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How will biodiversity loss compromise Earth's life support systems?

Scientists have evaluated two decades of research into declining biodiversity and concluded unequivocally that loss of species richness leads to a reduction in how well ecosystems function. The researchers evaluated the evidence for key biodiversity theories and predicted that scientific progress in the next five to ten years will provide the information we need to efficiently conserve certain ecological processes.

Over a century ago, Charles Darwin proposed that the number of species present in an ecosystem determines how productive it is (i.e. how much organic material (biomass) it produces) - since each species fulfils a particular function. This is commonly known as the "niche partitioning" theory.

The scientists evaluated 574 independent studies to find evidence relating to the "niche theory" and other key questions about the importance of primary producer (plant and algae) diversity to ecosystem productivity. The data from all these studies covered 541 different species across 30 different habitat types, or biomes. However, very few of the studies provided clear evidence of niche partitioning, begging the question why biodiversity has a strong impact on productivity. The weight of evidence confirmed that, on average, lower plant and algae biodiversity lessens the ability of ecosystem producers to capture light and nutrients, which decreases their efficiency in converting these resources into new biomass.

The scientists evaluated the logical hypothesis that ecosystem productivity will rapidly decline as biodiversity decreases, with global environmental change. Evidence suggests that initial losses of plant species through extinction will have a relatively small impact on ecosystem functioning, but increasing rates of species loss will lead to accelerated changes.

Scientists have previously estimated that 50 per cent of species need to be conserved for an ecosystem to function at 75 per cent of its maximum productivity. The new analysis indicated that these estimates are too low and that, on average, 92 per cent of species need to be conserved to maintain just 50 per cent of the maximum productivity.

In terrestrial ecosystems, high biomass in diverse communities is driven not only by one or two particularly productive species, but by species "complementarity" – whereby species use resources in ways that are unique in space or time. The exact mechanisms for complementarity are not yet well understood, but it may be due to the popular "niche theory", say the researchers.

Another factor, for example, may be a greater natural range of predators in diverse ecosystems, which keep the abundance of plant-eating pests to a minimum. There is also some evidence to suggest that CO_2 uptake from the atmosphere is compromised by low plant biodiversity, although more work is needed to better understand the controlling factors.

Importantly, the scientists also found that the effect of plant diversity on productivity was clearer when studies were carried out over longer time periods and larger geographical areas. This is important for future research design and suggests that past studies may have significantly underestimated the importance of plant biodiversity.

Although progress in this field has been impressive so far, current and future work will need to focus on more complex questions, such the issue of complementarity, how to apply experimental results to the scales at which conservation efforts are needed (e.g. islands, forests or national parks) and how the ecosystem effects of biodiversity loss compare to other environmental changes, such as pollution and habitat loss.

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Source: Cardinale, B, Matulich, K., Hooper, D. U et al. (2011). The functional role of producer biodiversity in ecosystems. *American Journal of Botany.* 98(3): 572-592.

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