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The true loss caused by biodiversity offsets

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ABSTRACT

Biodiversity offsets aim to achieve a "no-net-loss" of biodiversity, ecosystem functions and services due to development. The "no-net-less" objective assumes that the multi-dimensional values of biodiversity in complex ecosystems can be isolated from their spatial, evolutionary, historical, social, and moral context. We examine the irreplaceability of ecosystems, the limits of restoration, and the environmental values that claim to be compensated through ecosystem restoration. We discuss multiple ecological, instrumental, and non-instrumental values of ecosystems that should be considered in offsetting calculations. Considering this range of values, we summarize the multiple ecological, regulatory, and ethical losses that are often dismissed when evaluating offsets and the "no-net-loss" objective. Given the risks that biodiversity offsets pose in bypassing strict regulations, eroding our moral responsibility to protect nature, and embracing misplaced technological optimism relating to ecosystem restoration, we argue that offsets cannot fulfil their promise to resolve the trade-off between development and conservation. If compensation for biodiversity loss is unavoidable, as it may well be, these losses must be made transparent and adequate reparation must embrace socio-ecological uncertainty, for example through a Multi-Criteria Evaluation framework. Above all, strict protection legislation should be strengthened rather than watered down as is the current trend.

1. Introduction

To reach biodiversity protection targets for 2020, the EU will develop [by 2015] an initiative that ensures the "no-net-loss" of ecosystems and their services (e.g. through compensation or offsetting schemes) (EU Commission, 2011 p. 12). As in other parts of the world, ecological compensation via offsets has become a key component of environmental policy. Biodiversity offsets were implemented in the US, France, and Germany in the 1970s, but the policy has recently spread across many countries, accompanied by a convergence of methodology and guidelines. Biodiversity offsets are generally implemented following adherence to the "mitigation hierarchy" of "avoid, minimize, mitigate" within an environmental impact assessment (McKenney and Kiesecker, 2010). The offset involves trading the loss of biodiversity at an "impact site" for a commensurable gain at the "offset site". The biodiversity "gain" is provided via the restoration of degraded habitat, creation of new habitat (we refer to both as "restoration offsets") or the improved protection of threatened habitat (referred to as "averted loss" offsets). Since averted loss offsets do not strictly fulfil the additionality condition of a true "no-net-loss" policy objective (Quétier and Lavorel, 2011; Bull et al., 2012), several offset policies worldwide favour restoration and enhancement over protection, such as wetland mitigation in the US or fish habitat offsets in Canada (Bull et al., 2012; DEFRA, 2013).

Ecosystem restoration aims to accelerate the recovery of ecosystem attributes, such as composition, functionality, structure or resilience, to similar levels in a target (generally near-natural, mature) ecosystem chosen as a suitable reference (SER, 2004). However, early studies on the recovery of mitigation wetlands, following approval of the Clean Water Act in 1974, already reported low success levels in restoring plant cover (Race, 1985). At the time, restoration techniques were experimental, but after 30 years of practice, studies still document impaired biodiversity and functionality in restored ecosystems (e.g. Ballantine and Schneider, 2009; Moreno-Mateos et al., 2012). Data and logistic limitations often restrict these types of analyses to simple metrics of recovery, usually a few functional (e.g., carbon storage, organic matter in soils, denitrification) or compositional indices (e.g., species richness and abundance or cover). Recent work using more sensitive metrics, particularly of community composition and structure, shows that recovery of ecosystems may take centuries or longer, beyond the range of meaningful prediction or policy planning (Maron et al., 2012; Curran et al., 2014). Still worse, if a dynamic

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baseline is used for assessing gains and the assumed rate of background biodiversity loss is high, biodiversity loss can be "locked in" by the offsetting process (Maron et al., 2015-in this issue).

Despite these concerns, restoration offsets are being widely adopted (Madsen et al., 2011), accompanied by changes in conservation governance and funding strategies (e.g. Norton and Warburton, 2015). In this paper, we assess offset policy in light of current knowledge of social–ecological complexity and the current state of restoration ecology. We highlight how offsets lead to multiple losses along the different dimensions of value for ecosystems (i.e. ecological, instrumental, and non-instrumental values). After considering the ecological, regulatory, and ethical context of offsets, we argue that no-net-loss is not a progressive step toward no-loss, as the design of offset policies may worsen the present state of biodiversity and existing policies to protect it. Policymakers must therefore strengthen regulation to prevent loss altogether, and where clearly unavoidable, employ transparent and participative decision-making processes to resolve the associated trade-offs.

2. The uniqueness and complexity of ecosystems

When a biodiversity policy aims at "no-net-loss" of ecosystems (EU Commission, 2011), the potential scope of what is implied is enormous. The term ecosystem encompasses anything from a "pristine" tropical forest in Brazil to an intensive cornfield in Mexico. Specifying which ecosystems are eligible for a "no-net-loss" objective is of paramount importance (Gardner et al., 2013). For this paper, we restrict our scope to ecosystems that have not been subject to recent, radical shifts in their ecological or evolutionary trajectories directly due to human intervention. This includes anything from mature or old-growth forests to well-established, co-evolved cultural ecosystems, like low intensity managed grasslands or coppice woodland. A key premise of our argument is that almost any natural ecosystem, thus defined, is unique due to its social–ecological complexity, and cannot be replaced or perfectly substituted. Its uniqueness emerges from at least three environmental attributes: (i) place-specific environment (*spatiality*), (ii) distinctive history (*historicity*), and (iii) complex ecological processes and interactions (*complexity*; Fig. 1).

In terms of spatiality, the geology, geomorphology, and hydrological dynamics underlying any ecosystem are unique features that will strongly affect the living community. Geology determines the availability of nutrients (e.g. nitrogen or phosphorus) and elemental conditions (e.g. acid, basic, or toxic components). Geomorphology determines whether fine particles (essential to the development of soils) or bare rock develops, influencing the stability of physical structures. Hydrological dynamics determines the availability and form of water resources and, in the case of aquatic ecosystems, affects propagule availability and the distribution of water-borne organisms based on tolerance to flow speed (Hart and Finelli, 1999). The biotic surroundings of a given ecosystem also strongly influence its composition and dynamics, allowing an interchange of species and pathogens, connectedness with larger trophic webs, and so on.

Regarding historicity, a legacy of events, such as fire, colonization, or droughts, makes each natural site historically-specific. A deeper layer of historicity involves coevolutionary trajectories resulting from a combination of altered spatial patterns of habitat, heterogeneous selection pressures, and fluctuating gene flows across a landscape (e.g. the "geographic mosaic theory of coevolution"; Hagen et al., 2012). By abruptly changing these factors, human impacts may unpredictably

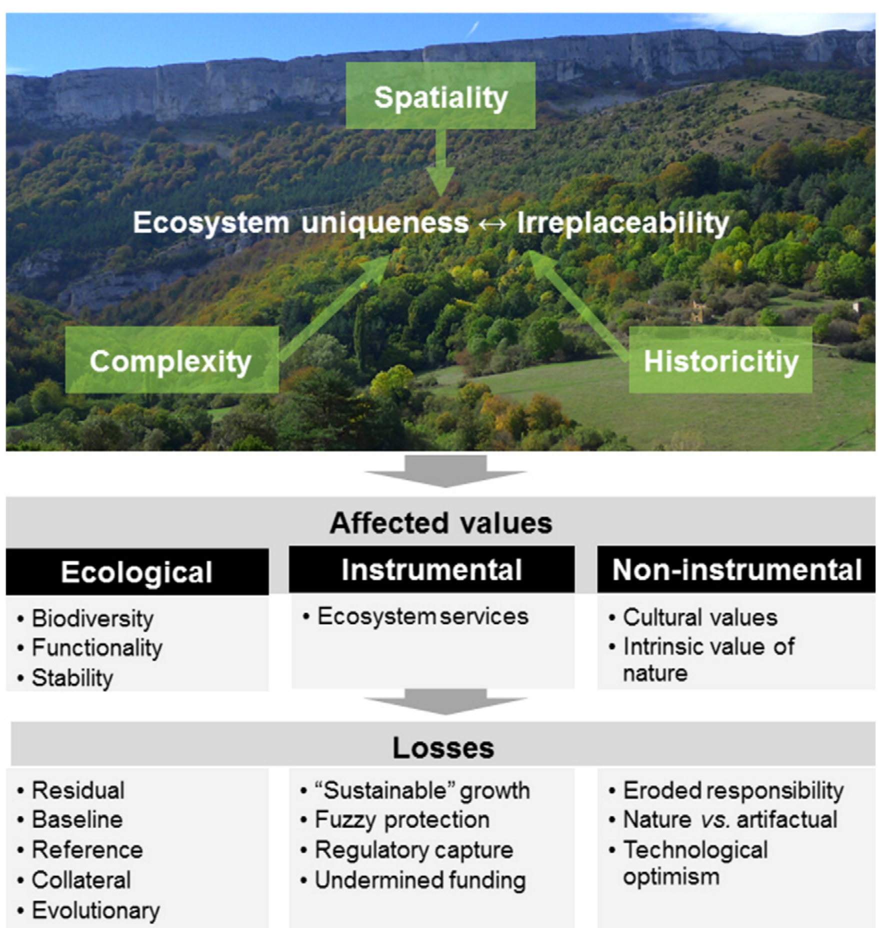

Fig. 1. Losses of ecosystem values caused by biodiversity offsets as a consequence of their irreplaceability.