



# ENGINEERING WITH NATURE: TOWARD SUSTAINABLE SYSTEMS

Todd S. Bridges, Ph.D.  
Senior Research Scientist (ST), Environmental Science  
US Army Corps of Engineers

US Army Engineer Research and Development Center

[Todd.S.Bridges@usace.army.mil](mailto:Todd.S.Bridges@usace.army.mil)

ASBPA  
November 1, 2018



US Army Corps  
of Engineers



**ERDC**  
ENGINEER RESEARCH & 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



The Nature Conservancy

And Many More!

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



# EWN<sup>®</sup> OVERVIEW

*Engineering With Nature<sup>®</sup>* began in 2010

- Engaging across USACE, other agencies, NGOs, academia, private sector, international collaborators
- Guided by a strategic plan
- Established through Proving Grounds
  - Galveston, Buffalo, Philadelphia
- Informed by focused R&D
- Demonstrated with field projects
- Advanced through partnering
- Shared by strategic communications
- Marking progress
  - 2013 Chief of Engineers Environmental Award in Natural Resources Conservation
  - 2014 USACE National Award-Green Innovation
  - 2015, 2017 WEDA Awards; 2017 DPC Award



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

US Army Corps of Engineers • Engineer Research and Development Center



# EWN<sup>®</sup> ACROSS USACE MISSION SPACE

## Navigation

- Strategic placement of dredged material supporting habitat development
- Habitat integrated into structures
- Enhanced Natural Recovery

## Flood Risk Management

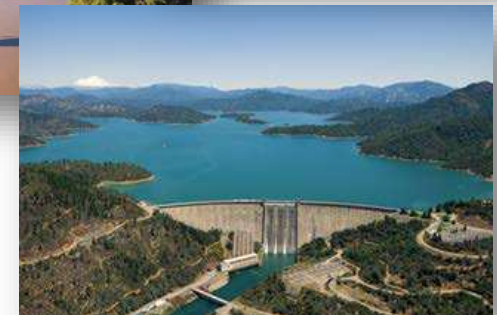
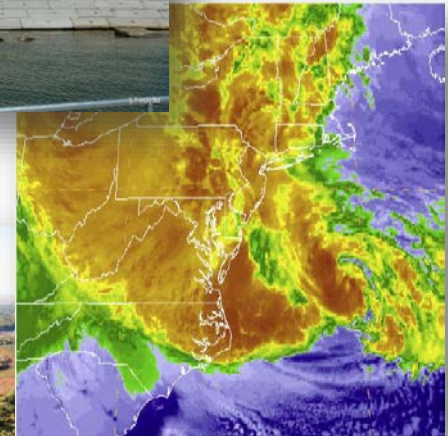
- Natural and Nature-Based Features to support FRM
- Levee setbacks

## Ecosystem Restoration

- Ecosystem services supporting engineering function
- “Natural” development of designed features

## Water Operations

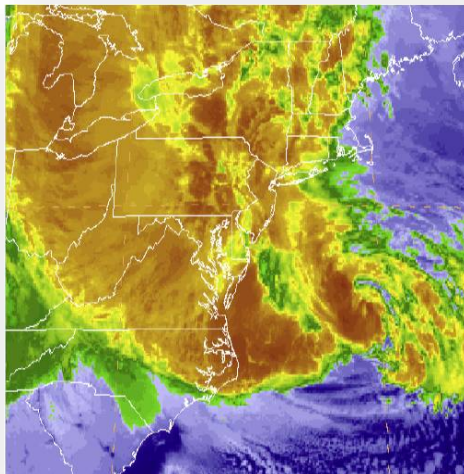
- Shoreline stabilization using native plants
- Environmental flows and connectivity



# LEVERAGING NATURE TO CREATE VALUE

## Following Hurricane Sandy:

- Risk industry-based tools used to quantify the economic benefits of coastal wetlands
  - Temperate coastal wetlands saved more than \$625 million in flood damages.
  - In Ocean County, New Jersey, salt marsh conservation can significantly reduce average annual flood losses by more than 20%.



### COASTAL WETLANDS AND FLOOD DAMAGE REDUCTION

Using Risk Industry-based Models  
to Assess Natural Defenses in the Northeastern USA

October 2016





# NATURAL AND NATURE-BASED FEATURES

NNBF are landscape features that are developed to provide engineering functions relevant to flood risk management while producing additional economic, environmental and social benefits.



## 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

# ONEHUNGA BAY FORESHORE RESTORATION AUCKLAND, NEW ZEALAND





# FORT PIERCE CITY MARINA, FLORIDA



---

US Army Corps of Engineers • Engineer Research and Development Center



# HUMBER ESTUARY; ALKBOROUGH, UK (INCREASED FLOOD STORAGE CAPACITY)



# Middle Harbour Port of Oakland, USA

2018 PIANC *Working with Nature* Award Winner



US Army Corps of Engineers • Engineer Research and Development Center



# HORSESHOE BEND ISLAND, 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 Awards:
  - 2015 WEDA Award for Environmental Excellence
  - 2017 WEDA Award for CC Adaption
  - 2017 DPC Award for Working, Building, and Engineering with Nature





# COLLABORATION ACROSS GOVERNMENT

## USACE/NOAA Collaboration Workshop: Natural and Nature-based Features, Charleston, SC; 1-3 March 2016



## USACE/NOAA-NMFS Collaboration Workshop Engineering With Nature, Gloucester, MA; October 5-6, 2016

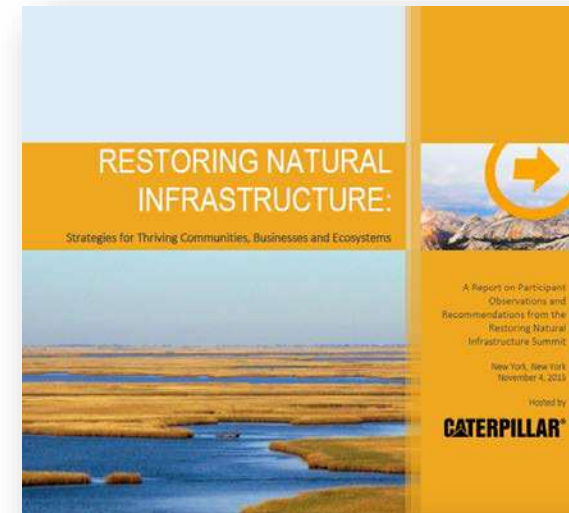


[www.engineeringwithnature.org](http://www.engineeringwithnature.org) (NNBF)

US Army Corps of Engineers • Engineer Research and Development Center

# COLLABORATION WITH THE PRIVATE SECTOR

- Caterpillar Inc.
  - ▶ Restoring Natural Infrastructure Summit; November 4<sup>th</sup>, 2015; New York City
  - ▶ Natural Infrastructure Initiative – USACE Collaboration Work Streams
    1. NI Opportunity Evaluation Tool.  
Capitalizing on enterprise-level capability: CE Dredge DST
    2. Evaluation and Decision Making
    3. Field Application and Demonstration
- Western Dredging Association (WEDA)
  - ▶ Collaborative technical workshop on engineering and construction techniques for Engineering With Nature



<http://www.caterpillar.com/en/company/sustainability/natural-infrastructure.html>

# COLLABORATION WITH ACADEMIA

- Texas A&M University
  - Partnering through the Coastal Science and Engineering Collaborative (CSEC)
  - Joint research on NNBF
  - EWN Seminar spring 2018
  - Developing graduate curriculum to support EWN



- University of Georgia
  - Institute for Resilient Infrastructure Systems (IRIS)
  - CRADA and Educational Partnering Agreement
  - Multiple levels of collaboration on EWN and NNBF
  - EWN curriculum development



*Institute for Resilient  
Infrastructure Systems*  
**UNIVERSITY OF GEORGIA**





# INTERNATIONAL GUIDELINES ON THE USE OF NATURAL AND NATURE-BASED FEATURES FOR SUSTAINABLE COASTAL AND FLUVIAL SYSTEMS

**Purpose: Develop guidelines for using NNBF to provide engineering functions relevant to flood risk management while producing additional economic, environmental and social benefits.**

- Publish NNBF technical guidelines by 2020:
  - ▶ Multi-author: government, academia, NGOs, engineering firms, construction companies, etc.
  - ▶ Addressing the full project life cycle
  - ▶ Guidelines in 4 Parts
    - Overarching
    - Coastal Applications
    - Fluvial Applications
    - Conclusions



US Army Corps of Engineers®



Rijkswaterstaat  
Ministry of Infrastructure  
and Water Management



Stanford  
University



HR Wallingford



ecology and environment, inc.  
Global Environmental Specialists



Tonkin+Taylor



THE WORLD BANK



Environment  
Agency



# COMMUNICATING BEST PRACTICE

## National Large Wood Manual

Assessment, Planning, Design, and Maintenance of Large Wood in Fluvial Ecosystems: Restoring Process, Function, and Structure

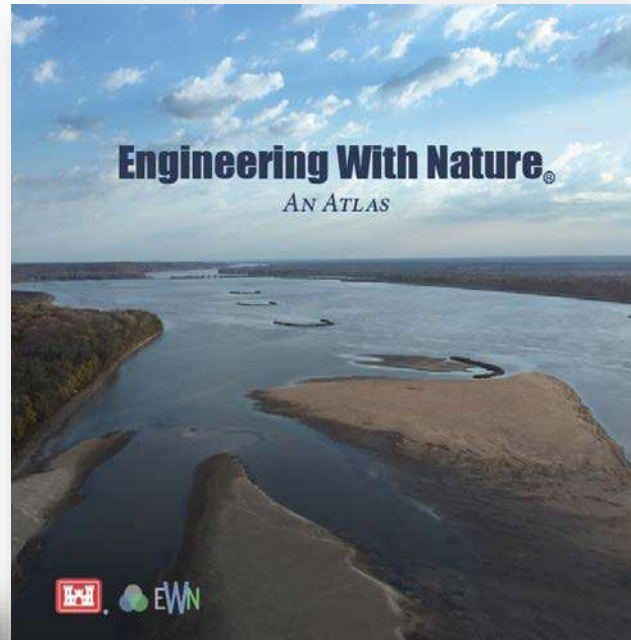
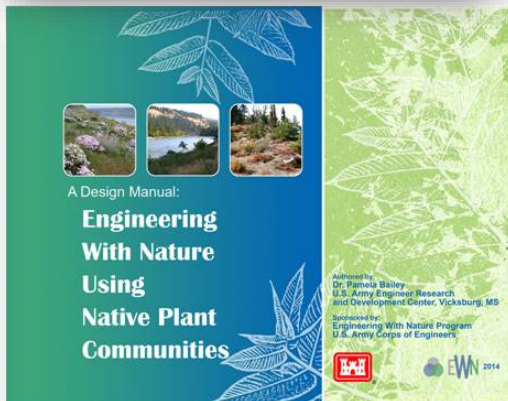
January 2016



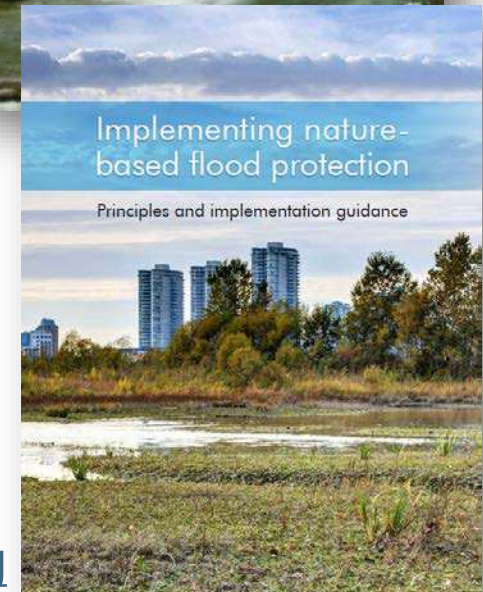
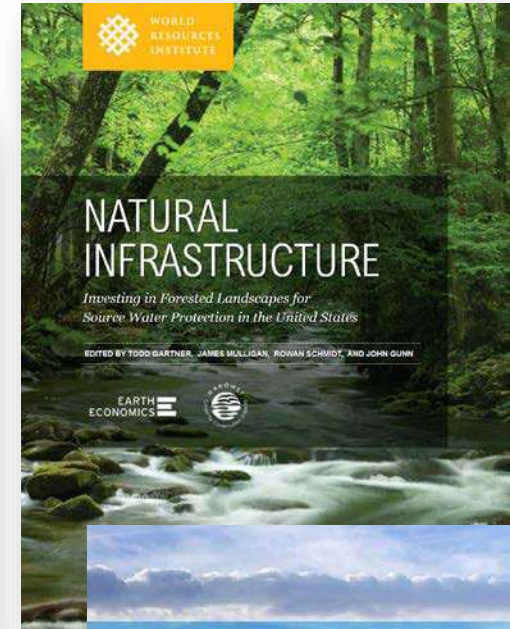
U.S. Department of the Interior  
Bureau of Reclamation



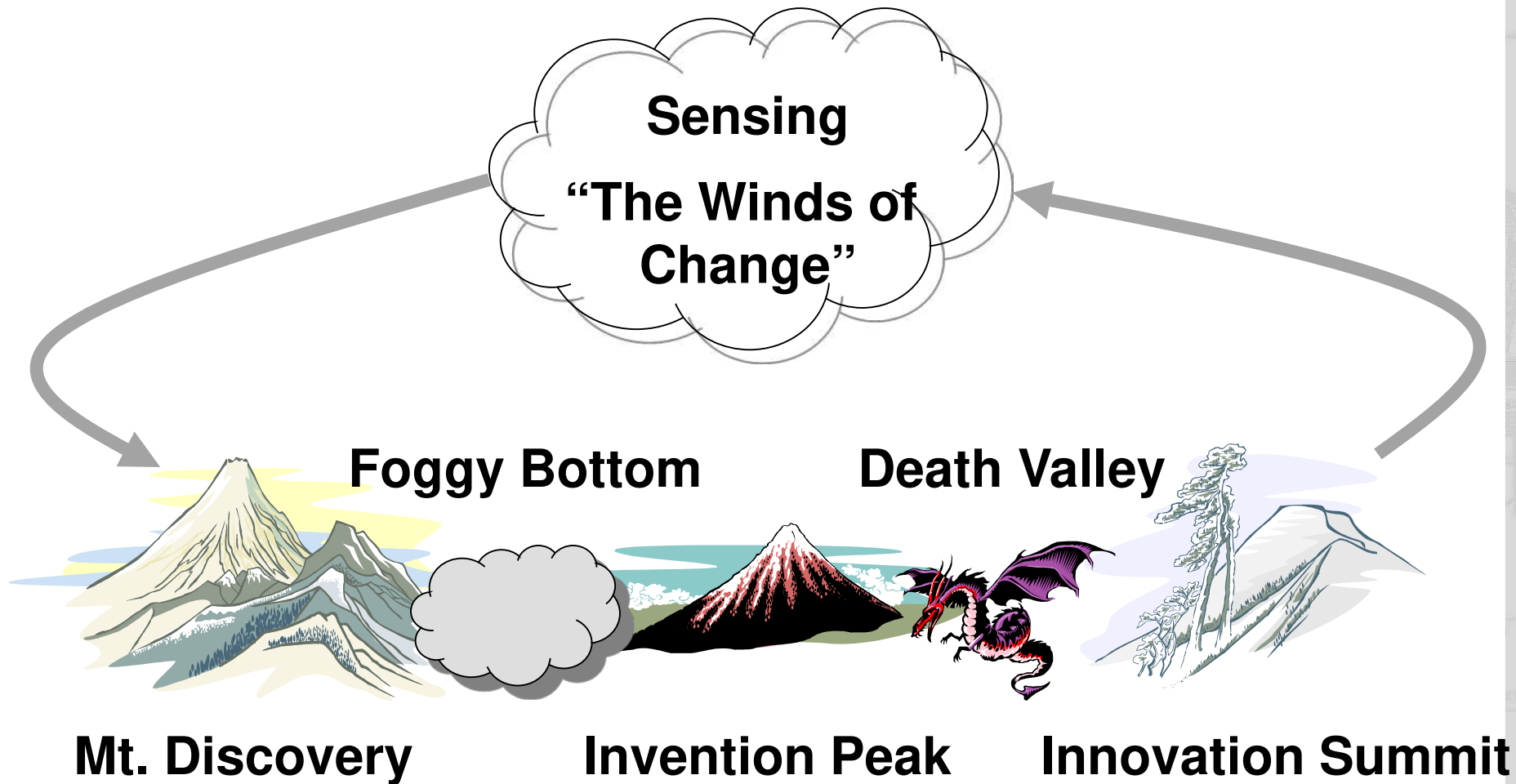
U.S. Army Corps  
of Engineers  
Engineer Research and  
Development Center



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



# ***“The Land of Technology Development and Application”***





# INCENTIVES



- **Public agency goals**
  - E.g., USACE establishing national goals and metrics for: 1) dredged material beneficial use, 2) Natural and Nature-Based Features
- **Private company goals**
  - E.g., Dow Chemical commits to produce \$1B in value by 2025 through nature's services and functions
- **Ports**
  - E.g., Port of Huelva 20% discount in concession fees in exchange for a commitment to environmental improvement
- **Regulatory programs**
  - E.g., USACE national / regional permits for living shorelines / nature-based solutions
  - Reduced mitigation requirements
- **Cost-sharing**
  - E.g., public-public and public-private partnerships, e.g., USACE-NOAA, USACE-USFWS; USACE-EPA; USACE-TNC



# MEANS

- Innovate
- Diversify projects to meet the need:
  - Wetlands
  - Islands
  - Tidal flats
  - Subtidal features: reefs, ridges, relief
- Scale up the size of projects to fully address the needs and opportunities
- Keep the projects “real”
  - Beware of over-design, -constraint, -requirement
  - Affordability is key
- Document the produced benefits and values created
- Coordinate communication across partnering organizations for maximum impact

