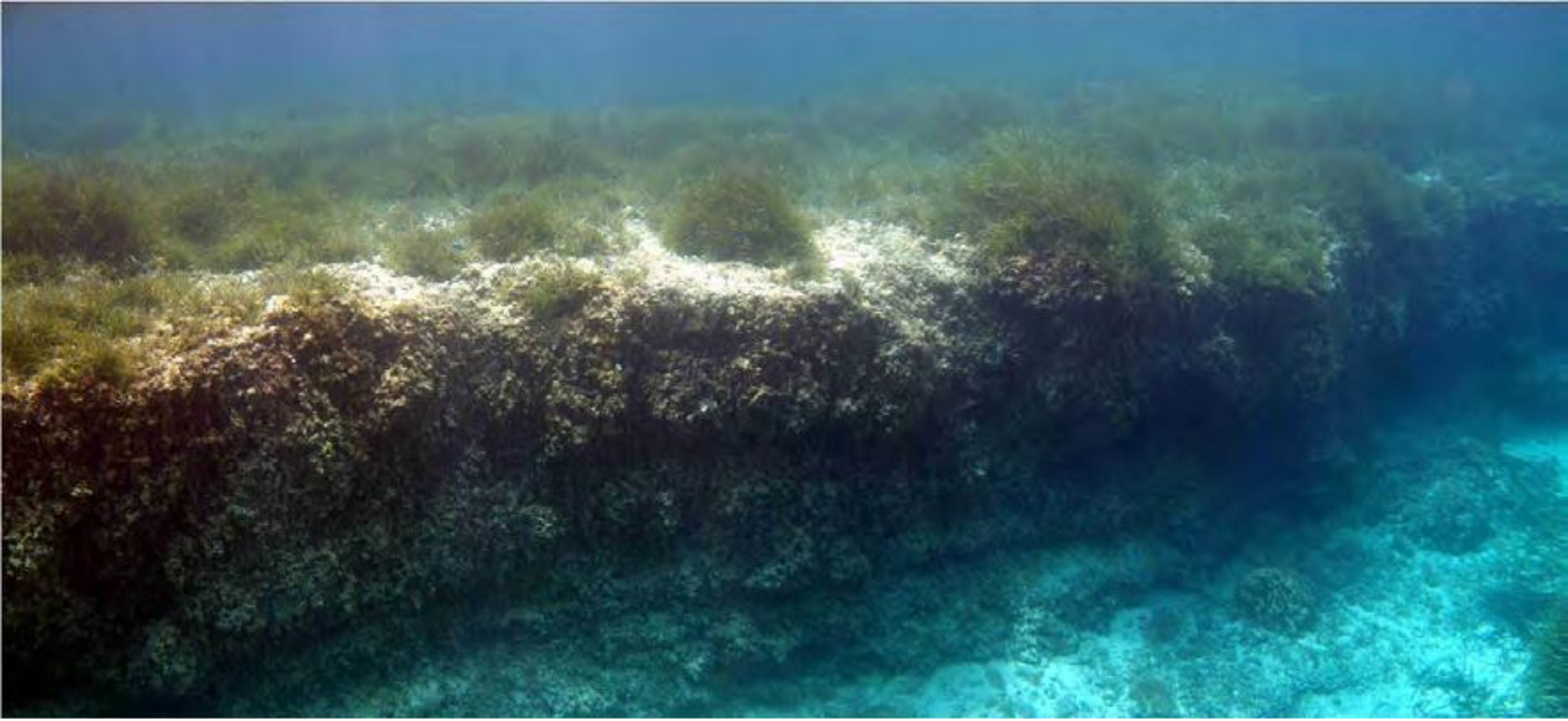


Blue Carbon stored in the seagrass beds of the world

James W. Fourqurean, Hilary A. Kennedy, Nuria Marbà, Miguel A. Mateo, Gary A. Kendrick and Carlos M. Duarte

9th INTECOL International Wetlands Conference
Orlando, Florida , 3-8 June 2012

- **Tropical seagrass beds are among the most productive ecosystems, rivaling agricultural crops like corn and soybeans and coastal wetlands**

- **Valuable providers of ecological goods and services (most valuable ecosystem according to Constanza et al 1997)**

Estimates of global CO_2 flux in seagrass beds

	NCP	low estimate of global extent	Integrated NCP	high estimate of global extent	Integrated NCP
	tons CO_2e $ha^{-1}y^{-1}$	km^2	Tg CO_2e y^{-1}	km^2	Tg CO_2e y^{-1}
Mean	4.4	300000	130.7	600000	261.4
Upper 95th cl of mean	6.2	300000	185.5	600000	371.1
Lower 95th cl of mean	2.5	300000	75.9	600000	151.8
maximum	85.4	300000	739.2	600000	1478.3

For comparison, mean NCP for:

wetlands = 0.6 tons CO_2e $ha^{-1}y^{-1}$

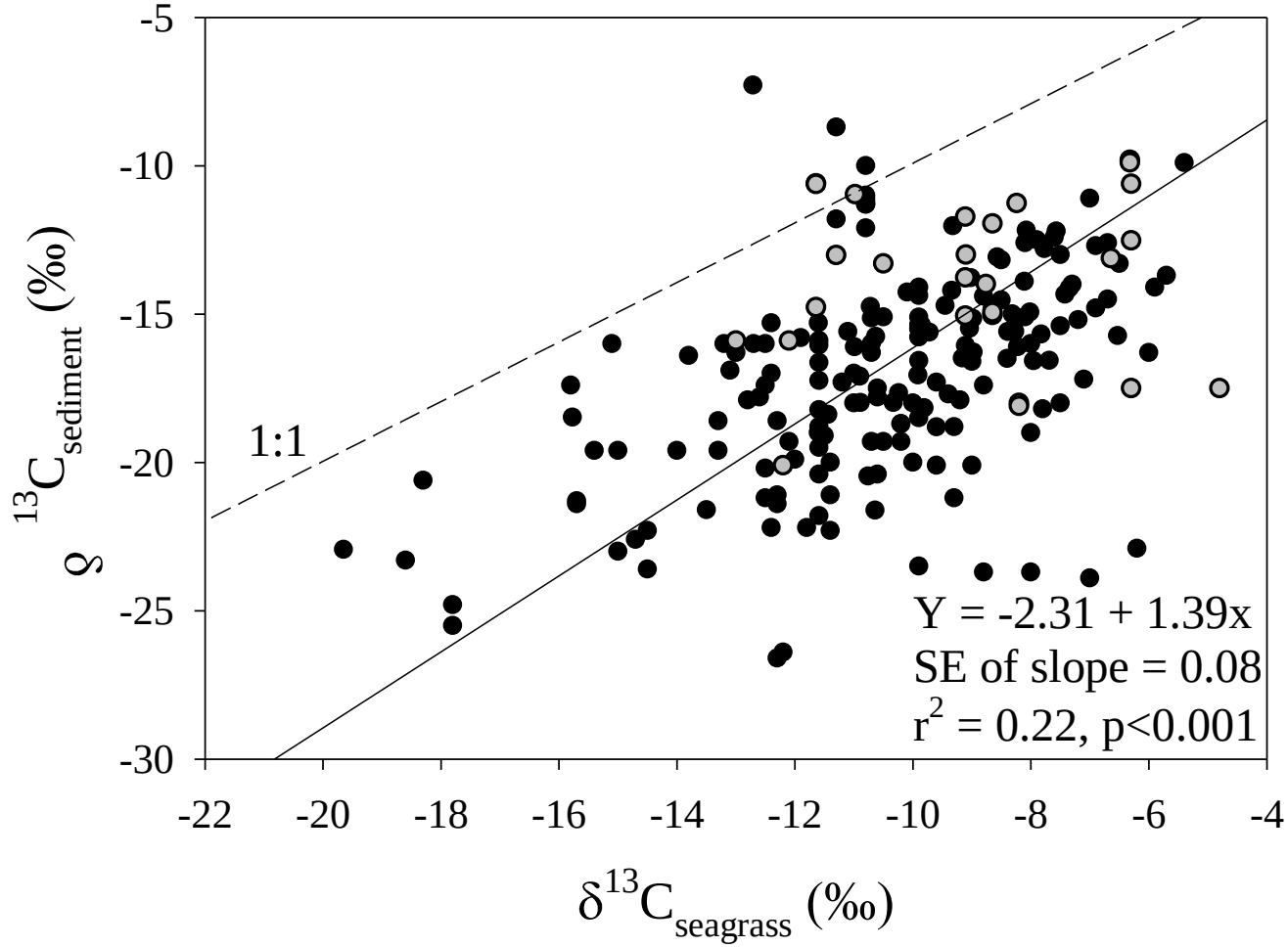
Amazon rainforest: 3.7 tons CO_2e $ha^{-1}y^{-1}$

Duarte et al 2010 *Global Biogeochem. Cycles*

But what about the value of the Blue Carbon stored in the system?

Carbon fixed in seagrass beds does not all stay in the seagrass beds

Only about half of the C buried in seagrass beds is derived from seagrass



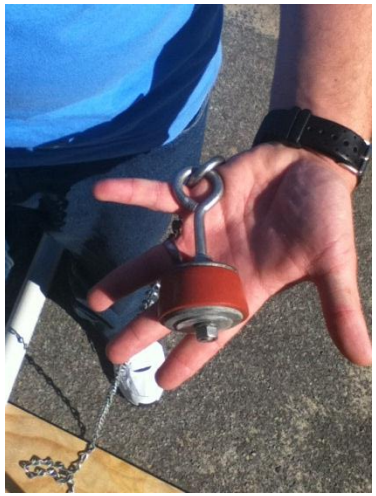
Kennedy et al 2010 *Global Biogeochem. Cycles*

So, how much C is stored in seagrass ecosystems?

- Measuring C storage in some seagrass ecosystems:
  - Florida Bay
  - Shark Bay
  - Western Mediterranean
- Literature review of C stores in seagrasses
- Estimates of the sizes of stocks and potential fluxes of CO_2 following habitat loss

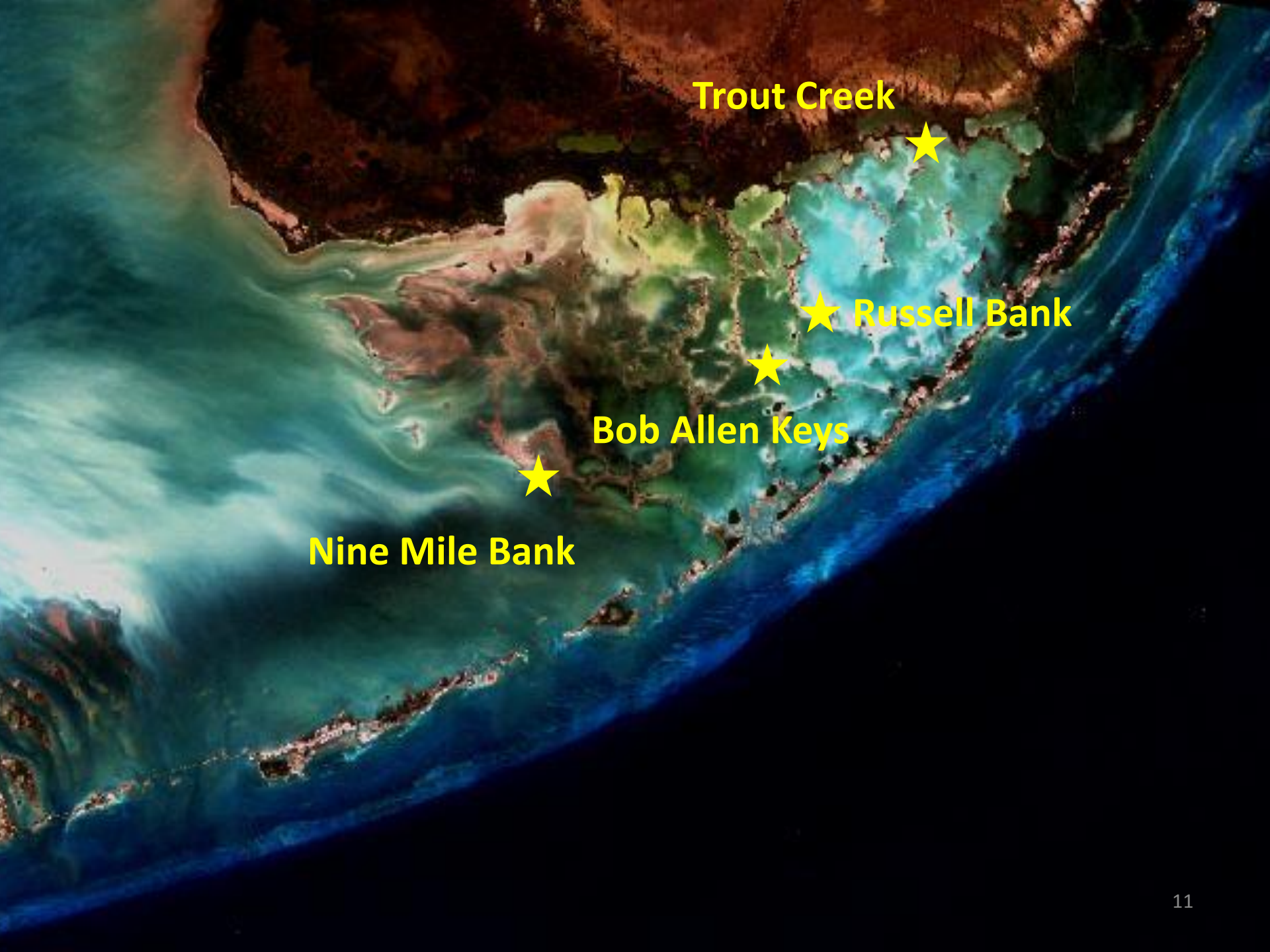
Measuring C stored in living biomass

Measuring C stored in seagrass soils: Piston corer to collect uncompressed cores



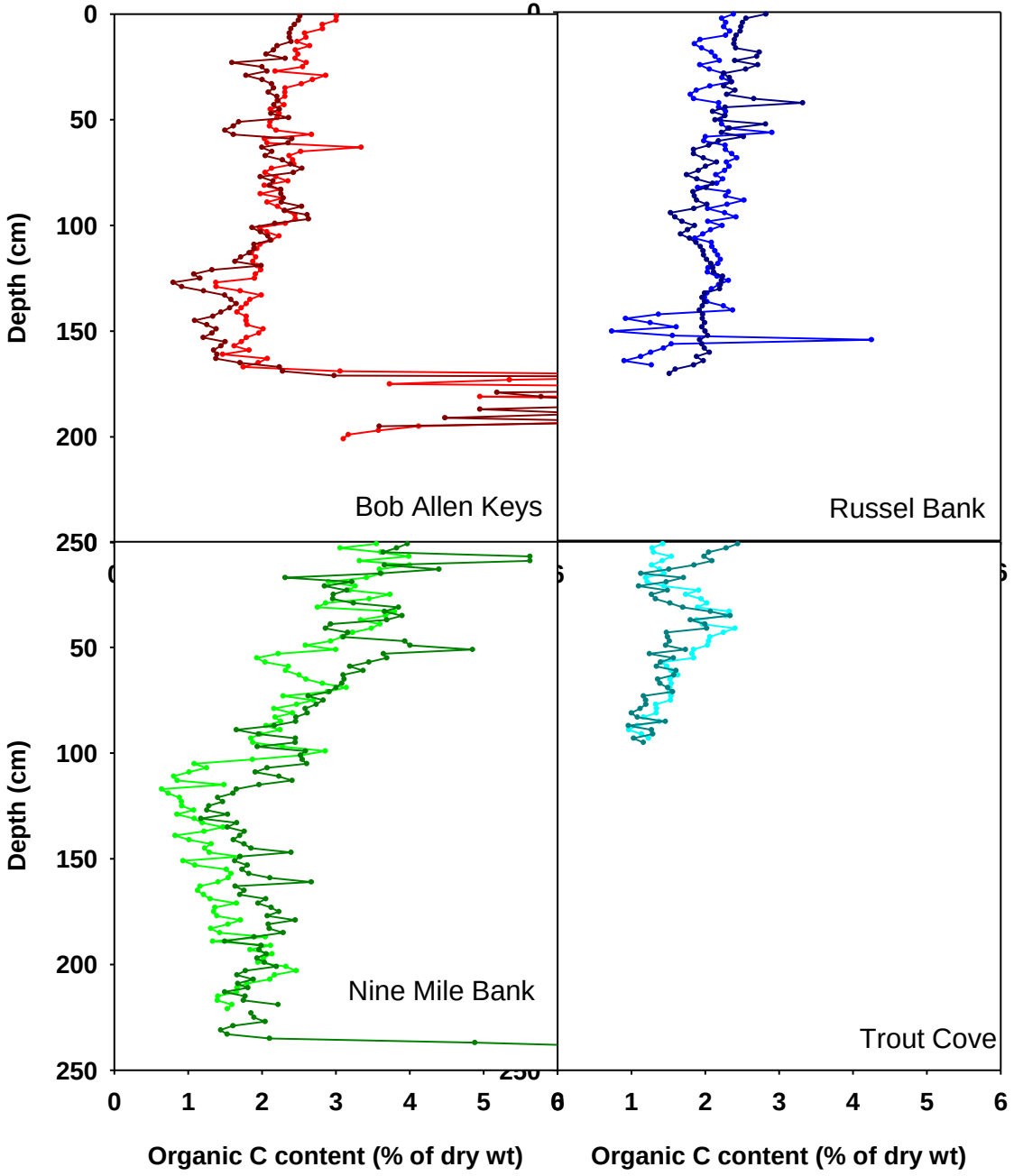
Need:

- volumetric measures of Dry Bulk Density (mass of soil per volume)
- Carbon content of soil (as a fraction of mass)
  - Organic matter, or Loss on Ignition (LOI)
  - C_{org}


Trout Creek
Russell Bank
Bob Allen Keys
Nine Mile Bank

C_{org} generally decreases downcore in Florida Bay seagrass soils.

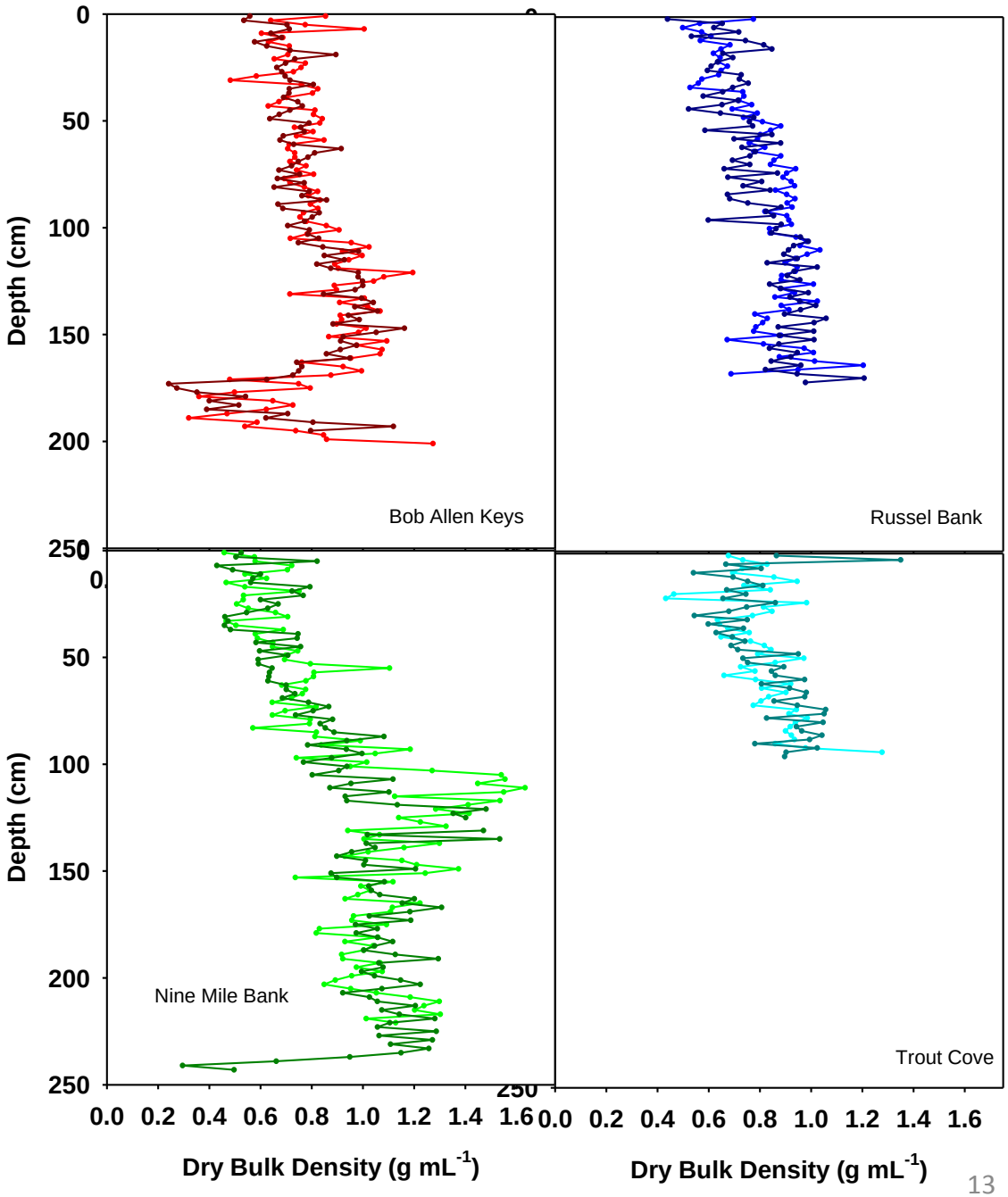
Buried peats have high C_{org}



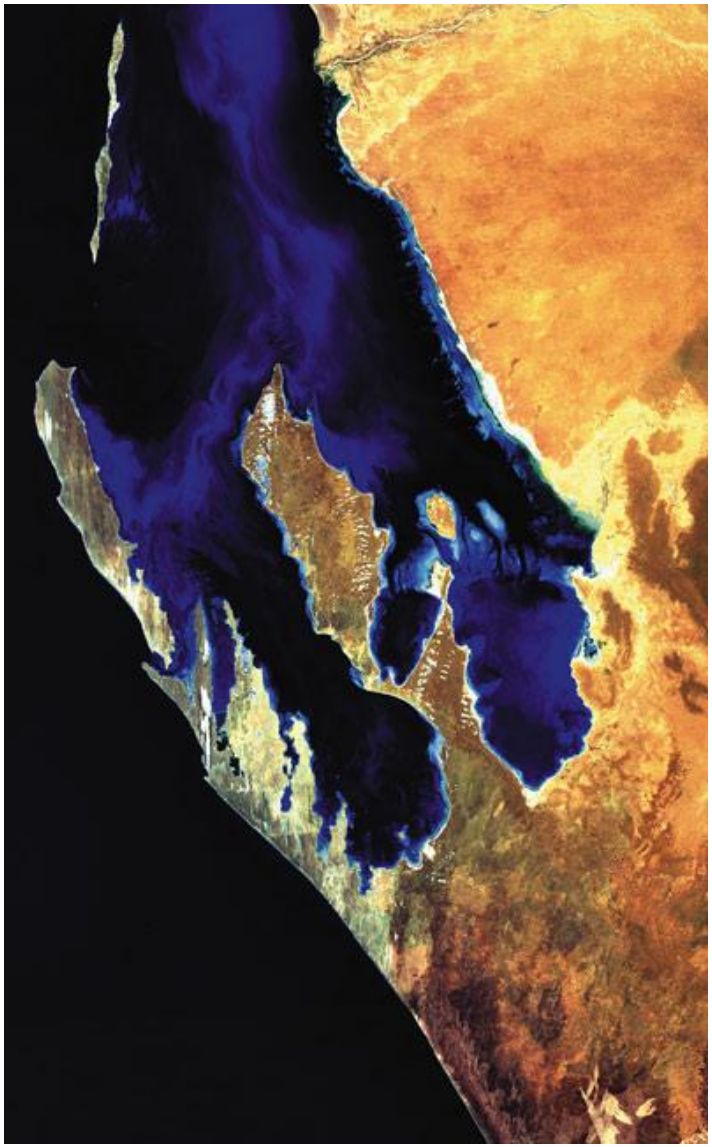
Fourqurean et al. In Press *MFR*

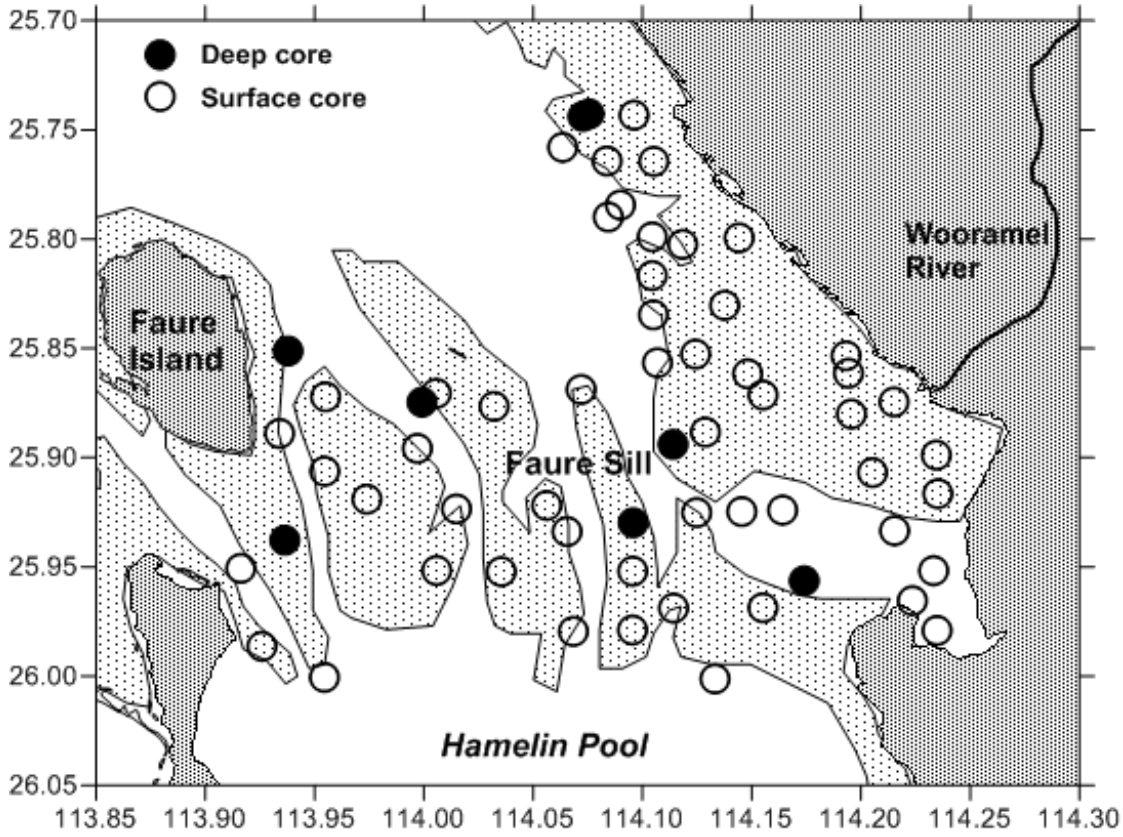
DBD generally increases downcore in Florida Bay seagrass soils.

Buried peats have low DBD

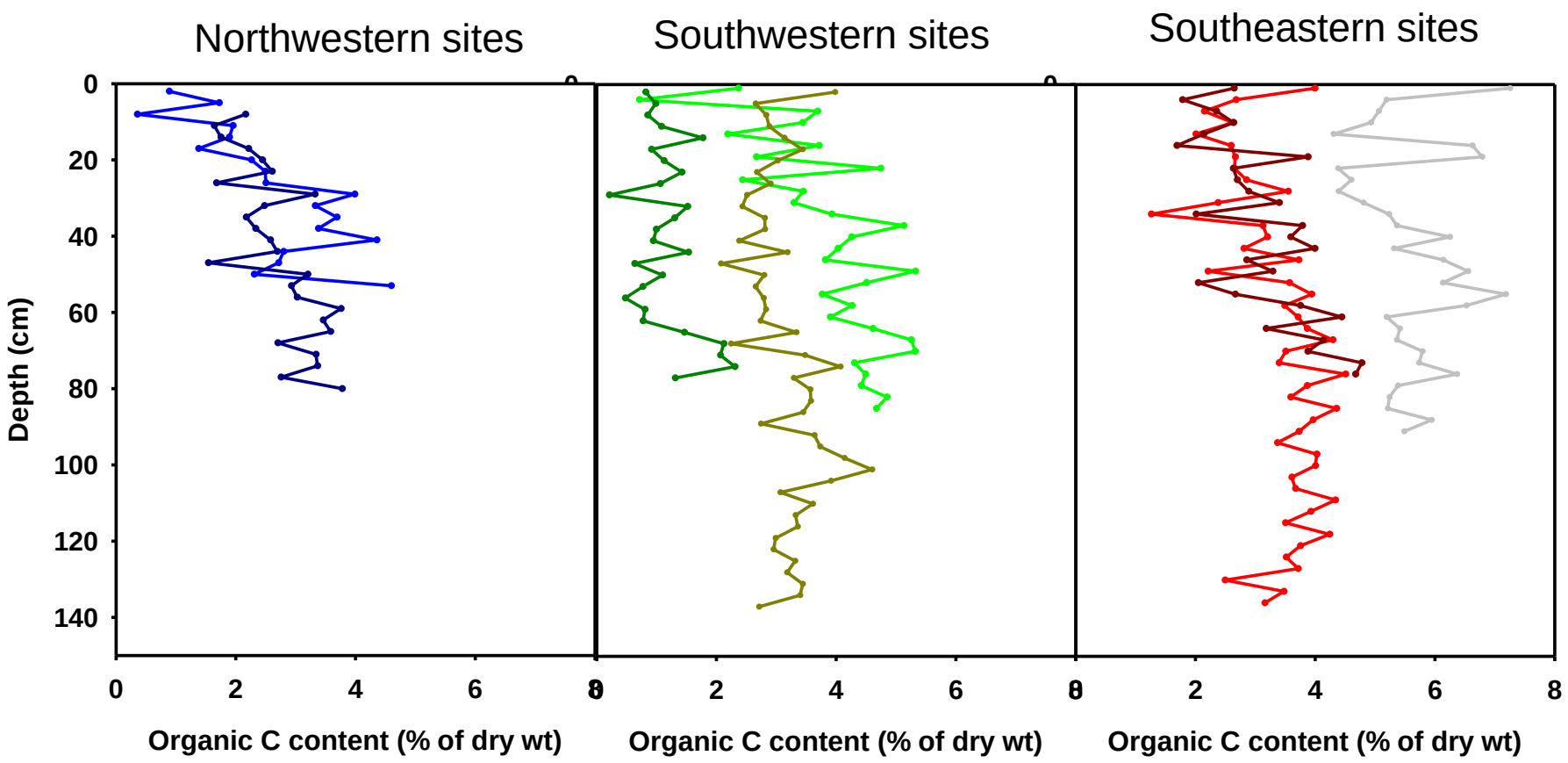


Fourqurean et al. In Press *MFR*



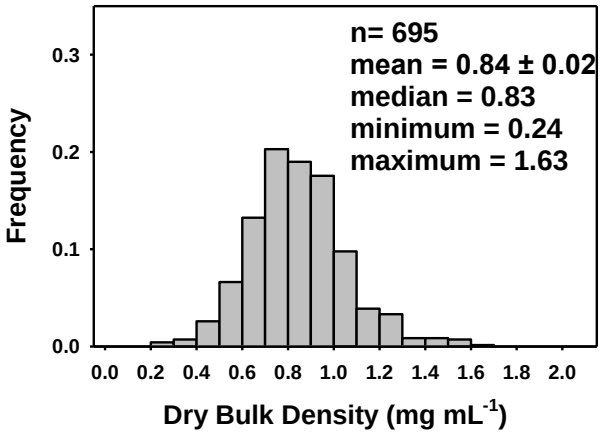

Deep core
Surface core
Faure Island
Faure Sill
Wooramel River
Hamelin Pool
25.70
25.75
25.80
25.85
25.90
25.95
26.00
26.05
113.85
113.90
113.95
114.00
114.05
114.10
114.15
114.20
114.25
114.30

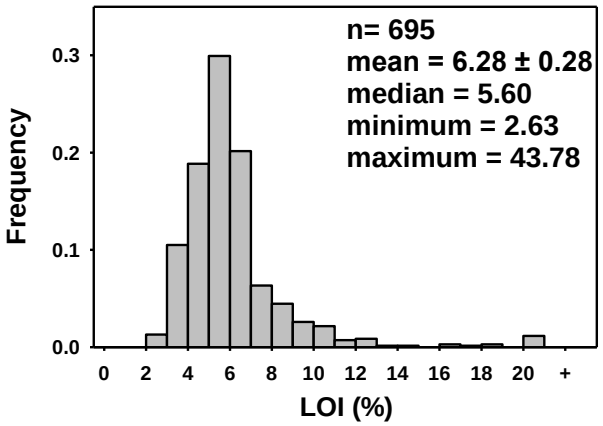
C_{org} is constant or increases down-core in Shark Bay

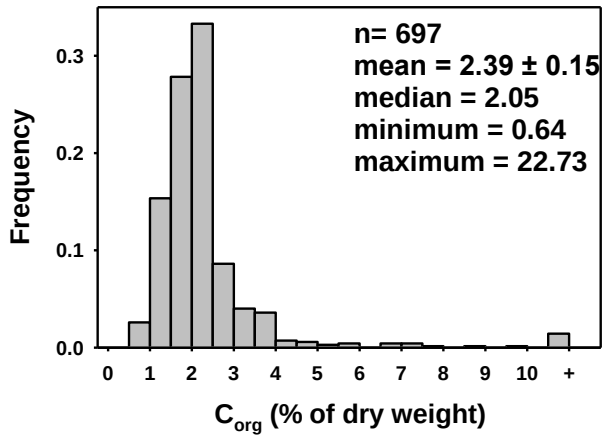


Fourqurean et al. In Press *MFR*

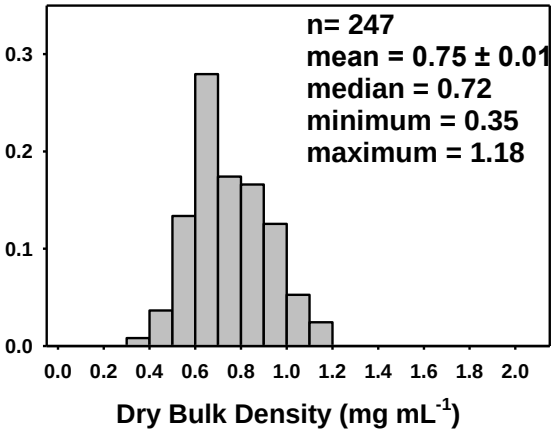
Florida Bay

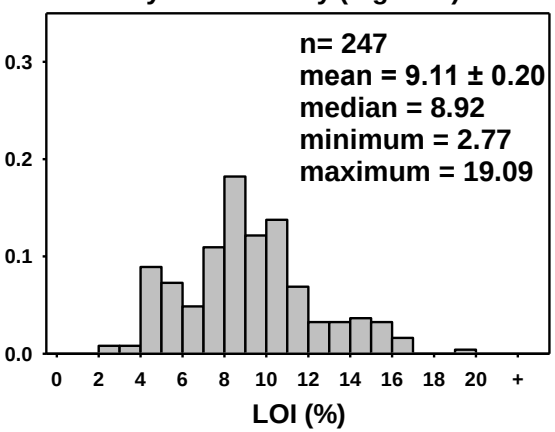


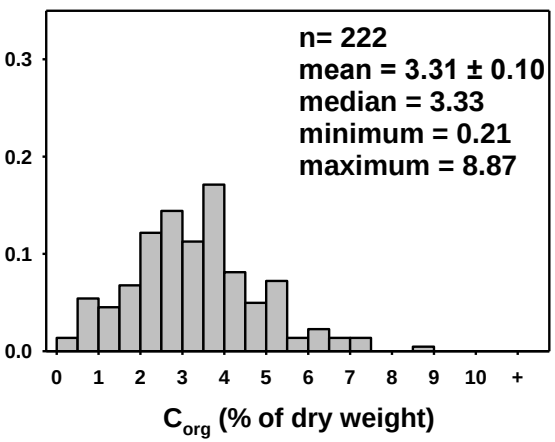




Shark Bay

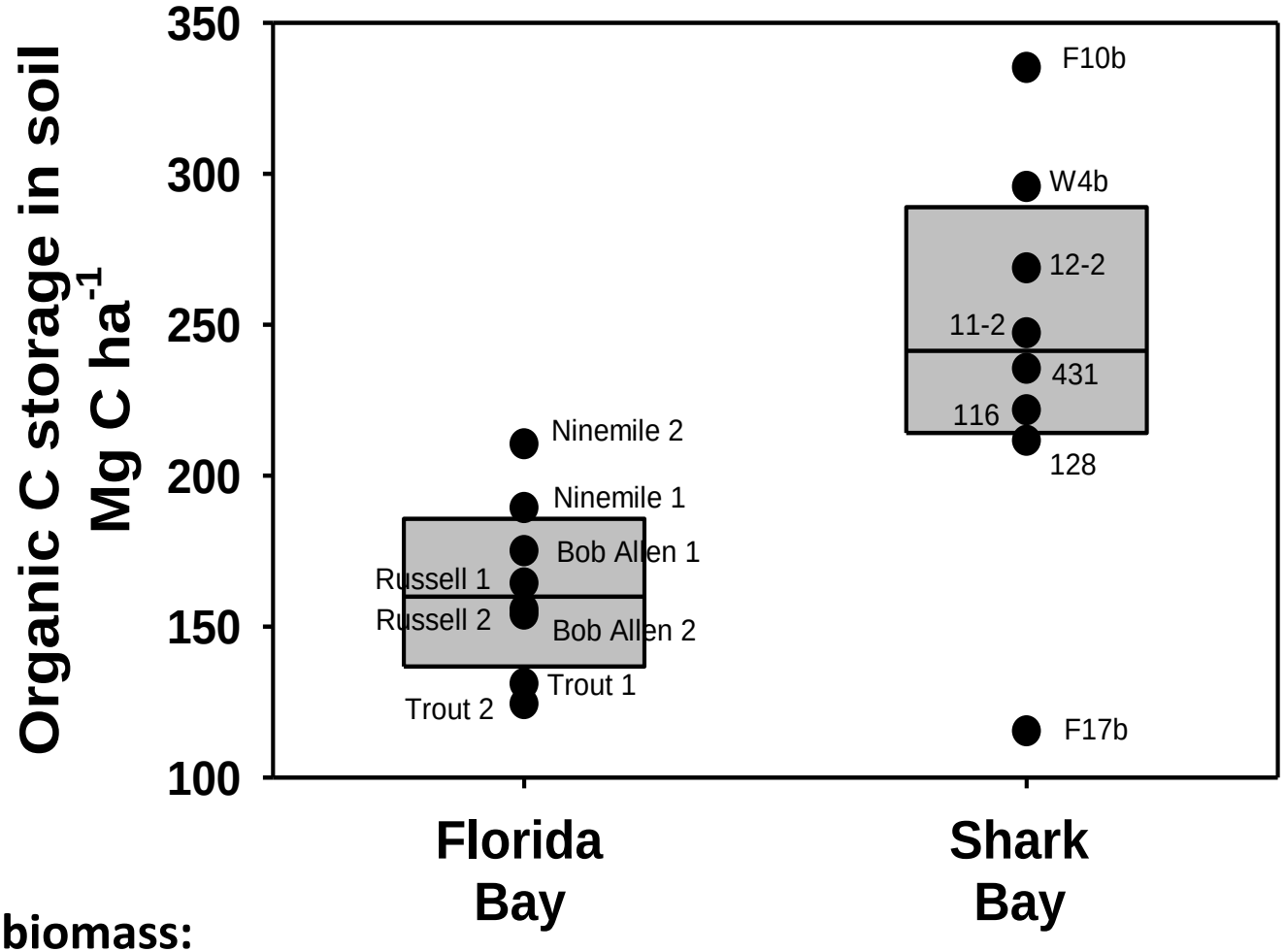






Fourqurean et al. In Press *MFR*

C_{org} stocks in top m of seagrass beds



Seagrass biomass:

Florida Bay **1.14 MgC ha^{-1}**

Shark Bay **4.75 MgC ha^{-1}**

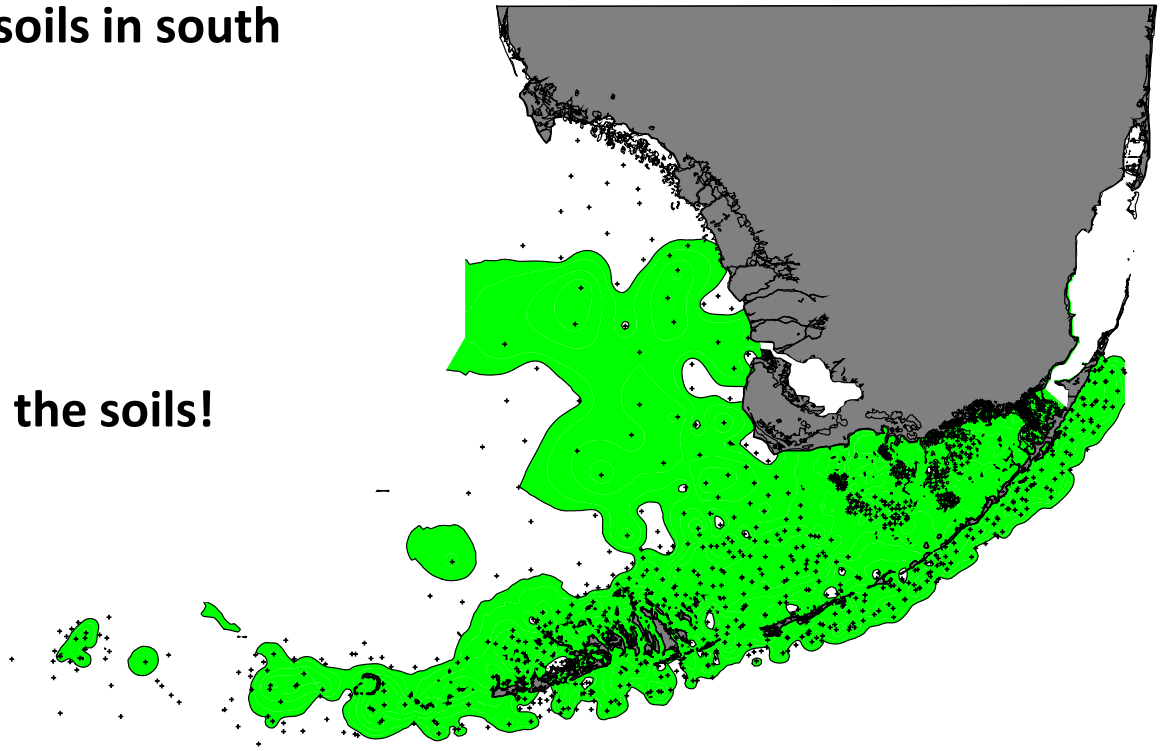
Fourqurean et al. In Press *MFR*

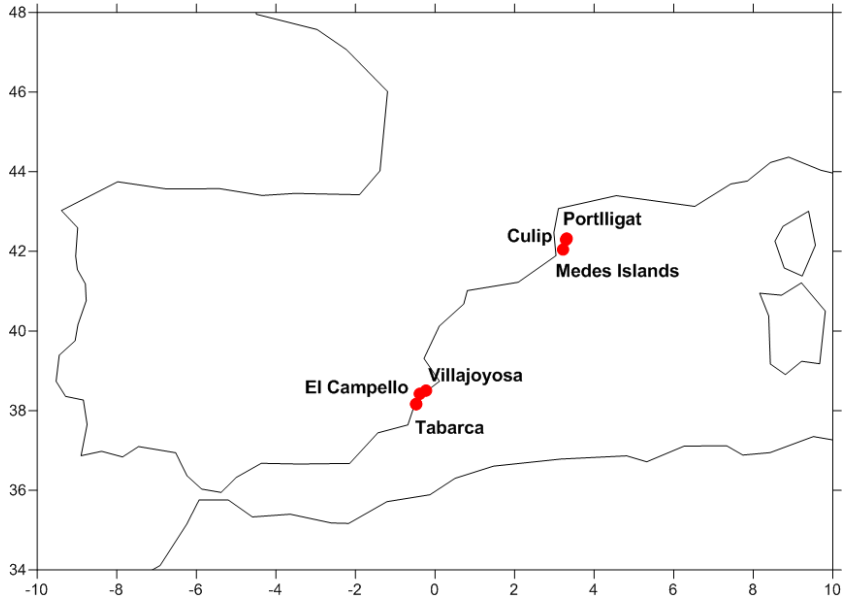
There are about 18,000 km^2 of seagrass beds in south Florida

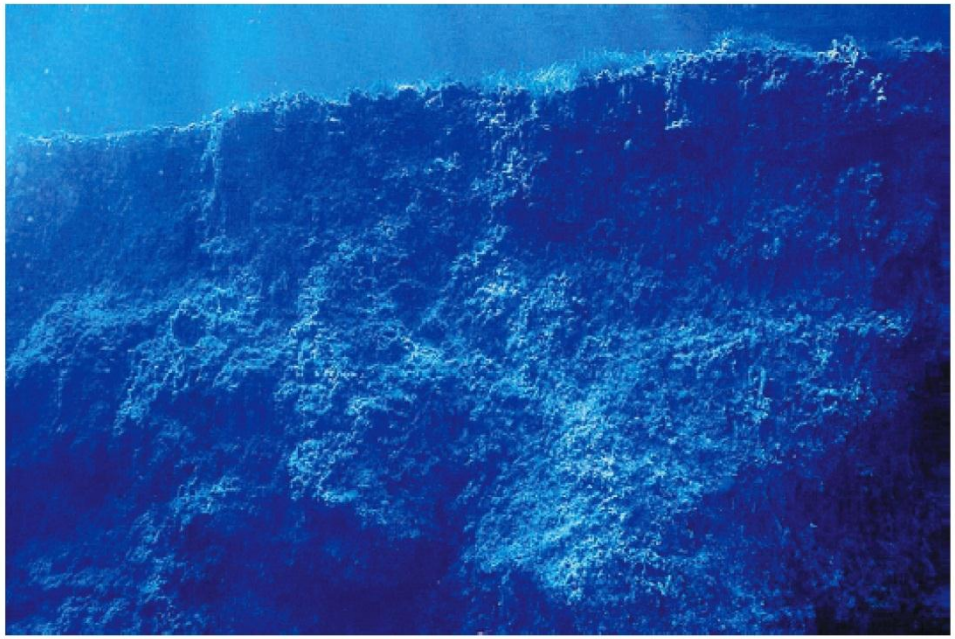
A very rough estimate of carbon stored in the top meter of seagrass soils in south Florida:

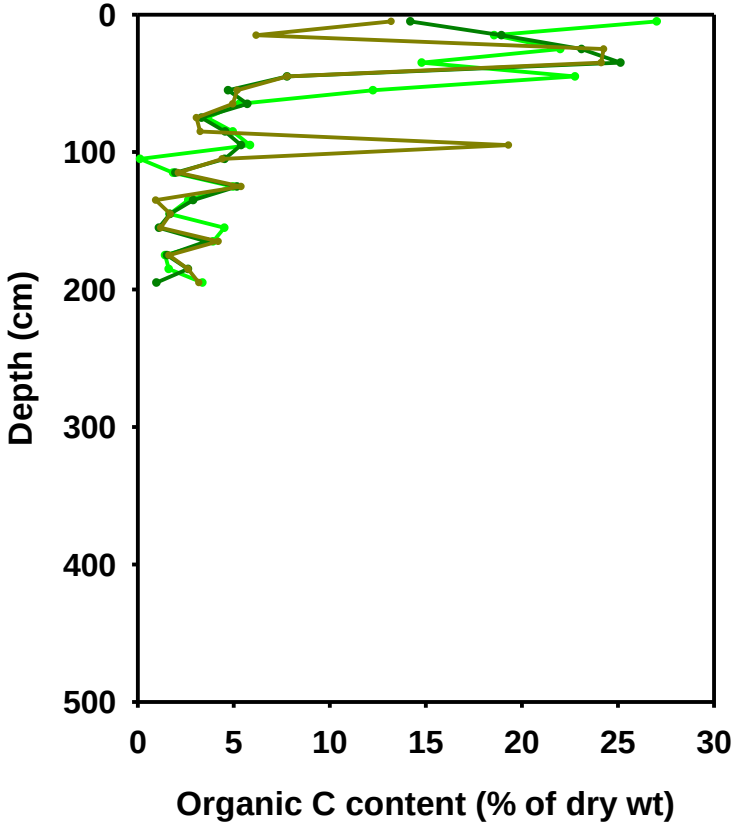
18,000 km^2 of seagrasses
594 tons CO_2e ha^{-1}

1 x 10^9 tons CO_2e stored in the soils!



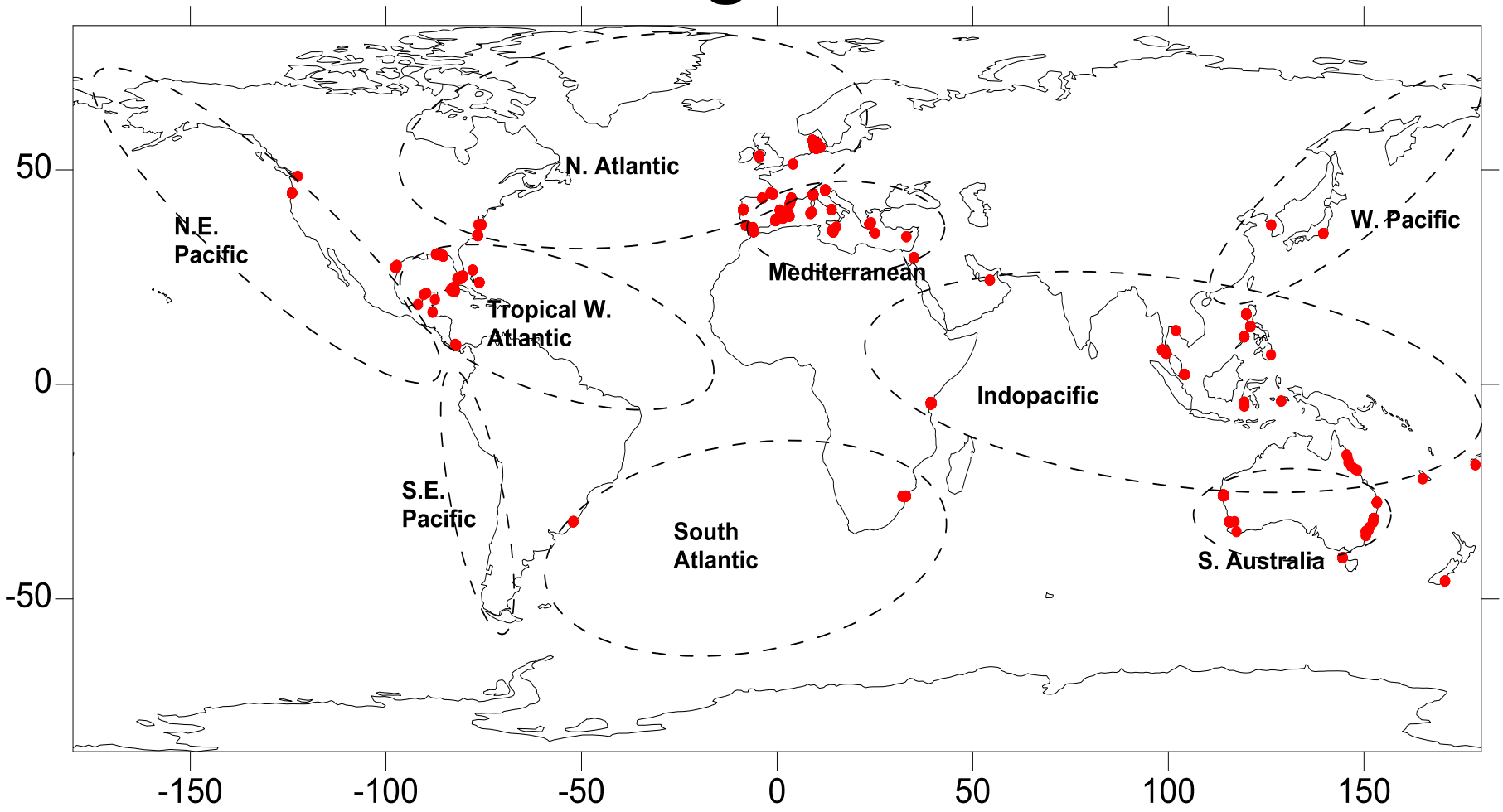






Mateo et al 1997 *ECSS*

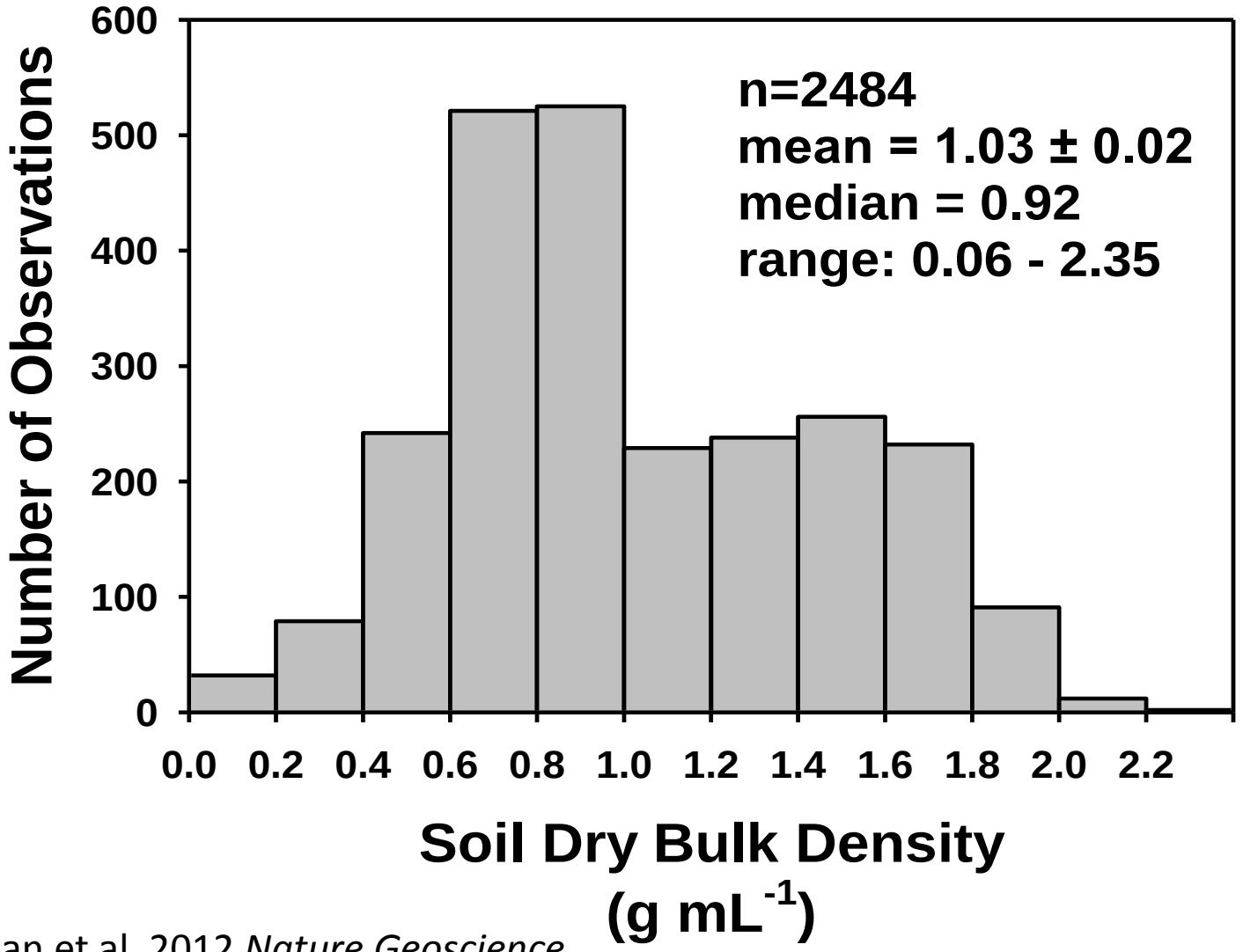
Distribution of seagrass C stock data



We compiled 3640 observations from 946 distinct locations

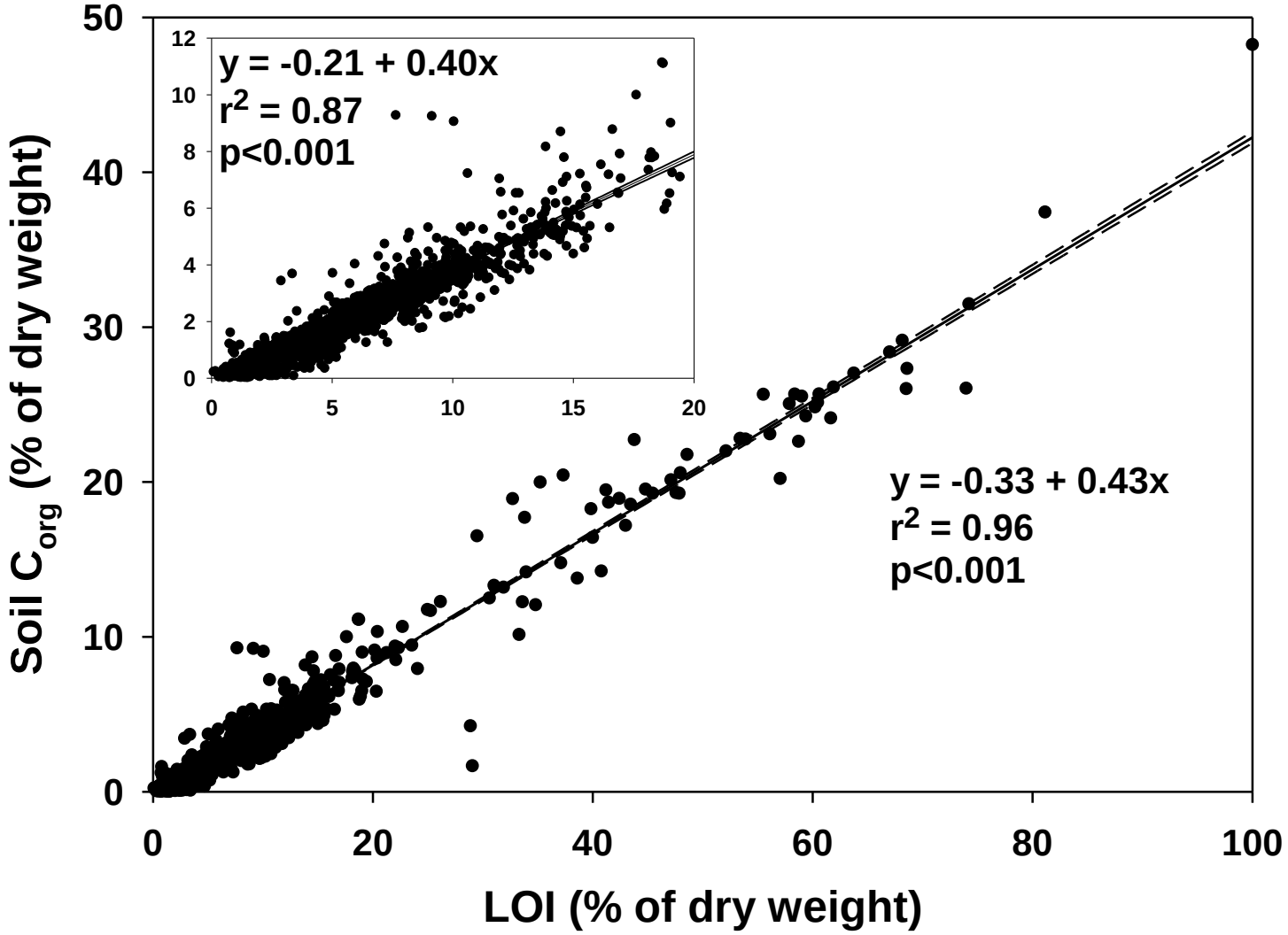
Fourqurean et al. 2012 *Nature Geoscience*

Global distribution of seagrass soil DBD



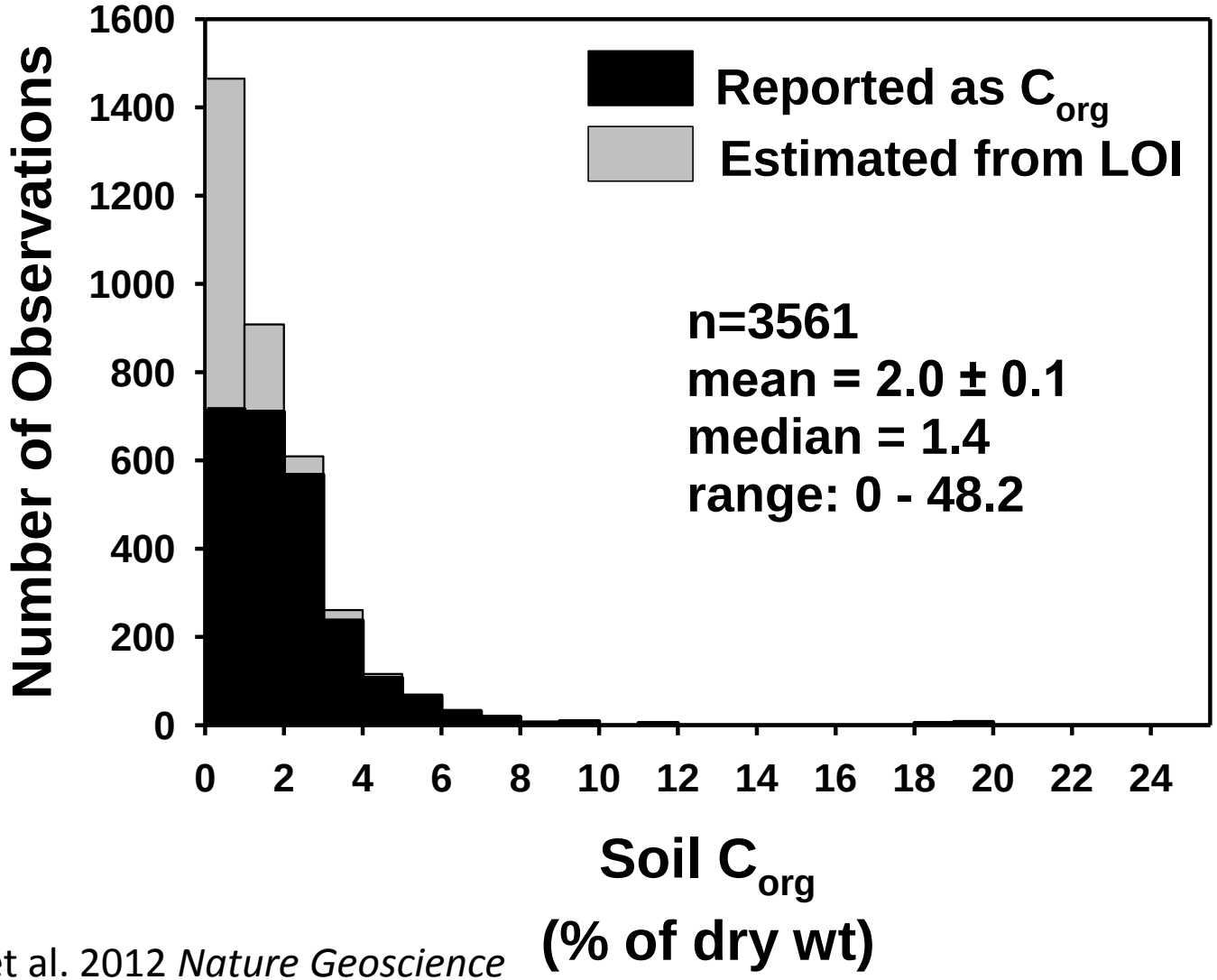
Fourqurean et al. 2012 *Nature Geoscience*

LOI can be used to predict C_{org}



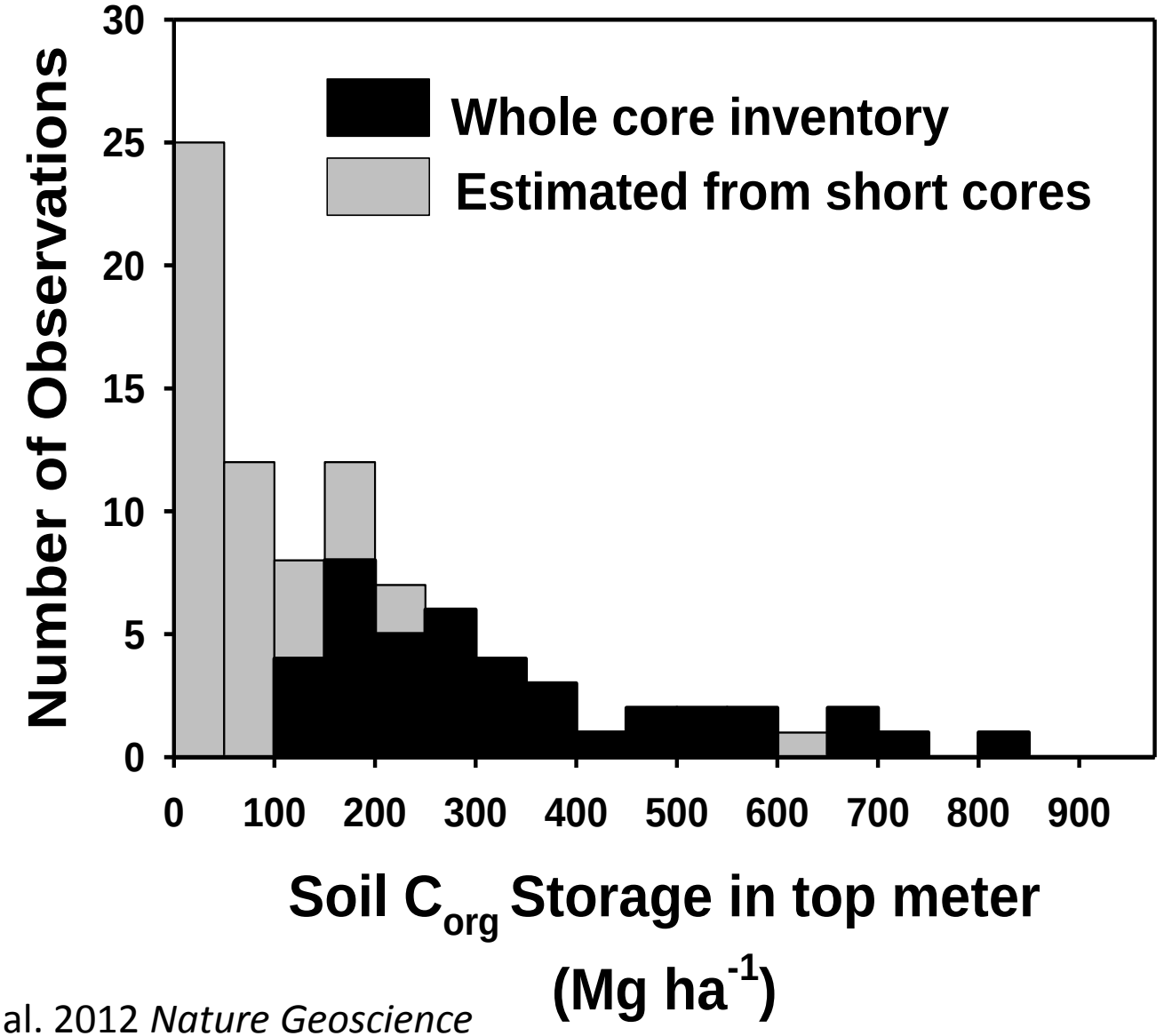
Fourqurean et al. 2012 *Nature Geoscience*

Global distribution of soil C_{org} in seagrass meadows



Fourqurean et al. 2012 *Nature Geoscience*

Global estimates of seagrass soil C_{org} stocks



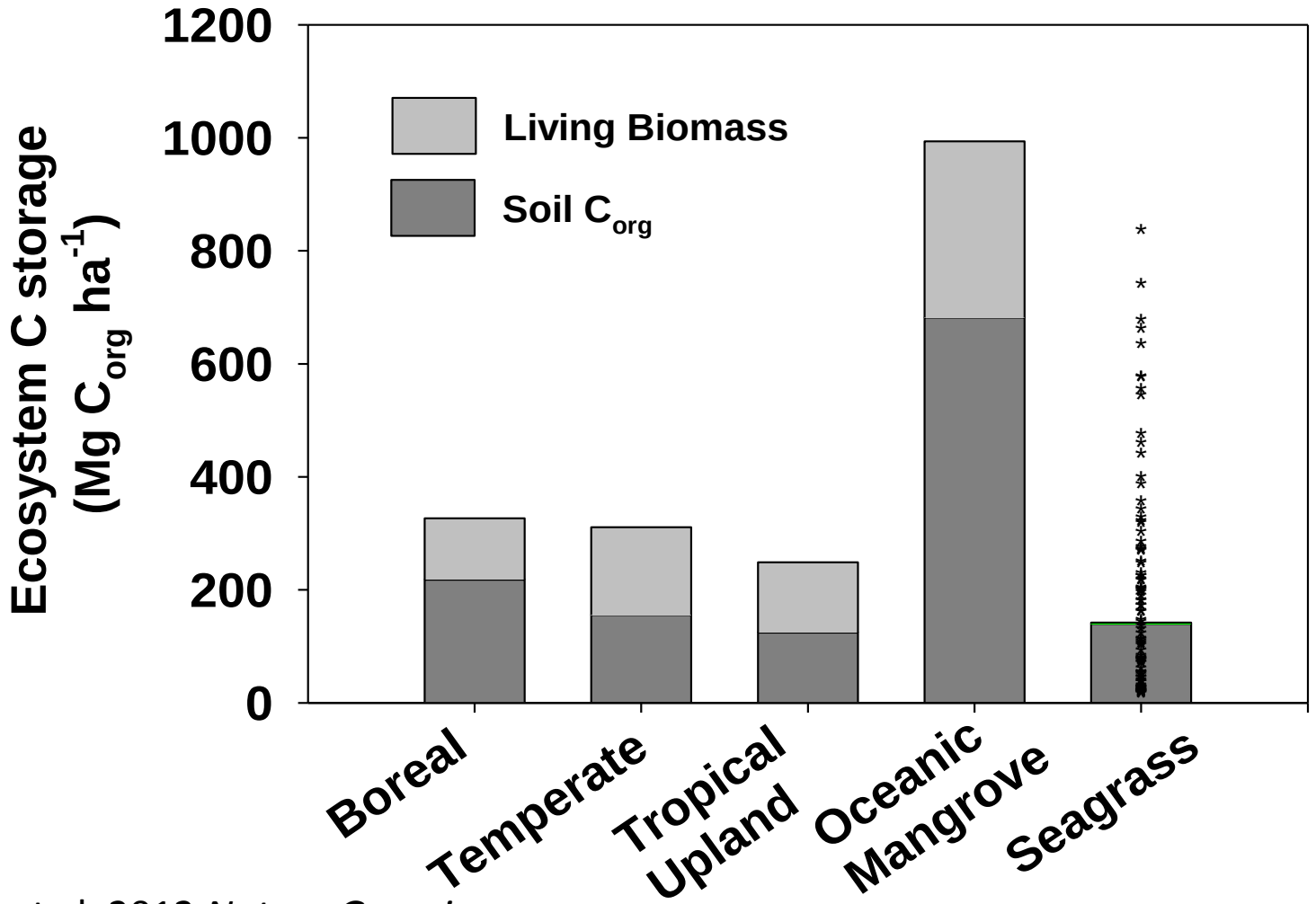
Fourqurean et al. 2012 *Nature Geoscience*

Regional estimates of Seagrass C_{org} stocks

Region	Living Seagrass Biomass MgC ha^{-1}			Soil C_{org} MgC ha^{-1}	
	n	Mean ± 95%CI		n	Mean ± 95%CI
Northeast Pacific	5	0.97 ± 1.02		1	64.4
Southeast Pacific	0	ND		0	ND
North Atlantic	50	0.85 ± 0.19		24	48.7 ± 14.5
Tropical Western Atlantic	44	0.84 ±0.17		13	150.9 ± 26.3
Mediterranean	57	7.29 ± 1.52		29	372.4 ± 74.5
South Atlantic	5	1.06 ± 0.51		5	137.0 ± 56.8
Indopacific	47	0.61 ± 0.26		8	23.6 ± 8.3
Western Pacific	0	ND		0	ND
South Australia	40	2.32 ± 0.63		9	268.3 ± 101.7
Global Average	251	2.51 ± 0.49		89	194.2 ± 20.2

Fourqurean et al. 2012 *Nature Geoscience*

Some seagrass beds rival C-rich terrestrial forests and mangroves



Fourqurean et al. 2012 *Nature Geoscience*

How big are Global Seagrass Blue Carbon stores?

- 300,000-600,000 km^2 of seagrasses
- Median estimate of seagrass biomass:

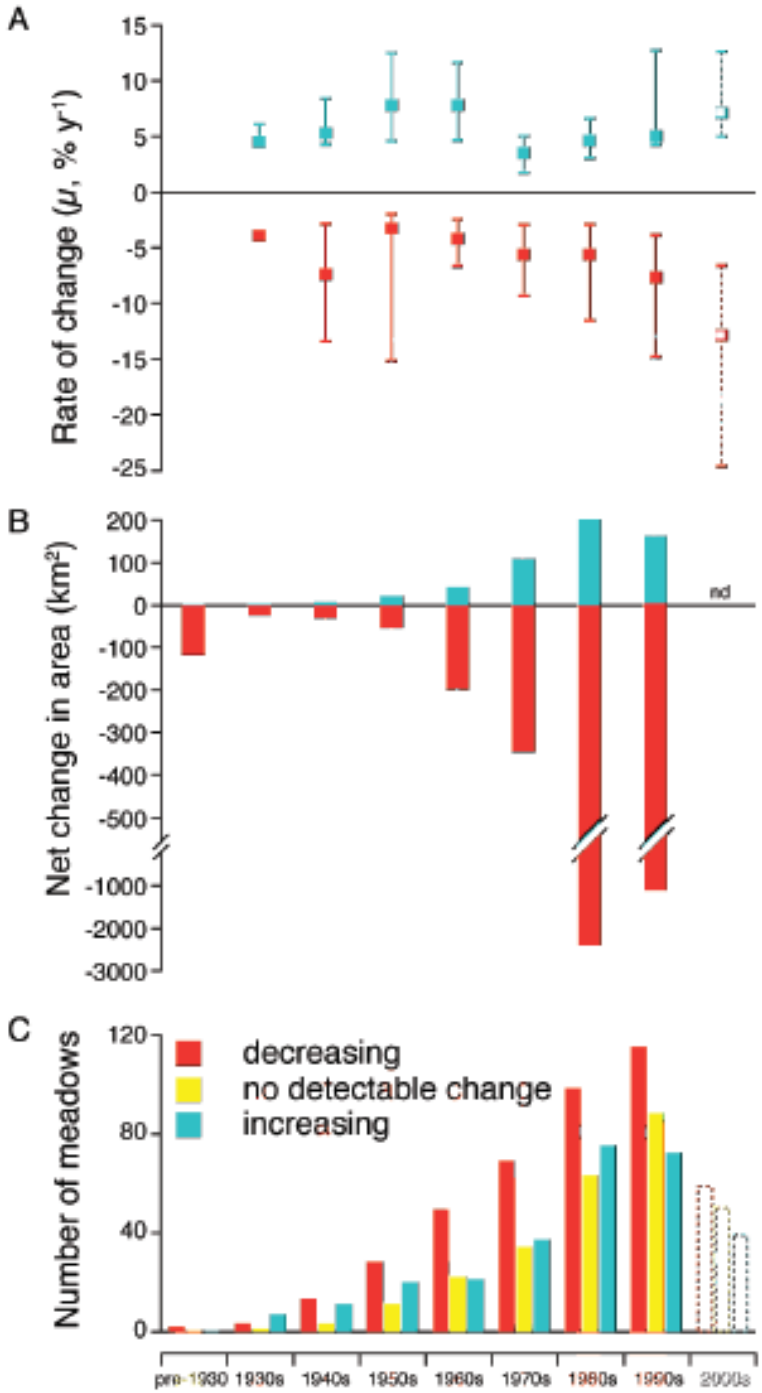
  2.5 Mg C_{org} ha^{-1}
- Median estimate of seagrass soil Corg (top meter)

  139.7 Mg C_{org} ha^{-1}
- Global seagrass biomass:

  75.5 and 151.0 Tg C
- Global seagrass Soil C_{org}:

  4.2 - 8.4 Pg C

  (earlier estimate of salt marshes and mangrove combined is 10 Pg C (Chmura et al 2003)



Reports of seagrass losses and the rates of decline are increasing dramatically

Waycott et al. 2009 *PNAS*

What are the consequences of seagrass loss to global C budget??

- Seagrass loss has averaged 1.5% y^{-1} since the beginning of the 20th century
- Resulting loss of seagrass biomass:

  11.3 – 22.7 Tg C y^{-1}

- Resulting loss of seagrass soil C_{org} (top meter)

  63 – 297 Tg C y^{-1}

- These rates are roughly 10% of total CO_2 fluxes attributable to land use change

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- **NSF – FCE LTER**
- **NSF – Earth Systems History**
- **Australian Government Caring for our Country grant**

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