

# Engineering With Nature for Project Benefits



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## Engineers Australia

*“Sustainable Dredging and Sediment Management: Assessing and Managing Environmental Effects and Benefits”*

September 7-11, 2015



US Army Corps  
of Engineers.

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Engineer Research and  
Development Center



# Engineering With Nature...

***...the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaborative processes.***

## Key Elements:

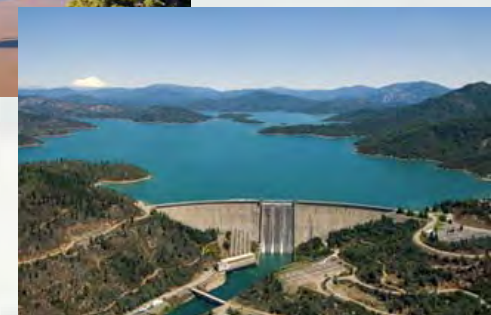
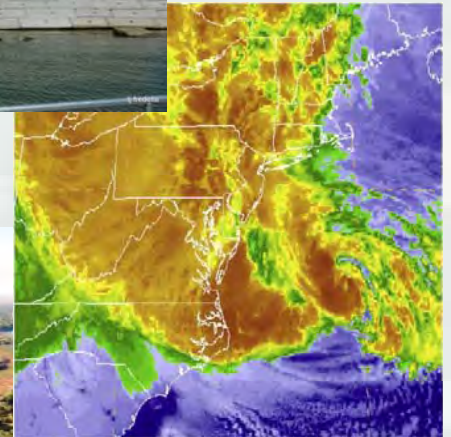
- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners





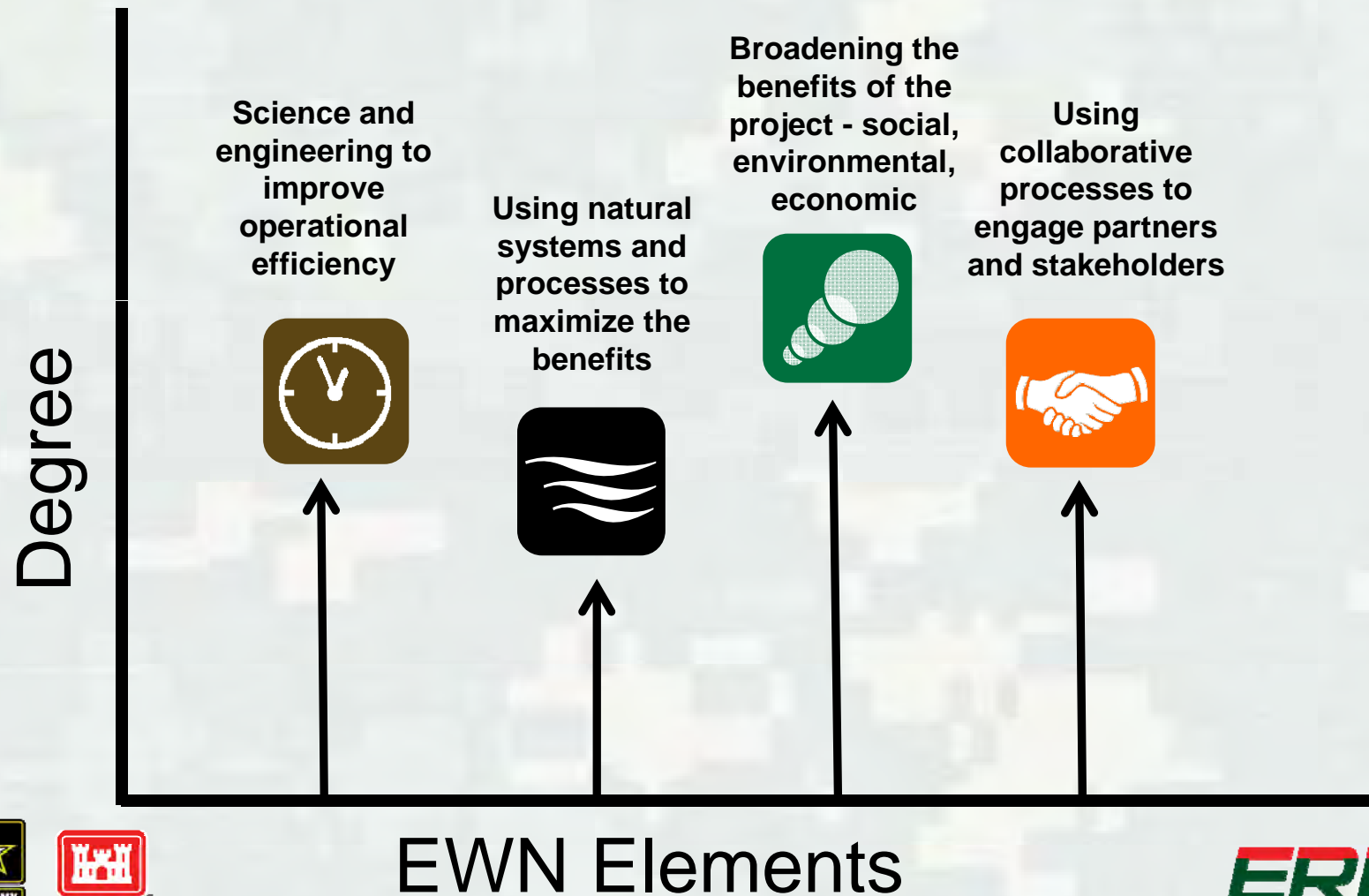
# EWN Across USACE Mission Space

- Navigation
  - ▶ Strategic placement of dredged material supporting habitat development
  - ▶ Habitat integrated into structures
- Flood Risk Management
  - ▶ Natural and Nature-Based Features to support coastal resilience
  - ▶ Levee setbacks
- Ecosystem Restoration
  - ▶ Ecosystem services supporting engineering function
  - ▶ “Natural” development of designed features
- Water Operations
  - ▶ Shoreline stabilization using native plants
  - ▶ Environmental flows



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# Engineering With Nature Elements



EWN Elements

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# EWN Status

- *Engineering With Nature* initiative started within USACE Civil Works program in 2010. Over that period we have:
  - ▶ Engaged across USACE Districts (23), Divisions, HQ; other agencies, NGOs, academia, private sector, international collaborators
    - Workshops (>20), dialogue sessions, project development teams, etc.
  - ▶ Implementing strategic plan
  - ▶ Focused research projects on EWN
  - ▶ Field demonstration projects
  - ▶ Communication plan
  - ▶ District EWN Proving Grounds established
  - ▶ Awards
    - 2013 Chief of Engineers Environmental Award in Natural Resources Conservation
    - 2014 USACE National Award-Green Innovation



[www.engineeringwithnature.org](http://www.engineeringwithnature.org)

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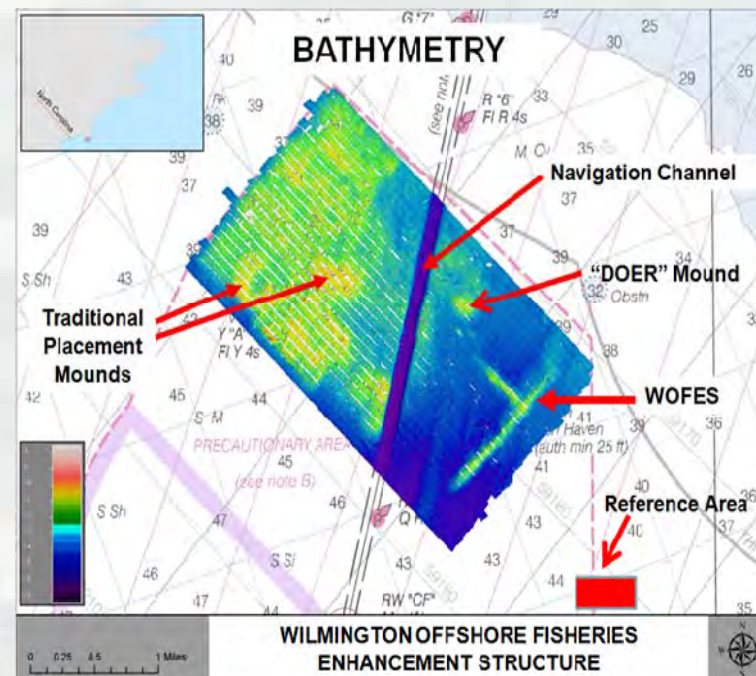
# Evia Island, Galveston Bay, TX

- 6-acre island was constructed using sediment dredged during the deepening of the Houston Ship Channel in 1998
- Island provides substantial bird and other habitat
- Producing significant environmental benefits



# WOFES, Wilmington, NC

- Created in 1994-1997 from 764,600 cubic meters of limestone dredged as part of the Wilmington channel deepening
- Located three nautical miles off of the mouth of the Cape Fear River in North Carolina
- The location and design of the reef involved extensive participation by stakeholders, and the North Carolina Department of Environment and Natural Resources supported the project as a local sponsor
- Produced significant social benefits as a popular destination for fishing

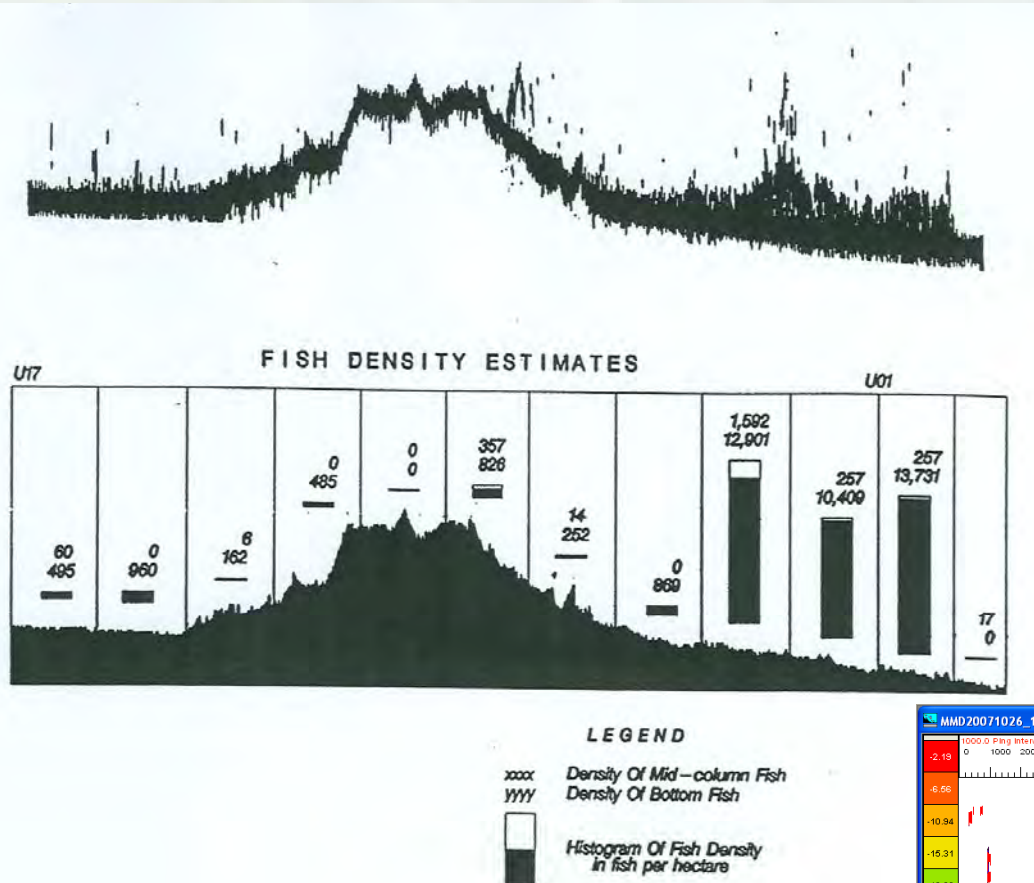


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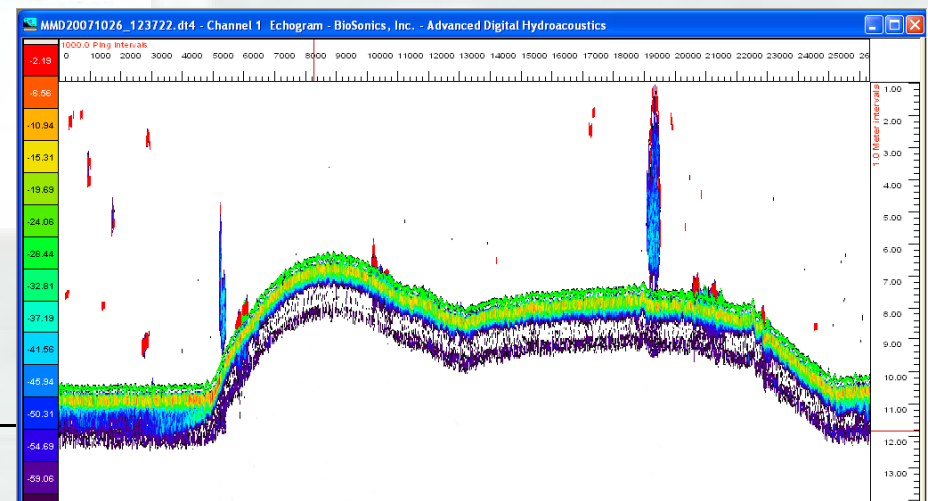
# Mobile Offshore Dredged Material Mound



Hydroacoustics and trawling data used to document fisheries benefits provided by topographic relief created with dredged material

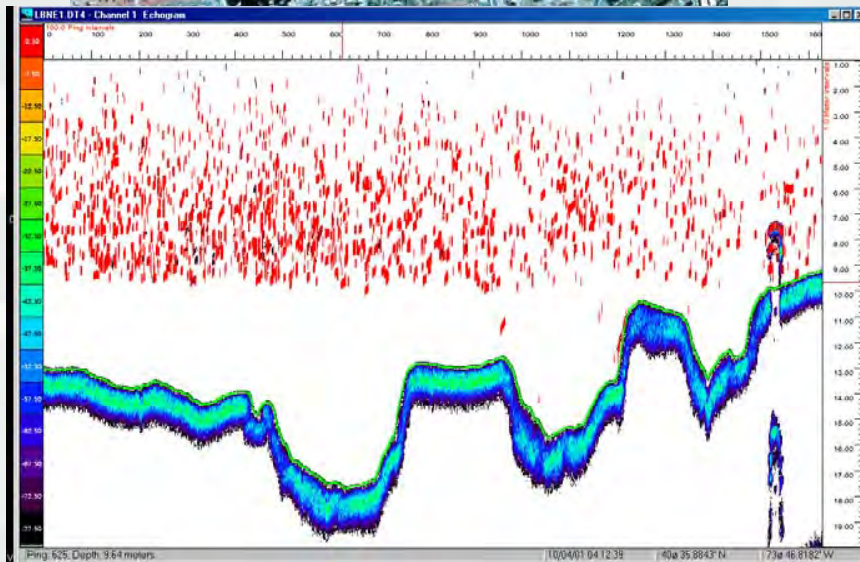
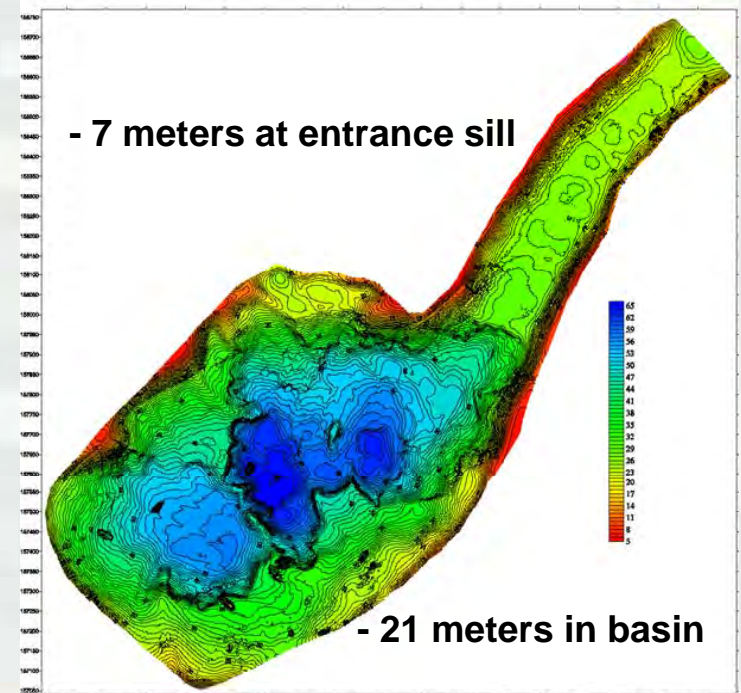


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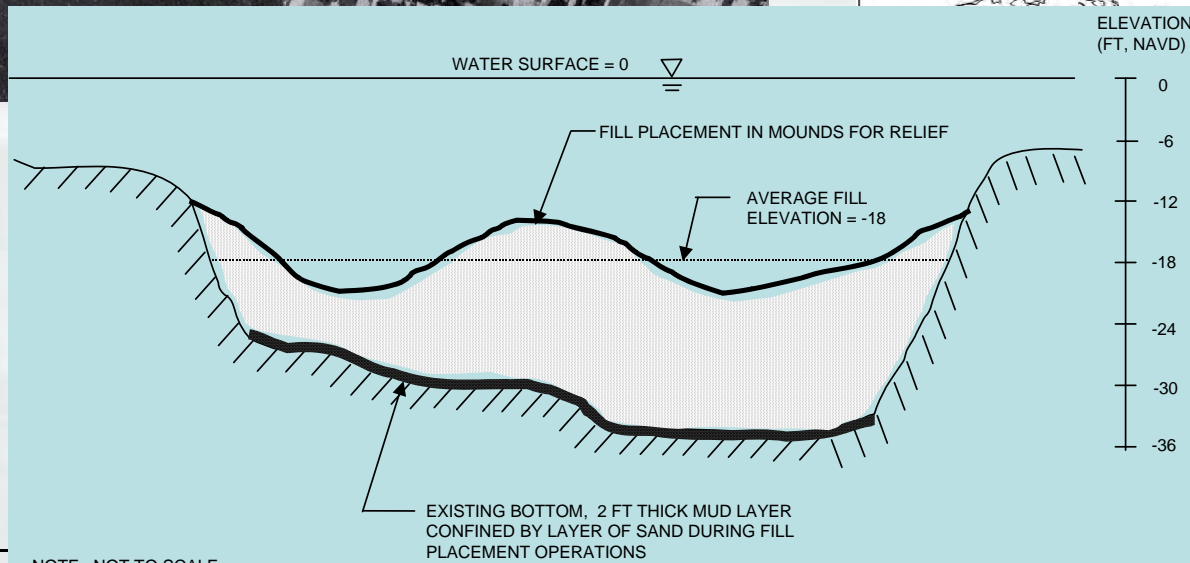
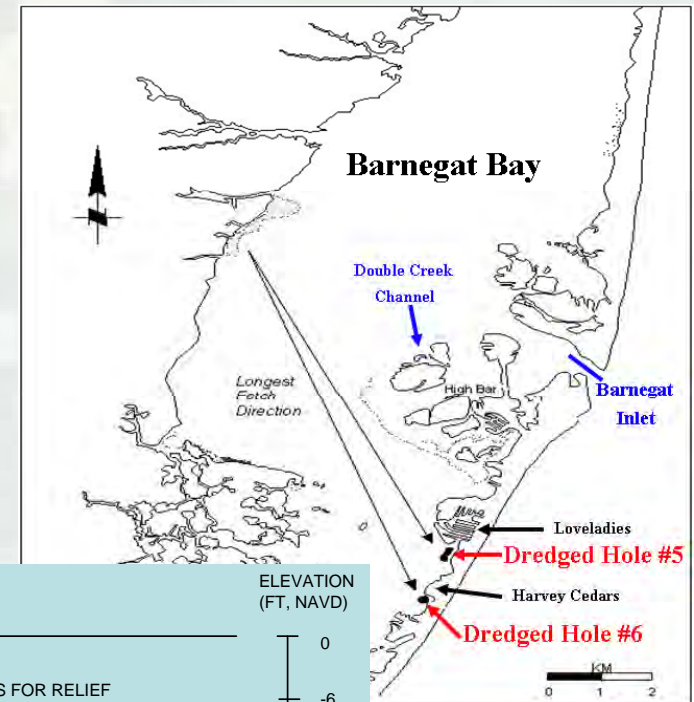
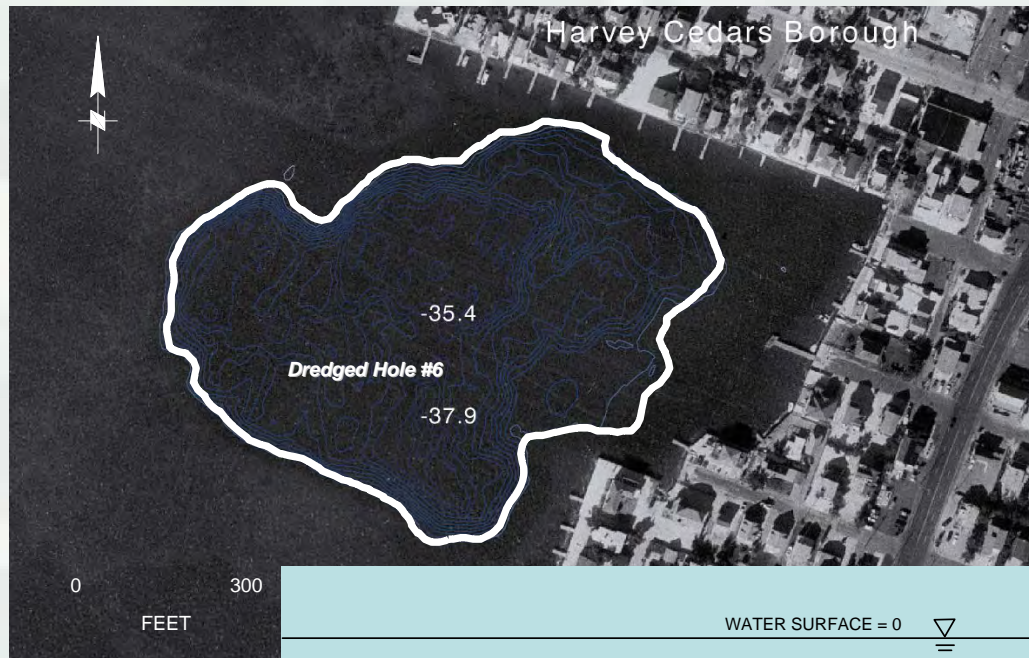




# Environmental Restoration of Holes/Pits



# BARNEGAT BAY – HOLE #6



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NOTE: NOT TO SCALE,  
VERTICAL SCALE EXAGGERATED

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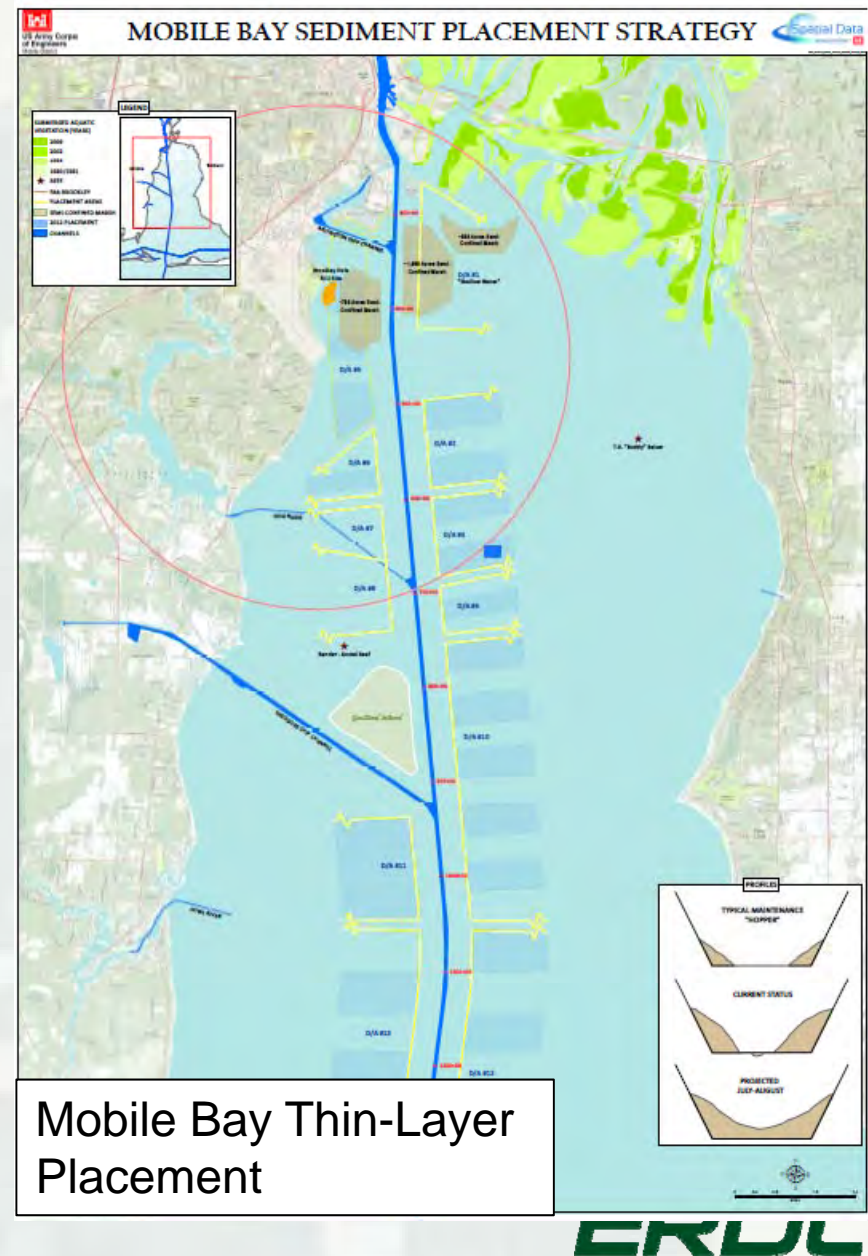


# Strategic Sediment Placement in Mobile Bay

- 25 years ago, in-bay disposal of dredged material was banned
  - Shoreline erosion and loss of habitat followed
- Thin-layer placement was demonstrated on full-scale to restore sediment processes
- Many opportunities for in-water beneficial use
- Ecosystem benefits being documented



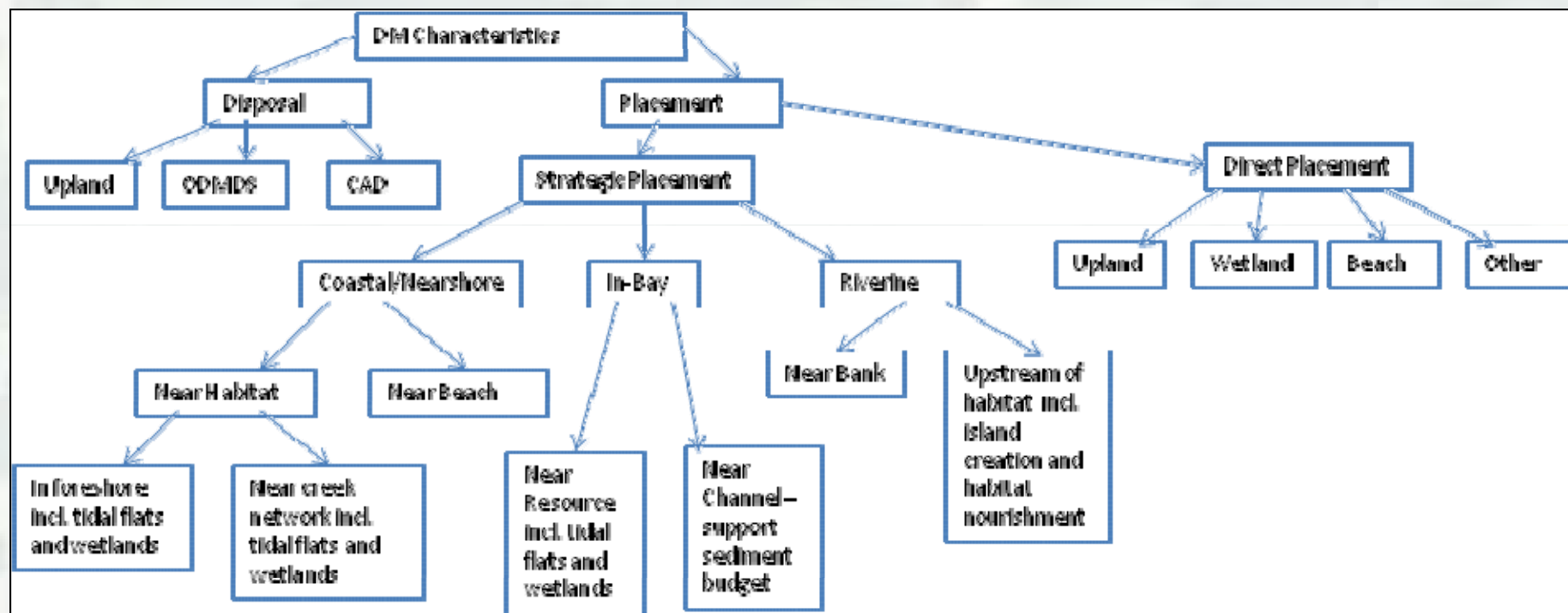
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# Strategic Sediment Placement



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# Horseshoe Bend, Atchafalaya River

- Options for managing dredged material via shore-based wetland creation were exhausted
- Strategic placement of sediment (0.5-1.8 mcy/1-3 yrs) was used to create a ~35 ha island
- Producing significant environmental and engineering benefits
- Project won WEDA's 2015 Award for Environmental Excellence

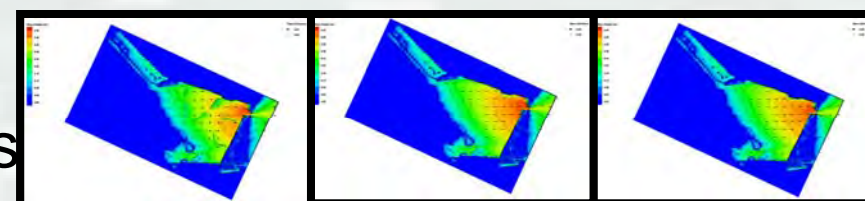


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# Hamilton Wetland, San Pablo Bay

- Beneficial use of dredged material to restore army air field to wetlands
- Dredged material was placed directly to contour wetland
- ERDC monitoring of new wetland to quantify waves, other physical processes and accretion
- ERDC modeling wave generation and dissipation, testing different shapes for barriers to fetch
- Plants will volunteer in tidal areas as sufficient accretion occurs



Linear Berms (As-Built)

No Berms (Control)

Mounds (ala Sears Pt.)





# Coastal NJ, Philadelphia District



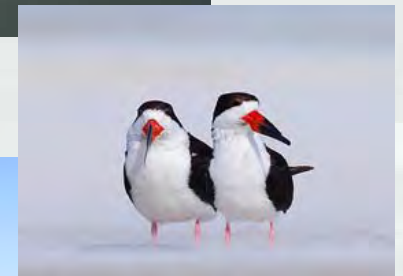
December 2014



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Stone Harbor



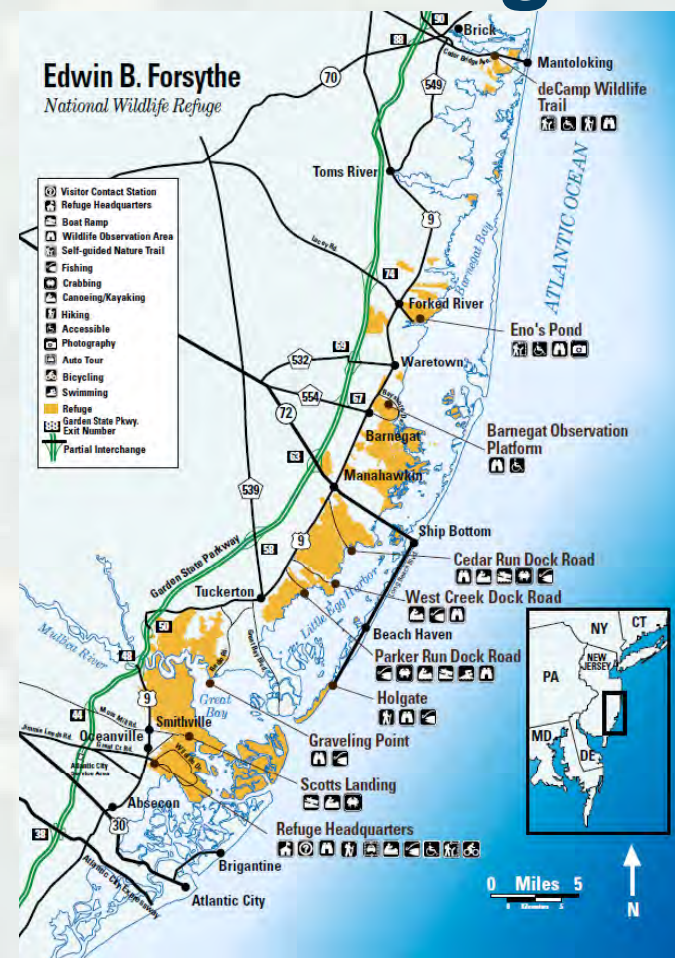
Avalon

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# US Fish and Wildlife Service Forsythe National Wildlife Refuge

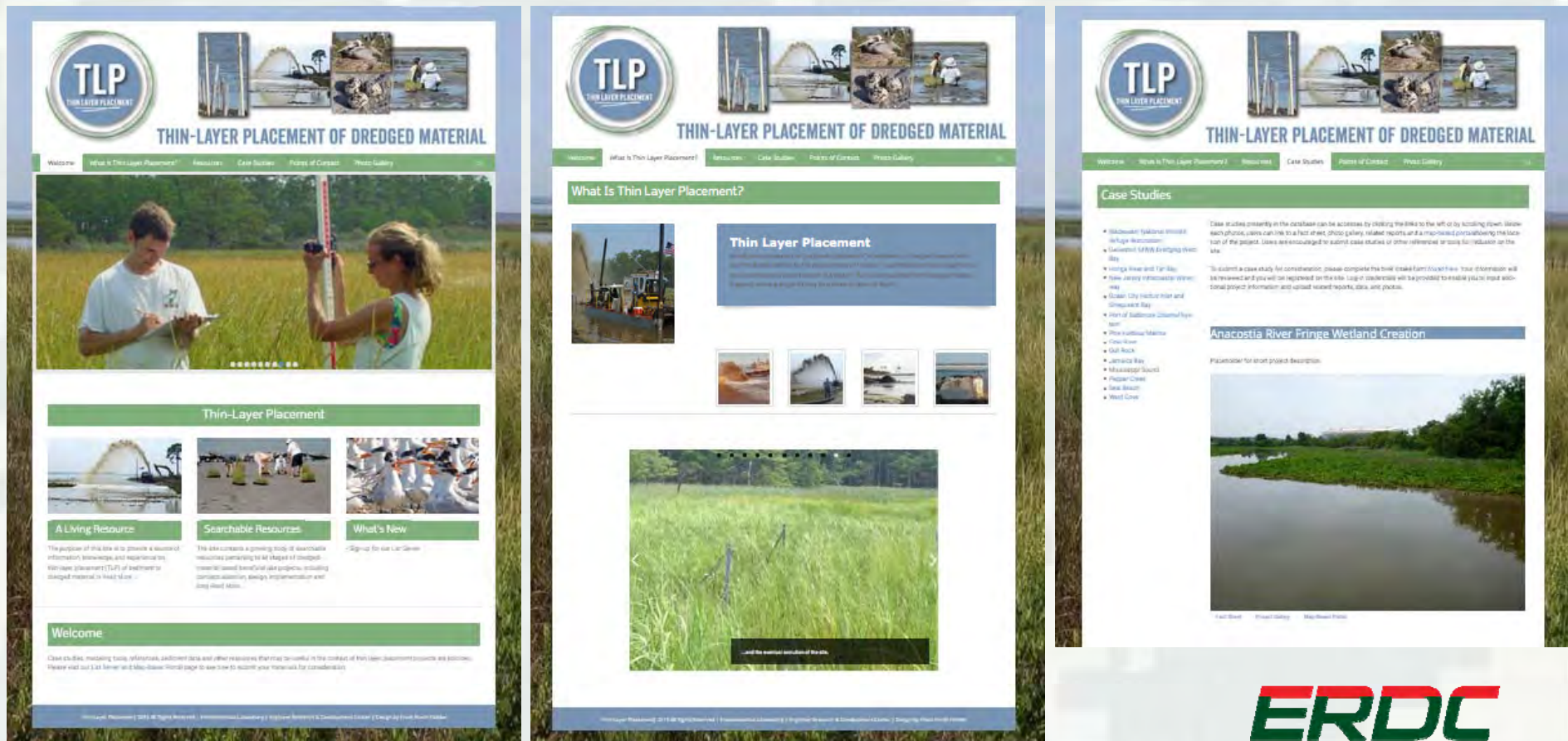
- Forsythe NWR: >40,000 acres of wetlands and other habitat in coastal NJ
- Collaboration objective: Enhance ecosystem resilience through engineering and restoration
- Means: Smart use of sediment resources and EWN principles and practices





# Thin-Layer Placement Website

Coming soon to  
[www.engineeringwithnature.org](http://www.engineeringwithnature.org)

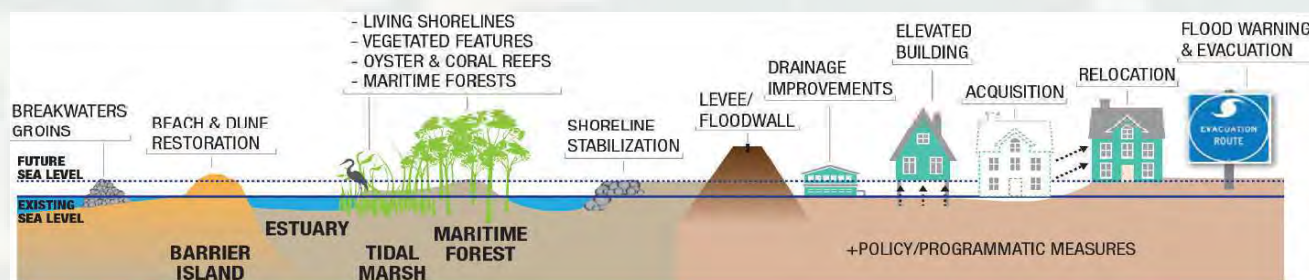
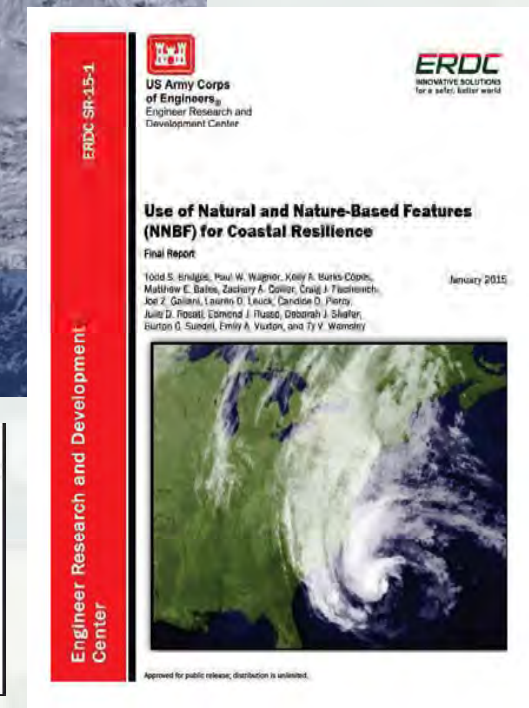


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# Natural and Nature-Based Features: North Atlantic Coast Comprehensive Study

- Opportunities to integrate Natural and Nature-Based Features (NNBF) with structural and non-structural measures to provide multiple lines of defense against storms and sea level rise, generating a full array of relevant economic, environmental and social ecosystem goods and services.



See Bridges et. al., 2015  
<http://www.nad.usace.army.mil/CompStudy>



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## Natural and Nature-Based Infrastructure at a Glance

GENERAL COASTAL RISK REDUCTION PERFORMANCE FACTORS:  
STORM INTENSITY, TRACK, AND FORWARD SPEED, AND SURROUNDING LOCAL BATHYMETRY AND TOPOGRAPHY



### Dunes and Beaches

#### Benefits/Processes

Break offshore waves  
Attenuate wave energy  
Slow inland water transfer

#### Performance Factors

Berm height and width  
Beach Slope  
Sediment grain size and supply  
Dune height, crest, width  
Presence of vegetation



### Vegetated Features:

#### Salt Marshes, Wetlands, Submerged Aquatic Vegetation (SAV)

#### Benefits/Processes

Break offshore waves  
Attenuate wave energy  
Slow inland water transfer  
Increase infiltration

#### Performance Factors

Marsh, wetland, or SAV elevation and continuity  
Vegetation type and density



### Oyster and Coral Reefs

#### Benefits/Processes

Break offshore waves  
Attenuate wave energy  
Slow inland water transfer

#### Performance Factors

Reef width, elevation and roughness



### Barrier Islands

#### Benefits/Processes

Wave attenuation and/or dissipation  
Sediment stabilization

#### Performance Factors

Island elevation, length, and width  
Land cover  
Breach susceptibility  
Proximity to mainland shore



### Maritime Forests/Shrub Communities

#### Benefits/Processes

Wave attenuation and/or dissipation  
Shoreline erosion stabilization  
Soil retention

#### Performance Factors

Vegetation height and density  
Forest dimension  
Sediment composition  
Platform elevation



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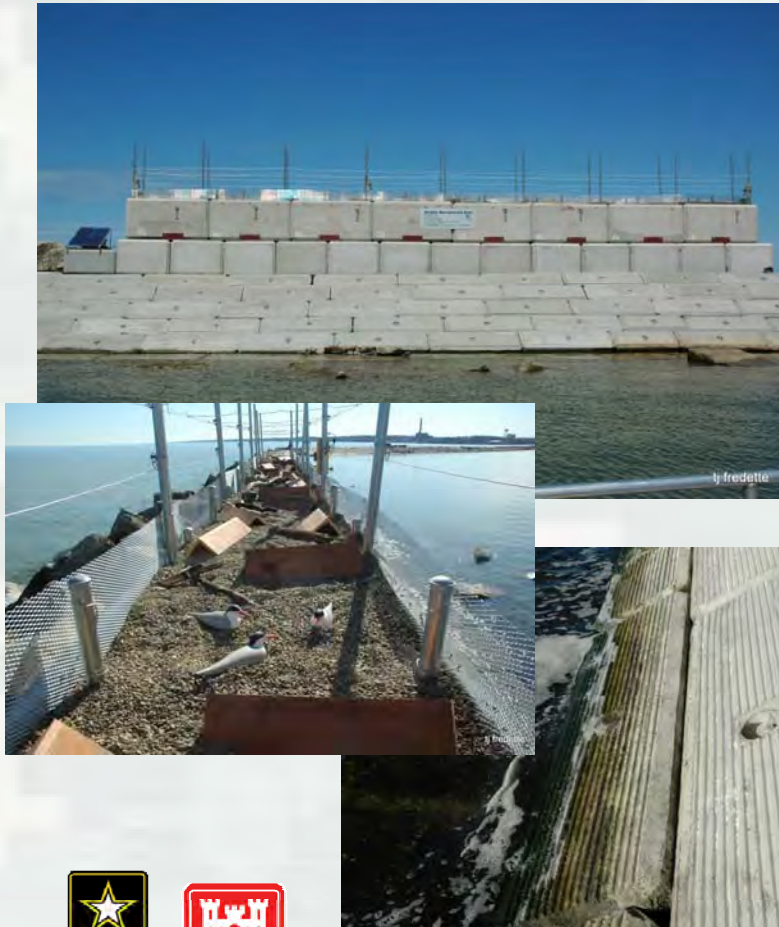
## Implementation Framework



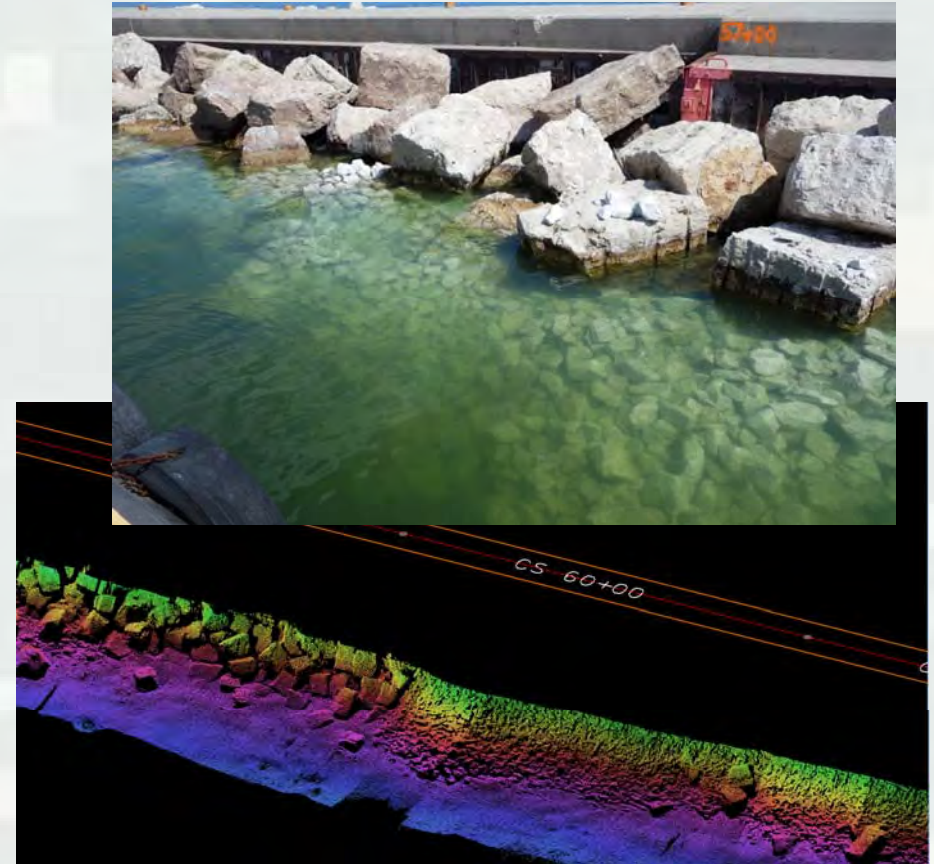


# Example EWN Solutions: Green Breakwaters

## Ashtabula Harbor



## Milwaukee Harbor



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# ***Coastal Resilience: The Environment, Infrastructure, and Human Systems***

- USACE was the primary sponsor and host (USEPA and USDOE were co-sponsors)
  - ▶ Dr. Todd Bridges, Conference Chair
  - ▶ Ms. Cynthia Banks, Conference Organizer
- 85 participants from 8 countries (Barbados, Fiji, Mexico, The Netherlands, South Africa, South Korea, United Kingdom, and United States)
  - ▶ Diversity of organizational perspectives:
    - USACE, NOAA, USEPA, USFWS, OMB, CEQ, DOE, US Navy, Treasury Department, State Department, TNC, AAPA, Water Institute of the Gulf, National Wildlife Federation, Great Lakes Dredge & Dock Company, Environ Corp., Dewberry, several universities, and many other organizations
- Conference consisted of a series of plenary presentations and panel discussions
  - ▶ Share information about science and engineering relevant to coastal resilience



The audio and visuals for each presentation are at:  
<http://el.erdcl.usace.army.mil/ewn/workshop.cfm?List=14MayCR>





# USACE Galveston and Buffalo Districts: EWN “Proving Grounds”

- EWN Proving Ground Kick-Off Workshops
  - ▶ October (SWG) and December (LRB) 2014
  - ▶ ~70 participants
  - ▶ SWG, SWD, LRB, ERDC, IWR and HQ
- Identified opportunities to implement EWN within current and future programs and projects
- Emphasis on solution co-development



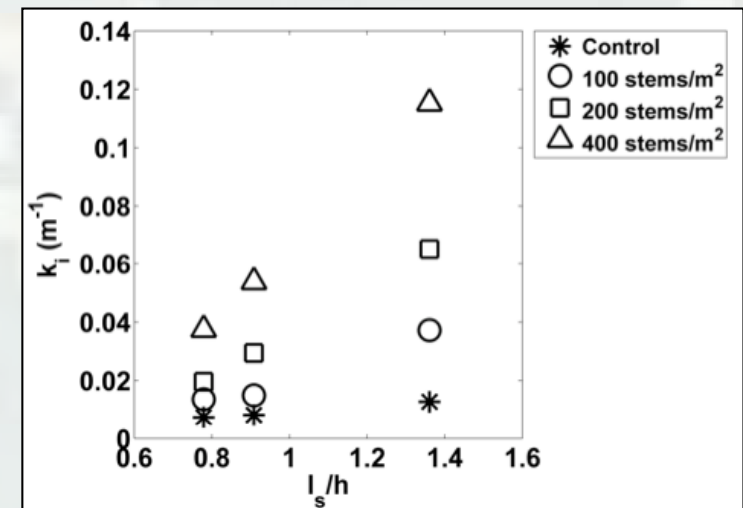
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# R&D Example: Engineering Performance of NNBF

- What are the engineering benefits of wetlands with respect to waves?
- Flume studies being performed in the 10 ft flume
  - Complemented by examination of sediment processes and field studies
- Wave attenuation was found to:
  - increase with stem density
  - increase with submergence ratio
  - slight increase with incident wave height
- Results used to update STWAVE



# EWN Action Demonstration Projects, 1

- Sediment Retention Engineering to Facilitate Wetland Development (San Francisco Bay, CA)
- Realizing a Triple Win in the Desert: Systems-level Engineering With Nature on the Rio Grande (Albuquerque, NM)
- Atchafalaya River Island and Wetlands Creation Through Strategic Sediment Placement (Morgan City, LA)
- Portfolio Framework to Quantify Beneficial Use of Dredged Material (New Orleans and New England)
- Engineering Tern Habitat into the Ashtabula Breakwater (Ashtabula, OH)
- Living Shoreline Creation Through Beneficial Use of Dredged Material (Duluth, MN)
- A Sustainable Design Manual for Engineering With Nature Using Native Plant Communities



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# EWN Action Demonstration Projects, 2

- Landscape Evolution of the Oil Spill Mitigation Sand Berm in the Chandeleur Islands, Louisiana
- Guidelines for Planning, Design, Placement and Maintenance of Large Wood in Rivers: Restoring Process and Function (Collaboration with BoR)
- The Use and Value of Levee Setbacks in Support of Flood Risk Management, Navigation and Environmental Services (a strategy document)
- Strategic Placement of Sediment for Engineering and Environmental Benefit (an initial guide to opportunities and practices)

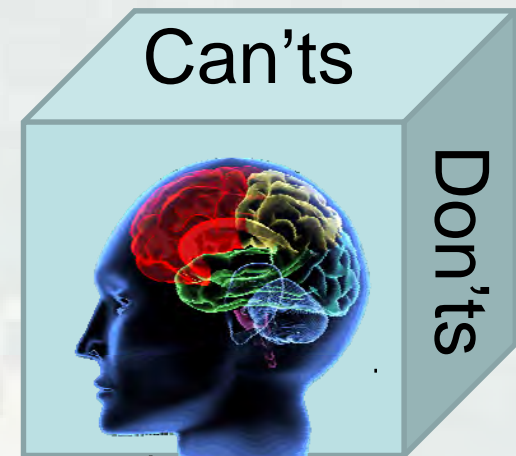


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# Advancing Expanded Benefits...

- More visioning about what benefits the project could produce
  - ▶ Developing a robust value proposition
- More partnering with others
- Less focus on historical constraints
- Document the benefits that are produced



# High Points



- Focus energy to motivate and facilitate innovation in both technical and business processes
- Accelerate progress through co-development of solutions!
- Important to elevate communication about advancing practice
  - ▶ Creating project value

