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Research article

Accounting for no net loss: A critical assessment of biodiversity offsetting metrics and methods

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ABSTRACT

Biodiversity offset strategies are based on the explicit calculation of both losses and gains necessary to establish ecological equivalence between impact and offset areas. Given the importance of quantifying biodiversity values, various accounting methods and metrics are continuously being developed and tested for this purpose. Considering the wide array of alternatives, selecting an appropriate one for a specific project can be not only challenging, but also crucial; accounting methods can strongly influence the biodiversity outcomes of an offsetting strategy, and if not well-suited to the context and values being offset, a no net loss outcome might not be delivered. To date there has been no systematic review or comparative classification of the available biodiversity accounting alternatives that aim at facilitating metric selection, and no tools that guide decision-makers throughout such a complex process. We fill this gap by developing a set of analyses to support (i) identifying the spectrum of available alternatives, (ii) understanding the characteristics of each and, ultimately (iii) making the most sensible and sound decision about which one to implement. The metric menu, scoring matrix, and decision tree developed can be used by biodiversity offsetting practitioners to help select an existing metric, and thus achieve successful outcomes that advance the goal of no net loss of biodiversity.

1. Introduction

Biodiversity offsets are defined as "measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development" (International Finance Corporation, 2012, p.2; BBOP, 2012a; ten Kate et al., 2014). These are based on the explicit calculation of losses and gains at the impact and offset sites, looking to establish ecological equivalence between both areas to achieve the goal of no net loss in biodiversity, when compared to a specific reference scenario (Gardner et al., 2013; Maron et al., 2018). As extensively discussed in scientific literature, the need to account for biodiversity values is one of the aspects that distinguishes offsets from other types of compensation programs (e.g., Quétier and Lavorel, 2011; Bull et al., 2014; Quétier et al., 2014; Gonçalves et al., 2015). However, this distinction is not always respected in practice.

Calculating the biodiversity gains required to achieve no net loss is inherently critical to the design and monitoring of the effectiveness of biodiversity offsets; as well as establishing a transparent reference scenario, either fixed or dynamic, against which to assess the goal of no net loss (Maron et al., 2018). Given the importance of quantifying biodiversity values, in a context where there is a meaningful no net loss objective, a wide array of equivalence accounting methods and indicators, known as metrics or currencies (BBOP, 2012b; Bull et al., 2013) have been developed for this purpose (Bezombes et al., 2017). Some intended for broad application, and others oriented to particular contexts or objectives (Bull et al., 2014). Under some circumstances, it is possible to use direct measures of biodiversity at the species or population level (e.g., number of individuals of a particular species). However, in other instances, because of the multi-scale and multi-level characteristics of biodiversity, currencies based on surrogate measures capable of accounting for multiple biodiversity components simultaneously may be more pertinent and more feasible (Business and Biodiversity Offsets Program [BBOP] 2012a).

Some of these indirect currencies use area as a proxy for habitat losses and gains, as in the case of many U.S. species conservation banks, which aim to compensate losses from project development on an acre-by-acre basis (Fox and Nino-Murcia, 2005; Carreras and Toombs, 2017). Others use aggregated currencies, usually based on a combination of area and a measure of either habitat functionality (e.g., the Canadian Fish Habitat Framework, Fisheries and Oceans Canada, 2002) or habitat quality (e.g., the Habitat Hectares metric of the Australian

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State of Victoria, Parkes et al., 2003). More elaborated currencies, although not as widespread, include ecosystem services as biodiversity targets (e.g., a South African policy considers ecosystem services, Brownlie and Botha, 2009; Jacob et al., 2016), or even include indicators that quantify additional aspects of biodiversity value (e.g., a pilot U.K. policy considers habitat 'distinctiveness', Department for Environment, Food and Rural Affairs, 2011).

With interest in biodiversity offsets increasing worldwide, new accounting methods that respond to particular ecological, political, and socioeconomic contexts are continuously being developed (ten Kate et al., 2011; BBOP, 2012c). New scientific studies are also appearing, assessing these methods in terms of both their scientific robustness and applicability, identifying consistent challenges, and shedding light on potential ways to strengthen them (e.g., Bull et al., 2014; Bezombes et al., 2017). As the pressure over the need for more robust accounting methods and metrics keeps building, new approaches are inevitably being developed, and offset practices seem to be moving away from a streamline approach that promotes certainty, efficiency, and predictability.

As practitioners look for uniformed and shared methods among the increasing pool of existing options, it is important to recognize that the selection of biodiversity metrics, and the accounting methods in which they are embedded, can strongly influence the biodiversity outcomes of an offsetting strategy (BBOP, 2012a; Bull et al., 2014; Bezombes et al., 2017). Selection of alternatives that are not well-suited to the local context and biodiversity values being offset may result in a project that fails to deliver a no net loss outcome, even if it appears on paper to do so. For this reason, understanding the differences between alternative biodiversity accounting methods and metrics, recognizing the implications of their use, and choosing the most appropriate ones given the context of a particular offsetting application is both crucial and challenging.

To date, there has been no systematic review or comparative classification of the available biodiversity accounting alternatives according to their suitability overall or for specific contexts. Here we fill this gap by (1) taking stock of the different accounting methods and metrics that are available to quantify impact losses and offset gains; (2) deeply examining the assumptions and contextual frameworks under which these were developed; and (3) classifying alternatives, their suitability, and implications for use according to a set of criteria developed through consultation with scientific and practitioner stakeholders. The results of this analysis can support practitioners to systematically review and select the most appropriate accounting metric, and apply the corresponding accounting method, when designing and implementing offsets, streamlining offset measures and promoting efficiency among these practices.

2. Methods

The methodological framework included the development of semi-structured interviews with stakeholders working with biodiversity offsets and a systematic review of current metrics, and accounting methods in which these are embedded, for measuring biodiversity values. The analysis involved the identification and assessment of current alternatives considering, among other factors, the results of the interviews conducted. The scope of the assessment includes methods and metrics developed for terrestrial and wetland ecosystems. Those specifically designed for aquatic ecosystems, both marine and continental, were not part of the study, as the metric comparative assessment was based on standards that have been developed focusing on terrestrial habitats.

2.1. Identification of stakeholder-defined criteria for selecting accounting methods and metrics

Qualitative interviews with stakeholders involved in the design ('designers'), implementation ('implementers'), and research ('researchers') of biodiversity offsets at the international level (i.e., biodiversity offset expert panel) were conducted. The objective was to determine which characteristics these stakeholders consider to be most relevant when selecting a method and metric for accounting biodiversity values under different contexts. Eight interviewees from non-governmental organizations (NGOs), government and academic institutions, international organizations, and private companies involved in biodiversity offsets across different regions were contacted in order to obtain results that reflect the different perspectives on the topic, both geographically and thematically (Table 1).

Table 1
Interviewees, geographic focus of work experience, and their professional affiliations.

Affiliation	Designers	Implementers	Researchers
NGO	1 (Latin America)	1 (Latin America, North America, Africa, Asia)	
Academia	1 (Latin America)		1 (Europe)
Government	1 (Latin America)		
Private company		1 (Latin America)	1 (Global)
Collaborative platform	1 (Global)		

Interviews followed an open structure of themed conversational questions, following Mason (2002) approach for generating qualitative data; research questions used to guide the conversations, and their corresponding sub-categories, are presented in the Supporting Information. We analyzed responses to identify areas of consensus regarding desirable attributes of biodiversity offset accounting methods and metrics. We did this by coding the responses into common themes for their examination in terms of the presence and amount of specific counts, using the basics of the content analysis technique (Mayring, 2000). The identified attributes were then used as criteria against which to evaluate and characterize existing metrics and corresponding accounting methods.

2.2. Review and characterization of biodiversity offset metrics and methods

We used the Systematic Review (SR) process to identify and characterize current metrics, and corresponding accounting methods, for measuring biodiversity when designing offset strategies (Cook et al., 1997; Mulrow, 1994; Tranfield et al., 2003). This approach is suitable for evaluating and summarizing extensive literature and, in contrast to classical qualitative review methods, it comprises an explicit and systematic process effective for counteracting biases for the development of accurate conclusions. The SR was conducted in a three-stage process following the guidelines proposed by Tranfield et al. (2003).

2.2.1. Stage 1: planning the review

This first stage involved the identification of the review questions. These were collaboratively developed between the authors and biodiversity offset experts and practitioners involved during the interview process (i.e., the biodiversity offset expert panel).

- Q1: What are the different available metrics, and corresponding accounting methods, for measuring biodiversity values in the context of offsetting strategies and what are their characteristics?
- Q2: What are the best existing metrics, and corresponding accounting methods, for measuring biodiversity values according to standards of biodiversity accounting best practice and the stakeholder-defined criteria previously identified?
- Q3: For what type(s) of biodiversity offset project(s) is each methods and metric most suitable?