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Will ocean life have time to adapt to climate change?

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Direct effects of climate warming on biodiversity pose a serious conservation challenge for marine life, according to new research just published in the peer-reviewed journal *Science*.[1] The research concludes that marine life may need to relocate and readjust faster than life on land, challenging the idea that ocean life could respond more gradually to climate change than land species due to slower warming in the oceans.

Credit: Megan Saunders

'Analyses of global temperature found that the rate at which marine life needs to relocate is as fast, or in some places faster, than for land species,' says paper co-author, Dr Elvira Poloczanska from CSIRO's Climate Adaptation Flagship . ' . 'This is despite ocean warming being three times slower than [on] land.'

Dr Poloczanska adds that, globally, an increasing number of species are responding to climate change by changing their distributions and the timing of life cycle events such as breeding, spawning and migrations.

She says that a 1°C change in ocean temperature may mean that marine plants and animals will have to travel hundreds of kilometres to stay in their comfort zones. This can present major problems for marine organisms, particularly those that are unable to move long distances, such as corals.

The collaborative work was led by Dr Mike Burrows from the Scottish Association of Marine Science and Dr David Schoeman of the University of Ulster, United Kingdom. It was carried out through the Marine Impacts Working Group at the National Centre for Ecological Analysis and Synthesis, California. Dr Poloczanska and Associate Professor Anthony J. Richardson – from the CSIRO Flagship and the University of Queensland and a co-author of the*Science* paper – led the working group.

The team measured the pace of change in temperatures over the past 50 years, including the shift in temperature across

the landscape and seascape.

Assoc. Prof. Richardson says the rate at which marine life relocates depends not only on how much the temperature changes, but also on how far a species needs to travel to reach its preferred temperature conditions. Marine species need to travel long distances to find a preferred temperature zone, because temperature varies relatively little across much of the oceans compared to on land.

'On the land in flat areas such as deserts, for example, animals and plants must relocate over long distances to find a change in temperature, but in mountainous areas, this change can be found in shorter distances,' he says.

'Marine animals and plants will have to travel long distances in many parts of the ocean, where temperature changes relatively little, to remain in their preferred temperature.

'In warm areas such as the Equator, which is a marine biodiversity hotspot, marine life will have to travel very far to find a suitable temperature zone, and we are concerned that threats to biodiversity [there] may be high.'

Credit: Megan Saunders

Seasonally, marine species will need to rapidly adjust their timing for reproduction activities, such as flowering for plants and breeding migrations for animals.

'The seasonal temperature cycle is relatively reduced in the ocean compared with land, so again this means that if a plant or animal wants to maintain its thermal environment and keep pace with warming, it will need to move its reproduction earlier in the year as much, or more, in the ocean than on land,' adds Assoc. Prof. Richardson.

The study also showed that patterns of climate change are not uniform, with different regions warming – and in some cases, even cooling – at different rates. Large areas of the Southern Ocean, for example, are cooling, which could lead to shifts in the distribution of marine life away from polar regions.

'While organisms may respond to aspects of climate change other than temperature, we studied the global thermal environment because it is probably the most important variable controlling global distribution and timing of marine life,' says Dr Poloczanska.

'Although we only looked at the ocean surface, and many marine species live deeper, the majority of these ultimately rely on [primary] production at the sunlit ocean surface or have larval stages that disperse in shallower depths.'

1 Burrows MT, Schoeman DS, Buckley LB *et al.* (2011) The pace of shifting climate in marine and terrestrial ecosystems, Science, **334** (6056)

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