Kachemak Bay Research Reserve

National Estuarine Research Reserve System Science Collaborative

Smithsonian Environmental Research Center

Waquoit Bay National Estuarine Research Reserve

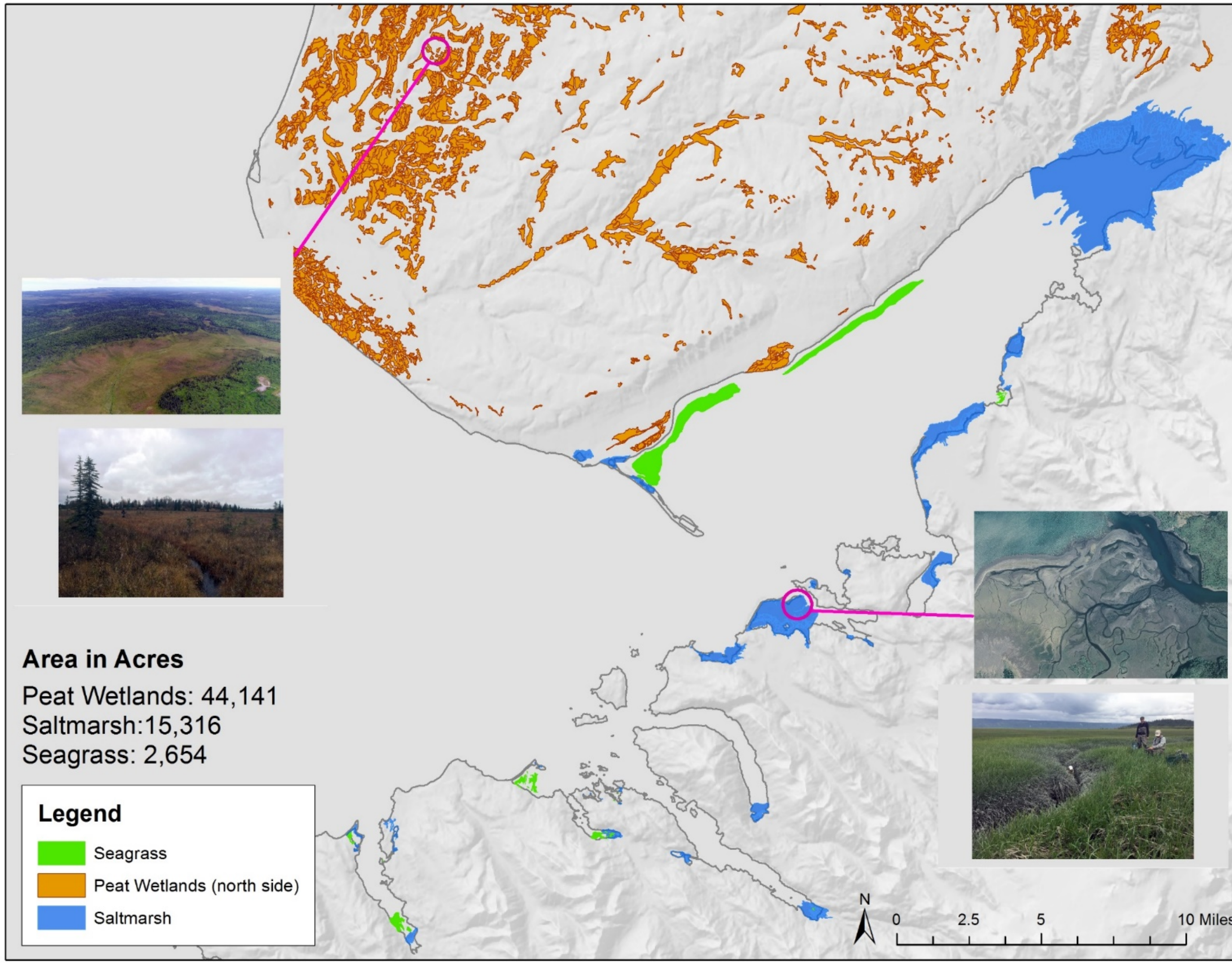
What’s a Wetland Worth?

Understanding Measurement Tools for Blue Carbon and Financial Incentives for Conservation of Kenai Peninsula Wetlands

Kenai Peninsula's "Blue & Turquoise" Carbon

Coowe Walker, KBNERR

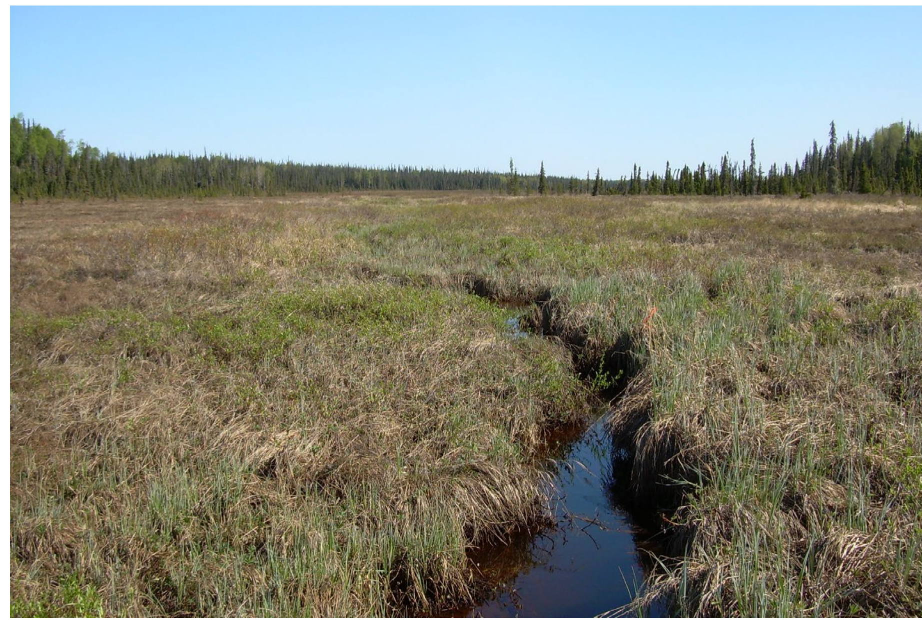
Wetlands in the KBNERR region



Peatland Functions and Values

PEATMAN,
http://peatman.eu/

Peatland
tea!



Assessing Blue and Turquoise Carbon Potential in the Kachemak Bay Region

KBNERR

Smithsonian Environmental Research Center

Waquoit Bay NERR

funding from the NERR Science Collaborative

NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM SCIENCE COLLABORATIVE

Background - Blue and Turquoise Carbon on the Kenai Peninsula

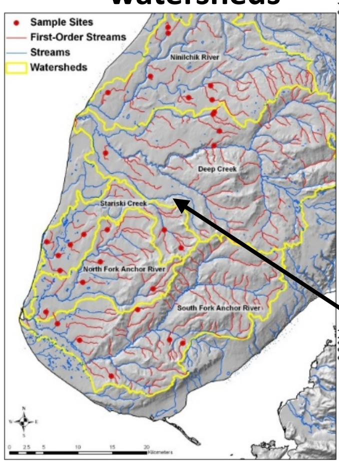
Smithsonian Environmental Research Center

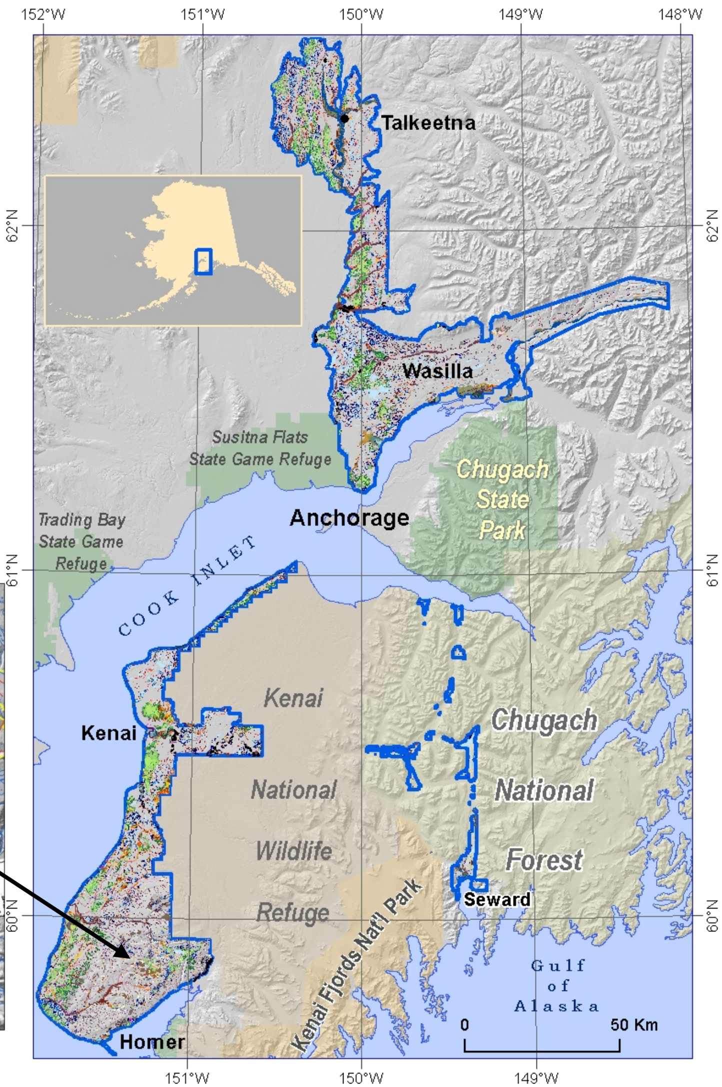
Dennis Whigham and Pat Megonigal
Smithsonian Environmental Research Center

Steve Crooks
Silvestrum Climate Associates

With a big THANKS to Steve Baird and Mike Gracz' Cook Inlet wetland study

Headwater streams watersheds





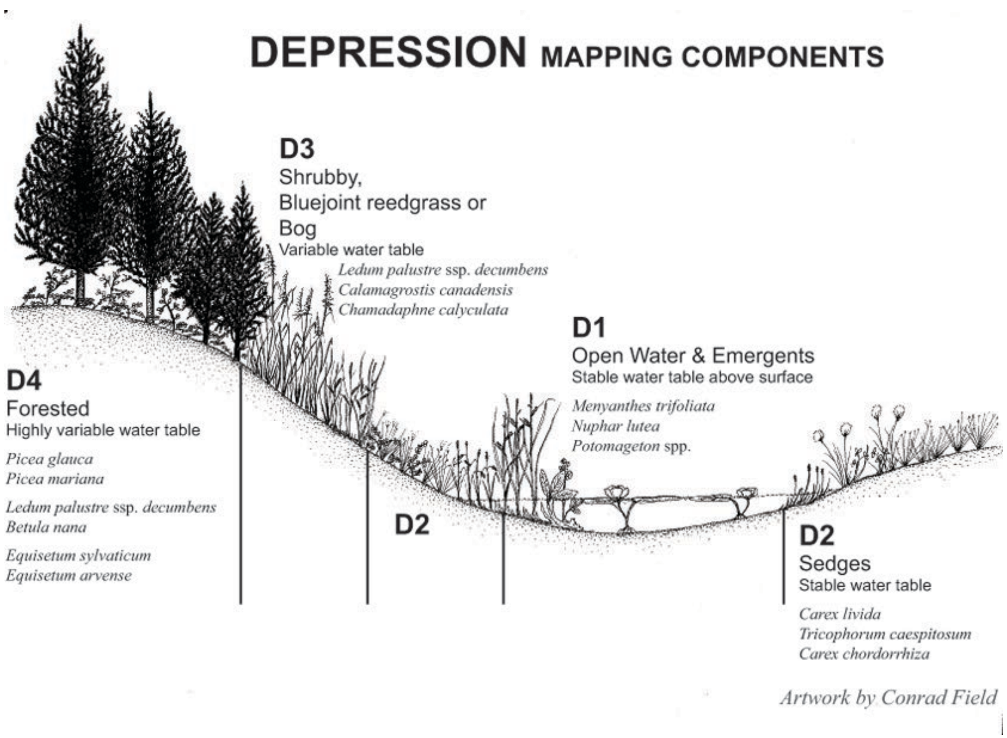
Mapped non-tidal and tidal wetland from Homer to north of Anchorage.

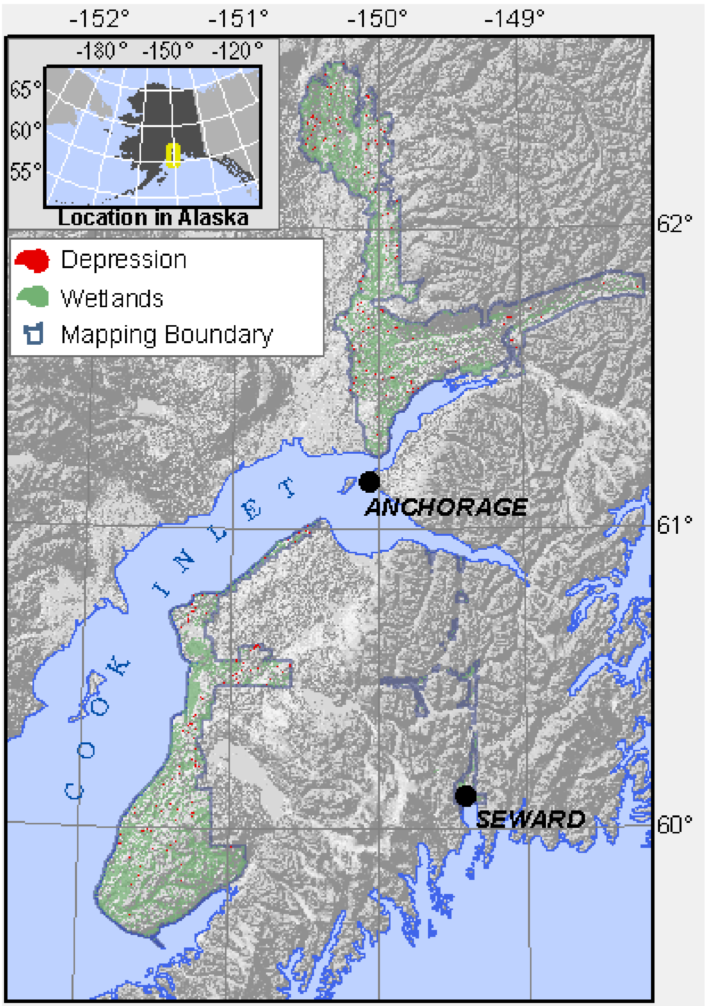
Source: study: **Mike Gracz' Cook Inlet wetland** **http://cookinletwetlands.info**

Summary data for wetlands mapped by Mike Gracz. Two types are on predominantly mineral soils and I could not find data on the web site for the headwater fen type. Values are means ± SE

Wetland type	Categories	Hectares	Peat Depth cm	pH	Conductivity µS/cm	
Depression	4	5,307	178 (25)	4.7 (.2)	39 (7)	
Discharge Slope	8	37,075				Mineral
Drainage Way	7	17,310	103 (26)	5.6 (.3)	101 (12)	
Headwater Fen						
Kettle	4	16,176	154 (17)	5.4 (.3)	67 (6)	
Lakebed	5	32,623	156 (24)	5.1 (.2)	55 (6)	
Riverine	4					Mineral
VLD Trough		1,628	262 (81)	5.2 (.1)	67 (11)	
Spring Fen	3	1,008	194 (17)	5.4 (.3)	77 (5)	
Tidal	12	5,468	36	7.3	1153	
Tidal D'Way	6	3,309	181 (86)	6.4 (.4)	298 (76)	
Wetland Upland	1	8,452	16	6.5		

In this slide and those that follow, subtypes are indicated





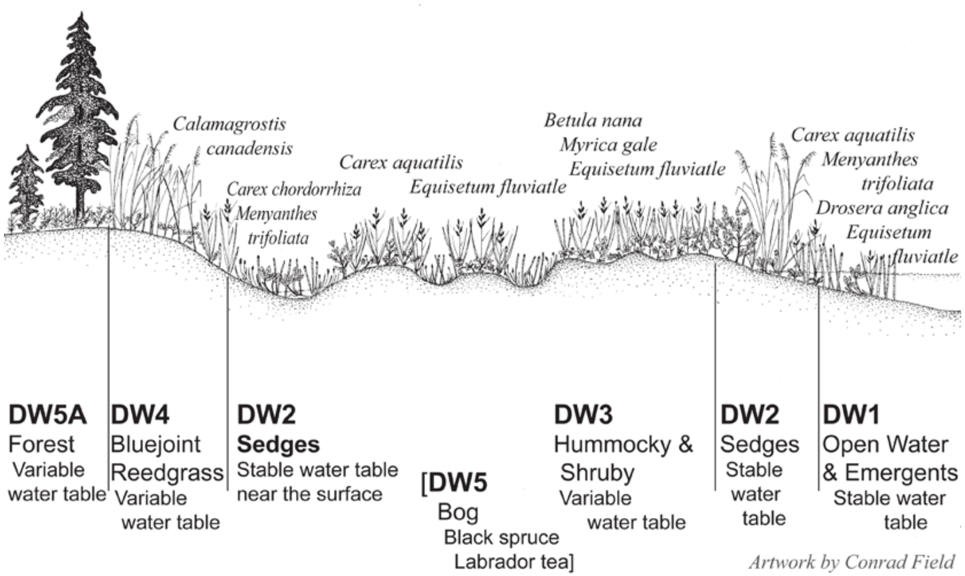
5,306 Ha

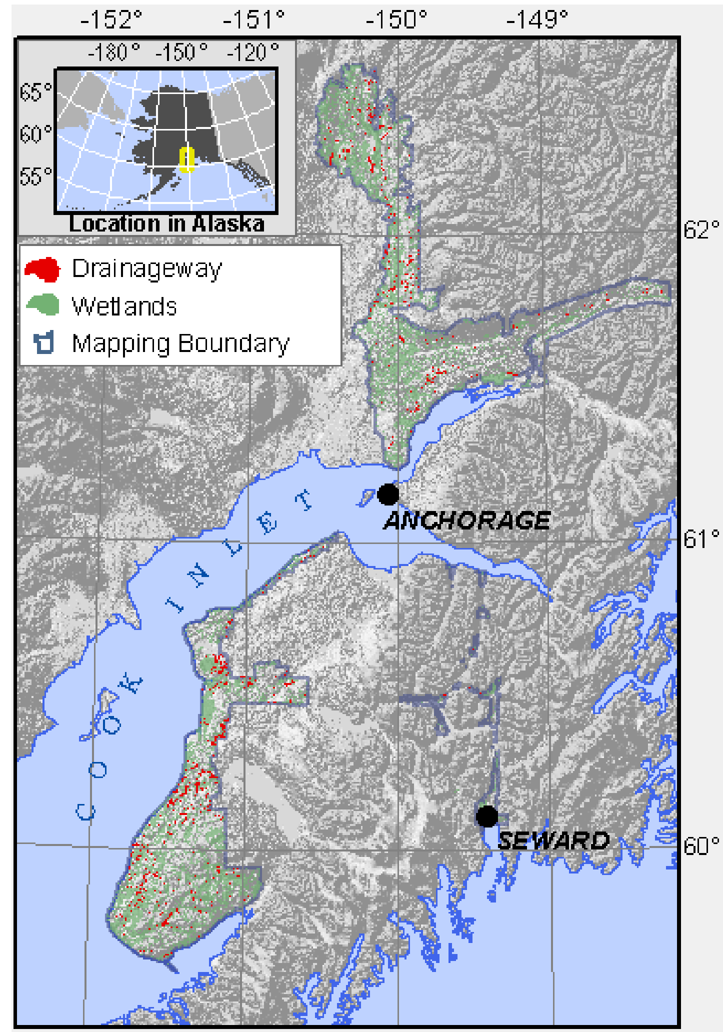
178 (25) = mean peat depth (cm)

Depression

RELICT GLACIAL DRAINAGEWAY

HYDROLOGIC COMPONENTS

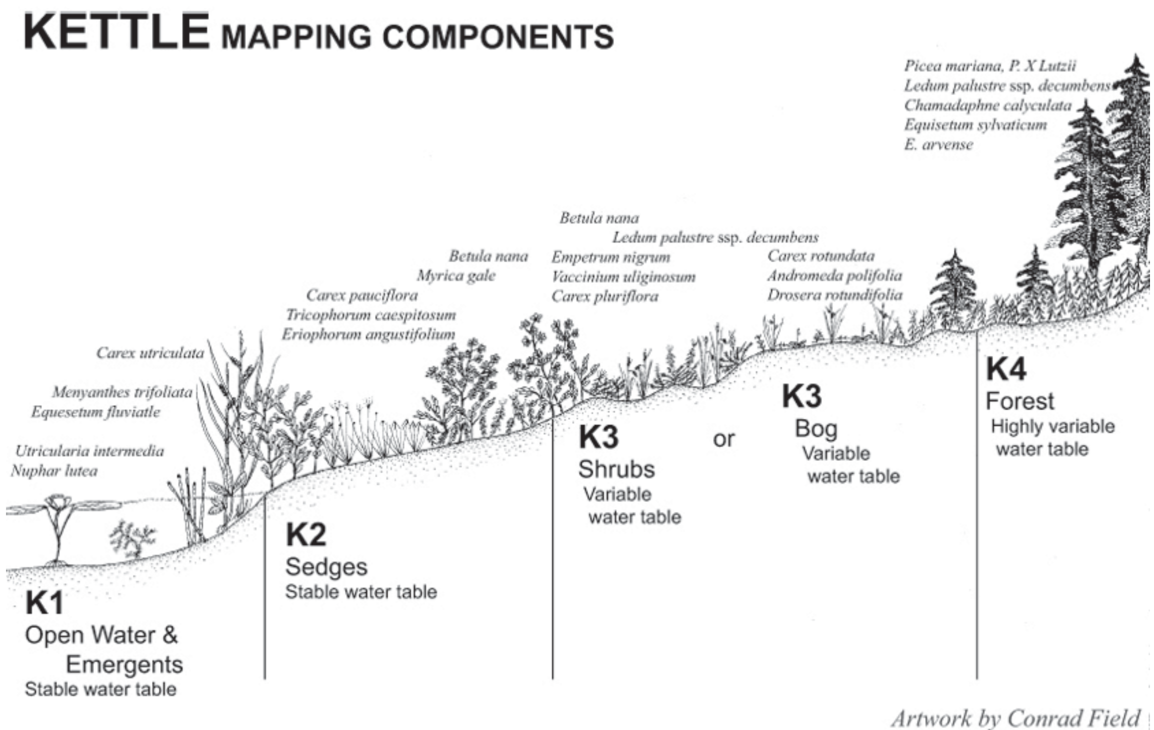




17,310 Ha

103 (26) = mean peat depth (cm)

Relict Drainageway

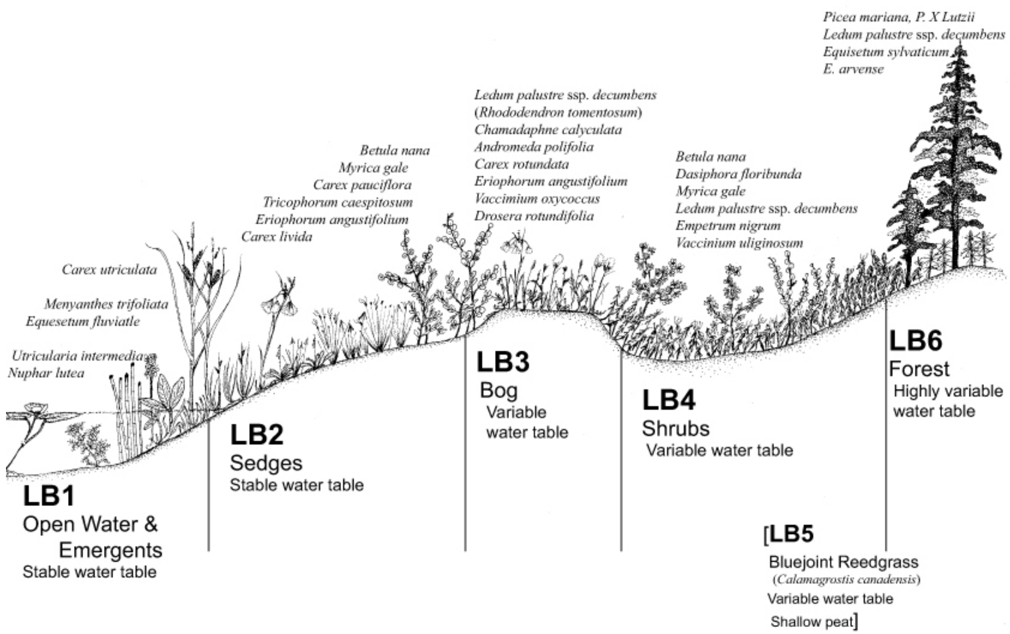


16,176 Ha

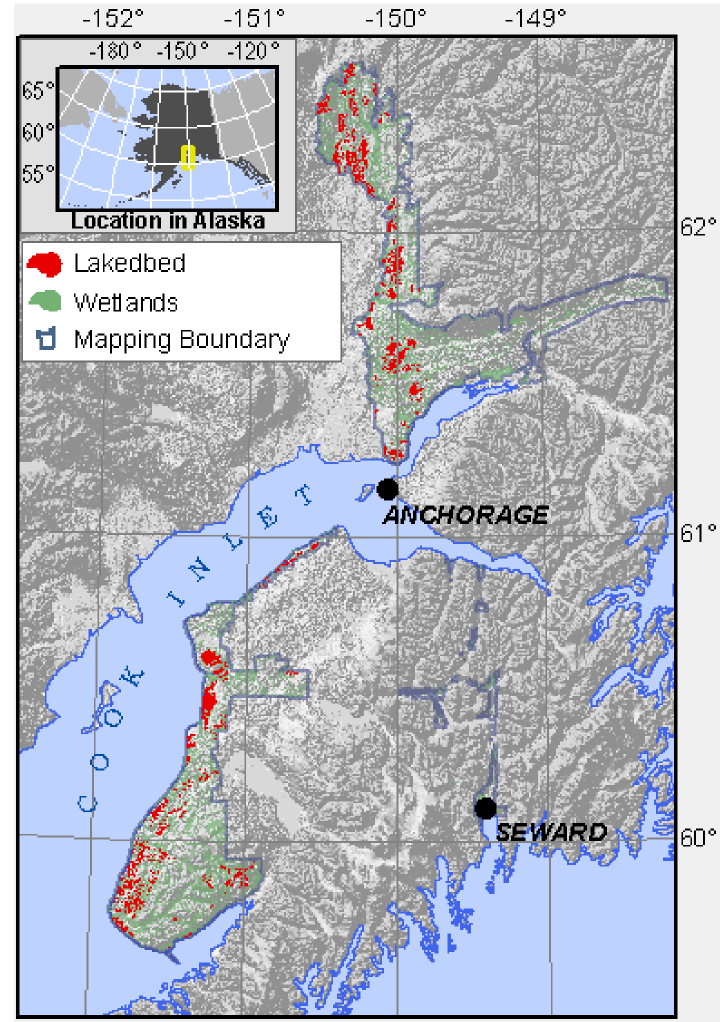
154 (17) = mean peat depth (cm)

Kettle

RELICT GLACIAL LAKEBED HYDROLOGIC COMPONENTS



Artwork by Conrad Field

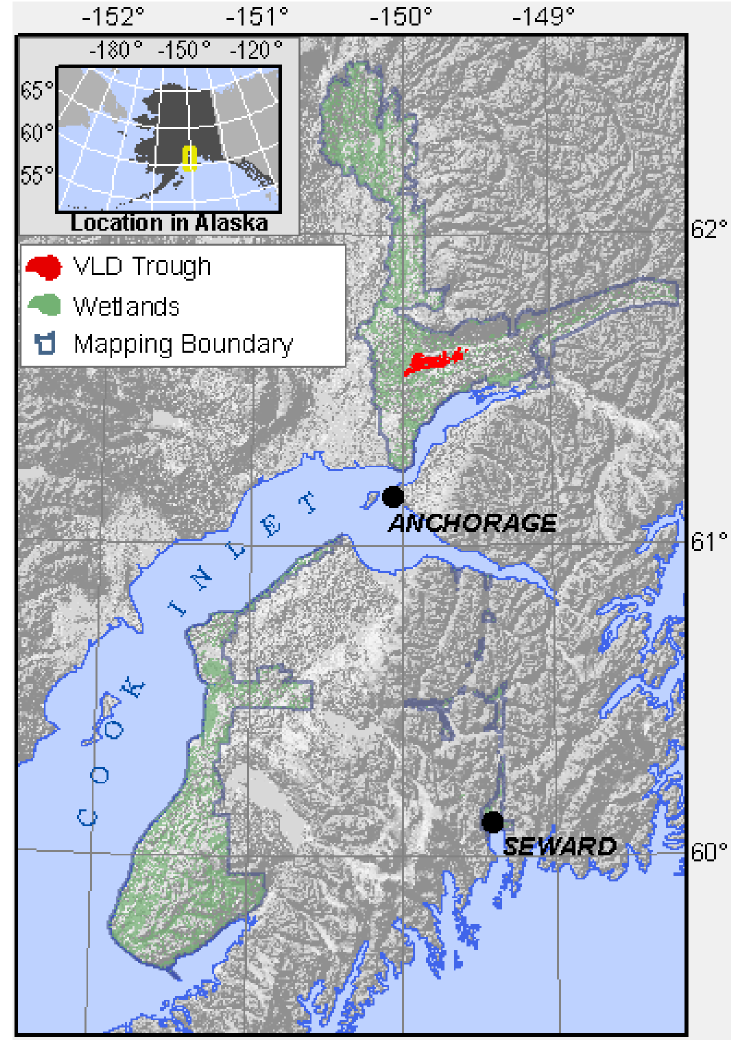


32,623 Ha

156 (24) = mean peat depth (cm)

Relict Lakebed

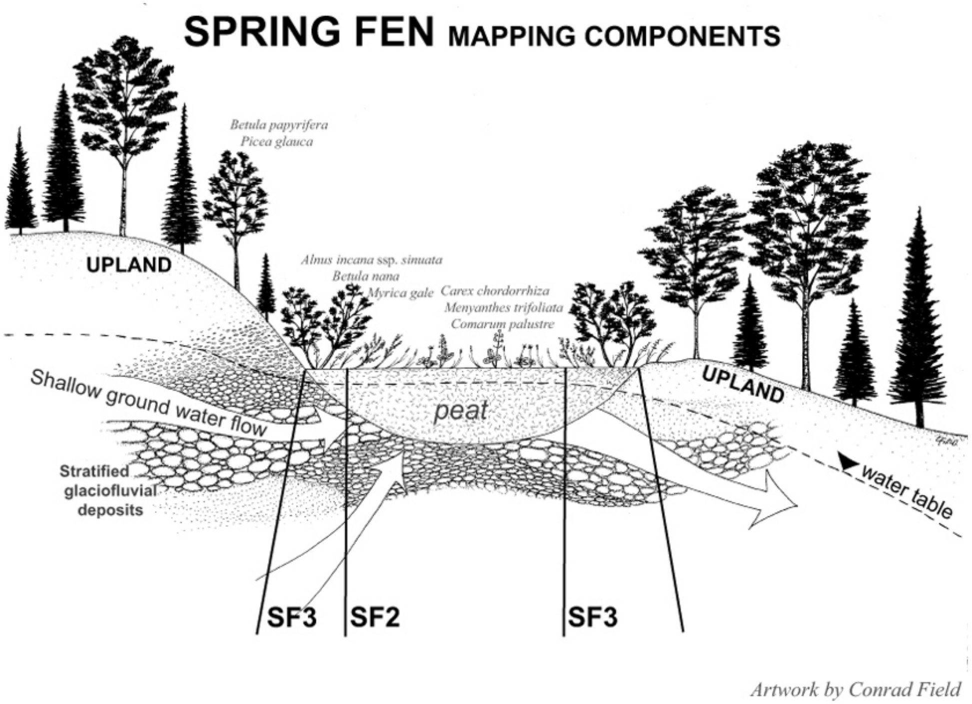
VLD = Very Large Dunes

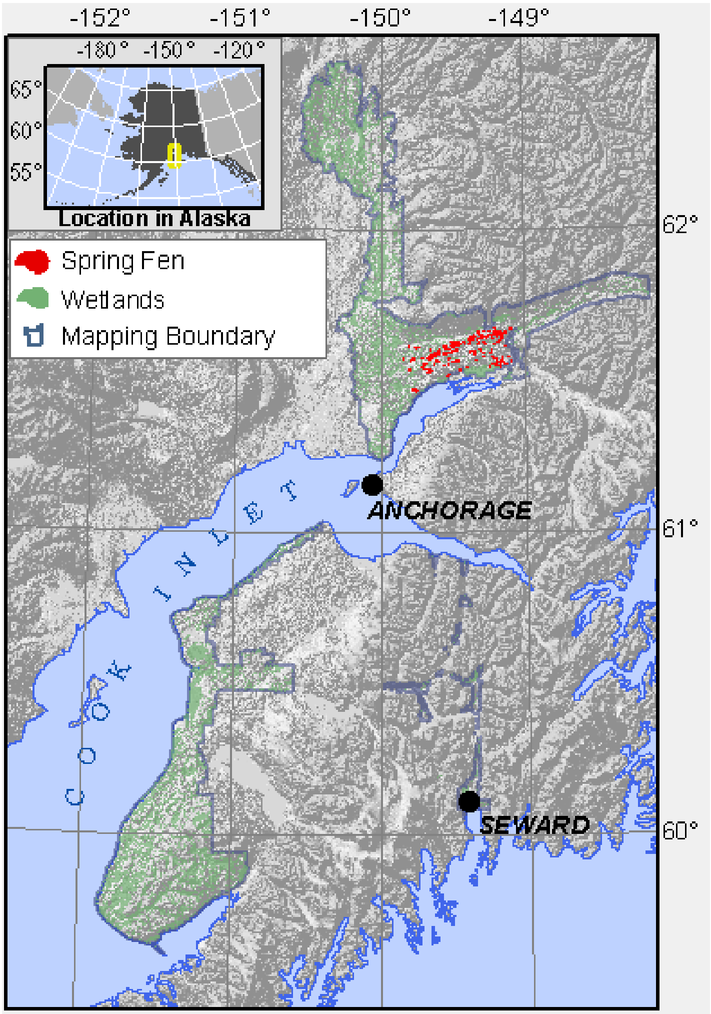


1,628 Ha

262 (81) = mean peat depth (cm)

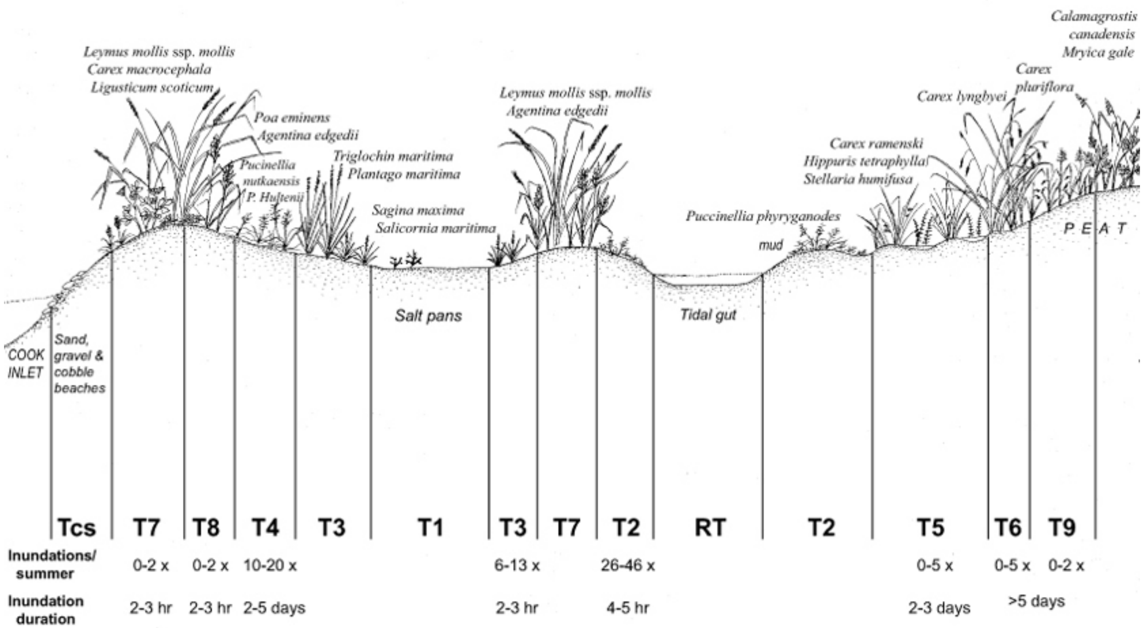
VLD Trough


SPRING FEN MAPPING COMPONENTS
Betula papyrifera
Picea glauca
UPLAND
Alnus incana ssp. sinuata
Betula nana
Myrica gale
Carex chordorrhiza
Menyanthes trifoliata
Comarum palustre
UPLAND
Shallow ground water flow
peat
Stratified glaciofluvial deposits
water table
SF3
SF2
SF3
Artwork by Conrad Field


-152°
-151°
-150°
-149°
-180° -150° -120°
65°
60°
55°
Location in Alaska
Spring Fen
Wetlands
Mapping Boundary
62°
61°
60°
ANCHORAGE
SEWARD
COOK INLET

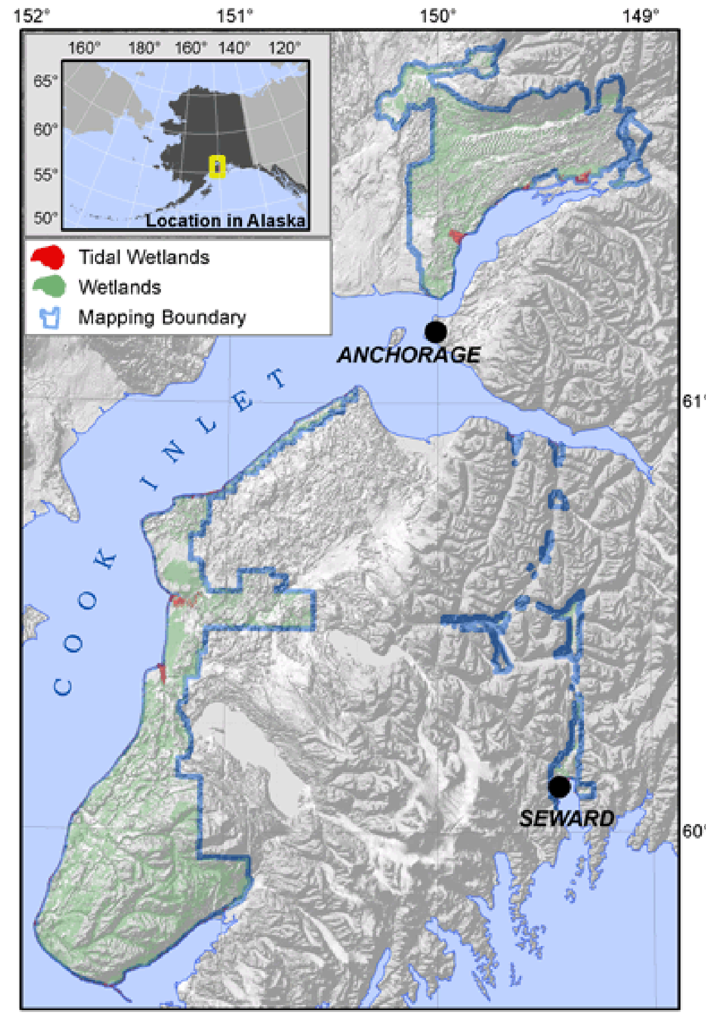
Spring Fen

TIDAL WETLAND HYDROLOGIC COMPONENTS



5,468 Ha

36 = mean peat depth (cm)

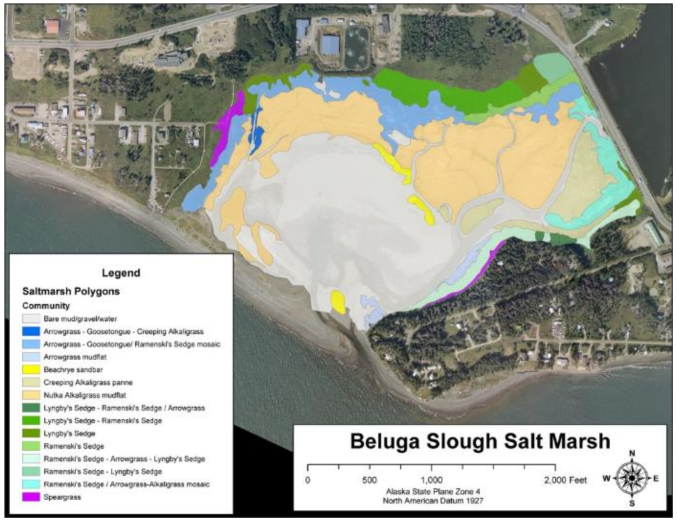


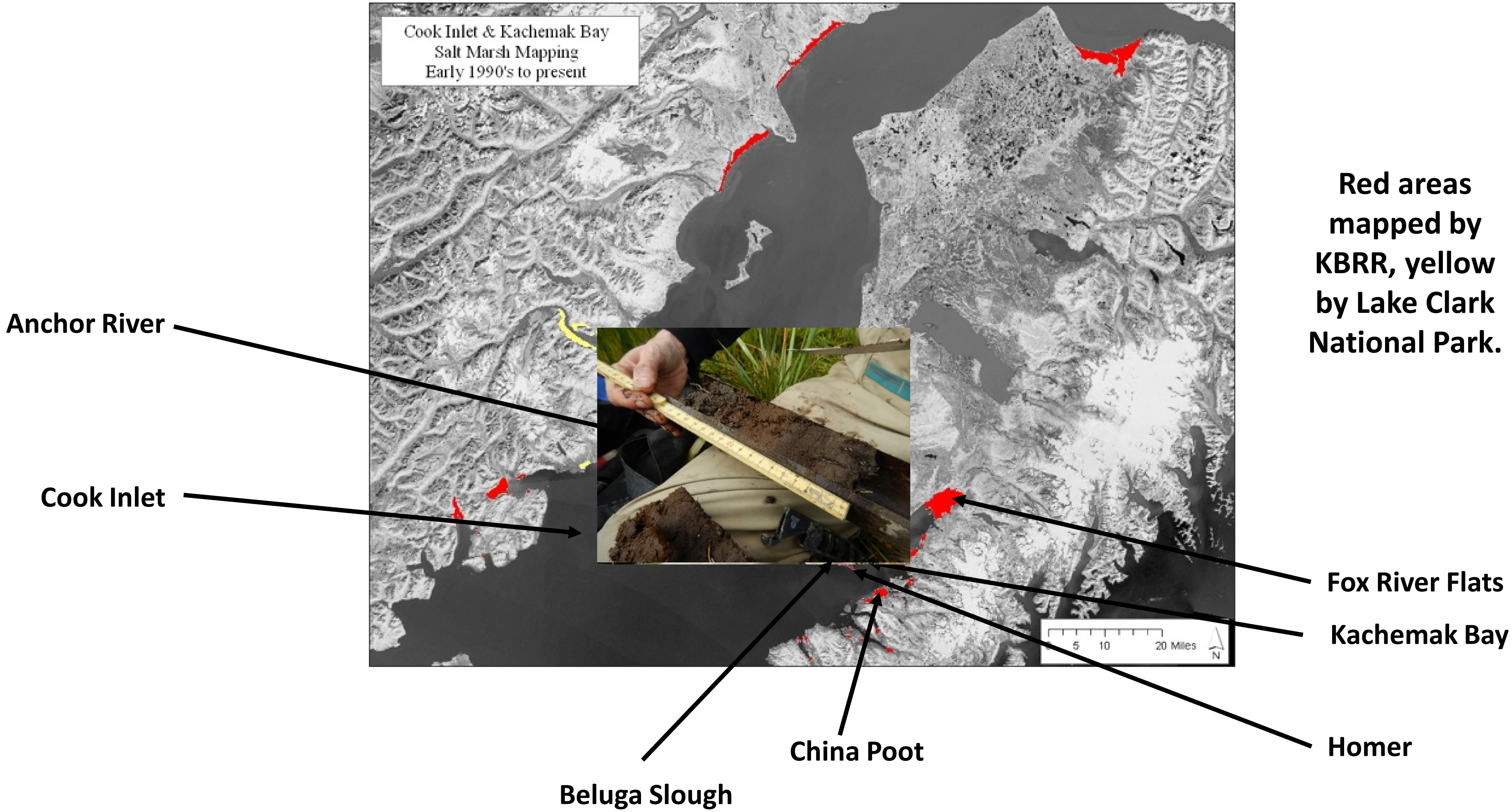
Tidal Wetland

Salt Marsh Mapping and Monitoring at Kachemak Bay Research Reserve

Following slides provided by Steve Baird

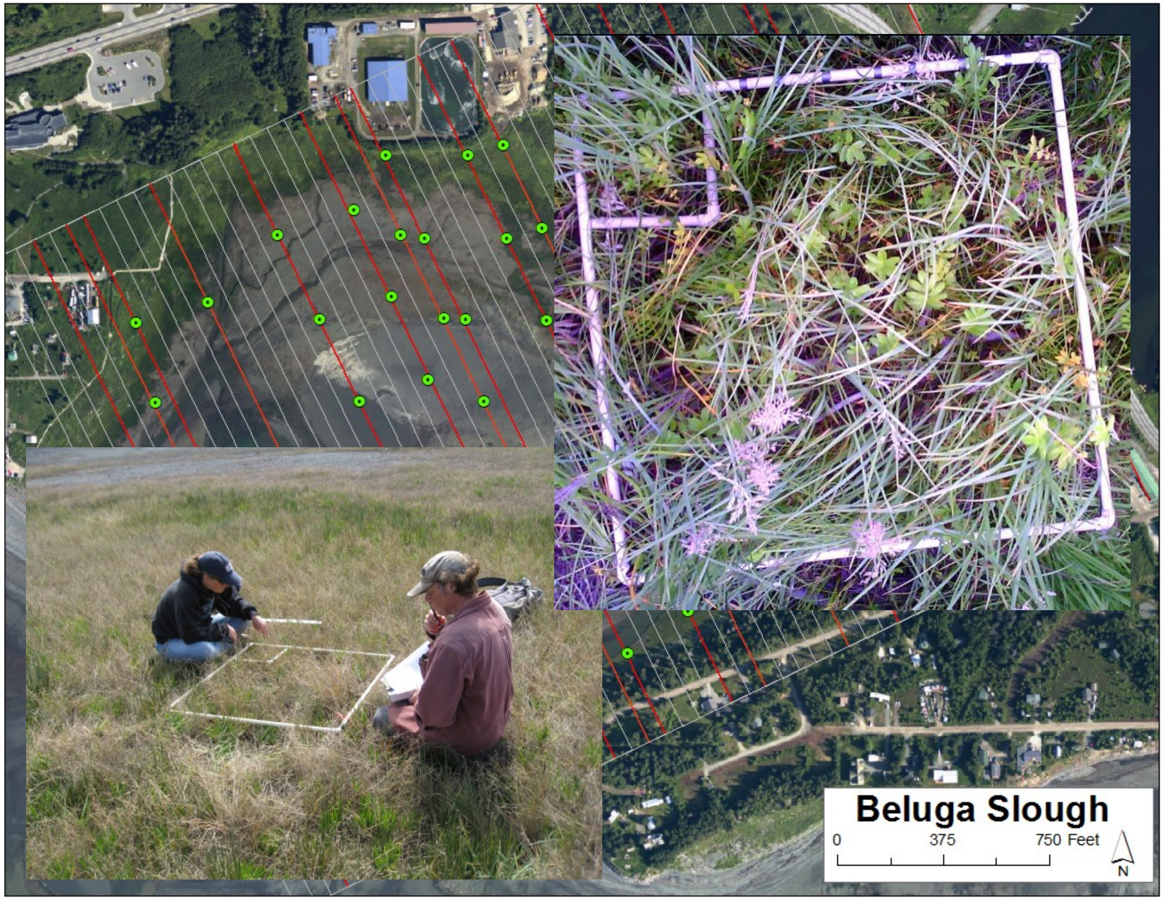
An example, Beluga Slough - 15 plant communities mapped.
Sampled by Lisa Schile

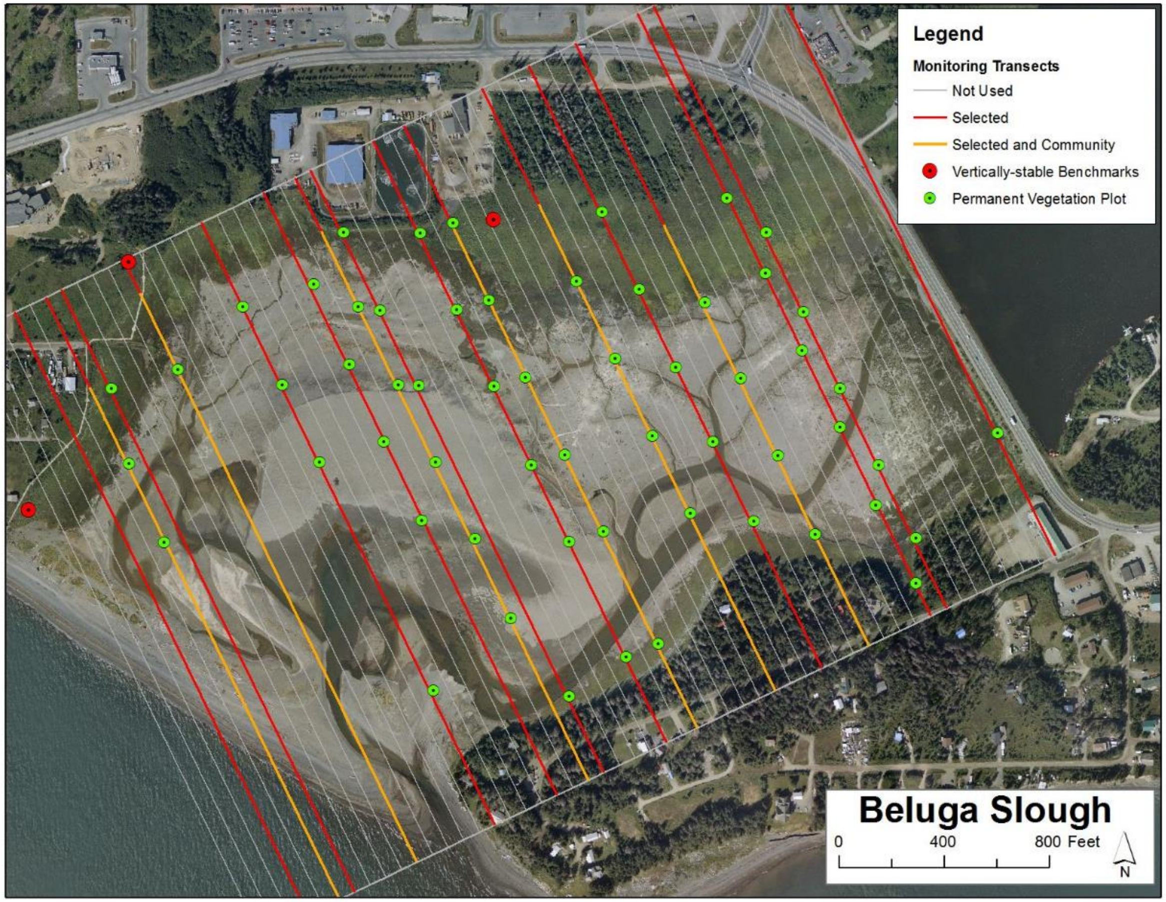




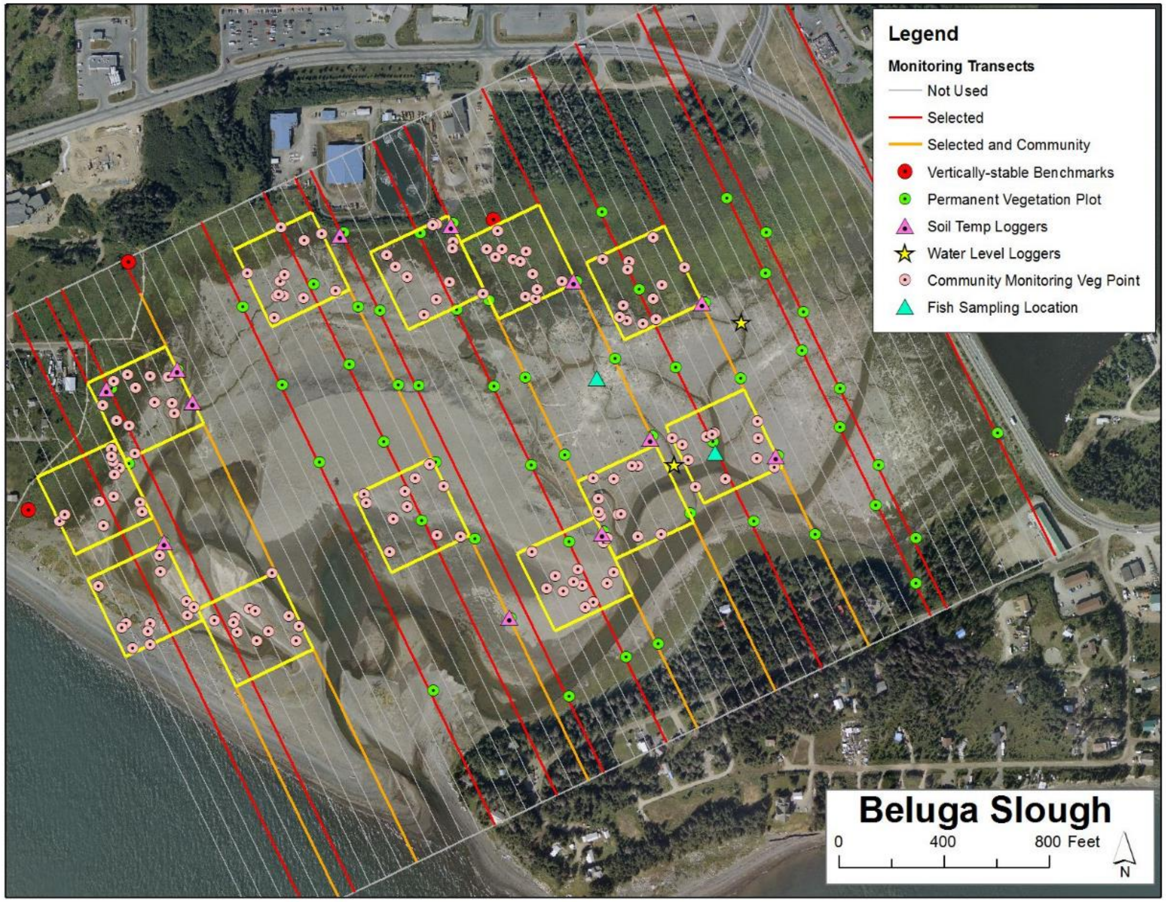
Red areas mapped by KBRR, yellow by Lake Clark National Park.

2010 NERRS Biomonitoring

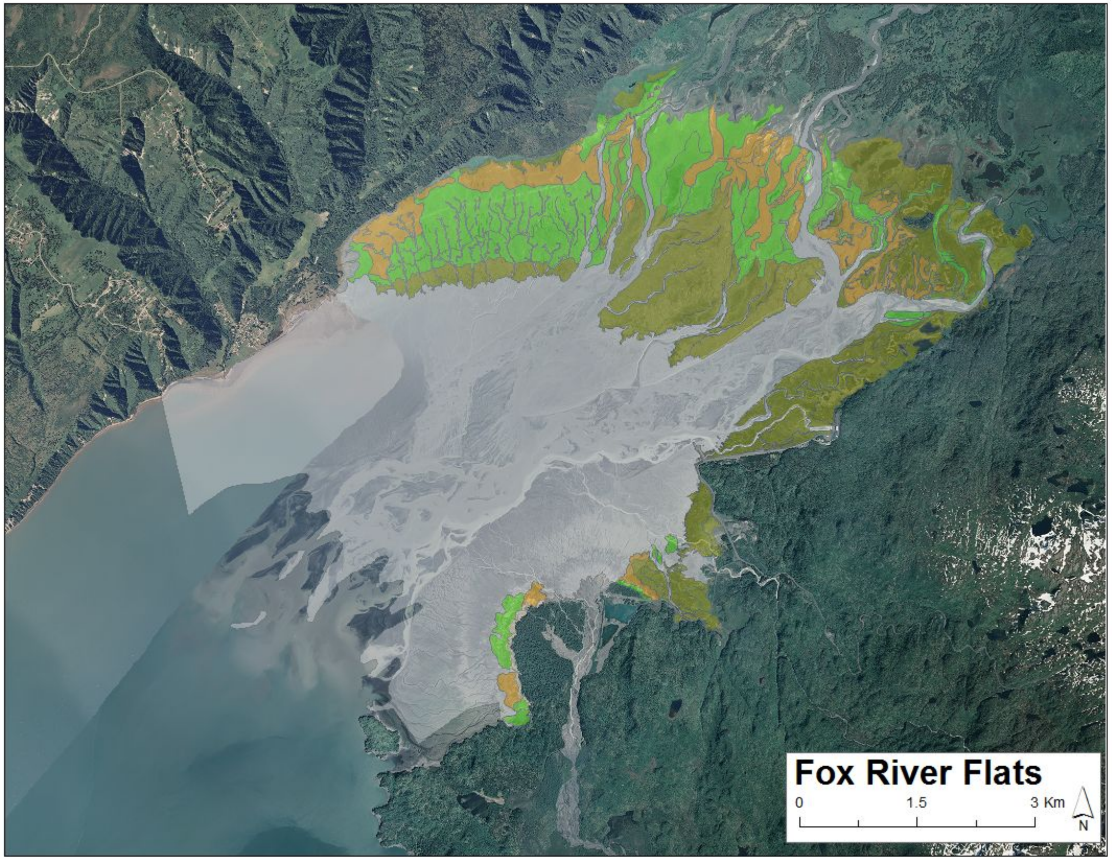




Legend
Monitoring Transects
Not Used
Selected
Selected and Community
Vertically-stable Benchmarks
Permanent Vegetation Plot
Beluga Slough
0
400
800 Feet
N


Legend
Monitoring Transects
Not Used
Selected
Selected and Community
Vertically-stable Benchmarks
Permanent Vegetation Plot
Soil Temp Loggers
Water Level Loggers
Community Monitoring Veg Point
Fish Sampling Location
Beluga Slough
0 400 800 Feet
N

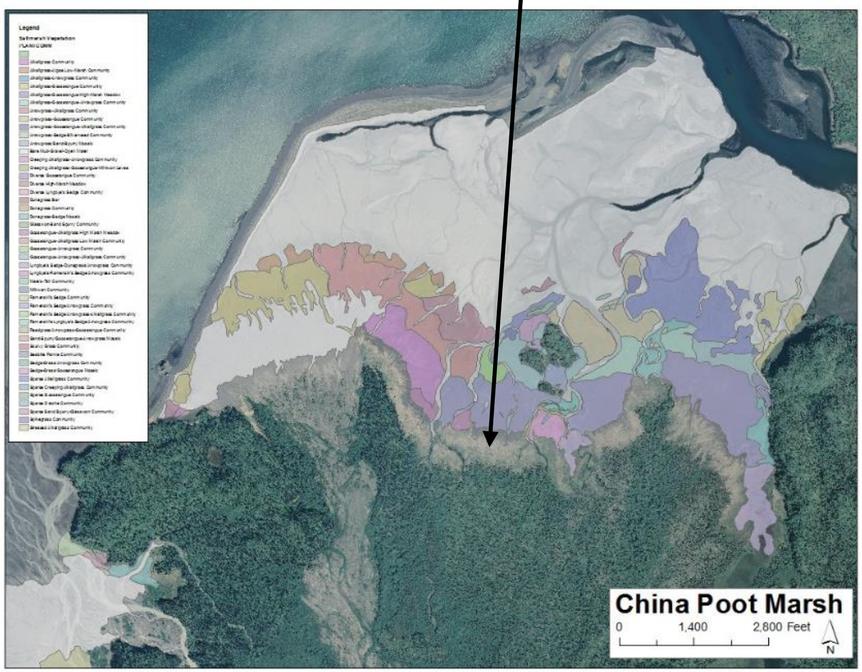
Fox River Flats – at head-of-tide in K. Bay. Glacial sediments dominate the area

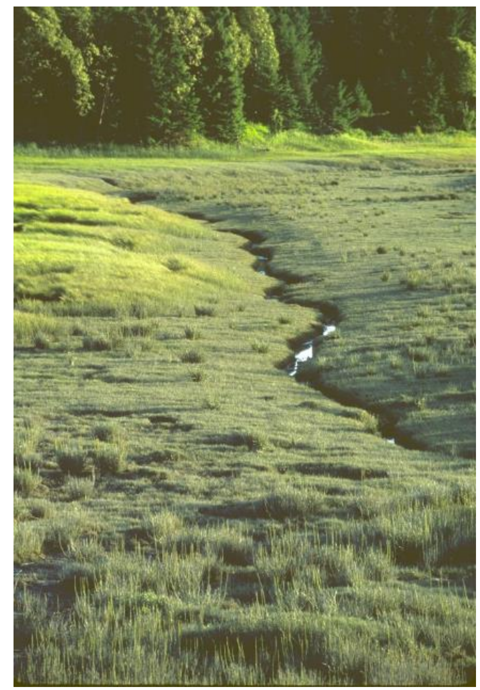


China Poot – Complex plant communities mapped.

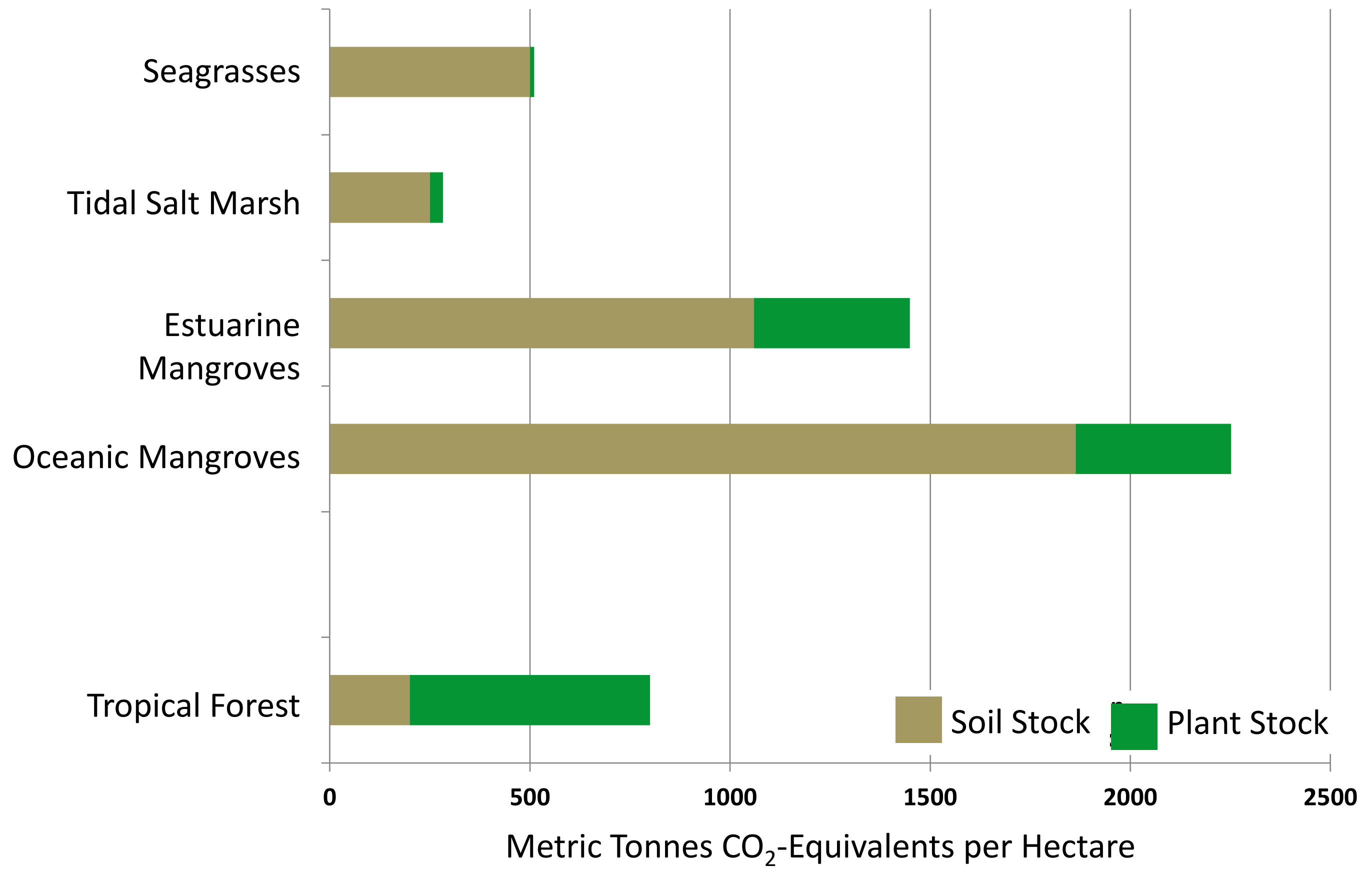
Sunken forest at upland/wetland border from 1964 earthquake.

Sampled by Lisa Schile





Soil and Plant Carbon Stocks



Murray et al. 2010, Nicholas Institute Policy Brief


Peat Harvesting

Development

Agriculture

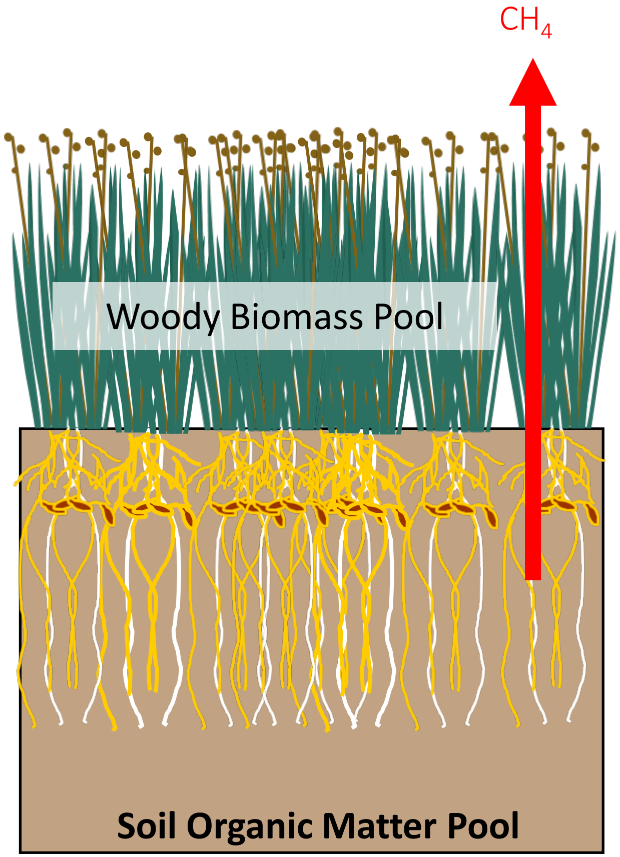
Shrimp Farming

Cost for Loss of Blue Carbon Ecosystems

Table 1. Estimates of carbon released by land-use change in coastal ecosystems globally and associated economic impact.

	Inputs			Results	
Ecosystem	Global extent (Mha)	Current conversion rate (% yr^{-1})	Near-surface carbon susceptible (top meter sediment+biomass, Mg CO_2 ha^{-1})	Carbon emissions (Pg CO_2 yr^{-1})	Economic cost (Billion US$ yr^{-1})
Tidal Marsh	2.2–40 (5.1)	1.0–2.0 (1.5)	237–949 (593)	**0.02–0.24 (0.06)**	**0.64–9.7 (2.6)**
Mangroves	13.8–15.2 (14.5)	0.7–3.0 (1.9)	373–1492 (933)	**0.09–0.45 (0.24)**	**3.6–18.5 (9.8)**
Seagrass	17.7–60 (30)	0.4–2.6 (1.5)	131–522 (326)	**0.05–0.33 (0.15)**	**1.9–13.7 (6.1)**
Total	33.7–115.2 (48.9)			**0.15–1.02 (0.45)**	**6.1–41.9 (18.5)**

Wetland Budget Components



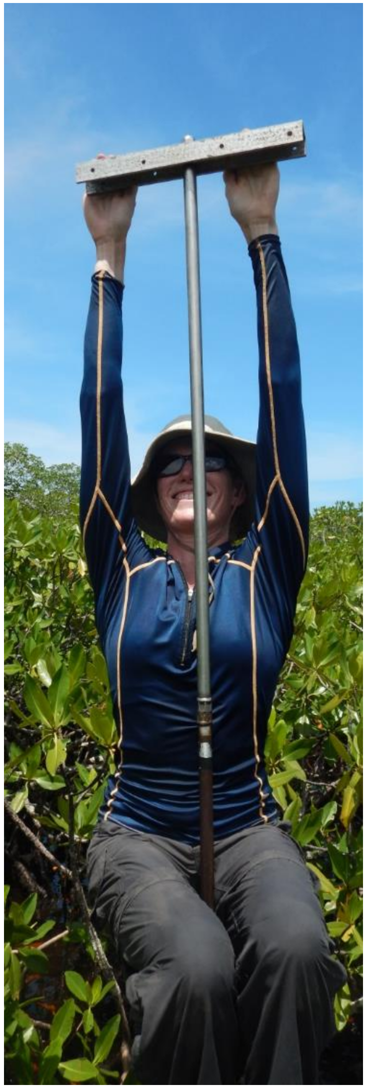
+ Δt

Strata 1
Seaward fringe
Strata 2
Rhizophora
dominated
Strata 3
Scrub
forest
Strata 4
Tidal Salt
Freshwater marsh
Terrestrial vegetation
100 m

Types of coring devices

Gouge auger

Russian peat corer



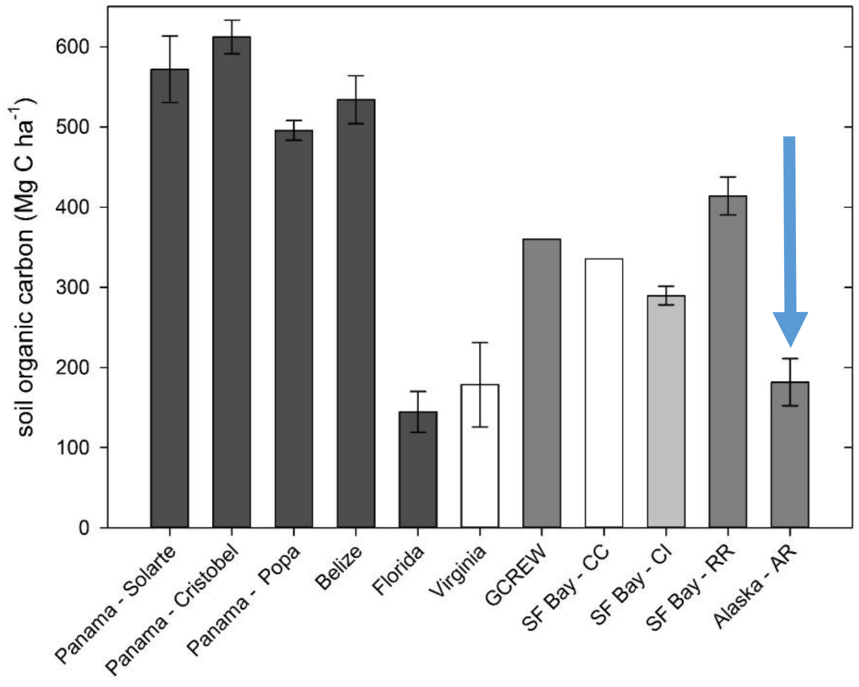
Core to Refusal Depth (1 m minimum)

Carbon Density = Bulk Density x [C]

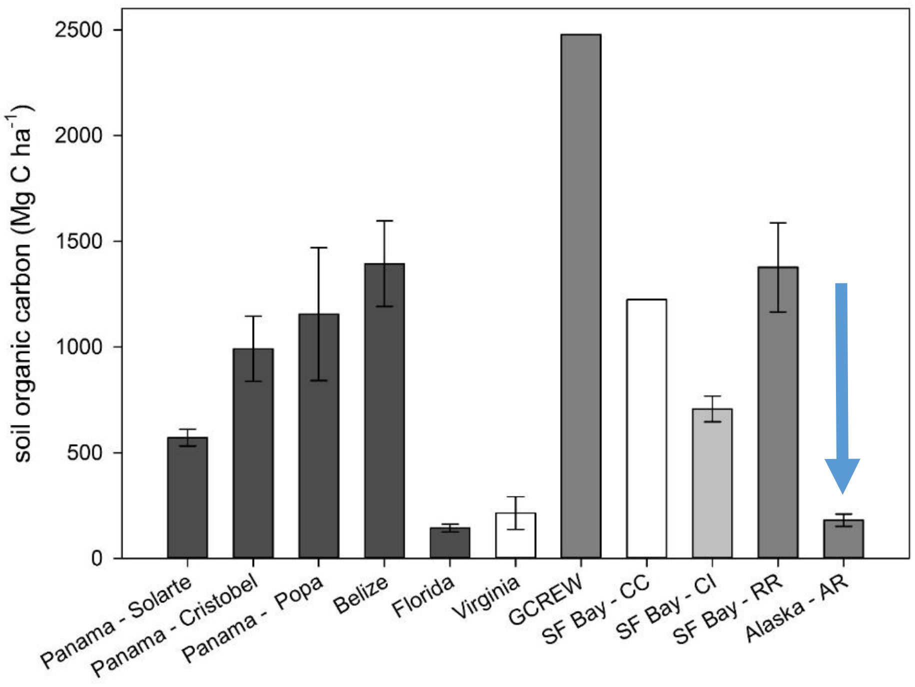
Point C Pool $= \sum_{depth} \text{Carbon Density}$

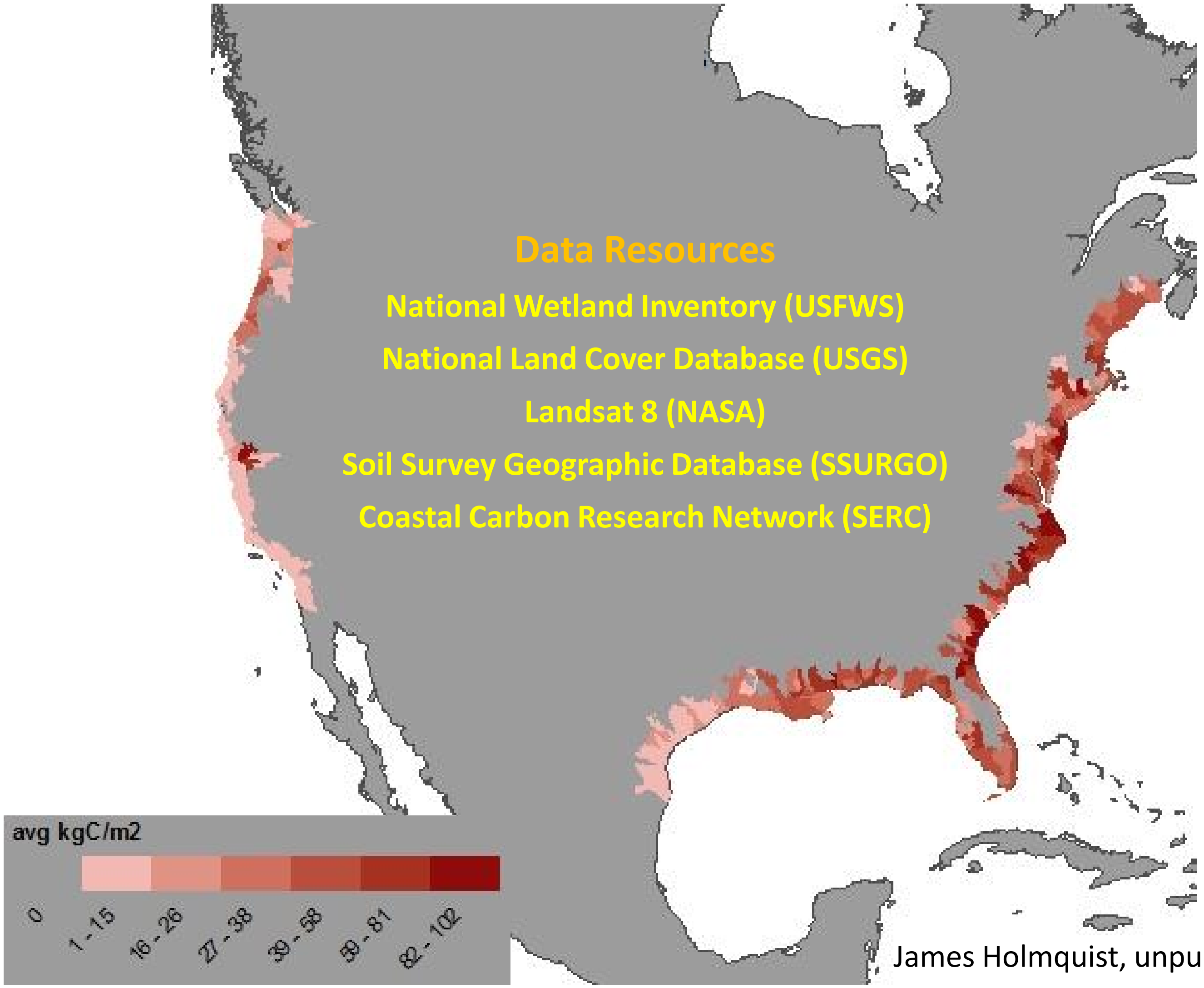
Total Pool = Point Pool x Wetland Area

Soil Carbon Storage
Top 1 meter



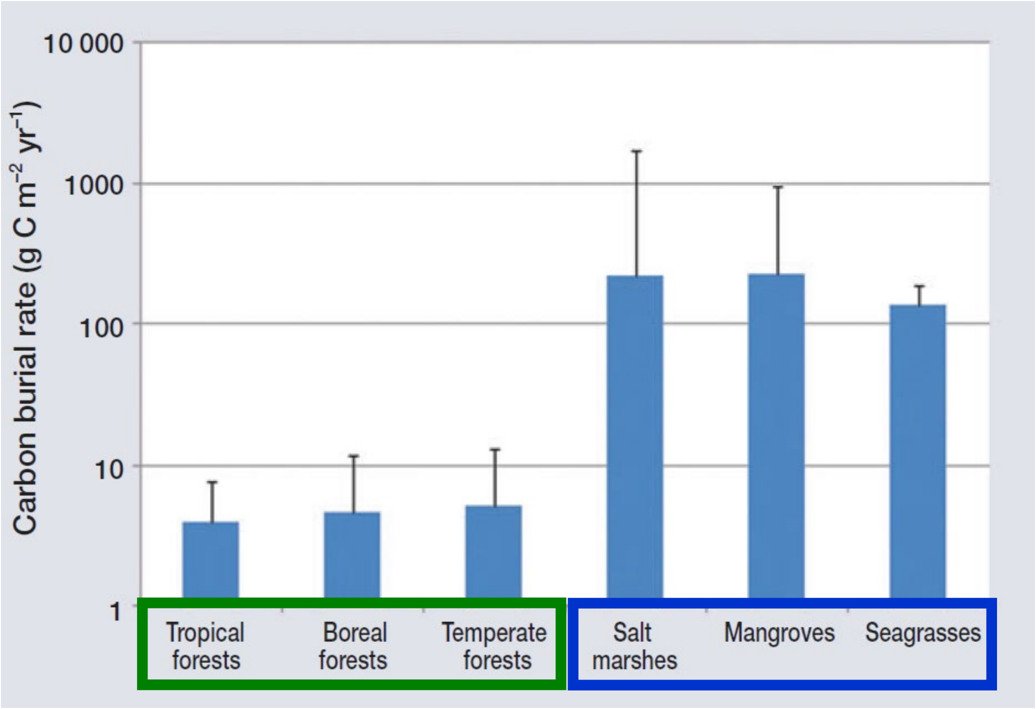
Soil Carbon Storage
Full Soil Profile





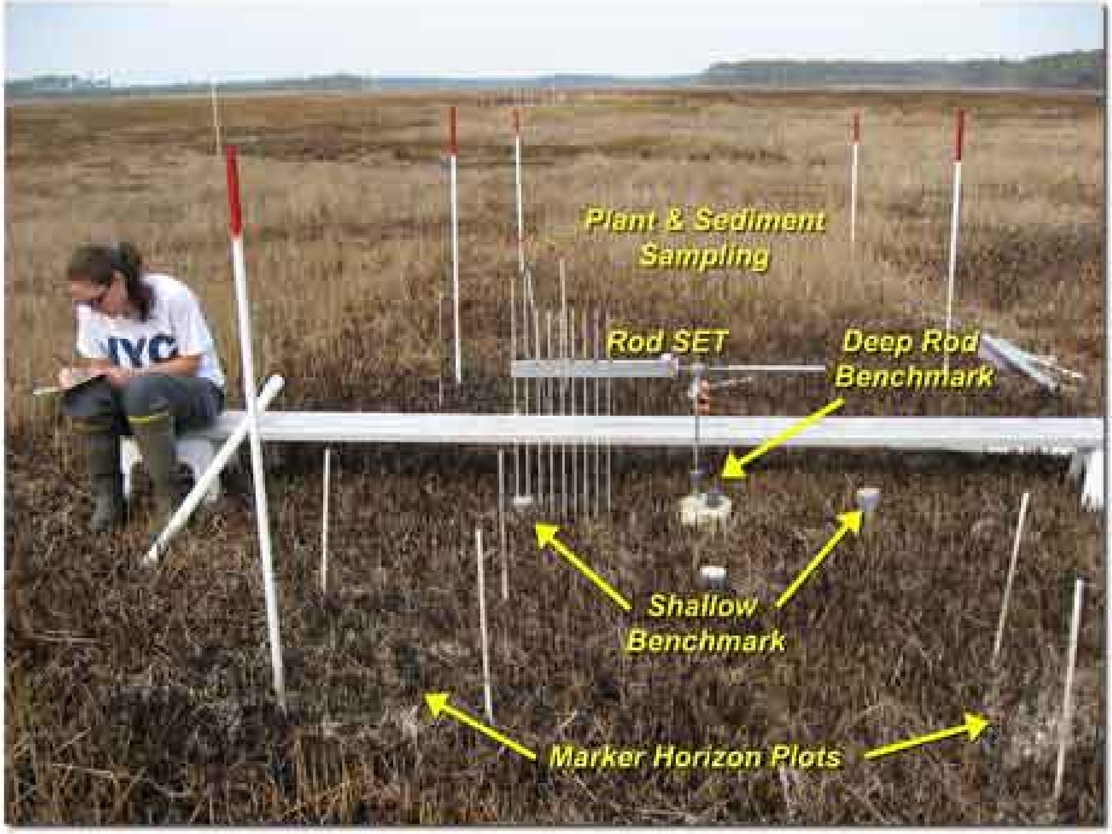
James Holmquist, unpublished

Annual Rate of Carbon Storage

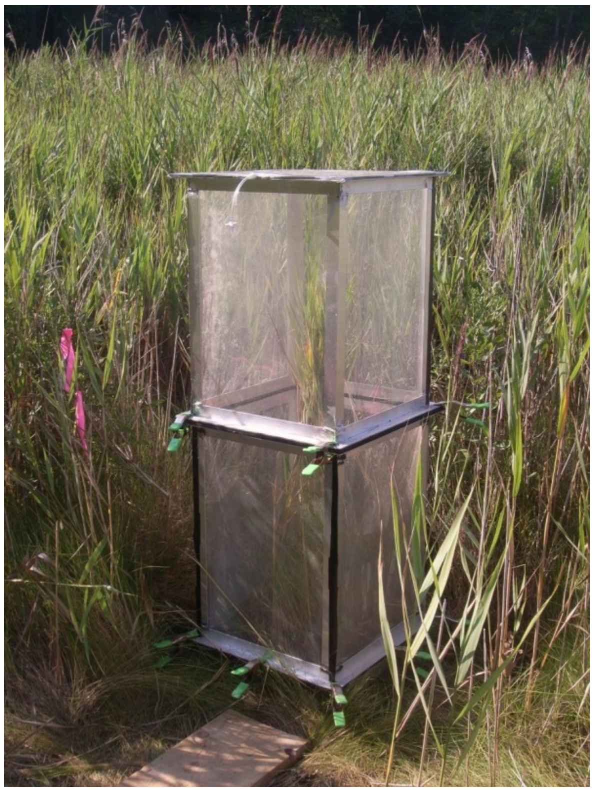


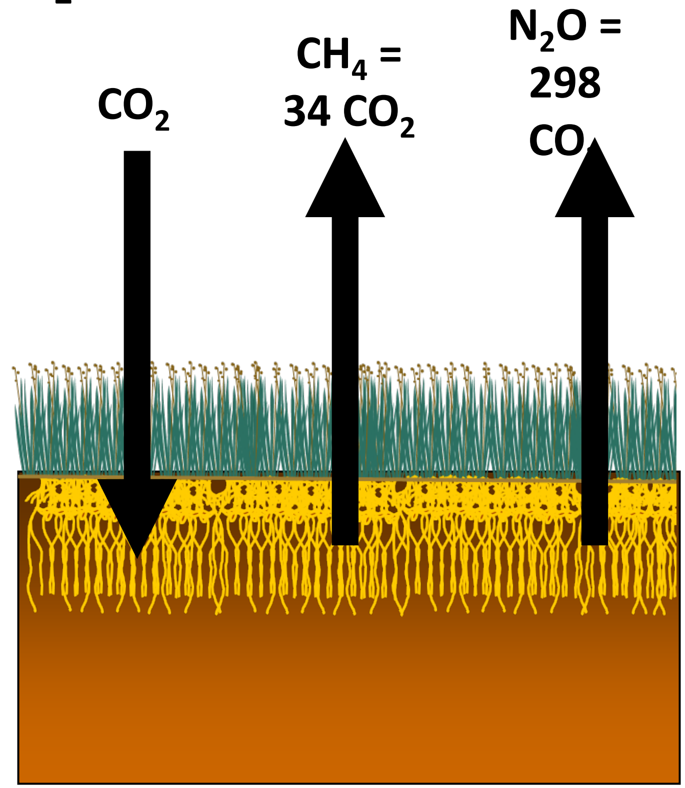
McLeod et al. 2011, Frontiers

Soil Elevation Tables

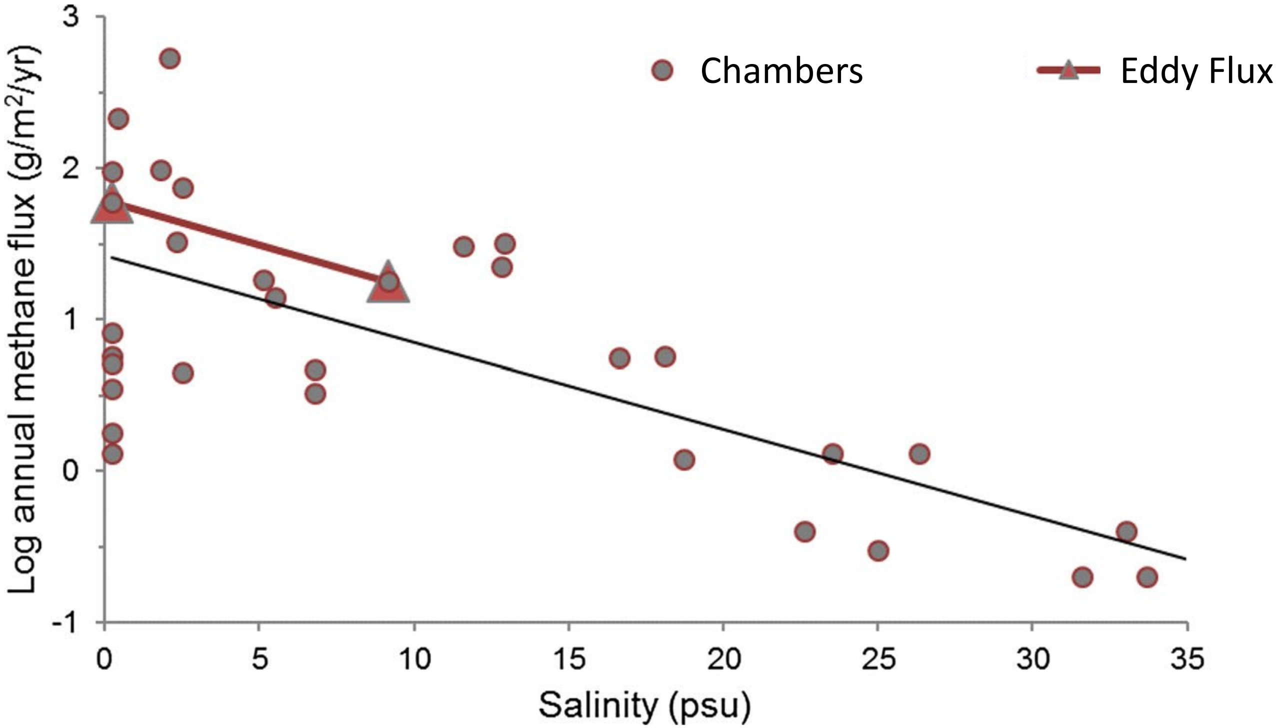


Radiative Forcing by CH_4 and N_2O





Salinity Proxy for Methane Emissions



Holm et al. (2016) *Wetlands*
Poffenbarger et al. (2011) *Wetlands*

Soil Carbon Lost To Erosion Site

Inclusion of Coastal Wetlands into the U.S. Inventory of GHG Emissions & Sinks

Stephen Crooks

Silvestrum Climate Associates

Tom Wirth

U.S. Environmental Protection Agency

Tiffany Troxler

Florida International University

Nate Herold, Meredith Muth,

Ariana Sutton-Grier, Amanda McCarty

National Oceanic & Atmospheric Administration

Blanca Bernal, James Holmquist & Pat Megonigal

Smithsonian Environmental Research Center

Steve Emmett-Mattox, Stefanie Simpson

Restore America's Estuaries

Blue Carbon: Integrating Data Applied to IPCC Emissions Factors and Carbon Markets.

12th International Symposium

on Biogeochemistry of Wetlands

April, 25, 2018

Photo: Jacqueline Rose

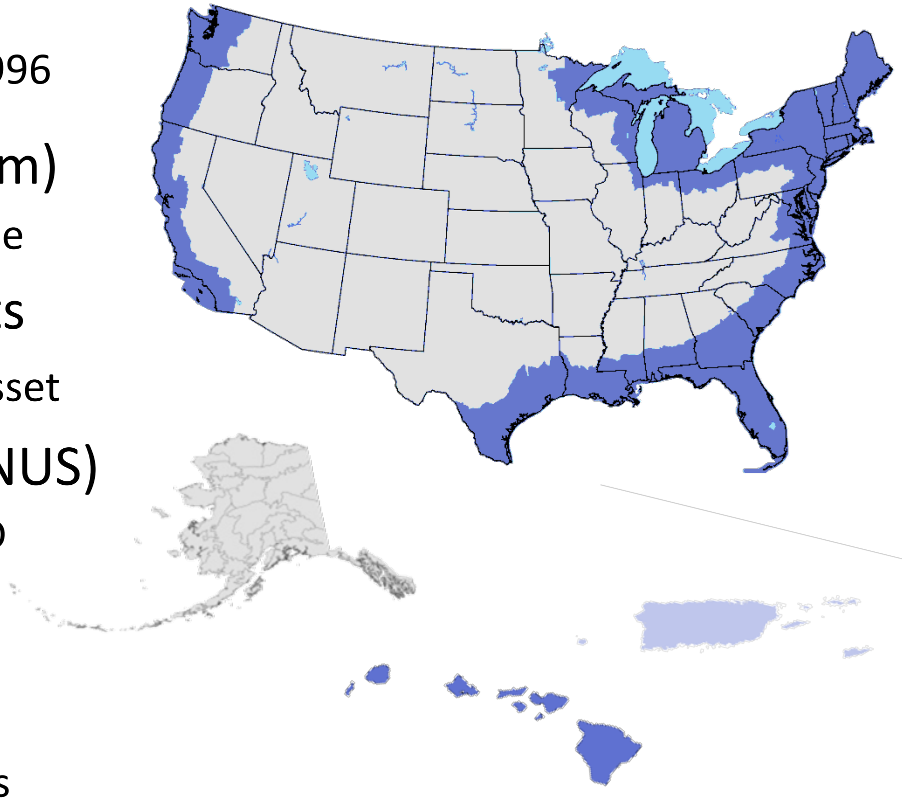
United States: Emissions of Interest

- Emissions and removals of CO_2 and CH_4 on intact and restoring wetlands.
- Drainage and excavation activities
- Conversion of wetlands to open water
- Forestry activities on wetland soils
- CH_4 emissions from impounded waters
- Aquaculture

C-CAP Regional Land Cover and Change

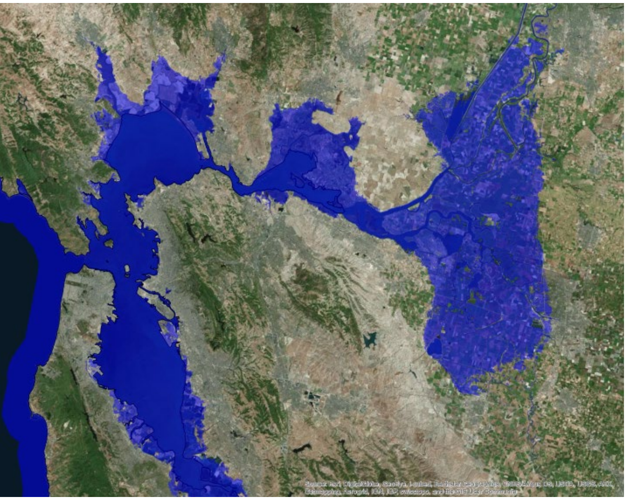
coast.noaa.gov/digitalcoast/data/ccapregional

- National Coastal Land Cover Monitoring Program
  - –Updated every five years since 1996
- Based on Landsat imagery (30m)
  - –Regional to county scale in scope
- Consistent, Accurate Products
  - –FGDC National Geospatial Data Asset
- 25% of the contiguous U.S. (CONUS)
  - –Coastal expression of the NLCD
- Additional Coastal Detail
  - –Focus on wetland categories
  - –More dates / longer time series



Extent of Coastal Land Area

Tide data
Lidar surface
C-CAP land cover

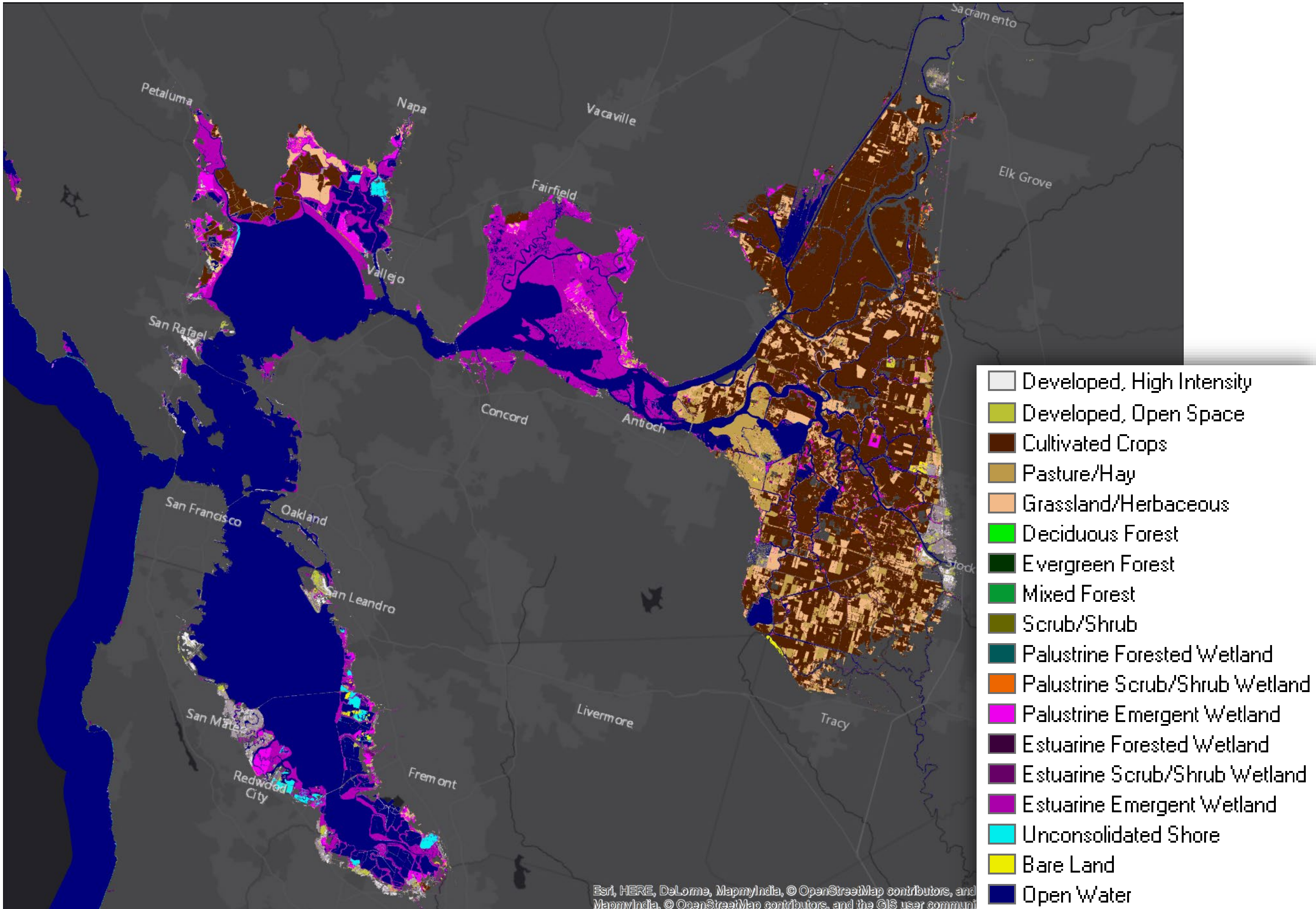


San Francisco Bay – San Joaquin River, CA

New Orleans – Mississippi River, LA

Chesapeake Bay – Blackwater National Wildlife Refuge, MD

San Francisco Estuary, CA



Connecting Blue Carbon to Carbon Markets

Wetlands Restoration and Conservation (WRC)
Adopted into Standard Oct 4, 2012
http://v-c-s.org/wetlands_restoration_conservation

Other Categories:
- Afforestation, Reforestation, Revegetation (ARR)
- Agricultural Land Management (ALM)
- Improved Forest Management IFM)
- Reduced Emissions from Deforestation and Degradation (REDD)

VCS VERIFIED CARBON STANDARD
A Global Benchmark for Carbon

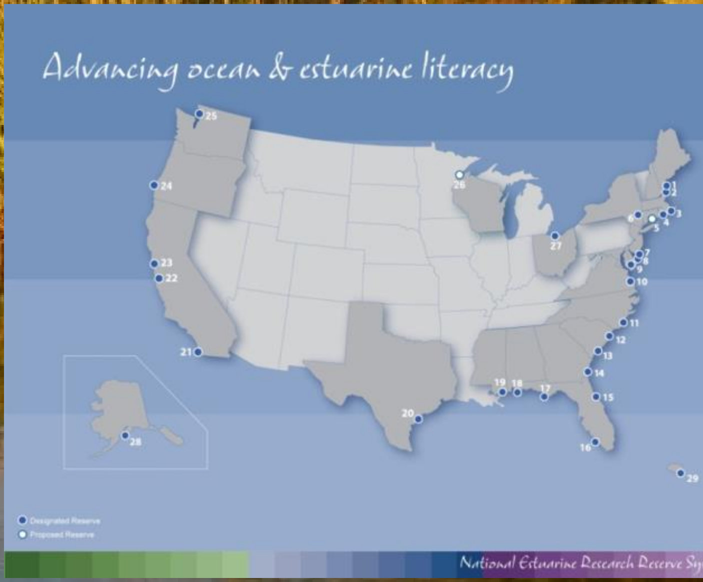
RESTORE AMERICA'S ESTUARIES

Q&A

- How are wetlands valued by local landowners and resource managers?
- What are current threats or opportunities for wetland conservation?

Blue Carbon and the science and the methods used to track greenhouse gases in a New England salt marsh

James Rassman
Tonna-Marie Surgeon-Rogers



Waquoit Bay National Estuarine Research Reserve

National Oceanic and Atmospheric Administration, U.S. Department of Commerce

1

How/Why We got involved in Blue Carbon – Our Landscape

2

BWM 1 – Science – Methodology - Modeling

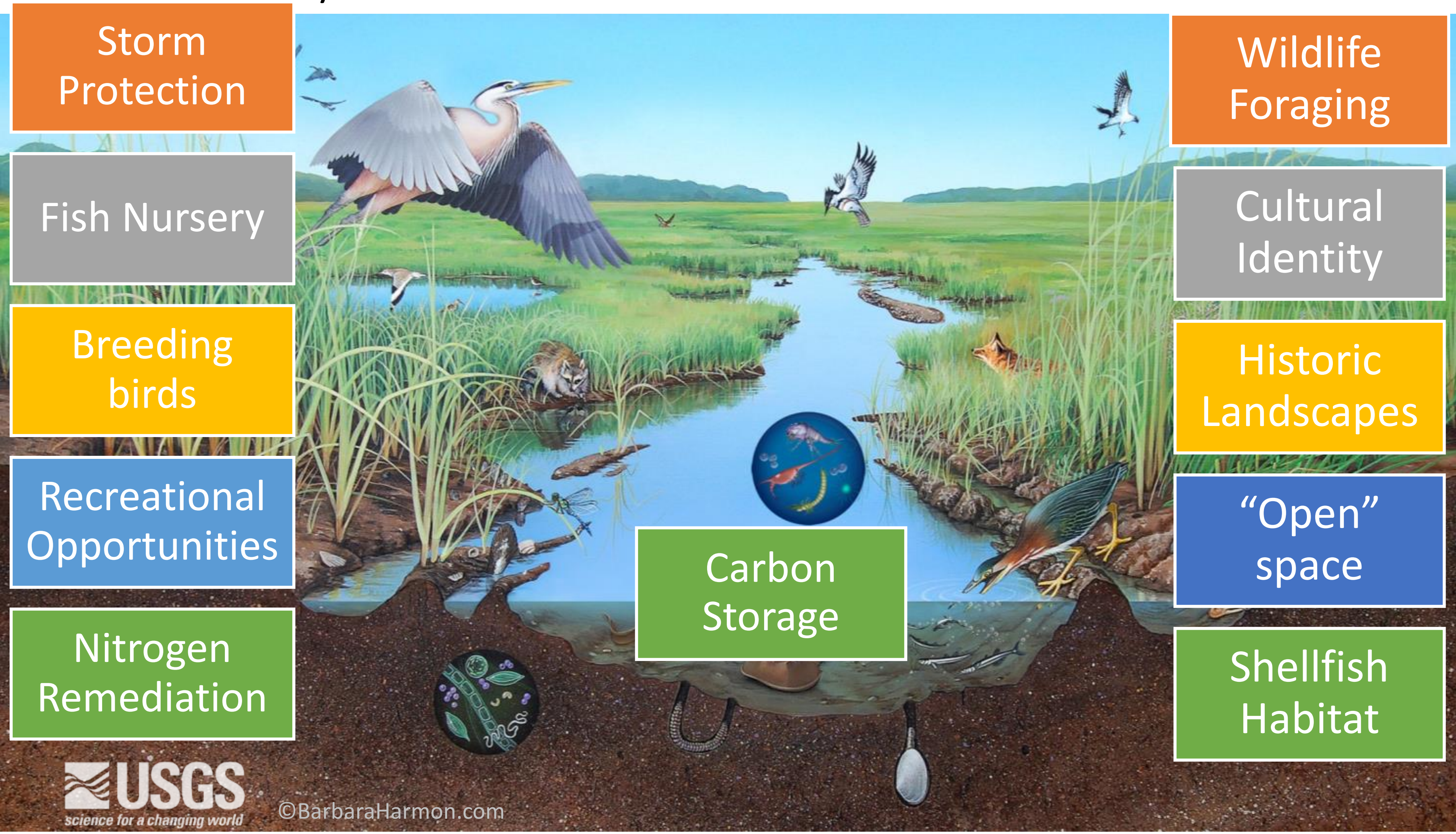
3

BWM 2 – Model Generalization – Science - Carbon Project Feasibility Analysis

"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."

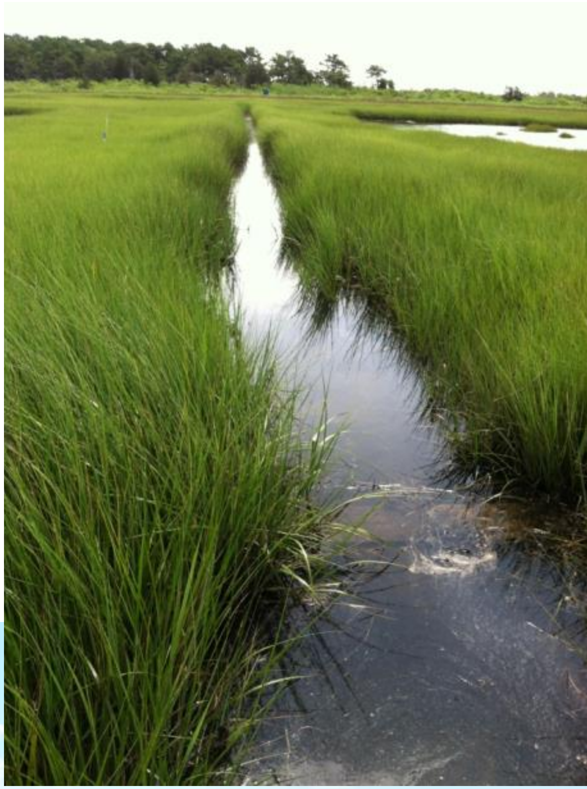
Report: Blue Carbon – The Role of Healthy Oceans in Binding Carbon, UNEP (2009)

It’s not just about blue carbon… all ecosystem services



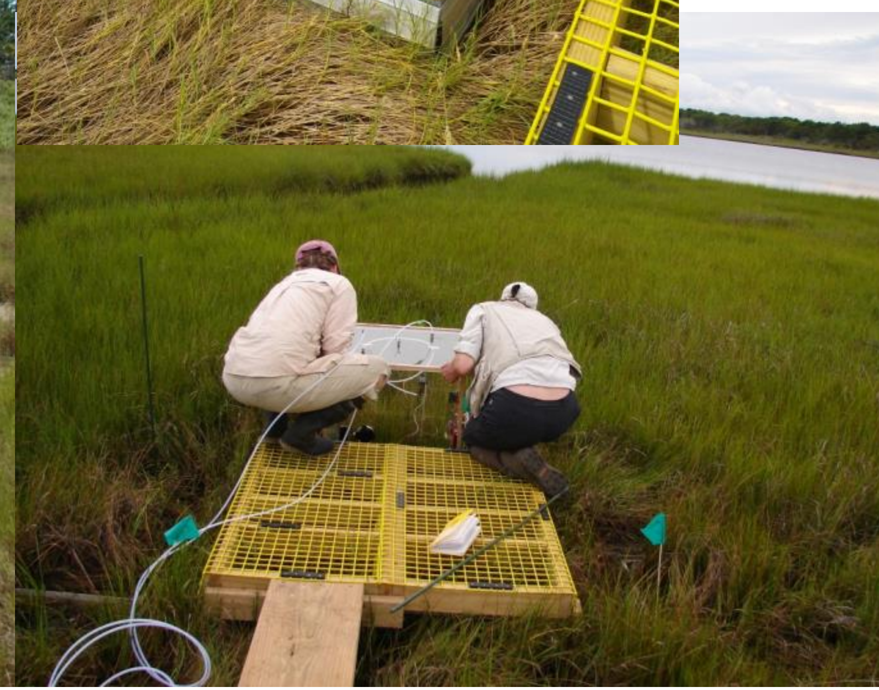
Where is the Carbon?

“Seeing” the Carbon in a New England Salt Marsh

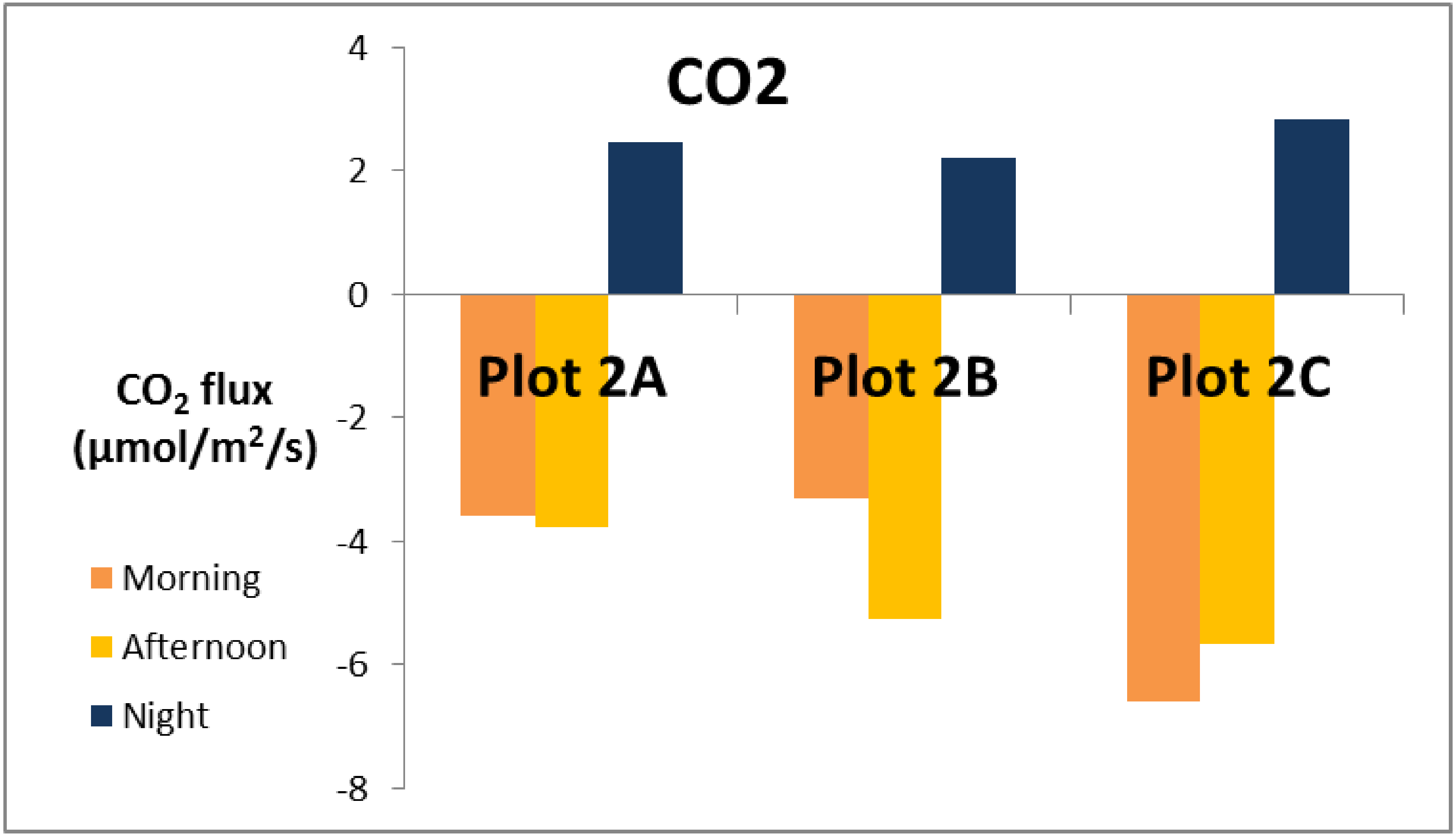



MBL
Biological Discovery in Woods Hole
USGS
science for a changing world
THE UNIVERSITY OF RHODE ISLAND
THINK BIG WE DO
NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM SCIENCE COLLABORATIVE
RESTORE AMERICA'S ESTUARIES
MANOMET
Center for Conservation Sciences
FIU
FLORIDA INTERNATIONAL UNIVERSITY

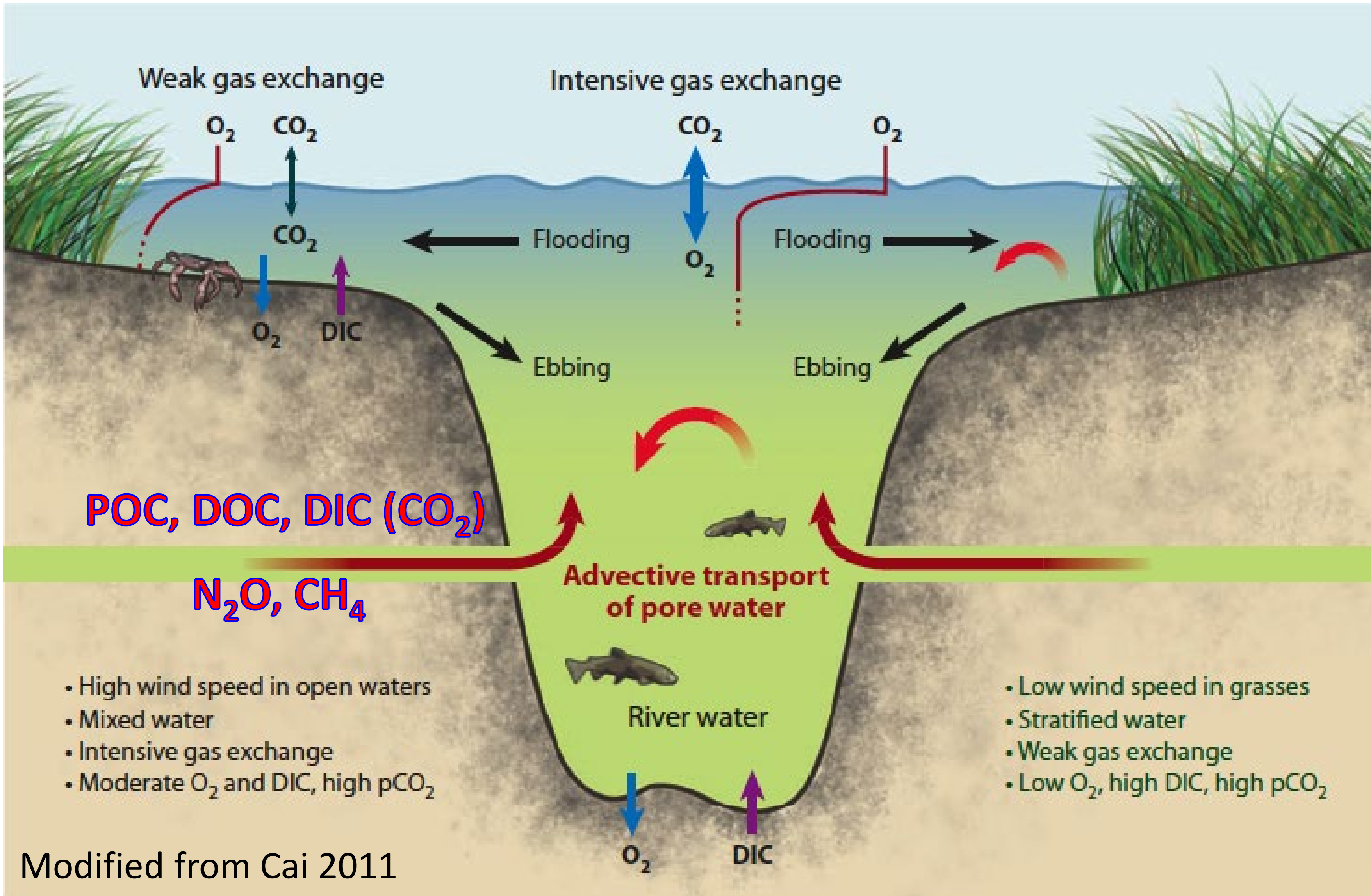
GHG flux measurement



Diurnal pattern of CO2 fluxes

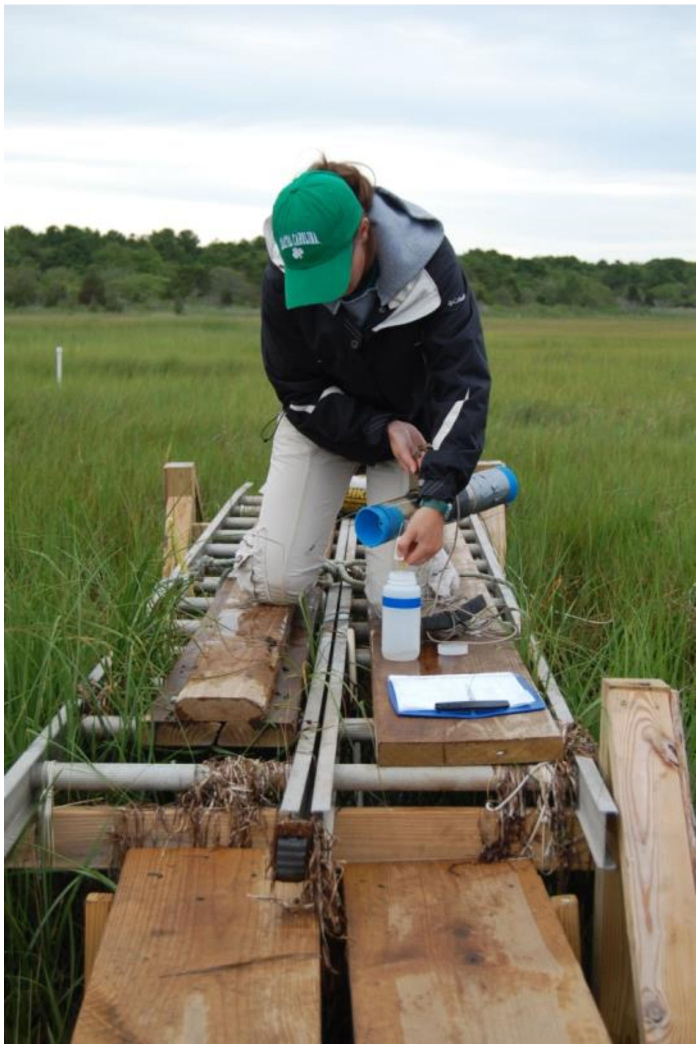


In tidal wetland carbon and GHG budgets we also need to consider the lateral fluxes: C fluxes may be large…



Modified from Cai 2011

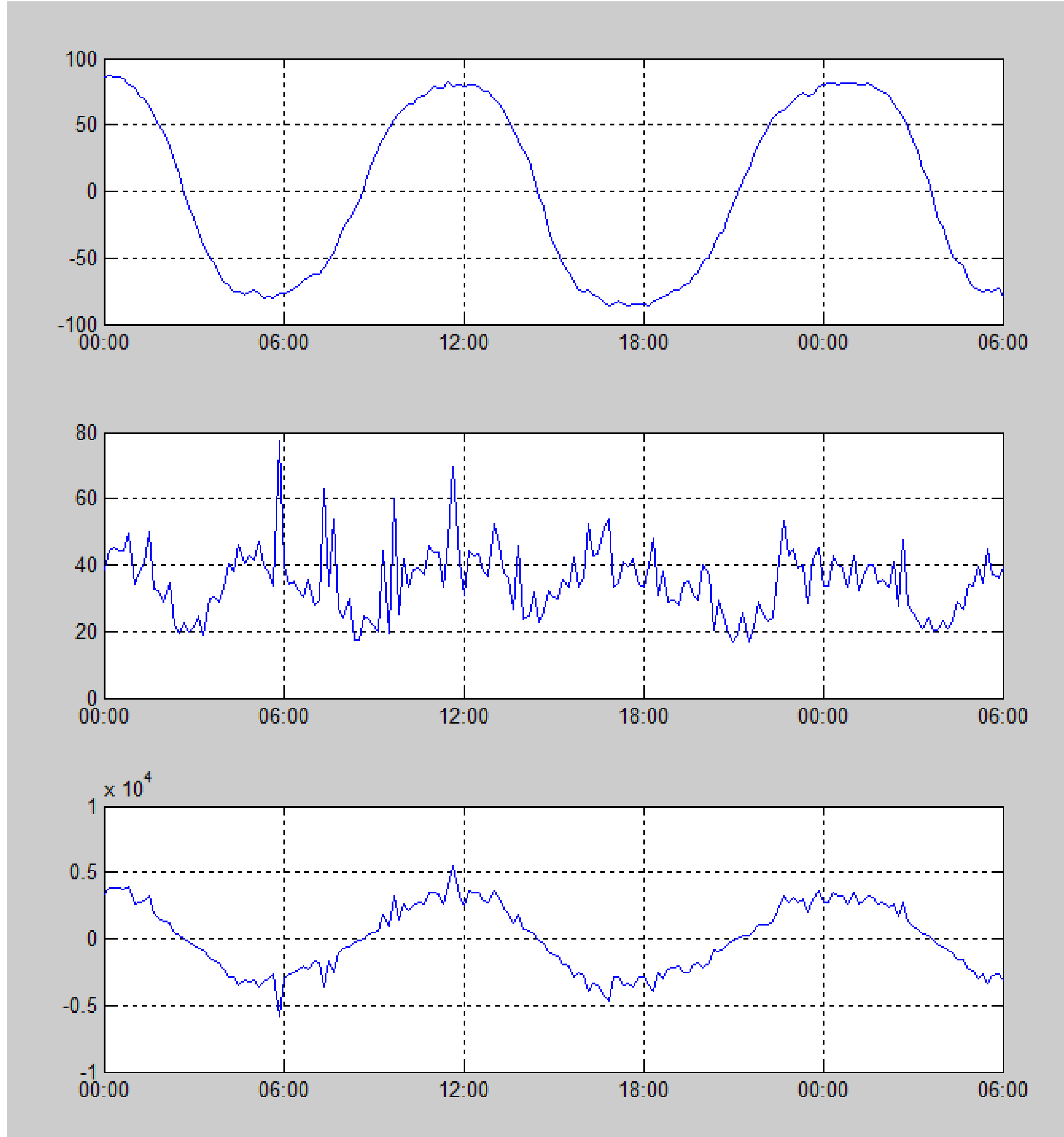
Measuring Lateral Fluxes in the Marsh



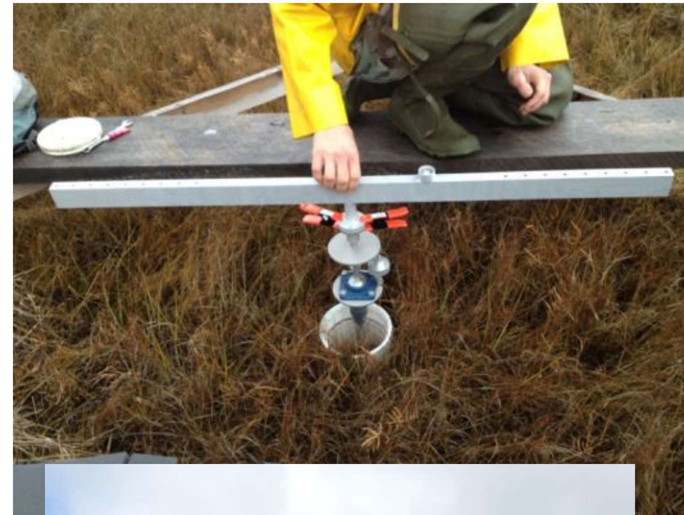
Water flux (u x A), m^3/s:
-High-frequency measurements to reduce error
-Maximum channel coverage
-Consistent procedure

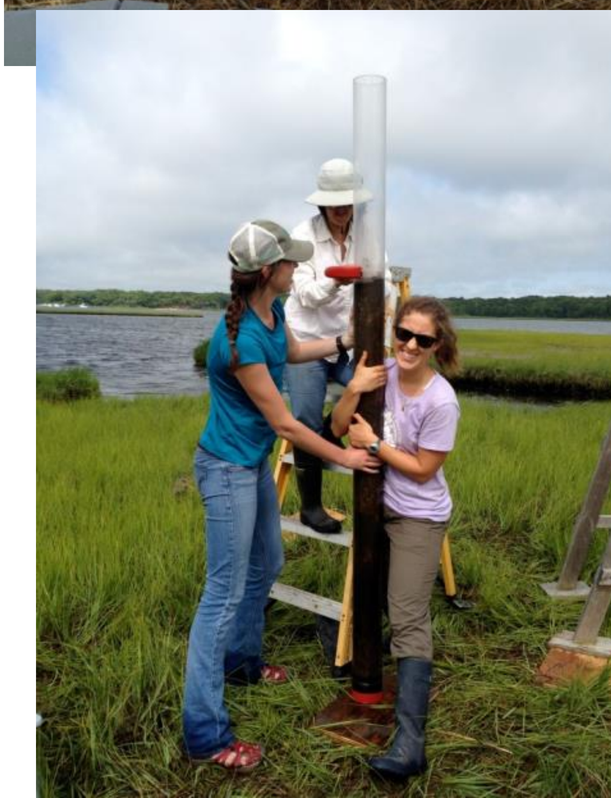
Concentration (c), mg/m^3:
-Sufficient vertical/lateral sampling
-

Total flux (u x A x c), mg/s



Biomass, Accretion, and Storage





What do you need to know to predict Carbon Storage

Light (PAR)

Air and Soil Temperature

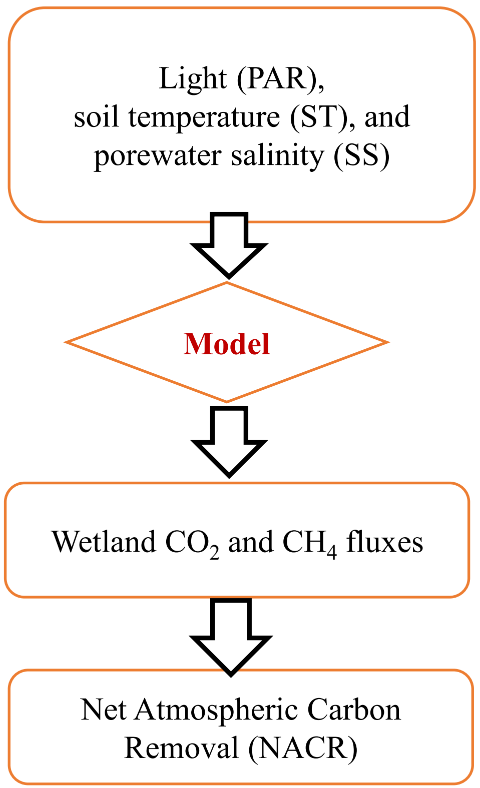
Salinity

Depth of Water

Habitat Type

Nitrogen

Degradation/Restoration



Division of Ecological Restoration

Blue Carbon Calculator:

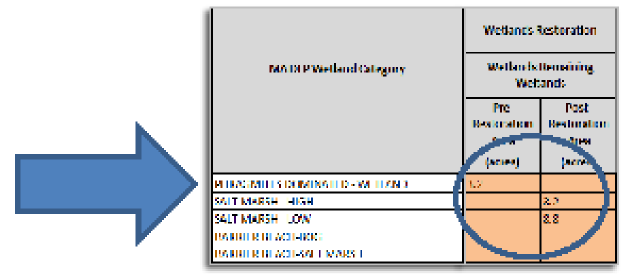
A Simple Methodology for Determining the Greenhouse Gas (GHG) Impact of Aquatic Ecological Restoration Projects

Coastal wetlands capture and bury carbon at high rates. This carbon is called blue carbon. Restored salt marshes are especially capable of sequestering blue carbon and reducing harmful methane emissions. The Blue Carbon Calculator is a first-generation tool to assess GHG impacts of aquatic ecological restoration projects, with a focus on coastal wetlands.

It's Simple!

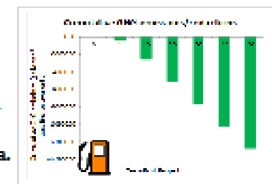
1. **Enter Expected Land Cover Changes**

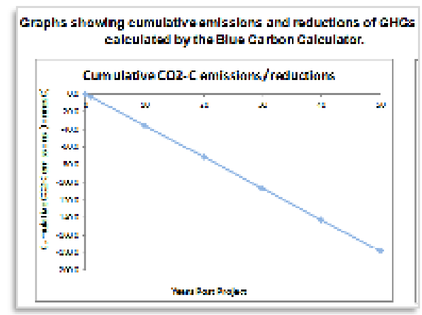
The user enters the land area for each type of land cover change resulting from a project.



2. **See the Green House Gas Budget**

Annual emissions resulting from each change in land cover are calculated based on internationally accepted data. Results appear on the "Calculator" worksheet.

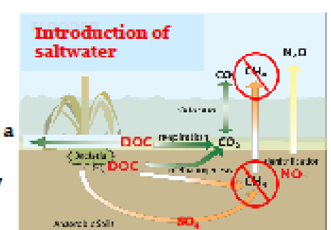




Damde Meadows, a salt marsh restoration in Hingham, has major blue carbon benefits equal to capturing 120,000 gallons of gas over 50 years.

How Does it Work?

As tides are restored, methane (CH_4) emissions decline as a site converts from a freshwater to a saltwater environment. Carbon is stored in the soils more readily under a healthy marsh condition.



Source: Figure adapted from http://cs.water.usgs.gov/projects/2009-05.html

Information derived from a contract with Abt Associates

For more information and to download the calculator visit: mass.gov/der

Bringing Wetlands to Market Methodology and guidance

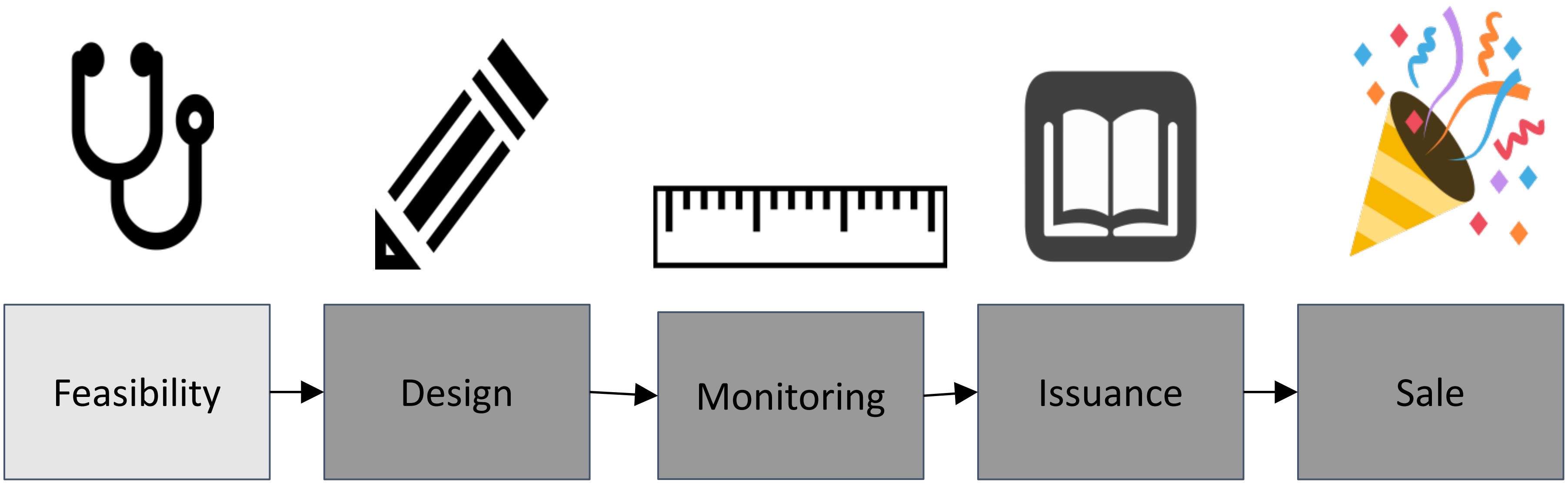
RAE:

- Tidal Wetland GHG Offset Methodology
- Guidance to parallel with methodology
- Outreach/ collaboration

$2.0 B

Market based payments for forest carbon since early 2000s

Carbon Project Cycle

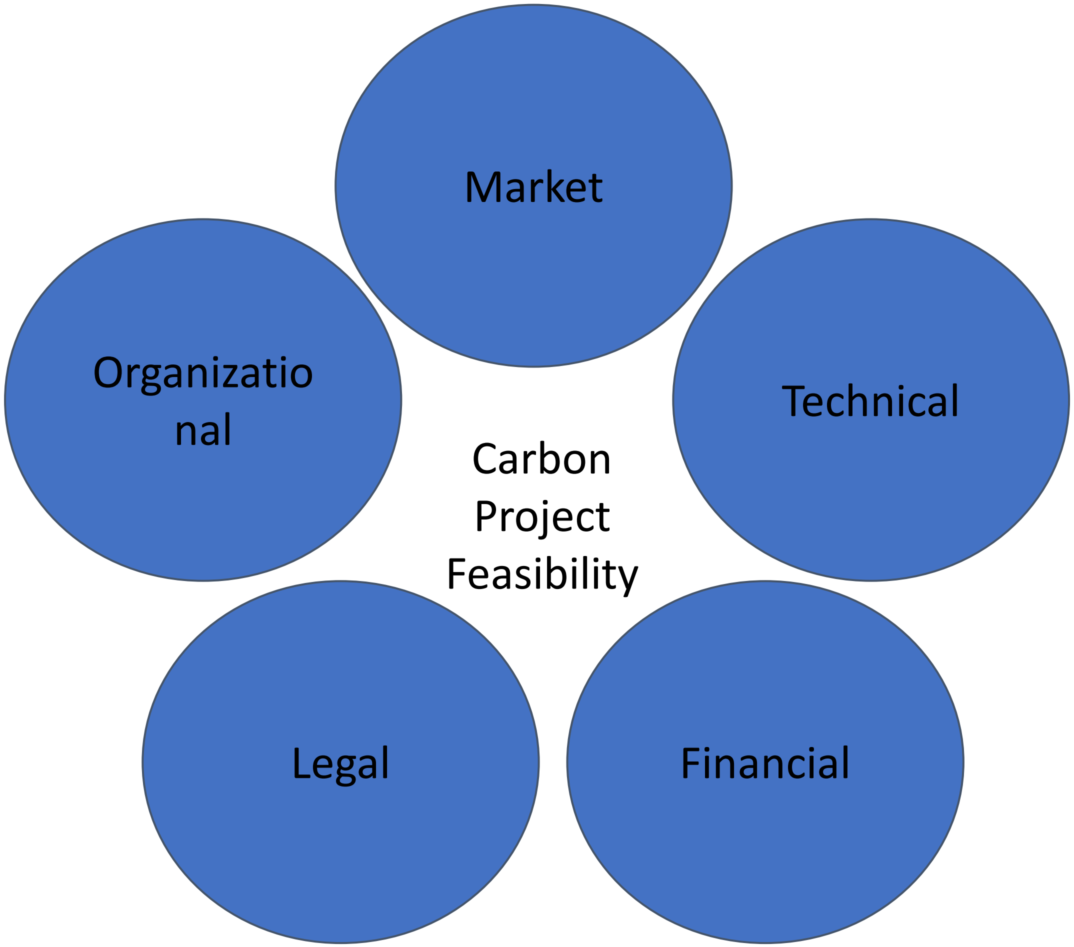


Objectives of Feasibility Study

Questions to answer:

1. What are the costs, benefits, risks, of developing a carbon project to help finance restoration of blue carbon ecosystem?
2. What is the opportunity to help finance broader restoration of similar ecosystems across the region?

Carbon Project Feasibility



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- Florida International University\West Virginia University– *Omar Abdul-Aziz*
- Manomet Center for Conservation Sciences – *Tom Walker*
- Restore America's Estuaries – *Steve Emmett-Mattox, Steve Crooks*
- *The Friends of Herring River*
- *Herring River Restoration Committee*
- Many state and local stakeholders
- NERRS Science Collaborative
- National Estuarine Research Reserve Association
- Waquoit Bay National Estuarine Research Reserve Staff

WBNERR Presentation

WAQUOIT BAY
NATIONAL
ESTUARINE
RESEARCH
RESERVE

Q&A

- Are stakeholders currently aware of wetland ecosystem services or financial incentives for conservation?
- Are there specific strategies for engagement and awareness building that would work best for our local landowners?

Kachemak Bay Research Reserve

NATIONAL ESTUARINE
RESEARCH RESERVE SYSTEM
SCIENCE COLLABORATIVE

Smithsonian Environmental
Research Center

WAQUOIT BAY
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Wrap up and Next Steps

July 18-20 Field Based Workshops