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Biodiversity loss link with disease 'consistent'

Places with low biodiversity more prone to pathogen spread and emergence

The white-footed mouse is the most competent host in the northeastern USA for the bacterium that causes Lyme disease, and for the ticks that transmit the bacteria.

Image credit: J. Brunner, 2008

A high diversity of plant and animal life could either enhance or limit the spread of infectious diseases, but scientists writing in *Nature* today weighed up the evidence to find that on balance, the risk of pathogen spread and emergence increases with biodiversity loss.

"This pattern occurs across ecological systems that vary in type of pathogen, host, ecosystem and transmission mode," write Felicia Keesing, of Bard college in New York, and colleagues, in a review article.

The authors cite as an example West Nile fever, for which **studies** point to a high risk of human cases in areas with a low diversity in bird species that harbour the virus. Hantavirus pulmonary syndrome is another example, where a lower diversity in small mammals can raise the prevalence of the virus in rodent hosts, leading to higher human exposures.

Population growth over the past few decades has brought record changes in the rate with which living organisms become extinct, and this is estimated to surge further over the next 50 years. The loss in diversity of plant and animal ecosystems, species and genes threatens human well-being because people benefit from living in an environment with a healthy capacity to provide essential 'ecosystem services' such as recycling of nutrients and water purification.

High extinction rates are also bound to impact on infectious diseases, which "by definition involve interactions among species", say Keesing and colleagues. But the effect may not necessarily be detrimental: although high biodiversity could mean that pathogens are more likely to die out when passed on to unfavourable hosts, it could also boost disease transmission by providing a bigger 'pool' of novel infectious agents.

"However, in recent years, a consistent picture has emerged," they write. Their literature review suggests that biodiversity loss can affect disease transmission in three ways: by changing the density of animals that carry and transmit pathogens in a particular area, changing the behaviour of animals in a way that affects contact patterns with other animals and pathogens, or by changing the state of health of disease-host and vector animals.

"Connections between biodiversity and disease are now sufficiently clear to increase the urgency of... efforts to preserve natural ecosystems and the biodiversity they contain," say Keesing and colleagues.

In analysing how biodiversity loss impacts on disease transmission, one of the difficulties has been separating the effects of a lower number of living organisms in a particular area (density) from the effects of lower variation (diversity). But the authors say recent studies suggest that the spread of disease can increase as a result of reduced biodiversity even when the number of disease hosts remains unchanged.

"Reducing biodiversity can increase disease transmission when the lost species are either not hosts for the pathogen or are suboptimal ones," they explain. In each case, the species that remain and that harbour the pathogen would be more prevalent in a less biodiverse area. They add that species most likely to be lost with declining diversity are those that tend to reduce pathogen transmission.

So the authors propose that one way to manage disease spread is by managing diversity. "The addition of particular species — for example, natural enemies or competitors — can reduce the impacts of established pathogens."

But they also point to unanswered questions, including the effect of biodiversity changes on immune function and the microbiome (the microbial cells in a particular organism). "The effects of microbial diversity within and upon host bodies show intriguing similarities to the effects of macroscopic species diversity on disease transmission in aquatic and terrestrial ecosystems."

In discussing the effect of biodiversity loss on disease emergence, which some scientists suggest amounts to a **new epidemiological transition**, Keesing and colleagues suggest a more complex mechanism and say that environmental pressures, **socio-economic factors**, and drug resistance could play a role.

They suggest that efforts to prevent new zoonoses should focus on predicting **emergence 'hotspots'**, where biodiversity should then be protected and pathogens monitored. But they caution against more drastic measures in light of the complex dynamics between biodiversity and pathogen transmission. "Managing potential emergence hotspots by attempting to eliminate them is likely to backfire because the species most resilient to habitat destruction and degradation may be those that amplify pathogen transmission."

Reference and link

1. Keesing F, Belden LK, Daszak P, Dobson A, Harvell CD, Holt RD, *et al*. Impacts of biodiversity on the emergence and transmission of infectious diseases. *Nature* 2010. **doi**: 10.1038/nature09575

US Environmental Protection Agency information on biodiversity and human health

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