The Relationship Between Carbon Burial and Sediment Deposition in Salt Marshes: A Comparison of a Coastal Lagoon and Coastal Plain Estuary in the Mid-Atlantic U.S.

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Background: Current Trends in Literature

- Salt marshes offer many ecosystem services
- Highly efficient at carbon (C) sequestration

Table 1. Carbon burial and global area of vegetated coastal ecosystems

Ecosystem	*Carbon burial rate* (*g C* m^{-2} yr^{-1}) *mean ± SE*	*Global area* (km^2)	*Global carbon burial** (*Tg C* yr^{-1}) *mean ± SE*	Sources: *Global area*	Sources: *Carbon burial*
Salt marshes	218 ± 24 (range = 18–1713) *n* = 96 sites	22 000**– 400 000	4.8 ± 0.5 87.2 ± 9.6	Chmura *et al.* (2003); Duarte *et al.* (2005a)	Chmura *et al.* (2003); Duarte *et al.* (2005a)
Mangroves	226 ± 39 (range = 20–949) *n* = 34 sites	137 760– 152 361	31.1 ± 5.4 34.4 ± 5.9	Giri *et al.* (2010); Spalding *et al.* (2010)	Chmura *et al.* (2003); Bird *et al.* (2004); Lovelock *et al.* (2010); Sanders *et al.* (2010)

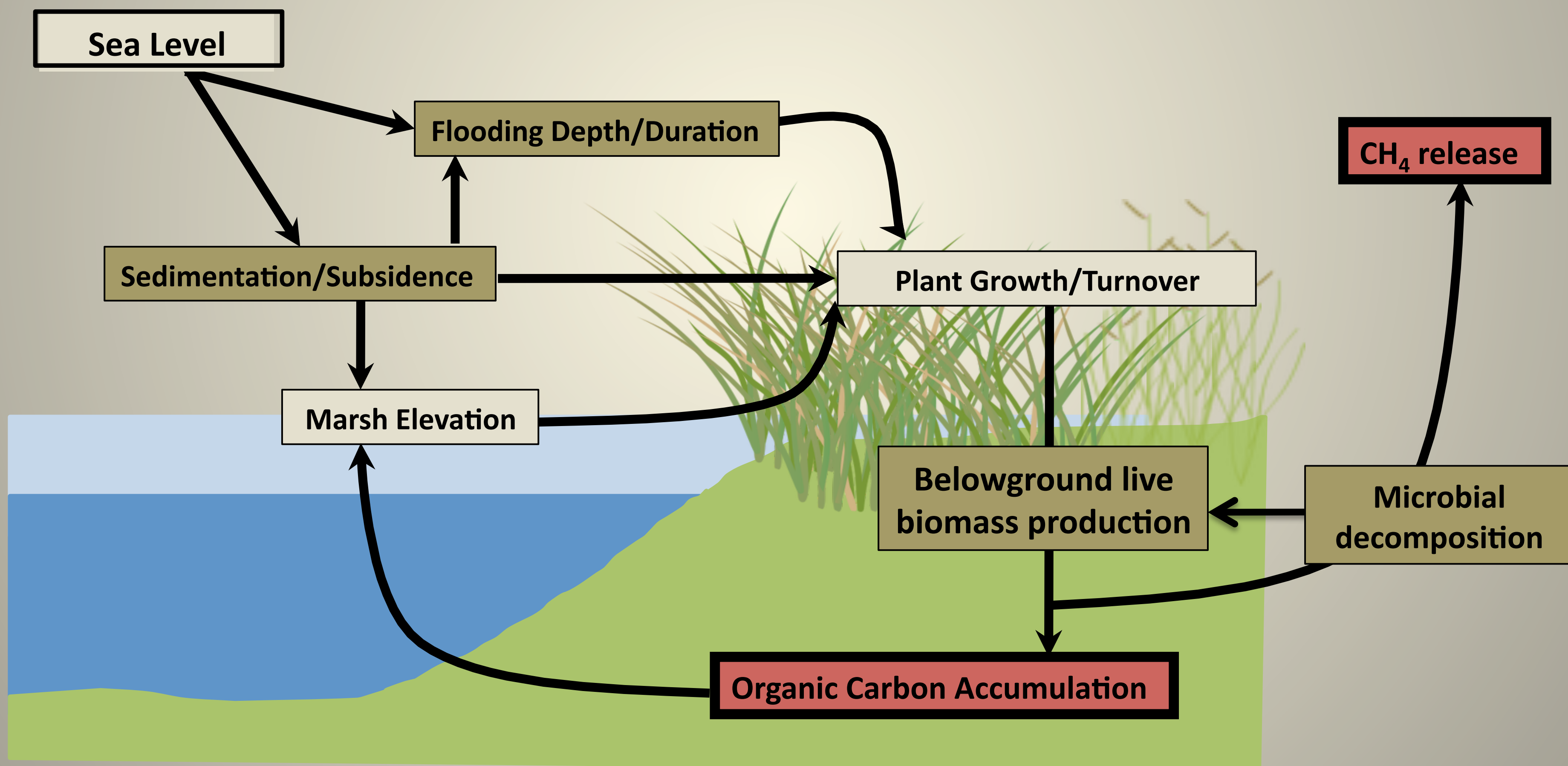
(Table modified from Mcleod et al. 2011.)

- Increase soil volume over millennia
- Release relatively minimal amount of methane (CH_4), nitrous oxide (N_2O)

(Choi and Wang 2004, Chmura 2011, Mcleod et. All 2011.)

Accumulation of C in Salt Marsh Soils

- Occurs when plant productivity exceeds microbial decomposition
- Rates of accumulation depend upon several fine-scale controls



(Adapted from Cahoon 2007.)

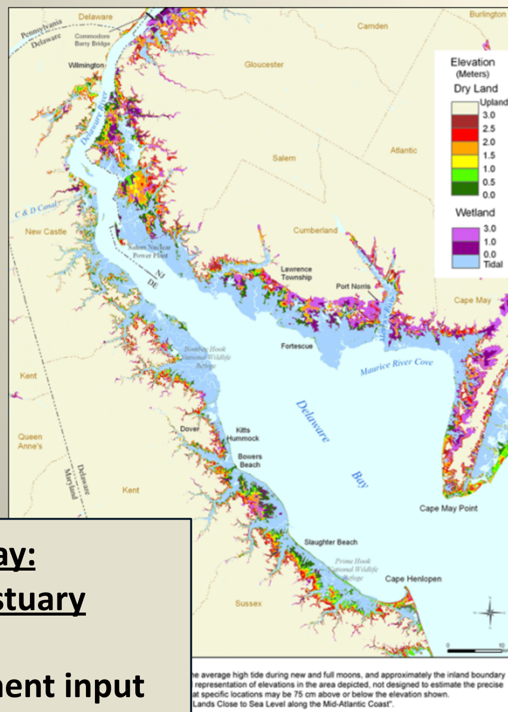
Problem Statement

- Factors affecting rates of C sequestration are poorly understood, vary greatly
- Few studies geared toward quantifying relative magnitude of influence
- Few studies compare two types of estuaries

Research Goals

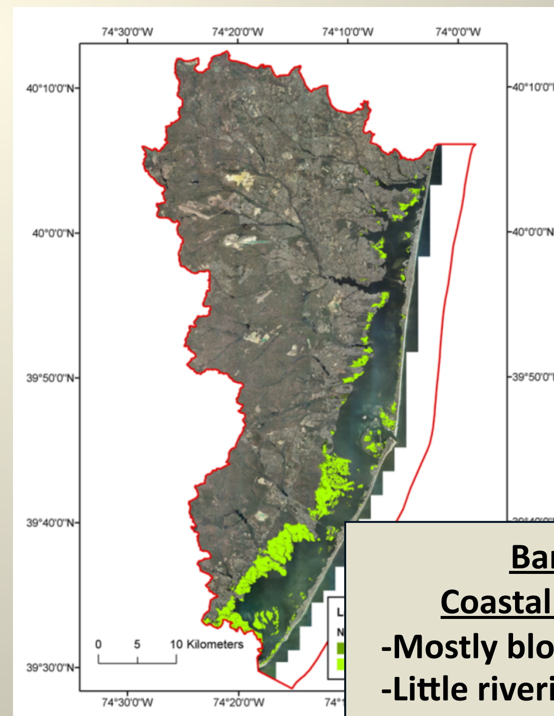
1) *Elucidate fine-scale controls that influence C accumulation in salt marsh soils*

2) *Examine relative magnitude of influence of fine-scale controls in two estuary types*
   - *Sediment deposition/accumulation*
   - *Belowground biomass production*
   - *Organic matter accumulation*



Delaware Bay:
Coastal Plain Estuary
-Open to ocean
-High riverine sediment input

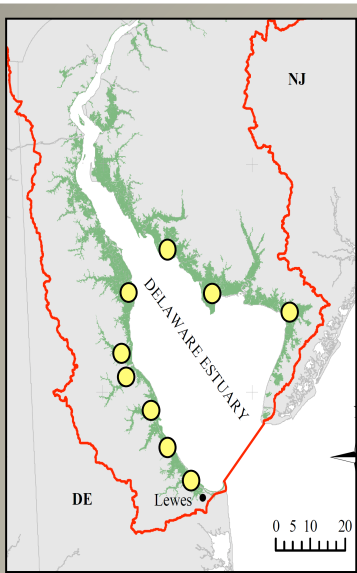
(J.G. Titus and J. Wang . U.S. EPA 2008.)

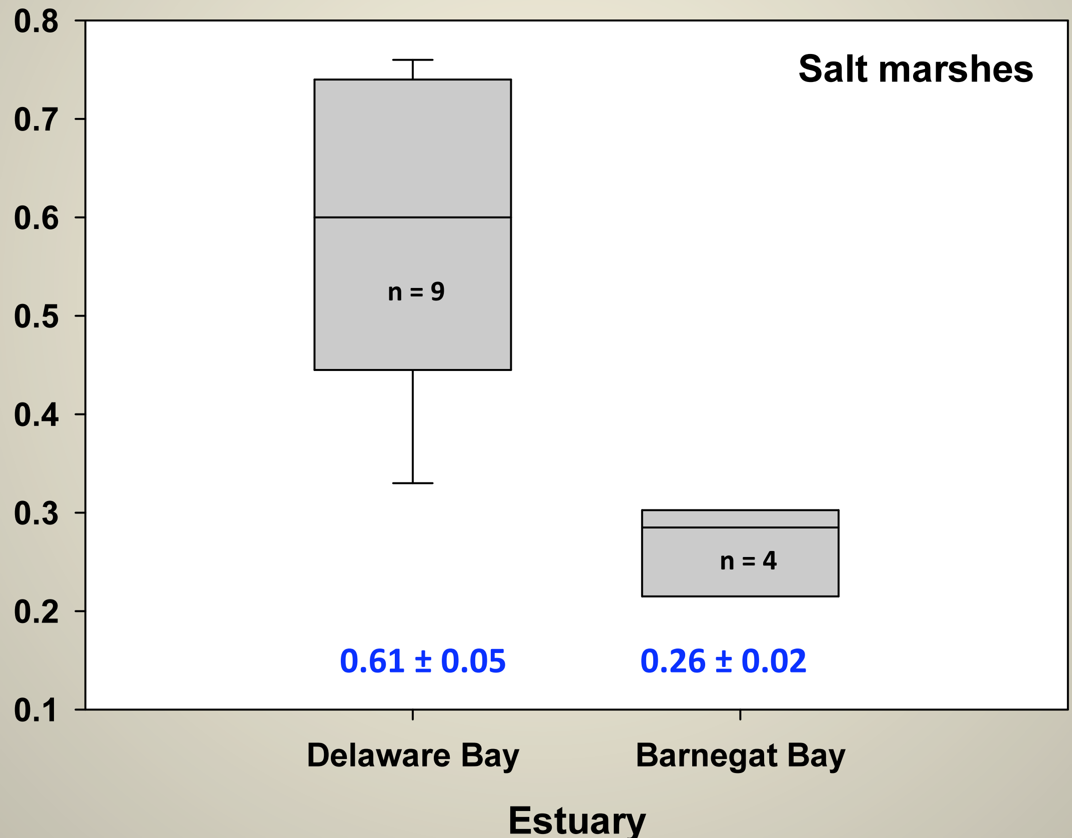


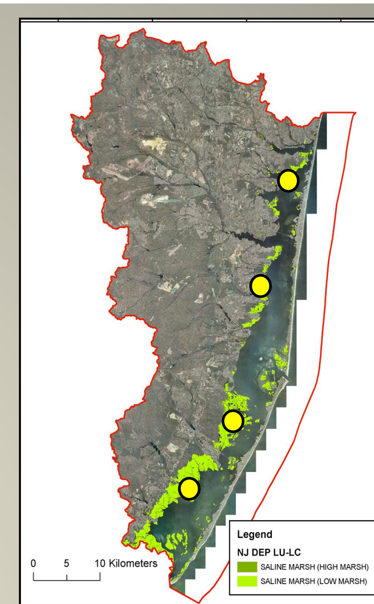
Barnegat Bay:
Coastal Lagoon Estuary
-Mostly blocked from ocean
-Little riverine sediment input

(N.J. DEP)

Preliminary Accretion Data

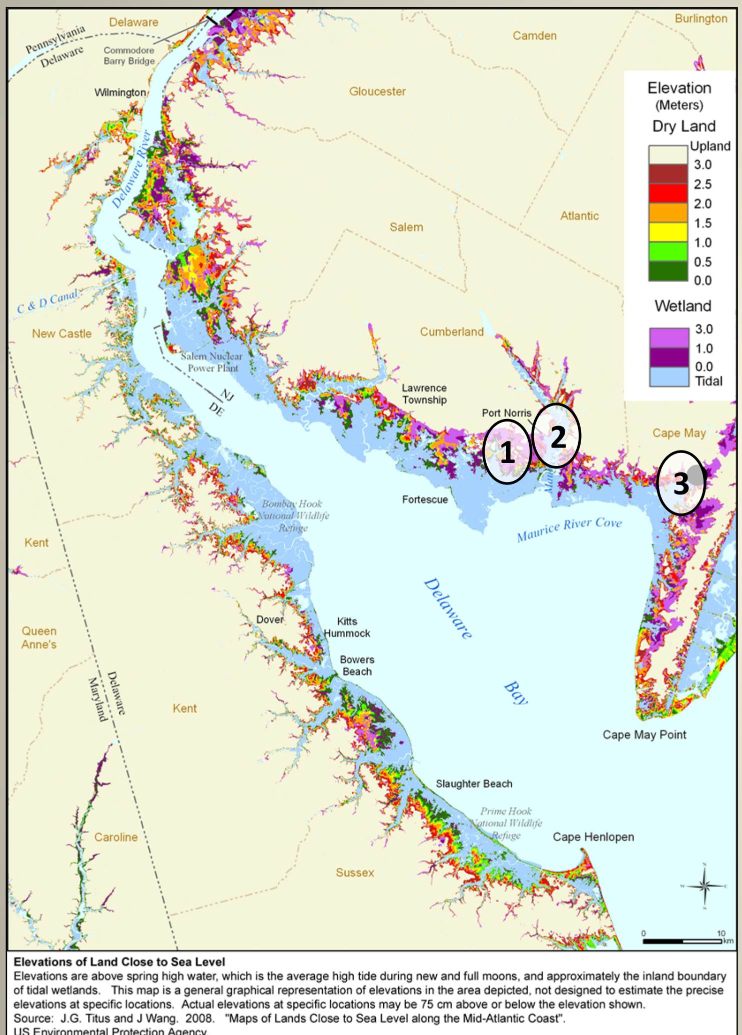






(Sommerfield and Velinsky 2011.)

Study Locations: Coastal Plain



(J.G. Titus and J. Wang . U.S. EPA 2008.)

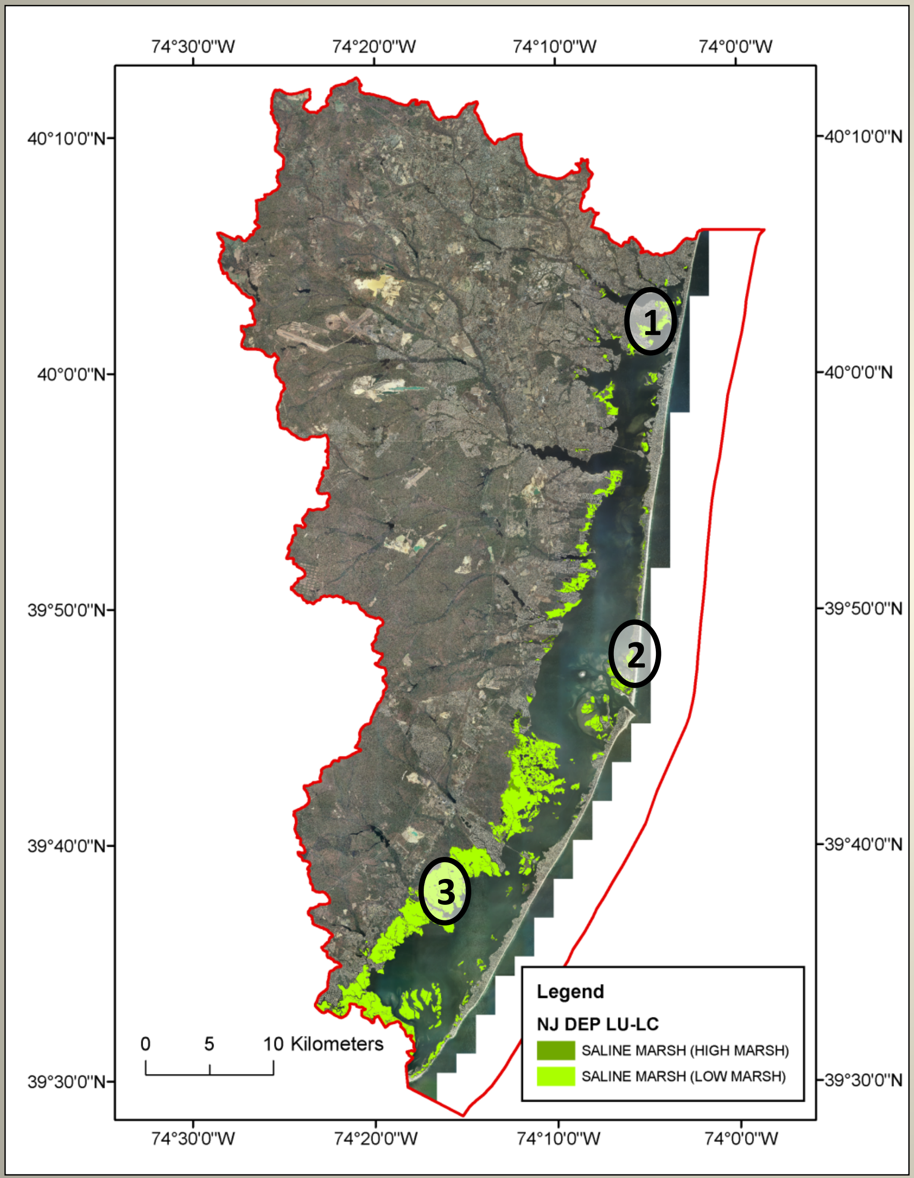
Delaware Bay

1) Dividing Creek

2) Maurice River

3) Dennis Creek

Study Locations: Coastal Lagoon



(N.J. DEP)

Barnegat Bay

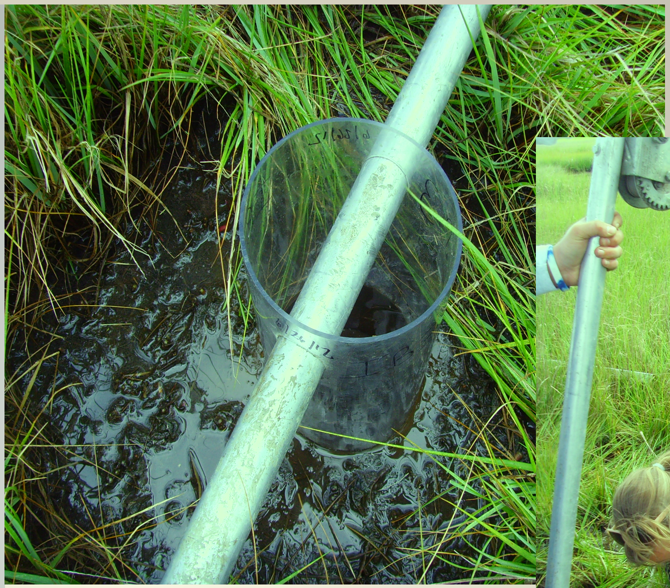
1) Reedy Creek

2) Island Beach State Park

3) Horse Point

Sample Collection & Design

- 3 replicate cores per marsh
  - ~ 15.25cm diameter (6in)
  - ~1 m deep
- Stratified near, middle and far distances from estuary
- Collected in short form *Spartina alterniflora*

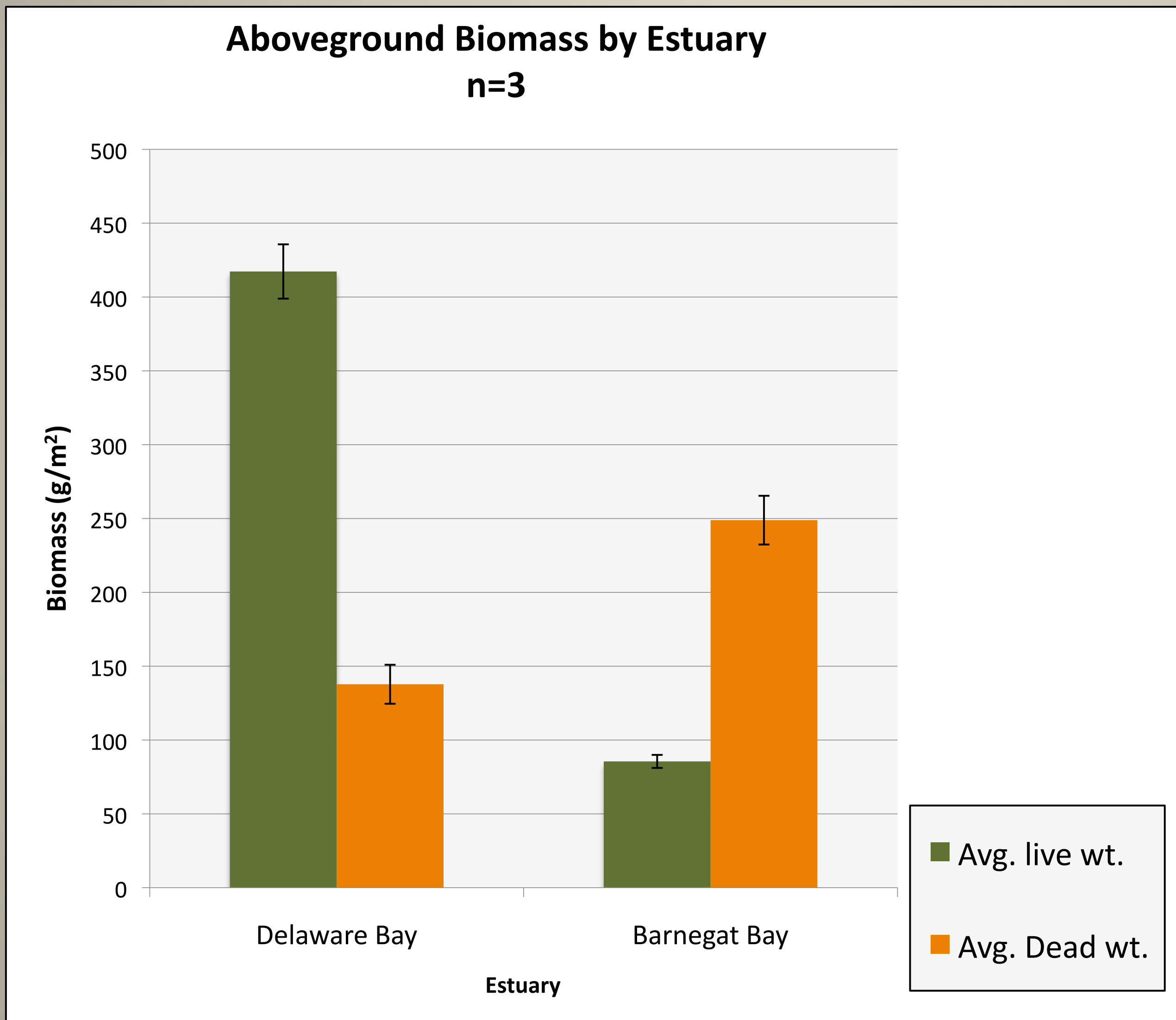


(Image: Google earth.)

Sample Processing

- Cores cut in 2cm depth sections
- Sections halved
  - Cs^{137} and Pb^{210} dating
  - Loss on Ignition (%OM)
  - Nutrients (C, N, P)
  - Labile vs. Refractory C
  - Belowground biomass composition

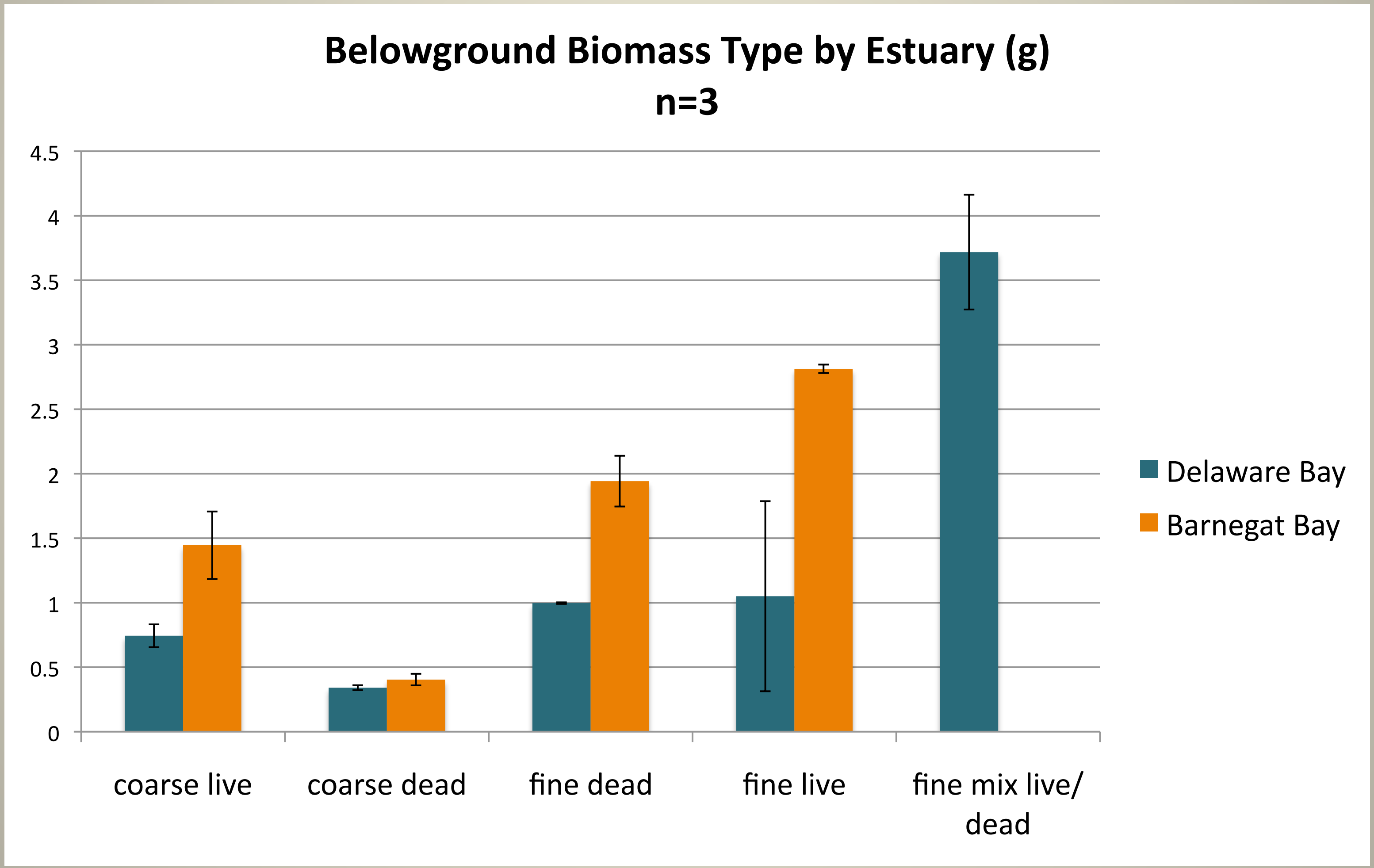
Results: Aboveground Biomass



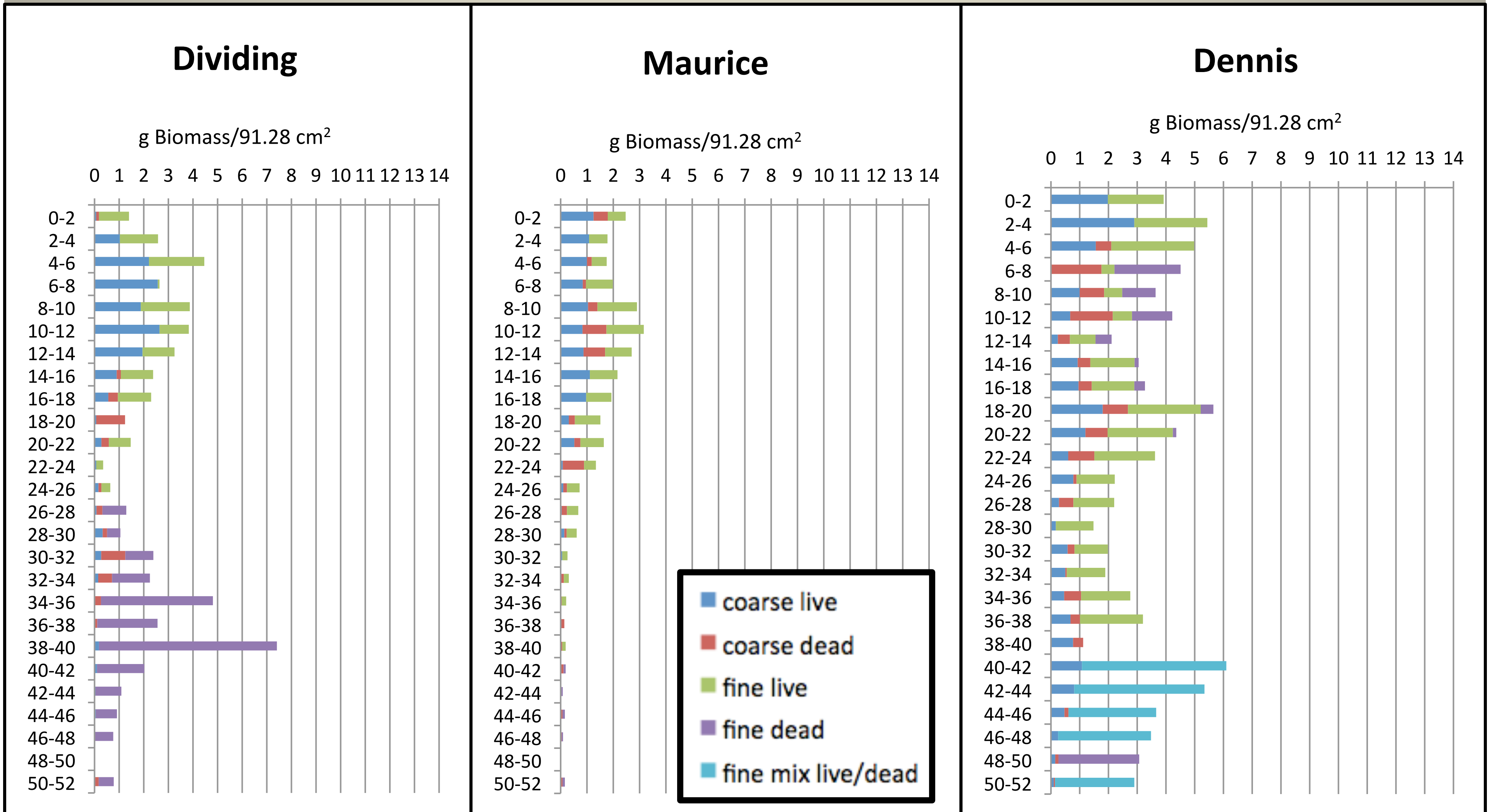
Live:
P-value= .02276*

Dead:
P-value= .02941*

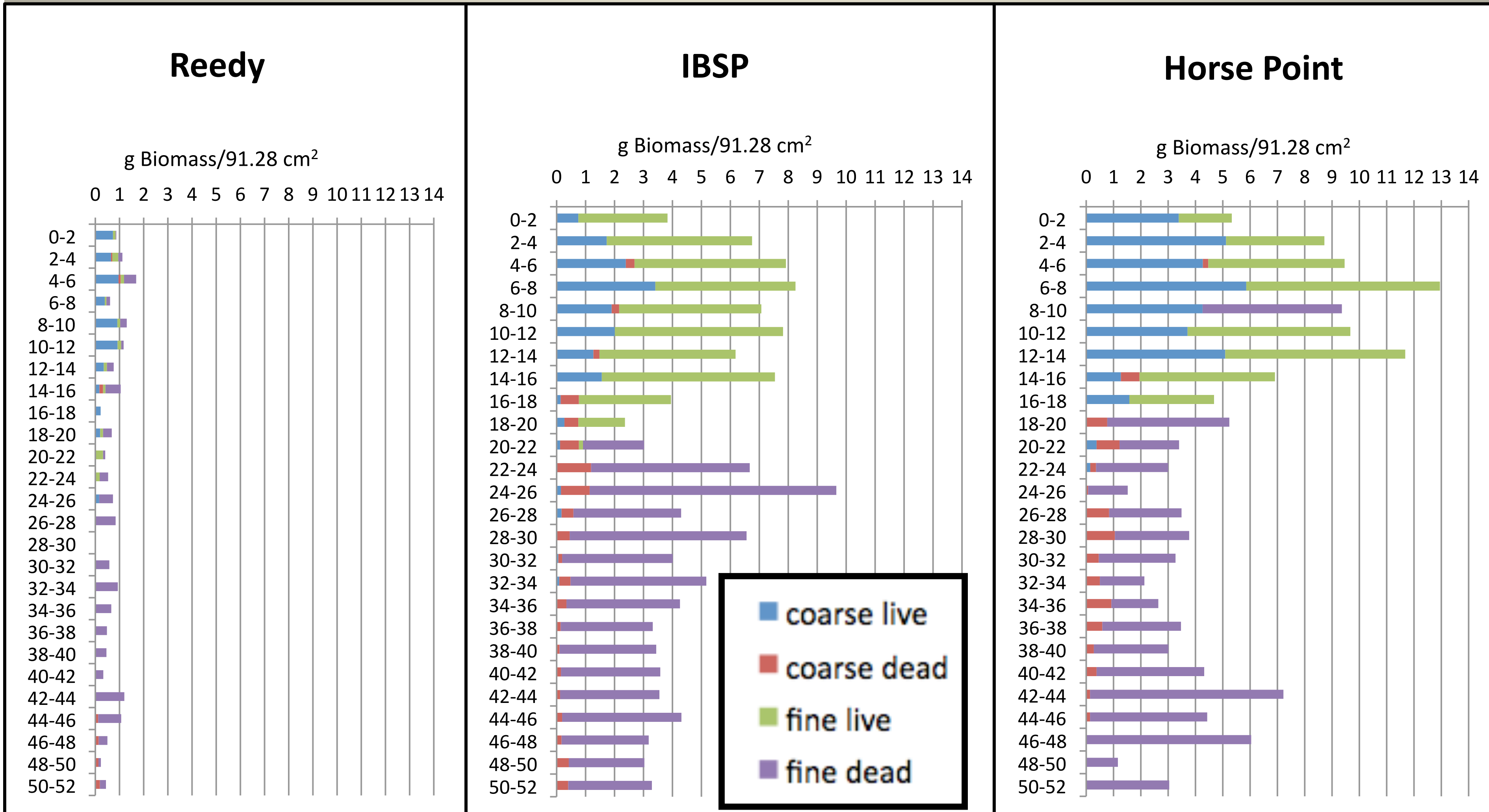
Results: Belowground Biomass



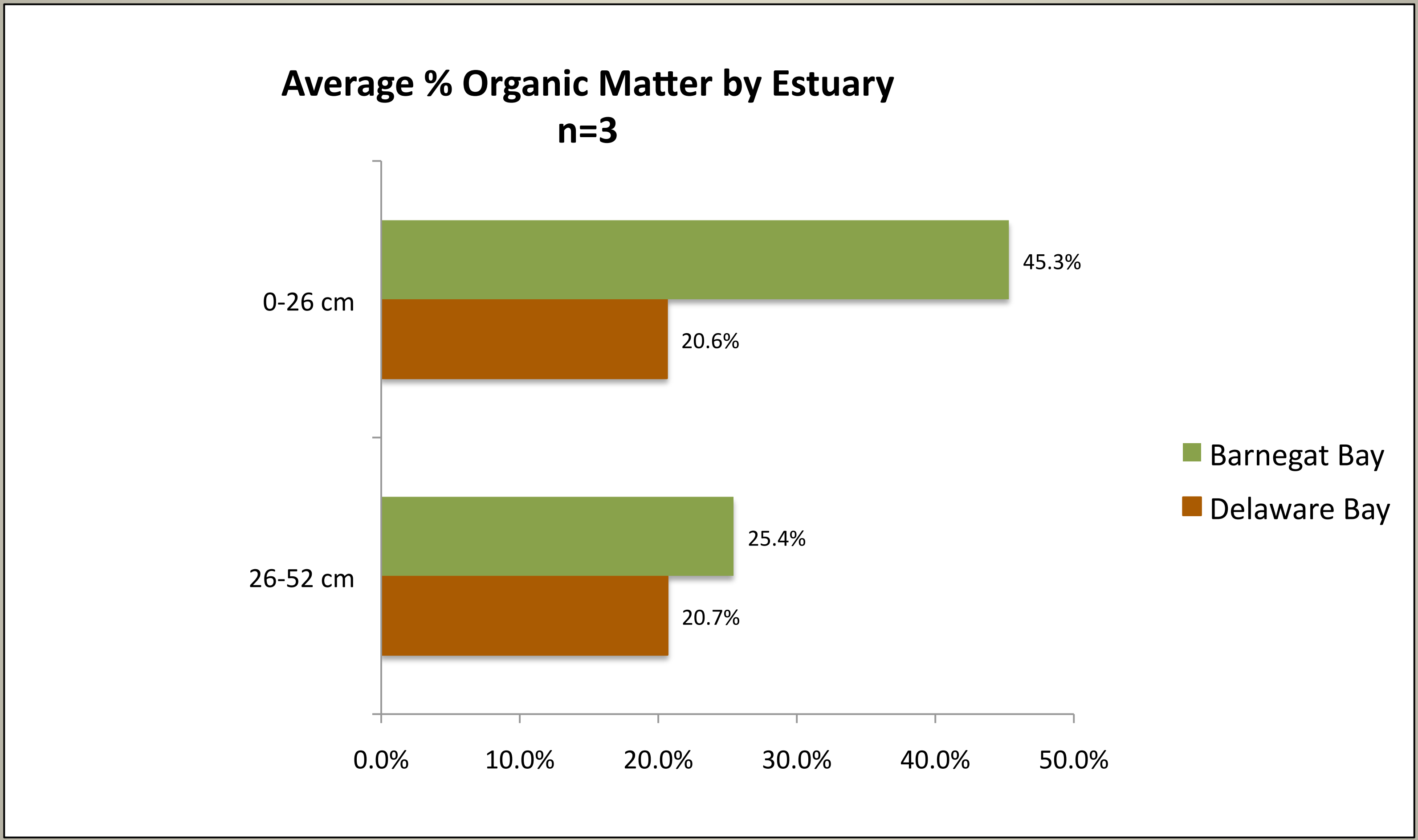
Belowground Biomass Profiles: Delaware Bay



Belowground Biomass Profiles: Barnegat Bay



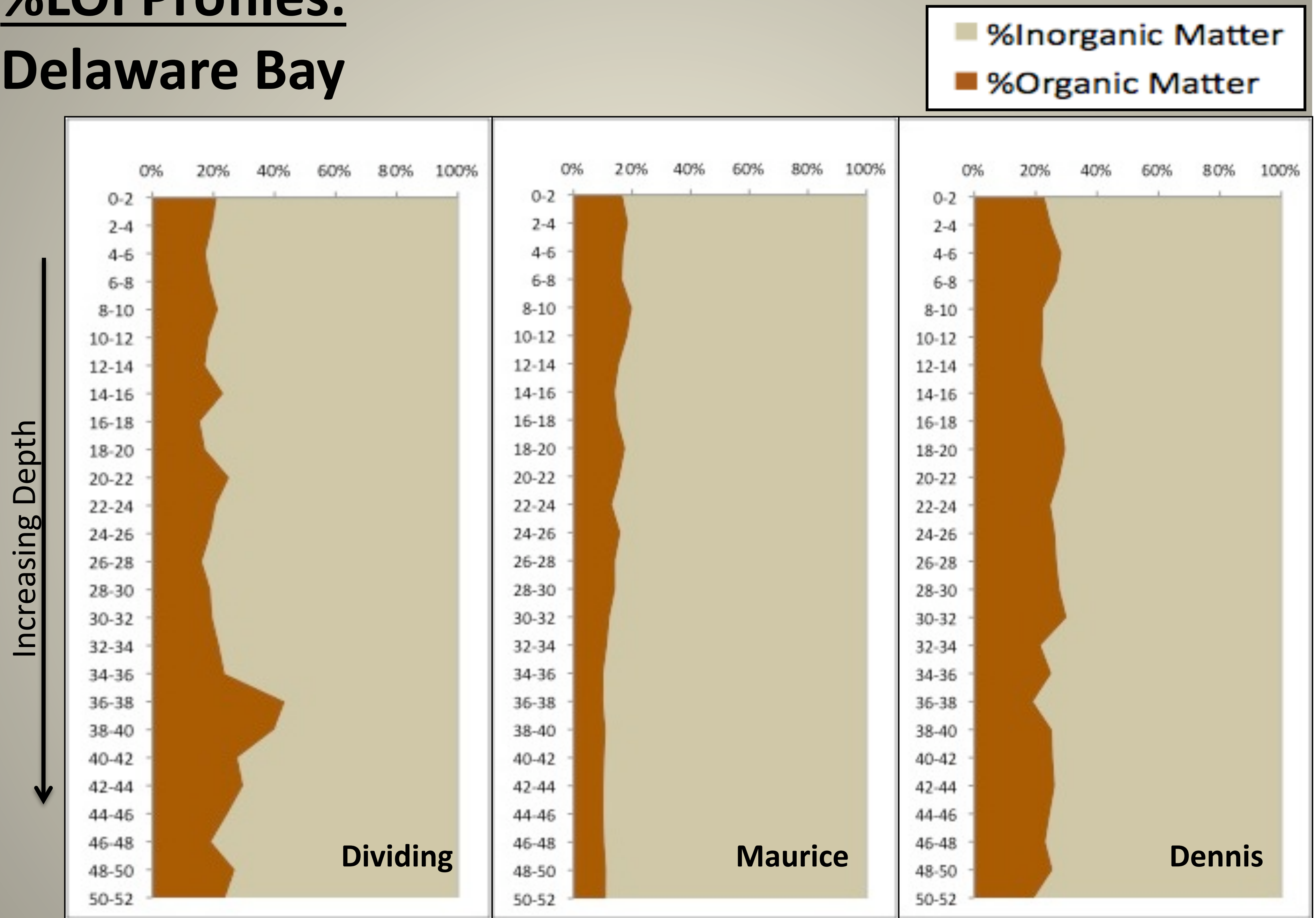
Results: Loss on Ignition (%OM)



$$\text{Organic C} = (0.001217)*\text{OM}^2 + (0.3839)*\text{OM}$$

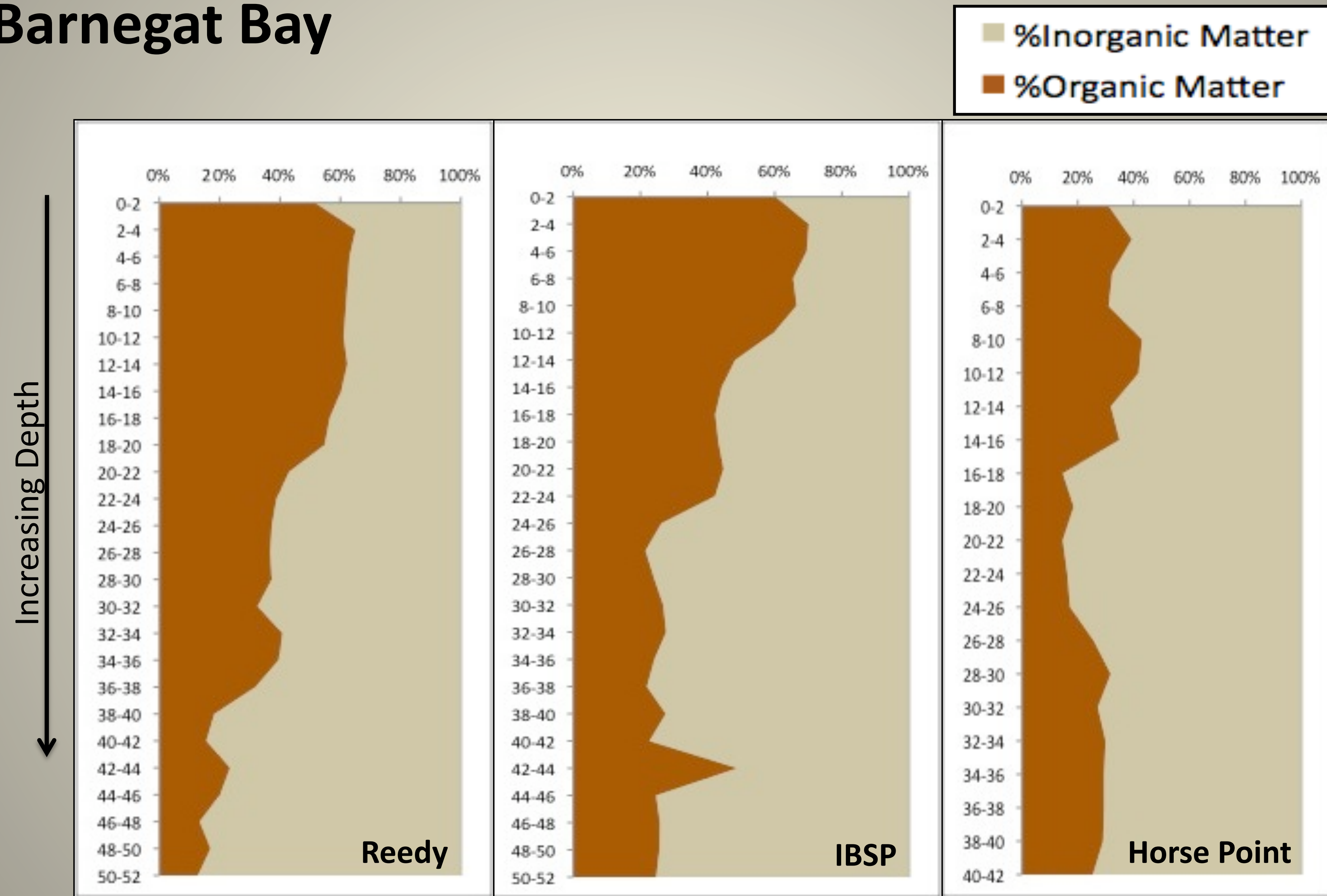
Equation from Callaway et. al 2012

%LOI Profiles:
Delaware Bay



%LOI Profiles:

Barnegat Bay



Conclusions

- DB: higher live:dead ratio of aboveground biomass
- BB: on average higher amounts belowground biomass
- Biomass depth profiles:
  - Composition of root structures diverse in DB
  - IBSP and Horse point similar, Reedy creek extremely low
  - Did not correspond to %OM profiles
- %OM depth profiles: uniform in DB and concentrated near surface BB
- BB marshes more dependent on plant growth for accretion
- Depending on accretion rates, we hypothesize that C burial rates will be greater in DE Bay