Regional Sediment Management & Nearshore Placement Techniques in Southern Lake Michigan

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ERDC
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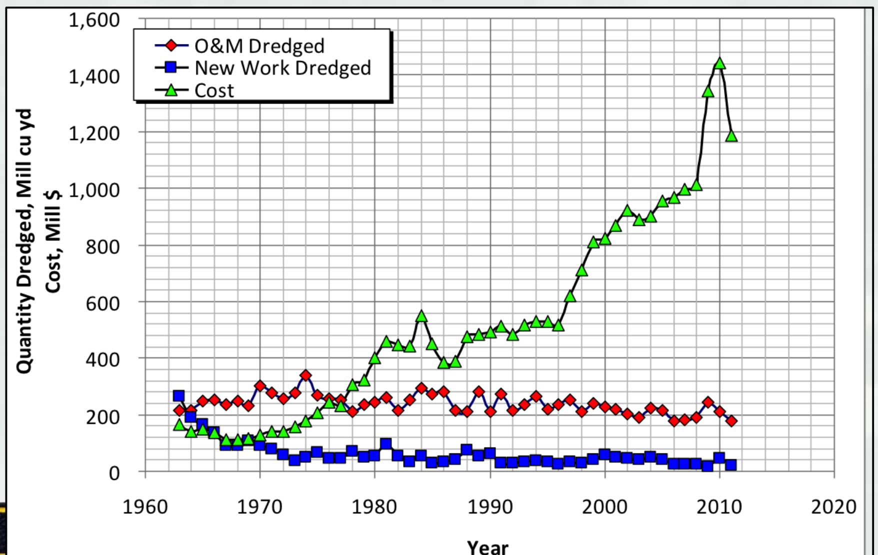
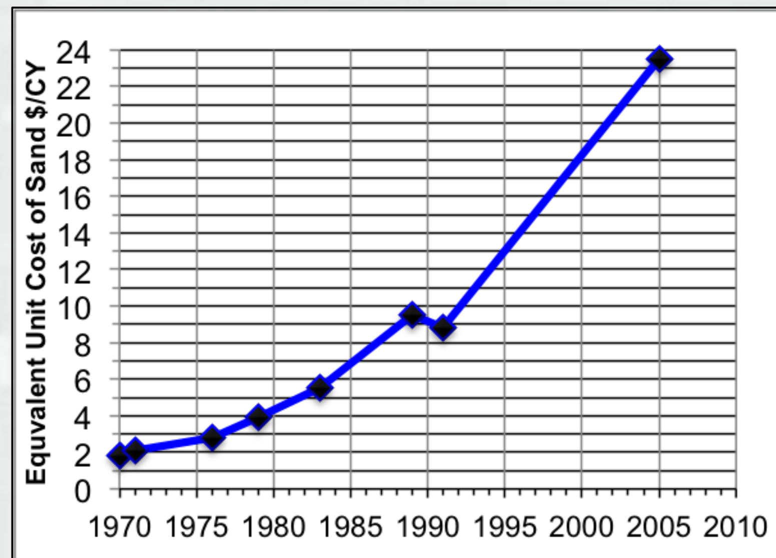
…..The Corps moves 200 Million cu yds of sediment annually

…At a cost of more than $1 Billion per year



US Navigation Channels

O&M & New Work Volumes and Cost



Broward Co Shore Protection Project

Cost of Sand

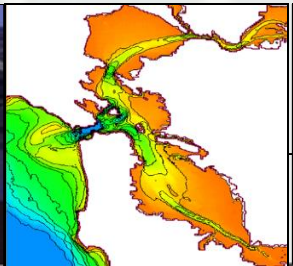
Regional Sediment Management…

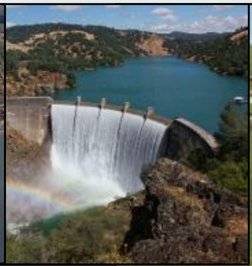
Est 1999, CERB Charge

…a systems approach using best management practices for more efficient and effective use of sediments in coastal, estuarine, and inland environments = Healthy Systems

- Navigation, Flood Risk Mgmt, Ecosystem, Emergency Mgmt:
  - Short/long-term economically viable & environmentally sustainable solutions
- Recognizes sediment as a valuable resource (local and regional)
- Link and leverage across multiple projects, authorities, business lines
- Improve operational efficiencies & natural exchange of sediments
- Consider regional implications of local actions - Adaptive Management
- Enhance & share tools, technologies, lessons learned for RSM approaches
- Improved relationships through collaboration and decision making






RSM Goals and Strategies

Reduce Upland/CDF Disposal

Bypass Backpass Sediments

Reduce Erosion

Save Capacity

- Keep sediments in the system
- Mimic natural sediment processes
- Reduce unwanted sedimentation
- Environmental enhancement
- Maintain & protect infrastructure

Stabilize Structures

Reduce Channel Shoaling

Reduce Runoff

Ecosystem Habitat Restoration

RSM Program Funding Process

- Annual Request for Proposals: *Submittals Due* *****22 June 2018*****
- Submittals THROUGH:
  - ► District RSM POC
  - ► District Navigation BL Leader
  - ► MSC RSM POC and MSC Navigation BL Leader
- Submittals TO:
  - ► HQ, Navigation Business Line Manager
  - ► ERDC Nat'l RSM Program Manager
- Review Team: Districts (Coastal/Inland OP, PD, EN); HQ CWG/Inland Leads
- Recommend Program/Budget: ERDC RSM PM/Deputy PM & TD Nav
- Approval: HQ Navigation Business Line Manager
- Required from all initiatives
  - ► Quarterly Progress Reports, Fact Sheets, Present RSM IPR& Workshop
  - ► Lessons Learned: RSM TN/TRs, Newsletters

LRD and RSM FY18

- LRB – Lake Erie Sediment Budget
- LRB – Lake Ontario Sediment Budget
  - Update of Baird 2011
- LRC – SfM Study of Nearshore Placement (on hold due to dredge schedule for Waukegan Harbor)
- LRE/CHL – Sediment Source to Sink Lag Time
  - Determine source of shoaling and time it takes from erosion to deposition
- LRD (LRC) – GLTM Program Outreach
- CHL – Regional Sediment Budget Work flows, Tools, and Web App
  - Standard database schema for sediment budgets with LRD effort

LRD Sediment Budget Effort

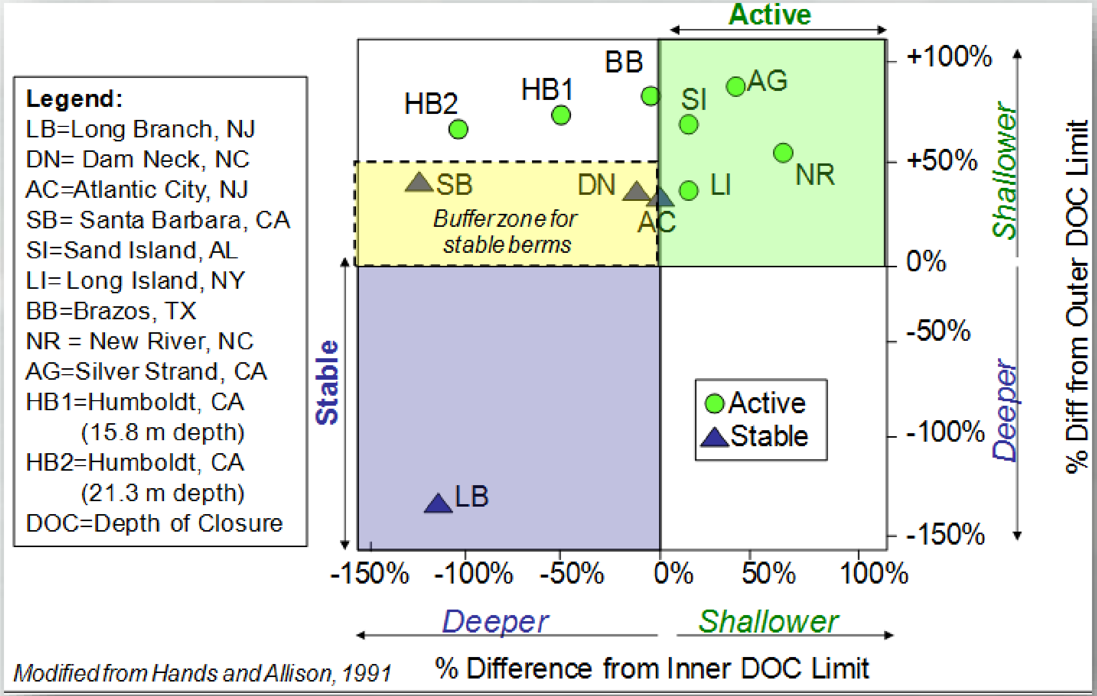
- Develop a seamless sediment budget for GL
- Consolidate existing sediment budget work for future work
- Create central repository for GL sediment budgets
  - Used to track and easily added to
- Currently developing conceptual sediment budget for GL
- Working with stakeholders to quire existing sediment budgets and data
- Funded by GLRI and RSM
- SBAS Workshop in LRE February 2018
  - DOTS and RSM

Nearshore Placement

- Dredged material placement in the nearshore in a manner and at locations that permits natural forces to disperse the dredged material toward other locations where it can deliver benefits
  - Maximize benefits
  - Minimize rehandling
  - Minimize negative environmental impacts
  - Reduced cost (vs. direct placement)
  - Increase beneficial use applications
- Typically consist of dredged sediment from navigation projects that is incompatible with natural beach sediment

Nearshore Placement

- Sediment placed in the nearshore in either an elongate (bar-like) feature or a mound
  - Stable berms- remain stationary for years
  - Active/Feeder berms- sediment dispersed by waves and currents



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Nearshore Placement

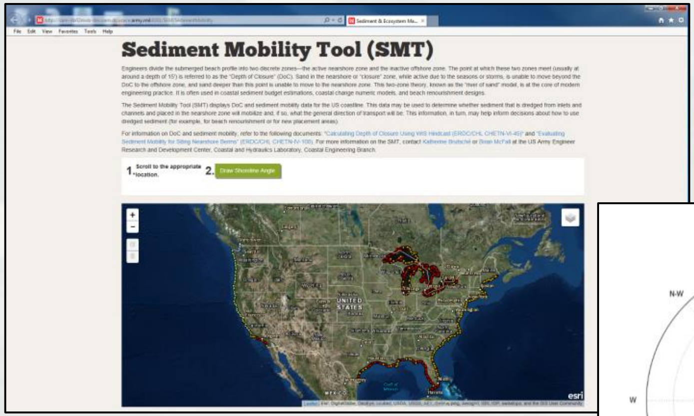
- Nearshore placement is becoming an increasingly utilized method for beneficial use of dredged material
  - Less costly than beach nourishment, fewer restrictions, fewer environmental concerns
- Important to have a better understanding of what happens once the sediment is placed
- Update to current design guidance to answer key regulatory questions
- Need to quantify benefits of nearshore placement

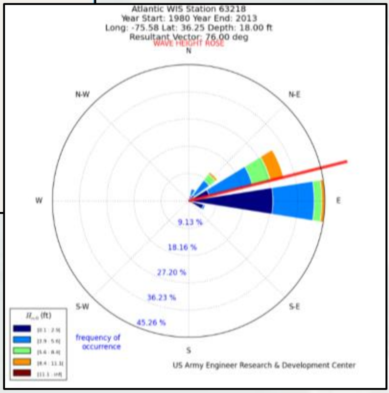
Important Questions

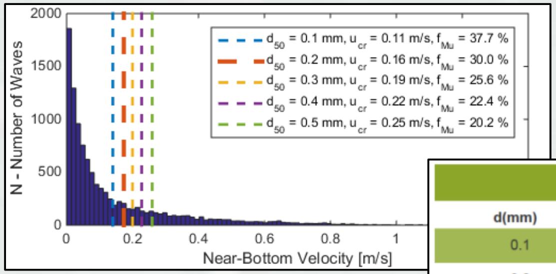
- Will sediment move once it is placed in the nearshore?
- Where will the sediment move?
- How much sediment will move?
- How long will it take for the sediment to move?

Sediment Mobility Tool

- Sediment Mobility Tool (SMT) is a web tool that predicts:
  - Frequency of sediment mobilization at nearshore placement sites
  - Cross-shore sediment migration direction
  - Axis of wave dominated sediment transport
- WIS data are downloaded from server in real-time to calculate SMT predictions







WIS Station 63218, 155° Shoreline Angle, Nearshore Placement Depth: 18 ft

d(mm)	Predicted Sediment Migration
0.1	53% offshore
0.2	95% onshore
0.3	100% onshore
0.4	100% onshore
0.5	100% onshore

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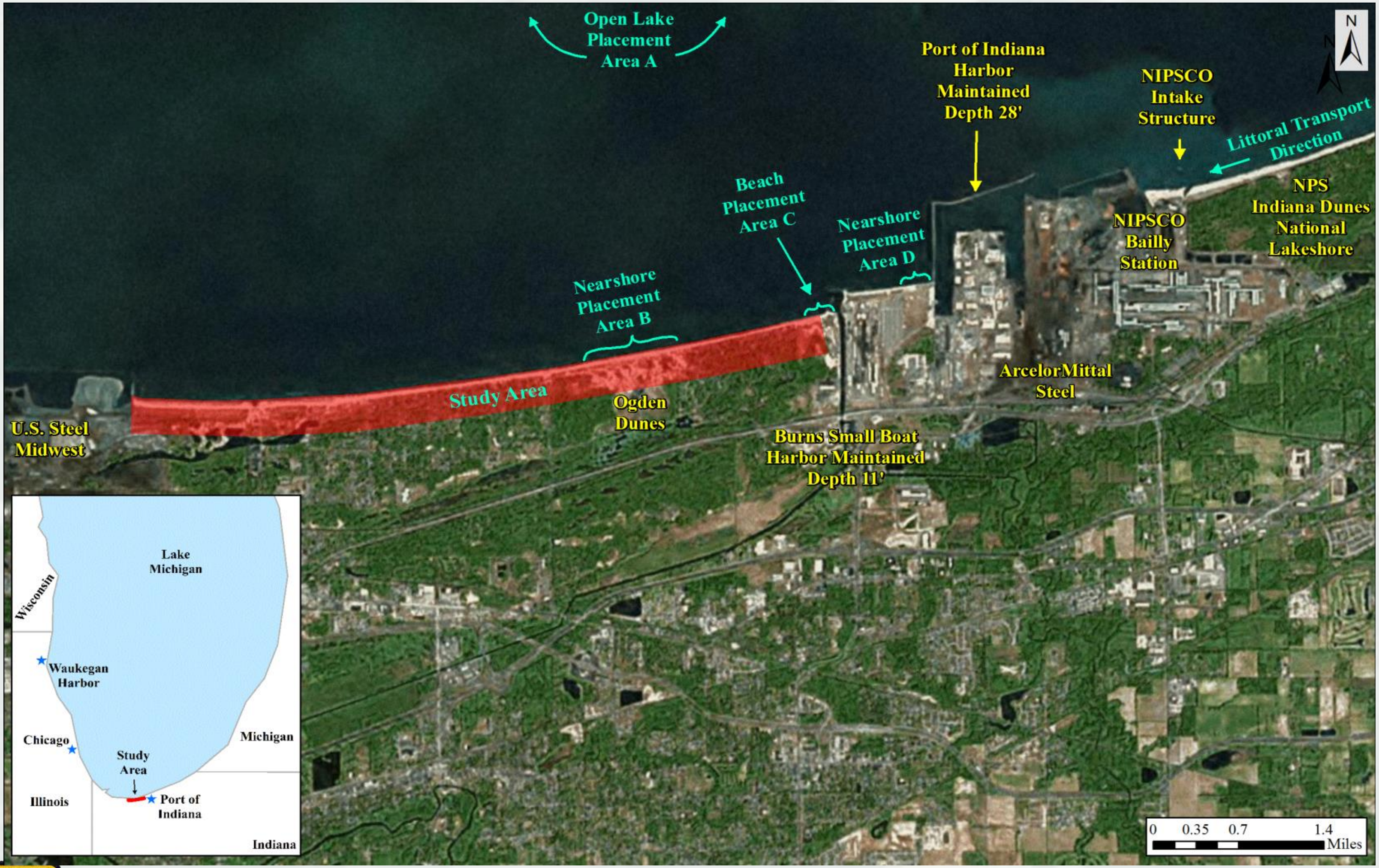
Southern Lake Michigan

- USACE Chicago District routinely places sediment dredged from Burns Waterway Harbor and placed in the nearshore of Ogden Dunes, Indiana
  - Nearshore placement is least cost alternative over direct placement
- Area is critically eroding despite nearshore placement
- Determine effectiveness of nearshore placement

Study Area

- Approximately 6 miles of coastline in Southern Lake Michigan
- Bounded on the east by Burns Small Boat Harbor jetty
- Bounded on the west by eastern bulkhead of U.S. Steel landfill
- Net transport from east to west
- Harbor and Northern Indiana Public Service Company (NIPSCO) water intake dredged frequently

Study Area



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Research Tasks

- Determine effects of existing placement practices
  - Historical shoreline change analysis
- Develop innovative strategies for placing material in the nearshore more effectively
  - Run SMT
- Develop a monitoring plan
- Use strategies and monitoring plan to optimize placement in 2016
- Collect and analyze field data
- Numerical modeling effort

Historical Shoreline Analysis

- Aerial imagery prior to 1998 was digitized and georeferenced using UTM Zone 16
- Due to water level fluctuations in the lake, the date of the imagery was used in conjunction with NOAA Tides and Currents database
- Net shoreline change was determined between each successive photo
- Digital Shoreline Analysis Tool (DSAS) was used to determine net shoreline change statistics
  - Transects were created every 50 m using DSAS
- Compare shoreline analysis to dredging record

Data Acquisition

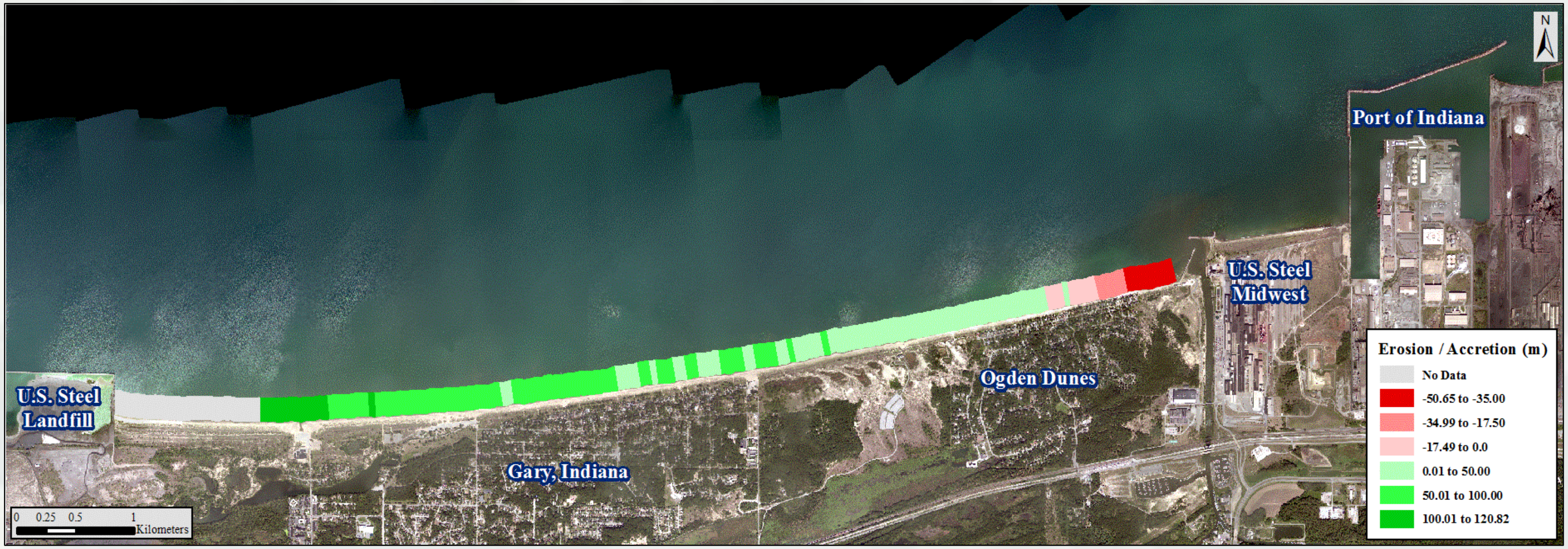
- Aerial imagery from 1969-2014
- Dredging and placement records from both Burns Waterway Harbor and NIPSCO water intake 1996-2015

Project	Year	Quantity m^3	Quantity yd^3	Placement Location
Port of Indiana Harbor	1996	203,000	266,000	Open lake placement - Area A
	2007	174,000	228,000	Open lake placement - Area A
	2008	42,000	55,000	Open lake placement - Area A
	2013	54,000	70,000	Nearshore placement – Area D
	2014	50,000	65,000	Nearshore placement – Area B
	2014	54,000	70,000	Nearshore placement – Area B
	2015	42,000	55,000	Nearshore placement – Area B
	2016	57,000	75,000	Nearshore placement – Area B
Burns Small Boat Harbor	1985	46,000	59,000	Beach placement - Area C
	1986	51,000	67,000	Beach placement - Area C
	2000	109,000	143,000	Beach placement - Area C
	2009	61,000	80,000	Nearshore placement – Area B
NIPSCO Intake (NIPSCO Dredged)	1980	210,000	275,000	Unspecified open lake placement
	1982	167,000	218,000	Shoreline at BGS
	1986	245,000	320,000	Nearshore placement – Area B *
	1989	220,000	288,000	Nearshore placement – Area B *
	1992	160,000	209,000	Nearshore placement – Area B *
	1995	90,000	118,000	Nearshore placement – Area B *
	1997	112,000	146,000	Nearshore placement – Area B *
	1999	126,000	165,000	Nearshore placement – Area B *
	2016	50,000	65,000	Nearshore placement – Area B
NIPSCO Intake (USACE Dredged)	2006	23,000	30,000	Nearshore placement – Area B
	2007	174,000	228,000	Nearshore placement – Area B
	2008	80,000	105,000	Nearshore placement – Area B
	2009	84,000	110,000	Nearshore placement – Area B

* NIPSCO 1986 to 1999 dredges placed 75% of the material nearshore at Ogden Dunes and 25% nearshore at Beverly Shores.

Overall Shoreline Change

1969-2014



Date Range	Range Low (m)	Range High (m)	Range Average (m)
1969 to 1973	-29.79	12.73	-2.57
1973 to 1998	-66.55	78.98	10.88
1998 to 2005	17.65	75.89	42.34
2005 to 2010	-14.28	32.90	6.83
2010 to 2012	-14.74	16.68	2.09
2012 to 2014	-21.67	14.22	-0.92
1969 to 2014	-50.65	120.82	45.37

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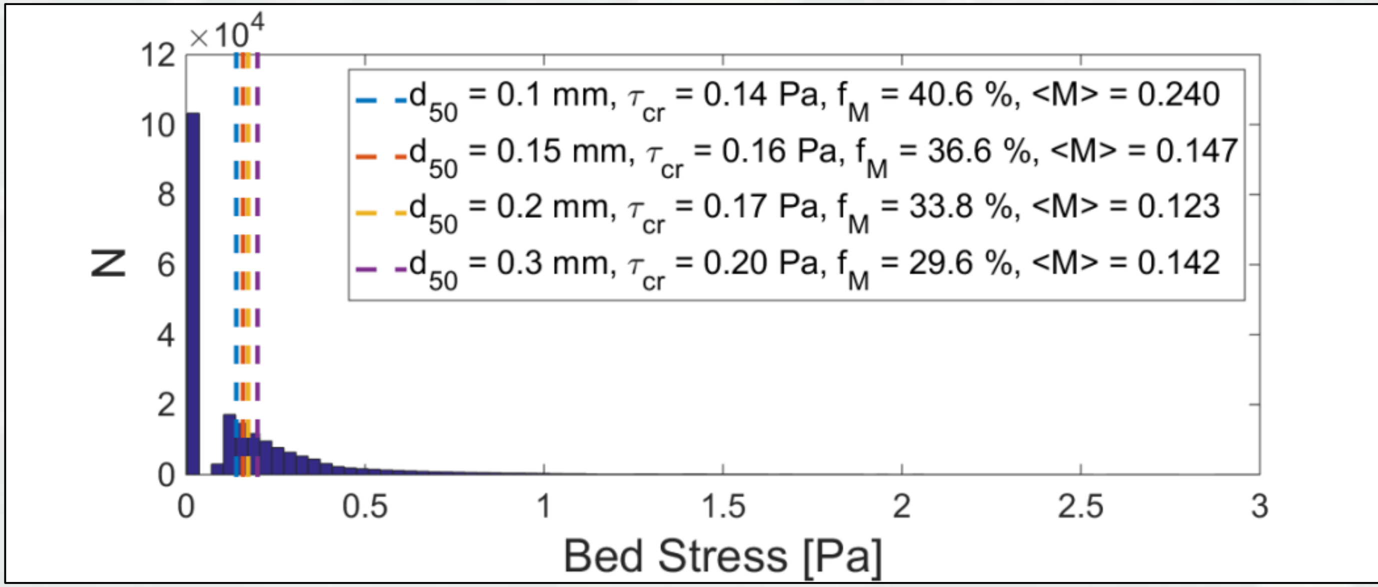
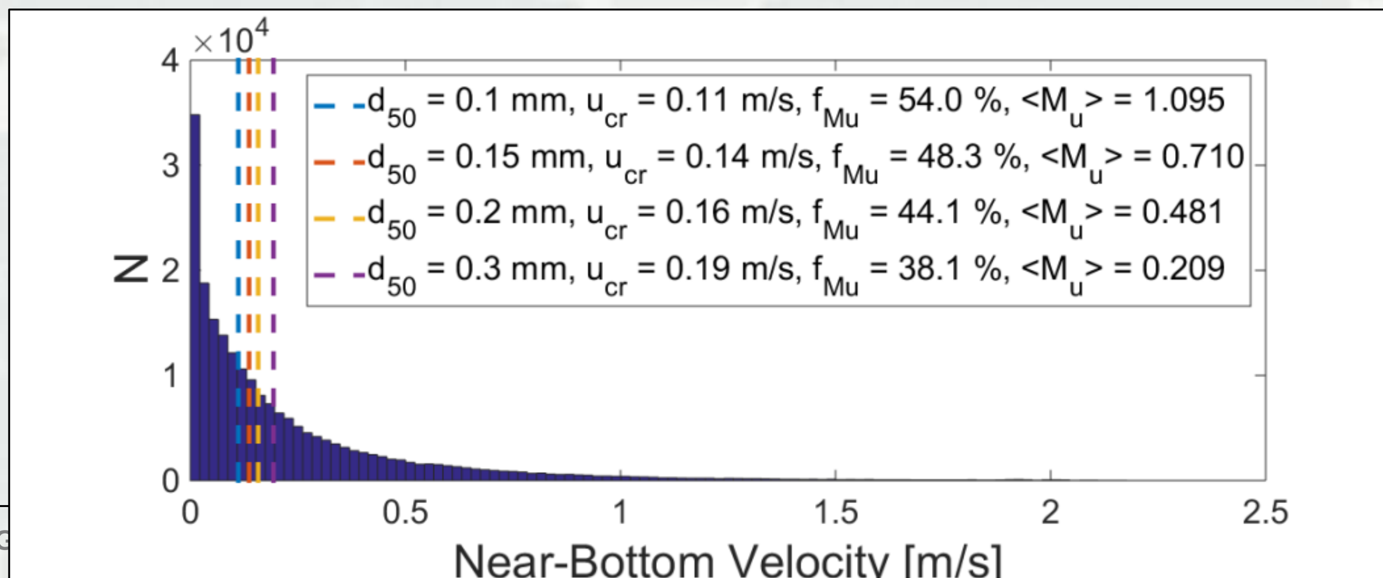
Sediment Mobility Tool

- WIS waves used from 1976 to 2014
- 18 ft placement depth
- 0.15 mm grain size

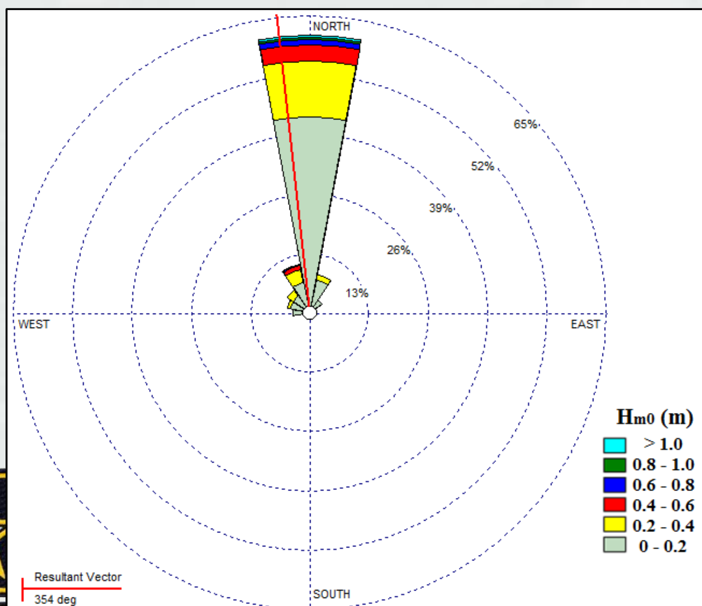




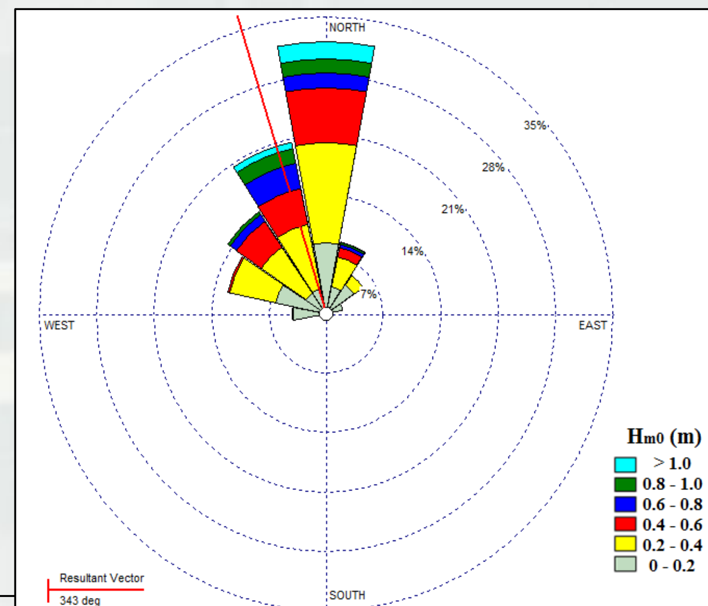
Sediment Mobility Tool

d$_{50}$ (mm)	Typical Waves		Storm Events	
	Frequency of Mobilization	Sediment Migration	Frequency of Mobilization	Sediment Migration
0.1	41% - 54%	68% Onshore	79% - 87%	51% Offshore
0.15	37% - 48%	91% Onshore	76% - 84%	72% Offshore
0.2	34% - 44%	97% Onshore	73% - 81%	85% Onshore
0.3	30% - 38%	99% Onshore	68% - 76%	96% Onshore

Typical Waves



Storm Waves



Shoreline Analysis and Nearshore Placement Techniques

- Overall, accretion along the shoreline due to nearshore placement of sediment is seen
- Exception is immediately adjacent to harbor, likely due to breakwaters
- SMT predicts sediment will move onshore, except during storm events
- Recommendation: place material as shallow as possible in berm like feature

Publications

ERDC/TN RSM-18-6
April 2018

Physical Monitoring Methods for the Nearshore Placement of Dredged Sediment

by Zachary J. Tyler, Brian C. McFall, Katherine E. Brutsché, Erin C. Maloney, and David F. Bucaro

PURPOSE: This Regional Sediment Management Technical Note (RSM-TN) provides an introduction to equipment and methods for monitoring the nearshore placement of dredged sediment. Topical information regarding instrumentation, physical monitoring techniques, and field operations planning is included and closes with an example monitoring plan from Ogden Dunes, IN. This overview is intended for U.S Army Corps of Engineers (USACE) District Project Managers, Planners, and Engineers tasked with developing a plan to monitor the evolution of a nearshore placement and its impact to adjacent beaches.

BACKGROUND: The placement of dredged sediment in the nearshore zone is a common method used in regional sediment management (RSM) due to its potential benefits including the addition of material to the littoral system, enhancement of the beach profile, and reduction of wave energy on the beach. The term *nearshore placement* refers to the practice of placing material sub-aqueously in the nearshore zone regardless of shape of the designed feature. Nearshore placements are often referred to as nearshore berms when constructed to be a specific shape, typically a bar or mound. The USACE generally does not require physical monitoring of nearshore placements, but local, state, or regulatory entities may require placement areas be monitored in order to quantify benefits or any potential negative impacts (Beck et al. 2012). These effects may include fine-grained sedimentation of beaches as well as sediment transport into navigational channels or environmentally sensitive areas. The quantification of benefits, effects, and behavior of nearshore placement projects is important in optimizing their use as an RSM strategy.

MEASUREMENT INSTRUMENTATION AND TECHNIQUES: The important measurement parameters in nearshore placement monitoring fall into three categories. The first category includes spatiotemporal geomorphic parameters such as location, depth, dimensions, and placement volume and their changes over time. These parameters are often measured using bathymetric and topographic surveying or remote sensing approaches. The second category includes geophysical sediment and fluid parameters such as grain size, porosity, relative density of the native and placed sediments, turbidity, and sediment transport rate. These parameters are quantified using sediment and water sampling in conjunction with in situ measurements. The third category is focused on measuring hydrodynamic parameters such as wave height, wave period, wave direction (for offshore and nearshore waves), water level (including tide, wind, and wave-driven components), flow velocity, and flow direction. Hydrodynamic parameters are generally measured using in situ instruments mounted on the seafloor or in the water column and more recently can also be measured using remotely sensed data.

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Regional Sediment Management: Integrated Solutions for Sediment Related Challenges

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ERDC/CHL TR-18-3

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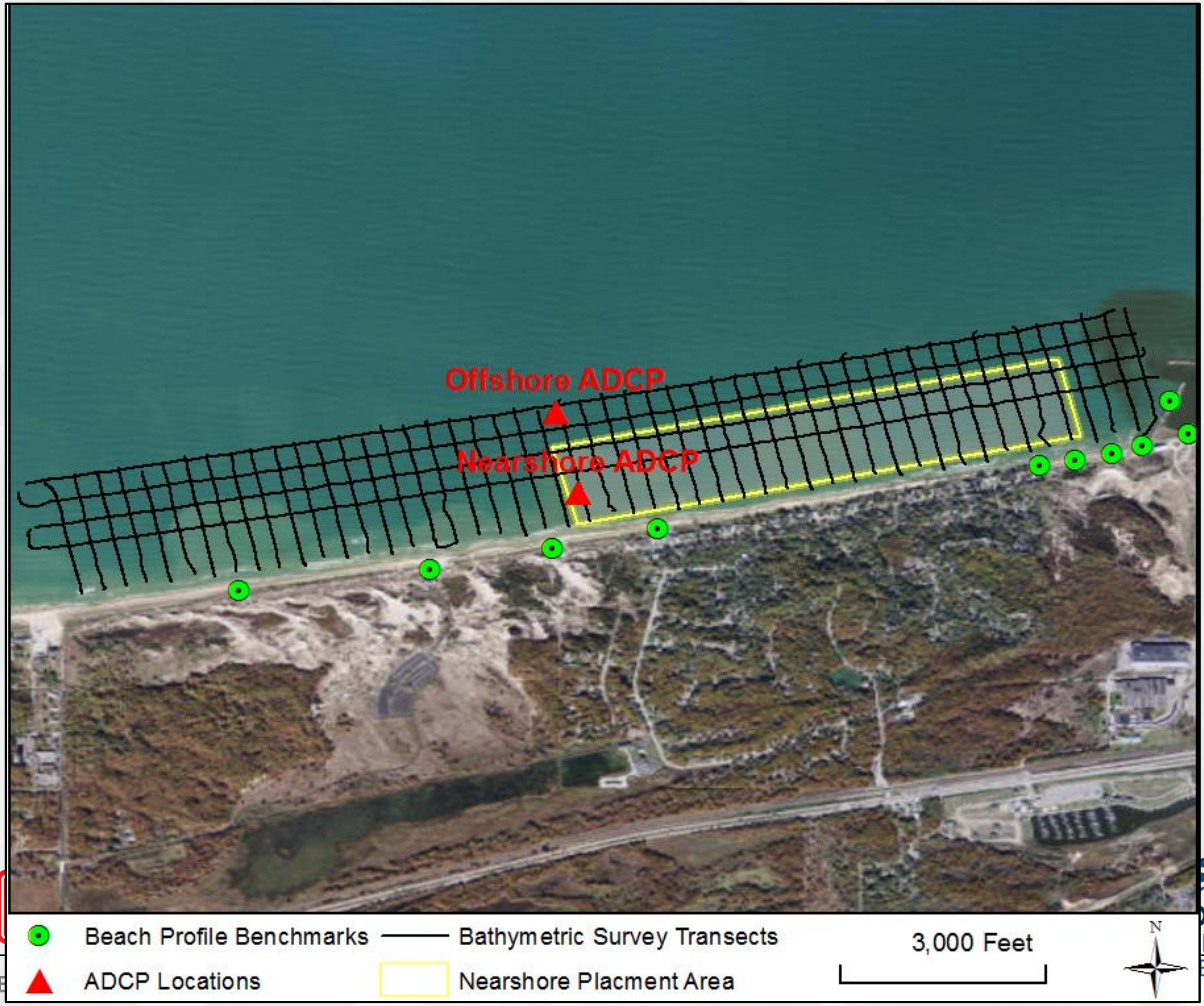
Regional Sediment Management (RSM) Program

Nearshore Placement Techniques in Southern Lake Michigan

David E. Arnold, Brian C. McFall, Katherine E. Brutsché, Erin C. Maloney, and David F. Bucaro

March 2018

Monitoring Plan



Monitoring Plan

Timeline of data collection

JUNE
June 2: 1st **ADCP** Survey
June 15: Start dredging

JULY
July 15: End dredge placement
July 20: 2nd **ADCP** Survey
July 25: 1st **MBES** Survey

AUGUST - NOVEMBER
Aug 9: Beach Survey
Sept 8: 3rd **ADCP** Survey, 2nd **MBES** Survey**
Oct 11-12: 4th **ADCP** + Beach Survey
Nov 15: 5th **ADCP** Survey

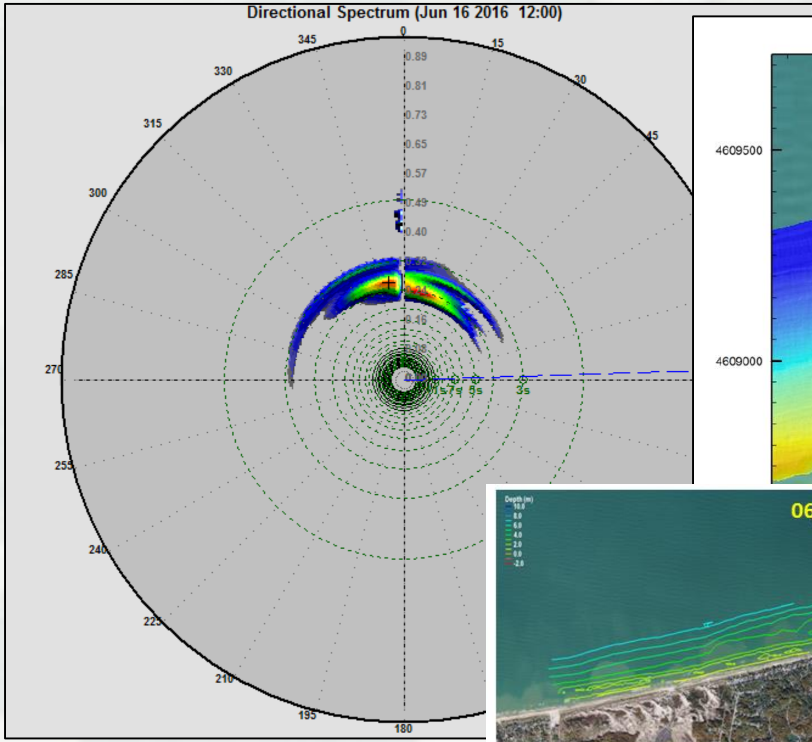
****NIPSCO dredge placement observed**

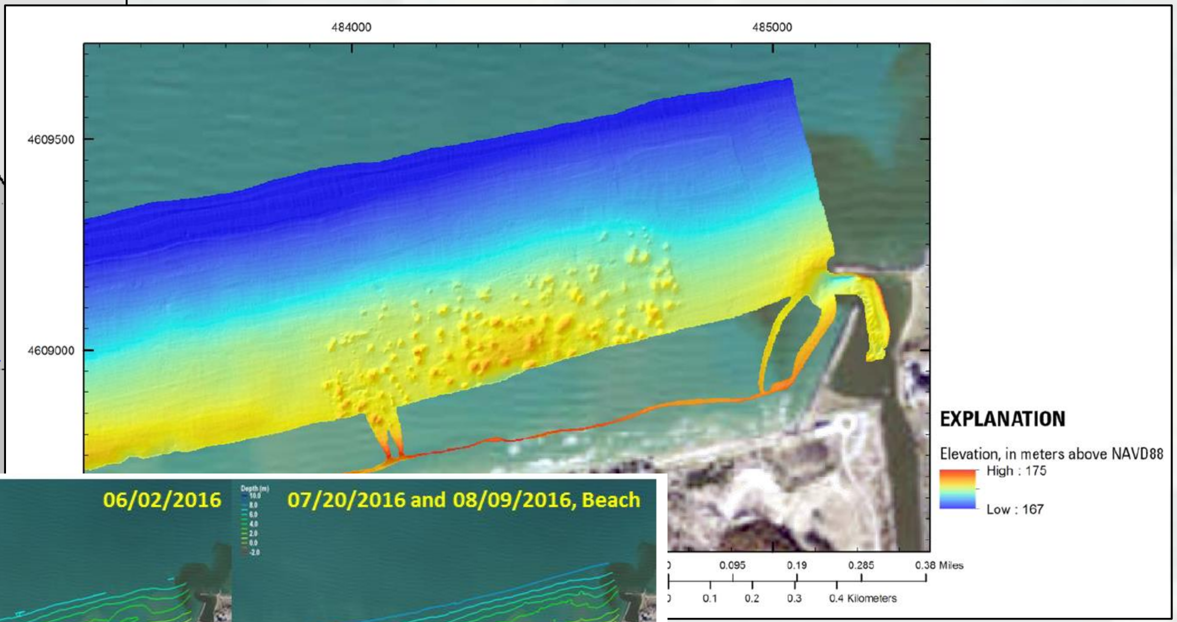
Wave/Current Data: 06/02 – 10/28
2 Uplooking ADCPs measuring waves/currents…only the one in shallower water was recovered

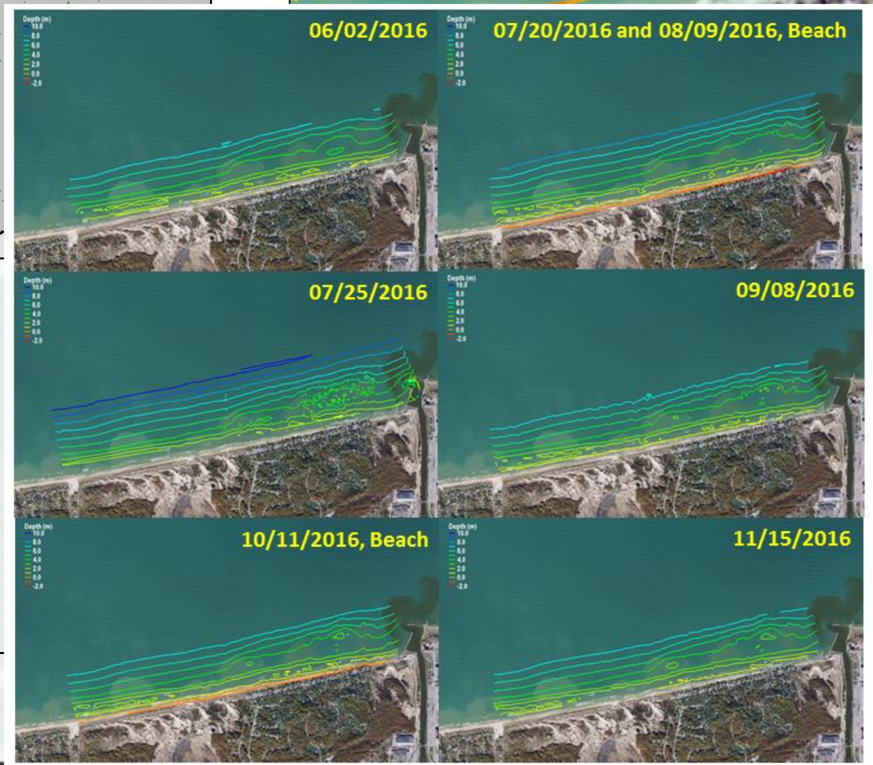

RTK-dGPS beach survey


NIPSCO dredge placement

Initial Data







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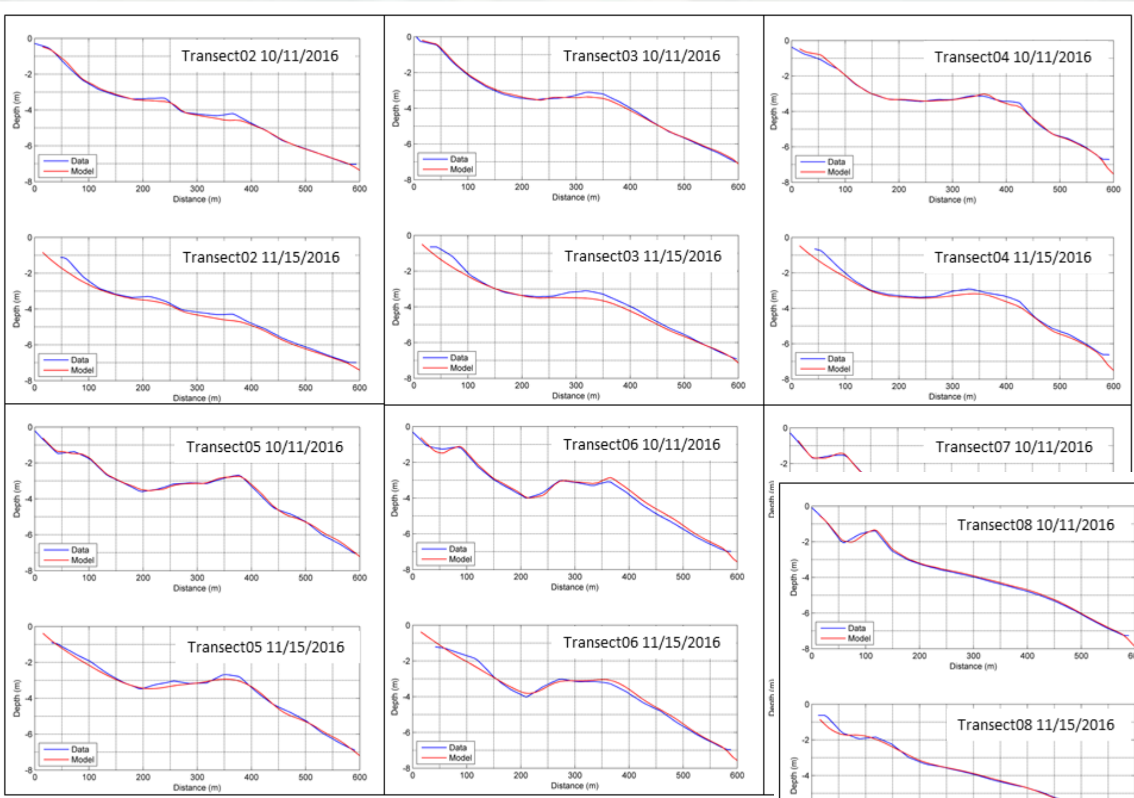

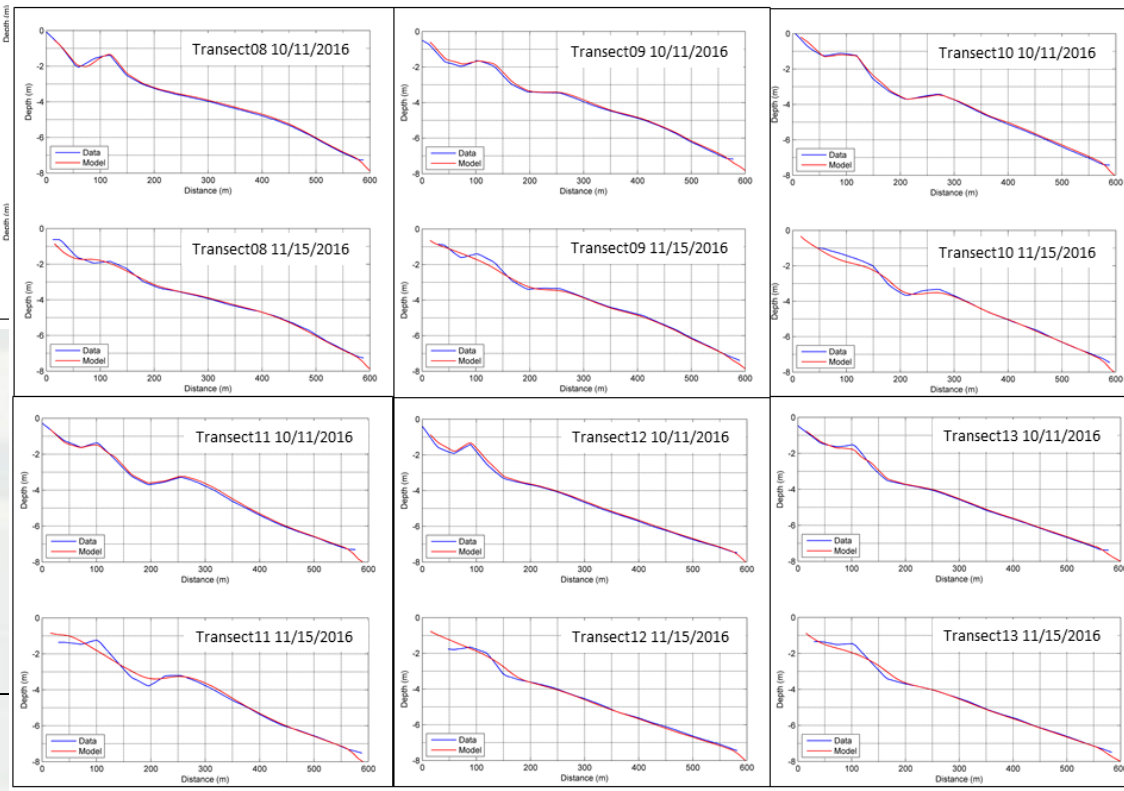

Ongoing Research

- Continued processing of data
- Numerical modeling
  - ▸ CMS Wave and Flow
  - ▸ Particle Tracking Model
- Beach profile changes to calculate shoreline and volume changes
- Calculate wave dissipation across the berm

Questions?