Climate change disrupts core habitats of marine species, finds modeling study

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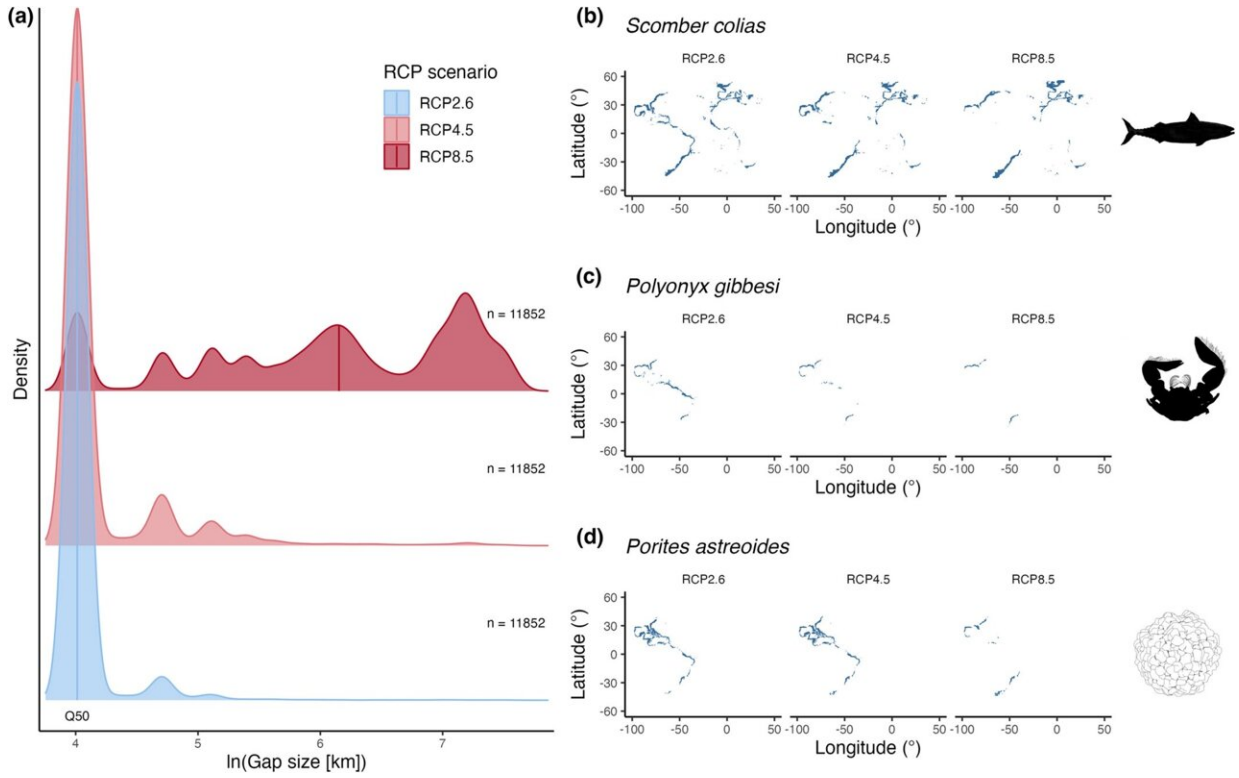

(a) Density distributions of the size of newly emerging gaps between the southernmost predicted occurrence in the northern hemisphere and the northernmost predicted occurrence in the southern hemisphere of species that currently have continuous distributions around the equator (n = 11852). Colors represent the distribution of gap sizes for the different Representative Concentration Pathway (RCP) scenarios. The Q50 line indicates the position of the median. Gap sizes >2000 km are rare and, therefore, not displayed. The maximum gap sizes are 8.36 (4259 km, RCP2.6), 8.56 (5223 km, RCP4.5), and 8.83 (6821 km, RCP8.5). (b–d) Projected future global distribution patterns

under the different RCP scenarios for three example species: the Atlantic Chub Mackerel (b, Scomber colias), the Eastern tube crab (c, Polyonyx gibbesi), and the Mustard hill coral (d, Porites astreoides). Distributions illustrate the difference in emerging gap size under RCPs 2.6, 4.5, and 8.5. Credit: *Global Change Biology* (2023). DOI: 10.1111/gcb.16612

A comprehensive modeling study indicates the extent to which climate change threatens marine ecosystems and their biodiversity. According to the study, the core habitats of a large proportion of marine species could not only shift poleward, but also shrink significantly by the end of the century. In addition, currently continuous habitats around the equator may be disrupted.

If climate change continues at the current pace, it is very likely that a majority of marine species will lose considerable amounts of their currently suitable habitat ranges by the end of this century. This is the result of a modeling study published in the current issue of the scientific journal *Global Change Biology*.

The interdisciplinary team of researchers included scientists of the Helmholtz Institute for Functional Marine biodiversity at the University of Oldenburg (HIFMB), the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) and the GEOMAR Helmholtz Centre for Ocean Research in Kiel.

"Ocean's biodiversity changes faster than in terrestrial ecosystems. To be able to protect marine species and with them all the marine resources that humans depend on, it is important to understand where and how marine species communities may change," says Dr. Irene Roca, biologist and former researcher at the HIFMB, who led the study together with HIFMB marine ecologist Dr. Dorothee Hodapp.

Scientists are already observing that many marine species have started shifting their distributional ranges with the changing environmental conditions as a consequence of global warming. However, understanding and projecting what marine biodiversity might look like in the future and how the extent of habitats might change is a difficult task due to many unknowns, Hodapp points out.

"Many species are only poorly studied and we don't know exactly how the environmental conditions will look like in about in a few decades," she says. Moreover, previous projections often considered temperature as the sole environmental factor driving future biodiversity changes.

To overcome these problems to a certain extent, the researchers based their modeling efforts on occurrence data of more than 33.500 marine species and seven environmental factors such as water depth, water temperature, salinity, and oxygen concentration. Based on this information and assuming three different CO_2 emission scenarios the team estimated whether and where the species are likely to occur in the future.

The results indicate that species' so-called core habitat ranges—that is the marine area in which chances are higher than 50 percent that a particular species occurs based on its preferred environmental conditions—may not only shift but may also be considerably reduced in case of the high CO_2 emission scenario.

In addition to habitat loss, the results give an idea about how the preferred habitat area of many species may be disrupted. "Especially along the equator, our model projections revealed areas which are ill-suited for most marine species, for instance because of high temperatures," Roca explains. If such regions developed in the future this would disrupt currently continuous equatorial habitat ranges.

Fragmented habitats lead to smaller population sizes which can put species at higher risk to go extinct. However, in the long-run new species could also develop. Another problem is that species can only keep pace with changing environmental conditions to varying degrees, Hodapp explains. This can lead to a restructuring of food webs and changes in the interactions between habitat-forming species, such as corals, and their inhabitants.

"Even though our model does not account for such interspecific interactions, the results provide valuable clues on how differently marine environments and communities are likely to change depending on the future CO_2 emission scenarios," the marine ecologist says.

Being aware of such a high risk of a fundamental reorganization of marine life will pose further challenges to conservation management, she adds. "We need to think ahead and work on effectively implementing the recent international agreements on biodiversity protection."

More information: Dorothee Hodapp et al, Climate change disrupts core habitats of marine species, *Global Change Biology* (2023). DOI: 10.1111/gcb.16612

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