Journal of Biogeography (*J. Biogeogr.*) (2007) **34**, 758–759

COMMENTARY

How can you conserve species that haven't been found?

The broad objective of systematic conservation planning is the planning of conservation actions to effectively secure the persistence of all species; it has traditionally focused on the development of protected areas. If we ignore efficiency then the task is simple and impractical – conserve everything. If we cannot conserve everything, then decisions need to be made. In theory, to be sure that we have secured viable populations of every species, we would need to know, at a bare minimum, the distribution and abundance of every species that requires conservation. This has occurred for some vertebrate groups in some regions but rarely for plants and almost never for any invertebrates and micro-organisms, except at a small spatial scale (e.g. butterflies in some European countries). It is currently inconceivable that we will have detailed distribution maps for many important components of biodiversity, like the microfungi, at the scale of continents or countries, this century (with possibly a few exceptions, see the Swedish Taxonomy Initiative at the Swedish Species Information Centre, http://www.artdata.slu.se). This realization has fostered a flowering of research in developing and testing the value of biodiversity surrogates.

Biodiversity surrogates for conservation planning include both known or predicted distributions of species (taxonomic surrogates) and ecological classifications, such as forest types (ecological surrogates). The perfect taxonomic surrogate group is one which, by ensuring the long-term persistence of every species in that group, ensures the persistence of all of biodiversity. Such a group does not exist. However, given the need to make timely decisions we need surrogate groups that do a fair job of conserving other groups. A lot of effort has been put into testing cross-taxonomic surrogacy (e.g. Howard *et al.*, 1998; Fleishman *et al.*, 2001; Su *et al.*, 2004) with mixed success: some species groups *sometimes* deliver efficient conservation plans for other groups of species.

In general, the effectiveness of one group of species as a surrogate for another group depends on the congruence of community similarity between sites among the groups considered (Su *et al.*, 2004). The measured effectiveness of surrogates also depends on how the problem is formulated. Because it is very difficult to make predictions on the long-term persistence of species, which is the ultimate objective, the formulation of the problem is often simplified to a question of representation at the present time. Given uncertainty about existing and new distributions, a group of species may even turn out to be a bad surrogate for itself in the future, if its future pattern of community similarity will have little overlap with the present one.

To use one or more groups as conservation surrogates, or to test the adequacy and performance of surrogates, we ideally need plausible distribution maps for entire taxa. This presents significant problems because there are inaccuracies in distribution maps for known species, and in many cases there are unknown species that, obviously, have unknown distributions. Constructing distribution maps for known species using existing data is a well-studied area of conservation biology and will not be discussed further here (see Elith *et al.*, 2006). But how does one solve the second problem, and develop a conservation plan for species that have not yet been discovered?

To our knowledge Bini *et al.* (2006) are the first authors to have taken the bold step of constructing distribution maps for species that have not yet been discovered. Their innovative approach raises many opportunities for improved systematic conservation planning and the more accurate evaluation of conservation surrogates.

The Brazilian Cerrado contains 131 anurans, of which 20 were described in the 1990s. Diniz-Filho *et al.* (2005) predict that the number of anurans in the region will saturate at about 160 species by about 2050. On this basis there are about 30 undescribed anuran species in the region. Bini *et al.* (2006) ask a provocative question: If we made a conservation plan based on the distribution of the 131 species we know now, how would that differ from a conservation plan we could make in 2050 when we hope to know almost all the species and their distributions? To answer this question they needed to invent the distributions of 29 species of hypothetical anurans. They did this and their conservation planning at the scale of 1° cells.

The likelihood that a new species will exist in a 1° cell will depend on the amount of previous survey effort in that planning unit and its suitability for anurans. Bini *et al.* (2006) created a statistical model based on work by Rangel & Diniz-Filho (2005) that enabled them to predict the relative chance that any cell has an undiscovered species as a function of survey effort, or survey effort and one of two environmental variables (creating three scenarios). For each of the 29 hypothetical species a cell was chosen as the 'initial cell' in proportion to this relative chance and its range was expanded to neighbouring cells if they were sufficiently similar with respect to the survey effort and environmental parameters. By careful choice of how similar two cells had to be for successful range expansion they created, 100 times for each of three scenarios, the distribution of each hypothetical species with a median size of four cells matching the range size distribution of real species described since 1980. Armed with 131 species distributions and replicates of 29 hypothetical species distributions they then needed to see how information about these species would influence spatially explicit conservation planning priorities.

Using the freely available conservation planning software SITES (Possingham *et al.*, 2000), Bini *et al.* (2006) created spatially explicit conservation priorities for the known 131 species and compared it with conservation priorities for all 160 species, with the hypothetical species included. Using their randomization process they were able to prove that the overall priority

www.blackwellpublishing.com/jbi
doi:10.1111/j.1365-2699.2007.01717.x

for the reserve system moved significantly northwards by about 10° of latitude regardless of the protocol by which new species were positioned and their distributions created.

This dramatic result can be interpreted in several ways: we should urgently carry out more anuran surveys in the north of the Cerrado, we should use the prioritizations with the hypothetical species to make reserves in the north now, or, given that survey effort is probably correlated with threat, we can wait to set aside reserves in unsurveyed areas because they are unlikely to be under immediate threat. Given these possible responses, work needs to be done to unpack the policy implications of this intriguing new research.

One area of research that follows directly from Bini *et al.*'s (2006) work is the question of whether the variables used to generate new species – environmental data and data on survey effort – could be good surrogates for conservation planning themselves. Maybe, instead of creating new species, we could simply bias reserve selection towards sites with low survey effort and favourable environmental characteristics for anurans.

Bini *et al.*'s (2006) paper also sparks an intriguing question about the value of data in conservation planning. How much effort should we spend gathering data before we start making conservation decisions? Early in a conservation planning process the value of data is large, but the value of data decays through time for two reasons. First the value of new information decays simply because the difference it will make to spatial priorities declines as more is known. Second, the value of data collection diminishes as the number of options for implementation declines because there is less available land and/or the level of conservation is all the socio-economic system will tolerate.

Broadly speaking there are several sorts of actions that are part of the conservation planning process. Each of these takes time and money that could be allocated to other actions and must be traded off against each other. For example, two important actions are assembling data and implementation of conservation. When assembling biodiversity data, there are choices about what sort of data to assemble and what new surveys are required. More field work can lead to information about undiscovered species *and* improved area of occupancy maps (Rondinini *et al.*, 2005). Alternatively more effort could be put into using raw distribution and biophysical data for more sophisticated spatial models for predicting the area of occupancy of species and undiscovered species. This is where Bini *et al.* (2006) have taken a novel step.

Assuming resources are limited, more effort put into improving any data will leave fewer resources for applying on-ground conservation. How much effort we spend on assembling data depends on how much it will improve conservation decisions and how quickly options are being lost. Given that conservation actions such as reserve acquisition are relatively expensive compared with data acquisition, Balmford & Gaston (1999) argued that it is invariably cost effective to spend more money on data acquisition. Bini *et al.* (2006) open the door to another view, that data modelling may be more cost effective than data collection, especially where the taxa of interest are cryptic and the unsurveyed areas are remote. In another novel approach, Ferrier (2002) proposed a technique that models compositional change over the landscape rather than individual species. Either way, the economic costs of both data acquisition and modelling must be traded off against not just the cost of conservation action (as implied by Balmford & Gaston, 1999) but also the progress of time. If we spend time collecting and analysing data we miss opportunities for conservation action because critical areas for an efficient and effective conservation system may be lost through land conversion. This points to an entirely new branch of conservation planning – how much and what kind of research should we do before, and while, we are taking conservation action?

HUGH P. POSSINGHAM[1], HEDLEY GRANTHAM[1] AND CARLO RONDININI[2]

[1]The Ecology Centre and Australian Environmental Decision Analysis Centre, School of Integrative Biology, The University of Queensland, Brisbane 4072, Qld, Australia and
[2]Department of Animal and Human Biology, Università 'La Sapienza', Viale dell'Università 32, 00185 Rome, Italy
E-mail: h.possingham@uq.edu.au; h.grantham@uq.edu.au

REFERENCES

Balmford, A. & Gaston, K.J. (1999) Why biodiversity surveys are good value. *Nature*, **398,** 204–205.

Bini, L.M., Diniz-Filho, J.A.F., Rangel, T.F.L.V.B., Pereira Bastos, R. & Plaza Pinto, M. (2006) Challenging Wallacean and Linnean shortfalls: knowledge gradients and conservation planning in a biodiversity hotspot. *Diversity and Distributions*, **12,** 475–482.

Diniz-Filho, J.A.F., Bastos, R.P., Rangel, T.F.L.V.B., Bini, L., Carvalho, P. & Silva, R.J. (2005) Macroecological correlates and spatial patterns of anuran description dates in the Brazilian Cerrado. *Global Ecology and Biogeography*, **14,** 469–477.

Elith, J., Graham, C.H., Anderson, R.P. *et al.* (2006) Novel methods improve prediction of species' distributions from occurrence data. *Ecography*, **29,** 129–151.

Ferrier, S. (2002) Mapping spatial pattern in biodiversity for regional conservation planning: where to from here? *Systematic Biology*, **51,** 331–363.

Fleishman, E., Blair, R.B. & Murphy, D.D. (2001) Empirical validation of a method for umbrella species selection. *Ecological Applications*, **11,** 1489–1501.

Howard, P.C., Viskanic, P., Davenport, T.R.B., Kigenyi, F.W., Baltzer, M., Dickinson, C.J., Lwanga, J.S., Matthews, R.A. & Balmford, A. (1998) Complementarity and the use of indicator groups for reserve selection in Uganda. *Nature*, **394,** 472–475.

Possingham, H.P., Ball, I.R. & Andelman, S. (2000) Mathematical methods for identifying representative reserve networks. *Quantitative methods for conservation biology* (ed. by S. Ferson and M. Burgman), pp. 291–306. Springer-Verlag, New York.

Rangel, T.F.L.V.B. & Diniz-Filho, J.A.F. (2005) An evolutionary tolerance model explaining spatial patterns in species richness under environmental gradients and geometric constraints. *Ecography*, **28,** 253–263.

Rondinini, C., Stuart, S. & Boitani, L. (2005) Habitat suitability models and the shortfall in conservation planning for African vertebrates. *Conservation Biology*, **19,** 1488–1497.

Su, J.C., Debinski, D.M., Jakubauskas, M.E. & Kindscher, K. (2004) Beyond species richness: community similarity as a measure of cross-taxon congruence for coarse-filter conservation. *Conservation Biology*, **18,** 167–173.

Editor: Dov Sax