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Blue Carbon Stability: Spanning Across Geographical Boundaries

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UNIVERSITY OF CENTRAL FLORIDA 1963

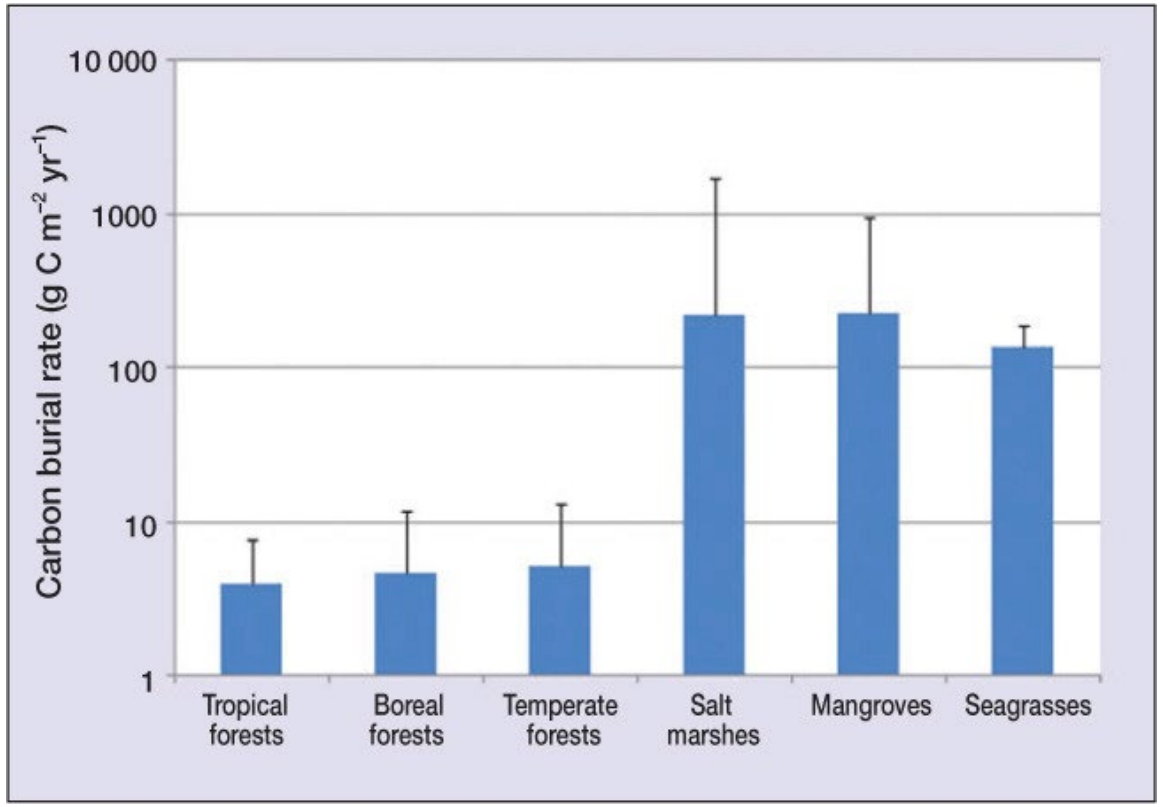
Aquatic Biogeochemistry Laboratory at UCF

Why Wetlands?

- Wetlands provide several ecosystem services
  - Nutrient transformations
  - Critical habitat
  - Flood/storm protection
  - Recreation/aesthetic
  - Carbon storage
- Wetlands make up 6-7% of the land surface, store 20-30% of the global carbon[1]
- Globally, wetlands are considered one of the most productive ecosystems[1]

Coastal Wetlands

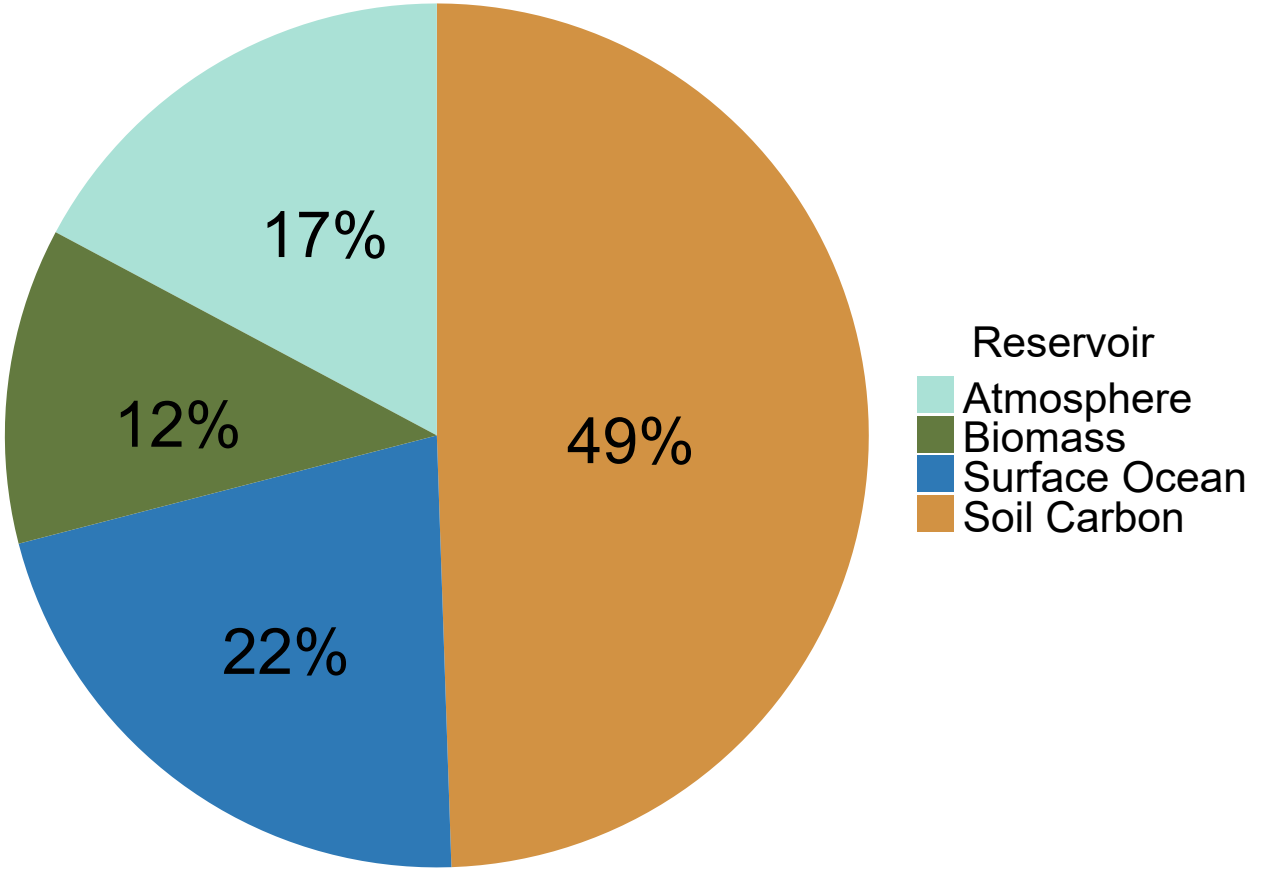
- Compared to terrestrial forests, coastal wetlands
  - Store 3-5x more carbon per area[2]
  - Sequester carbon 10x faster[3]
  - Stored belowground



Mcleod et al., 2011[3]

Soil Organic Matter

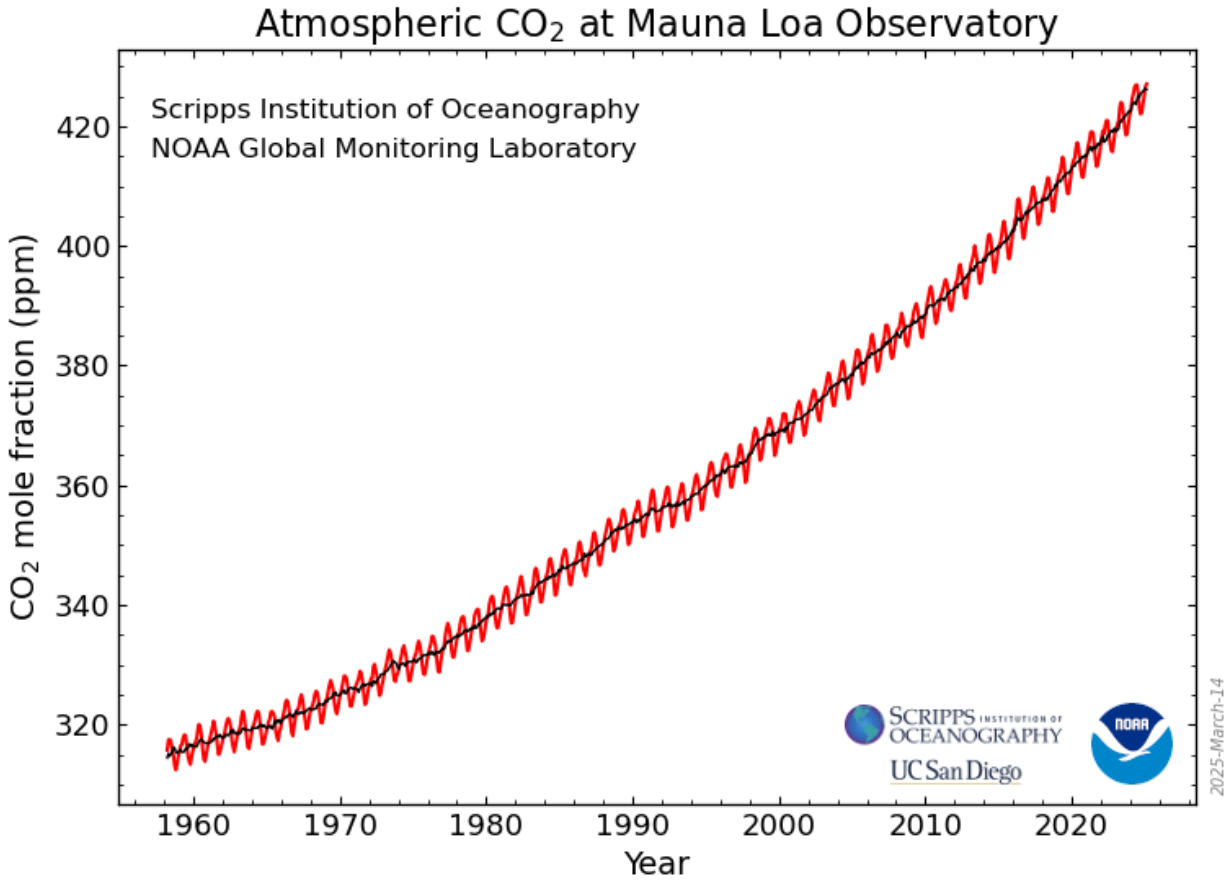
- Soil is the largest reservoir of biologically active carbon
  - 62% of the soil carbon is soil organic matter[4]
- Soil organic matter is molecules synthesized from living organism
- This organic carbon can exist within cells or extracellular within the soil profile



Biologically active carbon reserviors[5]

Soil and Climate Change

- Soil organic matter management is a potential CO_2 removal method (IPCC)[6]
- Research emphasizing mechanisms for protecting carbon from decomposition
- Forms of stable carbon

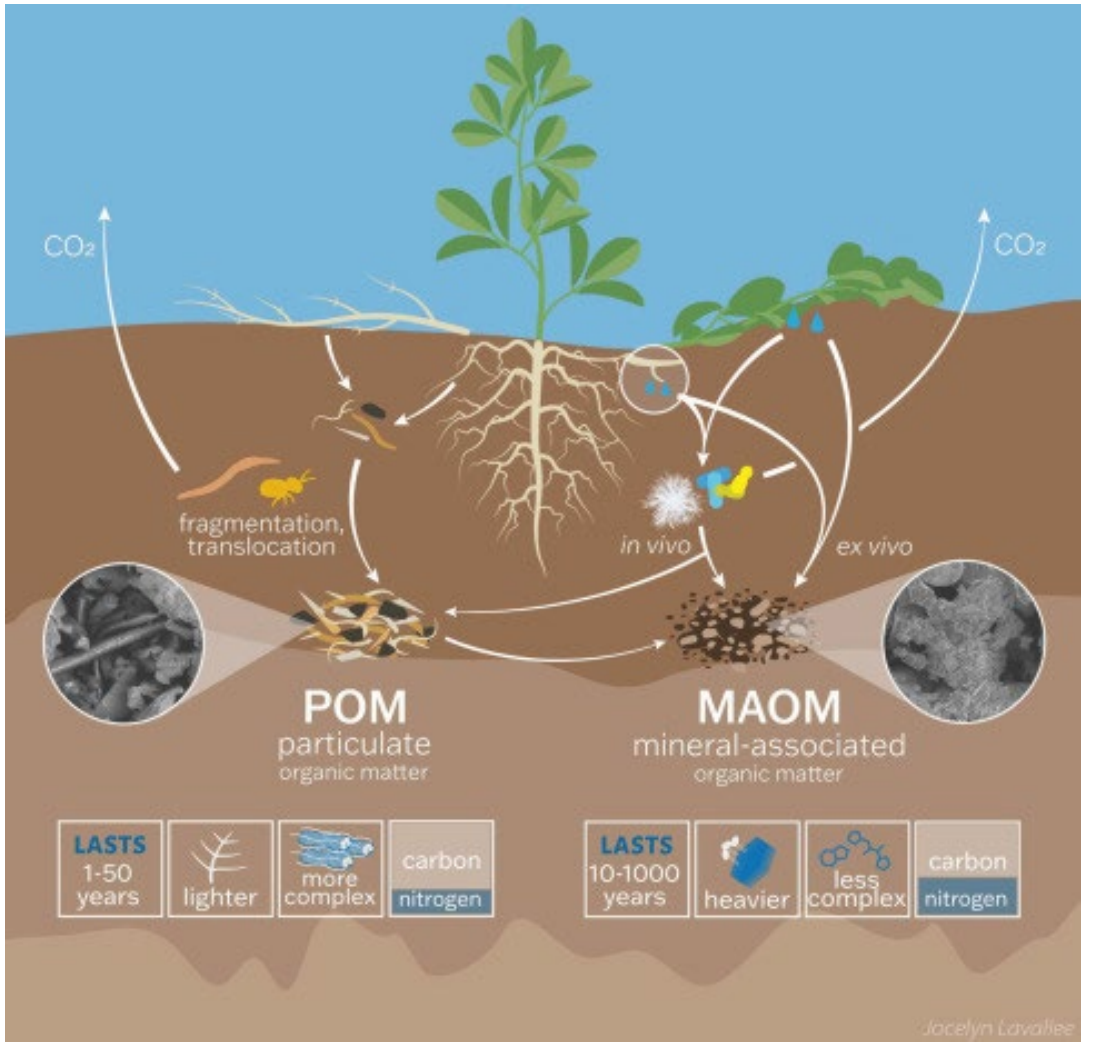


NOAA, 2025[7]

Soil Organic Matter Fractionation

- Particulate Organic Matter (POM)
  - Plant matter dominant
  - >53 μm
  - Light fraction (<1.85 g cm^{-3})
  - Biochemical protection

- Mineral Associated Organic Matter (MAOM)
  - Mineral dominant
  - <53 μm
  - Heavy fraction (>1.85 g cm^{-3})
  - Physiochemical protection

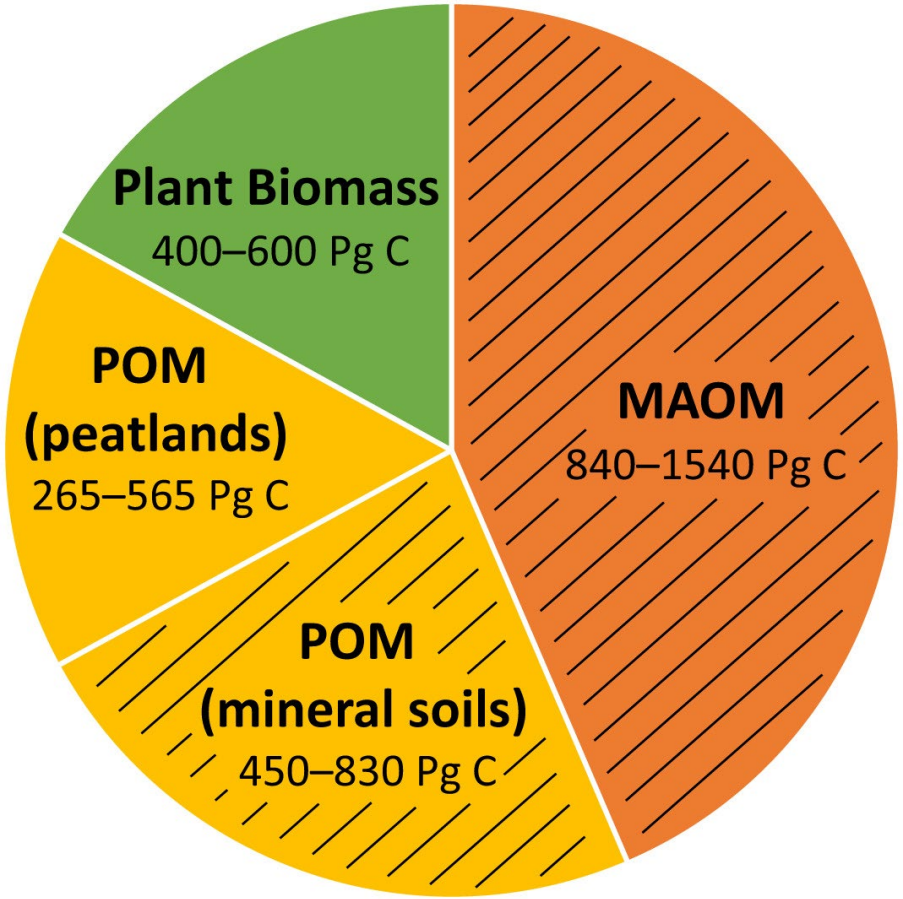


Cotrufo and Lavallee, 2022

Terrestrial MAOM Pools Studied Extensively

~34-51% of total carbon

1971-2021
Grassland
Cropland
Temperate Forest
Tropical Forest
Savanna
Shrubland
Boreal Forest
Shrubland

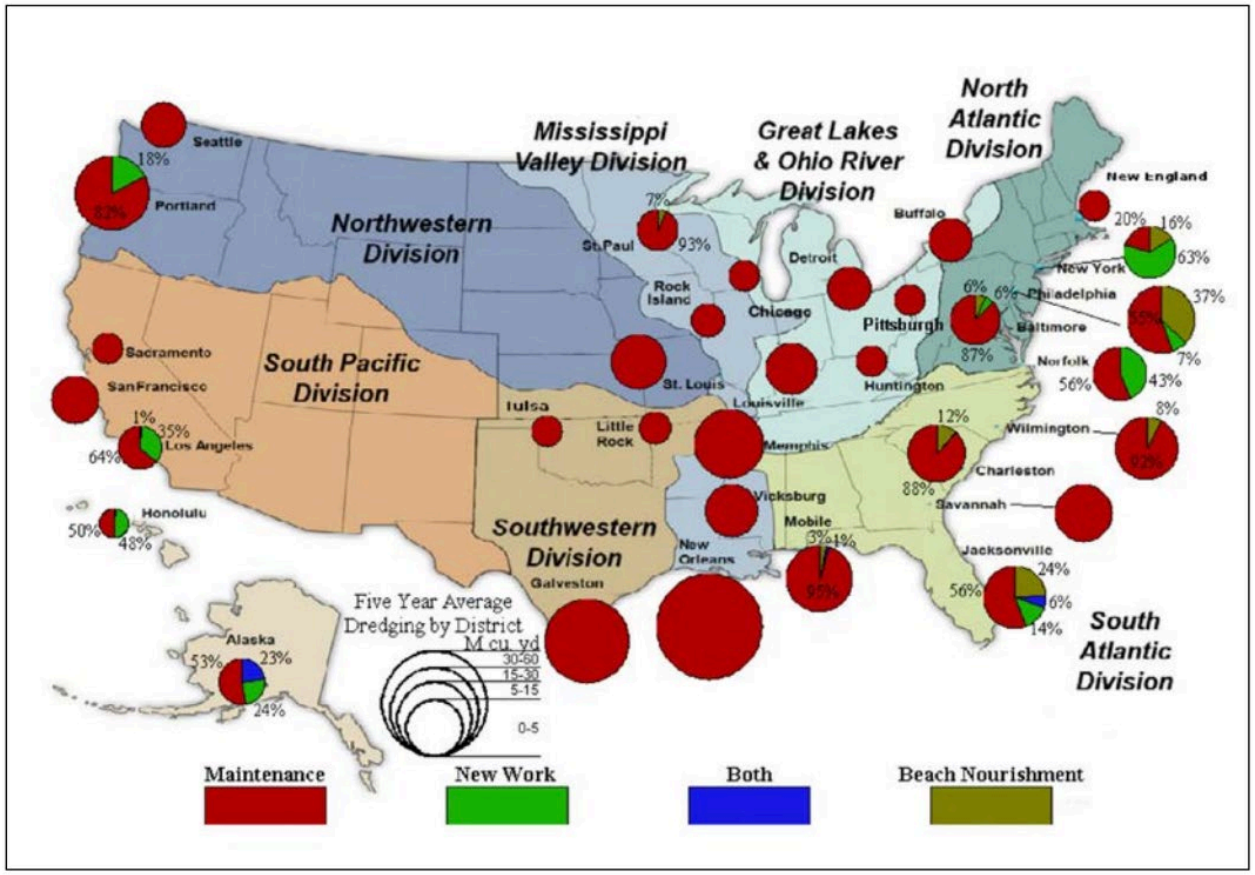


Global terrestrial pools of organic carbon
Sokol et al., 2022

- MAOM is **understudied** in wetlands as a potential form of carbon protection

Wetland Restoration Practices

- U.S Army Corps of Engineers (USACE) is responsible for navigable waterways
- Between 2008-2012, 152 million m^3 of dredged sediment was removed[10]
- 95% of the dredged sediment is suitable for restoration projects[18]
  - Beach nourishment
  - Riverine bank restoration
  - **Wetland creation and restoration**



Average Annual Dredging between 2008-2012[10]

Minerals in Wetlands

- Restoration techniques use dredged sediment to create and restore coastal wetlands
  - Fine dredge = silt and clay
  - Coarse dredge = sand
- Dredge layer often ranges from a few to 50 cm
  - Thin layer placement[11]
- Can using dredge sediment in restoration promote MAOM formation in wetlands?

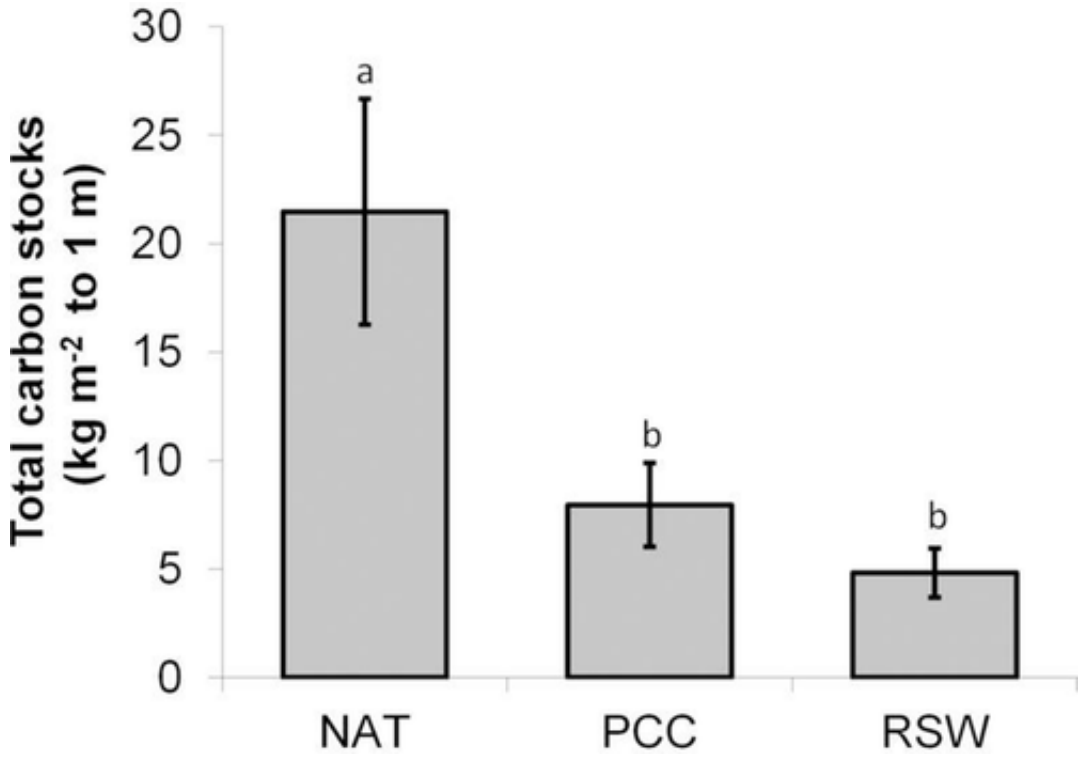
Berkowitz et al., 2017

Dredged sediment from a restored site

Restored and Created Wetlands

- Restored wetlands have less total carbon than natural wetlands[12,13]
- Belowground processes (carbon accumulation) take longer than aboveground (plant communities)

- USACE restored wetlands may have less total carbon
- **But do they have more stable carbon (MAOM)?**



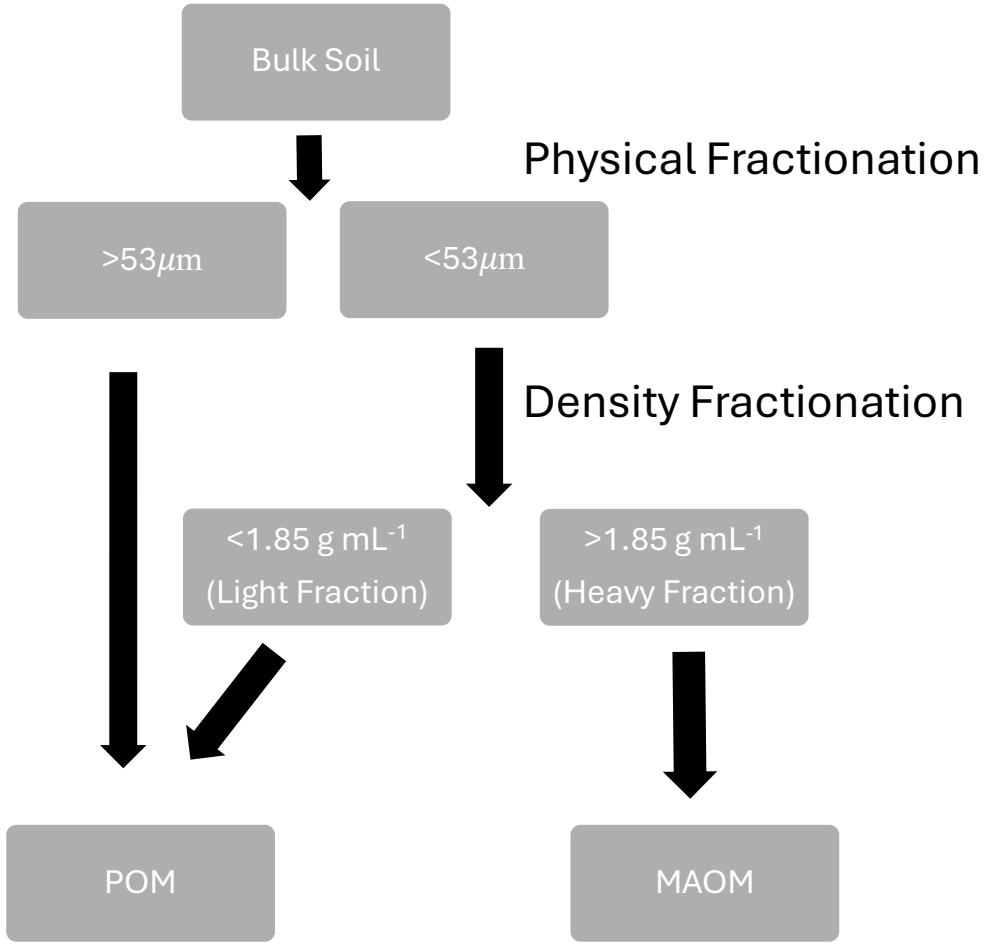
Fenstermacher et al., 2016

Sampling Methodology

- Coastal wetlands from across the U.S
  - Apalachicola Bay, FL
  - Biloxi Bay, MS
  - Chesapeake Bay, MD
  - San Pablo Bay, CA
  - Lake Erie, MI
- Stratified random sampling by vegetation
- 7 soil cores of 50 cm at each site

Laboratory Analysis

- MAOM via physical and density fractionation
  - Wet sieving with dispersant
  - Density fractionation with sodium polytungstate
  - MAOM analyzed for total carbon



Apalachicola Bay, Florida

Drake Wilson Island

Created in 1976
(45 Years)
fine and coarse
dredge

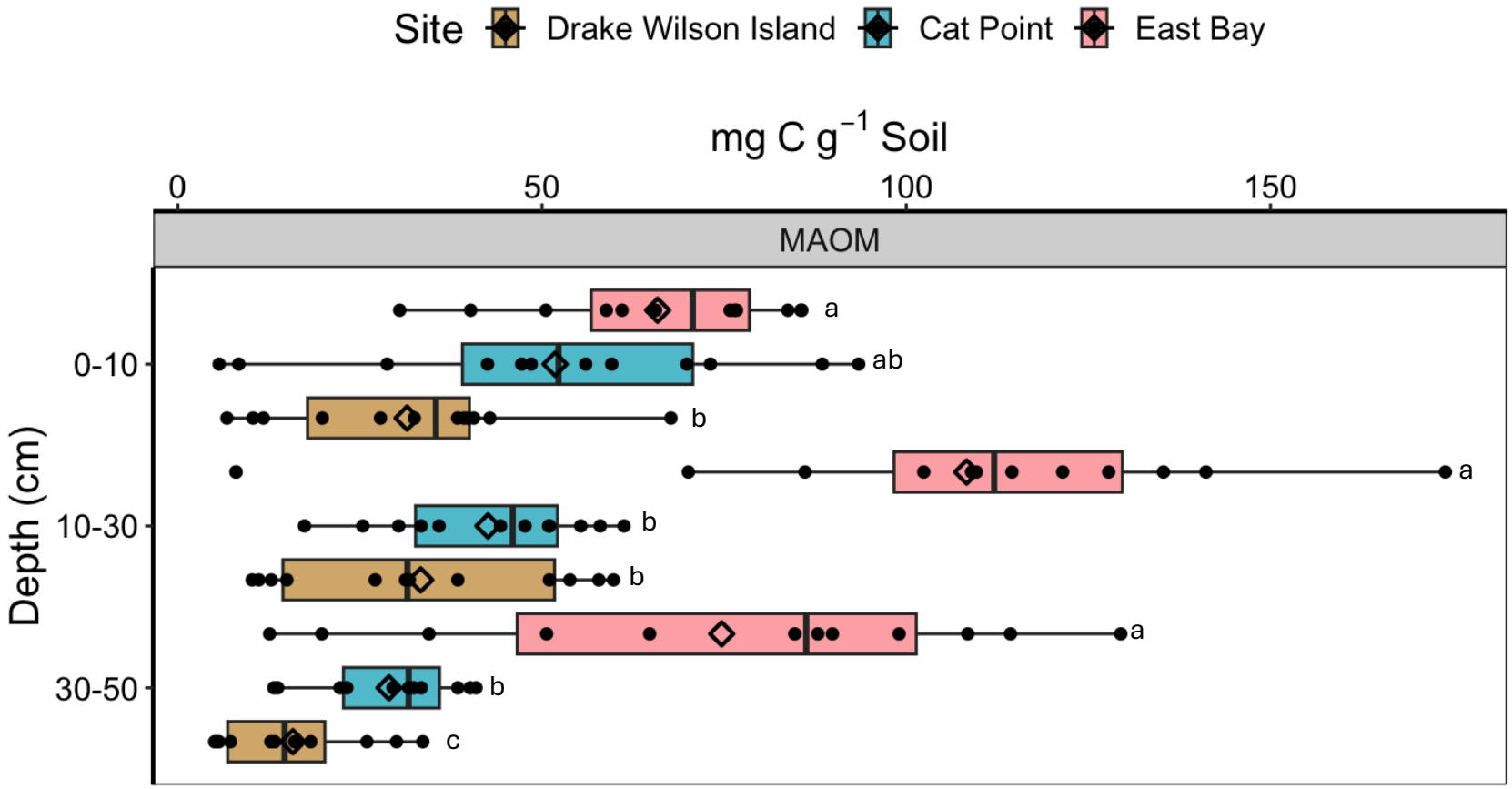
Cat Point

USACE reference site
high mineral content

East Bay

Reference site
high organic content

Apalachicola Bay, Florida



Different letters denote p <0.05 across sites within the same depth

Deer Island- Biloxi Bay, Mississippi

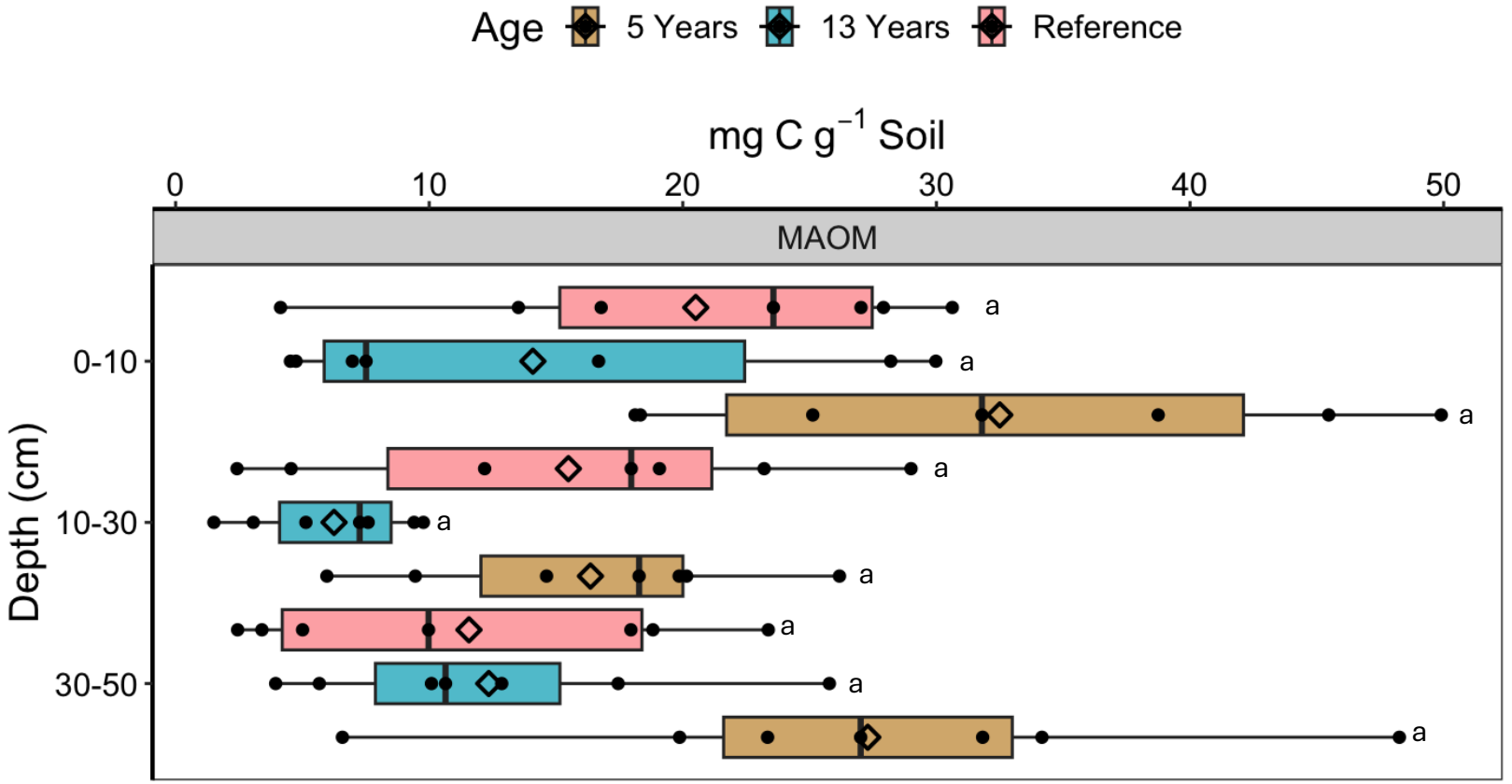
- Restoration events in 2011 and 2018
- Reference was western side of the barrier island

5 Years

13 Years

Reference

Deer Island- Biloxi Bay, Mississippi



Different letters denote p <0.05 across sites within the same depth

Poplar Island- Chesapeake Bay, Maryland

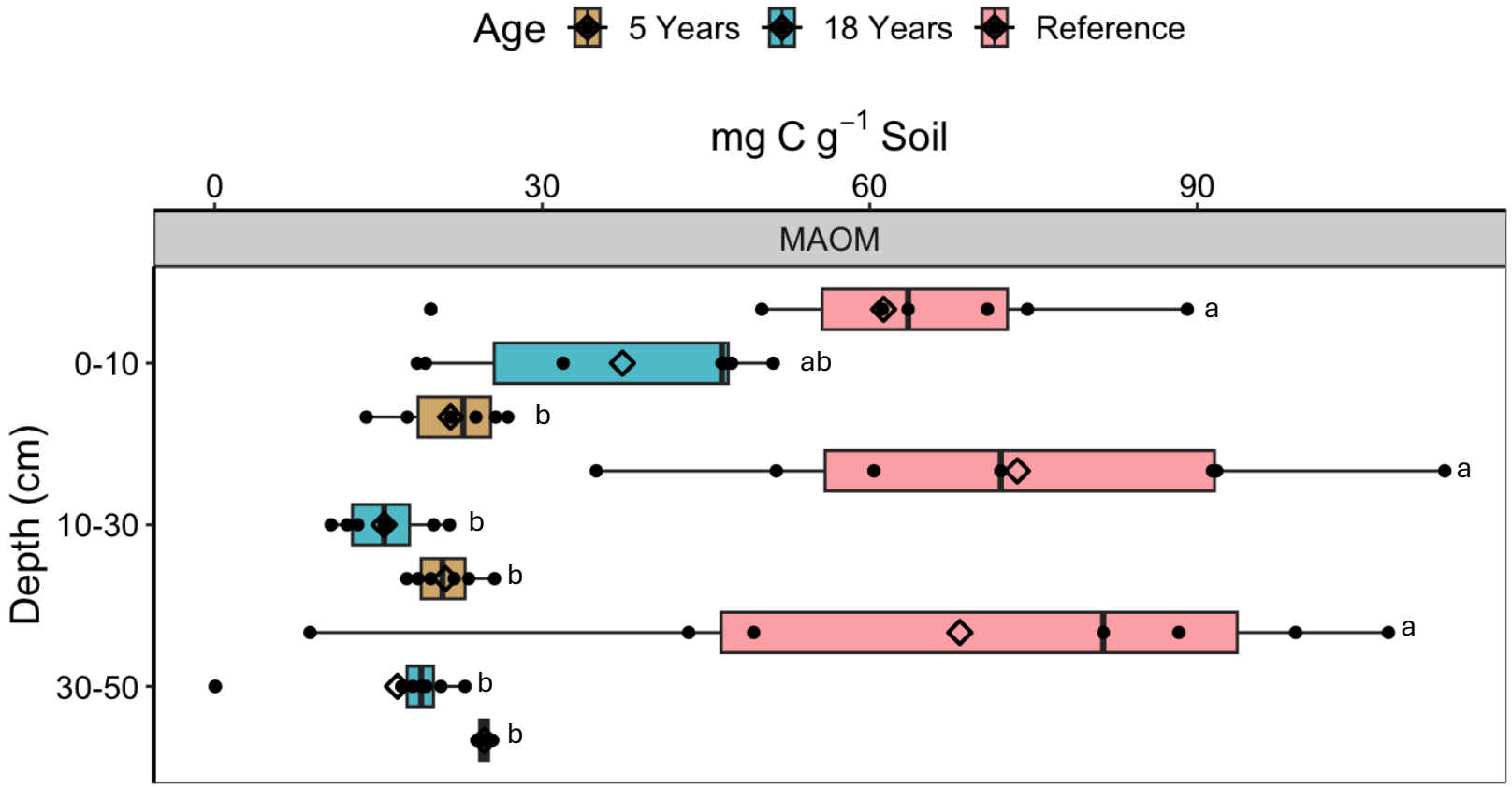
- Two restored sites from 2005 and 2018
- Nearby barrier island as a reference

5 Years

18 Years

Reference

Poplar Island- Chesapeake Bay, Maryland



Different letters denote p <0.05 across sites within the same depth

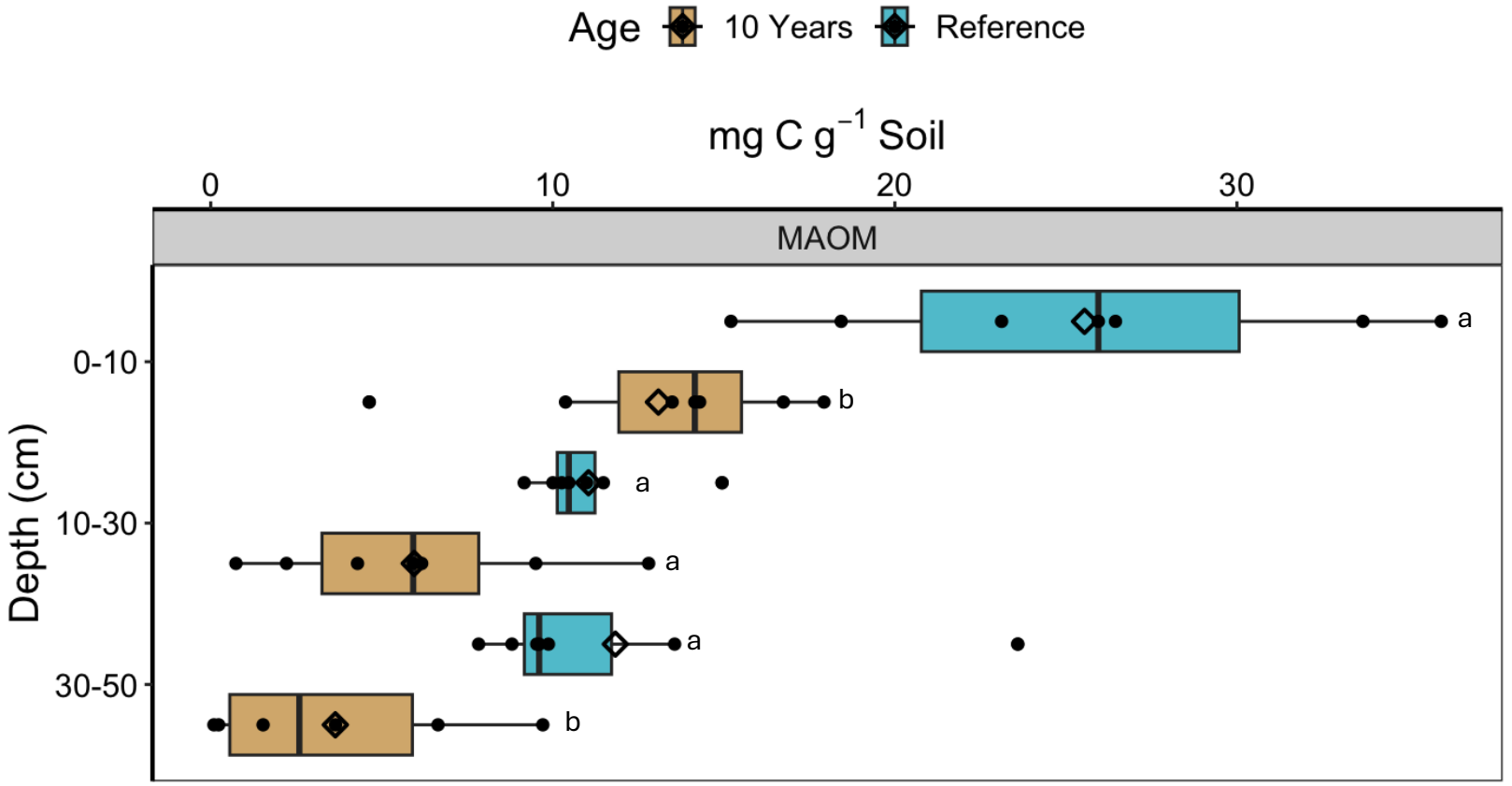
San Pablo Bay, California

Restored (2013)

Reference

Oxidized iron at restored site

San Pablo Bay, California



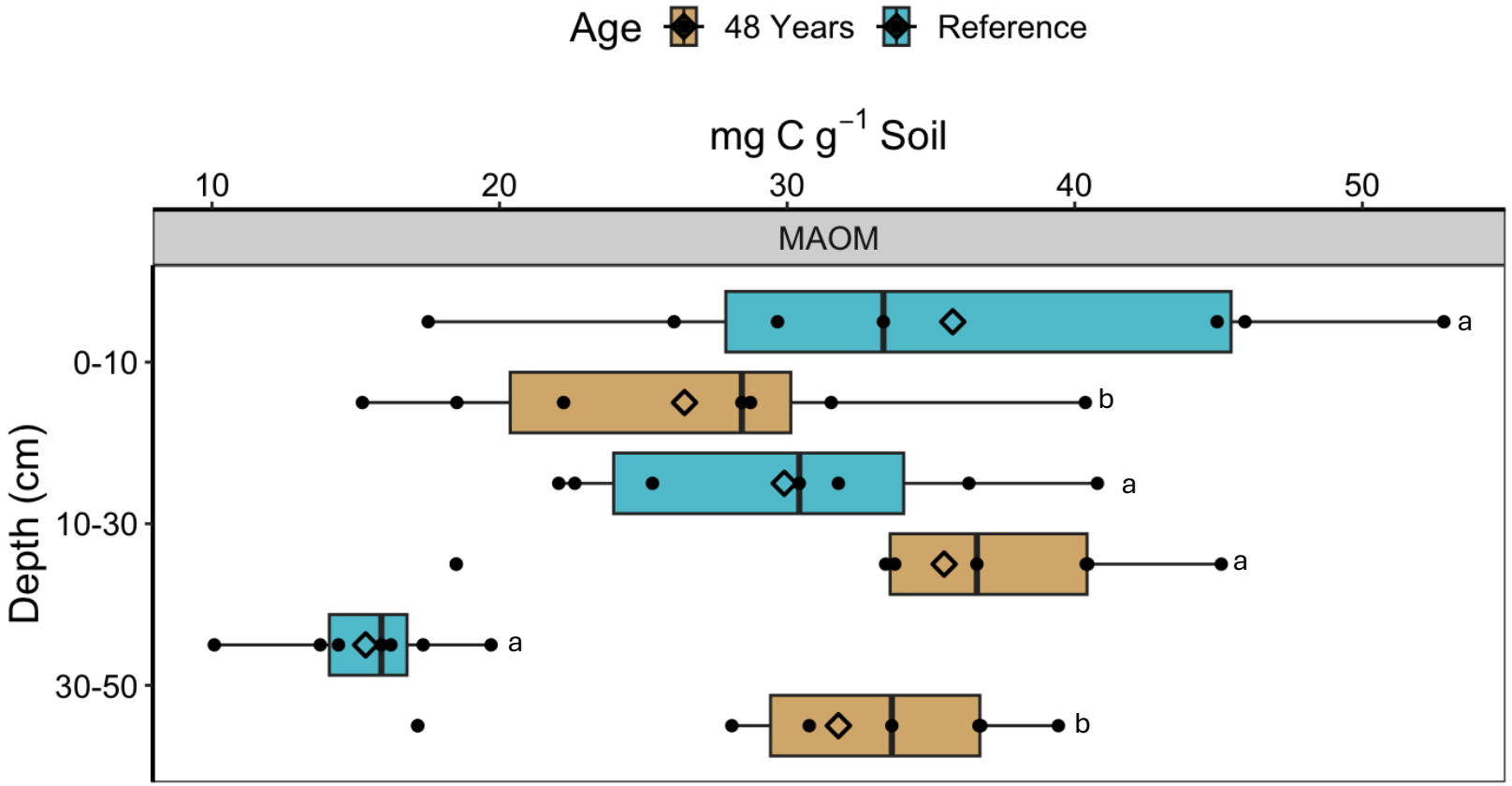
Different letters denote p <0.05 across sites within the same depth

Lake Erie, Michigan

Restored in 1981
(43 years)

Reference

Lake Erie, Michigan



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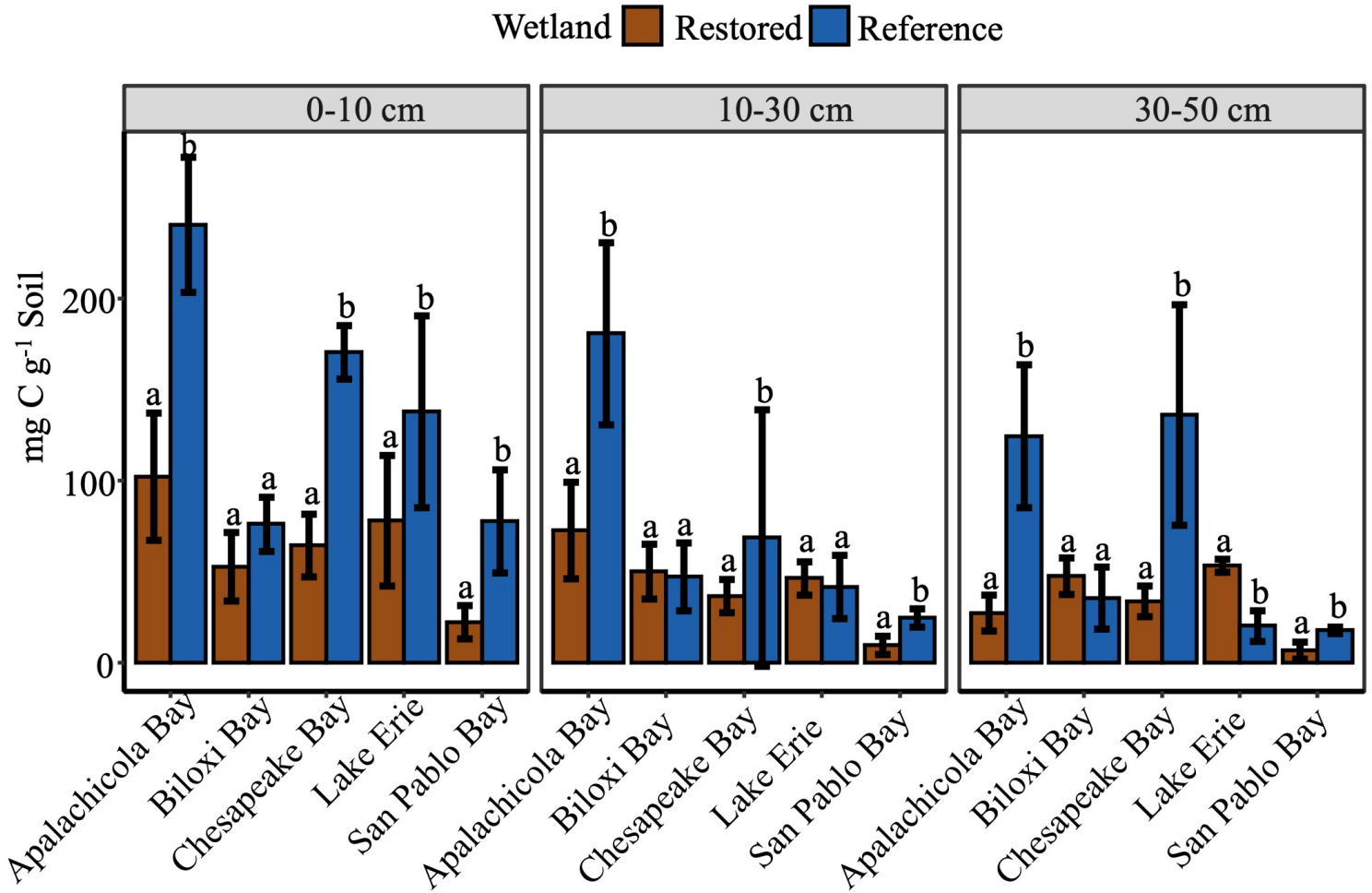
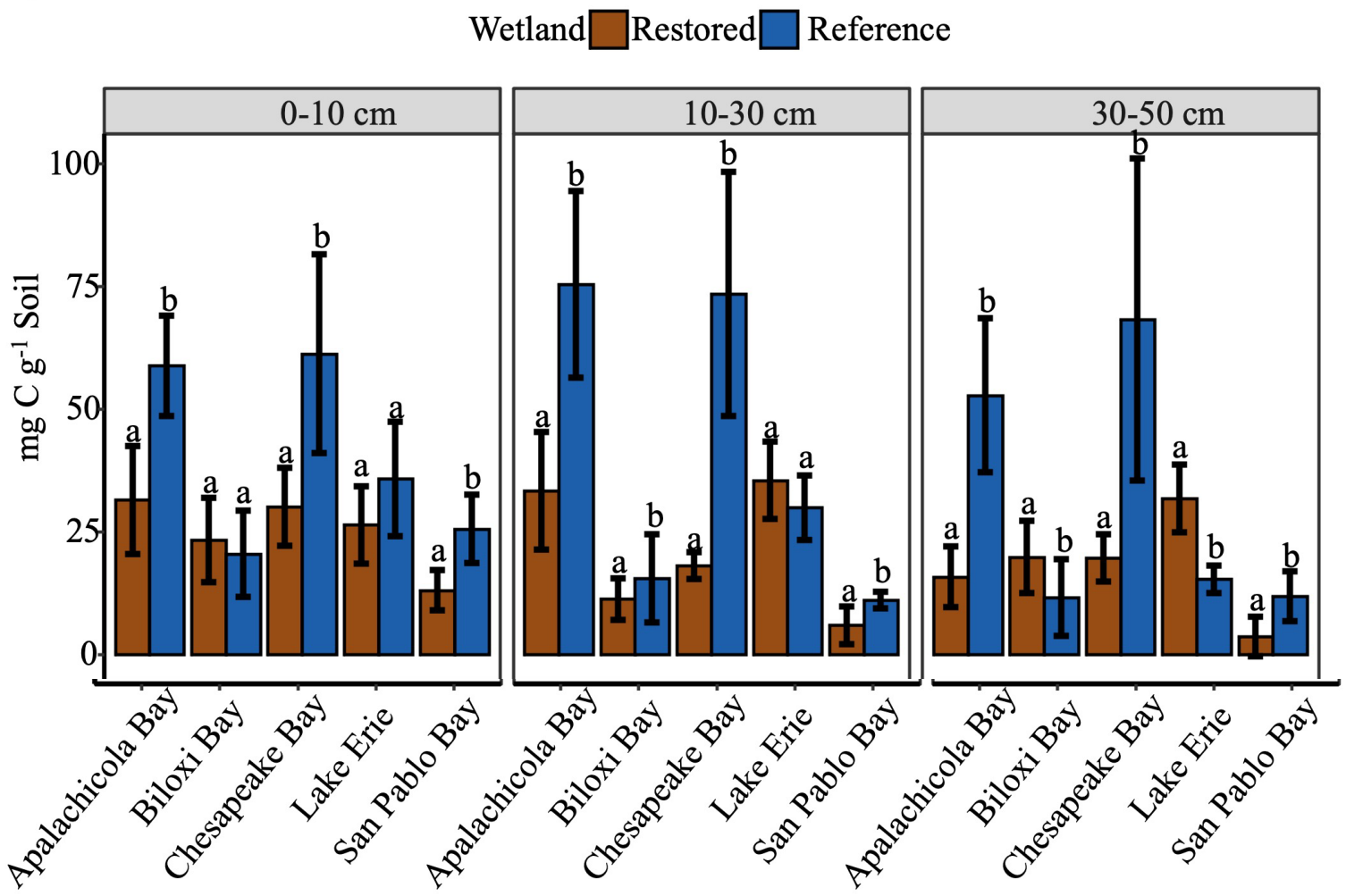
Reference Sites Had More Total Carbon



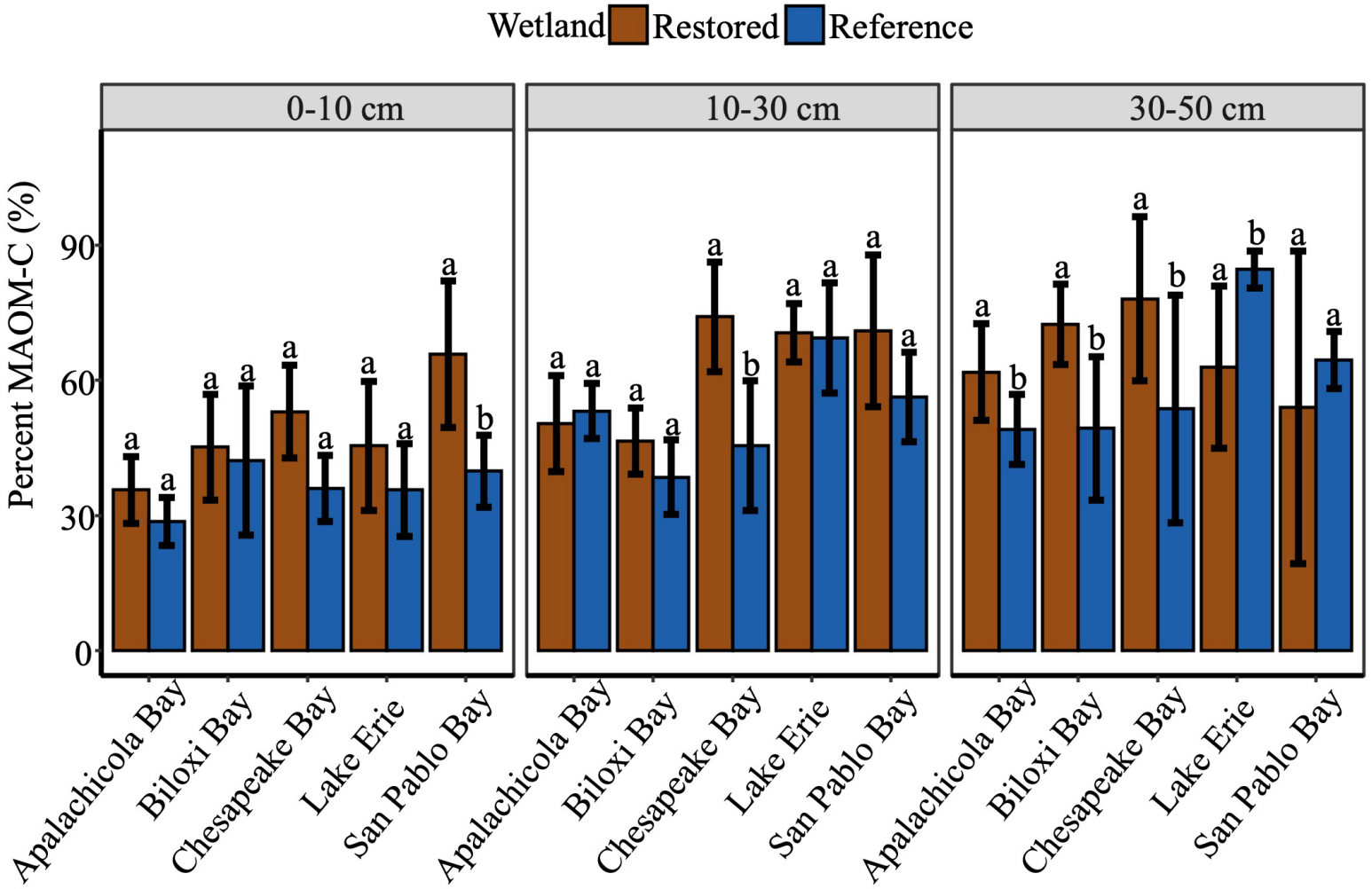
Error bars represent 95% confidence interval

Reference Sites Had More MAOM-C



Error bars represent 95% confidence interval

Restored Sites Had Greater Proportion of MAOM



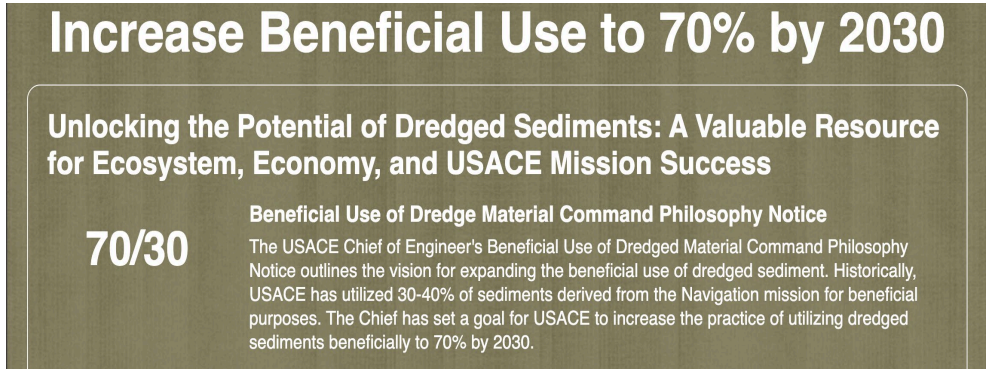
Error bars represent 95% confidence interval

Key Findings

- Reference wetlands had greater total carbon and MAOM-C across regions
- Restored wetlands had greater percent MAOM-C across regions
- Percent MAOM-C increased with depth, suggesting preservation
- Percent MAOM-C is considered an indicator of residence time in the soil[14]
  - A greater proportion of MAOM-C leads to a greater residence time and resilience in carbon pools

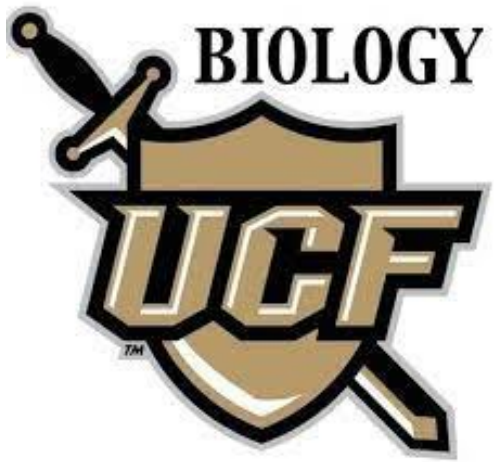
Real World Applications

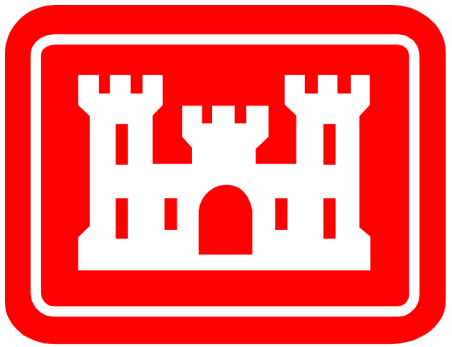
- Restoration events are increasing[15]
- Expand past counting carbon for restoration assessments
  - Carbon stability can be a useful indicator for restoration “success”
- Further understanding of MAOM in wetlands soils can lead to practices to promote MAOM the most effectively



USACE[15]

Thank You!





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ABL MAOM Presentations

Dr. Lisa Chambers

- Tuesday, 8:30-9:10am
- Stability Matters: A New Perspective on Wetland Soil Carbon

Mercedes Pinzon-Delgado

- Thursday, 9:50-10:10am
- Tracing Nitrogen Pathways in Coastal Wetlands: The Role of MAOM in a Changing Landscape

Mumtahina Riza

- Thursday, 10:30-10:50am
- How to Increase Mineral-Associated Organic Matter Formation in Organic Rich Soils

Questions?

Citations

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15. Citation Format: If you wish to cite information or content from this website, we recommend using the following format: Beneficial Uses of Dredged Sediment. US Army Engineer Research and Development Center Dredging Operations Technical Support Program. Accessed [Date], https://budm.el.erdc.dren.mil