Elephant numbers and distribution in the Tsavo–Amboseli ecosystem, south-western Kenya

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Abstract

We assessed how elephants use two Maasai group ranches—Kimana and Kuku—that straddle Tsavo West, Chyulu Hills and Amboseli National Parks in south-western Kenya, and investigated their relative distribution, numbers and ranging patterns. Elephant sightings, fresh elephant dung counts and questionnaire interviews with local people revealed that elephants were widely distributed. Kimana Community Wildlife Sanctuary was reported as the place elephants were most likely to be found within the two communal areas. *Acacia xanthophloea* riverine woodland and *Acacia tortilis* woodlands were the habitats highly associated with elephants during the dry season. Bull elephant groups were dominant in the wet and dry seasons. Elephant movement from Kuku Group Ranch into Kimana Group Ranch was restricted by an electric fence and other human activity into two narrow strips, 1.66 km and 0.45 km wide, to the north and south of Kimana fence. We believe that the future of Kuku and Kimana Group Ranches as an elephant dispersal area depends on how fast initiatives are made to halt the continuing loss and fragmentation of the critical elephant habitat in the area. Immediate interventions need to explore options that enlist landowners' support in conserving these habitats within the ecosystem.

Additional key words: elephant movement, dispersal areas

Résumé

Nous avons évalué comment les éléphants utilisent deux groupes de ranches masaï (GR) – Kimana et Kuku – qui se trouvent dans les Parcs Nationaux de Tsavo-ouest, Chyulu Hills et Amboseli, au sud-ouest du Kenya, et étudié leur distribution relative, leur nombre et les patterns de répartition. Les observations d'éléphants, les comptages de crottes fraîches et l'interview de la population locale ont révélé que les éléphants sont largement distribués. Le sanctuaire communautaire de la Faune de Kimana s'avéra être, des deux sites étudiés, l'endroit où il était le plus probable de trouver des éléphants. La forêt riveraine à *Acacia xanthophloea* et les zones boisées à *Acacia tortilis* étaient des habitats fortement associés à la présence d'éléphants pendant la saison sèche. Les groupes de mâles étaient dominants pendant la saison des pluies et la saison sèche. Les déplacements des éléphants du Groupe de ranches de Kuku vers le Groupe de ranches de Kimana étaient limités à deux bandes étroites de 1,66 km et 0,45 km de large, au nord et au sud de la clôture de Kimana, par des clôtures électriques et par d'autres activités humaines. Nous croyons que l'avenir des deux groupes de ranches, Kuku et Kimana, en tant qu'aires de dispersion des éléphants, dépendra de la rapidité des initiatives qui mettront fin à la perte et à la fragmentation continuelles de l'habitat critique pour les éléphants dans la région. Lors d'une intervention qui doit être immédiate, il faudra explorer les options qui font le compte des propriétaires qui s'engagent à supporter la conservation de ces habitats, au sein de l'écosystème.

Mots clés supplémentaires : déplacements d'éléphants, aires de dispersion

Introduction

Two Maasai group ranches, Kimana and Kuku, straddling Amboseli, Tsavo West and Chyulu Hills National Parks (NP) are used by elephants from these protected areas. Studies in parts of the Tsavo–Amboseli ecosystem indicate that forage quality (Western and Lindsay 1984) and water distribution (Western 1975; Western and Lindsay 1984), human settlement and actual presence of humans (Kangwana 1993) influence elephant use of the ecosystem. Elephants select habitats with abundant forage and their mean group size varied within habitats (Western and Lindsay 1984).

The Amboseli elephants known to frequently use Amboseli NP are a discrete population that probably overlaps with elephants from Tsavo West and Chyulu Hills NPs in the Kimana Community Wildlife Sanctuary (Kimana Sanctuary) (Moss 2001). Elephants from Amboseli NP also use the lower Kilimanjaro slopes (Poole and Reuling 1997). The demographics and behavioural aspects of the Amboseli elephant population have been documented through long-term studies by the Amboseli Elephant Research Programme (AERP). There were 1087 elephants in 1999 comprising 52 families and 183 adult males (Moss 2001). Their population today is estimated to be 1300 elephants (S. Sayialel, pers. comm. 2005).

Elephant dung count is the most common indirect method of counting elephants (Barnes 1996). This method was used to determine elephant occupancy levels on Maasai settlements in the Amboseli area (Kangwana 1993) and in different habitats in the Athi–Kapiti plains (Gichohi 1996). Recently, periodical aerial elephant counts that covered Kuku and Kimana Group Ranches (GR) were undertaken (Omondi et al. 2002). The counts do not adequately show the fluid nature of elephant use of the Kuku–Kimana area as can be captured by regularly recording elephant signs such as dung and tracks. Elephant distribution within community land can be evaluated through existing local knowledge. For instance, the Maasai people, ancestral inhabitants of this area, have historically interacted with elephants on a daily basis and possess a wealth of knowledge on elephant use of the area.

Further understanding of how elephants use the private land among the Amboseli, Chyulu and Tsavo West NPs is critical considering the evolving changes in land use and a growing human population that may negatively affect elephant use of the area. The Maasai have, for instance, shifted their lifestyle from pastoralism to a much more diverse and sedentary economy that includes crop farming (Kioko 2005). This coupled with increased crop farming by immigrants from Tanzania and other parts of Kenya has led to accelerated encroachment into the wetlands and subsequent displacement of elephants (Kioko 2005). We give the scope of elephant use of Kuku and Kimana GR, the most important range for dispersal of Amboseli elephant into the Tsavo–Amboseli ecosystem, and investigate their relative distribution, numbers and ranging patterns.

Study area

Kuku (1310 km^2) and Kimana (251 km^2) Group Ranches are in Oloitokitok Division in Kajiado District, south-western Kenya. The two, together with neighbouring group ranches (Olgulului, Imbirikani and Rombo) and individually owned land on the lower slopes of Mt Kilimanjaro, are a dispersal area for elephants and other wildlife (fig. 1). The semi-pastoral Maasai are the predominant inhabitants although in the recent past there has been an influx of immigrant farming communities from other parts of Kenya and Tanzania (Berger 1993). In 1996, Kimana Sanctuary, a 30-km^2 block in Kimana GR, was established to generate wildlife-based tourism income for its members (Kioko 2005). Group ranches, introduced in 1968 under the Group Ranch Act, were a way to settle the Maasai (Graham 1989). In 1981 group ranch members preferred to own individual parcels of land so subdivided the ranches among themselves. In 2004 Kimana GR was subdivided among the 843 registered members. Kuku GR remains communally owned; the swamps have, however, been allocated to the group ranch members who either farm or lease them.

Mt Kilimanjaro, 5895 m high, and the Chyulu Hills Range, 2300 m high, have a dominant influence on the climate and water distribution in the Amboseli ecosystem. Rainfall is highly variable and poorly distributed. It occurs in two seasons (Pratt and Gwynne 1978) and ranges from 300 mm within the group ranches to 900 mm on the eastern slopes of Mt Kilimanjaro (Berger 1993). The 'short' rains occur between November and December and 'long' rains from March to May. The short rains are more critical with most droughts associated with their failure (Musembi 1986).The permeable nature of volcanic rocks forms regionally distributed aquifers from Mt Kilimanjaro that are important sources of water (Omenge and Okello 1992) in an area that has only two permanent rivers (fig. 1). Dominant species are the yellow fever tree (*Acacia xanthophloea*), riverine and umbrella thorn (*Acacia tortilis*) woodland, wait-a-bit thorn (*Acacia mellifera*) and mixed *Commiphora* bushland (Kioko 2005). The area is famous for its wildlife and abundance of bird species (Berger 1993).

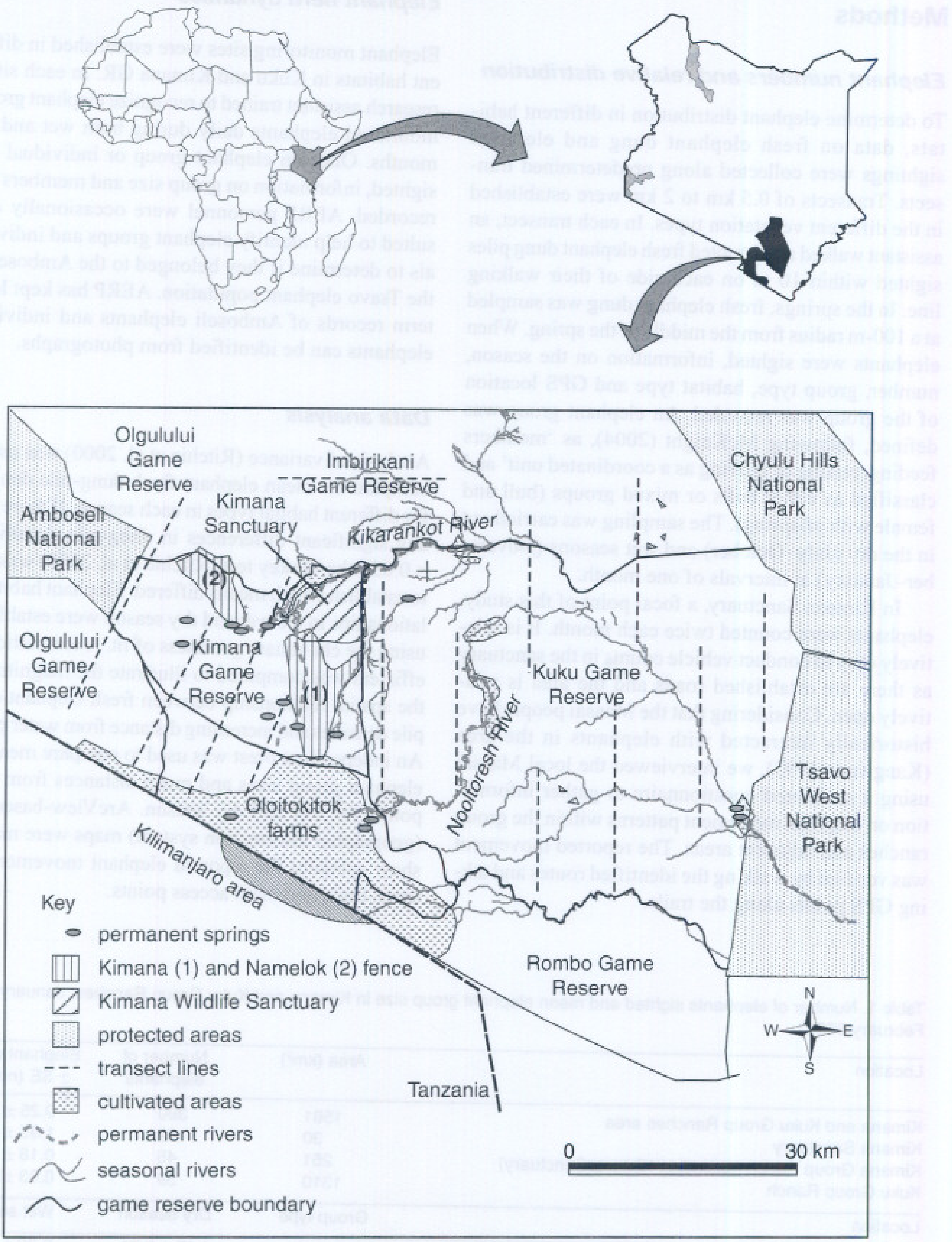

Figure 1. Location of Kuku and Kimana Group Ranches in relation to Amboseli, Chyulu Hills and Tsavo National Parks.

Methods

Elephant numbers and relative distribution

To determine elephant distribution in different habitats, data on fresh elephant dung and elephant sightings were collected along predetermined transects. Transects of 0.5 km to 2 km were established in the different vegetation types. In each transect, an assistant walked and counted fresh elephant dung piles sighted within 10 m on each side of their walking line. In the springs, fresh elephant dung was sampled at a 100-m radius from the middle of the spring. When elephants were sighted, information on the season, number, group type, habitat type and GPS location of the group was recorded. An elephant group was defined, following McKnight (2004), as 'members feeding, resting or moving as a coordinated unit' and classified as either bulls or mixed groups (bull and female with offspring). The sampling was carried out in the dry (July–October) and wet seasons (November–January) at intervals of one month.

In Kimana Sanctuary, a focal point of this study, elephants were counted twice each month. It is relatively easy to conduct vehicle counts in the sanctuary as there are established roads and the area is relatively open. Considering that the Maasai people have historically interacted with elephants in the area (Kangwana 1993), we interviewed the local Maasai using a structured questionnaire to gather information on elephant movement patterns within the group ranches and adjacent areas. The reported movement was verified by walking the identified routes and taking GPS points along the trails.

Elephant herd dynamics

Elephant monitoring sites were established in different habitats in Kuku and Kimana GR. In each site, a research assistant trained to recognize elephant groups monitored elephants daily during both wet and dry months. Once an elephant group or individual was sighted, information on group size and members was recorded. AERP personnel were occasionally consulted to help identify elephant groups and individuals to determine if they belonged to the Amboseli or the Tsavo elephant population. AERP has kept long-term records of Amboseli elephants and individual elephants can be identified from photographs.

Data analysis

Analysis of variance (Ritchie et al. 2000) was used to compare the mean elephant fresh dung-pile densities for different habitat types in each season. If there were any significant differences in dung-pile densities ($p < 0.05$), the Turkey test (Ritchie et al. 2000) was used to establish which means differed. Elephant habitat relationships in the wet and dry season were established using the chi-square goodness of fit. A correlation coefficient was computed to illustrate the magnitude of the spatial relationship between fresh elephant dung-pile densities and increasing distance from water points. An independent *t*-test was used to compare means for elephant group sizes and mean distances from water points for wet and dry season. ArcView-based GIS (geographic information system) maps were made to show spatially the reported elephant movement patterns, trails and main access points.

Table 1. Number of elephants sighted and mean elephant group size in Kimana and Kuku Group Ranches, January 2003–February 2004

Location	Area (km^2)	Number of elephants	Elephant density ± SE (no/km^2)
Kimana and Kuku Group Ranches area	1561	390	0.25 ± 0.1
Kimana Sanctuary	30	59	1.95 ± 0.96
Kimana Group Ranch (excluding Kimana Sanctuary)	251	45	0.18 ± 0.08
Kuku Group Ranch	1310	39	0.03 ± 0.014
Location	**Group type**	**Dry season**	**Wet season**
Kimana and Kuku Group Ranches (excluding Kimana Sanctuary)	mixed	4.47 ± 0.71	9.30 ± 1.55
Kimana Community Wildlife Sanctuary	mixed	17.75 ± 3.83	5.05 ± 0.81
Kimana Community Wildlife Sanctuary	bull	3.36 ± 0.42	3.27 ± 0.37
Kimana and Kuku Group Ranches (excluding Kimana Sanctuary)	bull	3.53 ± 1.20	4.96 ± 0.56

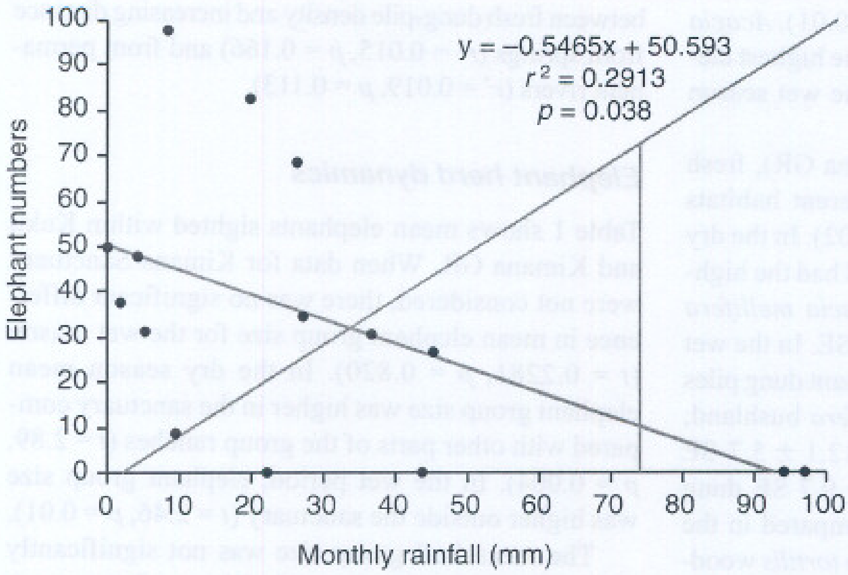

Figure 2. The relationship between rainfall (mm) and mean monthly elephant numbers in Kimana Community Wildlife Sanctuary.

Results

Elephant numbers and relative distribution

Elephant density was significantly higher in Kimana Sanctuary compared with other parts of the group ranches (table 1). The monthly mean number of elephants in the sanctuary was 34 ± 6.49 SE for the period January 2003–February 2004. Elephant numbers in the sanctuary increased during the dry season and at times there were no elephants there during the rainy season (fig. 2). The total number of elephants observed in different habitats varied between wet

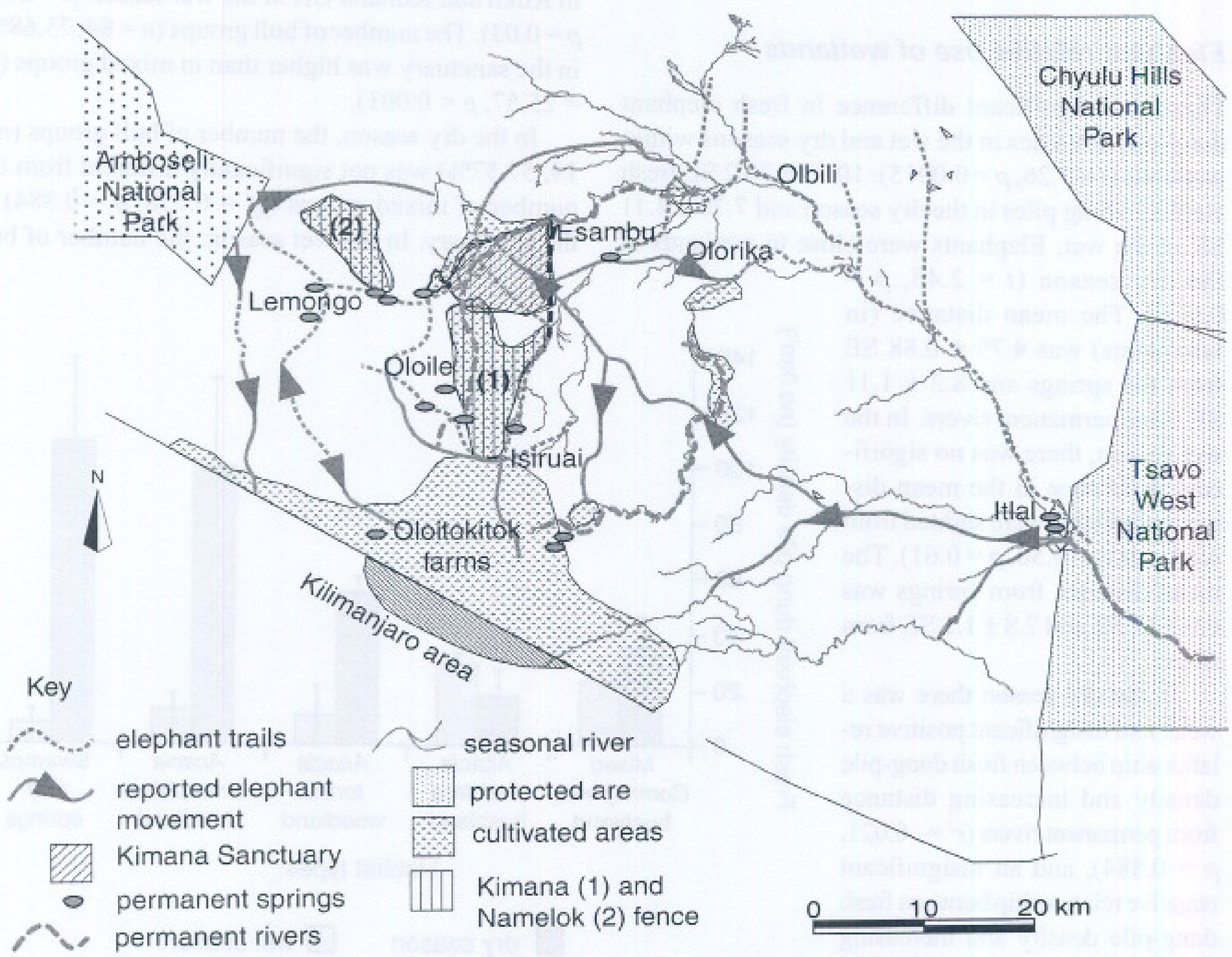

Figure 3. Elephant movement within Kuku and Kimana Group Ranches in relation to Amboseli, Chyulu Hills and Tsavo West National Parks.

and dry seasons ($\chi^2 = 26.50$, $df = 5$, $p < 0.01$). *Acacia xanthophloea* riverine woodlands had the highest elephant numbers: 97 (74.04%) during the wet season and 461 (80.17%) during the dry.

In the entire area (Kuku and Kimana GR), fresh dung-pile densities varied in the different habitats (Kruskal-Wallis $H = 8.79$, $df = 3$, $p = 0.02$). In the dry season, *Acacia xanthophloea* woodland had the highest density of 98 ± 32 SE, while *Acacia mellifera* bushland had the lowest: 17.20 ± 9.40 SE. In the wet season, the highest density of fresh elephant dung piles (12.1 ± 5.70 SE) was in *Acacia mellifera* bushland; *Acacia xanthophloea* woodland had 12.1 ± 5.7 SE and *Acacia tortilis* woodland 10.80 ± 9.7 SE dung piles. When each habitat type was compared in the wet and dry seasons (fig. 3), only *Acacia tortilis* woodland ($t = 3.54$, $p < 0.001$) and *Acacia xanthophloea* woodland ($t = 3.14$, $p < 0.001$) had significant differences in mean fresh dung-pile densities.

Elephant relative use of wetlands

There was significant difference in fresh elephant dung-pile densities in the wet and dry seasons within wetlands ($t = 3.26$, $p = 0.0015$): 10.73 ± 30.2 SE fresh elephant dung piles in the dry season and 7.70 ± 4.11 SE in the wet. Elephants were close to wetlands in the dry season ($t = 2.45$, $p = 0.016$). The mean distance (in kilometres) was 4.79 ± 0.88 SE from the springs and 8.2 ± 1.11 SE from permanent rivers. In the wet season, there was no significant difference in the mean distance elephants were sighted from wetlands ($t = 0.50$, $p = 0.61$). The mean distance from springs was 6.9 ± 13 SE and 7.8 ± 1.1 SE from rivers.

In the dry season there was a weak and insignificant positive relationship between fresh dung-pile density and increasing distance from permanent rivers ($r^2 = -0.021$, $p = 0.884$), and an insignificant negative relationship between fresh dung-pile density and increasing distance from springs ($r^2 = 0.054$, $p = 0.059$). In the wet season, there was a weak positive relationship between fresh dung-pile density and increasing distance from springs ($r^2 = 0.015$, $p = 0.166$) and from permanent rivers ($r^2 = 0.019$, $p = 0.113$).

Elephant herd dynamics

Table 1 shows mean elephants sighted within Kuku and Kimana GR. When data for Kimana Sanctuary were not considered, there was no significant difference in mean elephant group size for the wet season ($t = 0.2281$, $p = 0.820$). In the dry season mean elephant group size was higher in the sanctuary compared with other parts of the group ranches ($t = 2.89$, $p = 0.004$). In the wet period, elephant group size was higher outside the sanctuary ($t = 2.46$, $p = 0.01$).

The mean bull group size was not significantly different in wet or dry season in Kimana Sanctuary ($t = 0.143$, $p = 0.88$); however, bull group size differed significantly between the sanctuary and other areas in Kuku and Kimana GR in the wet season ($t = 2.19$, $p = 0.03$). The number of bull groups ($n = 84$, 73.68%) in the sanctuary was higher than in mixed groups ($\chi^2 = 25.57$, $p < 0.001$).

In the dry season, the number of bull groups ($n = 19$, 57.57%) was not significantly different from the number of mixed groups ($\chi^2 = 0.758$, $p = 0.384$) in the sanctuary. In the wet season, the number of bull

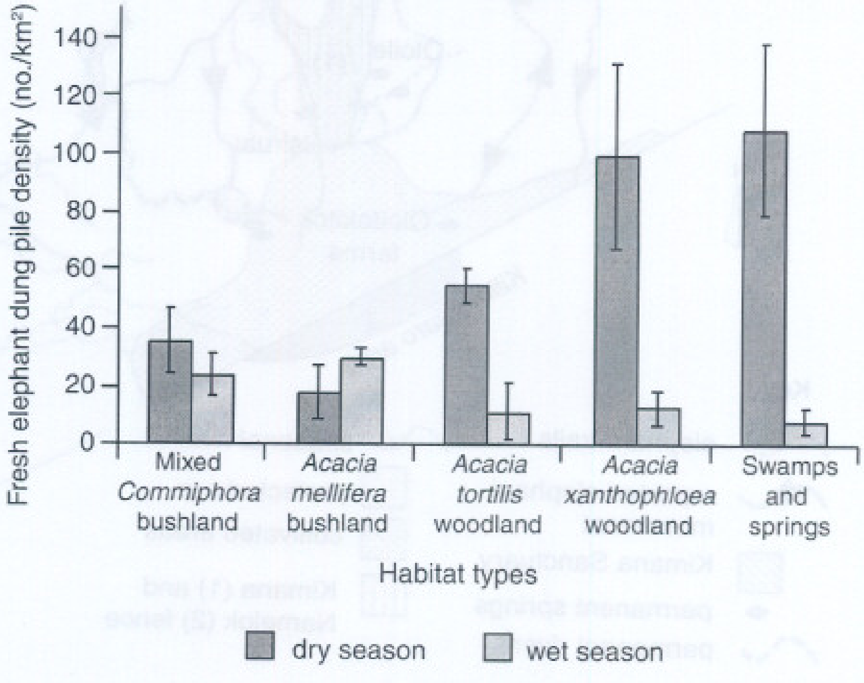

Figure 4. Mean fresh elephant dung piles for different habitat types in the Kuku–Kimana area in wet and dry seasons.

groups ($n = 65$, 81.3%) in the sanctuary was higher than mixed groups ($\chi^2 = 31.25$, $p < 0.001$). There were more bull groups ($n = 51$, 81%) than mixed groups ($n = 12$, 17%) in the wet season ($\chi^2 = 24.14$, $p = 0.001$) and more bull groups ($n = 60$, 80.0%) than mixed groups ($n = 15$, 20%) during the dry season outside the sanctuary ($\chi^2 = 27$, $p < 0.001$).

Elephant movement

Elephant trails were clearly defined in the dry season and led into and out of the wetlands (fig. 4). Elephant movement between Kimana and Kuku GR was constricted into two access points. Elephants from Kimana GR entered the neighbouring Kuku GR through a 1.66-km strip in Isinet and a 0.45-km strip in Impiron. The Impiron point is between Kimana fence and Impiron farmlands on the southern end of Kimana fence. The Isinet access point is to the northern end of Kuku and Kimana GR and falls between Kimana fence and Isinet farms.

Elephants were widely reported within the group ranches; only 7.8% ($n = 61$) of the residents did not see elephants in their home area. Most of the inhabitants ($n = 255$, 78.5%) knew in which areas elephants were 'commonly' found within the group ranches. In Kimana GR, Kimana Sanctuary ($n = 174$, 46.63%), Oloile ($n = 39$, 10.46%) and Lemongo ($n = 25$, 6.7%) were reported as the areas in which one was most likely to see elephants. In Kuku GR, Itlal ($n = 54$, 25.96%), Isiruai ($n = 18$, 8.65%) and Olorika ($n = 17$, 8.17%) were reported as the most likely places. Most of the places reported in Kuku GR were in the area adjacent to Tsavo West NP and in the area north-west of Chyulu Hills NP. Mbirikani GR, neighbour to Kuku GR, Kimana swamp ($n = 60$, 25.32%), Olbili ($n = 47$, 19.83%) and Esambu ($n = 21$, 8.86%) were reported as the areas where elephants were most likely seen.

Discussion and conclusions

Elephants widely use Kuku and Kimana GR. The use pattern is characterized by peak concentration in the wetlands in the dry season. Kimana Sanctuary, partially a wetland, is an important elephant range in the two group ranches. The flood plain on the edges of the sanctuary and a wetland-associated riverine habitat in the sanctuary produce forage that sustains elephants and other wildlife during the dry season. The sanctuary may have become increasingly important after loss and fragmentation of wetlands in the group ranches by crop cultivation and human settlement.

While elephants relatively associated with permanent water points in the dry season, the weak relationship suggests that a multitude of factors influence elephant use of Kuku and Kimana GR. Elephants use water points at night to avoid conflict with people fetching water or watering their livestock. Increased human activity within the group ranches is likely to limit elephant use of them. This will negatively affect the eco-tourism enterprises that depend on big game species such as elephants.

The lack of seasonal change in the mean group size for both male and mixed groups in Kimana Sanctuary and other parts of the group ranch may imply that specific individuals and groups use the area seasonally. The area is mainly associated with male elephants. Males move further from water points in the dry season than groups with young (Stokke and Du Toit 2002). The presence of lactating calves may limit how far the group can move from water, quality forage and shade. The groups with young in Kimana Sanctuary remained in the riverine *Acacia xanthophloea* woodland during the day; they were observed to leave the sanctuary in the afternoon and return early morning.

While there existed defined elephant cluster areas, their daily movement pattern was triggered by the need to have access to water and a wider feeding area. There was a sudden shift in elephant movement within wetlands, with elephants suddenly leaving areas once the temporary source of water dried. Mpanduji et al. (2003) observed that permanent river systems influenced elephant movement in the Selous–Niassa wildlife corridor in Tanzania. In the group ranches, the riverine-associated *Acacia xanthophloea* woodland was the habitat most likely to have reliable shade, forage, escape cover, and a nearby drinking and wallowing site for elephants.

Elephants avoided human disturbance by staying in core areas such as Kimana Sanctuary during the day and moving out at night. At night they are able to exploit a wider range with potentially diverse food resources and with little disturbance from humans. The continuing disappearance of elephant corridors in Kimana and Kuku GR is a major threat to elephant dispersion into the wider Amboseli–Tsavo ecosystem. Movement of Amboseli elephants from Kimana GR into Kimana Sanctuary and Kuku GR has been confined by farming and human settlement into two narrow strips on both extremes of Kimana fence, and even these strips are increasingly becoming fragmented.

The distribution of elephants across landscapes is influenced by rainfall, presence of permanent water points, human presence and habitat characteristics. It is likely that destruction of elephant range through farming and human settlement led to the high concentration of elephants in areas such as Kimana Sanctuary in the dry season. Such an elephant nucleus faces isolation and its future is at stake. Since these elephants are a focus for community-based tourism, a key economic base for the local people is likely to be lost. We urge that measures be put in place urgently to safeguard elephant pathways into the wider Amboseli ecosystem. This will require an elephant management strategy that seeks to solicit landowners' support through initiating elephant conservation education programs and implementing economic incentives to landowners that are viable, within criticial elephant habitats such as corridors and wetlands. In the long term an integrated land-use policy is essential to make it possible for both humans and wildlife to use the Amboseli ecosystem.

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