

# Engineering With Nature for Sustainable and Resilient Water Resources Infrastructure



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28 July 2015**



**US Army Corps of Engineers  
BUILDING STRONG®**

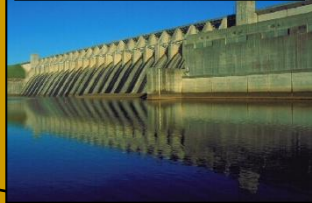


# USACE Civil Works Value to the Nation

**Recreation areas:**  
370 M Visitors/yr  
Generate \$16B in  
economic activity,  
270,000 jobs



**¼ of Nation's  
Hydropower:**  
\$1.5B + in  
power sales



**12,000 miles of  
Commercial Inland  
Waterways**  
transport goods at  
½ the cost of rail or  
1/10 the cost of  
trucks



**926 Shallow &  
Deep Draft  
Harbors**



**#1 Federal Provider  
Of Outdoor Recreation**  
54,879 Miles Of Shoreline  
at USACE Lakes



**Stewardship of  
12 Million Acres  
Public Lands**



**~14,500 Miles of  
Levees**



**Emergency  
Operations**

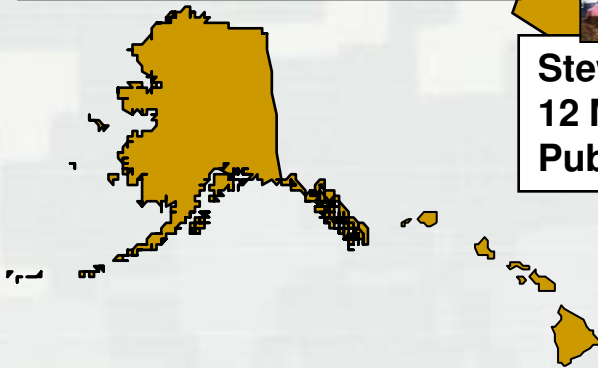


**Regulatory  
Responsibilities**



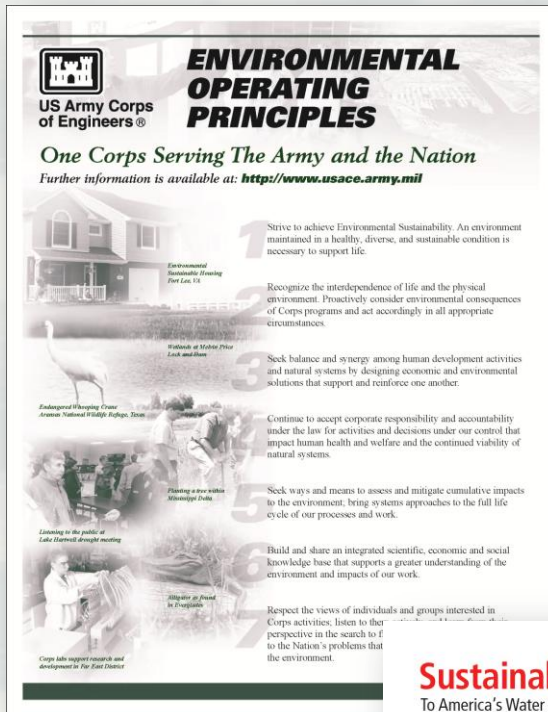
**137 Major Environmental  
Restoration Projects**

**Ports & Waterways Convey > 2.37 billion Tons Commerce**  
**Ports Provide Strategic Deployment Capability**  
**Harbor Maintenance Trust Fund collects \$1.7 billion revenue**





# Advancing USACE Practice



## Goals:

- More efficient, cost effective engineering and operational practices.
- More collaboration and cooperation, less unproductive conflict.

- Sustainable projects. Triple-win outcomes integrating social, environmental and economic objectives.

**Vision:** "Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation's water resources challenges."

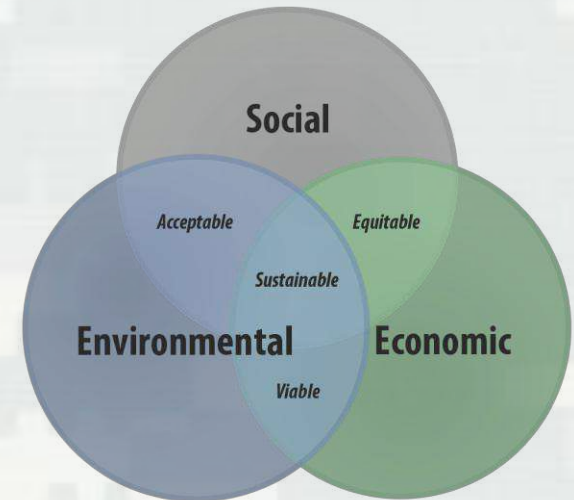


# Engineering With Nature...

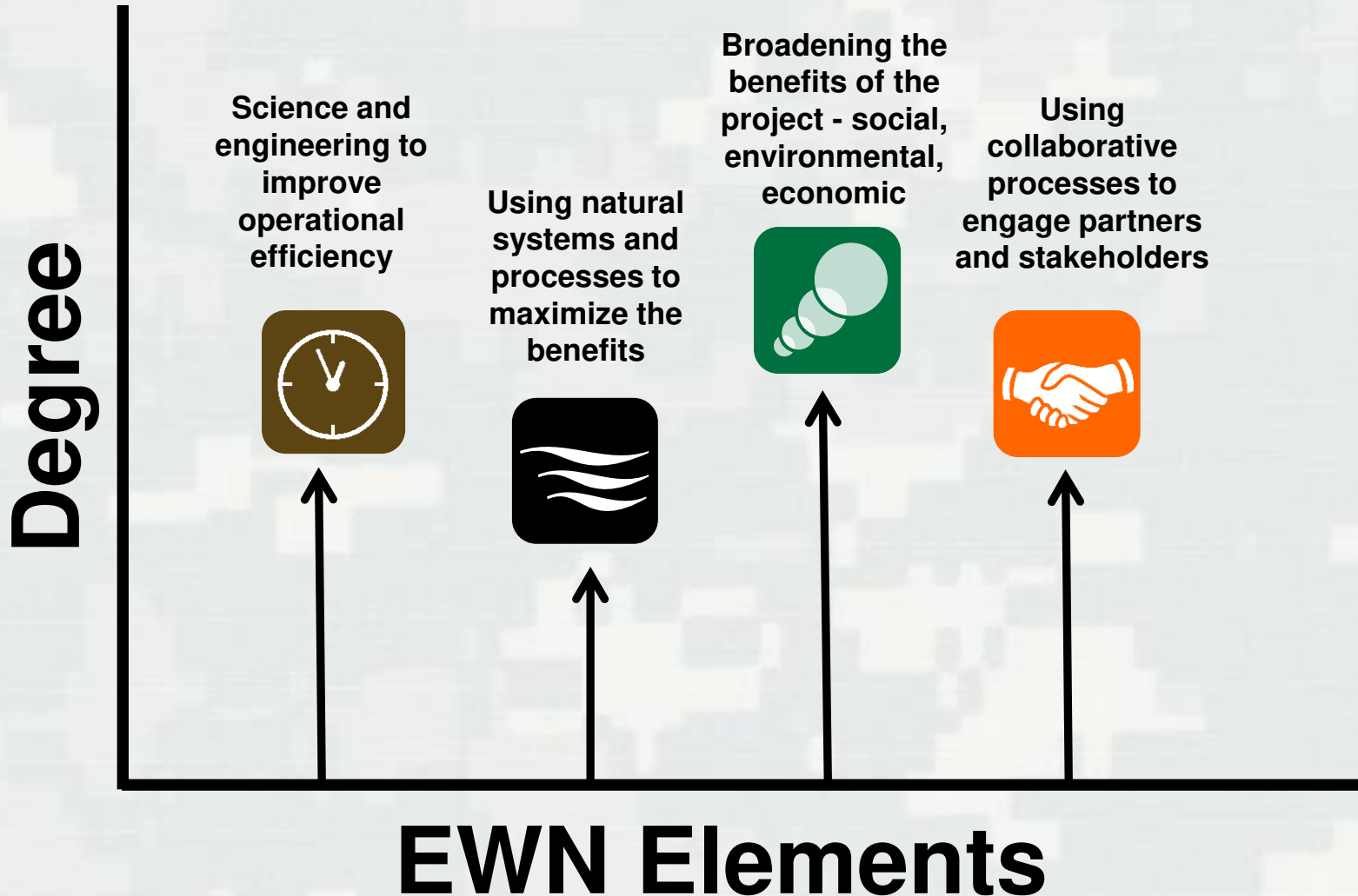
*...the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaborative processes.*

## 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



# *Engineering With Nature* Elements



# Case Study #1

- Evia Island (Galveston Bay, TX)
- 6-acre island was constructed using sediment dredged during the deepening of the Houston Ship Channel in 1998
- Birds making use of habitat provided by the island
- Producing significant environmental benefits





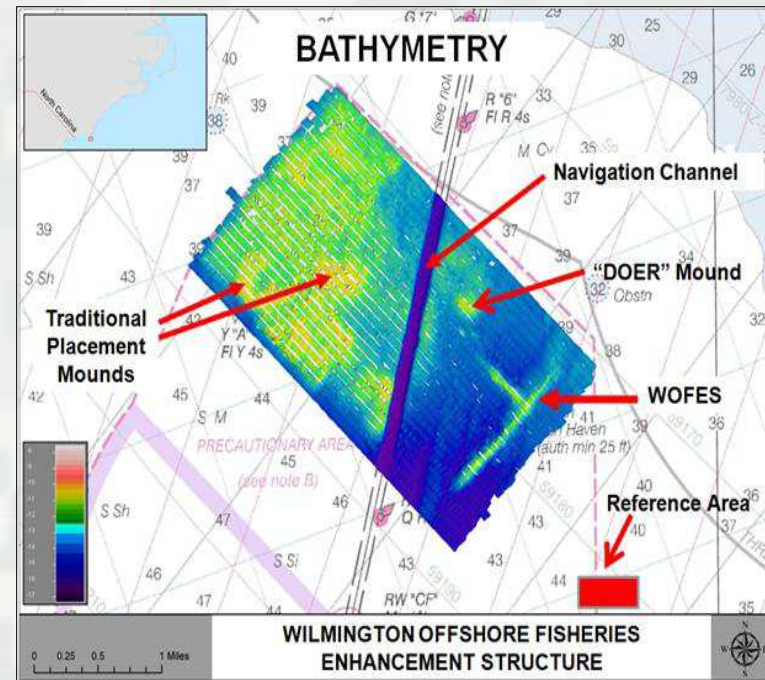
# Case Study #2

- Horseshoe Bend Island Creation along the Atchafalaya River (Morgan City, LA)
- As placement sites continue to become exhausted, there was a need for more creative placement alternatives in the Gulf Coast.
- In 2002, strategic placement of the sediment dredged from Horseshoe Bend occurred at the mid-river open water placement area.
- Strategic placement of between 0.5 to 1.8 million cubic yards of sediment was conducted every 1-3 years developing an ~35 ha island mid-river.
- Producing significant environmental and economic benefits



# Case Study #3

- Wilmington Offshore Fisheries Enhancement Structure (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 tournament participants





# 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
  - ▶ Awards
    - 2013 Chief of Engineers Environmental Award in Natural Resources Conservation
    - 2014 USACE National Award-Green Innovation
    - 2015 Western Dredging Association Environmental Excellence Award



# Hurricane Sandy

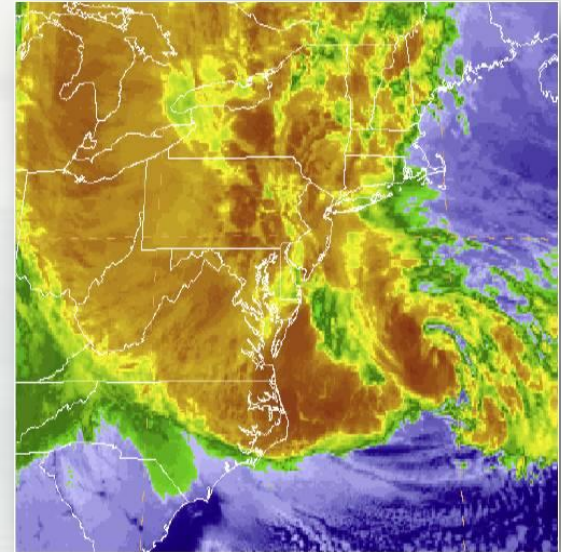
## Storm Impacts and Damages:

### ► Human

- 286 people killed (159 in the US)
- 500,000 people affected by mandatory evacuations
- 20,000 people required temporary shelter
- Extensive community dislocations – continuing today in some areas

### ► Economic

- \$65B in damages in the U.S.
- 26 states affected (10 states and D.C are in the NACCS study area)
- 650,000 houses damaged or destroyed



# In the Context of Coastal Resilience...

- What opportunities are there for achieving better alignment of natural and engineered systems?
  - ▶ Can improved alignment reduce risks to life and property?
  - ▶ What range of services can be produced through such alignment?
  - ▶ What are the science and engineering needs in order to achieve better alignment?



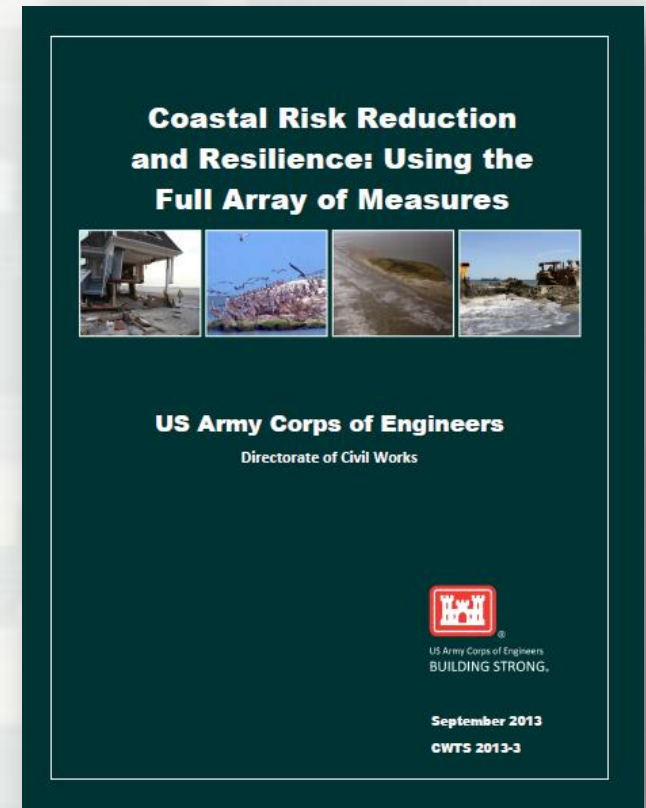
Sustainable Solutions Vision: “Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation’s water resources challenges.”





# Systems: Coastal Risk Reduction and Resilience

*“The USACE planning approach supports an **integrated approach** to reducing coastal risks and increasing human and ecosystem community resilience through a combination of **natural, nature-based, non-structural and structural measures**. This approach considers the engineering attributes of the component features and the dependencies and interactions among these features over both the short- and long-term. It also considers the **full range of environmental and social benefits** produced by the component features.”*



## 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

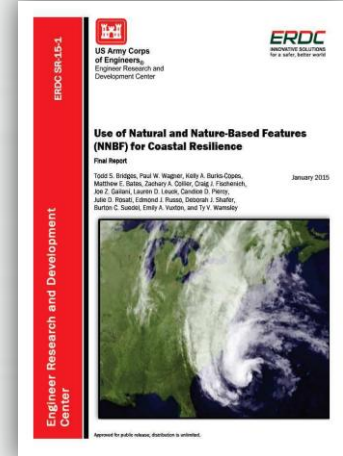
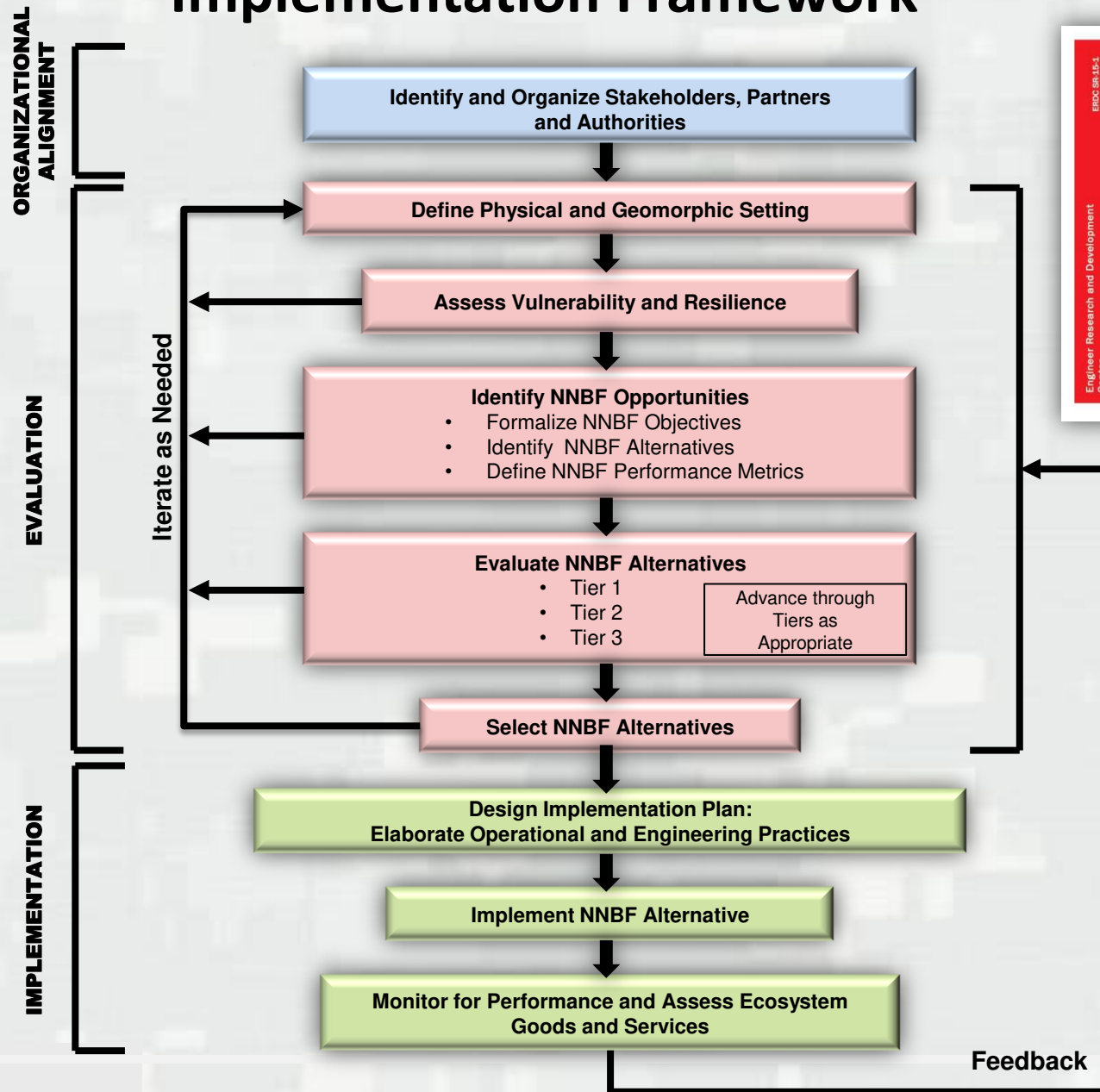
#### Benefits/Processes

Wave attenuation and/or dissipation  
Shoreline erosion stabilization  
Soil retention

#### Performance Factors

Vegetation height and density  
Forest dimension  
Sediment composition  
Platform elevation

# Natural and Nature-Based Features Evaluation and Implementation Framework





# ***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>

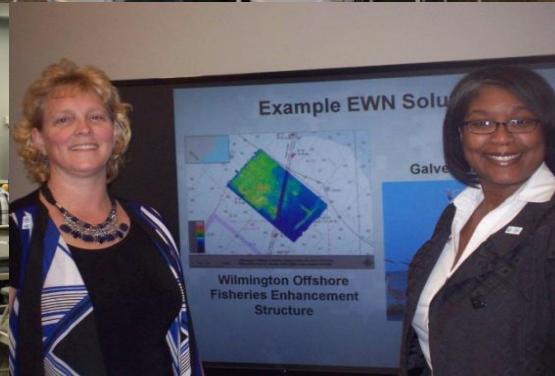
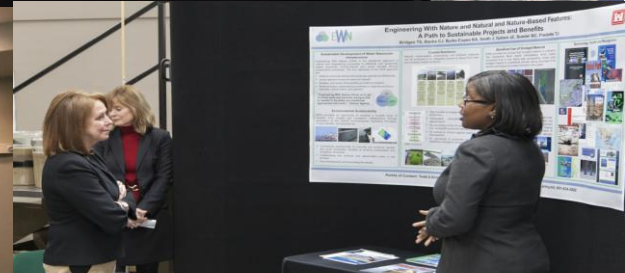
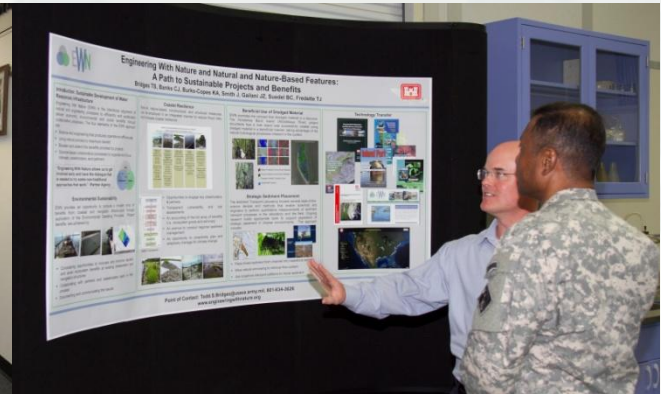
**ERDC**







# Engagement and Solution Co-Development





# 2013 EWN Action Demonstration Projects

- 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



# 2014 EWN Action Demonstration Projects

- 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)



# USACE *Engineering With Nature* Across USACE

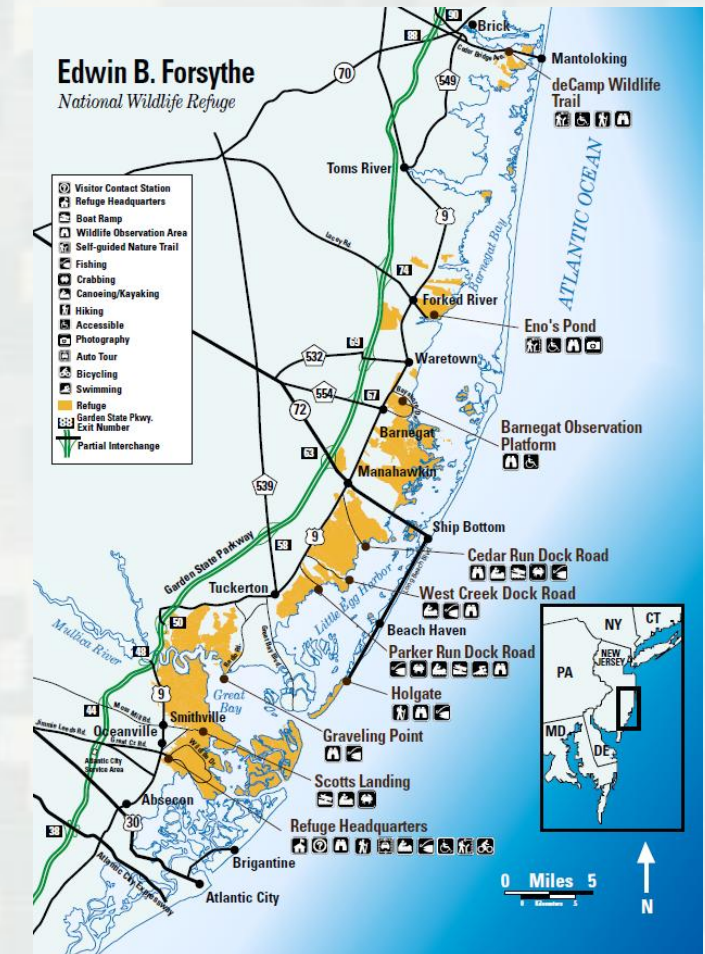
- Collaborating with Philadelphia, Detroit, San Francisco, New Orleans Districts on using sediment to enhance coastal resilience
- Galveston and Buffalo Districts serving as “proving grounds” for district-wide integration of EWN principles and practices





# Forsythe National Wildlife Refuge

- Forsythe NWR:  
>40,000 acres of wetlands and other habitat in coastal NJ
- Objective: Enhance ecosystem resilience through engineering and restoration
- Means: Apply EWN principles and practices



# Science, Engineering, Technology Research Targets

- Advance understanding of important, fundamental processes
  - ▶ E.g., sediment transport through wetlands, environmental goods and services provided by engineered features, engineering performance of NNBF
- Improved modeling systems that engage users, stakeholders and decision-makers
  - ▶ E.g., rapidly deployed, visual interfaces to engage stakeholders in the process, amenable to “what if” evaluation
- Reliable, cost-efficient monitoring technologies for measuring system evolution and infrastructure/feature performance
- Demonstration/pilot project opportunities to innovate, evaluate, and learn at relevant field scales
  - ▶ Facilitating necessary collaboration
  - ▶ Evolving organizational culture and practice
  - ▶ Producing credible evidence of success



# Creating Value by Engineering With Nature

- Value arguments resonate
- Moderate the hyper-focus on environmental risks/impacts from conventional infrastructure
  - ▶ NNBF can produce multiple benefit streams
  - ▶ There are potentially valuable allies in “unlikely” places
- Need for complementing sustainability policies with education and research

