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NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUND WATER AND ECOSYSTEMS RESTORATION RESEARCH

Stream Restoration as an Approach for Managing Nitrogen in Urban Watersheds: Minebank Run Stream Restoration Project as a Case Study

Background

Bioreactive nitrogen (nitrite and nitrate) is a nonpoint-source pollutant that effects ecosystem function and threatens human health. Urban streams transport lots of nitrogen to estuaries, such as the Chesapeake Bay. Billions of dollars are spent to restore streams, yet little is known about the effectiveness of restoration. Stream restoration may be a cost-effective way to manage nitrogen in urban streams. This research aims to quantify the benefits of stream restoration.

Before

After

Objective

- Assess ecosystem service 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

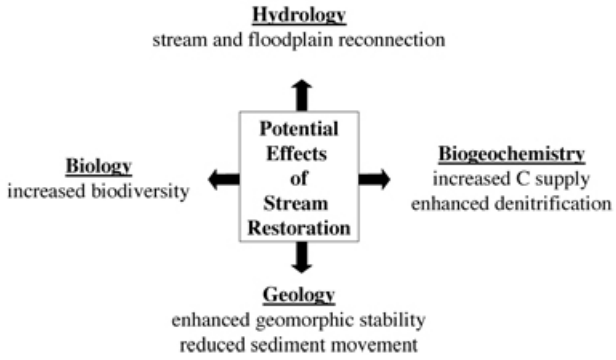
The research approach is to examine Minebank Run, an urban stream in Towson, Maryland, before and after restoration, to identify biogeochemical controls of microbial denitrification, a natural process occurring in ground water that removes bioreactive nitrogen by transformation to a biologically inactive gas form. Stream restoration stabilizes stream banks, reconstructs stream meanders and riffle zones, and plants riparian vegetation. It may increase denitrification by reconnecting hydrology and increasing carbon availability to microbes. Identifying restoration techniques where high denitrification activity occurs may provide important nitrogen management tools and help direct future restoration efforts.

Major Findings

Hydrology and dissolved organic carbon dictate nitrate dynamics in urban streams. Hydrology of unrestored urban streams is flashy, causing incision and floodplain disconnection. Restoration alters stream hydrology and improves geomorphic stability, reducing erosion and sediment transport. Hot spots of denitrification occur in streams where organic matter accumulates and in the root zone of riparian vegetation. Significant denitrification occurs in the stream channel and ground water, especially where carbon concentration is high and the stream is connected with the floodplain. Thus, removal of bioreactive nitrogen appears to be limited by the supply of carbon necessary for microbial activity.

In situ measures of denitrification show a two-fold increase in rates in the restored stream reach. Denitrification increases when ground water residence time increases. Urban streams retain ecosystem function and can be restored in ways that improve their ability to process nitrogen.

Restoration of urban streams generally should incorporate mechanisms that slow down stream flow and add dissolved organic carbon. EPA's research suggests that restoration is a potentially sustainable means of managing nitrogen in urban streams.



Publications

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*. doi: 10.1111/j.1526-100X.2008.00438.x

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Striz, E.A. and P.M. Mayer. "Assessment of Near-Stream Ground Water-Surface Water Interaction (GSI) of a Degraded Stream Before Restoration (PDF)." (56 pp, 3.72 MB) (EPA/600/R-07/058) August 2008

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Mayer, P.M. "Restored Streams Enhance Ability to Remove Nitrogen – Science In Action (PDF)." (1 pp, 108 KB) (EPA/600/F-07/003) June 2007

Doheny, E.J., R.J. Starsoneck, E.A. Striz, and P.M. Mayer. (2006). "Watershed Characteristics and Pre-Restoration Surface Water Hydrology of Minebank Run, Baltimore County, Maryland, Water Years 2002–04." U.S. Geological Survey Scientific Investigations Report #2006–5179, 42 p.

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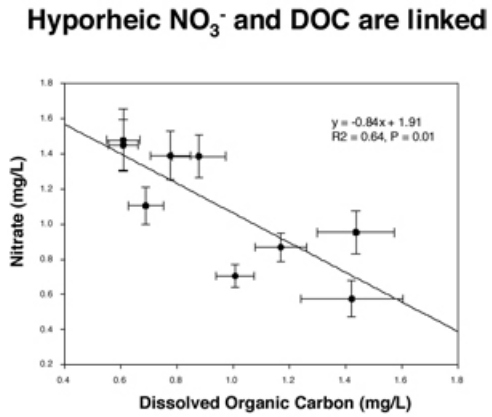
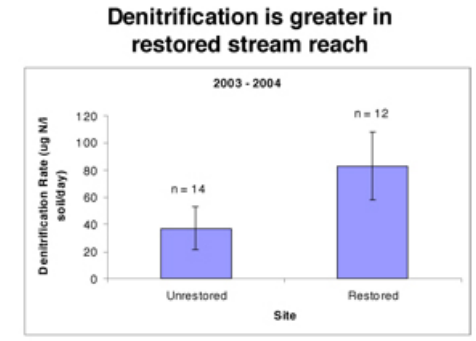
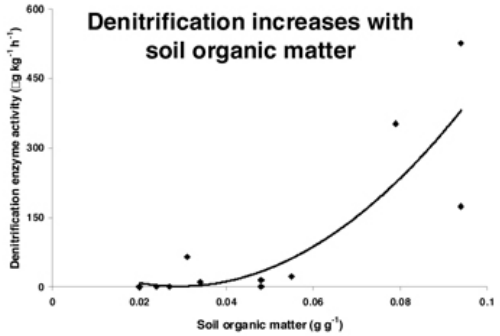


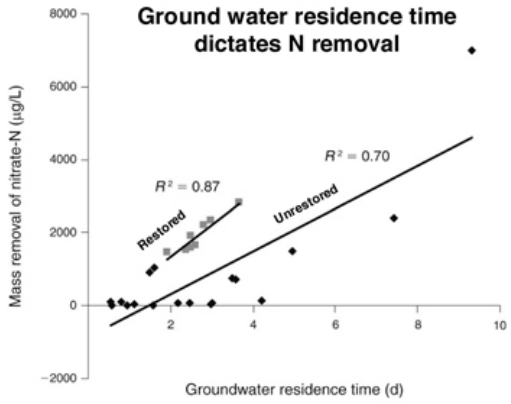
Source: Mayer et al.(JEQ in review)



Source: Kaushal etal 2008 Ecological Applications



Source: Gift etal 2008 Restoration Ecology



Source: Kaushal etal 2008 Ecological Applications

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