Ecological Indicators 78 (2017) 282–291

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Mismatches between supply and demand in wildlife tourism: Insights for assessing cultural ecosystem services

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ARTICLE INFO

Article history:
Received 11 August 2016
Received in revised form 16 February 2017
Accepted 17 March 2017
Available online 27 March 2017

Keywords:
Africa
Charisma
Cultural ecosystem service
Demand
Mammals
Mismatch
Nature-based tourism
Supply

ABSTRACT

Assessing cultural ecosystem services provided by biodiversity requires a combination of ecological and social approaches. In this study, we investigated the capacity of large African mammal species to provide the cultural ecosystem service of wildlife tourism by using a supply and demand framework. First, we tested the relationship between supply and demand for large mammal species in wildlife tourism. Second, we tested whether the trophic level and body size of mammals influenced the mismatch between supply and demand, and whether the patterns of mismatches were consistent among four protected areas (PAs) in three Southern African countries. To quantify supply of species, we counted large mammals along 196 five km road transects within the four PAs; to estimate demand, we gathered 651 face-to-face questionnaires of wildlife tourists and distinguished between their expectation and hope to see specific species. Results show that a higher supply of large mammal species increased the expectation to see a species (linear regression slope $\beta = 0.28$, $p < 0.01$), whereas supply did not affect the hopes to see a specific species ($\beta = -0.04$, $p = 0.63$). Analyses of mismatches revealed that predator species were more demanded in relation to their supply than ungulates. Finally, we found that the demands of wildlife tourists for mammal species in relation to their supply were consistent across the four PAs. Supply-demand analyses reveal that species' traits, in particular trophic level, shape the hopes of wildlife tourists to see specific mammal species. We propose that the quantification of supply-demand mismatches can be used to identify charismatic species and relevant species' traits, and can be applied for wildlife tourism assessments within as well as across regions. Supply-demand analyses provide a useful framework and deliver indicators for better assessing cultural ecosystem services involving wildlife and nature-based tourism, and can be used for conservation management.

1. Introduction

The concept of ecosystem services has emerged in science and policy to evaluate the benefits that humans derive from nature (MEA, 2005). This concept links ecological and social systems and thus involves interactions between ecological and social factors that jointly determine the status of ecosystem services (Bennett et al., 2015; Reyers et al., 2013). Therefore, assessments of ecosystem services should quantify the capacity of ecosystems to supply ecosystem services and simultaneously consider the human demand for these services (Burkhard et al., 2012; Geijzendorffer et al., 2015; Martín-López et al., 2014). Similarly, the concept of supply and demand has been utilized in a biodiversity context to provide information on how people perceive and value biodiversity (Christie et al., 2006; Martín-López et al., 2007). For instance, rare species can receive a disproportionate interest from people (Courchamp et al., 2006; Hall et al., 2008), whereby low supply (*i.e.* rarity) induces a high demand. Therefore, a good understanding of the relationship between supply and demand for biodiversity is fundamental to assess biodiversity-based ecosystem services.

Assessments of the ecosystem services provided by biodiversity (Cardinale et al., 2012; Mace, 2014) benefit from analyses of the mismatch between supply and demand for a particular ecosystem service (Geijzendorffer et al., 2015). The purpose for understanding this mismatch is twofold. First, mismatches between supply and demand can reveal spatial or temporal patterns in ecosystem service delivery (Geijzendorffer et al., 2015). Second, supply-demand

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http://dx.doi.org/10.1016/j.ecolind.2017.03.035
1470-160X/

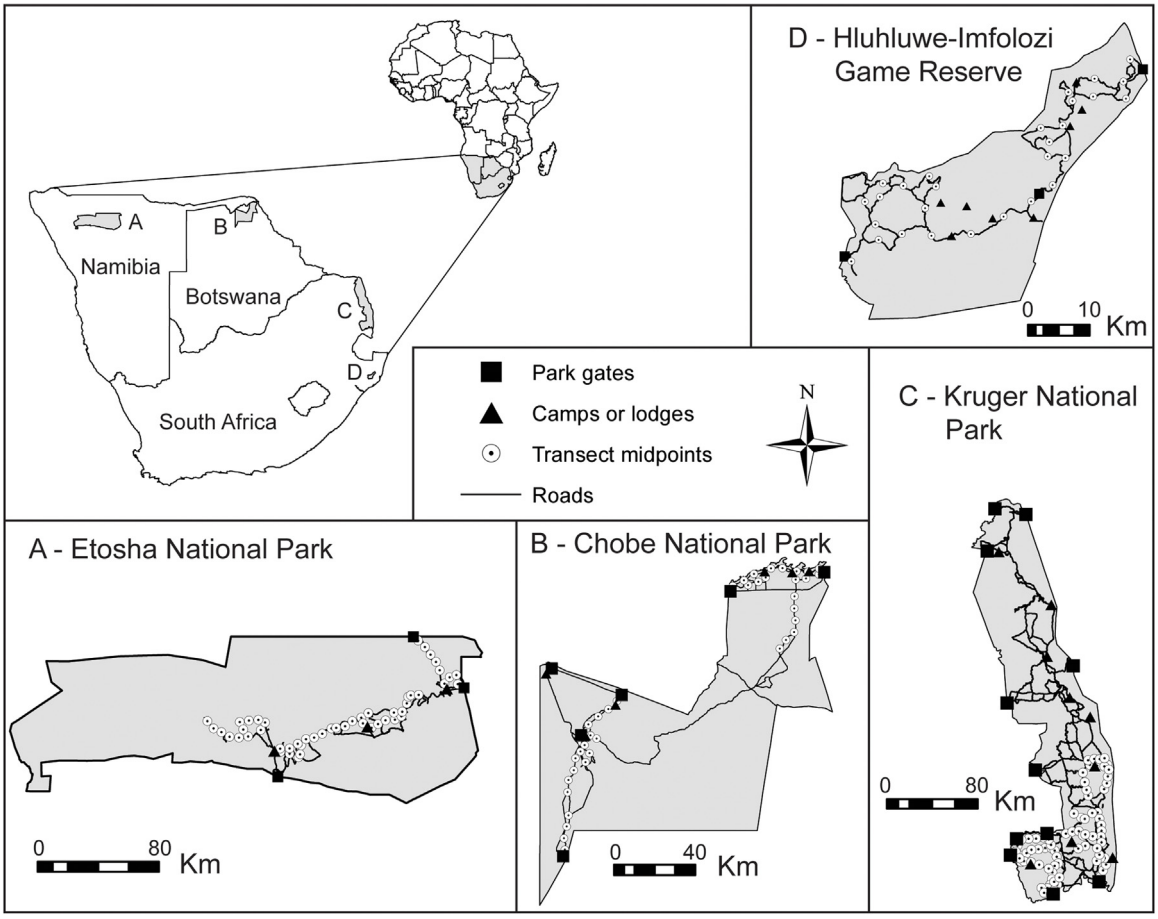

Fig. 1. Map of the Southern African region and details of the four protected areas constituting the study areas.

mismatches can identify the importance of specific components of biodiversity and consequently might serve as a basis for biodiversity conservation (Palomo et al., 2014). For instance, wildlife tourism is a cultural ecosystem service that directly depends on different components of biodiversity specifically demanded by tourists, such as threatened species (Willemen et al., 2015). To our knowledge, previous studies on wildlife tourism have not attempted to quantify the supply-demand mismatch of particular wildlife species that provide this cultural ecosystem service.

Wildlife tourism is a key component for developing countries' economies (Balmford et al., 2015; Naidoo et al., 2011) and is especially important for the economic growth of many Southern African countries. African protected areas (PAs) harbour a unique diversity of large mammal species and this diversity attracts millions of local as well as international tourists each year (Balmford et al., 2015; Lindsey et al., 2007). Observations of wildlife in Southern African PAs involve interactions between visitors and biodiversity. When visiting PAs, tourists are primarily interested in wildlife sightings, in particular in observing specific animal species. In fact, predators like lion (*Panthera leo*) and leopard (*Panthera pardus*) and large ungulates like elephant (*Loxodonta africana*) and rhinoceros (*Diceros bicornis* and *Ceratotherium simum*) have been recognized as playing important roles in providing cultural ecosystem service (Buckley, 2013; Di Minin et al., 2013; Lindsey et al., 2007; Maciejewski and Kerley, 2014). Hence, inherent characteristics of animals such as their trophic level (predator vs ungulate) or their body size can mediate the relationship between the supply of wildlife tourism by large mammals and the associated demand from wildlife tourists. We suggest that analyses of supply-demand mismatches should allow simultaneously testing for the effects of trophic level and body size effects, which could provide new indicators and important insights for the management of wildlife tourism and PAs.

In the present study, we aim to assess the cultural ecosystem service of wildlife tourism provided by biodiversity through investigating the supply of large mammal species and its demand by wildlife tourists in four PAs in three countries of Southern Africa (Namibia, Botswana, South Africa). This study is unique as it simultaneously identifies supply and demand for wildlife tourism, combining ecological and social assessments in order to develop new indicators applied to the cultural ecosystem services framework. We adopt a visitor's perspective in which the supply of large mammal species corresponds to the *perceived* probability of seeing a specific large mammal species by wildlife tourists. We relate this supply to species-specific demands expressed by wildlife tourists during their visits to PAs to analyze, for the first time, the relationship between supply and demand in wildlife tourism. The specific objectives are: (1) to investigate the relationship between supply and demand for specific large mammal species in wildlife tourism, (2) to quantify the mismatch between supply and demand, and (3) to assess whether the mismatch is related to the trophic level and body size of the species and whether these relationships are consistent across the four PAs.

2. Methods

2.1. Study area

We collected data regarding the supply and demand in wildlife tourism in four PAs, namely Etosha National Park (Namibia;