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Opinion Article

Pleiotropy and charisma determine winners and losers in the REDD+ game: all biodiversity is not equal.

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Abstract

REDD+ may see billions of dollars paid to developing countries to improve forest management. This could potentially provide co-benefits for biodiversity conservation. Whilst this issue has been assessed several times in the existing literature, biodiversity itself has tended to be treated as homogenous. Here we propose a new framework in which to disaggregate and assess potential biodiversity beneficiaries of REDD+: pleiotropy and charisma. Pleiotropy describes the dependence of a species' conservation status on habitat loss alone. Pleiotropically-linked species are threatened principally by forest loss and are most likely to benefit from activities such as reduced deforestation. Non-pleiotropically-linked species are also threatened by other processes such as hunting, and will require extra funding outside REDD+ such as premium payments for their conservation. Charisma describes the degree to which species may be able to generate premiums. We consider that the incorporation of these two dimensions into the REDD+ debate will facilitate a more nuanced discussion of biodiversity co-benefits amongst researchers and other stakeholders than has so far been the norm.

Keywords: biodiversity, carbon, charisma, pleiotropy, REDD+

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Introduction

Deforestation and forest degradation account for an estimated 12% of all human-induced carbon emissions, or an estimated 15% if peat is included [1]. Reducing emissions from deforestation and forest degradation, and the conservation, sustainable management and enhancement of forest carbon stocks in developing countries (REDD+) is a proposed solution. This would involve billions of dollars being paid to tropical forest countries to improve forest management [2]. However tropical forests are not only carbon rich [3], they are also exceptionally biologically diverse, containing up to half of all earth's species [4]. Implementing REDD+ therefore has the potential to mitigate both climate change and biodiversity loss simultaneously.

The REDD+ debate is complex and some uncertainties remain over the ultimate nature of a future implemented mechanism. With regards to the biodiversity benefits of REDD+ implementation, a central aspect of research thus far has been assessment of the spatial overlap between high carbon-value forests and high species-diversity forests, including the impact on areas outside high carbon-value forests [5]. This simple spatial congruence has been further developed by considering the cost-effectiveness of incorporating biodiversity into REDD+ [6]. On a larger scale, the incentives for biodiversity-rich countries to participate in REDD+ under different emissions reference levels have also been addressed [7].

Our argument is that even when high biodiversity countries participate in REDD+ (but hereafter RED in order to focus our argument on reduced deforestation only, following the example of 7), and even where there are overlaps between high biodiversity and high carbon areas, RED implementation will not necessarily benefit all forest species equally.

This is because whilst habitat loss is the major driver of biodiversity loss in tropical forest areas [8], it is not the only one. Multiple threats such as disease, invasive species, hunting and persecution may continue within a forest even if deforestation is reduced (e.g. 9). Because of this, some apparently intact tropical forests are being emptied of much of their wildlife [10, 11].

Since RED is a climate change mitigation strategy rather than biodiversity conservation initiative, but will nonetheless have impacts on biodiversity and forest-dependent people, the UNFCCC has developed safeguards to mitigate negative impacts to either group [12]. However unless these safeguards are detailed and are a condition of receiving carbon payments, forests where biodiversity continues to be lost, or even 'empty forests', could potentially still provide the benefits of carbon emission reductions required under RED.

Pleiotropy

Outside of the context of pilot projects developed by biodiversity conservation organisations, which may aim to use carbon funds to support their conservation goals more generally, the extent to which a particular tropical forest species might benefit from RED would depend upon the degree to which that species' conservation status is determined by habitat loss. Species will lie somewhere on a continuum from those whose status is dependent almost entirely upon the availability of particular forest, through to species whose conservation status is determined to a larger extent by the other threats such as invasive species. Within any area coming under RED management, those taxa whose conservation status is affected almost entirely by forest loss are most likely to benefit. These species would come as part of the package of RED activities. By genetic analogy we describe such species as 'pleiotropically-linked' to the forest. That is, when a change in this single threat process conserves many species. Examples include the trees that compose the forest itself, and the smaller organisms protected through the umbrella species effect such as most beetles and arachnids [13]. On the other hand, taxa that are affected by forest loss, but are also heavily constrained by other threats such as hunting, are less likely to be conserved solely as a result of RED. Such 'non-pleiotropic' taxa do not necessarily come as part of the package and will need additional activities to ensure their conservation. Examples include duikers (*Cephalophinae*) and tigers (*Panthera tigris*), both of which suffer habitat loss as a major threat in addition to unsustainable hunting for meat (duikers; 14) and parts (tigers, 15).

This distinction between the pleiotropic and non-pleiotropic groups is important since the available evidence from the existing voluntary carbon market shows that investors perceive there to be large biodiversity benefits simply from investing in forest carbon [16]. Yet whilst many species in a tropical forest probably are indeed pleiotropically-linked (Fig. 1, quadrants 1 & 2), many species that the wider public, and presumably future RED investors or fund managers are concerned about, are probably not [17]. Assuming the private sector is involved in a future RED programme, or otherwise assuming that RED fund donors expect to achieve biodiversity co-benefits, the respective investors and fund managers may become disillusioned if they anticipate that non-pleiotropic species such as tigers and chimpanzees will benefit from their money, whilst implementation actually conserves only the pleiotropic species like beetles.

Therefore, some species of conservation concern will continue to need additional conservation inputs over and above the habitat benefits that RED provides (Fig 1. quadrants 3 & 4). Researchers have proposed that the cost of this could be met by wildlife premium payments in RED for single species conservation efforts such as for tigers [18], whereas other researchers suggest sourcing biodiversity conservation funds from elsewhere to match carbon payments [7; 19 reviews financial instruments for carnivore conservation].

Charisma

If either wildlife premiums or matching funds are indeed feasible with a future RED mechanism, the question will then become whether there is a willingness to pay premiums or provide matching funds for the different non-pleiotropic species or groups of species. Humans prefer to pay to conserve charismatic, high-profile animals [20, 21]. For instance, tigers suffer from multiple threats, but they are highly charismatic and have high potential to generate some form of premium payment (18; Fig 1. quadrant 3). However other groups such as duikers also suffer multiple threats including in particular over-exploitation [14], but they may be less straightforward candidates for attracting premiums (Fig 1. quadrant 4). These overlooked species and communities may therefore require additional conservation funding outside of the context of RED and premium payments.

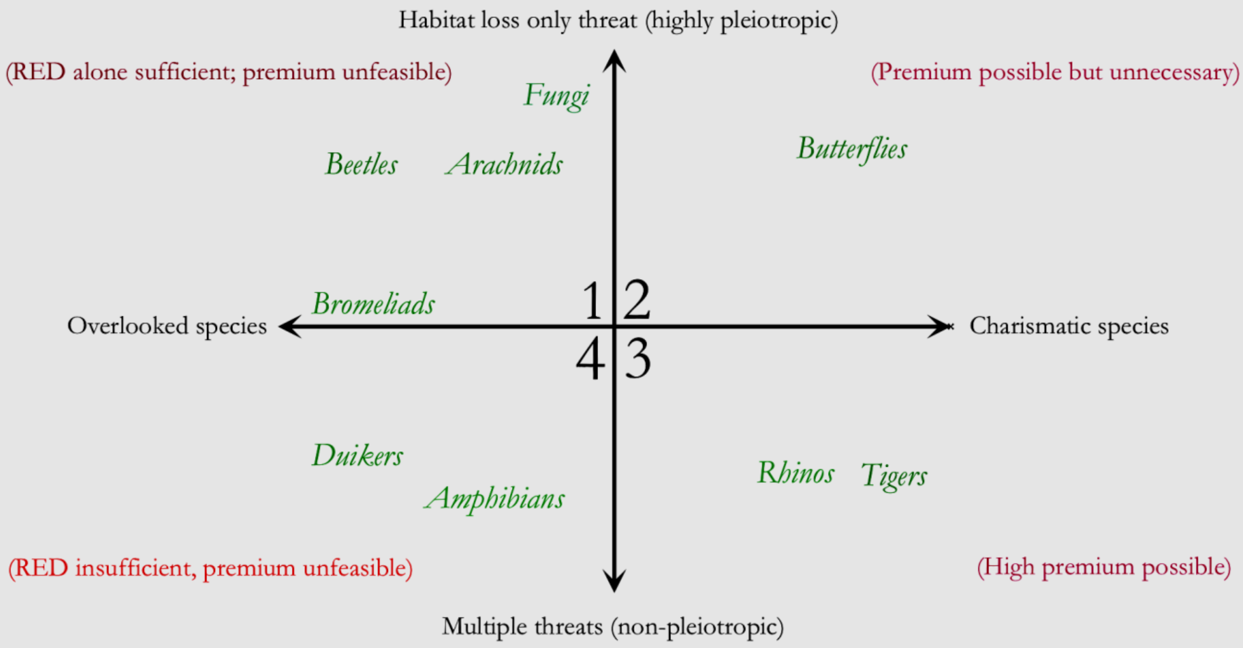

Fig. 1. Two dimensions to assess potential biodiversity beneficiaries of RED: Pleiotropy and charisma.

Clearly, reducing forest loss through RED would mitigate a major threat to species in all quadrants, and a species' range would need to overlap with RED activity in the first instance to benefit. However the threat processes affecting tropical forests are complex, as is the capacity of species to generate price premiums for their conservation. So the impact of RED on biodiversity conservation may not be uniform. The existence of potentially overlooked groups emphasises the need to integrate targeted biodiversity conservation programmes explicitly within RED to ensure maximum biodiversity benefits. Spatial overlaps of hotspots of carbon and of overall biodiversity are an important element of the equation but will not yet necessarily lead to a win-win for all species in a RED forest. Targeting should therefore not just focus on the charismatic non-pleiotropic species, but explicitly consider the threats to other categories of species like duikers (See Figure 1). This is particularly pertinent to discussions of the 'permanence' of forest carbon.

Permanence concerns whether forest carbon retained today through RED will still be retained in the future. Crucially, reductions in the populations of non-charismatic seed dispersers from forests, or worse the complete emptying of such species from forests (e.g. for wildmeat consumption) can lead to cascade effects in an ecosystem. This can cause reductions in the germination of new trees and eventually reduce a forest's carbon stock [13].

We believe the pleiotropy and charisma concepts provide two useful dimensions with which to start characterising different classes of potential RED biodiversity beneficiaries. Whilst we do not claim to have yet quantified the degree of charisma and pleiotropy of the species shown in figure 1, we have qualified the relevance of doing so. The incorporation of these two dimensions into the RED debate will facilitate a more nuanced discussion of biodiversity co-benefits amongst researchers and other stakeholders than has so far been the norm.

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