Sustainable Sediment Management

Burton Suedel, Ph.D.

Research Biologist

EWN Senior Advisor

Chairman, PIANC Environmental Commission

PIANC Smart Rivers 2025 Memphis

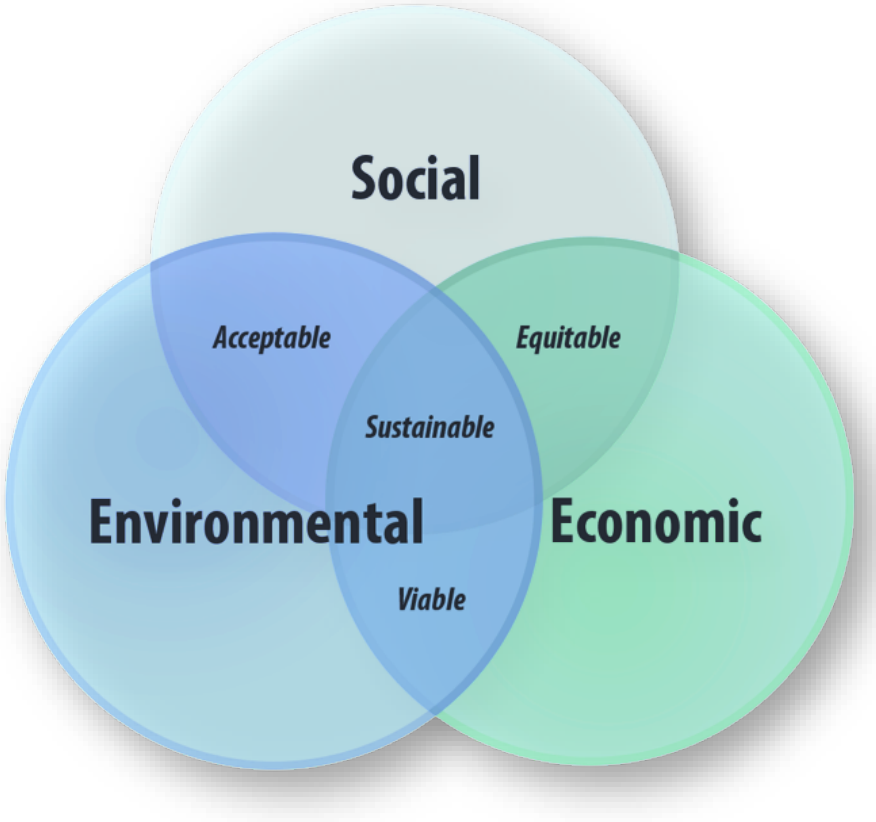
Short Course

8 September 2025

Bottom Photo: P.J. Hahn

Sustainability

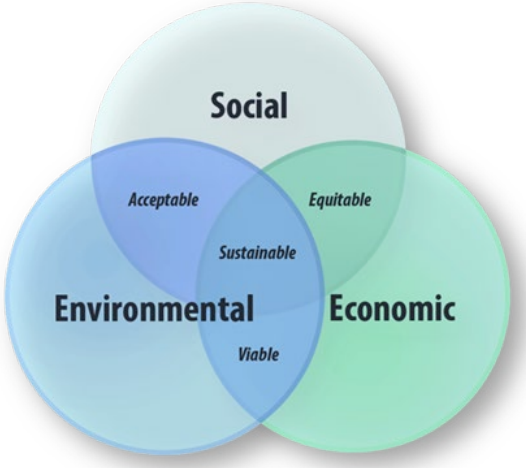
Sustainability is achieved by efficiently investing resources to create present and future value



Triple Wins can be Achieved when Sustainably Managing Dredged Material

Multi-Function Benefits

- Engineering on or for nature becomes engineering With nature
- Bridging organizational missions and sectors (e.g., flood risk management, navigation, ecosystem restoration) to expand the value proposition for solutions
- Diversifying the financing of solutions to produce economic, environmental, and social value

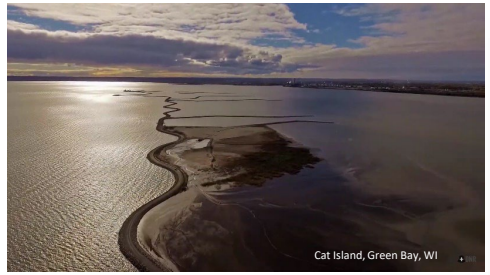



SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES 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

Beneficial Use: Status and Opportunities

"Beneficial use" is using dredged sediment to achieve additional benefits beyond its removal from a channel/waterway, including other economic, environmental or social benefits

- **USACE has a long track record of BU**
  - ~30-40% of dredged material beneficially used over last 20 years (60 out of 200 mcy/yr)
    - >1.5 billion cy used in beach construction over last 100 years
    - 50,000 acres of wetlands created in south Louisiana since 1970s
- **BU supports:**
  - Climate change adaptation through Engineering With Nature®
  - Habitat for fish and wildlife
    - Tribal equities, T&E species
  - Social value to enhance resilience of communities and vulnerable/ underserved populations
- **BU challenges:**
  - Budget constraints
  - Federal Standard interpretation
  - State policies/regulations
  - Advancing the 'technology'



Beneficial Uses of Dredged Material

Beneficial Use

- Agriculture, horticulture, forestry, and aquaculture
- Aquatic habitats
- Parks and recreation
- Strip mine reclamation, solid waste landfill and alternative uses
- Beach/Shoreline nourishment
- Construction and industrial/ commercial uses
- Island habitats
- Multipurpose uses and other land use
- Upland habitats
- Wetland habitats

Disposal

- Confined (diked) placement
- Confined aquatic disposal

BUDM/Disposal/ Transitional Placement

- Open-water placement

USACE Memo: Expanding Beneficial Use of Dredged Material in the USACE 28 August 2023

Expanding BUDM - Policy

DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY CORPS OF ENGINEERS
441 G STREET NORTHWEST
WASHINGTON DC 20314-1000

CECG

25 January 2023

Beneficial Use of Dredged Material Command Philosophy Notice

Teammates,

Today I am formally issuing a Beneficial Use of Dredged Material Command Philosophy Notice which outlines my vision for expanding the U.S. Army Corps of Engineers beneficial use of dredged material (BUDM) program. This philosophy notice aligns with two of my four key priorities for the organization, Partnerships and Innovate.

Dredged material is a valued resource that is not to be wasted, but instead used for benefits to the ecosystem, economy, and to deliver the USACE mission more effectively and efficiently across our portfolio of Navigation, Flood Risk Management and Aquatic Ecosystem Restoration projects.

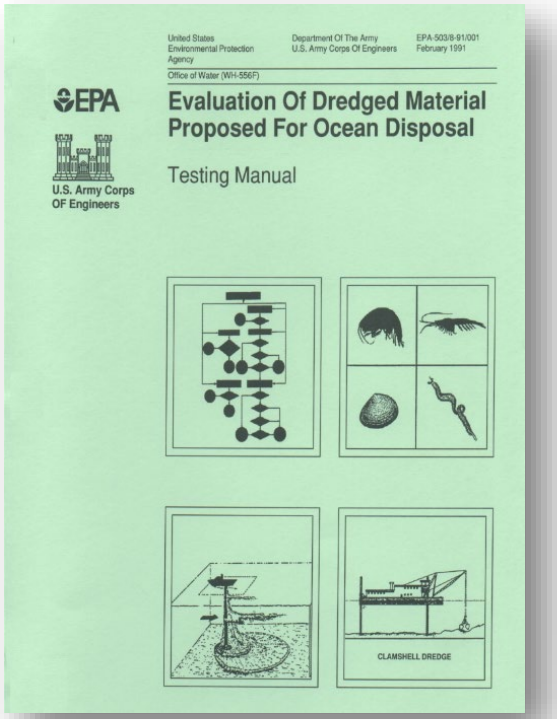
Through a symbiotic relationship with navigation dredging, you are being called to generate productive and positive uses of dredged material. If there is a need for USACE to dredge an authorized channel, the operational strategy should inherently include beneficial use placement options. Equally, if there is a need for sediment, gravel, or rock material to implement a project, beneficial use from dredging operations within authorized channels should be considered as a source in the planning and execution strategy. We must do these things in compliance with applicable laws and regulations, including the Federal Standard for dredged material disposal or placement. A proper analysis of the total lifecycle cost of dredging and placement as well as the full benefits will result in an accurate determination of the Federal Standard.

USACE historically uses 30-40% of the sediments derived from the Navigation mission for beneficial purposes. I have established a goal for USACE to advance the practice of BUDM to 70% by the year 2030 (“70/30 Goal”).

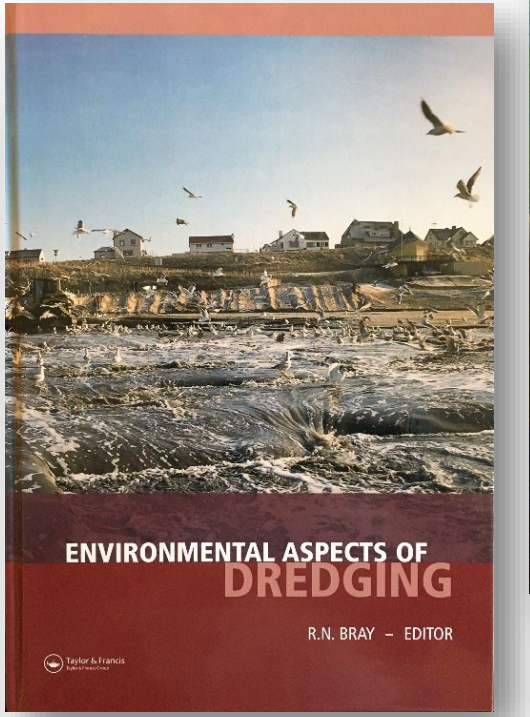
WRDA 2024
Section 1130 Maximizing Sediment Beneficial Use

“(B) NATIONAL GOAL.—To the greatest extent practicable, the Secretary shall ensure that not less than 70 percent by volume (as measured in cubic yards) of suitable dredged material obtained from the construction or operation and maintenance of water resources development projects is used beneficially.’’

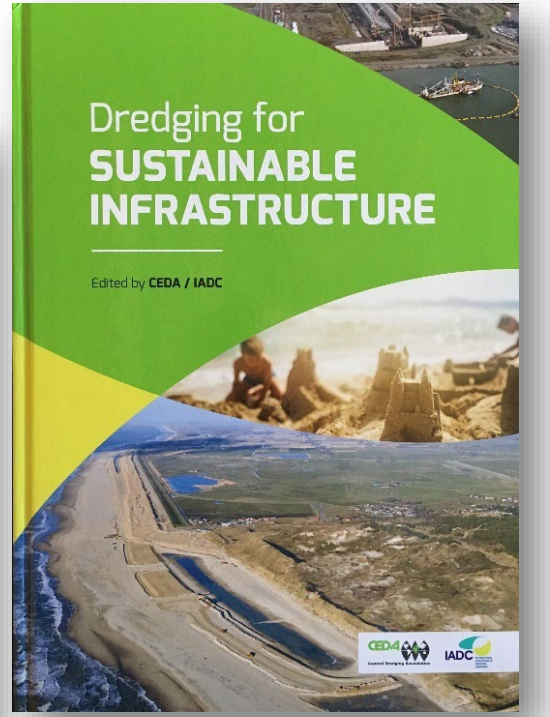
Progressive Evolution



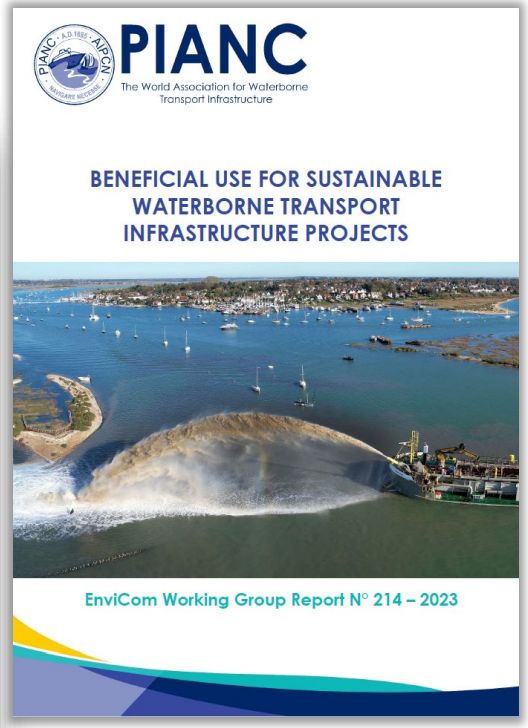
1977/1991



2008



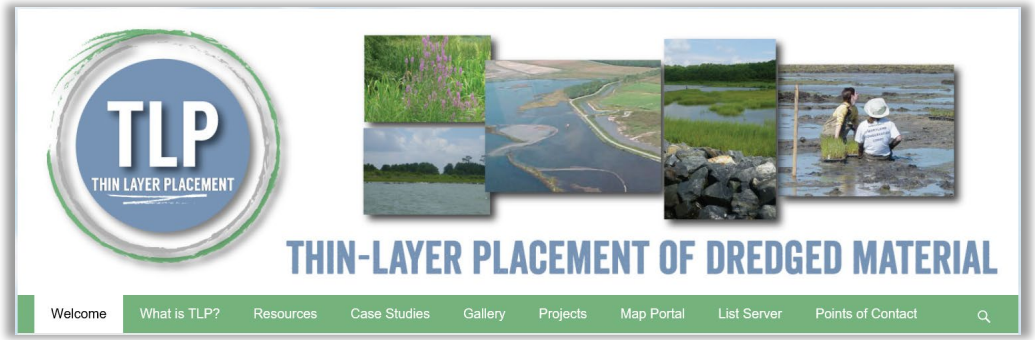
2018



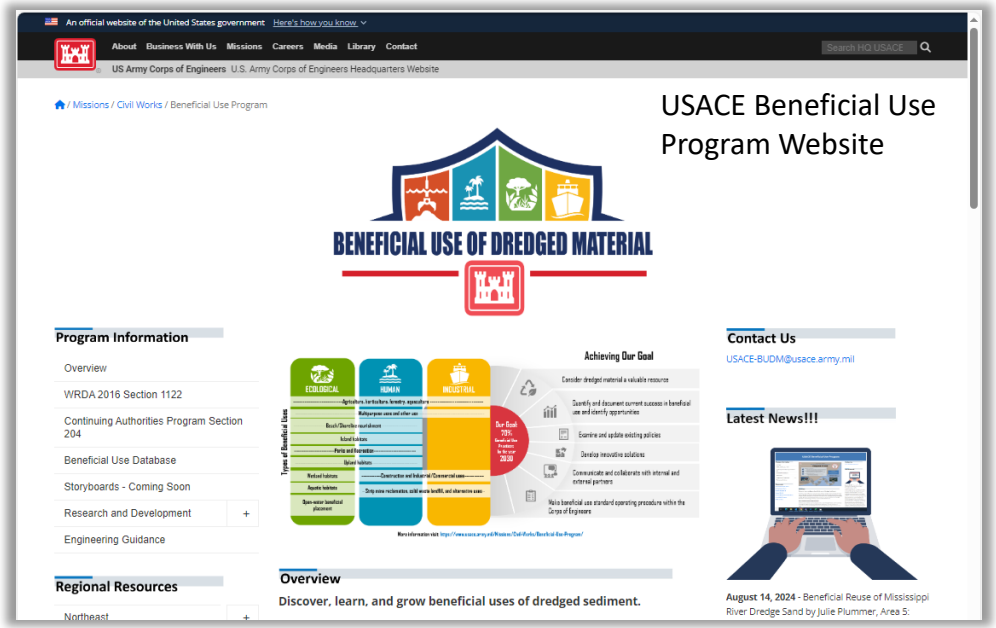
2023

Some Web-based BU Resources

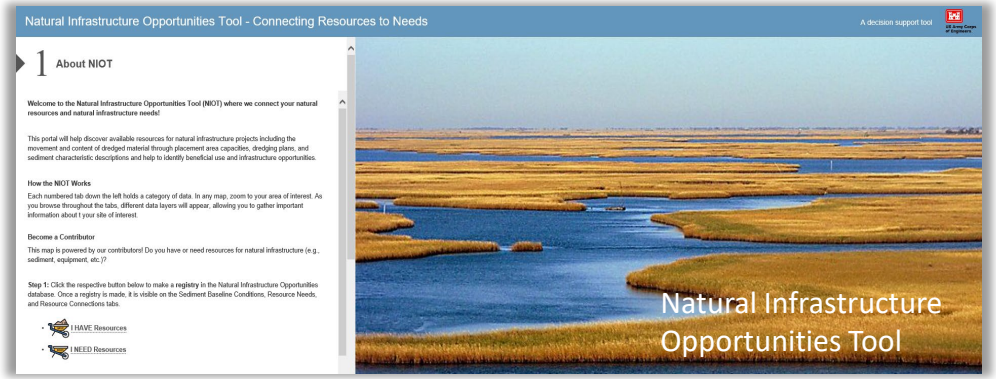
https://budm.el.erdc.dren.mil/



https://tlp.el.erdc.dren.mil/



https://www.usace.army.mil/Missions/Civil-Works/Beneficial-Use-Program/



https://ewn.erdc.dren.mil/?page_id=601

International Resources and Guidance

PIANC - Dredged Material as a Resource

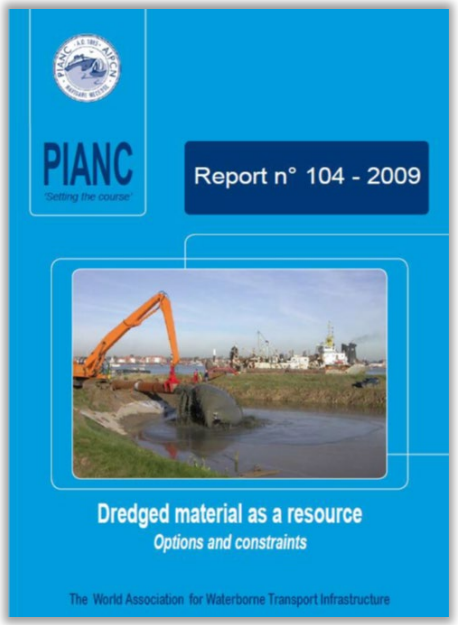
- Report published in 2009
- PIANC WG 214 Sediment Beneficial Use (2023)

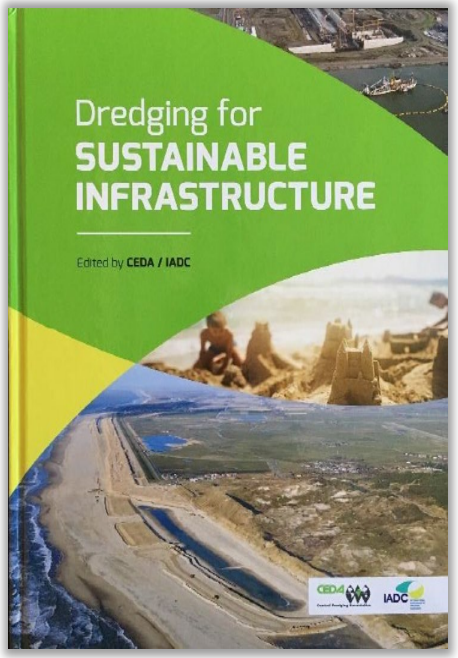
Central Dredging Association (CEDA)

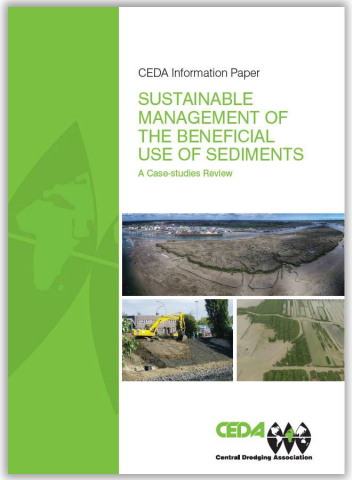
- Sustainable Management of the Beneficial Use of Sediments
- Assessing the Benefits of Using Contaminated Sediments
- BU Case Studies - https://dredging.org/resources/ceda-publications-online/beneficial-use-of-sediments-case-studies

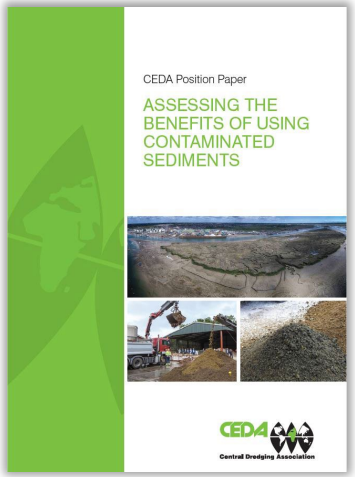
Dredging for Sustainable Infrastructure

- Considers and analyzes social, environmental and economic costs and benefits of a project for guiding development of sustainable infrastructure
- Commitments to process improvement and innovation to conserve resources, maximize efficiency, increase productivity, and extend useful lifespan of assets and infrastructure
- Comprehensive stakeholder engagement and partnering to enhance project value



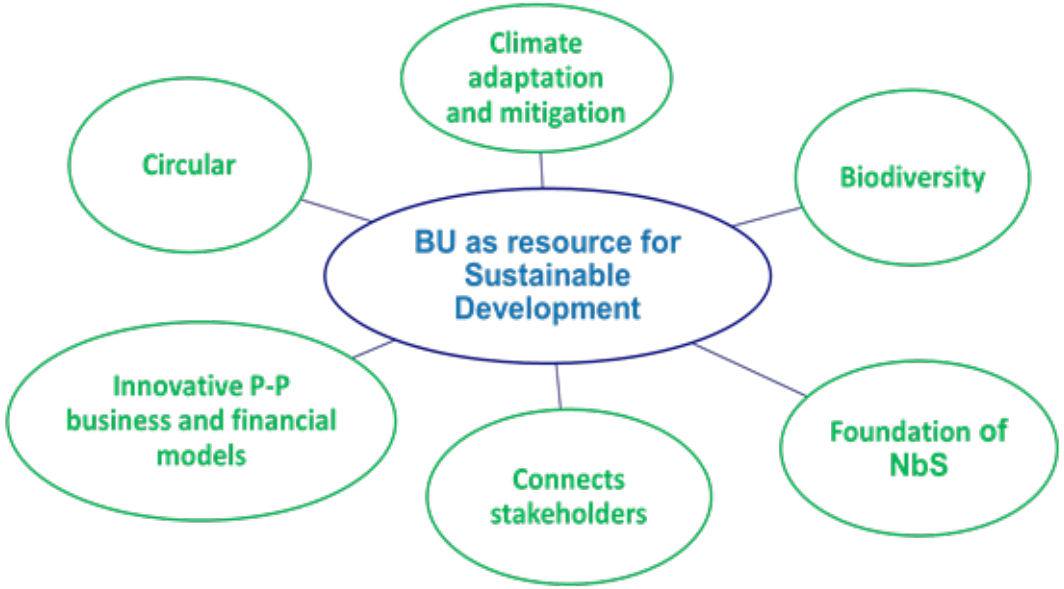


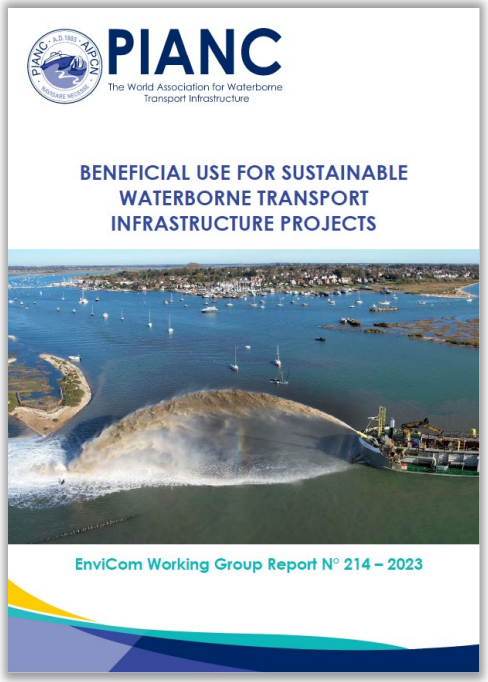




Beneficial Use and Sustainable Development

- Sustainability often is described through three pillars:
  - Environmental
  - Social
  - Economic
- BU linked to recognized features of sustainability, achievable through the three pillars, especially those related to natural resources





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

- Producing Efficiencies
- Using Natural Process
- Broadening Benefits
- Promoting Collaboration

www.engineeringwithnature.org

COLLABORATE

- Within USACE (EWN Proving Grounds, Cadre)
- With others (Multi-Sector Network for EWN)

RESEARCH

- Innovation in practice
- Tools for delivery
- Taking the “long view”
- Establishing future targets and conditions

IMPLEMENT

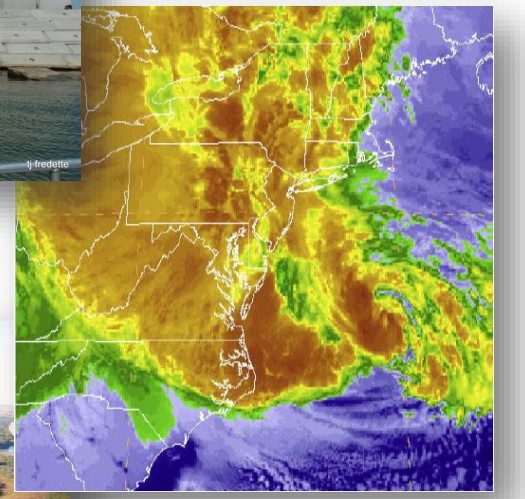
- Across the spectrum of applications/missions
- From design and planning, to O&M

COMMUNICATE

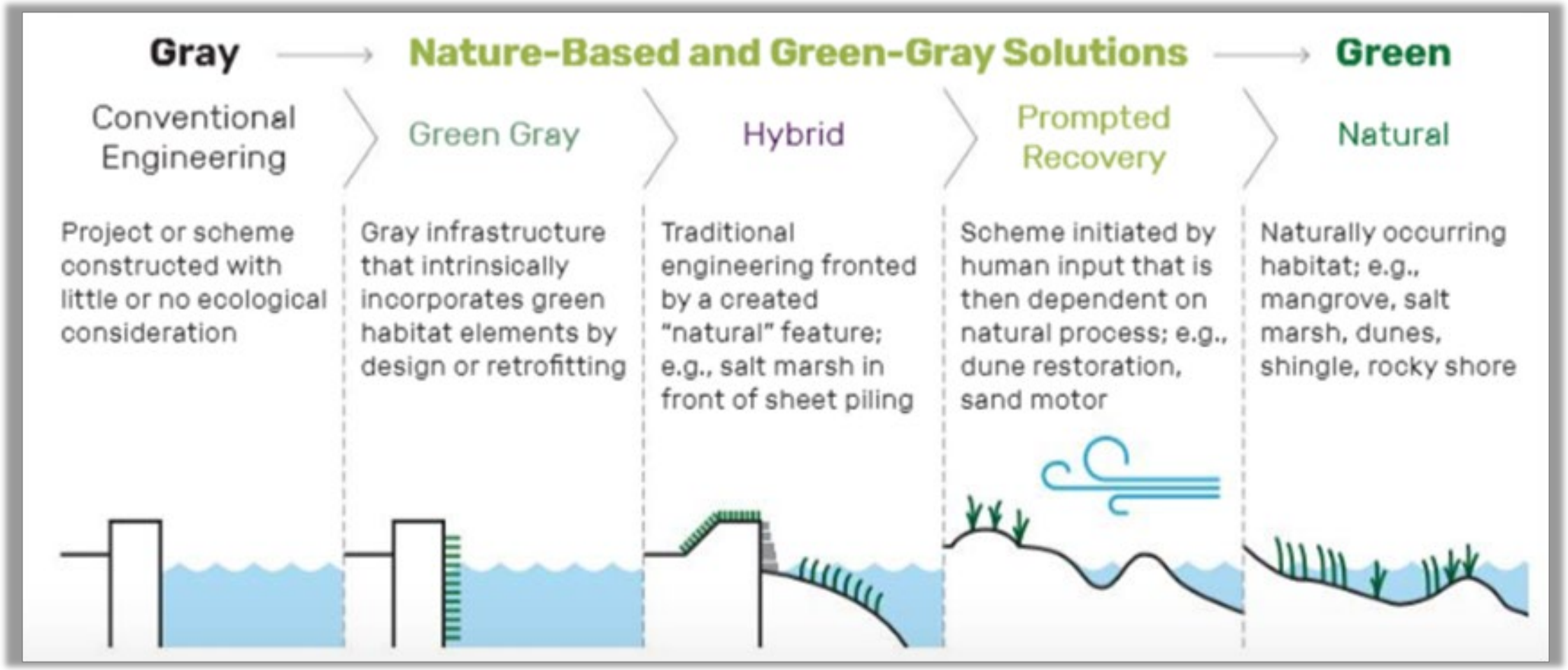
- Publications (tech notes, reports, journal articles)
- Highly visual, collaborative products
- Education, e.g., academic curricula, training

EWN® Across USACE Mission Space

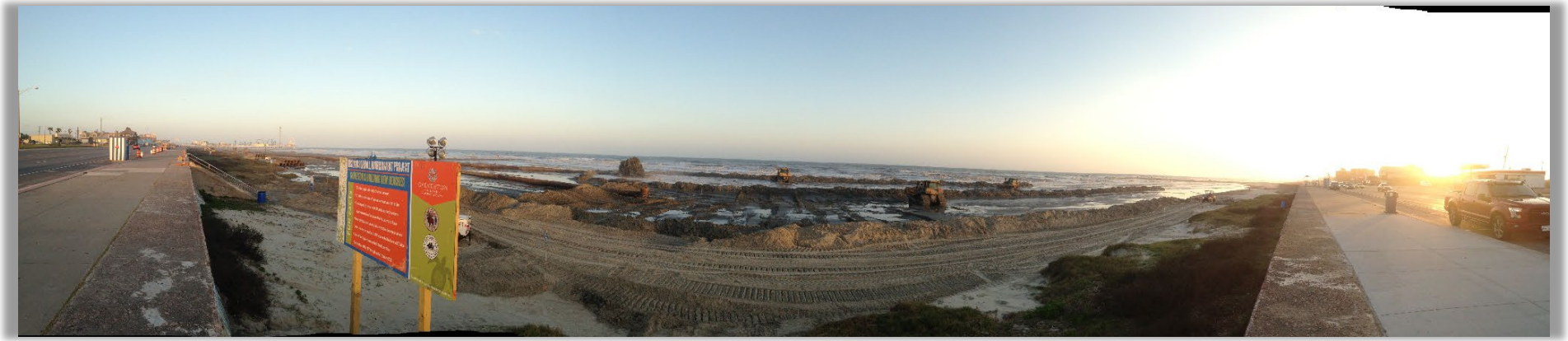
- **Navigation**
  - Strategic placement of dredged material supporting habitat development
  - Habitat integrated into structures
  - Enhanced Natural Recovery
- **Flood Risk Management**
  - Natural and Nature-Based Features to support FRM
  - Levee setbacks
- **Ecosystem Restoration**
  - Ecosystem services supporting engineering function
  - “Natural” development of designed features
- **Water Operations**
  - Shoreline stabilization using native plants
  - Environmental flows and connectivity



Spectrum of Nature-based Techniques

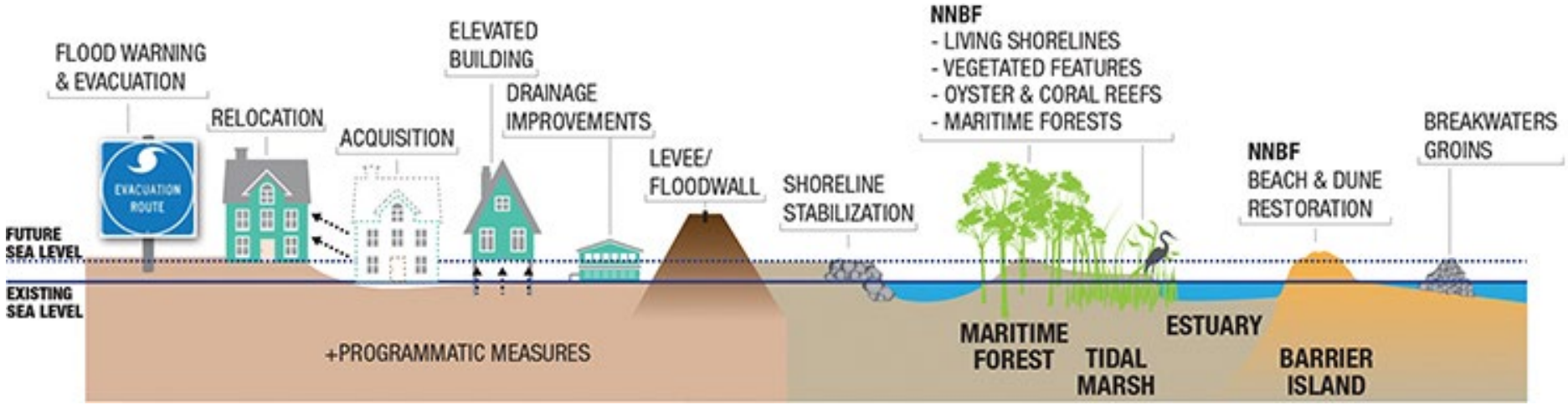


BU Opportunities to Engineer With Nature



Opportunities

- 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
- Generate full array of relevant economic, environmental, and social ecosystem services

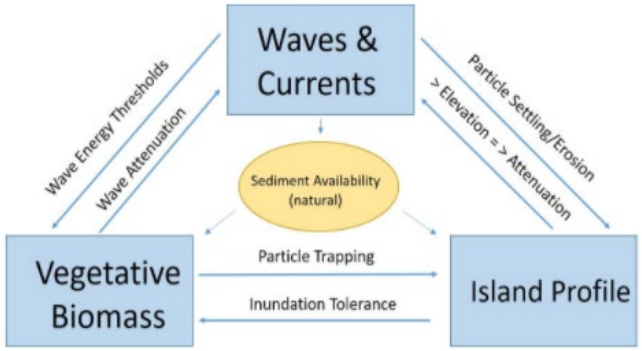


The Power of Partnership: SMIIL

Seven Mile Island Innovation Laboratory

- Collaboration and partnership that is building first-of-their-kind NBS projects in coastal New Jersey
  - Began in conversation
  - Accelerated by a storm (Sandy)
  - Progressed through piloting
  - Now in full-scale implementation

The Power of Partnership: Swan Island



https://coastalscience.noaa.gov/project/evaluating-efficacy-of-island-restoration-and-enhancement-for-coastal-protection/

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International Guidelines on Natural and Nature-Based Features for Flood Risk Management

Table of Contents

16 September 2021

NNBF Guidelines
- >1,000 pages, 5-year effort
- >70 multi-sector organizations
- >170 authors and contributors

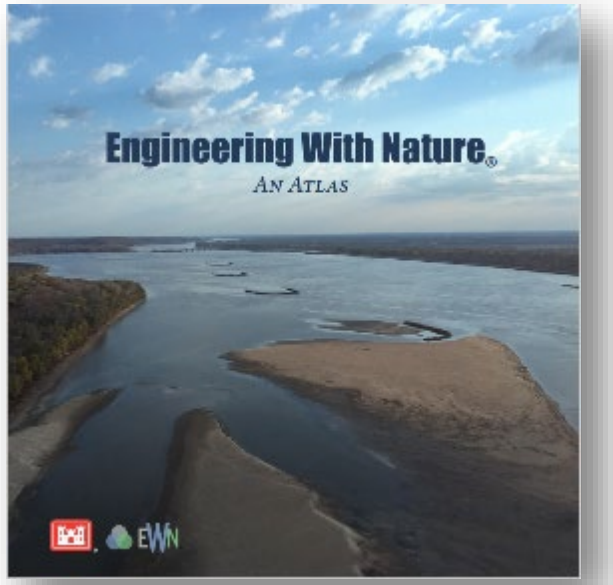
https://ewn.erdc.dren.mil/?page_id=4351

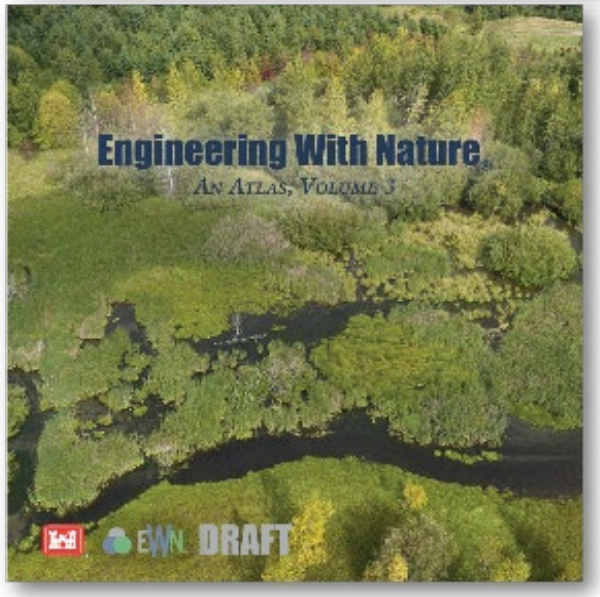
Engineering With Nature

The Atlas Series

EngineeringWithNature.org

- **Volume 1**
  - 56 Projects, 27 USACE
- **Volume 2**
  - 62 Projects, 23 USACE
- **Volume 3**
  - 58 Projects, 15 USACE





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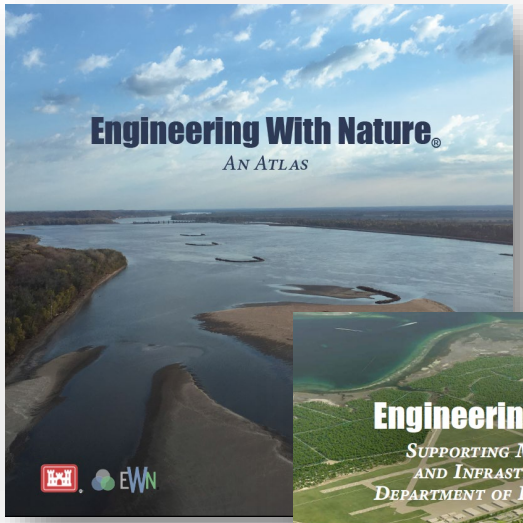
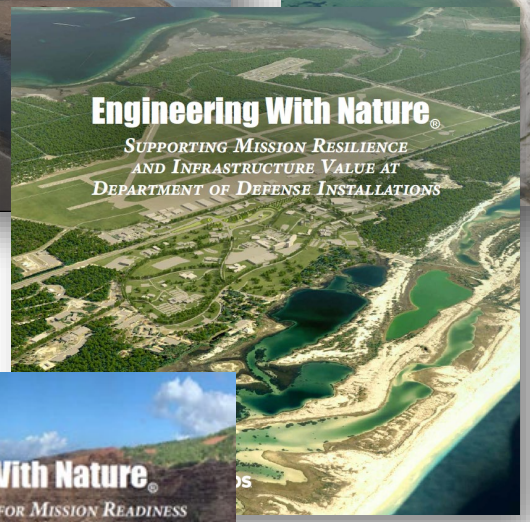
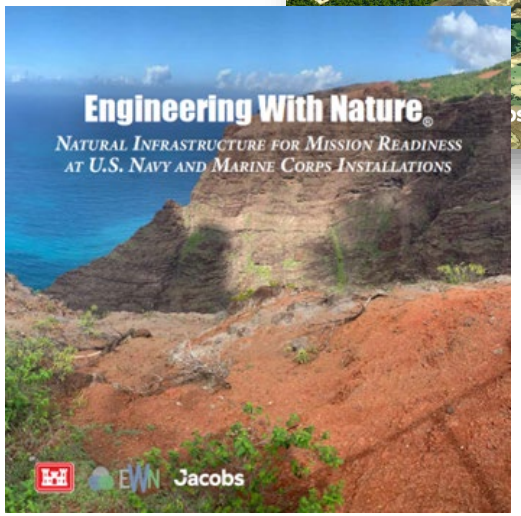
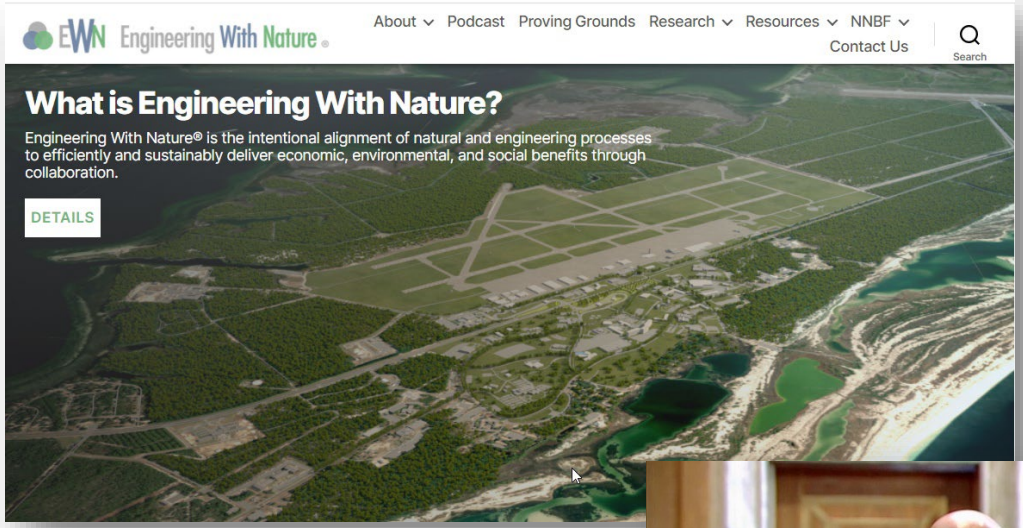
Communicating Nature-Based Solutions









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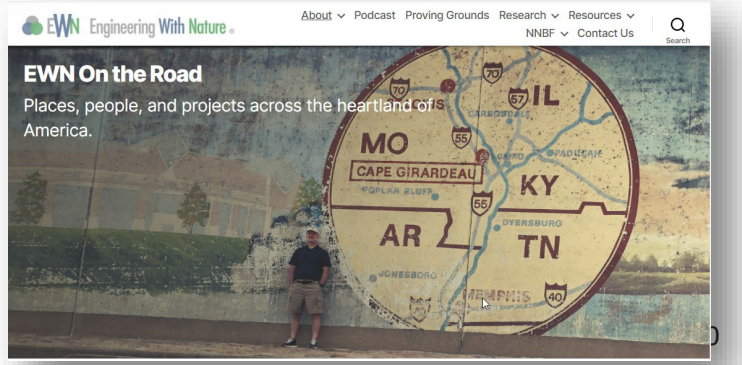

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Podcast Series

▶ Read Summary

S5 Trailer – The Engineering With Nature® Podcast
Realizing the Value of Nature Length: 18 minutes, Air Date: November 16, 2022 Season 5 of the Engineering With Nature® Podcast launches on November 30. Host Sarah Thorne recently talked about highlights from Season 4 and what's ahead for Season 5 with Todd Bridges, Senior Research
View Episode

S5 E1 – ERDC Labs Collaborating on Leading Edge 3D Printing Nature-Ba...
In the premier episode of Season 5 of the Engineering With Nature® Podcast, host Sarah Thorne, and Burton Suedel, Research Biologist at the Engineer Research and Development Center (ERDC), are talking with two ERDC colleagues – Alan Kennedy, who is in the Risk Branch of the Environmental
View Episode

S5 E2 – Nature-Based Solutions from the Halls of the Exec Office of the P...
What happens when a nation focuses on addressing the critical challenges posed by climate change by investing in nature? That's what we're talking about in Season 5, Episode 2, of the Engineering With Nature® Podcast.
View Episode

S5 E3 – What do You Want to Know about Nature? The National Nature A...
The first ever National Nature Assessment (NNA) is currently underway to better understand how nature is faring in the United States and what it means to all our lives. That's the focus of our discussion in Season 5, Episode 3, of the Engineering With Nature® Podcast.
View Episode

S5 E4 – Measuring What Matters
How do we measure what's most important to us? And how do we translate those values into decisions about infrastructure projects so that they can deliver a diverse set of economic, environmental, and social benefits? That's the focus of our discussion in this episode of the
View Episode

S5 E5 – Accelerating NBS Progress through N-EWN Multisectoral Collabo...
The Network for Engineering With Nature (N-EWN), which we introduced in Season 1, Episode 10, is a community of researchers, practitioners, and educators who are working together to advance the practice of Engineering With Nature (EWN). We're back in Season 5, Episode 5, to talk with N-EWN's
View Episode

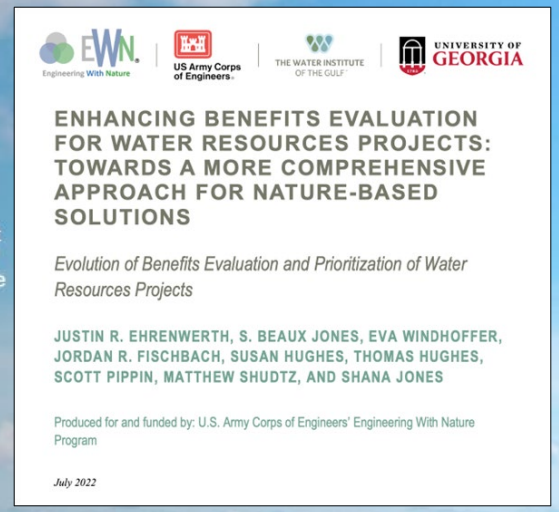
S5 E6 – A Conversation about EWN, Innovation, and Leadership with LTG ...
In this episode, Lieutenant General Scott Spellmon joins Todd Bridges, Senior Research Scientist for Environmental Science and National Lead for the Engineering With Nature (EWN) Program, and host, Sarah Thorne, as their special guest. Lt. Gen. Spellmon is the 55th Chief of Engineers and the
View Episode

S5 E7 – Celebrating the 30-Year USACE Career of Todd Bridges
This very special episode of the EWN Podcast features Todd Bridges, Founder and National Lead of the Engineering With Nature Program. We're celebrating his 30-year career and retirement from the US Army Corps of Engineers (on February 28, 2023), and discussing his visionary leadership of EWN
View Episode

S5 E4 – Measuring What Matters

How do we measure what's most important to us? And how do we translate those values into decisions about infrastructure projects so that they can deliver a diverse set of economic, environmental, and social benefits? That's the focus of our discussion in this episode of the Engineering With Nature® Podcast. Host Sarah Thorne

MORE



EWN®
THE ENGINEERING WITH NATURE® PODCAST

Season 8
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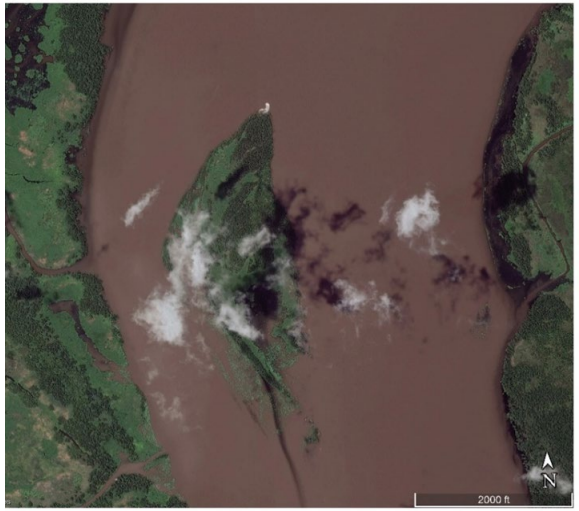
FeedSpot TOP NATURE PODCAST

EWN® Podcast

Examples of Sustainable Sediment Management Consistent with Engineering With Nature®

West Bay (P.M. Quigley)

Hamilton and Sears Point



Horseshoe Bend Island

Swan Island

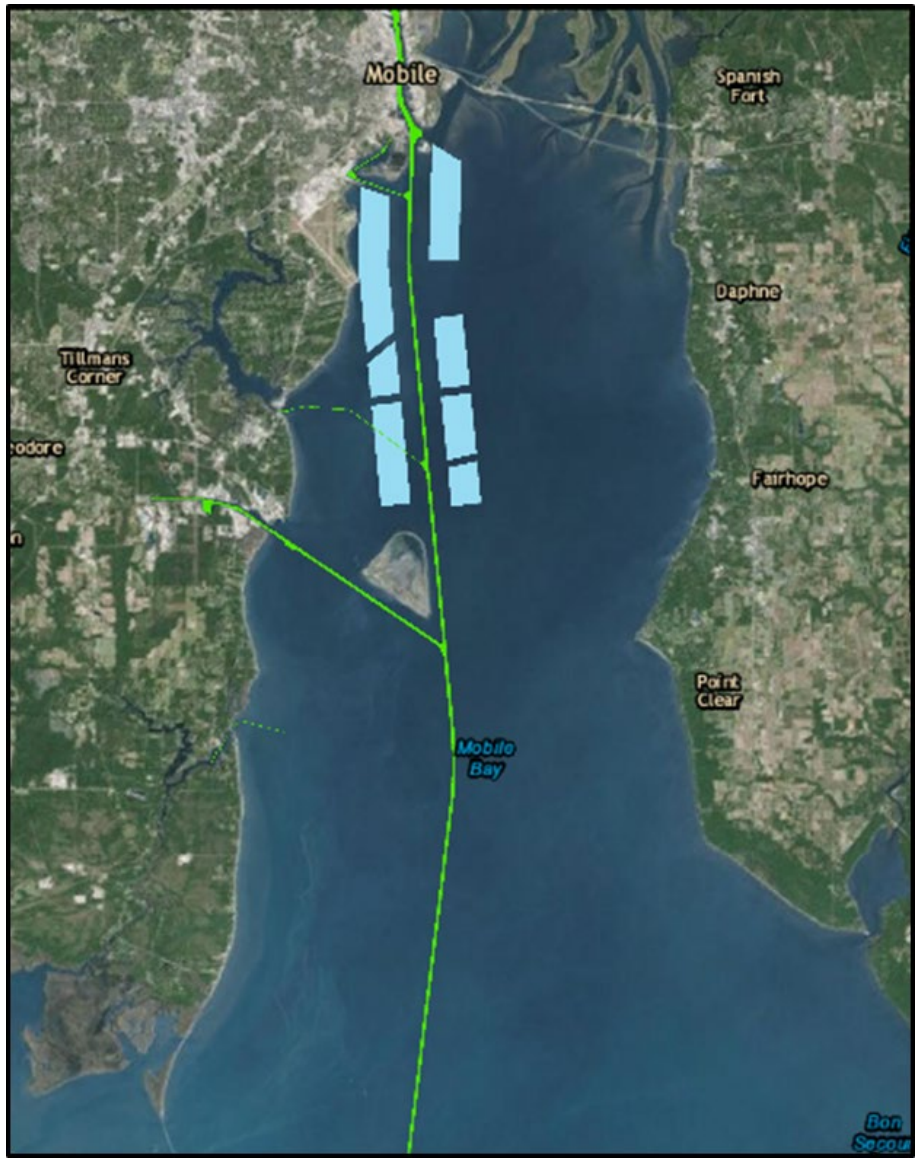
Cat Island, Green Bay, WI

- Habitat restoration project reconstructing three islands providing 272 acres of habitat
- Shorebirds, waterfowl, amphibians, turtles, invertebrates, and furbearing mammals
- 2.5-mile-long wave barrier
- Restore 1,225 acres shallow water and wetland habitat
- BU fine sands dredged from navigation channel
- 2.5 mcy capacity
- 20-30 years DM capacity

Photo: Port of Green Bay

Mobile Bay Thin Layer Placement

- 25 years ago, in-bay disposal of dredged material was banned
- Shoreline erosion and loss of habitat followed
- Thin-layer placement was demonstrated on full-scale to restore sediment processes
- Many opportunities for in-water beneficial use
- Ecosystem benefits being documented



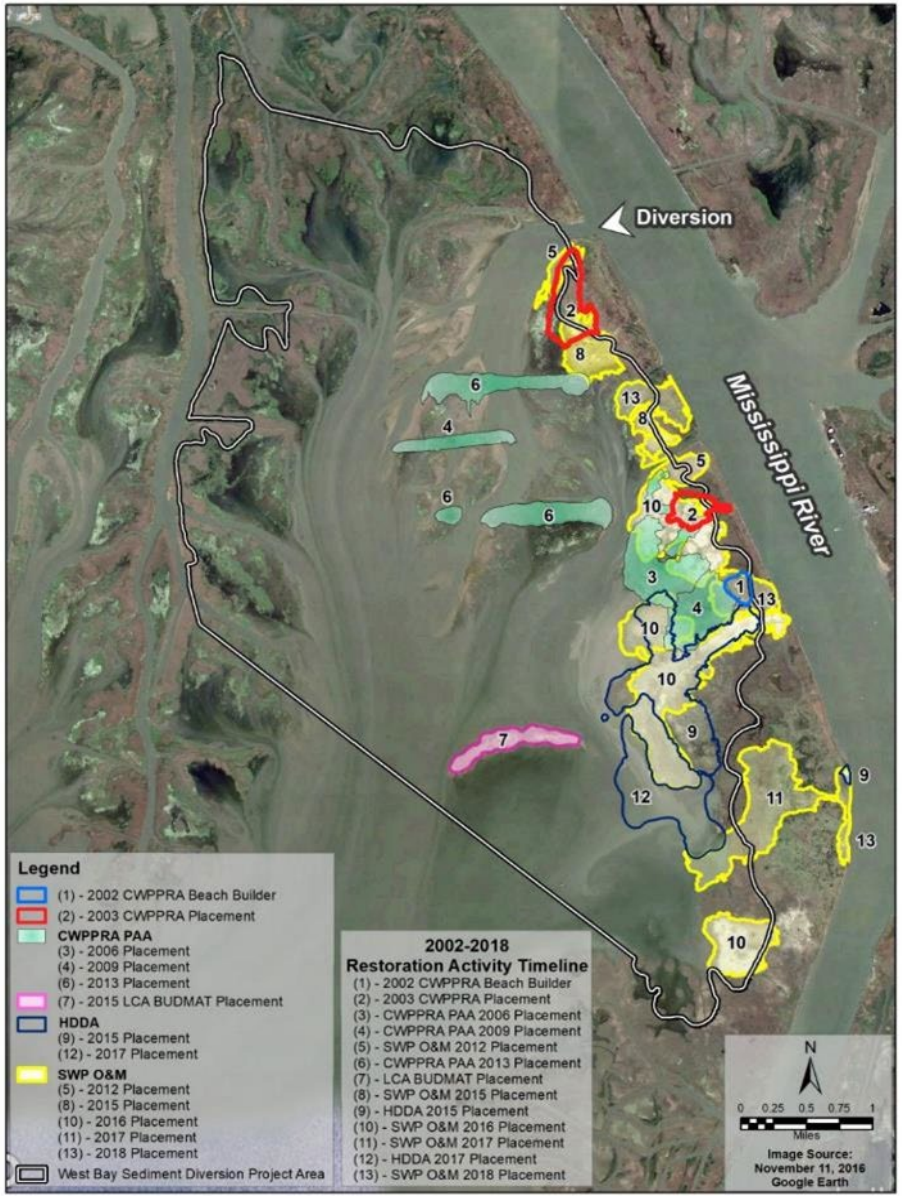
Middle Harbour Port of Oakland, USA

2018 PIANC *Working with Nature* Award Winner

West Bay, Louisiana

- 12,000-acre sub-delta at Head of Passes
- Lost >70% of land since the 1940's
- Stability of Federal navigation bankline was threatened
- Bank notched in 2003 to mimic natural crevasse
- First 5 years evidence of land building minimal
- Dynamic berms (SREDs): to increase sediment deposition
- Multiple direct and strategic placement events (see figure)
- Restored 2,300 acres of land since 2005

Year	SRED	Cubic Yards of Dredged Sediment	Land Created (Acres)
2009	1	386,233	35
2013	2	1,325,614	97
	3	1,308,435	86
	4	328,567	13
2015	5	2,299,295	80



Clinton River Mouth Wetland Restoration Project

EWN Atlas V2 Project

Challenges:

- Construction of CDF in 1960's destroyed large portion of wetland complex; had become phragmites monoculture

Opportunities:

- Improve quality and resiliency of coastal wetland for fish and wildlife species where extreme lake level fluctuations and ice scour occur
- Remove invasive species, plant native ones
- Install root-wad wave breaks and use dredged material to create emergent wetland habitat
- Promote real estate and commercial development interest
- Increase recreational activities
- Improve quality of life for local community
- Serve as recruiting tool for local businesses

Root wads for anchoring to the lake bottom as a wave break. (Photo by Keith Kropfreiter, USACE Detroit District)

Clinton River Mouth Wetland Restoration Project

- Short-term stabilization: Root wads as NNBF will degrade naturally, gives native wetland vegetation time to establish, providing long-term stabilization
- Long-term stabilization: Planting of native vegetation
- Site attracts coastal and wetland species such as yellow perch and northern pike
- Wetlands provide nursery habitat for juvenile fish and valuable resting habitat along Mississippi Flyway
- Project adjacent busiest boat launches in SE Michigan, improving local housing values and bringing in additional tourism revenue to the region

Earth anchors securing the root wads to the bottom. (Photo by Keith Kropfreiter, USACE Detroit District)

Placing dredged material from the navigation channel in the wetland. (Photo by Keith Kropfreiter, USACE Detroit District)

Deer Island Missouri River

EWN Atlas V2 Project

Challenges:

- Alterations & redirecting river's energy disconnected historical alluvial plain from natural fluvial processes
- Narrow, deep, and fast-flowing river resulted with very little depth or flow diversity; natural bankline habitats disappeared

Opportunities:

- USACE NWK, MVP, NWO created high-quality, shallow-water unconfined habitat by excavating over 1.5 mcm of DM from 3.2 km river stretch
- Widened navigation channel, creating a shallow bench with diversity of depths and velocities
- Main channel supports navigation; side channel supports habitat for wildlife
- Utilized extensively by least tern + pallid sturgeon, shovelnose sturgeon, sauger, flathead catfish, mammals, reptiles, amphibians
- Provides easy access for recreation

Preconstruction view of Deer Island in 2012. (Photo by Dave Crane, USACE Omaha District)

Center of the project site during construction. (Photo by Dave Crane, USACE Omaha District)

Woodland Islands, Lower Columbia River

Challenges:

- Loss of hydrologic and geomorphic processes
- String of islands degrading (erosion)
- Loss of wetland and other habitats, especially for anadromous fish

Opportunities:

- Sediment BU from adjacent navigation channel during routine maintenance
- Develop semi-stable landforms above and below water
- Intertidal shallow water low velocity and wetland habitats (willow plantings)
- Natural processes are shaping the created habitat supporting multiple species

Woodland Island downstream feature constructed in fall 2020 from 200,000 cy dredged sediment and subsequent grading for restoring riverine habitats (Columbia River Estuary Study Taskforce).

USACE Philadelphia District: EWN in New Jersey Back Bays

Mordecai Island

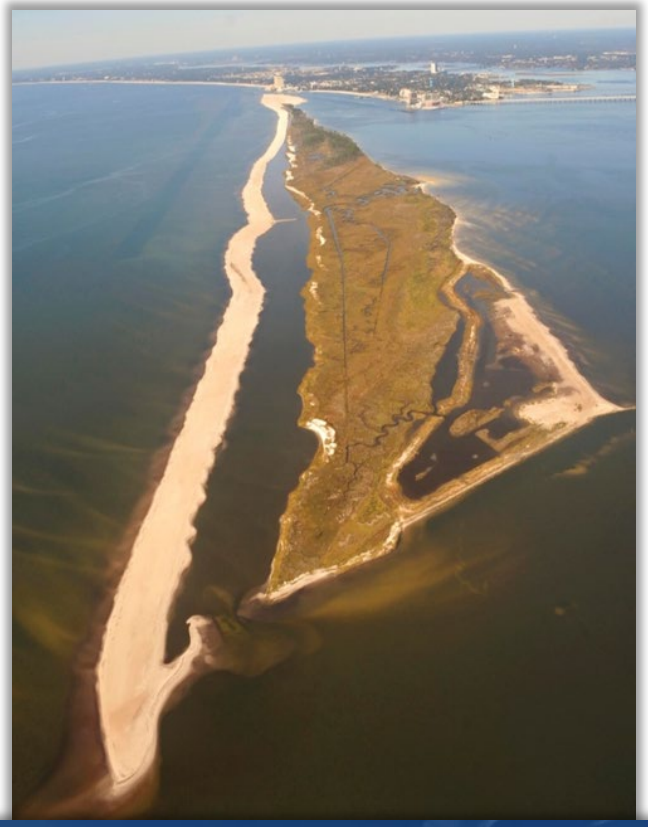
Stone Harbor

Avalon

Black Skimmer (*Rynchops niger*)

Deer Island, Biloxi, MS

- Biloxi Harbor Navigation Project - 12-ft deep navigation channel
- BU of dredged material to restore marsh, create terrestrial and aquatic habitat, provide a more resilient shoreline for future storm events, create long term disposal capacity
- Hurricanes over time destroyed forests, significantly eroded shoreline, and left elevations too low to support marsh vegetation
- Filled breach in west end of the island
- 1.95 mcy DM to restore southern shoreline using 2.5-mile-long wave barrier
- Strategic vegetation plantings (625,000+ plants)
- Construction of a 1 mcy lagoon for BU dredged material from navigation channels
- Providing significant environmental, coastal storm, and recreational benefits



Fort Pierce Island, Florida

- Marina severely damaged during Hurricane Frances in 2004
- Living breakwater system
- 100-yr storm protection
- 150,000 cy beneficial use
- Ecological benefits:
  - 20 acres habitat features
  - Mangrove plantings
  - Tidal lagoon
  - Oyster reefs
  - Shorebird nesting
  - Seagrasses
- Increase in Revenue
  - Marina Capacity
  - Eco-tourism – fishing, birding

Bonanza Bar Island, Ohio River

EWN+BU

- For 20+ years (since 2000), dredged sediment has been mounded and the energy from the Ohio River is used to shape the bar
  - Placement location informed by historical navigation charts indicating bar location >50 years past
  - Both hydraulic and mechanical dredging methods
  - Allowed for more efficient dredge placement
  - Reduced timing, frequency, and cost of dredging in the adjacent navigation channel
  - Providing valuable ecological habitat (esp. native mussels & back channel) and recreational opportunities

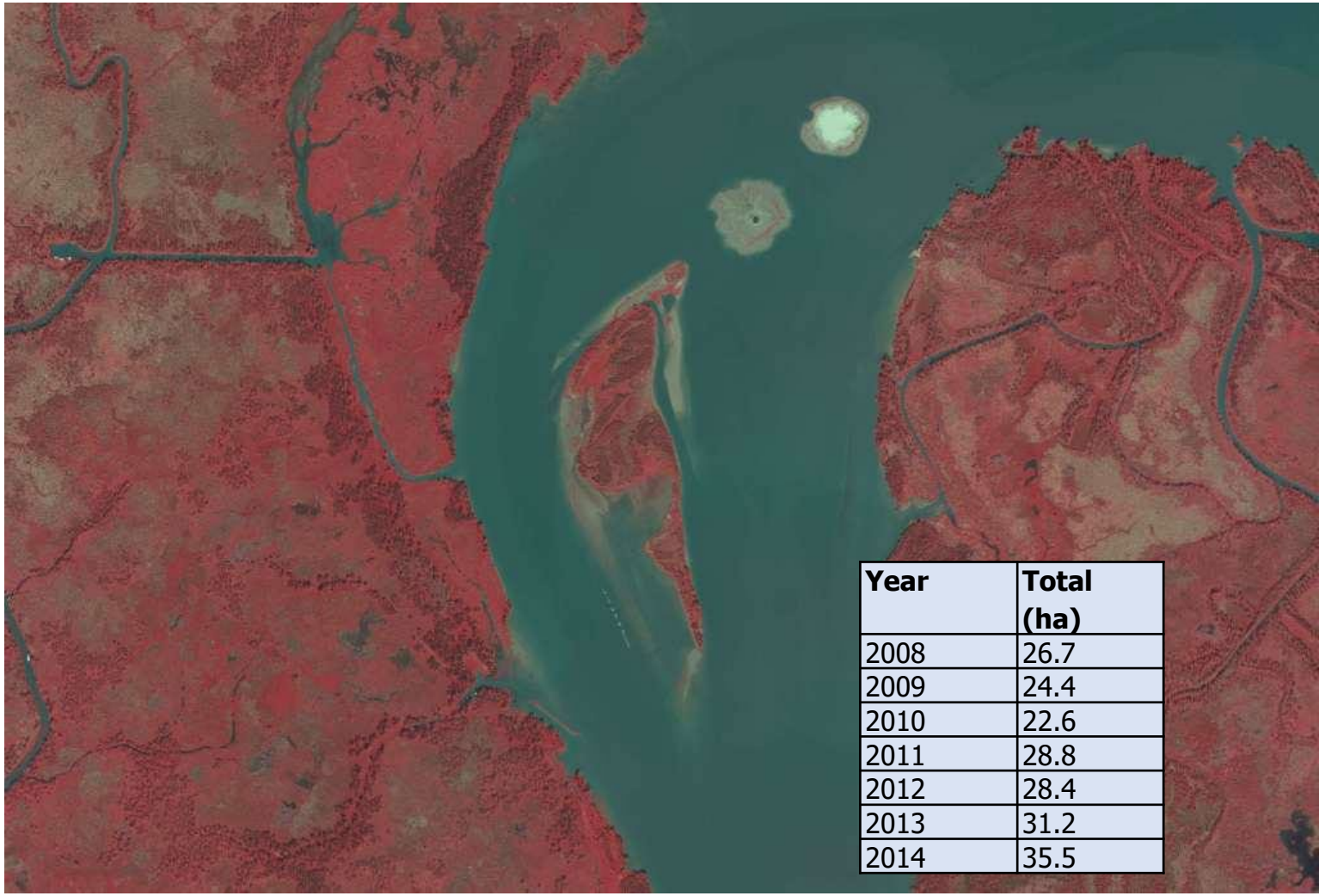
Horseshoe Bend Island

Challenge:

- Capacity of Bankline
- Disposal Areas Exhausted

Preferred Alternative:

- Mid-River Mounding of
- Dredged Material
- ~~Conversion of Wetland Disposal Areas into Upland~~
- ~~Open Water Disposal in Atchafalaya Bay~~



Year	Total (ha)
2008	26.7
2009	24.4
2010	22.6
2011	28.8
2012	28.4
2013	31.2
2014	35.5

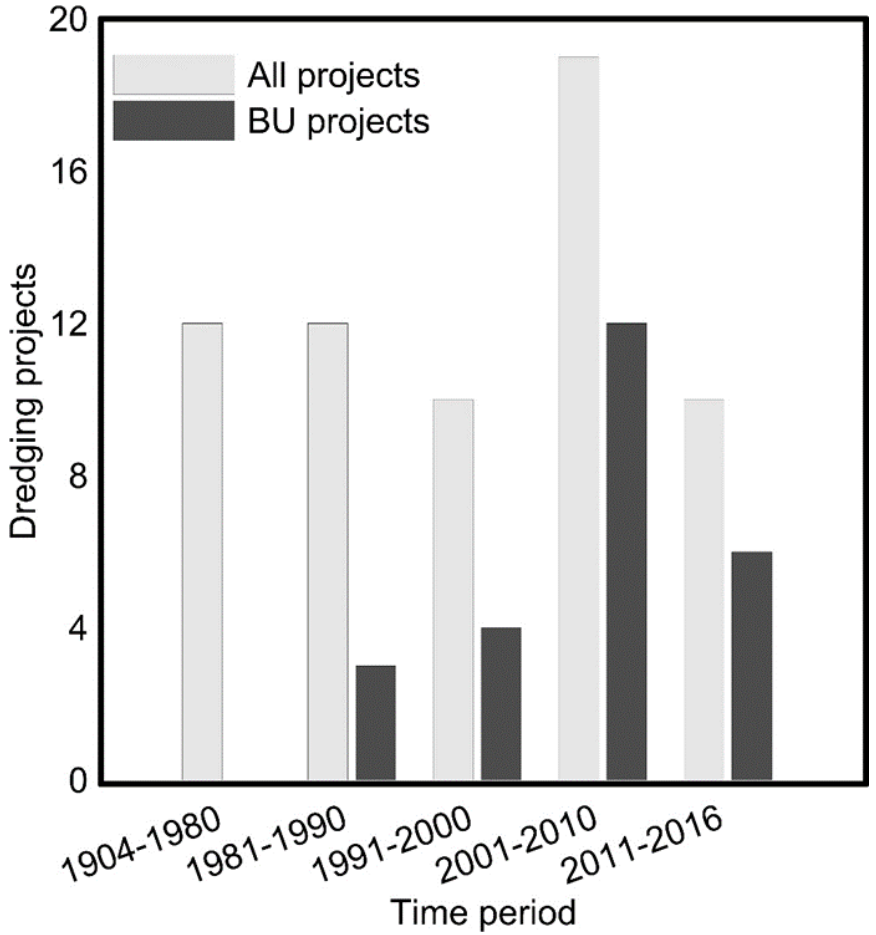
Creating Present and Future Value

- Island formation reduced dredging requirements
- Natural channel formed east of the island due to self-scouring
- US Coast Guard realigned channel
  - channel length reduced
  - sharp bends eliminated, improving navigation safety
- Reduction in long-term dredging requirements
- Resultant carbon savings and reduced air pollution

Satellite imagery showing the evolution of Horseshoe Bend island from December 2013 (left) to January 2024 (right). The small light-colored land features immediately upstream of the island in both images are remnants of recently placed dredged material. The river continues to shape the island through natural processes.

Beneficial Use Projects: >40 years of Functional Trade-offs

- Historic process → dredged "spoil" considered waste
- Increase in beneficial use or dredged materials over time
- Early assessments or habitat improvement (1970s)
- Long term trajectory of restored features remains unknown
- Revisited six historic wetland BU restoration sites after >40 yrs to evaluate project outcomes



Berkowitz and Szimanski (2020)

Beneficial Use Projects: >40 years of Functional trade-offs

- Projects constructed using dredged materials (1974 to 1978)
- Represent some of the oldest wetland restoration sites in the US for which data are available
- Recreated the previous study at 6 locations to evaluate conditions after >40 years

There was no Google Earth in 1978!

Beneficial Use Projects: >40 years of Functional trade-offs

Conclusions:

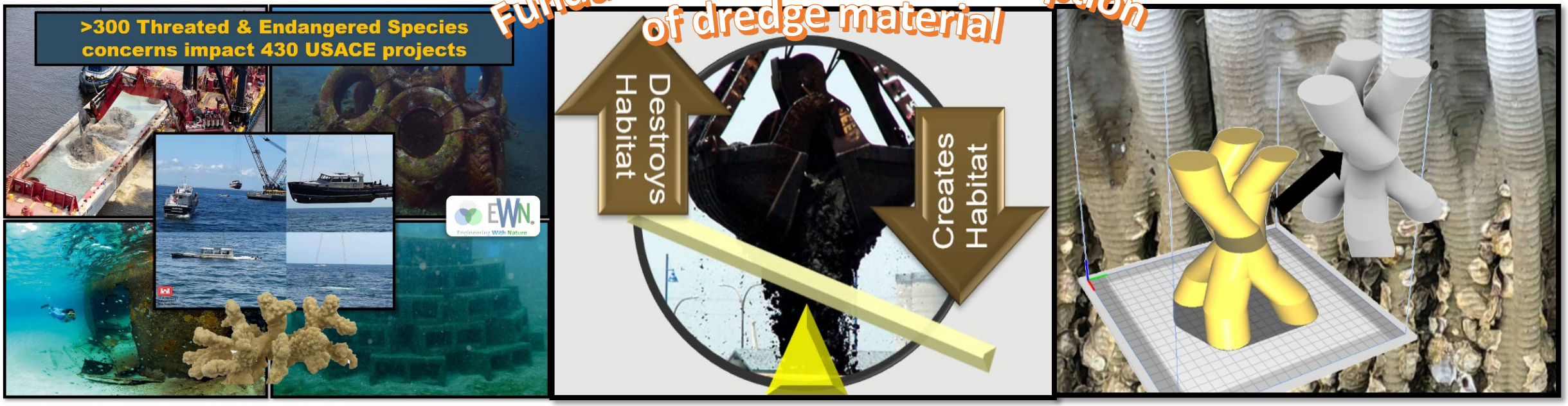
- The created wetlands persisted >40 years, without “hard” infrastructure
- Constructed wetlands continue to improve, but have not (and may not) reach reference conditions
- Despite this, the projects provide valuable functions although the magnitude of some functions differ from reference conditions

Recommendations:

- We *should* use natural processes to create sustainable wetlands
- We *should* focus on maximizing the available wetland functions
- We *should not* focus on mimicking natural conditions to determine success/failure

3DP natural materials

- Establish & foster collaborative partnerships through EWN principles to exposure **technology roadmap for AM for Nature-inspired Infrastructure**, habitat restoration, and coastal resilience, leveraging **beneficial use of dredged material** and sediments as feedstock



Fundamentally **change perception** of dredged material

Sediment Beneficial Use: The Way Forward

Pursue Multiple Opportunities

- Sediment as a resource
- Increasingly limited volumes remaining in CDFs
- Cost of dredging and disposal
- Both short- and long-term value
- Sustainability / circular economy / public interest
- Public / stakeholder engagement and education
- Brownfields applications using stabilized sediment
- Sea level rise and coastal resilience
- Biodiversity enhancement

Placing dredged material from the navigation channel in the wetland. (Photo USACE Detroit District)

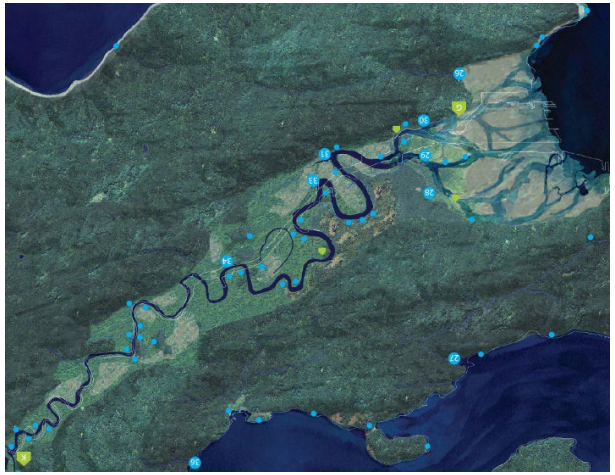
Take Home Message and Path Forward

- Many opportunities to apply EWN principles through beneficial use
- Keeping sediment in the system is a sustainable nature-based solution
- Focus energy to motivate and facilitate innovation in both technical and business processes
- Accelerate progress through co-development of solutions
- Promote beneficial use by documenting and demonstrating how past projects were implemented and successfully stood test of time
- USACE ERDC R&D funding: DOER, DOTS, RSM, EWN may provide opportunities

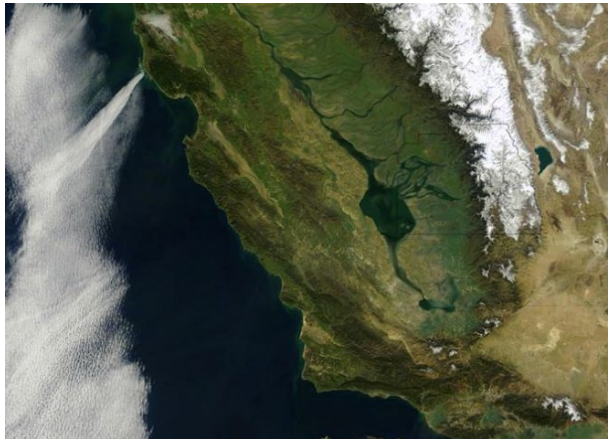
Swan Island Pre-placement (top)
and Post-placement (bottom)

The Nature Spectrum

"Wild and Free-Flowing Nature" — *"Tamed and Conquered Nature"*



Duwamish River, WA 1800s



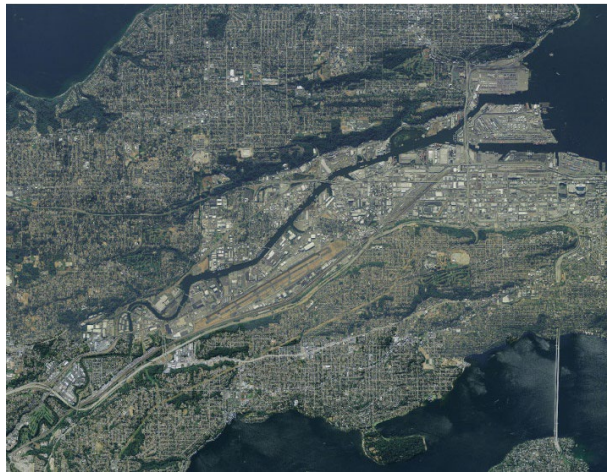
San Joaquin Valley, CA 1800s

"Not either / or, but <u>and</u>"

(Structural vs. Natural)

Achieving Nature-Engineering Balance

- Vision for sustainable systems
- Community needs and values
- Collaboration across boundaries
- Communication with others
- Innovation in engineering
- Enabling policy



Duwamish River, WA today

San Joaquin Valley, CA today

Questions?

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