Abstracts

Tuesday, April 29

Session E5: Nutrient Monitoring and Modeling to Restore and Protect Freshwaters

3:30 – 5:00 pm | Room 233

Total Phosphorus Mass Balance Modeling in the Lower Boise River, Southwestern, Idaho

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Abstract
The U.S. Geological Survey (USGS), in cooperation with Idaho Department of Environmental Quality, developed two mass-balance models for total phosphorus (TP) in the lower Boise River. The models will inform the development of a TP total maximum daily load (TMDL) for the lower Boise River. USGS collected water samples and measured streamflow at 25 main-stem, tributary, and irrigation return sites during 3 synoptic sampling events. The City of Boise coordinated sample collection from effluent at 6 wastewater treatment facilities (WWTFs) and the Idaho Department of Water Resources provided discharge information for diversions. The timing of synoptic sampling events allowed the USGS to evaluate TP loading in the Boise River during irrigation season, shortly after irrigation season ended, and shortly before the subsequent irrigation season began.

Effluent from municipal WWTFs represented the largest source of phosphorus in the watershed during each sampling event. However, it is unknown how much phosphorus from point sources is diverted from the river in irrigation supply water and subsequently returned to the Boise River through drains, tributaries, or shallow groundwater. During irrigation season in August, substantial groundwater discharge to the Boise River was measured in the downstream end of the study reach, and phosphorus loading from groundwater represented 57 percent of the measured load in the river near the mouth. Sensitivity analyses indicated that phosphorus reductions from both point and non-point sources are necessary to meet the TMDL during the compliance period (May 1 to September 30). During the non-irrigation season in late October and early March, shallow groundwater discharge to tributaries and drains comprised the majority of groundwater gains in the Boise River, and represented 31 and 15 percent of the load in the river near the mouth, respectively. Although mass balance models do not account for biological or depositional processes both the October and the March models indicated that phosphorus cycling through aquatic plants and/or bed sediment may influence phosphorus loading in the Boise River. Sensitivity analyses of the October and March models show that point-source reductions will have a greater effect on lowering phosphorus concentrations in the river during the non-irrigation season.

Continuous Nitrate Measurements in an Urban Stream Affected by Wastewater

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Abstract
Indian Creek, in Johnson County, Kansas, is an urban stream that receives discharge from two wastewater treatment facilities. As part of a larger study to assess the effects of wastewater discharge and treatment facility upgrades on the environmental and biological conditions of Indian Creek, nitrate was monitored continuously (every 15 minutes) using a *in situ* UV photometer from March 2012 to June 2013 at six sites along a 13.2 kilometer reach of the creek. The relation between sensor and laboratory-measured nitrate concentrations was linear over a range of streamflow and environmental conditions (R2=0.97, n=132), but sensor-measured concentrations generally were about 15% higher than laboratory-measured concentrations. The difference between sensor and

laboratory-measured concentrations was not consistently related to other measured variables such as streamflow, temperature, specific conductance, turbidity, and dissolved organic carbon. The nitrate sensors in Indian Creek provide a reliable estimate of concentrations in the stream at a much greater frequency than discretely-collected data and with less error than surrogate models previously used to estimate continuous concentrations at one of the Indian Creek study sites (R2=0.79). Continuous nitrate measurements can be used to quantify among-site differences, diurnal and seasonal variability, and loads from point and non-point sources and be related to in-stream processes such as primary production and respiration. Understanding the dynamics, fate, and transport of nitrate in Indian Creek will help document the efficacy of wastewater treatment processes and the development of effective nutrient reduction strategies, watershed management plans, and best management practices.

Identifying Nutrient Reference Sites in Nutrient-Enriched Regions: Using Algal, Invertebrate, and Fish-Community Measures to Identify Stressor-Breakpoint Thresholds in Indiana Rivers and Streams, 2005–9

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Abstract
In this study, nutrients, periphyton chlorophyll *a* (Chl-*a*), invertebrate- and fish-community data collected during 2005-9 were analyzed from 318 sites on Indiana rivers and streams. Study objective was to determine which invertebrate and fish taxa attributes best reflect the conditions of Indiana streams along a gradient of nutrient concentrations by (1) determining statistically and ecologically significant relations among the stressor (TN, TP and Chl-*a*) and response (invertebrate and fish community) variables; and (2) determining the levels at which invertebrate- and fish-community measures change in response to stressor variables.

Recursive partitioning identified statistically significant low and high breakpoint thresholds for invertebrate and fish measures. Combined community mean low and high TN breakpoint thresholds were 1.03 and 2.61 mg/L, respectively. Mean low and high breakpoint thresholds for TP were 0.083 and 0.144 mg/L, respectively. Mean low and high breakpoint thresholds for periphyton Chl-*a* were 20.9 and 98.6 (mg/m2), respectively. Additive quantile regression analysis found similar thresholds to those determined by breakpoint analysis for some stressor variables.

TN and TP concentrations in the study showed a nutrient gradient that spanned three orders of magnitude. Sites were divided into Low, Medium, and High nutrient groups based on the 10th and 75th percentiles. Using an analysis of similarity, invertebrate and fish communities were similar along the nutrient gradient, demonstrating there was not a species trophic gradient. Within all nutrient groups, invertebrate and fish communities were dominated by nutrient tolerant taxa.

To determine if low nutrient concentrations at some sites were caused by algal uptake and not oligotrophic conditions, sites with low nutrient concentrations (< 10th percentile for TN or TP) were examined based on the Low (< to 10th percentile) and High (> 75th percentile) periphyton Chl-*a* concentrations. Within low nutrient sites, invertebrate and fish communities were statistically different between Low and High periphyton Chl-*a* categories. High periphyton Chl-*a* group was dominated by tolerant herbivore and omnivore taxa indicating that low nutrient concentrations are a result of nutrient uptake and increased algal growth. The study highlights the importance of assessing multiple lines of evidence when attempting to identify the trophic condition of a site.

Publicly Accessible Decision Support System of the SPAtially Referenced Regressions on Watershed Attributes (SPARROW) Model and Model Enhancements in South Carolina

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Abstract
The U.S. Geological Survey (USGS) National Water Quality Assessment program has developed a web-based decision support system (DSS) to provide free public access to the steady-state SPAtially Referenced Regressions On Watershed attributes (SPARROW) model simulation results on nutrient conditions in streams and rivers and to offer scenario testing capabilities for research and water-quality planning. Access to the decision support system is through a graphical user interface available online at http://cida.usgs.gov/ sparrow. Nationally, the SPARROW DSS models are based on the modified digital versions of the 1:500,000-scale River Reach File and 1:100,000-scale National Hydrography Dataset stream networks.

For South Carolina, the DSS has total nitrogen and total phosphorus models for the South Atlantic-Gulf and Tennessee Region based on the Enhanced River Reach File 2.0. The system can be used to estimate nutrient conditions in unmonitored streams in South Carolina and to produce estimates of yield, flow-weighted concentration, or load of nutrients in water under various land-use conditions, changes, or resource management scenarios. This model divides larger river basins into stream catchments and models nutrient contributions by source inputs and land use within each of those catchments. The model information, reported by stream reach and catchment, provides contrasting views of the spatial patterns of nutrient source contributions, including those from urban (wastewater effluent and diffuse runoff from developed land), agricultural (farm fertilizers and animal manure), and specific background sources (atmospheric nitrogen deposition, soil phosphorus, forest nitrogen fixation, and channel erosion). However, the large scale and static nature of the model (modeled only for the 2002 water year) have produced some limitations on the application of the decision support system on the state level.

To address those limitations, the USGS is working cooperatively with the Resources for the Future program to adapt the steady-state model for South Carolina to a dynamic model that will simulate seasonal-average loads, yields, and concentrations during the period 2001-2003. Temperature and an Enhanced Vegetation Index from Moderate Resolution Imaging Spectroradiometer (MODIS), a National Aeronautics and Space Administration Terra-satellite-borne sensor, will be used as input to the dynamic model to characterize seasonal uptake and release of nitrogen during land-to-water transport.