BRINGING WETLANDS to MARKET
Nitrogen & Coastal Blue Carbon

**Capitalizing on Coastal Blue Carbon**

The Conference Center at Massasoit Community College | *May 12-13, 2015*

WAQUOIT BAY
NATIONAL ESTUARINE RESEARCH RESERVE

USGS
science for a changing world

# The state of blue carbon science:

## a short review of achievements and gaps

# The state of blue carbon science:

## a short review of achievements and gaps

**Lisamarie Windham-Myers**

National Research Program, Menlo Park, CA

Thank you WBNERR and colleagues for the invitation.

Acknowledgements : many colleagues who shared slides or data

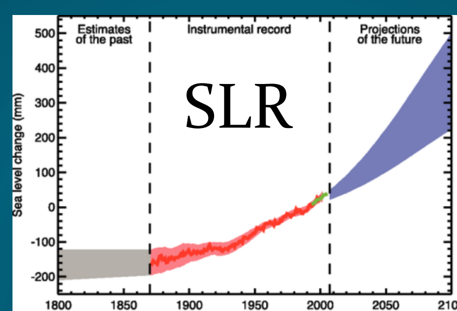
USGS science for a changing world

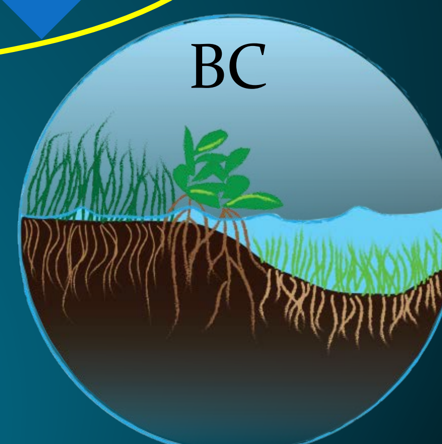
# The state of blue carbon science:
## a short review of achievements and gaps

Chmura et al 2003

Duarte et al 2005

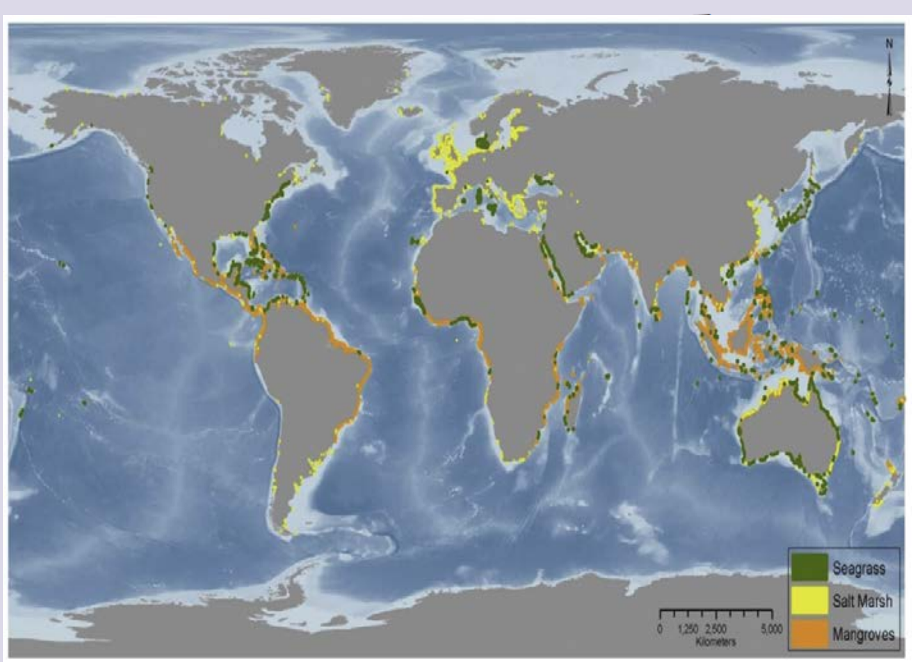




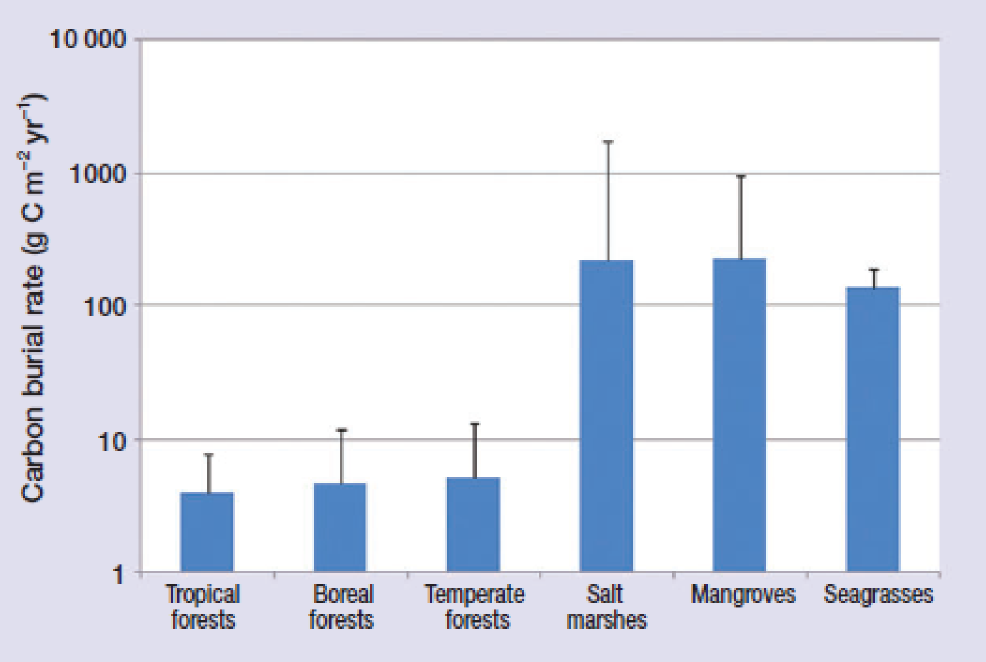



# Eyes of the world are on us: Policy

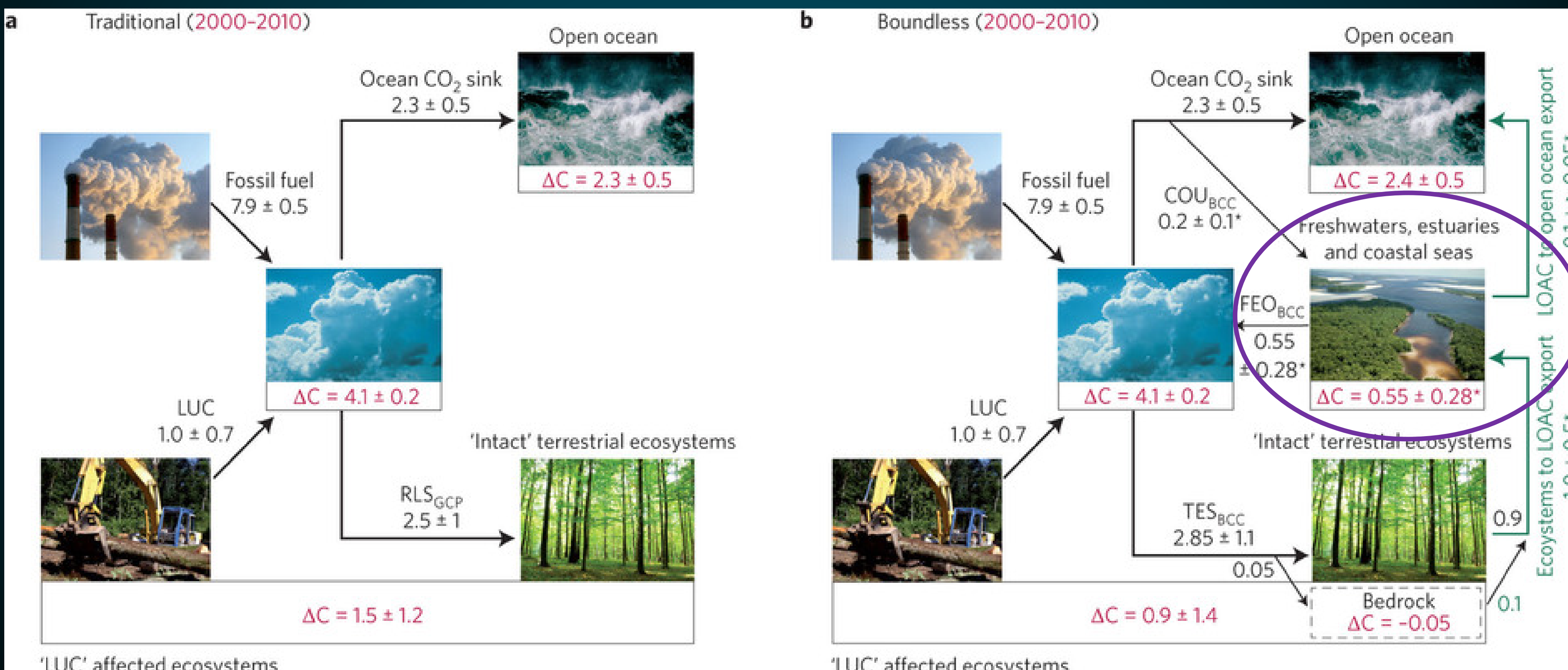
Emissions: Pendleton et al 2012




Burial Rates: McLeod et al 2011



# Eyes of the world are on us: Terrestrial C Budget




Philippe Regnier et al. 2013. Nature Geoscience 6: 597-607

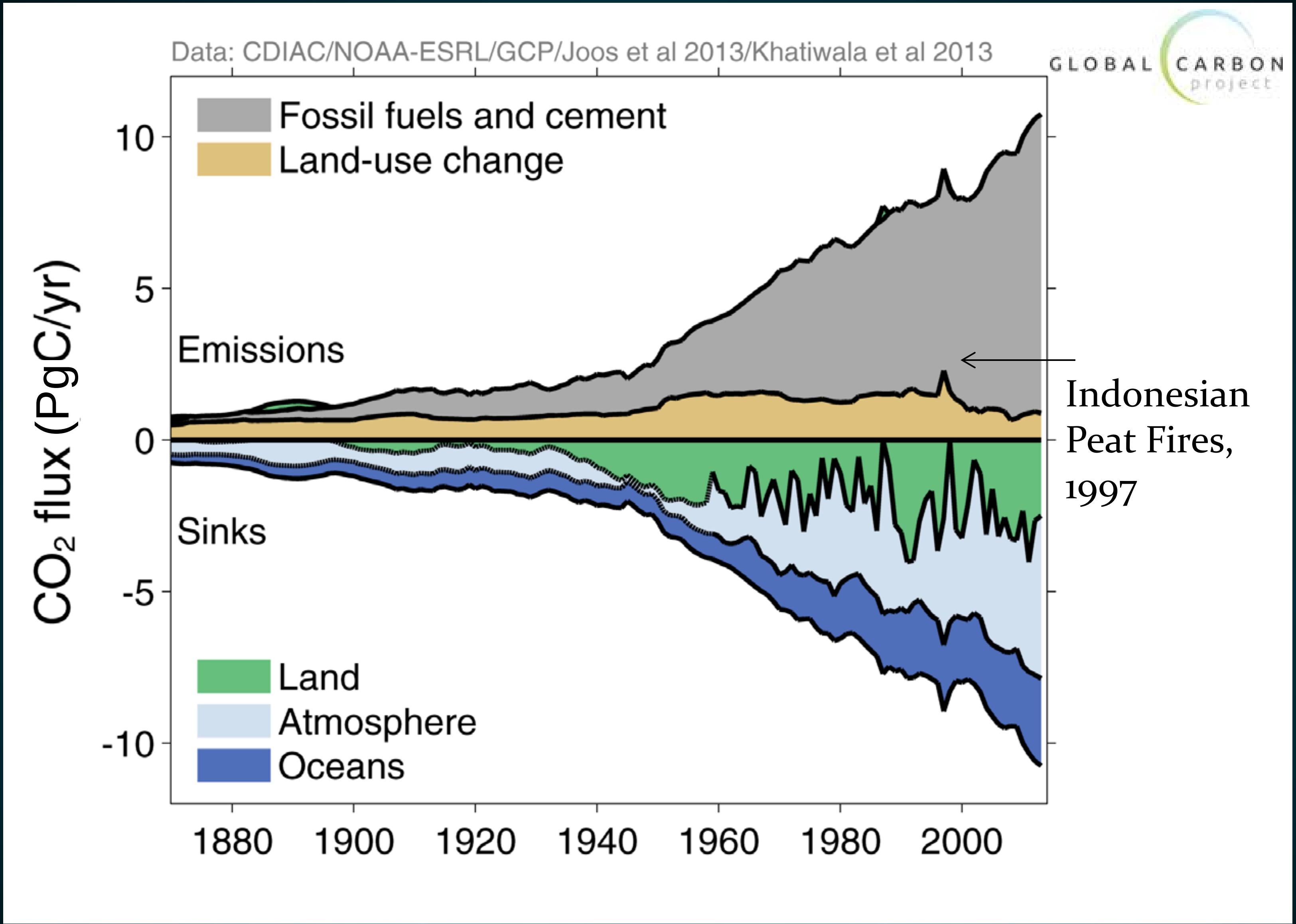
# Eyes of the world are on us: Marine C Budget

| Global Coastal C Flux (depth <200m = 4.7 % of ocean) | Pg C $yr^{-1}$ | % of total ocean C flux Dunne et al. 2007 |
|---|---|---|
| Primary Production | 6.5 | 12 |
| Export Production | 2.0 | 21 |
| Burial | 0.67 | 86 |

## 0.1 – 0.2 Pg C $y^{-1}$ in coastal vegetated wetlands

(25% of burial)

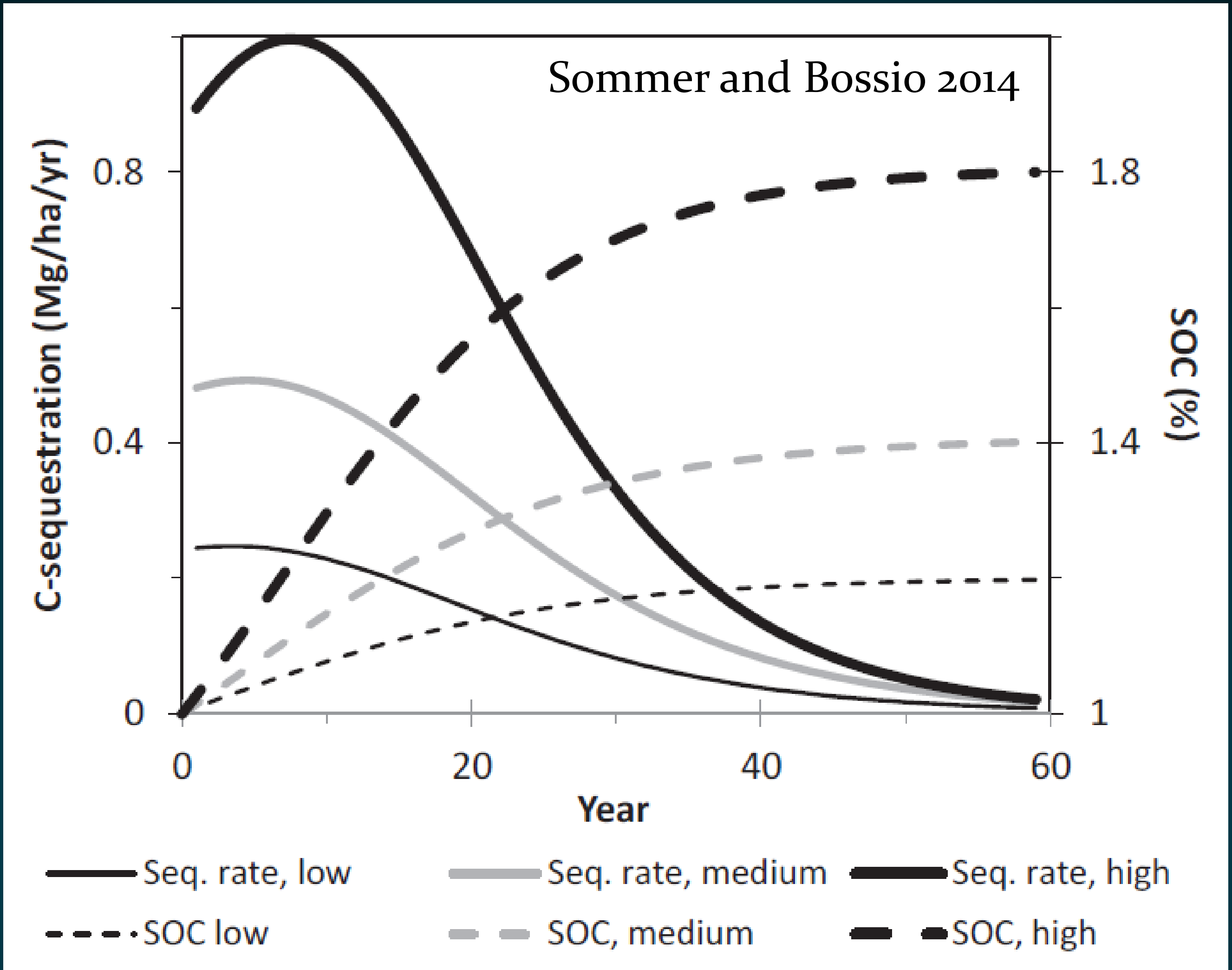
# Blue Carbon Flux (0.2 Pg): Small Fraction of Global C flux



# OUR CHALLENGE:
# Standing on the shoulders of giants AND **remaining grounded**

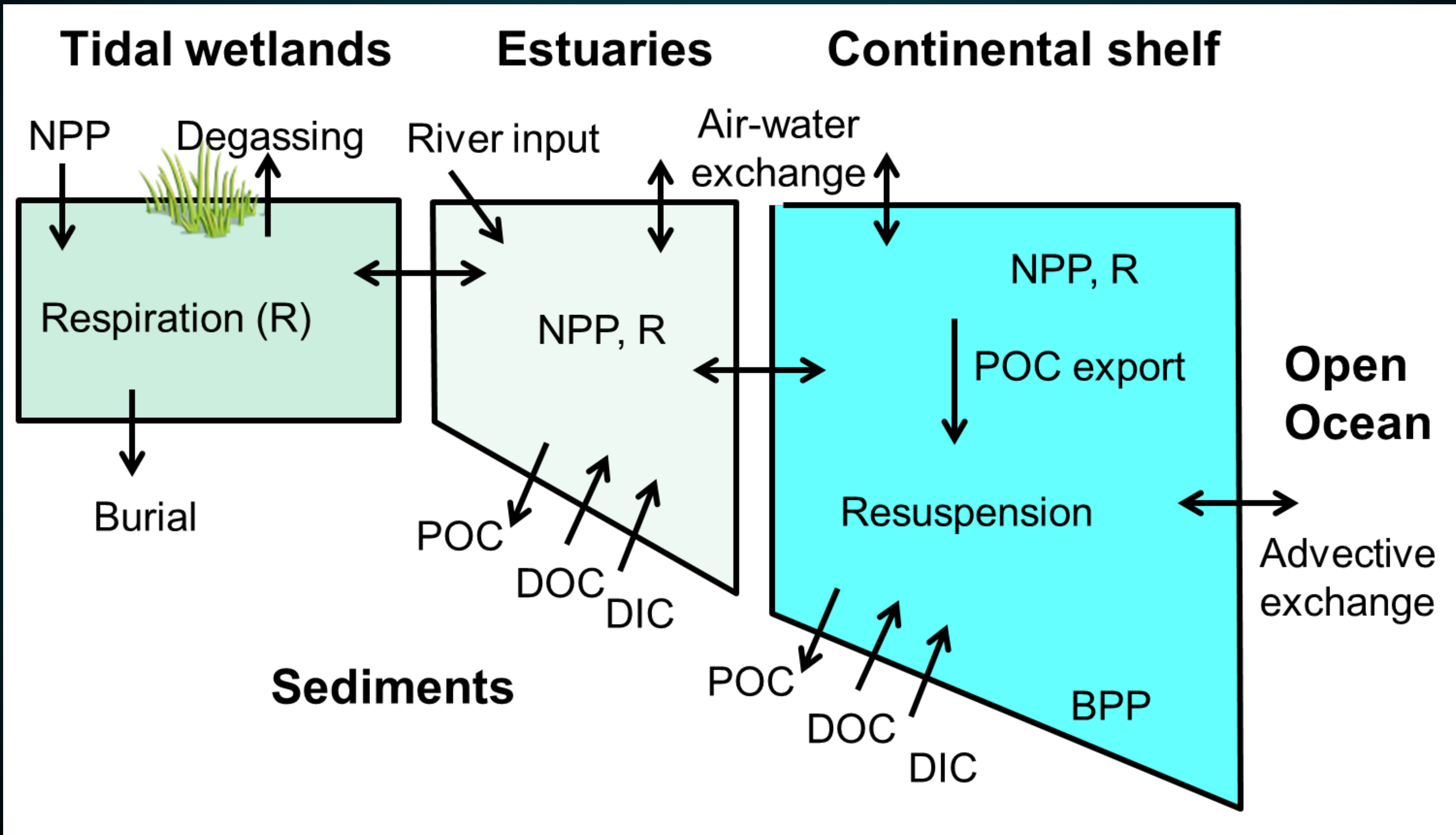
- Do the best science possible
- Avoid "overselling" – clear terminology and timescales
  burial v storage v sequestration
- Consider C sequestration just **1** ecosystem service among many

# Climate mitigation: Wetlands v. agricultural soil management

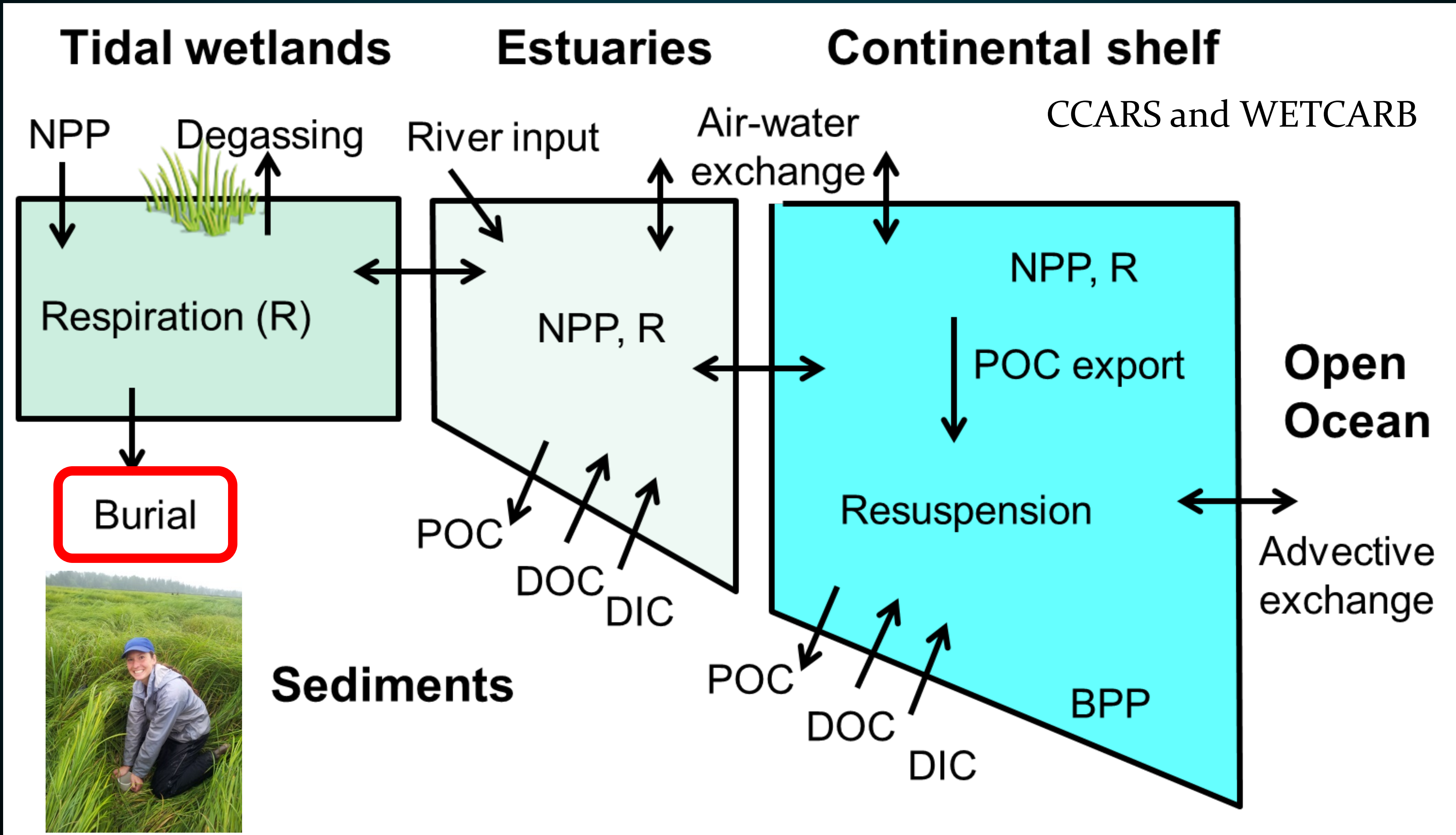



**Global saturation after 31-64 Pg C**

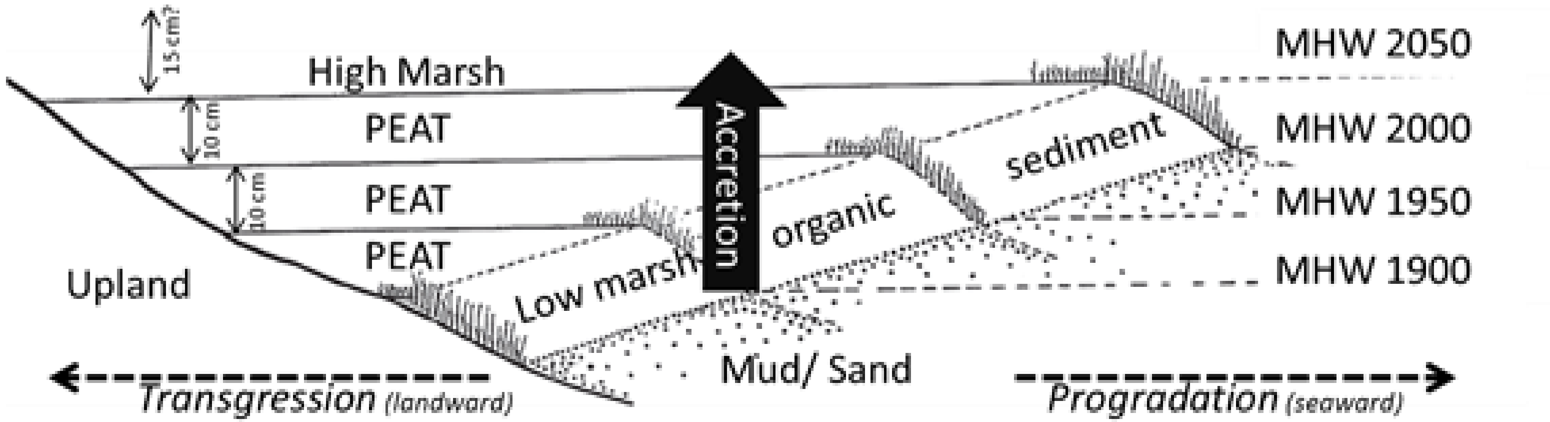
# Land-ocean carbon accounting (CCARS, WETCARB): relies on remote sensing, modeling



# Blue Carbon: Soil grows continuously, does not saturate

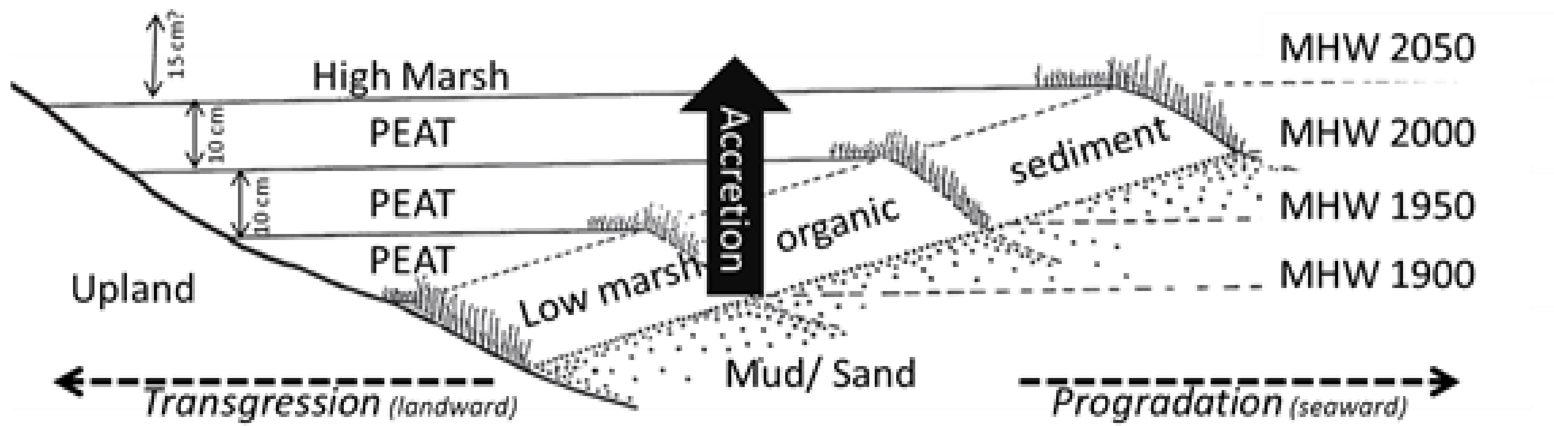


# Carbon accumulates as marshes grow: out, in and up



# Carbon accumulates as marshes grow: out, in and up

Sediment + OrgMatter limited

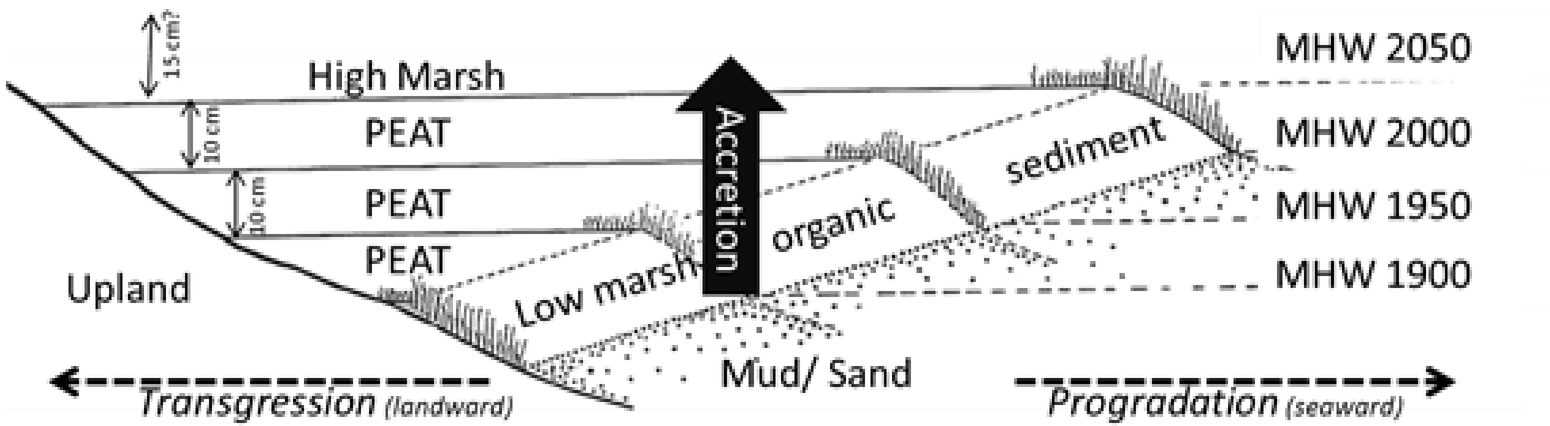



Physically limited
Topography and Sea Level Rise

Sediment limited

# Carbon accumulates as marshes grow: out, in and up

Sediment + OrgMatter limited




Physically limited
Topography and Sea Level Rise

Sediment limited

# Carbon is vulnerable, lost when drained or eroded

# Best Science Possible: for C cycle science OR accounting

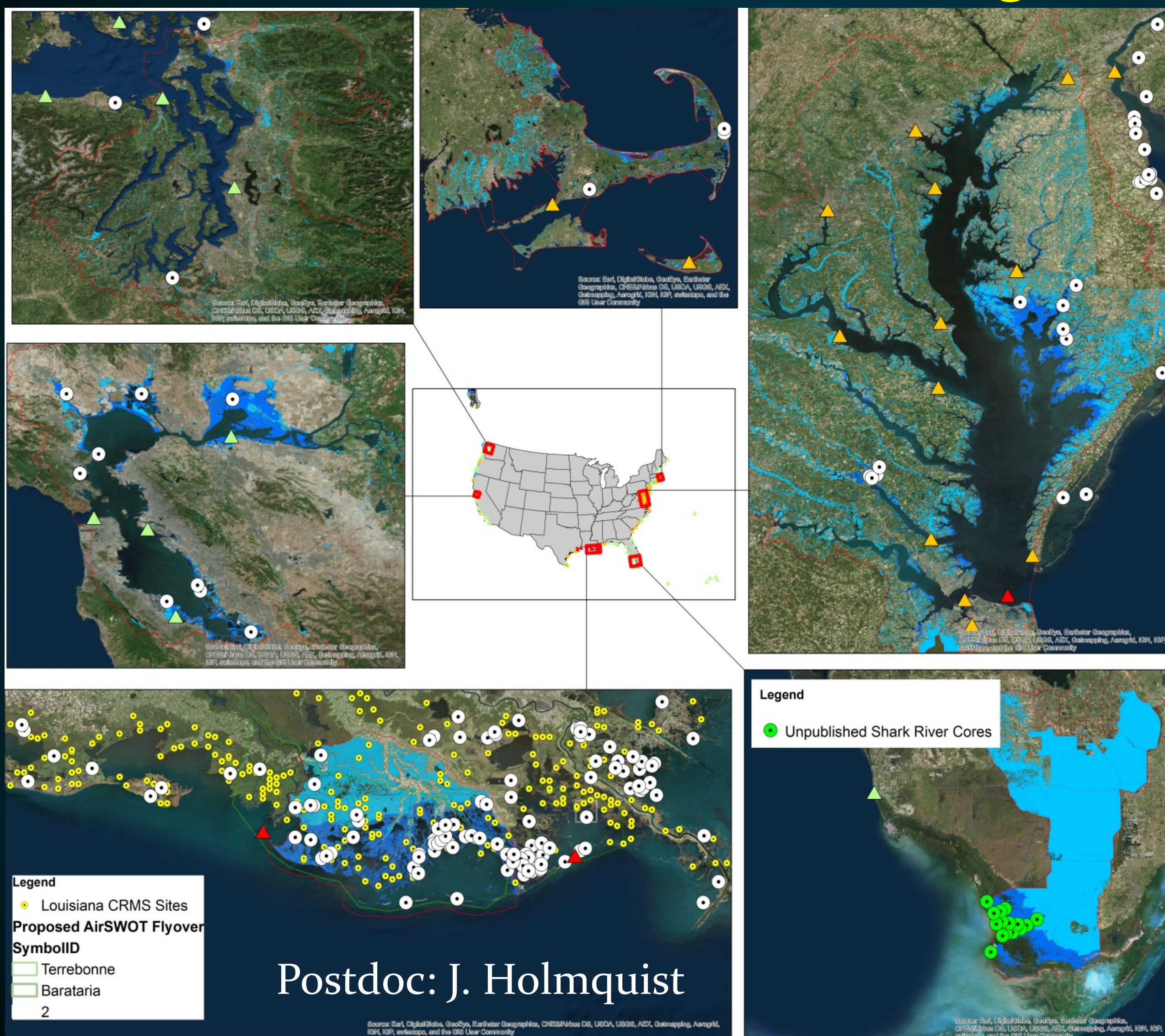
1. Data mining
2. Accurate mapping (granularity)
3. Ecosystem-level accounting
4. Stock measurements
5. Provenance
6. Resilience and fate of coastal soil C
7. Multiple stressors
8. Greenhouse gas modeling

# Best Science Possible: Data mining

## NASA Blue CMS

18 PI's, 2014-17

Monitoring, reporting and verification (MRV) system

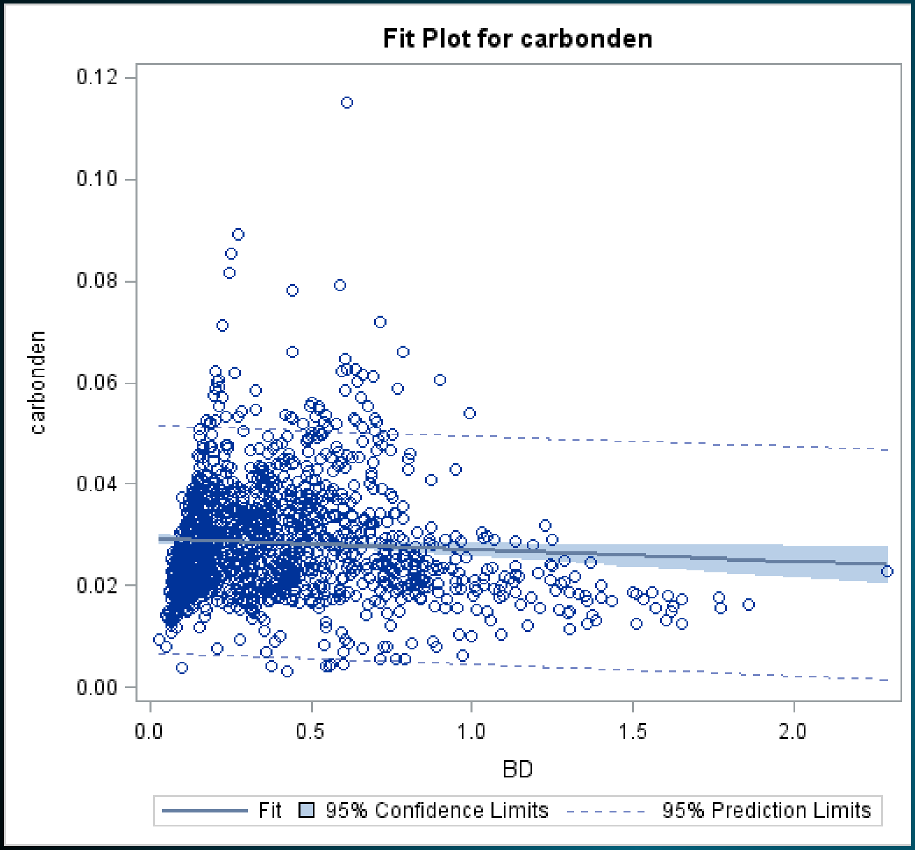


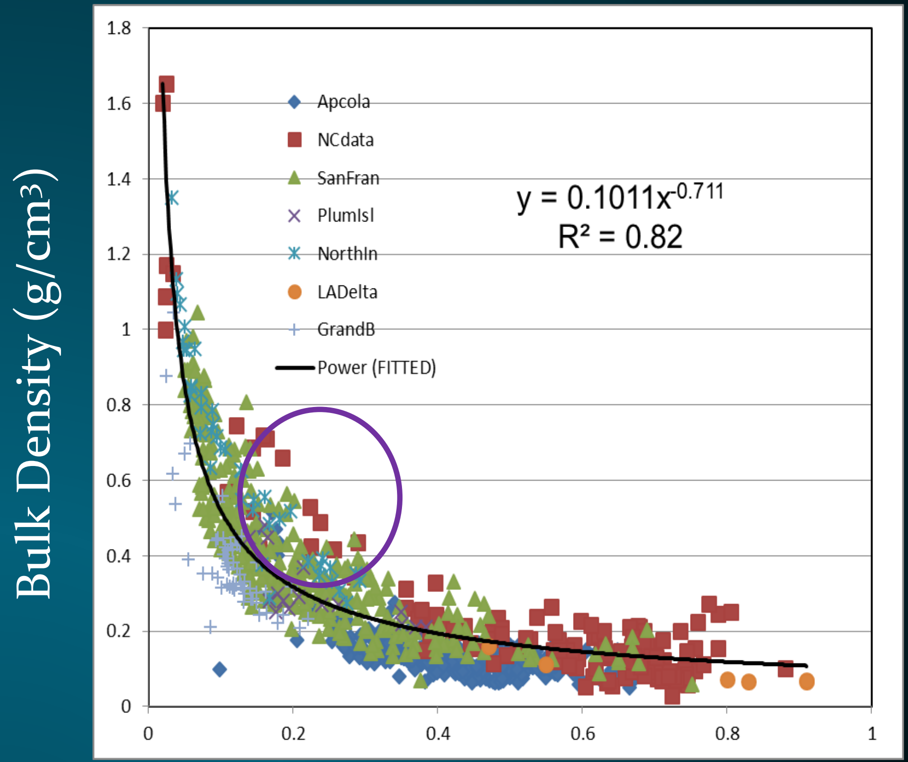

Postdoc: J. Holmquist

# Best Science Possible: Data mining

## Carbon density: mean = 0.028 +- 0.01 gC/cm³ (+- SD)

Meta-analysis of 1358 tidal marsh soils – Jim Morris (in prep)



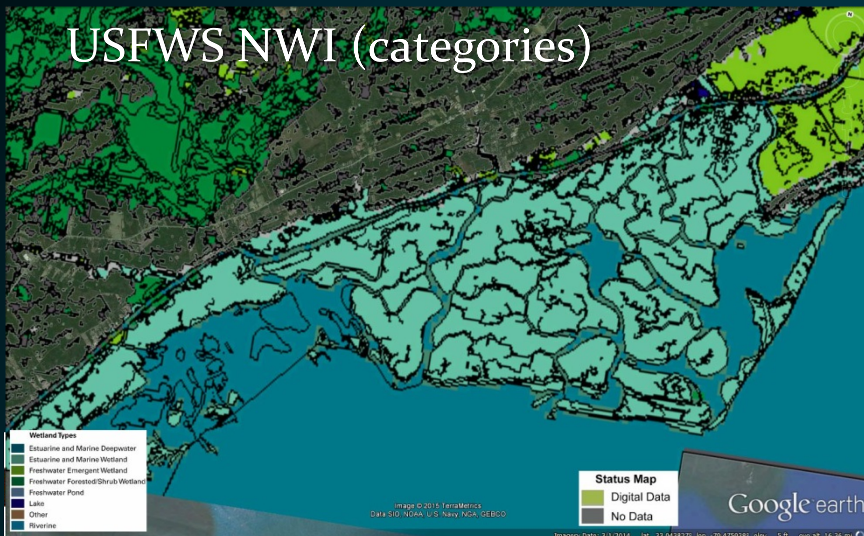

Weight Loss Upon Ignition (LOI) (g/g)

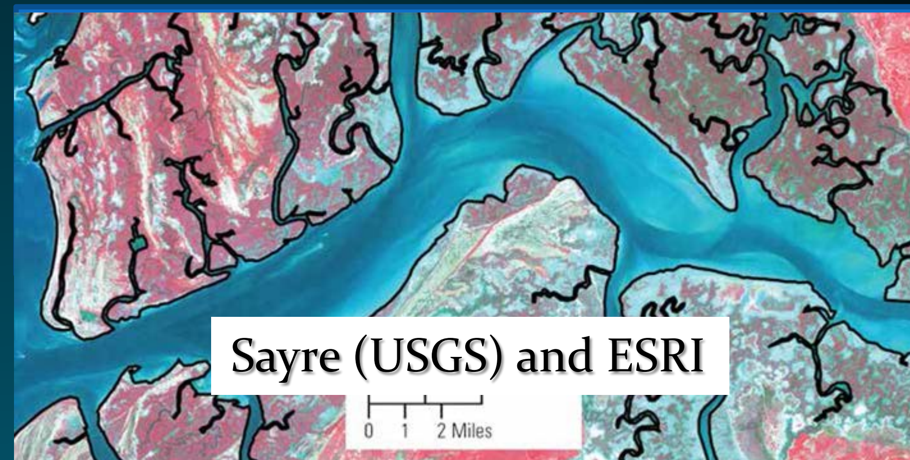
# Best Science Possible: Accurate mapping (categories)

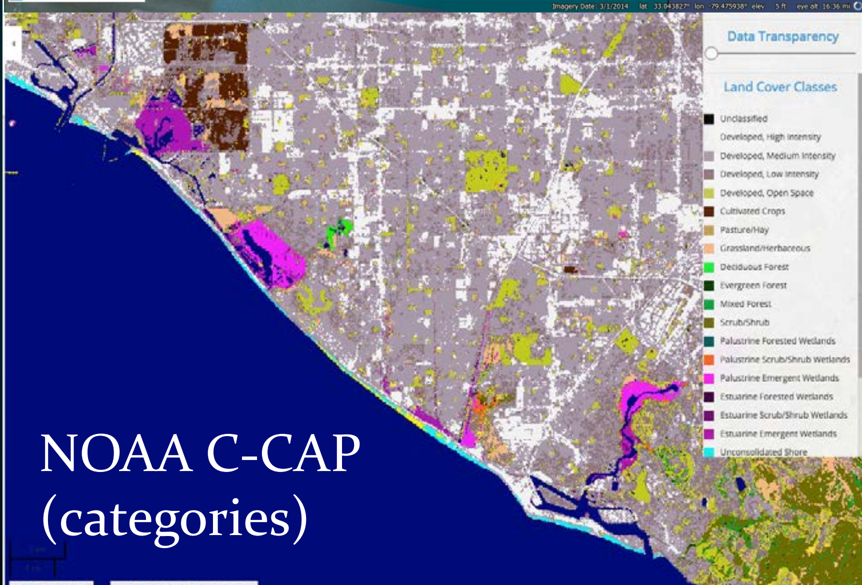


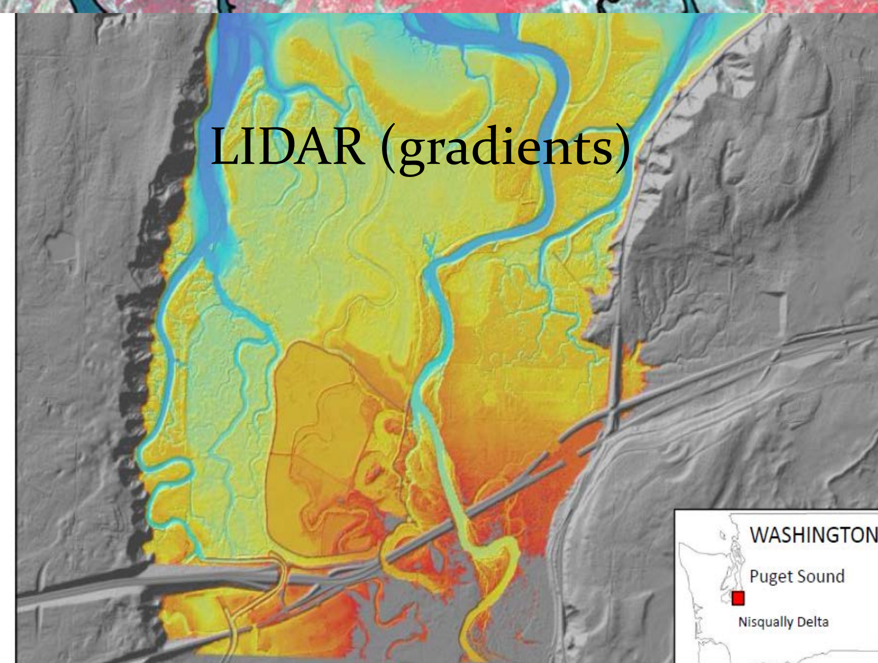
New Report: CEC 2014, N. America's Blue Carbon (Chmura, Short, Torio et al.)

# Best Science Possible: Accurate mapping (subhabitats)

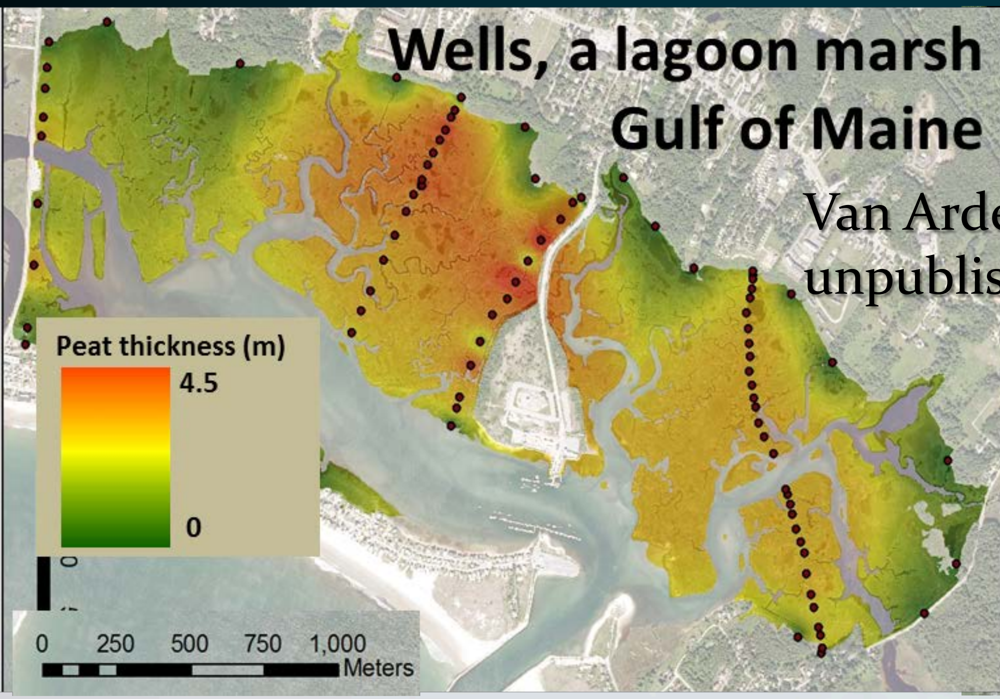


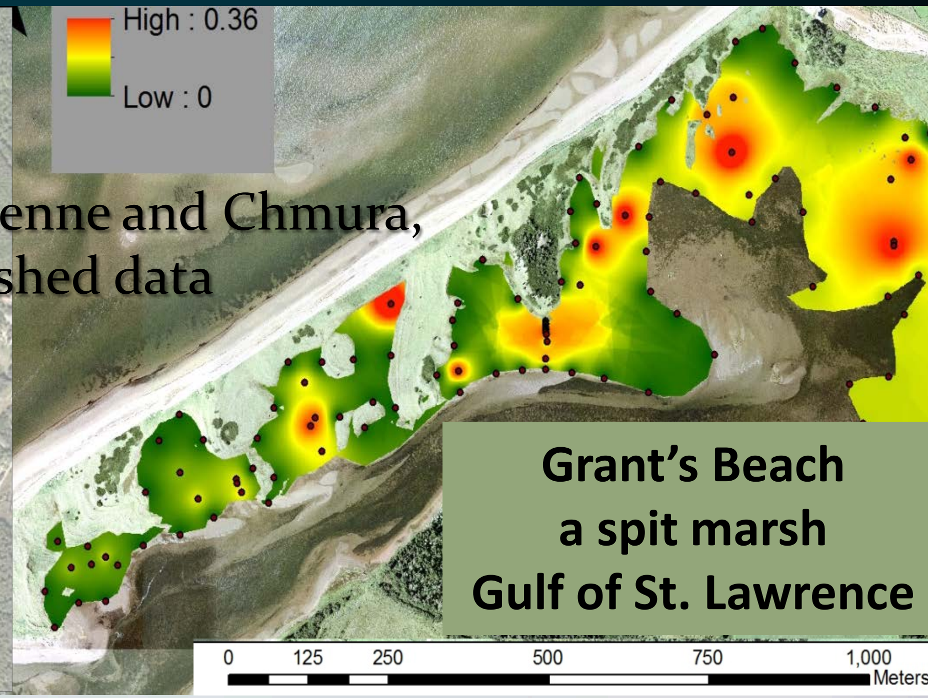



# Best Science Possible: Stock measurements (beyond 1 m)




Van Ardenne and Chmura, unpublished data

Soil cores / probing are necessary for peat depth
GPR influenced by salinity, saturation

>4 meters (12.17.2014)
Megonigal and Schile,

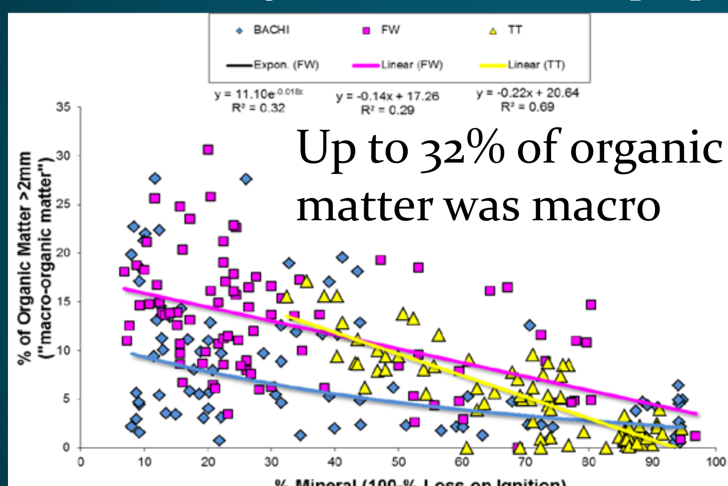
# Best Science Possible: Provenance (identity, age, source)

Example from freshwater tidal CA delta

Isotopes $^{13}C/^{12}C$ as low as $4/sample

All macroorganic matter (>2mm) = autochtonous

Windham-Myers and Drexler, in prep


# Resilience and fate: example of Louisiana vs. California

## Projected Coastal LA Trends

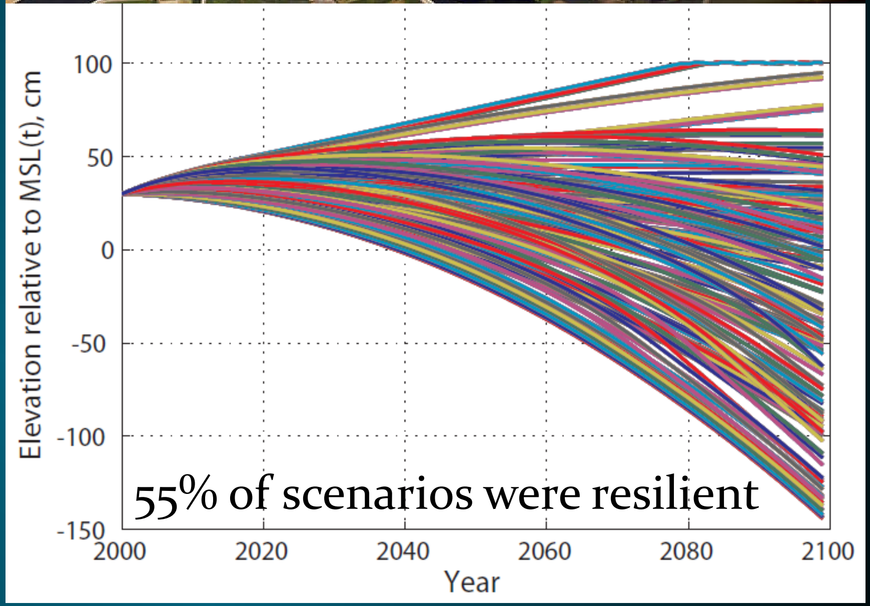
Land Loss 1956-2000
Projected Land Loss 2000-2050

Land Gain 1956-2000
Projected Land Gain 2000-2050

Land
Water

(NWRC, 2006)

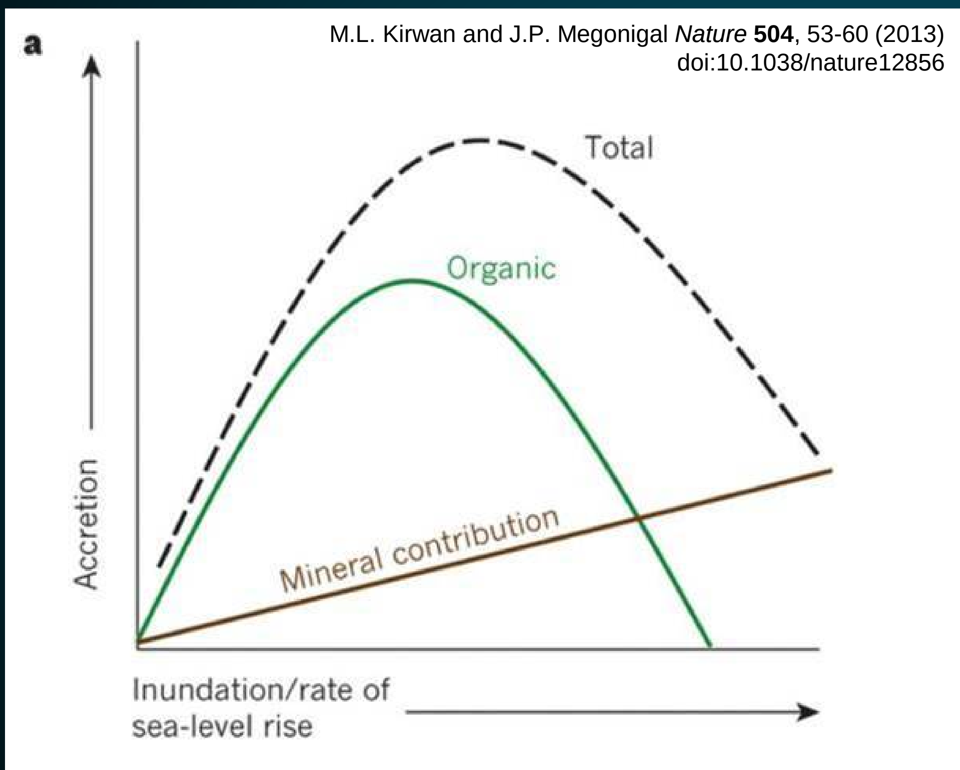
## Projected CA Delta Islands



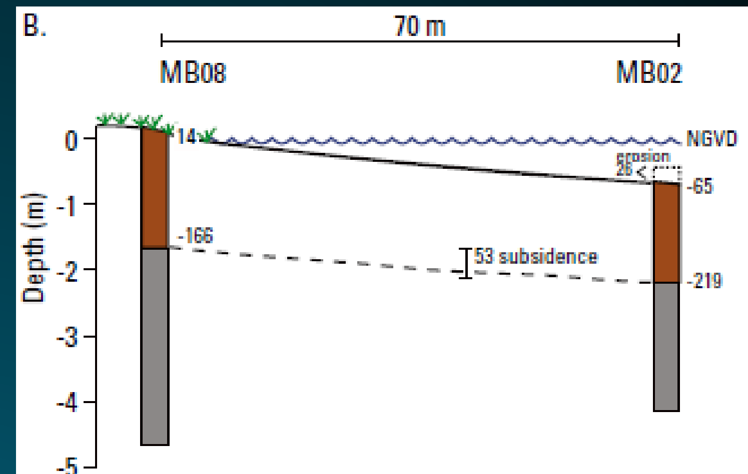

(Swanson et al 2015, SFEWS)

# Resilience and fate : eroding v submergence v oxidation

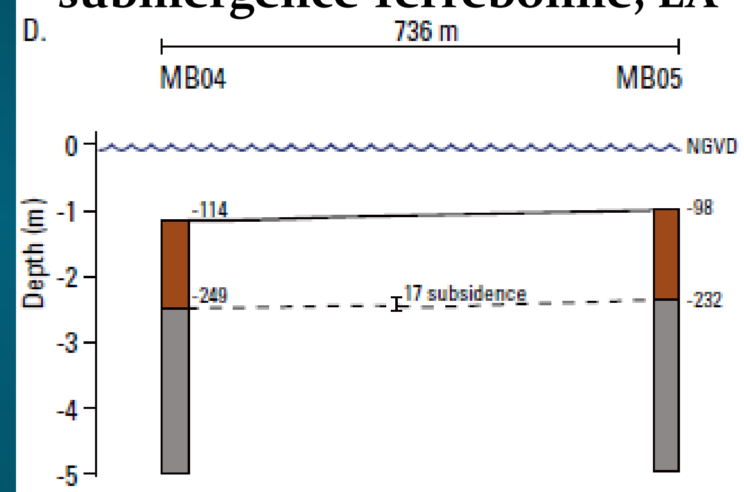
Marshes are inherently resilient to sea level rise.
But every marsh has its own tipping point



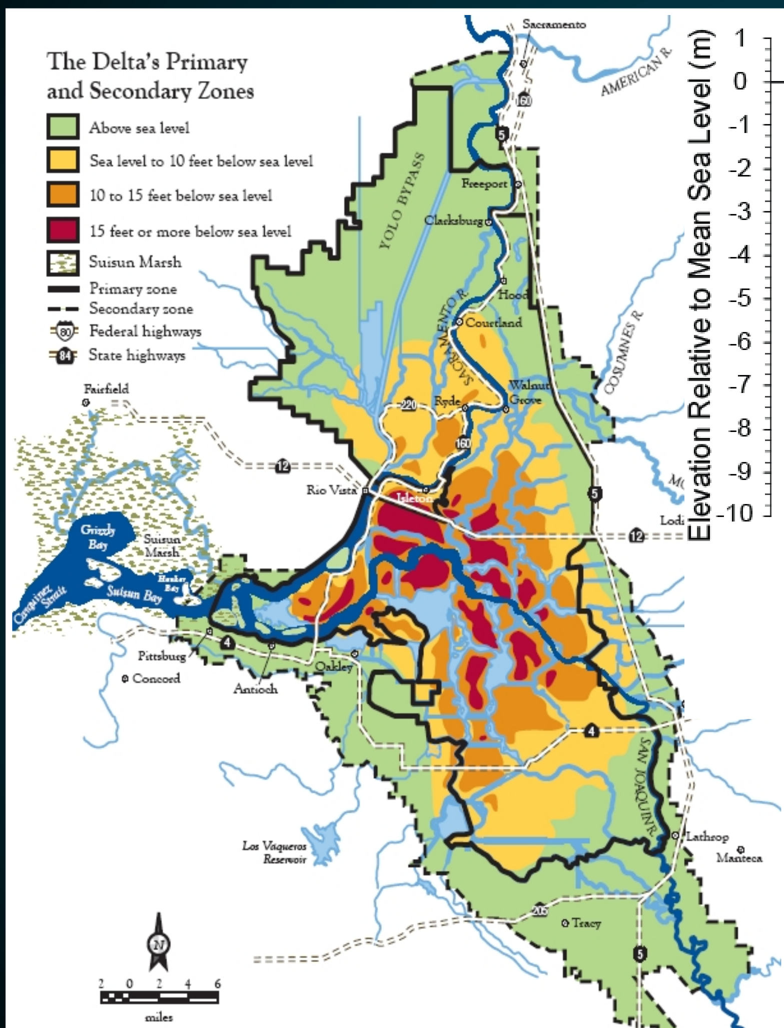

M.L. Kirwan and J.P. Megonigal *Nature* **504**, 53-60 (2013) doi:10.1038/nature12856

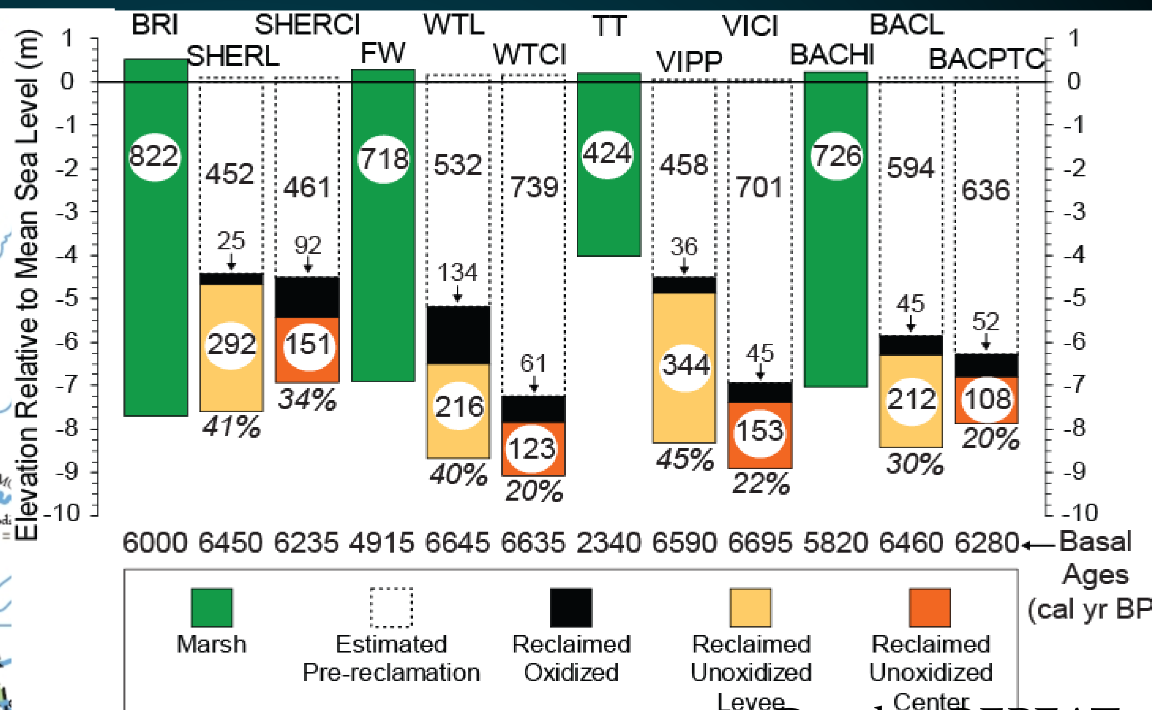


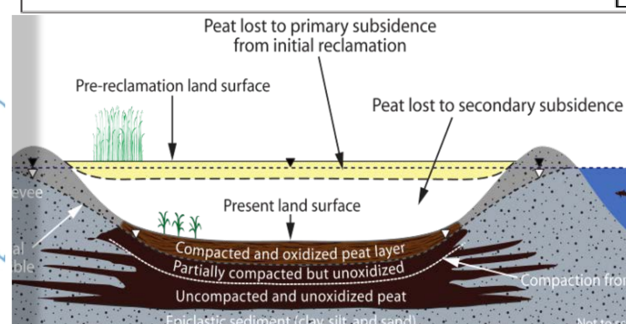

**Morton et al 2003 – USGS OFR submergence Terrebonne, LA**



# Best Science Possible: Oxidation rate (modeling/monitoring)



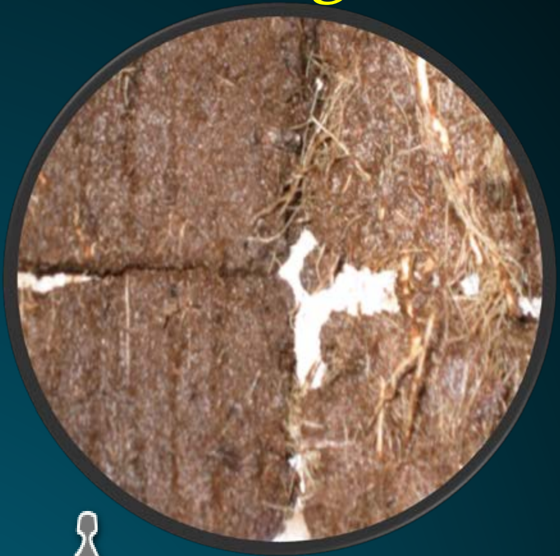




Drexler, REPEAT, USGS

# Best Science Possible: Multiple Stressors – e.g. Florida

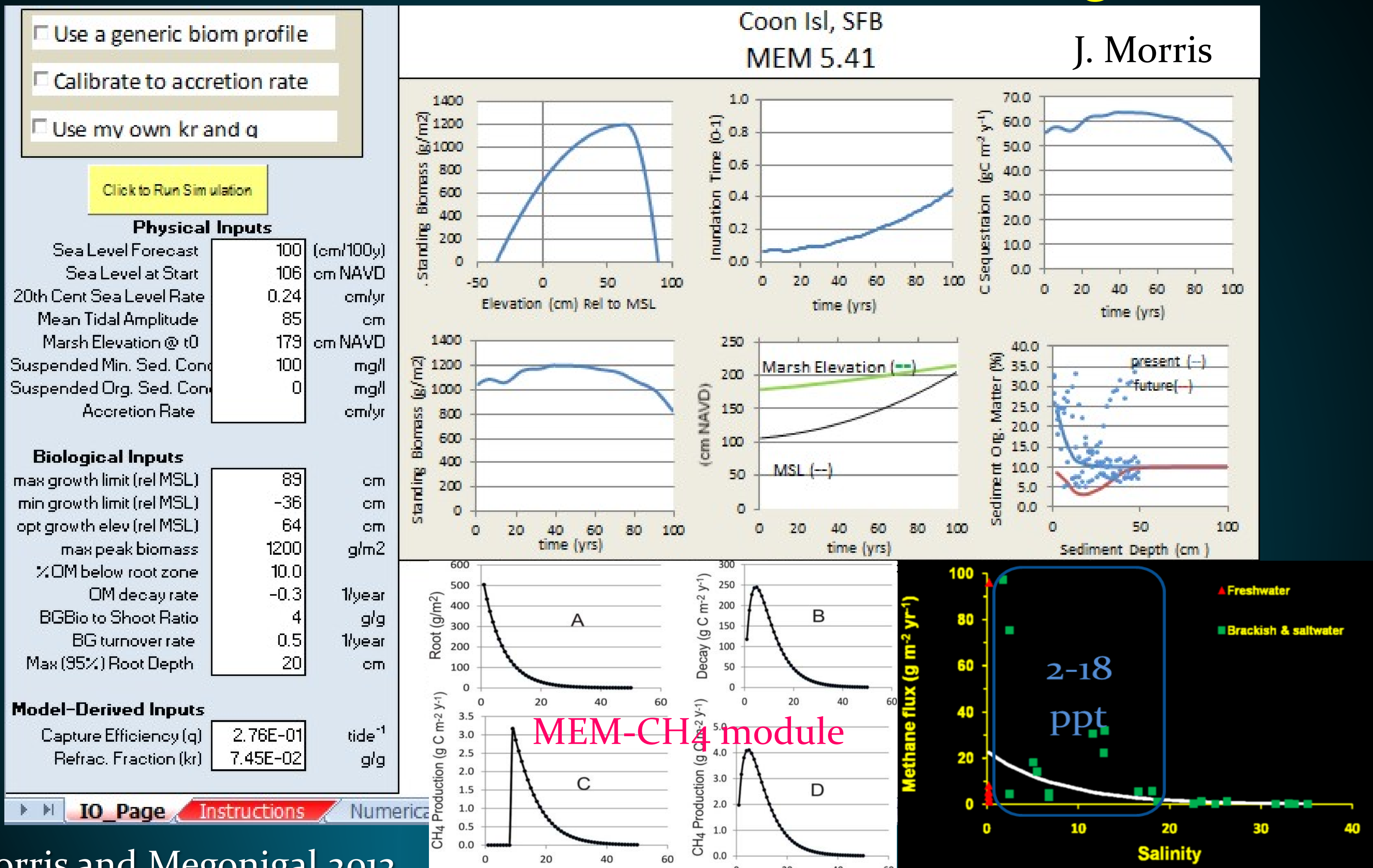

SLR and Salinity intrusion in FL Everglades
T. Troxler - NSF-LTER field experiment



SOIL C BALANCE

- Temperature & pH
- TEA availability
- Substrate quality
- Soil fertility
- Decomposers
- Plant stressors
- Disturbance
- Hydrology

# Best Science Possible: Process-based modeling (projections)



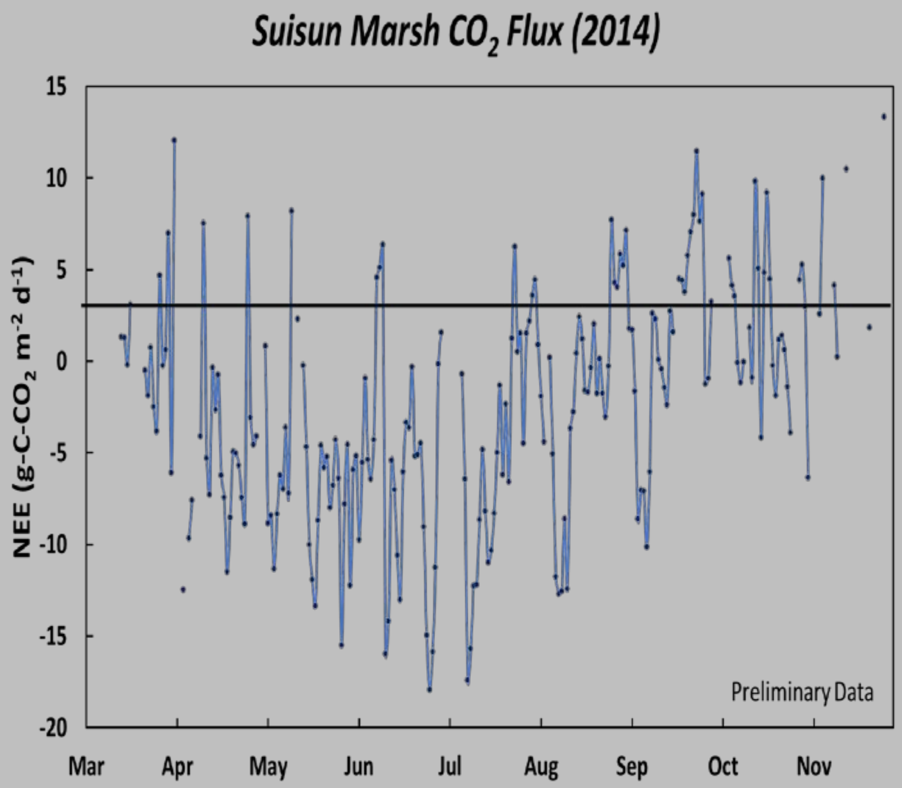

Morris and Megonigal 2012

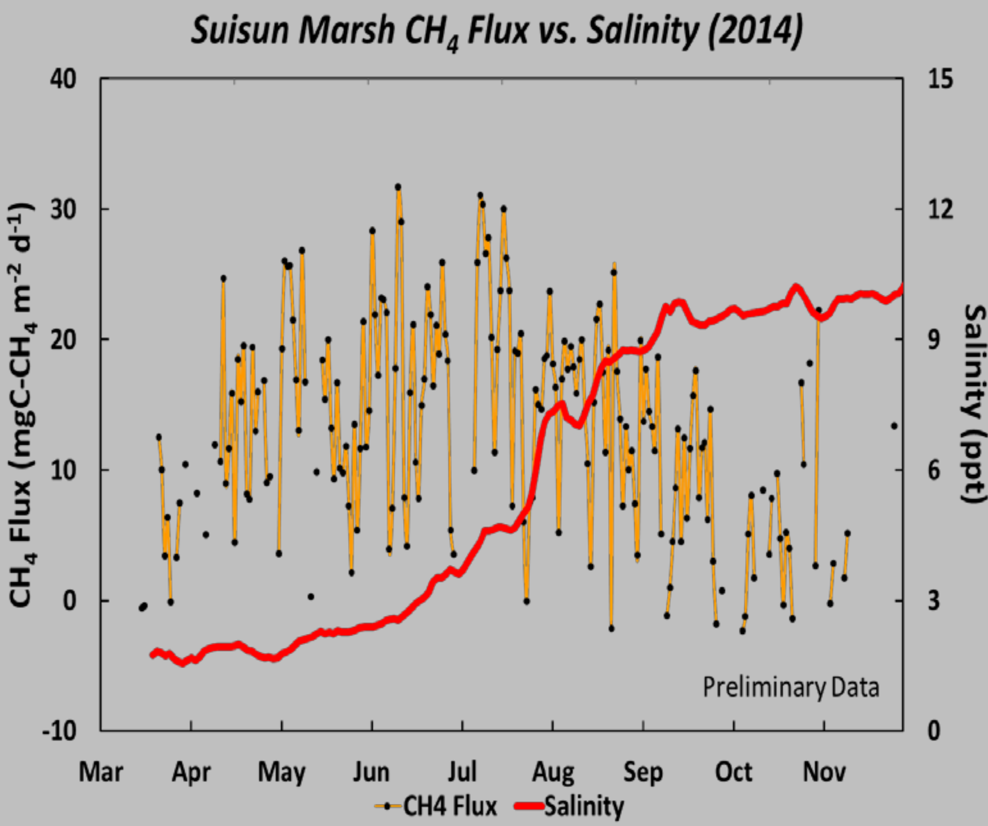
Poffenbarger et al. 2013

# Best Science Possible: Greenhouse gases

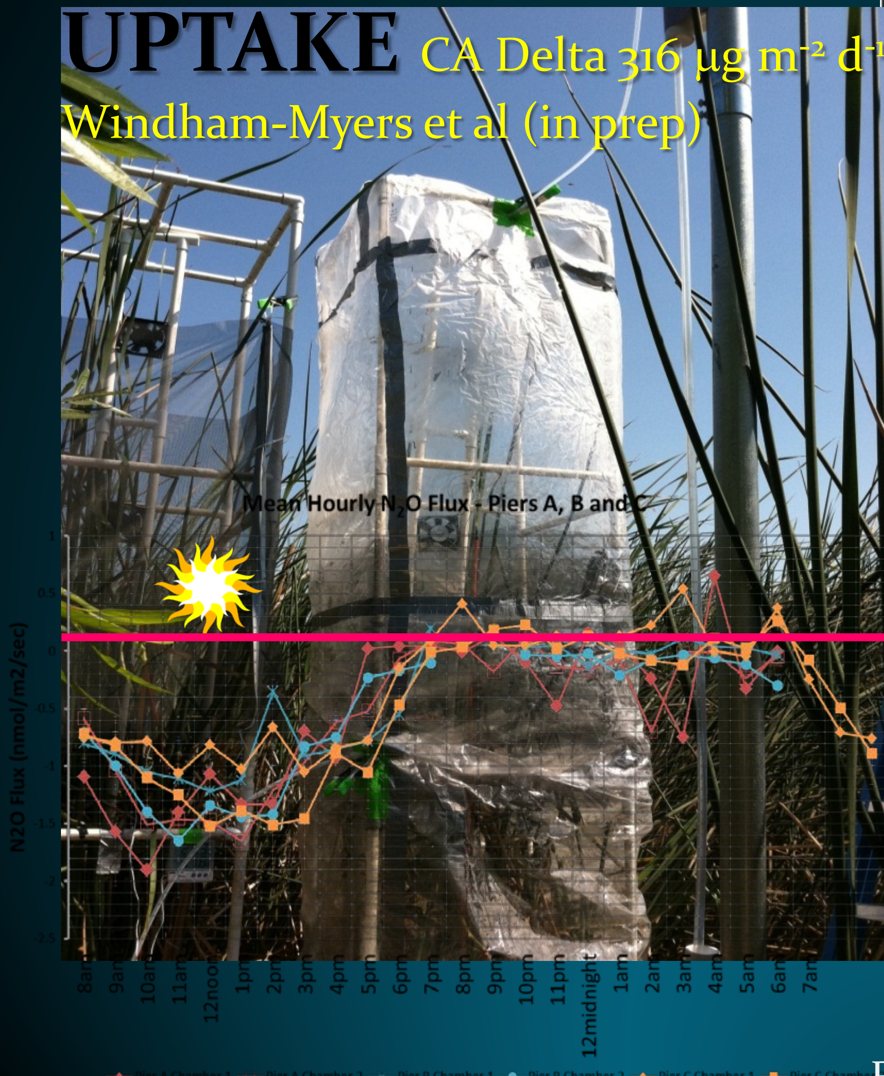
Preliminary Eddy-Covariance for Methane Flux
Brackish Marsh – San Francisco Bay NERR

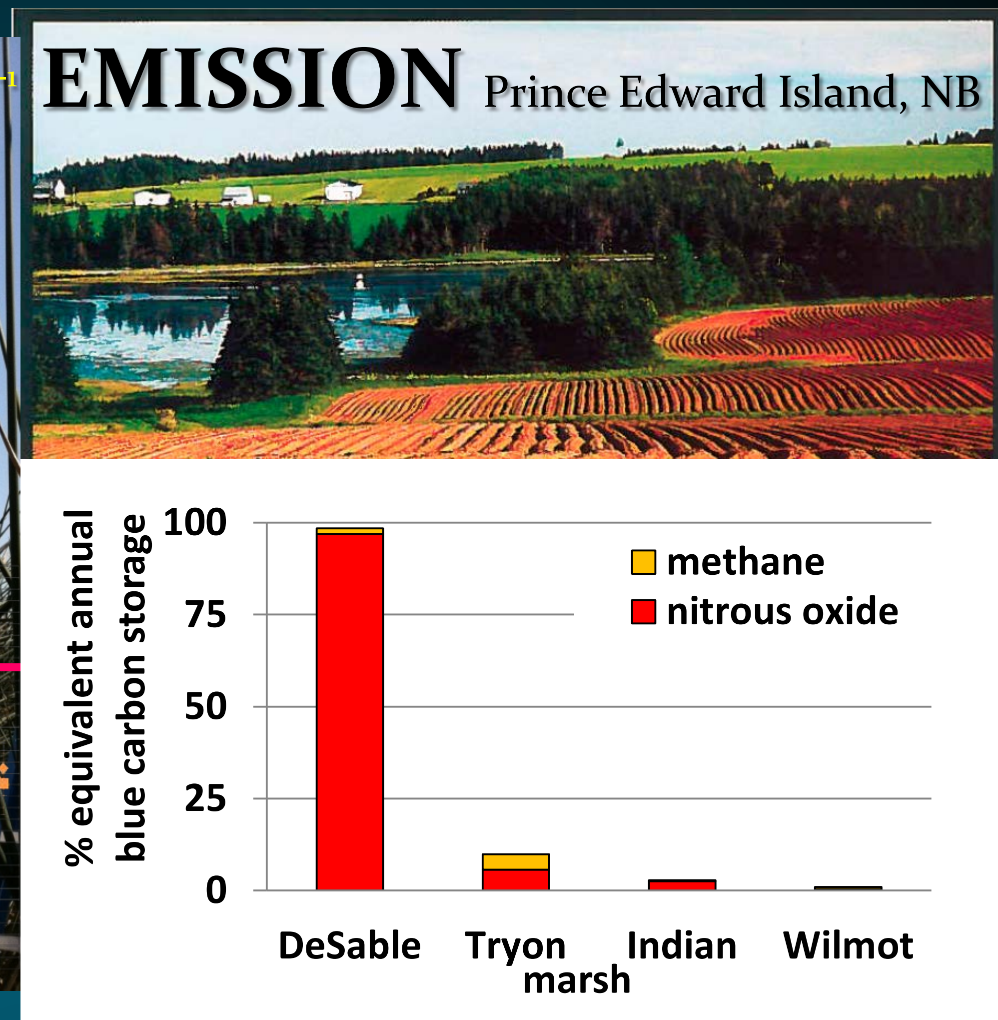
Draft provided by F. Anderson (USGS)



# Best Science Possible: Nitrous oxide (chambers – high uncertainty)




See Chmura et al 2011, ERL and
Roughan, Kellman, Smith & Chmura in review *Science*

# Ecosystem Level Blue Carbon Accounting : Focal Sites with USGS involvement in modeling , monitoring and management


Nisqually NWR (FWS): salt-marsh C accretion rate and source, management, foodweb, NECB, $CH_4$ flux

San Francisco Bay National Estuarine Research Reserve (NOAA) : brackish marsh C accretion rate, NECB, $CH_4$ flux

Waquoit Bay National Estuarine Research Reserve (NOAA): salt-marsh C accretion rate and source, NECB, $CH_4$ &N2O

Chesapeake Bay Smithsonian Environmental Research Center: brackish marsh C accretion rate, $CH_4$ flux

Great Dismal Swamp and Pocosin Lake NWR (FWS) fresh-water wetland C accretion rate, $CH_4$ flux, land management

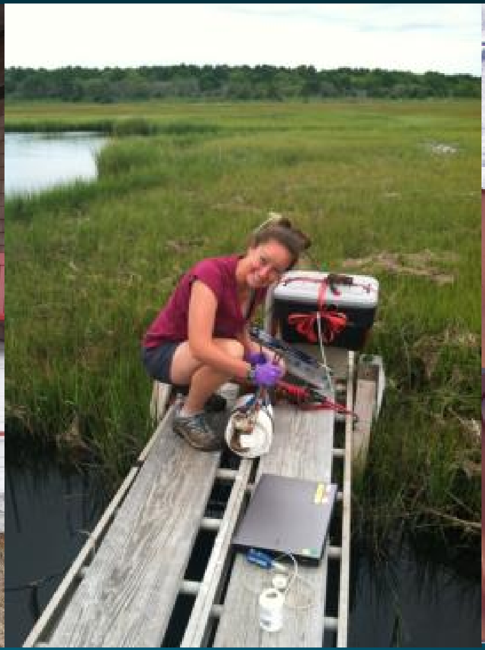
LCMAP mangrove change detection pilot study

Barataria-Terrebonne-Atchafalaya: salt-marsh C accretion rates, modeling, CRMS (NWRC)

Shark River, Everglades (NSF, NPS): mangrove C accretion rate, NECB

Ding Darling NWR (FWS) mangrove remote sensing, stress mapping, C stock, accretion rate, and management

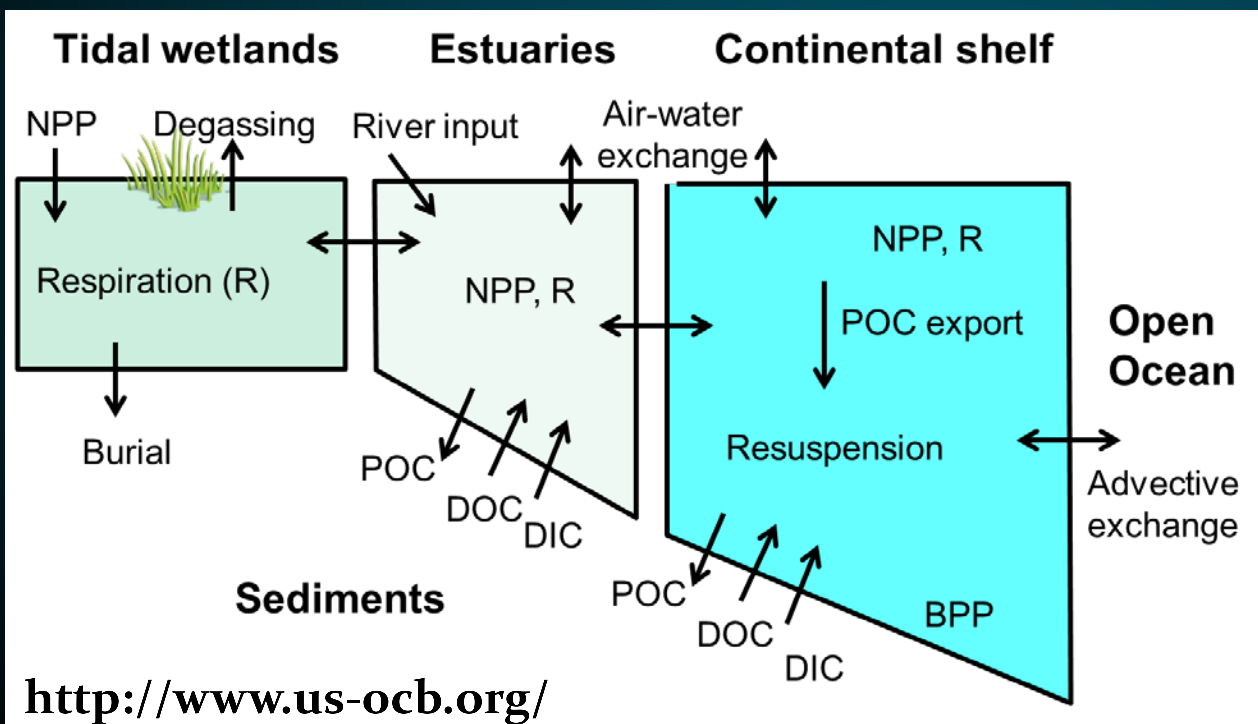
# Ecosystem Level Blue Carbon Accounting : Waquoit Bay NERR

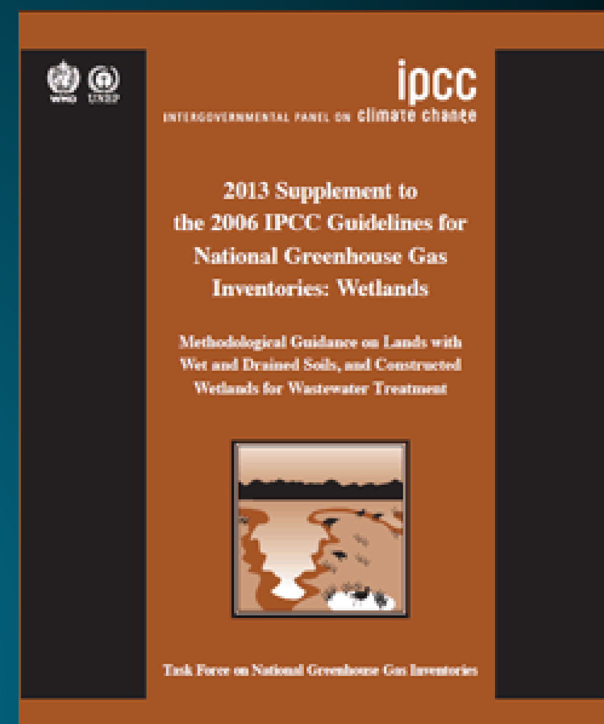


- Doing the best science possible
- Avoiding “overselling”
- Considering C sequestration just 1 of many ecosystem services

Capitalizing on Coastal Blue Carbon, Brockton, Massachusetts, 05.12. 2015

# Science and Policy eyes of the world are on us. Carpe Diem – Seize the Moment!



Section #2

# THIS IS A SECTION DIVIDER PAGE