Galapagos study highlights importance of biodiversity in the face of climate change

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The researchers modeled the effects of biodiversity by analyzing wave strength in conjunction with the foraging abilities of various fish. Credit: Witman Lab

As the world's climate continues to change, biologically diverse communities may be most capable of adapting to environmental challenges.

While biodiversity's importance in adaptation may be well appreciated

already, new research by Brown University biologists studying the effects of wave turbulence on sea creatures paints a clearer picture of why biologically diverse communities are more likely to thrive.

"Lately, there has been a lot of support in the news for maintaining biodiversity," said study author Robert Lamb, a recent Ph.D. graduate from Brown who conducted the study as a biology graduate student. "But rarely do people explain why that is so important. This research helps show why diversity really matters: A more diverse community is more resistant to rapidly changing environmental conditions."

Co-author Jon Witman, a professor of biology at Brown, added that the group's research "will help us understand how whole marine communities—not just single components—will be affected by increasing environmental stress in this era of climate change."

The study, published in *Ecology*, also emphasized the impact of creatures' mobility on their resilience.

Working in the Galapagos Islands, the Brown biologists studied wave motions, conducted underwater experiments and used marine life censuses to evaluate the effects of wave turbulence on sea urchins and fish feeding on algae. The researchers found that urchins were unable to feed in areas with intense waves and therefore preferred sheltered locations. In contrast, fish dominated in more turbulent areas. Unlike urchins, many fish species are highly mobile, allowing them to dart to the seafloor to feed on algae between rough waves and quickly retreat when conditions become dangerous.

Highly mobile foragers appear to favor turbulent areas because these locations contain particularly abundant food sources. Another facet of the study compared the biomass of algae in wave-exposed versus wave-sheltered areas, and it found that wave turbulence enhances algae

growth, likely because the motion of the water promotes the delivery of nutrients.

Lastly, the researchers modeled the effects of biodiversity by analyzing wave strength in conjunction with the foraging abilities of various fish. In other words, they predicted the extent to which foraging rates would drop if different numbers of species disappeared from the ecosystem. They found that biodiversity was most important for ecosystems in rapidly changing areas (i.e., areas with intermediate to high wave exposure).

Biodiversity significantly increases grazing rates in these areas—and grazing is crucial, Lamb said, because a fish's meal serves as the first source of energy in a chain reaction that perpetuates the entire ecosystem. A surgeonfish that consumes algae, for example, can then serve as a food source for an animal higher on the food chain, such as a shark or a sea lion. Fish also help corals grow by reducing competing algae. A more diverse community is likely to include species with greater mobility and tolerance toward stressful environmental conditions, thereby fulfilling these important ecological roles.

Lamb said that the findings are particularly important to consider in the context of climate change.

"We must maintain diverse communities through management of our fisheries and marine protected areas," he said. "Diverse and healthy ecosystems will be more resilient to the types of changes that are undoubtedly going to occur."

Going forward, the research team will continue their work in the Galapagos Islands. They're currently conducting chemical analyses to evaluate how the diets of fish are affected when surface waters warm up during El Niño conditions. During El Niño, nutrients sink deep into the

ocean, leaving less food for fish that swim closer to the surface.

"For about six months, the sea's surface temperature heats up by about 2.5 degrees Celsius, which is equivalent to many prognoses of long-term climate change," Lamb said. "So it gives us a fast-forward window into the future of what these food webs may actually look like."

Lamb expects that this research will further emphasize the importance of biodiversity.

"A more diverse community would be more likely to be accessing a variety of food types," he said, "so if any one particular food type disappears because temperatures increase or because the oceans become acidified or for another environmental reason, there would be other species consuming different food resources that might be able to persist."

More information: Robert W. Lamb et al, Consumer mobility predicts impacts of herbivory across an environmental stress gradient, *Ecology* (2019). DOI: 10.1002/ecy.2910

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