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Global relationships between biodiversity and nature-based tourism in protected areas

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ABSTRACT

The relationships between biodiversity conservation and ecosystem services (ES) are widely debated. However, it is still not clear how biodiversity conservation and ES interact with different strategies in and surrounding protected areas (PAs), the cornerstone for biodiversity conservation. Here, we present results on the interplay between biodiversity conservation and nature-based tourism (a cultural ES), while controlling for environmental and socioeconomic factors in and surrounding terrestrial PAs worldwide. Results indicate that nature-based tourism is more frequent in PAs that are of higher biodiversity, older, larger, more accessible from urban areas and at higher elevation. High population density surrounding PAs and national income levels are also major socioeconomic factors related to nature-based tourism. Furthermore, PAs managed mainly for biodiversity conservation have nearly 35% more visitors than those managed for mixed use. Strict management for biodiversity is also associated with increased biodiversity. These results show the importance of biodiversity in addressing nature-based tourism and suggest this interrelationship could be altered by different management strategies used by PAs.

1. Introduction

For more than a century, designating and managing protected areas (PAs) has been done with a goal of allowing current use of biodiversity, usually through tourism, while preserving resources for future generations (Beissinger et al., 2017). But since the first designation of PAs, there have been conflicts over the appropriate goals in managing such areas (Dietz, 2017a; Joppa and Pfaff, 2010; Liu et al., 2012; Mace, 2014; Tallis and Lubchenco, 2014; Watson et al., 2014). One goal emphasizes the protection of natural systems and biodiversity (nature for itself) (Mace, 2014). The other emphasizes the contribution of ecosystem services (ES) from PAs to human well-being (nature for people) (Mace, 2014). Some PAs are managed with a sharp focus on the sole goal of preserving biodiversity; others are managed with an intent to enhance the provision of multiple types of ES. Of course, preservation of natural systems and biodiversity can contribute to cultural ES, including nature-based tourism (Bayliss et al., 2014; Clements and Cumming, 2017). Additionally, biodiversity may enhance the production of a wide variety of ES beyond just cultural ES (Chung et al., 2015; Smith et al., 2017; Turner et al., 2012) but it is not necessarily the case that managing a PA for biodiversity will optimize overall provision of ES (Karp et al., 2015; Naidoo et al., 2008). Thus, understanding the relationship between ES and biodiversity is a major challenge for sustainability science (Carpenter et al., 2009; Chan et al., 2006; Graves et al., 2017; Ouyang et al., 2016; Turner et al., 2007).

Two further complexities emerge because PAs are not isolated from the rest of the world. First, PAs are often surrounded by a large "buffer zone" that is outside the direct management of the PA but that affects and is affected by what happens in the PA (DeFries, 2017). Further, PAs are telecoupled with non-adjacent systems in several ways that influence the supply of and demand for ES (Bagstad et al., 2013; Liu et al., 2016a). Most visitors to PAs have traveled from distant places to visit them (Liu et al., 2013; Xiao et al., 2017). PAs may provide water purification that have benefits to people hundreds or thousands of kilometers away, and in turn may be affected by upstream degradation of water quality (Watson et al., 2014). Agricultural activities surrounding PAs can negatively influence biodiversity conditions in PAs (Bailey et al., 2016; Palomo et al., 2013). The demand for agricultural products from the surrounding PAs may also be local, regional or global (Liu et al., 2015b). Finally, invasive species, which threaten many PAs, may have their origins across the globe and climate change (Tuanmu et al., 2012), a severe threat to many PAs, has its drivers distributed globally

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as well (Pimm et al., 2014; Zhong et al., 2015).

For many PAs, one of the most important ES is providing an attractive destination for nature-based tourism, which is both regional and global in origin. Such tourism may be influenced in complex ways by how PAs are managed (Graves et al., 2017; Karp et al., 2015). In some PAs, managing primarily for biodiversity might discourage nature-based tourism, while in others such management might be compatible with high demand for visits. Agricultural landscape surrounding PAs may provide additional attractions that could either increase or decrease demand for tourism at a PA (Baudron and Giller, 2014; Fleischer et al., 2018; Jie et al., 2013; Liu et al., 2012).

For individual PAs, we can trace plausible paths by which biodiversity conservation strategies change demand for nature-based tourism via environmental and socioeconomic changes in the PA and surrounding areas. But there is little empirical analysis of the overall effects of PA management on tourism demand and supply. To address this gap in the literature, we used data from PAs worldwide to examine the number of visitors to PAs as a function of the number of species in the PA and the management strategy being used, while controlling for environmental and socioeconomic factors. In addition, we investigated how different conservation strategies influence biodiversity and other factors both inside and outside PAs. Our analysis addresses two questions. First, how does biodiversity and nature-based tourism interact in PAs that may be governed by different conservation strategies? Second, which environmental and socioeconomic factors in and surrounding PAs influence visitation to PAs? Our analysis is based on terrestrial PAs that have visitation information between 2000 and 2014. Our results can contribute to a better understanding of how biodiversity and nature-based tourism interact in PAs and how these interactions may be altered by different conservation strategies used by PAs.

2. Methods

2.1. Data

The dataset was obtained by aggregating data from a number of international institutions, national statistical agencies, online datasets and the grey literature (Table A.1). Our key dependent variable was the average annual visitor numbers for each PA. The final dataset contained 929 PAs in 50 countries with the annual visitor numbers at some point in the period 2000 to 2014 (Fig. 1 and Table A.2). We calculated visitation as the average annual visitor numbers in each PA over the 15-year period.

The two key independent variables are the management strategy being used at the PA and its biodiversity. Management strategy was operationalized as the IUCN management category. The IUCN management category is based on the primary management objectives of PAs, which should apply to more than 75% of the PA area (Dudley, 2008). The IUCN category facilitates global assessments across different countries by providing an international standard for classifying management strategies of PAs. The primary objective of categories II–IV is to protect biodiversity (PAs managed for biodiversity), while categories V–VI are to both protect nature and use natural resources sustainably (PAs managed for mixed use) (Baudron and Giller, 2014; Dudley, 2008; Joppa et al., 2008; Laurance et al., 2012). For example, Categories II–IV focus on minimizing human activities keeping the system in “as a natural state as possible”, but Categories V–VI allow sustainable use of natural resources (e.g., hunting and/or forestry) to balance interaction between people and nature (Dudley, 2008). Dividing all PAs into two groups helps to differentiate conservation management practices between those that manage for nature for itself (II–IV) and those that manage for nature and people (V–VI). We divided all 929 PAs into two groups (II–IV and V–VI): 677 PAs in Category II–IV were coded 1 and 252 PAs in Category V–VI were coded 0. We excluded marine PAs and PAs which had not been classified into one of the IUCN management categories. PAs in IUCN category Ia and Ib where visitor access is strictly limited were also excluded. To include active management PAs, we selected PAs that were designated and managed at the national or sub-national level. The designated PAs have a long-term commitment to conservation with legal means (IUCN and UNEP-WCMC, 2017).

Second, biodiversity was operationalized as the number of species of birds, mammals and amphibians within the PA (Jenkins et al., 2013; Pimm et al., 2014). The biodiversity mapping website (http://biodiversitymapping.org) provided a global map of species ranges for birds, mammals and amphibians based on data from IUCN (IUCN, 2014) and BirdLife International NatureServe (BirdLife International NatureServe, 2013). A species range polygon underlies these mapping efforts. We selected mammals, birds and amphibians because these species have most comprehensive data at a global level and because they seem likely to be the species that will influence visitors’ preferences (Hausmann et al., 2017a; Siikamäki et al., 2015). The species range maps provide current species native range “determined by using known occurrences of the species” as well as “the knowledge of habitat preferences, suitable habitat, elevation limited, and other expert knowledge of the species and its range (IUCN, 2014).” Although the species range maps are the best available global datasets, we note the maps may overestimate species richness as the range of potential distribution tends to be larger than

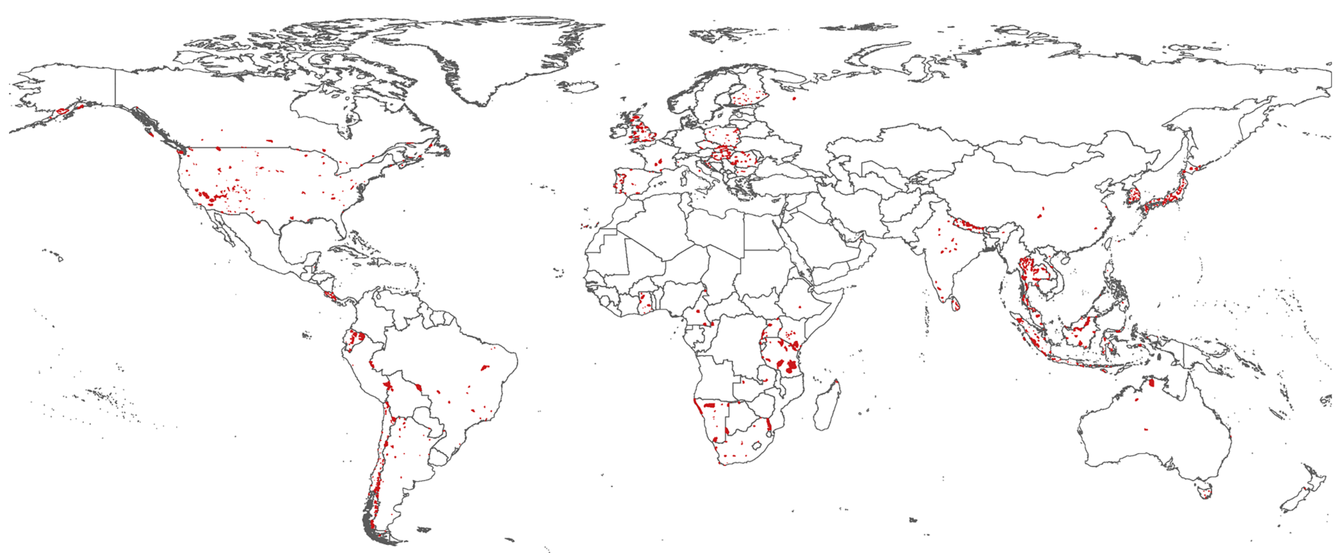

Fig. 1. 929 PA locations in the world.