**Are We Any Closer to Knowing How Many Species There Are on Earth?**

Are there half a million? 100 Million? After decades of research, there is no consensus

By [Geoffrey Giller](http://www.scientificamerican.com/author/geoffrey-giller) | April 8, 2014



Estimates of global species richness over six decades have failed to converge and remain highly uncertain, argues a new paper.
*Caley et al. 2014 / Trends in Ecology and Evolution*

How many species are there? For decades scientists have been asking—and trying to answer—this question. Guesses, estimates and calculations have been as low as half a million and as high as [100 million](http://www.scientificamerican.com/article/how-many-species-inhabit-the-earth/). But despite increasingly sophisticated models and a greater understanding of ecology, we’re no closer to a number, or even a range, than we were several decades ago, argues [a new paper](http://www.sciencedirect.com/science/article/pii/S0169534714000263) published in the April *Trends in Ecology & Evolution.*

Knowing the total number of species in the world—or at least having a good approximation—is important for both symbolic and practical reasons, says Julian Caley, a researcher at the Australian Institute of Marine Science and the lead author of the paper. “It gives us an indication of what we actually know about these really important ecosystems and how they function,” he says. Without baseline knowledge of how many species are out there, “you can’t know what you’re **managing**,” he says. Scientists working to protect or restore ecosystems won’t know whether or not they’ve been successful with regards to species saved.

To date, scientists have catalogued approximately [1.5 million species](http://www.catalogueoflife.org/).

Caley and his co-authors looked at published estimates of the total number of species in the world as well as reckonings of the number of terrestrial insects, terrestrial arthropods, marine species and coral reef–dwelling species. Within each group, the researchers found that there was no indication that the estimates were converging on a number or a range. “Six decades on nothing has changed,” Caley says.

The main problem, Caley says, is that new estimates usually fail to take previous work into account. “No one really refers to the information that’s already gained,” he says. Caley also points out that many of these past estimates used multiple different techniques to arrive at their estimates, including extrapolations based on the density of species in a study area or the rate at which new species are being discovered and described. But a larger problem is that many are just single-number estimates. Normally, he explains, statistical calculations have an associated margin of error. This range incorporates the likelihood that the actual number of species is not, say, five million—it could be five million plus or minus three million, for a total range of two million to eight million species globally. (This was, in fact, the estimate of one paper that included a range.)

The new paper calls for future estimates to include these ranges and to be statistically based, instead of what the authors call “simple best guesses.” When taking past work into account, the authors wrote, estimates that are not statistically based should carry less weight or possibly be excluded altogether.

Nigel Stork, a professor at the Griffith University’s School of Environment in Queensland, Australia, is a co-author of [the paper](https://www.sciencemag.org/content/339/6118/413), published January 2013 in *Science*, that gave the two million to eight million species range. Stork agrees about the need for improved statistical approaches when making estimates. He takes issue, however, with Caley’s conclusion that there is no convergence of global species estimates. “[Caley] says that the global species richness estimates haven’t converged,” Stork notes. “I don’t necessarily agree.” Caley’s paper reaches that conclusion by including what Stork calls “sheer guesses.” If only papers with statistically based methodologies are included, then there is convergence, as Stork and others wrote in their paper.

In addition to including previous data as part of future studies, as Caley suggests, Stork says that there are other interesting approaches currently being investigated. For example, there is a rough correlation between body size and number of species; there tend to be more species of small animals as compared with larger ones. And Caley and his colleagues are also working on suggestions for how best to incorporate past data into new models and estimates.