Take a Closer Look

Water Quality in the Gulf... Taking Steps to Protect It

By C.S. Snyder

Seasonal low oxygen levels–less than 2 milligrams per liter or 2 parts per million–in the bottom of shallow (less than 100 ft. deep) coastal waters in the northern Gulf of Mexico are causing a biological concern. This low-oxygen condition is referred to as hypoxia. Hypoxia has probably always been present, but measurements since 1985 indicate it is increasing in size in the Gulf of Mexico (**Figure 1**). And it may be lasting longer into the fall than in the past. Discharge and layering of nutrient-rich, warmer Mississippi River freshwater, over cooler, denser saline water is necessary for the development and persistence of hypoxia conditions. Excess nitrate-nitrogen delivery by the Mississippi and Atchafalaya Rivers, originating from 31 states in the Mississippi River Basin, is believed to be fueling hypoxia conditions in the Gulf of Mexico.

> Rainfall patterns, stream flow, and nutrient management in the 31 states within the Mississippi River Basin (MRB), all affect water quality in the Mississippi River, and ultimately the Gulf of Mexico. There is a false perception that fertilizer nitrogen use is the major factor impacting Gulf water quality. In reality, the volume of water flow from the Mississippi Basin, and the time when runoff-producing rains occur, have been the most significant factors affecting Mississippi River and Gulf of Mexico water quality in the last 20 years.

Fertilizer nitrogen use, primarily in the upper Mississippi River Basin states, has been frequently singled out and blamed as "the cause" of hypoxia, especially in media articles that have sensationalized the hypoxia phenomenon in the Gulf and labeled the area as "The Dead Zone." However, there are a number of nitrogen sources in addition to fertilizer: soil organic matter; manure; lawn, golf course, athletic field, and other urban runoff; municipal waste and industrial discharge; forest and natural area runoff; and atmospheric deposition.

An abundance of nutrients, primarily nitrogen and phosphorus, in water helps stimulate the production of microscopic aquatic plants called phytoplankton, which are a source of food for marine life. When phytoplankton die, they fall through the water column to the bottom mud. As bacteria in the mud use the organic matter as a food source, they consume oxygen from the water and accelerate hypoxia development.

Some marine scientists believe hypoxia is reducing the per-effort-catch of shrimp, crabs, and some fish by bottom-dragging trawlers. Fish that swim in the upper part of the coastal waters still get enough oxygen and are not affected. There has been no measured negative economic impact on Gulf fisheries so far. Still, there is a growing fear that Gulf fisheries resources are threatened and that poor water quality could hurt tourism.

The U.S. Geological Survey (USGS) estimates that the total annual nitrate-nitrogen discharge to the Gulf is equivalent to about 2.6 pounds of nitrogen from each acre in the Mississippi River Basin. Putting that number in perspective, it would be an amount equivalent to about 9% of the fertilizer nitrogen applied annually to major U.S. crops in the Basin.

Historically (1955 to 1999), nitrate-nitrogen delivery to the Gulf has been strongly associated with both total water flow to the Gulf from the Mississippi and Atchafalaya Rivers and a two-year lag in fertilizer nitrogen use in the Mississippi River Basin states (two years prior to current annual water flow).*

There have been many agricultural production changes in recent years which may have altered this historic relationship:

- increased tile drainage in the upper Mississippi Basin,
- land grading and surface drainage improvements in the lower Mississippi Basin,
- increased conservation and no-till production,
- new site-specific fertilizer application technologies, and
- increased crop yields, resulting in greater removal of nutrients in harvested crops.

Nitrogen use statistics show that corn production per pound of nitrogen has increased from about 0.76 bushels per pound of nitrogen in 1980 to about 1.03 bushels per pound of nitrogen in 2000: **a 35% increase in apparent fertilizer use efficiency.**

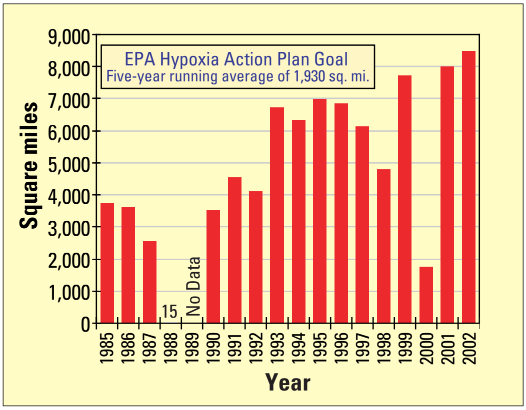

Figure 1. Approximate size of the hypoxia zone in the northern Gulf of Mexico. *Source: N. Rabalais, Louisiana Universities Marine Consortium.*

Best management practices are being used by more farmers to increase soil and water protection and achieve more efficient production.

To evaluate the potential impact of these more recent agricultural changes, the data on water flow to the Gulf of Mexico by the Mississippi and Atchafalaya Rivers, fertilizer nitrogen use in the Mississippi River Basin, and nitrate-nitrogen discharge to the Gulf from 1980 to 1999 were reviewed. This review showed that nitrate-nitrogen delivery since 1980 has been predominantly controlled by the volume of water flow and **not** fertilizer nitrogen use (**Figures 2** and **3**). The flow of fresh water to the Gulf accounted for 79% of the variation in annual nitrate-nitrogen discharge to the Gulf, while fertilizer nitrogen use in the Mississippi River Basin accounted for only 1% of the variation in the annual delivery of nitrate-nitrogen to the Gulf of Mexico from 1980 to 1999.

A recent summary of soil test results in North America shows that 47% of the soil samples test medium or lower in phosphorus and 43% of samples test medium or lower in potassium. Inadequate phosphorus and potassium fertility management reduces crop yields, limits farmer profit, and is probably also limiting nitrogen use efficiency in many crops.

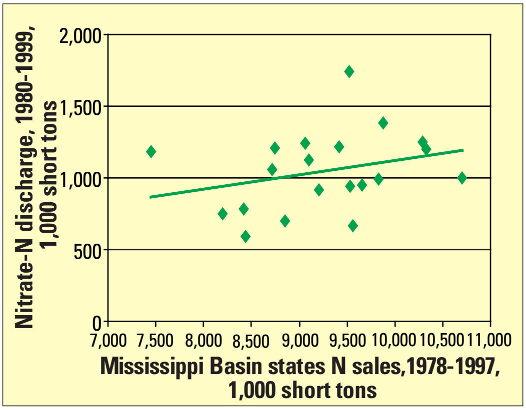

Figure 2. Nitrate-nitrogen discharge to the Gulf of Mexico vs. two year lag in Mississippi River Basin fertilizer nitrogen sales. *Source: U.S. Geological Survey (Don Goolsby) and The Fertilizer Institute.*

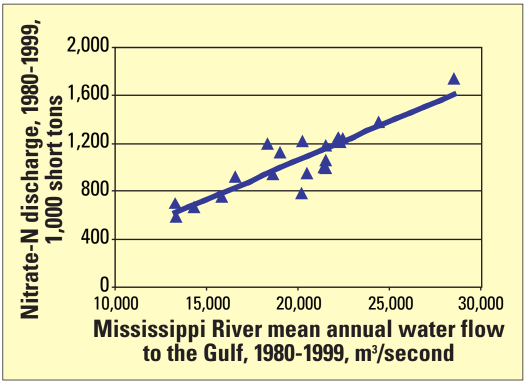

Figure 3. Nitrate-nitrogen discharge to the Gulf of Mexico vs. Mississippi River mean annual water flow. *Source: U.S. Geological Survey (Don Goolsby).*

In spite of these nutrient deficit challenges, there has been progress in the following areas:

- Farmers have been voluntarily implementing best management practices (BMPs) to increase soil and water protection while striving for higher yields and more efficient production.
- Fertilizer industry is partnering with university scientists and educators, Certified Crop Advisers (CCAs), and others to encourage farmers to delay fall nitrogen (typically anhydrous ammonia) applications until soil temperatures at a 4- to 6-in. depth are consistently below about 50 to 55°F in the upper Mississippi River Basin.
- In Basin states where nitrogen sources other than anhydrous ammonia predominate and where justified by agronomic research, timely split applications of nitrogen are being encouraged to improve crop nitrogen use-efficiency.

Members of the agricultural community are striving to improve management. Industry and university-sponsored educational programs, and voluntary stewardship action by farmers, are helping to reduce the potential for loss of nitrogen from fields to local streams, and ultimately to the Gulf of Mexico. All involved in agriculture want to protect and preserve our water resources and are committed to wise resource stewardship through intensive management. BC

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**(Source: USGS Fact Sheet 135-00: http://ks.water.usgs.gov/Kansas/pubs/fact-sheets/fs.135-00.html).*