

# Resilient Coastal Sites

in the Gulf of Mexico



Representative coastal sites that will be resilient to climate change

The Nature Conservancy  
Eastern US Region

Mark Anderson  
Analie Barnett

The Nature Conservancy  
#28860457



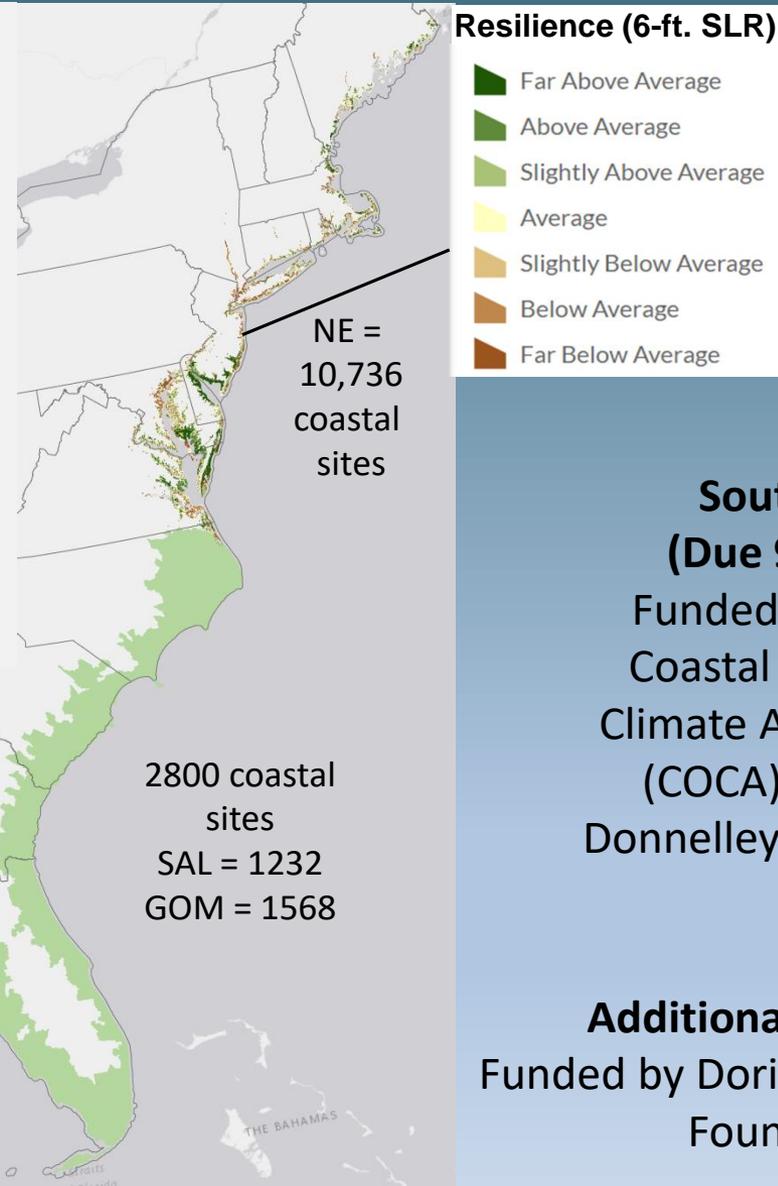
# Study Area and Project Goals

Assess and rank the relative resilience of individual sites to sea level rise.

## Products

**Maps and Datasets** that allow users to assess an area of interest for its ecological resilience

**A Report** that explains the concepts of site resilience, how we measured it, and how to interpret the results.

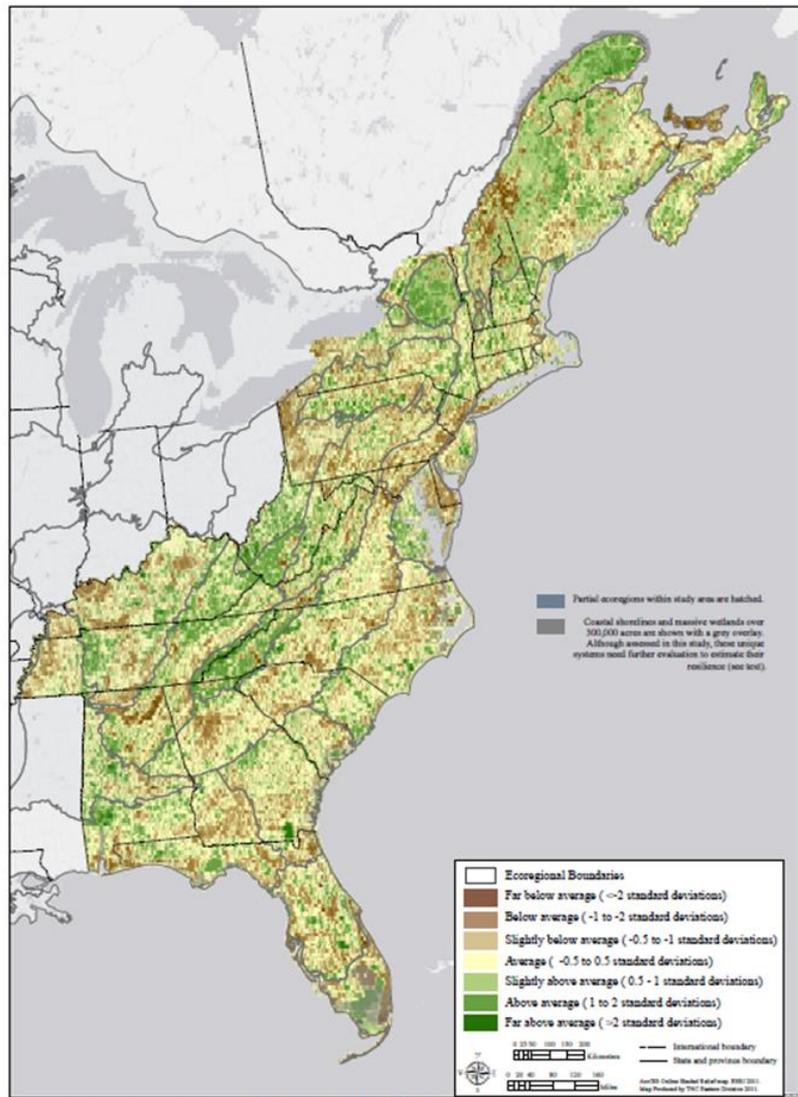


**Northeast  
(2017)**  
Funded by  
USFWS

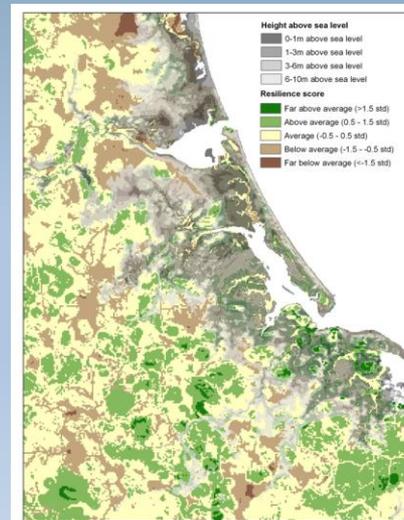
**Southeast  
(Due 9/2019)**  
Funded by NOAA  
Coastal & Oceans  
Climate Applications  
(COCA), and the  
Donnelley Foundation

**Additional Gulf Coast**  
Funded by Doris Duke Charitable  
Foundation

# Conserving Nature's Stage



**Regional Terrestrial Resilience Score**  
Stratified by Setting and Ecoregion with Regional Override



Using enduring geophysical features to identify sites that will represent biodiversity and be more resilient to climate change

# Why Care about Tidal Habitats?



Tidal Habitats are our most **productive and diverse habitats**



Hundreds of specially adapted species such as salt marsh grass, salt marsh aster, salt marsh skipper, clapper rail



Rare species such as salt marsh sparrow, black rail



Tidal flats provide resource areas for crabs and shorebirds



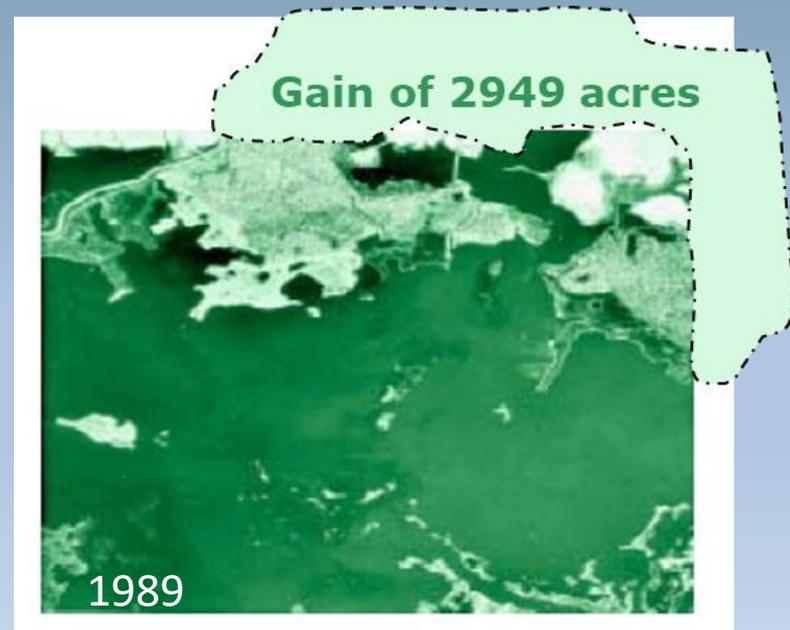
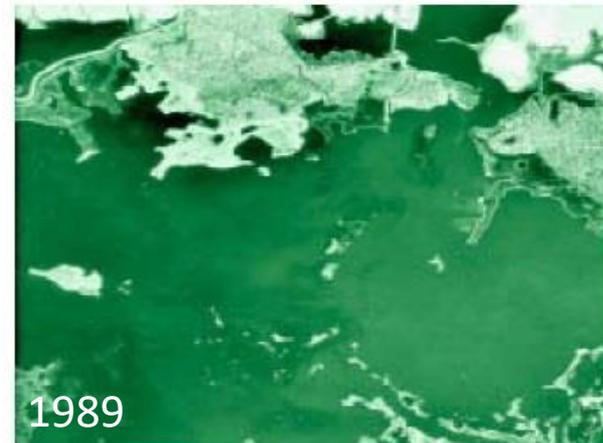
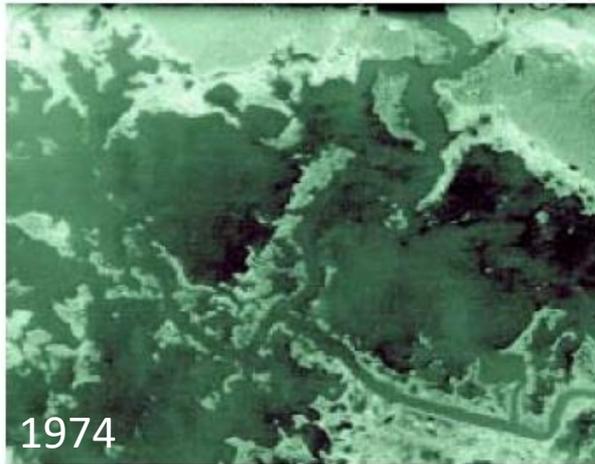
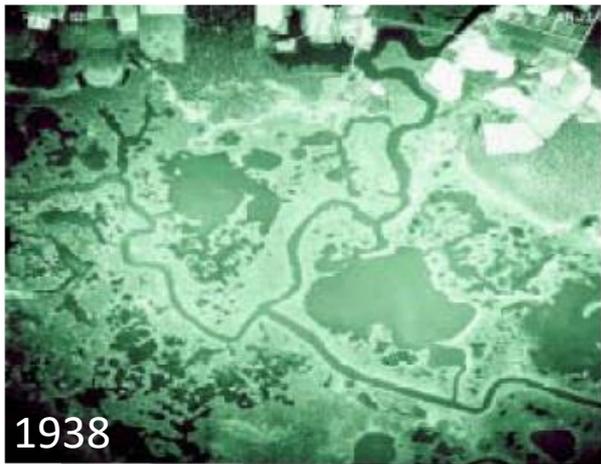
They perform **essential functions**

- Stabilize shorelines
- Buffer human communities from flood and storm effects
- Serve as fish nurseries
- Cycle nutrients

# The Challenge

Blackwater National Wildlife Refuge

Loss of 5028 acres over 68 yrs. (1' SLR)





Mark Anderson

# Steering Committee



Analie Barnett

## NATIONAL

- CH2M & Jacobs:** Jason Bird, Rick Gorsira
- National Audubon Society:** Walker Golder
- NOAA:** Carolyn Currin
- USFW:** Tim Jones, Todd Hopkins, Rua Mordecai
- USGS:** P. Soupy Dalyander, Blair Tirpak

## THE NATURE CONSERVANCY

- North Carolina:** Brian Boutin
- South Carolina:** Liz Fly
- Georgia:** Ashby Worley, Wade Harrison
- Florida:** Laura Geselbracht
- Alabama:** Mary Kate Brown
- Mississippi:** Thomas Morhman
- Louisiana:** Bryan Piazza, Dave Harlan
- Texas:** Jorge Brenner, Lily Verdone
- Global Marine:** Zach Ferdana, Marta Ribera
- Southeast:** Mary F. Conley
- Gulf of Mexico:** Christine Shepard

## STATE

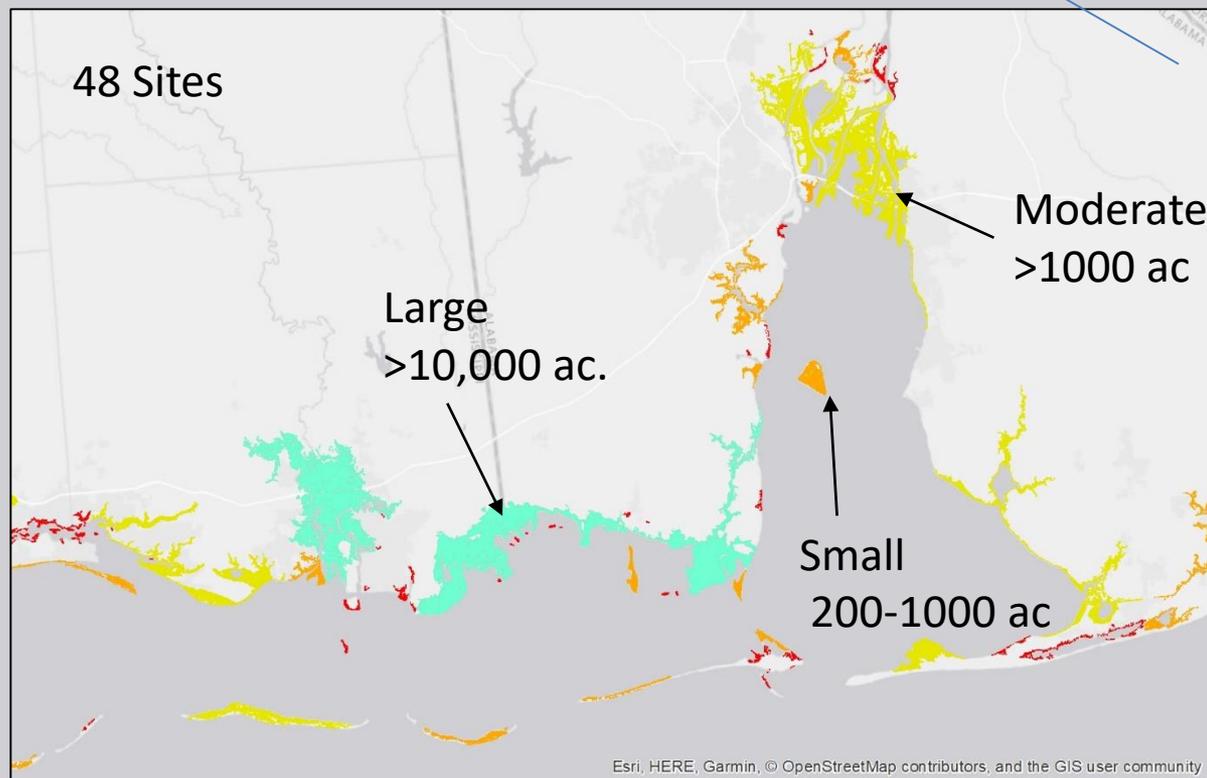
### **South Atlantic**

- East Carolina Univ.:** Reide Corbett
- NC Dept. Env. Natural Resources:** Anne Deaton
- SC Aquarium:** Albert George
- SC Audubon:** Sharon Richardson
- SC Dept. of Natural Resources:** Blaik Keppler
- SC Sea Grant Consortium:** Sarah Watson
- Univ. of SC:** Kirstin Dow
- GA Southern Univ.:** Chester Jackson
- Univ. of GA:** Clark Alexander, Jill Gambill
- FL Audubon:** Jerry Lorenz

### **Gulf of Mexico and Florida**

- FL DEP:** Whitney Gray, Keith Laakkonen, Michael Shirley
- FL F&W:** Corey Anderson, Lily Swansboro-Becker
- FL International Univ.:** Tiffany Troxler
- Tampa Bay National Estuary Program:** Ed Sherwood
- MS State:** Steve Ashby, Jennifer Roberts, Eric Sparks, Mark Woodrey
- MS/AL Sea Grant:** Tracie Sempier
- AL DCNR:** Carl Ferraro
- AL USACE:** Susan Rees

# Sites: 1568 Tidal Complexes



Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

Sites

Each Site is scored based on its Resilience Characteristics

Resilience Score

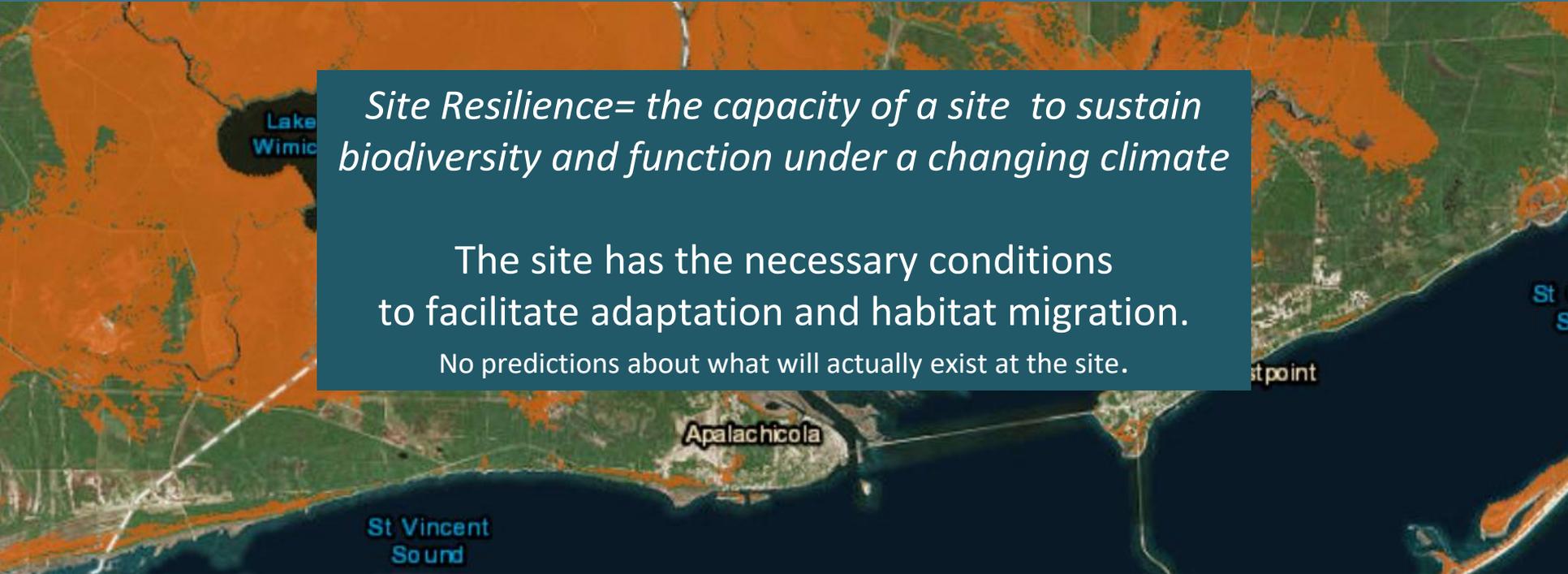
Average

Far Above Average

Below Average

- Far Above Average
- Above Average
- Slightly Above Average
- Average
- Slightly Below Average
- Below Average
- Far Below Average

# Resilience Characteristics



*Site Resilience= the capacity of a site to sustain biodiversity and function under a changing climate*

The site has the necessary conditions to facilitate adaptation and habitat migration.

No predictions about what will actually exist at the site.

## PHYSICAL

- Large migration space
- Many tidal zones
- Large tidal complex
- High shared edge

## CONDITION

- No anthropogenic barriers
- Ample sediment supply
- Adequate water quality
- Freshwater flow

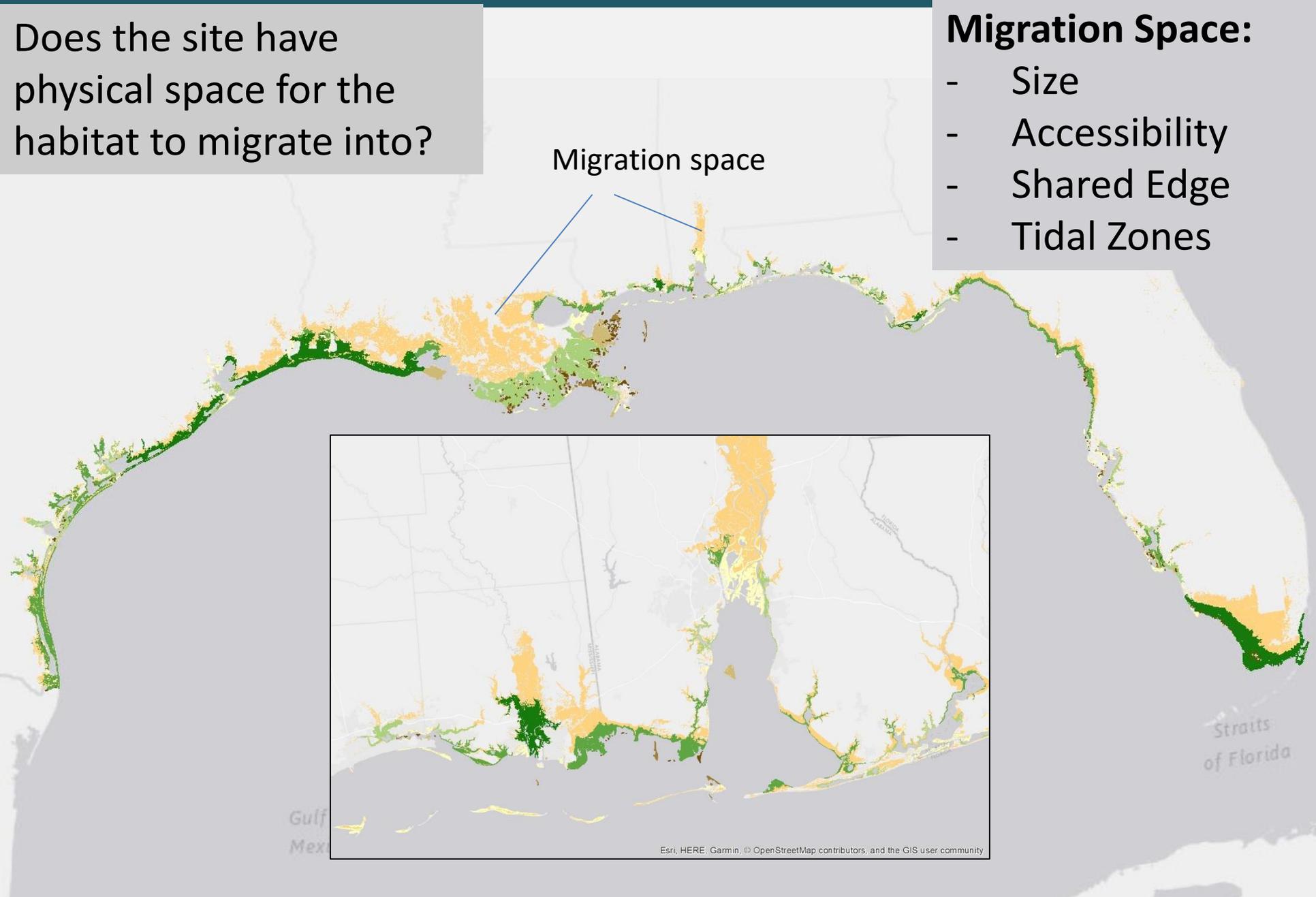
# Resilient Coastal Sites: Physical

Does the site have physical space for the habitat to migrate into?

## Migration Space:

- Size
- Accessibility
- Shared Edge
- Tidal Zones

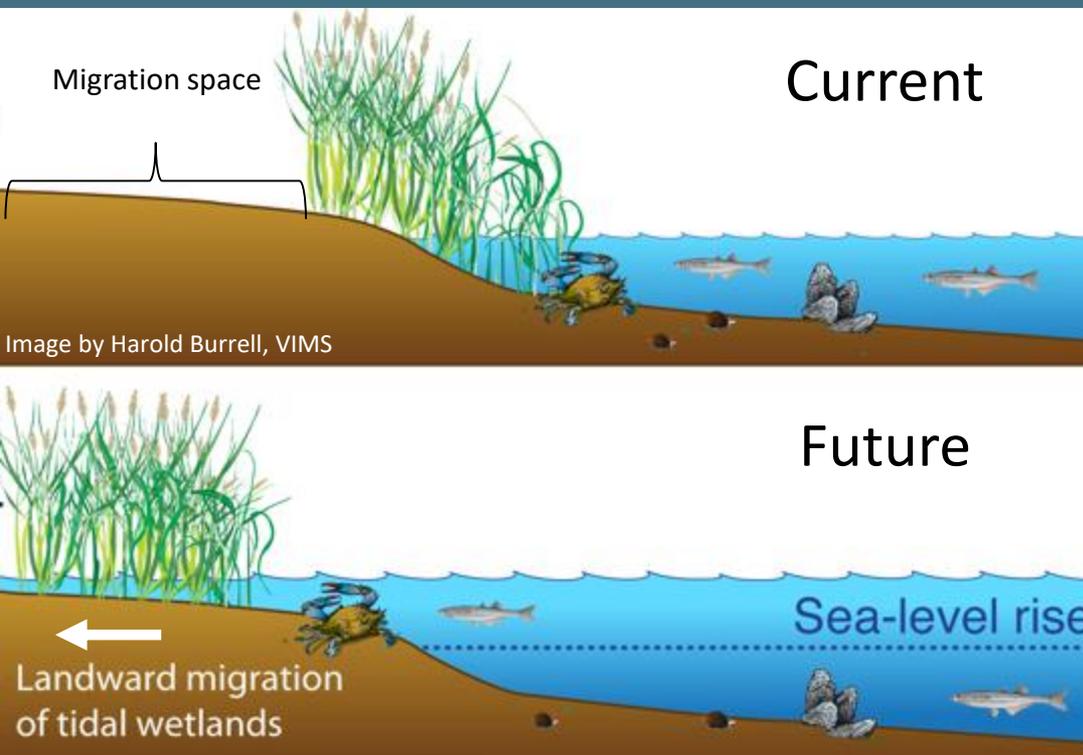
Migration space



Gulf  
Mex

Straits  
of Florida

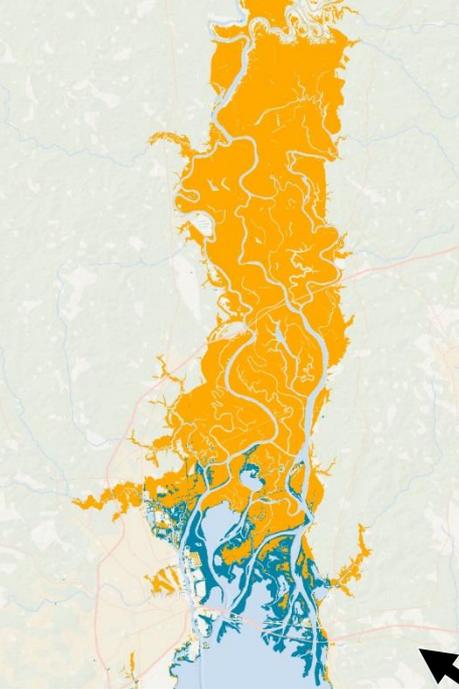
# Migration Space



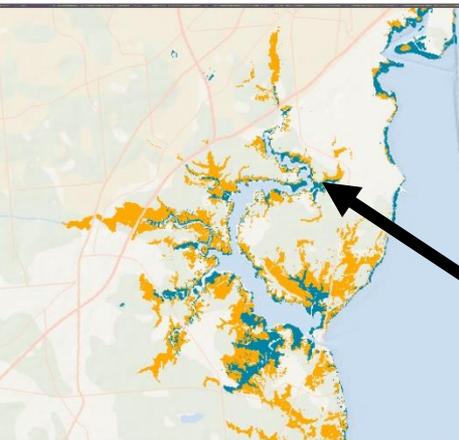
**Migration space** = the area of adjacent low-lying land suitable for supporting tidal habitats in the future, and into which the current habitats could migrate as sea levels rise.

# Migration Space is Physically Determined

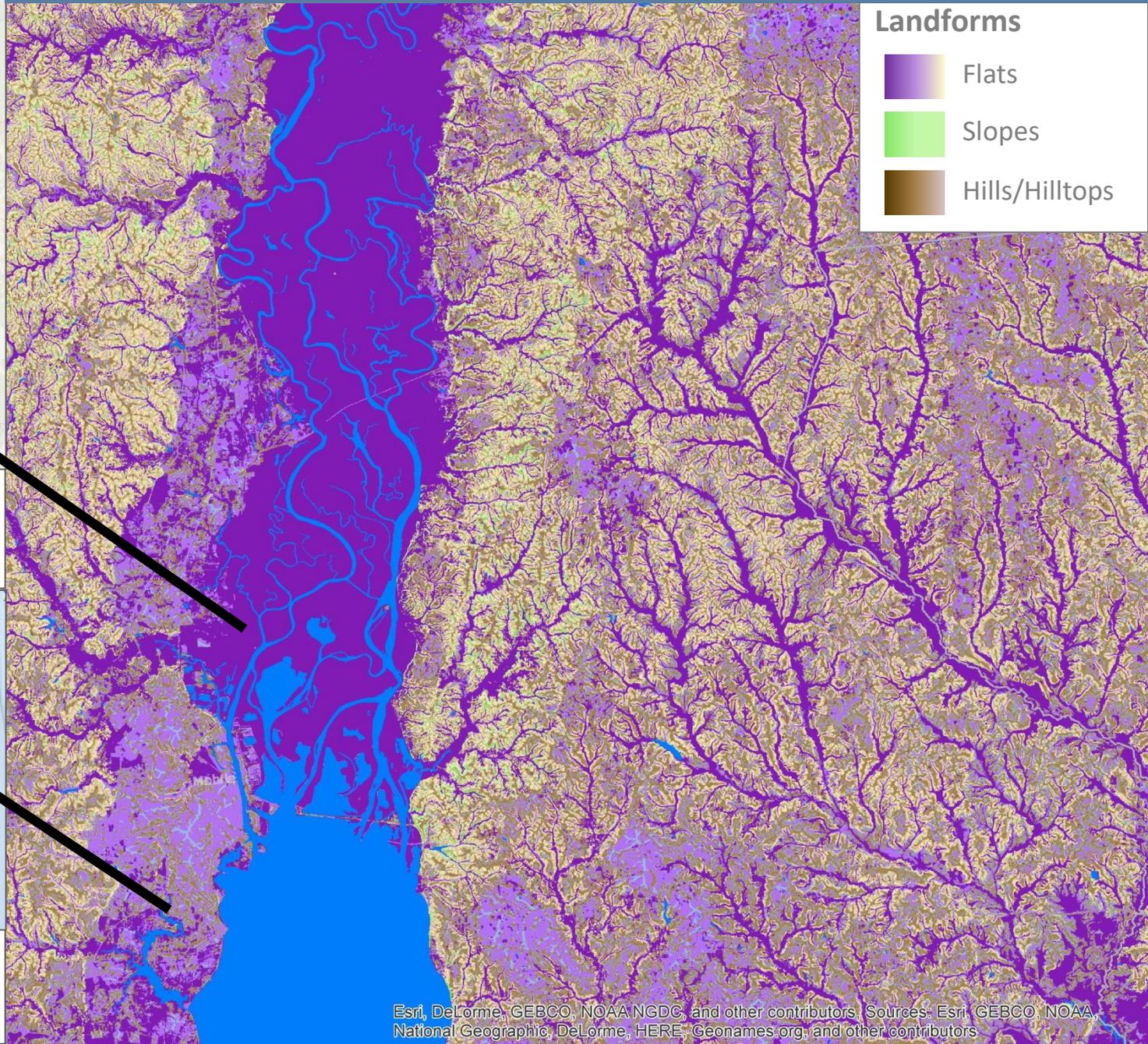
## Landforms



Large migration space due to extensive unconfined low flats

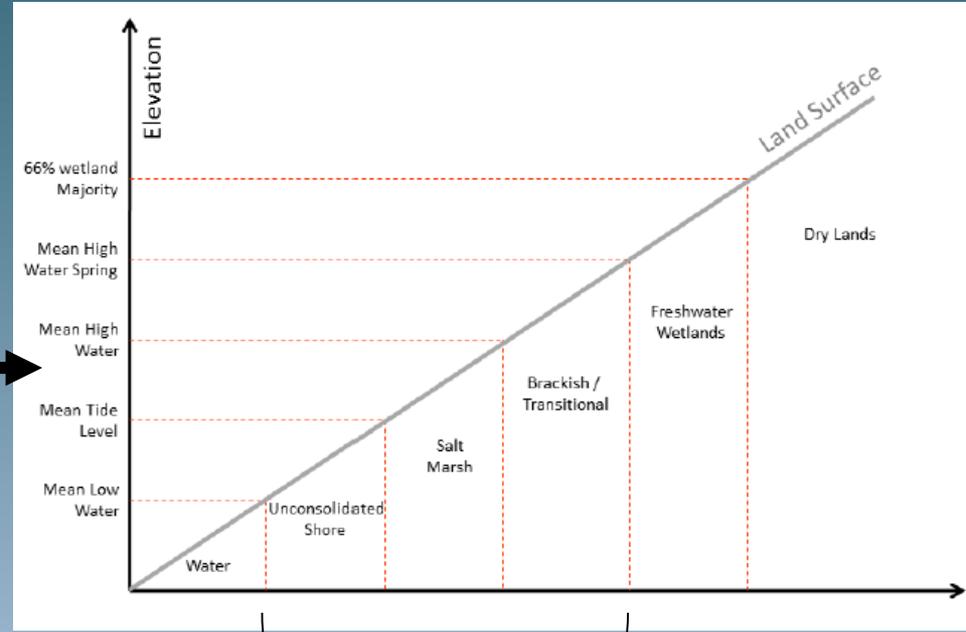
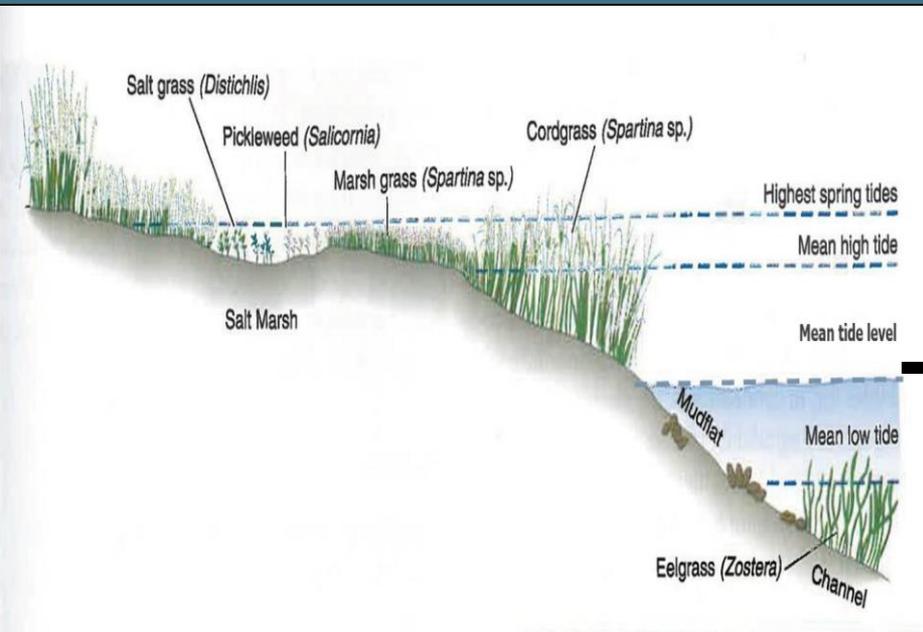


Small migration space due to more confining topography



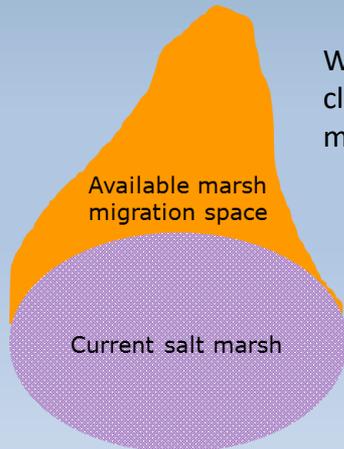
# Migration Space Delineation

Migration space derived from augmented NOAA SLR Viewer<sup>1</sup> marsh migration data;

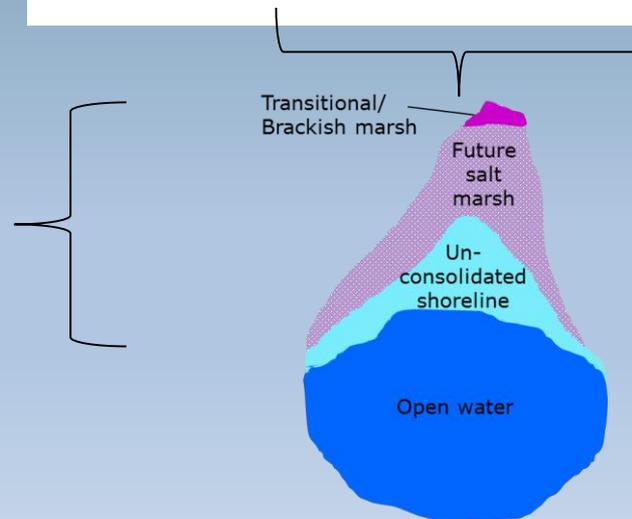


We **don't predict** what will be in the migration space

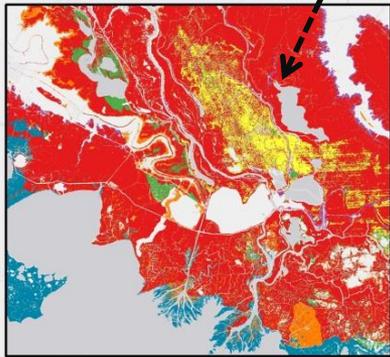
We **retain** the information on tidal zones for a metric capturing diversity of tidal zones



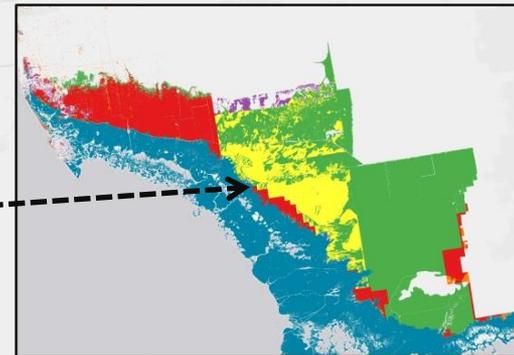
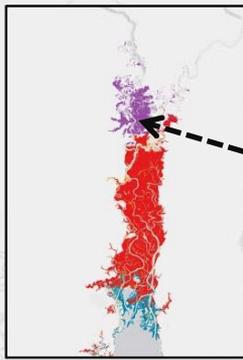
We **simplify** these 3 classes into 1 migration space



Becomes open water at 0.5-FT SLR in NOAA



Area not modeled in NOAA project (NOAA extent ends where red is not showing)



 Tidal Complex (NOAA CCAP 2010)

### Migration Space Comparison

#### Source SLR Model

 NOAA only

 SLAMM only

 USGS only

 SLAMM, USGS

 NOAA, SLAMM

 NOAA, USGS

 NOAA, SLAMM, USGS

- **NOAA** = 2018 SLR Viewer marsh migration data for 6.5-ft SLR
- **SLAMM** = June 2015 GCPLCC SLAMM 2100 2-m SLR model <http://warrenpinnacle.com/prof/SLAMM/GCPLCC/>; resampled to 30 m for this comparison
- **USGS** = 2100 2-m SLR model with barriers, unadjusted (Enwright et al. 2015) <http://dx.doi.org/10.3133/ds969>

# Physical Characteristics of a Site

## St. Andrew Bay (Lagoon)



## Physical Characteristics

How much accessible migration space? (space for future marsh)

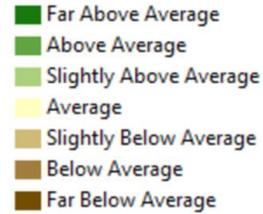
How many tidal zones are within it? (proxy for future habitats)

How much shared edge? (ease of migration)

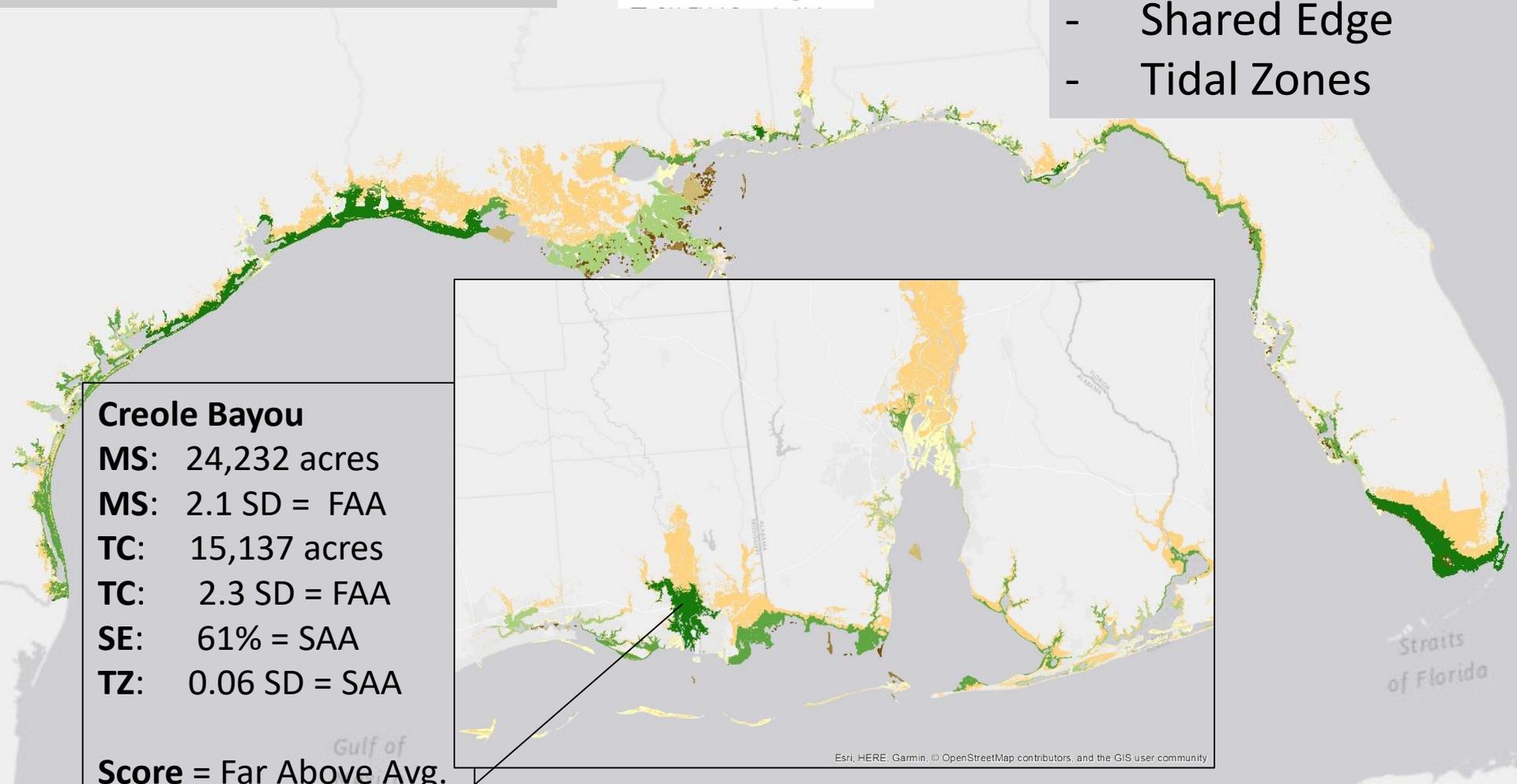
How large is the current complex? (source of biotic material)

# Results: Physical Score

Does the site have physical space for the habitat to migrate into?



- Migration Space:**
- Size/Access
  - Current Complex
  - Shared Edge
  - Tidal Zones



**Creole Bayou**  
MS: 24,232 acres  
MS: 2.1 SD = FAA  
TC: 15,137 acres  
TC: 2.3 SD = FAA  
SE: 61% = SAA  
TZ: 0.06 SD = SAA  
**Score = Far Above Avg.**

# Migration Space Size Threshold

Objective: Ensure migration space is of adequate size

*To get a positive score*

*Criterion 1:* MS size must be greater than average relative to its coastal shoreline region

*Criterion 2:* Average migration space size at least as big as existing complex

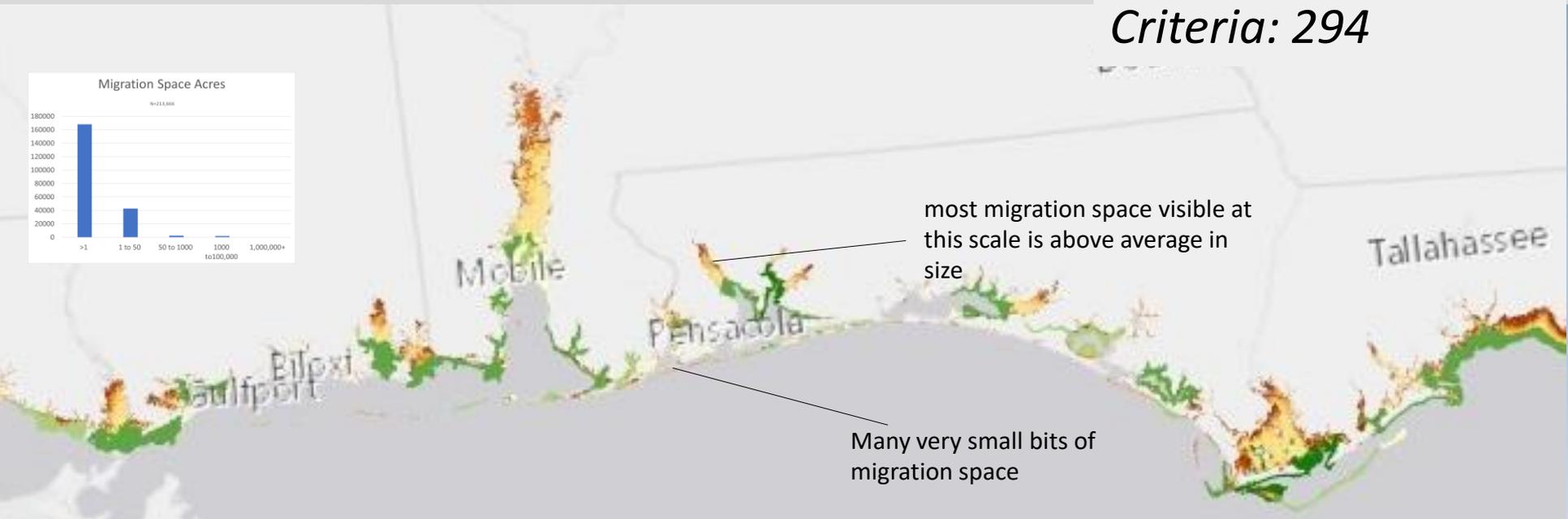
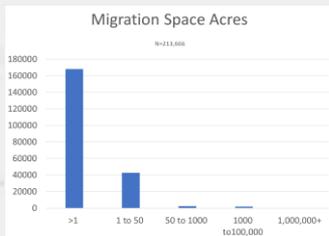
AND predicted to increase in size,

AND not on a barrier island with a downward trend in size

**Gulf of Mexico**

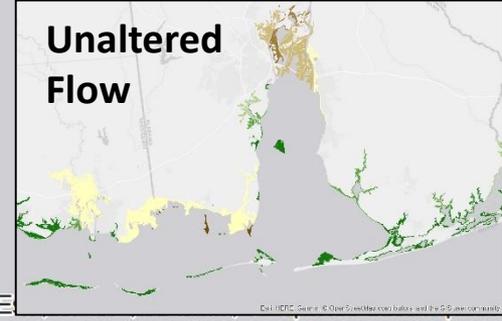
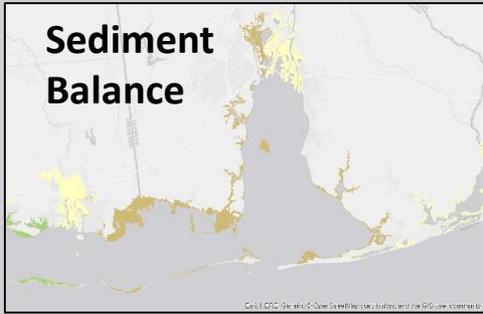
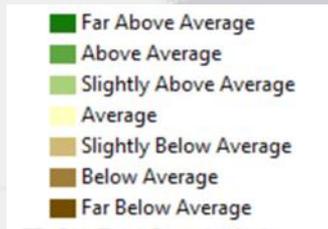
**= 1568 sites**

*Criteria: 294*



# Resilient Coastal Sites: Condition

Does the site have the condition characteristics needed to facilitate habitat migration?



Straits of Florida

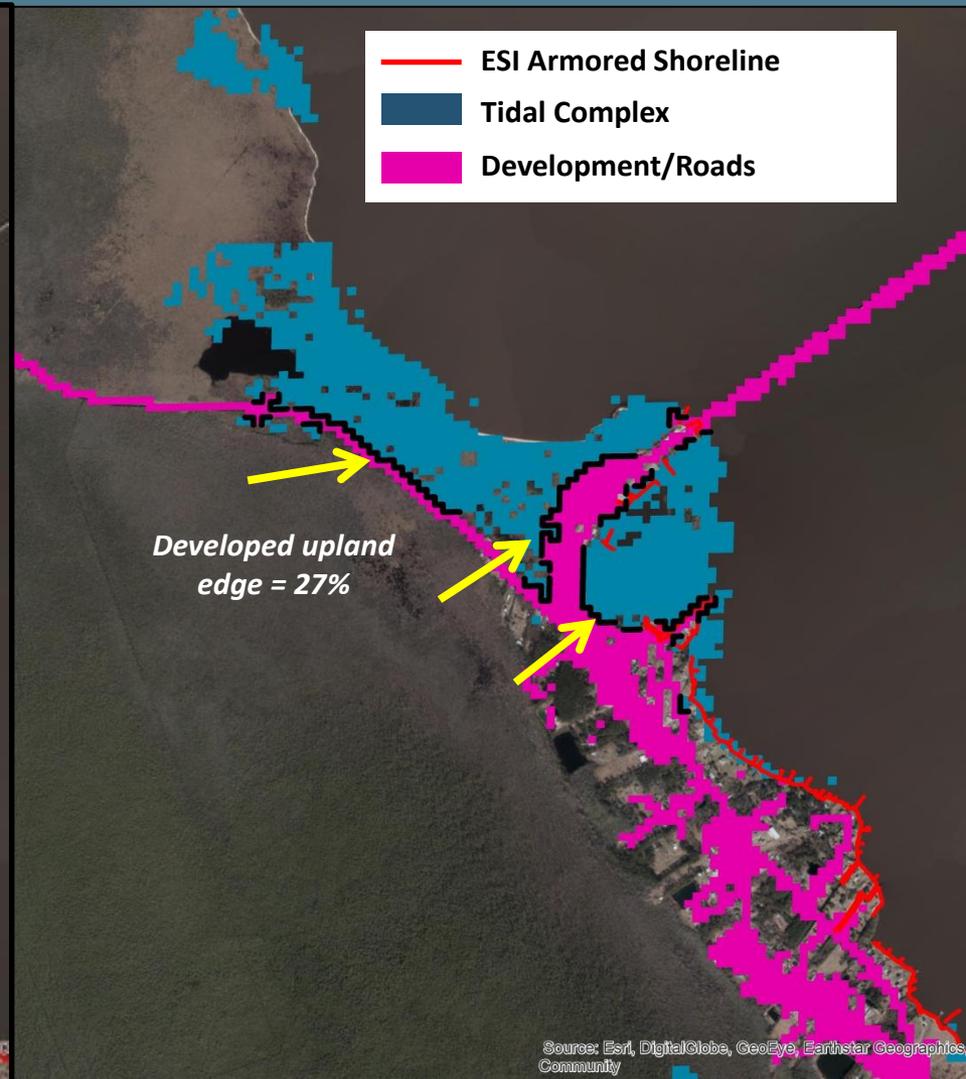
E

tributors, and the GIS user community

# % Developed Upland Edge

Tidal Complex with Developed Areas and Armored Shoreline (red)

Developed Upland Edge:  
% of tidal complex upland edge flanked by development or roads

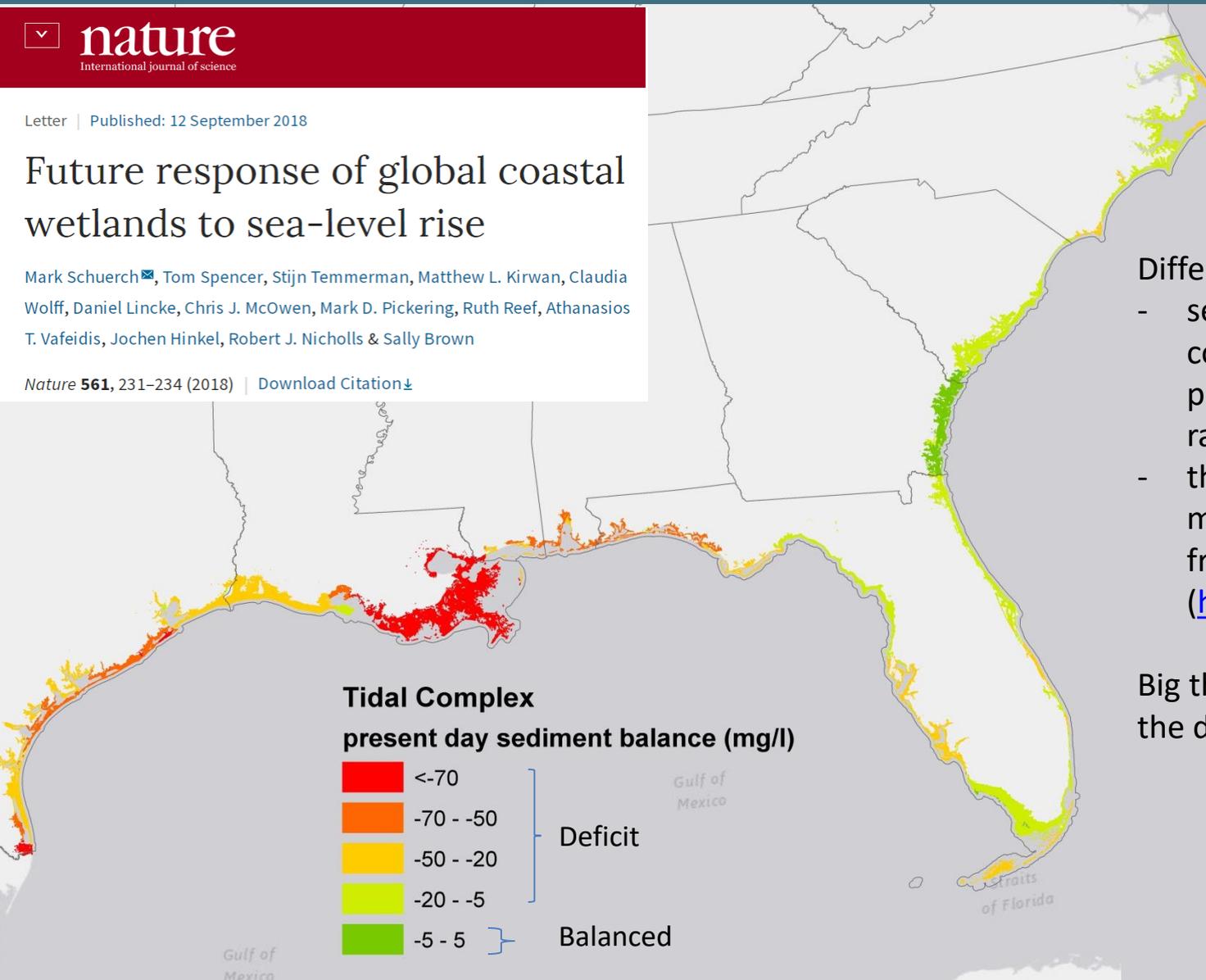


# Sediment Balance

## Future response of global coastal wetlands to sea-level rise

Mark Schuerch , Tom Spencer, Stijn Temmerman, Matthew L. Kirwan, Claudia Wolff, Daniel Lincke, Chris J. McOwen, Mark D. Pickering, Ruth Reef, Athanasios T. Vafeidis, Jochen Hinkel, Robert J. Nicholls & Sally Brown

*Nature* **561**, 231–234 (2018) | [Download Citation](#)



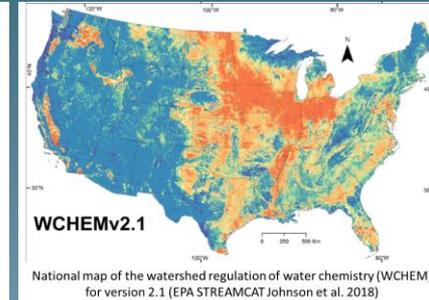
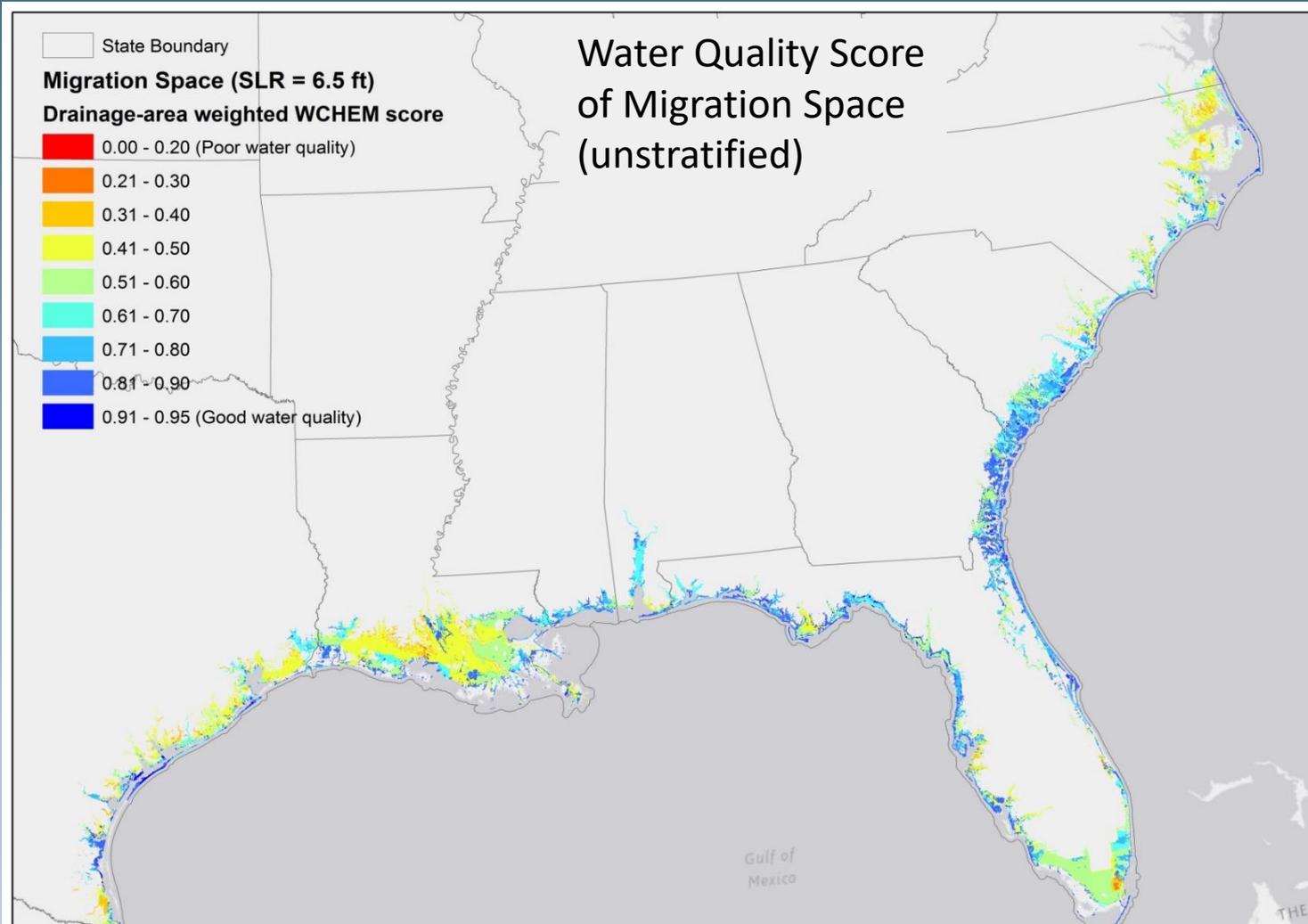
Difference between

- sediment needed for coastal wetlands to keep pace with current SLR rates
- the actual total suspended matter concentration from satellite data (<http://globcolour.info>).

Big thanks to Dr. Schuerch for the data!

# Water Quality

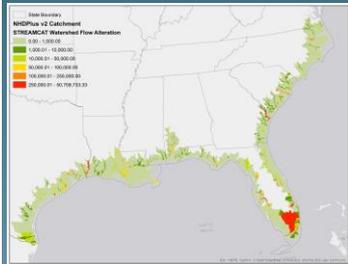
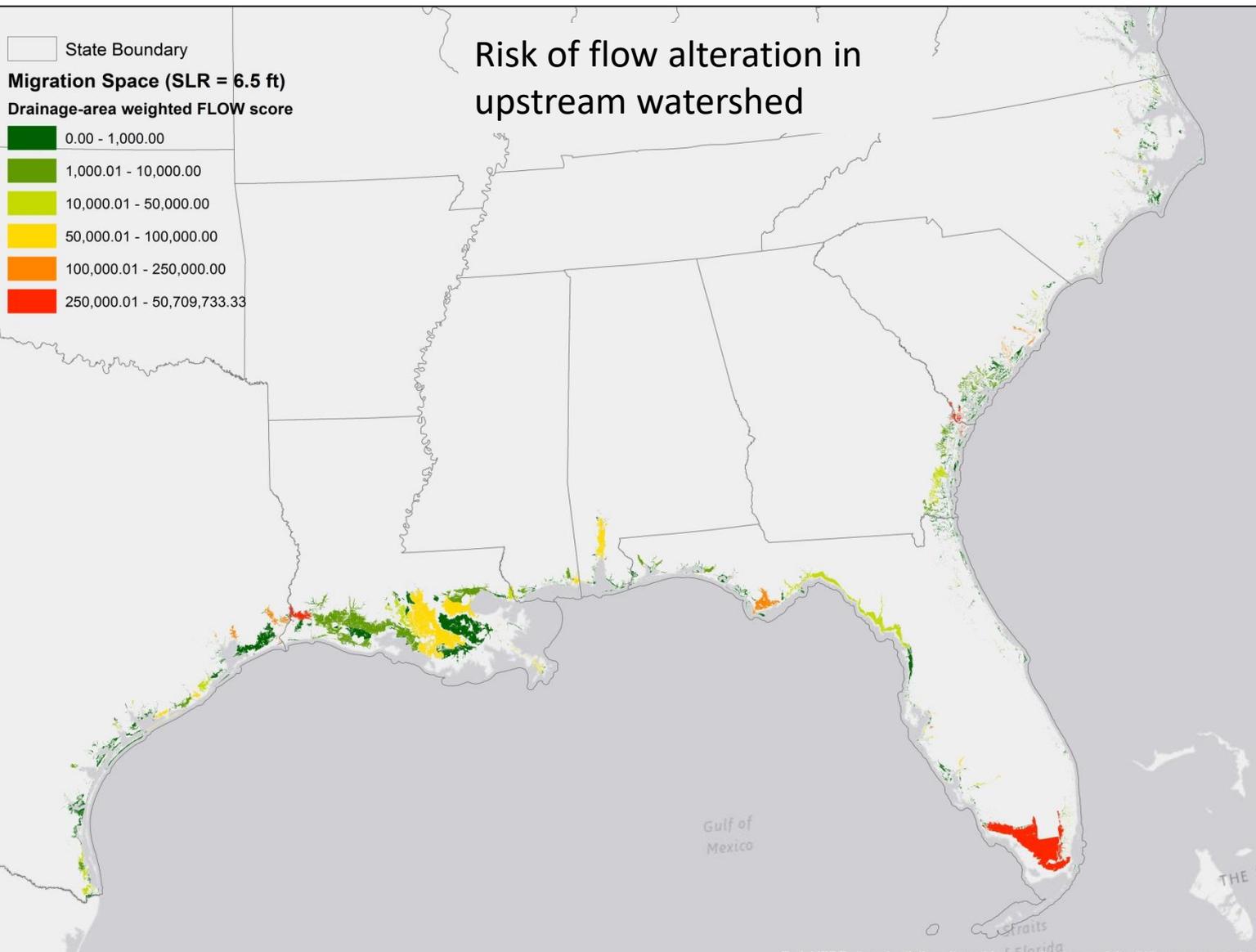
National Rivers and Stream Assessment water quality index is response variable  
(total nitrogen, total phosphorus, and turbidity)



National map of the watershed regulation of water chemistry (WCHEM) for version 2.1 (EPA STREAMCAT Johnson et al. 2018)

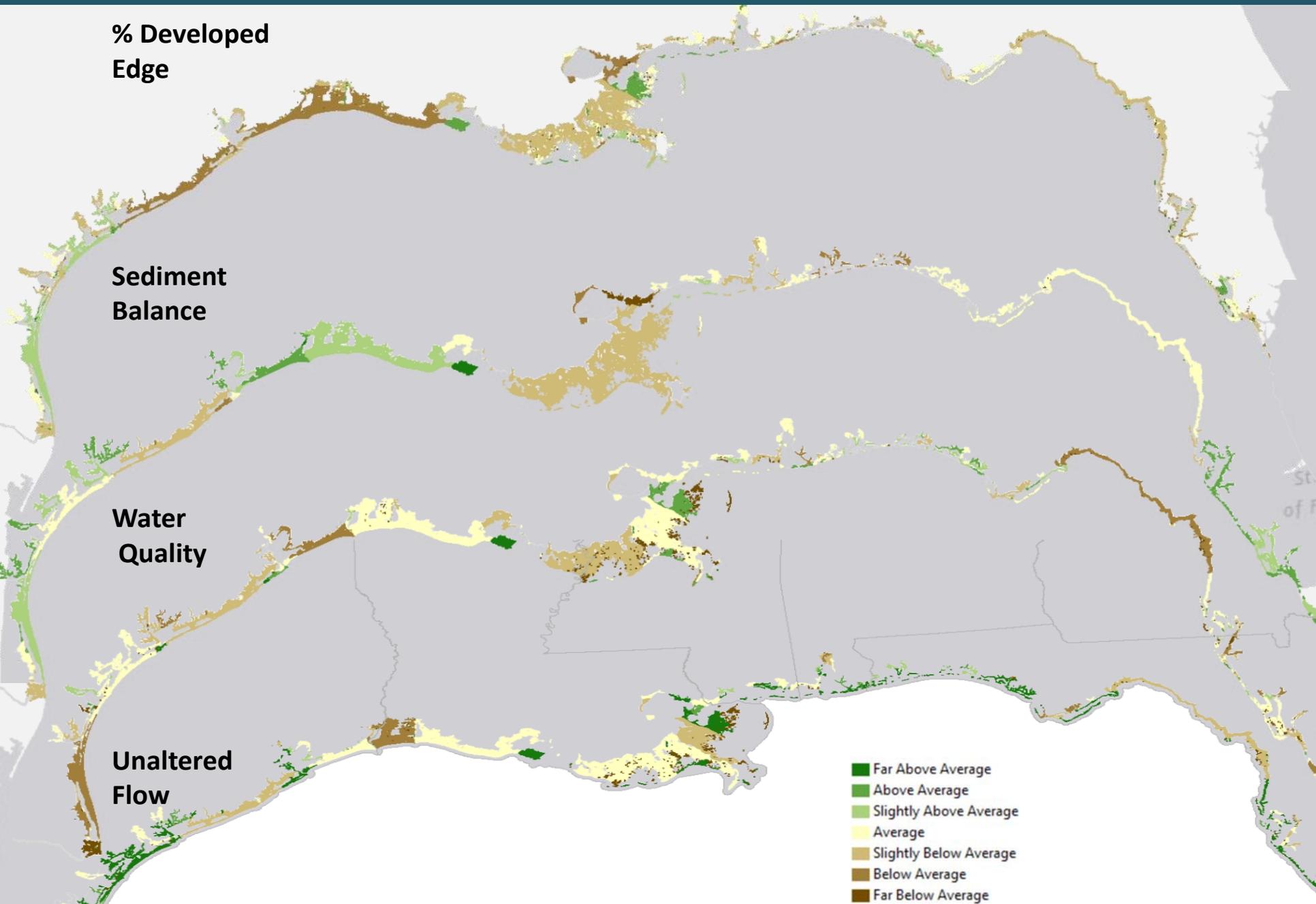
# Flow Alteration

*Unaltered freshwater flushing of all CSR's*



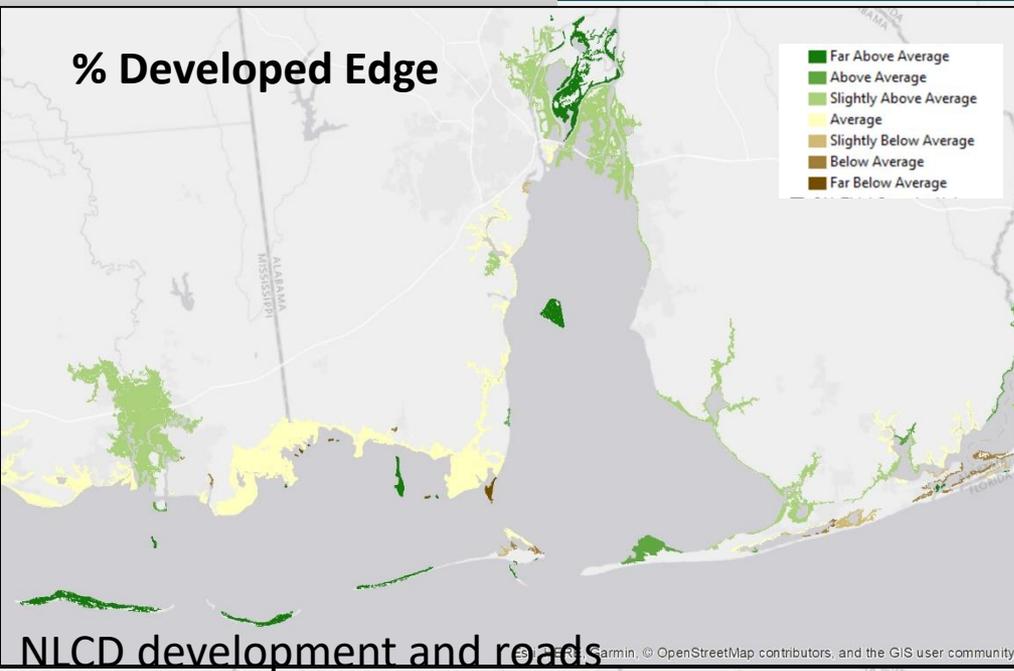
EPA  
STREAMCAT:  
Percent of  
Normal  
volume of all  
reservoirs  
per unit area  
of watershed  
(cubic  
meters/squa  
re km)

# Resilient Coastal Sites: Condition

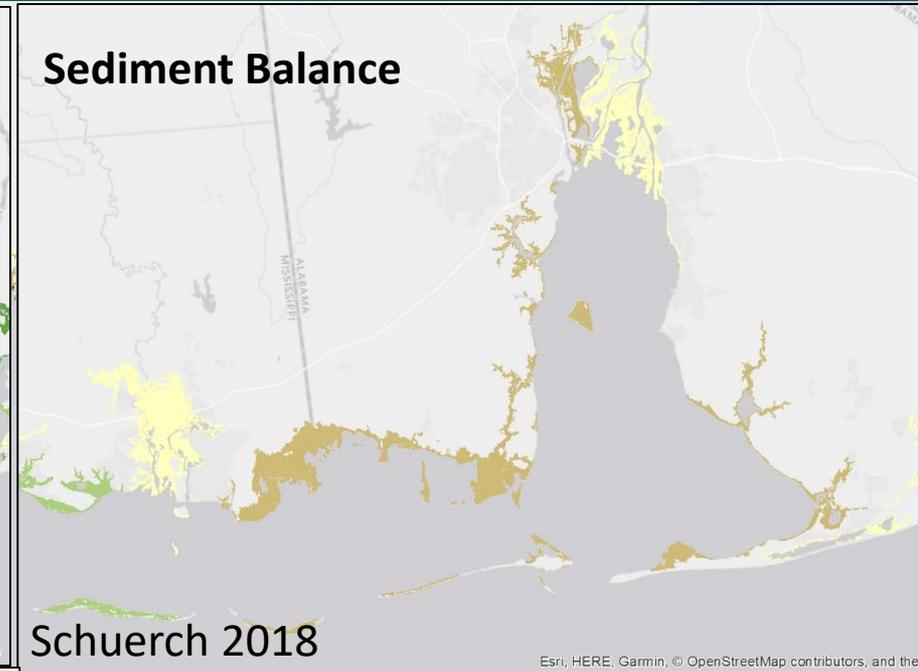


# Resilient Coastal Sites: Condition

## % Developed Edge



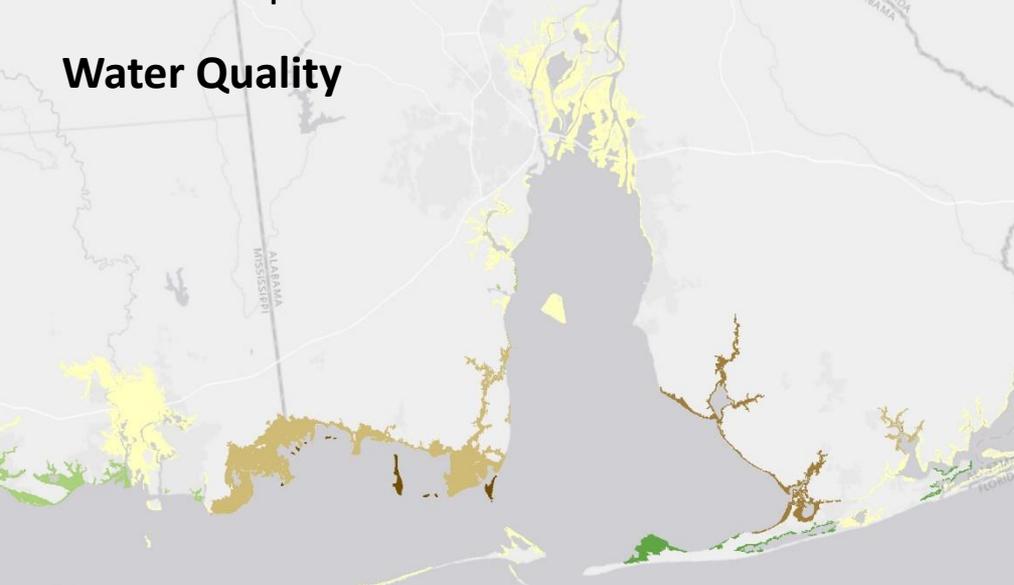
## Sediment Balance



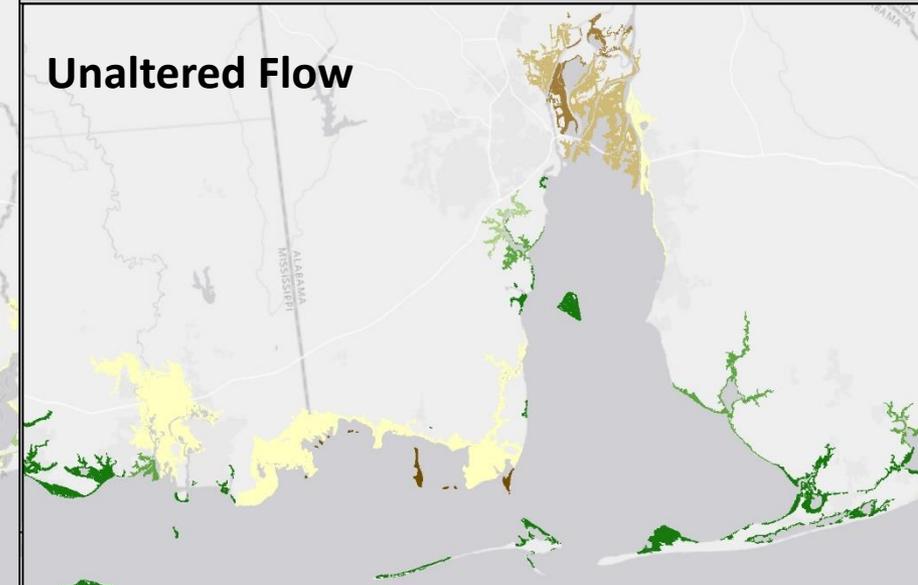
NLCD development and roads

Schuerch 2018

## Water Quality



## Unaltered Flow

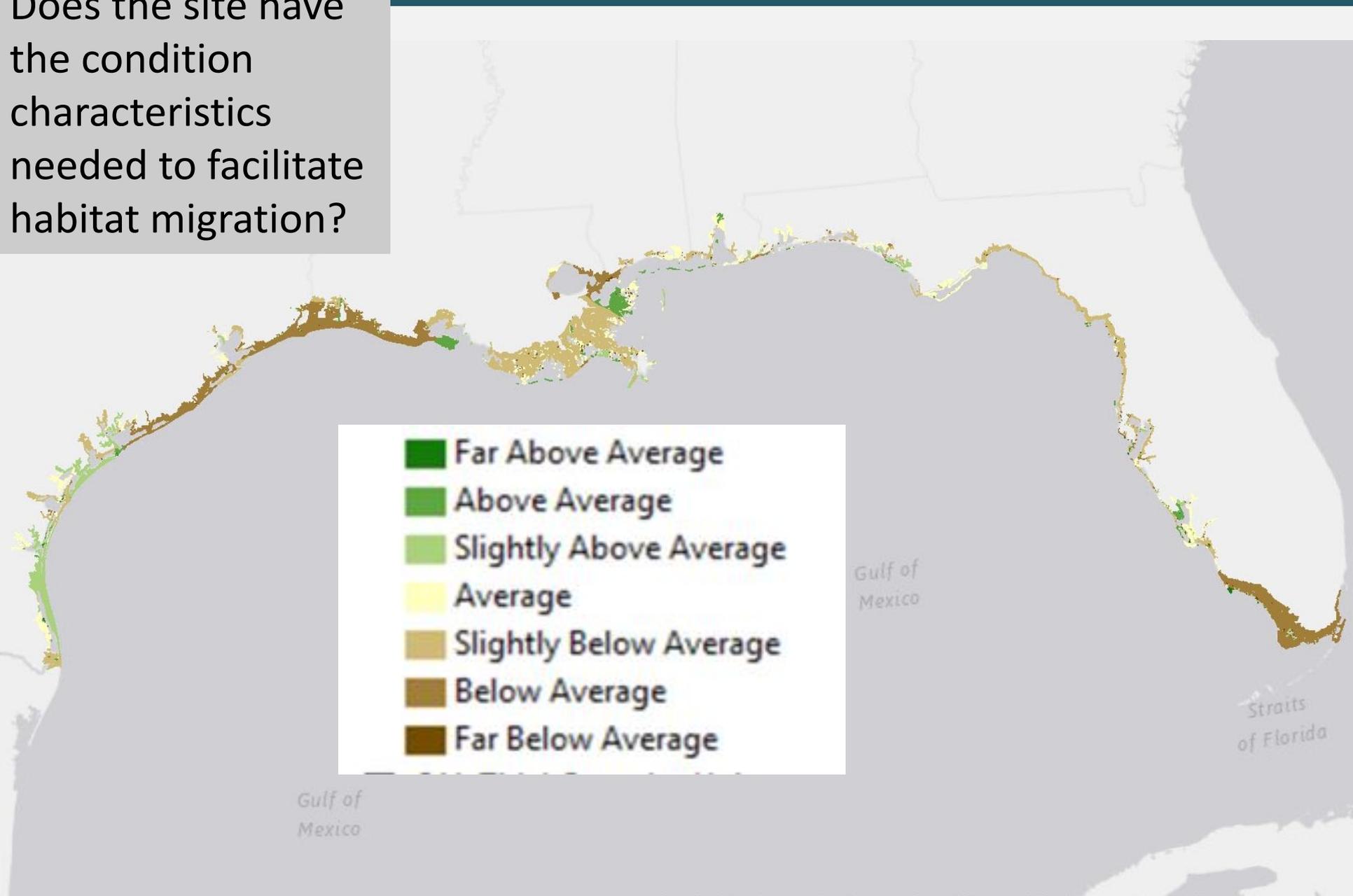


EPA STREAMCAT water chemistry index 2.1: N, P, T

EPA STREAMCAT Water Stored by Dams

# Results: Condition Score

Does the site have the condition characteristics needed to facilitate habitat migration?



# Resilient Coastal Sites: Condition

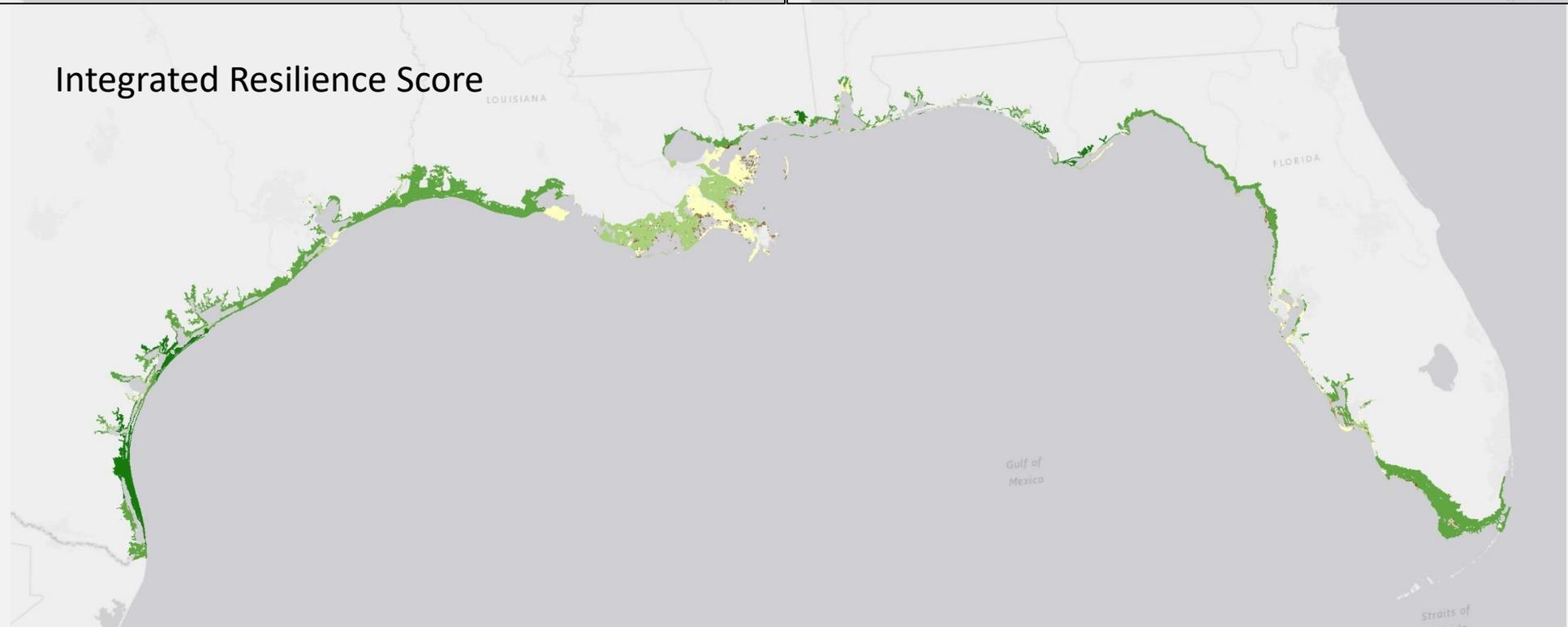
Physical Score



Condition Score



Integrated Resilience Score



# Coastal Shoreline Regions

## Legend

### GOM Coastal Shoreline Regions Aug. 2018

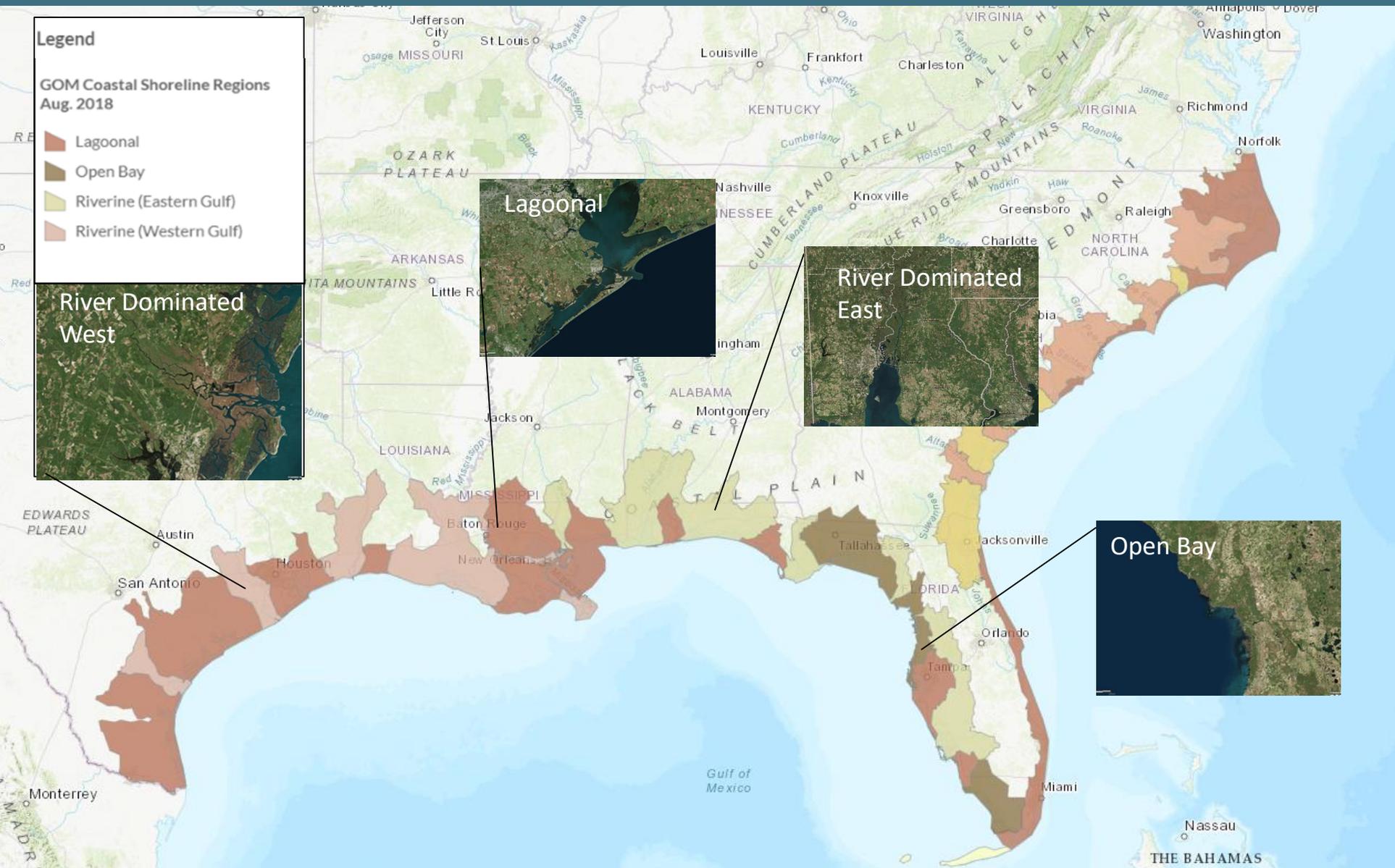
- Lagoonal
- Open Bay
- Riverine (Eastern Gulf)
- Riverine (Western Gulf)

River Dominated  
West

Lagoonal

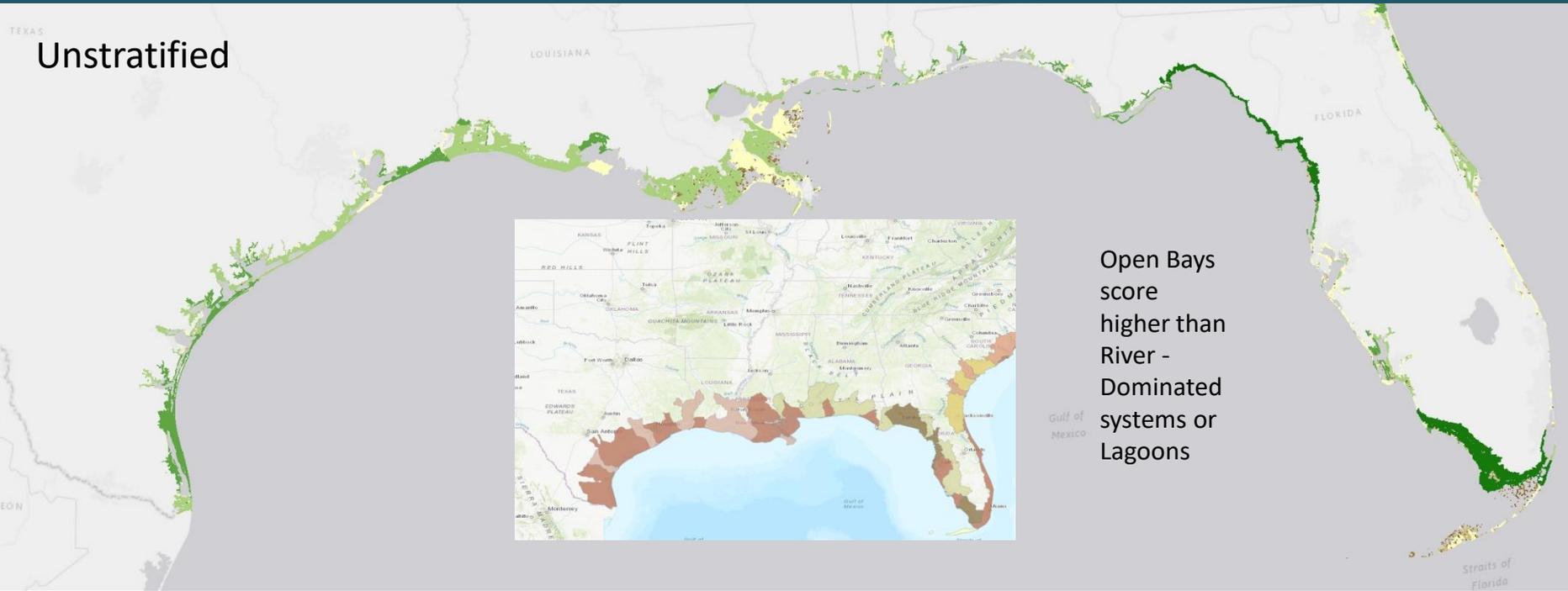
River Dominated  
East

Open Bay



# Stratification by Coastal Shoreline Region

Unstratified

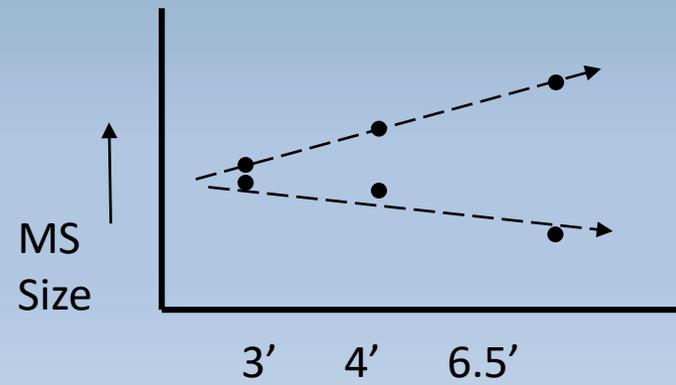
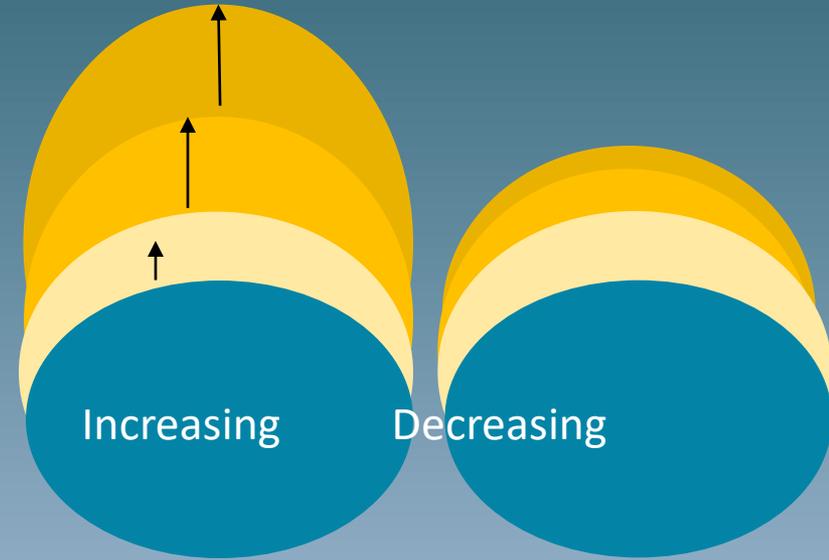
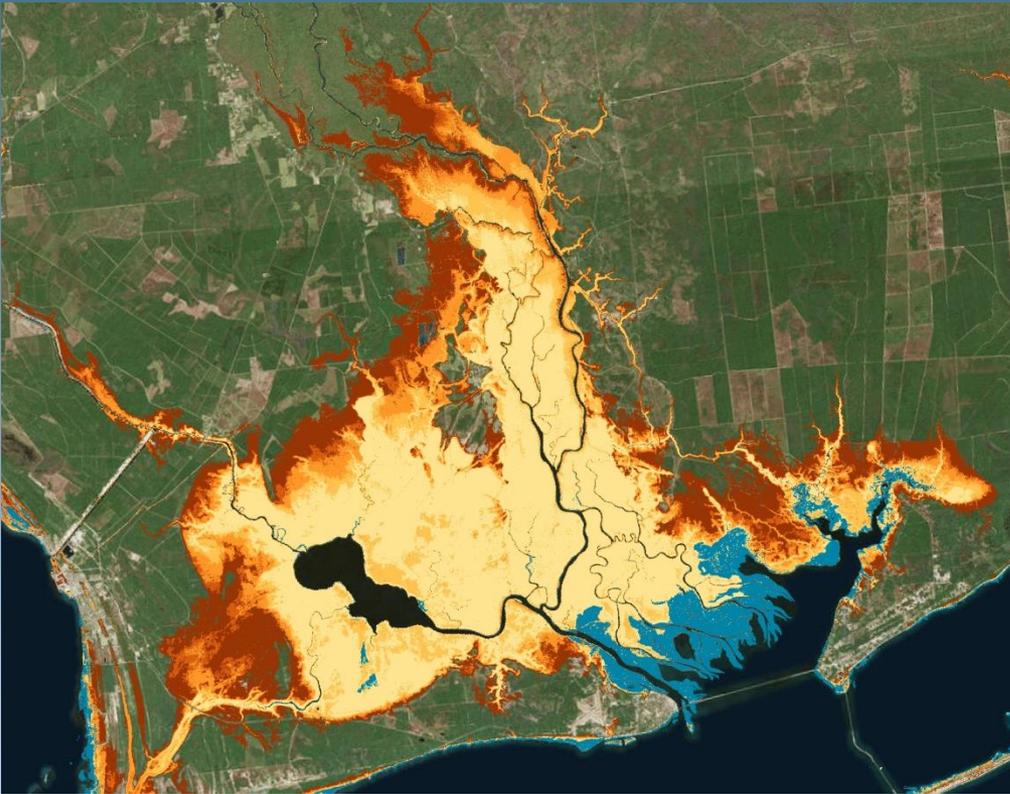


Stratified



# Dealing with an Uncertain Future

Scenarios, Migration Space Trend, and Buffer Areas



## Proposal:

- Positive migration space trend = + 0.50 SD to final resilience score
- No Trend or Negative = no impact on final resilience score

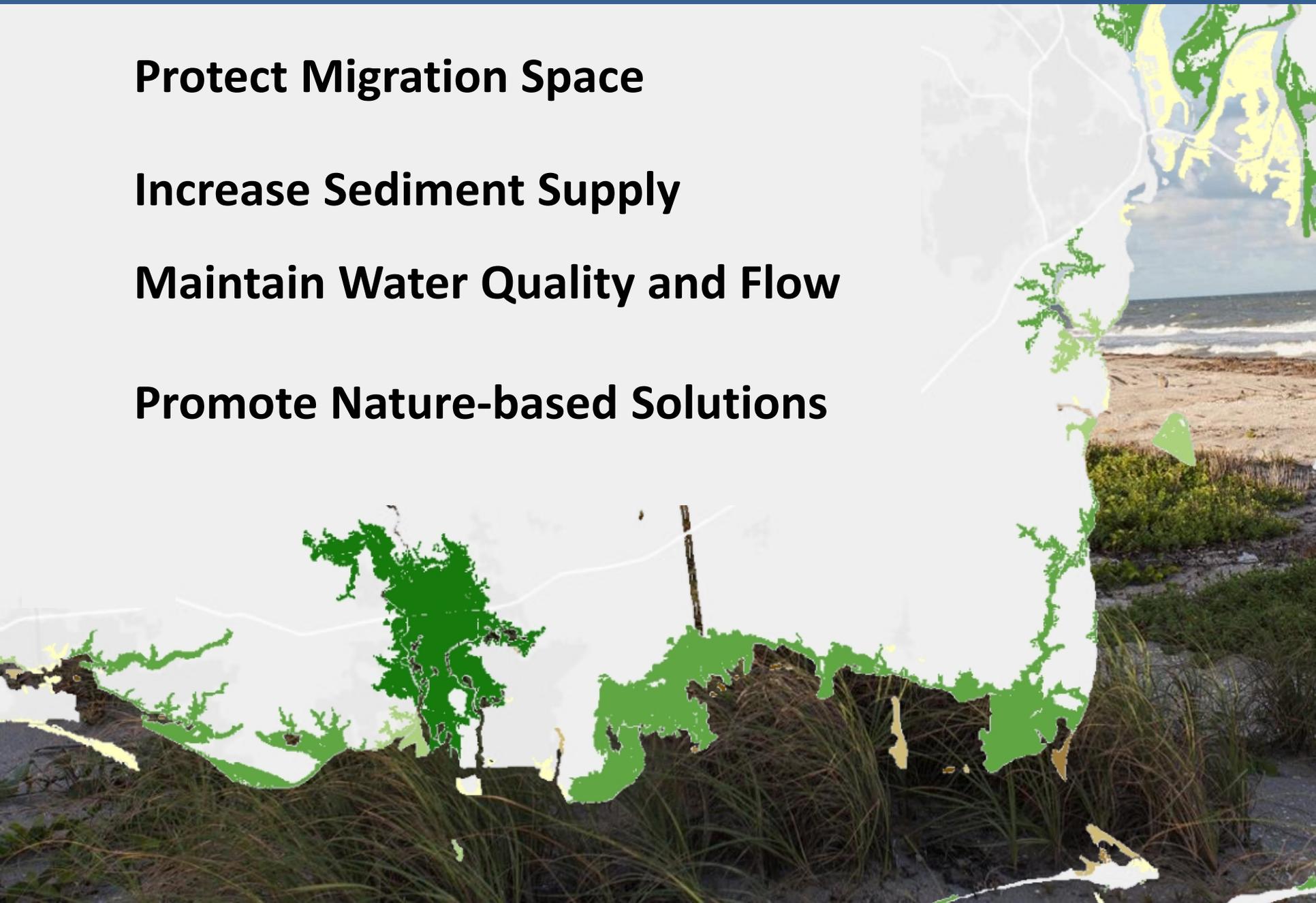
# Strategies

**Protect Migration Space**

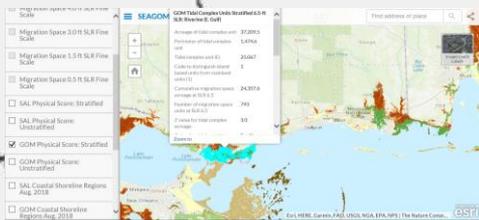
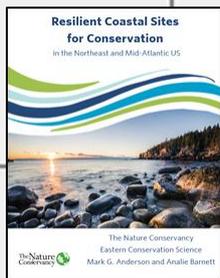
**Increase Sediment Supply**

**Maintain Water Quality and Flow**

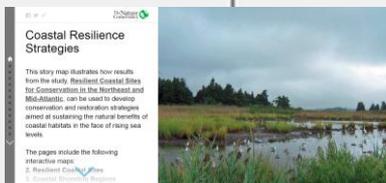
**Promote Nature-based Solutions**



# Resilient Coastal Sites: Products



- Website
- Report
- Web Mapping Tools
- Story Maps
- Data Downloads

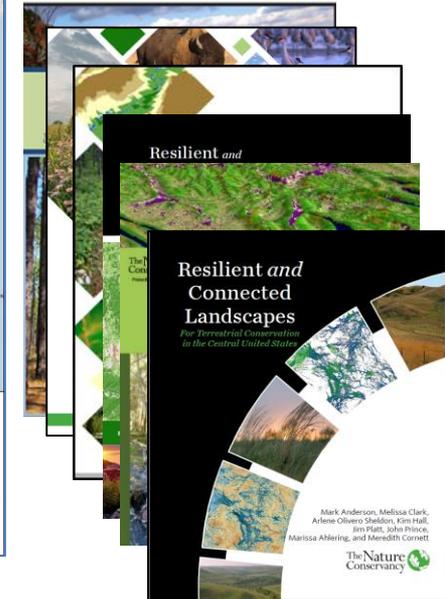
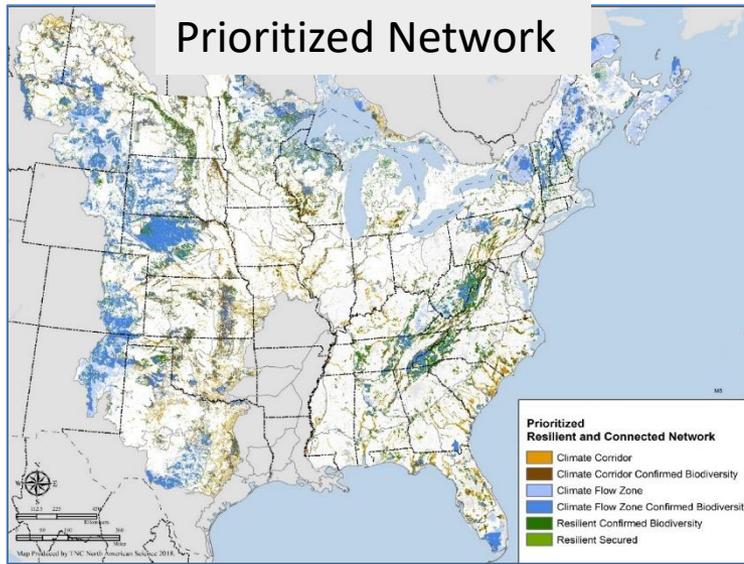
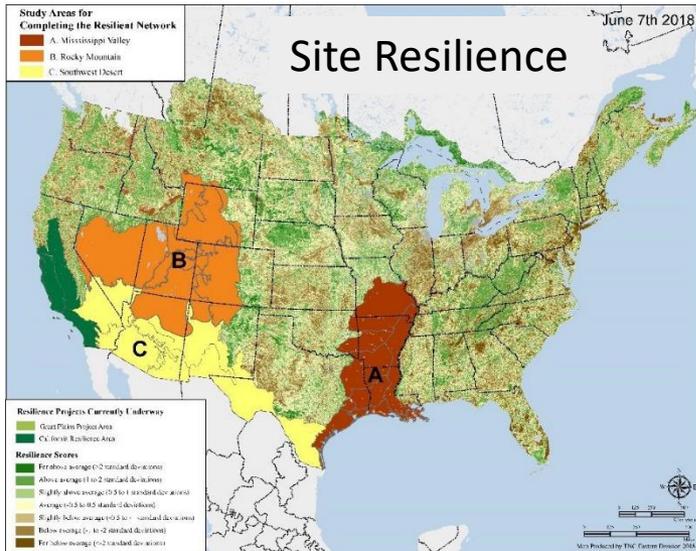


Wild Dunes, South Carolina

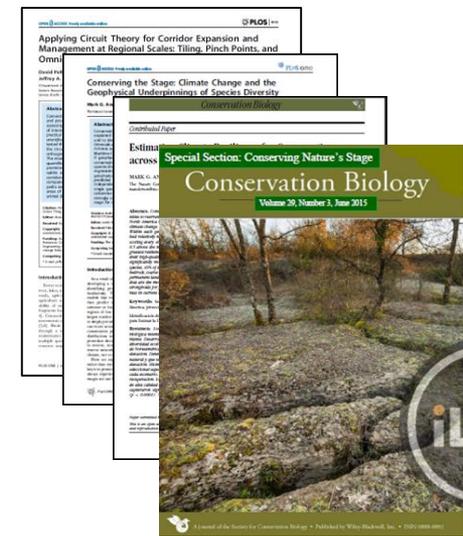
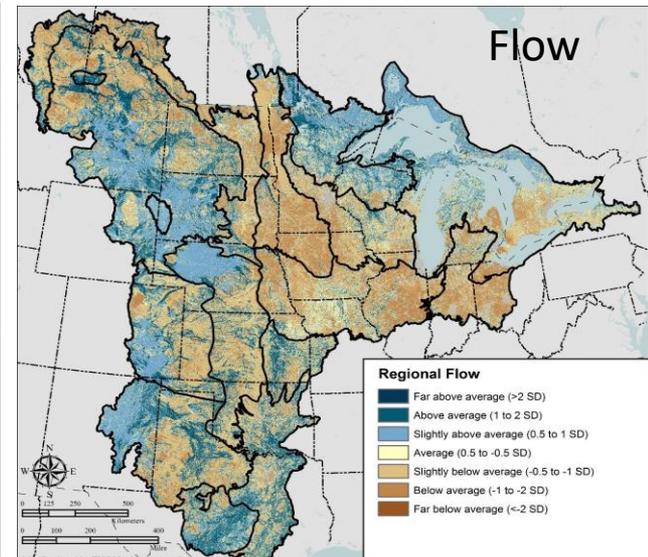
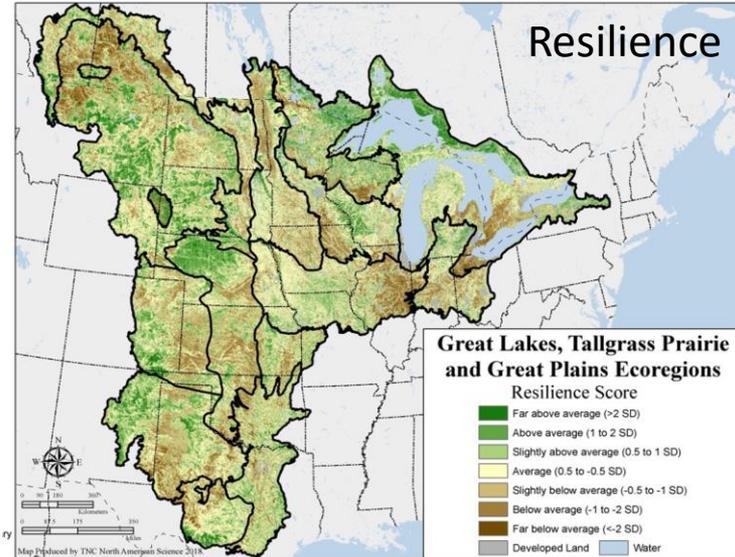
# Conservation Gateway

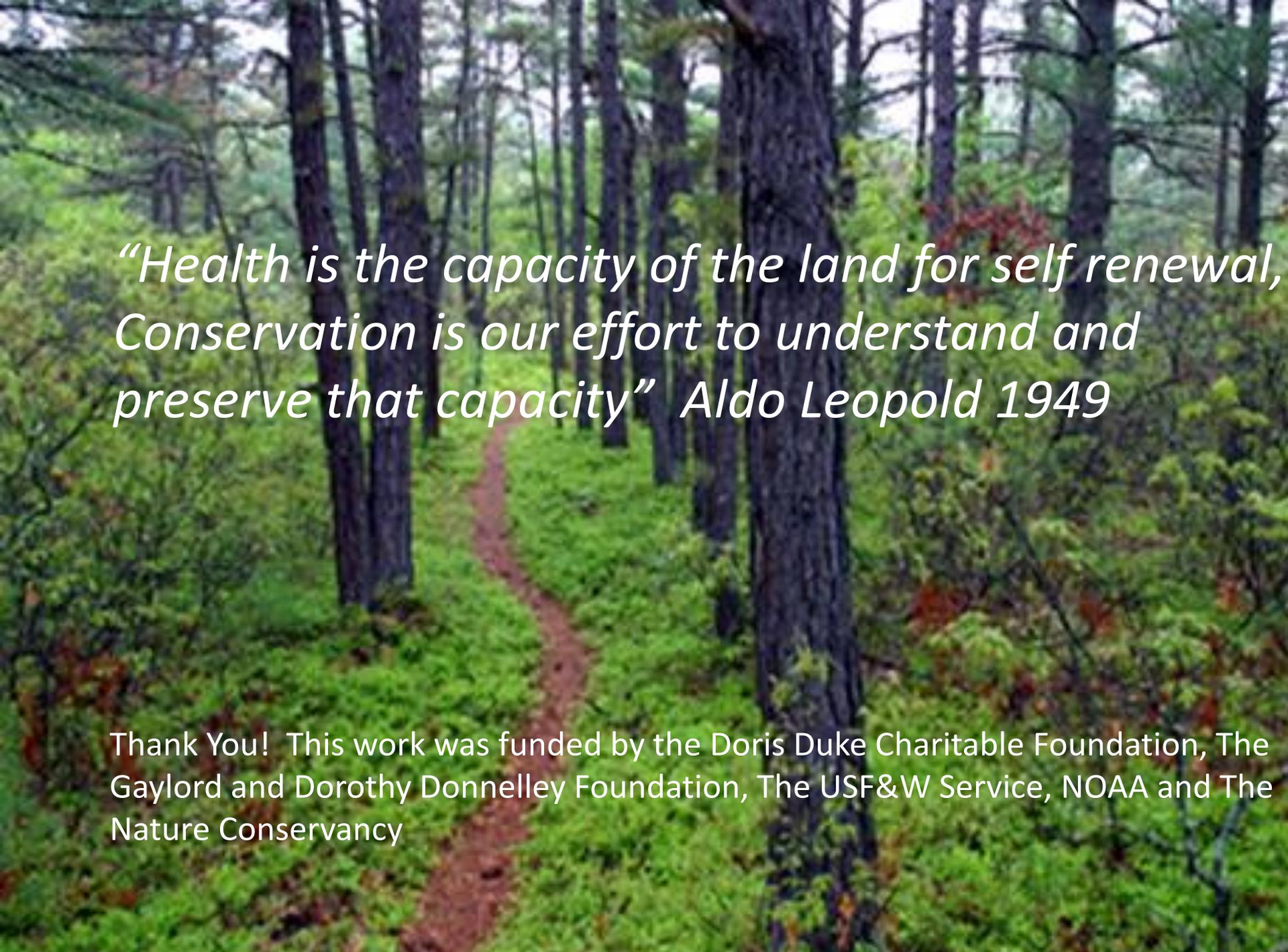
## Web Tools and Story Maps

## Papers and Reports



## Continuous Datasets:





*“Health is the capacity of the land for self renewal,  
Conservation is our effort to understand and  
preserve that capacity” Aldo Leopold 1949*

Thank You! This work was funded by the Doris Duke Charitable Foundation, The Gaylord and Dorothy Donnelley Foundation, The USF&W Service, NOAA and The Nature Conservancy