A Pilot Study Of Septic Impacts On Water Quality:
Using Boron Concentrations And Isotopes As A Source Tracer
Status Report: **March 1, 2009 through February 28, 2010**

Statement of Regional or State Water Problem-

Septic systems are designed to reduce environmental impact from household wastes. However, when septic densities are too high or when septic systems fail, nutrients and toxic pathogens may be released into groundwater where it can contaminate drinking wells, or may move through the hydrologic cycle to surface water.

Septic systems are not the only source of nutrients and pathogens; natural processes also release them into the ecosystem. Therefore, simply measuring the nutrient concentration in lakes, ponds or rivers is not indicative of septic system pollution. Similarly, pathogens found in human waste are also found in animal waste. For this reason, tracers are often used to map the spatial distribution of septic effluent. The use of tracers to understand the transport and fate of groundwater (including groundwater pollutants), is a common hydrologic practice. Determining concentrations and distribution of concentrations of unique, conservative tracers is a common practice. Stable isotope tracers also have the ability to distinguish between natural and anthropogenic nutrients based on source-unique isotopic ratios or fractionation. For this reason, stable isotope tracers are good tools for assessing the impact of septic systems on ground and surface water. In particular, we are interested in Boron isotopes because of the potential for B (as borate) to serve as a tracer of septic effluent.

Boron has been used in arid environments as a tracer of water sources, but we are not aware of its use in the northeast, and we are not aware of existing borate data from natural waters in the northeast. We hypothesize that borate from septic systems will be higher than natural background. Because we cannot know a prioi if total borate will be indicative of septic influence, we are proposing to augment borate data will B isotopes to differentiate human from natural concentrations. If successful, this method will provide a new tool for regulators and environmental groups to monitor water quality and determine sources of contamination

Objectives:

1.- To initiate analysis of boron and other possible tracers in water samples collected at septic tanks, test wells and near-shore for a range of septic systems of various ages in a range of suitable and unsuitable soils/slopes.

2.-To also conduct sampling that brackets sewage treatment plants as well as sample the outflow from such facilities.

3.-To evaluate the use of various tracers for human septage influx that include boron as well as caffeine and a limited number of target compounds that should be commonly used pharmaceutical/personal care products (PPCPs).

4- To support graduate student research for a Master's thesis project involving boron and PPCPs.

5- The dissemination of the results of the analysis to cooperating agencies, water managers, educators and the public on a local, statewide and regional basis.

Methods:

The septic study was primarily based at the Squam Lakes where we have already conducted an extensive water and nutrient budget study and have compiled a complete GIS analysis system that includes septic system locations and specifications. The Squam Lakes (Squam and Little Squam Lake) benefit from the absence of point sources of pollution like wastewater treatment facilities, industrial facilities or large agricultural operations in close proximity to the shore; however, the role of non-point sources of pollution continues to be an issue. In 2001, Schloss et al. conducted a preliminary survey of septic systems around the Squam Lakes. They found that certain basins were at elevated risk of pollution by septic systems where age of system/design, soil characteristics and slopes were unfavorable to septic waste treatment. This study collected environmental samples from five of the basins found to be at high risk for pollution, one basin at moderate risk, and one basin found to be at low risk of pollution by shore side property septic systems. Shallow water samples were collected using a Van Dorn sampler at 0.5 meters or less. Samples were also collected bracketing 2 sewage treatment plants and at their direct outflow pipe. Samples were analyzed for specific anions/cations, boron, boron isotopes, and, using a modified HPLC/MS procedure: acetaminophen (a common analgesic), caffeine, carbamazepine (an antiepileptic, mood stabilizer) and trimethoprim (an antibiotic) at the NH DES Water Quality laboratory. As part of a companion study funded through the NH WRRC samples were also analyzed for Total Phosphorous in the UNH Center for Freshwater Biology Analytical Laboratory. The emerging contaminants caffeine and triclosan were analyzed through ELISA procedures using very high sensitivity test kits from Abraxis and will be reported upon elsewhere.

Major Findings and Significance:

As of February 28, 2010 samples were still being processed and analyzed. However, we remain on track for our expected end date of December 2010. A graduate student thesis defense has been set for late May and the Master's Thesis involving the PPCPs and HPLC/MS analytical modifications for those species is currently in review. A manuscript is also being written for submission to a journal such as *Science of the Total Environment.*

Preliminary Boron results indicate that Boron concentrations in control areas are low indicating low natural background concentrations and the possibility of Boron as a tracer for septage.

Publications, Presentations, Awards:

Forthcoming Masters Thesis in review:

R. Harvey. 2010. Pharmaceuticals and Personal Care Products in the Environment Master's Thesis. Plymouth State University Center for the Environment

Manuscript in work:

Occurrence of Acetaminophen, Caffeine, Carbamazepine and Trimethoprim in Central NH; a Pilot Study

Outreach:
"Pharmaceuticals and Personal Care Products in the Environment" – a fact sheet by R. Harvey for the Squam lakes Association.

Number of students supported:

Graduate:
Jeff Schloss PhD Natural Resources and Earth Systems Science
Rebecca Harvey MS Environmental Science and Policy Plymouth State University