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EDITORIAL

Biodiversity offsetting: what are the challenges, opportunities and research priorities for animal conservation?

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Governments, businesses, financial institutions and local communities are increasingly using biodiversity offsets, also known as compensatory mitigation, as a putative mechanism to achieve ‘no net loss’ (NNL) of biodiversity as a result of specific development projects (McKenney & Kiesecker, 2010; Quetier & Lavorel, 2011; Gardner *et al*., 2013). The Business and Biodiversity Offsets Programme (BBOP), an international collaboration for the development of offset methodologies, defines biodiversity offsets as ‘the measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people’s use and cultural values associated with biodiversity’ (BBOP, 2009). Proposals are already proceeding in the European Union (EU) for a NNL initiative as part of the ‘EU Biodiversity Strategy to 2020’ – with possible operational principles that include offsetting schemes (see http://ec.europa.eu/environment/nature/biodiversity/nnl/index_en.htm). Madsen *et al*. (2011) identified legislation mandating compensatory biodiversity conservation mechanisms (including offsets) in 45 countries, with a further 27 under development and this number is likely to have grown since.

At the same time, substantial concerns have been raised regarding the potentially irreparable damage caused by biodiversity offsets (FoEE, 2014), particularly if implemented in areas of high conservation value; doubts have also been cast over how achievable the concept of NNL of biodiversity is as a conservation goal (Bull *et al*., 2013). Crucially, examinations of the moral and ethical considerations regarding biodiversity offsetting are lacking, as is debate about the implications for local democracy and governance, despite such schemes gathering pace. Indeed, it would appear that biodiversity offsetting schemes are increasingly being embraced even though the methodologies and overriding conceptual framework are still under development (Bull *et al*., 2013; Gardner *et al*., 2013). Supporters of biodiversity offsetting, however, believe that the schemes provide new opportunities for habitat creation and restoration and an economic value for nature that, to date, is often ignored in decision making. Additionally, BBOP advocates strict adherence to a ‘mitigation hierarchy’ (i.e. avoidance, minimization, rehabilitation/restoration, offset), which views the role of biodiversity offsets as a ‘last resort’, after all reasonable measures have been taken first to avoid and minimize the impact of a development project and then to restore biodiversity on-site.

Central to the success and broader uptake of biodiversity offsetting schemes is whether they actually work. There is limited quantitative information available on the outcomes of offset projects. The implementation record of such schemes in the literature to date is mixed (see recent reviews by Bull *et al*., 2013; Gardner *et al*., 2013) and significant gaps in the evidence exist, some of which we identify and discuss in the succeeding text. According to Bull *et al*. (2013), this is part of a broader problem: the lack of post-implementation evaluation in conservation. Moreover, studies so far have highlighted a number of practical and theoretical challenges to the current definition of biodiversity offsetting schemes (see Gardner *et al*., 2013) that will have to be overcome before conservationists consider them to be an ecologically defensible mechanism that can help reconcile conservation and development.

There are significant areas where progress is needed to ensure biodiversity offsetting can be informed by robust scientific evidence. First, the implications of biodiversity offsetting in a range of habitats are unclear; most studies to date have focused on wetlands and grasslands but the implications of such schemes for ecologically sensitive habitats such as old-growth forests, marine habitats and upland moorland are poorly understood (Bull *et al.*, 2013). Furthermore, biodiverse brownfield (land previously used for industrial purposes) and greenfield (undeveloped land in a city or rural area either used for agriculture or unmanaged) sites, which tend to be of high cultural value because of their proximity to densely populated areas, are potentially more prone to future development but are less well studied or monitored.

Second, research is needed to understand the management actions and time scales required to restore sites to functioning ecosystems equivalent to pristine habitats lost during development. In a recent study, Curran *et al.* (2014) used a meta-analytic approach to analyze data from comparative studies of secondary growth and old-growth habitat and found that species richness, similarity and assemblage composition can take hundreds to thousands of years to converge to old-growth reference values, concluding that biodiversity offsetting is inappropriate in these habitats. There is considerable skepticism in the scientific community that the current science of restoration ecology is capable of delivering the biodiversity gains sufficient to achieve NNL (Palmer & Filoso, 2009). An important goal of restoration is to recover the ecosystem services provided by the diversity of species and their interactions (e.g. pollination, seed dispersal and pest control), but our current understanding of the ecological processes and time scales underlying this recovery is often incomplete and poorly integrated across different ecosystems. Montoya, Rogers & Memmott (2012) suggest conceptual advances in biodiversity–ecosystem functioning, food-web theory and metacommunity theory that could be developed to address some of these issues. Recent studies have, for example, used an ecological network approach to evaluate ecological restoration by focusing on species interactions and associated ecosystem functioning (Devoto *et al.*, 2012; Pocock, Evans & Memmott, 2012). Such approaches could be used to help better understand the ecological importance of specific habitats (Evans, Pocock & Memmott, 2013) and determine spatial mixes of habitats in biodiversity offset design.

Third, some biodiversity offsetting schemes use 'habitat banking' and 'multipliers' to address uncertainty (Gardner *et al.*, 2013). Offset 'banks' are essentially where providers have created offset projects in exchange for biodiversity credits, which can subsequently be sold to compensate for developments with comparable residual ecological impacts (Bull *et al.*, 2013). To account for uncertainty, multipliers are used to increase the amount of compensation. For example, South Africa's Western Cape offset policy requires compensation of 30 ha of land for every hectare cleared in critically endangered habitats (DEADP, 2007). Arbitrary multipliers such as this take a risk-averse approach but may be insufficient to address associated losses or total failure of an offset scheme (Moilanen *et al.*, 2009). The development of a comprehensive framework for treating uncertainty in offsets is therefore a research priority.

Fourth, designing a biodiversity offset to help ensure NNL requires consideration of the wider landscape context of development effects and offset activities, the timing of offset delivery, the approach taken for defining and calculating biodiversity losses and gains, and the definition of the overall offset accounting system and approaches to managing risk (Gardner *et al.*, 2013). According to Mann *et al.* (2014), the key question regarding biodiversity offsetting is what can be counted as equivalent in terms of destroying versus conserving nature? A major difficulty with the concept of biodiversity credit trading is that measuring commensurable units for biodiversity seems to be far more complex and place-specific. As a result, an accepted and universal design for biodiversity offsetting schemes is urgently needed.

Fifth, it has been argued that, by not according any specific value to nature, it is easily forgotten in decision making (Mace, Norris & Fitter, 2012). Yet from a conservation perspective that affords intrinsic value to all life as defined by the Convention on Biological Diversity, the moral and ethical implications of biodiversity offsetting schemes, which essentially treats nature as a commodity to be traded and offset against other commodities, are deeply problematic. Similar to the debate surrounding the valuation of the ecosystem services provided by nature for human benefit (Miller, Soulé & Terborgh, 2014), the cultural and spiritual assumptions and implications underpinning biodiversity offsetting as a tool for animal conservation must be examined within national, regional and local contexts – recognizing that scientists and policymakers are not operating in a vacuum, but should draw from and be answerable to wider societal values.

We believe Gardner *et al.* (2013) provide a useful conceptual framework of the offset-related conditions and design activities necessary to evaluate efforts to achieve NNL conservation outcomes. However, we also acknowledge that the scientific knowledge gaps are significant and that much more research is needed to ensure that biodiversity offsetting schemes do benefit animal conservation. To overcome the above-mentioned issues, constructive, critical engagement is required between conservation scientists and decision makers, which could be facilitated by building more interdisciplinary programs that allow more transparency and common understanding of concepts and issues among stakeholders. It will then be possible to give biodiversity offsetting projects adequate scrutiny and move them from being a largely symbolic policy to a useful tool that can reconcile nature conservation and resource development.

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