U.S. Efforts Towards Incorporating Coastal Wetlands into National Greenhouse Gas Inventories

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NASA Coastal Monitoring System Applications Workshop, Pasadena, California
November 16, 2015

Ecosystems in focus for climate change mitigation

Forest

Peatland

Mangroves

Tidal Marshes

Seagrass

Ecosystem services of Coastal Blue Carbon ecosystems: mangroves, seagrass and marshes

- Biological diversity
- Water quality
- Flood and storm protection
- Forest and non-timber forest products
- Aesthetic and ecotourism values
- Fish and Shellfish
- Carbon Sinks

White House on Coastal Blue Carbon

- **Climate and Natural Resources Working Group (CNRWG) of the U.S. Council on Climate Preparedness and Resilience** (2014). Priority Agenda: Enhancing the Climate Resilience of America's Natural Resources. https://www.whitehouse.gov/sites/default/files/docs/enhancing_climate_resilience_of_americas_natural_resources.pdf

- **Coastal Green Infrastructure and Ecosystem Services Task Force.** (2014). Ecosystem-Service Assessment: Research Needs for Coastal Green Infrastructure. Washington, DC: Office of Science and Technology Policy. https://www.whitehouse.gov/sites/default/files/microsites/ostp/cgies_research_agenda_final_082515.pdf

- ***Council on Environmental Quality***. *Incorporating Ecosystem Services into Federal Decision Making* [Memorandum for Executive Departments and Agencies]. 7 October, 2015. Washington, DC: Executive Office of the President of the United States. https://www.whitehouse.gov/sites/default/files/omb/memoranda/2016/m-16-01.pdf

Carbon Market – Coastal Wetlands

RESTORE AMERICA'S ESTUARIES

Tidal Wetland and Seagrass Restoration Methodology

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.

All three GHGs: N_2O, CH_4, CO_2

METHODOLOGY FOR TIDAL WETLAND AND SEAGRASS RESTORATION

RESTORE AMERICA'S ESTUARIES

Title	Methodology for Tidal Wetland and Seagrass Restoration
Version	20141007
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
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OPEN ACCESS Freely available online

PLOS ONE

Estimating Global "Blue Carbon" Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems

Linwood Pendleton[1], Daniel C. Donato[2*], Brian C. Murray[1], Stephen Crooks[3], W. Aaron Jenkins[1], Samantha Sifleet[4], Christopher Craft[5], James W. Fourqurean[6], J. Boone Kauffman[7], Núria Marbà[8], Patrick Megonigal[9], Emily Pidgeon[10], Dorothee Herr[11], David Gordon[1], Alexis Baldera[12]

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)**

Compare to national emissions from all sources

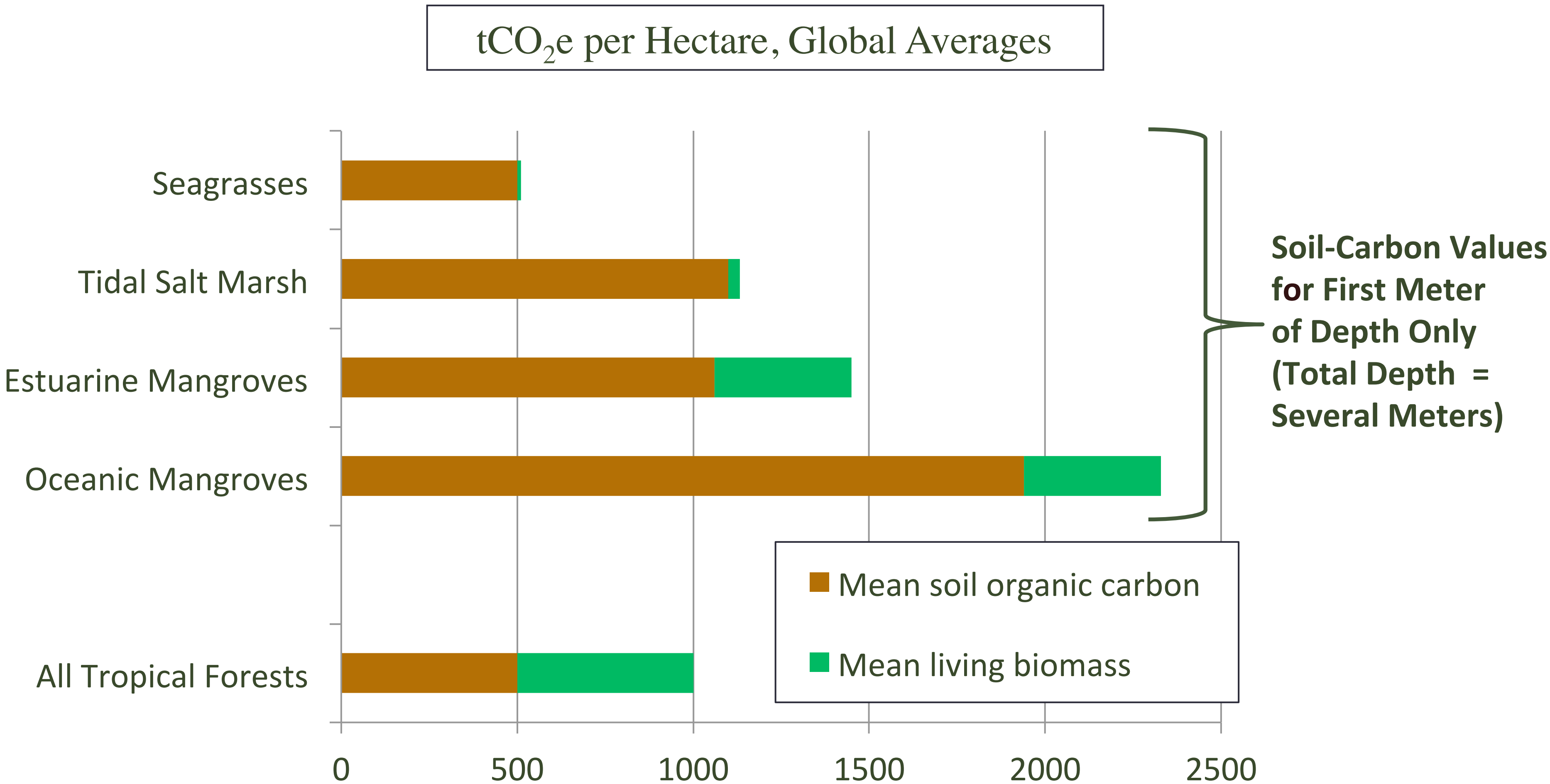
Poland

Japan

Long-term carbon sequestration and storage

Carbon from plants gather in soil and builds up over thousands of years

Distribution of carbon in coastal ecosystems

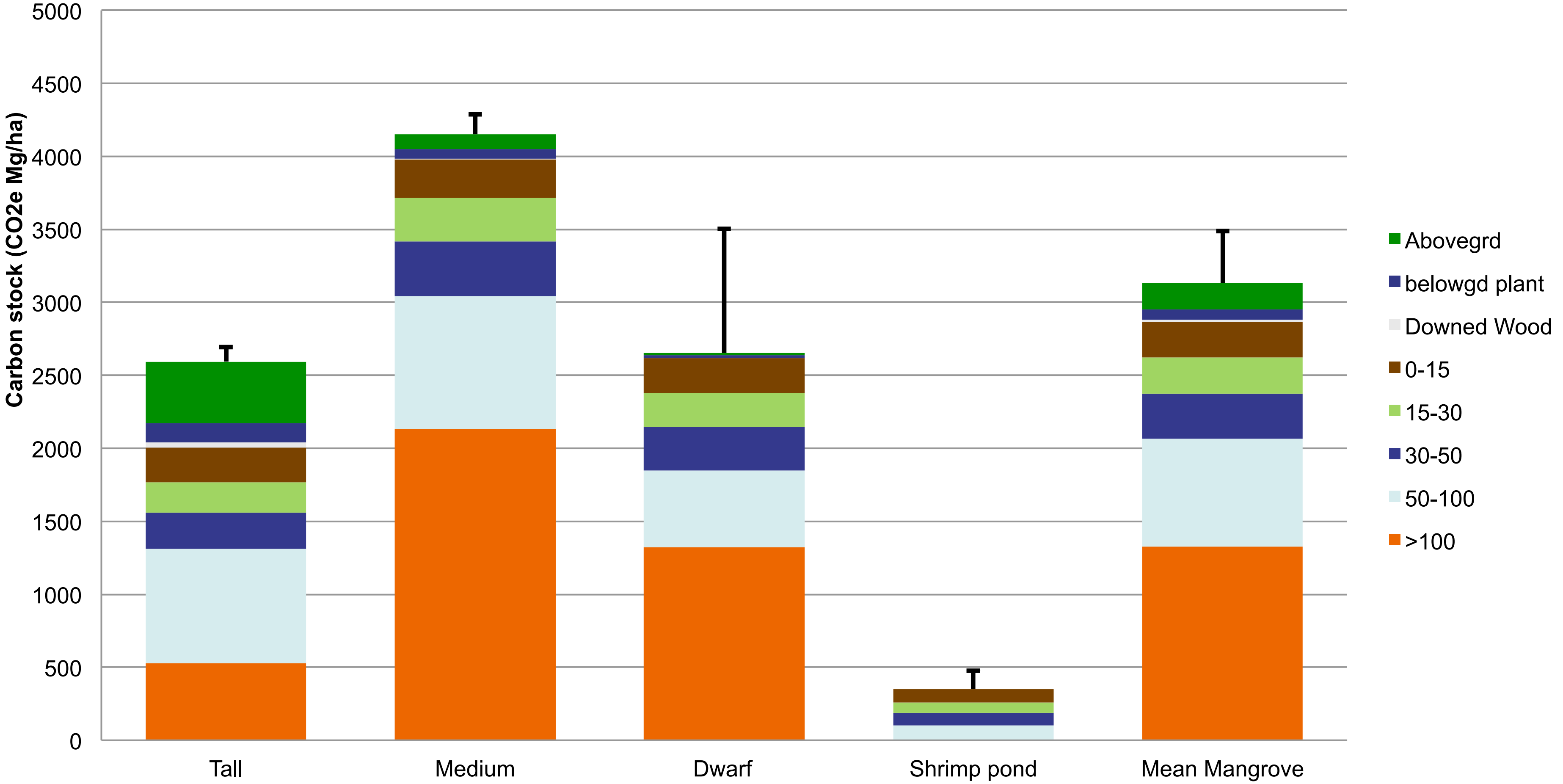


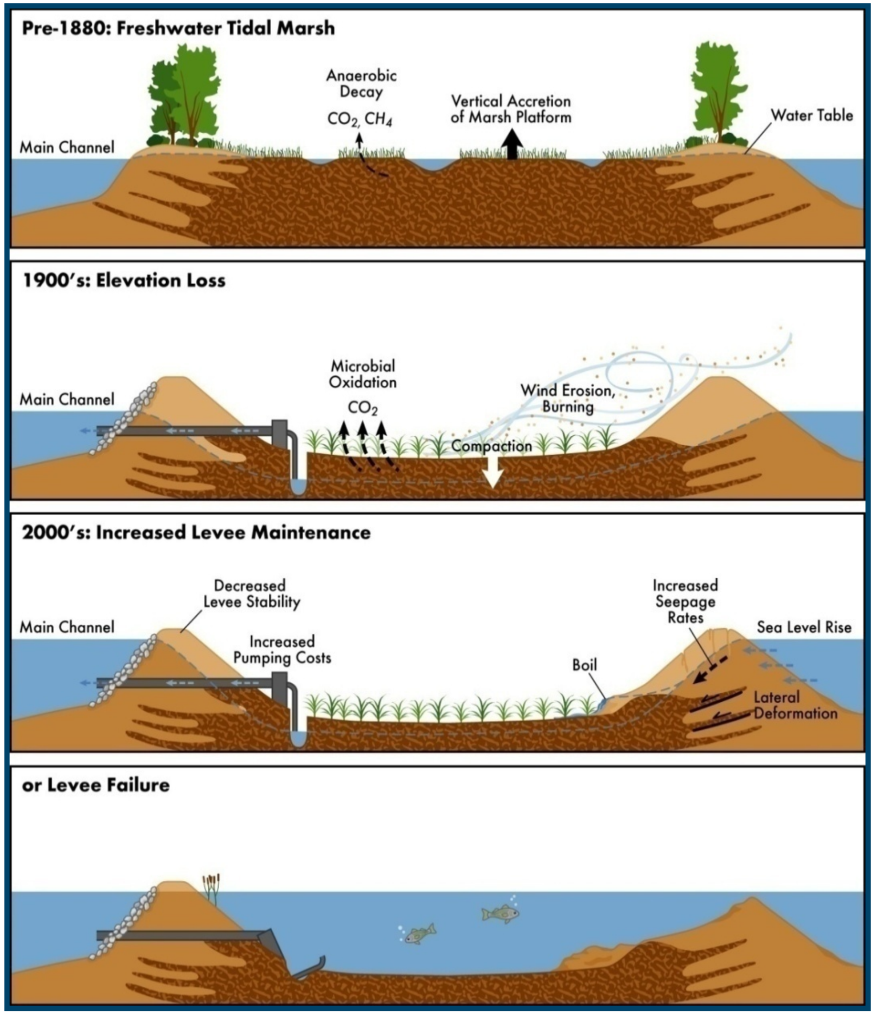
Data summarized in Crooks *et al*., 2011; Murray *et al*., 2011, Donato et al., 2011, Fourqurean et al 2013

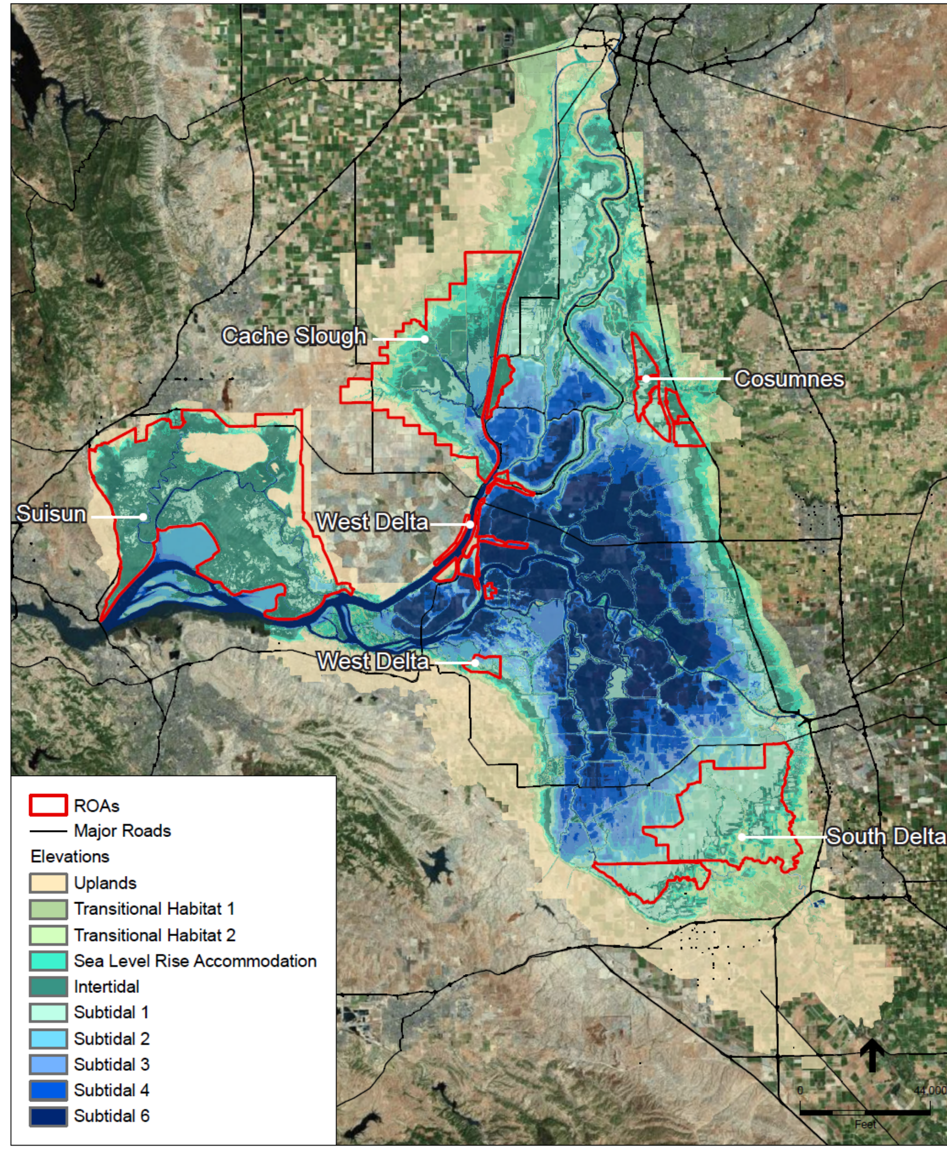
CARBON STOCKS OF NEOTROPICAL MANGROVES ARE AMONG THE LARGEST OF ALL TROPICAL FORESTS

Ecosystem C stocks in CO_2e, Republica Dominicana 2012

Kauffman et al. 2013)







SOURCE:

DWR 2007 LiDAR; ESA-PWA 2012

Bay Delta Science Conference.

Figure 1

Elevations and ROAs of Delta-Suisun Marsh Planning Area

Emissions from One Drained Wetland: Sacramento-San Joaquin Delta

Area under agriculture **180,000 ha**

Rate of subsidence 2.5 cm / yr

1-3 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

Carbon Capture Wetland Farm Bio-Sequestration

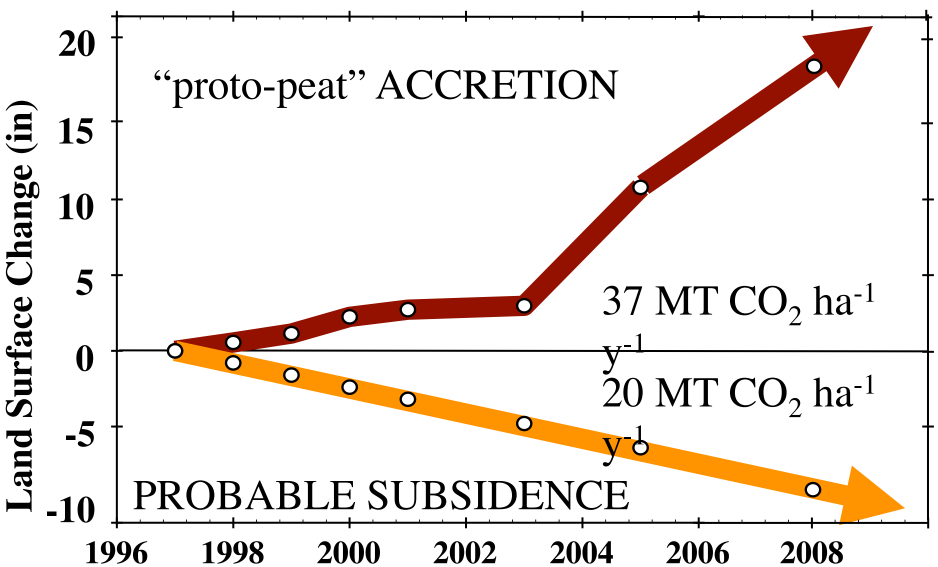
Stops peat oxidation and accretes “proto-peat” rapidly

Continuously submerged about 1 ft

Low oxygen conditions

Balance between plant growth and reduced decomposition

Average annual soil sequestration: 1 kg C m^{-2} yr^{-1} in soil



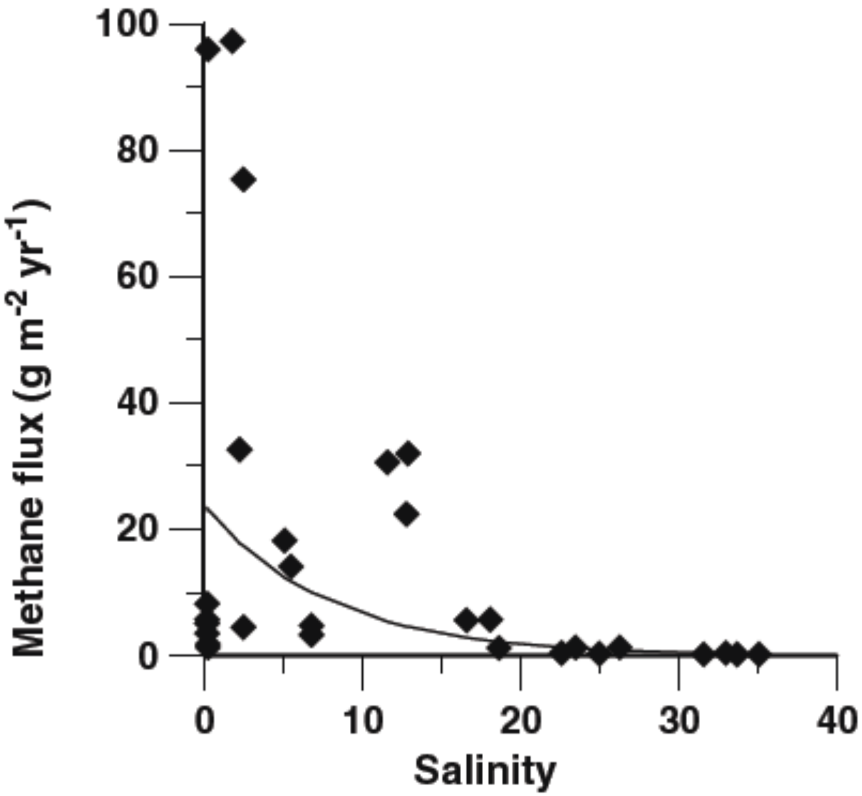
USGS
U.S. Department of the Interior
U.S. Geological Survey

Miller et al. 2008, SFEWS

Methane emissions impaired tidal drainage

Demonstration Project(s)

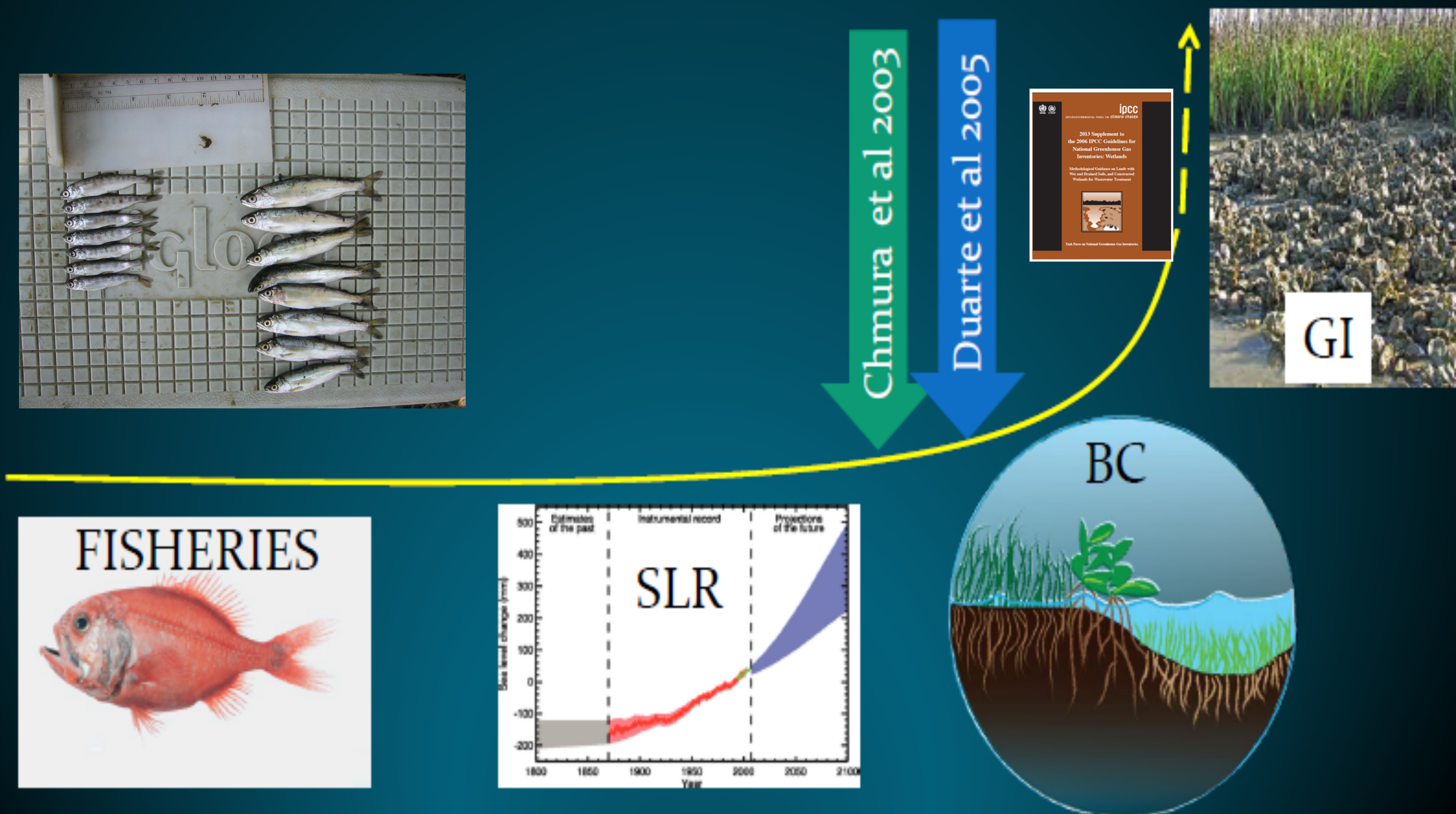
- Herring River Restoration, Cape Cod National Seashore – carbon project feasibility study



Poffenbarger, Needleman and Megonigal 2011

The state of blue carbon science:

a short review of achievements and gaps



IPCC Guidelines for National Greenhouse Gas Inventories

- 1995 Guidelines
- 1996 Revised IPCC Guidelines
- 2000 Good Practice Guidance and Uncertainty Management
- 2003 Good Practice Guidance for Land Use, Land-Use Change and Forestry
- 2006 IPCC Guidelines
- 2013 IPCC Wetlands Supplement
- 2013 Revised Supplement to the Kyoto Protocol

IPCC Land Classification

Forest land

- All woody vegetation according to national definitions

Cropland

- Crops including rice and agro-forestry not included above

Grassland

- All rangelands and pastures not included above

Settlements

Wetlands

- Wetlands not included above (peat use and flooded lands)

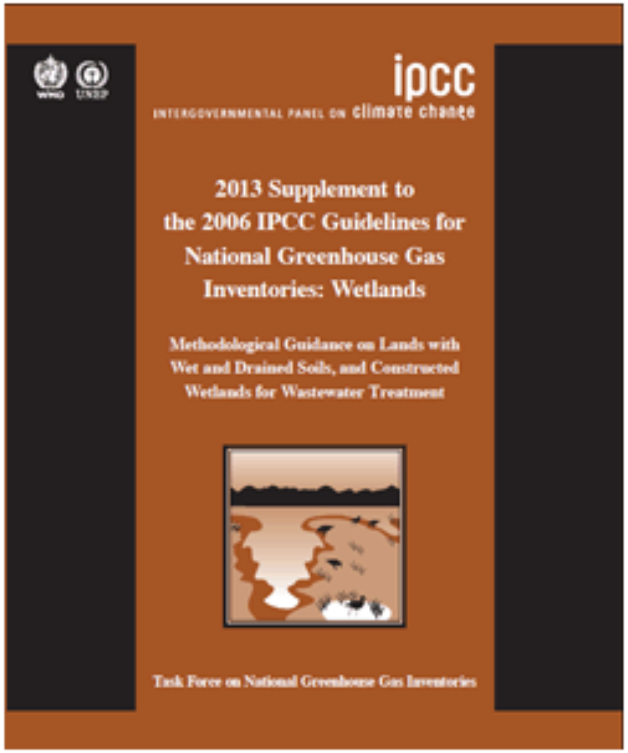
Other Lands

- Includes bare soil, rock, ice and lands not included above

2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands

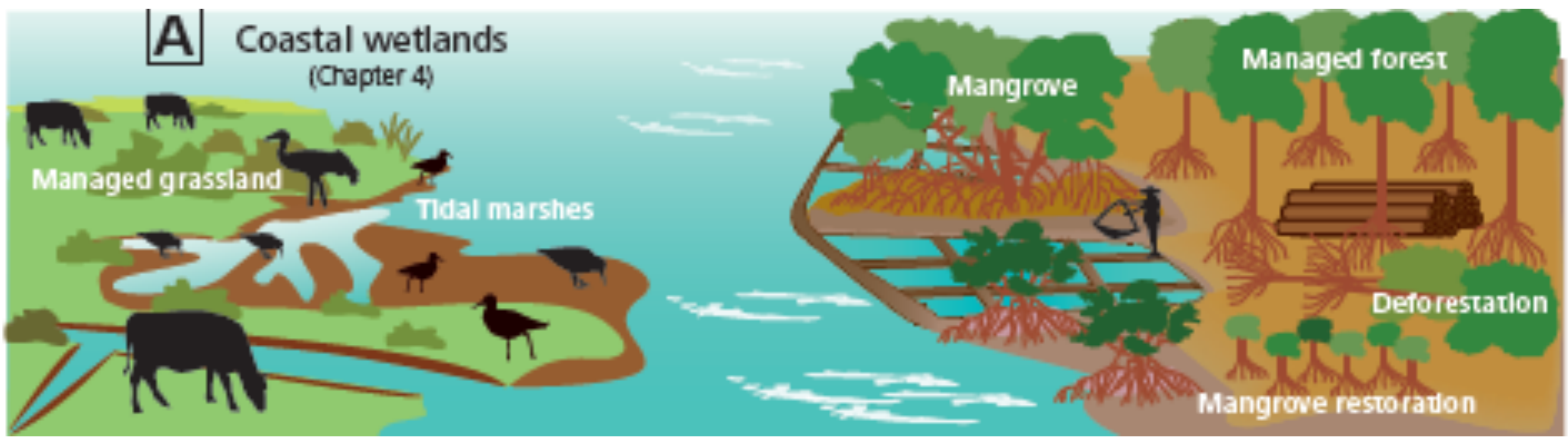
- Introduction
- Cross cutting guidance on organic soils
- Rewetting and restoration of organic soils
- Coastal wetlands
- Other freshwater wetlands
- Constructed wetlands
- Good practice and implications for reporting

- Adopted by IPCC Oct 2013, Published Feb 2014
- http://www.ipcc-nggip.iges.or.jp/



Chapter 4: Coastal Wetlands of the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*

- Updated default data for estimation of C stock changes in mangrove living biomass and dead wood pools
- New generic methodological guidance and data on:
  - CO_2 emissions and removals on coastal wetlands on organic and mineral soils for specific management activities
  - N_2O emissions during aquaculture use
  - CH_4 emissions from rewetted soils and creation of mangroves and tidal marshes



U.S. Coastal Wetland Carbon Working Group

U.S. National Oceanic and Atmospheric Administration (Coastal Management, Habitat Conservation, International), U.S. Environmental Protection Agency (Climate Change, Wetlands), U.S. Geological Survey, U.S Forestry Service, Environmental Science Associates, Florida International University, Smithsonian Environmental Research Center, Restore America's Estuaries, Colorado State University, Pennsylvania State University, Texas A & M.

U.S. Coastal Wetlands: Potential Emissions and Removal

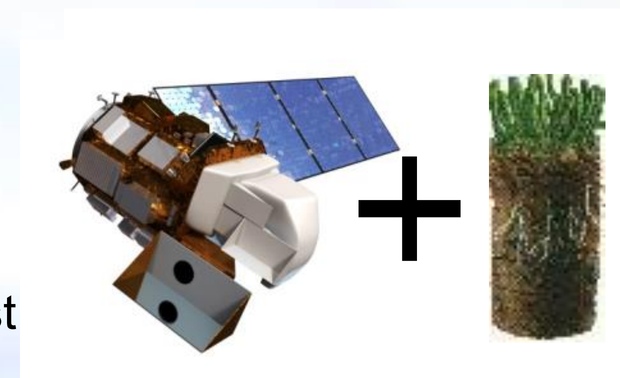
- Drainage and excavation
- Human induced subsidence of wetlands (erosion)
    - (e.g. Mississippi Delta)
- Methane emissions from tidally disconnected /impounded waters
- Forestry activities on coastal wetlands.
- Aquaculture (operations)
- Restoration of coastal wetlands and seagrasses

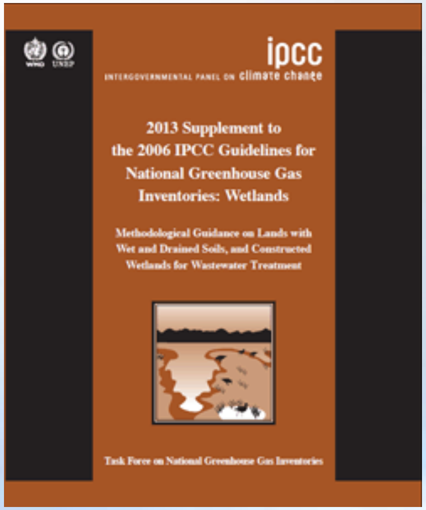
"Blue" Carbon Monitoring System

Linking soil and satellite data to reduce uncertainty in coastal wetland carbon burial: a policy-relevant, cross-disciplinary, national-scale approach

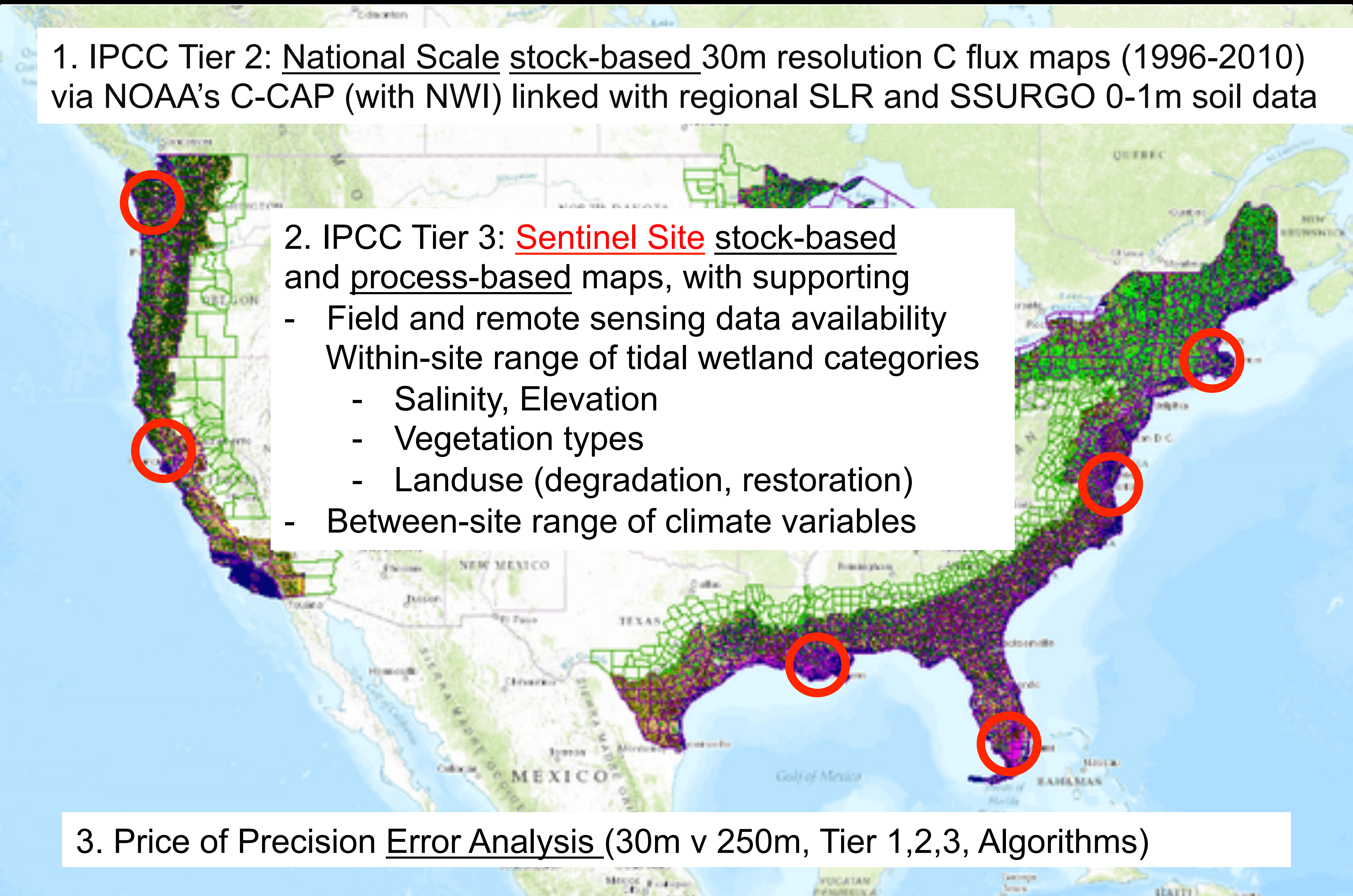
Lisamarie Windham-Myers (18 Science PIs; October 2014-17)

Federal		Non Federal	
USGS	Brian Bergamaschi	U. South Carolina	Jim Morris
	Kristin Byrd	U. Maryland/NOAA	Ariana Sutton-Grier
	Judith Drexler	U. San Francisco	John Callaway
	Kevin Kroeger	Florida Intl. U.	Tiffany Troxler
	John Takekawa	Texas A&M U.	Rusty Feagin
	Isa Woo	Independent	Stephen Crooks
Postdoc:	Meagan Gonneea		
NOAA-NERR	Matt Ferner		
Smithsonian	Pat Megonigal		
	Don Weller		
	Lisa Schile		
Postdoc:	James Holmquist		
NASA-JPL	Marc Simard		





“Blue” CMS – Product Goals



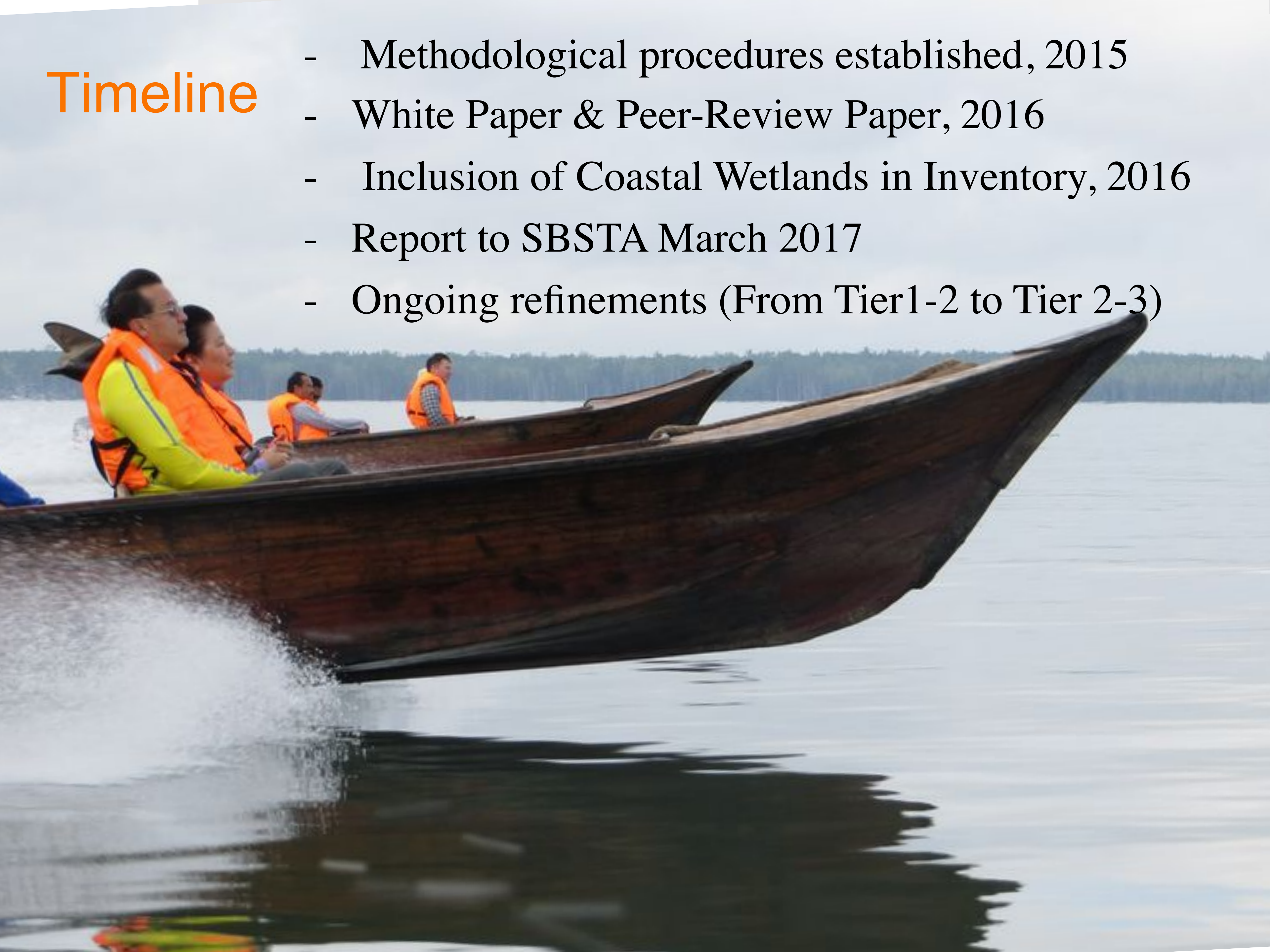
1. IPCC Tier 2: National Scale stock-based 30m resolution C flux maps (1996-2010) via NOAA’s C-CAP (with NWI) linked with regional SLR and SSURGO 0-1m soil data

2. IPCC Tier 3: Sentinel Site stock-based and process-based maps, with supporting
- Field and remote sensing data availability
  Within-site range of tidal wetland categories
  - Salinity, Elevation
  - Vegetation types
  - Landuse (degradation, restoration)
- Between-site range of climate variables

3. Price of Precision Error Analysis (30m v 250m, Tier 1,2,3, Algorithms)

Timeline

- Methodological procedures established, 2015
- White Paper & Peer-Review Paper, 2016
- Inclusion of Coastal Wetlands in Inventory, 2016
- Report to SBSTA March 2017
- Ongoing refinements (From Tier1-2 to Tier 2-3)



Support Request

Carbon Science Information:

National Inventory

Linking vegetation / geomorphology to CH_4 and CO_2 fluxes

CH_4 emissions coastal wetlands impounded waters

Fate of mobilized (eroded) carbon

Mapping of wetland distribution and change (seagrass?)

Markets and predictive tools

Nearshore suspended sediment concentrations

N_2O & CH_4 emissions coastal lowlands (agriculture etc)

Frequency:

Inventory emissions and removals reported annually.

Suspended sediment annualized in models