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TITLE: Nitrate addition stimulates microbial decomposition of organic matter in salt marsh sediments

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ABSTRACT:

Salt marshes sequester carbon at rates more than an order of magnitude greater than their terrestrial counterparts, helping to mitigate climate change. As nitrogen loading to coastal waters continues, primarily in the form of nitrate, it is unclear what effect it will have on carbon storage capacity of these highly productive systems. This uncertainty is largely driven by the dual role nitrate can play in biological processes, where it can serve as a nutrient-stimulating primary production or a thermodynamically favorable electron acceptor fueling heterotrophic metabolism. Here, we used a controlled flow-through reactor experiment to test the role of nitrate as an electron acceptor, and its effect on organic matter decomposition and the associated microbial community in salt marsh sediments. Organic matter decomposition significantly increased in response to nitrate, even at sediment depths typically considered resistant to decomposition. The use of isotope tracers suggests that this pattern was largely driven by stimulated denitrification. Nitrate addition also significantly altered the microbial community and decreased alpha diversity, selecting for taxa belonging to groups known to reduce nitrate and oxidize more complex forms of organic matter. Fourier Transform-Infrared Spectroscopy further supported these results, suggesting that nitrate facilitated decomposition of complex organic matter compounds into more bioavailable forms. Taken together, these results suggest the existence of organic matter pools that only become accessible with nitrate and would otherwise remain stabilized in the sediment. The existence of such pools could have important implications for carbon storage, since greater decomposition rates as N loading increases may result in less overall burial of organic-rich sediment. Given the extent of nitrogen loading along our coastlines, it is imperative that we better understand the resilience of salt marsh systems to nutrient enrichment, especially if we hope to rely on salt marshes, and other blue carbon systems, for long-term carbon storage.

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