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Estimating the global conservation status of more than 15,000 Amazonian tree species

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Commentary: Estimating the global conservation status of more than 15,000 Amazonian tree species

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A commentary on

Estimating the global conservation status of more than 15,000 Amazonian tree species
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Amazonian forests provide ecosystem services that are critical at the planetary scale. Unfortunately, human land use threatens to drive many rainforest species to extinction. In a recent study, ter Steege et al. (2015) provide valuable insight into the threats that current and future deforestation potentially pose for Amazonian tree species. In any such large-scale analysis dealing with thousands of poorly-known species, there are clearly going to be many assumptions and possible sources of uncertainty. Here, I highlight two major assumptions used by ter Steege et al. (2015) to simplify their analyses—namely in the handling of widespread species and rare species. These assumptions have the potential to strongly influence predictions of how many and which species are at risk of being lost to deforestation over the coming decades.

Some tree species are likely to be endemic to the lowland Amazon; however, there are also certain to be many species that have ranges extending to higher elevations, different ecoregions, or even different continents. While ter Steege et al. perfunctorily acknowledge (in their online Supplemental Material) the potential problems caused by widespread tree species with geographic ranges extending beyond the defined Amazonian study area, they make no attempt to quantify how pervasive of a problem this may be or to account for it in any of their analyses. Rather, ter Steege et al. assume that rates and patterns of deforestation outside the Amazon mirror those occurring inside the Amazon. This goes against the core proposition of the study that spatial patterns of species' distributions, population densities, and the rates of deforestation, all combine in determining the degree to which species are threatened by habitat loss.

To get a sense of how many species may have ranges extending beyond the Amazon, I mapped the locations where Amazonian tree species are known to occur based on their herbarium collections records. More specifically, I downloaded all georeferenced occurrence records available through the Global Biodiversity Information Facility (GBIF; http://www.gbif.org/) for the nearly 5000 Amazonian tree species occurring in the Amazon Tree Diversity Network's (ATDN; http://atdn.myspecies.info/) forest plots and queried how many of these "common" species have recorded occurrences outside of the Amazon. I found that the vast majority (81%) of species have $\geq$1 occurrence outside the defined study region, one-fourth of the species have $\geq$50% of their occurrences outside the study region, and one-tenth of species have >90% of their occurrences outside the study region. Even if these extra-Amazonian populations are in some cases cryptic species, it is clear that many, if not most, Amazonian tree species are not actually endemic to the Amazon. For at least these widespread species, the data and methods employed by ter Steege et al. (2015) are insufficient to accurately estimate their true "global conservation status."

In the case of rare species, there are believed to be ~11,000 Amazonian tree species (i.e., ~2/3 of total Amazon tree diversity) that are too rare to occur in any of the ATDN's networked inventory plots (ter Steege et al., 2013). ter Steege et al. (2013, 2015) estimated the population sizes of these rare species based on an extrapolation of a rank-abundance curve created for the common species that do occur in their plots. ter Steege et al. (2015) then estimated the range sizes for rare species by assuming a fixed relationship between population size and range size. This methods explicitly disregards the different ways that species can be rare (i.e., the classic "7 forms of rarity"; Rabinowitz, 1981) by assuming that all rare species have small geographic ranges and that no rare species have large, low-density ranges. It is difficult to test this assumption due to the inherent relationship between a species' density and its detection probability. However, it is easy to imagine that there may exist widespread species that occur at such low densities that they are effectively "invisible" to current census techniques—especially considering that the ATDN's plots include <0.8 million of the nearly 400 billion trees that they estimate to be growing in the Amazon (i.e., a sampling intensity of 0.0002%; ter Steege et al., 2013, 2015). In some cases, the ATDN may get "lucky" and a widespread low-density species will occur as a singlet or small number of individuals within one of their plots. According to the methods of ter Steege et al. (2015), however, the ranges of all species occurring in only a single plot, regardless of the number of individuals, are truncated to an arbitrarily set area (e.g., <444 km from the plot where it occurs). A clear priority for future research in tropical forests is to understand the true nature of rarity.

The handling of rare and widespread species by ter Steege et al. likely adds large uncertainties to the predicted global extinction risks of many individual species. However, it is still possible that the cumulative result, that between about 30 and 60% of Amazonian tree species are threatened with extinction due to deforestation, is valid. The same two concerns about widespread and rare species were raised in a response to a previous study by Hubbell et al. (2008) that estimated the extinction risks posed by Amazonian deforestation (Feeley and Silman, 2008). A subsequent analyses by Feeley and Silman (2009) was then attempted with the explicit goal of at least partially bypassing these assumptions through the use of occurrence records, habitat maps and estimates of deforestation rates outside the Amazon (at the same time introducing other assumptions and possible sources of errors). Feeley and Silman (2009) predicted that Amazonian plant species will lose an average of 17 or 30% percent of their ranges by 2050 under Increased-Governance or Business-As-Usual models of deforestation—estimates that are strikingly similar to the new loss rates predicted by ter Steege et al. (ter Steege et al. predict that the population sizes of common Amazonian tree species will decrease by an average of 11 or 35%). In other words, while the data, methods, assumptions, and limitations differed greatly between studies, the final predictions were accordant. If nothing else, these studies all indicate that very high numbers of Amazonian species are already, or soon will be, threatened by deforestation. Add in the largely-unexplored effects of other human disturbances such as climate change, fire, forest degradation and defaunation (Peres et al., 2010), and it is clear that no matter what the underlying assumptions, the Amazon's future is very dire indeed.

AUTHOR CONTRIBUTIONS

KJF confirms being the sole contributor of this work and approved it for publication.

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