The Problem

of Hypoxia in the Northern Gulf of Mexico

Nearly all marine animals depend on oxygen dissolved in the water. Where oxygen depletion is severe, the food web that supports bottom feeders, such as shrimp and drum, is disrupted, as well as the natural processing of organic matter, nutrients, and pollutants. Growth of marine organisms is inhibited when dissolved oxygen is less than about 5 mg/l. Mobile organisms leave as dissolved oxygen levels decrease below 2 mg/l, and trawlers in these areas produce little or no catch. Burrowing organisms first emerge from the sediment, and then die, if oxygen concentrations remain near 0.5 mg/l for prolonged periods. In areas where the oxygen concentrations are below 0.2 mg/l, the sediment is typically black, and sulfur-oxidizing bacteria form mats on the seafloor. Toxic hydrogen sulfide may be found where bottom waters are completely devoid of oxygen (anoxic).

Hypoxia is the condition in which dissolved oxygen is below the level necessary to sustain most animal life—generally defined by dissolved oxygen levels below 2 mg/l (or ppm). The largest hypoxic zone in U.S. coastal waters—and in the entire western Atlantic Ocean—is found in the northern Gulf of Mexico on the Louisiana/Texas continental shelf (Figure 1.1). The area affected, which is about the size of the state of New Jersey, has increased since regular measurements began in 1985 (Figure 1.2).

The fishery resources of the Gulf are among the most valuable in the United States, generating $2.8 billion annually. Although economic analyses have not shown a statistically significant correlation with the extent of hypoxia, catch per unit of effort for brown shrimp, one of the most commercially valuable species in the Gulf, has trended down since the late 1970s. If experiences in other coastal and marine systems are applicable to the Gulf of Mexico, then the potential impact of worsening hypoxic conditions could be the decline (perhaps precipitous) of ecologically and commercially important species.

In October 1998, Congress passed the Harmful Algal Bloom and Hypoxia Research and Control Act, which the President signed into law as P.L.105-383 on November 13, 1998. This law calls for an "integrated assessment of hypoxia in the northern Gulf of Mexico that examines: the distribution, dynamics and causes; ecological and economic consequences; sources and loads of nutrients transported by the Mississippi River to the Gulf of Mexico; effects of reducing nutrient loads; methods for reducing nutrient loads; and the social and economic benefits of such methods." P.L.105-383 also calls for the development of a plan of action to reduce, mitigate, and control hypoxia in the northern Gulf of Mexico. The Action Plan will be developed by the Mississippi River/Gulf of Mexico (MR/GM) Watershed Nutrient Task Force. This integrated assessment is intended to provide scientific information to both specialists and nonspecialists as a basis for the Action Plan. This assessment does not make specific recommendations for action, nor is it the only source of information that the MR/GM Task Force will consider in developing the Action Plan.

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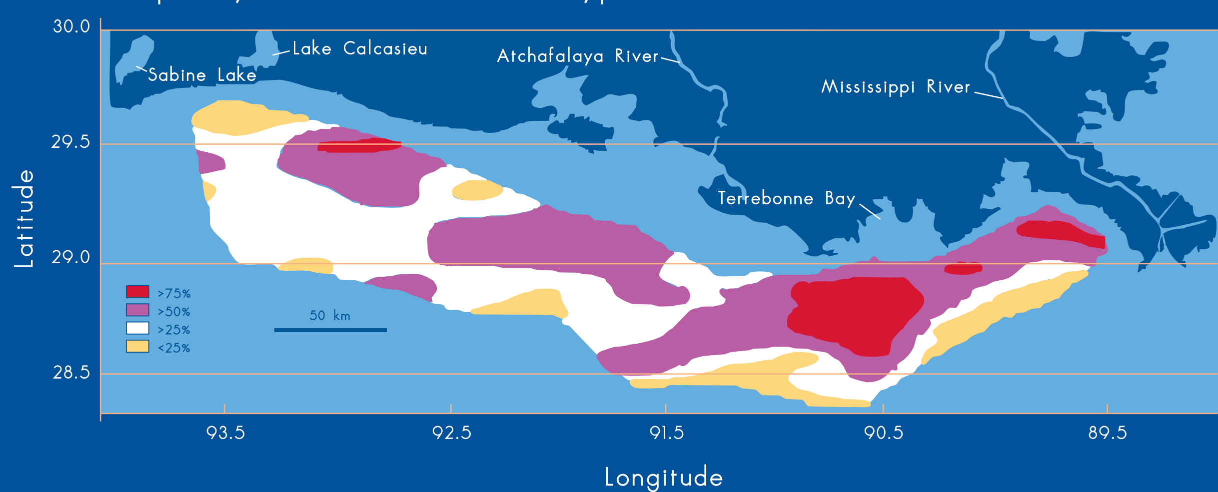
The National Science and Technology Council's Committee on Environment and Natural Resources had already taken steps in 1997 to assess the state of scientific knowledge and understanding of Gulf of Mexico hypoxia, and by March 1998 it had developed and approved an assessment plan in conjunction with the MR/GM Task Force. The plan called for six teams of experts from inside and outside of government to develop six reports that examine various interrelated aspects of hypoxia. The teams were established to review and analyze existing data and apply existing models of the watershed–Gulf system. The six peer-reviewed reports are based on a massive amount of direct and indirect evidence collected and reported over many years of scientific inquiry, including in-depth studies of oceanographic, hydrologic, agricultural, economic, and other questions related to the issue of hypoxia in the Gulf.[1]

This integrated assessment draws heavily from the six reports, freely using both their findings and their words, and explicitly cites them only when it refers to specific information a reader may want to examine in greater detail. The assessment summarizes the state of knowledge of the extent, characteristics, causes, and effects

The frequency of occurrence of hypoxia has been mapped from mid-summer "snapshots" obtained by sampling a 60- to 80-station grid in the Gulf annually from 1985 through 1999.

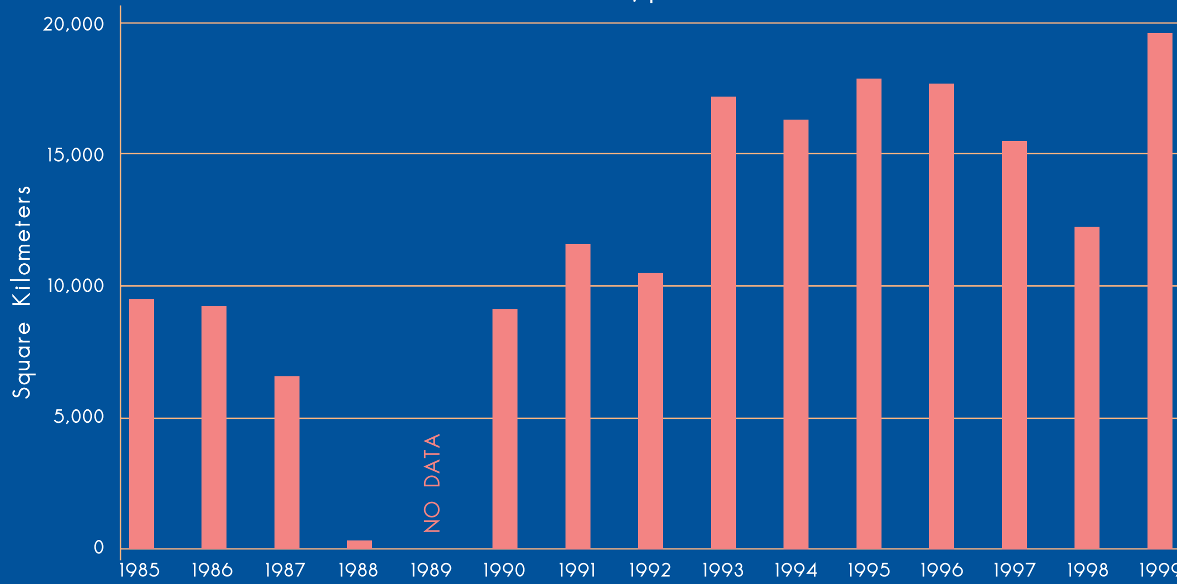
FIG. 1.1 Frequency of Occurrence of Hypoxia in the Gulf of Mexico: 1985–99



Source: Based on data from Rabalais, Turner, and Wiseman.

[1] The six topic reports underwent a rigorous peer review with oversight by an independent editorial board. In addition, the six topic reports were available for a 90-day public comment period. The reports and the comments received on them are available at <http//www.nos.noaa.gov/products/pubs_hypox.html>. This assessment has been written with consideration of all that information. The assessment was available, in draft form, for a 60-day public comment period. Those comments are also posted on this web site and were carefully considered in producing the assessment in this final version.

FIG. 1.2 Areal Extent of Mid-summer Hypoxia: 1985–99



Source: Nancy Rabalais, Louisiana Universities Marine Consortium.

Annual mid-summer cruises have been conducted systematically over the past 15 years (with the exception of 1989). Hypoxia in bottom waters covered an average of 8,000–9,000 km^2 in 1985–92 but increased to 16,000–20,000 km^2 in 1993–99.

of hypoxia in the northern Gulf of Mexico. It outlines a range of approaches for reducing those effects and examines the costs and benefits associated with those approaches. It also describes additional research and monitoring needed to reduce uncertainties, to track progress following any efforts developed in the Action Plan, and to identify potential future adjustments to any initial actions that may be taken to reduce hypoxia and improve water quality.