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Original Research Article

Seasonal movements of wildlife and livestock in a heterogenous pastoral landscape: Implications for coexistence and community based conservation

Peter Tyrrell [a, *], Samantha Russell [a, b], David Western [b]

[a] South Rift Association of Landowners, P.O. Box 15289, Nairobi 00509, Kenya
[b] African Conservation Centre, P.O. Box 15289, Nairobi 00509, Kenya

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ABSTRACT

Rangelands across the world are home to millions of pastoral people and vast wildlife populations, which create a complex landscape for conservation. Community based conservation has been used to promote human-wildlife coexistence on pastoral lands, protecting wildlife outside of official protected areas. With the spread of community based conservation within the rangelands there is a need for more information on successful management practices. This study provides an example of this in the South Rift, Kenya, where seasonal movements of pastoralists aid coexistence. We used Density Surface Modelling (DSM), a novel tool for conservation managers in the rangelands, to predict wildlife and livestock abundance across the landscape and seasons. Wildlife grazers, zebra (*Equus burchelli)* and wildebeest (*Connochaetes taurinus)*, follow expected metabolic patterns, feeding on short grass outside the conservation area in the wet season, before returning to the taller-lower quality grazing in the conservation areas during the drought. Browsing wildlife, impala (*Aepyceros melampus)* and Grant's gazelle (*Nanger granti),* move from open grassland and bushland areas into thicker, denser browse as the seasons progress towards the drought. Livestock, both shoats (*Ovis aries*, and *Capra aegagrus hircus)* and cattle (*Bos indicus*), are managed by community grazing committees, who enforce a grazing plan that creates spatial–temporal separation between wildlife and livestock. They exploit the high-quality grazing in the livestock area during the wet season while conserving pasture in the conservation area, which is utilized only as forage is depleted. This ensures that wildlife has access to a diverse resource base across all seasons and potentially reduces competition, allowing for a diverse and abundant wildlife community to coexist with livestock. This highlights the importance of the presence and maintenance of spatial and temporal heterogeneity of forage resources, through livestock management, for community based conservation. We encourage more community based conservation initiatives in pastoral landscapes to incorporate livestock management into planning.

* Corresponding author.
E-mail addresses: peterdavidtyrrell@gmail.com (P. Tyrrell), samantharuss@gmail.com (S. Russell), dwestern@africaonline.co.ke (D. Western).

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1. Introduction

Rangelands cover a vast area of the world's surface, support the livelihoods of thousands of pastoralists and contain some of the largest wildlife populations in the world (e.g. Mduma et al., 1999; Lund, 2007). This mixture of vast landscapes, large wildlife populations, and presence of pastoralists and their livestock creates a complex landscape for conservation. Historically, conservation in rangelands was focused on landscape preservation and fortress conservation of large wildlife populations (Adams, 2005), but since the 1970's, pastoralists communities have begun to be reintegrated into the conservation agenda, and community-based conservation initiatives have started to increase the space for wildlife, protect the livelihoods of indigenous pastoralists, and engage communities in participatory ecosystem management (Berkes, 2004; Western et al., 2015b).

Community conservation initiatives often create mixed-use landscapes containing both wildlife and livestock. This results in trade-offs of costs and benefits between wildlife and people, the balance of which can dictate the success of conservation interventions. Wildlife in conservancies can create substantial local revenue through wildlife-based tourism or wildlife utilization (Groom and Harris, 2008; Naidoo et al., 2016), but living with wildlife can have significant costs: predation of livestock (Zimmermann et al., 2010); complex disease interactions (Kock et al., 2009); and competition for grazing resources (Odadi et al., 2011). In particular, wildlife is viewed across many savannah rangelands as directly competing for forage resources with livestock, and often livestock is blamed for the large declines in wildlife seen in many community areas (e.g. Ogutu et al., 2016, 2011). Management decisions are often made based on this assumption, with livestock excluded for the benefit of wildlife. The tradeoff between the two is generally far more complex, and in some circumstances livestock can increase wildlife's access to forage resources (Butt and Turner, 2012; Odadi et al., 2011; Western, 1982). The dominance of livestock in communal lands means that finding solutions that reduce the negative aspects of the trade-off, and encourage coexistence between livestock and wildlife are an important goal for biodiversity conservation within the rangelands, and for reducing wide scale declines in wildlife numbers.

The situation is similar in the rangelands of Kenya, where pastoralists have used the rangelands for several thousand years (Williamson, 2000). While these rangelands are known for their large wildlife populations, livestock biomass generally considerably outweighs that of wildlife (Bourn and Blench, 1999). Until 50 years ago, wildlife and livestock coexisted at high densities over much of the Kenyan rangelands (Ogutu et al., 2016). Recently, country-wide declines in wildlife have highlighted the need for protection of wildlife outside of government protected areas and across the rangelands, which now contain 60% of Kenya's wildlife (Western et al., 2009b). In Kenya, wildlife conservancies, both private and community based, are one of the tools used to protect wildlife in these areas. The number of conservancies in Kenya has grown rapidly, from less than 5 in the early 1990's to over 140 in 2016 covering 30,000 km^2 (KWCA, 2016). Conservancies are now vital for the long term survival of wildlife both outside and inside protected areas (Dolrenry et al., 2014; Ihwagi et al., 2015; Mose et al., 2012; Western et al., 2015b). Many of these conservancies are community conservancies, involving multiple indigenous landowners, often pastoralists, whose predominant source of livelihood is livestock based.

Despite the importance of coexistence on community conserved lands, there are few examples of areas where both livestock and wildlife not only co-occur but also thrive. Most studies of wildlife populations in East Africa have focused on areas within, or bordering, government protected areas (e.g. Fryxell et al., 2005; Mose et al., 2013), with few studies solely focusing on community areas that have both wildlife and livestock present. We present work that was conducted in an unsubdivided, community conserved and managed ecosystem, which has relatively high densities of both wildlife and livestock (Russell et al., submitted). This area, the South Rift Valley, Kenya, is inhabited by indigenous Maasai pastoralists, who have a long history of coexistence with wildlife. Within many community and protected areas across East Africa seasonal wildlife movements have been drastically altered or stopped altogether (e.g Mose and Western, 2015), with this area as an exception to this rule. In this ecosystem, wildlife movements are not constrained by any physical barriers, such as settlement or fencing, and appear to respond to metabolic requirements, with wildlife grazers moving down a seasonal forage biomass gradient across the heterogeneous grazing areas (Russell et al., submitted). Similarly, livestock have access to spatially and temporally heterogeneous rangelands, with movements managed to maintain heterogeneity, with clearly designated seasonal grazing areas for livestock (Russell et al., submitted). This heterogeneity appears to allow spatial and temporal separation of resource use between wildlife and livestock, which could help reduce competition, provide late season forage, and potentially promote coexistence and high productivity of both groups (Ash et al., 2004; Fynn et al., 2016; Russell et al., submitted). In the early 2000's community conservation areas were set aside to protect wildlife, gain revenue from tourism, and protect the areas grass banks, which contain critical dry season forage for livestock.

In the South Rift, it appears that seasonal changes in spatial abundance of wildlife and livestock is important for the high productivity of both wildlife and livestock, and their ability to coexist. Until recently, it was hard to document changes in animal spatial abundance. However a new technique, using density surface models (DSM), has led to novel methods for analyzing, modelling and predicting patterns of species abundance (Miller et al., 2013). This technique uses line transect methodology and distance sampling methodology (Buckland et al., 2001) combined with generalized additive models (GAMS; Wood, 2006), to use spatial variables to predict patterns of abundance across a landscape.

In this study, we used DSMs with the following aims. First, to document and visualize spatially the seasonal movement of wildlife and livestock in a community conserved landscape. Second, to understand the factors influencing changes in spatial abundance between seasons. Russell et al. (submitted) suggest that wildlife movements are not constrained and are in accordance with their metabolic requirements. Using DSMs, we incorporate several spatial covariates which allow for