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Faustian bargains? Restoration realities in the context of biodiversity offset policies

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ABSTRACT

The science and practice of ecological restoration are increasingly being called upon to compensate for the loss of biodiversity values caused by development projects. Biodiversity offsetting—compensating for losses of biodiversity at an impact site by generating ecologically equivalent gains elsewhere—therefore places substantial faith in the ability of restoration to recover lost biodiversity. Furthermore, the increase in offset-led restoration multiplies the consequences of failure to restore, since the promise of effective restoration may increase the chance that damage to biodiversity is permitted. But what evidence exists that restoration science and practice can reliably, or even feasibly, achieve the goal of 'no net loss' of biodiversity, and under what circumstances are successes and failures more likely? Using recent reviews of the restoration ecology literature, we examine the effectiveness of restoration as an approach for offsetting biodiversity loss, and conclude that many of the expectations set by current offset policy for ecological restoration remain unsupported by evidence. We introduce a conceptual model that illustrates three factors that limit the technical success of offsets: time lags, uncertainty and measurability of the value being offset. These factors can be managed to some extent through sound offset policy design that incorporates active adaptive management, time discounting, explicit accounting for uncertainty, and biodiversity banking. Nevertheless, the domain within which restoration can deliver 'no net loss' offsets remains small. A narrowing of the gap between the expectations set by offset policies and the practice of offsetting is urgently required and we urge the development of stronger links between restoration ecologists and those who make policies that are reliant upon restoration science.

1. Introduction

As the world's population passes seven billion, escalating conflicts between development and environmental conservation continue to diminish the Earth's stocks of natural capital. Projections suggest another 200 million to 1 billion hectares of terrestrial remnant vegetation will be converted for human land uses by 2050 (Millennium Ecosystem Assessment, 2005; Tilman et al., 2011). Biodiversity offsets (sometimes termed compensatory mitigation) are increasingly being used in an attempt to reduce this fundamental conflict between development (e.g. for mining, agriculture and urban development) and conservation (ten Kate et al., 2004; Kiesecker et al., 2009; McKenney and Kiesecker, 2010; Suding, 2011).

For the purposes of this paper, we define 'biodiversity offsetting' as compensating for losses of biodiversity components at an impact site by generating (or attempting to generate) ecologically equivalent gains, or 'credits', elsewhere (i.e. an offset site) (see Table 1 for definitions). As such, we consider only 'direct' offsets, rather than approaches to compensating for losses using indirect means, such as financial contributions not directly tied to generating ecologically equivalent biodiversity credits. Although some actions commonly referred to as 'biodiversity offsets' may not require demonstration of ecological equivalence of losses and gains, such equivalence is increasingly considered a fundamental aspect of the definition of a biodiversity offset (Business and Biodiversity Offsets Program, 2012).

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Table 1
Definition of terms as used in this review.

Term	Definition
Biodiversity offsetting	The process of compensating for losses of biodiversity values at an impact site by generating ecologically equivalent gains, or 'credits', elsewhere (i.e. an offset site)
Biodiversity value	The aspect of biodiversity affected by the development or activity at the impact site, or generated at the offset site (e.g. a threatened species, a set of ecological functions, or a particular ecosystem type); often captured in a metric which combines information about condition and status
Biodiversity credit	A unit of a specified biodiversity value generated at an offset site to compensate for units of biodiversity lost at an impact site
Ecological equivalence	When the types of biodiversity values lost and gained are the same in nature and magnitude
Impact site	The site at which biodiversity values are lost or damaged
Offset site	The site at which additional biodiversity credits are generated through protection and/or restoration
Restoration	Activities aimed at increasing biodiversity values at a site, such as pest or weed control, management of regrowth vegetation, replanting of particular species, or implementation of a particular fire regime

Biodiversity offsets can be achieved in two main ways: (1) via averted loss from ongoing or anticipated impacts (e.g. avoided deforestation or degradation) at a site through the removal of threatening processes and (2) by enhancement of a degraded site through restoration and rehabilitation ('restoration offsets'). Averted loss can only generate 'gains' compared to a baseline of ongoing decline; restoration offsets are necessary if a cessation or reversal of biodiversity decline is to be achieved. In this review, we focus on restoration offsets and their potential to achieve genuine compensation for biodiversity losses.

A large range of restoration approaches is invoked in the context of offsets, including species, community and ecosystem-level interventions that vary from translocations of single taxa to multi-species introductions, ecosystem repair and generation of new ecosystems through revegetation (e.g. Harper and Quigley, 2005; Department of Sustainability and Environment, 2006; Gibbons and Lindenmayer, 2007). Biodiversity offsetting thus often relies heavily on restoration actions to generate biodiversity credits (to offset specific biodiversity losses or to trade for future losses, depending on the particular offset framework). Therefore, in many parts of the world, offset policies have become a significant driver of ecological restoration work (ten Kate et al., 2004; Robertson and Hayden, 2008; Palmer and Filoso, 2009).

Biodiversity offsetting may be conducted within a voluntary framework, with requirements negotiated between stakeholders, or within a statutory framework that is mandated by regional or national environmental legislation. Objectives vary among projects, but an increasingly cited goal is to achieve 'no net loss' or 'net gain' of biodiversity. Indeed, to avoid ambiguity and try and limit abuse of the term, the Business and Biodiversity Offsets Program (BBOP – http://.bbop.forest-trends.org/) considers no net loss as central to the definition of a biodiversity offset. The currency used to measure biodiversity losses and gains also varies, but may include particular ecological functions, size or viability of threatened species populations, and the extent and/or 'quality' of vegetation associations and habitat types. Commonly, an index based on a set of biodiversity attributes is used (e.g. the Habitat Hectares approach of Parkes et al., 2003). Usually, but not always, there is a requirement or preference for ecological equivalence—i.e., that gains must comprise the same type of biodiversity attributes that are lost (also called 'in kind' or 'like-for-like' offsets).

Such ambitious policy objectives as no net loss or net gain are often underpinned by the implicit belief that restoration ecologists and practitioners are, in general, able to restore or recreate ecosystems that contain equivalent biodiversity values to those that are lost. Yet restoration ecology is a relatively young and inexperienced discipline with a still-embryonic and patchy evidence base. Furthermore, given the complexity and variability of natural systems, the ecological community is increasingly recognizing that recreating or restoring ecosystems to some specified former state is often unlikely to be feasible (Hobbs et al., 2011), especially within reasonable time-frames. Thus, many current biodiversity offset approaches and expectations potentially push the limits of both scientific knowledge and practical feasibility (Stokstad, 2008; Palmer and Filoso, 2009; Hobbs et al., 2011).

In this paper we ask: to what extent are the demands that biodiversity offset policies make of restoration ecology realistic and feasible, given the state of current science? First, we briefly review recent growth in biodiversity offset-led restoration and its implications for restoration practice. Second, we examine the effectiveness of established biodiversity offset programs and review the current limits of restoration science. We then introduce a simple classification of the main sources of risk of failure in offsets from a restoration science perspective, and identify the types of biodiversity values for which offsetting may be: (a) feasible and low-risk, (b) higher risk and requiring of careful management, and (c) essentially unfeasible and inappropriate. Finally, we discuss potential responses to each of the risk factors, thereby helping to identify the domain in which restoration offsets may be effective mitigation tools.

2. The rapid expansion of offset-led restoration

The number and influence of biodiversity offset programs are growing rapidly. Madsen et al. (2010) identified 39 active biodiversity offset programs (i.e., comprising frameworks governing suites of individual offset projects) worldwide and 25 in some stage of development. The geographic reach of such programs is extensive. The regions that have most actively embraced biodiversity offsetting to date are North America and Australasia (with a combined total of 36 programs active or in development), although biodiversity offsetting is increasing in popularity elsewhere (Madsen et al., 2010). There are four active offset programs in Asia, (and another four in early development) resulting in the protection or restoration of approximately 26,000 hectares annually (Madsen et al., 2010). Many countries in South America have biodiversity offset-type programs at different stages of development, including the National Biodiversity Policy in Brazil, and '*Decreto 1753*' in Colombia, both of which include legislation outlining environmental mitigation principles (Madsen et al., 2010). South Africa has three offset policies being formulated, and although Europe has few programs in place, several are currently being piloted (including in the United Kingdom; DEFRA, 2011; Madsen et al., 2010). In addition to these government-mandated approaches, many companies undertake voluntary mitigation, particularly when operating in countries with limited legal protection for biodiversity (e.g. Tinto, 2004; Darbi et al., 2009; Newmont Golden Ridge Limited, 2009).

The proliferation of biodiversity offset programs and projects is driving a rapidly-growing demand for ecological restoration and management of newly-protected areas. Biodiversity offsetting under existing programs (encompassing a variety of definitions) is currently estimated to result in the protection or restoration of