

Author Response to Referee Comment 1 (RC1)

EGUSPHERE-2026-180

Desalinization-driven deep microbial reactivation destabilizes iron-bound carbon in coastal wetland restoration

Journal relation	Biogeosciences (via EGUsphere interactive discussion)
Comment being addressed	Public reply to RC1
Document purpose	Point-by-point response with revised-text excerpts for transparency. The full revised manuscript will be submitted only through the formal revision workflow.

Opening response

We sincerely thank Referee #1 for the careful, constructive, and encouraging review of our manuscript. We greatly appreciate the referee's positive assessment of the value of the 0-100 cm soil-profile perspective and the relevance of this study for coastal wetland restoration. We are encouraged that the referee considers the dataset valuable and the mechanistic framework potentially useful.

We also appreciate the referee's thoughtful suggestions regarding (i) fuller discussion of carbon-nitrogen coupling, (ii) more cautious wording concerning the fate of destabilized carbon, (iii) clearer acknowledgment of the temporal scope of the 18-month dataset, and (iv) improved internal consistency between the Abstract, Methods, Results, and Discussion. These comments have been very helpful in improving the clarity, consistency, and interpretive rigor of the manuscript.

Summary of manuscript-wide revisions made in response to RC1

- 1) Expanded the Discussion to address nitrogen-pool restructuring and likely carbon-nitrogen coupling under PM.
- 2) Softened wording related to climate impacts and carbon emissions, and reframed the interpretation around soil carbon destabilization and net soil-C loss.
- 3) Explicitly framed the study as an 18-month early post-treatment assessment in the Abstract, Introduction, and Discussion.
- 4) Removed the amino-sugar / microbial necromass statement from the Abstract and Conclusion to restore internal consistency.
- 5) Clarified that the stock values discussed in the manuscript are based on the fixed-depth (FD) approach.
- 6) Improved the resolution and readability of Figure 1 for the revised submission.

Major Comment 1. Coupling of carbon and sediment nitrogen transformations

Reviewer comment

The manuscript reports substantial restructuring of nitrogen pools under PM, but the implications of these shifts for sediment nitrogen dynamics and their interaction with deep microbial reactivation deserve deeper discussion.

Response: We thank the referee for this important suggestion and fully agree that the restructuring of nitrogen pools under PM deserves fuller discussion, especially given the stoichiometric coupling of carbon and nitrogen cycling in coastal wetland sediments. In the original manuscript, we reported pronounced declines in TN together with altered NH_4^+ and NO_3^- distributions under PM, but we did not sufficiently discuss how these patterns may interact with the observed carbon depletion. In the revised manuscript, we expand the Discussion to address this point explicitly.

Importantly, because the present study quantified nitrogen pools rather than process-specific rates, we now avoid overinterpreting these patterns as direct evidence for specific pathways such as nitrification, denitrification, DNRA, or anammox. Instead, the revised text focuses on nitrogen-pool restructuring and its likely interaction with profile-scale carbon dynamics and microbial biomass redistribution.

Revised text to be inserted in the Discussion

"Alongside carbon loss, PM induced substantial nitrogen-pool restructuring, including marked reductions in TN and altered distributions of NH_4^+ and NO_3^- across the profile. These changes suggest that rapid desalinization not only modified carbon availability and microbial biomass distribution, but also altered the stoichiometric context within which decomposition proceeded. Because our study quantified nitrogen pools rather than process-specific transformation rates, these results should not be interpreted as direct evidence for particular N-cycling pathways. Nevertheless, the co-occurrence of nitrogen-pool redistribution and deep-soil microbial biomass increases supports the view that PM reorganized coupled C-N dynamics across the profile, potentially reinforcing the destabilization of previously protected subsoil carbon."

Major Comment 2. The fate of destabilized carbon

Reviewer comment

The decline in soil carbon under PM cannot yet be partitioned between microbial mineralization to greenhouse gases and lateral export/leaching. Therefore, references to climate impacts or carbon emissions should be moderated.

Response: We fully agree. Our data demonstrate net depletion of soil carbon stocks and destabilization of Fe-associated carbon, but they do not directly resolve the ultimate fate of the lost carbon. As the referee correctly notes, the observed decline could reflect a combination of microbial mineralization, dissolved or colloidal export, and/or redistribution within the profile.

In response, we have revised the wording throughout the manuscript so that it more precisely reflects what is directly supported by the present dataset. In particular, we replace stronger phrases related to climate impacts or carbon emissions with more accurate terms such as soil carbon destabilization, net soil-C loss, or potential carbon-loss pathways. We also strengthen the limitations section to state explicitly that, without pore-water chemistry and direct greenhouse-gas flux measurements, we cannot partition the loss of Fe-OC or total soil C among mineralization, lateral export, or internal redistribution.

Representative revised wording

Abstract / main text wording changed from broad implications about carbon emissions to: "Integrated across 0-100 cm, PM was associated with a net soil-C decline of 65 +/- 12 Mg C ha⁻¹ over 18 months, indicating substantial profile-scale carbon destabilization following rapid desalinization."

Discussion wording revised to: "Without pore-water chemistry and direct greenhouse-gas flux measurements, we cannot definitively partition the fate of the destabilized carbon among microbial mineralization, dissolved export, or redistribution within the profile."

Major Comment 3. Temporal limitations

Reviewer comment

The 18-month timeframe captures only the initial perturbation response. This temporal limitation should be stated more explicitly earlier in the Abstract and Introduction.

Response: We thank the referee for this helpful suggestion and agree completely. The present dataset captures the initial 18-month post-treatment response, not a long-term equilibrium or stabilized restoration trajectory. In the revised manuscript, we now state this limitation more explicitly in the Abstract, Introduction, and Discussion so that the paper is framed as an assessment of early profile-scale biogeochemical responses rather than long-term carbon outcomes.

Revised text in the Abstract and Introduction

Abstract: "We conducted an 18-month field experiment to evaluate the early profile-scale

response of subsoil carbon stabilization to plastic mulching (PM) and deep tillage (DT) in a *Spartina alterniflora*-invaded estuarine wetland."

Introduction: "Here, we conducted a full-profile (0-100 cm) assessment of early iron-carbon-microbe responses 18 months after implementing two widely used restoration interventions, plastic mulching and deep tillage, in order to evaluate initial post-treatment changes rather than long-term equilibrium outcomes."

Minor comments

Minor Comment 1. Abstract clarification regarding amino-sugar biomarkers

Reviewer comment

The Abstract refers to amino-sugar biomarkers and microbial necromass C, but these methods and results are not presented in the main text.

Response: We sincerely thank the referee for identifying this inconsistency. The statement concerning amino-sugar biomarkers and microbial necromass C was inadvertently retained from an earlier draft and is not sufficiently supported by the methods and results presented in the current manuscript. To ensure full consistency between the Abstract, Methods, Results, and Conclusion, we remove these statements from the revised manuscript.

Revised text

The following sentence has been deleted from the Abstract and Conclusion: "Amino-sugar biomarkers indicated coherent shifts in microbial necromass C with Fe-OC dynamics, suggesting vulnerability of long-lived, microbially derived subsoil C under rapid desalinization."

Minor Comment 2. Carbon stock calculations

Reviewer comment

Section 2.5 mentions both fixed-depth (FD) and equivalent soil mass (ESM) approaches, but only the FD formula is presented and the results do not clearly specify which method was used.

Response: We thank the referee for this important comment. The stock values discussed in the current manuscript are based on the fixed-depth (FD) approach. The original wording in Section 2.5 implying that both FD and ESM were used was not sufficiently precise and may have caused confusion. In the revised manuscript, we revise Section 2.5 so that the analytical basis of the reported stock values is fully transparent.

Revised Methods text (Section 2.5)

"SOC stocks were calculated using the fixed-depth (FD) approach. For each layer, fixed-depth SOC stock (SOCS_FD, Mg C ha⁻¹) was calculated as: $SOCS_FD_i = SOC_i \times BDi \times Di \times 0.1$, where SOC_i is organic carbon concentration (g kg⁻¹), BDi is bulk density (g cm⁻³), and Di is layer thickness (cm) for the i th layer. The constant 0.1 converts the result to Mg C ha⁻¹."

Minor Comment 3. Figure clarity

Reviewer comment

Ensure that Figure 1 has sufficient resolution so that the schematic text remains legible.

Response: We thank the referee for this practical suggestion. We have regenerated Figure 1 at higher resolution and improved the readability of the schematic labels and panel text for the revised submission.

Closing note

Once again, we sincerely thank Referee #1 for the constructive and thoughtful review. We believe that these revisions substantially improve the clarity, consistency, and interpretive rigor of the manuscript. We hope that the revised version will address the referee's concerns satisfactorily.

Prepared for upload as an Author Comment supplement (Reply to RC1)