Capitalizing on Coastal Blue Carbon

Tonna-Marie Surgeon Rogers
Waquoit Bay National Estuarine Research Reserve

Outline

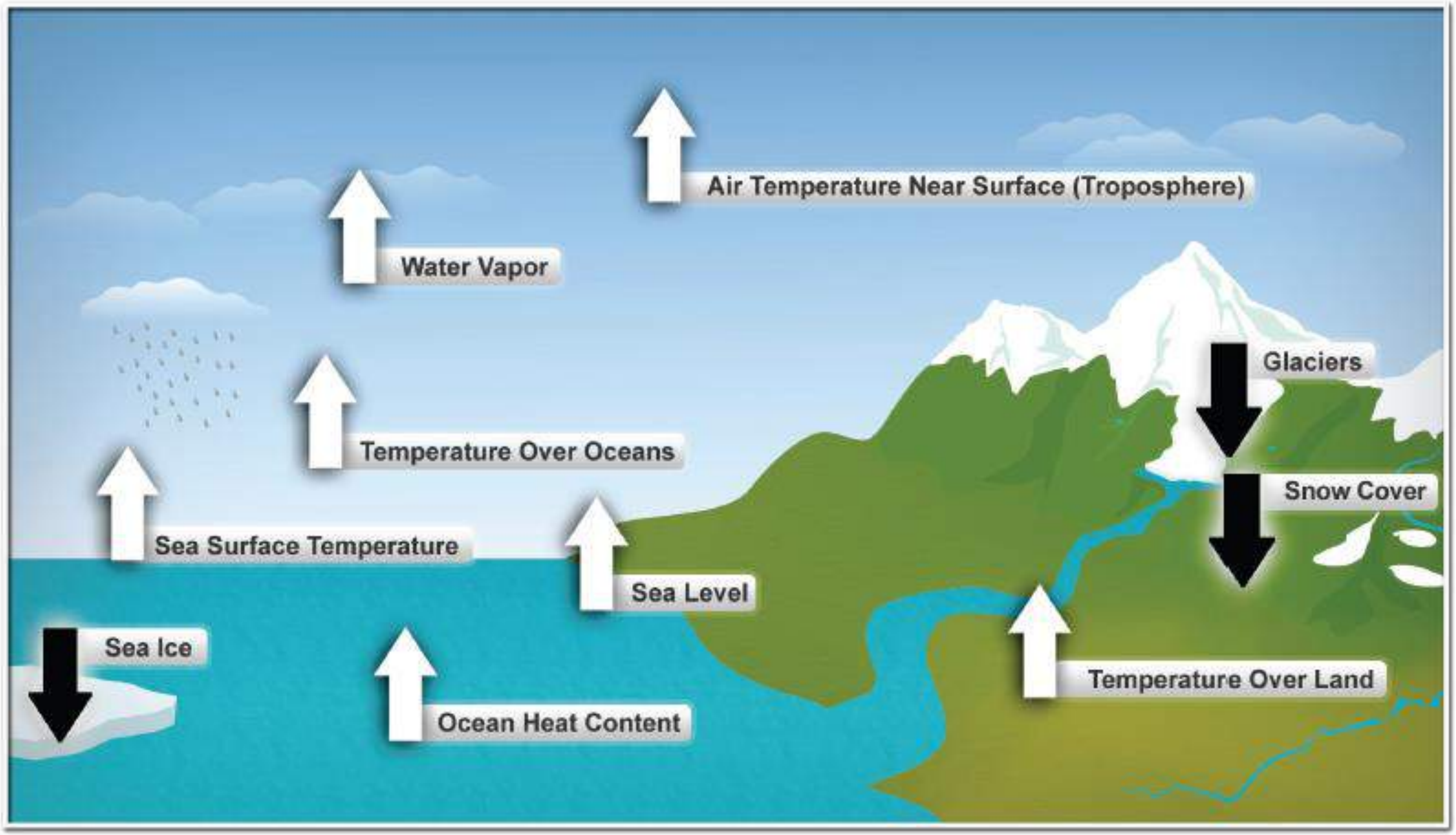
1 An Introduction to Blue Carbon

2 OVERVIEW – Bringing Wetlands To Market (BWM) Project & Results

3 Using BWM Science & Tools – How Can We Capitalize on Blue Carbon?

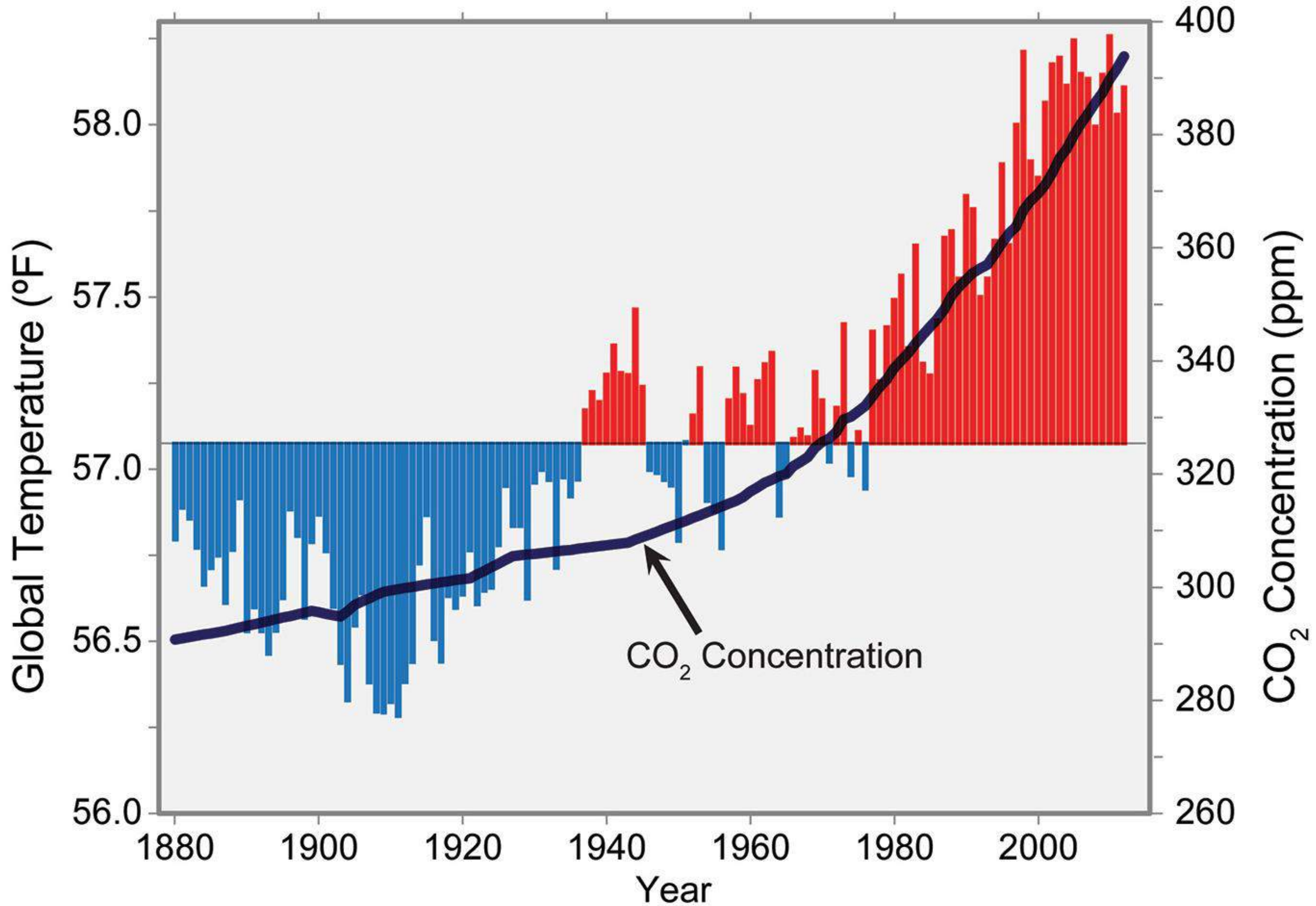
Our Changing Climate

Ten Indicators of a Warming World



Source: NOAA NCDC

Our Changing Climate

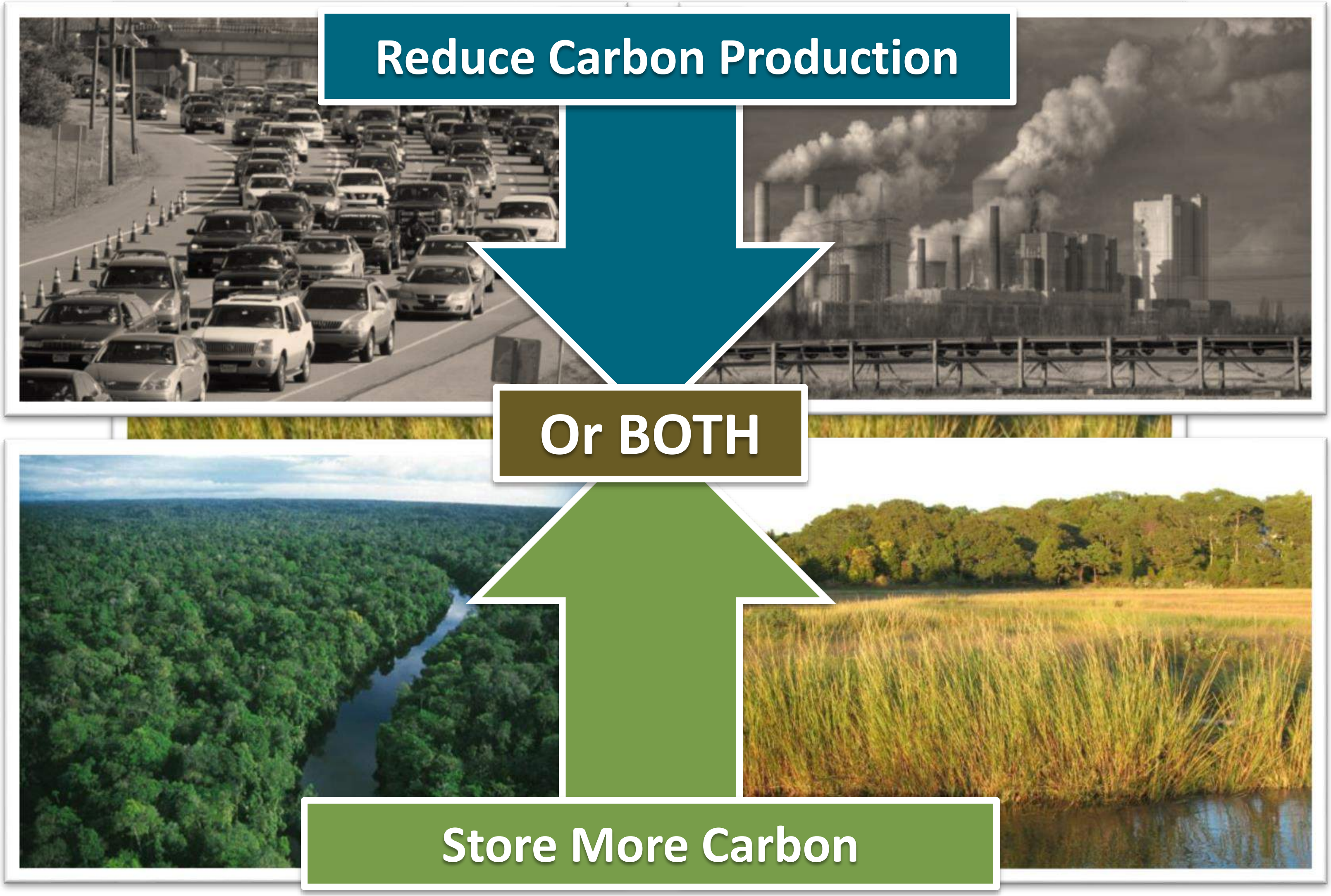


Source: NOAA NCDC

"If the world is to decisively deal with climate change every source of emissions and every option for reducing these should be scientifically evaluated and brought to the international community's attention."

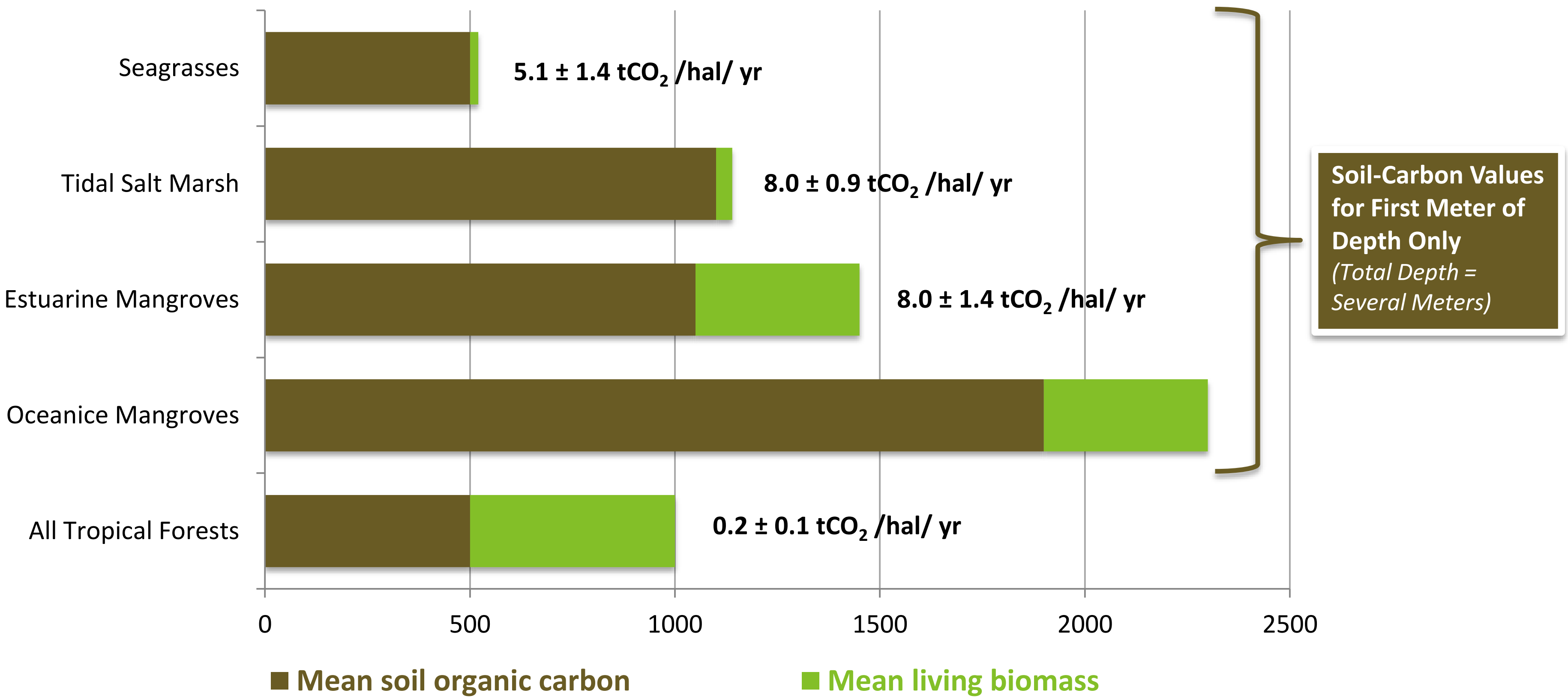
Report: Blue Carbon – The Role of Healthy Oceans in Binding Carbon, UNEP (2009)

Addressing The Problem



Distribution of Carbon in Coastal Ecosystems

tCO_2e per Hectare, Global Averages



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

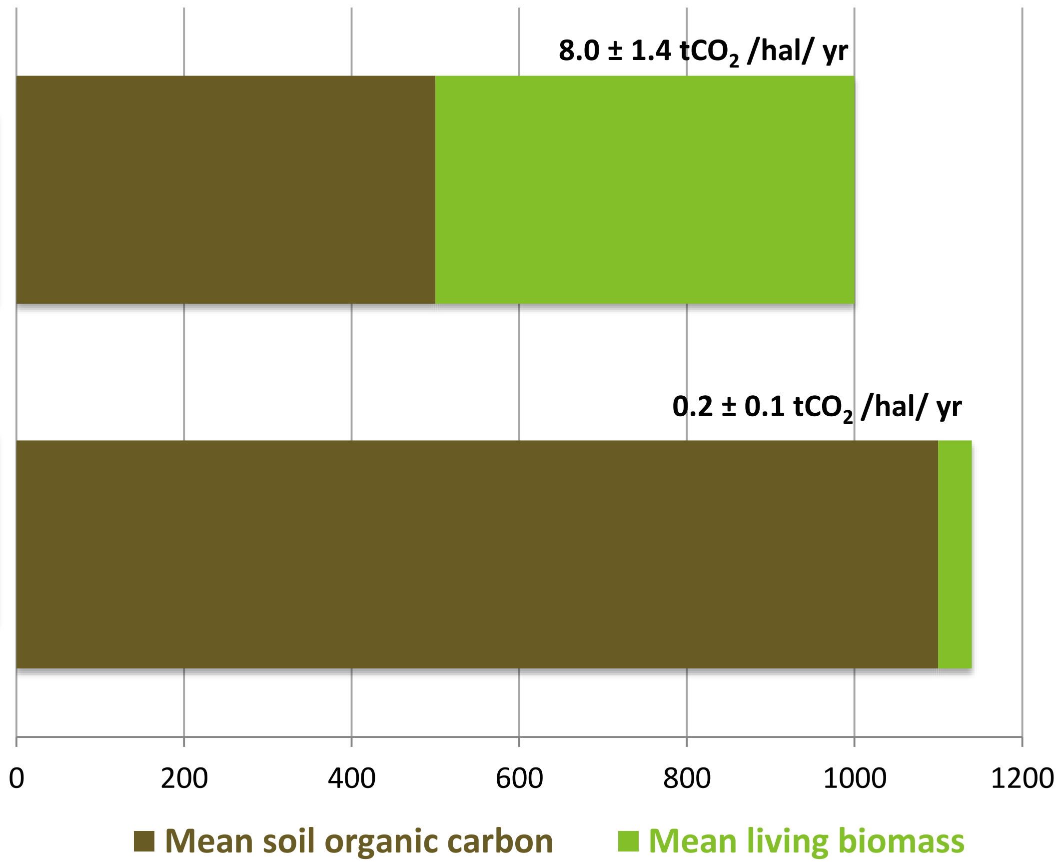
Riches in the Soil – The Wetland Carbon Bank

ALL TROPICAL FORESTS

TIDAL SALT MARSH

tCO_2e per Hectare, Global Averages

Soil-Carbon Values for First Meter of Depth Only (Total Depth = Several Meters)



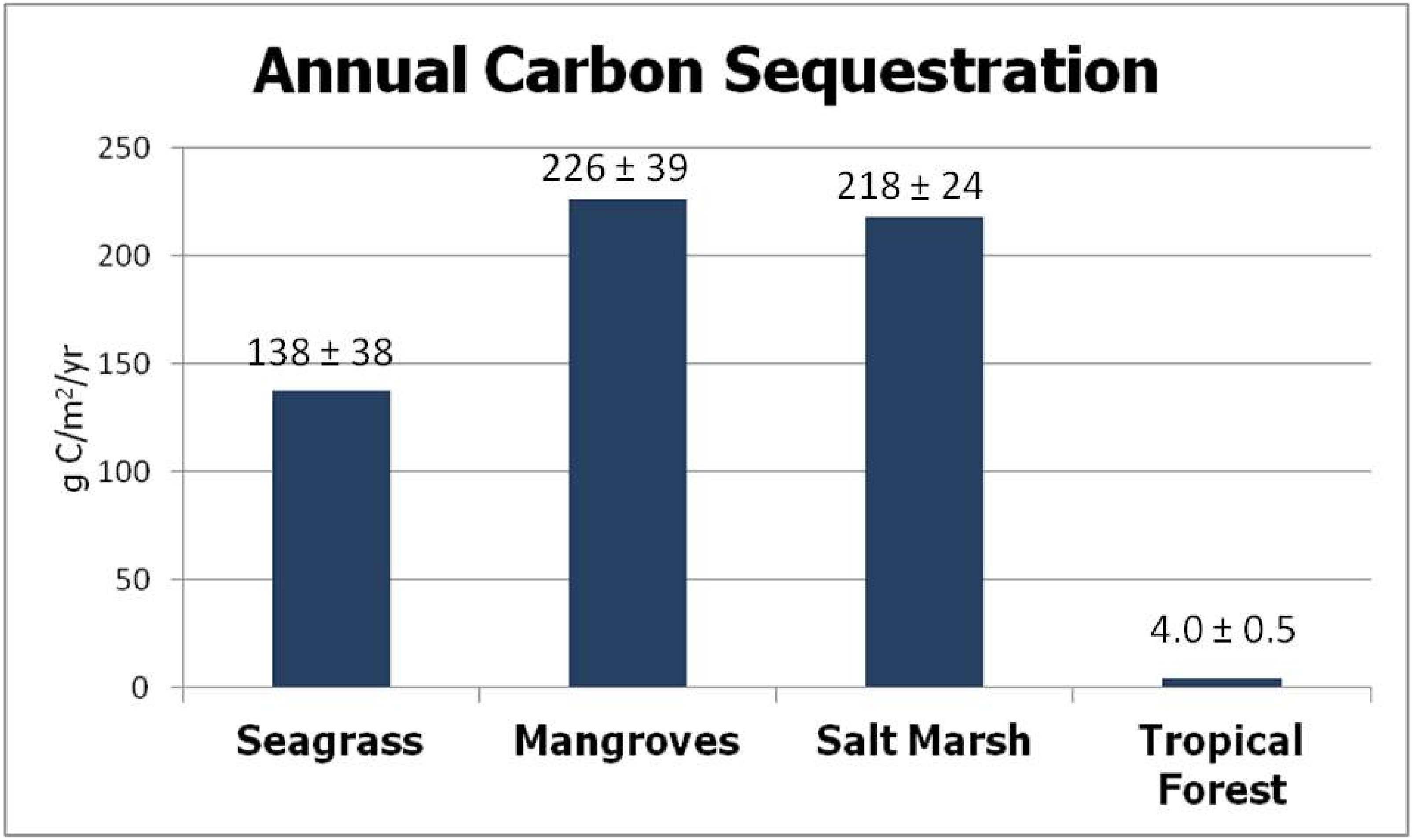
Source: Data summarized in Crooks *et al.*, 2011; Murray *et al.*, 2011

Coastal Blue Carbon is…..

The greenhouse gases (GHGS) sequestered by, stored in and released by coastal marine ecosystems such as salt marshes, seagrass beds, mangroves and other tidal wetlands.

A newly recognized ecosystem service of coastal wetlands for climate change mitigation.

How Well Do Coastal Wetlands Sequester Carbon?



Source: McLeod *et al*. (2011)

Coastal Wetlands Under Threat……Impact on Blue Carbon??

- Sea level rise
- Storms
- Temperature increase
- Nutrient loading
- Land use conversion
- Tidal restriction

DEGRADING OR DESTROYING WETLANDS CAN RELEASE YEARS OF STORED CARBON BACK INTO THE ATMOSPHERE…..INCREASING GHG EMISSIONS!

Emissions from One Drained Wetland: Sacramento-San Joaquin Delta

Area under agriculture	**180,000 ha**
Rate of subsidence (in)	1 inch

3-5 million tCO_2/yr released from Delta

1 $GtCO_2$ release in c.150 years

4000 years of carbon emitted

Equiv. carbon held in 25% of California's forests

Accommodation space: 3 billion m^3

Slide courtesy Steve Crooks, ESA

NEED TO BETTER UNDERSTAND GHG FLUXES AND CARBON STORAGE IN COASTAL WETLANDS

WAQUOIT BAY NATIONAL ESTUARINE RESEARCH RESERVE

BRINGING WETLANDS TO MARKET: NITROGEN AND COASTAL BLUE CARBON PROJECT (BWM)

WAQUOIT BAY NATIONAL ESTUARINE RESEARCH RESERVE

Acknowledgements:

- USGS – *Kevin Kroeger, Meagan Gonneea*
- Marine Biological Laboratory – *Jianwu (Jim) Tang*
- Univ. of Rhode Island – *Serena Moseman-Valtierra*
- Florida International University – *Omar Abdul-Aziz*
- Manomet Center for Conservation Sciences – *Tom Walker*
- Restore America's Estuaries – *Steve Emmett-Mattox, Steve Crooks*
- *Other project contributors from all partner organizations*
- Many state and local stakeholders
- NERRS Science Collaborative
- National Estuarine Research Reserve Association
- Waquoit Bay National Estuarine Research Reserve Staff

Waquoit Bay National Estuarine Research Reserve

National Estuarine Research Reserve System Science Collaborative

USGS science for a changing world

The University of Rhode Island

MBL Biological Discovery in Woods Hole

Manomet Center for Conservation Sciences

FIU Florida International University

Restore America's Estuaries

NERRA

Why We Did This Work - State of Our Coastal Wetlands

BENEFITS

- Carbon Storage
- Habitat
- Filter Pollutants
- Recreation/Aesthetics
- Storm Protection

DRAMATIC LOSS

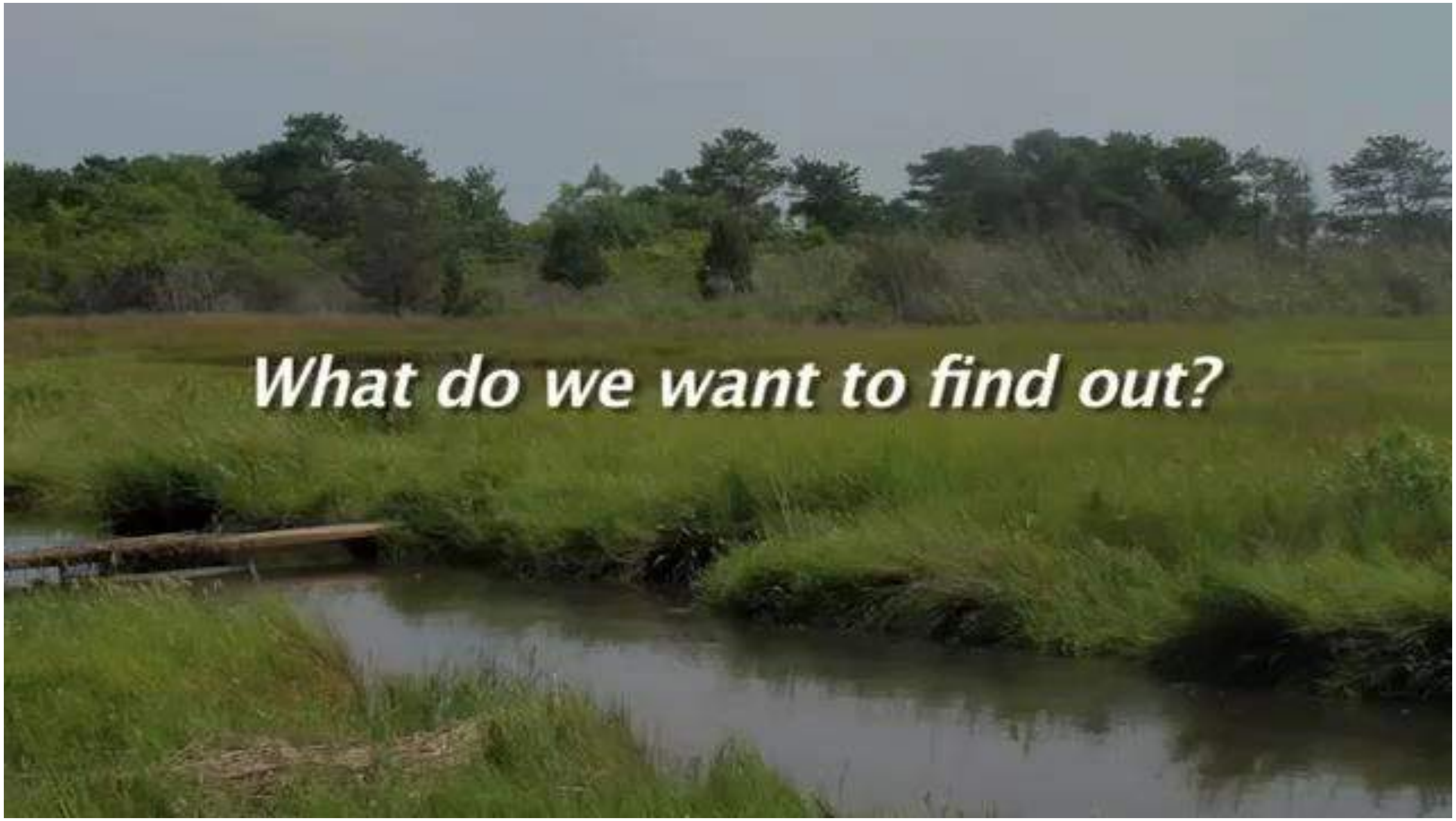
- 50 % of US wetlands lost since 1800s
- Historic Loss >> 1, 496,079 acres
- Annual restoration rate ~ 1 % of goal
- 0.7 – 7% global habitat loss – unsustainable!

BARRIER TO RESTORATION

$$$$

Why We Did This Work -Nitrogen Loading An Important Local Issue

BWM Research Questions



BWM In A Nutshell

Address Important Science Gaps
Develop New Tools for Managers and Policymakers

Innovative Science

GHG Budgets

Environmental Drivers

Habitat Relationships

Field Investigations & Lab Analyses

Predicting C Storage

For a selected wetland, can we predict GHG flux and carbon storage change under different conditions?

Develop User-Friendly Model

Carbon Markets & Financing

Can we use blue carbon to generate financing and investment for wetlands restoration & conservation?

Wetlands Carbon Offset Methodology

Economic Analysis

Is it worth doing a carbon market project?

Local Case Study – How much are methane benefits potentially worth?

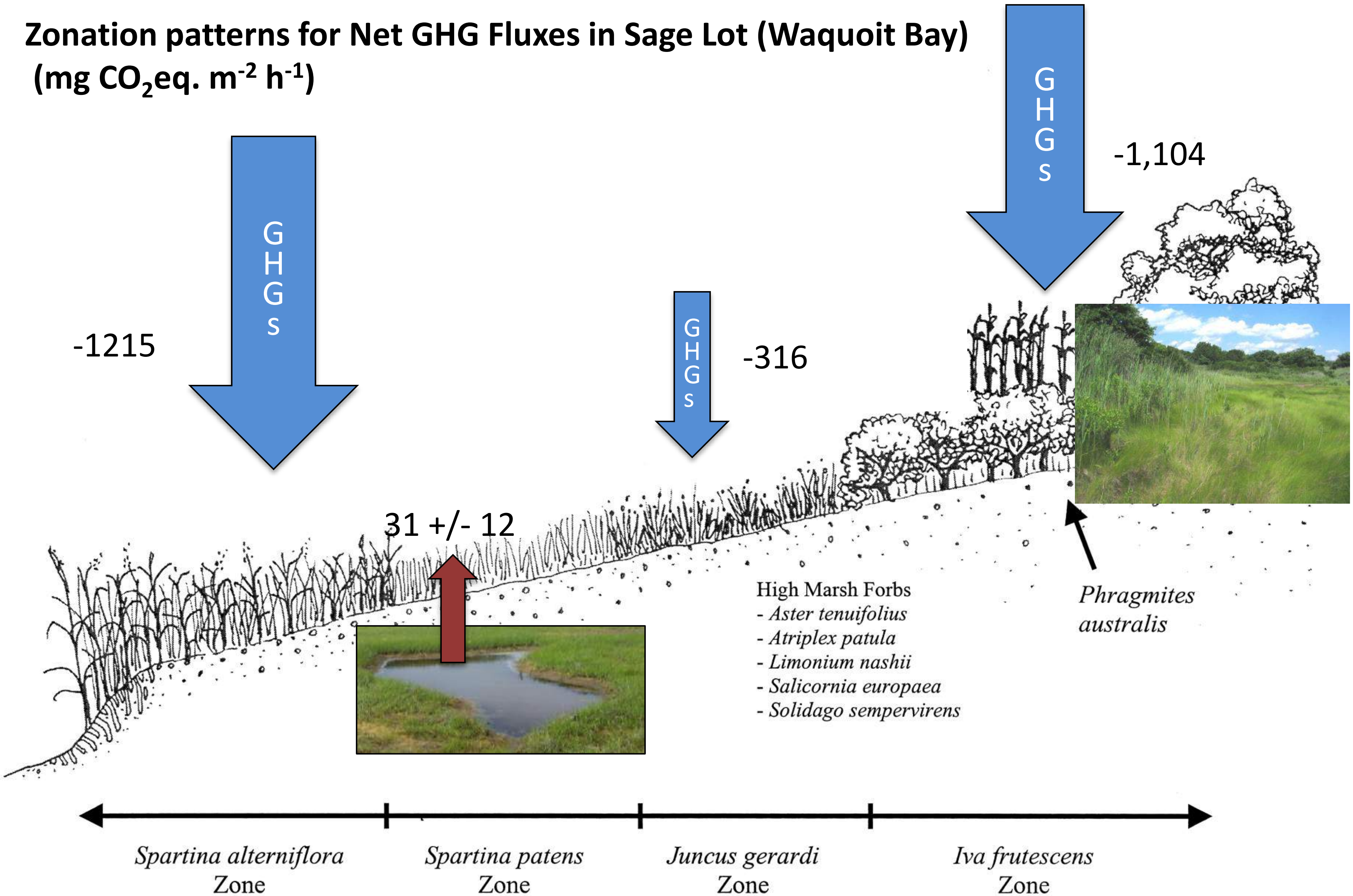
COLLABORATION WITH END USERS

SUMMARY RESULTS

Summary Findings - GHG Relationship with Plant Zones

- CO_2 uptake was higher in low marsh vs. high marsh zone. Surprisingly it was the greatest in the invasive *Phragmites* zones.
- Pools with bare standing water, where plants had died were sources of CO_2 rather than sinks indicating that SLR may threaten carbon storage functions of salt marshes.

Zonation patterns for Net GHG Fluxes in Sage Lot (Waquoit Bay)
(mg CO_2eq. m^{-2} h^{-1})



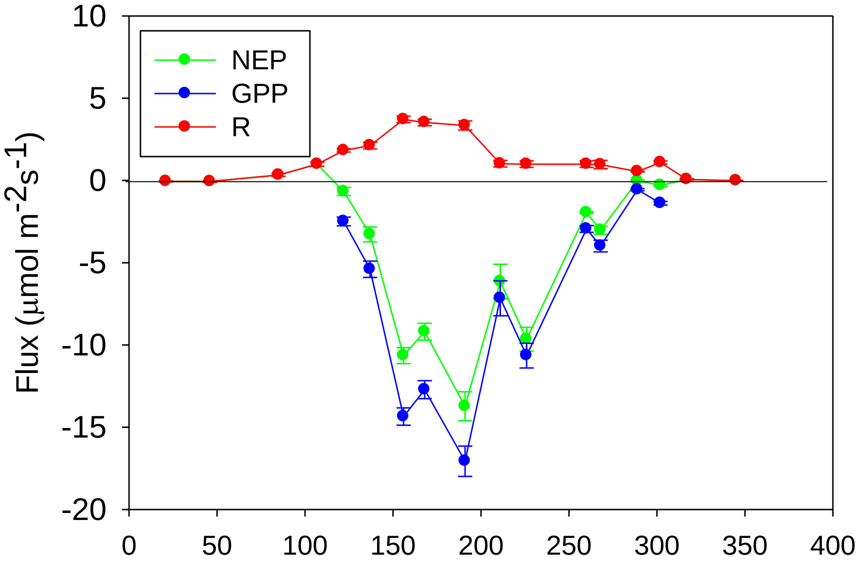
Slide courtesy S. Moseman-Valtierra

Key Findings – GHG Budgets and Nitrogen Impacts

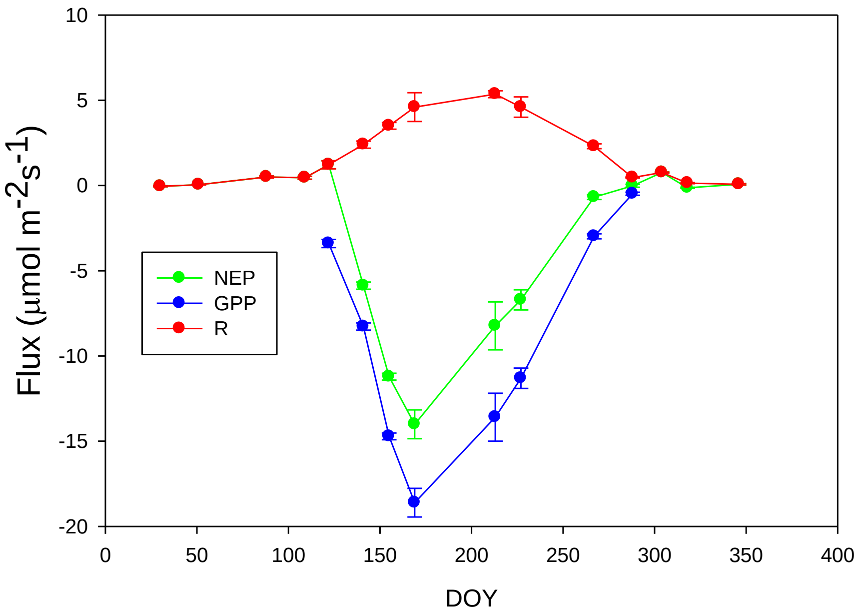
- The studied salt marsh is acting as a significant carbon sink. Methane and nitrous oxide fluxes are small when compared to CO2.
- For the range of N loading (1-10 gN $m^{-2}y^{-1}$) examined no significant change was observed in the GHG fluxes or carbon storage. However, salt marsh GHG emissions may be significantly changed when N loading increases to a threshold level.
- N_2O fluxes are not significant in tested marshes, but adding N may result in high N_2O fluxes.
- Higher belowground biomass were found at the high N loading sites, but not seen for aboveground biomass.

CO_2 fluxes across N gradient

Low N

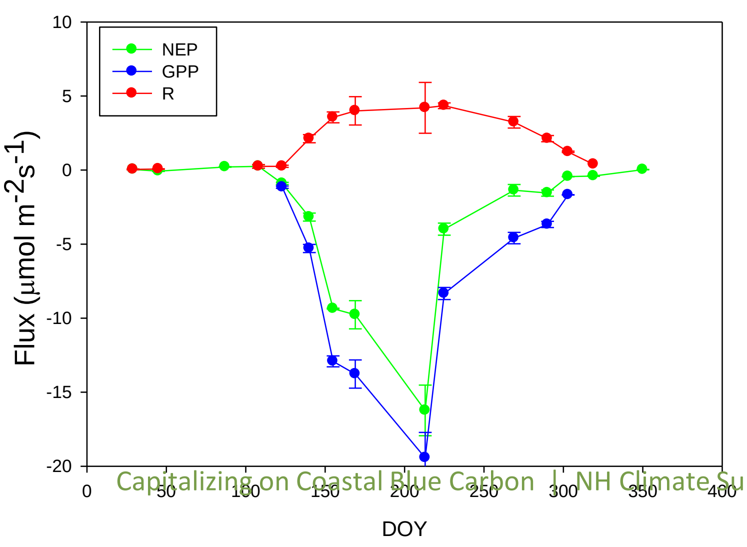


Hamblin Pond

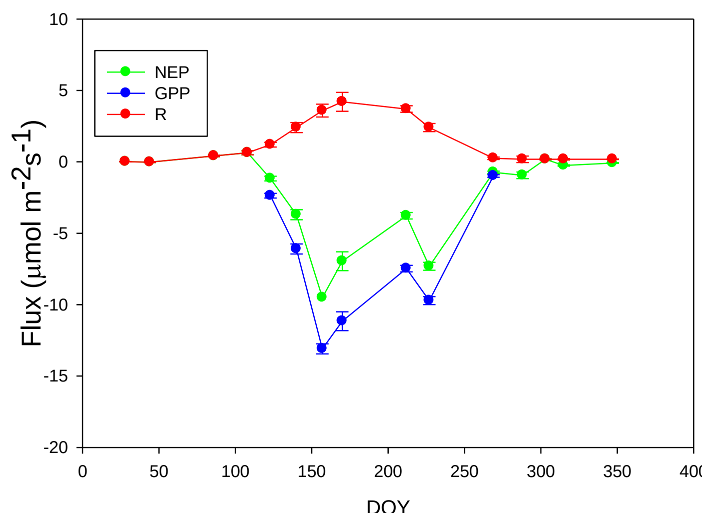


Great Pond

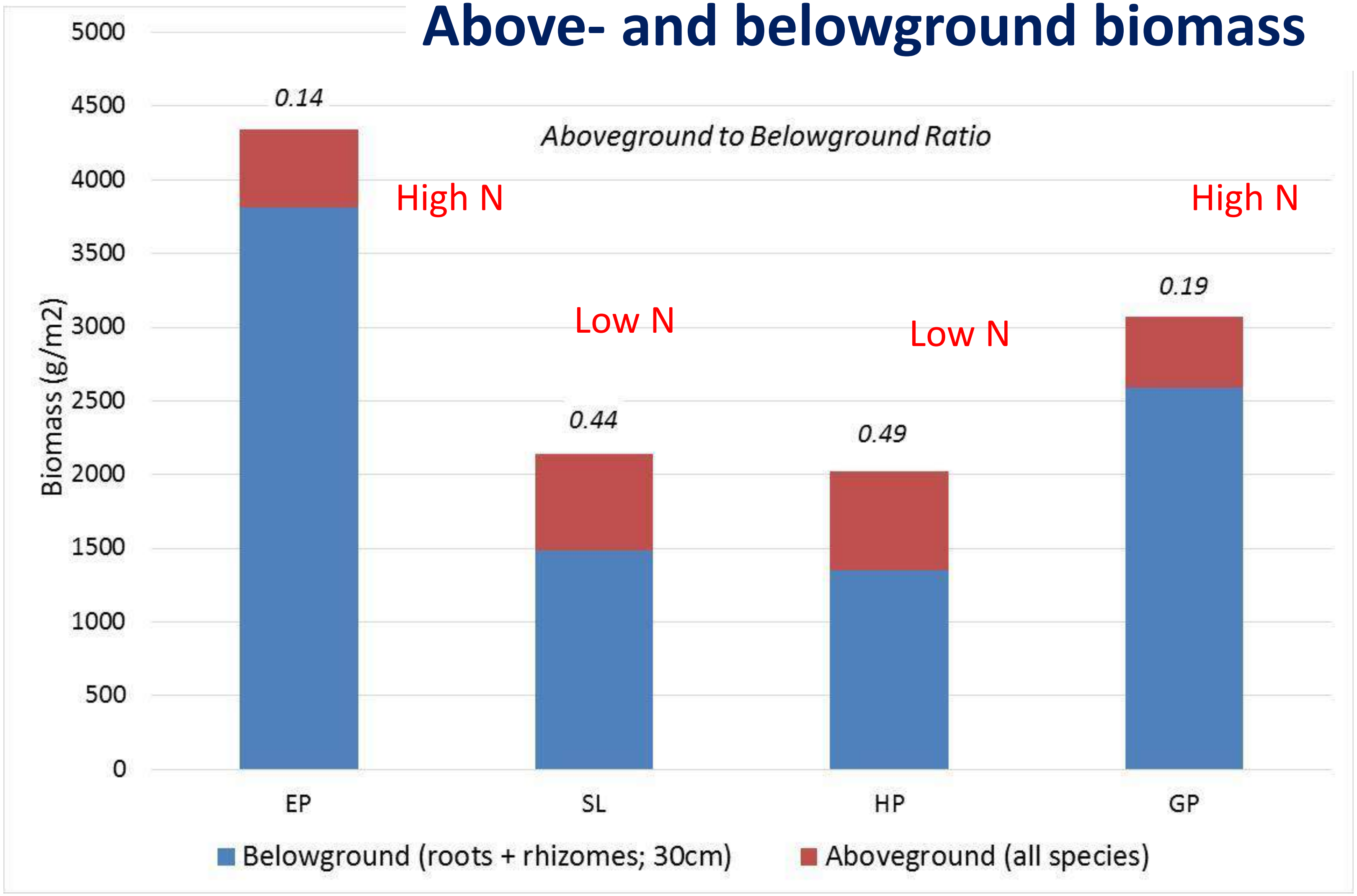
High N



Eel Pond

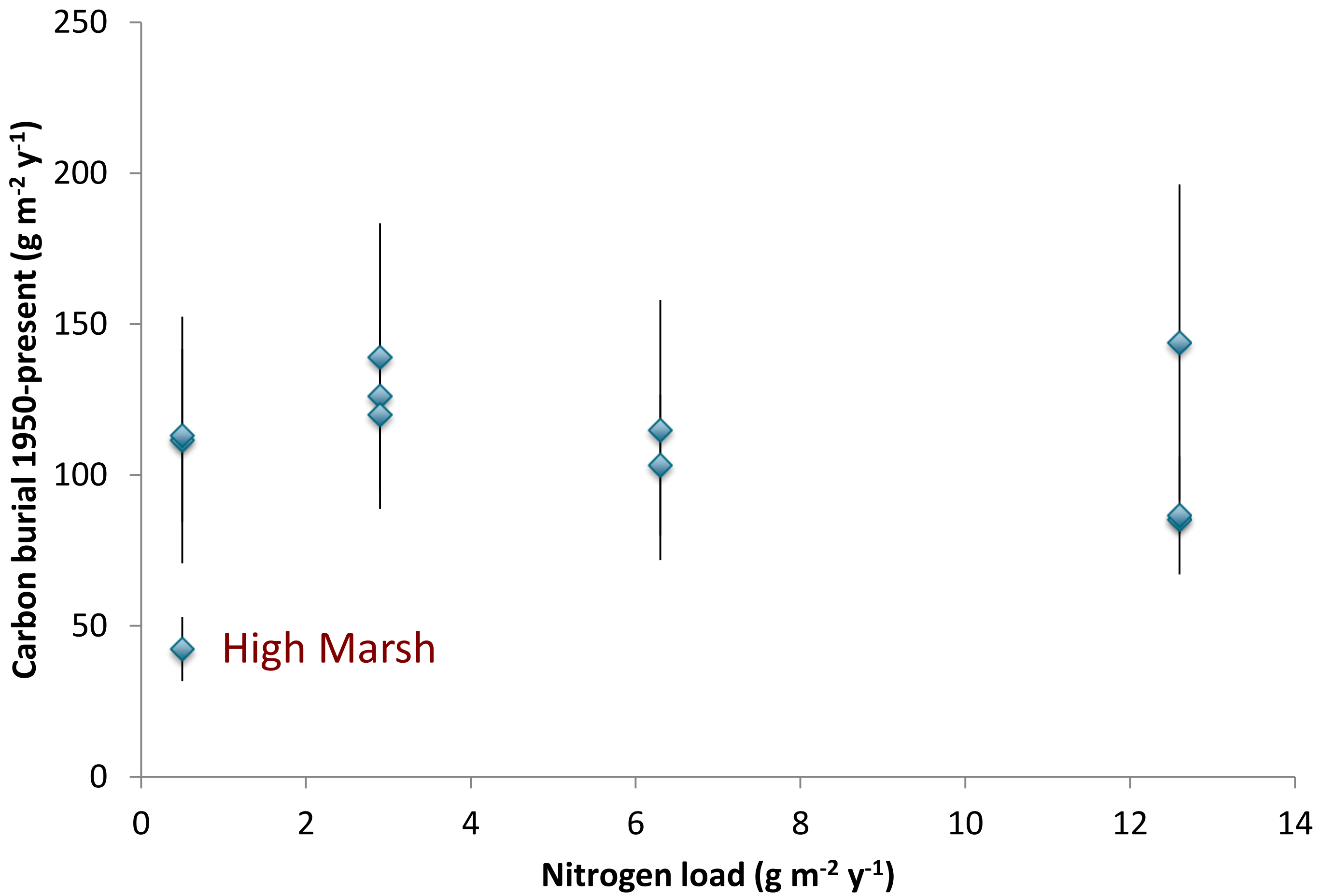


Above- and belowground biomass

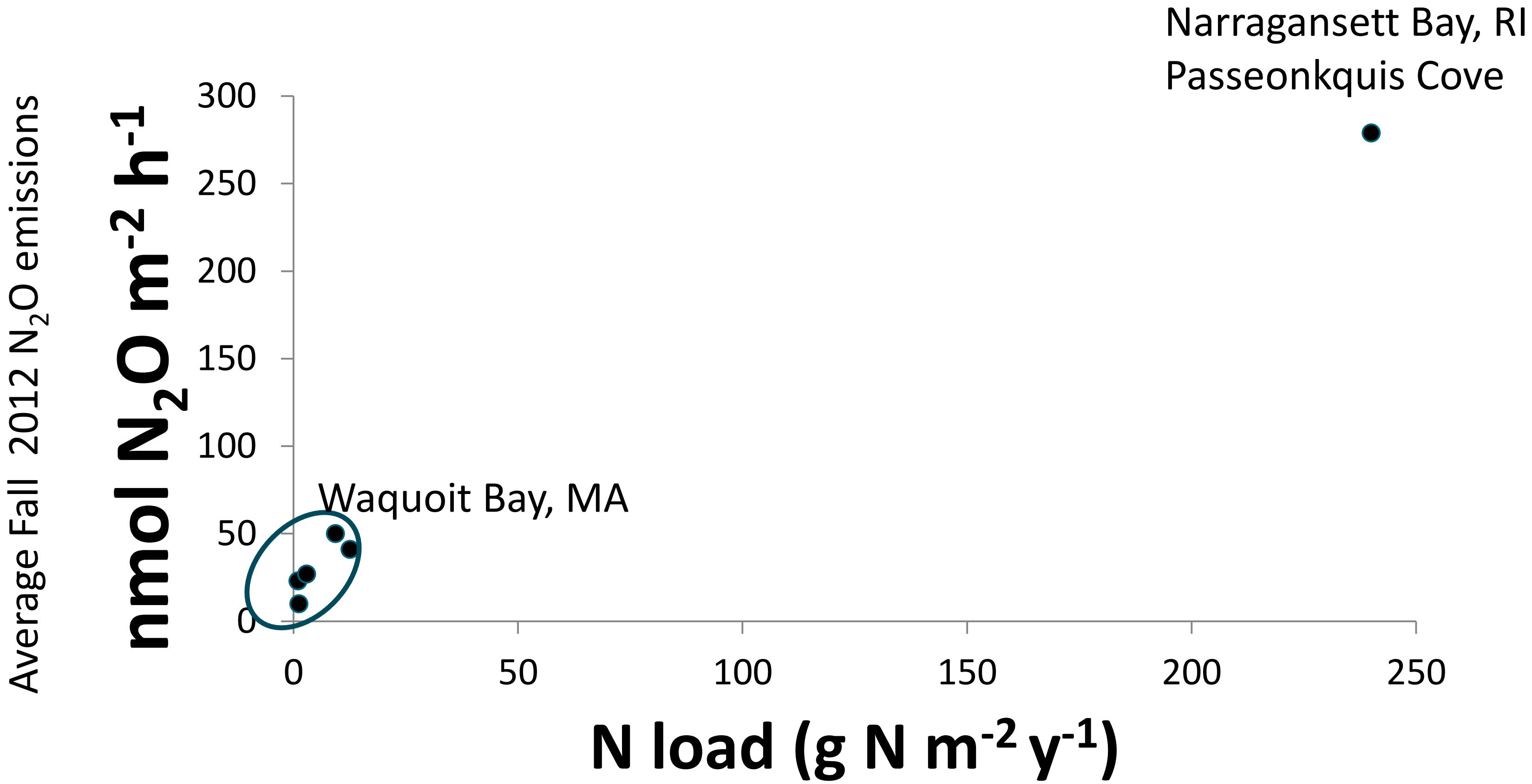


Slide courtesy of J. Tang

There is no difference in carbon burial across the nitrogen gradient within Waquoit Bay.

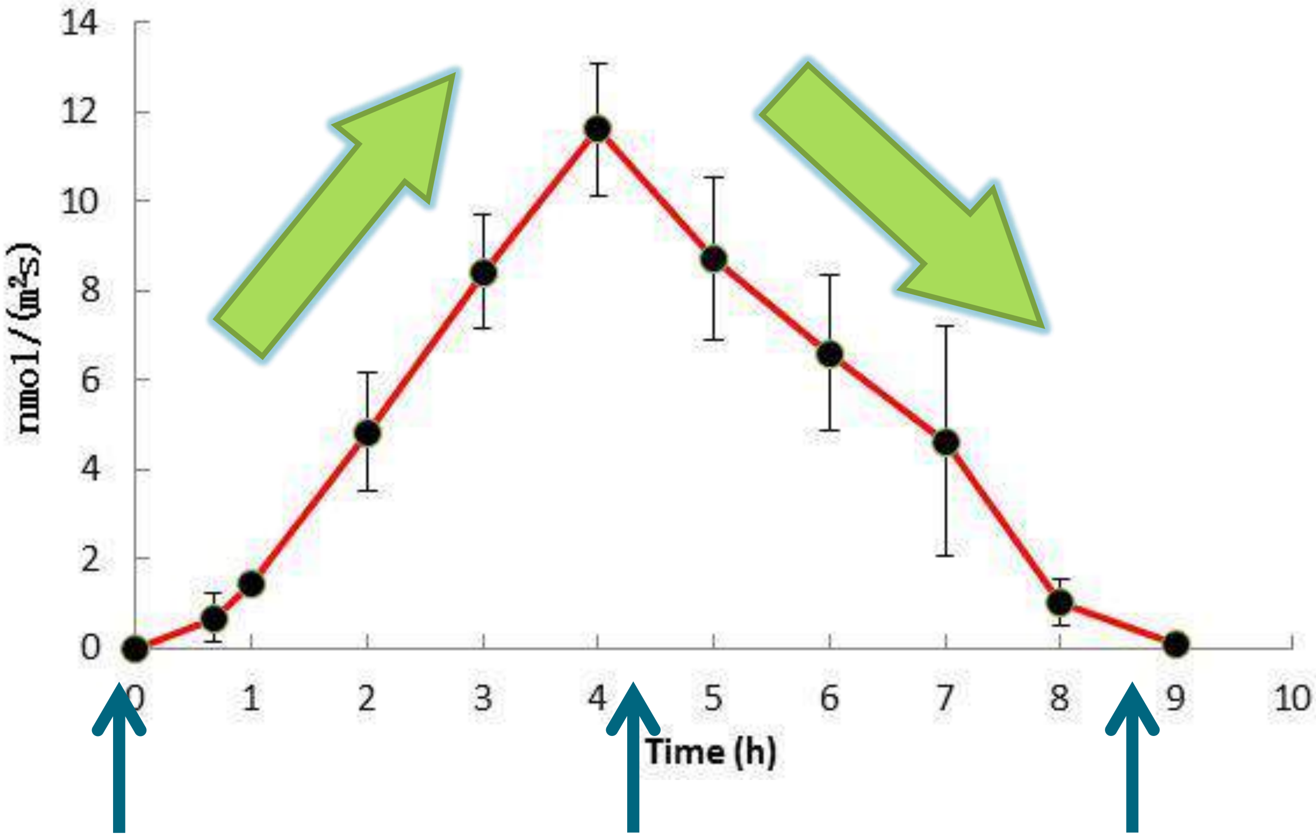


N_2O emissions vs marsh nitrogen load

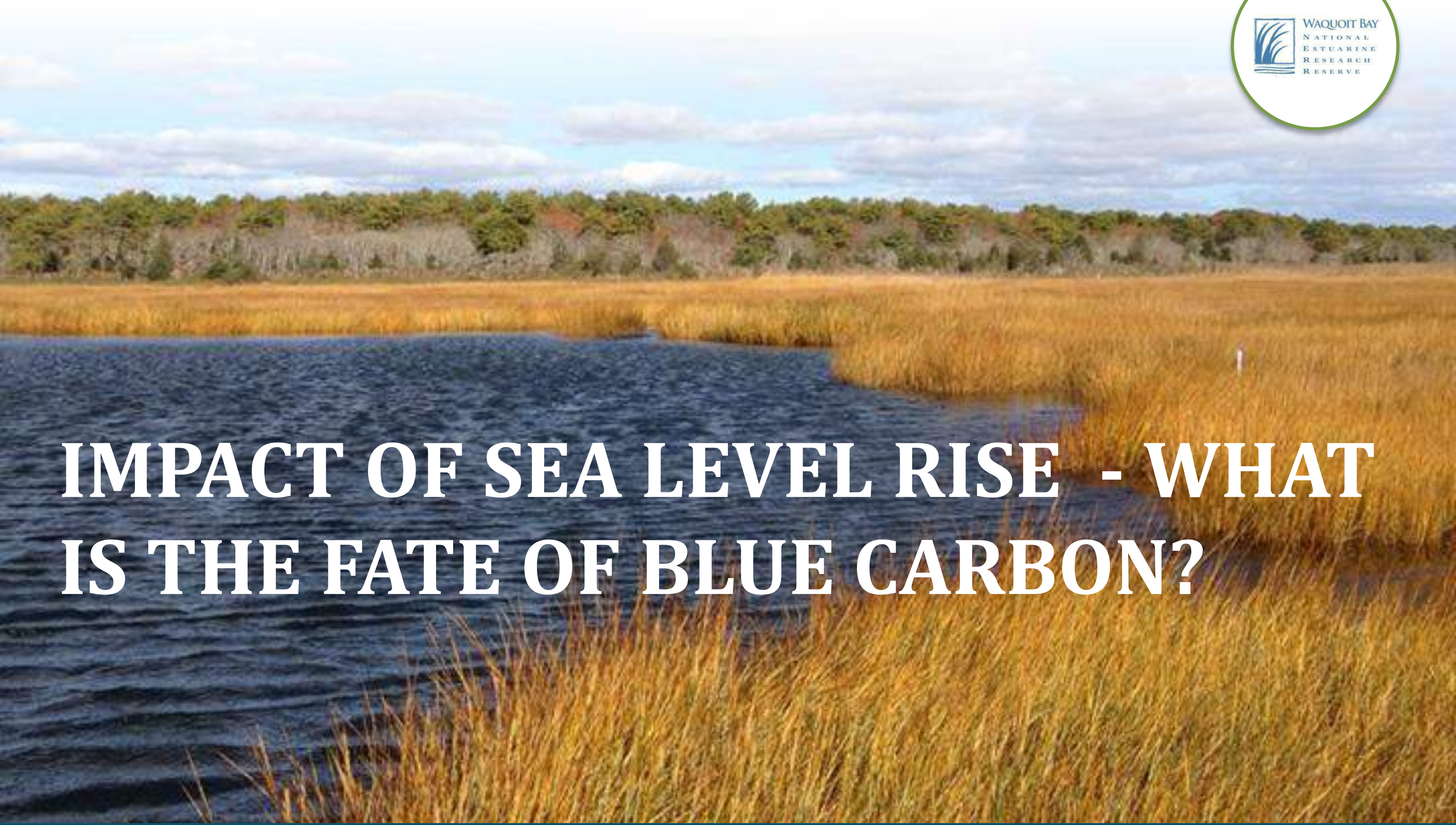


Slide courtesy: S. Moseman-Valtierra

Short-term N addition experiment: N_2O flux response to 1.4 gN/m^2

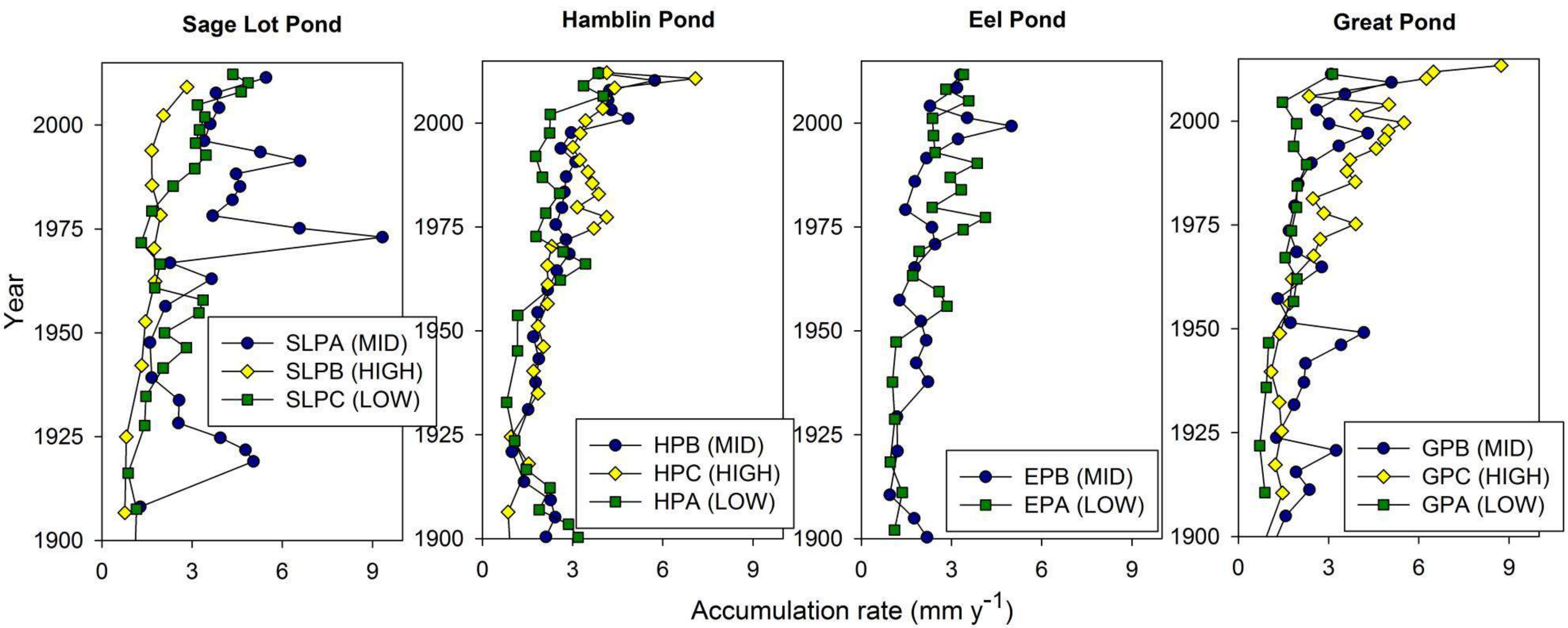


Adding time： 11:50-11:55 am **High tide started** **Marsh platform was flooded**



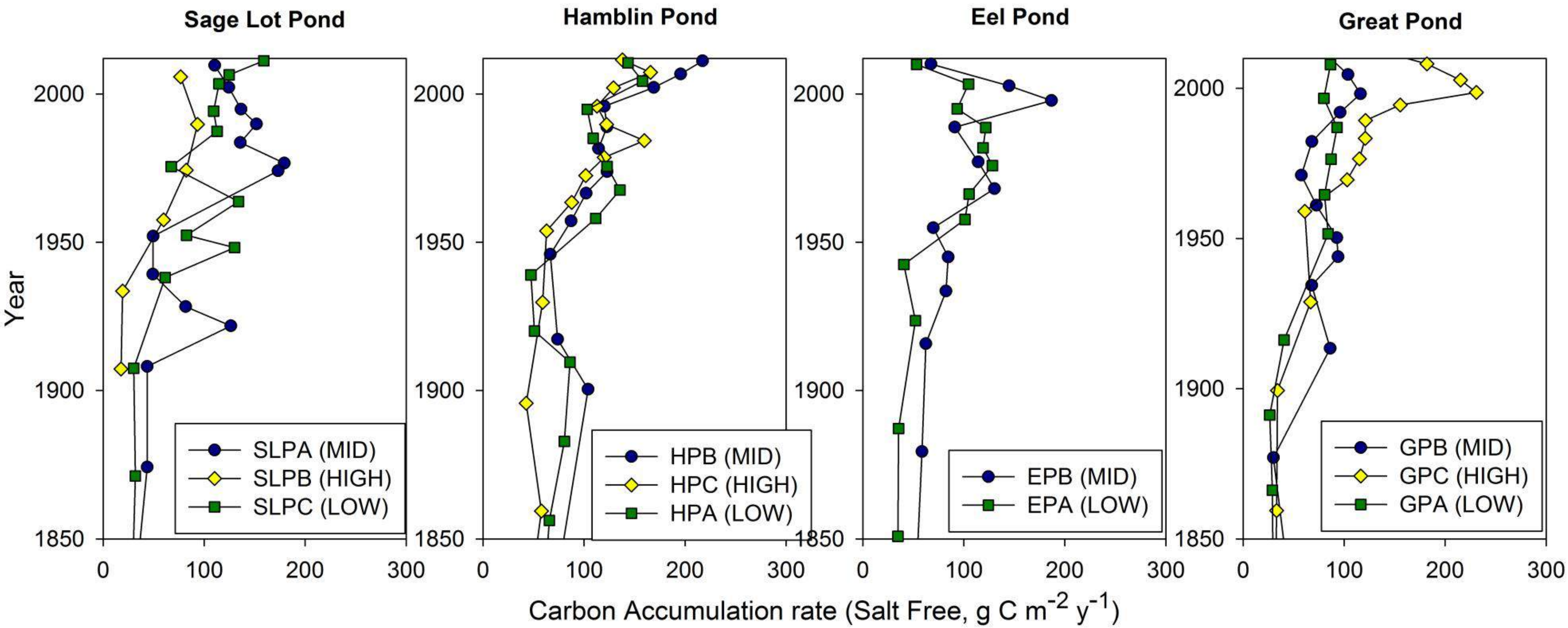
IMPACT OF SEA LEVEL RISE - WHAT IS THE FATE OF BLUE CARBON?

Accumulation rates are increasing in all marshes.



Rates in 1900 were 1-2 mm/year.
Modern rates are 3-5 mm/year.

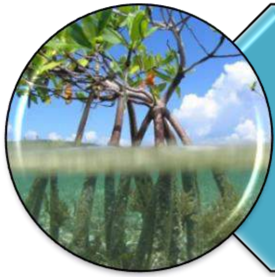
Carbon burial has increased since 1900 due to higher accumulation rates, not increased soil carbon content.



Sea Level Rise and Carbon Storage

- Observed marshes are responding better than anticipated to SLR especially given that they have low sediment supply. Marsh position has stabilized in the tidal frame suggesting that marsh growth has accelerated in response to sea level rise.

BWM User – Friendly Model



Serve as a tool to aid tidal wetland restoration and maintenance projects

Reduces the cost of wetland C and GHG flux monitoring by estimating them from climatic and environmental drivers

The model can predict wetland GHG fluxes and C sequestration under various IPCC climate change and sea level rise scenarios

Model Structure and Work-Flow

Model Inputs

- Photosynthetically active radiation
- Water depth relative to the marsh elevation
- Soil salinity
- Soil temperature

Model Outputs

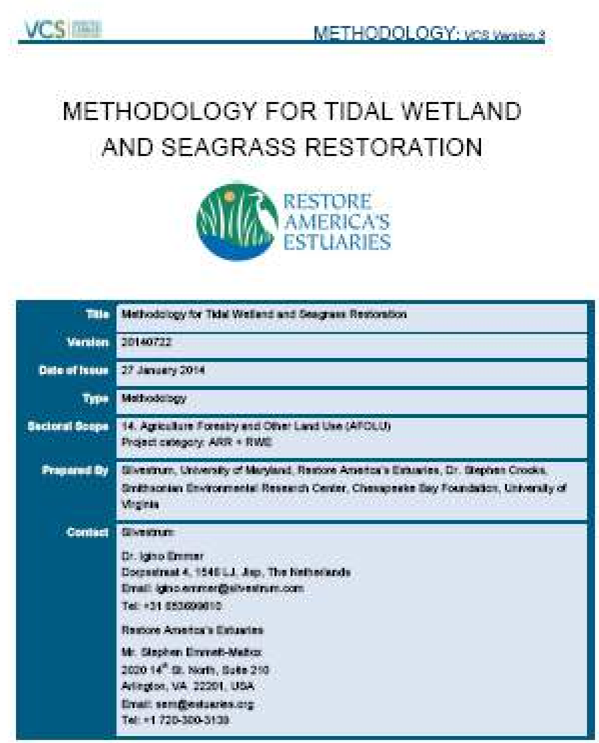
- Predicted instantaneous wetland CO_2 and CH_4 fluxes
- Net CO_2 and CH_4 fluxes over the growing period
- Net Ecosystem Carbon Balance (NECB) gC/m2 and metric ton C/hectare

METHODOLOGY TO ENABLE CARBON FINANCING

Tidal Wetland and Seagrass Restoration Methodology

Goals

- Carbon finance for restoration
- Ecologically appropriate
- Scientifically credible
- Meet requirements of stringent GHG standards
- Broadly applicable to restoratio[n]
- Flexible in its use
- Practicable



VCS METHODOLOGY: VCS Version 3

METHODOLOGY FOR TIDAL WETLAND AND SEAGRASS RESTORATION

RESTORE AMERICA'S ESTUARIES

Title	Methodology for Tidal Wetland and Seagrass Restoration
Version	20140722
Date of Issue	27 January 2014
Type	Methodology
Sectoral Scope	14. Agriculture Forestry and Other Land Use (AFOLU) Project category: ARR + RWE
Prepared By	Silvestrum, University of Maryland, Restore America's Estuaries, Dr. Stephen Crooks, Smithsonian Environmental Research Center, Chesapeake Bay Foundation, University of Virginia
Contact	Silvestrum Dr. Igino Emmer Dorpsstraat 4, 1546 LJ, Jisp, The Netherlands Email: igino.emmer@silvestrum.com Tel: +31 653699610 Restore America's Estuaries Mr. Stephen Emmett-Mattox 2020 14th St. North, Suite 210 Arlington, VA 22201, USA Email: sem@estuaries.org Tel: +1 720-300-3139

RESTORE AMERICA'S ESTUARIES

Slide courtesy: Steve Emmett-Mattox

Habitats – all tidal wetlands and seagrasses, globally

- Marshes, all salinity ranges
- Mangroves
- Seagrasses
- Forested tidal wetlands

Eligible Activities

- Restoration via enhancing, creating and/or managing hydrological conditions, sediment supply, salinity characteristics, water quality and/or native plant communities.

Submitted to the Verified Carbon Standard

- Final approval expected this summer

Slide courtesy: Steve Emmett-Mattox

RESTORE AMERICA'S ESTUARIES

Policy Applications of Blue Carbon

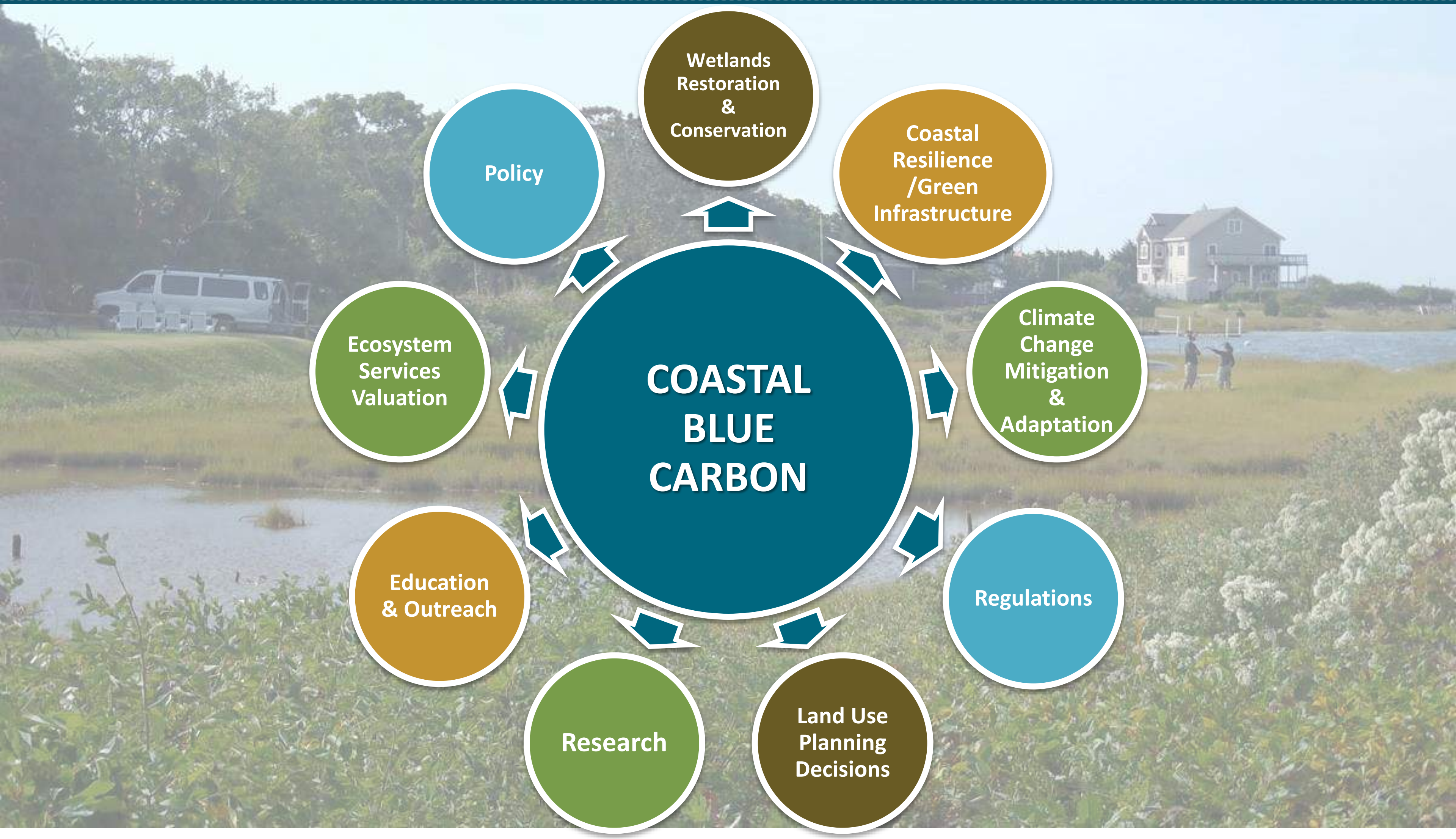
- Federal Level – NOAA asked where could blue carbon into existing environmental policies
  - Clean Water Act, Natural Resources Damage Assessment, Coastal Zone Management Act, and National Environmental Protection Act
  - Decided that integrating blue carbon considerations should be done
  - Could result in more habitat conservation and climate mitigation benefits
  - President's priority agenda for Enhancing Resilience of America's Natural Resources now includes managing and enhancing of U.S> carbon stocks as a priority

Sutton-Grier et al. 2014. Marine Policy and Pendleton and Sutton-Grier et al. 2013.

State Level Applications of Blue Carbon

- California's Global Warming Solutions Act
- Massachusetts – GHG Accounting Project
- Ecosystem Valuation Project – New Hampshire

Different Pathways to Capitalize



It's Not Just About Blue Carbon….ALL Ecosystem Services

Healthy Resilient Coastal Ecosystems……Might Surprise Us!

"If the world is to decisively deal with climate change every source of emissions and every option for reducing these should be scientifically evaluated and brought to the international community's attention."

Report: Blue Carbon – The Role of Healthy Oceans in Binding Carbon, UNEP (2009)

Thank you!

Learn more at: www.waquoitbayreserve.org

The Colors of Carbon

BLUE CARBON

Carbon stored in marine ecosystems *(e.g. salt marshes and seagrasses)*

GREEN CARBON

Terrestrial carbon stored in plants and soils *(e.g. forests and agricultural lands)*

BROWN CARBON

Greenhouse gases from burning of fossil fuels

BLACK CARBON

Particles from impure combustion *(e.g. soot and dust)*