Carbon Crediting for Tidal Marshes: Projects in Maryland

Brian Needelman
University of Maryland

Patrick Megonigal
Smithsonian Environmental Research Center

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Outline

- Background on blue carbon work in Maryland
- Quantifying greenhouse gas balances in restored marshes
  - Methane emissions
  - Carbon sequestration verification
- Potential carbon crediting demonstration projects in Maryland

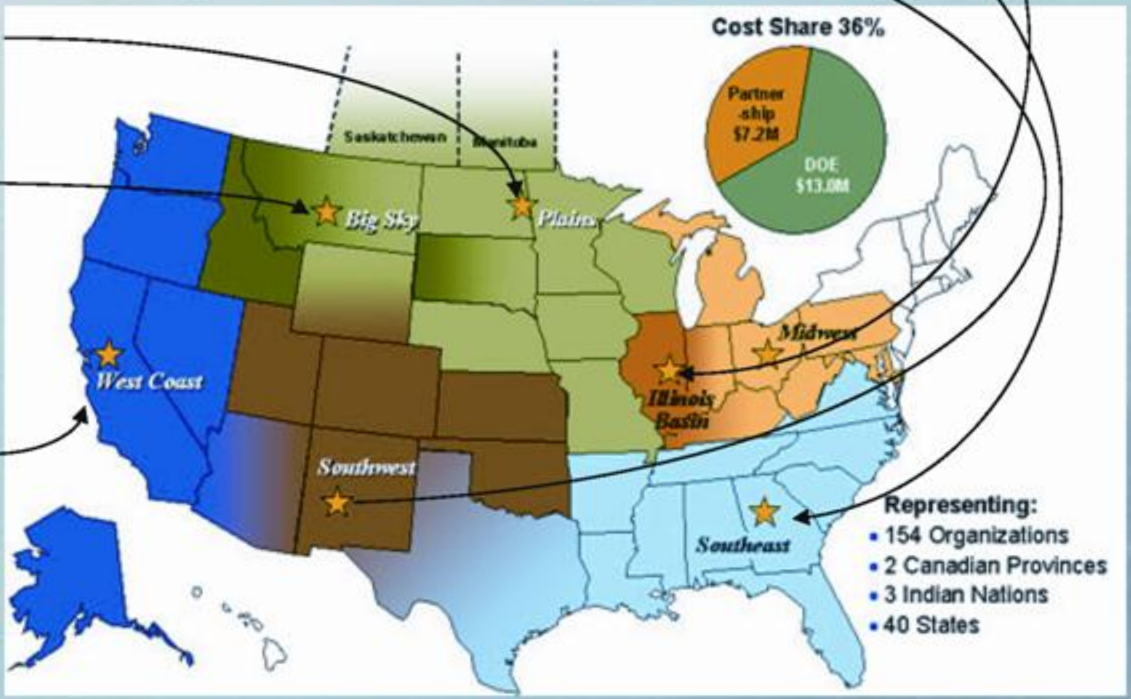
Background on blue carbon work in Maryland

Midwest Regional Carbon Sequestration Partnership

The MRCSP is One of Seven DOE Regional Partnerships Across the U. S.

The other six are:

- Geological Carbon Sequestration Options in the **Illinois Basin**
- **Southeast** Regional Carbon Sequestration Partnership
- **Southwest** Regional Partnership for Carbon Sequestration
- **Plains** CO_2 Reduction Partnership
- **Big Sky** Regional Carbon Sequestration Partnership
- **West Coast** Regional Carbon Sequestration Partnership



See http://www.netl.doe.gov/coal/Carbon%20Sequestration/partnerships/index.htm for more information from NETL on the seven partnerships.

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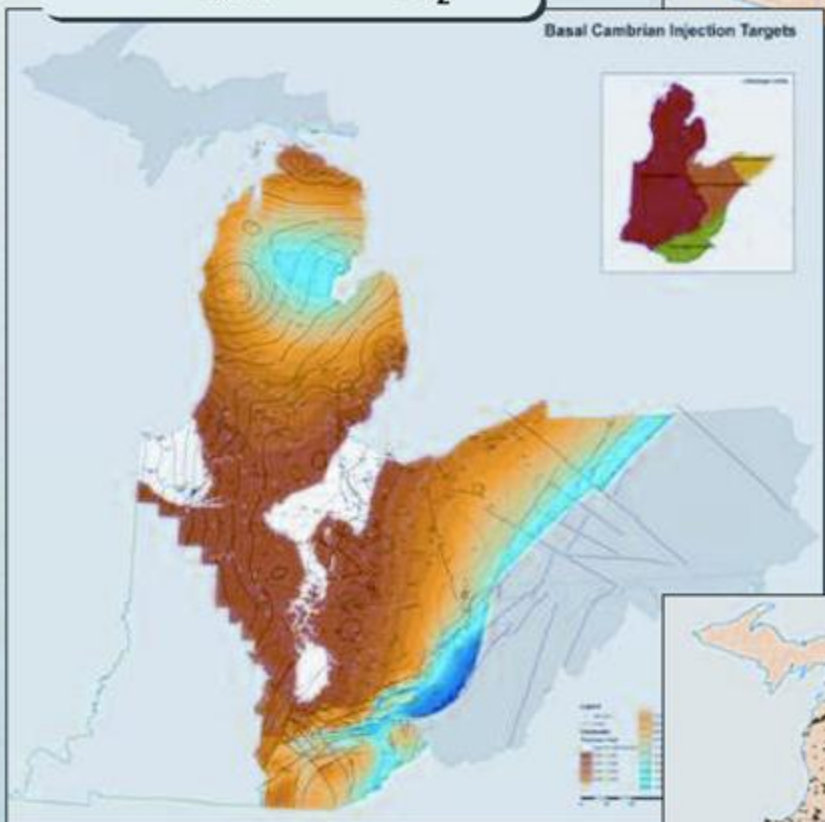
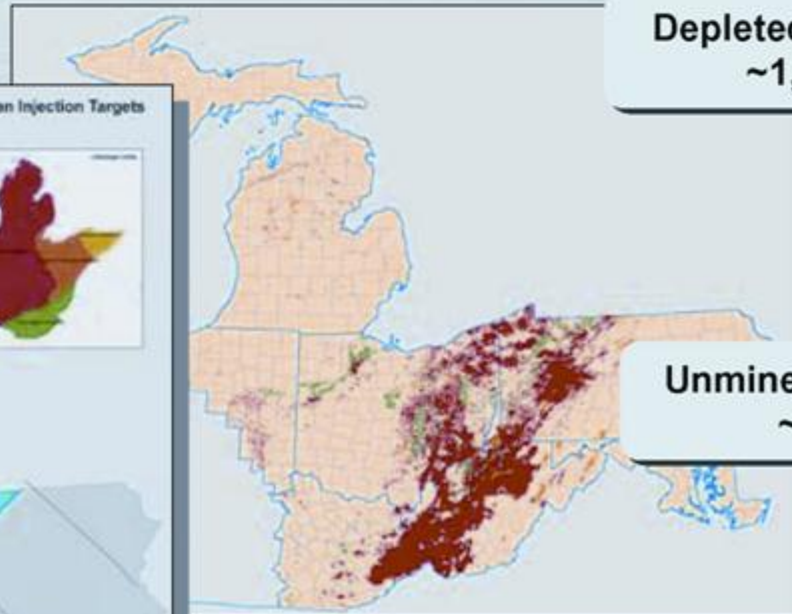
MRCSP

The geological potential of the region is vast and well positioned relative to sources

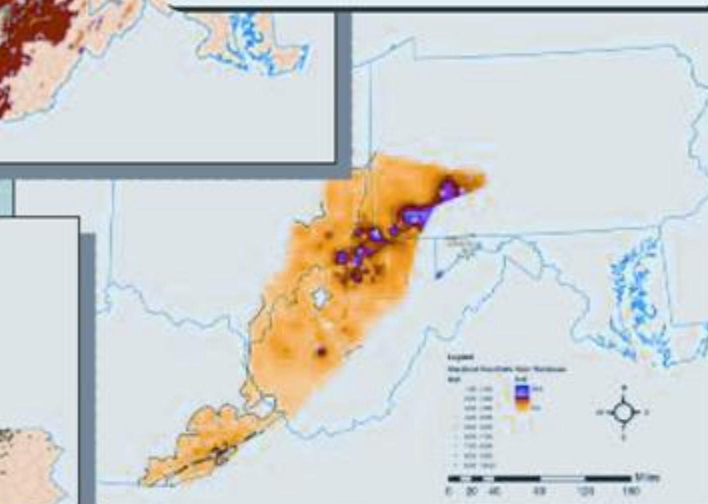
Deep saline formations:
~475,000 $MMTCO_2$



Depleted oil and gas fields
~1,400 $MMTCO_2$



Unmineable coal and shale
~350 $MMTCO_2$



Data from over 40,000 wells have been analyzed

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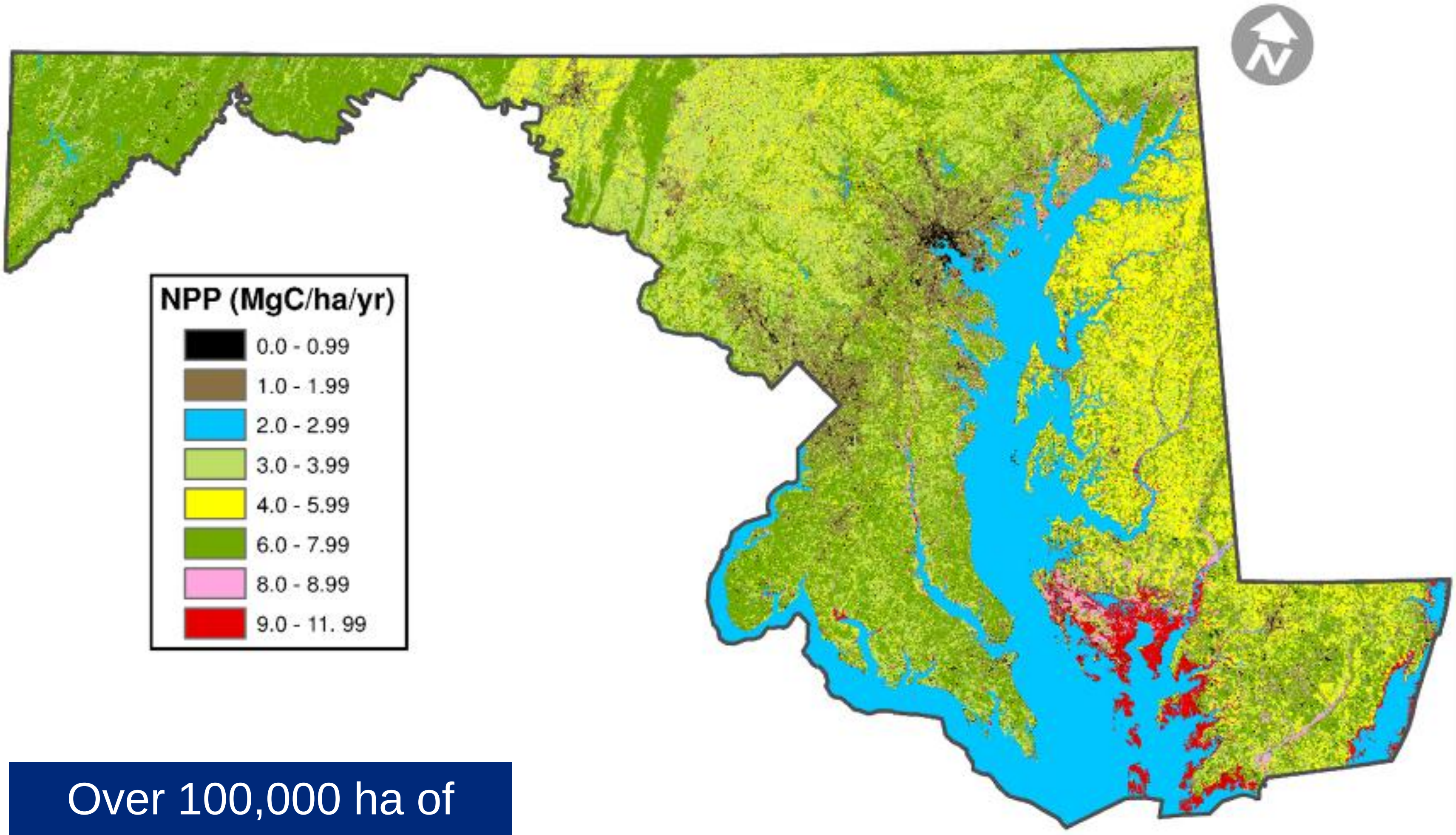
MIDWEST REGIONAL CARBON SEQUESTRATION PARTNERSHIP

Maryland Net Primary Productivity estimates based on land use class and literature values



Over 100,000 ha of estuarine wetlands in Maryland

Strebel, 2007

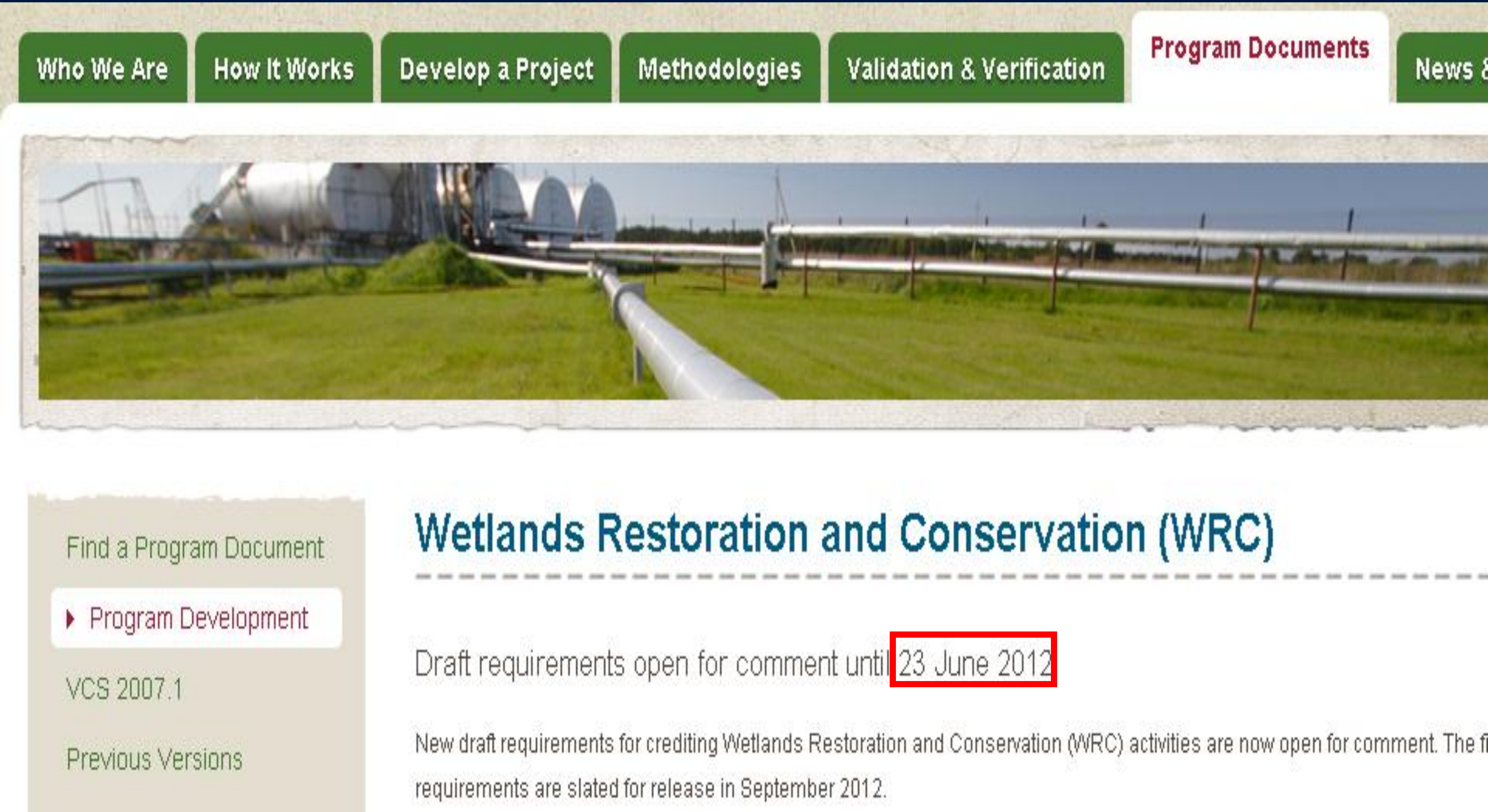
Regional Greenhouse Gas Initiative (RGGI or "Reggie")

- Nine Northeast and Mid-Atlantic states
- Cap-and-trade program for power plants in the region
  - Compliance began 2009
  - Regional emissions capped at ~1990 emissions
  - Cap reduced 10% in 2018

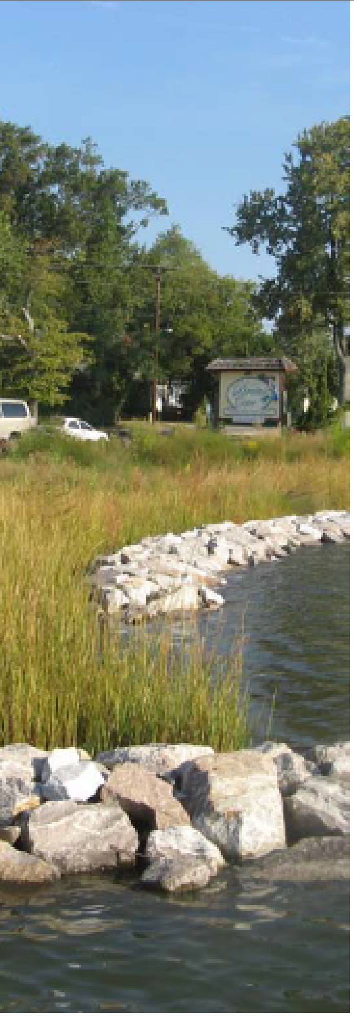
Carbon offsets in RGGI

- None sold to date
- Performing 2012 mandatory review
- Discussing additional offset categories
  – 2012 – forestry & ozone
  – 2015 – wetlands
- Process options
  – Independent RGGI protocol
  – Accept other protocols (e.g. VCS)
  – Accept offsets from other markets
- North America 2050 Initiative (NA 2050)

Verified Carbon Standard



- http://v-c-s.org/ -- search “wetlands restoration”



Chapter 5: Mitigating Greenhouse Gases Through Coastal Habitat Restoration

Brian A. Needelman*
University of Maryland
*Corresponding author: bneed@umd.edu

Janet E. Hawkes
HD1 LLC

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Climate change is caused by increasing concentrations of greenhouse gases in the earth's atmosphere. Coastal habitats, like all of the earth's ecosystems, both release and remove greenhouse gases from the atmosphere. The role of coastal habitats and oceans in carbon sequestration has received increased attention since the recent publications of "Blue Carbon: A Rapid Response Assessment" by the United Nations Environment Programme (Nellemann, 2009) and "The Management of Natural Coastal Carbon Sinks" by the International Union for Conservation of Nature (Laffoley and Grimsditch, 2009). Habitat restoration projects will have a net positive or negative effect on greenhouse gases in the atmosphere depending on how they affect the release and removal of greenhouse gases. State, regional, and national greenhouse gas mitigation programs may use restoration projects that cause a net reduction in greenhouse gas concentrations. Restoration projects may also be eligible for funding through carbon credit or carbon offset programs. If a project leads to a net increase in greenhouse gases, however, this effect should be considered against other benefits of restoration.

Background on Greenhouse Gases

The earth's atmosphere provides a critical service of heat retention, acting as a blanket for the earth—without it the world would freeze. Sunlight warms the earth; the earth in turn radiates heat outward. Certain gases in the atmosphere trap most of this radiated heat—this is known as the greenhouse effect. The significant greenhouse gases, in order of decreasing impact, are water vapor, carbon dioxide, methane, ozone, nitrous oxide, and chlorofluorocarbons (CFCs). Human activities have increased the atmospheric concentration of many greenhouse gases, particularly carbon dioxide, methane, ozone, nitrous oxide, and chlorofluorocarbons.

Carbon dioxide (CO_2)

The carbon dioxide concentration in the atmosphere has risen from about 280 ppm (parts per million) prior to the industrial revolution to a current level above 390 ppm, an increase due largely to emissions from the burning of fossil fuels and from deforestation. The Intergovernmental Panel on Climate Change (IPCC) has estimated that the concentration of carbon dioxide will rise to between 450 and 1000 ppm over the next century (IPCC, 2007).

In a process called the carbon cycle, there is a constant exchange of carbon atoms present within carbon dioxide (CO_2) and carbon atoms in the inorganic and organic matter on the earth's surface. The quantity of carbon dioxide in the atmosphere represents a tiny percentage of the total carbon on earth; it is highly sensitive to changes in the larger, earth-bound

Restore-Adapt-Mitigate: Responding to Climate Change through Coastal Habitat Restoration

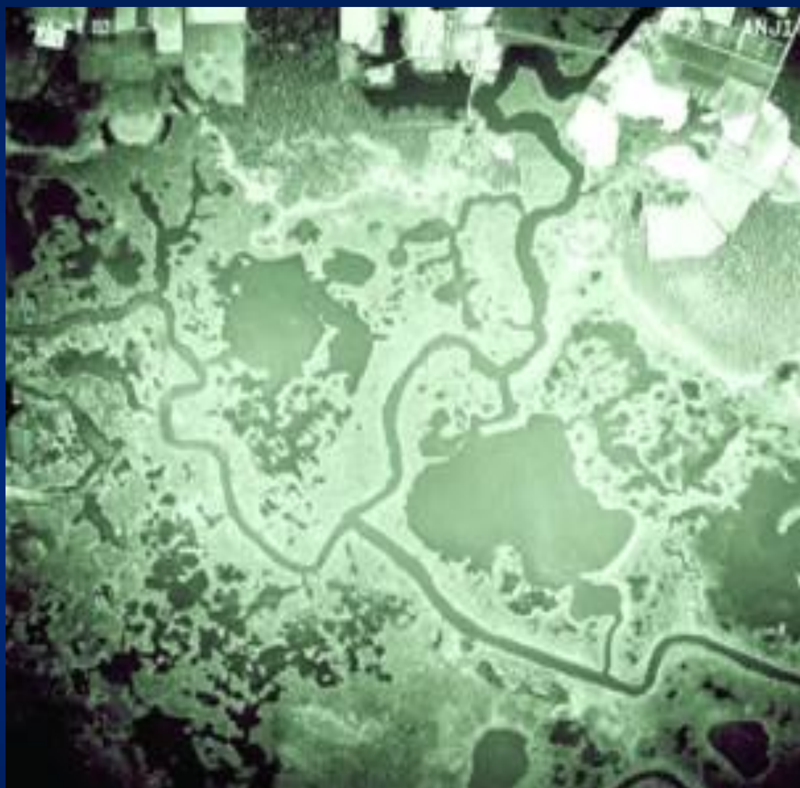
Download at http://www.estuaries.org/reports/

Quantifying greenhouse gas balances in restored marshes

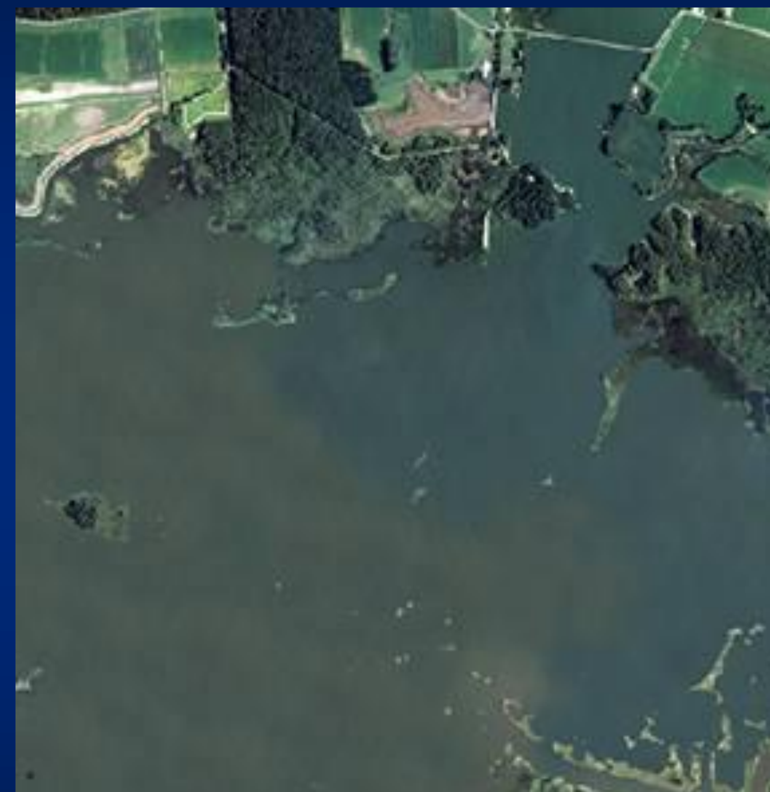
- Methane emissions
- Carbon sequestration verification

Blackwater National Wildlife Refuge

1938

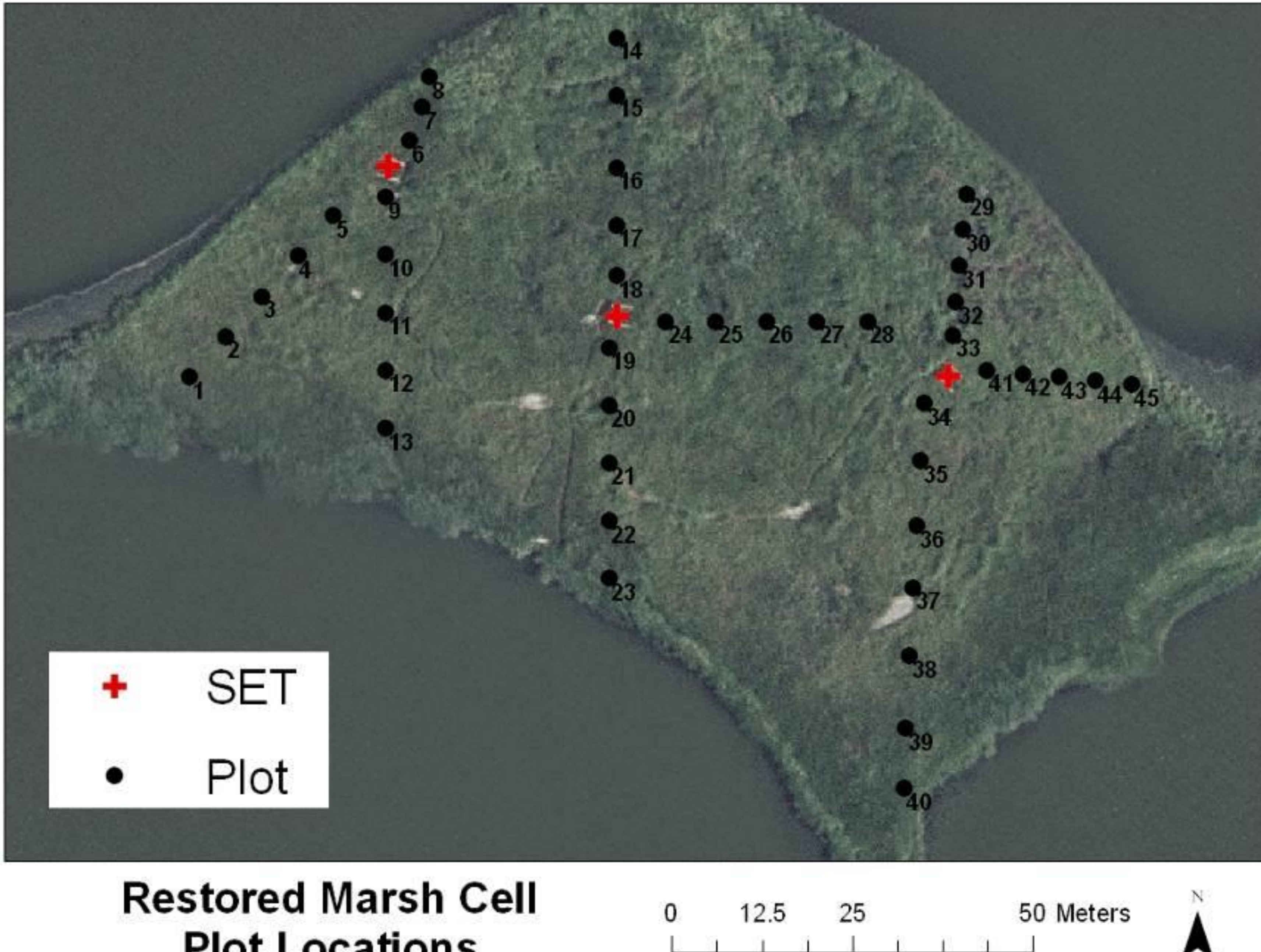


2005



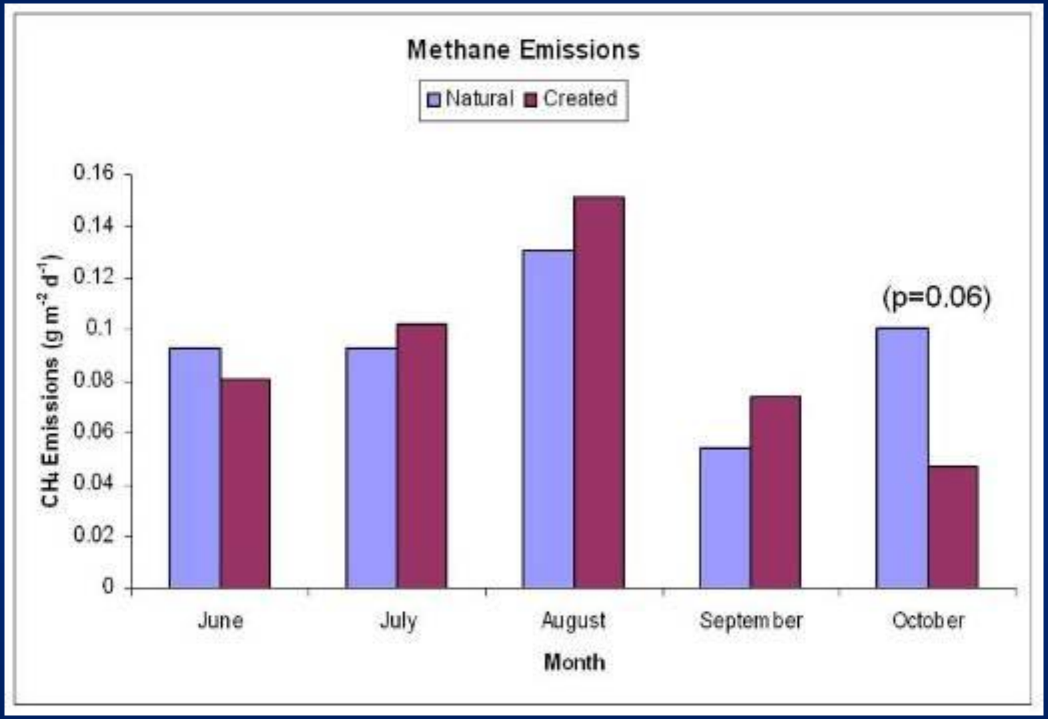
Early photo – scanned NAPP photos provided by Dixie Birch USFW – 2005 True Color Orthophotographs

Marsh restoration using local dredged material



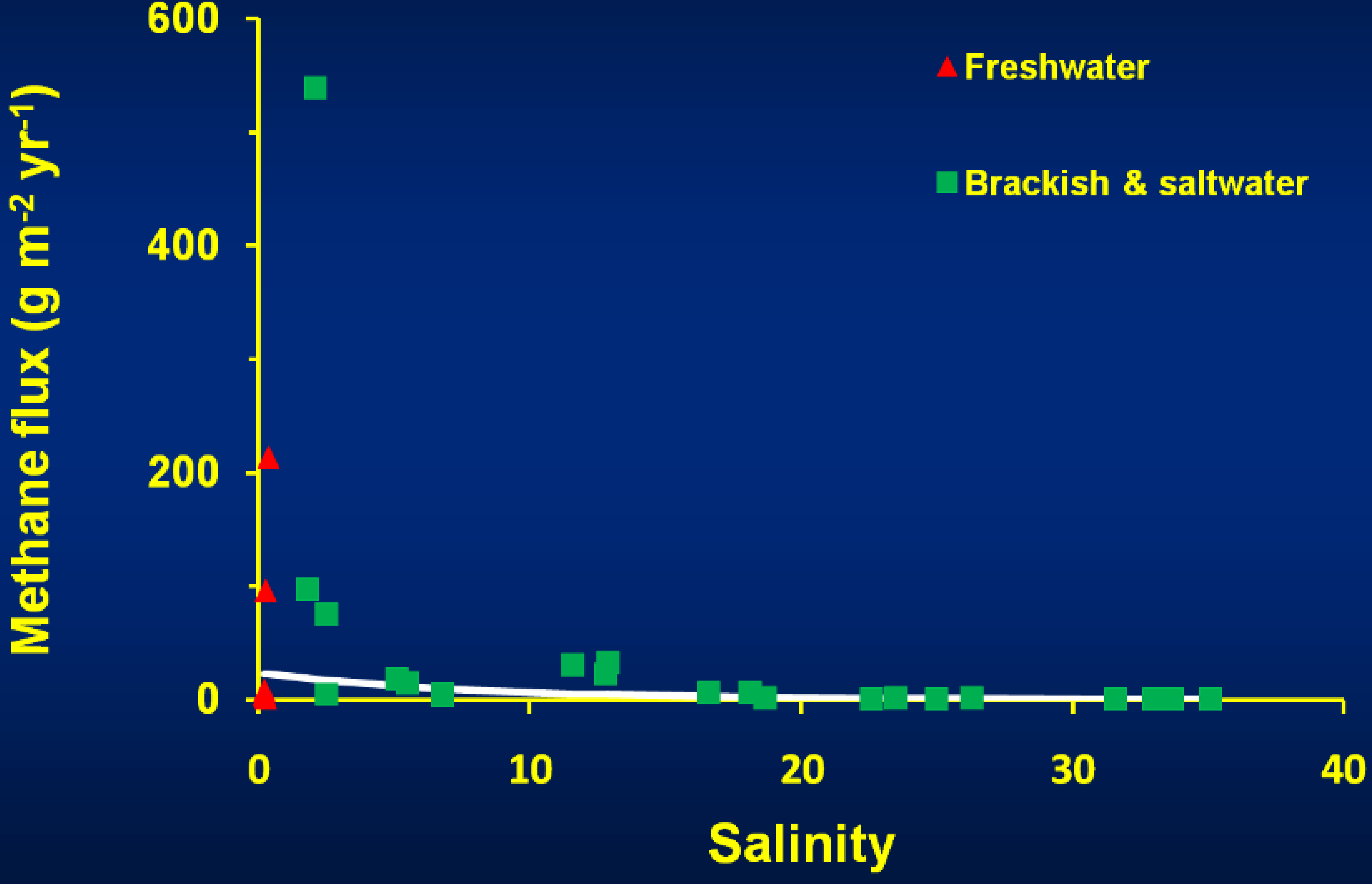
Restored Marsh Cell Plot Locations

Methane emissions at Blackwater



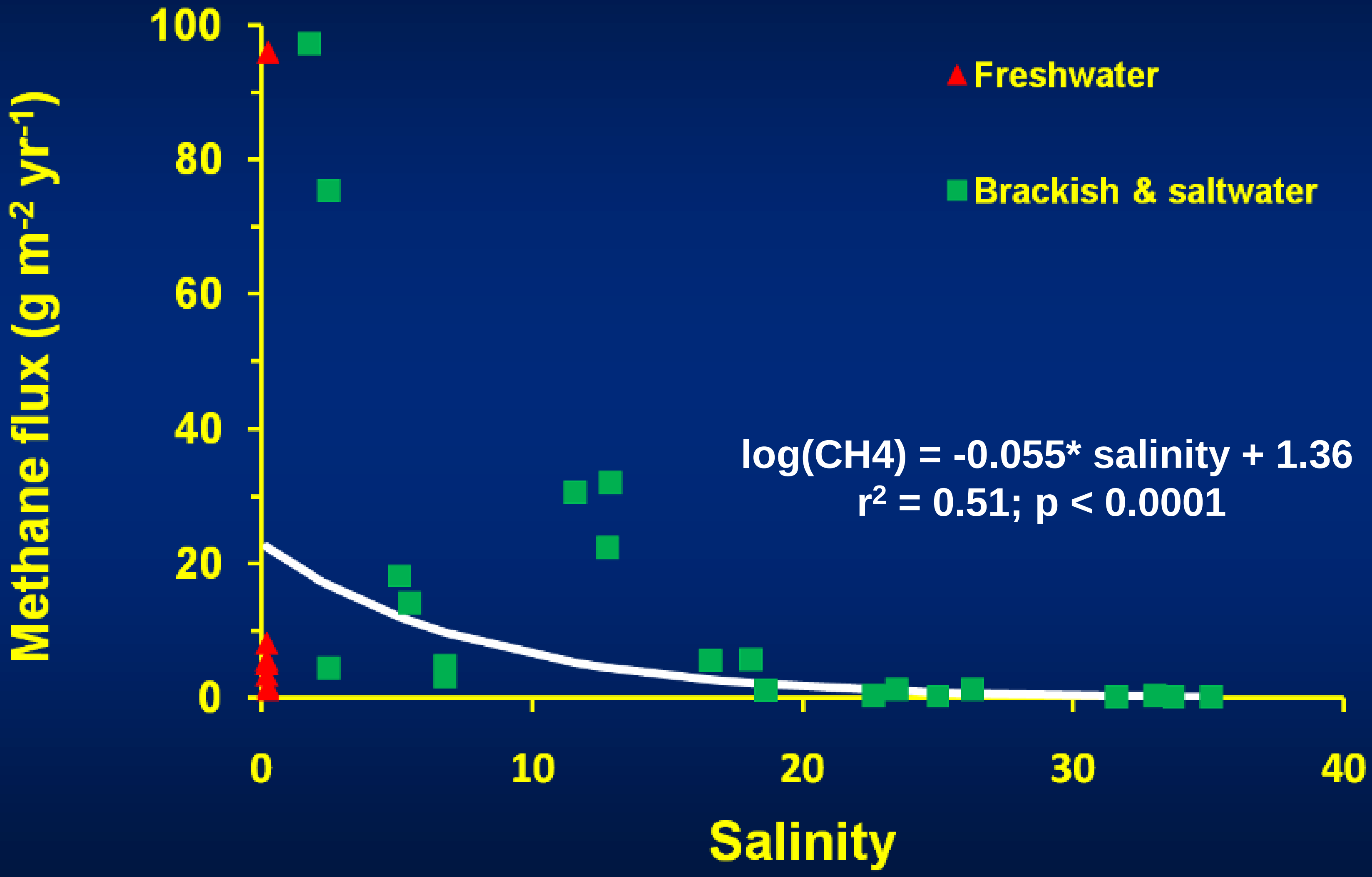
Megonigal, unpublished data

Salinity versus methane flux



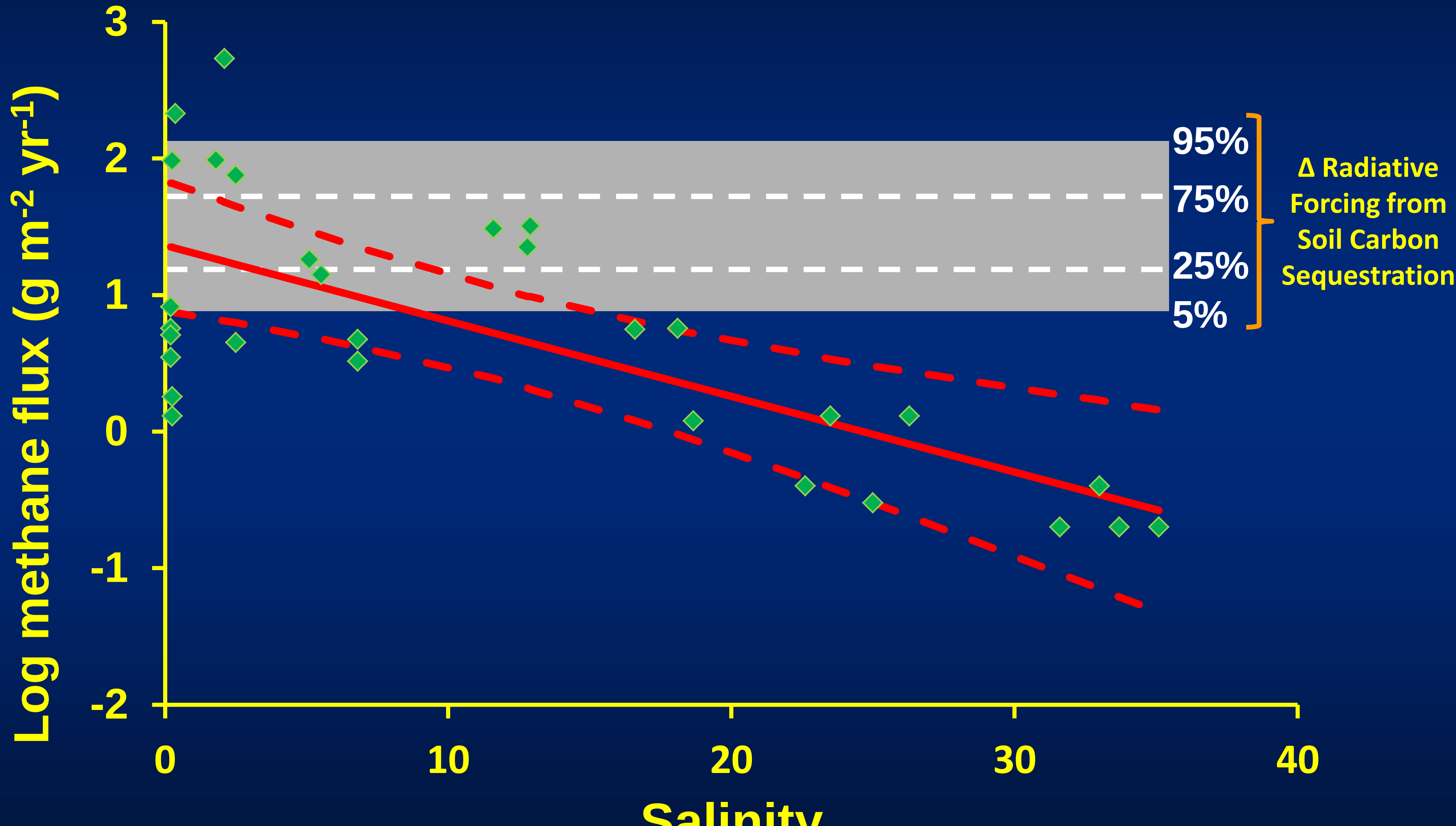
Hoffenbarger, Needelman & Megonigal, Wetlands, 2011

Salinity versus methane flux



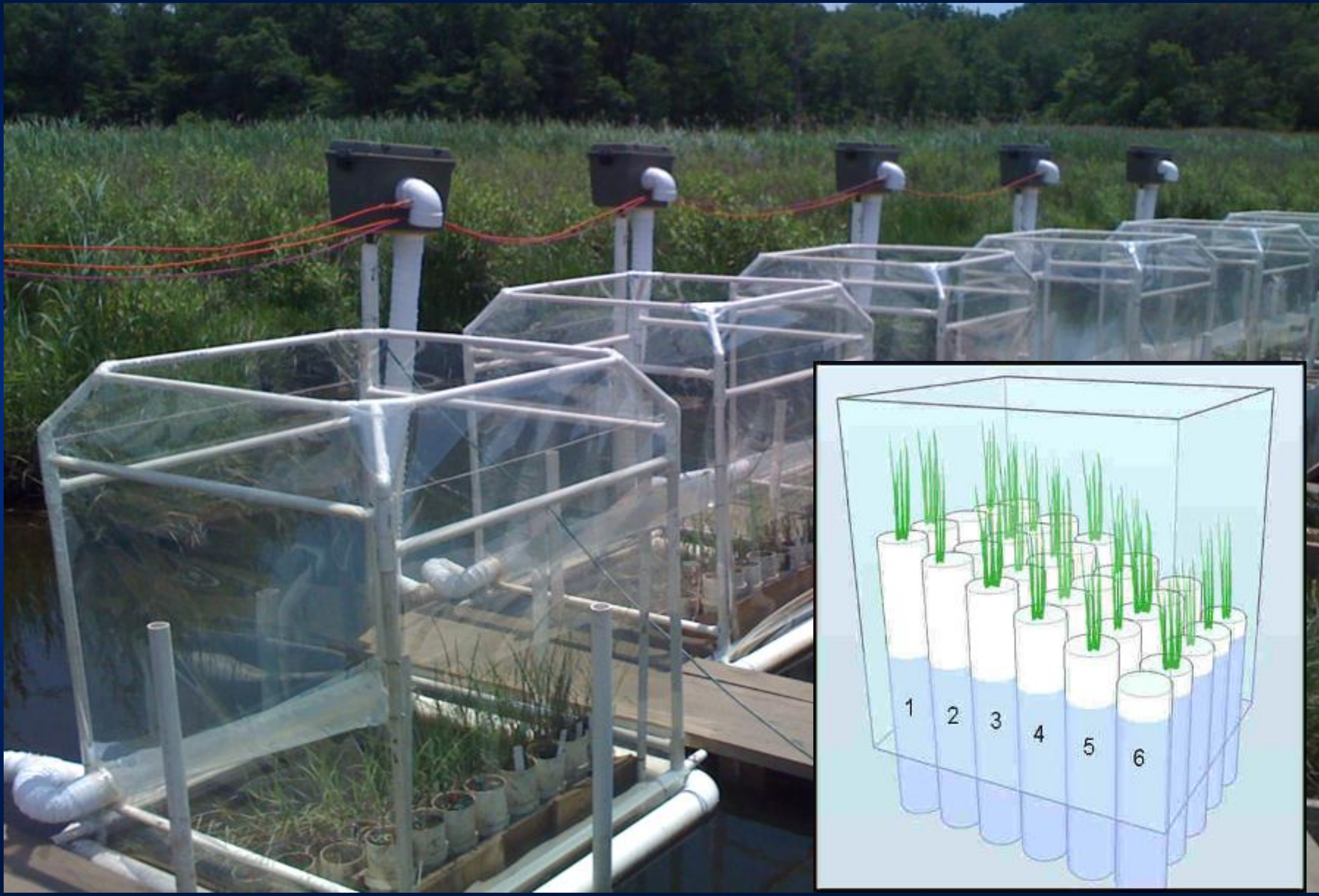
Hoffenbarger, Needelman & Megonigal, Wetlands, 2011

Climate Benefits of Sequestration Offset by Methane

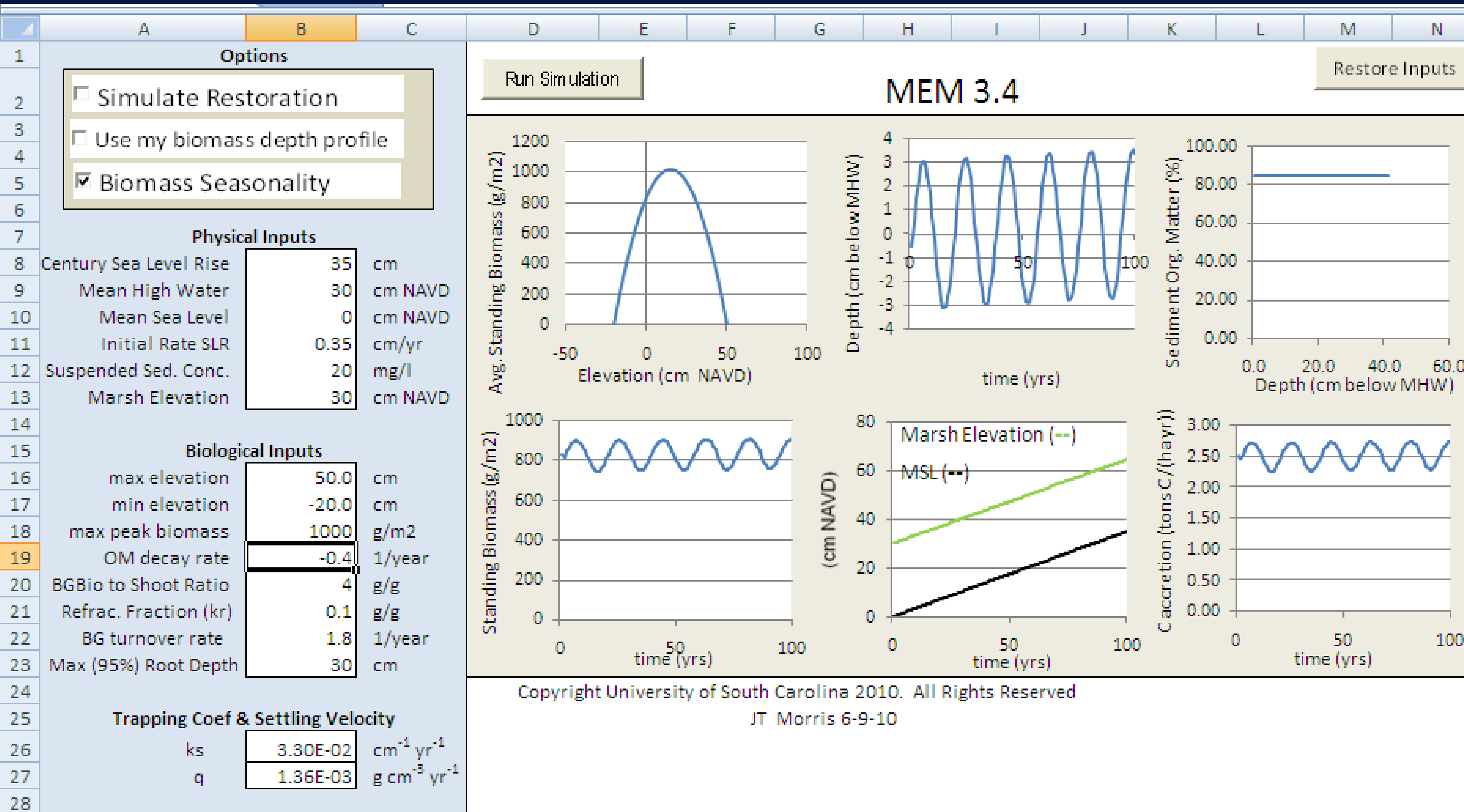


Hoffenbarger, Needelman & Megonigal, Wetlands, 2011

SERC Global Change Research Wetland Marsh Organ Facility



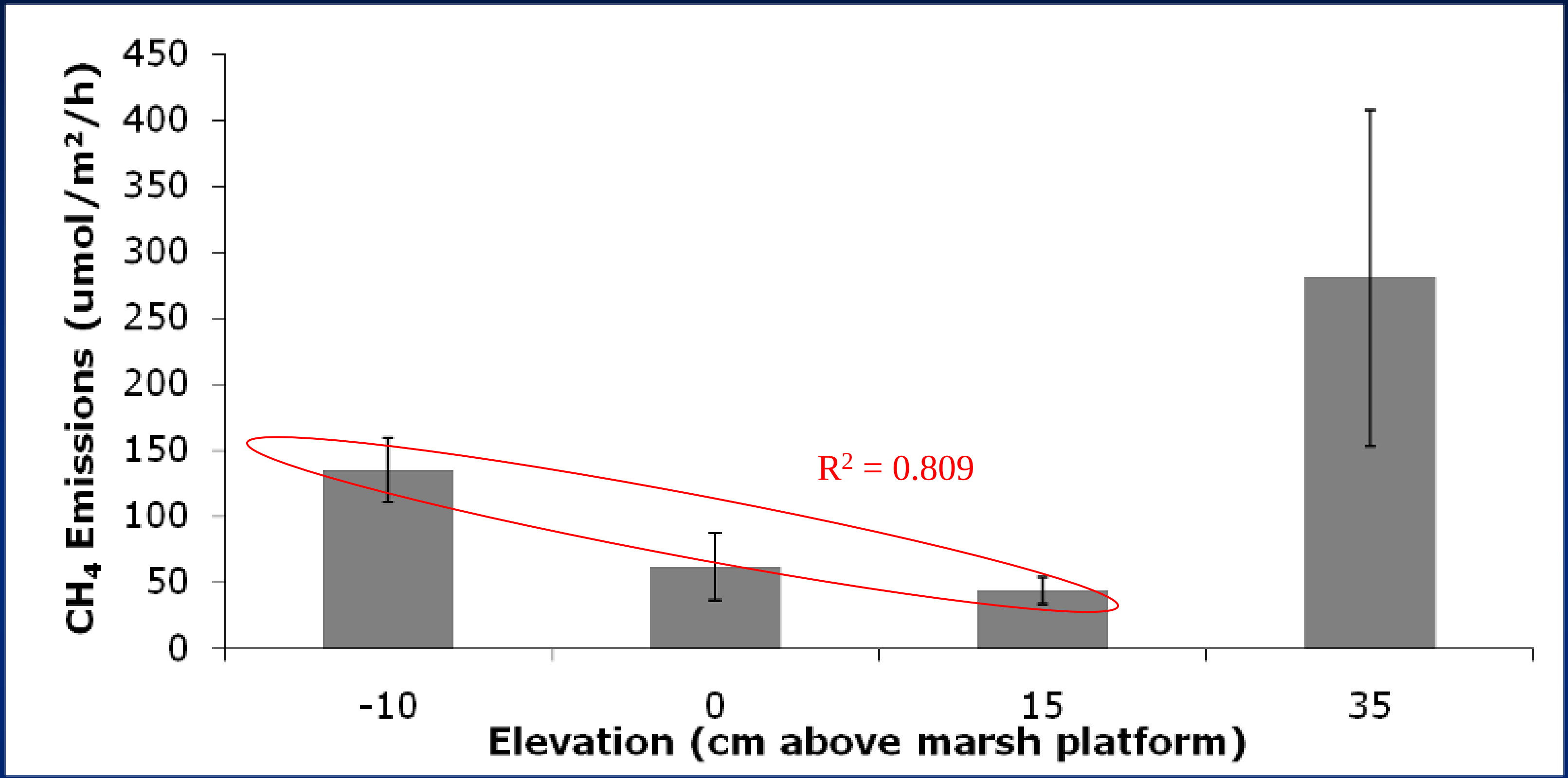
Marsh Equilibrium Model (MEM)



Morris, in preparation

Measuring methane emissions

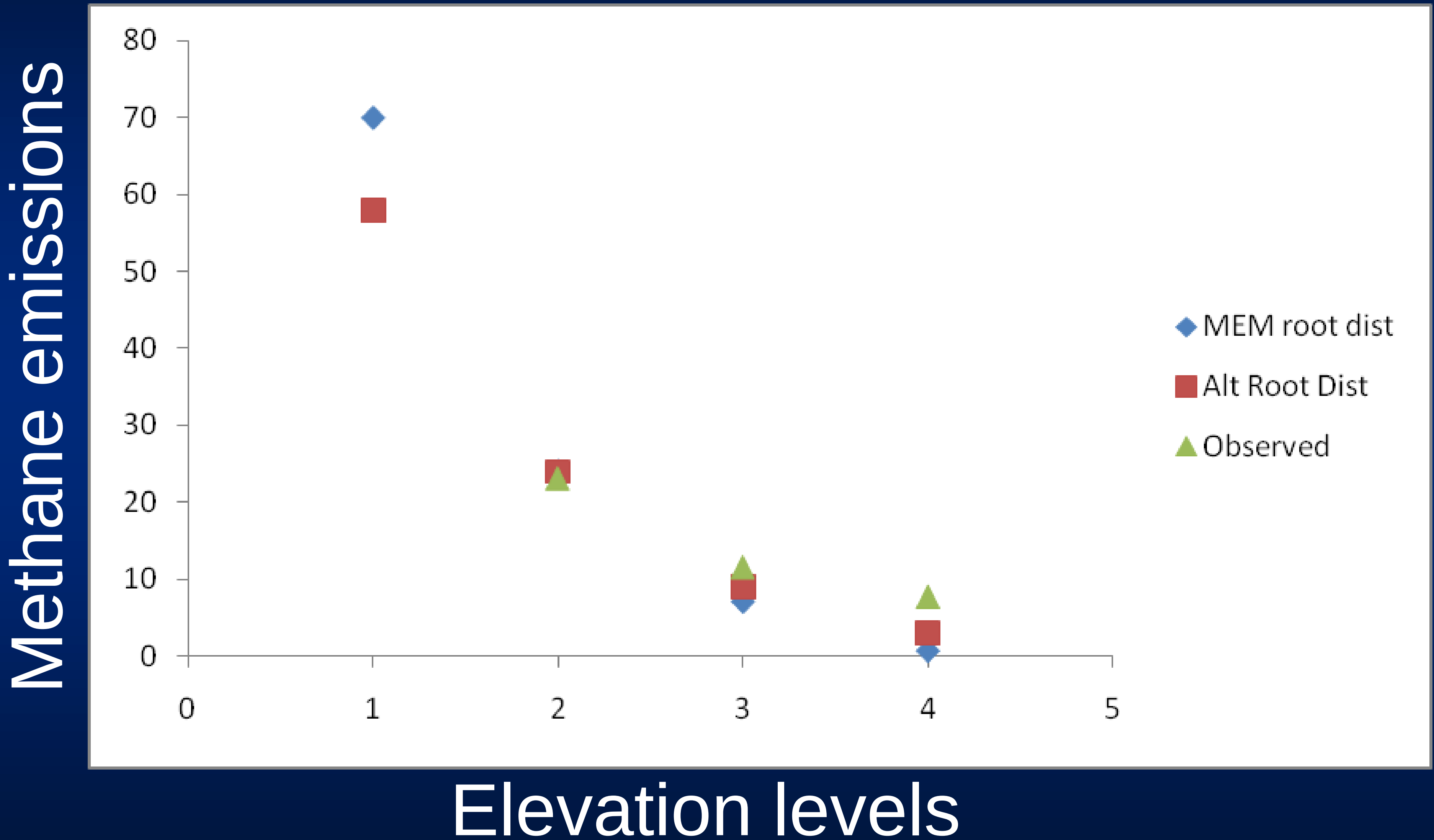
Methane Emissions from Marsh Organ Experiments



wet ← rising sea level ← dry

- *Spartina patens & Schoenoplectus americanus* Community
- Elevated CO_2 and N Fertilized Treatments Pooled

Marsh Equilibrium Model -- Methane (MEM-M)



Megonigal, unpublished

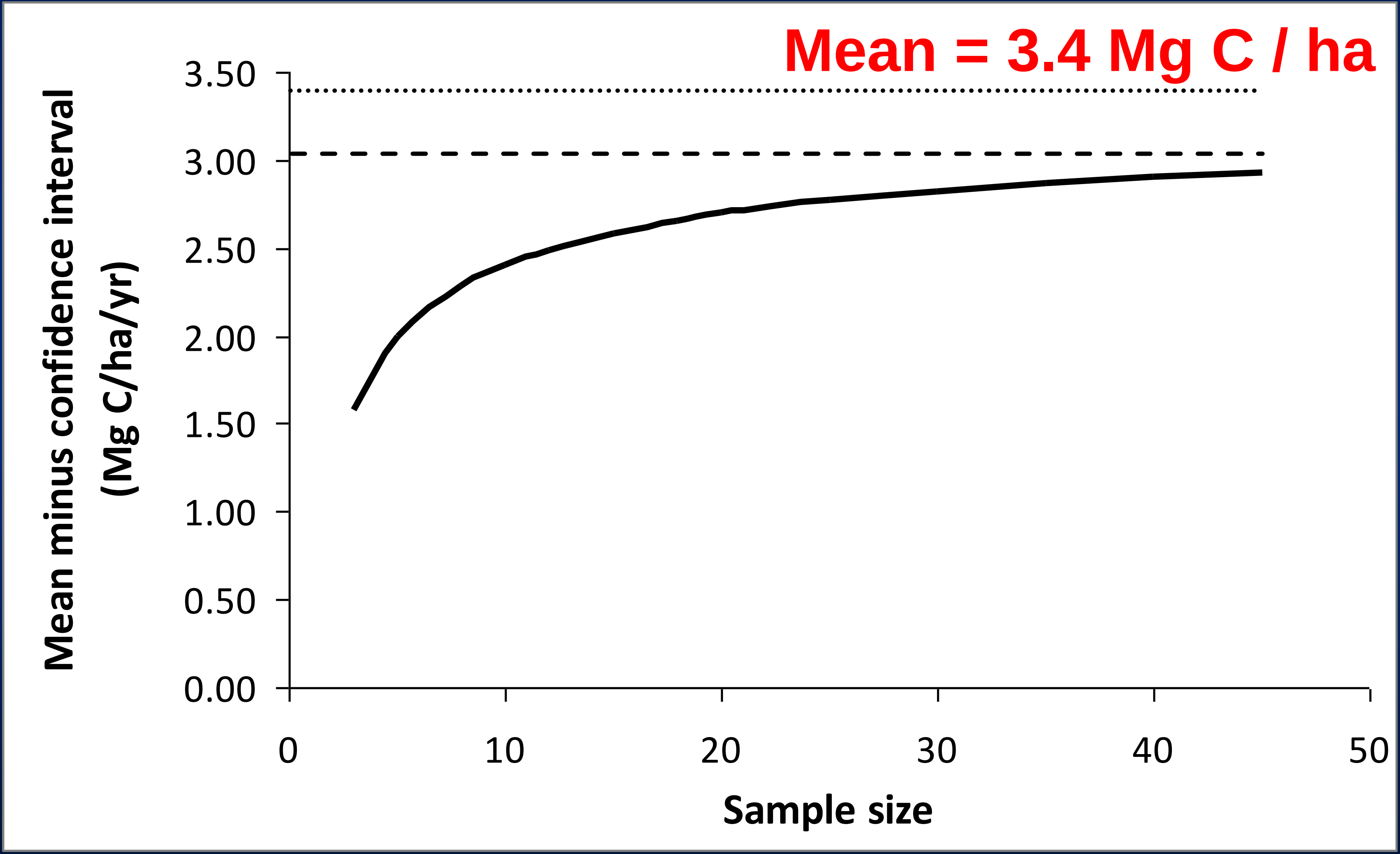
Cost-realistic, statistical estimation of carbon sequestration rates

- Traditional radionuclide methods often not applicable
  - Expensive
  - Don’t represent post-restoration rates
  - Limited spatial replication
- Challenges
  - Cost
  - Sampling depth
  - Spatial variability

Carbon sequestration rates

- **Natural site**
  - **3.4 to 5.7 Mg/ha/yr**
  - **Mean 4.4 Mg/ha/yr (443 g/m^2/yr)**
- **Restored site:**
  - **0.8 to 5.9 Mg/ha/yr**
  - **Mean 3.4 Mg/ha/yr (340 g/m^2 per year)**
  - **Standard deviation 1.3 Mg/ha/yr**

Conservative quantification for carbon crediting



Potential carbon crediting demonstration projects in Maryland

Potential carbon credit demonstration: Restoration of ditch-drained marshes

Potential carbon credit demonstration: Avoided losses with Blackwater NWR Shoreline Protection

Matt Whitbeck


Thank you
Brian Needelman
bneed@umd.edu
Pat Megonigal
megonigalp@si.edu
Funding
Maryland Department of Natural Resources Power Plant Research Program
Restore America's Estuaries

Value of carbon sequestration for marsh restoration
(3 Mg CO_2/yr; 50 years)

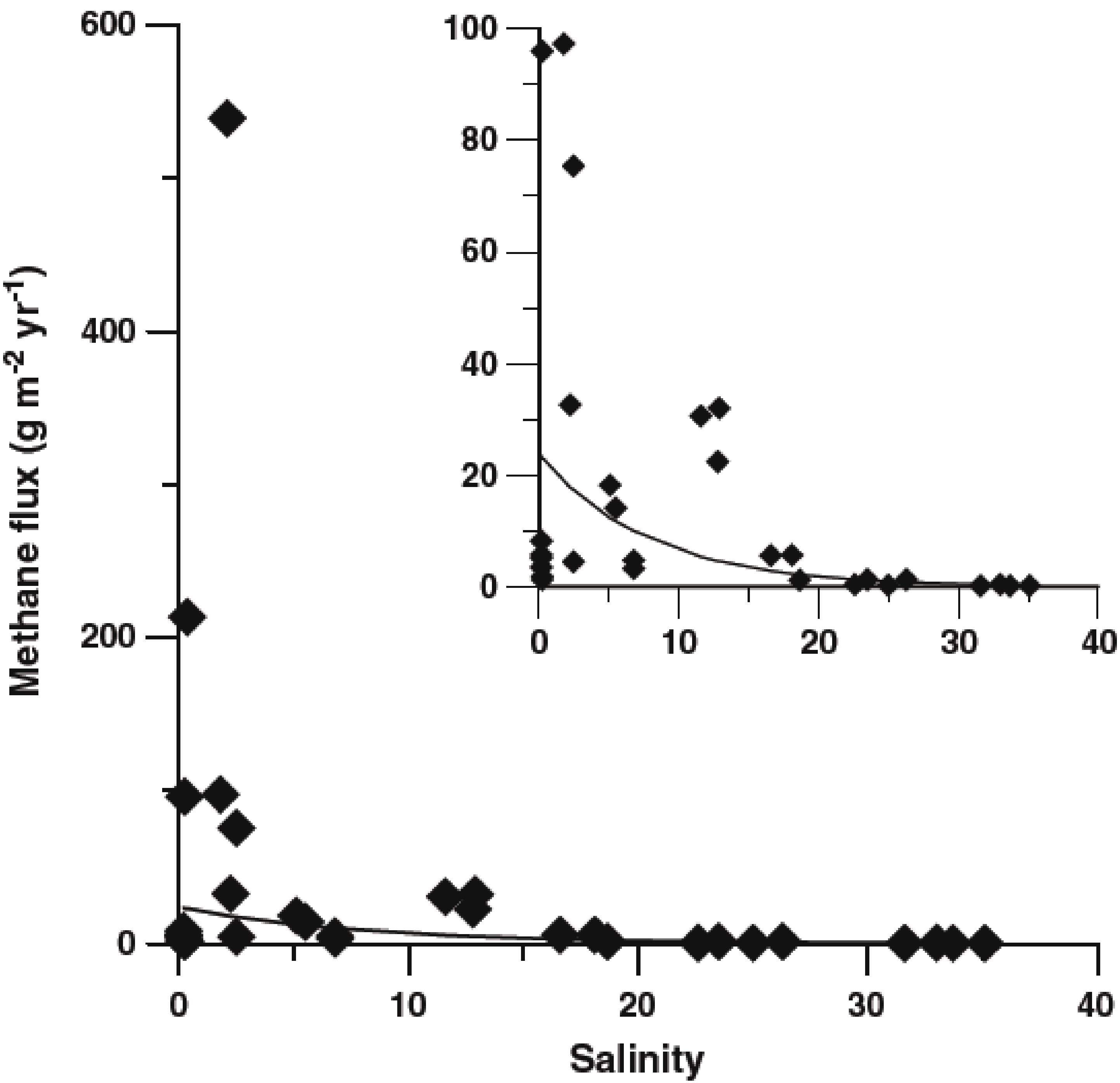
Price per Mg CO_2	40 ha	400 ha
$5.00	$75,000	$750,000
$10.00	$150,000	$1,500,000
$40.00	$600,000	$6,000,000
$80.00	$1,200,000	$12,000,000

Before subtracting baseline, methane, uncertainty, insurance, verification, …


May 2003
Volunteers planted 70,000 units combined of Olney's 3-square (*Schoenoplectus americanus*), salt marsh bulrush (*Schoenoplectus robustus*), and smooth cordgrass (*Spartina alterniflora*)

Literature (methane flux)

- DeLaune et al. 1983
- Bartlett et al. 1985
- Bartlett et al. 1987
- Kelley et al. 1995
- Magenheimer et al. 1996
- Van der Nat and Middelburg 2000
- Neubauer et al. 2000
- Megonigal and Schlesinger 2002
- Nedwell et al. 2004
- Marsh et al. 2005
- Hirota et al. 2007
- Wang et al. 2009
- Field sites at the Blackwater National Wildlife Refuge



Poffenbarger, Needleman & Megonigal, *Wetlands* 2011

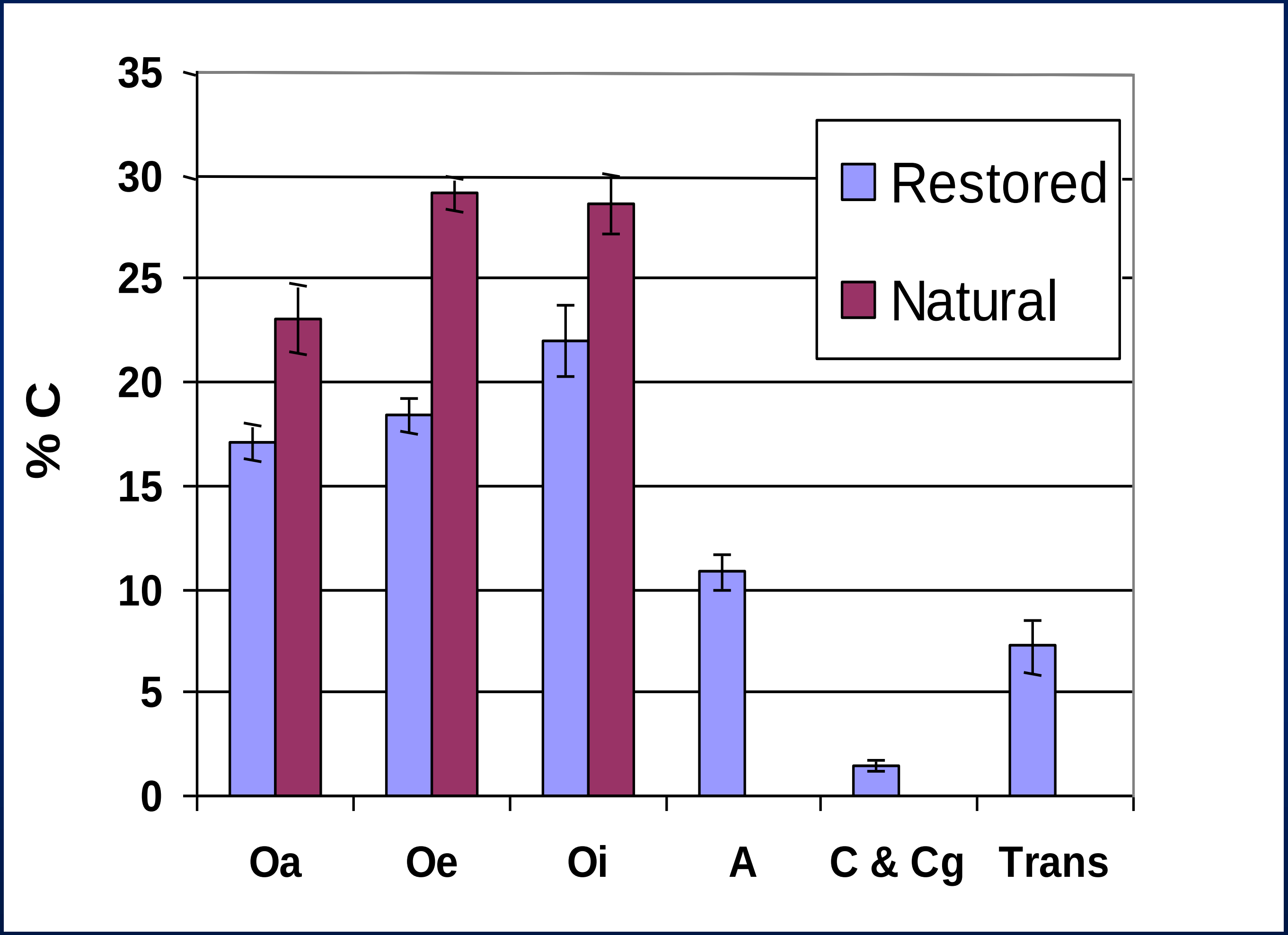
Methane emissions and carbon sequestration equivalents

Salinity Class	Salinity Range	Methane emissions ($g\ m^{-2}\ yr^{-1}$)				N	Carbon sequestration equivalent of methane emissions ($Mg\ C\ ha^{-1}\ yr^{-1}$)*		
	ppt	Mean	Min	Max	Std Dev	N	Mean	Min	Max
Fresh	<0.5	42[a]	1	213	76	8	2	0.1	12
Oligohaline	0.5-5	179[ab]	5	539	243	4	10	0.3	31
Mesohaline	5-18	16[bc]	3	32	11	8	0.9	0.2	2
Polyhaline	>18	1[c]	0.2	6	2	10	0.1	0.0	0.3

*Calculated based on a methane global warming potential of 21 (100-year time horizon).

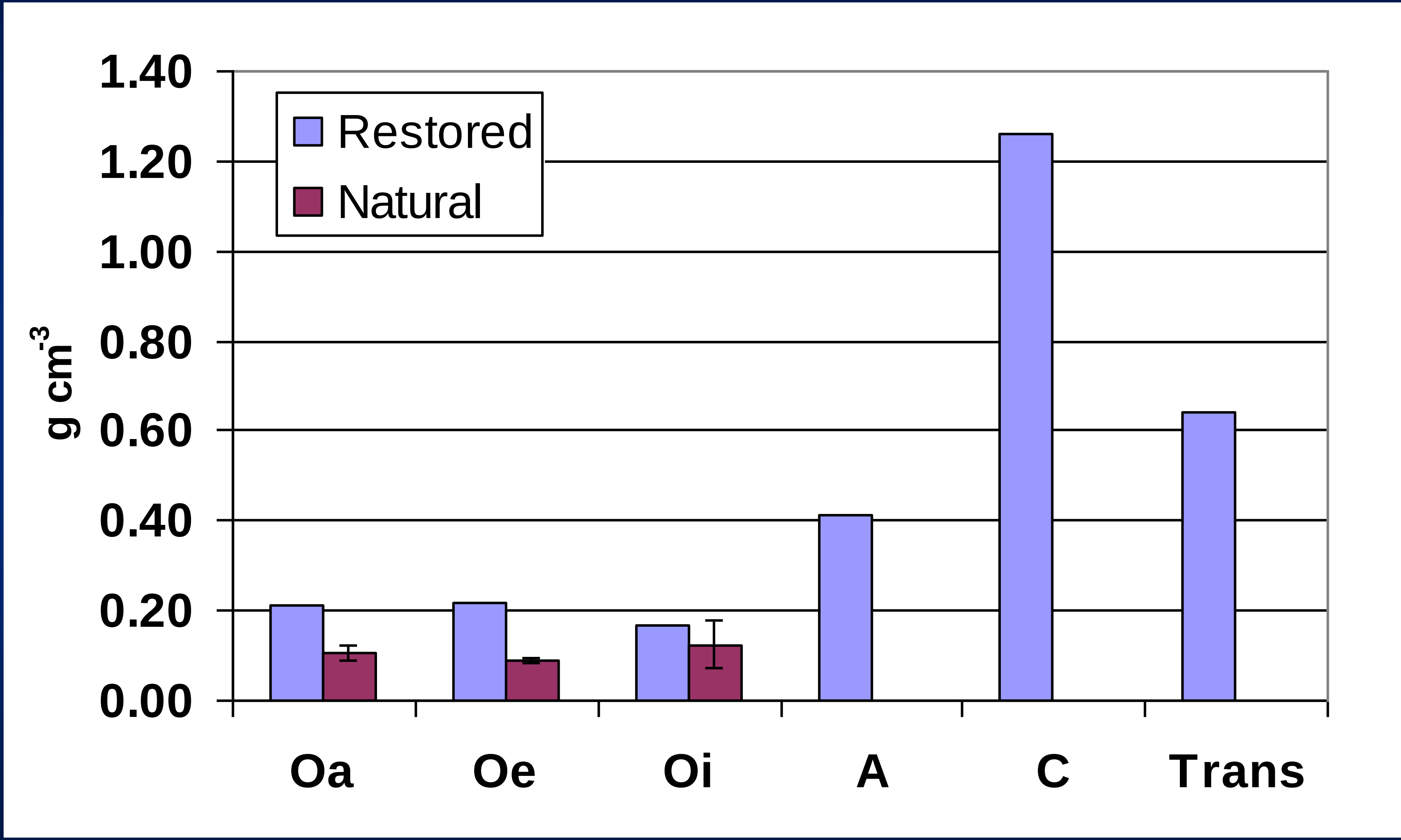
Hoffenbarger, Needelman & Megonigal, Wetlands, 2011

Mean Carbon Concentration (mass basis)



Wills, S.A., B.A. Needelman, and R.W. Weil. Carbon distribution in restored and reference marshes at Blackwater National Wildlife Refuge. Archives of Agronomy and Soil Science. (In press)

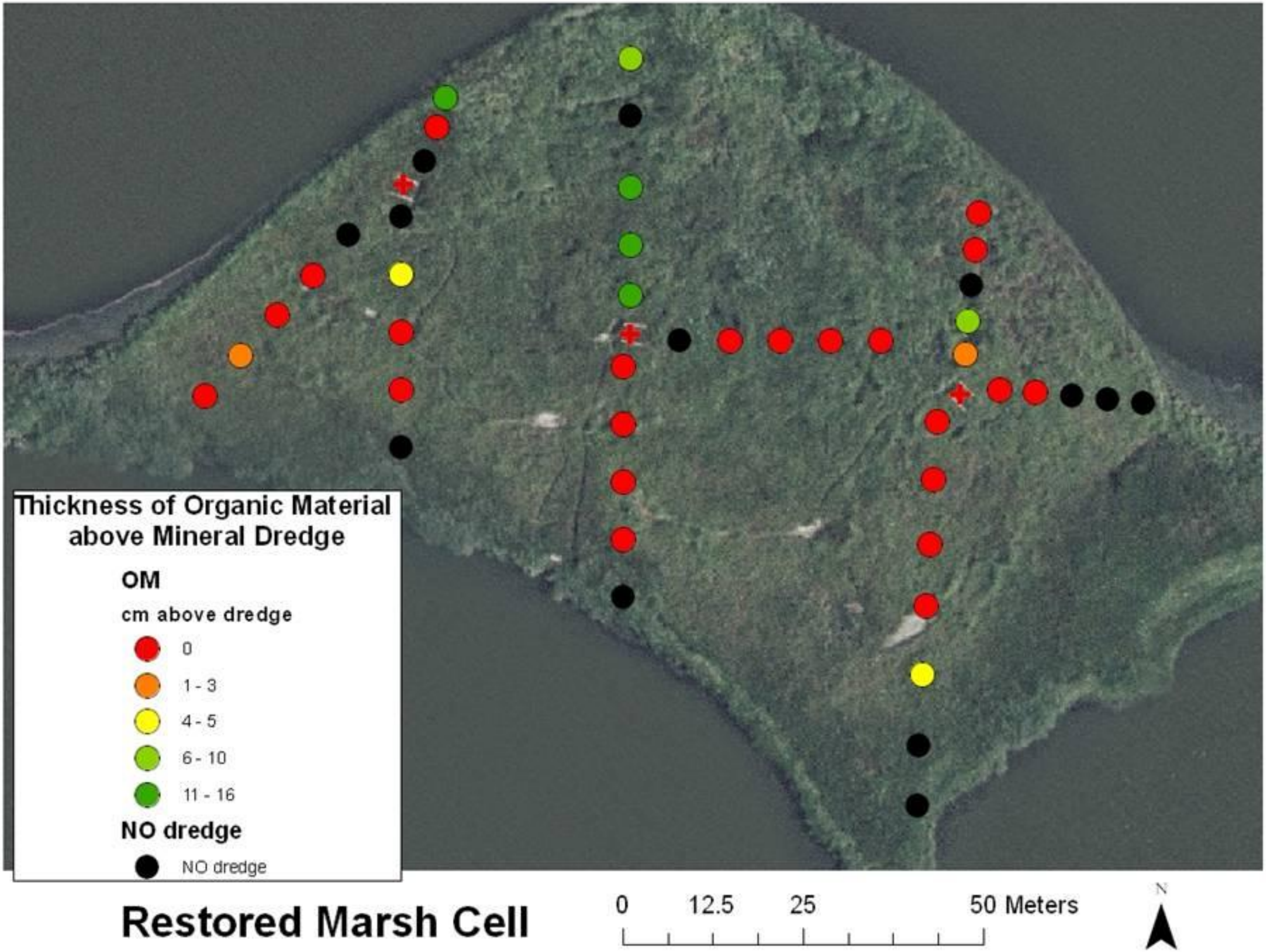
Bulk Density



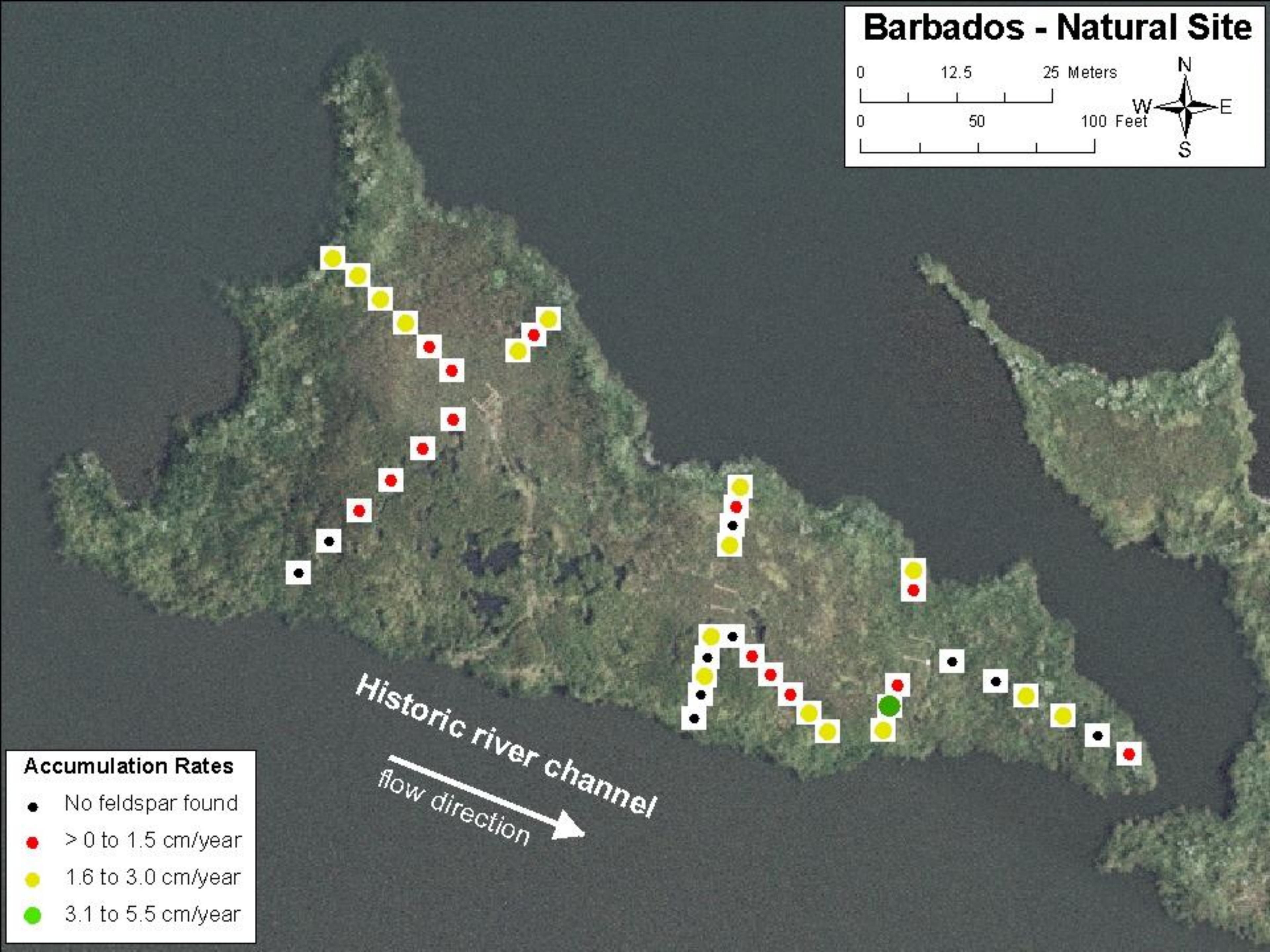
Organic (“O”) horizons

Mineral organic-rich (“A”) horizons

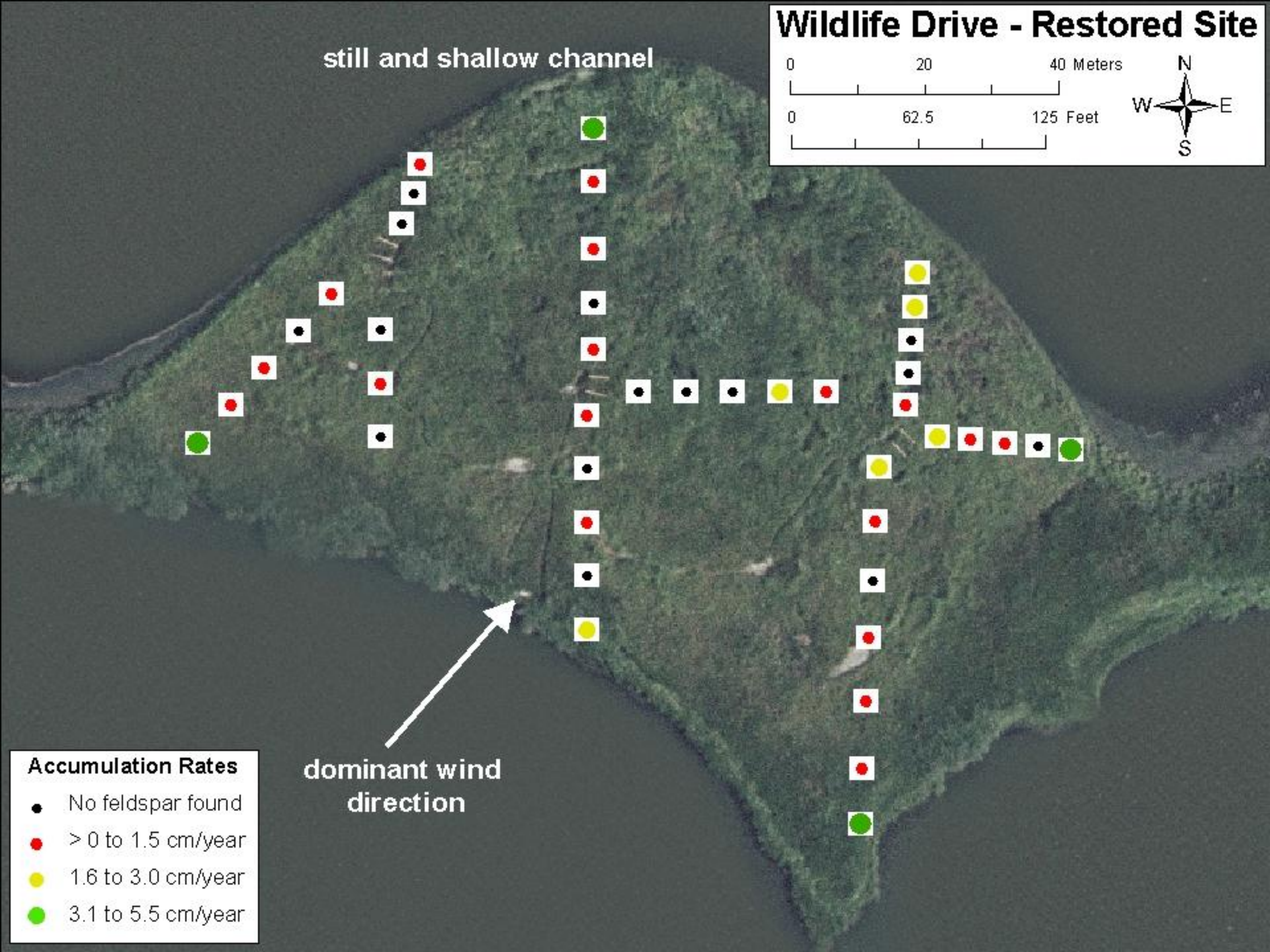
Mineral organic-poor (“C”) horizons



Restored Marsh Cell



Barbados - Natural Site
0
12.5
25 Meters
0
50
100 Feet
N
W
E
S
Historic river channel
flow direction
Accumulation Rates
No feldspar found
> 0 to 1.5 cm/year
1.6 to 3.0 cm/year
3.1 to 5.5 cm/year


Wildlife Drive - Restored Site
0
20
40 Meters
0
62.5
125 Feet
N
W
E
S
still and shallow channel
dominant wind
direction
Accumulation Rates
No feldspar found
> 0 to 1.5 cm/year
1.6 to 3.0 cm/year
3.1 to 5.5 cm/year