Forecasting Sea Level Rise, Wave Risk, and Vulnerability of Infrastructure in Estuarine Marshes

FSBPA 2023

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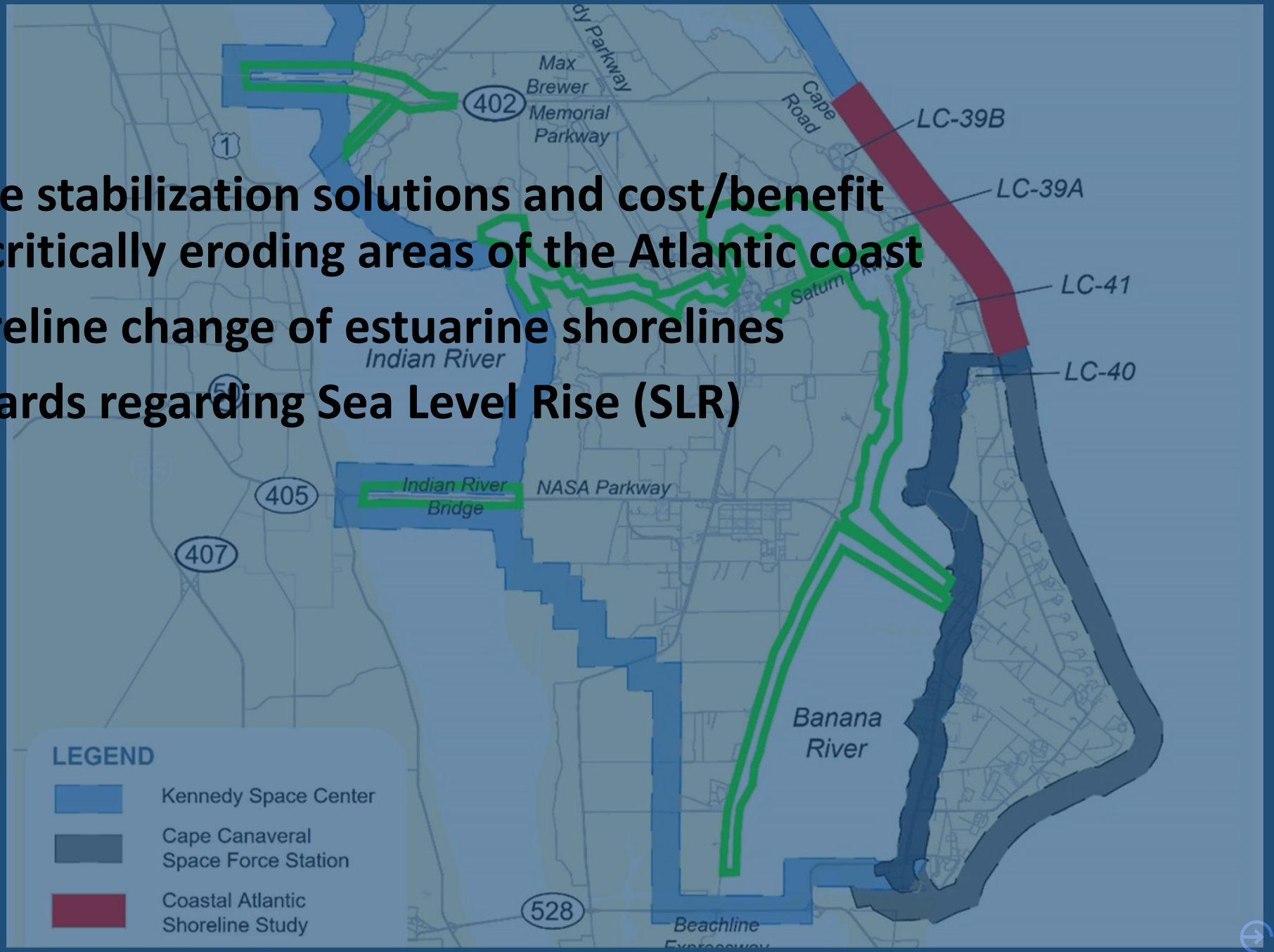
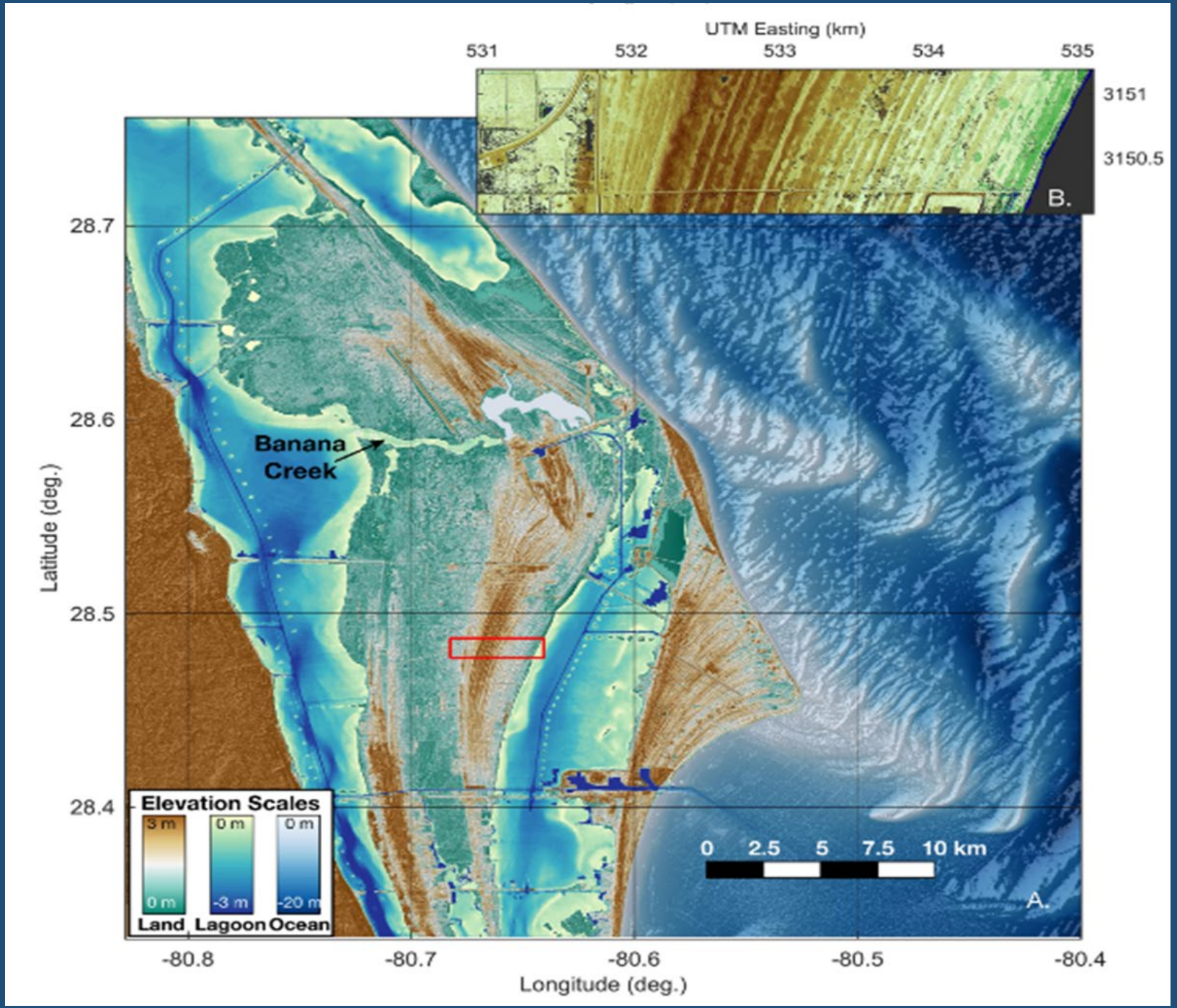
Project Goals

- Provide shore stabilization solutions and cost/benefit analysis for critically eroding areas of the Atlantic coast
- Analyze shoreline change of estuarine shorelines
- Forecast hazards regarding Sea Level Rise (SLR)



Regional History



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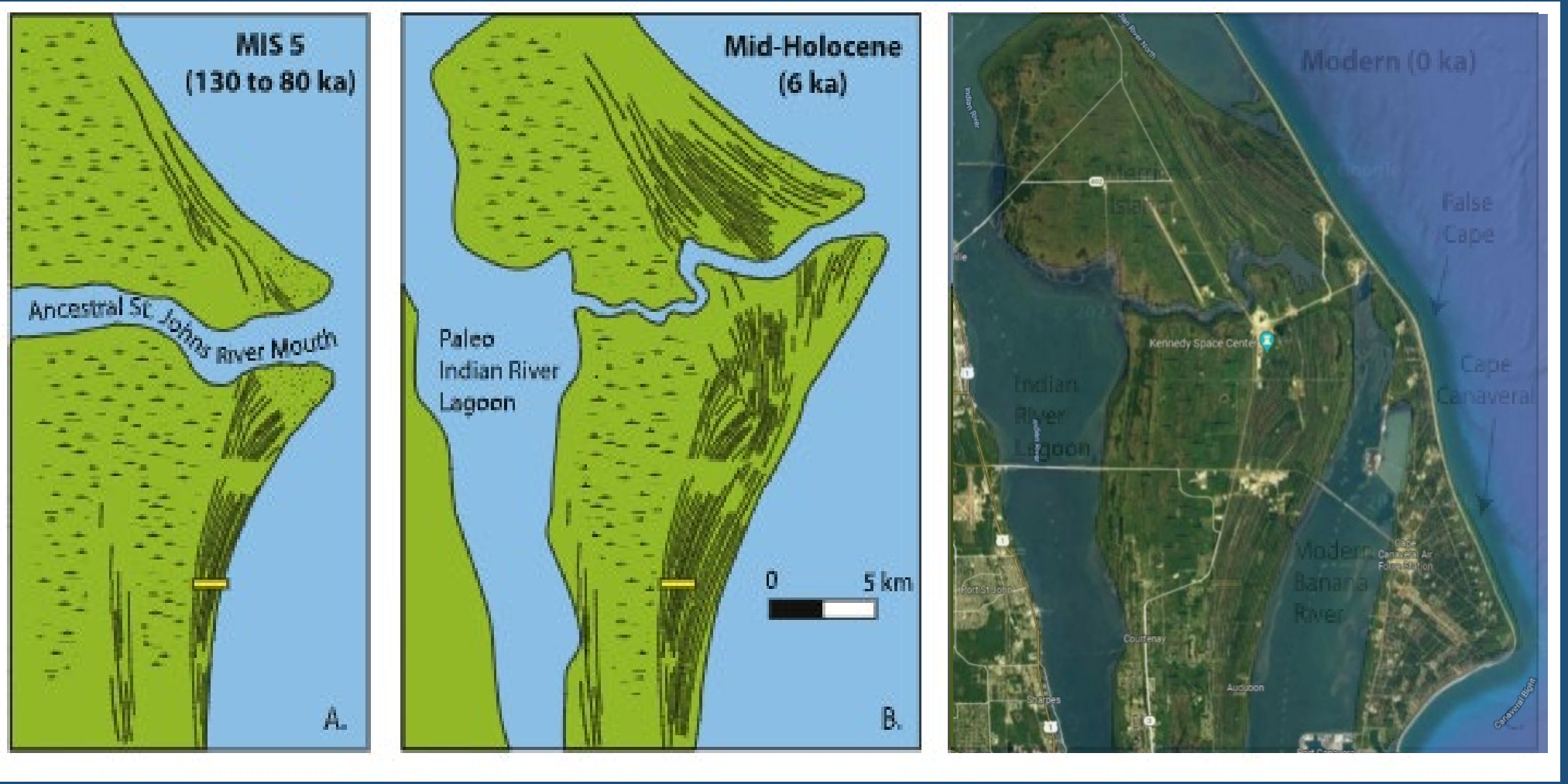

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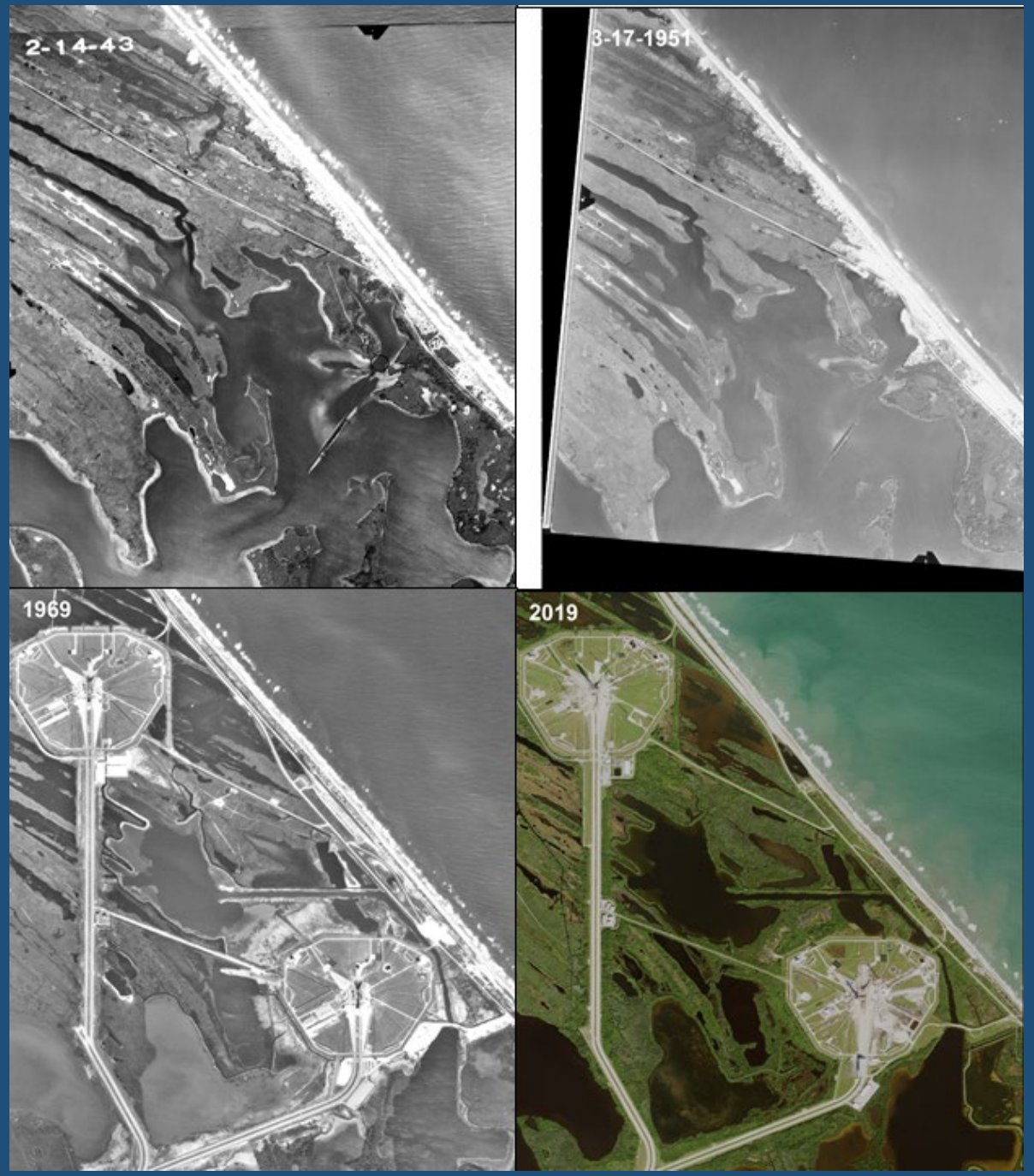
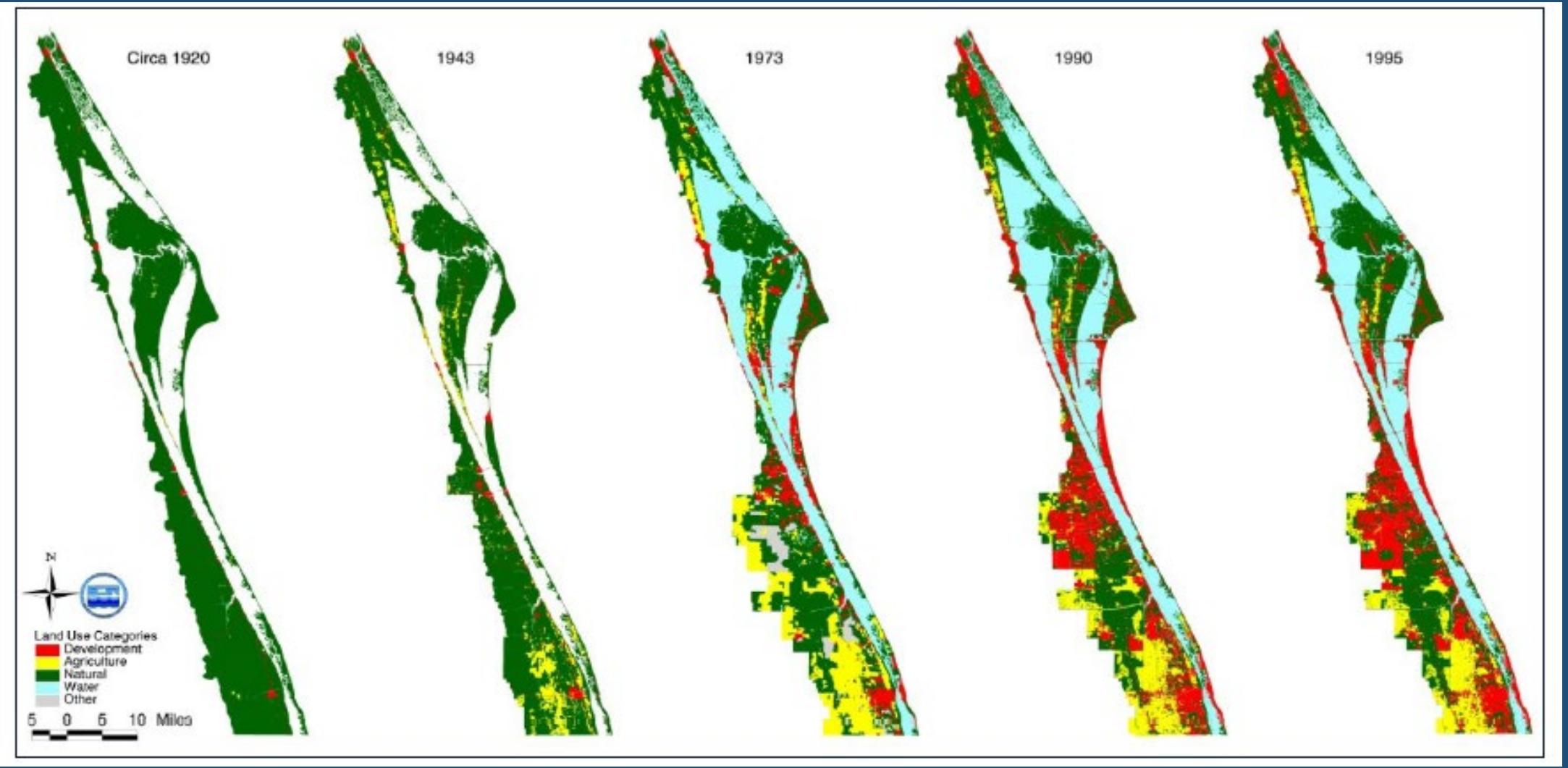


Land Use Changes



Mosquito Impoundments

aecom.com

How Do We Paint the Picture of Risk

- Shoreline erosion rates
- Exposure to wave risk
- Exposure to Sea Level Rise Inundation
- Estimated future risks

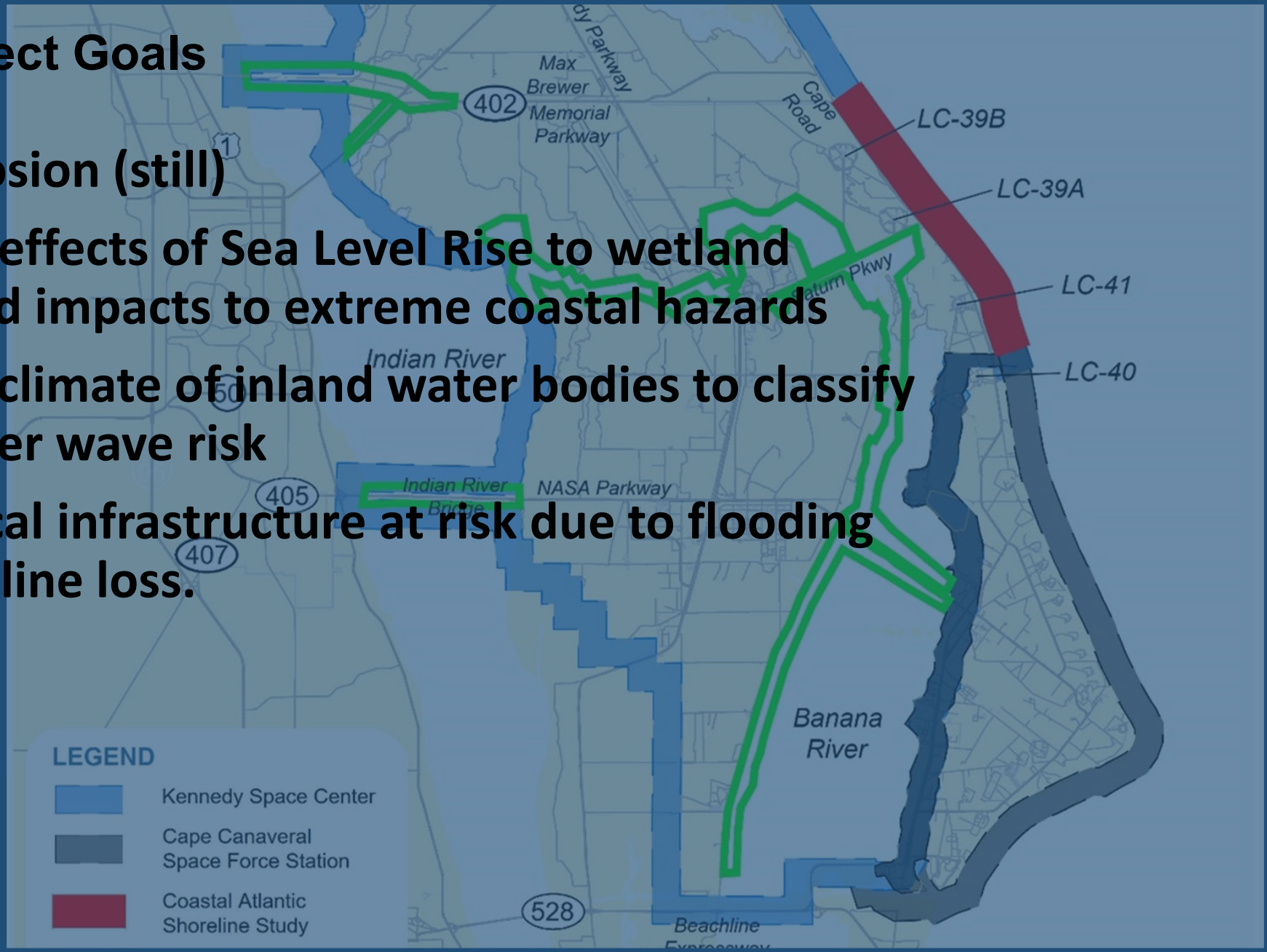
Examples of Hazards

Current Hazards

- Land use changes have disrupted marsh building cycles and ecological systems.
- Sea level rise contributing to marsh submergence.
- Periodic tropical events, fetch-limited waves, and boat wake contributing to shoreline loss through wave erosion.
- Infrastructure in the marsh is threatened by both shoreline loss and marsh inundation.
- Shoreline loss and marsh submergence lead to increased wave hazard risk during storm events.

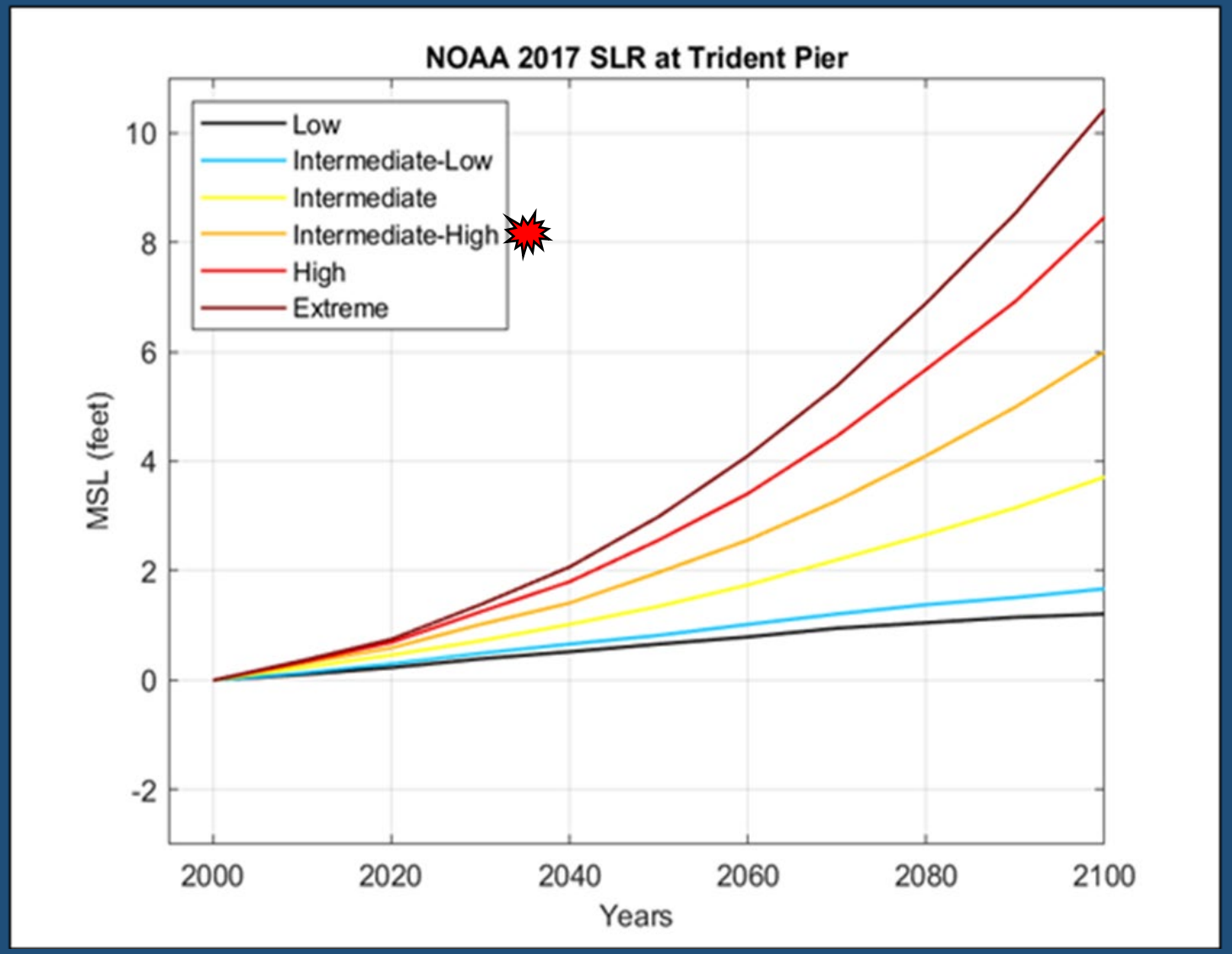
(Revised) Project Goals

- Shoreline erosion (still)
- Evaluate the effects of Sea Level Rise to wetland migration and impacts to extreme coastal hazards
- Assess wave climate of inland water bodies to classify areas of higher wave risk
- Identify critical infrastructure at risk due to flooding and/or shoreline loss.



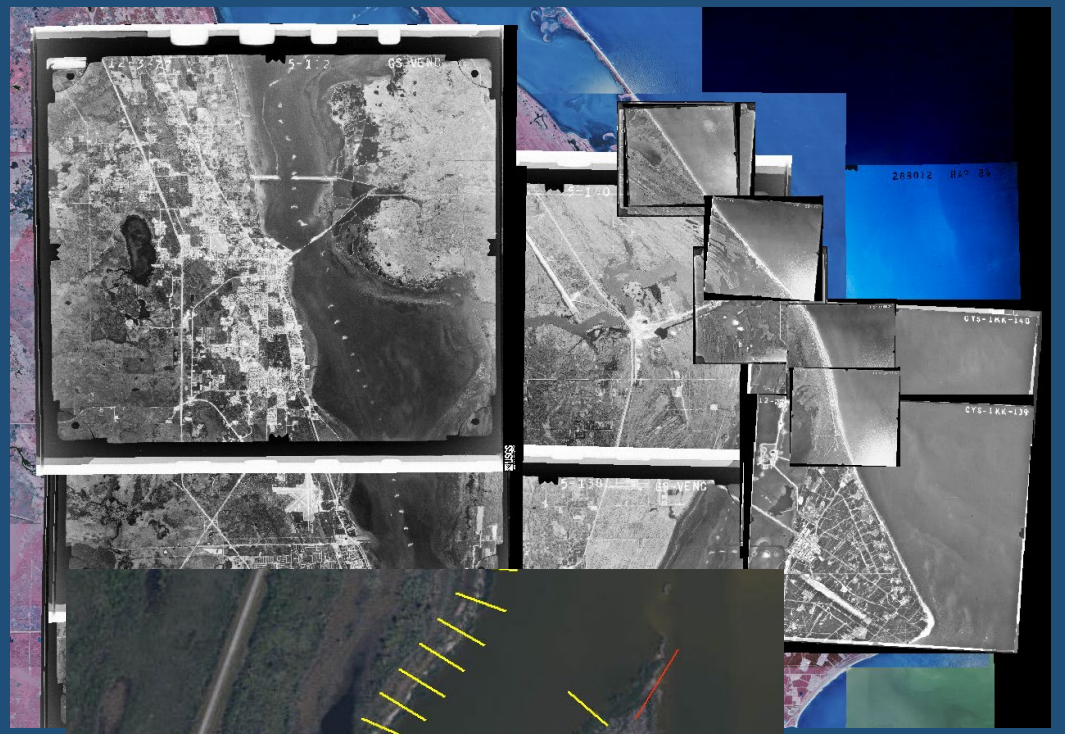
Sea Level Rise

- Client requested use of NOAA Intermediate-high scenario
- SLR contributions were added to modeling water levels to determine future hazards



Shoreline Change Analysis

- Data Collection
- Photo Rectification
- Shoreline delineation
- DSAS Analysis
- Shoreline Loss Classification



DSAS for Shoreline Change Analysis

An official website of the United States government Here's how you know

USGS science for a changing world

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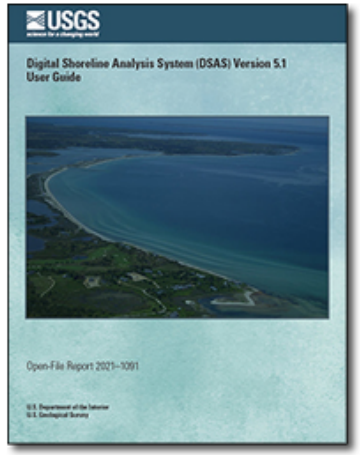


Digital Shoreline Analysis System (DSAS) Version 5.1 User Guide

Open-File Report 2021-1091

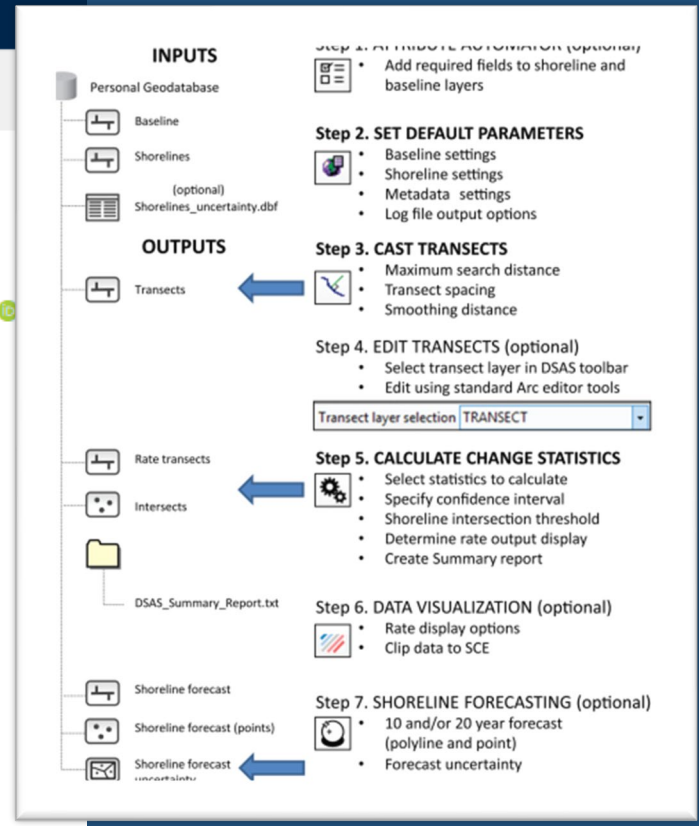
By: Emily A. Himmelstoss, Rachel E. Henderson, Meredith G. Kratzmann, and Amy S. Farris

https://doi.org/10.3133/ofr20211091

Tweet

Links

- Document: **Report** (11.2 MB pdf)
- Project Site: **Digital Shoreline Analysis System (DSAS)**
- Software Release: **Digital Shoreline Analysis System version 5.1**
- Download citation as: RIS | Dublin Core



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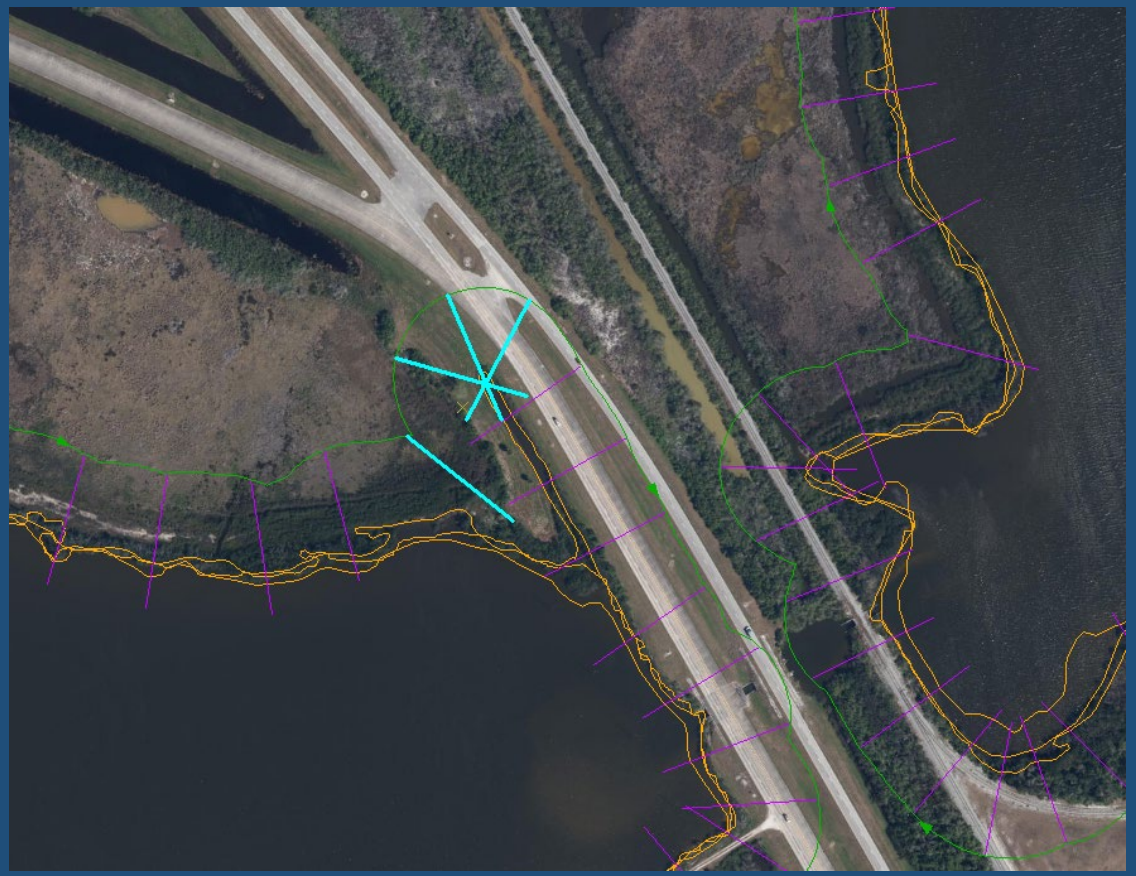

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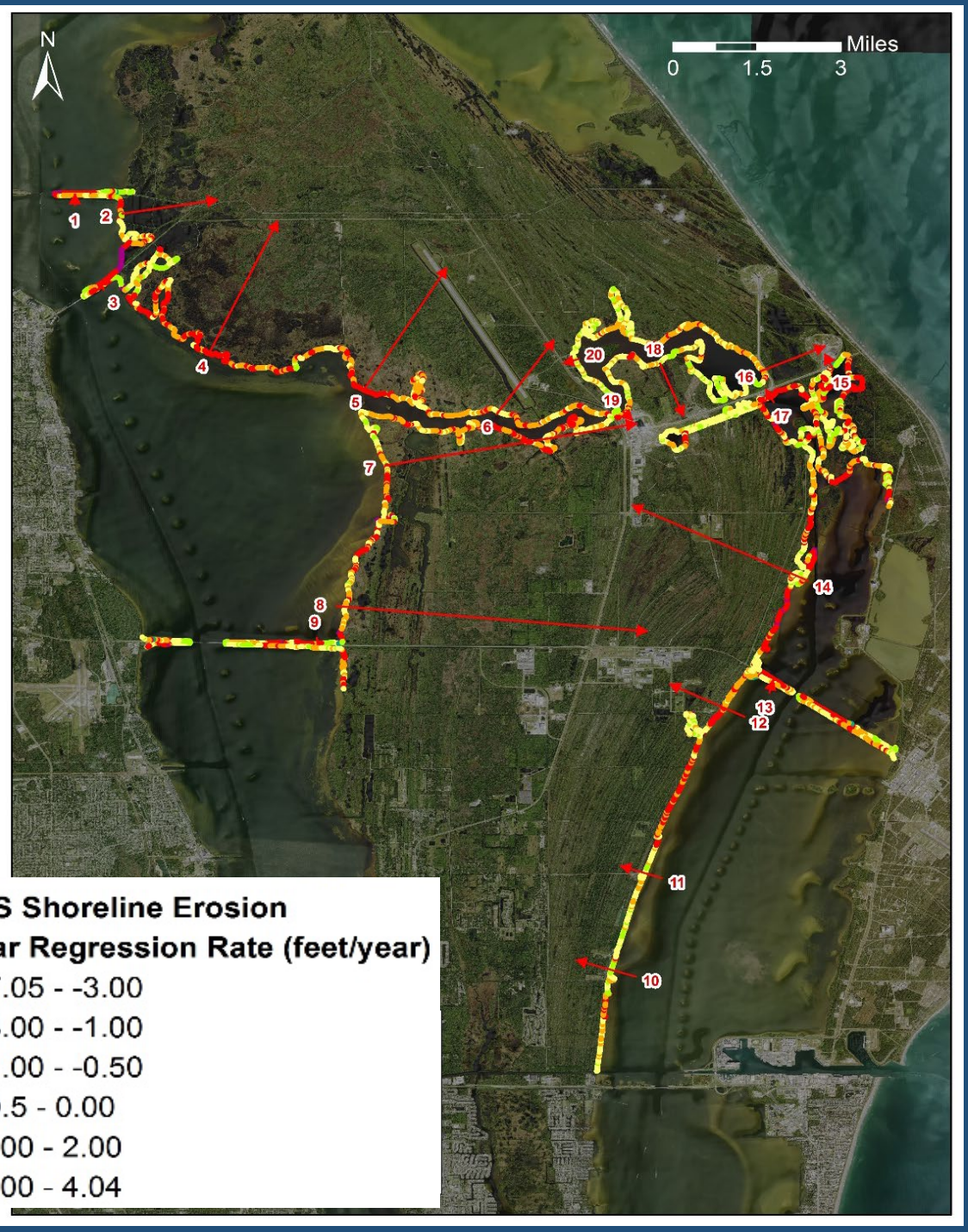
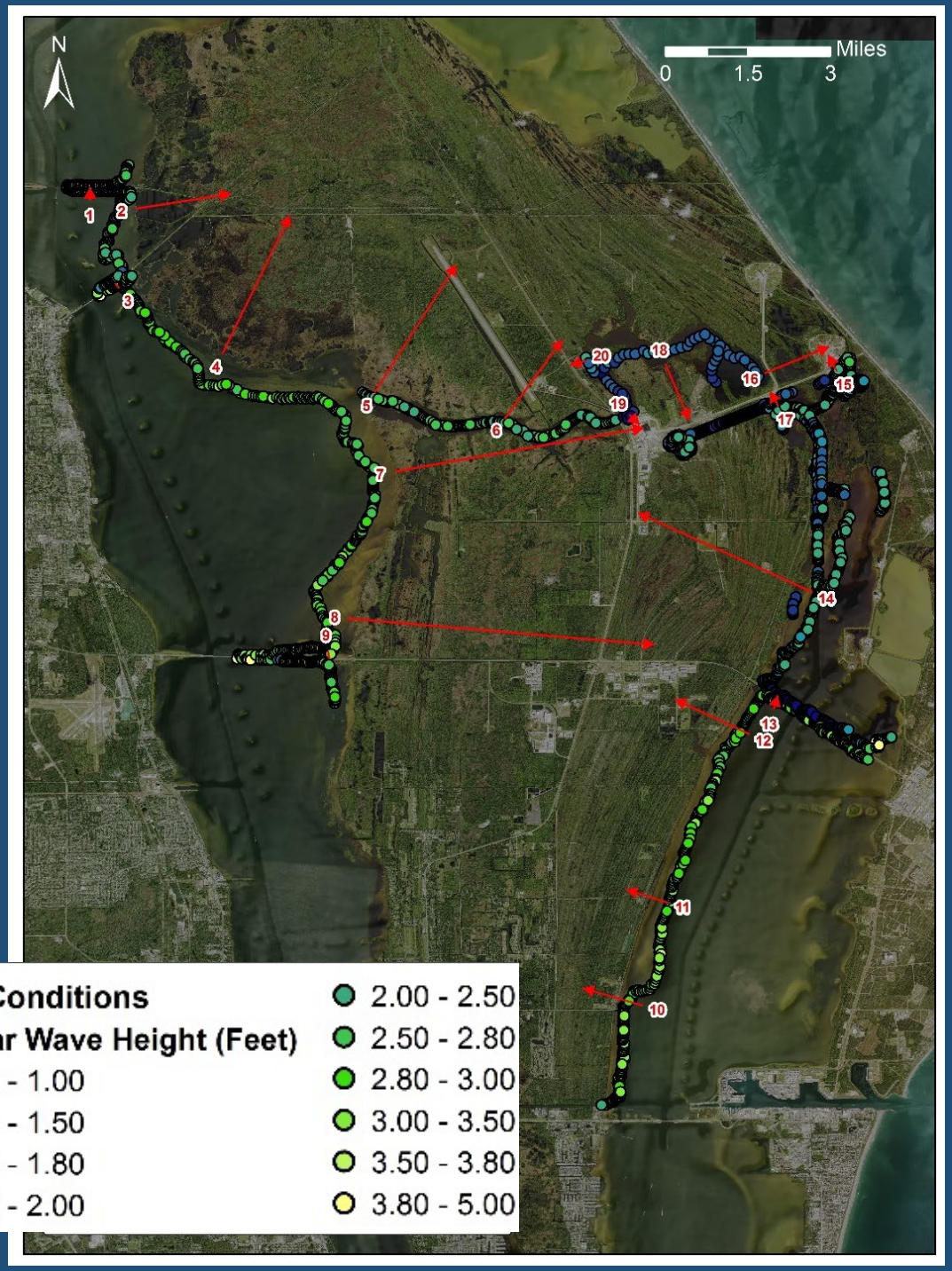


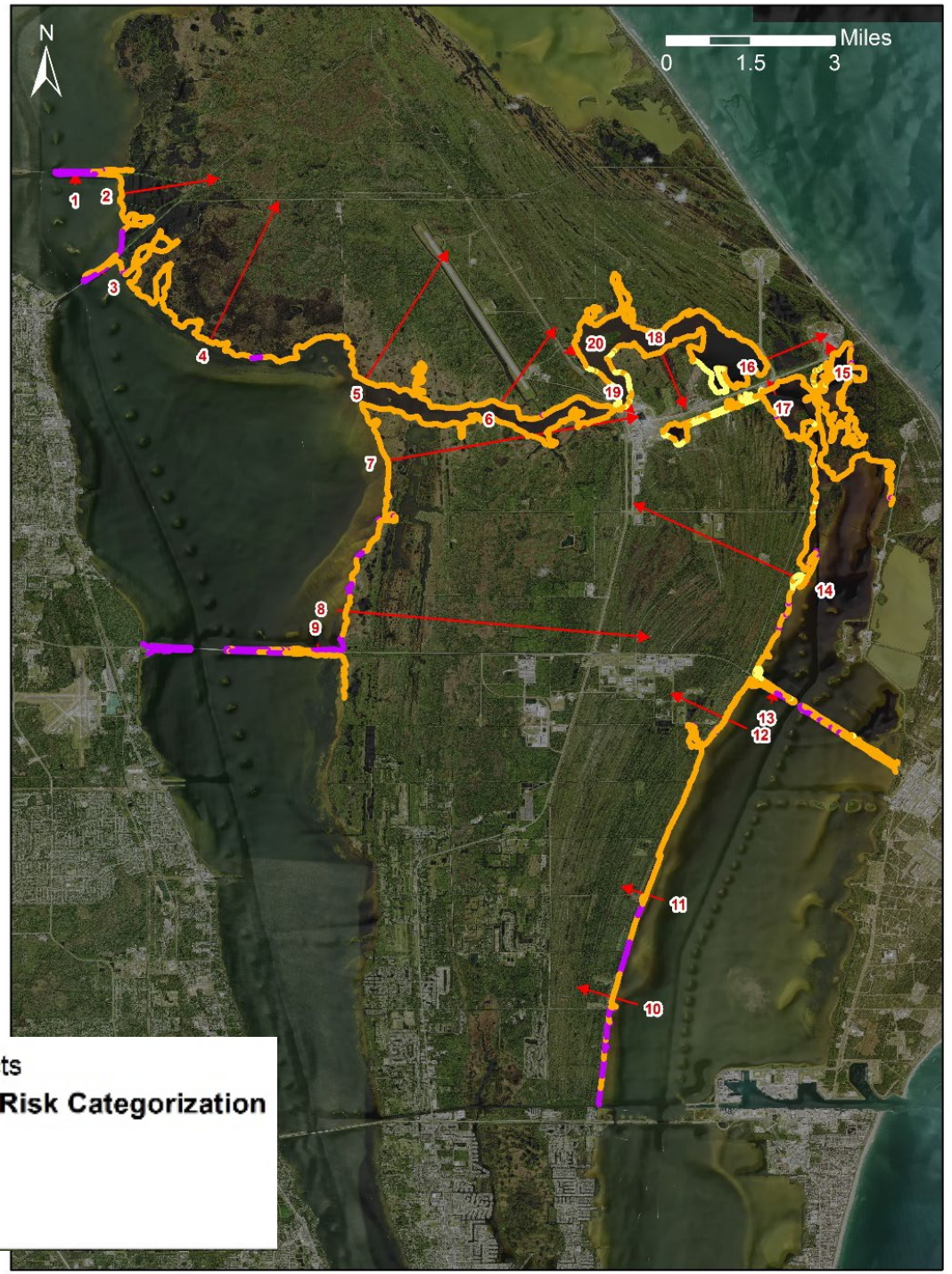
Wave Analysis



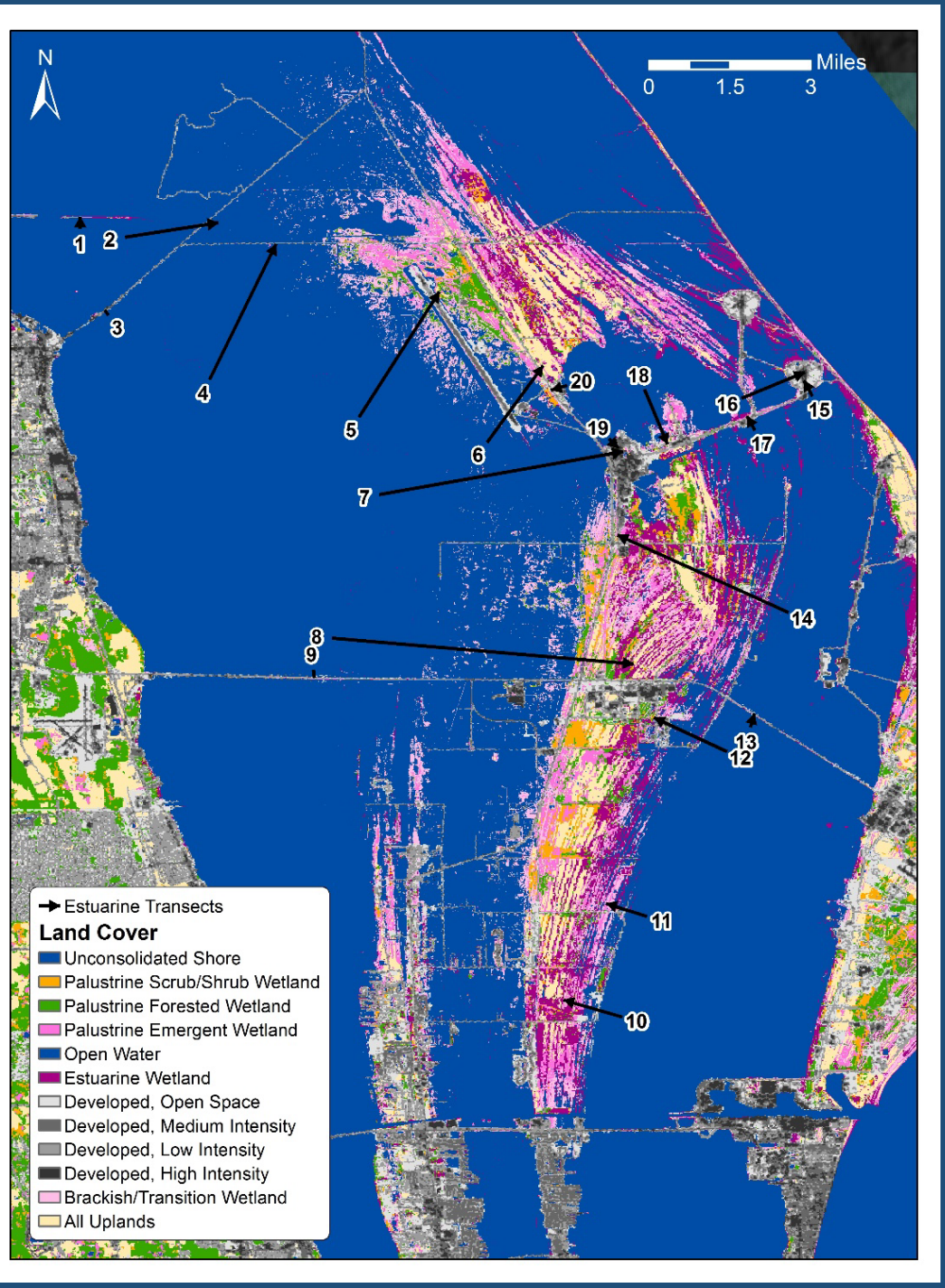
Shore Classification

Wave Height	Shoreline Erosion Rate (ft/yr)		
	> 3	0.5 - 3	< 0.5, or accretion
< 1.5'	High	Moderate	Low
1.5 - 3'	High	Moderate	Moderate
> 3'	High	High	High

Low	Moderate	High
6.35%	83.16%	10.49%



Marsh Migration



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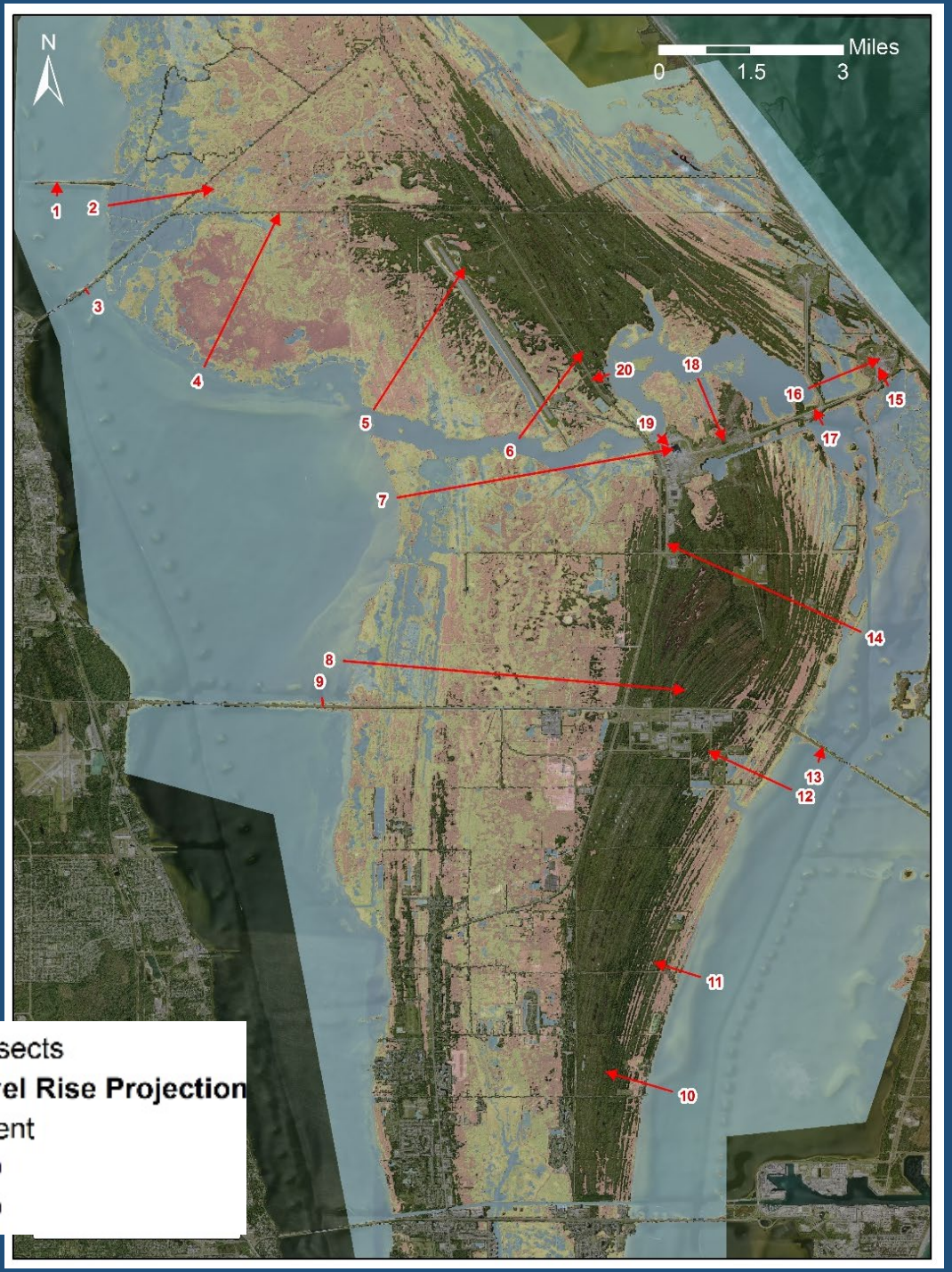


Overland Wave Modeling

Transects

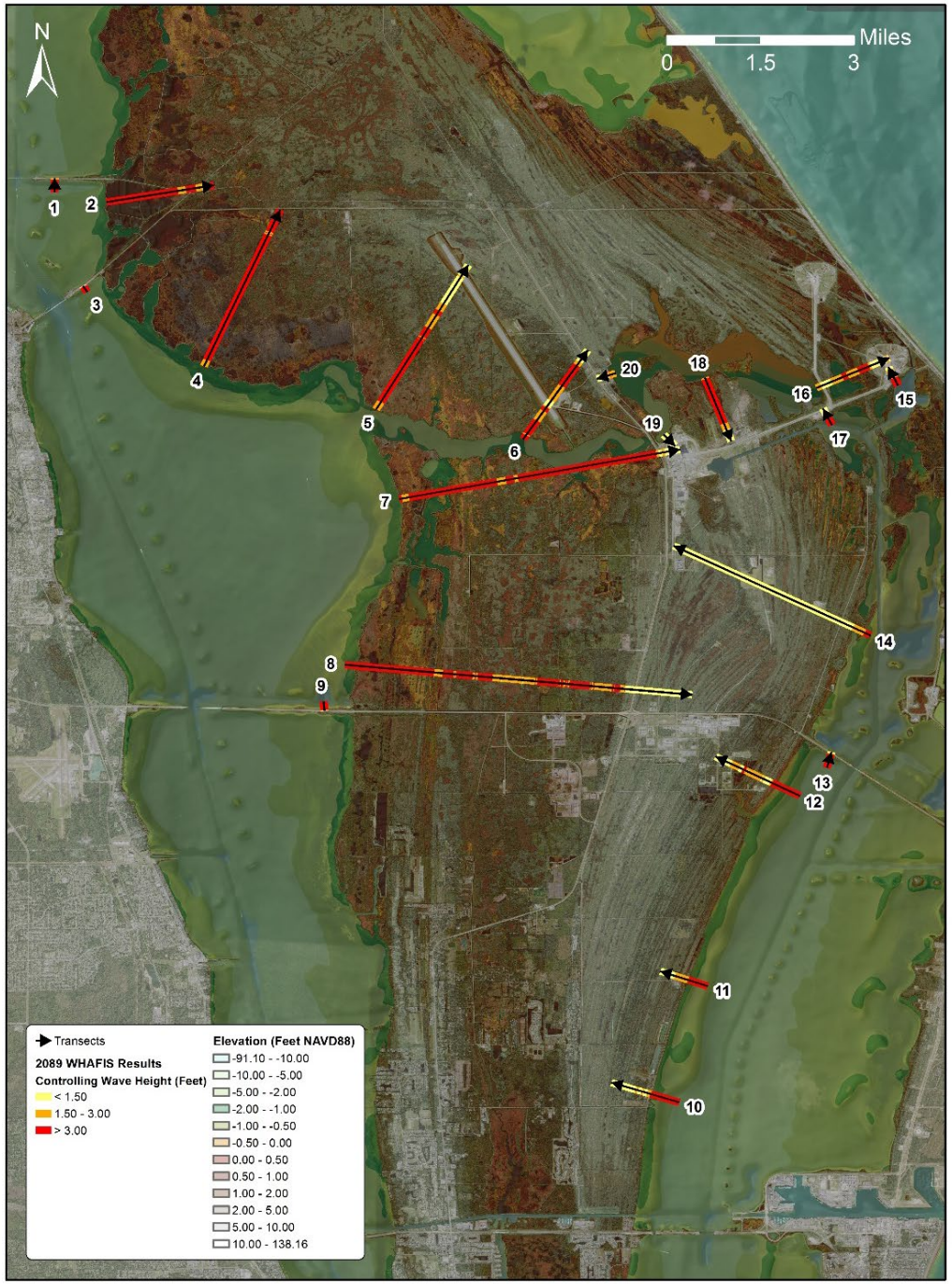
2089 WHAFIS Results

Controlling Wave Height (Feet)

- < 1.50
- 1.50 - 3.00
- > 3.00

Elevation (Feet NAVD88)

- -91.10 - -10.00
- -10.00 - -5.00
- -5.00 - -2.00
- -2.00 - -1.00
- -1.00 - -0.50
- -0.50 - 0.00
- 0.00 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- 2.00 - 5.00
- 5.00 - 10.00
- 10.00 - 138.16



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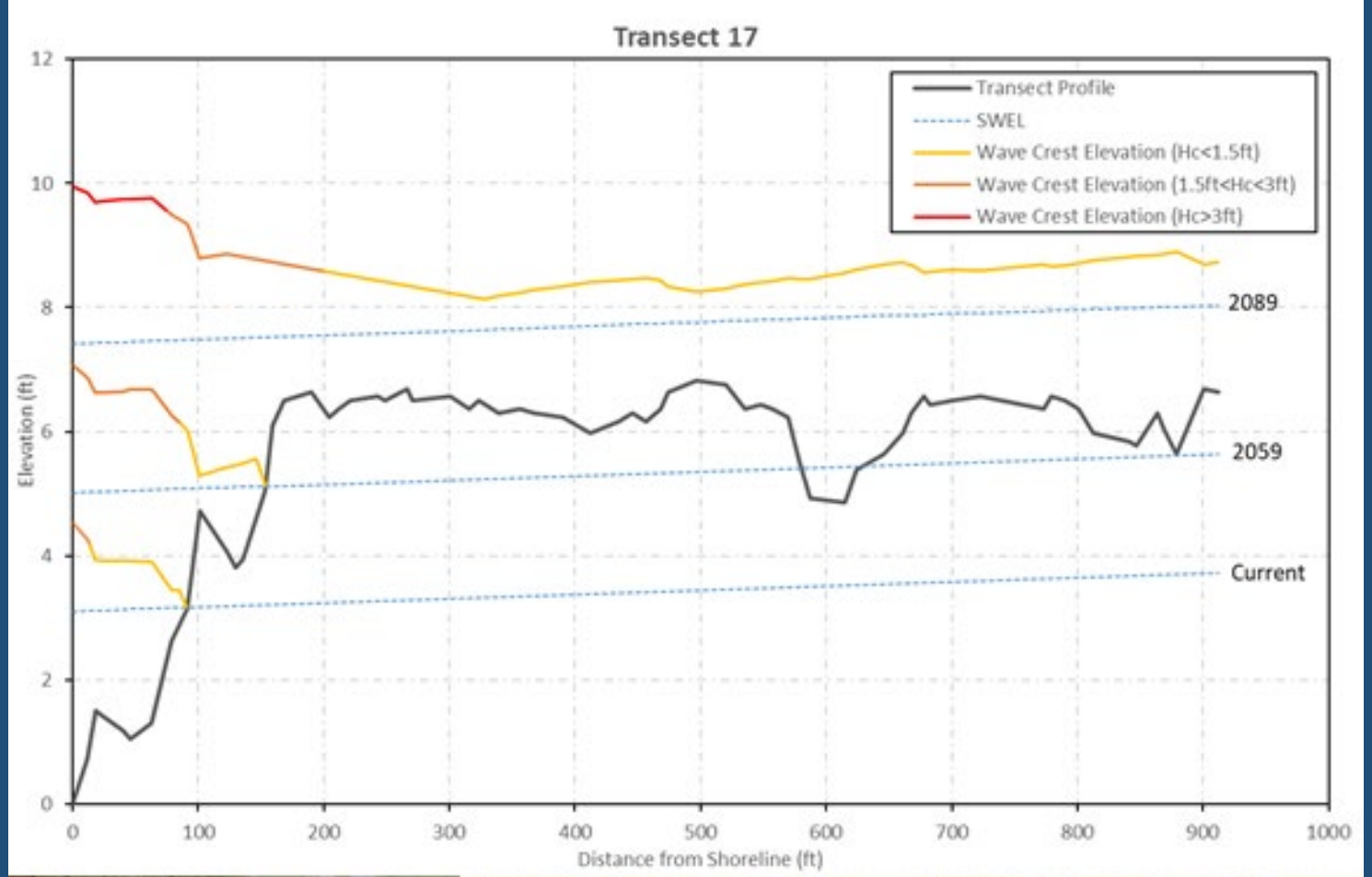

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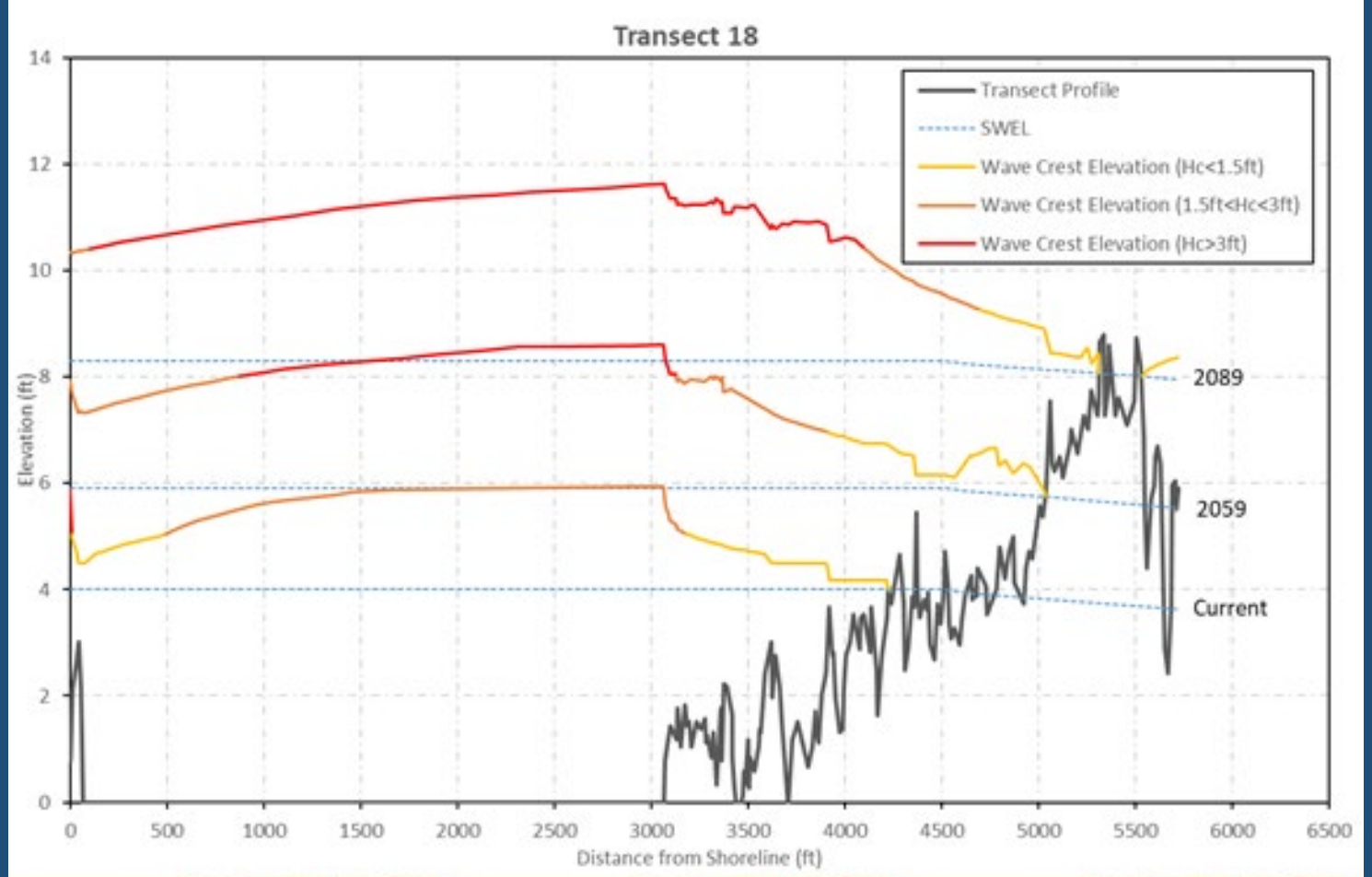
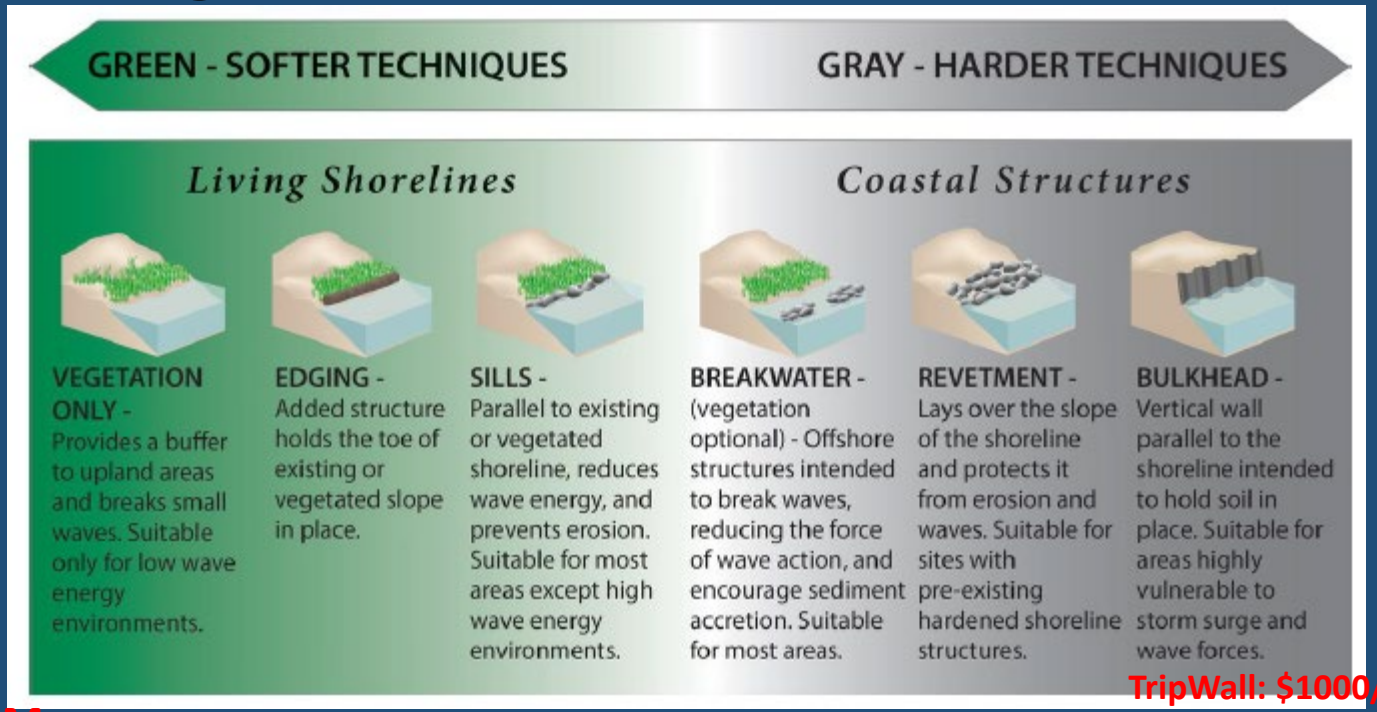


Potential Mitigation Strategies



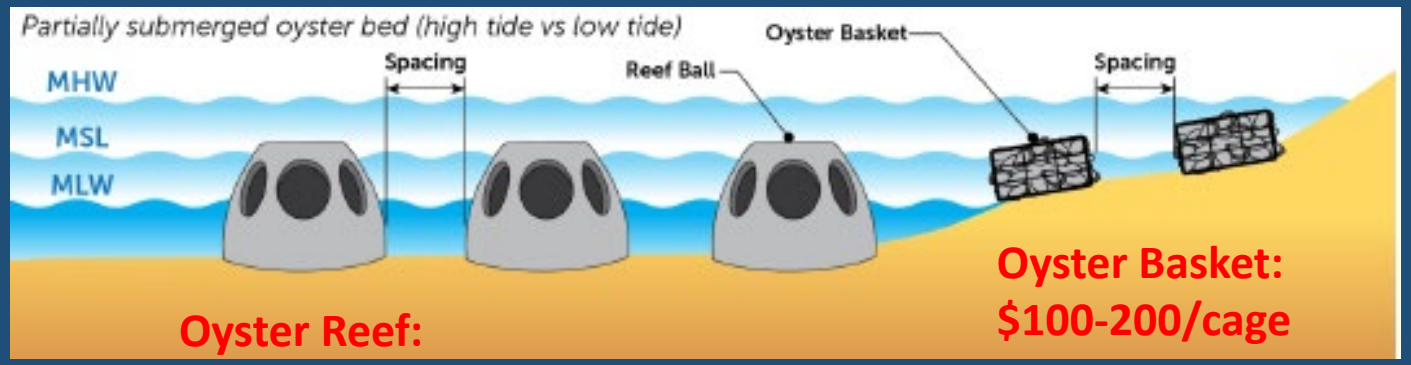
Mangroves: $95K/AC

TripWall: $1000/ft

Sheetpile Seawall: $1750/ft

Riprap: $80-100/ton

NOAA, 2017

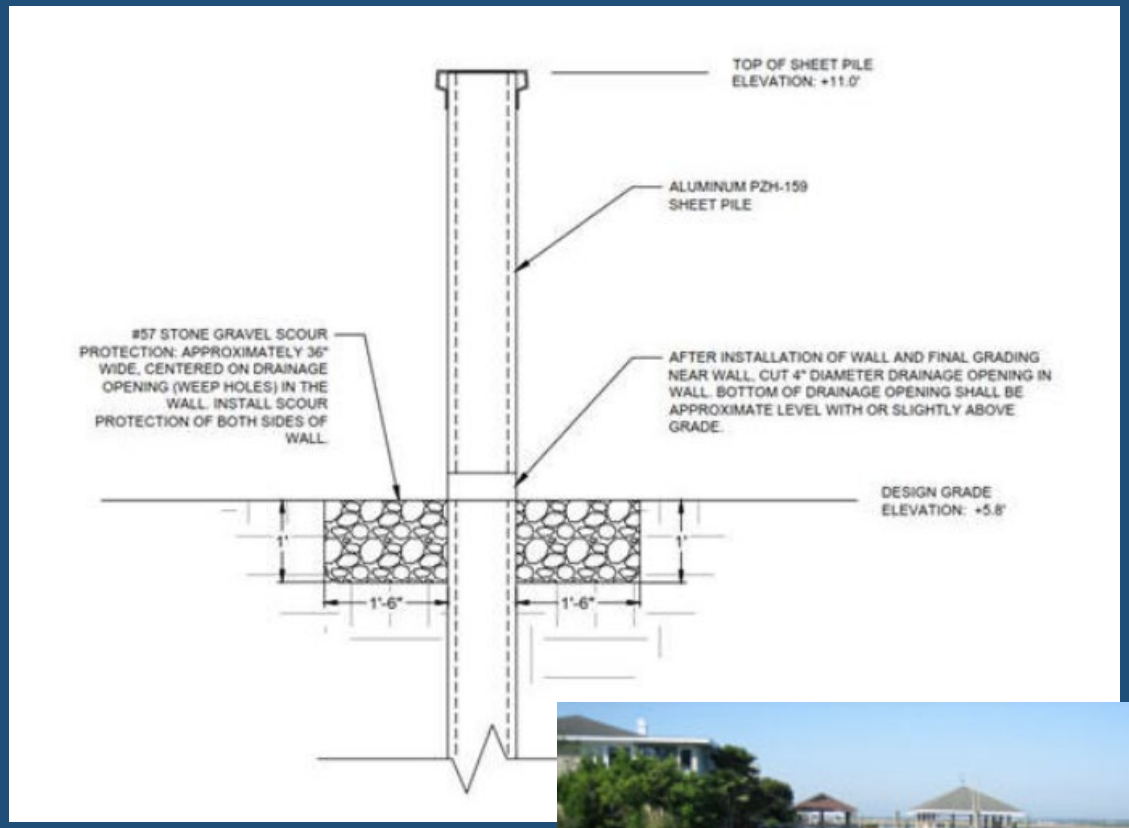


Oyster Reef: $200-300/ball

Oyster Basket: $100-200/cage

TXGLO, 2021

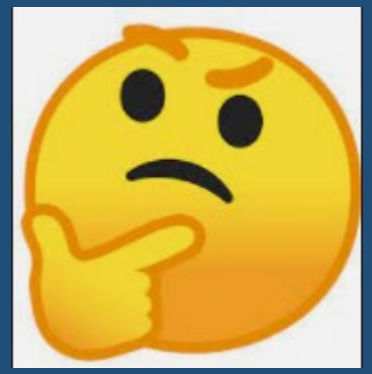
Potential Mitigation Strategies



Conclusions

- A robust evaluation of estuarine hazards can be conducted through a series of 1D analyses using open source/public data
- The basic analysis can be enhanced through additional analyses, including 2D modeling
- The compound 1D modeling approach can be a cost-effective way to evaluate multiple risks for marsh communities
- When planning for development or mitigation, you should include future-looking datasets and hazards

Lessons Learned



- The data gathering can take a long time (who knew?)
- Data development for modeling inputs can be the most intensive part of the process
- The study should model multiple facets to derive appropriate conclusions; Estuarine environments are extremely complex, and some behaviors may have multiple causes. PLAN ACCORDINGLY.
- Sometimes the high-quality datasets you got aren’t useable because they’re not comparable… (bummer…)
- On-going construction/remediation can impact results.

Questions?