European Commission

Science for Environment Policy

Diverse fish communities have greater resistance to climate change

Marine fisheries play a key role in feeding human populations, but are faced with the twin threats of overexploitation and climate change. Using a comprehensive database of global reef-fish communities, a team of researchers has found that the greater the diversity of fish in an assemblage, the less vulnerable that assemblage is to climate change. The researchers suggest climate change mitigation efforts should include a focus on maintaining a wide range of species in at-risk communities.

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Fish are an important contributor of animal protein to the diets of people across the world, so ensuring environmental sustainability for fisheries is very important for food security. This is why the EU's Common Fisheries Policy[1], which also stresses the need for economic and social sustainability for fishing communities, is so important. Environmental, economic and social factors must all be considered when establishing quotas, ensuring that the ecosystem's capacity to deliver services is not compromised. Better understanding the functioning of marine ecosystems can help to achieve this.

This study focused on understanding one particular characteristic of marine ecosystems: biodiversity. The number of different species an ecosystem contains (a key aspect of biodiversity) is often linked with both productivity and stability, but the scale of its impact has proved controversial owing to a lack of conclusive studies on real-world ecosystems.

Biodiversity is declining in many areas, and it is important to work out what effect this decline is having on the resilience of fish stocks to climate change and harvesting by humans. A fish community's capacity for production can be measured using fish biomass (the total quantity or weight of fish in a given area), which can be established through a combination of fish censuses[2] conducted by SCUBA divers and data on species-specific length–weight relationships[3].

The researchers employed a global dataset of over 4 500 surveys of fish assemblages inhabiting tropical and temperate reefs around the world to obtain biomass values, and collected data on 25 environmental and human-impact variables (e.g. dissolved nutrients and size of local human populations) to test the impact those variables have on biomass. They used two indicators of diversity — species richness (the number of different species represented in an ecological community) and functional diversity (the range of things that organisms can do in an ecosystem) — and found these two indicators showed an effect on fish biomass comparable in magnitude to the effect of human and climate influences.

The most important finding, however, came from the team's analysis of how different stressors interact. Not only does high biodiversity directly increase fish biomass, as functionally distinct fishes use the range of available resources more efficiently, it also controls it indirectly by buffering biomass against the negative effects of climate change, potentially because diverse communities contain species with a range of thermal niches. In regions with the greatest diversity, the mean biomass at high temperatures was greater than in less diverse regions, and the negative impacts of temperature variability (which reduces biomass) were halved.

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1. The Common Fisheries Policy (CFP): www.ec.europa.eu/fisheries/cfp/index_en.htm
2. The Reef Life Survey: http://reeflifesurvey.com/
3. FishBase: http://www.fishbase.org

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These findings are highly relevant to the global fishing industry and indicate that the maintenance of diverse fish communities will be key if fisheries are to remain productive in oceans that are already experiencing the effects of climate change. However, this study is particularly relevant for high-latitude regions such as Europe, which are surrounded by cool, nutrient-rich oceans, and are home to a relatively small array of fish species compared to the tropics. The researchers obtained separate estimates of the dependence of fish biomass on species richness for different regions, including the North Sea and the Mediterranean, and found that biomass is most sensitive to changing diversity in these locations. If high-latitude marine ecosystems are particularly vulnerable to climate change, as these results suggest, fisheries policies in these regions should be modified to include a focus on maintaining biodiversity.

The authors also suggest that the ability of biodiversity to 'buffer' against the negative impacts of climate change may be a more general phenomenon, noting similar results seen in a study[4] of grassland plants. This could necessitate a new approach to climate change mitigation efforts, with an increased focus on maintaining a wide array of species in at-risk communities.

4. Isbell, F., Craven, D., Connolly, J., *et al*. (2015). Biodiversity increases the resistance of ecosystem productivity to climate extremes. *Nature*, 526: 574–577. Doi:10.1038/nature15374: www.nature.com/nature/journal/v526/n7574/abs/nature15374.html