Remote Sensing Applications: Society and Environment 2 (2015) 56–65

Contents lists available at ScienceDirect

Remote Sensing Applications: Society and Environment

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

Spatial overlap between sympatric wild and domestic herbivores links to resource gradients

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ARTICLE INFO

Article history:
Received 29 July 2015
Received in revised form
5 November 2015
Accepted 5 November 2015
Available online 1 December 2015

Keywords:
Wildlife–livestock interface
Neighborhood density function
GPS
Habitat overlap
African buffalo

ABSTRACT

In this study, we investigated the relationship between resource gradients and overlap between wild and domestic herbivores in a southern African ecosystem. We used an Enhanced Vegetation Index (EVI) to identify and test the presence of resource gradients i.e. vegetation greenness between agricultural areas and conservation areas in South-eastern Zimbabwe, part of the Great Limpopo Transfrontier Conservation Area. We then tested whether these resource gradients coincide with GPS collared cattle (*Bos taurus*) movements into wildlife areas, as well as drive spatial overlaps between cattle and the GPS collared African buffalo (*Syncerus caffer*). Results showed that resource gradients although variable, exist between the conservation area and surrounding agricultural area. Cattle used the conservation area less than expected during the dry season when vegetation greenness in the communal land was relatively lower than in the conservation area. Significant spatial segregation between cattle and buffalo occurred during the wet season and late dry season, while spatial aggregation occurred during the early dry season. Intensity of habitat overlap between cattle and buffalo during the early dry season was relatively high in habitats preferred by both species. Our results suggest that cattle movement into conservation areas is linked to resource gradients.

1. Introduction

Increasing human and livestock populations adjacent to conservation areas have led to an intensification of wildlife–livestock interactions resulting in competition over resources and conflicts associated with predation, crop destruction, and disease transmission (de Garine-Wichatitksy et al., 2013). Minimizing contacts between wildlife and livestock in order to reduce these risks remains a key challenge for biodiversity conservation, livestock production and the health of socio-ecological systems (Lamarque et al., 2009). Identifying key factors influencing interactions between livestock and wildlife is therefore critical for land use planning and other management tools where livestock production co-exists with wildlife conservation.

Several factors that include biophysical, social and human activities (Redfern et al., 2003; Hebblewhite and Merrill, 2008; Winnie et al., 2008) have been linked to animal movements. However, food availability has remained a key

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http://dx.doi.org/10.1016/j.rsase.2015.11.001
2352-9385/

driver of herbivore movements as it is closely linked to their survival and reproduction (McLoughlin and Ferguson, 2000; Berger, 2004). For instance, the large scale migration patterns of animals in the Serengeti-Mara ecosystem has been hypothesized to correlate with rainfall patterns that lead to new green forage (Jarman and Sinclair, 1979; Boone et al., 2006). Similarly at local scales related processes could occur as variations in forage availability in space and time lead to resource gradients that are likely to influence animal movement. We therefore hypothesize that resource gradients that are linked to changes in forage availability drive movement and overlaps between livestock and wildlife at interfaces between agricultural and wildlife areas. This is based on the premise that increased human and livestock populations result in the emergence and intensification of resource gradients between agricultural and conservation areas. Despite being important, the nature of resource gradients and their effect on livestock movement remains underexplored.

Resource driven movements often result in interaction between species. Under resource-limited conditions, it is hypothesized that sympatric species of similar body size and diet are likely to compete (Vavra et al., 1999; Augustine et al., 2011). Animals are therefore expected to respond to resource competition by altering habitat use or diet (Loft et al., 1991; Fritz et al., 1996). Such changes in foraging behavior likely lead to spatial partitioning, especially when both livestock and wildlife species are involved (Sinclair, 1985; Hibert et al., 2010). However, few studies have considered spatial partitioning or quantified spatial habitat overlap in a spatially explicit manner for sympatric wild and domestic herbivores. Furthermore, these studies have often relied on aerial survey data or field observations which, although useful, often cover a short period to enable detection of potential competition. Thus, methods that can allow detection or quantification of spatial interaction in a spatially explicit manner over a longer period become important. In this regard, the use of Global Positioning Systems (GPS) could allow detection of the overlap patterns between livestock and wildlife at this scale and further provide opportunities of evaluating the influence of resource gradients.

In this study, we investigated whether resource gradients linked to changes in forage availability exist between agricultural and wildlife conservation areas. We tested whether cattle (*Bos taurus*) movement into wildlife areas was linked to resource gradients, as well as agricultural fields. We also investigated the spatial response of the African buffalo (*Syncerus caffer*) to the presence of semi-free range cattle inside the conservation area, as well as, quantifying variations in habitat overlaps. Our hypotheses were: (1) cattle movements into the conservation area are driven by resource gradients, (2) the cropping cycle influences cattle movement into the conservation area, and (3) cattle movement into the conservation area results in spatial segregation with the African buffalo during resource limited periods.

2. Methods and materials

2.1. Study area

The study was conducted at a wildlife–livestock interface in the Southeast Lowveld of Zimbabwe within the Great Limpopo Transfrontier Conservation Area (GLTFCA) between August 2008 and November 2009. The area consists of two land use types, an agricultural area, (Malipati communal land) and a conservation area consisting of Gonarezhou National park (GNP) and Malipati Safari area hereinafter referred to as the conservation area (Fig. 1). The area is semi-arid with a mean annual rainfall of 300–600 mm. Most of the rainfall received annually occurs between November and April. Mean annual temperature ranges from 25 °C to 27 °C (Chenje et al., 1998) with a mean maximum temperature of 33 °C in October and a mean minimum temperature of 13.3 °C in June based on the records of the Meteorological Services Department, Zimbabwe. Altitude varies from 300 m to 600 m above mean sea level (Chenje et al., 1998). Soils in the study area are predominantly basalt-derived vertisols (Nyamudeza et al., 2001). The vegetation of the study area is mainly composed of Mopane-dominated woodland (*Colophospermum mopane*). Other dominant vegetation types in the study area include *Combretum*-dominated woodland, *Acacia*-dominated shrubland and riparian woodland. Open grasslands also occupy a smaller area while agricultural fields extensively span across the study area creating a heterogeneous landscape. Mwenezi River which runs through the study area supports both wildlife and livestock.

Within the communal land, land use activities include livestock production and cropping (Nyamudeza et al., 2001). Livestock particularly cattle have been observed to use the adjacent conservation area for illegal grazing with an average of 167 cattle being observed at peak times (Murwira et al., 2013).

The conservation area contains a diverse range of wildlife species such as the African elephant (*Loxodonta africana*), giraffe (*Giraffa camelopardalis*), buffalo (*Syncerus caffer*) and some rare species in Zimbabwe such as the wild painted dog (*Lycaon pictus*), bat eared fox (*Octocyon megalotis*), roan antelope (*Hippotragus equines*) and nyala (*Tragelaphus angasii*) (Dunham et al., 2010).

2.2. Cattle and buffalo data

In order to understand fine scale movements of cattle and overlaps with buffalo herds, we used GPS collars (African Wildlife Tracking collars, Pretoria, South Africa) fitted on randomly selected cattle and buffalo herds. We selected twelve cattle herds (with farmers joining the protocol on a voluntary basis) in the communal land and four buffalo herds in the southern region of GNP (based on groups located by helicopter). One adult lead cow was selected to represent each cattle herd and fitted with a GPS collar. Buffalo were immobilized using established techniques by helicopter (Burroughs et al., 2006; Lagrange, 2006). A total of three GPS collars were fitted per selected buffalo group in order to enhance chances of detecting potential overlaps with cattle since buffalo herds are known to be subject to fission and fusion (Prins, 1996). The