

Southeast Coast Ecological Conservation

Investigating the Development of Ghost Forests Due to Saltwater Intrusion
along the Savannah River, Georgia Coastline of the United States

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25TH DEVELOP
ANNIVERSARY

Background



Image Credit: NOAA



- **↑ Saltwater intrusion (SWI) into freshwater** systems
 - Ghost forest formation



- **Natural and anthropogenic drivers intensifying SWI**



Community Concerns

- Loss of biodiversity
- Inhibited carbon sequestration
- Declining drinking water quality and supply
- Dangerous storm surges
- Climate change adaptation strategies



Image Credit: Dr. William Conner, USGS

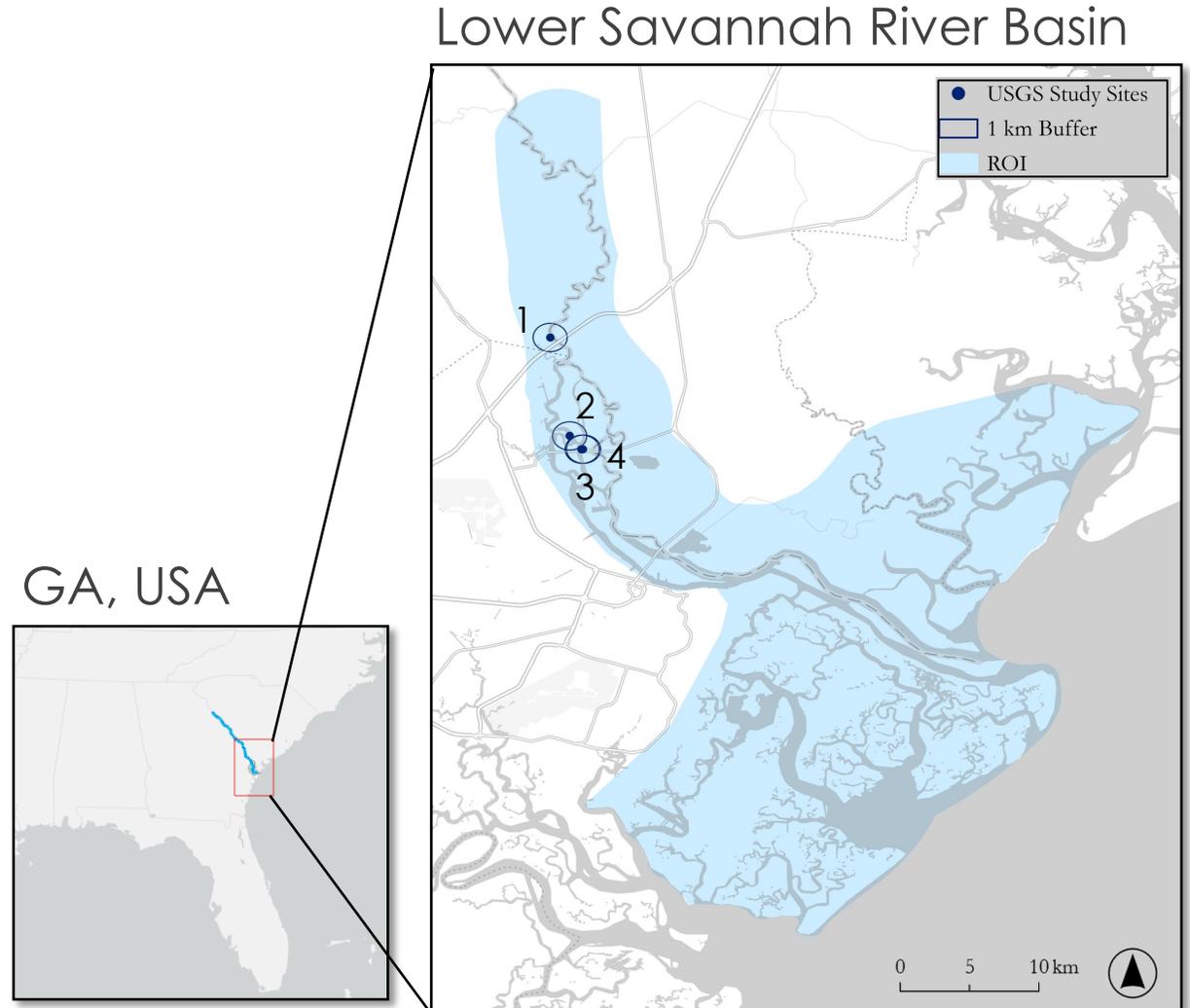


Study Area & Period

- Lower Savannah River, Georgia
 - HUC10 Watershed
 - Savannah National Wildlife Refuge
- Time Frame: Growing Season of 2013 – 2023 (March – Sept)



Image Credit: U.S. Fish & Wildlife Service. Bald cypress in bottomland hardwood forest at Savannah National Wildlife Refuge.



Objectives



Investigate Changes

in sea level rise (SLR) and vegetative health



Synthesize & Analyze

trends in saltwater intrusion (SWI)

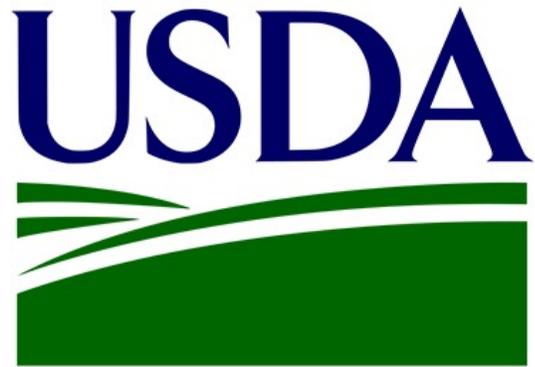


Validate and Correlate

NASA Earth observations (EO) with in-situ (field-derived) data



Project Partners



- Southeast Regional Climate Hub



- Wetland and Aquatic Research Center (WARC)
- Florence Bascom Geoscience Center (FBGC)



- Department of Biology, Georgia Southern University



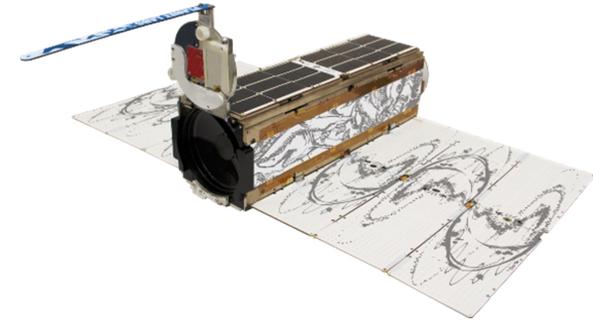
Earth Observations (EOs)



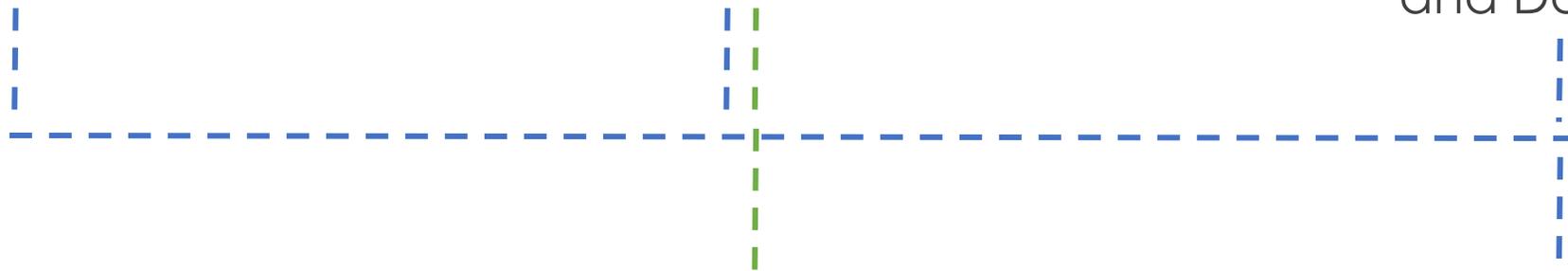
Landsat 7 ETM+



Landsat 8 OLI



Planet Scope Rapid Eye
and Dove



Land Classification

NDVI Parallel Processing



Methodology – NDVI Parallel Processing

Inputs

Landsat 8 OLI

PlanetScope
Dove

Processing

Filter by date and ROI
Water Mask
Cloud Mask

Filter by date and ROI
Water Mask

Analysis

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

ee.ReducerMean

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

ee.ReducerMean

Output

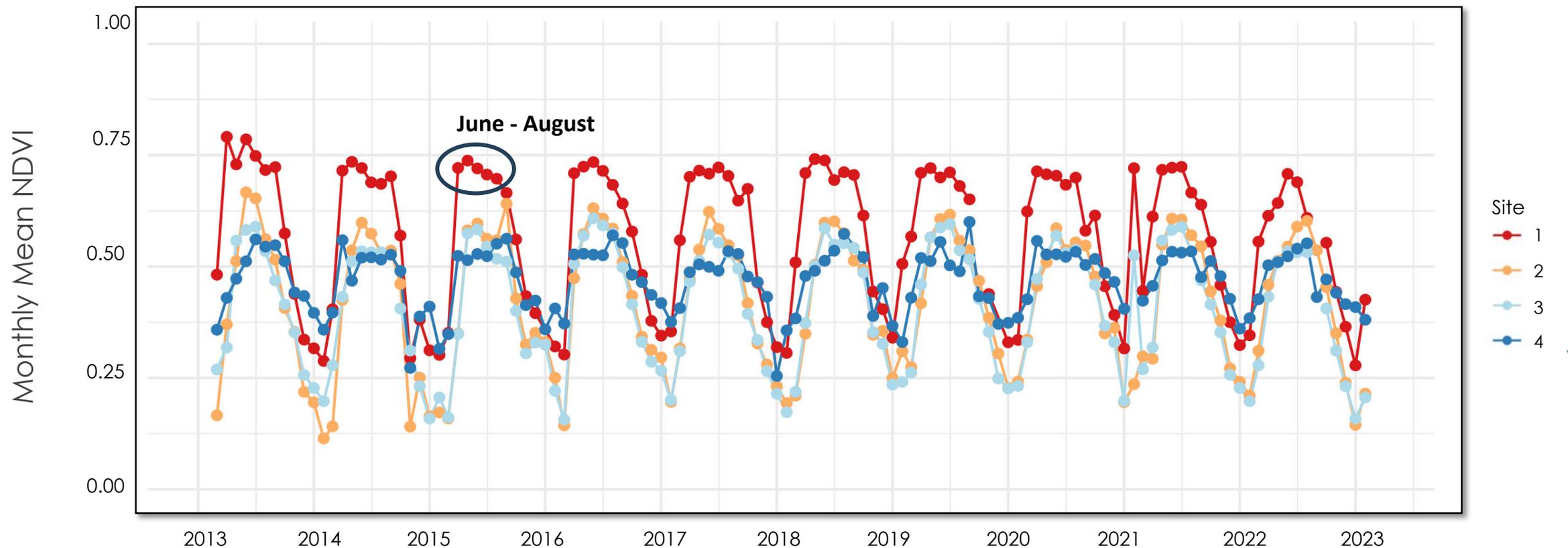
12 Month
Mean NDVI

Mean NDVI
per month



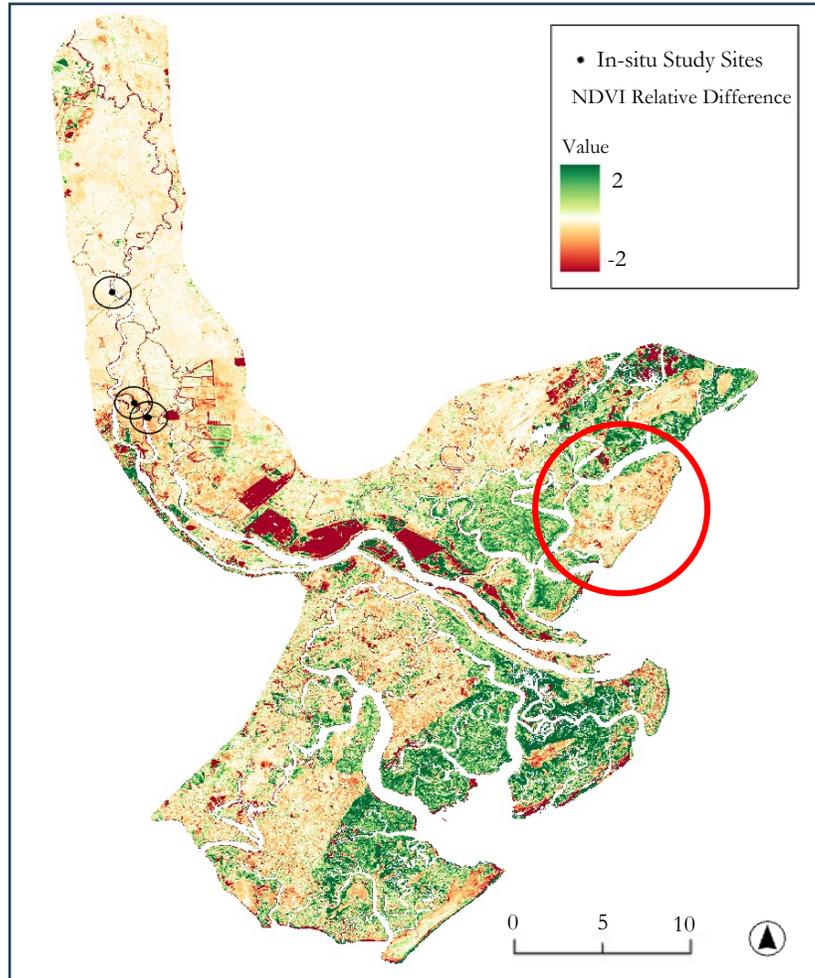
Results – NDVI Time Series (Landsat 8)

Monthly Mean NDVI 2013 – 2023

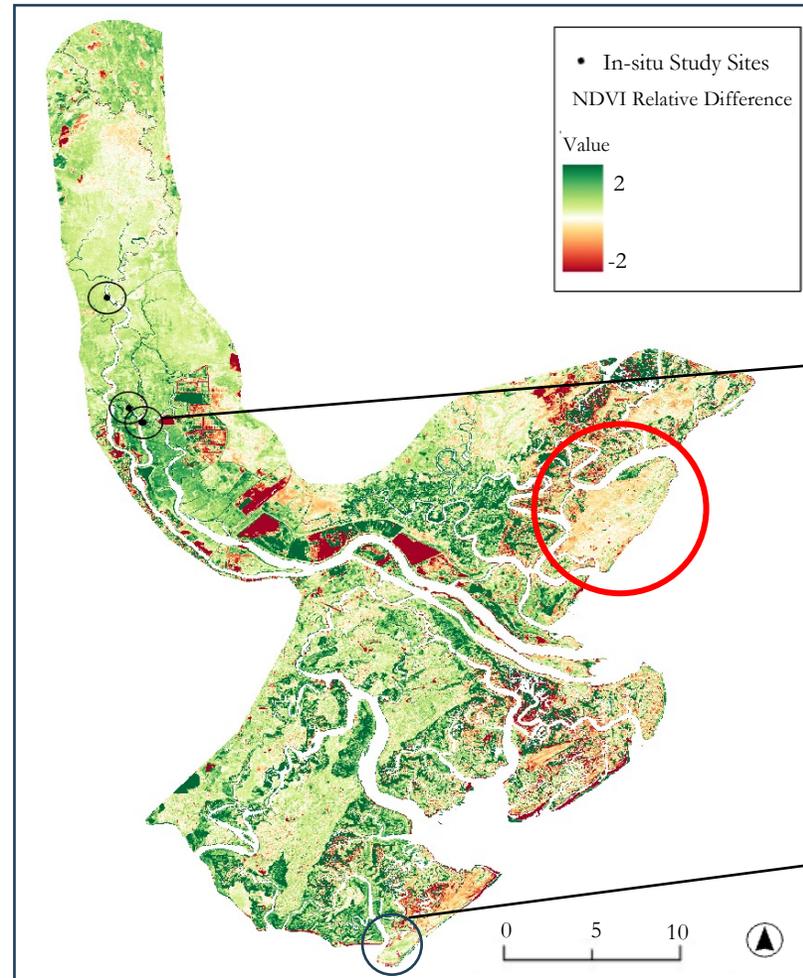


Results – NDVI Parallel Processing (Landsat 8)

Δ NDVI = June 2022 – June 2014



Δ NDVI = March 2023 – March 2013

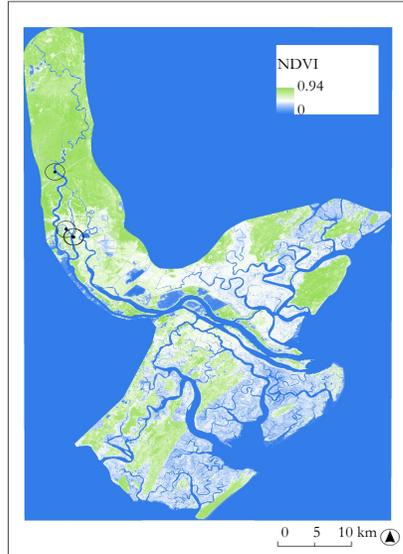


Images Credit: Maxar, ESRI

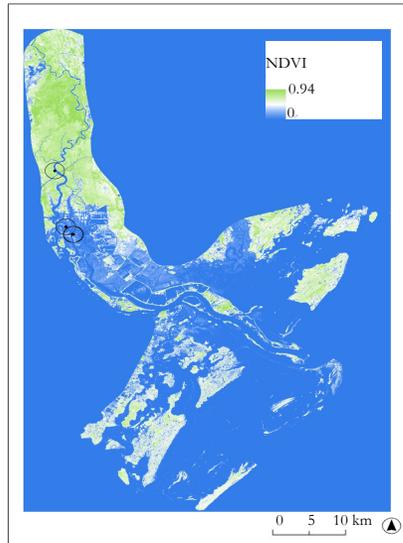


Results – NDVI Parallel Processing (Planet)

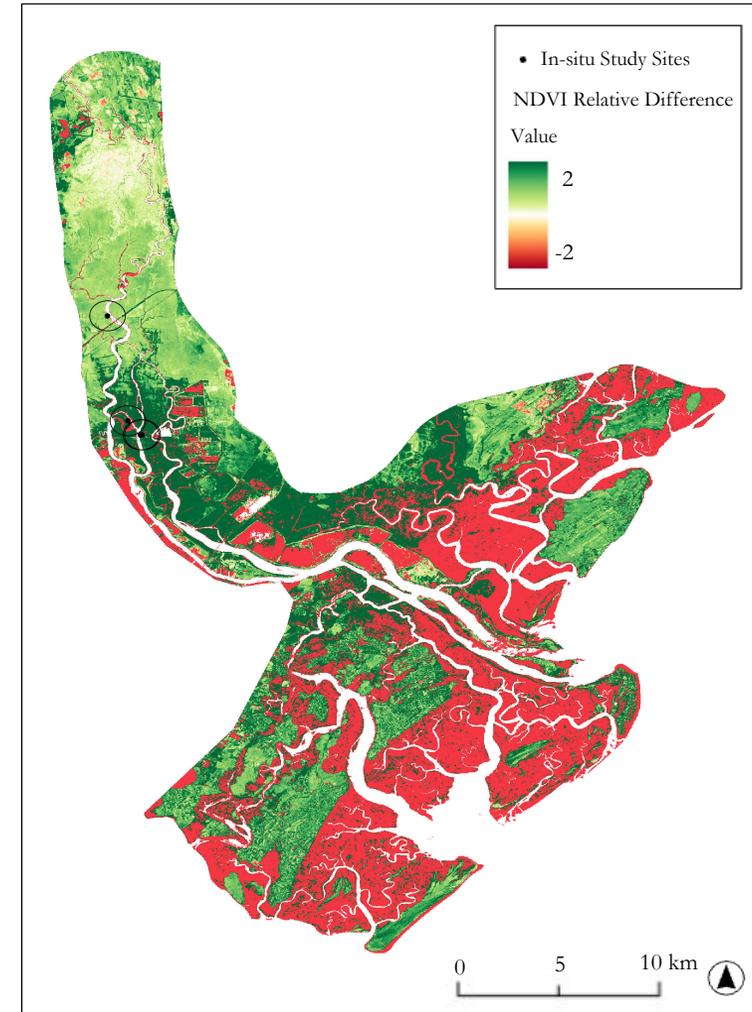
April 2023
Planet NDVI
for Overall
Study Site



April 2023
Planet NDVI
for Overall
Study Site



Δ NDVI = April 2023 – April 2013



Results – NDVI Parallel Processing (Planet)

Planet NDVI
Plot Maps
for USGS Sites
(April 2023)



Site 1



Site 2

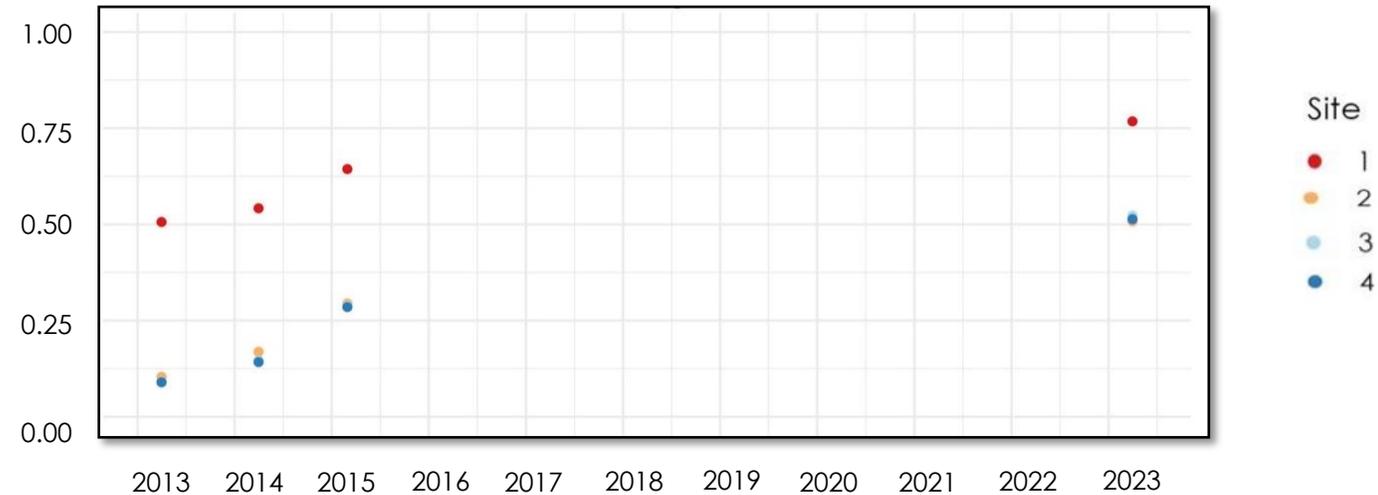


Site 3

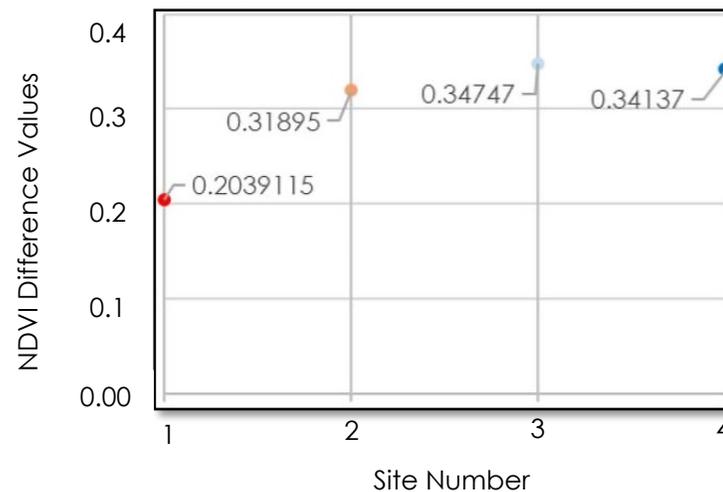


Site 4

(2013 – 2015 & 2023) Planet NDVI Values for USGS Plot Sites



Planet NDVI Plot Site Difference Calculation
(2023) NDVI – av mean (2013,2014,2015) NDVI



Methodology – Random Forest Land Classification

Inputs

Processing

Analysis

Output

Landsat 8 OLI

Seasonal
composite
(May – Sept)

Urban Mask
Cloud Mask
Water Mask

Delineate
training
points

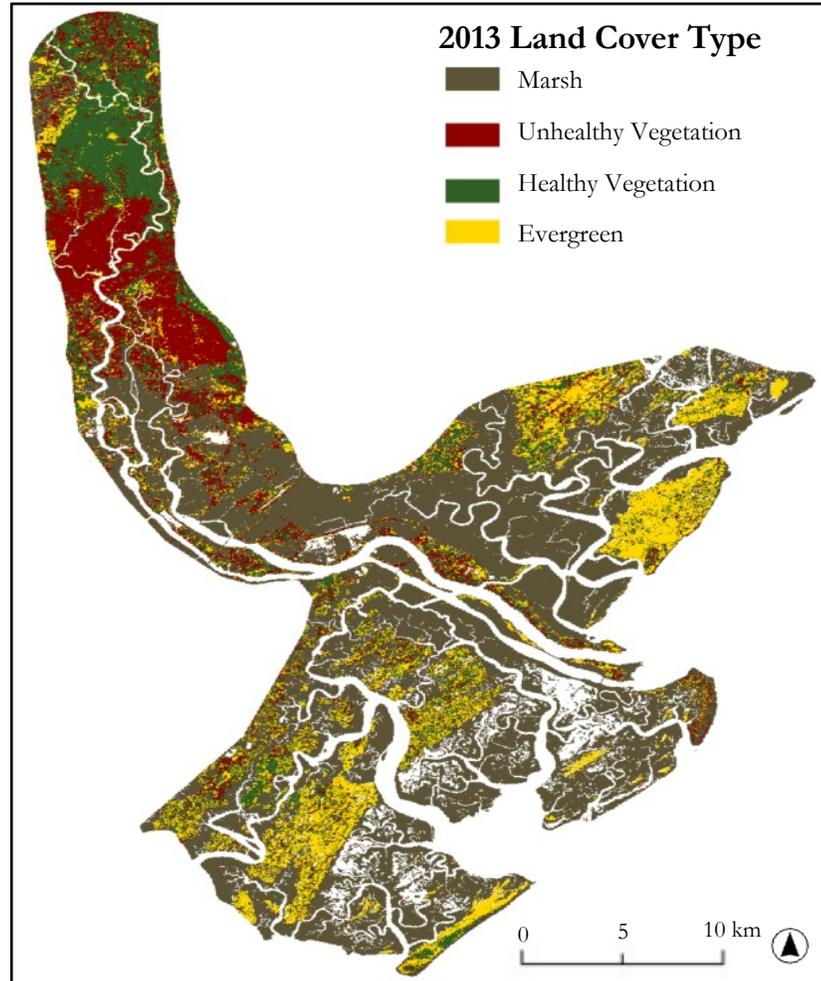
Random
Forest Land
Cover
Classification

10 land cover
images (1 per
year)

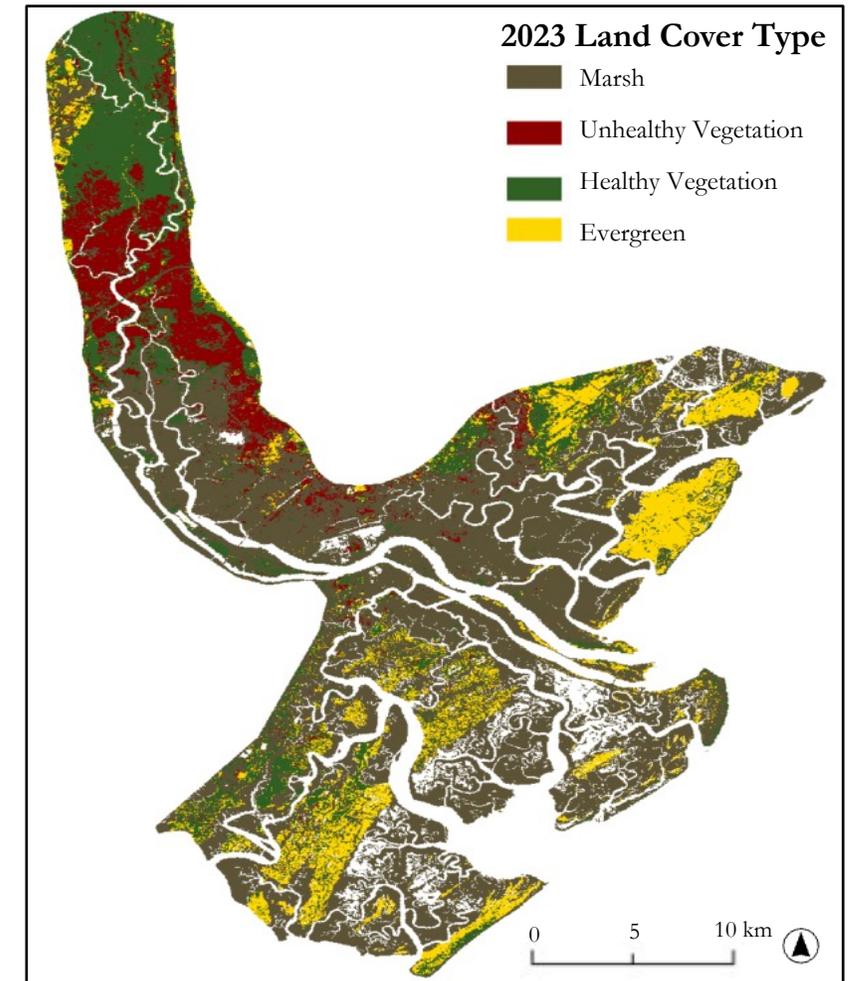


Results – Land Cover Classification (Landsat 8)

Growing Season Composite = May to Sept 2013

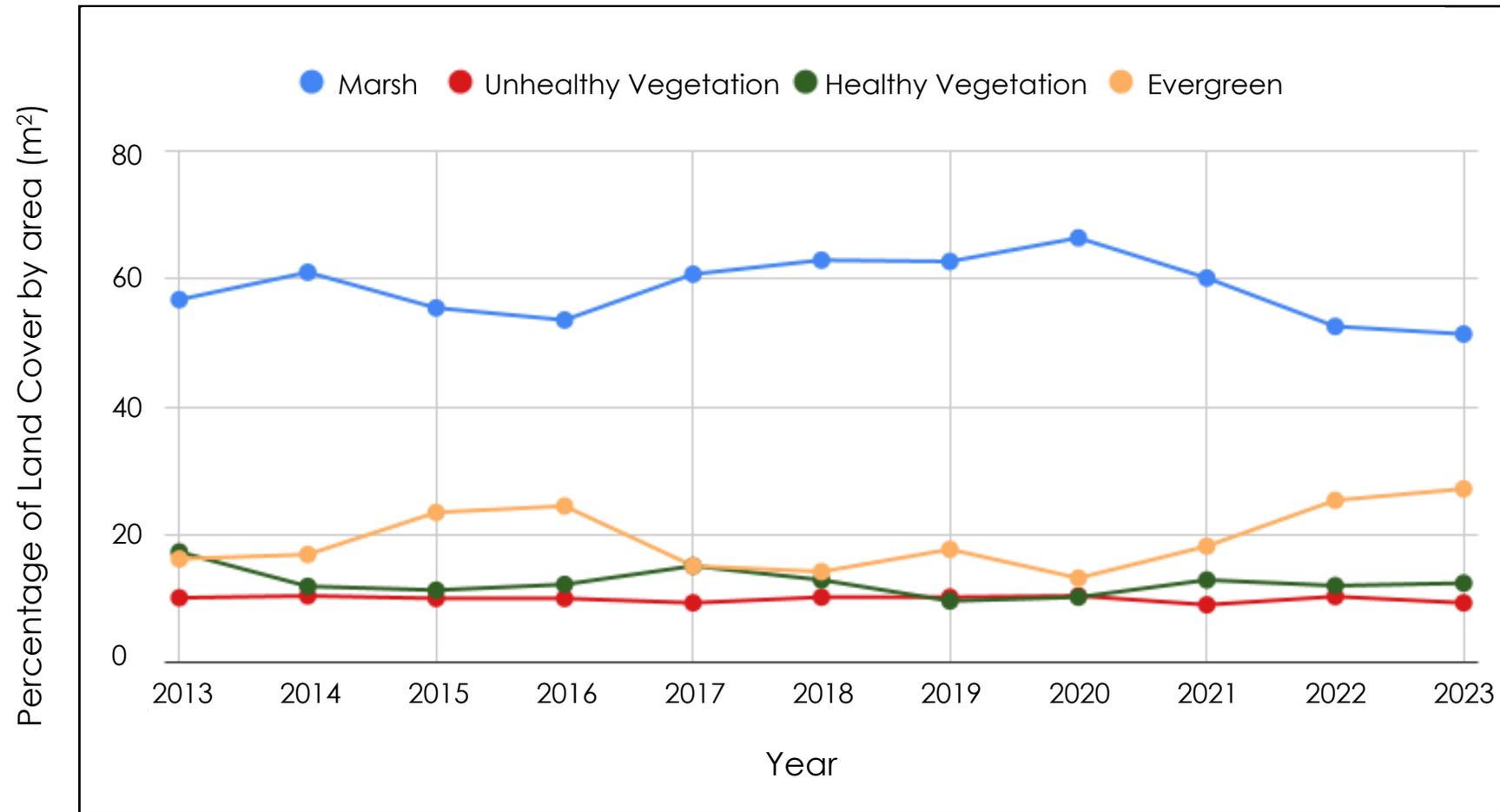


Growing Season Composite = May to Sept 2023



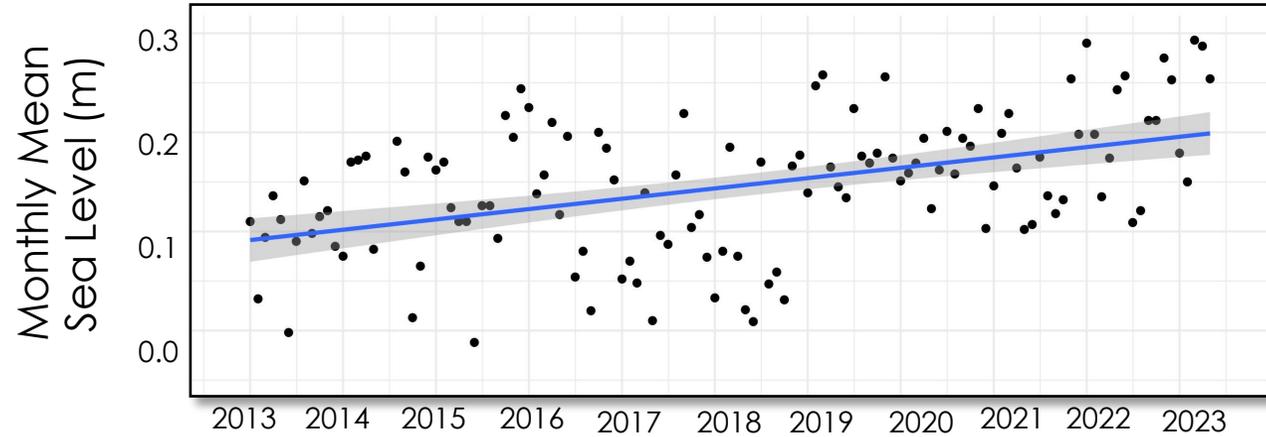
Results – Land Cover Classification

Land Cover Classification Time Series 2013 – 2023

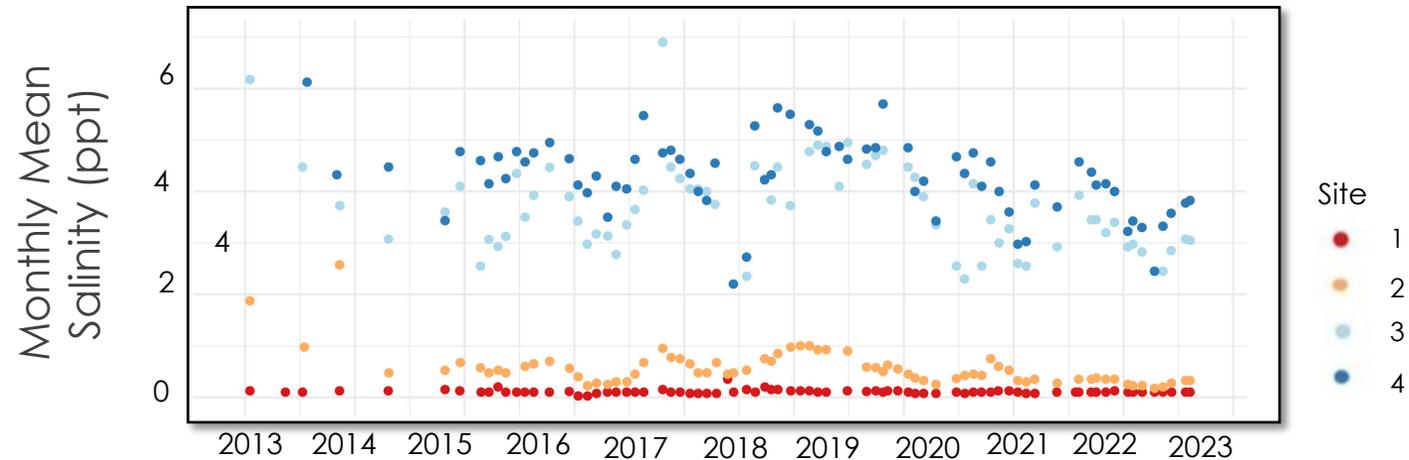


Results – In Situ Data

Sea Level Rise Trend 2013 – 2023

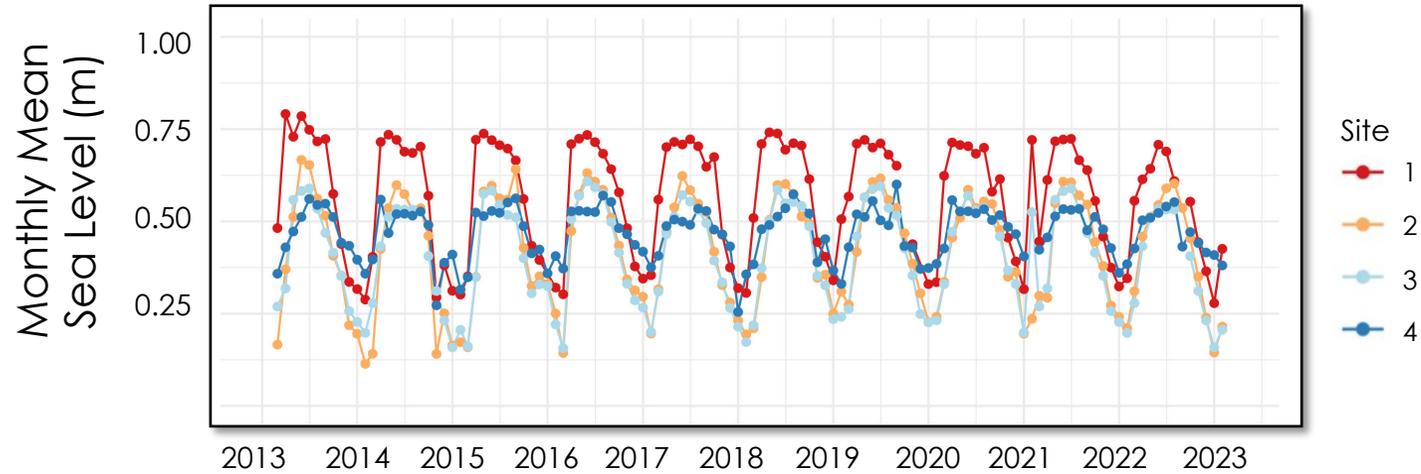


USGS Porewater Salinity Measurements 2023 – 2021

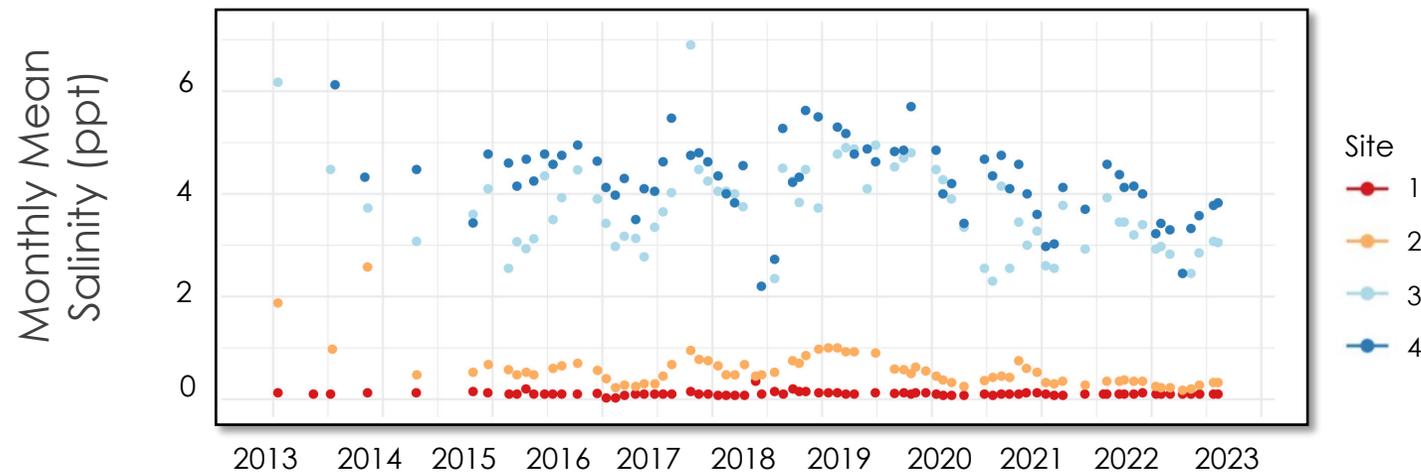


Results – Long Term Trends

Monthly Mean NDVI 2013 – 2023



USGS Porewater Salinity Measurements 2013 – 2021





Limitations and Uncertainties

- **Landsat 8 NDVI:** Cloud coverage
- **Planet Imagery:** API accessibility
- **Land cover classification:**
 - # of training points
 - Temporal variation
 - Mixed pixels/resolution limitations
 - Edge effects
- **Salinity:** Data availability

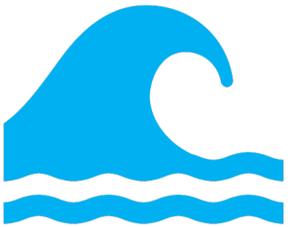
Conclusions



- **Landsat 8 NDVI values decreased over time while Planet NDVI values increased**, potentially due to varying spatial resolutions



- **Marshes were stable and dominant over time**, possibly due to ecological saline adaptation
- **Evergreen areas experienced the highest fluctuations and increased over time**, leading to potential ecological effects



- **Salinity levels were highest at the southernmost study sites** closest to the coast
- **As salinity increased, NDVI decreased**



Future Work



Image Credit: USDA Forest Service



- ↑ temporal/spatial resolution
- ↑ Scale & number of variables
- Investigate other drivers of SWI



- Attempt different classification algorithms, ↑ # of training points



- ↑ porewater salinity data & sites



Acknowledgments

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- Dr. Ken Krauss, Wetland and Aquatic Research Center (WARC)
- Dr. Gregory Noe, Florence Bascom Geoscience Center (FBGC)

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