

# Natural and Nature-based Solutions for the Texas Coast

## Developing a Decision Support System to Quantify a Full Array of Benefits

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Coastal Science and Engineering Collaborative (CSEC) Workshop

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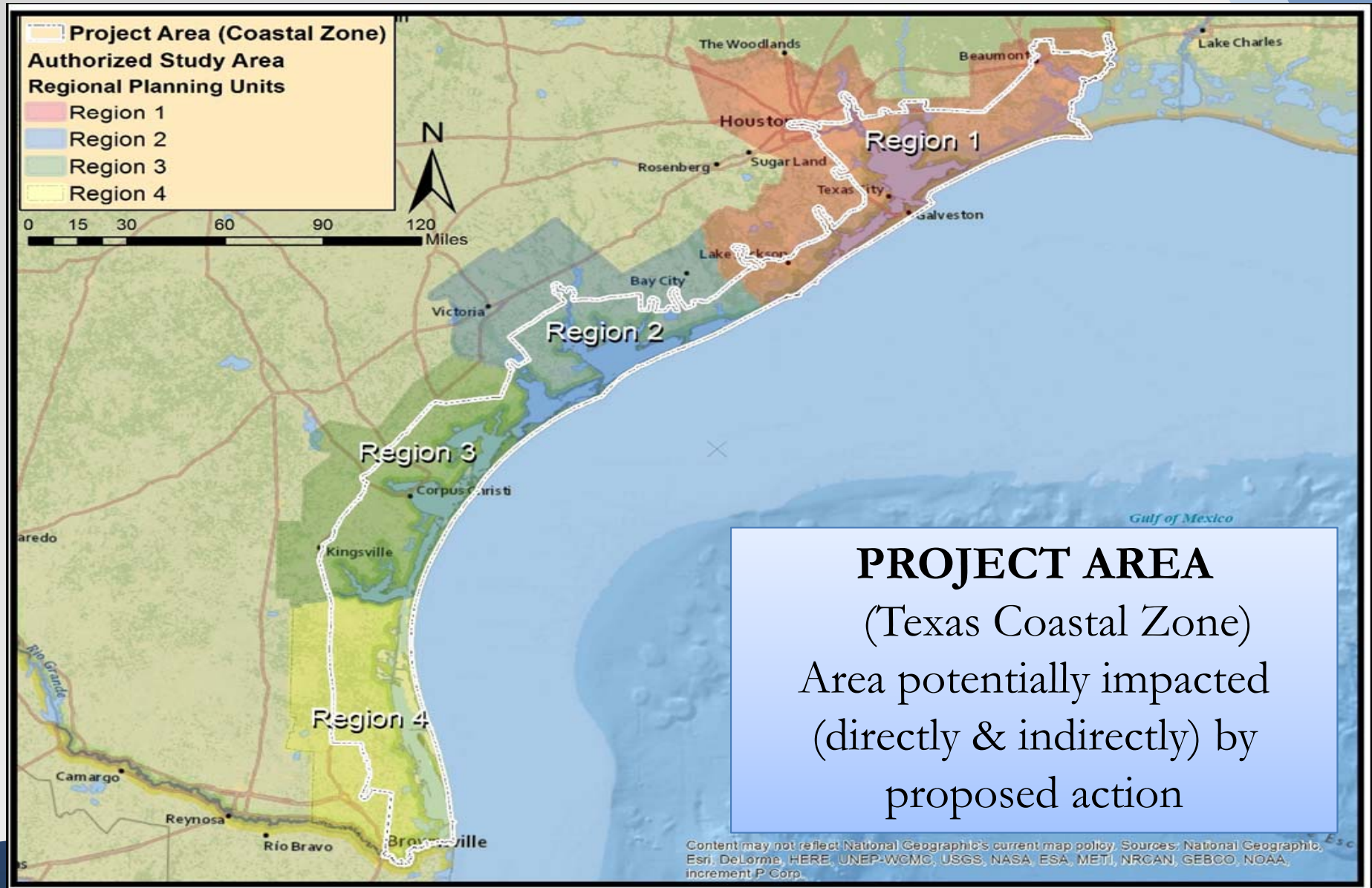


# The problem in a nutshell

- Coastal projects are not isolated, but rather exist at the **interface** of population centers and their supporting waterways
- We need a rapid assessment approach that can operate in the **3x3x3** SMART planning paradigm
- Plans will contain a **full array of measures**: natural, nature-based, non-structural and structural.
- So we need to capture the **full range** of benefits: Environmental + Social + Economic
- We need a **desk-top application** that is fast AND science-driven

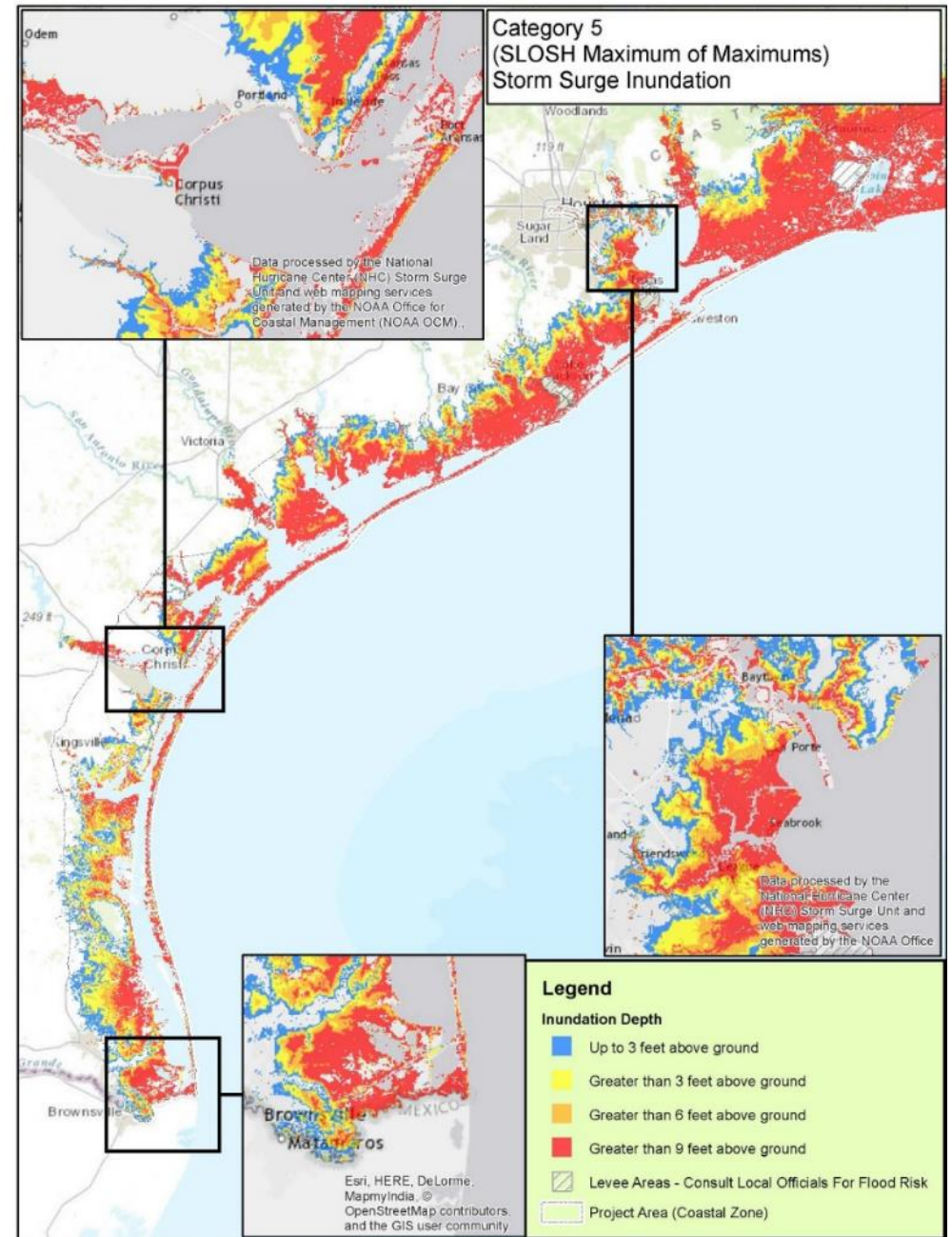


# Let's Set the Stage: USACE TX Coastal Study



# Climate Change: What happens if. . .

Trend  
Continues:  
Limited  
Flooding of  
other  
Developed Area  
of the Coastal  
Texas



# Coastal TX Study Authority

*(Section 4091, Water Resources Development Act (WRDA) of 2007 Public Law (P.L.) 110-114)*

*Sec. 4091. Coastal Texas Ecosystem Protection and Restoration, Texas.*

*(a) In General.—The Secretary shall develop a **comprehensive plan** to determine the feasibility of carrying out projects for flood damage reduction, **hurricane and storm damage reduction**, and **ecosystem restoration** in the coastal areas of the State of Texas.*

*(b) Scope.—The comprehensive plan shall provide for the **protection, conservation, and restoration of wetlands, barrier islands, shorelines**, and related lands and features that **protect critical resources, habitat, and infrastructure** from the impacts of coastal storms, hurricanes, erosion, and subsidence.*

*(c) Definition.—For purposes of this section, the term “coastal areas in the State of Texas” means the coastal areas of the State of Texas from the **Sabine River on the east to the Rio Grande River on the west** and includes **tidal waters, barrier islands, marshes, coastal wetlands, rivers and streams, and adjacent areas.**”*



# Chasing the Big Blue Rabbit

“Call it climate change, call it the big blue rabbit. I don’t give a hoot what you call it – the military has to respond to those kinds of things.”

Brig. Gen. Mark McCleod  
Commander, Defense Logistics Agency,  
Energy, Defense Logistics Agency, Fort Belvoir, VA

**Resilience** is the ability of a system to **prepare for**, **resist**, **recover**, and **adapt** to achieve functional performance under the stress of natural hazards and human-related disturbances through time.

**Vulnerability** is the opposite side of the coin . . . . .  
i.e., the degree to which a system is susceptible to, and unable to cope with, the adverse effects of natural hazards or human-induced disturbances over a period of time or temporal reference

(exposure + sensitivity + adaptive capacity)

## Climate Change, National Security and the Big Blue Rabbit



Stars and Stripes magazine’s Wyatt Olson recently published a very interesting and thorough article titled “PACOM not waiting for politics to plan for climate change challenges.” The article details the reasons U.S. Pacific Command is taking climate change seriously, and some of what it’s doing to combat the threat.

A great quote from the piece, which perfectly encapsulates the national security community’s risk management approach to climate change, comes

from Brig. Gen. Mark McCleod. He stated:

*Seventy percent of the bad storms that happen in the world are in the Pacific,” he said. “Call it climate change, call it the big blue rabbit, I don’t give a hoot what you call it — the military has to respond to those kinds of things.*

The article outlines PACOM’s partnerships with Pacific nations on combating climate change/ the big blue rabbit, particularly the small island states. Olson notes:

*Indeed, despite claims by some that global warming is a myth, there’s growing accord among analysts and military thinkers around the world that the repercussions of climate change will require the same application of strategy the military would employ when grappling with any foe. To that end, PACOM initiated a series of forums held throughout the region designed to brainstorm military-civil solutions to climate-related security issues. Pacific Command is already collaborating with several small island nations to help them cope with problems from rising sea level, such as saltwater encroachment into ground water.*

The Center for Climate and Security’s Francesco Femia is quoted in the piece as well. In describing the significance of the 2014 Quadrennial Defense Review (QDR), which identified climate change as a threat multiplier and emphasized some of the broader human security implications of climate change (food, water and energy, for example), Femia said the QDR:

*... opens the door for the Department of Defense and PACOM in the region to look more broadly at how they can help in terms of working with nations and partner militaries in helping those nations be prepared for events before they occur...*

On the role of PACOM, and how climate change presents an opportunity for U.S. leadership in the region, Femia noted:

*In a lot of ways, the front line on this issue is PACOM, given its [humanitarian disaster relief] responsibilities... So we’re actually seeing the U.S. military playing a leading role in figuring out how climate change plays into our relationships in the area — including, from a more traditional security perspective, how we assist in the resilience and operational planning in terms of climate-related threats in the region...*

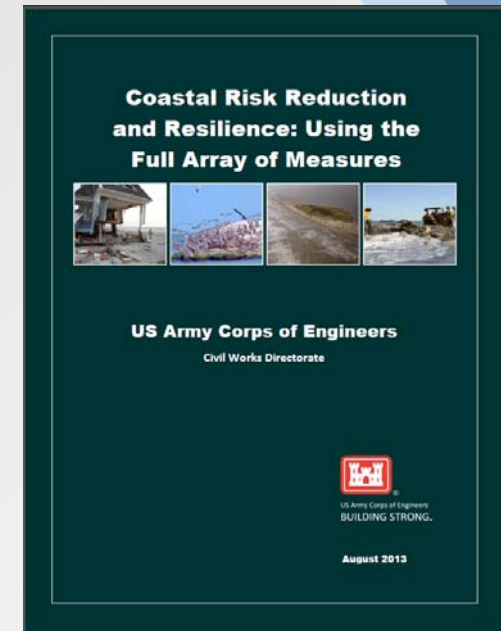
<http://climateandsecurity.org/2014/08/13/climate-change-national-security-and-the-big-blue-rabbit/>

# Multiple Lines of Defense

**Natural features** are created and evolve over time through the actions of physical, biological, geologic, and chemical processes operating in nature. Natural coastal features take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests. The relationships and interactions among the natural and built features comprising the coastal system are important variables determining coastal vulnerability, reliability, risk, and resilience.

**Nature-based features** are those that **may mimic** characteristics of natural features but are **created by human** design, engineering, and construction to provide specific services such as coastal risk reduction.

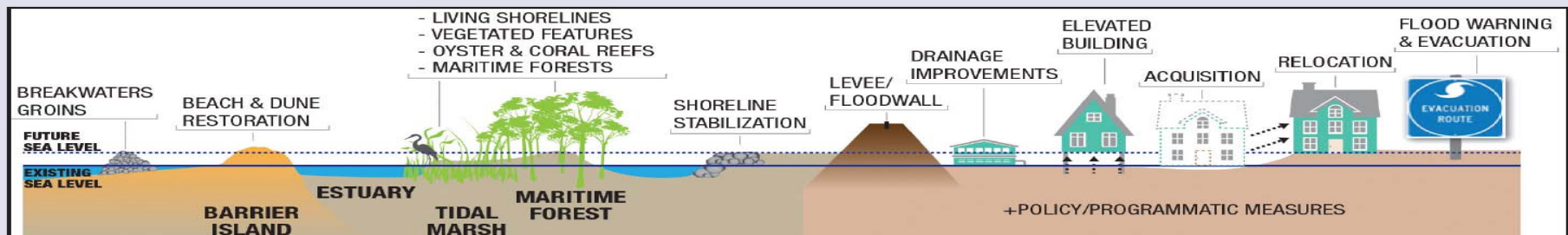
The **built components** of the system include nature-based and other structures that support a range of objectives, including erosion control and storm risk reduction (e.g., seawalls, levees), as well as infrastructure providing economic and social functions (e.g., navigation channels, ports, harbors, residential housing).



<http://www.corpsclimate.us/ccacrrr.cfm>

**Improved coastal storm risk management measures are needed**






Employing three primary strategies—**protect, accommodate, and retreat**—coastal communities should consider a system of **comprehensive, resilient, and sustainable** coastal storm risk management measures. The system should include a **combination of measures** (structural, NNBF, and nonstructural measures) to form **resilient, redundant, robust, and adaptable strategies** and measures that are tailored to enhance life safety, local site conditions, and societal values.



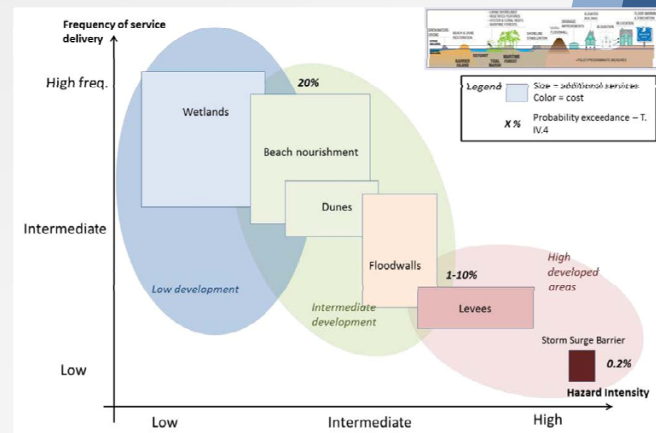
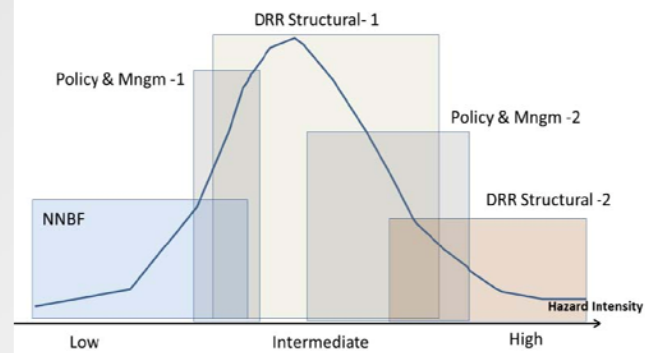
**Figure II-1. Combinations of measures may be used to improve redundancy and resilience associated with coastal flood risk management.**

# Natural and Nature-Based Infrastructure at a Glance

**GENERAL COASTAL RISK REDUCTION PERFORMANCE FACTORS:**  
 STORM INTENSITY, TRACK, AND FORWARD SPEED; SURROUNDING LOCAL BATHYMETRY AND TOPOGRAPHY

				
<b>Dunes and Beaches</b>	<b>Vegetated Features</b>	<b>Oyster and Coral Reefs</b>	<b>Barrier Islands</b>	<b>Maritime Forests/Shrub Communities</b>
<b>Benefits/Processes</b> Breaking of offshore waves Attenuation of wave energy Slow inland water transfer	<b>Benefits/Processes</b> Breaking of offshore waves Attenuation of wave energy Slow inland water transfer Increased infiltration	<b>Benefits/Processes</b> Breaking of offshore waves Attenuation of wave energy Slow inland water transfer	<b>Benefits/Processes</b> Wave attenuation and/or dissipation Sediment stabilization	<b>Benefits/Processes</b> Wave attenuation and/or dissipation Shoreline erosion stabilization Soil retention
<b>Performance Factors</b> Berm height and width Beach slope Sediment grain size and supply Dune height, crest, and width Presence of vegetation	<b>Performance Factors</b> Marsh, wetland, or SAV elevation and continuity Vegetation type and density	<b>Performance Factors</b> Marsh, wetland, or SAV elevation and continuity Vegetation type and density	<b>Performance Factors</b> Marsh, wetland, or SAV elevation and continuity Vegetation type and density	<b>Performance Factors</b> Marsh, wetland, or SAV elevation and continuity Vegetation type and density

**RISK SPECTRA – POTENTIAL DAMAGE**



Supporting material: for ex. references and description in Page 106 – Appendix S - NNBF

<http://www.corpsclimate.us/ccacrrr.cfm>

Reguero et al. 2014 (in press)



# Lines of Defense Under Consideration

- Low surge protection
  - Offshore breakwaters
  - Reduce waves and coastal erosion



# Lines of Defense Under Consideration

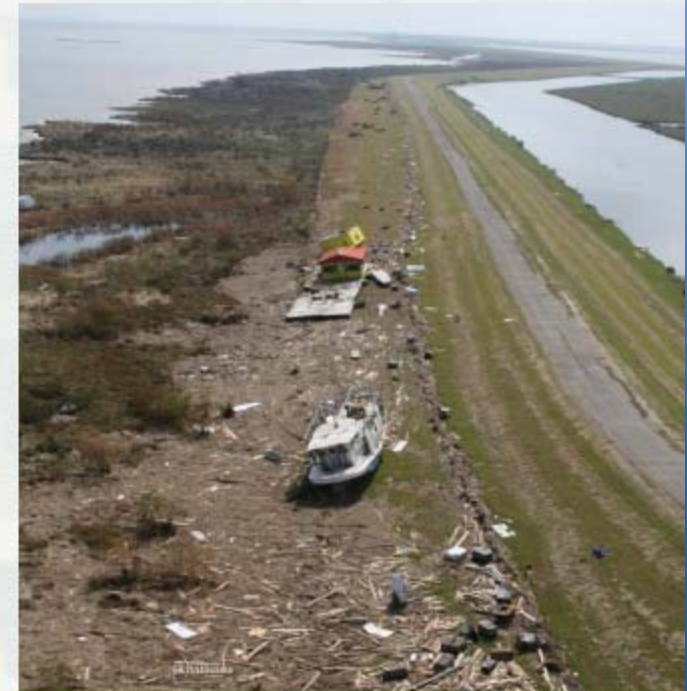
- Low/medium surge protection
  - Marsh, beach and dune restoration



# Lines of Defense Under Consideration

- High surge protection
  - Levees/flood walls
  - Block storm surge from moving inland

Freeport Hurricane Protection System



Texas City Levee  
Hurricane Ike Aftermath



**BUILDING STRONG**®

# Lines of Defense Under Consideration

- High surge protection
  - Seawalls/flood gates
  - Protect developed areas from storm surges
  - Prevent storm surge from entering coastal inlets and bays

Galveston Seawall



Dutch Floodgate



# Ecosystem Restoration Ideas

Oyster Reef Restoration – photo courtesy TNC



Bird Island Creation – Galveston Bay



Marsh Restoration – Neches River



Shoreline Protection –  
GIWW in Jefferson Co (courtesy TNC)



Beach Restoration – SPI



# The Constraint: SMART PLANNING

New USACE Planning Paradigm:

**S**pecific

**M**easureable

**A**ttainable

**R**isk Informed

**T**imely

- 3 x 3 x 3 SMART Planning
  - Completed in 3 yrs
  - For no more than \$3M
  - 3 levels of vertical alignment
- Balance uncertainty & level of detail

SMART Feasibility Study Process

18-36 MONTHS



Focus on alternatives evaluation to identify a tentative plan for more detailed design .

Focus on scaling the measures and features for the recommended plan/LPP.

# What is needed. . . . .

**Performance Metrics** that provide **specific** measures of production or indicators of system response that can be used to **consistently** estimate and report the anticipated **consequences** of an alternative plan with respect to a particular planning and engineering objectives.

They must articulate the exact information that will be collected, modeled, elicited from experts, or otherwise developed and presented to decision makers to characterize plan performance and engineering designs.

They must provide the ability to **distinguish** the relative degree of ecosystem response (conveyed in terms of impacts or benefits) **across alternatives and designs**, either qualitatively or quantitatively, in ways that make sense and will help decision makers consistently and transparently compare alternatives and designs.

Good performance metrics are:

- Complete and concise
- Transparent and unambiguous
- Accurate
- Direct
- Understandable
- Operational



# State of the Science: State of the Practice

- Site selection exercise – purely qualitative exercise
- All benefits/impacts MUST be quantified
- Currently limited to the “Certified Model” Rule
- Also limited by the “HEP” Rule  
(Quantity x Quality)
- And we don't have much time (May 2018)





# State of the Science: State of the Practice

Which means. . . .

- We have to use what's available – species-based tools

## Barrier Islands/dunes

WVA Model

## Oyster Reefs

Oyster Community Model

## Tidal Flats

Mottled duck

Least tern

Red drum

## Islands

Brown pelican

Roseate spoonbill

Forster's tern

## Submerged Aquatic Vegetation

Red drum

Brown/white shrimp

Spotted seatrout

Atlantic croaker

Redhead

## Marsh (Salt & Brackish)

Atlantic croaker

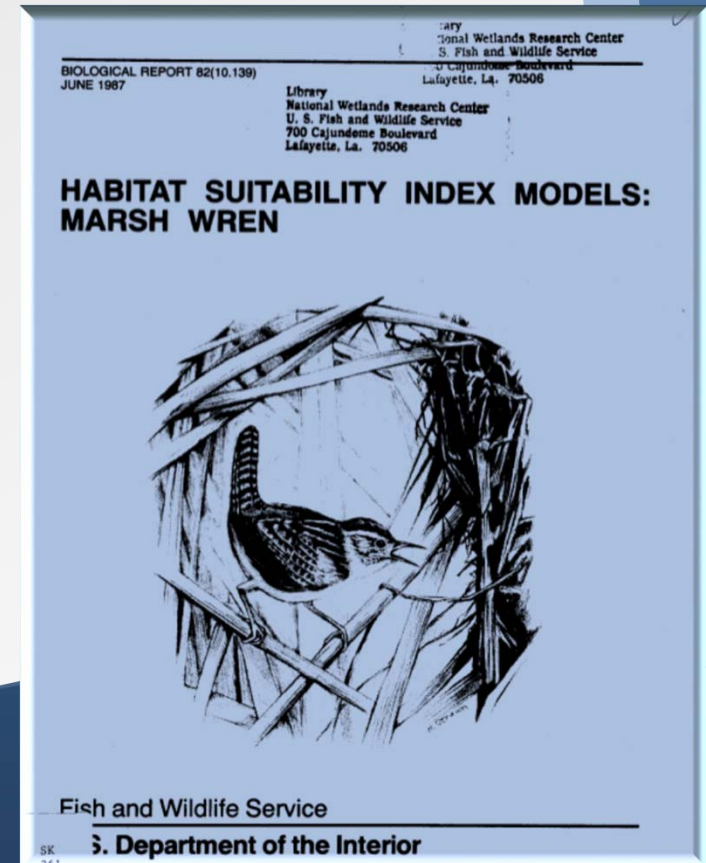
Red drum

Spotted seatrout

Brown/white shrimp

Northern pintail

Marsh wren



# State of the Science: State of the Practice

But. . . . What we really want is a Decision Support System . . . .

- A suite of community-based models like the WVA & Oyster
- Based on a data-driven process – using readily available data and developing a plan to fill the gaps
- An internet-based system would be ideal – Dial-a-Plan
- Using a spatially explicit – GIS-driven dataset
- And then we need to train the work force



# Food for Thought . . . .

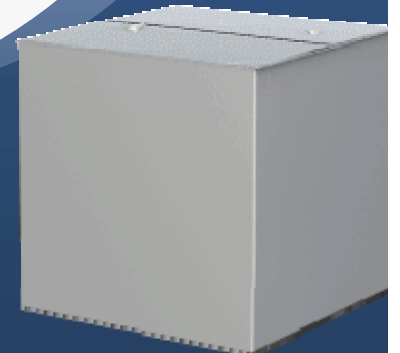
## How can we account for NNBF Benefits?

### **Ecosystem Goods and Services**

Tangible items or intangible commodities generated by self-regulating or managed ecosystems whose composition, structure, and function are comprised of natural, nature-based and/or structural features that produce socially-valued benefits that can be utilized either directly or indirectly to promote human well-being.

Key Take-home points:

1. EGS can be derived from either built or natural capital (or a combination of the two)
2. Their value is simply a way to depict their importance or desirability to the consumers.
3. The ability of ecosystems to provide goods and services is dependent on critical ecosystem processes tied to structure and function either alone or in concert.



# EGS production by NNBF & Traditional Solutions

**Ecosystem**

**Service Provision**