

# **Report as of FY2009 for 2009WI217B: "The Lethal and Sublethal Effects of Elevated Groundwater Nitrate Concentrations on Infaunal Invertebrates in the Central Sand Plains"**

## **Publications**

- Articles in Refereed Scientific Journals:
  - ◆ R.S. Stelzer, B.L. Joachim. 2010. Effects of elevated nitrate concentration on mortality, growth, and egestion rates of *Gammarus pseudolimnaeus* amphipods. Archives of Environmental Contamination and Toxicology. 58:694-699.

## **Report Follows**

**Selected Reporting Period:** 7/1/2009 - 6/30/2010

**Submitted By:** Robert Stelzer

**Submitted:** 5/28/2010

## Project Title

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WR08R003: The Lethal and Sublethal Effects of Elevated Groundwater Nitrate Concentrations on Infaunal Invertebrates in the Central Sand Plains

## Project Investigators

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Robert Stelzer, University of Wisconsin-Oshkosh

## Progress Statement

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The research plan for Year Two of this project originally called for assessing the effects of elevated nitrate in porewater on amphipods in the field (in a stream that receives groundwater with very high nitrate concentration in the Central Sand Plains of Wisconsin). However, based on the equivocal results that we obtained from Year One (laboratory phase) it would probably not have been fruitful to move to the field phase of this project as originally conceived. Thus, we proposed to shift the focus of the work planned for Year Two. In a separate project, funded by the United States Forest Service, we have been measuring nitrate retention in Emmons Creek (in the Central Sand Plains). We have found, somewhat surprisingly, that nitrate retention is high in this high-N stream and that groundwater discharge is strongly related to the magnitude of nitrate retention. A paper from this work is currently in press in *Biogeochemistry*. It is unclear where the nitrate retention is occurring in Emmons Creek, although the positive relationship between groundwater discharge and nitrate retention suggests that processes in the sediments are involved. Because of the likely role of sediments in contributing to nitrate retention the focus of Year Two of our current WRI project is nitrogen biogeochemistry in stream sediments. The objectives for Year Two are:

- 1) To determine denitrification rates in the sediments of Emmons Creek and to assess if denitrification rates change with sediment depth
- 2) To determine nitrate and chloride concentration profiles in the sediments of Emmons Creek using a combination of porewater samplers (peepers) and piezometer nests.

We think this two-pronged approach will shed light on processes and patterns that contribute to reach-scale nitrate retention in Emmons Creek and in other groundwater-fed streams. We have measured denitrification rates and assessed variation in groundwater nitrate concentration in sediments from upwelling locations in Emmons Creek for three seasons (summer and fall 2009, spring 2010). Sediment cores to 30 cm depth were collected and acetylene inhibition was used to measure denitrification rates of core sections. Peepers and wells to a depth of 70 cm were used to measure gradients in groundwater nitrate concentration.

## Principal Findings and Significance

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### Principal Findings and Significance

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#### Description

Mean areal denitrification rate in Emmons Creek was 60 mg N<sub>2</sub>O-N m<sup>-2</sup> h<sup>-1</sup>. Core sections deeper than 5 cm accounted for 66 percent of the areal denitrification rate. Nitrate profiles suggested that nitrate loss occurred along upwelling flow paths at sediment depths between 5 and 45 cm. Our results suggest that nitrate processing can be substantial at depth in groundwater-fed streams and are consistent with the positive relationship between nitrate retention and groundwater discharge in Emmons Creek. Our results also suggest that denitrification estimates based only on shallow sediment cores may underestimate denitrification rates in lotic ecosystems.

This project has resulted in the training of two undergraduate students and one graduate student at UW Oshkosh during the last year. One of the students, Jordan Geurts, is currently employed as a research technician with the United States Department of Agriculture in Madison, WI. The training that he received on the project helped prepare him for his current position at the USDA.

## Committees, Memberships & Panels

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|--------------------|---|
| <b>Group Name</b>  | American Water Resources Association- Wisconsin Section |
| <b>Description</b> | Vice President  |
| <b>Start Date</b>  | 3/5/2010  |
| <b>End Date</b>    | 3/5/2011  |

## Journal Articles & Other Publications

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| <b>Publication Type</b>                    | Peer-Reviewed Journal Article/Book Chapter   |
| <b>Title</b>                               | Effects of elevated nitrate concentration on mortality, growth, and egestion rates of <i>Gammarus pseudolimnaeus</i> amphipods |
| <b>Author(s)</b>                           | R.S. Stelzer, B.L. Joachim   |
| <b>Publication/Publisher</b>               | Archives of Environmental Contamination and Toxicology   |
| <b>Year Published</b>                      | 2010   |
| <b>Volume &amp; Number</b>                 | 58   |
| <b>Number of Pages</b>                     | 694-699  |
| <b>Description</b>                         |  |
| <b>Any Additional Citation Information</b> |  |

## Other Project Support

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**Source** University of Wisconsin Oshkosh Faculty Development Program  
**Dollar Value** \$6,153  
**Description** Augmented the current WRI project by providing a month summer salary and funds for additional supplies  
**Start Date** 5/1/2009  
**End Date** 2/2/2010

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**Source** United States Forest Service  
**Dollar Value** \$45,579  
**Description** The capacity of forest streams for nutrient uptake: a comparison between a high nitrogen and low nitrogen ecosystem  
**Start Date** 6/1/2006  
**End Date** 12/31/2010

## Partners

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**Name/Organization** Dr. William Richardson and Mr. Lynn Bartsch  
**Affiliation** Upper Midwest Environmental Sciences Center (USGS)  
**Affiliation Type** Federal  
**Email** wrichardson@usgs.gov  
**Description** The PI has collaborated with Dr. Richardson and Mr. Bartsch on the portion of the project involving measuring denitrification rates

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**Name/Organization** Dr. Eric Strauss  
**Affiliation** University of Wisconsin La Crosse  
**Affiliation Type** Local & State  
**Email** strauss.eric@uwlax.edu  
**Description** The PI has collaborated with Dr. Strauss on the portion of the project involving measuring denitrification rates

## Presentations & Public Appearances

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**Title** The dark side of the hyporheic: nitrogen processing and profiles in deep stream sediments  
**Presenter(s)** Stelzer, R.S., L.A. Bartsch, W.B. Richardson, and E. Strauss  
**Presentation Type** Professional meeting  
**Event Name** Joint meeting of the North American Benthological Society and the American Society of

**Event Name** Limnology and Oceanography  
**Event Location** Santa Fe, NM  
**Event Date** 6/6/2010  
**Target Audience** Scientific audience  
**Audience Size**  
**Description**

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**Title** Nitrate processing below the hyporheic zone in a sand plains stream  
**Presenter(s)** Stelzer, R.S., L.A. Bartsch, W.B. Richardson, and E. Strauss  
**Presentation Type** Professional meeting  
**Event Name** American Water Resources Association (Wisconsin Section) Annual Meeting  
**Event Location** Madison, WI  
**Event Date** 3/5/2010  
**Target Audience** Mixed  
**Audience Size** 50  
**Description**

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**Title** Effects of elevated nitrate concentration on mortality, growth, and egestion rates of Gammarus pseudolimnaeus amphipods  
**Presenter(s)** Stelzer, R.S., B.L. Joachim, S.L. Eggert and M.A. Muldoon  
**Presentation Type** Poster session  
**Event Name** Annual Meeting of the North American Benthological Society  
**Event Location** Grand Rapids, MI  
**Event Date** 5/17/2009  
**Target Audience** Scientific audience  
**Audience Size** 100  
**Description**

## **Undergraduate Students Supported**

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New Students: **3**  
Continuing Students: **1**