Innovative Methods to Evaluate Minimizing Dredging Requirements using Three-Dimensional Spatial Data

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Outline:

- Joint Airborne Lidar Bathymetry

  Technical Center of Expertise

  - ✓ New sensor developments
- National Coastal Mapping Program
  - ✓ Surveys and products
- Dredging Requirements

US Army Corps of Engineers
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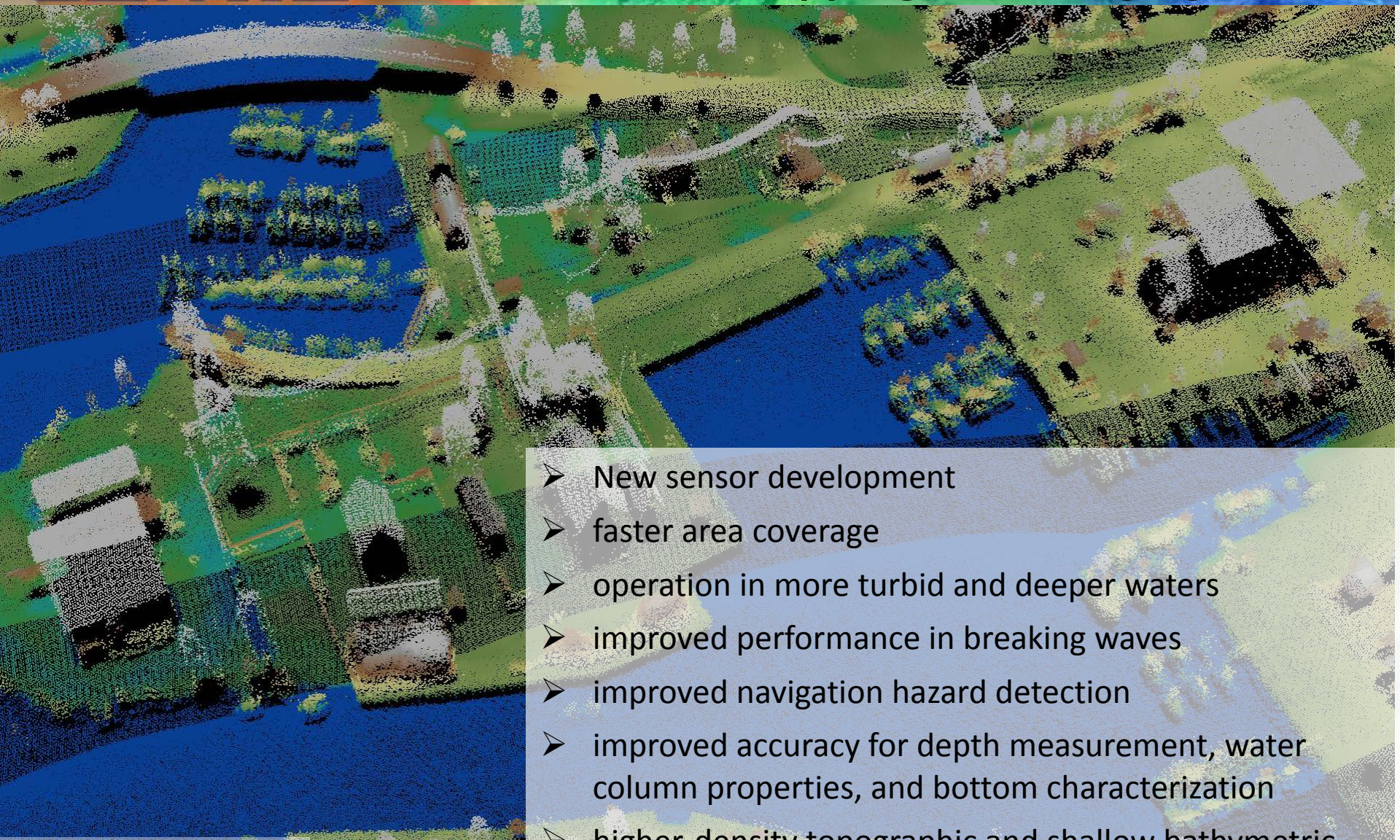
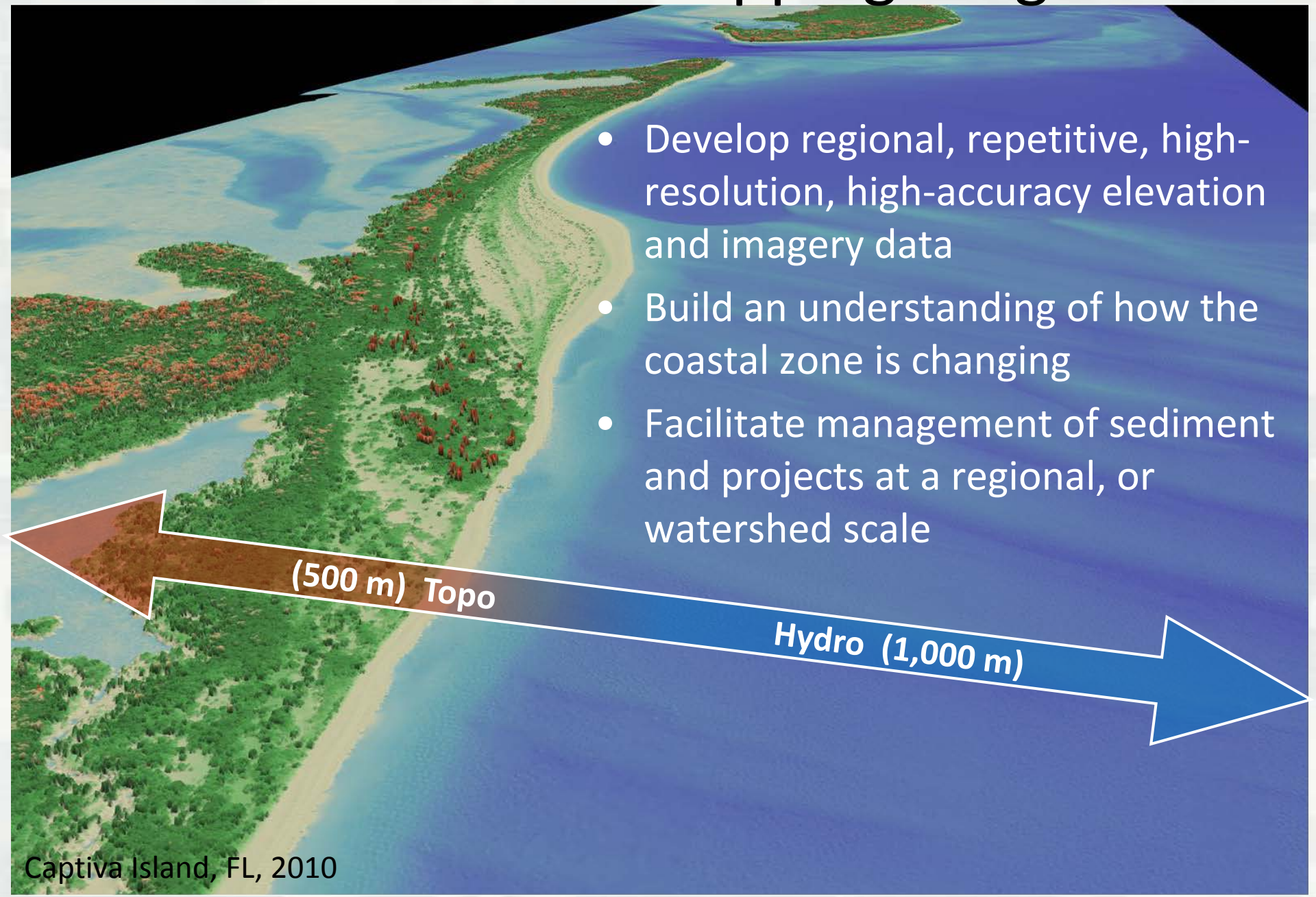
Coastal Zone Mapping and Imaging Lidar



- New sensor development
- 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

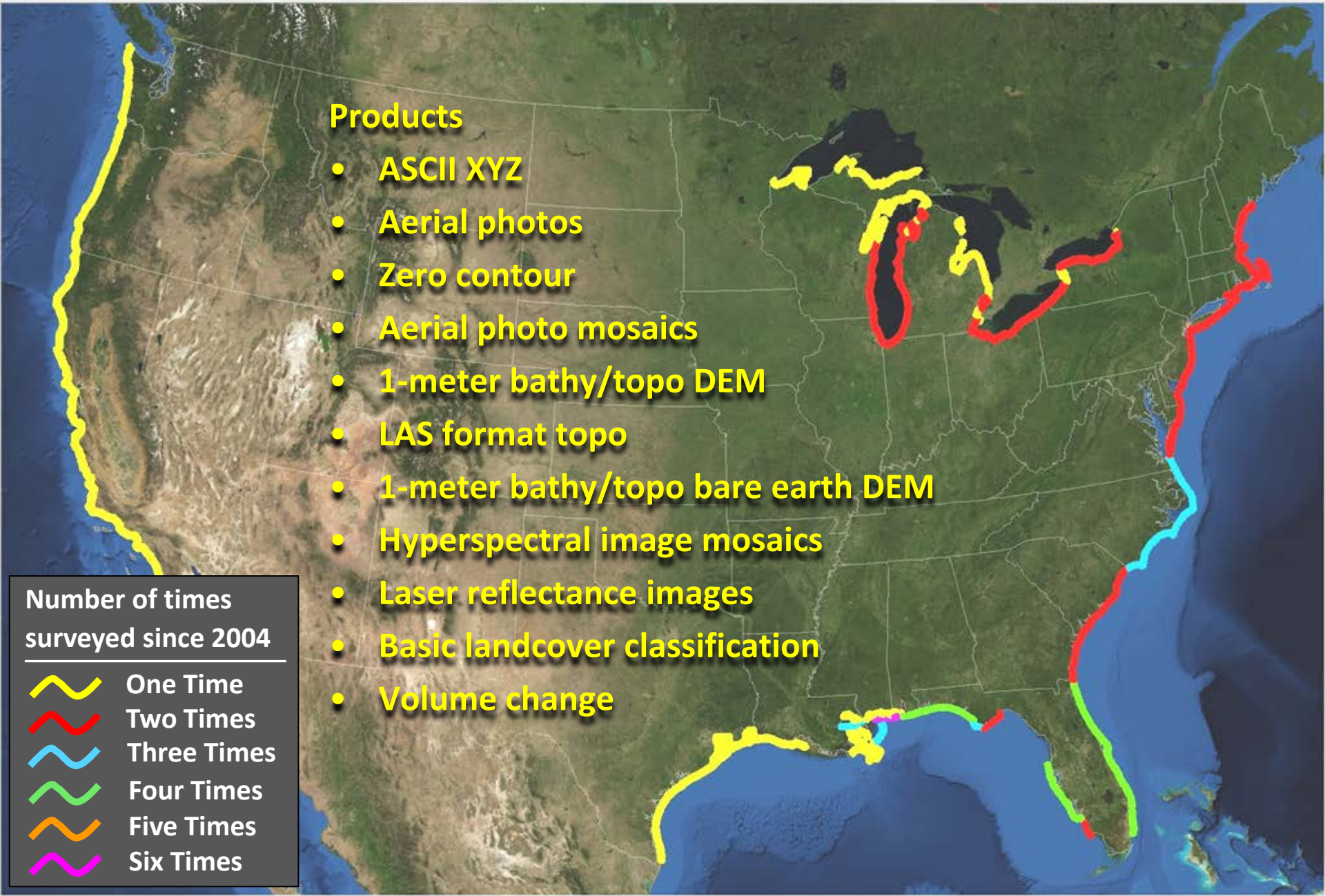
Sturgeon Bay, WI
Point Cloud

National Coastal Mapping Program

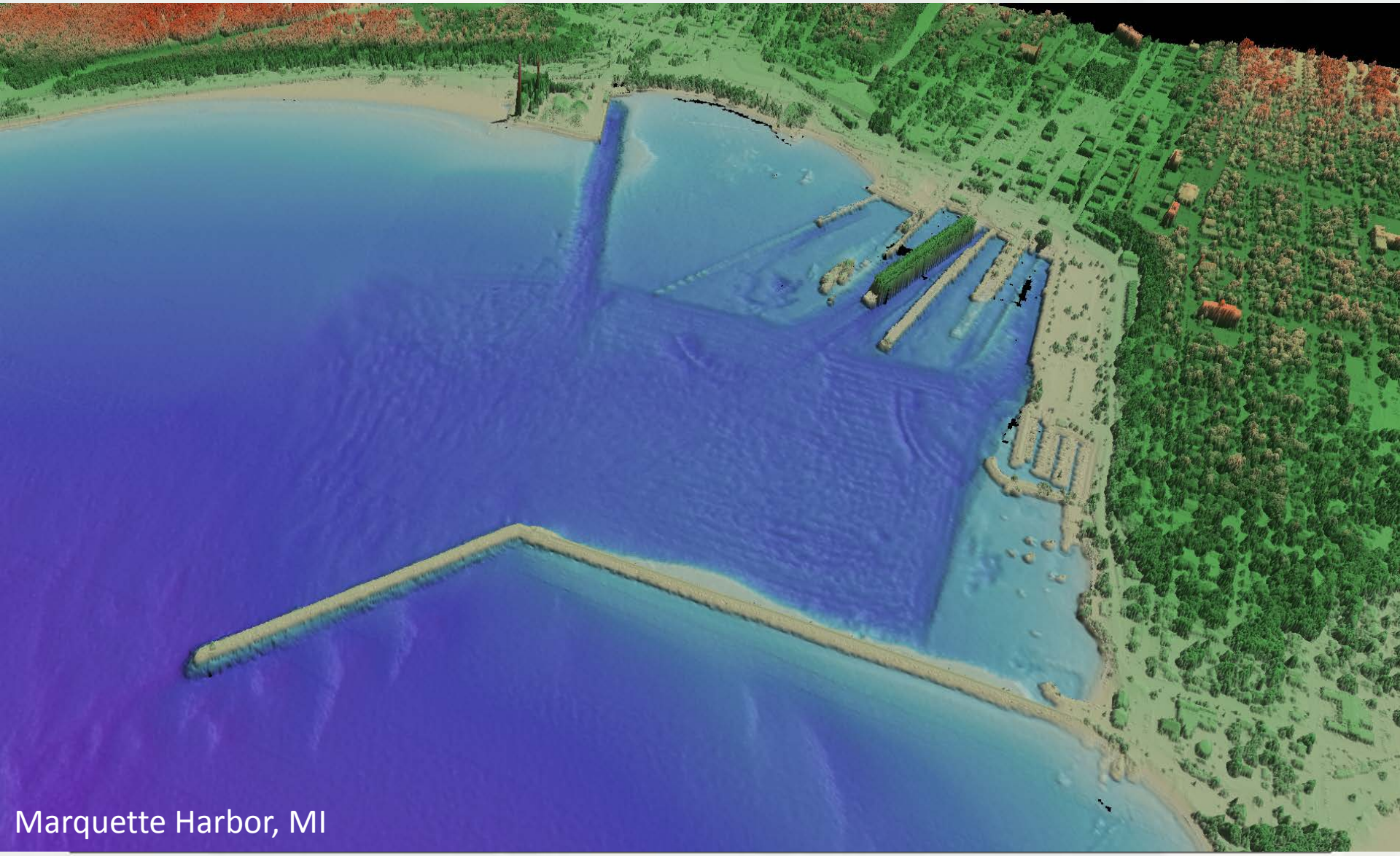


- Develop regional, repetitive, high-resolution, high-accuracy elevation and imagery data
- Build an understanding of how the coastal zone is changing
- Facilitate management of sediment and projects at a regional, or watershed scale

National Coastal Mapping Progress



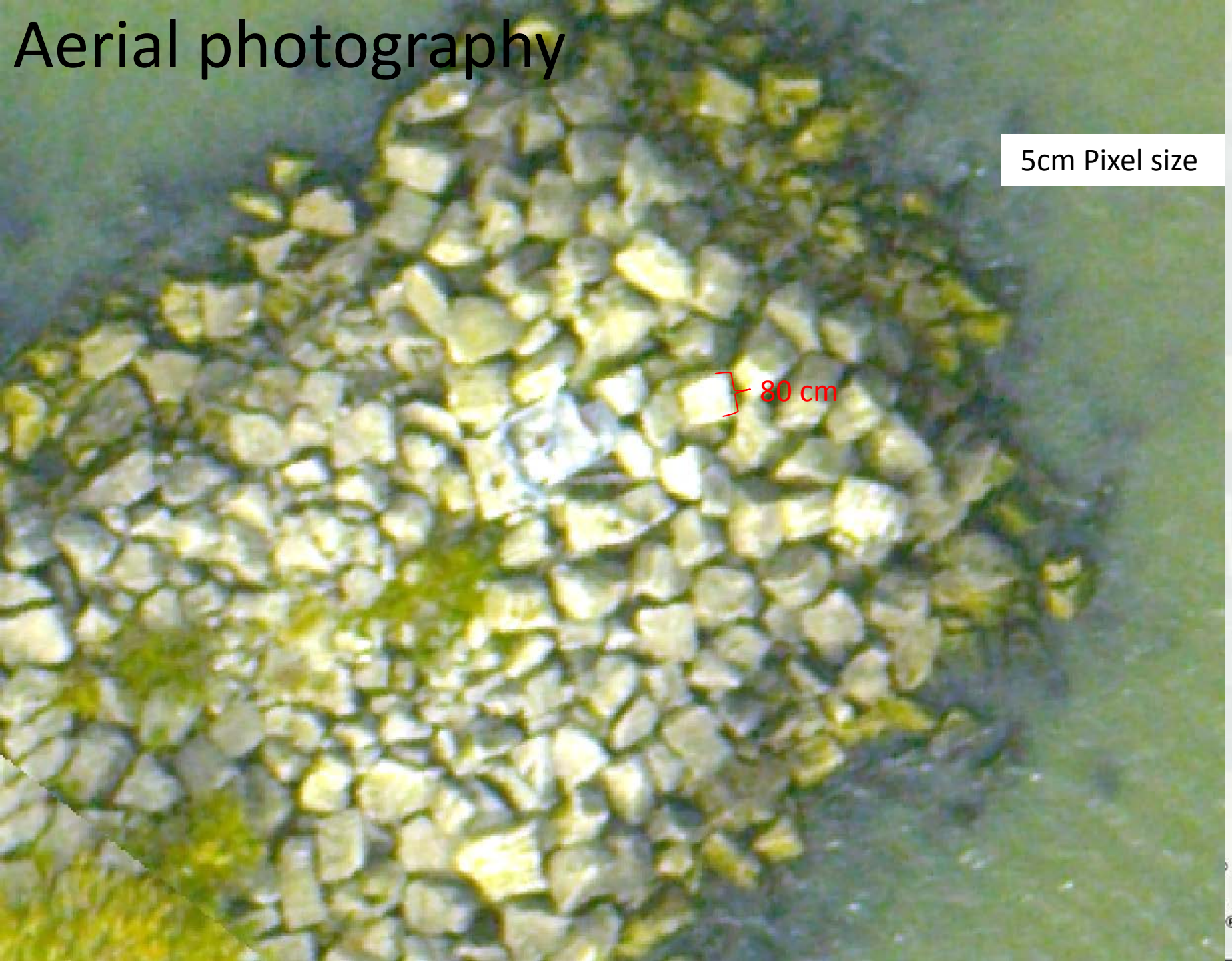
Bathymetry and Topography



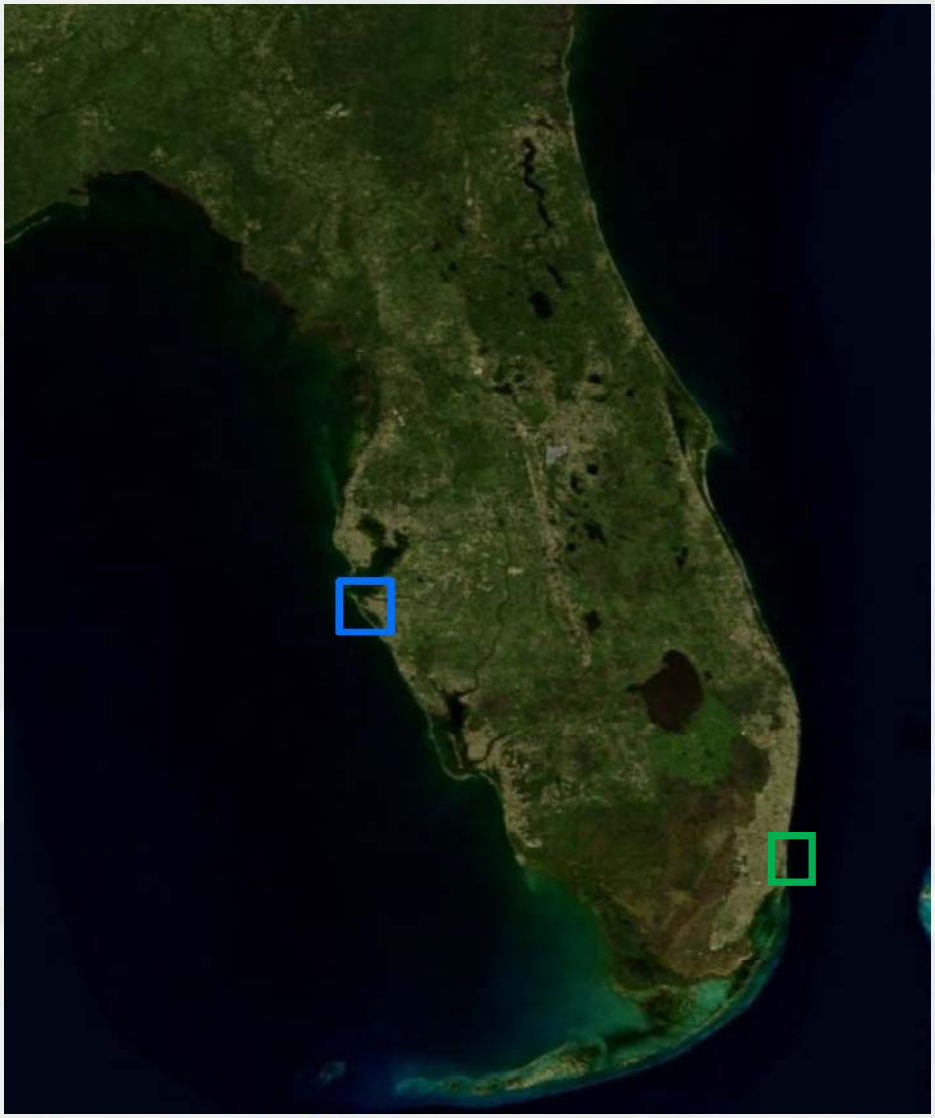
Marquette Harbor, MI

Aerial photography

Aerial photography



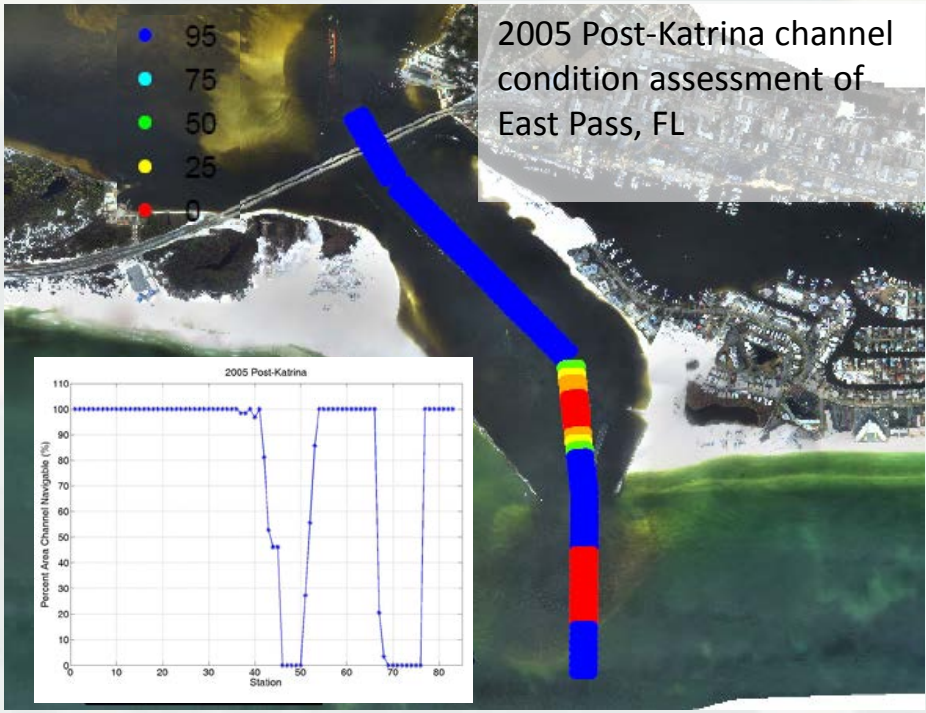
Site –Florida Coast



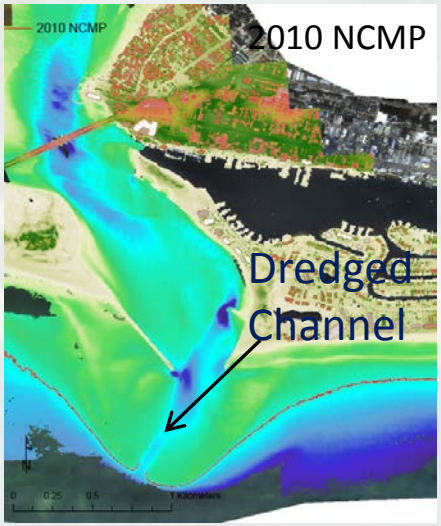
- Bakers Haulover Pass, FL
  - East Coast
  - Tide dominated
  - Survey data:
    - 2004, 2004 post-hurricane, 2006, 2009
- New Pass, FL
  - West Coast
  - Mixed energy
  - Survey data:
    - 2004, 2006 post-hurricane, and 2010

Methods

- Channel condition assessment using bathymetric data and channel framework
  - Channel availability
  - Identify shoaling hot-spot areas
  - Morphological trends to find ways to efficiently manage dredging requirements at shallow draft channels
- Statistical approach
  - Averages, maximum, and minimum
  - Linear regression analysis



2005 Post-Katrina channel condition assessment of East Pass, FL



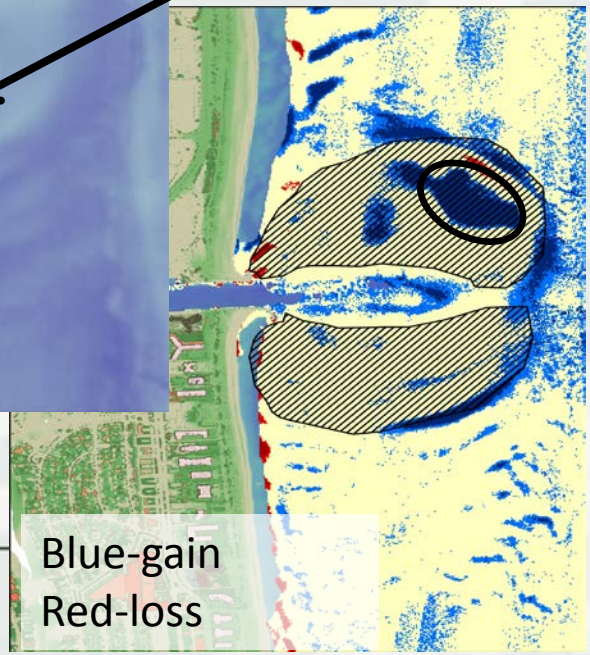
❖ Identify areas of concern after storm events and use multiple surveys to show migration of the channel

Bakers Haulover Pass

- East Coast of Florida
- Tide dominated
- Ebb shoal is symmetric about the channel
- Ebb shoal mined for beach nourishment
- Loss of sediment during 2004 hurricane
- North ebb shoal mined in 2005

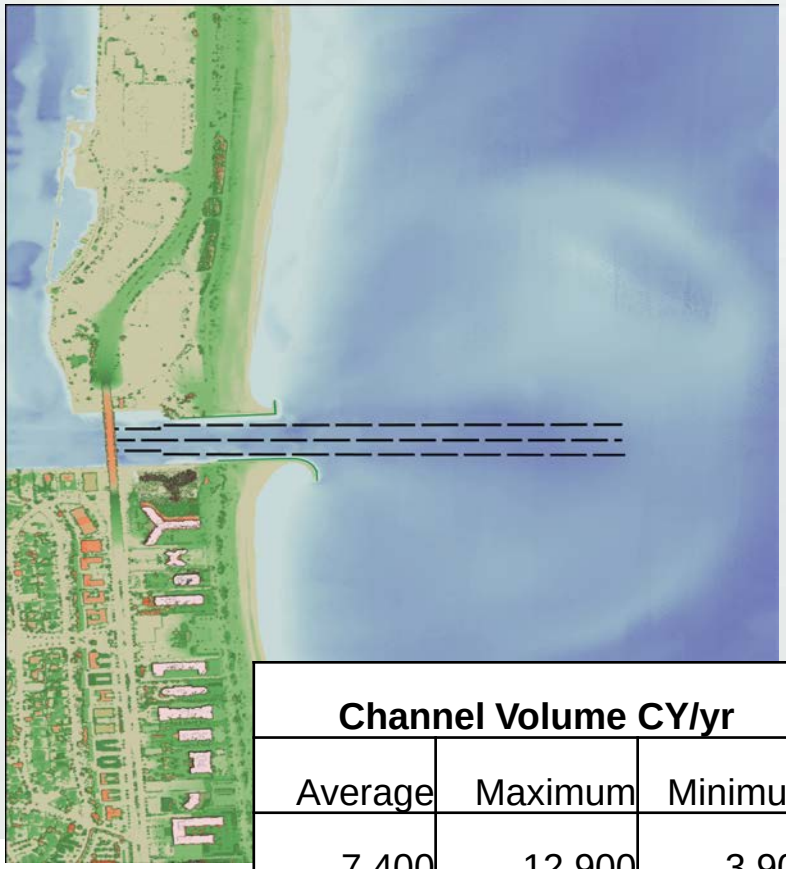
Volume Change (CY)

Survey	North Shoal	South Shoal	Total
10/2009--6/2004	266,158	174,736	440,894
10/2009--1/2006	232,284	150,703	382,987
1/2006--11/2004	106,561	21,548	128,109
11/2004--6/2004	-81,090	-64,643	-145,733

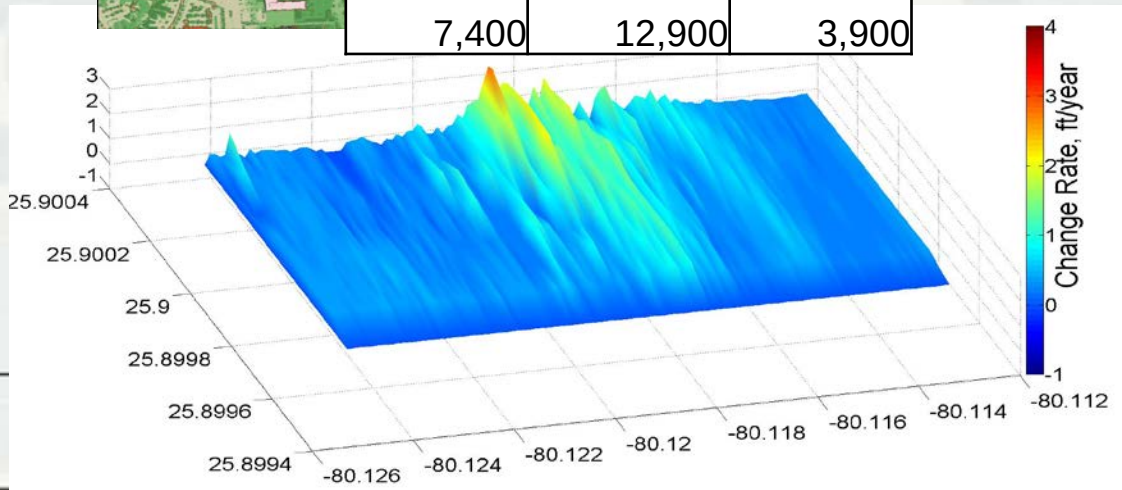


Bakers Haulover Pass

- Straight channel alignment
- Jetties structures on both sides of the inlet
- Spur jetty to trap sediment in fillet on both sides
- Change rate consistent for majority of channel
- North center portion experiences the most change

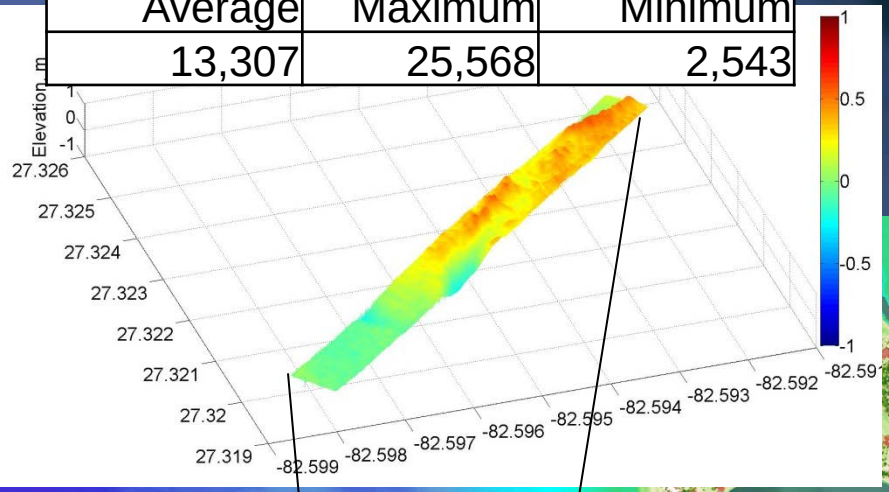


Channel Volume CY/yr		
Average	Maximum	Minimum
7,400	12,900	3,900

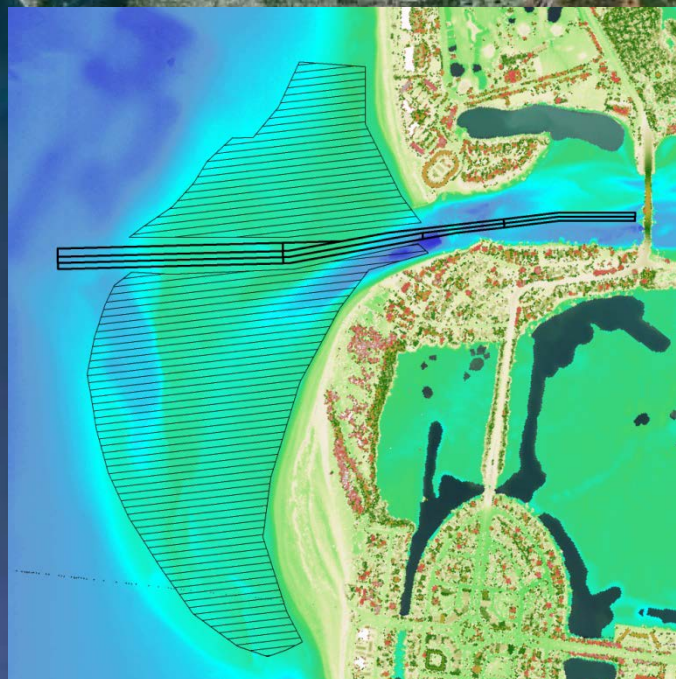


New Pass, FL

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

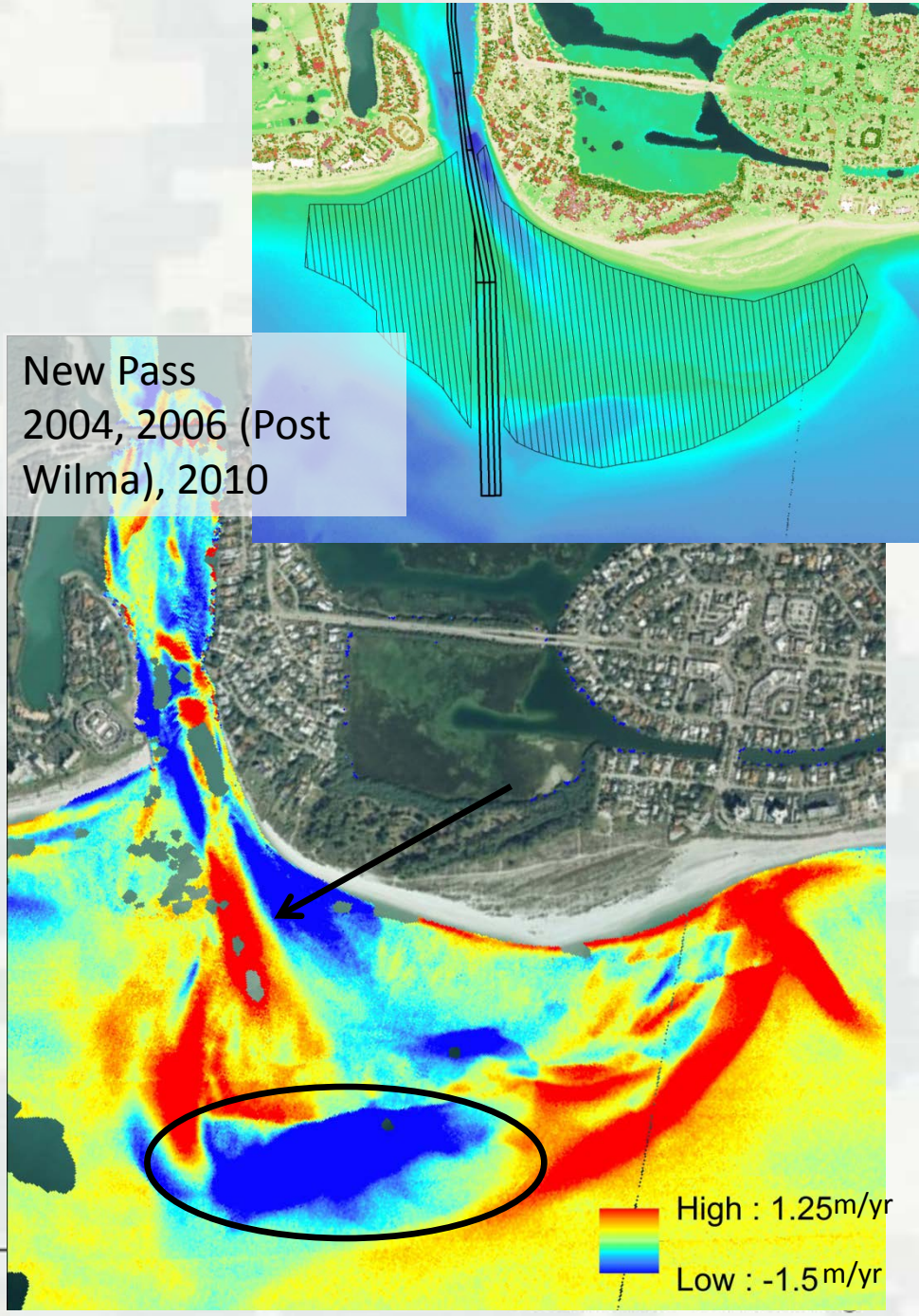
Y = dataset (DEM)

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

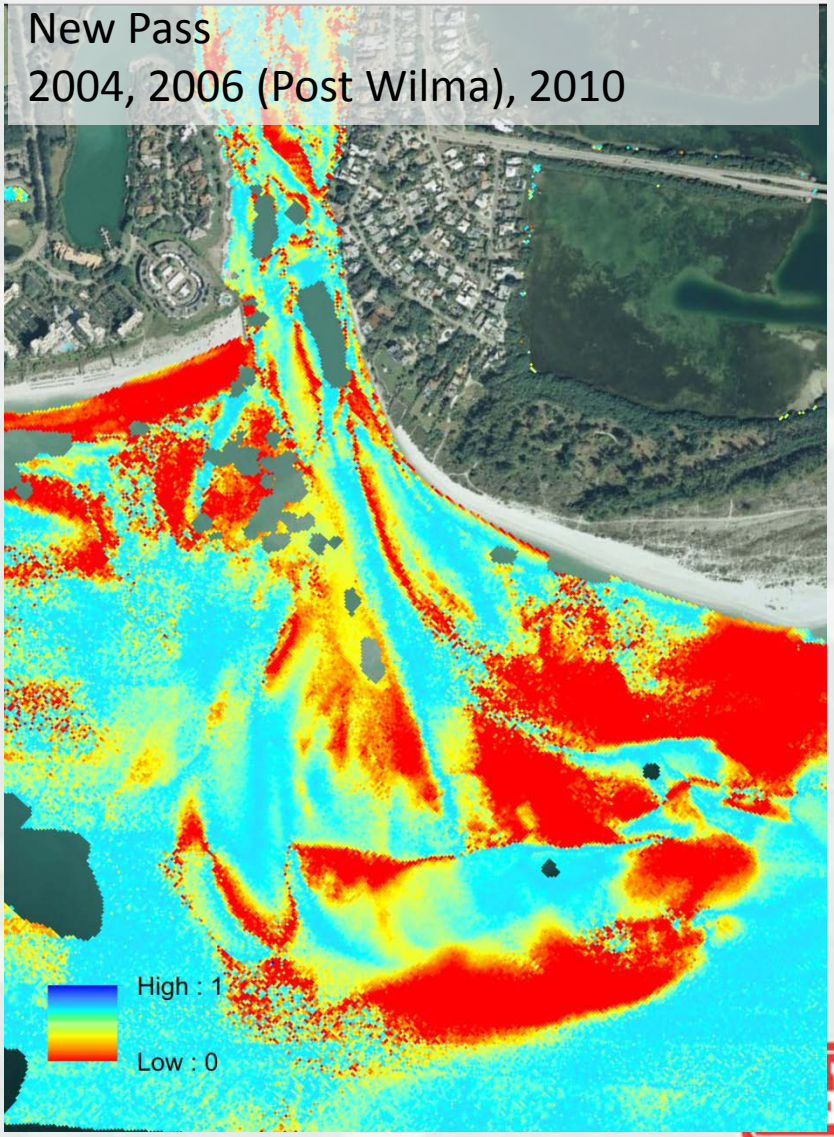
Change Rate

- 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 (2006 survey)



Conclusion

- JALBTCX performs operations, R&D in airborne bathymetric lidar and complementary technologies in support of navigation, coastal engineering and environmental monitoring requirements of USACE.
- Survey sandy shorelines of U.S. on recurring basis (~ 5 year cycle)
  - Data access: jalbtcx.org
- Shoaling rates using repeat surveys
  - Repeat surveys will improve trend analysis – linear regression
  - Identify hot-spot areas
  - provide insight into improving channel performance to efficiently dredge and management sediment

Thank You!

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www.jalbtcx.org