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COMMENTARY

Setting conservation priorities when what you see is not what you get

Mark Vellend[1] & Heather M. Kharouba[2]

1 Département de biologie, Université de Sherbrooke, Sherbrooke, QC, Canada
2 Department of Zoology, University of British Columbia, Vancouver, BC, Canada

Correspondence
Mark Vellend, Département de biologie, Université de Sherbrooke, 2500 boulevard de l'Université, Sherbrooke, QC, Canada, J1K 2R1.
Email: mark.vellend@usherbrooke.ca

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Seeing is believing. So, when we see high biodiversity in a particular site, we tend to assign the site a high conservation value. This basic approach forms the basis of a wide range of conservation prioritization schemes and algorithms (e.g. Moilanen, 2007; Ball, Possingham & Watts, 2009). But in a world subject to rapid environmental change in the form of anthropogenic habitat alteration, climate change and species introductions, a snapshot of present biodiversity may provide a misleading picture of the capacity of a site to harbor biodiversity over the long term. Appreciation of this reality has compelled ecologists to ask whether historical habitat changes have set in motion population declines that have yet to result in local extinctions, but which certainly will if we don't do something about it. In other words, are remnant habitat patches burdened with an 'extinction debt'?

The logic behind the idea of extinction debts meshes well with intuition based on the basic biology of terrestrial plants. For example, when conditions for growth and regeneration deteriorate, mature perennial plants may nonetheless persist for many years, resulting in very slow population declines. So it is not surprising that many of the studies on extinction debt have focused on terrestrial plants. But what about more mobile, short-lived organisms with much greater proclivity for rapid population changes? Soga & Koike (2013) aimed to test for an extinction debt of butterflies in remnant forest patches in an area of Tokyo, Japan, where forest cover has declined markedly over the past 40 years.

Temperate-zone butterflies are very well studied, and indeed are quite well known for fitting the metapopulation paradigm of frequent local colonization and extinction events (Hanski, 1999). Moreover, specialist butterflies are thought to be more sensitive to habitat alterations than generalists (Krauss, Steffan-Dewenter & Tscharntke, 2003; Davies, Margules & Lawrence, 2004). In this context, Soga and Koike's results are rather surprising in pointing to the presence of a substantial extinction debt, albeit only for specialist species – those restricted to forest habitats or with only one annual generation. For these specialists, current species richness is more closely correlated with forest patch area circa 1971 than with contemporary patch area. They also found that species richness in patches having experienced the greatest recent area reductions was significantly greater than in otherwise comparable patches whose sizes have been historically more stable, suggesting high amounts of unpaid extinction debt in recently formed small patches.

The general conservation implications of these results are less than perfectly clear, and indeed quite fascinating to ponder. On one hand, results such as these can point us to habitat patches where diversity is likely to decline in the near future, and therefore where we might invest limited conservation resources. This is the conclusion drawn by Soga and Koike, who wisely point to the possibility of improving habitat quality (e.g. floral resource abundance) given the near impossibility of increasing patch sizes in an urban area. From another point of view, however, if such patches indeed are home largely to the 'living dead', perhaps focusing limited conservation resources on these patches is a lost cause. If one had to choose between a patch that currently has 20 species but which is expected to decline to 10 species at equilibrium (or some kind of quasi-equilibrium) and a stable patch with 15 species, which would you choose? The easy answer is to say both, but in the real world, such difficult decisions must be made.

To broaden the context beyond butterflies in Tokyo, what about regenerating habitat patches where diversity is expected to increase in the future? The flipside of extinction debt is 'colonization credit' – species currently absent from a habitat patch but expected to eventually colonize given that suitable conditions have been recently created (Jackson & Sax, 2010). This process is likely to become increasingly important with species' distributional shifts lagging behind climatic changes. In addition, immense portions of the earth are in some state of recovery from intense land use (Cramer, Hobbs & Standish, 2008), and such areas are likely to accrue species over time. Should we invest conservation resources in fostering recovery of a young 50-ha patch of forest (where few if any specialist native butterflies are present), or in halting the decline of diversity in a mature 20-ha patch of forest with an extinction debt? Again, there is no easy answer.

In terms of a future research agenda, it is important to keep in mind that most 'findings' of an extinction debt, including this one, are in fact predictions rather than observations of diversity change over time. The extinction debt map created for Tokyo provides a nice set of predictions for how diversity should change in the future, which can only be tested by returning to these patches 5, 10 or 20 years down the road. There is also the question of how seriously to take patch-level predictions. The data provide a compelling case that, in general, small patches with recent reductions in area bear the greatest extinction debts. But there is plenty of unexplained variance in the magnitude of extinction debt among patches. So, if two very similar patches (i.e. with identical predicted diversity) are estimated to have extinction debts of 5 and 10 species, respectively, is this difference 'real' or is it due to error in estimating their future equilibrium diversity? For this and other regions, seeing will be believing.

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