Herring River Restoration Project

"Return of the Tide"

Friends of Herring River

Annual Meeting

August 15, 2017

www.friendsofherringriver.org

Friends of Herring River Mission

Promote the restoration and environmental vitality of the Herring River Estuary

- Conduct public education, awareness and outreach activities
- Raise design and construction funds
- Administer grants and contracts

Agenda

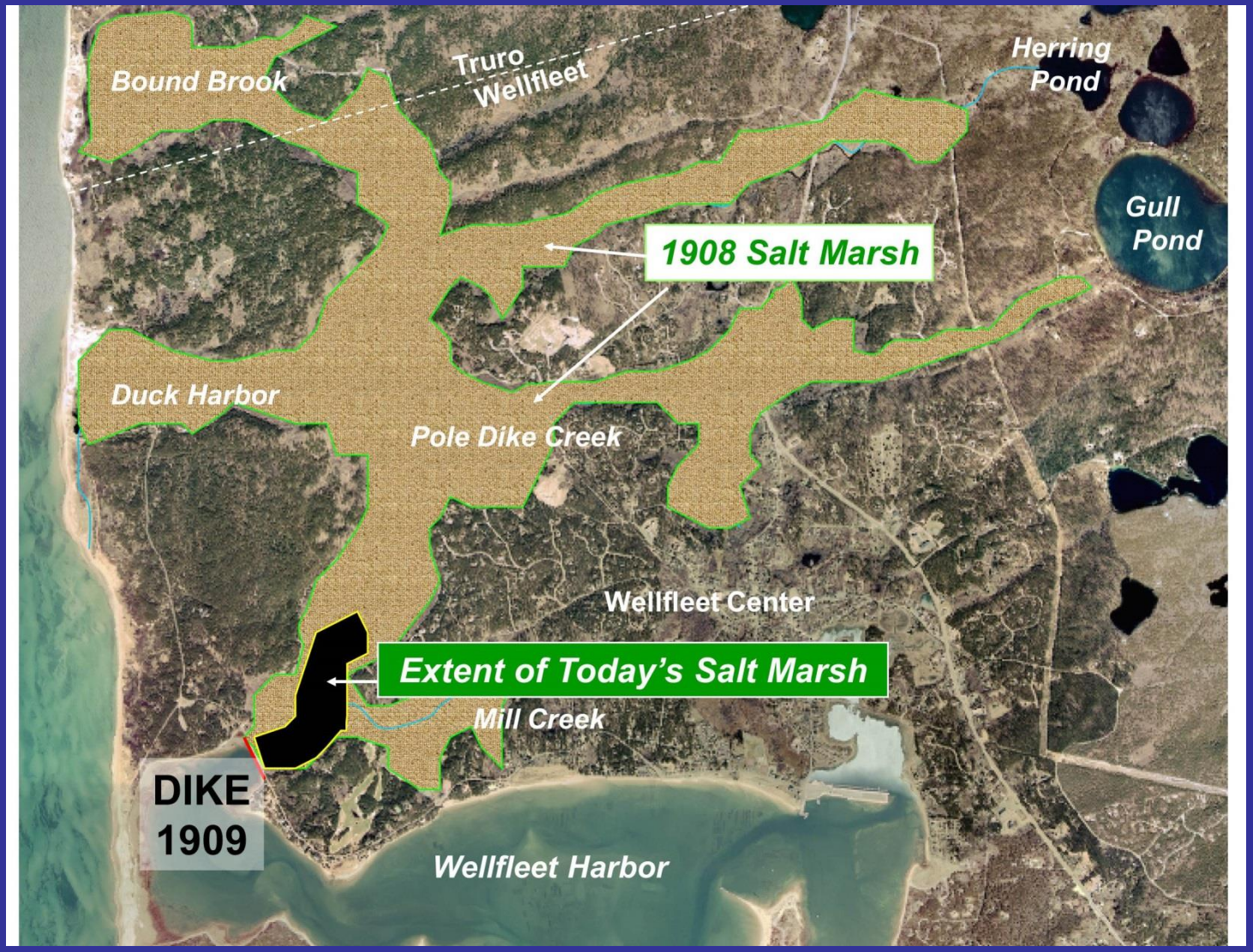
- Welcome
  - Introductions
  - Blue Carbon
- Where have we been?
  - Environmental Studies
  - Engineering and Design
- Where are we now?
  - Preparing permit applications
- Where are we going?
  - Obtain Permits
  - Fundraise

Restoring a Native Ecosystem

Herring River was once…

- a thriving 1,000-acre salt marsh that hosted a rich diversity of fish and wildlife
- an aquatic nursery for Cape Cod Bay and ocean waters
- a vibrant part of the local economy, supporting a large herring fishery

That all changed in 1909…



100+ Years of Tidal Restriction:

- Loss and subsidence of tidal marsh – and the habitat, aquatic nursery, storm protection and carbon storage it provides
- Degraded water quality
- Closure of shellfish beds due to contamination
- Impediments to river herring passage
- Increased mosquito nuisance

The Restoration Project

Objective:

- Restore self-sustaining coastal habitats

How:

- Remove existing restrictions in the river
- Return natural tidal flow

Why?

- Prevent ongoing degradation of the estuary
- Current dike is in poor condition
- Achieve ecological and social benefits

Benefits of Restoration

Restore coastal habitats:

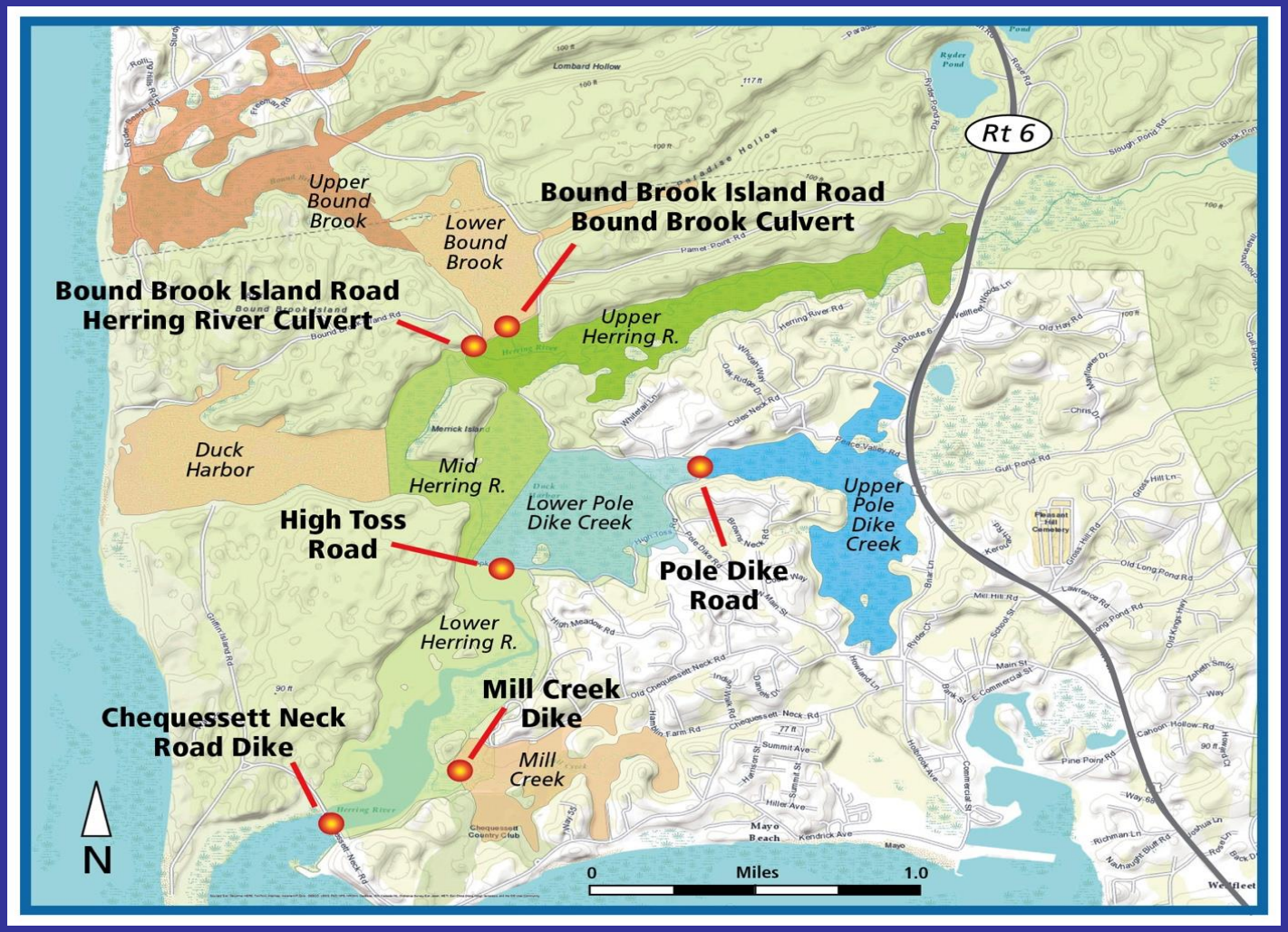
- Improve Water Quality
- Naturally Sustainable Salt Marsh Habitat
- 200+ Acres Clam and Oyster Habitat
- Habitat for Marine Species; Striped Bass, Winter Flounder, Diamond-back Terrapin
- Nursery for Near- and Off-Shore Marine Habitats
- 11+ Miles River Miles for River Herring
- Access to 160 Pond Acres for Spawning

Benefits of Restoration

Restore ecosystem services:

- Recreation: Boating, Hiking, Fishing
- Reduce Methane Emissions - Cs
- Natural Mosquito Control: Tidal Flushing of Breeding Areas, Larvae-eating Fish
- Managing Sea Level Rise
- Local Economy: shellfishing, recreation, spending

Major Projects



Supporting Organizations

- Association to Preserve Cape Cod
- Cape Cod Conservation District
- Cape Cod National Seashore *
- Coastal America Foundation
- Conservation Law Foundation
- Ducks Unlimited
- Friends of Cape Cod National Seashore
- Friends of Herring River
- Herring River Technical & Stakeholder Committees
- MA Audubon
- MA Bays Program
- MA Division of Ecological Restoration *
- MA Environmental Trust
- National Park Service
- Natural Resource Conservation Service *
- The Nature Conservancy
- National Oceanic & Atmospheric Administration *
- Town of Truro *
- US Geological Survey
- US Fish & Wildlife Service *
- Town of Wellfleet *
- Truro Conservation Trust
- Wellfleet Conservation Trust

*** Herring River Restoration Committee**

Next Steps

- Obtain local, state & federal permits
- Continue on-going work with owners of low-lying properties
- Secure project funding
- Final design & construction bids
- Begin construction (est. 2020)

Blue Carbon

"The term blue carbon, while not a common term, is simply the carbon captured by the world's ocean and coastal ecosystems."

Dr. Kevin Kroeger. PhD, Research Biogeochemist, United States Geological Service, Woods Hole Oceanographic Institute

Blue Carbon in the Herring River: Can We Reduce Greenhouse Gas Emissions through Wetland Restoration?

Kevin D. Kroeger
USGS Woods Hole Coastal & Marine Science Center

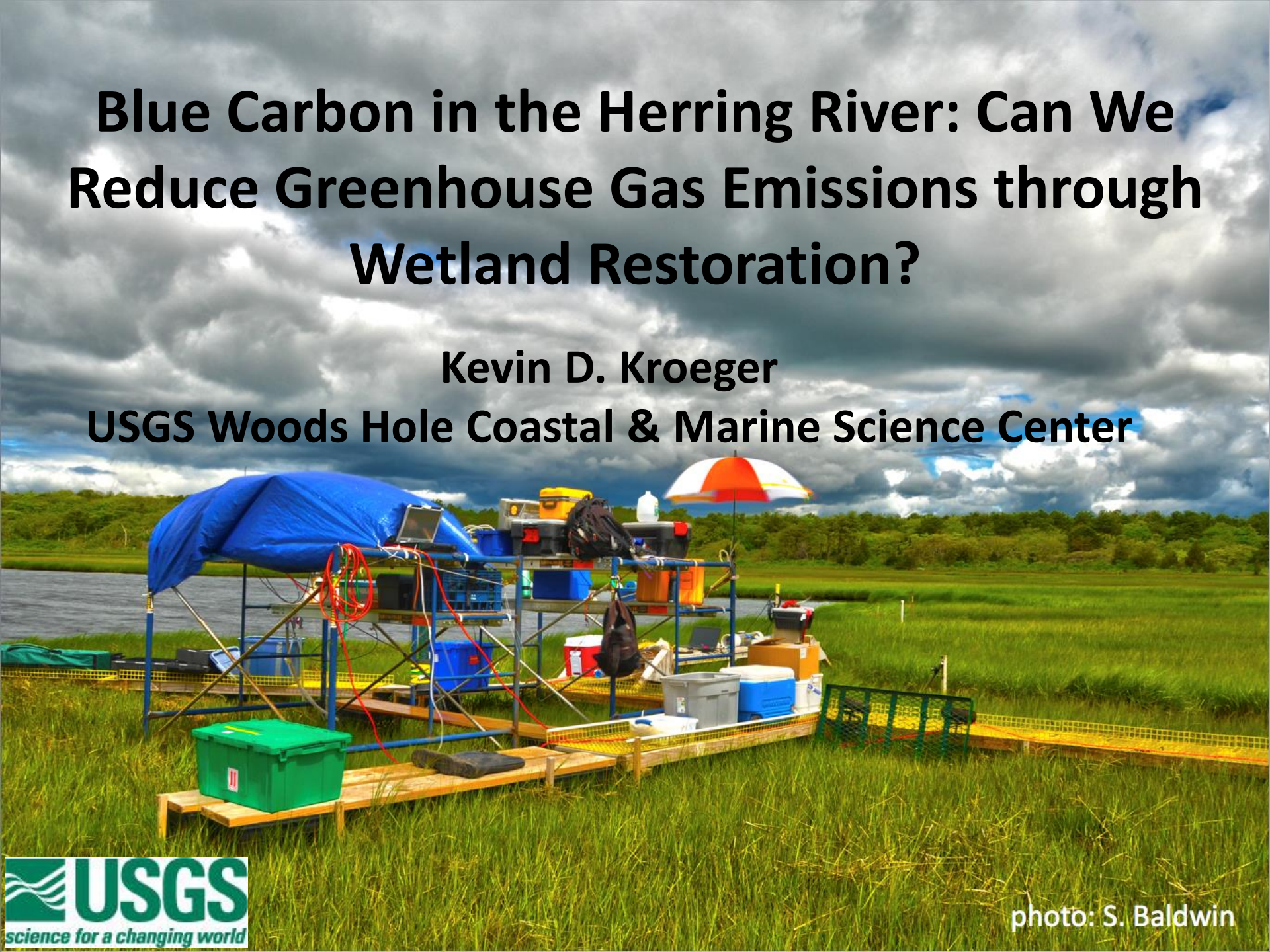


photo: S. Baldwin

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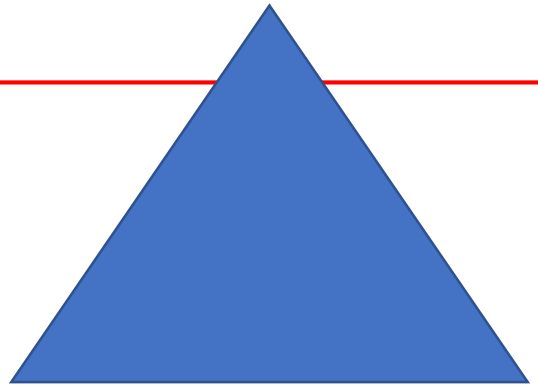
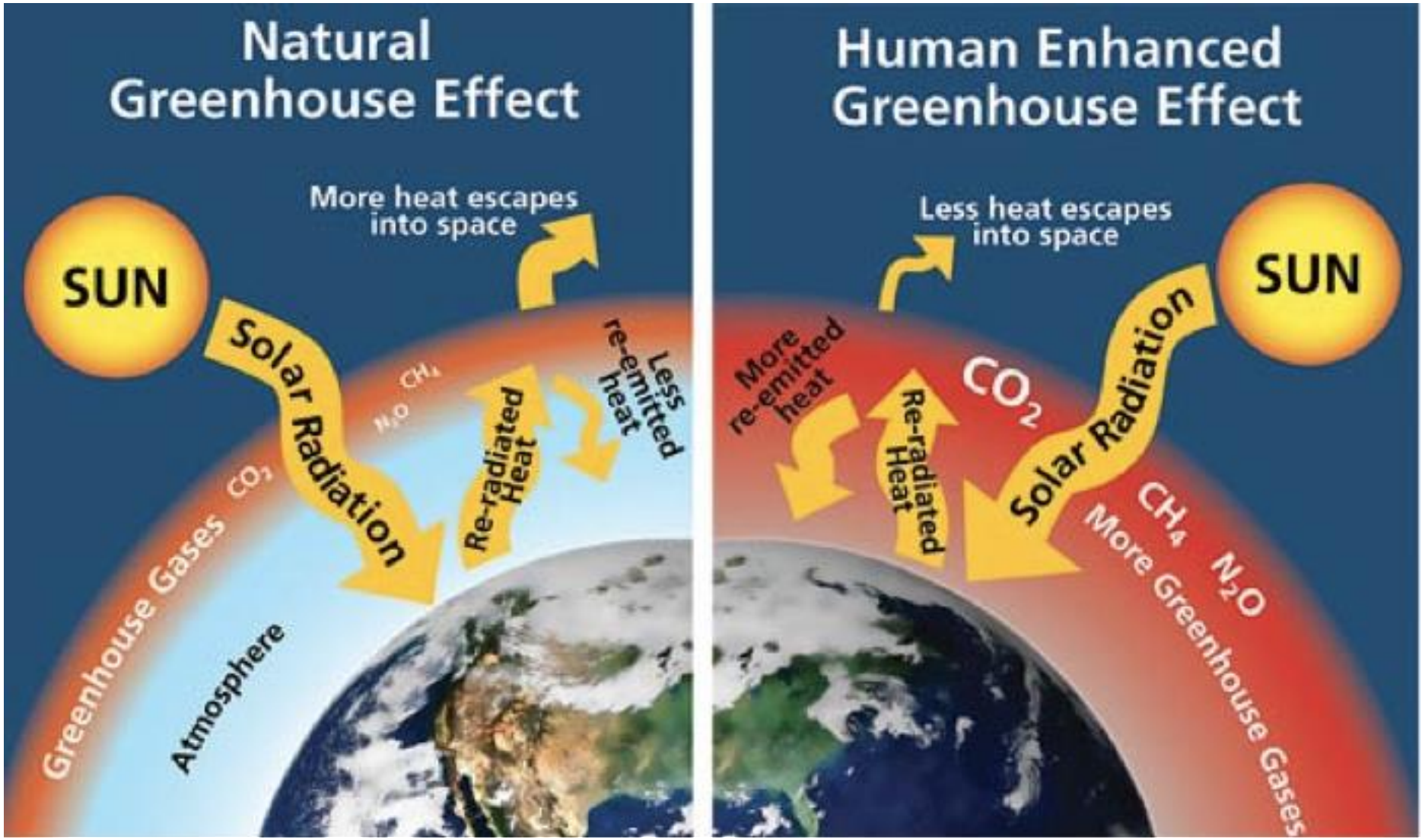
Bottom line, provocative conclusions:

- For several centuries it has been widespread practice to both impound and drain coastal wetlands.
- Those altered wetlands produce substantial CH_4 and CO_2 emissions, equivalent to emissions from millions of automobiles.
- At present, there are no incentives to reduce those emissions, and so the situation is analogous to setting thousands of fires, allowing them to burn for decades to centuries, and then ignoring them in our attempts to reduce emissions.
- Inventorying the emissions and crediting reduction in the emissions can incentivize a new and potent method for emissions reduction.

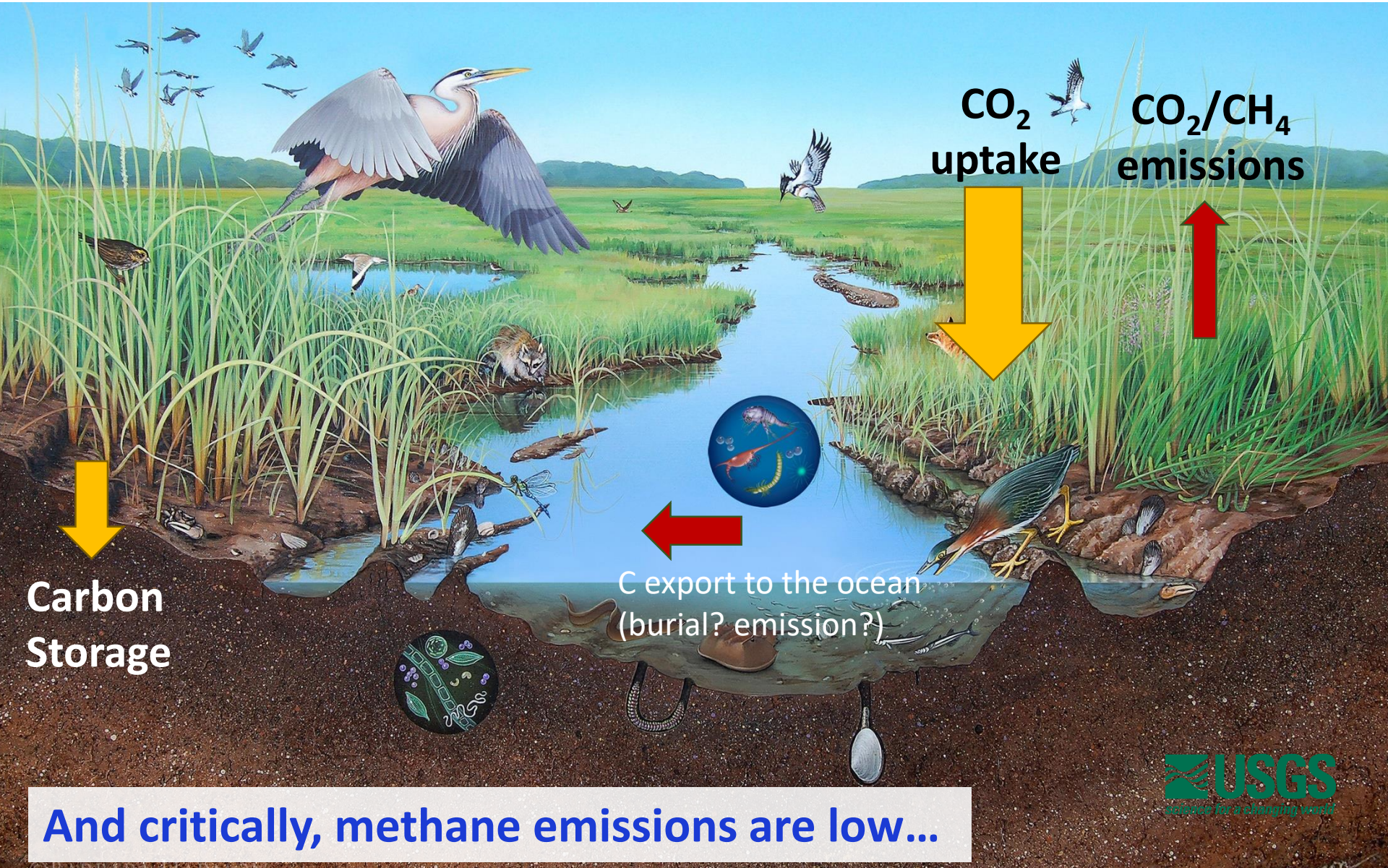


The Rest of the Story

Increasing concentrations of greenhouse gases, primarily carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) cause an increase in the amount of heat trapped in the atmosphere.



How do salt marshes interact with climate? Salt marsh plants remove carbon dioxide from the atmosphere. Some of the carbon is stored for centuries as soil carbon.



And critically, methane emissions are low…

Why do marshes store so much carbon? They grow upward every year at about the same rate as sea level rise, roughly ¼ inch. The soil is composed of plant roots and trapped sediment, and so as the grow upward, they build large carbon stores over many centuries, keeping CO_2 out of the atmosphere:

This is an "Ecosystem Service" referred to as "Blue Carbon"

Photos M. Gonneea

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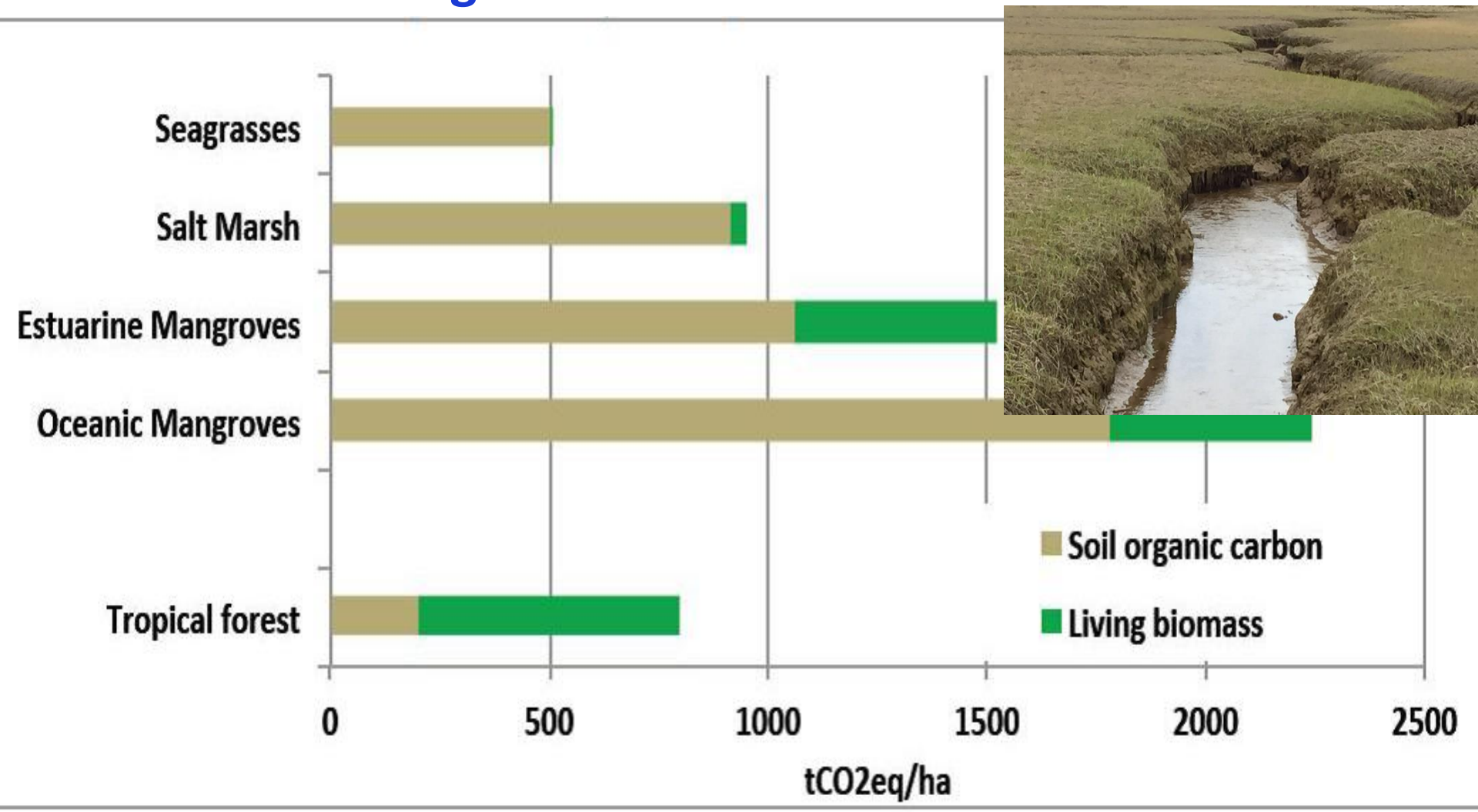
And they build large carbon stores, compared to forests. This has led to the idea that we can protect and restore wetlands with a goal to store carbon.



Carbon Stocks (tonnes CO_2equivalents per hectare)

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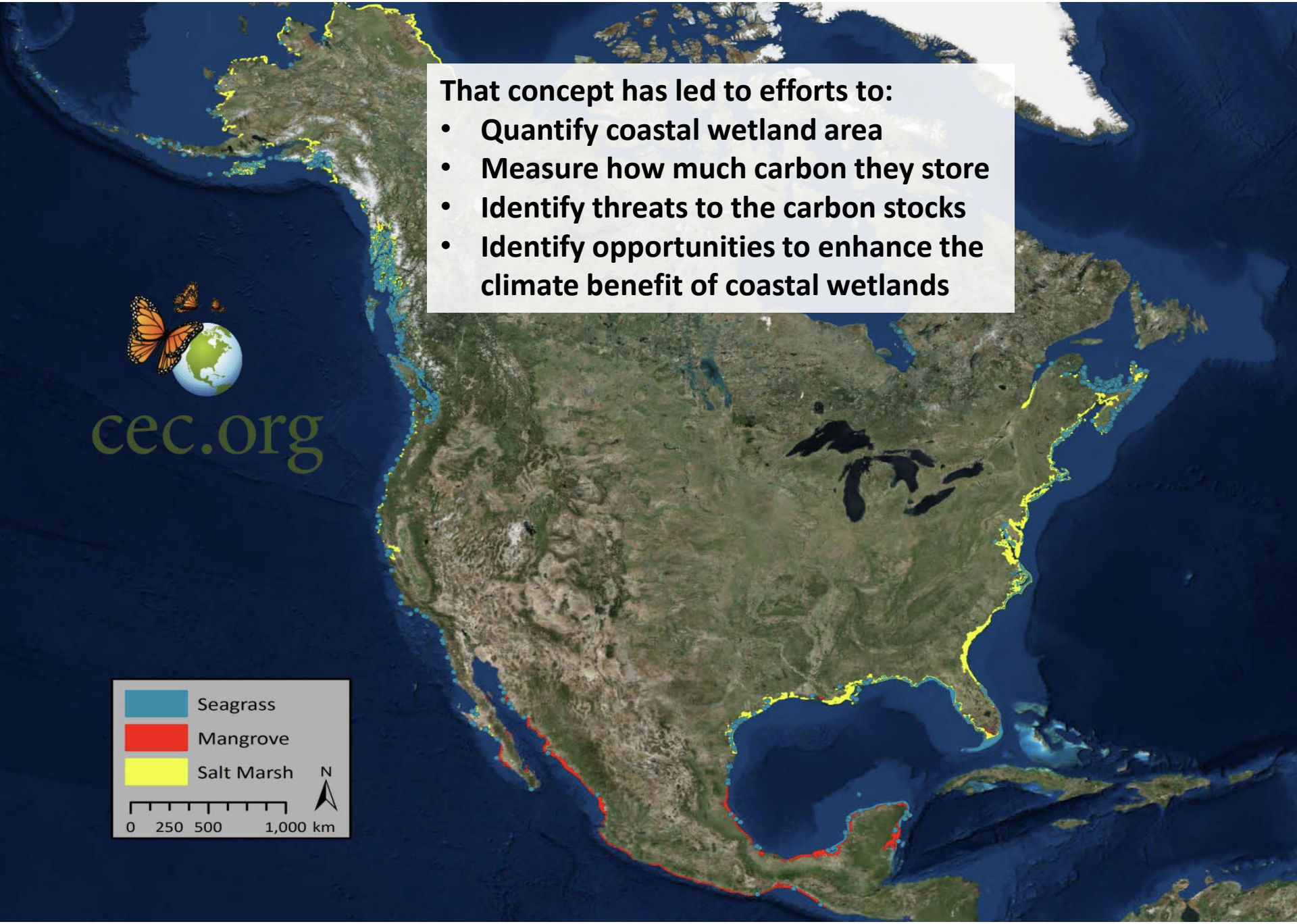
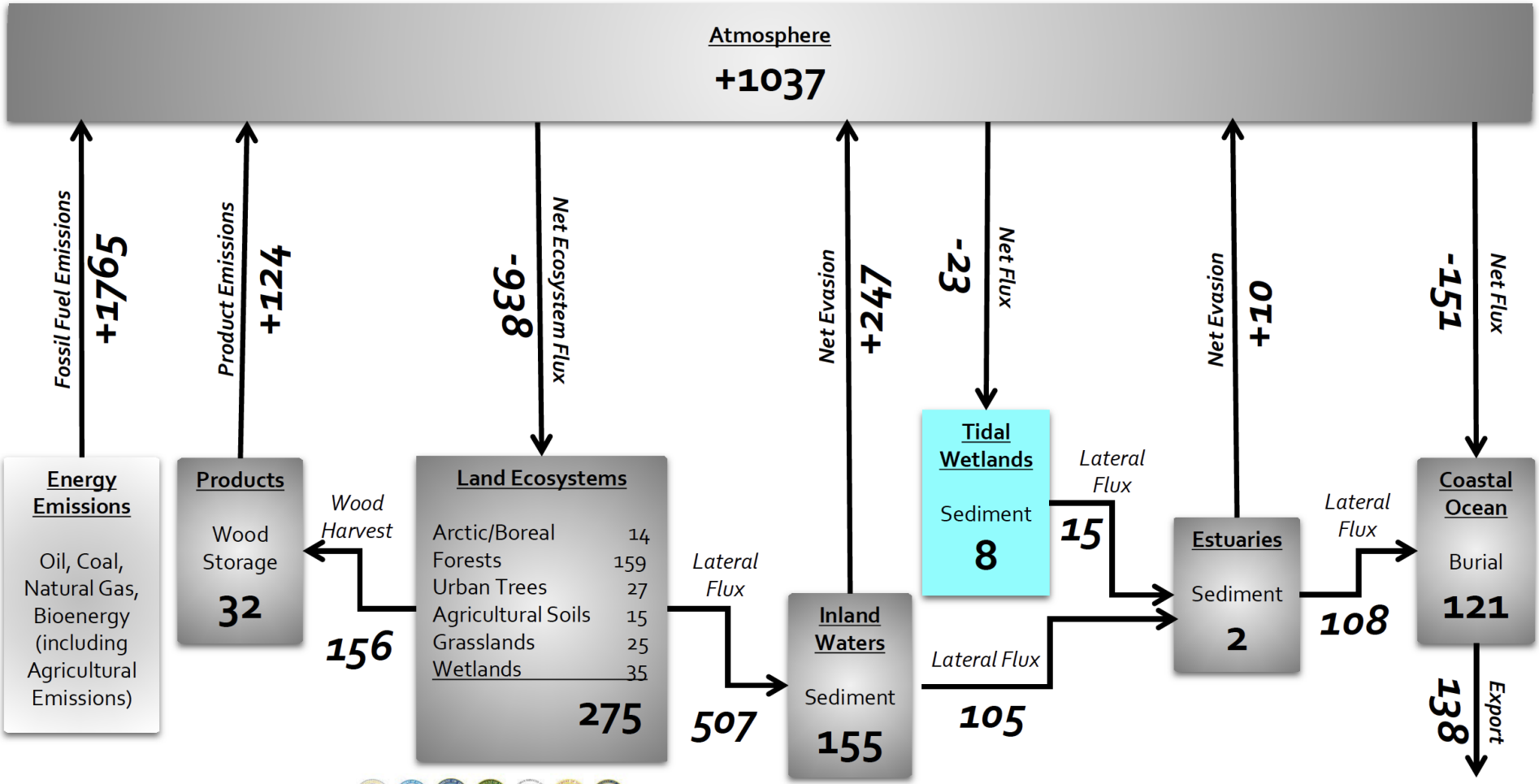


That concept has led to efforts to:

- **Quantify coastal wetland area**
- **Measure how much carbon they store**
- **Identify threats to the carbon stocks**
- **Identify opportunities to enhance the climate benefit of coastal wetlands**

SOCCR-2: Coastal zones are net sinks of carbon

Tidal wetlands are small but significant sinks



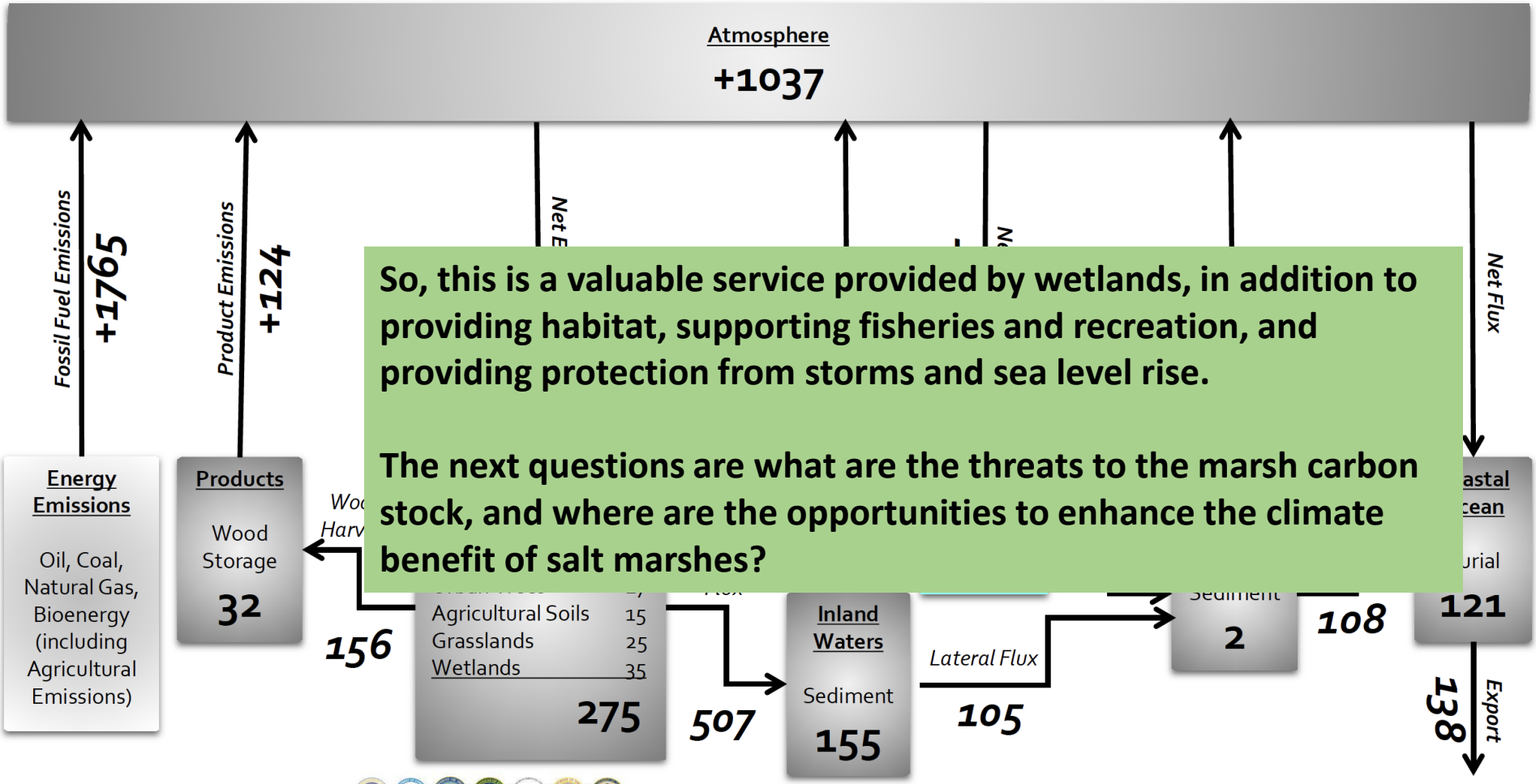
globalchange.gov
U.S. Global Change Research Program

Slide from Lisa Windham-Myers

CO_2 uptake equivalent to ~1.3% of national fossil fuel emissions; Or equivalent to emissions from 640,000 automobiles.

SOCCR-2: Coastal zones are net sinks of carbon

Tidal wetlands are small but significant sinks



So, this is a valuable service provided by wetlands, in addition to providing habitat, supporting fisheries and recreation, and providing protection from storms and sea level rise.

The next questions are what are the threats to the marsh carbon stock, and where are the opportunities to enhance the climate benefit of salt marshes?

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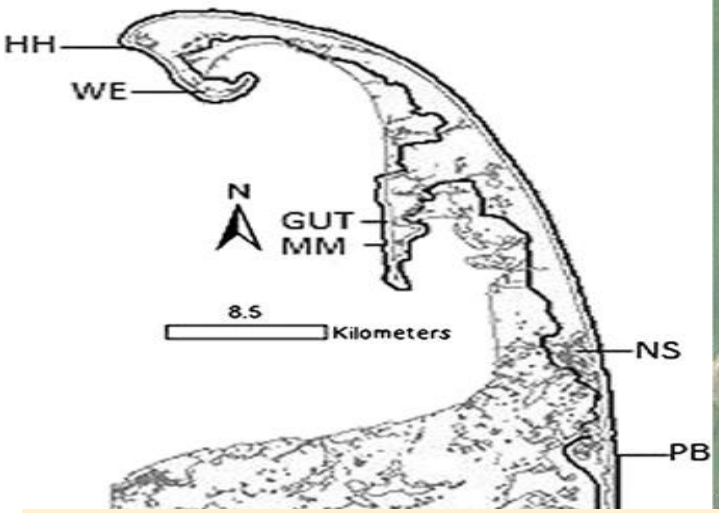
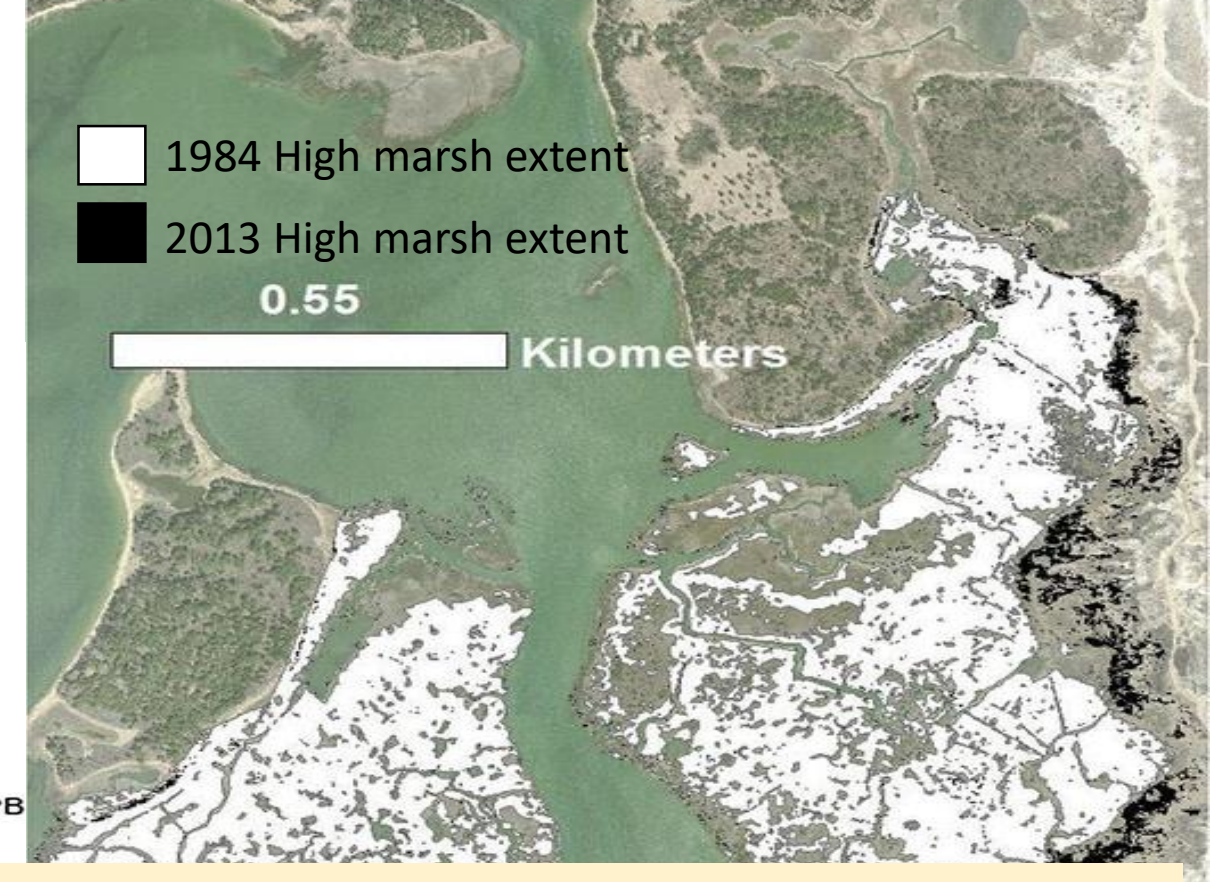
Slide from Lisa Windham-Myers

CO_2 uptake equivalent to ~1.3% of national fossil fuel emissions; Or equivalent to emissions from 640,000 automobiles.

Pleasant Bay (PB)

From: Smith, NPS/CCNS (2015) Wetlands 35: 127-136

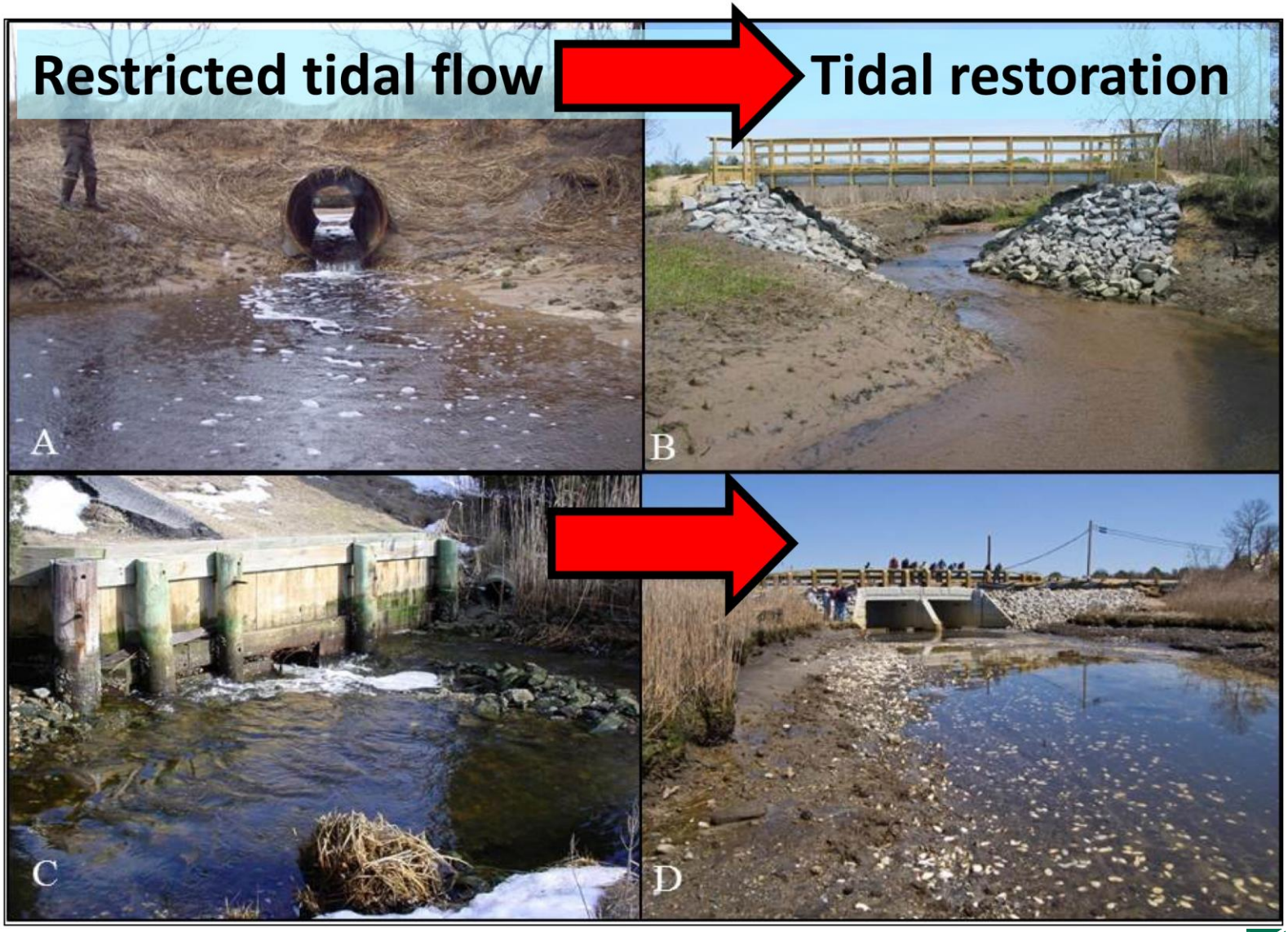




- **In the past, the greatest threats were filling, drainage and impoundment, and those actions have altered or eliminated roughly half of U.S. pre-colonial marshes.**
- **Inundation and erosion due to accelerating sea level rise are likely the greatest current and future threats to salt marshes.**
- **Transition from high to low marsh is widespread in recent decades. And it may be a precursor to drowning/conversion to open water.**
- **There is uncertainty about whether the marshes will be able to keep up with sea level rise. And it is not known what will happen to the carbon already stored in marsh soils as they erode and inundate: Risk of a major new emission.**

What about opportunities to protect or restore marshes and their carbon sink? Typically, people have in mind wetland conservation or creation…

But to some people “wetland restoration” means something else…



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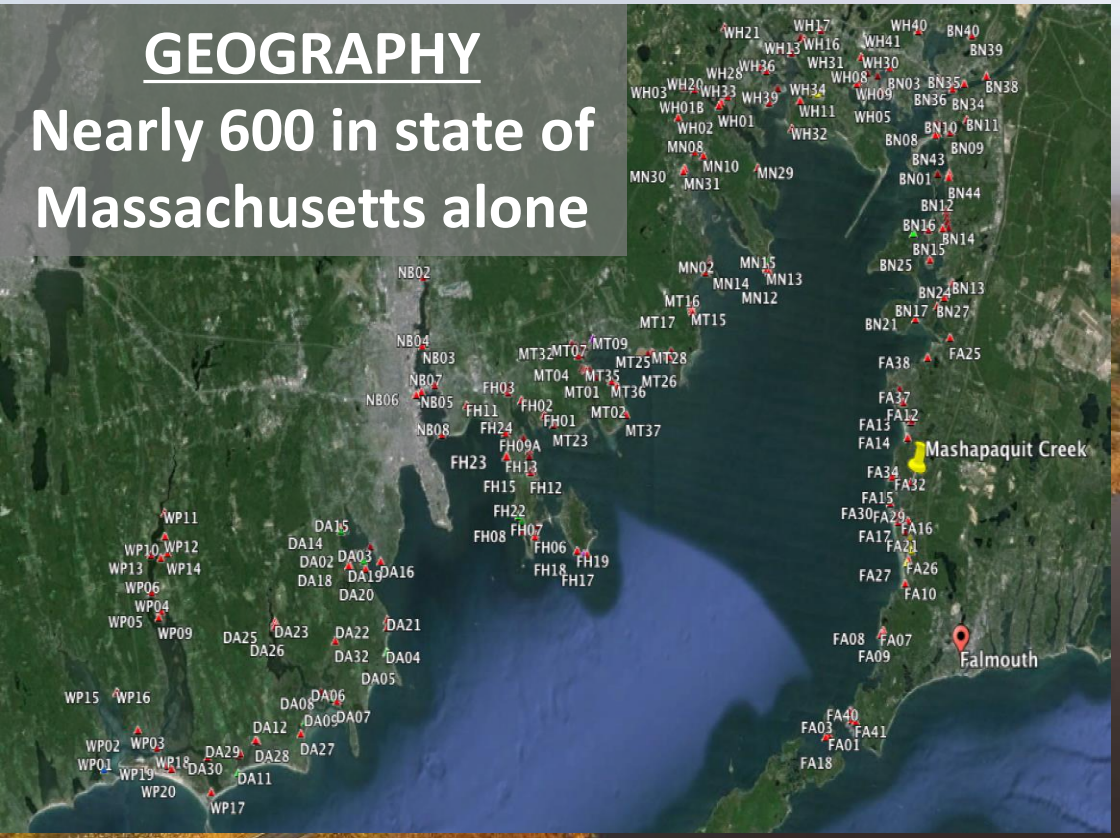
At first tidal restriction and restoration seemed irrelevant to our investigation of carbon storage in wetlands. But then we realized there might be important changes in greenhouse gas exchanges with the atmosphere…

Identified Tidal Restrictions in Buzzards Bay, Mass

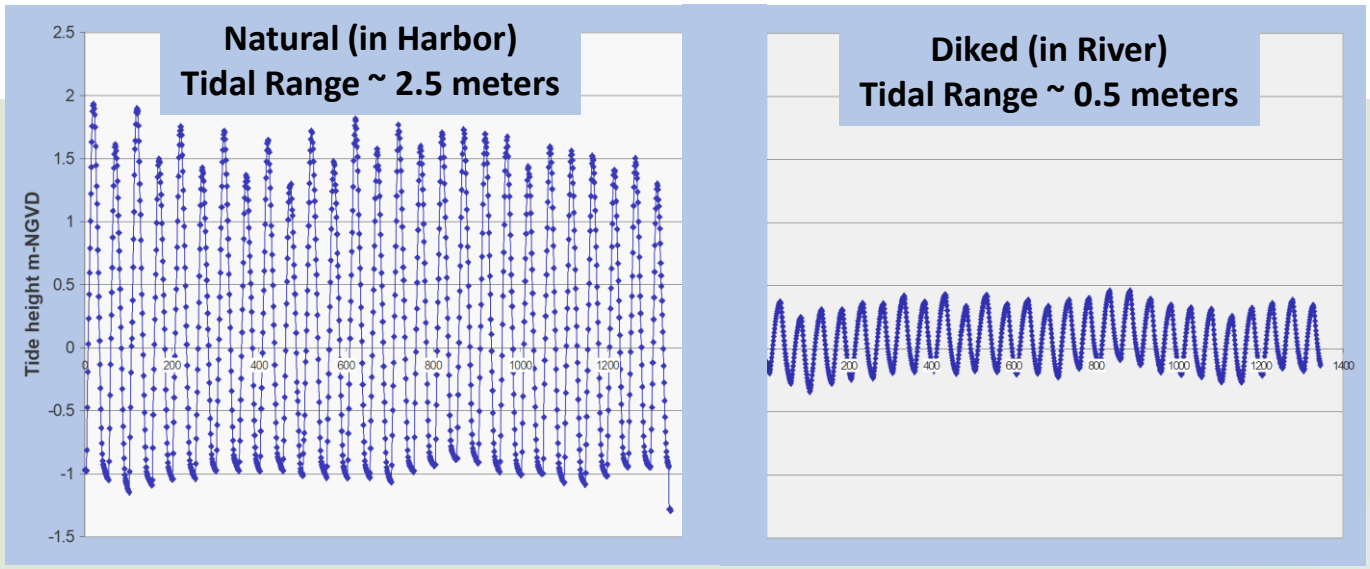
GEOGRAPHY

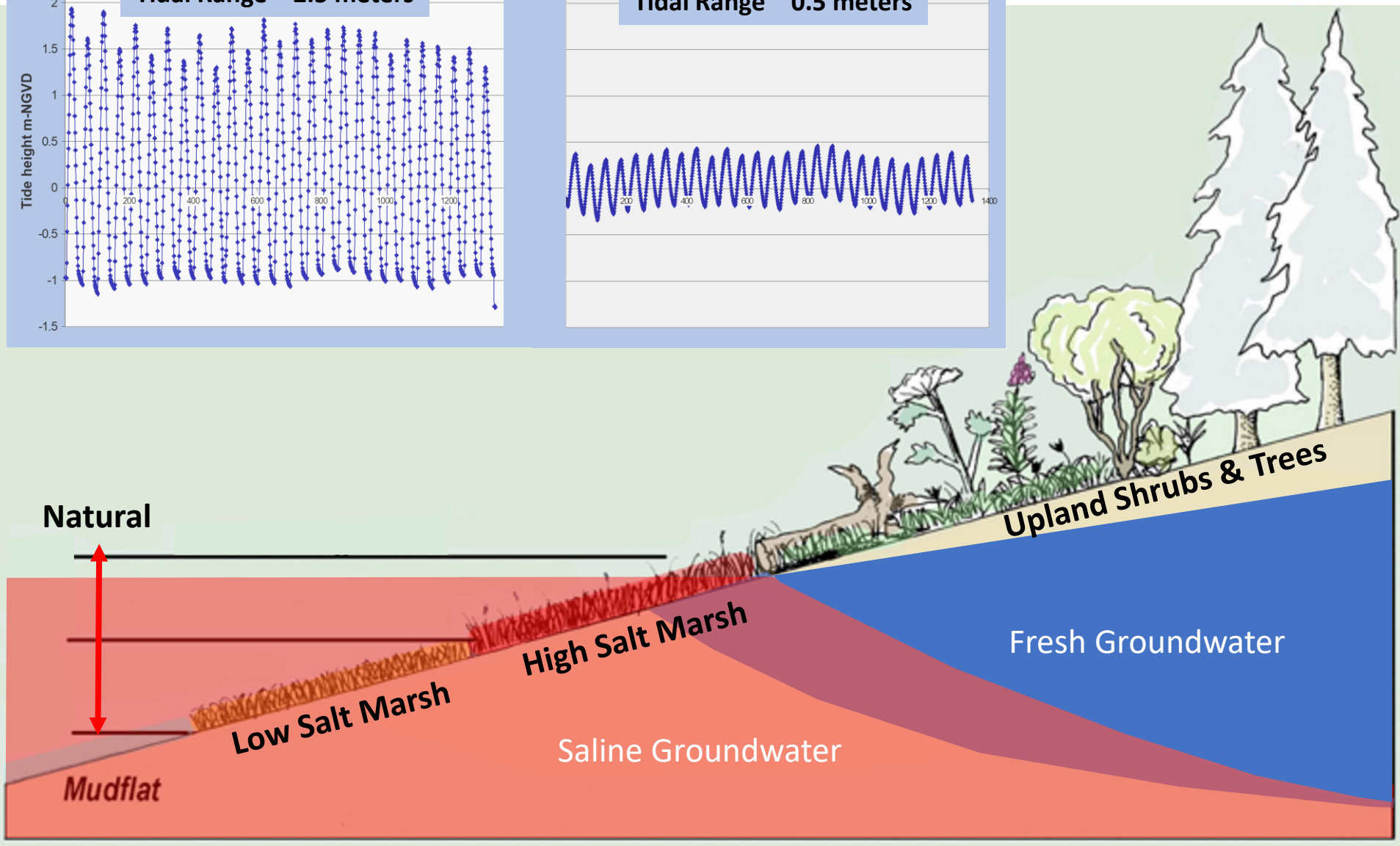
Nearly 600 in state of Massachusetts alone



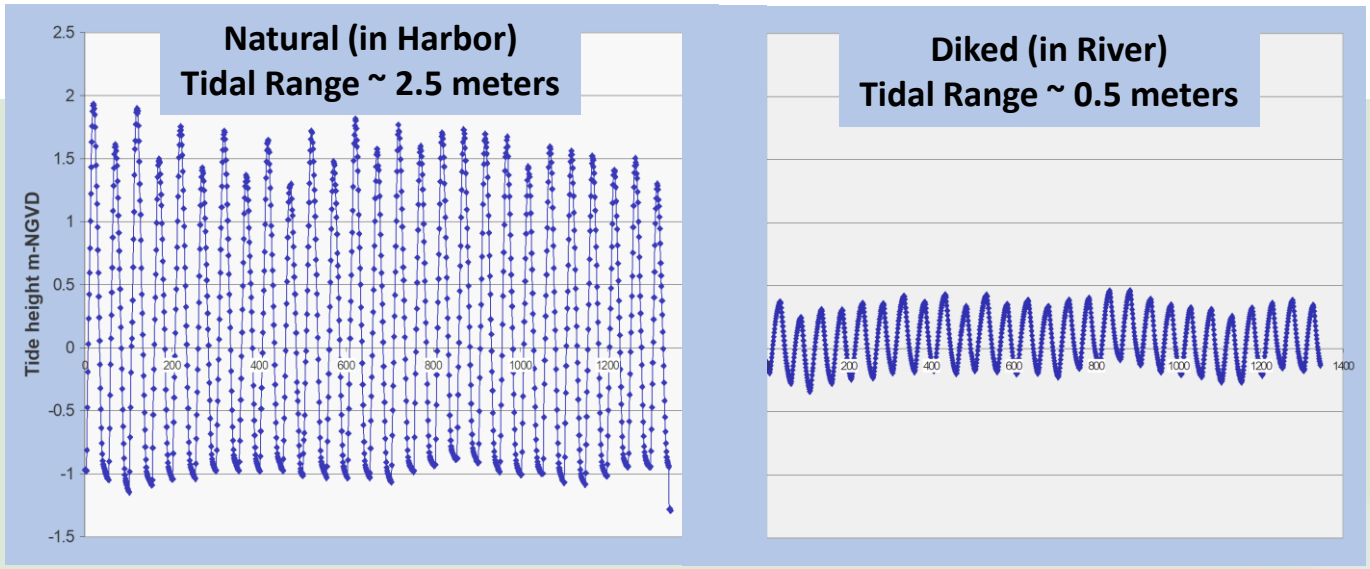
And, if so, then it's important because, it turns out, there are lots of tidal restrictions, everywhere you look.

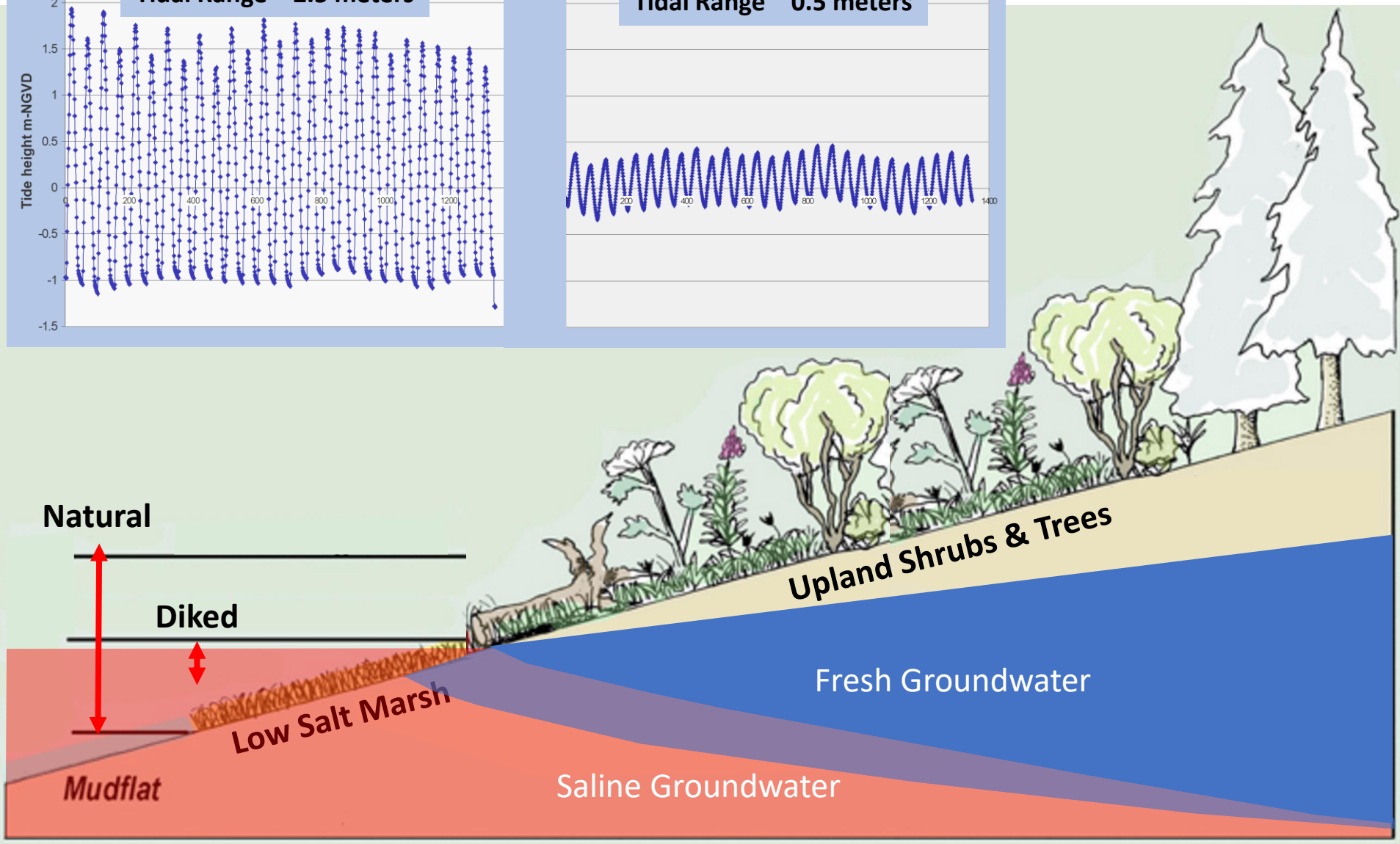
Changes in water flows cascade through entire ecosystem





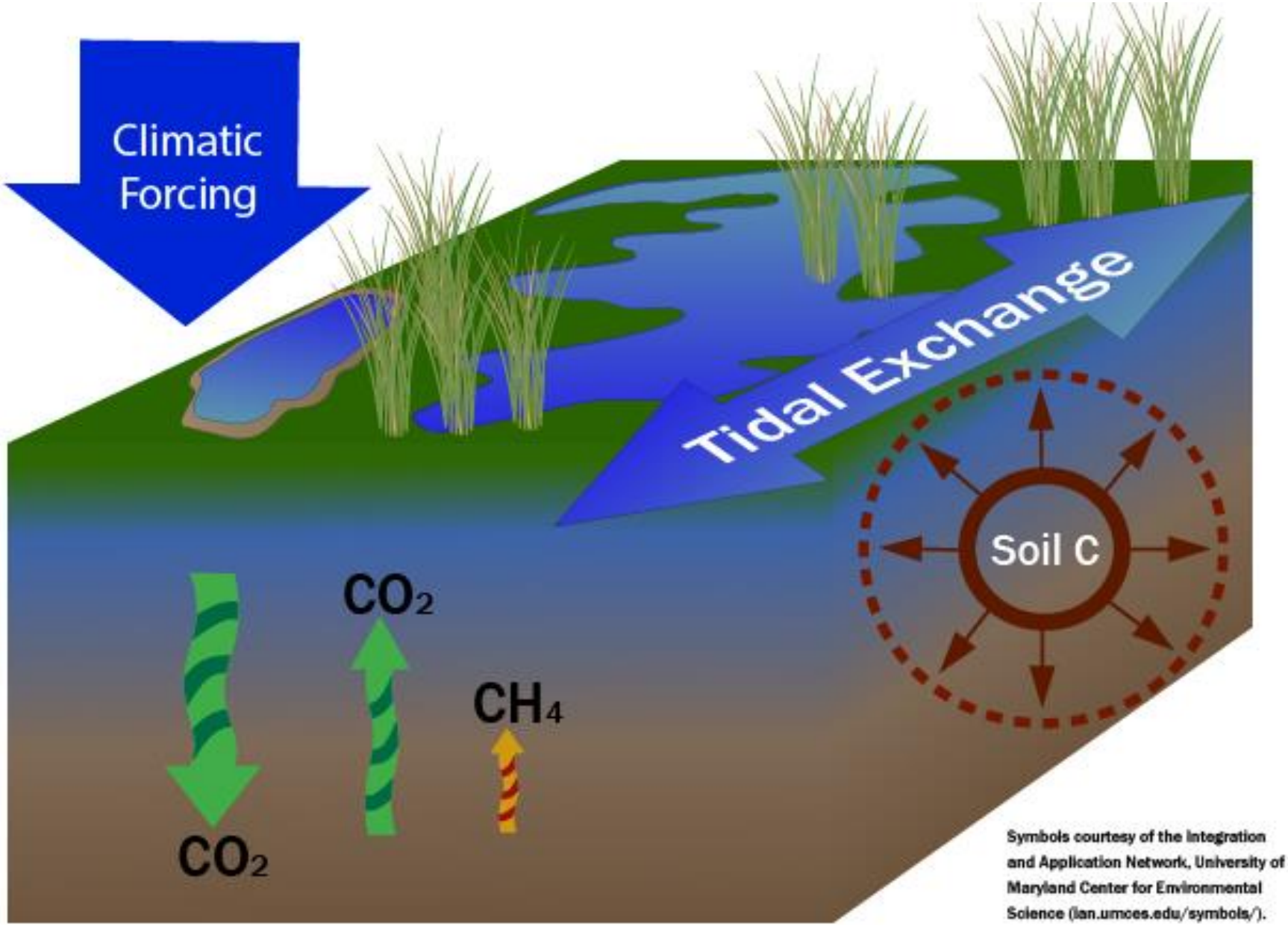
With the tide blocked, wetlands may be drained or impounded…



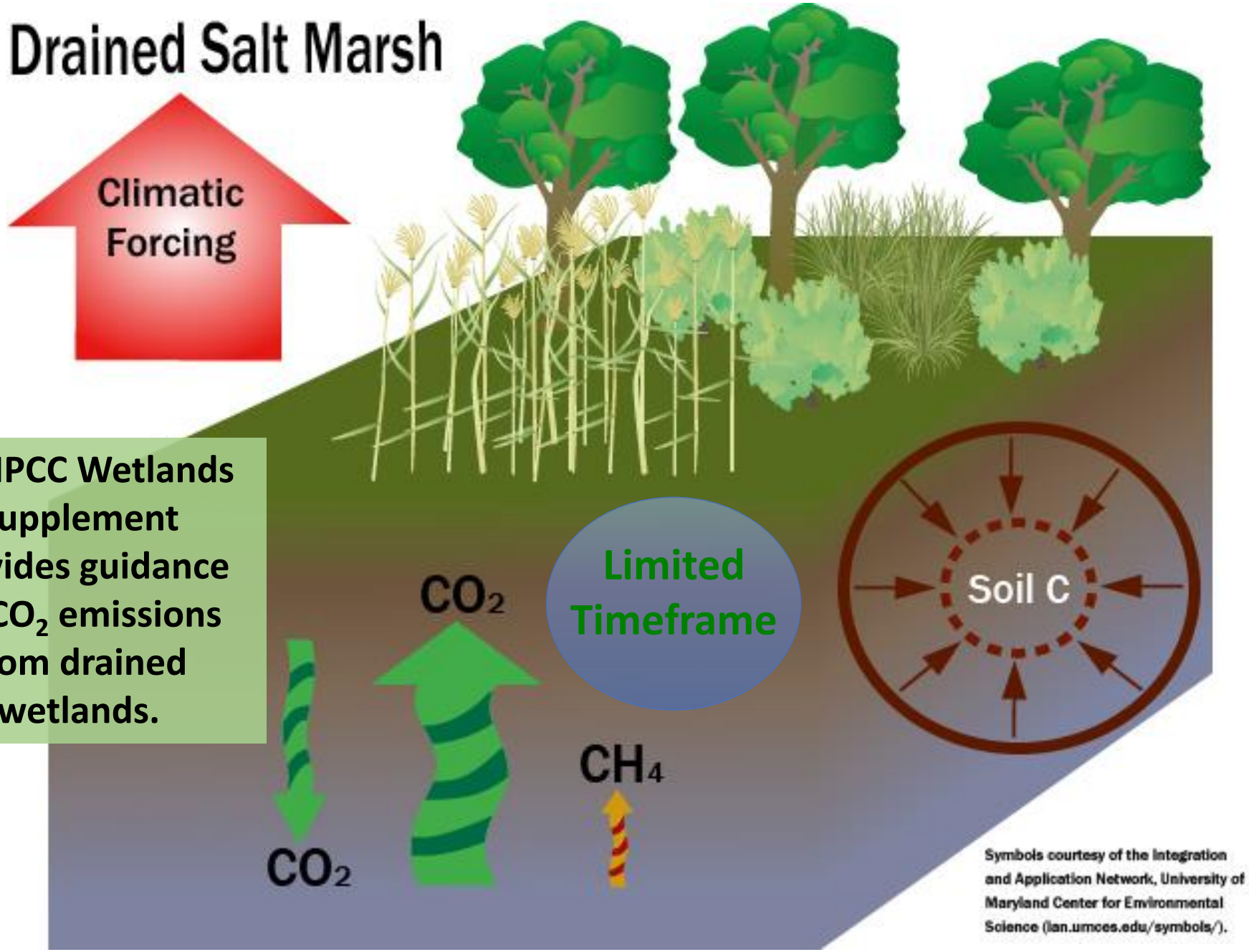


- **What do drainage and impoundment mean for greenhouse gas emissions?**

Salt Marsh with Natural or Restored Tidal Flow



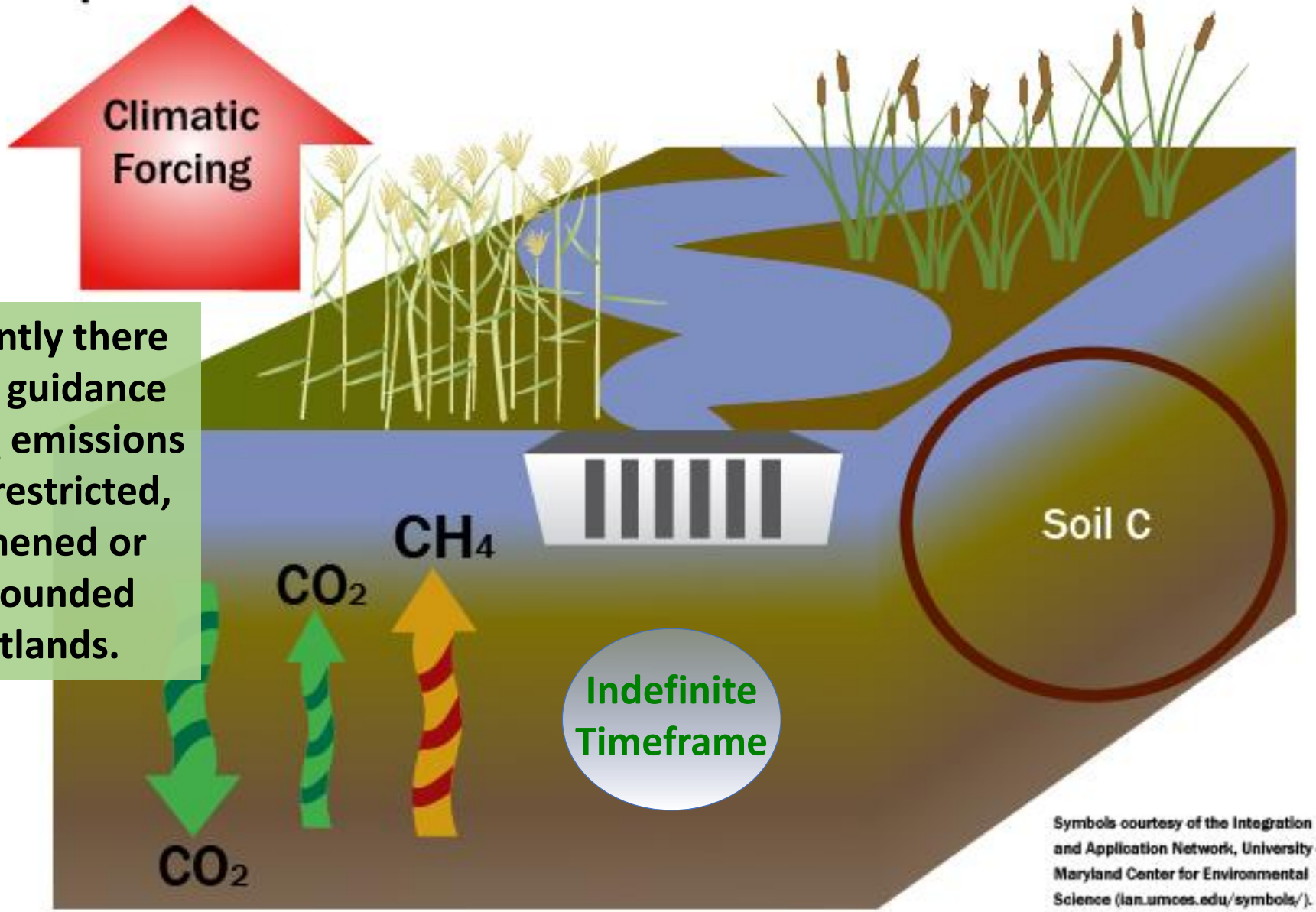
Graphics, Jennifer O'Keefe Suttles



The IPCC Wetlands Supplement provides guidance on CO_2 emissions from drained wetlands.

Graphics, Jennifer O'Keefe Suttles

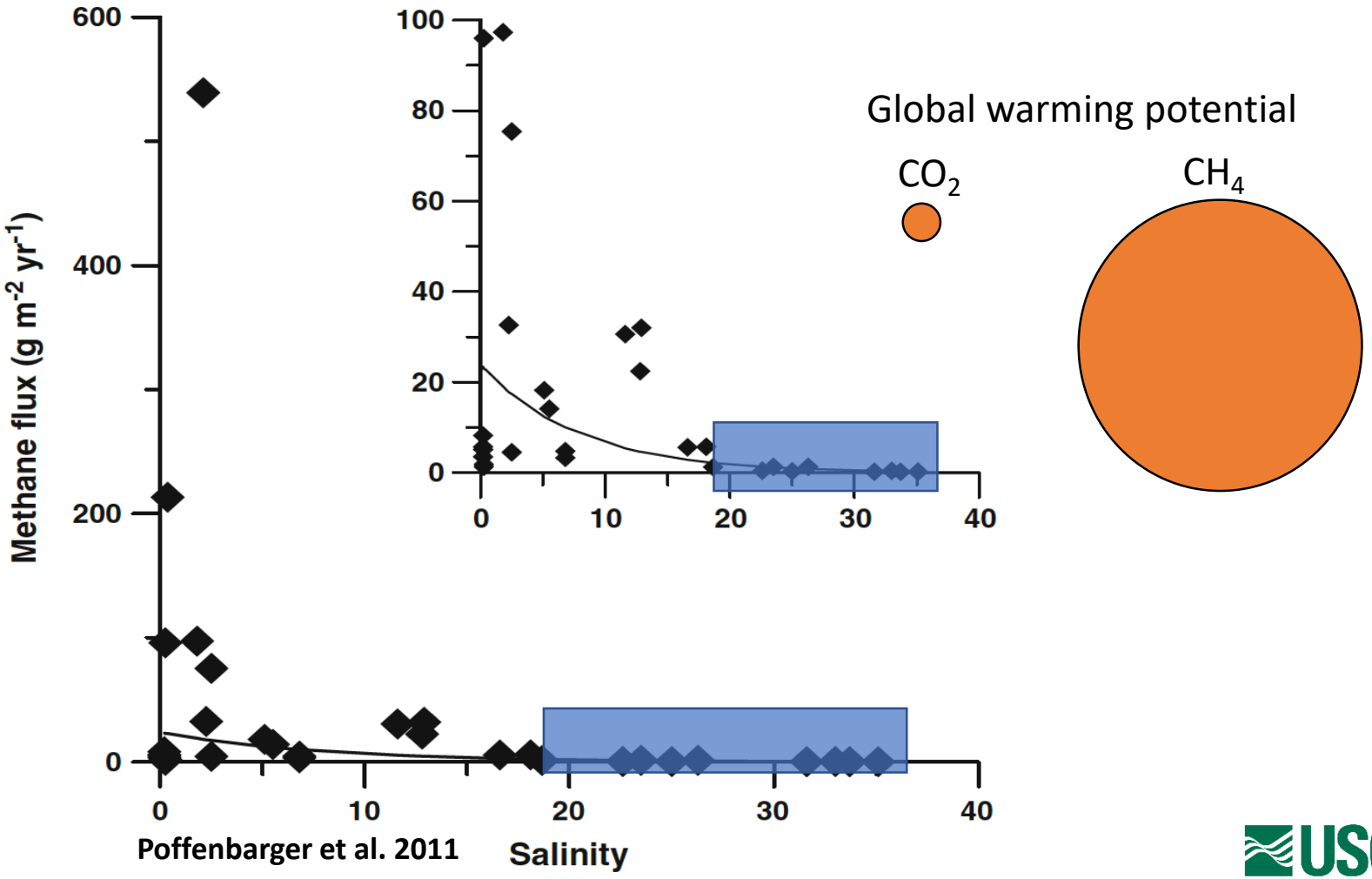
Impounded Salt Marsh With Restricted Tidal Flow



Presently there is not guidance on CH_4 emissions from restricted, freshened or impounded wetlands.

Graphics, Jennifer O'Keefe Suttles

Methane emissions are typically very low at higher salinity, but if we cause freshening by impounding fresh water, in many cases methane emissions are likely to increase.



Poffenbarger et al. 2011

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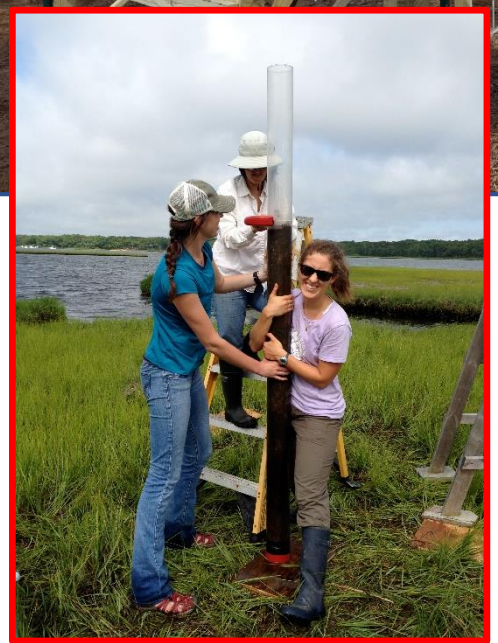
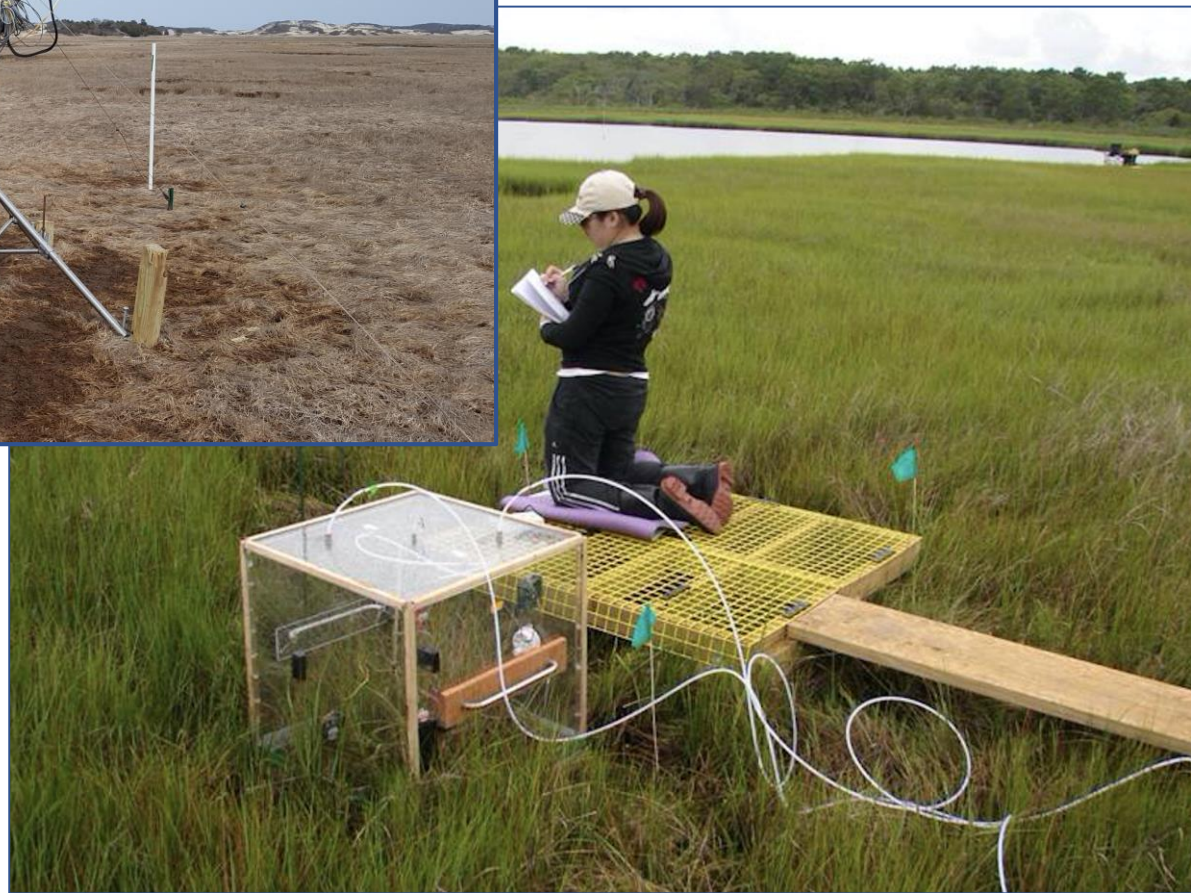
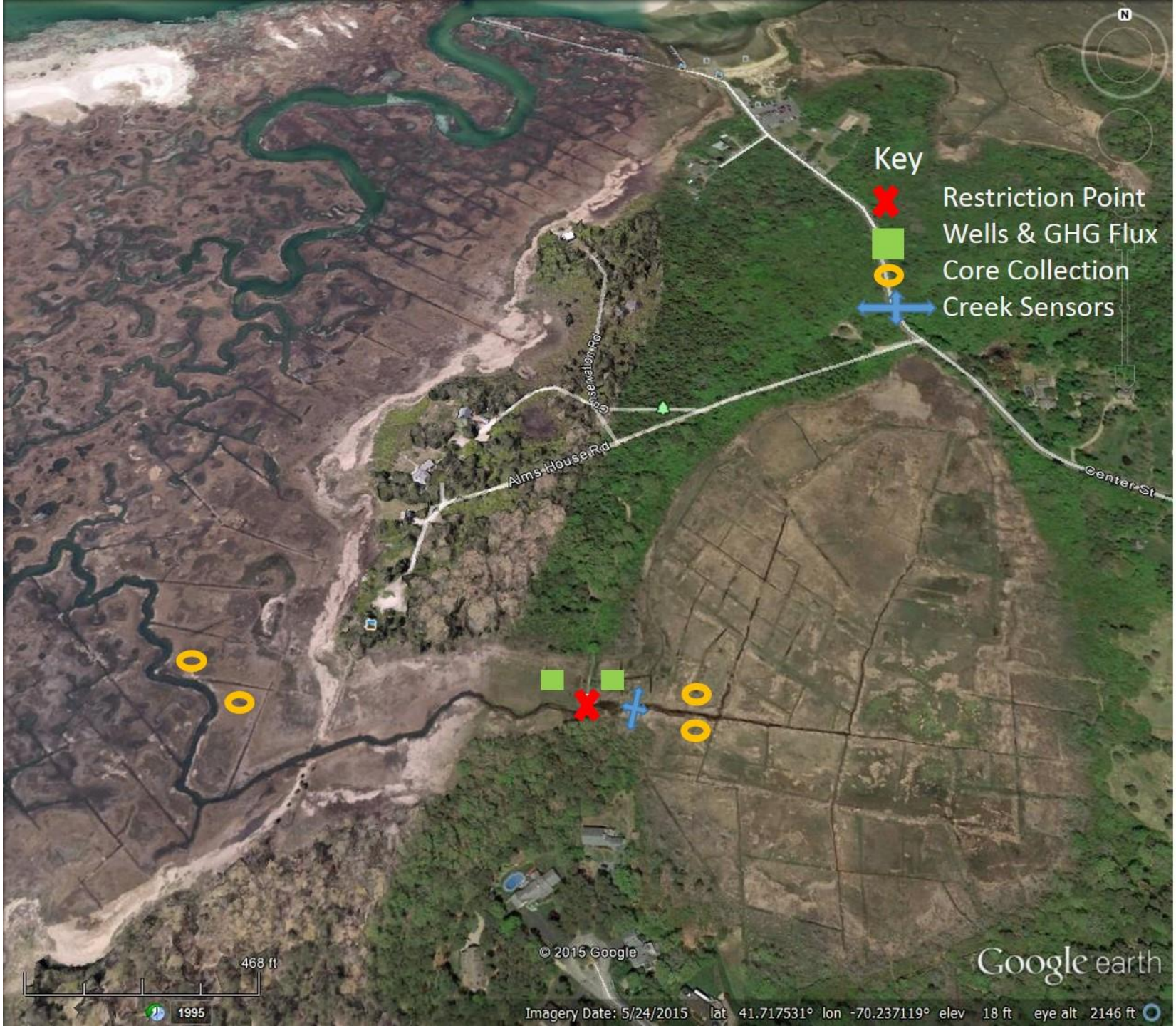
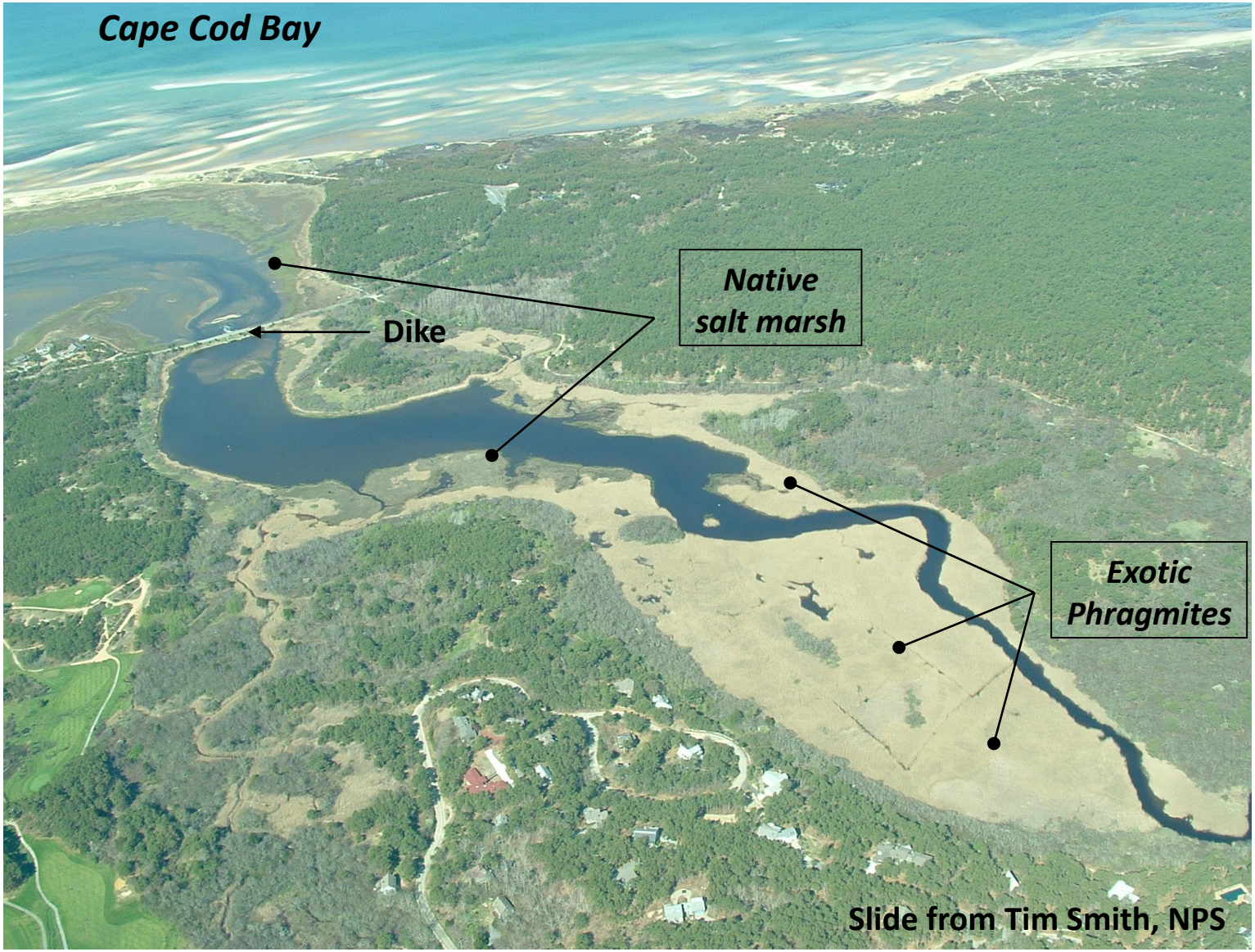
To answer the questions about the effects of tidal restriction and restoration on carbon dioxide uptake or emission, and changes in methane emissions, we are measuring gas fluxes, changes in soil carbon, and transport of carbon in water in a series of tidally-restricted and restored sites along Cape Cod Bay.





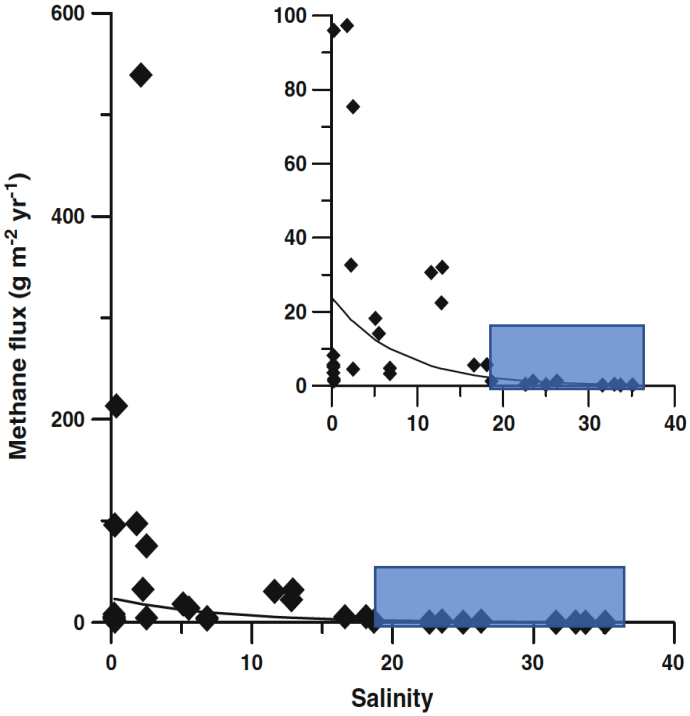

Key
Restriction Point
Wells & GHG Flux
Core Collection
Creek Sensors
Alms House Rd
Center St
468 ft
© 2015 Google
Google earth
1995
Imagery Date: 5/24/2015 lat 41.717531° lon -70.237119° elev 18 ft eye alt 2146 ft

An important example is the Herring River, Cape Cod National Seashore: ~1000 acres of tidally restricted wetland, that is proposed for restoration, and contains both drained and freshened/impounded former salt marsh.

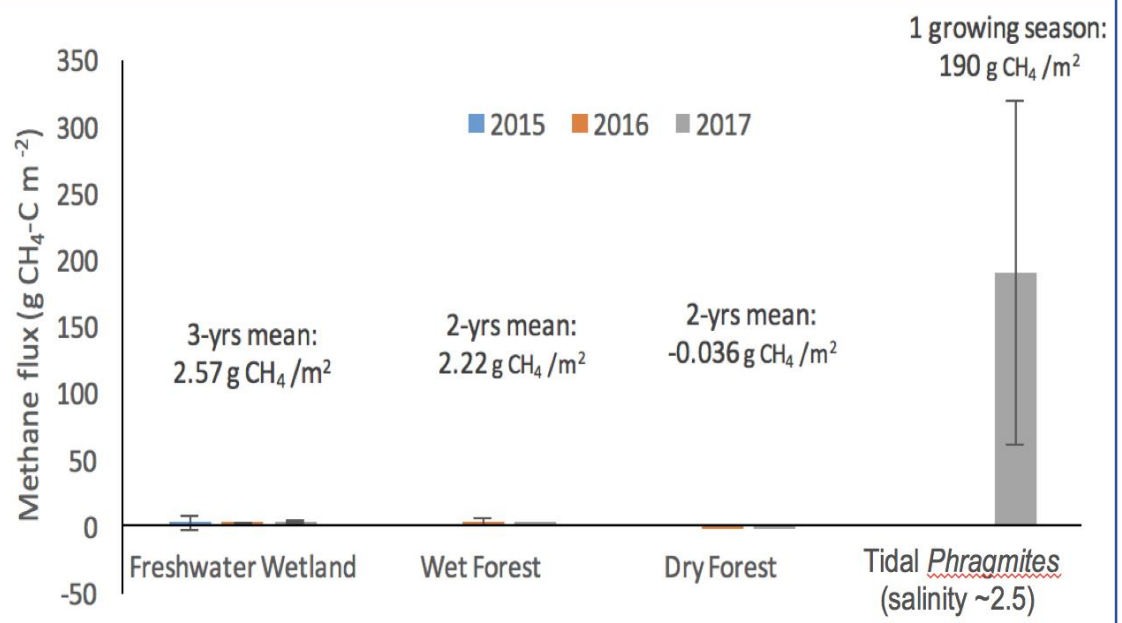


Research is still in progress, but results so far show that methane emissions within various settings in the Herring River do fall within the wide range reported for lower salinity wetlands: <u>The Phragmites wetland is a methane hotspot.</u>

Methane emissions as a function of salinity, across a broad range of settings (literature compiled by Poffenbarger et al. 2011)



Methane emissions in tidally-restricted, former salt marsh (F. Wang, et al. preliminary data).



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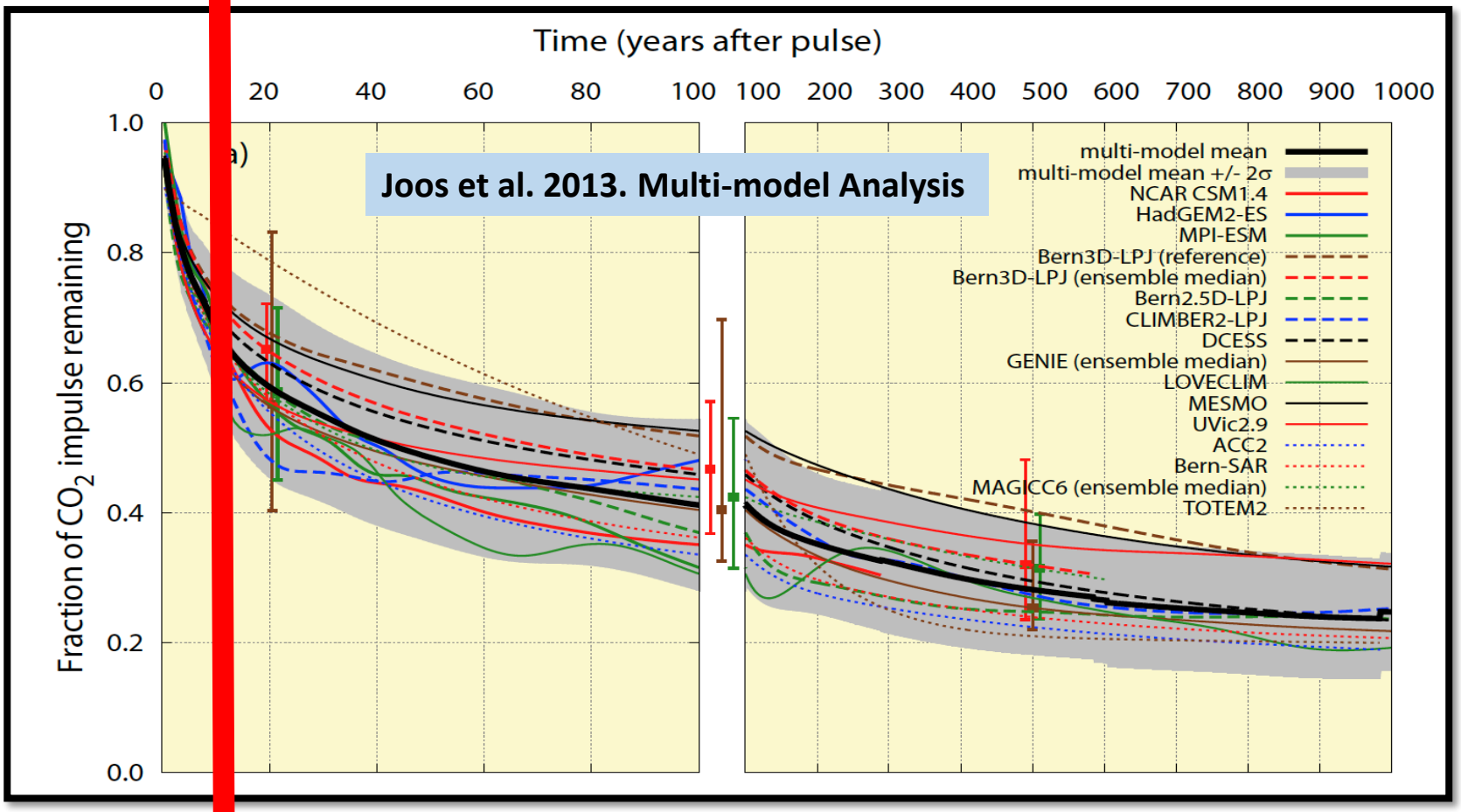
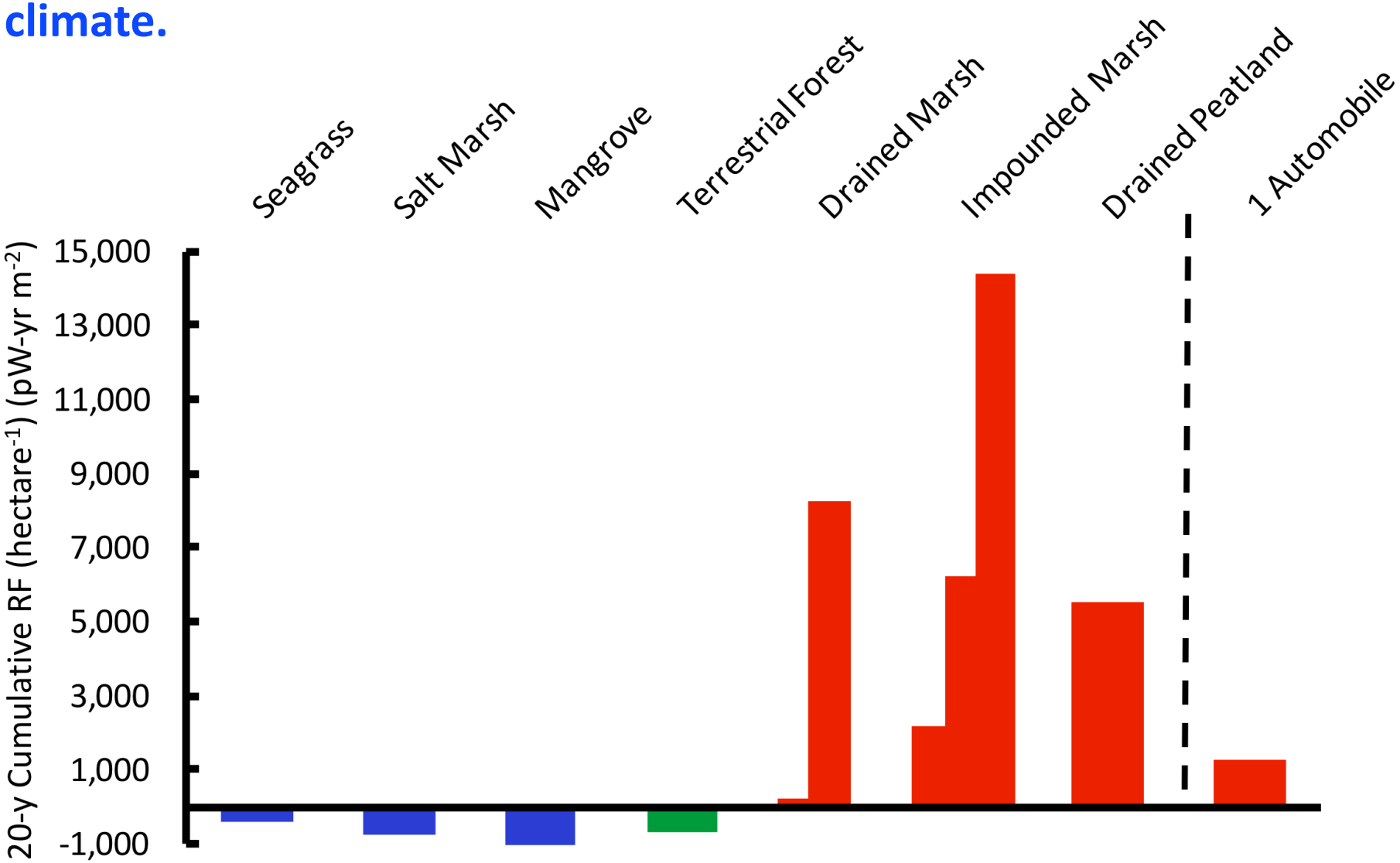
So how do we compare the impact of methane vs. carbon dioxide? The best approach is through radiative forcing calculations (though in truth, they can't really be compared).



12 year lifetime of methane

Methane is about 90 times more powerful, but only stays in the atmosphere for about 12 years. CO_2 is removed slowly over thousands of years. But, a key point is that with marsh restoration we can stop a long-term source of methane.

Comparing the heat trapped by methane vs. CO_2 shows that gas emissions in tidally-restricted wetlands have a powerful impact on climate.



Kroeger et al. In Revision

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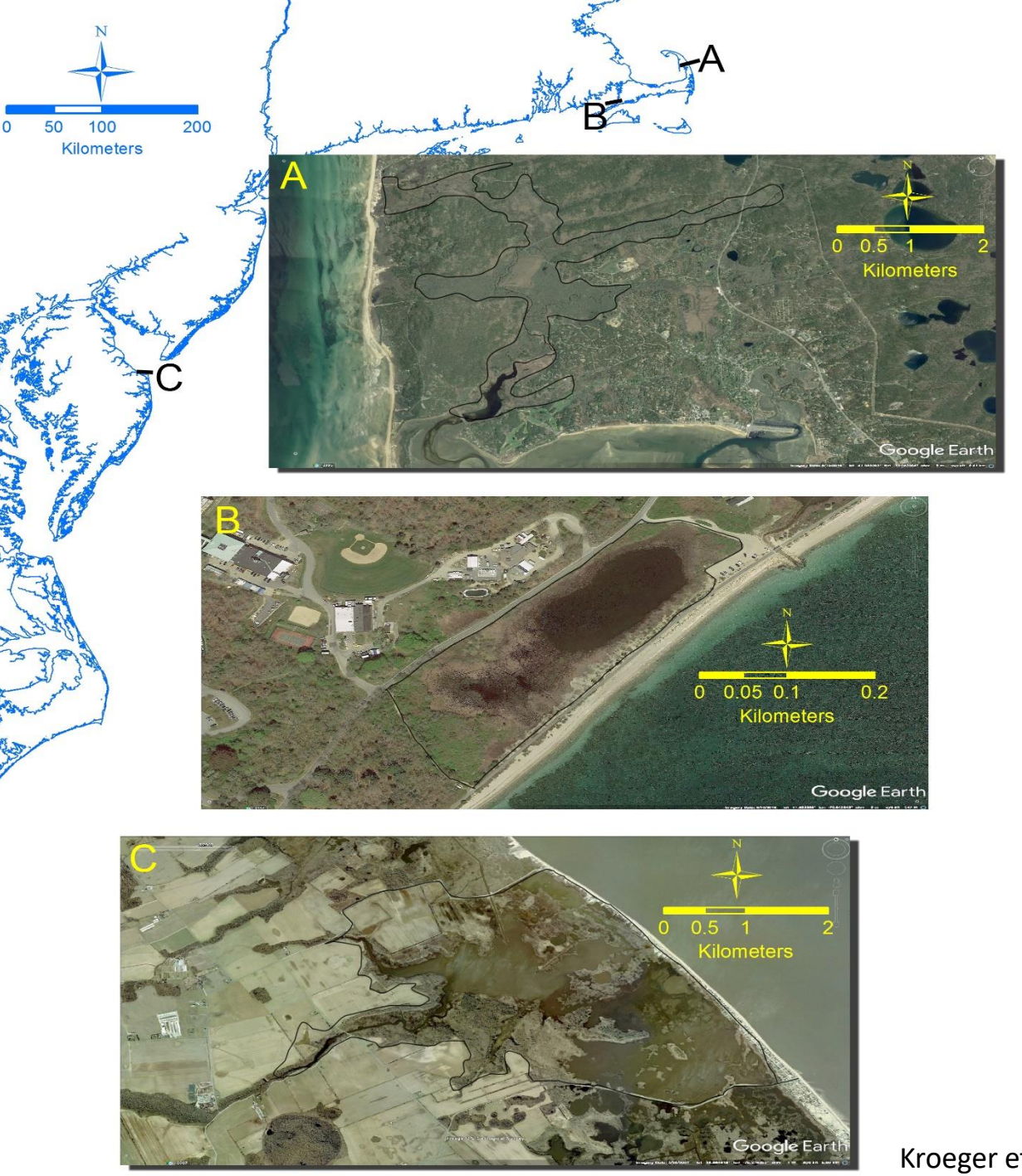

Geography

Large impact per acre, but how many acres are there?

Features are difficult to quantify. Are spatially extensive, generally not mapped, and often no longer recognized as former salt marsh.

Examples:

A. Herring River, NPS ~400 hectares

B. Woods Hole pond

C. Prime Hook NWR ~1600 hectares

Kroeger et al., In Revision; Figure, Sandra Brosnahan

- ~2,700 km^2 impounded, freshened wetland on US Atlantic coast
- 28,000 to 145,000 tonnes enhanced CH_4 emissions per year
- Over a 20 yr period, radiative forcing equivalent to 20 yrs emissions from 0.6 to 3.1 M automobiles
- Significant potential for emissions reductions
- Working to include in the Inventory of US GHG Emissions and Sinks, as well as analysis of C market feasibility in Herring River

Kroeger et al. In Revision

Location	Tidal Wetland in Study Area (km^2)	Wetland Area Affected (km^2)	Fraction of wetland area affected (%)
Transportation-Related Restrictions:			
Southern Maine[24]	32	9	28
New Hampshire[24]	26	5	20
Massachusetts[46]	212	58	27
North Shore[47]	113	6	5
Cape Cod[48]	70	20	28
Buzzards Bay[49]		33	
Rhode Island[52]	16	11	70
Total Transportation	286	84	29
Diked and Impounded for Waterfowl or Mosquito Management:			
N. Carolina[9]	643	21	3
S. Carolina[9]	2,041	285	14
Georgia[9]	1,590	32	2
Florida (Atlantic)[9]	778	143	18
Total Diked	5,053	482	10
Total impounded tidal wetlands U.S. Atlantic coast, Transportation + Diked	9,710[10]	3,787	39
Total area impounded and freshened:			
U.S. Atlantic coast	9,710	2,650	27

The good news is that we know how to restore the wetlands. In addition to restoring threatened salt marsh habitat, we can expect to reduce greenhouse gas emissions as well: Preliminary calculations indicate that in the first 40 years following restoration of the Herring River, GHG benefits will be equivalent to taking 276 cars off the road for 40 years. That benefit will increase during the decades beyond 40 years.

CONCEPTUAL RENDERING OF BRIDGE

Acknowledgements…

- Collaborators: Meagan Gonneea, Steve Crooks, Jianwu Tang, Faming Wang, Serena Moseman-Valtierra, Amanda C. Spivak, Neil K. Ganju, John W. Pohlman, Aleck Wang, Adrian Mann, Sandra Brosnahan, T. W. Brooks, Jennifer O'Keefe, Michael Casso, Omar-Abdul Aziz, Steve Emmett-Mattox, Jordan Mora, Christopher Weidman, Kate Morkeski, Linda Kraemer, Thomas Kraemer, Sophie Chu, Joanna Carey, P. Ganguli, E. Bergeron, Najjar et al., Windham-Meyers et al., J. Colman, T. Smith, J. Rassman, T. Surgeon-Rogers
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  - **USGS LandCarbon Program**
  - **NOAA WHOI & MIT Sea Grant**
  - **NOAA Science Collaborative**
  - **NSF Chemical Oceanography; Postdoctoral Fellowship Program**
  - **National Park Service**
  - **Friends of Herring River**

Questions?

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