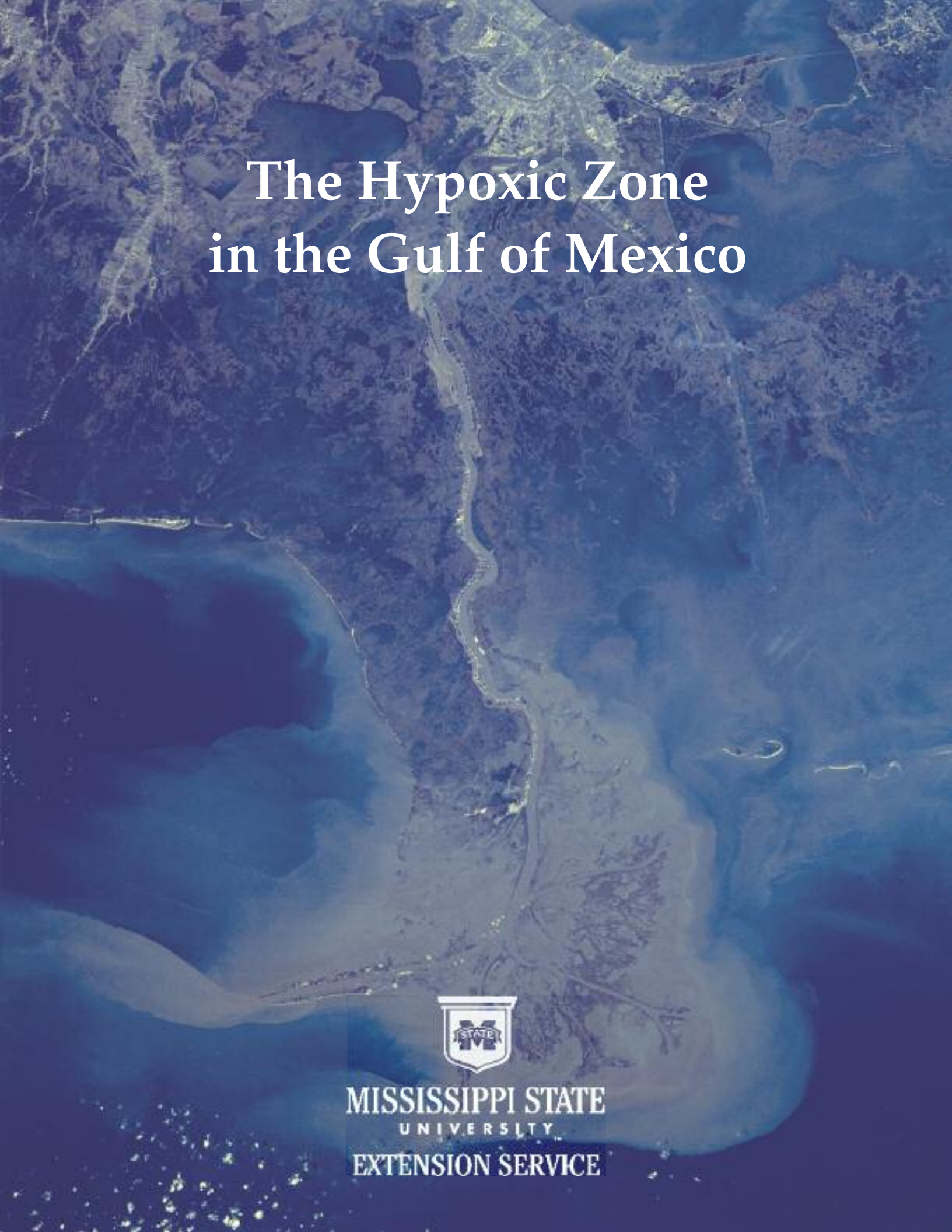
The Hypoxic Zone in the Gulf of Mexico



MISSISSIPPI STATE
UNIVERSITY
EXTENSION SERVICE

References

Council Committee on Environmental and Natural Resources. 2003. An Assessment of Coastal Hypoxia and Eutrophication in U.S. Water. National Science and Technology.

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. 2004. A Science Strategy to Support Management Decisions Related to Hypoxia in the Northern Gulf of Mexico and Excess Nutrients in the Mississippi River Basin: prepared by the Monitoring, Modeling, and Research Workgroup of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, U.S. Geological Survey Circular 1270, 58 p.

Diaz, R. J., and A. Solow. 1999. Ecological and Economic Consequences of Hypoxia: Topic 2 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico. NOAA Coastal Ocean Program Decision Analysis Series No. 16. NOAA Coastal Ocean Program, Silver Spring, MD. 45 pp.

Burrage, D. Citizens' Pollution Prevention Handbook. Mississippi Cooperative Extension Service, Mississippi State University, Publication 1939.

National Wetlands Research Center. Restoring Life to the Dead Zone: Addressing Gulf Hypoxia, a National Problem. United States Geological Survey Fact Sheet 016-00.

Diaz R. J. and R. Rosenberg. 2008. Spreading Dead Zones and Consequences for Marine Ecosystems. Science. Volume 321, Issue 5891, 926-929 pp.

Boyd, C. E. 2000. Water Quality: an Introduction. Kluwer Academic Publishers.

Image Acknowledgements

Figure 1. Mississippi River Birdfoot Delta. NASA Space Shuttle Earth Observations Photography database, Photo # STS51C-143-0027.

Figure 2. Mississippi River Watershed. J. Allen. 2009. U.S. EPA Gulf of Mexico Program Office.

Figure 3. The Eutrophication Process. Council Committee on Environmental and Natural Resources. 2003. An Assessment of Coastal Hypoxia and Eutrophication in U.S. Water. National Science and Technology. Redrawn by J. Heard, Mississippi State University.

Figure 4. Low Oxygen Event along the Shores of Mobile Bay, Alabama.http://oceanservice.noaa.gov/education/kits/estuaries/media/estuar10d_600.jpg

The Hypoxic Zone in the Gulf of Mexico and What It Means to You

Since at least the 1950s, a zone of low dissolved oxygen has been forming in the northern Gulf of Mexico at the mouth of the Mississippi River. Occurring primarily in the summer, this zone stretches from the Birdfoot Delta in Louisiana westward to the upper Texas coastline (Figure 1). This zone of low oxygen is called the hypoxic zone, or more commonly, the "dead zone."

"Hypoxic" means there are extremely low levels of oxygen in the water that can harm ocean animals. When the water is hypoxic, ocean animals cannot breathe. Shrimp, crabs, and bottom-dwelling fish are most at risk of oxygen depletion and possible death because low oxygen levels are usually closer to the bottom.

This dead zone creates both environmental and economic consequences, including reduced commercial and recreational fish harvest; increased fuel costs for boats having to travel outside of the low-oxygen zone to find fish, shrimp, and crabs; and changes in species composition. The hypoxic zone varies in size each year; it has been as large as the state of Massachusetts (more than 8,000 square miles). The northern Gulf of Mexico hypoxic zone is the second largest in the world.

Figure 1. Mississippi River Birdfoot Delta.

Hypoxia

Hypoxic zones have been measured worldwide since the 1980s. The hypoxic zone in the northern Gulf of Mexico is located in the most productive commercial and recreational fishery in the contiguous United States. According to the National Ocean Economics Program, the commercial domestic landings for the Gulf of Mexico weighed in at more than 1.4 billion pounds valued at greater than $689 million in 2007.

The hypoxic zone is created when nutrients such as nitrogen, phosphorous, and organic carbon enter the Gulf of Mexico in amounts too great for the normal food chain to use or break down. The nutrients enter with freshwater inflow from the Mississippi River watershed (Figure 2). The Mississippi River watershed includes 31 states and two Canadian provinces.

The runoff from the watershed is essential for maintaining productive fisheries, marshes, and barrier islands. However, excessive nutrients and organic matter can potentially decrease the biological diversity of this region. The principal human contributing factor that increases nutrient supply is stormwater runoff from cities and lawns, sewer treatment facilities, industry, and agriculture.

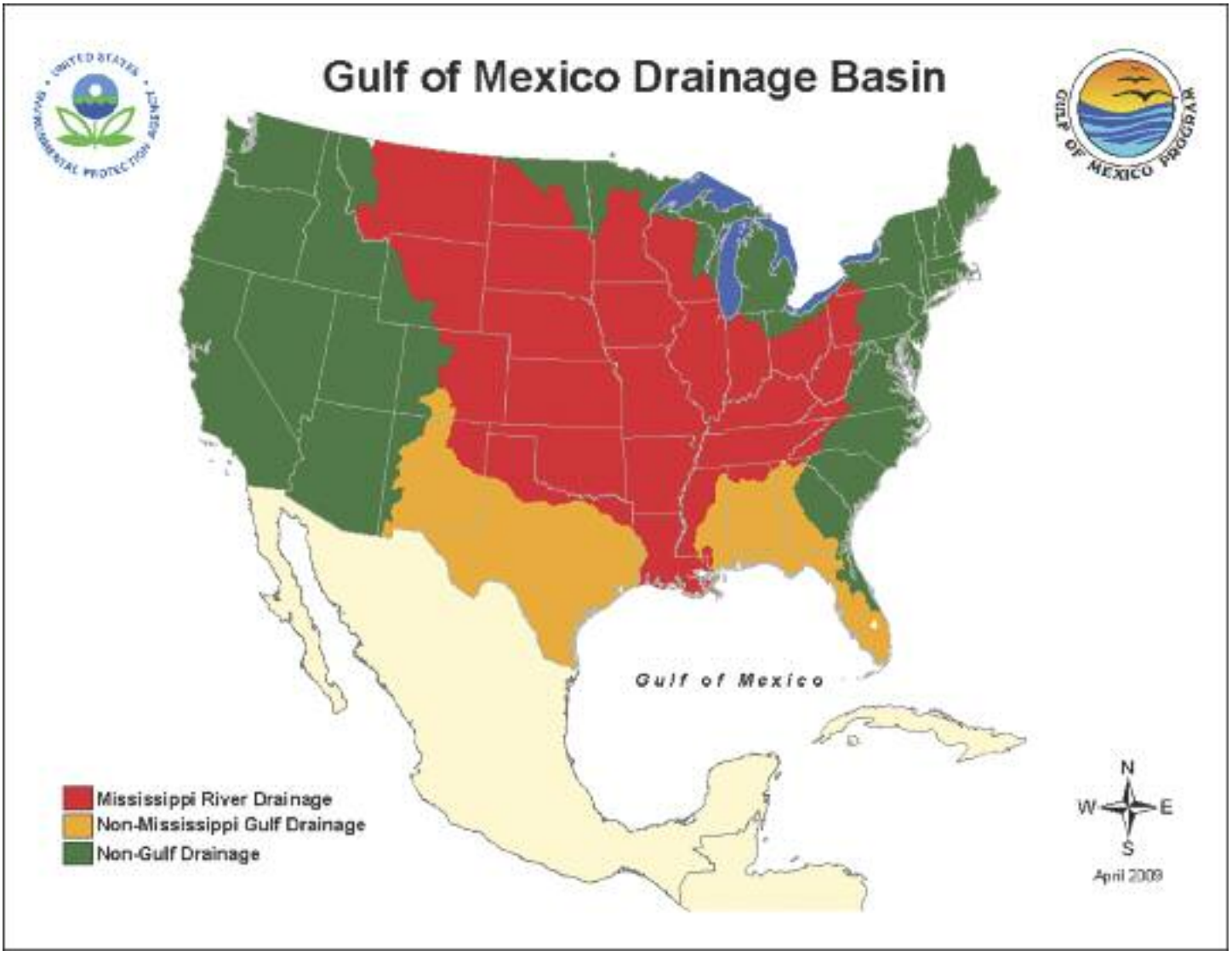


Figure 2. Mississippi River watershed.

Eutrophication

Eutrophication occurs when a water body is rich in nutrients. This encourages excessive plant growth and blooms of phytoplankton. Phytoplanktons are microscopic organisms that live in fresh and saline water (for example, green algae, blue-green algae, diatoms, and red algae). They form the base of the marine and freshwater food chain. Phytoplankton growth is regulated by water temperature, solar radiation, pH, turbidity, and nutrient concentrations.

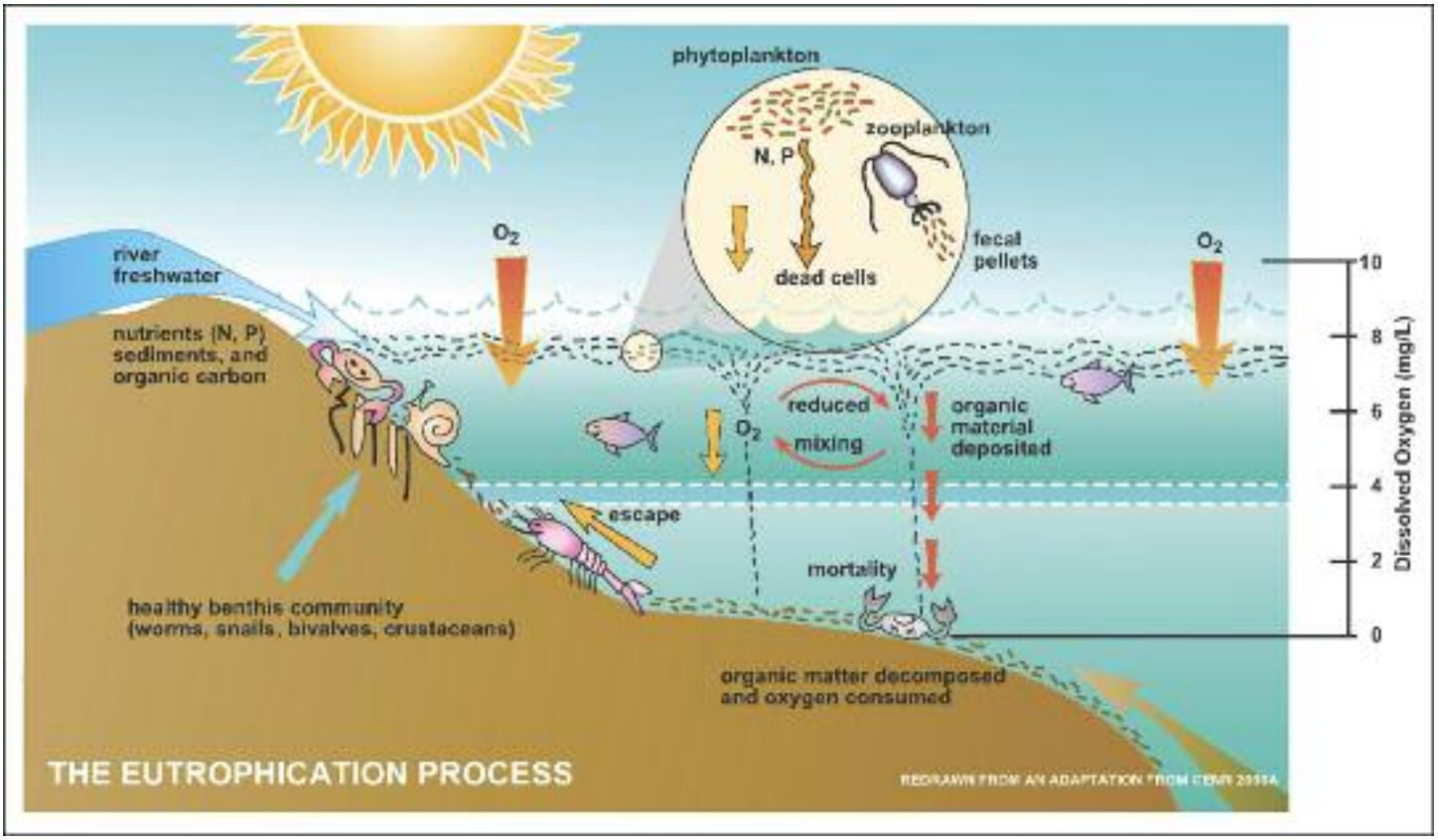


Figure 3. The eutrophication process.

The concentration of a phytoplankton bloom is especially dependent on nutrient availability, particularly nitrogen and phosphorus. Phytoplankton blooms tend to die suddenly. Bacteria living on the bottom use the dead algae and organic matter as a food source and use up most of the available oxygen. If a large algae bloom dies and most of the oxygen is used up, a hypoxic zone is created. Most organisms cannot live without oxygen. As hypoxic conditions persist, marine organisms such as fish tend to move out of the low-oxygen area. Animals that cannot move out of the area (oysters) or move fast enough (shrimp and crabs) may die or become severely stressed (Figure 3).

Massive fish deaths have occurred in hypoxic zones throughout the world (Figure 4). Fish kills are not a typical occurrence in the northern Gulf of Mexico hypoxic zone. These kills typically occur in confined water bodies like lakes and bays that are eutrophic.

Waters with low oxygen typically contain an abundance of a few species that are tolerant of poor water quality, and none of the more sensitive species. This creates a water body with low biological diversity.

Figure 4. Low oxygen event along the shores of Mobile Bay, Alabama.

Sources of Pollution

There are two main types of pollution that enter the Mississippi River watershed: point and non-point source pollution. Point source pollution is well-defined effluent discharged by way of a pipe, channel, or conduit (Figure 5). The major point source contributors are municipal sewage plants, power plants, paper mills, feed lots, textile mills, and mineral mining areas. Non-point source pollution is storm water runoff that accumulates pollution from a broad area. Non-point source pollution is caused by urban, agricultural, and construction runoff, and air pollution (Figure 6).

Increased levels of nitrogen and phosphorus from point and non-point pollution can produce algae blooms. Soil erosion into streams and rivers increases turbidity (cloudy water), reduces water depth, and smothers benthic species. Increased amounts of organic matter from leaf particles and dead plant material will increase microbial activity, which can further increase demand for oxygen.

Point sources of pollution are regulated through the National Pollutant Discharge Elimination System (NPDES). A permit is required, and the water often must be treated in order for its quality to comply with NPDES permit limitations before it is discharged. Non-point source pollution is harder to regulate because it is difficult to define its source and to improve regulations on parties responsible for it.

Best management practices tend to be incorporated into agricultural, construction, and other sectors' business plans. The best way to work with homeowners is through environmental education to assure they understand the possible environmental impacts of products they use in their lawns and gardens.

Figure 5. Point source pollution.

Figure 6. Non-point source pollution.

How Can I Help Prevent the Gulf of Mexico Hypoxic Zone?

When excess nutrients from your lawn or garden enter a ditch or stream, they create pollution in the watershed. A watershed is an area of land that drains water, sediment, and dissolved materials to a common receiving water body such as a stream, river, or lake. Nutrients and organic matter in the Mississippi River watershed that are not used by biological organisms will eventually drain into the Gulf of Mexico. That is why it is so important to educate the public about reducing the amount of potential pollutants into streams.

You may have wondered what you can do to protect wild redfish, trout, crabs, shrimp, and oysters in the Gulf of Mexico. Homeowners can take many steps to prevent non-point source pollution from entering our waterways.

One of the best ways to protect the healthy water conditions that aquatic and land animals need to survive is to pay close attention to how you fertilize your lawn and garden. The two first steps are to follow the directions on the fertilizer container exactly and to have your soil tested. This information will help you understand when to apply fertilizers and how much to apply to maintain a healthy yard and garden.

Have your soil tested by the Extension Service before applying fertilizer. A soil test will tell you the pH of your yard or garden and tell you how much of each plant nutrient you should apply for particular plants. A soil pH of 6.5 to 7.0 is optimum. Certain essential plant elements will not be available outside of the 6.5 to 7.0 pH range.

When the soil pH is lower than 6.5, you should apply lime to increase the pH. It is generally recommend that you apply lime in the fall or winter. This is because it takes limestone a long time to react with the soil to reduce acidity. Applying lime is considered to be an insurance policy for your yard.

Avoid getting fertilizer in ditches, drainage ways, and water bodies. Also, do not get fertilizer on hard surfaces such as driveways because it can easily be washed into storm drains. Always remember that storm drains flow into streams, rivers, and eventually the Gulf of Mexico.

Another suggestion is to apply slow-release fertilizers with at least one-fourth of the nitrogen in the slow-release form.

Instead of only growing grass in your yard, consider planting native plants, trees, and shrubs. Not only do these native species require little or no fertilizer, they also have adapted over thousands of years to live in the local climate and soil conditions.

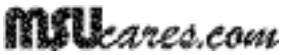
If you pick out native plants that produce food for wildlife, you will have the added bonus of seeing more songbirds and local wildlife in your yard. When you go to your local nursery or garden center, ask which native plants would be best for your yard.

Additional actions homeowners and city planners can take to prevent non-point source pollution include these:

- protect the land next to streams, rivers, and the Gulf
- prevent soil from being removed from construction sites by erosion
- pump out septic tanks on a regular schedule
- Use constructed wetlands to treat stormwater

There also are local watershed stewardship programs (such as baykeeper and riverkeeper) that you can get involved with to help promote awareness.

MISSISSIPPI STATE
UNIVERSITY
EXTENSION SERVICE



By **Christopher A. Boyd**, Assistant Extension Professor, Coastal Research and Extension Center, and **Troy Pierce**, U.S. Environmental Protection Agency Gulf of Mexico Program Office.

Publication 2583

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. MELISSA J. MIXON, Interim Director (500-01-10)