New research reveals low-oxygen impacts on West Coast groundfish

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Researchers developed a sturdy, protective housing for oxygen sensors attached to trawl nets to protect them from damage. Survey vessels now carry such sensors on all of their tows to document associations between species and dissolved oxygen levels. Credit: NOAA Fisheries/Northwest Fisheries Science Center

When low-oxygen "dead zones" began appearing off the Oregon Coast in

the early 2000's, photos of the ocean floor revealed bottom-dwelling crabs that could not escape the suffocating conditions and died by the thousands.

But the question everyone asked was, "What about the fish?" recalls Oregon State University oceanographer Jack Barth. "We didn't really know the impacts on fish. We couldn't see them."

Scientists from NOAA Fisheries' Northwest Fisheries Science Center and Oregon State have begun to answer that question with a new paper published in the journal *Fisheries Oceanography*. The paper finds that low-oxygen waters projected to expand with climate change create winners and losers among fish, with some adapted to handle low-oxygen conditions that drive other species away.

Generally the number of fish species declines with oxygen levels as sensitive species leave the area, said Aimee Keller, a fisheries biologist at the Northwest Fisheries Science Center and lead author of the new paper. But a few species such as Dover sole and greenstriped rockfish appear largely unaffected.

"One of our main questions was, 'Are there fewer species present in an area when the oxygen drops?' and yes, we definitely see that," Keller said. "As it goes lower and lower you see more and more correlation between species and oxygen levels."

Deep waters off the West Coast have long been known to be naturally low in oxygen. But the new findings show that the spread of lower oxygen conditions, which have been documented closer to shore and off Washington and California, could redistribute fish in ways that affect fishing fleets as well as the marine food chain.

The lower the oxygen levels, for example, the more effort fishing boats

will have to invest to find enough fish.

"We may see fish sensitive to oxygen levels may be pushed into habitat that's less desirable and they may grow more slowly in those areas," Keller said.

Researchers examined the effect of low-oxygen waters with the help of West Coast trawl surveys conducted every year by the Northwest Fisheries Science Center to assess the status of groundfish stocks. They developed a sturdy, protective housing for oxygen sensors that could be attached to the trawl nets to determine what species the nets swept up in areas of different oxygen concentrations.

The study combined the expertise of fisheries scientists such as Keller who assess fish stocks with oceanographers such as Barth who track ocean conditions to look at the relationship between the two.

"Initially, we would tell them where the low oxygen was, and they would trawl within areas ranging from low to high oxygen," Barth explained. Later, oxygen sensors were deployed on all tows during the groundfish survey. "They would look at the catch and the species richness. We tried to get it down to the individual species level, where we could tell which fish correlated with which oxygen levels."

Low-oxygen waters appear off the West Coast in two ways, Barth said. The first is the eastward movement of deep, oxygen-poor water that laps up against the West Coast. The second occurs when wind-driven upwelling brings nutrients to the surface, fueling blooms of phytoplankton that eventually die and sink to the bottom. Their decay then consumes the oxygen, leaving what scientists call hypoxic conditions where oxygen levels are low enough to adversely affect marine organisms.

The scientists examined the effects of varying oxygen levels on four representative species: spotted ratfish, petrale sole, greenstriped rockfish and Dover sole.

Spotted ratfish and petrale sole were the most sensitive to changes in oxygen levels, with their presence declining sharply as the amount of oxygen dissolved in the water declines. But greenstriped rockfish and Dover sole were largely unaffected by dissolved oxygen levels.

Dover sole is adapted to low-oxygen waters, with gill surface areas two to three times larger than other fish of similar size that allow it to absorb more oxygen from the same amount of water. Dover sole also are among a few fish species that can reduce their oxygen consumption to very low concentrations, probably an adaptation to low-oxygen conditions.

The research is continuing, with trawl survey vessels carrying oxygen sensors on all of their tows since 2009, Keller said. Further data should provide insight into the response of additional fish species to low oxygen conditions, Keller said.

More information: *Fisheries Oceanography*, onlinelibrary.wiley.com/doi/10 … 1/fog.12100/abstract

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