

SCOTT H. ENSIGN DISSERTATION ABSTRACT

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Title: Ecology and biogeochemistry of tidal freshwater rivers

Objectives: The tidal freshwater zone (TFZ) is a dynamic ecotone between coastal rivers and their estuarine end members. Nutrient cycling, hydrology, and food webs of the TFZ are different from non-tidal rivers and estuaries, but the implications of these differences for ecosystem management are presently unknown. Transformations of nutrients within the TFZ are mediated by the activity of phytoplankton and bacteria, and this microbial community is in turn affected by resource availability and predation. Disentangling the importance of these bottom-up and top-down regulators on basal production is a critical step in developing a mechanistic understanding of material fluxes through the TFZ to downstream ecosystems. The potential for top-down control of production in the TFZ is of particular interest in coastal rivers of the eastern U.S. in light of ongoing attempts to restore anadromous fish populations. Re-establishment of planktivorous, migratory fish such as river herring may reduce zooplankton abundance, thus indirectly affecting phytoplankton growth and nutrient transport.

The objective of this study is to develop a mechanistic model of the factors regulating nutrient transport through TFZs, including how biogeochemical processes are affected by tidal hydrology, potential resource limitations on primary and secondary production, and the indirect effects of anadromous fish on riverine food webs.

Approach: This study will focus on nitrogen and phosphorus because these elements often stimulate excessive algal growth in coastal aquatic ecosystems. Denitrification, a microbial process through which nitrogen is converted to a relatively inert form, will be measured within sediment cores from intertidal habitats of the TFZ using a membrane inlet mass spectrometer. Geomorphic and biogeochemical controls on denitrification will be identified using in-situ monitoring of redox, soil moisture, and water level in riparian soils. The role of nitrogen, phosphorus, irradiance, and residence time in controlling phytoplankton and bacterial production will be evaluated using laboratory-based mesocosm experiments. Limitations to this production by zooplankton grazing will be evaluated in mesocosm experiments, as well. These data will be synthesized using ecological network analysis where the interactions between nutrients, phytoplankton, zooplankton, and anadromous fish will be explored.

Expected Results: This research will advance our understanding of how nutrient inputs to coastal rivers affect riverine productivity and the potential fates of this productivity within the food web. These data will provide guidance for establishing nutrient loading criteria for tidal freshwater rivers, and improve watershed nutrient loading models with information on how nutrient transformation occurs within the TFZ. Knowledge of zooplankton-phytoplankton interactions in these coastal rivers will provide guidance on how to interpret water quality changes during anadromous fish population recovery in these systems.