Fertilizer Runoff Overwhelms Streams and Rivers--Creating Vast "Dead Zones"

The nation's waterways are brimming with excess nitrogen from fertilizer--and plans to boost biofuel production threaten to aggravate an already serious situation

By David Biello on March 14, 2008

The water in brooks, streams and creeks from Michigan to Puerto Rico carries a heavy load of pollutants, particularly nitrates from fertilizers. These nitrogen and oxygen molecules that crops need to grow eventually make their way into rivers, lakes and oceans, fertilizing blooms of algae that deplete oxygen and leave vast "dead zones" in their wake. There, no fish or typical sea life can survive. And scientists warn that a federal mandate to produce more biofuel may make the situation even worse.

Researchers led by aquatic ecologist Patrick Mulholland of the Oak Ridge National Laboratory in Tennessee report in *Nature* that streams and other waterways are losing their ability to filter excess nitrates from fertilizers and sewage. They discovered this by releasing a concentrated nitrate solution carrying an unusual isotope of nitrogen into 72 different streams—ranging from heavily altered urban waterways to pristine rivulets—and then tracked the isotope to find out how much made it downstream. The amount at the end indicated each stream's ability to naturally remove the pollutant—a measure of its health.

"We found that they continue to take up nitrate, but they remove a smaller fraction of the overall nitrate as you overload them," Mulholland says. "This is probably the reason we're seeing hypoxia [low oxygen levels] and other problems in coastal waters."

Typically, bacteria remove excess fertilizer from water through a chemical process known as denitrification, which enables them to convert nitrate to nitrogen that is then released into the atmosphere as a gas. The team found, however, that bacteria in the streams they studied only eliminated an average of 16 percent of the nitrogen pollution; bacteria in the most undisturbed streams performed the best, removing as much as 43 percent.

"Denitrification is the only process that we know for sure removes nitrogen from water," Mulholland says. "The other 84 percent [of the pollution] was just taken up by algae, microbes and other organisms in the stream bottom. A portion of that is probably also denitrified, and it could be a large portion. But we don't know that fate of that material."

What is clear is that a significant portion of such fertilizer is still making its way through the soil and water to the sea. As a result, algae and other microorganisms take up the nitrogen, bloom and, after they die, suck the oxygen out of coastal waters. Such "dead zones" have appeared seasonally near most major river mouths, including those emptying into Maryland's Chesapeake Bay as well as the Gulf of Mexico, where lifeless waters now cover more than 7,700 square miles (20,000 square kilometers) during the summer months.

The bulk of this nitrate comes from fertilizer running off agricultural fields. Scientists warn that a boom in crops such as corn for biofuel will only make matters worse. Last year, U.S. farmers planted more than 90 million acres (35 million hectares) of corn for the first time since the 1940s as a result of growing demand for that crop for both fuel and food.

Based on this trend, geographer Simon Donner of the University of British Columbia and atmospheric scientist Christopher Kucharik of the University of Wisconsin–Madison predict that nitrogen pollution from the Mississippi River Basin—the nation's largest watershed—will increase as much as 34 percent by 2022 if corn kernels continue to be the source of a growing proportion of ethanol fuel that U.S. energy legislation mandates.

That would also make it almost impossible, they say, to reduce the New Jersey-size dead zone

at the Mississippi's outlet into the Gulf of Mexico to less than 2,000 square miles (5,000 square kilometers), as recommended by a 2001 U.S. Environmental Protection Agency task force.

In fact, the scientists wrote this week in *Proceedings of the National Academy of Sciences*, the only way to increase ethanol production from corn and reduce nitrogen runoff would be for Americans to stop eating meat, thereby freeing up corn used as livestock feed for other uses.

Potential solutions to overloaded streams seem equally difficult, such as restoring their natural flow or reducing the fertilizer and sewage draining into them. "We need to either maintain or, in many cases, restore the integrity of this stream network, including the smallest streams," Mulholland says. "That [also] means not utilizing all the land to grow crops."

He adds: "Certainly, the outlook is not great because there is a lot of pressure to go in the other direction."