# *Engineering With Nature in Rivers*

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# Creating Value through Alignment…

- What opportunities are there for achieving better alignment of natural and engineered systems?
  - Can improved alignment reduce risks to life, property and ecosystems?
  - 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."

# Value and Use of Natural Systems

## Following Hurricane Sandy:

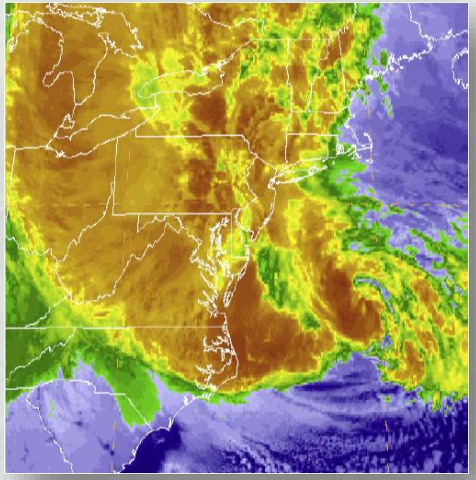
- Risk industry-based tools used to quantify the economic benefits of coastal wetlands
  - Temperate coastal wetlands saved more than $625 million in flood damages.
  - In Ocean County, New Jersey, salt marsh conservation can significantly reduce average annual flood losses by more than 20%.

**COASTAL WETLANDS AND FLOOD DAMAGE REDUCTION**

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

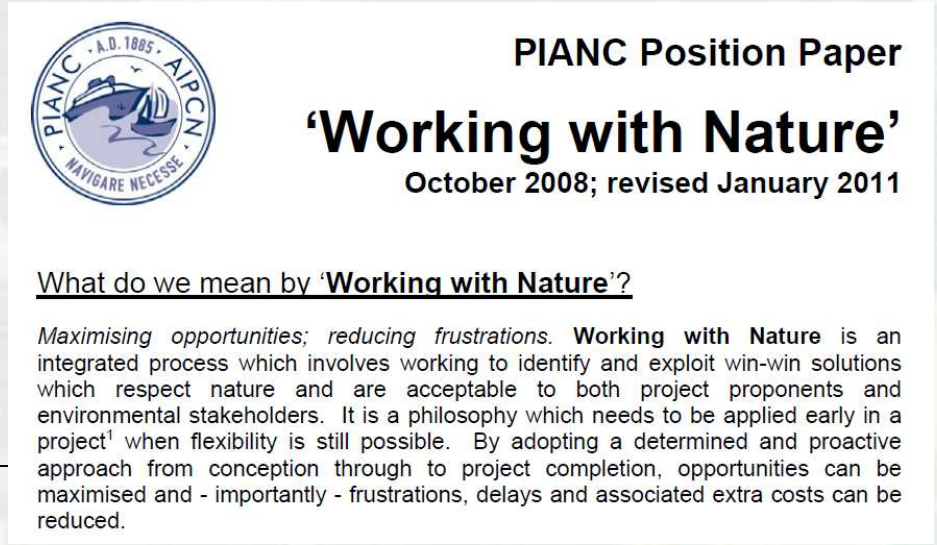
October 2016

UNIVERSITY OF CALIFORNIA SANTA CRUZ · The Nature Conservancy · Wildlife Conservation Society · LLOYD'S TERCENTENARY RESEARCH FOUNDATION



# Working with Nature: *Background*

- Developed as a position paper by PIANC's Environmental Commission in 2007-2008
  - ► Supported by CEDA and IADC
- Endorsed by PIANC Executive Committee
- Aims to provide a practical framework for sustainable navigation infrastructure development



PIANC Position Paper

**'Working with Nature'**

**October 2008; revised January 2011**

What do we mean by '**Working with Nature**'?

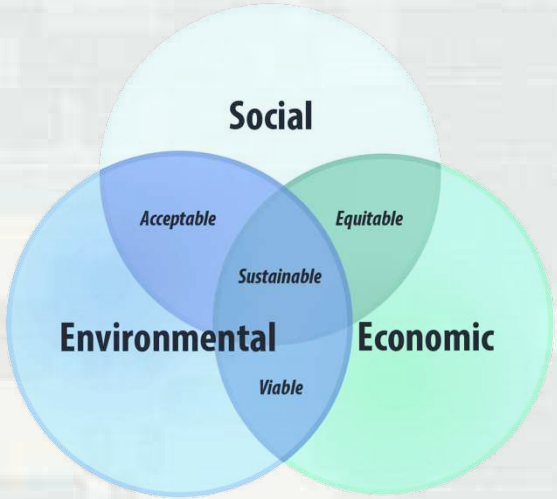
*Maximising opportunities; reducing frustrations.* **Working with Nature** is an integrated process which involves working to identify and exploit win-win solutions which respect nature and are acceptable to both project proponents and environmental stakeholders. It is a philosophy which needs to be applied early in a project[1] when flexibility is still possible. By adopting a determined and proactive approach from conception through to project completion, opportunities can be maximised and - importantly - frustrations, delays and associated extra costs can be reduced.

# Engineering With Nature™…

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

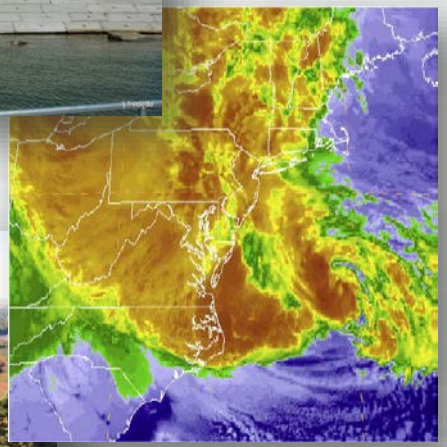
Key Elements:

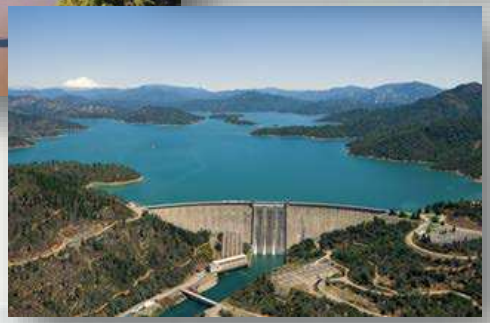
- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners



# 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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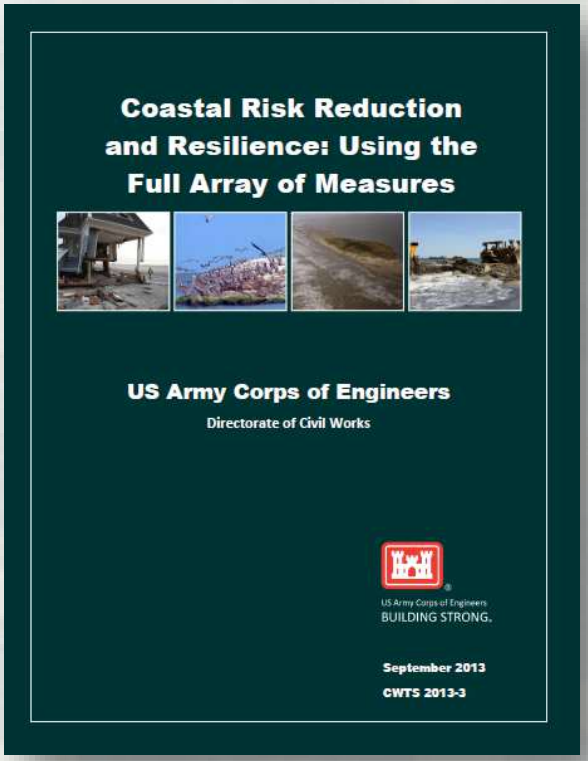
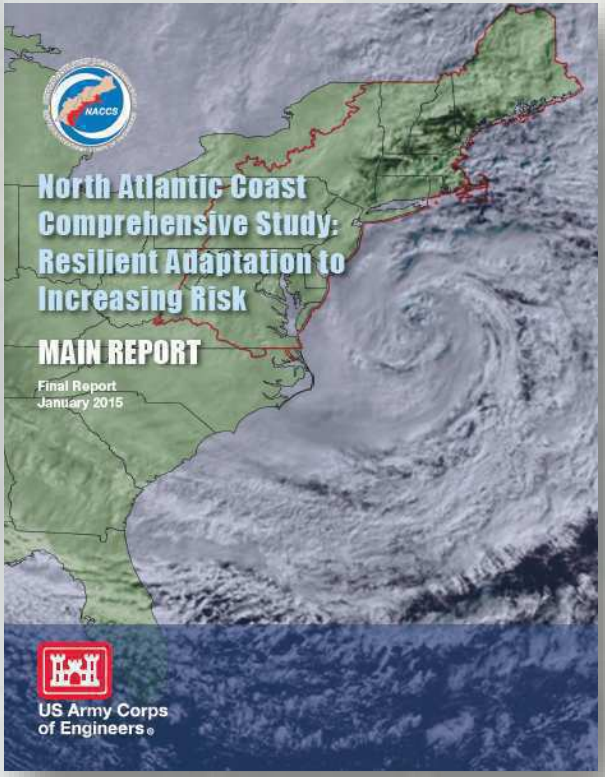
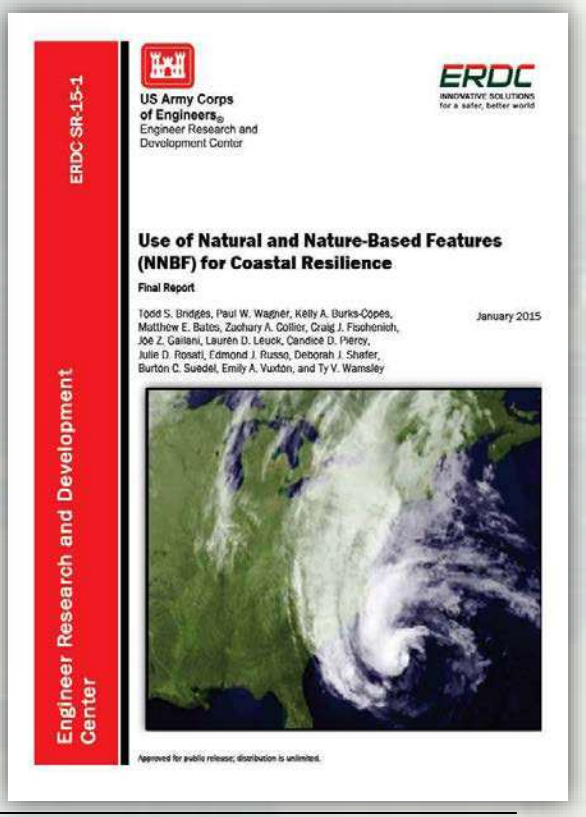
# The North Atlantic Coast Comprehensive Study






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

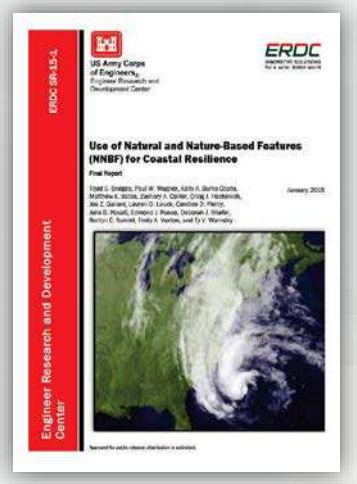
**Select NNBF Alternatives**

**Design Implementation Plan: Elaborate Operational and Engineering Practices**

**Implement NNBF Alternative**

**Monitor for Performance and Assess Ecosystem Goods and Services**

**Feedback**



# Fort Pierce City Marina, Florida

# Enhancing Ecosystem Value

Upper Mississippi River Training Structures: Chevrons

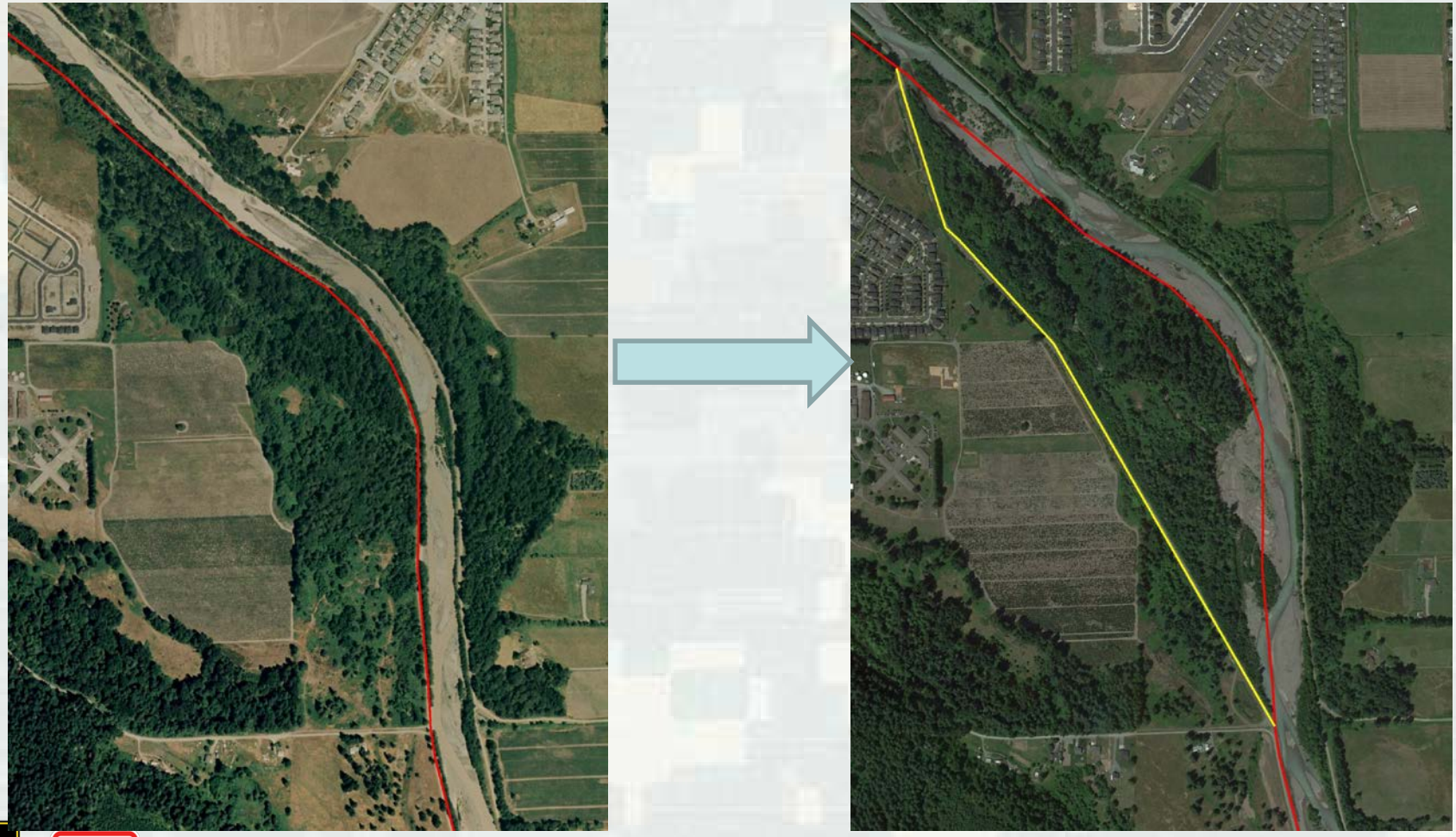
Loosahatchie Bar, Memphis

Milwaukee Harbor Breakwater

# Soldier's Home Levee Setback

April 2006

June 2016



Original Levee

Setback Levee

# Chehalis Basin Floodplain Restoration



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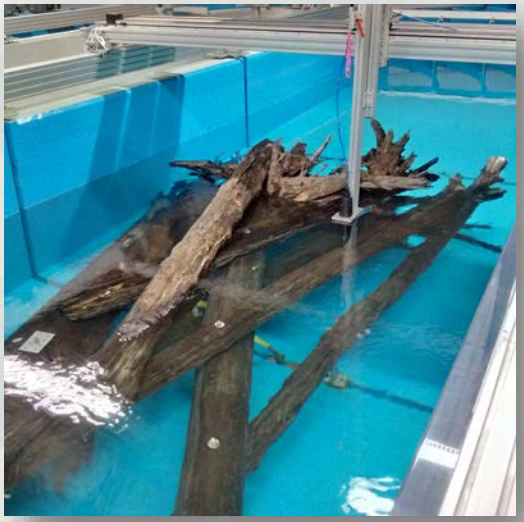
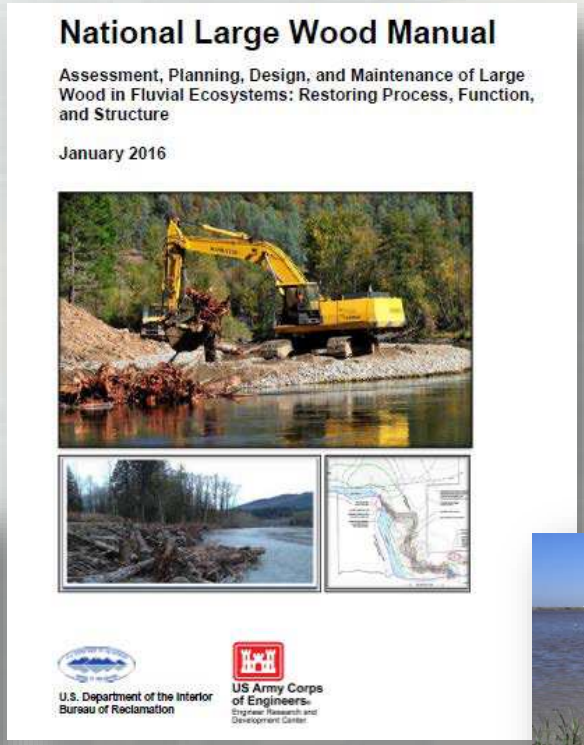
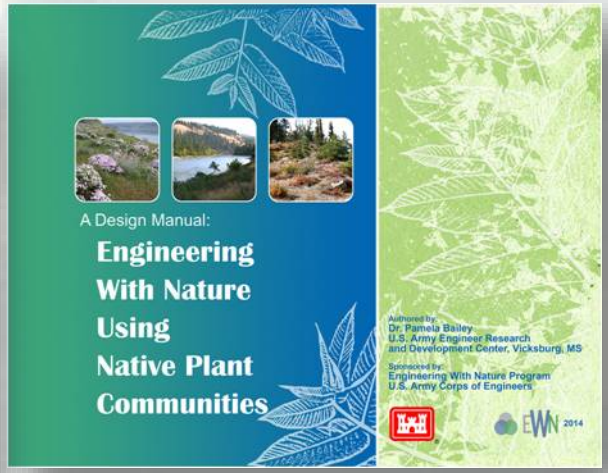
RAMBOLL ENVIRON

THE CHEHALIS TRIBE

# Engineering with Natural Materials



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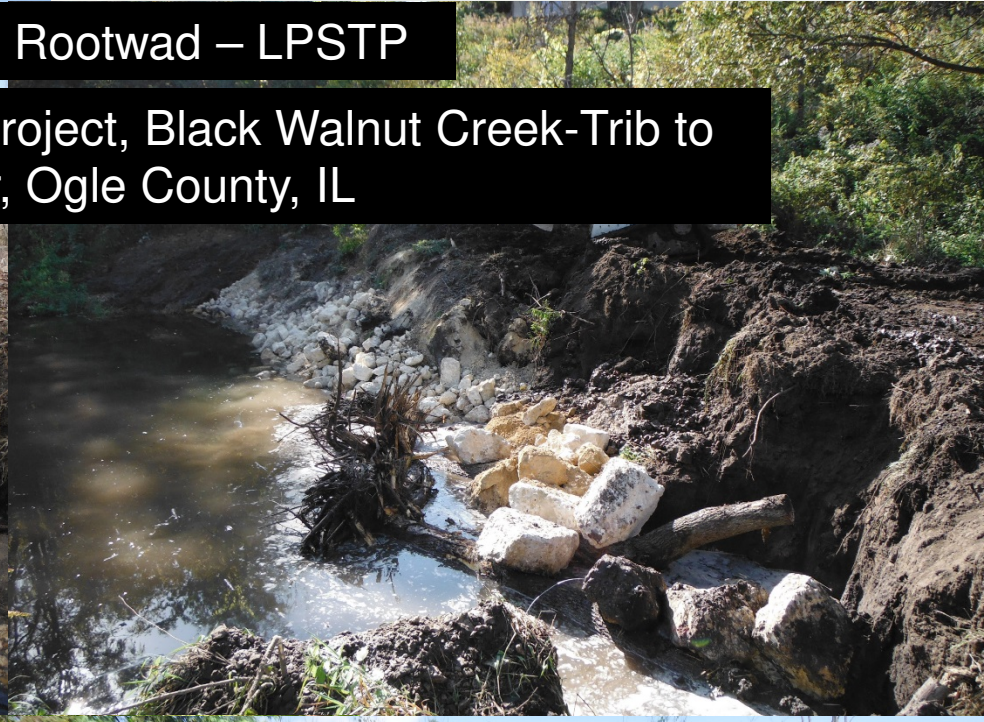
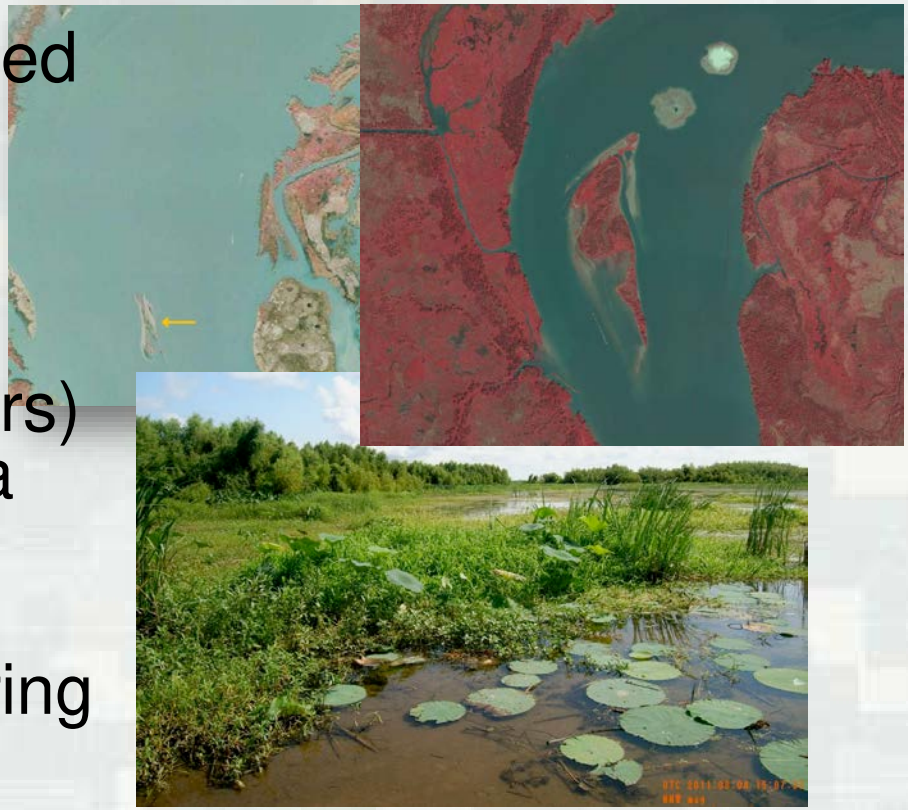
# Bank Stabilization: Rootwad – LPSTP

## TNC-USFWS Restoration Project, Black Walnut Creek-Trib to Rock River, Ogle County, IL



# 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




# Laws and Mandates: Water Infrastructure Improvements for the Nation Act (WIIN Act) 2016

SEC. 1184. Consideration of measures.

(a) Definitions.—In this section, the following definitions apply:

(1) NATURAL FEATURE.—The term “natural feature” means a feature that is created through the action of physical, geological, biological, and chemical processes over time.

(2) NATURE-BASED FEATURE.—The term “nature-based feature” means a feature that is created by human design, engineering, and construction to provide risk reduction in coastal areas by acting in concert with natural processes.

(b) Requirement.—In studying the feasibility of projects for flood risk management, hurricane and storm damage reduction, and ecosystem restoration the Secretary shall, with the consent of the non-Federal sponsor of the feasibility study, consider, as appropriate—

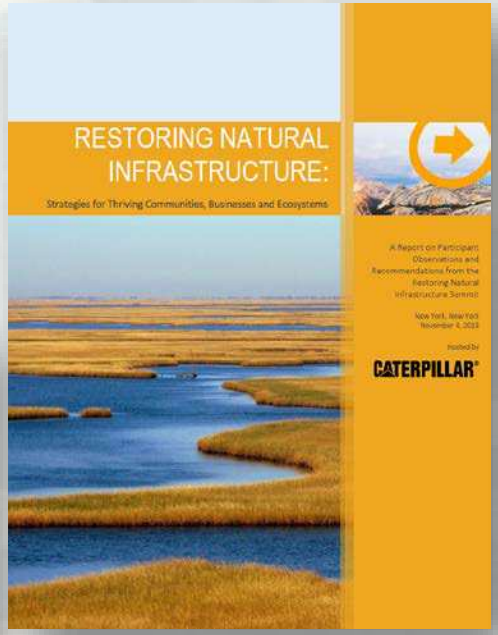
(1) natural features;

(2) nature-based features;

(3) nonstructural measures; and

(4) structural measures.

# The Private Sector:
# Caterpillar Corporation's
# *Restoring Natural Infrastructure Summit*
## 4 November 2015, New York City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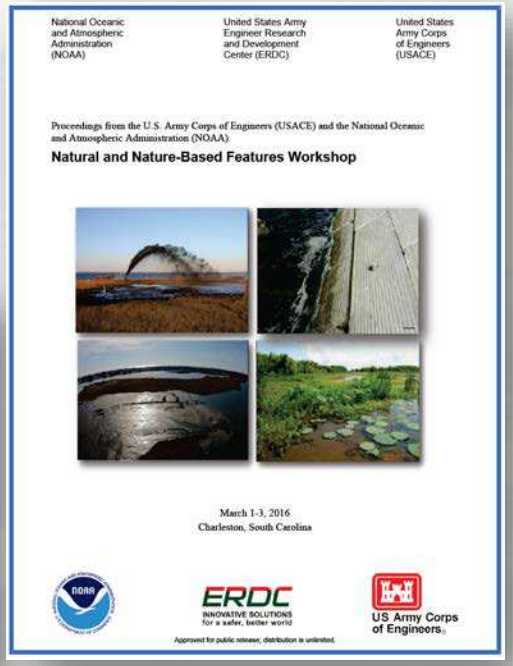
http://www.caterpillar.com/en/company/sustainability/natural-infrastructure.html

# Collaboration: USACE Galveston, Buffalo, and Philadelphia Districts-- The 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

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


www.engineeringwithnature.org (NNBF)

# International Guidelines for Use of Natural and Nature-Based Features for Sustainable Systems

- Publish coastal NNBF technical guidelines by 2020:
  - Multi-author: government, academia, NGOs, engineering firms, construction companies, etc.
  - Addressing the full project life cycle: planning, design, engineering, construction, and maintenance
  - Guidelines in 3 Sections
    - Overarching topics
    - Coastal Applications
    - River/Inland Applications

# 1906 San Francisco Earthquake

# Agnews State Hospital, 1906