USACE *Engineering With Nature* (EWN) and *Regional Sediment Management* (RSM): "Proving Grounds"

Dr. Todd Bridges
Senior Research Scientist
EWN Program Manager
Engineer Research and Development Center
Environmental Laboratory

Ms. Linda Lillycrop
USACE RSM Program Manager
Engineer Research and Development Center
Coastal and Hydraulics Laboratory

Coastal Engineering Research Board Meeting
Galveston, TX
1-3 September 2015

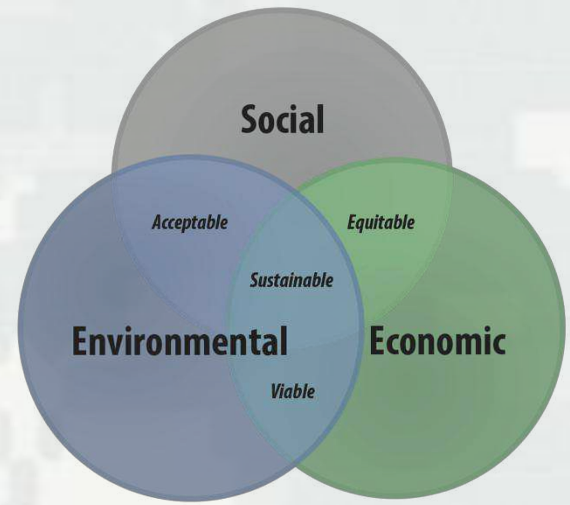
US Army Corps of Engineers®
BUILDING STRONG®

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:

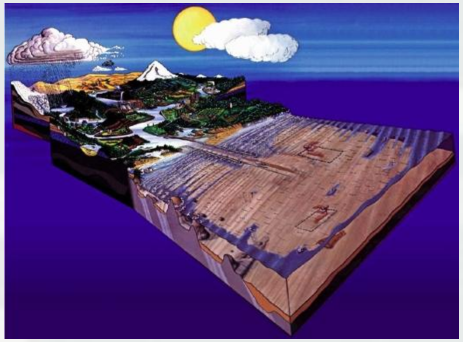
- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners

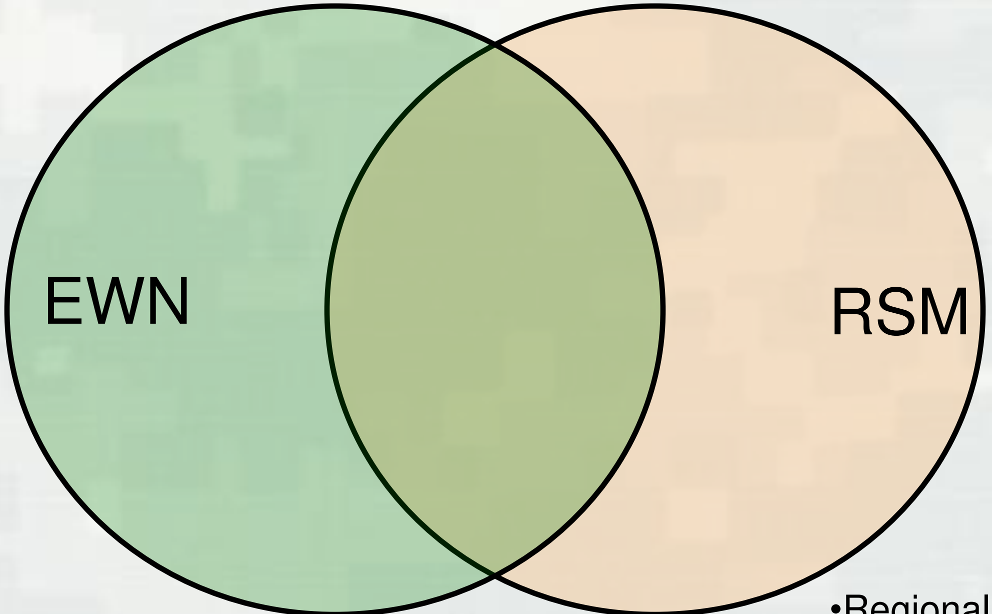


Regional Sediment Management…

…a systems approach to deliberately manage sediments in a manner that maximizes natural and economic efficiencies to contribute to sustainable water resource projects, environments, and communities.

- Recognizes sediment as a valuable resource
- Regional strategies across multiple projects and business lines guide investments to achieve long-term economic and environmental value and benefits
- Enhances relationships with stakeholders & partners to better manage sediments across a region (local actions with regional benefits)
- Share data, tools, technology, and lessons learned





EWN

- Engineering for NNBF
- Habitat development associated with infrastructure
- Ecosystem services supporting engineering function
- Environmental flows for water and natural resources development
- Erosion control using natural features
- Levee setbacks for FRM and ecosystem development
- Etc

EWN/RSM

- Strategic/direct placement for BU
- Dune creation or enhancement
- Wetland creation or enhancement
- Restoration by filling degraded holes
- Thin-layer placement to restore sediment/ecosystem processes
- In river/bay placement of sediments for environmental feature development
- Biodegradable sediment containment
- Etc

RSM

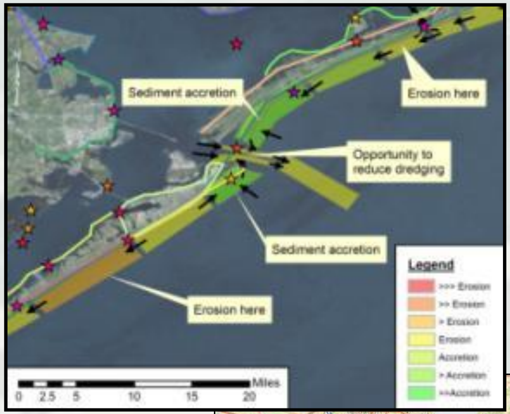
- Regional sediment management implementation strategies
- Optimized management of sediment within a system
- Reduce lifecycle maintenance costs
- Increase dredged sediment placement /reservoir capacity
- Sediment bypass inlets/reservoirs
- Structures to better manage sediments in a system
- Sediment budgeting for riverine , estuarine, and coastal sediments
- Etc

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

RSM Status

- 1999, Established USACE RSM Program (ERDC Lead)
  - 67th CERB meeting Charge: *Establish USACE RSM Program*
- 1999-2015:
  - Technical transfer, District funded proposals/demonstrations
    - District Participation: 20 Coastal, 7 Inland; 105 Funded proposals
  - R&D Enhancements for RSM approaches
  - Annual In-Progress-Review; Successes and Challenges Workshops
  - District Organized Stakeholder Workshops
  - Awards
    - 2003: Gulf Guardian Award
    - 2015: ASBPA USACE Award
    - 2015: USA Today Corps Core Leaders
  - Publications
    - 56 Technical Notes, 20 Technical Reports
- 2014/2015:
  - Established RSM National Center (District Lead)
  - Established RSM Board of Directors
- Avg Annual RSM Value, Nav Sediments on Beaches = $156M

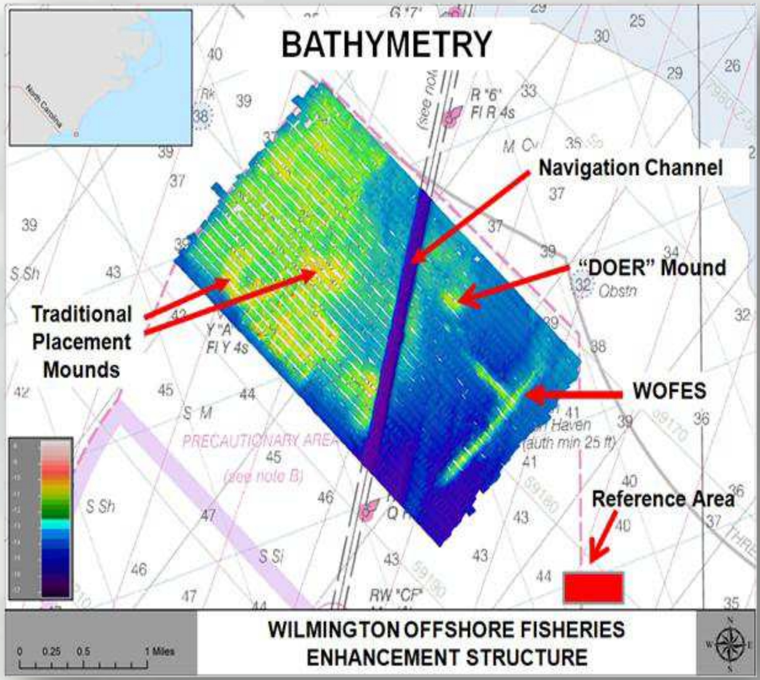


Evia Island, Galveston Bay, TX

- 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

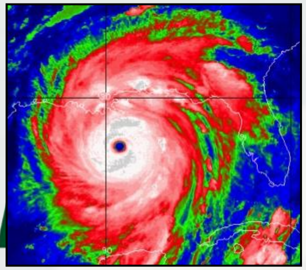
- Created in 1994-1997 from 764,600 cubic meters of limestone dredged as part of the Wilmington channel deepening
- Located three nautical miles off of the mouth of the Cape Fear River in North Carolina
- The location and design of the reef involved extensive participation by stakeholders, and the North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



Perdido Pass, AL

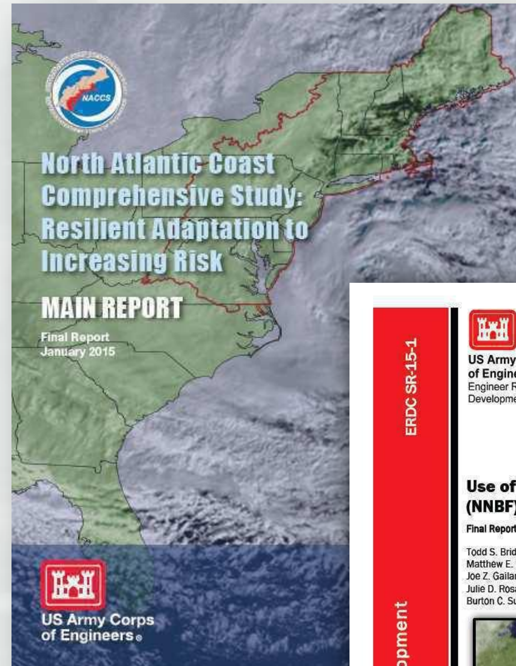
Shoreline Erosion, Sand Bypassing, Nearshore Placement, Reduce Rehandling, Bird and Beach Mouse Habitat

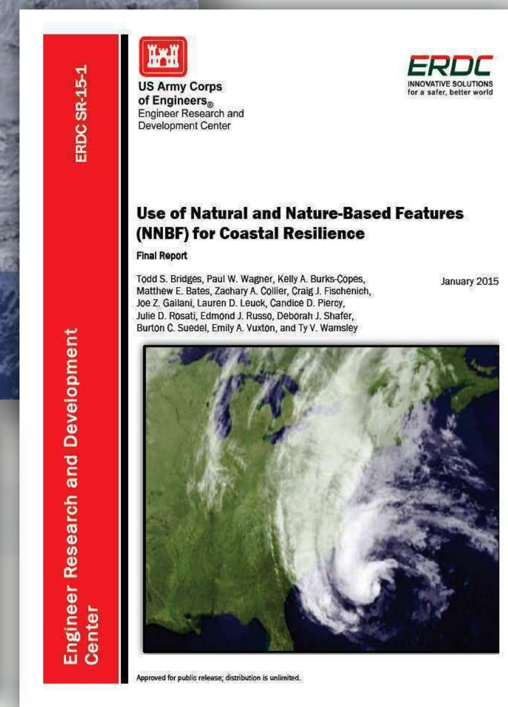
Shoaling Area
Placement Area

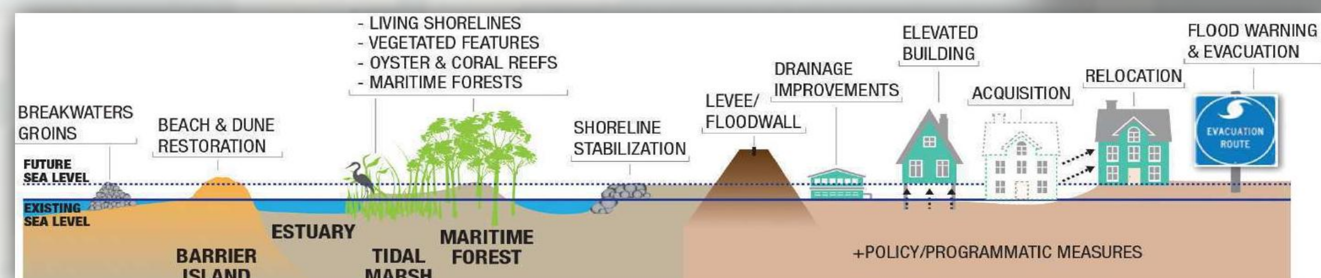


Natural and Nature-Based Features: North Atlantic Coast Comprehensive Study

- 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

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

Coastal NJ, Philadelphia District

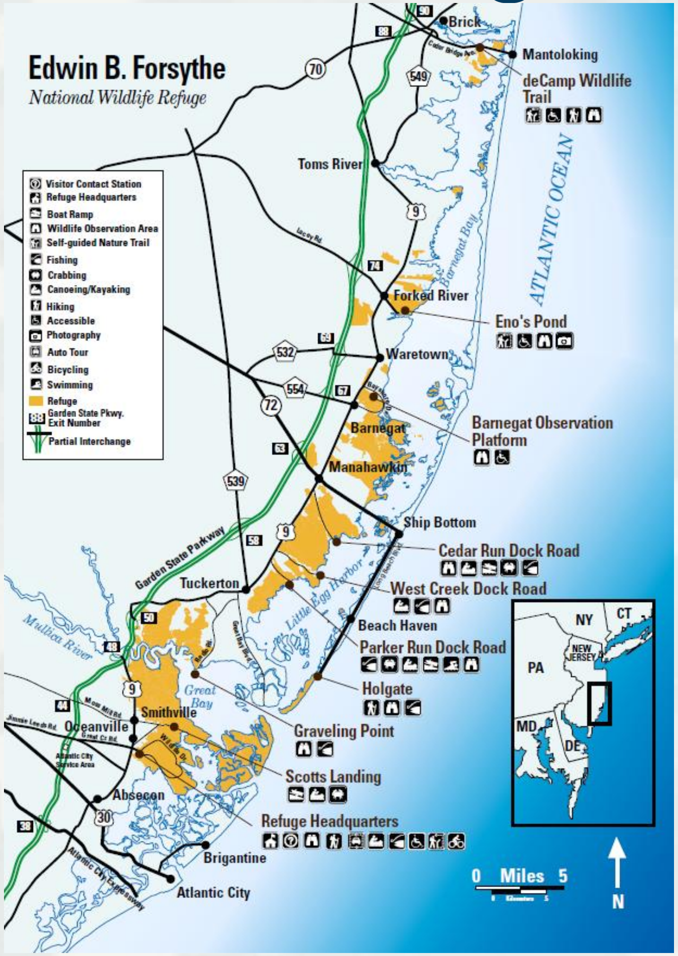
December 2014

Stone Harbor

Avalon

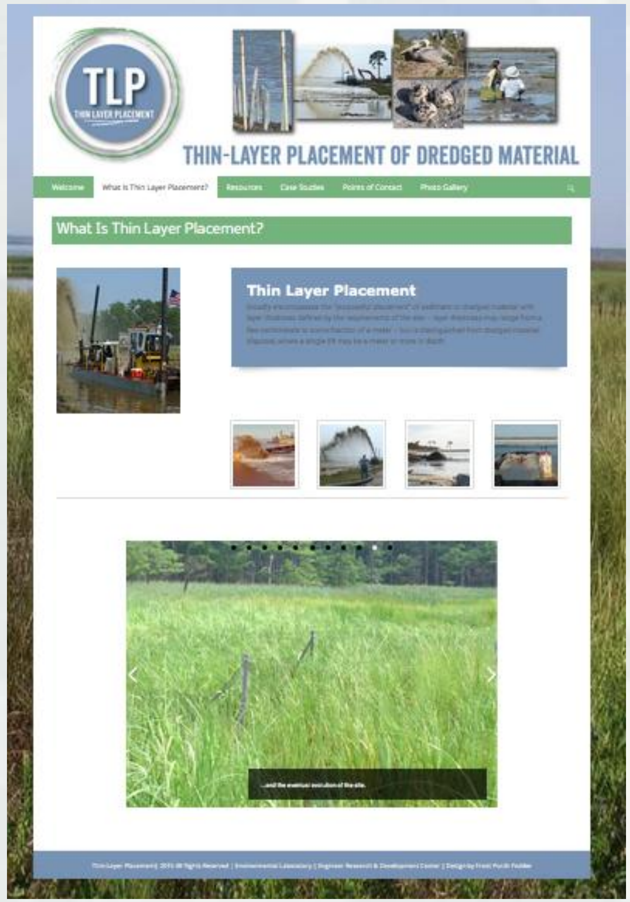
US Fish and Wildlife Service Forsythe National Wildlife Refuge

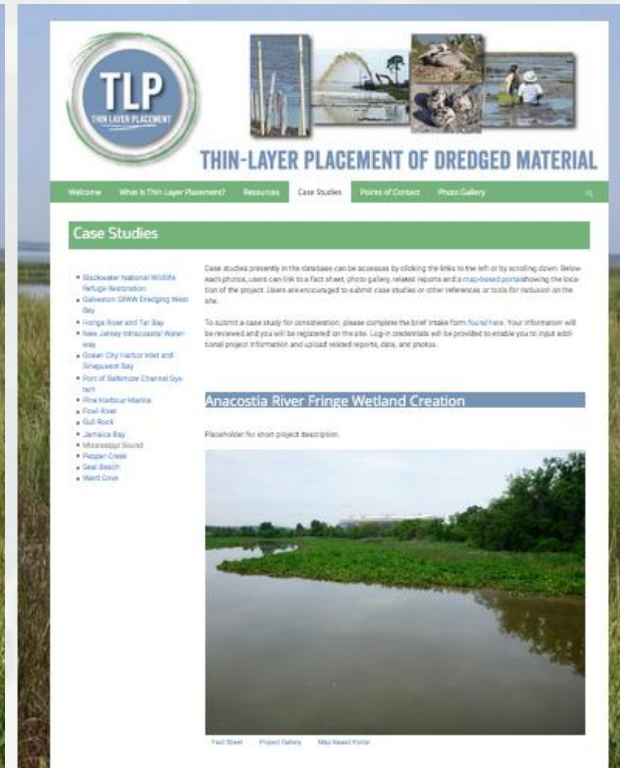
- Forsythe NWR: >40,000 acres of wetlands and other habitat in coastal NJ
- Collaboration objective: Enhance ecosystem resilience through engineering and restoration
- Means: Smart use of sediment resources and EWN principles and practices



Thin-Layer Placement Website

http://el.erdc.usace.army.mil/ewn/





Horseshoe Bend, Atchafalaya River

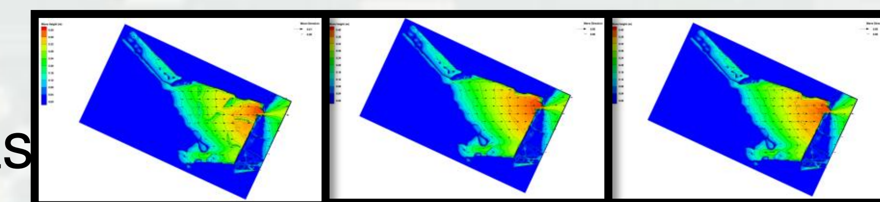
- Options for managing dredged material via shore-based wetland creation were exhausted
- Strategic placement of sediment (0.5-1.8 mcy/1-3 yrs) was used to create a ~35 ha island
- Producing significant environmental and engineering benefits
- Project won WEDA's 2015 Award for Environmental Excellence





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.)

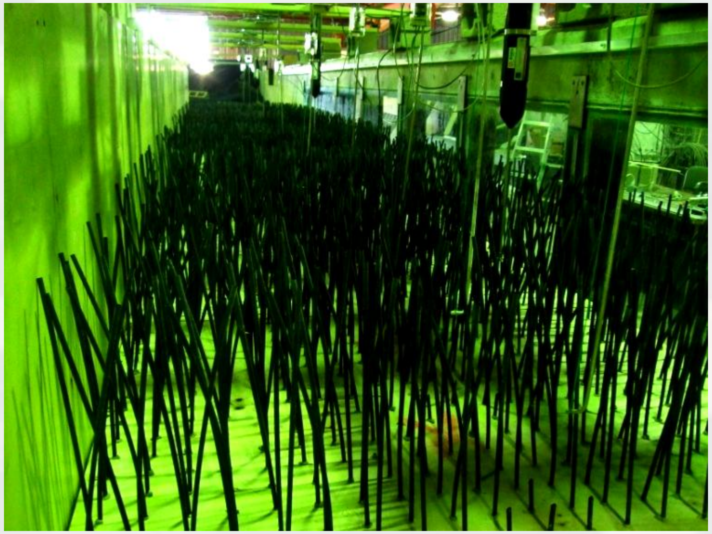
USACE Galveston and Buffalo Districts: EWN "Proving Grounds"

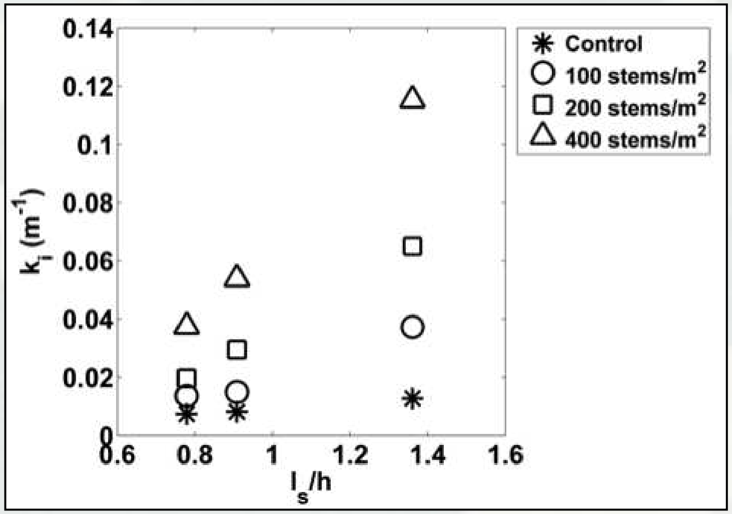
US Army Corps of Engineers®
Buffalo District
BUILDING STRONG®

- 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

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





Science, Engineering, Technology Research Targets

- Fundamental processes
  - Sediment transport through and around NNBF
  - Long-term engineering and environmental performance of features
  - Environmental Services provided by engineered features and structures
  - Processes contributing to system-scale resilience
- Modeling systems that support broad-scale application
  - Planners, stakeholders and decision-makers
  - Engineering design
  - Operations and maintenance
- Reliable, cost-efficient monitoring technologies
  - Measuring system evolution
  - Infrastructure/feature performance
- Demonstration/pilot projects to innovate, evaluate, and learn at relevant field scales
  - Facilitate necessary collaboration
  - Evolve organizational culture and practice
  - Produce credible evidence of success
  - Fuel the "power of the story"

Concluding Thoughts

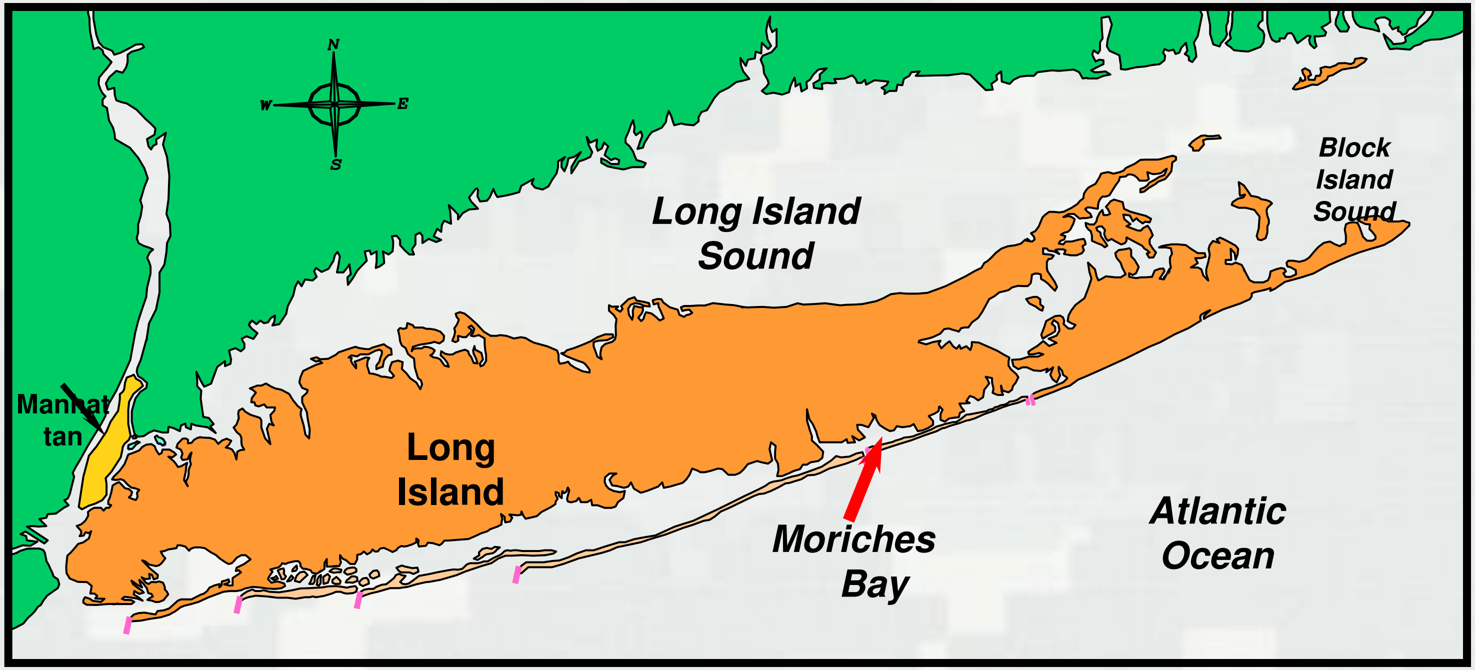
- Focus energy to motivate and facilitate innovation in both technical and business processes
- Important to elevate communication about advancing practice within and external to USACE
- Accelerate progress through co-development of solutions!
  - Districts with ERDC
  - USACE with others

Back-up Slides
Additional Examples

Long Island, NY

(Navigation, Shore Protection, and Beach Recreation)

Endangered Shorebird Habitat



JACKSONVILLE DISTRICT NASSAU, DUVAL, ST. JOHNS COUNTIES

Objectives

- Make navigation & shore protection more sustainable and maximize benefits
- Maintain sediment supply in the system
- Increasing capacity for upland and ODMDS
- Restore inlet bypassing and enhance environment
- Maximize leveraging and collaboration opportunities
- Integrate RSM into GRRs, DMMPs, State plans

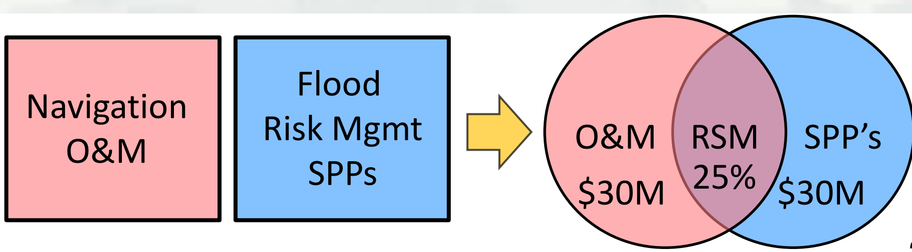
Benefits

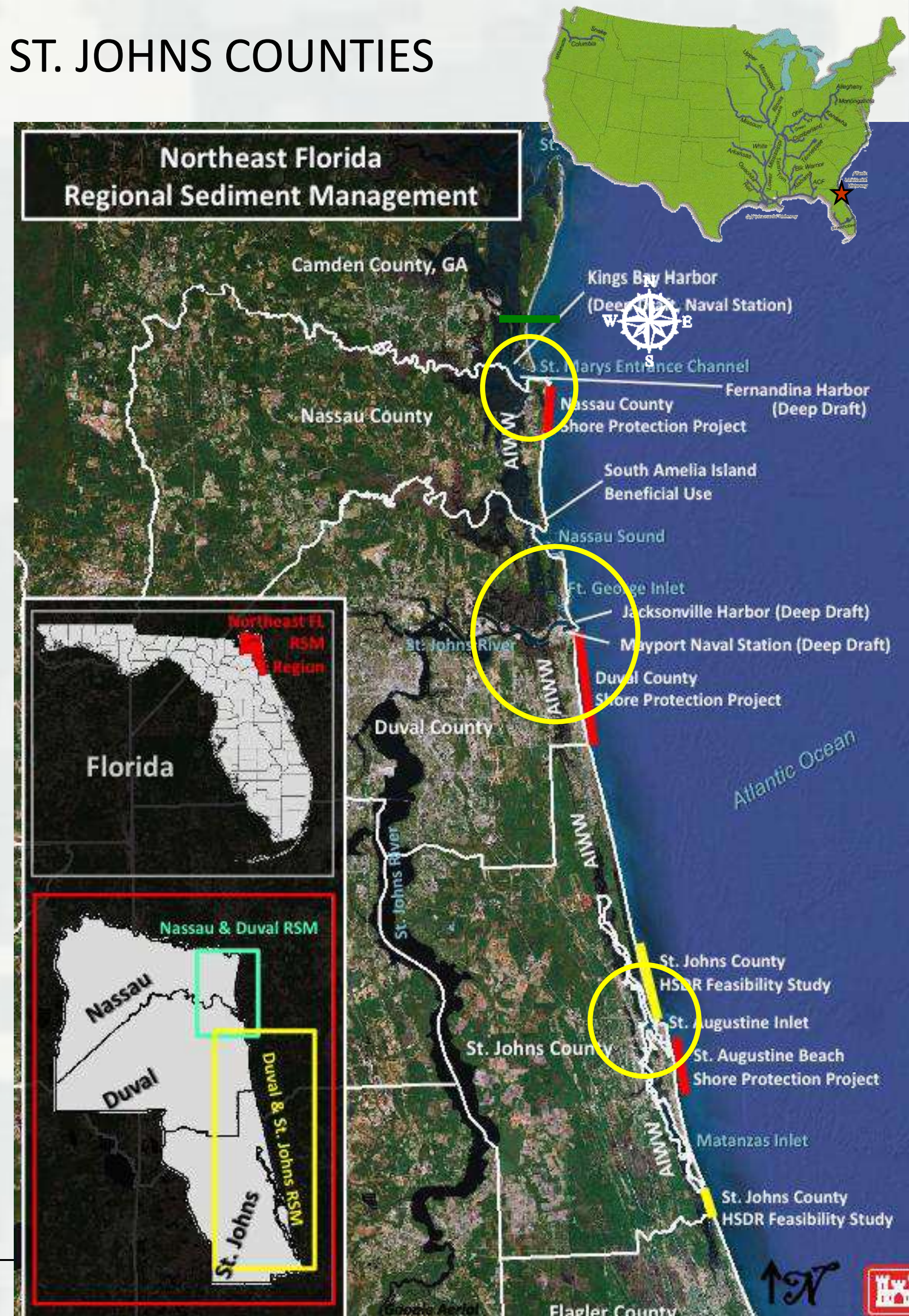
St Johns County

- Leveraging funding CG-SPP & O&M-Dredging
- Combine Mob/Demob & Combined permits
- Emergency sand sources
- Environmental - less dredging
- $5-7 M cost savings

Jacksonville Harbor

- Remove Mile Point Training wall
- Reduce Buck Island CDF use/ Increase site capacity
- BU to restore Great Marsh Island/Env benefits
- $9 M cost savings (< disposal distance, < dredge)
- Nearshore placement SPP





NWP Oregon Shoreface Sediment Stabilization

Description

• Increased shoaling at Yaquina Entrance due to aeolian transport
• Sediment transports to S jetty, then migrates to channel
• Limited federal/state resources for dredging

Objectives

• Reduce aeolian transport from the dunes and beaches south of the Yaquina South Jetty
• Reduce dredging need in the Navigation Channel
• Reduce funding and equipment constraints
• Leverage construction funds from Port of Newport

Accomplishments/Lessons Learned

• Up to 40,000 CY may be captured in sand fencing saving roughly $300,000
• $.03/CY sand fencing VS $7.50/CY hopper dredging
• Allows dredge YAQUINA to focus on other priorities
• Add'l sand fencing may further reduce dredging need, and continue to reduce aeolian transport in the FNC
• Sand fencing will build the foredune

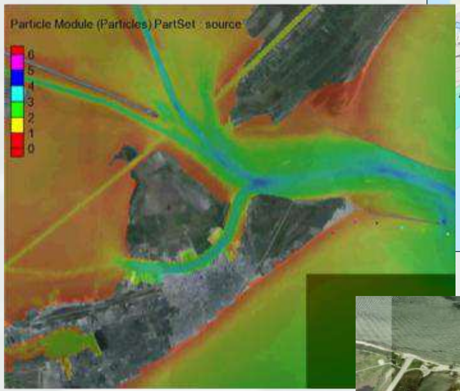
SWG Galveston Entrance Channel

Description

- Funding challenge to maintain Galveston Entrance Channel Galveston Harbor, upland PAs
- Dredge approx 2MCY every 18-24 months

Objectives

- Find solutions (structural/non-structural) to reduce channel sedimentation & increase dredging cycle
- Develop solutions to keep sediment in suspension
- Allow more flexibility to manage overall project



Maximum Sediment Saved by Implementing Each Alternative Individually

- Sand-tighten jetties: 113,000 CY/YR
- Prevention of wind-blown sand: 21,000 CY/YR
- Back-passing plant with spur dikes 150,000 CY/YR
- Close boat cut in North Jetty: 160,000 CY/YR
- Place PA A material on beach: 300,000 CY/YR

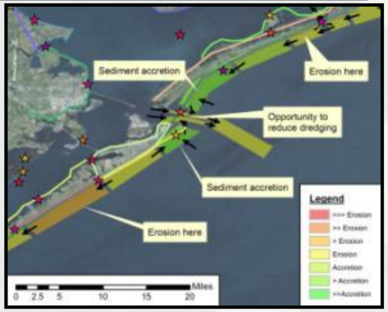
MAXIMUM POSSIBLE SAVINGS OF ALL ALTERNATIVES:

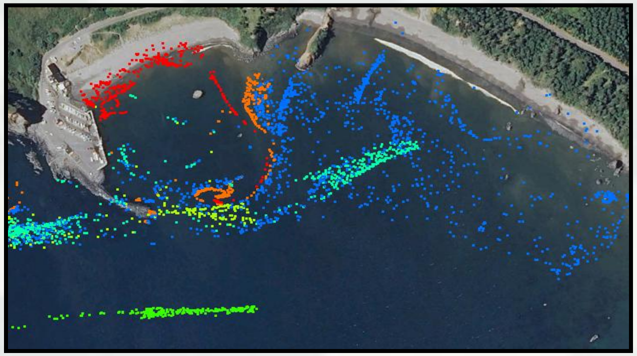
707,000 CY/YR* ~ $2.8M/YR (based on $4/CY)

Proposed fencing/vegetation for reducing wind-blown sand

Application of Existing ERDC-Produced Capability

- Sediment Budget Analysis System (SBAS)
- Coastal Modeling System (CMS)
- Advanced Circulation Model (ADCIRC)
- Steady State Spectral Wave Model (STWAVE)
- Wave Information Study (WIS)
- Genesis/Gencade
- SBEACH
- Sediment Mobility Tool
- Short & Long-Term FATE Models (STFATE/LTFATE)
- Particle Tracking Model (PTM)
- Sedflume
- Coastal Mapping Data
- eCoastal/CE-Dredge
- Others…





NNBF Research Questions

- How will objectives for NNBF be determined, within the context of a specific setting, site, application?
  - How will performance metrics be selected with respect to different project, design and engineer objectives?
  - How will these metrics be related to a success measure for NNBF?
- What services (broadly speaking) are provided by categories or groups of NNBF?
  - What is the typical range of service level? What factors are most significant in affecting breadth or level of service?
  - What ecosystem goods and services are being gained, lost or degraded by the inclusion of NNBF?
  - How will background conditions be determined, both physical and biological, against which performance of NNBF will be measured?
- How will NNBF contribute to coastal/system resilience?
  - Resilience in what sense (ecological/engineering/community)?
  - How will resilience contributions be measured?

NNBF Research Questions, Cont'd

- How will nearshore NNBFs (e.g., wetlands, dunes, etc) enhance wave and surge attenuation?
  - How will these elements of performance be measured? What metrics will be used?
  - How will the influence on wave energy be measured over time?
  - How will water level measurements be made and extrapolated?
  - How will erosion processes be measured?
  - How will these processes be evaluated in order to inform the design of the NNBF?
- What is the minimum spatial scale at which specific types of NNBF have demonstrable/measurable/meaningful affects on storm, sea level rise, or other physical processes?
  - Can a response function be quantified between wetland area, for example, and surge reduction, wave attenuation, storm damage reduction, etc.?
- Are there identifiable dependencies or associations among NNBF as pertains to performance in storm damage reduction (or any other service metric) that indicates that these features be implemented in specific combinations or associations on the landscape?
  - How will NNBF integrated with structural measures (bulkheads, levees, seawalls, breakwaters, etc.) affect the overall performance of the system?
  - How will structural measures affect NNBF?
  - How will NNBF affect structural measures?

NNBF Research Questions, Cont'd

- How will NNBF be affected by storm events (or other forms of disturbance or stress) over time?
  - How will these measures of effect be related to the long-term performance of NNBF?
  - Will post-event degradation of the feature be compensated by natural processes/recovery or will engineering intervention be required to restore the NNBF? How will this need be measured and determined?
  - What are the long-term O&M requirements for NNBF in order to maintain function?
- How can NNBF performance measurements be used to conduct cost-benefit analysis?
  - How will effectiveness be determined for both "storm damage reduction" and "ecosystem restoration" benefits?
- Will processes induced by the NNBF (for example shoaling or change in local hydrodynamics) impinge on existing infrastructure functions (e.g., navigation, etc.)?
- Is there the potential for the NNBF to stimulate the spread of invasive species? If so, are there ways to inhibit this effect?
- How will trade-offs between engineering functions and habitat functions (e.g., to T&E species) be evaluated?