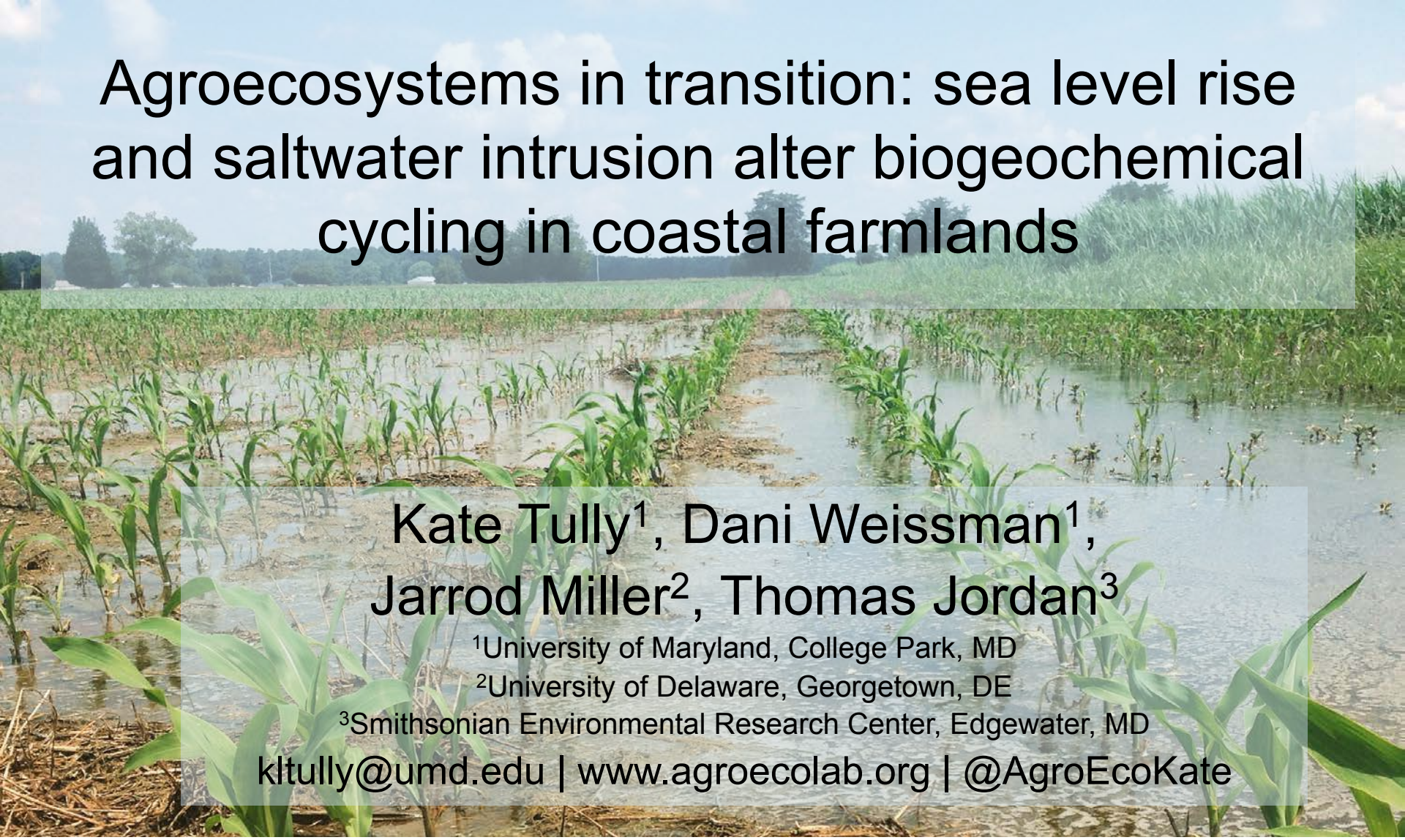
Agroecosystems in transition: sea level rise and saltwater intrusion alter biogeochemical cycling in coastal farmlands



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Drivers of saltwater intrusion

Sea level rise

Rise relative to land and water table elevation

Storms and tides

Frequency and intensity can push saltwater far inland

Drought

Frequency and duration can lead to saltwater incursion

Water management

Ground and surface water extraction for human use

Connectivity

Water control structures: tide gates, levees, canals, ditches

Salinization

- Ionic strength
- Alkalinization
- Sulfidation

Coastal forest loss

Formation of ghost forests as seedlings cannot germinate

Species invasion

Spread of salt-tolerant invasive species degrade habitat quality

Yield declines

Salt can reduce crop yields and farm profitability

Eutrophication

Nutrient loading causes algal blooms and fish death

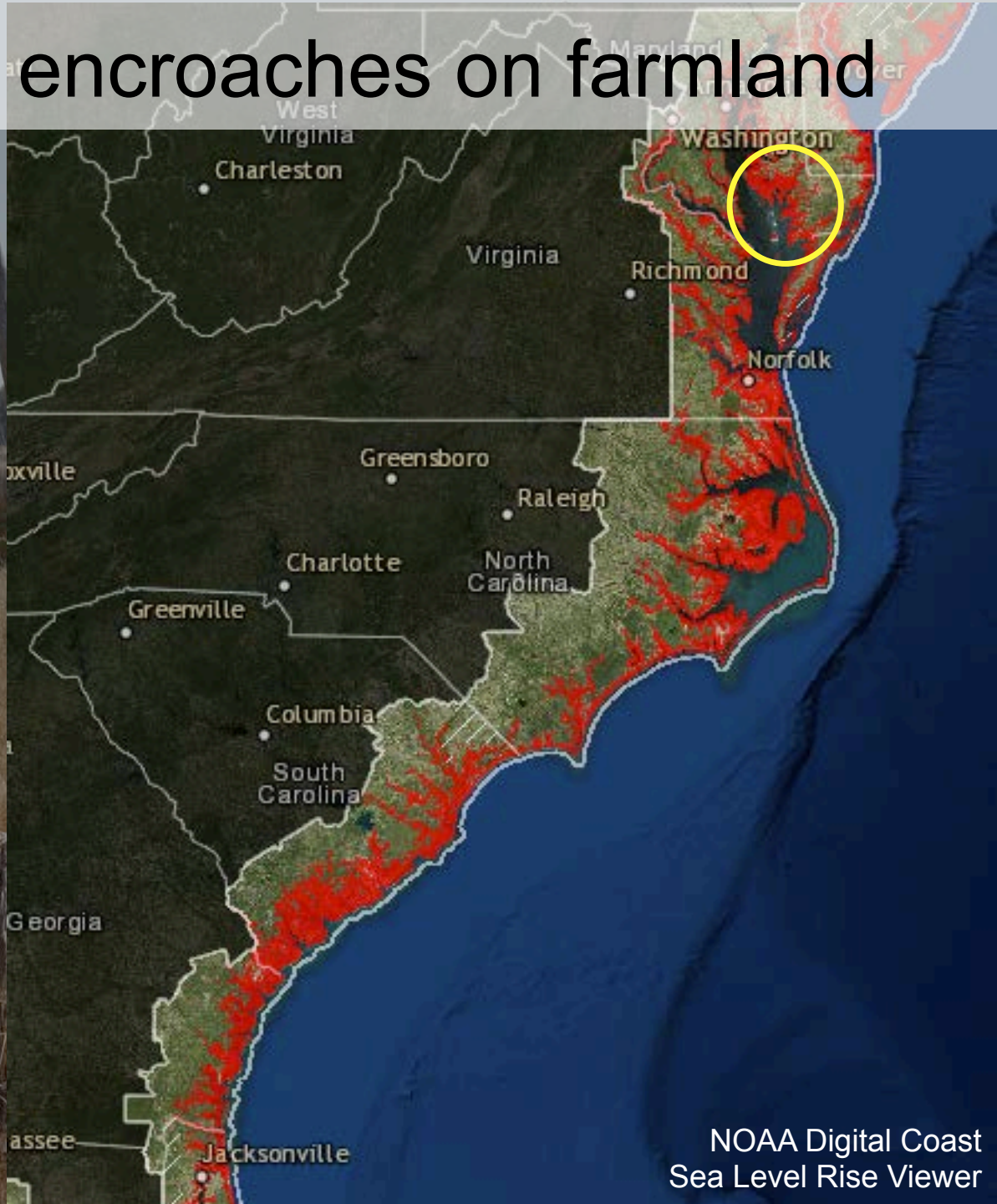
Marsh migration

Sea-level rise forces tidal marshes into uplands

Tully et al. in press Bioscience

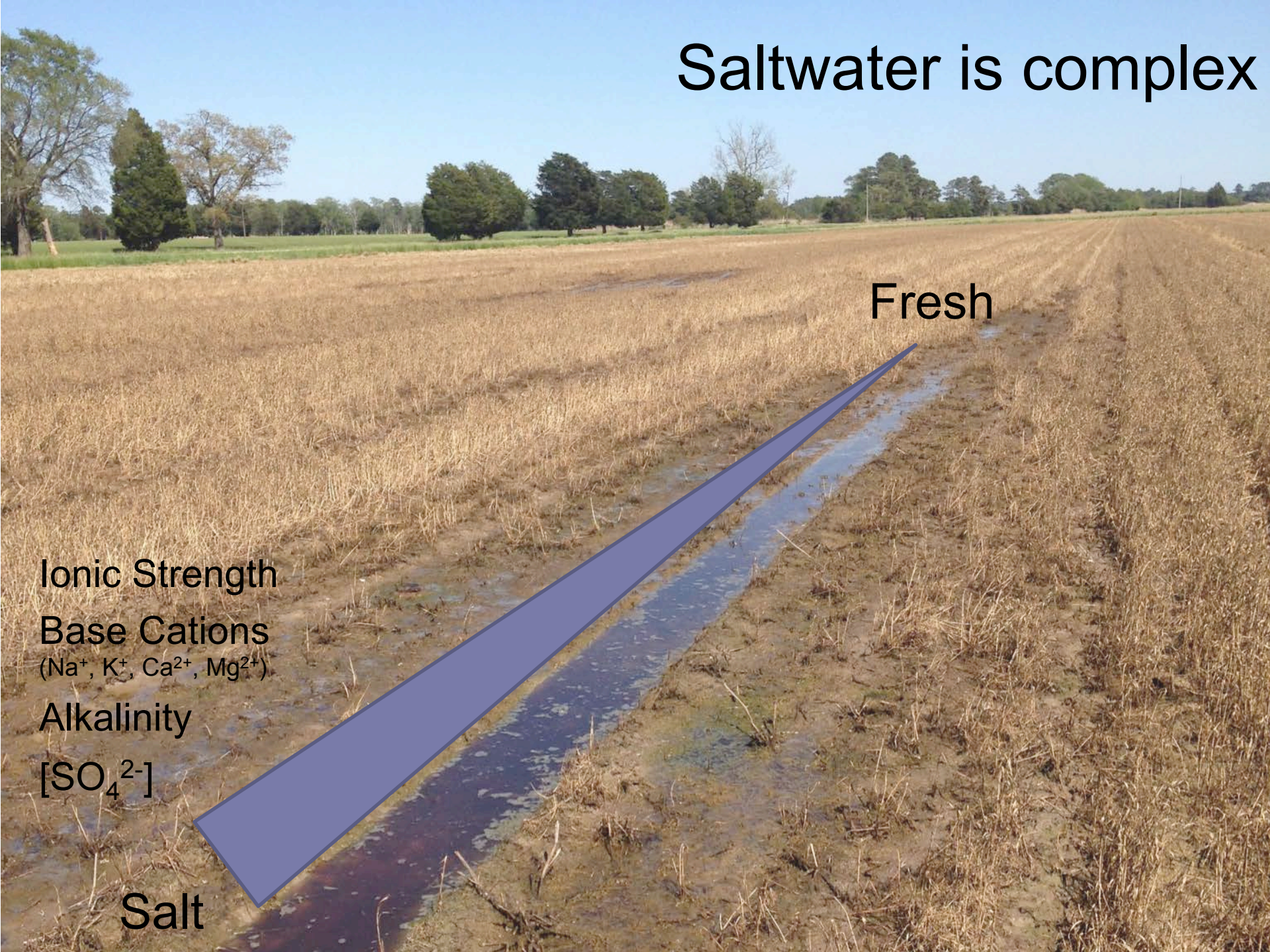
Saltwater intrusion in uplands

Coastal flooding encroaches on farmland

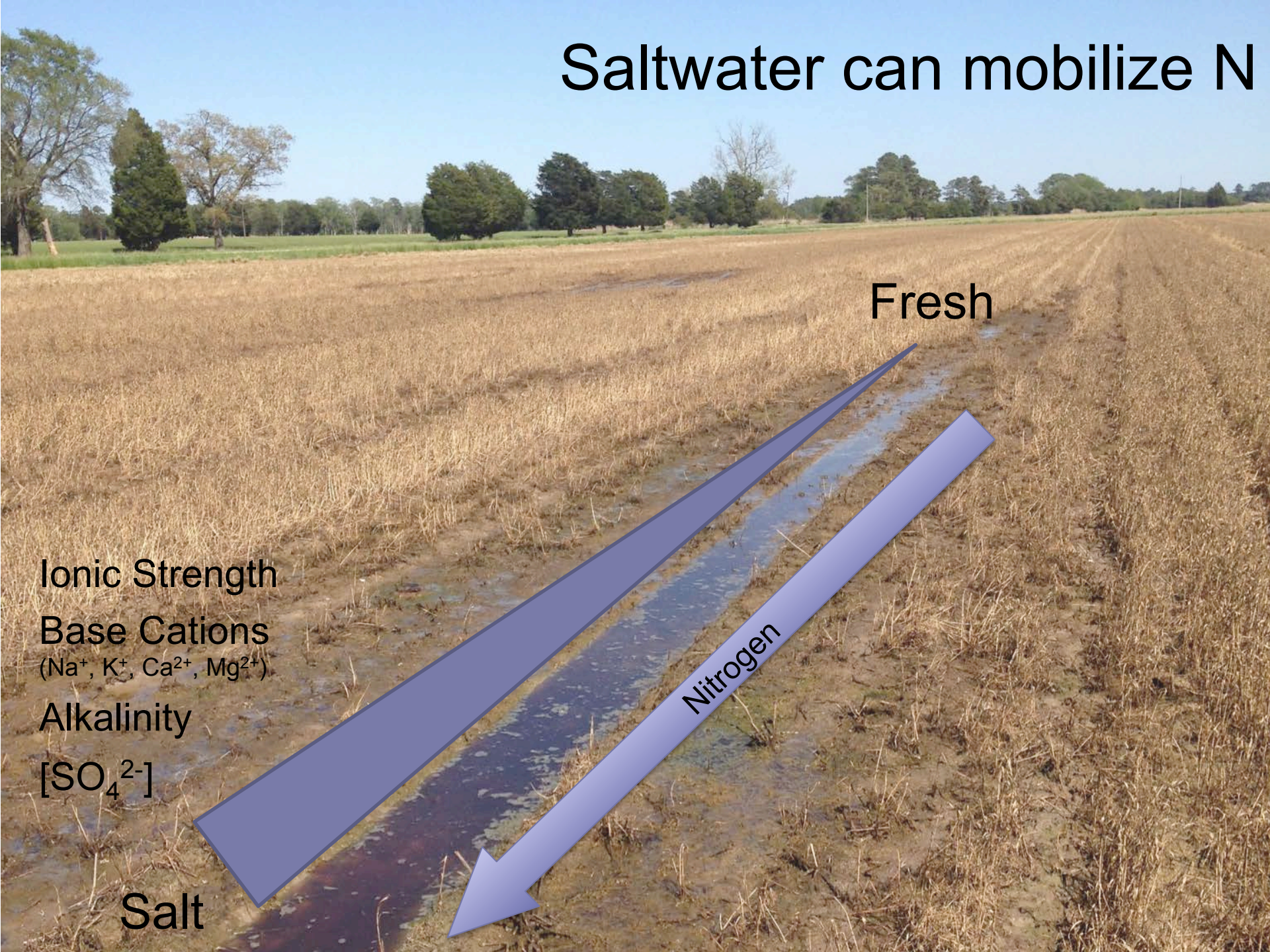


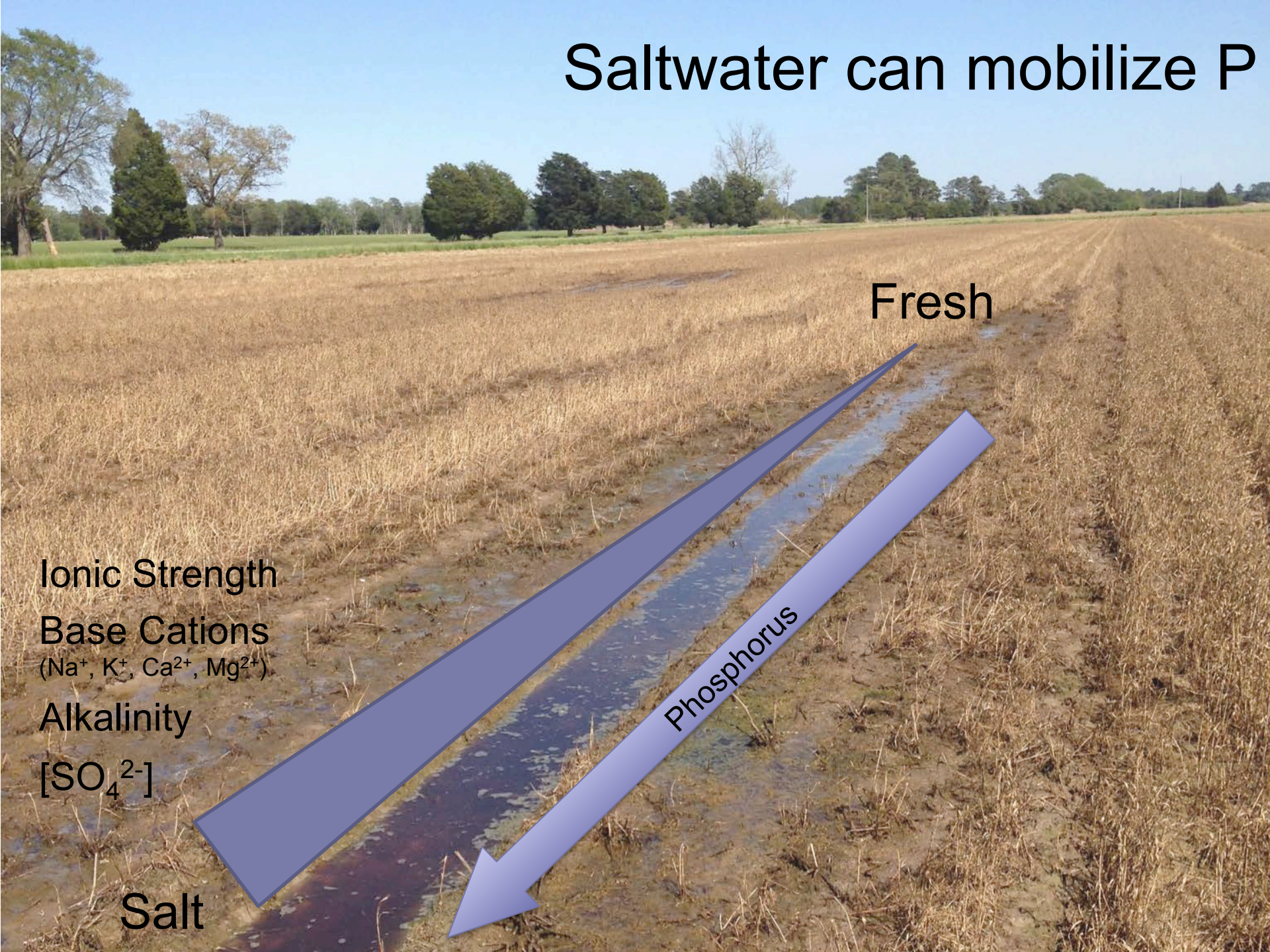
NOAA Digital Coast
Sea Level Rise Viewer

Saltwater is complex



Saltwater can mobilize N

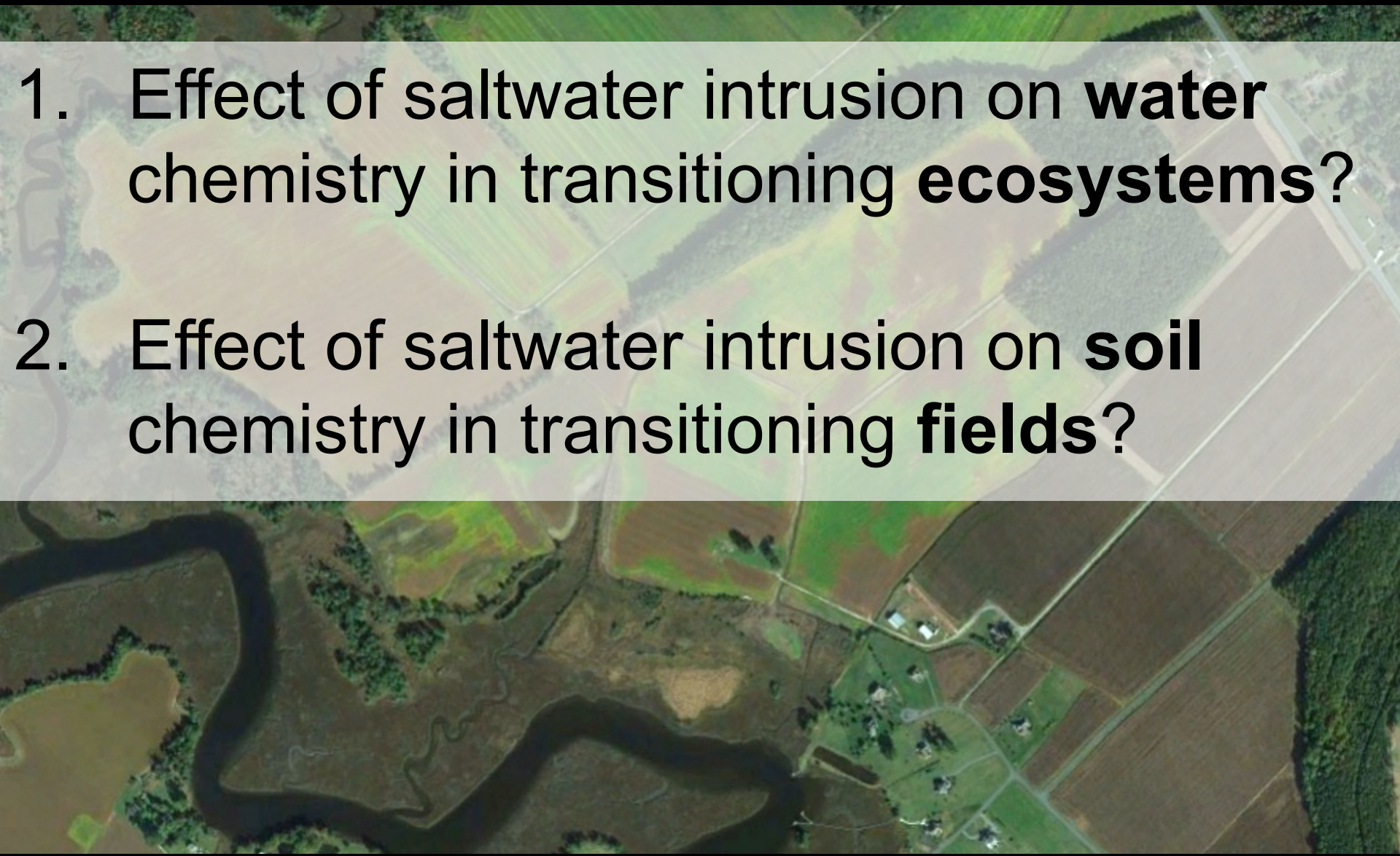



Saltwater can mobilize P
Fresh
Phosphorus
Ionic Strength
Base Cations
(Na+, K+, Ca2+, Mg2+)
Alkalinity
[SO4 2-]
Salt

Agriculture impacts water quality in the Chesapeake Bay

Some fields may be hotspots

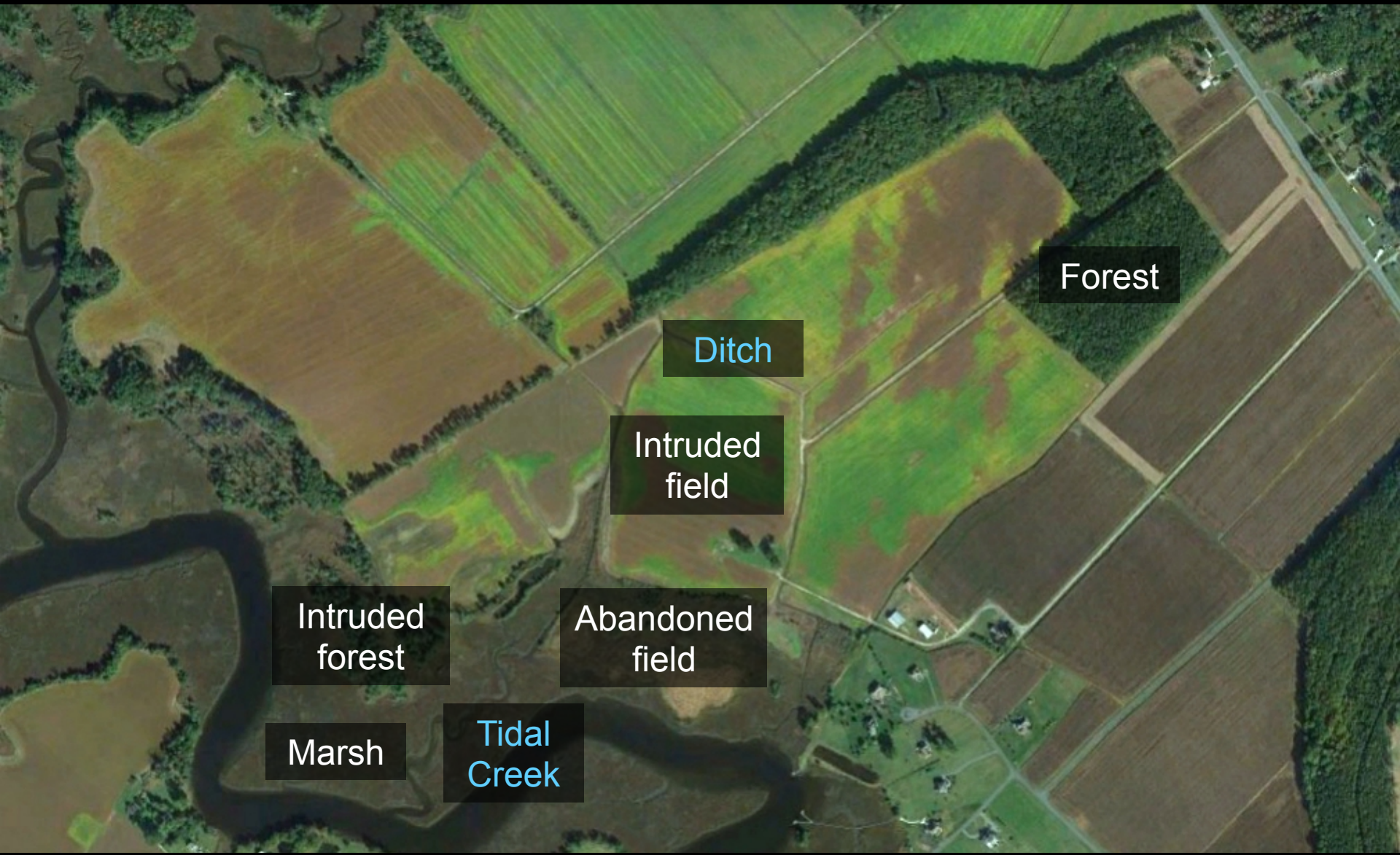
Research Questions: Transitions



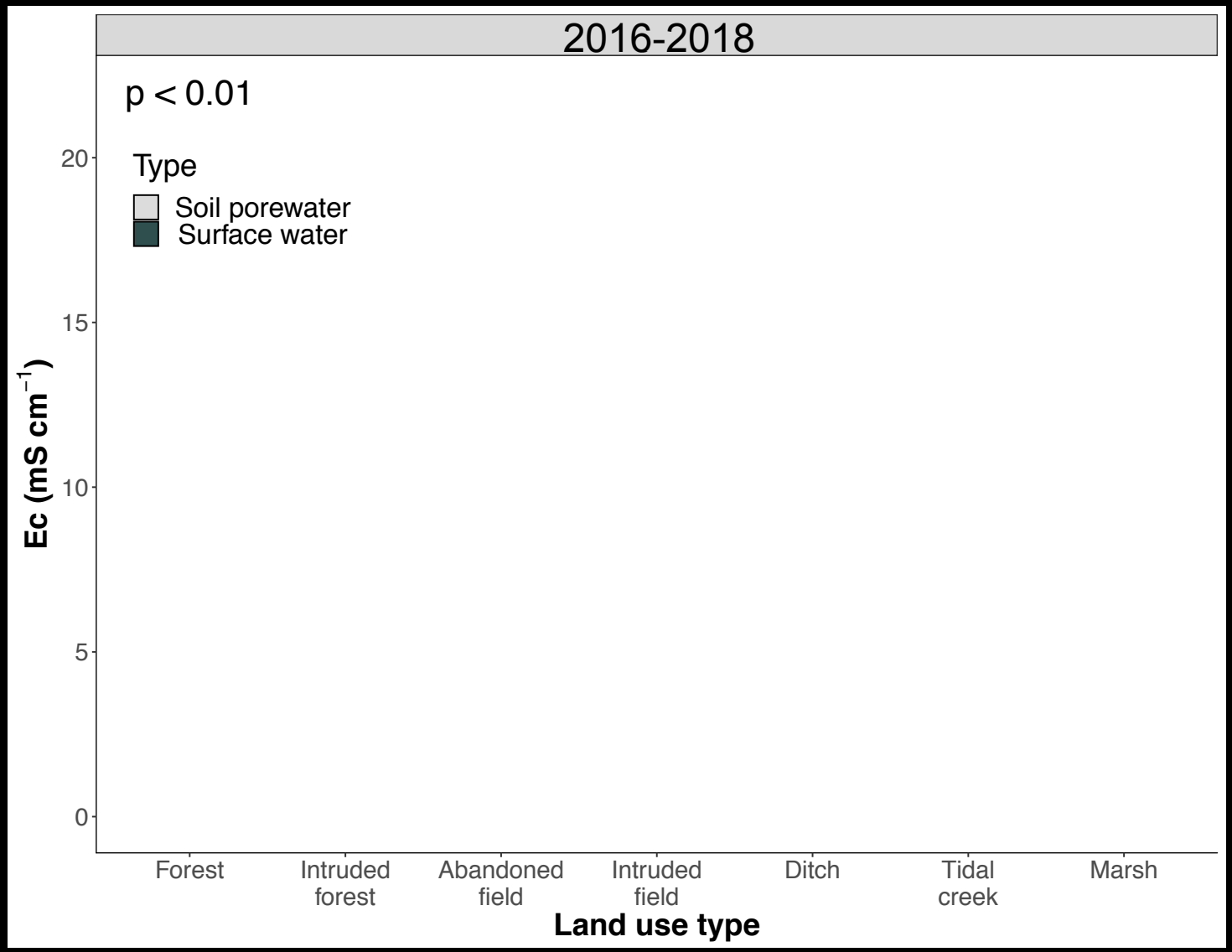
1. Effect of saltwater intrusion on **water** chemistry in transitioning **ecosystems**?

2. Effect of saltwater intrusion on **soil** chemistry in transitioning **fields**?

Study design: ecosystems in transition

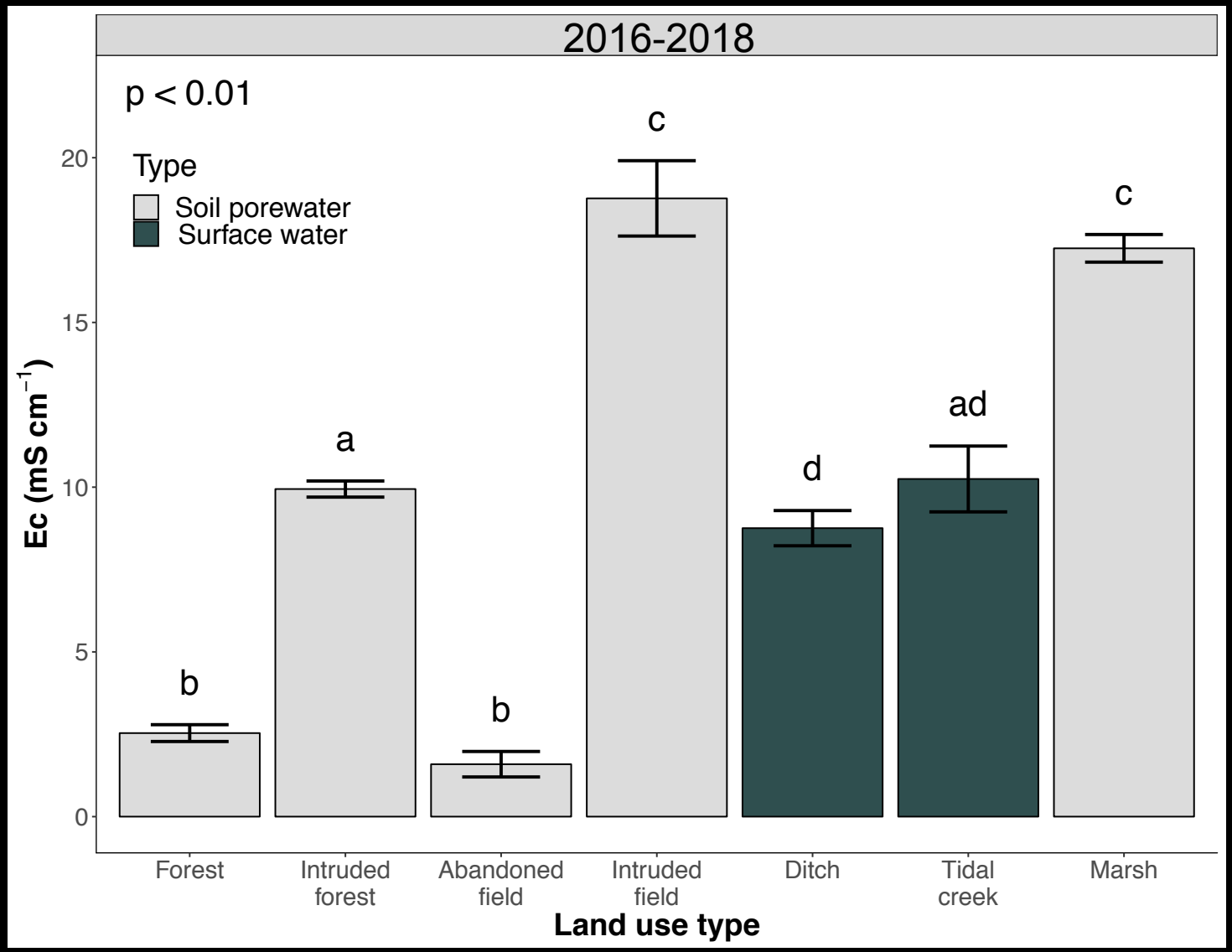


Similar conductivity in marshes & intruded fields (that means these are SALTY fields!)



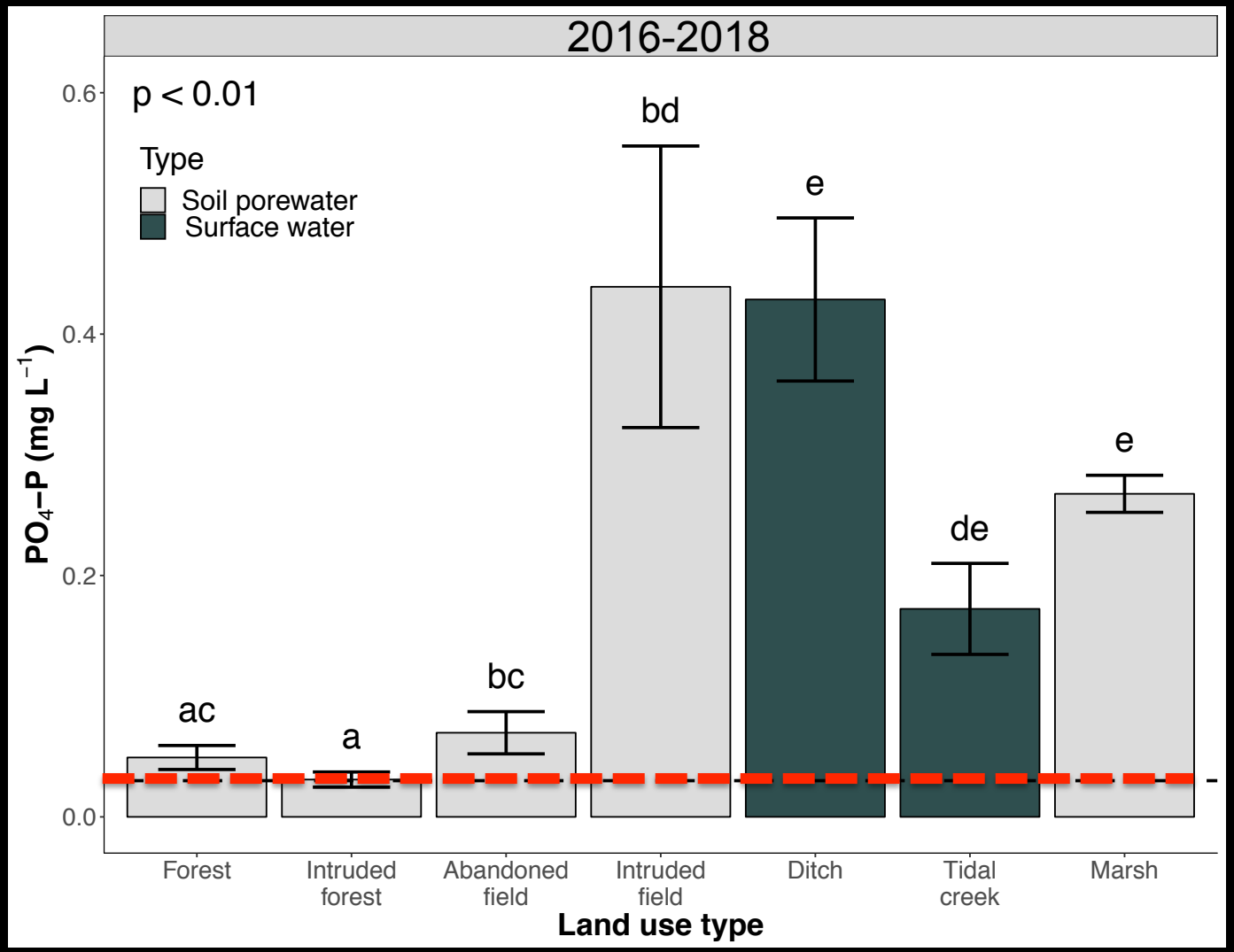
2 mS/cm ≈ 1 ppt @ 25°C

Similar conductivity in marshes & intruded fields (that means these are SALTY fields!)



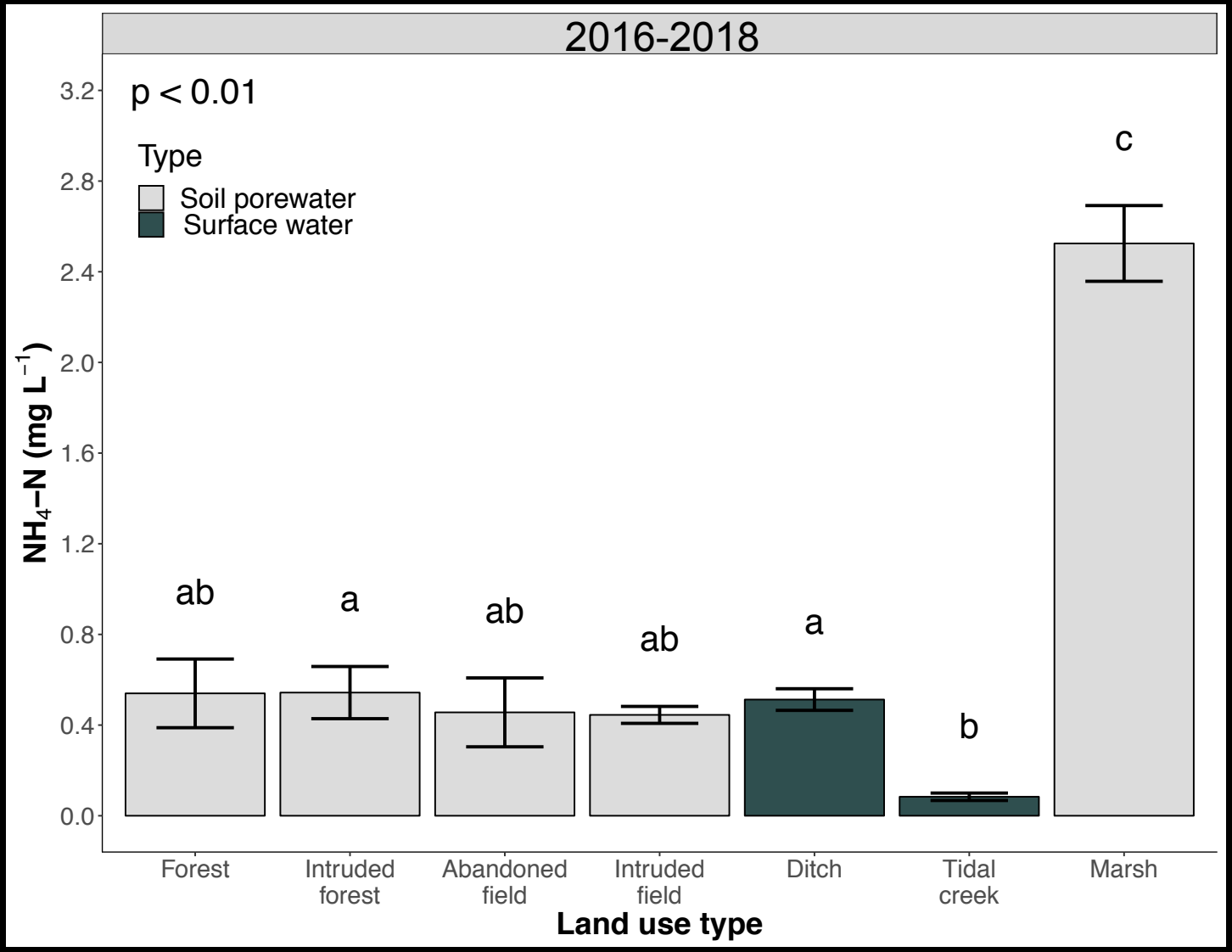
2 mS/cm ≈ 1 ppt @ 25°C

High phosphate levels in intruded fields, ditches, and marshes



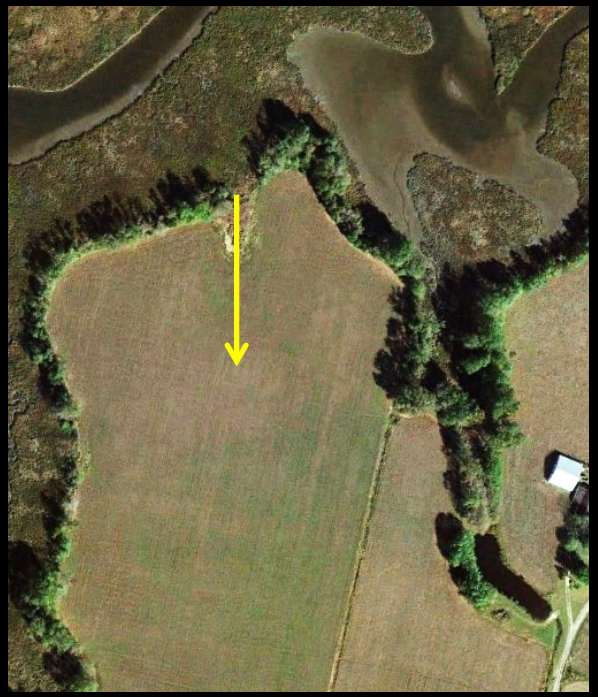
0.03 mg/L = EPA stream eutrophication limit

High ammonium levels in marshes



Study design: fields in transition

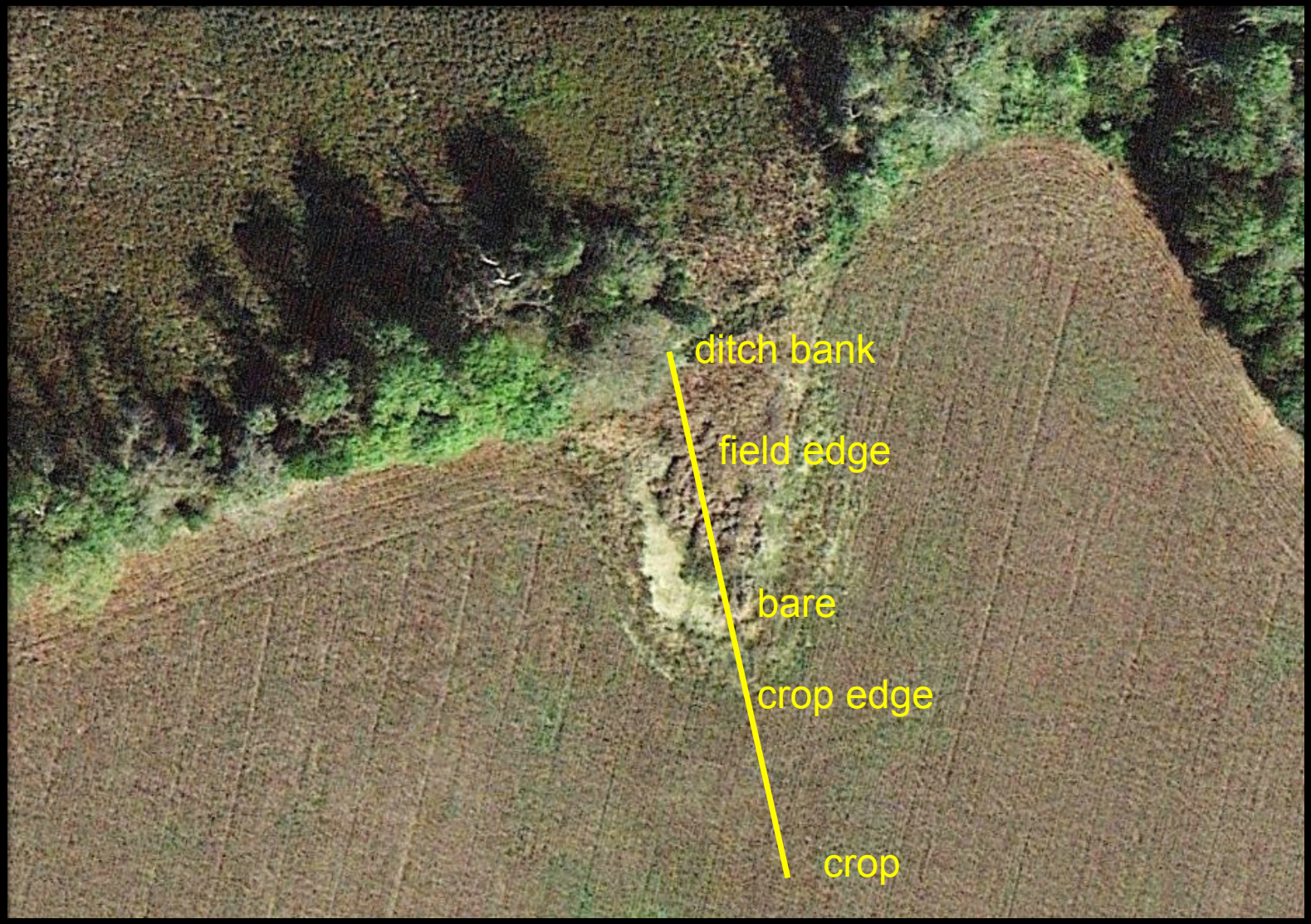
corn field



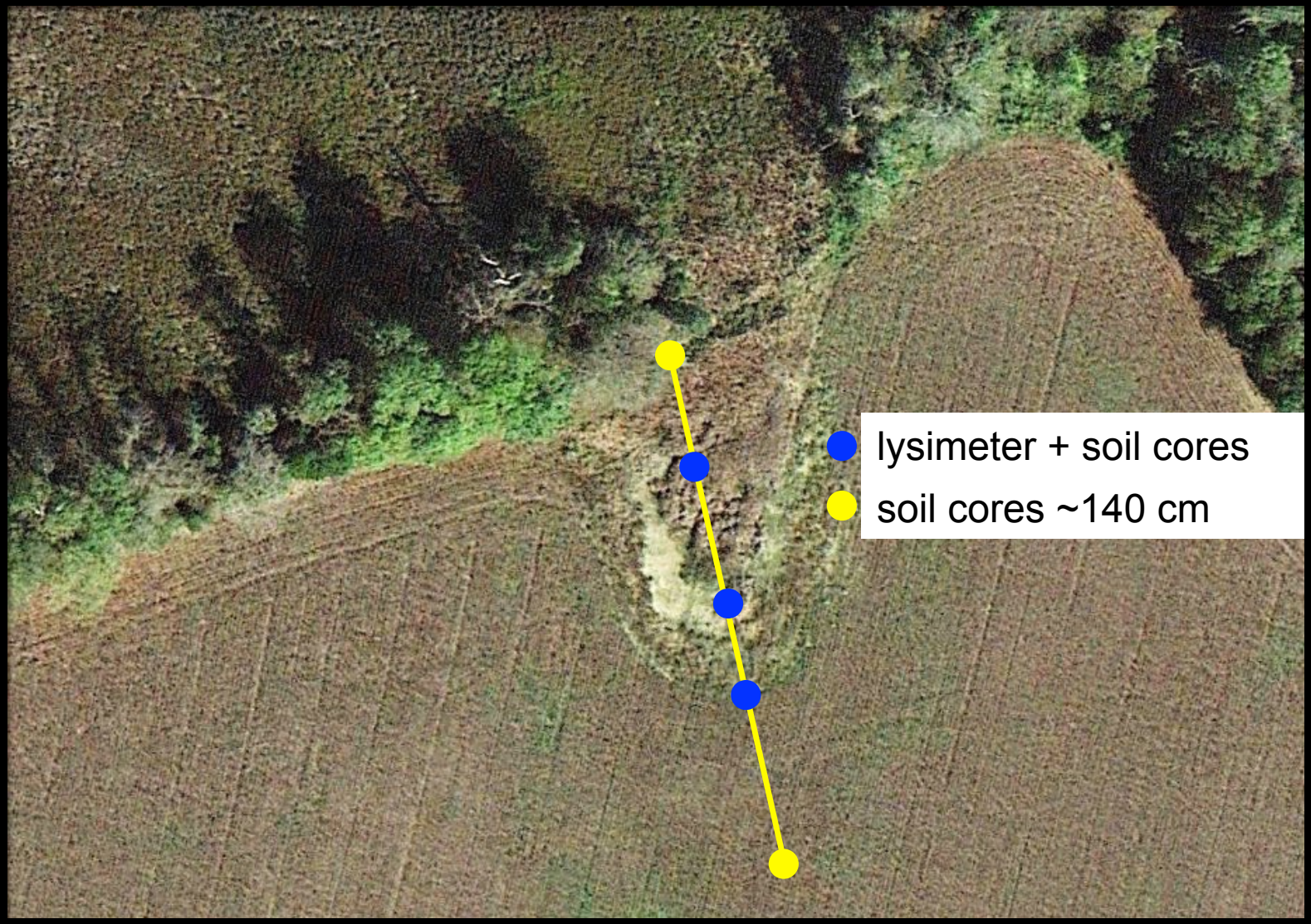
soy field

sorghum field

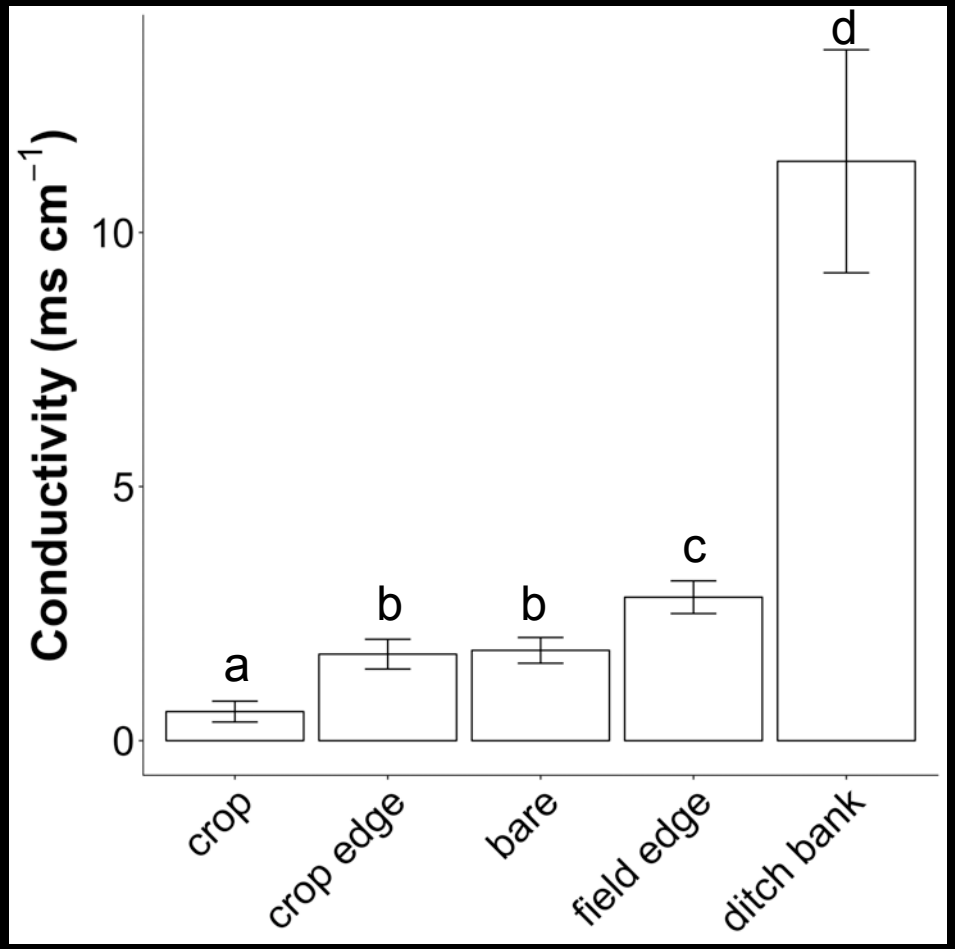
Study design: fields in transition



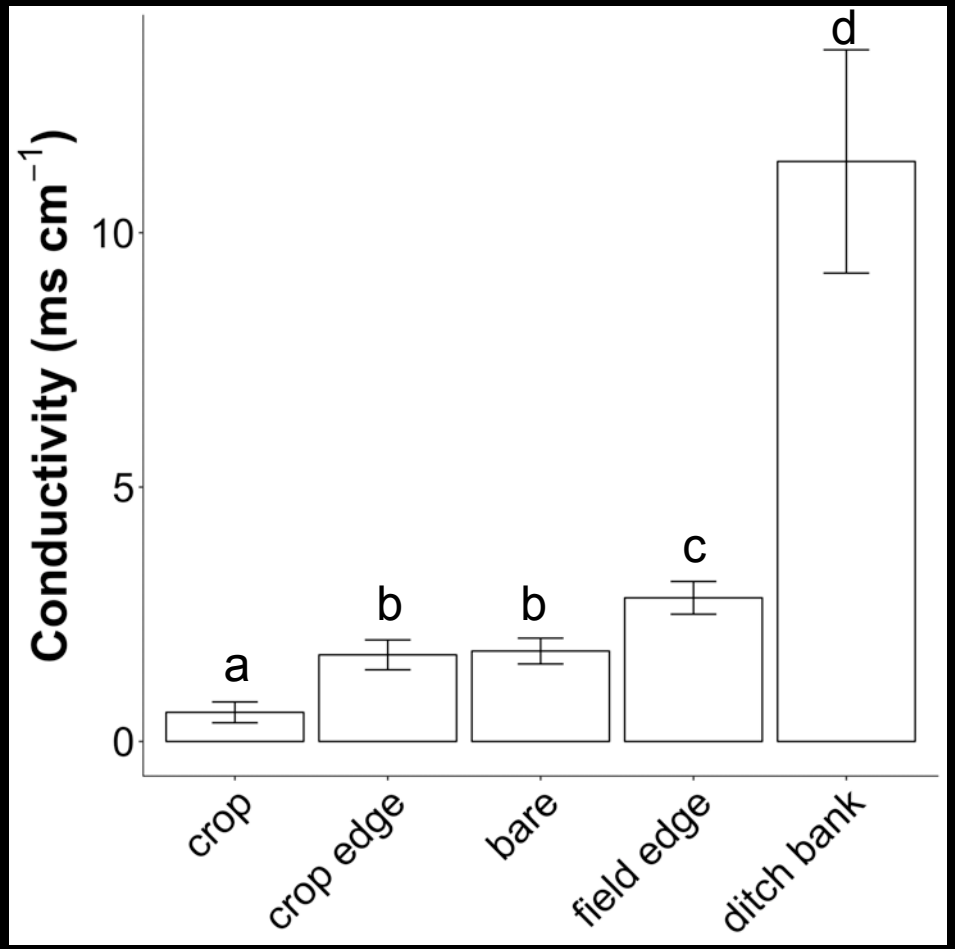
Study design: fields in transition

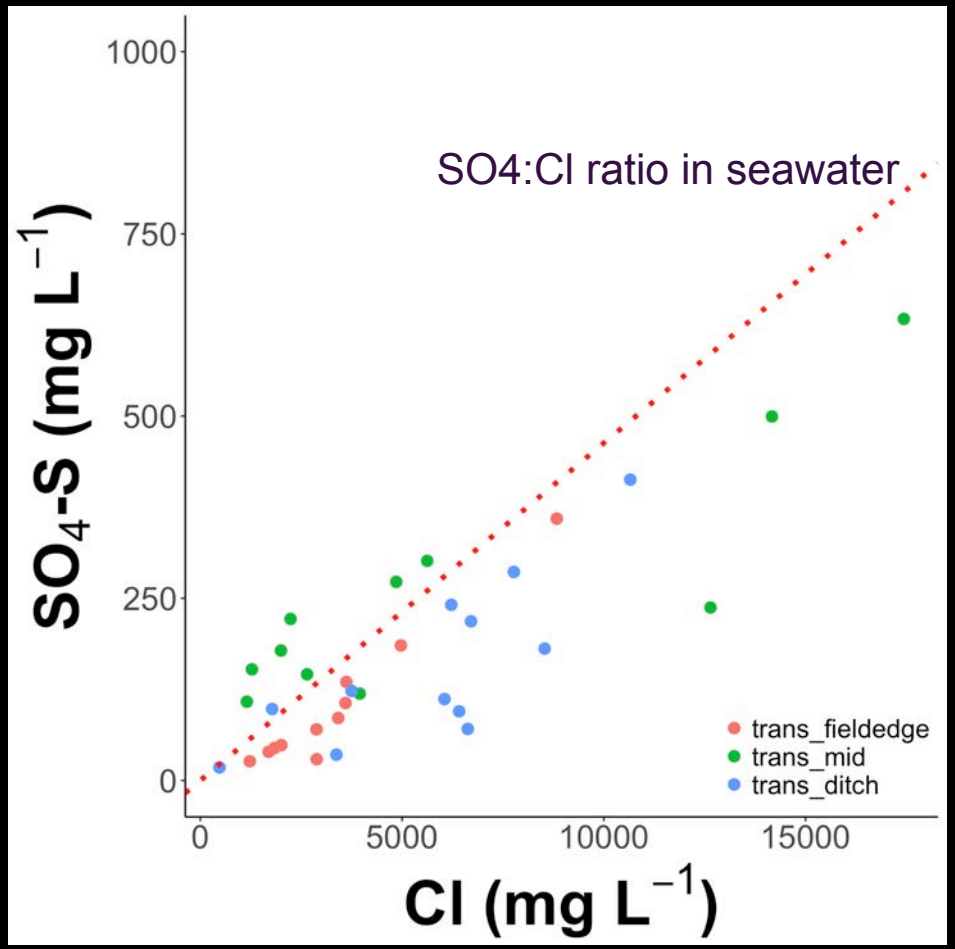


Soil conductivity decreases from ditch bank



Soil conductivity decreases from field edge
Evidence of sulfate reduction





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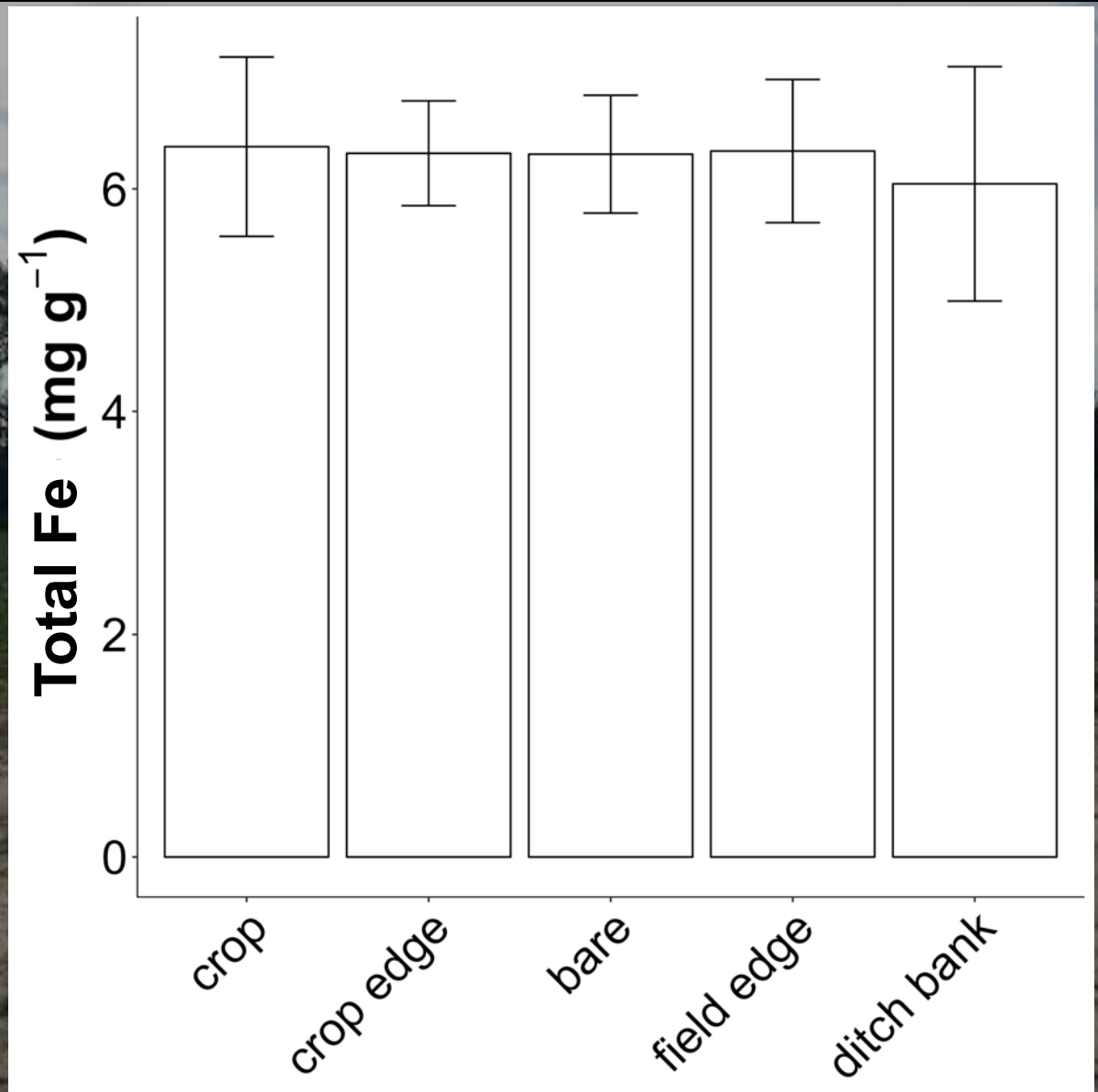
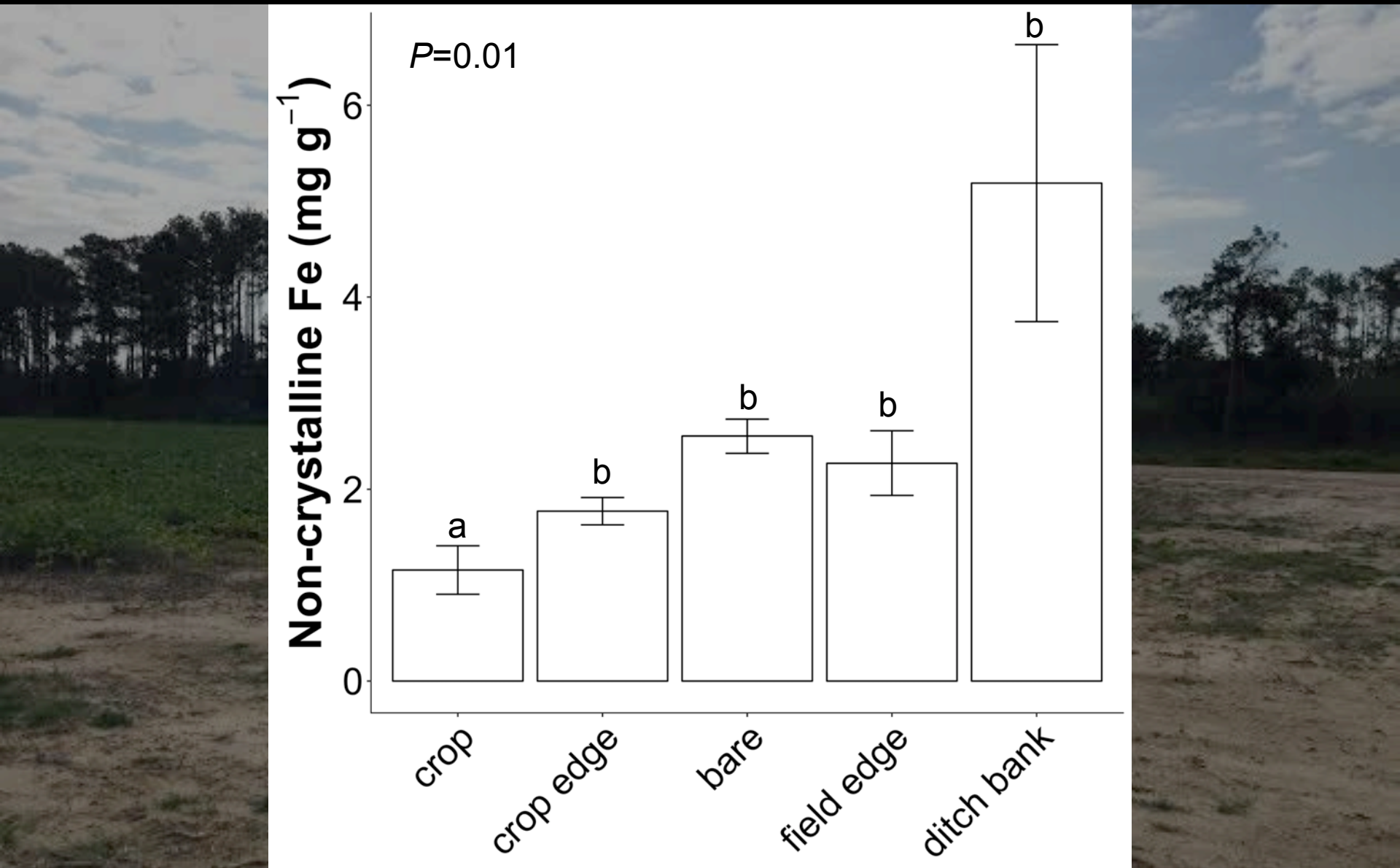
Total soil iron similar across transitions

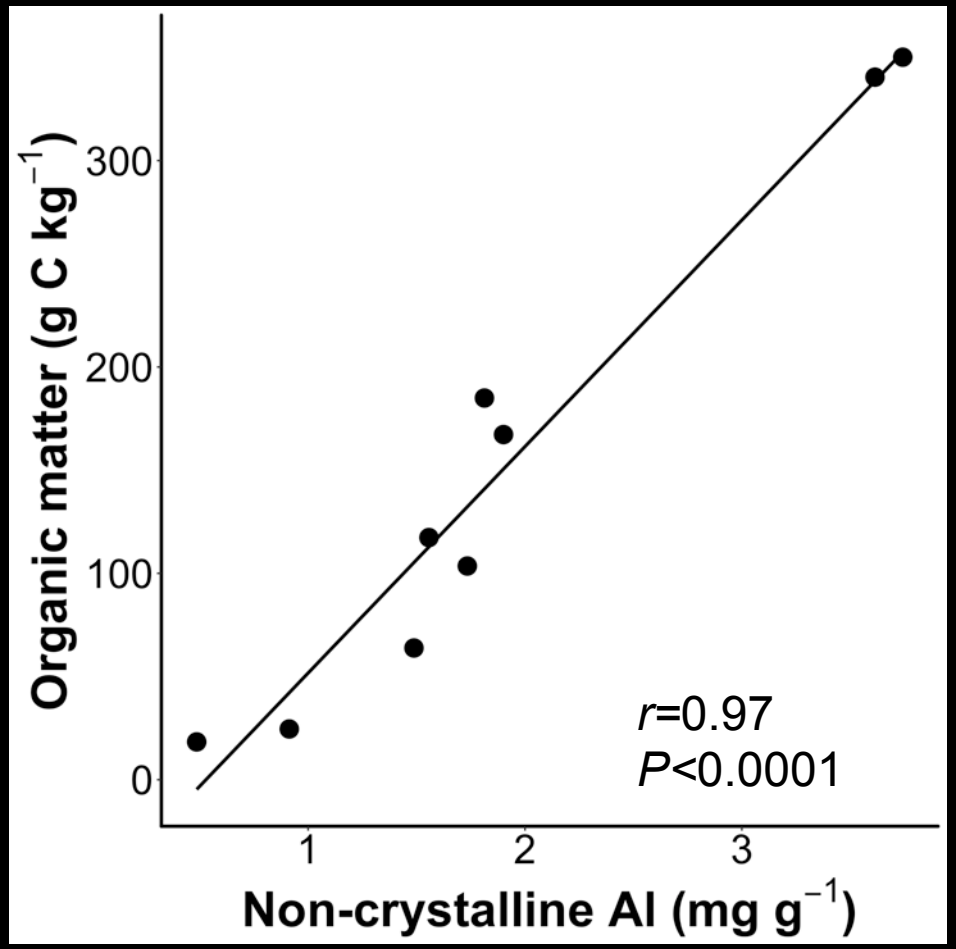


Results: fields in transition

Non-crystalline iron increases toward the ditch



Correlation between organics and non-crystalline metal complexes



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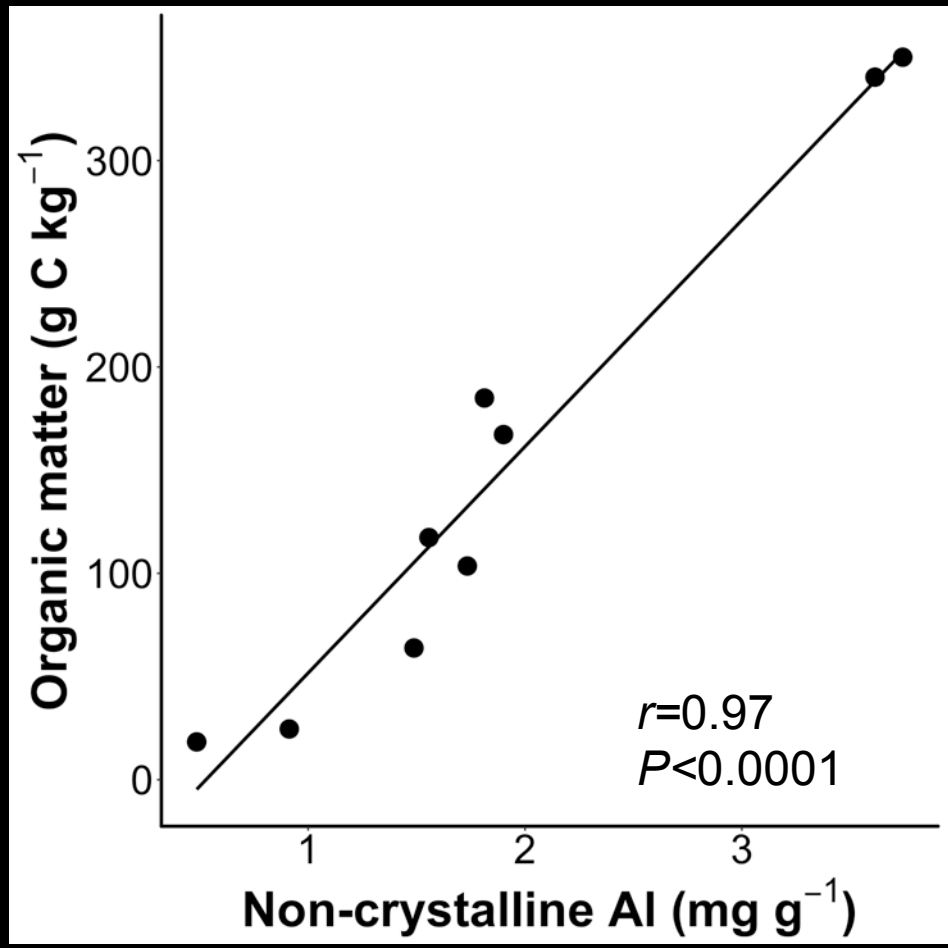
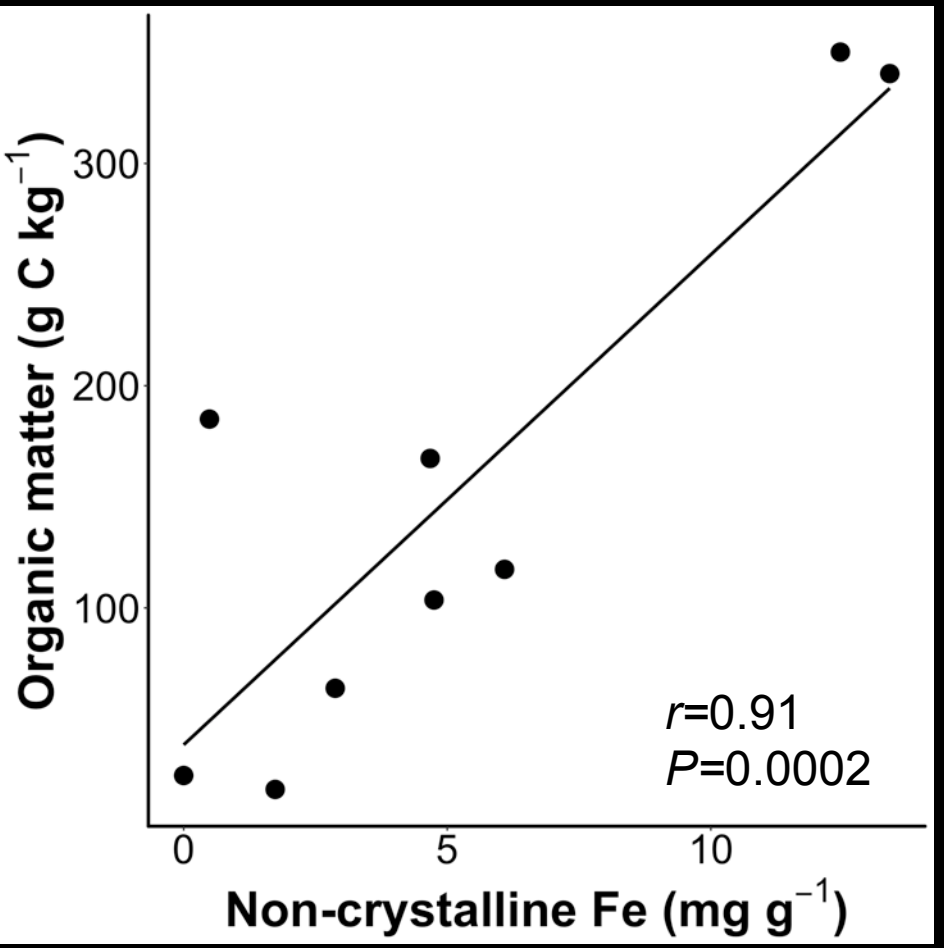
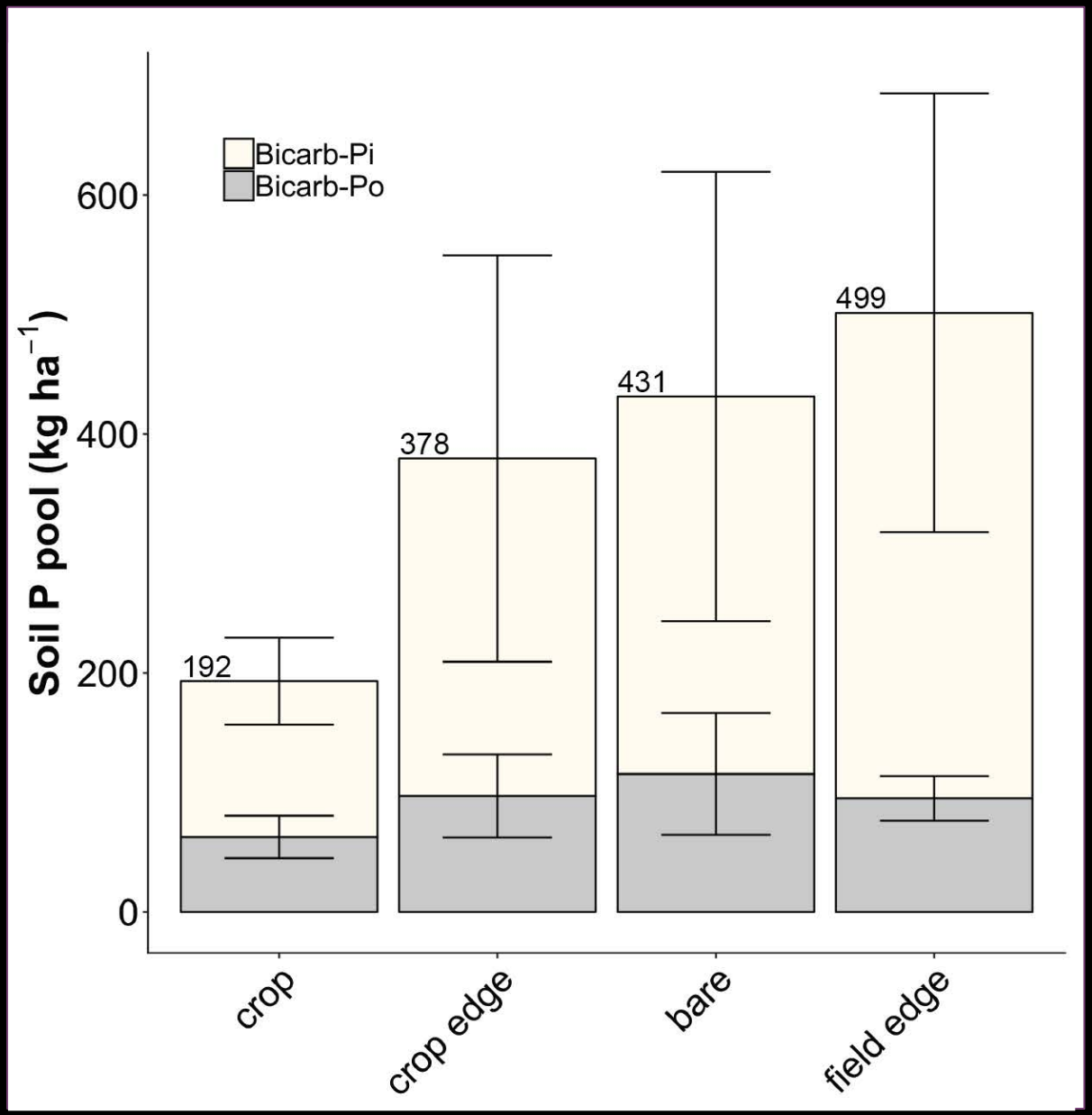




Tully et al. 2019 Biogeochemistry

Results: fields in transition

Soil P pools largest at field edges – poised for loss

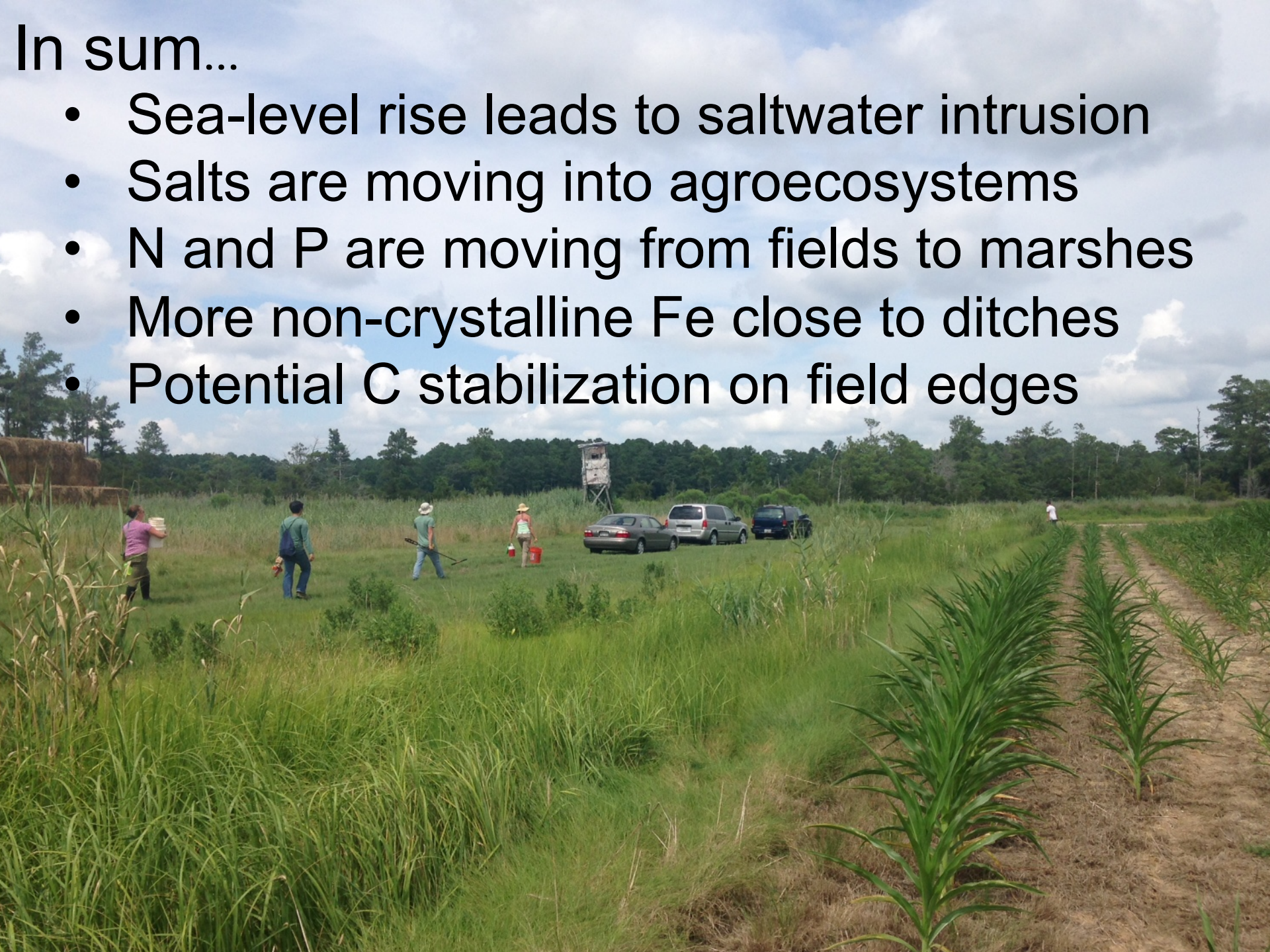


Farmer responses to saltwater intrusion

Protect

Adapt

Retreat



In sum…

- Sea-level rise leads to saltwater intrusion
- Salts are moving into agroecosystems
- N and P are moving from fields to marshes
- More non-crystalline Fe close to ditches
- Potential C stabilization on field edges

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Jarrod Miller

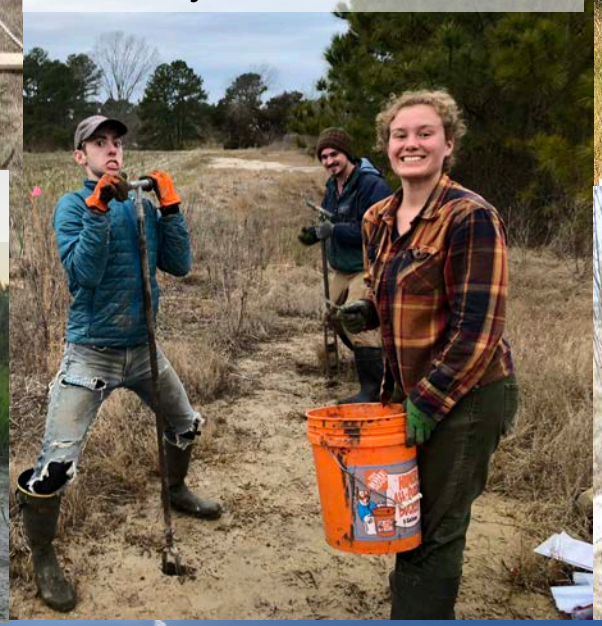
Dani Weissman

Natalie Ceresnak

Elizabeth Reguera

Cullen McAskill

So many interns!



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Thank you!

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Keryn Gedan
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Logistical Support
- Farmer partners
- Larry Fykes (MD Soil Cons. District)

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