ENGINEERING WITH NATURE TO CREATE SUSTAINABLE VALUE

Dr. 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

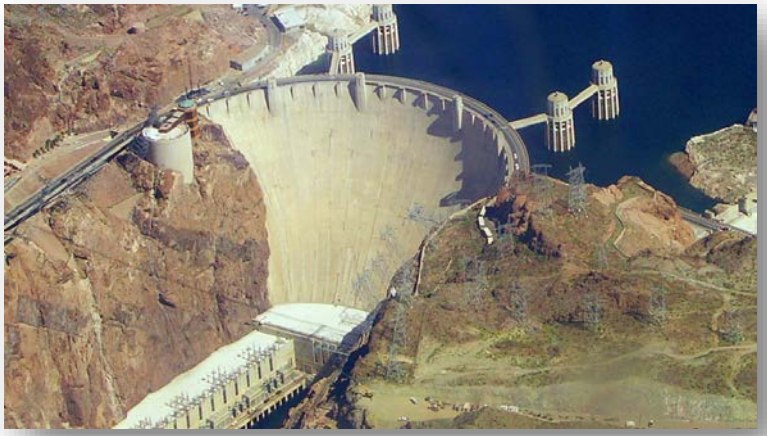
Sustainable Sediment Management and Dredging
November 28-30, 2018

US Army Corps of Engineers

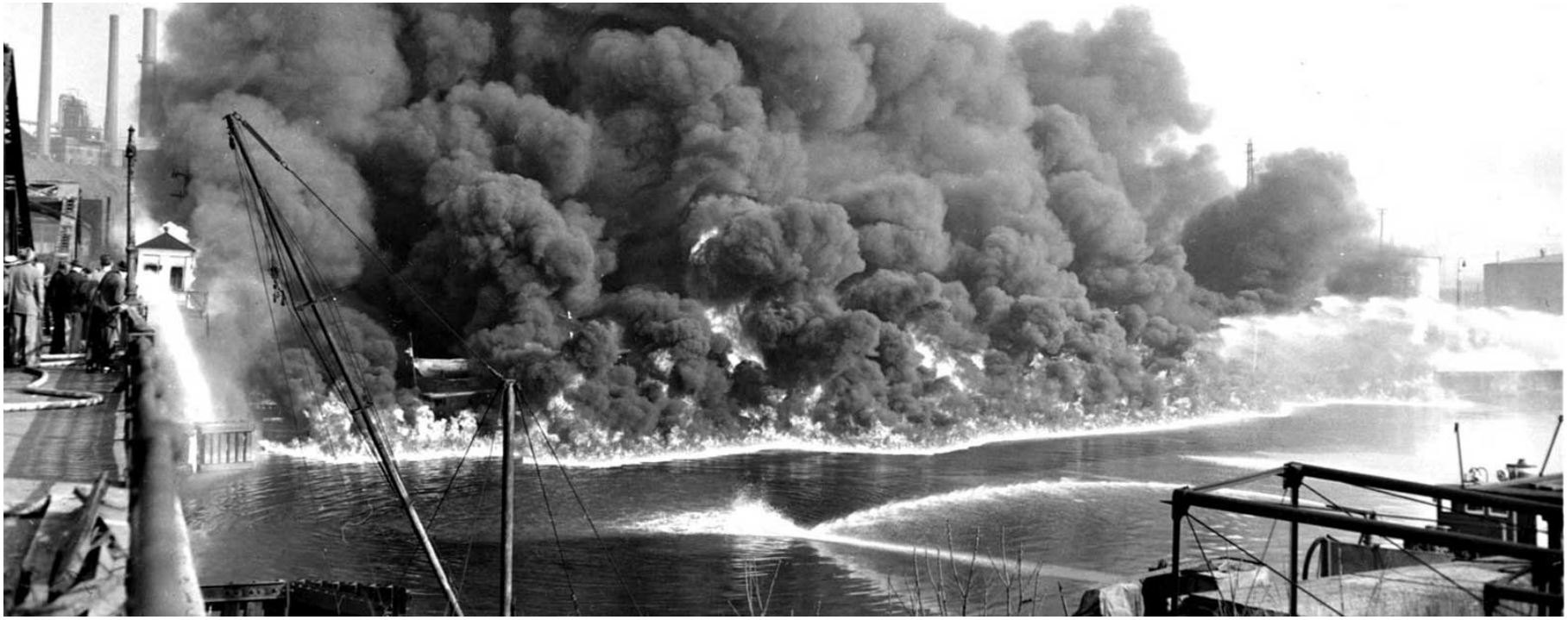
ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

1900-2000: THE CENTURY OF INFRASTRUCTURE (US)

- 4,071,000 miles of roadway
  - 47,182 miles in the Interstate system
- 149,136 miles of mainline rail
- 640,000 miles of high-voltage transmission lines
- 614,387 bridges
- 90,580 dams
- 155,000 public drinking water systems
- 30,000 miles of levee
- 4,500 military installations
- 926 ports



Cuyahoga River; Cleveland, OH



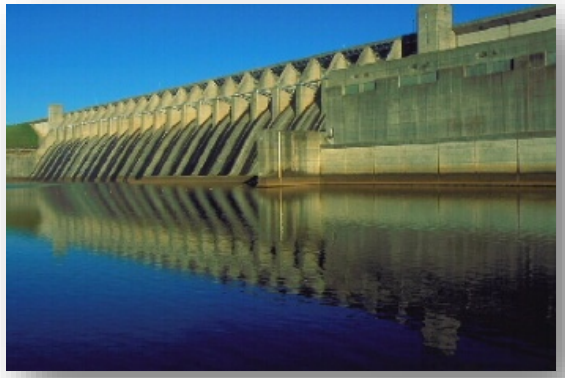
THE 1970's: THE DECADE OF ENVIRONMENTAL LAW AND REGULATION

- National Environmental Policy Act of 1969
- Clean Water Act 1972
- Marine Protection, Research, and Sanctuaries Act of 1972
- Coastal Zone Management Act of 1972
- Endangered Species Act of 1973
- Resource Conservation and Recovery Act of 1976
- Comprehensive Environmental Response, Compensation and Liability Act of 1980

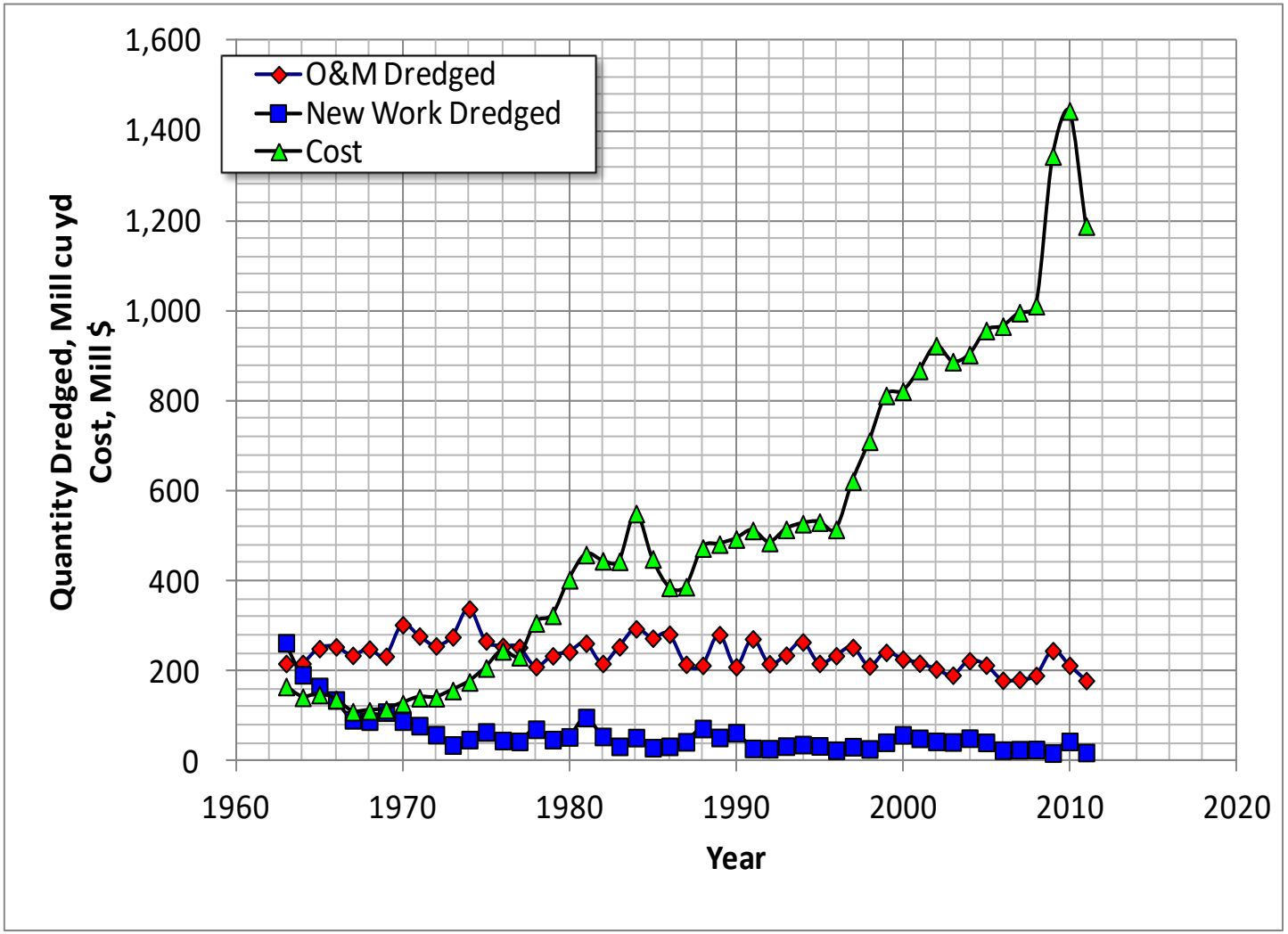
USACE INFRASTRUCTURE

US Army Corps of Engineers.

- 25,000 miles of navigation channel
  - Supporting 926 ports
- 707 dams
  - 75 hydroelectric power facilities
  - 55,390 miles of shoreline
- 14,500 miles of flood levee
- 236 lock chambers at 192 lock sites
- 929 navigation structures
- 844 bridges
- 12 million acres of public land and water

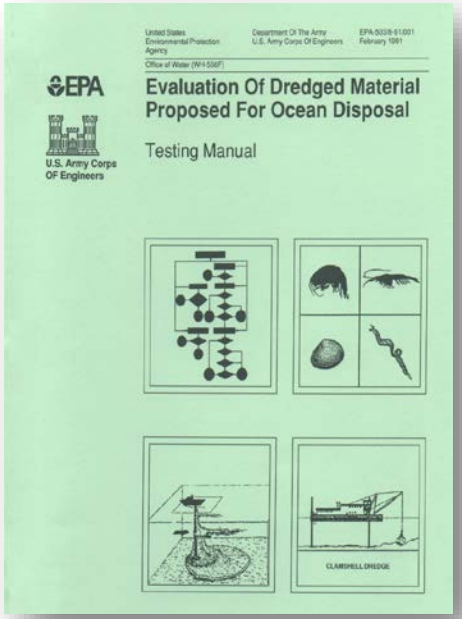


THE ESCALATING COSTS OF DREDGING

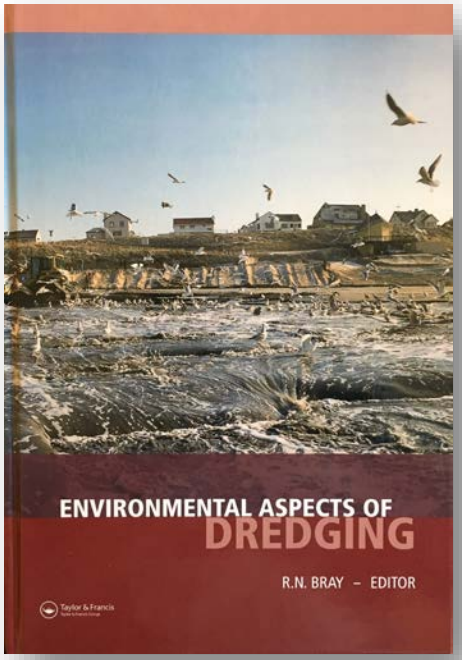


PROGRESSIVE EVOLUTION

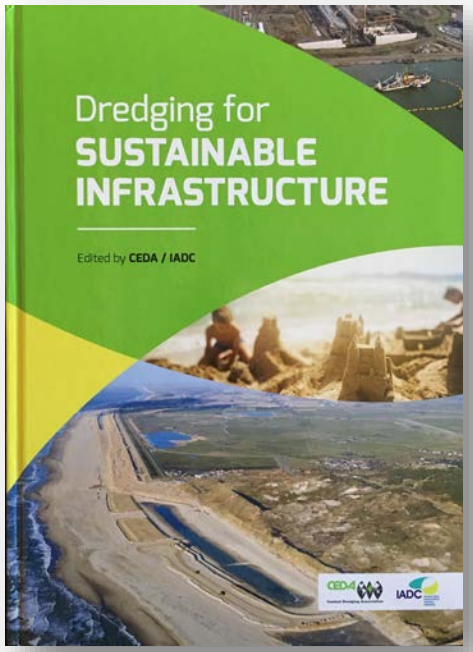
Fax machine
Cell phone
Internet
www
Amazon.com



1977/1991



2008

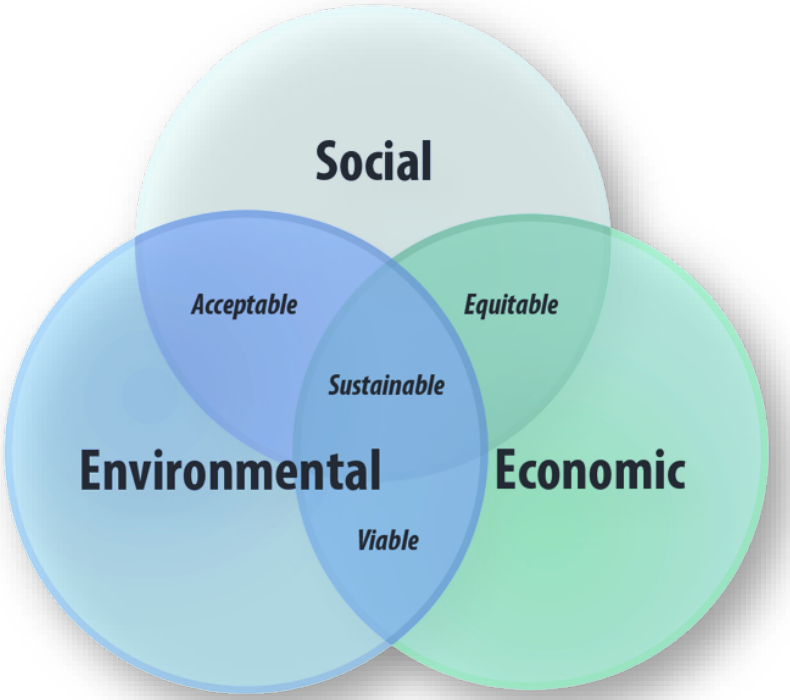


2018


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

SUSTAINABILITY

Sustainability is achieved by efficiently investing resources to create present and future value



A "SUSTAINABILITY LEDGER" FOR SEDIMENT MANAGEMENT

Efficiency

- Reducing sedimentation in channels & reservoirs
- Reducing transport distances for dredged material
- Reducing dredging time
- Expanding operational flexibility
- Linking multiple projects

Value Creation

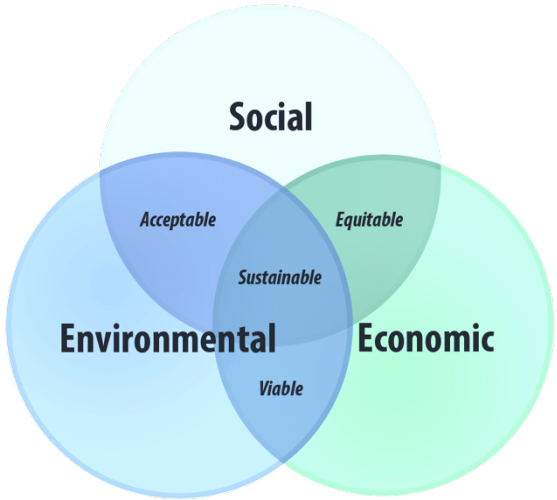
- Restoring natural sediment processes to sustain landscapes
- New nature-based features that reduce flood risks
- Budget space for additional infrastructure work
- New habitat for fish and wildlife
- New features that provide recreational and other social value

Engineering With Nature®

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

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



www.engineeringwithnature.org

EWN® OVERVIEW

Engineering With Nature® 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

EWN® STRATEGIC PLAN

Wave I: Broaden and Deepen Partnerships

- Build the organization and internal capacity to support, grow, and sustain EWN
- Expand by engaging districts and early adopters throughout USACE
- Expand by engaging agency partners and key external stakeholders
- Establish/expand collaboration through agreements with key international partners
- Advance EWN through effective governance

Wave II: Expand Capabilities

- Continue to develop science and technical alliances
- Leverage social science to better engage agency partners and stakeholders, and build capacity
- Expand and focus the EWN research agenda to strengthen capabilities

Wave III: Expand Applications and Communication

- Support and document multi-scale demonstrations of EWN practices
- Support and reinforce EWN progress through ongoing engagement and communication
- Enable EWN application through development of policies and guidance

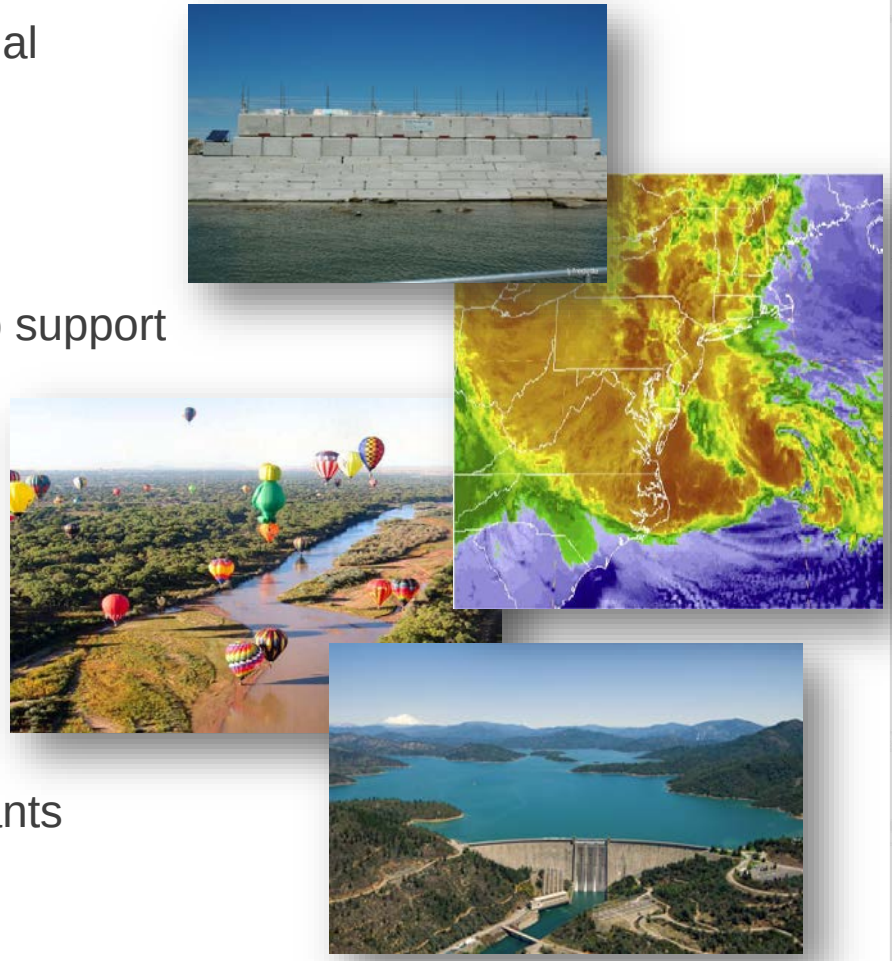
EWN® ACROSS USACE MISSION SPACE

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

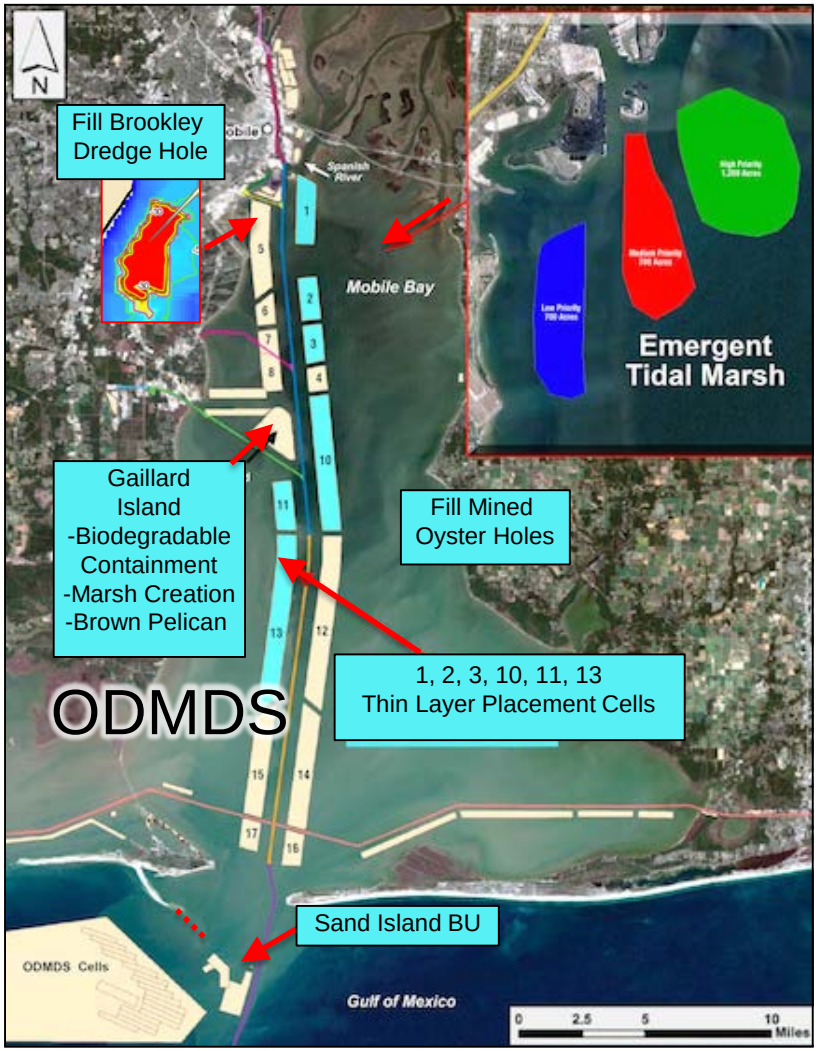
Flood Risk Management
- Natural and Nature-Based Features to support FRM
- Levee setbacks

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

Water Operations
- Shoreline stabilization using native plants
- Environmental flows and connectivity



MOBILE BAY: APPLYING RSM AND EWN



WRDA86:

Place all dredged sediments in ODMDS

- 4.0 mcy/yr, Hopper Dredge, 20-Miles
- Tripled maintenance costs

2014 decision reversed:

- EWN approaches and techniques
- RSM Interagency Work Group

$12M annual value

Thin Layer Placement in Mobile Bay

Sand Island Beneficial Use Area (SIBUA)

-Downdrift benefits to Dauphin Island

-Protect lighthouse

Fill dredge holes

-Brookley Hole, Oyster Holes

Gaillard Island

- Biodegradable Containment
- Marsh Creation
- Brown Pelican

Future in-Bay placement:

Thin Layer Placement

-1000 acre emergent marsh

Middle Harbour Port of Oakland, USA

2018 PIANC *Working with Nature* Award Winner

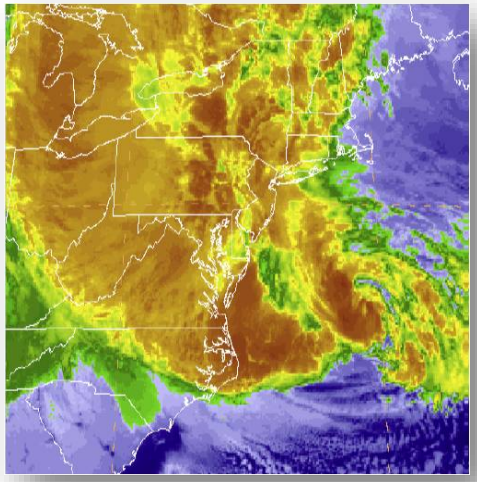
NATURAL AND NATURE-BASED FEATURES

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

LEVERAGING NATURE FOR ENGINEERING 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

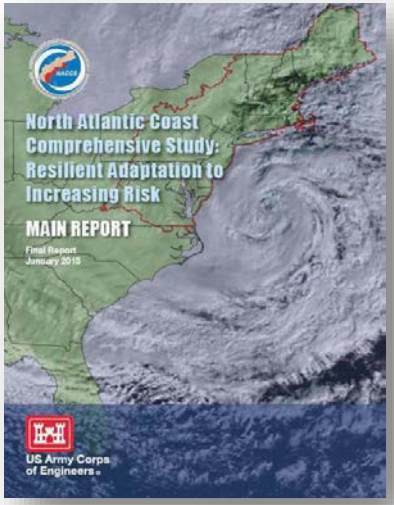
Using Risk Industry-based Models
to Assess Natural Defenses in the Northeastern USA

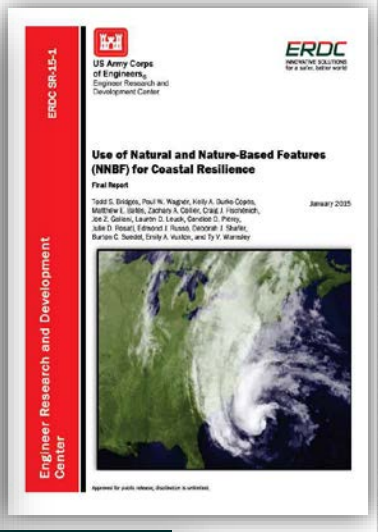
October 2016

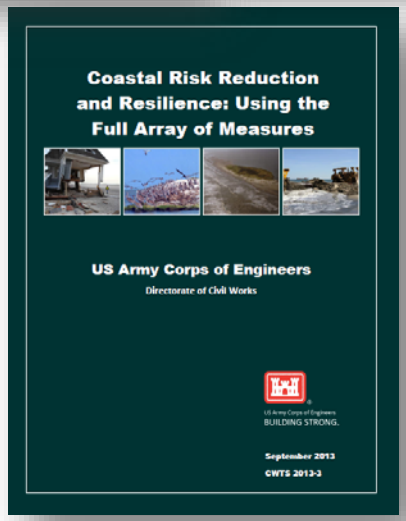
UNIVERSITY OF CALIFORNIA SANTA CRUZ · The Nature Conservancy · Wildlife Conservation Society · LLOYD'S TERCENTENARY RESEARCH FOUNDATION

RESILIENCE THROUGH INTEGRATED SOLUTIONS

"The USACE planning approach supports an integrated strategy for reducing coastal risks and increasing human and ecosystem community resilience through a combination of the full array of measures: natural, nature-based, nonstructural, and structural. 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."







Coastal Risk Reduction and Resilience. Todd Bridges, Roselle Henn, Shawn Komlos, Debby Scerno, Ty Wamsley, and Kate White. CWTS 2013-3. Washington, DC: Directorate of Civil Works, US Army Corps of Engineers.

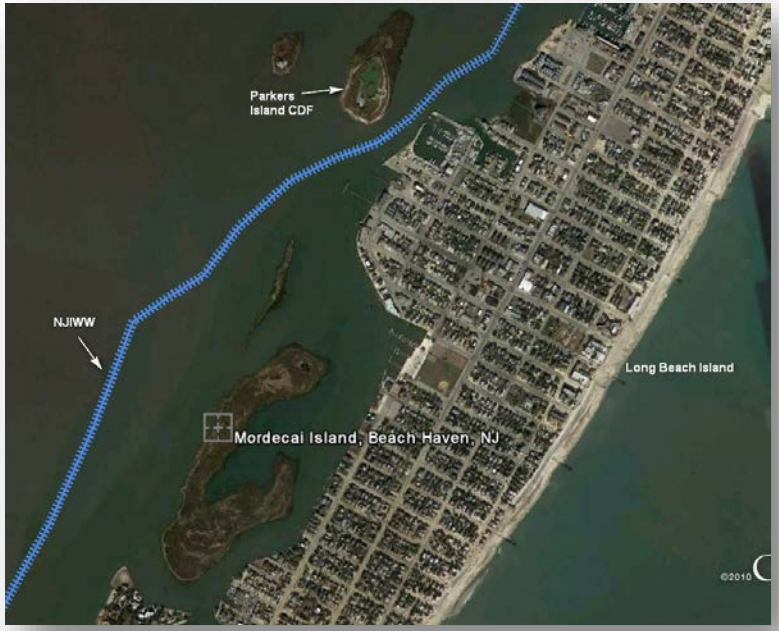
USACE PHILADELPHIA DISTRICT: EWN IN BACK BAY NEW JERSEY

Mordecai Island

Stone Harbor

Avalon

ISLAND CREATION, ENHANCEMENT, REPURPOSING

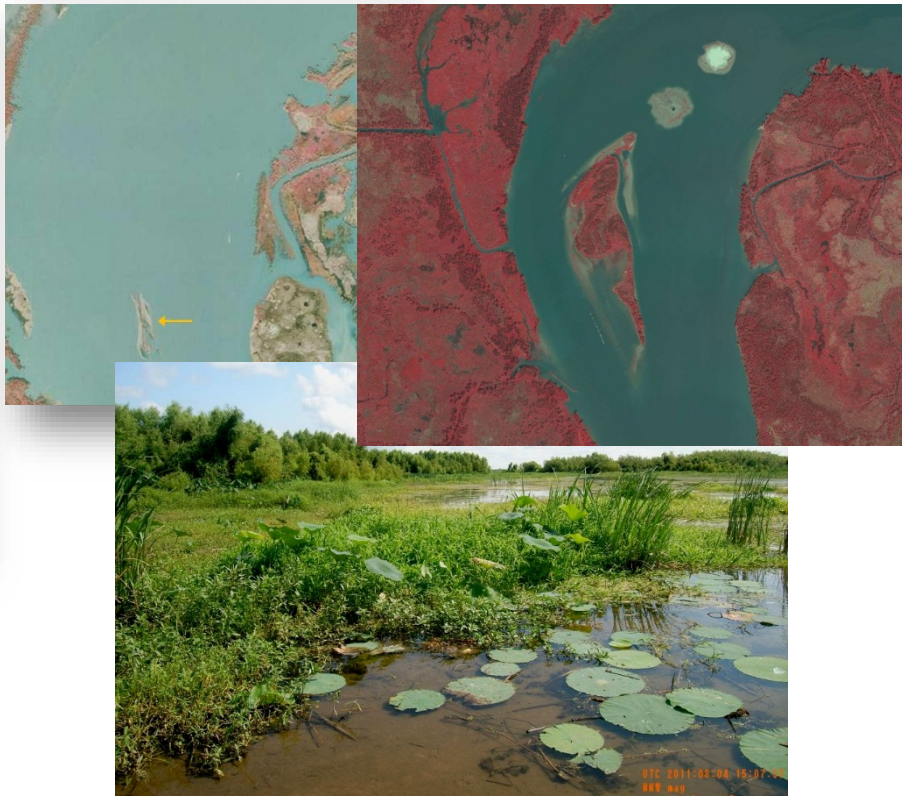


ONEHUNGA BAY FORESHORE RESTORATION AUCKLAND, NEW ZEALAND

CAT ISLAND ON GREEN BAY, WISCONSIN

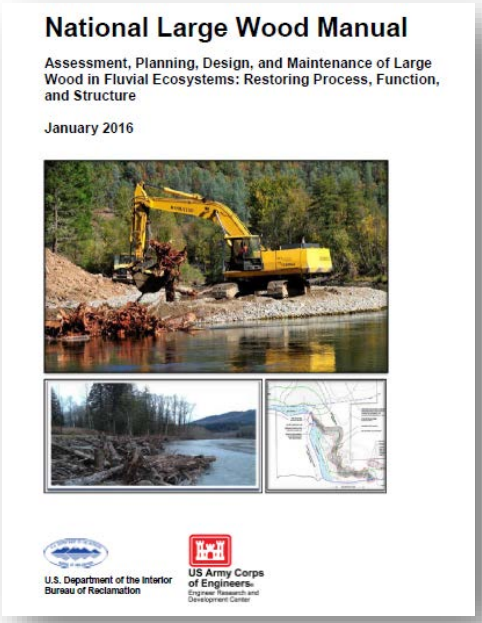
ENGINEERING WITH NATURE IN RIVERS

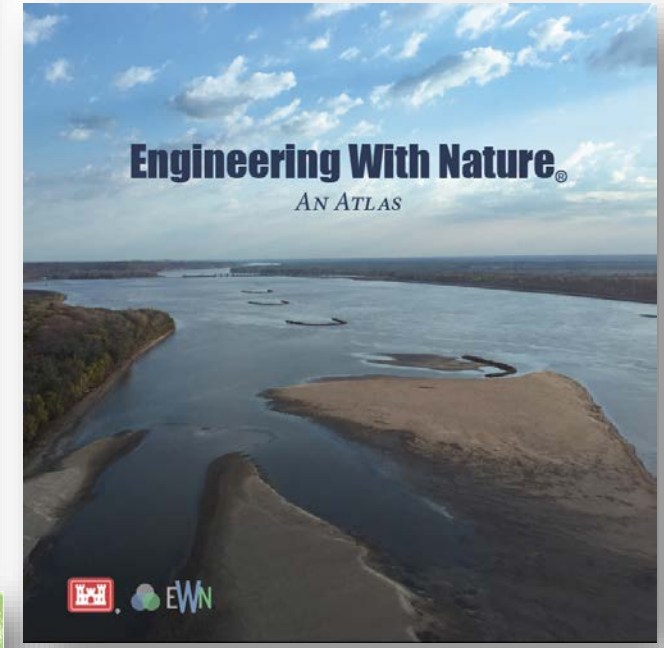
Upper Mississippi River Training Structures: Chevrons

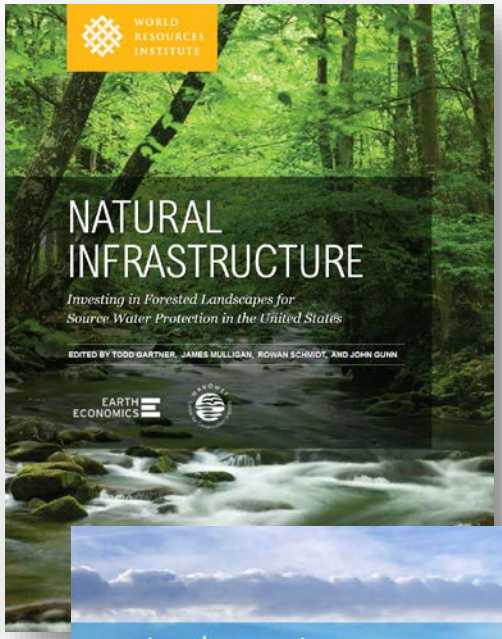


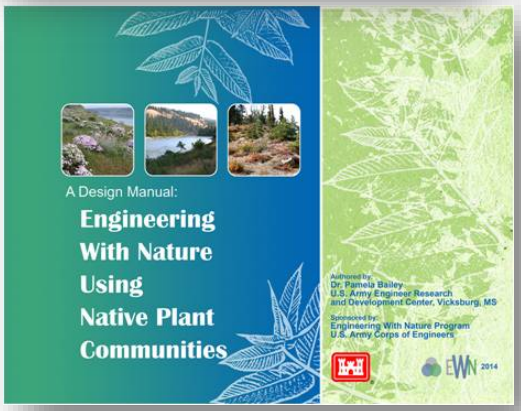
Horseshoe Bend Island, Atchafalaya River

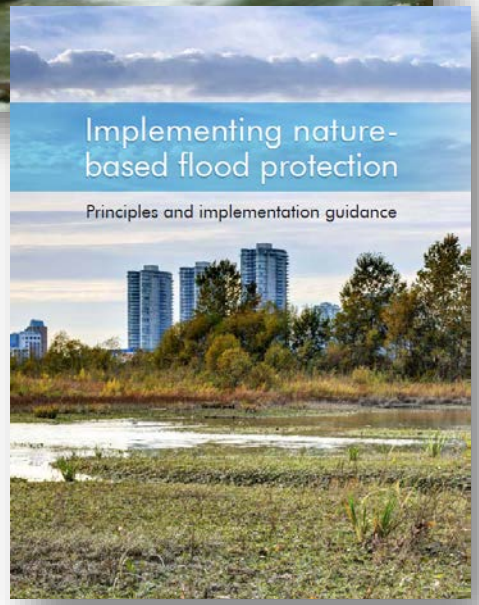
COMMUNICATING BEST PRACTICE











www.engineeringwithnature.org

ENGINEERING WITH NATURE®: AN ATLAS

Innovating New Aproaches as a Global Community of Practitioners

Engineering With Nature is an important initiative for the U.S. Army Corps of Engineers.

When we leverage natural systems and processes through integrated water resources management, we can develop more sustainable solutions and systems. By broadening our view of potential outcomes, we can find ways to deliver a broader array of services, benefits, and value from investments made in infrastructure systems.

Innovation and adaptive management are key elements to advancing our engineering practice and Engineering With Nature. Trying something new—developing and implementing new approaches, methods, and practices—involves taking risks. We use risk-informed decision making to guide our application of new approaches. We adaptively manage those risks as we learn and adjust our approach.

The project examples highlighted in this book illustrate the diverse opportunities and growing community of organizations and practitioners that are contributing to Engineering With Nature. A global community of practitioners provides a means for learning from others and capitalizing on the insights gained to develop better projects in the future. Strong partnerships provide a foundation for successful projects.

I hope you enjoy learning from the projects in this book while considering future ways that you can contribute to Engineering With Nature.

James Dalton
Director of Civil Works
U.S. Army Corps of Engineers

"Engineering With Nature is an important initiative for the U.S. Army Corps of Engineers."

James Dalton

www.engineeringwithnature.org

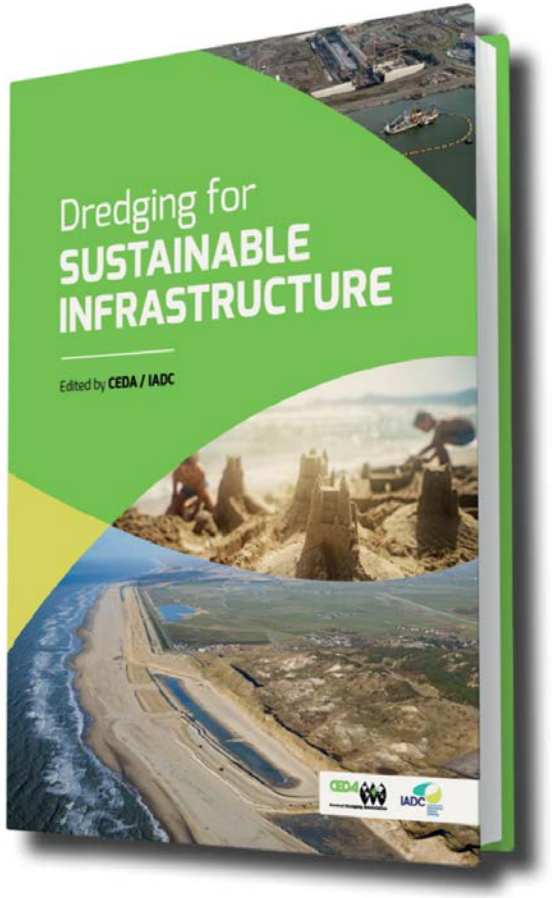
Dredging for Sustainable Infrastructure

Integrating Dredging with Sustainable Development

By Todd Bridges and Tiedo Velinga

Guiding Principles

1. *Comprehensive consideration and analysis of the social, environmental and economic costs and benefits of a project is used to guide the development of sustainable infrastructure.*
2. *Commitments to process improvement and innovation are used to conserve resources, maximize efficiency, increase productivity, and extend the useful lifespan of assets and infrastructure.*
3. *Comprehensive stakeholder engagement and partnering are used to enhance project value.*



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 (NNBF)

COLLABORATION WITH THE PRIVATE SECTOR

- Caterpillar Inc.
  - Restoring Natural Infrastructure Summit; November 4th, 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

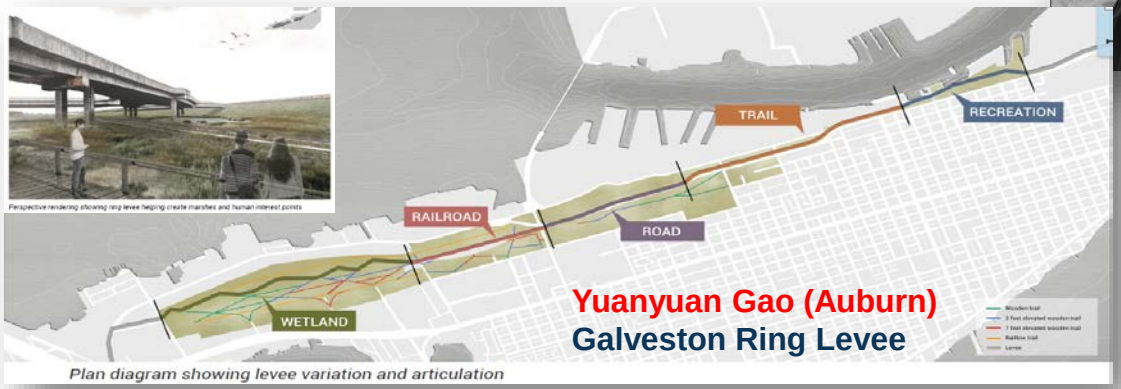
- Texas A&M University
  - Partnering through the Coastal Science and Engineering Collaborative (CSEC)
  - Joint research on NNBF
  - EWN Seminar spring 2018
  - Developing graduate curriculum to support EWN

- 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

LANDSCAPE ARCHITECTURE AND COASTAL TEXAS (SPRING 2018)

- Coastal Texas Protection and Restoration Feasibility Study (Initiated, October 2015)
  - USACE, TX-GLO
- Cornell and Auburn Studio Classes (Spring 2018)
  - Brian Davis and Rob Holmes
- Interaction: field site visit, interactive input/feedback sessions, final report
- Case study summary: Demonstrating the value of LA for infrastructure



Plan diagram showing levee variation and articulation

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-TNC

THE WAY

Engineering With Nature

- Look forward, not back!
  - Where should sediments be placed and managed to create the most value *in the future*?
- Keep it real!
  - Beware of over-design, over-constraint
  - Affordability is key!
  - Strategic placement presents a *real* opportunity
- Innovate!
  - What would it take to get to 100% beneficial use?