Researchers find spatial scale changes ecological processes driving disease

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Researchers from the University of South Florida (USF) and a colleague at the Institute of Zoology in Beijing, China have found that outbreaks of three emerging diseases and parasites - West Nile virus, Lyme disease and amphibian chytridiomycosis - are driven by different ecological processes at different spatial scales. Their data also suggests that focusing on a single spatial scale can lead to inaccurate estimations of the impact humans are having on biodiversity, disease emergence, and the environment.

A paper describing their research was published this week in the *Proceedings of the National Academy of Sciences*.

"Humans are contributing to unprecedented rates of infectious disease emergence, climate change and biodiversity loss," said study leader Jeremy Cohen, a graduate student in USF's Department of Integrative Biology. "However, whether human ecological impacts affect the distribution of disease and other organisms differently at local or regional scales has been a compelling question, one that the research team wanted to answer."

Because understanding emerging diseases is critically important to both biodiversity conservation and human health, the team's research goal was to determine whether and how spatial scales influenced the perceived importance of various ecological processes to disease distributions across the US. The researchers subsequently examined how human activities drive the distributions of three important diseases and parasites: West

Nile virus, carried by mosquitoes, Lyme disease, carried by ticks, and a fungus causing worldwide declines of amphibian populations.

Their results suggest that human alterations to biodiversity affect disease distributions at local scales while climate change is impacting disease at regional scales. They also found that factors were important at the scales where they tended to vary the most, a finding providing a likely mechanism for the study results.

"Our multi-scale analysis demonstrated that in the US, the drivers of three emerging diseases and parasites - amphibian chytridiomycosis, West Nile virus and Lyme disease - are based on spatial scales that modulate the strength of ecological processes," said study co-author Dr. Jason Rohr, an associate professor in the USF Department of Integrative Biology. "Moreover, our findings were consistent across a bacterium, virus and fungus, invasive species and native species."

"If human impacts stretch across multiple scales, scientists who only look at data at a single scale may be missing key details about why diseases are spreading," said Cohen. "In other words, it is unlikely that a single scale can be used to identify all the factors influencing the distribution of human and wildlife pathogens."

Although the results of this study have been hypothesized by scientists for decades, cross-scale analyses involving fine and broad-scale data could not be carried out until sufficient computing power and large datasets became available, said study co-author Dr. David Civitello, a postdoctoral fellow in the USF Department of Integrated Biology.

"As humans continue to modify species composition, dispersal, and climate across scales, it is critical that we fully understand the consequences related to these changes," said Civitello. "Without multi-scale analyses, we are likely to underestimate the impact of human

activity on biodiversity and the environment."

More information: Spatial scale modulates the strength of ecological processes driving disease distributions, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1521657113

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