RAPID FORMATION OF POTENTIAL ACID SULFIDE SOILS FOLLOWING WETLAND RESTORATION

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Biogeochemistry of Wetlands

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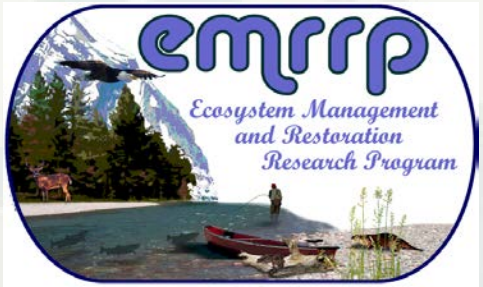

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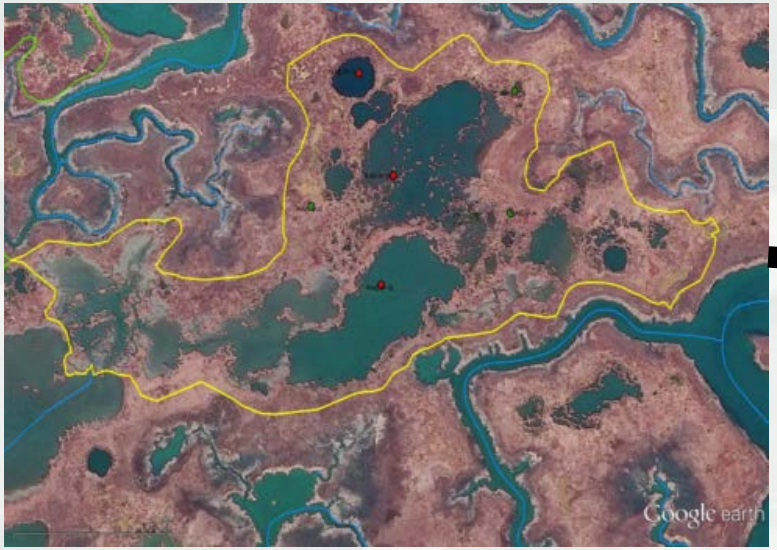

Google earth

Need for wetland restoration:

Coastal wetlands degradation

Urban development, sea level rise, salt H2O intrusion, lack of sediment inputs

Degradation linked to marsh drowning; fragmentation; subsidence; sea level rise

Dredged materials → potential sediment source

Thin layer placement restoration implemented

Little data on biogeochemical effects

Potential formation of FeS/acid sulfate soils?

Iron sulfate soils (FeS)

Naturally occurring in wetlands

Microbial SOM oxidation → Anaerobic conditions

$Fe^{3+}(s) \rightarrow Fe^{2+}(aq)$ $SO_4^{2-}(aq) \rightarrow S^{2-}(aq)$

$$Fe^{2+}(aq) + S^{2-} \rightarrow FeS_{2\,(s)}\,(s)$$

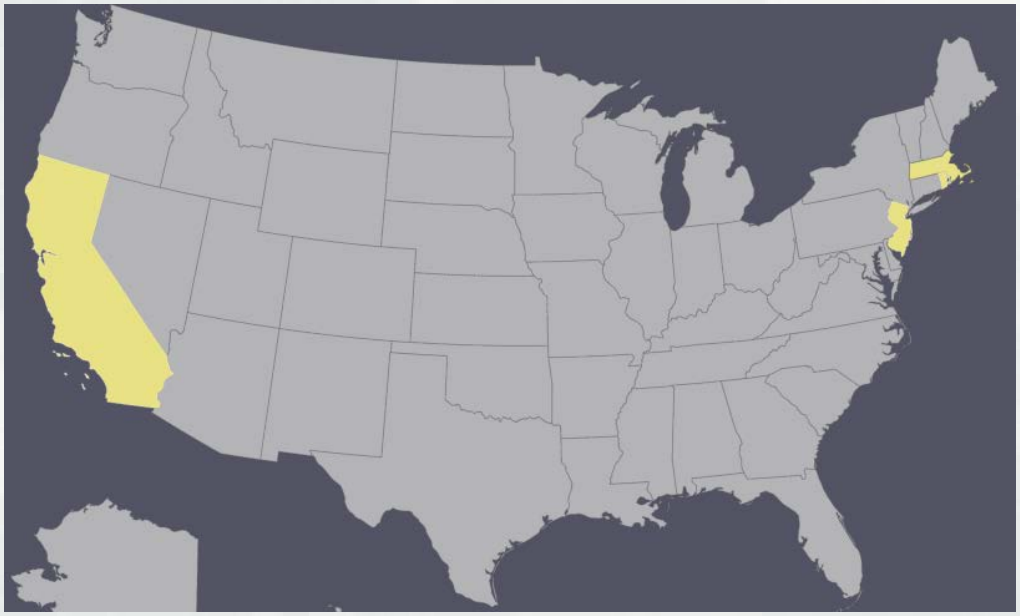
Stable under anaerobic conditions

Generate acidity when oxidized

$$FeS_{2\,(s)} + 3.75\,O_2 + 3.5\,H_2O \rightarrow H_2SO_{4\,(aq)} + Fe(OH)_{3\,(s)}$$

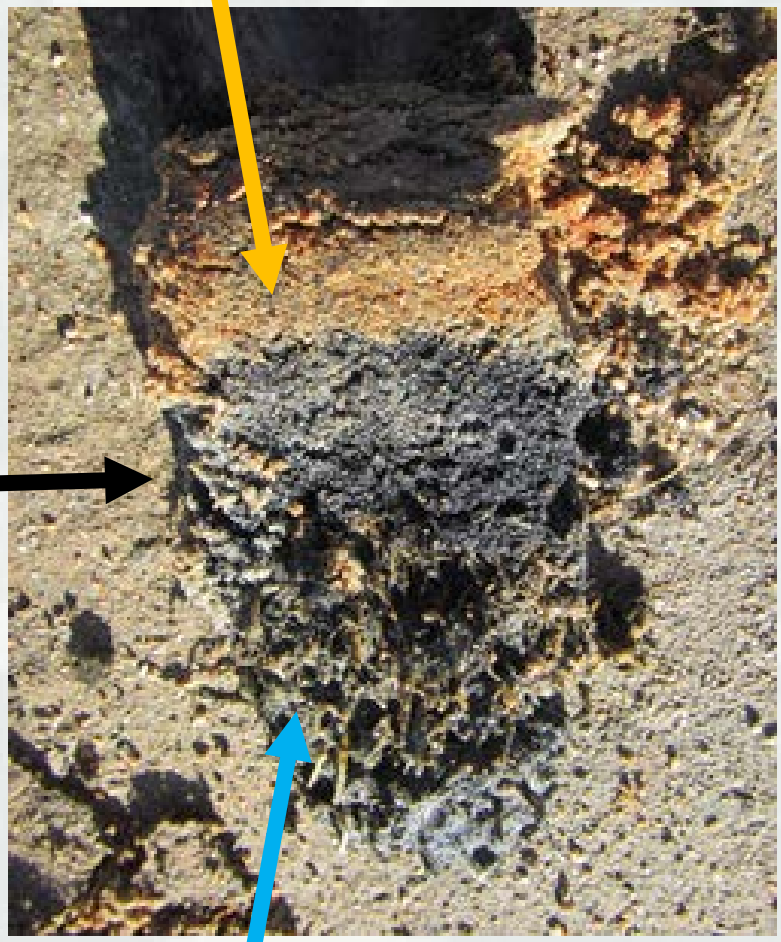
Cat clay soils or *poison earth soils*

Aerobic soil incubation pH <4; may reach <2



Sediment added for restoration

Black FeS



Marsh soil

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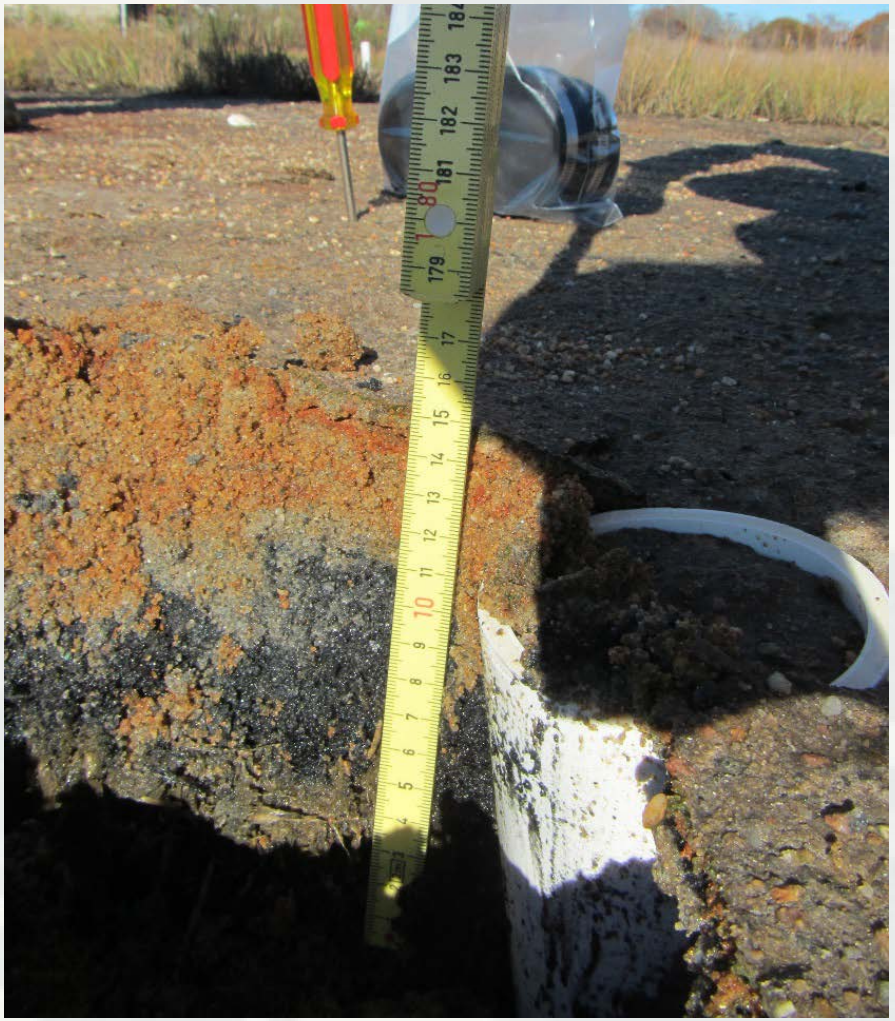

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Objectives:

1. Investigate potential FeS formation
2. Implications for restoration

Approach

1. Case studies - Reports of black soils forming following restoration activities
2. Laboratory - incubation to investigate FeS formation in simulated restoration context

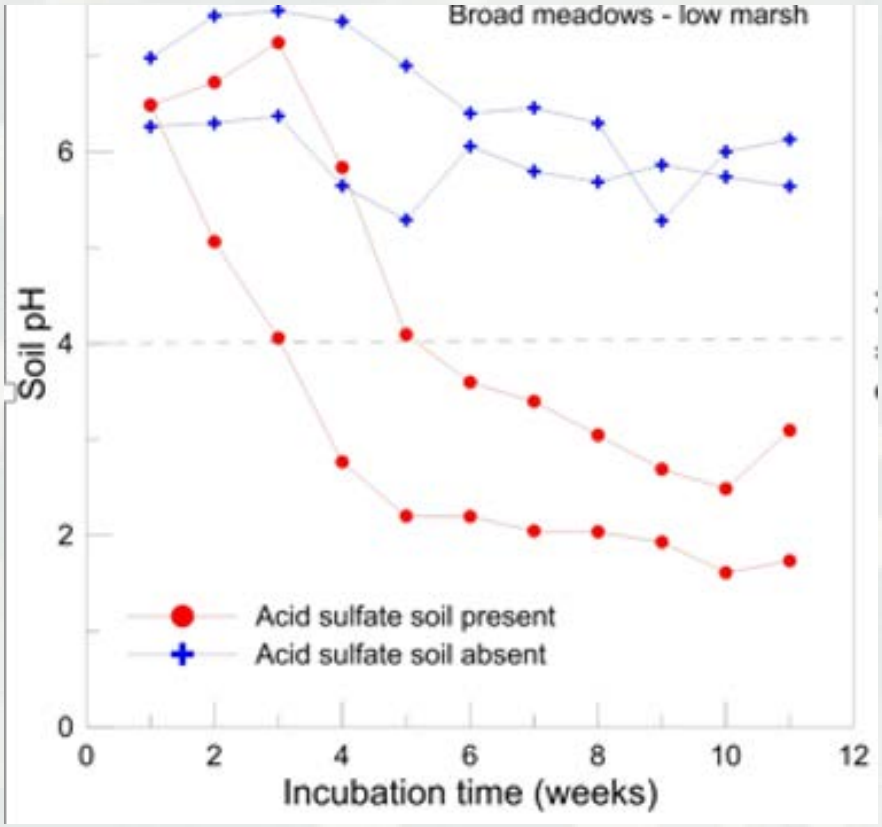
Case studies - field data

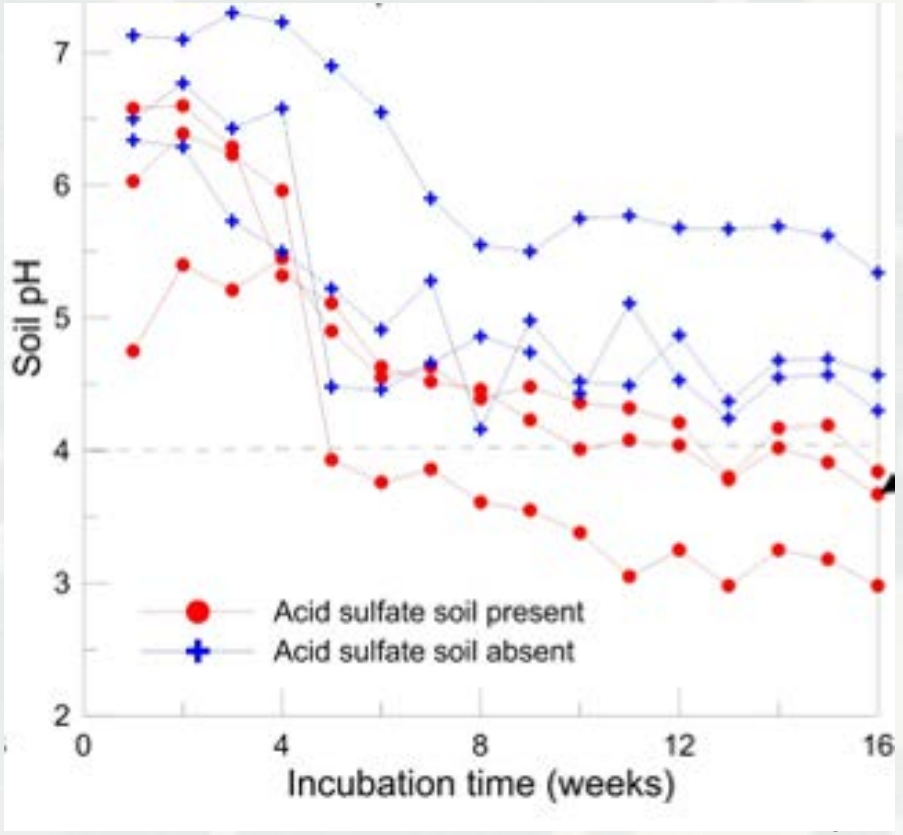
- Document FeS formation
- H2O2
- HCl
- IRIS tubes

Case studies - lab data

16wk aerobic incubation documents soil pH → <4

FeS present in BOTH native marsh and restored areas





Incubation experiment

Can we form FeS in the lab?

3 treatments: Drained, flooded, simulated tidal treatments

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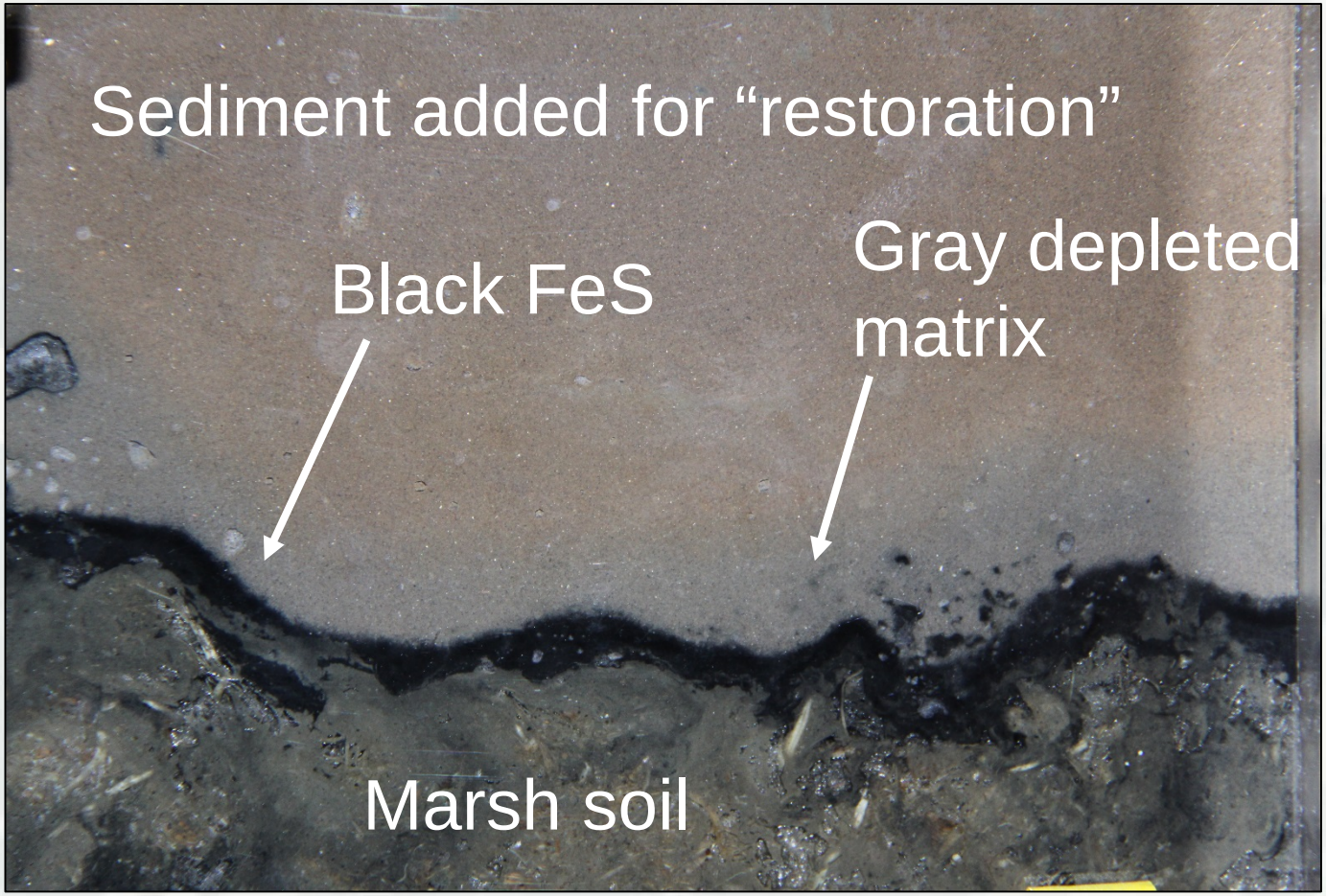
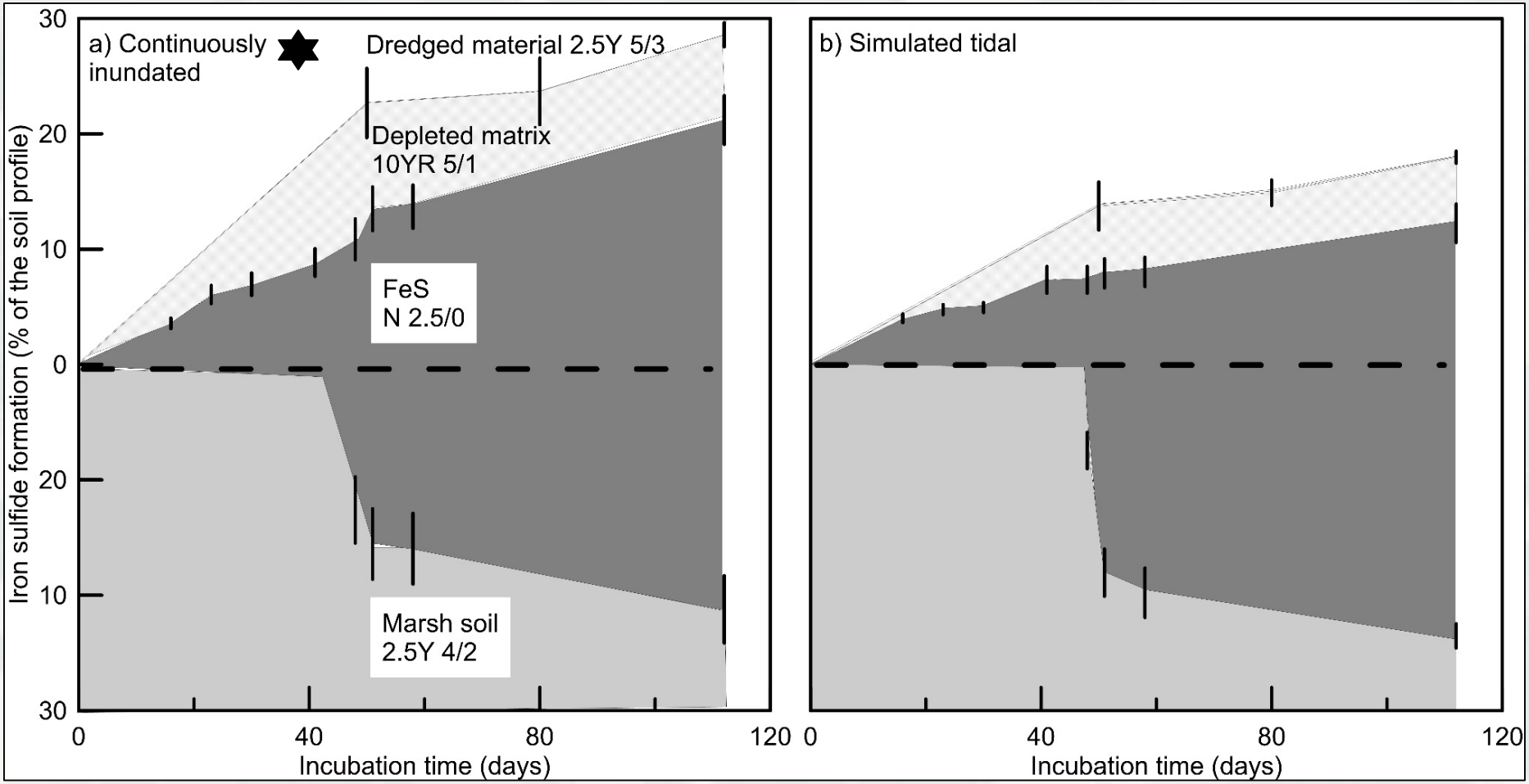
Soil morphology

4-6 wks



Soil morphology



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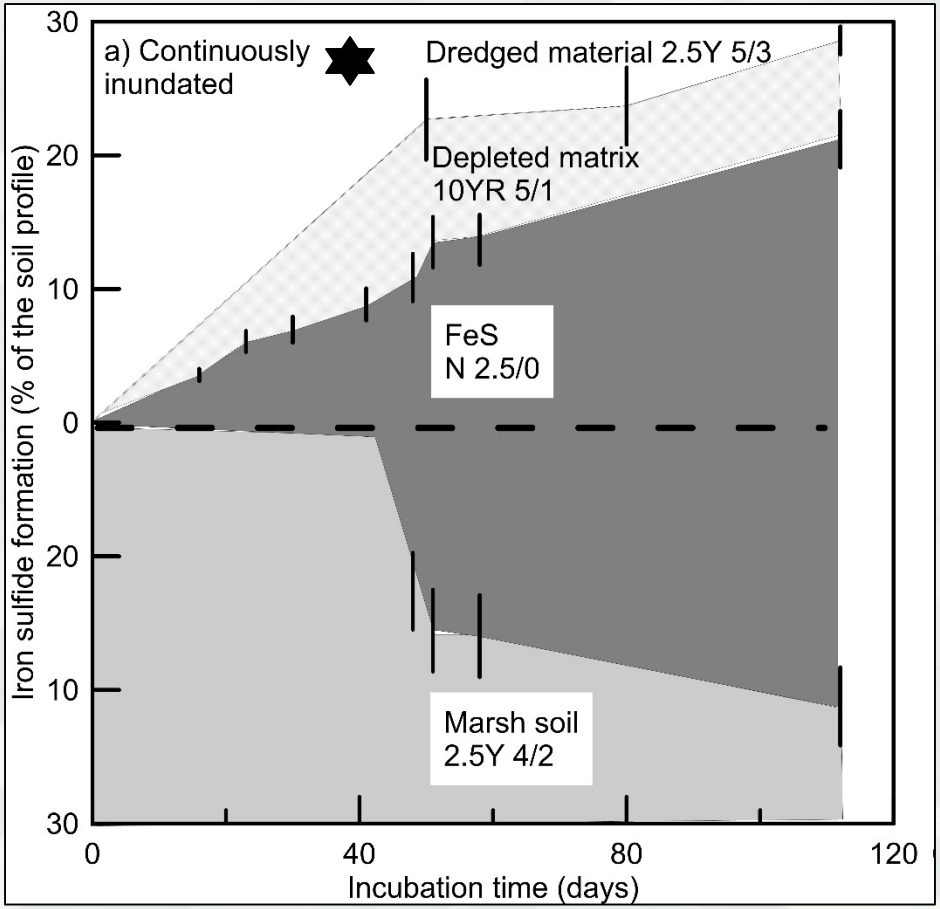
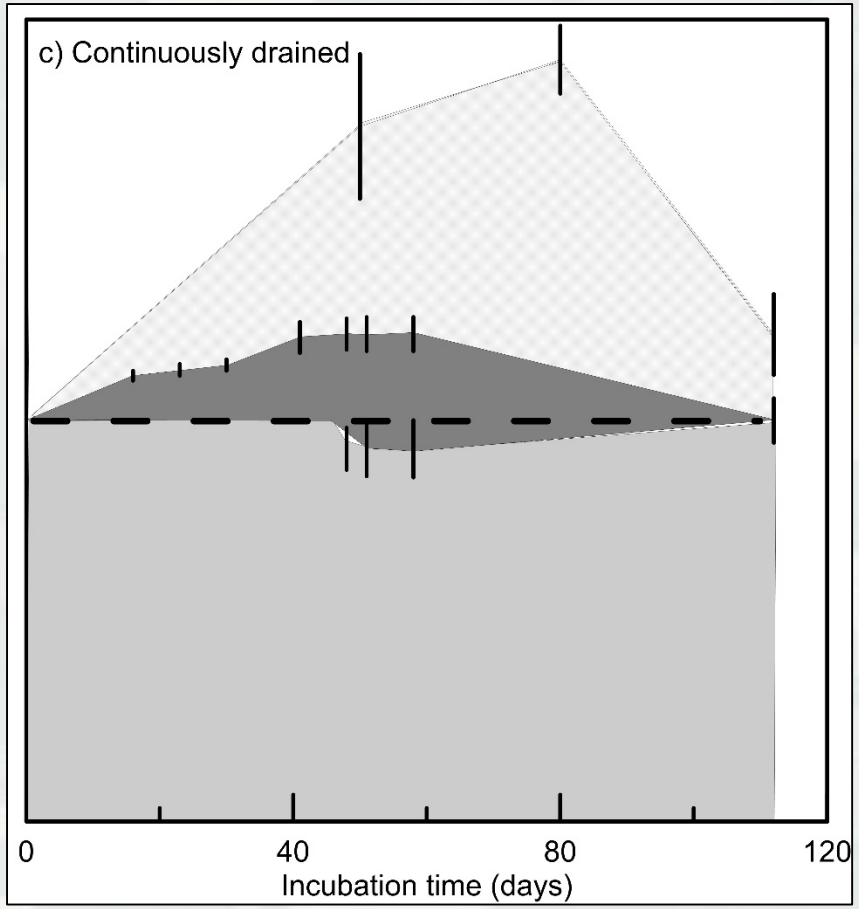
Soil morphology





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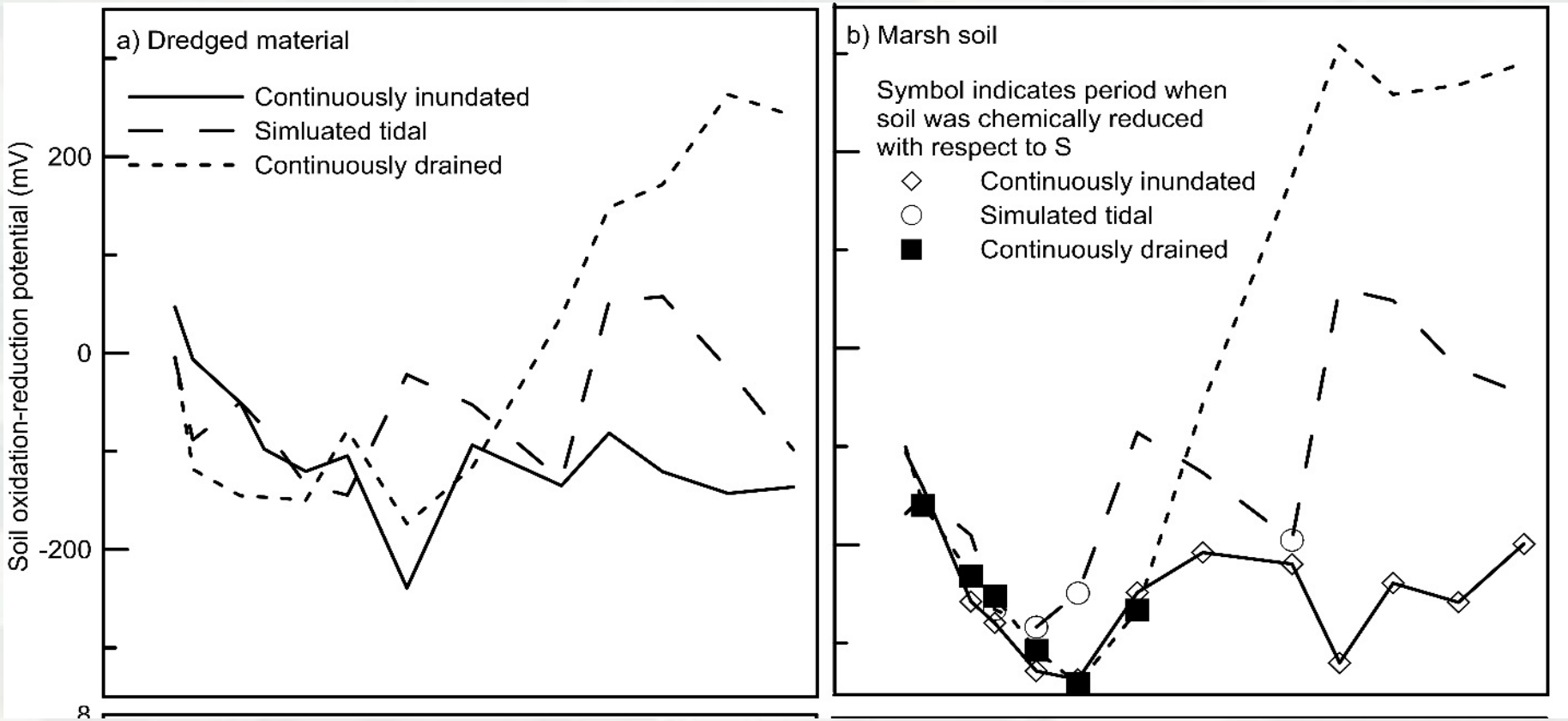
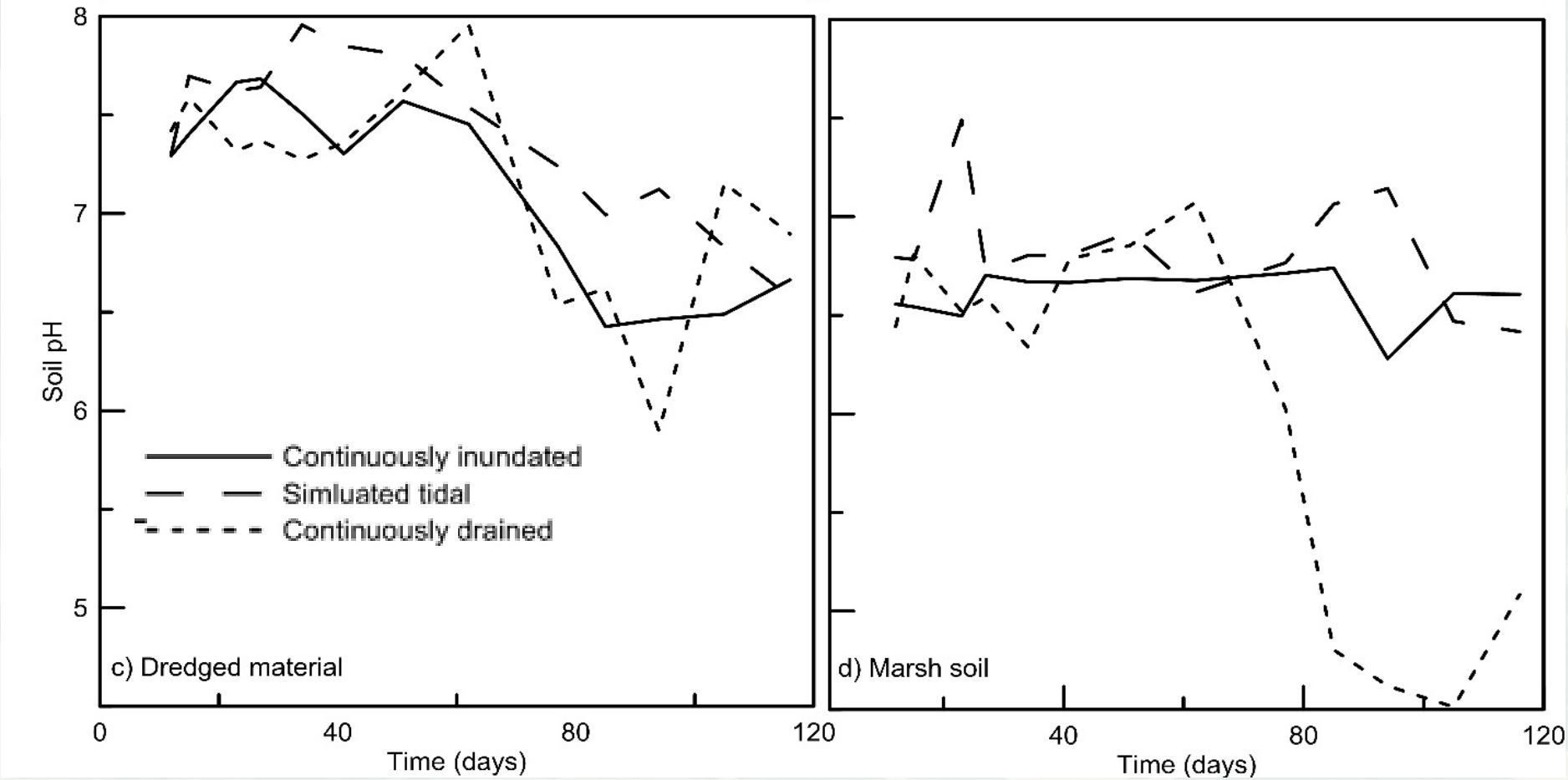
Redox potential



Soil pH - drainage induced acid condition



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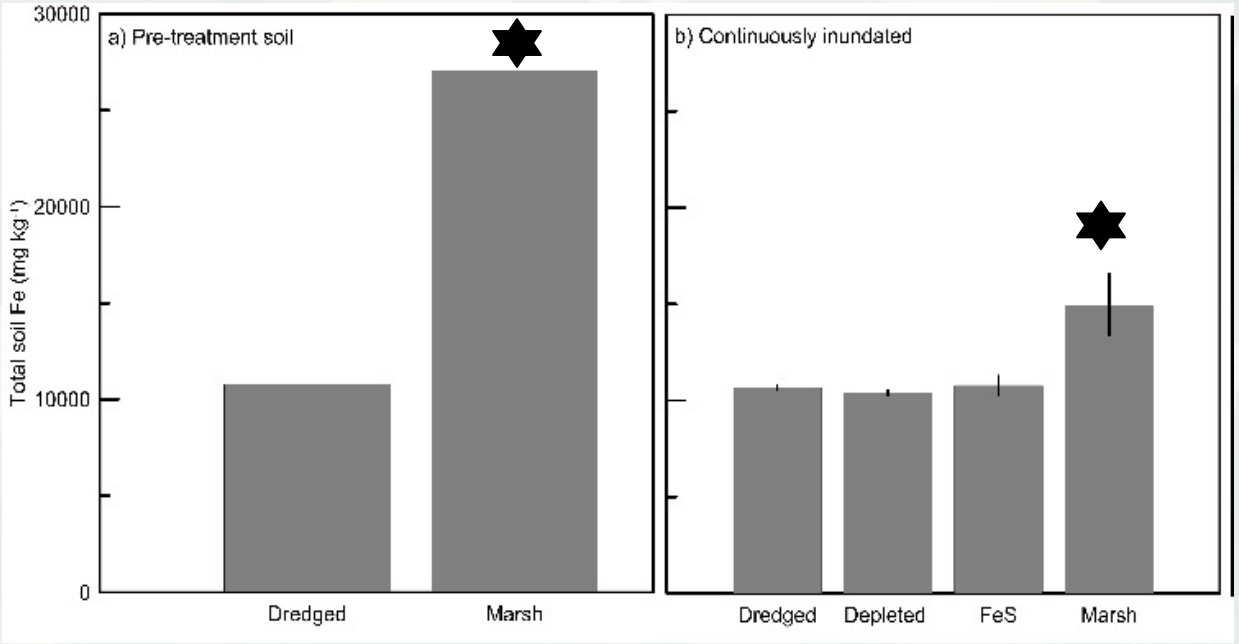

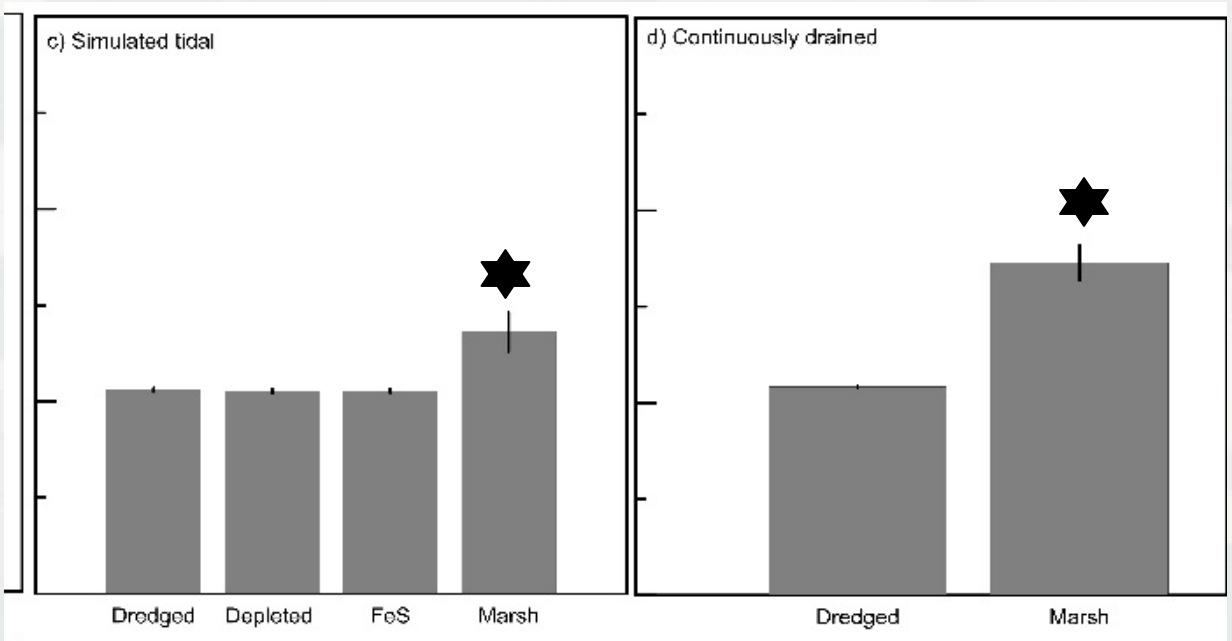

Total soil Fe lost from marsh soil

Constant in dredged material

Fe^{2+} originating in marsh soil

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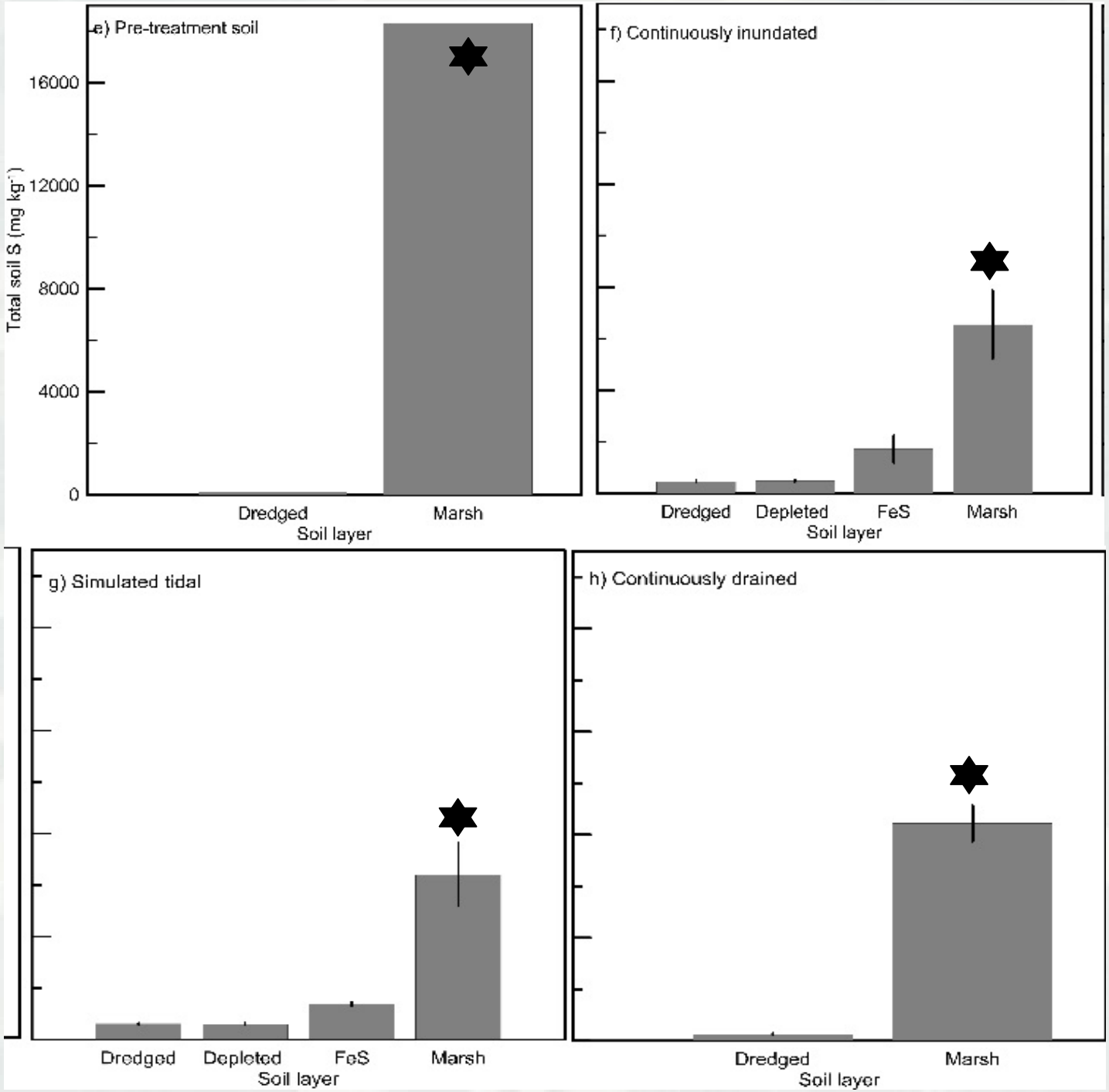

Total soil S lost from marsh soil

Migrating into dredge material

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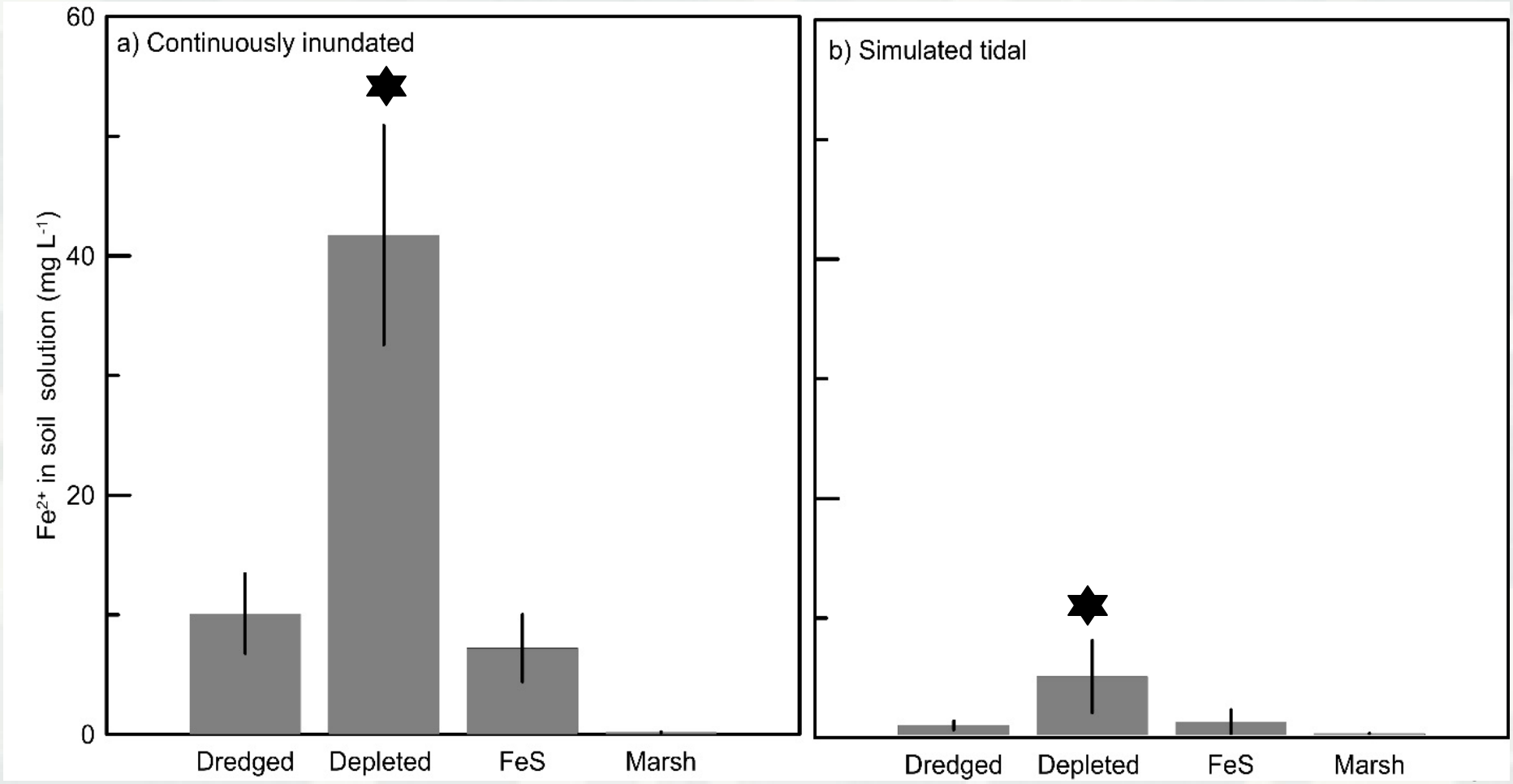
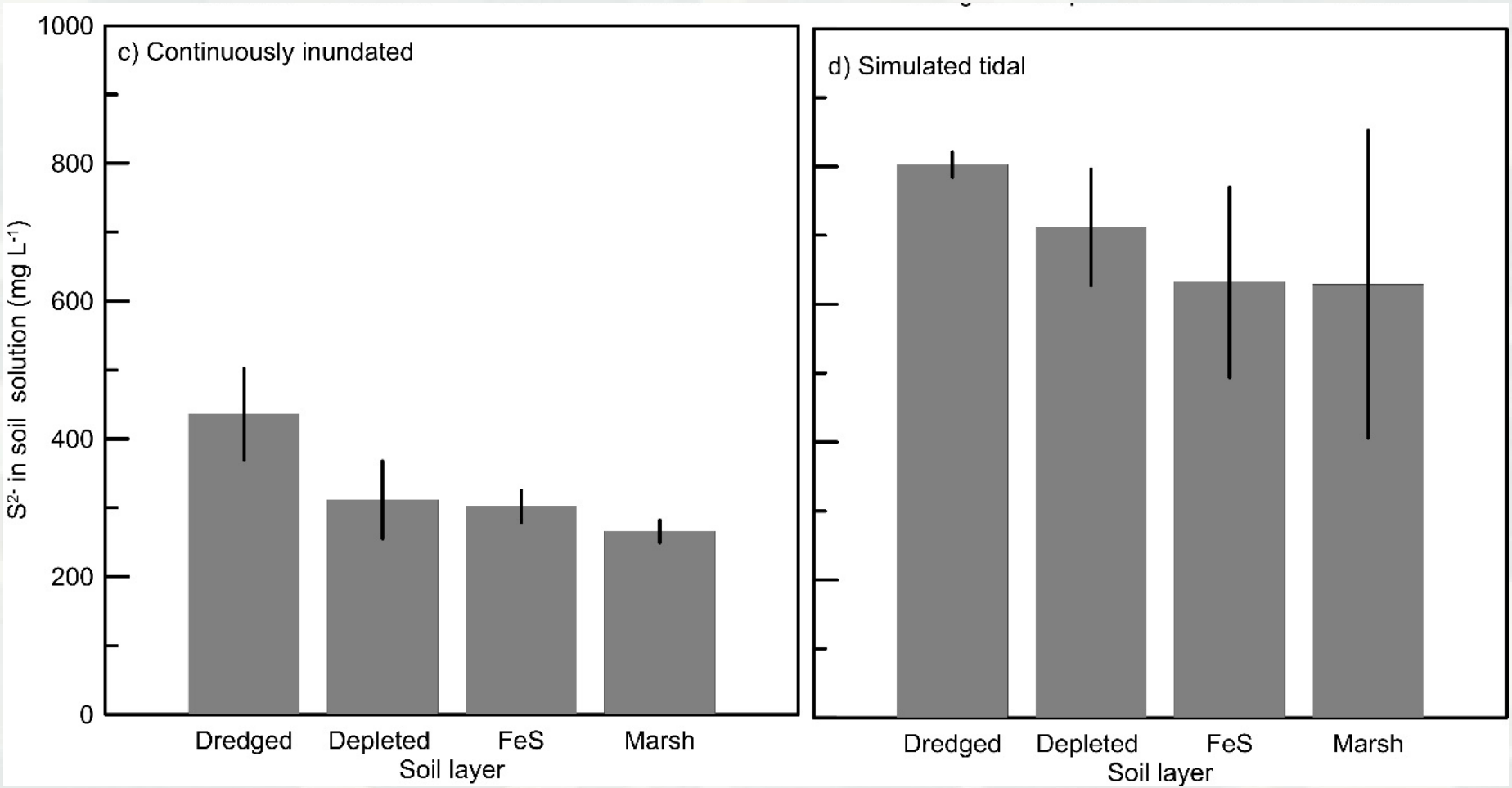
Dissolved Fe^{2+} concentrated in depleted layer



Dissolved S^{-2} throughout profile



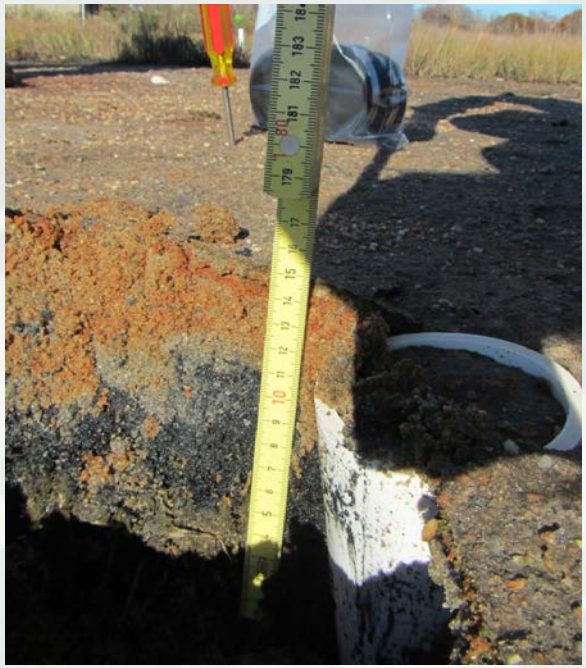
Conclusions

Few restoration projects consider biogeochemistry

FeS formed rapidly

Changed soil morphology

FeS >>> Flooded >> Tidal > Drained



S^{2-} and Fe^{2+} migrating in profile

Potential for soil acidification

Implications for restoration

Questions?

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