Influences of Salinity Intrusion on Belowground Decomposition: Implications for Surface Elevation Change

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USGS
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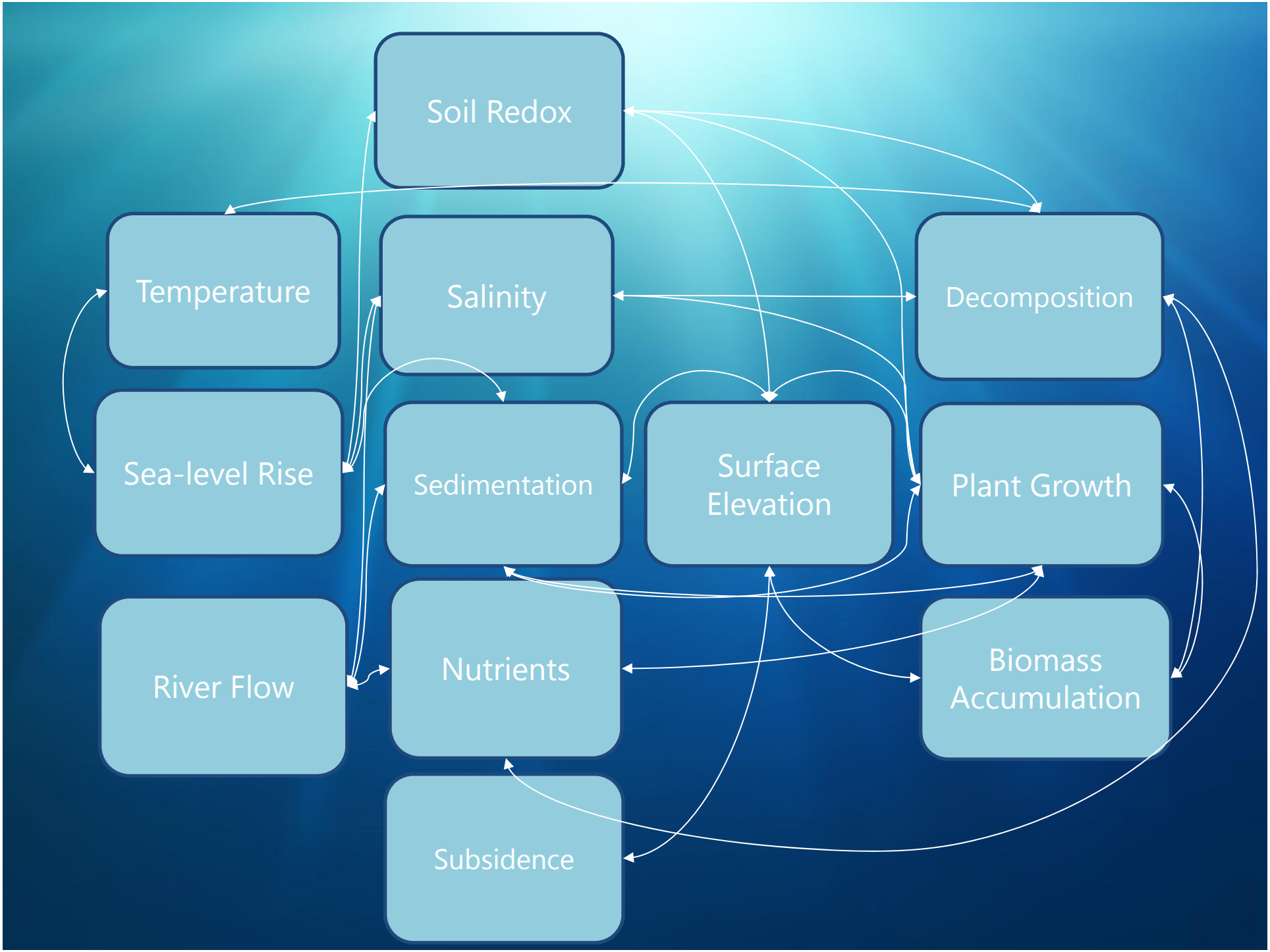
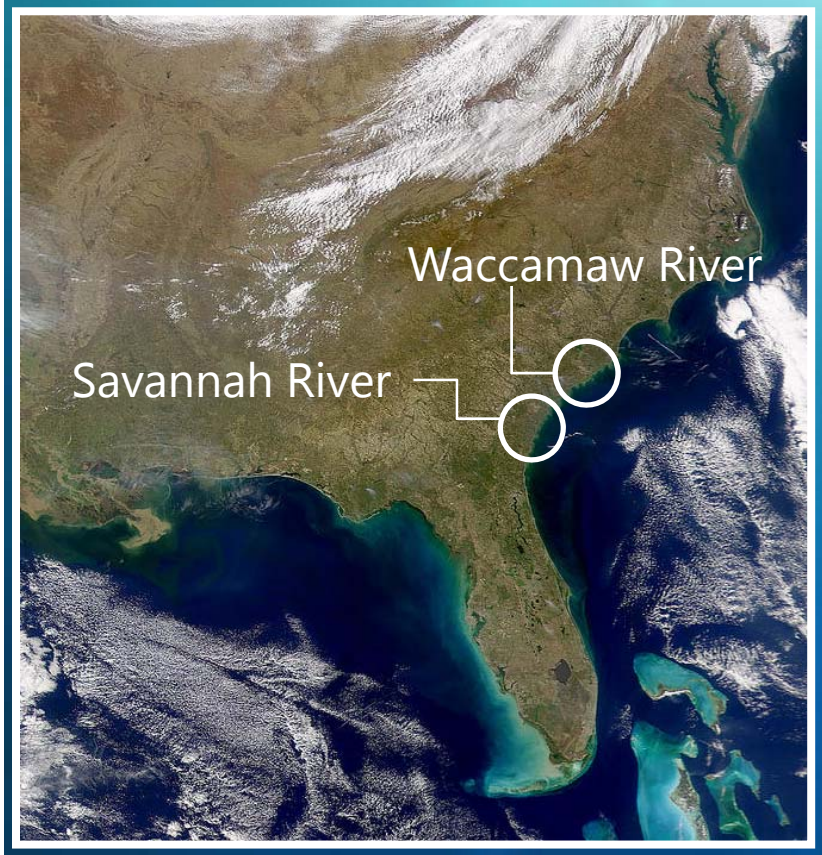

Soil Redox
Temperature
Salinity
Decomposition
Sea-level Rise
Sedimentation
Surface Elevation
Plant Growth
River Flow
Nutrients
Biomass Accumulation
Subsidence

Study Site



Experimental Design

Salinity Gradient

Methods

Roots and Rhizomes

- Litterbags
- Labile and refractory materials
- Long-term = 1 year
- Single exponential decay model: $Y = ae^{-kt}$

Cellulose

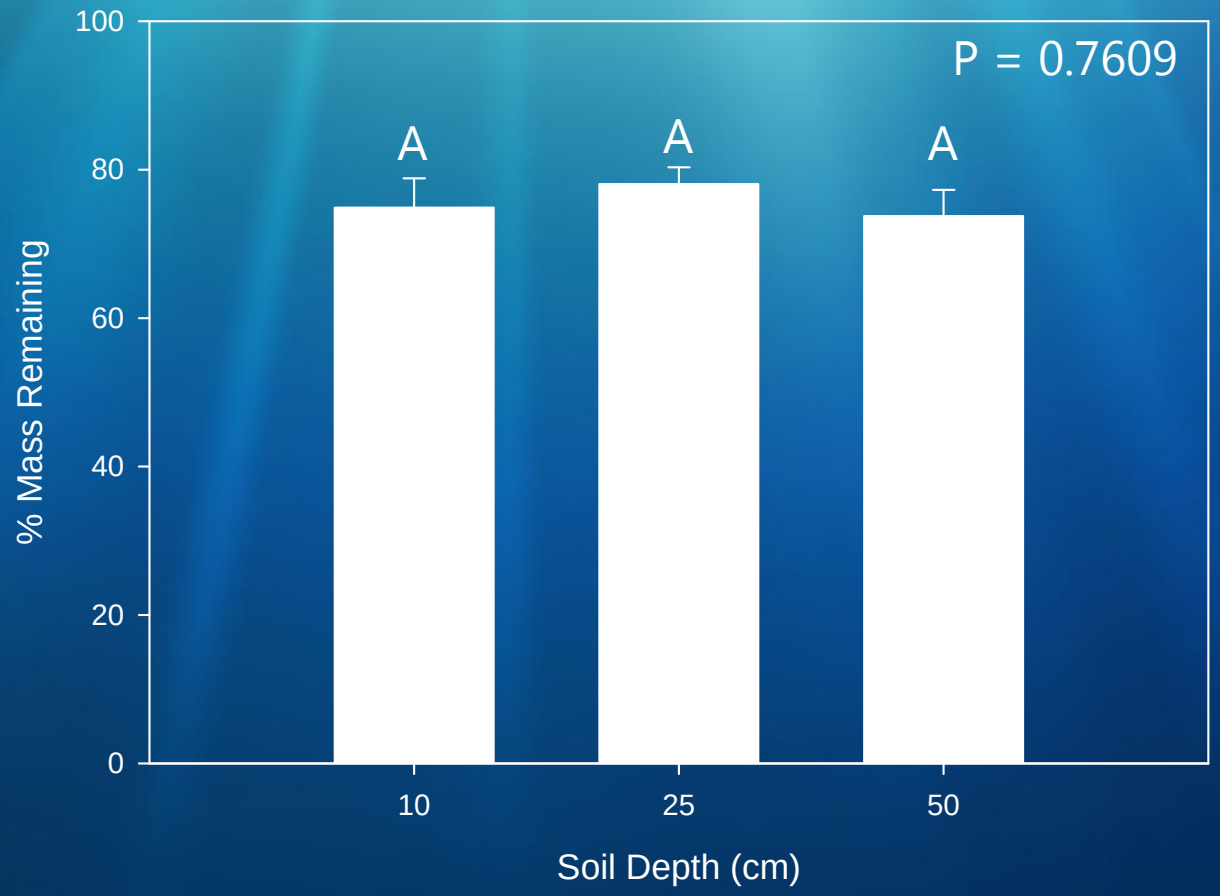
- Cotton Strips
- Labile material only
- Short-term ~ 14 days
- %Tensile strength lost

Physico-chemical Drivers of Decomposition

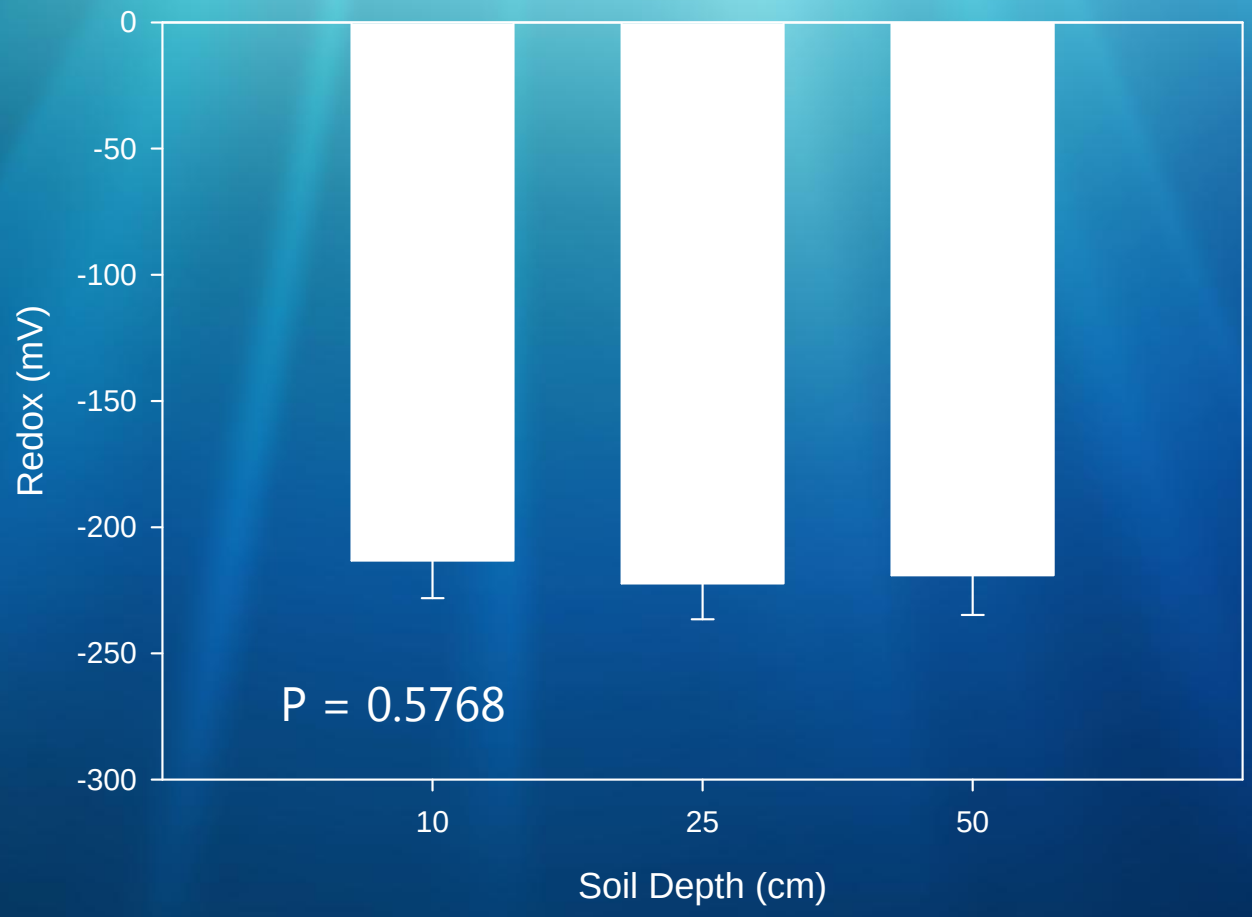
Physico-chemical Drivers of Decomposition

Temperature	• 10 cm depth • April 2011-Ocotber 2011
Redox	• 10cm, 25cm 50 cm depth • October 2010, 2011
Salinity	• October 2010-2011, 60 cm well depth
Organic Matter Composition	• Root and Rhizomes, initial material • Lignin, Cellulose, Total Carbon, Total Nitrogen

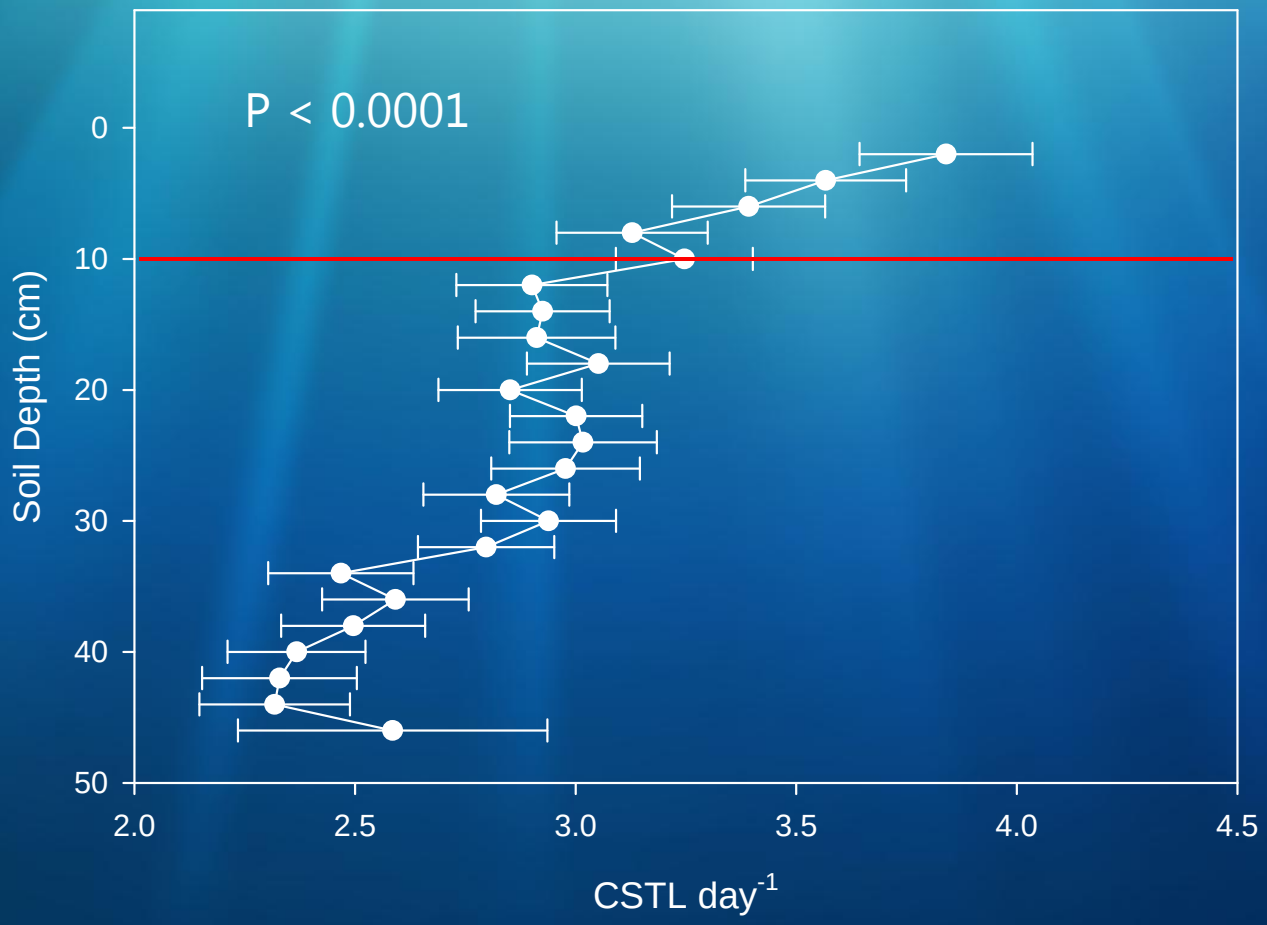
Depth Effect
Roots and Rhizomes



Depth Effect
Redox

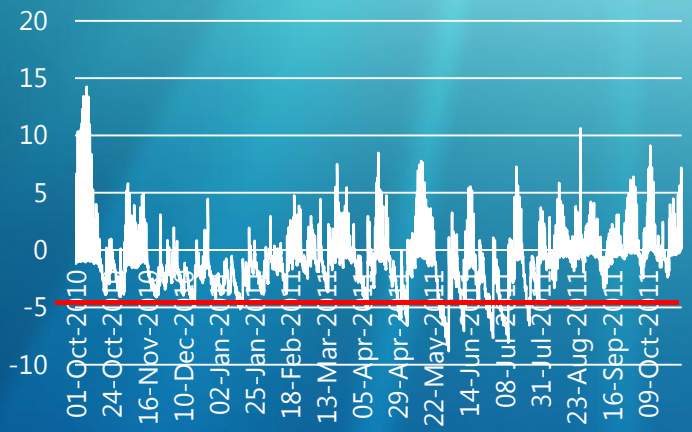


Depth Effect
Cellulose

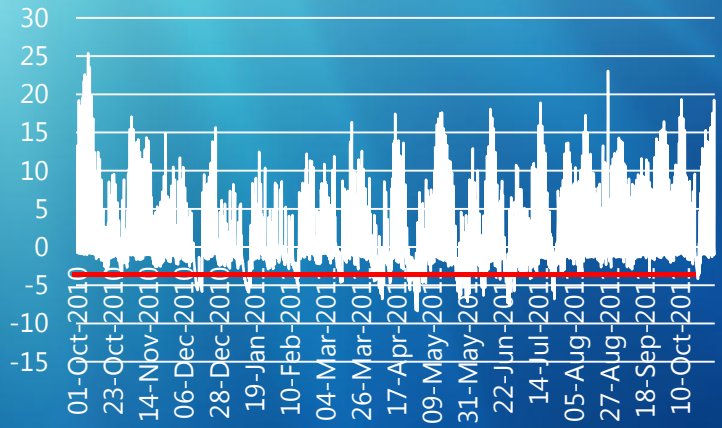


Hydrology

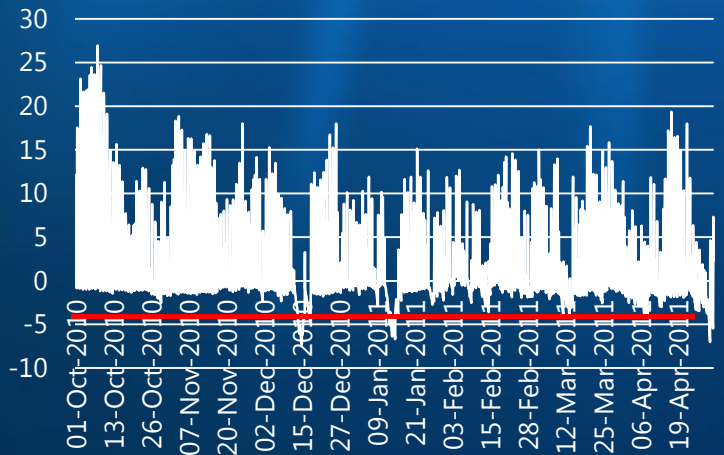
Waccamaw Upper



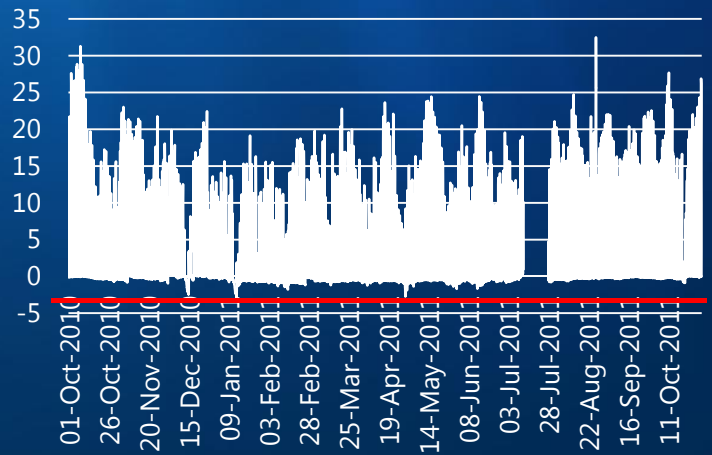
Waccamaw Middle



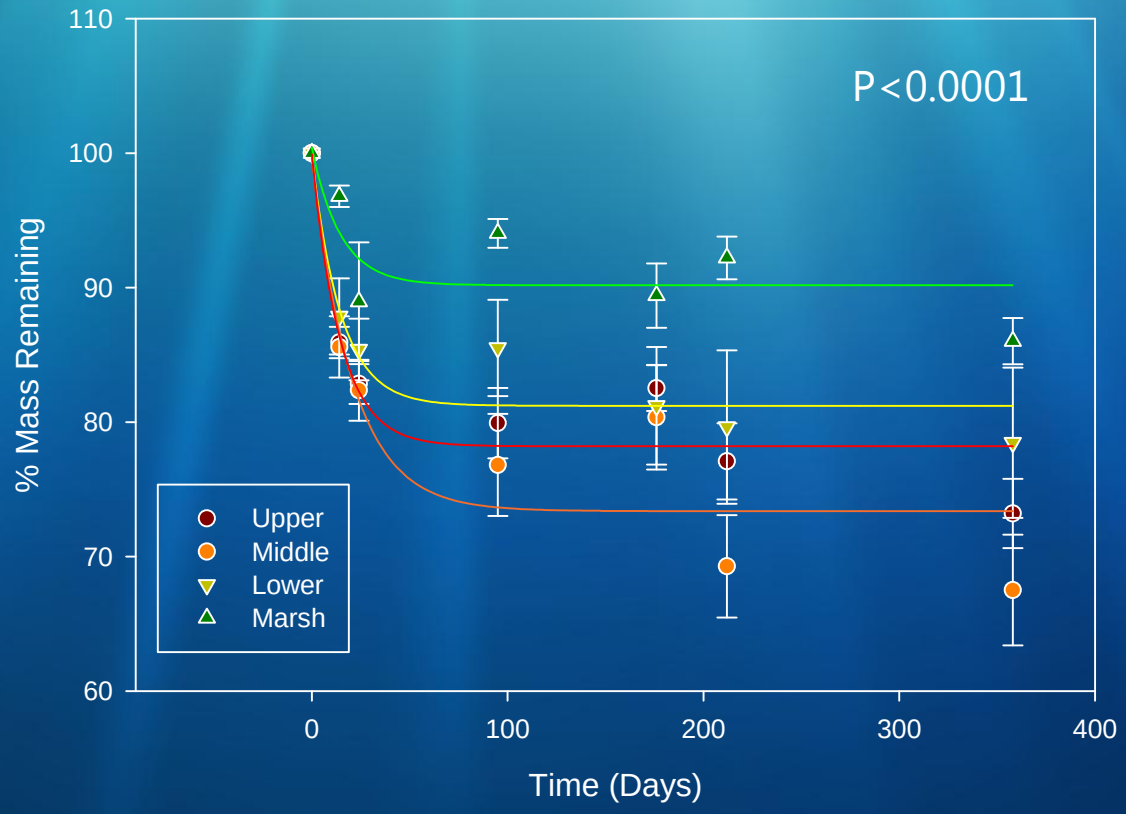
Waccamaw Lower



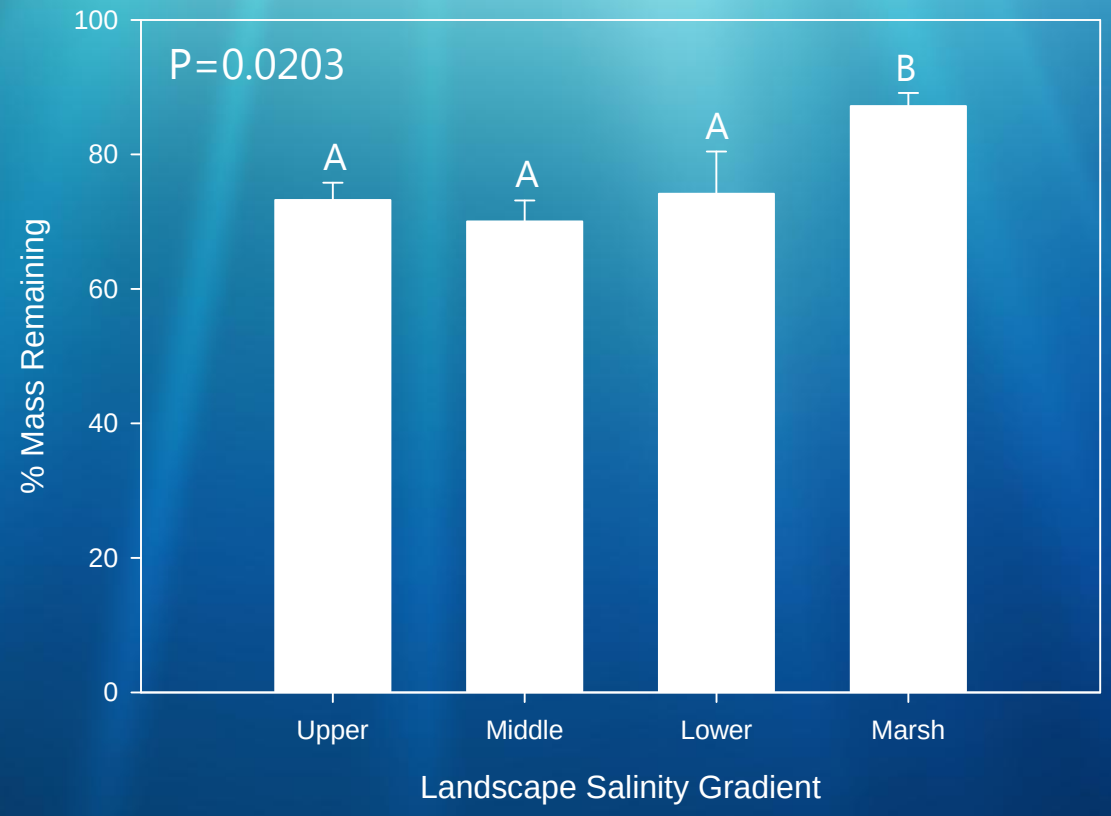
Waccamaw Marsh



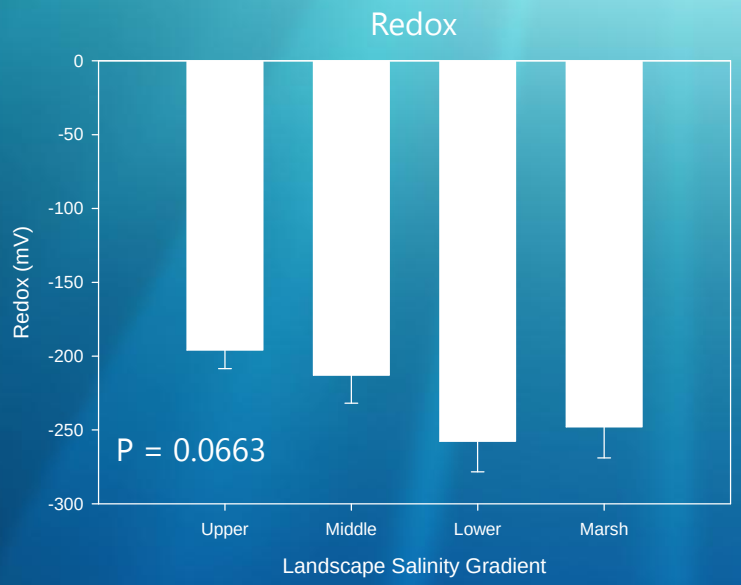
Site (Salinity) Effect
Root and Rhizome Decomposition

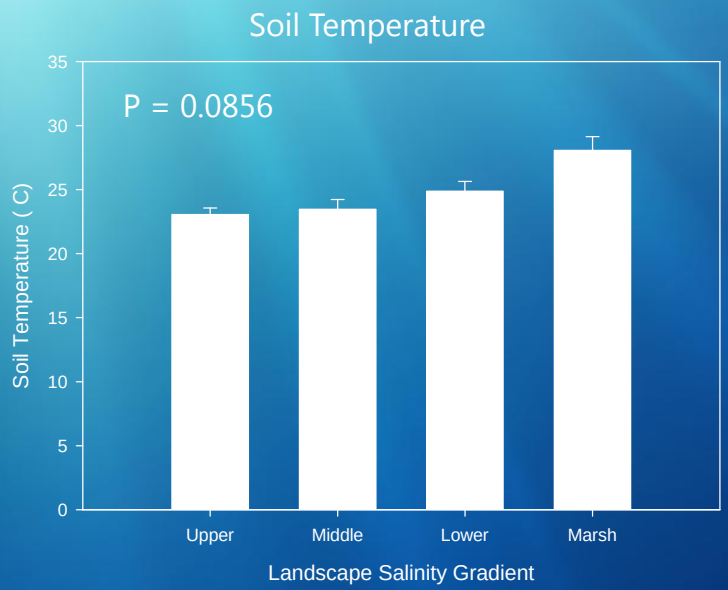


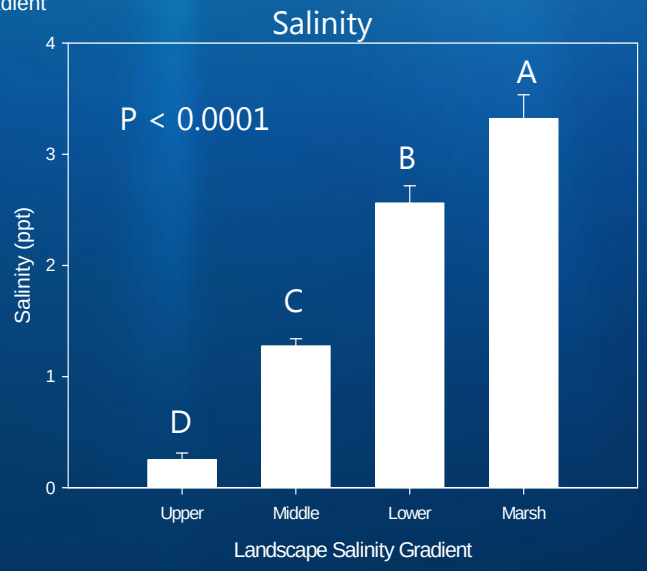
Site (Salinity) Effect
Root and Rhizome Decomposition



Physico-chemical Characteristics

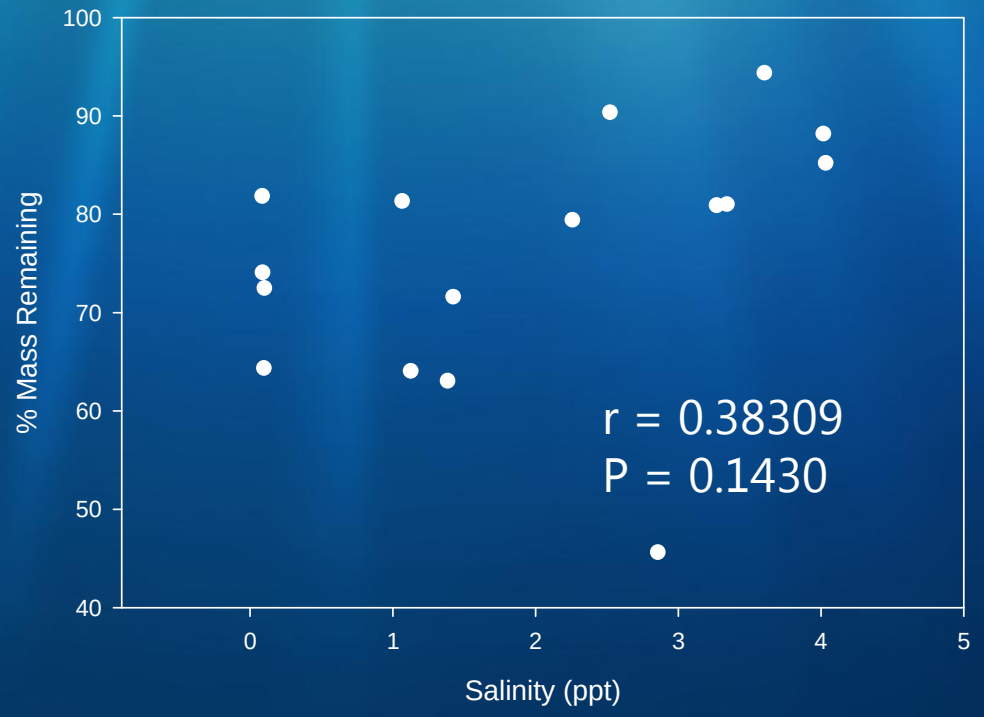




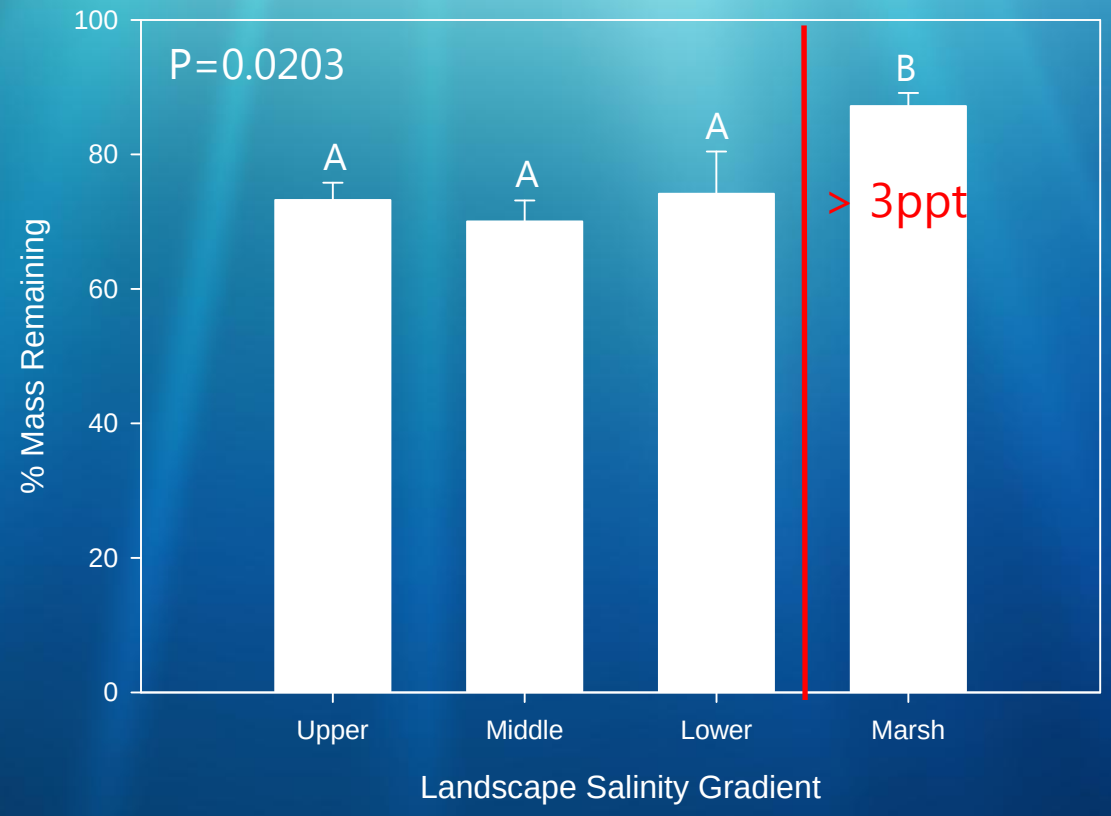


Root and Rhizome Decomposition

Pearson Product-Moment Correlations	Redox Potential (mV)	Temperature (°C)	Porewater Salinity (ppt)
% Mass Remaining	r = -0.18041 P = 0.5037	r = 0.47682 P = 0.2322	**r = 0.38309** **P = 0.1430**



Root and Rhizome Decomposition

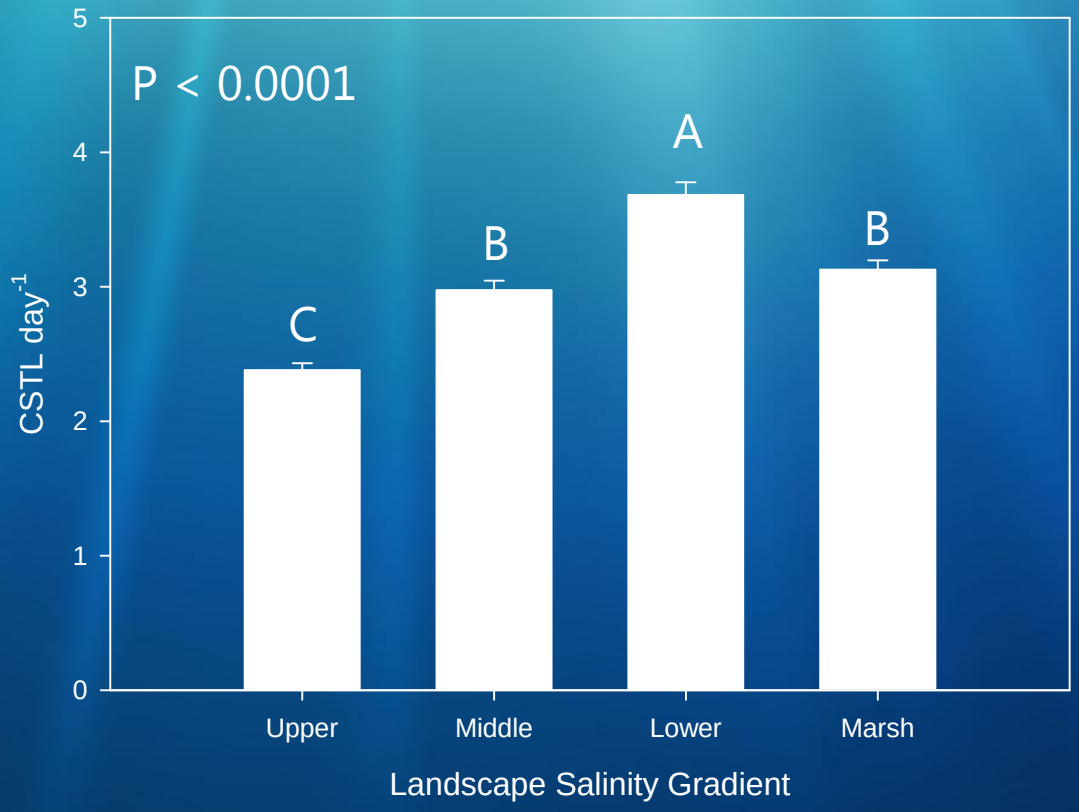


Root & Rhizome Chemical Composition

Site	Lignin	Cellulose	Carbon : Nitrogen	Lignin : Nitrogen
Upper	35.1 (3.9) a	20.3 (0.9) bc	44.5 (1.2) bc	35.8 (1.5) b
Middle	34.9 (0.6) a	22.4 (0.9) ab	48.7 (3.8) b	38.6 (2.9) a
Lower	26.5 (6.0) b	18.0 (1.7) c	**41.1 (0.9) c**	**29.0 (3.4) d**
Marsh	**22.3 (1.3) b**	**24.2 (0.5) a**	61.6 (2.9) a	32.0 (3.1) c

Different letters indicate significant differences between site/salinity treatments

Results
Cellulose

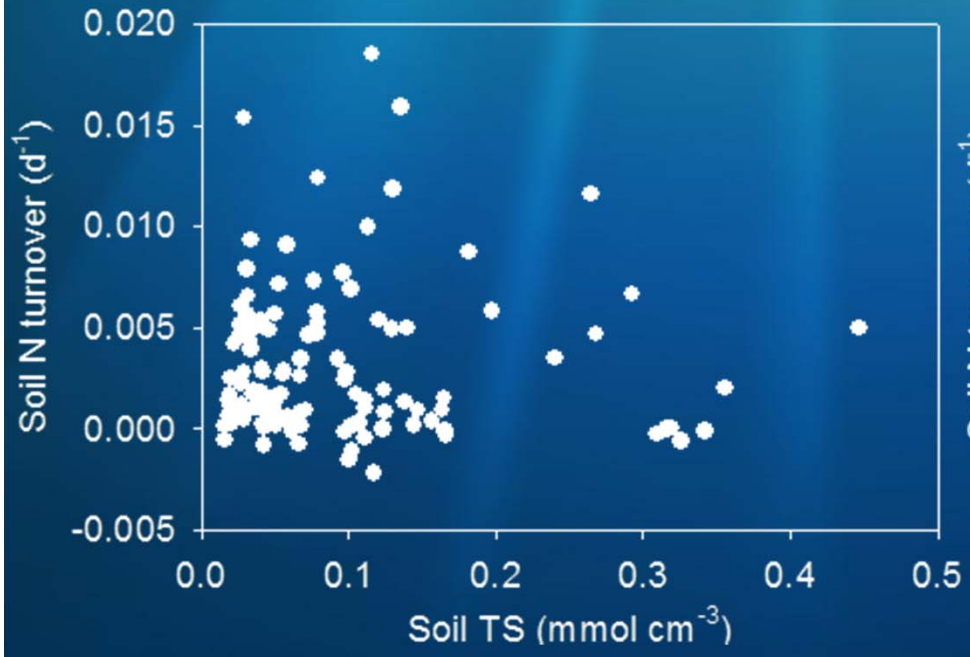


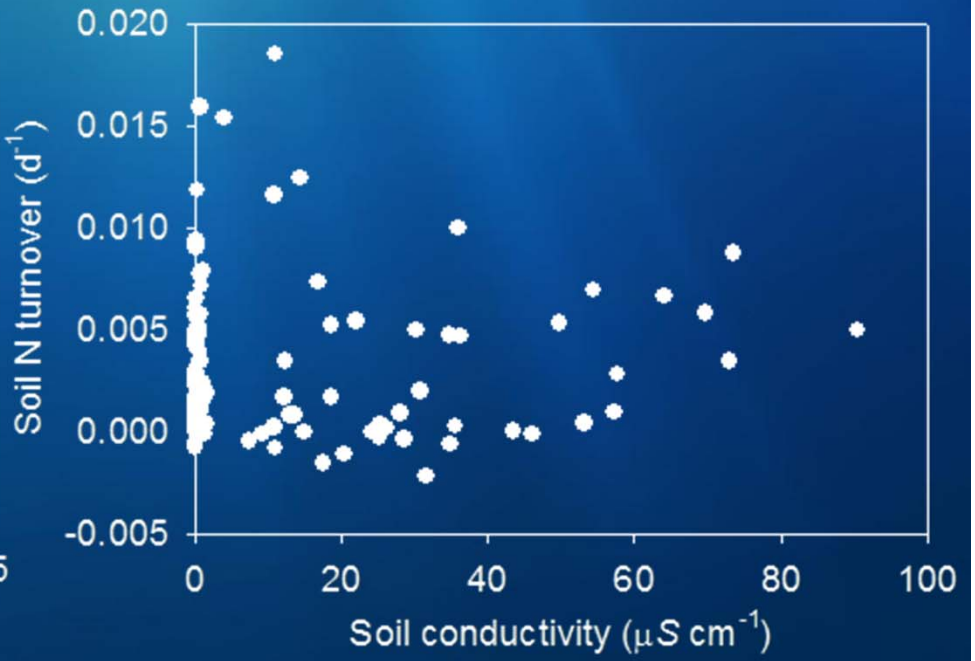
Possible Mechanisms
Stimulated Decomposition of Labile Material

- Sulfate Introduction
  - Stimulated respiration
  - C- mineralization: Weston et al., 2011; Weston et al., 2006
- Nitrogen Availability
  - Salinity-induced plant mortality or stress with subsequent nutrient pulse, or lower Nitrogen uptake and increased Nitrogen availability.

Mineralization of Soil N

Pearson Product-Moment Correlations (n=120)	Total sulfur	Conductivity
N mineralization flux ($\mu mol\ m^{-2}\ d^{-1}$)	r = -0.088 P = 0.338	r = -0.076 P = 0.412
N turnover (d^{-1})	r = 0.017 P = 0.852	r = 0.055 P = 0.551

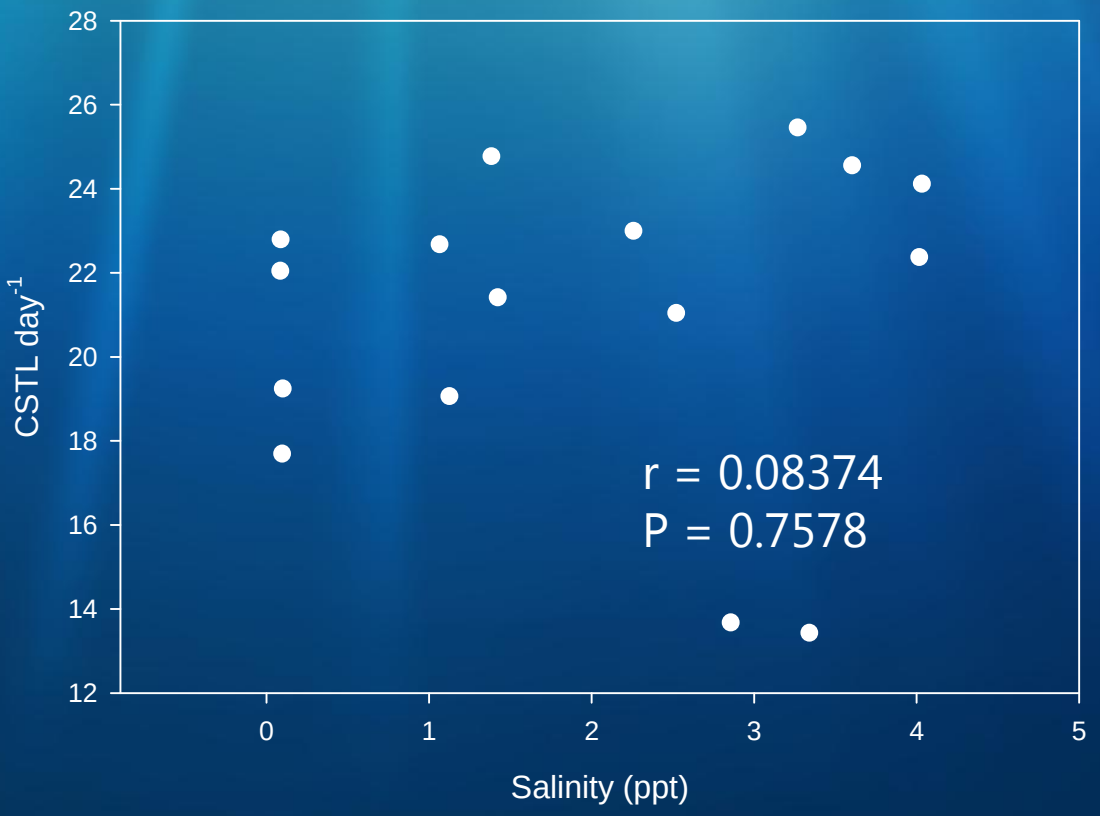




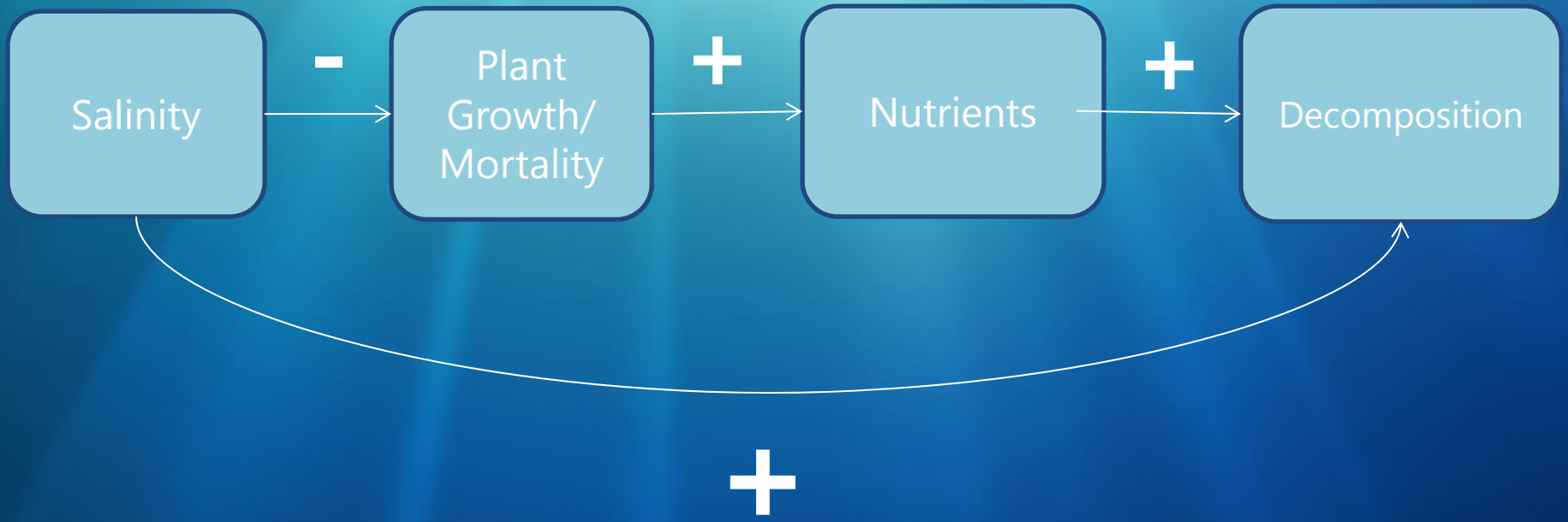
Noe et al., *in review*

Cellulose Decomposition

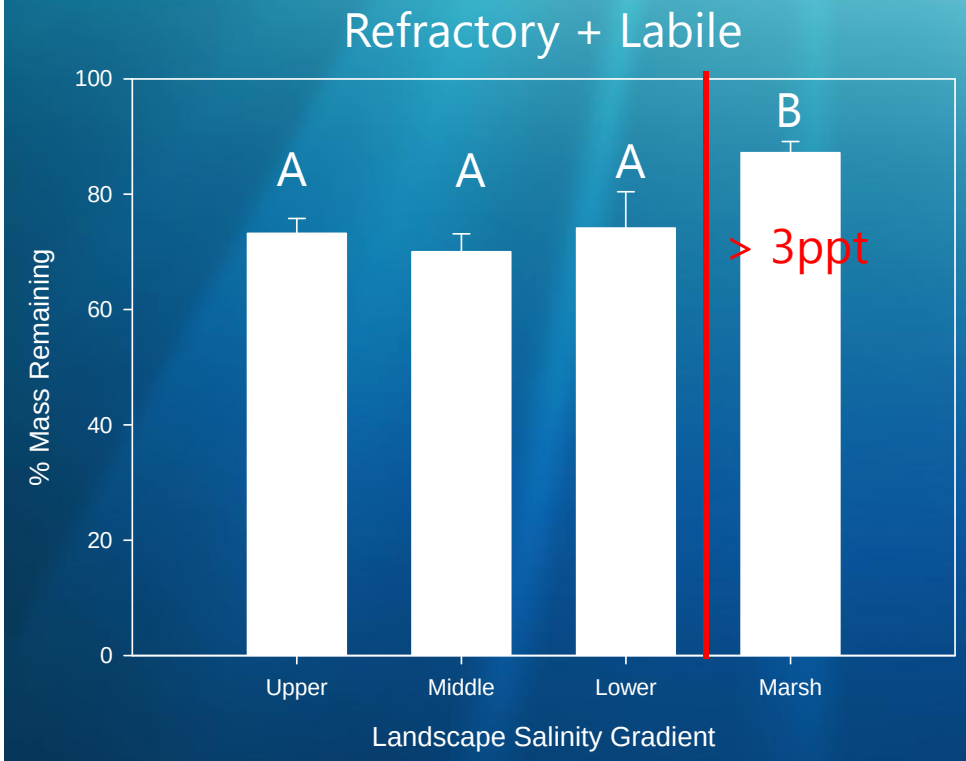
Pearson Product-Moment Correlations	Redox Potential (mV)	Temperature (°C)	Porewater Salinity (ppt)
CSTL day^{-1}	r = -0.03203 P = 0.9063	r = 0.39566 P = 0.3319	r = 0.08374 P = 0.7578

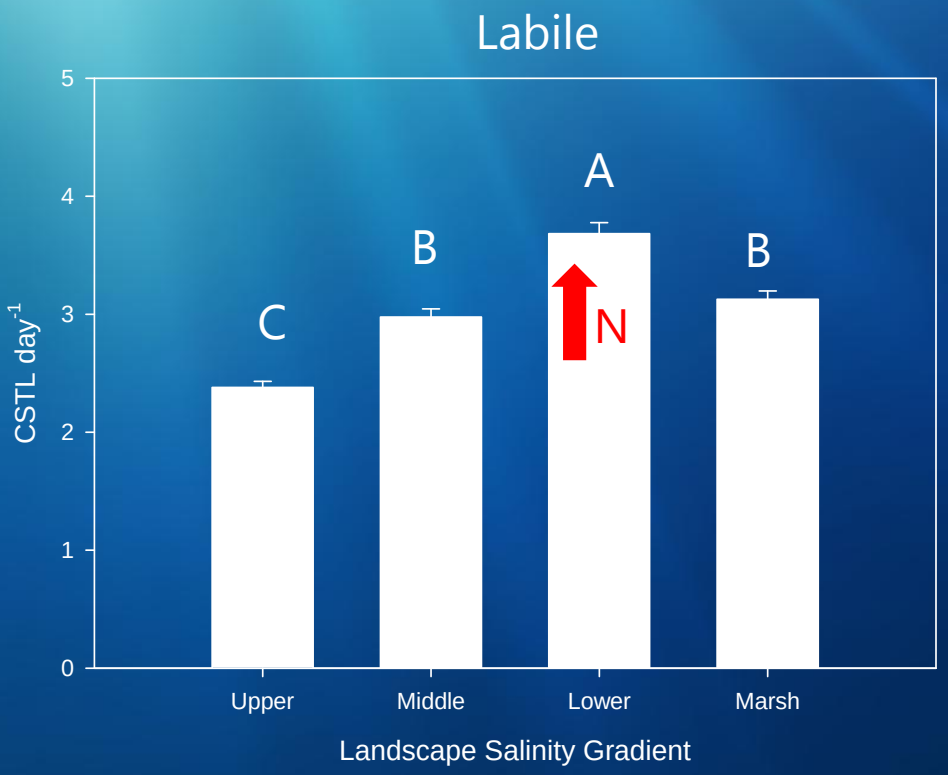


Indirect Effects

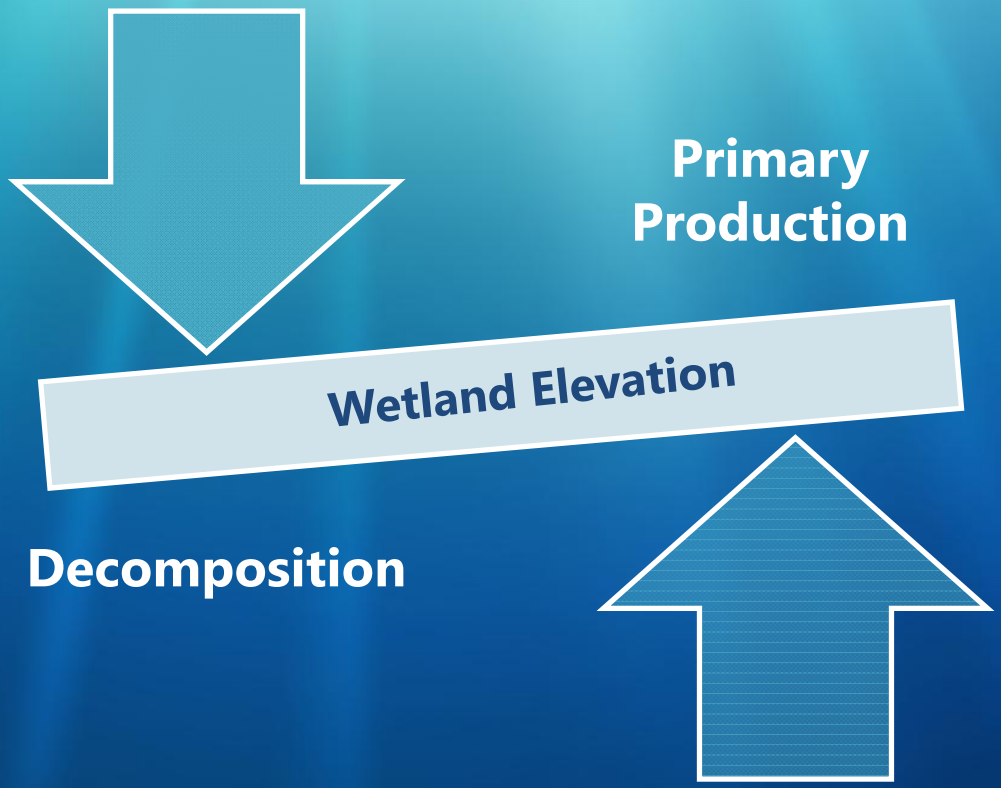


Refractory vs. Labile

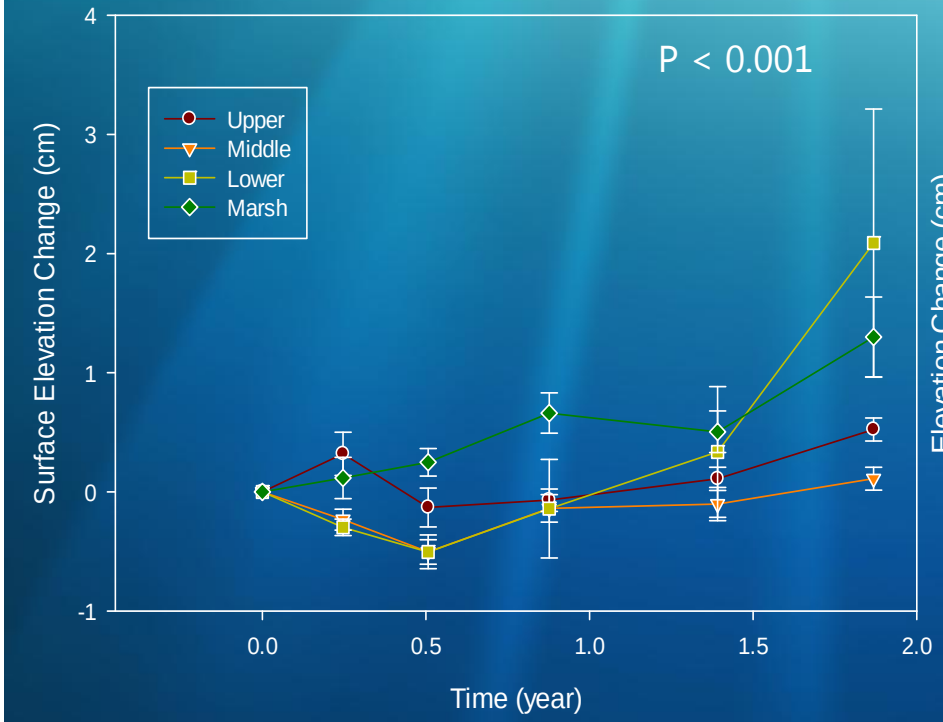




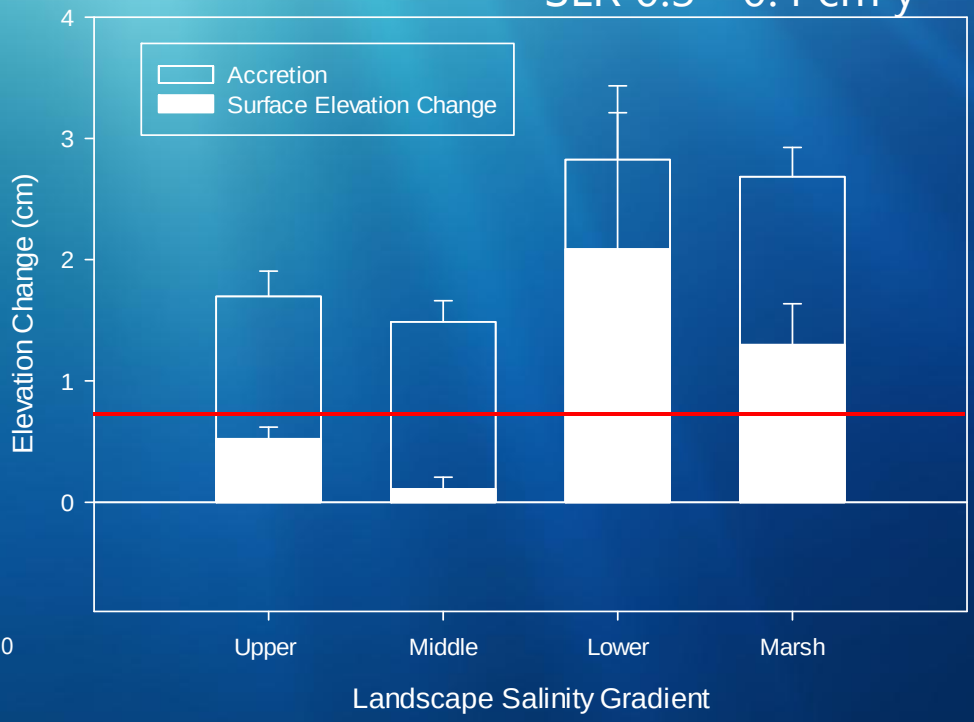
Implications



Implications:
Surface Elevation Change



SLR 0.3 - 0.4 cm y^{-1}



Conclusions

- Decomposition of refractory organic matter is limited when salinity exceeds 3ppt.
- There is not effect of salinity on decomposition of refractory material between 0-3ppt
- Decomposition of labile organic matter is stimulated in the degraded forest. Stimulation may be due to nutrient pulse/ increased nutrient availability resulting from salinity-induced plant mortality or stress.
- Decomposition of labile organic matter is limited in the marsh, either from adverse impacts of salinity on microbial activity or lack of nutrient availability.
- Marsh elevation is increasing and likely due to a combination of decreased organic matter decomposition and increased primary production.