ASSESSING CONTROLS ON DENITRIFICATION IN VEGEATED AND NON-VEGETATED RIVER ISLANDS: A PAIRED ISLAND MONITORING STUDY

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Outline of Problem:

This project investigates the role of river islands in nitrate attenuation in the lower Platte River near Grand Island, NE. A large body of research has shown that groundwater-surface water exchanges within riverbed sediments tend to be "hotspots" of chemical cycling, and can lead to nutrient or pollutant attenuation (Ranalli and Macalady, 2010; Zarnetske et al., 2011). Riverbeds can exhibit high rates of denitrification (the reduction of nitrate and nitrite to N_2 gas) because they accumulate abundant organic carbon and there is a high degree of exchange between groundwater and surface water (see for example Grimm and Fisher, 1984; Holmes et al., 1996; Krause et al., 2009; Zarnetske et al., 2011). Based on hydrological and chemical similarities with riverbeds, it is likely that denitrification occurs also in river islands and that they serve as a nutrient sink for nitrogen-rich streams (Zarnetske et al., 2011; Hill et al., 1998).

Although extensively studied from geomorphological and ecological standpoints, the hydrochemical functioning of river islands remains largely unexplored. In terms of hyporheic processes, river islands differ from riverbeds in two important ways: islands are partially unsaturated, which may promote increased mixing between groundwater and surface water during river stage fluctuations. Additionally, some islands are vegetated, which increases available organic carbon, the main chemical reductant for nitrate (Williams, 1978). *The objective of this project is to isolate the role of vegetation on denitrification and quantify denitrification rates in one vegetated and one unvegetated river island.* This objective is directed by the following hypotheses:

1. *Higher rates of denitrification (in terms of mol(cc*day)$^{-1}$) occur in vegetated islands than in unvegetated islands due to greater organic carbon accumulation.* It is hypothesized that organic carbon abundance promotes island water denitrification by: i) serving as the main chemical reductant for NO_3^- (Hill and Cardaci, 2004), and ii) reducing hydraulic conductivity and thereby increasing island water mean residence times (Boulton et al., 1998).

2. *Denitrification rates are reduced during periods of large river stage fluctuations in both vegetated and unvegetated islands.* Stage fluctuations are hypothesized to reduce denitrification rates by increasing hydraulic gradients, which increase water transmission rates between islands and the river, and hence reduce water residence times (Boulton et al., 1998). Stage fluctuations may also introduce oxygenated river water which buffers denitrification.

Significance and Anticipated Results

The Platte River receives excess pesticides and fertilizers from its predominantly agricultural watershed, the presence of which is listed amongst Nebraska's top water quality challenges (NWRRI, 2009; Schlesinger, 2006). This project will fill a gap in the understanding of in-river denitrification, which is a critical but poorly characterized nutrient sink in agricultural watersheds. Furthermore, the study will introduce a new continuous water sample collection method to hyporheic zone research. The resulting dataset (including a conceptual model of river

island hydrology, and high resolution temporal variations in water chemistry and island denitrification rates) will be the most detailed island hydrogeochemical record in the literature.

References

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Applicant Biosketch

EDUCATION			
2011-13		M.S.	**University of Nebraska-Lincoln** Earth and Atmospheric Sciences-*Hydrogeology*
2006-11		B.S. Summa Cum Laude Geology Department Honors University Honors	**University of Wisconsin-Eau Claire** Geology-*Hydrogeology &Water Chemistry*
Summer 2009		In Residence	**University of Minnesota-Morris** NSF REU on Glacial Geology

GRANTS/SCHOLARSHIPS			
2011-13	$8,000	Assessing controls on denitrification in vegetated and non-vegetated river islands: A paired island monitoring study	University of Nebraska Chancellors Fellowship
2011-12	$5,000	Assessing controls on denitrification in vegetated and non-vegetated river islands: A paired island monitoring study	Phi Kappa Phi Honor Society Scholarship
2010-11	$5,800	Comparison of Geophysical Techniques for Soil Texture Estimation	U.S. Dept. of Education Grant: McNair Achievement Program
2010-11	$5,000	Comparison of Geophysical Techniques for Soil Texture Estimation	NSF: Excellence in Science, Technology, Engineering, and Math (ESTEAM) scholarship
2008	$300	Ground penetrating radar survey of the Blue Hills Felsenmeer, Wisconsin: Profile of a relict talus slope	North-Central Geological Society of America Research Grant