**The Gulf of Mexico 'Dead Zone'**

Substantial increases in synthetic nitrogen fertilizer production and fossil fuel combustion, and land-use changes involving clearing and conversion, crop cultivation, and drainage of wetlands, among other factors, have significantly altered the global nitrogen cycle. The increased rate of nitrogen input is affecting the quality of the atmosphere and, in many regions, soil, groundwater, lakes and streams, and estuarine and nearshore marine environments.

While nitrogen is essential to the high productivity of estuaries and other coastal regions, an excessive supply can set into motion a cascade of detrimental effects. Microscopic algae (phytoplankton) are stimulated into high production and, if not incorporated into the food web, can form dense growths or blooms. Dead and dying cells sink and are decomposed by bacteria and other microbes. The decomposition process requires, and can remove, substantial amounts of oxygen from the surrounding water and, in conjunction with stratification (where bottom waters are isolated from the atmosphere and hence oxygen resupply), may lead to 'hypoxia' - the condition in which dissolved oxygen is below the level necessary to sustain most animal life.

**The Problem**

* The largest oxygen-depleted area - or 'dead zone' - in the entire western Atlantic Ocean occurs in the northern Gulf of Mexico on the Louisiana/Texas continental shelf. Stretching westward from the mouth of the Mississippi River in water up to 200 feet deep, it encompassed approximately 7900 square miles in 2007, an area almost as large as the state of New Jersey, and the third-largest ever recorded. The dead zone is a seasonal occurrence triggered by the high influx of nutrient-laden freshwater washing down from the Mississippi with the onset of melting snow and spring rains; it typically forms in May - though sometimes as early as February - and remains until September or October.
* The dead zone forms in one of the most productive fisheries areas of the United States, and has led to increasing concern that catches are being adversely affected - or will be affected if hypoxic conditions continue or worsen.
* While the causes of eutrophication and hypoxic water conditions have been well-characterized, still relatively little is known of their overall impacts in the Gulf of Mexico. In general terms, however, effects of hypoxia include the direct mortality of organisms, including fish and their food base, high losses of benthic or bottom-dwelling plants and animals, reductions in numbers of species, and disruption of fish spawning, recruitment, and migration.

**The Causes**

* The primary human-related factor in the formation of the dead zone is agriculture. It is estimated that about 1.6 million metric tons of nitrogen - primarily from the highly fertilized agricultural regions of southern Minnesota, Iowa, Illinois, Indiana, and Ohio - enters the Gulf annually from the Mississippi Basin. Close to one million metric tons of this is nitrate (the most important form of nitrogen involved in the creation of the dead zone), an amount some three times more than what was discharged in 1970.
* Agriculture (fertilizer and livestock manure) accounts for 65% of the nitrogen flux to the Gulf; soil erosion, ground-water discharge and atmospheric deposition are estimated at 24% while municipal (mainly wastewater treatment systems) and industrial point sources contribute some 11%.
* High losses of wetlands and riparian areas throughout the U.S. - in large part due to agricultural expansion - have exacerbated the problems associated with nutrient pollution. Wetlands and riparian vegetation, such as forests, are important natural 'sinks' in that they can retain nitrogen or convert nitrate to nitrogen gas.

**The Context**

* The northern Gulf of Mexico has undergone significant change over the last decades due to human activity. Along with nutrient pollution and eutrophication, impacts have accrued from: fisheries, especially the extreme levels of bycatch and the damage to seabed habitats associated with shrimp trawling; destruction of wetlands related to flood control measures and construction of shipping channels; chemical pollution; and introduced species.
* While there is concern that hypoxic conditions in the northern Gulf of Mexico are resulting in a decline in Gulf of Mexico fisheries productivity, studies have been unable to detect an impact. While this can be seen as positive, scientists have also noted that this does not mean that an impact hasn't occurred, or that serious detrimental changes to fisheries will not occur if conditions continue or worsen. Rather, the complexity inherent in ecological systems, and the confounding effect of numerous stressing agents - such as fisheries and wetland loss - make it extremely difficult to delineate clear cause-and-effect relationships.
* Recent analyses consider that a 50% reduction of nitrogen loading to the Gulf is possible if a variety of efforts are implemented. These include: modification of farm practices towards the more efficient use of fertilizer and manure; creation and restoration of wetlands and riparian ecosystems; reflooding of former wetlands; controls on nitrogen discharges from sewage treatment plants and industries; and changes in flood control measures throughout the Mississippi Basin. The reversal of hypoxic conditions is, however, likely to be slow and many decades of scientific monitoring may be required in order to verify system recovery.
* The increase in the availability and mobility of nitrogen has only more recently become an issue of global significance and scientific concern. Effects worldwide include threats to human health in the form of high nitrate levels in drinking water, losses of important trace nutrients in soil, the formation of acid rain and photochemical smog, and a variety of impacts in coastal waters including increases in harmful algal blooms and declines in commercial fisheries. In addition, nitrogen in the form of nitrous oxide is a contributor to the 'greenhouse effect' as associated with climate change.

# ****FOR IMMEDIATE RELEASE****

October 19, 2007

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**NOAA Initiates Three-Year $781,000 Project to Unravel Gulf Deadzone Mysteries**

NOAA has awarded first-year funding of $284,000 to researchers at the University of Texas at Austin Marine Science Institute (UTMSI) as part of a three-year $781,000 project to develop a better understanding of how nutrient pollution from the Mississippi River affects the large area of low oxygen water called the “dead zone” in the Gulf of Mexico. The project will also look at how the dead zone affects commercially and recreationally important fish and shellfish.

Funds were awarded through NOAA’s Northern Gulf of Mexico Hypoxia and Ecosystems Research Program.

“A better understanding of the underlying causes of the dead zone is essential for predicting its effect on the Gulf fisheries and the region,” said retired Navy Vice Adm. Conrad C. Lautenbacher, Ph.D., under secretary of commerce for oceans and atmosphere and NOAA administrator. “The goal of this research is to help develop a range of options that coastal and upriver resource managers can use to prevent and reduce nutrient pollution that contributes to the dead zone.”

This project will provide data to verify water quality models and help resource managers determine the quantitative relationships between nutrient pollution and development, magnitude, longevity, and distribution of the dead zone. Findings will also support the development of more accurate predictive models of hypoxia development on the Louisiana continental shelf.

The dead zone is an area in the Gulf of Mexico where seasonal oxygen levels drop too low to support most life in bottom and near-bottom waters. It is caused by a seasonal change where algal growth, stimulated by input of nutrients such as nitrogen and phosphorus from the Mississippi and Atchafalaya rivers, settles and decays in the bottom waters. The decaying algae consume oxygen faster than it can be replenished from the surface, leading to decreased levels of dissolved oxygen.

This past summer off the coast of Louisiana and Texas, an area of deep water covering 7,900 square miles was declared hypoxic. It is the third largest Gulf of Mexico dead zone on record since measurements began in 1985, and represents an area approximately the size of the state of New Jersey. Also, it is more than one and a half times the average annual dead zone area measured since 1990, 4,800 square miles. The largest dead zone ever recorded covered 8,494 square miles in 2002.

The research program, managed by NOAA’s Center for Sponsored Coastal Ocean Research, seeks to provide resource managers with new tools, techniques, and information to make informed decisions, and assess alternative management strategies regarding hypoxia. Supported projects are leading to the development of a fundamental understanding of the northern Gulf of Mexico ecosystem, with a focus on the causes and effects of the hypoxic zone, and the prediction of its future extent and impacts on ecologically and commercially important living resources.

In fiscal year 2007, the NOAA National Ocean Service, through the center, provided approximately $10 million in competitive grants to institutions of higher education, state, local and tribal governments, and other non-profit research institutions to assist NOAA in fulfilling its mission to study our coastal oceans.

In 2007 NOAA, an agency of the U.S. Commerce Department, celebrates 200 years of science and service to the nation. From the establishment of the Survey of the Coast in 1807 by Thomas Jefferson to the formation of the Weather Bureau and the Bureau of Commercial Fisheries in the 1870’s, much of America's scientific heritage is rooted in NOAA.

NOAA is dedicated to enhancing economic security and national safety through the prediction and research of weather and climate-related events and information service delivery for transportation, and by providing environmental stewardship of our nation's coastal and marine resources. Through the emerging Global Earth Observation System of Systems (GEOSS), NOAA is working with its federal partners, more than 70 countries and the European Commission to develop a global monitoring network that is as integrated as the planet it observes, predicts and protects.

# Major Flooding on the Mississippi River Predicted to Cause Largest Gulf of Mexico Dead Zone Ever Recorded

###### June 14, 2011

The Gulf of Mexico's hypoxic zone is predicted to be the largest ever recorded due to extreme flooding of the Mississippi River this spring, according to an annual forecast by a team of NOAA-supported scientists from the Louisiana Universities Marine Consortium, Louisiana State University and the University of Michigan. The forecast is based on Mississippi River nutrient inputs compiled annually by the U.S. Geological Survey (USGS).

Scientists are predicting the area could measure between 8,500 and 9,421 square miles, or an area roughly the size of New Hampshire.If it does reach those levels it will be the largest since mapping of the Gulf "dead zone" began in 1985. The largest hypoxic zone measured to date occurred in 2002 and encompassed more than 8,400 square miles.

The average over the past five years is approximately 6,000 square miles of impacted waters, much larger than the 1,900 square miles which is the target goal set by the Gulf of Mexico/Mississippi River Watershed Nutrient Task Force. This collaboration between NOAA, USGS and university scientists facilitates understanding links between activities in the Mississippi River watershed and downstream impacts to the northern Gulf of Mexico. Long-term data sets on nutrient loads and the extent of the hypoxic zone have improved forecast models used by management agencies to understand the nutrient reductions required to reduce the size of the hypoxic zone.

Hypoxia is caused by excessive nutrient pollution, often from human activities such as agriculture that results in too little oxygen to support most marine life in bottom and near-bottom water. The hypoxic zone off the coast of Louisiana and Texas forms each summer and threatens valuable commercial and recreational Gulf fisheries. In 2009, the dockside value of commercial fisheries in the Gulf was $629 million. Nearly three million recreational fishers further contributed more than $1 billion to the Gulf economy taking 22 million fishing trips.

While there is some uncertainty regarding the size, position and timing of this year's hypoxic zone in the Gulf, the forecast models are in overall agreement that hypoxia will be larger than we have typically seen in recent years. ***— Jane Lubchenco, Ph.D., under secretary of commerce for oceans and atmosphere and NOAA administrator***

During May 2011 stream-flow rates in the Mississippi and Atchafalaya Rivers were nearly twice that of normal conditions. This significantly increased the amount of nitrogen transported by the rivers into the Gulf. According to USGS estimates, 164,000 metric tons of nitrogen (in the form of nitrite plus nitrate) were transported by the Mississippi and Atchafalaya Rivers to the northern Gulf. The amount of nitrogen transported to the Gulf in May 2011 was 35 percent higher than average May nitrogen loads estimated in the last 32 years.

"The USGS monitoring network and modeling activities for water quantity and quality helps us 'connect the dots' to see how increased nutrient run-off in the Mississippi watershed during a historic spring flood event impacts the health of the ocean many hundreds of miles away," said Marcia McNutt, Ph.D., USGS director. "This work on Gulf hypoxia is a great example of interagency teamwork between NOAA and USGS to work across the land-sea boundary."

Coastal and water resource managers nationwide require new and better integrated information and services to adapt to the uncertainty of future climate and land-use changes, an aging water delivery infrastructure, and an increasing demand on limited resources. NOAA and USGS, as well as the U.S. Army Corps of Engineers, have signed an agreement that will further facilitate collaboration in the future. These agencies, with complementary missions in water science, observation, prediction and management, have formed this partnership to unify their commitment to address the nation's water resources information and management needs.

This year's forecast is just one example of NOAA's growing ecological forecasting capabilities, supported by both NOAA and USGS science, which allow for the protection of valuable resources using scientific, ecosystem-based approaches.

The actual size of the 2011 hypoxic zone will be released following a NOAA-supported monitoring survey led by the Louisiana Universities Marine Consortium between July 25 and August 6. Collecting these data is an annual requirement of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force Action Plan.

NOAA has been funding investigations and forecast development for the dead zone in the Gulf of Mexico since 1990 and currently oversees the two national hypoxia programs authorized by the Harmful Algal Bloom and Hypoxia Research and Control Act.

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*Answer all questions thoroughly and in complete sentences.*

**The Gulf of Mexico “Dead Zone”**

1. List the factors that are causing changes in the nitrogen cycle.

2. Describe the steps that occur when an excessive amount of nitrogen is supplied to coastal waters.

Microscopic algae…

Dead/dying cells…

Decomposition process…

Leading to…

3. Describe the size of the dead zone in the Gulf of Mexico.

4. When and why does it occur?

 What is the concern?

5. List the effects of hypoxia.

6. How much nitrogen enters the Gulf annually? What percentage of this is nitrate?

7. Make a pie chart describing three sources of nitrogen flux to the Gulf and their percentages.

8. Why are wetlands and riparian areas important (what are their advantages)?

9. List some of the impacts of human activity on the Gulf of Mexico in addition to nutrient overload and eutrophication.

10. Explain why it’s difficult to show that hypoxic conditions have resulted in a decline in fisheries productivity.

11. What implementations might reduce the nitrogen levels in the Gulf? What is the downside to such an attempt?

12. List at least four (4) effects of excessive nitrogen supply on a worldwide level.

**NOAA Initiates Three-Year $781,000 Project to Unravel Gulf Dead Zone Mysteries**

1. Why is it essential to understand the causes of the dead zone?

2. What are the goals of the research program?

3. What is the dead zone? What causes it?

4. How much larger was the 2007 dead zone than the average?

5. What was the largest size ever recorded?

6. Explain why NOAA is important. What does the organization contribute to the scientific community?

**Major Flooding on the Mississippi River Predicted to Cause Largest Gulf of Mexico Dead Zone Ever Recorded**

1. Why was the 2011 “dead zone” predicted to be the largest ever recorded?

2. How large was it predicted to be?

3. Compare the average size of the hypoxic zone from 2006 to 2011 with the target set by the Gulf of Mexico/Mississippi River Watershed Nutrient Task Force.

4. Describe the value of both commercial and recreational fisheries in the Gulf.

5. How much nitrogen (NO3- and NO2-) was estimated to be moved into the Gulf by the two major rivers?

 How much higher than the average was this?

6. Explain why new integrated information and services are needed for the three agencies involved.

7. In 2011, the dead zone was actually found to be only 6,765 square miles in size. Compare this to the prediction, and hypothesize why it was not the same.