HYPOXIA IN THE GULF OF MEXICO: A GROWING PROBLEM

Throughout the world, coastal waters are being affected by hypoxia, a condition in which dissolved oxygen levels are too low to sustain most marine life. In the United States, a major area suffering from hypoxia is the Gulf of Mexico. At the heart of this hypoxia problem — and any feasible solution — is Midwest agriculture.

Hypoxia occurs as a result of nutrient over-enrichment and water stratification in coastal systems. As the nitrogen concentration of the water increases, more organic matter is formed. When this organic matter dies, it falls to the lower reaches of the body of water where it is degraded by biological activity, a process that consumes oxygen. Density differences between the freshwater from the Mississippi River and the saltwater in the Gulf result in a stratified water system with little mixing between the two layers. As a result, oxygen-rich surface water cannot reach the oxygen-depleted bottom waters.

While the size of the hypoxic zone in the Gulf of Mexico varies annually due to factors such as temperature and stream flow, it has more than doubled in size since it was first measured in 1984, reaching a record size of over 8,500 square miles in 2002.[1] It is now generally accepted that the rapid increase in hypoxia here and throughout the world is more than just a natural phenomenon.

INSTITUTE FOR AGRICULTURE & TRADE POLICY

Nitrate-nitrogen flowing to the Mississippi River Basin from agricultural lands is the major source of nutrients leading to hypoxia in the Gulf of Mexico.[2] While far away geographically, the Gulf hypoxia problem is intimately linked to the Midwest via the Mississippi River. The Upper Mississippi River Basin comprises only 15% of the Mississippi River drainage basin's area, but contributes more than half of the nitrate-nitrogen reaching the Gulf.[3] Most of this nitrogen comes from agriculture. Overall, about half of the nitrogen reaching the Gulf comes from commercial fertilizer and about 15 percent comes from animal manure. The rest comes from sources including urban runoff, industrial point sources and atmospheric deposition.[4]

Environmental and Ecological Impacts of Hypoxia

Hypoxia is essentially a form of habitat loss, eliminating areas in which fish and other marine organisms can survive. The zone of hypoxic water can also block the migration of marine organisms. Even under conditions in which dissolved oxygen levels are not low enough to kill marine organisms, stress due to insufficient amounts of dissolved oxygen can disrupt their life cycles and increase their susceptibility to predation.[5] The increased nitrogen concentration that leads to hypoxia can result in reduced marine biodiversity, the proliferation of algae that block sunlight and impede photosynthesis, and the outbreak of toxic algae blooms.[6]

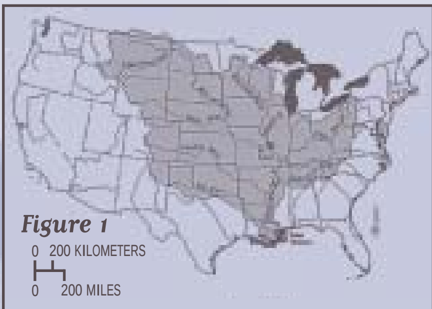
Social and Economic Impacts of Hypoxia

Caught in the middle of this growing environmental problem are Midwest farmers and Gulf fishermen, particularly shrimpers. As agricultural commodity prices have plummeted and farm communities continue to decline, many farmers feel they have no choice but to intensively fertilize and maximize production of a few low-value commodities. The new farm bill, which increases subsidies for grain production, promises to accelerate this pattern. Such farm practices will likely increase hypoxia impacts on fisheries downstream as well as impair local water quality.

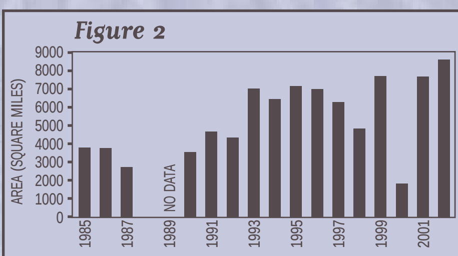
Hypoxia has the potential to damage the commercial fisheries of the Gulf of Mexico and the livelihoods of the many people who depend on them. While it has been difficult to quantify the economic impacts of hypoxia in the Gulf, damage caused by hypoxia to fisheries in other parts of the world indicates the potential future of the Gulf. For example, of the 26 commercial fish species harvested in the Black Sea forty years ago, only six support viable fisheries today, a decline partly attributed to hypoxia.[7] Although shrimp landings in the Gulf of Mexico have not declined significantly, the catch per unit effort has, indicating that Gulf fisheries may well be in danger.[8]

The Contributions of Midwest Agriculture to the Hypoxia Problem

The increased nitrogen concentration in the Mississippi River is largely the result of current Midwestern farming systems. Row crops such as corn and



The Mississippi River drainage basin, major tributaries, and the areal extent of the 1999 midsummer hypoxic zone.
Source: Goolsby, D.A. 2000. Mississippi Basin Nitrogen Flux and Believed to Cause Gulf Hypoxia. Eos, Transactions of the American Geophysical Union 81: 325-327.



Esimated size of the Midsummer Hypoxic Zone in the Gulf of Mexico, 1985-2002.
Source: Modified from Rabalais, N. N., R. E. Turner and D. Scavia.2002. Beyond science into policy: Gulf of Mexico hypoxia and the Mississippi River. BioScience 52 (2): 129-142.

soybean dominate the Midwestern landscape and have displaced perennial crops and wetlands. Land planted in corn and soybean can lose 30 to 50 times more nitrogen than that planted in perennial plant systems such as hay, alfalfa and grass.[9] The dependence of Midwest agriculture on commercial fertilizer is at the heart of agriculture's contribution to the hypoxia problem. The nitrogen flux to the Gulf has almost tripled from 1950 to the present, concomitant with the rapidly expanding use of fertilizers and areas of row crops in the upper Midwest.[10] The proliferation of tile drainage on cropped land, which expedites the passage of nitrates into the Mississippi, has also contributed to the problem.

Another concern is the growth of large animal confinements. Animal manure is a rich source of nitrogen, much of it originating from corn and soybean animal feed.[11] Many confinements produce more manure than can be utilized by crops on nearby lands. As with fertilizers, any manure nutrients that are over-applied to cropland are prone to running off into a waterway with the next rain.

Policy Recommendations for the Alleviation of Hypoxia in the Gulf of Mexico

Alleviating hypoxia in the Gulf of Mexico will require significant changes in Midwest farming practices.[12] Some straightforward changes in nutrient management – like not applying nitrogen in the fall and following recommended application rates – will help. Recent modeling studies from Illinois have indicated that a small reduction in fertilizer or manure use, on the order of ten to 15 percent, would not affect yield but may reduce nitrate output from row crops by as much as 30 percent. Creative approaches that couple education with economic incentives will be needed to encourage farmers to reduce fertilizer use.

Another policy option is the inclusion of nitrogen "traps" in the landscape. Such an approach uses natural processes to improve the environmental integrity of the system. These traps include wetland areas that promote the conversion of nitrate into atmospheric nitrogen (denitrification), grasslands that take nitrogen up in harvested crops, and modifications of tile drainage systems to slow water flow and create areas for nitrogen removal.

Yet the root of the hypoxia problem is an overabundance of corn and soybean production in the Midwest. Farmers need profitable alternative crops with accessible markets. If opportunities are available, farmers will take advantage of them. Current farm policies provide government support and reduced financial risk for only a few "program" crops. Instead, we need to promote policies that shift the focus to a diversified agricultural system.

The priority of farm policy should be to foster an agriculture that creates healthy food systems, protects natural resources and revitalizes rural communities and family farms. An agriculture that is reinvented based on options that replace or greatly reduce the need for nitrogen and row crops is critical to reach these objectives.

1 Rabalais, N.N. July 26, 2002. Louisiana Universities Marine Consortium Press Release.
2 Goolsby, D.A., W.A. Battaglin, G.B. Lawrence, R.S. Artz, B.T. Aulenback, R.P. Hooper, D.R. Keeney, G.J. Stensland. 1999. Flux and Sources of Nutrients in the Mississippi-Atchafalaya River Basin: Topic 3 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico. NOAA Coastal Ocean Program Decision Analysis Series No. 17.
3 Goolsby, D.A., W.A. Battaglin and R.P. Hopper. 1997. Sources and Transport of Nitrogen in the Mississippi River Basin. Presented at the American Farm Bureau Federation Workshop, St. Louis, Missouri, July 14-15, 1997.
4 United States Geological Survey. 2000. Nitrogen in the Mississippi Basin – Estimating Sources and Predicting Flux to the Gulf of Mexico. USGS Fact Sheet 135-00.
5 Pew Oceans Commission. 2001. Marine Pollution in the United States.
6 Vitousek, P.M., J. Aber, R.W. Howarth, G.E. Likens, P.A. Matson, D.W. Schindler, W.H. Schlesinger and G.E. Tilman. 1997. Human Alteration of the Global Nitrogen Cycle: Causes and Consequences. Ecological Applications 7:737-750.
7 Downing, J.A., J.L. Baker, R.J. Diaz, T. Prato, N.N. Rabalais, R.J. Zimmerman. 1999. Gulf of Mexico Hypoxia: Land and Sea Interactions. Council for Agricultural Science and Technology Task Force Report.
8 Downing et al., 1999.
9 Randall, G. 2001. Present Day Agriculture in Southern Minnesota – is it Sustainable? USGS, 2000.
10 Nierenberg, D. 2001. Toxic Fertility. World Watch Magazine. March/April 2001.
11 Keeney, D.R. 2002. Reducing Nonpoint Nitrogen to Acceptable Levels with Emphasis on the Upper Mississippi River Basin. Estuaries 25:720-726.
12 McIsaac, G.F., M.B. David, G.Z. Gertner and D.A. Goolsby. 2001. Eutrophication: Nitrate Flux in the Mississippi River. Nature 414:166-167.

Thank you to Dr. Nancy Rabalais for her assistance with this fact sheet.

For more information on IATP's work on hypoxia and related topics, go to www.agobservatory.org
Institute for Agriculture and Trade Policy 2105 First Avenue S. Minneapolis, MN 55404 (612) 870-0453