Biological Conservation 216 (2017) 18–25

Contents lists available at ScienceDirect

Biological Conservation

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

Free-ranging livestock threaten the long-term survival of giant pandas

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ARTICLE INFO

Keywords:
Endangered species
Forest conservation
Free-ranging livestock
Giant panda
Protected area management
Species distribution modelling

ABSTRACT

China has implemented forest policies and expanded protected areas to halt deforestation and protect giant panda habitats. These policies simultaneously encouraged local communities to raise livestock that then freely range in forests. This grazing had unintended consequences. As an alternative livelihood, it has become the most prevalent human disturbance across the panda's range. How do free-ranging livestock impact giant panda habitats and what are the implications for future conservation and policy on a larger scale? We use Wanglang National Nature Reserve as a case study. It has seen a nine-fold livestock increase during past 15 years. We combined bamboo survey plots, GPS collar tracking, long-term monitoring, and species distribution modelling incorporating species interaction to understand the impacts across spatial and temporal scales. Our results showed that livestock, especially horses, lead to a significant reduction of bamboo biomass and regeneration. The most intensively used areas by livestock are in the valleys, which are also the areas that pandas prefer. Adding livestock presence to predictive models of the giant panda's distribution yielded a higher accuracy and suggested livestock reduce panda habitat by 34%. Pandas were driven out of the areas intensively used by livestock. We recommend the nature reserve carefully implement a livestock ban and prioritise removing horses because they cause the greater harm. To give up livestock, local communities prefer long-term subsidies or jobs to a one-time payment. Thus, we recommend the government provide payments for ecosystem services that create jobs in forest stewardship or tourism while reducing the number of domestic animals.

1. Introduction

Habitat loss and fragmentation from deforestation, agriculture expansion, road construction, and other disturbances have divided the wild population of giant pandas (*Ailuropoda melanoleuca*) into 33 isolated populations in six mountain ranges in China (State Forestry Administration, 2015). Climate change will further fragment their distribution (Fan et al., 2014; Shen et al., 2015; Songer et al., 2012; Tuanmu et al., 2013). With the Natural Forest Conservation Project (NFCP) and Grain to Green Program (GTGP), the deforestation that was once the biggest threat to pandas has drastically reduced (Liu et al., 2008). These two programmes are among the largest payment for ecosystem services and forest conservation policies in the world (Schomers and Matzdorf, 2013; Xu et al., 2006; Bennett, 2008). NFCP protects and restores the forest via a ban on logging. It provides payment for economic losses from restrictions and funding for reforestation and management (Schomers and Matzdorf, 2013). GTGP aims to return croplands on steep slopes to forest or grassland to reduce soil erosion and restore forest with in-kind grain and cash payments (Xu et al., 2006). Moreover, China has devoted unparalleled resources to conserve pandas including establishing 67 nature reserves that now cover > 54% of the panda's range (State Forestry Administration, 2015). These actions also protect a substantial fraction of China's other endemic vertebrates (Li and Pimm, 2016).

A previously unrecognised threat is now emerging — livestock grazing. It has become the most prevalent human disturbance throughout the panda's distribution (Hull et al., 2014; State Forestry Administration, 2015). More than one-third of the transects during the fourth national survey of giant panda showed evidence of livestock grazing (State Forestry Administration, 2015). How livestock grazing influences the survival of giant pandas has become an urgent and critical question.

Previous studies show an overlap in the spatial distribution of pandas and livestock (Kang et al., 2011; Ran et al., 2002a; Ran et al., 2002b; Wang et al., 2015; Zhou et al., 2016) and grazing of bamboos (Hull et al., 2014). They fail to answer whether livestock grazing is a significant threat. The differences in distribution between species could be a result of their interspecies interaction, or just from different habitat

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http://dx.doi.org/10.1016/j.biocon.2017.09.019
Received 26 April 2017; Received in revised form 25 August 2017; Accepted 8 September 2017

preferences. A way to differentiate these two possible causes requires the study of long-term changes. Up to date, only one study (Zhang et al., 2017) has used such data. There is no quantitative estimate of how much area of panda habitat is degraded or lost due to livestock.

Species distribution models are widely used in conservation planning and species management (Guisan and Thuiller, 2005), and more recently in projecting the impacts of climate change and other human disturbance on the distribution of biodiversity (Araujo et al., 2008; Pearson and Dawson, 2003). Most studies only consider the relationships between a species and its abiotic environment and ignore interspecific interactions (Elith and Leathwick, 2009; Wisz et al., 2013). With the emerging threats from livestock, it is critical to examine whether incorporation of the livestock data could better predict the suitable habitats for pandas. If so, we can use such data for targeting areas with conflicts over habitat use and so improve conservation planning.

We examined livestock grazing using the case of Wanglang National Nature Reserve (referred to as Wanglang hereafter), which was established in 1965 to protect pandas. There has been no logging, agriculture, or human residence ever since. Local people living outside the reserve began to raise free-ranging livestock there and their numbers have increased nine-fold since 2004 (Fig. 2 in Supplementary materials). This case study quantifies their impacts.

We ask four questions. First, what are the immediate and long-term impacts of livestock grazing on bamboos that constitute 99% of a panda's diet (Schaller, 1985)? Second, has the increasing number of livestock changed the distribution of giant pandas? Third, how does the incorporation of livestock influence the accuracy of predicting giant panda habitat? Finally, how does the total area of giant panda habitat change after the increase in livestock and where are the most dramatic changes?

2. Materials and methods

2.1. Data collection

Wanglang is in the northern Min Mountains (Fig. 1), covers 323 km^2 and has elevations from 2300 to 4980 m. It is part of the South-Central China biodiversity hotspot (Myers et al., 2000). Around half of the area is under 3200 m, which is the upper limit for bamboos, and is potential panda habitat. Baima township is the only human residence outside Wanglang. It has four villages and a total population of 1686. Twelve households from the neighbouring village have livestock (horse and cattle) inside Wanglang.

2.1.1. Sign surveys

We collected data from 2013 to 2014 from 20 m by 20 m plots with systematic sampling, placing 124 plots in summer and another 188 plots in winter. They were at least 300 m apart to avoid spatial correlation. (The radius of the panda home range is 300 m (Hu et al., 1985).) In each plot, we recorded presence (as shown by scats, tracks, and other signs), absence, and relative abundance using scats of pandas, cattle, or horses. We also took vegetation measurements. Two measurements assessed the impacts of grazing from cattle and horses in a plot: the percentage of bamboo cover that was grazed in a plot and the percentage of bamboo leaves on a culm grazed by livestock. The feeding signs from livestock can be easily distinguished from other wildlife as they are less selective of individual culms. Moreover, the grazing effects of wildlife are relatively low (Hull et al., 2014). Using ArcMap 10.2, we derived estimates of factors that may influence the habitat usage (Liu et al., 1999) including tree cover (Sexton et al., 2013), slope, elevation, aspect, distance to river, distance to paved road and trails.

2.1.2. Bamboo plots

We examined the impacts on bamboos from livestock grazing between heavily grazed sites (> 50% of the bamboos being grazed) and livestock-free areas nearby, separated by natural barriers such as a

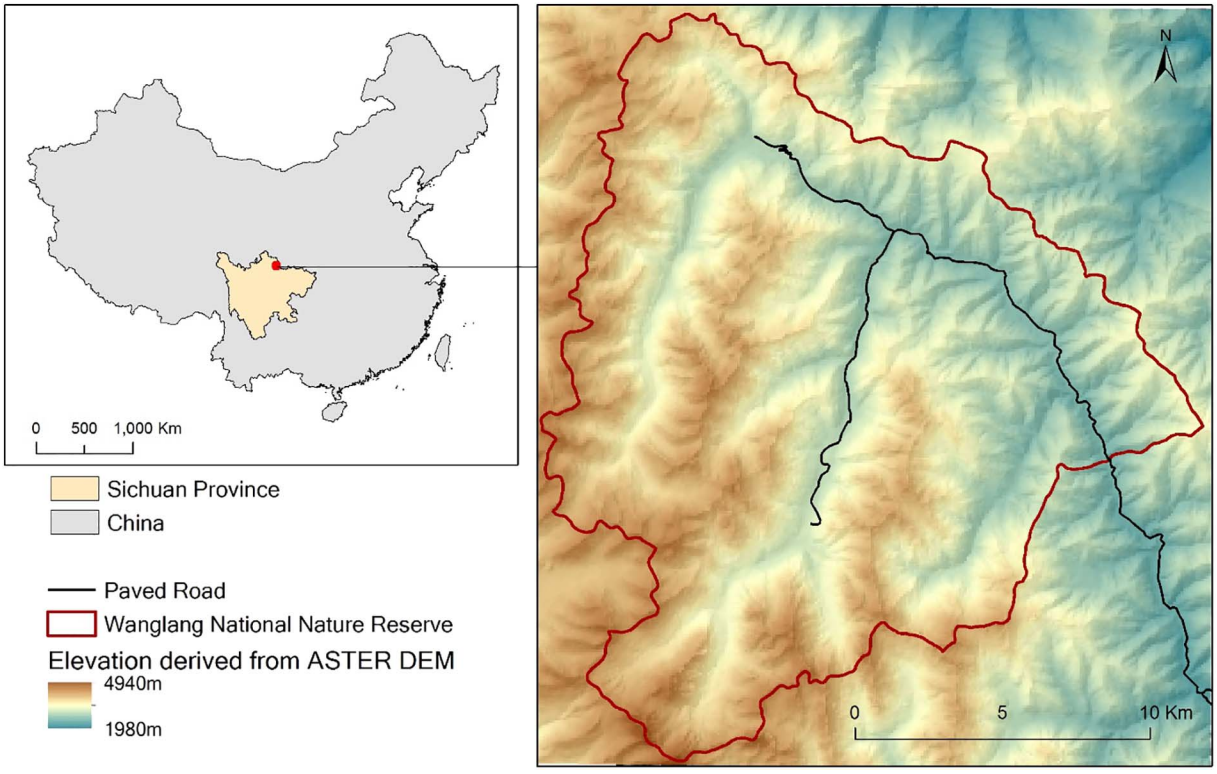

Fig. 1. Study area - Wanglang National Nature Reserve. It is in the northern region of Sichuan Province, in the Min Mountains.