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Title: The Effects of Hydrologic Connectivity, Age-Related Soil Properties, and Microtopography on Nitrogen Dynamics in Created Wetlands of the Virginia Piedmont

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Abstract

Wetlands are unique ecosystems that provide the essential ecosystem service of excess nutrient retention, processing, and removal from the landscape. In the early 1990s the U.S. adopted a “no net loss” policy towards wetlands in order protect these remaining wetland resources from the impacts of development. Under this policy the practice of wetland mitigation banking became the preferred method of compensating for “unavoidable” structural and functional impacts to natural wetlands. Created and restored wetlands, however, do not necessarily develop the same structural or functional capacity of their natural counterparts in the required five to ten year monitoring period. This study investigated the soil and hydrologic properties of four created non-tidal freshwater wetlands of varying ages and two natural non-tidal freshwater reference wetlands in the northern Virginia Piedmont physiographic process.

The purpose of this study was to identify how the design features of hydrologic connectivity and disking-induced microtopography influence nitrogen cycling in created wetlands and investigate whether created wetland soils develop with age in order to support nitrogen processing and removal comparable to that of natural wetlands. Ammonification, nitrification, and net nitrogen mineralization (ammonification + nitrification) were determined using *in situ* incubation of modified ion exchange resin cores and denitrification potential was determined with denitrification enzyme activity. Principal component analyses were conducted on hydrologic and soil variables to identify hydrologic connectivity, soil moisture, and soil condition indices. Total nitrogen sedimentation and ammonification rates increased with hydrologic connectivity index. Nitrification and denitrification potential increased with soil moisture and soil condition indices and with greater soil surface roughness and relief (microtopography). Net nitrogen mineralization also increased with soil condition index. Nitrogen flux rates demonstrated age-related patterns, with younger created wetlands having lower rates of ammonification, nitrification, nitrogen mineralization, and denitrification potential than older created wetlands, which had flux rates similar to natural reference wetlands. Results demonstrated a clear, but variable age-related trajectory of coupled soil and nitrogen cycling development in created wetlands that trend toward natural wetlands. Findings of this study support the incorporation of hydrologic connectivity and microtopography into the design and regulatory evaluation of created wetlands in order to improve their ecosystem service of water quality improvement through the functional development of nitrogen cycling.