FIELD NOTES

Bridging the Rift: demonstrating large mammal landscape connectivity from Amboseli National Park to the greater Maasai Mara

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Introduction

Elephant movements are non-random, driven by the need for resources such as food and water (Western and Lindsay 1984) and social and reproductive opportunities (Croze and Moss 2011). Savannah elephants are sexually segregated, meaning that males and females use landscapes very differently (Stokke and Du Toit 2002; Shannon et al. 2006). However, for both sexes, movement patterns vary by season and habitat (Duffy et al. 2011) and are affected by both anthropogenic influences (Graham et al. 2009; Loarie et al. 2009) and individual life history stage. Individual movement patterns are also highly variable, with a five-fold difference in home range sizes commonly reported within the same study (Ngene et al. 2017). With such high variability and sensitivity to environmental and anthropogenic change (Goldenberg et al. 2018; Ihwagi et al. 2018), most of the research to date focuses on individuals already in adulthood, where strategies for males centre on growth, competition, and reproductive opportunities (Taylor et al. 2020), or on pressures at the human-elephant interface such as crop foraging or fence breaking (Wilkie and Douglas-Hamilton 2018; Troup et al. 2020).

Despite the persistent myth that males are solitary, a growing body of evidence shows that, like females, male elephants socialize have long-standing bonds and friendships (Lee et al. 2011), depend on knowledgeable others (Allen et al. 2020), and require social stability for individuals to develop successfully (Slotow and Dyk 2001). How then do males manage this transition from a matriarchal multigenerational family structure, to mature individuals balancing friendships and the intensity of male-male competition (Evans and Harris 2008; Poole et al. 2011; Murphy et al. 2019)? If males are indeed risk-takers (Chiyo et al. 2011), then how do they buffer and manage risks as they develop their own strategies, and what are the long-term consequences of early experience and strategy adoption for survival and reproductive success? To answer this first question regarding the transition to independent ranging, in 2019 the Amboseli Trust for Elephants (ATE) fitted eight collars to dispersal-age males. In this paper, we focus on the movements of one male, *Esposito*, as a case study in ecosystem connectivity.

Figure 1. *Esposito*, in May 2021 during a routine check to ensure that his collar fitted well. © *Amboseli Trust for Elephants*

Methodology

The life histories of Amboseli elephants have been continuously monitored since 1972, following methodologies described by Moss et al. (2011). The targets for the collaring study were selected based on known dispersal dates and family history. Savannah Tracking Ltd GSM-satellite collars were fitted in July 2019, set to hourly fixes and a minimum 12-hourly reporting schedule. Permissions were obtained from the Kenya Wildlife Service (KWS), and deployment was carried out with the support of a KWS vet and fitting team from Save the Elephants (STE). The collars were monitored for fit whenever the animals were resighted. *Esposito*, born in May 2003 to the EA family (first identified in September 1972) was 16.16 years old at the time of collaring (Fig. 1). As the oldest son of his mother, he had started spending time away from his family at the age of 11.0 years and was fully independent by age 12.75 (within the normal range of 7.42–19.9 years, median age 14.5 years (Lee et al. 2022). After independence, *Esposito* was sighted four times during ATE's long term monitoring.

Results

After collar deployment in 2019, *Esposito* showed a sedentary pattern, focused in bushland-dominated habitat to the north of Amboseli National Park (NP). From September 2022 he began an incredible journey, covering 1,780 km over 28 weeks (Fig. 2). In the first phase of his journey south of Bisil, he was seen in the company of other elephants, mostly young males, but was not sighted after that. *Esposito's* exploration covered three phases: first movements in a southerly direction to South Rift, second a cross-border movement to Lake Natron, and third walking back to the base of the Ngurumen Escarpment, a known elephant hotspot and connection between the South Rift and the extreme east of the greater Maasai Mara ecosystem. On 23 January 2023 the collar stopped reporting, and supposing unit failure we began searching together with the Mara Elephant Project (MEP) to attempt to recollar *Esposito* but were unable to locate him. On 27 April 2023, MEP rangers recovered *Esposito's* collar in thick forest in the Loita Hills; a straight-line distance of approximately 185 km from the home range of his natal family in Amboseli NP. The collar began reporting again once back in mobile signal and we found it had 'dropped' in early March 2023.

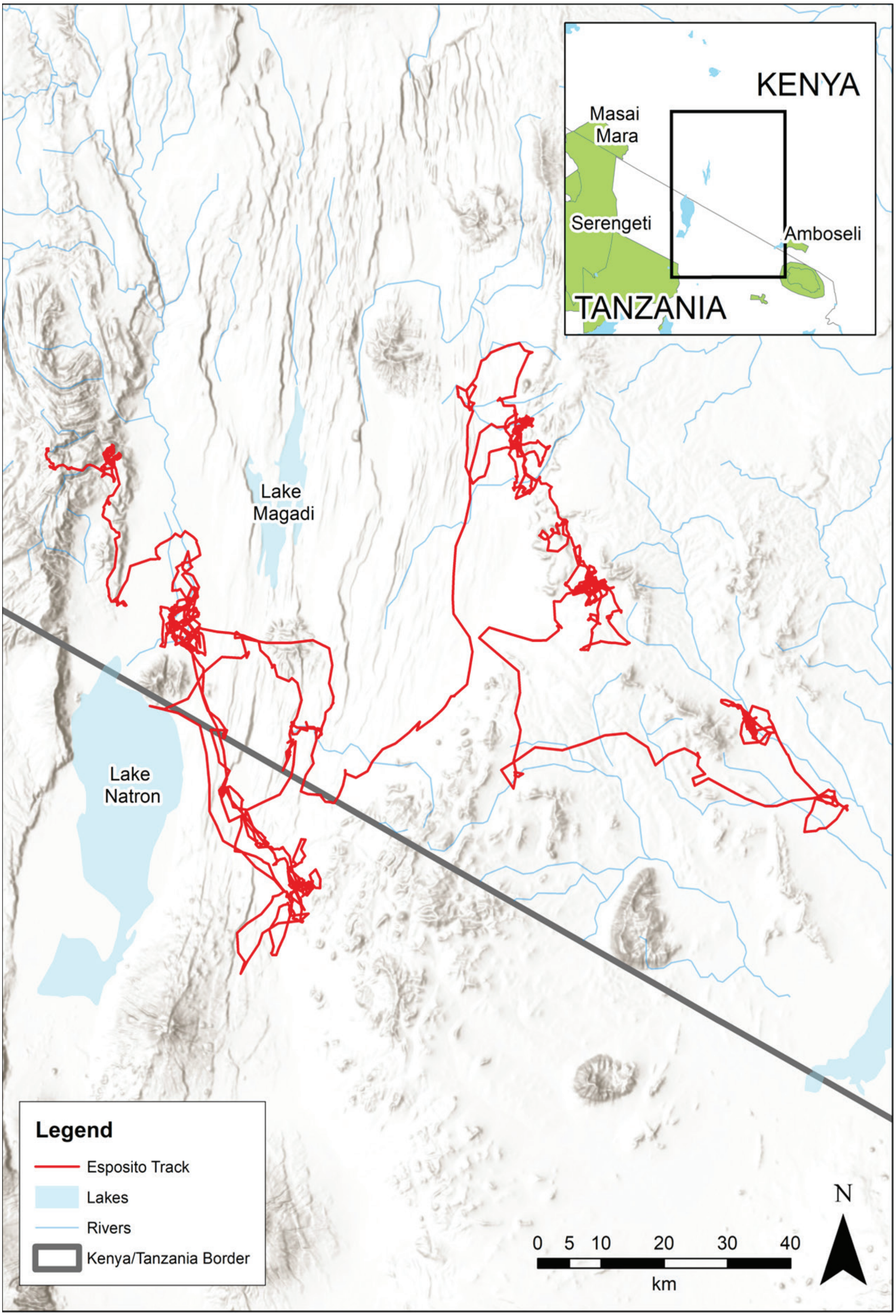

Figure 2. Track movement for male *Esposito*, collared in Amboseli NP and travelling to the greater Maasai Mara ecosystem via Lake Natron.

Discussion

Although the Amboseli elephant population has long been known to be contiguous with those in the Tsavo NPs, Lake Magadi area and Lake Natron West (Kenana et al. 2013; Ngene et al. 2017), this is the first demonstration of elephant population connectivity between Amboseli NP and the greater Maasai Mara ecosystem. This case may be a rare or unique movement in modern times, but at this time of changing land use and land ownership structures (Tyrrell et al. 2022a,b), it is both encouraging to see large mammal connectivity on this scale, and an urgent reminder of what is at stake if conservation policies are allowed to fail (Western et al. 2020). Collaring operations of this type are not without risk—deploying collars ethically should always require a sound exit strategy to avoid compromising welfare, especially because the growth rate of males at this life history stage means collars can easily be outgrown. Nonetheless, we feel further tracking data on this population cohort will help (in combination with other methods, such as genetics) to understand how frequently long-range dispersals occur, and if these are permanent movements or provide bridges where animals move back and forth. *Esposito* returned to Amboseli NP on 27 June 2023, and we were able to recollar him on 1 July, again with support from KWS and STE. With this new collar we expect to be able to confirm any repeat journeys to the Mara.

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References

Allen CRB, Brent LJN, Motsentwa T, Weiss MN, Croft DP. 2020. Importance of old bulls: leaders and followers in collective movements of all-male groups in African savannah elephants (*Loxodonta africana*). *Scientific Reports* 10: 13996. https://doi.org/10.1038/s41598-020-70682-y

Chiyo PI, Lee PC, Moss CJ, Archie EA, Hollister-Smith JA, Alberts, SC. 2011. No risk, no gain: effects of crop raiding and genetic diversity on body size in male elephants. *Behavioral Ecology* 22 (3): 552–558. https://doi.org/10.1093/beheco/arr016

Croze H and Moss CJ. 2011. Patterns of Occupancy in Time and Space. In Moss, Croze, Lee (Eds.). *The Amboseli Elephants: A Long-Term Perspective on a Long-Lived Mammal*. University of Chicago Press.

Duffy KJ, Dai X, Shannon G, Slotow R, Page B. 2011. Movement patterns of African elephants (*Loxodonta africana*) in different habitat types. *South African Journal of Wildlife Research* 41 (1): 21–28. https://doi.org/10.3957/056.041.0107

Evans KE and Harris S. 2008. Adolescence in male African elephants, *Loxodonta africana*, and the importance of sociality. *Animal Behaviour* 76 (3): 779–787. https://doi.org/10.1016/j.anbehav.2008.03.019

Goldenberg SZ, Douglas-Hamilton I, Wittemyer G. 2018. Inter-generational change in African elephant range use is associated with poaching risk, primary productivity and adult mortality. *Proceedings of the Royal Society of London Series B Biological Sciences* 285 (1879): 20180286. https://doi.org/10.1098/rspb.2018.0286

Graham MD, Douglas-Hamilton I, Adams WM, Lee PC. 2009. The movement of African elephants in a human-dominated land-use mosaic. *Animal Conservation* 12 (5): 445–455. https://doi.org/10.1111/j.1469-1795.2009.00272.x

Ihwagi FW, Thouless C, Wang T, Skidmore AK, Omondi P, Douglas-Hamilton I. 2018. Night-day speed ratio of elephants as indicator of poaching levels. *Ecological Indicators* 84: 38–44. https://doi.org/10.1016/j.ecolind.2017.08.039

Kenana L, Bakari S, Bitok E, Machoke N, Mukeka J, Mwiu SN, Kyale D, Cheptei J. 2013. Dry season cross border aerial census report. Technical report Kenya Wildlife Service and Tanzania Wildlife Research Institute.

Lee PC, Moss CJ, Njiraini N, Poole JH, Sayialel K, Fishlock VL. 2022. Cohort consequences of drought and family disruption for male and female African elephants. *Behavioral Ecology* 33 (2): 408–418. https://doi.org/10.1093/beheco/arab148

Lee PC, Poole JH, Njiraini N, Sayialel CN, Moss CJ. 2011. Male Social Dynamics: Independence and Beyond. In Moss, Croze, Lee (Eds.). *The Amboseli Elephants: A Long-Term Perspective on a Long-Lived Mammal*. University of Chicago Press.

Loarie SR, Aarde RJV, Pimm SL. 2009. Fences and artificial water affect African savannah elephant movement patterns. *Biological Conservation* 142 (12): 3,086–3,098. https://doi.org/10.1016/j.biocon.2009.08.008

Moss CJ, Croze H, Lee PC (Eds.). 2011. *The Amboseli Elephants: A Long-Term Perspective on a Long-Lived Mammal*. University of Chicago Press.

Murphy D, Mumby HS, Henley MD. 2019. Age differences in the temporal stability of a male African elephant (*Loxodonta africana*) social network. *Behavioral Ecology* 31 (1): 21–31. https://doi.org/10.1093/beheco/arz152

Ngene S, Makonjio Okello M, Mukeka J, Muya S, Njumbi S, Isiche J. 2017. Home range sizes and space use of African elephants (*Loxodonta africana*) in the Southern Kenya and Northern Tanzania borderland landscape. *International Journal of Biodiversity and Conservation* 9 (1): 9–26. https://doi.org/10.5897/IJBC2016.1033

Poole JH, Lee PC, Njiraini N, Moss CJ. 2011. Longevity, Competition, and Musth: A Long-Term Perspective on Male Reproductive Strategies. In Moss, Croze, Lee (Eds.). *The Amboseli Elephants: A Long-Term Perspective on a Long-Lived Mammal*. University of Chicago Press.

Shannon G, Page BR, Duffy KJ, Slotow R. 2006. The role of foraging behaviour in the sexual segregation of the African elephant. *Oecologia* 150: 344–354. https://doi.org/10.1007/s00442-006-0521-1

Slotow R, van Dyk G. 2001. Role of delinquent young "orphan" male elephants in high mortality of white rhinoceros in Pilanesberg National Park, South Africa. *Koedoe* 44 (1): 85–94. https://doi.org/10.4102/koedoe.v44i1.188

Stokke S, Du Toit JT. 2002. Sexual segregation in habitat use by elephants in Chobe National Park, Botswana. *African Journal of Ecology* 40: 360–371. https://doi.org/10.1046/j.1365-2028.2002.00395.x

Taylor LA, Vollrath F, Lambert B, Lunn D, Douglas-Hamilton I, Wittemyer G. 2020. Movement reveals reproductive tactics in male elephants. *Journal of Animal Ecology* 89 (1): 57–67. https://doi.org/10.1111/1365-2656.13035

Troup G, Doran B, Au J, King LE, Douglas-Hamilton I, Heinsohn R. 2020. Movement tortuosity and speed reveal the trade-offs of crop raiding for African elephants. *Animal Behaviour* 168: 97–108. https://doi.org/10.1016/j.anbehav.2020.08.009

Tyrrell P, Amoke I, Betjes K, Broekhuis F, Buitenwerf R, Carroll S, Hahn N, Haywood D, Klaassen B, Løvschal M, Macdonald D, Maiyo K, Mbithi H, Mwangi N, Ochola C, Odire E, Ondrusek V, Ratemo J, Pope F, Russell S, Sairowua W, Sigilai K, Stabach JA, Svenning JC, Stone E, 2022a. OPEN Landscape Dynamics (landDX) Data Descriptor an open-access spatial-temporal database for the Kenya–Tanzania borderlands. *Scientific Data* 9: 8. https://doi.org/10.1038/s41597-021-01100-9

Tyrrell P, Buitenwerf R, Brehony P, Løvschal M, Wall J, Russell S, Svenning JC, Macdonald DW, Du Toit JT, Kamanga J. 2022b. Wide-scale subdivision and fencing of southern Kenyan rangelands jeopardizes biodiversity conservation and pastoral livelihoods: Demonstration of utility of open-access landDX database. *Frontiers in Conservation Science* 3: 889501. https://doi.org/10.3389/fcosc.2022.889501

Western D, Lindsay W.K. 1984. Seasonal herd dynamics of a savanna elephant population. *African Journal of Ecology* 22: 229–244. https://doi.org/10.1111/j.1365-2028.1984.tb00699.x

Western D, Tyrrell P, Brehony P, Russell S, Western G, Kamanga J. 2020. Conservation from the inside-out: Winning space and a place for wildlife in working landscapes. *People and Nature* 2: 279–291. https://doi.org/10.1002/pan3.10077

Wilkie RD and Douglas-Hamilton I. 2018. High-resolution tracking technology reveals distinct patterns in nocturnal crop-raiding behaviour of an African elephant (*Loxodonta africana*) in Amboseli, Kenya. *Pachyderm* 59: 41–48. https://pachydermjournal.org/index.php/pachyderm/article/view/79