POLICY PERSPECTIVE

A process for assessing the offsetability of biodiversity impacts

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Abstract

Biodiversity offsetting is increasingly being used to reconcile the objectives of conservation and development. It is generally acknowledged that there are limits to the kinds of impacts on biodiversity that can or should be offset, yet there is a paucity of policy guidance as to what defines these limits and the relative difficulty of achieving a successful offset as such limits are approached. In order to improve the consistency and defensibility of development decisions involving offsets, and to improve offset design, we outline a general process for evaluating the relative offsetability of different impacts on biodiversity. This process culminates in a framework that establishes the burden of proof necessary to confirm the appropriateness and achievability of offsets, given varying levels of: conservation concern for affected biodiversity; residual impact magnitude; opportunity for suitable offsets; and feasibility of offset implementation in practice. Rankings for biodiversity conservation concern are drawn from existing conservation planning tools and approaches, including the IUCN Red List, Key Biodiversity Areas, and international bank environmental safeguard policies. We hope that the proposed process will stimulate much-needed scientific and policy debate to improve the integrity and accountability of both regulated and voluntary biodiversity offsetting.

Introduction

Biodiversity offsets are widely recommended (e.g. IAIA 2005) to compensate for residual losses of biodiversity due to development impacts through commensurate gains. Established principles (e.g. BBOP 2012a) state that gains through offsets must be achievable "on the ground." It is therefore necessary to demonstrate that offsets are both appropriate (balance biodiversity losses and gains) and deliverable. Decisions concerning development consent or funding invariably depend on a subjective weighing of social, economic, and environmental impacts against benefits, where residual impacts may be compensated for by offsets. We aim to improve the consistency and defensibility of such decisions, and the overall offset design process, by providing guidance on the relative "offsetability" of biodiversity impacts: i.e. the appropriateness of risks to biodiversity and achievability of offsets.

It is generally accepted that there are limits to what can be offset on a like-for-like basis: some residual impacts cannot be fully offset owing to the inherent vulnerability or irreplaceability of affected biodiversity (BBOP 2012a). At the extreme, offsets would not be possible for impacts that cause global extinction (BBOP 2012a), but there are other cases where they may be considered

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inappropriate because risks to biodiversity persistence are too high. These cases reflect levels of biodiversity loss that are unacceptable to society, and are ideally defined by conservation goals within national or subnational biodiversity strategies, policies or plans (e.g. Lochner *et al.* 2003). Ultimately, the value of any offset guidance thus depends on its integration with higher-level biodiversity policies/plans that clarify assumptions, specify conservation goals, and address cumulative impacts.

Relative offsetability of biodiversity impacts is fundamentally defined by what offsetting is intended to achieve. In the absence of appropriate policies or plans containing biodiversity goals at a global level, we make several assumptions in order to assess offsetability in a generally applicable way. First, a clear, spatially and temporally referenced definition of "no net loss" is necessary. We assume a minimum target of no net loss at the global scale, compared to background rates of loss, although this may cause local-level losses to biodiversity (Gibbons & Lindenmayer 2007). Second, we assume "like-for-like" offsetting, which is a basic condition for achieving no net loss (BBOP 2012a). "Like-for-like-or-better" is an offset strategy in some countries but is constrained by lack of robust methods for quantifying exchanges of different biodiversity (Quétier & Lavorel 2011)—although some hold promise (e.g. Ludwig & Iannuzzi 2006; Overton *et al.* 2012). Third, we only consider existence values of biodiversity because ecosystem service values vary more widely among human societies and may be substitutable.

Experience in the use of offsets is growing (Madsen *et al.* 2010), but guidance on best-practice remains limited (e.g. BBOP 2012a). We aim to strengthen this guidance by proposing a process to assess relative offsetability, drawing from existing offset approaches and conservation planning and environmental impact assessment concepts. For a review of existing limits to offsetability, see Supporting Information.

Our proposed process is intended to support more rigorous and consistent approaches to use of offsets by providing advice about the level of evidence, or "burden of proof," necessary to demonstrate that there is limited danger to biodiversity in shifting from the often lower-risk status quo to a new position (with development and offsets). Nonetheless, we recognize that offsetability is only one of many offsetting issues that require consideration. Other key issues include: definition of no net loss goals, exchange rules (e.g. substitutability of quality or type of biodiversity), additionality, and permanence; measurability; technical and financial capacity for monitoring and oversight; ecological uncertainty; and inherent market and political issues (e.g. bias, fraud) with commodification and trading of biodiversity (Salzman & Ruhl 2000; Walker *et al.* 2009; McKenney & Kiesecker 2010; BBOP 2012a). Further, we recognize that offsetability is only one factor in deciding whether a development project should ultimately go ahead.

Components of a process to assess relative offsetability

We consider the key issues affecting offsetability to be biodiversity conservation concern, residual impact magnitude, theoretical offset opportunity and practical offset feasibility. We propose a process to address each of these in turn, summarized in Fig. 1. The process culminates in a burden of proof framework. The area of analysis should encompass all potential impacts, and for spatially explicit impacts will thus almost always be larger than the predicted project impact area. Throughout, given inevitable uncertainties and error margins, it is important that a precautionary approach be taken, e.g. when ranking biodiversity conservation concern, quantifying residual impacts, or assessing likelihood of offset success.

To improve transparency and replicability, we propose quantitative thresholds for categories wherever possible in this process. Where it is not possible to set globally relevant quantitative thresholds, we recommend their development at a national or subnational level. At the same time, we recognize that definition and measurement of ecological and social metrics is fraught with complexity (Salzman & Ruhl 2000). Quantitative thresholds are also inherently controversial because they identify fixed transition points between categories, while ignoring the range of variation within them. Case-specific discretion will thus inevitably be necessary in making complex decisions that might affect the conservation status of biodiversity.

Assessing biodiversity conservation concern

We categorized biodiversity features according to their irreplaceability (Margules & Pressey 2000) and vulnerability (Wilson *et al.* 2005) in order to assess varying levels of conservation concern. While this framework of vulnerability and irreplacability has been used extensively and provides a useful starting point, biodiversity conservation concern rankings should ideally be locally derived from systematic conservation plans that identify biodiversity priorities based on a clear conservation goal with specific targets.

We limit our consideration of biodiversity features here to species and ecosystems (sensu Odum 1971), because lack of data are likely to preclude integration of ecological processes as envisioned by Ferrier & Drielsma (2010). To minimize inappropriate and inadvertent exchanges of dissimilar biodiversity, ecosystem classification should be quantitatively derived from inventory data (e.g.

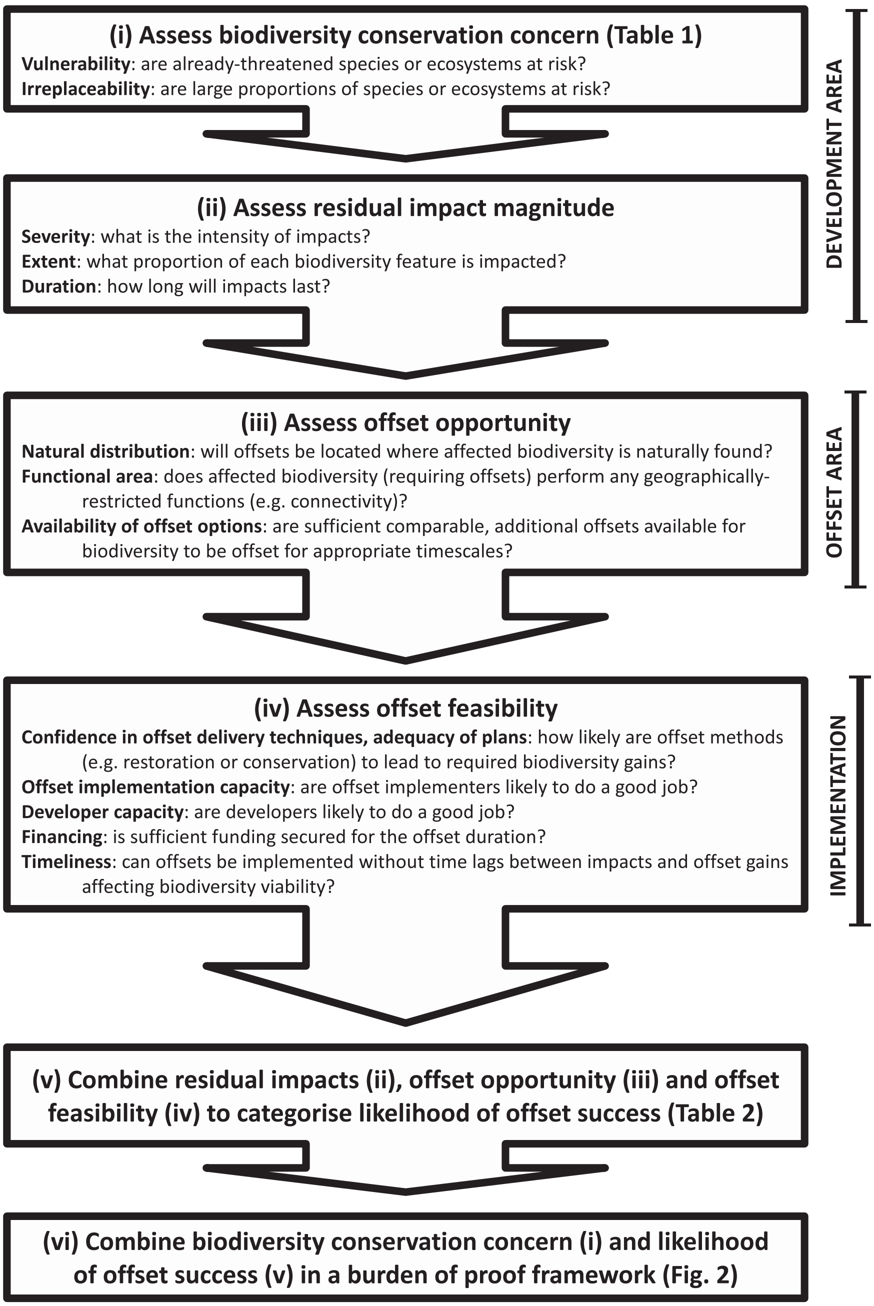

Figure 1 Simplified summary of the proposed process to assess relative offsetability. This process should be iteratively applied during project design and implementation as information on impacts and offsets improves.

Leathwick *et al.* 2003) to clarify: (i) compositional variation within classes, (ii) overlap between classes (Faith *et al.* 1987) and (iii) the pattern of ecosystem nesting among classes (O'Neill *et al.* 1986). Classification should strike an appropriate balance between (i) provision of maximum opportunities for biodiversity offsetting, which requires low-resolution classifications (few classes), and (ii) understanding landscape-level impacts, enabling accurate assessment of irreplaceability and identification of similar biodiversity for offsetting impacts, which all require high-resolution classifications (many classes) to minimize risks of unrecognized biodiversity loss.

We draw irreplaceability rankings (Table 1) from existing global conservation prioritization approaches. The highest irreplaceability rank (≥95%) is that used to identify Alliance for Zero Extinction sites (Ricketts *et al.*

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Table 1 A system for categorising biodiversity conservation concern, based on irreplaceability and vulnerability rankings

Irreplaceability of area of analysis	Vulnerability of biodiversity feature				
	Critically Endangered	Endangered	Vulnerable	Near Threatened/ Least Concern	Data Deficient/ Not Evaluated
≥95%	Extremely High	Extremely High	Very High	High	Assign to a threat level or apply precautionary approach
≥10%	Extremely High	Very High	High	Medium	
≥1%	Very High	High	Medium	Low	
≥0.1%	High	Medium	Low	Low	
<0.1%	Medium	Low	Low	Low	

Note: Irreplaceability is the percentage of the global range or population of a biodiversity feature sustained by the area of analysis. Vulnerability categories refer to relative risk of extinction in the wild.

2005) and critical habitat (tier 1 of criteria 2 and 3; IFC 2012). The second rank (≥10%) equates to tier 1 of criterion 1 for identification of critical habitat (IFC 2012). The third rank (≥1%) equates to thresholds for identification of Ramsar sites (criteria 6 and 9), Key Biodiversity Areas (for globally significant congregations and source populations: Langhammer *et al.* 2007) and tier 2 of criteria 2, and criteria 3b and 3e, for critical habitat (IFC 2012). The rankings are based on the principle that the susceptibility of biodiversity to reductions in distribution or population increases in a nonlinear way (Walker *et al.* 2008; Cardinale *et al.* 2012). We follow Langhammer *et al.* (2007) in considering the "percentage of global range/population" to include (i) that sustained on a regular basis during a species' lifecycle (to include sites important for temporarily geographically restricted species) and (ii) the contribution of an area as a source for an overall population.

We use the most widespread categorization of species' extinction risk (IUCN 2001), also adopted by some international bank environmental safeguards (e.g. IFC 2012), to determine vulnerability rankings (Table 1). These categories are quantitatively defined and have recently been extended to apply to ecosystems as well as species (Rodríguez *et al.* 2011, 2012).

Table 1 describes five conservation concern categories, representing relative risks of global extinction of a biodiversity feature. The categorization is flexible insofar as it allows for greater definition in countries with good biodiversity data, while categories could be aggregated (e.g. Medium and Low) in countries with limited biodiversity data. Biodiversity conservation concern categories are precautionary, such that an area of analysis is classified in the highest conservation concern category for any biodiversity it contains (whether or not impacts are predicted on that biodiversity).

Extinction risks linked to project development inherently include both risks of loss of biodiversity as a consequence of development impacts and risks of offset failure. The two are inextricably linked because an offset would not be required without the development and its accompanying impacts. Likewise—at least with regulated offsets—a development cannot proceed without agreement to offset significant residual impacts.

Assessing residual impact magnitude

Affected biodiversity, particularly that categorized in Table 1 as being of highest conservation concern, should be the focus for evaluating the magnitude of residual impacts. Ideally, impacts might be measured in terms of decreased probability of persistence (e.g. Ferrier & Drielsma 2010), but such metrics often require unattainable amounts of data (Fieberg & Ellner 2000). Instead, practical environmental impact assessment approaches often consider three key components, which we refer to as severity, extent, and duration.

We define "severity" as the intensity of impacts at a defined scale (usually spatial). Even where impacts are spatially extensive, they might not be of high severity (e.g. low-level air pollution) and vice versa. We define "extent" as the scale of expected impacts, as a proportion of the population or range of a given biodiversity feature (inversely related to viability of the remaining portion of that feature). We refer to "duration" of impacts as varying from short-term to permanent. In general, impacts of higher severity, larger extent, and/or longer duration will have a higher magnitude, thus raising the risk of irreplaceable loss and so lowering impact offsetability. Over and above impact magnitude, impact significance is ultimately related to persistence of biodiversity in relation to no net loss goals, that is viability of unaffected portions of affected biodiversity features until offset gains are secured. Residual impacts on features of high conservation concern risk being, but would not automatically be, of high significance.

Assessing offset opportunity

We define "offset opportunity" as the availability of areas or actions that offer suitable opportunities for achieving comparable, additional, lasting gains to compensate for impacts through offsets. Key issues considered below are natural distribution and "functional areas" of affected biodiversity (we consider functional areas to be those in which affected biodiversity performs ecological functions, regardless of service values to humans), and availability of offset options. These all provide external limits to the practicality of offsets, and are typically outside of developers' control. Offset opportunity will be highest where biodiversity to be offset is of moderate–high vulnerability but of low–moderate irreplaceability (BBOP 2012b), occurs naturally near the impact area, and the availability of offset options is sufficient to produce comparable, additional, lasting biodiversity gains given local land tenure and legislation. Quantitative computational methods could assist in resolving complex decisions on optimal spatial location of development and offsets (Obermeyer *et al.* 2011), optimal offset actions (Pouzols *et al.* 2012), or both (Koh *et al.* 2012).

Offsets should be within the natural distribution of affected biodiversity features and the defined scale of "no net loss" goals. Very occasionally, it might be desirable to offset biodiversity features outside of natural distributions, e.g. in new climate envelopes for species with poor dispersal (Loss *et al.* 2011).

Affected biodiversity may underpin important ecological and evolutionary processes or functions, such as habitat connectivity, that are restricted to limited functional areas and cannot readily be substituted (and therefore offset on a like-for-like basis). For example, wetlands often cannot effectively be offset in areas remote from impacts, because they play particularly important roles in local ecological function. It will thus be necessary in some cases to restrict offsets to within the same functional area (e.g. to watersheds for wetlands in the United States; Madsen *et al.* 2010), preferably close to the impact area.

The availability of offset options will usually depend on the amount of relevant habitat (or area for restoration) that is not occupied by other, unchangeable land uses or already effectively protected in some way (i.e. it allows for additional and lasting offsets: BBOP 2012a). Similar considerations apply for offsets that are not spatially explicit. At minimum, it must be possible to produce comparable biodiversity gains from the available offset area or actions given local legislation and land tenure. Opportunity is greatest when the biodiversity to be offset is—at a regional level—declining in area/condition (and it is possible to counter this decline) or already degraded (and restoration is demonstrably feasible).

Assessing offset feasibility

Considerations of "offset feasibility" include confidence in offset techniques, technical capacity (of developers and offset implementers), financing and timeliness of offsets (Gibbons & Lindenmayer 2007; BBOP 2012a). These are all internal limits to the practicality and ecological persistence of offset gains, being factors which developers can improve in order to increase chances of offset success. Offsets will be most feasible where offset implementers and developers have proven experience, offset gains can be produced prior to impacts, and secure, long-term financing is in place at the outset. Offsets will also be more feasible where there is public scrutiny of both offset delivery and government oversight (Walker *et al.* 2009).

The degree to which predicted offset gains are likely to be achieved is partly a function of the extent to which relevant offset delivery techniques (interventions to protect or restore biodiversity) have proven success in generating and sustaining relevant biodiversity gains, given the ecological, political, legislative, and social context. For less proven techniques, such as restoration of complex ecosystems, higher standards of proof may be required from developers (e.g. through empirical demonstrations). Additionally, requirements for financial assurance could incentivise delivery (Burgin 2008; Maron *et al.* 2012).

In addition to the need for proven offset delivery techniques, the success of an offset depends heavily on capacity for implementation—including the implementer's size, skills, and experience in relevant offset techniques—and independent monitoring and reporting (ideally including fully funded, independent, and publicly accountable verification).

Developer environmental capacity, particularly proven successful experience in similar types and scales of developments, largely determines the degree to which developers pose a threat beyond predicted residual impacts—e.g., developer capacity is a key compliance consideration for IFC (2012). Developers with less environmental capacity might not be permitted to conduct developments in situations of higher biodiversity conservation concern, or might only be permitted to do so with additional precautionary measures.

There will be greater confidence in offset success where adequate financing is in place before project impacts, via a sound financial mechanism (e.g. a sound costed business plan or endowment fund), for achievement and long-term management of offset gains. Financial assurance (e.g. insurance, bonds, trust funds) is often required at particular stages in the development process, and could ensure security of offsets in case of divestment or commercial failure (Gerard 2000; Miller 2005; Teresa 2008; Maron *et al.* 2012).

Time lags between losses due to impacts and gains due to offsets are likely to increase impact magnitude and extinction risks, but can be avoided or reduced via habitat or species banking (Bekessy *et al.* 2010), or might

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Table 2 Example system for assessing the likelihood that project impacts can be successfully offset on the basis of residual impact magnitude, offset opportunity, and feasibility (as indicated by offset planning, budget provision, timeliness and capacity)

Issue	Sub-issue	Criterion	Class 1 (lowest likelihood)	Class 2	Class 3	Class 4 (highest likelihood)
Residual impact magnitude	Severity	Declines of each biodiversity feature at a set scale (e.g. per square kilometre)	Severe	Major	Minor	Very limited (but still significant)
	Extent	Proportion of range/population of each biodiversity feature impacted	Majority	Large	Small	Very small (but still significant)
	Duration	Length of impacts, relative to viability of affected biodiversity	Permanent	Long-term	Medium-term	Short-term
Offset opportunity	Options	Potential for restoring affected biodiversity functions elsewhere	None	Possible	Possible	Possible
		Offset options within natural range	Limited	Limited	Reasonable	Great
		For restoration offsets, condition to which offset can be restored compared to impacted feature	Worse	Worse	Equal or Better	Better
		For averted loss offsets, landscape-level condition of affected biodiversity	At or near original; increasing	Good; decreasing	Reasonable; decreasing rapidly	Poor; decreasing rapidly
Offset feasibility	Technical	Availability of proven relevant methods for restoration, protection, etc.	No proven methods	Few proven methods	Some proven methods	Many proven methods
		Adequacy of long-term offset implementation plans	Inadequate	Credible plan exists	Credible plan exists	Credible plan exists
		Adequacy of long-term offset monitoring plans	None	Lacking detail	Adequate	Excellent
	Financial	Funding for long-term offset implementation	Post-impacts	Post-impacts	Some pre-impacts	Fully pre-impacts
		Funding for long-term offset monitoring	None	Inadequate	Lacks funding for independent input	Includes funding for independent input
	Temporal	Time after impacts until offset gains replace affected biodiversity, relative to viability	Long-term	Medium-term	Short-term	Gains prior to impacts
	Capacity	Capacity of offset implementer for relevant methods at necessary scale	Negligible	Limited	Some	High
		Capacity of developer to keep residual impacts within predicted magnitudes	Negligible	Limited	Some	High

Note: Subjective terms (e.g. "major") will need clear, preferably quantitative, definition when locally applied. Overall likelihood of offset success is indicated by the lowest class for which a project is ranked on any table row, from Class 1 (lowest likelihood) to Class 4 (highest likelihood).

be acceptable for offsets of less susceptible biodiversity if local extinction is improbable. Even in such cases, it might not be appropriate to offset biodiversity that cannot be restored in timeframes that are "reasonable," both for relevant policy frameworks (e.g. related to human generation lengths and social planning cycles; Morris *et al.* 2006; Treweek *et al.* 2009) and for affected biodiversity (e.g. related to generation lengths and ecology; Maron *et al.* 2010). For example, emergent forest trees and their epiphytic biodiversity can take many centuries to grow (Gardner *et al.* 2007).

Combining residual impact magnitude, offset opportunity, and offset feasibility to categorize likelihood of offset success

Once residual impact magnitude, offset opportunity and offset feasibility have been identified, they can be combined to categorize the likelihood of offset success. "Success" relates to whether particular no net loss targets can be achieved, and thus implicitly requires consideration of whether unaffected portions of affected biodiversity features remain viable after impacts. An example categorization system is presented in Table 2, using a precautionary

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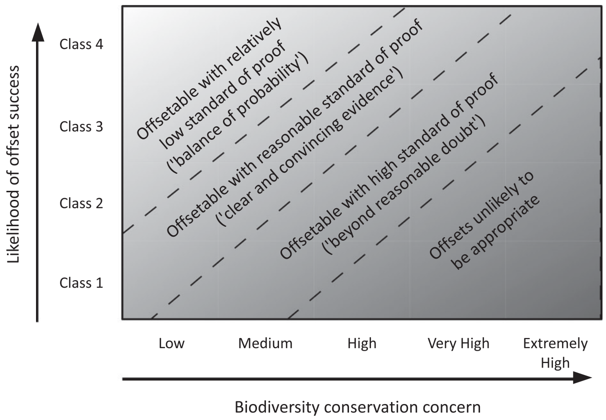

Figure 2 Burden of proof conceptualization of offsetability, combining biodiversity conservation concern and likelihood of offset success. A practical framework may thus, e.g. view offsets as unlikely to be appropriate for: Class 1 likelihood of offset success for areas of High, Very High, and Extremely High conservation concern; Class 2 for Very High and Extremely High concern; and Class 3 for Extremely High concern.

approach whereby offset success is classified in the lowest likelihood category for which it is ranked on any row of the table. This basic model should be improved, wherever possible, through development of national or subnational quantitative thresholds for each issue, via a stakeholder consultation process. Practical frameworks exist for quantitative comparison of impacts and conservation action (conceptually overlapping "offset feasibility") given varying data quality (e.g. BirdLife International 2006).

Combining biodiversity conservation concern with likelihood of offset success in a burden of proof framework

The concept of "burden of proof" is central to the "polluter pays" and precautionary principles and should thus be a central consideration in development decisions (Cameron & Abouchar 1991). We therefore use this concept to underpin assessment of the offsetability of development impacts. The burden of proof refers to the obligation that lies with the developer to present evidence showing there is limited danger to biodiversity in shifting from the often lower-risk status quo (no additional development) to a new position (with development and offsets). The normal standard of proof in Civil Law (including environmental law) is "balance of probability." Criminal Law usually requires the higher standard of "beyond reasonable doubt."

We use a burden of proof framework (Fig. 2) to combine biodiversity conservation concern (highest-ranked conservation concern assessed using Table 1) with likelihood of offset success (lowest-ranked likelihood assessed using Table 2) in order to assess the level of proof required for an offset. This framework should be iteratively applied during project design and implementation as information on impacts and offsets improves: project/offset design and implementation should be adaptively managed accordingly.

The burden of proving that a lower conservation concern category may be appropriate would lie with the developer, e.g. by funding independent surveys elsewhere to increase the known range of a species and thus decrease conservation concern for the area of analysis. The burden of proof would also lie with developers to prove a high likelihood of success of proposed offsets in fully compensating for residual impacts. Developers might not achieve higher standards of proof if they cannot measure project impacts or offset gains, cannot reduce uncertainty to appropriate levels (Maron *et al.* 2012), only provide limited documentation, or fail to provide supporting evidence from acknowledged experts. Significant incentives would thus exist for reducing residual development impacts, and associated offset requirements for those impacts.

In order to achieve biodiversity strategy goals, decision-makers are likely to find it necessary to prohibit developments altogether (i.e. to set absolute upper limits to offsetability) in situations of higher conservation concern or, more practically, where offsets have a low likelihood of success. At minimum, it is likely that only projects that could demonstrate a high likelihood of success (as categorized in Table 2) with a high standard of proof should be allowed to proceed in situations of Extremely High Conservation Concern and most Very High Conservation Concern. Situations of Medium Conservation Concern and Low Conservation Concern offer progressively more room for regulators to allow projects with a lower standard of proof or likelihood of success. Situations of Low Conservation Concern might be viewed as the lower threshold for offsetting, at which offsets might not be required if cumulative loss is not a significant issue.

Conclusions

Biodiversity offsetting offers the potential for significant improvement on the status quo of development without adequate compensation for residual impacts. The uptake of offsets is rapidly increasing around the world. Nonetheless, offsets are controversial and have many inherent difficulties (e.g. Walker *et al.* 2009), too numerous and complex to address here. We present a general process and burden of proof framework to provide guidance on one specific issue: the offsetability of impacts. The

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framework should not be used to decide which projects are approved (so-called "go/no-go" decisions), but rather to help inform such decisions alongside other social, economic, and environmental considerations. Instead, our process—particularly if adapted locally by governments, financiers, or industry—is intended to inform project planning and design. Our process assigns the substantial burden of proving offsetability to developers, thus providing clear incentives for rigorous adherence to the mitigation hierarchy that will ultimately improve the acceptability of proposals and minimize dependence on inappropriate offsets.

We adopt criteria from existing conservation science, but further improvements are necessary following practical testing. The criteria are sufficiently general that they should be applicable to any country or region if adjusted to incorporate local societal values. Indeed, adjustments to our process are currently being explored to inform offset policy development within New Zealand. We hope that the proposed process will stimulate further science and critical policy thinking to ensure that biodiversity offset policy and implementation is effective in helping to address the objectives of both conservation and development.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Brief review of existing guidance on offsetability

Key legislation and policy relating to upper limits for offsets

Previous BBOP guidance on offsetability

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