Why biodiversity might not always be such a good thing for our health

"The entire paper is an enormous bummer," Chelsea Wood told me during the annual meeting of the Ecological Society of America in Portland, Oregon in August [2017]. She was referring to research she had published in June as part of a special theme issue, which she had helped to compile and edit, of the Philosophical Transactions of the Royal Society B. The issue explored the link between biodiversity and infectious disease, and Wood had just presented her findings before a packed room. It was a tough audience, she said.

"The news that ecologists want to hear is that biodiversity is something that we can market as an intervention that has co-benefits — an intervention that pays for itself," she said. "And we don't see any evidence of that in our data set. Not even a hint of it."

Wood is an assistant professor at the University of Washington's School of Aquatic and Fishery Sciences, and she is a prominent voice on one side of what has become a contentious and heated ecological question: Is biodiversity beneficial to human health or not? The argument centers around what's known as the "dilution effect" — the idea that preserving and protecting an abundance of other species can help to dilute the risk of diseases spreading among humans.

The notion was first proposed in 2001 in relation to the spread of Lyme disease, and in some circles, it has become settled science. "The evidence is already in," Newsweek declared in 2009. "The loss of biodiversity is itself a threat to public health." In 2015, the Earth Island Journal asserted unequivocally that "biodiversity limits disease outbreaks among humans and wildlife."

Proponents of the theory believe the dilution effect is widespread, and they champion human health policies that include conservation initiatives. But critics say the evidence for this remains thin, and they call such ideas both panglossian and irresponsible. Both sides have sizeable support among researchers, and the back and forth in scientific journals has become acrimonious at times.

That's how science is supposed to work, of course. The problem is that very little coverage of this debate has migrated into the popular science press — and in that sense, science journalists are succumbing to the same sort of publication biases that we bemoan among scientists themselves: Studies that support appealing ideas get widespread coverage, while ambiguous findings or ones that counter "feel good" stories are ignored.

Presenting a false balance, as is often seen with climate change reporting, is problematic. But so, too, is presenting a false consensus. It undermines the public's understanding of science while providing ammunition to those claiming the media is biased and unreliable.

Intuitively, the dilution effect makes sense.

Take West Nile virus, for example. It's a bird disease, but people can catch it when bitten by *Culex* mosquitoes. Where there are more birds overall, it would be statistically less likely for a female mosquito

to bite an infected animal, reducing the number of infected mosquitoes buzzing around. Similarly, mosquitoes that are infected would be more likely to come across and seek out a blood meal from another bird than from a human. And some bird species will be more resistant to the infection, helping to check its overall spread.

All of these mechanisms would lead to a “dilution” of the disease and ultimately, a reduction in the number of human disease cases — or at least that’s the theory. It’s also exactly what researchers in a 2008 study published in PLOS One found. When they compared bird species richness to West Nile transmission during the 2002 outbreak in the eastern United States, they found a strong, negative correlation between the diversity of birds and cases of the virus. And they aren’t the only ones to find evidence for a dilution effect. A 2015 meta-analysis boldly states so in its title: “Biodiversity inhibits parasites: broad evidence for the dilution effect.”
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Jason Rohr is an associate professor at the University of South Florida and senior author of that paper. “There was general support for the hypothesis that when you increase biodiversity you get decline in parasites per host or in parasite prevalence,” he told me in an interview. The results are convincing enough that Rohr says conservation should be seen as a prophylactic. Much like exercise and a balanced diet are considered effectively safe methods of supporting health, “general biodiversity conservation,” he said, “should be approached as a general proactive strategy to disease management.”

But that’s where critics of the dilution effect strongly disagree. They see the literature very differently.

“A key element of their argument is that our previous meta-analysis, which failed to find unequivocal support for dilution effects in zoonotic disease systems, should be discounted,” write Daniel Salkeld and his colleagues in a critique of the paper by Rohr and his colleagues. Their work focused in on just human pathogens, and found “weak support at best for the dilution effect” and “evidence of publication bias toward publishing reports of a negative relationship between biodiversity and disease,” Salkeld argued.

The bitter debate isn't just about interpretation of results. Critics also say the research to date is flawed because it has only examined a small subset of human pathogens. Studies focus on accessible disease systems like Lyme and West Nile virus — ones that Wood says almost exclusively affect affluent Westerners. Rohr and his co-authors included just 14 human diseases, for example (though the analysis included schistosomiasis, which predominantly affects the developing world).

By broadly claiming the majority of infectious diseases will follow the patterns of West Nile and Lyme, Wood says Rohr and other proponents are trying to apply a "pretty thinly supported idea that's been demonstrated only in diseases of rich people" to diseases of poverty in developing countries.

That's why she and her colleagues decided to focus on the infectious diseases tracked by the World Health Organization's global burden of disease database instead. "We felt like it was really important to figure out whether dilution worked for these more important diseases because people were starting to call for conservation as this intervention," Wood told me, "and we felt that was really irresponsible because the evidence is so thin."

Wood and her colleagues examined the change in disease burden for 24 infectious diseases over two decades, including notorious killers like HIV/AIDS, tuberculosis, and malaria. Using per-person disability-adjusted life years as their measure of lethal and non-lethal health impacts, they examined a variety of potential drivers of these diseases in 60 intermediate-sized countries, including forestation and urbanization — which Wood considers proxies for biodiversity tied to conservation action — as well as a calculated measure of biodiversity per unit area.

"Contrary to the dilution effect hypothesis, increases in biodiversity over time were not correlated with improvements in human health, and increases in forestation over time were actually associated with increased disease burden," the authors concluded. Or, as Wood puts it, "If anything, conservation is potentially a problem for infectious disease transmission."

Of course, Rohr and other proponents were quick to find flaws with this analysis.

"I could go on and on and on and talk about all of the factors that are conflated with biodiversity by using urbanization or deforestation as a proxy," he told me. To Rohr, the study doesn't "provide a real solid test of the hypothesis relative to studies that do a better job of isolating the effects of biodiversity."

And so continues the disagreement among scientists — a debate that remains invisible for many general readers.

Indeed, based on media coverage over the last 10 years, it would seem the dilution effect is universally supported.

"A new study shows that biodiversity serves as a bulwark against the transmission of diseases and parasites," Conservation Magazine's Sarah DeWeerdt writes in an article covering the 2015 meta-analysis by Rohr and his co-authors. DeWeerdt's piece was titled "The bloodsucking consequences of biodiversity

decline."

Such stories sometimes include conditional words like "may" and "might," but they often fail to provide voices of critics like Wood. And while there have been instances of balanced coverage — by NPR, for example, or Takepart, or a nuanced piece, which included Wood's perspective, published by Smithsonian magazine in May — such articles tend to take their inspiration from new research and papers that *support* the dilution hypothesis, relegating Wood and her colleagues to counterpoints instead of leads.

Sometimes, counterpoints are lacking altogether. "Biodiversity protects ecosystems against infectious diseases, researchers have concluded," a 2010 Nature news story boldly stated. The only outside comment comes from Conservation International senior scientist Will Turner, who did not doubt the universality of the findings. "The clear message is that we degrade ecosystems at our own peril," Turner told Nature. Similar coverage came from NPR.

But the most glaring issue seems to be what studies are chosen for coverage. Those that find evidence for the dilution effect are readily picked up by a diversity of outlets. A search for "dilution effect" brings up article after article on such studies, including coverage in prestigious outlets like The New York Times. Studies that find amplification of disease by biodiversity or no relationship at all are generally overlooked. I could only find these two old pieces from Futurity and Bioscience Technology reporting the meta-analysis that didn't find support for the dilution effect, and a few articles in outlets like The Scotsman and Farmer's Weekly covering a recent paper suggesting biodiversity may actually increase risk of Lyme disease.

"When papers that support the dilution effect come out, they tend to get tons and tons of press coverage," said Wood. "In contrast, when you're telling the story that nature is actually dangerous for people, that has less legs."

The bias in reporting gives the impression that the dilution effect is fairly uncontroversial. But ecologists as a group are far less certain than such coverage would suggest. "We have a lot of people now who are of the opinion that sometimes you see dilution, and sometimes you see amplification, and sometimes neither," says Skylar Hopkins, a postdoctoral associate with the National Center for Ecological Analysis and Synthesis at the University of California, Santa Barbara. Andrew MacDonald, a National Science Foundation postdoctoral research fellow at Stanford University, echoed this idea. "At least at this stage, there's a lot more that we need to learn about the ecology of disease," he said, "and how it relates to diversity."

Both researchers say they are somewhat frustrated that the press coverage they've seen so far is lopsided. "It's not necessarily exciting to share work that has a whole bunch of caveats," MacDonald said. "The challenge for science journalists in general is how to talk about scientific uncertainty and how to get that across to the general public, who might be more interested in a yes/no answer," MacDonald says.

Hopkins adds that hypotheses like the dilution effect need to be handled with extra care. “The argument here is that we can reduce human risk of disease and that’s a really big deal,” she said, “so we don’t want to promise that if that’s not something that can actually be delivered as a solution.”

Ultimately, that’s Wood’s biggest concern, too. “We need to not close our eyes to the fact that conservation can sometimes increase human disease risk,” she said.

Of course, Wood would be upset if her research was used as an excuse to halt conservation efforts. “I didn’t get into this business because I want people to cut down forests,” she emphasizes. But she also fears that claiming conservation will broadly reduce disease could lead to unintended consequences.

“My position is not that the dilution effect *never* happens — that is absolutely the opposite of what I think,” said Wood, pointing out several studies that have found evidence. “But there’s also whole bunch of parasites that show the opposite response.” Wood says she “would be 100 percent behind efforts to use conservation to control infectious diseases,” if those efforts put the time and resources into examining how their actions affect the diversity of human pathogens in the area.
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“Our argument is that you really need to understand the whole spectrum of responses of disease to environmental changes, because otherwise, conservation is a roll of the dice in terms of public health,” she explained. “We want people to go into conservation with their eyes wide open so that they can plan for potential collateral impacts.”

Any associated costs with implementing disease monitoring or prophylactic measures given that risk, Wood says, are “very minor when compared to the potential damage you could do through a conservation project that initiates an epidemic.”

It’s a sentiment that journalists would be wise to heed as well. After all, when covering hypotheses like the dilution effect that are hotly debated amongst scientists, the costs of diligent coverage are minor compared to the potential harms of shoddy reporting.

One-sided coverage not only undermines the media's credibility and the public's trust in the process of science. Such weighted stories imply advocacy, even if carelessly. And if, as Wood supposes, anoutbreak occurs after our tacit approval, then we, too, would share in the blame for the lives destroyed byit.

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