

Even biodiverse coral reefs still vulnerable to climate change and invasive species

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Parrotfish. Credit: Professor Nick Graham, Lancaster University

A new study reveals clear evidence highlighting the importance of fish

biodiversity to the health of spectacular tropical coral reef ecosystems.

This is the case for reefs that are pristine and also those that have been affected by stresses, such as bleaching events caused by warming oceans.

However, the study's results show that even though [strong relationships](#) between diversity and a healthy ecosystem persist, human-driven pressures of warming oceans and [invasive species](#) still diminish ecosystems in various ways.

This highlights that protecting fish biodiversity is a key factor for improving the survival chances of coral reef ecosystems in the face of rapid environmental change. But the researchers caution that without removing human-driven stressors, protecting biodiversity alone might not be enough.

Dr. Casey Benkwitt, of Lancaster Environment Centre and lead author of the study, said: "Our study, which is the first of its kind to look at relatively pristine coral, reveals the strong link between rich biodiversity and a thriving ecosystem. This relationship is still evident even when an ecosystem has been degraded and provides further clarity on just how crucial it is to maintain biodiversity to give [tropical coral reefs](#) a fighting chance to thrive in an uncertain future.



Angelfish. Credit: Dr. Casey Benkwitt

"However, the bad news is that the functioning of these fragile ecosystems is still vulnerable and was impaired in different ways by climate change and invasive species on nearby islands."

A team of researchers conducted surveys on coral reefs around ten islands in the remote Chagos Archipelago—the largest uninhabited and unfished coral reef area in the Indian Ocean.

Their surveys counted the number of different fish species on reefs as a

measure of biodiversity. They also measured how well an ecosystem was functioning relative to fish biodiversity at different islands using two key indicators -the biomass of fish living on a reef, and a measure of productivity, which is the rate at which biomass is produced.

Dr. Benkwitt, said: "We were surprised that the positive effects of biodiversity on ecosystem functions were so strong because such clear patterns are rare in ecological data. These results match previous studies on less pristine coral reefs, and in other terrestrial and marine systems. To see the same patterns in so many places suggests the positive relationship between diversity and ecosystem function may be one of the few general rules in ecology."

Importantly, the researchers also looked at coral reefs under pressure from multiple human-driven factors. This is the first time scientists have measured these kinds of effects outside of a lab.



Fusiliers. Credit: Dr. Casey Benkwitt

The scientists had data from before and after a major heatwave in 2016 that caused bleaching and death of corals. This coral loss caused biodiversity to plummet by 17 per cent. Because of the strong relationship between biodiversity and ecosystem function, such losses in biodiversity caused by warming oceans will result in coral ecosystems that are not able to function as well.

Professor Nick Graham of Lancaster University and co-author of the study said: "The large negative effects of coral bleaching on biodiversity is worrisome as warming events are becoming more and more common. Because high diversity is key to ecosystem function, this means that preserving biodiversity may be increasingly important, but also increasingly challenging, in the future."

The scientists also studied coral reefs experiencing a reduction in nutrients caused by invasive rats on nearby islands. The rats, which arrived with people on boats decades ago, decimate wild bird populations, resulting in fewer droppings. These bird droppings act as fertiliser for the reefs when washed off into the sea, increasing fish growth rates and the amount of fish on a reef.

The researchers found that the coral reefs near islands with rats, and therefore with fewer seabird nutrients washing off to reefs, experienced lower levels of biomass. This shows that even when maintaining biodiversity, coral [reef](#) ecosystems are still vulnerable to human-caused stressors.

Dr. Benkwitt said: "The bleaching event and loss of nutrients each

reduced ecosystem functions in different ways. This means that managing each stressor will have complementary benefits for coral reefs. While biodiversity is clearly important to ecosystem function, [biodiversity](#) conservation may become more difficult and may not fully sustain [ecosystems](#) unless underlying stressors, such as climate change, are reduced."

The findings are outlined in the paper 'Biodiversity increases [ecosystem functions](#) despite multiple stressors on [coral reefs](#)', which has been published in the journal *Nature Ecology and Evolution*.

More information: Biodiversity increases ecosystem functions despite multiple stressors on coral reefs, *Nature Ecology and Evolution* (2020).
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