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Hot waters make it hard for fish to breathe

Climate change causes eelpout population to crash from suffocation.

by Katharine Sanderson
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The warming of the oceans is having a cruel effect on some fish: they can't breathe fast enough to survive in a hotter home.

Hans Prtner and Rainer Knust from the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany, studied the viviparous eelpout (*Zoarces viviparus*), a fish that lives in the northern Wadden Sea. When summer water temperatures were about 20 degrees C the fish were fine, but after a hot summer of 25 degrees C, the fish population crashed to nearly zero.

The reason, the team concluded after lab studies of the fish, is that the animals' cardiovascular systems were working at the limits of their comfort zone. As the fishes' metabolism speeds up in higher temperatures, they need more oxygen, but their hearts can't pump fast enough to provide it.

Every species has a temperature range, or 'thermal window', within which it can breathe comfortably. The eelpout of the Wadden Sea are now butting up against the upper limits of their window, says Prtner. The fish don't like to move too far from their natural habitat, so are unlikely to swim north to cooler waters. The alternative is suffocation.

The largest of the species die off first, says Prtner, because it takes even more energy to pump oxygen around a large animal than a smaller one.

What makes things worse is the fact that warmer waters contain less dissolved gas, including oxygen. And warm conditions may become more common in the future: these waters have warmed by 1.13 degrees C over the past 40 years.

Combined, the future looks bleak for fish struggling to catch a breath, they report in *Science*.

Hotting up

Michael St John, an oceanographer at Hamburg University's Institute for Hydrobiology and Fisheries Science in Germany says that Prtner's physiology experiments are first rate. But he suspects there are a raft of different effects causing the eelpout crashes.

Other factors to do with warming waters can spell bad news for fish, such as new predators or competing species that arrive in their habitat. But Prtner says that the physiological process of oxygen demand is the first thing to respond to warmer seas, and is the major mechanism to blame for the decline of the eelpout.

The notion that animals have a thermal window within which they are comfortable is not new. But the eelpout study is unique in showing how climate change can cause a species to cross the upper limits of their window and crash.

Tobias Wang, a zoophysiologicalist at Aarhus University, Denmark, is impressed that Prtner has linked observations of populations declining with this physiological explanation. Both he and Prtner suspect that this mechanism will cause many other species to crash too.

The eelpout will need to shift their thermal window if they are to survive the higher temperatures of their habitat. But there is no sign of that happening, says Prtner. "They may be able to adapt over long times but the current speed of global warming won't allow that."

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1 Prtner O., Knust R., et al. *Science*, 315. 95 - 97 (2007).

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