

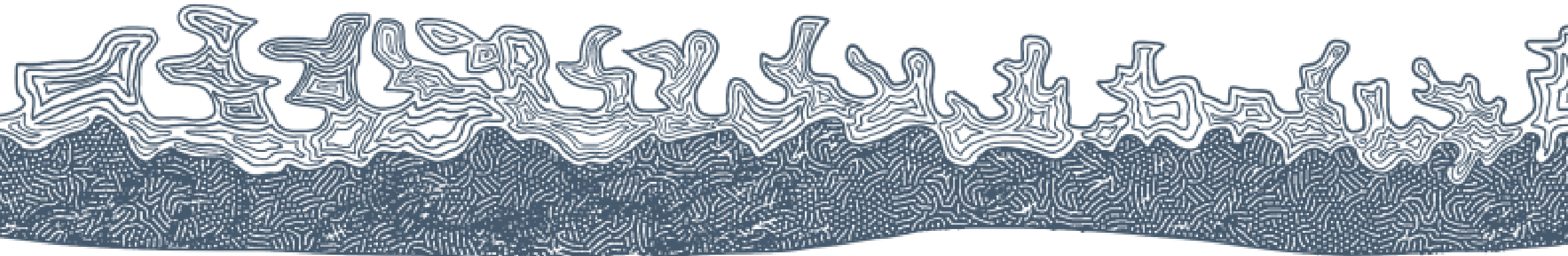


UNIVERSITY OF  
**GEORGIA**

*Institute for Resilient  
Infrastructure Systems*

# *Sediment Management for the 21<sup>st</sup> Century: The Planet and People Need a Better Way*

Dr. Todd S. Bridges  
College of Engineering  
University of Georgia

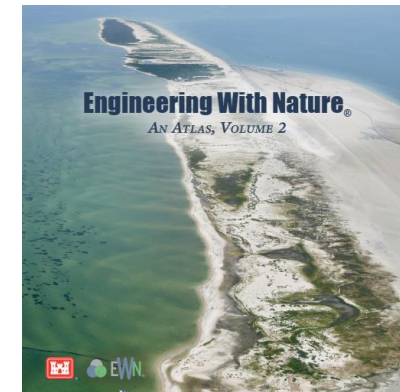
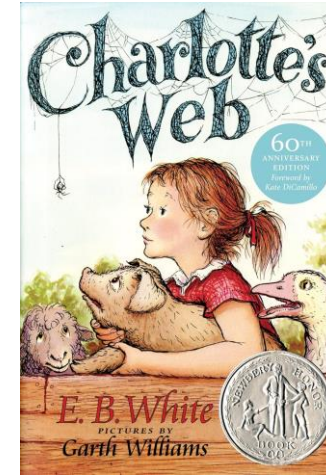


# To begin...

“I would feel more optimistic about a bright future for man if he spent less time proving that he can outwit Nature and more time tasting her sweetness and respecting her seniority.” –E.B. White

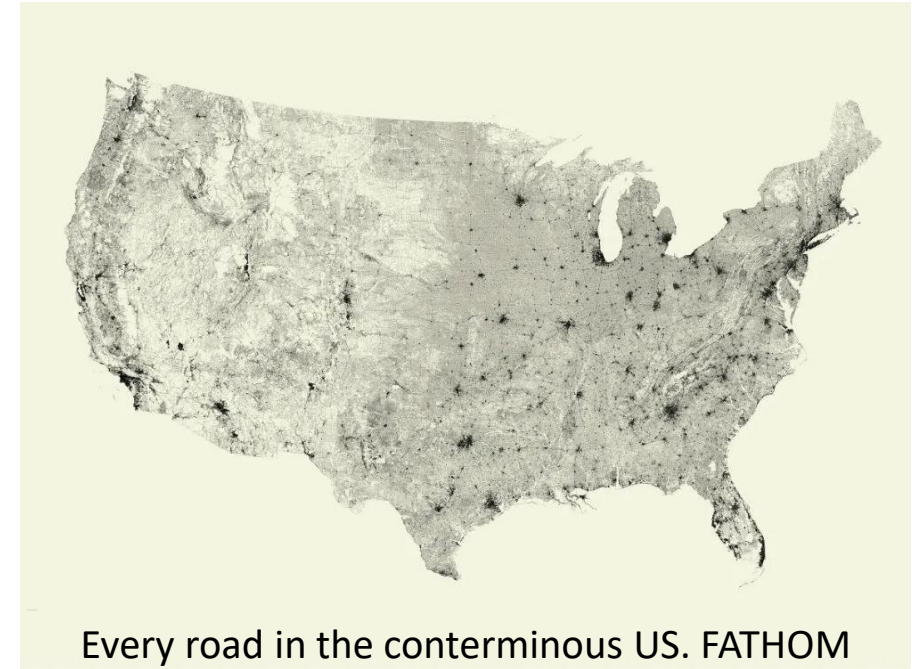
“The thing the ecologically illiterate don't realize about an ecosystem is that it's a system. A system! A system maintains a certain fluid stability that can be destroyed by a misstep in just one niche. A system has order, a flowing from point to point. If something dams the flow, order collapses. The untrained miss the collapse until too late. That's why the highest function of ecology is the understanding of consequences.” — Frank Herbert

“Living in harmony with Nature is about going with the flow.” –TSB



# *The Costs of Disrupted Flow*

- >4 million miles of roadway in US
- >1 million vertebrate animals are killed on US roadways every day
  - ~200 human deaths, 26,000 injuries, and >\$8 billion in property damage and other costs annually in US
- >200 trillion insects are killed on roads annually worldwide



# Old Practices: Shaping Flows, Landscapes, and Ecosystems

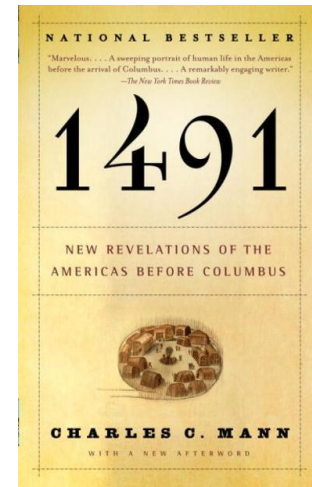
*“Such a fire is a splendid sight when one sails on the [Hudson and Mohawk] rivers at night while the forest is ablaze on both banks.”*

Adriaen van der Donck (Dutch settler in the Hudson Valley, 1641)

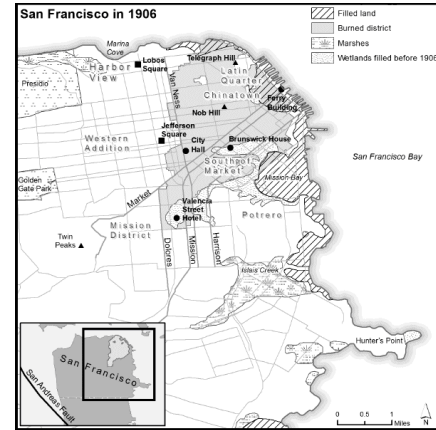
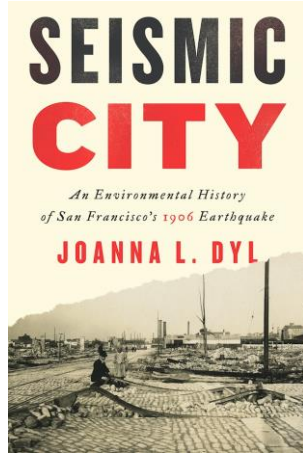
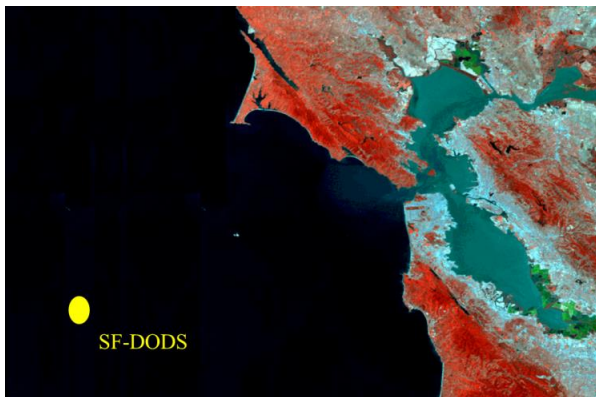
*“Indian fire had its greatest impact in the middle of the continent, which Native Americans transformed into a prodigious game farm.”*

*“Carrying their flints and torches, Native Americans were living in balance with Nature—but they had their thumbs on the scale.”*

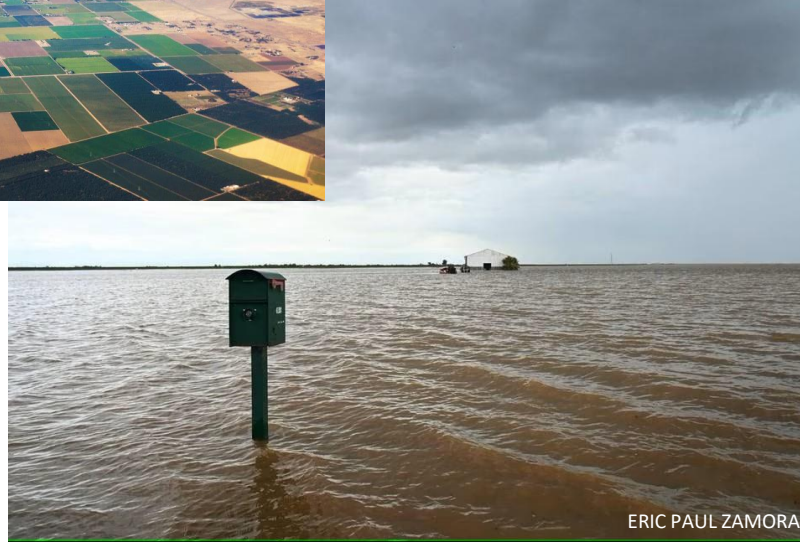
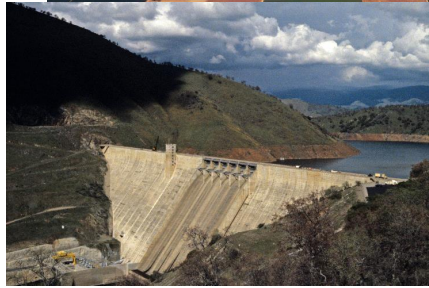
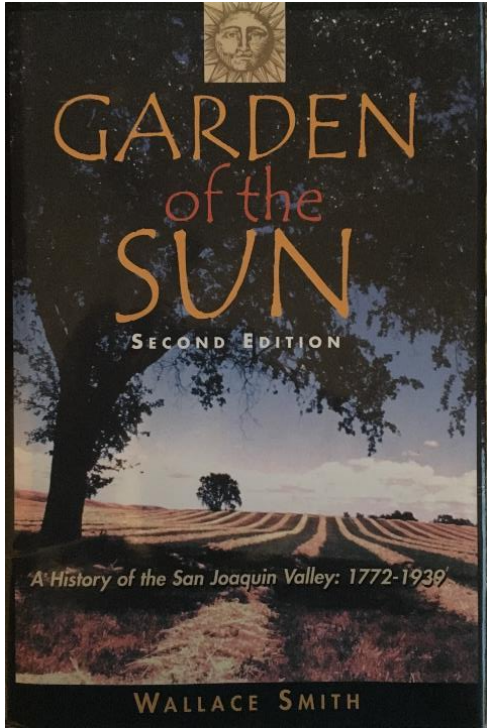
Charles C. Mann



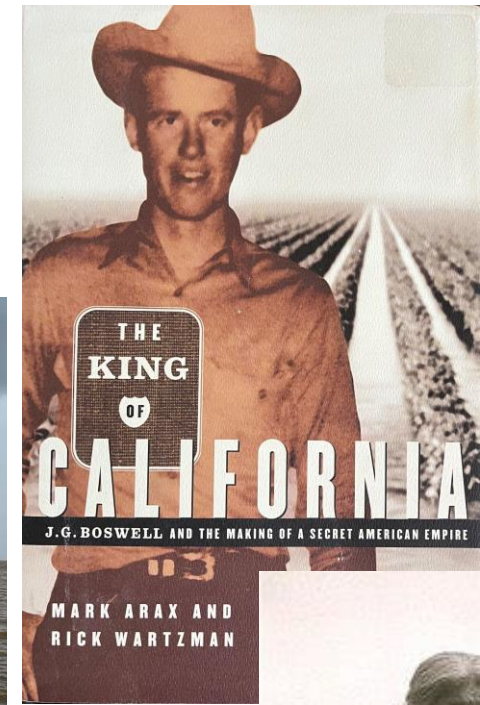
# San Francisco Bay



# The San Joaquin Valley and Tulare Lake Basin



ERIC PAUL ZAMORA



Yoimut (c. 1856-1937)

“You ask me, ‘Will Tulare Lake ever fill up again?’ I got only one thing to say. Yes. It will fill up, and everybody living down there will have to go away. I’d like to see that time for myself. I am the last full-blood Chunut left.”



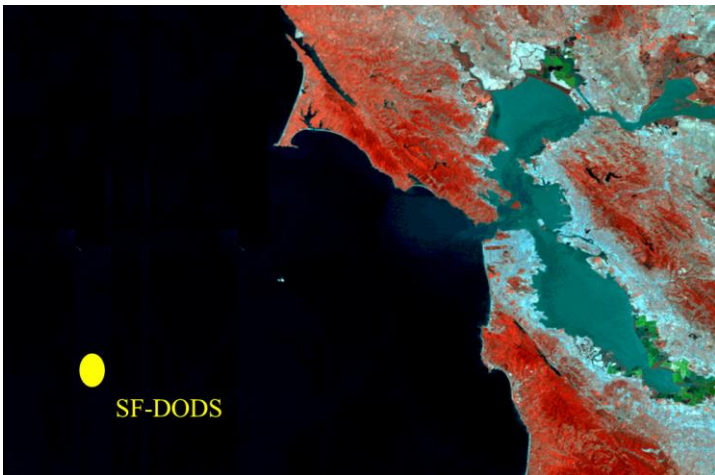
CRAIG KOHLRUSS



California “Satellite” Image, ca. 1851 by Mark Clark

<https://amp-fresnobee-com.cdn.ampproject.org/c/s/amp.fresnobee.com/news/weather-news/article273465780.html>

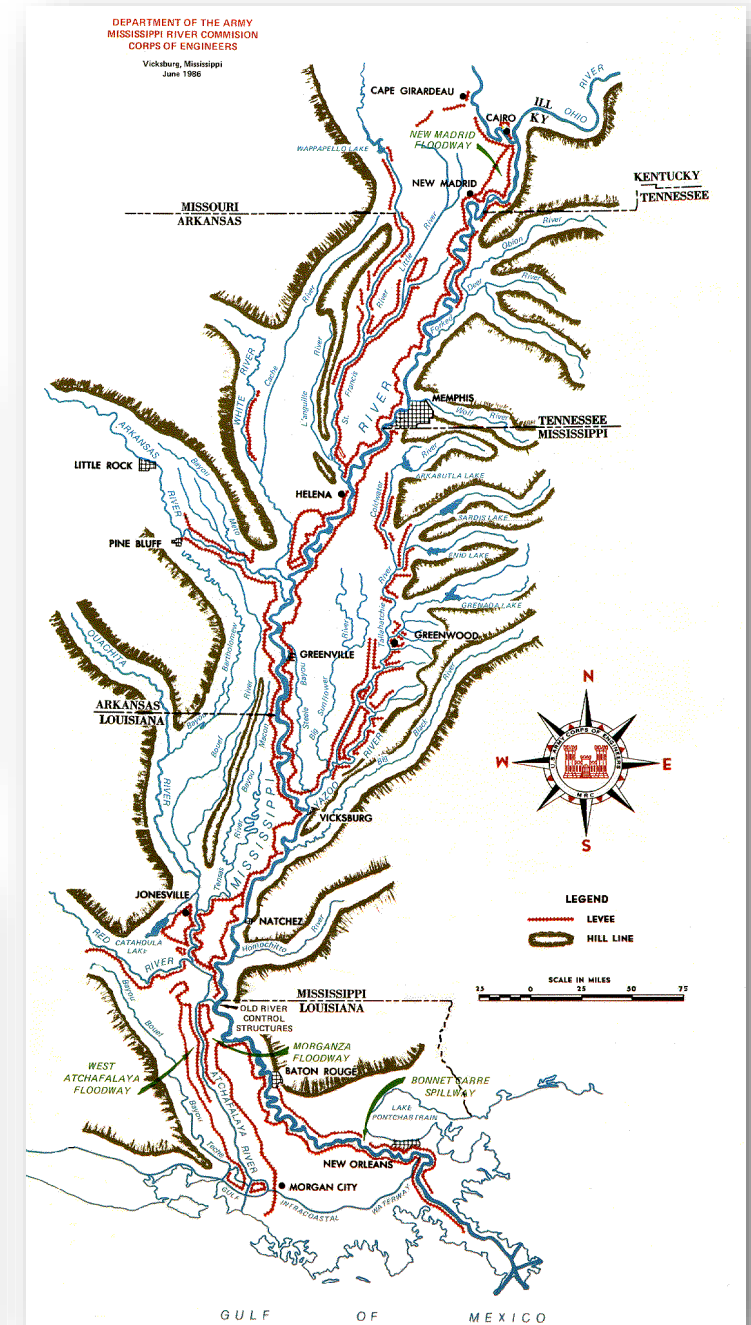
# The Story of US Wetlands



**Wetland Acreage in Conterminous US**  
ca. 220,000,000 acres in 1700s  
ca. 110,000,000 acres today

# MISSISSIPPI RIVER & TRIBUTARIES PROJECT

- >3,700 miles of levee system (embankments and floodwalls)
- 1,000 miles of articulated concrete mattress revetment
- Floodways:
  - Birds Point - New Madrid (Cairo, IL)
  - Morganza
  - West Atchafalaya
  - Atchafalaya Basin
  - Bonnet Carré
- 4 Back Water Areas (St Francis, White, Yazoo, Red Rivers)
- Old River Control Complex

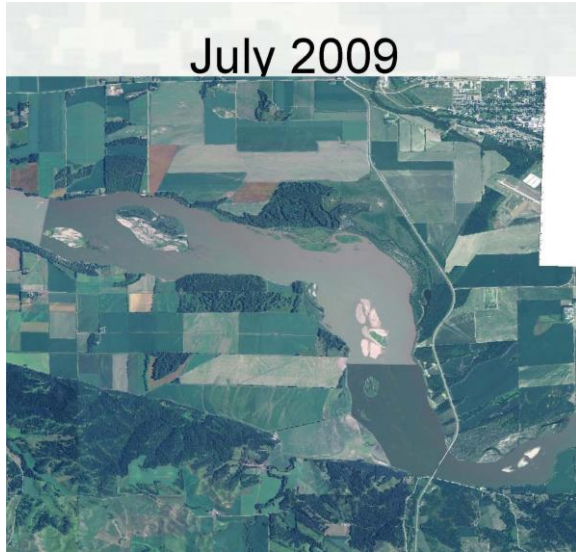




# But High Flows Also Create...

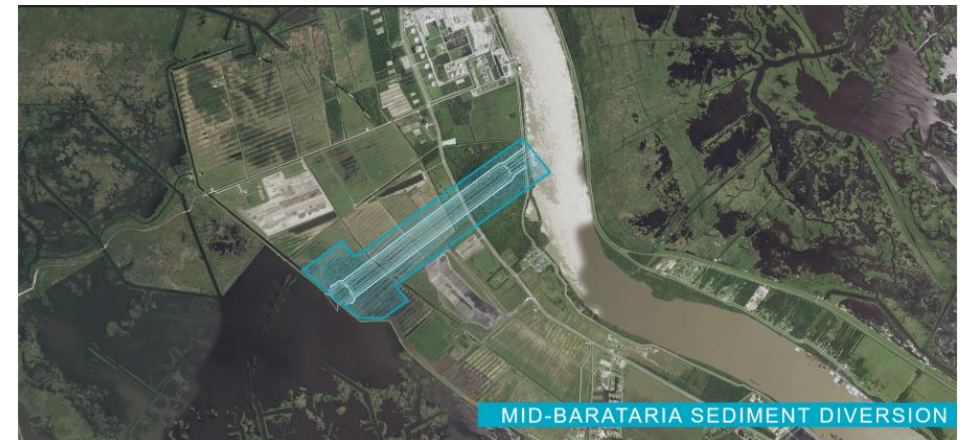
## Upper Missouri River Sandbar Habitat

- \$25 million to construct 650 acres of sandbar
- 16,000 acres created by the flood of 2011

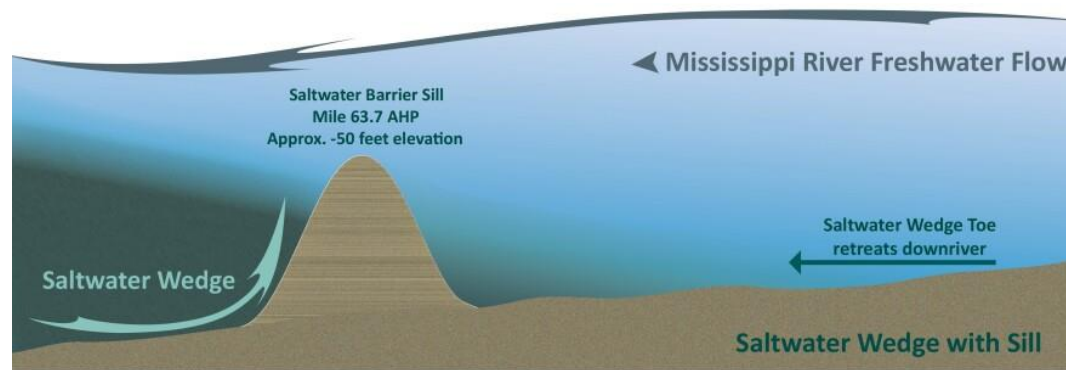
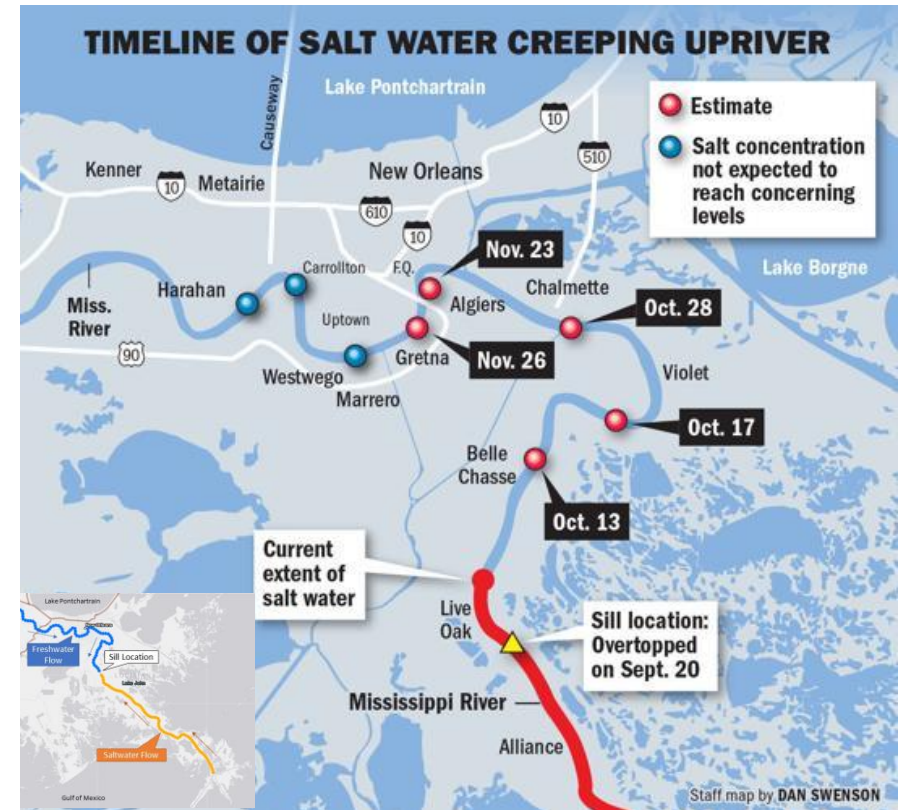


Courtesy: G. Pavelka  
USACE, 2012

## Mississippi River Delta



# MS River Saltwater Intrusion: Hazard x Climate Change x Engineering Legacy



# “Overshot” Engineering

*The Netherlands-*

**“We are world champions in making land dry. Now we are trying to turn that system around, because we overshot.”**

Peter van Dijk, Dutch blueberry grower

**“There is nothing natural about the Netherlands.”**

Dr. Gertjan Zwolsman, policy advisor at Dunea

*They’re ‘World Champions’ on Banishing Water. Now, the Dutch Need to Keep It.*  
Raymond Zhong, NYT Oct 10, 2022



Rhine River at Lobith, the Netherlands, in Aug 2022, when the river’s discharge hit a record low.



Lake Oroville; July 2021



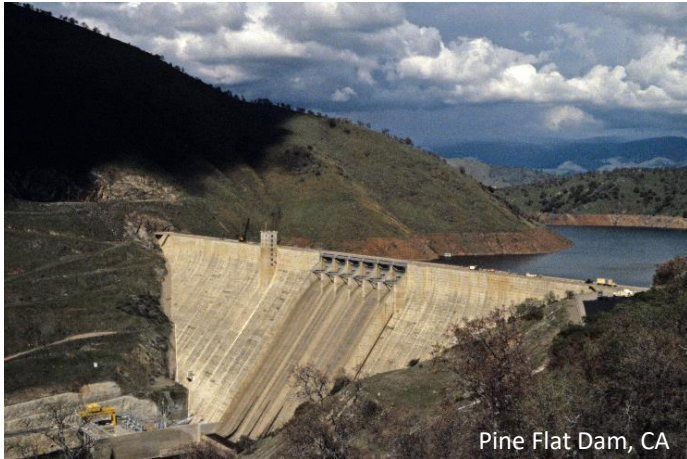
1,600 barges stalled along the MS River near Lake Providence, LA due to lower water; Oct 2022



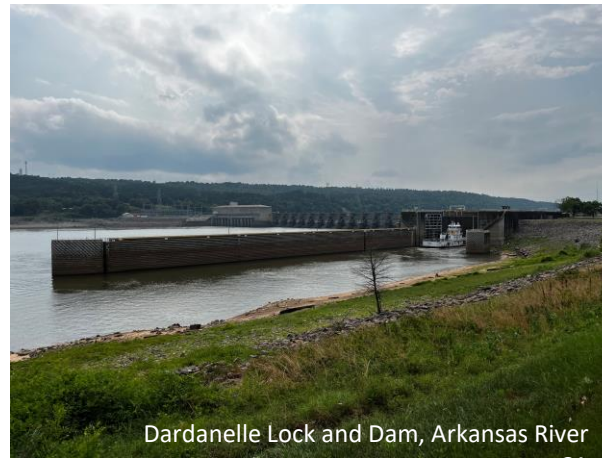
PHOTOGRAPH BY VIT CERNY, ANADOLU AGENCY/GETTY IMAGES

Hunger Stone; Elbe River, Czech Republic; summer 2022  
"Wenn du mich siehst, dann weine" ("If you see me, weep").

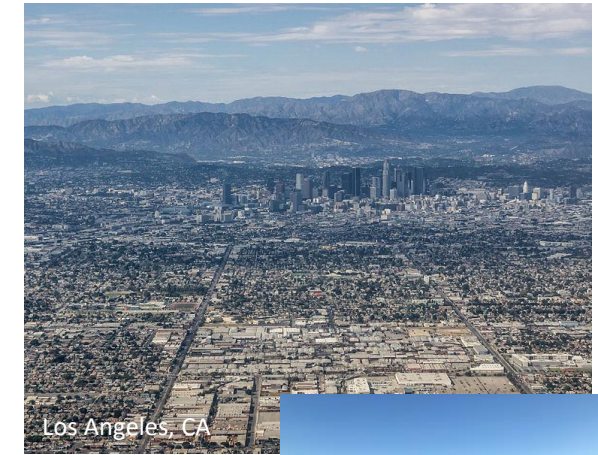
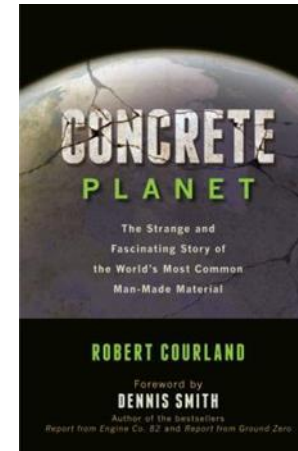
# The 3 Parts of the Planetary Predicament: Hazard + Climate Change + Landscape Transformation thru Engineering



Pine Flat Dam, CA



Dardanelle Lock and Dam, Arkansas River



Los Angeles, CA

>90,000 dams in the US, impounding  
>600,000 miles of river



MS River levee near Cairo, IL



Levee at Dogtooth Bend

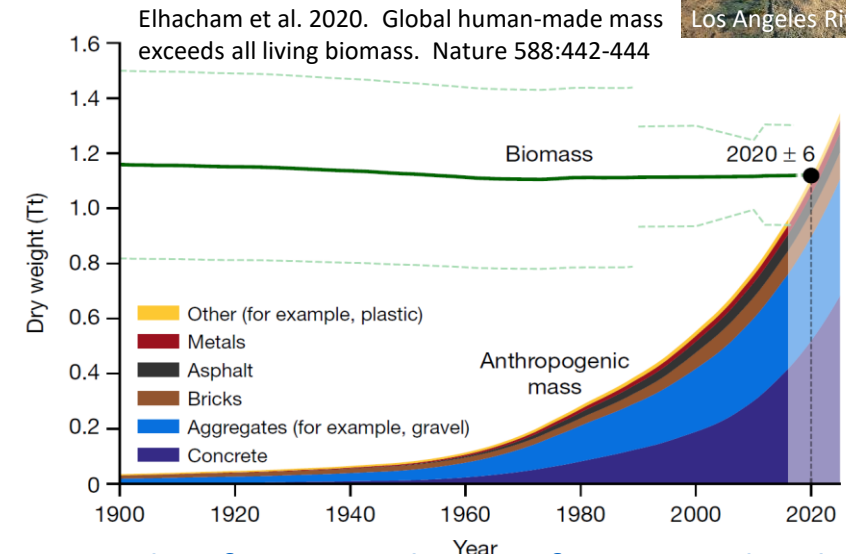


River Bank, St. Louis, MO

250,000 sq. miles of paved  
surface on the planet



Los Angeles River



24,500 miles of levee in National Levee Database;

<https://levees.sec.usace.army.mil/#/>

>100,000 miles of levee total estimate for US;

<https://eos.org/research-spotlights/algorithm-detects-thousands-of-missing-levees-from-u-s-database>

# The Tools of Transformation



Murden



Fresno Scrapper, invented by James Porteous, 1883



Bay State Dredging Company, 1884



Essayons



Miocene Ditch construction, Nome River, AK, 1901-03



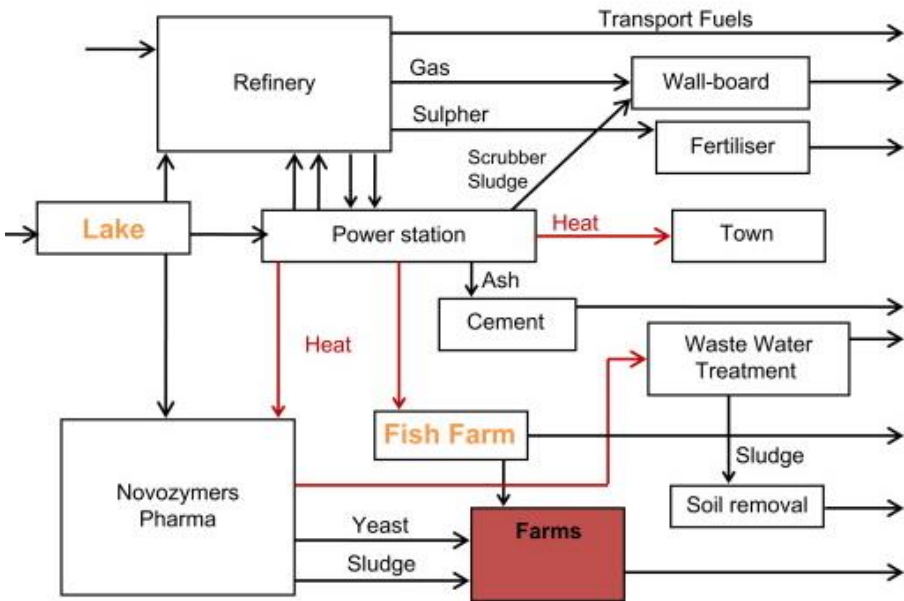
Goetz

# Regenerative, Nature-Positive Outcomes and the Circular Economy

**Sustainability:** “create and maintain conditions under which humans and nature can exist in **productive harmony**, that permit fulfilling the social, economic and other requirements of present and future generations.”

NEPA (1969)

Industrial Ecology: Kalundborg



The circular economy model:  
less raw material, less waste, fewer emissions

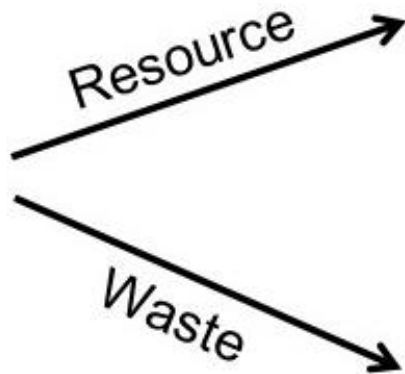


SUSTAINABLE DEVELOPMENT GOALS  
17 GOALS TO TRANSFORM OUR WORLD

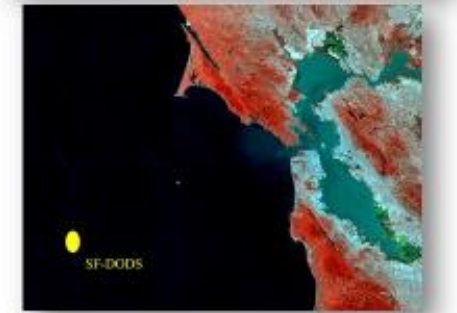
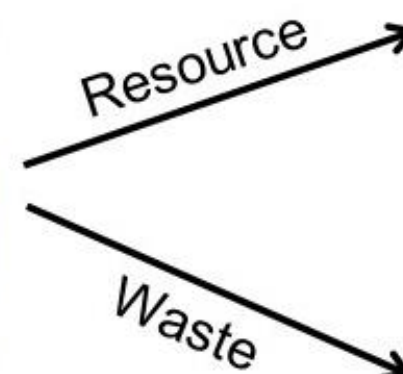


# Application to Dredging

What is an empty aluminum can?



What is sediment?

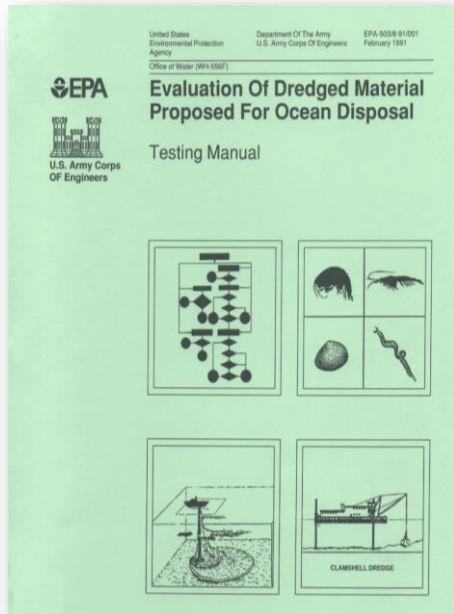


\*From a presentation I gave at the National Dredging Meeting in May 2012

Fax machine  
Cell phone  
Internet  
www  
Amazon.com

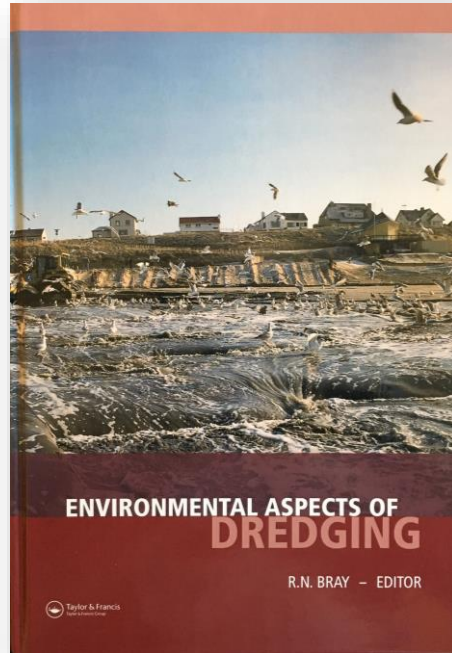
# Progress

## *Dredging for Sustainable Infrastructure*



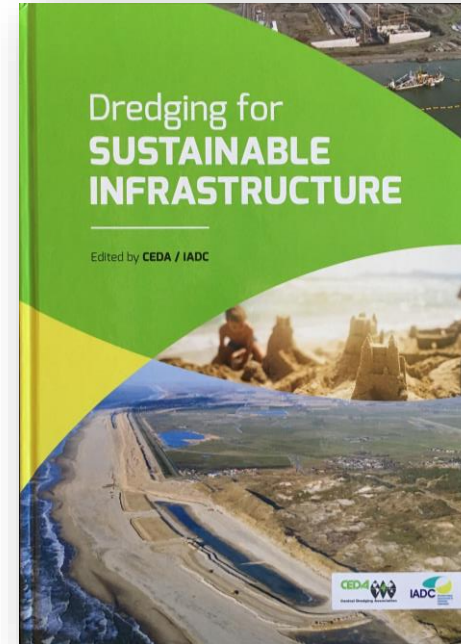
1977/1991

OTM 1977/1991: Will disposal of dredged material “unreasonably degrade or endanger: human health, welfare, or amenities, marine environment, ecological systems, or economic potentialities.”



2008

CEDA 2008: “It is, therefore, of the utmost importance that we be able to determine whether any planned dredging will have a positive or negative impact on the environment.”



2018

CEDA 2018: “This book ...presents state-of-the-art guidance to achieve dredging projects that fulfill their primary functional requirement, while adding value to the (natural and socio-economic) system based on a thorough understanding of the natural system and proactive engagement of stakeholders throughout.”

Chapter 2: *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.



# Beneficial Use Benefits: *The USACE '70 x 30' Goal*

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

 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”).

Achieving our vision will require purposeful documentation and an innovative pursuit both internally and externally with our partners and stakeholders. You will need to leverage available solutions, strategies, and tools to the maximum extent practicable while developing and applying new approaches and technologies to address the associated engineering challenges.

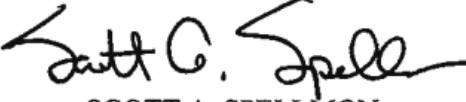
Districts and divisions are hereby called upon to participate in supporting this shared vision, provide input into the actions to be undertaken, and ensure ultimate success of the BUDM program.

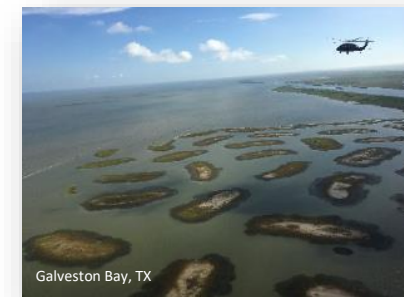
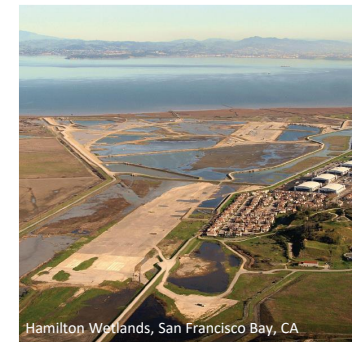
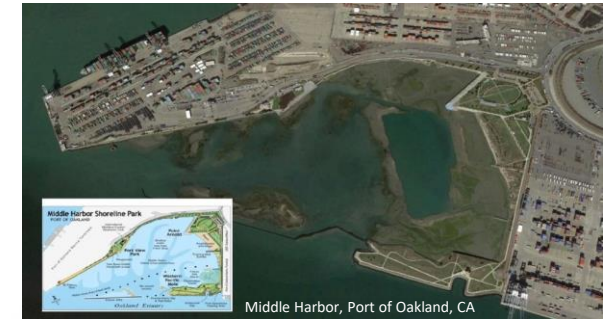
Now is the time to get involved. For more information on how to get involved, contact Tiffany Burroughs, Chief Navigation, HQUSACE by phone at (202) 761-4474 or by email at [tiffany.s.burroughs@usace.army.mil](mailto:tiffany.s.burroughs@usace.army.mil)

BUILDING STRONG!  
  
SCOTT A. SPELLMON  
Lieutenant General, US Army  
Commanding

*“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.”*

*“I have established a goal for USACE to advance the practice of BUDM to 70% by the year 2030 (“70/30 Goal”).”*

BUILDING STRONG!  
  
SCOTT A. SPELLMON  
Lieutenant General, US Army  
Commanding



# Beneficial Use and the “Federal Standard”

*Federal standard* means the dredged material disposal alternative or alternatives identified by the Corps which represent the **least costly** alternatives consistent with **sound engineering practices** and meeting the **environmental standards** established by the 404(b)(1) evaluation process or ocean dumping criteria. 33 CFR 335.7

## WRDA 2020, SEC. 125: BENEFICIAL USE OF DREDGED MATERIAL

- It is the policy of the United States for the Corps of Engineers to maximize the beneficial use, in an environmentally acceptable manner, of suitable dredged material...
- the Secretary shall consider—(i) the suitability of the dredged material for a full range of beneficial uses; and (ii) the economic and environmental benefits, efficiencies, and impacts...
- The economic benefits and efficiencies from the beneficial use of dredged material considered by the Secretary under subparagraph (A) shall be included in any determination relating to the “Federal standard”...

“There are at least 3 categories of beneficial use: good, better, and best.”

TSB

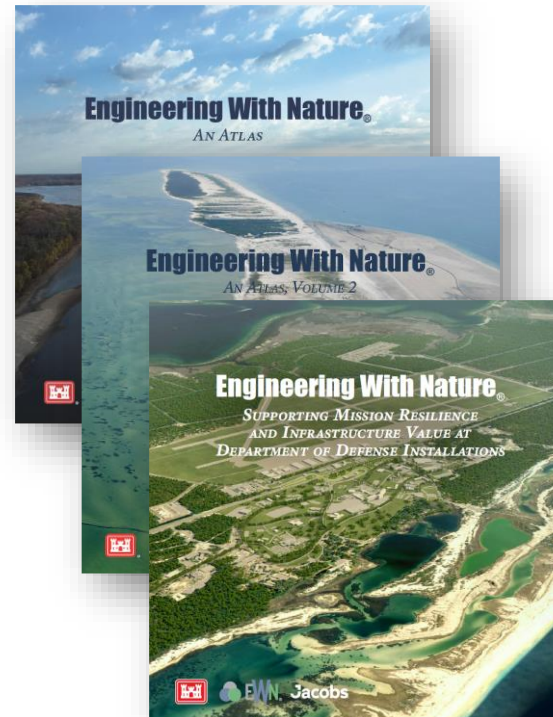
# Engineering With Nature®



*...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
- Increase and diversify infrastructure value
- Science-based collaboration to organize and focus interests, stakeholders, and partners



“We absolutely want to do more engineering with nature everywhere we work across the Corps, you have my commitment.”

— LTG Scott A. Spellmon, 55th Chief of Engineers, to the House Committee on Transportation & Infrastructure, Water Resources & Environment Subcommittee (24 June 2021)

# Ecological Engineering, 1962

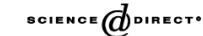
***Ecological Engineering: “the practice of joining the economy of society to the environment symbiotically by fitting technological design with ecological self design.”***  
***HT Odum, 2003***



Port Aransas Nature Preserve



Available online at [www.sciencedirect.com](http://www.sciencedirect.com)



Ecological Engineering 20 (2003) 339–361



Concepts and methods of ecological engineering

Howard T. Odum<sup>a</sup>, B. Odum<sup>b,\*</sup>

<sup>a</sup> Environmental Engineering Sciences, P.O. Box 116450, University of Florida, Gainesville, FL 32611-6450, USA

<sup>b</sup> 2160 N.W. 9th Ave., Gainesville, FL 32603, USA

Received 14 June 2002; accepted 4 August 2003

## Abstract

*Ecological engineering* was defined as the practice of joining the economy of society to the environment symbiotically by fitting technological design with ecological *self design*. The boundary of ecological engineering systems includes the ecosystems that self organize to fit with technology, whereas environmental engineering designs normally stop at the end of the pipe. For example, the coastal marsh wildlife sanctuary at Port Aransas, Texas, developed when municipal wastewaters were released on bare sands. The energy hierarchy concept provides principles for planning spatial and temporal organization that can be sustained. Techniques of ecological engineering are given with examples that include maintaining biodiversity with multiple seeding, experimental mesocosms, enclosed systems with people like Biosphere 2, wetland filtration of heavy metals, overgrowth and climax ecosystems, longitudinal succession, exotics, domestication of ecosystems, closing material cycles, and controlling water with vegetation reflectance.

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**Keywords:** Ecological engineering; Waste recycle; Self organization; Energy hierarchy; Energy; Transformity; Emdollars; Maximum power



Howard T. Odum, 1924–2002

## 1.1. Definitions

defines what *ecological* of its principles, and lication with examples Ecological engineering of cooperative environ- we applied the name system self design. By used worldwide with Society of Ecological

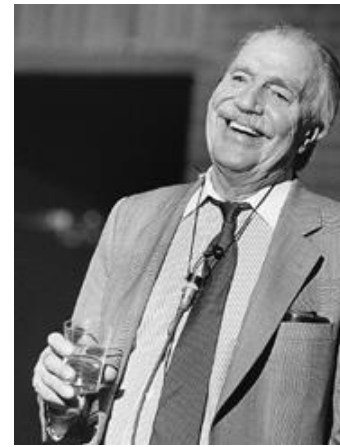
Engineering is sometimes described as the study and practice of solving problems with technological designs. The sketch in Fig. 1a shows the environment and the economy coupled symbiotically by exchange of materials and services. Environmental engineering develops the technology for connecting society to the environment. But the technology is only half of the interface with environment. The other half of the interface is provided by the ecosystems as they *self organize* to adapt to the special conditions. Ecological engineering takes advantage of the ecosystems as they combine natural resources and outputs from the economy to generate useful work.

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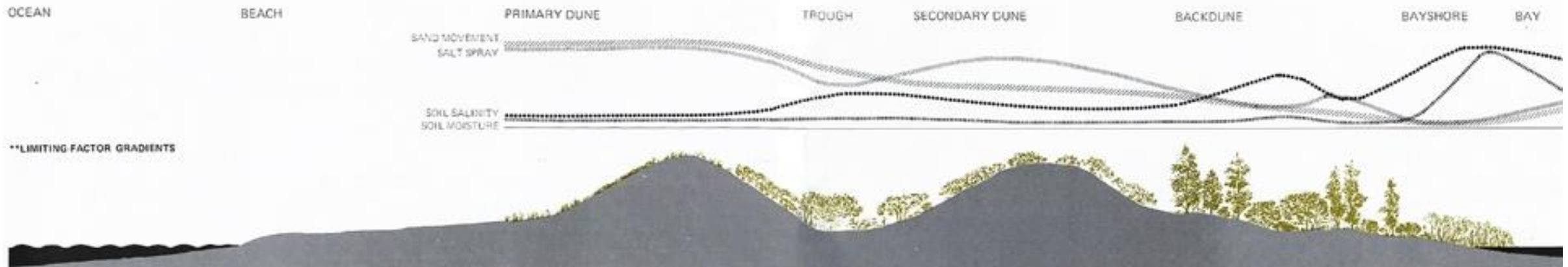
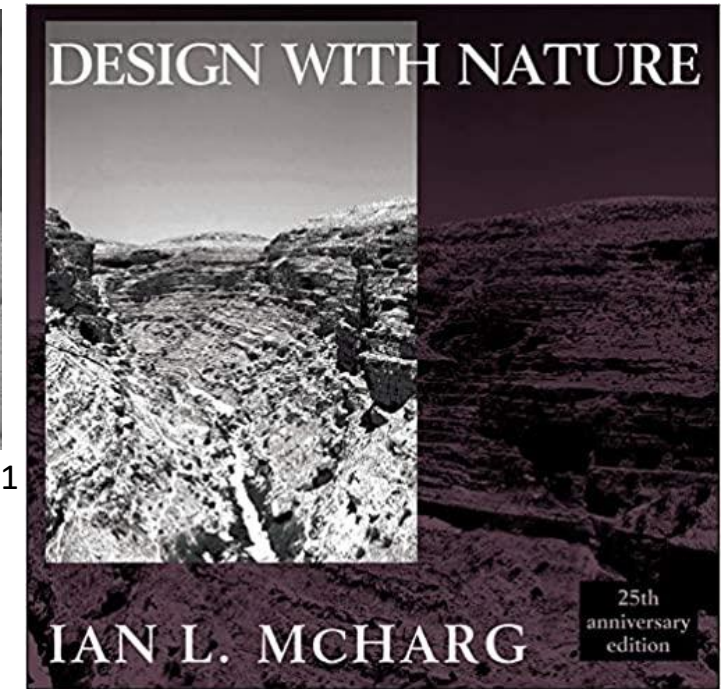
# Design with Nature, 1969

“McHarg’s emphasis is not on either design or nature by itself, but upon the preposition *with*, which implies human cooperation and biological partnership. He seeks, not arbitrarily to impose design, but to use to the fullest the potentialities—and with them, necessarily, the restrictive conditions—that nature offers.”

Lewis Mumford, Introduction to *Design with Nature*



Ian McHarg, 1920-2001



“Between the sea and man stood two barriers, the one natural, the other its human surrogate: dune and dike” McHarg, *Design with Nature*

# Nature-Based Solutions: A White House Priority

2022  
Earth Day EO



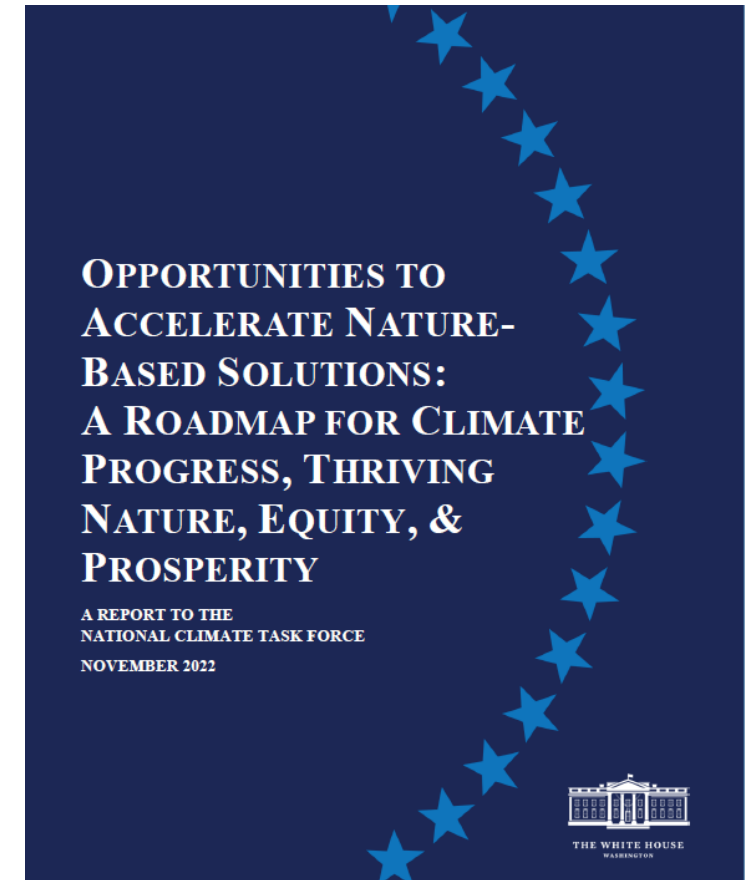
BRIEFING ROOM

## Executive Order on Strengthening the Nation's Forests, Communities, and Local Economies

APRIL 22, 2022 • PRESIDENTIAL ACTIONS

**EO 14072, Sec. 4. Deploying Nature-Based Solutions to Tackle Climate Change and Enhance Resilience:** *“To further amplify the power of nature, including its ability to absorb climate pollution and increase resilience in all communities, today’s Executive Order calls for the following:”*

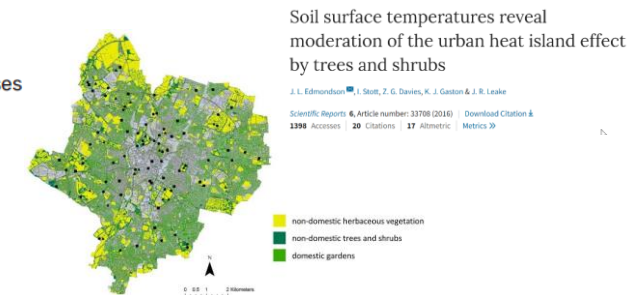
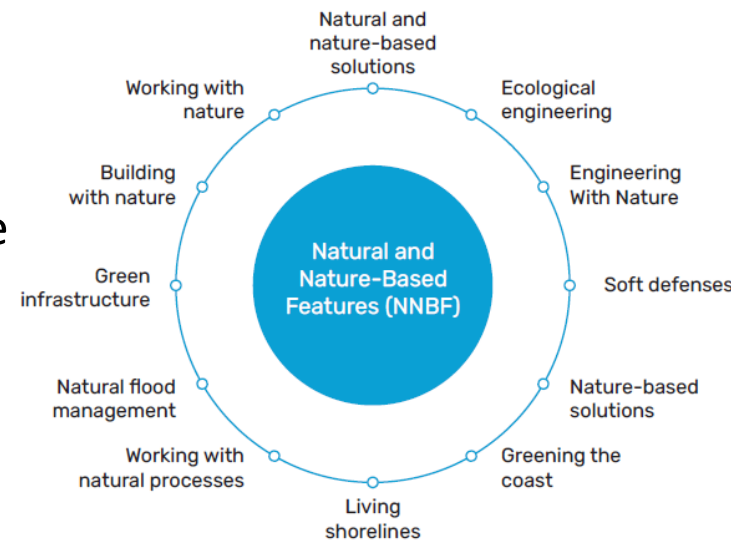
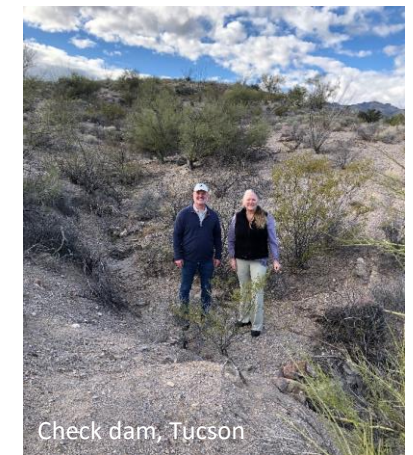
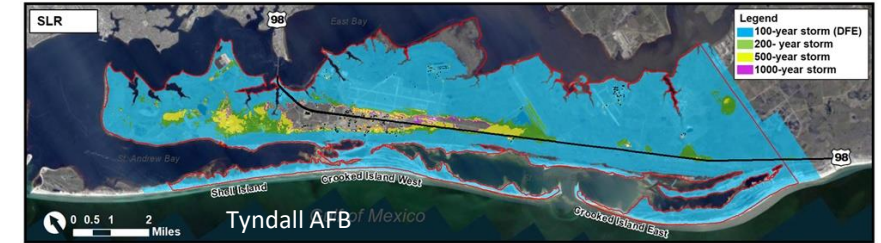
- 1) **Report on Nature-Based Solutions**
- 2) **Guidance on Valuing Nature**
- 3) **First U.S. National Nature Assessment**



**Nature-based Solutions: “Actions to protect, sustainably manage, or restore natural or modified ecosystems to address societal challenges, simultaneously providing benefits for people and the environment.”**

# Nature-Based Solutions: *Conserving, restoring, and engineering nature for the benefit of people and nature*

- **Coastal Storm Risk Management;** e.g., an island-wetland complex that attenuates storm surge and waves.
- **Inland Flood Risk Management;** e.g., a restored inland floodplain that provides space for high flows.
- **Surface Heat Reduction;** e.g., creation of green space, forest restoration.
- **Drought and Wildfire Resilience;** e.g., restored native vegetation + grazing + ‘slow-water’ interventions + ecological forest management.
- **Water Resilience;** a constructed freshwater wetland that absorbs excess nutrients and recharges depleted groundwater aquifers.
- **Climate Change Mitigation;** e.g., restored native grasslands / plant communities that sequester carbon in soils.



# The Importance of Leadership Intent on Nature-Based Solutions...

*“My vision for the future is driven by a sense of urgency. I’d like the Army Corps, a capable and talented organization, to be innovative in developing new strategies and to build climate resilience to better protect and prepare communities for some of the challenges they’re facing. We need to take advantage of nature-based infrastructure and figure out how we can bring multiple benefits to our projects so that we’re not just doing flood risk and coastal storm management but are also helping to further environmental restoration and even augment water supply where we can.”*

**Michael Connor, ASA(CW)**  
*Municipal Water Leader, May 2022*



*“Serious consideration of NNBFs is non-negotiable.”*

**Eric L. Bush, SES**  
*Chief, Planning and Policy (HQUSACE)*  
*July, 2022*





# Applying the Full Range Practices for Sustainable Sediment Management and Beneficial Use

Sediment “Recharge” via Dredging



Direct Wetland “Nourishment”



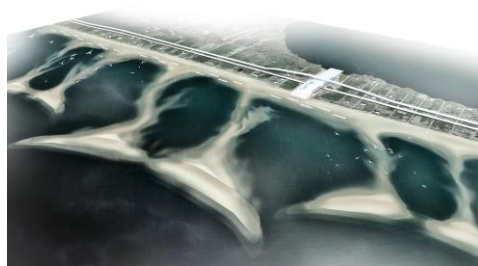
Wetland Creation



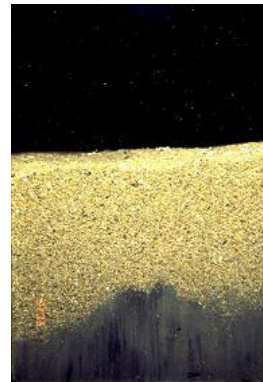
Island Enhancement or Restoration



Engineering / Operational Effort



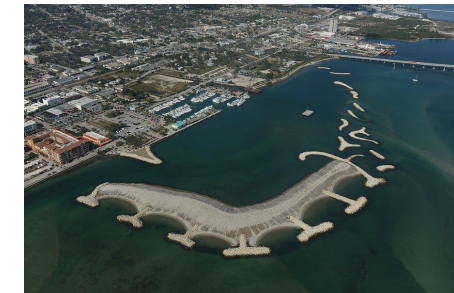
Strategic Placement



Thin-Layer Placement for Bottom Contouring

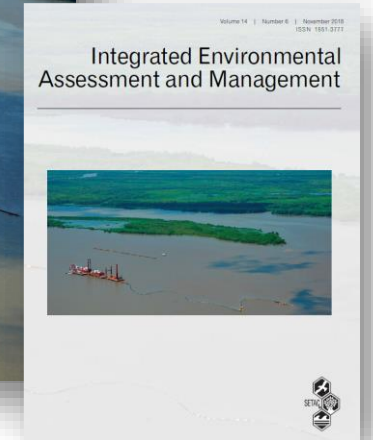


Beach and Dune Construction



New Island Construction

# Documenting NBS Benefits: Horseshoe Bend Island, Atchafalaya River, Louisiana, USA



## Quantifying Wildlife and Navigation Benefits of a Dredging Beneficial-Use Project in the Lower Atchafalaya River: A Demonstration of Engineering with Nature®

Christy M Foran,<sup>†</sup> Kelly A Burks-Copes,<sup>‡</sup> Jacob Berkowitz,<sup>‡</sup> Jeffrey Corbino,<sup>§</sup> and Burton C Suedel<sup>\*‡</sup>

### Project Awards:

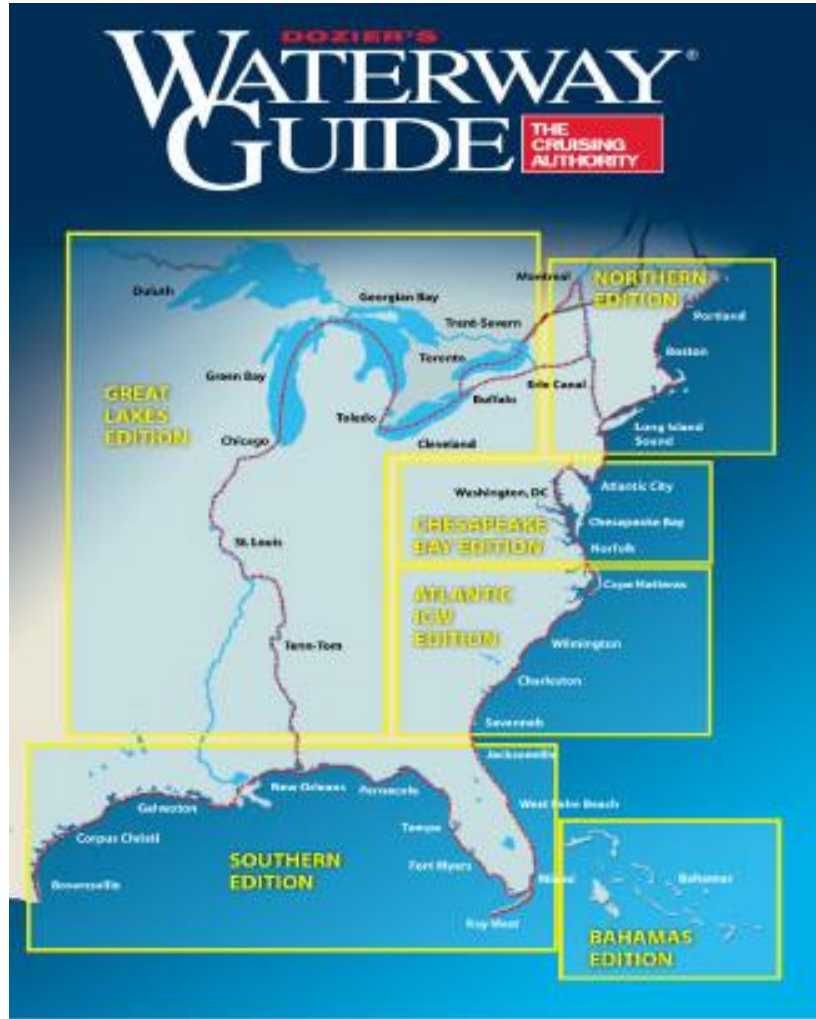
- 2015 Western Dredging Association Award for Environmental Excellence
- 2017 Western Dredging Association Award for Climate Change Adaption
- 2017 Dredging and Port Construction Award for Engineering with Nature
- 2020 USACE Green Innovation Award



# Fort Pierce City Marina, Florida



# Island Creation, Enhancement, Repurposing



US Intracoastal Waterway: Massachusetts to Brownsville, TX: 3,000 miles

# ***A Call to Action: A Regenerative, Nature-Positive Navigation System***

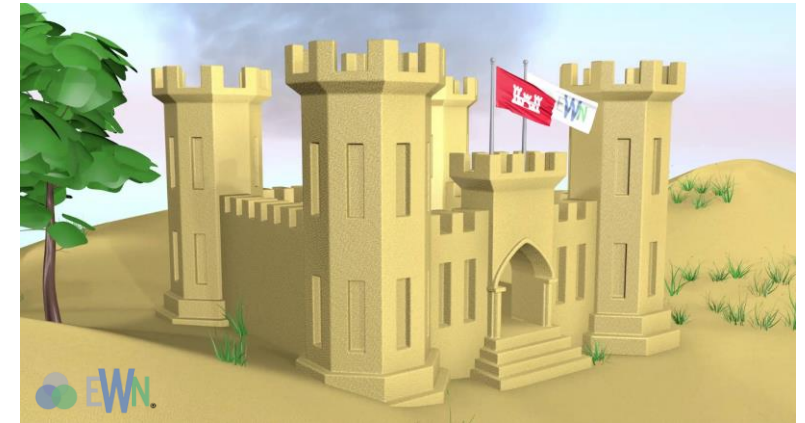
***An Imperative for the 21<sup>st</sup> Century: 100% Beneficial Use of Dredged Sediment***

~~“Spoil”~~

~~“Disposal”~~

Beneficial Use Innovation: *There’s something for everyone to do!*

- Government Agencies: Innovate policy, procedure, and business practices
- Ports / Navigation Sector: Pursue multi-purpose projects
- Regulatory Agencies: Efficiently pursue win-wins
- Dredging / Engineering Companies: Innovate engineering and operational practices
- Environmental NGOs: Facilitate P3s



**Think of dredged material volumes in terms of “wetland units”**  
**How many acres of wetland could 250 mcy of sediment create?**

**50,000-100,000 acres!**

# Mission, Responsibility, and Codes: ASCE

- ASCE Code of Ethics, Fundamental Canons
  - “Engineers shall hold paramount the safety, health, and welfare of the public and shall strive to comply with the principles of **sustainable development** in the performance of their professional duties.”
- ASCE Policy Statement (418) on “the role of the civil engineer in **sustainable development**”
  - ASCE “defines sustainability as a set of economic, environmental, and social conditions (aka "The Triple Bottom Line") in which all of society has the capacity and opportunity to maintain and improve its quality of life indefinitely without degrading the quantity, quality, or the availability of economic, environmental, and social resources. **Sustainable development** is the application of these resources to enhance the safety, welfare, and quality of life for all of society.”
- ASCE supports the following steps to achieve a **sustainable project**:
  - Perform Life Cycle Assessment from Planning to Reuse.
  - Use Resources Wisely.
  - **Plan for Resiliency. Sustainability requires planning for the impact natural and man-made disasters and changing conditions can have on economic, environmental, and social resources.**
  - Validate Application of Principles.

# *The Elements of Going-with-the-Flow Engineering*

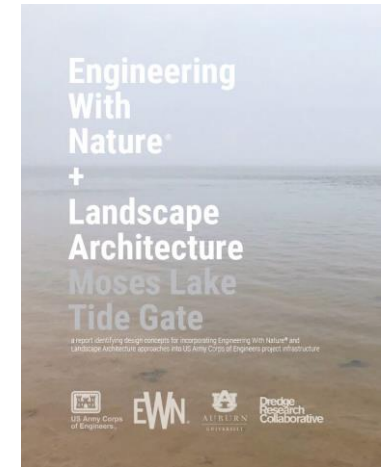
- Nature-first thinking
- The human factor
- Multi-purpose benefits
- Upscaled partnering
- Guidance
- Storytelling

“We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.” –Aldo Leopold



Dam Removal, Klamath River: Copco No. 2

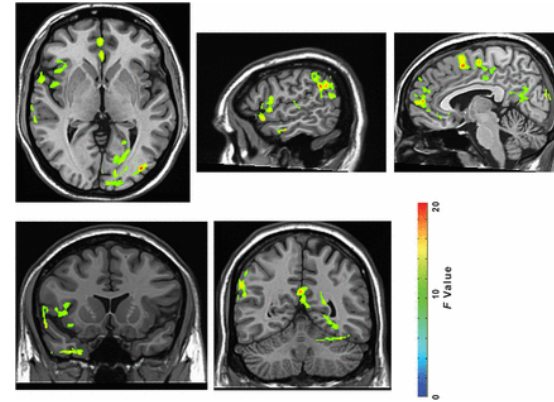
# Plan and Design with 'Nature-First Thinking'





# Elevate the Human Dimension

- Science says that nature directly supports human wellbeing!
  - Physical health
    - Blood pressure
    - Healing
    - Immunity
    - Etc.
  - Mental health
    - Cognitive function
    - Anxiety
    - Depression
    - Socialization
    - Etc.



## Nature experience reduces rumination and subgenual prefrontal cortex activation

Gregory N. Bratman, J. Paul Hamilton, Kevin S. Hahn, Gretchen C. Daily, and James J. Gross  
PNAS July 14, 2015 112 (28) 8567-8572; first published June 29, 2015 <https://doi.org/10.1073/pnas.1510459112>

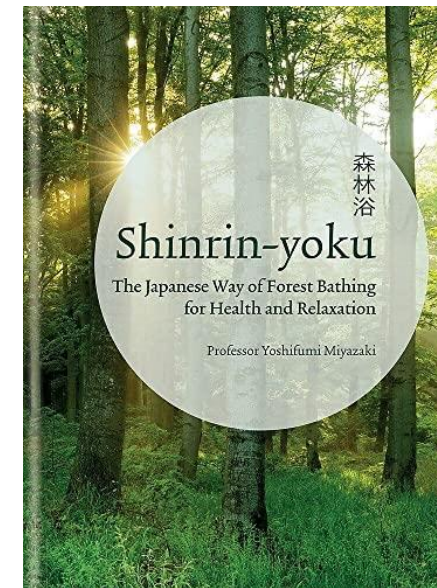
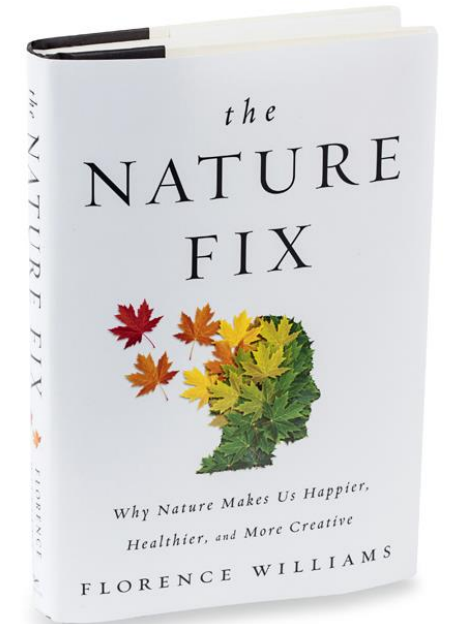


## scientific reports

## Urban street tree biodiversity and antidepressant prescriptions

Melissa R. Marselle<sup>1,2,3,4</sup>, Diana E. Bowler<sup>1,2,4</sup>, Jan Watzema<sup>1,2</sup>, David Eichenberg<sup>1,2,5</sup>, Toralf Kirsten<sup>6,7</sup> & Aletta Bonn<sup>1,2,4</sup>

***“It is a scientific fact that the occasional contemplation of natural scenes... is favorable to the health and vigor of men...”*** Frederick Law Olmsted (1822-1903)



# Evaluating Diverse, Multi-Purpose Benefits

*Policy Research: Current federal alternative evaluation process does not comprehensively value economic, environmental, and social benefits. These constraints screen out or exclude Nature-Based Solutions (NBS) and could lead to outcomes inconsistent with the Administration's priorities around community resilience and equity.*

## Approach:

- **Summarize** historical and current alternative evaluation policies and practices
- **Identify** 6 historical planning studies that considered NBS alternatives suitable for case study analysis
  1. Jacksonville Harbor (NAV, South East)
  2. Jamaica Bay Reformulation (CSRM, North East)
  3. Southwest Coastal (CSRM, Gulf Coast)
  4. South Platte River and Tributaries (FRM, North West)
  5. West Sacramento (FRM, Pacific)
  6. South San Francisco Bay Shoreline (FRM, Pacific)
- **Review** updated valuation methods and planning frameworks that incorporate environmental and social benefits
- **Analyze** case studies using updated methods and exploratory analysis to look beyond current policy constraints

*National Summit: Measuring What Matters  
November 30, 2022; Washington D.C.*



***"It matters because it matters to the President."***

***"Our sponsors no longer want to see 'off the shelf' solutions."***

***"We can't value everything, but we need to value what we can."***

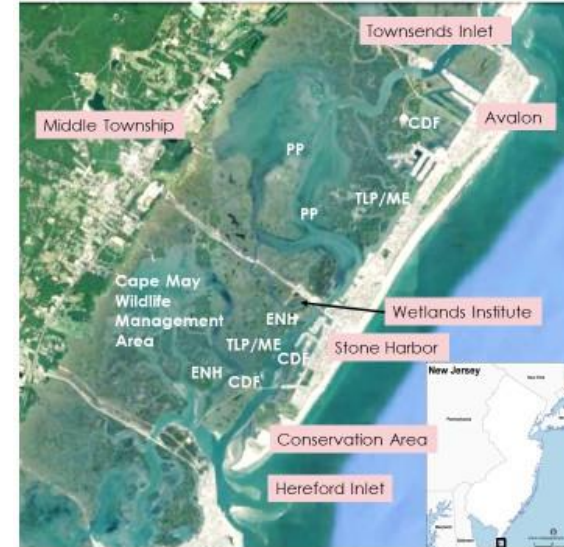
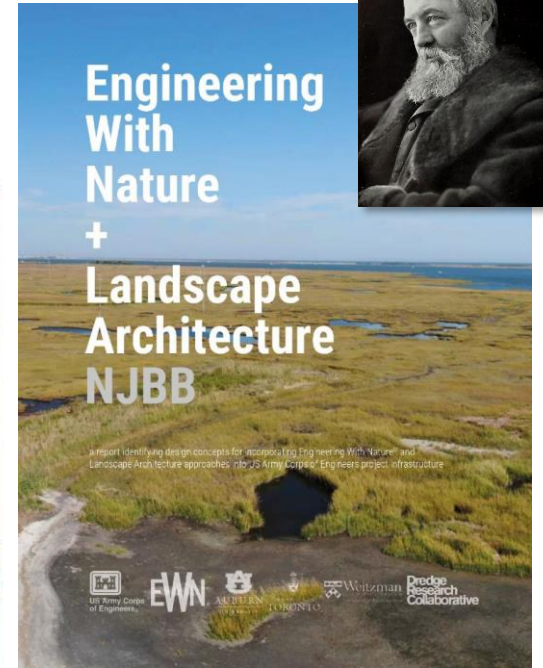
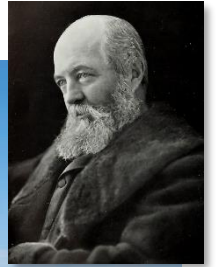
**Michael L. Connor, ASA(CW)**

<https://ewn.erdcdren.mil/?p=7841>

# Upscaled Partnering: SMIL

## Seven Mile Island Innovation Laboratory

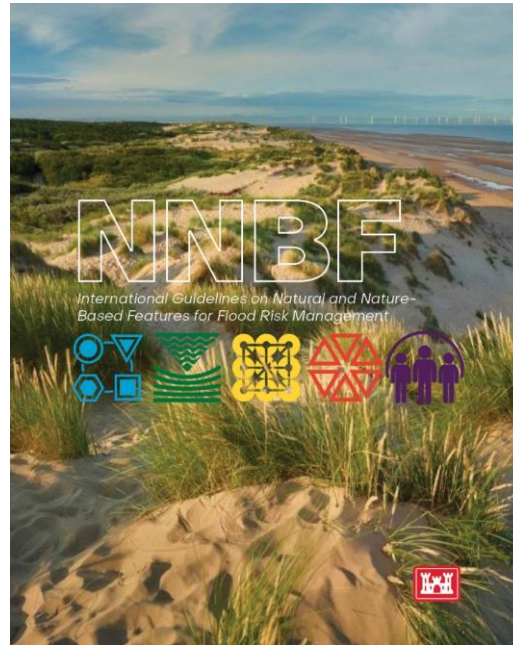
- Collaboration and partnership that's building first-of-their-kind NBS projects in coastal New Jersey
  - Began in conversation
  - Accelerated by a storm (Sandy)
  - Progressed through piloting
  - Now in full-scale implementation



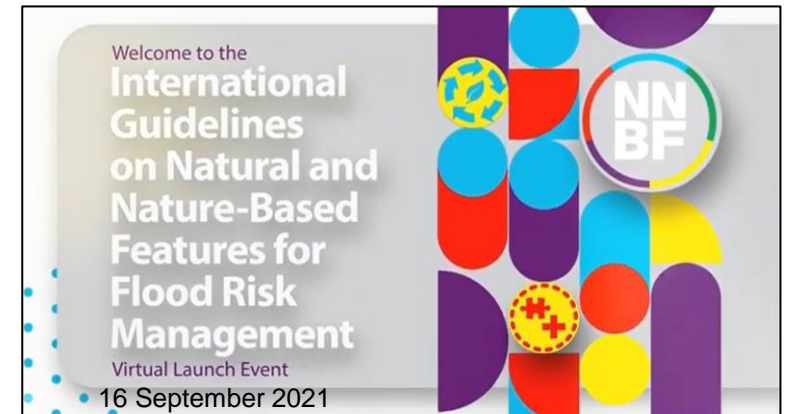
# Develop Guidance: *International Guidelines on Natural and Nature-Based Features for Flood Risk Management*

## NNBF Guidelines Table of Contents

- Chapter 1. Introduction
- Chapter 2. Principles, Frameworks, and Outcomes
- Chapter 3. Community Engagement
- Chapter 4. Systems Approach
- Chapter 5. Performance
- Chapter 6. Benefits and Costs of NNBF
- Chapter 7. Adaptive Management
- Chapter 8. Introduction to Coastal Systems
- Chapter 9. Beaches and Dunes
- Chapter 10. Coastal Wetlands and Intertidal Areas
- Chapter 11. Islands
- Chapter 12. Reefs
- Chapter 13. Plant Systems
- Chapter 14. Environmental Enhancements
- Chapter 15. Introduction to Fluvial Systems
- Chapter 16. Fluvial Systems and Flood Risk Management
- Chapter 17. Benefits and Challenges of NNBF in Fluvial Systems
- Chapter 18. Fluvial NNBF
- Chapter 19. Fluvial NNBF Case Studies
- Chapter 20. The Way Forward



[https://ewn.ercd.dren.mil/?page\\_id=4351](https://ewn.ercd.dren.mil/?page_id=4351)



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

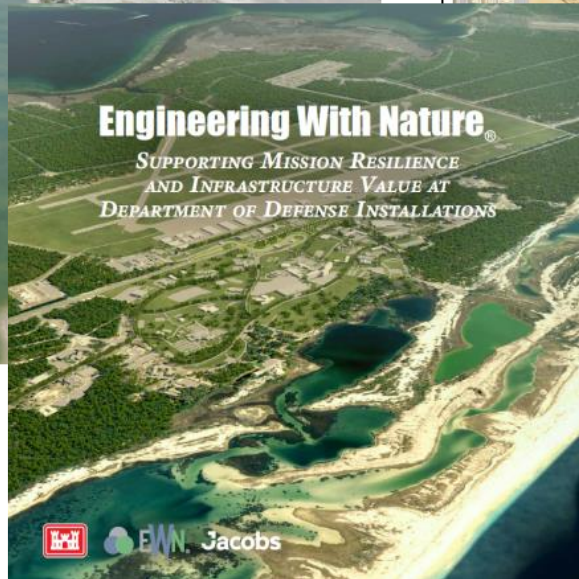
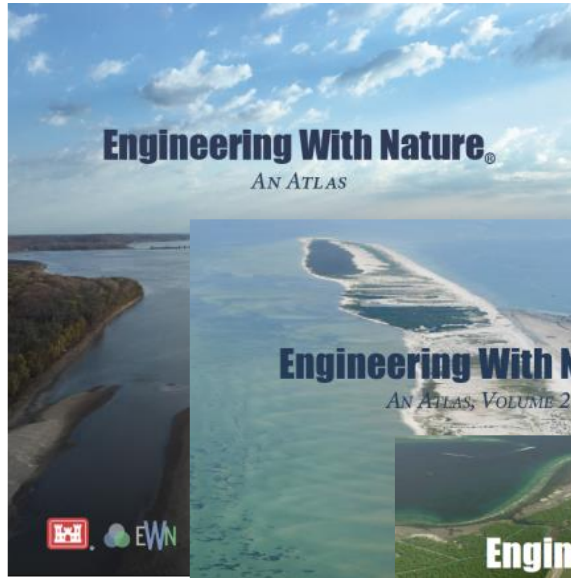


*Winner, Environment Agency Flood & Coast International Excellence Award, 2022*

**NNBF Guidelines**

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

# Storytelling to Spark Conversation, Thinking, and New Ideas



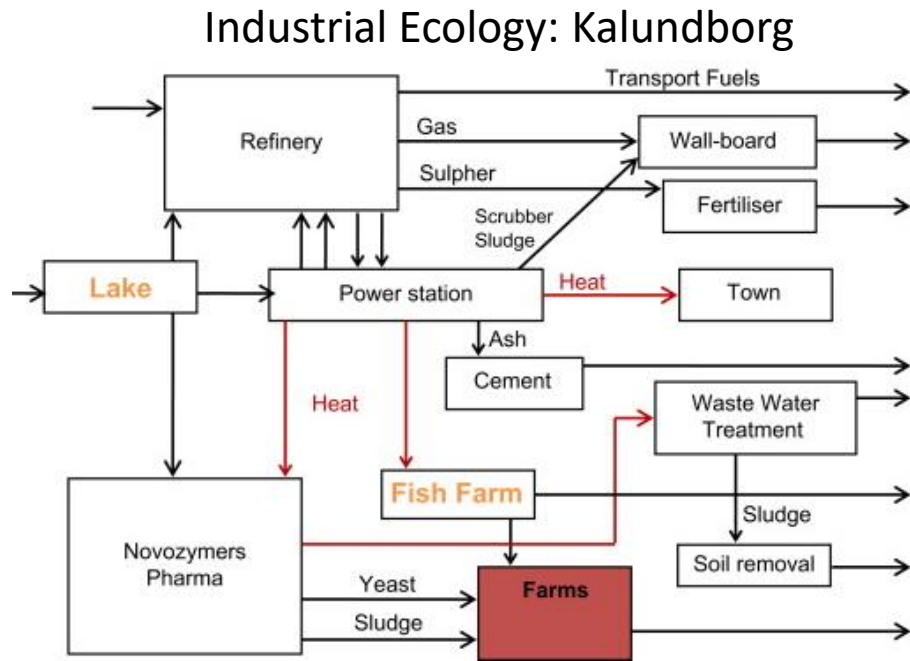
<https://iris.uga.edu/resilient-future-podcast/>



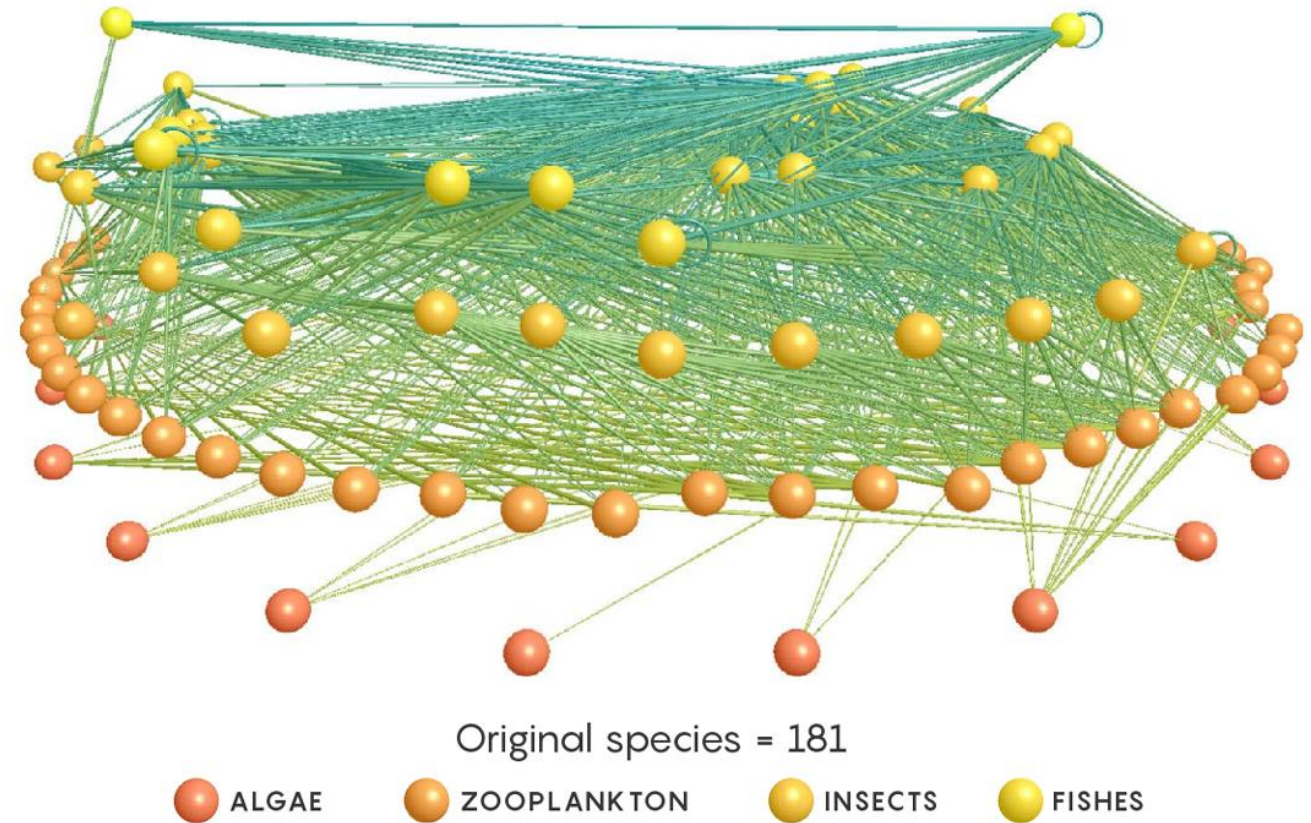
<https://ewn.erd.c.dren.mil/?p=3586>



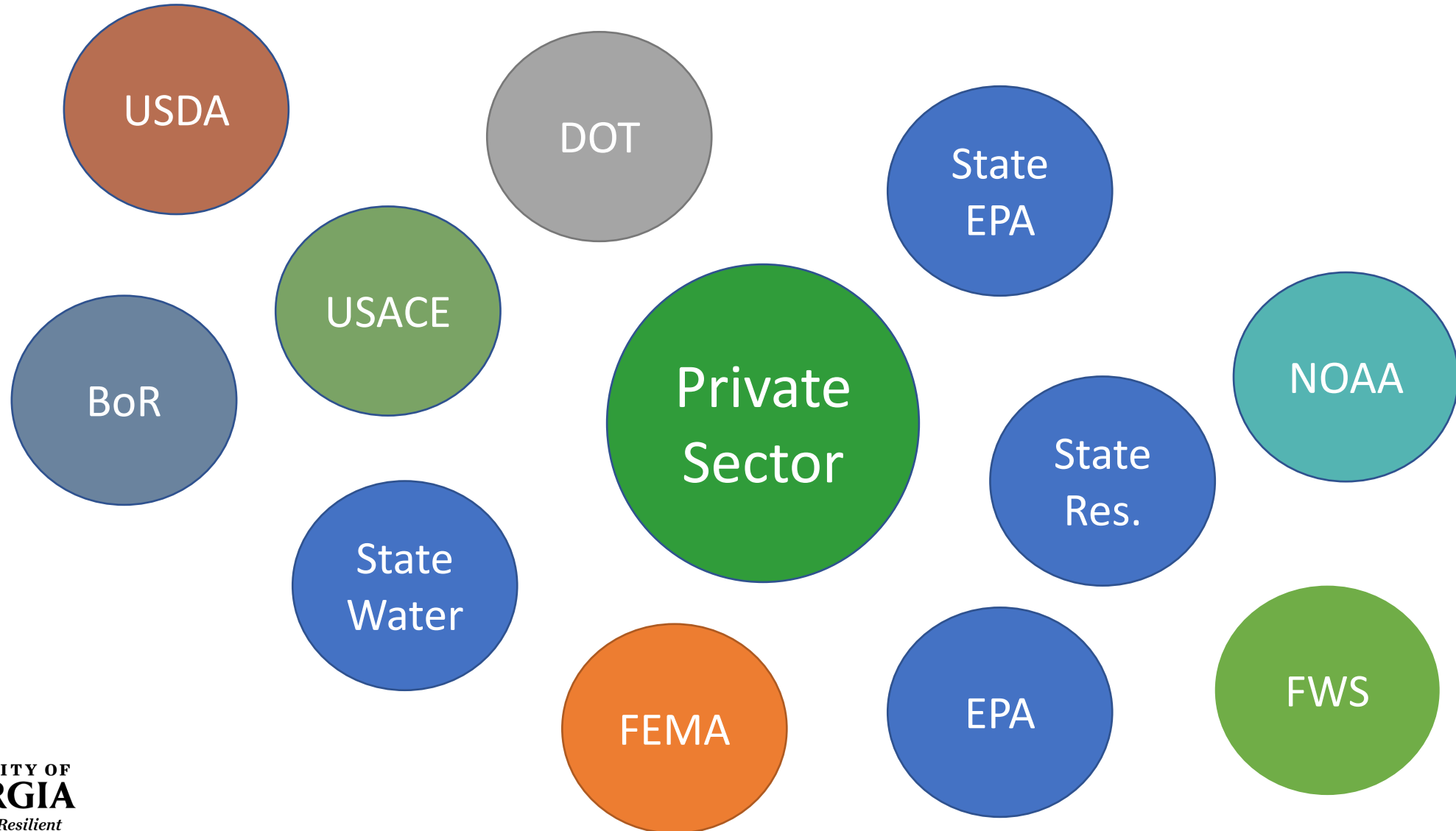
# The 'Industrial Ecology' of BU and NbS Implementation



**Food Web of Little Rock Lake, Wisconsin**



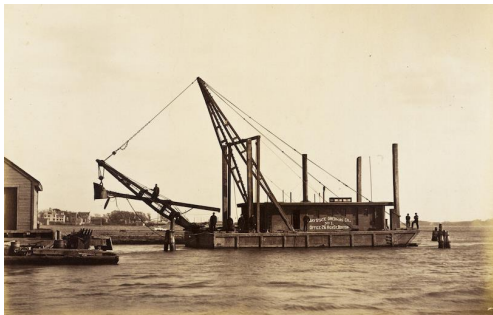
# The 'Industrial Ecology' of BU and NbS Implementation



# Partnership for Construction and Operations Innovation

- **Goal:** Develop and deliver innovative, leap-ahead technologies and business practices to dramatically accelerate schedules, reduce costs, increase channel and infrastructure reliability, and increase value through expanded beneficial use of sediments.

- Revolutionize dredging technology and operations.
- Expand and nationally diversify dredging capacity.
- Develop technologies to expand the creation of beneficial use value.



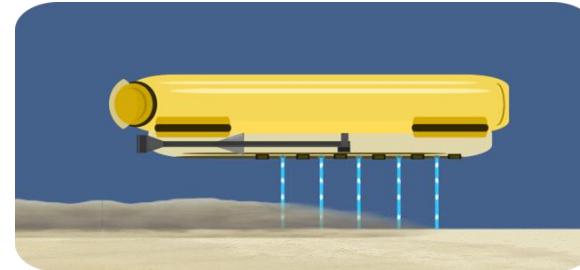
Bay State Dredging Company, 1884



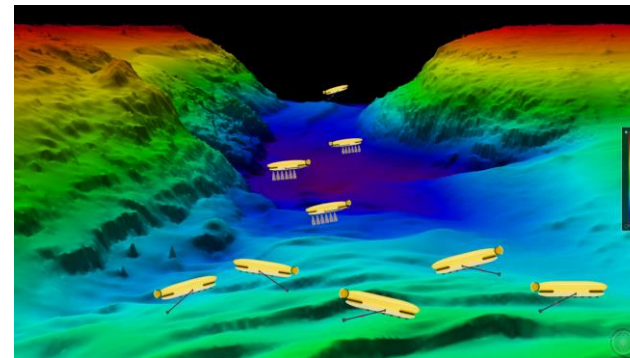
"Dredging by Roomba, 2030"



Mini-Robotic Submersible Dredge (MRS-D)



Autonomous Hydrodynamic Dredging Drones



"Swarms" of networked dredging drones for 24-7-365 dredging



Sediment Distribution Pipe, Seven Mile Island Innovation Laboratory; with Barnegat Bay Dredging Company



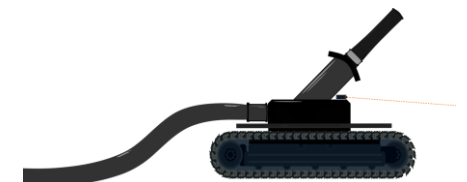
Bed Load Collector; Cuyahoga River, OH



Thin-Layer Placement; Avalon, NJ



Thin-layer capping of contaminated sediment

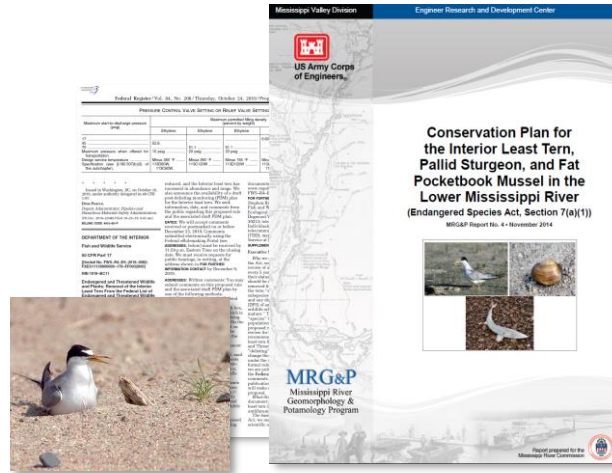




# Partnership for Nature-Positive Sediment Management

• **Goal:** Transform the relationships, business practices, and technology to deliver nature-positive infrastructure projects.

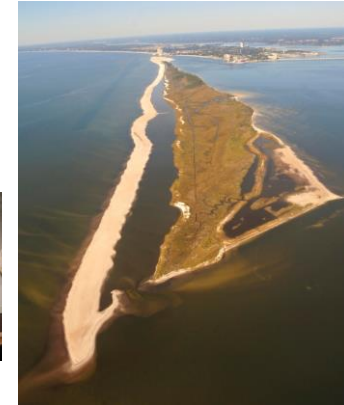
- Dramatically reduce the costs of environmental compliance and mitigation.
- Dramatically increase the environmental value of engineering solutions.
- Transform conflict into collaboration .
- Co-develop new solutions for 21<sup>st</sup> century Nature-based Solutions.



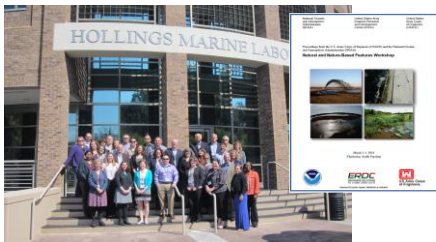
USACE research investment and collaboration with USFWS leads to delisting of ILT, efficient conservation



Stimulating new ideas, best practice, building collaborations



Deer Island, MS restoration, BU, coastal resilience



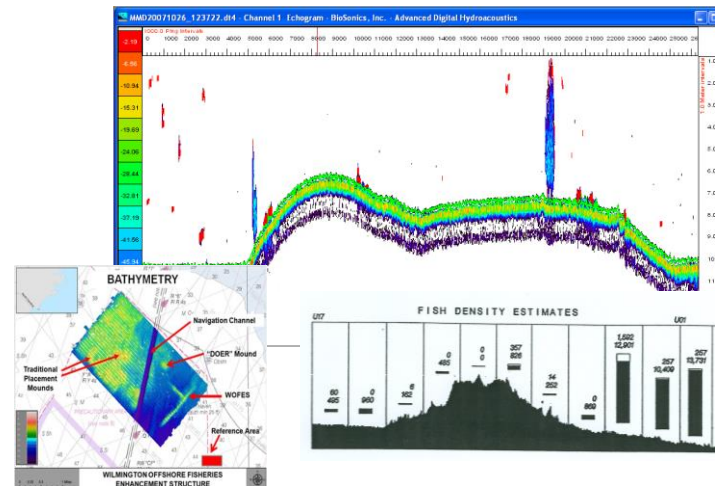
Collaboration with regulatory and resource agencies on EWN produces innovation and win-wins



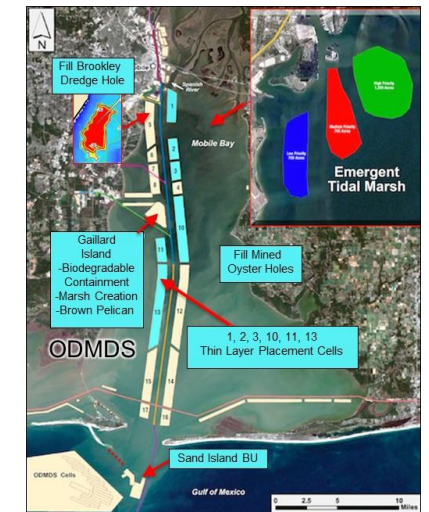
Seven Mile Island Innovation Laboratory, NJ



U.S. ARMY CORPS OF ENGINEERS  
**THREATENED & ENDANGERED SPECIES TEAM (TEST)**



Positive "reef effect" of offshore dredged material management areas on local fisheries



Collaboration on reversal of WRDA 1986 prohibition on in-bay placement in Mobile Bay

# The Institute for Resilient Infrastructure Systems



**Vision:** *Natural and conventional infrastructure working together for thriving communities, businesses and natural systems.*

- >50 faculty, researchers, staff spanning 15 colleges, public service organizations, and extension programs at UGA.
- >60 graduate students focused on resilient infrastructure.
- >12 collaborative research and implementation projects with communities and military installations.
- Partnering across sectors.
- Producing high-impact products, education, and training for a new wave of 21<sup>st</sup> century professionals.
- The Network for Engineering With Nature (N-EWN), <https://n-ewn.org/>.

<https://iris.uga.edu/>

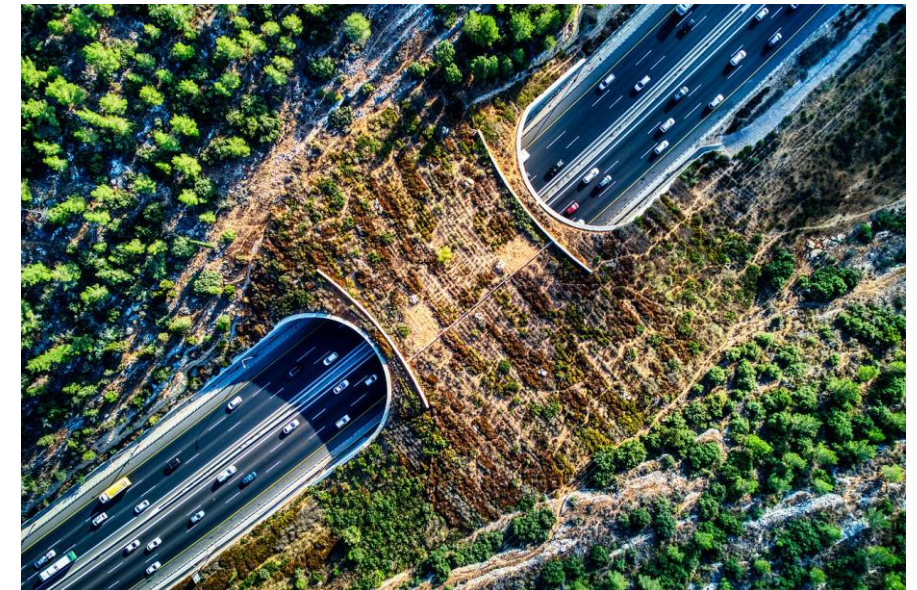
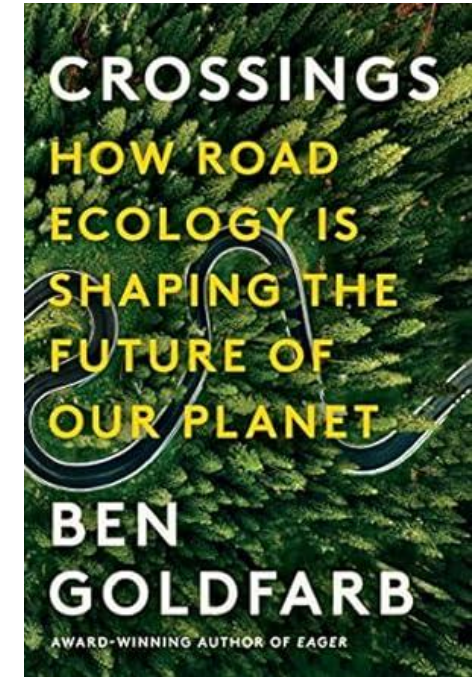
# Industry Summit on Nature-based Solutions

- UGA, Athens, GA; November 7-8, 2023
- 100 participants from 50 for-profit and non-profit organizations across private sector
- Focused on means for accelerating and upscaling NbS across the country
- Outcomes
  - Share information on projects, capabilities, and technologies
  - Identify private sector perspectives, needs, and opportunities
  - Co-develop a 10-year vision and plan of action for national implementation of NbS



# *The Benefits of 'Going with the Flow'*

- What are the big opportunities for making our rivers, waterways, and coastlines more sustainable and resilient?
- What challenges and opportunities are there for more BU and NbS?
- What guidance, tools, technologies, materials, etc. are needed support progress?
- What advancements in policy and regulation are needed?
- How should we be training/educating for the future?



Wildlife crossing, Highway 1 (Israel)