Are Our Salt Marshes Rising to the Challenge of Sea Level Rise?

Meagan Eagle Gonneea

U.S. Geological Survey, Woods Hole Coastal & Marine Science Center

WBNERR Research on the Reserve, April 3, 2017

USGS
science for a changing world


Wrangell, AK
Image © 2013 TerraMetrics
13.7 km
Google earth


4
MERCURY

FULBRIGHT

MIT·WHOI

JOINT PROGRAM IN OCEANOGRAPHY/APPLIED OCEAN SCIENCE & ENGINEERING


Year 1


Year 2


Year 3


Year 4


Year 5

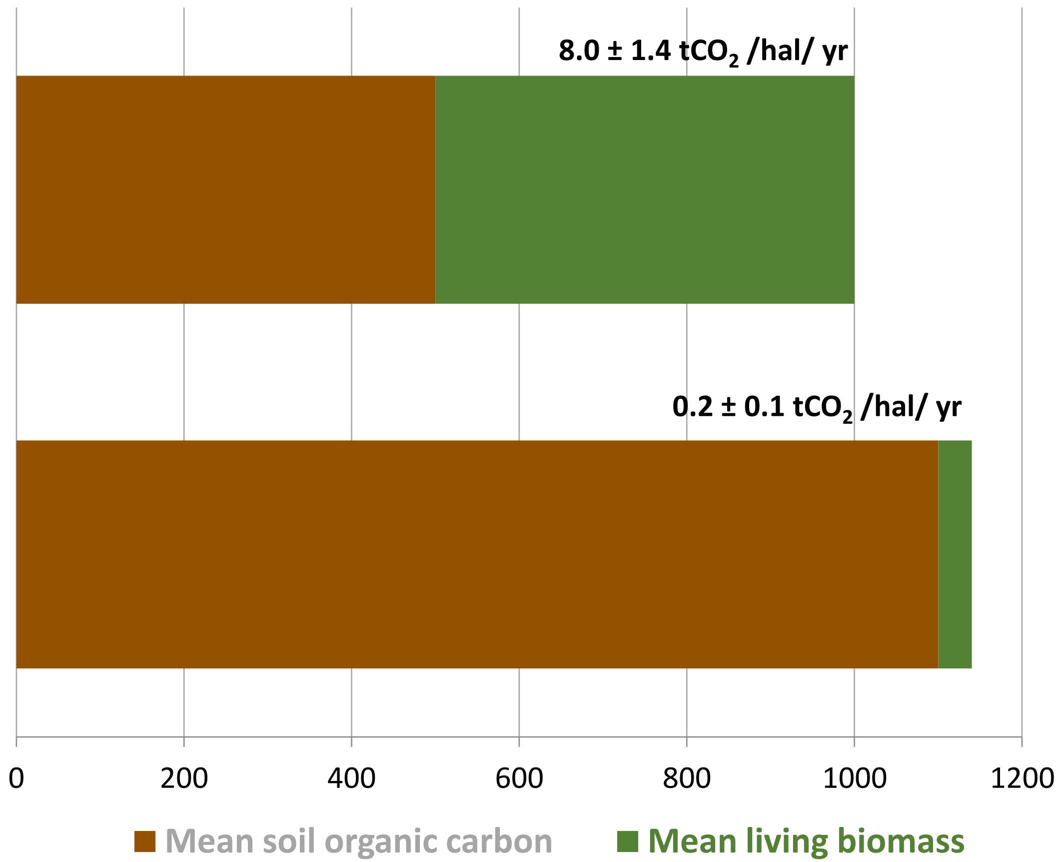
Riches in the Soil – The Wetland Carbon Bank

ALL TROPICAL FORESTS

TIDAL SALT MARSH

tCO_2e per Hectare, Global Averages

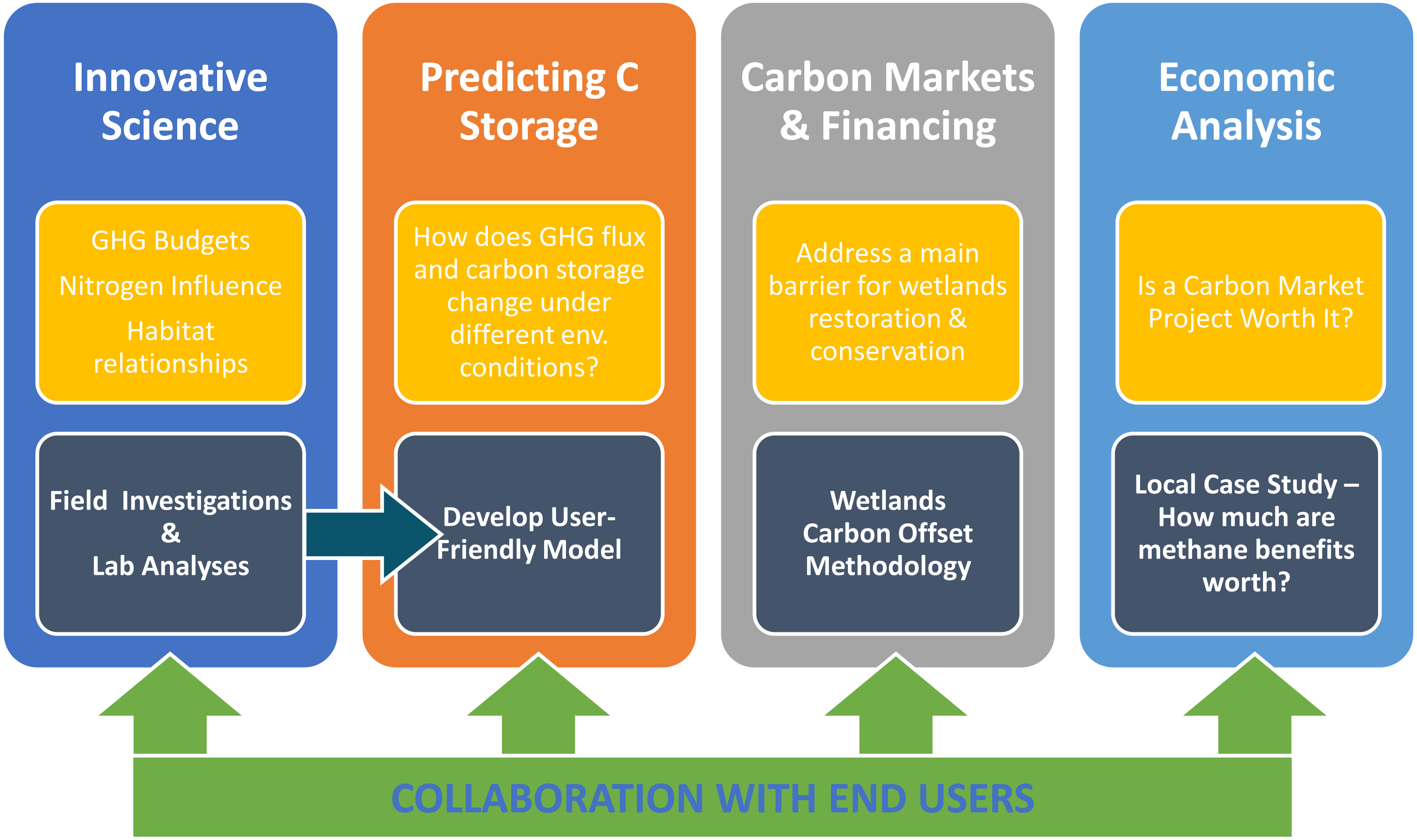
Soil-Carbon Values for First Meter of Depth Only (Tot



Source: Data summarized in Crooks *et al.*, 2011; Murray *et al.*, 2011

BWM In A Nutshell

Improved Understanding of C Dynamics and Biogeochemical Processes
New Tools for Managers and Policymakers



How Did We Engage With End Users?

Field Trip

Road Show Presentations with State Agency Staff

One-on-One

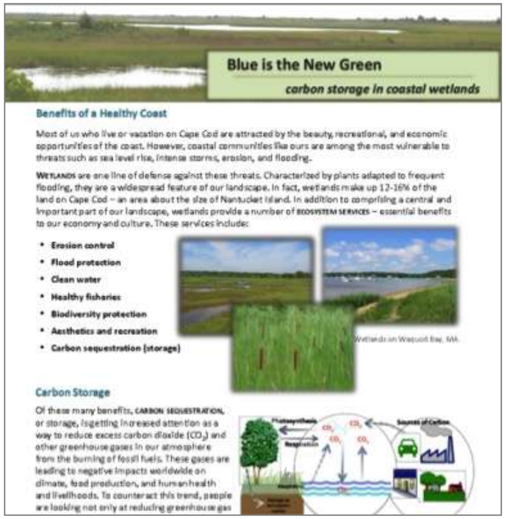
Workshops & Webinars

Early Interviews

E-Newsletter

NERRS Transfer Projects

EDUCATIONAL PRODUCTS
(videos, fact sheets, etc.)



Blue is the New Green

carbon storage in coastal wetlands

Benefits of a Healthy Coast

Most of us who live or vacation on Cape Cod are attracted by the beauty, recreational, and economic opportunities of the coast. However, coastal communities like ours are among the most vulnerable to threats such as sea level rise, intense storms, erosion, and flooding.

WETLANDS are one line of defense against these threats. Characterized by plants adapted to frequent flooding, they are a widespread feature of our landscape. In fact, wetlands make up 12-16% of the land on Cape Cod – an area about the size of Nantucket Island. In addition to comprising a central and important part of our landscape, wetlands provide a number of ECOSYSTEM SERVICES – essential benefits to our economy and culture. These services include:

- **Erosion control**
- **Flood protection**
- **Clean water**
- **Healthy fisheries**
- **Biodiversity protection**
- **Aesthetics and recreation**
- **Carbon sequestration (storage)**

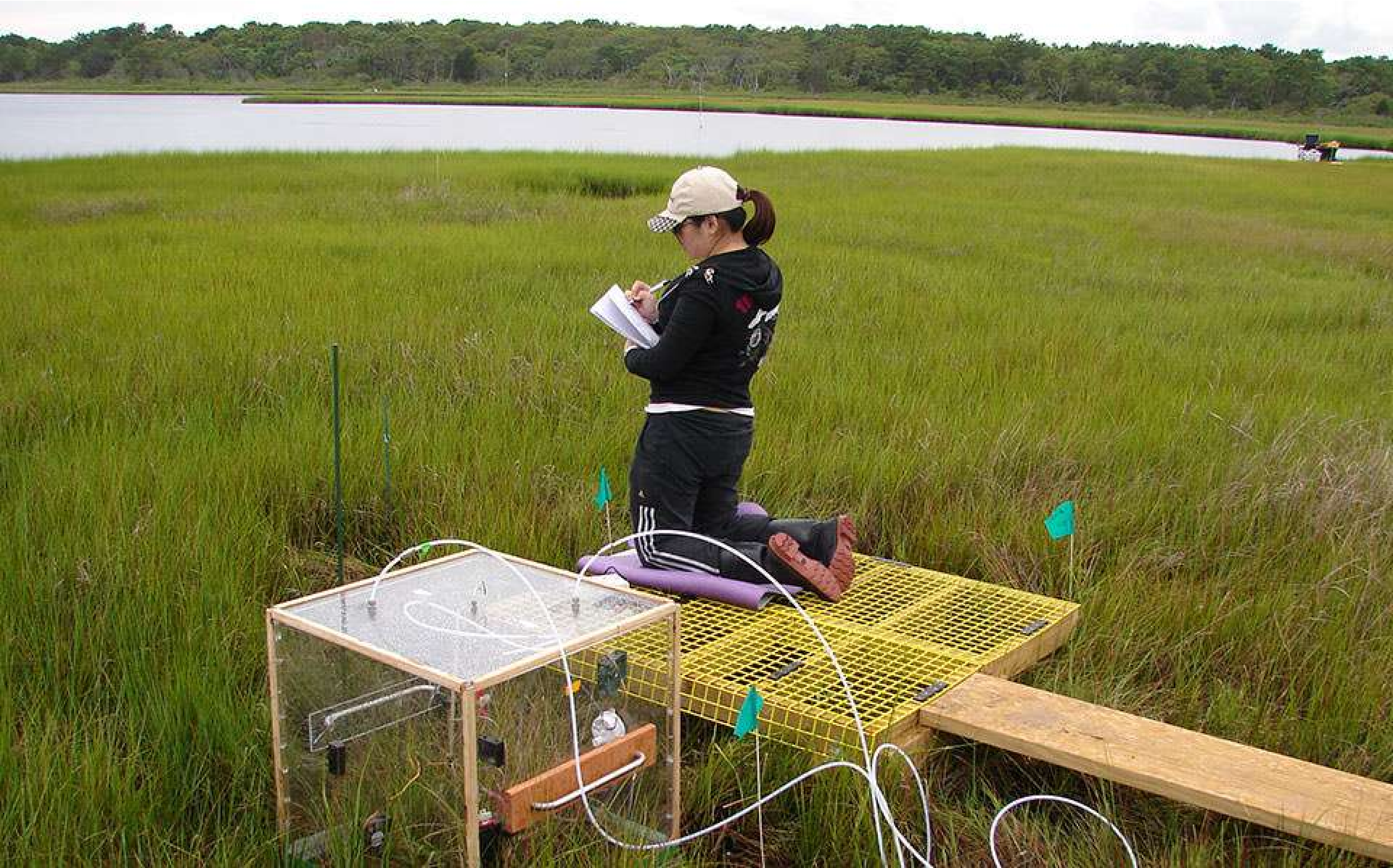
Wetlands on Waquoit Bay, MA

Carbon Storage

Of these many benefits, CARBON SEQUESTRATION, or storage, is getting increased attention as a way to reduce excess carbon dioxide (CO_2) and other greenhouse gases in our atmosphere from the burning of fossil fuels. These gases are leading to negative impacts worldwide on climate, food production, and human health and livelihoods. To counteract this trend, people are looking not only at reducing greenhouse gas

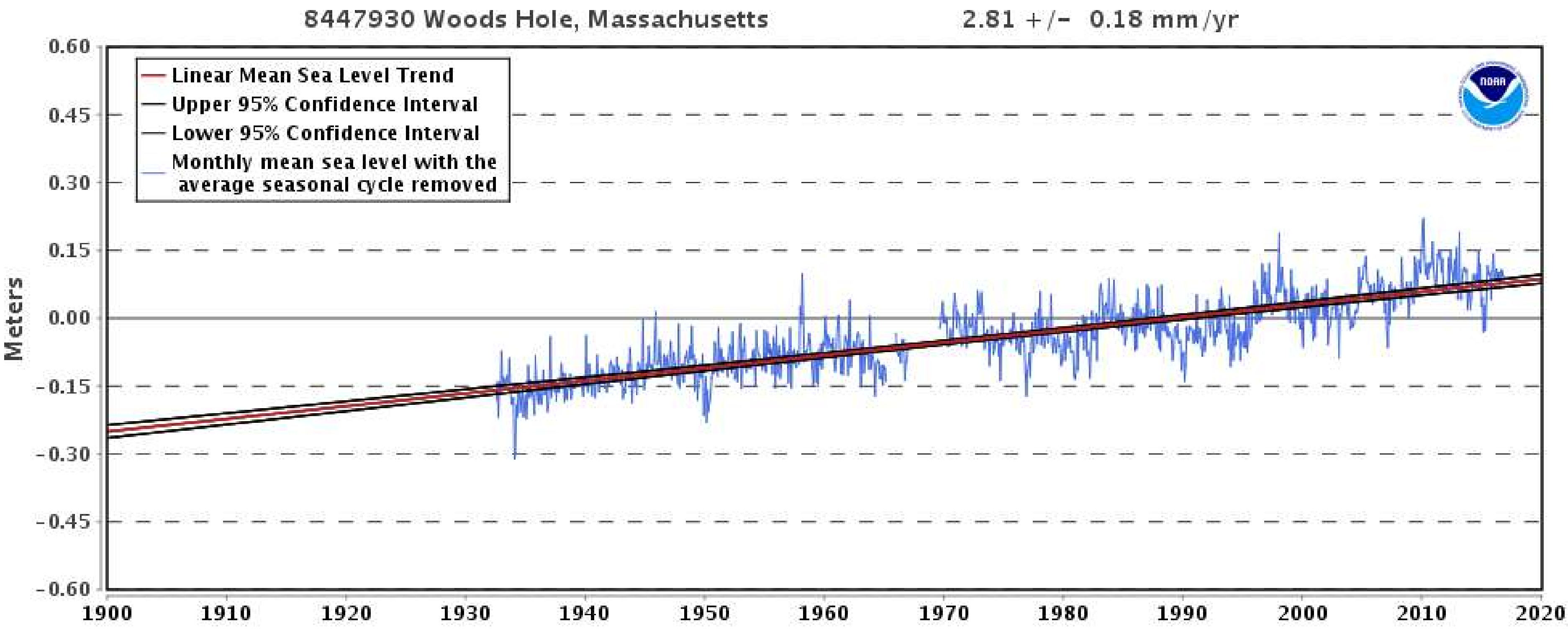
Economic Analysis Stakeholder Meeting & Engaging NPS & Herring River Project Team

Survey to Assess Knowledge of Wetland Ecosystem Services and Blue Carbon

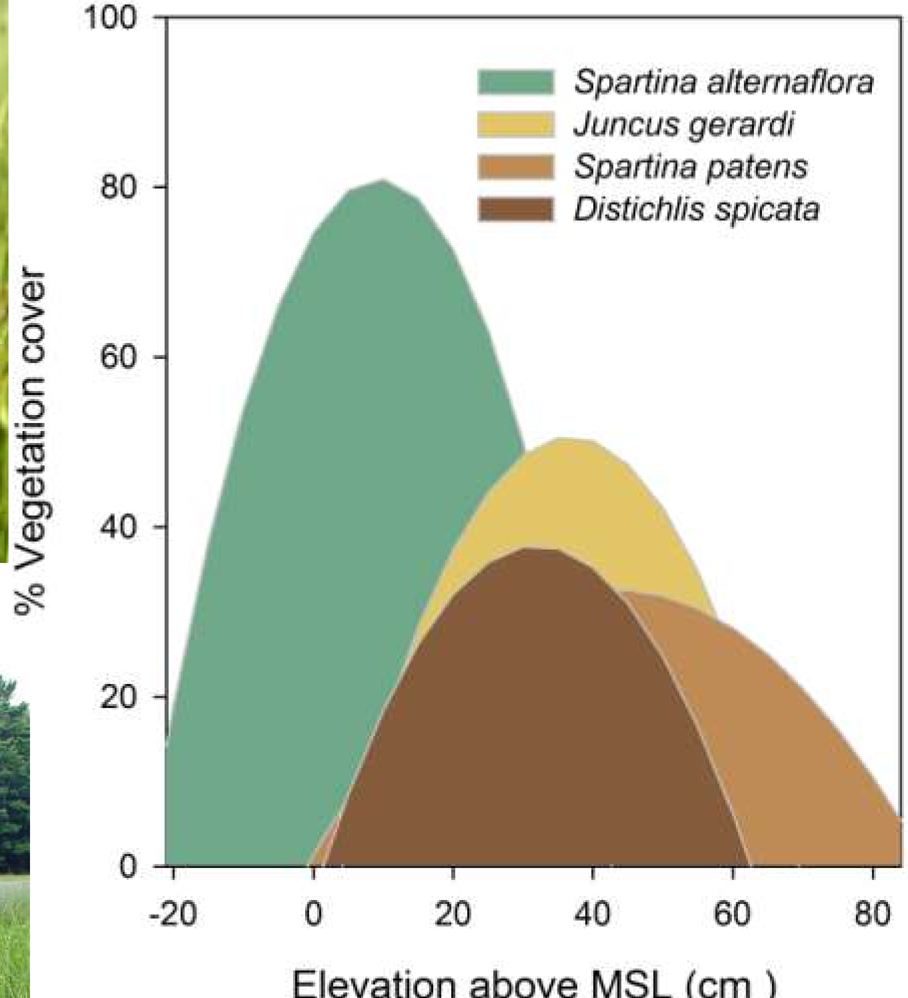


New England sea level rise is rapid—
2.8 mm per year since 1932.

Woods Hole NOAA Water Level Station

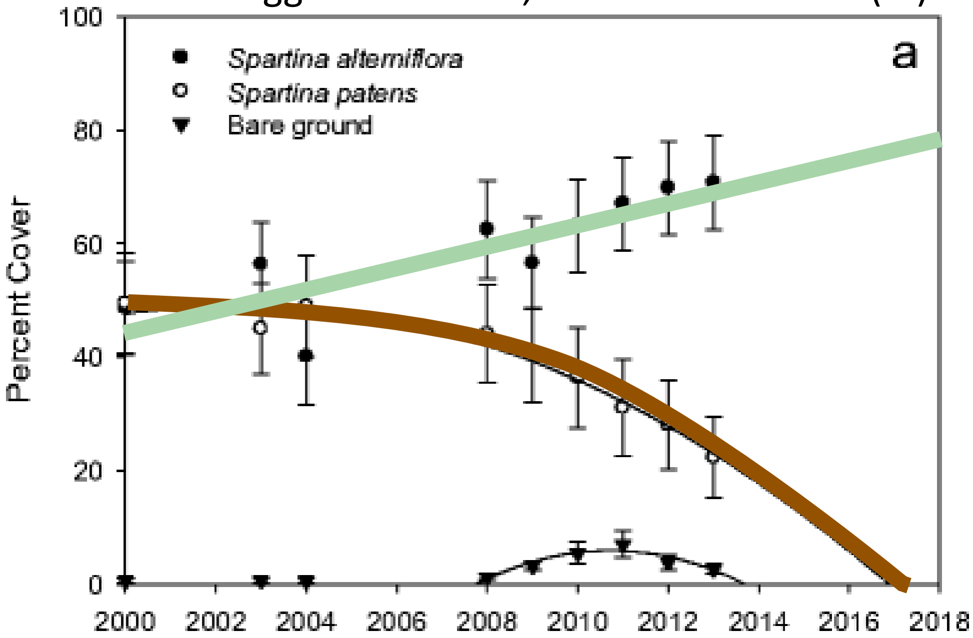



Data collected by J. Mora, WBNERR monitoring program

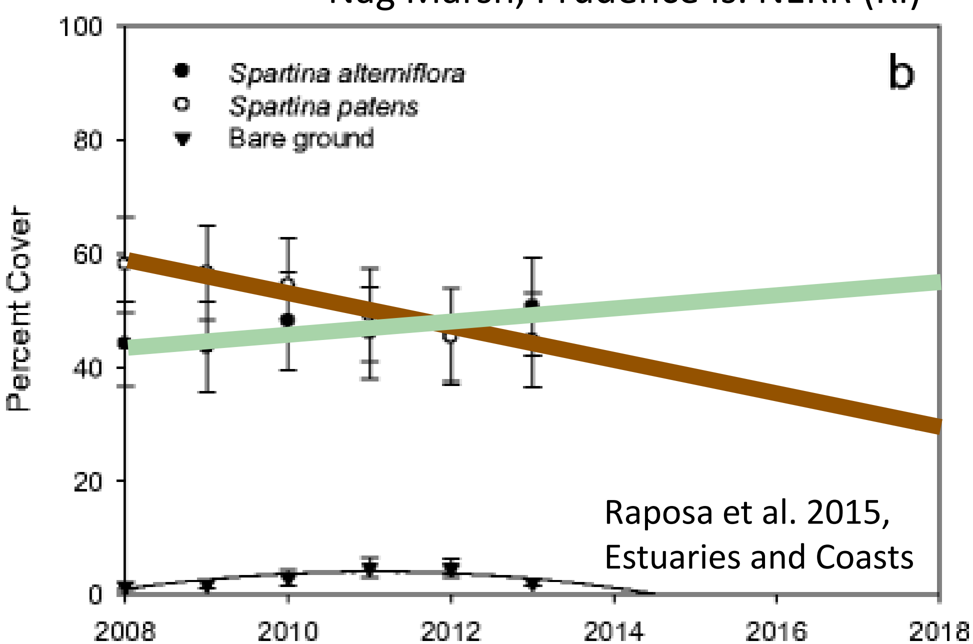


How has 28 cm change in sea level in 100 years impacted the marsh?

Coggeshall Marsh, Prudence Is. NERR (RI)



Nag Marsh, Prudence Is. NERR (RI)



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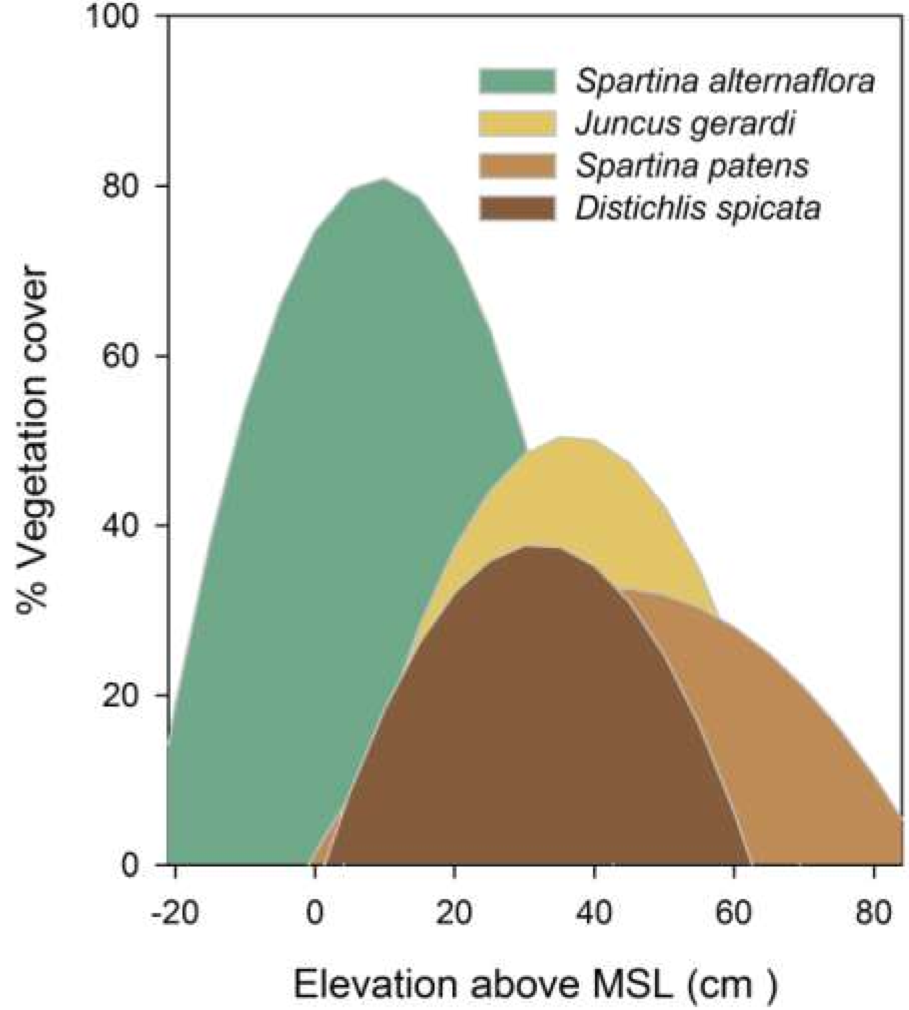
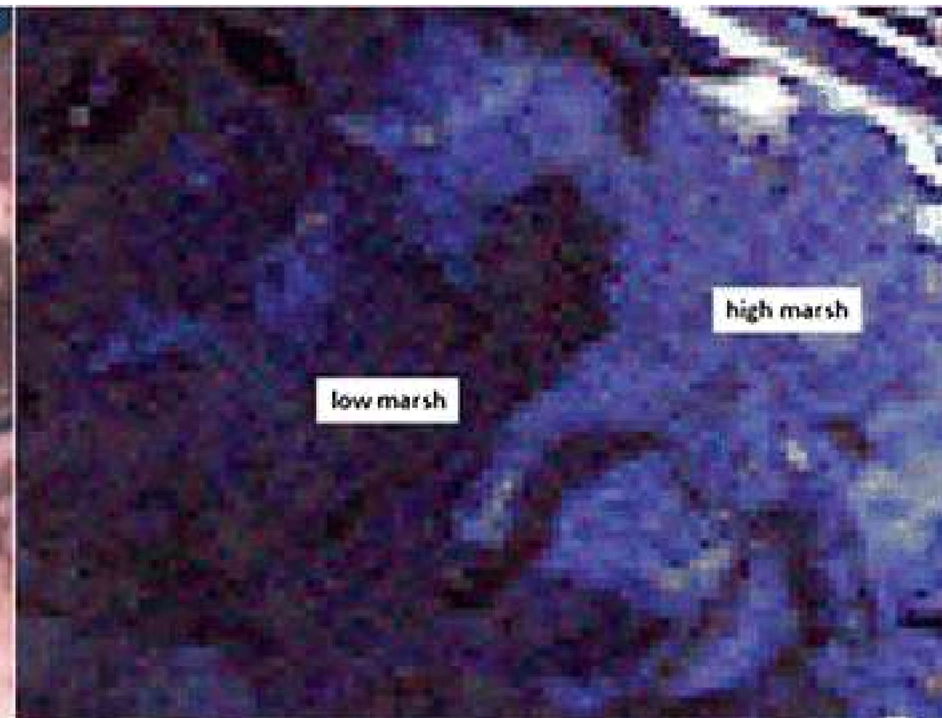


How do we know how vegetation has responded to sea level rise?

If we only look back several decades, satellite and aerial imagery provide clues.

Color infrared

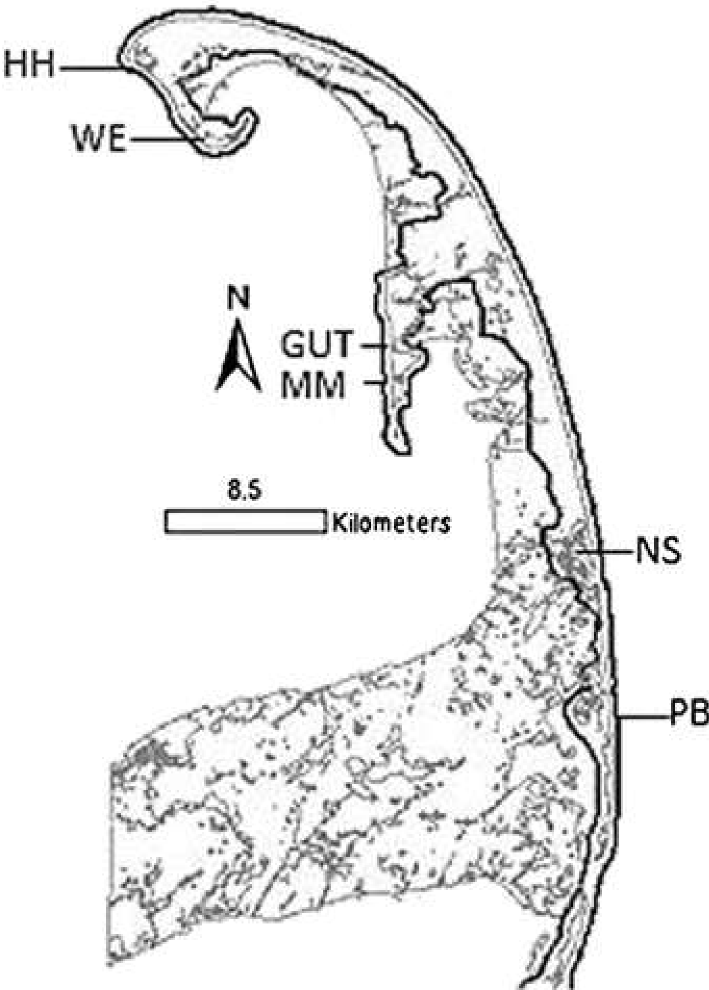
8-band satellite

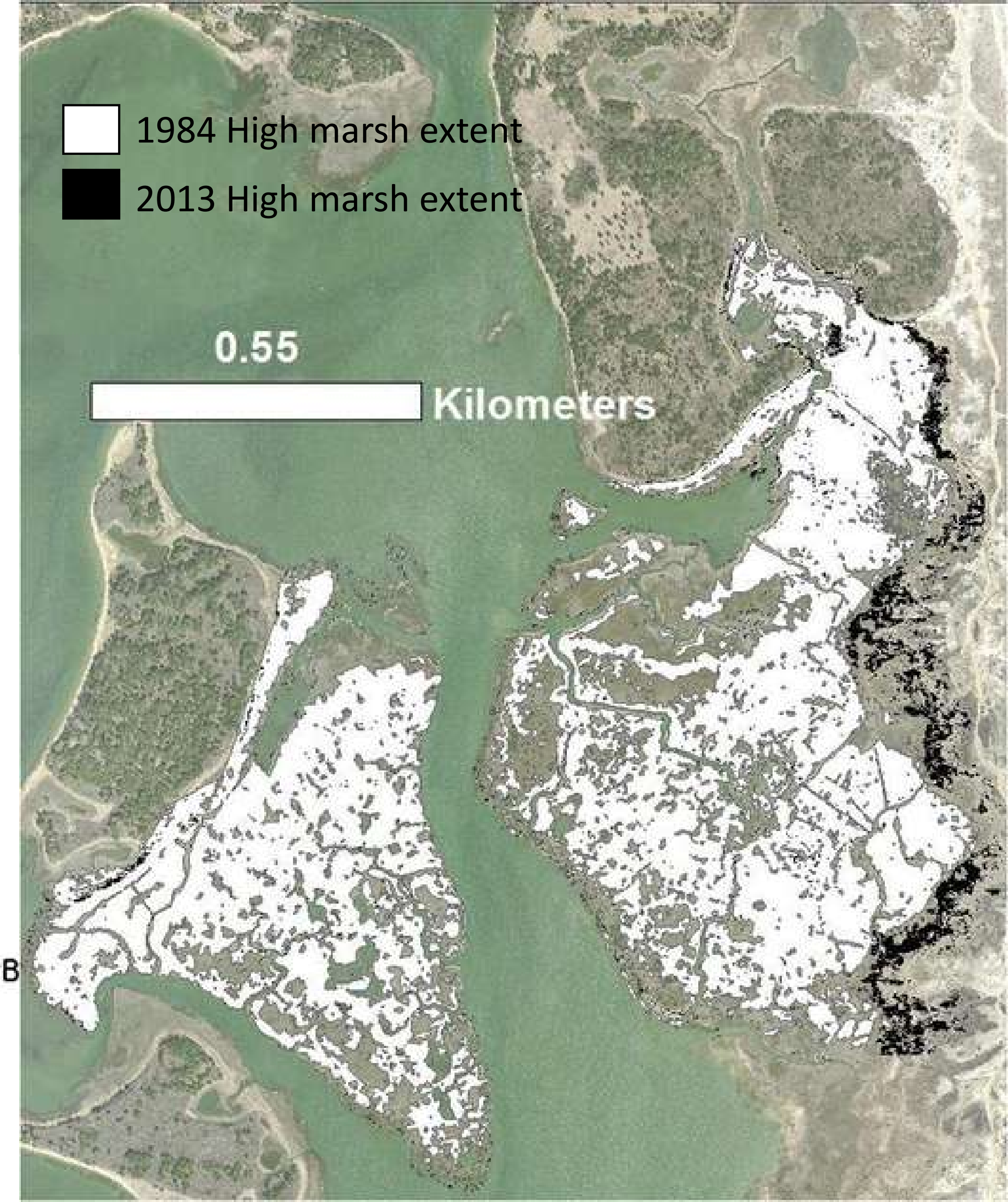


From: Smith (2015)
Wetlands 35: 127-136

Pleasant Bay (PB)

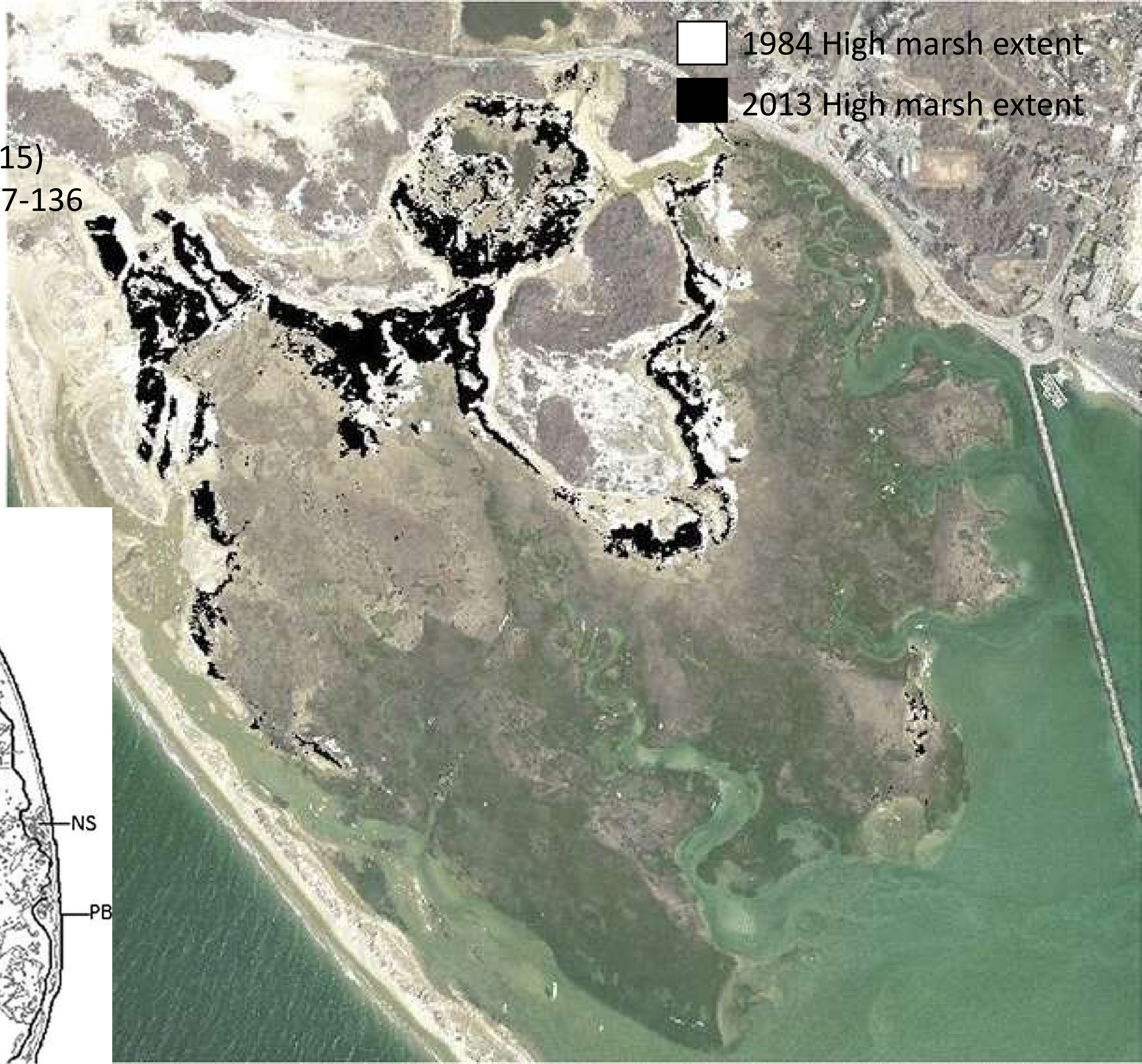
From: Smith (2015)
Wetlands 35: 127-136

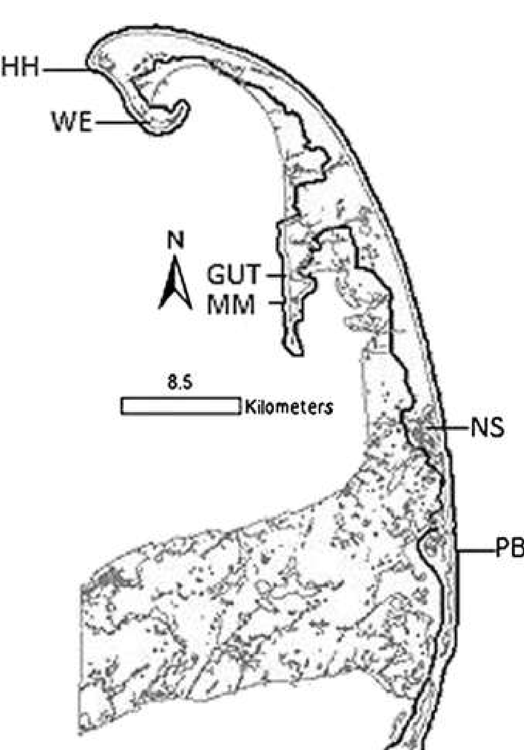


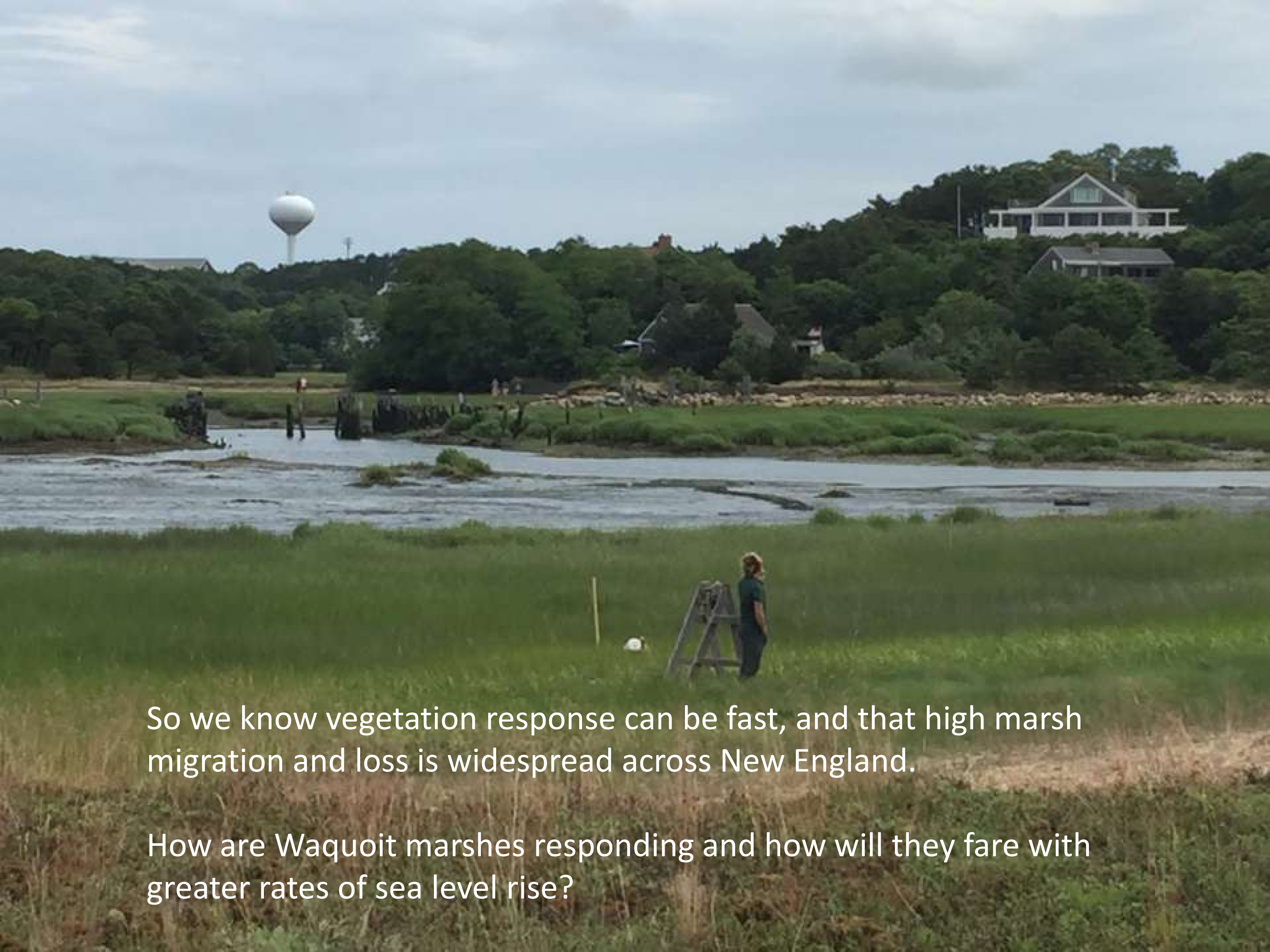


Wellfleet (WE)

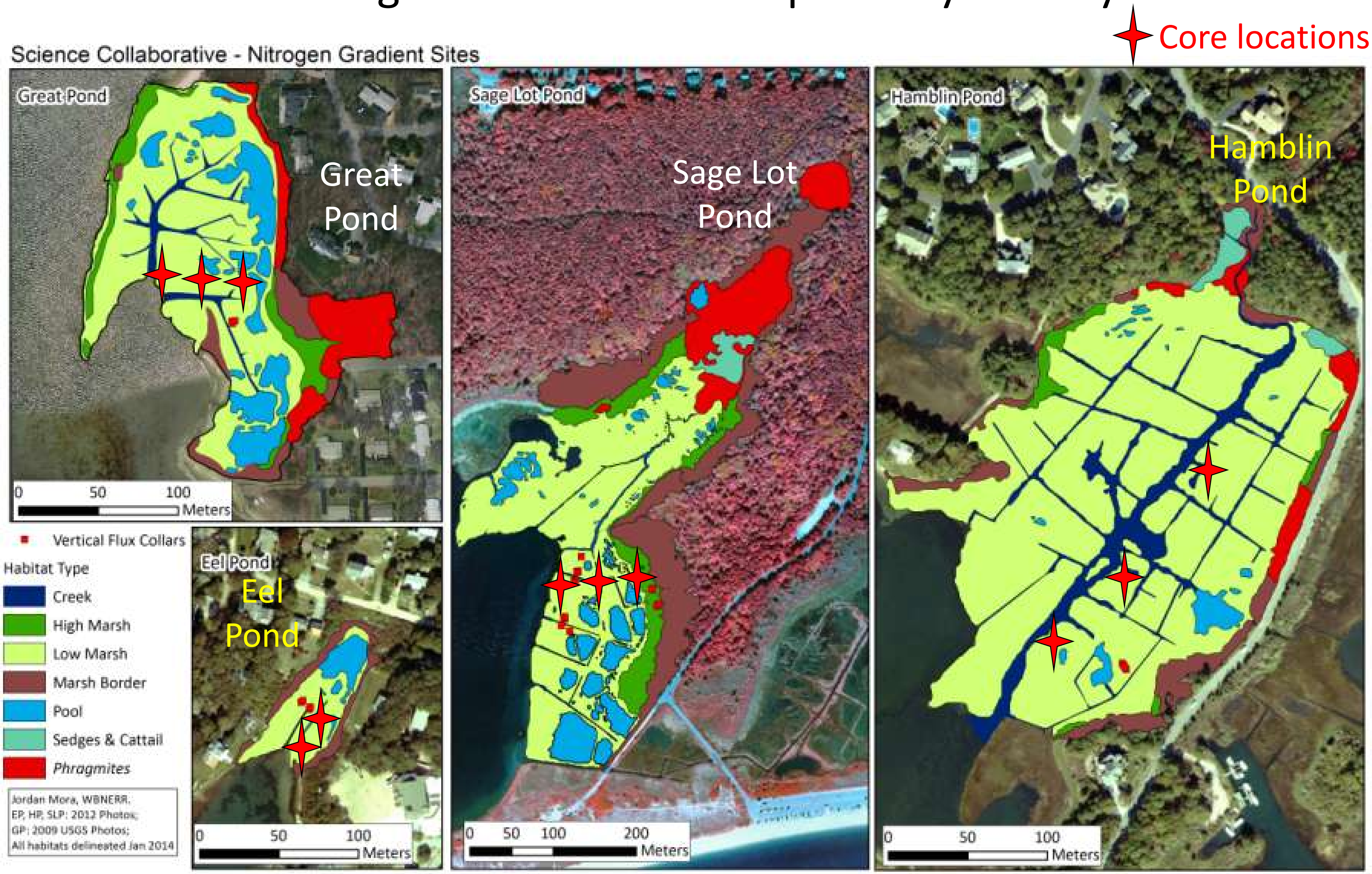
From: Smith (2015)
Wetlands 35: 127-136



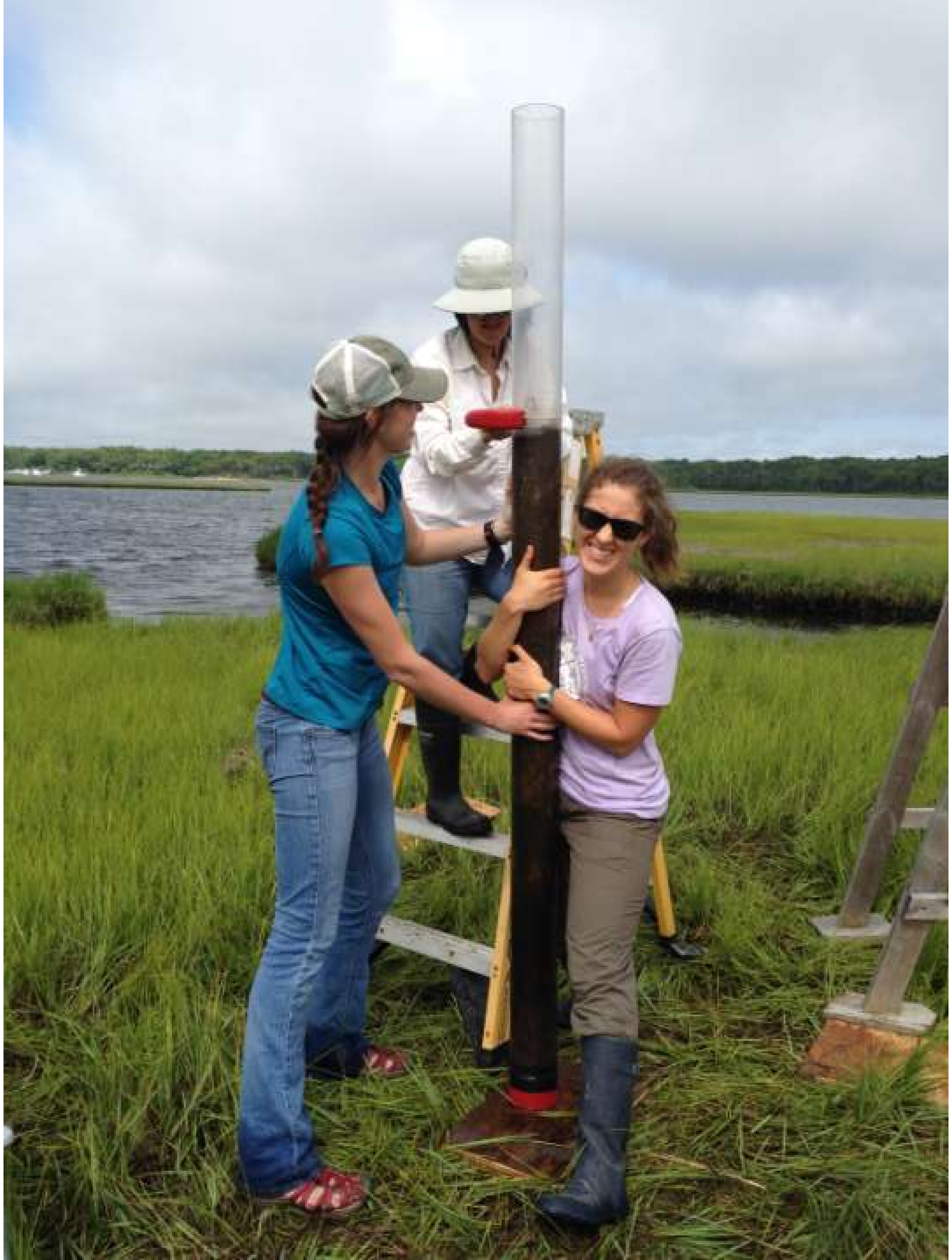



So we know vegetation response can be fast, and that high marsh migration and loss is widespread across New England.
How are Waquoit marshes responding and how will they fare with greater rates of sea level rise?

10 sediment cores were collected in low marshes and 1 core in the high marsh across Waquoit Bay estuary.



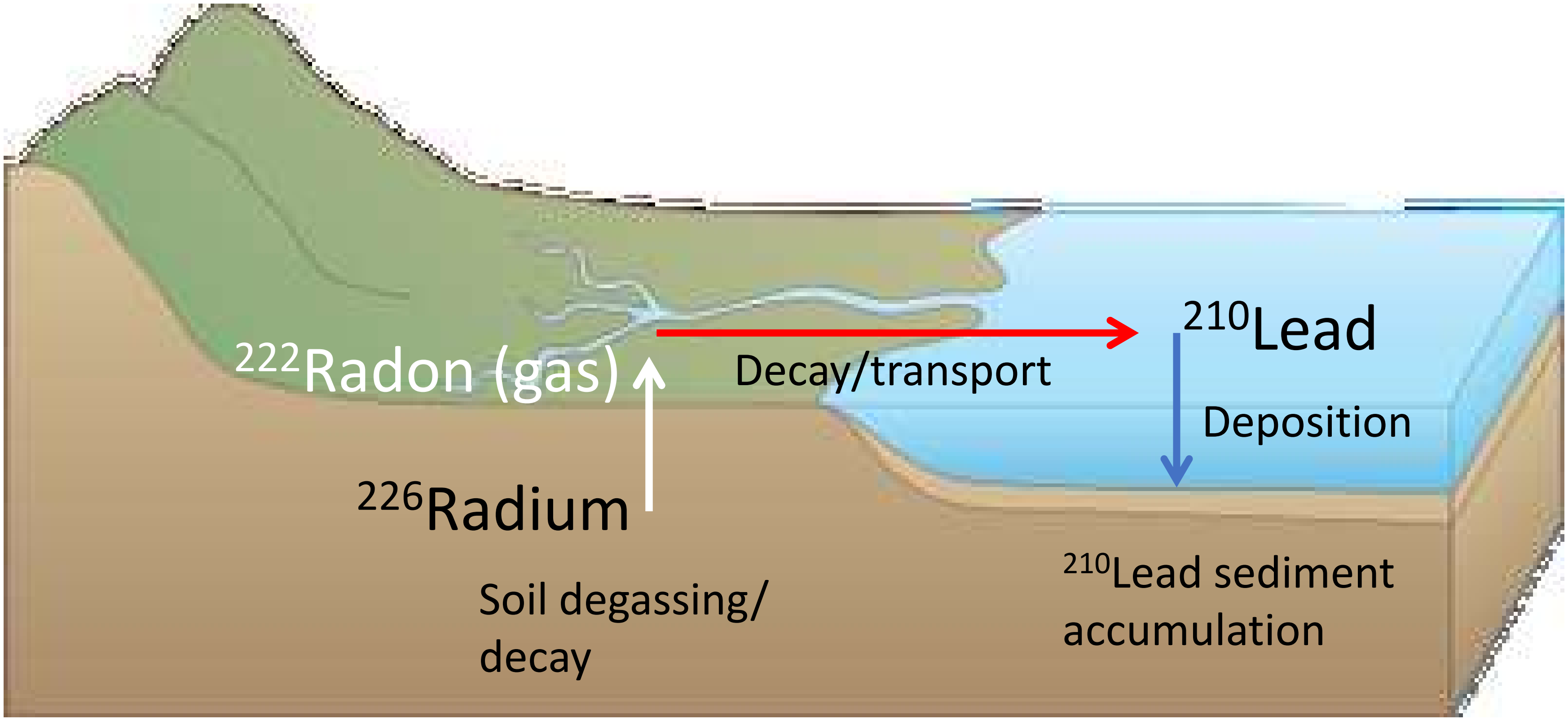
Map produced by J. Mora, with data from the WBNERR monitoring program



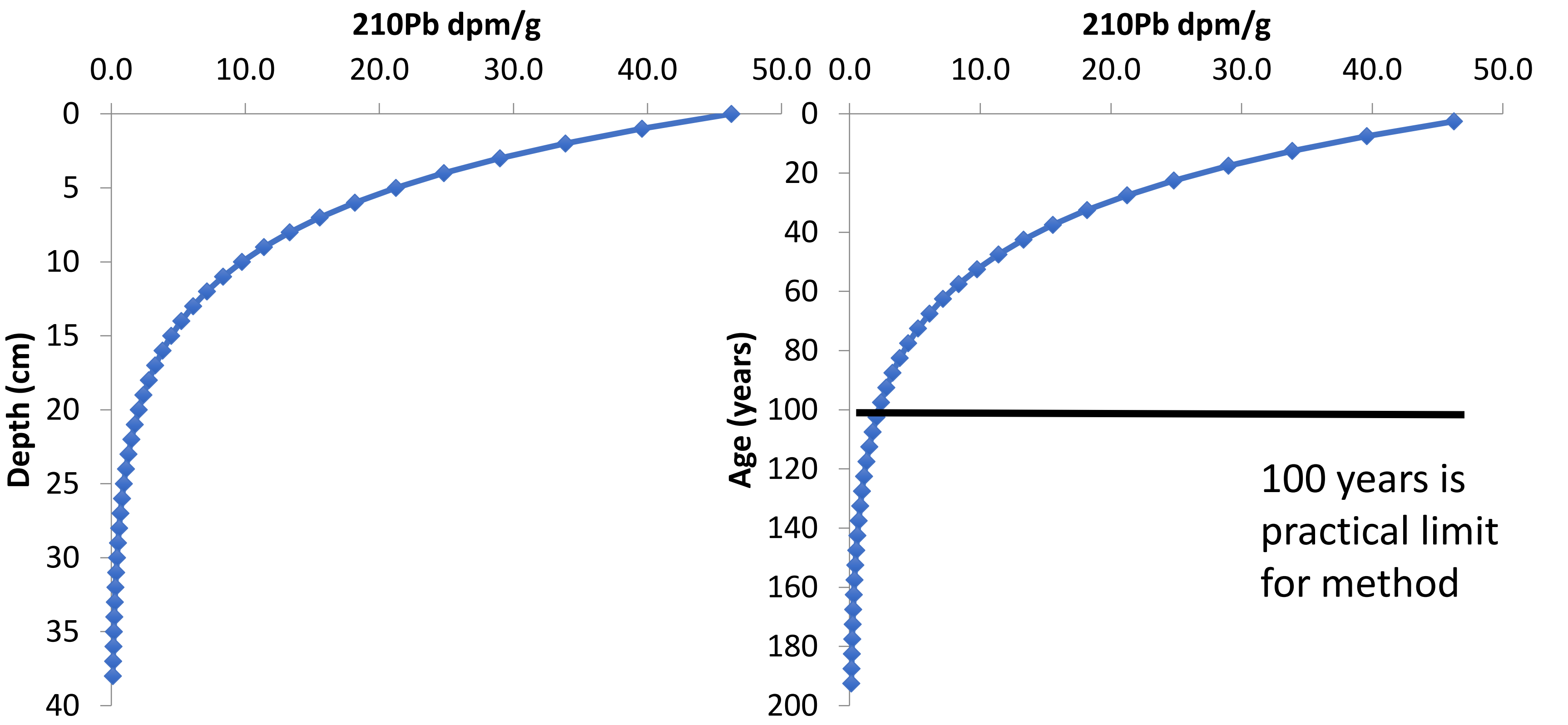

FRONT


FRONT

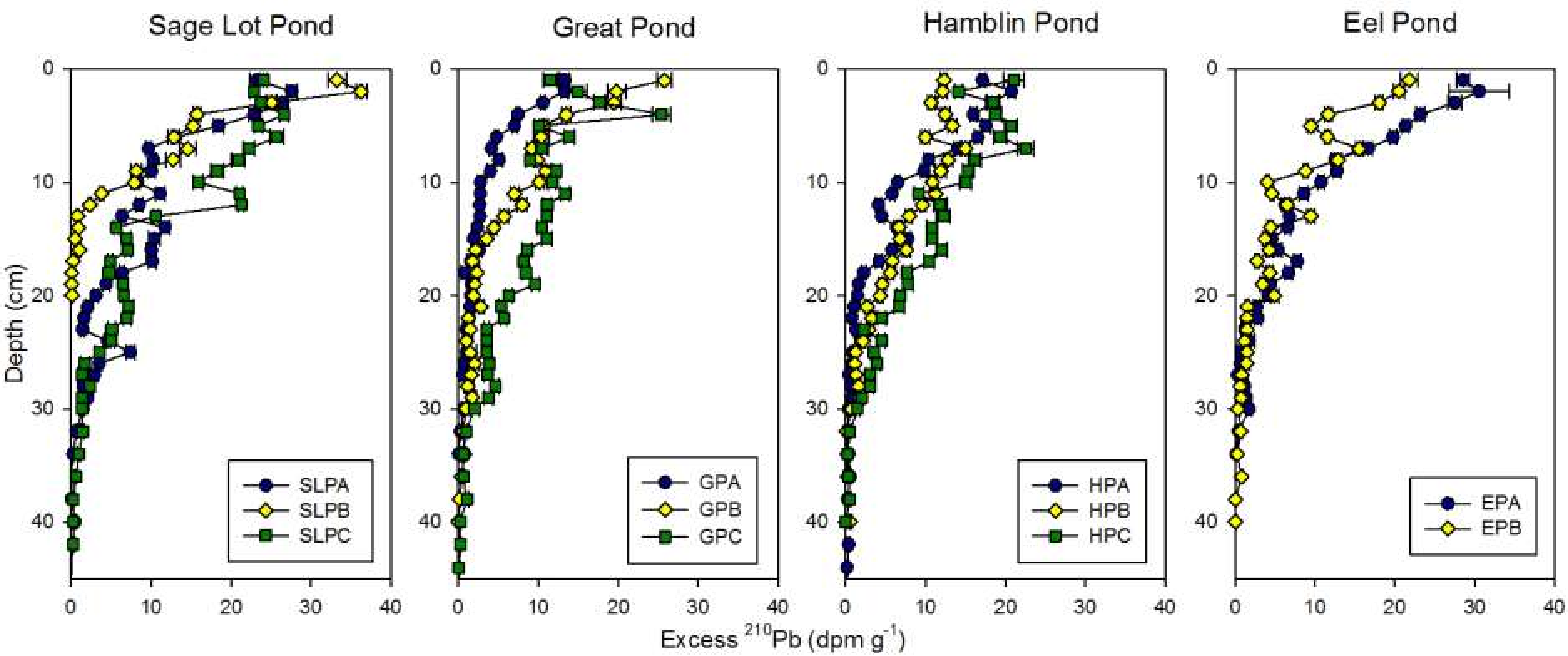
Naturally occurring radio isotope lead-210 was used to date sediments over the past century.



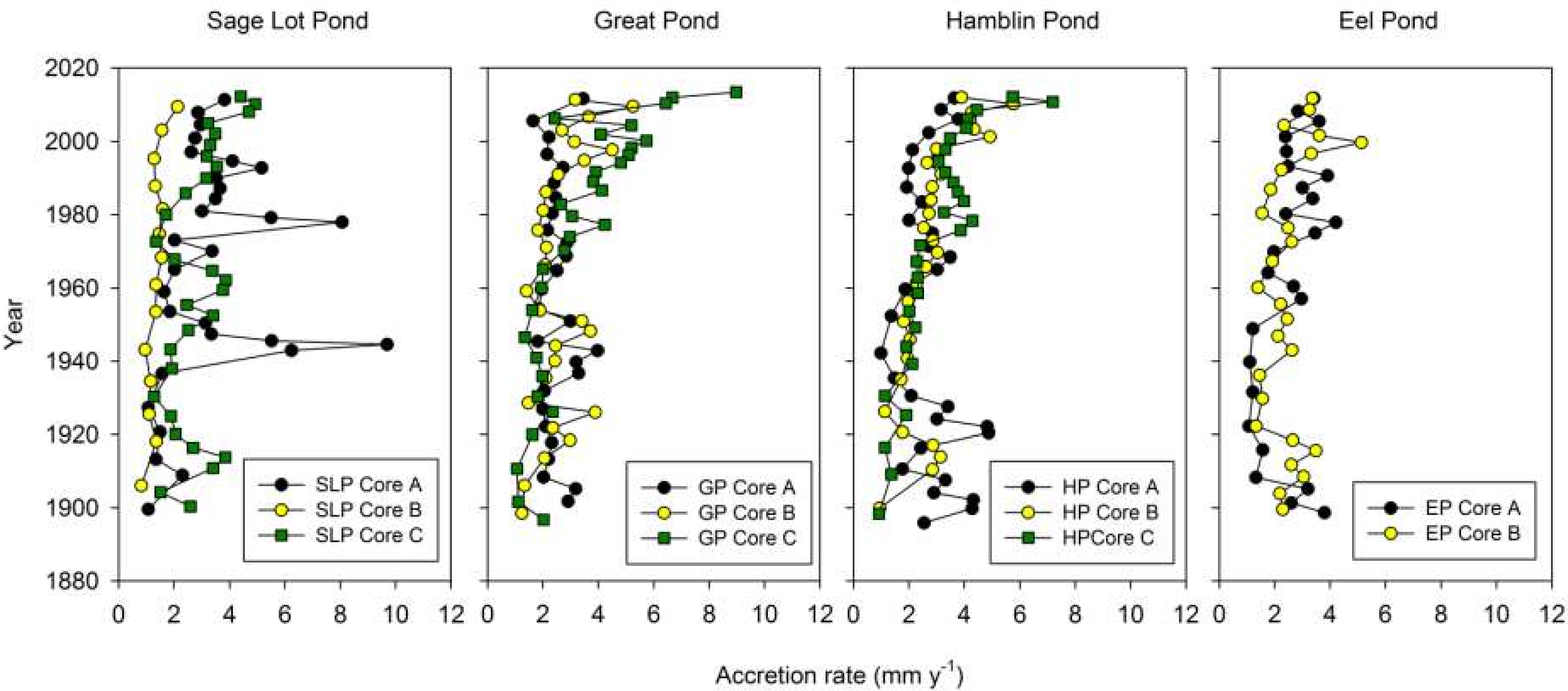
High resolution sediment ages were determined from sediment ^{210}Pb profiles, which has a half-life of 22.3 years.

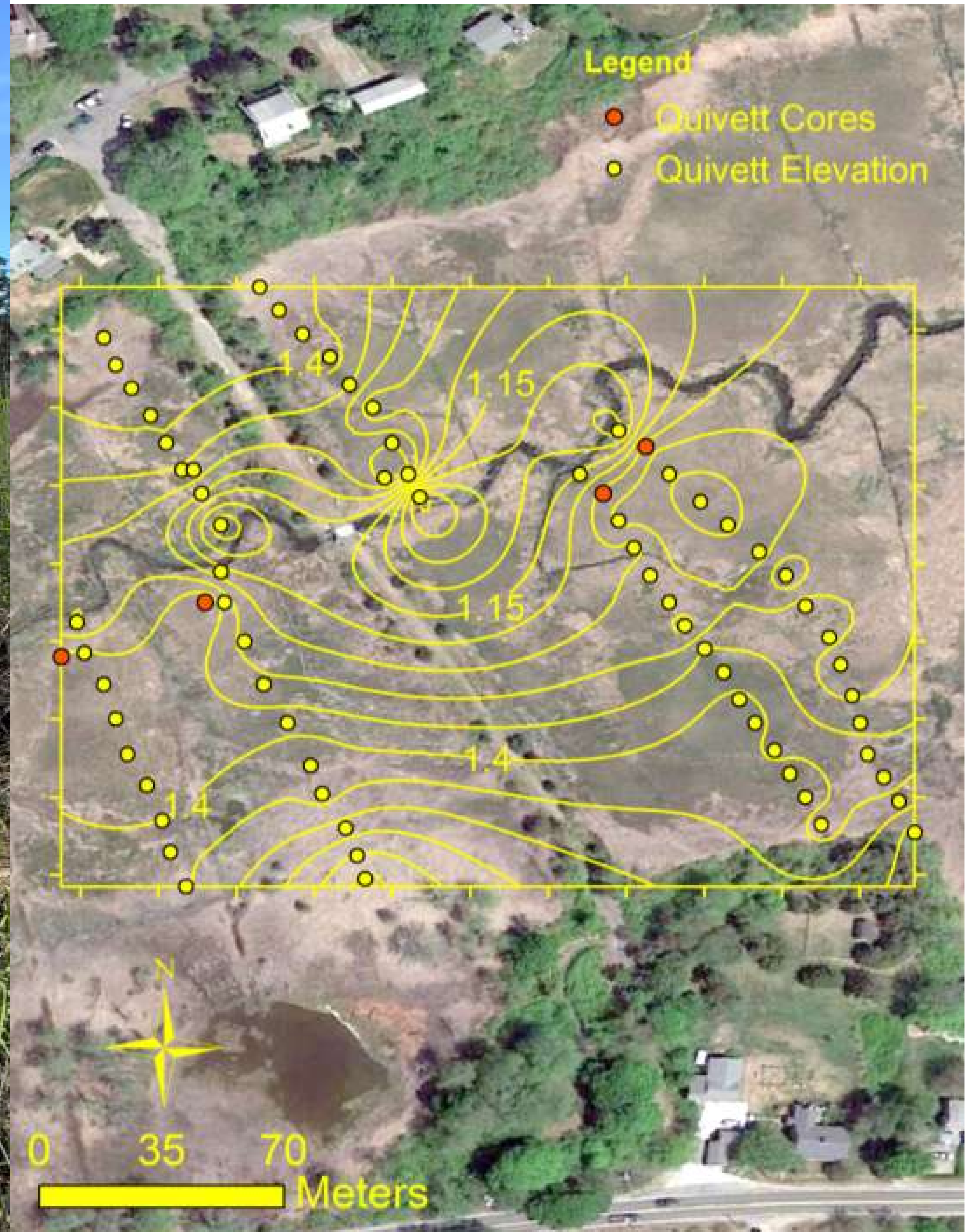


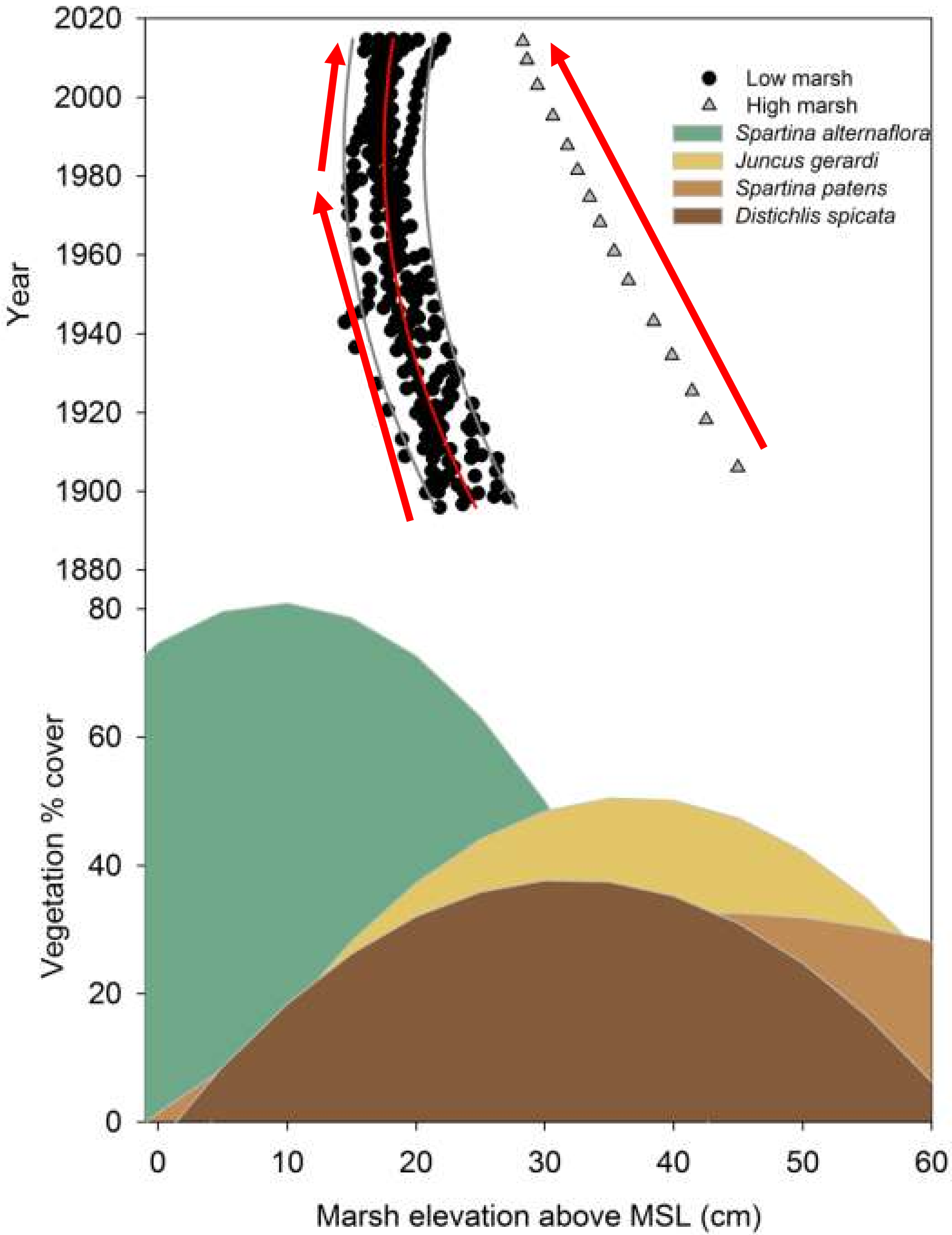
Excess ^{210}Pb profiles for all Waquoit Bay cores.



Vertical accretion, or growth, for salt marshes since 1900.



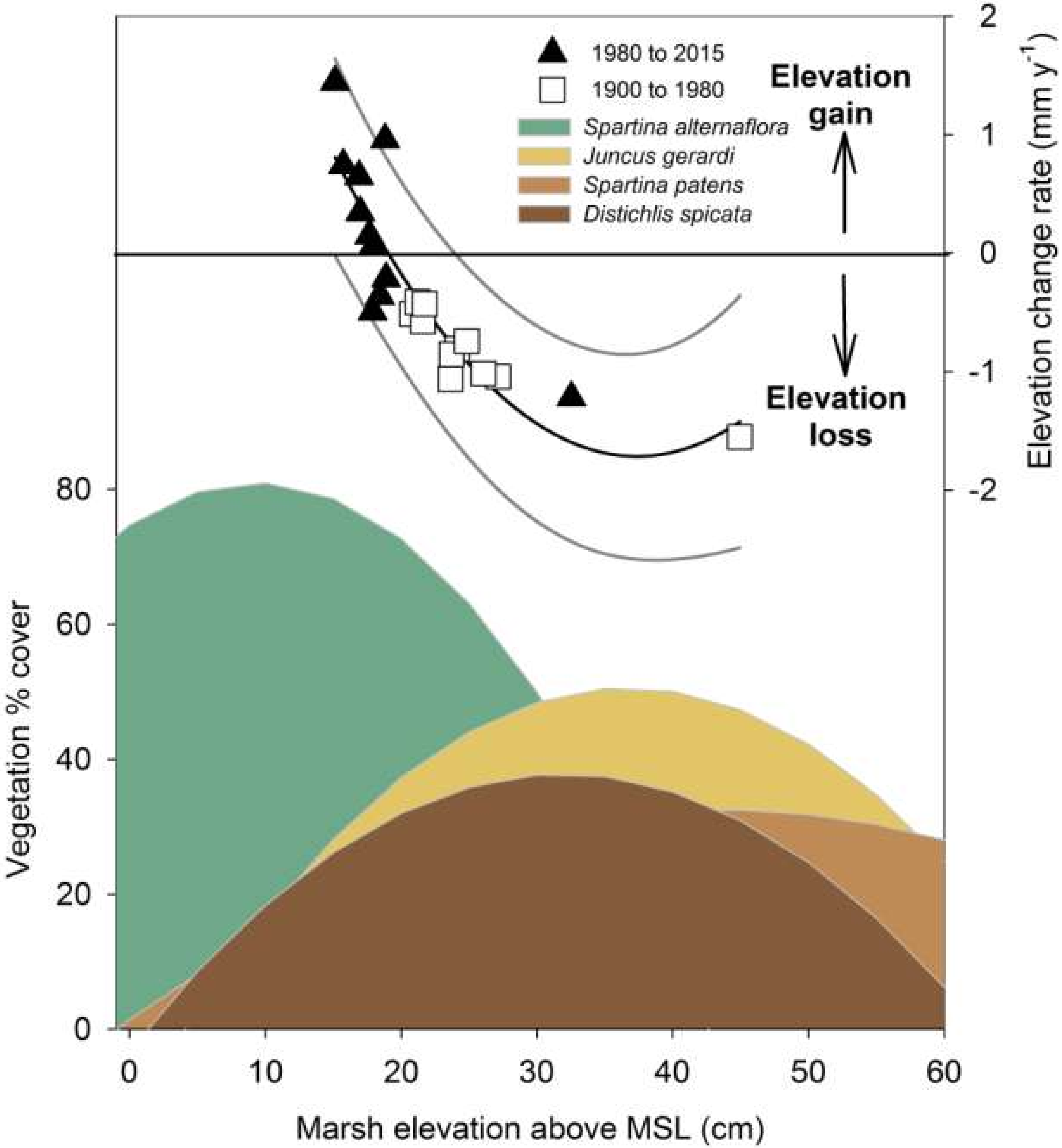

Legend
Quivett Cores
Quivett Elevation
1.4
1.15
1.15
1.4
1.4
N
0
35
70
Meters



High marsh is losing elevation through time.

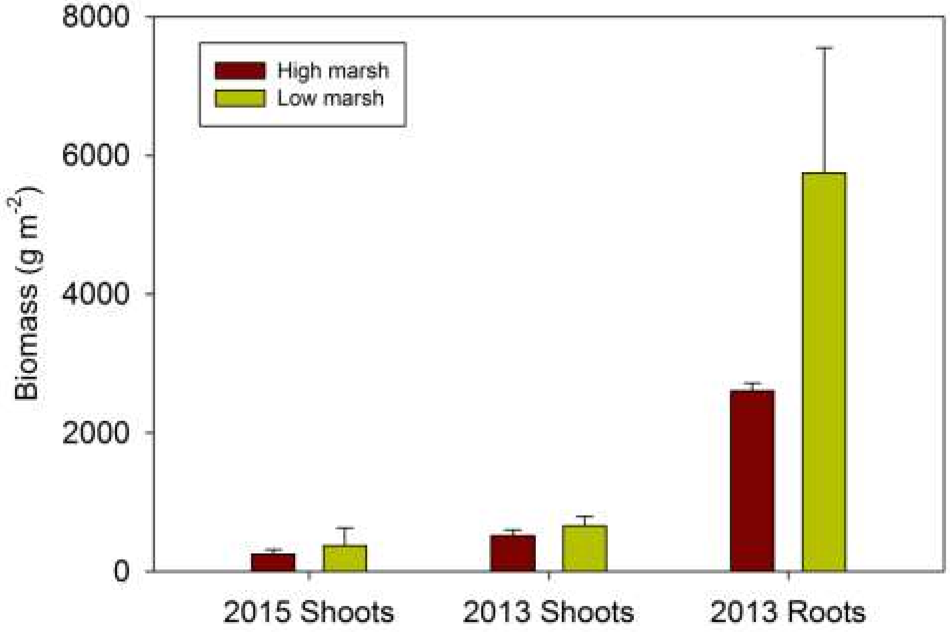
This supports the observation that high marsh is converting to low marsh as a result of the high marsh vertical growth rate less than the rate that sea level is rising.

The low marsh accretion rate initially was lower than sea level rise, but in the past two decades has increased, regaining some elevation capital



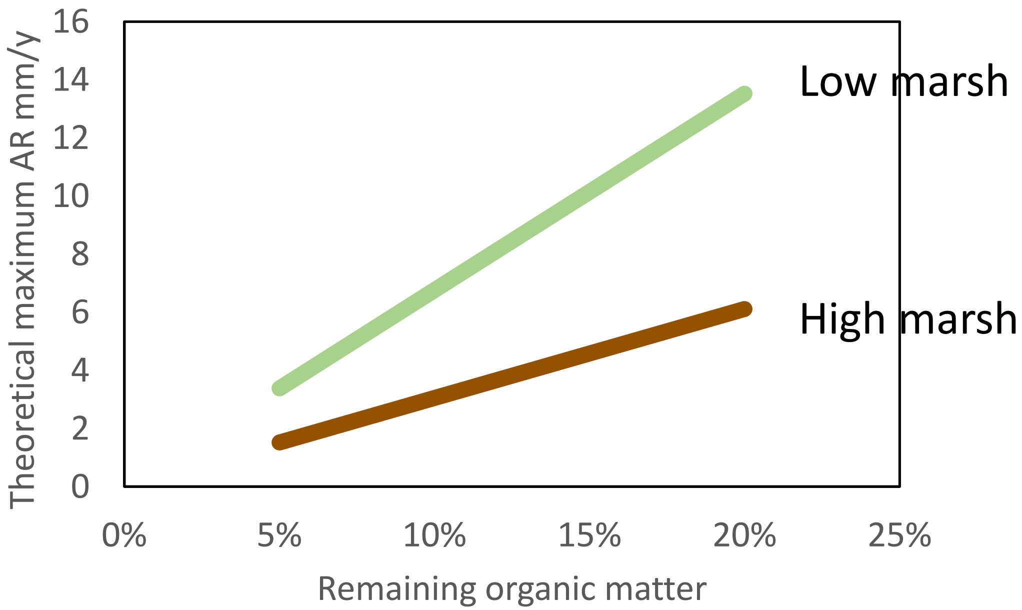
Marshes lost elevation from 1900 to 1980. Elevation loss in the high marsh was 1.5 mm y^{-1}, compared to sea level rise rates of 2.8 mm y^{-1}.

Since 1980, many marshes have switched to elevation gains relative to sea level rise. The rate of elevation loss in the high marsh continues, suggesting the high marsh is at maximal growth.

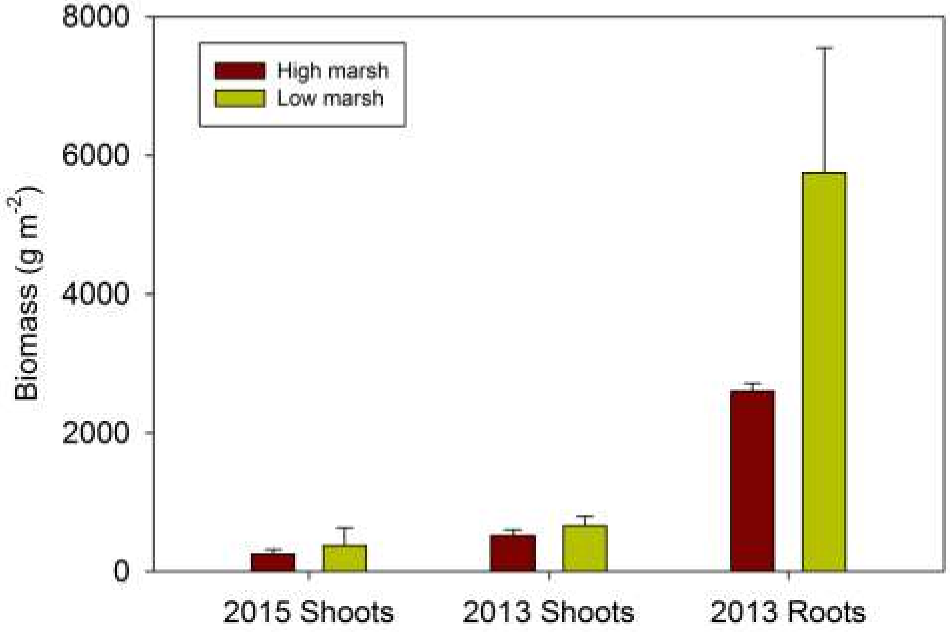


Productivity, both above ground shoots and below ground roots, is greater in the low marsh.

Organic matter provides the majority of the volume of salt marsh peat.



Using the density of organic matter, it is possible to calculate the theoretical maximum accretion rate based on how much of the organic matter produced each year is preserved in sediments.



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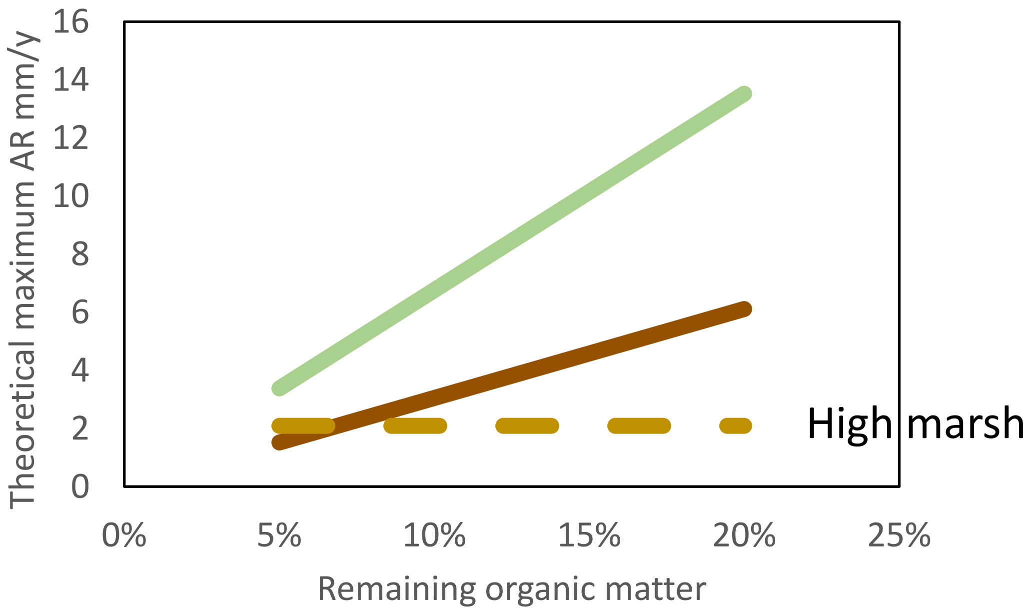

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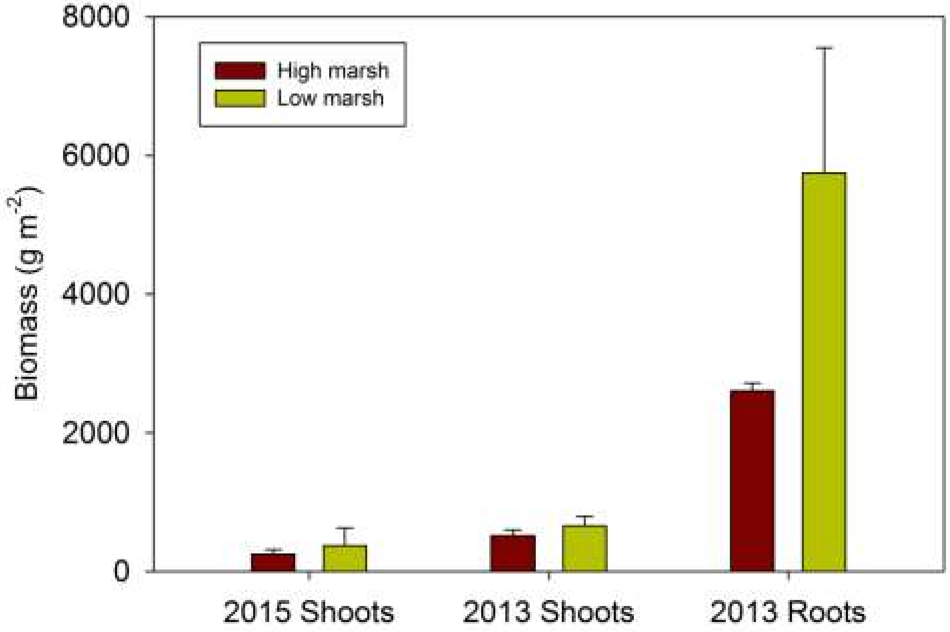

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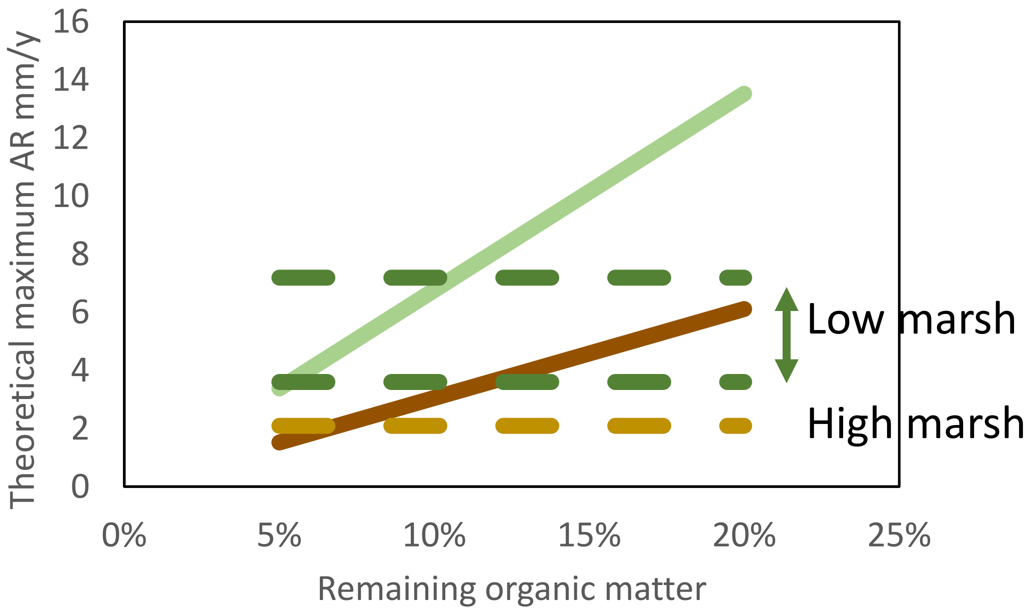

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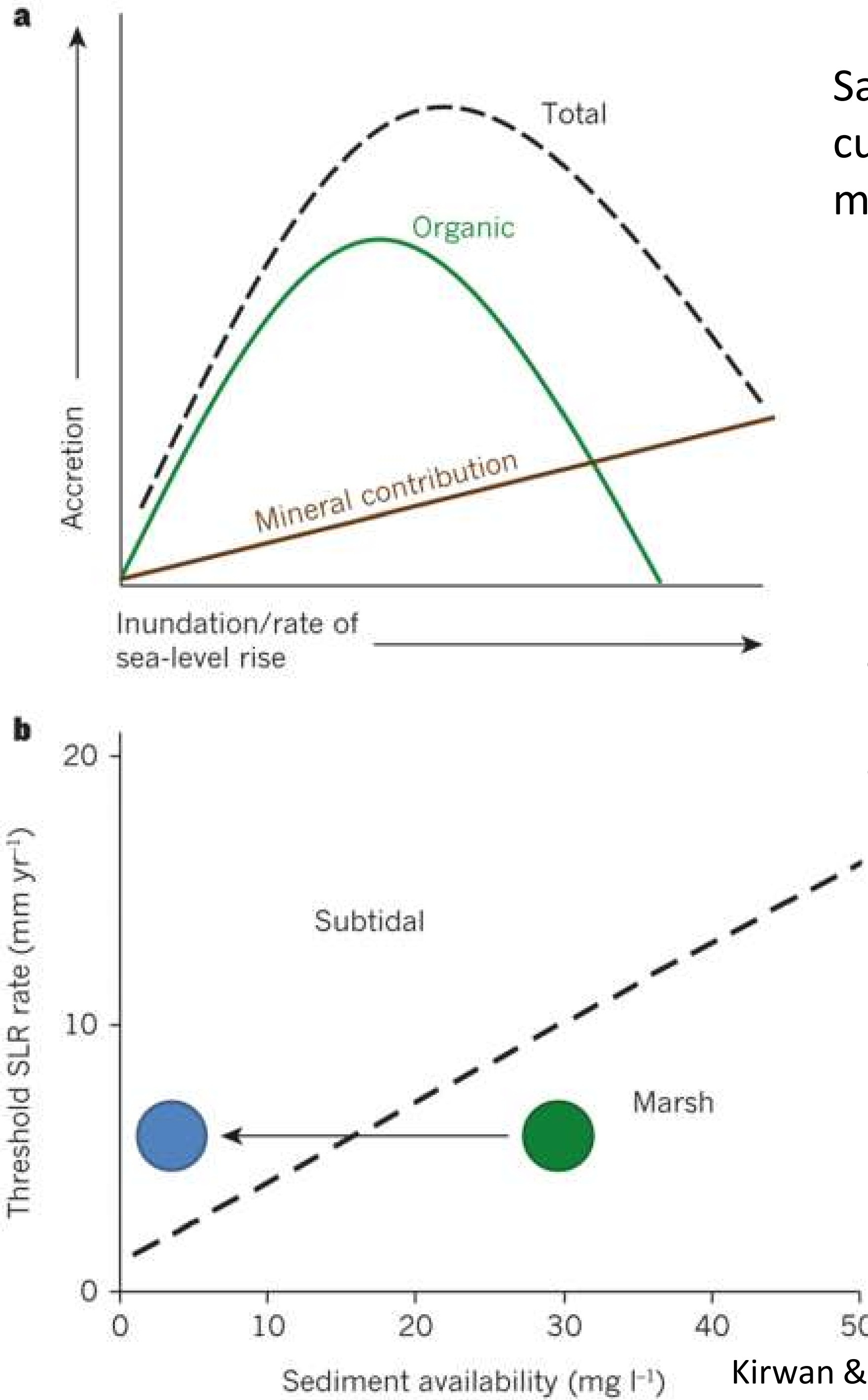
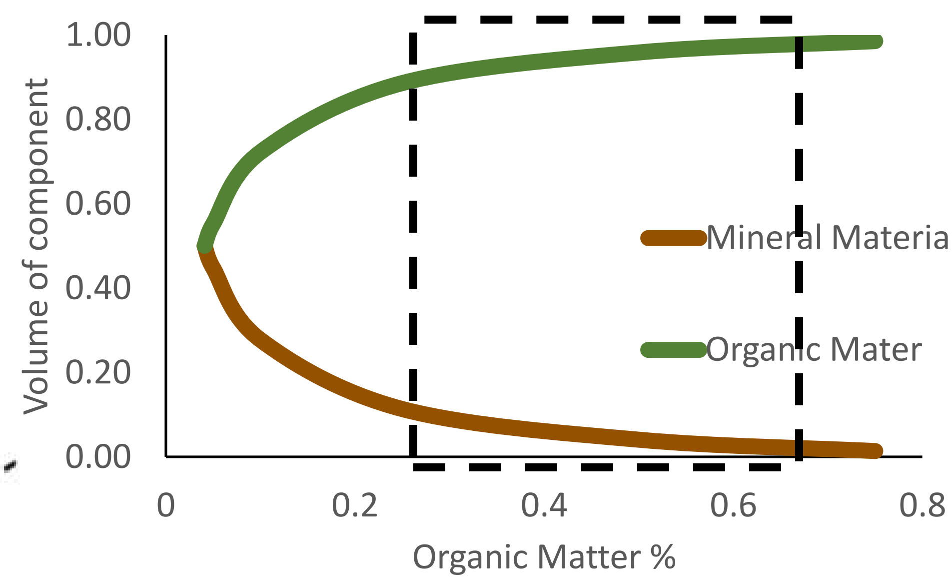
So how will salt marshes respond to increasing rates of sea level rise?

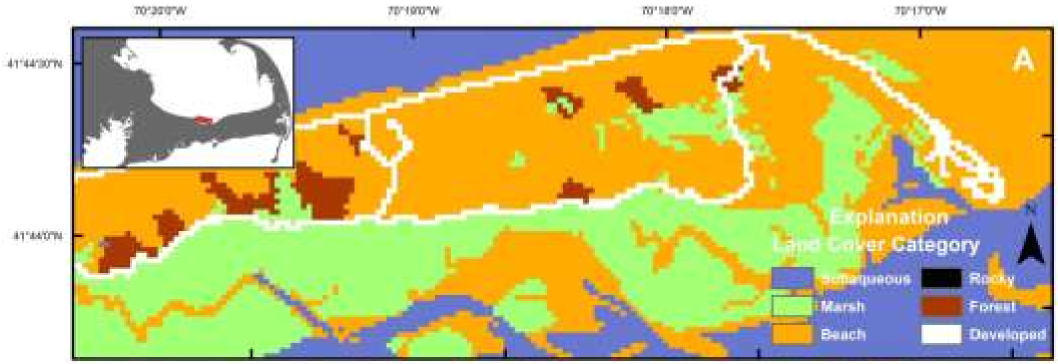
Salt marsh resilience to sea level rise is currently conceptualized as dependent on mineral sediment supply.



Kirwan & Megonigal, 2013

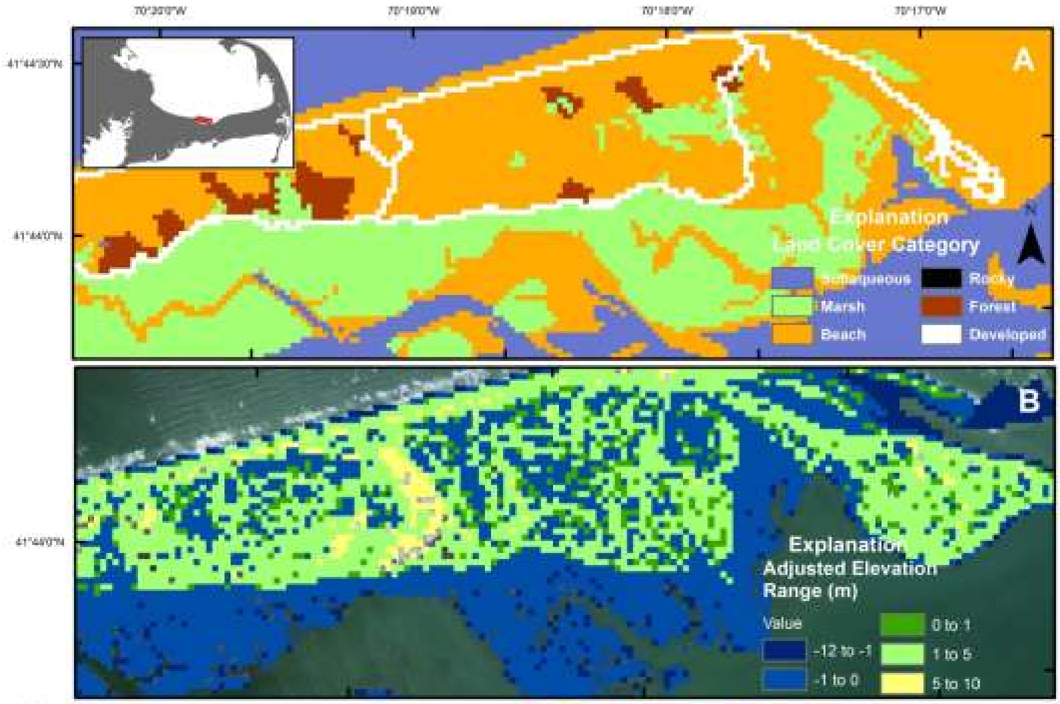


For organic rich marshes, such as we have on Cape Cod, organic matter is the main contributor to sediment volume and vertical accretion.



Land cover categories for Barnstable Great Marsh.

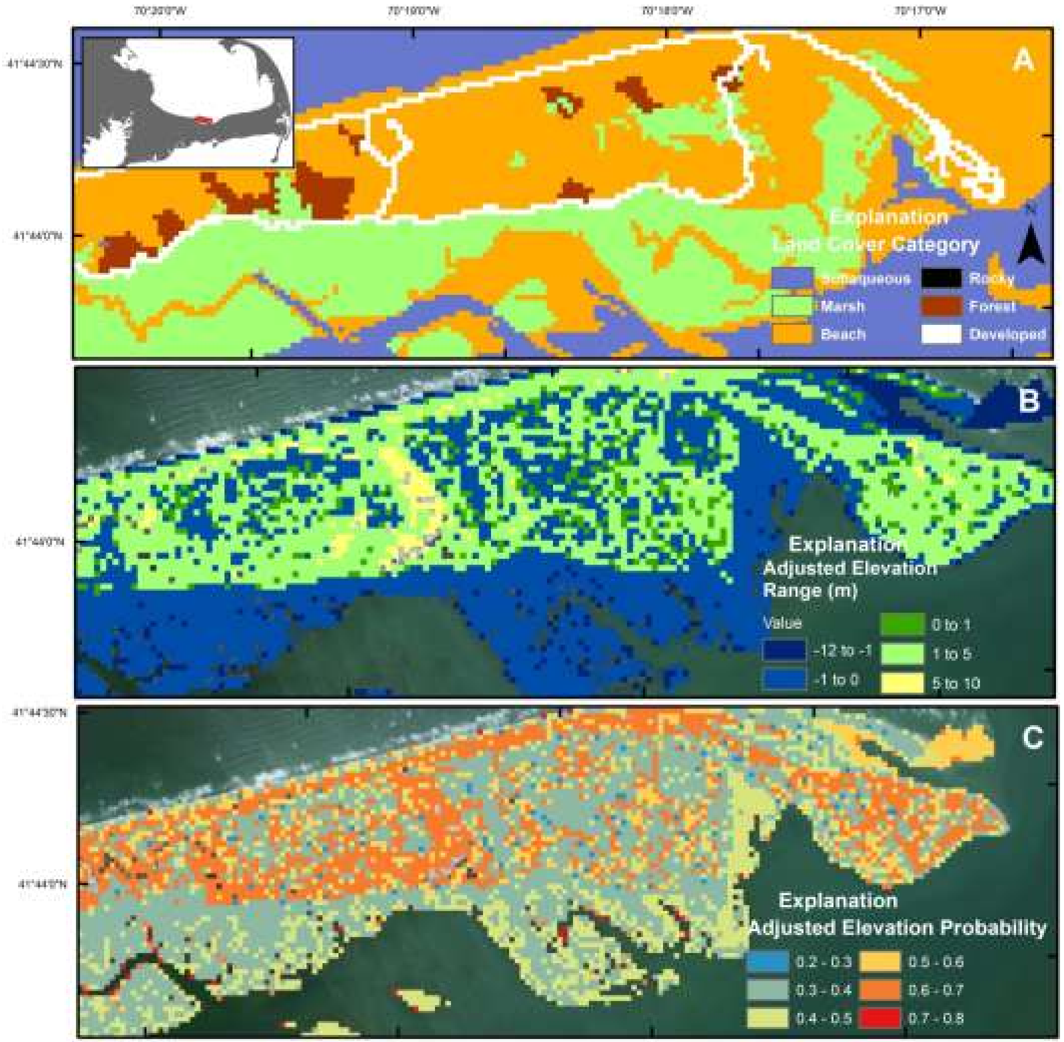
Lentz et al. 2014 Open File Report: USGS 2014-1252



Land cover categories for Barnstable Great Marsh.

Current elevation

Lentz et al. 2014 Open File Report: USGS 2014-1252

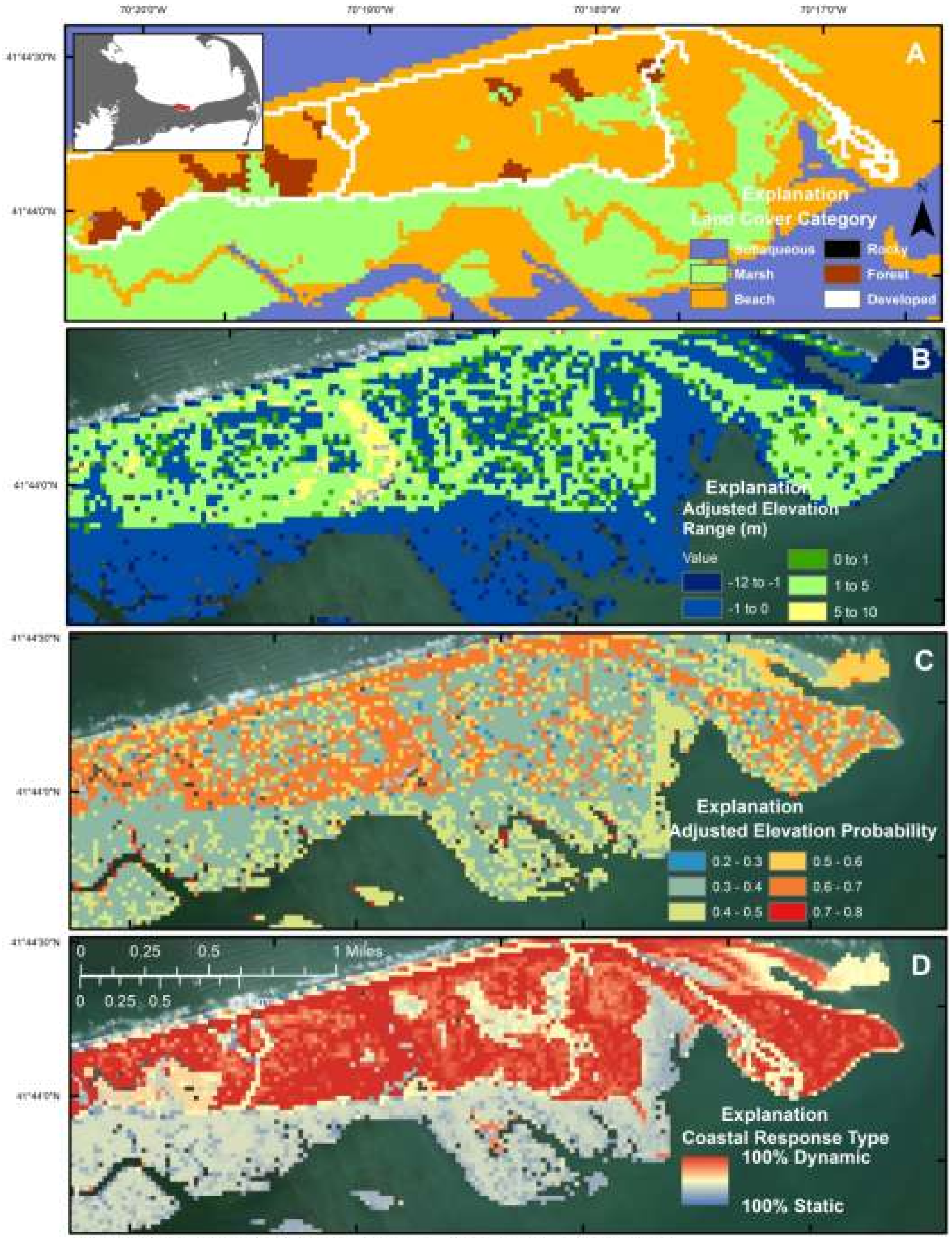


Land cover categories for Barnstable Great Marsh.

Current elevation

Likelihood that elevation will adjust to sea level rise.

Lentz et al. 2014 Open File Report: USGS 2014-1252



Land cover categories for Barnstable Great Marsh.

Current elevation

Likelihood that elevation will adjust to sea level rise.

Where dynamic elevation change is expected (neutral colors are either no change or unknown.)

Lentz et al. 2014 Open File Report: USGS 2014-1252

U.S. Geological Survey is tasked with conducting science in support of management of our nation’s land and marine resources for safe, productive, and resilient communities and economies.

Located on the Woods Hole Oceanographic Institution campus.