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The last 10 years have seen the lowest concentrations of oceanic oxygen levels within Monterey Bay since the 1930s, says Francisco Chavez, an oceanographer at the Monterey Bay Aquarium Research Institute.

OXYGEN-STARVED WATERS

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HYPOXIC ZONES MOVING CLOSER TO WEST COAST SHORES, INCREASING THREATS TO MARINE LIFE

Zones of low oxygen, where marine life is threatened, are expanding in the world's oceans, including in Monterey Bay.

But here and along the western coast of the U.S., more may be at play than the algal blooms responsible for most occurrences of dead zones — areas that are so depleted of oxygen that they can no longer support marine life.

Most low-oxygen areas occur from algal blooms in estuaries or along coastal regions, such as in the Gulf of Mexico and Peru. In Monterey Bay, agricultural runoff can trigger the explosion of marine algae, which deplete the water of oxygen as they decompose. More than 400 of these dead zones have occurred worldwide.

More recently, though, massive die-offs of Dungeness crabs and fish in Oregon and abalone in Northern California have revealed another source of hypoxic, or low oxygen, water. These

die-offs can occur when deeper offshore water, which is low in oxygen, is brought to shore by winds. And these subsurface waters off the western coast of the U.S. are growing alarmingly lower in oxygen.

Francisco Chavez, oceanographer at the Monterey Bay Aquarium Research Institute, reviewed about 100 years of oceanic oxygen levels within Monterey Bay.

"The last 10 years have seen the lowest concentrations since the 1930s," he said.

In addition, a natural patch of deeper water that is normally hypoxic is expanding. These zones of ocean, which exist worldwide from 600 to 3,000 feet below the surface, are now shallower and closer to shore. Most animals cannot survive in these zones, which contain less than 90 percent of the oxygen found in surface waters.

The zones provide a

natural buffer between bottom-dwelling species and shallower ones.

One animal that thrives in this zone is the Humboldt squid, a voracious predator that entered Monterey Bay nearly 10 years ago, perhaps taking advantage of the lower oxygen.

But scientists can't explain why this zone is expanding.

The "million-dollar question" is whether it's natural variation or human-induced, said Chavez.

Larry Crowder, science director for the Center for Ocean Solutions in Monterey, brought local researchers together in a public forum this month from Stanford's Hopkins Marine Station and Woods Institute, Monterey Bay Aquarium and MBARI. The center's ongoing effort helps link policy managers with scientists on emerging issues like sea-level rise and algal blooms.

Water quality manager Martha Sutula from the Southern California Coastal Water Research Project emphasized the importance of collaborating with scientists and thinking ahead about possible management actions — despite there being limited data and uncertainty in the science.

For instance, fisheries managers would need to know if they should manage fish stocks or endangered species differently.

"The questions managers need to know is, 'How severe is this problem and is it our problem?'" Sutula said.

Whether these hypoxic areas affect fisheries isn't clear. Fiorenza Micheli of Stanford University said there is no evidence to show the amount of fish caught are affected, but the composition of the fish caught has changed.

For instance, bottom-dwellers such as cod,

flounder and shellfish are replaced by smaller, open-ocean species at the bottom of the food web like mackerel and sardines. This shift has occurred in Peru, where the collapse of sardine and anchovy fisheries showed instances of low oxygen.

Though biological responses to this shift will vary, Micheli said, there will likely be "winners and losers."

"We need to think of the social and economic consequences and how these fishery shifts may affect communities in California," she said.

While everyone agreed more research is needed, it might be harder for those living along the coast to understand a problem exists.

Crowder said it's one reaction when people can see dead fish wash up onshore; it's another thing when it's unseen.

"Oxygen is declining along this coast and, without a doubt, will have an impact on marine resources. And the question is — what's driving that?" said Crowder.