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SYMPTOMS OF NITROGEN SATURATION IN A RIPARIAN WETLAND[1]

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Abstract. Riparian forests are in a unique position in the landscape since they form a transition between uplands and aquatic systems. These ecosystems may be highly susceptible to nitrogen (N) saturation since they may be subject to high inputs of N from upland areas. We measured potential net N mineralization and nitrification, soil inorganic N levels, microbial biomass carbon (C) and N content, and the N content of litter as indicators of N saturation in two riparian zones on the eastern and western sides of a stream. The sites had similar soils, vegetation, and hydrology, but differing upland land use. The eastern or "enriched" site was downgradient of a dense residential housing development (built in the 1950s) that produced high groundwater nitrate (NO_3^-) concentrations. The western or "control" site had an undeveloped upland. Our objectives were (1) to evaluate if groundwater NO_3^- loading had induced changes in surface soil N-cycle processes that are symptoms of N saturation in the enriched site and (2) to evaluate these changes in relation to inputs and outputs of N to the site. Soil inorganic-N levels, litter N content, and potential net N mineralization and nitrification were significantly higher on the enriched site relative to the control site, suggesting that the enriched site was N saturated. However, input–output analysis indicated that the enriched site was still a sink for upland-derived NO_3^-. High rates of denitrification and storage of N in soil organic matter appear to moderate N saturation on the enriched site.

Key words: denitrification; forest nutrient cycling; groundwater nitrate; microbial biomass; mineralization; nitrification; nitrogen saturation; riparian forests; wetlands.

INTRODUCTION

Nitrogen (N) is generally considered to be the primary factor limiting production in forest ecosystems (Vitousek and Howarth 1991). However, some studies suggest that forest systems have been receiving N additions in excess of their needs and that losses of N from these systems are occurring (Friedland et al. 1984, Nihlgard 1985, Rascher et al. 1987). Nitrogen "saturation" has been defined as the availability of ammonium (NH_4^+) and nitrate (NO_3^-) in excess of the demand for plant and microbial nutrition (Aber et al. 1989). An ecosystem that is saturated with N will not retain N from external sources.

Symptoms of N saturation that may be seen in an ecosystem include increased rates of nitrification in soils, increased N leaching to groundwater, lowered resistance of plants to pests and pathogens, increased frost damage, and species composition changes (Aber et al. 1989, Johnson and Ball 1990, Skeffington 1990). Nitrogen saturation may also be linked to acidification of soils and aluminum mobilization into groundwater (McNulty et al. 1990). However, a forest system may receive high inputs of N and show little or no symptoms of saturation if sufficient denitrification, plant uptake, or storage of N in organic matter are occurring (Aber et al. 1989). The effects of N saturation on a particular ecosystem are dependent on the vegetation present, site history, the C:N ratio of the soil organic matter, and the nature and extent of external N inputs (Brown et al. 1988).

Riparian forests are in a unique position in the landscape since they form a transition between uplands and aquatic systems. These ecosystems may be highly susceptible to N saturation since they may be subject to high inputs of N from upland areas. Riparian wetlands potentially act as filters for much of the water draining from upland sources and have been found to be important regulators of water quality in agricultural watersheds (Lowrance et al. 1984, Peterjohn and Correll 1984, Jacobs and Gilliam 1985).

In this study two riparian forests were evaluated for

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