From the backyard to the ocean: New study shows streams act as key nitrogen filters

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Amy Burgin, a Michigan State University PhD student, does gas sampling to track the flow of a non-radioactive nitrogen isotope in a stream that is part of the Kalamazoo River watershed in western Michigan. Credit: Michigan State University

As spring arrives across the country, tourists returning to beaches will face the reality of "red tide" -- harmful blooms of algae that make water unfit for swimming and pose risks to humans and sea life.

What they may not realize is that the small streams running through their neighborhoods play a critical role in filtering out the nitrogen that feeds the algae blooms.

A new study published in this week's edition of the journal *Nature* by 31 scientists from across the country sheds new light on streams' role as a nitrogen filter, and uncovers data that show increases in nitrogen caused by human activities can make it harder for the streams to do their jobs.

"The filtering is a serial process and it's bigger than any one stream," said Patrick Mulholland, the study's lead author and a researcher with the University of Tennessee, Knoxville, and Oak Ridge National Laboratory. "What you see in your backyard, though, matters to the health of coastal oceans."

Excess nitrogen in streams is caused in large part by human activities, particularly overuse of nitrogen-based fertilizers, said Mulholland, and as nitrogen accumulates in increasingly larger bodies of water, it feeds the harmful algae growth that leads to red tide.

In addition, the excessive growths of algae consume large amounts of oxygen when they die and decompose, sometimes enough to make the water unable to support many forms of aquatic life. This problem has been especially pronounced in recent years in the Gulf of Mexico, impacting regional fisheries.

Mulholland and his colleagues, including UT Knoxville professor Lee Cooper, studied how a special, easily traceable form of nitrate made its way through 72 different streams across the U.S. and in Puerto Rico. They found that algae, fungi and bacteria in the streams consumed the nitrate, in essence causing the stream to store the nitrogen.

Nitrate -- used in the study because it is the most common form of nitrogen pollution -- also was permanently removed from the streams by certain bacteria that converted it into harmless nitrogen gas in a process called denitrification.

The researchers used the data they collected from the individual streams to create a model of how streams work to remove nitrogen. In doing so, they found that the streams are most effective as nitrogen filters when they were not overloaded with nitrogen from fertilizers and other human activity.

"There's a relationship between the concentration of nitrogen and how efficiently the streams can remove it," Mulholland said. "With too much nitrogen, they can be overloaded and unable to process the nitrogen as well."

He said the results showed that nitrogen was removed most effectively in cases where the nitrate entered the stream network near its origins and had the chance to make its way through a number of increasingly larger streams before moving into larger bodies of water, such as lakes, esturaries and the ocean.

"If we want to improve the situation, we need to do a better job reducing nitrogen inputs to our waters," he said.

The streams included in the study were located across a wide variety of regions and in areas where land is put to a number of different uses in order to get a broad perspective on how streams act as nitrogen filters.

Source: University of Tennessee at Knoxville

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