Report for 2002AR5B: Phosphorus Concentrations and Sediment Phosphorus Flux in Streams and Reservoirs: Effect of Chemical Amendments

- Conference Proceedings:
  - Haggard, B.E., M.D. Matlock, I. Chaubey, P.B. DeLaune, and P.A. Moore, Jr. , Stream phosphorus retention in the Illinois River Basin: ecological services and water-quality criteria, Proceedings Report, Arkansas Water Resources Center Annual Conference, April 2002
  - Haggard, B.E., S.A. Ekka, M.D. Matlock, I. Chuabey, P.B. DeLaune, and P.A. Moore Jr. Release of phosphorus from stream and reservoir sediments: effect of chemical amendments, Proceedings Report, Arkansas Water Resources Center Annual Conference, April 2003
  - Ekka, S.A., B.E. Haggard, M.D. Matlock, and I. Chaubey. Impact of wastewater treatment plants in stream of the Illinois River Basin, Proceedings Report, American Water Resources Association Spring Specialty Conference, May 2003
- Other Publications:
  - Haggard, B.E., S.A. Ekka, M.D. Matlock, and I. Chaubey. Phosphorus sources in the Illinois River Basin: effect of chemical amendments on sediment-phosphorus interactions, Annual Meeting North American Benthological Society, May 2003
  - Haggard, B.E., W.R. Green, K.L. White, M.D. Matlock, I. Chuabey, and P.A. Moore, Jr. Phosphorus sources in a watershed: phosphorus concentrations and loads at the Illinois River, Arkansas. Phosphorus Management Workshop, Division of Agriculture, University of Arkansas, Fayetteville, Arkansas, October 2002
  - Haggard, B.E., M.D. Matlock, I. Chaubey, and S.A. Ekka. Stream and Sediment Phosphorus Concentrations in the Illinois River Drainage Area, Northwest Arkansas. Science and Technology Seminar Series, College of Mathematics and Natural Sciences, Northeastern State University, Tahlequah, Oklahoma, October 2002

Report Follows:

Problem and Research Objectives

Watershed managers must consider: (1) the effect of wastewater treatment plants on phosphorus concentrations and loads in streams, and (2) the importance of internal P flux from reservoir bottom sediments, when developing watershed management strategies to mitigate water quality problems. The specific objectives of this research are to evaluate stream water P concentration and sediment – P interactions in several Arkansas streams below WWTPs, estimate and compare internal and external P fluxes in the Eucha Basin, and assess the effects of chemical amendments on P flux from stream and reservoir sediments.

Methodology

In spring 2002, water-quality samples were taken from three points along a transect perpendicular to stream flow at each of the 30 sites identified from the Illinois River South of Siloam Springs, Arkansas (U.S. Geological Survey Station No. 07195430) upstream into Mud, Osage and Spring Creeks. Physico-chemical parameters (conductivity and pH) were measured at a single point at each site. Water samples were filtered through a 0.45 μm membrane using a syringe filter unit; 20 ml of filtered water was preserved via acidification using concentrated HCl to pH < 2, and 20 ml of filtered, unacidified water was saved. Filtered water samples were stored on ice and in the dark until return to the laboratory where soluble reactive P (SRP) was determined using an autoanalyzer and the ascorbic acid reduction method.

In summer 2002, a single water-quality sample was collected from the center of the channel at each site on Mud, Osage and Spring Creeks including one site upstream and four downstream of the municipal wastewater treatment plant (WWTP) discharge. Physico-chemical parameters (dissolved oxygen, conductivity and pH) were measured at a single point at each site. A portion of the water sample was filtered through a 0.45 μm membrane using a syringe filter unit; 20 ml of filtered water was preserved via acidification using concentrated HCl to pH < 2, and 20 ml of filtered unacidified water was saved. 125 ml of unfiltered water was acidified using concentrated HCl to pH < 2, and another 125 ml of unfiltered, unacidified water was saved. Water samples were stored on ice and in the dark until return to the laboratory where SRP, NO_3, NH_4, total nitrogen (TN) and Cl- were determined using an autoanalyzer.

Beginning in summer 2002, a single sediment sample was collected from one site upstream and three downstream from the municipal WWTP discharge on Mud, Osage and Spring Creek during routine water-quality samplings. The benthic sediments were collected using a trowel from the top 5-10 cm of the streambed, and sediment samples were stored on ice and in the dark until return to the laboratory. Upon return to the laboratory, sediments were sieved through a 4.75 mm sieve and the fraction of sediments < 4.75 mm in diameter were used in subsequent extractions. Sediments were extracted for exchangeable NH_4 and PO_4 as described in the proposal, and the sediment equilibrium P concentration (EPC_0) was determined as described in the proposal. The ability of the sediments to buffer increasing P concentrations and loads was determined by the slope of

the relation between P sorbed and final P concentrations in the EPC extraction sediment slurry solutions (as opposed to the PSI as suggested in the proposal).

Principal Findings and Significance

Our initial evaluation of phosphorus concentration and retention in streams of the Illinois River drainage area in Arkansas provided some interesting results. The greatest increase in phosphorus concentrations was observed in Spring Creek just downstream on the City of Springdale's wastewater treatment plant; the City of Rogers' and Fayetteville's wastewater treatment plants had a much smaller impact. Phosphorus retention was generally least in streams with greater flows.

A significant result of our investigations was that the addition of aluminum sulfate and calcium carbonate affected stream sediment-phosphorus interactions. Specifically, the chemical amendments reduced the amount of exchangeable phosphorus and equilibrium phosphorus concentration of the stream sediments while increasing the ability of the stream sediments to buffer increasing phosphorus loads.