

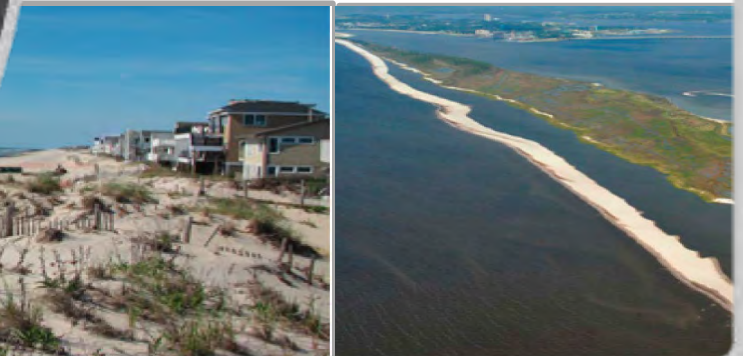
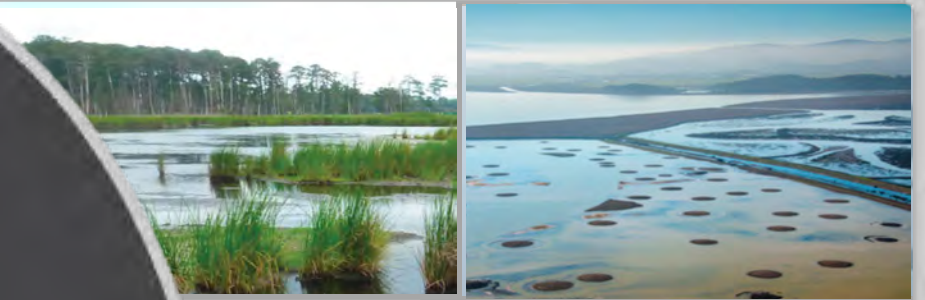


U.S. ARMY

Engineering With Nature®

Dr. Todd S. Bridges
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National Lead, USACE Engineering With Nature®
US Army Corps of Engineers
Todd.S.Bridges@usace.army.mil

Honolulu Climate Change Commission
15 June 2021



US Army Corps
of Engineers



The Multi-Hazard World



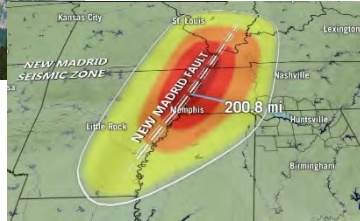
David Johnston, USGS



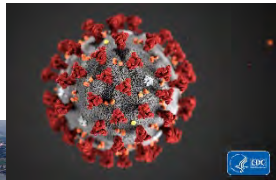
Mt. Saint Helens, 1980



San Francisco, 1906



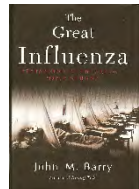
New Madrid Seismic Zone



COVID-19, 2020-X



HABs, Lake Erie; 2008-2017



H1N1, 1918-1919



Beirut, Lebanon; 2020



Fukushima, 2011



Three Mile Island, 1979



Deepwater Horizon, 2010



Camp Fire; CA 2018



Banqiao dam failure; China, 1975



Hurricane Katrina, 2005



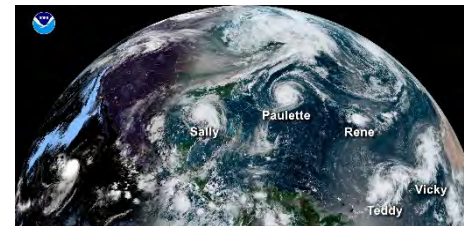
Flood of 1927; Tallulah, LA



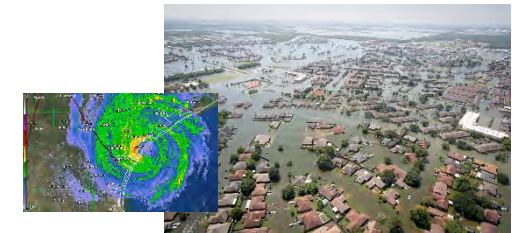
Dust Bowl, 1930s



Offutt AFB, 2019



2020 record-setting storm season



Hurricane Harvey, landfall and Houston, 2017



9/11



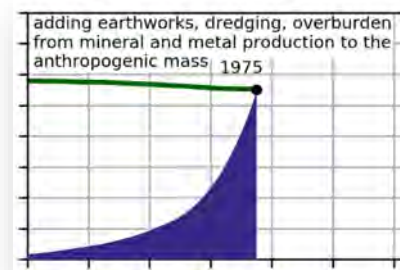
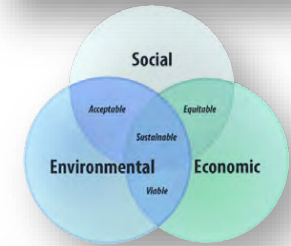
Civil unrest, 2020



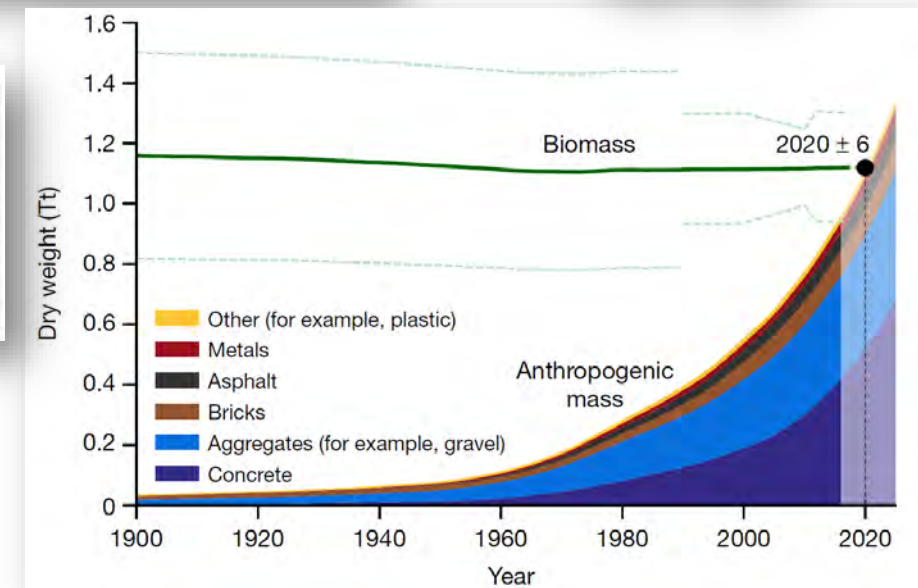
Medfly "bio-attack"; CA, 1989

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
- >30,000 miles of flood levee
- 155,000 public drinking water systems
- 4,500 military installations
- 926 ports, 25,000 miles of navigation channel



Elhacham et al. 2020.
Global human-made mass exceeds all living biomass.
 Nature 588:442-444



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

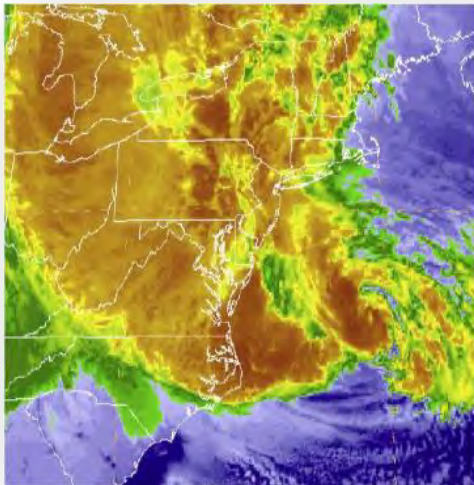


*"The mission of US Army Corps of Engineers is to deliver vital public and military engineering services; partnering in peace and war to strengthen our nation's security, energize the economy and reduce risks from disasters. **Engineering With Nature supports this mission which is why it will always be an important initiative for the Corps.**"* LTG Scott A. Spellman, 55th Chief of Engineers, Commanding General, USACE

Leveraging Nature for Engineering Value: *Wetlands*

Wetland Value During Hurricane Sandy:

- Risk industry tools used to quantify the economic benefits of coastal wetlands
 - Temperate coastal wetlands averted 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

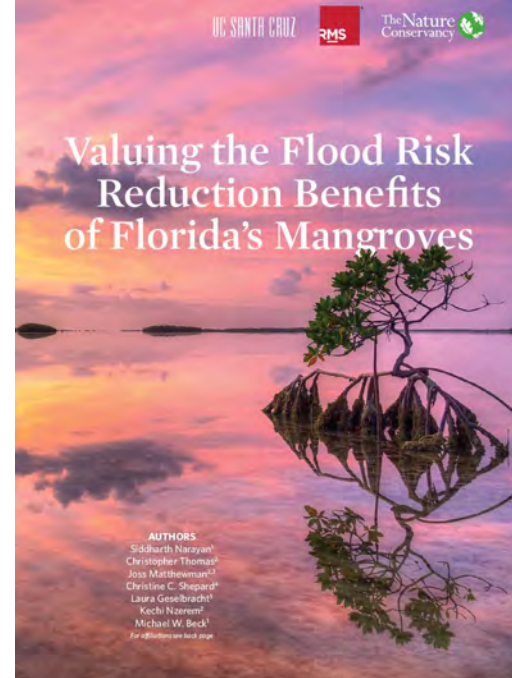
October 2016



Leveraging Nature for Engineering Value: *Mangroves*

Flood Risk Value of Florida Mangroves:

- Used an insurance industry catastrophe model to quantify the flood reduction benefits of mangroves across Florida
- During Hurricane Irma:
 - Mangroves averted \$1.5 billion dollars in flood damages to properties
 - 25% savings in counties with mangroves
 - >600,000 people living behind mangrove forests saw reduced flooding across Florida



Nature-Based Solutions

Diversified Value

■ Engineering

- E.g., reduced flood risk, infrastructure maintenance

■ Economic

- E.g., increased property values, recreation

■ Environmental

- E.g., sustainable habitat, biodiversity

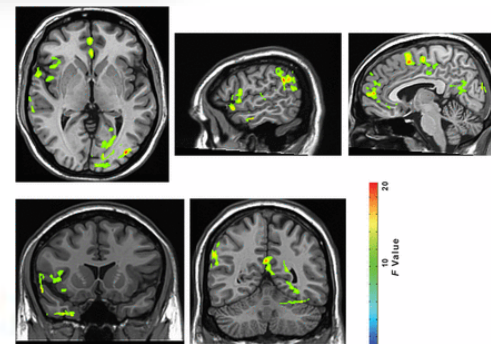
■ Social

- E.g., human health, community resilience



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>



Federal Register / Vol. 84, No. 206 / Thursday, October 24, 2019 / Proposed Rules 56977

PRESSURE CONTROL VALVE SETTING OR RELIEF VALVE SETTING

Maximum start-to-discharge pressure (psig)	Maximum permitted filling density (percent by weight)				
	Ethylene	Ethylene	Ethylene	Hydrogen	Methane
17				6.60	
45					22.5
75					12 psig
Maximum pressure when offered for transportation	51.1	51.1	51.1		22.5
Design service temperature Specification (see § 180.607(b)(5) for subcooler)	Minus 200 °F 113000W	Minus 200 °F 1130120W	Minus 155 °F 1130120W	Minus 423 °F 113A175W, 113A300W	Minus 200 °F 113C120W

DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service

50 CFR Part 17
(Docket No. FWS-R4-ES-2018-0002; FWS111200000-178-FR0022000) RIN 1018-BC11

Endangered and Threatened Wildlife and Plants; Removal of the Interior Least Tern From the Federal List of Endangered and Threatened Wildlife.

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Proposed rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), propose to remove the inland population of the least tern (Interior least tern) (*Sterna (now Sterna) forsteri*) from the Federal List of Endangered and Threatened Wildlife. The Interior least tern is a bird that nests adjacent to major rivers at the Great Plains and Lower Mississippi Valley. This proposed action is based on a thorough review of the best available scientific and commercial data, which indicate that the Interior least tern has recovered and no longer meets the definition of an endangered or a threatened species under the Endangered Species Act of 1973, as amended (Act). Our review shows that climate identified for the species at the time of listing, i.e., habitat loss, curtailment of range, predation, and inadequacy of regulatory mechanisms, have been eliminated or

reduced, and the Interior least tern has increased in abundance and range. We also announce the availability of a draft post-listing monitoring (PDM) plan for the Interior least tern. We seek information, data, and comments from the public regarding this proposed rule and the associated draft PDM plan.

DATES: We will accept comments received or postmarked on or before December 23, 2019. Comments submitted electronically using the Federal eRulemaking Portal (see **ADDITIONAL INFORMATION**, below) must be received by 11:59 p.m. Eastern Time on the closing date. We must receive requests for public hearings, in writing, at the address shown in **FOR FURTHER INFORMATION CONTACT** by December 9, 2019.

ADDRESSES: Written comments You may submit comments on this proposed rule and the associated draft PDM plan by one of the following methods:

(1) Electronically: Go to the Federal eRulemaking Portal: <http://www.regulations.gov>. In the Search box, enter FWS-R4-ES-2018-0002, which is the docket number for this rulemaking. Then, click on the Search button. On the resulting page, in the Search panel on the left side of the screen, under the Document Type heading, click on the Proposed Rule box to locate this document. You may submit a comment by clicking on "Comment Now!"

(2) By hard copy: Submit to U.S. mail or hand-delivery to: Public Comments Processing, Attn: FWS-R4-ES-2018-0002, U.S. Fish and Wildlife Service, MS: BPHK, 5275 Lees Ferry Pkwy, Falls Church, VA 22041-3803.

We request that you send comments only by the methods described above. We will post all comments on <http://www.regulations.gov>. This generally means that we will post any personal information you provide us (see **Public Comments**, below, for more information).

Document availability: The proposed rule, draft PDM plan, and supporting documents are available at <http://www.regulations.gov> under Docket No. FWS-R4-ES-2018-0002.

FOR FURTHER INFORMATION CONTACT: Stephen Kelle, Field Supervisor, U.S. Fish and Wildlife Service, Mississippi Ecological Services Field Office, 6628 Dapwood View Parkway, Jackson, MS 39213; telephone (601) 521-1122. Individuals who use a telecommunications device for the deaf (TDD), may call the Federal Relay Service at (800) 877-8339.

SUPPLEMENTARY INFORMATION:

Executive Summary

Why we need to publish a rule. Under the Act, we are required to conduct a review of all listed species of least once every 5 years (5-year review) to review their status and determine whether they should be classified differently or removed from listed status. In the Act, the term "species" includes any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate fish or wildlife which subsists as a discrete unit. Therefore, we use the term "species" to refer to the Interior population of the least tern in this proposed rule. In our 2013 5-year review for the Interior least tern, we recommended removing the Interior least tern from the Federal List of Endangered and Threatened Wildlife (i.e., "delisting" the species). However, to change the status of a listed species under the Act, we must complete the formal rulemaking process. Therefore, we are publishing this proposed rule in the Federal Register and seeking public comments on it. Within 1 year of the publication of this proposed rule, we will make a final determination on the proposed.

What this document does. This document proposes to delist the Interior least tern (*Sterna (now Sterna) forsteri*).

The basis for our action. Under the Act, we may delist a species if the best scientific and commercial data indicate

Mississippi Valley Division Engineer Research and Development Center

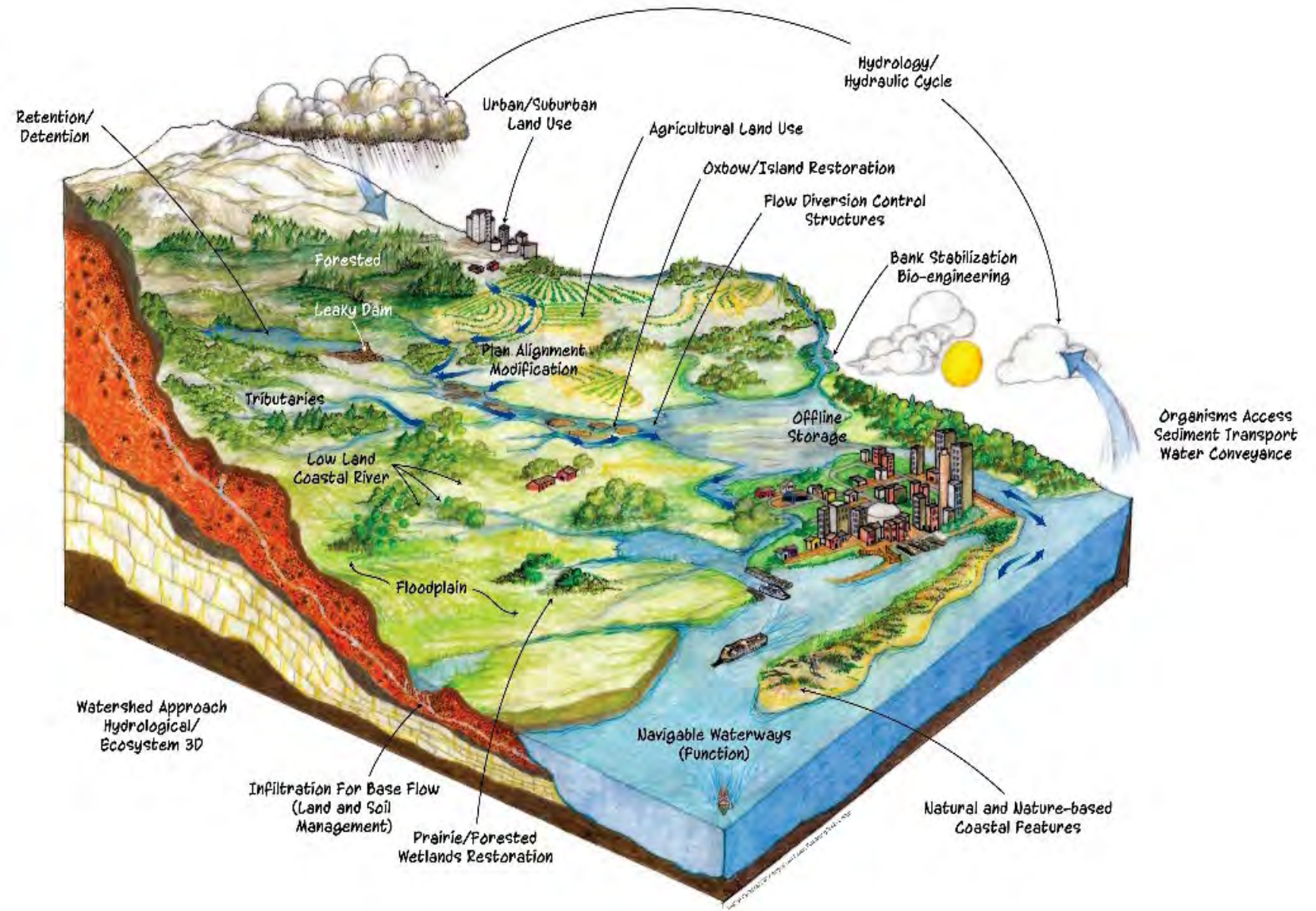
US Army Corps of Engineers

Conservation Plan for the Interior Least Tern, Pallid Sturgeon, and Fat Pocketbook Mussel in the Lower Mississippi River (Endangered Species Act, Section 7(a)(1))

MRG&P Report No. 4 - November 2014

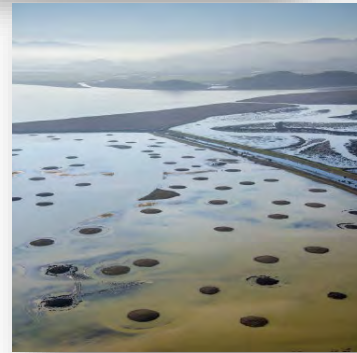
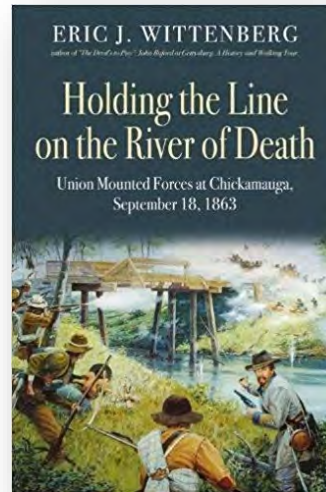
MRG&P
Mississippi River
Geomorphology &
Potamology Program

A Systems View of Solutions



Overarching Strategies

- **Hold the Line, “Hard”**
 - Galveston Seawall
 - Coast of Belgium
- **Retreat**
 - Savannah Lighthouse
 - Hamilton, Sears Point, CA
 - Belgium, Scheldt River Estuary
- **Advance**
 - New wetland, mangrove, island construction
 - New Jersey Bay Bays
 - Sabine to Galveston



Upstream Intervention in the UK: *Spreading out the Flow*



Puyallup River, WA: Soldier's Home Levee and Floodplain

April 2006

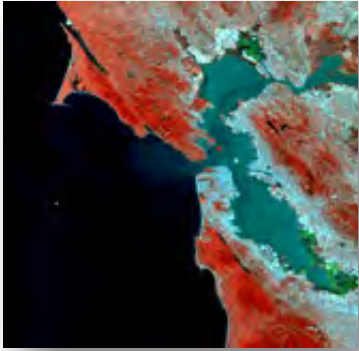


June 2016



US Army Corps of Engineers • Engineer Research and Development Center

Hamilton and Sears Point Wetlands; San Pablo Bay, CA



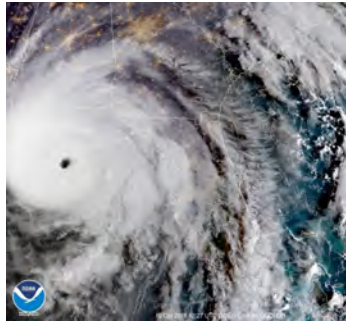
Hamilton Army Airfield; 6 mcy BU, 500 acres
Sonoma Land Trust; 1,000-acre tidal restoration

Fort Pierce City Marina, Florida

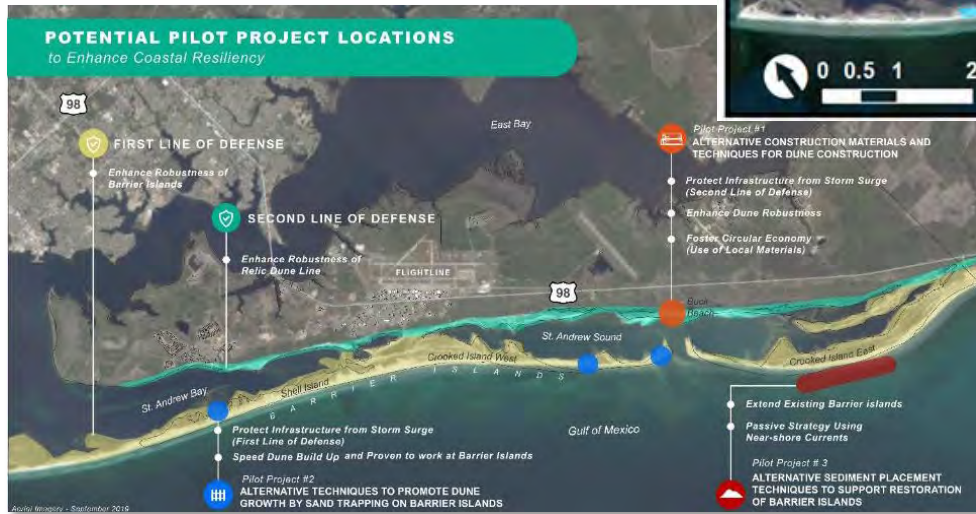
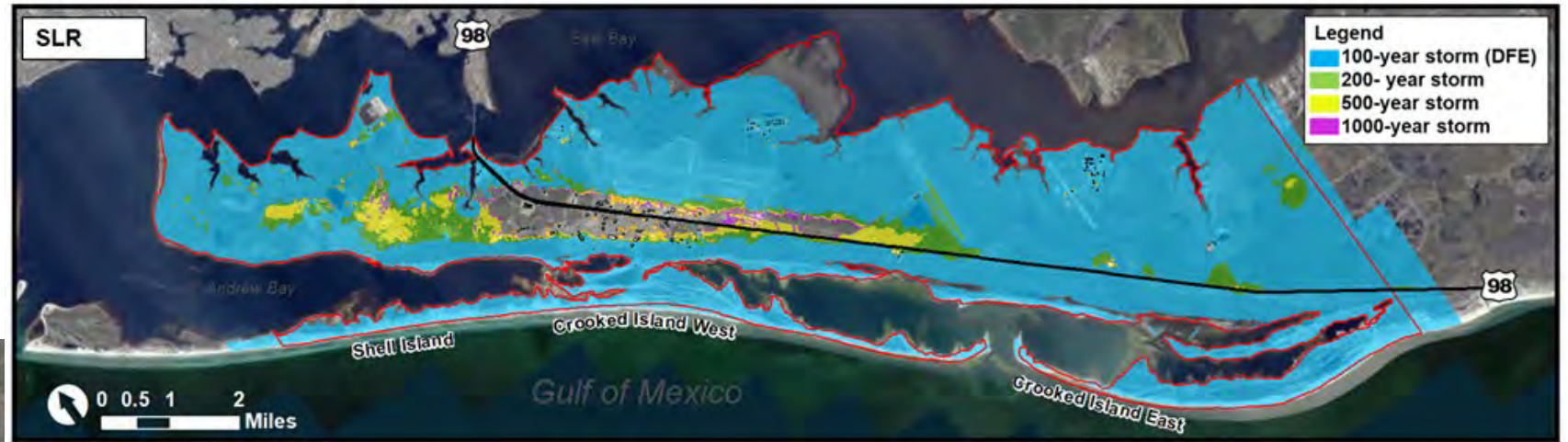


US Army Corps of Engineers • Engineer Research and Development Center

EWN[®] Applied to Tyndall Air Force Base Rebuild

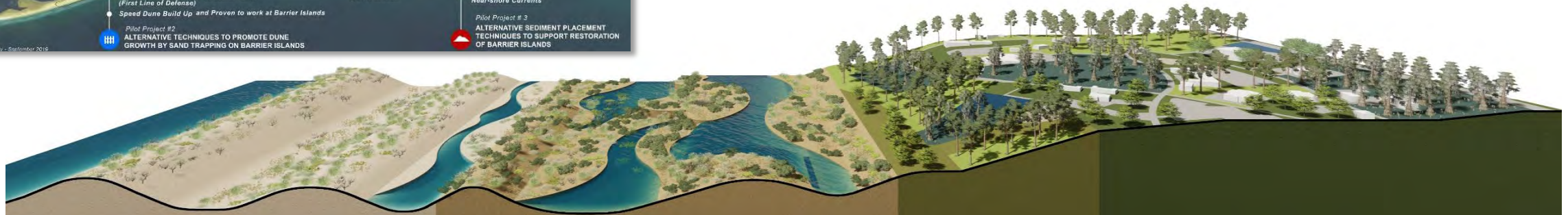


Hurricane Michael, 10-11 OCT, 2018



Tyndallcoastalresilience.com

EngineeringWithNature.org,
EWN Podcast Episode 3, BG Melancon



US Army Corps of Engineers • Engineer Research and Development Center

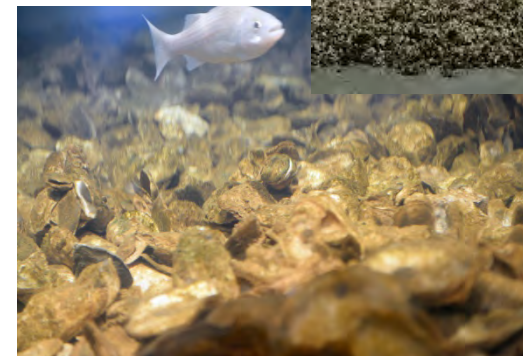
Defense Advanced Research Projects Agency (DARPA): REEFENSE



- **Program Vision:** Develop hybrid biological and engineered reef-mimicking structures to mitigate wave and storm damage that increasingly threaten DoD personnel and infrastructure
- **Program Funding:** \$50M over 5 years
- **ERDC Role:** Leading Independent Verification & Validation Team
- 3 Technical Areas
 - Structure Design and Structure
 - Adaptive Biology
 - Ecosystem Engineering
- 5 Year Program
 - Pre-design and Deployment (18 months)
 - Ecosystem Optimization (18 months)
 - Environmental Resilience (24 months)
- 2 Reef Habitats
 - Oyster
 - Coral



Lum, 2014



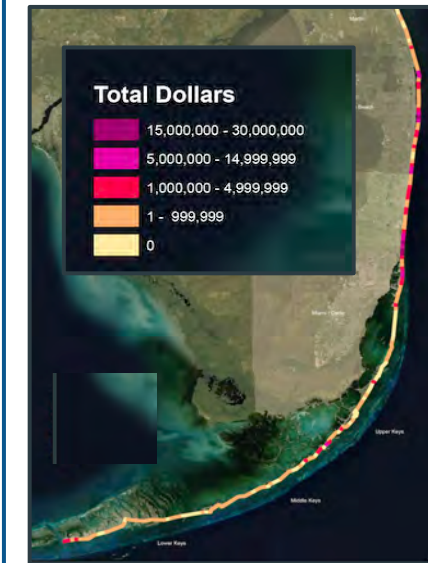
MDGovPics, 2013



REEFENSE

US Coral Reef Task Force

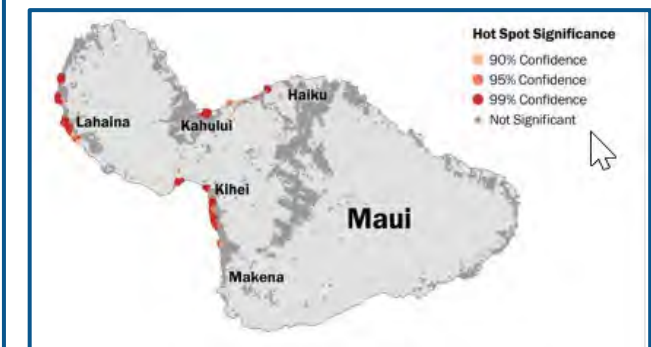
- **Mission:** USCRTF was established in 1998 to preserve and protect coral reef ecosystems.
- **USACE Role:** USACE is a Task Force member & supporting the “restoration and intervention” working group (RIWG).
- **RIWG Initiative:** Team is creating a handbook for community-based coral reef restoration projects that reduce flood risk, including:
 - Site Selection
(*risk – exposure – opportunities - impact*)
 - Project Scoping
(*cost benefit analysis – alternatives analysis - maintenance*)
 - Application Development
(*scope – budget – schedule - data documentation – match – administration*)
- **Stakeholder Engagement:** testing the handbook with State and local partners for effectiveness and usability.
- **Project Partners:** FEMA, NOAA, USACE, USGS, UC Santa Cruz.



Annual hazard risk reduction value of theoretical restoration along Florida's reef tract.

Source: <https://doi.org/10.3133/ofr20211054>

Optimal locations for restoration on Maui.

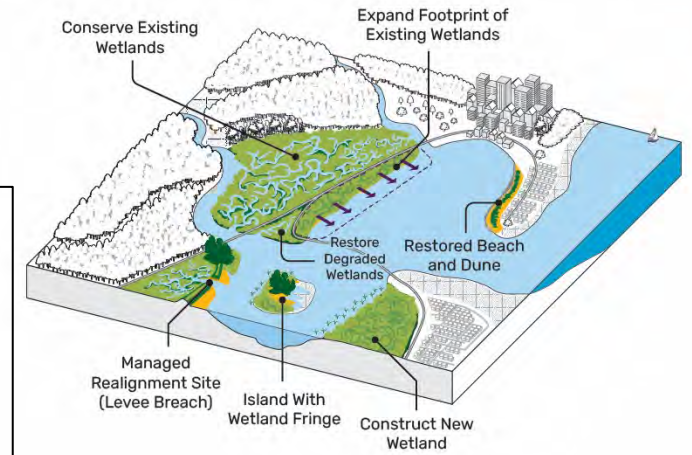


Source: <https://www.fema.gov/case-study/mapping-risk-reduction-benefits-coral-reef-conservation>

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

NNBF Guidelines Table of Contents

- Chapter 1. Introduction
- Chapter 2. Principles, Outcomes, and Frameworks
- Chapter 3. Engaging Communities and Stakeholders in Implementing Natural and Nature-Based Features
- Chapter 4. Planning and Implementing Natural and Nature-Based Features Using a Systems Approach
- Chapter 5. NNBF Performance
- Chapter 6. Benefits and Costs of NNBF
- Chapter 7. Adaptive Management
- Chapter 8. Introduction to NNBF in Coastal Systems
- Chapter 9. Beaches and Dunes
- Chapter 10. Coastal Wetlands and Tidal Flats
- Chapter 11. Islands
- Chapter 12. Reefs
- Chapter 13. Plant Systems, Submerged Aquatic Vegetation, and Kelp
- Chapter 14. Enhancing Structural Measures for Environmental, Social, and Engineering Benefits
- Chapter 15. Introduction to Fluvial Section
- Chapter 16. Fluvial Systems and Their Influence on Flood Risk Management
- Chapter 17. Challenges and Benefits of Natural and Nature-Based Features in Fluvial Systems
- Chapter 18. Description of Fluvial Natural and Nature-Based Features
- Chapter 19. Fluvial Natural and Nature-Based Features – Case Studies
- Chapter 20. The Future



NNBF Guidelines

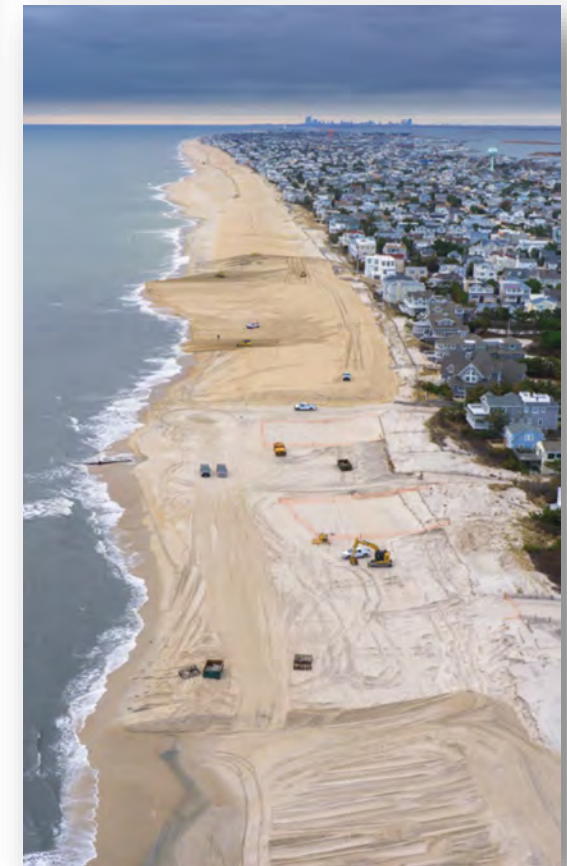
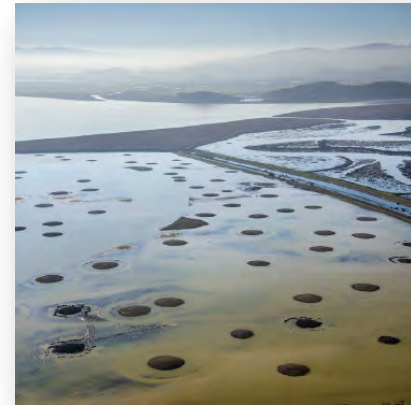
- Publication summer 2021
- 1,000 pages
- >170 authors and contributors from >70 organizations and 10 countries

www.engineeringwithnature.org

Nature-Based Solutions

Conserving, restoring, and engineering nature for the benefit of people and ecosystems

- **Project delivery**—“faster, cheaper”
- **Project performance**—complete solutions
- **Adaptability**—scalable, phaseable, flexible
- **Sustainability**—self-repair
- **Value to the Nation**—multi-functional benefits
- **Diversified investment**—diversified value→diversified partnerships
- **Social license**—community and stakeholder support and participation
- **Regulatory efficiency**—resolving conflict through win-win solutions



The Spectrum

“Wild and Free-Flowing Nature”

“Tamed and Conquered Nature”



Duwamish River, WA 1800s

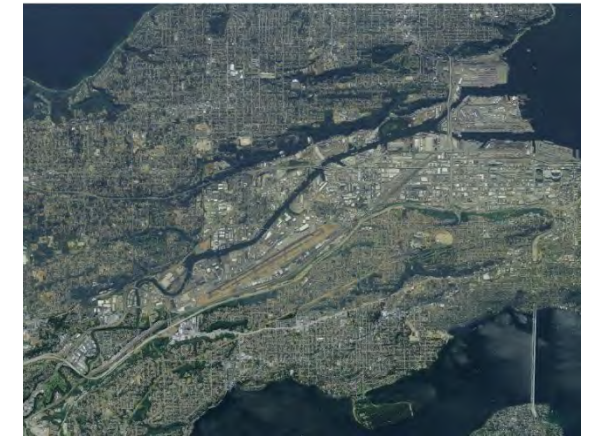


San Joaquin Valley, CA 1800s

Achieving Nature-Engineering Balance

Priorities for Advancing EWN

- 21st century vision for water infrastructure
- Policy and its implementation supporting the vision
- Modernized approach to community and stakeholder engagement
- Comprehensive approach to benefits evaluation
- Incremental development of engineering guidance



Duwamish River, WA today



San Joaquin Valley, CA today