Title: Is projected sea level rise an emerging threat to the estuary nitrogen cycle?

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Abstract:

Microbial communities involved in sedimentary nitrogen (N) cycling are important regulators of N recycling and removal in estuaries and coasts. Projected sea level rise can alter physiochemical features of tidal ecosystems causing changes in N metabolism as a result of shifts in microbial community structure. We examined the activities and structure of sediment communities during low and high tides in the tidal reaches of Cape Fear River Estuary (CFRE), southeastern North Carolina, to understand the impacts of seawater intrusion on microbial communities responsible for estuarine N cycling processes. ^{15}N tracer incubations were conducted to measure potential rates of denitrification, anaerobic ammonium oxidation (anammox), dissimilatory nitrate reduction to ammonia (DNRA), and nitrification. Changes in microbial community structure in response to increased salinity were assessed using quantitative PCR (Q-PCR) of the functional genes involved in N transforming pathways. Shifts in N transformation activities were observed with changes in salinity. Nitrification activity tended to increase with increasing salinity and subsequent release of ammonium from sediments. Notable changes in anammox, denitrification and DNRA were observed, indicating a potential for shifts in the N metabolism of sediment communities with changing tides. Q-PCR results demonstrated the changes in denitrifier abundance corresponding to denitrification activities. Similarly, changes in abundance of ammonia oxidizing prokaryotes correlated with observed changes in nitrification over the tidal cycle.

Three types of manipulation experiments were also designed and used to examine the impacts of saltwater intrusion on anammox and denitrifying communities in the freshwater reaches of the CFRE. Microcosm experiments were used to test the short-term effect (one week) of increased salinity (10 ppt) on sediment freshwater communities while mesocosm settings were developed to provide long-term exposure (4 months) to brackish water (10 ppt). In addition, *in situ* sediment transplant experiments were designed to simulate projected sea level rise as sediment communities were exposed to an *in situ* gradient of estuarine conditions with tidal exchange for 9 months. ^{15}N tracer incubation experiments showed resilience and recovery of both anammox and denitrification activities. Pyrosequencing analysis of 16S rRNA and functional genes revealed structural adaption of microbial communities to the long-term exposure of increased salinity. Thus, this study showed structural adaptation and functional resilience of freshwater microbial communities to seawater intrusion in tidal freshwater ecosystems, which indicates sustainability of estuarine N cycling processes given the emerging threat of sea level rise.