Engineering With Nature

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US Army Corps of Engineers

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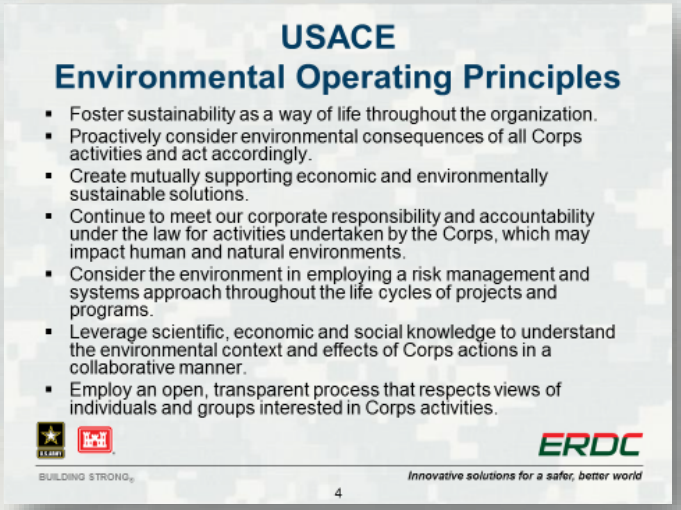
Engineer Research and Development Center

Advancing Technical Practice



Outcomes:

- Cost-effective engineering and operational practices
- Efficient resolution of environmental conflicts
- Sustainable delivery of project benefits. 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."

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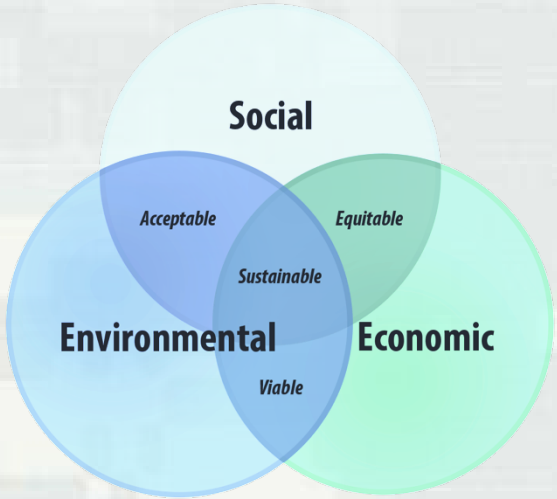
Engineering With Nature…

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

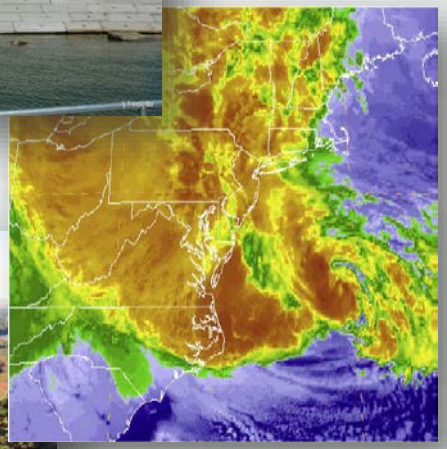
Key Elements:

- 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
  - Enhanced Natural Recovery
- 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 and connectivity



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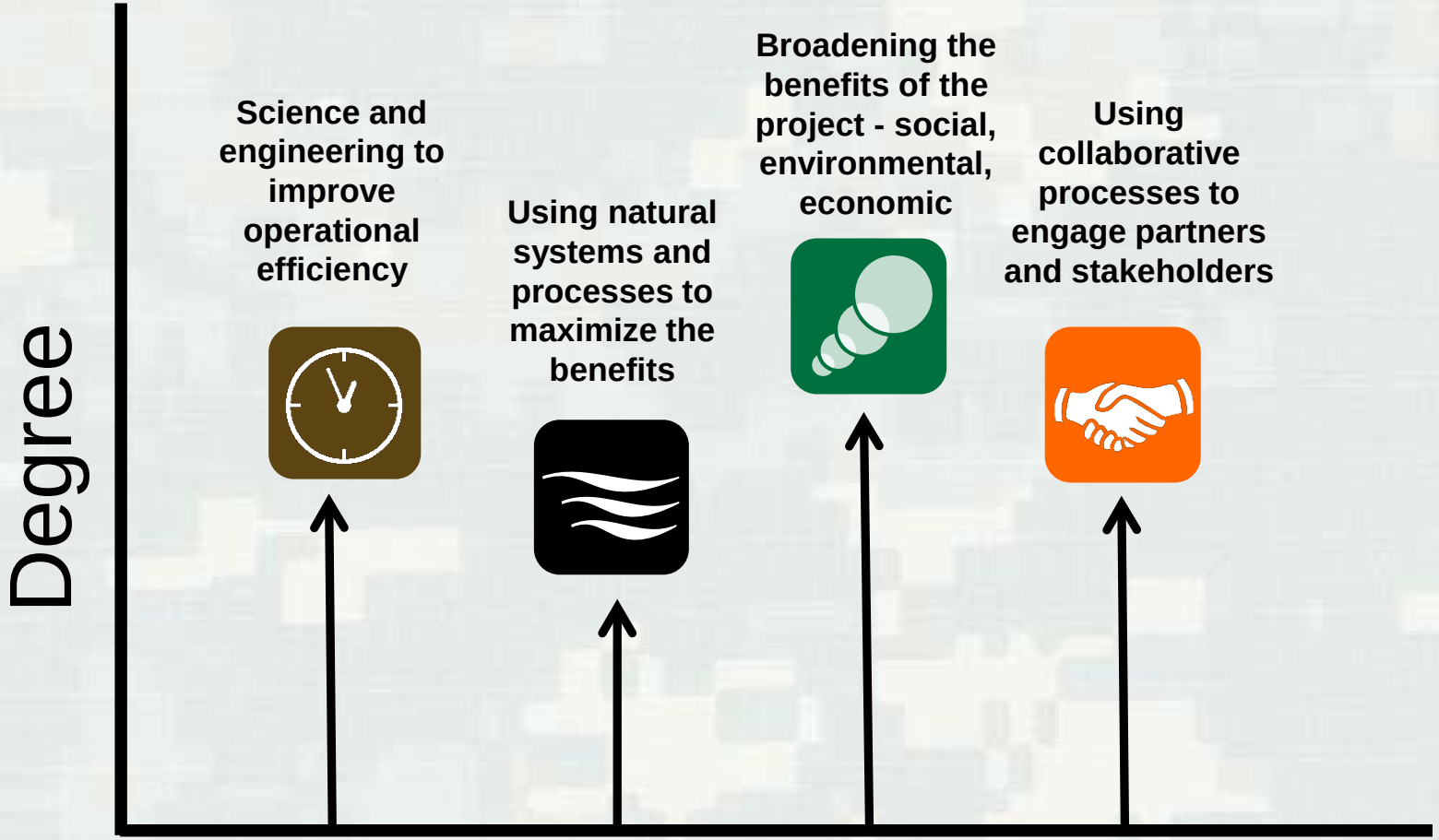
Engineering With Nature

Elements



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

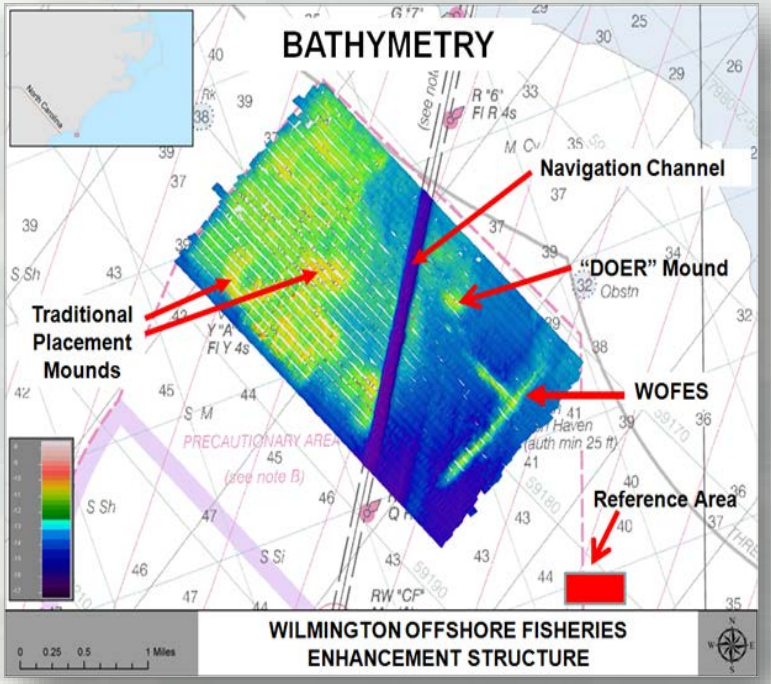
www.engineeringwithnature.org

USACE Galveston, Buffalo, Philadelphia Districts: EWN "Proving Grounds"

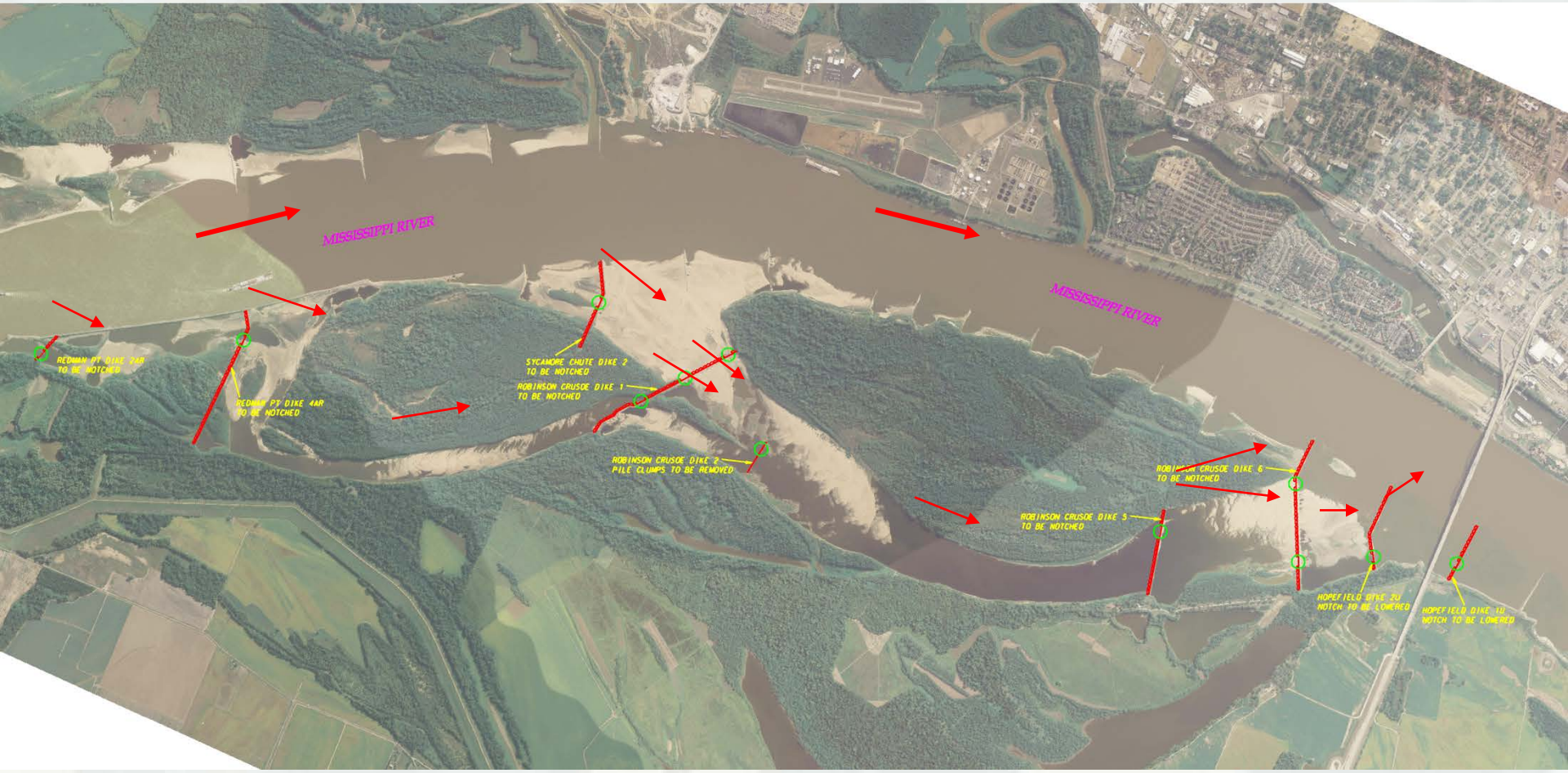
- EWN Proving Ground Kick-Off Workshops
  - October (SWG) and December (LRB) 2014; June 2016 (NAP)
  - District, Division, EWN Leadership Team
- Identify opportunities to implement EWN across current and future programs and projects
- Emphasis on solution co-development

WOFES, Wilmington, NC

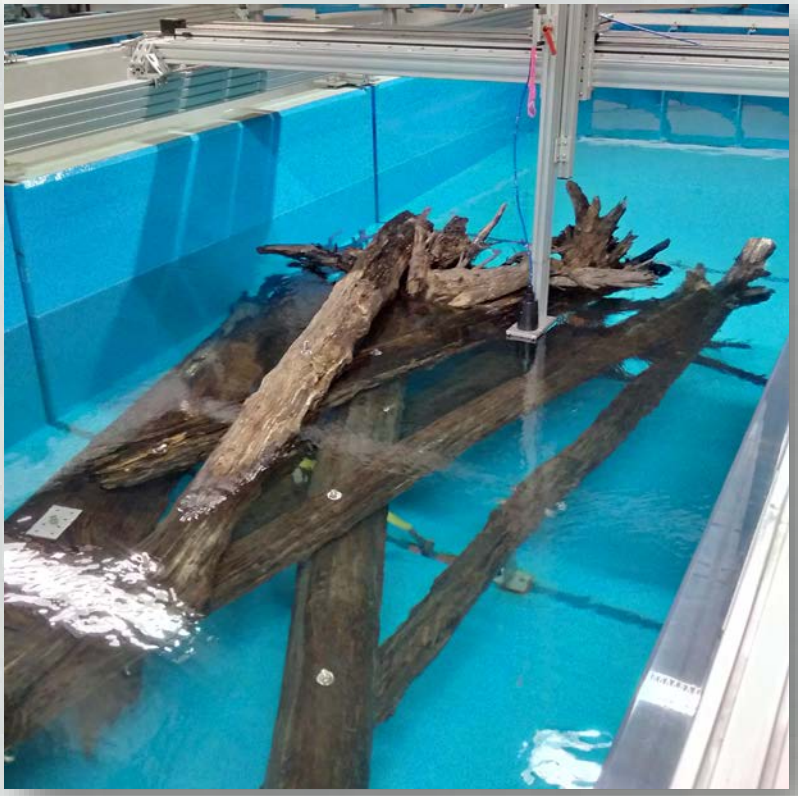
- Created in 1994-1997 from 764,600 cubic meters of limestone dredged as part of the Wilmington channel deepening
- Located three nautical miles off of the mouth of the Cape Fear River in North Carolina
- The location and design of the reef involved extensive participation by stakeholders, and the North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

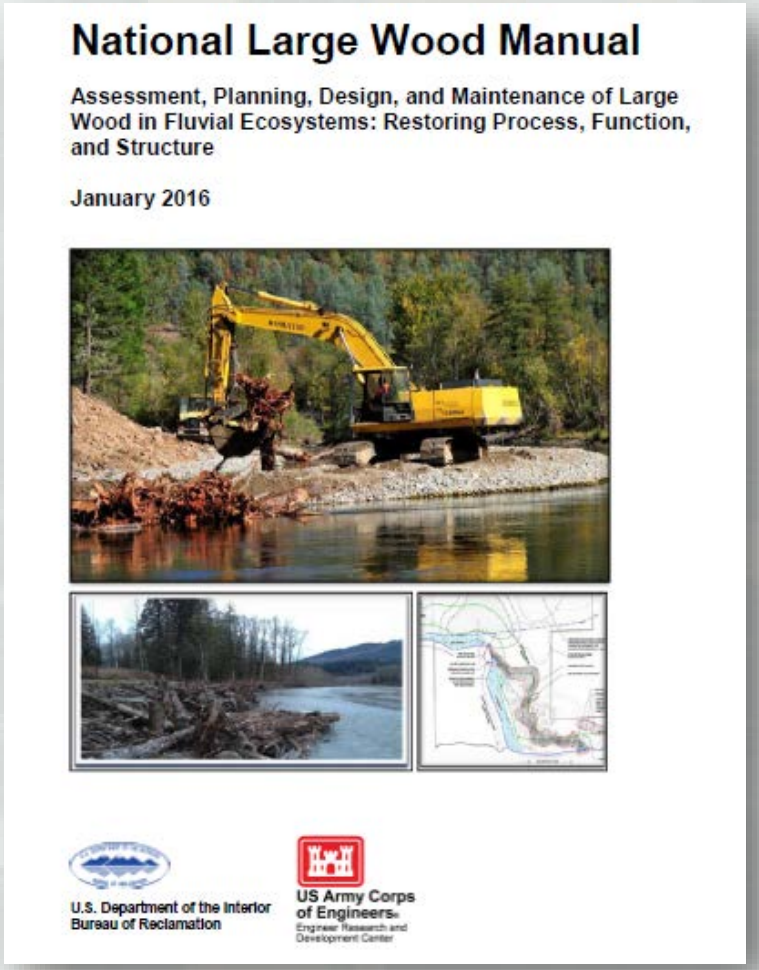


Loosahatchie Bar



Natural Materials

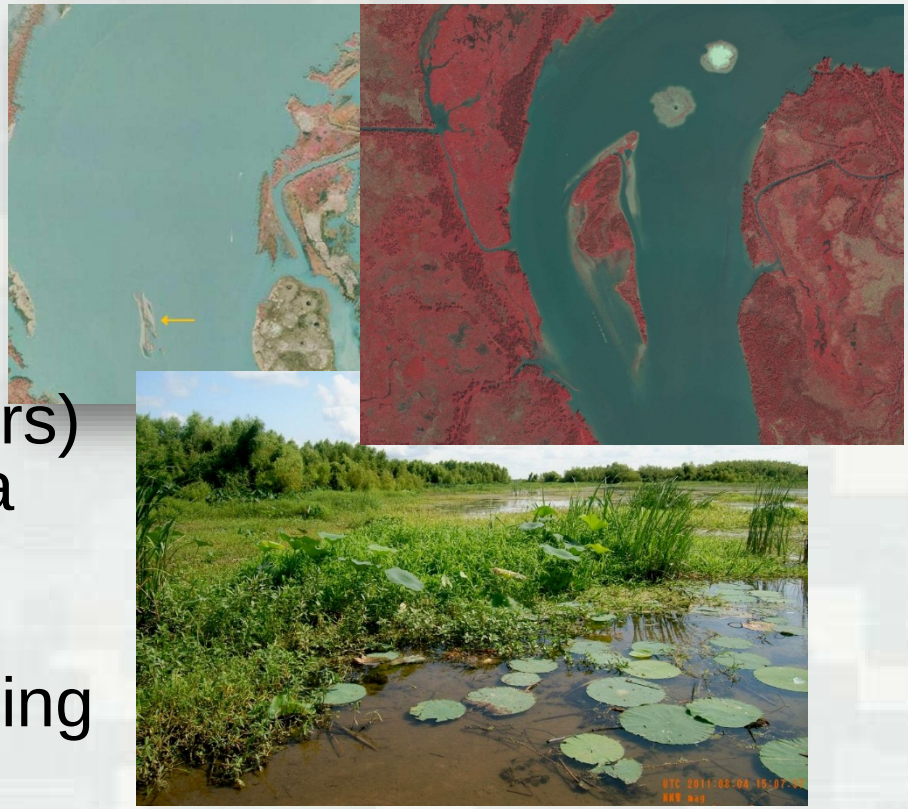




https://ewn.el.erdc.dren.mil/Tools.html

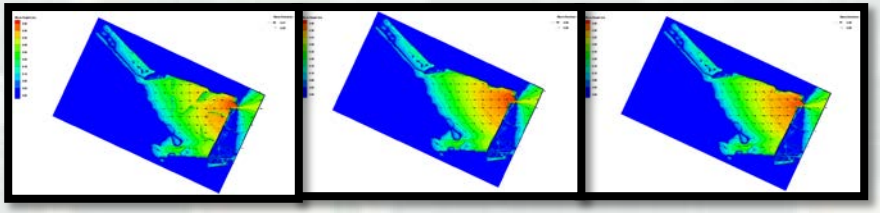
Horseshoe Island EWN Project Atchafalaya River

- Options for managing DM 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 and Sears Point Wetland Development, San Pablo Bay

- Accelerate wetland development using berms to support sedimentation during tidal inundation
- Remotely monitoring physical processes: wind, waves, currents suspended sediments, settling velocities, etc.
- Modeling wave generation and dissipation, testing different shapes/configurations of berms

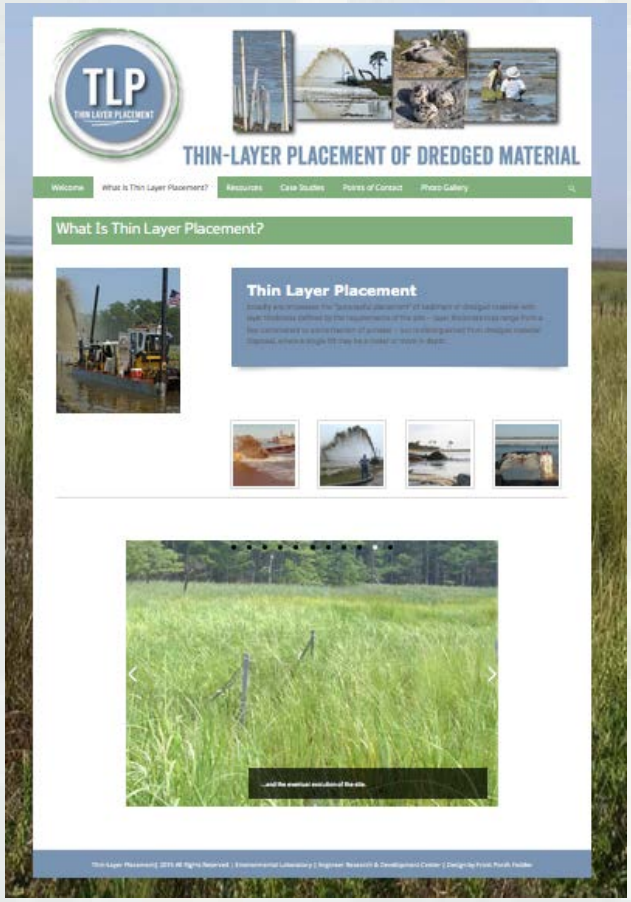


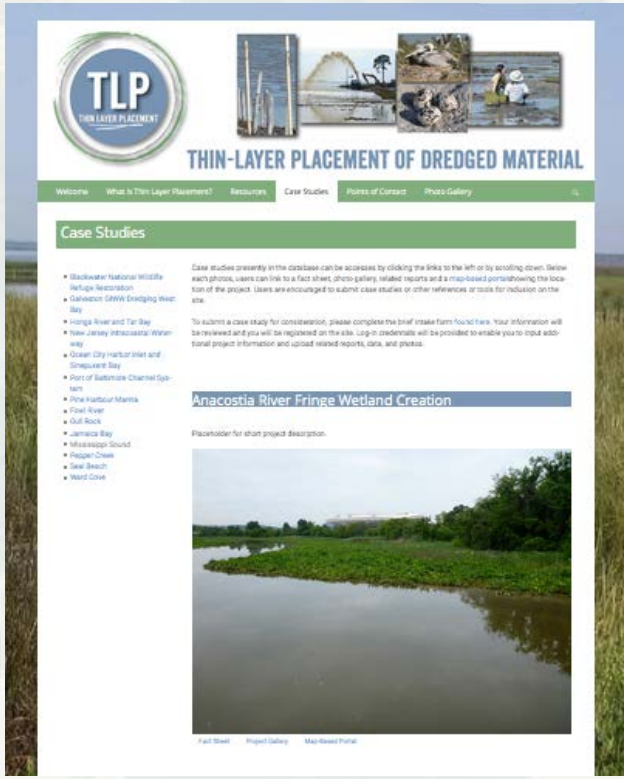
Linear Berms (As-Built) | No Berms (Control) | Mounds (ala Sears Pt.)

Duluth Harbor TLP

Thin-Layer Placement Website

www.engineeringwithnature.org (under tools)
https://tlp.el.erdc.dren.mil/





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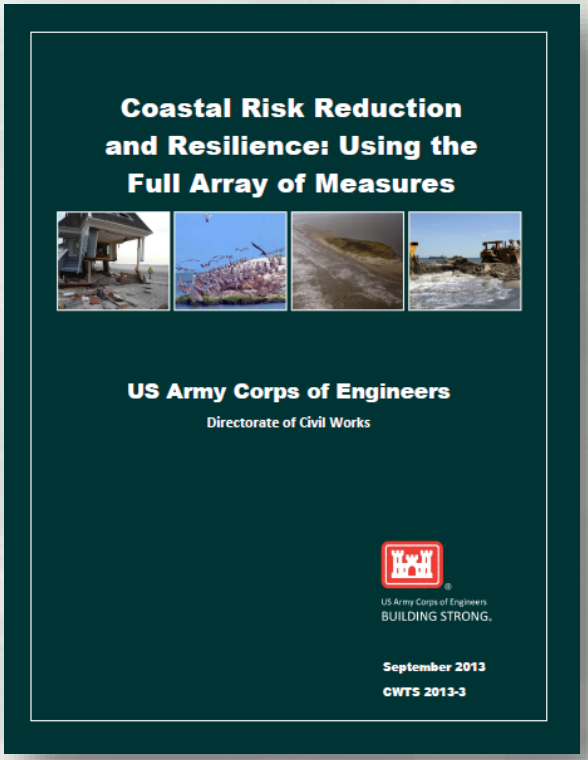
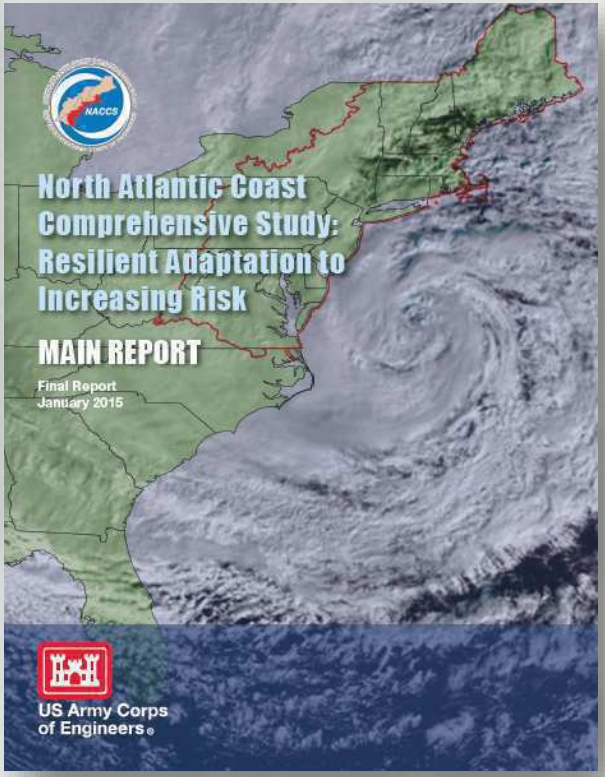
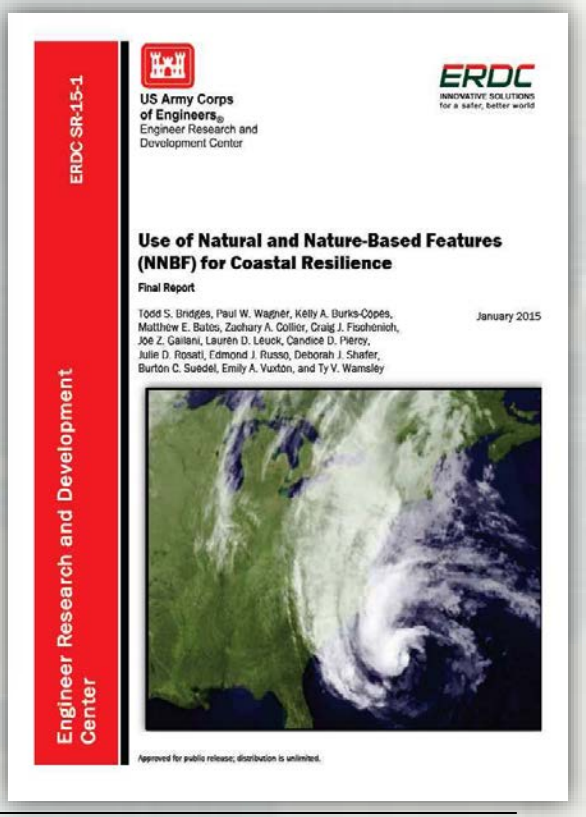
The North Atlantic Coast Comprehensive Study







http://www.nad.usace.army.mil/CompStudy

Engineering Performance: Nature-Based Features Work in Different Ways

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

ORGANIZATIONAL ALIGNMENT

EVALUATION

IMPLEMENTATION

Iterate as Needed

Identify and Organize Stakeholders, Partners and Authorities

Define Physical and Geomorphic Setting

Assess Vulnerability and Resilience

Identify NNBF Opportunities
- Formalize NNBF Objectives
- Identify NNBF Alternatives
- Define NNBF Performance Metrics

Evaluate NNBF Alternatives
- Tier 1
- Tier 2
- Tier 3

Advance through Tiers as Appropriate

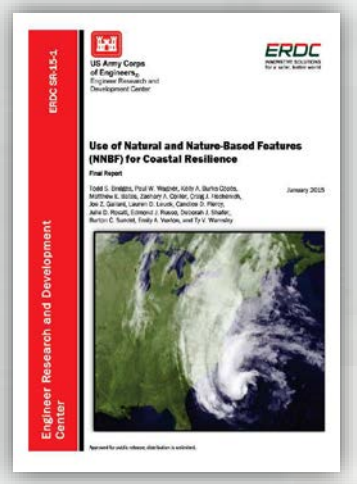
Select NNBF Alternatives

Design Implementation Plan: Elaborate Operational and Engineering Practices

Implement NNBF Alternative

Monitor for Performance and Assess Ecosystem Goods and Services

Feedback



Caterpillar Corporation's *Restoring Natural Infrastructure Summit* 4 November 2015, New York City

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NY DEC and Sea Grant

Exploring Nature-Based Shoreline Erosion Management Practices Along NY's Great Lakes and Connecting Channels

5 November 2015, Rochester, NY

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Sea Grant New York

Sea Grant University of Wisconsin

A Workshop for Practitioners:
Exploring Nature-Based Shoreline Erosion Management Practices Along NY's Great Lakes and Connecting Channels

November 5, 2015 -- 8:30am to 5:00pm
International Arrivals Hall
Rochester International Airport
1200 Brooks Ave, Rochester, NY 14624

Goal

To gain an understanding of the various types of nature-based shoreline (NBS)* protection techniques and approaches that may be applicable to NY's Great Lakes shorelines, to manage erosion and stabilize shorelines while maintaining coastal processes and preserving or enhancing nearshore habitat. A secondary goal is to establish a dialogue and coordinated strategy among regional experts and practitioners to promote the implementation of nature-based shoreline management practices for erosion management along NY's Great Lakes shorelines.

Workshop Objectives

- Learn how nature-based shoreline methods are being used and how they may apply to NY's Great Lakes shorelines;
- Assess opportunities and constraints for implementing nature-based shoreline projects;
- Identify data, research, outreach, and resource needs to advance nature-based shorelines in NYS's Great Lakes;
- Identify demonstration project opportunities by region/reach;
- Identify next steps to work towards a coordinated management approach.

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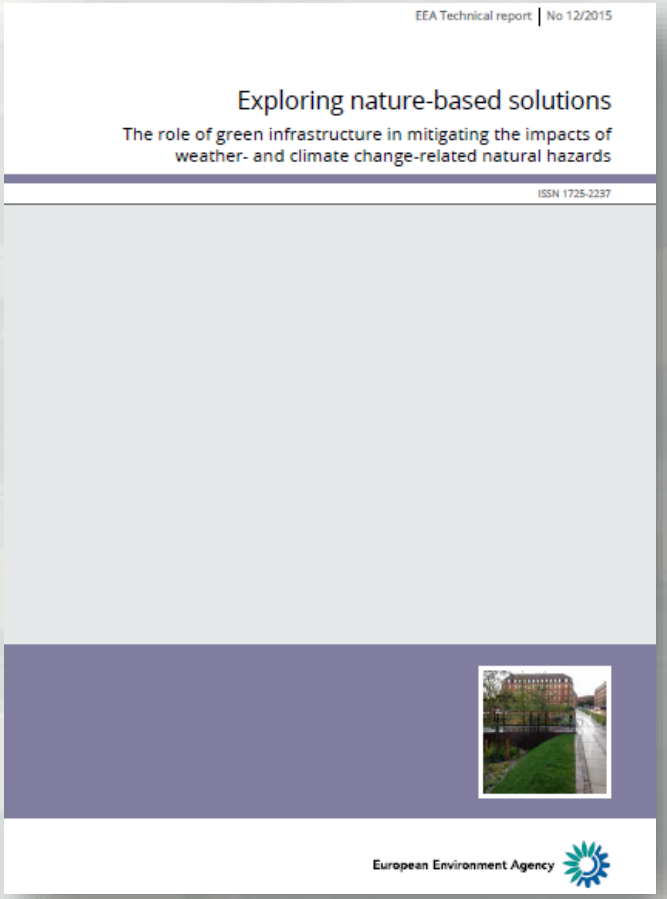
Exploring nature-based solutions: the role of green infrastructure in mitigating the impacts of weather- and climate change-related natural hazards

- "…instead of automatically defaulting to grey solutions like dikes and pipes for flooding, we first should look at restoring floodplains or wetlands. Rather than building sea walls, we need to think about conserving sand banks...Planners should compare green to grey and identify new opportunities for investing in nature, including a combination of green and grey approaches when nature-based solutions alone are insufficient. As planners explore how to accommodate infrastructure demands in the future, the lesson is clear: think about green before investing in grey."



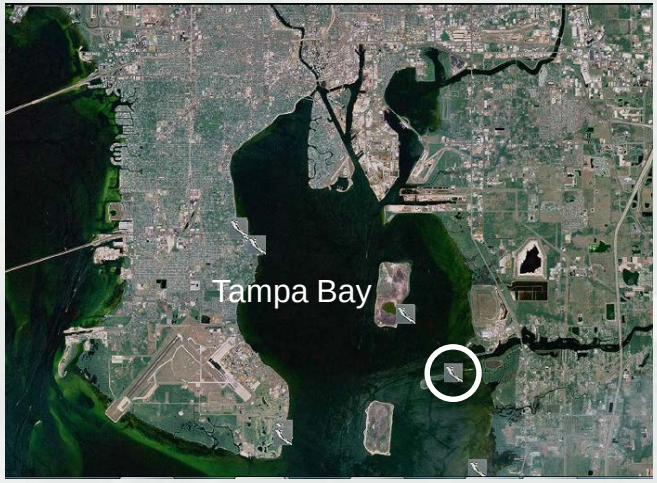
EEA Technical Report No 12/2015

USACE – NOAA Collaboration Workshop on Natural and Nature-Based Features Charleston, SC; 1-3 March 2016

Fort Pierce City Marina

Alafia Banks Bird Sanctuary, FL

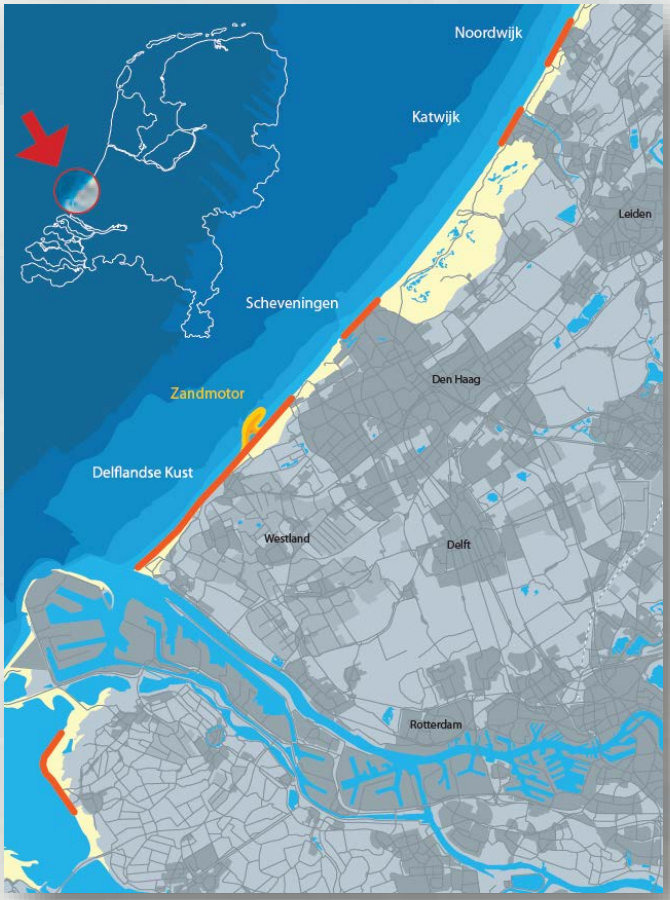
- 8000 lb reef module breakwaters (930 ft)
- Shore protection for Audubon bird sanctuary islands
- Help restore oyster populations
- Provide habitat



www.reefball.org

Cat Island
Green Bay, Wisconsin

Dutch Sand Engine



- 2011 construction
- 21.5 mcm of sand

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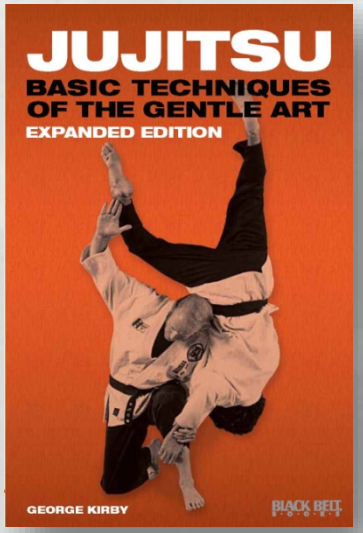
Opportunities to *Engineer With Nature*

- **Key Factors, the 4 Ps**
  - ► Processes
    - Physics, geology, biology…
    - Foundation of “coastal engineering Jujitsu”
  - ► Programmatic context
    - Planning, engineering, constructing, operating, or regulating
  - ► Project scale
    - Individual property owner to an entire coastal system
  - ► Performance
    - Configuring the system
    - Quantifying the benefits



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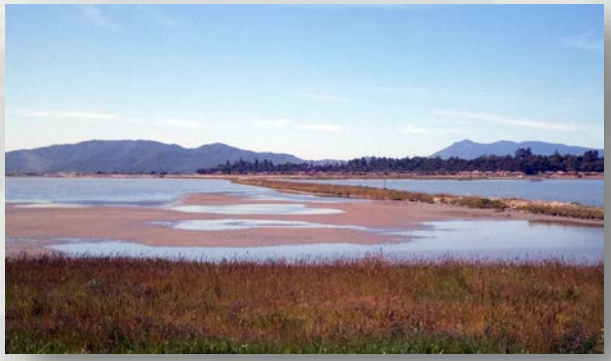
EWN Action Demonstration Projects, 1

- 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)
- Nature-Based Features Creation Through Beneficial Use of Dredged Material (Duluth, MN)

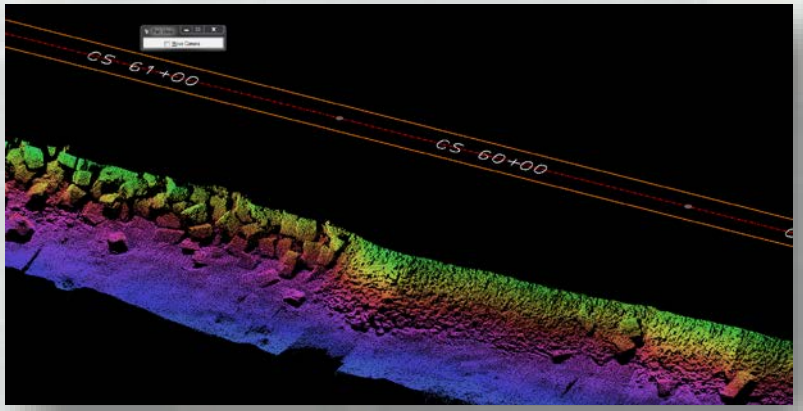


EWN Action Demonstration Projects, 2

- A Sustainable Design Manual for Engineering With Nature Using Native Plant Communities
- 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)

EWN Action Demonstration Projects, 3

- Use of Activated Carbon to Manage Contaminant Exposures Associated with Open-Water Placement
- Engineering With Nature using Native Plant Community Development on Dredge Material Placement Areas
- Contaminant Management through Species Management: Reducing Risks by Controlling Carp
- Engineering With Nature for Breakwaters
- Engineering With Nature for Locks and Dams



EWN High Points

- Conservation / development of natural systems support future sustainability and resilience
  - Incentivizing and financing
- Focus energy to facilitate innovation in both technical and business processes
- Elevate communication about advancing practice
- Accelerate progress through co-development of solutions
  - Across government
  - Between government and industry
  - Among government, industry, academia, and NGOs