Plant Impacts on Competition Between Tidal Marsh Microbes

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Background

- Carbon storage and greenhouse gas emissions both influenced by microbial respiration
- Environmental factors (e.g. salinity) impact decomposition
- Differences in soil carbon (due to plant inputs) can also impact respiration

Main Question

- What is the importance of electron donors, electron acceptors, and the environment on microbial respiration?

Nature Precedings : doi:10.1038/npre.2009.3630.1 : Posted 17 Aug 2009

Background: Microbial Respiration

- Get energy by transferring electrons from a *donor* to an *acceptor*

- Aerobic respiration

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

e^- donor e^- acceptor


National Geographic

Infobarrel.com


Telegraph.uk.co


Khamaid.org

Nature Precedings : doi:10.1038/npre.2009.3630.1 : Posted 17 Aug 2009

Microbial Respiration

- Anaerobic respiration: multiple pathways
- Different pathways compete for:
  - Common donors: acetate and H_2
  - Common acceptors: NO_3, Fe(III), SO_4, CO_2
- Competition for substrates favors pathways with more energy yield
  - NO_3 > Fe(III) > SO_4 > HCO_3/CO_2 (methanogenesis)

Why are these different anaerobic pathways important?

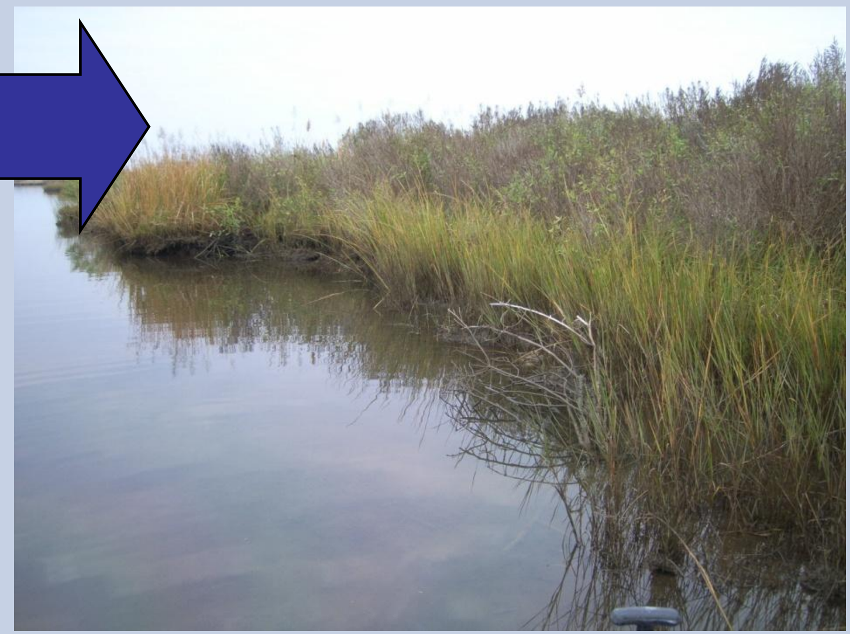
- Wetlands sequester carbon
- But microbial processes also emit CO_2 and CH_4
- CH_4 8x the radiative forcing of CO_2
- Other microbial pathways can outcompete methanogenesis

What conditions promote these alternative metabolic pathways that are more climate friendly?

Reciprocal Transplant Experiment

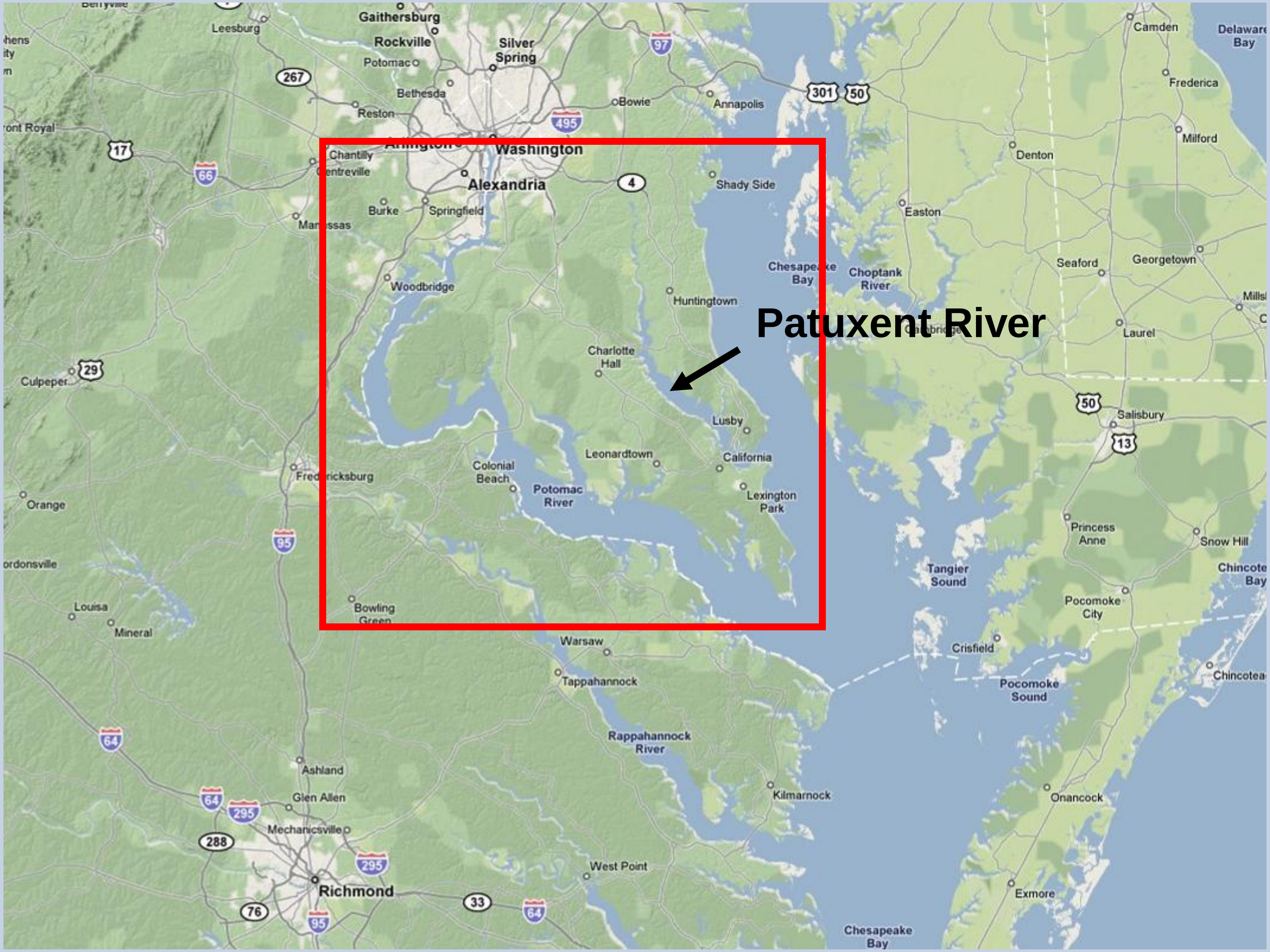
1) Fresh
2) Brackish
3) Brackish @ Fresh
4) Fresh @ Brackish

Freshwater marsh

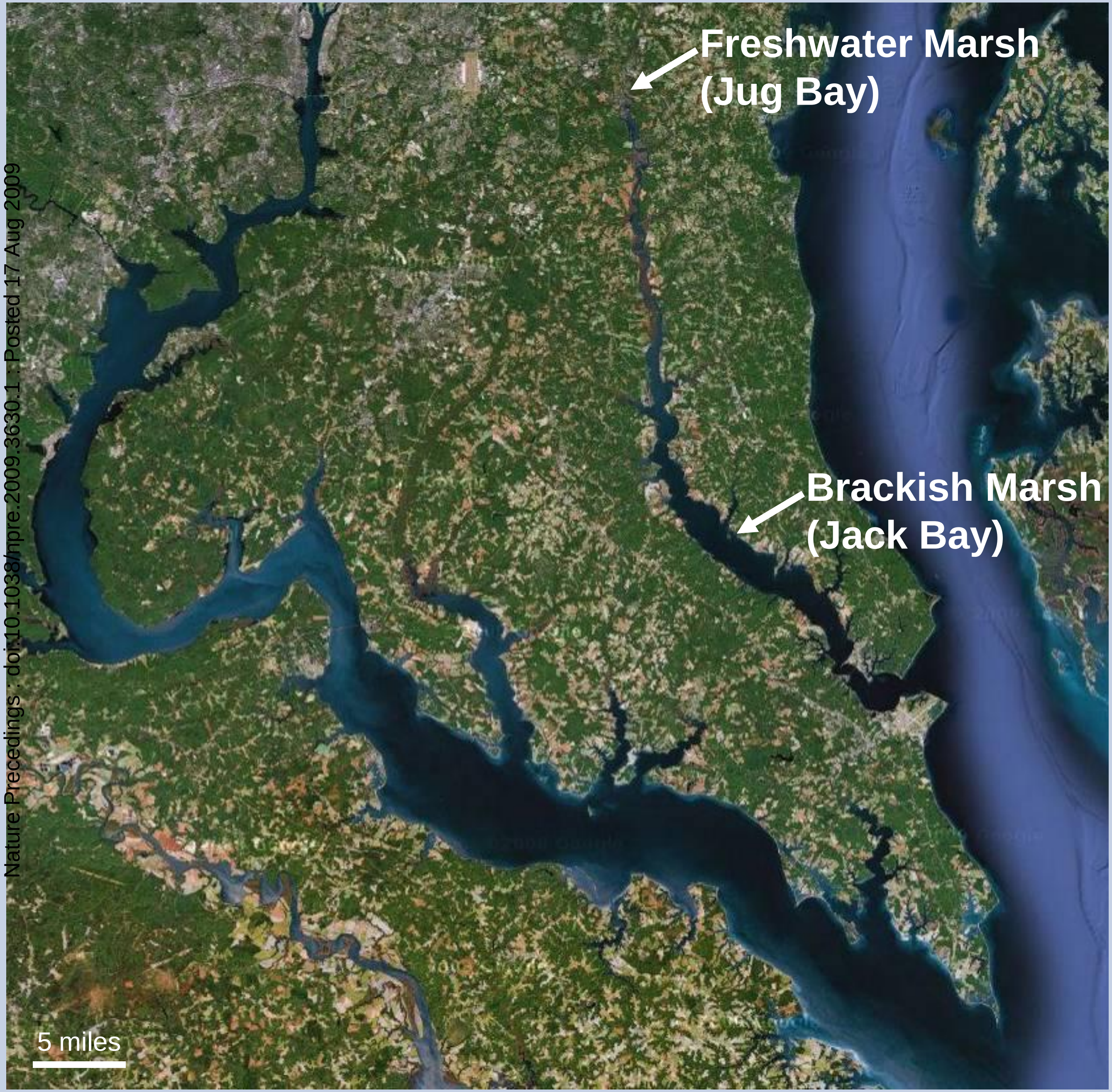


Brackish marsh

Field Site Locations



Field Site Locations



Brackish Marsh Salinity ~10-12ppt

Site comparison: Soils

Brackish site:

54% organic matter

Freshwater site:

18% organic matter

Site comparison: Plants

Brackish site: smooth cordgrass (*Spartina alterniflora*) and salt grass (*Distichlis spicata*)

Freshwater site:
arrow arum (*Peltandra virginica*) and pickerel weed (*Pontederia cordata*)

Study Design

- Manipulating donors via differences in soil C
- Manipulating acceptors via differences in salinity and soils
- Manipulating environmental conditions (e.g. pH) via the transplant

Field Set-Up

- Collected soils from 2 sites
  - Freshwater
  - Brackish
- 20 samples at each
  - 10 from each site
- Buried 10-15 cm down (Spring 2007); collected Fall 2008

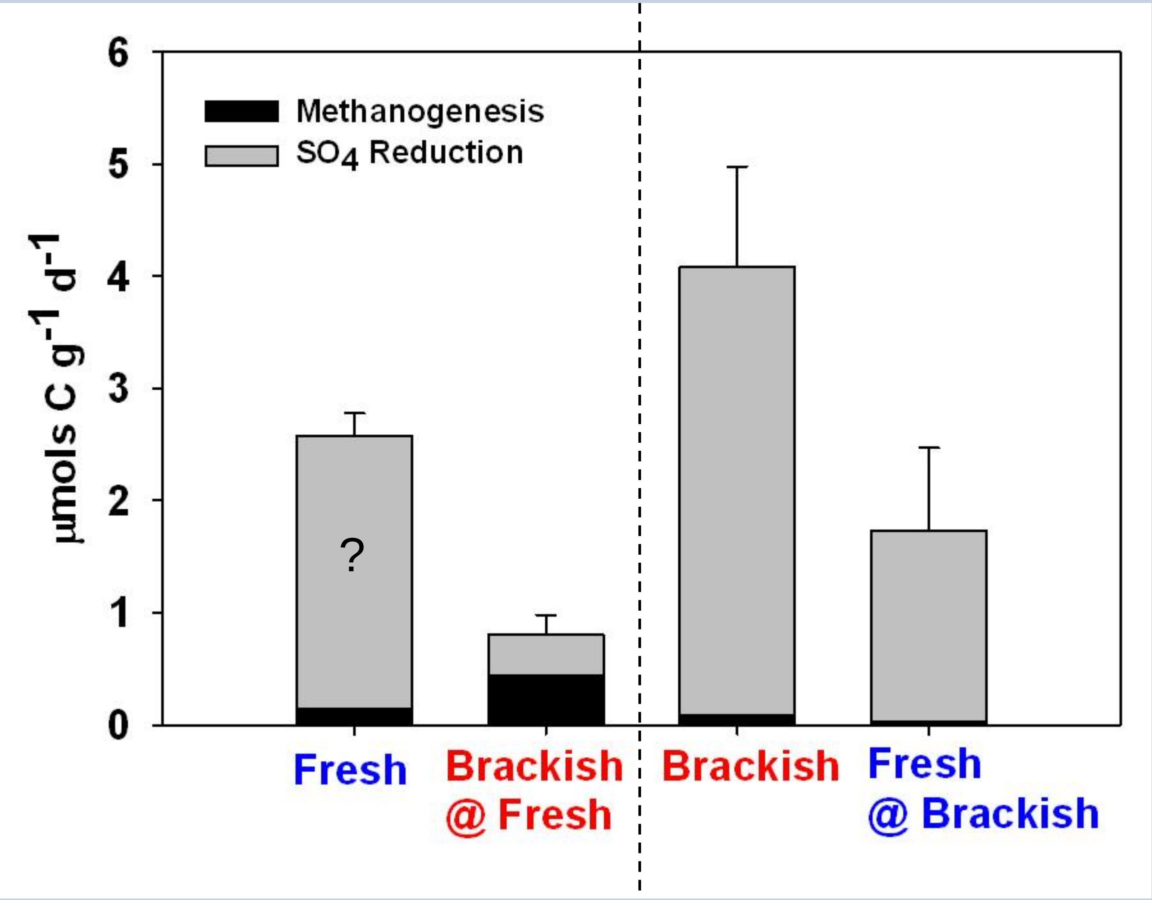
Lab Set-Up

Anaerobic incubations to measure

- Denitrification
- Fe(III) reduction
- SO_4 reduction (^{35}S technique)
- Methanogenesis
- CO_2 production

Results: Summed Anaerobic Metabolism

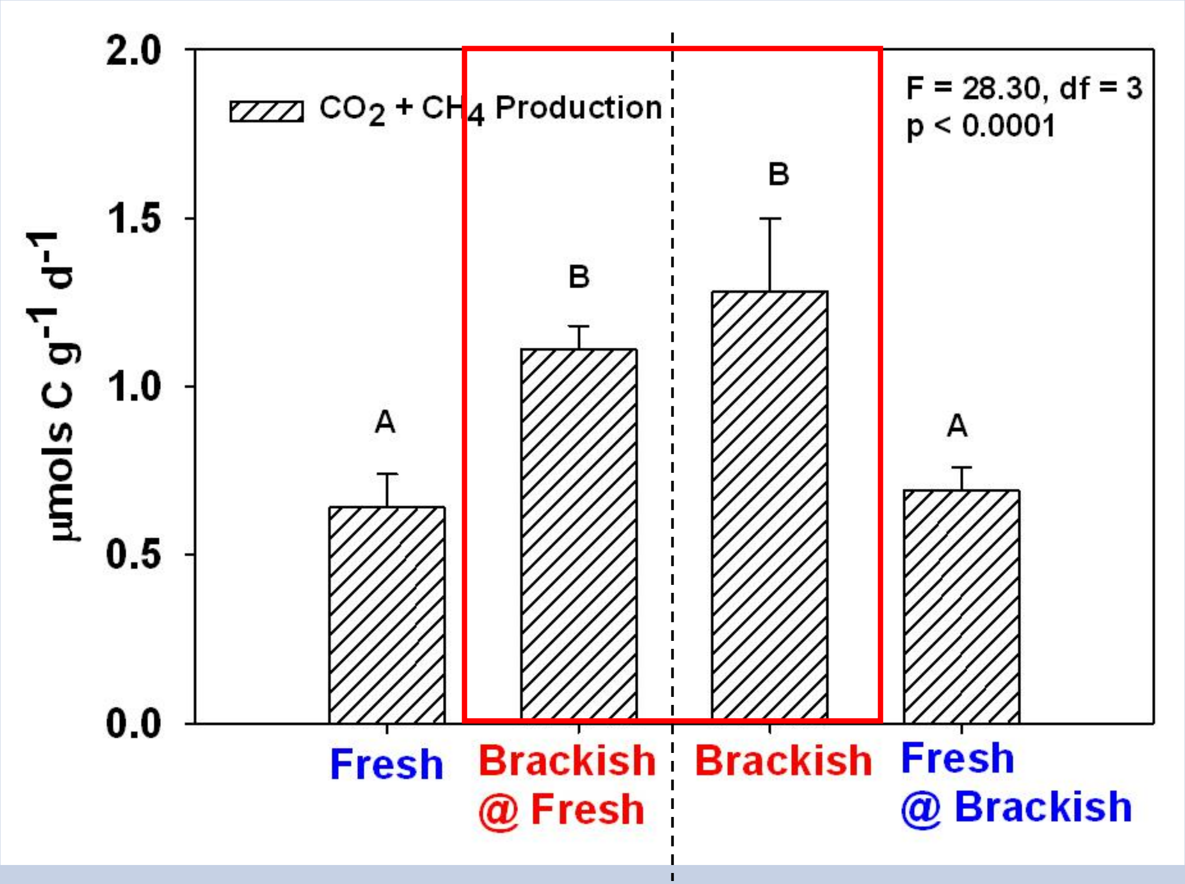
Site: Fresh Site: Brackish



Freshwater Soils = blue Brackish Soils = red

Results: Decomposition

Site: Fresh Site: Brackish

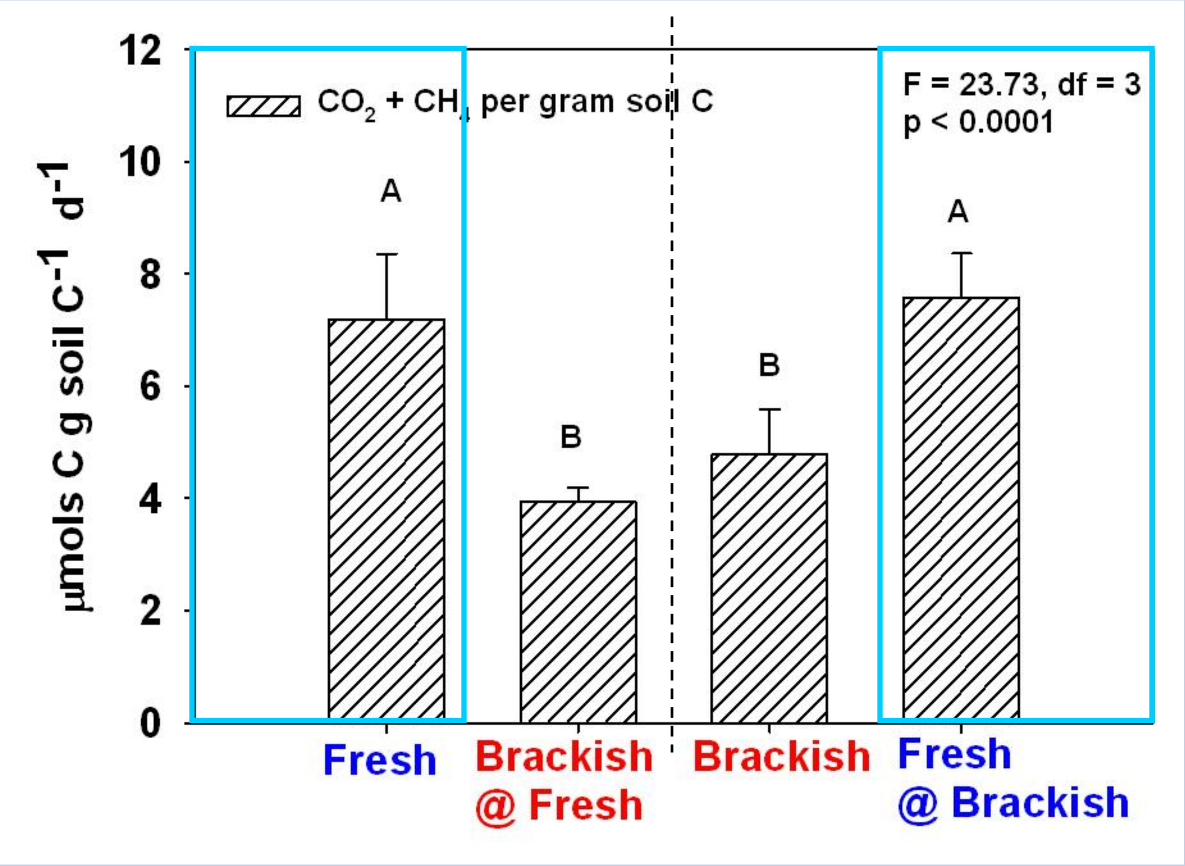


We see the highest rates of decomposition at **brackish site** and similar rates for both soils whether they were transplanted or not.

But how do these rates differ if we account for the large differences in soil carbon? (Freshwater Site soil organic matter ~18% Brackish Site soil organic matter ~54%)

Results: Decomposition normalized by soil carbon content

Site: Fresh   Site: Brackish



Brackish

Fresh

On a per gram soil C basis, we see the **highest rates of decomposition** from the **freshwater soils** (at either location) suggesting that **C quality** (driven by the difference in the quality of plant C inputs) is an important driver of microbial respiration rates.

Conclusions

- Carbon **quality** important driver of microbial respiration rates
- Plant carbon inputs have lasting legacy on microbial competition in wetlands
- Plant communities impact carbon storage and greenhouse gas emissions by influencing soil microbial processes

Ongoing Research

- Evidence that microbial respiration rates change when forced down a particular pathway (Weston et al. 2006)
  - With salinity intrusion into freshwater sediments, sulfate reduction became main microbial respiration pathway
  - C mineralization more than **doubled**

Ongoing Research

- To explore the finding of Weston et al. we're redoing the sampling and rate measurements on soils collected May 2009

AND

- We're doing short and longer term incubations measuring rates when forcing microbes down a particular path
  - enrichments of SO_4 or Fe(III)

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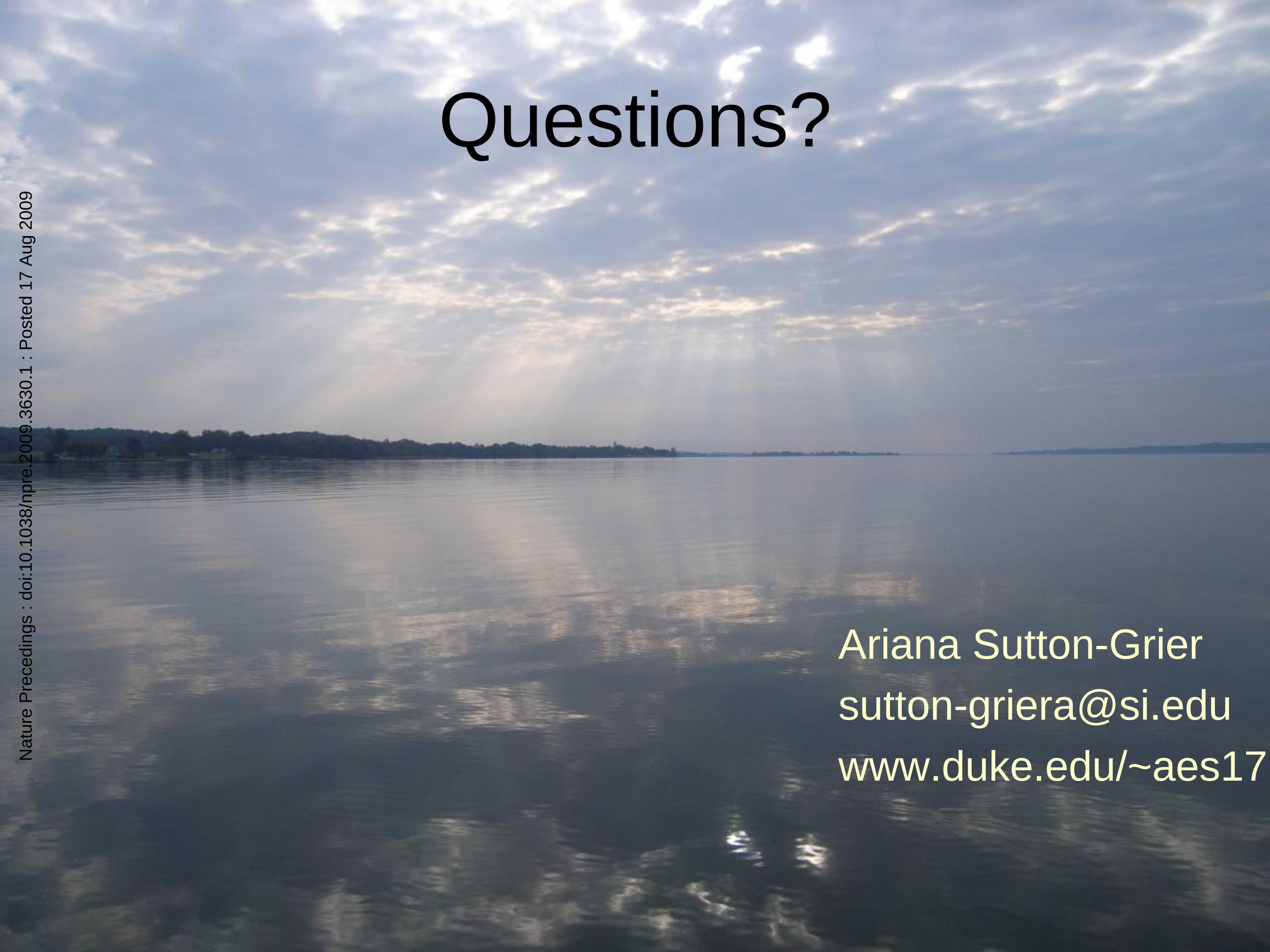

Questions?

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