A Grey crowned crane (*Balearica regulorum*) on the Lewa-Borana Landscape

Research and Monitoring Annual Report 2017

Authors

David Kimiti, Mary Mwololo, Timothy Kaaria, Ian Lemaiyan,

Saibala Gilisho, Francis Kobia, and Edwin Kisio

EXECUTIVE SUMMARY

This report provides a summary of the activities of the Research Department on the Lewa-Borana Landscape (LBL) throughout 2017. The year once more received below average rainfall, although there was a modest increase on 2016 levels. The spectre of human wildlife conflict again reared its ugly head in 2017, with numerous fence breakages by elephants into agricultural boundary communities as well as livestock depredation by carnivores.

During the year, the landscape received 455 ± 110 mm of rainfall. The south-north rainfall gradient continued to be clearly visible and affecting differences in rainfall distribution. The highest rainfall was recorded in the southern end of the landscape, with 629 mm at the Subuiga station, and lowest in the north, with only 218 mm recorded at the Mlima Mbogo station. This uneven rainfall distribution continues to affect grazing plans and forage availability for wildlife.

The population of rhino on the landscape remained relatively stable, with a net increase of Black rhino from 83 to 87, and white rhinos from 74 to 80. The declining body condition of a handful of black rhino in Q3, primarily lactating females, elicited concern and necessitated the implementation of a supplementary feeding programme. Bales of lucerne mixed with cuttings of euphorbia were provided on known feeding areas frequented by these target animals, and uptake was successful. We present these results in addition to a summary of long-term black rhino population performance analysis carried out in collaboration with Keryn Adcock of the African Rhino Specialist Group.

The predator population on the landscape remained healthy, with efforts to control high lion densities continuing to be implemented. Three females were successfully fitted with contraceptive implants as part of a trial population control initiative. All three animals will continue to be monitored and recommendations developed from these results. Four sub-adult male lions emigrated north into Samburu National Reserve, in response to the arrival of an adult male lion in late 2016. This lion, *Chalisa*, was ultimately responsible for majority of our lion-related human-wildlife conflict, and was translocated successfully to Tsavo East National Park. Subsequent tracking of his GPS collar showed him travelling hundreds of

kilometres away from his translocation area, ending up currently in the Shompole/Ol Kiramatian ecosystem near Magadi. This experience is providing valuable insight into the efficacy of problem animal translocation. Finally, a striped hyena den was identified on the LBL, and efforts to comprehensively describe and monitor this sub population are underway.

Ungulate surveys continued to show inverted population pyramids, with the populations of four species comprised of less than 30% of infants and juveniles. Hartebeests remained one of the species of highest concern, with only 10% of observed animals being infants or juveniles. Grevy's zebra foals between 0-3 months remained extremely susceptible to predation, further complicating the ability of the resident population to self-recruit. Buffaloes were the only exception to this trend with nearly 41% of the observed population comprising of infants and juveniles. The decline in giraffe numbers on the LBL has necessitated the intensification of monitoring protocols for this species. Collaborations are currently underway to create and maintain a giraffe monitoring database for the landscape on the Image Based Ecological Information System (IBEIS), complementary to the current Grevy's zebra monitoring database. Body condition scores of ungulates assessed indicated that there was no discernible dip in the physical state of majority of the animals, and therefore there was no need for supplementary feeding.

Elephants continued to pose a challenge within the landscape and the neighbouring communities with regards to exclusion zones and boundary fences. There were nearly 300 cases of fence breakages, primarily on the exclusion zones. In addition, there were increased instances of elephants resorting to crawling under the exclusion zone fences, with 81 incidences involving 99 individuals. Most of these incidences occurred in Q3 during the height of the prolonged dry period. Efforts continue to be undertaken to respond to these cases and mitigate damage.

Vegetation assessments revealed reduced grass biomass and cover compared to 2016. This trend was strongly influenced by rainfall. Plant cover reduction/ basal gap increases were observed in patches on the black cotton soils, but the primary causes for this phenomenon were unclear. Elephants continued to be the main source of damage to woody vegetation, and the concurrent lack of woody plant seedlings in our sampling plots raises the spectre of continued woodland cover reduction on the landscape. Grazing planning was again complicated by dwindling water and forage resources, although this was nevertheless managed by the NRTT and LBL teams given the difficult circumstances.

Implications for management

- Early warning systems for determining timing of supplementary feeding to endangered species should be designed, tested, and implemented.
- Efforts to even out distribution of black rhinos across both the eastern and western sides of the landscape need to be explored.
- Contraception trials on lionesses on the LBL should be expanded to include more breeding females to further reduce population growth given the current population sex and age structure.
- The proposal for a Grevy's zebra-hartebeest breeding area should be fast-tracked as one of the ways to halt the decline in recruitment rates of these key species on the landscape.
- Efforts to identify and translocate, trim or attach tusk braces onto fence breaking elephants should continue to be tested in advance of the mid-2018 dry period.
- There is need to evaluate the timing and duration of livestock *boma* placement on the landscape vis-à-vis boma legacy effects and increasing basal cover on black cotton soils.
- A comprehensive ecosystem health assessment should be carried out on the LBL.
- Climatic data collection on the LBL needs to be enhanced, given the availability and affordability of comprehensive consumer weather monitoring stations.
- Research and monitoring capacity and intensity on the Borana portion of the landscape needs to be strongly supported to allow consistency in data collection extent and effort.

TABLE OF CONTENTS

1.0 INTRODUCTION

In 2017, the Lewa-Borana landscape Research and Monitoring department continued to collect ecological monitoring data and conduct applied research to support management decisions. There was a focus on further capacity building for the team, with a full-time Elephant Monitoring Officer recruited and a Head of Research and Monitoring added to the management team. Additionally, the Research and Monitoring department initiated baseline data collection for two new thematic areas, hydrology and avifauna, which will be expanded upon in 2018. As part of this, a grey crowned crane survey was carried out in Q4 2017, which identified 32 individual birds. Increased monitoring and consultation through 2018 is going to help us refine the methodology used and validate these numbers.

Depressed rainfall continued to affect the landscape, impacting negatively on vegetation, specifically the quantity and quality of the forage base. Consequently, communities surrounding the LBL were allocated to graze on the Landscape as per existing grazing protocols. Dry seasons can have a negative impact on the health and survival of wildlife due to the lack of access to fresh feed and water. Wildlife species, especially endangered ones, can however benefit immensely from supplementary feeding programmes. Such a program was implemented on LBL in Q3 targeting specific old and lactating black rhino individuals. This is discussed further under the rhino section.

Elephant monitoring was intensified in 2017 following increased human-elephant conflicts (HEC) mainly involving our neighbouring communities. This led to introduction of night patrols aimed at deterring potential fence breakers. We also deployed camera traps to capture individuals breaking fences at night. The number of elephant crawling under the exclusion zone fences also increased. They continue to pose a challenge to our deterrence protocols.

Below we provide annual summaries from our major thematic areas, and where possible provide comparative analyses to previous years.

2.0 RHINO MONITORING

The Black rhinoceros (*Diceros bicornis*) is classified as critically endangered on the IUCN red list (IUCN 2010). Yet, only 50 years ago, in the 1960s, it was estimated that there were over 100,000 black rhinos roaming in Africa (Emslie & Brooks 1999). The Southern White Rhino (*Ceratotherium simum)* is also listed as threatened on the same list (IUCN, 2010). Rhino conservation remains one of the most critical functions of conservation organisations in Kenya. Through significant investments, the rhino population on the LBL continued to grow until the last few years when growth seems to have significantly slowed down. On the LBL, monitoring the performance of these populations continued in the year and findings are discussed below.

2.1 Black rhino population performance

The black rhino population on LBL increased from 83 to 87 individuals as at the end of Q4 2017. Eight births (Table 2.1) and four mortalities (Table 2.2) were recorded. The actual growth rate achieved was 3.3% which was better compared to -1.7% experienced in 2016. Moving forward, growth rates will not be documented annually, but using a three-year moving window (Fig 2.1).

Table 2.1: Black rhino births

Calf name	Dam	Sire	Date of birth
Mejh Calf 3	Mejh	Denny	12th Apr 2017
Lucy Calf 1	Lucy	Hoppy	13th Apr 2017
Edwina Calf 1	Edwina	Denny	14th May 2017
No 17 Calf 1	No 17	Denny	23rd May 2017
Natumi Calf 4	Natumi	Lucky	4th Jun 2017
Waiwai Calf 7	Waiwai	Lucky	5th Jun 2017
Juno Calf 2	Juno	Junkie	28th Sept 2017
Nashami Calf 5	Nashami	Ibong	29th Oct 2017

Table 2.2: Black rhino deaths

Rhino name	Dam	Date of death	Age at death (years)	Cause of death
No 6 Calf 4	No 6	3rd Mar 2017	0.6	Accident
Lucy Calf 1	Lucy	9th Jul 2017	0.2	Accident
Ibong	Solio Cow	16th Jul 2017	32	Accident
Juniper	Juno 1	12th Oct 2017	29	Accident

2.2 Black rhino growth rates and mortality rates

In 2017, the LRD collaborated with Keryn Adcock from the African Rhino Specialist Group (AfRSG) to collate and interpret long-term data collected on the Lewa Landscape. The goal of this exercise was to facilitate better visualization and analysis of long-term black rhino performance on Lewa (Fig 2.1). This included analysing actual and potential life statistics including and excluding the population modifications done in 2013 (Borana translocation) and in 2015 (Sera Wildlife Conservancy translocation; Fig 2.1 and Table 2.3). In the three-year period between 2015 and 2017, the average annual actual growth rate was at 0.5% while the average annual mortality rate stood at 6.2% (Fig 2.1).

In a bid to understand the dynamics that may be causing the declining growth rates, the Lewa data was analysed using three-year moving window intervals in order to eliminate the sharp spikes that are sometimes experienced due to extreme rainfall variability. Again, this was to look at what point the growth rate started decreasing. Three phases and preliminary causes were seen to have made a negative change in the growth curve.

Phase one; between 2000 and 2007 the conservancy recorded positive growth as a low population meant there was surplus nutritious browse for the black rhinos (Fig 2.1). Maintaining a lower population size and increasing browse availability will generally have a positive effect on rhino population growth (Adcock & Elmslie, 2003).

Phase two; between 2008 to 2013, Lewa experienced a negative growth rate due to human induced and natural mortalities. During this period, drought played a major role in reducing browse availability for rhino and increasing competition as other mega herbivores like elephants moved into Lewa (LRD, 2009). Deficiencies in browse availability can reduce rhino productivity as well as induce calf mortalities due to insufficient nutrition to calves from the mothers (Muya & Oguge 2000). At the peak of this period, poaching was a major problem, further reducing the actual growth rates through to the end of 2012 (Fig 2.1).

Phase three; between 2013 and 2017. After human induced mortalities were eradicated, management interventions to move out rhino came into place (Lewa 2013 and 2015 Rhino translocation reports). In 2013, 11 individuals were moved to Borana Conservancy, which is now co-managed as a single contiguous landscape with Lewa. In 2015 nine individuals were translocated to Sera Community Conservancy. These translocations, in conjunction with natural mortalities further affected the population growth rates through to the end of the period in focus (Fig 2.1).

We further conducted a comparative analysis to find out if the population performance would have been significantly different if translocations out had not happened, and all other factors remained constant (Fig 2.2). The findings show that between 2013 – 2017, the average biological growth rate would have only been enhanced minimally in each 3-year moving average (Table 2.3). However, the population would subsequently have significantly exceeded the carrying capacity resulting to increased negative effects of overpopulation; including increases in browse competition, calf mortality, and fights. In effect, any population growth due to retention of breeding individuals would have been offset and perhaps overwhelmed by these negative cofounding factors.

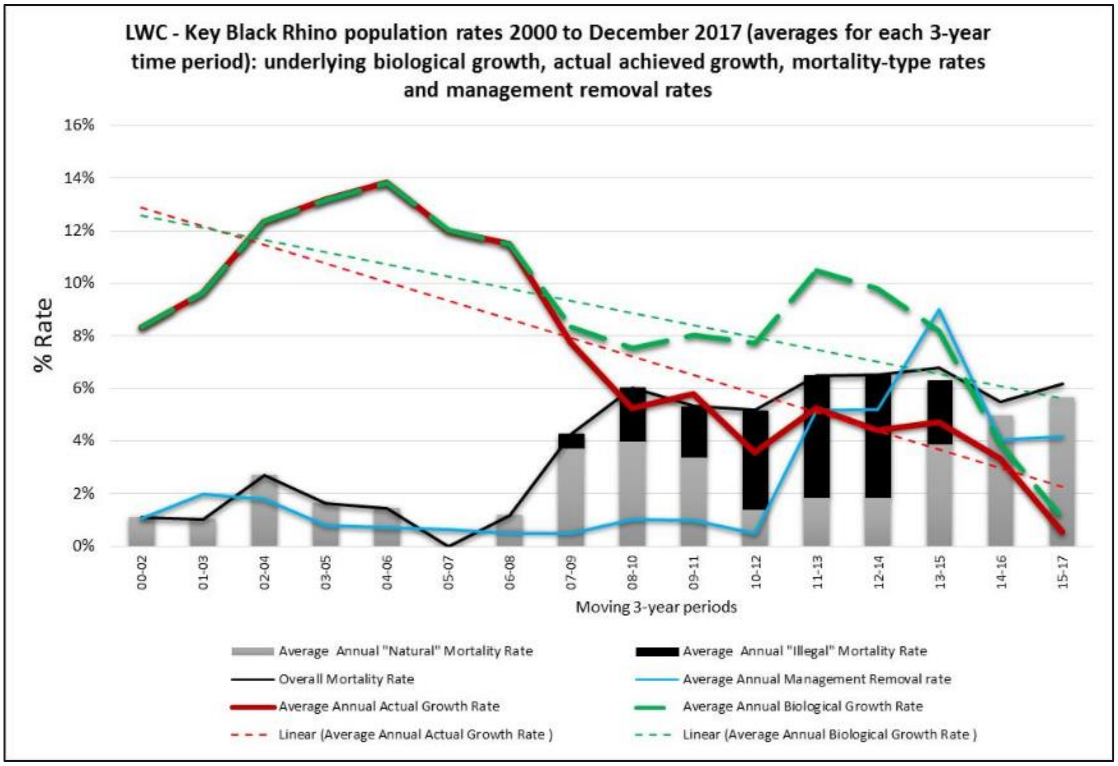


Figure 2.1: Key black rhino population rates between January 2000 to December 2017

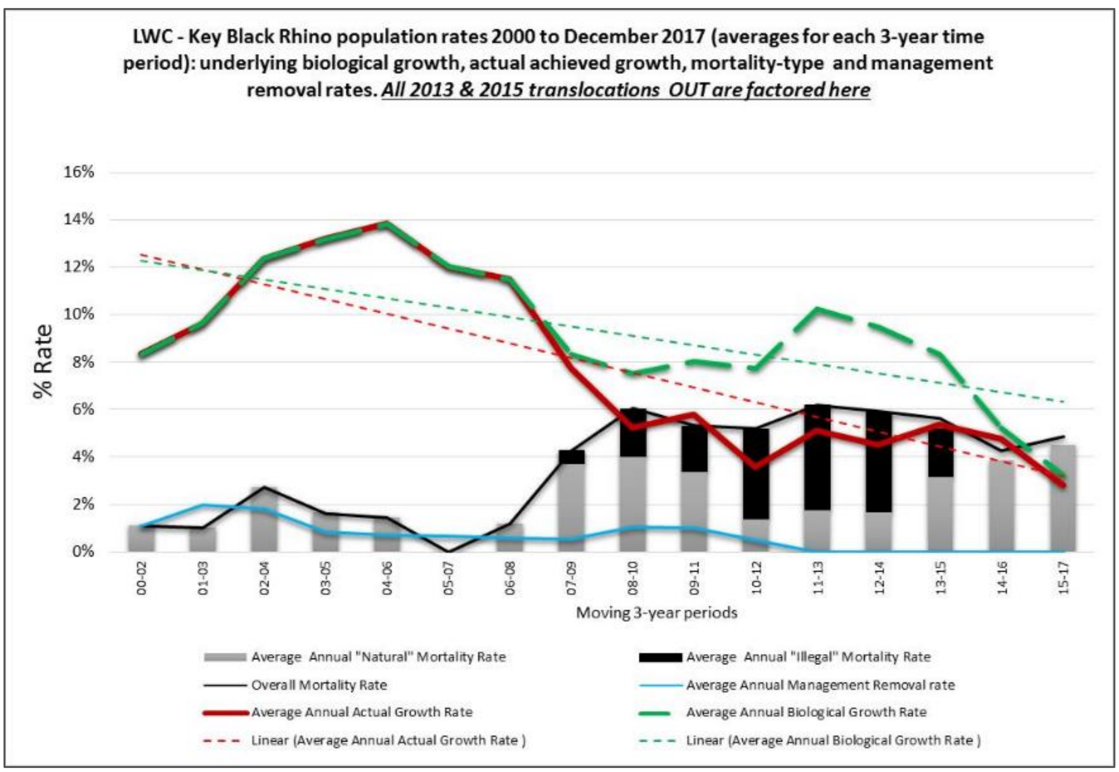


Figure2.2: Graph showing key black rhino population rates as at January 2000 to December 2017

Table 2.3 - Comparison of actual and biological growth rates with and without rhinos that were translocated OUT of Lewa in 2013 and 2015

	Moving 3-year periods		
	13-15	**14-16**	**15-17**
Average annual actual growth rate *(rhinos translocated OUT in 2013 & 2015 are excluded here)*	4.7%	3.3%	0.5%
Average annual actual growth rate *(rhinos translocated OUT in 2013 & 2015 are included here)*	5.4%	4.8%	2.8%
Average annual biological growth rate *(rhinos translocated OUT in 2013 & 2015 are excluded here)*	8.2%	3.9%	1.1%
Average annual biological growth rate *(rhinos translocated OUT in 2013 & 2015 are included here)*	8.3%	5.2%	3.2%

These life tables indicate that population performance of black rhino on the LBL has experienced a slow down over the last few years. Part of this depression can be attributed to the less than ideal rainfall conditions experienced across the landscape in the same period. Much of the low growth, however, is likely tied to the fact that the Lewa portion of the landscape has been over its estimated Ecological Carrying Capacity (ECC) for a while. Figures from 2006 put the estimated ecological carrying capacity for the Landscape at 70 animals for Lewa, and the 83 for the Borana side. Unconfirmed figures by Antony Wandera (unpublished) put the updated ECC at 58 Black rhino for the Lewa side and 65 for the Borana side of the landscape. Currently, the Lewa side is occupied by 62 animals; slightly above this updated estimate ECC of 58, and close to exhausting the original ECC of 70 animals. Population performance is therefore unlikely to improve, unless part of the Lewa black rhino population emigrates to the Borana portion, either naturally or through translocations.

Inter calving Intervals (ICI) and age at first calving

The average ICI of breeding females stood at 2.96 years while the average age at first calving was at 8.3 years across a 3-year moving average window (2015-2017). However, in 2017 alone, the average ICI and age at first calving stood at 2.8 years and 7.3 years respectively.

Based on breeding prediction using the individual females' ICI, three black rhinos are expected to calf in 2018 (Table 2.4). However, four females namely; *Senewa* (8 years), *Bahati 2* (8 years), *Wanjiku* (10 years) and *Rensuen* (10 years) are yet to calf despite being well above 7 years of age. Investigations into such lengthy periods of these females before their first calf need to be conducted.

Table 2.4: Black rhinos expected to calf in 2018

Rhino name	Age (Years)	Predicted calving month	Mean ICI (Years)
Ndito	28	Aug 2017	2.6 ± 0.4
Sonia	26	Aug 2017	2.6 ± 1.1
Winnie	13	Sep 2017	2.8 ± 0.2

2.2 White rhino population performance

The White rhinoceros (*Ceratotherium simum*) population recorded an 8.1% population growth in the year (Fig 2.3). This is attributed to 86% (N=6) survival rate of infants born in the year and a year to year reduction in mortality specifically caused by intra-specific male aggression. The LBL's relatively stable grasslands continue to support the growing white rhino population. However, assessment of the ECC needs to be carried out to ensure that LBL's white rhino population remains healthy and the ecosystem remains uncompromised. In 2018, the long-term data sets of this population will analysed in a similar fashion as that of the black rhino. Below, we provide results of the 2017 monitoring efforts and discuss the implications thereof.

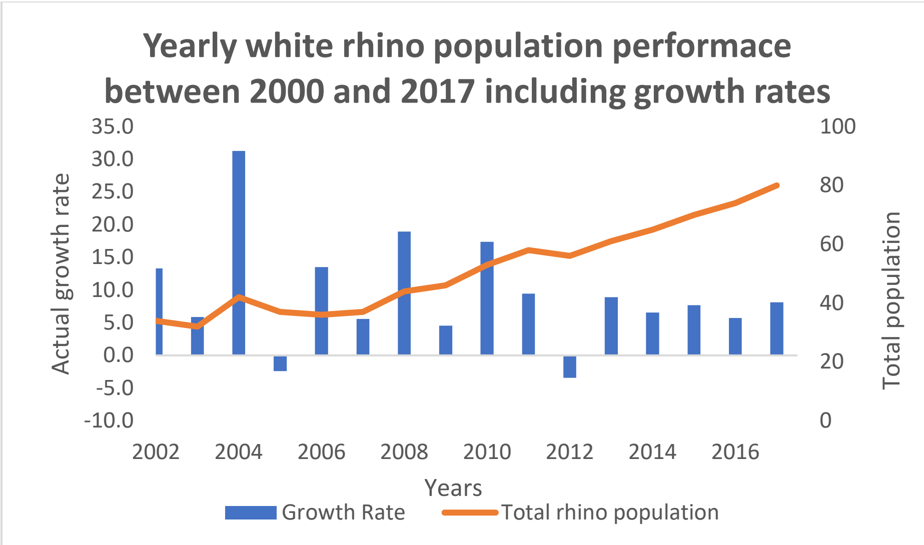


Figure 2.3: Graph showing hite rhino population performance, 2000 to 2017

In the year the white rhino population rose from 74 to 80 individuals (Fig 2.3). Six births (Table 2.5) and one mortality occurred.

Table 2.5: White rhino births

Calf name	Dam	Sire	Date of birth
Queen Calf 2	Queen	Owuan	24th Jan 2017
Schini Calf 5	Schini	Imado	15th Mar 2017
Titilei Calf 4	Titilei	Samawati	5th May 2017
Njoki Calf 1	Njoki	Samawati	30th May 2017
Naserian Calf 2	Naserian	Samawati	2nd June 2017
Ramadhan Calf 4	Ramadhan	Moru	18th Sep 2017
Ruudi Calf 1	Ruudi	Samawati	29th Dec 2017

2.2.1: White rhino deaths

One white rhino calf; Ramadhan Calf 4 (1 day old) was accidently trampled by the mother. The calf was found half predated on by a mesocanivore a day after birth.

2.3 Spatial ecology

2.3.1 Sighting frequency

The average sighting frequency (SF) was 1.95 ± 0.25 days and 1.3 ± 0.06 days for black and white rhinos respectively.

2.3.2 Rhino home ranges

In the year, black rhino ranging areas remained stable as only one adult male showed a massive increase in its ranging area. This was due to the death of a dominant bull; *Ibong* around the south west area of the LBL. *Ngiririma* (8 years), increased his ranging area to the Ngare Ndare Forest area (Fig 2.4).

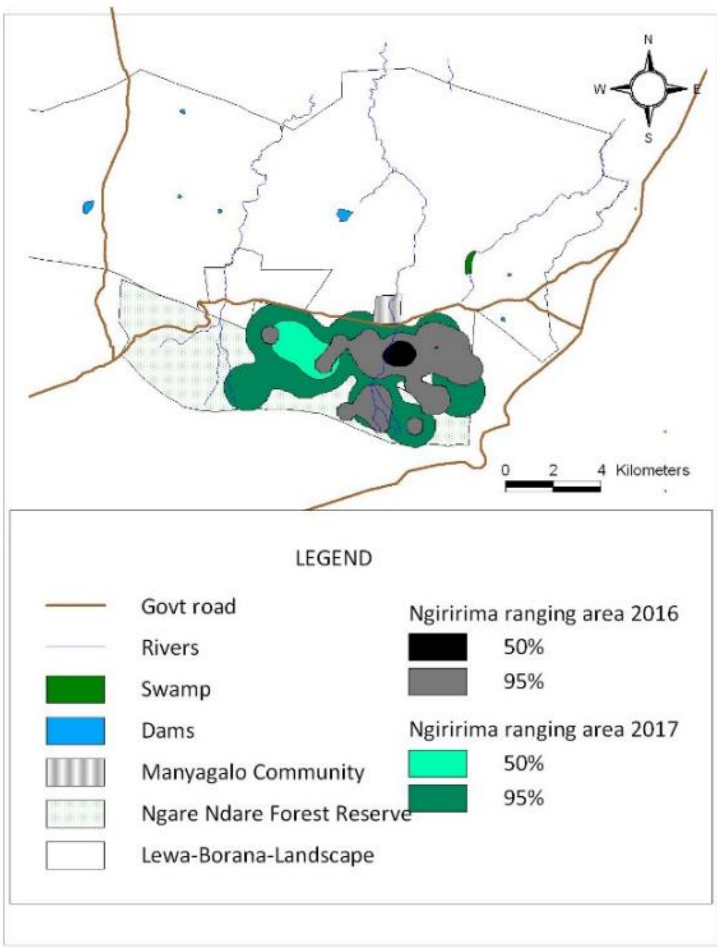
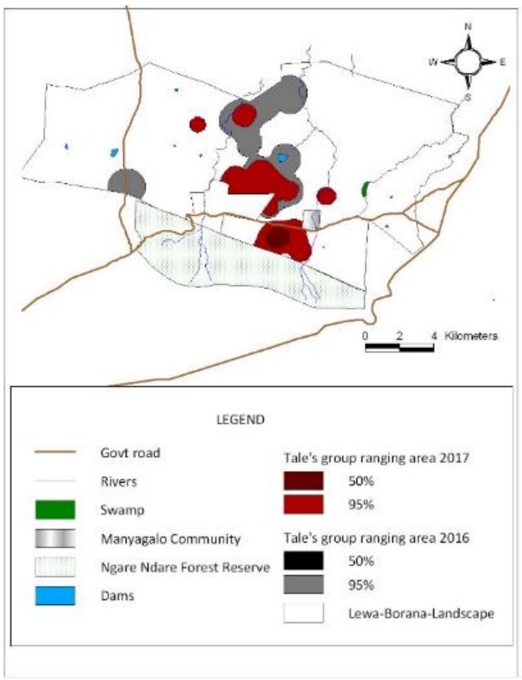


Figure 2.4: Ngiririma's ranging area

Seven white rhinos in two groups namely *Tale*'s group (*Tale* (F), 18 years; *Lomunyak* (M), 1.9 years; *Chandaria* (M), 6.6 years; and *Semenya* (F), 3.6 years) extended their ranging areas towards the western side of the LBL before venturing onto the open plain below the Ngare

Ndare Forest (Fig. 2.5). This extension may have been caused by the dry spell during the year.

Three males and one female; *Robin* (M) (7.5 years), *June* (M) (8.7 years), *Gilbert* (M) (6.5 years) and *Lucille* (F) (7.4 years) also increased their ranging area to the south east of the LBL's core area around LBL headquarters (Fig. 2.6). This group also extended their ranging area in search of water and pasture during the dry period and have shown signs of settling in the area.



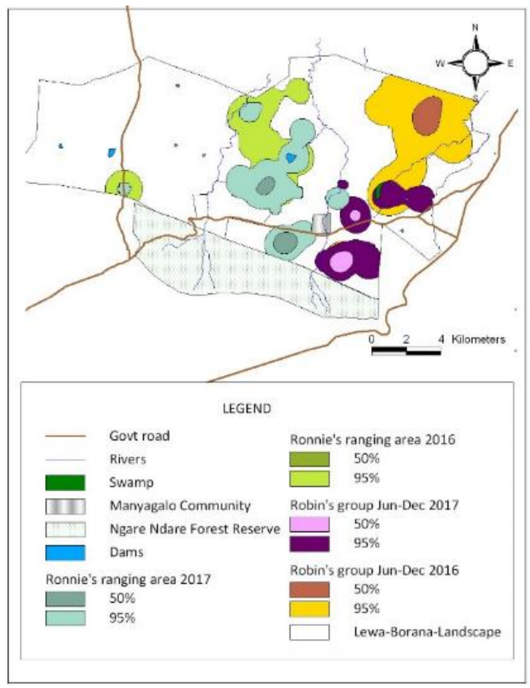


Figure 2.5: Tale's group ranging area **Figure 2.6**: Robin's group and Ronnie ranging area

2.4 Rhino vet interventions

- *Kitui* (2.8 years), the hand-raised calf was reported limping by his keepers on 9th January. He was diagnosed and treated for a sprained toe. The calf has fully recovered.
- *Gilbert* (6.5 years), was ear notched on 25th January 2017.
- *Jubilee* (9 months) was found inside a hole on 26th February. She was successfully reunited with the mother.

- *Mandela* (9 years) was observed limping with the front right leg on 21st March. He had fought with another territorial male *Owuan* (18 years). Physical examination revealed multiple abrasions on the rump, face, and a missing nail. He was treated and started recovering well.
- *Mandela* (9 years) had a second treatment after he was involved in yet another altercation with *Owuan* on 7th June 2017. He was treated for horn punctures on the left hind leg and rump.
- On June 8th, *Gordon* (9.9 years) was herded using a helicopter back to the LBL after he was chased out of the conservancy to the Makurian community on the North of LBL by *Dominique* (9.7 years).
- *Hatari* (4.5 years) was ear notched on 28th June 2017.
- *Tulifu* (5.1 years) was ear notched on 29th June 2017.
- *Moonshot* (2.4 years) had a wire removed from his hind leg and was also ear notched on 5th September 2017.
- *Emso* (3.6 years) was ear notched on 14th October 2017.

2.5 Body Condition Scoring (BCS) and feeding

The LBL Rhino BCS was created following methods described by Adcock *et al.* (2003). The BCS ranges from 1-5 with 1 indicating an emaciated and 5 indicating and obese rhino (Table 2.6). The middle score of 3 describes an animal in good health whose hip and shoulder bones are faintly visible, ribs are lightly covered and spinal vertebrae are not obvious.

Table 2.6: Black rhino condition score chart

Scale	Description
1	Very poor (emaciated)
2	Poor (thin)
3	Fair (average)
4	Good (ideal)
5	Excellent (heavy)

Five of the females determined in Q3 to have a BCS of 3 improved to a BCS of 3.5 after the continued supplementary feeding and the subsequent rains of December when supplementation was discontinued.

2.6 Conclusions

Body condition is directly related to the ECC and habitat loss. Lewa should consider reducing the number of black rhino on the Lewa side to reduce browse competition and inevitably improve rhino ranging areas. Restoration of patches of woodlands would also be instrumental in increasing forage available to Black rhino. The LRD, in collaboration with Southampton University and Marwell Wildlife, will be conducting a black rhino feeding behaviour study in Q1 and Q2 2018 to further explore forage availability dynamics. Management will have to weigh the trade-offs inherent in either maintaining a high population with possibly low growth rates or low rhino population with high growth rates. An assessment of rhino genetics to accurately assign sires to calves would be ideal. This would allow management to make informed decisions during translocations of rhinos in future.

3.0 PREDATOR MONITORING

3.1 Introduction

The LBL, supports a full complement of large predators like, lion (*Panthera leo*), spotted hyena (*Crocuta crocuta*), cheetah (*Acinonyx jubatus*) leopard (*Panthera pardus*) and wild dog (*Lycaon pictus*) in addition to medium and small-body sized predators (e.g. serval cat, caracal, black – backed and side-striped jackal). Monitoring these predators is important in understanding the predator – prey dynamics within the landscape. We have advanced our monitoring technology to the use of GSM –GPS collars that ensure timely and accurate data collection.

3.2 Lion population biology

3.2.1 Population performance

The total lion population was 44 animals. The age and sex structure of the population is shown in Table 3.1. The adult sex ratio of male to female was 1:1.5. Sixteen cubs were born to six females, but five died, translating to 69% survival rate. In addition, three sub adults (one male and two females) died. The adult and cub survival rate is shown in Table 3.2. To reduce impacts on key prey species by predators, permission was sought and granted from KWS to implement a contraception programme through implants. The details of this are captured in our Q3 Research and monitoring reports as well as our Q3 implant report (LRD 2017a, b). However, in summary, there have been no observed changes in health, as well as no observed mating events.

Table 3.1: Lion population structure on LBL

Age class	Male	Female	Not sexed	Total by age class
Cubs	0	1	10	11
Sub adults	2	1	0	3
Adults	12	18	0	30
Total by sex	**14**	**20**	**10**	**44**

Table 3.2: Adult and cub survival rate

Year	Adult survival rate	Cub survival rate
2014	100%	13%
2015	100%	100%
2016	100%	33%
2017	100%	69%

We also documented the dispersal of four young males to the Samburu ecosystem. One adult male *Chalisa*, was translocated to Tsavo East National Park (Table 3.3). *Chalisa* came to LBL from Samburu in December 2016 and he turned out to be responsible for over 70% of depredation cases in the community area north of the landscape (LBL RD Q3 report).

Table 3.3: Population performance of lions on LBL

Year	Births	Deaths	Immigration	Emigration	Translocation out	Total
2016	12	0	1	3	0	44
2017	16	8	0	4	1	44

3.3 Hyena population biology

3.3.1 Population performance

In the year, 123 spotted hyenas aggregated into five clans: *Nala*, *Utalii*, *Shamba, Charlie* and *Borana* were identified via their spot patterns (Table 3.4). Twelve striped hyenas were also identified from one of the dens. However, they had abandoned the den by end of the year. This is typical hyena behaviour as a clan usually uses one communal den at a given time and move their cubs from time to time to other locations, creating new communal dens (Boydston *et al*., 2006; Kruuk, 1972).

In 2016, six individuals were collared from 5 different clans to ease in data collection. By the end of 2017 three of these collars had malfunctioned. Replacement of these collars will begin in 2018.

Table 3.4: Population structure of the spotted hyena on LBL

	Adults			Sub adults			Cubs			
Clan name	**M**	**F**	**Unsexed**	**M**	**F**	**Unsexed**	**M**	**F**	**Unsexed**	**Total**
Borana	1	0	2	0	0	0	0	0	0	3
Charlie	1	2	14	1	0	2	2	0	16	38
Nala	1	3	21	2	0	7	0	0	11	45
Shamba	0	2	2	0	0	6	0	0	4	14
Utalii	1	5	7	1	0	2	0	0	7	23
Total by sex	4	12	46	4	0	17	2	0	38	123

3.4 Spatial ecology

3.4.1 Lion

The population of lion on LBL comprised of six main prides and one coalition. Their territories overlapped but each pride maintained a specific core area (Fig. 3.1a, b). *Harry's* coalition home range overlapped with that of the six prides. This coalition occupied the largest home range on the landscape, covering an area of 234 km^2. Males ordinarily utilize a larger area than females, being much bigger in body size, therefore resulting in higher energy needs (Schaller 1972). Females with young cubs tend to restrict their movement especially if the home range they occupy has enough prey and vegetation cover as in the case with *Suzie's* and *Dalma's* prides. *Bredymark* and *Carissa* spent most of the year as part of one pride, but have shown signs of exploring the landscape away from each other.

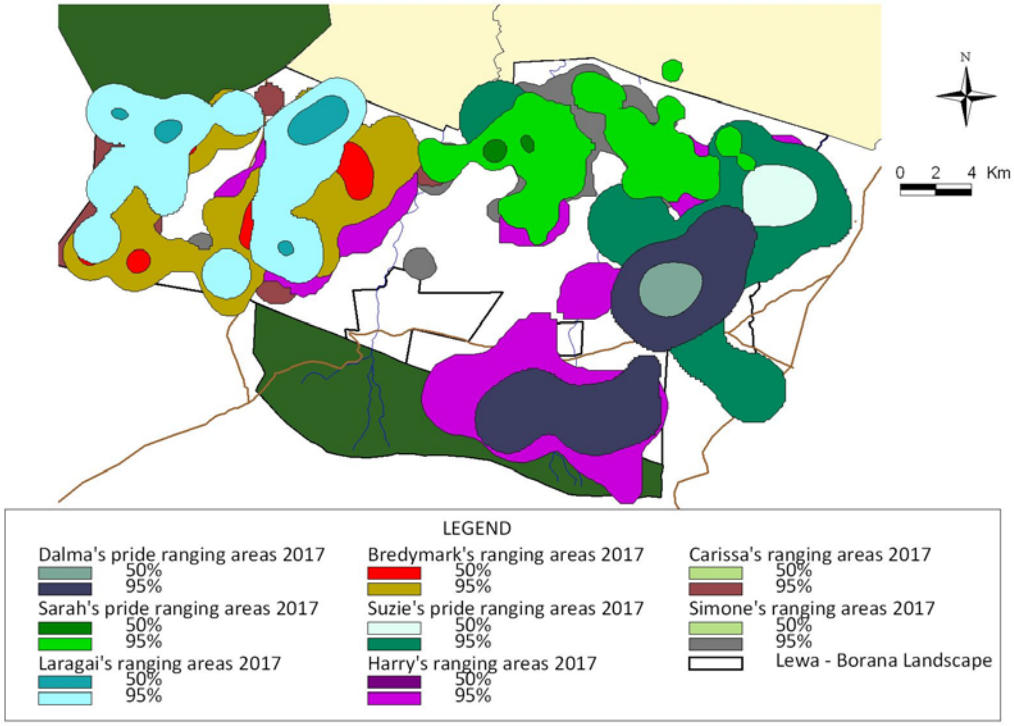


Figure 3.1a: Home ranges of the different lion prides and coalitions on the LBL

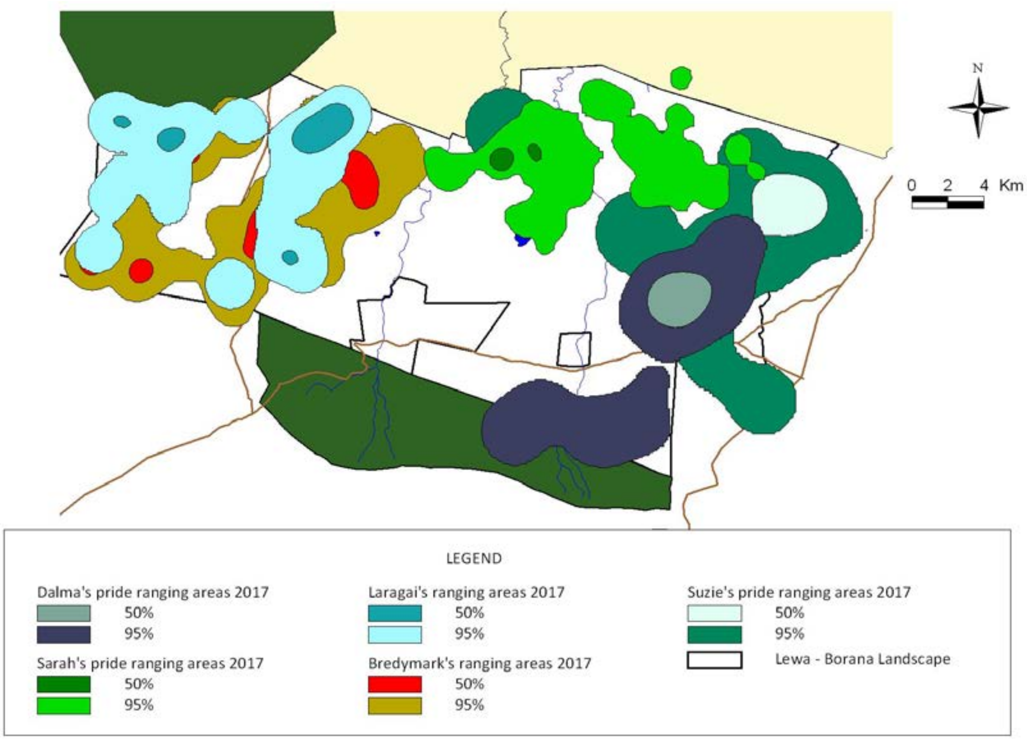


Figure 3.1b: Home ranges of the different lion prides and coalitions on the LBL (with *Harry, Dalma*, and *Carissa's* ranges removed for clarity).

Table 3.2: Home range sizes (km^2) of lions on LBL

Pride name	**Area (km^2)**
Harry's coalition	234 km^2
Sarah's pride	166 km^2
Suzie's pride	51 km^2
Dalma's pride	60 km^2
Laragai's pride	177 km^2
Bredymark's pride	60 km^2

3.4.2 Hyena

The population of spotted hyena on LBL was monitored on three clans. Their home ranges were developed using telemetry collar data from four collared individuals. There was no overlap of home ranges on the four clans, showing strong inter-clan avoidance (Fig. 3.2).

Hyena mortality on LBL is minimal. We lost two adults in the year: an adult female was killed by lions while an adult male named *Utalii* was killed while predating on goats in Leparua community.

3.4 Human carnivore conflicts

In the year, we noted an increase in carnivore- livestock conflict cases mainly during the dry season. A total of 48 incidences were reported in the greater landscape, resulting in the death of 71 head of livestock (Table 3.5).

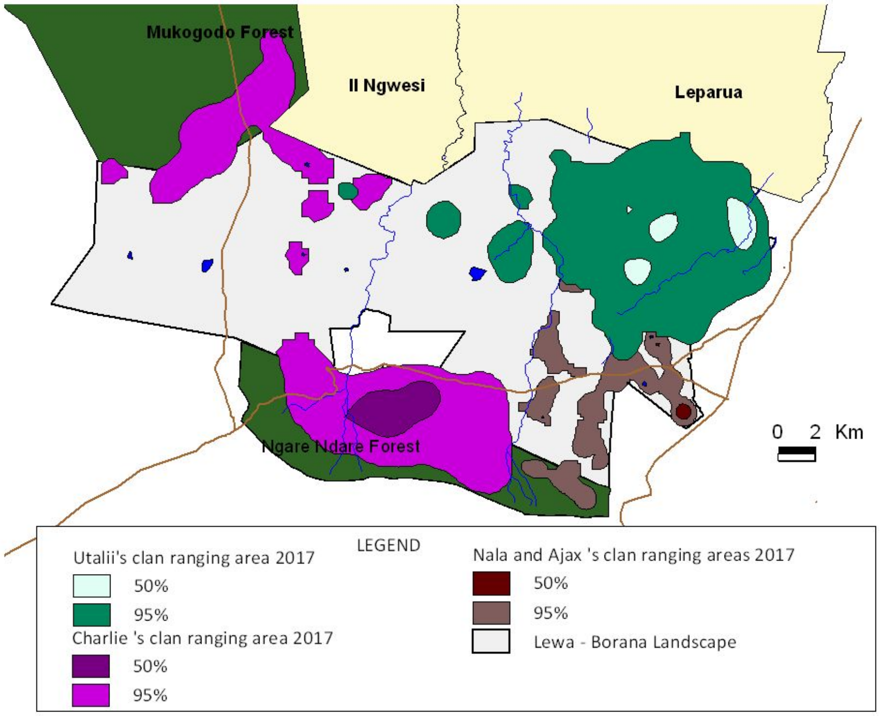


Figure 3.2: Home ranges of the three hyena clans on LBL

Lions were responsible for most of the cases followed by hyenas and leopard. *Chalisa* was responsible for 23% of the total incidences. In an effort to reduce these incidences, Lewa collaborated with Lion Landscapes, Ewaso Lions and KWS to translocate this lion Tsavo East NP in August. Since then, carnivore-livestock-conflicts have reduced by 20%.

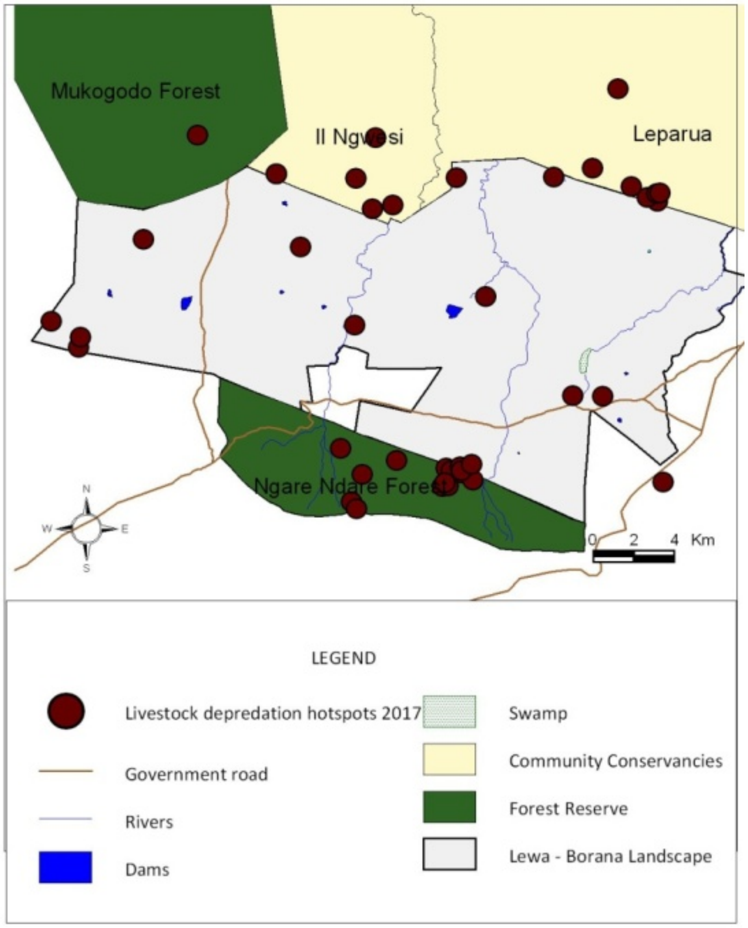


Figure 3.3: The spatial distribution of livestock depredation on LBL.

Table 3.5: Cases of livestock depredation on LBL

Carnivore causing conflict	**No. of livestock**	**Cattle**	**Shoats**	**Camels**
Lion	66	43	21	2
Hyena	4	0	4	0
Leopard	1	0	1	0
Total deaths	**71**	**43**	**26**	**2**

3.5 Wildlife mortality

Monitoring wildlife mortality is an important aspect in understanding some of the mechanisms that affect the dynamics of species. Among others, the information is vital in managing populations effectively (Caughley 1966; Raithel *et al* 2007). A total of 232 wildlife mortality cases were recorded on LBL, resulting from three primary causes: predation, old age and fence entanglement. For some cases where we could not assign the cause of death, we recorded it as unknown (Fig. 3.4).

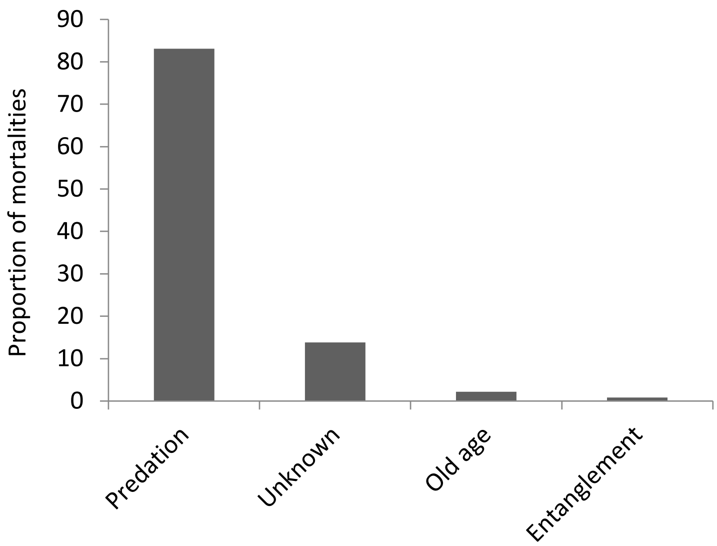


Figure 3.4: Causes of wildlife mortality on LBL

Cases of predation by lions and hyenas on the landscape were monitored using the GPS cluster point method (Davidson *et al*. 2013) from collared animals. None of these cases was directly attributed to hyenas. However, hyena tracks and scat were recorded on lion kill sites, suggesting that the hyenas were scavenging. Seven prey species contributed to lion diet (Fig. 3.5)

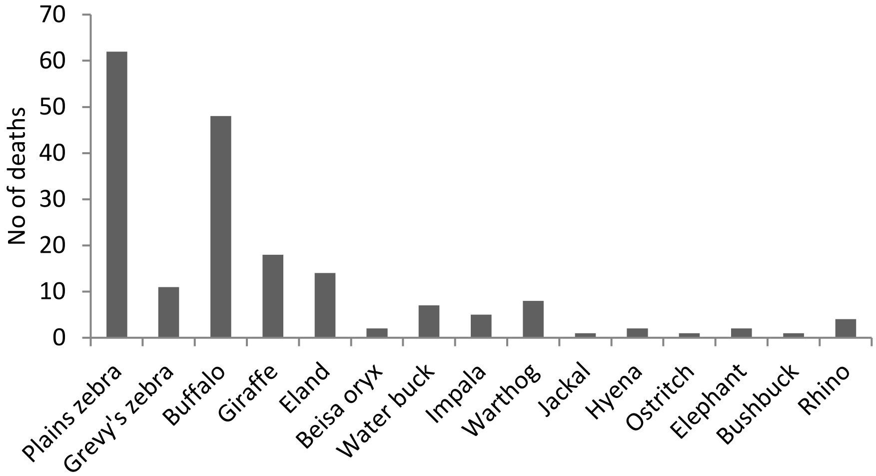


Figure 3.5: Number of observed mortality cases per species on LBL

3.6 Prey selectivity by lions

To assess prey preference and selectivity by lions, Jacobs Index (D) was used (Jacobs, 1974).

D=r-p/r+p-2rp.

Where r is the proportion of the total number of kills of a particular species and p is the proportional availability of the prey species killed. Jacob's index ranges between – 1 (highly avoided) and +1 (highly selected). Eland, Plains zebra and giraffe remained the three species that lions on LBL have proportionately taken according to their availability over the last four years. Grevy's zebra and buffalo show no selection this year compared to the previous years. This could possibly be a switch of diet as this year warthog show a degree of selection compared to the previous year.

Table 3.6: Comparison of prey selectivity index from 2014 to 2017

Species	2014	2015	2016	2017
Plains zebra	0.3	0.2	0.4	0.2
Grevy's zebra	0.3	0.3	0.3	0.0
Impala	-0.7	-0.6	-0.1	-0.8
Waterbuck	0.4	0.4	0.1	0.1
Eland	0.0	0.4	0.2	0.4
Beisa oryx	0.2	-0.6	-0.3	-0.6
Warthog	0.7	0.7	-0.3	0.5
Giraffe	0.4	0.2	0.4	0.4
Buffalo	-0.8	-0.5	-0.2	0.0

3.7. Scat analysis

A total of 137 scats samples from lions (n=51), cheetahs (n=26) and hyenas (n=60) were collected and analyzed for prey hair content. The results showed that Plains zebra is the key prey species for these three large predators. The proportion of hairs found in both lions and hyenas scat (Fig. 3.7) indicated that there is diet overlap between the two species. This could be an indication of hyenas scavenging on lion kills. However, hyenas are moderately successful hunters themselves, and could have been responsible for a proportion of kills (Holekamp *et al*. 1997). The presence of cattle, goat and sheep hairs in lions and hyenas scat could indicate increased livestock depredation on the landscape. However, there have been past incidents of livestock dying of starvation along the government road, offering hyena plenty of opportunity to scavenge on the carcasses.

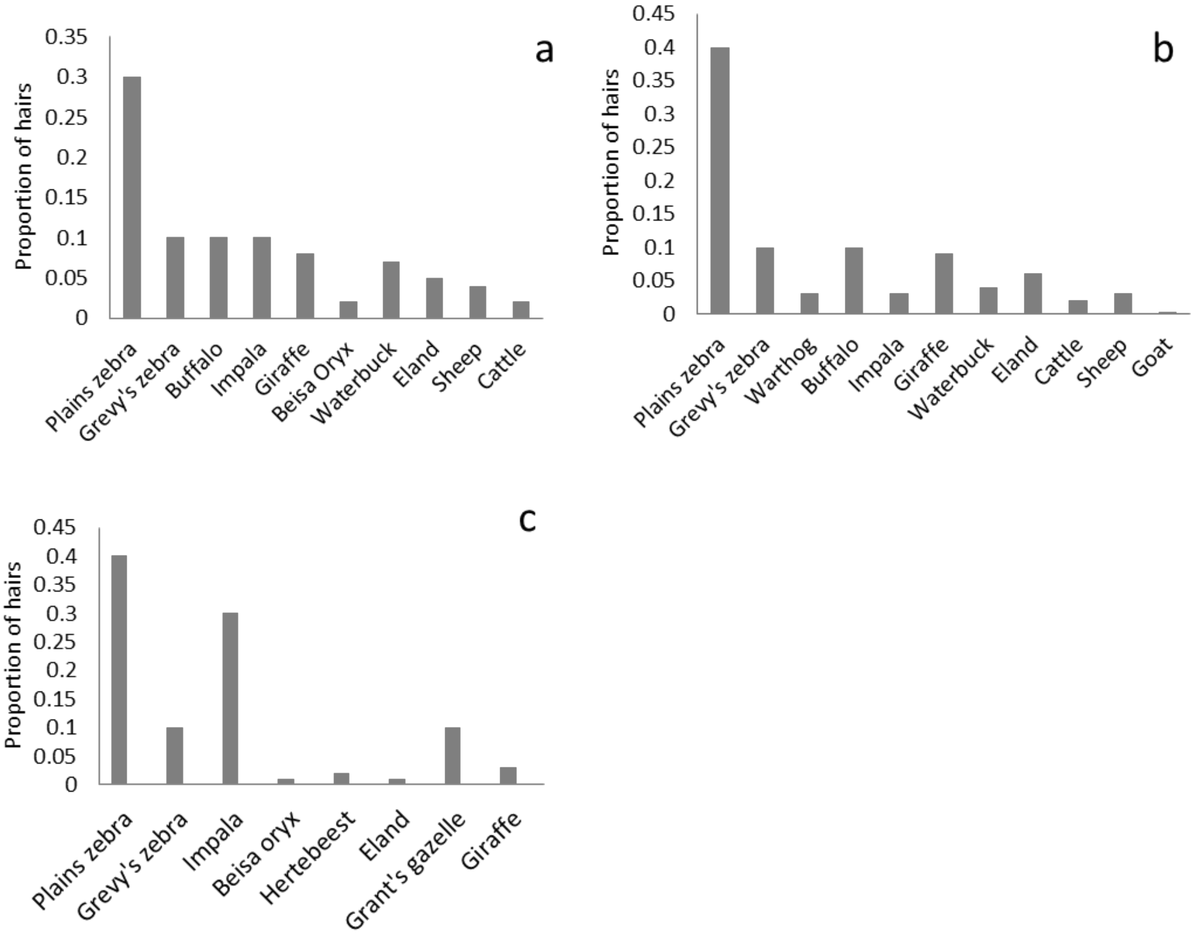


Figure 3.7: Proportion of prey species hairs found in (a) lions, (b) hyenas and (c) cheetahs scat

Conclusion and recommendations

Striped hyena population dynamics are not well understood on LBL. This is a species listed as Near-Threatened by IUCN (AbiSaid & Dloniak 2015), and as such, it would be necessary to monitor it in a similar fashion as the Spotted hyena. Although the cheetah population on the LBL is low, the high proportion of Grevy's zebra hair in their scat means it will be important to continue monitoring their range overlap and interaction with lactating Grevy's zebra.

Collars are a key tool for monitoring elusive animals such as lions and hyenas. There is a need to replace the currently inactive collars in order to ensure data continuity. Given high reproductive capacity of the LBL population as well as the high survival rate of both cubs and adults, the lion contraception programme needs to be expanded to have a higher impact. The hyena population on the LBL also needs to be monitored more closely as hyenas are very likely having as yet undocumented impacts on vulnerable prey species.

Human wildlife conflicts were observed to increase during the dry season as opposed to the wet season. Monitoring on the seasonal movements of all prides should therefore be intensified so as to mitigate these conflicts and better understand the dynamics driving them.

4.0 UNGULATE MONITORING

4.1 Introduction

The LBL, being a predominantly savannah ecosystem, supports a higher biomass of herbivores than any other vertebrates. Of these species, a subset has been selected for long term monitoring as indicator species. The performance of these species from year to year is instrumental in giving the management a general reflection of ecosystem health.

The indicator herbivore species selected include: Grevy's zebra (*Equus grevyi*), Plains zebra (*Equus quagga*), buffalo (*Syncerus caffer*), Beisa oryx (*Oryx beisa*), hartebeest (*Alcelaphus buselaphus lelwel*), giraffe (*Giraffa camelopardalis*) and eland (*Taurotragus oryx*).

We monitored age and sex structure, body condition scores (BCS) of all aforementioned species. For the endangered Grevy's zebra, we further monitored foal survival rates and population performance. We also monitored wildlife activities in three migratory gaps connecting Lewa to adjoining conservation areas using infra-red camera traps.

4.2 Results

Adult male to female sex ratio determines the growth potential of a given ungulate population. This is because they constitute the reproductive class of a given population (Rubenstein *et al*. 2016, unpublished report).

Based on a comparison of sex ratio, the comparison of the 2016 and 2017 data indicates that Grevy's zebra and Plains zebra growth potential rose from low to medium and medium to high respectively (Table 4.1). Although a majority of species monitored exhibited an increase in the proportion of infants and juveniles; an indicator of potential for population growth, only buffalo had more than 30% representation of infants and juveniles in the population (Table 4.1). As the proportion of infants and juveniles approaches 30%, the population is increasingly self-sustaining as enough individuals are recruited to replace adult deaths (Rubenstein *et al.* 2016, unpublished report) (Table 4.1).

Table 4.1: Adult sex ratio and growth potential of monitored ungulates

	Adult to juveniles/infants ratio		**Adult male to female sex ratio**		**Growth potential**		**Percentage of infants and juveniles of the total**	
Year	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**
Grevy's zebra	4:1	3.5:1	1:1.4	1:1.9	Low	Medium	20	22
Plains zebra	4:1	4.6:1	1:2	1:2.6	Medium	High	20	18
Giraffe	7:1	6.9:1	1:1.8	1:2.1	Medium	Medium	13	13
Eland	3.4:1	3.8:1	1:3.8	1:3.8	High	High	23	21
Hartebeest	6.2:1	4.3:1	1:2.7	1:2.5	High	High	14	19
Buffalo	1.2:1	1.4:1	1:2.6	1:2.5	High	High	44	42
Beisa oryx	5.2:1	3.1:1	1:2	1:2.2	Medium	Medium	16	24

Grevy’s zebra

79 Grevy’s zebra foals were born in 2017, of which 44 are currently surviving. Of the 79 foals born in 2017, 37% were females while the rest were males. This male – skewed progeny sex ratio indicates that majority of adult females giving birth are old (> 10 yrs. Saltz & Rubenstein 1995). Of the 44 foals that survived in 2017, only 30% (n=14) were females. This trend is

expected to further increase bias towards males in the population. This will lower the future growth potential of Grevy's zebra even further. In 2016, comparatively, 90 Grevy's zebra foals were recorded. Out of these, only 38% (n=34) foals were surviving by December 2017.

The vulnerability to predation of foals decreases as they continue to grow with 6 – 12 months age class recording the least deaths ($\chi^2 = 23.029$, df = 2, $p = 0.0001$, Fig. 4.1).

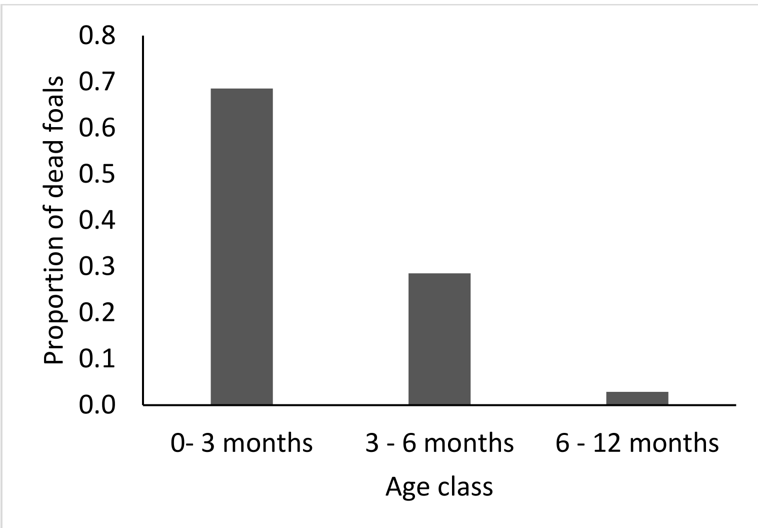


Figure 4.1: Proportional age class of dead foals in 2017

4.3 Assessment of Body Condition Scores (BCS) of selected ungulate species

BCS is an indicator of both nutritional status and stored fat reserves in ungulates (Ezenwa *et al.* 2009). We conducted a BCS survey for the ungulates we monitor during the third quarter of the year (July - September) when we experienced very little rains. The assessment reviewed that drought was not sufficient to warrant intervention of any given ungulate (Table 4.3). While there was a concern about a specific herd of buffalo, there was not enough widespread drop in body condition to warrant intervention. Similar assessment was done during the wet season averaging a body score of 4 for all the ungulates.

Table 4.2: Species Body Condition Scores (BCS)

Body Condition Score (BCS)	Species						
	Buffalo	**Beisa Oryx**	**Eland**	**Giraffe**	**Hartebeest**	**Plain's zebra**	**Grevy's zebra**
5 (Obese)	0	0	0	5	0	5	0
4	268	28	18	15	11	47	254
3	45	39	8	18	11	110	0
2	26	0	0	0	0	0	0
1 (Emaciated)	0	0	0	0	0	0	0
Total by species sampled	**339**	**67**	**26**	**38**	**22**	**162**	**254**
Totals as per the LBL game count 2017	**1391**	**220**	**192**	**251**	**62**	**1236**	**292**
Percentage of the total population sampled	**24%**	**31%**	**13.5%**	**15%**	**36 %**	**13%**	**87%**

Values against the body scores represents number of individuals of a given species that have that body score.

4.3 Wildlife movement through corridors

Wildlife movement along the migratory corridors connecting Lewa and contiguous conservancies have been recorded since the infra-red camera traps were installed in the three gaps in 2011. Consistent monitoring started in 2014 and therefore this report will present analysed data for the period starting from 2014 to 2017. The general trend of total crossing events for the gaps for four years is shown in Fig. 4.2.

Since elephants exhibits periodical movements of dry and wet periods (Garstang *et al.* 2014 and Sankaran *et al*. 2005), detailed analyses will be presented for this species. These periods include February, July, August and September for the dry period while April, May, November and December form the wet period.

4.3.1 Mount Kenya Elephant Corridor Endpass

The general trend in this corridor indicates an increase in crossing events of wildlife from the year 2014 to 2017 (Fig. 4.2). The total crossing events of elephants from 2014 to 2017 during the dry periods (1,435 crossings) surpassed the wet periods (890 crossings) significantly ($\chi^2 = 127.75$, df = 1, p = 0.0001). Both the dry ($\chi^2 = 0.95401$, df = 1, p = 0.3287) and wet ($\chi^2 = 2.1753$, df = 1, p = 0.1402) periods did not show movements that were skewed to any direction for elephant. This means that while animals utilize the gaps more during the dry season, there was no net exit or entry.

4.3.2 Mount Kenya Elephant Corridor Underpass

The total crossing events of wildlife at the Mount Kenya Elephant Corridor Underpass increased from 2014 through to 2017. The year 2014 recorded the lowest crossing events while the following years recorded higher events with almost similar crossing events in 2015 and 2016 (Fig. 4.2). The total crossing events of elephants for the four years (2014 – 2017) during the dry period (1,659 crossings) surpassed the wet period (1,140 crossings) significantly ($\chi^2 = 96.235$, df = 1, p = 0.0001), indicating a net exit of elephants during the dry period.

For 2017, however, during the dry period, the total crossing events for elephants was not skewed to any direction ($\chi^2 = 0.00060277$, df = 1, p = 0.9804). During the wet period, the total crossing events towards Ngare Ndare forest was high compared to total crossing events towards the Corridor ($\chi^2 = 26.558$, df = 1, p = 0.0001).

4.3.3 Northern gap

The Northern gap indicates more crossing events in the year 2014 followed by a two-year consecutive drop in crossing events, before increasing again in 2017. The total crossing events of elephants for the four years (2014 – 2017) dry period (4,053 crossings) was surpassed by the crossing events for the wet period (10,234 crossings) significantly ($\chi^2 = 2674.1$, df = 1, p = 0.0001). During the dry period, the total crossing events for elephants was skewed towards Leparua Conservancy ($\chi^2 = 7.3844$, df = 1, p = 0.006579). Similarly, during the wet period, the total crossing events were skewed towards Leparua Conservancy (χ^2 = 15.478, df = 1, p = 0.0001). This would indicate that elephants were either migrating more towards the north, or were using different routes to get back into the conservancy.

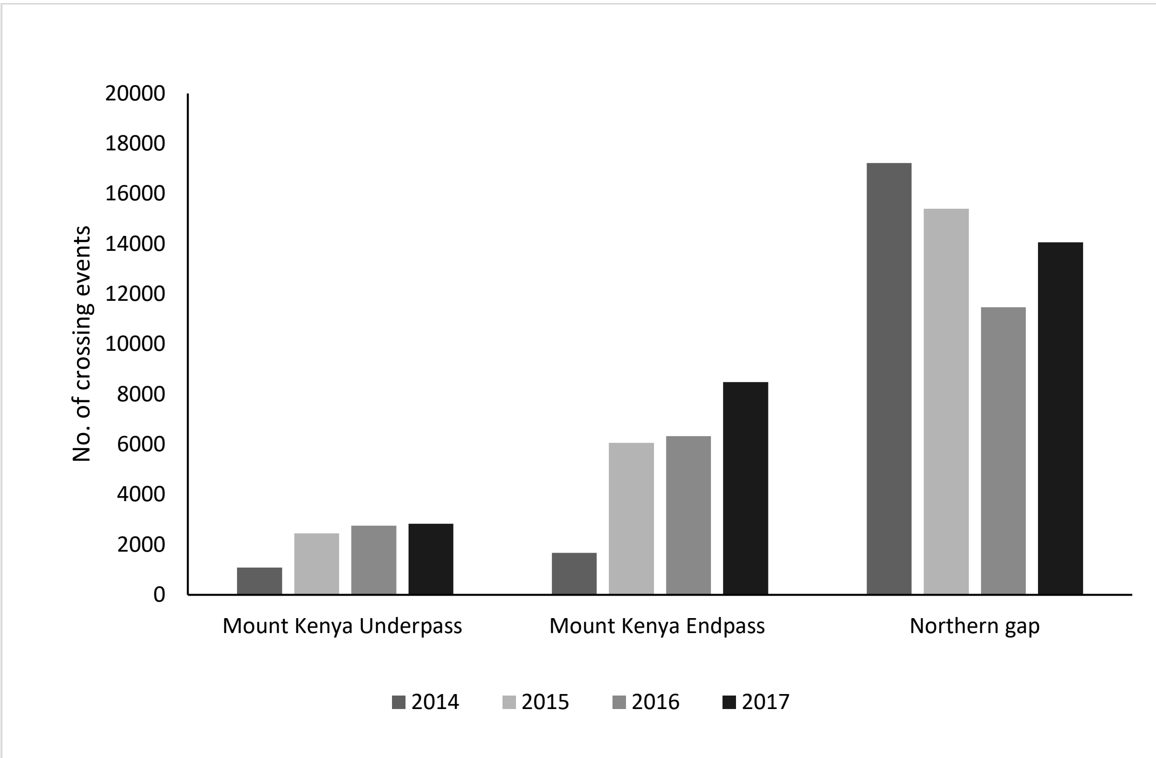


Figure 4.2: Comparison of the total number of crossing events of wildlife through the corridors from 2014 to 2017

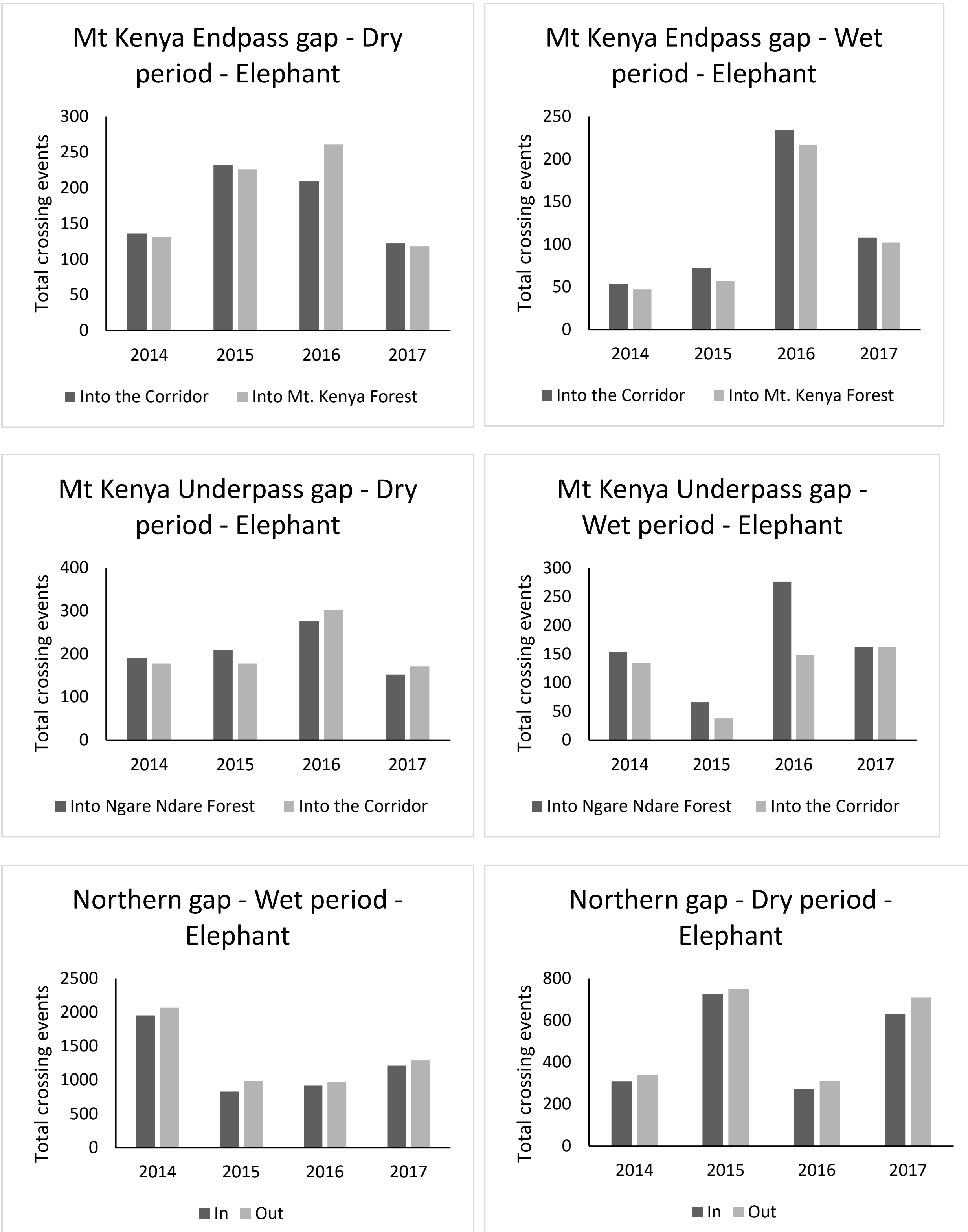


Figure 4.3: Graphs showing seasonal differences in use of gaps by elephants since 2014

Continuous use of corridors by wildlife underscores the very fundamental benefits of corridors which includes; facilitating wildlife movement, providing habitat and benefiting ecosystem processes (Bennett 1998). This has been documented on the LBL where previous studies have showed that wildlife, particularly elephants use the Mount Kenya Elephant corridor as part of their home range, passage way and as foraging sites (Sian 2016; Winmill 2014).

4.4 Rapid assessment of the status of giraffes

Giraffe populations have been in decline across their range given increasing habitat degradation and loss. Specifically, a December 2016 IUCN Red List Assessment raised a red flag about the status of the Reticulated giraffe in particular. To better understand the population status of this species, the LRD, in collaboration with San Diego Zoo Global, Giraffe Conservation Foundation, Northern Rangelands Trust, and the Twiga Walinzi initiative, carried out a rapid assessment on the LBL in early 2017. The assessment was carried out using a road transect, and all unique giraffe encounters were recorded and resulting photos analysed using the Giraffe Spotter database and pattern recognition system.

The rapid assessment resulted in 138 separate giraffe encounters, with a total of 194 individuals identified; 73 males and 121 females. The age structure of the population was also analysed. Results showed a population heavily skewed towards adults. Of the 194 giraffe identified, only 13 were juveniles, worryingly mirroring the inverted population pyramids exhibited by other vulnerable species on the LBL like the Grevy's zebra and Lelwel's hartebeest. This assessment is a valuable snapshot that confirms some of the concerns that the LBL management has raised about the prey base on the Landscape. Follow up assessments through the Great Grevy's Rally and the annual game count in early 2018 will further help confirm and contextualize these results.

4.5 Conclusion and Recommendation

Grevy's zebra births continue to be skewed more towards male offspring. This increases the likelihood of even lower growth potential of the population. Attempts to identify any environmental and physiological causes of this skewed progeny ratio need to be scaled up and possible solutions identified. We need to talk about the proposed GZ and hartebeest breeding area currently awaiting approval by the KWS. Also, link to the non-lethal population control on the lions. Also, we will continue enhancing our hyena monitoring protocols to understand their impact on the prey base especially on the GZ.

5.0 ELEPHANT MONITORING

5.1 Introduction

The African elephant (*Loxodonta africana*) is currently listed as Vulnerable on the IUCN Red List. Increasing elephant populations combined with increased land fragmentation has created a cycle of human-wildlife conflict, specifically through crop raiding elephants. On the LBL, monitoring and identifying of elephants breaking fences continued within the Landscape and the neighboring communities. Data collection was intensified this year following the recruitment of one of the field officers into the department to take up the role of elephant monitoring. During the reporting period, the elephant monitoring unit had to respond to an increased number of incidents in the LBL. This ensured timely follow up and positively identifying some of these individual elephants. Their information is later logged in the elephant monitoring database.

5.2 Trends in fence breakages

In total, 286 fence breakages were recorded. Out of these breakages, 56 % (n=161) occurred on the exclusion zones while 43% (n=125) were on the main boundary fence line. The most affected community areas were in *Ethi*, *Karimba,* and *Mutunyi* (Fig. 5.1).

All the breakages into these areas occurred at night and by dawn most of the elephants on the southern side of LBL would be back into the Ngare Ndare Forest. It was, therefore, difficult to identify the exact culprits. To mitigate this challenge, camera traps were fixed along the breakage hotspot areas to ensure that we got photographs of the animals for identification. In addition, rapid response teams from Lewa, Borana and the Ngare Ndare Forest Trust were deployed to these hotspot areas to deter the elephant before they could access the fence line. Though this proved to be an effective method of reducing conflicts, the costs, vastness and terrain of area of operation remained the greatest challenges.

The north-eastern main fence line adjoining *Mutunyi* community was also affected with breakages from elephant attempting to break into the farms. However, the majority of the crop invasions by elephant into these farms were elephant originating from the greater LMD area. The LMD is located to the north of LBL boundary, forming part of the migratory route of elephants through to Samburu National Reserve and further north.

The exclusion zones were not exempted from damage. Majority of exclusion zones have relatively dense woody vegetation which attracted the elephants. In addition, elephants were noted to access the exclusion zones by crawling under the wires. Six exclusion zones: *Lewa HQ, Kifaru, Karionga, Kona Safi, Sambara* and *Leparua* suffered most. Despite the upgrade that was carried out on *Lewa, Kariunga,* and *Kifaru* exclusion zones in 2014, cases of elephants crawling under the fences continued to increase.

To date, 81 cases involving 99 individuals (15 bulls and 84 individuals in 11 families) have been observed to be leaders in crawling under the exclusion zone fences. Most of these cases occurred in Q3 due to the dry conditions witnessed over the period. However, following the onset of November rain and the availability of forage in the landscape, the numbers of elephants have considerably gone down thus reducing pressure on LBL. Fence breakage incidences are expected to increase at the peak of the dry season in February 2018.

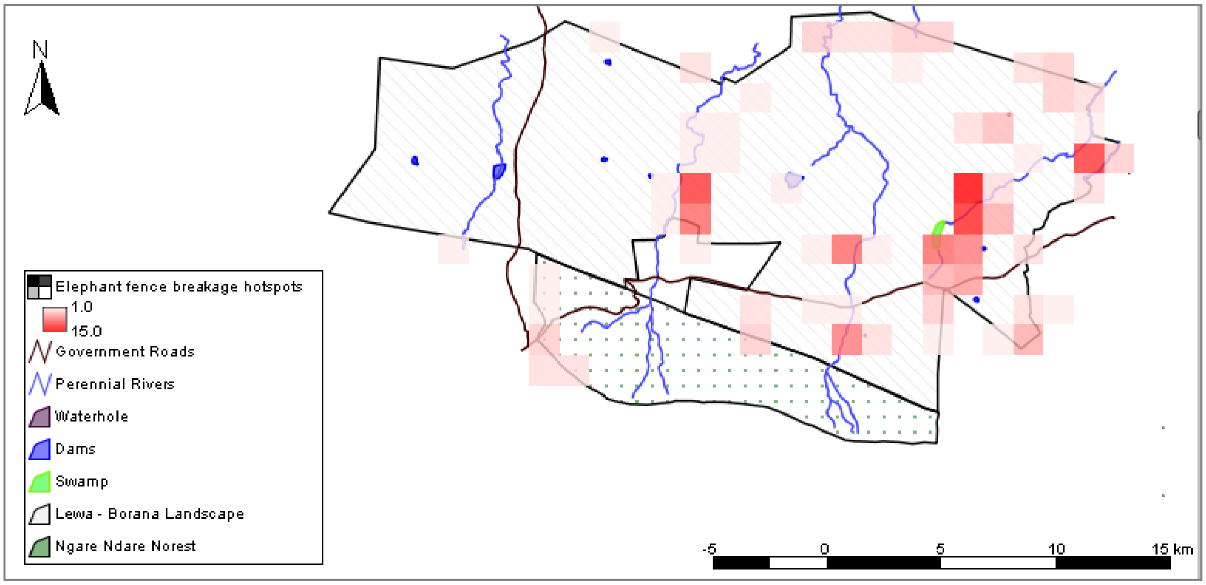


Figure 5.1: Heat map of elephant breakages incidences on LBL January – December 2017.

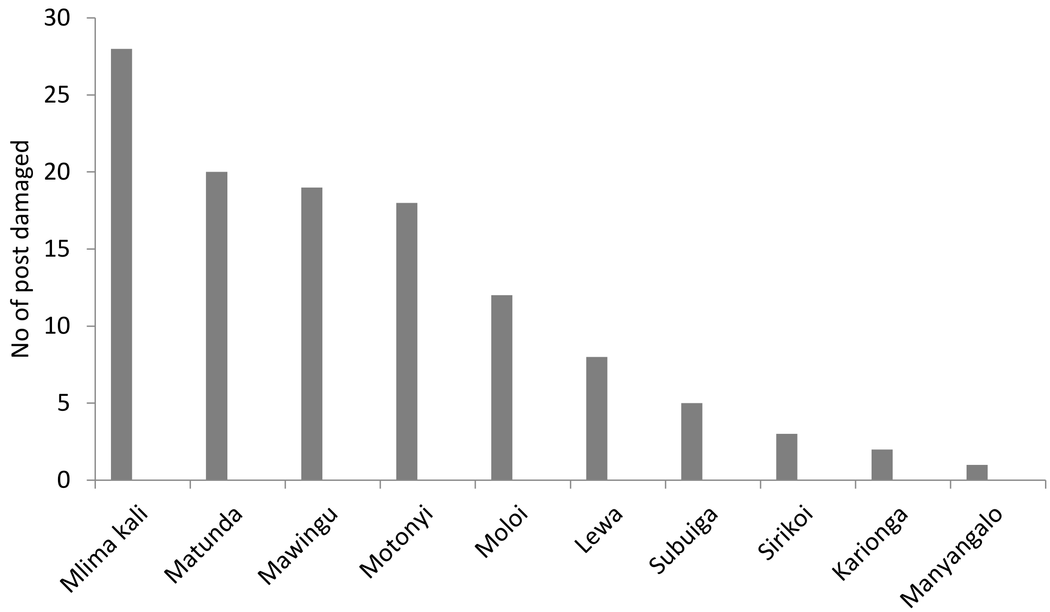


Figure 5.2: No of post damaged by elephant in 2017

5.4 Identification of fence breaking elephant

A total of 26 elephant bulls were identified as the rogue fence breakers. Nine of these; *One right tusker, Bullet, Mushauri, Tony, Gambela, Muindi, Mokiri, Kamaja* and *Kamongo* recorded more than 5 cases each, qualifying these individuals as persistent fence breakers. *Bullet, Mushauri, Melo, Tony, One-right tusker* and *Saidimu* had their tusks trimmed in the past. However, they have continued to learn new tactics of breaking the fences. (Mutinda *et al*., 2014).

With the above information and data, the 9 persistent fence breakers qualify to be translocated out in order to reduce human wildlife conflict (HWC) in the LBL. This and other mitigation strategies will ultimately reduce operational costs with regards to fence repairs and enhance relationships with the affected neighboring communities. The LRD team has visited the Save the Elephants 'Elephants and Bees' project in Voi, and will be trialing both this and elephant braces for feasibility and efficacy in our landscape.

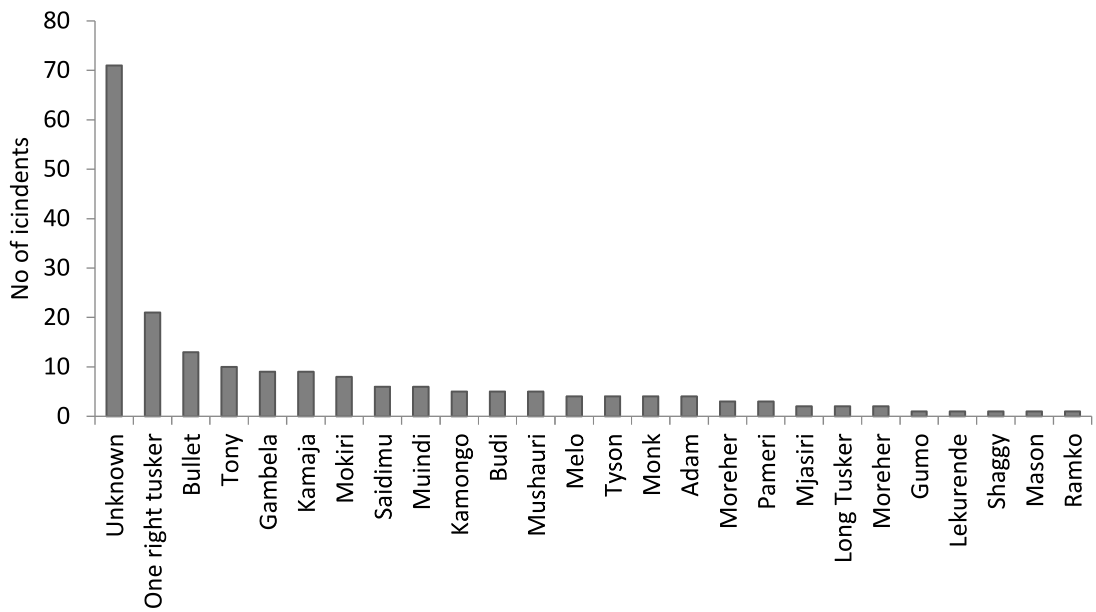


Figure 5.3: Elephant bulls responsible for fence breakages

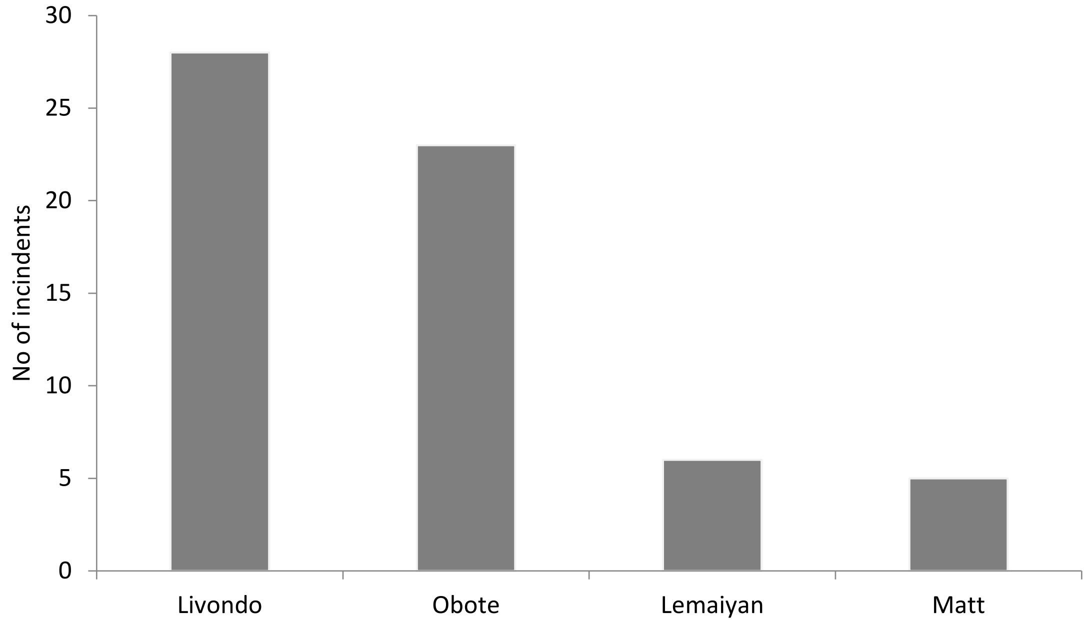


Figure 5.4: Elephant bulls responsible for crawling under the exclusion zones wires

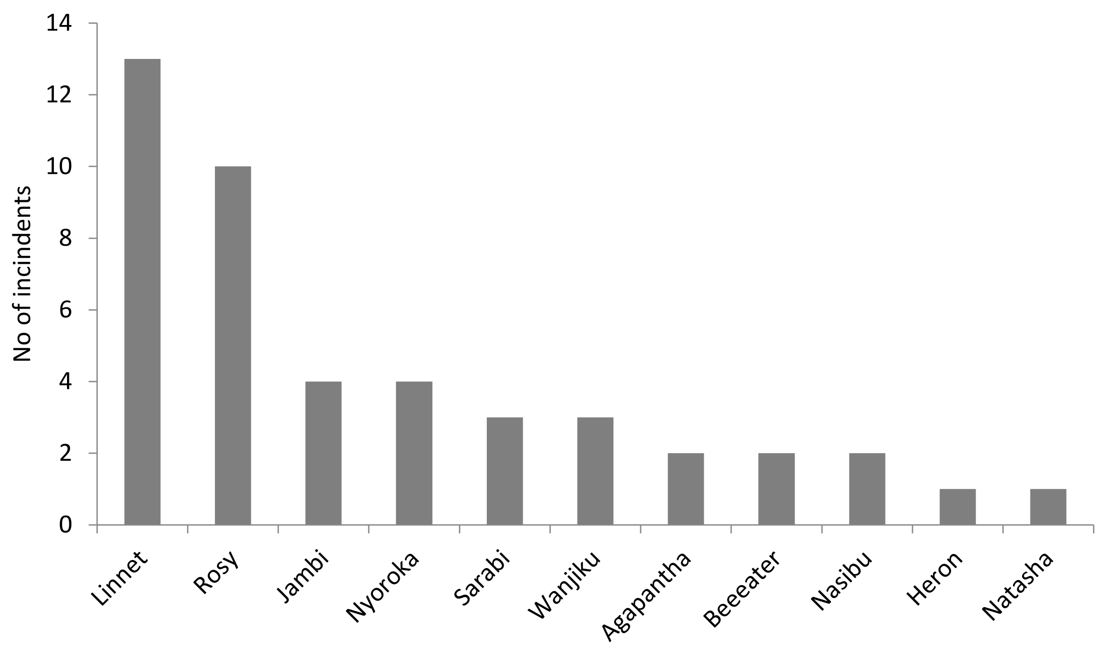


Figure 5.5: Elephant family groups responsible for crawling under the exclusion zones wires

5.5 Conclusion and recommendations

Fence breakage incidents continue to be a major challenge along areas bordering agricultural communities especially during the dry seasons. Efforts to mitigate these conflicts will continue to be implemented in 2018. This will include trimming of tusks, trialing of tusk braces, innovative fence construction techniques, trialing of bee hive fences on some of the most vulnerable areas and any other identified mitigation techniques. At the time of writing, translocation of target elephants is ongoing across the LBL in partnership with KWS, and post-translocation monitoring of both the removed elephants as well as the impact on breakages will be crucial.

6.0 VEGETATION MONITORING

6.1 Long term habitat changes on Lewa

Given the importance of identifying and characterizing long-term vegetation changes, Lewa has in the past invited a team of volunteer ecologists to assess changes on the landscape using monitoring points established in 1979-80. This team, led by ecologist and environmental consultant Wim Giesen, carried out a repeat survey of their long-term datasets in 2016. Below, we briefly describe their methodology, summarize the results, and discuss the findings.

6.1.1 Background

In 1979-1980 a seven-month MSc field ecological study was carried out at Lewa by Lex Linsen and Wim Giesen (Linsen & Giesen 1983). This study described the climate, soils, geology, geomorphology, vegetation, wildlife and rangeland utilization, and a range of maps were also produced including vegetation and soils/geomorphology. The aim of the study was to identify the cause of the 'steady decline in yield of the ranch since it had been acquired by the Craig family in 1952', hence a significant part of the study was devoted to determining the carrying capacity of the ranch for both wildlife and livestock and identifying signs of overgrazing. The two volumes of the report were provided to Lewa Downs in 1983, along with a photo album depicting various common plant species and brief descriptions of these.

A repeat study was carried out in 2006 to compare the existing situation with that during the 1979-1980 study. This study worked on the assumption that changes in management and wildlife dynamics of the area had possibly resulted in changes to woody vegetation cover. This was a reasonable assumption, as a significant increase in large herbivores such elephants and giraffes had resulted in widespread and conspicuous tree damage. On the other hand, installation of exclusion zone fences had reduced pressures on certain habitats such as riparian vegetation dominated by fever trees. Lastly, protection of the Ngare Ndare Forest and restoration of Lewa Swamp had also had an effect on woody vegetation.

The 2016 study had two main objectives: i) assess the degree of (further) changes in woody vegetation since 2006, and ii) assess possible changes in the herbaceous layer (grasses and forbs) since 1979-80.

6.1.2 Data collection

The first phase of this study involved remote sensing of habitat changes. The authors took advantage of lower resolution but free satellite images from Landsat 4, 5, and 7. A proxy for vegetation productivity, namely 'normalized difference vegetation index' (NDVI) was selected as a metric of interest, and measured for the dry season. NDVI is a relatively simple graphical indicator based on 'greenness' of a landscape remotely observed by satellite. While other methods also exist, NDVI is one of the most successful of many attempts to simply and quickly identify vegetated areas and their condition, and remains the most well-known and used index to detect live green plant canopies in multispectral remote sensing data. The NDVI is calculated from individual spectral measurements as follows:

$$NDVI = \frac{(NIR - VIS)}{(NIR + VIS)}$$

where VIS and NIR stand for the spectral reflectance measurements acquired in the visible (red) and near-infrared regions, respectively.

These spectral reflectances are themselves ratios of the reflected radiation over the incoming radiation in each spectral band individually, hence they take on values between 0.0 and 1.0. By design, NDVI therefore varies from -1.0 to +1.0. Differences in NDVI therefore reflect changes in greenness and hence changes in vegetation. Given that the images were taken in the dry season, the NDVI changes are mainly linked to changes in woody vegetation and not the herbaceous vegetation layer. The NDVI values were used to identify areas on Lewa that had the highest differences in woody vegetation cover between 1978 and 2016.

In 1978, 138 sampling points (referred to as relevees in Giesen's reports) were established and a combination of quadrats (plots) and line transects (line point intercept) used for quantifying herbaceous and woody vegetation respectively. These were updated in 2006 via stratification, resulting in 78 relevees. The 2016 relevees were distributed as follows:

- 32 repetitions of 1980 relevees,
- 20 repetitions of 2006 relevees,
- 10 relevees of important change sites identified by NDVI analysis (see 3.3.1),
- 4 relevees of new sites on the Lewa section of the LBL

During all sampling periods, the relevees were used to collect information on species composition, cover, as well as woody vegetation density. Complete methodology and full descriptions of the methods are available in the full report upon request.

6.1.3 Results summary and discussion

1978-2016

Overall, tree cover was found to have decreased from 24% to 9% across Lewa, with the main causes identified as feeding by large browsers, exacerbated by changes in rainfall patterns complicating recovery. NDVI analyses identified a few areas where tree cover has increased in the period under study. The main areas are the Ngare Ndare Forest, Lewa Swamp, and the *Acacia xanthophloea* (fever tree) riverine vegetation near the LWC headquarters. The increase in NDVI around the Lewa Swamp area matches with reported expansion of both water volume as well as vegetation cover in some areas of the swamp over the years (Davidson, unpublished report). Areas with a decrease in tree cover appear to be mainly in the central and northern valleys, mid/central and mid-northern plains (Fig. 6.1).

Grass cover was found to have increased from an average of 50% in 1980 to 70% in 2016. The increase in grass cover was higher in the hills than in the plains ecological units (45% and 29% respectively). Plains and hills ecological units showed a slight difference in tree/shrub cover decline, with 10% more cover reduction in the plains. The shrub-grass dynamics in the plains may therefore be more pronounced in the plains than in the hills. The average number of species increased 40% from 15.6 per relevee in 1980 to 21.8 per relevee in 2016. The average number of grasses and sedges increased from 3.9 to 4.7, forbs from 6.9 to 10.5, and trees/shrubs from 4.7 to 6.5 species. The plains vegetation unit, however, only showed an increase in the number of forb species, while the riverine vegetation unit only showed a significant increase in the number of trees/shrub species.

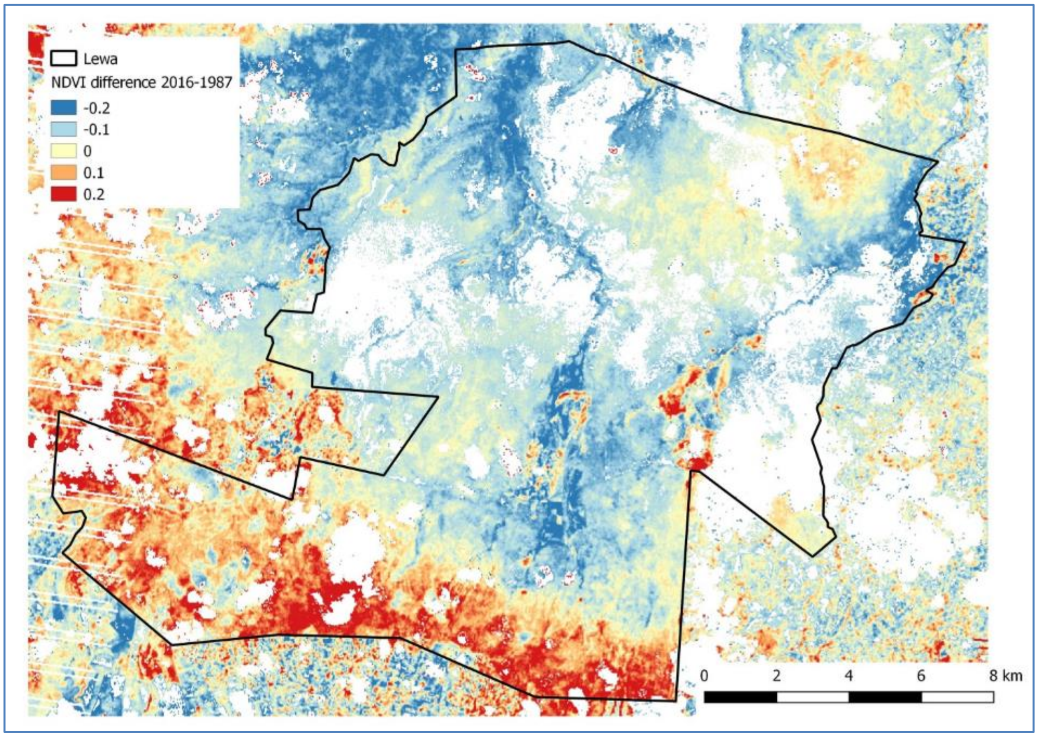


Figure 6.1. Graphical representation of an NDVI analysis for 1987-2016. Areas in red are where there is a substantial increase in 'greenness' (i.e. tree cover), while the areas in blue depict areas with a decrease in tree cover.

2006-2016

At most of the nine (9) sites where there was an increase in woody vegetation up to 2006, this trend continued up to 2016, with an average increase in tree cover of 48% from 2006-2016; most of these 'increaser' sites had exclusion zone fencing (Fig. 6.2). At the eleven (11) sites where woody vegetation was decreasing up to 2006, this trend was on average reversed (with an increase in tree cover of 37%) by 2016 due to the introduction of new exclusion zone fencing between 2006 and 2016.

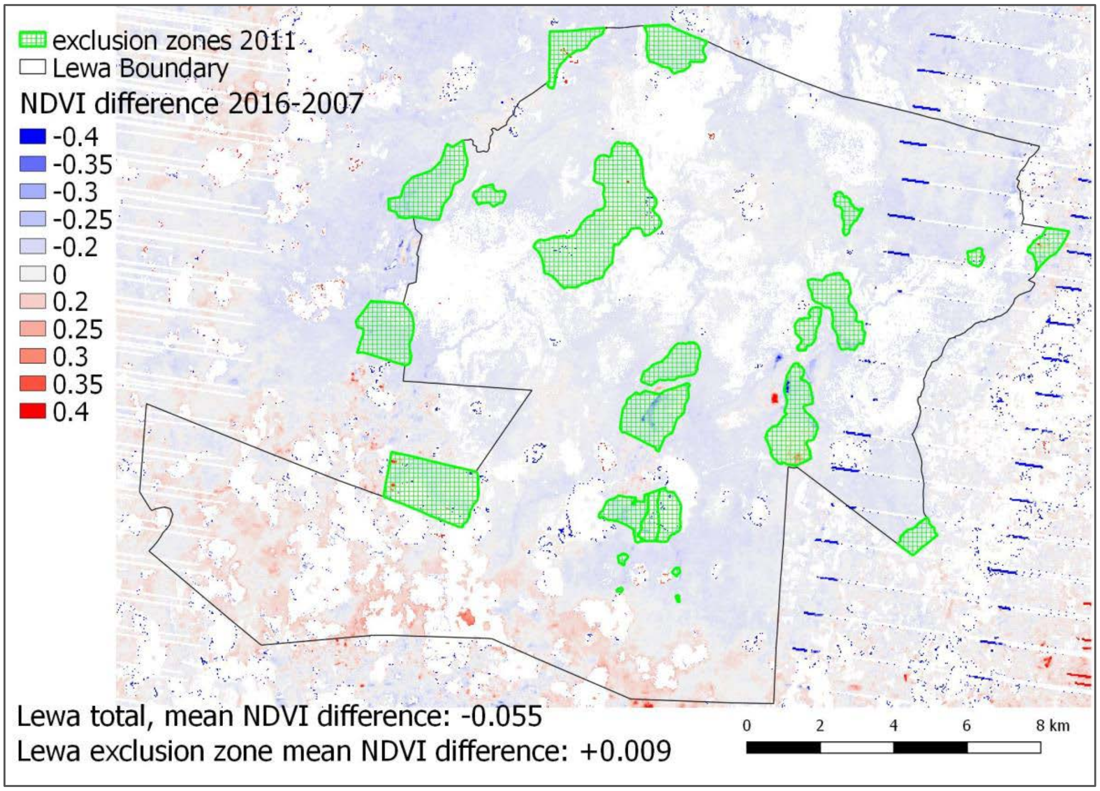


Figure 6.2. An overlay between the NDVI differences (2016-2007) and the exclusion zones.

From this, it is apparent that exclusion zones appear to be functioning well in some areas (e.g. Sirikoi, Lewa headquarters), but are not doing so well in other areas (e.g. mid-northern and northern). Partly, this is because some exclusion zones have recently been established. However, some fenced off areas have also been breached by elephants that have broken the fences to browse on the protected woodlands. Recent innovations in the design of the fencing (i.e. equipped with 'stingers') may improve the level of protection, but past experience shows that sooner or later, wildlife will probably find a new point or method of entry and fencing may in the long run have only mixed results.

These long-term changes in woody vegetation vis-a-vis grasslands corroborate anecdotal information about long-term vegetation changes observed by different individuals across the landscape (I. Craig, S. Brown, pers. comm., Fig. 6.3) and provides the necessary quantitative data to demonstrate and analyse these changes.

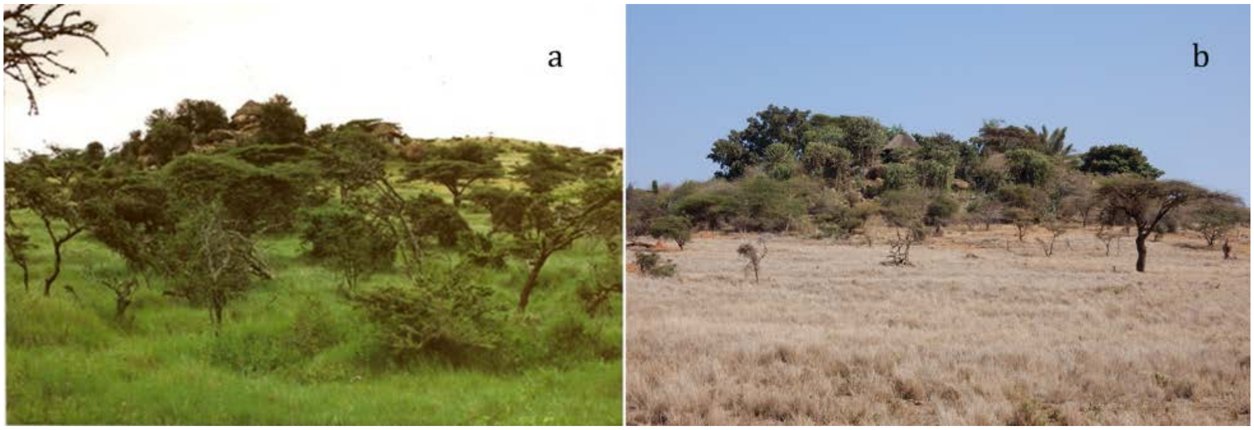


Figure 6.3: View from the bottom of the hill at Ian's house in **a**) 1990, wet season and **b**) 2017 dry season

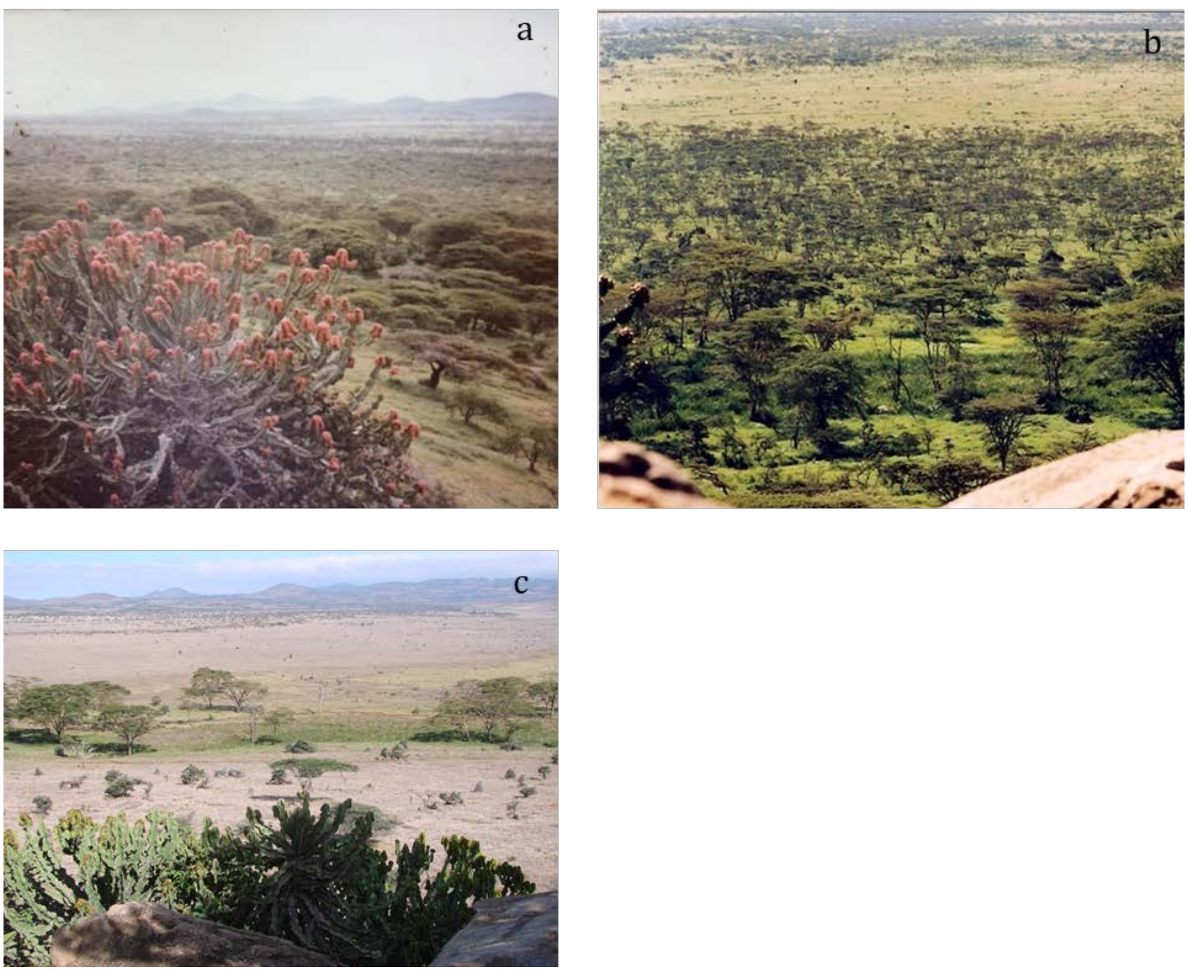


Figure 6.4: View from Ian's dining area in **a**) 1983, wet season, **b**) 1990 wet season, and **c**) 2009, dry season.

6.1.5 Conclusion and recommendations

The report identifies woody vegetation cover reduction as a pressing issue and recommends setting up of more exclusion zone areas. Upgrading the existing exclusion zone areas to make them elephant proof is ongoing. In addition, plans are at an advanced stage to establish total exclusion zones to promote woody vegetation recovery. Areas with high density of seedlings are especially recommended for expansion and establishment of total exclusions. The report also recommends increased monitoring of the hydrological changes on the LBL. This activity has commenced in partnership with the Southwest Research Institute (https://www.swri.org/). Black cotton soils need to be monitored given their reduction in grass cover despite a reduction in tree/shrub cover in many places. Grazing intensity on these soils should also be monitored, and experimental grazing exclusion plots constructed to tease out the different dynamics at play.

7.0 RANGELAND MANAGEMENT

7.1 Livestock grazing programme on Lewa

Livestock grazing on Lewa is undertaken for two main objectives: 1) graze less selectively thereby enhancing growth and quality of palatable species for the benefit of wildlife; and 2) extend economic benefits to community areas adjacent to Lewa, thereby contributing to the improvement of the community livelihoods.

Concentrated or bunched herds are understood to; 1) break up compacted soil thereby increasing water infiltration and plant growth, 2) enhance seed burial, lying of litter, and dunging effects, and that 3) time-controlled grazing rotations, with adequate rest periods, enhance plant recovery from defoliation.

By the end of Q4, a total of 1,060 head of Northern Rangelands Trust –Trading (NRTT) cattle were grazing on Lewa. This number fluctuated throughout the year as the animals that had attained the recommended weight were sold off. Additionally, and in reference to the second objective, a total of 2,000 head of cattle (exclusive of calves) drawn from Il Ngwesi and Leparua Conservancies, Eastern communities and all CBOs affiliated to Ngare Ndare Forest

Trust were allowed to graze on Lewa as a short-term strategy to mitigate the effect of the drought. These cattle were grazed in a controlled system, which involved bunching them into herds of 300 (±50) to positively trample the grassland. This planned grazing system has been shown to increase cattle performance, rangeland condition, as well as wildlife species richness even within relatively short time frames (Odadi *et al*. 2017). Daily follow up was carried out to ensure cattle were not unduly constrained and their health was not compromised.

Borana Conservancy has had a long running livestock to market program aimed at producing quality beef steers from community cattle (Borana Conservancy, 2017). The programme also took on 516 steers from community herds in late 2016. Of these, 411 were sold off in 2017. Additional animals were subsequently added onto the programme, to a current total of 333 steers. In addition to the steers programme, Borana also provided grazing allotments to neighbouring communities, taking on 1,200 cattle with 800 calves. These cattle were drawn from six communities, namely Ethi, Ngare Ndare, Sang'a, Nadung'oru, Makurian, and Chumvi. The success of this community steer programme will be evaluated in 2018.

7.2 Grazing blocks

In total, 15,560 acres on Lewa were grazed by livestock in 2017 representing 78% of the total acres projected to be grazed in 2017 (Fig. 7.1a). This increase in the size of grazing blocks was as a result of shift in the original projection in order to accommodate the community cattle at the beginning of the year. Visual assessment of quantity and quality of forage availability, presence or absence of rainfall since last grazing period, and the proximity to the water were some of the factors that were considered prior to allowing cattle into these grazing blocks. Subsequent follow up and supervision was also made to ensure cattle did not negatively impact the grassland.

Following good rainfall received in November, 4,000 acres are projected to be grazed in Q1 2018 (Fig. 7.1b). Planned grazing procedures will be replicated in 2018. This plan will be amended to accommodate all grazing challenges that will arise due to unpredicted weather.

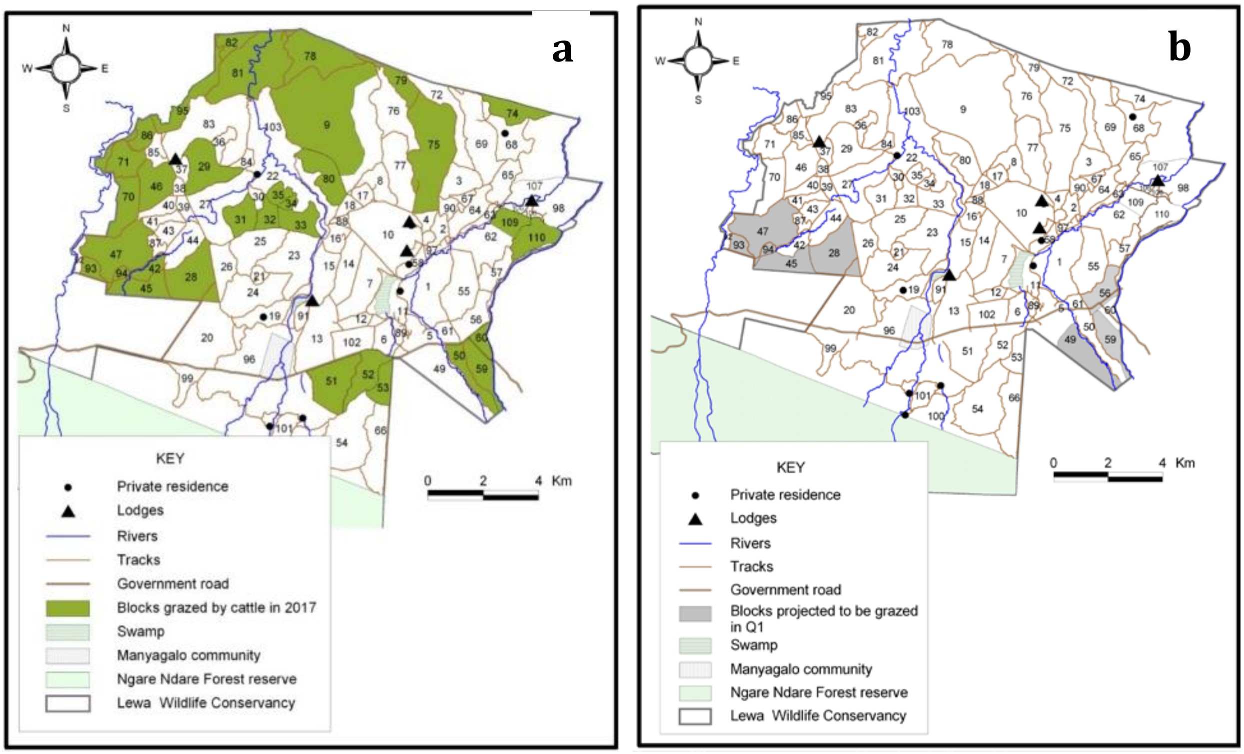


Figure 7.1. Map of Lewa showing **a**.) grazed blocks in 2017 and **b**.) projected blocks to be grazed in Q1 2018

7.3: Conclusion and recommendation

Cattle grazing on Lewa has become increasingly difficult due to challenges, occasioned by the prevailing dry spell in 2017. This has necessitated constant shifts and changes in original projections. Following the short rains received in October/November, the vegetation has greatly recovered thus reducing the current grazing pressure on Lewa and in the surrounding community areas. Efforts will continue to be made to ensure a long-term strategy is put in place to mitigate emerging drought challenges and provide early warning grass and forage deficiencies on LBL. This will involve engaging the stakeholders; the county governments of Laikipia and Isiolo and the community, working in partnership with NRT.

LRD will also initiate new protocols in 2018 to asses and understand grazing impacts on dynamic soil properties, specifically compaction, aggregate stability, and infiltration rates. This will ensure that livestock grazing continues to meet its core objectives of improving the grasslands for wild herbivores, as well as providing support to community cattle.

8.0 HYDROLOGY

8.1 Introduction

As part of continuing efforts to understand ecosystem structure and function on the LBL, an understanding of the hydrology within and beyond our immediate ecosystem is imperative. As such, the Research and monitoring department is currently engaged in various endeavours to quantify water inputs and outputs across the landscape, as well as how these fluxes change across time.

8.2 Existing water use quantification

The first phase of this process will involve quantification of current inflows onto the landscape through various avenues (rainfall, rivers, springs, and boreholes), as well as the current abstraction levels. While quantifying inputs and outputs certainly poses several logistical challenges, a reasonable baseline is quantifying water use from metered outlets across the LBL. We are currently in the process of collecting and collating these records, but preliminary findings from the reporting period indicate few temporal and spatial differences in water use for 2017 (Fig. 8.1). There were no immediately uniform patterns of monthly use across connections throughout the year, although there were visible peaks in January, June (due to marathon activities), and November for the main Lewa Headquarters line. Further work is needed to better understand these variations in usage, some of which at first glance seem counter-intuitive. For example, the Sambara wildlife water point seems to have recorded more discharge in November, which also happens to be during the height of the wet season.

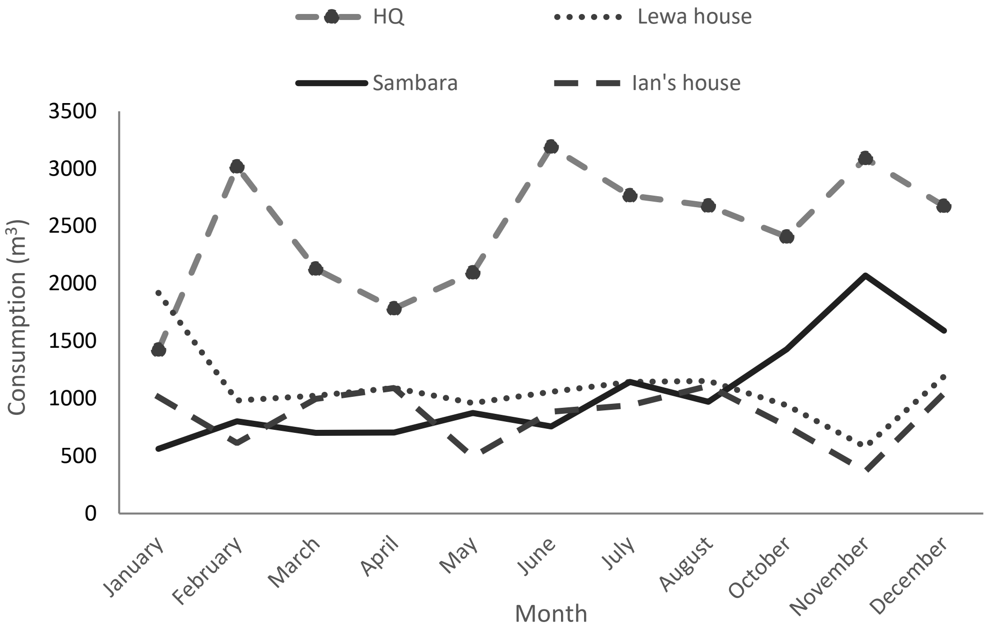


Figure 8.1. Monthly water consumption for 2017 from four metered connections across Lewa. Note; September records are missing

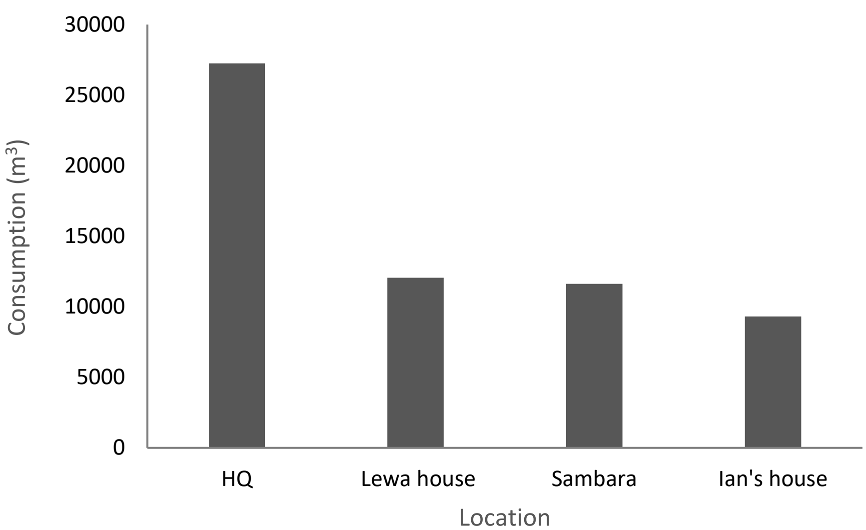


Figure 8.2. Annual consumption rates from metered connections on Lewa

The research department is currently implementing steps to collate borehole and river extraction data more extensively from the different entities on the landscape. The engagement with SwRI will continue through 2018, with their preliminary report on the hydrology of the LBL likely to be released for general distribution in early Q2, 2018.

9.0 AVIFAUNA

The LBL Research and Monitoring department upscaled its avifauna research in 2017, with two trainings conducted for key team members to familiarise themselves with the methodology and background involved in this key thematic area. A 3-day survey of bird species on the LBL was carried out in collaboration with the Peregrine fund and National museums of Kenya that identified 219 bird species in the landscape and produced an updated preliminary bird list (Appendix 2). In addition, a snap assessment of the Grey crowned crane was carried out by the NMK in Q4 that identified 32 individuals. Moving forward, this work will continue being upscaled to increase robustness of data collection and eventually identify key species of interest that will serve as ecological indicators for management.

10.0 ACKNOWLEDGEMENTS

The Lewa Borana Landscape (LBL) Research Department would like to thank all parties who worked with us in 2017. In particular, we acknowledge the management of Lewa and Borana Conservancies, Lewa Canada, Lewa USA and Lewa UK for their continued support; Al Ain Zoo, UAE for their continuous financial support of major wildlife monitoring programmes. In addition, we acknowledge all the other technical and financial support to Lewa and Borana to undertake their conservation programmes.

11.0 REFERENCES

AbiSaid, M. & Dloniak, S.M.D. (2015). Hyaena hyaena. The IUCN Red List of Threatened Species 2015: e.T10274A45195080. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T10274A45195080.en.

Adcock, K. & Emslie, R.H. (2003). Monitoring African rhino: an AfRSG update of "Sandwith's" training course for field ranger, 5th edition: trainee's guide.

Adcock, K. (2004). Report on the findings of a survey of browse conditions for black rhino at Ndumu Game Reserve, Kwazulu-Natal, 27–31 April 2004, Unpublished

Anon. (1994). Cattle body condition scoring (Online), Available at: https://www.daf.qld.gov.au/__data/assets/pdf_file/0015/53520/Animal-HD-Investigation-Condition-scores.pdf

Bennett, A. F. (1998). Linkages in the Landscape: the role of corridors and connectivity in wildlife conservation. IUCN.

Borana Conservancy (2017). Quarterly report, January-March. Borana Wildlife Conservancy.

Boydston, E.E., Kapheim, K., & Holekamp, K. E. (2006). Patterns of den occupation by the spotted hyena (*Crocuta crocuta*). Afr. J. Ecol. 44: 77-86.

Caughley, G. (1966). Mortality patterns in mammals Ecology 47:906- 918.

Emslie, R.H. (1998). Strategic white rhino conservation in the private sector. Unpublished report, IUCN/SSC African Rhino Specialist Group, IUCN, Gland, Switzerland.

Emslie, R.H. (1998). Strategic white rhino conservation in the private sector. Unpublished report, IUCN/SSC African Rhino Specialist Group, IUCN, Gland, Switzerland.

Ezenwa, V. O., Jolles, A. E., & O'Brien, M. P. (2009). A reliable body condition scoring technique for estimating condition in African buffalo. African Journal of Ecology, 47(4): 476–481. https://doi.org/10.1111/j.1365-2028.2008.00960.x

Garstang, M., Davis, R. E., Leggett, K., Frauenfeld, O. W., Greco, S., Zipser, E., & Peterson, M. (2014). Response of African Elephants (Loxodonta africana) to Seasonal Changes in Rainfall. PLoS ONE, 9(10): e108736. http://doi.org/10.1371/journal.pone.0108736z

Hejcmanova, P., Vymyslicka, P., Zackova, M., & Hejcman, M. (2013). Does supplemental feeding affect behavior and foraging of critically endangered western giant eland in an ex situ conservation site? African Zoology 48: 250-258.

Hillman, J.C & Hillman, A. K. (1975) Mortality of wildlife in Nairobi National Park, during the drought of 1973-1974. African Journal of Ecology 15:1-18.

Hines, A. M., Ezenwa, V. O., Cross, P., & Rogerson, J.D. (2007). Effects of supplemental feeding on gastrointestinal parasite infection in elk (Cervus elaphus): Preliminary observations. Veterinary Parasitology 148: 350-355.

Holekamp, K. E., Smale, L., Berg, R., & Cooper, S. M. (1997). Hunting rates and hunting success in the spotted hyena (Crocuta crocuta). Journal of Zoology, 242(1), 1-15.

Jacobs, J. (1974). Quantitative measurement of food selection. Oecologia (Berl.) 14: 413–417.

Muya, S.M. & Oguge, N.O. (2000). Effects of browse availability and quality on black rhino (Dicernos bicornis michaeli Groves 1967) diet in Nairobi National Park, Kenya. African Journal of Ecology. 38: 62-71.

Odadi, W. O., Fargione, J., & Rubenstein, D. I. (2017). Vegetation, wildlife and livestock responses to planned grazing management in an African pastoral landscape. Land Degradation & Development.

Parham, J. & C. Stewart (2016). Detecting plains and Grevy's Zebras in the real world. IEEE Xplore 2016: 1-9. DOI: 10.1109/WACVW.2016.7470122

Saltz, D., & Rubenstein, D. I. (1995). Population Dynamics of a Reintroduced Asiatic Wild Ass (Equus Hemionus) Herd Author (s): David Saltz and Daniel I . Rubenstein Reviewed work (s): Population dynamics of a reintroduced asiatic wild ass (Equus hemionus) herd1. America, 5(2): 327–335.

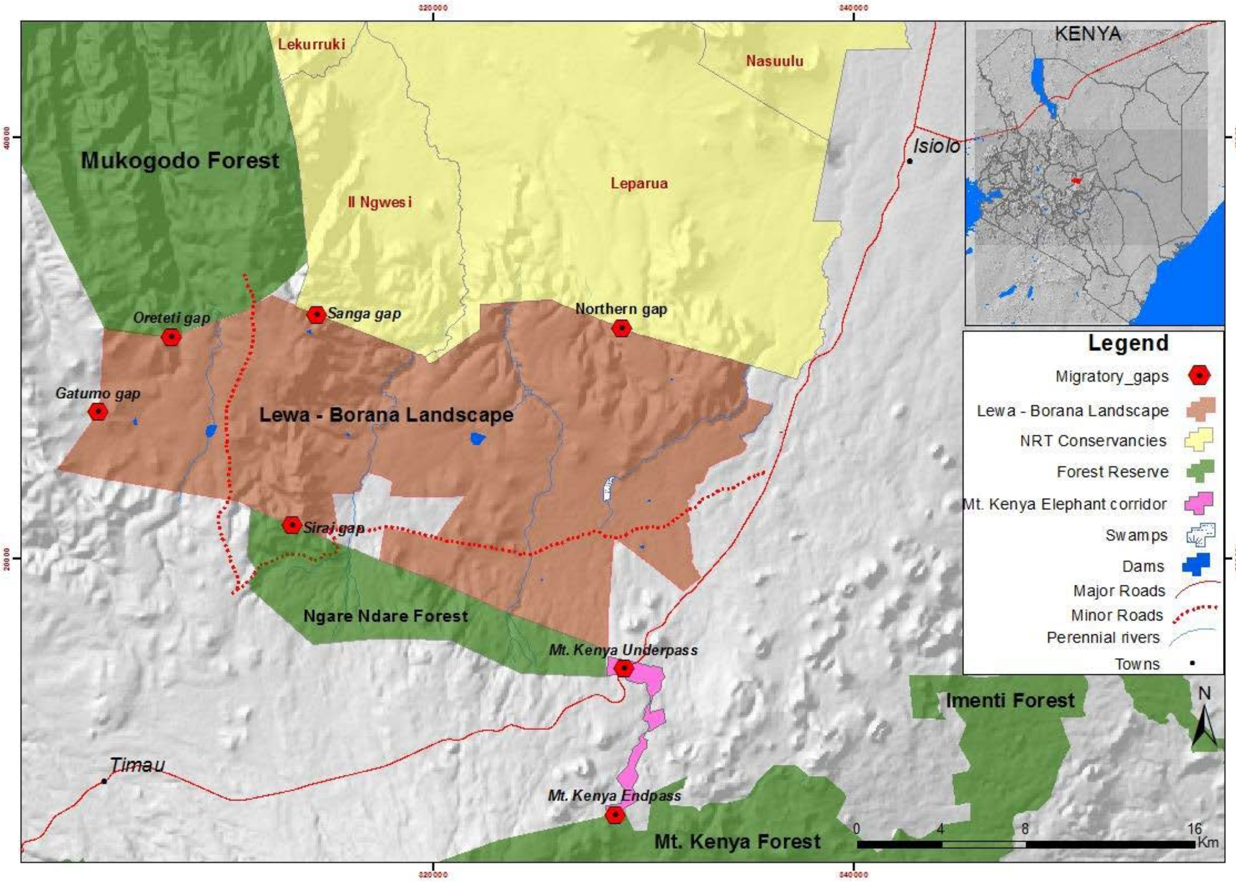
Sankaran M., Hanan N., Scholes R., Ratnam J., Augustine D., Cade B., Gignoux J., Higgins S., Le Roux X., Ludwig F., Ardo J., Banyikwa F., Bronn A., Bucini G., Caylor K., Coughenour M., Diouf A., Ekaya W., Feral C., February E., Frost P., Hiernaux P., Hrabar H., Metzger K., Prins H., Ringrose S., Sea W., Tews J., Worden J. and Zambatis N. (2005). Determinants of woody cover in African savannas. Nature.;438:846–849. doi: 10.1038/nature04070.

Sian G. (2016). Movement and distribution of the african elephant (Loxodonta africana) within the Mount Kenya elephant corridor, MSc. Thesis.

Winmill E. (2014). The Mount Kenya elephant corridor's utilisation by elephants and its perceived success, MSc. Thesis.

Appendices

Appendix 1



Map showing the location of the Lewa – Borana landscape in relation to the adjacent conservation areas

Appendix 2:

LBL Bird list

COMMON NAME	SCIENTIFIC NAME
Ostrich	*Struthio camelus*
Helmeted Guineafowl	*Numida meleagris*
Crested Francolin	*Francolinus sephaena*
Scaly Francolin	*Francolinus squamatus*
Yellow-necked Spurfowl	*Francolinus leucoscepus*
Egyptian Goose	*Alopochen aegyptiaca*
African Black Duck	*Anas sparsa*
Yellow-billed Duck	*Anas undulata*
Red-billed Teal	*Anas erythrorhyncha*
Marabou Stork	*Leptoptilos crumeniferus*
Sacred Ibis	*Threskiornis aethiopicus*
Hadada Ibis	*Bostrychia hagedash*
Cattle Egret	*Bubulcus ibis*
Grey Heron	*Ardea cinerea*
Hamerkop	*Scopus umbretta*
Pink-backed Pelican	*Pelecanus rufescens*
Great Cormorant	*Phalacrocorax carbo*
Greater Kestrel	*Falco rupicoloides*
Lanner Falcon	*Falco biarmicus*
Secretarybird	*Sagittarius serpentarius*
African Black-shouldered Kite	*Elanus caeruleus*
White-backed Vulture	*Gyps africanus*
Rüppell's Vulture	*Gyps rueppellii*

Lappet-faced Vulture	*Torgos tracheliotus*
Black-chested Snake Eagle	*Circaetus pectoralis*
Brown Snake Eagle	*Circaetus cinereus*
Bateleur	*Terathopius ecaudatus*
Eastern Chanting Goshawk	*Melierax poliopterus*
Gabar Goshawk	*Micronisus gabar*
Great Sparrowhawk	*Accipiter melanoleucus*
Augur Buzzard	*Buteo augur*
Tawny Eagle	*Aquila rapax*
Verreaux's Eagle	*Aquila verreauxii*
African Hawk Eagle	*Aquila spilogaster*
Crowned Eagle	*Stephanoaetus coronatus*
Kori Bustard	*Ardeotis kori*
White-bellied Bustard	*Eupodotis senegalensis*
Black Crake	*Amaurornis flavirostra*
Common Moorhen	*Gallinula chloropus*
Grey Crowned Crane	*Balearica regulorum*
Blacksmith Plover	*Vanellus armatus*
Spur-winged Plover	*Vanellus spinosus*
Black-winged Plover	*Vanellus melanopterus*
Crowned Plover	*Vanellus coronatus*
Three-banded Plover	*Charadrius tricollaris*
Marsh Sandpiper	*Tringa stagnatilis*
Chestnut-bellied Sandgrouse	*Pterocles exustus*
Black-faced Sandgrouse	*Pterocles decoratus*
Speckled Pigeon	*Columba guinea*
Dusky Turtle Dove	*Streptopelia lugens*

Red-eyed Dove	*Streptopelia semitorquata*
Ring-necked Dove	*Streptopelia capicola*
Laughing Dove	*Streptopelia senegalensis*
Emerald-spotted Wood Dove	*Turtur chalcospilos*
Tambourine Dove	*Turtur tympanistria*
Namaqua Dove	*Oena capensis*
Fischer's Lovebird	*Agapornis fischeri*
Hybrid Lovebird	*Agapornis fischeri x personatus*
Meyer's Parrot	*Poicephalus meyeri*
African Orange-bellied Parrot	*Poicephalus rufiventris*
Hartlaub's Turaco	*Tauraco hartlaubi*
White-browed Coucal	*Centropus superciliosus*
African Scops Owl	*Otus senegalensis*
Verreaux's Eagle Owl	*Bubo lacteus*
Pearl-spotted Owlet	*Glaucidium perlatum*
African Palm Swift	*Cypsiurus parvus*
Nyanza Swift	*Apus niansae*
Little Swift	*Apus affinis*
Horus Swift	*Apus horus*
Speckled Mousebird	*Colius striatus*
Blue-naped Mousebird	*Urocolius macrourus*
Narina Trogon	*Apaloderma narina*
Rufous-crowned Roller	*Coracias naevius*
Lilac-breasted Roller	*Coracias caudatus*
Grey-headed Kingfisher	*Halcyon leucocephala*
Striped Kingfisher	*Halcyon chelicuti*
Malachite Kingfisher	*Alcedo cristata*

Pied Kingfisher	*Ceryle rudis*
Little Bee-eater	*Merops pusillus*
Cinnamon-chested Bee-eater	*Merops oreobates*
White-throated Bee-eater	*Merops albicollis*
Hoopoe	*Upupa epops*
Green Wood-hoopoe	*Pheoniculus purpureus*
Abyssinian Scimitarbill	*Rhinopomastus minor*
Crowned Hornbill	*Tockus alboterminatus*
African Grey Hornbill	*Tockus nasutus*
Red-billed Hornbill	*Tockus erythrorhynchus*
Von der Decken's Hornbill	*Tockus deckeni*
Yellow-rumped Tinkerbird	*Pogoniulus bilineatus*
Red-fronted Tinkerbird	*Pogoniulus pusillus*
Red-fronted Barbet	*Tricholaema diademata*
Spot-flanked Barbet	*Tricholaema lacrymosa*
White-headed Barbet	*Lybius leucocephalus*
Red-and-yellow Barbet	*Trachyphonus erythrocephalus*
D'Arnaud's Barbet	*Trachyphonus darnaudii*
Lesser Honeyguide	*Indicator minor*
Greater Honeyguide	*Indicator indicator*
Nubian Woodpecker	*Campethera nubica*
Bearded Woodpecker	*Dendropicos namaquus*
African Grey Woodpecker	*Dendropicos goertae*
Chin-spot Batis	*Batis molitor*
Rosy-patched Bushshrike	*Rhodophoneus cruentus*
Brown-crowned Tchagra	*Tchagra australis*
Black-backed Puffback	*Dryoscopus cubla*

Northern Puffback	*Dryoscopus gambensis*
Slate-coloured Boubou	*Laniarius funebris*
Tropical Boubou	*Laniarius aethopicus*
Brubru	*Nilaus afer*
Grey Cuckoo Shrike	*Coracina caesia*
Northern White-crowned Shrike	*Eurocephalus rueppelli*
Taita Fiscal	*Lanius dorsalis*
Common Fiscal	*Lanius collaris*
Black-headed Oriole	*Oriolus larvatus*
Common Drongo	*Dicrurus adsimilis*
African Paradise Flycatcher	*Terpsiphone viridis*
Pied Crow	*Corvus albus*
Fan-tailed Raven	*Corvus rhipidurus*
White-bellied Tit	*Parus albiventris*
White-headed Saw-wing	*Psalidoprocne albiceps*
Black Saw-wing	*Psalidoprocne pristoptera*
Plain Martin	*Riparia paludicola*
Barn Swallow	*Hirundo rustica*
Rock Martin	*Ptyonoprogne fuligula*
Lesser Striped Swallow	*Cecropis abyssinica*
Red-rumped Swallow	*Cecropis daurica*
Rufous-naped Lark	*Mirafra africana*
Flappet Lark	*Mirafra rufocinnamomea*
Fawn-coloured Lark	*Mirafra africanoides*
Red-capped Lark	*Calandrella cinerea*
Short-tailed Lark	*Pseudalaemon fremantlii*
Fischer's Sparrow Lark	*Eremopterix leucopareia*

Rattling Cisticola	*Cisticola chiniana*
Ashy Cisticola	*Cisticola cinereolus*
Pectoral-patch Cisticola	*Cisticola brunnescens*
Tawny-flanked Prinia	*Prinia subflava*
Buff-bellied Warbler	*Phyllolais pulchella*
Yellow-breasted Apalis	*Apalis flavida*
Chestnut-throated Apalis	*Apalis porphyrolaema*
Grey Apalis	*Apalis cinerea*
Grey-capped Warbler	*Eminia lepida*
Grey-backed Camaroptera	*Camaroptera brachyura*
Grey Wren Warbler	*Calamonastes simplex*
Common Bulbul	*Pycnonotus barbatus*
Yellow-whiskered Greenbul	*Andropadus latirostris*
Zanzibar Greenbul	*Andropadus importunus*
Cabanis's Greenbul	*Phyllastrephus cabanisi*
Little Rush Warbler	*Bradypterus baboecala*
Brown Woodland Warbler	*Phylloscopus umbrovirens*
Yellow-bellied Eremomela	*Eremomela icteropygialis*
Red-faced Crombec	*Sylvietta whytii*
Banded Parisoma	*Parisoma boehmi*
African Hill Babbler	*Pseudoalcippe abyssinica*
Rufous Chatterer	*Turdoides rubiginosa*
Black-lored Babbler	*Turdoides sharpei*
Northern Pied Babbler	*Turdoides hypoleuca*
Montane White-eye	*Zosterops poliogastrus*
Wattled Starling	*Creatophora cinerea*
Greater Blue-eared Starling	*Lamprotornis chalybaeus*

Rüppell's Starling	*Lamprotornis purpuroptera*
Superb Starling	*Lamprotornis superbus*
Hildebrandt's Starling	*Lamprotornis hildebrandti*
Violet-backed Starling	*Cynniricinclus leucogaster*
Red-billed Oxpecker	*Buphagus erythrorhynchus*
Yellow-billed Oxpecker	*Buphagus africanus*
Olive Thrush	*Turdus olivaceus*
Cape Robin Chat	*Cossypha caffra*
White-browed Robin Chat	*Cossypha heuglini*
Spotted Palm Thrush	*Cichladusa guttata*
White-browed Scrub Robin	*Cercotrichas leucophrys*
Brown-tailed Rock Chat	*Cercomela scotocerca*
Northern Anteater Chat	*Myrmecocichla aethiops*
Little Rock Thrush	*Monticola rufocinereus*
White-eyed Slaty Flycatcher	*Melaenornis fischeri*
Southern Black Flycatcher	*Melaenornis pammelaina*
African Grey Flycatcher	*Bradornis microrhynchus*
African Dusky Flycatcher	*Muscicapa adusta*
Collared Sunbird	*Hedydipna collaris*
Amethyst Sunbird	*Chalcomitra amethystina*
Scarlet-chested Sunbird	*Chalcomitra senegalensis*
Bronze Sunbird	*Nectarinia kilimensis*
Northern Double-collared Sunbird	*Cinnyris reichenowi*
Marico Sunbird	*Cinnyris mariquensis*
Variable Sunbird	*Cinnyris venustus*
White-browed Sparrow Weaver	*Plocepasser mahali*
Grey-capped Social Weaver	*Pseudonigrita arnaudi*

Black-capped Social Weaver	*Pseudonigrita cabanisi*
Kenya Rufous Sparrow	*Passer rufocinctus*
Grey-headed Sparrow	*Passer griseus*
Chestnut Sparrow	*Passer eminibey*
Yellow-spotted Petronia	*Petronia pyrgita*
White-billed Buffalo Weaver	*Bubalornis albirostris*
Red-billed Buffalo Weaver	*Bubalornis niger*
Speckle-fronted Weaver	*Sporopipes frontalis*
Baglafecht Weaver	*Ploceus baglafecht*
Spectacled Weaver	*Ploceus ocularis*
Speke's Weaver	*Ploceus spekei*
Red-headed Weaver	*Anaplectes melanotis*
Yellow-bellied Waxbill	*Coccopygia quartinia*
Common Waxbill	*Estrilda astrild*
Red-cheeked Cordon-bleu	*Uraeginthus bengalus*
Blue-capped Cordon-bleu	*Uraeginthus cyanocephalus*
Purple Grenadier	*Granatina ianthinogaster*
Green-winged Pytilia	*Pytilia melba*
Red-billed Firefinch	*Lagonosticta senegala*
Cut-throat Finch	*Amadina fasciata*
Bronze Mannikin	*Spermestes cucculatus*
African Silverbill	*Euodice cantans*
Mountain Wagtail	*Motacilla clara*
African Pied Wagtail	*Motacilla aguimp*
Yellow-throated Longclaw	*Macronyx croceus*
Pangani Longclaw	*Macronyx aurantiigula*
Grassland Pipit	*Anthus cinnamomeus*

Plain-backed Pipit	*Anthus leucophrys*
African Citril	*Crithagra citrinelloides*
Reichenow's Seedeater	*Crithagra reichenowi*
Brimstone Canary	*Crithagra sulphurata*
Streaky Seedeater	*Crithagra striolata*
Thick-billed Seedeater	*Crithagra burtoni*
Cinnamon-breasted Bunting	*Emberiza tahapisi*