

# Remote sensing for the MTS

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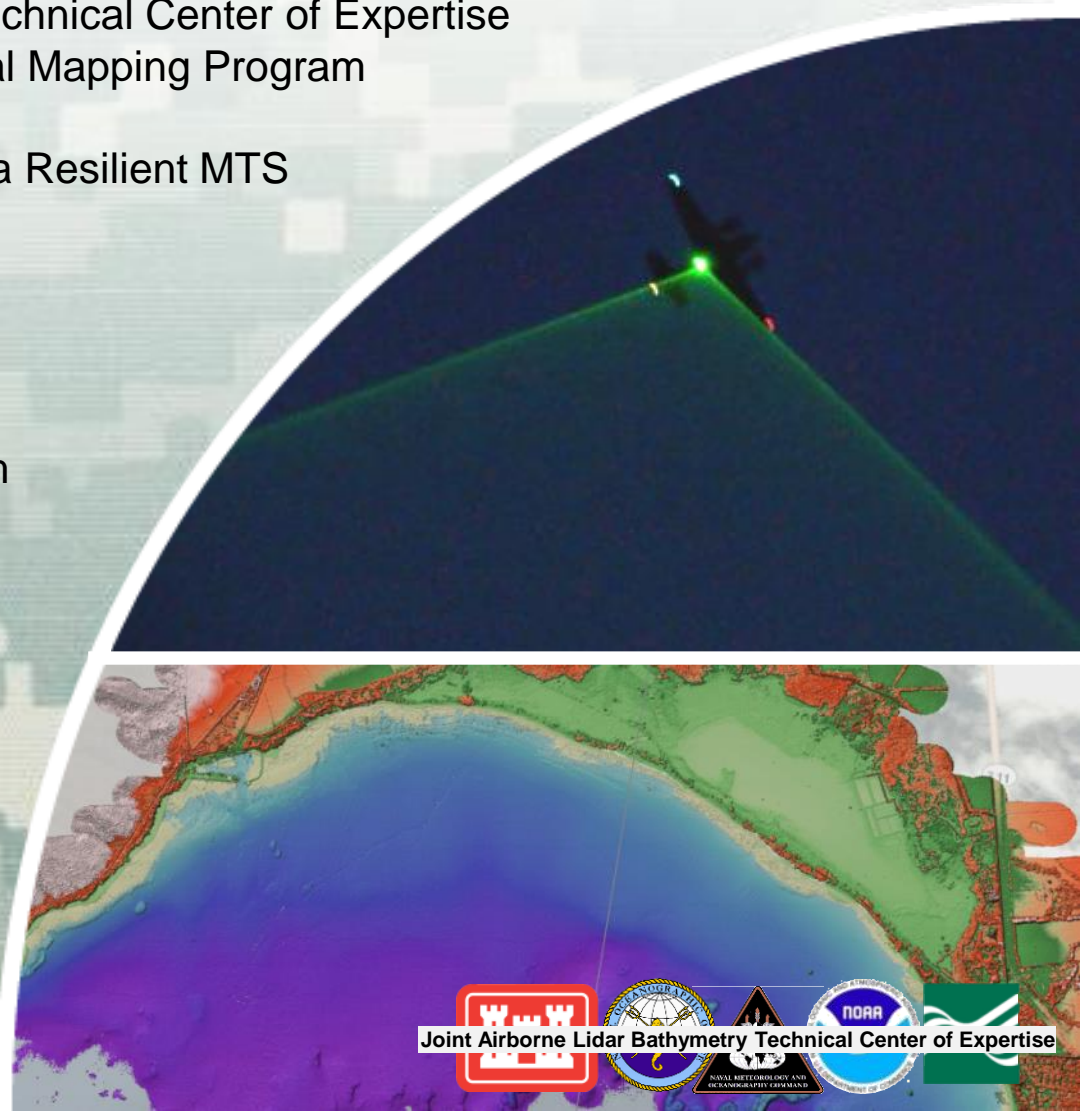
24 June 2014, Innovative Technologies for a Resilient MTS

## Outline

- Background
  - JALBTCX
  - National Coastal Mapping Program
- Indicators for resilience
- Microbotic infrastructure assessment



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# Joint Airborne Lidar Bathymetry Technical Center of Expertise



Aircraft

Surveys

## OPERATIONS

Procedures

People

Hardware



Software

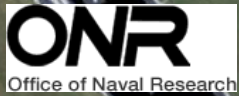
## RESEARCH AND DEVELOPMENT

Algorithms

Data  
exploitation



Annual Technical Workshop, 9-12 June 2015



Dynamic Aviation



# USACE National Coastal Mapping Program

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

(500 m) Topo

Hydro (1,000 m)

# National Coastal Mapping Progress

## Products

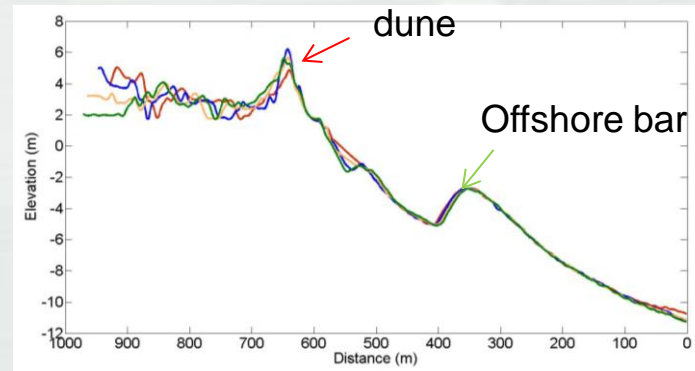
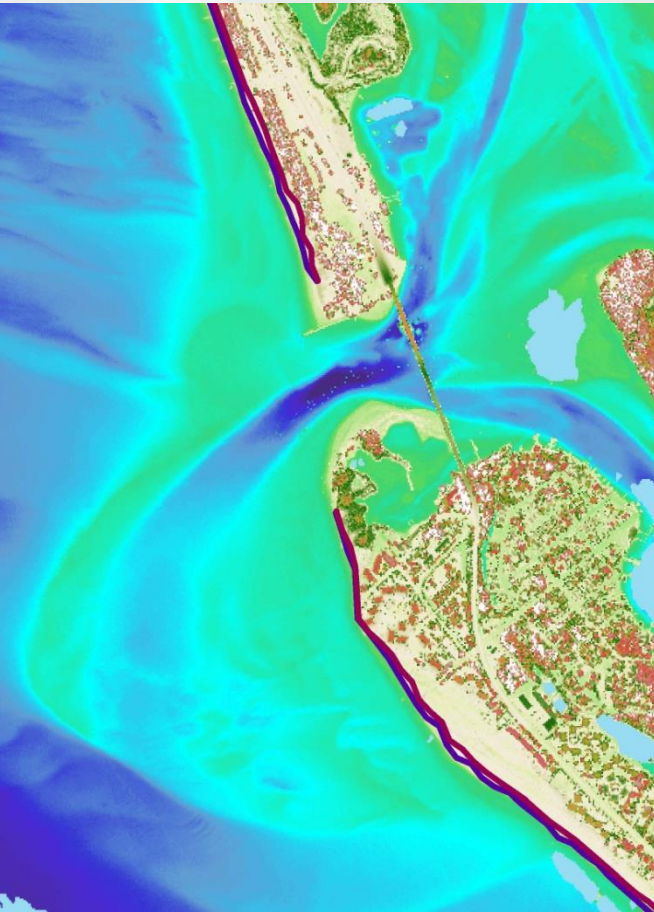
- ASCII XYZ
- Aerial photos
- Zero contour
- Aerial photo mosaics
- 1-meter bathy/topo DEM
- LAS format topo
- 1-meter bathy/topo bare earth DEM
- Hyperspectral image mosaics
- Laser reflectance images
- Basic landcover classification
- Volume change

Number of times surveyed since 2004



# Dunes

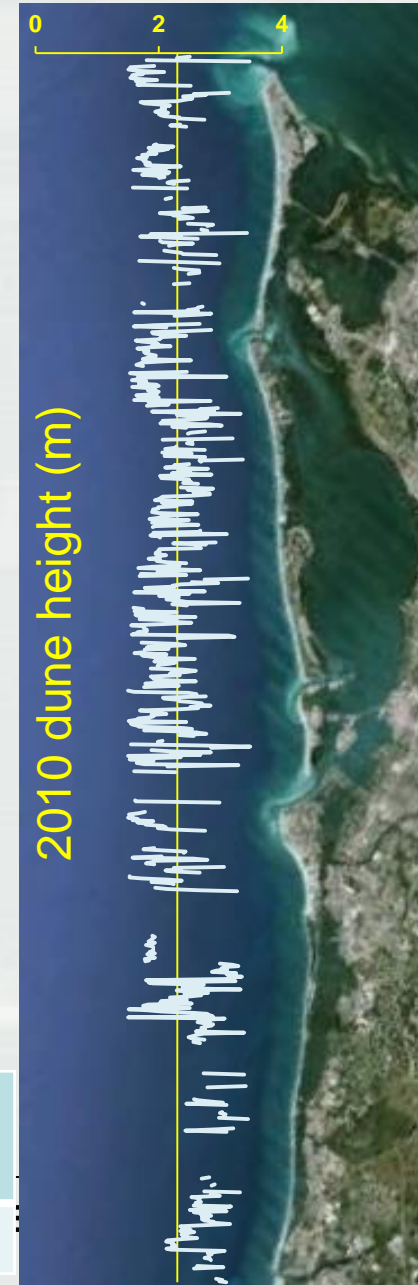
- Provide natural buffer from waves/runup to upland areas
- Volume of sediment available for beach recovery
- Included as part of beach nourishment projects



- Dune height – crest of the first dune
- Dune toe – slope change in dune

2010 Dune Height

2 m



# Zero Contour—"shoreline"

2010 Beach Width

24 m

Zero Contour Change Rate

1.3 m

- Beach width provides buffer before the dune as well as recreational benefits
  - Defined as the distance between the zero contour and the dune toe
  - Active portion of the beach
- Contour change rate
  - Used to determine hot spots of erosion and cumulative change can identify extent of inlet influence

2010 beach width (m)

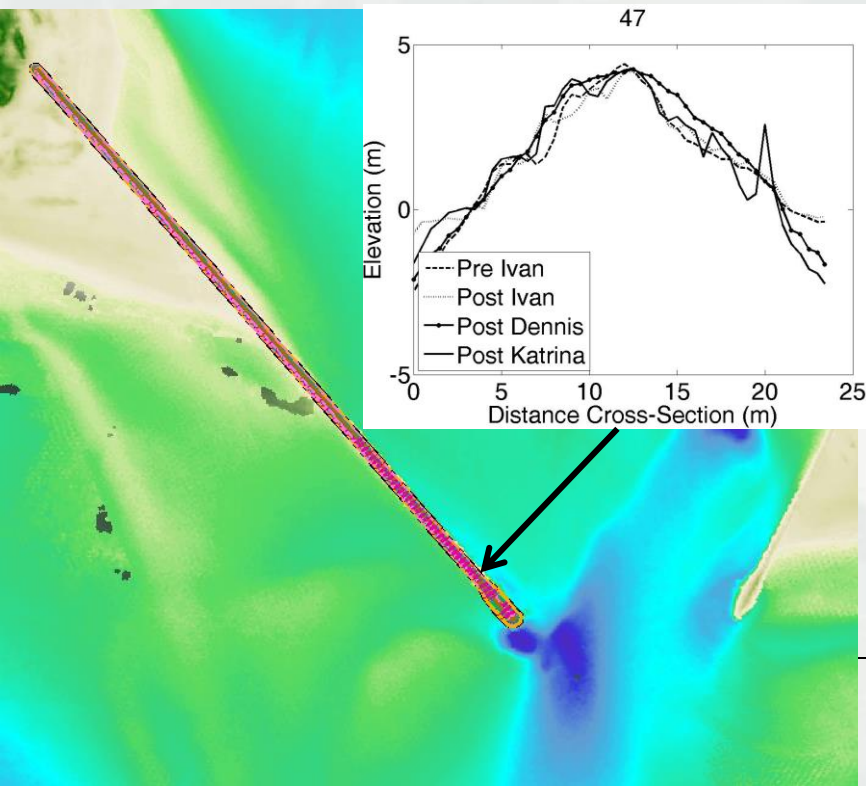


2004-2010 change rate (m/yr)



# Structures

- Jetty structures stabilize the inlet, prevent sediment from entering the channel, and may provide protection for vessel traffic through the inlet.
- Remote sensing data used to monitor structure condition and prioritize maintenance.

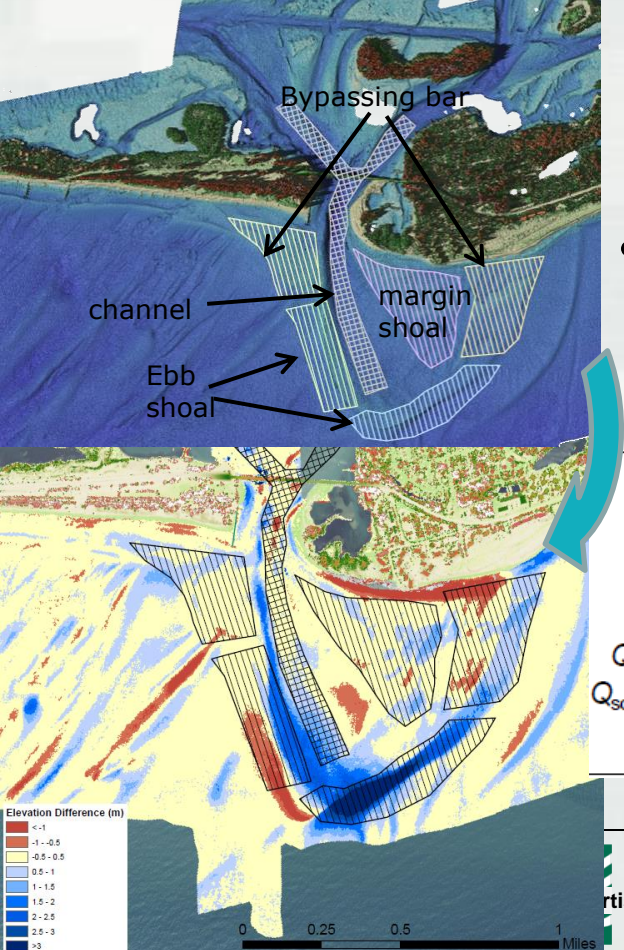


- Bathymetric data used to determine if jetty sand tightening is needed

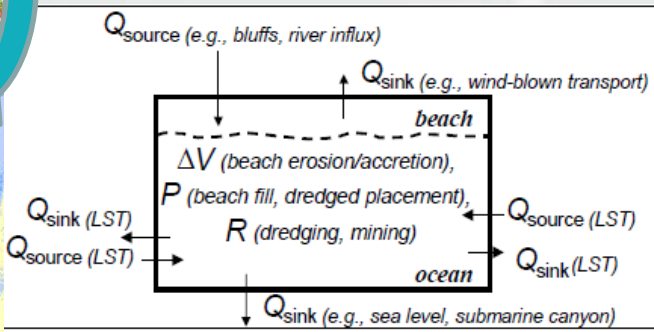


# Ebb Shoal

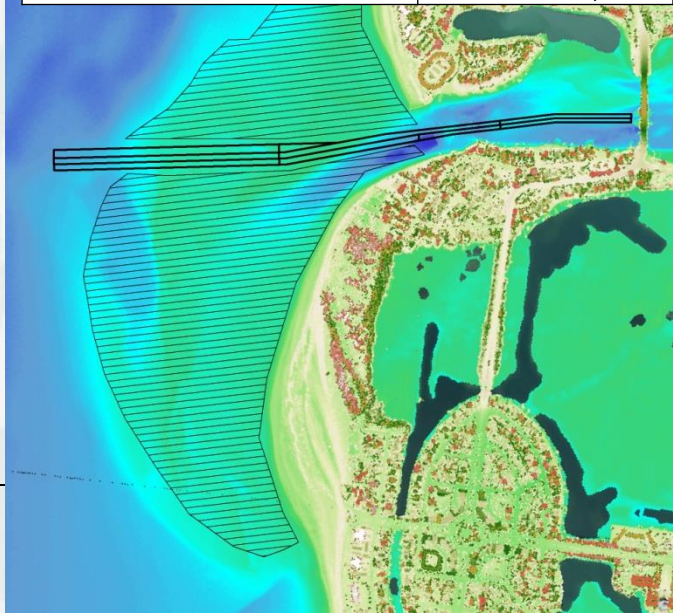
- Migration of sediment in ebb shoal may fill in navigation channels
- Sediment provides nourishment to downdrift beaches and can be mined for projects



- Volume provides input into sediment budget



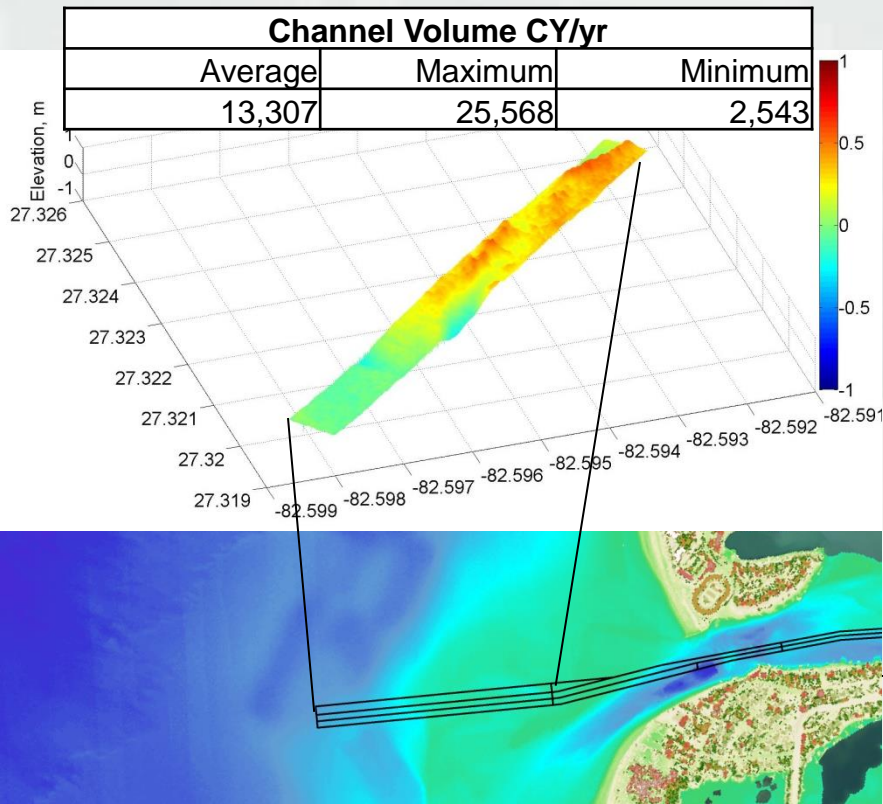
Volume Change (CY)	
Survey	Total
6/2010--6/2004	6,932
6/2010--1/2006	-89,785
2010--11/2004	-65,302
1/2006--6/2004	147,968
1/2006--11/2004	292,443
11/2004--6/2004	-163,402



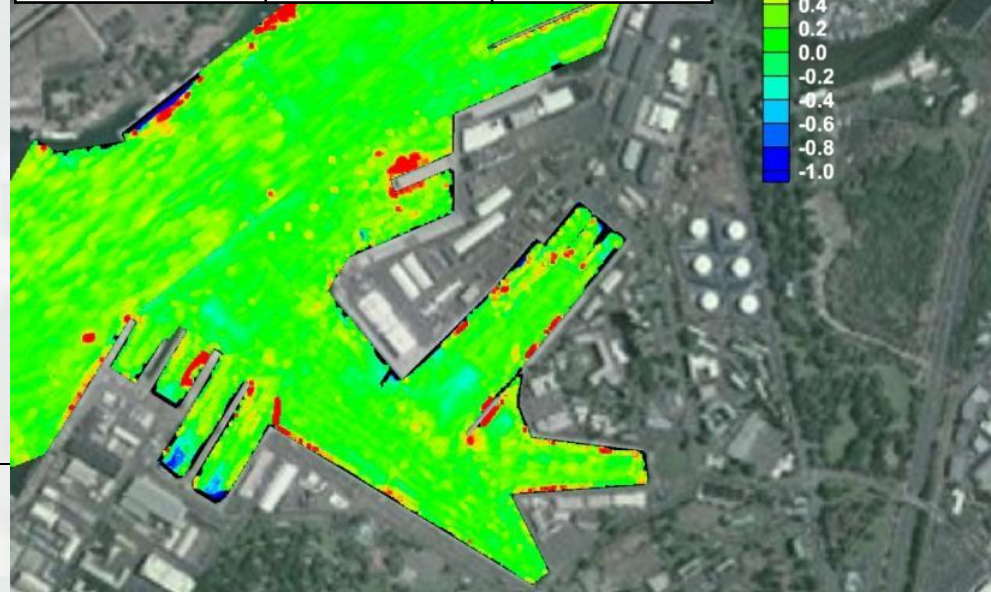


# Channel Navigability

- Channel shoaling can reduce navigability and may require dredging.
- Spatial data used to determine dredging requirements and identify shoaling hotspots and other morphological trends.
- Prioritize dredging needs for shallow draft channels.



Area	Avg. (cu yds/yr)	Max (cu yds/yr)
South Channel	8,514	88,675
South East Loch	11,300	115,069
Total	19,814	203,744



# 2012 Post-Sandy Volume Assessment

Details
Add
Basemap
Save
Share
Print
Measure
Bookmarks

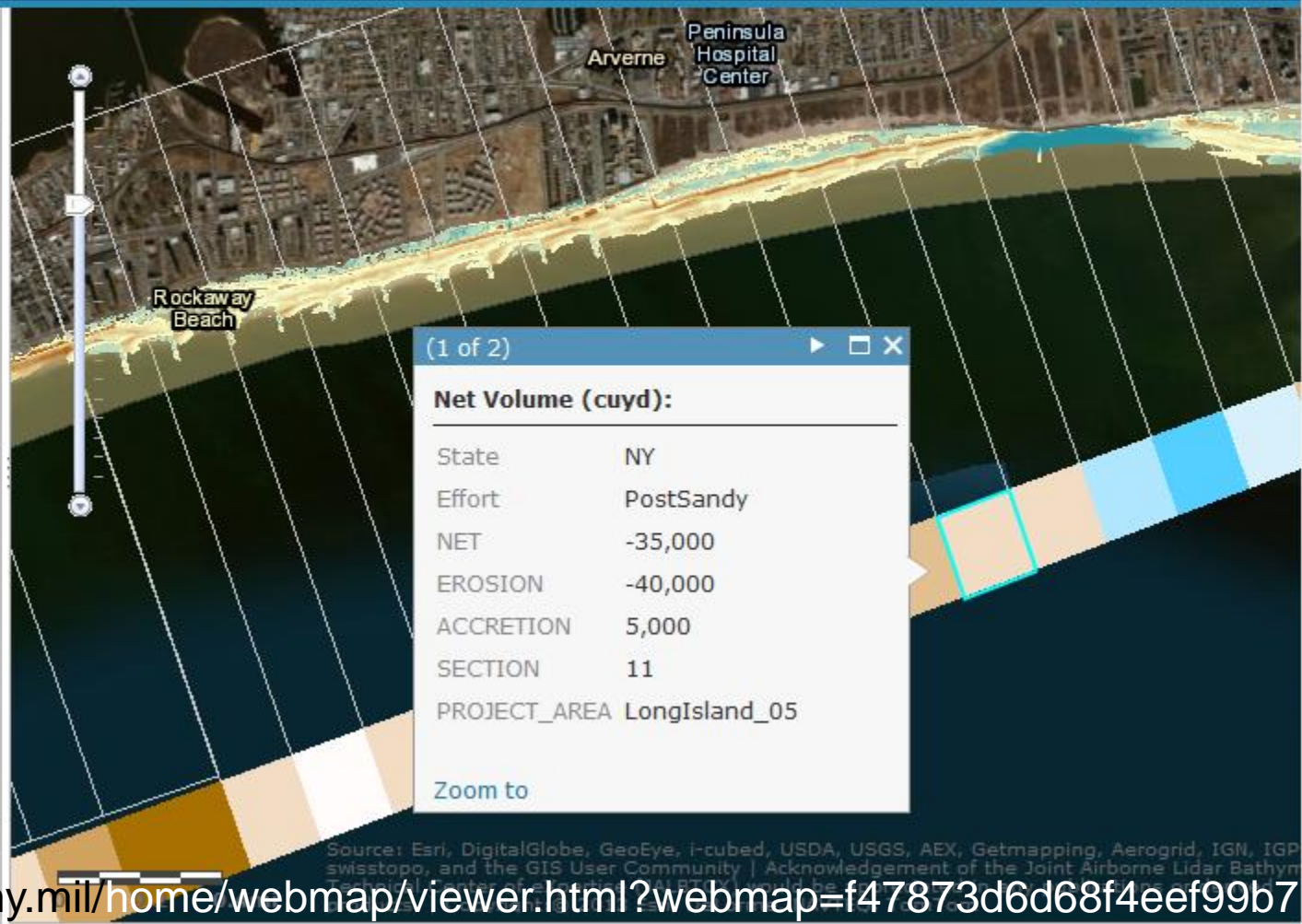
**Legend**

NAD Comparison Areas

Polygons

- <all other values>
- Coney Island
- FIJI\_placement
- Keanesburg
- Lawrence\_Hrabor
- NJ\_1
- NJ\_2
- NJ\_4
- Rockaway\_placement\_are
- WOSI\_placement\_areas
- Westhampton Placement Area
- nj\_3

Alongshore Sections



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community | Acknowledgement of the Joint Airborne Lidar Bathymetry Technical Center of Excellence (JALBTCX) would be appropriate.

# Dune Vegetation Density

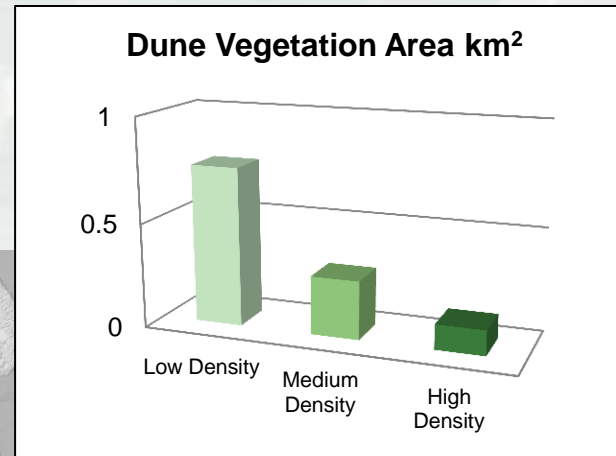
- Helps stabilize dunes and reduces erosion by trapping sand
- Provide habitat for critical species, including TE species

Dune Vegetation Density Area:

Low:  $0.75\text{km}^2$

Medium:  $0.28\text{km}^2$

High:  $0.12\text{km}^2$



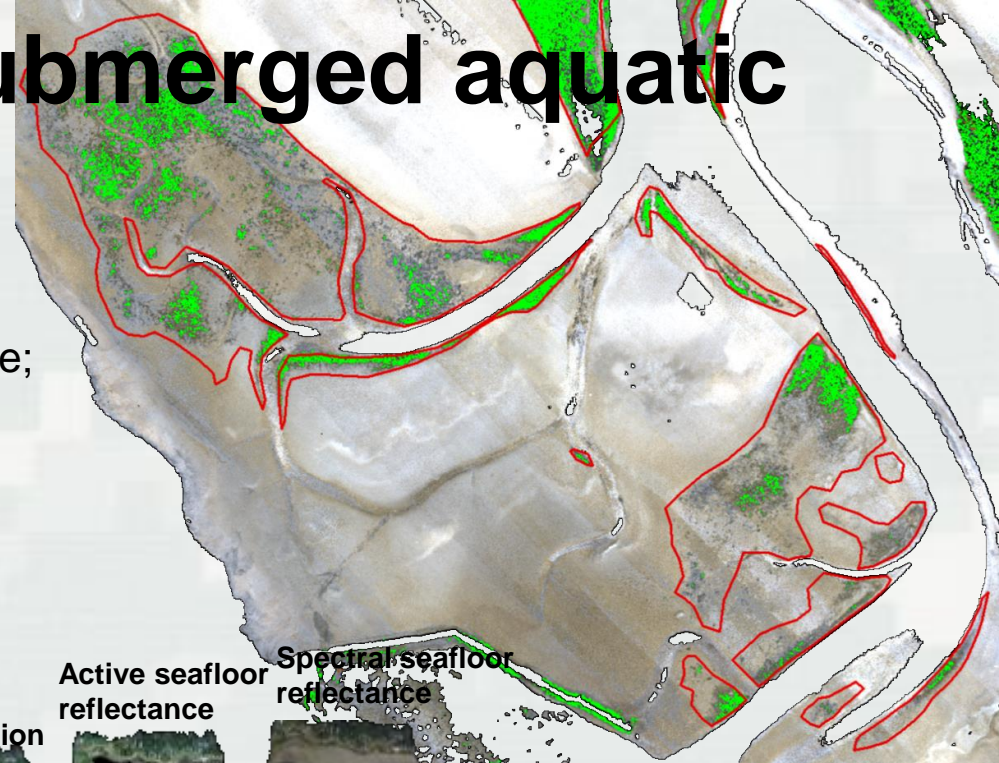
- Extract vegetation within the dune field



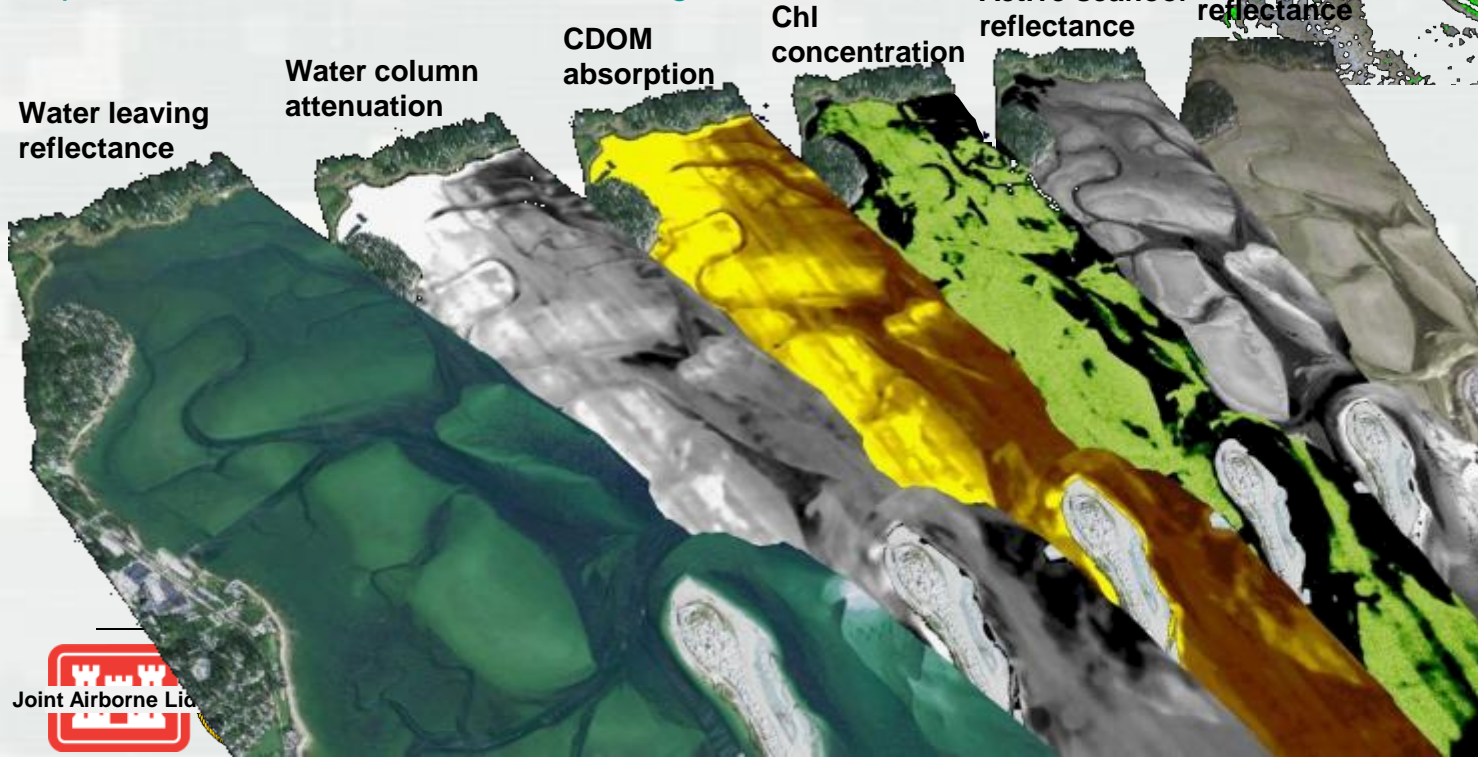
# Discrimination of submerged aquatic vegetation species

**Background:** Dredging impacts to SAV vary by species; CWA lists SAV as a Special Aquatic Site; Mapping species is important for:

- Planning dredging operations
- Mitigating ecological damage
- Monitoring SAV



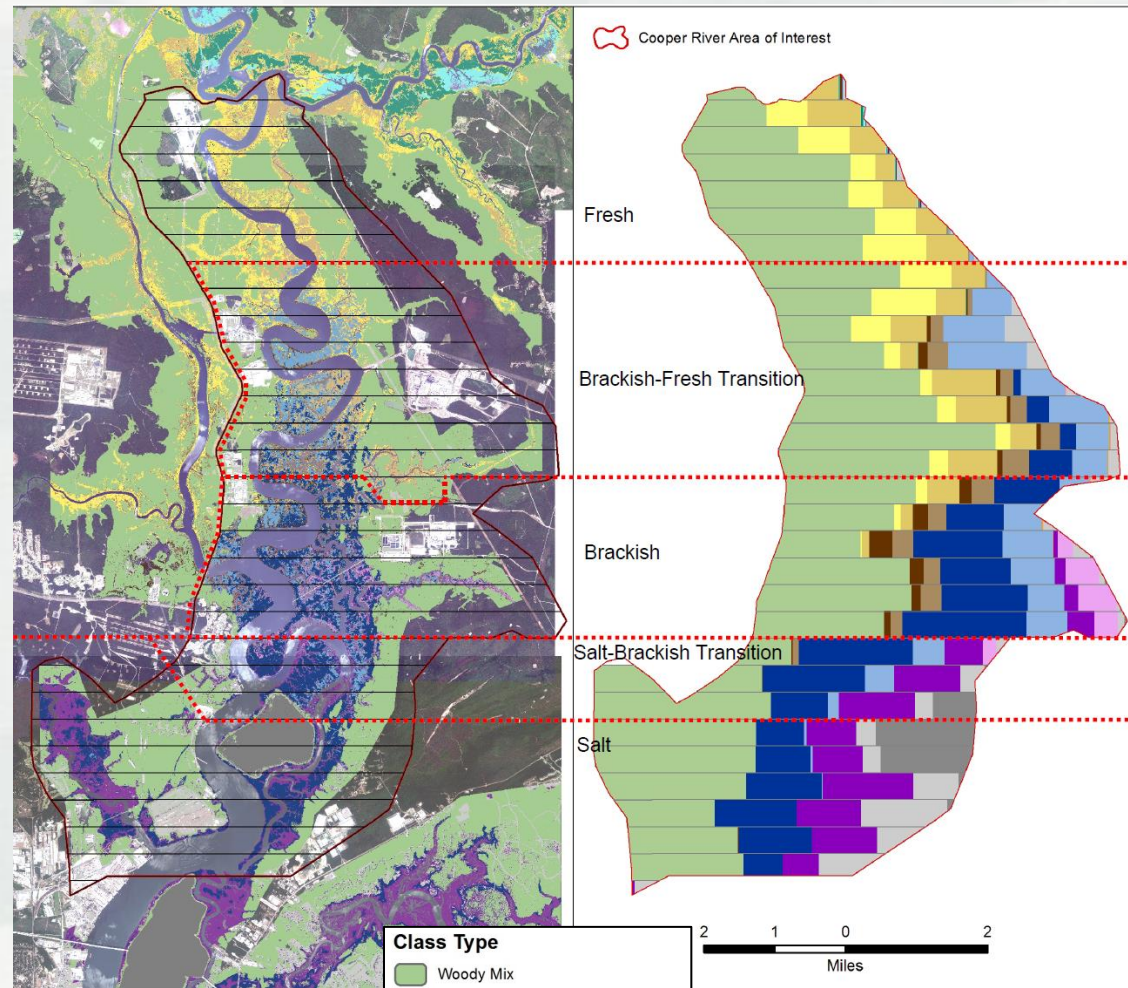
<http://www.coastalamericafoundation.org/savdoer.html>



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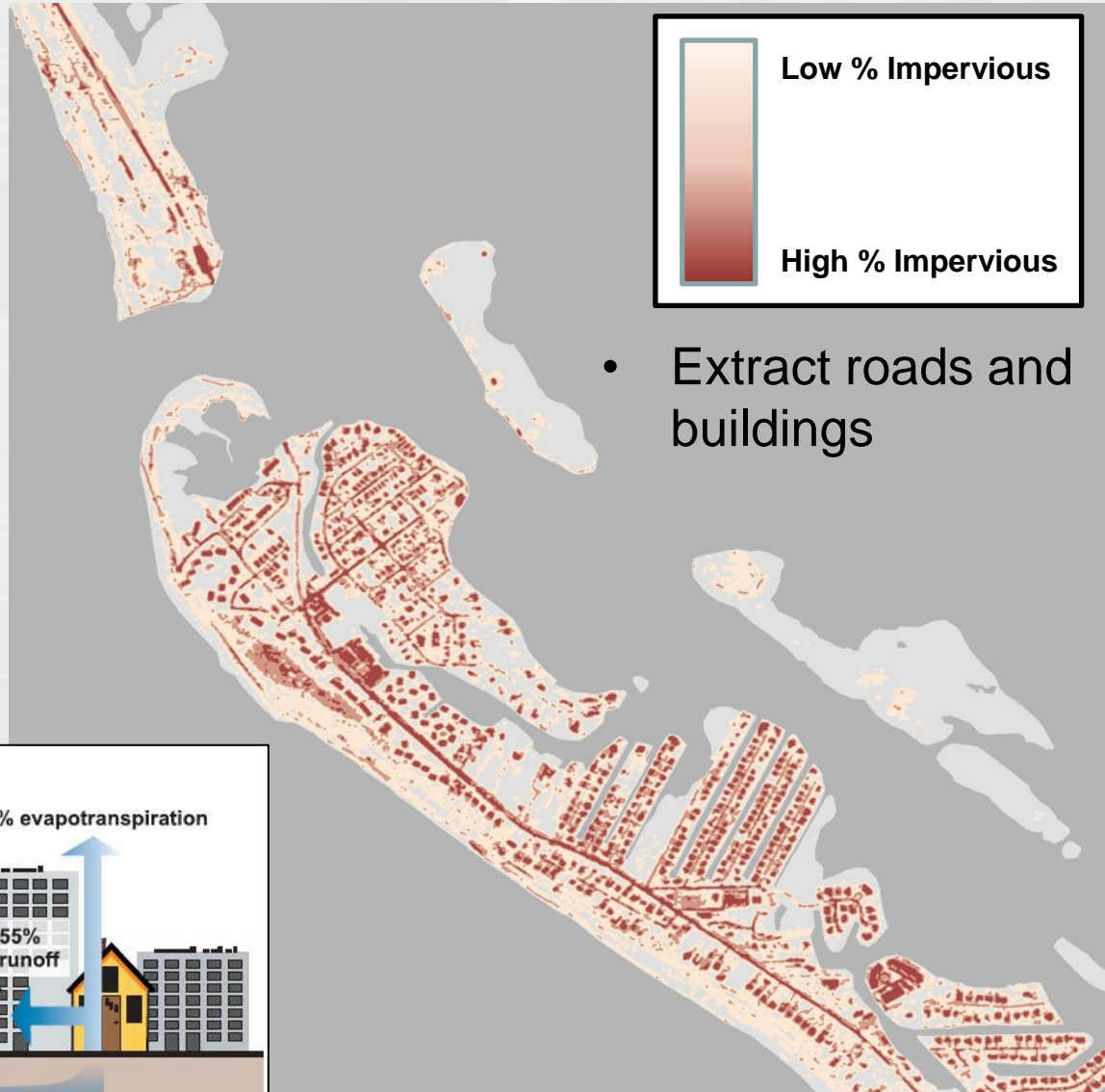
# Wetland Density

- Depict critical transition zones between freshwater, brackish and saltwater marshes:
  - 2,000-ft transect blocks delineated for an area of interest
  - In each block, the percent area of each class type was extracted
- Transect analysis illustrates wetland community distribution and abundance, and critical points of corresponding salinity changes

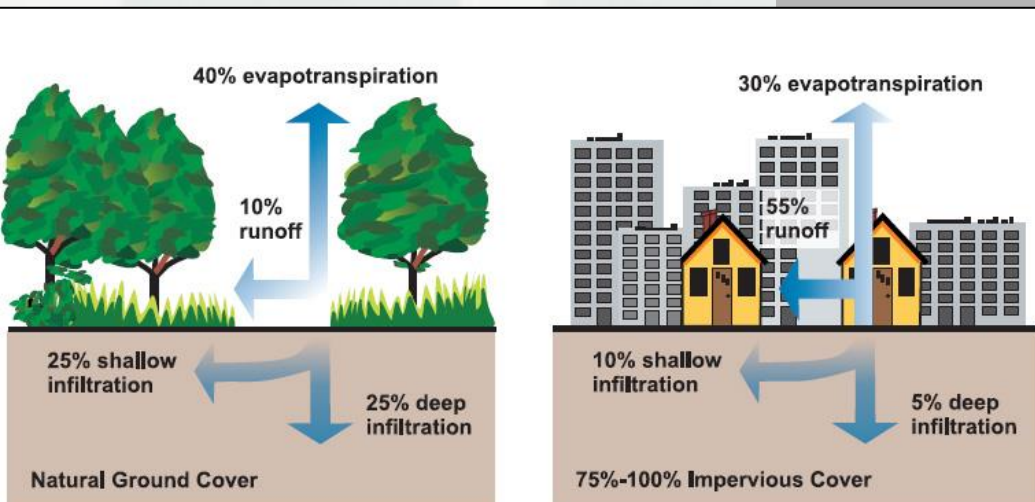


# Impervious Surface Density

- Increase potential for runoff and erosion
- Decrease water filtration and groundwater recharge
- Reduce ecological productivity through decreased water quality and replacement of natural habitat



- Extract roads and buildings



# Coastal engineering indices

combined coastal engineering geomorphology index



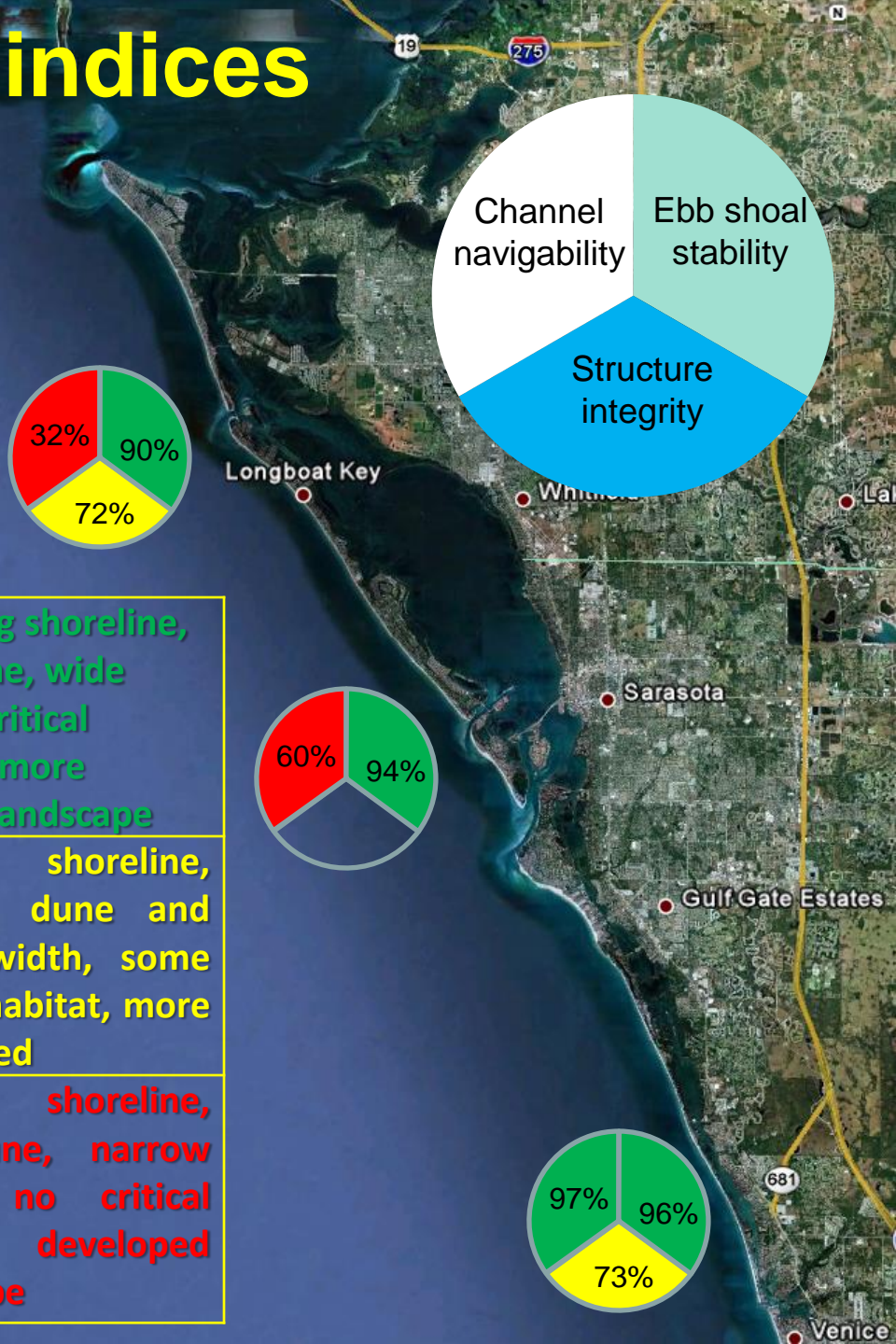
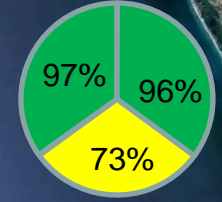
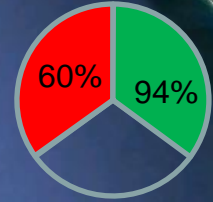
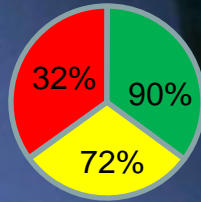
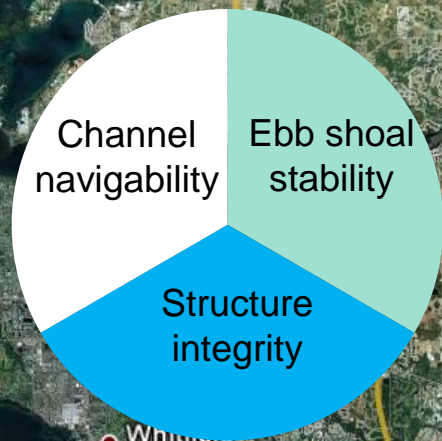
combined environmental index



human use index

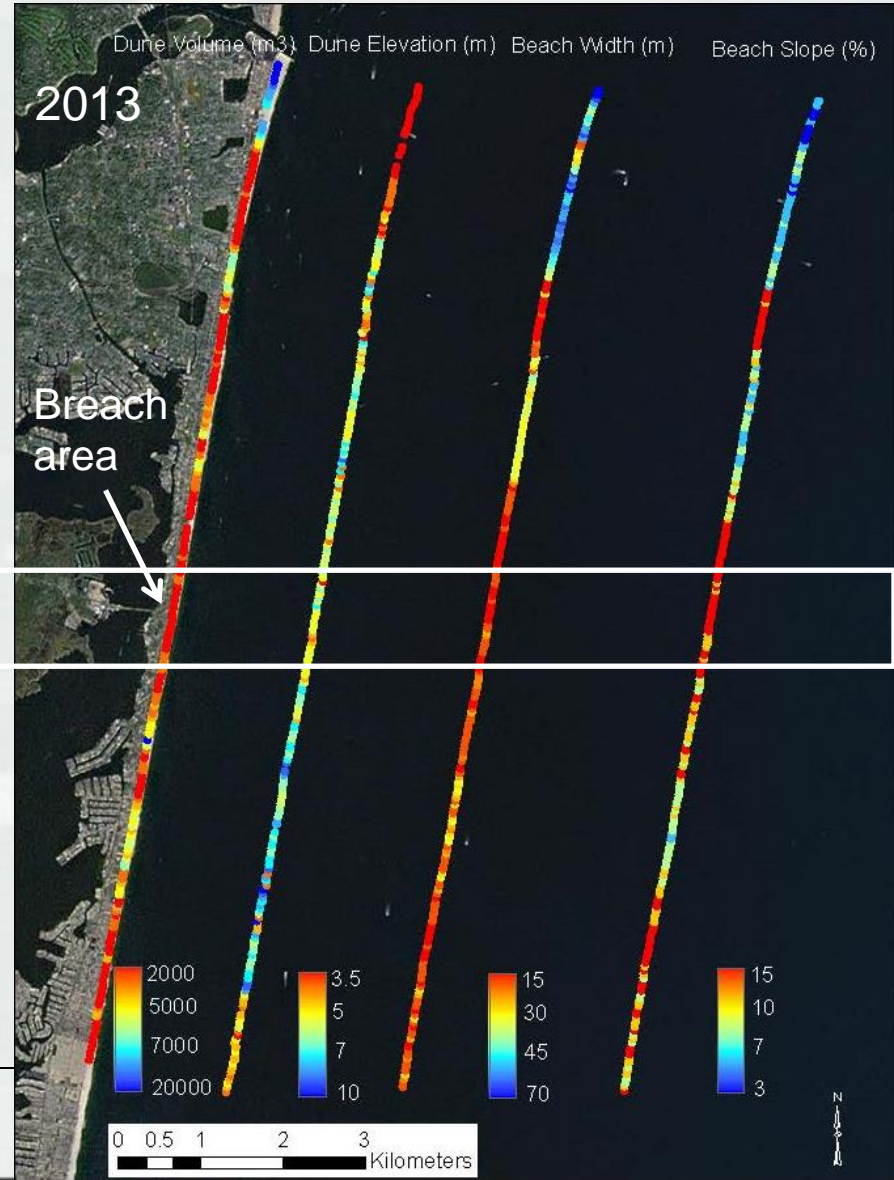
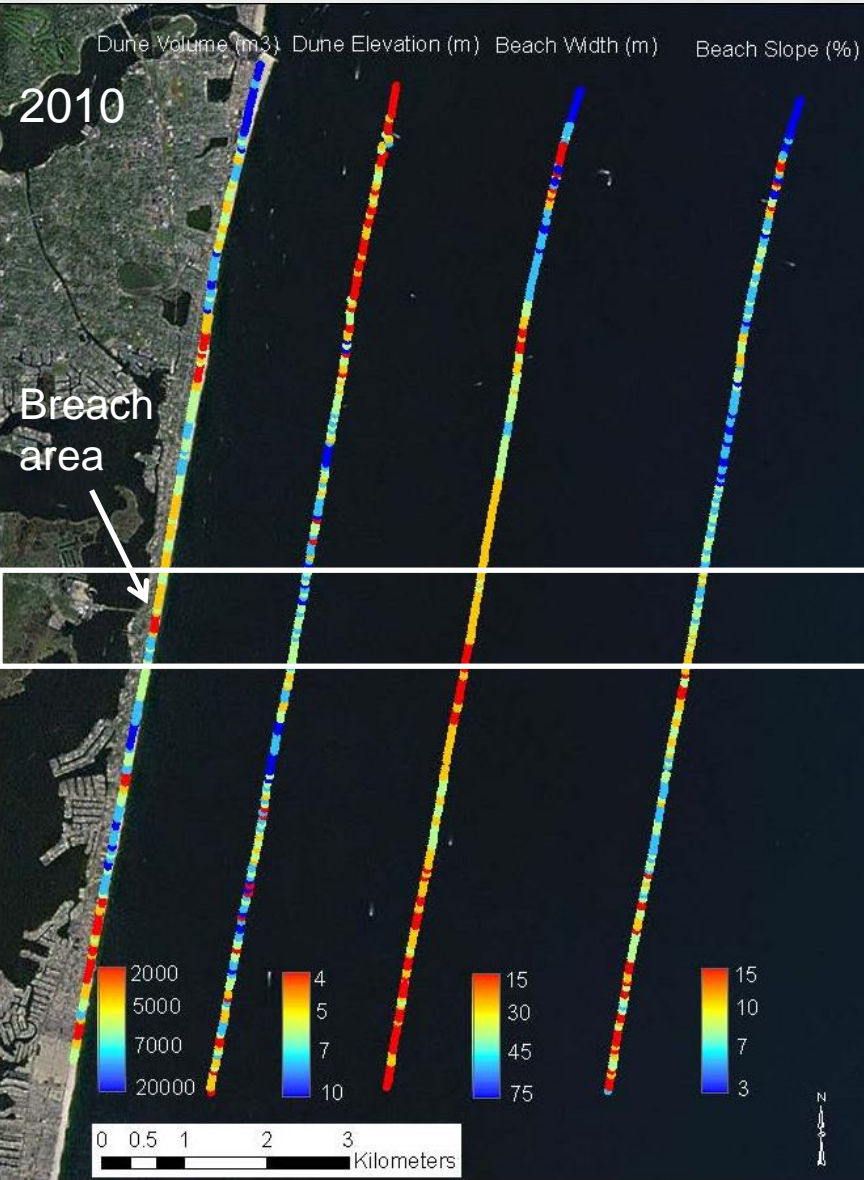


<b>Green</b>	Accreting shoreline, high dune, wide beach, critical habitat, more natural landscape
<b>Yellow</b>	Stable shoreline, medium dune and beach width, some critical habitat, more developed
<b>Red</b>	Eroding shoreline, low dune, narrow beach, no critical habitat, developed landscape



# Mantoloking, New Jersey 2010 vs 2013

	2010	2013
Average Dune Elevation (m)	5.8	5.2
Average Dune Field Volume (m3)	6688	5680
Average Dune Field Area (m2)	1648	1643
Beach Width (m)	32.8	26.7
Beach Slope (%)	8.4	9.8

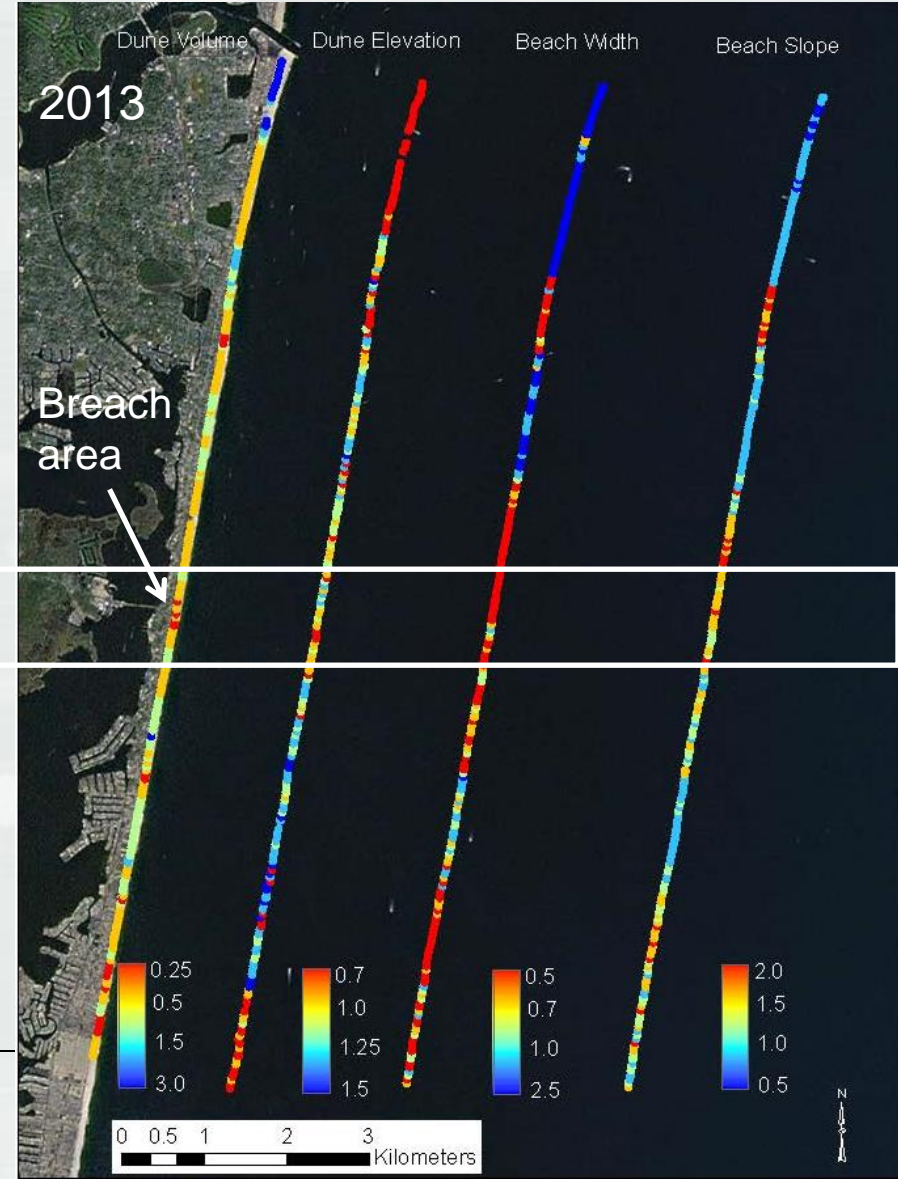
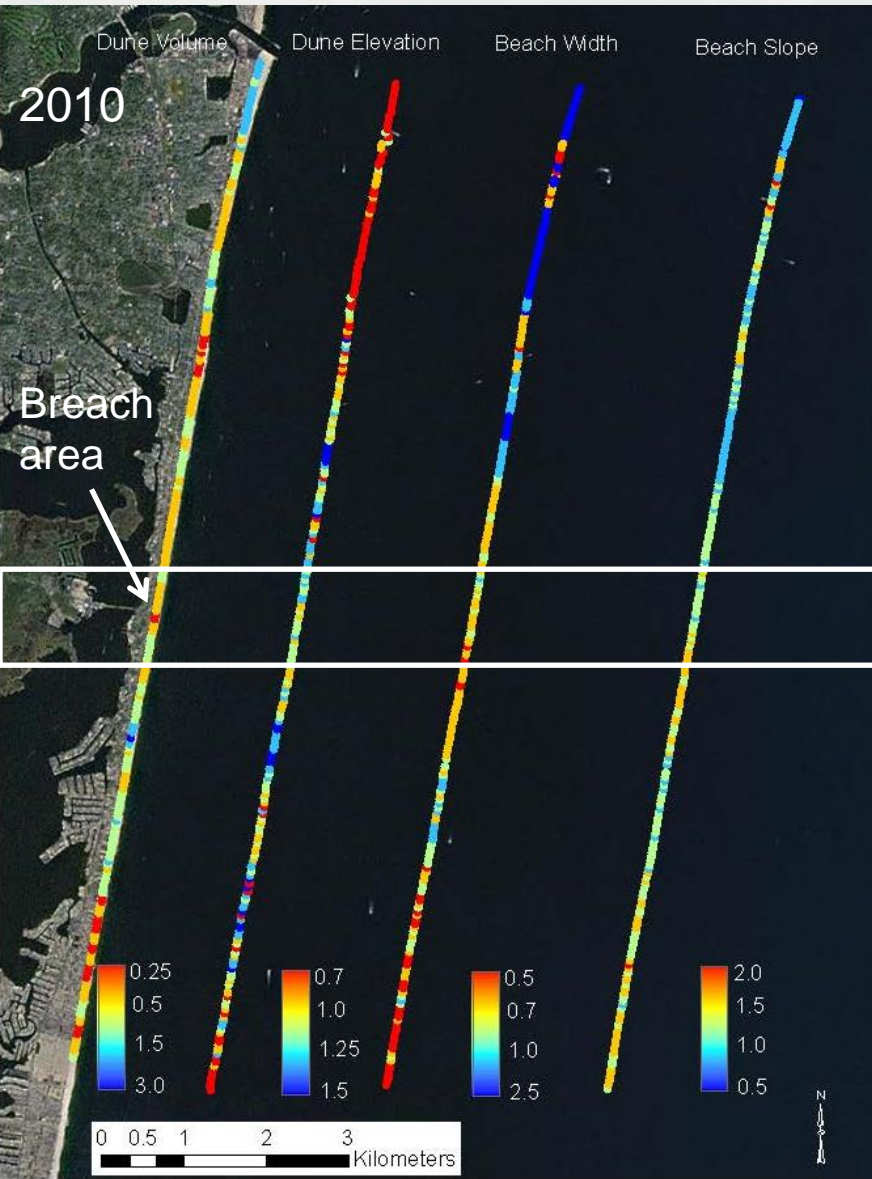




# Mantoloking, New Jersey

## Average Comparison

	2010	2013
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# Quantifying Environmental Goods and Services

## Demographics/ Cadastre

- ▶ Population
- ▶ Schools
- ▶ Public accessibility

## Soils

- ▶ Hydric
- ▶ Infiltration rate

## Habitat

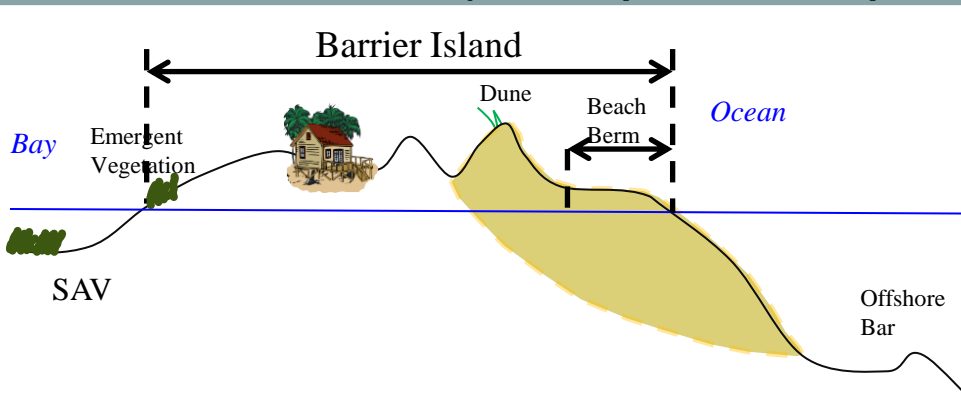
- ▶ T&E species
- ▶ Biodiversity
- ▶ Native/non-native
- ▶ Fisheries
- ▶ Connectivity
- ▶ Transition zones
- ▶ Spatial pattern factor

## Geographic extent of

- ▶ Beach
- ▶ Vegetation cover
- ▶ Mudflat/sandflat
- ▶ Impervious cover
- ▶ Bluff
- ▶ Dune
- ▶ Salt marsh
- ▶ Scrub-wetland brackish/fresh
- ▶ Forest swamp brackish/fresh
- ▶ Maritime shrubland
- ▶ Maritime forest
- ▶ SAV
- ▶ Riparian
- ▶ Herb marsh fresh
- ▶ Pond
- ▶ Terrestrial grass
- ▶ Terrestrial shrub
- ▶ Terrestrial forest
- ▶ Tree cover
- ▶ Water cover
- ▶ Dune vegetation

## Morphology

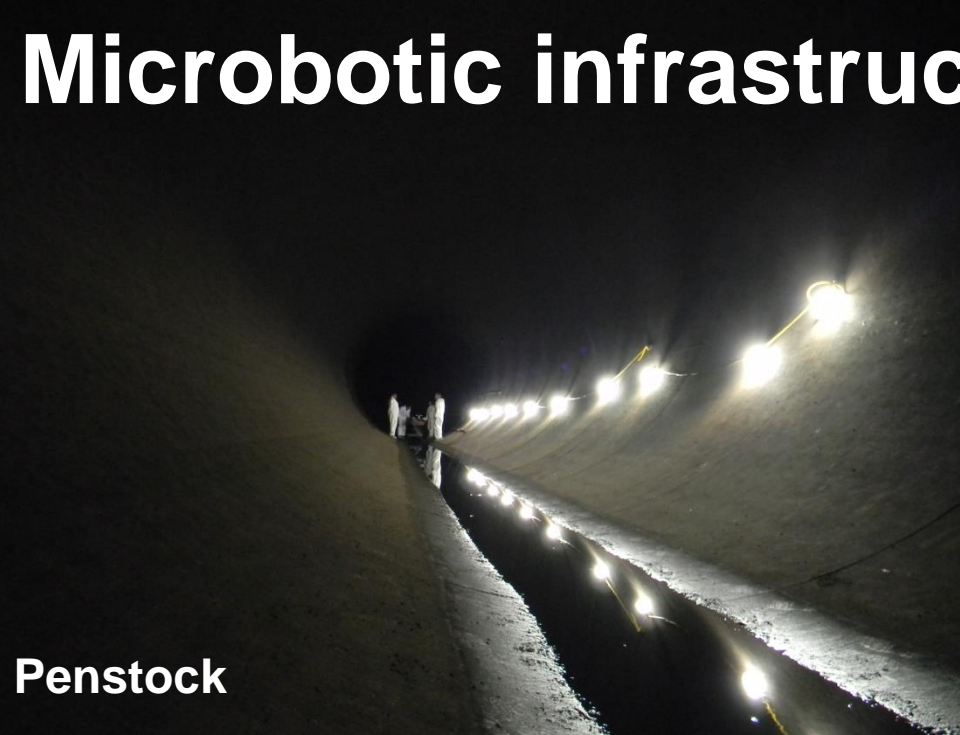
- ▶ Beach height/volume/slope
- ▶ Dune height/volume/slope
- ▶ Watershed size
- ▶ Floodplain size
- ▶ Distance to shore (of offshore features)
- ▶ Length shoreline shadowed (")
- ▶ Height (")
- ▶ Barrier island height/width
- ▶ Distance to inlet
- ▶ Alongshore gradient discontinuities
- ▶ Excursion from equilibrium beach profile (bar volume)



# Microbotic infrastructure assessment

Problem: Inspection of some infrastructure components is high-risk and resource-intensive

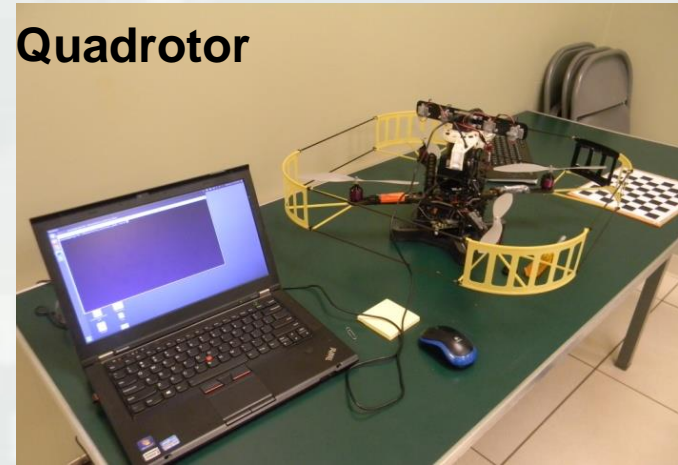
Penstock



Tainter gates



Quadrotor



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# Microbotic infrastructure assessment

## Autonomous Navigation in Confined Indoor Environments with a Micro-Aerial Vehicle

Shaojie Shen and Nathan Michael



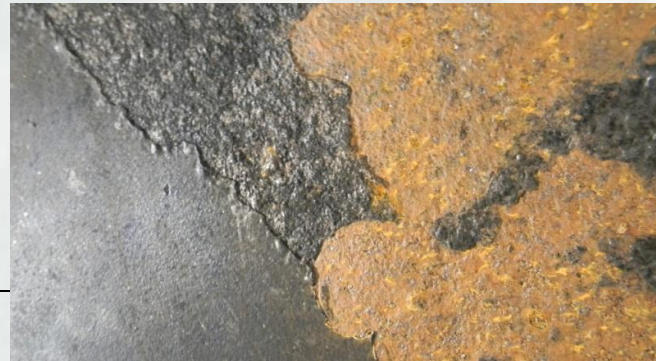
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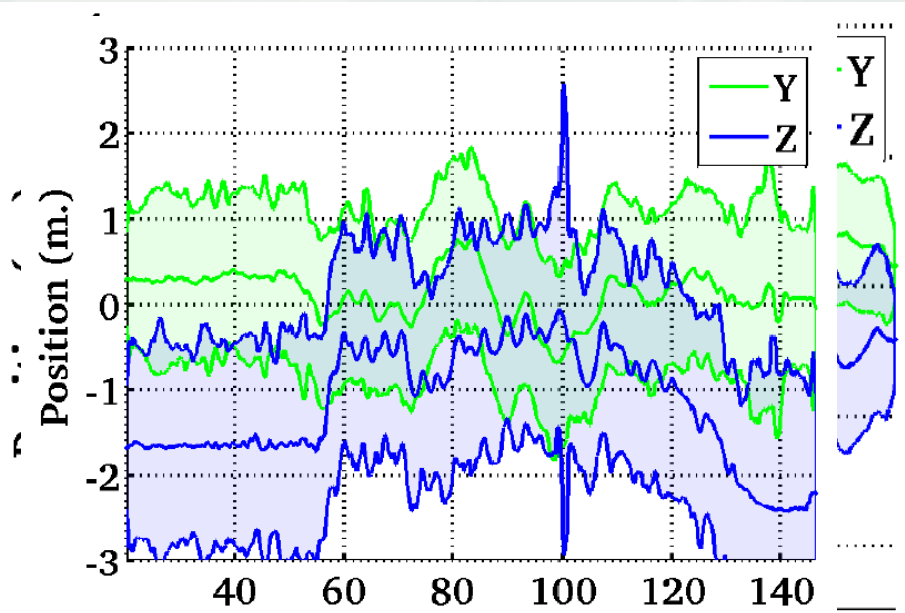
# Microbotic infrastructure assessment

- Challenges to autonomous navigation in penstocks
  - ▶ Constrained, featureless environment
  - ▶ Poor illumination
  - ▶ 3D, not just 2.5D
  - ▶ Dust, water
- Tainter gate challenges
  - ▶ GPS blocking
  - ▶ Curvature of gates

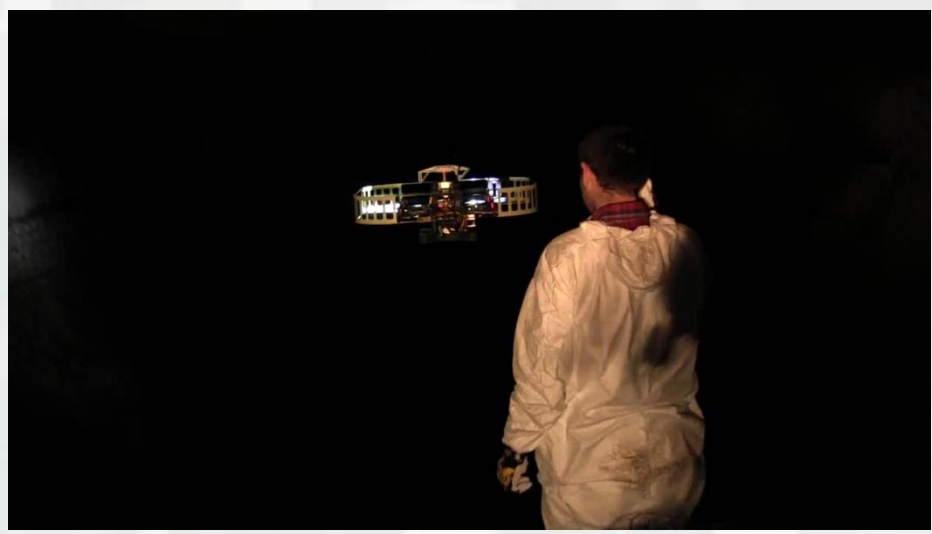


# Microbotic infrastructure assessment

□ Quadrotor flies in the horizontal, circular-cross-section portion of the tunnel



-User command to increase height  
 -Sensor occlusion by human  
 -Temporary failure of Y estimation followed by a recovery  
 -Wet surfaces and puddles cause sensor failure



- 8/19/13 Site Visit, Allatoona Lake, Penstock

*Shaded regions represent uncertainty in estimation*



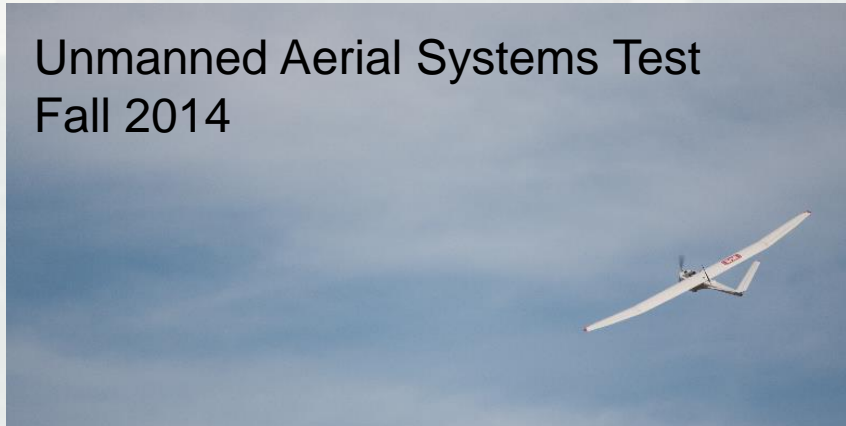
# Microbotic infrastructure assessment



➤ <https://www.youtube.com/watch?v=3jkWU9o5UIA>

<http://youtu.be/1Y-jNXrqEhs>

Unmanned Aerial Systems Test  
Fall 2014



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# Questions?

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