Climate change may be sparking new and bigger "dead zones"

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Climate change seems to be starving some waters of oxygen

By Barbara Juncosa

“Wasteland” conjures up visions of dusty desolation where life is fleeting and harsh—if it exists at all. Oceans, too, have their inhospitable pockets. Scientists are discovering that climate change—and not just fertilizer from farm use—may be spurring the emergence of barren underwater landscapes in coastal waters. Expanding dead zones not only spell trouble for biodiversity, but they also threaten the commercial fisheries of many nations.

Dead zones are not new; they form seasonally in economically vital ecosystems worldwide, including the Gulf of Mexico and Chesapeake Bay. Agricultural runoff sparks many of these die-offs; increased use of nitrogen fertilizers has doubled the number of lifeless pockets every decade since the 1960s, resulting in 405 dead zones now dotting coastlines globally.

But lesser-known wastelands are also emerging—without nutrient input from farms. Alarms about such dead zones first sounded in Oregon during the summer of 2002. Usually “we see many schools of fish and lots of different species,” says David Fox of the Oregon Department of Fish and Wildlife, but surveys revealed dead fish and invertebrates littering the seafloor. The culprit was hypoxia—low-oxygen conditions, which can occur after the decomposition of organic matter in areas where deep waters well up to the surface.

The emergence of hypoxic areas so close to shore has startled researchers, comments Jack Barth, a physical oceanographer at Oregon State University. A decade ago scientists needed to sail out 50 miles or more to find hypoxic water off Oregon, but he says, the zone was now so close that “a long baseball homer hit off of highway 101” could land in it. To scientists’ surprise and dismay, “hypoxia has become a feature of the coast,” with its reemergence near shore every summer, states Francis Chan, a marine ecologist, also at Oregon State.

Ordinarily upwelling systems such as that off Oregon teem with life. As coastal winds push surface waters offshore, cold, nutrient-rich waters from below replace them, stimulating plankton blooms that serve as food for many marine organisms. In fact, upwelling systems lead to such productive ecosystems that they support some 20 percent of the world’s fisheries’ yield while making up just 1 percent of the ocean surface.

Dead zones can form, however, when these systems become supercharged, either because of fertilizer runoff or, as in the case of Oregon, because of changes in ocean circulation. When upwelling intensifies, more nutrients go to the surface, where plankton growth skyrockets. Those that are not eaten eventually die and rain down into deeper waters, where bacteria use available oxygen to decompose them. Hypoxia results when the rate of this widespread organic decay outpaces fresh supplies of oxygenated surface water.

Besides Oregon, other regions are seeing signs of enlarging dead zones. In South Africa, shifts in the upwelling ecosystem have been documented since the early 1990s. Recurring episodes of hypoxia along the coast have resulted in an increased frequency of commercially valuable rock lobsters traveling closer to shore in search of oxygenated waters, only to become stranded when the tide recedes. Along the coasts of Chile and Peru, where hypoxic episodes have taken place for thousands of years, changes may be brewing as reports of huge numbers of Humboldt squid and fish washing up on beaches after low-oxygen events have increased in recent decades. Prolonged hypoxia in these systems could precipitate “a drop in species diversity, with some groups, such as crustaceans, disappearing more quickly,” says Lisa Levin, a marine ecologist at the Scripps Institution of Oceanography.

Andrew Bakun of the University of Miami thinks that global warming may be driving the changes in upwelling, an idea he first proposed in 1990. As continents heat up, the pressure difference between air over warmer landmasses and that over the cooler ocean increases, which could strengthen coastal winds that drive the upwelling process. Short periods of unusually strong winds, for example, preceded each hypoxic event in Oregon. Although long-term wind data have proved difficult to analyze, coastal winds in Chile and South Africa appear to have intensified in recent decades.

Climate models have also predicted large-scale declines in oceanic oxygen. As surface waters warm up, they become less efficient at absorbing oxygen and act as a cap, preventing the mixing of oxygen into deeper layers. If upwelled into coastal regions, these deep waters—depleted in oxygen but rich in nutrients—may prime local areas for hypoxia. Studies have documented a drop in oxygen levels across the Pacific Ocean, possibly contributing to the emergence of hypoxia in Oregon.

The primary challenge facing scientists is lack of sufficient long-term data for upwelling systems, states Jane Lubchenco, an Oregon State marine ecologist. A recent symposium highlighted the urgent need for more monitoring, as well as the importance of continued communication among scientists. “It is clear that these systems are not exactly alike,” Lubchenco notes, but comparing them may help researchers figure out how hypoxia develops. Ultimately, predicting future changes will be crucial in determining if—or more likely, when—expanding low-oxygen zones might choke fisheries worldwide.

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