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Article *in* African Journal of Ecology · June 2016

DOI: 10.1111/aje.12310

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African Journal of Ecology

Short Communication

Evidence of strong spatial segregation between elephant subpopulations in the contiguous Laikipia–Samburu ecosystem in Kenya

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Introduction

Connectivity within populations affects important ecological and evolutionary processes like gene flow, disease dynamics, and cultural exchange (Noad *et al.*, 2000; McCallum & Dobson, 2002; Epps *et al.*, 2005). Understanding connectivity is especially relevant in the context of conservation as landscape-level changes may alter wildlife movement. Such changes disproportionately affect wide-ranging species (Seidler *et al.*, 2015), and those whose movement corridors are not protected (Didier *et al.*, 2011). However, assessing connectivity across and within populations is difficult given the ephemeral and often cryptic nature of dispersal. Comparative, long-term data sets of known individuals can provide critical information and insights for wildlife managers and policymakers to determine whether and how subpopulations are connected.

The Laikipia–Samburu elephant (*Loxodonta africana* Blumenbach) population is the second largest in Kenya with approximately 7415 individuals, primarily relying on range outside of governmentally protected areas (Poole *et al.*, 1992; Litoroh *et al.*, 2010). The 34,000 km^2 Laikipia–Samburu ecosystem is a complex land use mosaic comprised of private, government and community lands (Thouless, 1995), which represent varying levels of risk to the region's elephants (Ihwagi *et al.*, 2015). The region is undergoing large-scale development projects (*LAPSSET Corridor Development Authority*, 2015), with unknown consequences for elephants and other wide-ranging animals. Social interactions drive spatial segregation between elephant groups at the local scale (Wittemyer *et al.*, 2007). Social segregation may also occur at larger scales, but few opportunities to test this hypothesis exist. Understanding current levels of connectivity among elephants of the Laikipia–Samburu landscape can provide deeper insight to spatial segregation in this species as well as provide fundamental information for planners and researchers. Here, we elucidate the degree of overlap between individuals using two intensively studied areas within the spatially contiguous study ecosystem.

Methods

Photographic records of individual elephants using the 220 km^2 Samburu and Buffalo Springs National Reserves (SBSNR) (compiled through a monitoring project started in 1997) were compared with records collected on the 200 km^2 Mpala Ranch (compiled through a monitoring project started in 2009). The two study areas are separated by approximately 75 km (Fig. 1). SBSNR are protected areas in the lowlands of the ecosystem, surrounded by community conservancies and permanent settlements. In contrast, Mpala is embedded in a mosaic of smallholder farms and large private ranches on the Laikipia plateau. Both projects use ear and tusk idiosyncrasies to identify individuals (Wittemyer, 2001), facilitating comparison. Our comparative search included breeding females (N_{SBSNR} = 356, N_{Mpala} = 573) and dispersed males (N_{SBSNR} = 239, N_{Mpala} = 139) (Wittemyer, 2001).

Results and discussion

No overlap was identified among the photographically documented elephants using Mpala and SBSNR. This was unexpected given radio-tracking evidence of connectivity

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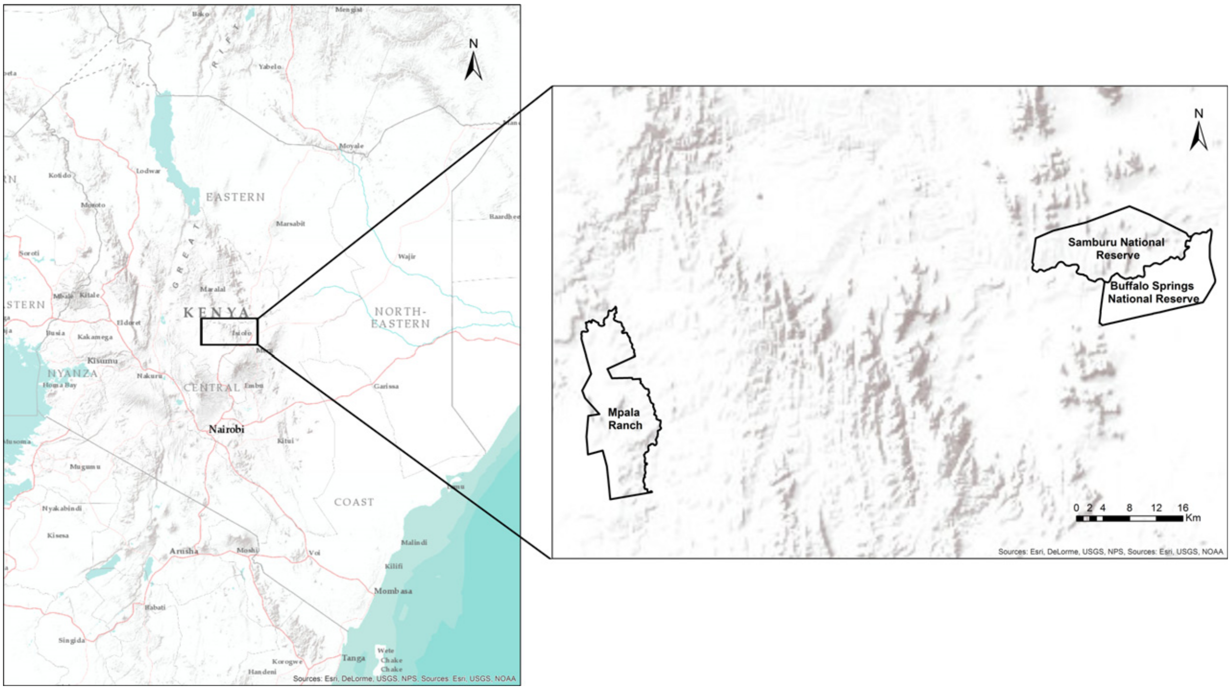

Fig 1 The study areas Mpala Ranch and Samburu and Buffalo Springs National Reserves are located in north central Kenya and are separated by approximately 75 km

between the two areas (Fig. 2), and the short distance between the two study areas relative to the tens of kilometres elephants can travel in a day and the thousands of square kilometres that can be encompassed in an elephant's home range (Wittemyer *et al.*, 2007; Wall *et al.*, 2013). Radio-tracking evidence revealed that one male (30–35 years old) and one female (20–25 years old) travelled between SBSNR and Mpala between 2012 and 2015. Given the social structure of elephant society (Douglas-Hamilton, 1972; Moss, 1988), the female was likely travelling with her family group (approximately 20 individuals), whereas it is unclear whether the male was alone or in a herd. Both elephants were collared in Samburu National Reserve (along with approximately two dozen elephants tracked at the same time).

The duration between elephant resightings from the long-term Samburu study varies among family groups, but in the extreme can span 10 years (i.e. the longest recorded time between two consecutive sightings of a family). The 6 year duration of the Mpala study could limit the ability to capture SBSNR elephants that (very) infrequently use Mpala. It is also possible that elephants using the two study areas were not detected while in the reserves. Radio-tracked elephants have entered the northern part of Mpala without detection. In Samburu, unidentified elephants from outside the subpopulation were observed using areas just outside the boundaries of the park (GW pers. obs.). Irrespective of incomplete sampling, it is clear strong intrapopulation structuring limits the interaction of the known elephants across the Laikipia–Samburu ecosystem.

Thouless (1995) suggested that the elephant use of the Laikipia plateau is relatively recent, with more elephants gradually moving into the area from the lowlands in response to increased poaching pressure and changing land management practices in the 1970s and 1980s. Thus, range use in this population may be changing continuously, with elephant knowledge of alternative habitats becoming increasingly crucial as development and ivory poaching continue in the region (Wittemyer *et al.*, 2014; (*LAPSSET Corridor Development Authority*, 2015).

Long-term data sets on known individuals are rare, but provide invaluable information on population processes (Clutton-Brock & Sheldon, 2010). Such data sets may be even more powerful when there is the potential for

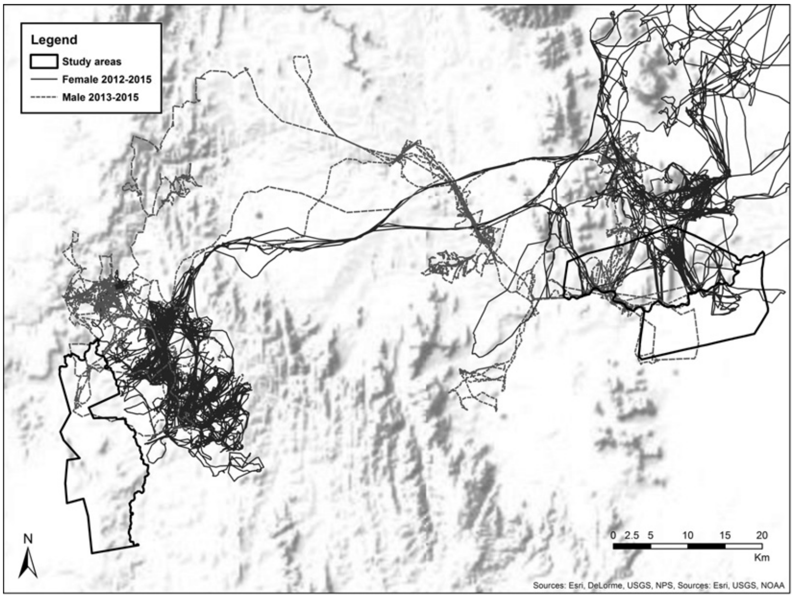

Fig 2 The paths of two radio-tracked elephants between 2012 and 2015 demonstrate connectivity between Mpala Ranch on the Laikipia plateau and Samburu and Buffalo Springs National Reserves in the lowlands despite zero overlap among the more than 1300 adult elephants identified in the two areas

comparison within species or populations. In this instance, comparable data sets revealed the surprising result that despite being separated by a short distance relative to an elephant's ranging ability (Wall *et al.*, 2013), these two subpopulations demonstrate strong spatial segregation. While radio-tracking data identified ephemeral connectivity between the two populations, it is notable that the use of Mpala by the tracked individuals was brief (a matter of hours for the male). This study demonstrates the value of both individual-based monitoring and tracking data sets to understand connectivity and segregation, where the combined data provide stronger inference than either data set alone. Range overlap outside Mpala and SBSNR among some individuals remains a possibility and rare connectivity events, as evident from radio-tracking data, suggest that genetic exchange may still occur despite the strong degree of segregation. Conservation efforts targeted at maintaining movement corridors can facilitate such exchange, which can be critical to subpopulation persistence (Keller & Waller, 2002; Okello *et al.*, 2008).

Older elephants are known to hold more information than younger elephants (McComb *et al.*, 2001; Polansky, Kilian & Wittemyer, 2015); the selective harvest of older elephants for their larger tusks in this population in recent years (Wittemyer, Daballen & Douglas-Hamilton, 2013) may thus threaten connectivity with the loss of corridor knowledge. Targeted movement studies addressing generational changes in movement may shed light on the long-term effects of ivory harvest for subpopulation connectivity. Our findings demonstrate the utility of GPS technology in identifying rare events that may have implications for population dynamics.

Acknowledgements

We thank the Kenyan Office of the President and the Samburu and Isiolo County governments for permission to work in the reserves. The Samburu team thanks donors of Save the Elephants and a National Science Foundation Graduate Research Fellowship grant (#DGE-1321845) for financial support. The Mpala team thanks Yvonne Ayisi, David Kimiti and Enock Ochieng for assistance with elephant tracking and identification, the Kenya Wildlife Service and the Mpala Wildlife Foundation for financial support, and Tim O'Brien for assistance with study design and data management.

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(*Manuscript accepted 1 March 2016*)

doi: 10.1111/aje.12310