VARIABILITY OF ORGANIC CARBON ACCUMULATION ON A TIDAL WETLAND COAST

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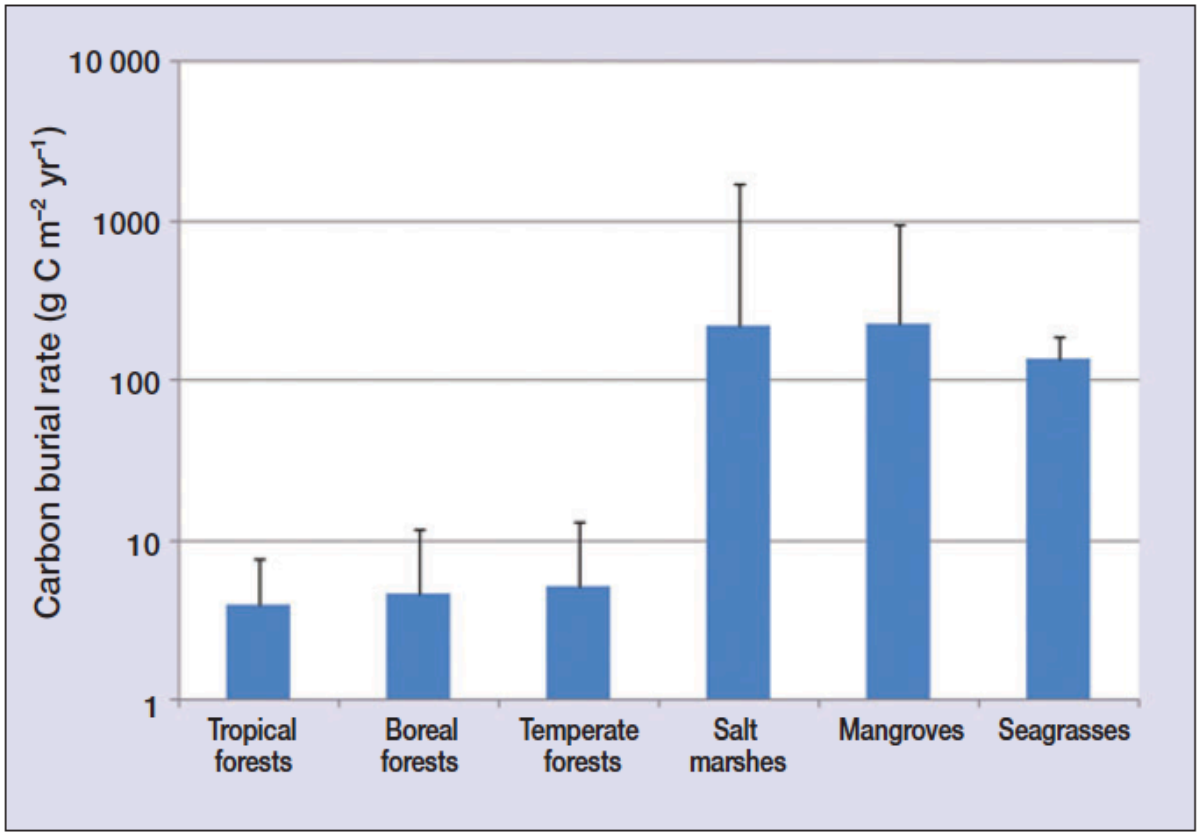
Carbon Burial in Soils and Sediments

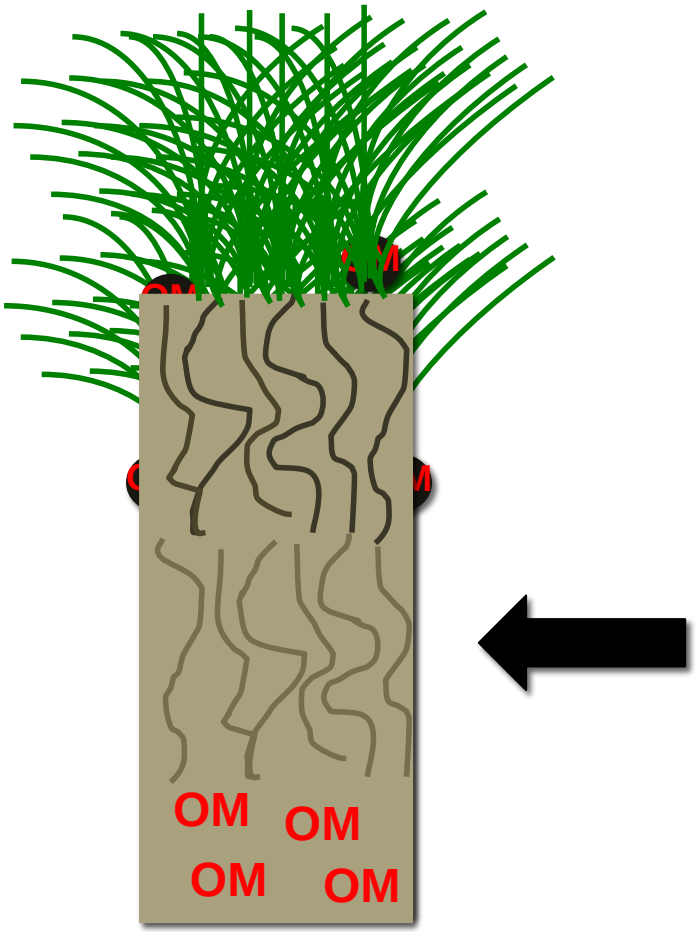


McLeod et al. 2011

Organic Matter Burial and Marsh Accretion

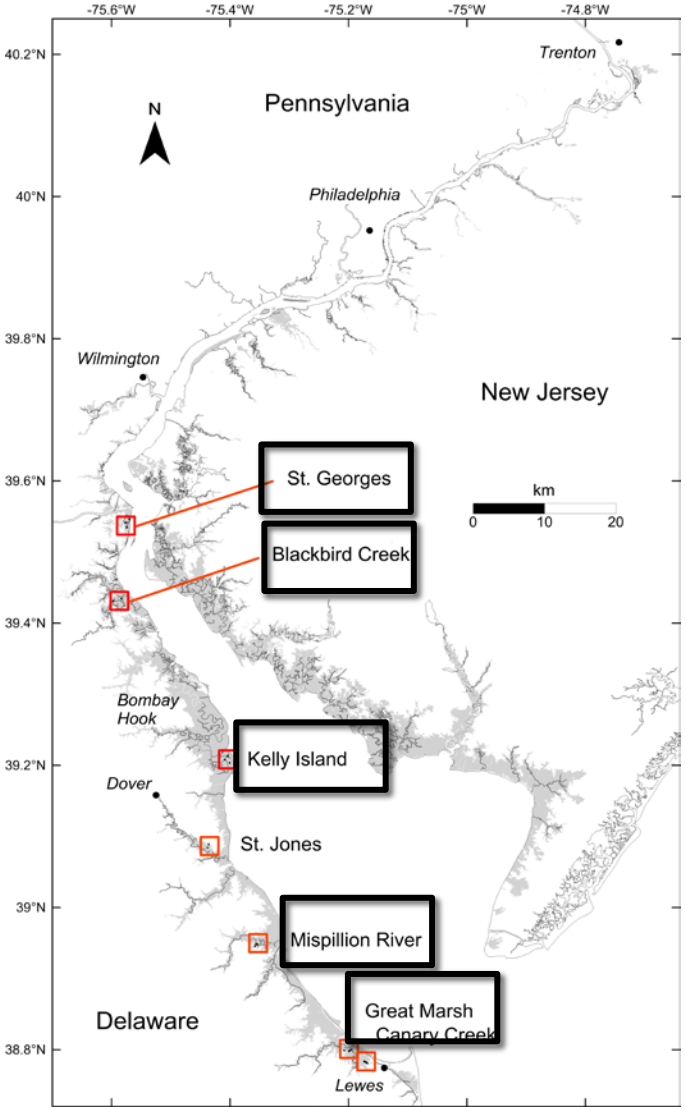
Belowground biomass production = soil volume

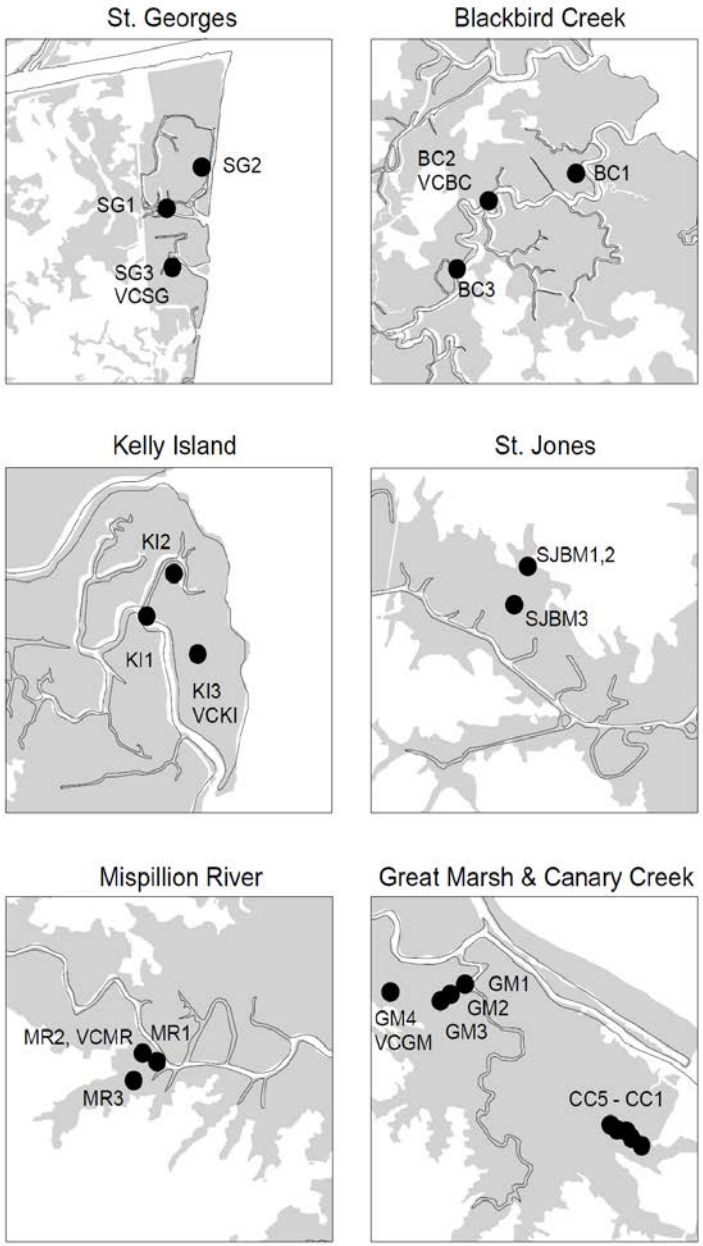
Mineral sediment deposition = more soil volume



Dead Root Biomass

Study Sites


-75.6°W
-75.4°W
-75.2°W
-75°W
-74.8°W
40.2°N
40°N
39.8°N
39.6°N
39.4°N
39.2°N
39°N
38.8°N
N
Pennsylvania
Trenton
Philadelphia
Wilmington
New Jersey
St. Georges
Blackbird Creek
km
0
10
20
Bombay Hook
Kelly Island
Dover
St. Jones
Mispillion River
Great Marsh
Canary Creek
Delaware
Lewes


St. Georges
SG2
SG1
SG3
VCSG
Blackbird Creek
BC2
VCBC
BC1
BC3
Kelly Island
KI2
KI1
KI3
VCKI
St. Jones
SJBM1,2
SJBM3
Mispillion River
MR2, VCMR
MR1
MR3
Great Marsh & Canary Creek
GM1
GM2
GM3
GM4
VCGM
CC5 - CC1

Goals and Objectives

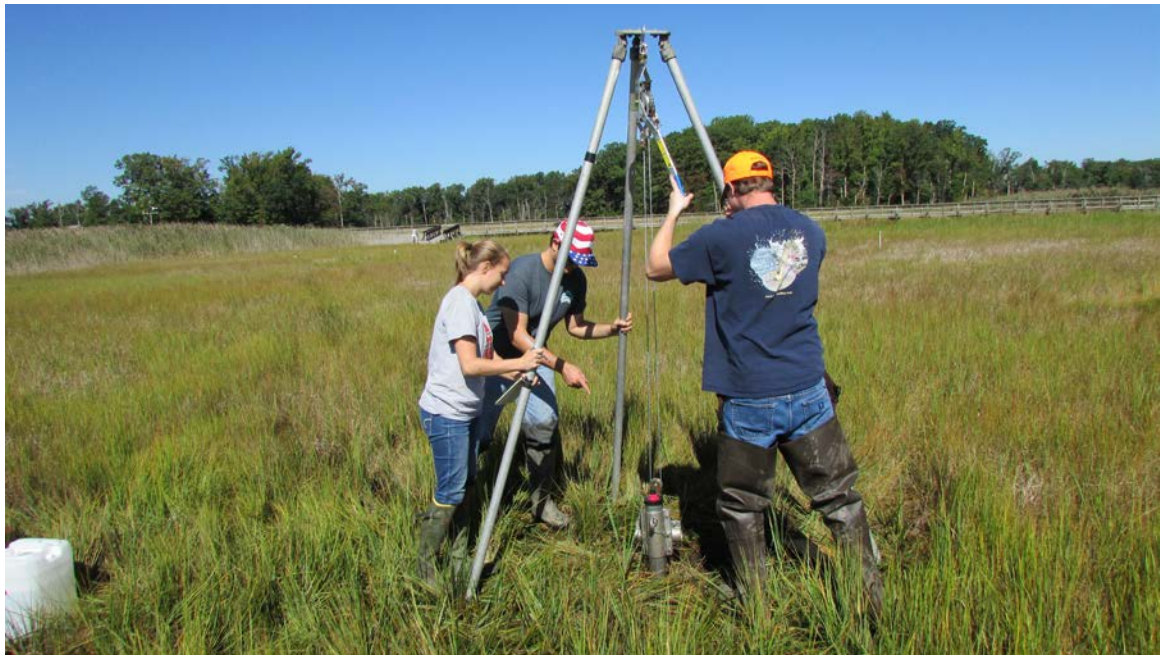
- Short-term carbon accumulation patterns and rates have been reported (28-439 g C m^{-2} yr^{-1})

1. Elucidate carbon accumulation associated with different soil organic matter pools
   - What is really being “sequestered”?

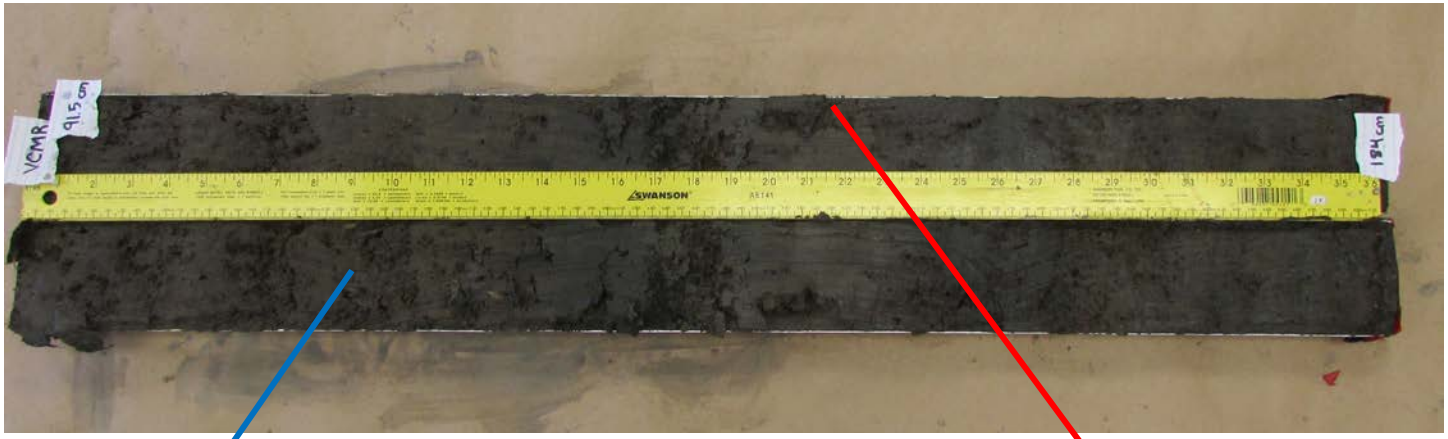
Methods

Core collection

- 5 long cores
  - Cores ranged in length from 200-230 cm



Pictured (left to right): Kaitlin Tucker, Brandon Boyd, Zac Duval



Bulk Material

- Dry Bulk Density
- Loss on Ignition (LOI)
- Organic Carbon

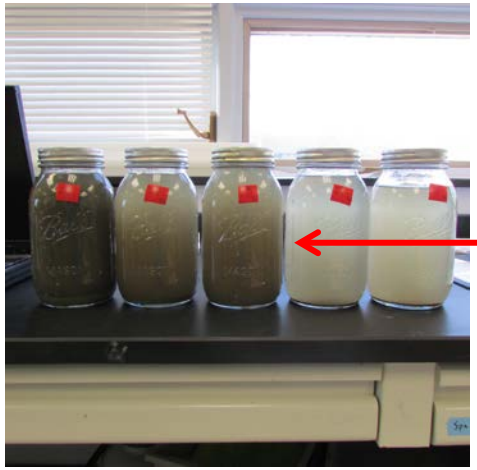
Size Fraction Analysis

- Plant Material
- ^{14}C Dating

>125µm

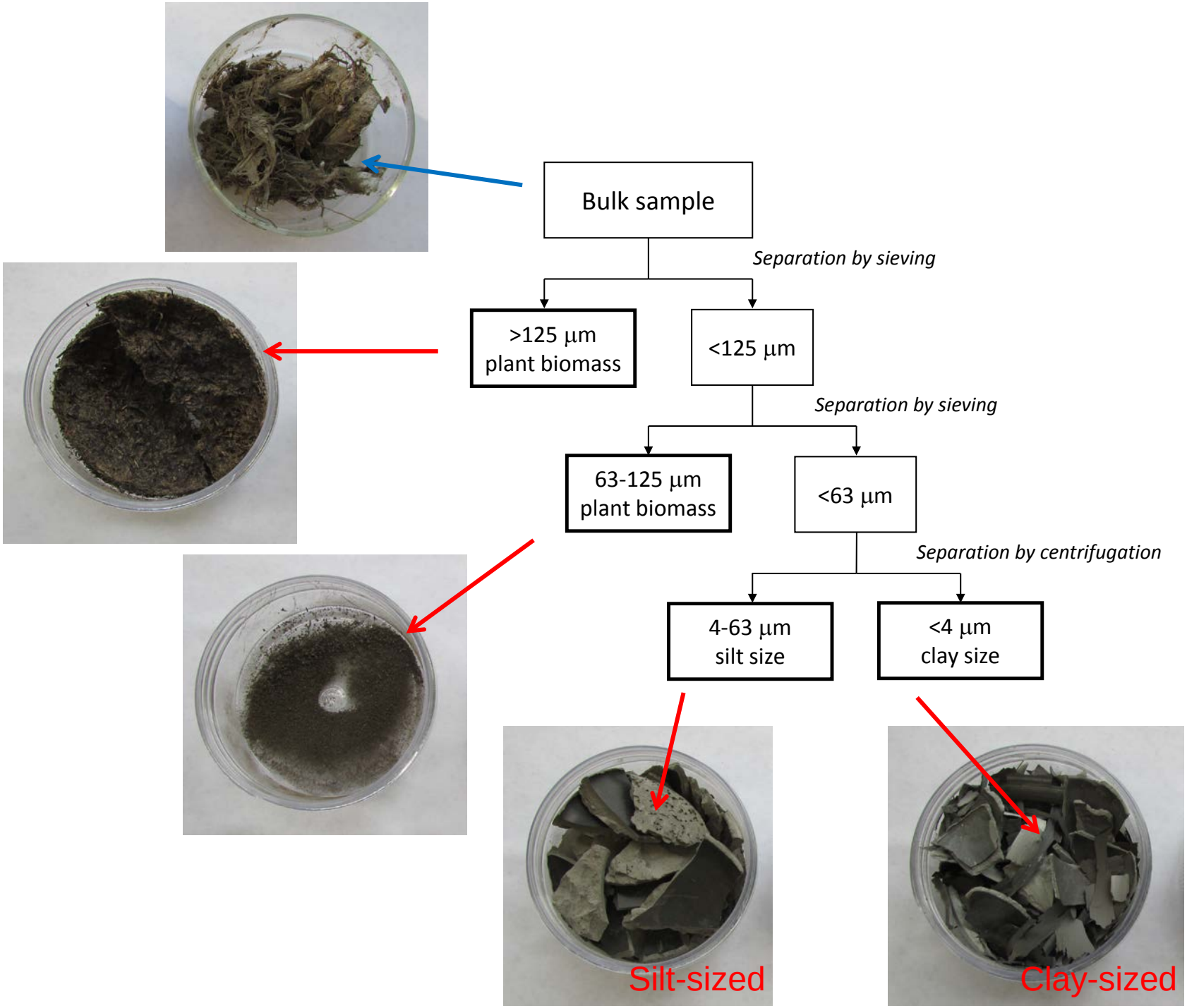
63-125µm

- Small
- Plant Material



Centrifuge and decant

600 RPM = 4-63µm
3000 RPM= <4µm


Bulk sample
Separation by sieving
>125 µm
plant biomass
<125 µm
Separation by sieving
63-125 µm
plant biomass
<63 µm
Separation by centrifugation
4-63 µm
silt size
<4 µm
clay size
Silt-sized
Clay-sized

Age Dating

Radionuclide	Half-life	Range
^{14}C	5,730 years	200 – 55,000 years

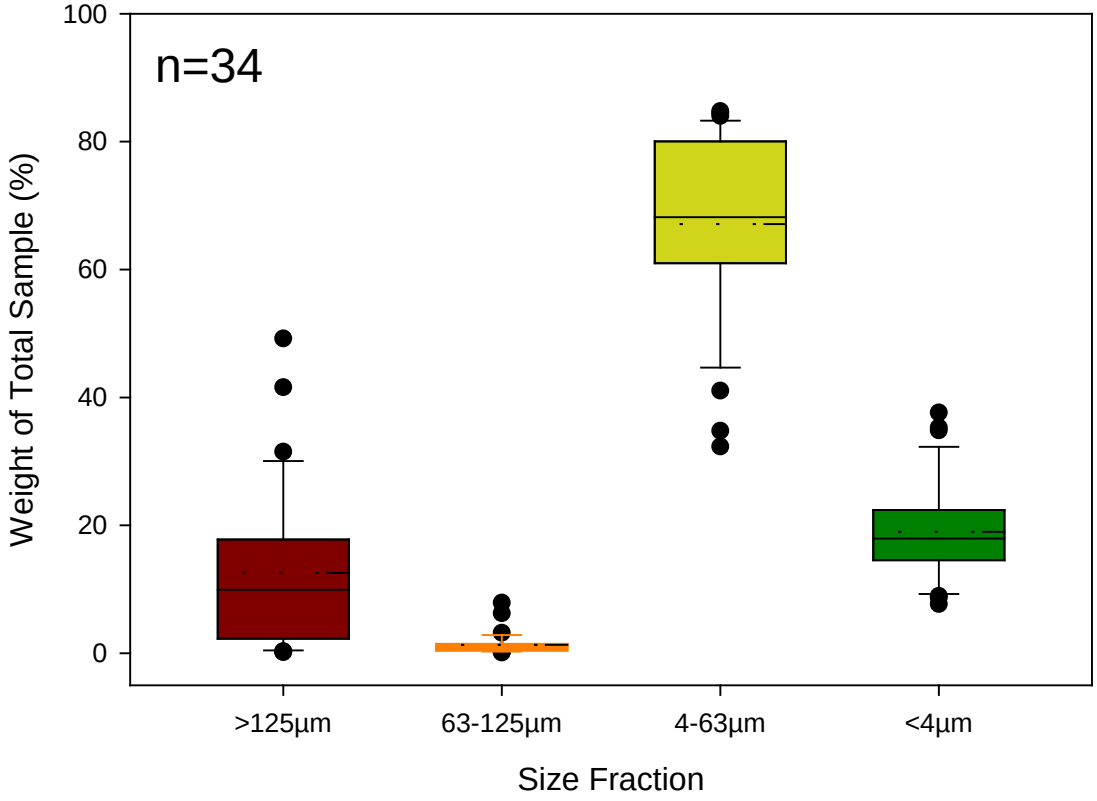
Radiocarbon analysis was completed at Woods Hole by Accelerator Mass Spectrometry.

1. Determine stratigraphic ages of the soil column

$$\sum_{i=0cm}^{z_i} (C_i \cdot \rho_{di} \cdot x \cdot 10{,}000)/t$$

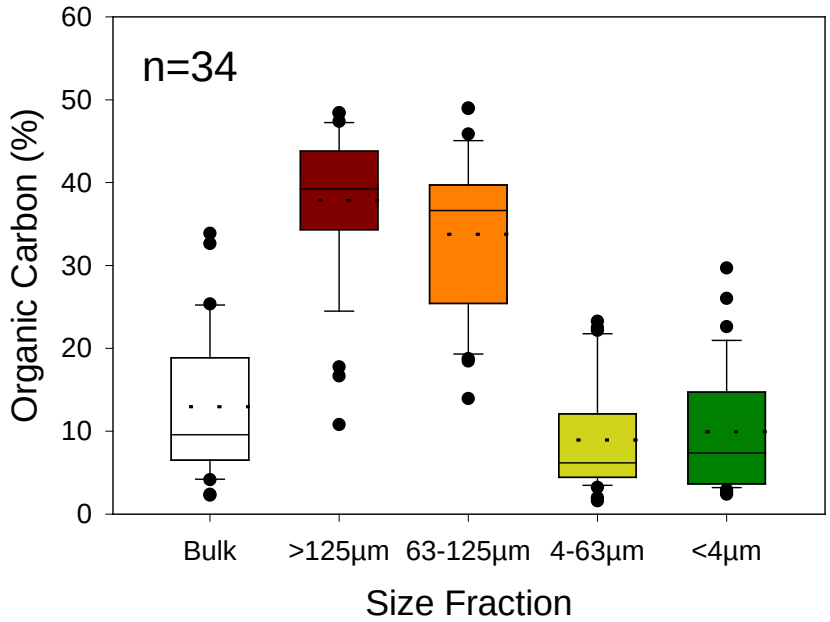
2. Establish relative ages of different carbon fractions

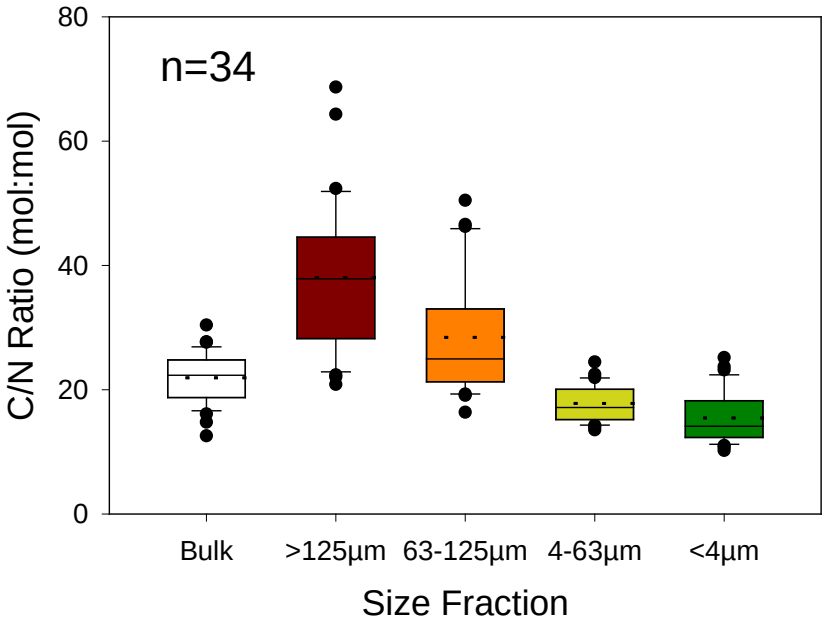
Soil Size Fractions Compose Bulk Material



Ranges:
>125µm = 0.16-49%
63-125µm = 0.2-8%
Silt-sized = 32-85%
Clay-sized = 8-38%

Composition of Soil Fractions





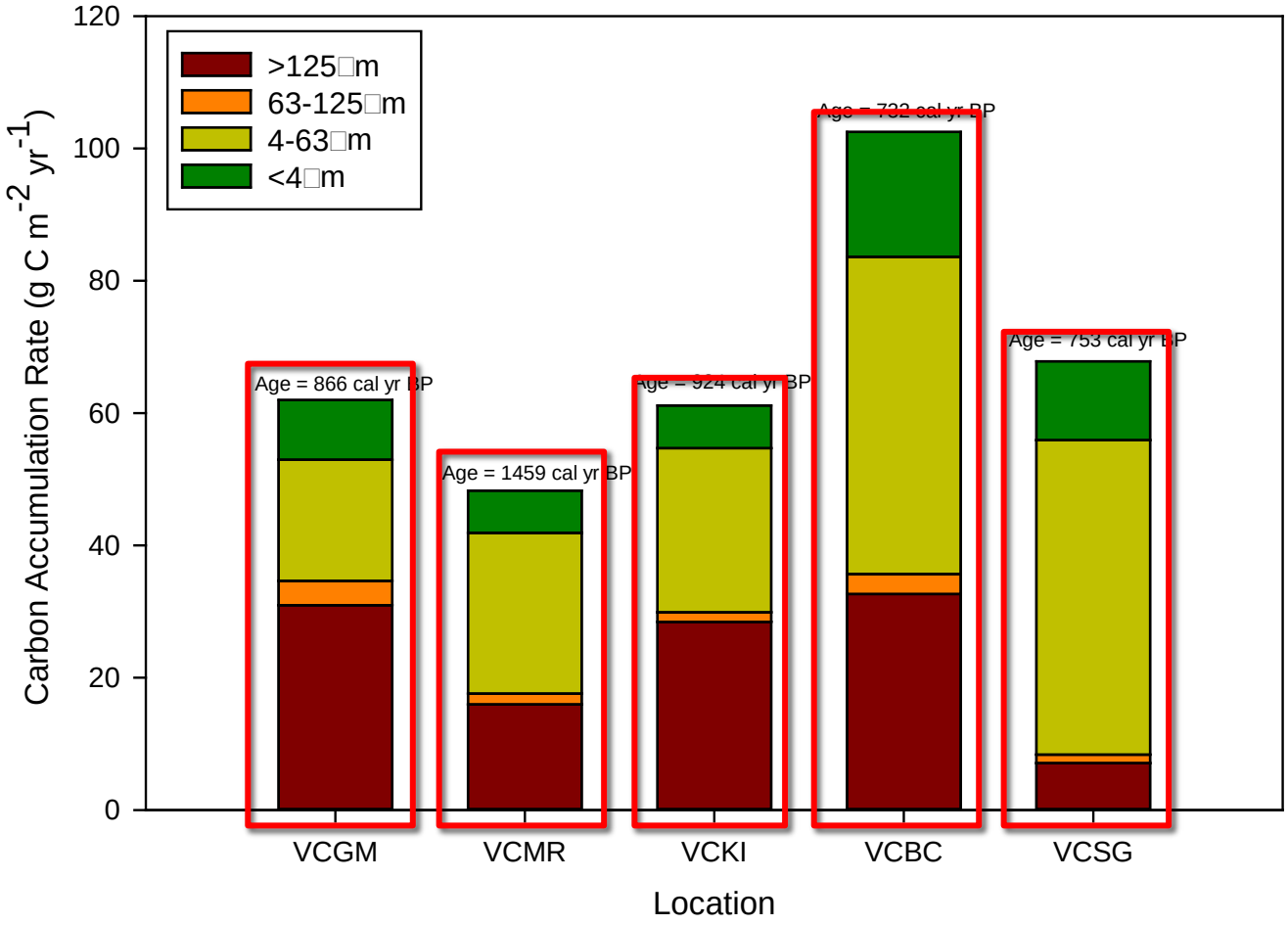
Average TOC:
>125µm = 38%
63-125µm = 33%
Silt-sized = 9%
Clay-sized = 9%

Bulk TOC= 13%

Average C/N:
>125µm = 38
63-125µm = 28
Silt = 18
Clay = 15

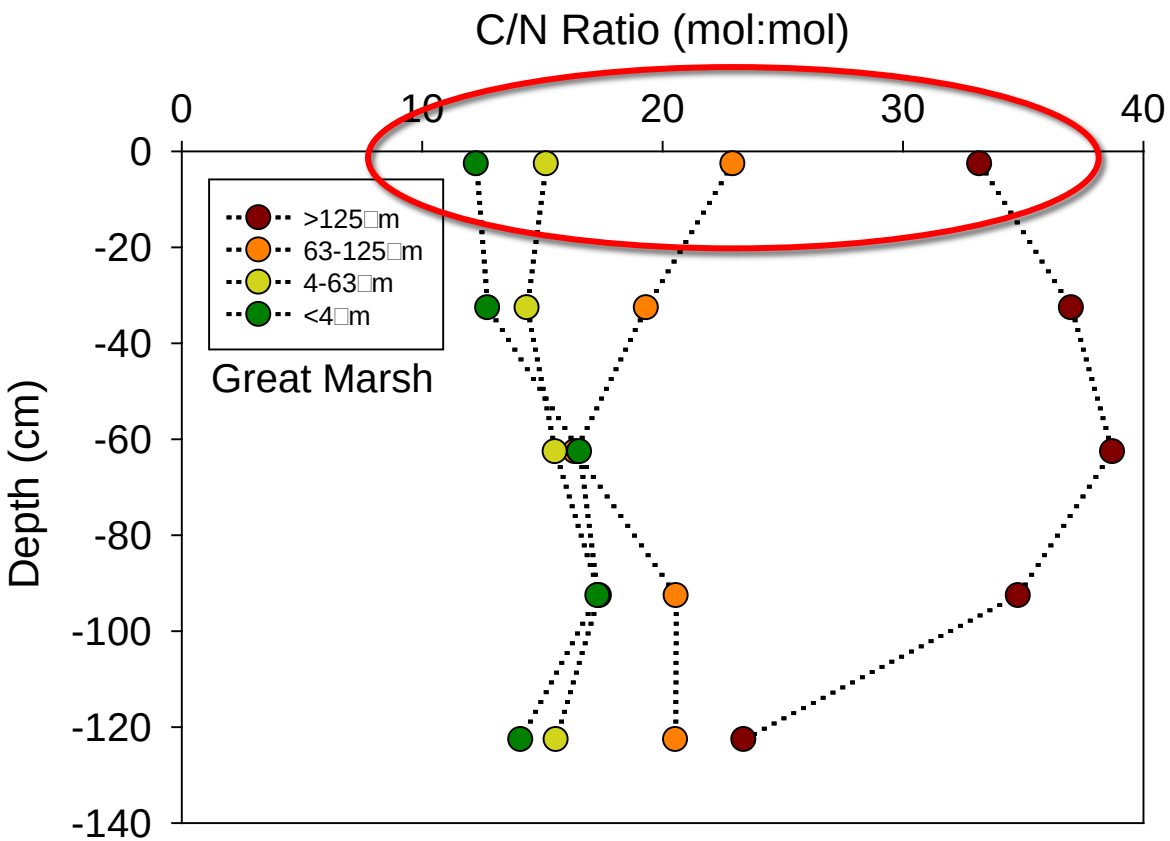
Bulk C/N= 22

Size Fraction Carbon Accumulation Rates



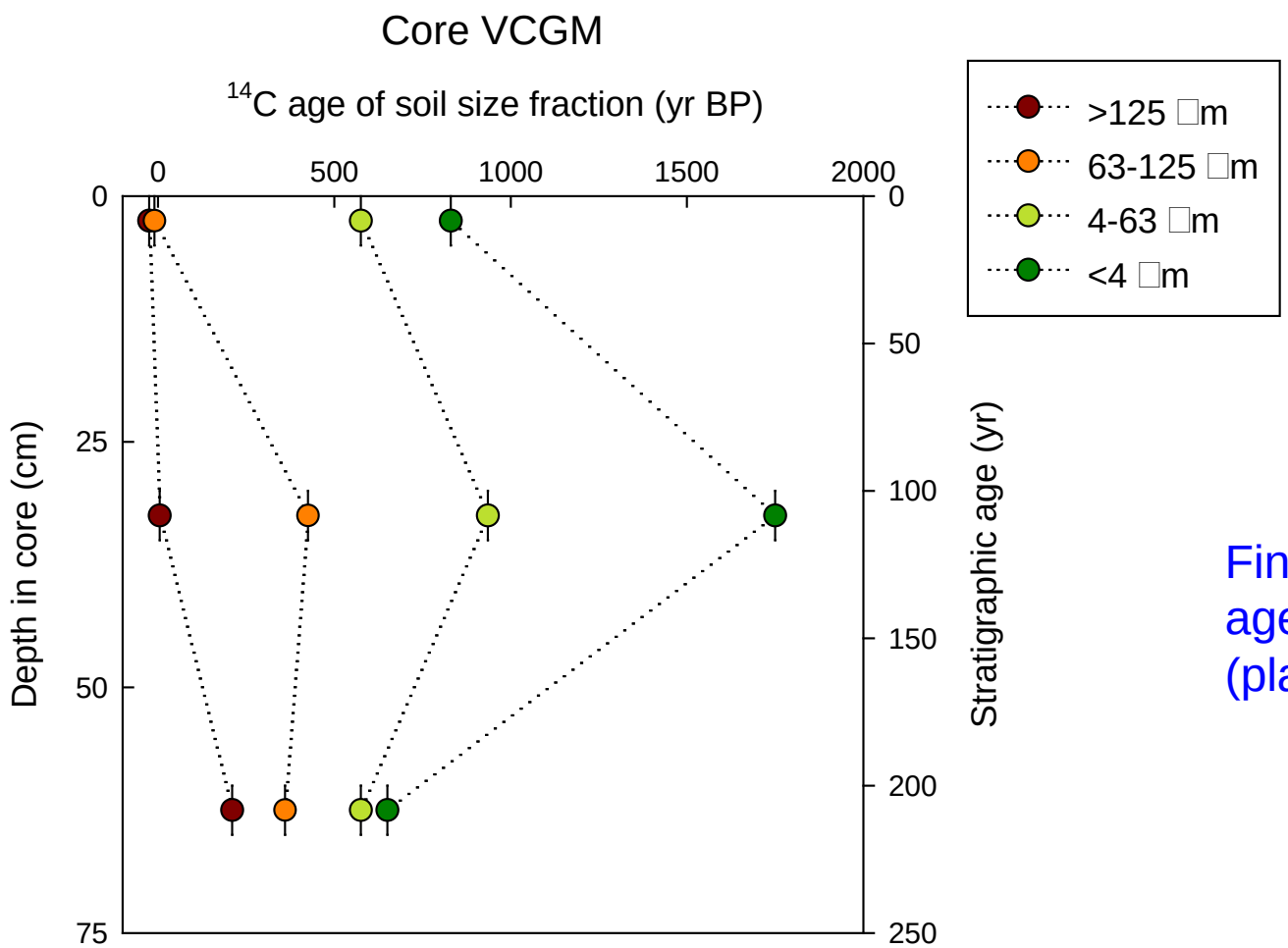
Fine-grained material contributes significantly to total CAR

Composition of Soil Size Fractions are Distinct



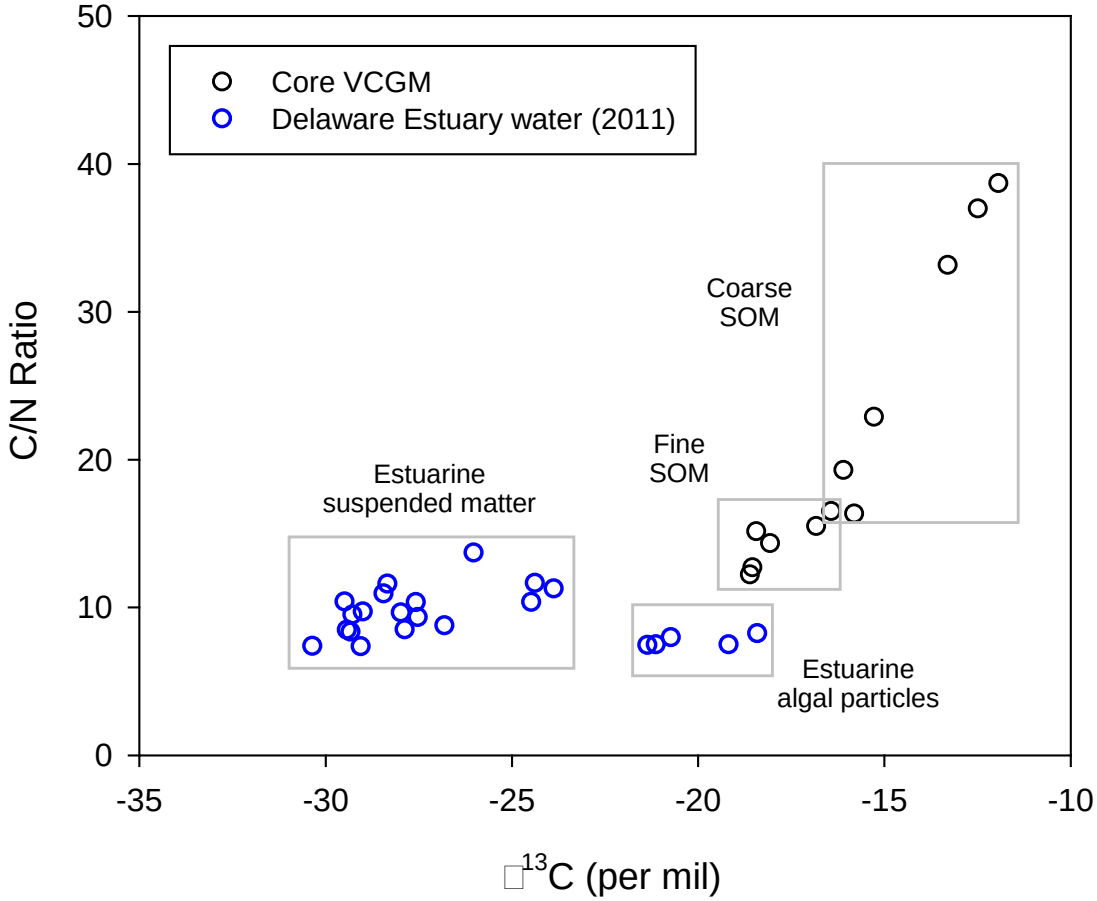
C/N ratios are different for all size fractions at the surface

Another Indication: Age



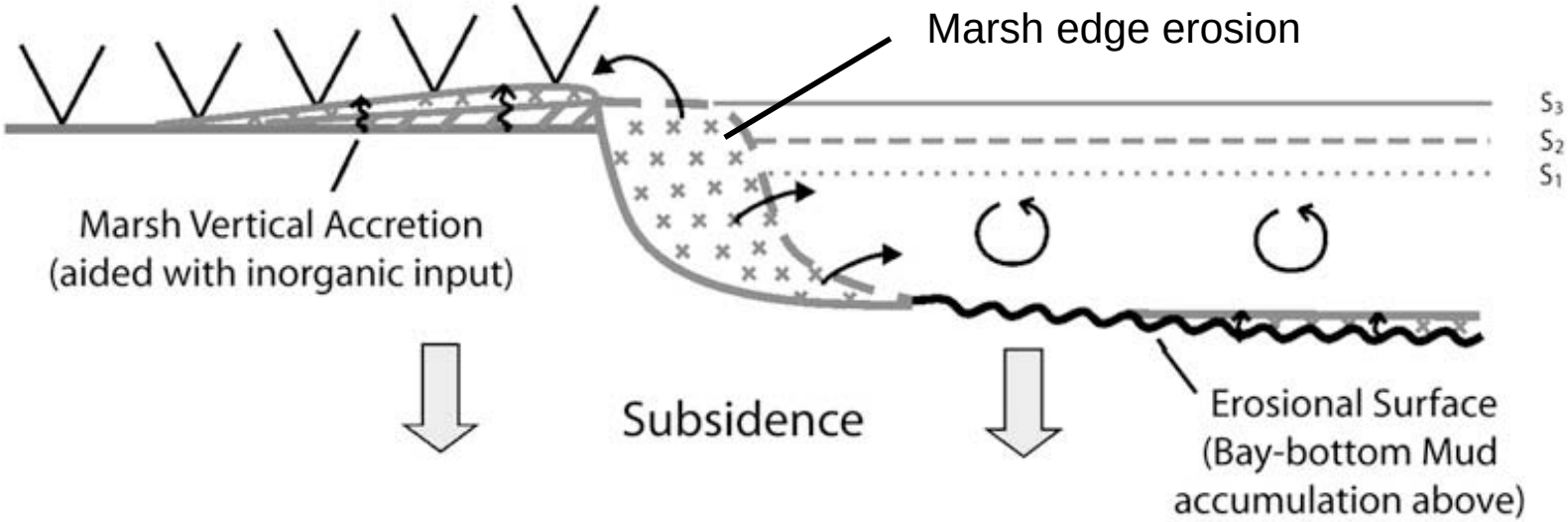
Finer material is more aged than coarser (plant) material

Composition of Soil Carbon



Spartina: -12 to -14.5‰
Algal Biomass: -18 to -21‰
Terrestrial: -24 to -31‰

Conceptual Model of Marsh Soil Formation



from Wilson and Allison (2008)

Conclusions and Findings

1. Fine-grained soil carbon contributed significantly to CAR
2. The source of fine-grained carbon appears to be aged plant matter
3. Implications for carbon sequestration and stocks in tidal marshes – need to know what is being “sequestered”

Future Work

- Radiocarbon dating
- Stable isotope analysis

Acknowledgements

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