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GENERAL COMMENTARY
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Response: Where Might We Find Ecologically Intact Communities?

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A Commentary on

Where Might We Find Ecologically Intact Communities?
by Plumptre, A. J., Baisero, D., Belote, R. T., Vázquez-Domínguez, E., Faurby, S., Jędrzejewski, W., et al. (2021). Front. For. Glob. Change 4:626635. doi: 10.3389/ffgc.2021.626635

INTRODUCTION

In an attempt to identify areas of the world that represent outstanding examples of ecological integrity, Plumptre et al. (2021) concluded that just 2.8% of Earth's terrestrial area could be considered to qualify. This analysis contrasts with other global assessments that show the extent of areas important for ecological integrity to be at least an order of magnitude higher (Newbold et al., 2016; Watson et al., 2016a; Beyer et al., 2020; Grantham et al., 2020; Hansen et al., 2020; Mokany et al., 2020; Riggio et al., 2020; Williams et al., 2020; De Palma et al., 2021). Plumptre et al. (2021) further argue their methodology and findings can inform Key Biodiversity Area (KBA) delineation.

We believe the methodology used by Plumptre et al. is highly problematic when it comes to scoping sites in relation to ecological integrity. We provide reasons why their methodology is inappropriate for the scoping of KBA site identification (IUCN, 2016). We urge readers of Plumptre et al. (2021) to consider carefully their interpretations of data and underlying ecological theory, the problems inherent in the methodology employed in the analysis, and how the results can be misrepresented in important and ongoing global policy discussions.

Definition of Ecological Integrity

Intact areas are synonymous with locations of high ecosystem integrity. They are associated with ecosystem characteristics of relatively undisturbed ecosystem functioning, structure, and composition (Nicholson et al., 2021). Plumptre et al. (2021) combine three types of measures of "intactness" to measure ecological integrity. The first is use of Human Footprint Index to identify areas of low human impact. The second is to require "faunal intactness" meaning that no faunal species have been lost historically, while the third is to require "functional intactness," meaning that none of the faunal species of interest have densities less than a somewhat arbitrary threshold.

This narrow species-focused approach to defining ecological integrity does not align with other definitions of ecological integrity that have been used for over three decades (Noss, 1990; Parrish et al., 2003; Keith et al., 2013). Such established definitions consistently focus on a balanced assessment of complementary ecosystem attributes of function, structure, and composition (relative to a reference state and measured on a spectrum, Nicholson et al., 2021). These established definitions have been used in the Convention on Biological Diversity (CBD) (OEWG, 2020) and in formulating appropriate targets and indicators (Hansen et al., 2021; Nicholson et al., 2021). Plumptre et al. use the combination of the three species-related thresholds to define a binary framework, within which a site is either "ecologically intact" or not. This is clearly counter to traditional definitions of ecological integrity that have typically been measured and understood along a spectrum (Wurtzebach and Schultz, 2016).

In essence, the Plumptre et al. definition requires that sites cannot have "outstanding integrity" if just one faunal species has been lost, or if there is evidence of "reduced abundance." We question the utility of such a definition. It is both theoretically and practically impossible to quantify species abundance for so many species (Whittaker et al., 2005). Whilst highlighting impacts of human activity on single species can be useful (e.g., Di Marco et al., 2018; O'Bryan et al., 2020), disregarding all other aspects of ecological integrity which may remain high in such places (i.e., those aspects associated with function, structure, and other elements of species composition; see also Hansen et al., 2021; Nicholson et al., 2021), is a very narrow view. Plumptre's et al.'s binary measurement also implies that areas which are not "perfect," are not intact (in the sense of overall species composition). Applying this approach to the marine realm would likely lead to a conclusion that none of the world's oceans (or even parts thereof) have outstanding ecological integrity (e.g., absence or reduced abundance of some cetacean species due to historical whaling). Interpreting integrity in this way is unhelpful to identifying priority areas for either research or conservation.

The threshold approach used by Plumptre et al. does not consider the critical issue of constant species turnover. Over longer time scales, locally extirpated species can be replaced through natural processes and there is often redundancy in ecosystem function (Gonzalez and Loreau, 2009; Walther, 2010). It also does not consider climate change, a phenomenon that is already leading to shifting and changing communities, with its often unknown consequences for ecosystem functions (Gonzalez and Loreau, 2009; Hobbs et al., 2009; Walther, 2010; Pacifici et al., 2015). Using the Plumptre et al. (2021) definition, no areas would likely qualify as intact owing to unknown but highly likely climate effects on species abundances.

Mapping Ecological Integrity

We can see at least five problems with the Plumptre et al. approach. Each, by themselves, render the results unreliable as a depiction of the current state of terrestrial ecological integrity.

First, Plumptre et al. used an arbitrary threshold (value of ≤ 4) derived from the Human Footprint (HFP) Index (Venter et al., 2016) to define areas of high ecological integrity. We know of no compelling scientific evidence that the HFPI is a sound basis for quantifying faunal abundance or functional intactness (see discussions in Di Marco et al., 2018; Watson et al., 2018; Mokany et al., 2020; O'Bryan et al., 2020). A threshold of ≤ 4 for a species does not mean that habitat scoring >4 is not important. Indeed, for mammals there is clear evidence that a wide range of HFP scores are associated with discrete mammal habitats (Di Marco et al., 2018). An arbitrary choice of a threshold is, in fact, central to all Plumptre et al.'s results and conclusions. Threshold choice immediately excludes >50% of Earth's terrestrial surface (see analysis in Watson et al., 2016b). Put another way, many areas considered by Plumptre et al. are simply discounted *a priori*, for no reason other than their HFP score is >4.

Second, Plumptre et al.'s analysis relies on identifying "extinct species," based on both global extinction and local extirpation. Plumptre et al. use a reference date of 1,500 AD. Such an arbitrary date has no scientific basis, as far as we are aware. Third, Plumptre et al. use historical species range data, that are known to be questionable (Rondinini et al., 2006; Jetz et al., 2008). The "range maps" relied upon by Plumptre et al. overestimate where species may have become extinct or extirpated. Use of these maps also assumes precision and accuracy of historical data for each species. Such data are typically inaccurate for even the most well-studied species and over timeframes of the last 50 years, let alone the last 500 years (Ramesh et al., 2017). Fourth, to estimate "functional intactness," Plumptre et al. use a set of indicators, based on reductions in density or habitat suitability for just 11 extant faunal species (some divided into subspecies), mostly different species of apes (superfamily: *Hominoidea*) and bears (family *Ursidae*). While we recognize that some of these might be keystone species (e.g., the African forest elephant *Loxodonta cyclotis*) (Blake et al., 2009), it is highly unlikely that these species are representative of the thousands of species in many ecosystems, and millions of species worldwide (Mora et al., 2011). There is no evidence to suggest these are representative species in most ecosystems. Fifth, four of the five suitability models used by Plumptre et al. (see Luna-Aranguré et al., 2020) to create a functional intactness metric were based solely on species' environmental niches. Such analysis lacks sensitivity to human impacts, a major driver of species response.

Policy Commentary

In addition to the methodological issues we outline above, we believe the Plumptre et al. study to be unsuited as a basis for policy (Wurtzebach and Schultz, 2016). Parties to the Convention on Biological Diversity (CBD) are currently negotiating the post-2020 Global Biodiversity Framework (GBF).[1] The current draft of the GBF[2] represents a growing consensus among the 196 governments that are Parties to the CBD (all but two of the world's national governments). The draft GBF states, "By 2030 [50%], of land and sea areas globally are under spatial planning addressing land/sea use change, retaining most of the existing intact and wilderness areas, and allow to restore [X%] of degraded freshwater, marine and terrestrial natural ecosystems

[1]https://www.cbd.int/conferences/post2020

[2]https://www.cbd.int/doc/c/3064/749a/0f65ac7f9def86707f4eaefa/post2020-prep-02-01-en.pd

and connectivity among them." While it might not have been the authors intention, their study could undermine existing efforts to protect and retain ecosystems that, using more common and robust measures, are regarded as being intact or of high integrity. Plumptre et al. argue that there are areas where rewilding is possible and that reintroducing a handful of vertebrate species into degraded ecosystems somehow will increase their intactness to allow it to then become a high integrity site. This is a peculiar interpretation that owes much to narrowly species-focused data.

We believe retaining all Earth's highly intact ecosystems should remain a focus of policy discussions. This is a more cost-effective approach than hoping to restore an ecosystem after it has been destroyed or degraded. Finally, and beyond the issues raised above, Plumptre et al. suggest that there are very few global sites that would qualify as intact under the IUCN Standard's Criterion C. We suggest more judicious application of criteria of structure, function, and composition would result in many more sites globally being recognized as having outstanding ecological integrity.

In summary, we question the approach and methods used by Plumptre et al. We are concerned to ensure that assessments of ecological intactness and integrity are as robust as possible, and that policy discussions remain based on the best science possible.

AUTHOR CONTRIBUTIONS

HG and JW wrote the first draft. All other coauthors contributed to the text. All authors contributed to the article and approved the submitted version.

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