NNBF Island Features

36th International Conference on Coastal Engineering

Short Course: NNBF for Coastal Resilience

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Coastal Island Features

Types and Settings

Coastal islands can be either primary coasts (formed by non-marine processes or secondary coasts (formed/maintained by marine processes)

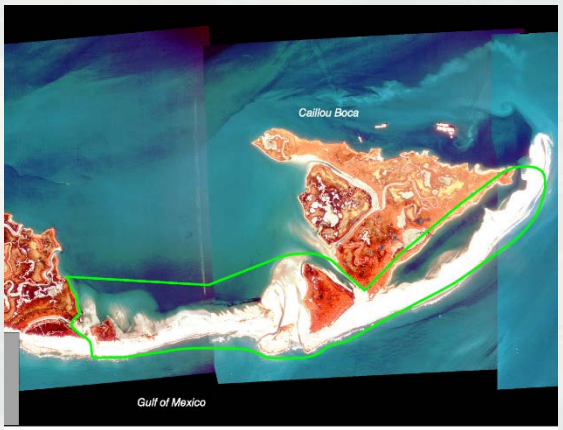
Island Types

- Barrier Islands originating from glacial remnants (ex: Cape Cod)
- Barrier Island with ongoing nourishment from river discharge (ex: Mississippi Gulf Coast)
- Barrier Islands with origins that are a combination of the above (ex: Outer Banks of North Carolina)
- Deltaic Islands: Networks of islands and distributary channels (ex: Mississippi River, Nile River)
- Coastal Spits – may become barrier or deltaic islands if breached

Coastal Islands are often a combination of multiple natural features, including beach/dune, mudflat/marsh, reef, SAV, and upland plant communities

Coastal Island Features

Evolution



Most islands are dynamic features, influenced by natural processes

- Uplifting/subsidence
- Storm activity (waves/surge/currents)
- Natural variability in sea level (or water level in lakes)
- High river flow and sediment discharge
- Coastal hydrodynamics and sediment dynamics

Island evolution is also influenced by anthropogenic activity

- Anthropogenic-induced sea level rise and climate change
- Controlled river flow and reduced sediment load
- Navigation channels, jetties, hardened structures, and other features influencing littoral transport
- Accelerated subsidence from underground resource extraction

Consideration: can disrupted processes that contribute to island loss be restored? – If not, post-restoration maintenance may be required

Coastal Island Nature-Based Features

Objectives/Benefits

- Flood Risk Management
  - Storm surge reduction
  - Short-wave reduction
  - Space to hold high-river discharge (deltaic islands)
- Ecosystems – interaction between diverse habitats
- Replace bird migratory resting locations which have been removed from mainland
- Economic: Fisheries, tourism
- Social: recreation
- Navigation:
  - Wave attenuation
  - Safe harbor

Chandeleur Islands Restoration Performance Study

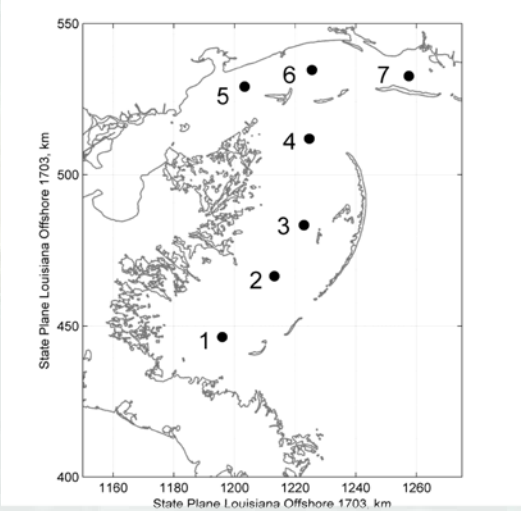


Table 2. Percent decrease of maximum significant wave heights when the restored barrier island scenario is compared to the existing conditions at each of the seven save locations.

Storm	Save Pt 1	Save Pt 2	Save Pt 3	Save Pt 4	Save Pt 5	Save Pt 6	Save Pt 7
1	-40%	-60%	-80%	-5%	-35%	-45%	0%
2	-35%	-60%	-80%	0%	-30%	-35%	0%
3	-35%	-60%	-80%	-5%	-35%	-50%	0%
4	-35%	-55%	-70%	-15%	-35%	-50%	-30%
5	-30%	-55%	-65%	-5%	-30%	-50%	-40%
6	-35%	-65%	-65%	-5%	-30%	-25%	0%
7	-30%	-55%	-70%	0%	-30%	-50%	0%
8	-35%	-65%	-90%	0%	-20%	-25%	0%
9	-35%	-70%	-75%	0%	-30%	-35%	-20%
10	-35%	-65%	-70%	0%	-30%	-35%	-35%
11	-35%	-65%	-65%	0%	-30%	-40%	-35%
12	-30%	-70%	-85%	0%	-20%	-20%	0%
14	-35%	-50%	-80%	0%	-30%	-35%	0%
15	-35%	-60%	-70%	-5%	-50%	-50%	-35%

From Grzegorzewski et al, 2009

Coastal Island Features

Considerations

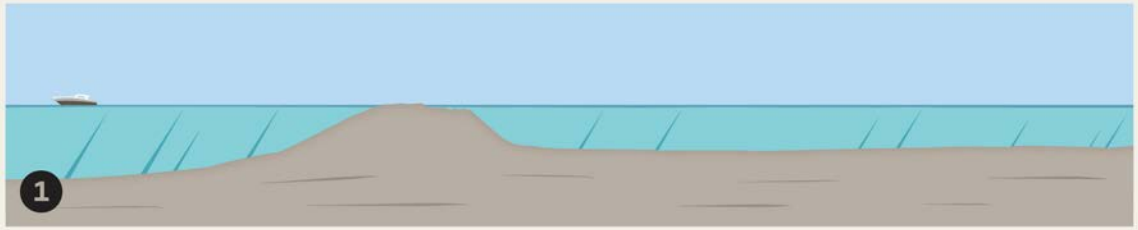
Metrics
- Cost/benefits
- Performance
- Resilience

Design

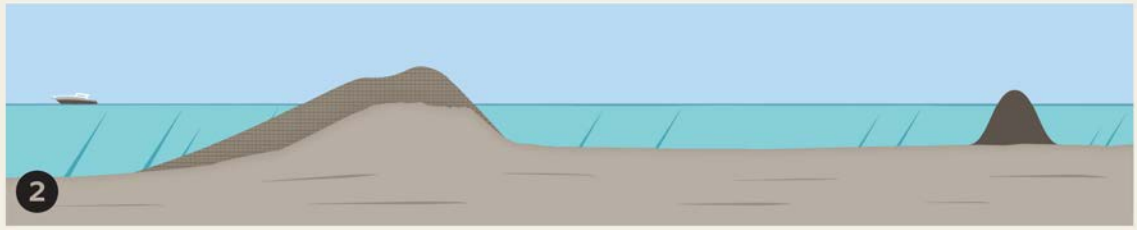
Impact on resources
- At borrow site
- Within area of influence
  - Habitat
  - Navigation/dredging

Construction
- Sediment source
- Adaptive management

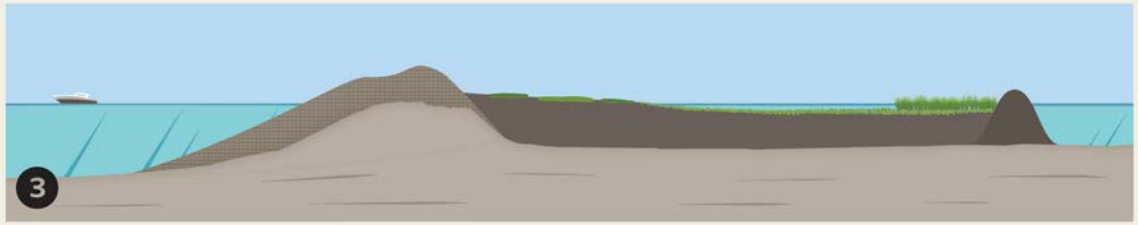
Maintenance
- Frequency
- Cost



Remnant island platform



Construction of beach/dune and retaining berm



Fill to create high and low marsh platform

Restoring Coastal Island Features

Ship Island, Mississippi Case Study

Ship Island is western-most in a string of barrier islands in the Gulf of Mexico protecting the Mississippi and Alabama Gulf Coasts from hurricane surge and short waves.

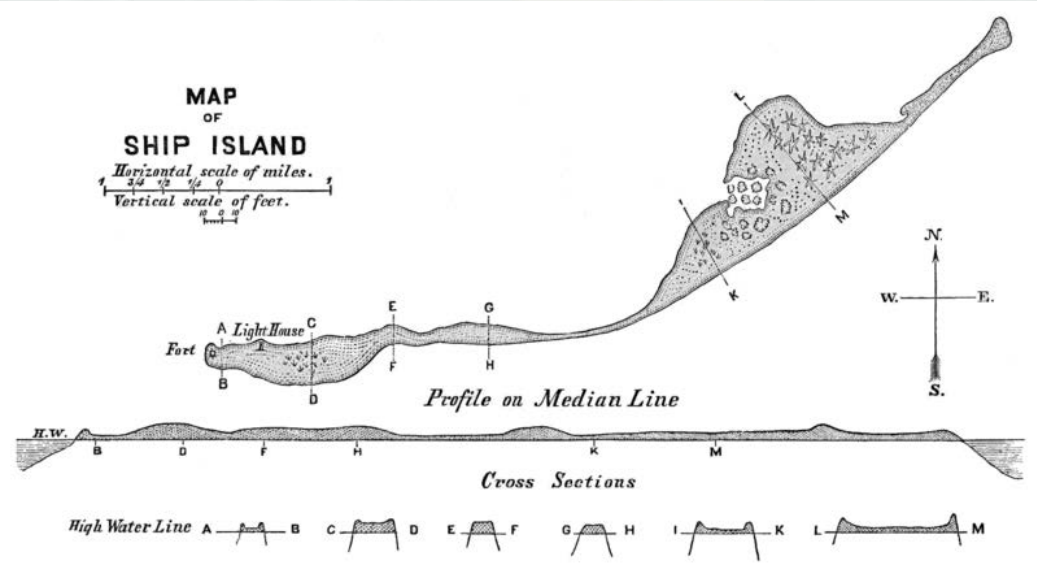
- Nourished and maintained by river discharge
- Diverse habitat including beach/dune, upland forest, SAV, and wetland
- Sediment supply severely impacted by impoundments and navigation channels
- Entire island chain degrading
- Permanent breach from Camille (1969)
- Breach greatly widened during Katrina (2005)
- Restoration for FRM value
- Owned by U.S. National Park Service – Design to restore diverse habitat (ecosystem and social value)

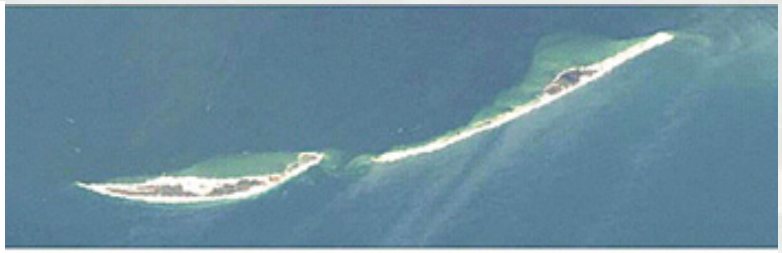
Restoring Coastal Island Features

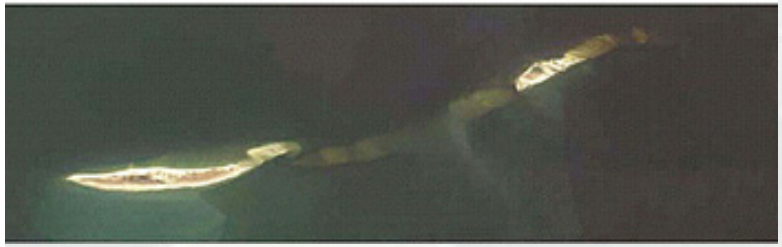
Ship Island, Mississippi Case Study

Objective: Restore Ship Island to Pre-Camille condition - Part of a comprehensive restoration plan for the Mississippi Gulf Coast

- Restore barrier island flood protection value
- Maintain estuarine ecosystem and resources of the Sound
- Restore natural and cultural resources of the barrier Islands
- Develop maintenance plan





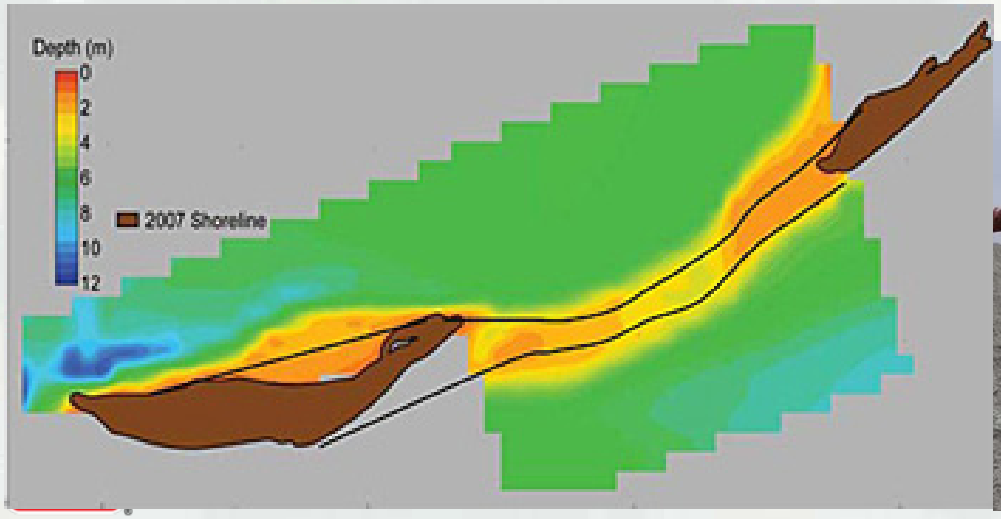


Restoring Coastal Island Features

Ship Island, Mississippi Case Study

Ship Island Construction

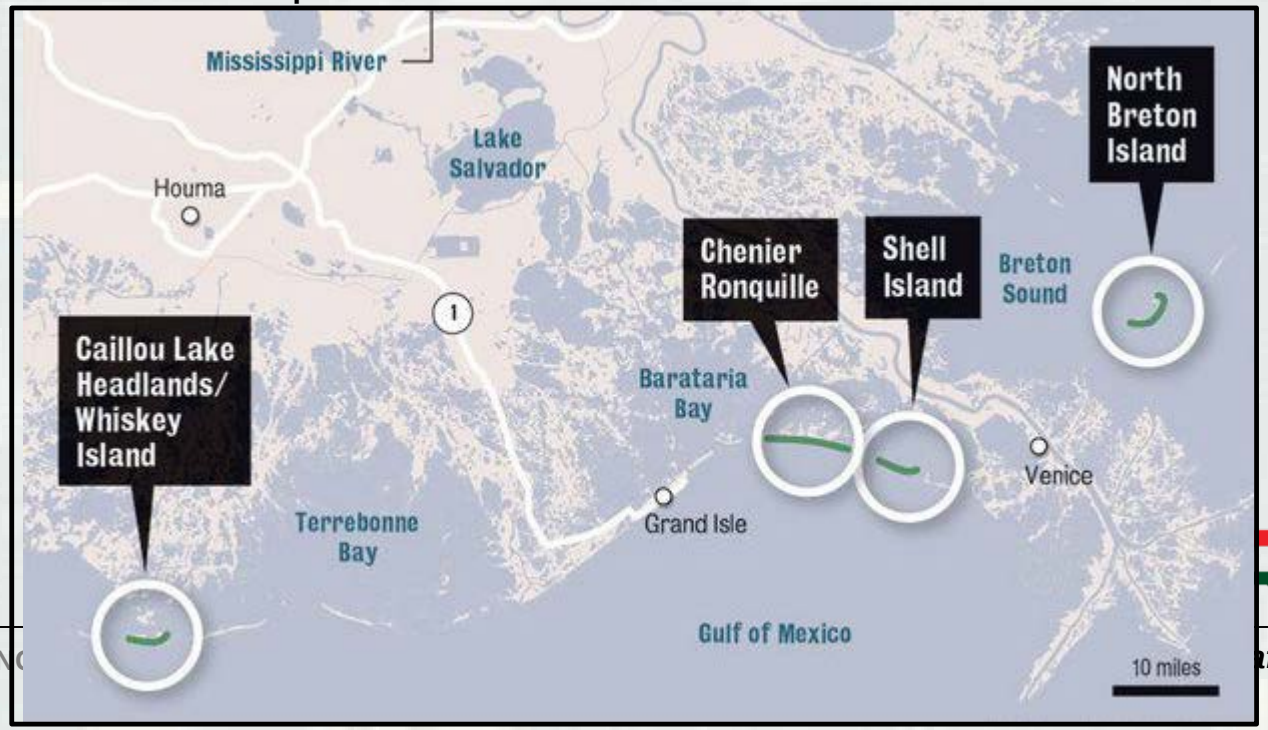
- 15 Mm^3 high quality sand from offshore source
- Contour to re-establish beach/dune, wetland and upland plant communities
- Protect remnant resources (wetland and SAV) during construction
- Support littoral zone transport using navigation dredged sediment
- Modeling supported nourishment plan – increased tidal currents through gap during closure
- Plantings will support recolonization



Restoring Coastal Island Features

Louisiana Barrier Island Case Study

- Barrier Island chains have traditionally protected vast wetlands along the Louisiana coast
- Island/wetland system protects low-lying inland communities from flooding
- Both barrier island and wetland systems are degrading → rapid land loss and vulnerable communities
- Restoration of both island and wetland systems is ongoing
- Maintenance will be required because of reduced river sediment loads



Restoring Coastal Island Features

Louisiana Barrier Island Case Study

Isle Deniers Chain

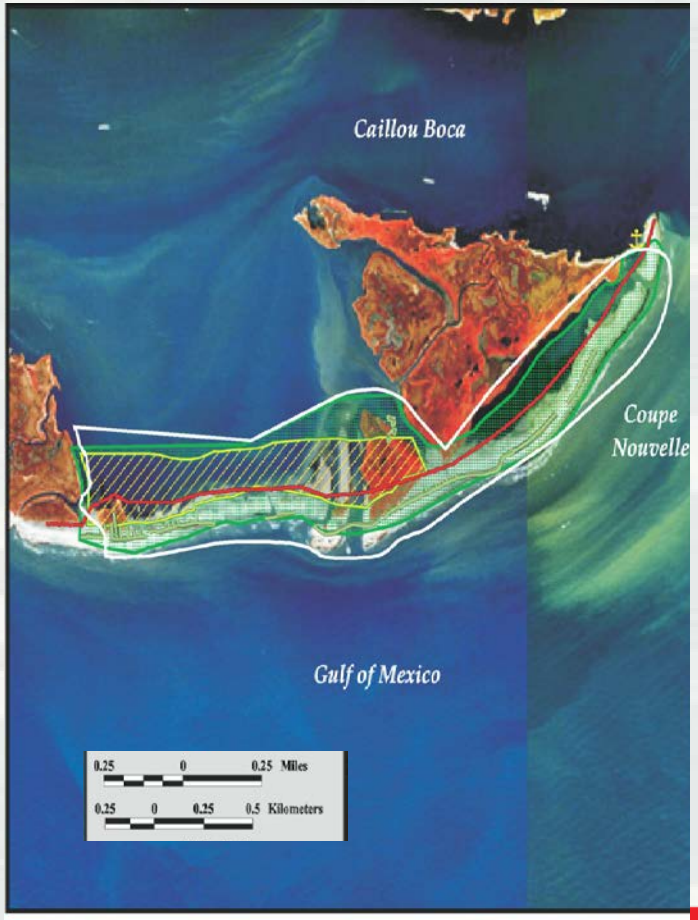
- Whiskey Island loss rate of 24 acres/year in the late 20th century
- Predicted to be completely submerged by 2010
- Phased restoration projects from 1999-present,
- Maintenance will be required because of reduced river sediment loads, subsidence, SLR and other processes
- Whiskey Island restoration designed to resist breaching during events
- Island over wash and roll-over included in design

Restoring Coastal Island Features

Louisiana Barrier Island Case Study

Whiskey Island restoration 1999

- Restore 3.2 miles of the 4-mile beach/dune system
- 650 acres of back-island marsh
- Phased restoration projects from 1999-present,
- Semi-confined placement
- 5,00 linear ft of tidal creeks
- 2.9 Mcy of dredged sediment from a source 4 miles offshore
- Second restoration required in 2007
- Lessons learned from first restoration
    - Most damage during Katrina (2005)
    - Additional width required
    - Increase dune height
    - Vegetation and sand-fence to stabilize placed sediments

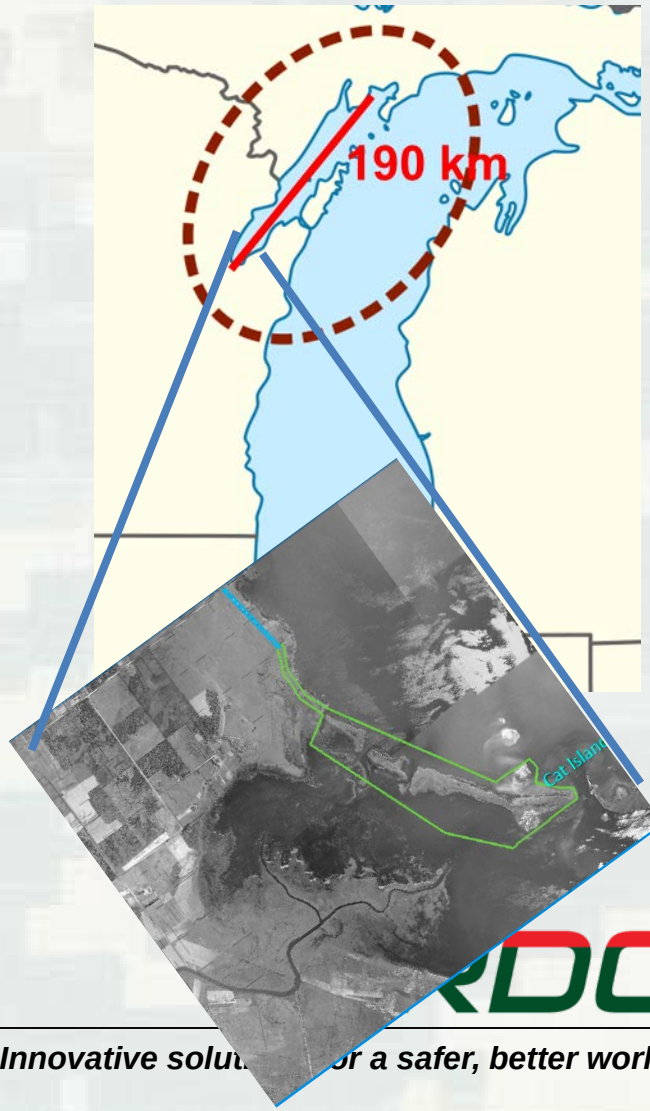


Restoring Coastal Island Features

Cat Island, Wisconsin Case Study

Island and wetland chain near the southern tip of Green Bay protects the City of Green Bay from wave action.

- Receding since the early 1900s due to sediment load reduction from the Fox River
- High lake levels and active storm seasons during the 1990s almost entirely removed feature remnants
- Increased wave erosion on southern tip of the Bay (City of Green Bay)
- Cannot restore transport patterns that nourished the features
- Little funding for restoration
- CDFs reached capacity



Restoring Coastal Island Features

Cat Island, Wisconsin Case Study

City of Green Bay, Green Bay Port Authority, State of Wisconsin, and USACE developed a plan restore Cat Island chain using dredged sediment

- Port Authority constructed wave barrier
- USACE placing dredged sediment behind the barrier
- Approximately 20 years will be required to complete construction
- Port authority will maintain barrier during construction
- Wetland and islands will be monitored during and post-construction
- Dredged material will be added as required to maintain the system
- Barrier will only be maintained if necessary

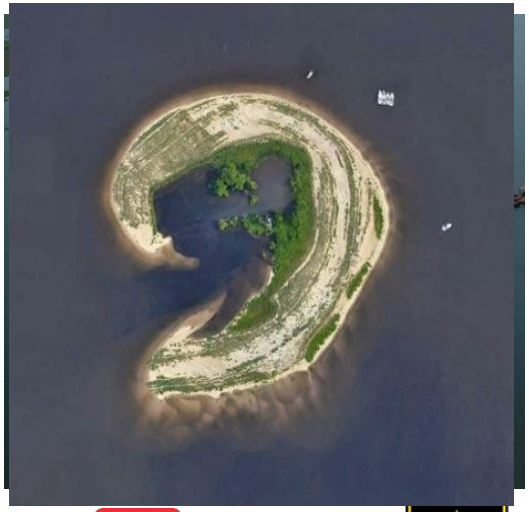
Restoring Coastal Island Features

Cat Island, Wisconsin Case Study

- 1.6 Mm^3 dredged sediment capacity
- Reduced dredging costs
- 110 hectares of wetland and island habitat
- Shore protection for the City of Green Bay
- Possible future placement capacity to maintain the system
- Three USACE mission areas addressed simultaneously
  - Flood risk management
  - Navigation
  - Ecosystem restoration

USACE Philadelphia District
Federal Navigation Projects

A Sediment Progression: From Confinement to In-Water Creation



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A “PERSISTENT” APPROACH

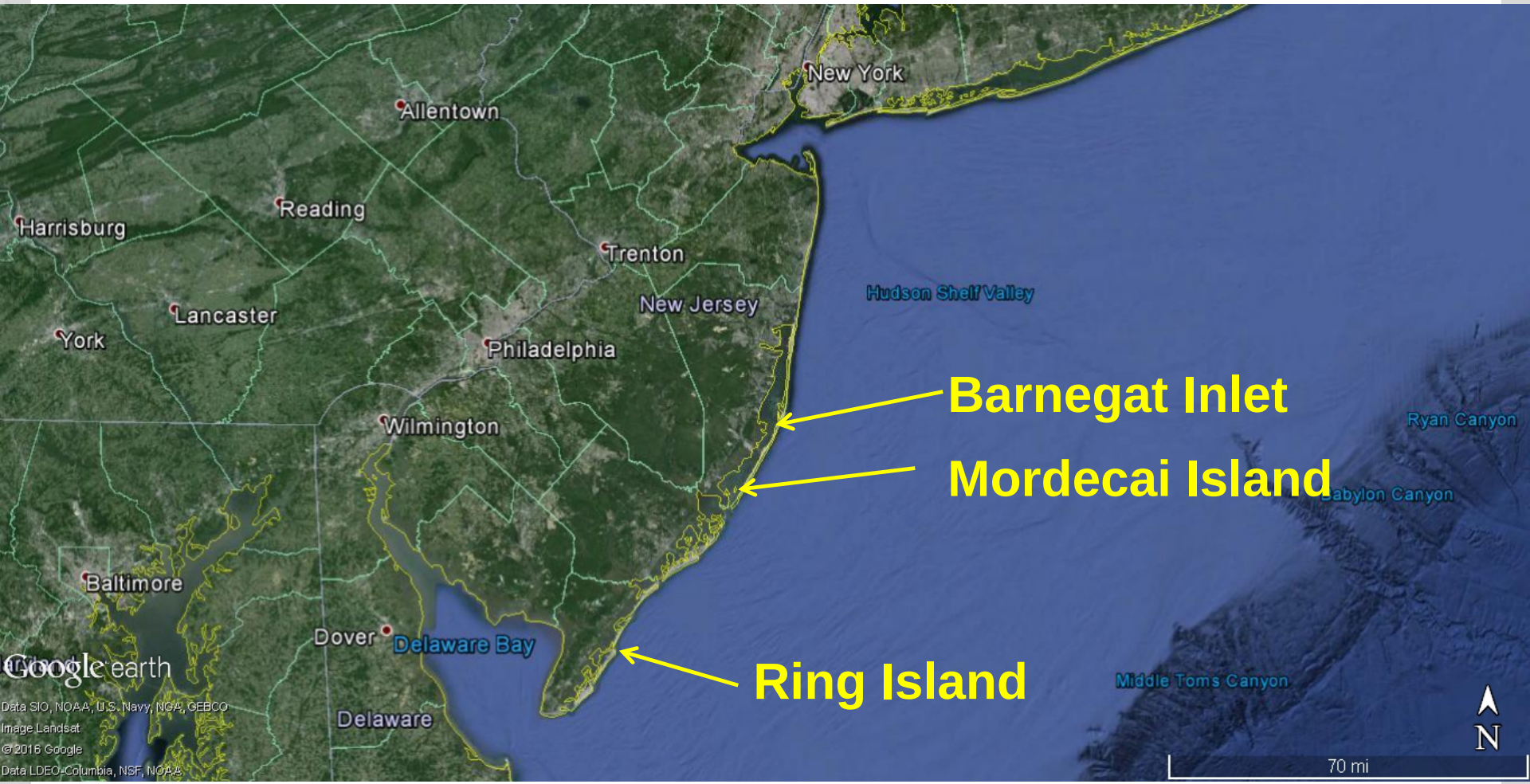
Post-Hurricane Sandy, federal channels in inlets and waterways required dredging

• **Navigation and Nature**: District took action to restore navigation, but also looked for opportunities to assist with shoreline & ecosystem recovery and build coastal system resilience

• **Technical Expertise**: Use of *Regional Sediment Management (RSM)* and *Engineering with Nature (EWN)* concepts to develop short-term (post-Sandy) and long-term dredging strategies

•**Team Approach**: Actions were aided by support from USACE North Atlantic Division and other districts, ERDC, NJDEP and other partners

Federal Channel Dredging with Island Creation Case Studies



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Ring Island, NJ: Habitat Creation And Thin-layer Placement Case Study

- Constructed August 2014
- Placed on land owned by NJDFW instead of Confined Disposal Facility
- 96% Sand from NJIWW
- Habitat creation
  - Shorebird usage
  - Also used by horseshoe crabs & terrapins
- Thin layer placement demo
- Raised elevation of habitat in March 2018, Adaptive Management!!
- Total of 9,000 cubic yds

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ERDC

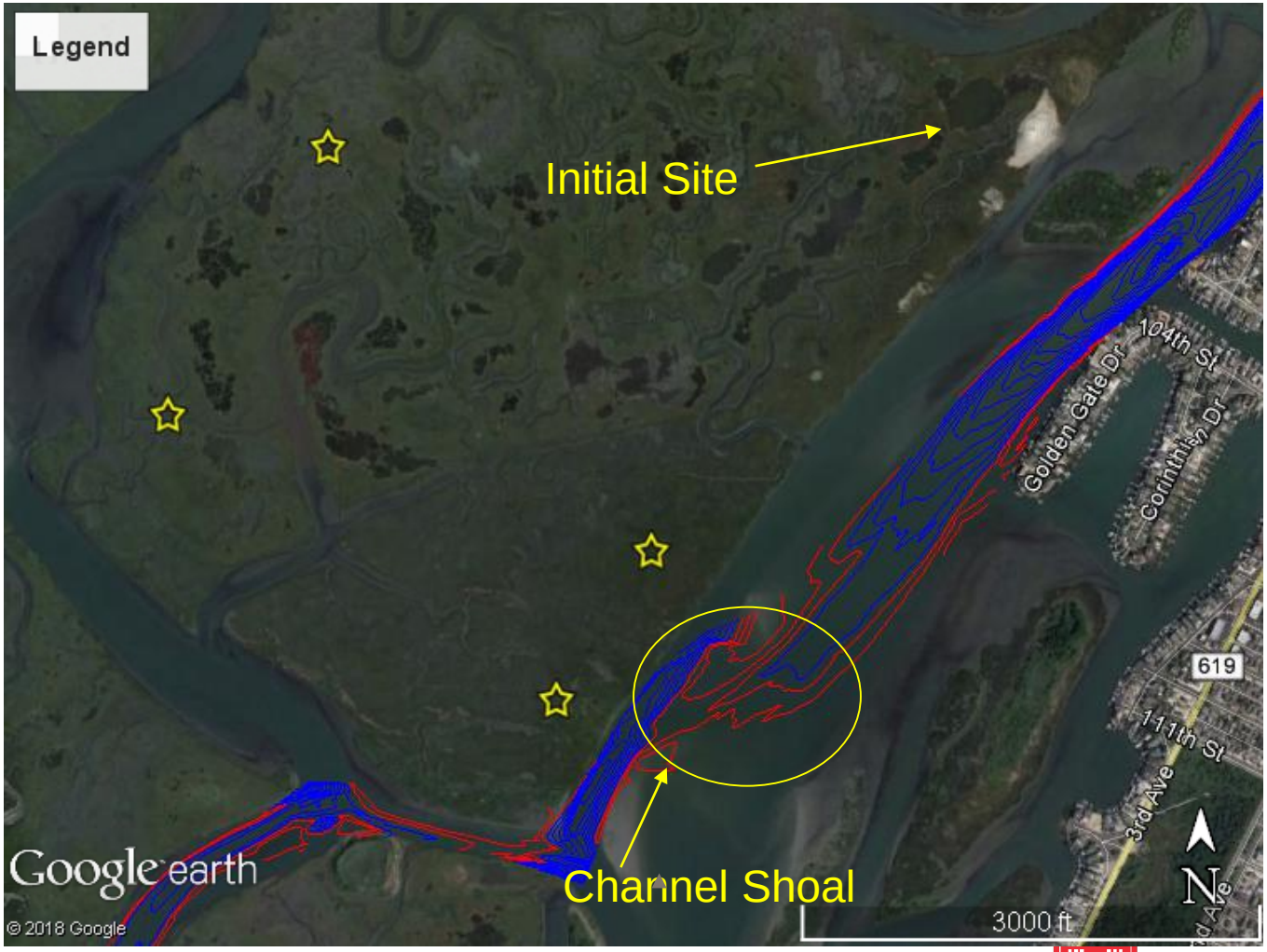
GreenVest One Step Ahead.

pH Princeton Hydro

The Nature Conservancy
Protecting nature. Preserving life.

Wetlands Institute

ADAPTIVE MANAGEMENT AND SYSTEMS APPROACH
FROM NNBF PILOTS TO SOLUTIONS



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MORDECAI ISLAND RESTORATION
BEACH HAVEN, NJ
CASE STUDY

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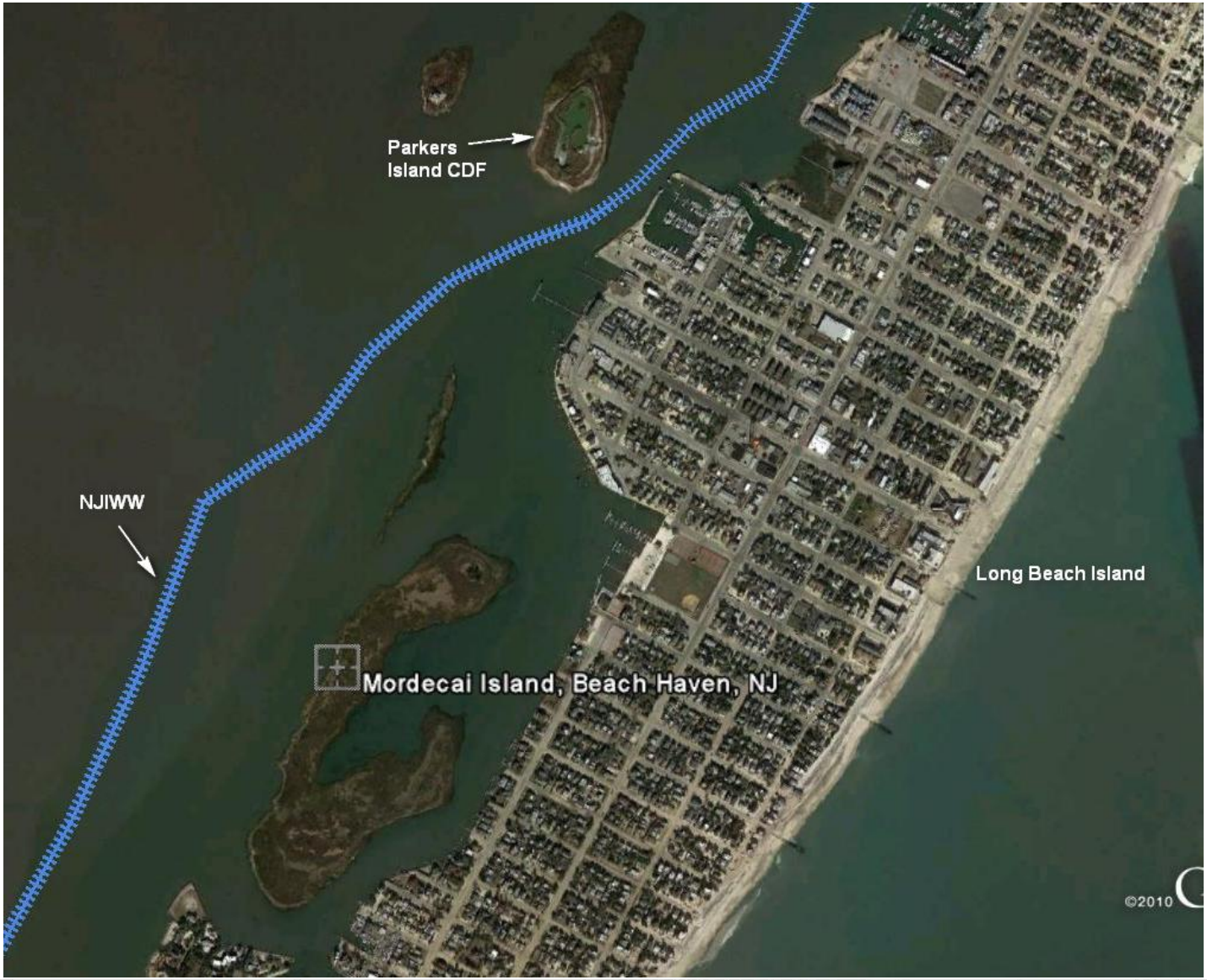
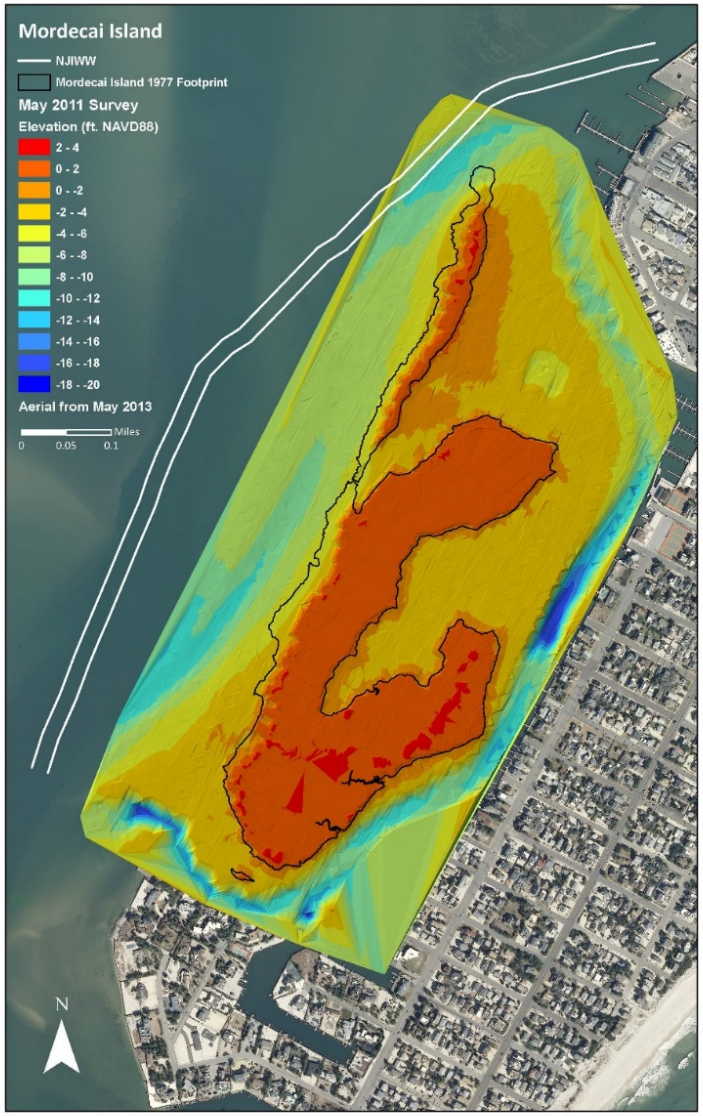
ACCELERATING PROGRESS WITH AN RSM/EWN SYSTEMS APPROACH: MORDECAI ISLAND NJ



MORDECAI ISLAND PROJECT AREA

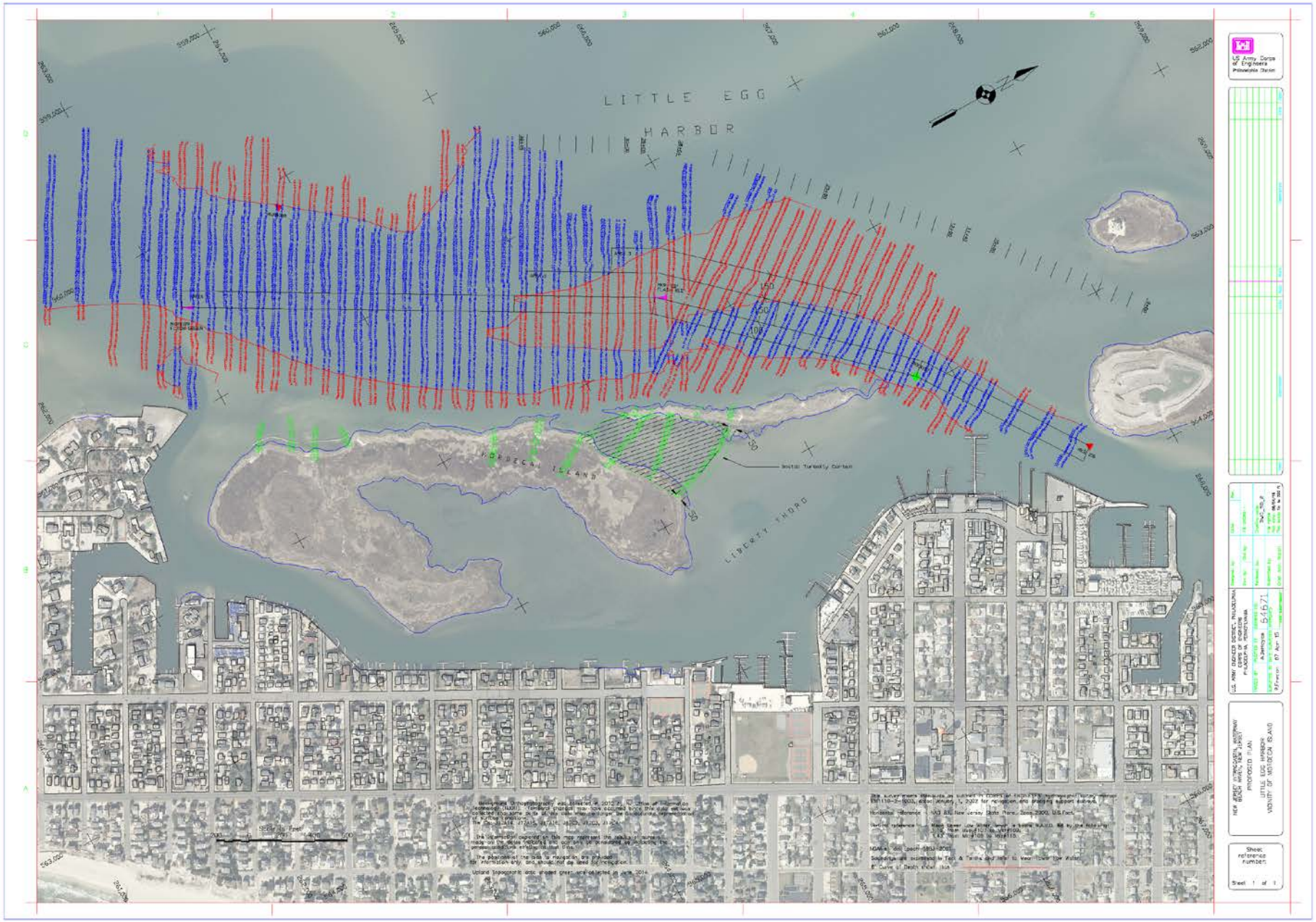
- Mordecai Island is composed of approximately 45 acres to the west of Beach Haven, Long Beach Island, NJ
- Island provides critical habitat to numerous species including the American Oystercatcher, Black Skimmer and American Bittern as well as terrapins
- Provides coastal protection for the back-bay community of Beach Haven
- Property owned by the Mordecai Land Trust

MORDECAI ISLAND PLANNING STUDY: ECOSYSTEM RESTORATION CONTINUING AUTHORITIES PROGRAM (CAP)



Continued erosion of Mordecai Island threatens a diversity of natural wildlife habitats including open marsh, salt ponds, exposed mud flats, shrub-dominated areas and shallow water eelgrass beds.

Previous work and partnerships were and are incredibly valuable!! Included NMFS & USFWS, Bureau of Coastal Engineering, Mordecai Land Trust, NOAA


LITTLE EGG
HARBOR
HORDECAL ISLAND
LIBERTY THORO
Scale in Feet
US Army Corps of Engineers
Philadelphia District
U.S. ARMY ENGINEER DISTRICT, PHILADELPHIA
CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA
Adelphia 64671
Fraction 07 Apr 15
NEW JERSEY INTRACOASTAL WATERWAY
BEACH HAVEN, NEW JERSEY
PROPOSED PLAN
LITTLE EGG HARBOR
VICINITY OF HORDECAL ISLAND
Sheet reference number:
Sheet 1 of 1

MORDECAI ISLAND CONSTRUCTED! NOVEMBER 2015

Contractors: Barnegat Bay Dredging Company, Fish Tec Inc. and GreenVest LLC

Mordecai Island
During Construction

STABILIZATION TECHNIQUES

POST-CONSTRUCTION MORDECAI ISLAND

Mordecai Island August 2017

MONITORING AND ADAPTIVE MANAGEMENT

Raised Habitat in Dec 2017

Build it and they will come….

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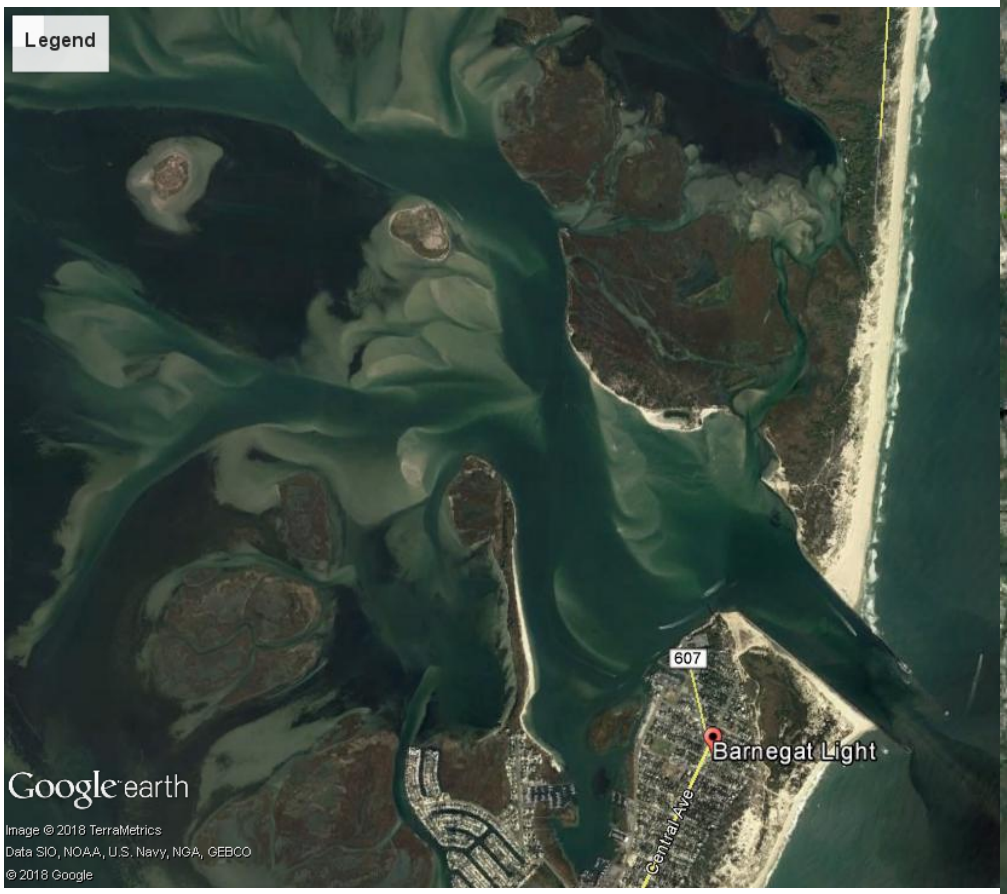
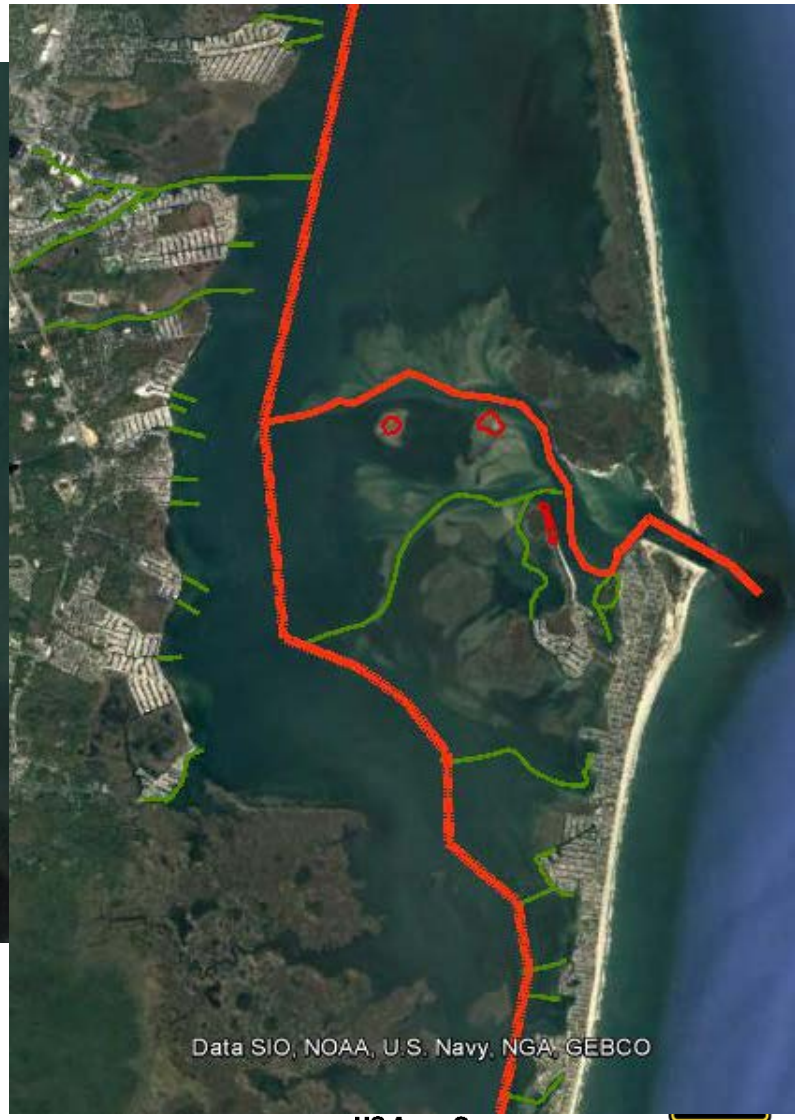
MORDECAI ISLAND CONSTRUCTION: DECEMBER 2017

BARNEGAT INLET, NJ
ISLAND BUILDING AND OPPORTUNITIES





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BARNEGAT INLET'S SEDIMENT RICH SYSTEM

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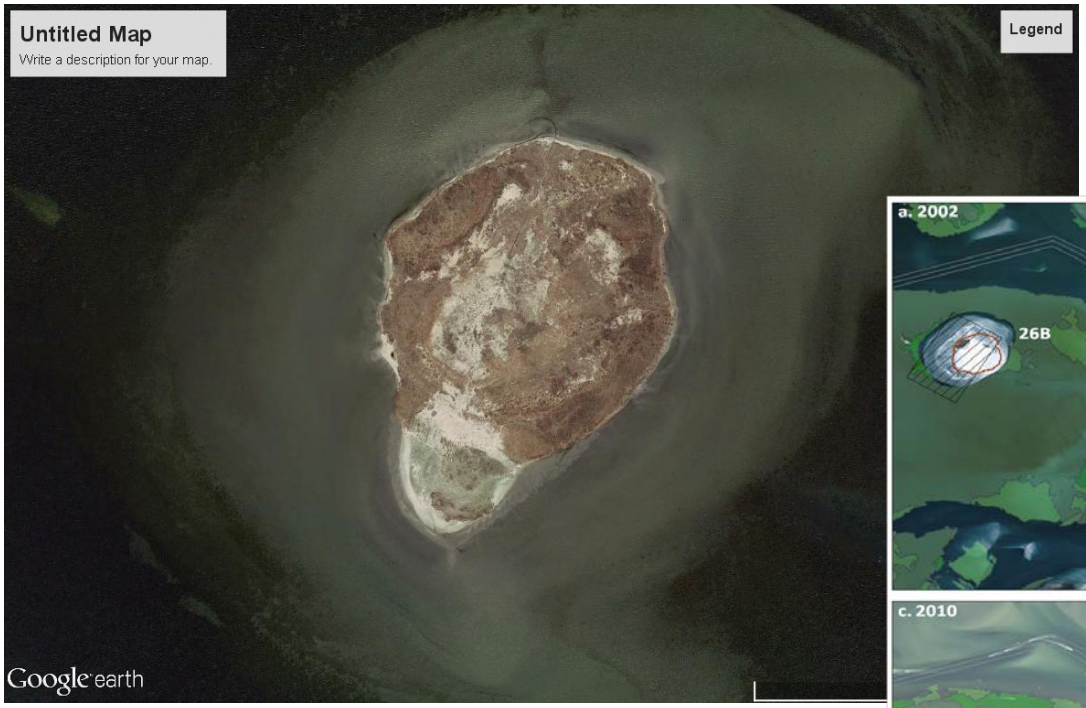
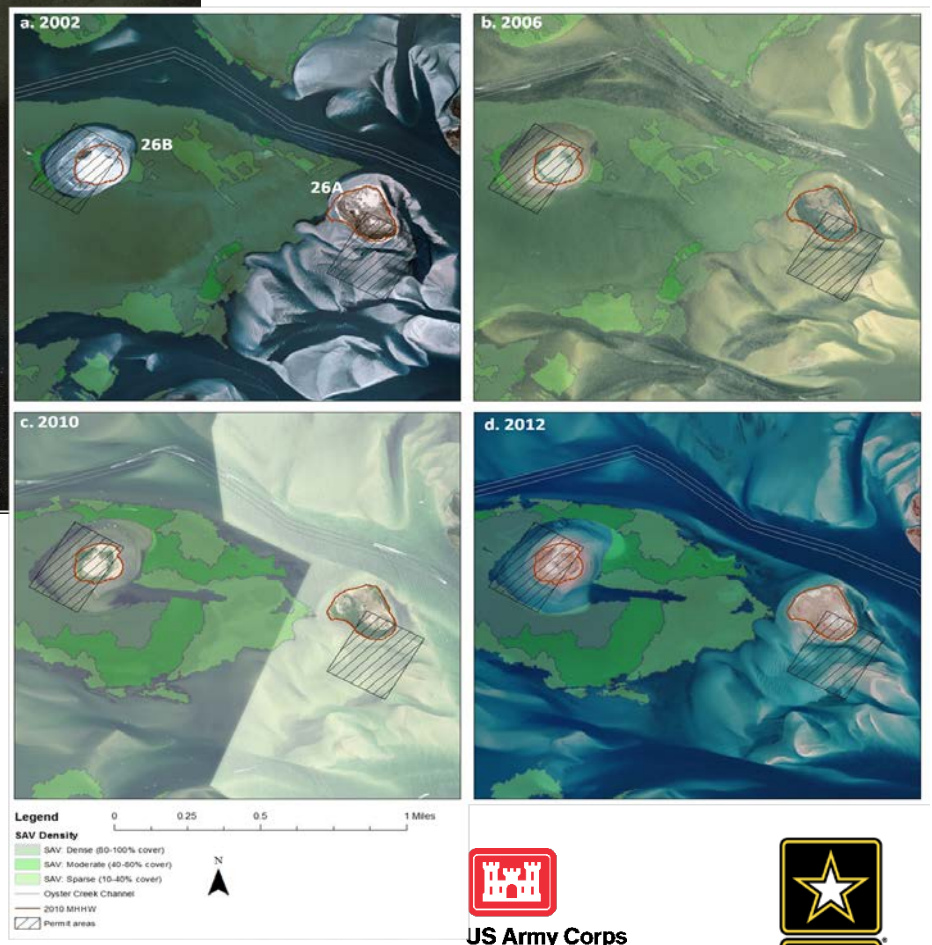
BARNEGAT INLET, NJ
ISLAND BUILDING AND OPPORTUNITIES





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Coastal Island Features

Conclusions

- Barrier and other coastal islands are an integral part of coastal resilience
- Most coastal islands are dynamic features
- Both anthropogenic and natural processes can contribute to reduced flood risk reduction function
- Design considerations include habitat components, size, cost and maintenance/monitoring
- Area influenced by constructed island features may be larger than other nature-based features
- Most nature-based island restoration will occur on existing island platforms
- Containment may be required to permit stabilization and plant growth
- Where possible, utilize dredged sediment to restore and maintain islands