US Army Corps of Engineers®

Engineering With Nature

Coastal Wetlands and NNBF
RAE Workshop, New Orleans, 12.08.22

Jacob F. Berkowitz, PhD, CPSS, PWS
US Engineer Research and Development Center
Jacob.F.Berkowitz@usace.army.mil
@wetlandsoil @Wetlands_Team

Coastal Wetlands and NNBF - Topics

1) Guidelines

Coastal wetlands: Chapter 10

Focus on flood risk & erosion management

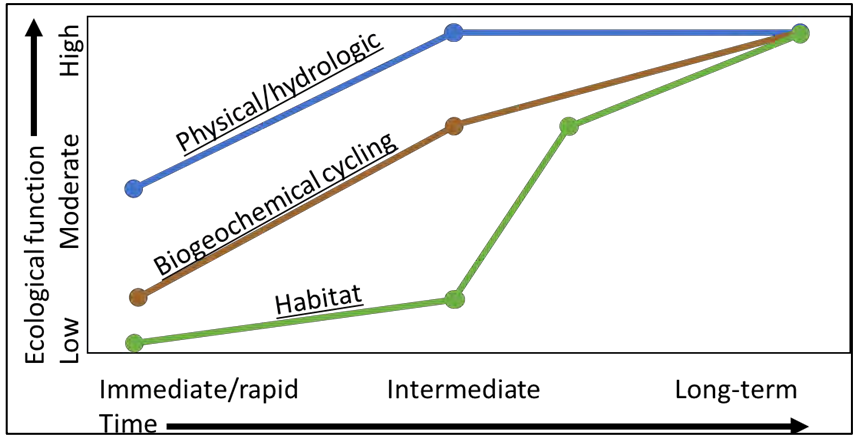
2) Backcasting

Trajectory of NNBF wetlands after >40 yrs

More inclusive view

3) Paradigm-forcing

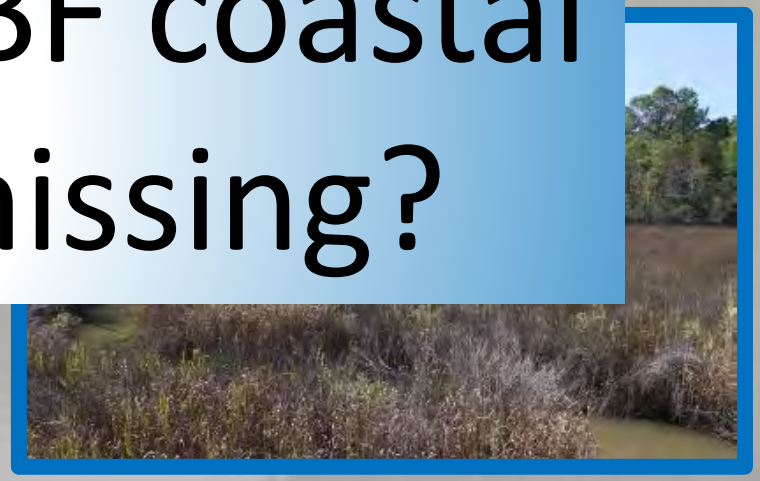
Moving from reference base to function, goods, & services design criteria



Holistic future perspective

What types of NNBF coastal wetlands are we missing?

Cattail marsh
1.3-2.6 ppt



Blackneedle rush marsh
>6.4 ppt

Tidal shrub community
2.6-6.4 ppt

Mangroves*
3-27 ppt

Coastal Wetlands and NNBF – Guideline considerations

In an environment where wetlands can persist

These boundaries are not rigid. Engineered

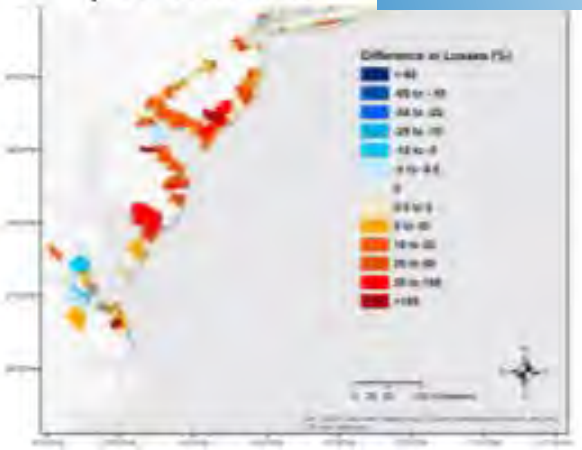
Where they can provide the desired co-benefits

Co-benefits are not uniformly produced at all locations.

ST documentation

What are NNBF coastal wetland co-benefits?

Where they can pr
performance



Wetlands in some areas can reduce flood damages but may increase them in others.

from Narayan and Beck 2017

Education, outreach, and guidance are required to ensure wetlands are accepted.

from TNC *Mangroves for Coastal Defense: Guidelines for coastal managers & policy makers*

Coastal Wetlands and NNBF – Guidelines Key messages (10)

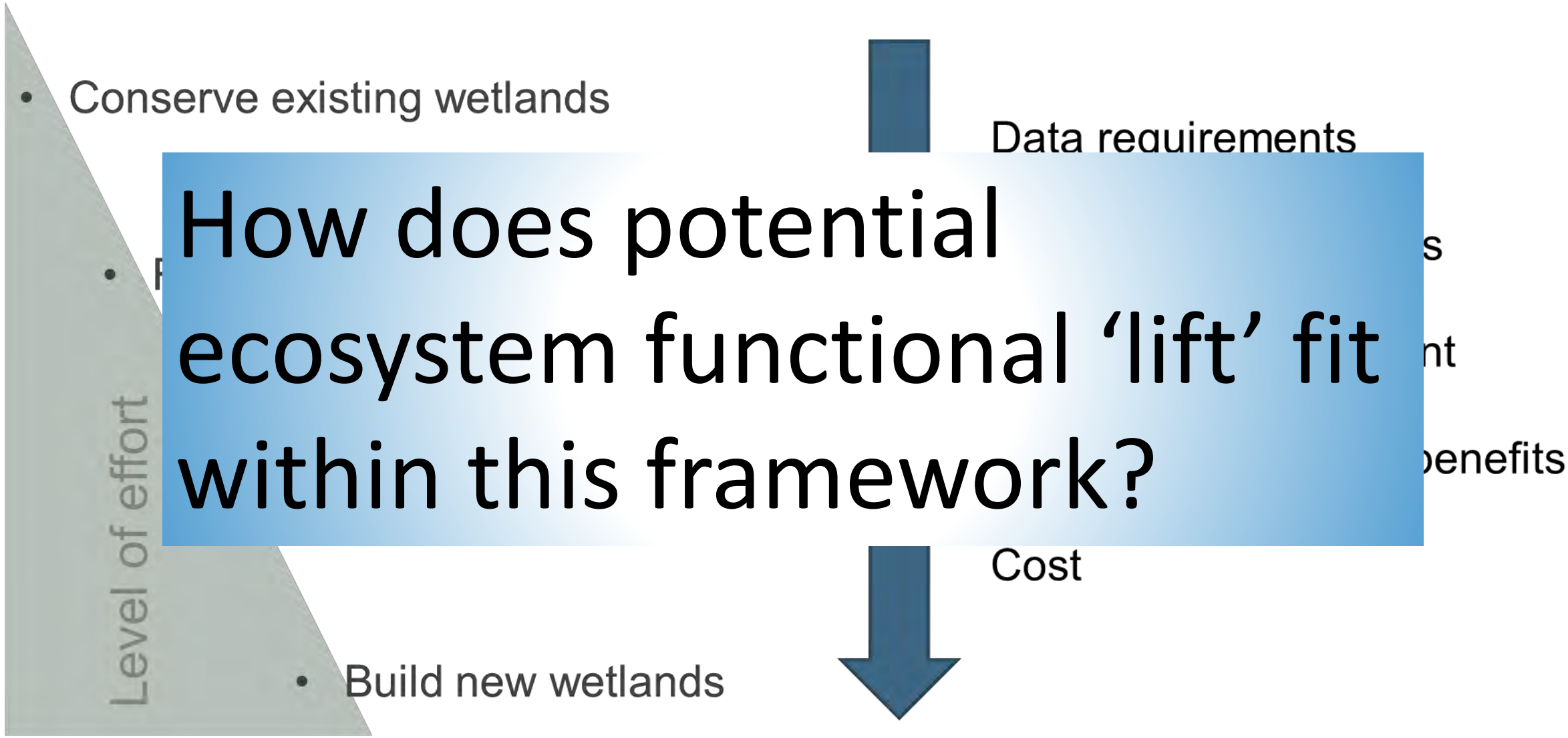
1. Reduce flood & erosion risk – increased friction
2. Accomplished by conservation, restoration, creation*
3. Performance → location, geometry/geomorphology, storm profile (water level, wave height & period)
4. Wave reduction → topography, vegetation, storm profile
5. Surge reduction → bi-directional (width & extent/length)

Coastal Wetlands and NNBF – Guidelines
Key messages (10)

6. Flood water attenuation → location & design (storage)
7. State of the science → more than other NNBF arenas
8. Can be self sustaining → Sediment supply, hydropattern, salinity, primary productivity… SLR, subsidence, decomp
9. Persistence → past and present ≠ future (sacrificial)
10. Performance change over time → vegetation, storm damage, recovery, and maintenance requirements

Coastal Wetlands and NNBF – Guidelines

HOW DO WE IMPLEMENT WETLAND NNBF SOLUTIONS?



How does potential ecosystem functional ‘lift’ fit within this framework?

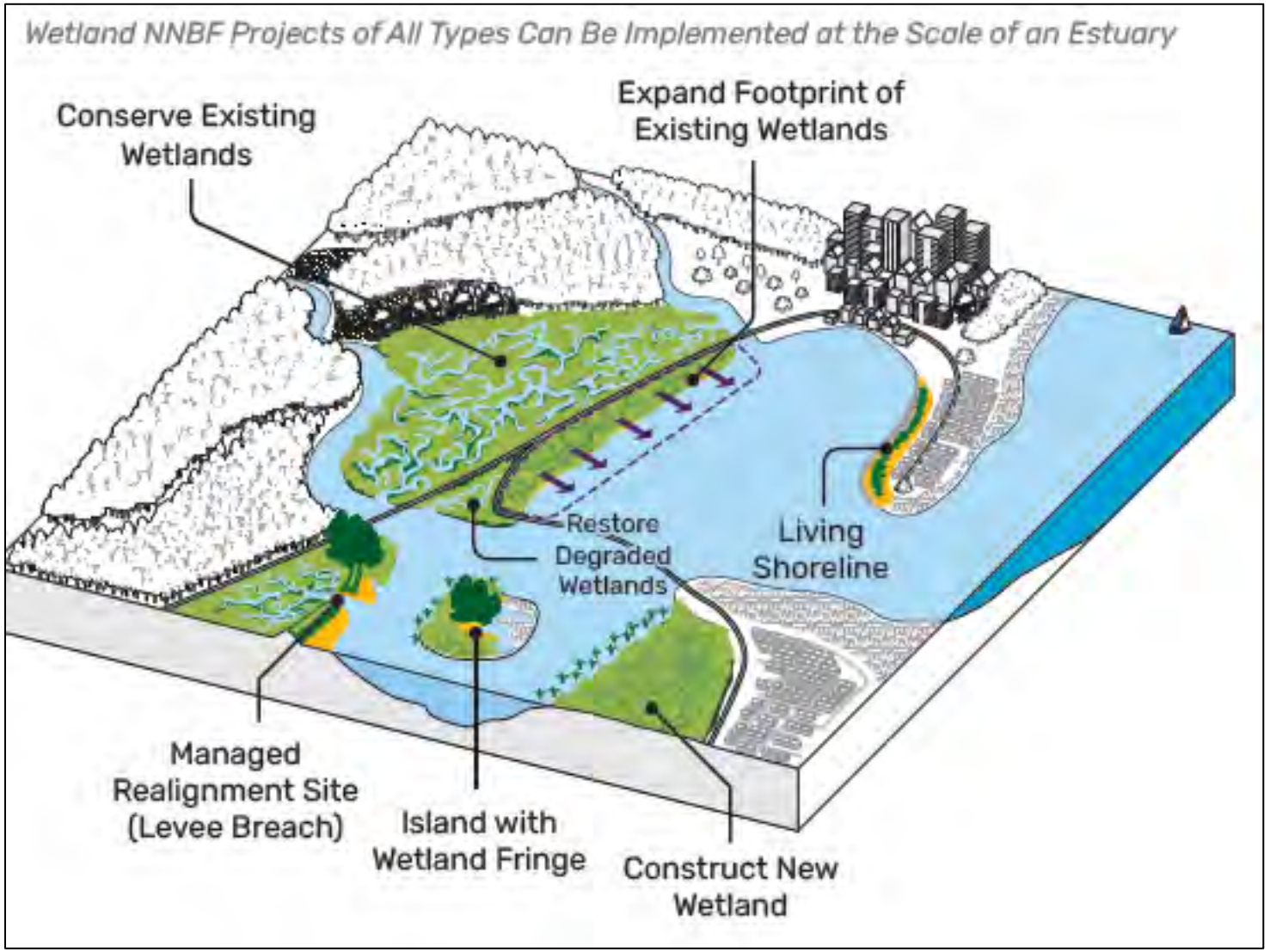
Coastal Wetlands and NNBF – Guidelines

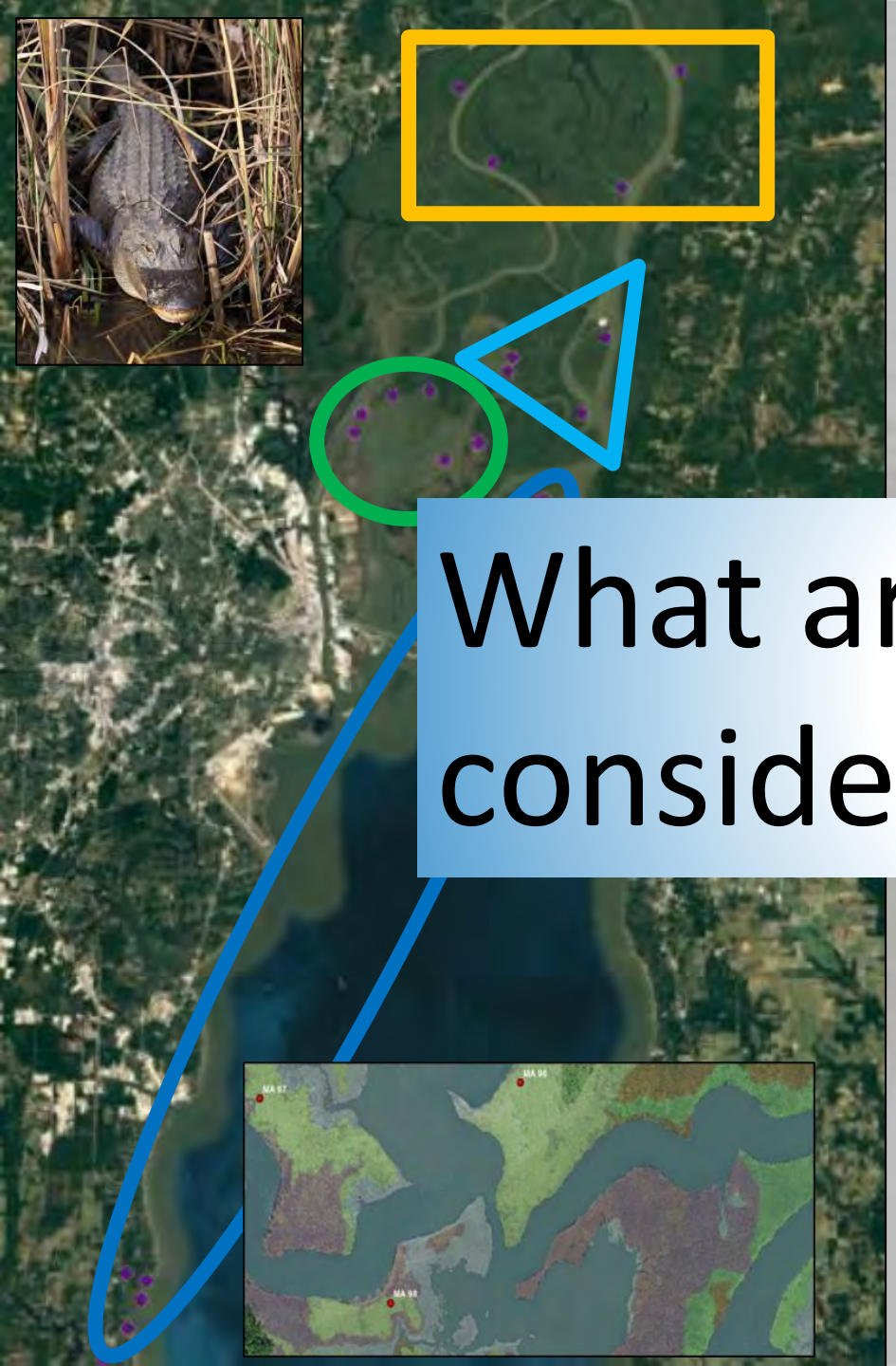
Few studies quantify FRM benefits

US coast $3200/ha-yr

Saved $2-36M/ha over 30 yrs → location, location

Intact wetlands → 20-30% reduced H. Sandy damage





Engineering With Nature

Wetland types differ by:

Geomorphology

Vegetation

What are other critical considerations?

Resiliency to stressors

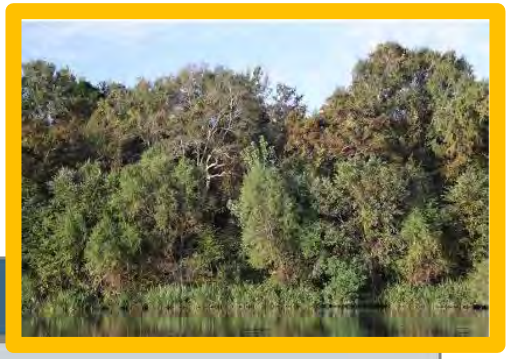
Disturbance

Surrounding landscape (LCLUC)

*Each impact NNBF opportunities, risks

Coastal Wetlands and NNBF – Guidelines

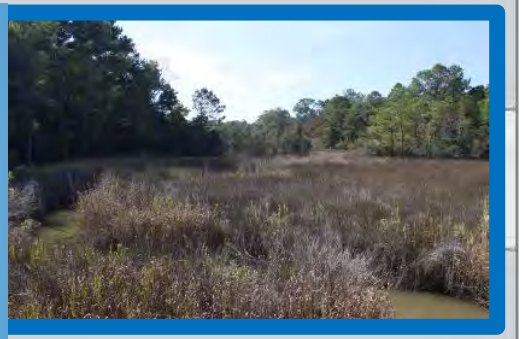
HOW DO YOU DESIGN A WETLAND NNBF SOLUTION?

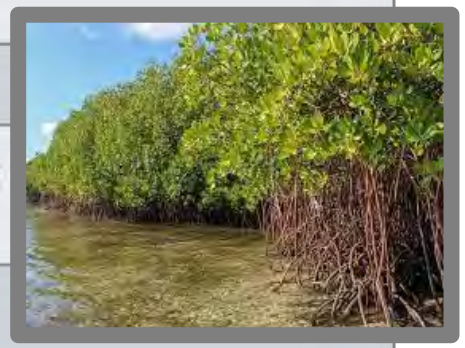


Focus on the aspects of the design you can control.

Design parameter	Performance factors
Size and configuration (x,y)	Location in estuary Distance from shoreline to upland or structure
Platform elevation (z)	
Channel network	
Vegetation	Species, height, shape, density, flexibility, roots, distribution
Sediment properties	Grain size, organic matter, bulk density, shear strength
Nearshore bathymetry	Depth, slope, sediment properties of adjacent subtidal mud/sand flats Proximity to deep water
Proximity to traditional defenses	Distance to defense, configuration and geometry of defense

What is the #1 thing out of our control?





Coastal Wetlands and NNBF – Guidelines

WETLAND NNBF: GUIDING PRINCIPLES AND SUMMARY

- Wetland NNBF combines aspects of flood/erosion risk management and wetland restoration.
- FRM capacity of wetlands depends on critical biophysical and geomorphological characteristics *including the location in the landscape.*
- The temporal and spatial dynamics of wetlands need to be considered.
- Wetland design solutions are diverse.
- Monitoring and maintenance are critical.
- Key questions remain to be addressed.
  - Sustainability, cost-benefit, performance, co-benefits


National Parks Foundation


TNC

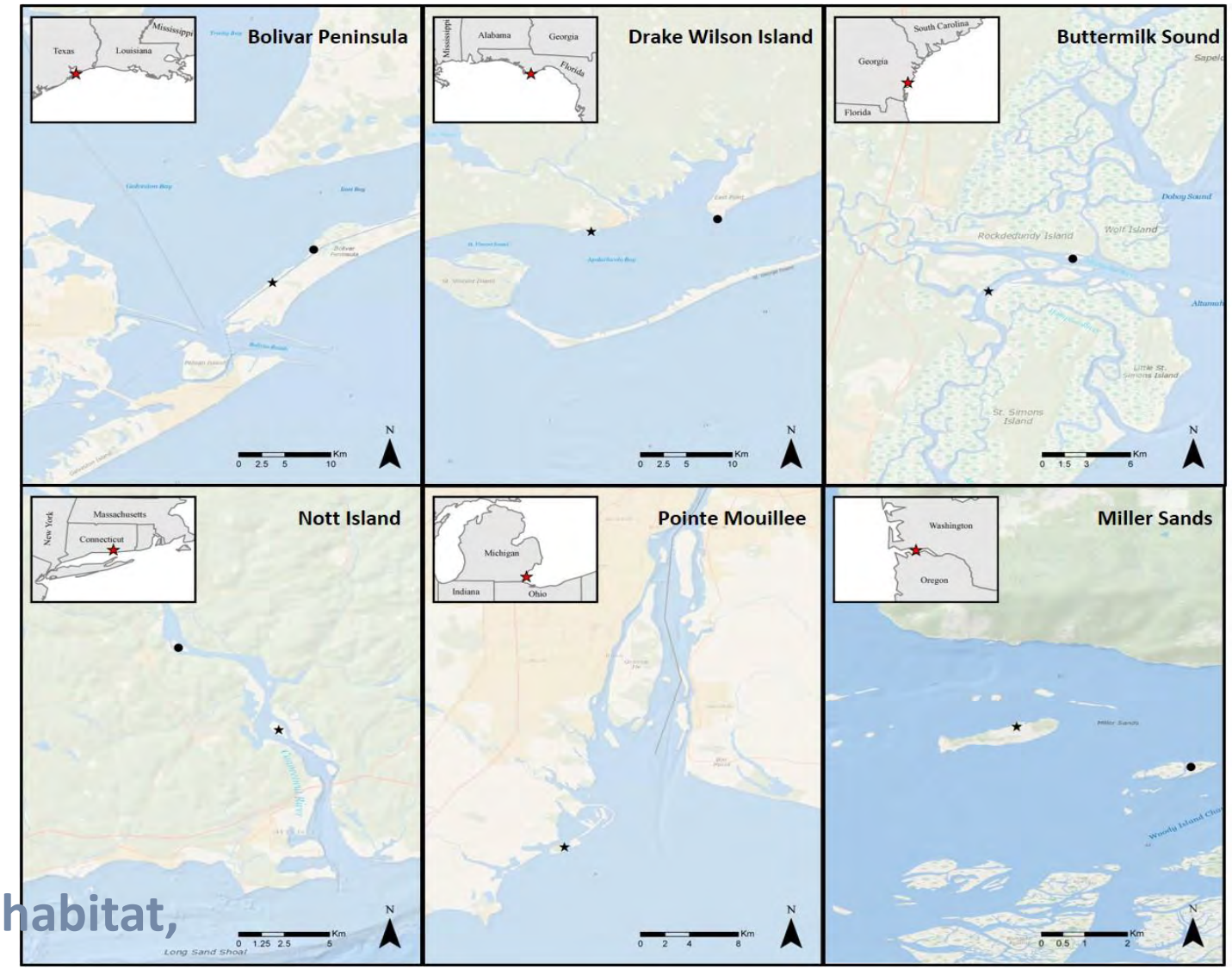
Coastal Wetlands and NNBF – Backcasting

-Assess long-term benefits of NNBF wetlands created using dredged material

-Six wetland sites with a wide range of geographic and geomorphic diversity

-Focus on ecological functions related ecosystem goods and services

Coastal Wetlands and NNBF – Backcasting locations



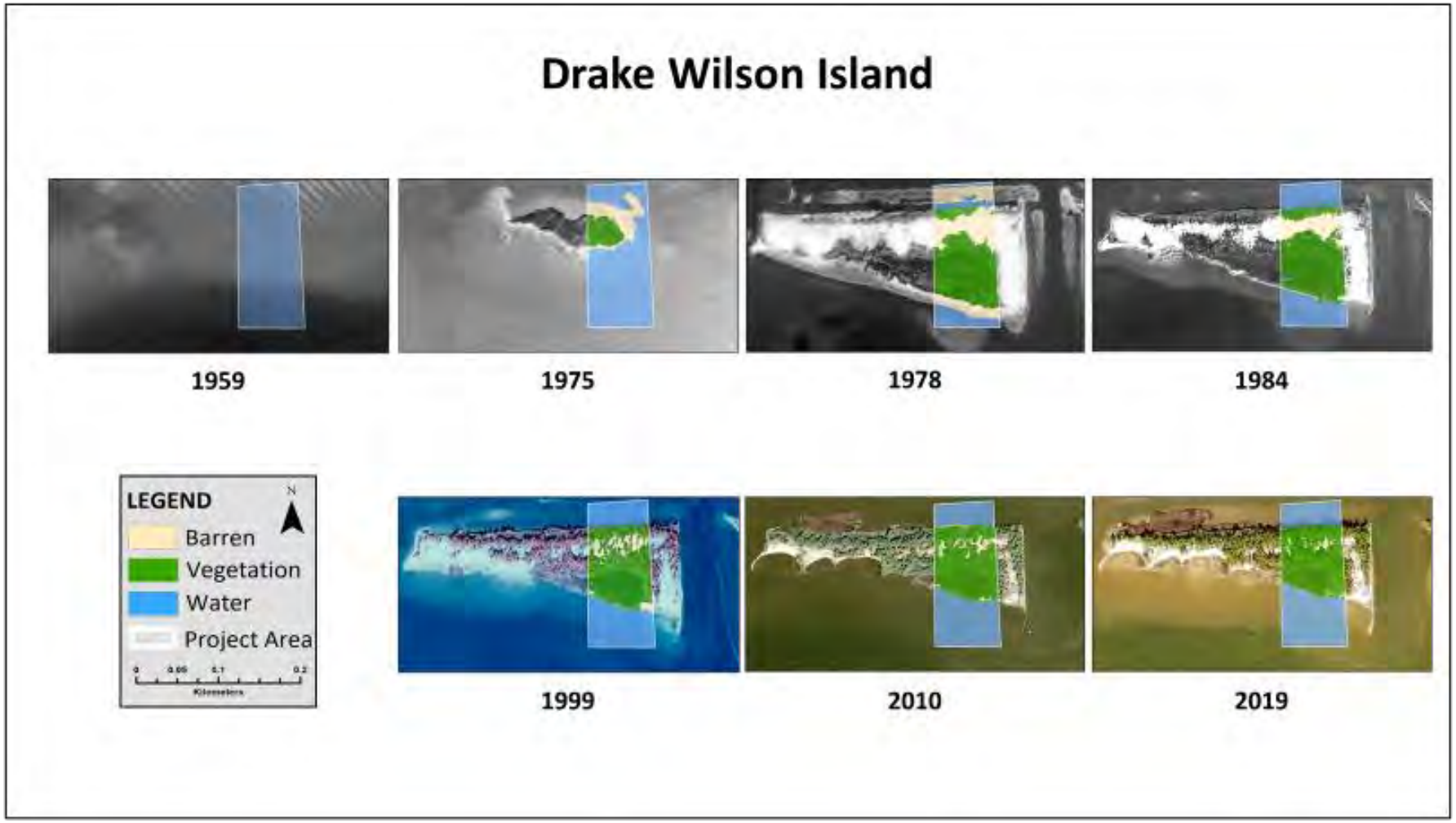
Projects constructed (1974-1978)

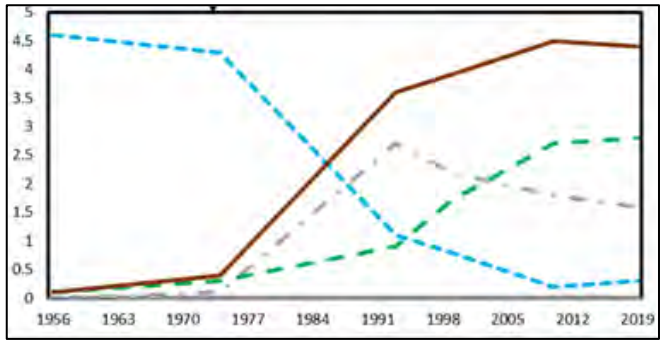
Oldest NNBF wetland with data

Re-created the previous study

Geomorphology, vegetation, avian habitat, and soils

Coastal Wetlands and NNBF – Backcasting outcomes





Coastal Wetlands and NNBF – Backcasting outcomes

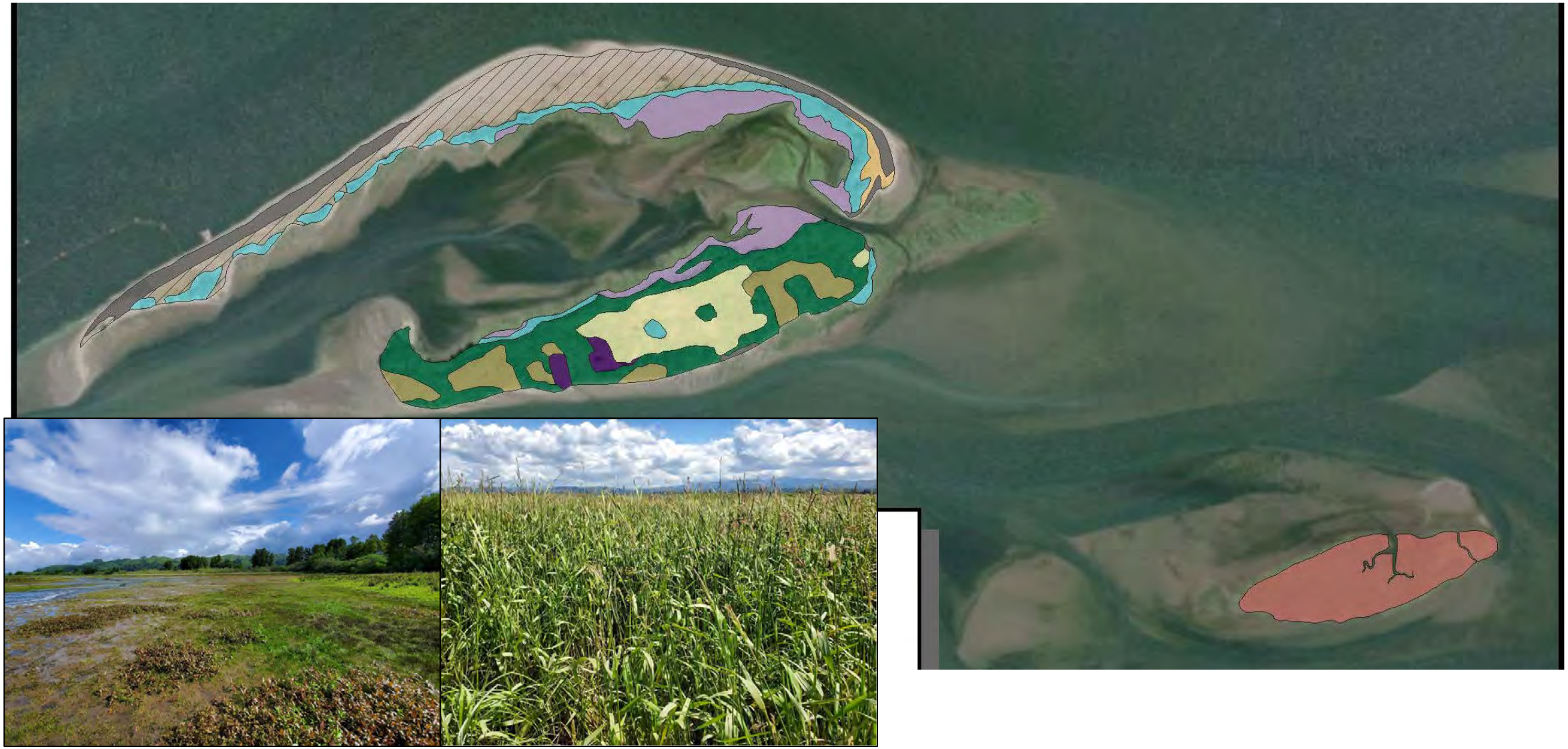
Restored sites became more similar to the reference areas over time

Remain on unique trajectories compared with unaltered natural wetlands

More diverse vegetation and avian communities than reference areas due to elevation gradients and a wider range of substrate characteristics

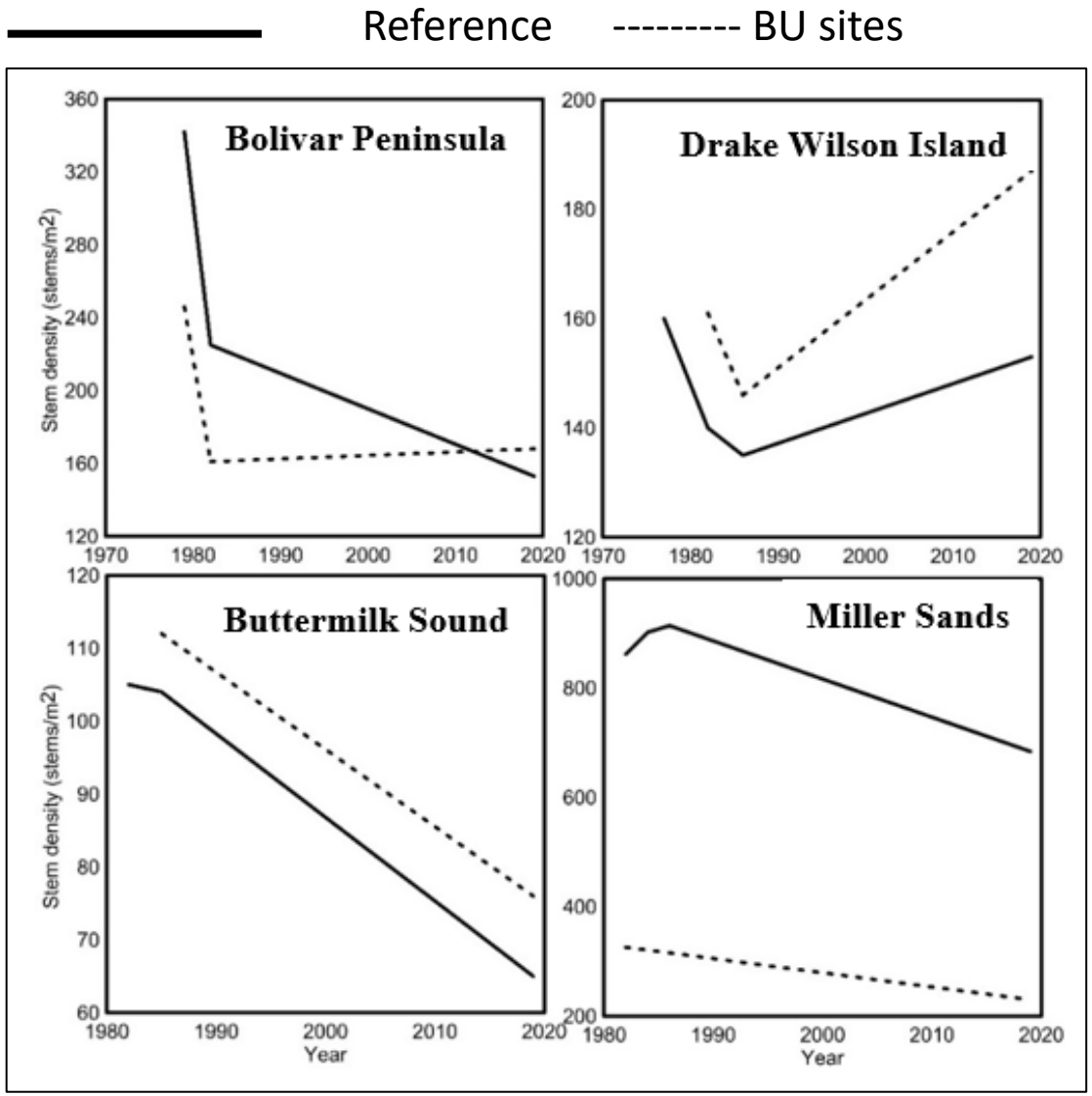
	Vegetation community assemblages (count)		Dominant species richness in target community types (count)			
Location	Beneficial use (BU) site	Reference location	Habitat type	BU (2019)	Historic	Reference (2019)
Bolivar Peninsula, TX	10	1	Low marsh	4	2	2
Drake Wilson Island, FL	6	8	Low marsh	2	2	2
Buttermilk Sound, GA	4	2	Marsh	3	4	3
Nott Island, CT	10	4	Meadow	16	5	NA
Pointe Mouillee, MI	7	NA	Marsh	7	4	NA
Miller Sands, OR	7	1	Marsh	18	17	15

Coastal Wetlands and NNBF – Backcasting outcomes



Coastal Wetlands and NNBF – Backcasting outcomes

Similar response to ecological perturbation as unaltered wetlands, despite differences in magnitude



Coastal Wetlands and NNBF – Backcasting summary

Projects differ from natural wetlands initially

Provide habitat for a variety of species

Show increasing similarity with natural areas over time when natural designs are mimicked

Fail to develop soil characteristics (e.g., C accumulation) equivalent to natural wetlands*

Opportunities to improve site conditions through management

- Selective species removal; sediment deposition

Need better linkages between ecological functions, ecosystem goods and service benefits to support lifecycle analysis*

Coastal Wetlands and NNBF – Paradigm-forcing

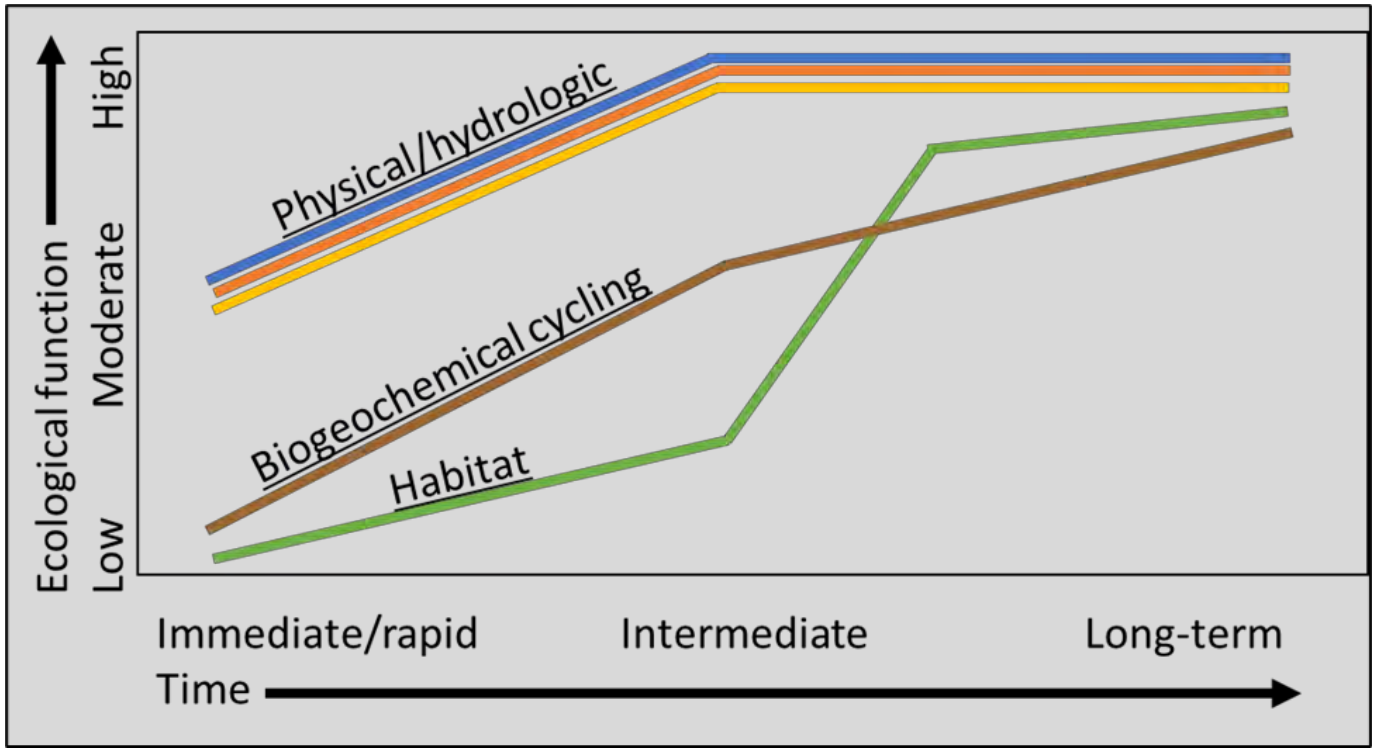
-Reference based metrics have value, often overvalued

-Must move to an ecosystem functional stance

-Historic focus on habitat, need holistic functional assessments

-Maximize available functions to improve delivery of ecosystem goods & services

-Inform design features



Coastal Wetlands and NNBF – Paradigm-forcing

Ecological functions	Ecological indicators
Physical functions	
Floodwater and sed… the ecosystem to te… following rain even…	Inundation and soil saturation… …y
Energy dissipation … attenuate and decre…	…t
Export elements an… ecosystem to expor… carbon, nutrients, sediment, and other materials to down-stream or down gradient areas	…r content, drainage patterns, field indicators of hydric soils

What indicators of physical function have you observed?

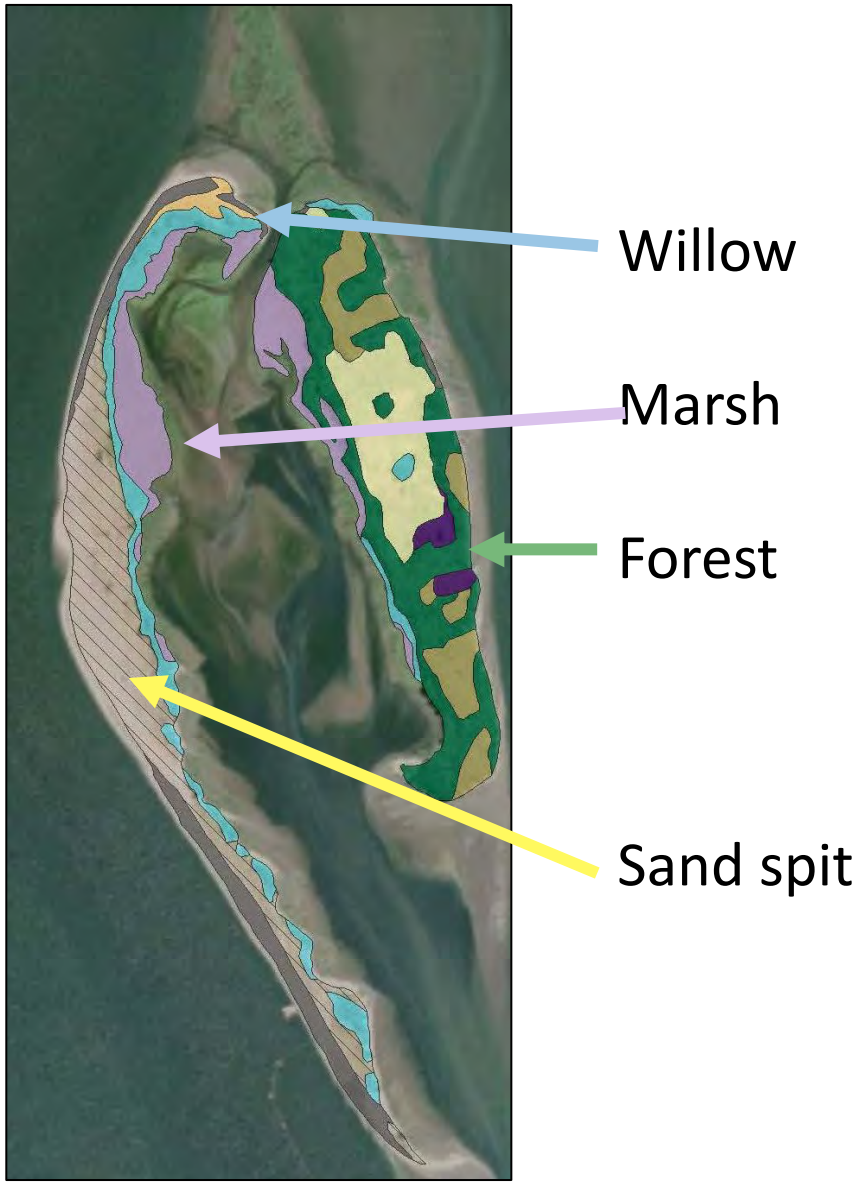
Ecological functions	Study locations and target habitat types													
	Bolivar Peninsula, TX				Drake Wilson Island, FL			Buttermilk Sound, GA			Nott Isla., CT	Pointe Mou., MI	Miller Sands,	
	Low marsh	High marsh	Herbaceous upland	Woody upland	Low marsh	sh	pland	h	sh	ed upland	eadow	r marsh	eadow	sh
Floodwater and sediment retention	X	X			X									
Energy dissipation	X	X			X									
Export elements & compounds	X	X			X									
Nutrient cycling	X	X	X	X	X									
Retention and transformation of elements and compounds	X	X			X	X		X	X			X		X
Sequester carbon	X	X			X	X		X	X			X		X
Maintain habitat for wildlife, fisheries, and plant communities	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Why do wetland features provide more functions?

Coastal Wetlands and NNBF – Paradigm-forcing

Connection to EGS*

How can the linkages between NNBF features & ecosystem functions be used as design criteria?



Connect for questions and discussion: Scan for pubs →

Email: Jacob.F.Berkowitz@usace.army.mil

Twitter: @Wetlandsoil Instagram: wetlands_team