Coastal South Carolina Water Resources

Isolated Wetlands Risk Assessment using NASA Earth Observations to Support Further Wetland Protections in Coastal South Carolina

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Meet the Team

Jake A. Ferus

Project Lead

Maisunath M. Amin

Yunjoo Cho

Sidney Eigeman

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About Wetlands

Image Credit: Mike Faherty

Freshwater Wetlands are areas where soils (hydric) are saturated with water seasonally or permanently, and vegetation is adapted to be water tolerant.

Emergent Wetlands
→ Plants grow out of the water

Wetland Forests
→ Forests with saturated soils

Aquatic Wetlands
→ Plants grow on or below the water

Benefits of Wetlands

Image Credit: Bernard Dupont

Image Credit: Hawaii Sea Grant King Tides Project

Image Credit: NASA

Provide crucial habitat for many plant and animal species

Mitigate floods & improve water quality

Sequester carbon effectively resulting in cleaner air quality

Threats to Wetlands

Image Credit: Michael Taylor and Adam Voiland

Rate of wetland loss is increasing 3.7-fold, contributing to **at least 35% estimated total loss** since 1970

Image Credit: Daniel Schwen
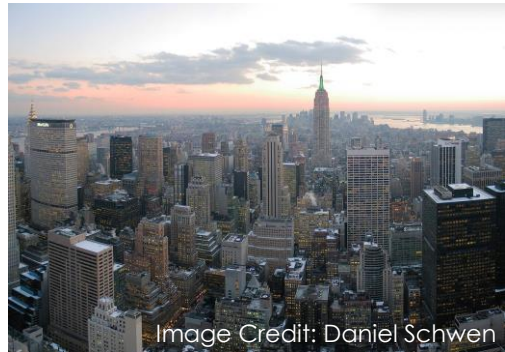
Urbanization practices including **contamination and land use change** can degrade wetland conditions

Image Credit: Britannica

Urban expansion puts a constant pressure on developing infrastructure across wetland areas

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Focus Area – Isolated Wetlands

Image Credit: Lisa Sorg

Isolated wetlands are defined by recent legislation. Although they have many of the same characteristics as non-isolated wetlands, they differ in their **distance from and connectivity with major waterways**.

Image Credit: U.S. Supreme Court

The **2023 Sackett v. EPA ruling excluded wetlands not adjoining navigable waters from federal protection** under the Clean Water Act, limiting their regulation to state laws despite their ecological importance.

Community Concerns


Image Credit: Brown Land + Plantation Advisors

*Although **isolated wetlands** are providing vital ecosystem services, they are **not being protected by federal law***

Isolated wetlands are under threat due to **urban development and land use change**

*Identifying **risk levels** of isolated wetlands and their **rate of change** are necessary for tracking their degradation*

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Study Area & Study Period
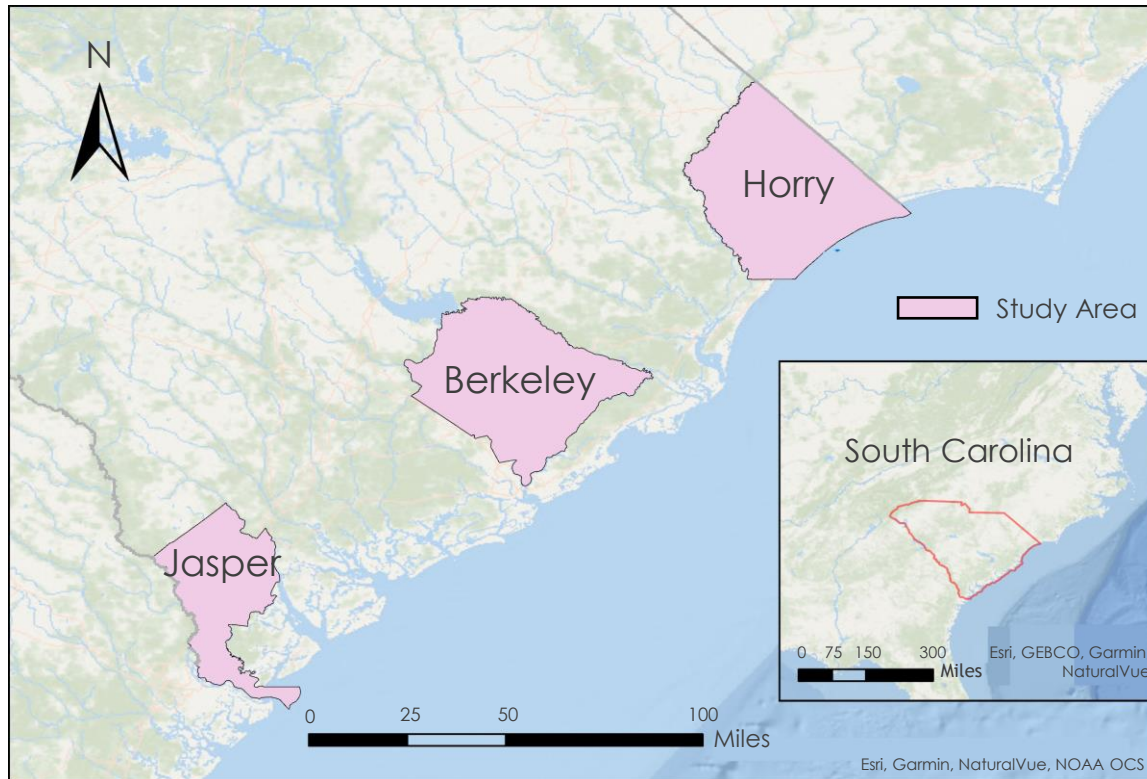
3 Coastal Counties in South Carolina

- Horry County (Northeast South Carolina)

- Berkeley County (East South Carolina)

- Jasper County (Southeast South Carolina)

Study Period: 2015 - 2025 (Oct. – Feb.)

Encapsulate changes and patterns over a 10-year period

Project Objectives

Map isolated wetlands within Horry, Berkeley, and Jasper Counties

Create 10-year wetland change maps (2015 – 2025)

Support partners with geospatial information for outreach and decision making
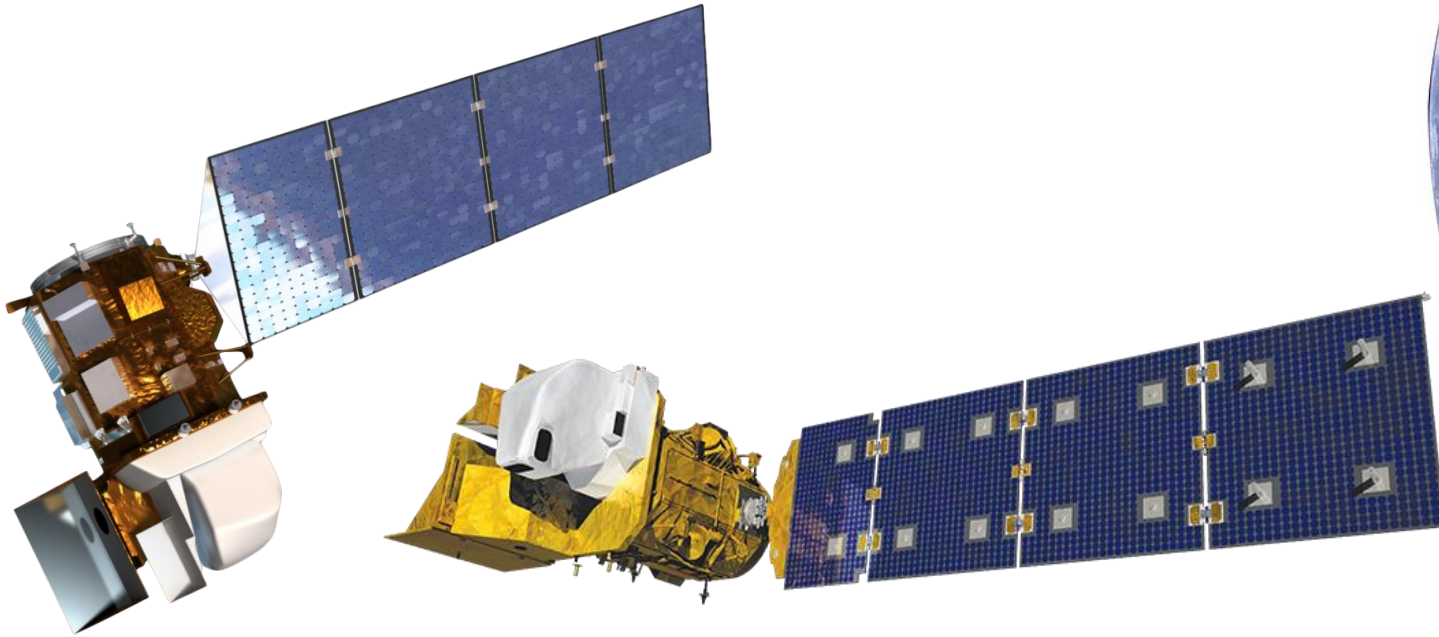
Partners

Coastal Conservation League

The Coastal Conservation League, a Charleston-based nonprofit, partners with communities, businesses, and citizen groups to protect the natural environment of South Carolina and promote sustainable policies. Their focus areas are:

- Air and Water
- Energy
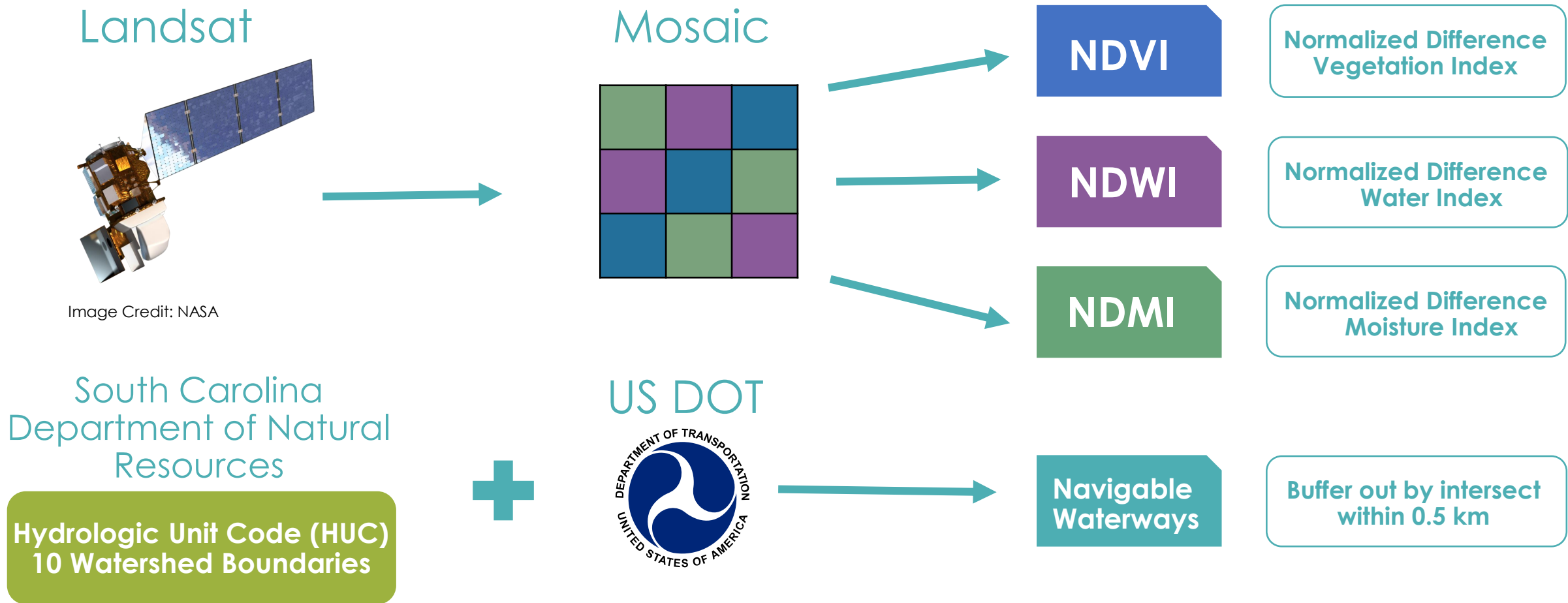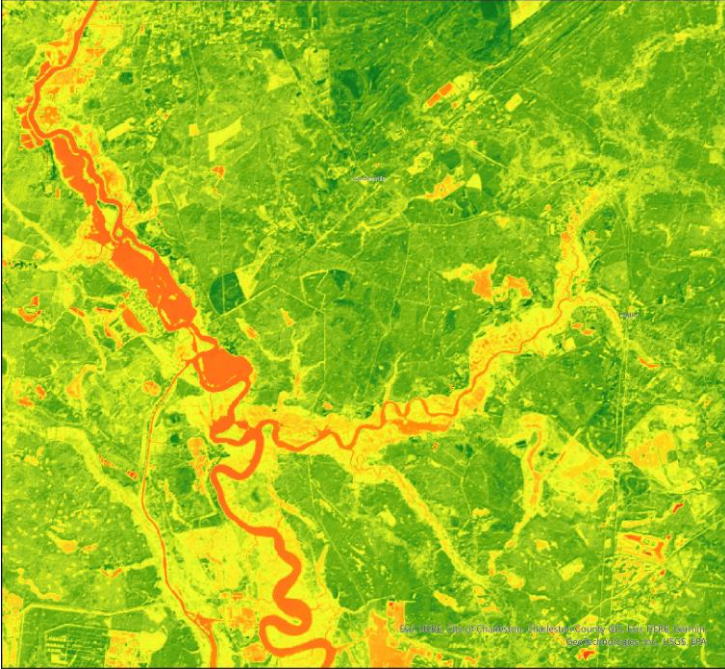- Food and Agriculture
- Land and Community
- Transportation

Image Credit: Becky Ryon

Image Credit: Becky Ryon

Earth Observations

Landsat 8 & Landsat 9:
30m resolution, 11 bands

Methodology – *Indices*

Landsat

Image Credit: NASA

Mosaic

NDVI — Normalized Difference Vegetation Index

NDWI — Normalized Difference Water Index

NDMI — Normalized Difference Moisture Index

South Carolina Department of Natural Resources

Hydrologic Unit Code (HUC) 10 Watershed Boundaries

US DOT

Navigable Waterways — Buffer out by intersect within 0.5 km
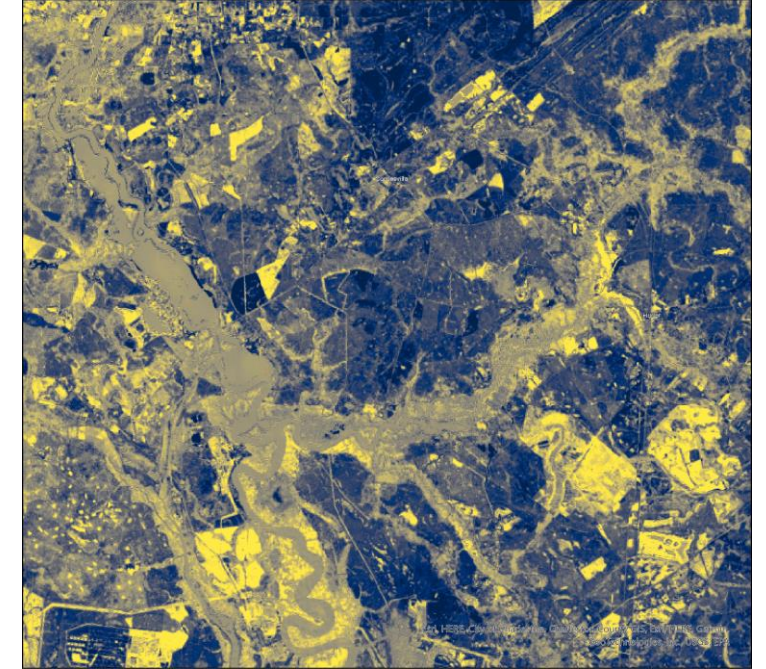
Methodology – *Indices*

NDVI – Vegetation
*(NIR – Red) /
(NIR + Red)*
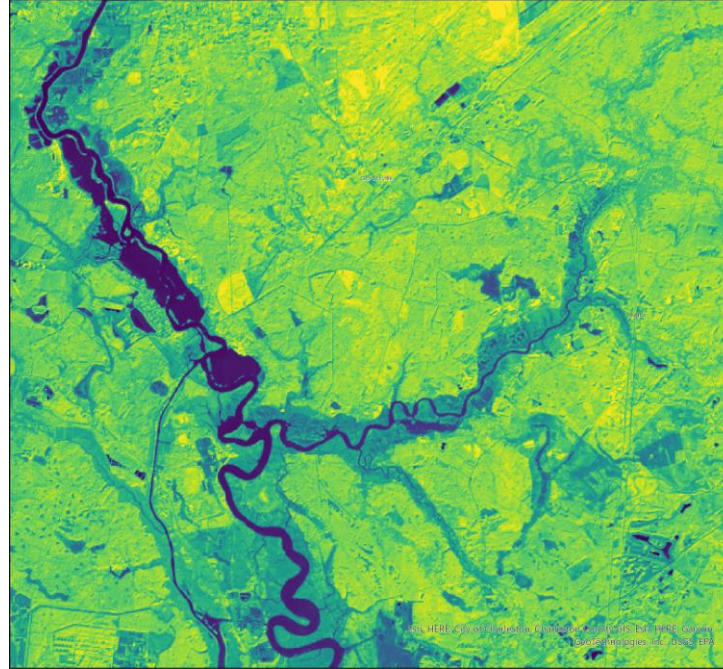
NDWI – Water
*(Green – NIR) /
(Green + NIR)*

NDMI – Moisture
*(NIR – SWIR1) /
(NIR + SWIR1)*

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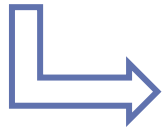
Methodology *– Modeling*

1 Training point collection

⌐→ Using false color Landsat imaging mosaic as base map

2 Supervised classification with **Random Forest**

⌐→ With addition of generated composite of the 3 indices
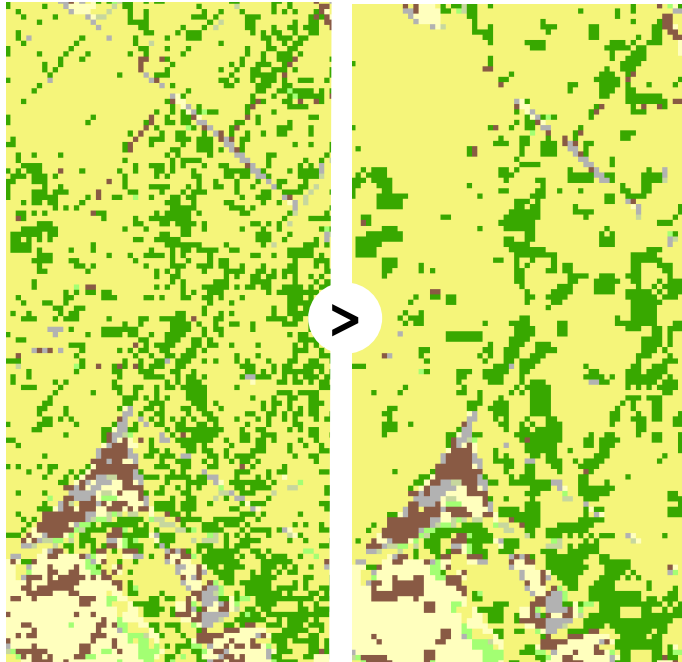
3 Wetland isolation

⌐→ Selection by 0.5km intersect

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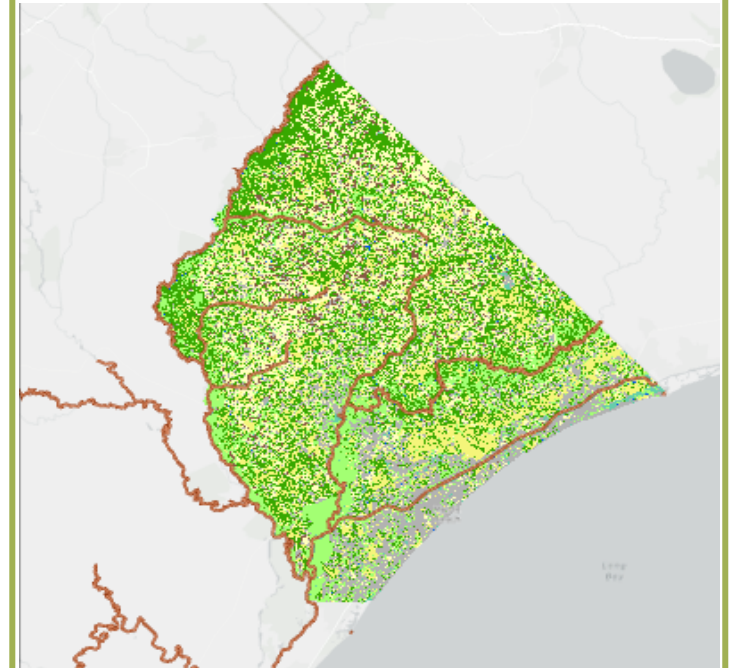# **Methodology** – *Processing Tools*

1

Majority filter

2

Digitization of navigable waterways

3

Intersect by location

Results – *Classified Land Cover Analysis*

Berkeley County

Legend
- Developed
- Water
- Bare Soil
- Upland Forest
- Upland Grassland
- Emergent Wetland
- Wetland Forest
- Aquatic Wetland

ESRI, Garmin, NaturalVue

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Results – *Classified Land Cover Analysis*

Berkeley County

2024-2025

Legend:
- Developed
- Water
- Bare Soil
- Upland Forest
- Upland Grassland
- Emergent Wetland
- Wetland Forest
- Aquatic Wetland

ESRI, Garmin, NaturalVue

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Results – *Classified Land Cover Analysis*

Jasper County

2015-2016

2024-2025

Legend:
- Developed
- Water
- Bare Soil
- Upland Forest
- Upland Grassland
- Emergent Wetland
- Wetland Forest
- Aquatic Wetland

ESRI, Garmin, NaturalVue

Coastal South Carolina Water Resources

Results – *Classified Land Cover Analysis*

Horry County

2015-2016

2024-2025

Legend:
- Developed
- Water
- Bare Soil
- Upland Forest
- Upland Grassland
- Emergent Wetland
- Wetland Forest
- Aquatic Wetland

ESRI, Garmin, NaturalVue

Results – Classification Change (2015-2016 & 2024-2025)

Legend:
- Developed
- Water
- Bare Soil
- Upland Forest
- Upland Grassland
- Emergent Wetland
- Wetland Forest
- Aquatic Wetland

2015-2016
- 2.7%
- 7.1%
- 4.1%
- 1.5%
- 26%
- 26%
- 35%
- 11%
- 12%

2024-2025
- 5.8%
- 9.4%
- 4%
- 5.3%
- 26%
- 33%
- 6%
- 11%
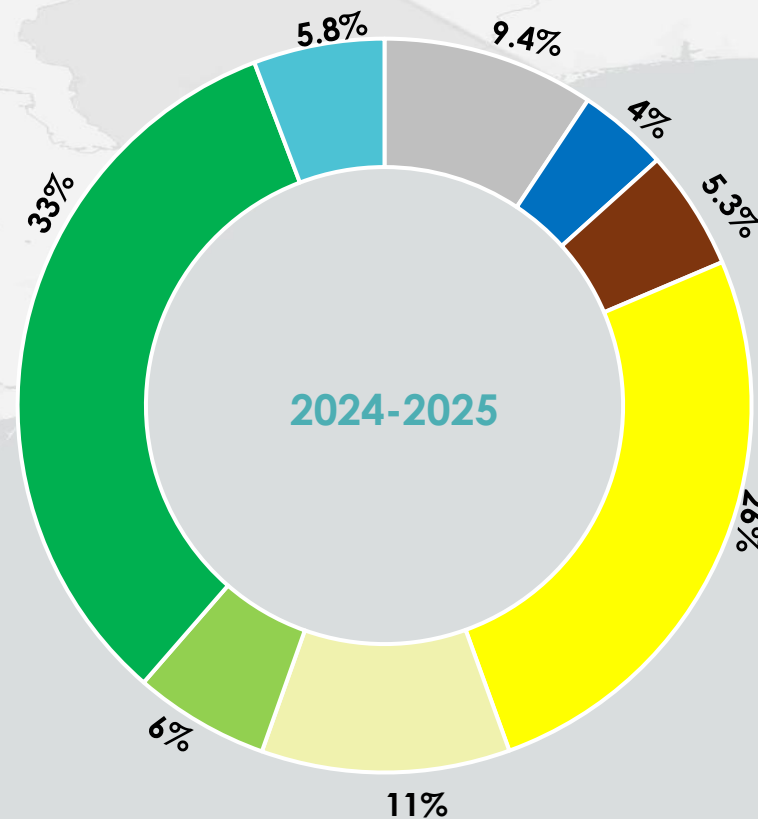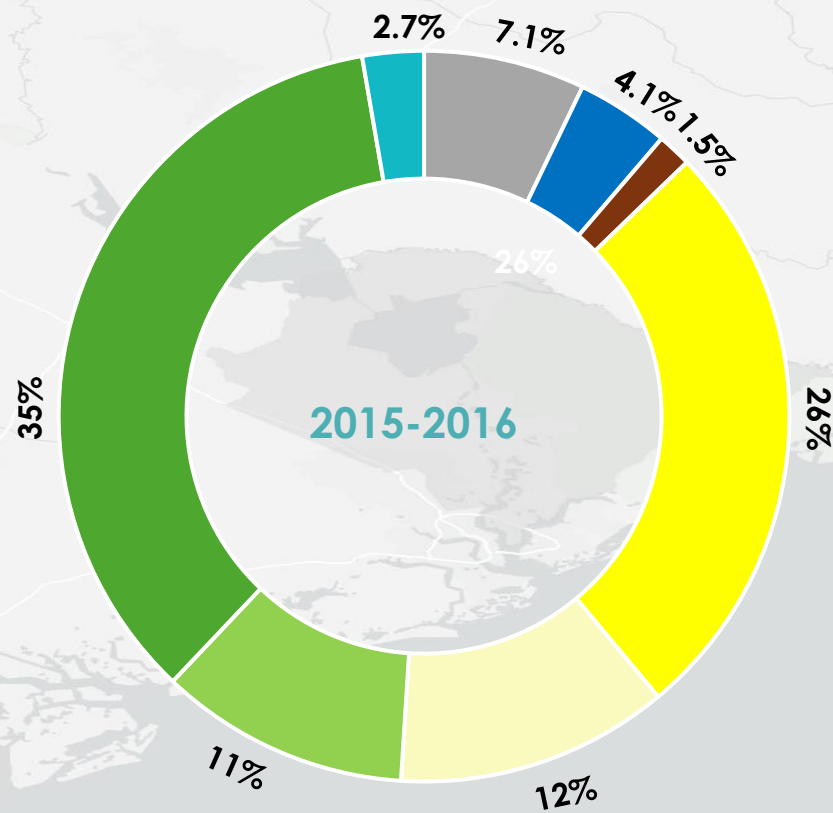
Charleston County GIS, Esri, Tom Tom, Garmin, FAO, NOAA, USGS

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Results – Classification Confusion Matrix (2015-2016)

Metric/Year	2015-16
P accuracy	0.63
Kappa	0.54

Classification (2015-2016)	Developed	Water	Bare Soil	Upland Forest	Upland Grass	Emergent Wetland	Wetland Forest	Aquatic Wetland	Total	U_Accuracy
Developed	0	9	0	0	0	0	0	1	10	0.9
Water	0	0	0	28	1	1	9	0	39	0.72
Bare Soil	0	0	0	2	16	1	0	0	19	0.84
Upland Forest	1	0	0	23	2	1	26	0	53	0.49
Upland Grassland	7	1	0	0	3	0	0	0	11	0.64
Emergent Wetland	0	0	10	0	0	0	0	0	10	1
Wetland Forest	0	0	0	1	1	6	5	3	16	0.375
Aquatic Wetland	0	3	0	1	0	3	0	3	10	0.3
Total	8	13	10	55	23	12	40	7	168	0
P_Accuracy	0.86	0.69	1	0.51	0.70	0.50	0.65	0.43	0	0.63

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Results – Classification Confusion Matrix (2024-2025)

Metric/Year	2024-25
P accuracy	0. 59
Kappa	0.49

Classification (2024-2025)	Developed	Water	Bare Soil	Upland Forest	Upland Grass	Emergent Wetland	Wetland Forest	Aquatic Wetland	Total	U_Accuracy
Developed	7	0	3	3	1	0	0	0	14	0.5
Water	0	10	0	0	0	0	0	0	10	1
Bare Soil	0	0	3	1	5	0	1	0	10	0.3
Upland Forest	0	0	0	28	0	1	10	0	39	0.72
Upland Grassland	0	0	2	0	11	0	3	0	16	0.69
Emergent Wetland	0	0	0	0	0	5	5	0	10	0.5
Wetland Forest	0	0	1	16	2	0	29	1	49	0.59
Aquatic Wetland	1	1	0	3	0	4	0	1	10	0.1
Total	8	11	9	51	19	10	48	2	158	0
P_Accuracy	0.88	0.91	0.33	0.55	0.58	0.50	0.60	0.50	0.00	0.59

Coastal South Carolina Water Resources

Results – *All Wetlands*

Jasper County

2015-2016

2024-2025

Legend:
- Connected Wetlands
- Isolated Wetlands
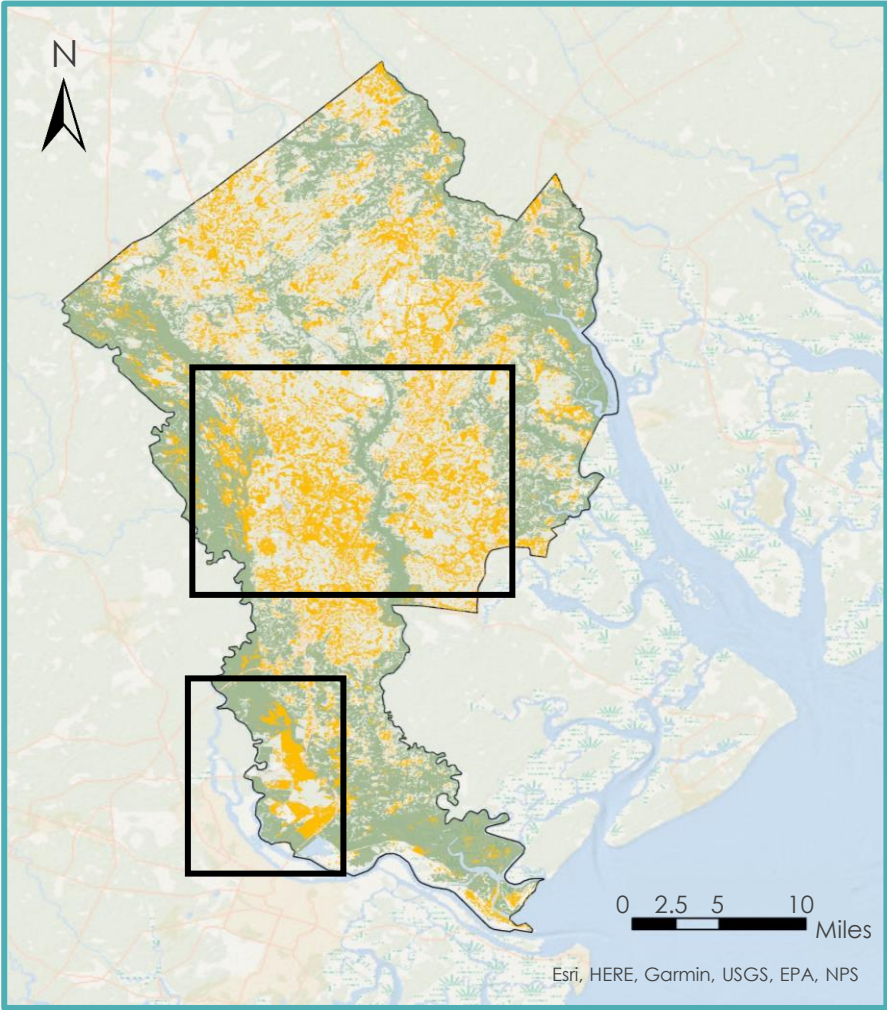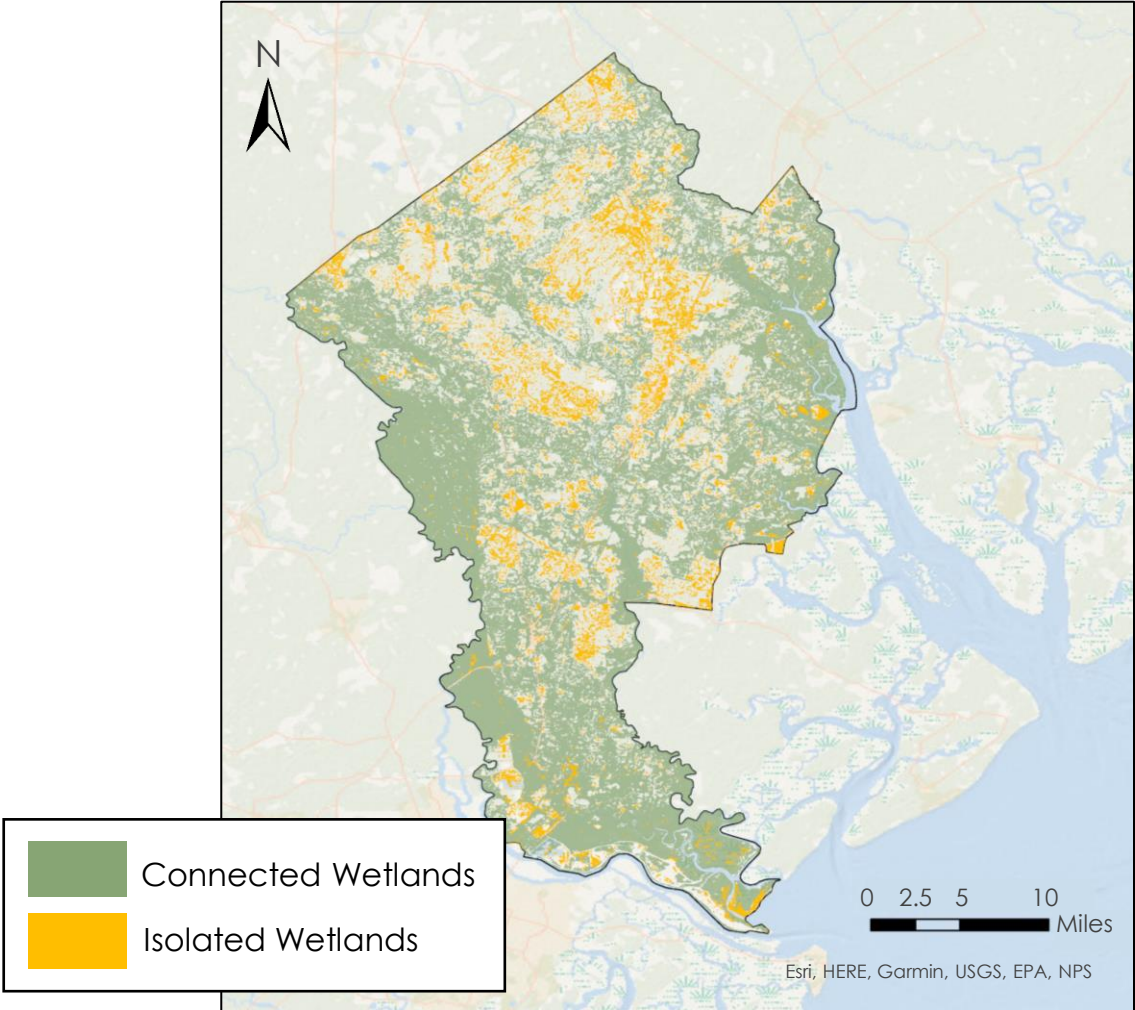
Results – *Percentage of Wetlands (**Jasper County**)*

Proportion to all Class Areas

- Connected: 47% (2015-2016)
- Isolated: 13% (2015-2016)
- Connected: 33% (2024-2025)
- Isolated: 21% (2024-2025)

Proportion to all Wetlands

- Connected: 79% (2015-2016)
- Isolated: 21% (2015-2016)
- Connected: 61% (2024-2025)
- Isolated: 39% (2024-2025)

Legend:
- Isolated Wetland
- Connected Wetland
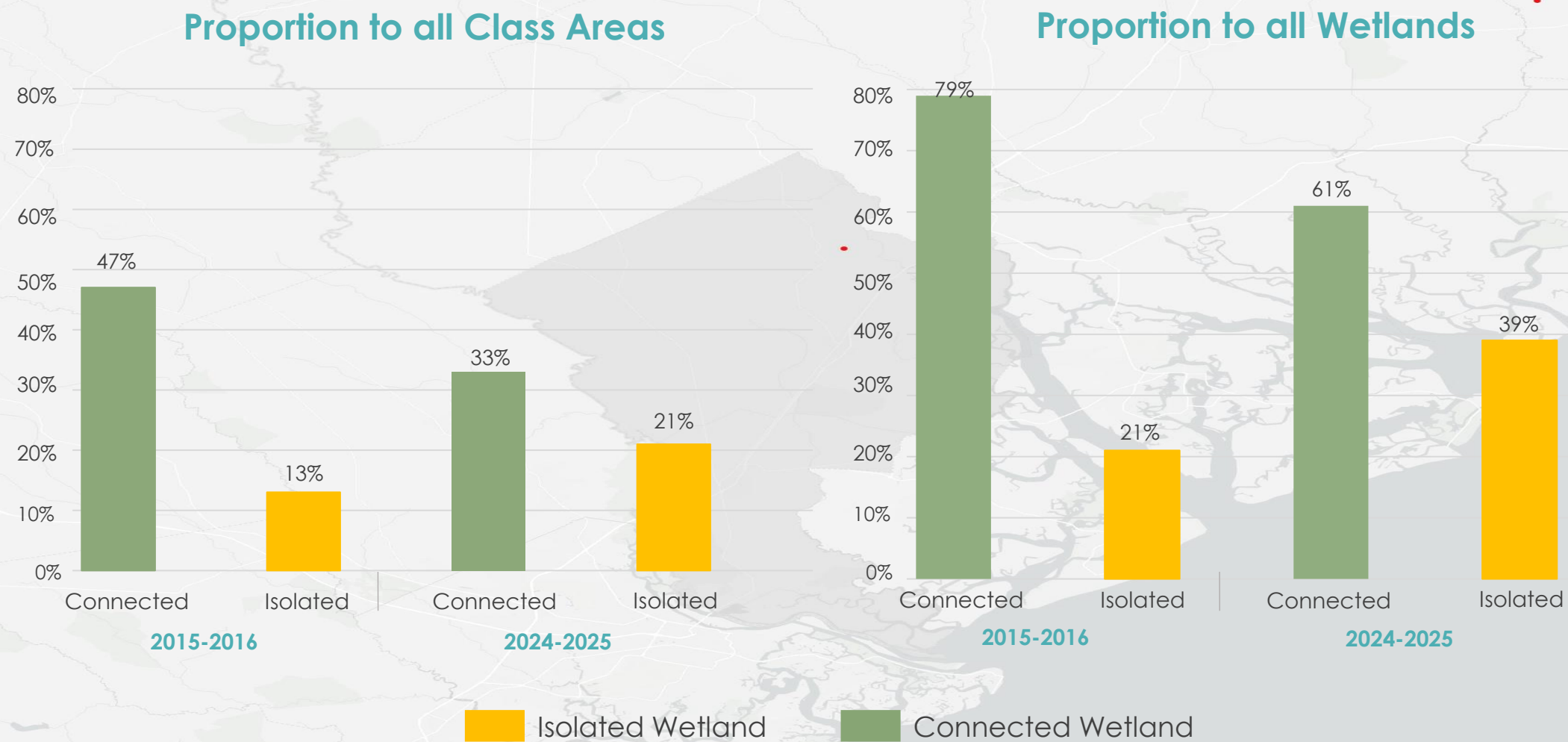
Charleston County GIS, Esri, Tom Accuracy, Garmin, FAO, NOAA, USGS

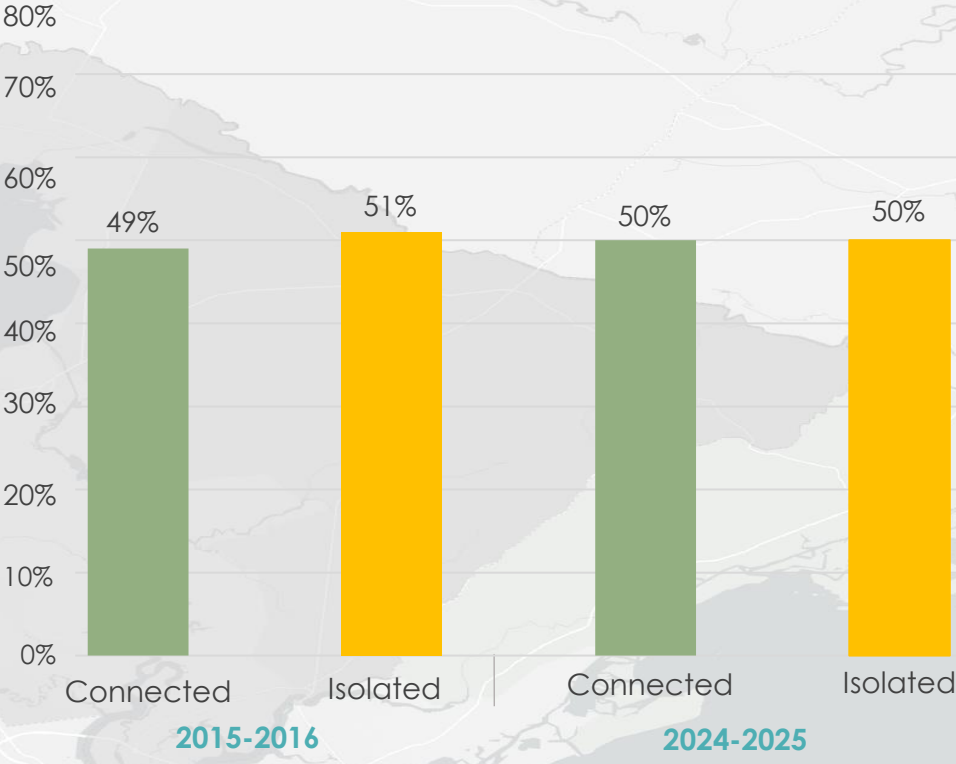# **Results** – *All Wetlands*

Berkeley County

2015-2016

2024-2025

Connected Wetlands
Isolated Wetlands
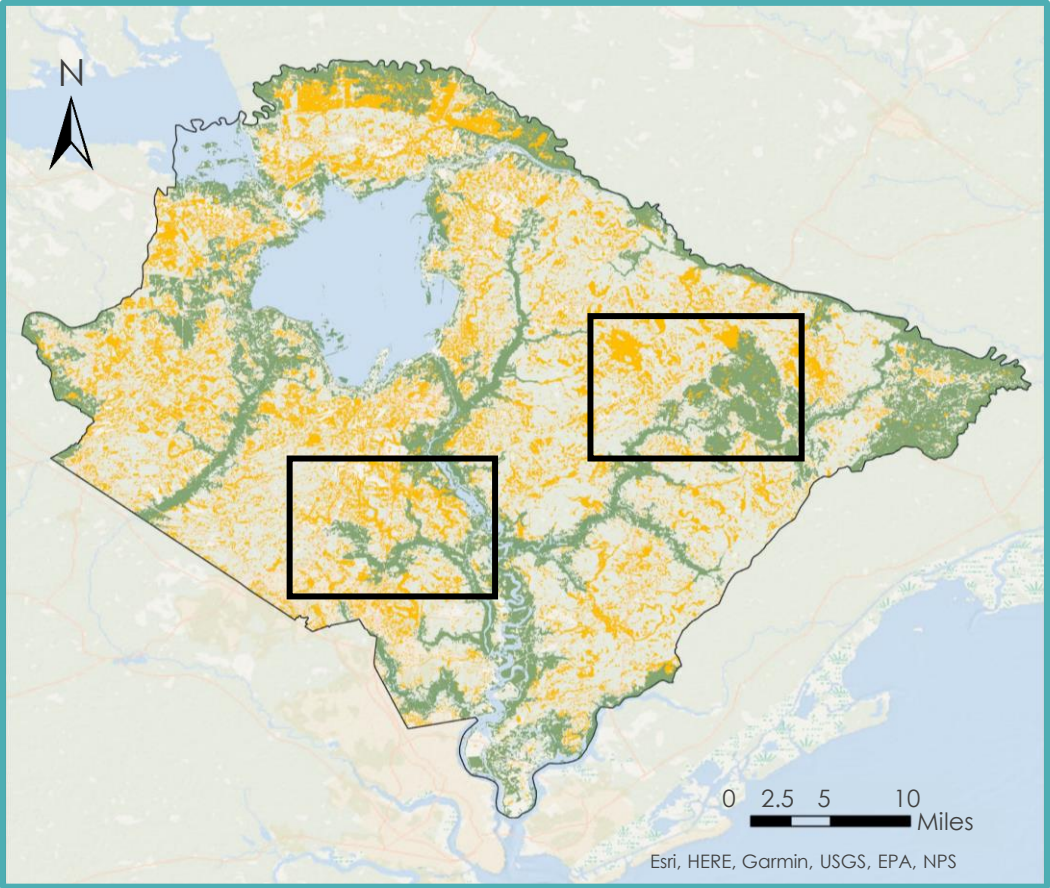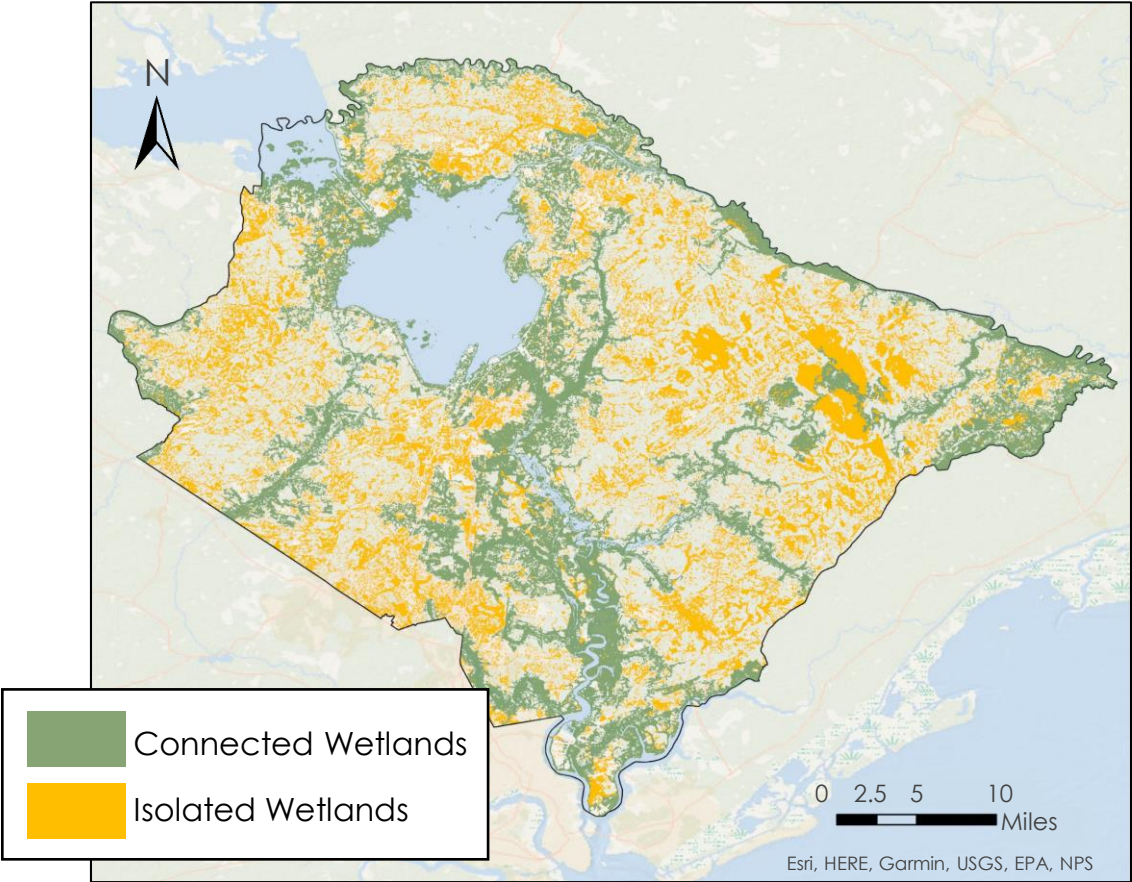
Results – *Percentage of Wetlands (Berkeley County)*

Proportion to all Class Areas
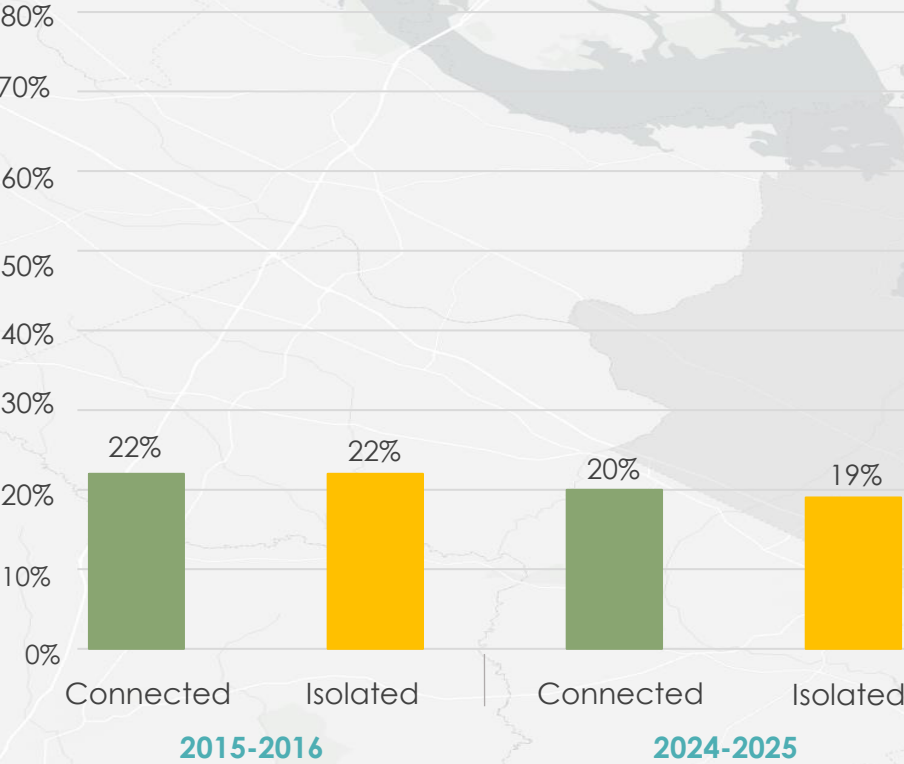
- 2015-2016: Connected 22%, Isolated 22%
- 2024-2025: Connected 20%, Isolated 19%

Proportion to all Wetlands

- 2015-2016: Connected 49%, Isolated 51%
- 2024-2025: Connected 50%, Isolated 50%

Legend: Isolated Wetland, Connected Wetland

Charleston County GIS, Esri, Tom Wamba, Garmin, FAO, NOAA, USGS

Results – *All Wetlands*

Horry County
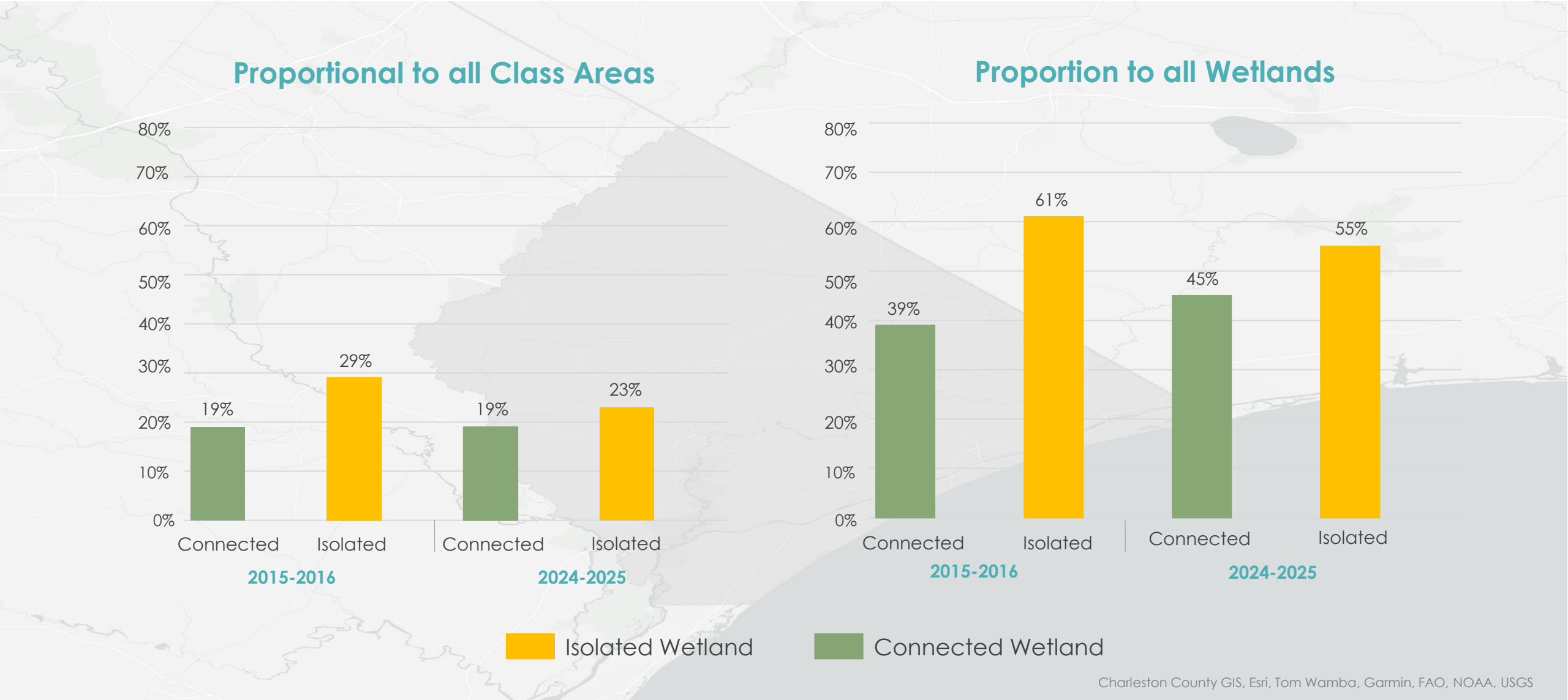
Connected Wetlands
Isolated Wetlands

Coastal South Carolina Water Resources
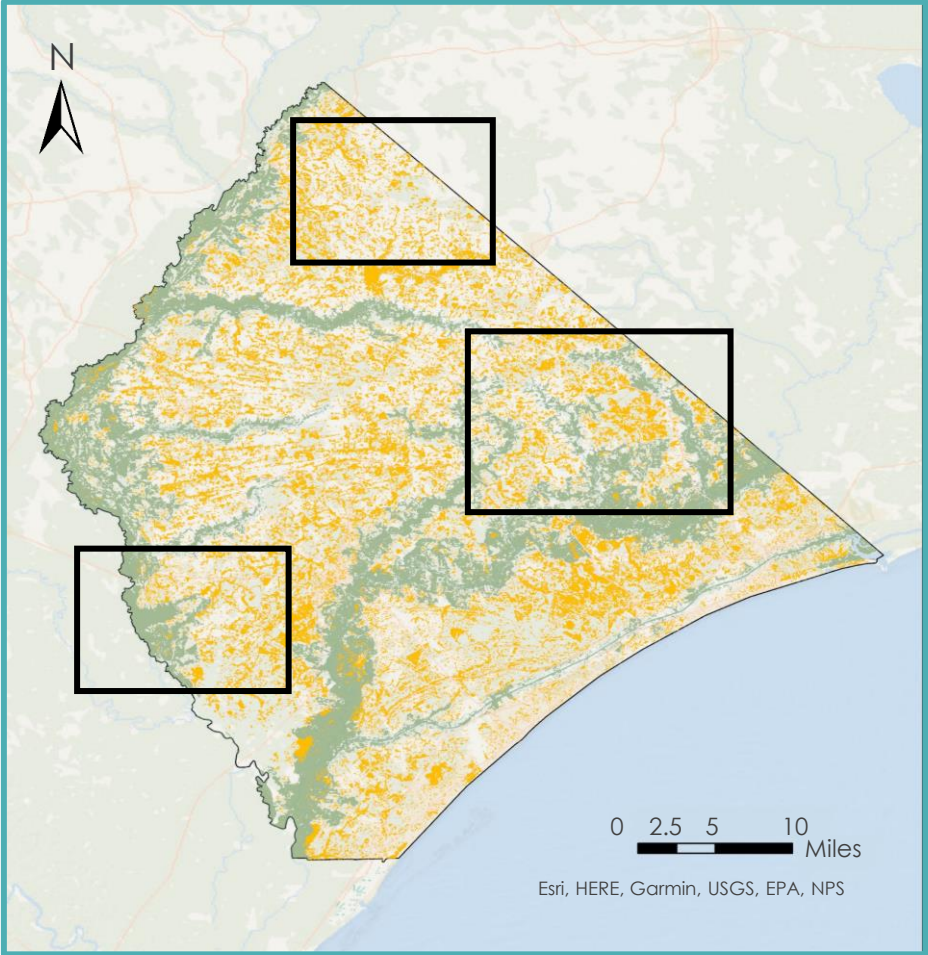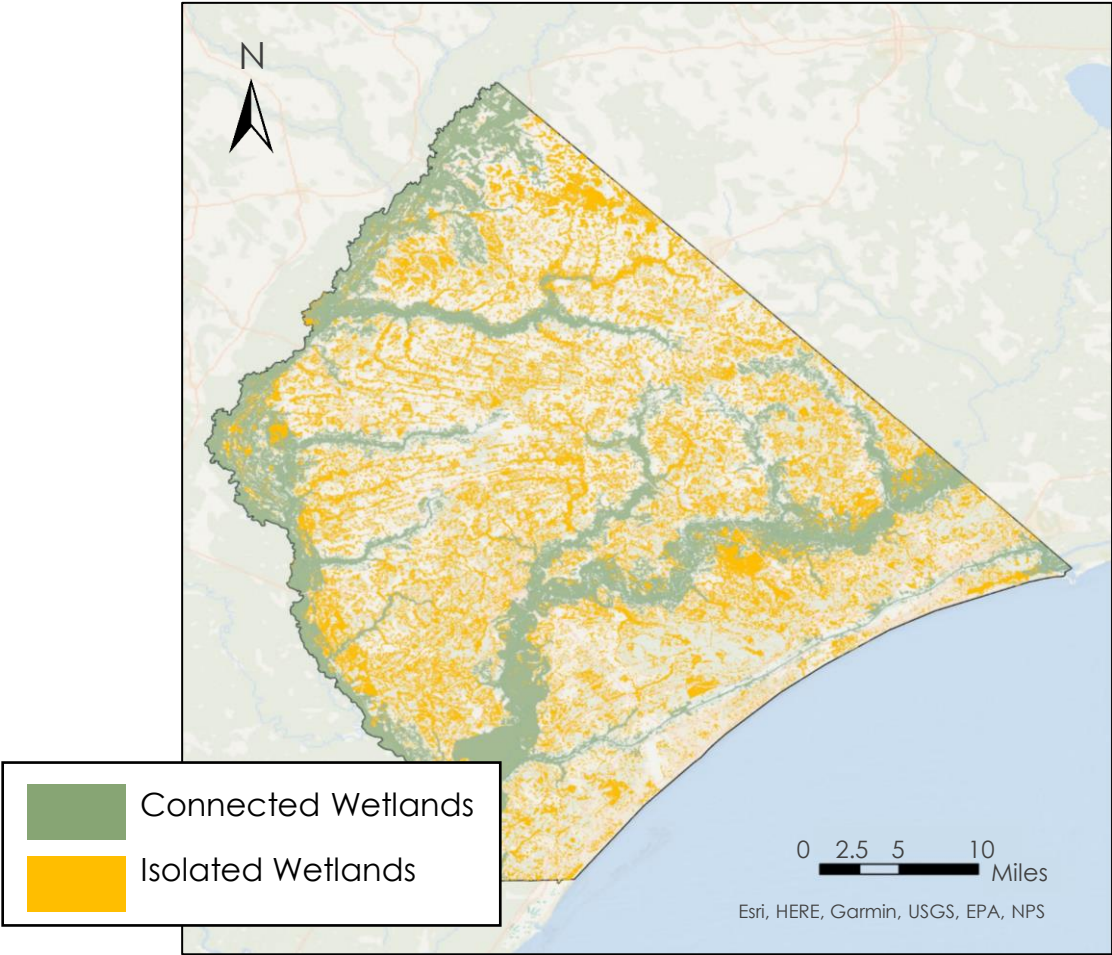
Results – *Percentage of Wetlands (**Horry County**)*

Proportional to all Class Areas

- Connected: 19% (2015-2016)
- Isolated: 29% (2015-2016)
- Connected: 19% (2024-2025)
- Isolated: 23% (2024-2025)

2015-2016 | **2024-2025**

Proportion to all Wetlands

- Connected: 39% (2015-2016)
- Isolated: 61% (2015-2016)
- Connected: 45% (2024-2025)
- Isolated: 55% (2024-2025)

2015-2016 | **2024-2025**

Legend: Isolated Wetland | Connected Wetland

Charleston County GIS, Esri, Tom Wamba, Garmin, FAO, NOAA, USGS

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Results – *Percentage of Wetlands (Overall)*
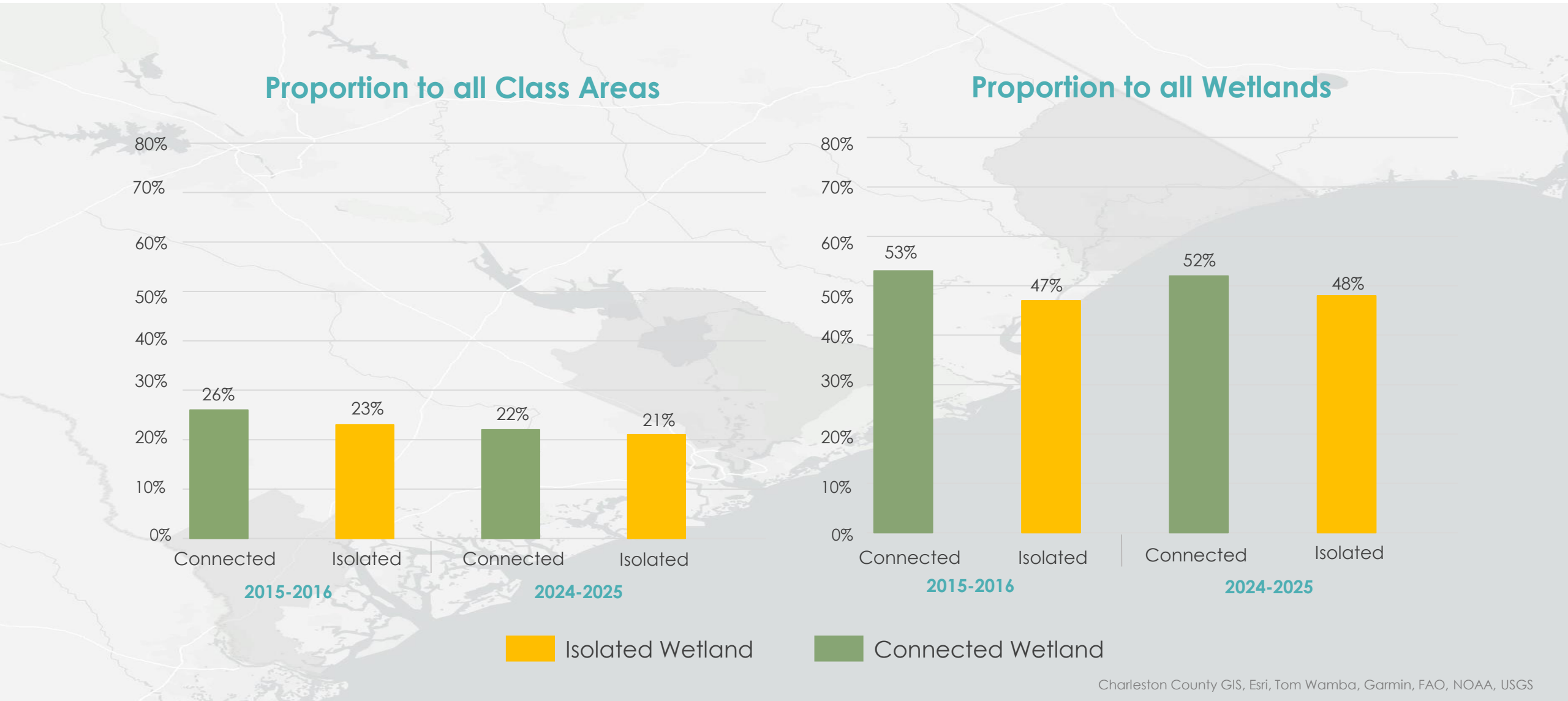
Proportion to all Class Areas

Bar chart — values:
- Connected (2015-2016): 26%
- Isolated (2015-2016): 23%
- Connected (2024-2025): 22%
- Isolated (2024-2025): 21%

Proportion to all Wetlands

Bar chart — values:
- Connected (2015-2016): 53%
- Isolated (2015-2016): 47%
- Connected (2024-2025): 52%
- Isolated (2024-2025): 48%

Legend: ■ Isolated Wetland   ■ Connected Wetland

Coastal South Carolina Water Resources

Results – *10-year Change Analysis*

Jasper County

Berkeley County

Horry County

Legend:
- Wetlands Lost
- Wetlands Gained

Results – *10-year Change Analysis*

Jasper County

Wetlands Lost

Wetlands Gained

0   5   10   Miles
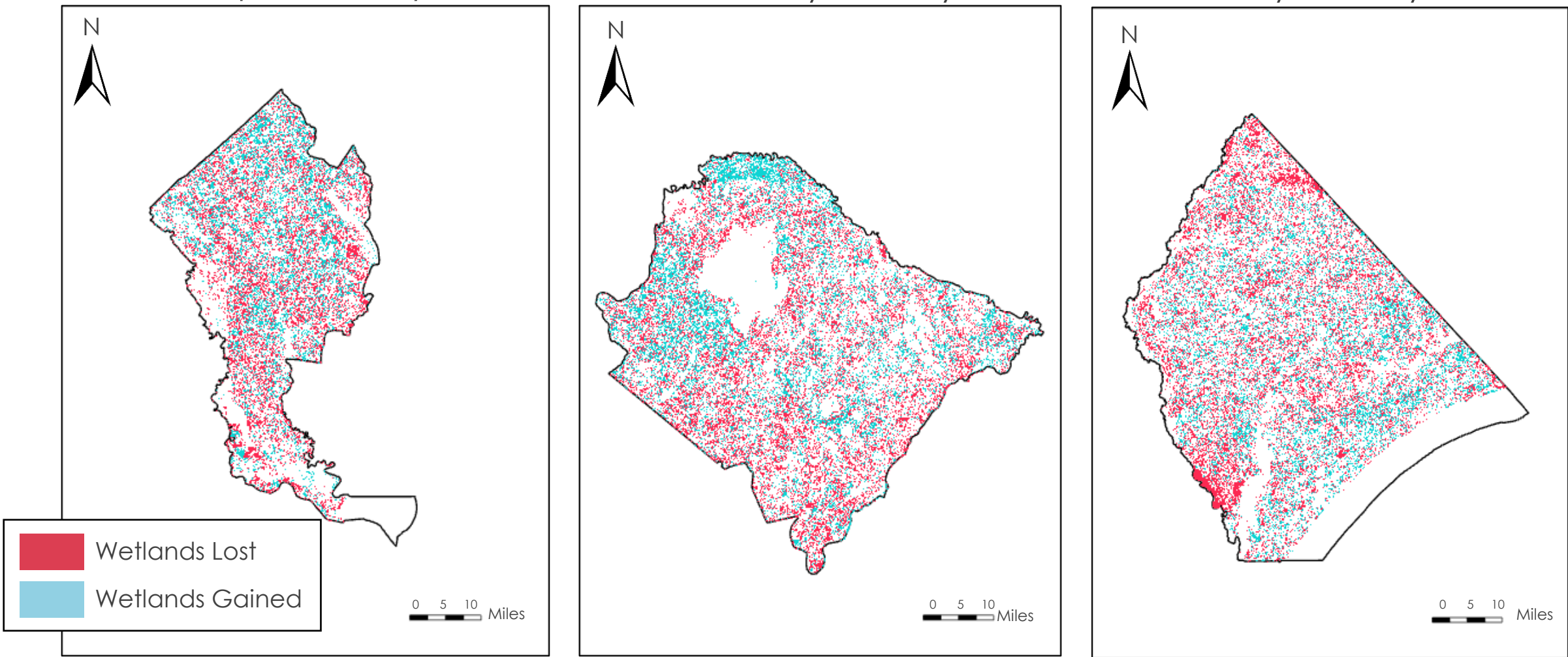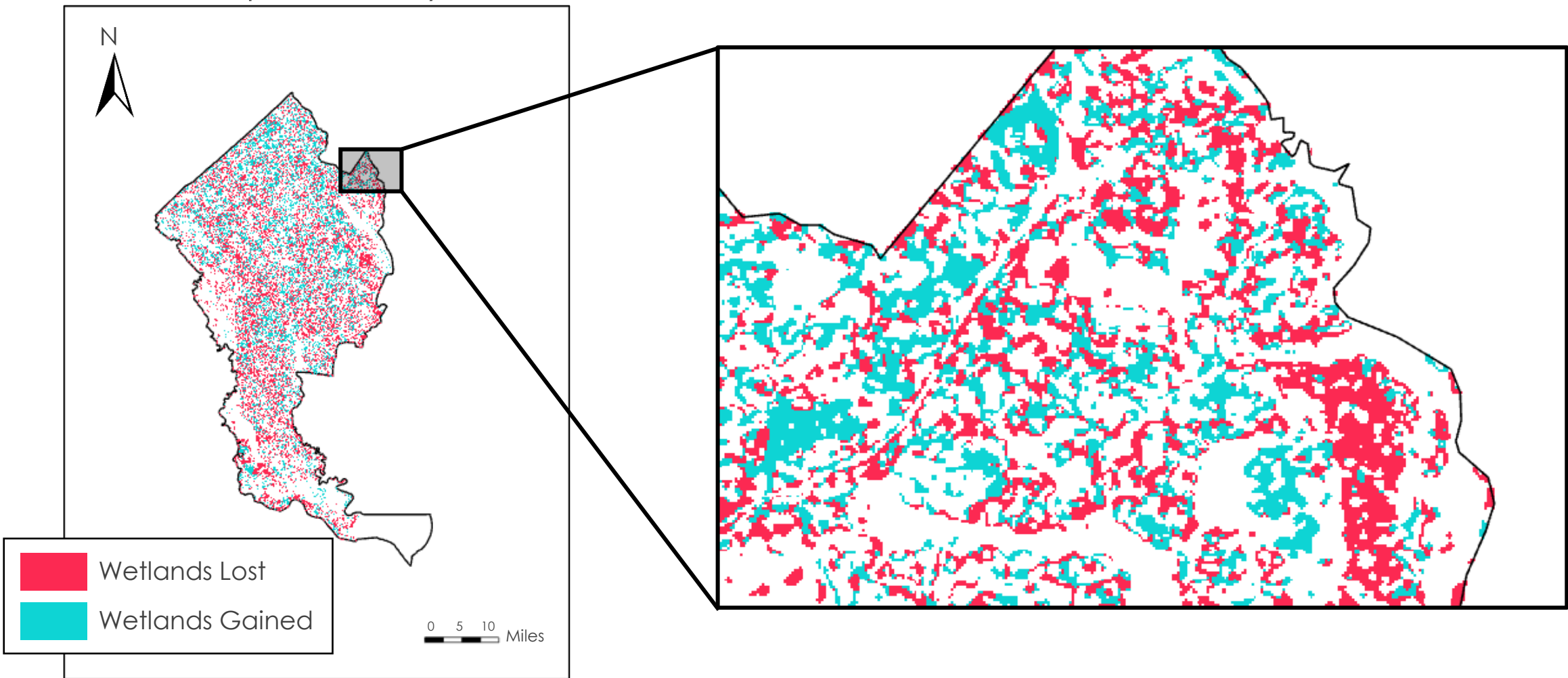
Results – *10-year Change Analysis (2015-2025)*
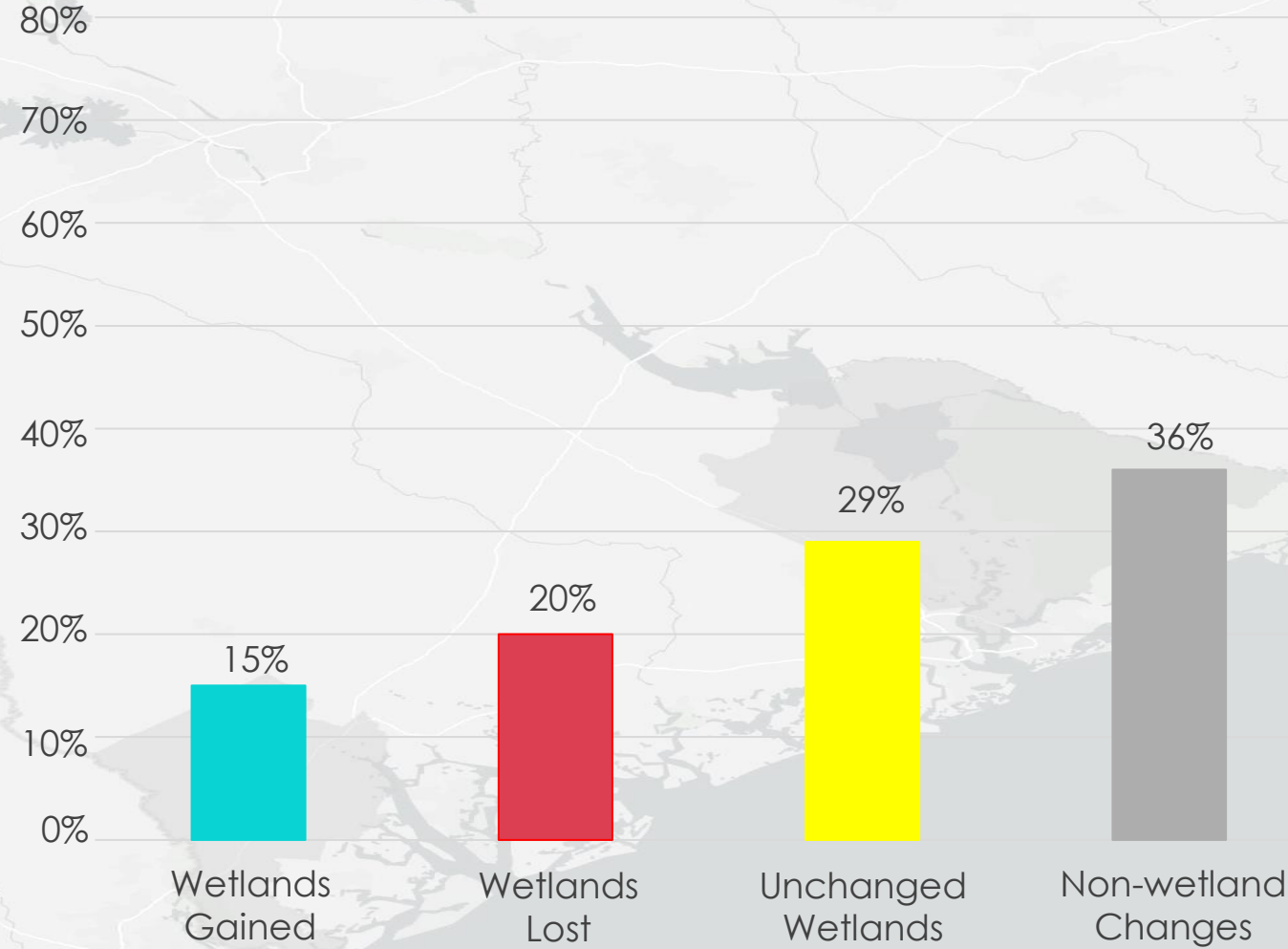
- **Wetlands Gained:** New wetlands form, or existing ones grow

- **Wetlands Lost:** Wetlands shrink or disappear due to land use changes

- **Non-wetland Uses:** Urban or agriculture areas

- Total aggregate change is about **5%**

Errors & Uncertainties
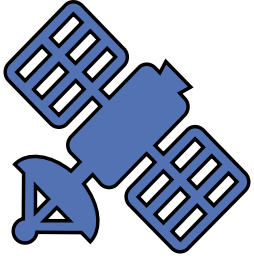
Satellite Imaging

- Landsat data mosaic from different dates

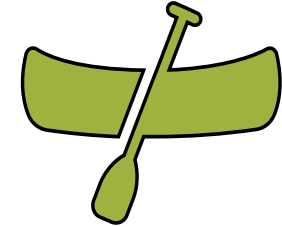- Seasonal variability in land cover and spectra values
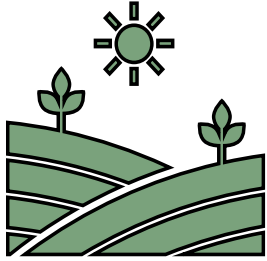
Ground Truth Certainty

- Limited field and on-site validation data

- Difference in National Wetland Inventory classification system
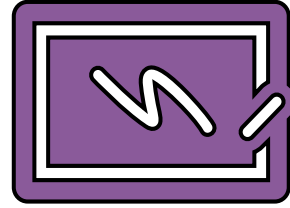
Corrections & Smoothing

- Possible error in adjustments made during processing

- Smaller areas lost during smoothing

Definition Uncertainty

- Unclear parameters used to define "protected" wetlands

- Subjective interpretation of "navigable waterways"

Feasibility

Wetland Assessment

Wetland distribution & isolation are well-represented

Earth observations are feasible for NDVI, NDMI, & NDWI

Landsat identification of wetlands and LULC

Partner Use

At-risk regions surrounding navigable waterways

Implications → public awareness and legislative campaigning

2nd Term Applications

Flood and inundation risk

Identifying impacted populations

Conclusion

1   Wetland areas decreased overall in 2024-2025 compared to 2015-2016.

2   Increased developed areas and agricultural lands may have led to decrease in wetlands over the 10 years.

3   Increased fragmentation due to urban infrastructure leads to more isolated wetlands.

4   Each county has shown different patterns of wetland change, with Jasper county showing the largest change.

Acknowledgements

NASA DEVELOP Personnel

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Becky Ryon, Grant McClure, Trapper Fowler, Anna Kimelblatt, Jessie White, Emma Berry

Backup Slides

Results – *Non-Isolated Wetlands (Protected)*

Jasper County

2015-2016

2024-2025

Connected Wetlands

Results – *Non-Isolated Wetlands (Protected)*

Berkeley County

2015-2016

2024-2025

Connected Wetlands

Esri, HERE, Garmin, USGS, EPA, NPS

Results – *Non-Isolated Wetlands (Protected)*

Horry County

Connected Wetlands

Coastal South Carolina Water Resources