



Diverse ecosystems vulnerable in changing environmental conditions

Changing environmental conditions could put diverse ecosystems, such as rainforests and coral reefs, at greater risk of multiple extinctions. A new study suggests that, rather than protecting ecosystems from collapse, high levels of biodiversity may actually prove risky in a situation such as climate change – where an unpredictable environment can suddenly extinguish a population needed to support an ecosystem, leading to knock-on effects further up the food chain.

The environment is increasingly changeable. Human activities, such as farming and the extraction of natural resources, affect the environment in many different ways, changing conditions across many different ecosystems. In particular, human-induced climate change may lead to more extreme weather events in the future, with climate models predicting that hurricanes, storms and heat waves will become more frequent. Understanding the effects of all these different changes on individual species, and species diversity more generally, is complex.

Theoretically, rich biodiversity should offer protection against environmental instability. While some species suffer, others will benefit, thus guarding against collapse of the ecosystem as a whole. On the other hand, the loss of one key species could unbalance an entire ecosystem, triggering a cascade effect or 'extinction cascade'. The researchers took a mathematical modelling approach to investigating the potential ecological effects of environmental change. They were particularly interested in any differences between the responses of species-rich and species-poor ecosystems to environmental change.

Their results, based on hypothetical food webs containing between 6 and 24 species, suggest that more diverse communities face a greater risk of extinction cascades. The researchers suggest that this means species-rich ecosystems, such as tropical rainforests and coral reefs, might be more vulnerable to environmental change.

They explain that, in more diverse communities, populations at the bottom of the food chain, usually plants, are regulated by competition between the different species. This means food webs containing more species are built on more but smaller populations. Each population is therefore closer to the threshold for extinction and are more likely to become extinct when environmental change causes numbers to fluctuate. These losses could then reverberate throughout the food web, leading to extinctions further up, first in herbivores and then carnivores.

'Specialist consumers', which rely heavily on one food source, rather than several, are more likely to become extinct. These findings are supported by a separate field experiment in which the stability of specialist herbivore populations declined with increasing plant species diversity, whilst the stability of 'generalist herbivores', which eat a range of plants, was unaffected or increased with increasing plant diversity.

Although in the long term, biodiversity should be beneficial for ecosystem stability, the study suggests that in the short-term, high biodiversity poses a risk to individual species within an ecosystem under changing environmental conditions, such as climate change.

The researchers go on to suggest that the higher number of species in a diverse ecosystem should mean that more remain even after an extinction cascade. However, the ecosystem then becomes less diverse and perhaps more vulnerable over the longer term.

Source: Kaneryd, L. Borrvall.,C., Berg, S. *et al.* (2012). Species-rich ecosystems are vulnerable to cascading extinctions in an increasingly variable world. *Ecology and Evolution*. 2(4): 858-874. DOI: 10.1002/ece3.218.

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