Factors associated with occurrence and expansion of *Phragmites australis* (Cav.) Trin Ex Steud. in Mississippi's low and intermediate elevation coastal marshes

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Background

- Cosmopolitan species, generally considered a nuisance species across North America
  - Aggressive competitor, associated with decreased vegetation diversity
  - Provides habitat
  - Robust physiology may help anchor marsh soils
- Non-native and native varieties present; species is widely variable in morphology and ability to tolerate various stressors
- Knowledge gaps related to Gulf Coast populations
  - Environmental tolerances and competitive ability of local ecotype of *P. australis*
  - Comparisons of the ecological niche of *P. australis* with Gulf Coast dominant marsh species, including *J. roemerianus*
  - Stability or lateral expansion of *P. australis* populations along the Mississippi, Alabama and Florida Panhandle Gulf Coasts
- Investigation of environmental tolerances of MS Gulf Coast populations is necessary to better understand future spread and resilience of *P. australis*-dominated marsh areas

Distribution of Mississippi Gulf Coast populations of *P. australis* along environmental gradients of salinity and elevation

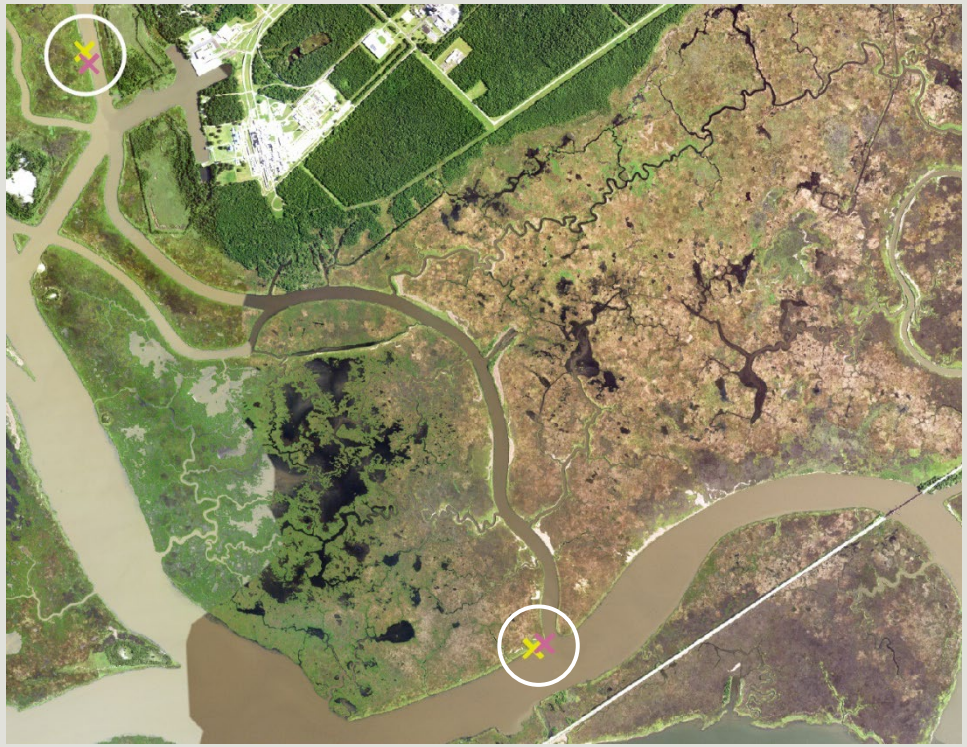
Goal: Characterize biotic and abiotic characteristics (salinity, elevation, and topography/near-shore bathymetry) associated with *P. australis* distribution along the Mississippi Coast, and how these characteristics interact

Research Questions

- What are the threshold elevations for *P. australis* and how do they compare to neighboring plant species?
- What levels of surface water salinity occur at *P. australis* dominated areas, and are these related to changes in threshold elevations of *P. australis* and neighboring plant species?
- Do topographic/bathymetric slopes of P. australis-colonized areas differ from adjacent areas?
- What differences in plant community composition exist between *P. australis* dominated marsh areas and adjacent marsh areas?

Study area

- Three estuarine areas along Mississippi Gulf Coast
  - Hancock County Marsh (Pearl River Estuary)
  - Jourdan River at St. Louis Bay
  - West Pascagoula River
- Three sites per estuary across gradient of salinity
- Four topographic transects per site (two *Phragmites*-dominated and two adjacent)
  - Transects oriented perpendicular to the shoreline
  - Paired transects randomly generated along relevant parts of the shoreline



Pearl River

Pascagoula River

Jourdan River

Transects

- Non-Phragmites
- Phragmites

Topographic data

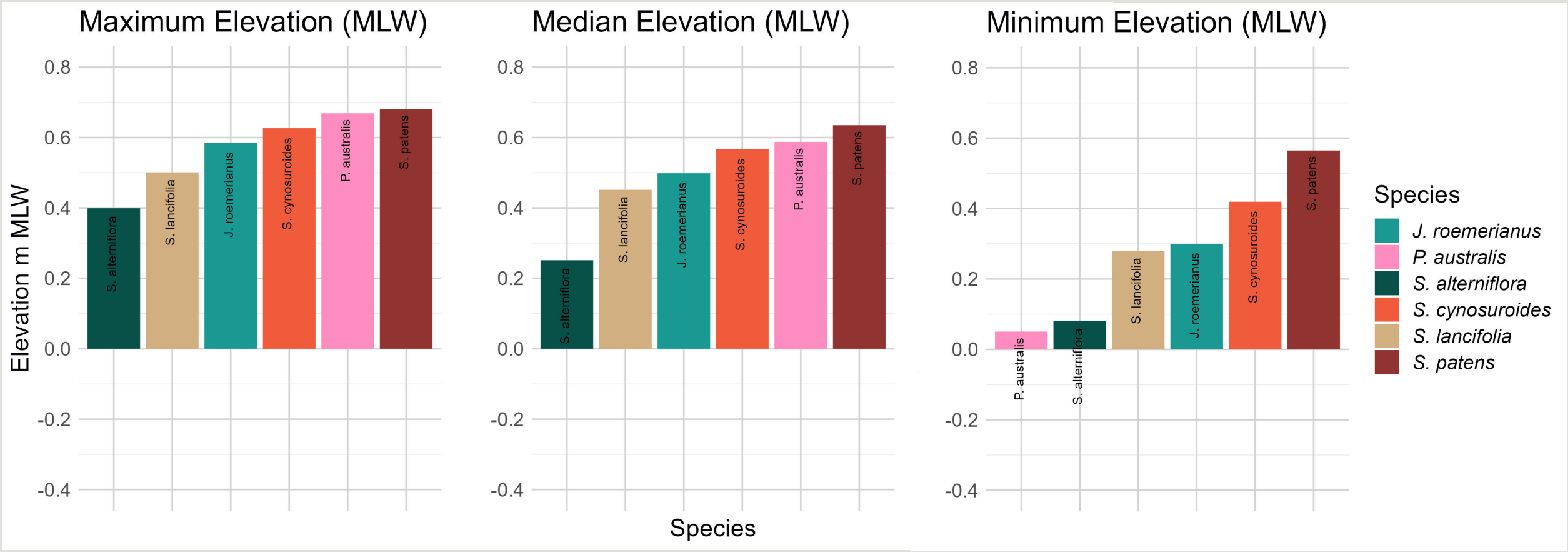
- Vegetation documented every 0.5 meters
  - Species presence/absence
  - Primary species (>50% cover), secondary species (25-50% cover)
- Positions recorded using RTN*-corrected GNSS**
  - Trimble R12i
  - GCGC CORS*** Network Real Time Corrections
  - ± 2 cm vertical and horizontal GNSS precision
  - NAD 1983 (2011) horizontal and NAVD88 vertical datums
- Converted to elevations to reference Mean Low Water based on nearest NOAA Tide Gauge for comparison across estuaries

*RTN: Real Time Network
**GNSS: Global Navigation Satellite System
*** CORS: Continuously Operating Reference Station

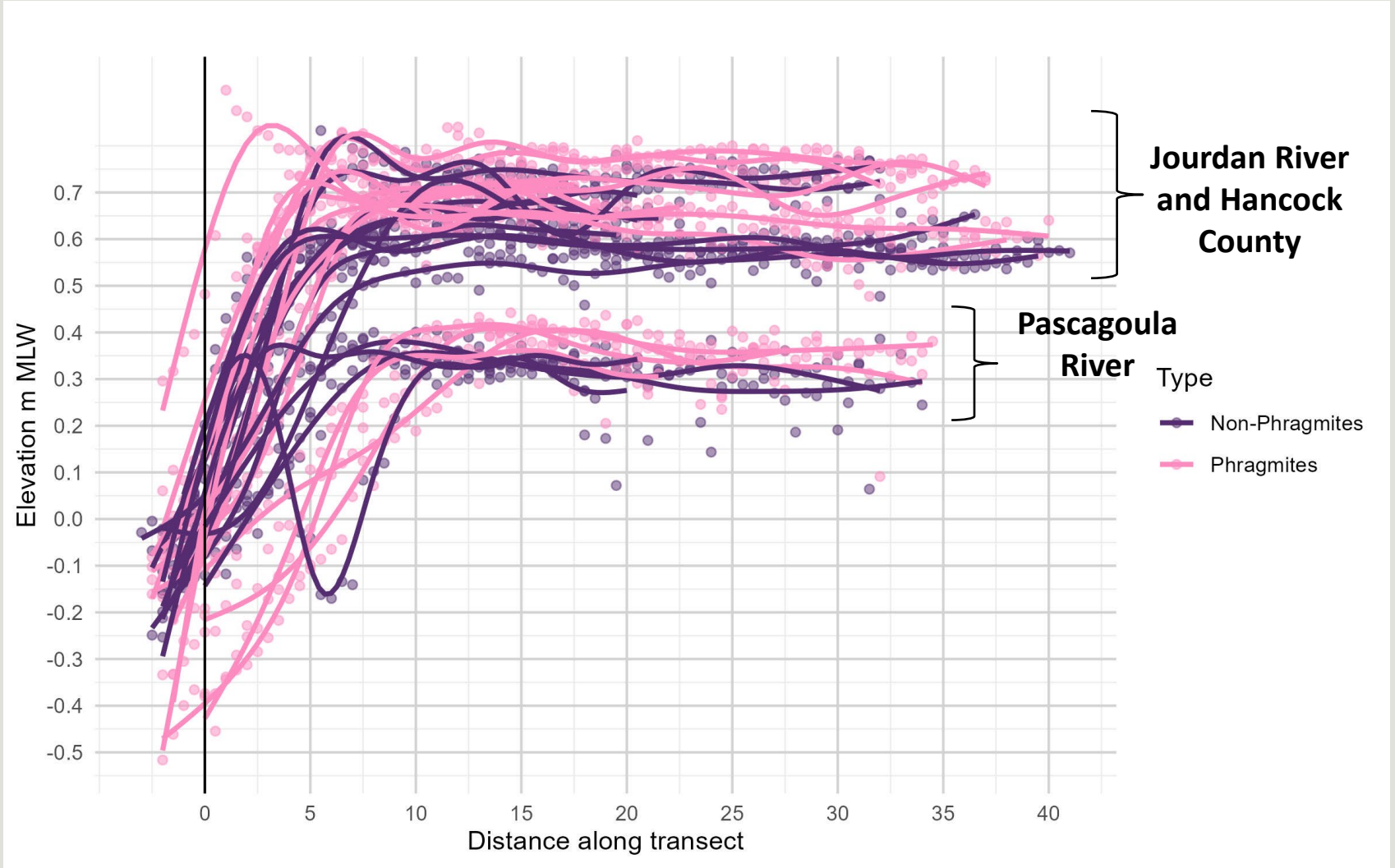
Salinity monitoring

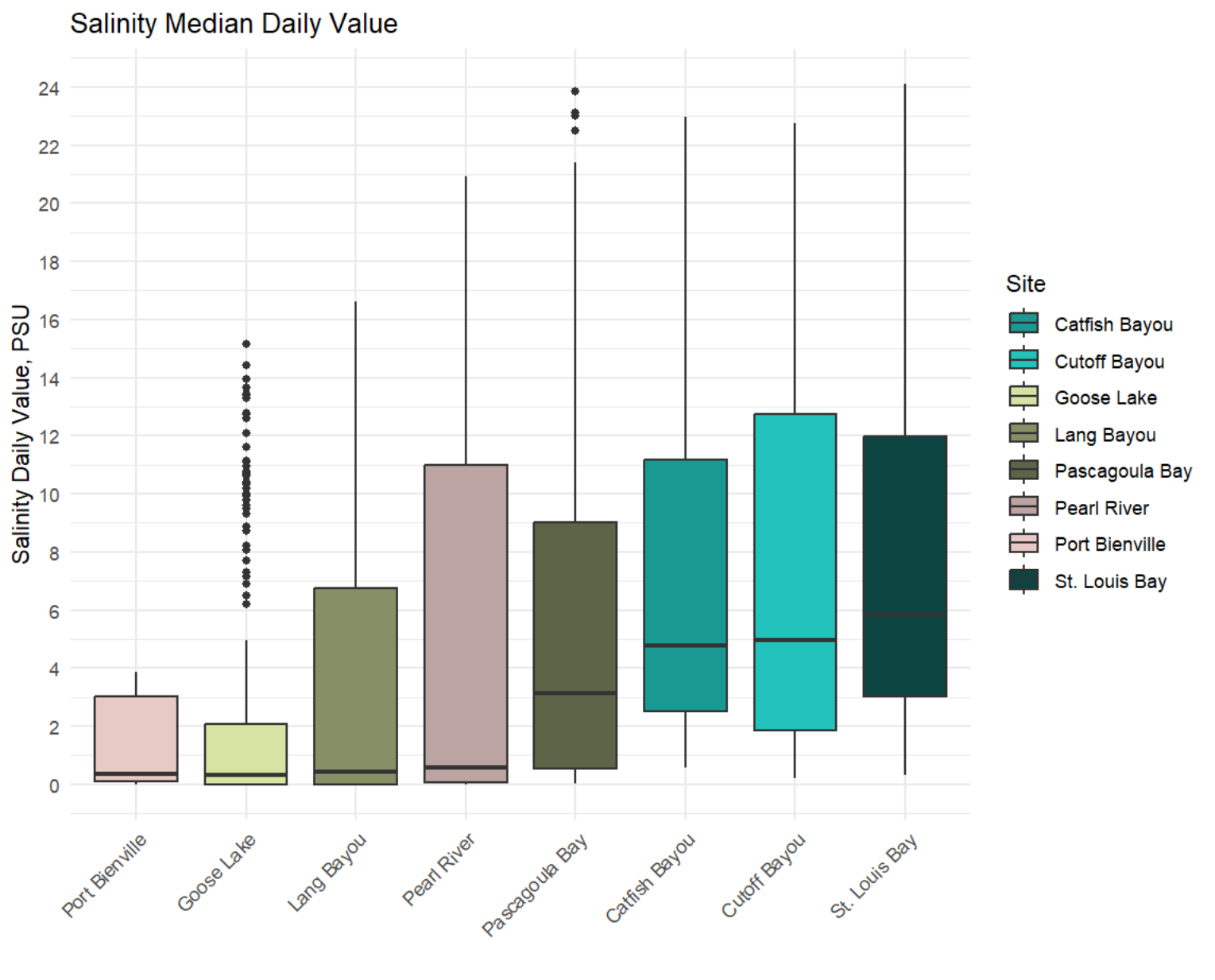
- Surface conductivity, temperature, and salinity recorded at 15 min intervals beginning in January 2023
  - Moored buoys
  - Star-Oddi CT
- Will examine relationships among sites in each estuary along with local USGS gauges to fill in data gaps and approximate past salinity levels

Preliminary results: plant species elevations



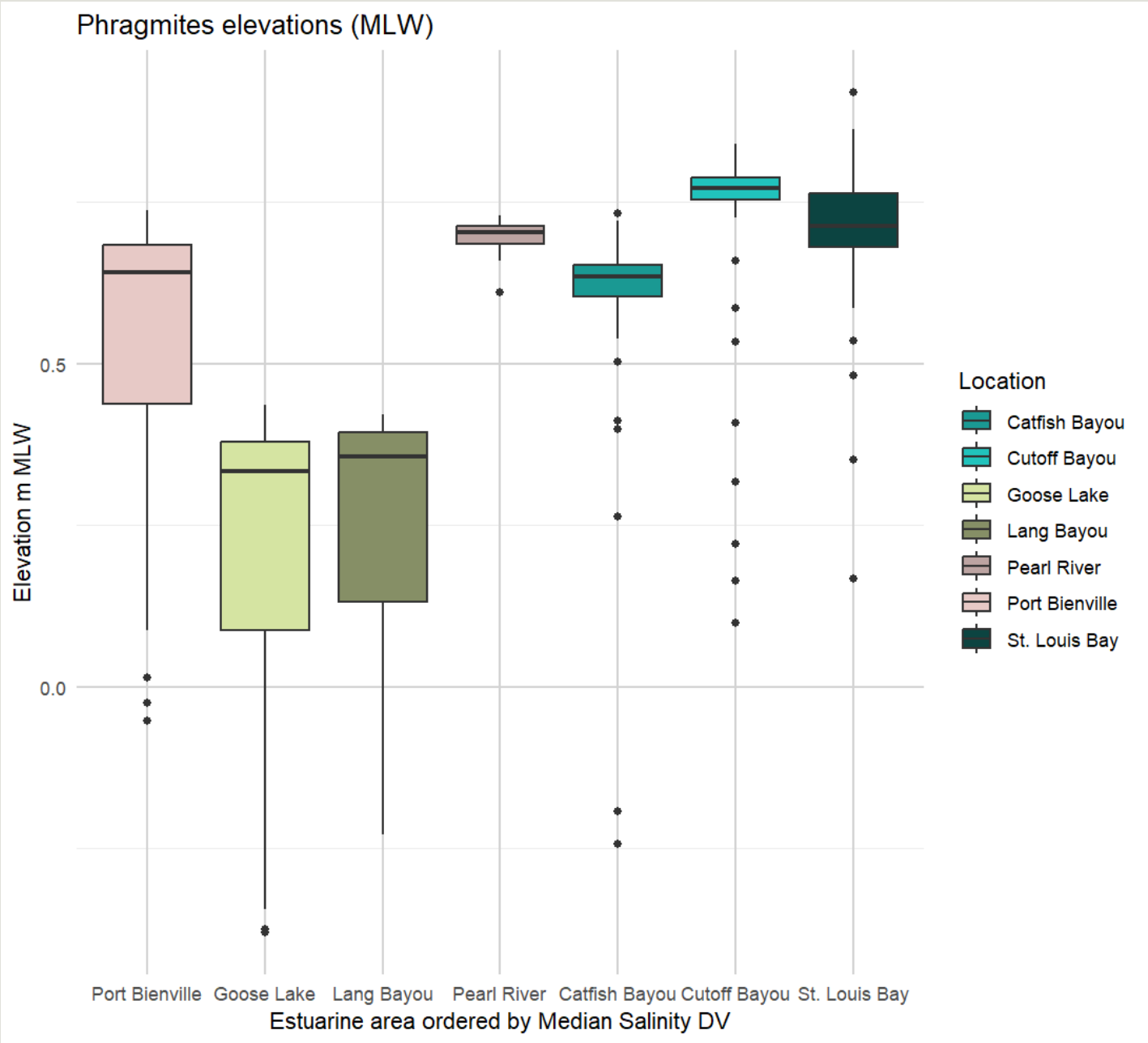
Preliminary results: topography





Preliminary results: Salinity

- Lower overall elevations coincided with lower salinity levels at Pascagoula River sites



Preliminary results: Salinity

- Lower overall elevations coincided with lower salinity levels at Pascagoula River sites
- Addition of final two sites (downriver in both Hancock County and Pascagoula) will help determine the strength of this relationship
- Random variable for estuary should also help clarify trends

Discussion: environmental tolerances and future expansion of *P. australis*

- Might expect greater expansion in low elevation areas with lower salinity
  - Preliminary image analysis supports this
  - Aligns with prevailing understanding of salt and brackish marsh zonation
- Phragmites may be able to anchor soils where other marsh species cannot continue to survive due to deep inundation, preserving marsh extent
  - Implications under sea level rise scenarios
  - Displacement of other species vs. expansion into uninhabitable areas (alternatives to *P. australis*)

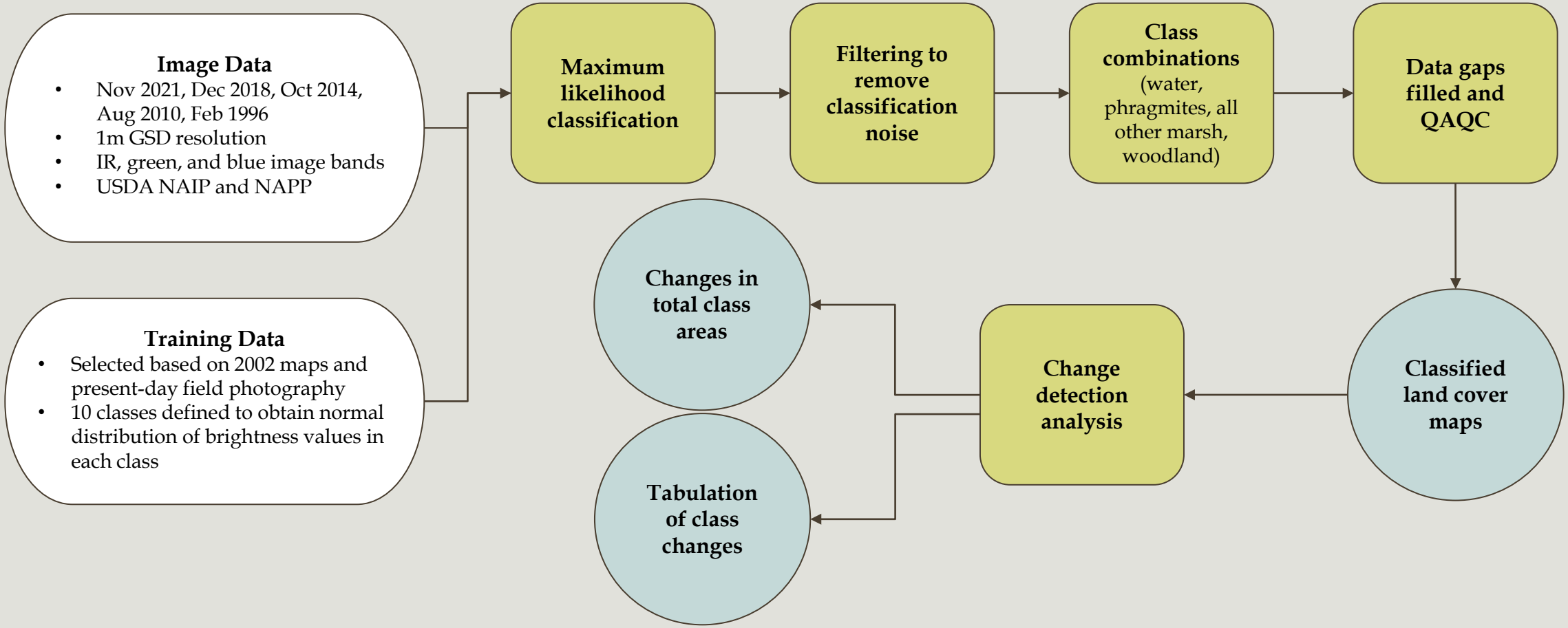
Remote sensing of changes in distribution of *P. australis* through time using aerial image data in three Mississippi estuaries

Goal: Determine rates and magnitude of change in *P. australis* extents in selected areas along the MS Gulf Coast, and investigate whether exposure is associated with expansion

Research Questions

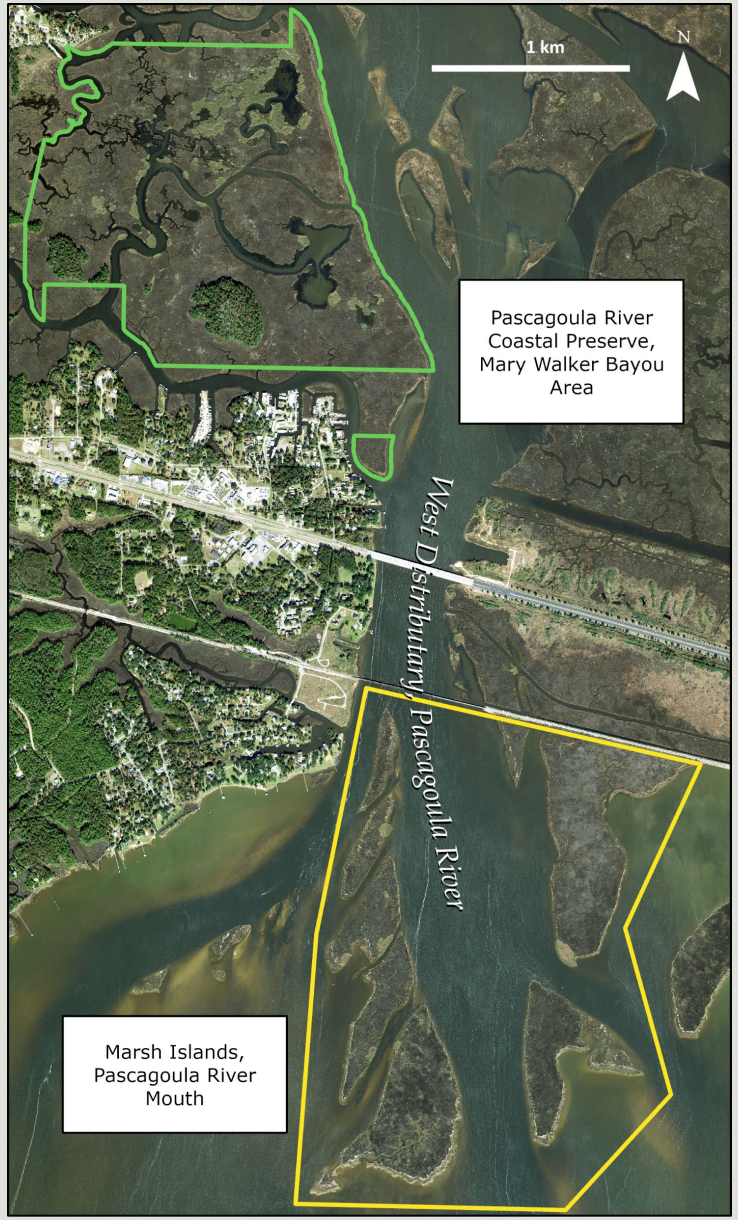
- How has *P. australis* extent changed over time (1996-2021)?
- How does this change in extent compare to the change in extent of other co-located marsh areas?
- What other land cover types are being colonized by *P. australis*, and at what rates?
- Is lateral expansion variable spatially, and is variability related to exposure?

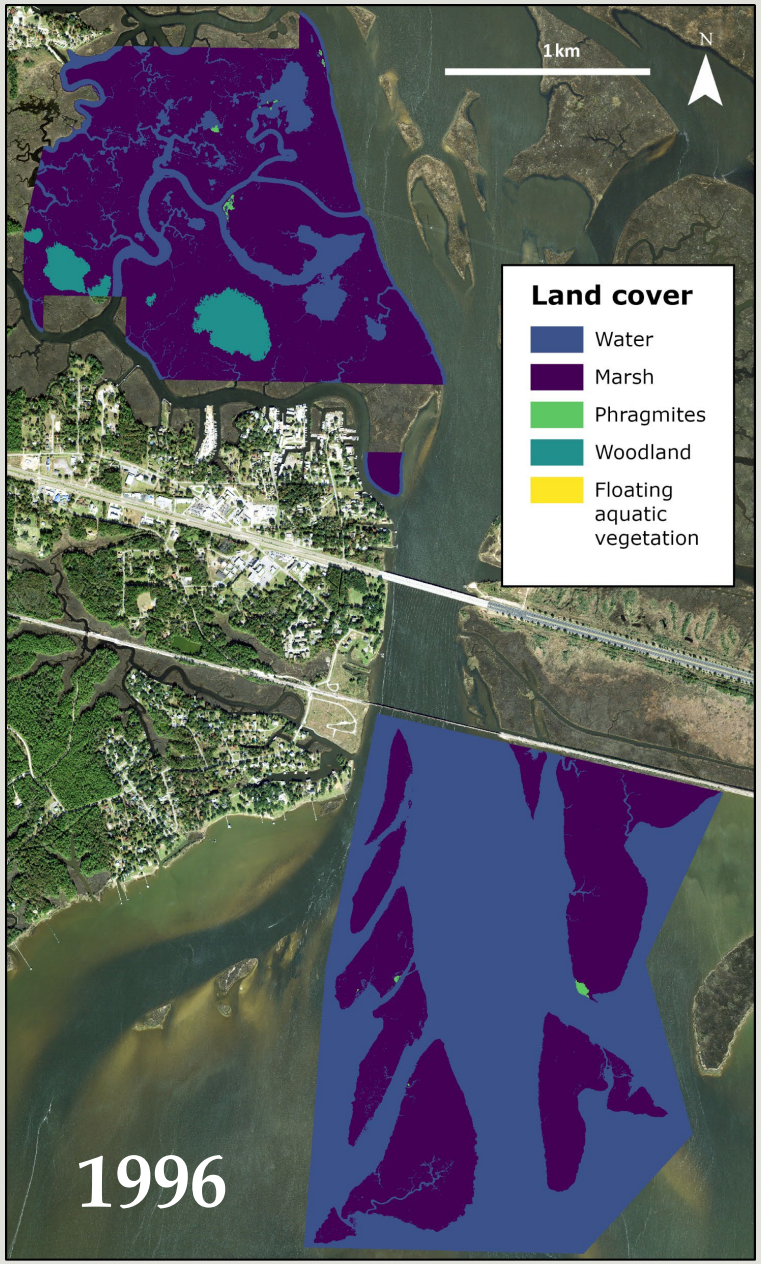
Image analysis methods



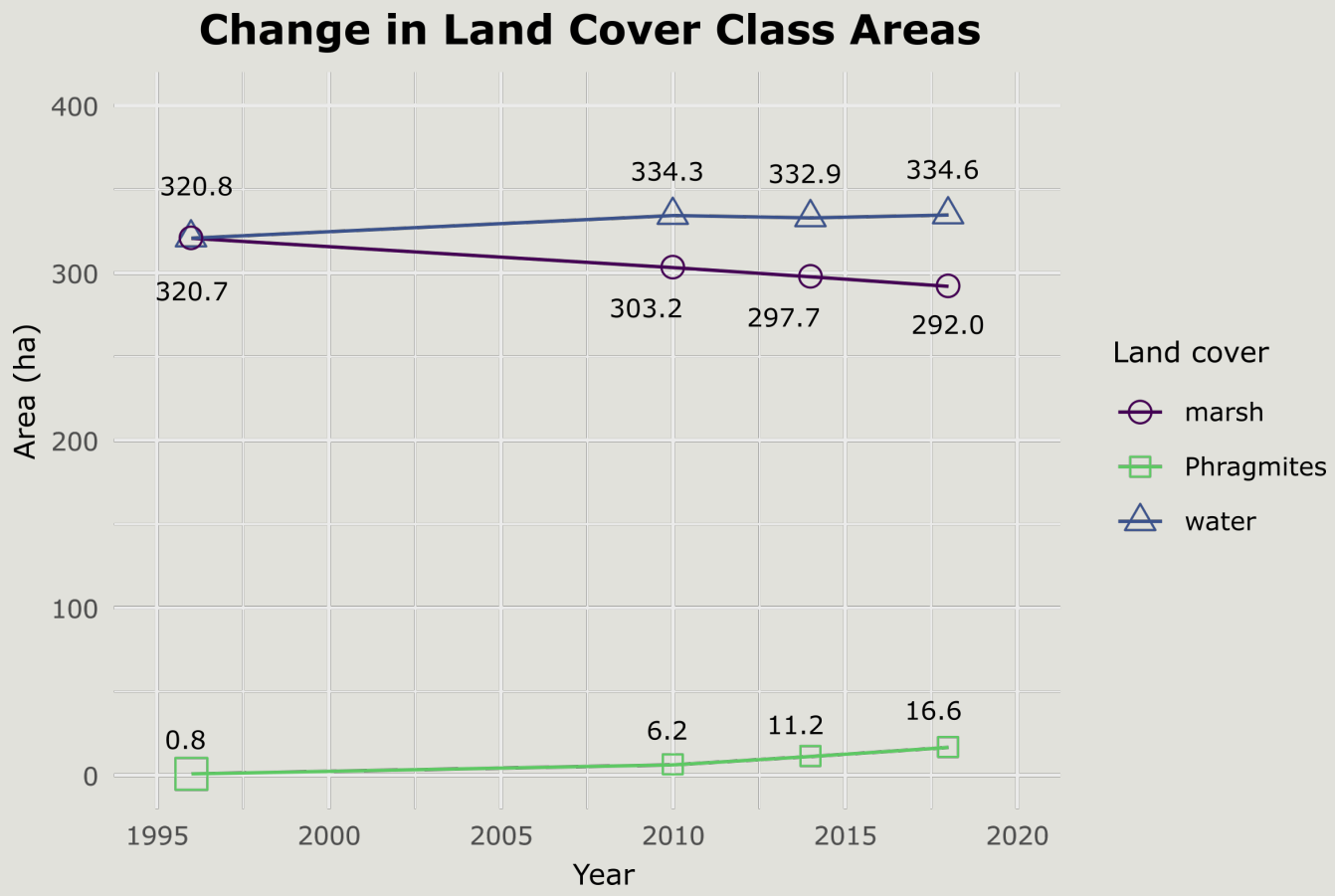
Preliminary results: Pascagoula River

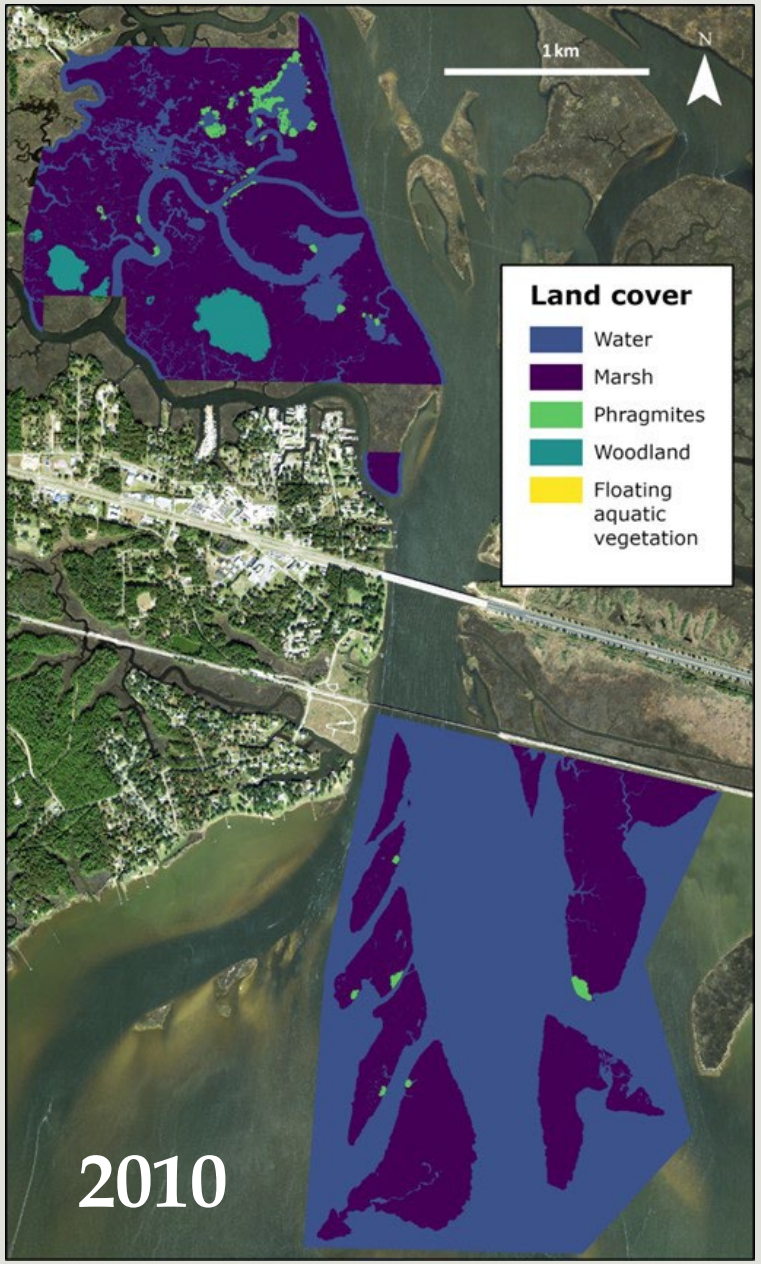
- Examined two areas in the Pascagoula River estuary which had a documented historical presence of *P. australis*
- Sites are subject to different levels of exposure to wind and wave action



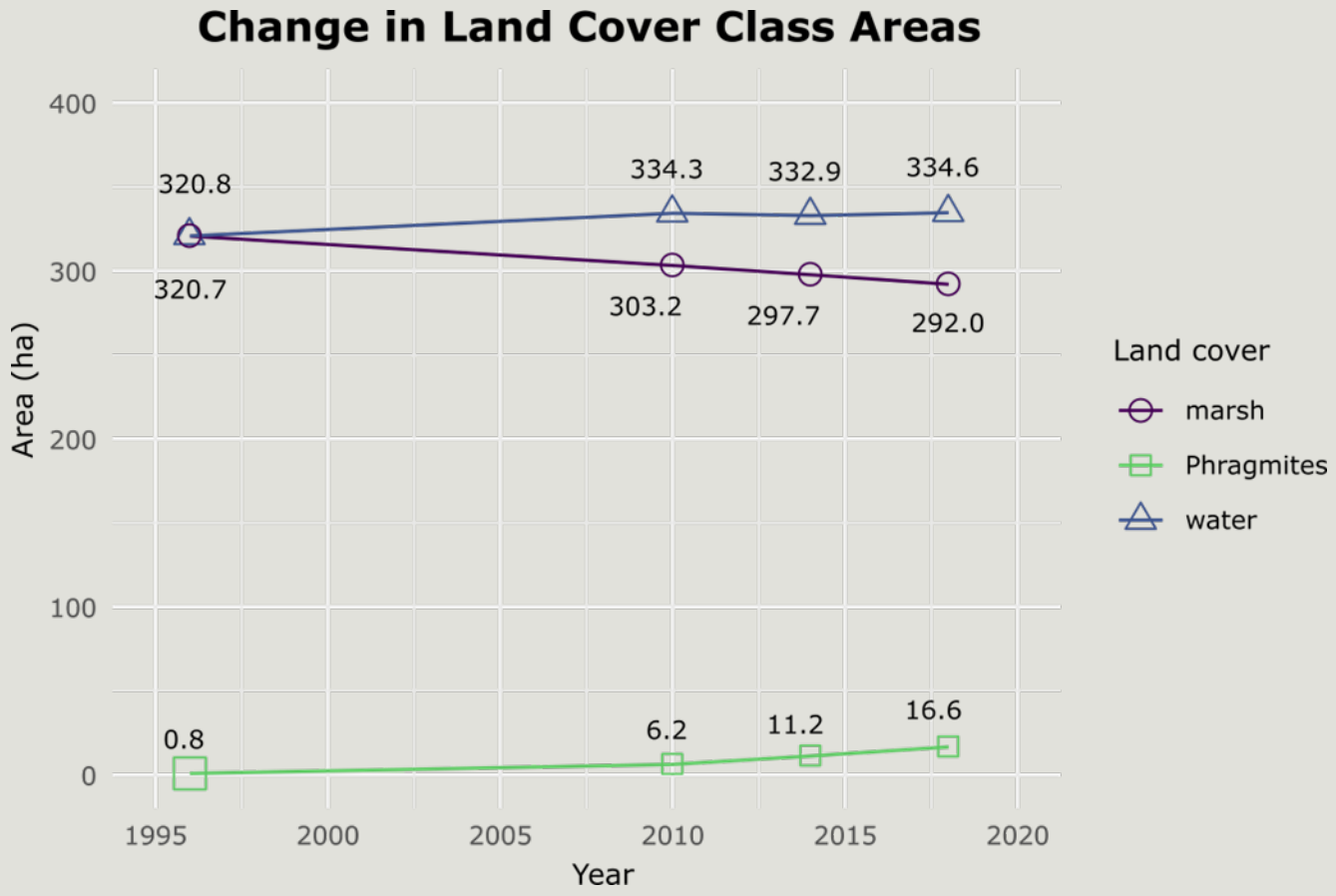


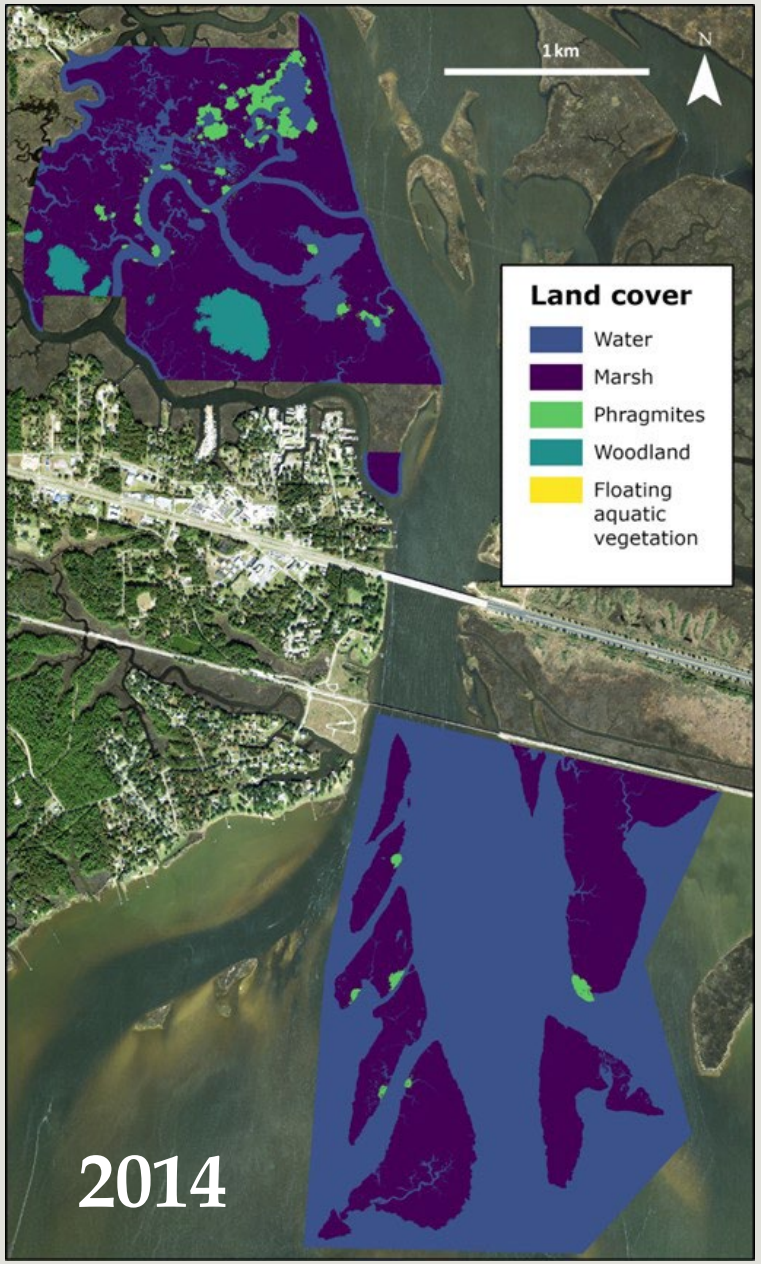
Pascagoula: 1996



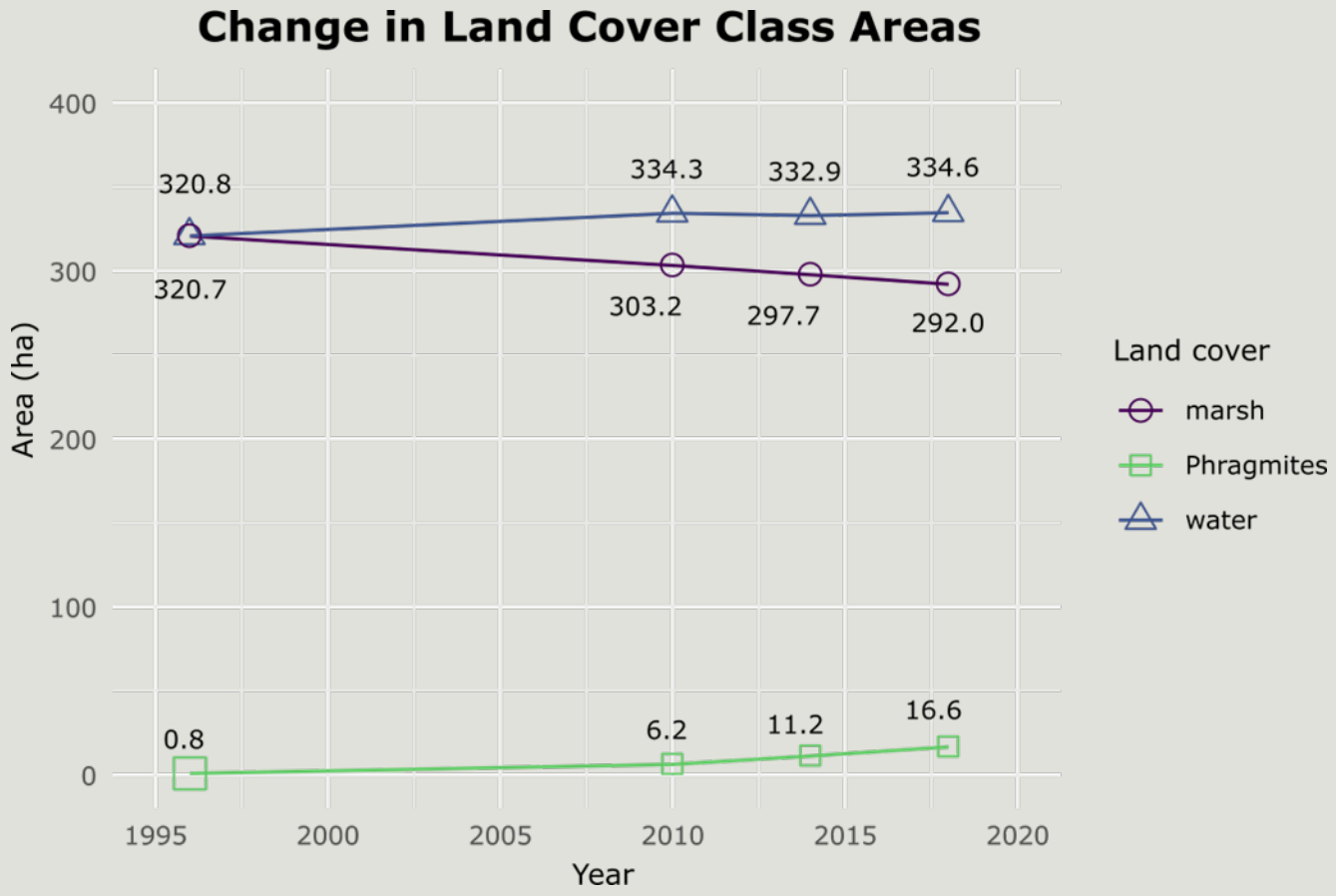


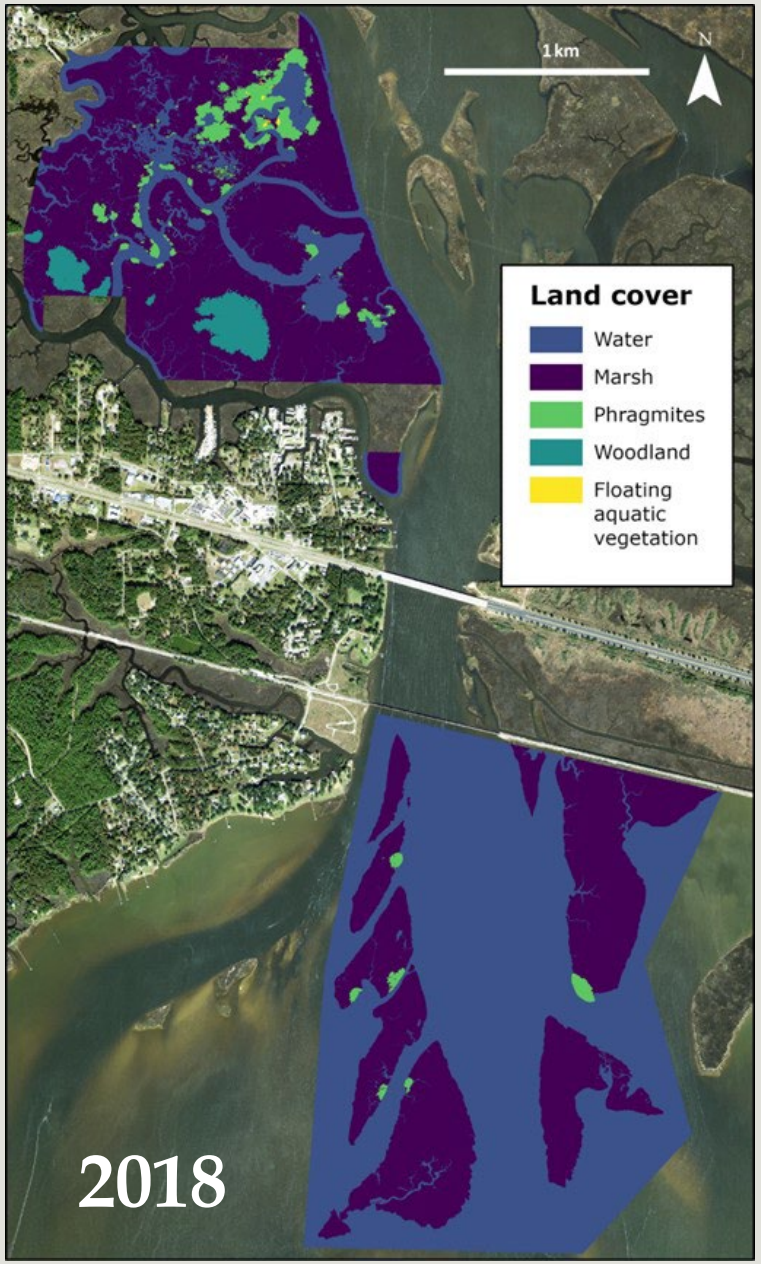
Pascagoula: 2010



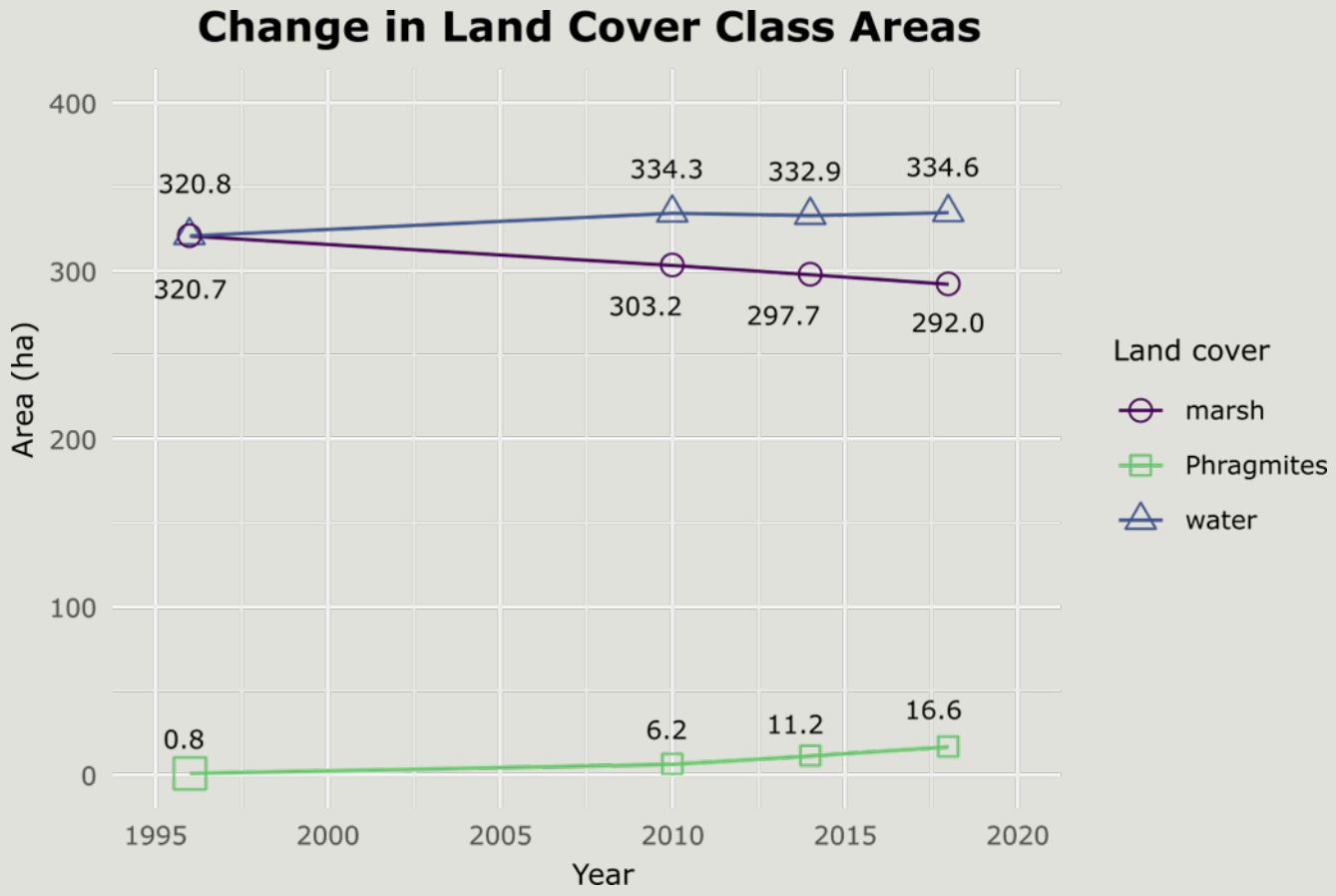


Pascagoula: 2014





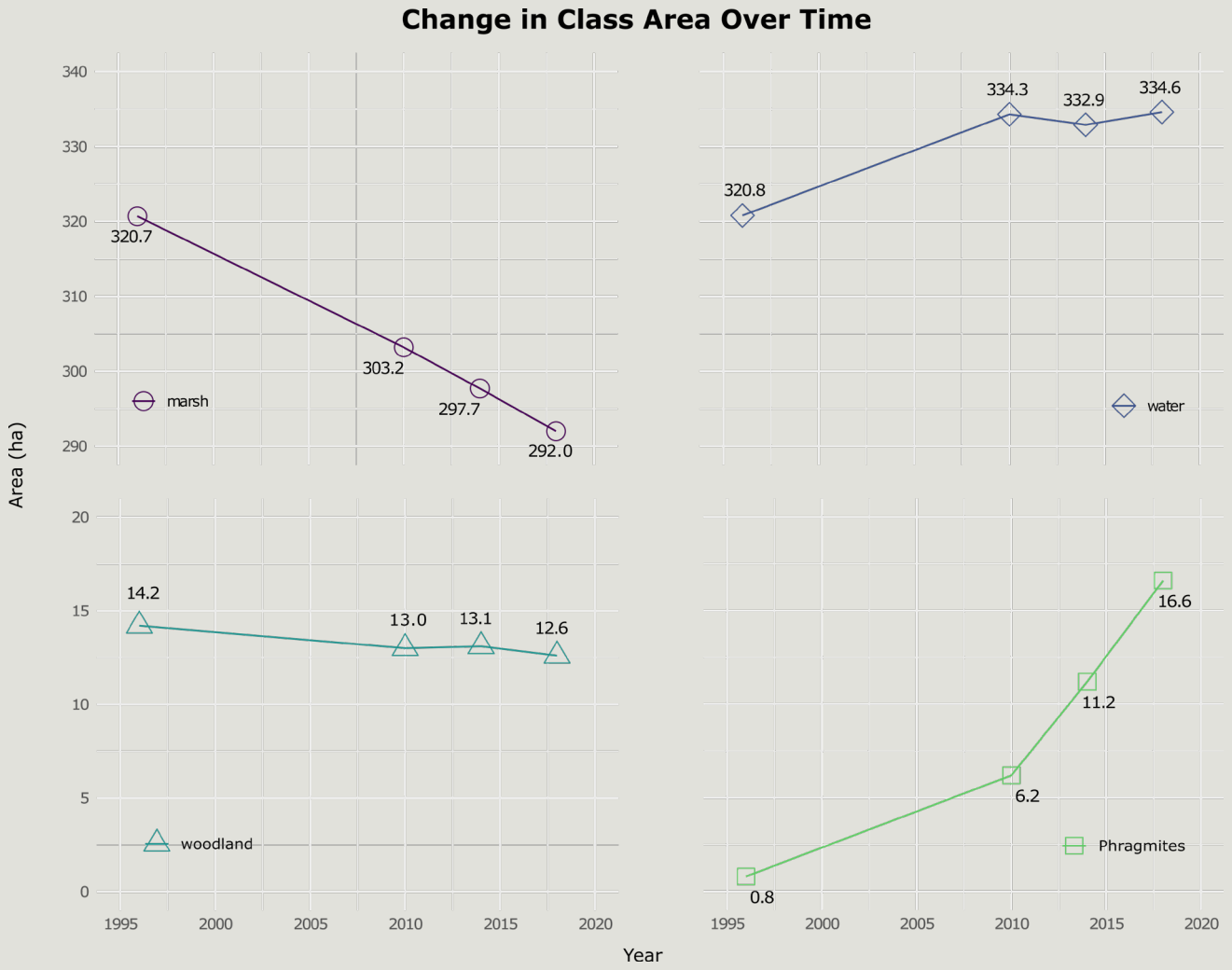
Pascagoula: 2018



Rates of Change

Annual rates of change in area (ha)

	Time Interval		
Land cover class	1996-2010	2010-2014	2014-2018
Marsh	-1.25	-1.39	-1.42
Water	0.96	-0.34	0.43
Phragmites	0.39	1.26	1.34
Woodland	-0.08	0.01	-0.12



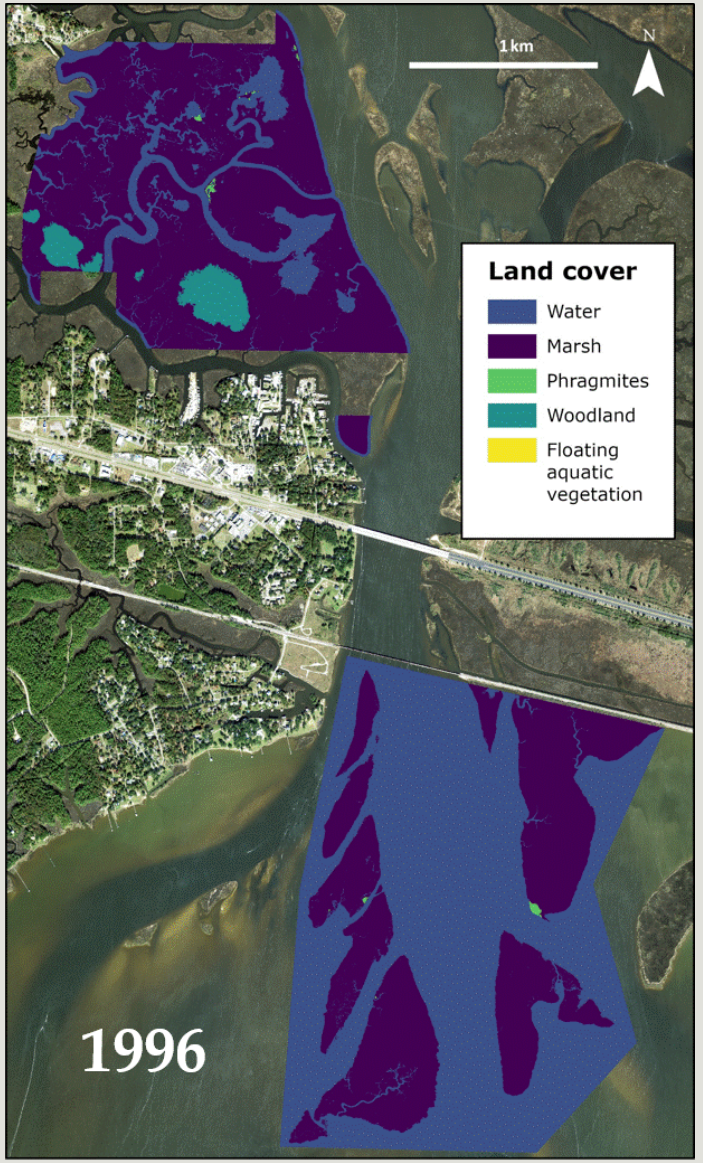
Comparison of sites

Annual rates of change, Mary Walker (ha/yr)

	Time Interval		
Land cover class	1996-2010	2010-2014	2014-2018
Marsh	-0.80	-0.51	-1.24
Water	0.58	-0.95	0.34
Phragmites	**0.31**	**1.12**	**1.21**
Woodland	-0.08	0.01	-0.12

Annual rates of change, Marsh Islands (ha/yr)

	Time Interval		
Land cover class	1996-2010	2010-2014	2014-2018
Marsh	-0.45	-0.81	-0.26
Water	0.38	0.40	0.30
Phragmites	**0.07**	**0.15**	**0.12**



Change analysis

- *P. australis* expansion into open water areas and other marsh areas were both lower at the Marsh Islands than at Mary Walker
- Rates of other marsh conversion to open water were similar across both areas
- At Mary Walker, the rate of *P. australis* expansion into other marsh habitats was higher than the rate of conversion of other marsh habitat to open water

Land Cover Conversions and Rates of Change (1996-2018)

	Mary Walker	*Marsh Islands*	*Total*
Marsh to Phragmites	10.9 ha (5000 m^2/yr)	1.45 ha (700 m^2/yr)	12.35 ha (5600 m^2/yr)
Water to Phragmites	2.79 ha (1300 m^2/yr)	0.61 ha (300 m^2/yr)	3.40 ha (1500 m^2/yr)
Marsh to Water	8.49 ha (3900 m^2/yr)	8.63 ha (3900 m^2/yr)	17.12 ha (7800 m^2/yr)

Discussion

- Total increase of 15.8 ha (39 acres)
  - Inland site (Mary Walker): 13.8 ha
  - Exposed site (Marsh Islands): 2.0 ha
- Increasing rates of change in *P. australis* extent (positive) and the extent of other marsh species (negative)
- Key takeaway: *P. australis* is colonizing areas previously occupied by both marsh vegetation and open water
    - When Phragmites area is combined with other marsh areas, total marsh extent increased between 1996 and 2018 at Mary Walker Bayou area
  - Both positive and negative implications for the future of our marshes in terms of biodiversity and species composition, ecosystem function
  - In terms of marsh shoreline movement over time, *P. australis* appears to be mitigating marsh loss due to relative sea level rise

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