

## Effects of watershed land use on nitrogen concentrations and $\delta^{15}$ nitrogen in groundwater

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**Abstract.** Eutrophication is a major agent of change affecting freshwater, estuarine, and marine systems. It is largely driven by transportation of nitrogen from natural and anthropogenic sources. Research is needed to quantify this nitrogen delivery and to link the delivery to specific land-derived sources. In this study we measured nitrogen concentrations and  $\delta^{15}\text{N}$  values in seepage water entering three freshwater ponds and six estuaries on Cape Cod, Massachusetts and assessed how they varied with different types of land use. Nitrate concentrations and  $\delta^{15}\text{N}$  values in groundwater reflected land use in developed and pristine watersheds. In particular, watersheds with larger populations delivered larger nitrate loads with higher  $\delta^{15}\text{N}$  values to receiving waters. The enriched  $\delta^{15}\text{N}$  values confirmed nitrogen loading model results identifying wastewater contributions from septic tanks as the major N source. Furthermore, it was apparent that N coastal sources had a relatively larger impact on the N loads and isotopic signatures than did inland N sources further upstream in the watersheds. This finding suggests that management priorities could focus on coastal sources as a first course of action. This would require management constraints on a much smaller population.

### Introduction

Eutrophication is a major agent of change affecting freshwater, estuarine, and marine systems. Increased N delivery stimulates production of phytoplankton and macrophytes, which can lead to a loss of important habitats such as sea-grass meadows (Morand and Briand 1996; Hauxwell et al. 2001). Loss of habitat has contributed to decreased commercially important fin and shellfish stocks (Baden et al. 1990). Degradation of water quality also affects land owners directly by decreasing the aesthetic value of coastal property. Eutrophied estuaries also suffer from hypoxia and anoxia (Zimmerman and Canuel 2000), which can result in major fish kills in embayments such as Narragansett Bay, Rhode Island (RIDEM 2003). As populations grow along coastal areas, there is an increasing need to understand how urbanization and associated nitrogen dynamics impact adjacent bodies of water.