and piling/column foundation must be designed to withstand water and wind loads acting simultaneously under base flood conditions

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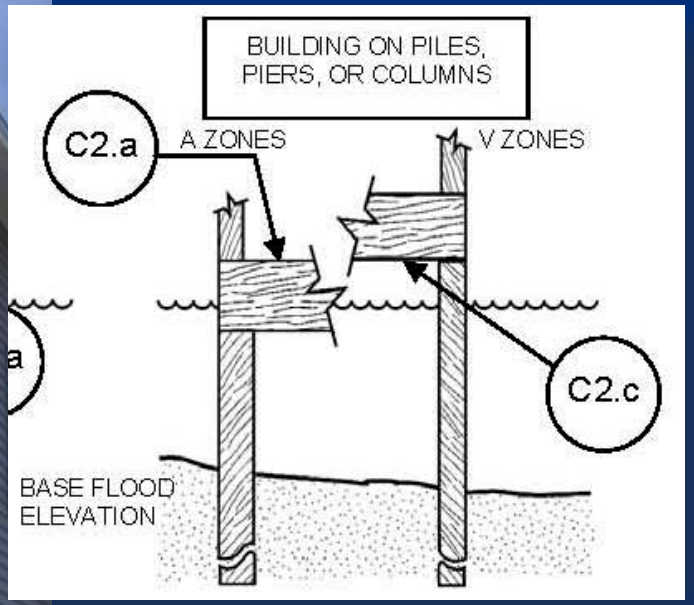
Lowest horizontal structural member



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Mitigation Action:

Shared opportunity… shared responsibility

STRUCTURE AND INFRASTRUCTURE PROJECTS

- Acquisition
- Elevation
- Retrofits
- Drainage

LAND USE PLANNING AND REGULATIONS

- Zoning
- Building Codes
- Ordinances
- Lakefront access

COMMUNITY IDENTIFIED PROGRAMS

- Storm Ready
- NFIP
- CRS
- BCEGS visibility

NATURAL SYSTEM PROTECTIONS

- Vegetation Mngt
- Wetland restoration
- Armoring guidance

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