Journal of Environmental Management
Volume 52, Issue 3, March 1998, Pages 289-305

Hypoxia in aquatic systems refers to waters where the dissolved oxygen concentrations are below 25 percent of their capacity. Most organisms avoid, or become physiologically stressed in, waters with oxygen below these levels. While hypoxia can occur naturally, large events often reflect environments stressed by human impacts. More than half of United States estuaries experience natural or human-induced hypoxic conditions at some time, but the frequency and duration of hypoxic events have increased during the past few decades. These hypoxic events degrade affected ecosystems and associated commercial fisheries.

Source: University of Texas at Austin Marine Science Institute (UTMSI) through NOAA's Northern Gulf of Mexico (NGOMEX) Hypoxia and Ecosystems Research Program.

Nutrients such as nitrogen and phosphorus are necessary for growth of plants and animals and support a healthy aquatic ecosystem. In excess, however, nutrients can contribute to fish disease, red or brown tide, algae blooms, and low dissolved oxygen. The condition where dissolved oxygen is less than 2 parts per million is referred to as hypoxia. Many species are likely to die below that level- the level of healthy waters is 5 or 6 parts per million. Sources of nutrients include point and non-point sources such as sewage treatment plant discharges, stormwater runoff from lawns and agricultural lands, faulty or leaking septic systems, sediment in runoff, animal wastes, atmospheric deposition originating from power plants or vehicles, and groundwater discharges.

Excessive nutrients stimulate the growth of algae. As the algae die, they decay and rob the water of oxygen. The algae also prevent sunlight from penetrating the water. Fish and shellfish are deprived of oxygen, and underwater seagrasses are deprived of light and are lost. Animals that depend on seagrasses for food or shelter leave the area or die. In addition, the excessive algae growth may result in brown and red tides which have been linked to fish kills, manatee deaths and negative impacts to scallops. Increased algae may also cause foul smells and decreased aesthetic value.

Source: EPA National Estuary Program

Modelling estuarine eutrophication in the context of hypoxia, nitrogen loadings, stratification and nutrient ratios

Tony A. Lowery
Strategic Oceanic Environmental Assessments Division, N/ORCA 1, SSMC4, National Oceanic and Atmospheric Administration, 1305 East West Highway, Silver Spring, MD, 20910, USA
Received 3 October 1996; accepted 25 February 1998. ; Available online 8 April 2002.

Abstract

Estuarine eutrophication is a serious ecological and economic problem. Hypoxic waters resulting from decomposing phytoplankton in stratified bottom-waters are often associated with estuarine eutrophication, with the degree of the phytoplankton accumulation and subsequent decomposition corresponding to the phytoplankton's density in the overlying water. In general, high phytoplankton densities occur when nutrient availability is high enough to maintain the phytoplankton population. High nutrient availabilities generally result from high nutrient loads entering estuaries from their watersheds. Therefore, the co-occurrence of stratified bottom-waters and high nutrient loadings predisposes estuaries to developing hypoxic bottom-waters. This paper presents a multinominal logistic regression model that predicts the status of estuaries as normoxic, borderline hypoxic, hypoxic and severely hypoxic based on nitrogen loadings, salinity stratifications and «phosphorus to nitrogen» load ratios. The model was applied to 10 US Gulf of Mexico estuaries and it correctly assigned eight of the 10 estuaries to their correct eutrophication status. Summaries of each estuary's probabilities for being normoxic, borderline hypoxic, hypoxic or severely hypoxic are presented along with their modelled responses to changes in nutrient loadings. Other model results include nutrient loading reductions associated with moving hypoxic and severely hypoxic estuaries into the normoxic and borderline status. This estuarine eutrophication model follows previously developed eutrophication models for lakes which were based on similar premises and have been successfully used to develop management policies. The estuarine eutrophication modelling approach provides a platform for evaluating nutrient reduction management strategies in the context of an estuary's modelled response to proposed nutrient reductions. Therefore, the modelling approach presented here is offered in support of developing management policies concerning estuarine eutrophication.

Hypoxia in aquatic systems refers to waters where the dissolved oxygen concentration is below 2 mg/L. Most organisms avoid, or become physiologically stressed in, waters with oxygen below this concentration. Hypoxia can also kill marine organisms which cannot escape the low-oxygen water, affecting commercial harvests and the health of impacted ecosystems. While hypoxia can occur naturally, it is often a symptom of environments stressed by human impact such as from excess nutrient enrichment from point and non-point sources. Over half of the U.S. estuaries now experience natural or human-induced hypoxic conditions at some time each year and evidence suggests that the frequency and duration of hypoxic events have increased over the last few decades.

The importance and national scale of hypoxia and nutrient pollution in U.S. waters is evidenced by the reauthorization of the Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA) and two national reports which describe the need and identify priorities for research related to nutrient inputs, eutrophication and hypoxia in U.S. coastal waters (i.e. Priority Topics for Nutrient Pollution in Coastal Waters: An Integrated National Research Program for the United States and An Assessment of Coastal Hypoxia and Eutrophication in U.S. Waters). The recently released reports by the U.S. Commission on Ocean Policy and the Pew Oceans Commission Report both identify non-point source pollution in coastal ecosystems as one of the nation’s most widespread pollution problems and the greatest pollution threat to coastal marine life.

Source: NOAA Center for Sponsored Coastal Ocean Research (CSCOR)

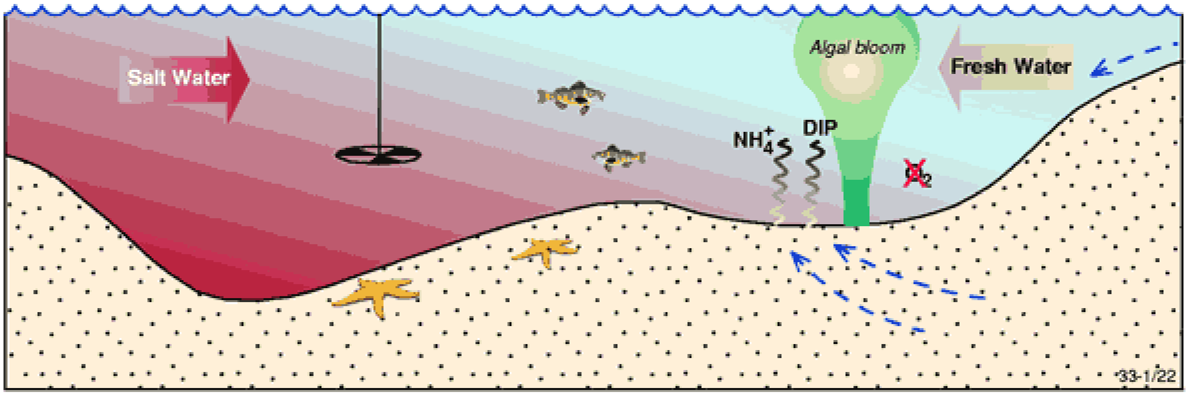

Figure 1. Conceptual model illustrating oxygen depletion and nutrient regeneration in bottom waters (and sediments) in the stratified portion of an estuary e.g. where saline water (red) underlies riverine water (blue).