

The OCEANA logo features a stylized white wave icon to the left of the word "OCEANA" in a bold, white, sans-serif font. The background of the entire page is a dark, blue-toned underwater photograph of a research vessel's deck at night, illuminated by various lights, with several people visible working on the deck.

OCEANA

WINTER 2015/2016 OCEANA.ORG

VICTORY

CREATING THE LARGEST
PROTECTED AREA IN THE AMERICAS



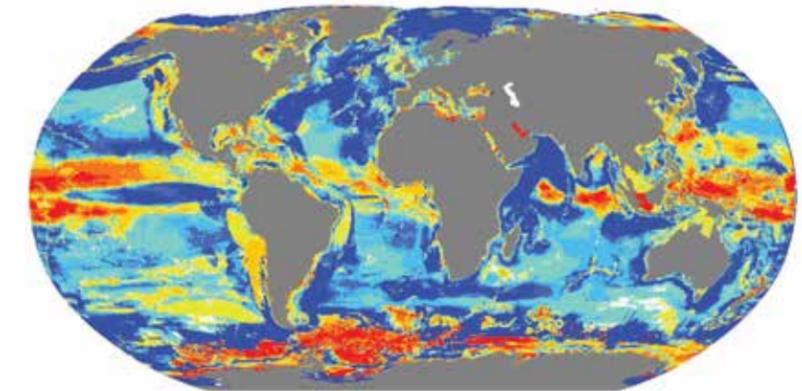
Daniel Pauly is a Professor of Fisheries at the Fisheries Centre of the University of British Columbia, the Principal Investigator of the Sea Around Us Project and a member of the Board of Oceana.

Struggling to Breathe: The Impact of Warming Oceans on Fish and Oxygen

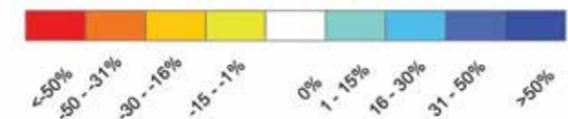
Marine fishes and invertebrates such as mussels, squids, shrimps or lobsters, like all animals, must take in oxygen and exhale carbon dioxide to survive. They must breathe, even if they do this, in a manner very different from us, through gills. Breathing is hard work for fish as water contains about 30 times less oxygen than air. If climate change warms the water fish live in, that water has even less oxygen and more dissolved carbon dioxide. Subsequently, fish have difficulties breathing.

This oxygen depletion is intensified by the fact that fish, unlike us, cannot regulate their body temperature. With increasing water temperatures, their metabolic rate increases. As a result, they need more oxygen and also produce more carbon dioxide. Furthermore, as the density difference between surface and deeper water layers increases with these changes, mixing between these layers is reduced, and the stratification of the ocean increases. Stratification acts as a barrier between the atmosphere and the water, preventing oxygen from penetrating into the deeper ocean.

For all these reasons, fish in warming oceans get less oxygen just when their oxygen requirements increase. Moreover, exhaling carbon dioxide (or rather excreting it through their gills) is more difficult when increasing amounts of atmospheric carbon dioxide is dissolved in the ocean, causing it to become more acidic. Fish that cannot



CHANGE IN CATCH POTENTIAL



Predicted impact of global warming on fish catches

Predicted impact of global warming on fish catches in 40-50 years, with red indicating declines of 50% and more (from Cheung, Lam, Kearney, Sarmiento, Watson, Zeller and Pauly 2009; Global Change Biology; see also IPCC, 5th Assessment, Summary for Policy Makers).

relocate remain smaller as a result, and/or their local population collapses.

However, the response of most fish to the increasing temperature (and reduced oxygen) of their habitats is to shift their distribution toward cooler waters—toward the poles—northward in the Northern Hemisphere and conversely in the Southern Hemisphere. Along the coasts of countries with temperate climates, such as much of the U.S. or Western Europe, this leads to warm-water fish species appearing in the catch and the cold-loving species becoming scarcer.

However, in the tropics, there are no 'hotter-water' species to replace the tropical species that are migrating out, while the non-migrating tropical species try to adapt. Hence, tropical fisheries will decline more due to global warming than in temperate areas. (See figure above for potential change in catch.) The implications for the food security of tropical developing countries are tragic.

Global warming has already had a big impact on fish and fishers. This will increase in the future, simply because fish must breathe.