Collaborative Activities on Blue Carbon in Maryland

Webinar #1:

Accounting for Maryland's Blue Carbon

December 8, 2021

This webinar explored the readiness of blue carbon science in Maryland to support the state greenhouse gas inventory and restoration projects interested in accessing carbon markets. Framing questions for this discussion include: What do we know about these ecosystems now? Where are the remaining uncertainties? Where should research focus to reduce these uncertainties? How could the state support the advancement of blue carbon science and its applications? Breakout sessions will provide an opportunity for participants to take a deeper dive into key topics and questions.

Agenda

Welcome	Dr. Peter Goodwin, *University of Maryland Center for Environmental Science*
State Perspectives	Dr. Rachel Lamb, *Maryland Department of the Environment*
Presentations	"The Basics of Blue Carbon" - Dr. Brian Needelman, *University of Maryland College Park*
	"Science of Inventory and Accounting" - Dr. James Holmquist & Dr. Patrick Megonigal, *Smithsonian Environmental Reserach Center*
	"Mapping Blue Carbon in Maryland" - Dr. Katie Warnell, *Duke University*
Panel Discussion	Moderator: Dr. Cindy Palinkas, *University of Maryland Center for Environmental Science*
Breakout Sessions	Four sessions based on the presentations

Recording of the Webinar

Maryland Department of Natural Resources · University of Maryland Center for Environmental Science · Maryland Department of the Environment · Sea Grant Maryland

Summary

Key Points

- Coastal ecosystems have very high carbon sequestration rates. The systems include marshes, seagrasses, tidal forested wetlands and mangroves.
- Accounting approaches are still refining methodology. Inventory of total carbon fluxes work by multiplying "emissions factors" by "activities data" (area). Future science and data resource needs were identified that will better inform accounting systems.
- Analysis and modeling shows that habitat changes cause carbon changes, and habitat changes are a result of sea level rise. Sea level rise causes the coastal zone to switch from a carbon sink to a carbon source. Management recommendations for coastal habitats and blue carbon under SLR: enhancement of existing marshes, consideration of SLR in coastal planning, reconnecting of freshwater wetlands to reduce methane emissions.

Breakout Sessions:

1. *Blue Carbon Basics:* The influence of time scale on the emissions and identifying science needs to better understand the blue carbon systems within the larger emissions scenarios. How to accoutn for the differences in fresh versus brackish waters, SAV's impact on it, and a brief entry into the potential impact of nitrous oxide, and lastly how microbial ecology likely impacts the emissions but the impact is not yet fully understood.
2. *Science of Inventory & Accounting.* In this breakout session, discussion included the differences in capabilities of various wetlands (established versus newly created), as well as the differences in saltwater and freshwater marshes for their capacity. Lastly, how water quality impacts the effectiveness of marshes.
3. *Mapping Blue Carbon Systems.* A key question of this breakout surrounded the projected maps and what if any impact future sea level rise, beneficial use of dredge material, and water quality might play in where the blue carbon systems are actually established.
4. *State Application.* Robust discussion around the feasibility of blue carbon systems being incorporated into the GGRA accounting, how Maryland is planning to approach, and acknowledging that individually the impact may be small, but collectively it could be meaningful.

Speaker Bios

Dr. Rachel Lamb 	Dr. Rachel Lamb is a Maryland Sea Grant State Science Policy Fellow in the Maryland Department of Environment's Climate Change Program. Rachel supports carbon assessments and accounting for Maryland's natural and working lands. She also works to advance supportive policy for strategic carbon sequestration activities relative to the state's Greenhouse Gas Reduction Act and broader participation in the Regional Greenhouse Gas Initiative (RGGI). Rachel earned her PhD in Geographical Sciences at the University of Maryland College Park (UMD) where her research centered on the applications of NASA Carbon Monitoring System science to advance strategic reforestation with co-benefits for biodiversity and human livelihoods.
Dr. Brian Needelman 	Dr. Brian Needelman is an Associate Professor of Soil Science at the University of Maryland in the Department of Environmental Science & Technology. He teaches and performs research in the fields of soil science, pedology, coastal wetlands, and coastal resiliency. His coastal wetland research focuses on blue carbon science and management and restoration practices to increase tidal marsh sustainability. His blue carbon research focuses on methods to improve the estimation of methane emissions and the development of carbon crediting systems for coastal wetland restoration and conservation projects.
Dr. James Holmquist 	Dr. James Holmquist is an ecologist specializing in wetlands and climate change issues at the ecosystem scale. He earned his BA in Biology form Loyola Marymount University, where he was also an undergraduate researcher in the Ballona Wetlands. During his Biology PhD work at the University of California, Los Angeles, he began to research feedbacks between wetland landscapes, atmosphere, and climate on millennial time scales. His dissertation focused on the Holocene-length history of peat initiation, carbon storage, and hydrology of remote boreal peat bogs in Northern Ontario, Canada. As a postdoc at UCLA and now with SERC, he leads efforts to measure carbon storage rates in coastal wetlands using dated sediment cores, as well as contribute to models of coastal resilience in the face of projected sea-level rise.

Dr. Patrick Megonigal 	Pat Megonigal is an ecosystem ecologist with interests in carbon and greenhouse gas cycling in wetlands and forests, particularly as they relate to global change. He is he lead investigator of the Global Change Research Wetland, a world class facility dedicated to unraveling the complex ecological processes that confer stability on coastal marshes as they respond to global environmental change.
Dr. Katie Warnell 	Katie Warnell is a policy associate for the Ecosystem Services Program. She is a graduate of Duke University's Master of Environment Management program with a concentration in ecosystem science and conservation and was awarded a geospatial analysis certificate. She has served as an intern at the Triangle Land Conservancy and as a research tech with the Duke University Superfund Research Center. She has conducted research on South Africa's bats with the Organization for Tropical Studies and was involved in a DukeEngage project on fish farming in Ecuador.
Dr. Cindy Palinkas 	Cindy Palinkas is an Associate Professor with the Horn Point Laboratory at the University of Marlyand Center for Environmental Science. She received her PhD in Geological Oceanography from the University of Washington. She specializes in the formation and preservation of sedimentary strata in the geologic record, sediment deposition and accumulation in intertidal, fuvial, estuarine and continental-shelf environments, radioisotope geochronology, and sediment-vegetation interactions.

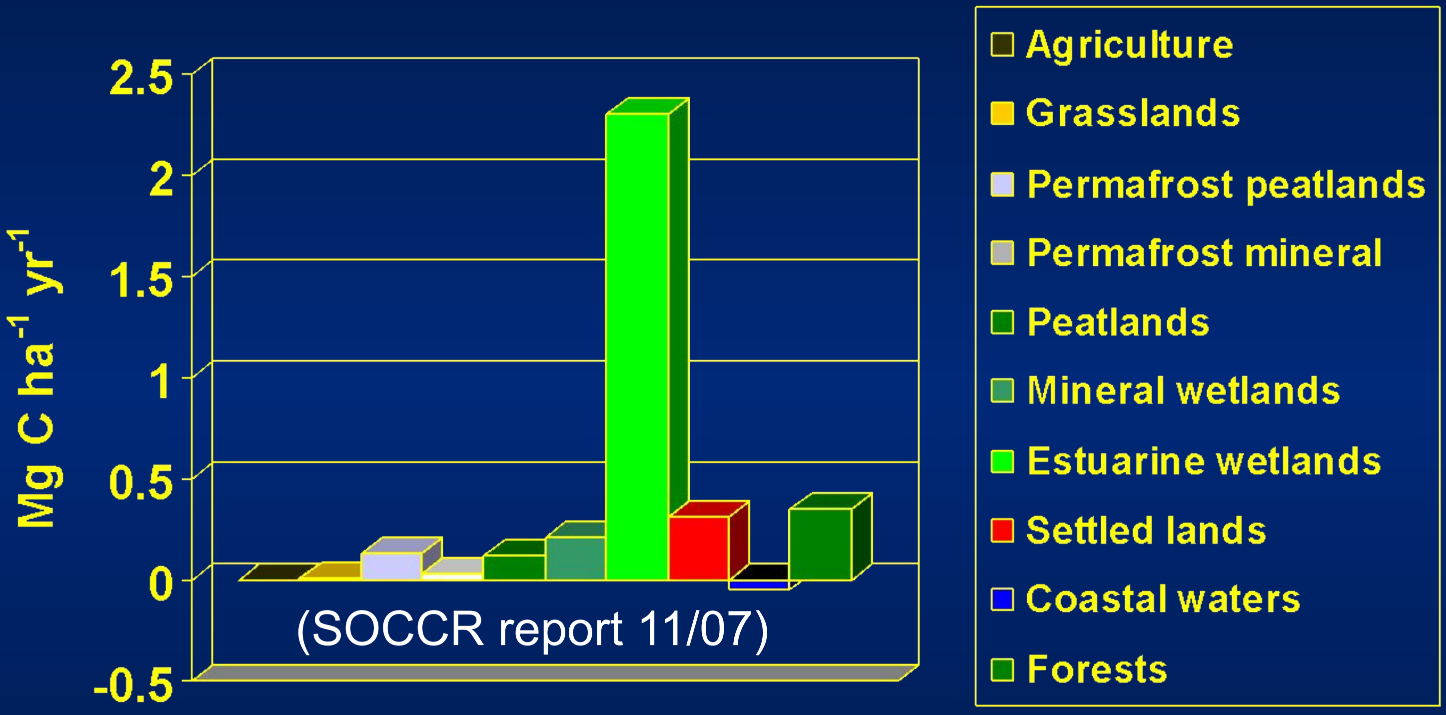
The Basics of Blue Carbon

Brian Needelman
University of Maryland

DEPARTMENT OF ENVIRONMENTAL SCIENCE & TECHNOLOGY
College of Agriculture & Natural Resources
www.enst.umd.edu

Webinar: Accounting for Maryland's Blue Carbon.
December 8, 2021

Blue Carbon: Coastal ecosystems have very high carbon sequestration rates



Carbon sequestration: removal of carbon dioxide (CO_2) from the atmosphere and storage in soils and plant biomass

Blue carbon: coastal wetland ecosystems

Marshes

Mangroves

Seagrasses

Tidal Forested Wetlands

Why such high rates of carbon sequestration?

High rates of photosynthesis

Accretion with sea-level rise: increasing soil volume over time

Slow rates of organic matter decomposition

"Blue carbon" is not all good: Methane emissions

- Methane (CH_4) produced in anaerobic wetland soils
- Powerful greenhouse gas that offsets some or all of the carbon sequestration benefit
- Minimal in high salinity wetlands
- Brackish and freshwater wetlands: highly variable and difficult to estimate

Nitrous oxide: An even stronger greenhouse gas

- Nitrous oxide (N_2O) emissions are generally very low in most tidal wetlands
- …. but may be elevated in some cases, such as high nitrogen inputs

Blue Carbon Inventory for Maryland

- How much carbon is already stored in Maryland coastal wetlands?
- Carbon sequestration rates
- Methane and nitrous oxide emissions
- Potential for blue carbon benefits through restoration, conservation, and creation projects
- Predicting change with sea level rise and other future scenarios

Generating blue carbon credits for carbon markets

- Requires human action causing a net reduction in greenhouse gases
- Net reduction determined by comparing the project with the "baseline scenario"
  - What would have happened in the absence of the project

Generating blue carbon credits for carbon markets

- Complicated and expensive
  - Large-scale or grouped projects best
- Blue carbon credits in high demand!

Example carbon credit projects

- Wetland creation (simple)
- Wetland restoration that increases long-term carbon sequestration rates
- Reducing methane emissions by increasing salinity
- Wetland conservation that prevents the loss of existing carbon stocks (e.g. eroded soils losing carbon)

Summary

- Blue carbon is an important ecosystem service provided by coastal wetlands
- Global interest and projects happening
- Blue carbon by itself unlikely to drive most MD wetland restoration and conservation projects
  - As one of many ecosystem services, blue carbon is significant and fundable
  - Possible exceptions now and in future

Thank you!

Brian Needelman
bneed@umd.edu

<u>Funding</u>
Maryland Department of Natural Resources
Restore America's Estuaries
NOAA, USDA

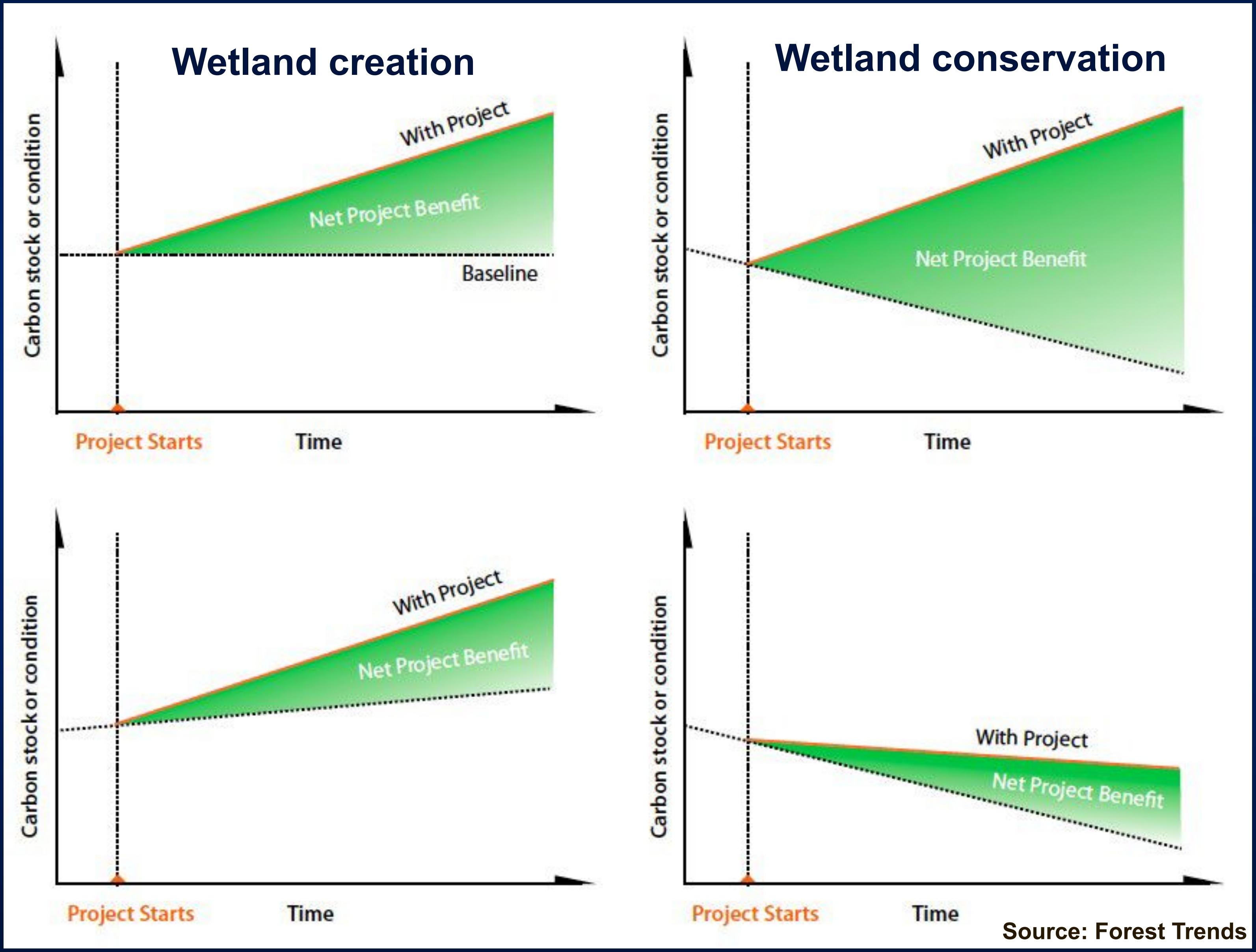
Derby et al. 2021. Vegetation and hydrology stratification as proxies to estimate methane emission from tidal marshes. Biogeochemisry.

Needelman et al. 2018. The Science and Policy of the Verified Carbon Standard Methodology for Tidal Wetland and Seagrass Restoration. Estuaries and Coasts.

Needelman et al. 2018. Blue Carbon Accounting for Carbon Markets. CRC Press.

Emmer et al. 2015. Coastal Blue Carbon in Practice: A Manual for Using the VCS Methodology for

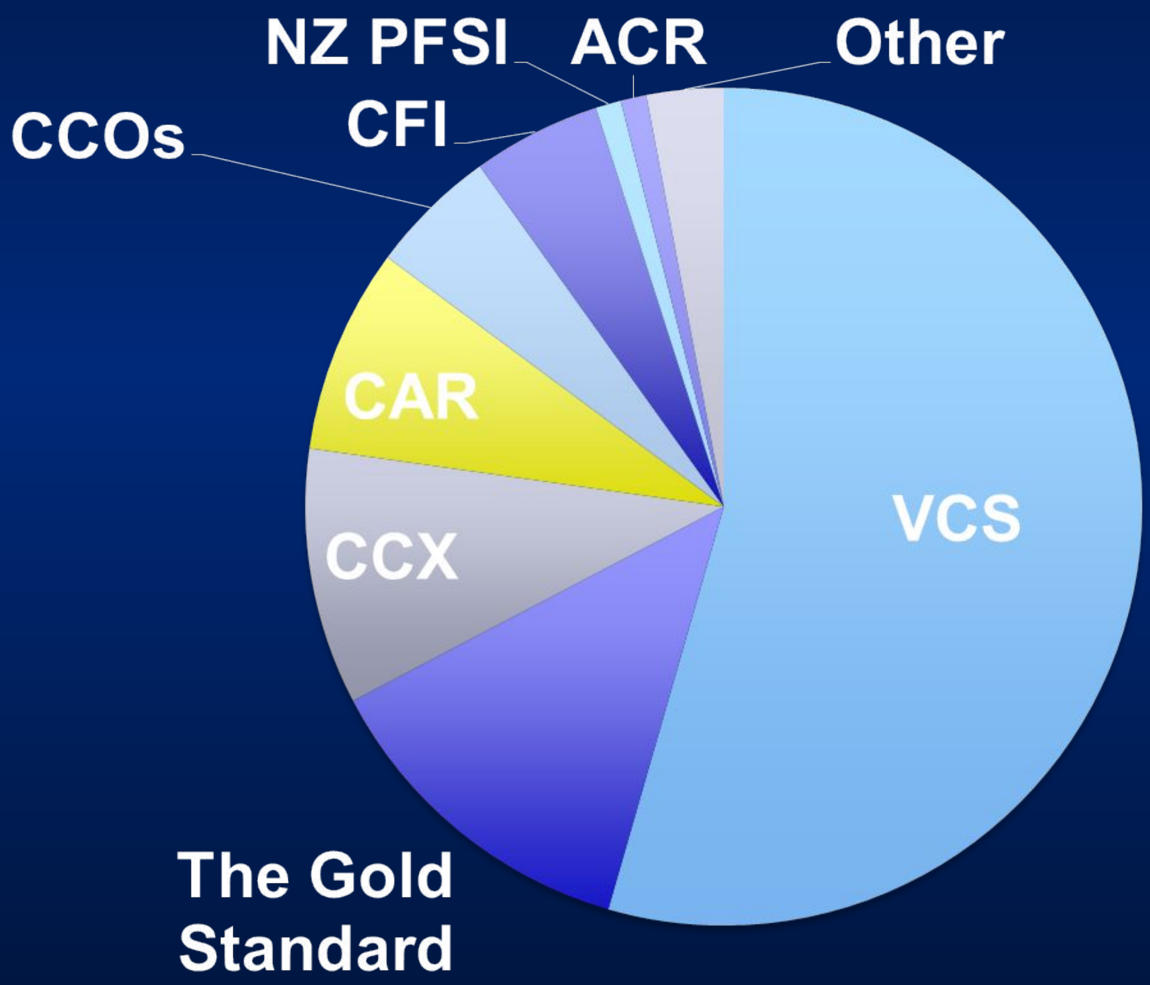
Baseline vs. Project scenarios



Methodology for Tidal Wetland and Seagrass Restoration, v. 1.0 Verified Carbon Standard (VCS)

Igino Emmer, Silvestrum
Brian Needelman, University of Maryland
Steve Emmett-Mattox, Restore America’s Estuaries
Steve Crooks, Environmental Science Associates
Pat Megonigal, SERC
Doug Myers, Chesapeake Bay Foundation
Matthew Oreska and Karen McGlathery, Univ. of VA
David Shock, Terracarbon

Verified Carbon Standard



State of the Voluntary Carbon Markets, 2013

VM0033

Methodology for Tidal Wetland and Seagrass Restoration, v1.0

This methodology outlines procedures to quantify net greenhouse gas emission reductions and removals resulting from project activities implemented to restore tidal wetlands. Such activities include creating and/or managing the conditions required for healthy, sustainable wetland ecosystems.

Projects applying this methodology are expected to generate greenhouse gas emission reductions and removals primarily by increasing both biomass and autochthonous soil organic carbon. Projects applying this methodology may be developed anywhere in the world.

Download Methodology

- Document History

Developers

Restore America's Estuaries

Silvestrum

Sectoral Scope

14. Agriculture, Forestry, Land Use

First Assessor

Environmental Services, Inc.

Second Assessor

DNV GL Climate Change Services

Status

Approved

Approval Date

https://www.estuaries.org/bluecarbon-resources

Restoration Practices

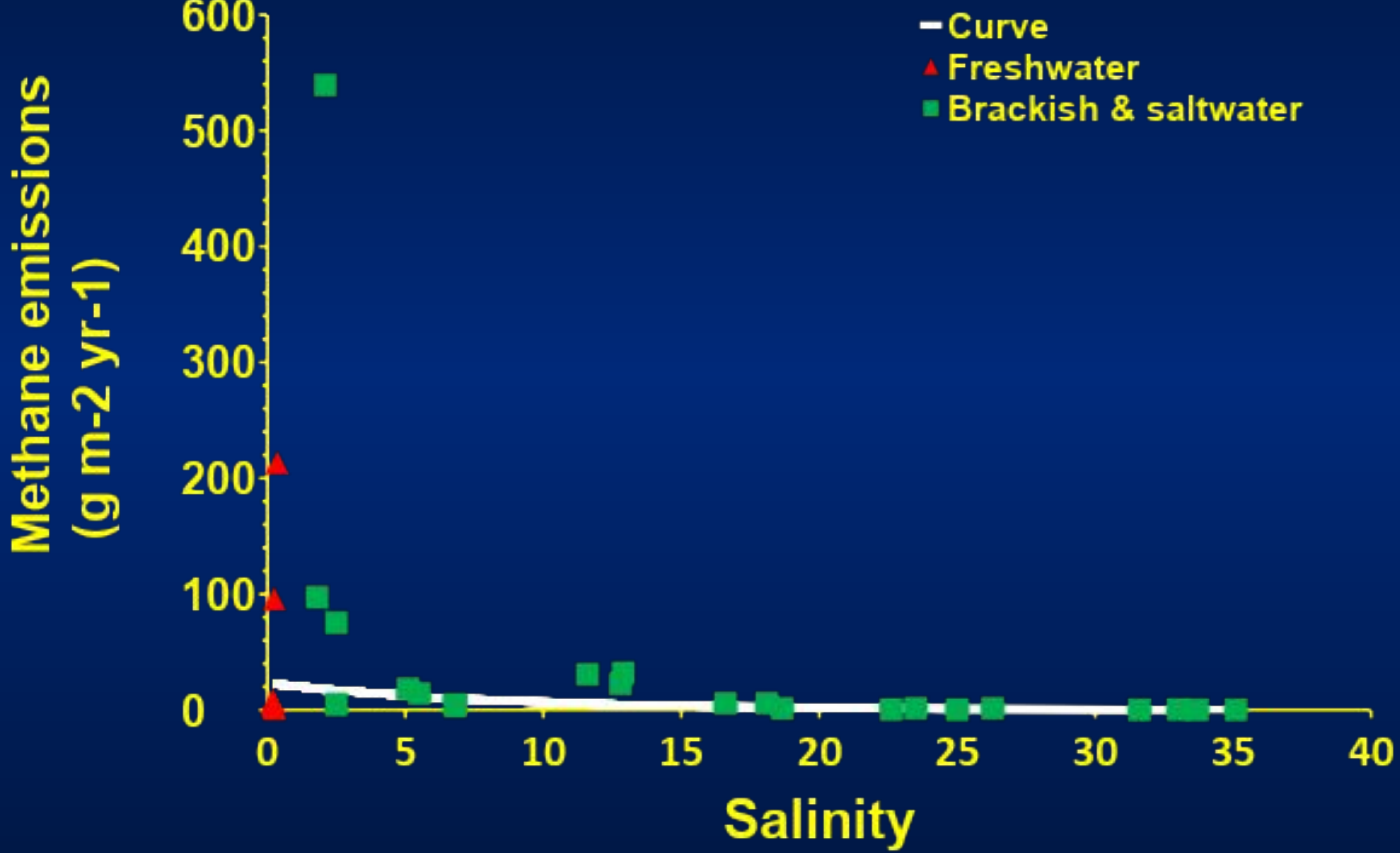
- Creating, restoring and/or managing hydrological conditions
- Altering sediment supply
- Changing salinity characteristics
- Improving water quality
- Introducing native plant communities
- Improving management practices

Value of carbon sequestration for marsh restoration (1.46 Mg C ha^{-1} yr^{-1}; 30 years)

Price per Mg CO_2	100 hectares	1000 hectares
$5.00	$80,300	$803,000
$10.00	$160,600	$1,606,000
$40.00	$642,400	$6,424,000
$80.00	$1,284,800	$12,848,000

Rare opportunity for post-project funding

Salinity versus methane emissions



Poffenbarger, Needelman & Megonigal, Wetlands, 2011

Prescribed fire and blue carbon

A word of caution

- One car = 1.6 acres of marsh

http://www.epa.gov/cleanenergy/energy-resources/refs.html#vehicles

Global warming potentials

- Definition: Global warming from instantaneous release of a gas over certain period of time (time horizon) relative to carbon dioxide

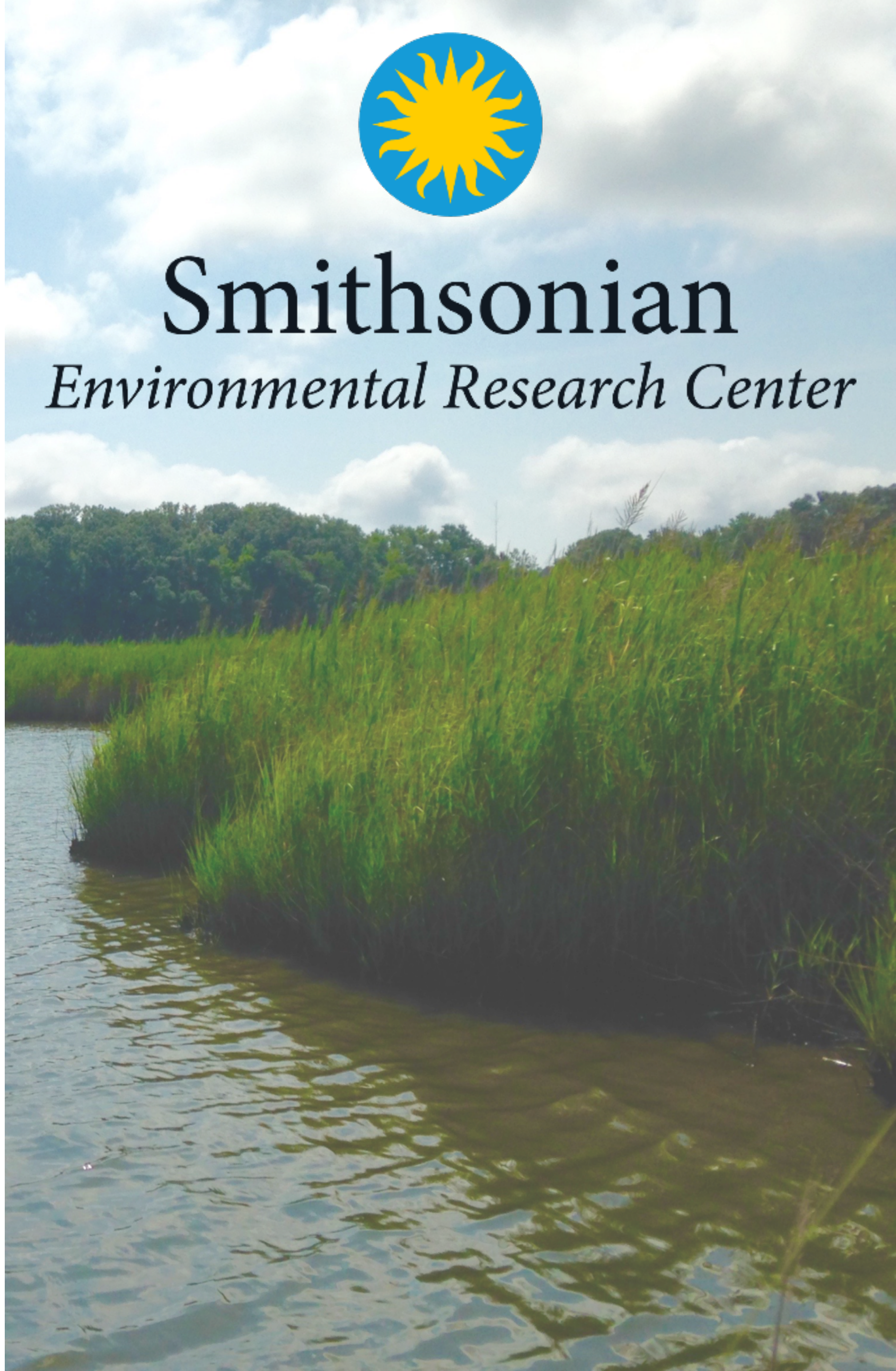
CO_2

CH_4

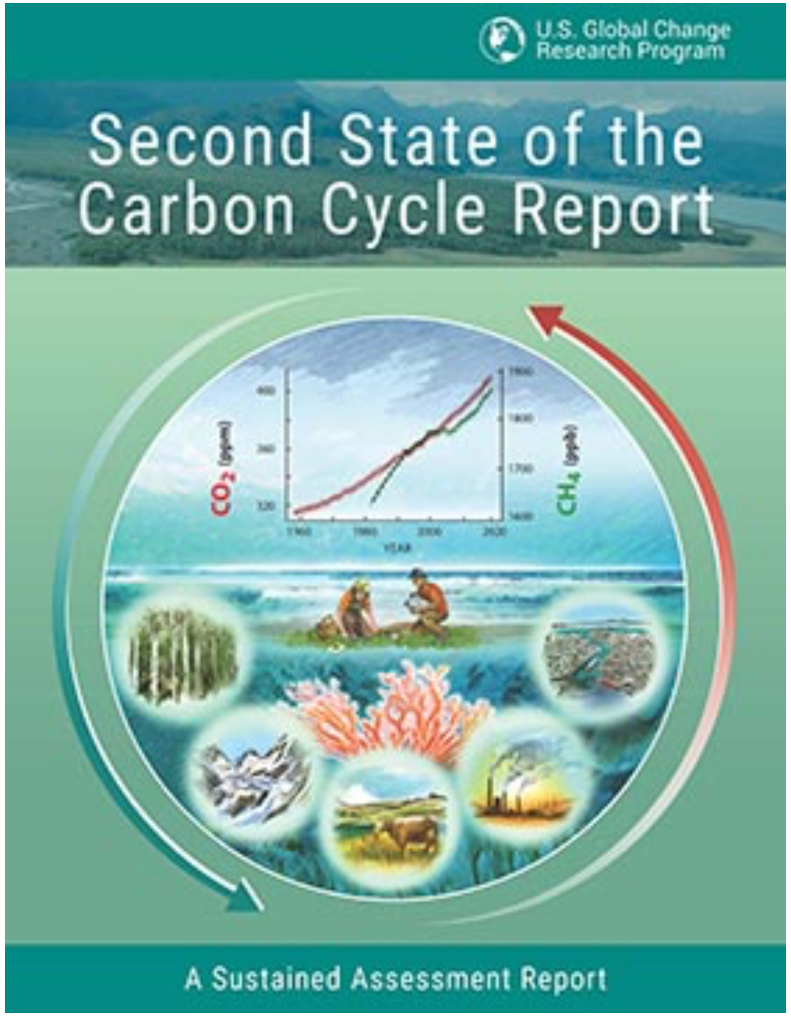
Science of inventory and accounting

James R Holmquist and J. Patrick Megonigal

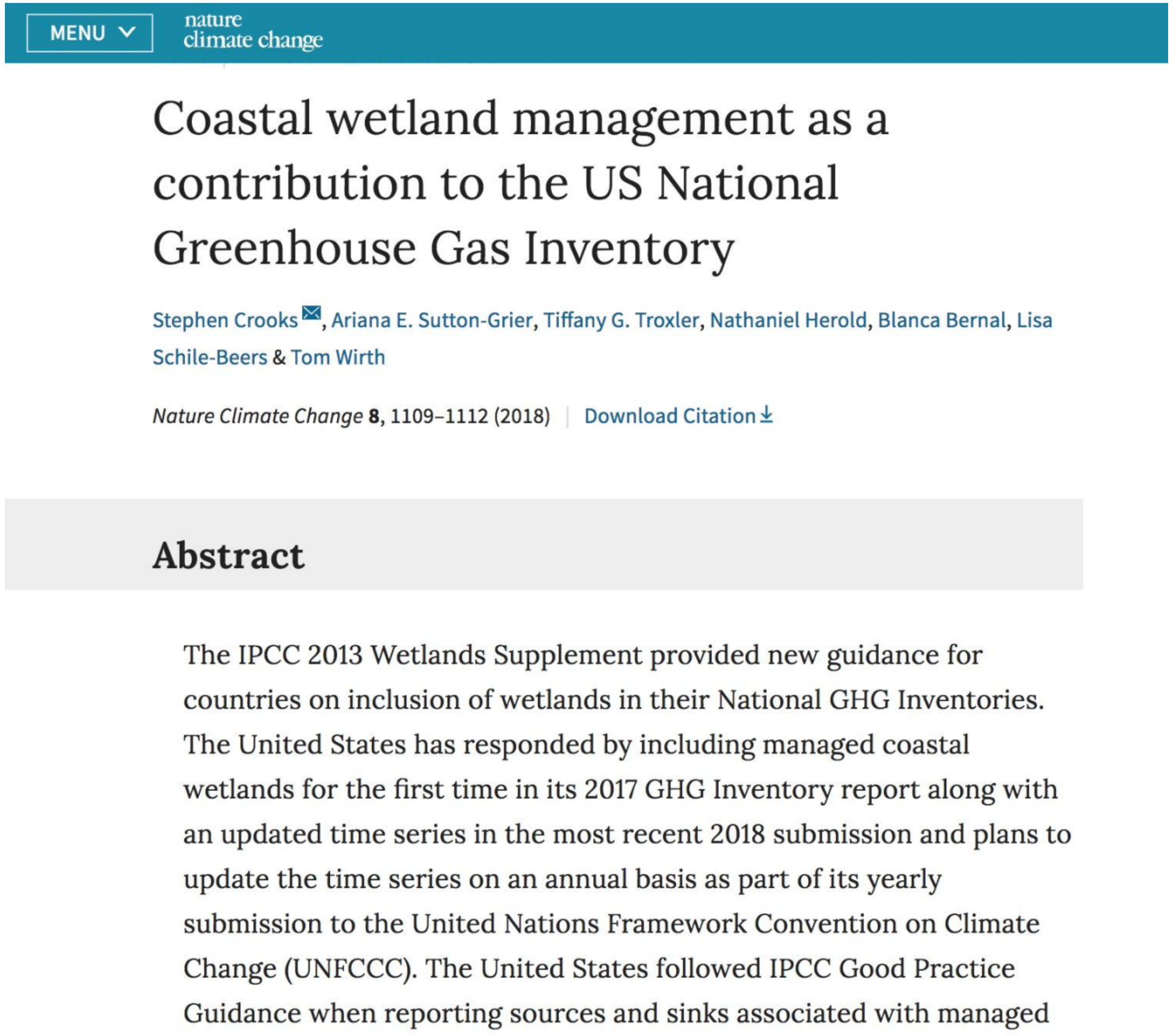
THE PEW CHARITABLE TRUSTS



Continental and National-Scale Coastal Carbon Accounting



Windham-Myers and Cai eds. (2018). Ch 12. *SOCCR-2.*


MENU
nature climate change

Coastal wetland management as a contribution to the US National Greenhouse Gas Inventory

Stephen Crooks, Ariana E. Sutton-Grier, Tiffany G. Troxler, Nathaniel Herold, Blanca Bernal, Lisa Schile-Beers & Tom Wirth

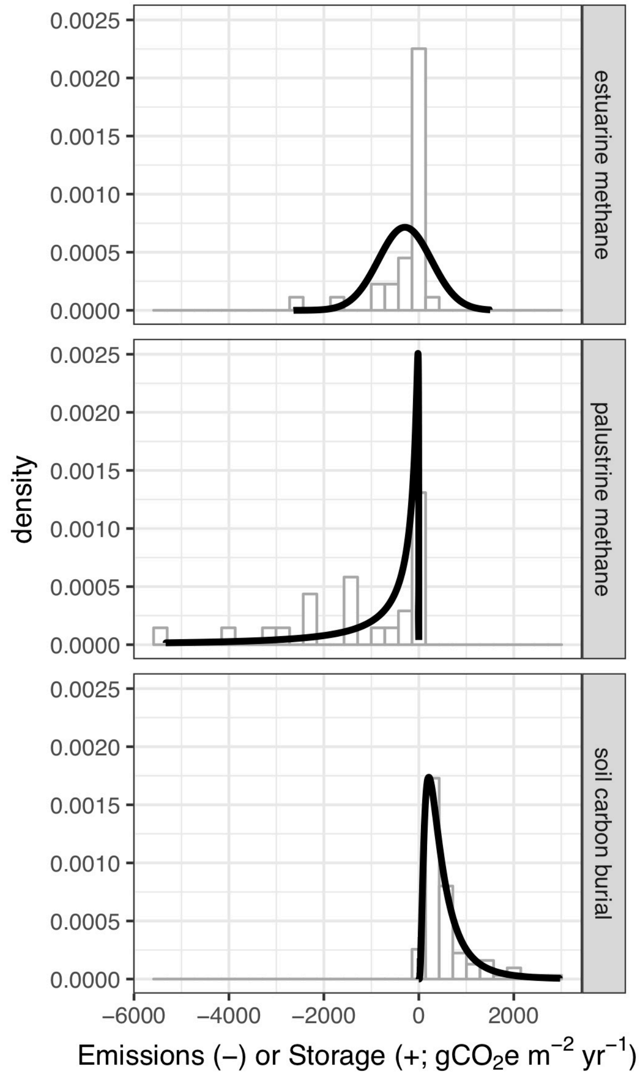
Nature Climate Change **8**, 1109–1112 (2018) | Download Citation

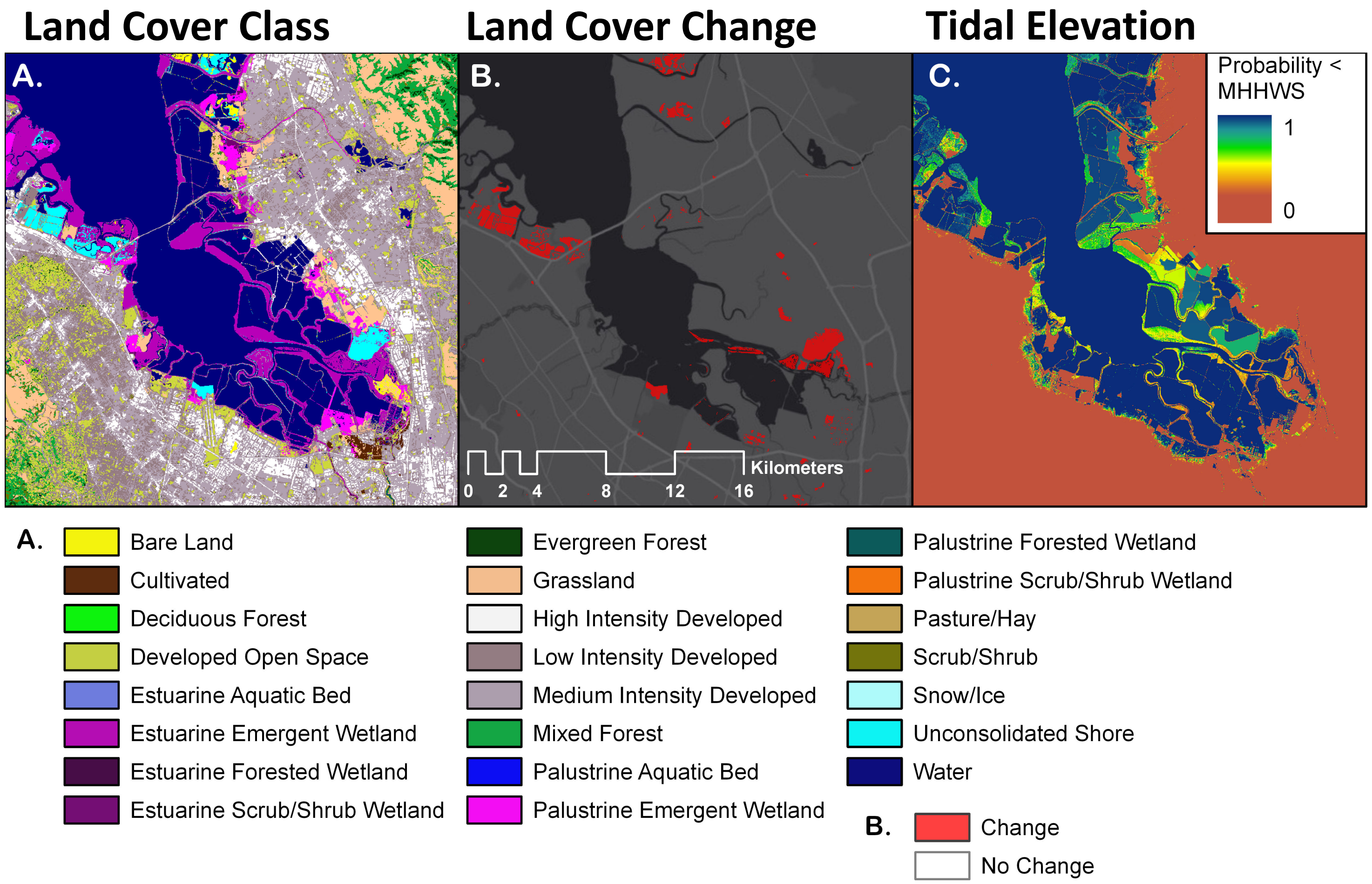
Abstract

The IPCC 2013 Wetlands Supplement provided new guidance for countries on inclusion of wetlands in their National GHG Inventories. The United States has responded by including managed coastal wetlands for the first time in its 2017 GHG Inventory report along with an updated time series in the most recent 2018 submission and plans to update the time series on an annual basis as part of its yearly submission to the United Nations Framework Convention on Climate Change (UNFCCC). The United States followed IPCC Good Practice Guidance when reporting sources and sinks associated with managed

Crooks et al (2018) *Nature Climate Change.*

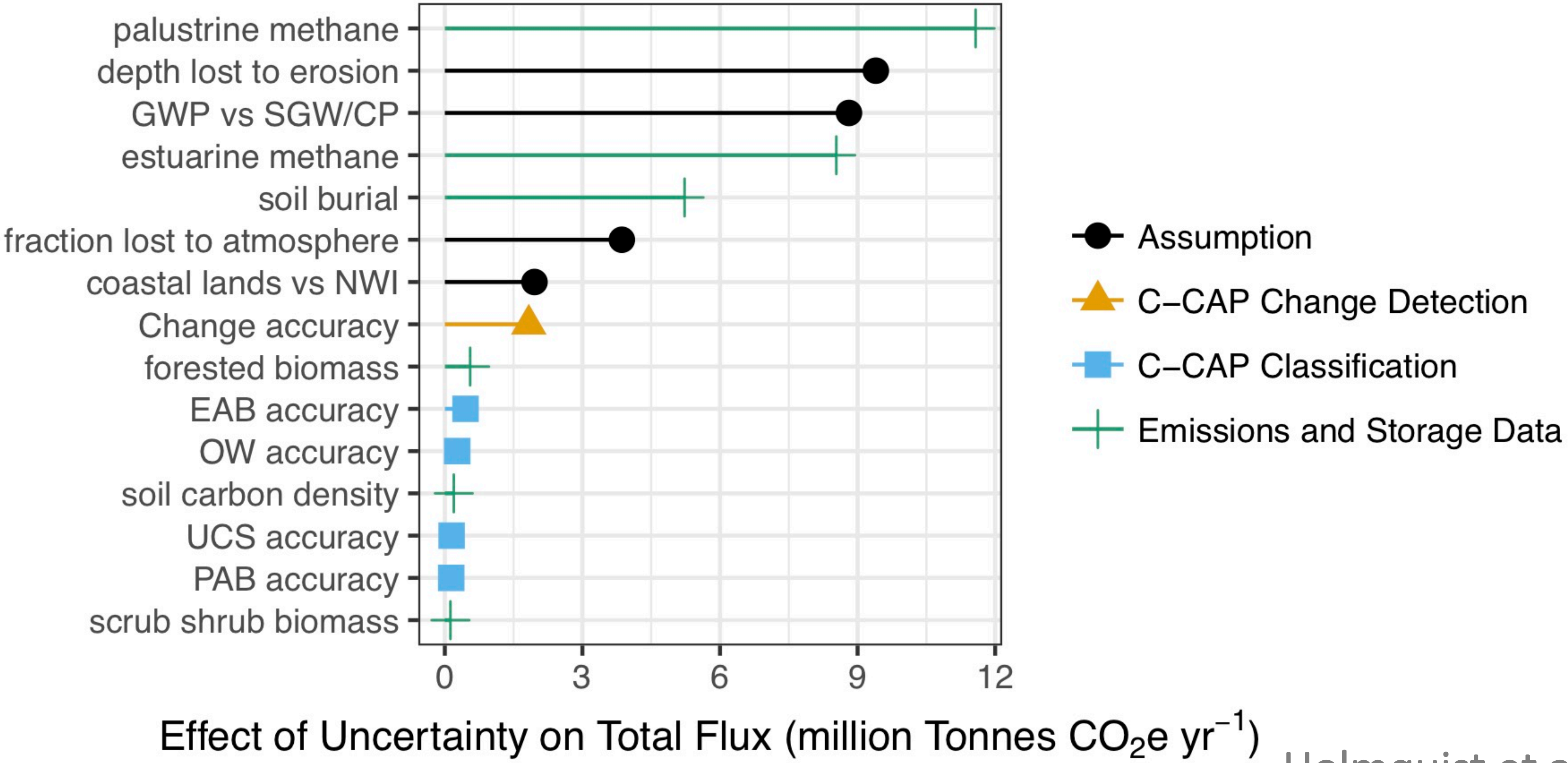
Inventory of total carbon fluxes work by multiplying “emissions factors” (flux / area) by ”activities data” (area).



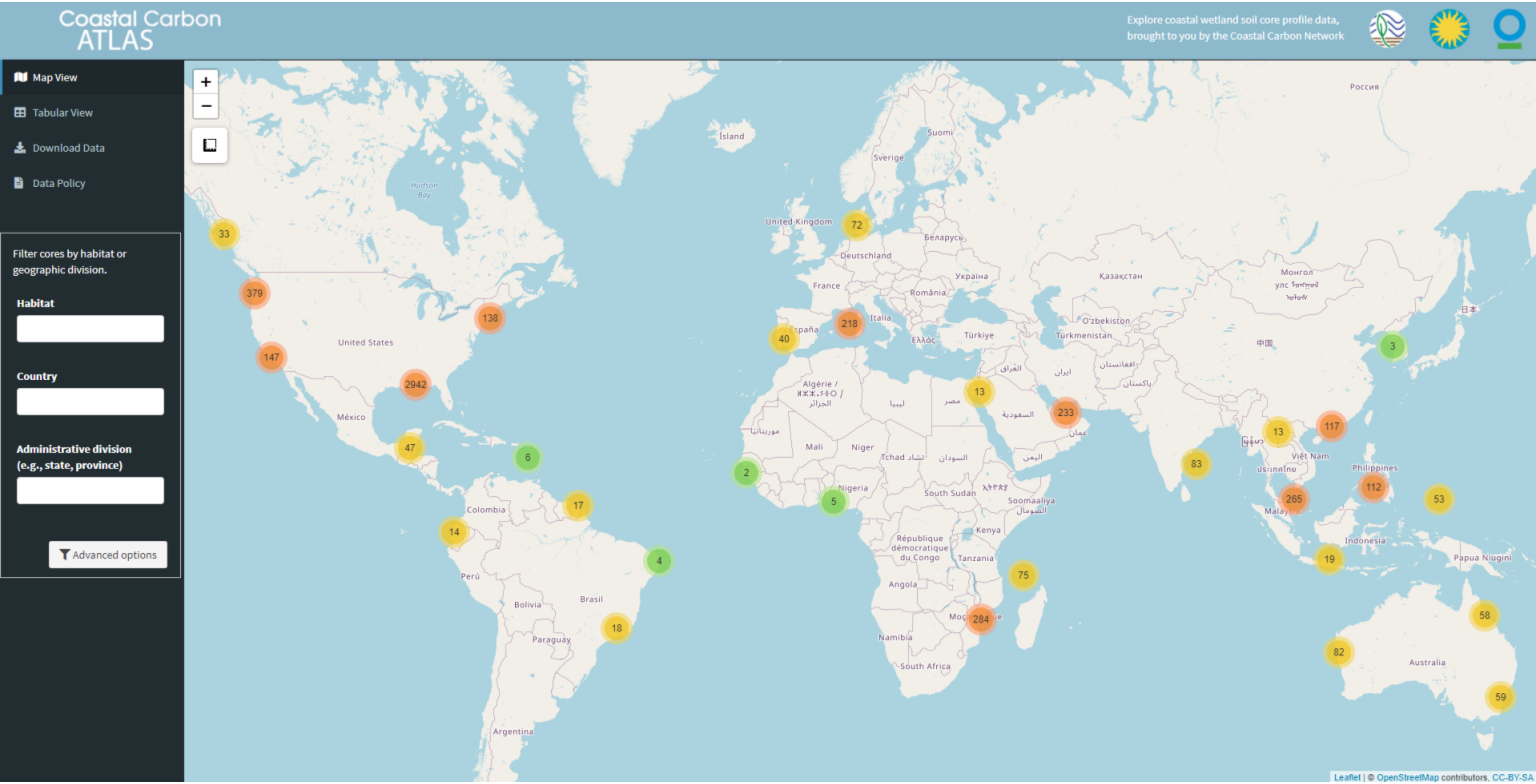


Holmquist et al. 2018 *Environmental Research Letters*

One-at-a-time sensitivity analysis shows methane, carbon burial, and assumptions dominate uncertainty.

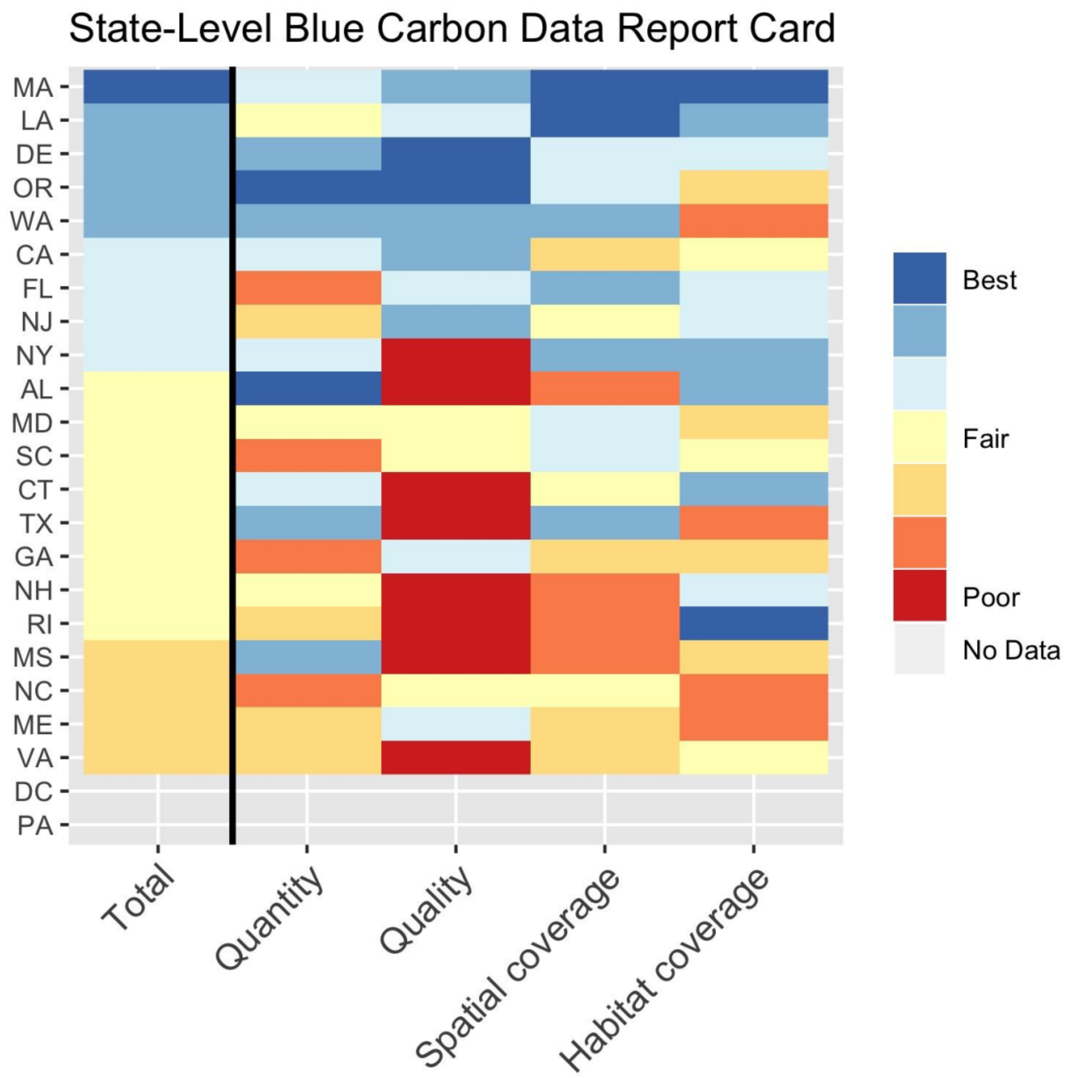


Holmquist et al. 2018
Environmental Research Letters

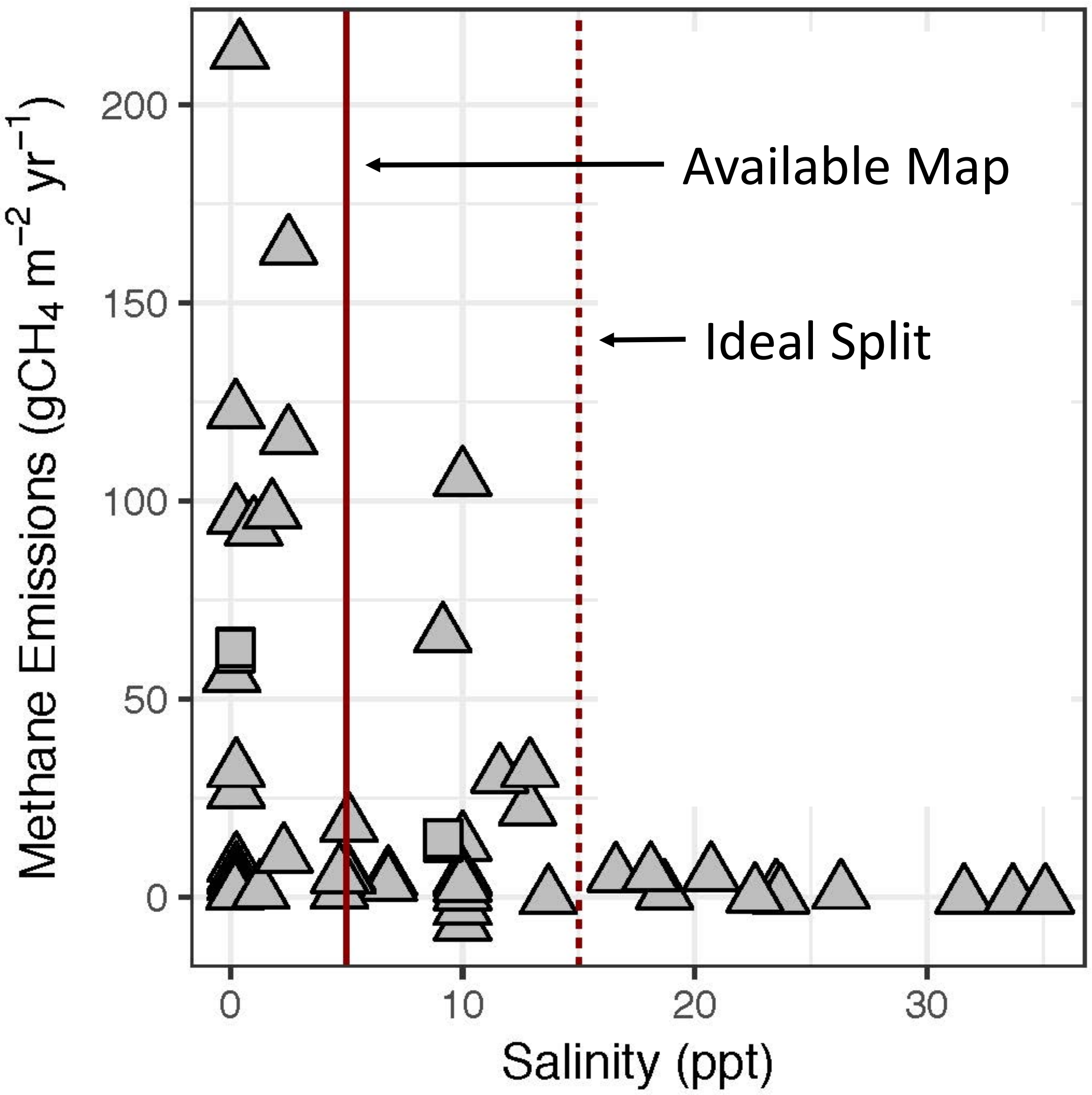


Coastal Carbon
ATLAS
Explore coastal wetland soil core profile data,
brought to you by the Coastal Carbon Network
Map View
Tabular View
Download Data
Data Policy
Filter cores by habitat or
geographic division.
Habitat
Country
Administrative division
(e.g., state, province)
Advanced options
Leaflet | © OpenStreetMap contributors, CC-BY-SA

Blue Carbon Report Cards communicate where new data resources are needed at the state level.

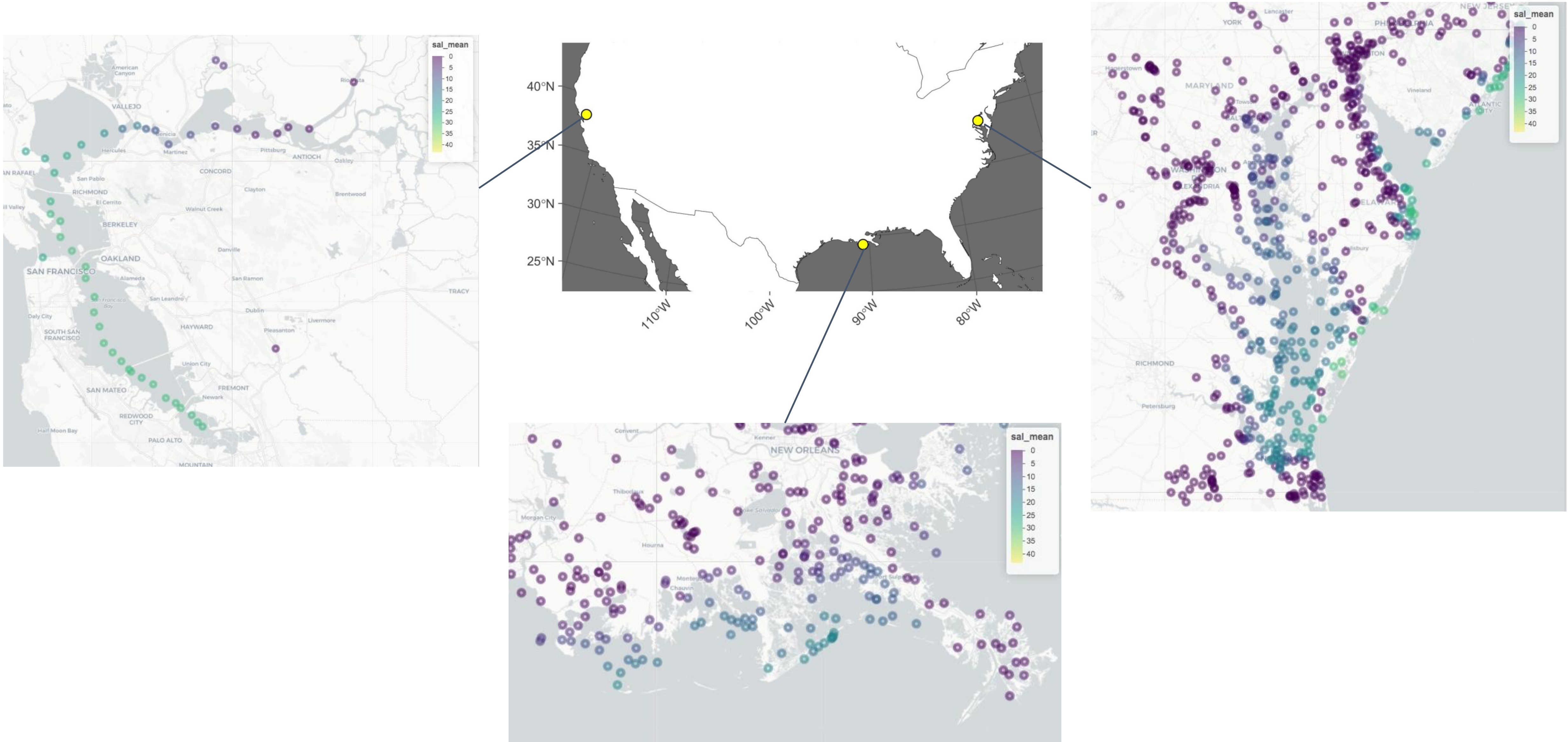


The maps we have to upscale methane emissions split between saltier and fresher wetlands at a spot not optimal for methane carbon monitoring. We need new maps.



Holmquist et al. 2018 *Environmental Research Letters.*

National Scale Salinity Mapping: Surface Water Salinity



Tidal wetland restoration

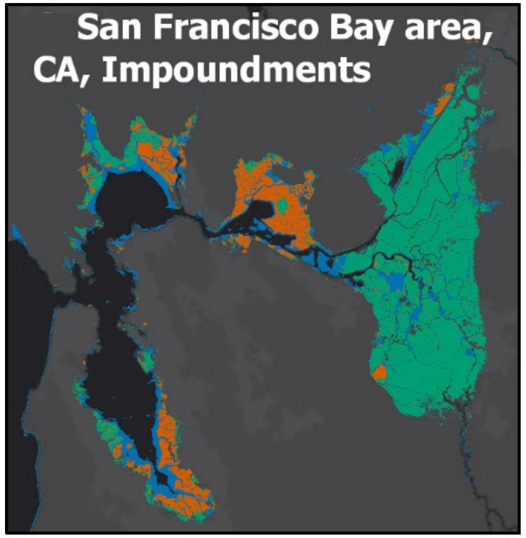
Credit: Kevin Kroeger

Landscape-Scale Quantification of Tidal Reintroduction Potential

1 GIS Classification & Mapping

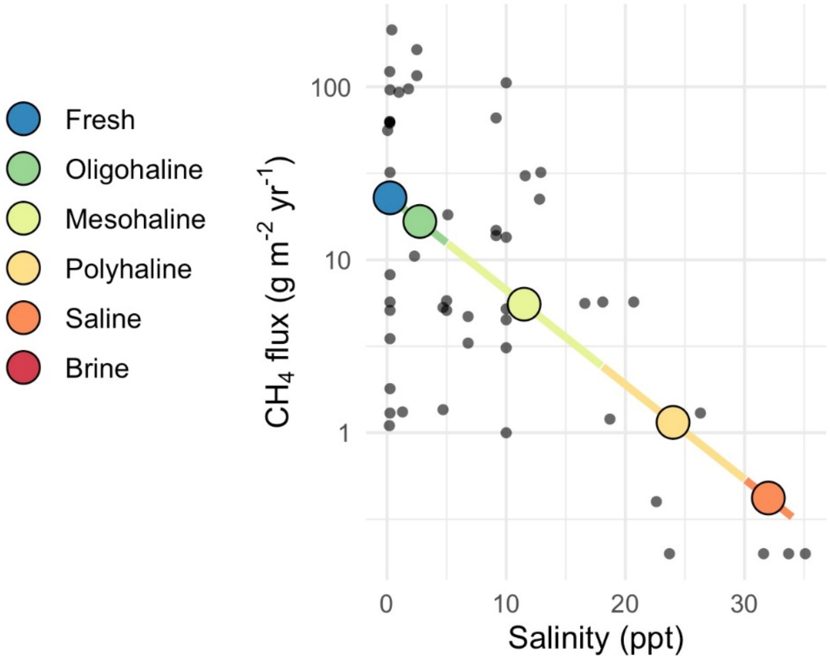
2 Relationship of CH_4 emissions to salinity

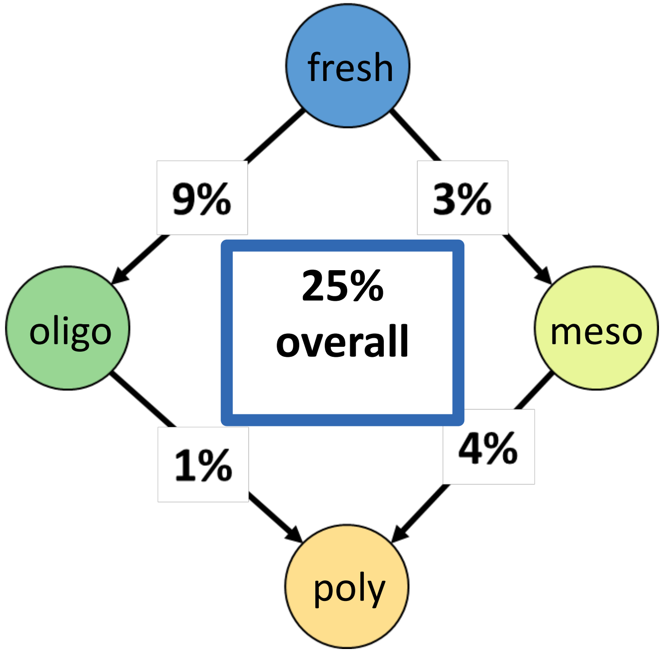
3 Proportion of sites with potential to restore to a more saline condition



Landcover Classes

- Diked/Impounded
- Non-Diked/Non-Impounded
- Non-Wetland/Non-Water





Jim Holmquist & Kevin Kroeger, unpublished

Please contact James Holmquist (HolmquistJ@si.edu) with questions.

Mapping blue carbon in Maryland: current status and future effects of sea level rise

Maryland Blue Carbon webinar – December 8, 2021

Katie Warnell and Lydia Olander (Duke University)
Carolyn Currin (NOAA)

Mapping current MD blue carbon

Current coastal habitats:

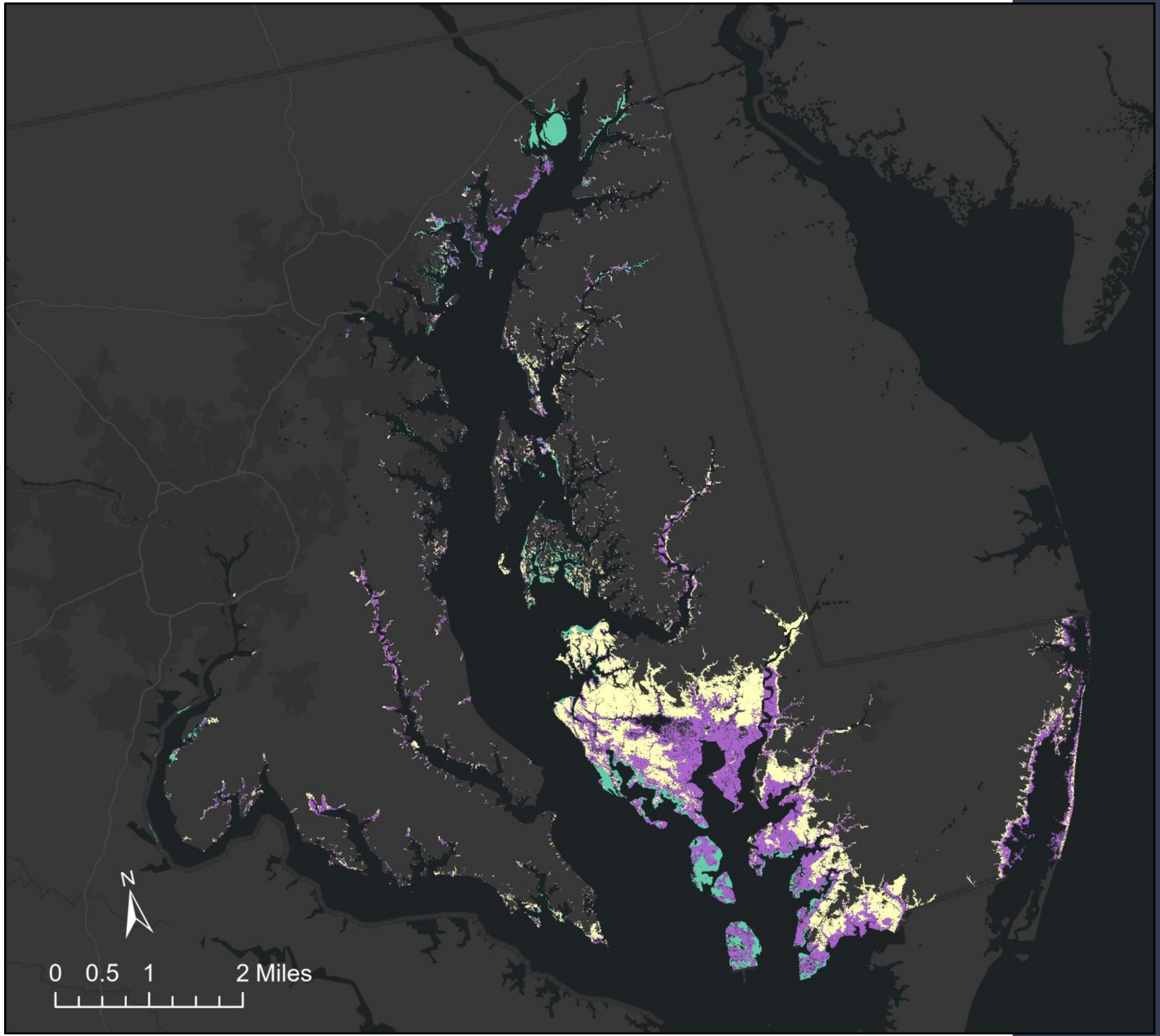
- Coastal marsh: 198,000 acres
- Seagrass: 56,000 acres
- Transition zone for 4' SLR: 211,000 acres

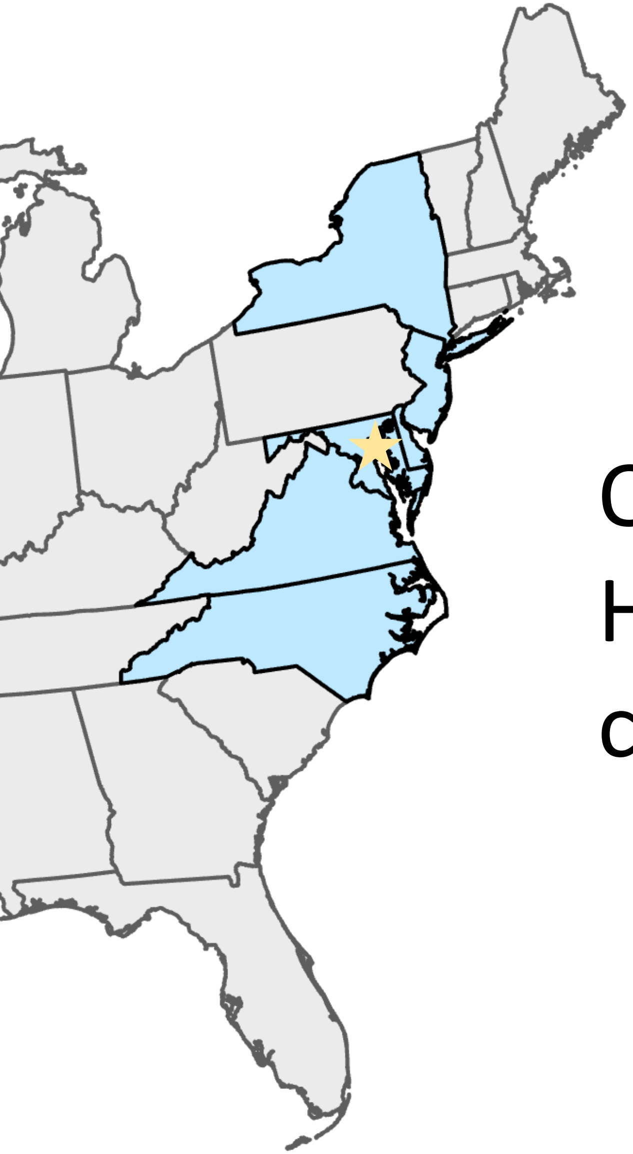
Current carbon stocks in these habitats:
73.3 million MT CO_2e

Current annual C sequestration by these habitats:

- Coastal marsh: 143,000 MT CO_2e/year
- Seagrass: 41,000 MT CO_2e/year
- Transition zone for 4' SLR: 185,000 MT CO_2e/year

MD net GHG emissions (2017): 67.4 MMT CO_2e
Blue carbon sequestration: 0.3% of net GHG emissions
Coastal zone carbon stocks: 109% of net GHG emissions



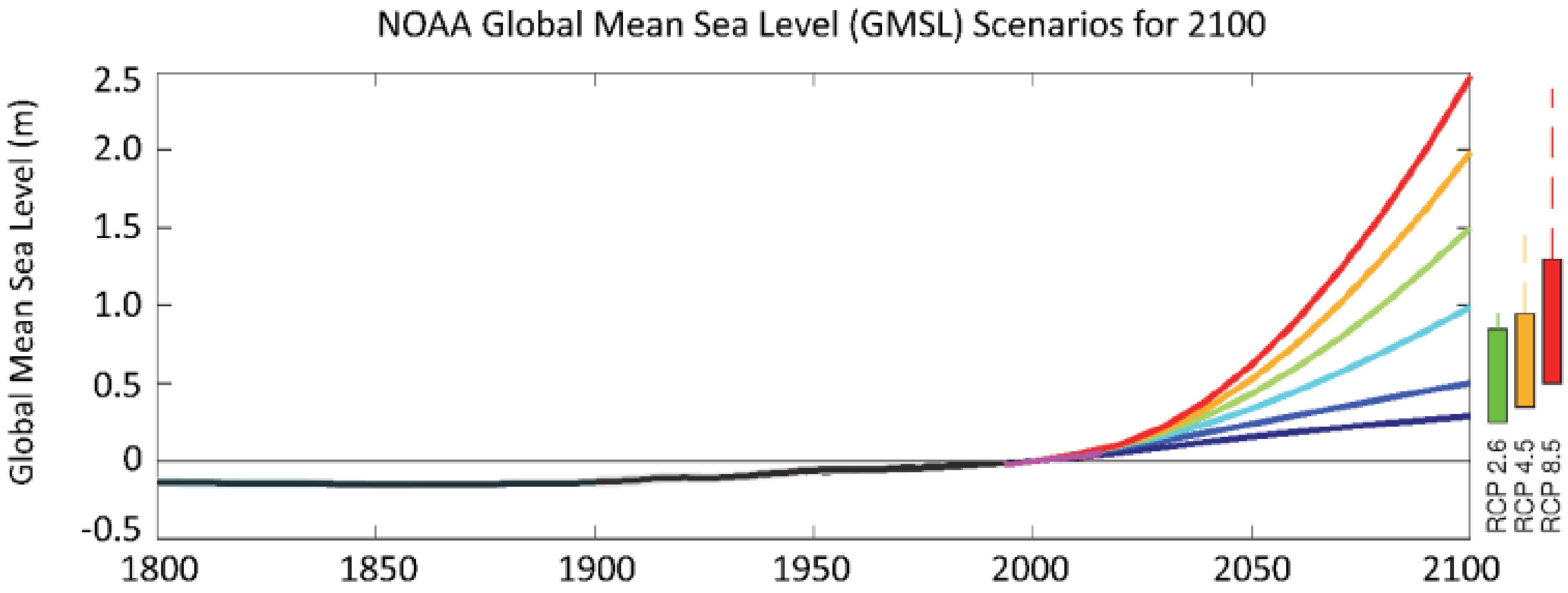


Our research question:

How will coastal habitats and blue carbon change due to sea level rise?

UNITED STATES
CLIMATE ALLIANCE

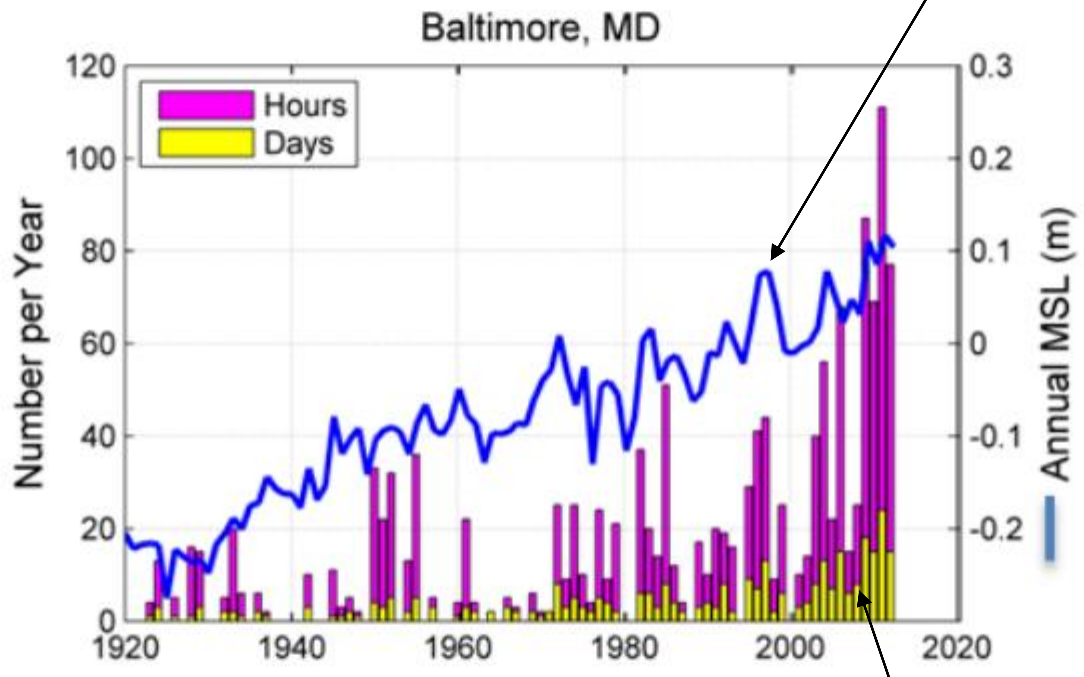
Sea level is rising globally



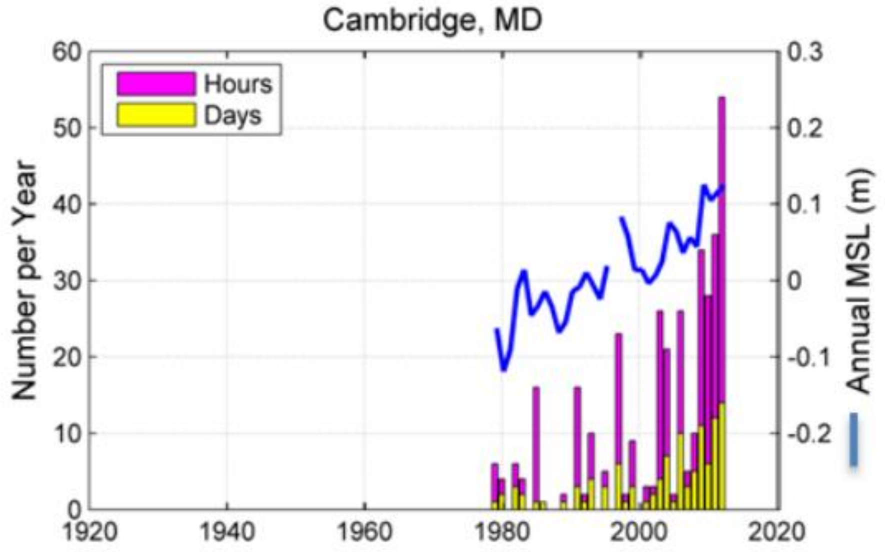
NOAA Technical Report 083, 2017

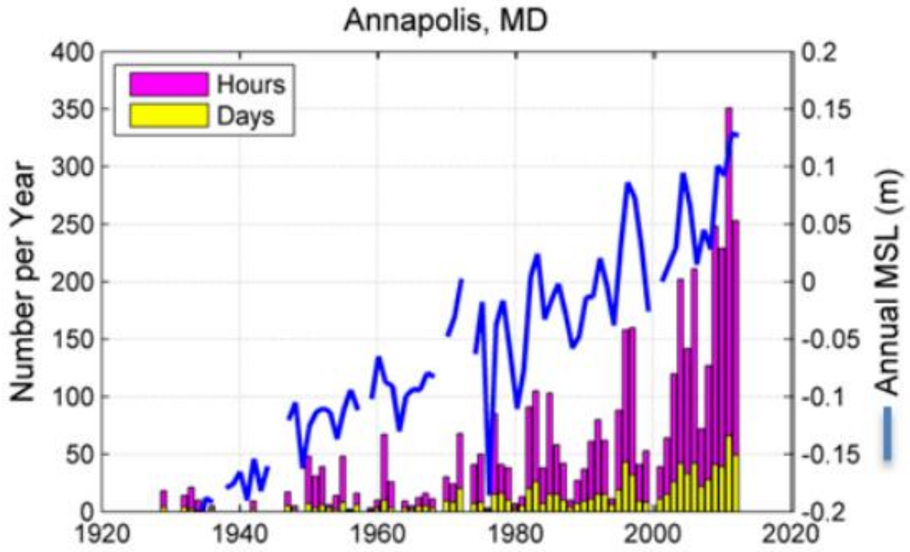
Sea level is rising globally and in Maryland

Mean sea level



Nuisance (sunny day) flooding events





NOAA Technical Report 073, 2014

Sea level rise impacts coastal habitats

Alicia Pimental, Chesapeake Bay Program

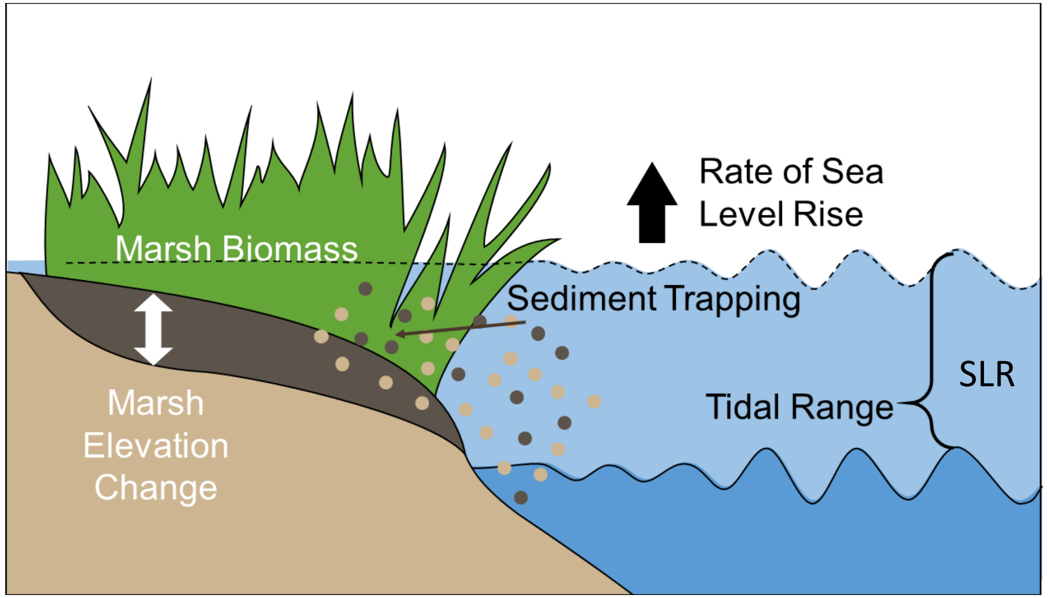
Will Parson, Chesapeake Bay Program

Carlin Finnerty, Chesapeake Bay Program

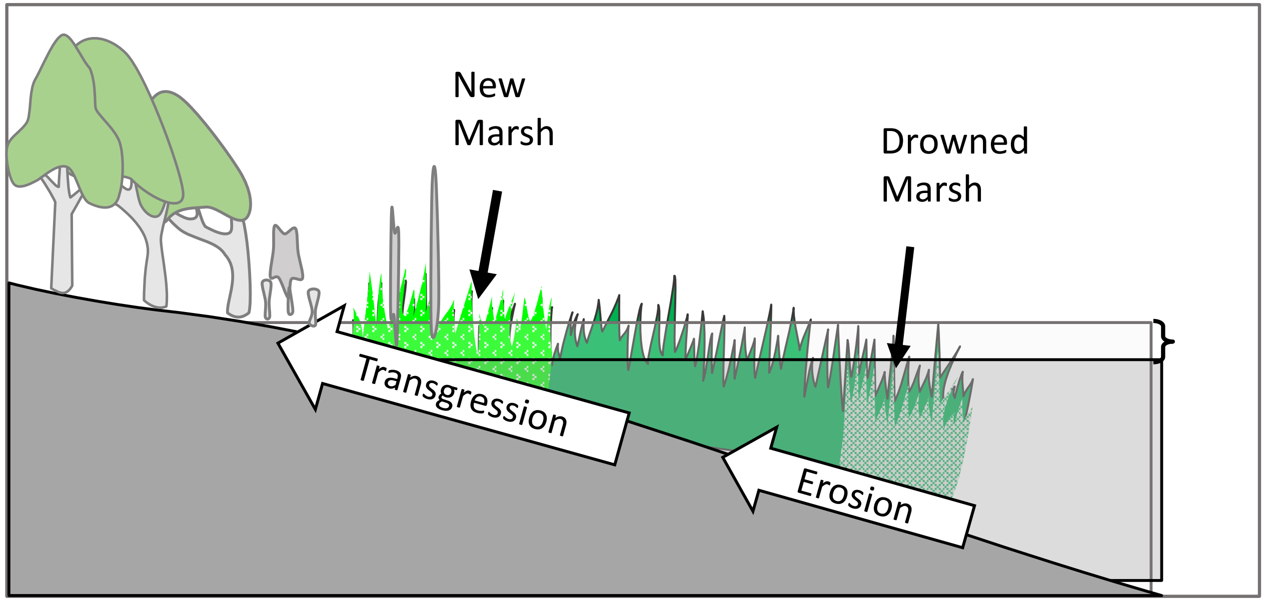
Carlin Stiehl, Chesapeake Bay Program

Coastal marsh responses to SLR

Keep Up (accretion)



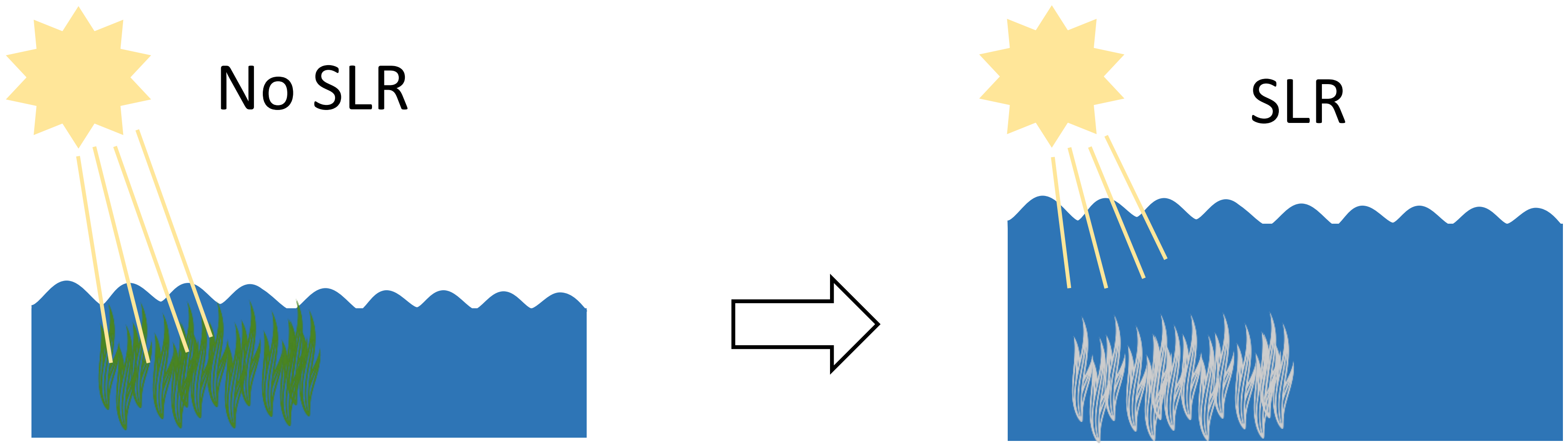
Move Up (migration)



…marshes that can’t keep up or move up will likely drown as they are inundated by SLR

Illustrations: Carolyn Currin/NOAA

Seagrass response to SLR



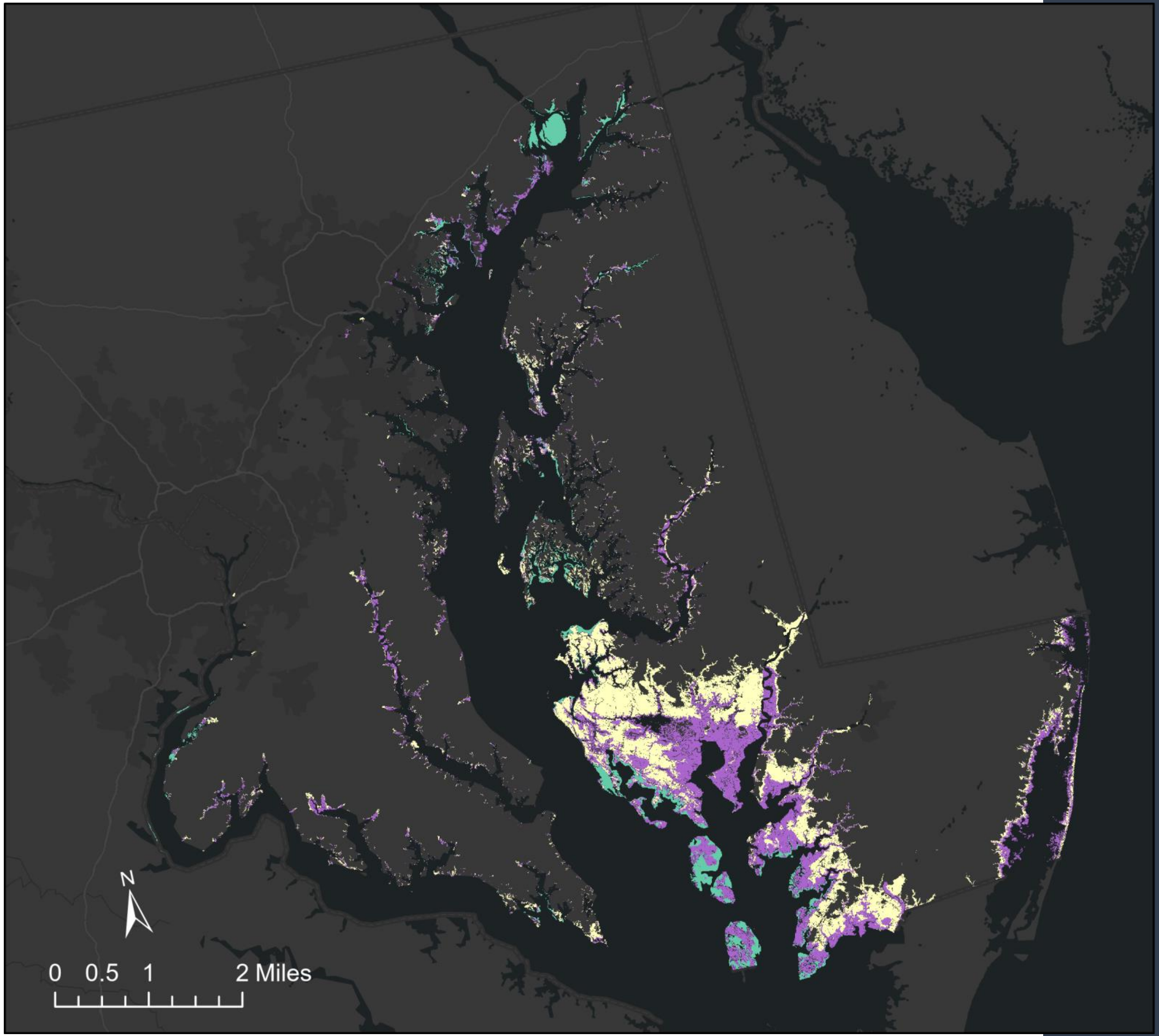
Seagrass grows in shallow water, where it gets sufficient light

Deeper water due to SLR – not enough light for seagrass to persist

Seagrass is unlikely to be able to migrate landward with SLR due to water quality issues.

Modeled coastal habitat change

2010 baseline – no SLR



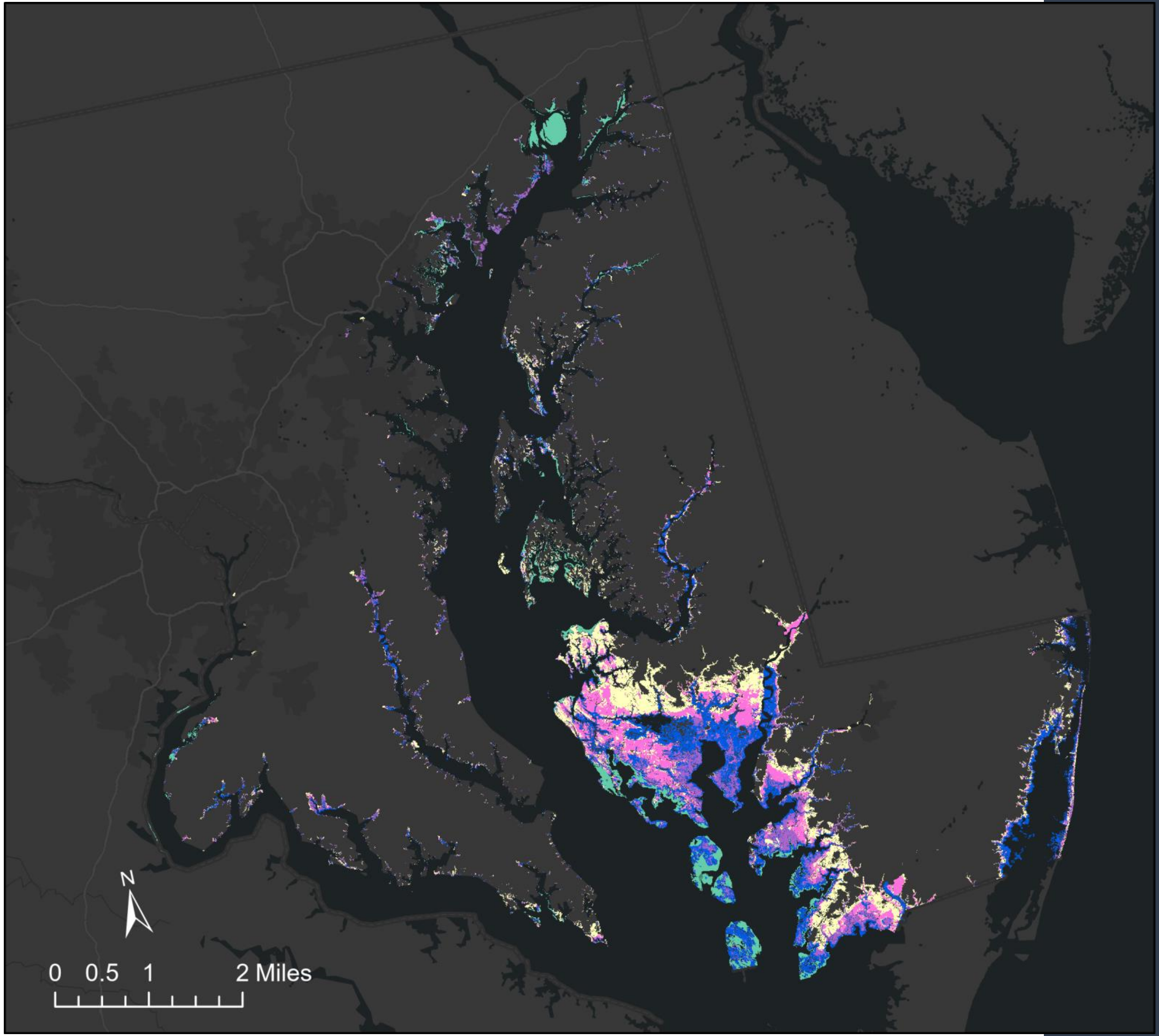
Original coastal marsh

Original seagrass

Transition zone – original habitats

Modeled coastal habitat change

2039 – 1 foot SLR



- Original coastal marsh
- Original seagrass
- Transition zone – original habitats
- Lost coastal marsh
- Lost seagrass
- Migrated coastal marsh

Modeled coastal habitat change

2062 – 2 feet SLR

Original coastal marsh

Original seagrass

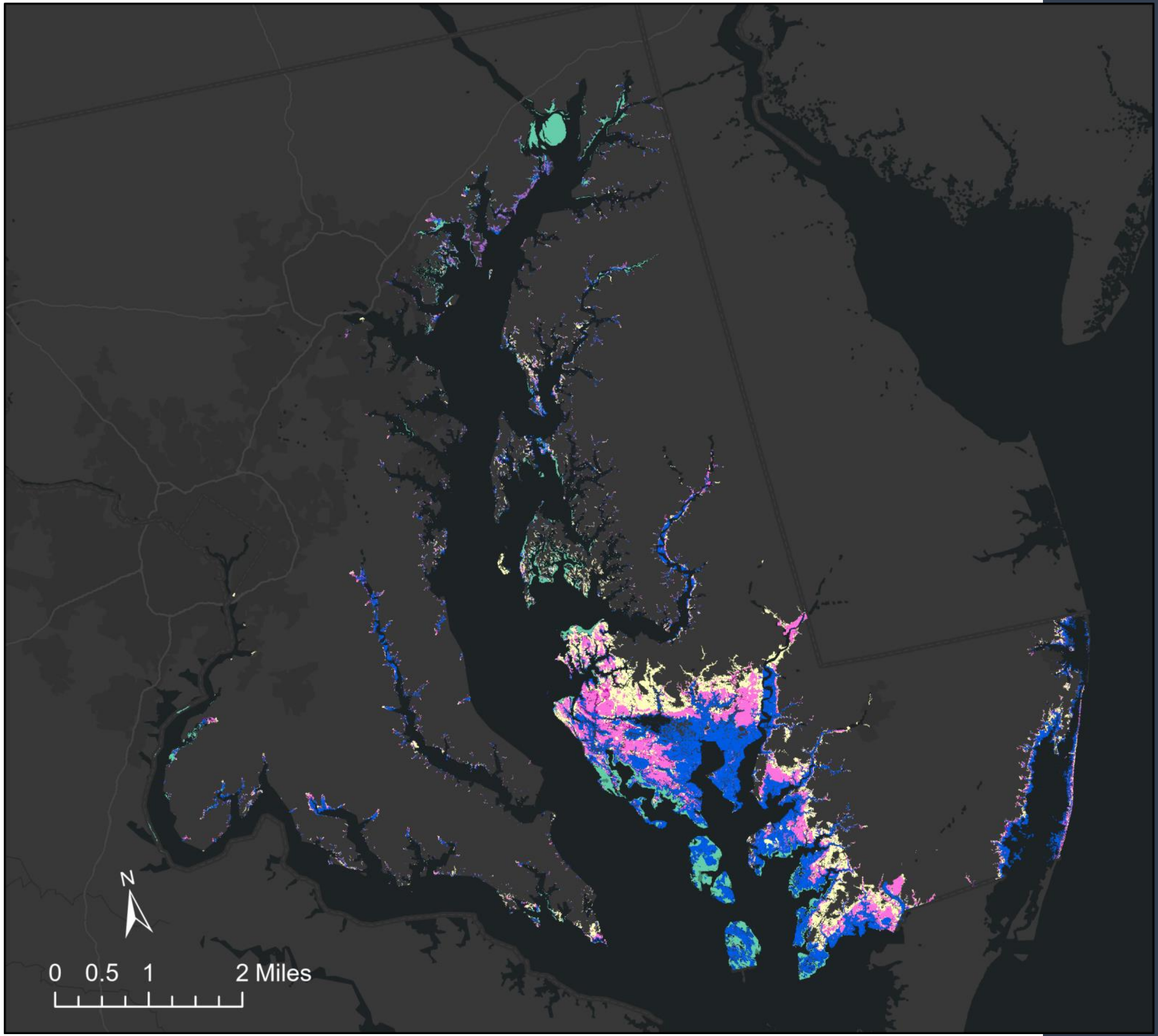
Transition zone – original habitats

Lost coastal marsh

Lost seagrass

Migrated coastal marsh

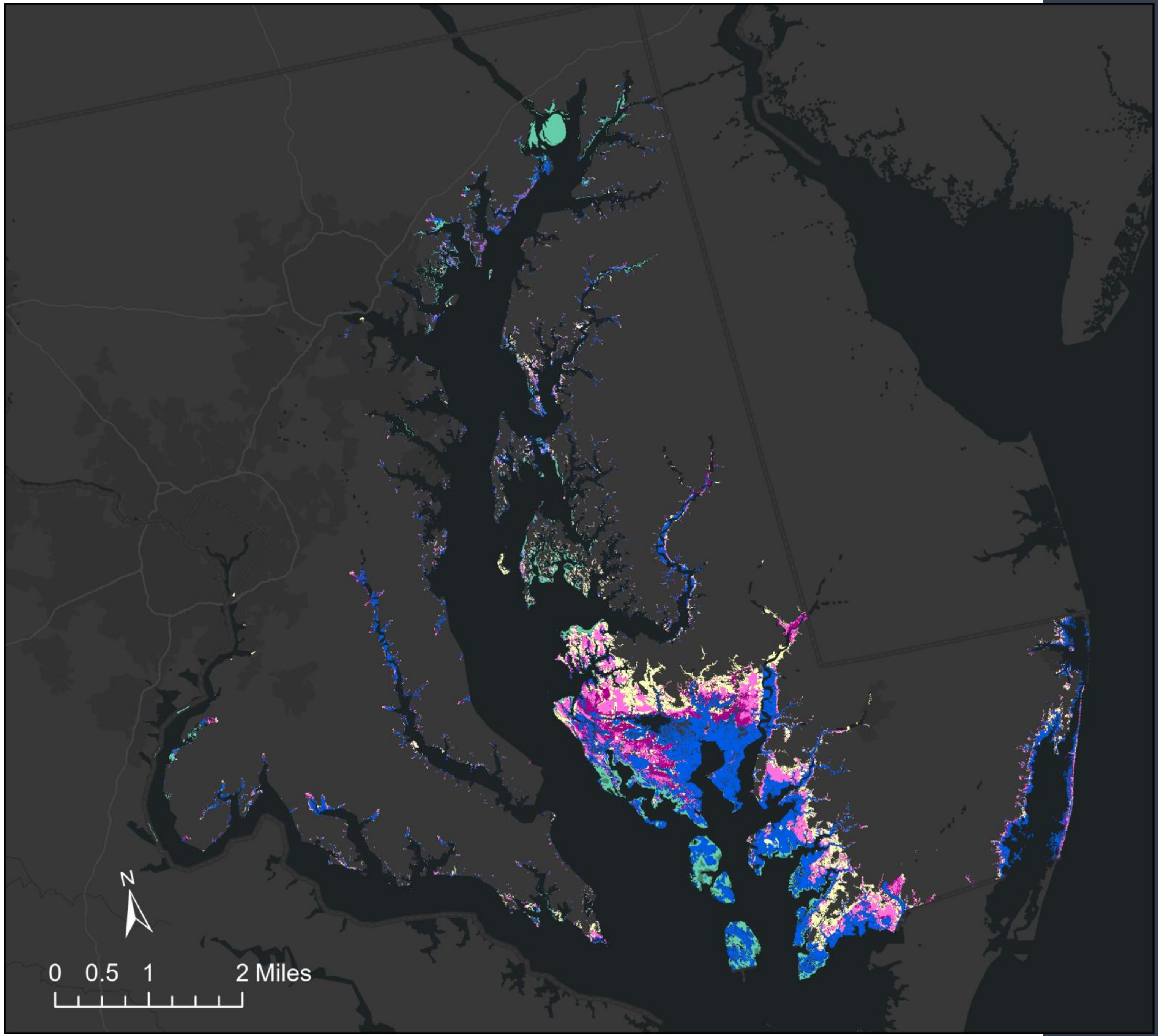
Lost migrated coastal marsh



Modeled coastal habitat change

2083 – 3 feet SLR

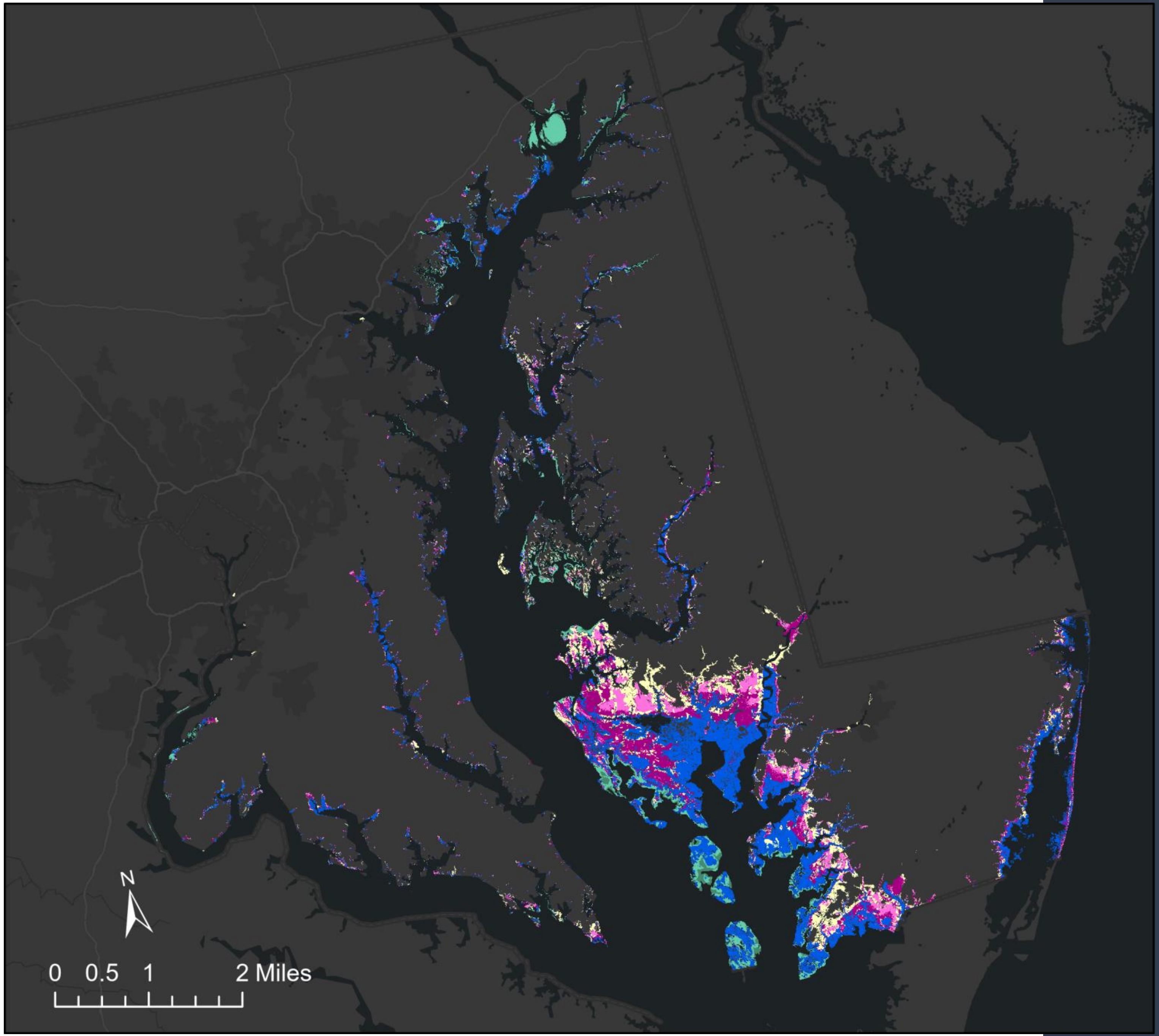
- Original coastal marsh
- Original seagrass
- Transition zone – original habitats
- Lost coastal marsh
- Lost seagrass
- Migrated coastal marsh
- Lost migrated coastal marsh



Modeled coastal habitat change

2104 – 4 feet SLR

Original coastal marsh
Original seagrass
Transition zone – original habitats
Lost coastal marsh
Lost seagrass
Migrated coastal marsh
Lost migrated coastal marsh



Habitat changes cause carbon changes

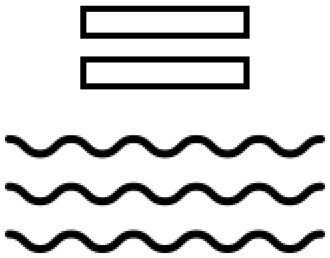
Habitat change	Carbon change
Loss of coastal marsh or seagrass	increased carbon emissions (decomposition and sediment loss)
Conversion of terrestrial habitats to coastal marsh	increased carbon emissions (biomass mortality) increased carbon sequestration (new marsh)
Conversion of freshwater wetlands to coastal marsh	decreased carbon emissions (lower methane emissions)

Carbon emissions

Carbon sequestration

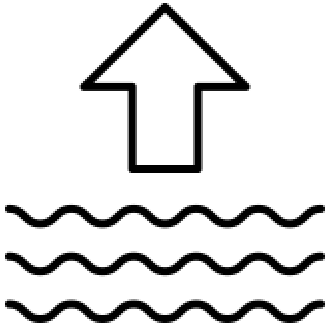
Sea level rise causes the coastal zone to switch from a carbon sink to a carbon source.

No sea level rise



42.1 MMT CO2-e sequestered

4 feet sea level rise



17.3 MMT CO2-e emitted

totals for Maryland, 2010-2124

Projecting future coastal habitat and BC: gaps and uncertainties

Habitat-related

- What areas will be available for inland marsh migration (especially agricultural land and coastal areas that may be developed in the future)?
- Habitat salinity: current and changes due to SLR
- Marshes' ability to keep up with SLR through vertical accretion
  - Marsh elevation relative to SLR – spatial resolution, local subsidence
  - Movement of sediment within marshes (eroded sediment from front edge deposited in the marsh interior)
  - Potential impact of temperature and CO2 concentrations on belowground biomass growth

Carbon-related

- Soil carbon sequestration rate in coastal marshes and seagrass beds
- Methane emissions from freshwater habitats
- Soil carbon emissions from drowned or eroded marshes
- Biomass carbon emissions from forest loss

Managing coastal habitats & blue carbon under SLR

- Enhance resilience of existing marsh (beneficial use of sediment, living shorelines, oyster reefs) to reduce loss of habitat & carbon
- Consider SLR in coastal planning – allow space for marsh migration, reduce development in high-risk areas
- Reconnect impounded freshwater wetlands to reduce methane emissions
- (Maybe) opportunities to reduce C emissions during habitat conversion

Katie Warnell & Lydia Olander, Duke University

Carolyn Currin, NOAA

katie.warnell@duke.edu

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