Biodiversity conservation

Uncertainty in predictions of extinction risk

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

Thomas *et al.*[1] model species-distribution responses to a range of climate-warming scenarios and use a novel application of the species–area relationship to estimate that 15–37% of modelled species in various regions of the world will be committed to extinction by 2050. Although we acknowledge the efforts that they make to measure the uncertainties associated with different climate scenarios, species' dispersal abilities and *z* values (predictions ranged from 5.6% to 78.6% extinctions), we find that two additional sources of uncertainty may substantially increase the variability in predictions.

First, the study by Thomas *et al.* is based on projections of species-range shifts from a variety of niche-based models supplied by different contributors using different modelling methods. For instance, generalized linear models were used to model plants in Europe, whereas generalized additive models were used for *Protea* species in South Africa, and genetic algorithms for taxa in Mexico. Although niche-based models are all based on the same principle, they use a variety of assumptions, algorithms and parameterizations. Therefore, combining assessments from different models is likely to introduce further unquantified model effects.

To illustrate this, we fitted four niche-based modelling techniques, using the same five bioclimatic variables[2], to distributional data for a representative sample of European plant diversity (1,350 endemic and non-endemic plant species) under a similar range of climate scenarios to those of Thomas *et al.*[1]. To estimate extinction risk, we used each of the three methods employed by them and compared two scenarios of dispersal abilities: universal and none (Table 1). Thomas *et al.*[1] consider differences in extinction predictions between a range of climate-warming scenarios, but our analyses indicate that differences might be at least as strong between models. For example, when using method (3) under a maximum expected warming scenario, predictions from the four models were in the range 2–4.2% with universal dispersal, and in the range 2.3–10.1% with no dispersal. By contrast, when using method (3) and only one model (generalized linear model), the range for predictions across the three climate scenarios was reduced: a range of 2.7–3.6% with universal dispersal, and 8.2–10.0% with no dispersal.

Second, although Thomas *et al.*[1] show (their Table 4) that their models are highly sensitive to the 'slope' (*z* value) of the species–area relationship, neither their models nor ours yet provide any means of quantifying the uncertainty arising from the simplistic link between proportionate reduction in area and extinction likelihood. Cases of long-term species persistence in remarkably small ranges (for example, on mountain tops and oceanic or land-bridge islands[3]) demonstrate that, although range reduction is a key driver of species decline, we need to investigate the scale-sensitivity of model outputs and translate projections of range reduction into projections of species losses.

These uncertainties mean that the range of possible extinction risks arising from climate change may be even wider than that reported by Thomas *et al.*[1].

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Reply: Thomas *et al.* reply to this communication (doi:10.1038/nature02719).

Table 1 **Projected percentage extinctions for different models**

Models	Universal dispersal			No dispersal		
	Expected climate change					
	Minimum	*Mid-range*	*Maximum*	*Minimum*	*Mid-range*	*Maximum*
ANN	2.0, 2.5, 3.0	0, 2.9, 3.7	2.6, 3.3, 3.9	4.8, 6.7, 7.5	6.1, 7.5, 8.7	5.8, 8.1, 9.2
GLM	2.3, 2.4, 2.7	2.5, 2.7, 3.1	3.0, 3.1, 3.6	6.3, 7.5, 8.2	6.8, 8.1, 9.0	7.5, 8.9, 10.0
GAM	2.4, 2.8, 3.2	2.6, 3.2, 3.8	3.1, 3.7, 4.2	5.6, 7.3, 8.4	5.9, 7.8, 9.1	6.7, 8.7, 10.1
CTA	0.9, 2.0, 1.7	1.8, 2.7, 2.7	1.1, 2.3, 2.0	2.0, 5.3, 5.5	2.9, 6.0, 6.5	2.3, 5.9, 6.3

Projected percentage extinction values, based on species–area (for $z = 0.25$) methods[1]. The three species–area estimates are ordered in each cell, with method (1) given first, followed by method (2), then method (3). ANN, artificial neural networks; GLM, generalized linear models; GAM, generalized additive models; CTA, classification tree analysis. Experiments for minimum, mid-range and maximum expected climate change were done at the UK Hadley Centre for Climate Prediction and Research for three emission scenarios (A2, B2 and A1, IPCC 2000; ref. 4).