Nitrate Isotopes as Tracers of Nitrogen Cycling Processes in Watersheds of Varying Land Use in New York

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Introduction

Dual isotope analysis of nitrate has proven to be a useful method for gaining insight to sources, rates of cycling processes, and transport through ecosystems. Early work focused on the transport of atmospheric nitrate through forested and mountain ecosystems, and concluded that this nitrate is rapidly transformed through nitrification such that the nitrified form dominated in streams. The technique has also been applied to understanding the role of denitrification in nitrate transport and sources of nitrate in multi-land use settings. Here, we investigate N cycling processes in six stream/river watersheds that represent a variety of land uses and landscape settings in New York.

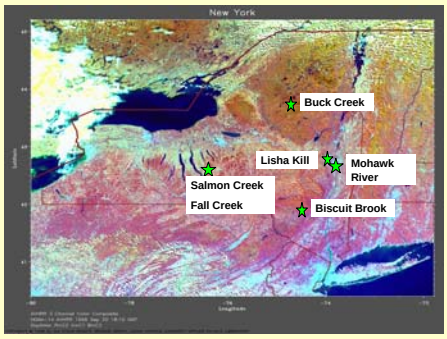

Figure 1 – Satellite photo of New York State with locations of six study streams shown.

Table 1 – Characteristics of six study watersheds.

Site	Dr. Area (km^2)	Forest (%)	Urban (%)	Agricul. (%)
Biscuit	9.6	100	---	---
Buck	3.1	99	---	---
Lisha	40	25	63	6
Fall	326	50	10	40
Salmon	126	30	---	70
Mohawk	9113	63	6	27

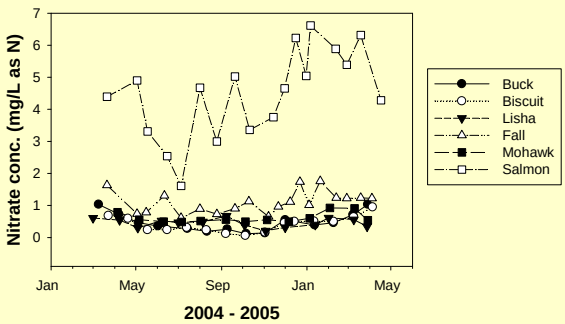

Figure 2 – Nitrate concentrations in the six study streams.

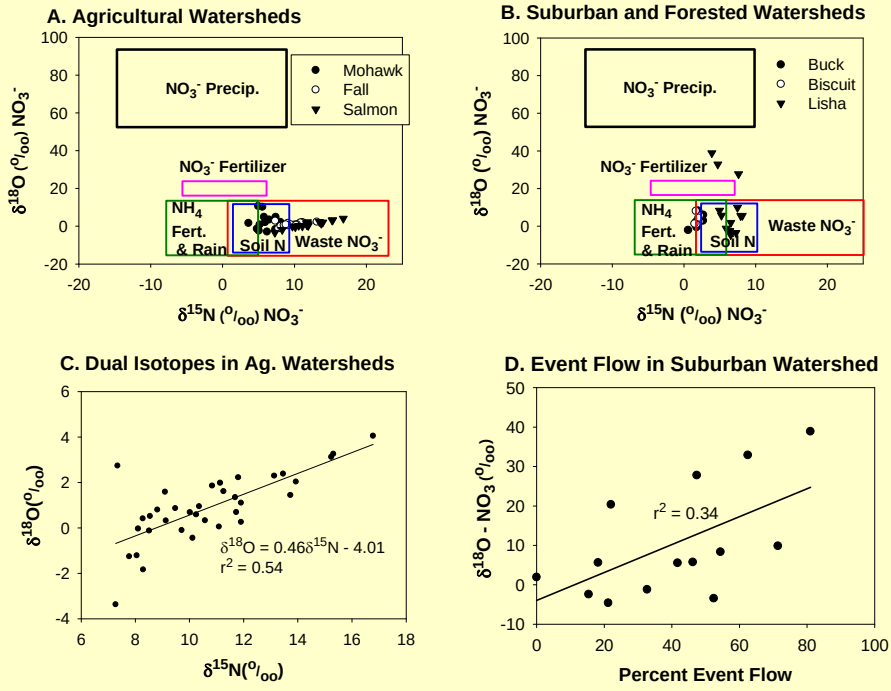

Figure 3 – Nitrate isotope data for watersheds of varying land use. A. Agricultural watersheds, B. Suburban and forested watersheds, C. Agricultural watersheds with slope of relation indicated, and D. Suburban watersheds as a function of event flow calculated through hydrograph separation.

Aerial images – At left is a section of the Lisha Kill showing typical suburban development in this watershed. At right is Salmon Creek near Ithaca showing the abundance of farmland in this watershed.

Discussion

Most data cluster within or near the soil source suggesting that nitrification is a major immediate source of nitrate to streams in a variety of land use settings. In the two agricultural streams, however, many of the samples lie within the waste source, which is probably nitrate derived from manure application to fields. The data in two of the agricultural watersheds (Fall and Salmon Creeks) follow a linear pattern with a 1:2 slope, indicative of denitrification. The samples with the highest $\delta^{18}O$ and $\delta^{15}N$ values are from samples collected largely in the summer, when warm temperatures should enhance rates of denitrification.

The highest $\delta^{18}O$ values measured were in the suburban stream, and these values increased as a function of the proportion of event flow in the stream. This suggests that large amounts of unaltered atmospheric nitrate are transported to the stream via the impermeable surfaces and storm sewers present in this watershed. It's somewhat surprising that atmospheric nitrate has a greater immediate impact on stream nitrate in a suburban setting than in the forested settings. It is important to keep in mind, however, that all of the nitrate present in these forested streams has an ultimate source from atmospheric nitrogen deposition.