Effects of Watershed Restoration on Nitrogen in a Stream Impacted by Legacy Sediments: Big Spring Run Stream Restoration Project as a Case Study

Background

Excess sediments and anthropogenic nutrients, especially nitrogen and phosphorous, are a leading cause of water quality impairment in streams and wetlands throughout the mid-Atlantic region of the United States. Legacy sediments, deposited as a function of historic mill dam construction, may contribute significantly to the sediment and nutrient load of streams and estuaries, including the Chesapeake Bay.

Removing legacy sediments may be a cost-effective, sustainable means to reduce sediment and nutrient pollution in watersheds. Therefore, identifying best management practices for streams and wetlands to mitigate the impacts of legacy sediments is an important goal for resource managers in the mid-Atlantic region.

Big Spring Run (BSR), a rural stream in Lancaster County, Pennsylvania, is impacted by legacy sediments from past mill pond dams. BSR has been the subject of long-term nutrient and sediment studies (Galeone, et al. 2006, Walter and Merritts 2008). Beginning in 2009, legacy sediments will be removed throughout a portion of the BSR watershed to expose buried wetlands and reconnect floodplain hydrology. This restoration effort represents a unique opportunity to assess the effects of watershed restoration on ecological function in a watershed, especially sediment and nutrient reduction.

Objective

- Assess ecosystem benefits of restoration
- Identify stream restoration methods that enhance nitrogen control
- Develop predictive models of stream hydrology and sediment movement
- Develop ecologically based guidelines for stream restoration

Approach

- Examine BSR before and after restoration to measure surface and ground water hydrology, nutrient dynamics, and microbial denitrification, a natural subsurface process that removes bioreactive nitrogen by transformation to a biologically inactive gas form
- Establish stream flow gages

- Characterize stream geomorphology and sediment movement
- Monitor surface water and ground water chemistry
- Measure ground water level, temperature, and hydraulic head among a network of piezometers established throughout the restoration and in control locations

Expected Results

Based on previous studies, geomorphic stability of restored streams may be greatly improved after restoration; far less sediment is transported and lateral migration of streams are halted. Significant denitrification activity occurs in the stream channel and hyporheic zone, especially where carbon concentration is high and the stream is connected with the floodplain. Thus, not only do we expect the source of sediments and nutrients to be removed after restoration, but we expect more bioreactive nitrogen to be removed in the stream channel and associated floodplain wetlands due to better hyporheic connection and retention and increased organic matter supply.

We expect that restoration involving legacy sediment removal will be a sustainable means of improving water quality in watersheds.

References

Craig, L.S., M.A. Palmer, D.C. Richardson, et al. (In press). "Stream Restoration Strategies for Reducing River Nitrogen Loads. *Frontiers in Ecology and the Environment.*

Gift, D., P.M. Groffman, S. Kaushal, et al. (In press). "Root Biomass, Organic Matter and Denitrification Potential in Degraded and Restored Urban Riparian Zones." *Restoration Ecology*.

Kaushal, S., P.M. Groffman, P.M. Mayer, et al. (2008). "Effects of Stream Restoration on Denitrification in an Urbanizing Watershed." *Ecological Applications*, 18: 789–804.

Walter, R.C. and D.J. Merritts. (2008). "Natural Streams and the Legacy of Water-Powered Mills." *Science*, 319: 299–304.

Galeone, D.G., R.A. Brightbill, D.J. Low, and D.L. O'Brien. (2006). "Effects of Streambank Fencing of Pastureland on Benthic Macroinvertebrates and the Quality of Surface Water and Shallow Ground Water in the Big Spring Run Basin of Mill Creek Watershed, Lancaster County, Pennsylvania, 1993-2001." Scientific Investigations Report #2006-5141, 183 p.

Forshay, K.J. and E.H. Stanley. (2005). "Rapid Nitrate Loss and Denitrification in a Temperate River Floodplain." *Biogeochemistry*, 75: 43–64.

Principal Investigators
Ken Forshay and Paul Mayer
U.S. EPA
Ground Water and Ecosystem Restoration Division
Ada, Oklahoma 74820

Collaborators
Dorothy Merritts and Robert Walter
Franklin and Marshall College

Dan Galeone, Allen Gellis, and Mike Langland
U.S. Geological Survey

Jeff Hartranft
Pennsylvania Division of Dam Safety

Ward Oberholtzer
Land Studies, Inc.