PhD Dissertation
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Title: Effects of a Macrophyte Community on Carbon and Nitrogen Cycling in Wetland Mesocosm Experiments and Hydrogeomorphic and Landscape Features on Denitrification in Nontidal and Tidal Floodplains of the Chesapeake Bay Watershed

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ABSTRACT

Floodplains and their wetlands are recognized for high rates of denitrification, a valued ecosystem function that contributes to the permanent removal of unwanted nitrogen from our soils and water. Saturation of floodplain soils often limits oxygen availability which promotes denitrification; at the same time, other ecosystem characteristics (*e.g.*, nitrate, carbon, pH, vegetation) exert direct and indirect controls over the microbial process that lead to variable rates of denitrification in the environment. Greater understanding of spatiotemporal patterns of denitrification in floodplains and ecological characteristics that can explain those patterns will inform the development of approaches for managing nitrogen across landscapes and in predicting floodplain response to disturbances (*e.g.*, climate change).

Two studies were conducted to understand controls of denitrification in nontidal and tidal floodplains of the Chesapeake Bay watershed. Largescale characteristics of floodplains, including hydrogeomorphic or landscape features (*i.e.*, climate, physiography, or ecosystem patterns), are of practical use for the prediction of denitrification due to emerging largescale datasets and because these characteristics may aggregate the effects of local vegetation or soil biogeochemical characteristics on denitrification.

Results from the investigation of 18 nontidal floodplains indicated that the highest rates of denitrification in floodplains are likely to be found in agricultural and urban watersheds with stream-floodplain hydrologic connectivity promoting sedimentation. All largescale predictors, including seasonal air temperature and channel width-to-depth ratio, explained between 43-57% of variation in the denitrification measurements and should be useful for prediction across the Chesapeake Bay watershed.

In tidal freshwater forested wetlands (TFFWs) along two adjacent rivers, denitrification enzyme activity (DEA) exhibited variability along a longitudinal gradient. DEA was greater in all tidal wetlands (three sites on each river) than nontidal forested wetlands (one site on each river), interpreted to be due to the coincident differences in soil moisture. Furthermore, DEA was positively related to soil organic matter, carbon, and nitrogen, and negatively related to bulk density in tidal hummocks, relationships which were all mediated by a longitudinal gradient: compared to upriver tidal sites, middle and downriver tidal sites had greater soil organic matter, carbon, and nitrogen, and lower bulk density. Modification to hydrogeomorphic processes from accelerated sea level rise may alter these longitudinal gradients in TFFWs.