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# EVALUATING CLIMATE RESILIENCE THROUGH STORMWATER AND WATERSHED MASTER PLANNING

SESWA Regional Stormwater Seminar

April 21, 2023

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# Presentation Overview

Watershed and Stormwater Master  
Plan Overview

Climate Projections

Identifying Vulnerabilities

Management Measures

Project Examples

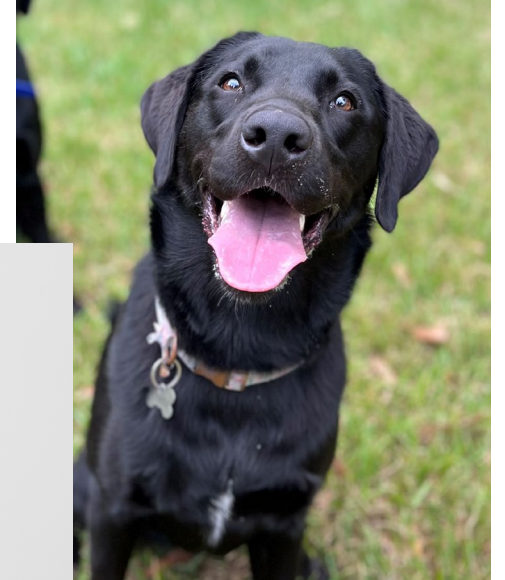
Discussion



# About Me

## Amanda Taylor, PE

- Civil/Coastal Engineer
- 9.5 years of experience
  - 6 with Louisiana Coastal Protection and Restoration Authority
  - 3.5 with Geosyntec Consultants
- 2013 LSU Graduate





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# Watershed and Stormwater Master Planning



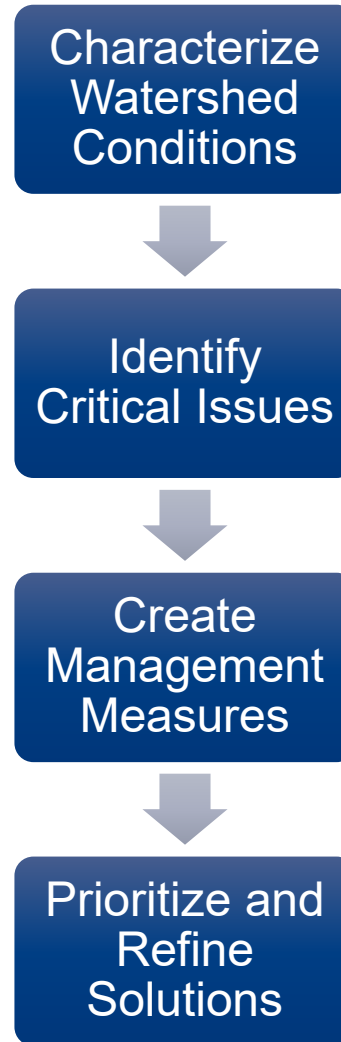


# What is a Watershed Management Plan?

*“Watershed planning provides an analytical framework for managing efforts to both restore water quality in degraded areas and protect overall watershed health.” – EPA, 2013*

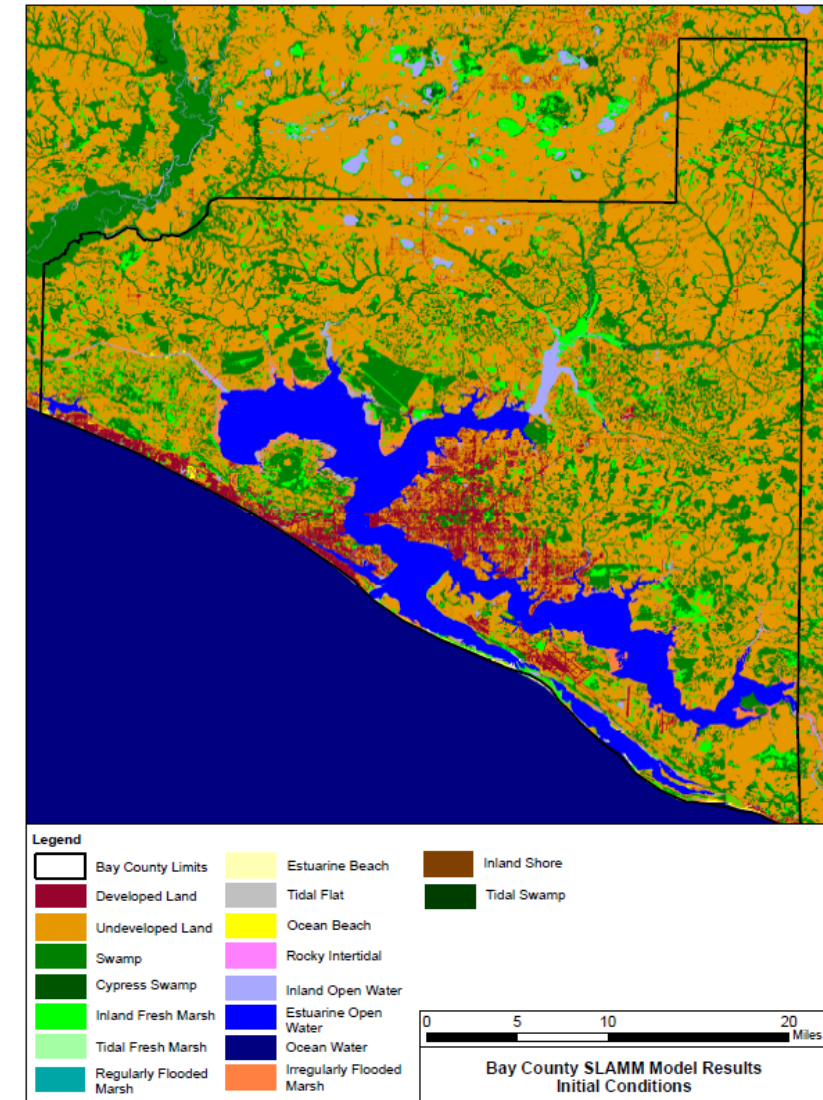
## Nine Key Elements

1. Identify causes and sources of pollution
2. Estimate pollutant loading
3. Describe management measures
4. Estimate technical and financial assistance needed
5. Develop information/education component
6. Develop project schedule
7. Describe interim, measurable milestones
8. Identify indicators to measure progress
9. Develop a monitoring component



# What is a Stormwater Master Plan?

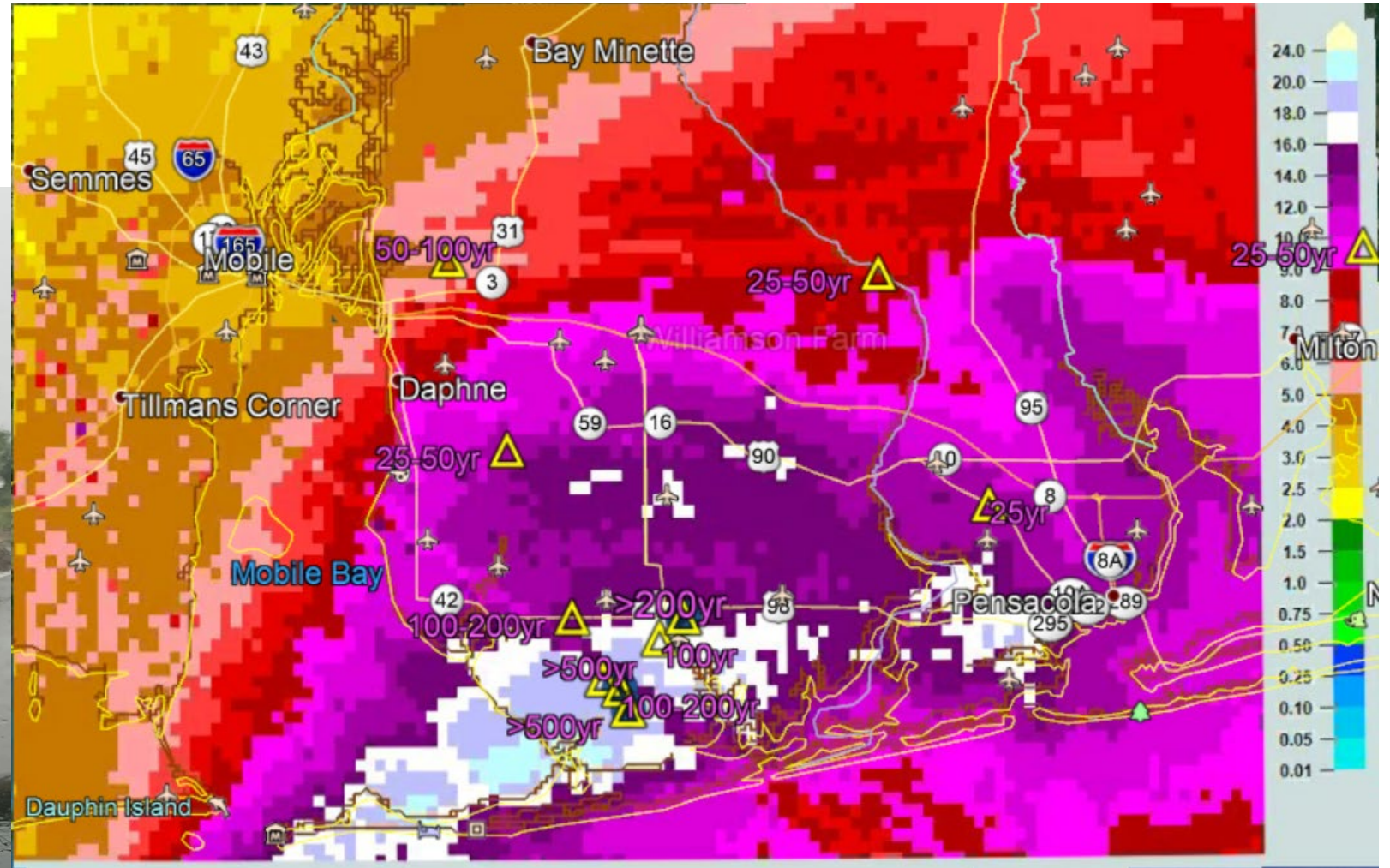
- A Stormwater Master Plan provides a clear, comprehensive, and forward-looking plan to implement a Community's stormwater management program.
- Common Components of a Stormwater Master Plan
  - Study area assessment
    - Water Quality, Ecology, etc.
  - Existing Stormwater Inventory
  - Current Operations and Maintenance Programs
  - Regulatory Requirements
  - BMP Evaluation
  - Funding and Recommendations





# What's Missing?

## Future Climate Impacts





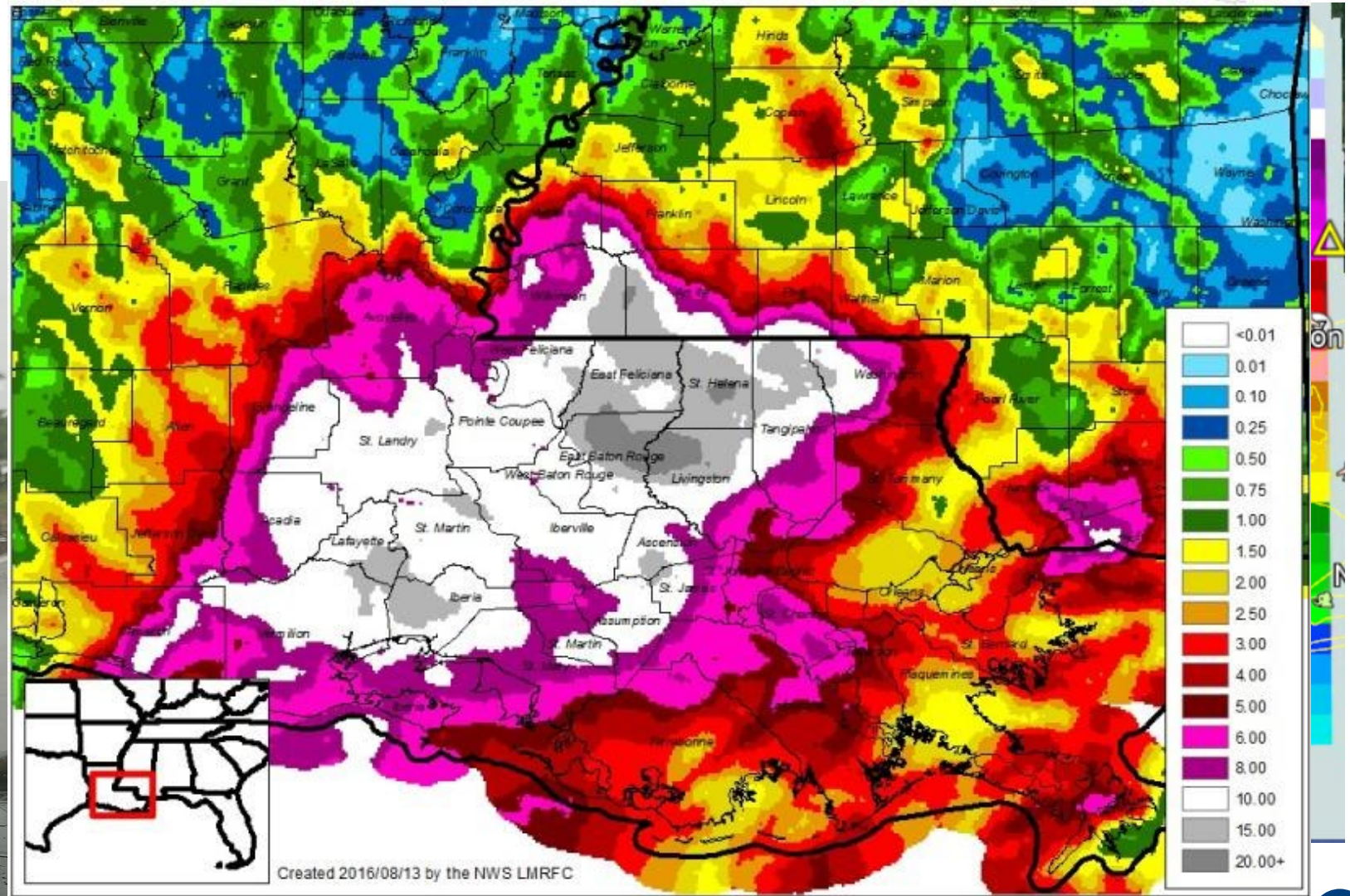
# What's Missing?

## Future Climate Impacts



### Best-Estimate Rainfall

2 day rainfall estimate ending August 13, 2016.





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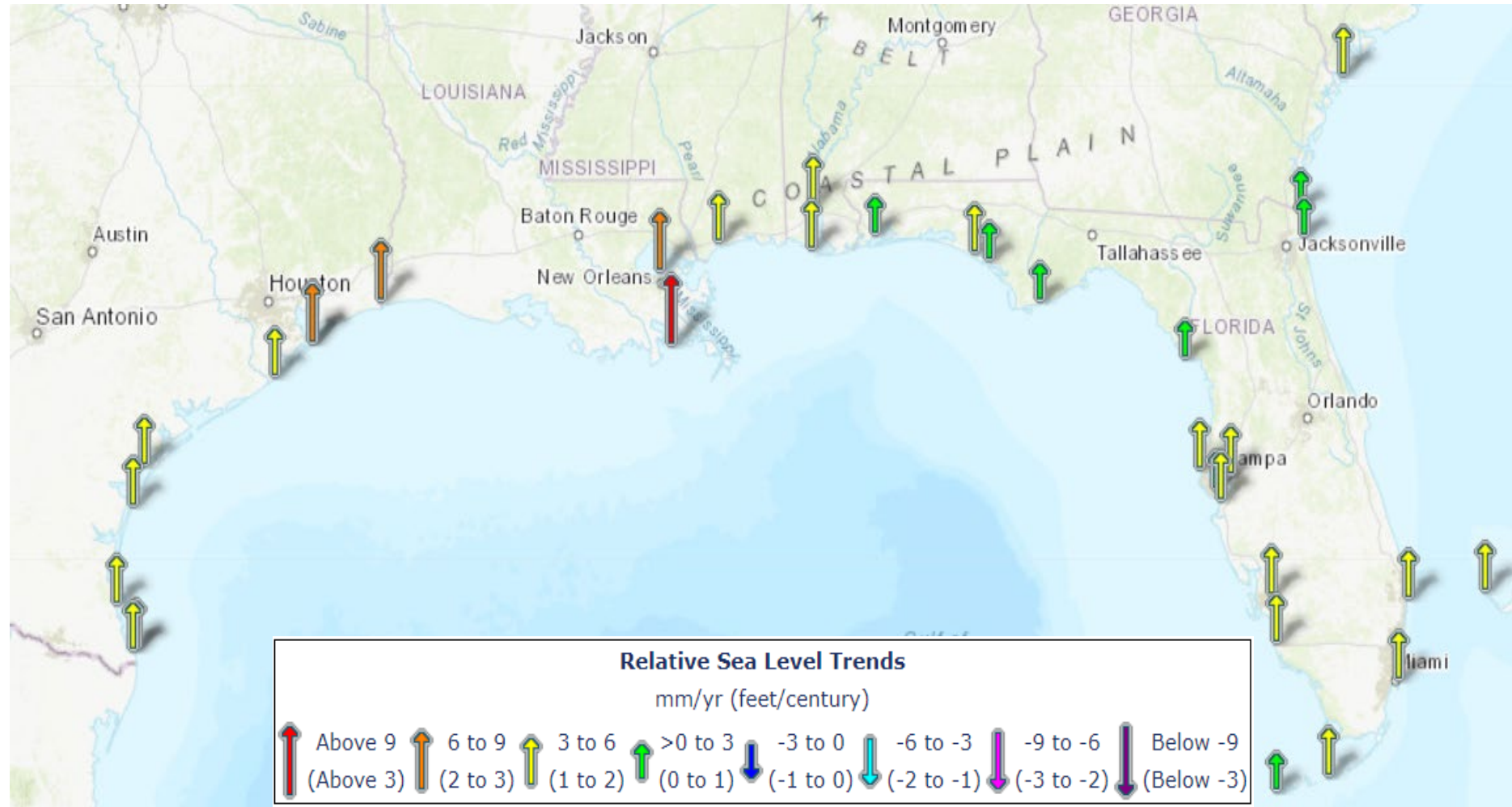
# Climate Projections



# Southeast Region/Gulf of Mexico

## Southeast sea levels trending up

- From 0-1 ft/century along Panhandle of Florida and GA/FL Atlantic border to above 3 ft/century in southeast LA



Sea Level Trends -  
NOAA Tides &  
Currents





# What can mean?

## Intermediate Scenario

1. Current MHHW
2. ~20-years (0.82 ft)
3. ~40-years (1.4 ft)
4. ~80 years (3.5 ft)

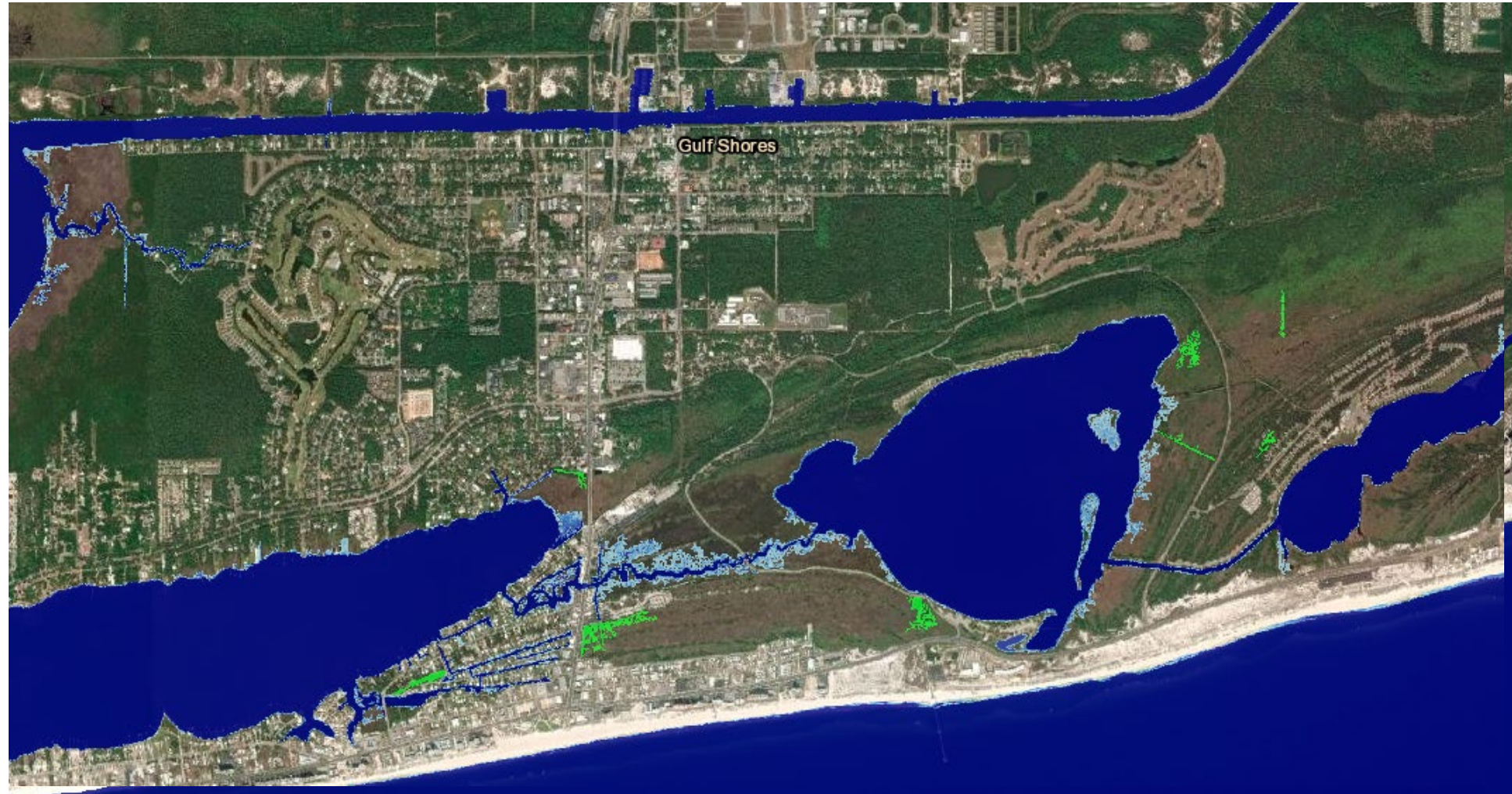




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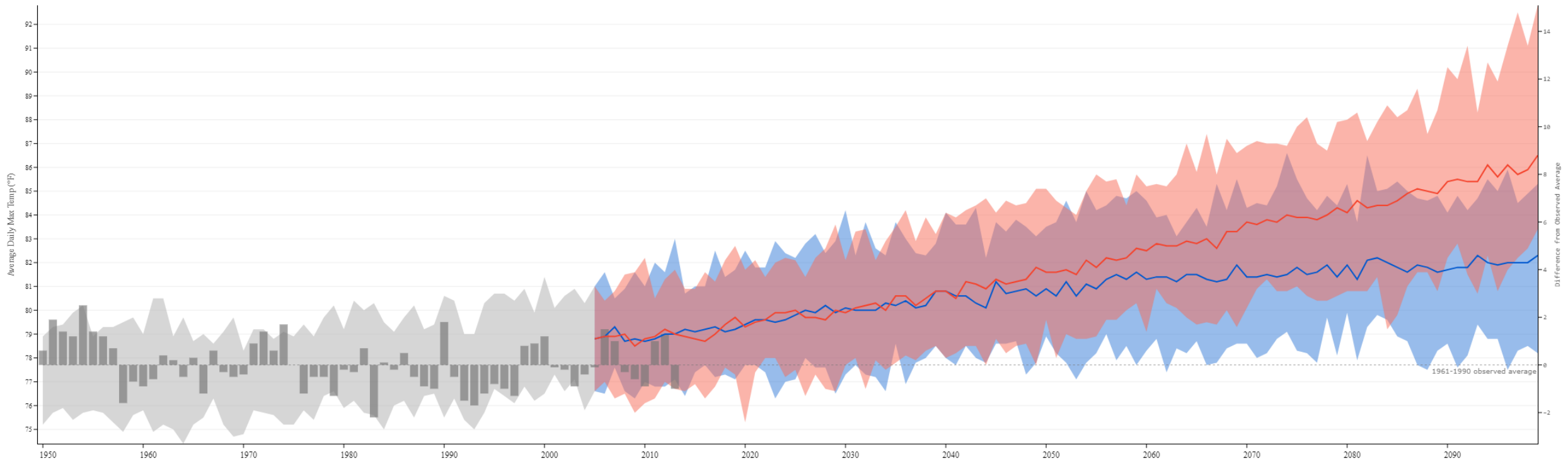
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# Southeast Region/Gulf of Mexico

## Temperature trending warmer

- Example – Baldwin County Average Maximum Daily Temperature increase approximately +4-9°F by 2100





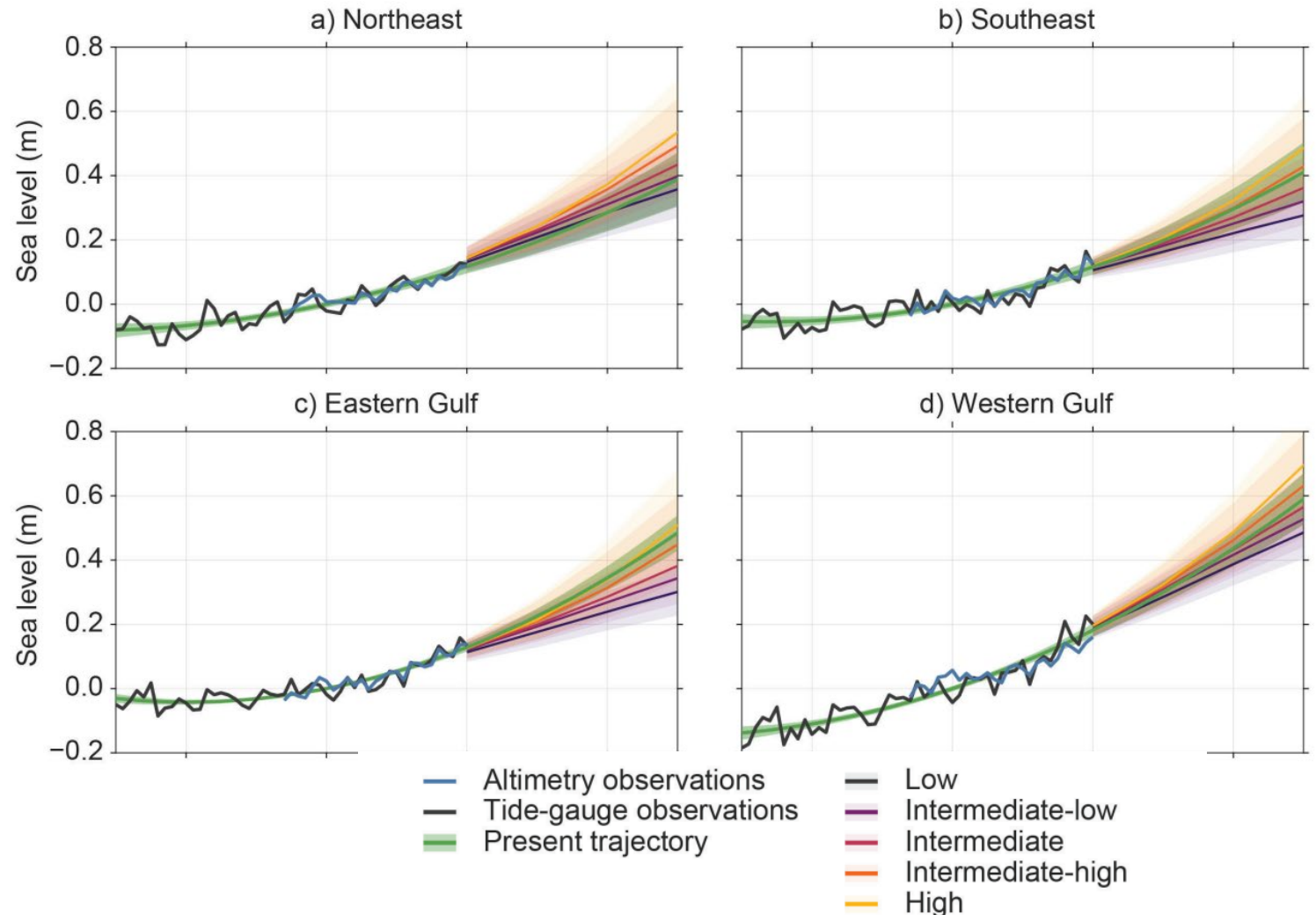
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# Identifying Vulnerabilities



# Factors Affecting Vulnerability

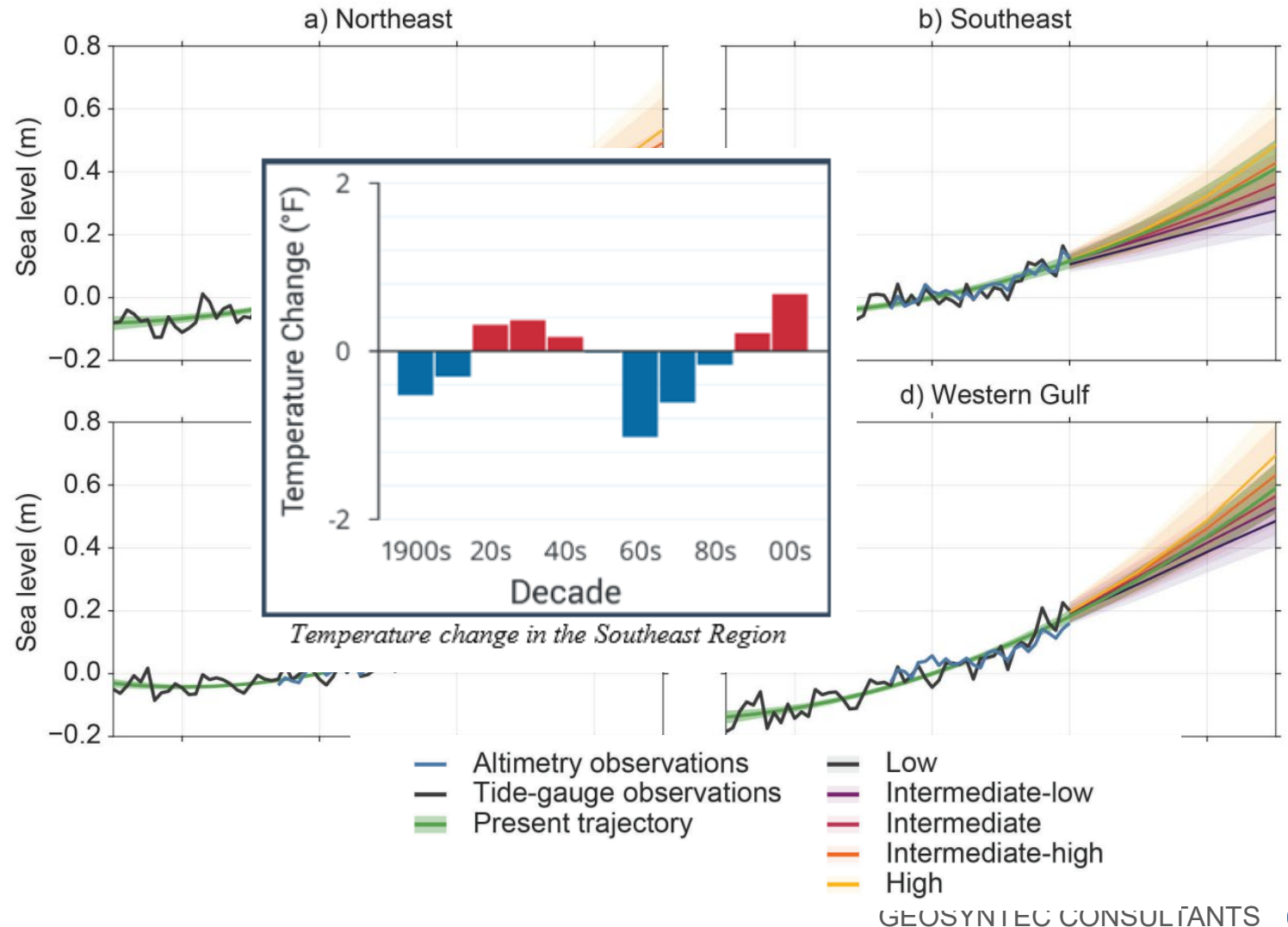
- Vulnerability - how susceptible a natural or human system is to coastal hazards, such as shoreline change, sea-level rise, flooding, and storm surge. Vulnerability is a function of a system's sensitivity and its capacity to adapt to impacts and changes
- Factors affecting vulnerability
  - Sea Level Rise (Sea Level Trends - NOAA Tides & Currents)
  - Temperature increase (Melillo, Richmond, & Yohe, 2014)
  - Extreme Weather Events (NOAA Historical Hurricane Tracks)
  - Societal and Economic Resources (TNC, 2020)
  - Infrastructure (roads, stormwater, etc.) (Bay County, 2022)





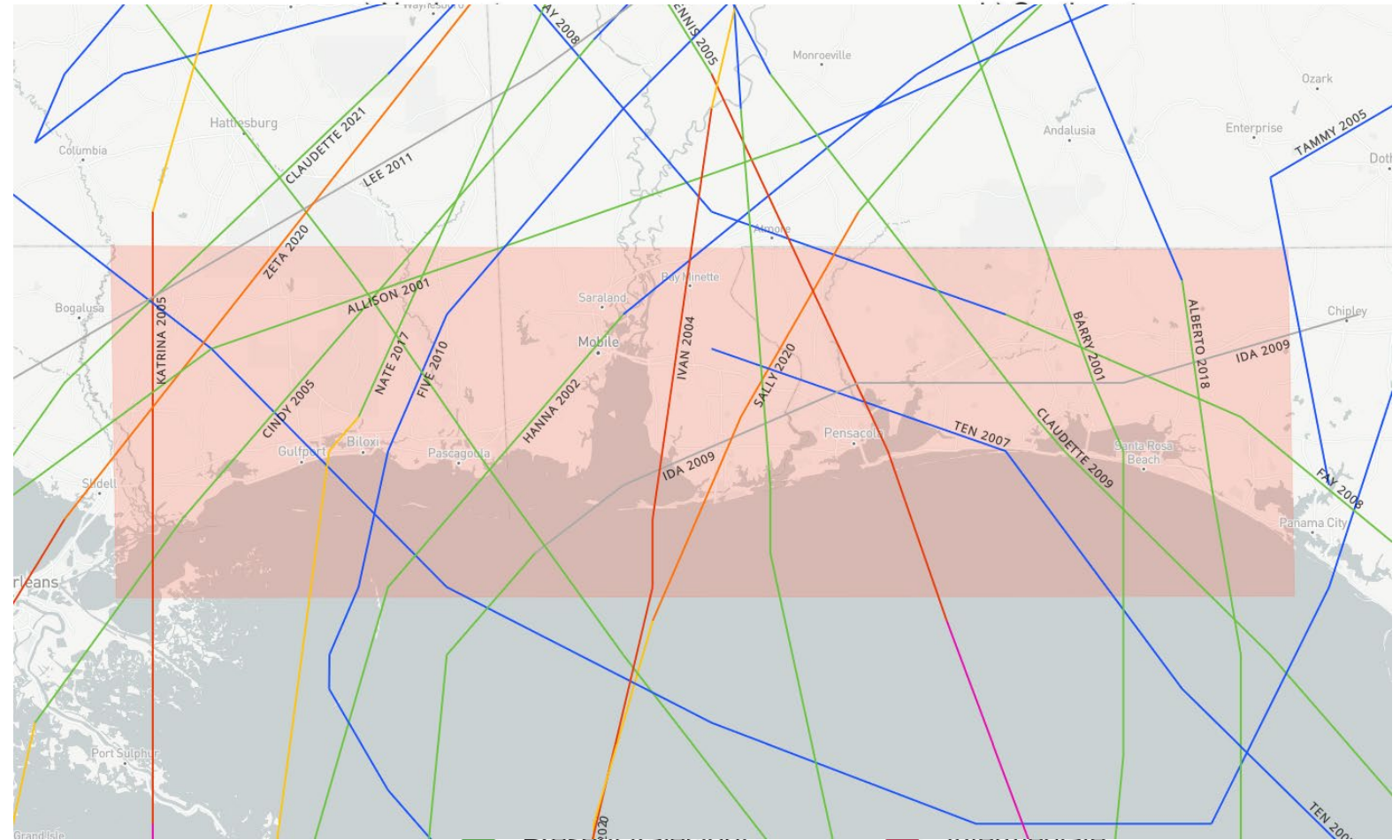
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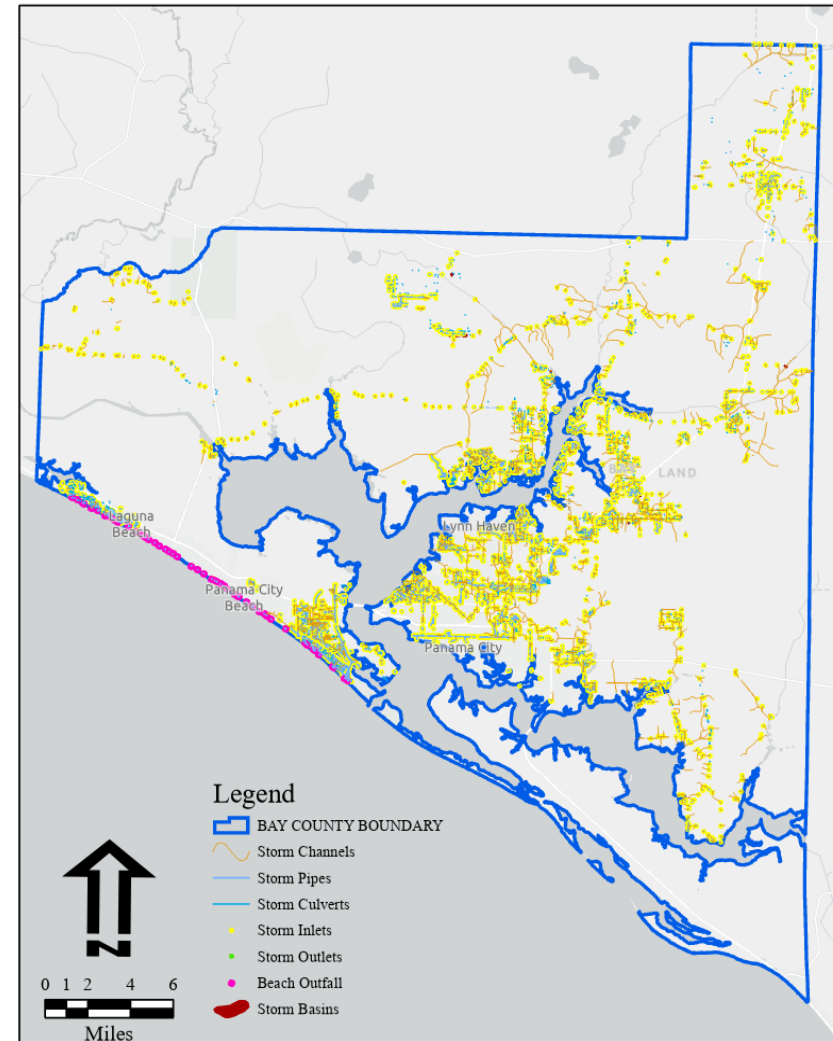


*Heavy Boating Traffic around the Islands of Perdido on Memorial Day 2020  
(Photo credit: Ken Cooper)*



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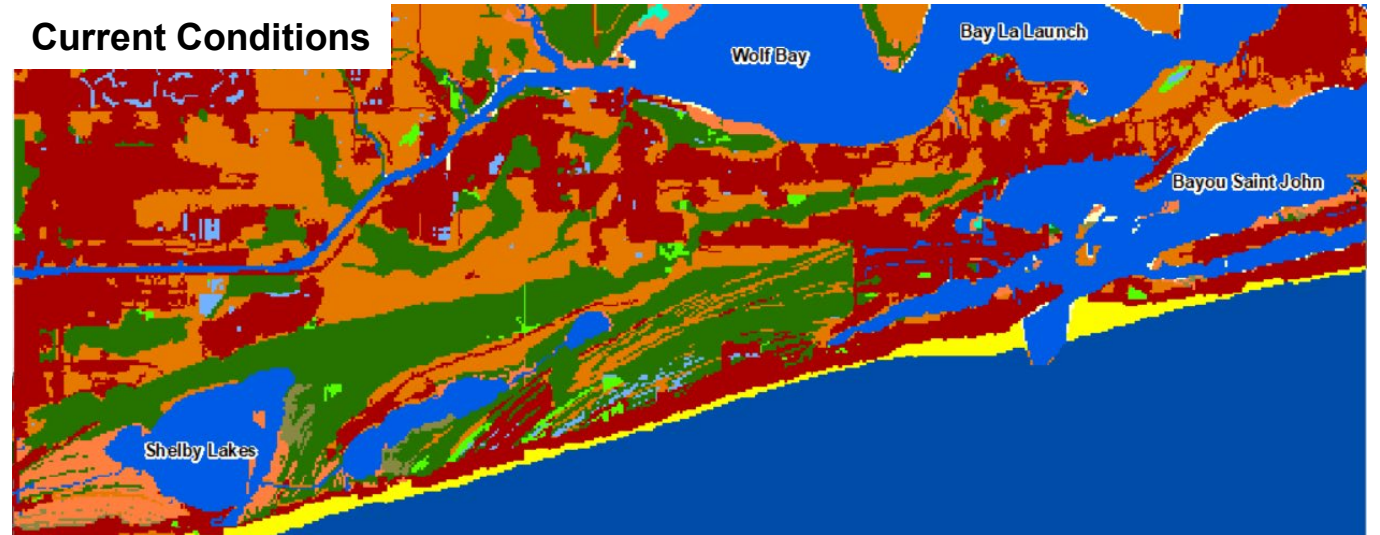




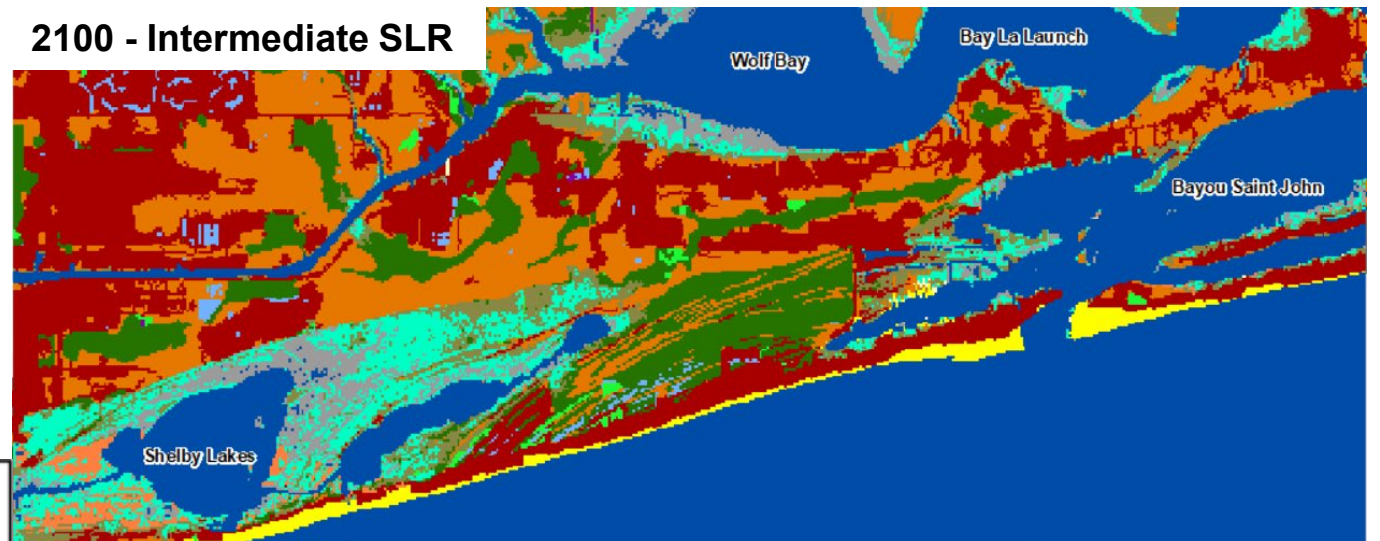
# Tools- SLAMM (Sea Level Affecting Marshes Model)

- Warren Pinnacle Consulting, Inc.
- Simulates potential impacts of long-term sea level rise on wetlands and shorelines
- Example
  - Orange Beach – Swamps surrounding Shelby Lakes convert to Tidal Flats and Regularly-Flooded marsh indicating area is more susceptible to flooding
  - Shorelines along Wolf Bay, Bay La Launch, and Bayou Saint John experience erosion

Current Conditions



2100 - Intermediate SLR

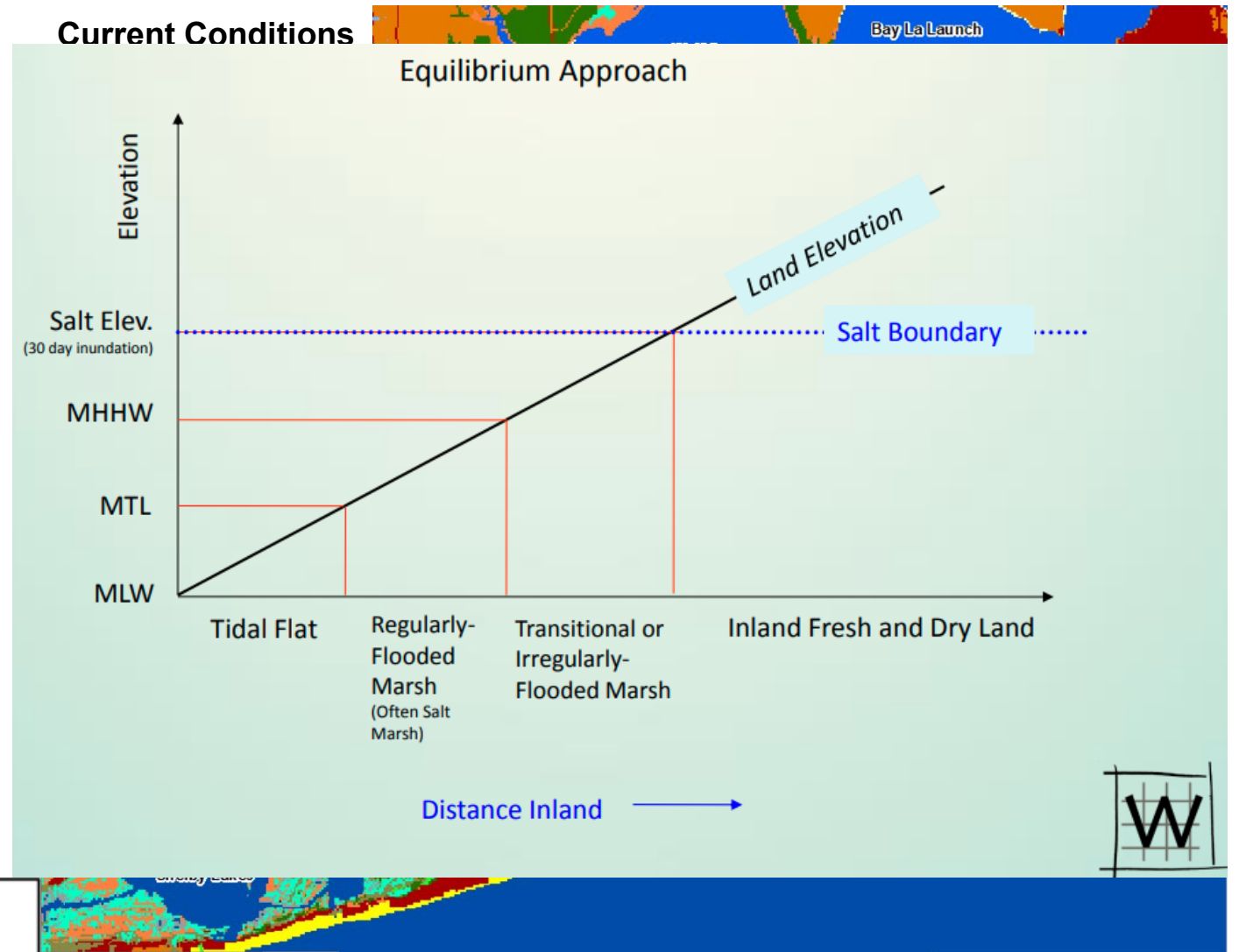


Developed Land	Inland Freshwater Marsh	Estuarine Beach	Inland Open Water
Undeveloped Land	Scrub/Shrub	Tidal Flat	Estuarine Water
Swamp	Regularly Flooded Marsh	Ocean Beach	Open Ocean
	Irregularly Flooded Marsh		



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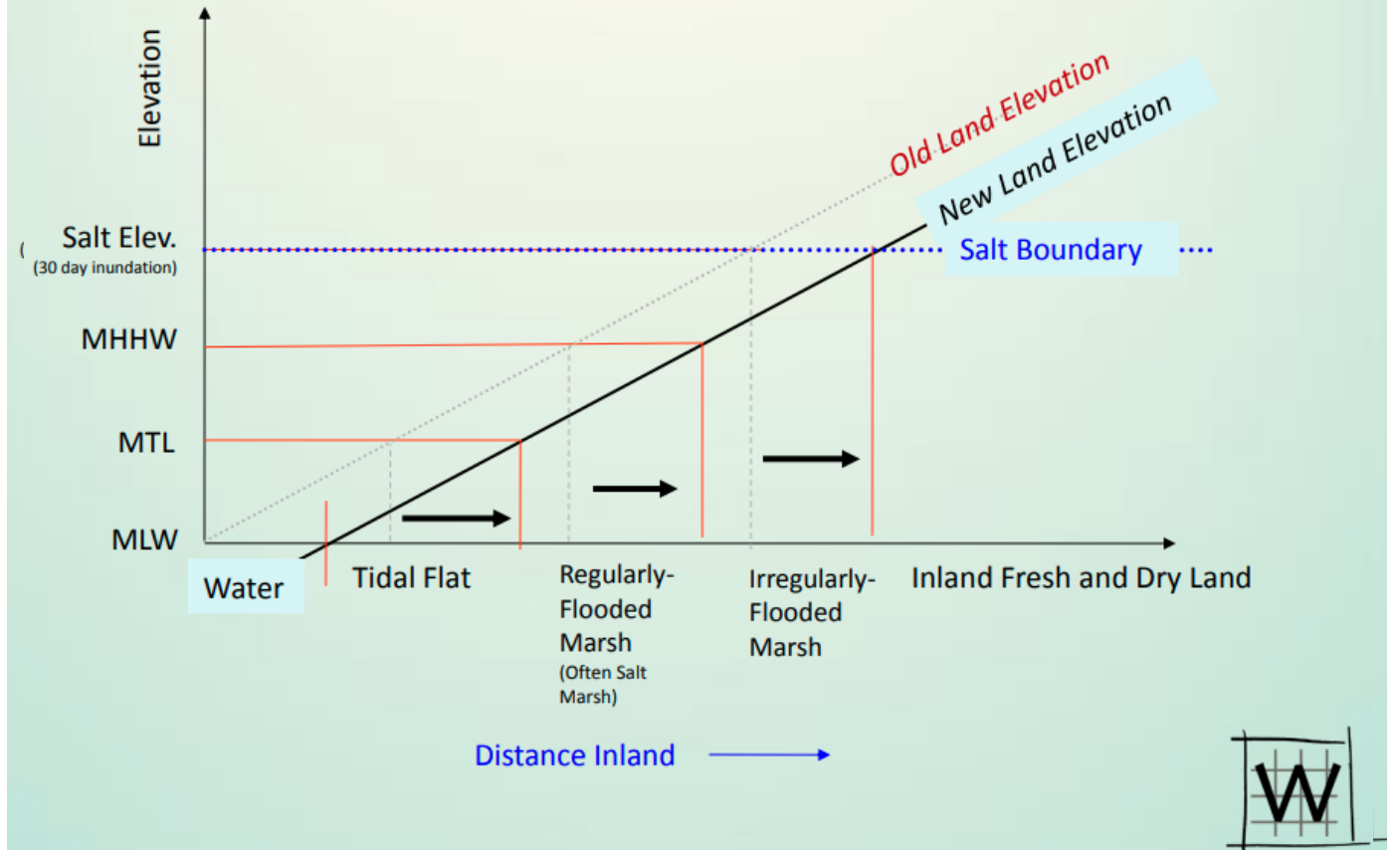
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Current Conditions



(Migration of Wetlands Boundaries due to Sea Level Rise)

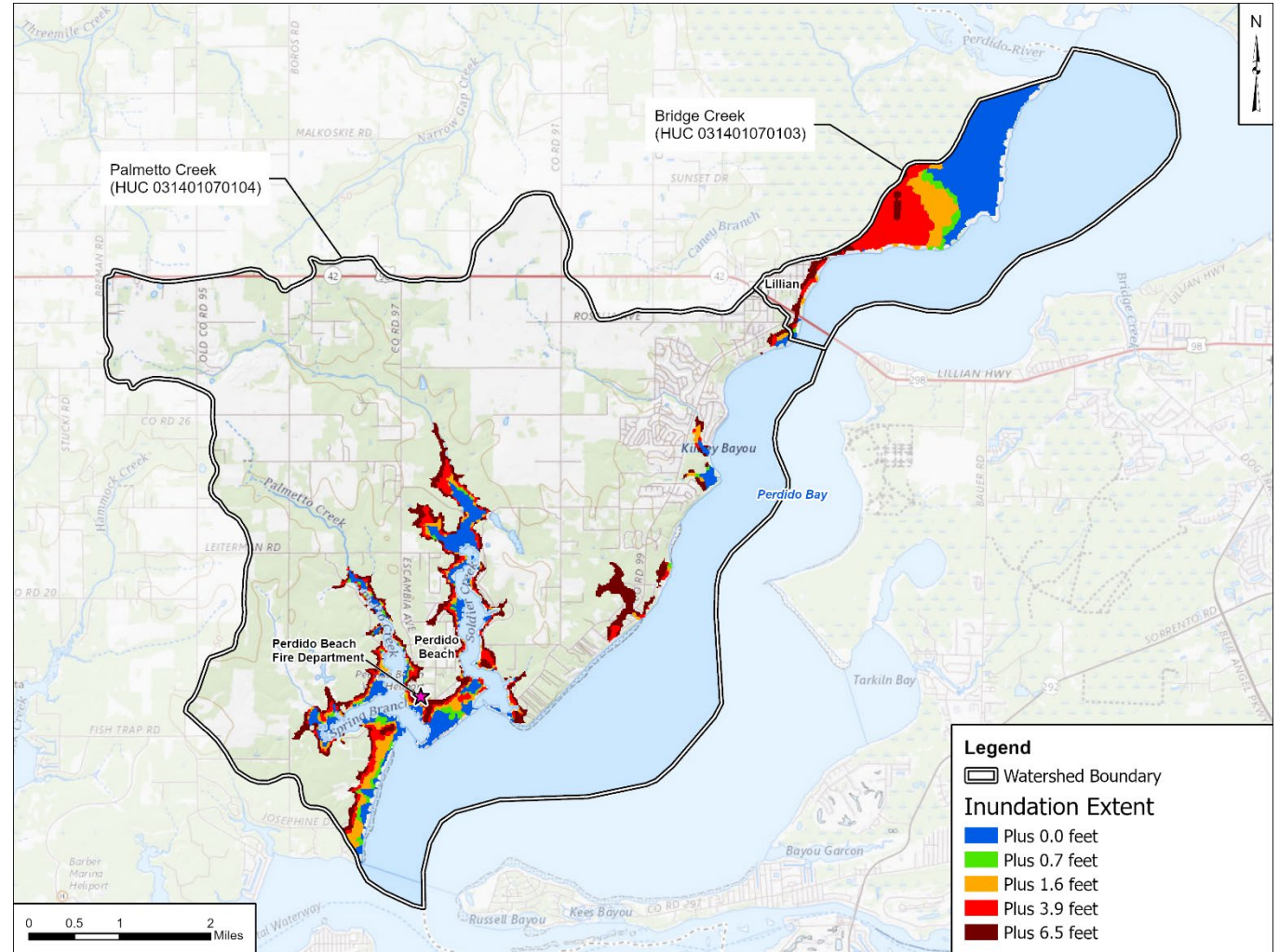


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Undeveloped Land	Scrub/Shrub	Tidal Flat	Estuarine Water
Swamp	Regularly Flooded Marsh	Ocean Beach	Open Ocean
			Irregularly Flooded Marsh



# Tools-SLOSH (Sea, Lake, and Overland Surges from Hurricanes)

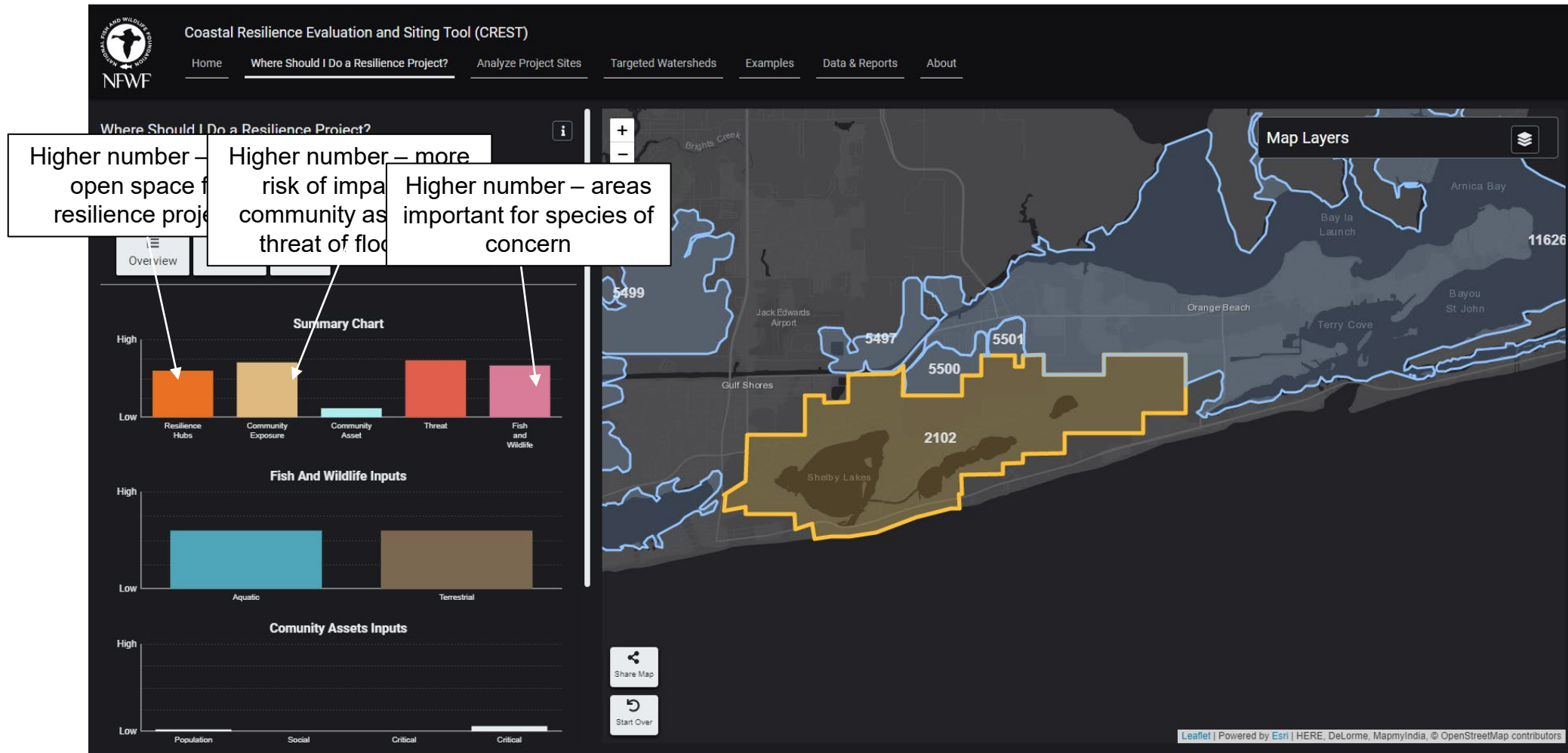
- National Weather Service
  - Developed to estimate storm surge heights from historical, hypothetical, or predicted hurricanes
- Example
  - Hurricane Ivan (2004)—Category 3 storm that made landfall near Pensacola





# Tools – CREST (Coastal Resilience Evaluation and Siting Tool)

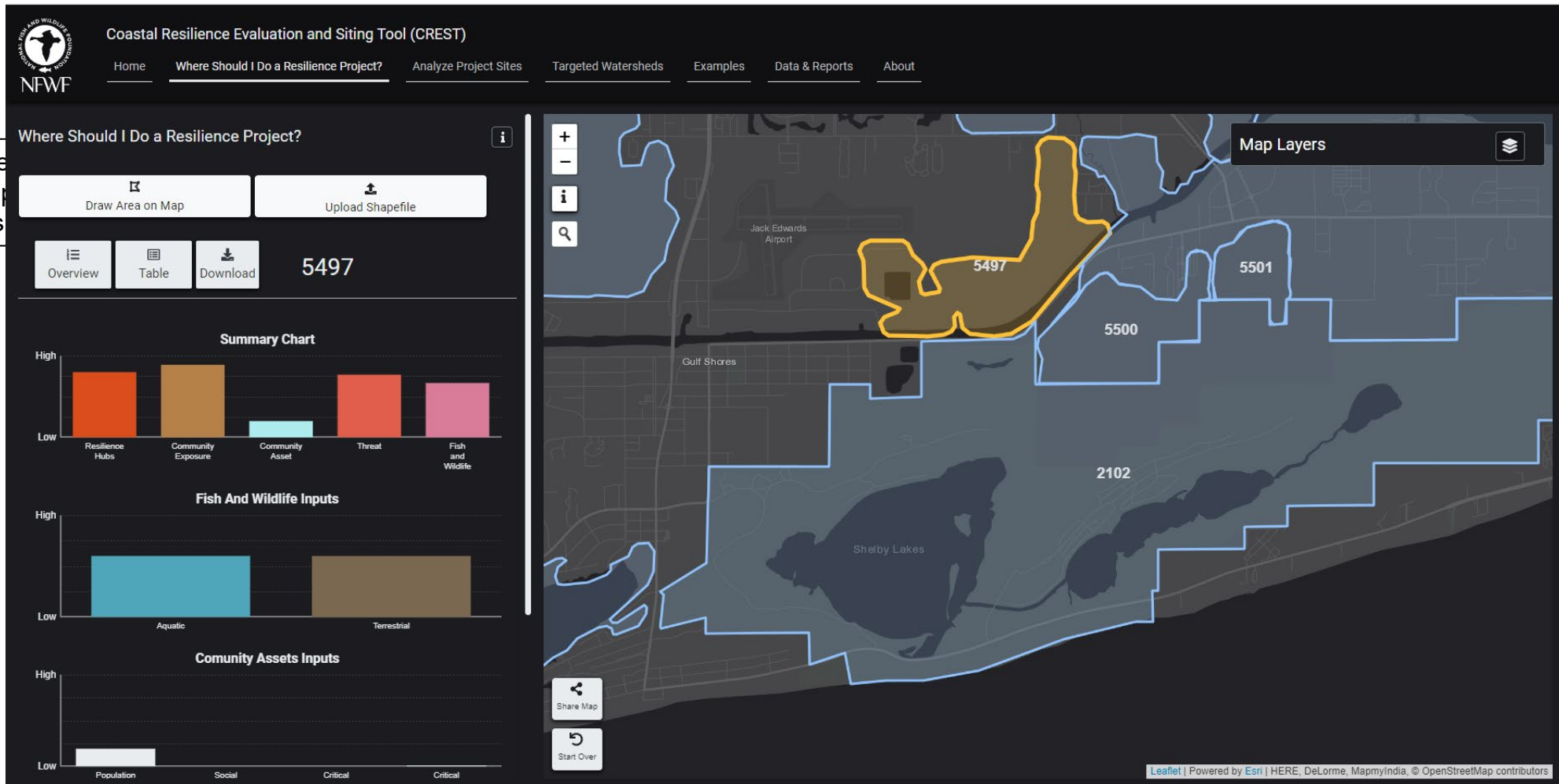
- Where should I do a Resilience Project?



# Tools – CREST (Coastal Resilience Evaluation and Siting Tool)

- Where should I do a Resilience Project?

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# Community Scorecard

## Maryland's *CoastSmart* Communities Scorecard



### A community self-assessment tool

This tool has been prepared by the Chesapeake & Coastal Service to provide Maryland's coastal communities with a practical method to assess their preparedness for the impacts of coastal hazards and increased future impacts due to a changing climate.



- State of Maryland's *CoastSmart* Communities Scorecard
  - self-assessment tool that allows governments to determine how well they are positioned to plan for coastal hazard impacts such as sea level rise, storm surge, flooding, etc.
  - provides a mechanism for local officials to identify specific ways they can prepare for these impacts by integrating coastal hazards into existing programs
- The scorecard is organized into five major sections:
  - 1) Risk and Vulnerability Assessment,
  - 2) People and Property,
  - 3) Infrastructure and Critical Facilities,
  - 4) Natural Resources, and
  - 5) Societal and Economic Impacts.



# Scorecard Example

Land-Use Planning		Yes	No
1. Does your community participate in the FEMA Community Rating System?		<input checked="" type="checkbox"/>	<input type="checkbox"/>
2. Does your community's comprehensive plan have a coastal hazard planning element or does the land use plan make recommendations to reduce coastal hazard vulnerability through planning? <i>If yes, does the comprehensive plan discourage development in vulnerable areas or identify specific land use tools that will be used to respond to coastal hazard threats?</i>		<input checked="" type="checkbox"/>	<input type="checkbox"/>
3. Are frequently flooded areas zoned or planned for open space or recreation and targeted for conservation easements and acquisitions?		<input type="checkbox"/>	<input checked="" type="checkbox"/>
4. Does the comprehensive plan recommend subdivision regulations that limit development within areas vulnerable to coastal hazards?		<input checked="" type="checkbox"/>	<input type="checkbox"/>
5. Does the comprehensive plan recommend subdivision regulations that limit development within the floodplain?		<input checked="" type="checkbox"/>	<input type="checkbox"/>
6. Does the comprehensive plan promote infill outside vulnerable areas?		<input type="checkbox"/>	<input checked="" type="checkbox"/>
7. Does the Sensitive Areas Element of the comprehensive plan consider coastal hazards in its policy recommendations?		<input type="checkbox"/>	<input checked="" type="checkbox"/>
8. Does the Water Resources Element of the comprehensive plan consider the impacts of climate change on drinking water availability?		<input type="checkbox"/>	<input checked="" type="checkbox"/>
9. Does the community have an adopted floodplain management plan?		<input checked="" type="checkbox"/>	<input type="checkbox"/>
10. Are planning horizons extended to incorporate potential long-term coastal hazards such as: <i>Sea-level rise?</i> <i>Coastal erosion?</i> <i>Increased storm activity and severity?</i>		<input type="checkbox"/>	<input checked="" type="checkbox"/>
11. Does the water and sewer plan include recommendations for relocation, abandonment or protection of infrastructure at risk to coastal flooding or other coastal hazards?		<input type="checkbox"/>	<input checked="" type="checkbox"/>
12. Does the community have a certified floodplain manager (CFM*) on staff?		<input checked="" type="checkbox"/>	<input type="checkbox"/>
13. Does your community have a floodplain manager or planner who participates in one of more of the following organizations? <i>Association of State Floodplain Managers (ASFPM) or Maryland Association of Floodplain and Stormwater Managers (MAFSM)?</i> <i>American Planning Association (APA) or Maryland APA chapter?</i> <i>American Society of Civil Engineers (ASCE) or state or local section of ASCE?</i> <i>American Public Works Association?</i>		<input checked="" type="checkbox"/>	<input type="checkbox"/>

14. Does the community have technical or computer mapping capabilities?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
15. Has the community adopted the 2010 Maryland Building Performance Standards (MBPS)?	<input type="checkbox"/>	<input type="checkbox"/>
16. Has the community conducted a build-out analysis using existing zoning? <i>Has the community evaluated the build-out analysis for vulnerability to coastal hazards?</i>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
17. Does the community require disclosure statements for vulnerable coastal properties?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
18. Does the community have a timeline or strategic plan for the relocation, abandonment or protection of buildings in areas at risk to coastal flooding or other coastal hazards?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
19. Does the community require the elevation of residential, nonresidential, and public buildings or infrastructure to be above base flood elevations, also known as freeboard, within the 100-year floodplain?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
20. Does your community require flood-proofing of residential, nonresidential, and public buildings or infrastructure within the 100-year floodplain?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
21. Does your community restrict rebuilding of structures destroyed by coastal hazards? <i>If rebuilding is allowed, is it required to be more resilient to coastal hazard impacts (e.g., elevated, smaller footprint, or set back from the coast)?</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
22. Does your community use an early flood warning system? <i>Do local communities have citizen action groups that alert at-risk property owners during an event; educate residents about evacuation routes and help residents get out during an event?</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<b>Total number of yes and no answers</b>	<b>14</b>	

**PEOPLE & PROPERTY:  
LAND USE PLANNING**

CoastSmart rating:

**14** of 28

Number of Yes answers:  
CoastSmart..... >20  
On The Right Track..... 10-20  
Getting Started..... <10





# Scorecard Example

## Land-Use Planning

1. Does your community participate in the FEMA Community Rating System?
2. Does your community's comprehensive plan have a coastal hazard plan that makes recommendations to reduce coastal hazard vulnerability through:
  - If yes, does the comprehensive plan discourage development in vulnerable areas used to respond to coastal hazard threats?
3. Are frequently flooded areas zoned or planned for open space or recreational easements and acquisitions?
4. Does the comprehensive plan recommend subdivision regulations that limit development to coastal hazards?
5. Does the comprehensive plan recommend subdivision regulations that limit development in vulnerable areas?
6. Does the comprehensive plan promote infill outside vulnerable areas?
7. Does the Sensitive Areas Element of the comprehensive plan consider coastal hazards?
8. Does the Water Resources Element of the comprehensive plan consider water availability?
9. Does the community have an adopted floodplain management plan?
10. Are planning horizons extended to incorporate potential long-term coastal hazards?
  - Sea-level rise?
  - Coastal erosion?
  - Increased storm activity and severity?
11. Does the water and sewer plan include recommendations for relocation, abandonment or protection of buildings and other coastal hazards?
12. Does the community have a certified floodplain manager (CFM\*) on staff?
13. Does your community have a floodplain manager or planner who participates in professional organizations?
  - Association of State Floodplain Managers (ASFPM) or Maryland Association of Floodplain Managers (MAFSM)?
  - American Planning Association (APA) or Maryland APA chapter?
  - American Society of Civil Engineers (ASCE) or state or local section of ASCE?
  - American Public Works Association?

## Recommendations & resources

In Maryland, growth and development are outlined in the Local Government Comprehensive Plan, a document officially adopted by the local governing body and reviewed every six years for possible update. The comprehensive plan establishes goals and objectives that serve to tell the world how the community wants to function and look in the future. The plan has legal significance in that zoning, the provision of water and sewer resources, and other local land-use actions must be consistent with the overall comprehensive plan. For this reason, incorporating coastal hazards into local comprehensive plans is recommended and longer planning horizons that incorporate climate change should be considered.

Ways in which a community can incorporate coastal hazards into comprehensive planning include:

- Add resilience to coastal hazards in the goals and objectives section of the comprehensive plan.
- Incorporate coastal hazard data and analyses into the existing elements of a comprehensive plan, or incorporate them into a new element such as a coastal management element or a sea-level rise planning element.
- Educate and inform community leaders and the public of the community's vulnerability to coastal hazards.
- Integrate hazard mitigation policies into the comprehensive plan.
- Include maps of coastal hazards in the land use plan element and plan for and zone vulnerable areas for open space conservation or limited development.
- Incorporate a post-disaster rebuilding policy into the comprehensive plan to limit rebuilding in high-hazard areas.

computer mapping capabilities?

Maryland Building Performance Standards (MBPS)?

Cost-benefit analysis using existing zoning?

Cost-benefit analysis for vulnerability to coastal hazards?

Statements for vulnerable coastal properties?

Relocation strategic plan for the relocation, abandonment or protection of buildings and other coastal hazards?

Relocation of residential, nonresidential, and public buildings or infrastructure to provide freeboard, within the 100-year floodplain?

Relocation of residential, nonresidential, and public buildings or infrastructure to provide freeboard, within the 100-year floodplain?

Relocation of structures destroyed by coastal hazards?

Relocation of structures destroyed by coastal hazards? (e.g., elevated, smaller footprint, or set back)

Relocation of structures destroyed by coastal hazards?

Relocation of structures destroyed by coastal hazards? (e.g., elevated, smaller footprint, or set back) groups that alert at-risk property owners during an event; educate residents about coastal hazards during an event?

<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	<input checked="" type="checkbox"/>
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<input checked="" type="checkbox"/>	<input type="checkbox"/>
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# Management Measures





# Developing a Management Measure

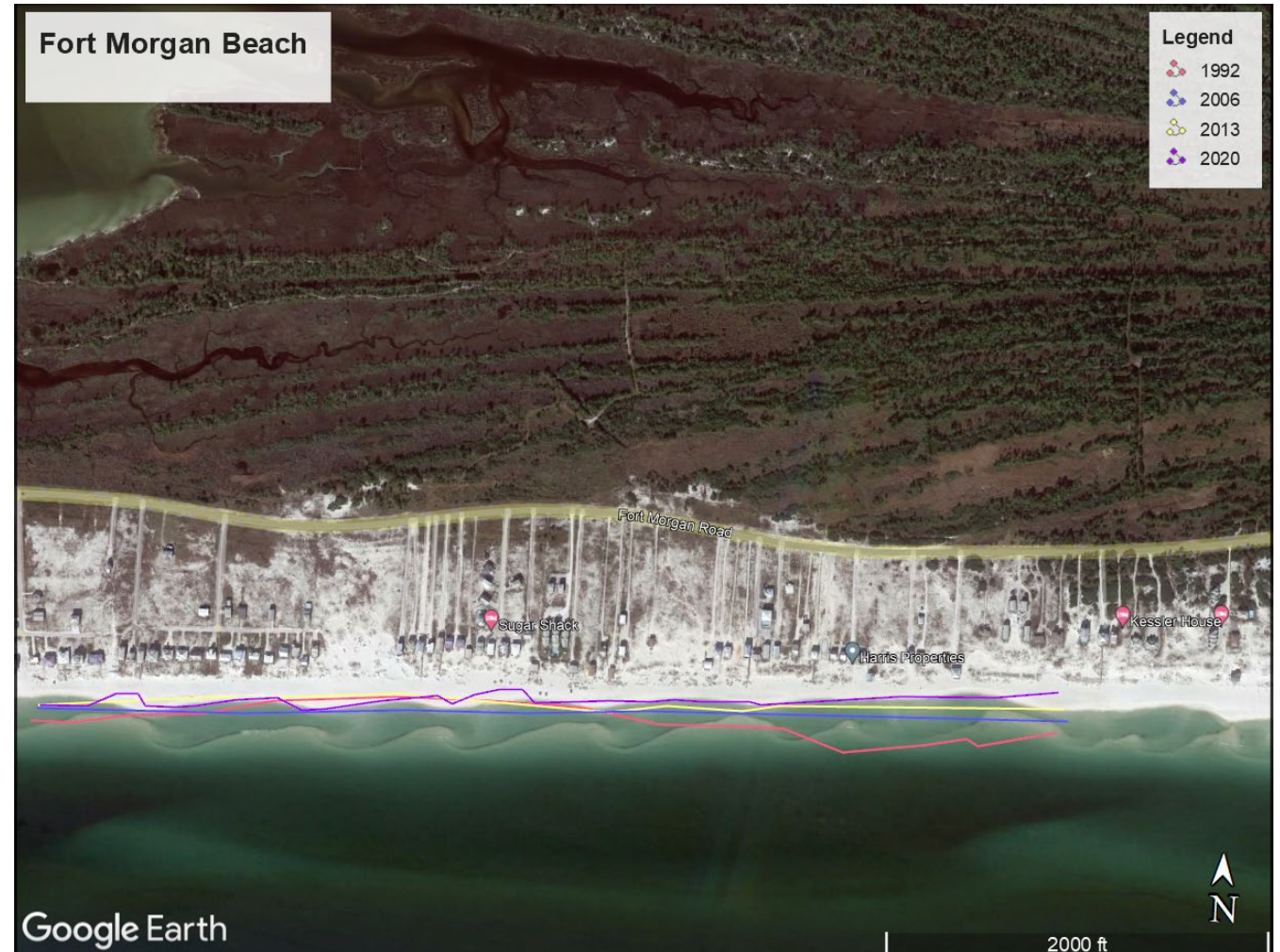
- Review vulnerability information
- Gather input from Community
- Identify a Critical Issue
- Explore structural and non-structural solutions
- Explore feasibility
- Develop implementation strategy and schedule
- Develop monitoring plan

## Gather Input



# Developing a Management Measure – Example 1

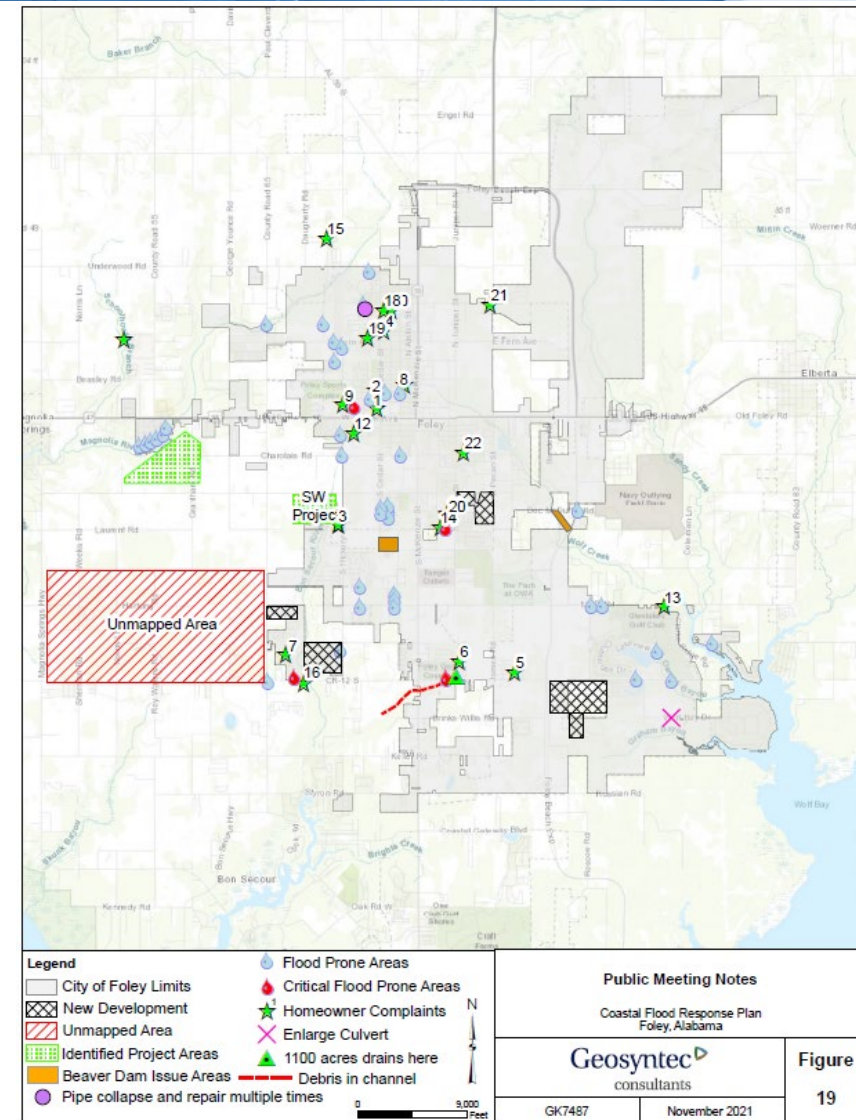
- Implementation
  - Where to get funding?
  - Who is going to champion the effort?
- Schedule
  - Year 1: identify directing agencies and funding sources
  - Years 2-5: Design and engineer the project
  - Year 5-7: Construct and monitor





# Developing a Management Measure – Example 2

- Gather input
- Identify Critical Issues
  - Major flooding
  - Debris in creeks
  - Undersized infrastructure
- Solutions
  - Localized projects – clearing debris, increase stormwater capacity of infrastructure, etc.
  - Regulatory – growth management plans, etc.
  - Comprehensive – Updated Stormwater Inventory
- Implementation
  - Highest Priority – Updated Stormwater Inventory



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# Example Projects

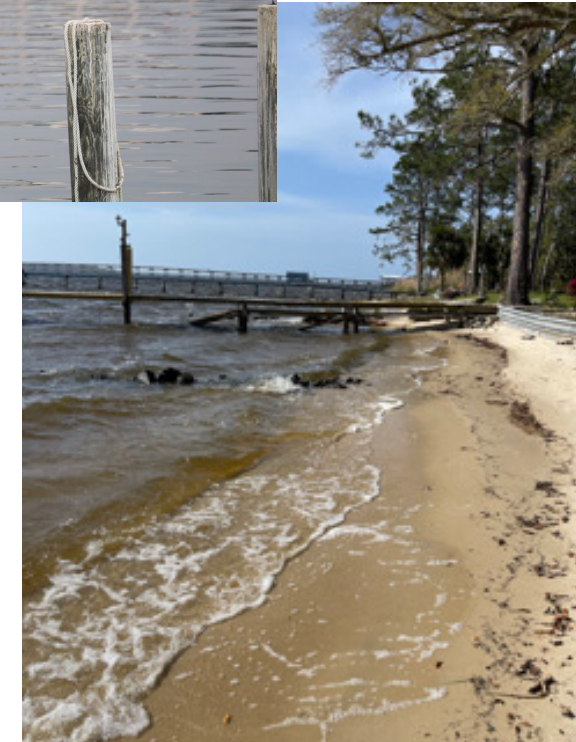




# Mobile Bay Watershed Management Plans



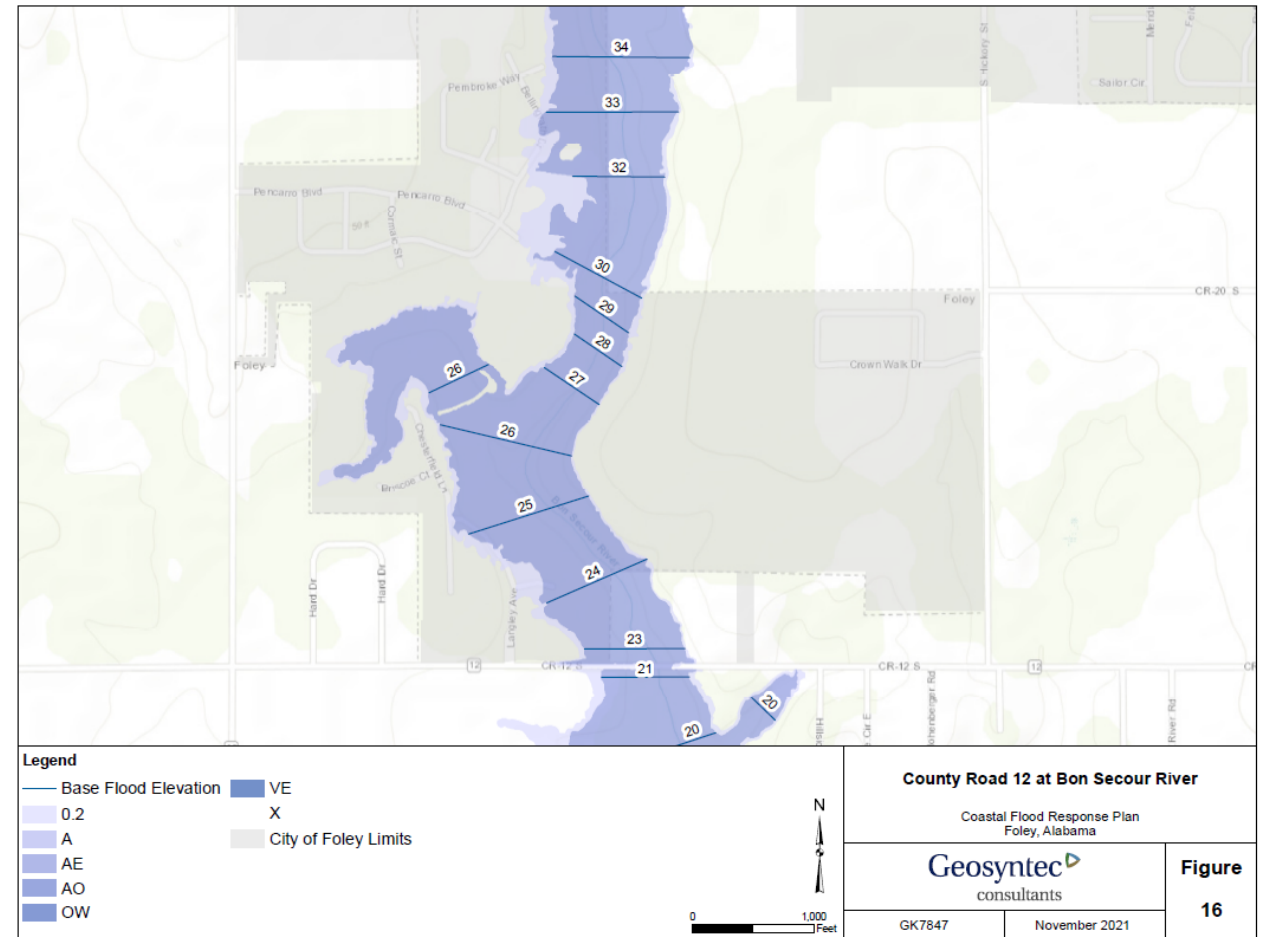
- **Three plans**
  - Gulf Frontal – Completed in 2020
  - D'Olive Creek – Completed in 2022
  - Western Perdido – Ongoing
- **Goal: Characterize the Watershed and identify critical issues and propose solutions to issues in Watershed**
- **Heavily relies on public outreach and community engagement in addition to data collection and interpretation**
- **Commonly used as a basis for grant applications**



# City of Foley Flood Response Plan



- Completed in 2021
- Goal: Identify flooding hazards and compile response actions
- Three main components:
  - Flood Hazard and Risk Assessment
    - Current and Future Climate Impacts
  - Currently Identified Flood Hazard Areas and Actions
    - Heavily influenced by local officials
    - Known problem areas and here's a set of actions performed during floods
  - Potential Measures
    - Management Measures to reduce repeat flooding
    - Management Measures to lessen future impacts

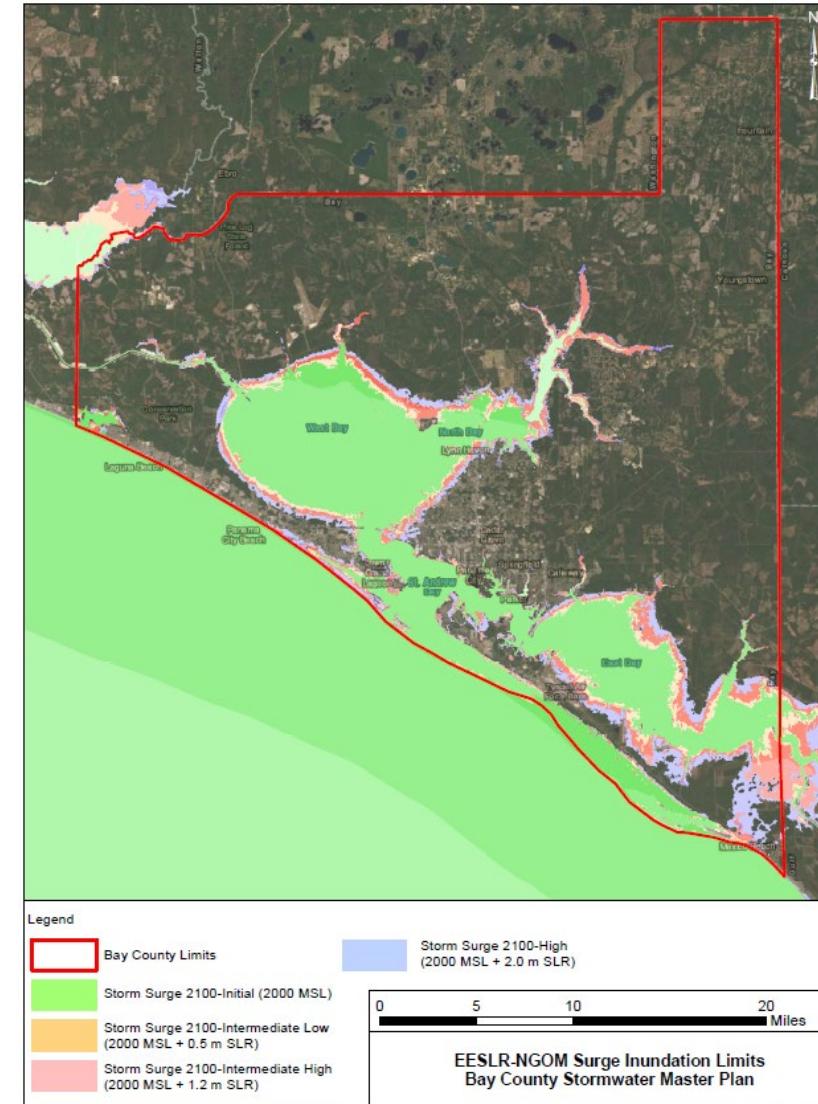




# Bay County Stormwater Master Plan



- Completed in 2023 with subconsultants
  - Baskerville Donovan, Inc.
  - The Balmoral Group
- Goal: Update Master Plan and Strategic Plan to guide next 5-10 years of stormwater management program
- Plan included:
  - Review of previous plan
  - Regulatory Review
  - Stormwater Facilities and Operations
  - Water Quantity
  - Water Quality
  - Ecology
  - BMPs
  - Vulnerability and Resilience Assessment
  - Funding
  - Implementation Strategies



# Closing Thoughts

- These Plans provide a good basis to address current issues throughout a community.
- Future climate impacts are becoming more frequent and should be evaluated now to preserve community resources.





Geosyntec<sup>®</sup>  
consultants



**Thank you!**