Scientific Solutions to Protect Our Future

Resiliency Planning, Design and Management

February 1, 2023

Meet the ESA Leadership Team

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For Today's Discussion

- ESA Delivers Resilient Projects: From Planning Through Management
- HEM Model and Project Examples – How We Developed it as Part of Blue Carbon
- Planning and Designing Resilient Projects
- Watershed Resilient Projects
- Questions and Answers

Environmental Science Associates (ESA)

- Over 52 years of environmental services
- 600+ staff across the US
- 60+ staff; 5 Florida offices
- Environmental, planning and natural systems design firm
- ESA staff have designed >150 habitat restoration projects
- We partner with our clients
  - Solution-oriented, strategic, innovative, multi-objective projects, and backed by science
- Technology focused
- 100% Employee Owned (ESOP)

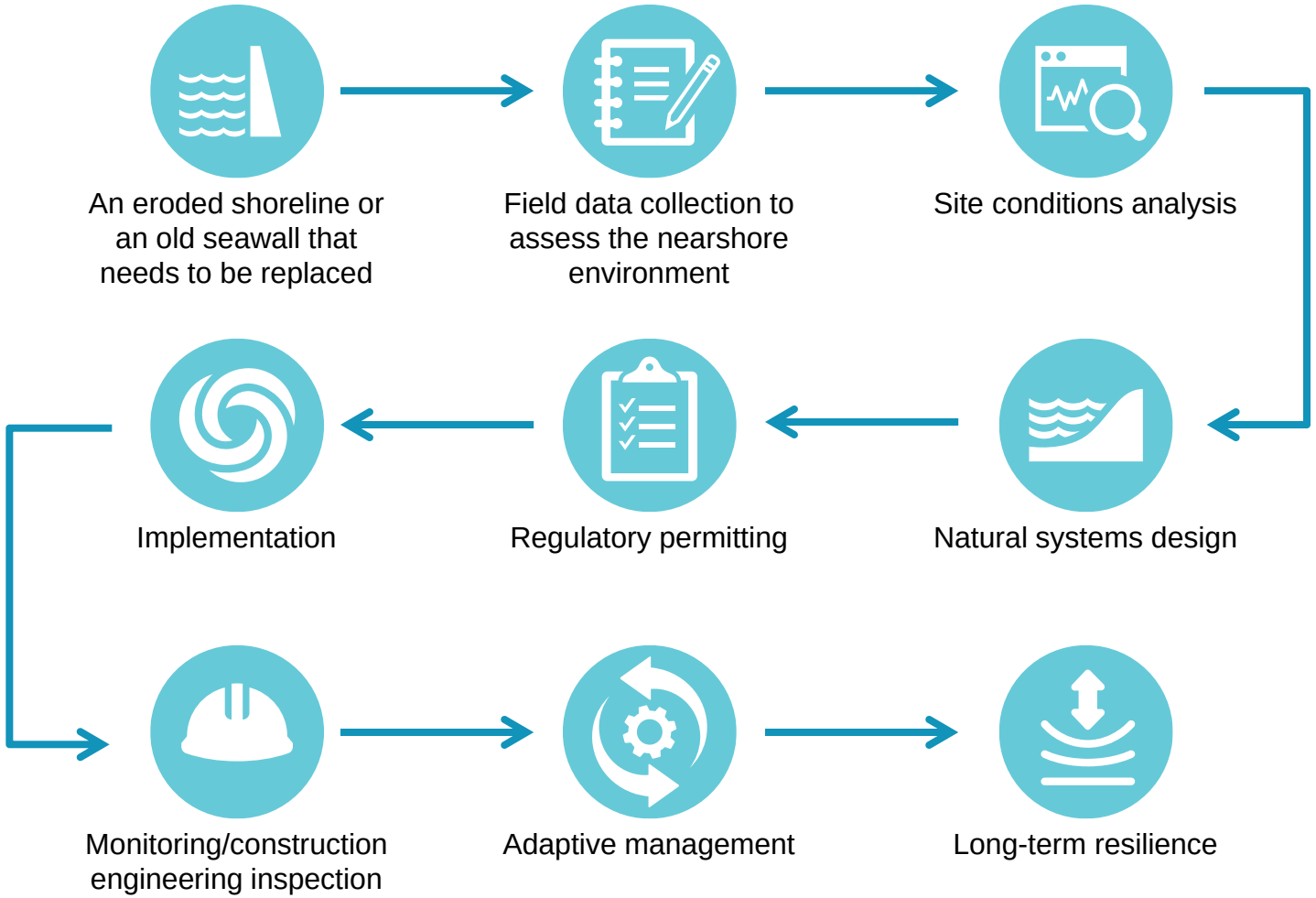
Key Market Areas

ESA Partnerships in Resiliency

ESA and their partners. We have partnered nationally and locally with federal, state and local agencies to implement successful restoration projects.

ESA Delivers Resilient Projects

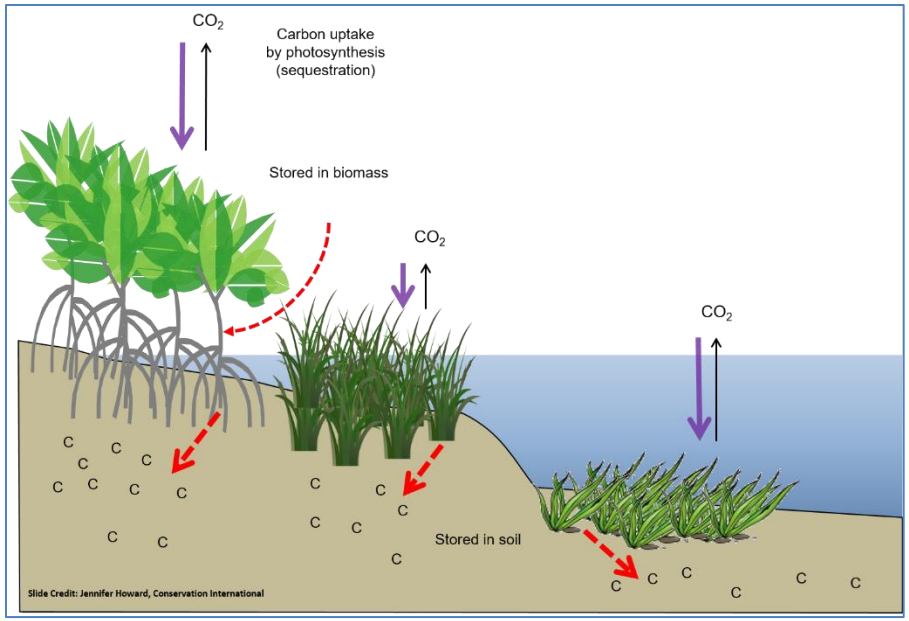
From Planning through Long-term Resilience



Overview of the Habitat Evolution Model (HEM)

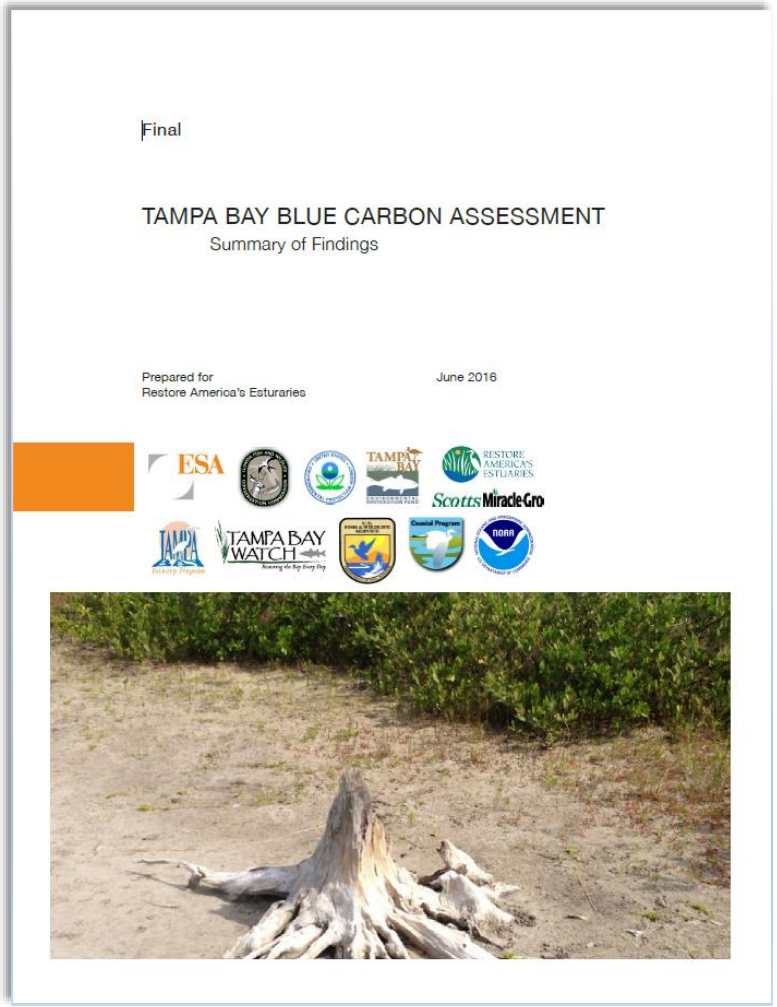
What is Blue Carbon?

- Blue carbon = uptake and sequestration of atmospheric carbon by coastal wetlands
- Benefits of enhancing blue carbon stocks
  - Reduced GHG emissions and carbon footprint
  - Improved coastal flood protection
  - Enhanced habitat diversity and food web for healthy fish and wildlife populations
  - Improved water quality



Tampa Bay Blue Carbon Assessment

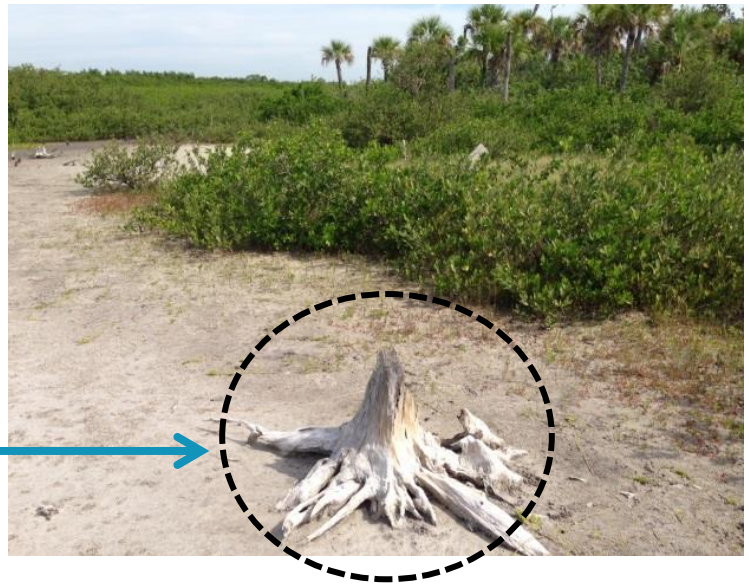
- ESA hired by Restore America's Estuaries and Tampa Bay Estuary Program for pilot project to:
  - Quantify existing and future blue carbon stocks in Tampa Bay
  - Estimate potential future climate mitigation benefits of coastal habitat restoration
  - Identify opportunities for enhanced ecosystem management for climate change benefits
  - Support increased capacity for, and investment in, habitat restoration and coastal adaptation



Coastal Habitat Migration with SLR

There is clear evidence that Tampa Bay coastal habitats are actively migrating in response to sea level rise (SLR)

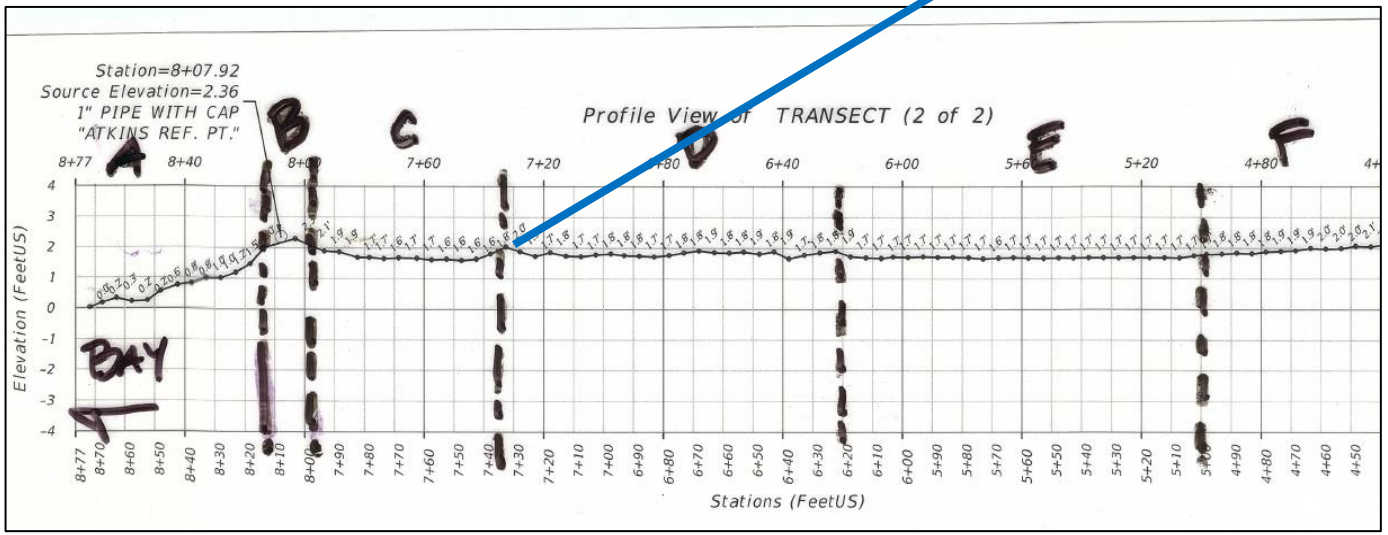
- Landward encroachment of mangroves into salt marshes
- Landward expansion of salt barrens onto coastal uplands
- Replacement of freshwater wetlands by tidal wetlands



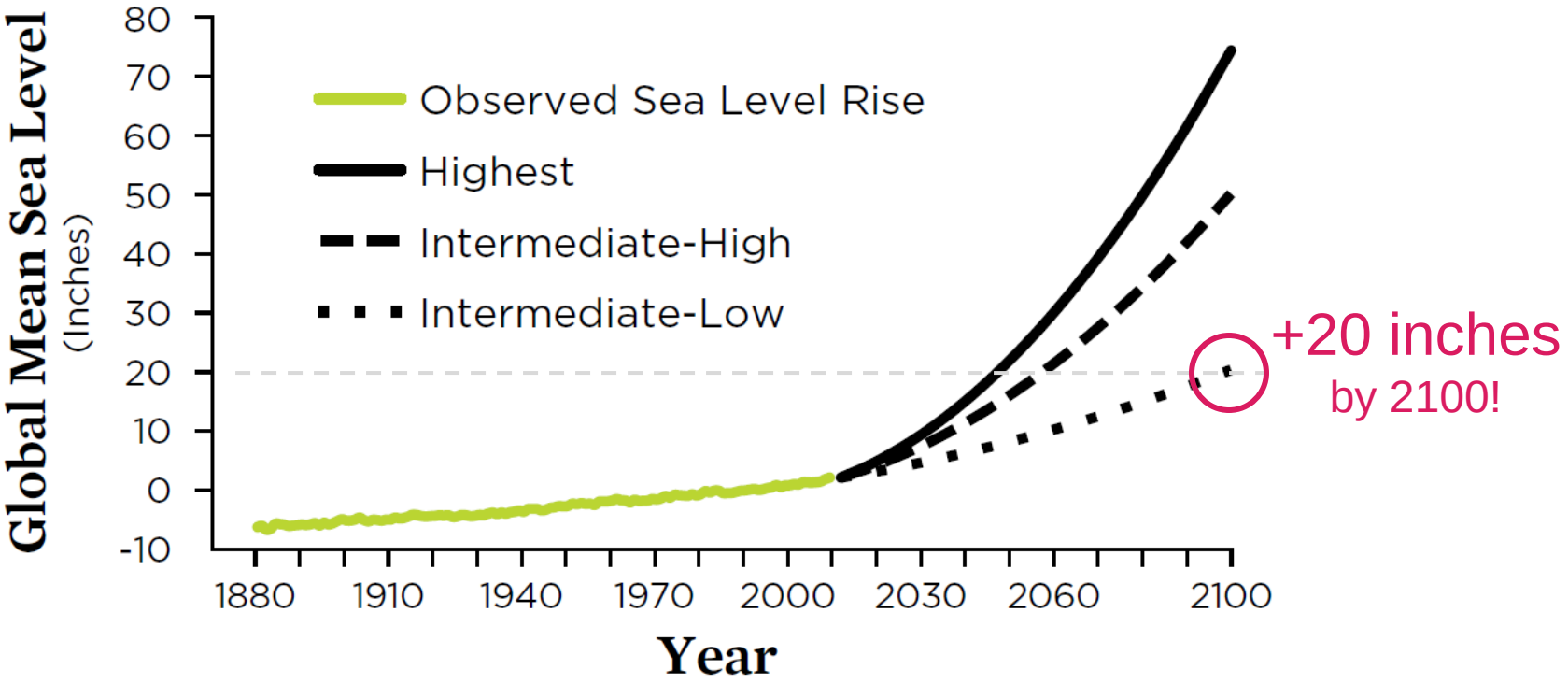
Cypress Tree Stump

Elevation Determines Coastal Habitat Zonation

- Elevation differences of as little as 0.1 foot often determine habitat zonation
- Elevation-driven habitat zonation is remarkably consistent around the bay

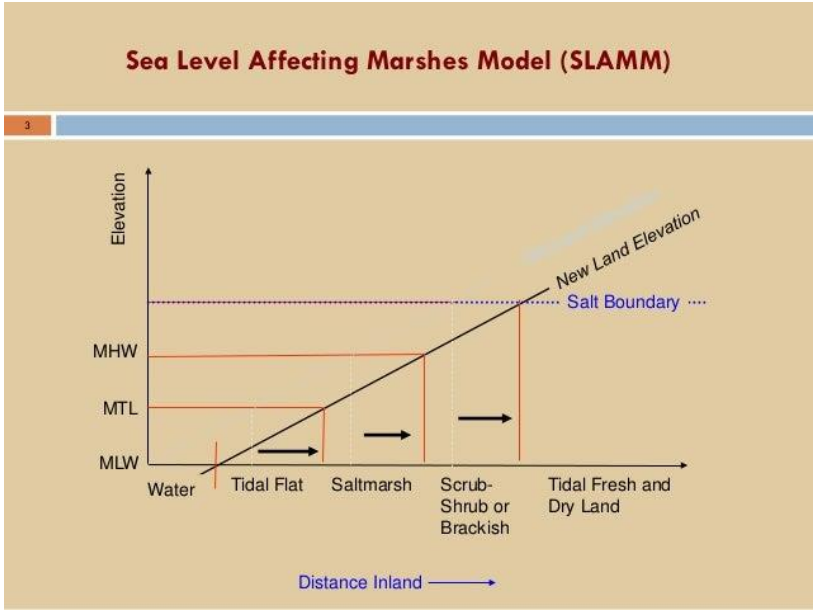


Even a Little is a Lot!



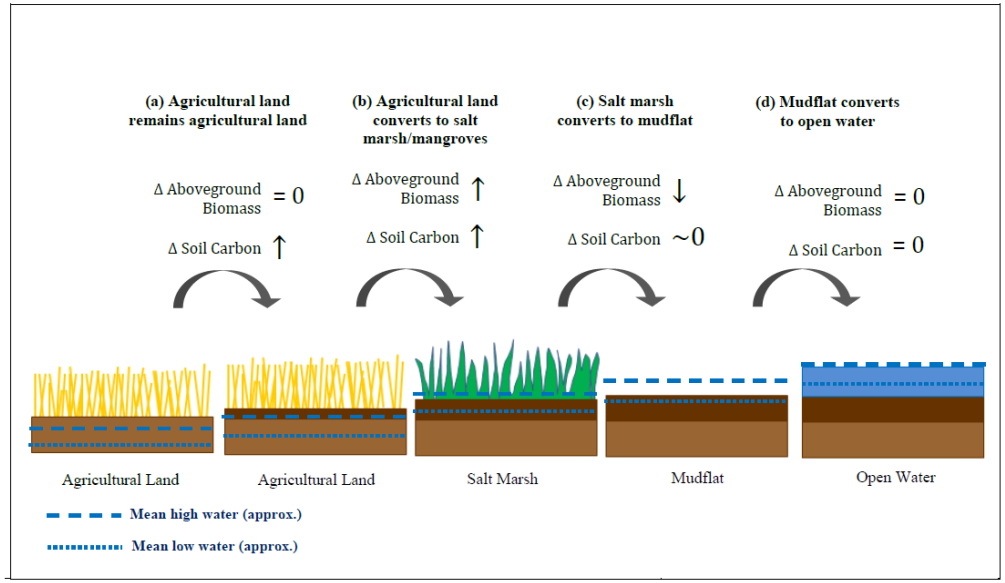
Sea Level Affecting Marshes Model (SLAMM)

- Public domain model developed by EPA
- Simulates salt marsh changes in response to SLR
- SLAMM limitations:
  - Does not accurately simulate the evolution of fringing high marsh and salt barrens
  - Does not accurately simulate the response of brackish marshes to localized freshwater inputs
  - Over-predicts the evolution of mangroves in subtropical estuaries
  - Does not simulate SLR effects on seagrass

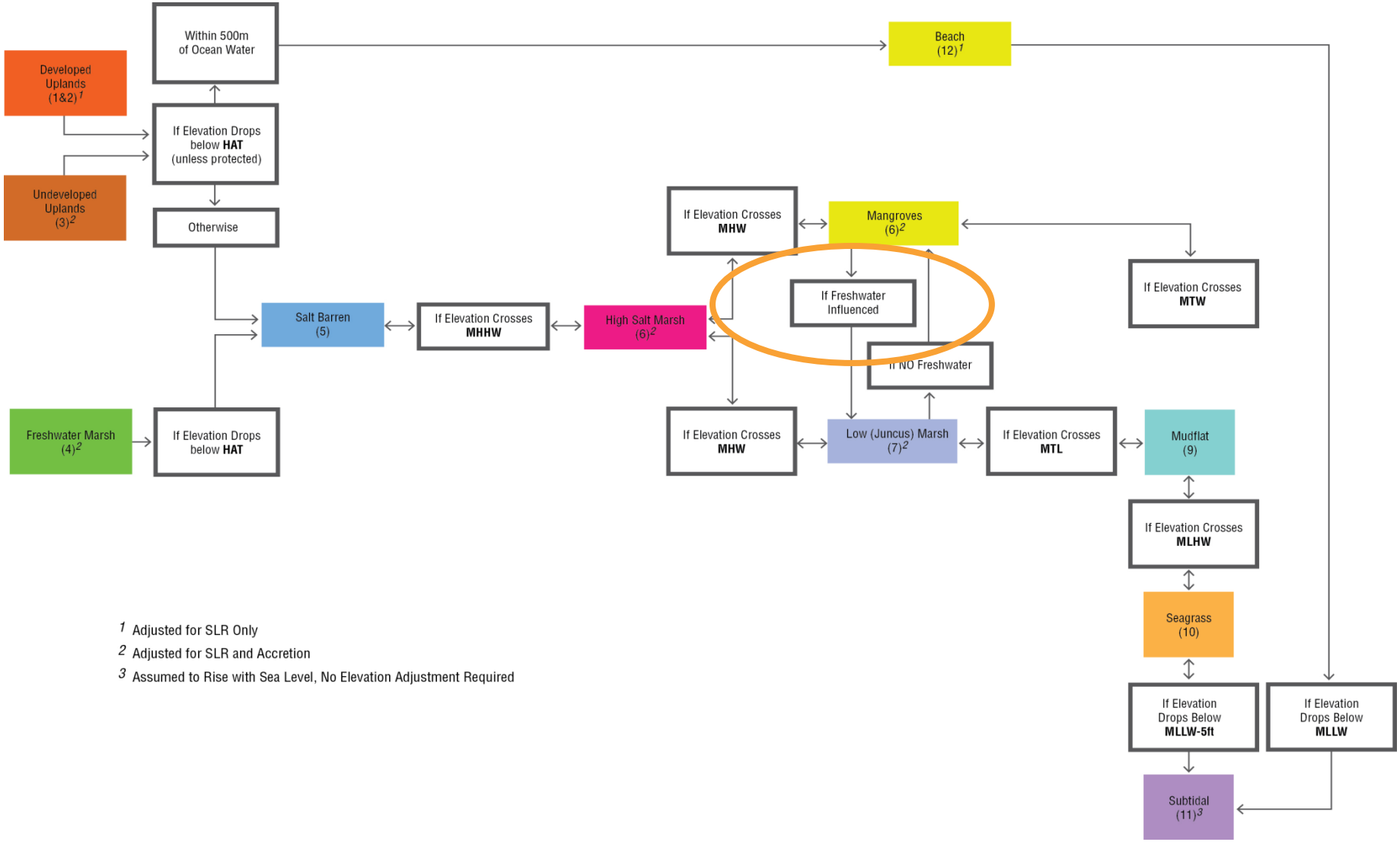


Habitat Evolution Model (HEM)

- HEM developed by ESA for the Tampa Bay Blue Carbon Assessment
  - Enhanced modification to the SLAMM model code
  - GIS raster-based model
  - Utilizes LiDAR elevation data collected across transects in Tampa Bay coastal wetlands
  - Predicts evolution of seagrass, mangroves, and marshes in response to SLR
  - Linked to Greenhouse Gas accounting framework
  - Applicable to other south Florida estuaries



Habitat Evolution Model (HEM) Decision Tree



1 Adjusted for SLR Only

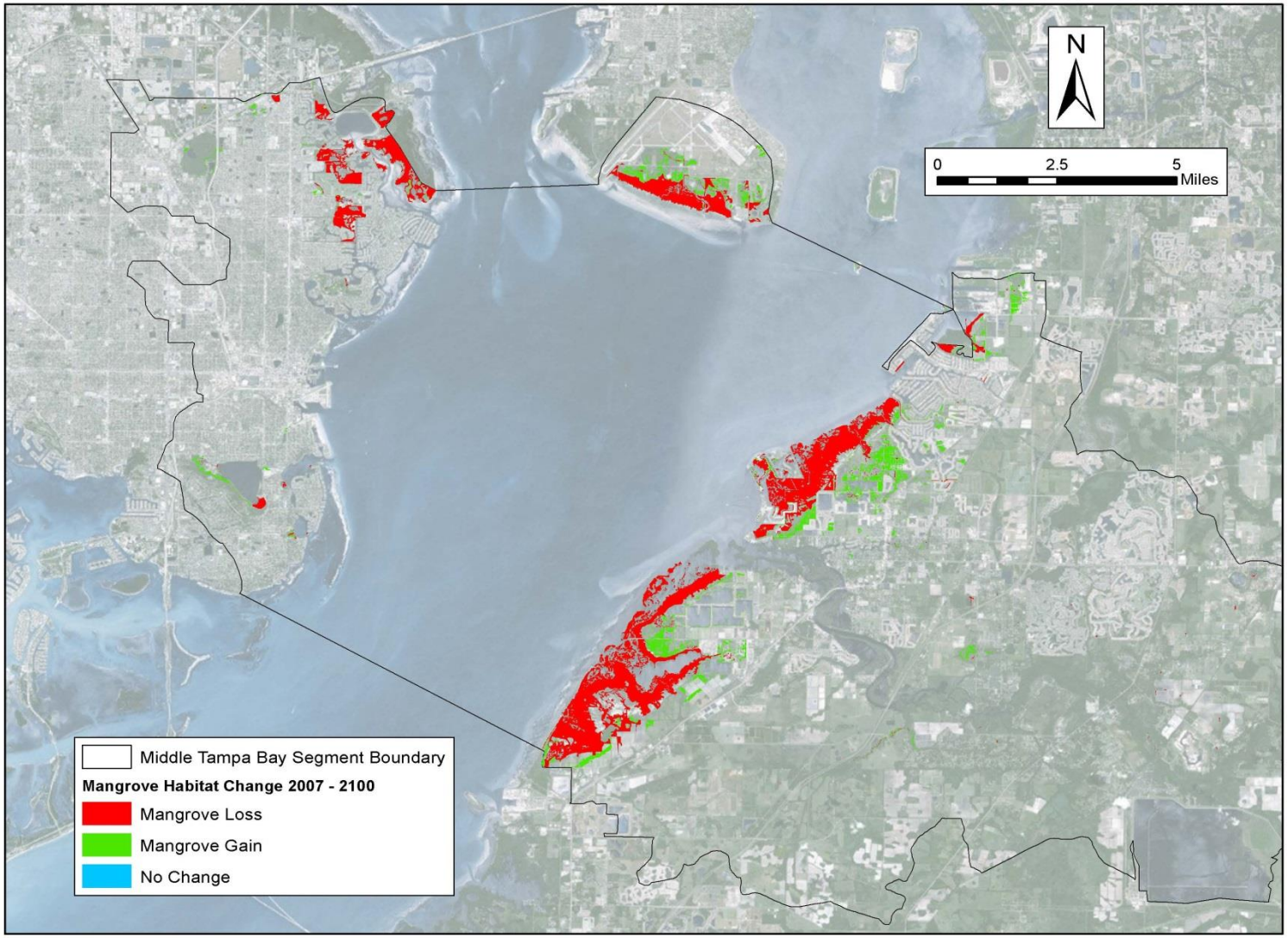
2 Adjusted for SLR and Accretion

3 Assumed to Rise with Sea Level, No Elevation Adjustment Required

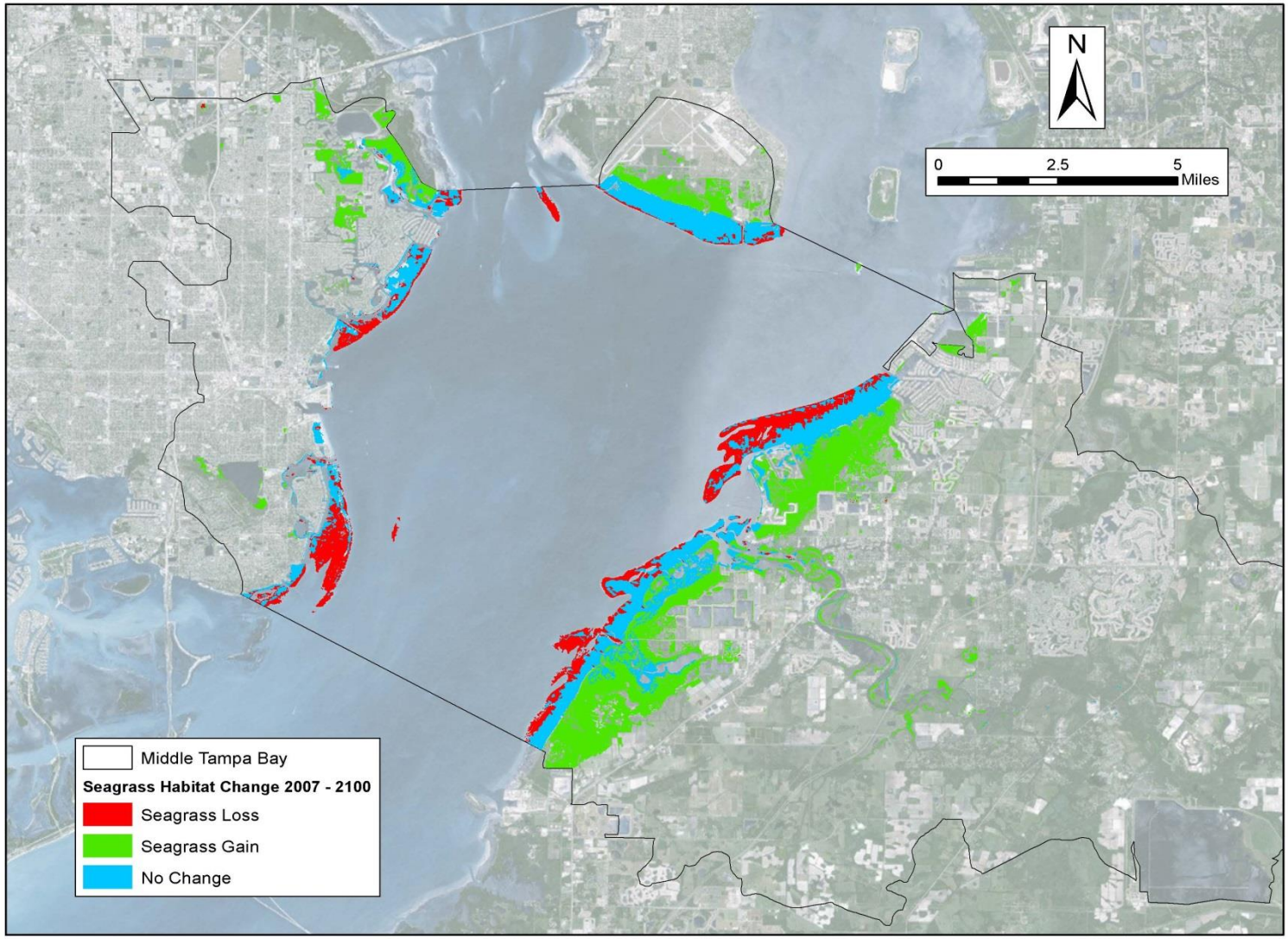
HEM 2100 Tampa Bay Predictions

Run	Modeled Acreage in 2007	Acreage in 2100		Acreage difference 2100-2007	
		(Run 1) Int. Low	(Run 3) Int. High	(Run 1) Int. Low	(Run 3) Int. High
Developed Upland- Hard	461,640	461,640	461,640	0	0
Developed Upland- Soft	210,310	210,310	210,310	0	0
Undeveloped Upland	230,600	227,370	222,870	-3,230	-7,730
Freshwater Marsh	81,390	79,260	77,590	-2,130	-3,800
Salt Barrens	1,520	2,870	2,280	1,350	760
High Salt Marsh	2,290	2,500	1,090	210	-1,200
Juncus Marsh	4,250	4,530	2,430	280	-1,820
Mangroves	13,990	16,040	4,870	2,050	-9,120
Mudflat	0	0	840	0	840
Beach	70	30	10	-40	-60
Seagrass	33,310	33,550	48,280	240	14,970
Open Water	338,710	339,960	345,880	1,250	7,170

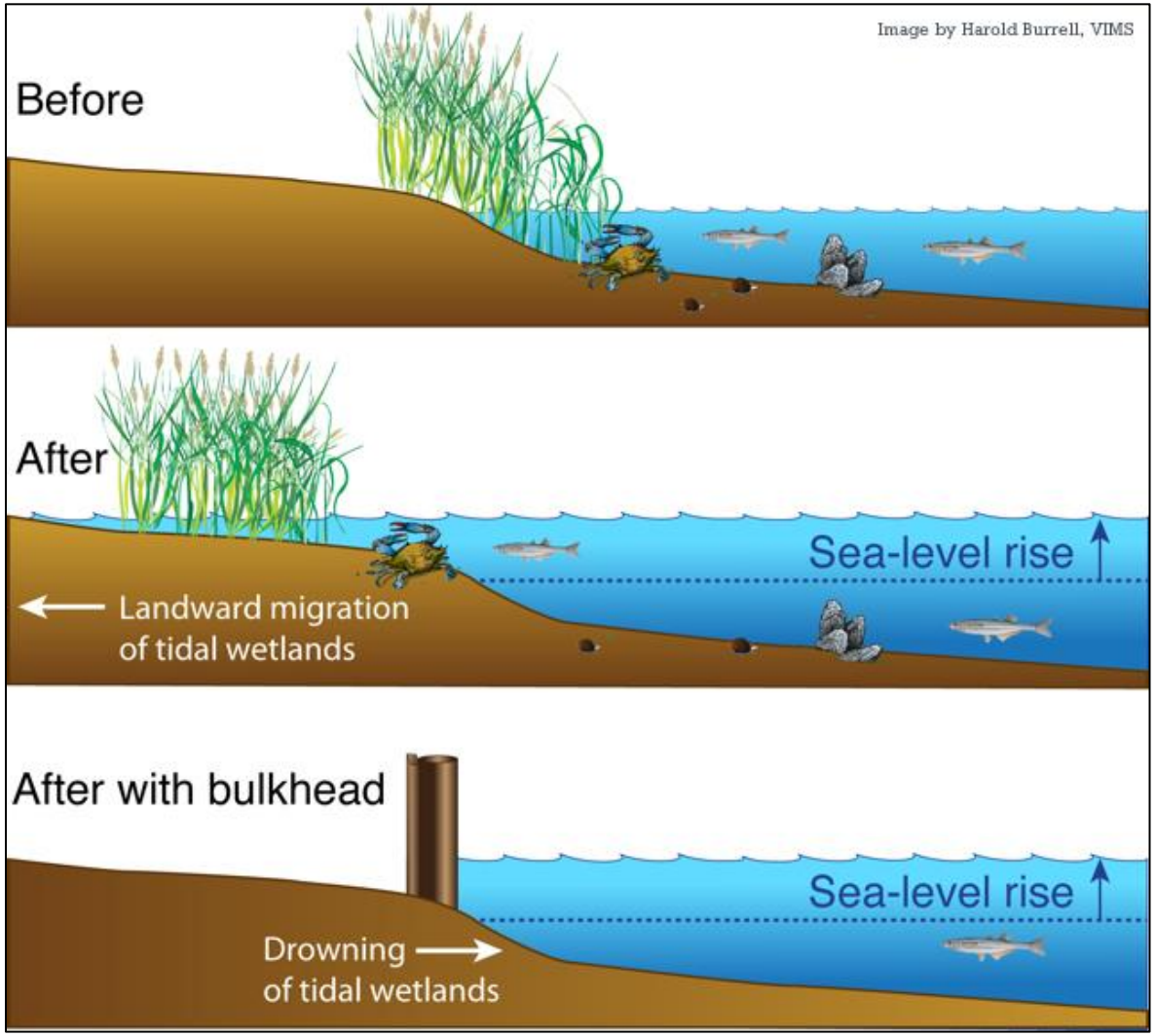
HEM 2100 Predicted Mangrove Changes (Int. High)



HEM 2100 Predicted Seagrass Changes (Int. High)

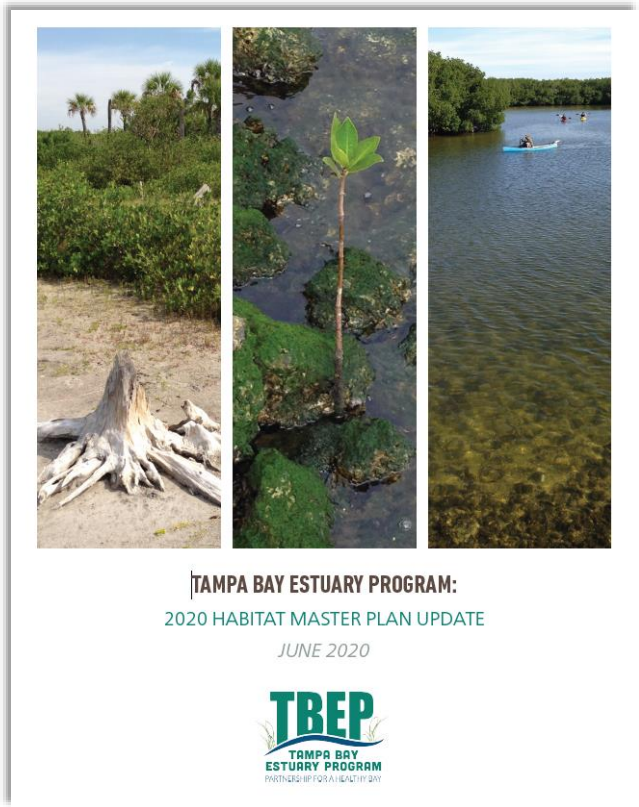


Urban Coastal Habitat Loss with SLR



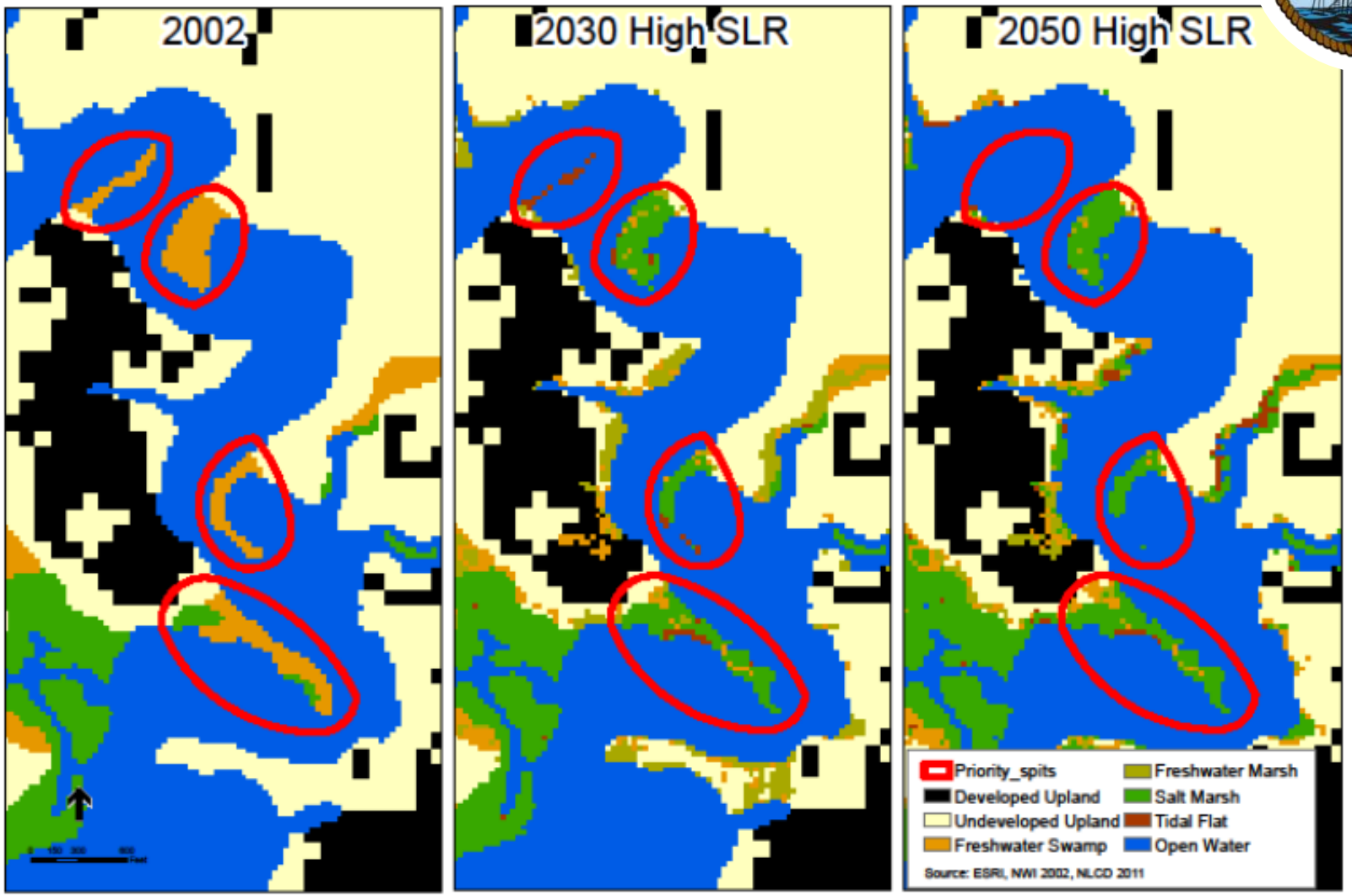
Other Applications of the HEM Model

- Charlotte Harbor National Estuary Program
  - Habitat Restoration Needs (HRN) project
  - Habitat Resiliency to Climate Change (HRCC) project
- Tampa Bay Estuary Program
  - 2020 Habitat Master Plan Update
- Mobile Bay National Estuary Program
  - Multiple Watershed Management Plans

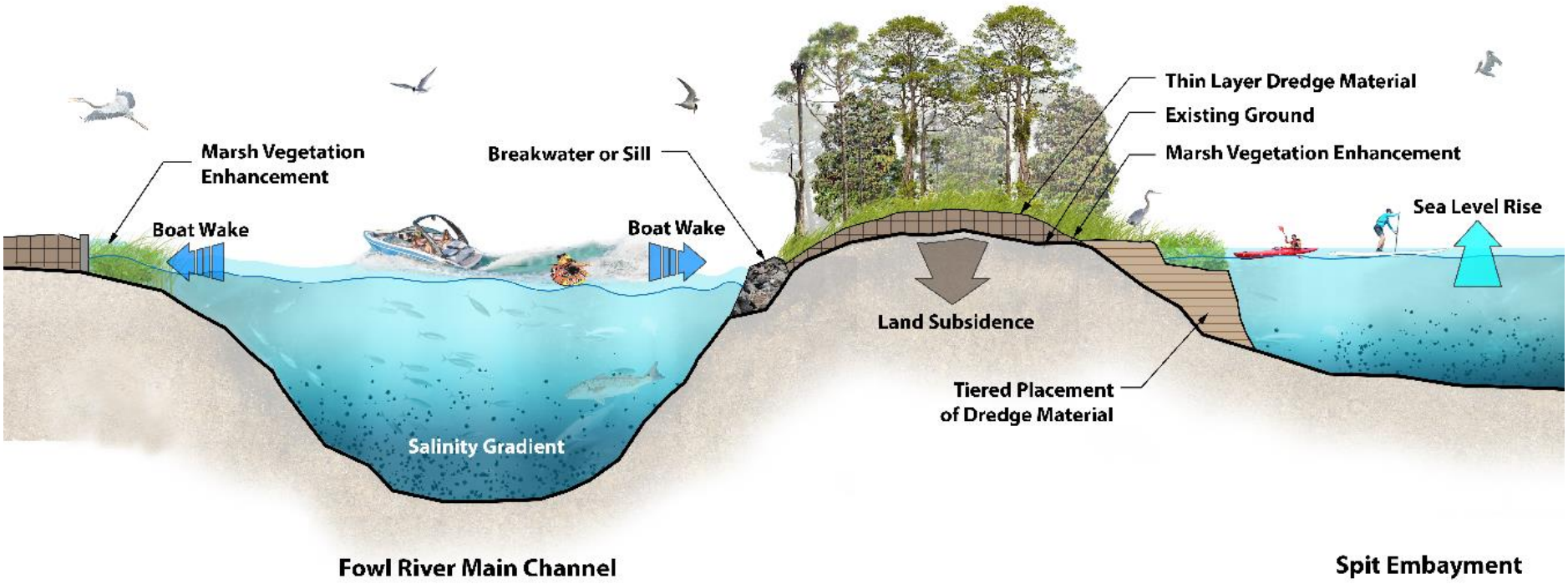


Planning & Designing Resilient Projects

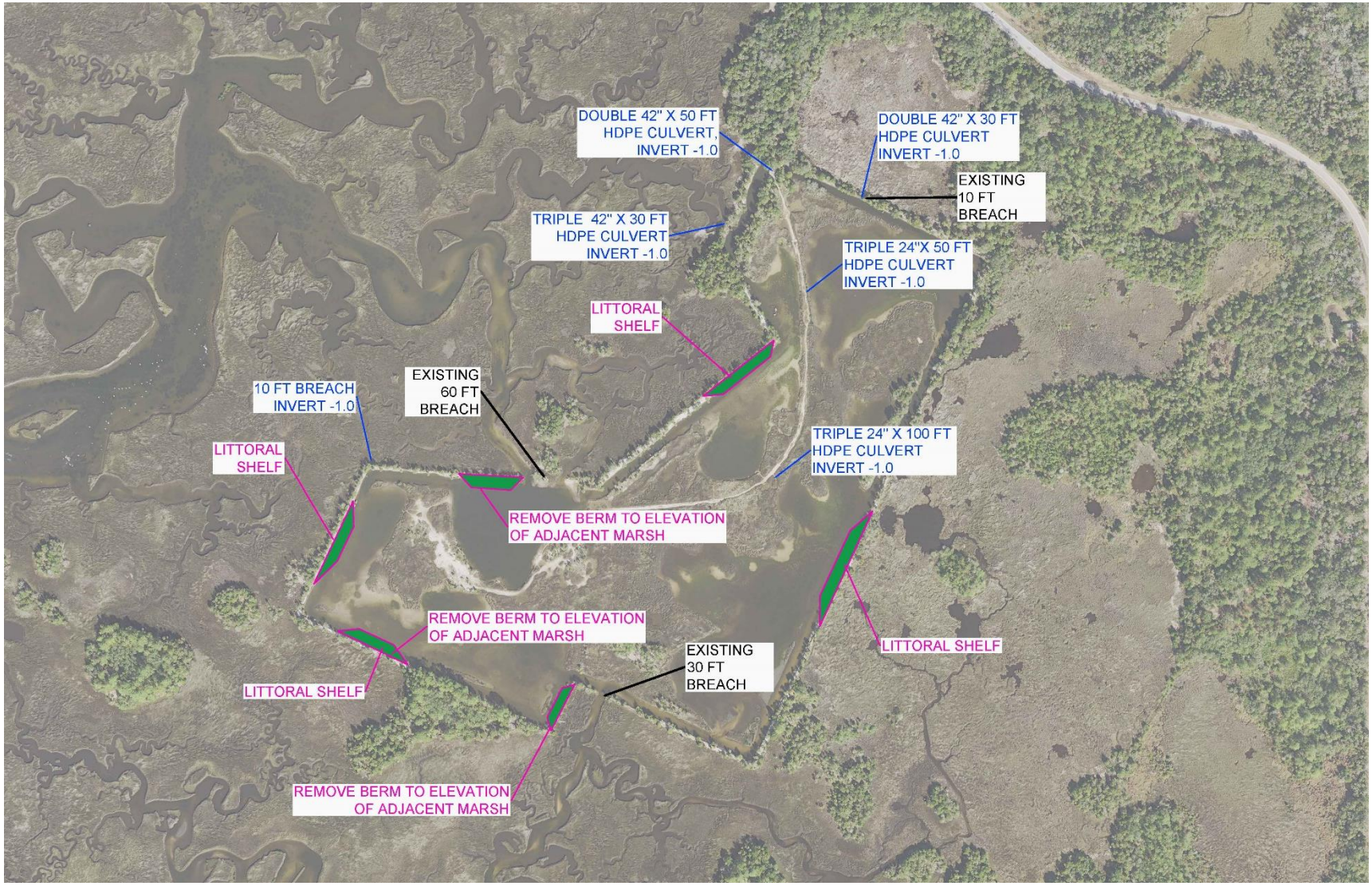
Application of the HEM



Fowl River Marsh Restoration



Red Fish Hole Feasibility Study – Citrus County



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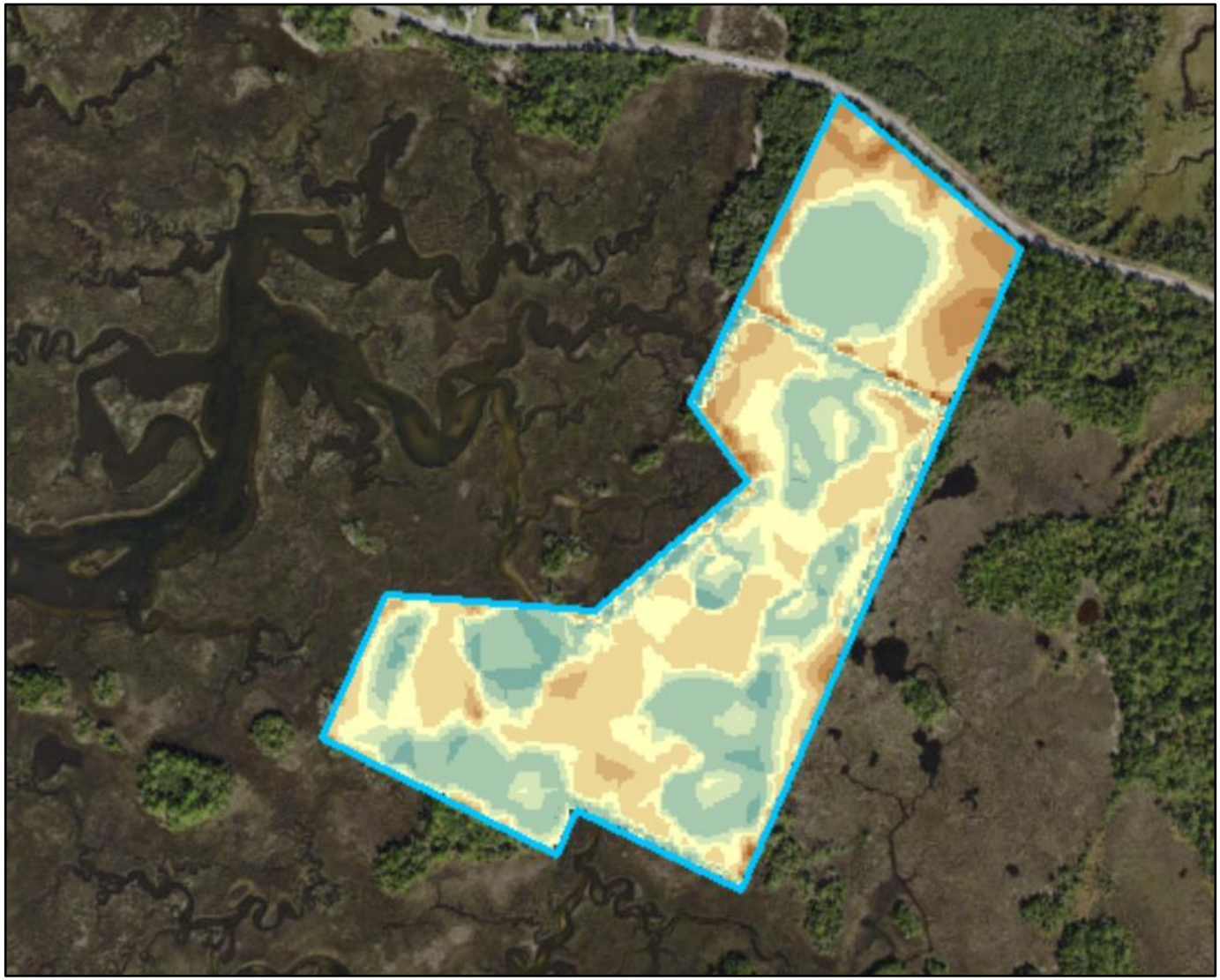

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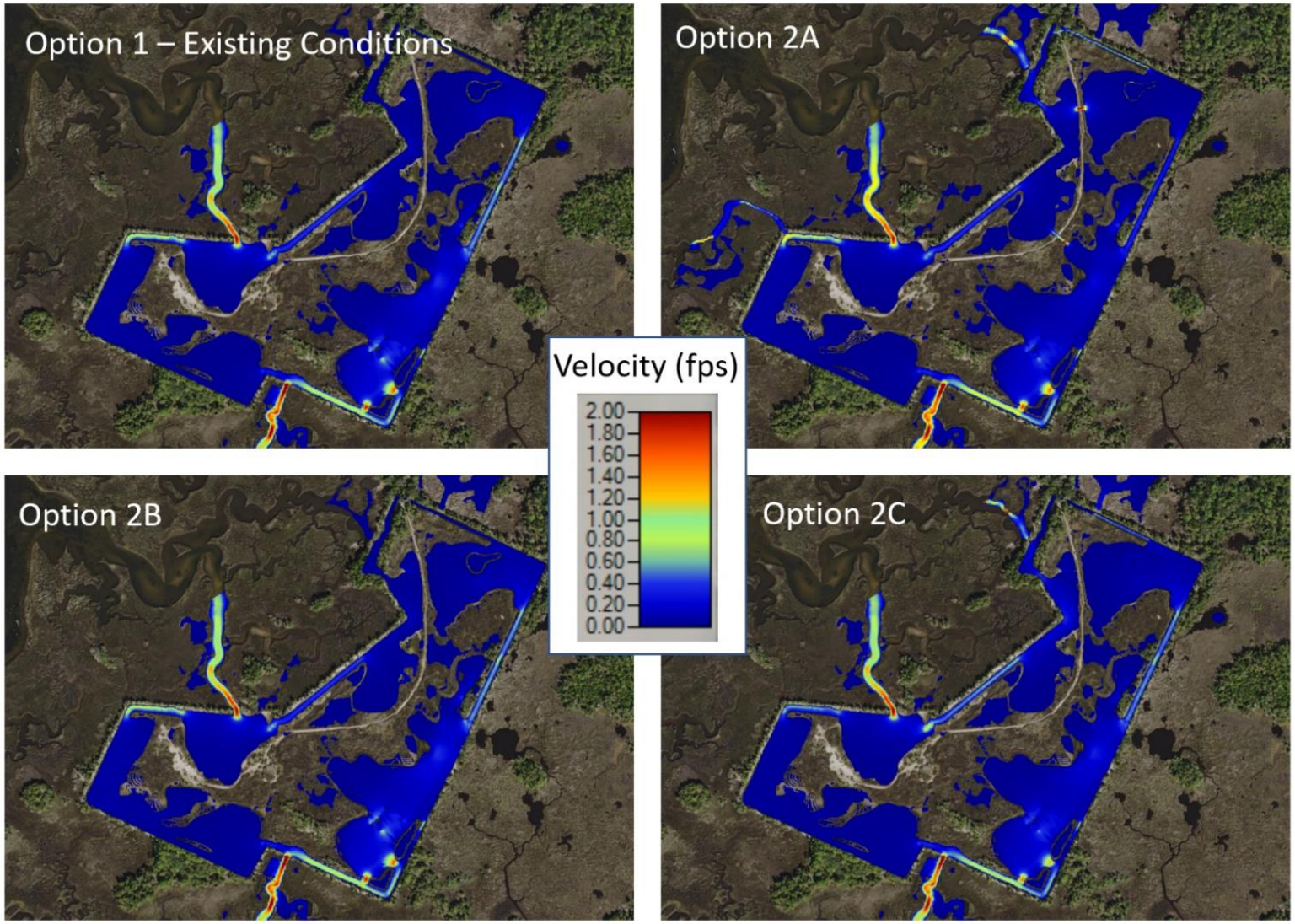
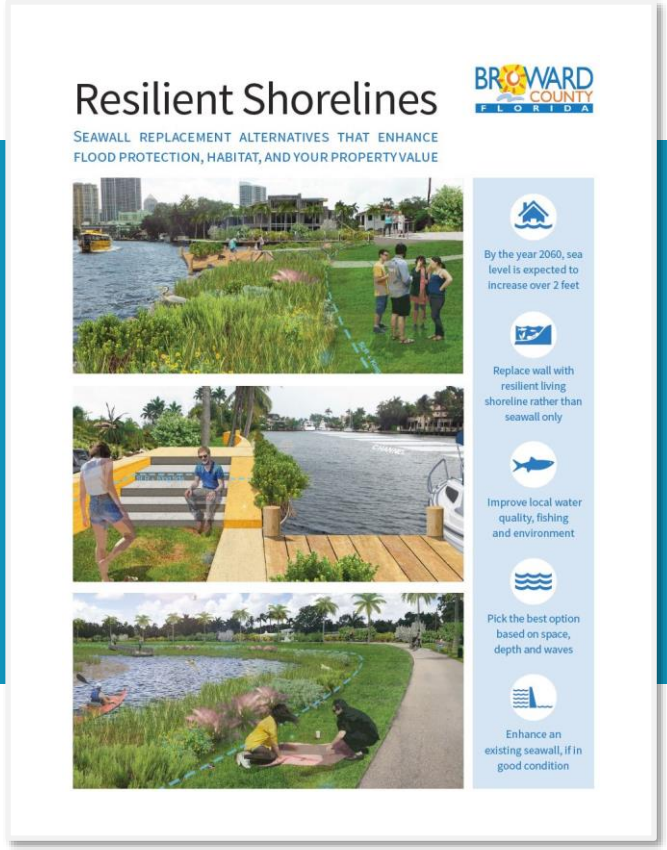


Planning Resilient Projects

Broward County Resilient Shorelines Guide

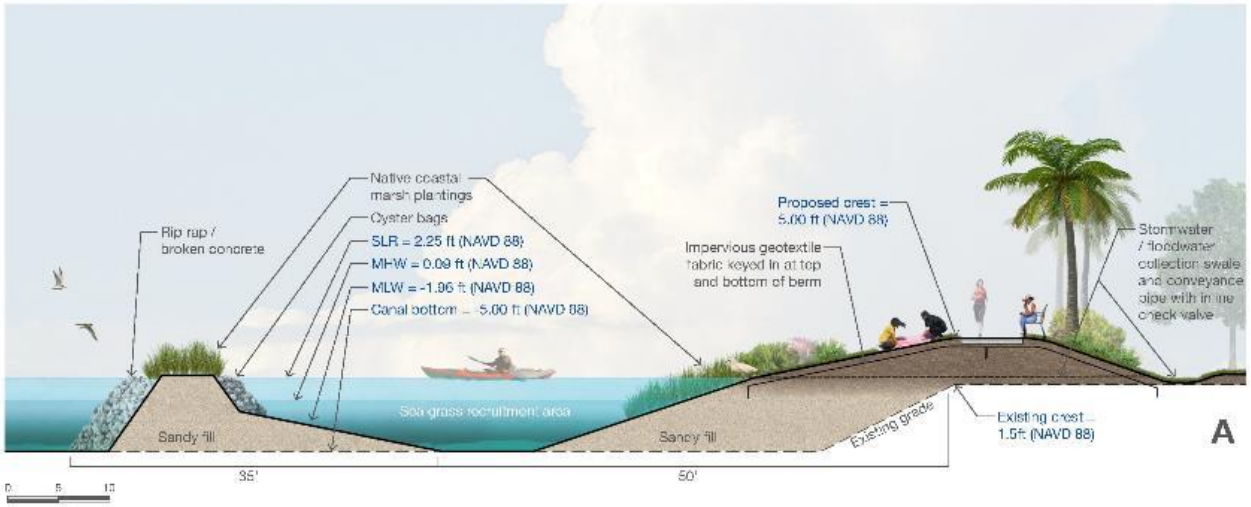
Land Use Policy 2.21.7

https://www.broward.org/Climate/Documents/ResilientShorelinesBrochure__compressed_06.23.2020.pdf

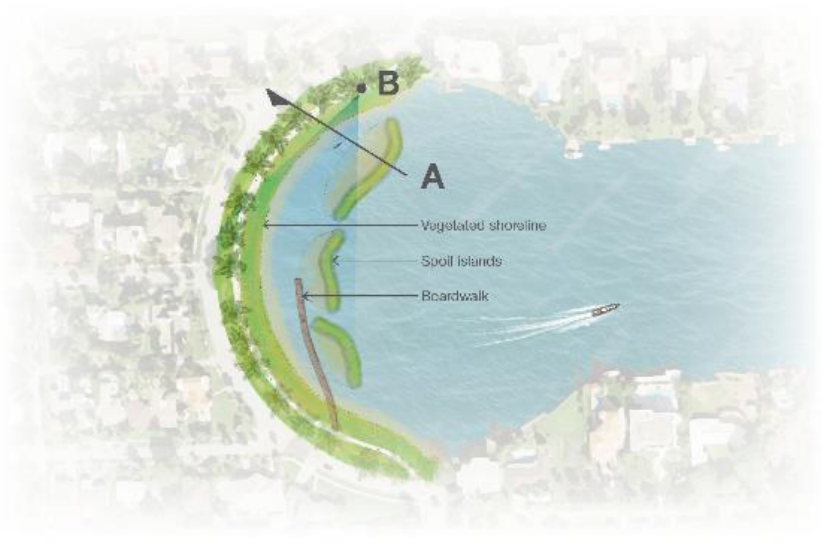


- 292 linear miles of hardened, and 98 miles of natural, coastal shorelines.
- Adopted by the Broward Board of County Commissioners, January 7, 2020, Land Use Policy 2.21.7 ensures regionally consistent tidal flood barrier elevations to provide a resiliency standard against coastal inundation.

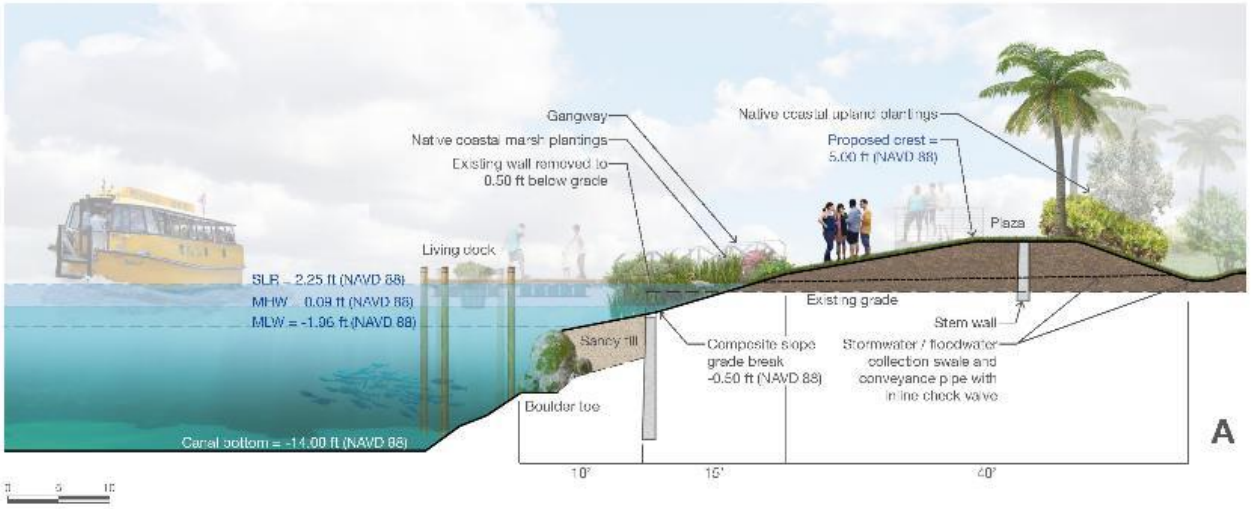
Shallow Water/High Wake



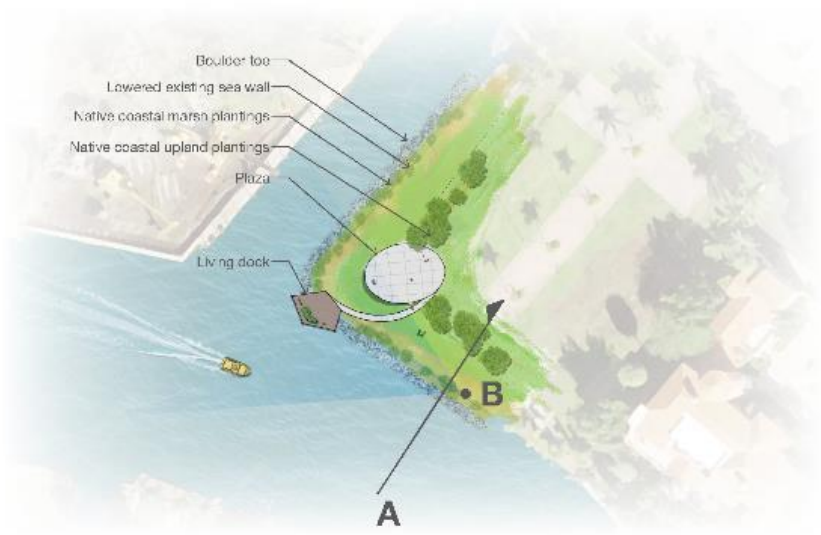
SHALLOW | HIGH WAKE



Deep Water/Low Wake



DEEP | LOW WAKE



Jungle Trail – Indian River County

Jungle Trail – Indian River County

Thank you

Questions & Answers

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