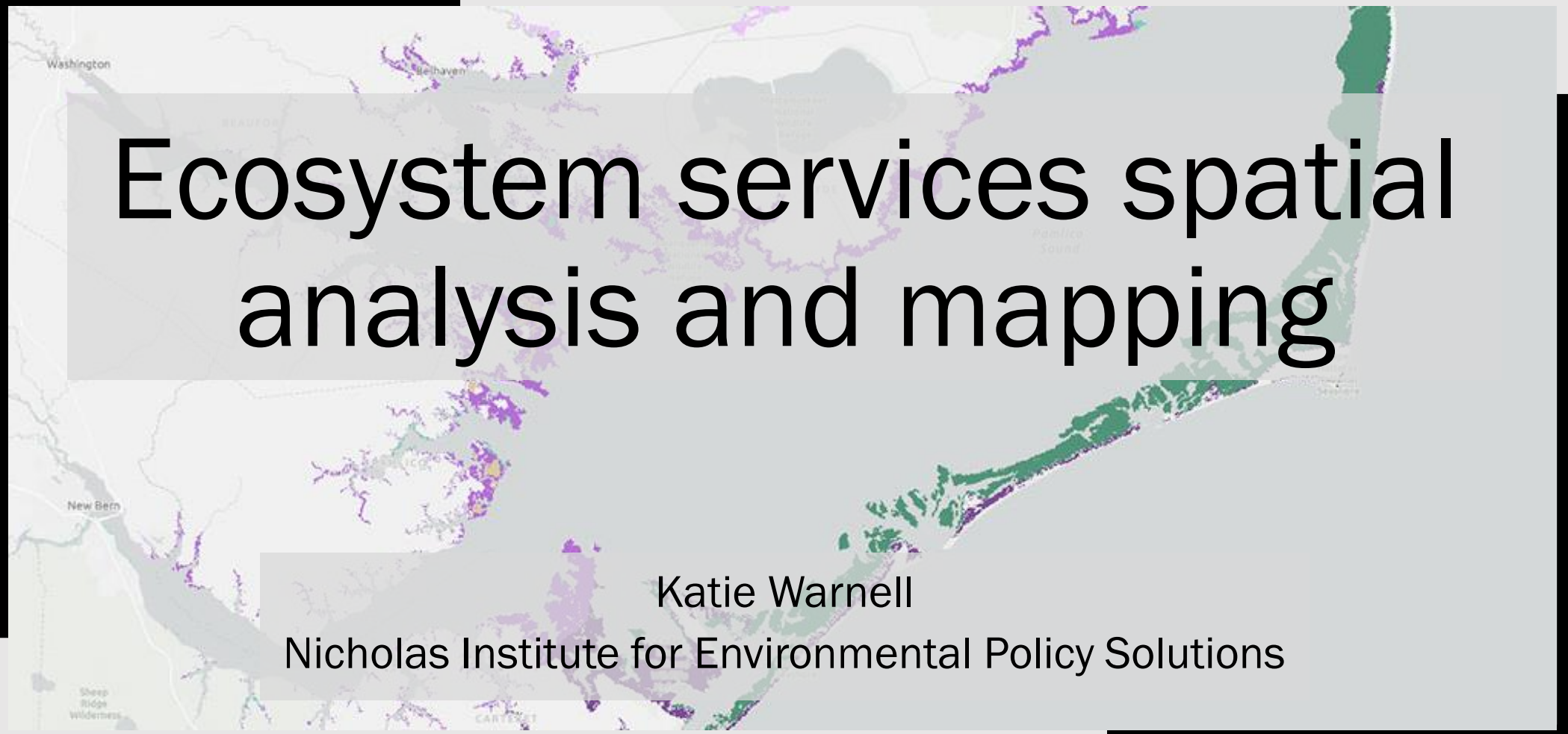
Ecosystem services spatial analysis and mapping



Katie Warnell

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FOR ENVIRONMENTAL POLICY SOLUTIONS

Linking academic knowledge and decision makers to solve environmental challenges

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Integrating ecosystem services into public and private decision making through improving methods, incentives and markets


Cultural Attraction
Water supply
Health benefits of exercise
Carbon sequestration
Flood prevention
Water filtration
What are ecosystem services?
Trout production

Thinking about ecosystem services spatially

Why map ecosystem services?

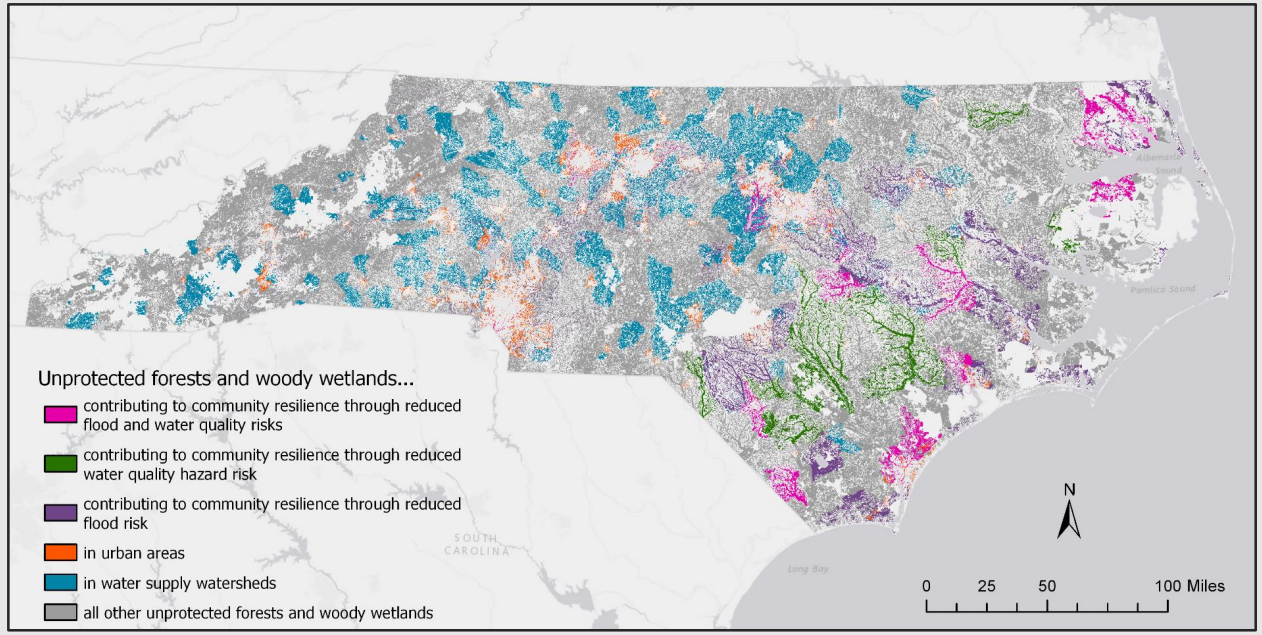
- Services are not uniform across the landscape
- Prediction/scenario modeling and comparing alternatives
- Prioritization – project and site selection
- Tracking changes over time
- Equity – who is affected by changes to ES provision

Consider supply of a service AND demand for a service

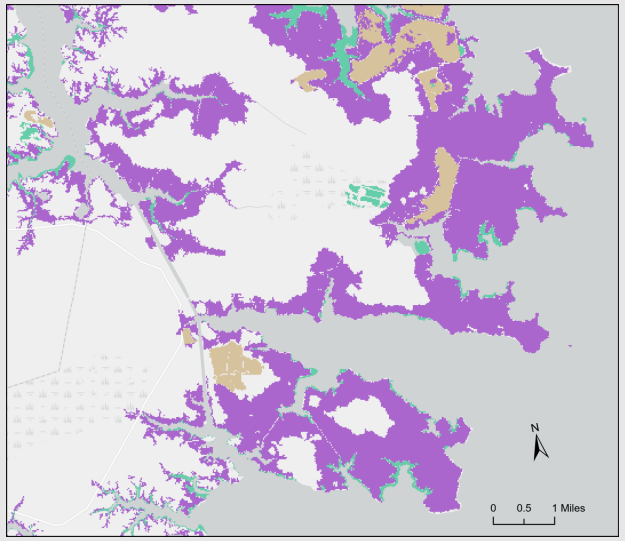
- How is supply of a service distributed spatially?
- How is demand for a service distributed spatially, and how does that relate to where supply exists?
- Usually requires multiple data types – ecological and social

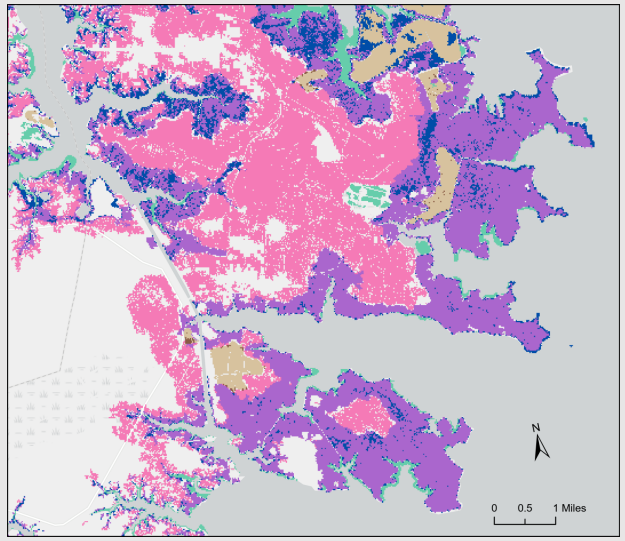
Spatial ecosystem services projects

North Carolina natural and working lands opportunities mapping

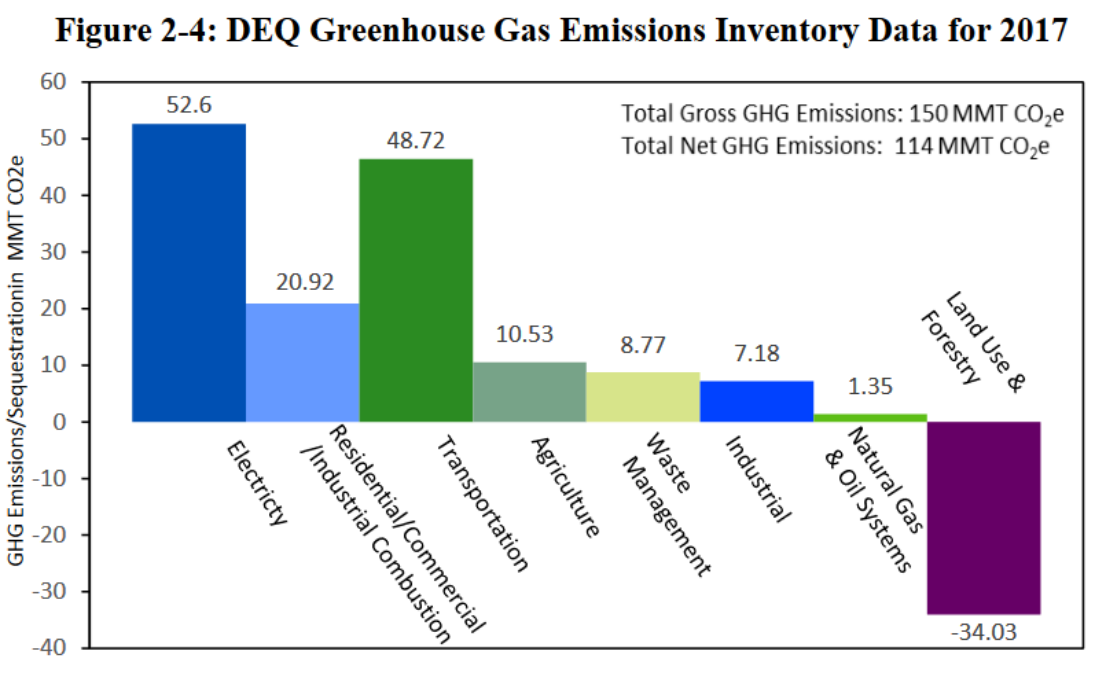


Coastal ecosystem services mapping for mid-Atlantic states





NC Natural & working lands opportunities mapping



EO 80: state goals for greenhouse gas mitigation, including reducing statewide greenhouse gas emissions to 40% below 2005 levels

Cabinet agencies shall integrate climate adaptation and resiliency planning into their policies, programs, and operations (i) to support communities and sectors of the economy that are vulnerable to the effects of climate change and (ii) to enhance the agencies' ability to protect human life and health, property, natural and built infrastructure, cultural resources, and other public and private assets of value to North Carolinians.

Natural & working lands working group formed to develop an action plan for NWL in NC.

No.	Shared Core Goal
1.	Enhance the ability of NWL to sequester carbon and mitigate GHG emissions.
2.	Build resilience in ecosystems and communities.
3.	Provide public health and ecosystem co-benefits.
4.	Create economic opportunities for agribusiness, recreation, and tourism.
5.	Ensure implementation of any action is a socially equitable process.

What can NC NWL provide in terms of climate and resilience benefits?

Key questions:

1. How much carbon could be stored and sequestered on NWLs?
2. How much (acres) of NWL can also support resilience?
3. What kinds of land management activities would provide how much of these climate and resilience benefits?
4. And where on the landscape could get maximize benefits (multiple benefits in one place)?

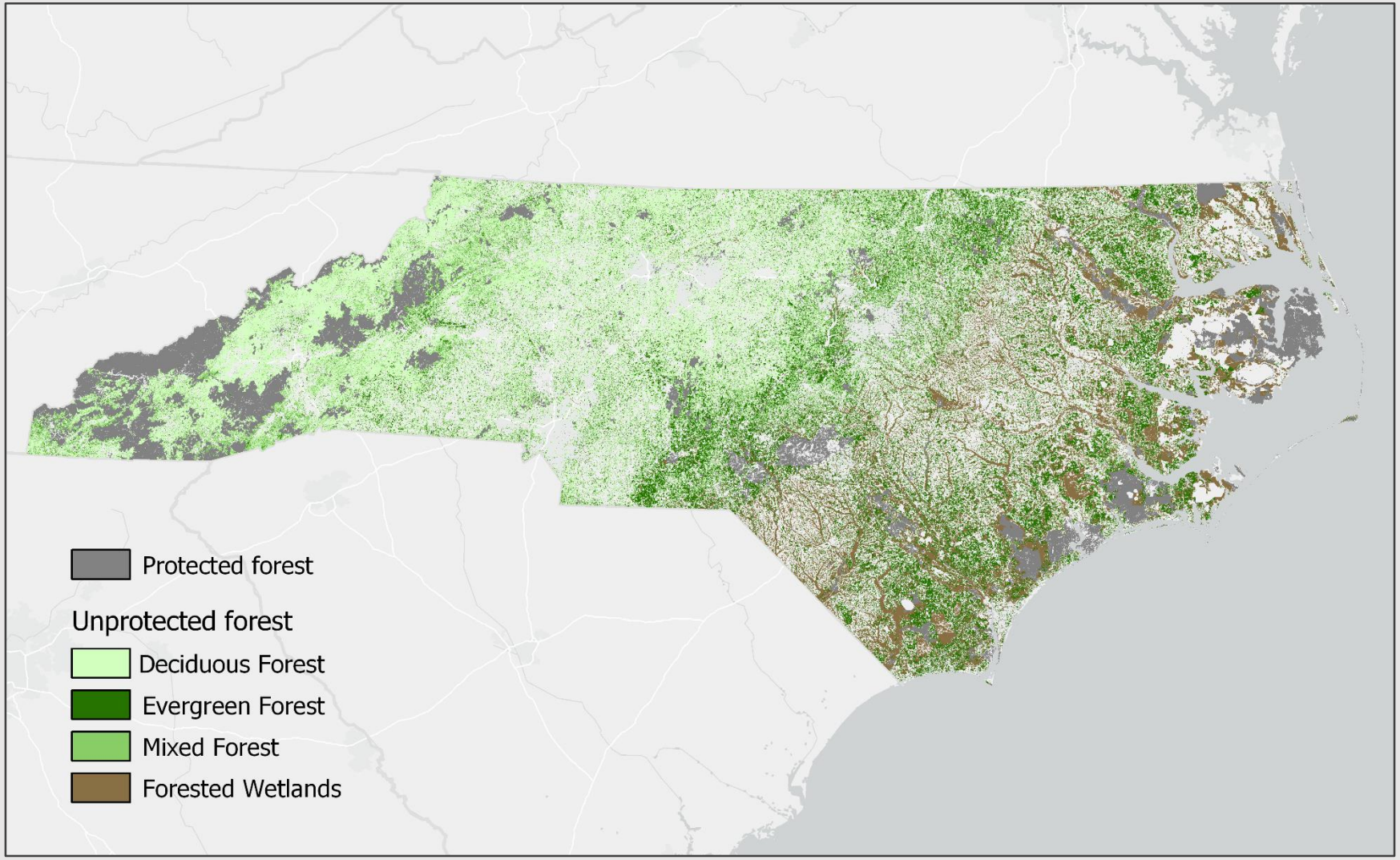
GOAL: To identify which NWL activities should be prioritized

Mapping for NWL Action Plan

	**Forests, wetlands, and floodplains**	Protection opportunities Reforestation opportunities
	**Floodplain buyouts**	Coordinated buyouts and restoration
	**Coastal habitats**	Protecting existing coastal habitats Facilitating marsh migration

Forests, wetlands, and floodplains

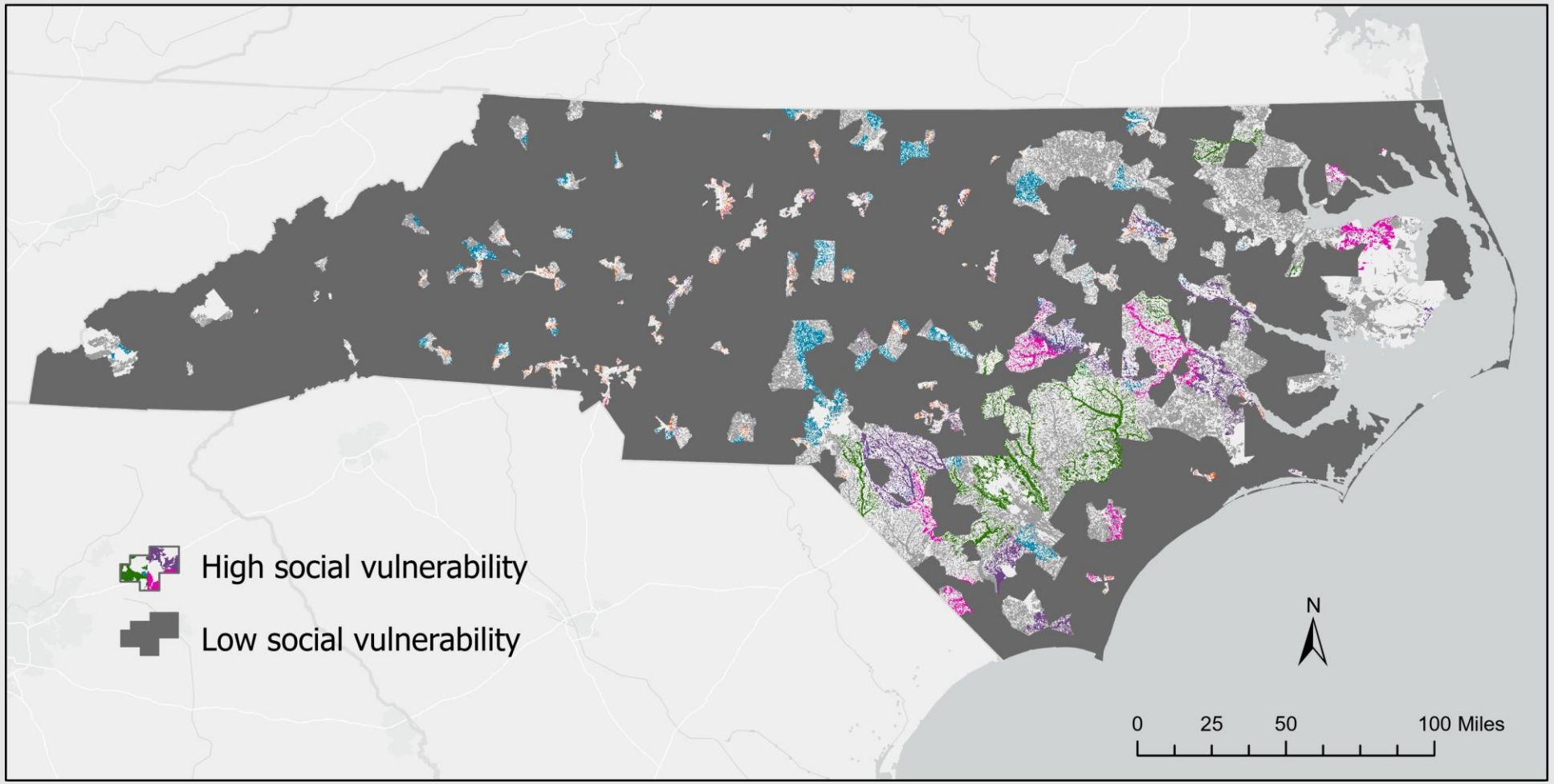
15.3 million acres of forest in NC are <u>not</u> within protected areas and could be cleared for development or other uses.



Forests, wetlands, and floodplains

More than 3 million acres of unprotected forests contribute to one or more community resilience benefits.

Where do unprotected forests contribute to community resilience?



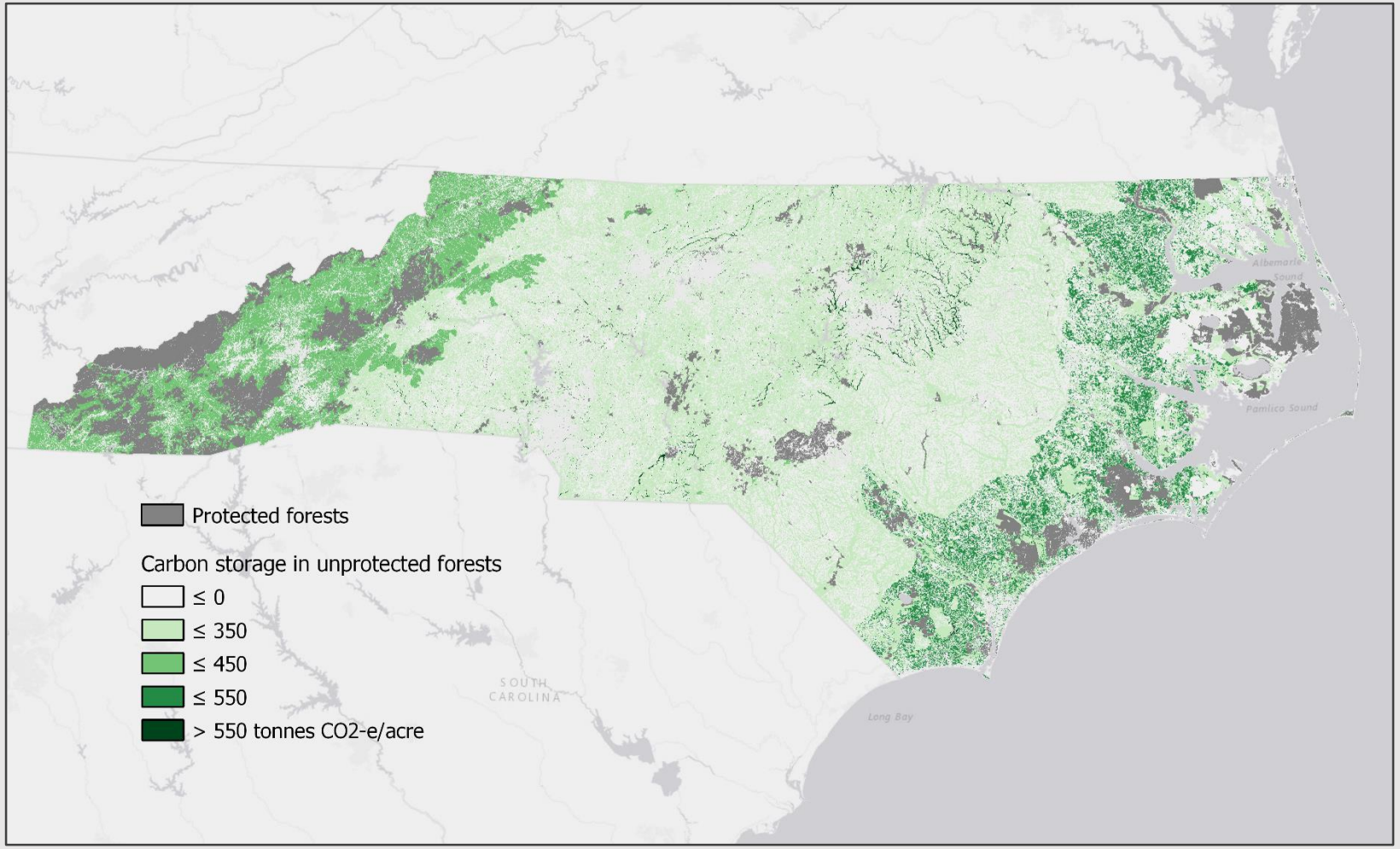
Forests, wetlands, and floodplains

How much carbon is stored in unprotected forests?

Carbon Storage Counter

Carbon stored in ...	If all of this carbon were released, it would be about equal to NC's total GHG emissions* for...
All unprotected forests and forested wetlands **5,500** million metric tons CO_2-eq	**36.6** years

* based on NC 2017 GHG Inventory



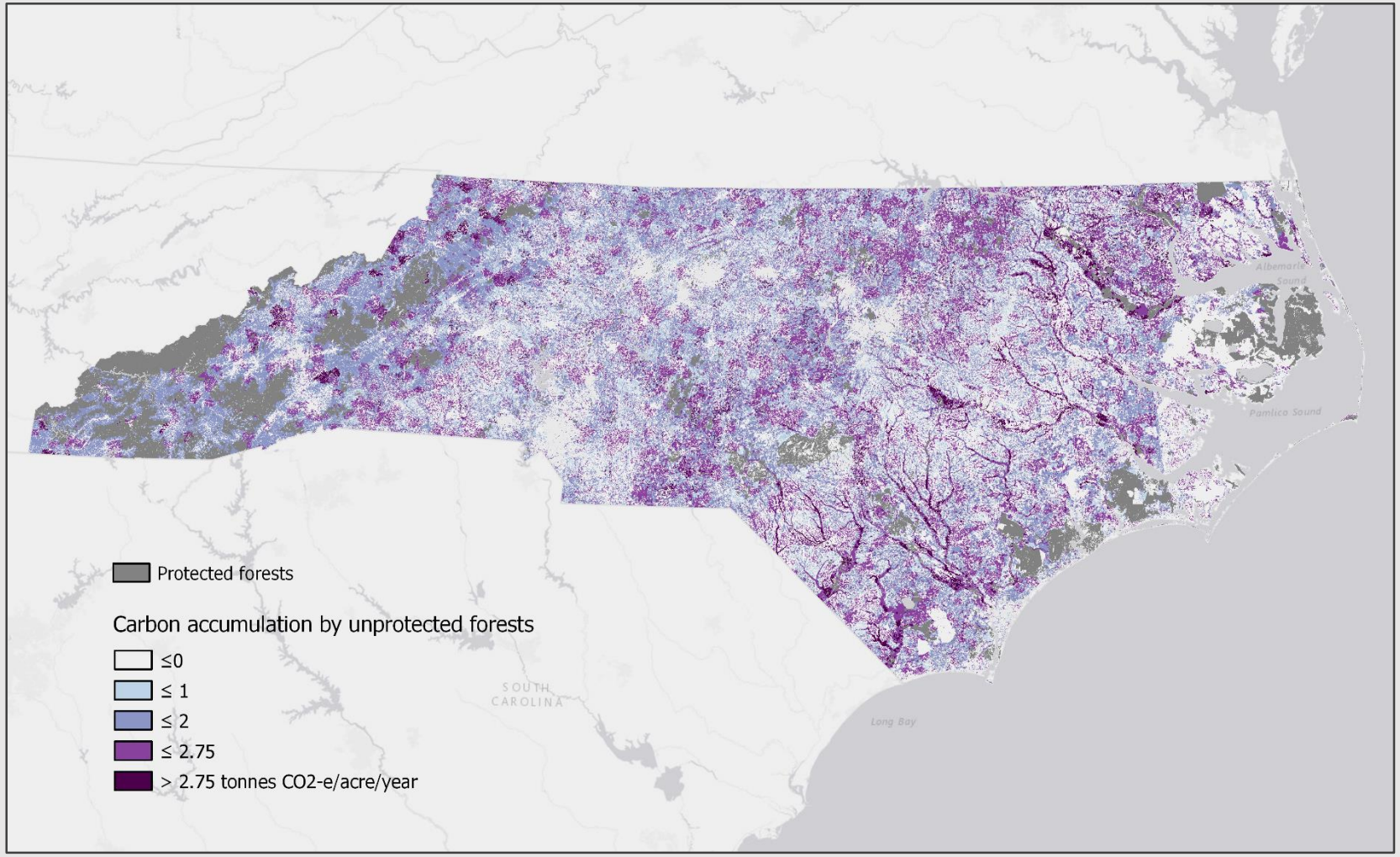
Forests, wetlands, and floodplains

Carbon Sequestration Counter

All figures in million metric tons CO_2-eq/year

26.8	Sequestration by unprotected forests
150.1	North Carolina's gross emissions (2017)

How much carbon do unprotected forests accumulate each year?



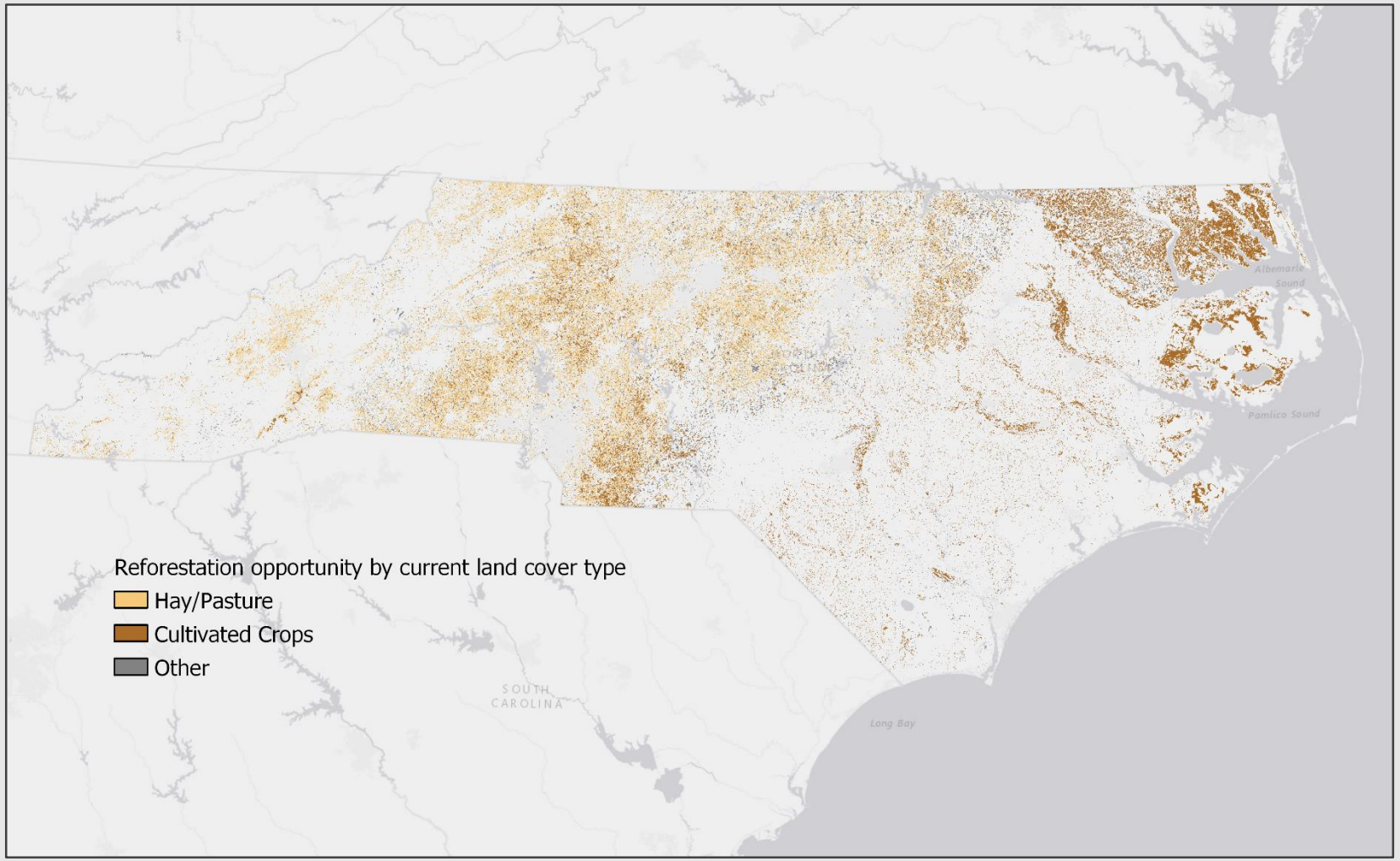
Forests, wetlands, and floodplains

Reforestation opportunities

How much opportunity for reforestation is there in NC?

5 million acres of land that is not currently forested, wetland, or developed has reforestation potential. Most of this land is currently being used for pasture or crops.

We would only expect marginally productive lands to transition to forest unless there are significant financial benefits to reforestation.



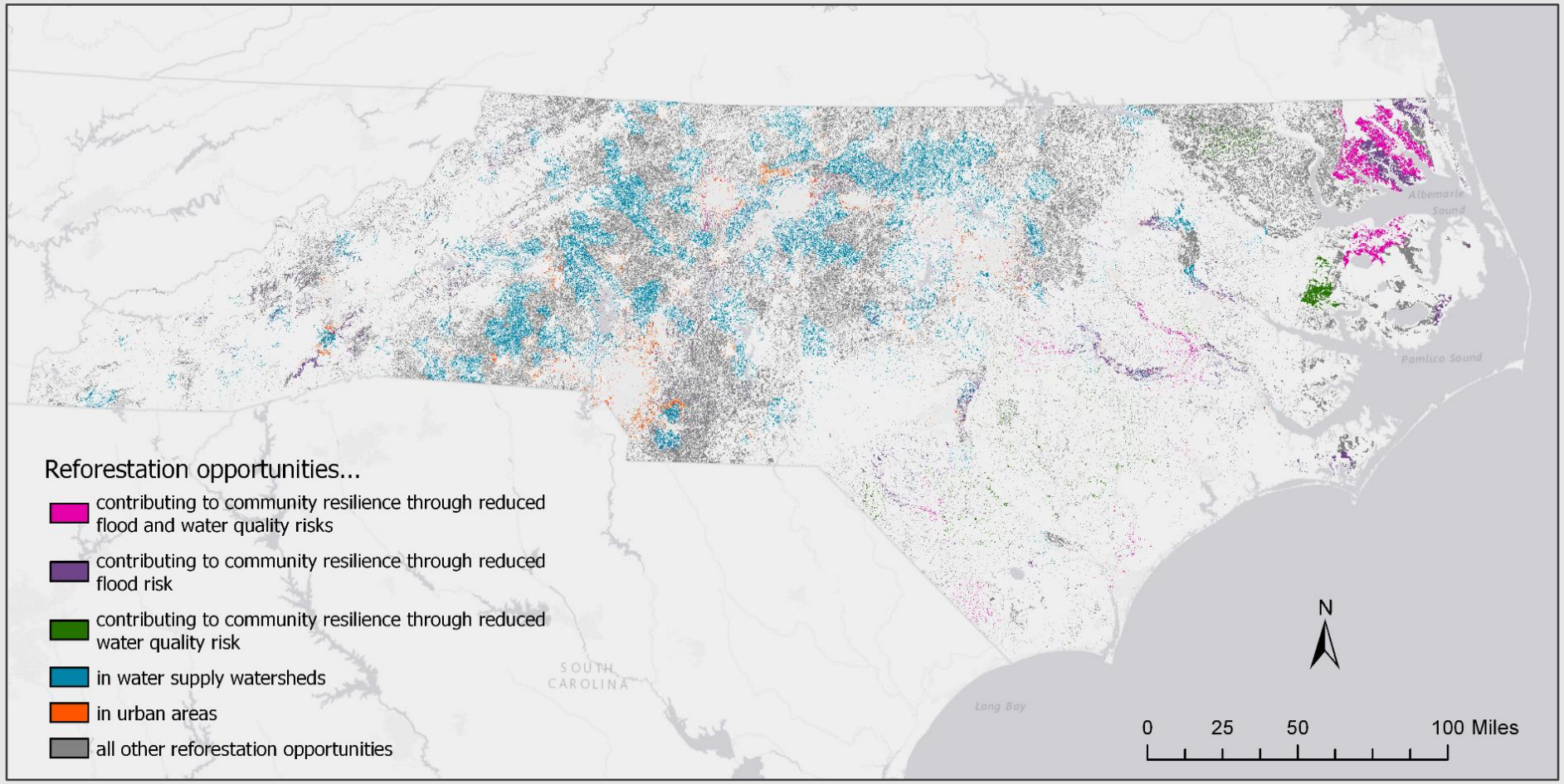
Reforestation potential identified as defined in Fargione et al. 2018.

Forests, wetlands, and floodplains

Reforestation opportunities

Where would reforestation contribute to community resilience?

1.8 million acres of reforestation opportunity would contribute to one or more community resilience benefits.



Forests, wetlands, and floodplains

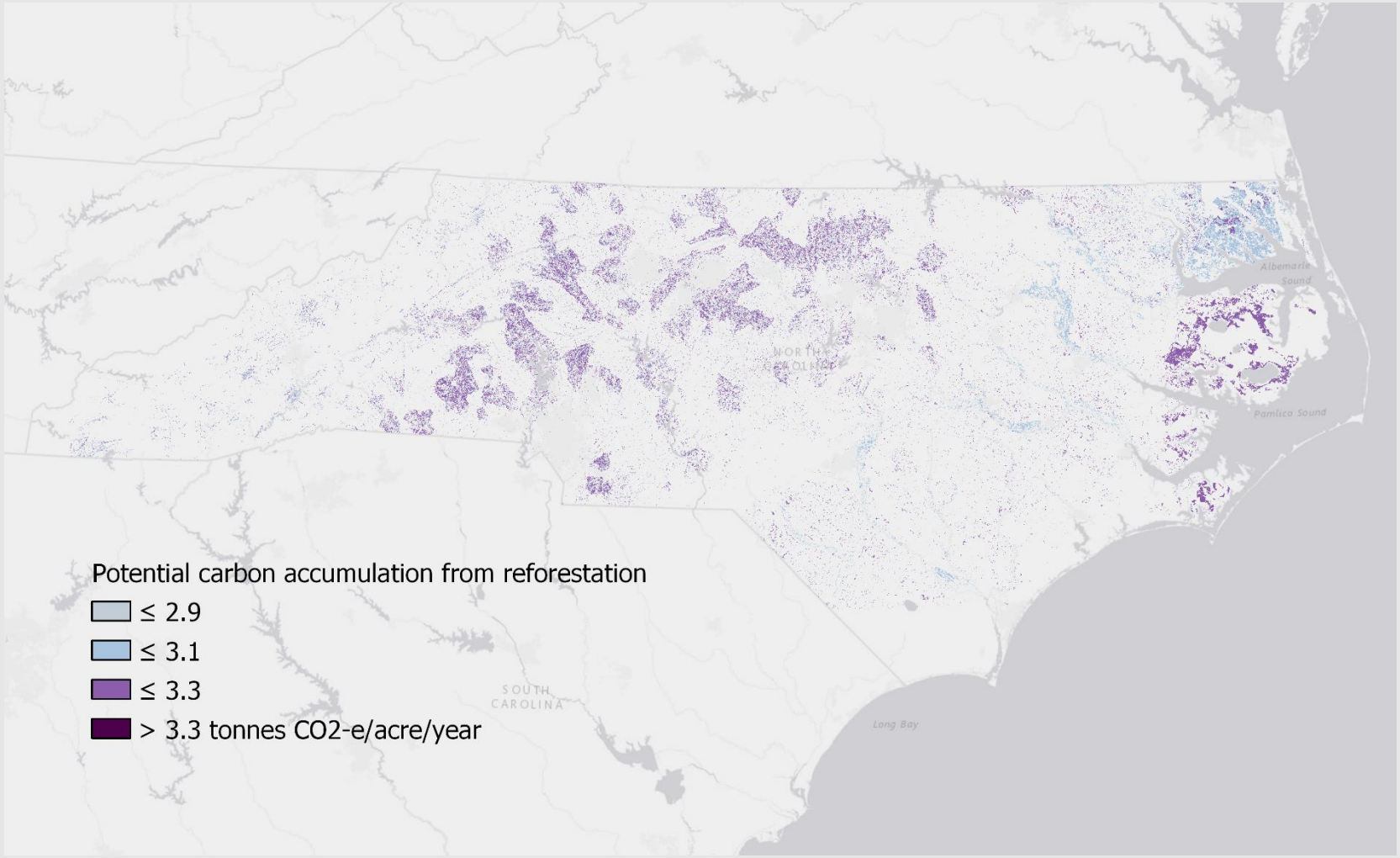
Reforestation opportunities

How much carbon could be accumulated by reforestation in priority resilience areas?

Carbon Sequestration Counter

All figures in million metric tons CO_2-eq/year

5.5	Potential sequestration by reforestation in priority resilience areas
150.1	North Carolina's gross emissions (2017)



Forests, wetlands, and floodplains

Reforestation opportunities

Recent update using newly released data from American Farmland Trust: excluding high-quality agricultural land from reforestation opportunity area.

	Original	Excluding high-quality agricultural land
Reforestation opportunity area	5.0 million acres	2.6 million acres
C sequestration of resilience priority areas	5.5 MMT CO2-e/year	0.79 MMT CO2-e/year

Pocosin mapping

Pocosins are shrub bogs found in eastern NC, important for habitat, hydrology, and carbon.

Many have been ditched/drained, leaving them vulnerable to fires, which release large amounts of carbon.

Current maps of pocosins in NC are from 1999. Interest from state and federal agencies and NGOs in updated maps to:

- Identify pocosin areas with restoration potential
- Better estimate carbon storage in pocosins (currently treated as forests, underestimates soil carbon)

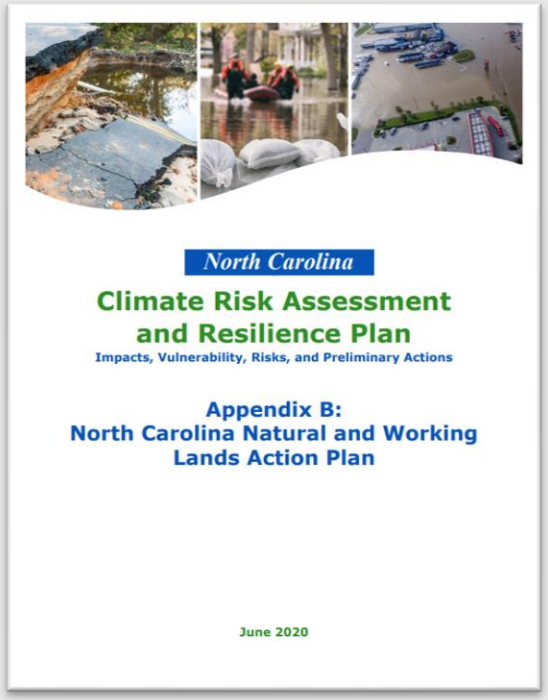
Pocosin mapping: Approach & challenges

Approach: Update 1999 maps by using the same methods with updated land cover and wetland maps

Challenges:

- Lack of detailed methods from 1999 mapping prevents easy update
- Accuracy issues with National Wetlands Inventory, which was used to identify wetland types and drainage
- Managed forests not distinguished from natural forests in land cover data
- Getting buy-in from pocosin experts on what constitutes a “good enough” map for our purposes

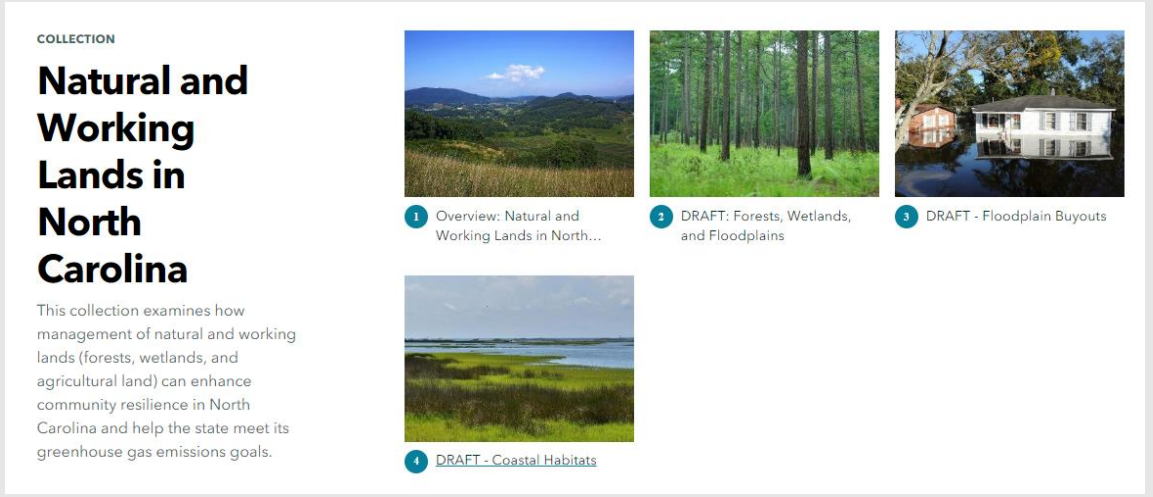
NWL maps: Uses & products



Natural & working lands action plan

- Potential geographic scope for recommended actions
- Carbon storage & sequestration estimates for recommended actions
- Resilience co-benefits of broad ("moonshot") actions

StoryMap collection presents this work in an accessible way and is easy to update



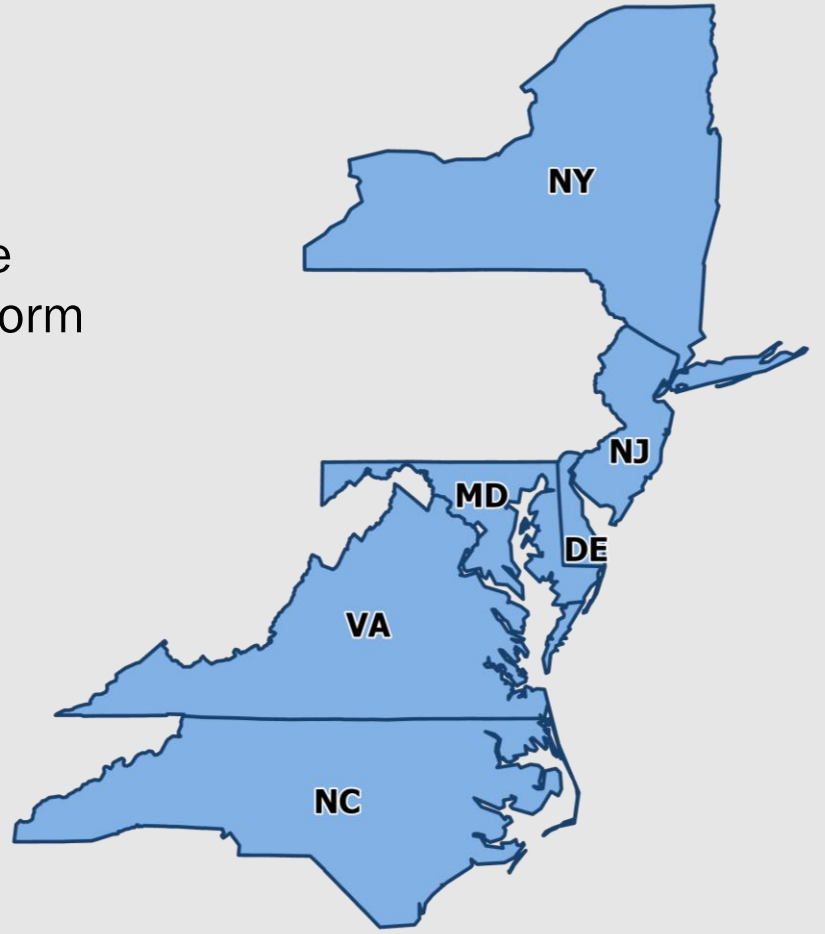
Ongoing **case studies** help stakeholders apply these data to their interests and questions:

- NC Land & Water Fund – tell the story of the benefits their protected lands provide
- Jordan Lake One Water – prioritize areas for conservation and restoration

Coastal ecosystem services mapping for mid-Atlantic states

Goals

- Provide spatial information about how coastal habitats enhance protection and provide carbon storage and sequestration, to inform coastal and climate mitigation planning
- Examine the effect of sea level rise on blue carbon storage and sequestration
- Identify key data gaps and research questions related to these analyses



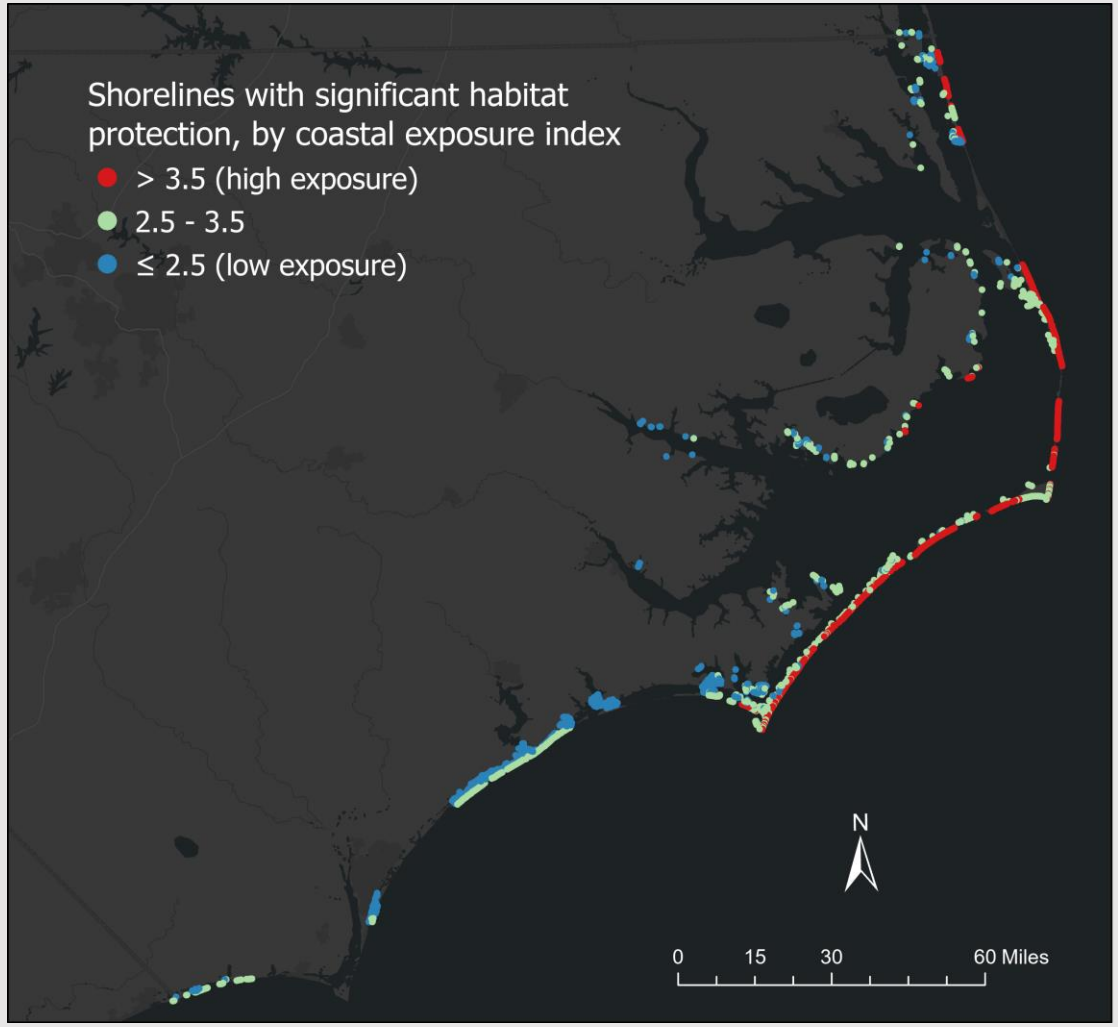
UNITED STATES CLIMATE ALLIANCE

Coastal protection mapping

Coastal habitats – marshes, dunes, coastal forest, seagrass, and oyster beds – protect nearby shorelines from waves and erosion.

InVEST
integrated valuation of ecosystem services and tradeoffs

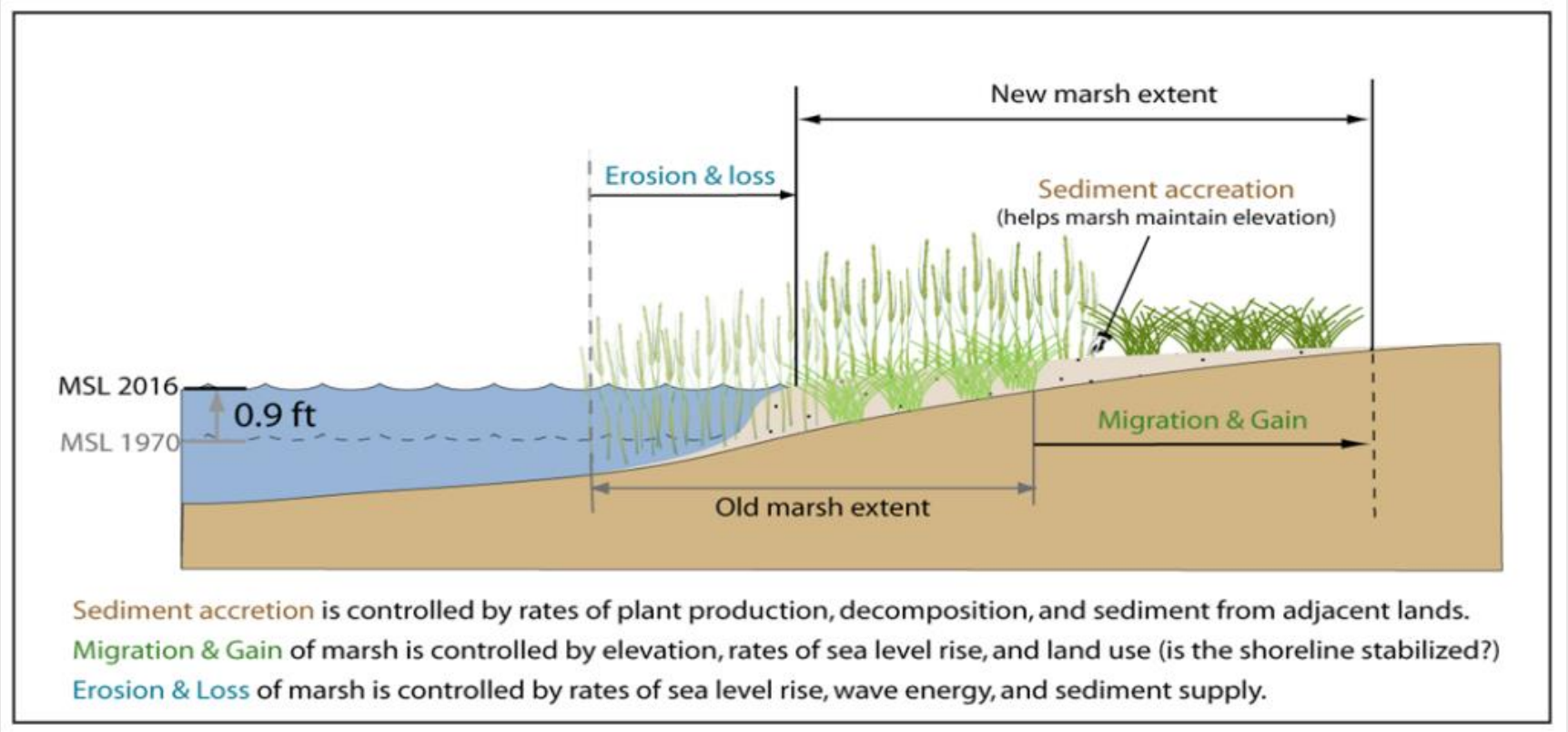
~~Coastal habitats~~
Geomorphology
Relief
Wave exposure
Wind exposure
Storm surge inundation
Sea level rise



Marsh responses to sea level rise

As sea level rises, marshes can:

- **Accrete** vertically to keep up with rising sea level
- **Drown** or erode if they cannot accrete fast enough
- **Migrate** inland into areas newly suitable for marsh due to higher sea level

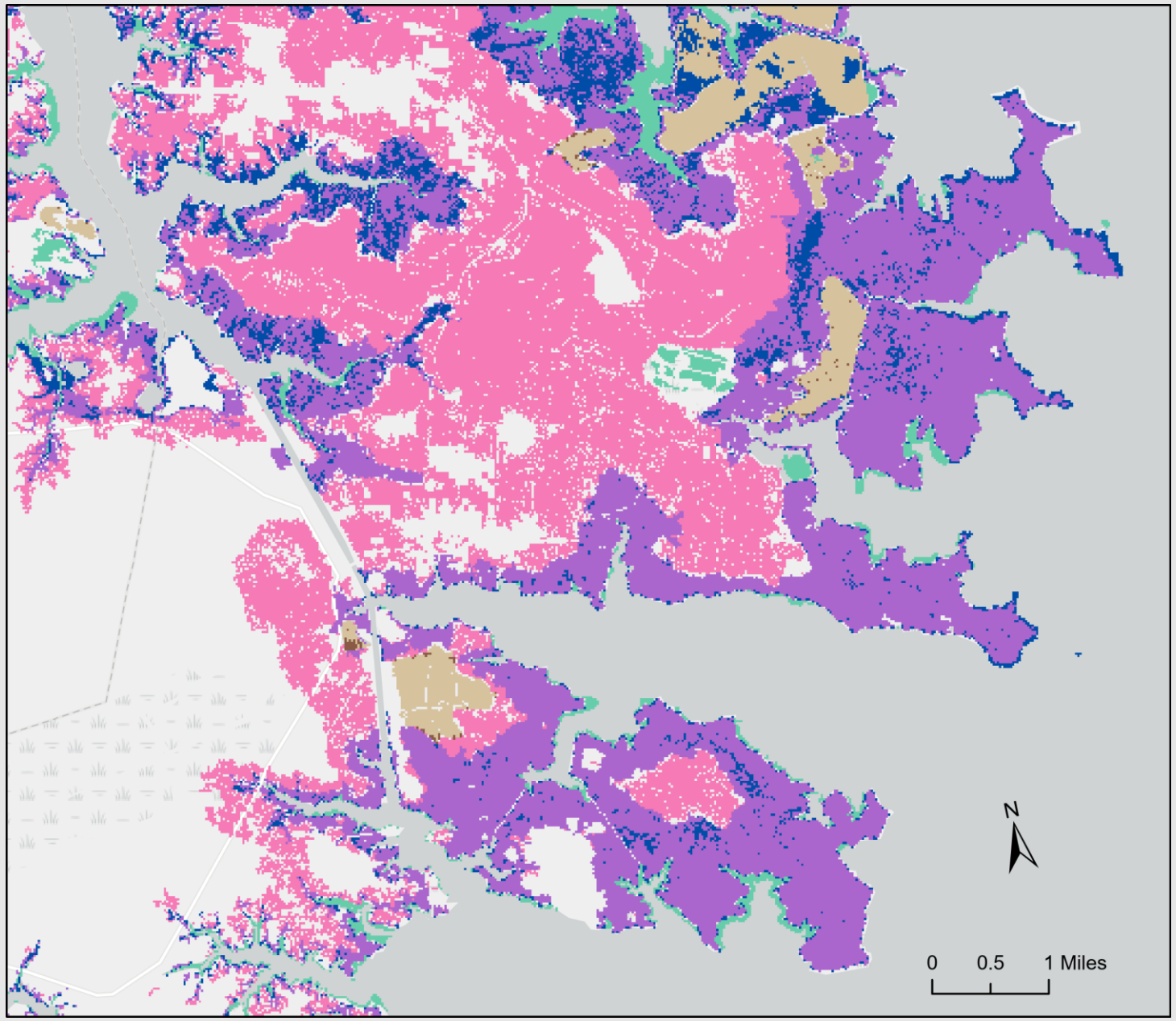


Projected coastal habitat change with SLR

- Existing marsh
- Seagrass
- Area that could be hydrologically connected to create/restore salt marsh
- Drowned marsh
- Eroded marsh
- Migration space marsh
- Hydrologically connected due to SLR

baseline

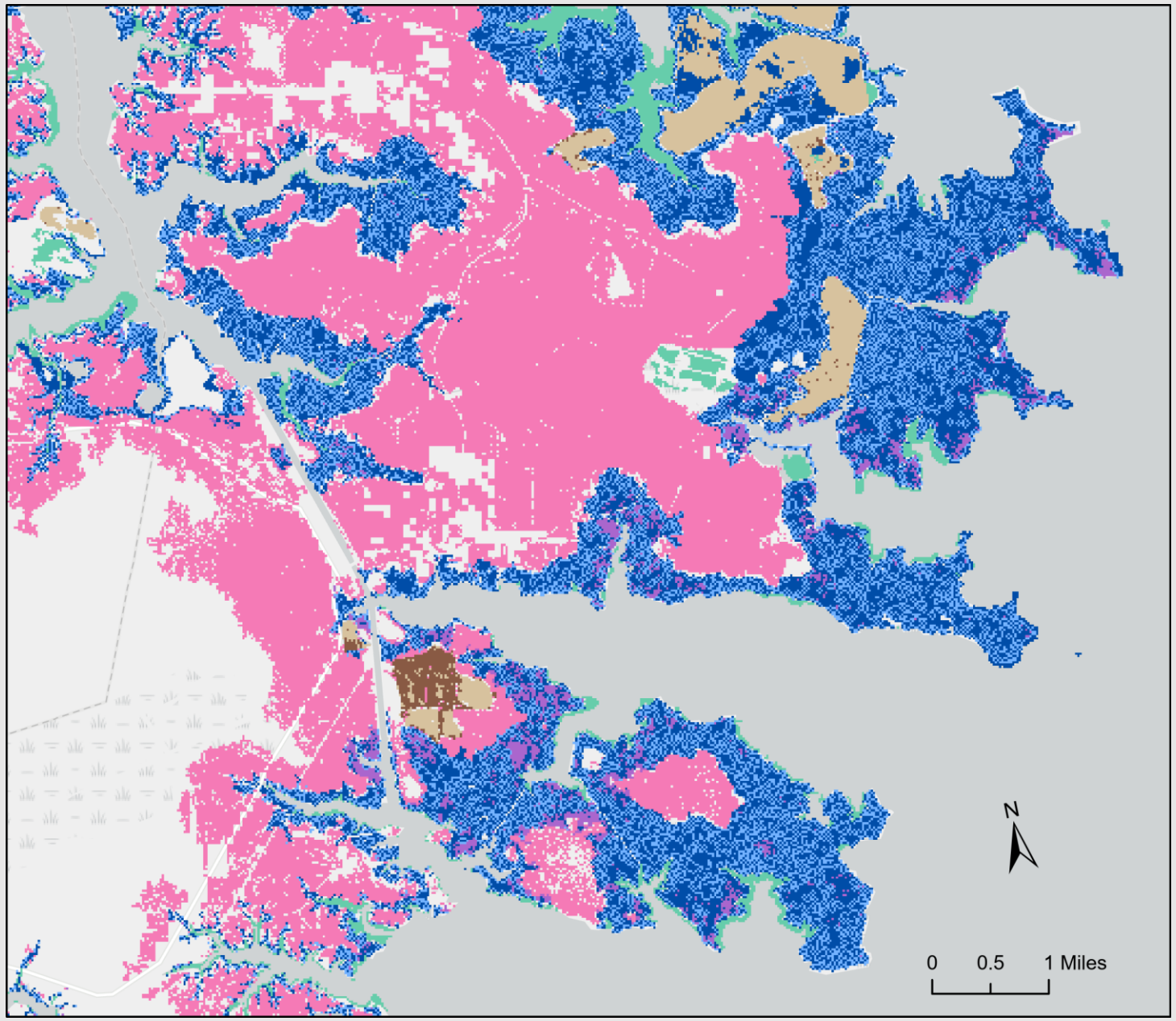
Projected coastal habitat change with SLR



Existing marsh
Seagrass
Area that could be hydrologically connected to create/restore salt marsh
Drowned marsh
Eroded marsh
Migration space marsh
Hydrologically connected due to SLR

2050, 1.5’ SLR

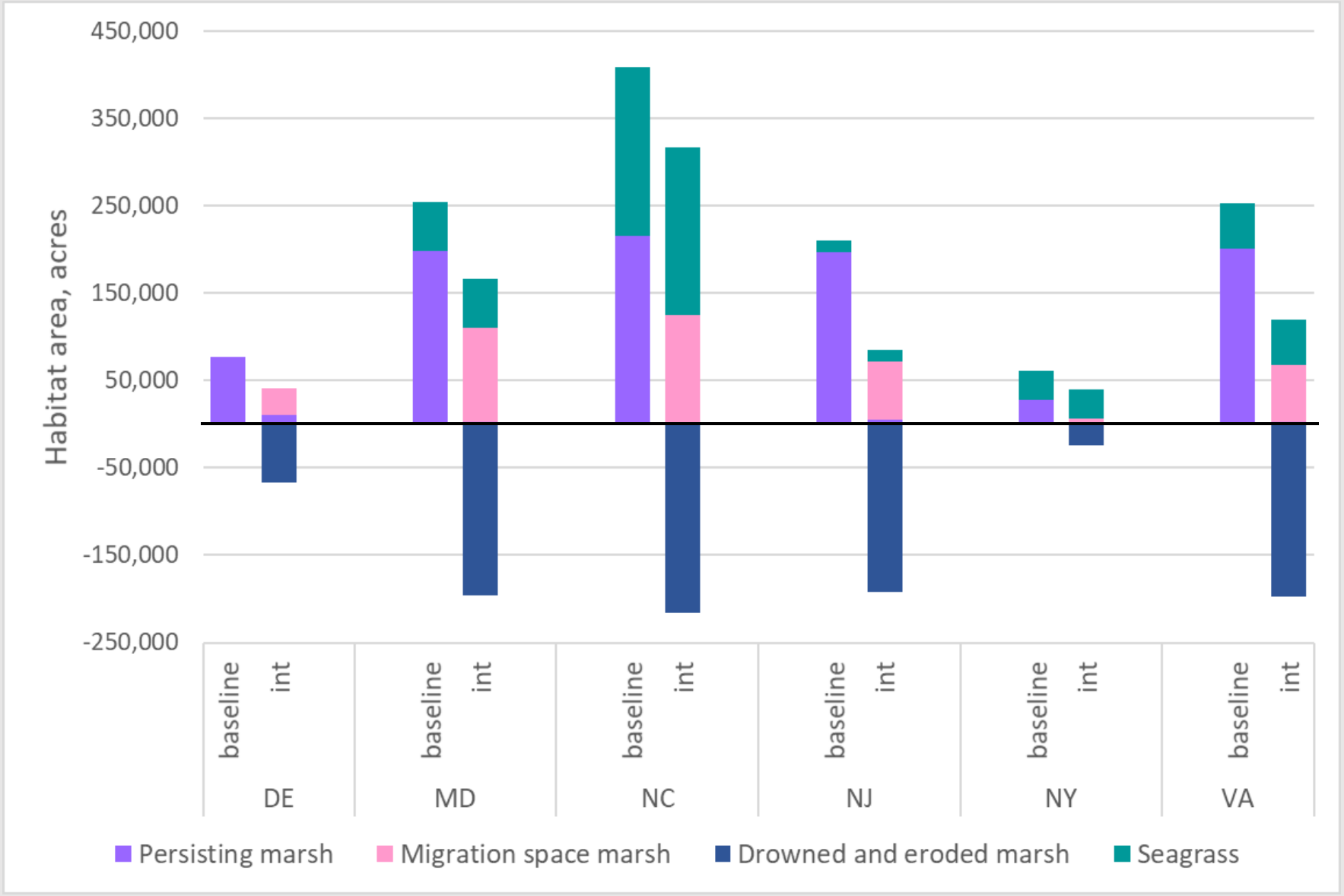
Projected coastal habitat change with SLR



- Existing marsh
- Seagrass
- Area that could be hydrologically connected to create/restore salt marsh
- Drowned marsh
- Eroded marsh
- Migration space marsh
- Hydrologically connected due to SLR

2100, 4’ SLR

Projected coastal habitat change with SLR



Intermediate SLR scenario (4’ SLR by 2100)

Carbon fluxes from habitat change

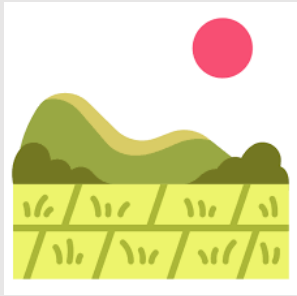
Marsh persistence

Carbon sequestration

Marsh loss
(drowning or erosion)

Carbon emission

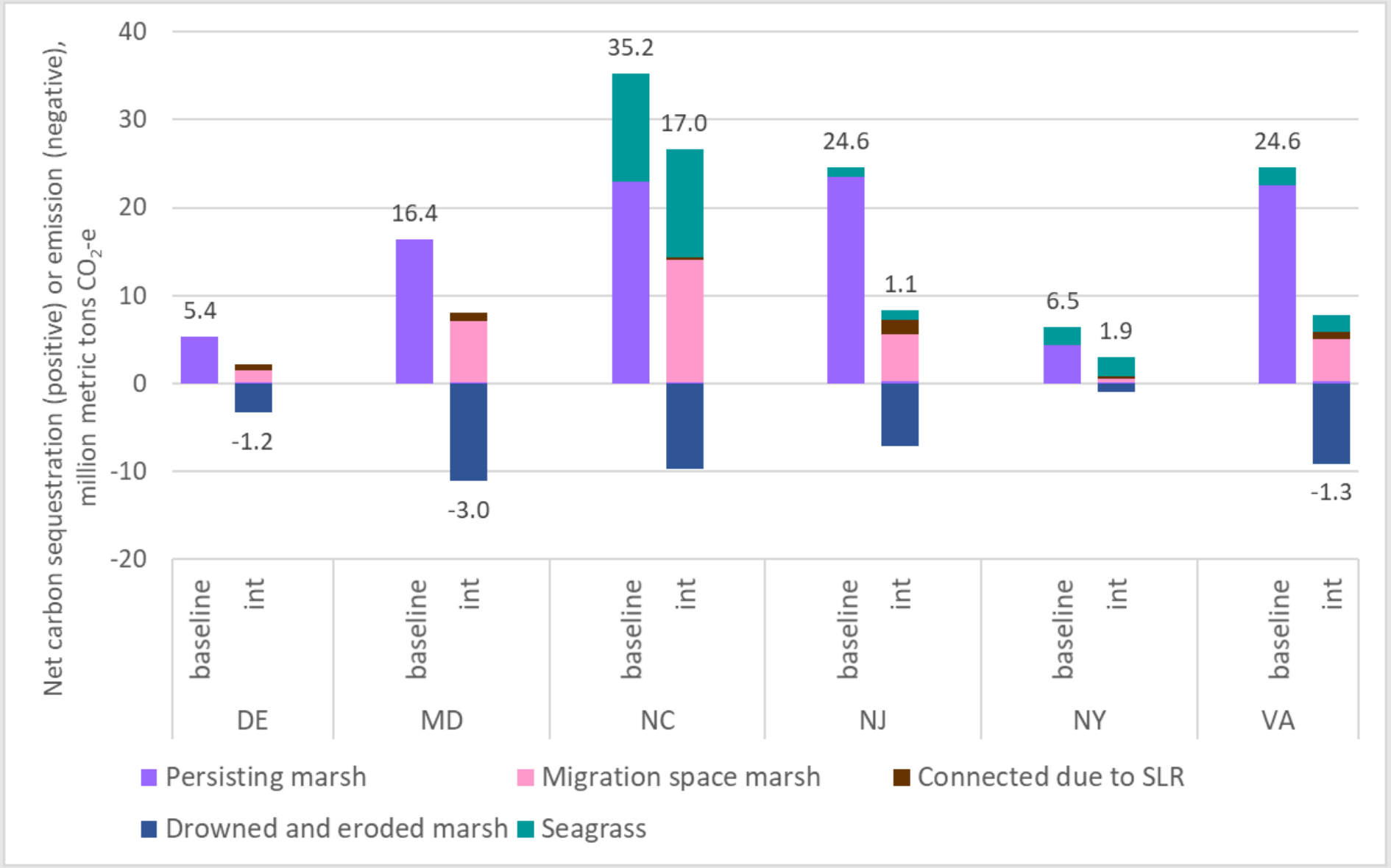
Marsh migration



Carbon sequestration

Carbon flux from lost habitat?

Net blue carbon flux with and without SLR



Dealing with uncertainty

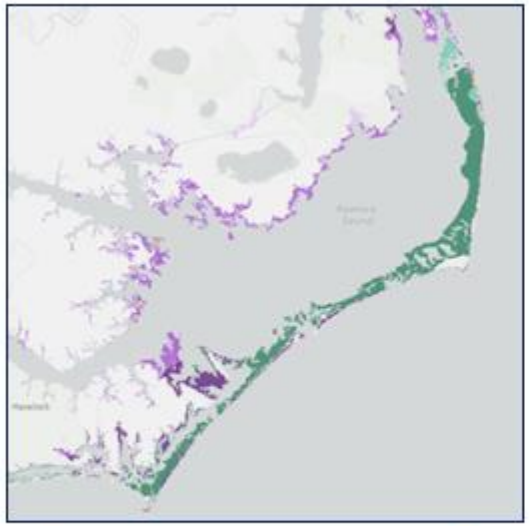
Alter input datasets by +/- percentage reflecting level of uncertainty, then rerun models.

- *Vertical accretion rates*
- *Sediment concentration*
- ***Salinity***
- *Horizontal erosion rate*

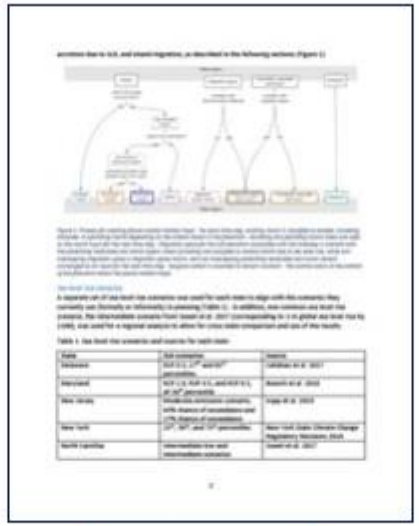
Adjust uncertain assumptions and rerun models.

- *Will seagrass beds be lost due to sea level rise?*
- *Does marsh salinity shift due to sea level rise?*
- *Are agricultural areas and areas projected for future development available for marsh migration?*

Coastal ES mapping: Uses & products



DATA AND WEB MAPS



METHODS

FACT SHEETS

States are incorporating these data into coastal planning processes, greenhouse gas inventories, and communication tools.

Next steps include the uncertainty analysis and blue carbon paper, expanding the analysis to other southeastern and Gulf Coast states, and a planned project to develop guidance for states on incorporating blue carbon into greenhouse gas inventories.

Learn more about these projects: nicholasinstitute.duke.edu/project/coastal-protection-and-blue-carbon-eastern-states

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