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WHAT IS HYPOXIA AND HOW DOES IT AFFECT FISHERIES?

During Louisiana's long coastal summers, May through September, a phenomenon known as *hypoxia*, or oxygen depletion, occurs in the waters of the state's continental shelf. Hypoxic areas, sometimes called "dead zones," are sections of the sea floor where dissolved oxygen is too low to sustain typical sealife. The number of tiny bottom-dwellers–polycheate worms, mud crabs, and snails, for example–is sharply reduced. Larger animals such as fish and shrimp leave, swimming to the surface where oxygen is adequate or to other parts of the Gulf of Mexico.

Oxygen Sustains Life

Dissolved oxygen is essential in water's ability to support life. Oxygen enters the water through the respiration of aquatic plants, which produce it during photosynthesis, and through the contact of surface water with air. A dissolved oxygen level of 4 milligrams per liter is enough to sustain most aquatic animals, but levels below 2 milligrams per liter cause varying degrees of stress and, sometimes, death. The absence of dissolved oxygen is called *anoxia* and most animals die if caught in anoxic water for any length of time.

Causes of Hypoxia

Water *stratification*, or layering, is one contributor to hypoxia. In the summer, when the sun is hot and winds are normally mild, water from the Mississippi and Atchafalaya rivers flowing into the gulf does not mix well with the saltwater but, instead, floats above it. The heavier saltwater stays close to the bottom. Dissolved oxygen remains in the lighter surface water, but oxygen in the lower layer of water and at the bottom is continuously depleted through the decay of organic matter and the respiration of bottom-dwelling animals. Bottom waters lose oxygen faster than surface waters can replace it. If stratification lasts longer than two or three days, hypoxia develops.

Occasionally, storms are responsible for widespread hypoxia. Most recently, Hurricane Andrew pushed an anoxic water mass ashore at Point au Fer, trapping and killing about 80 million fish. Louisiana's fishkill mounted to 187 million when, in the Atchafalaya basin, the hurricane first churned up organic material that robbed the water of oxygen as it decomposed and then flushed more hypoxic water out of the swamps.

The foremost cause of hypoxia, however, is the load of nutrients–nitrates, phosphates, and silicates–brought to the Gulf of Mexico by the Mississippi River. The river's watershed is the largest in the United States, draining 41 percent of the nation. On its southward journey past city sewage treatment plants, agricultural fields, industrial operations, and residential gardens, the river collects enormous amounts of these nutrients and ultimately empties them onto the continental shelf.

The river's discharge spreads in a thin layer above the heavier seawater, and its load of nutrients stimulates the growth of phytoplankton, masses of microscopic algae that die and fall to the bottom if uneaten by fish and zooplankton. Animal fecal pellets also sink, adding to the accumulation of waste. It's the subsequent decomposition of all this organic material by microorganisms, especially bacteria, that quickly strips the bottom waters of oxygen.

Summer water stratification is normal in the Gulf of Mexico and so is the decay of dead animals and plants by oxygen-consuming bacteria. But over-enrichment of the water by nutrients causes an abnormal production of phytoplankton and a resulting increase in decay.

Impacts on Sea Life

The basic threat to commercially important fish and shrimp species is the impact of hypoxia on their food supply. Research has found that, in hypoxic areas, the numbers and species of benthic animals--the tiny organisms that live on or beneath the water bottom and form a major source of food for fish--are far fewer than in bottom waters with normal oxygen levels. Thus, fish and shellfish crowd into oxygenated areas where they compete for food in smaller habitats and more easily fall prey to enemies.

Hypoxia can also affect shrimp spawning and migration. For example, white shrimp are bottom spawners; thus, the timing of egg release is critical if coincident with hypoxia. Brown shrimp spawn earlier and farther offshore than white shrimp, and their larvae migrate to inshore nursery areas before oxygen depletion is at its worst. But juvenile brown shrimp return to offshore waters during the height of hypoxic conditions, during which a normally risky journey becomes even more life-threatening.

Can Hypoxia Be Reduced?

Hypoxia has multiple sources and managing water quality in the Mississippi River to reduce it in the Gulf of Mexico would require a coordinated multistate effort. The states drained by the Mississippi River watershed would have to agree on methods to regulate nonpoint source pollution, upgrade sewer systems, and standardize agricultural technology and then to apply them on a massive scale. The Mississippi watershed–fifth largest in the world–may be too large and hypoxic processes too biologically complex for such a mass effort to be workable, even if the states could come to agreement. Controlling hypoxia may be more feasibly accomplished through a proliferation of smaller, local projects–for example, the regulation of industrial waste-water discharges or the improvement of water quality in local upriver freshwater systems that feed into the Mississippi.

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