NOAA Coastal Storms Initiative:

Community Based Research to Understand Lake Superior Coastal Storms Risk and Vulnerability at AuTrain, Michigan

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Michigan Technological University

Great Lakes Regional Meeting
NOAA Coastal Management Program
September, 2015

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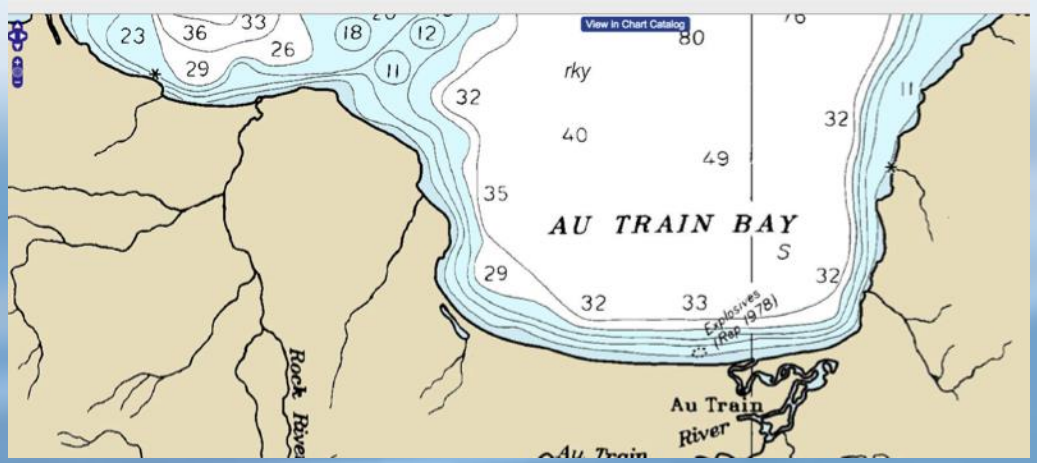
Great Lakes Research Center

Coastal Storms Team

- Michigan Tech
  - Guy Meadows
  - Colin Tyrrell
  - Amanda Grimm
  - Matthew Masarik



- Matt Warner - MDEQ Office of the Great Lakes
- Teresa Grout – Alger County Conservation District
  - Liz Coyne

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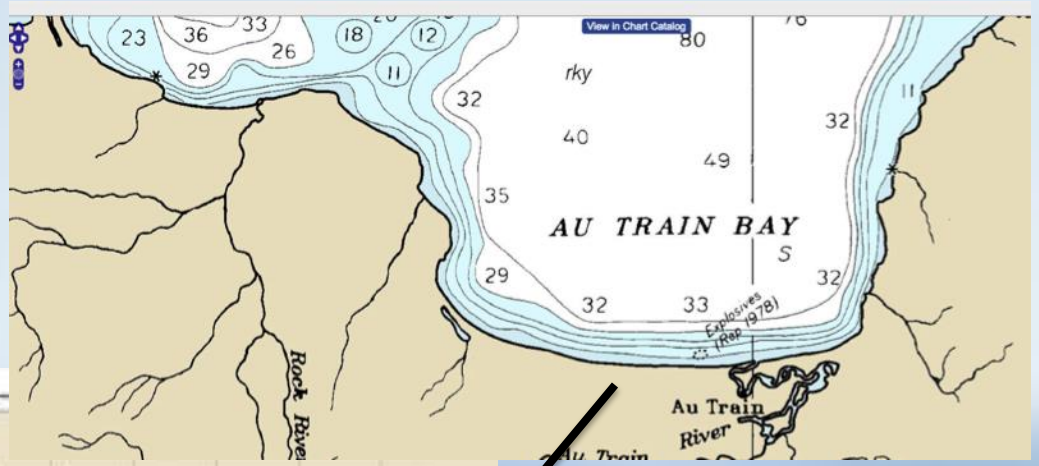
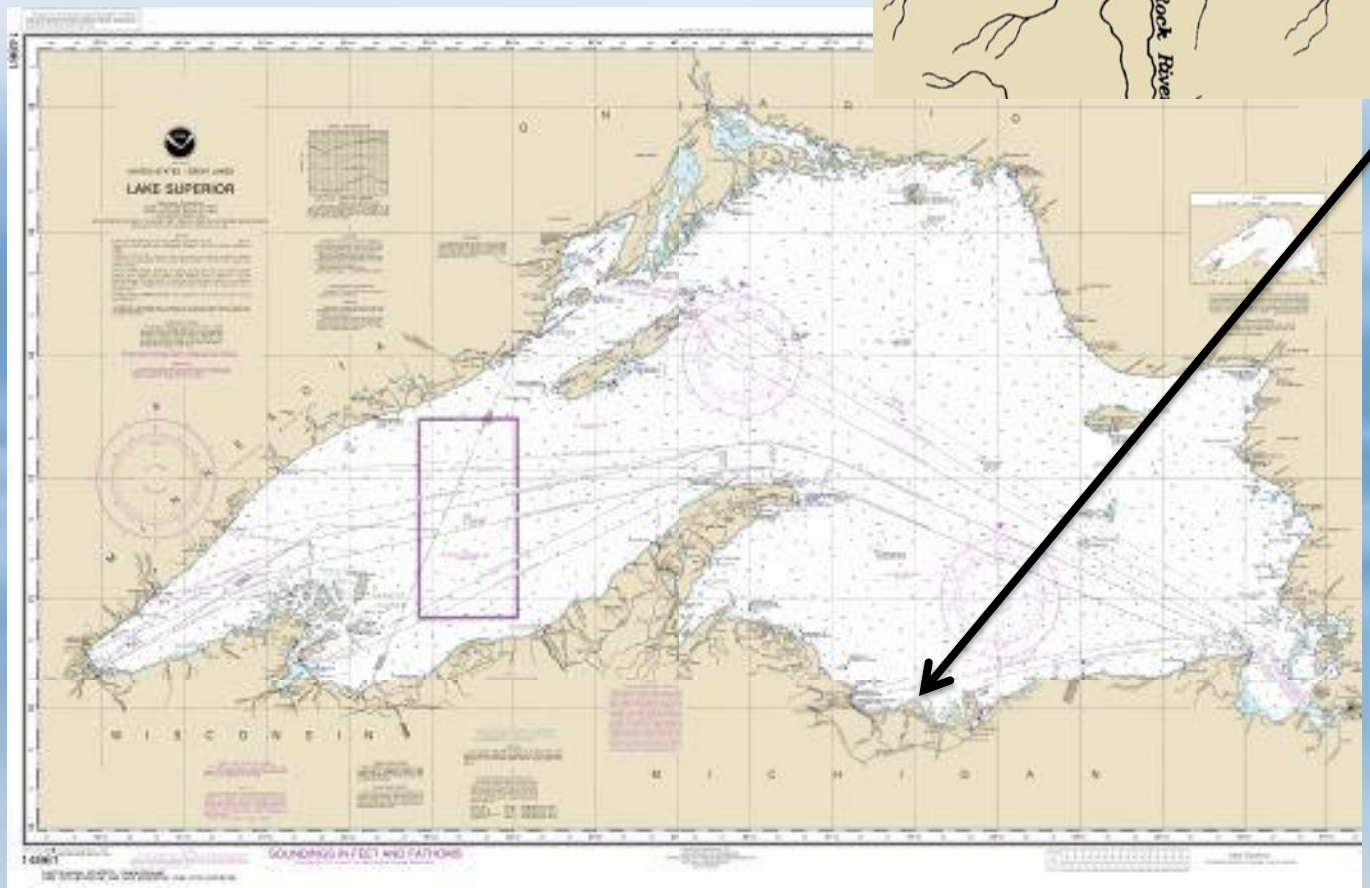
AuTrain Bay, Michigan
Lake Superior





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Monterey Bay and AuTrain Bay

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Project History

- Pre-Proposal submitted to NOAA Coastal Storms – December 2013
- Selected for full-proposal – February 2014
- Proposal Submitted to NOAA Coastal Storms - March 2014
- Project Start – June 2014
- Funding arrive – August 2014
- First field work – August2014
- Second field work and Board Meeting – June 2015

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Objectives

Enhancing shoreline mapping, visualization and management. The specific proposed objectives are as follows:

- Aid the community in understanding the coastal dynamics in operation and the associated risks to infrastructure.

- From an archive of remotely sensed, historical aerial and satellite coastal imagery
  - determine rates of shoreline change from human and natural impacts
  - develop mapping and visualizations to support management needs at the local and state level.

Objectives
(continued)

- Investigate the impacts of intense storm events on:
  - The community and the natural resources
  - The recreational value of the region (flooding, wetland composition, shoreline condition, etc.).

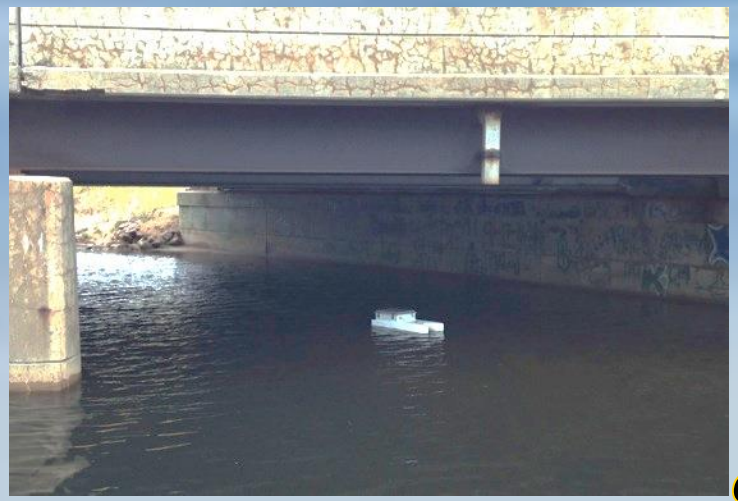
- Employ risk and vulnerability assessments to determine shoreline/flood/storm wave impacts and mitigation/adaptation strategies and techniques.

- Provide detailed scientific input to planning/policy decisions (e.g. land use ordinances, infrastructure siting) to address shoreline erosion/flooding impacts.

Scope of Work

Task One:

- Complete a high precision, nearshore hydrographic survey of AuTrain Bay
- Capture river characteristics near the mouth
- Deploy other sensors to better understand the dynamics of the nearshore



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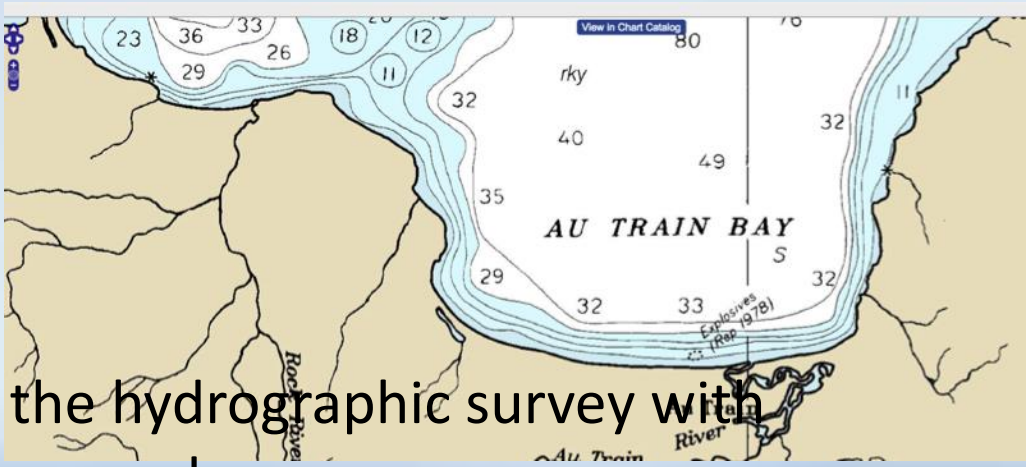
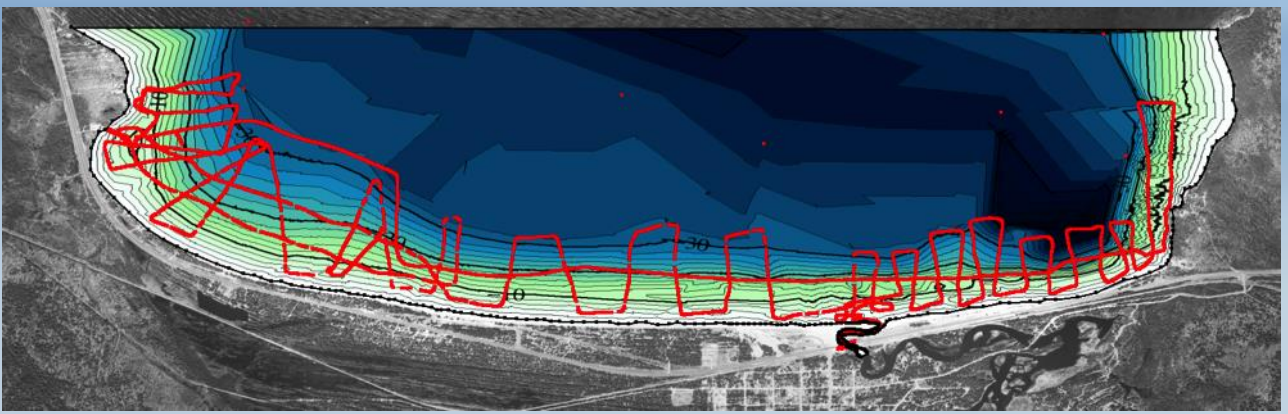
Scope of Work



Task Two:

- Geo-rectify and coordinate the hydrographic survey with ongoing land-use and land-cover changes
- Compiling existing maps and GIS products for AuTrain Bay; using an archive of remotely sensed, historical aerial and satellite coastal imagery to determine rates of shoreline change from human and natural impacts; and developing maps and visualizations to support management needs at the local and state level.



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Scope of Work

Task Three:

- Provide input conditions for the proposed nearshore modeling (Delft3D) of waves, currents and sediment transport

- Once an accurate description of nearshore and offshore 3-D bathymetry has been obtained, we will use the Delft3D hydrodynamic model to provide a detailed picture of the hydrodynamics for the region, which will be used to determine shoreline/flood/storm impacts and inform mitigation/adaptation strategies and techniques.

- Relation to Dangerous Nearshore Currents

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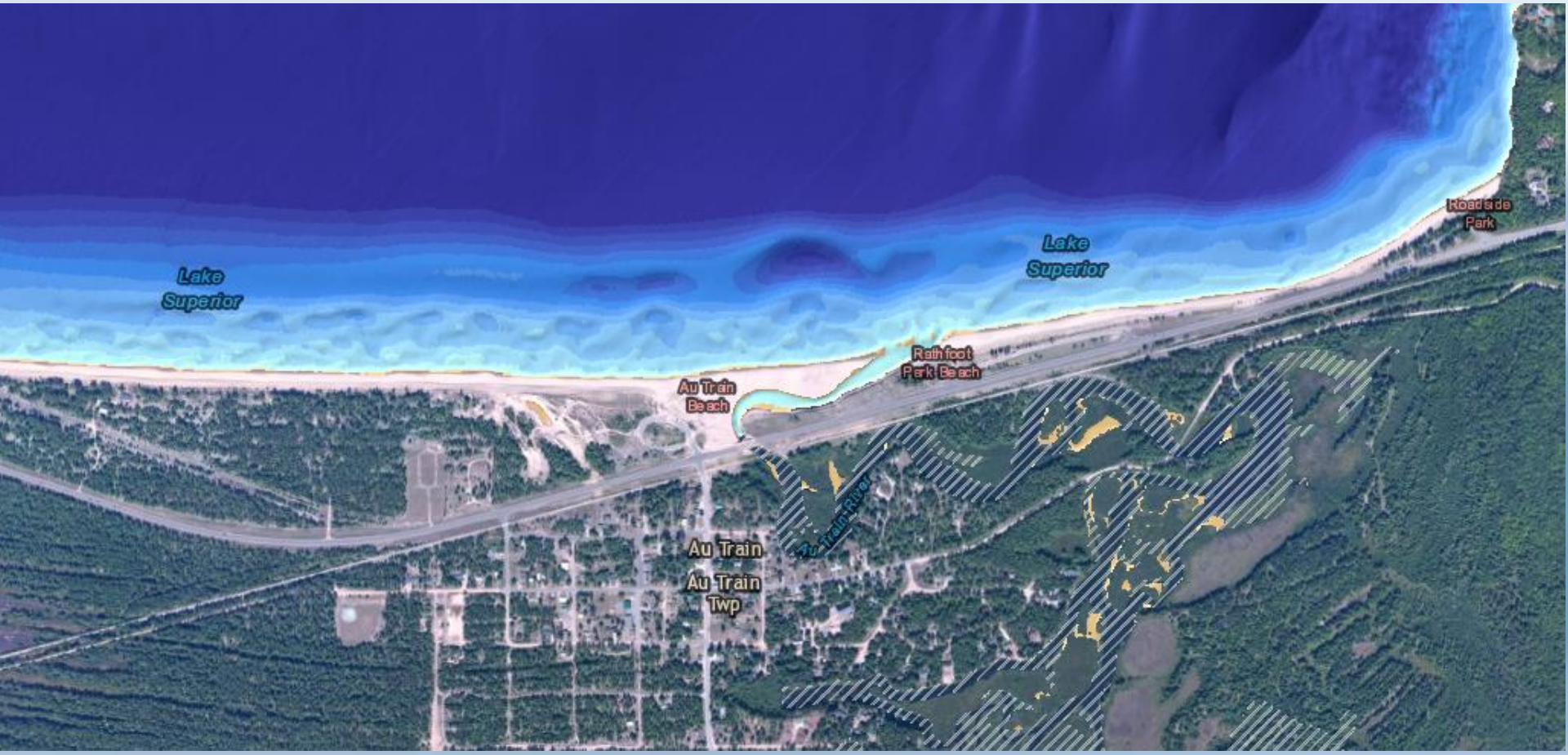
Analysis
Full NOAA LIDAR with new Hydro survey

Analysis

Full NOAA LIDAR Bathymetry



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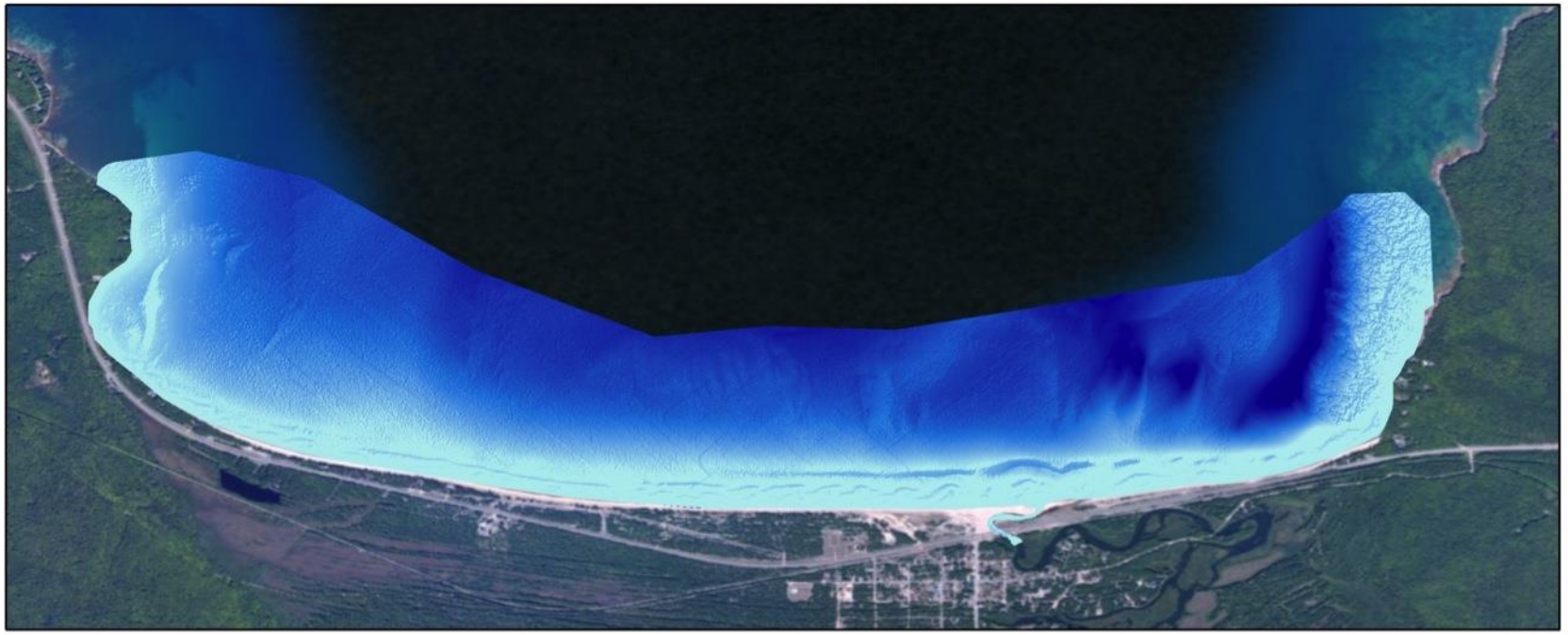
Nearshore Bathymetry



- **2011 lidar bathymetry updated with nearshore sonar bathymetry collected 2014**
- **Input for a nearshore hydrodynamic model of AuTrain Bay**

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Monitoring Shoreline Change from Aerial Imagery

- MTRI and Office of the Great Lakes, DEQ identified and compiled historical aerial imagery of AuTrain Bay
- This time series of imagery can be used to look at changes in the shoreline, the course of the AuTrain River, and sandbar channels associated with dangerous rip currents
- Aerial photos collected between 1939 and 2014 were collected, georeferenced when necessary, and digitized

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Monitoring Shoreline Change from Aerial Imagery

Year	Flight Date	Scale	Film	Flyer
1939	11/28/1939	1:20000	Black and White Panchromatic	AAA
1953	10/29/1953	1:15840	Black and White Infrared	PMA
1964	7/4/1964	1:15840	Black and White Infrared	USFS
1974	5/1/1974	1:130000	Color Infrared	NASA
1975	5/17/1975	1:15840	Black and White Infrared	USFS
1977	5/7/1977	1:24000	Black and White Infrared	MDNR
1978	5/7/1978	1:16000	Black and White Panchromatic	USGS
1988	6/20/1988	1:58000	Color Infrared	USGS
1993	9/4/1993	1:24000	Color Infrared	USACE
1993	5/7/1993	1:40000	Black and White Panchromatic	NAPPII
1998	4/26/1998	1:40000	Color Infrared	NAPPIII
2005	6/16/2005	1 m	Color	USGS (NAIP)
2006	6/4/2006	1 m	Color	USGS (NAIP)
2008	8/25/2008	0.3 m	color	USGS
2009	7/13/2009	1 m	color	USGS (NAIP)
2010		1 m	color	USGS (NAIP)
2012		1 m	color	USGS (NAIP)
2014		1 m	color	USGS (NAIP)

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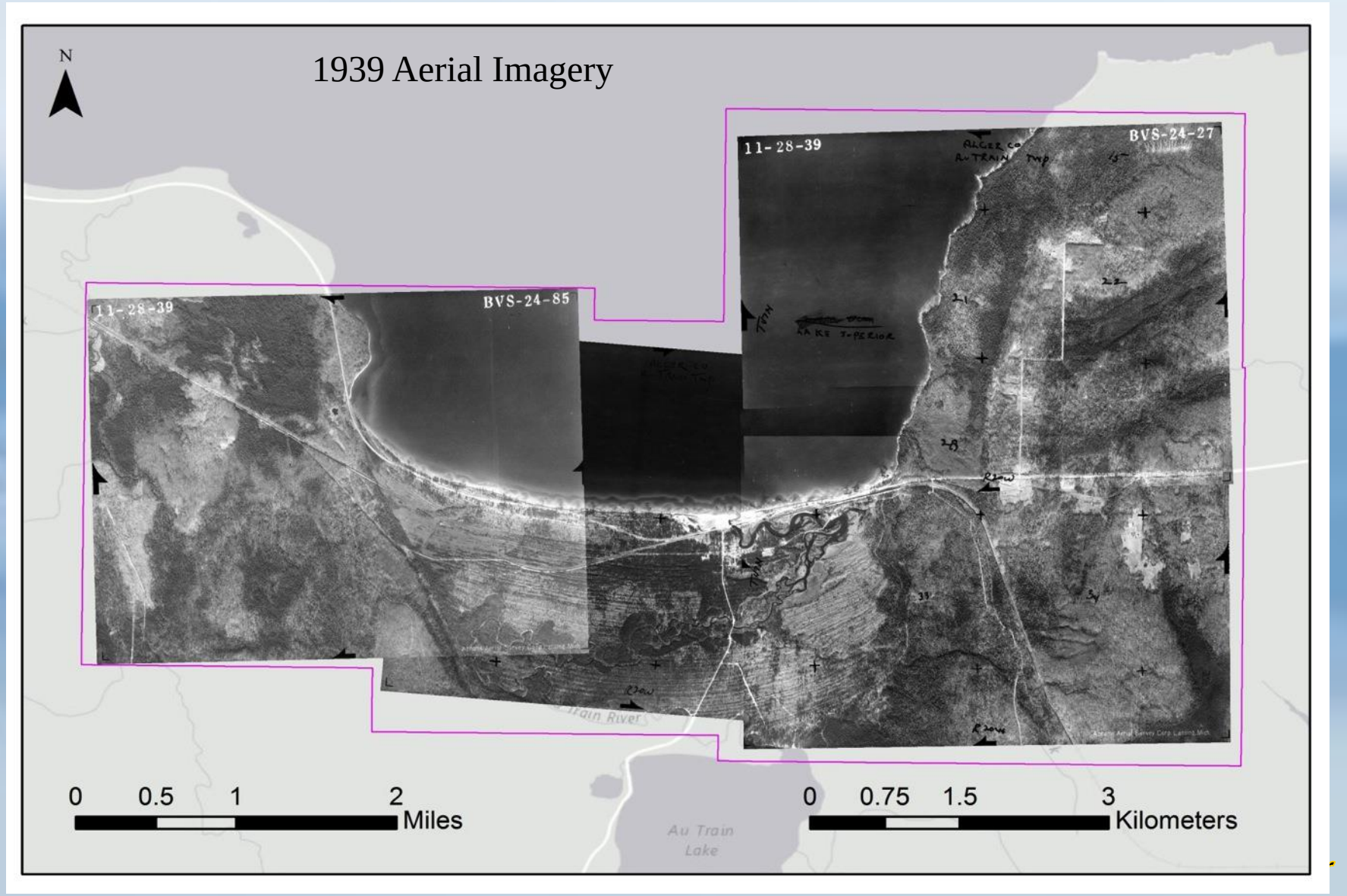
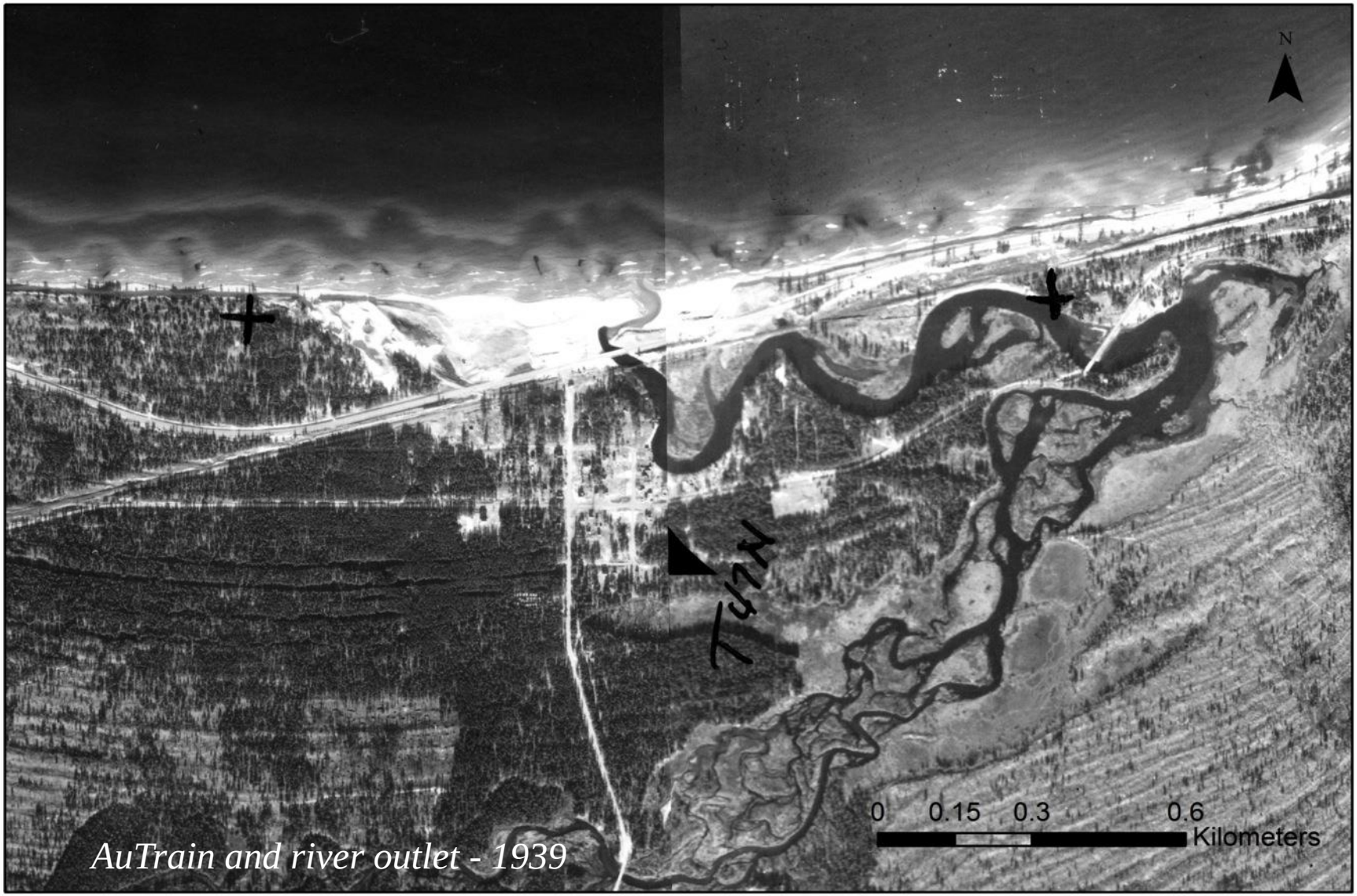
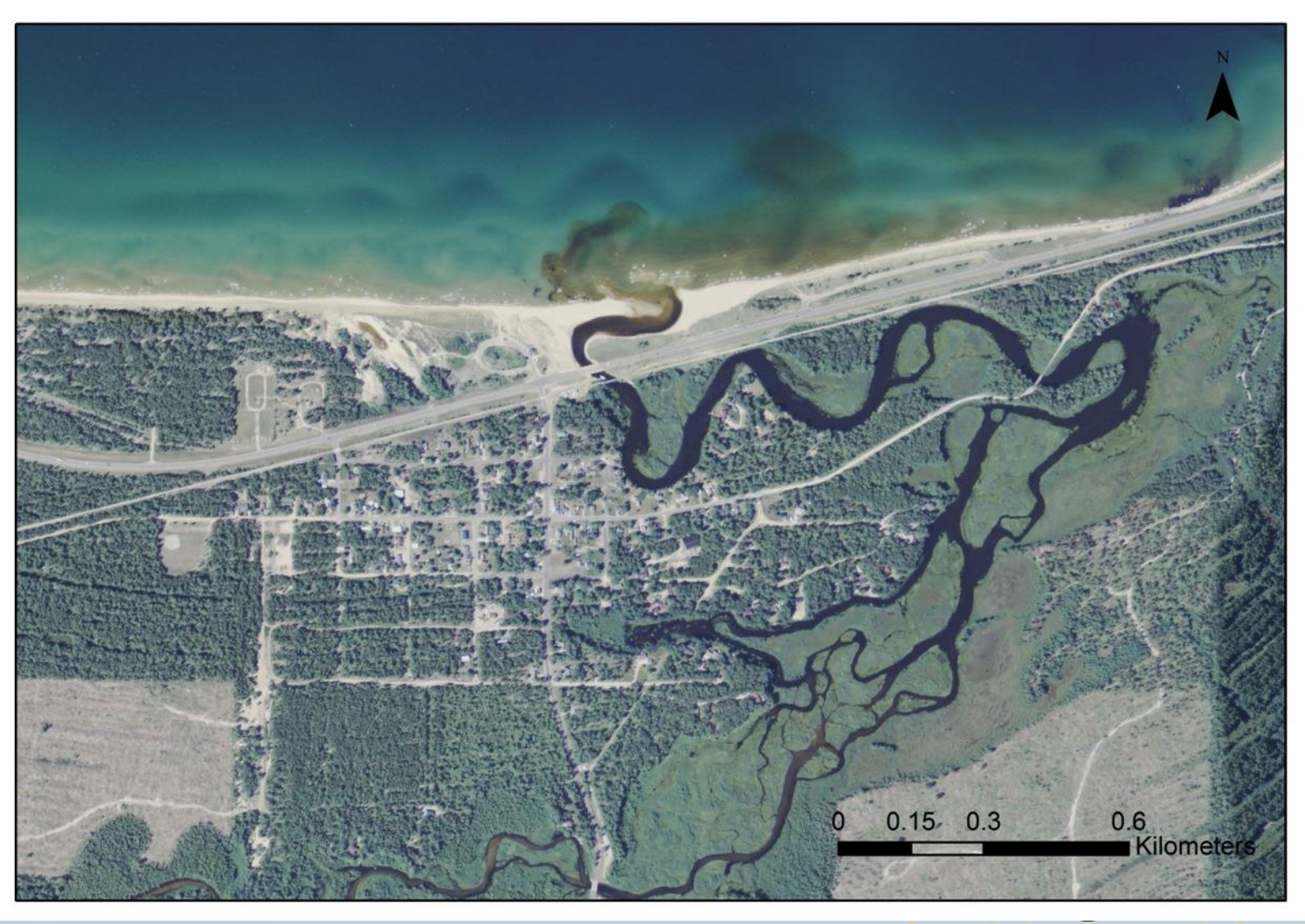
Monitoring Shoreline Change from Aerial Imagery



Monitoring Shoreline Change from Aerial Imagery



Monitoring Shoreline Change from Aerial Imagery



AuTrain and river outlet - 2014

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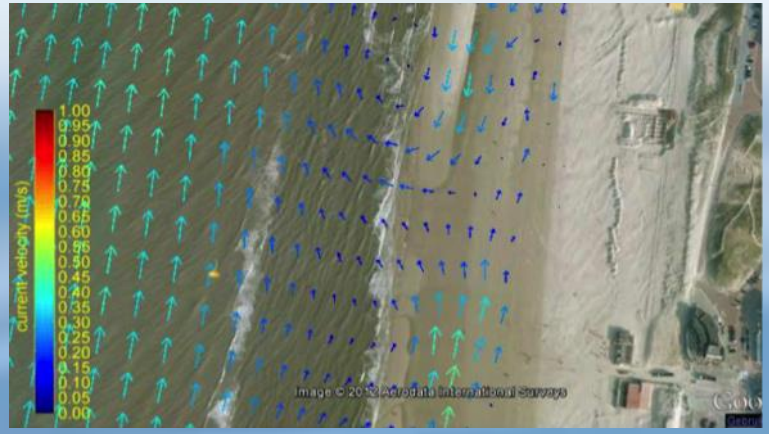
Delft3D Coastal Modeling

- Hydrodynamic modeling program that can quantify nearshore current and wave patterns, coastal morphology, and sediment transport
- Produces dynamic 3D simulations of water flow and sediment movement
- Helpful for understanding and predicting interactions between water level changes, rip currents, coastal erosion/deposition, and storm events



Example rip current prediction from Delft3D

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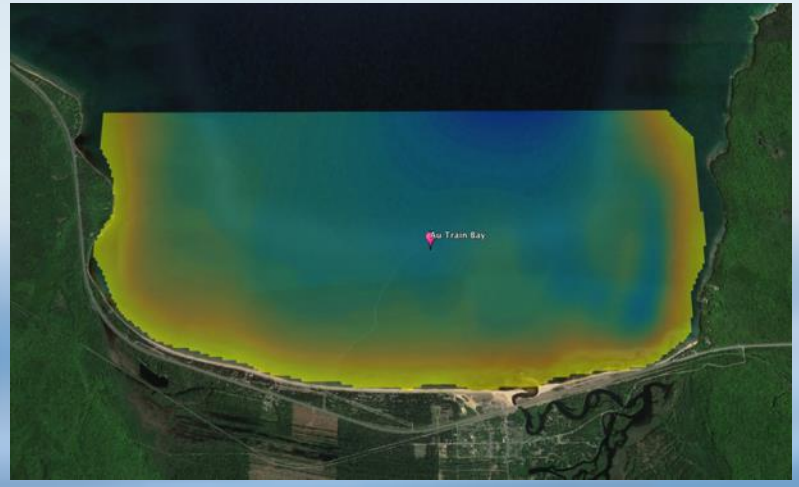
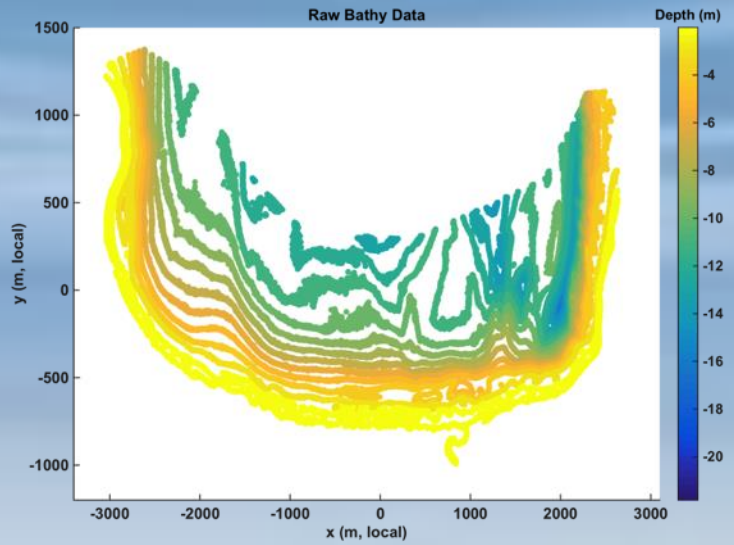
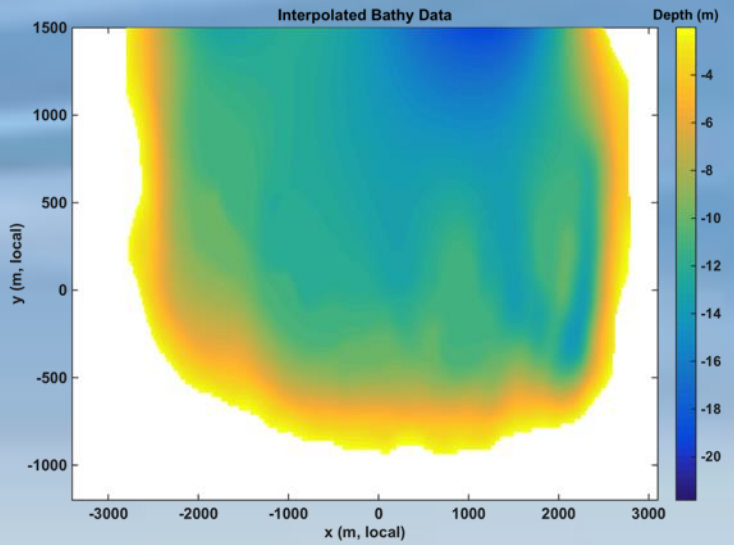
Bathymetry

- Bathymetry collected by MTU
- To link the coastal hydrodynamics with our data sources, we needed to extend the bathymetry out
  - Done mathematically using a least-energy extension to fill in missing spots
  - Also needed to interpolate data to a regular grid for model input







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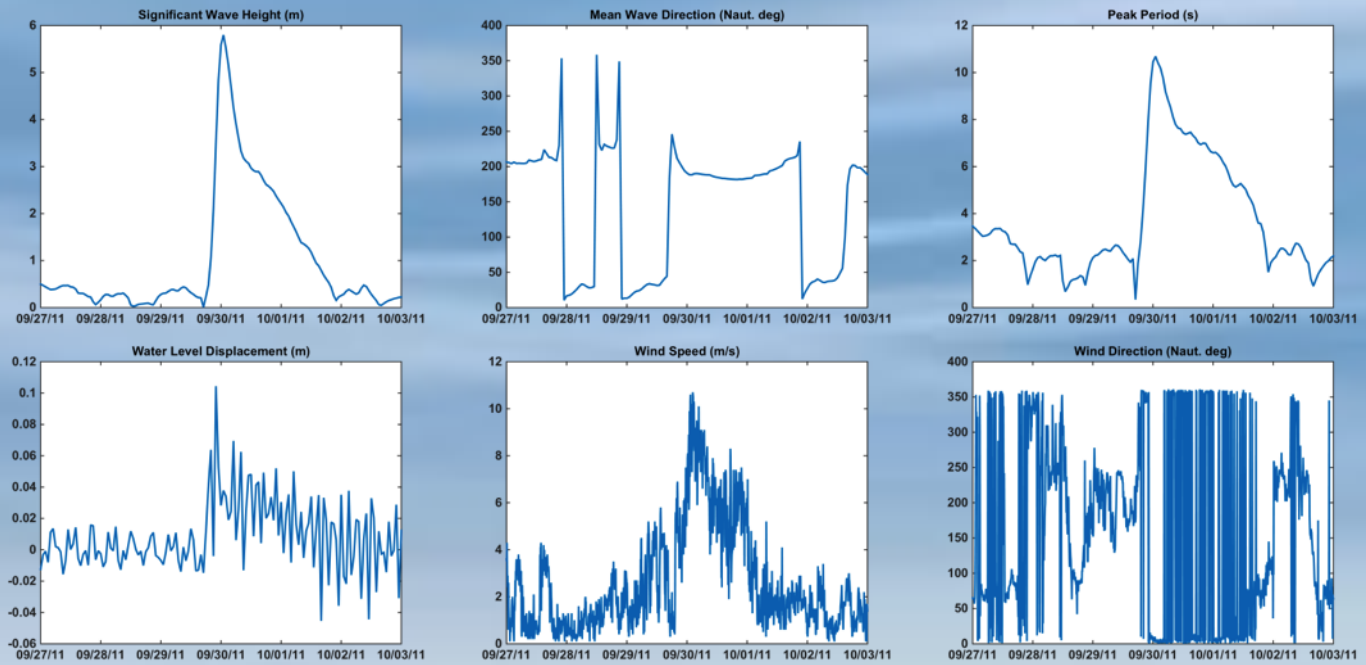
Input Data to Delft3D

- Period between 09/27/2011 – 10/03/2011 showed very extreme wave behavior, so we chose to test during this period (enhanced chance of seeing a rip current)
- Water level, wave direction, and wave height data was entered as boundary condition data along the northern boundary
- Wave direction data needed to be forced to be closer to perpendicular to the shore
  - Wave data taken from data point further out from shore where the directions can vary more than in the Bay



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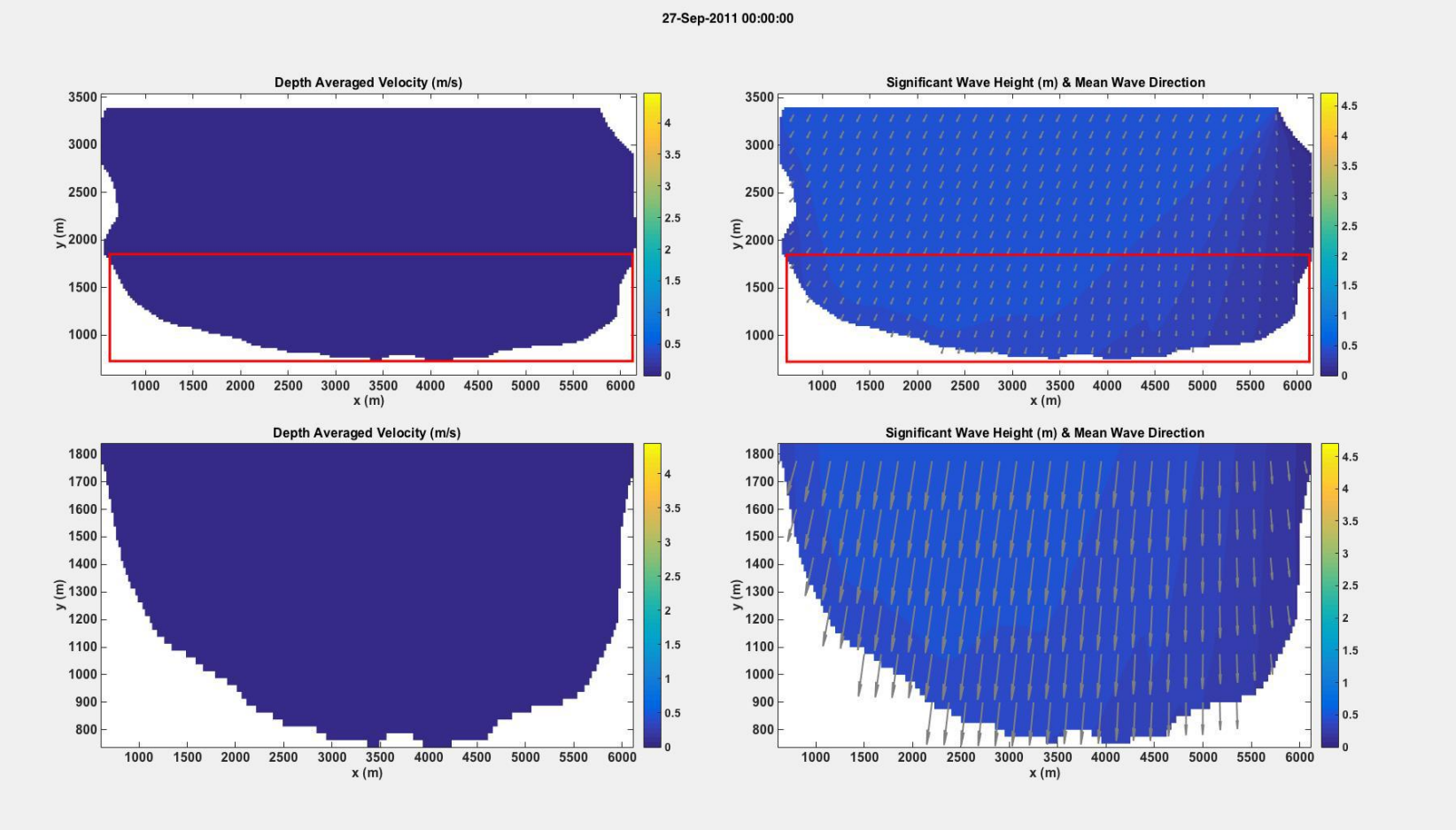
Output Results

- Left: Depth-averaged velocity (bottom = zoom into red box on top)
- Right: Significant wave height and mean wave direction



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Goals for AuTrain Township Meeting June 2015

- What are the critical coastal issues facing AuTrain and the Board ?
- What questions might we be able to answer ?
- Questions for the State of Michigan ?

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Michigan Coastal Zone Management Program

AuTrain Coastal Storms Program Project Support

Matt Warner
Coastal Hazards Specialist
Coastal Zone Management Program
Office of the Great Lakes

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Supporting AuTrain Efforts

- Committed to providing assistance to MTU
  - Assist with data collection, mapping
  - Provide DEQ GIS data resources (e.g. aerial imagery, GIS data layers)
- Share resources developed through beach safety efforts
- Provide historic recession information and other DEQ-specific data
- Support efforts to infuse science into local planning

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Beach Safety Resources

- CZM Strategy to improve beach safety from Dangerous Nearshore Currents (DNC)
- Improved understanding of DNCs
- Supported development of related resources (e.g. signs, outreach materials)

- More information and resources:

www.dangerouscurrents.org

www.CurrentSmart.org

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Imagery & Data Resources

http://superiorwatersheds.org/shorelineviewer2011/

SUPERIOR WATERSHED PARTNERSHIP AND LAND TRUST

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Historic Erosion Rates in AuTrain Township

- DEQ Erosion Studies have not calculated rates for AuTrain Township
- No existing designated High-Risk Erosion Areas in AuTrain Township
- DEQ coastal construction setback requirements not in effect

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Sand Dunes – AuTrain Township

- No designated Critical Dune Areas (CDA)
- State CDA regulations do not apply in AuTrain
- Any dune protection provisions would need to be locally implemented

Outcomes and Summary

- AuTrain community was grateful that NOAA, State of Michigan and Michigan Tech were interested in helping with coastal resiliency
- Recommendations are under development
- Will incorporate into Master Planning
- Dangerous Nearshore Current warnings and predictions (Delft3D) are underway

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Thank you

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