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News

Hidden assumption hypes species-loss predictions

Researchers question widespread method of assessing extinction rates.

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While single species, like the California condor (Gymnogyps californianus), teeter on the edge of extinction, scientists are grappling with how to predict future species extinction rates from data on habitat loss.Konrad Wothe / MINDEN PICTURES/Getty

A massive extinction resulting from habitat loss is under way — but perhaps not as rapidly as is often predicted.

A paper published today in Nature[1] explains why past predictions of extinction rates — for example, a 1980 US National Research Council report predicting losses of millions of species by the year 2000[2] — have not been realized.

"We have mathematically proven why these 'guesstimates' are flawed," says Fangliang He, an ecologist currently at Sun Yat-sen University in Guangzhou, China, and a co-author of the latest study.

In essence, says He, faulty assumptions are to blame. The most common method of predicting extinction rates relies on the species–area curve, the mathematical relationship showing that larger areas tend to contain greater numbers of species.

Researchers typically extrapolate backwards from this curve to calculate how many extinctions can be expected from a given amount of habitat loss. But that is inaccurate, say the study authors, because the area that must be removed to cause extinction is always larger than the area needed to encounter a species for the first time.

"Extrapolating backwards makes a hidden assumption that any loss of population, regardless of how small, commits a species to extinction — which is not reasonable," says Stephen Hubbell, a theoretical ecologist at the University of California, Los Angeles, and co-author of the paper.

Pinpointing the problem

The fundamental problem, says Hubbell, is that the species–area relationship doesn't describe how species are distributed in space. Using endemics–area relationships, which include spatial information, might provide a better estimate, the researchers reasoned.

Hubbell and He first derived endemics–area curves and species–area curves from sampling theory. Then they applied the two approaches to data from long-term studies of forest diversity in Asia, Africa and Latin America, conducted by the Smithsonian Tropical Research Institute's Center for Tropical Forest Science in Panama. They found that while the endemics–area curves were a close match with the observed data, the species–area curve produced an overestimate up to 160% higher than the data.

Georgina Mace, a conservation scientist at Imperial College London's Centre for Population Biology in Silwood Park, UK, says that the paper emphasizes how bad researchers are at predicting extinctions.

Researchers have previously attributed the overestimates to the time lag needed for species to go extinct after their habitat is reduced past sustainable levels — the 'extinction debt'. But He disputes this: "Currently no method exists that describes extinction debt," he says. Hubbell says that the study demonstrates how an overarching lack of theory can steer science in the wrong direction.

Hackles raised

But Stuart Pimm, a conservation ecologist at Duke University in Durham, North Carolina, says that Hubbell and He's paper is simply wrong. The authors, he says, make an inexcusable mistake: categorically claiming that all extinction rates using species–area relationships are overestimates, even though some papers using the method have been accurate.

In 1995, Pimm wrote a paper estimating extinction rates of birds in eastern North America due to historical deforestation[3]. Pimm says their method predicted that 4.5 species would be lost — and today, four have been lost and one teeters on the edge of extinction. "Our paper nailed the number on the head," he says. Hubbell and He overlooked dozens of other examples of studies that have successfully used species–area curves to predict extinction rates, he says.

Research using species–area relationships did result in overestimates 30 years ago, but many contemporary attempts vary the method to achieve accurate predictions, says Pimm. For example, researchers can look at how many species would survive in an area after it becomes isolated — rather than how many species occur in an intact area, as Hubbell and He do. The predictions of such papers show a very close calibration with what is observed, he says. "There's not one species–area curve; there are lots of species–area curves," Pimm adds.

But it doesn't work all the time, says Dov Sax, an ecologist at Brown University in Providence, Rhode Island. "There are a handful of cases where the species–area method is dead on, but lots of other cases where it hasn't worked well. I think everyone in the field is aware of that, but we haven't known what to do — so this paper is a helpful advance," he says. The next step, says Sax, is to test the predictions of the endemics–species relationship against actual observed species loss.

Unfortunately, it won't be easy to verify the new method, because fine-scale endemics–species distribution and habitat data are rare. "I hope our paper is an argument for jump-starting efforts to conduct 'bio-blitzes' to get a detailed understanding of the distribution of life on Earth," says Hubbell.

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1. He, F. & Hubbell, S. P. Nature 473, 368-371 (2011).
2. Natural Research Council Research Priorities in Tropical Biology (National Academy of Sciences, 1980).
3. Pimm, S. L. et al. Proc. Natl Acad. Sci. USA 269, 347-350 (1995).