Nature: Streams Remove Significant Amounts Of Nitrogen, Preventing Downstream "Dead Zones"

Media Contact: Beth Potier
603-862-1566
UNH Media Relations

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William McDowell is available at 603-862-2249 (office), 603-781-3561 (cell), or bill.mcdowell@unh.edu

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DURHAM, N.H. - Small streams play a significant role in retaining human-generated nitrogen, serving as the kidneys of watersheds by removing nitrogen before it ends up in estuaries and oceans, finds a paper published this week in the journal Nature. University of New Hampshire professor William McDowell and research scientist Jody Potter, both in the department of natural resources, are among the co-authors of the study, led by Patrick Mulholland of the Oak Ridge National Laboratory in Tenn.

"The major finding is that streams remove significant amounts of nitrogen that's coming off the landscape," says McDowell, noting that human-generated activities such as agricultural runoff, acid rain, and the human waste stream are major sources of nitrogen. "But while this process of denitrification - a bacterial process that converts nitrogen to a harmless nitrogen gas -- cleans up waterways, if we overuse it by putting too much nitrogen into the water it's not as effective."

Nitrogen removal in streams is important because it reduces the potential for eutrophication - the excessive growth of algae and aquatic plants - in downstream lakes and coastal marine waters.Eutrophication is linked to problems such as harmful algal blooms and oxygen depletion in places such as the Gulf of Mexico, where the Mississippi River creates a vast "dead zone" of oxygen depletion with adverse effects on fisheries.

A key finding of the study, titled "Stream denitrification across biomes and its response to anthropogenic nitrate loading," is that the effectiveness of streams to remove nitrate was greatest if the streams were not overloaded by nitrogen sources such as fertilizers and wastes from human activities. The largest percentage removal occurred when nitrate entered small healthy streams and traveled throughout the network before reaching larger rivers. As terrestrial ecosystems become increasingly saturated with nitrogen as a result of human activities, the authors caution that large-scale land conversion may negatively impact streams' ability to effectively remove nitrogen from the watershed.

The study, which undertook a huge field campaign to investigate nitrogen uptake and denitrification in 72 streams that drain watersheds of varying land-use types in the U.S. and Puerto Rico, is the first continental-scale assessment of total denitrification in small streams. McDowell oversaw field sites in Puerto Rico and Potter, who at the time of the study was McDowell's graduate student, worked in both Puerto Rico and Massachusetts.

The study is also unique in that it captures the entire denitrification process, measuring not

only the production of nitrous oxide but also N2, a harmless gas that is prevalent in the Earth's atmosphere.

Moving forward, McDowell notes that this study will inform the work of the National Ecological Observatory Network (NEON), of which he and several other UNH researchers are a part. McDowell will undertake long-term experimental manipulations of streams, adding nutrients to streams in a controlled way.

He also notes that the breadth of this project will carry forward. "We've developed this network of stream ecologists, and we can now answer questions at the continental scale," he says.

This study is published in the March 13, 2008 issue of Nature. It was funded by the National Science Foundation.

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Photographs are available to download:

http://www.unh.edu/news/img/miscellaneous/Icacos.tif

Caption: This stream in the Luquillo Mountains of Puerto Rico drains relatively intact forest with little human activity. Note the relatively clear water and thick riparian vegetation.Credit::William McDowell

http://www.unh.edu/news/img/miscellaneous/Vaca.jpg

Caption: This Puerto Rican stream is heavily affected by grazing in the watershed. Note the partially open canopy and relatively turbid stream water.Credit::William McDowell