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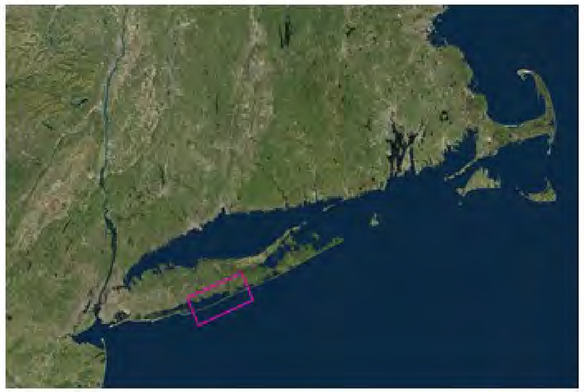
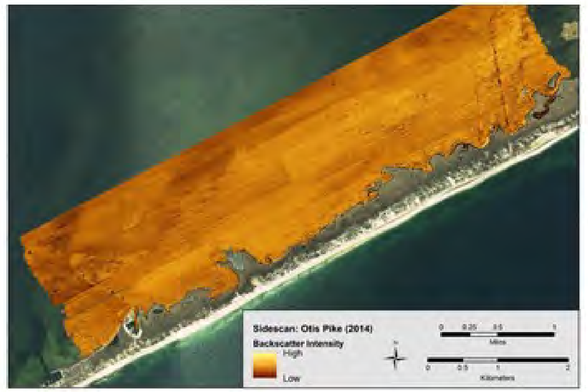
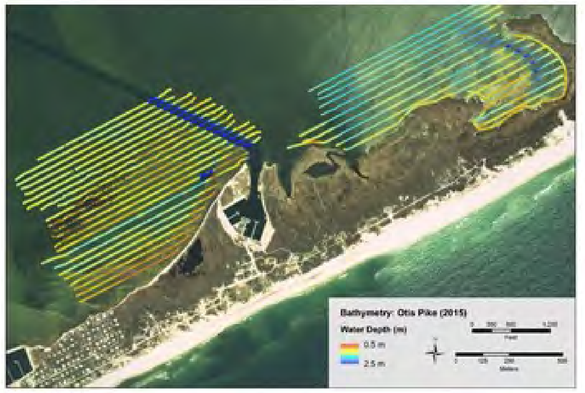
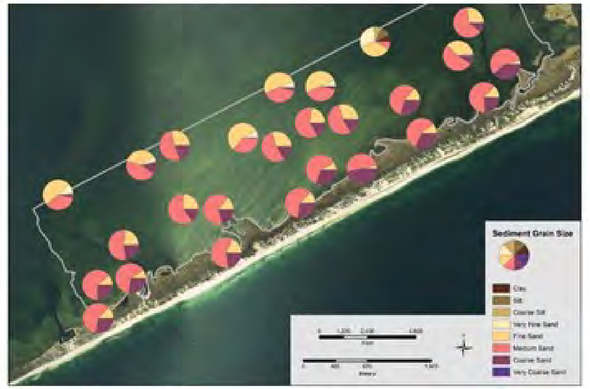
Coastal & Ocean Advisory and Support Team

Benthic habitat mapping to meet the needs of the National Park Service: An Example from Fire Island National Seashore Post-Hurricane Sandy









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Bryan A. Oakley – Eastern Connecticut State University

IOCM Seminar Series hosted by OneNOAA Science Seminars
26th August 2020

Presentation Overview

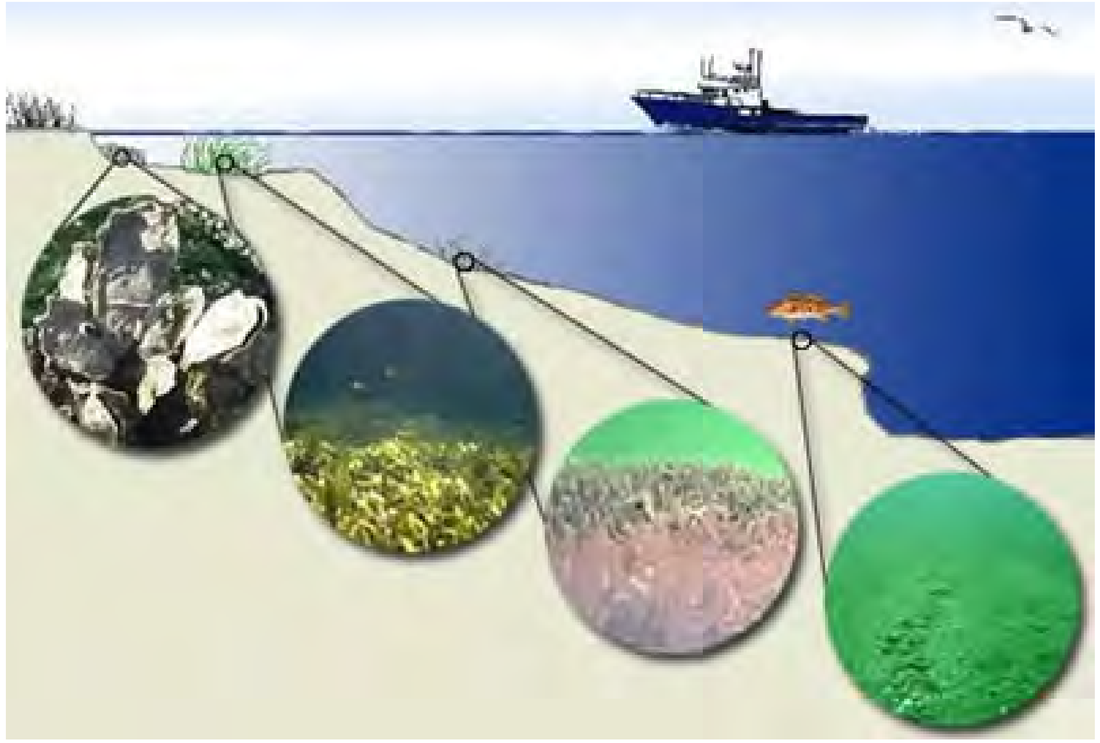
- Introduction to benthic habitat mapping and CMECS
- Value of benthic habitat mapping
- Fire Island National Seashore (FIIS) mapping project and management implications
- Reiterate value of benthic habitat mapping
- Benthic habitat mapping effort underway for all coastal and Great Lakes National Park Units

What is benthic habitat mapping?

- **Benthic** = Associated with the seafloor

- **Benthic habitat** = “a spatially defined area where the physical, chemical, and biological environment is distinctly different from the surrounding environment” (Kostylev et al., 2001)

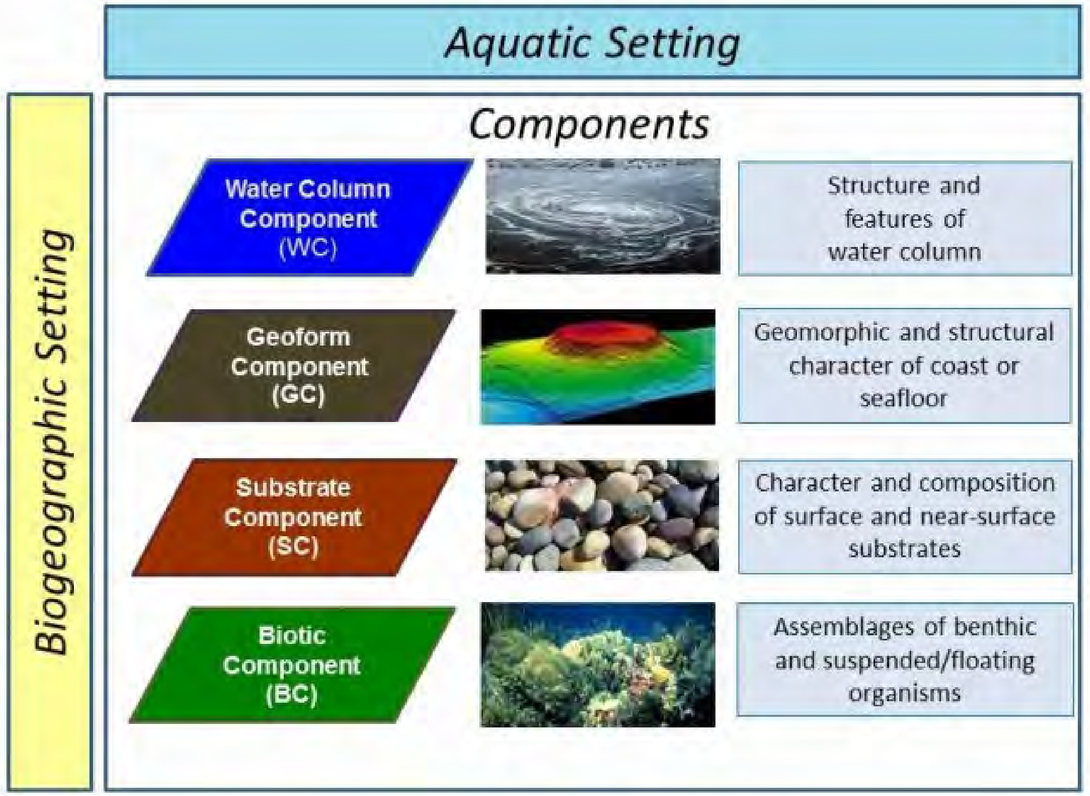
- **Benthic Habitat Mapping** = Illustrates biological & physical characteristics, distribution, and extent of seafloor environments in a geo-spatial context



From left: oyster bed, seagrass meadow, amphipod tube mat, sand flat.
(From *NOAA Coastal Services Center)*

CMECS

- Coastal and Marine Ecological Classification (CMECS)
- Framework provides common language
- Hierarchical structure
- Adopted by the FDGC in 2012 as the national standard



FGDC, 2012

biotope

Value of benthic habitat mapping

- Establish baselines or assess change
- Improve understanding of benthic habitats & ecosystem processes
  - Distribution, patterns, processes
  - Establish meaningful relationships
  - Develop habitat prediction models
  - Support other research efforts
  - Identify data gaps
- Identify habitats and species that are
  - Important food sources
  - Economically valuable
  - Sensitive / in need of protection
- Guide science- and ecosystem-based management strategies
- Better understand, assess, anticipate, and mitigate impacts caused by climate change, human activities, and natural processes

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Response to Hurricane Sandy

- Four concurrent mapping studies (2014-2018)
- One of first comprehensive habitat mapping studies undertaken by NPS
- **Goals:**

✓ Inventory of benthic resources and habitats

✓ Increase understanding of ecosystem structure and function on multidisciplinary level

✓ Understand changes due to Hurricane Sandy

✓ Develop baseline datasets, address data gaps

✓ Demonstrate the value of mapping and CMECS

✓ Demonstrate applicability for promoting resource stewardship and guiding science- and ecosystem-based management strategies

✓ Contribute to field of habitat mapping

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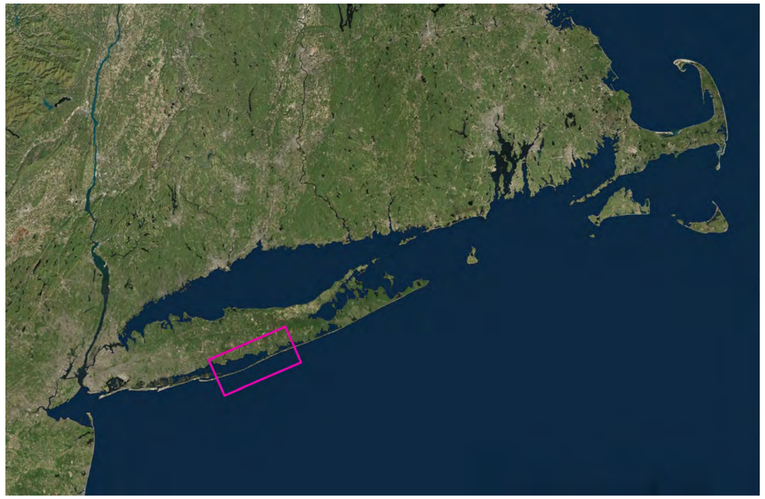
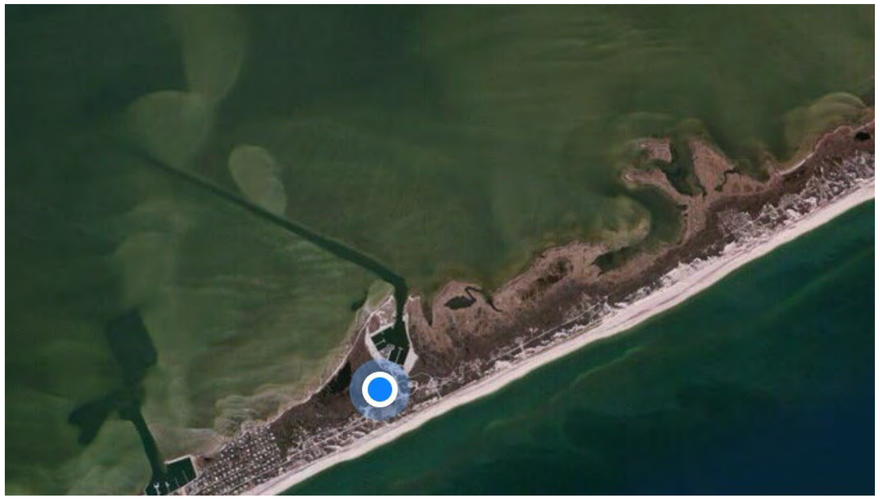
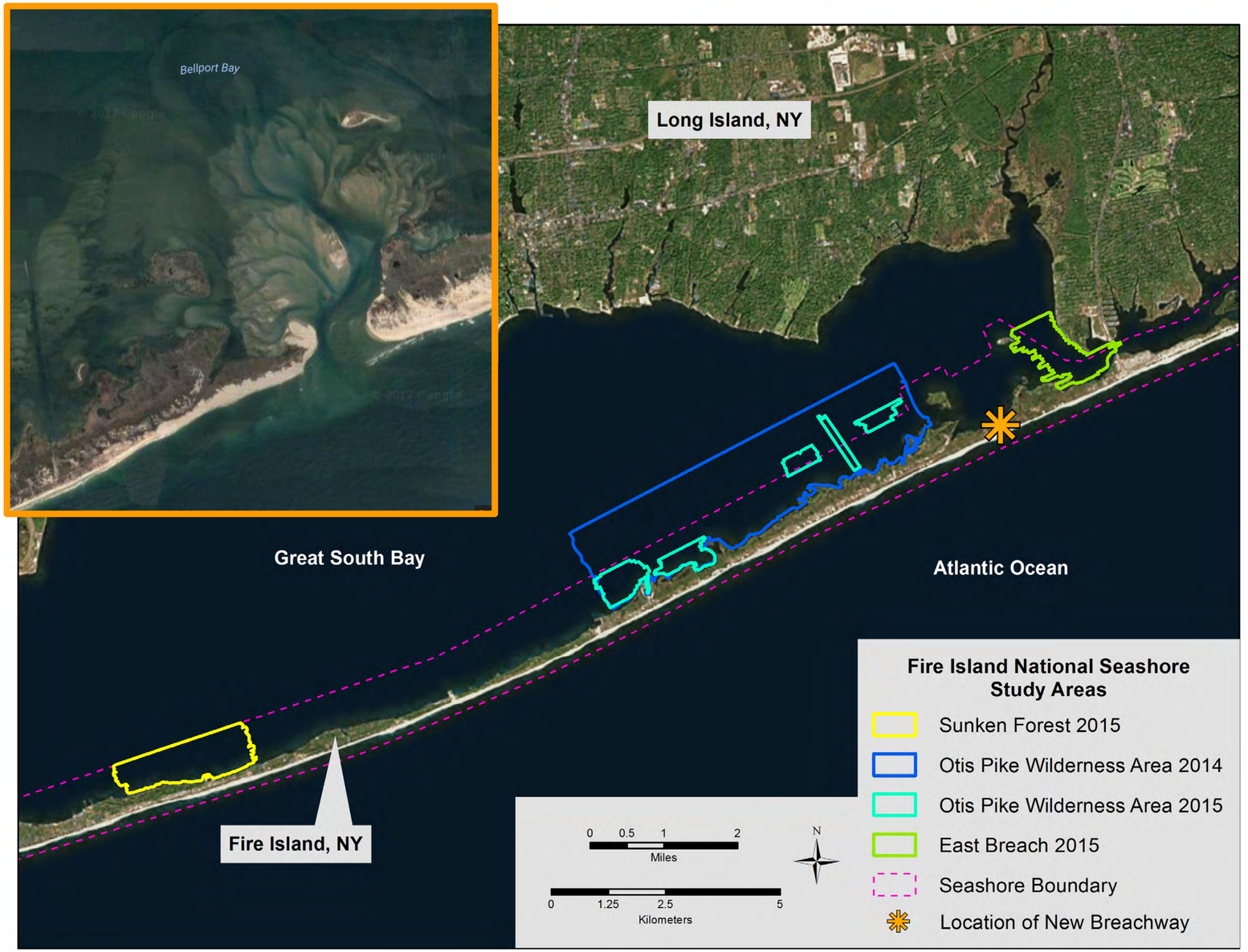




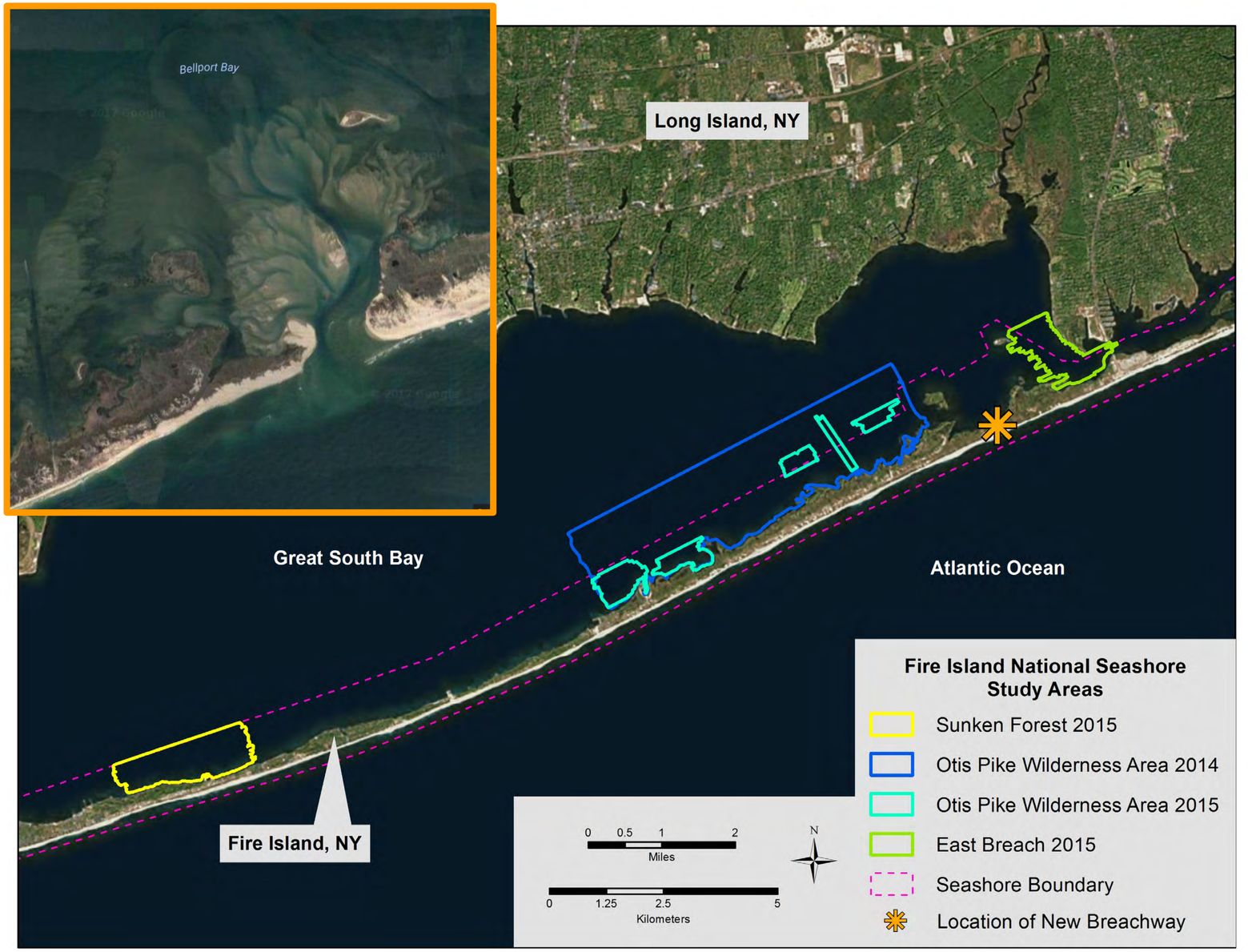
Addressing management needs

- What is needed??
  - Comprehensive baseline datasets
  - Infer changes
- Fueled by:
  - Hurricane Sandy
  - New breach → tidal inlet
  - Limited data
- Altered environmental conditions and associated biological communities



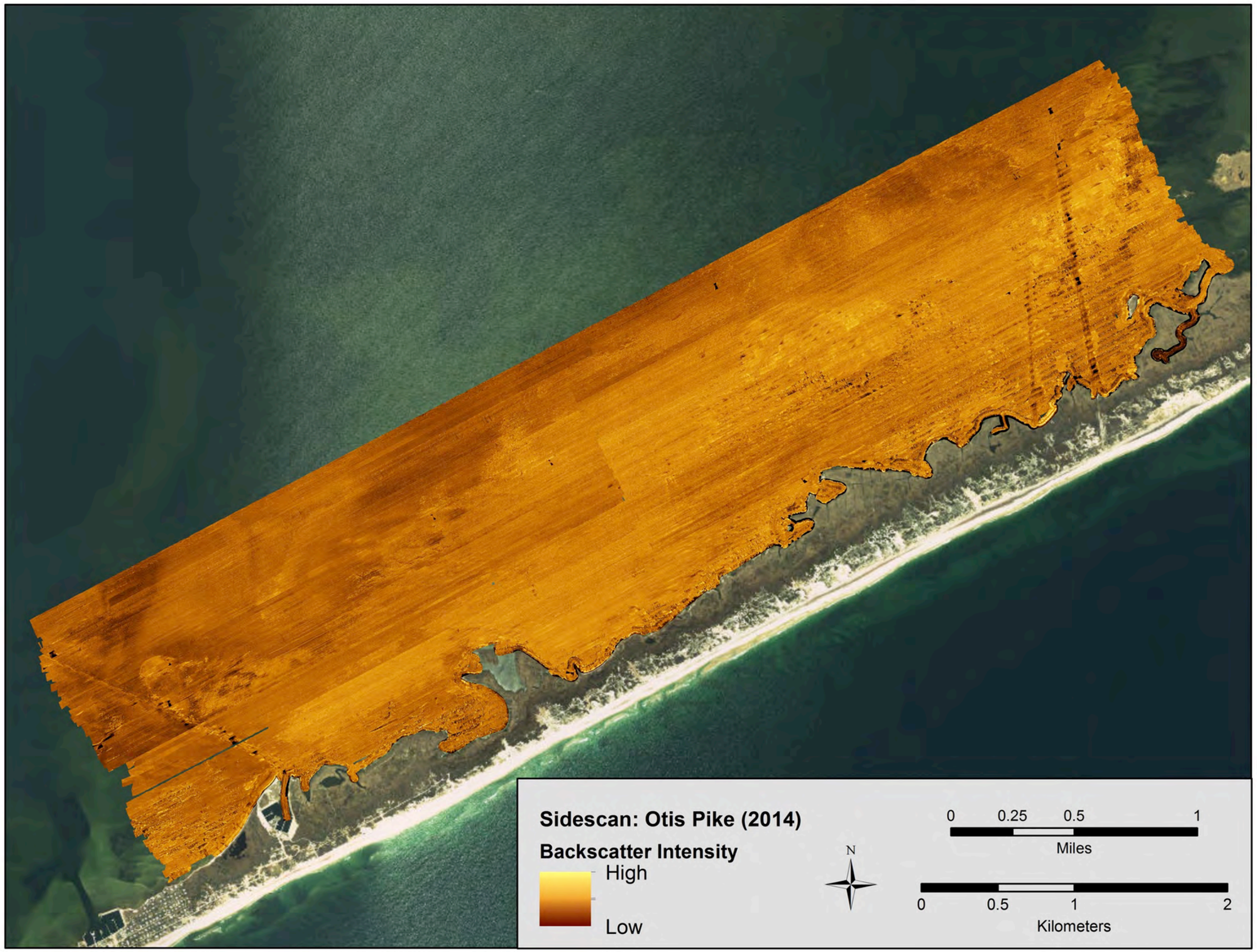
Mapping summary

- Study areas = Otis Pike, Sunken Forest, East Breach
- Sidescan = full coverage
- Bathymetry = partial coverage
- Grab Samples = sediment grain size & biology
- Imagery = Sediment Profile Imagery (SPI)

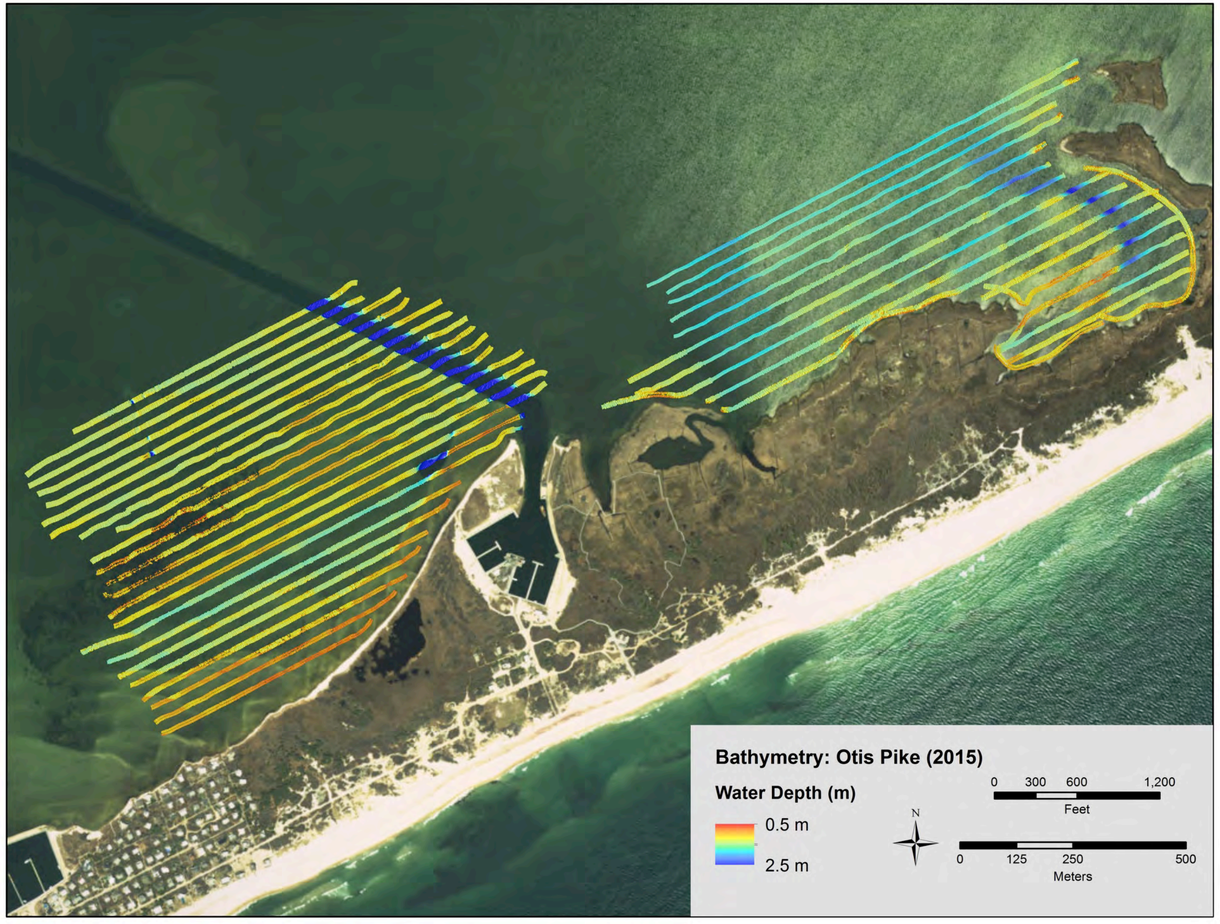


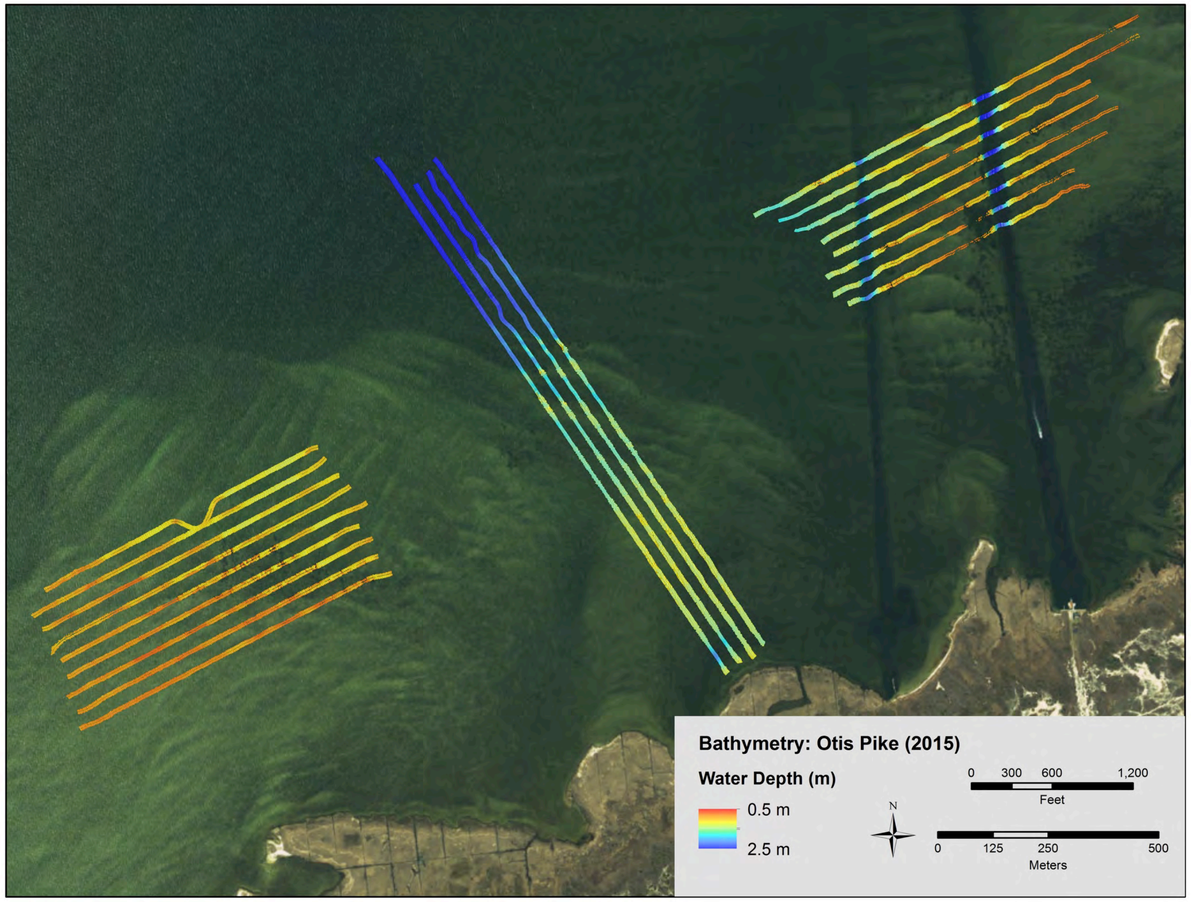
Otis Pike sidescan

- Full coverage
- 25 cm pixel resolution
- Sandy environment
- Seagrass beds



Otis Pike bathymetry



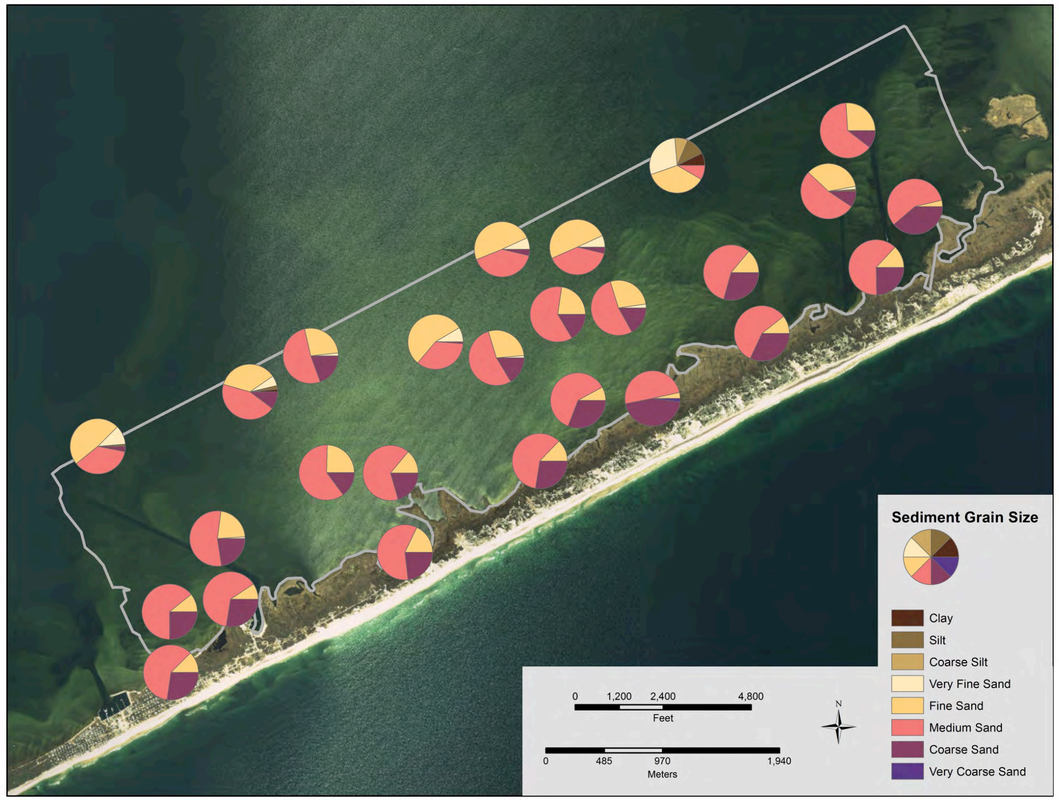


- Partial coverage
- 25 cm pixel resolution
- Very shallow

Otis Pike grab samples

- Sediment grain size
- Total organic content
- Macrofauna community composition

- Dominate sediment type = coarse, medium, and fine sands



Dominant macrofauna

AMPHIPODS

Ampelisca vadorum

Ampelisca verrilli

POLYCHAETES

Polygordius sp.

Owenia fusiformis

Polydora ligni

BIVALVES

Gemma gemma

Mulinia lateralis

Mytilus edulis

ECHINODERMS

Leptosynapta tenuis

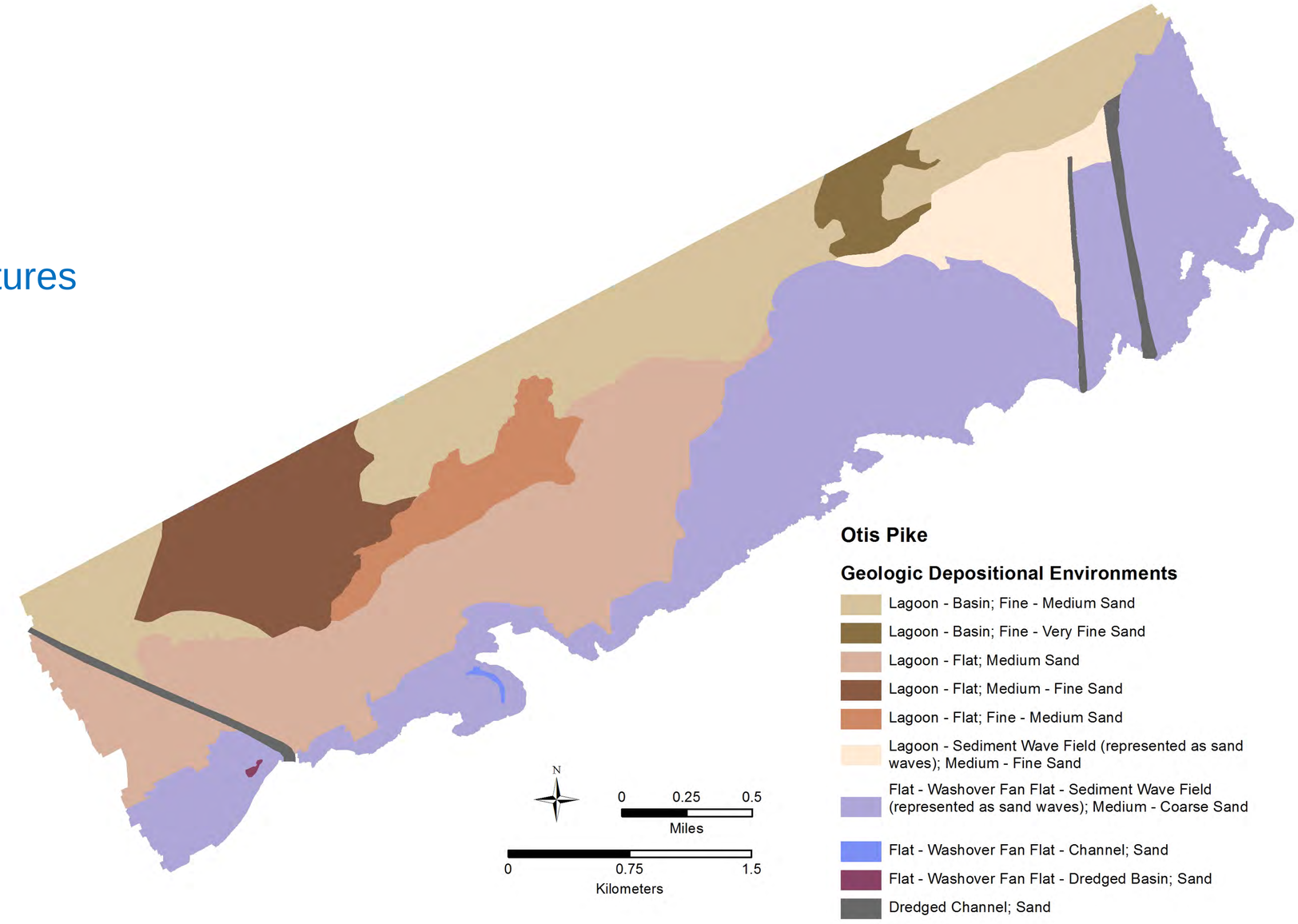
NEMATODES

Nematoda sp.

A. vadorum: http://indianriverblog.blogspot.com/2005/12/ampelisca-abdita-vs-anpleisca-vadorum.html
A. verrilli: http://www.marinespecies.org/aphia.php?p=taxdetails&id=101445
Polygordius: http://www.macrofauna.cl/fi/Poligordius_sp.html
O. fusiformis: https://www.marlin.ac.uk/species/detail/1703#:~:text=Owenia%20fusiformis.
P. ligni: https://naturalhistory2.si.edu/smsfp/irlspec/Polydora_ligni.htm#:~:text=Polydora%20mudworm,%20Polydora%20ligni.%20Photograph%20USGS%20NAS%20Program.
G. gemma: https://invasions.si.edu/nemesis/browseDB/SpeciesSummary.jsp?TSN=81511#:~:text=Image%20courtesy%20of%20Melissa%20Frey,%20Royal%20BC%20Museum
M. lateralis: https://catalog.shellmuseum.org/shells/southwest-florida-shells/mulinia-lateralis
M. edulis: https://inaturalist.ca/taxa/117650-Mytilus-edulis
L. tenuis: https://commons.wikimedia.org/wiki/File:Leptosynapta_tenuis_(YPM_IZ_031381).jpg
Nematode: https://www.aphotomarine.com/nematode_newlyn_harbour_08-04-15.html#:~:text=Marine%20nematode%20Species%20unknown%20-3%20-%20from%20sample%20of%20fouling

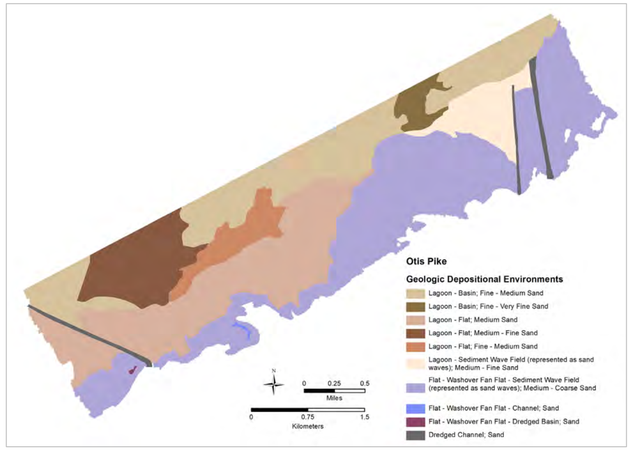
Otis Pike geology

- Large & small scale geological features
- Dominant sediment type
- Interpreted from:
  - Sidescan
  - Sediment grain size
  - Bathymetry
  - Aerial imagery
- Follows CMECS classification



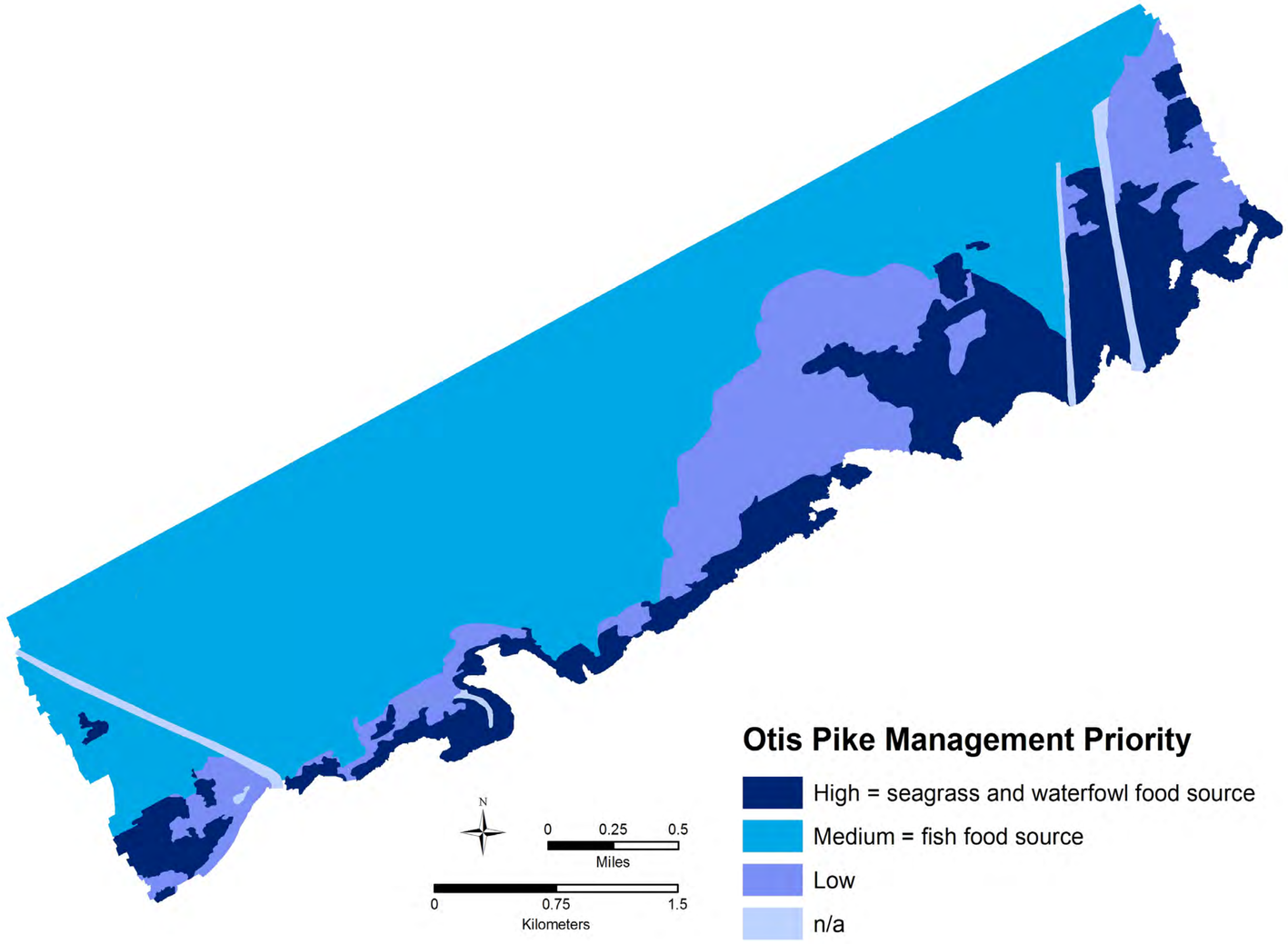
Habitat (biotope) classification

- Biotopes = habitats integrating biological and environmental attributes
- Biological component now integrated via CMECS Biotic component
- Found statistically significant relationship between biological communities and Geoform Level 1 component
  - ANOSIM R = 0.38 (p = 0.001)

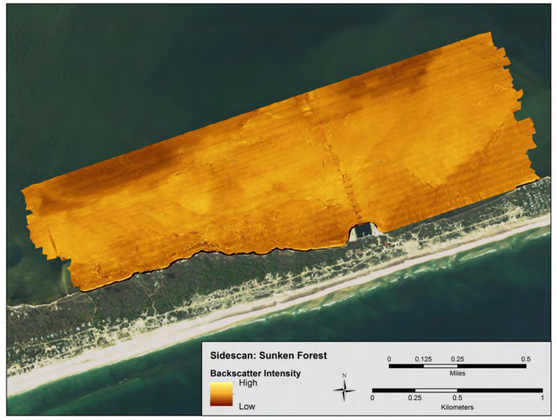


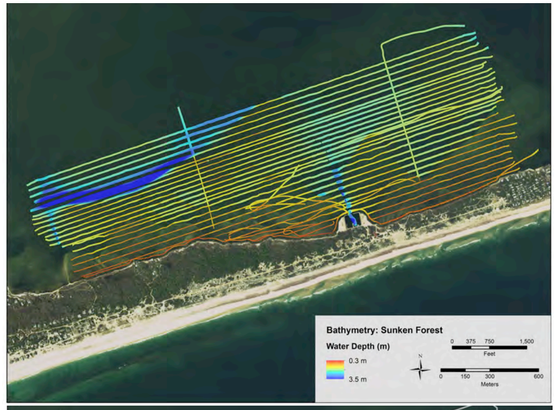
Science → Management

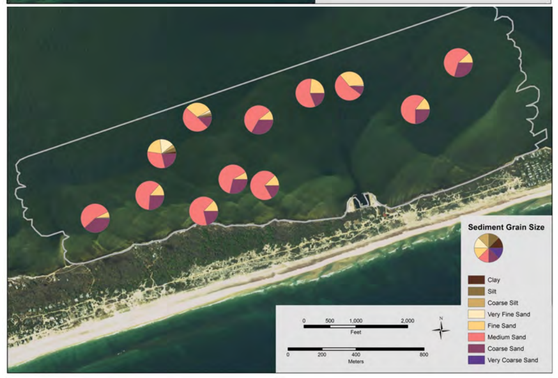
- Can prioritize biotopes with respect to relative ecological value
- User-defined set of criteria, e.g.
  - Presence of seagrass
  - Food source for fish and/or waterfowl
- **High** = areas that have both seagrass and offer food source to fish and/or waterfowl
- **Medium** = seagrass or food source
- **Low** = neither present

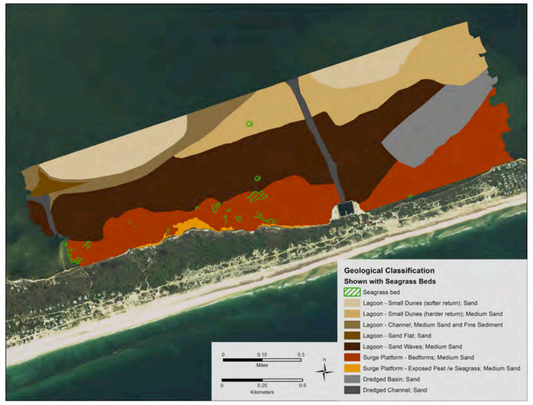


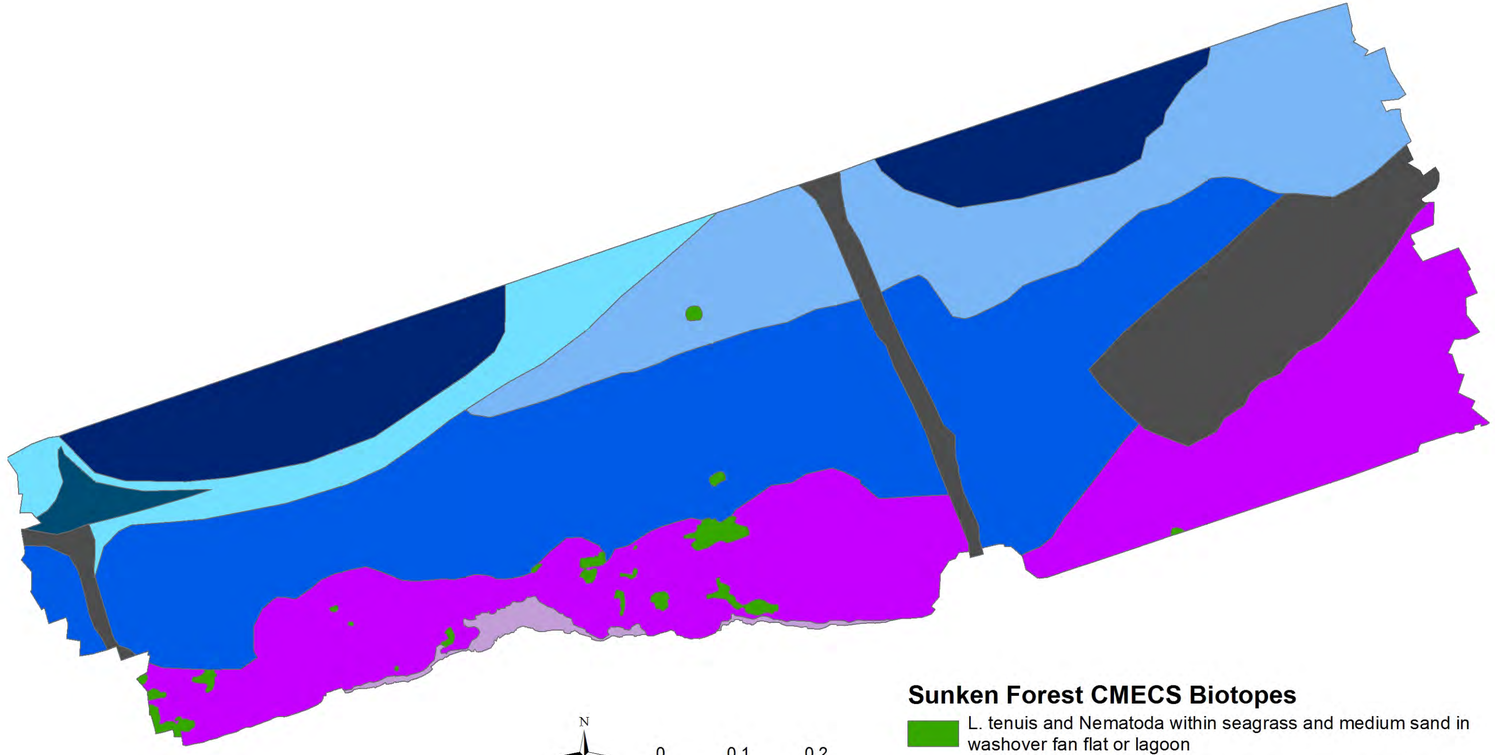
Sunken Forest → Repeat process

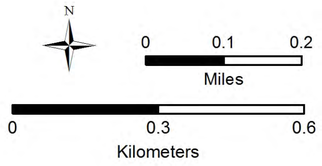








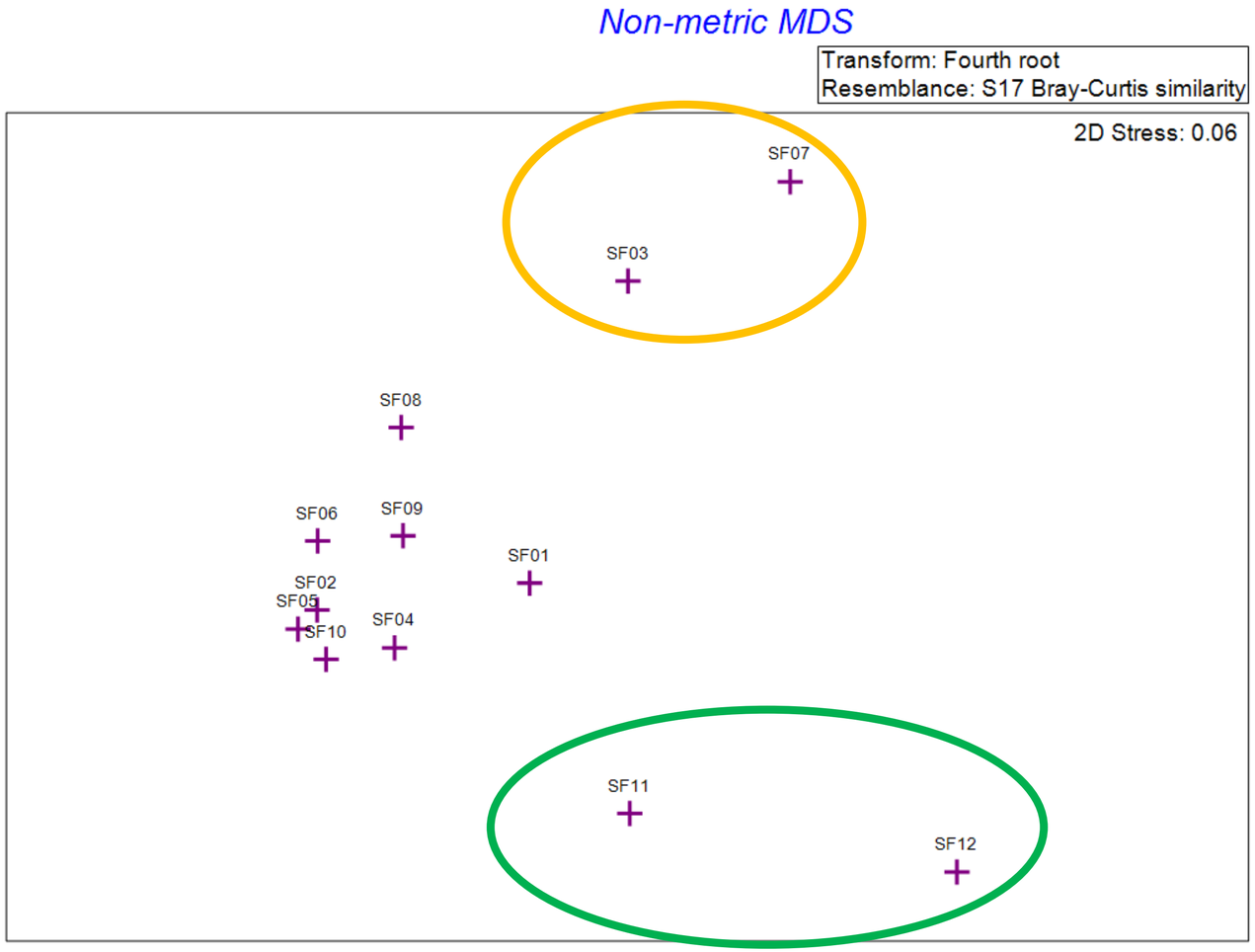


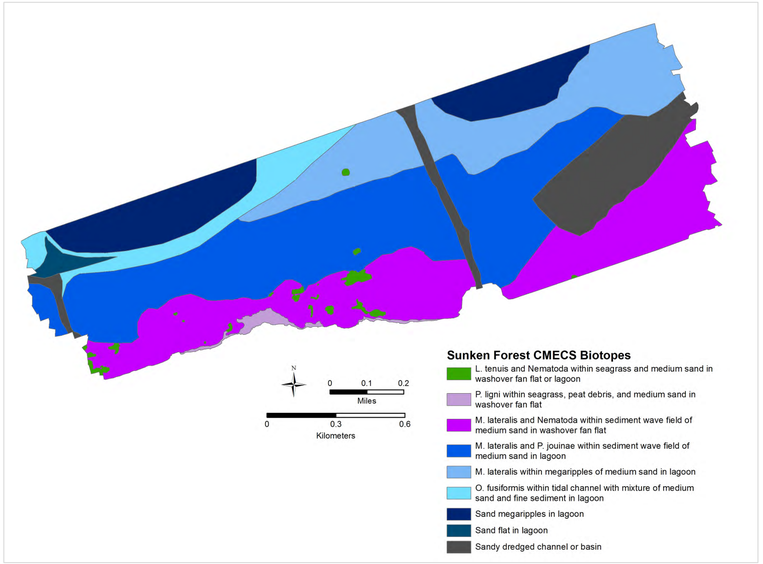


Sunken Forest CMECS Biotopes

- L. tenuis and Nematoda within seagrass and medium sand in washover fan flat or lagoon
- P. ligni within seagrass, peat debris, and medium sand in washover fan flat
- M. lateralis and Nematoda within sediment wave field of medium sand in washover fan flat
- M. lateralis and P. jouinae within sediment wave field of medium sand in lagoon
- M. lateralis within megaripples of medium sand in lagoon
- O. fusiformis within tidal channel with mixture of medium sand and fine sediment in lagoon
- Sand megaripples in lagoon
- Sand flat in lagoon
- Sandy dredged channel or basin

Sunken Forest identifying relationships





Science → Management

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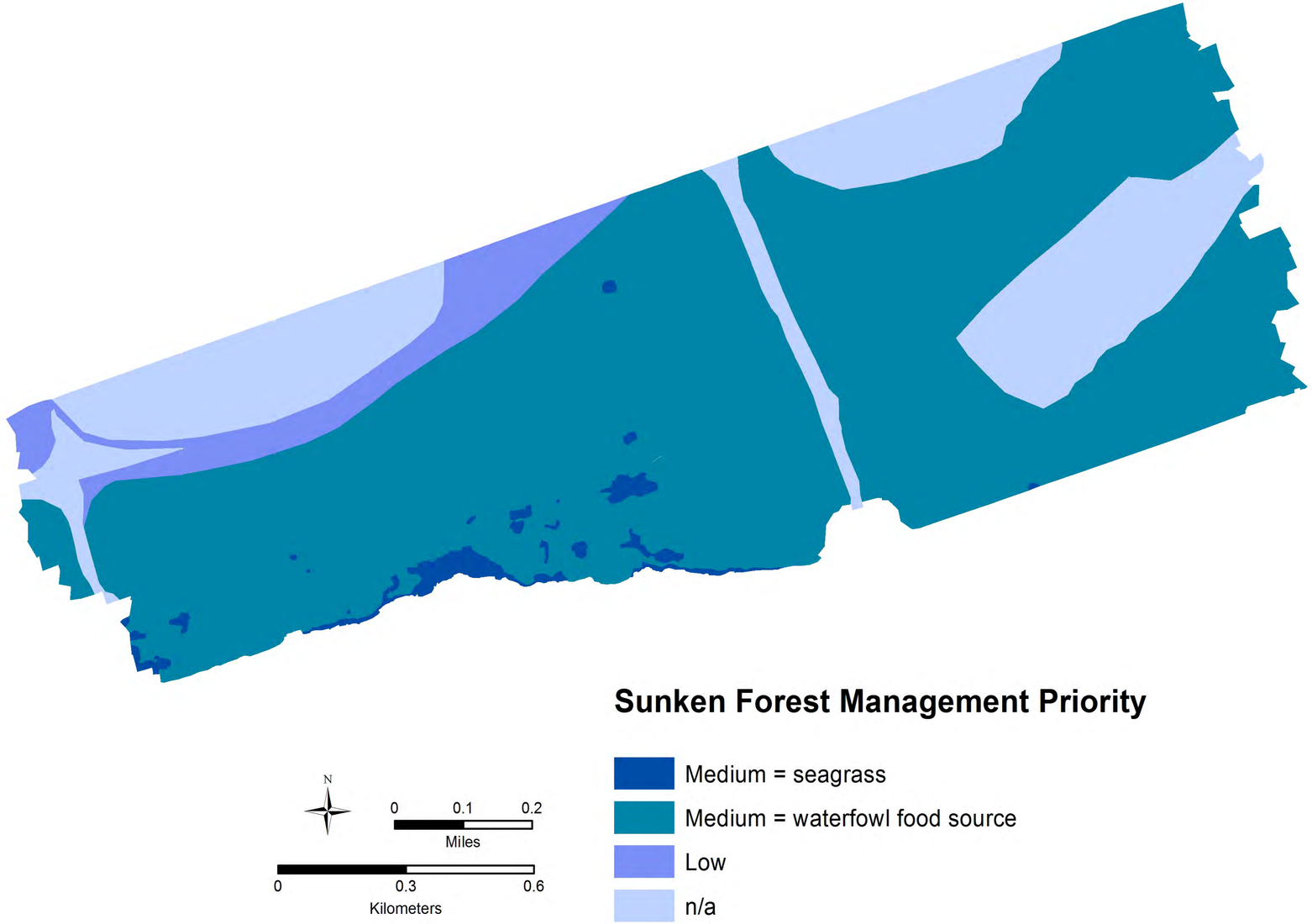
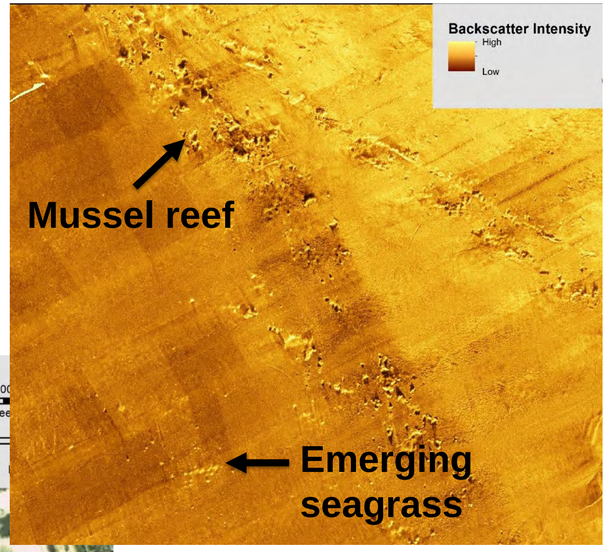
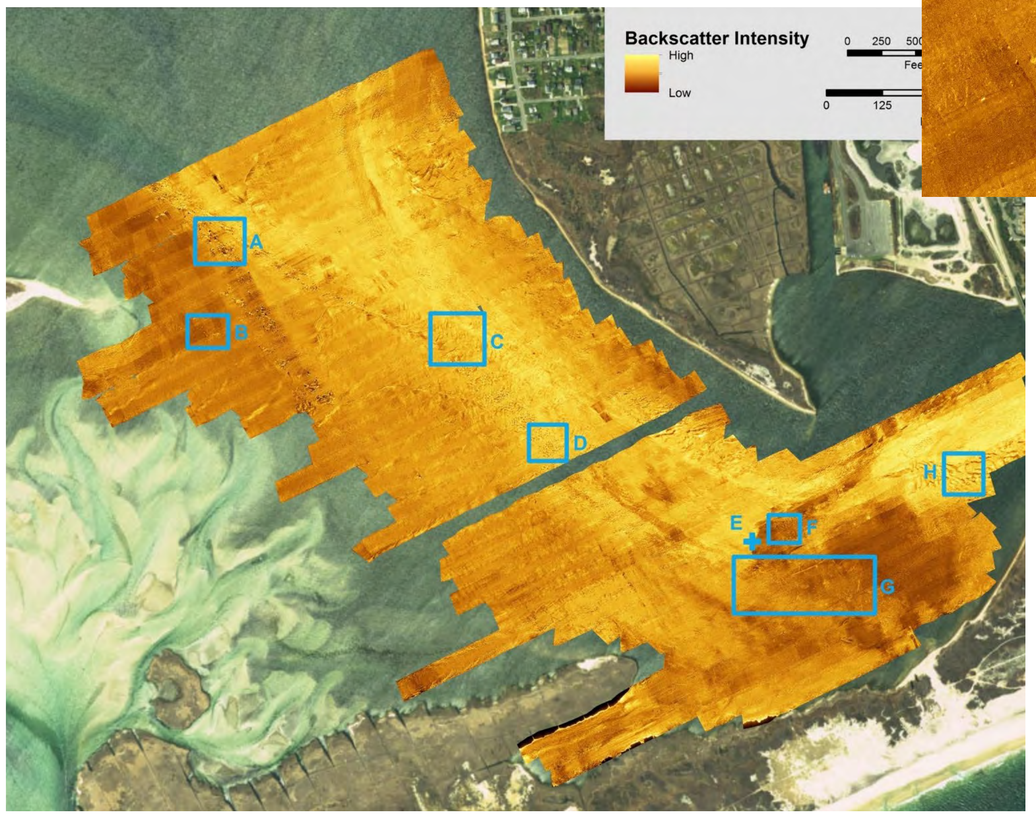
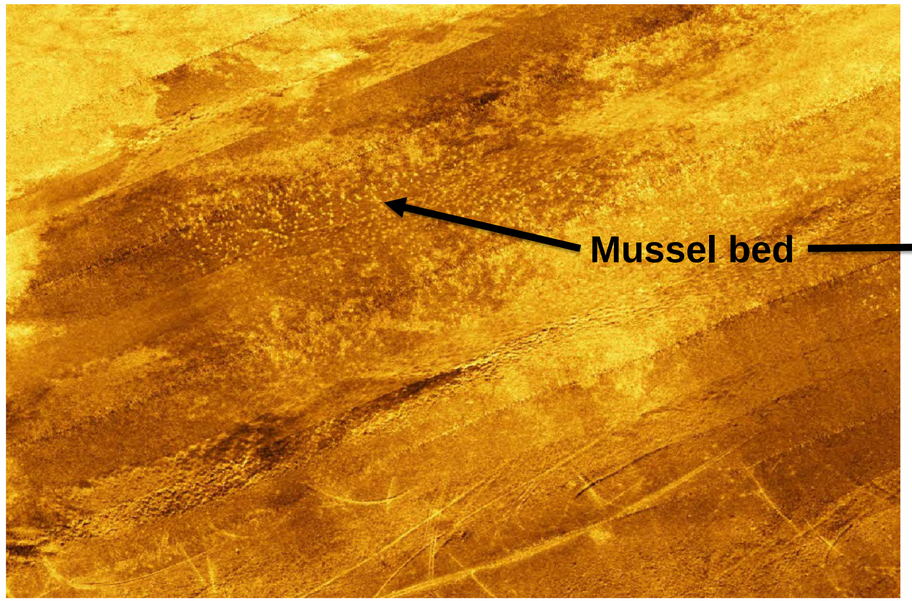


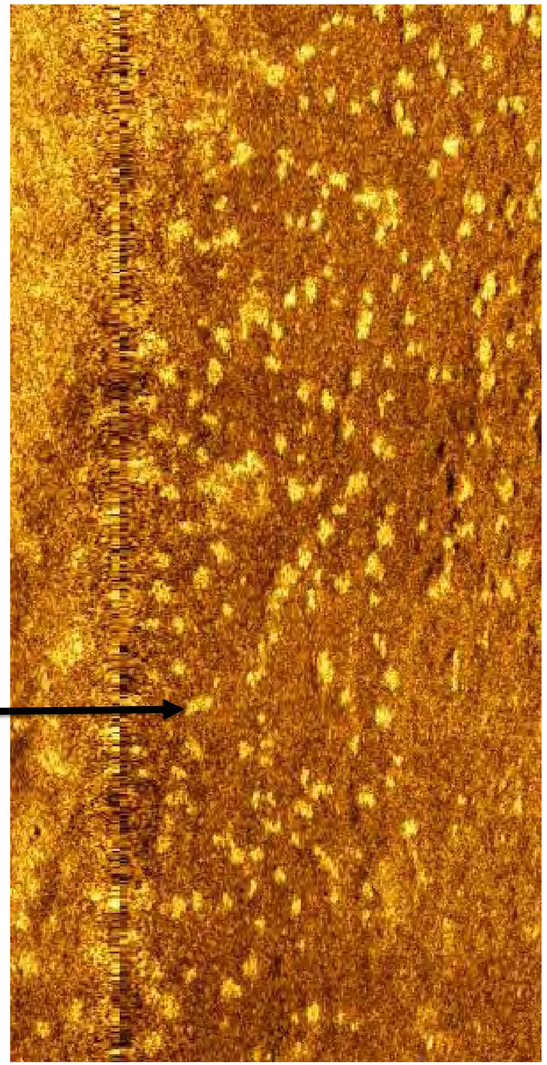
Science → Management

Increased influx of ocean water into Great South Bay due the new tidal inlet = positive ecological effects within the immediate area



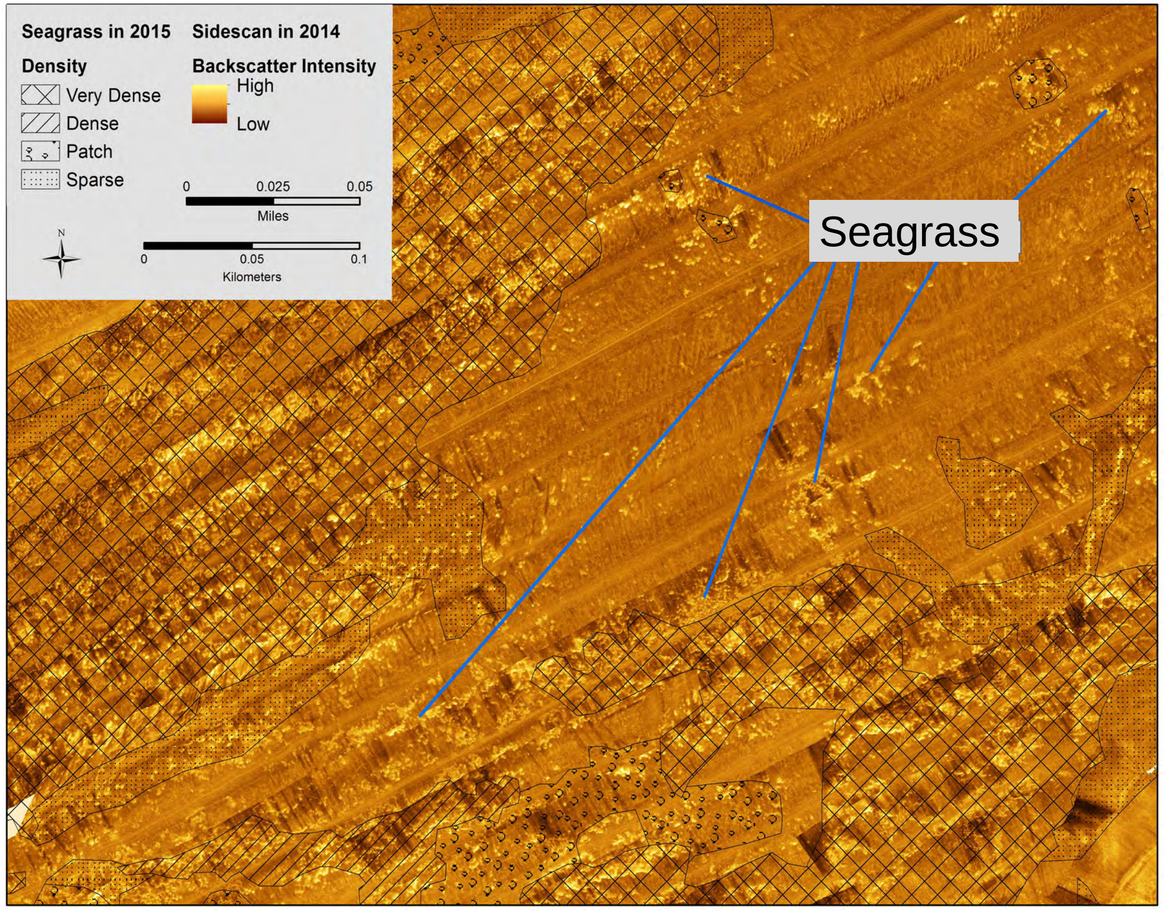


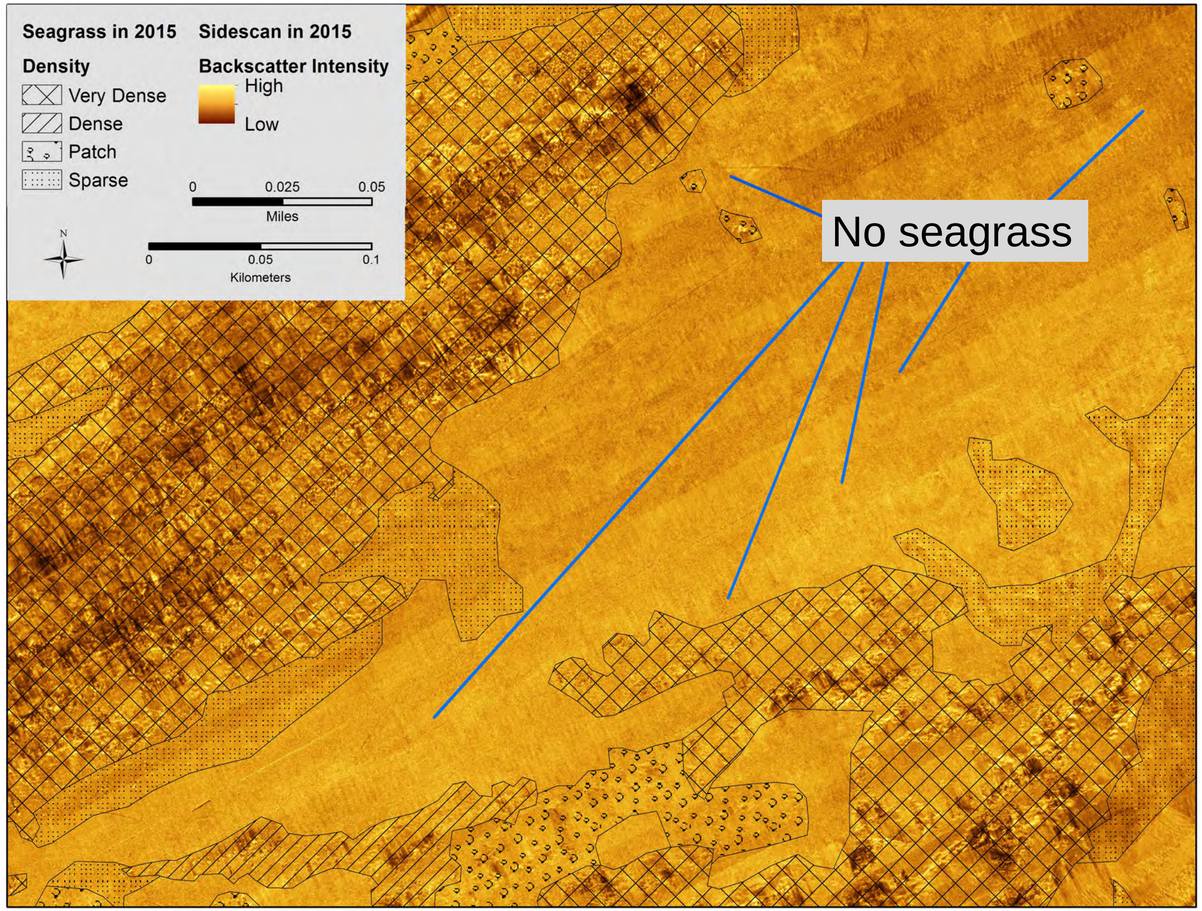




Science → Management

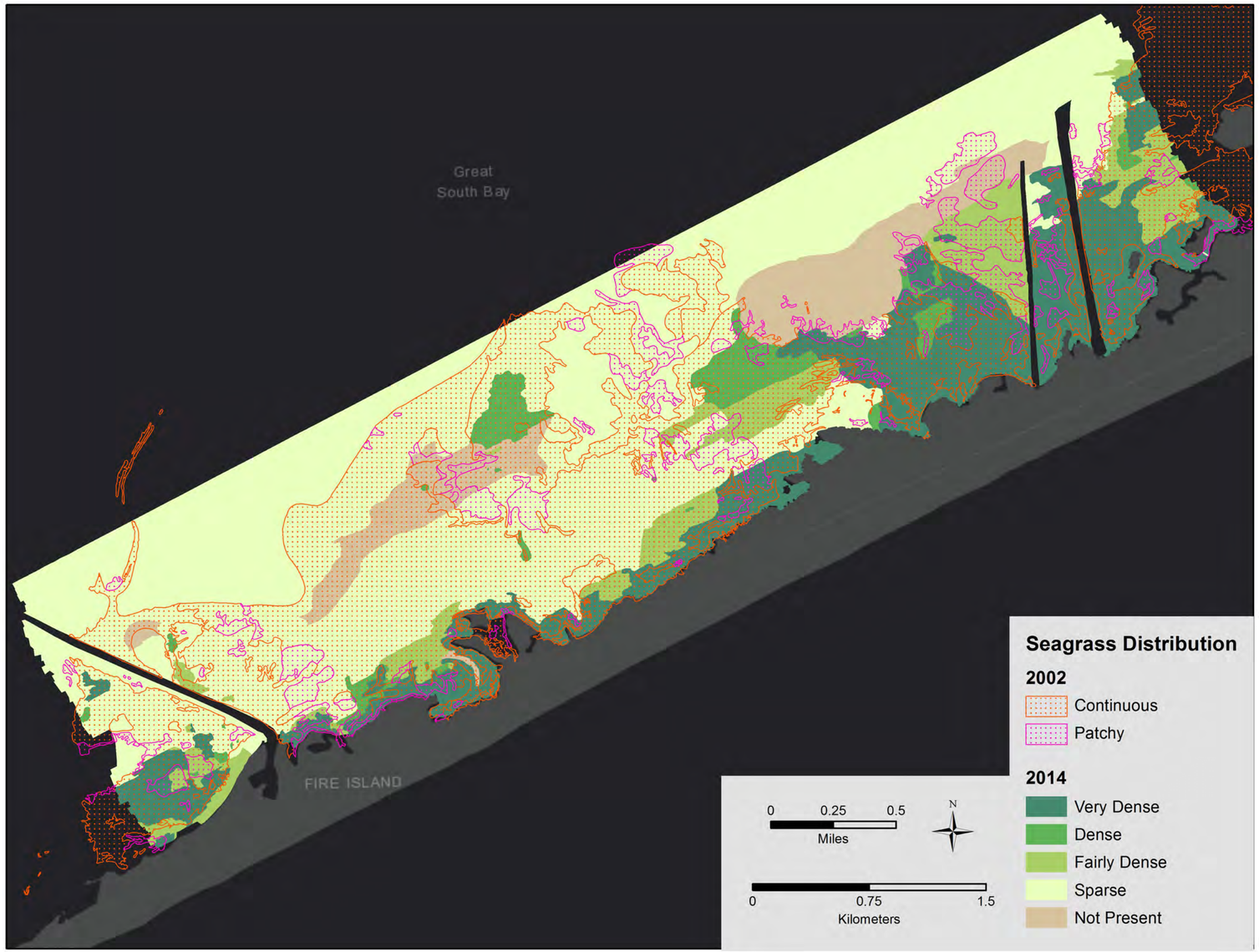
Otis Pike seagrass 2014-2015





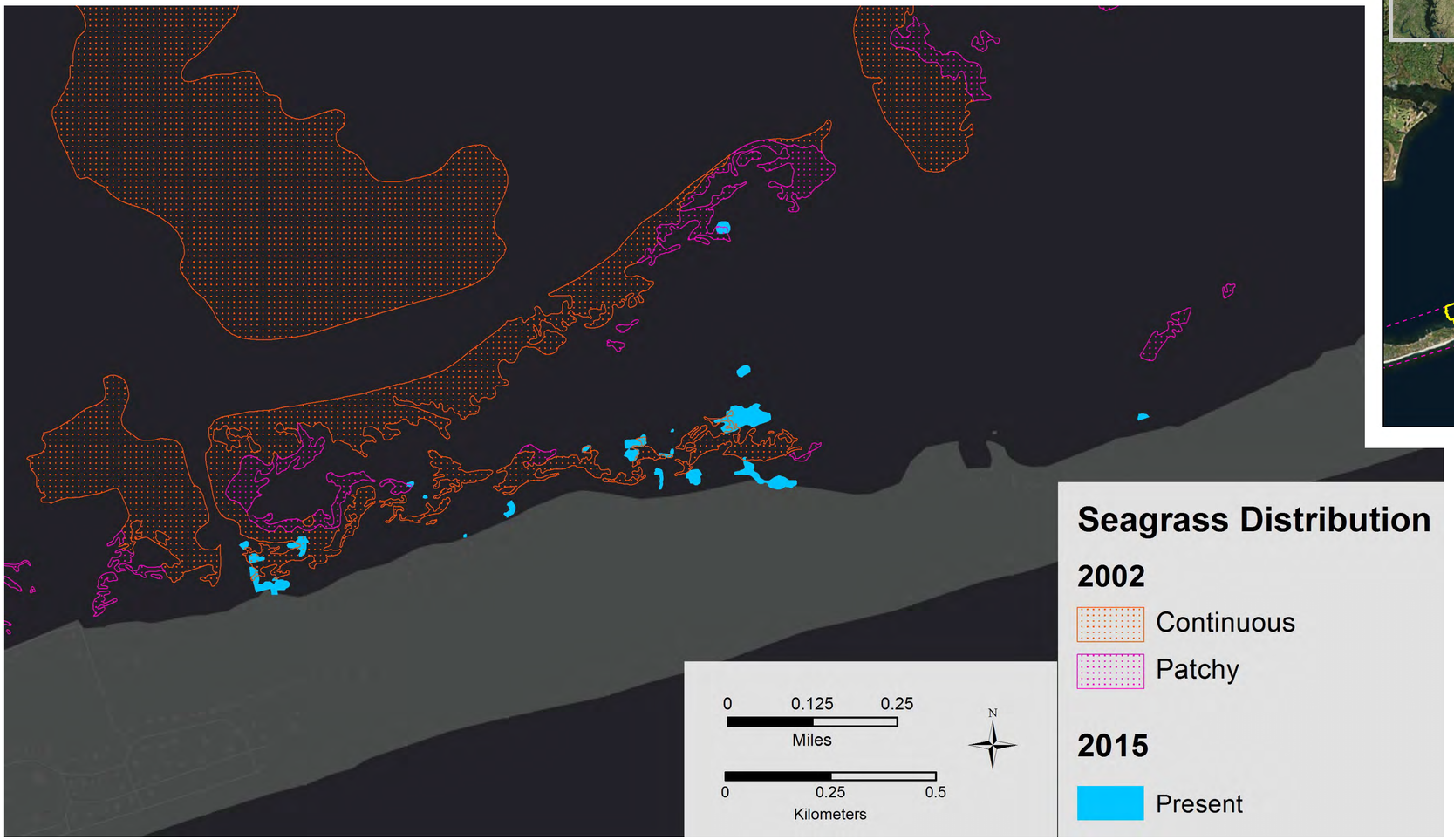
Science → Management
Otis Pike seagrass

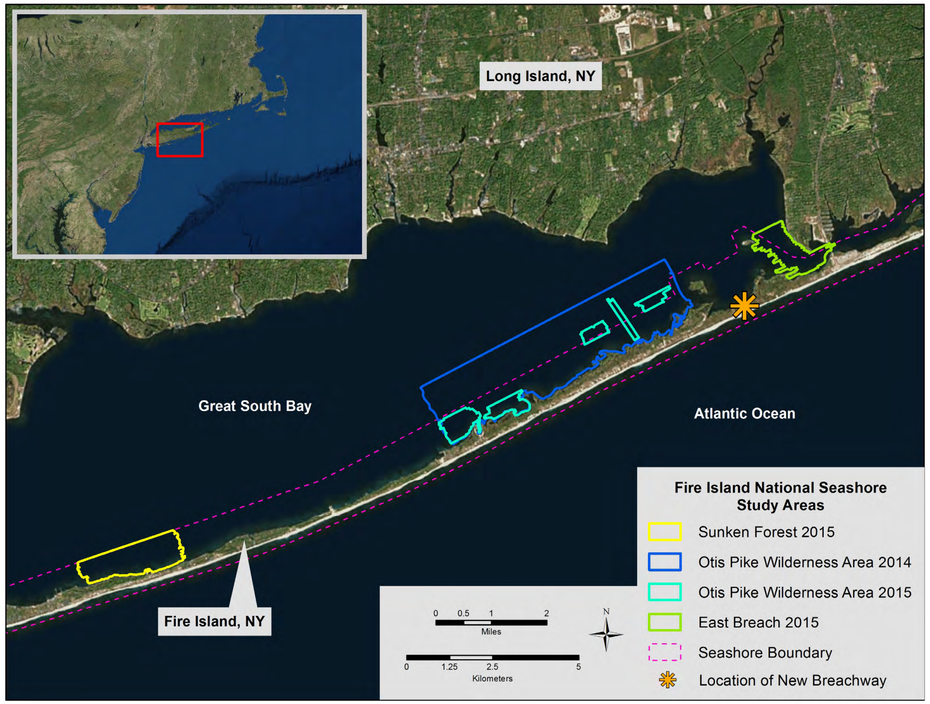
- 2014 vs 2002*
- Some expansion closest to new tidal inlet
- Substantial decline moving west
- Influx of ocean water
  - Alterations to circulation, flushing patterns
  - Increases in salinity, water clarity, light availability
  - Reduced water temperatures



* NYDOS, 2003

Science → Management
Sunken Forest seagrass



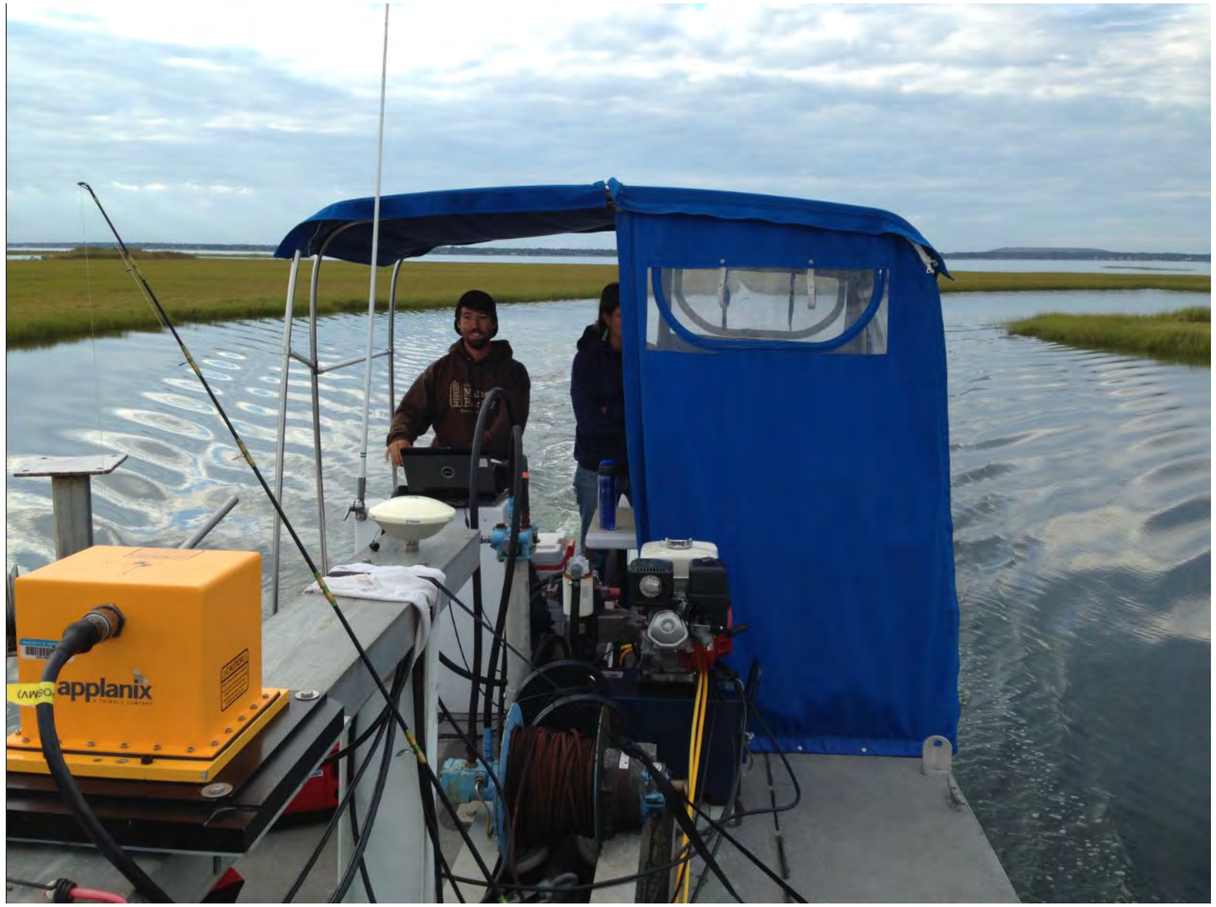


- 2015 vs 2002*
- 95% decline

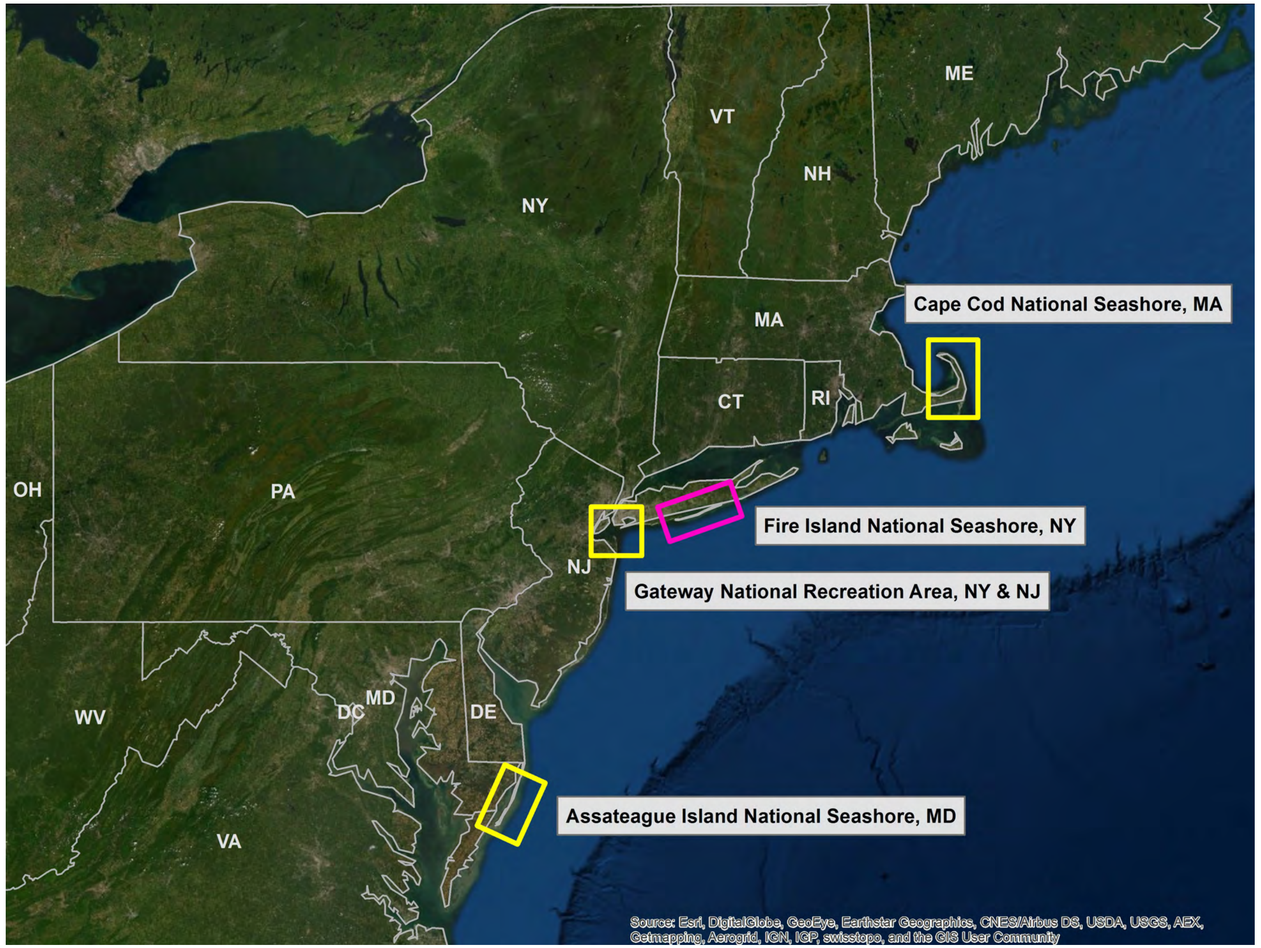
* NYDOS, 2003

Mapping at FIIS

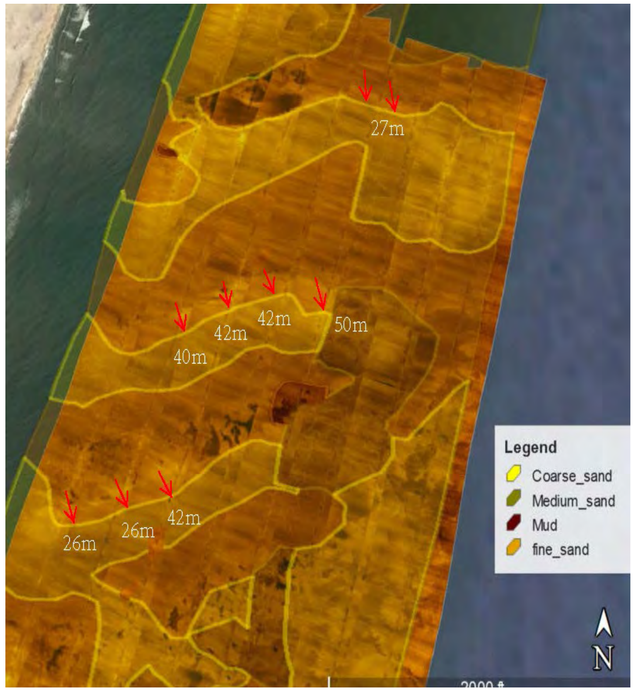
- Demonstrated value of benthic habitat mapping and CMECS from ecological and management perspectives
  - Provided inventory and baseline data to serve as point of comparison for future data, plan monitoring program
  - Provided specific examples of how data can used for making management decisions
- Classification approach produced statistically distinct biotopes that describe ecologically meaningful biotic-abiotic relationships
- Evidence that increased influx of ocean water into Great South Bay due the opening of new tidal inlet is having positive ecological effects within the immediate area
  - Agrees with general consensus
- Individual mapping datasets are useful on their own and together



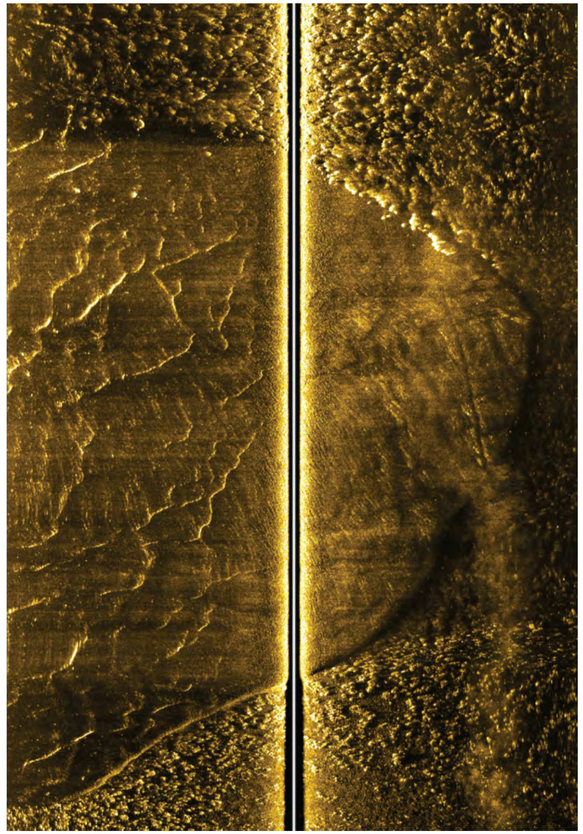
Benthic habitat mapping at other parks



GATE: Invasive species, the Japanese amphipod *Grandidierella japonica,* documented on bayside of park (Grothues et al., 2019)



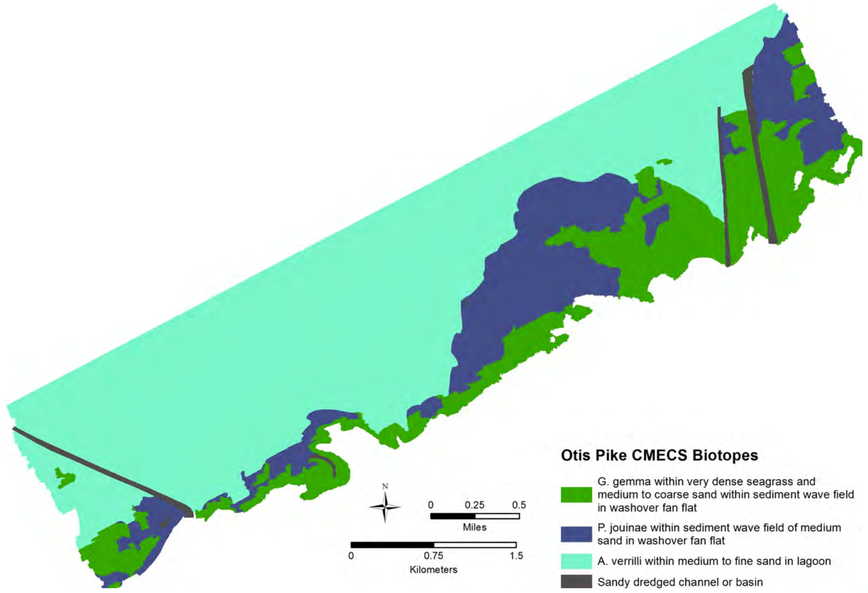
ASIS: Repeat sidescan surveys show temporal changes in sediment class boundaries (Trembanis et al., 2019)

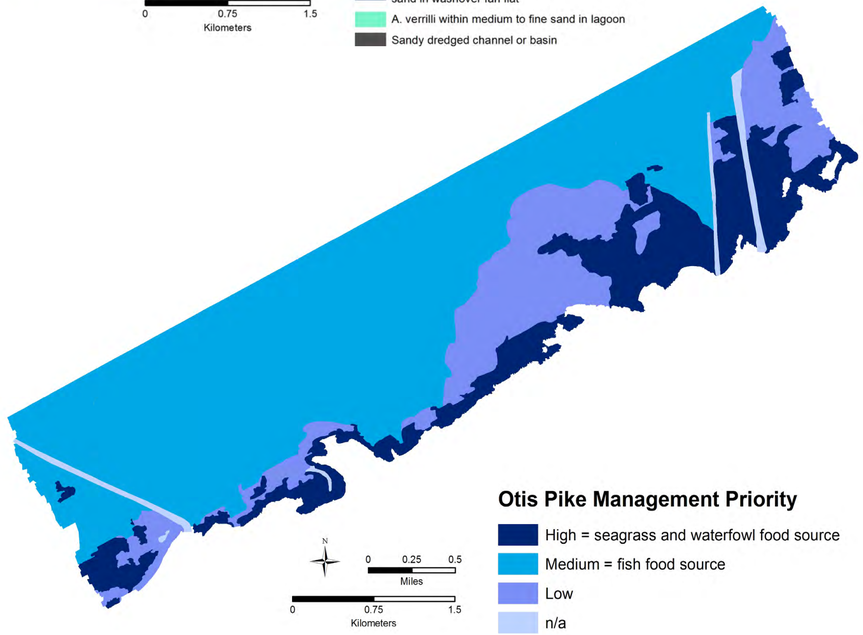


CACO: Sidescan record showing natural movement of sediment, burying eelgrass bed (Borrelli et al., 2019)

Value of benthic habitat mapping

- **Advance knowledge**
  - Benthic habitats and species
  - Biotic-abiotic relationships
  - Areas and species of interest (e.g. sensitive habitats, important prey species)
  - Sediment transport processes (e.g. ASIS; CACO)
  - Invasive species (e.g. GATE)
  - Support other research efforts, identify data gaps
- **Baseline data**
  - Need to know what is there before can appropriately manage
  - Serve as point of comparison
- **Continued monitoring**
  - Further understanding and assess change
  - Temporal component of the ecosystem
  - Dynamism, resiliency, and vulnerability of areas
- **Guide science-based decision making for resource regulators and managers**
  - Maintain balance protection and human use of submerged lands
  - Better understand, assess, anticipate, and mitigate impacts caused by climate change, human activities, and natural processes





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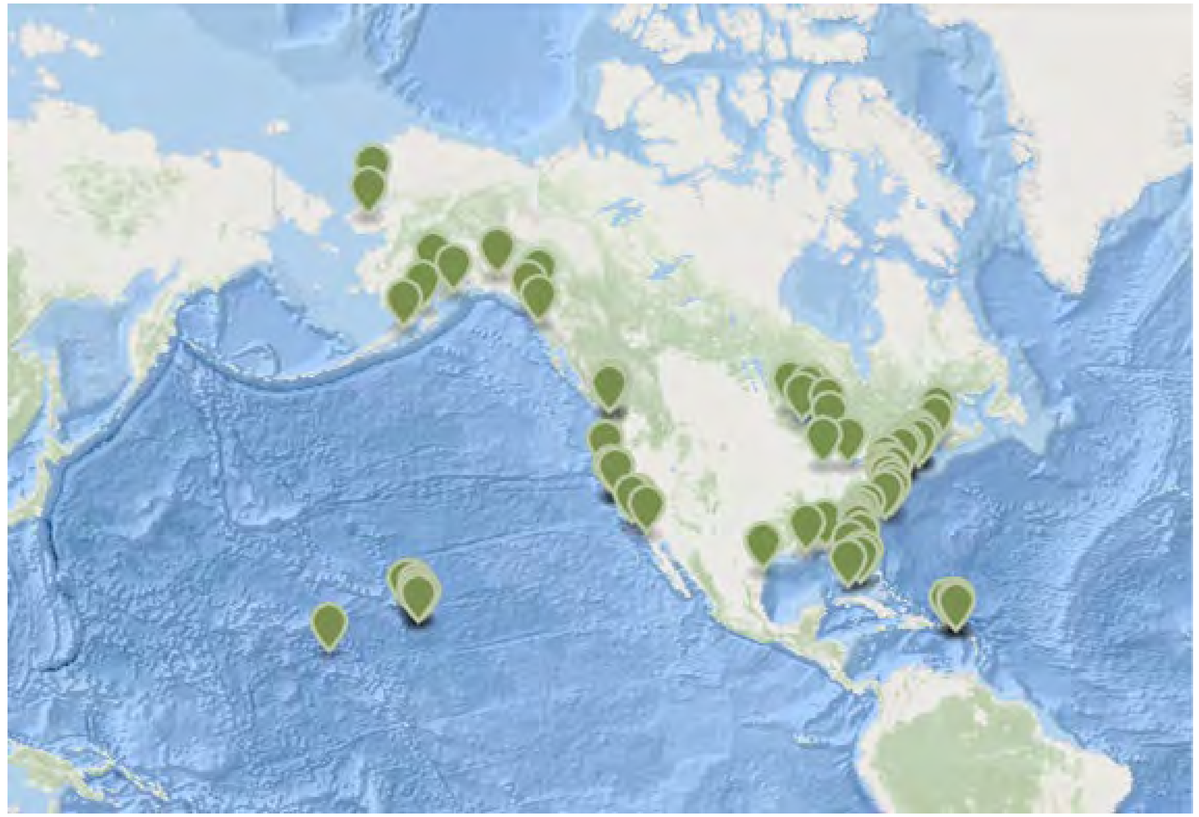
The National Park Service Manages

88 Ocean and Great Lakes Parks

Across 23 States and Four Territories.



11,000 Miles

Of coastline.

2.5 Million

Acres of ocean and Great Lakes waters.

89 Million

Recreation visits each year.

$5 Billion

Generated in economic benefits to local communities.

National Park Service
U.S. Department of the Interior

Coastal & Ocean Advisory and Support Team

COAST: Coastal and Ocean Advisory and Support Team

- Ocean and Coastal Resources Branch
  (Water Resources Division)

- Currently focused on seven “priority topics”
  - **Benthic habitat mapping**
  - Aquatic invasive species
  - Fisheries management
  - Harmful algal blooms
  - Restoration
  - Changes in sea and lake levels
  - Shoreline and sediment management

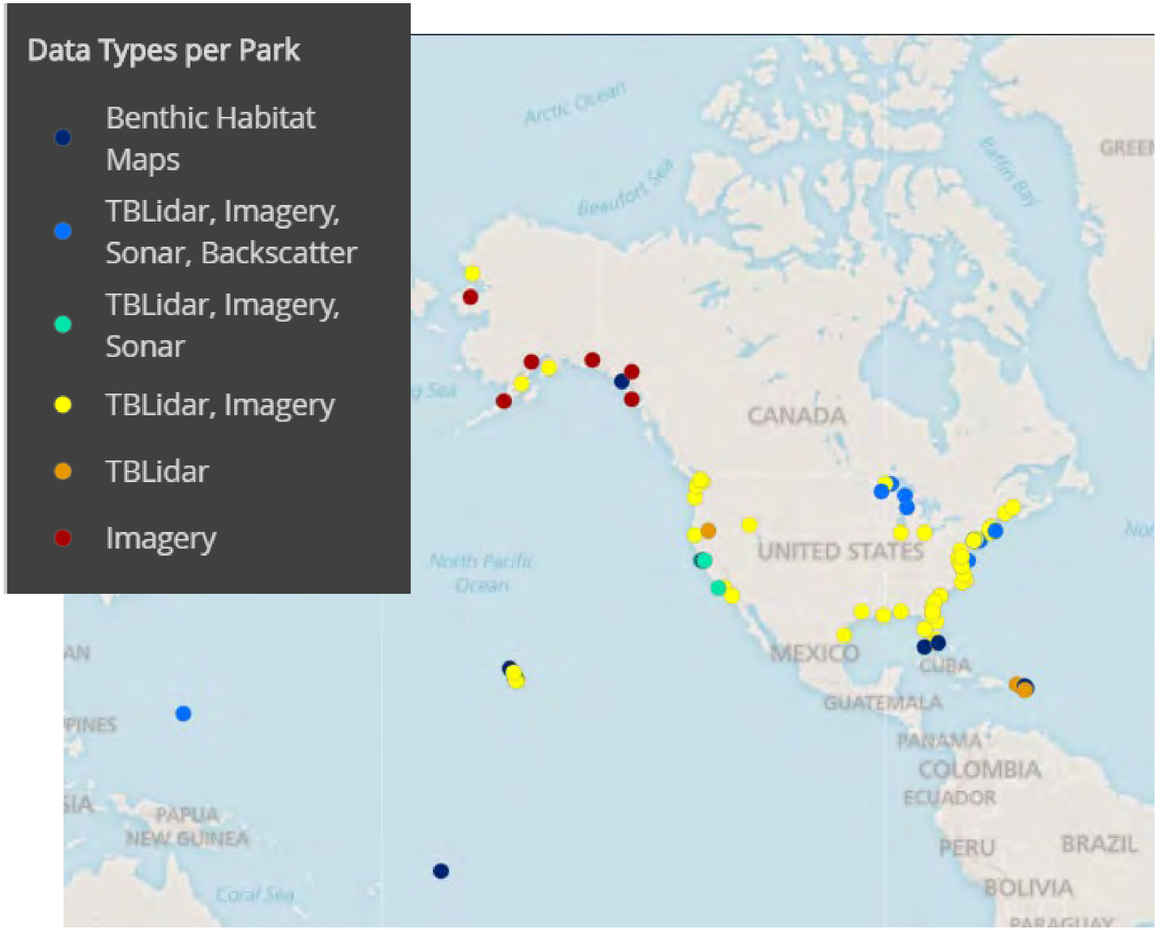
- Intended to benefit parks service-wide

- ~3 year timeframe

- **Interested in learning more?**
  - COAST SharePoint site (internal to DOI)
  - Contact: Monique_LaFranceBartley@nps.gov

Benthic Habitat Mapping Priority Project

- **Primarily using existing data**
- Mapping data sources
  - NOAA (HSD, RSD, NBS)
  - USGS CoNED
  - USACE JALBTCX
  - **Others?**
- Ground-truth data
  - Imagery (stills, video)
  - Grab samples
  - **Less accessible**



- **Project deliverables**
  - Topobathy maps
  - Geomorphic feature maps
  - Benthic habitat maps
  - Associated GIS data
  - Identify data gaps
  - SOPs

INPUT WELCOME!

- Suggestions
- Collaborations

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Coastal & Ocean Advisory and Support Team

FIIS Research

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COAST Projects

NPS COAST Team

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Interested to learn more, become involved, or have information to share?? Contact me!

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