Biological Conservation 165 (2013) 18–24

Contents lists available at SciVerse ScienceDirect

Biological Conservation

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

Short communication

Balancing the benefits of ecotourism and development: The effects of visitor trail-use on mammals in a Protected Area in rapidly developing China

Youbing Zhou [a,b,*], Christina D. Buesching [b], Chris Newman [b], Yayoi Kaneko [c], Zongqiang Xie [a], David W. Macdonald [b]

[a] State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences, No. 20 Nanxincun, Xiangshan, Beijing 100093, China
[b] Wildlife Conservation Research Unit, Department of Zoology, University of Oxford, The Recanati-Kaplan Centre, Tubney House, Tubney, Abingdon OX13 5QL, UK
[c] Wildlife Conservation Laboratory, Division of Ecosciences, Institute of Agriculture, Tokyo University of Agriculture and Technology, Saiwaicho 3-5-8, Fuchu-city, Tokyo 183-8509, Japan

ARTICLE INFO

Article history:
Received 30 October 2012
Received in revised form 10 May 2013
Accepted 11 May 2013
Available online 22 June 2013

Keywords:
Developing country
Mammal fieldsigns
Infrastructure
Nature-based tourism
Protected area
Trails

ABSTRACT

Despite economic benefits, particularly in developing countries, ecotourism can have unintended negative consequences for wildlife conservation in protected areas (PAs). We report the effects of tourist *Trail-Type* and *-Use* on the incidence of mammal fieldsigns in a PA in central China. Surveys conducted adjacent to five categories of trail-type and fieldsigns were scored for three duplicates of four 0.5 km transects (=60 transects). Higher *Trail Use* along more major *Trail Types* were associated with significantly fewer fieldsigns along transects close to trails, compared with more distant transects. Fieldsign scores along transects adjacent to less used, unpaved trails were far less affected. In multiple-regression models, species and guilds exhibited different fieldsign score responses to *Trail Type* and *Use*. In general, a paucity of larger mammal (>15 kg) fieldsigns was associated primarily with greater *Trail Use*, whereas fieldsign scores for smaller mammals were associated more strongly with human-modified forest types. As international demand for nature-based tourism continues to grow it is important to evaluate openly the consequences of providing public access to protected areas while conserving biodiversity.

1. Introduction

Ecotourism (i.e., nature-based tourism: Roe et al., 1997), to promote conservation (Balmford et al., 2009), can often provide a sustainable means for generating local community income without compromising, or with a manageable impact on, ecosystem conservation (Christ, 2003). Roe et al. (1997), however, challenge the 'common-sense' proposition that ecotourism is ecologically benign because ecotourists are environmentally sensitive, citing examples where ecotourism has had considerable negative impacts on species and biodiversity, even as quiet, non-consumptive recreation, e.g., hiking (see also Kiss, 2004). In response to these sorts of concern (Reed and Merenlender, 2008) more assessment and evaluation of how wildlife responds to the long-term effects of tourism is required, in order to inform protected area (PA) management.

PAs are often vitally important for safeguarding biodiversity (Hoffmann et al., 2010) and the annual revenue PAs accrue through ecotourism can be crucial in order for PAs to prosper (Christ, 2003). This is especially so in developing countries, with Kirkby et al. (2011) estimating that the revenue from ecotourism (and nature-based tourism) exceeds US$ 29 billion per year. Balancing PA conservation objectives against increasing visitor pressure creates a dilemma (Kiss, 2004), particularly in the developing world (e.g., China and India; Balmford et al., 2009). With 1.4 billion tourists projected to visit PAs worldwide by 2020 (Christ, 2003), it is crucial to investigate the consequences of public access (e.g. Klein et al., 1995; Salvador et al., 2011). To these ends noting changes in the behaviour of mammals can provide a barometer for disturbance (Reed and Merenlender, 2008; Benitez-Lopez et al., 2010). Mammals are often apex consumers and influence their associated ecosystems through top-down forcing and trophic cascades, which in turn often lead to myriad effects on other species and ecosystem processes (Estes et al., 2011).

Despite high human population density, China still contains high biodiversity (Mittermeier et al., 1997). China is the world's fastest growing economy, with annual GDP growing at 8–14% (Zhong and Wang, 2011), experiencing an increase in demand for

* Corresponding author at: State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences, No. 20 Nanxincun, Xiangshan, Beijing 100093, China. Tel.: +86 10 62836183; fax: +86 10 62836284.

E-mail addresses: zhouyb@ibcas.ac.cn (Y. Zhou), christina.buesching@zoo.ox.ac.uk (C.D. Buesching), chris.newman@zoo.ox.ac.uk (C. Newman), ykaneko7946@gmail.com (Y. Kaneko), xie@ibcas.ac.cn (Z. Xie), david.macdonald@zoo.ox.ac.uk (D.W. Macdonald).

0006-3207/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biocon.2013.05.007

nature-based recreation as a consequence of individuals having more disposable income (Karanth and DeFries, 2011). Simultaneously, the number of PAs in China increased from 600 in 1990 to 2588 by 2010; covering 14.9% of China's terrestrial surface in 2011 (Ministry of Environmental Protection, 2011). Of 1110 PAs in China surveyed by Zhong and Wang (2011), 93% had developed ecotourism, of which 84% received >10,000 visitors annually and 43% >100,000 per year. These PAs are typically <300 km^2 and highly fragmented, interwoven with human population centres. The mandate of managing PAs to conserve natural resources, while under pressure from commercial interests (e.g., tourism) and local human activities (e.g., forest products) (Karanth and DeFries, 2011), thus presents a particular challenge.

The framework for understanding ecotourism and its relationship to conservation is elucidated in Damania and Hatch (2005). Tourist activities that cause damage to wildlife attractions, which are focal to the motivation for tourists to make the visit, are detrimental to nature reserve success (see Kirkby et al., 2011). This can constitute a negative feedback: increasing tourist volume damages the attraction and thereby makes ecotourism unattractive as a business strategy. That is, success for the business damages the business. This situation can be difficult and costly to mitigate, creating an incentive to invest in other business models, such as amenities-based tourism (e.g., provision of restaurants, gift shops, children's play areas etc), taking attention away from the PA's conservation objectives and potentially leading to degradation of natural attractions.

Infra-structural development, facilitating ecotourism in PAs, such as access roads and hiking trails (Ramp et al., 2006), thus requires careful planning in order to allow tourists the access through the site that they desire, but not to the extent that this is detrimental to habitats and wildlife (within the PAs conservation purview). These effects can vary between species, guilds and habitats (Benitez-Lopez et al., 2010). We stress that at the Houhe National Nature Reserve (HNNR) PA tourists visit primarily in order to experience natural habitat, to enjoy fresh air and natural scenery, to take healthy walks and to look for dove tree (*Davidia involucrata*) blossoms (Song and Liu, 1999). Whether tourists see (large) mammals or not (or indeed detect their fieldsigns) is generally secondary to their enjoyment of their visit. As a consequence, there is a risk at HNNR that conservation of mammals could be subjugated in terms of PA management priorities against the advantages of providing more access to tourists.

We propose that the Type of Trail, and Use of Trail by tourists, interacting with Habitat Characteristics, may alter the activity of mammals in proximity to these disturbed areas, as evidenced by changes in the incidence of their fieldsigns along adjacent transects. Given this risk, but with regard to the responsibility the HNNR PA also has to conserve wildlife and habitats, here we explore how (i) *Trail Type* (extent of habitat modification) and (ii) *Trail Use* (visitor numbers along tourist trails) affected the activity, distribution and abundance of mammal species (>1 kg), as evidenced by fieldsigns and sightings. We examine responses at the levels of: (a) community, (b) guild (relative abundance of carnivore, ungulate and rodent fieldsigns), and (c) species. We consider implications for mammal distribution and abundance patterns, with particular reference to implications for mammals of different body sizes. We hypothesise that larger mammals, which typically have larger home ranges, will have a greater capacity (Laurance et al., 2008) to move away from trails within their range than do smaller mammals.

2. Material and methods

2.1. Study area

The study was conducted in Houhe National Nature Reserve, Hubei province, central China (HNNR; N30°2′45″–8′40″, E110°29′25″–40′45″, Fig. 1) between May and October 2007. The climate is subtropical with 4 distinct seasons, ranging from −6 °C to 0 °C in January and from 16 °C to 22 °C in July (Song and Liu, 1999). The reserve (10,340 ha), created in 1984, was designated as a "national reserve" in 2000, specifically to conserve biodiversity. 13,000–25,000 tourists have visited annually from 2004 (HNNR Administration, unpublished data). Infra-structural development (e.g. recreational roads, trails and parking) commenced in 2002.

2.2. Quantifying tourist trail characteristics and use

Two metrics were used to quantify the effects of tourism:

(i) *Trail Type* – to assess the effects of infra-structural modification to habitats facilitating tourism we classified HNNR's 14 km of roads and trails (termed 'Trails') into five categories (Fig. 1). Information on the typical usage of these trail types were provided by the HNNR manager (R.C. Wang, pers. comm.).

Type I: paved (bitumen) roads (8 km), 3–5 m wide, driven on by all tourists, local residents, and reserve staff as they arrive at HNNR. Of these 8 km, we included 3 km adjacent to visitor car parks;

Type II: paved (cement) trails (2.5 km – all included), 0.5–1.2 m, walked by ca. 90% tourists as well as local residents and reserve staff;

Type III: unpaved but well-maintained trails (2 km), 0.3–1 m wide, walked by ca. 20% tourists, mostly looking for dove tree blossoms (Song and Liu, 1999);

Type IV: well-maintained fire-fighting trails (3 km), 0.2–1 m wide. Officially closed to tourists, but still used by ca. 5% tourists;

Type V: un-maintained trails (3 km), 0.2–0.5 m wide, used only occasionally (<1%) by locals and trekking tourists.

(ii) *Trail Use* – Some tourists visit HNNR independently, while others join guided tours. To assess the number of tourists using trails we interviewed tourist guides and recorded the number of vehicles arriving at parking areas along Type I trails, then counted the number of visitors who walked onto each Trail Type. Further information is provided in Appendix A. While the more major trails were most used and closest to the car parks, we were interested in the affects of visitor numbers and the extent of habitat modification connected to trail-type, though we acknowledge the co-relationship with distance from car park.

2.3. Mammal fieldsign scoring protocol

At the start of the 2007 tourist season, three duplicate survey sites were selected for each of the five *Trail Types*. At each site, 0.5 km long and 2 m wide transect surveys, divided into 50 m sections using plastic ribbons, were conducted parallel to the trail, at distances of 50 m, 250 m, 500 m, and 1 km. This provided the variable '*Distance from trail*'.

Two survey duplicates were then conducted in the first two weeks of August and October, to coincide with the peak number of visitors to the park. All sites (60 × 0.5 km transects) were surveyed quietly at approximately 0.5–1 km/h between 08:00 a.m. and dusk, by the same personnel (YBZ + two trained local assistants), to avoid inter-observer bias. Any fieldsigns per 50 m section (e.g. direct sightings, sounds and spoor-footprints, faeces, diggings and tree scraping) indicated evidence for that species within that transect 10th, providing a metric for species activity along the transect, scaled 0–10 (Laurance et al., 2008); a more detailed description of fieldsign identification protocols, and the use of