Biodiversity conservation

Effects of changes in climate and land use

Arising from: C. D. Thomas *et al. Nature* **427,** 145–148 (2004)

Thomas *et al.*[1] argue, contrary to Sala *et al.*[2], that climate change poses an equal or greater threat to global biodiversity than land-use change. We contest this claim, however, on the grounds that Thomas *et al.* incorrectly apply species–area relationships.

The species–area relationship ($S = cA^z$, where S is the number of species, A is area, c and z are constants, and z is typically 0.25) predicts the number of species in an independently specified area. Instead, Thomas *et al.*[1] use the sum of the ranges of the species themselves to define the sampling area. Their method is circular because the sum of the ranges of S species is automatically correlated with S itself.

The problem with their entire species–area approach is evident in the first of the several, similar methods that Thomas *et al.*[1] propose. Rearranging the species–area formula shows that extinction risk (fraction of original species projected to become extinct) following reduction of independently specified habitat from $A_{original}$ to A_{new} is $1-(A_{new}/A_{original})^z$. Instead, Thomas *et al.*[1] begin with climate scenarios that predict range loss for individual species. They sum the areas of these species before and after global change to obtain aggregate areas to use in species–area formulae. By arguing that the sum of species' ranges after global change is less than that now, they conclude that extinction risk from global change is large, as great as that from land-use change. This conclusion is premature because the areas used in their calculation are not independent of the number of species. Furthermore, a summation double-counts area occupied by two or more species.

Previous work suggests that species' ranges have responded individualistically to historical climatic changes[3]. Records of historical climatic changes also show that extinction risk is unevenly distributed with respect to range size[4]. Hence, summing ranges does not correctly aggregate extinction risk across species because each species is equally weighted in the extinction-risk calculation. Future estimates of extinction risk might be based on working out the number of species whose areas will drop below a critical patch size because of climate change.

The effects of global change on extinction risk are difficult to anticipate. Global warming will increase some habitats and their species-holding capacity, just as warming reduces other habitats. The net effect for biodiversity of these habitat expansions and contractions is not obvious, particularly as species ranges may shift poleward from the tropics[5], where the greatest number of species is currently. Although we contest the species–area approach used by Thomas *et al.*[1], we acknowledge species' vulnerability to extinction from climate change[6]. And economic impacts from climate change also exist: for example, the dislocations caused by sea-level rise and the costs of adjusting to new climate cycles.

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