Automated Feature Extraction for Sediment Budgets

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US Army Corps of Engineers
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Outline

Joint Airborne Lidar Bathymetry Technical Center of Expertise

- ✓ New developments

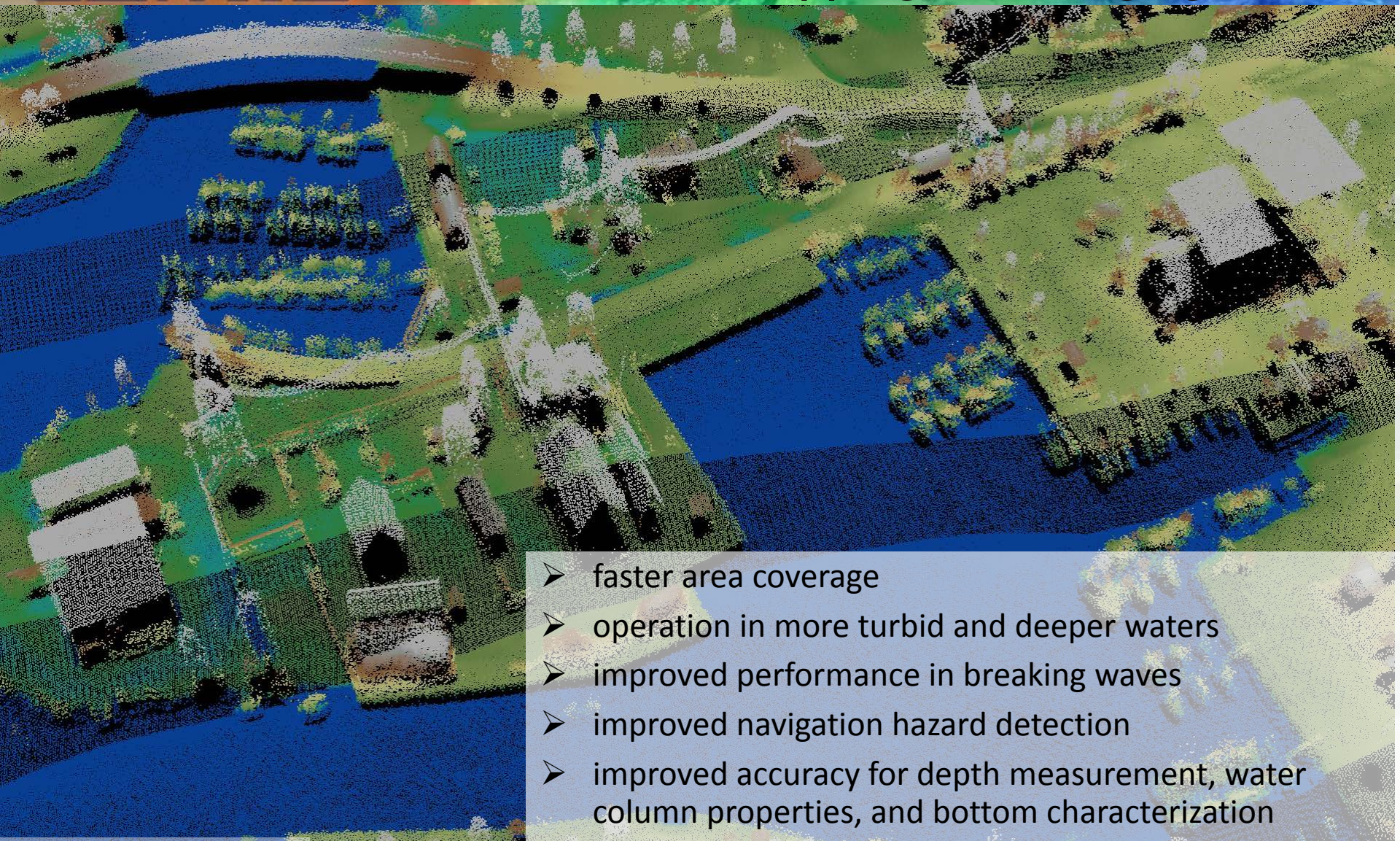
National Coastal Mapping Program

- ✓ Surveys
- ✓ Products

Sediment Budget

- ✓ Migration of features
- ✓ Compute pathways and fluxes
- ✓ New method

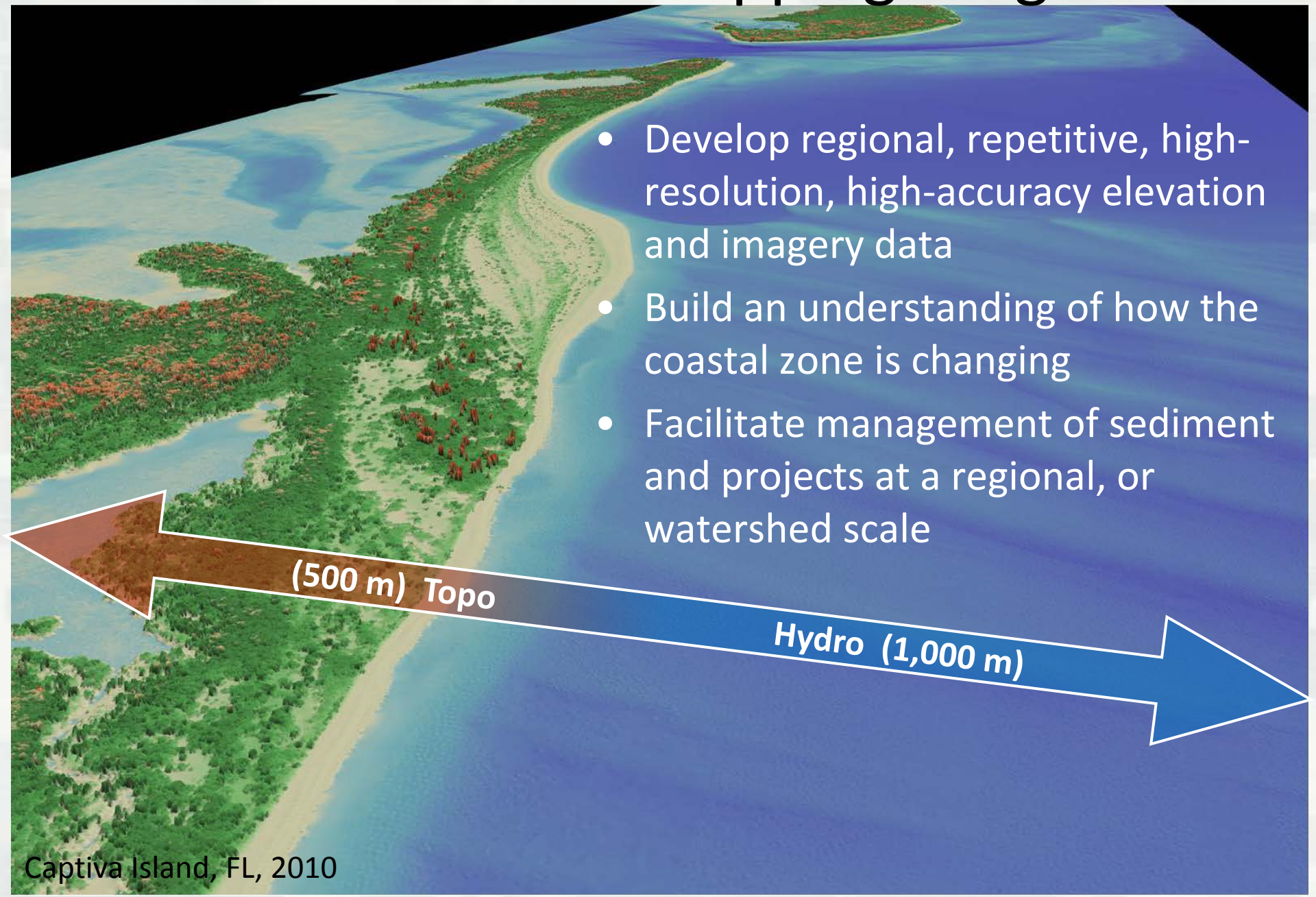
Coastal Zone Mapping and Imaging Lidar



- faster area coverage
- operation in more turbid and deeper waters
- improved performance in breaking waves
- improved navigation hazard detection
- improved accuracy for depth measurement, water column properties, and bottom characterization
- higher-density topographic and shallow bathymetric measurements

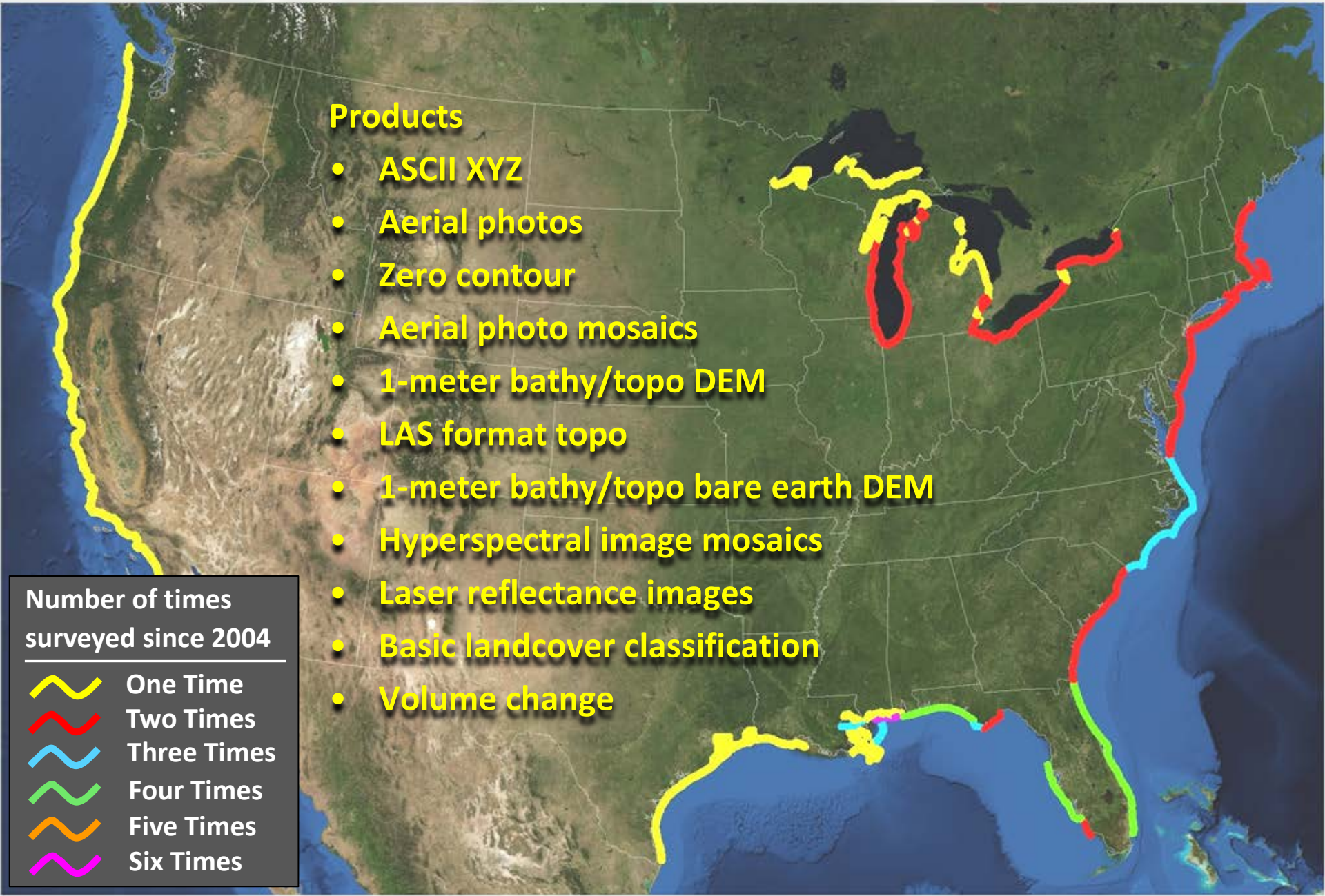
Sturgeon Bay, WI
Point Cloud

National Coastal Mapping Program

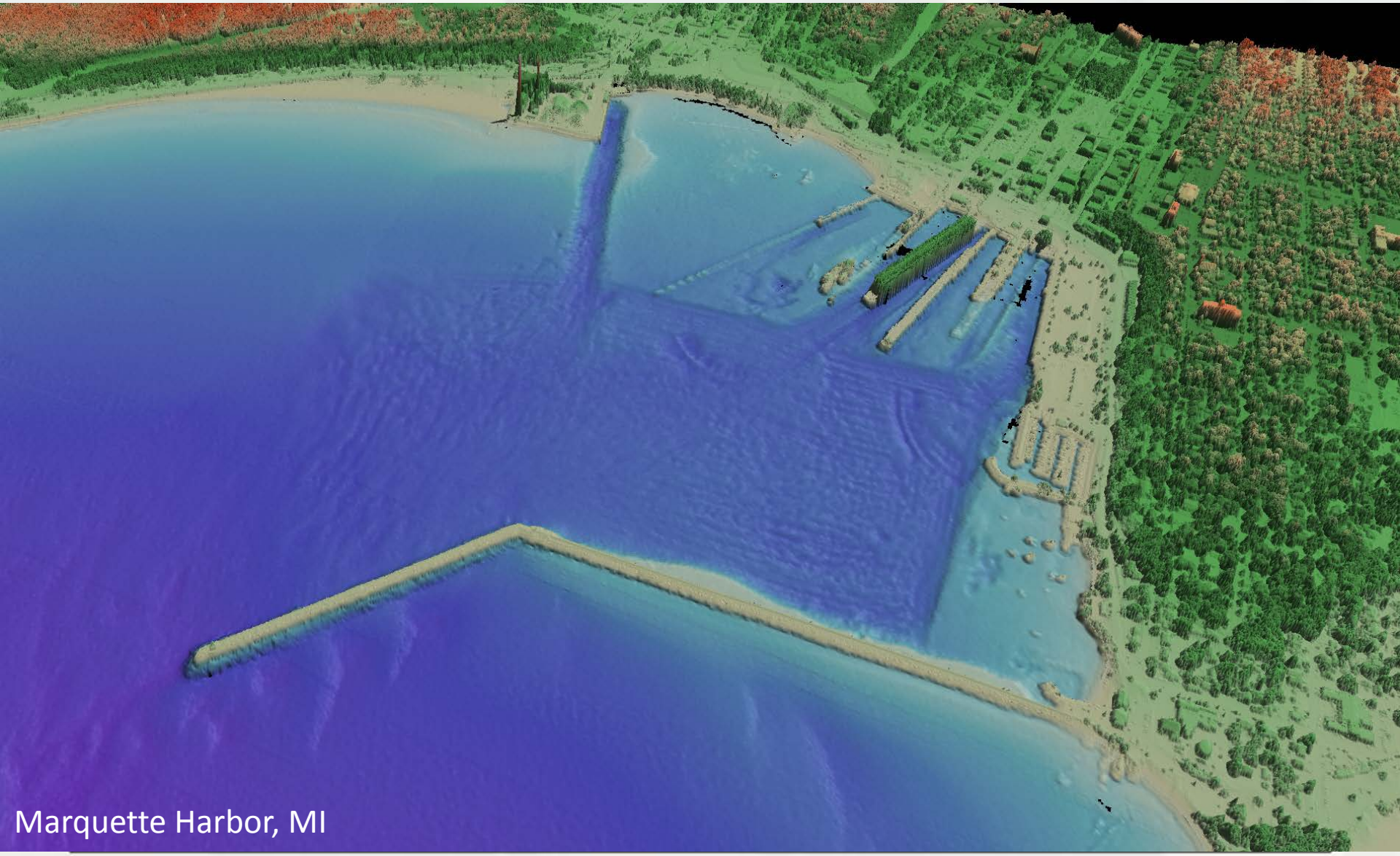


- Develop regional, repetitive, high-resolution, high-accuracy elevation and imagery data
- Build an understanding of how the coastal zone is changing
- Facilitate management of sediment and projects at a regional, or watershed scale

National Coastal Mapping Progress



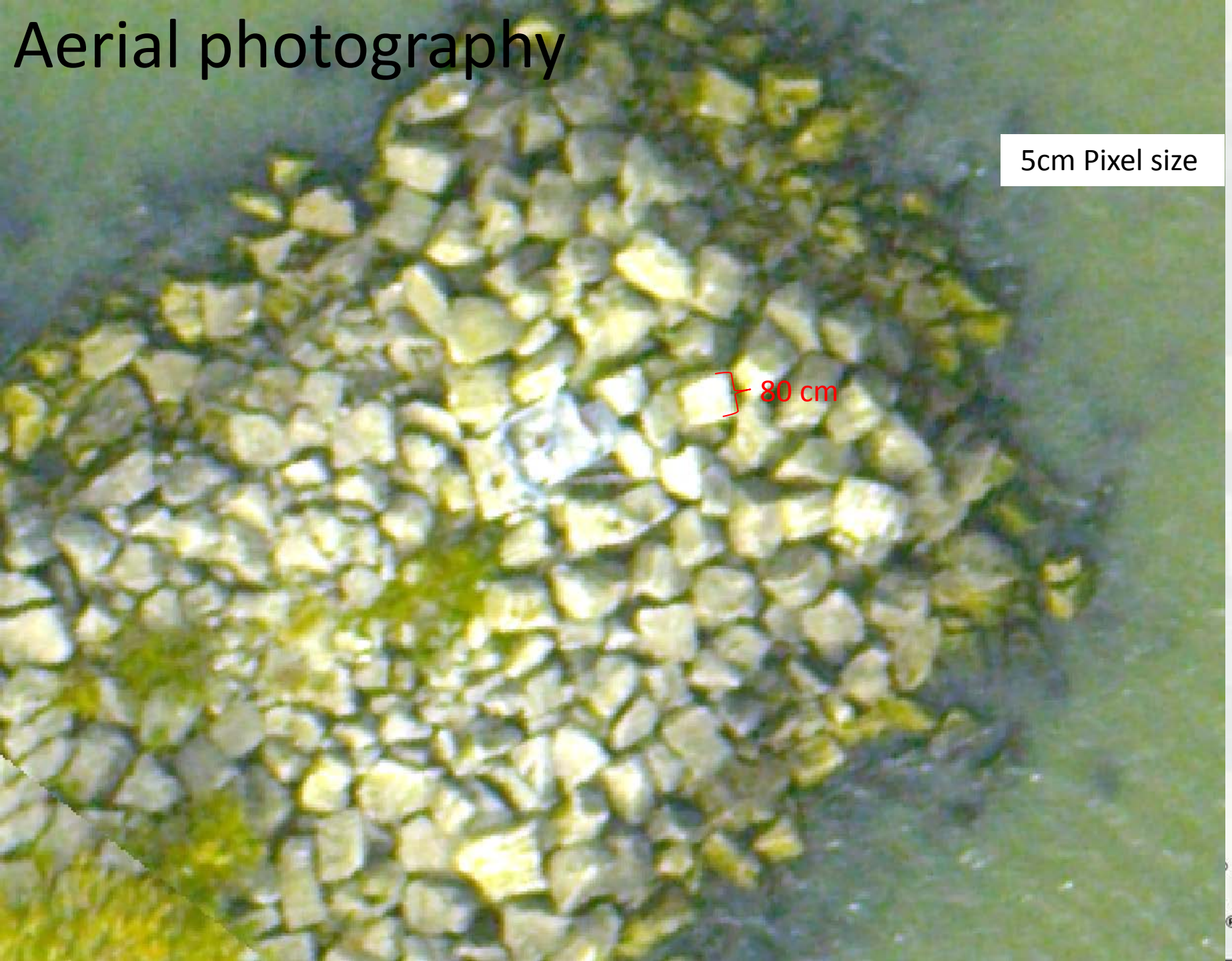
Bathymetry and Topography



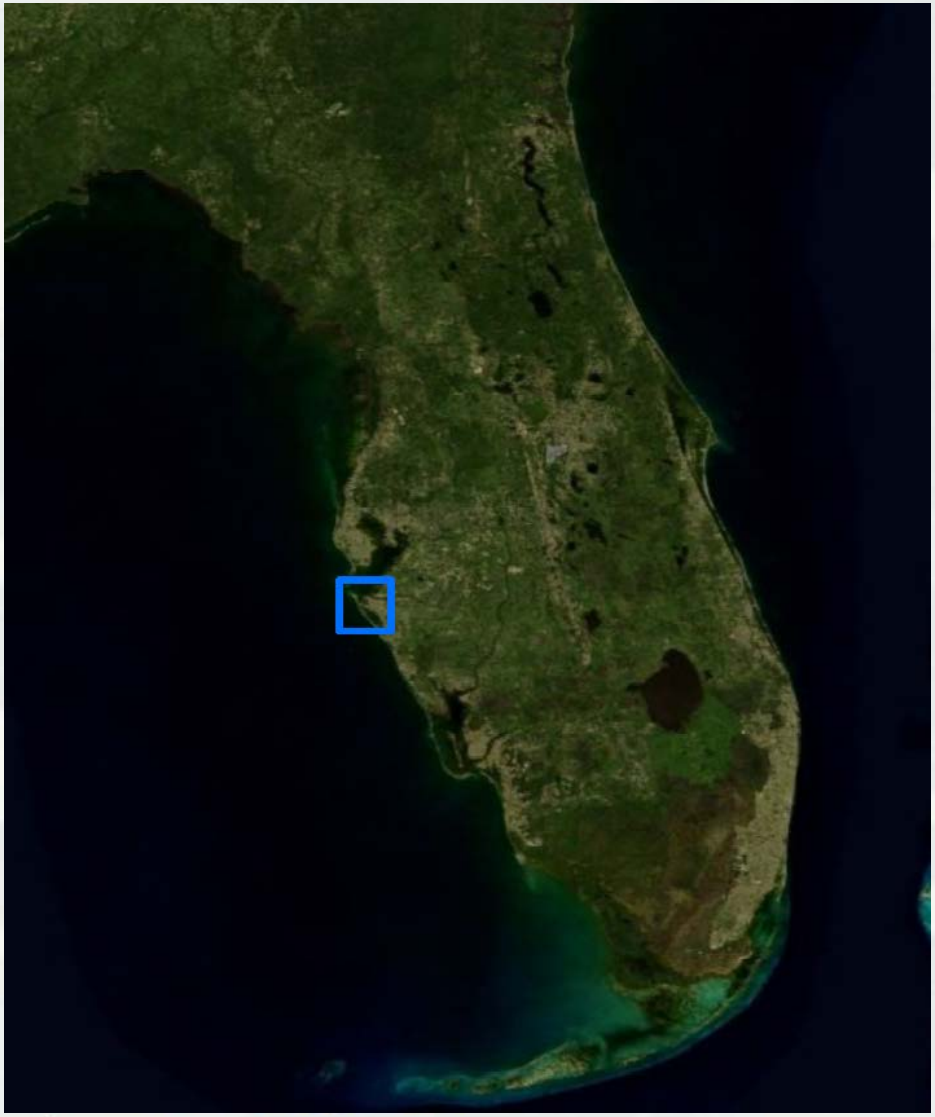
Marquette Harbor, MI

Aerial photography

Aerial photography

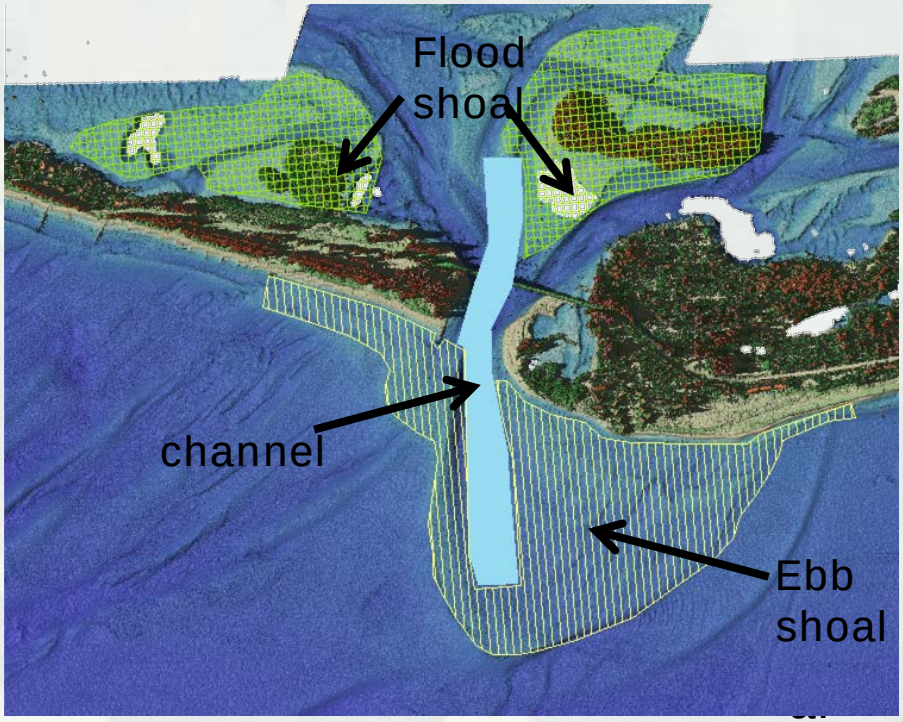


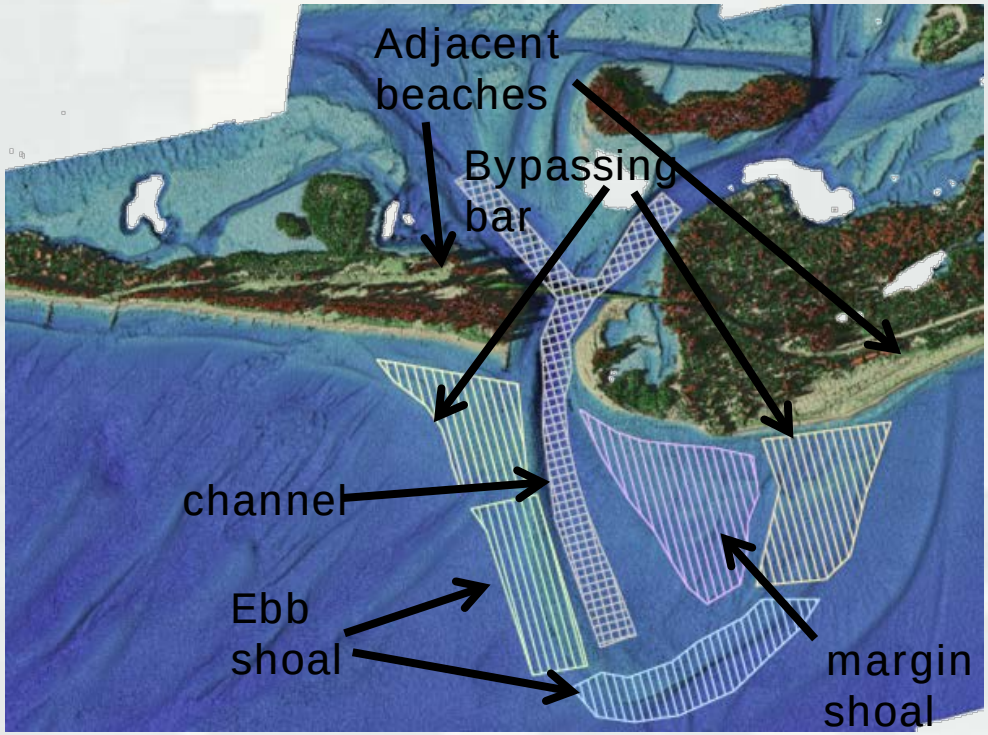
Site –Florida Coast



- 31 on West Coast
- Subset of data:
  - Longboat Pass
  - New Pass
- Survey data from 2004, 2006, and 2010
- 2006 dataset Post-Wilma

Ebb Shoal Features





Typical characteristic features:

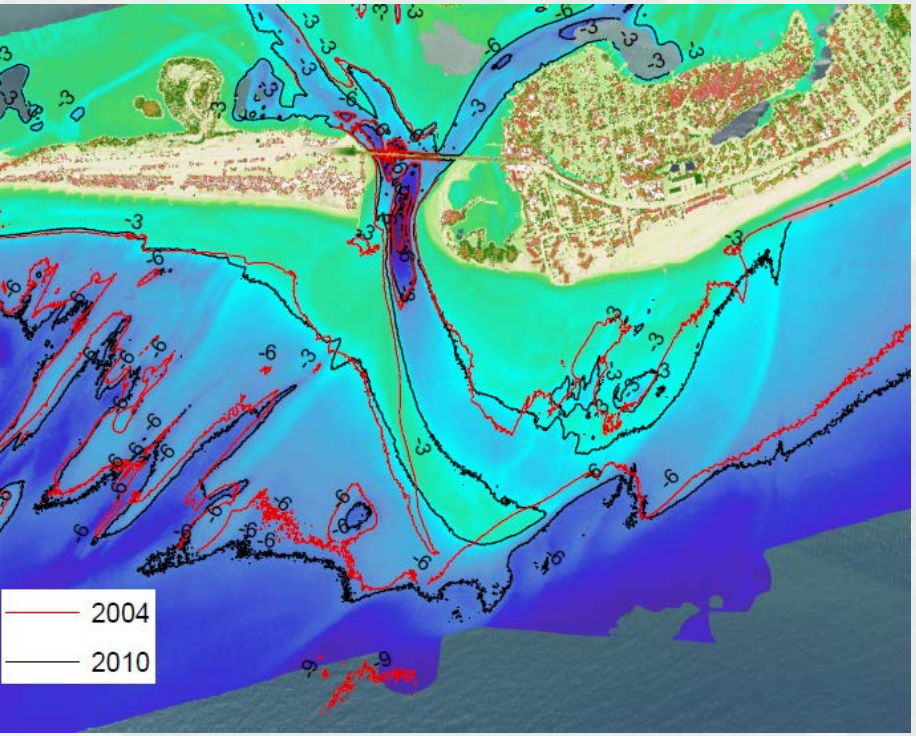
- Ebb shoal
- Bypassing bar
- Attachment bar

More complex divisions:

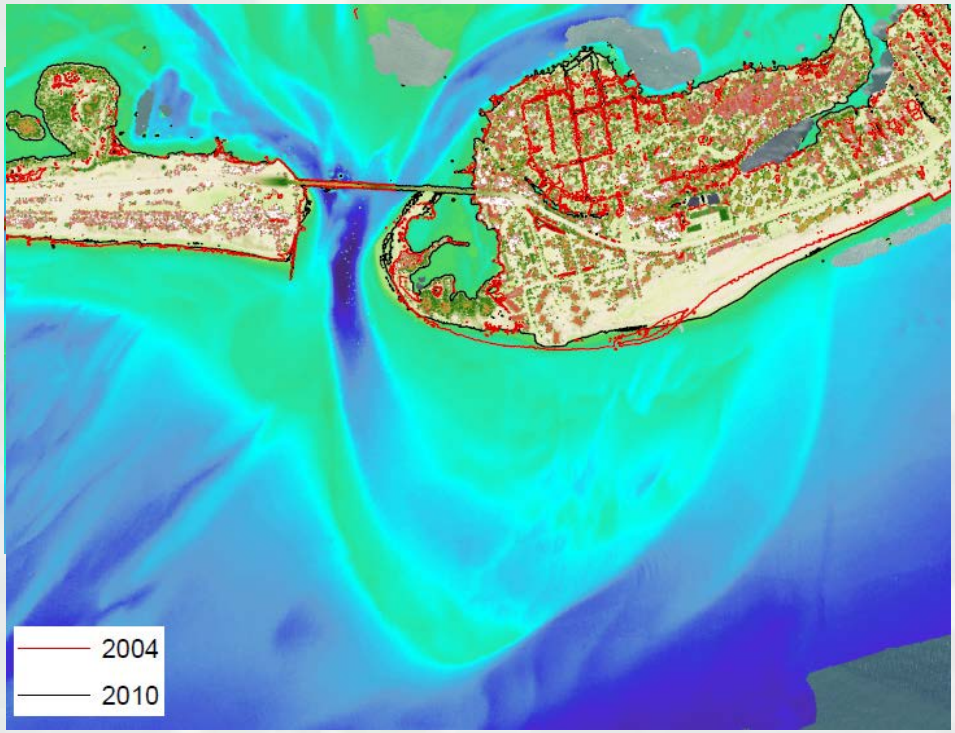
- Bypassing bar
- Ebb shoal for both sides of channel
- Jetty impoundment

- Dabees and Kraus (2008)

Contours

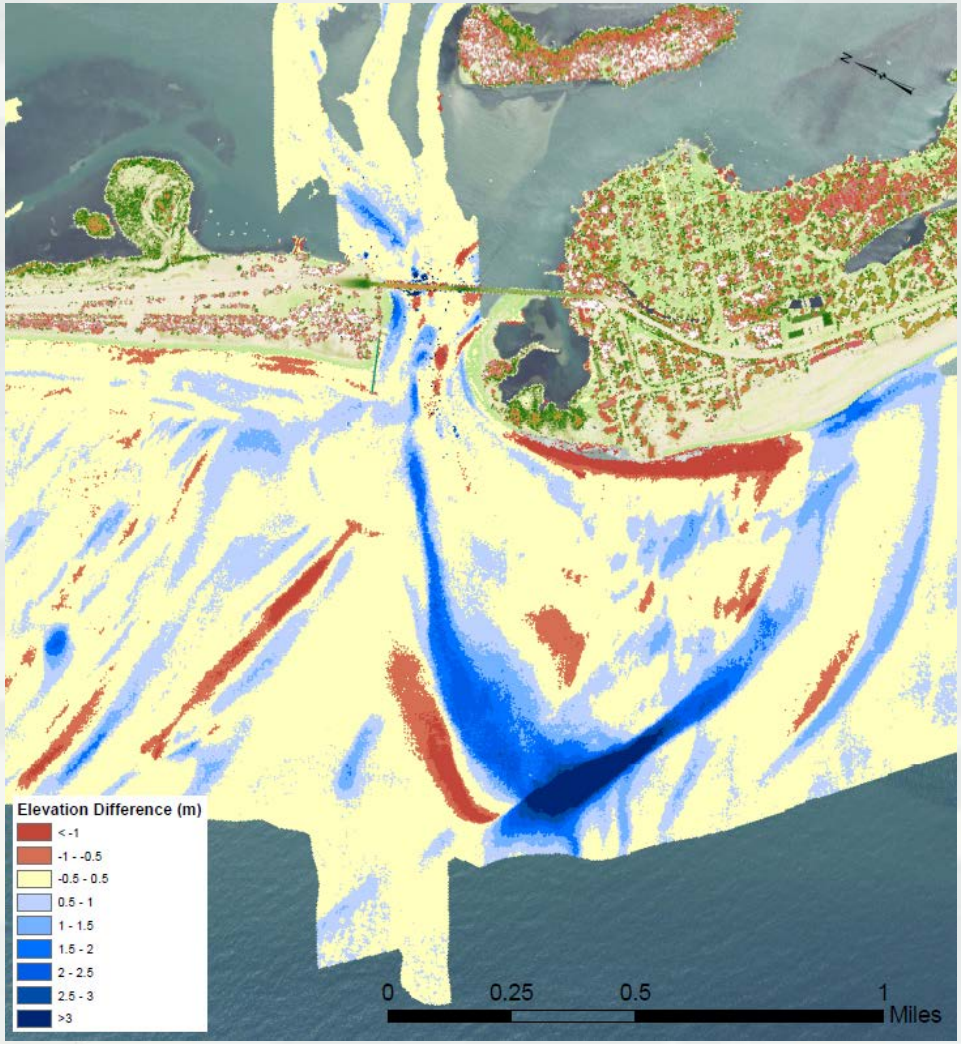


Offshore Contours
-3 m
-6 m



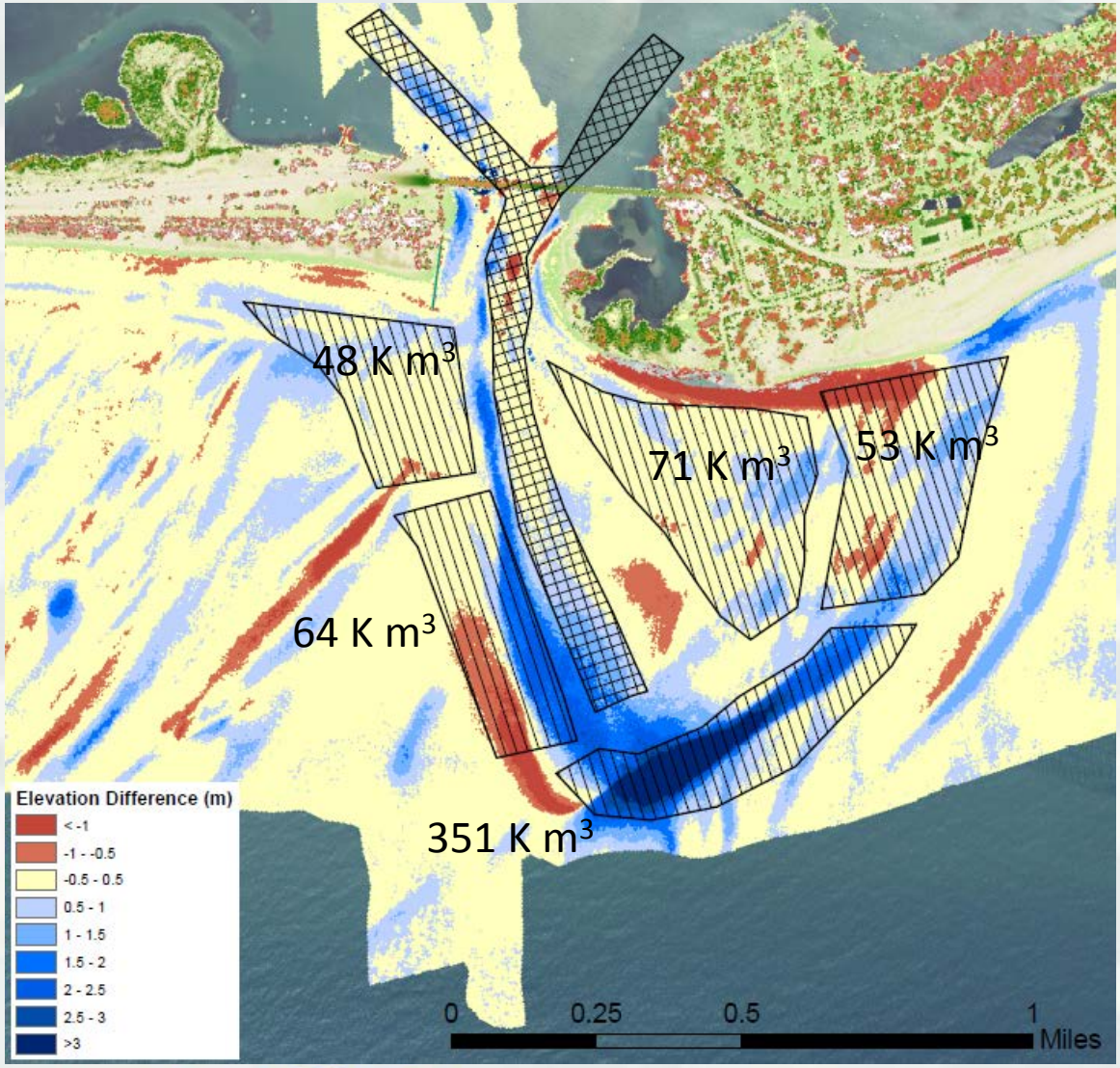
Shoreline Contours
- South side of inlet experienced considerable change

Elevation Difference



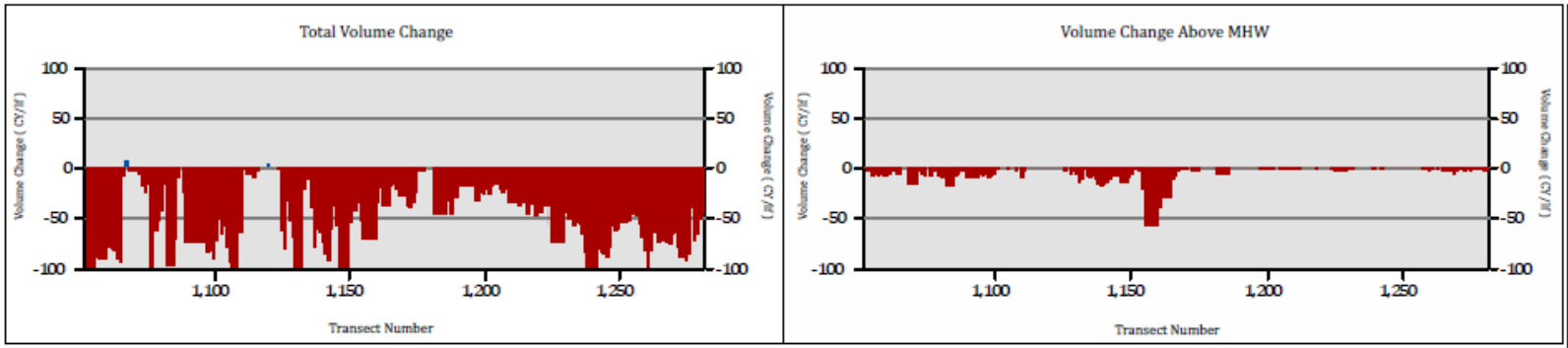
- Elevation difference for 2010 and 2004 survey
- Southward movement of sediment around the ebb shoal

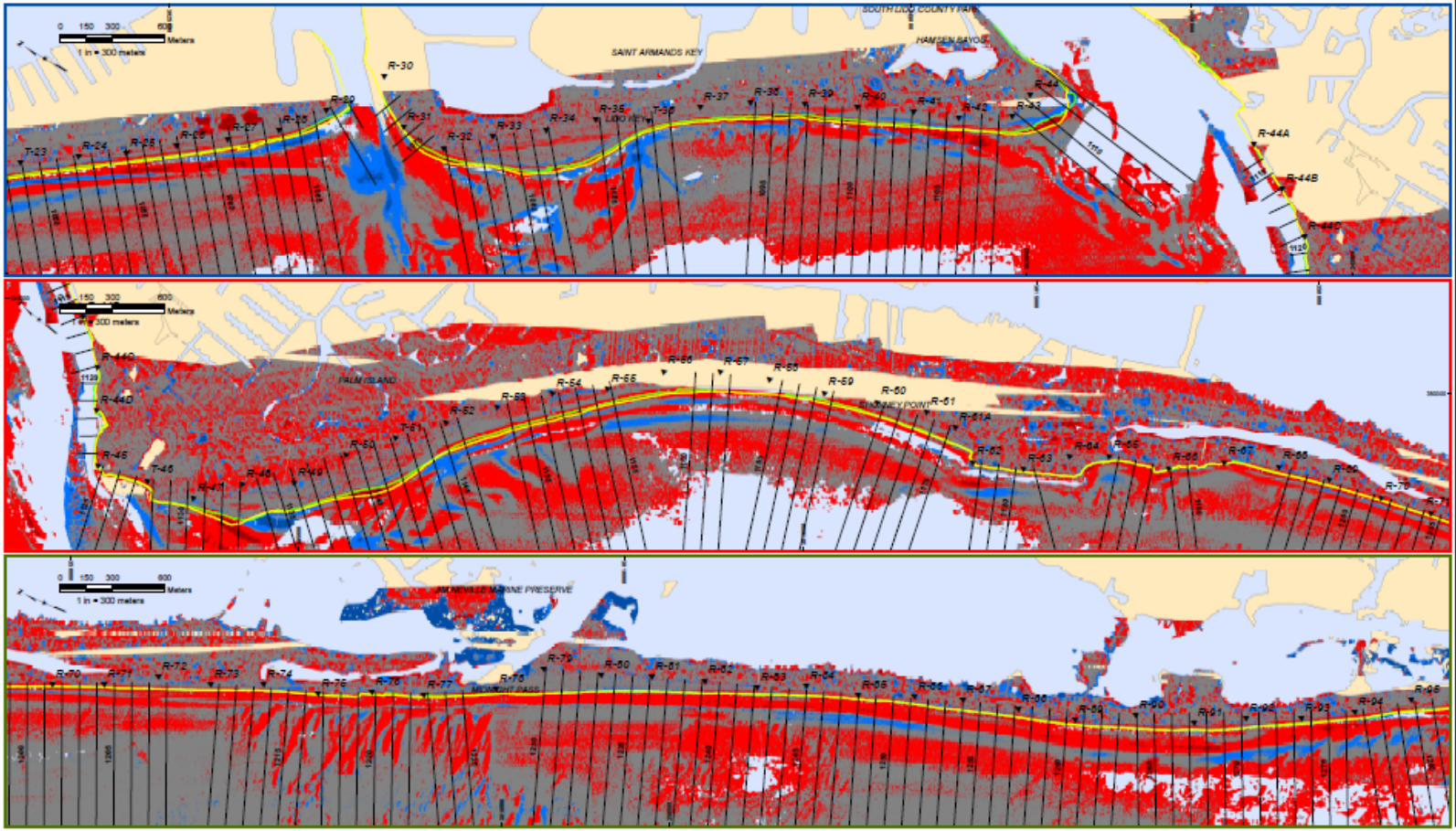
Volume Change

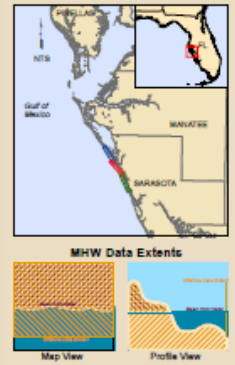


- Using elevation difference for 2010 and 2004 survey
- Inlet feature bins to quantify volume change

Volume Change







Legend

- State or Federal Survey Monuments
- 100 m Transects
- MHW May 2004
- MHW November 2004

Elevation Change (meters)

- > +1 m
- 0.2 m to 1 m
- -0.2 m to 0.2 m
- -1 m to -0.2 m
- > -1 m

Notes:

1. Coordinates are in meters based on Universal Transverse Mercator, Zone 17 North, North American Datum of 1983 (NAD 83).
2. Maps are rotated to maximize surface viewing from left to right. Check upper left corner of each frame for north arrow.
3. Surfaces are difference grids created by subtracting surface 2 from surface 1.
4. Volume change plots are normalized by distance between transects.
5. Transect spacing is 100 meters along the start of the transects.
6. For non-parallel transects, the distance is the average between the endpoints at the start and end of the transects.
7. Total volume change represents the volume change of overlapping data that is bounded by two adjacent transects.
8. Mean high water (MHW) volume change represents volume change between transects and above MHW.
9. MHW was calculated at 0.13 meters.

West Florida LiDAR Elevation Change Analysis

May 2004 to November 2004

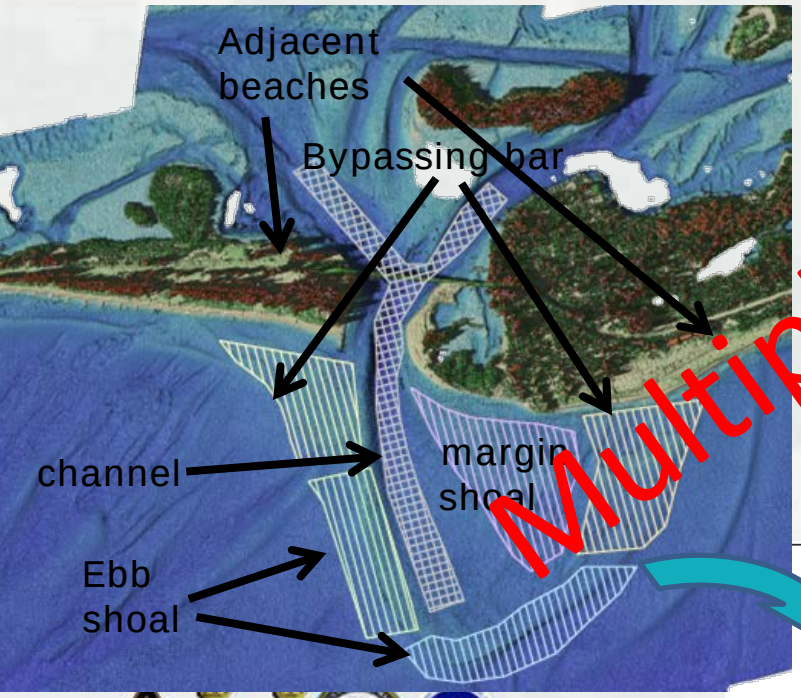
Sheet 5 of 11

Date Prepared: 06/21/2011

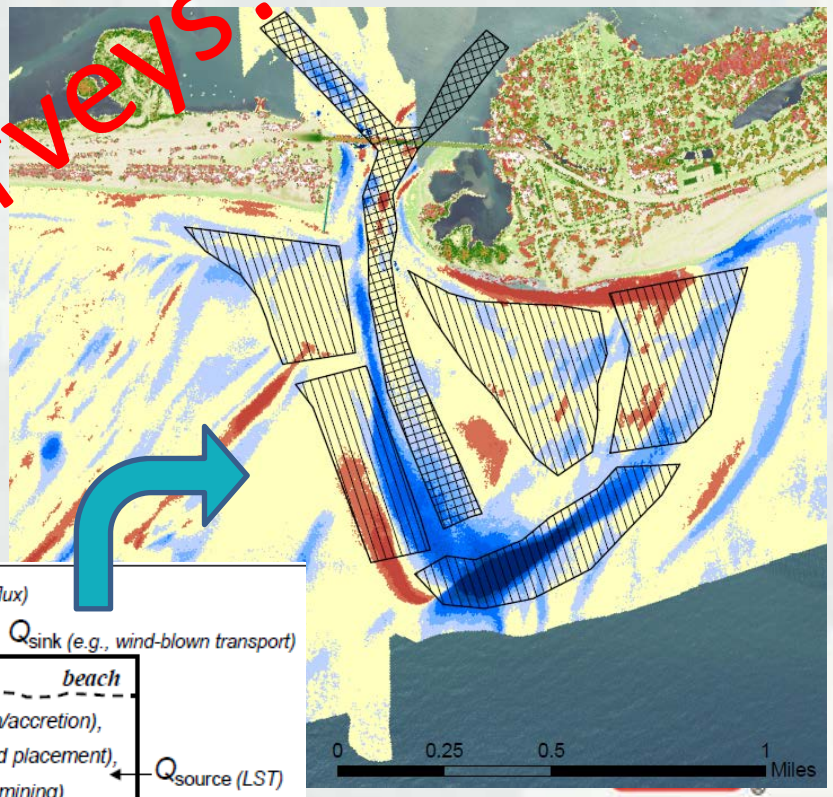
Coastal Planning & Engineering, Inc.
Joint Airborne Lidar Bathymetry Technical Center of Expertise

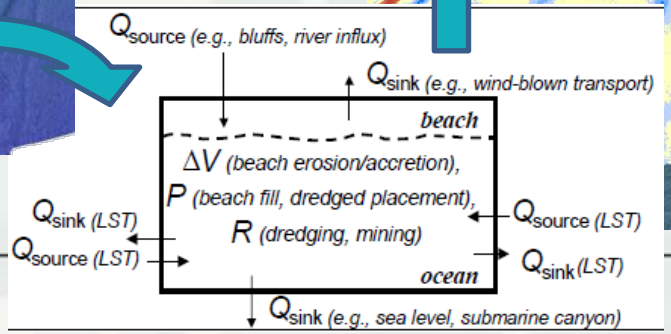
Sediment Pathways & Budget

- Delineate morphological features of the shoal system using automated feature extraction
- Quantify amount of sediment entering/leaving system
  - Sediment budget
- Volumes/ Volume change from bathymetric data to provide input into sediment budgets
- refine sediment budgets and identify areas of viable fill material



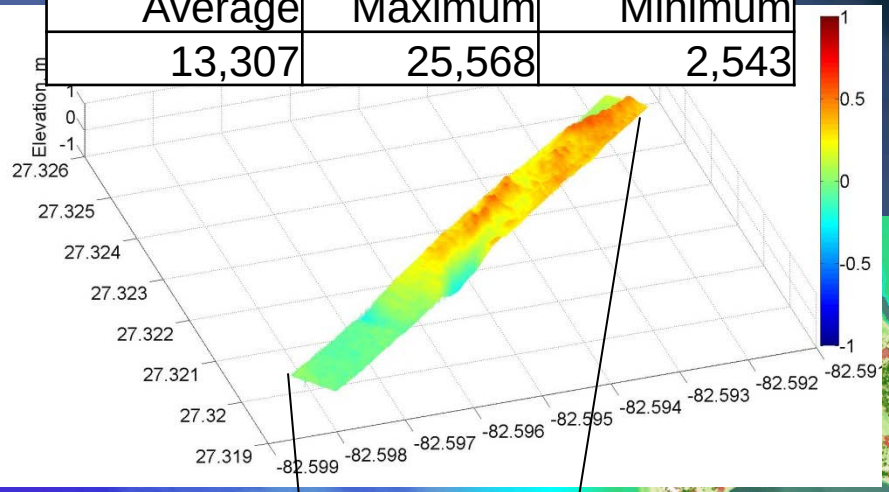
Multiple Surveys?



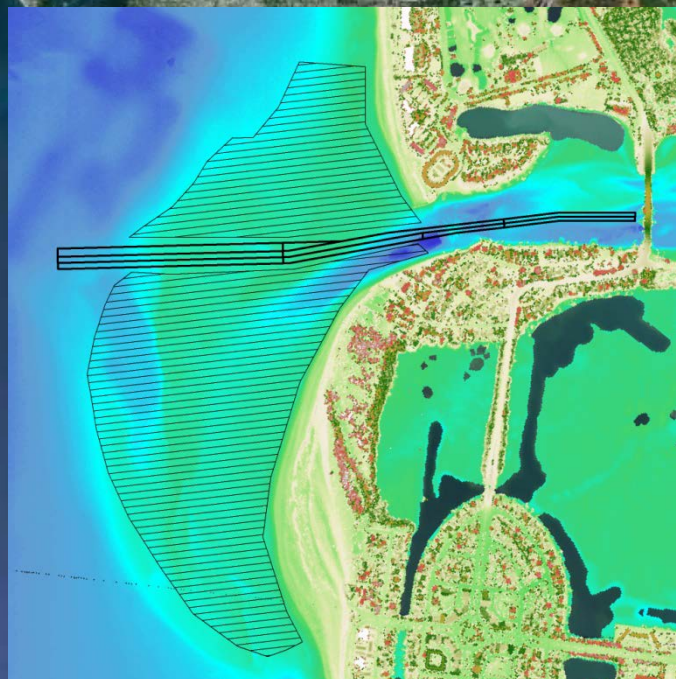


New Pass, FL

Channel Volume CY/yr		
Average	Maximum	Minimum
13,307	25,568	2,543



Volume Change (CY)	
Survey	**Total**
6/2010--6/2004	6,932
6/2010--1/2006	-89,785
2010--11/2004	-65,302
1/2006--6/2004	147,968
1/2006--11/2004	292,443
11/2004--6/2004	-163,402



Change Rate

$$y = Mx + C$$

$$M = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - \left(\sum x\right)^2}$$

$$R^2 = \frac{(n\sum xy - \sum x \sum y)^2}{\left\{n\sum x^2 - \left(\sum x\right)^2\right\}\left\{n\sum y^2 - \left(\sum y\right)^2\right\}}$$

X= time

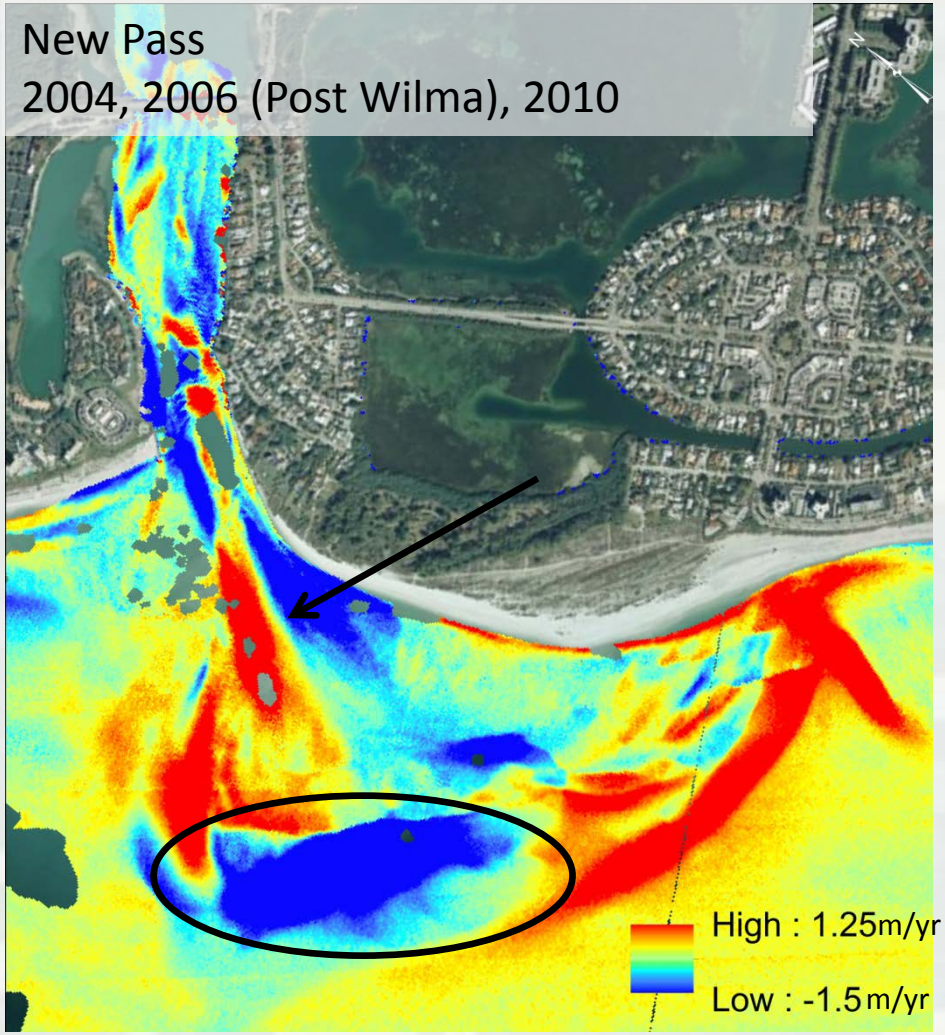
Y = dataset (DEM)

N= number of surveys

- Gaussian probability distribution assumed
- Changes due to storm events - waves
- Linear regression method
- M is the time trend
- R^2 is the correlation coefficient

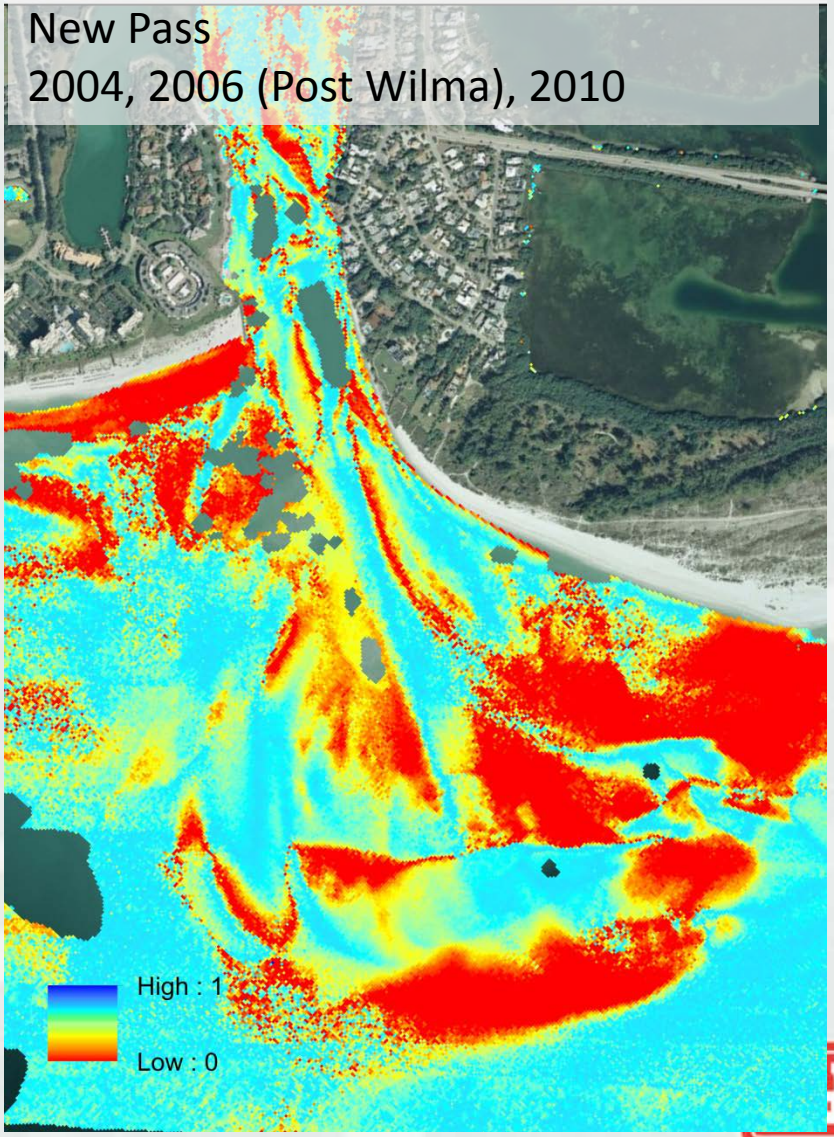
Change Rate

- New Pass, FL – mixed energy inlet
- 3 surveys – 1 post Hurricane Wilma (2006)
- High shoaling rate within channel and around the southern portion of the terminal lobe of the ebb shoal (red)
- Sediment mining on the outer boundary of ebb shoal (blue)



Change Rate

- Correlation Coefficient ~ 0 for outer boundary of ebb shoal
  - Areas with significant changes do not show trend
- Large changes in ebb shoal due to storm event, so linear fit not applicable



Tools/Methods –Next Steps

- Further automate the delineation of inlet features to provide input into sediment budgets, identify areas of viable fill material, assess impact of inlets to adjacent beaches, and monitoring the completed project to assess the functional performance
- Shoaling rates using repeat surveys
  - Repeat surveys will improve trend analysis
  - Identify hot-spot areas
  - provide insight into improving channel performance to reduce the need for dredging
- Performance metrics for channel and ebb shoal conditions
- Provide input into numerical models for morphological and coastal hazards analysis

Thank You!

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