A photograph of a lioness on Lewa Wildlife Conservancy

Research and Wildlife Monitoring Report

Q4 2015

By

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ACKNOWLEDGEMENT

The department is pleased to have had a very productive year in which numerous new developments and increased capacity for our work was achieved through the assistance of many stakeholders, experts and students. The Marwell Wildlife (MW) and University of Southampton’s MRES field course was hosted on Lewa for the third consecutive year. The alumni of the 2014 course provided the first ever census of hyena on Lewa and Borana Conservancy. Thanks to Elizabeth Preston for this important information that has led to the implementation of detailed studies on our apparently healthy hyena population. Sri Lankan student Surendranie Cabral studied the impact of elephants on exclusion zones in relation to insecurity in Lewa’s neighbouring landscapes.

Several manuscripts were published in peer-reviewed journals this year including a revealing description of Lewa’s fence breaking elephant behaviour by our own Dr. Matthew Mutinda and Geoffrey Chege. Not less than four papers were published by our team, led by Marc Dupuis-Desormeaux of the Lewa Canada Board, as part of his PhD. study. Marc will be defending his thesis in April 2016.

In the year, the department formally initiated collaborative wildlife monitoring activities with Borana Conservancy, thus establishing the long-term goal of expanding the monitoring and evaluation of ecosystems and wildlife over the wider landscape. We are energized by this development and thrilled to have Sam Taylor and his colleagues as extended members of our dedicated team.

Finally, we would like to thank the following individuals and institutions for their technical, financial and in-kind support to on-going research and monitoring activities on the Conservancy: The Board of Lewa in Kenya, USA, UK and Canada, Northern Rangelands Trust, Save The Elephants, The Borana Conservancy Board, Management and field monitoring teams, entire Management of Lewa, Al Ain Zoo, Zurich Zoo, Pettus Crowe Foundation, Zurcher Tierschutz, American Association of Zoo Keepers, Zoological Society of London, Kenya Wildlife Service, Susannah Rouse and members of the Lewa Conservation Committee.
EXECUTIVE SUMMARY

All information in this report pertains to research and monitoring performed on the Lewa and Borana Landscape (LBL) in 2015. We would like to note that the integration of the Borana Conservancy in our monitoring protocols is a work in progress. As such a number of elements are still being developed and results may not be available uniformly at this time. We will continue to develop these protocols over time and anticipate that future reports will include more ‘global’ results.

The Lewa Research Department (LRD) now intensively monitors 12 species of herbivores and carnivores in an effort to understand population trends and behaviour. An ecosystem-based approach to monitoring habitat and wildlife assemblages is being adopted to provide holistic insights to the management of the LBL. In addition, annual aerial game counts are undertaken to develop population trends and performance indicators, water resource monitoring using river flow gauges and rainfall data, and extensive vegetation monitoring of grazing availability and quality are regularly carried out.

Lewa has engaged with the Northern Rangelands Trust (NRT) to develop their Livestock to Market Programme. Lewa is using an intensive grazing programme where cattle are quarantined on the LBL to stimulate increased grass species diversity and improve grazing quality for wildlife.

Please note that indexed lists of figures and tables are found at the end of this report.

Rhino monitoring

The populations for black and white rhino on LBL is monitored and evaluated along similar guidelines as published for black rhino by Du Toit et al., 2001.

Rhino are continuously monitored and sighting frequencies reported to provide constant feedback on security, health, condition and location of each individual. With sighting frequencies of 1.6 days for black and 1.4 days for white rhino, we know that the black rhino population on Lewa and Borana stood at 61 and 20 animals respectively while the white rhino population was 70 at the close of 2015. Population performance benchmarks for these species are summarized for our landscape in Table 3.1.

Despite observed damage of woody vegetation habitat by elephant as well as the translocations out of the Lewa population, rhinos in the LBL are considered healthy and productive, within recognized performance limits. Body condition for rhino has been monitored on an ad hoc basis on Lewa. In 2015, concerns over black rhino health led to a review of their body condition scores and were found to be above average (see section 3.2.1.5). In future, the LRD will adopt a protocol of assessing a sample of the rhino for body condition annually, in the dry season and focusing on lactating females and geriatric individuals.

Based on the year’s review of population performance, it is recommended that additional translocations be considered to mitigate against the risk of skewed sex ratio in both black and white rhino populations. We recognize that Ecological Carrying Capacity (ECC) is a difficult metric to use as a continuous indicator for determination of population size. However, based on the 2004 estimates, Lewa is potentially close to...
its ECC of 70 black rhinos. ECC has never been calculated for white rhino. The LRD is investigating methodologies for a more fine scale assessment of wildlife carrying capacity in general.

**Predator monitoring**

The LRD has monitored lion intensively for 14 years. However, the first comprehensive systematic census for lion and hyaena was undertaken in 2015. The LRD will intensify monitoring and research of large carnivores in future but this report will focus on these two species in detail.

**Lion**

The known population of lion on the LBL stood at 34 animals, with an adult sex ratio of 1:1.6 (male to female). The change of territorial males on the LBL since the removal of Mufassa (PAC) in 2014 has resulted in several socio-spatial consequences for prides and coalitions alike. Population performance appears to have slowed down as seven cubs were born in 2013 (one died of unknown causes), but only two in 2014 (both died when the mother abandoned them) and 2015 respectively. Population performance benchmarks are presented for lion in Table 4.1. The removal of territorial males is known to cause major perturbation effects in highly socialized carnivores (Tuyttens *et al.*, 2000). These observations are indicative of such a disturbance in the LBL population; however, this is not necessarily a negative result. Previous reports have indicated the need to reduce or manage the lion population to minimize the effects of predation on endangered species and a proposal for the trial of ‘non-lethal’ management of lion within the LBL is currently awaiting review by the Kenya Wildlife Service (KWS) Board’s Conservation Committee.

Home ranges of lion generally overlapped by an average of 3.4%. However, core territories were distinct for each group. The fact that each group has a defendable core territory that does not overlap with their neighbours indicates that the lion population has a stable socio-spatial structure, where there are enough resources of habitat and food to support current numbers.

Dispersal of young lion in the Lewa population has been documented from collar telemetry and sightings data. A complex exchange of individuals between groups and properties has taken place and the movement of one individual, known as Yas, is presented to demonstrate the fluidity in the LBL lion population. Dispersal is vital to the health and survival of lion populations and the LRD is making an effort to understand how these groups are interacting in order to enable careful management of lion and their prey species.

Predation as measured for lion using Jacob’s selectivity index showed no significant difference in prey selection between 2014 and 2015. Predation by lion on critically endangered black rhino and endangered Grevy’s zebra has been a cause of major concern on Lewa. However, results indicate that these species are not targeted disproportionately to their availability. Thus, while an increase in lion numbers will represent a potential, proportional increase in predation of these species, their decline may not be directly attributed to predation by lion alone.
Hyaena

Monitoring hyaena has become a focal research area during 2015. Starting with the census of an estimated 80 animals on the LBL (Preston, 2015), the department is developing matched protocols for assessing predation and socio-spatial characteristics for use in comparison with the lion population. 11 hyaena dens have been located and mapped. These locations were earmarked for the deployment of GPS/GPRS collars and to allow regular follow-up monitoring of these groups to commence in Q1 2016.

Hyaena are voracious and effective predators. They range widely and are a highly adaptive species. Their contribution to large carnivore dynamics is not well understood generally and has not been documented on the LBL. Thus, this new area of work will seek to characterize their behaviour and impacts on the LBL.

Other large carnivores

Leopard (8) and cheetah (9) have been documented on LBL and individuals have been identified. Little work has been done on their ranging behavior or foraging dynamics to date, however, the LRD does intend to begin more detailed follow-up monitoring of these species as time and capacity allow. Most reports on these species as well as those of wild dog are generated from tourist sightings and field ranger reports. As a first step in developing monitoring protocols, we will begin to collate these reports and collect relevant demographic and territorial information from them.

Ungulate monitoring

To begin with, five species of ungulates were targeted for monitoring to develop protocols that would be applied to additional species as capacity was developed. By the close of 2015, seven ungulate species were being intensively monitored. More species will be added in time to provide a representative sample of the major groups including comprising of both Artiodactyla (even-toed ungulates) and Perissodactyla (odd-toed ungulates).

Ten year trend data for intensively monitored species is presented and discussed in terms of population performance. Owing to the fact that individual recognition among these species has not yet reached a repeatable and reliable level, we are not able to estimate standard vital rates for these populations. However, their age structure and proportional composition is compared seasonally to provide an indication of population stability. Most populations are dominated by adults and have low proportions of sub-adults and foals. This is of some concern as such a structure is indicative of shrinking population numbers.

Similar to other ungulate species, Grevy’s zebra showed no significant seasonal change in the population age classes. The survival rate for foals remained below the recommended 50% (Rubenstein, 2004). Grevy’s zebra remain one of the most utilized prey species for lion, although selectivity indexes show that they were taken in accordance with their availability. This means that they are not targeted specifically and hence may not be disproportionately preyed upon. Where lion and Grevy’s zebra exist on the same habitat, predation will remain a management issue because recruitment potential of foals and juveniles will be impacted.
Lewa and Borana landscape continuity

Between 2014 and 2015, the internal boundary fence between Lewa and Borana was partially removed. Some sections of this fence still remain in the form of exclusion zones. These allow all ungulates except giraffe and elephant to access the areas protected. The removal of the fence allows Lewa and Borana to be one continuous landscape. Following the removal of the fence, wildlife movement across the boundary point known as the Western gap has continued to be monitored since this is the only access point for elephant and giraffe crossing between the two properties.

Problem elephant monitoring

2015 recorded a significant reduction in fence breaking incidents. This was as a result of upgrading of the exclusion zone fences in five areas. The new fence configuration consists of 2 strands of wires and 1 metre long fixed outriggers or “stingers”.

Seven bulls have been identified for de-tusking due to their persistence in breaking fences. These are Michael, Tesh, Obote, Gumo, Livondo, Mwitia and Mokiri.

Some of the de-tusked individuals have been accessing exclusion zones by pushing over fence posts, snapping wires or crawling under the fence. Elephant slowly learn new tactics of breaking fences. Active monitoring will be continued to inform the efficiency of the management options undertaken and what can further be done to solve emerging issues. In this report, an assessment and recommendations are provided to shed light on further management opportunities for the control of fence breaking elephant which include: additional reconfiguration of remaining exclusion zones; and investigation of total exclusion from certain areas with rotated access for managing browser species. KWS have recently authorized the translocation of six problem elephant from LBL to Tsavo.

Rangeland management

Grass assessment

Biomass of grass and species diversity has been monitored on Lewa since 1996. More recently, a grazing management plan including grassland assessment protocols were developed (LRD, 2014). This is the major monitoring and evaluation tool employed to assess the quality of rangeland and fodder available to grazing species on Lewa. The LRD will expand rangeland monitoring to the Borana area in 2016.

Controlled cattle grazing

A total of 2,728 heads of cattle from NRT Trading grazed on Lewa utilizing 8,512 acres in 2015. Grazing reduced grass biomass in every grazed block. Subsequent data collected to monitor the changes in biomass showed that it slowly returned, accumulating to almost the same levels as it was before grazing, after one to two rainy seasons, unless re-grazing occurred.

There was no change in vegetation cover. Changes in vegetation quality as measured by the level of greenness and species diversity showed that both parameters increased during the wet season.
From these results, re-grazing should be encouraged after every growing season especially on areas with low species diversity.

Mowing

Mowing the unproductive grasslands was suggested as a complimentary activity to cattle grazing and a trial was proposed. However, only 70 acres out of the marked 574 acres were mowed owing to the early onset of rains and the expense of the exercise. Further mowing is planned for September - October 2016 to complete this trial.

Initial results showed a significant reduction in biomass from mowing, and where grazing and mowing was combined, this effect was amplified. Grass species diversity was high on both treatment types, i.e. “grazed and mowed” and “grazed”, but lowest on “control sites”. There was no significant effect on the proportional vegetation cover by any treatment.

An assessment of the impact of these methods is planned as part of an MSc. study in 2016. Based on the recommendations from this work, and depending on resource availability, mowing may be considered on a larger scale than that which is currently being undertaken.

Woody vegetation assessment

The highest levels of woody vegetation damage were recorded for Acacia tortilis and A. mellifera. Most of the damage was perpetuated by elephant and giraffe through feeding and trampling. Conversely, rhino and impala caused the least woody vegetation damage.

Some damaged trees were visually observed to recover through coppicing from the base of old stumps. There was a low proportion (0%) of seedlings encountered in woody vegetation sampling plots (n=28). This is of great concern for the regeneration of woody vegetation on Lewa. The LRD will be focusing on addressing this issue in 2016 by expanding monitoring of damaged and destroyed trees and quantifying the trees lost to other causes such as salinification from rising swamp water levels, diseases and insect infestation. Recommendations for the reseeding and regeneration of woody vegetation are provided in section 8.3.

Wildlife corridors

The loss of habitat and land fragmentation is one of the major contemporary threats to biological diversity. In some areas, corridors have become one of the tools of connecting fragmented landscapes for biodiversity conservation. The LBL has been monitoring wildlife movements along existing migratory corridors/gaps by use of camera traps. The seasonal analysis for all migratory gaps for the year was completed. Results indicate that wildlife moved into and out of the LBL depending on the seasons. This indicates that foraging and water resources may be predominant factors influencing the movement patterns of wildlife.
Measurement of rainfall

Environmental variables including rainfall are some of the factors that determine the performance of rangelands and wildlife species in an area. On Lewa, the annual rainfall has been measured on several sites with the long-term mean averaging 505 mm. In 2015, Lewa received 531 mm compared to 404 mm in 2014. However, the average amount of rainfall received annually between 2011 and 2015 was within the long-term mean range. In 2016, the LRD will commence measurement of other weather variables including temperature and humidity to further our understanding of the environment within LBL.

Conclusion

On-going monitoring and research work on Lewa indicate that majority of the wildlife species have either been stable or slowly declining in numbers. This excludes buffalo, warthog and hartebeest. Equally, whereas a number of rangeland manipulation techniques have been undertaken, changes have been observed in both the condition of woodlands as well as the grasslands. Continued monitoring and research of both the intra and interspecific interactions of wildlife, and the associations with the environmental variables is recommended in order to understand further majority of the factors contributing to such fluctuations. In addition, since the last estimates of the ECC of most wildlife on Lewa were completed in the late 1990’s, it is suggested that intensive population modeling be undertaken in order to set revisable ECCs for managing these species on the LBL. For the objectives of wildlife health and wellbeing, as well as to position LBL as a source of wildlife for restocking of adjacent and more distant habitat, it is important to maintain viable and stable wildlife populations.
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CHAPTER 1

1.0 INTRODUCTION

This report presents the wildlife, environmental and spatial ecology information and analysis generated on Lewa Wildlife Conservancy, Borana Conservancy and where applicable, within the Greater Conservation Area (GCA). In this report, the performance of the population of some of the threatened species as well as habitat is presented in the context of the relatedness with environmental variables.

In 2015, the department formally initiated collaborative wildlife monitoring activities with Borana Conservancy, thus establishing the long-term goal of expanding the monitoring and evaluation of ecosystems and wildlife over our immediate landscape and thus contributing to regional conservation effort.

The year ended with promise as we hosted Conservation Directors and teams from the Smithsonian Conservation Biology Institute (SCBI), San Diego Zoo Global (SDZG) and Marwell Wildlife (MW). We planned out a detailed “Road Map” for the development of core competencies in spatial ecology, population biology, genetics and education outreach. Drawing on the extensive experience and skill sets of these partners, we anticipate a groundswell of training and technology transfer at Lewa.

This Q4 2015 report will outline in detail the activities undertaken by LRD in 2015 on the Conservancy and also in Borana, providing interpretation from various programs and management recommendations where applicable.
The LBL area is bisected by the Ngare Ndare River valley and a minor escarpment of hills to its west. These features form a physical barrier separating Lewa’s lower (average 1,700 m) and Borana’s higher (average 1,940 m) elevations. The escarpment runs from South to North along the boundary and forms part of the East to West oriented Ngare Ndare Forest zone to the south. Wildlife access between the two properties is more frequently made using this forested zone and the dividing fence line that was dropped in 2014. The conjoined properties now bring the total area under the LRD’s monitoring umbrella to 391 km².

The LBL is centered on 37.36247 E and 0.25106 N and connected to other conservation areas in the landscape through wildlife gaps and a corridor to allow free movement of wildlife into and out of the Conservancy (Cabral, 2014 and Fig. 2.1). Following the removal of the fence line between Lewa and Borana, movement of wildlife (mainly elephant and giraffe) between these areas is still monitored through the old Western gap, which used to provide one point of linkage. The only other linkage is the Sirai gap on Borana’s southern boundary with the Ngare Ndare Forest (Fig. 2.1). The Western gap remains in place as a short, low stone wall and is monitored by a single Reonyx HC60 Hyperfire camera trap. Despite the removal of the internal fence, animals still appear to be habituated to crossing here. Two exclusion zones are in place between the properties along the boundary line, however, the other relatively smaller-bodied animals can cross under the 2-strand exclusion zone fences. Connection to the northern rangelands is via the Northern gap on the Lewa side, and Oreteti and Sanga gaps on the Borana side. On Borana, Gatumo gap is on the western boundary, while linkage to Mount Kenya is through the Mount Kenya Elephant corridor (Fig. 2.1).

The landscape is dominated by red clay and black cotton soils with a topsoil depth extending several meters deep. These soils are broken in places by sandstone outcrops forming numerous kopjes and giving way to the west of Borana to Gatumo plains and to the North of Lewa to a series of deep lava and granitic rock valleys. The LBL lies between the ecological zones of montane forest and semi-arid savannah grasslands. *A. seyal* and *A. drepanolobium* are the abundant plant species at higher altitudes while *A. mellifera*, *A. tortilis*, *A. nilotica* and *Commiphora* spp are abundant in lower altitudes. Consequently, the LBL has a diversity of habitat types including expansive grassland plains, steep hill slopes and riverine valleys with high altitude forest, acacia woodlands and savanna biomes. These have been classified into several ecotones.

Average temperatures range from 12 – 25°C and rainfall varies across the landscape but generally averages 505 mm p.a. Environmental conditions of rainfall, cloud cover/solar radiation and wind have become increasingly variable in recent years. However, rainfall follows a bimodal distribution pattern with long rains received from March to May and short rains received from October to December (Chege et al., 2006). Unpredictable rainfall often occurs between these times.
2.1 Landscape and management connectivity

In 2015, the LRD commenced collaborative wildlife monitoring with Borana Conservancy. To date, monitoring of rhino and predators has already been implemented and plans are underway to initiate elephant and ungulate monitoring in Q1 2016. Data for these activities were collected in a similar version as reported in the LRD Annual Report, 2014.

Note: For the current reporting period, the Lewa and Borana properties are analysed separately. This is to allow visibility of the populations’ coalescence as they get used to the new connectivity and habitat availability across the wider landscape. We anticipate that by Q2 2016, we will be able to amalgamate databases and report on the populations and landscapes as a single cohesive unit.
CHAPTER 3

3.0 RHINO MONITORING

3.1 Introduction

The success of rhino populations on the LBL is testimony to the dedicated investment in both wildlife security and ecological conservation on these properties. To have an overpopulation of a species is rare in modern conservation despite the ever increasing onslaught from poaching, diseases and environmental change. Over the years, the LBL populations of black and white rhino have performed exceptionally well and are only being kept in check by the application of intensive population management through translocations (from Lewa). In the five years (inclusive) between 2011 and 2015, total population numbers for black rhino on Lewa have been at the 2004 ECC levels in all but the years in which translocations occurred i.e. 2013 and 2015.

Working closely with KWS, NRT and Borana, Lewa has provided sound and successful precedents for the relocation of its black rhino stock to suitable and secure new habitats. This is a model whereby protected areas such as Lewa and Borana are contributing directly to species survival and the development of Kenya’s national wildlife heritage as well as the livelihoods, health and wellbeing of her people.

3.2 Results and discussion

3.2.1 Black rhino population biology

3.2.1.1 Population performance

The population of black rhino on Lewa was reduced to 61 from 70 animals by the translocation of nine animals to Sera Conservancy in 2015. This population had been increasing through reproduction until 2011, when it reached the ECC of 70 animals (Fig 3.1a). Within the same year, the population of black rhino in Borana remained at 20 animals (Fig. 3.1b). In the year, six births and an equal number of deaths were recorded on Lewa, while two births and one death were registered in Borana (Fig. 3.1a & 3.1b).

Figure 3.1a: Trend in the population of black rhino on Lewa, 2002 – 2015

Figure 3.1b: Trend in the population of black rhino in Borana, 2013 – 2015
**3.2.1.2 Biological growth rate**

In 2015, the population of black rhino on Lewa recorded a growth rate of -13%, which was the lowest since 2002 (Fig. 3.2a). This was as a result of the translocation of nine animals to Sera Conservancy. Similarly, there was a negative growth rate in 2013 (-11%), again, this was as a result of the translocation to Borana Conservancy as opposed to low reproduction or increased mortality. Apart from these two years, since 2002, the annual growth rate of Lewa’s black rhino has been varying with most years registering >6% p.a. rate which is the minimum recommended at the national level (KWS, 2012). The Borana population recorded a growth rate of 5.3%. In 2014, this population registered a negative growth rate (-9.5%) due to deaths and a returnee to Lewa (Fig 3.2b). Newly introduced populations are likely to suffer negative growth rate from low reproduction and deaths as they adapt to the new environment.

![Figure 3.2a: Black rhino growth rate on Lewa between 2002 – 2015](image)

![Figure 3.2b: Black rhino growth rate on Borana between 2013 - 2015](image)

**3.2.1.3 Mortality rate**

Six black rhino deaths were recorded on Lewa while one black rhino death was recorded on Borana (Table 3.1). This represented a 9.8% p.a. mortality rate, which was rated as “very poor” performance (du Toit et al., 2001). Due to the loss of the three rhino, most likely to hyaena, an intensive carnivore study on this predator has been planned to commence in Q1 2016. To mitigate further mortality of the hand raised rhino, the remaining two have been quarantined and moved to a new boma1 as a precaution to ensure that the calves remain healthy.

<table>
<thead>
<tr>
<th>Name</th>
<th>Cause of death</th>
<th>Date of birth</th>
<th>Date of death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samia’s Calf 4</td>
<td>Predation</td>
<td>22nd Feb, 2015</td>
<td>20th March, 2015</td>
</tr>
<tr>
<td>Sala’s Calf 3</td>
<td>Predation</td>
<td>30th April, 2015</td>
<td>17th May, 2015</td>
</tr>
<tr>
<td>Craig</td>
<td>Died during capture</td>
<td>12th December, 2009</td>
<td>23rd May, 2015</td>
</tr>
<tr>
<td>Aura</td>
<td>Poached</td>
<td>13th November, 2011</td>
<td>2nd July, 2015</td>
</tr>
<tr>
<td>Kilifi</td>
<td>Disease</td>
<td>12th June, 2013</td>
<td>16th August, 2015</td>
</tr>
<tr>
<td>Zenetoi’s Calf 1</td>
<td>Predation</td>
<td>1st March, 2015</td>
<td>22nd August, 2015</td>
</tr>
<tr>
<td>Hope</td>
<td>Disease</td>
<td>25th February, 2015</td>
<td>29th September, 2015</td>
</tr>
</tbody>
</table>

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1 A secure enclosure for cattle or wildlife where they are enclosed during the night for observation or security
3.2.1.4 Sex ratio
The sex ratio of adult males to females on Lewa was 1:1.4 which is considered as “moderate to good” (du Toit et al., 2001) (Table 3.2). However, there is concern over the sub-adult and calf sex ratios on Lewa which are heavily skewed towards males. In the current population, 54% and 63% of the sub-adults and calves respectively are males. This suggests a potential overpopulation of adult males within the next five years. This may lead to an increase in fatal territorial competition. Furthermore, fewer numbers of females being recruited to the breeding class will translate to low births and hence reduced growth rates. The sex ratio of adult males to females in Borana was 1:1 which is considered as “good – excellent” (du Toit et al., 2001).

3.2.1.5 Inter-calving interval and age at first calving
The inter-calving interval (ICI) is one of the main indicators of reproductive performance in a rhino population. Lewa’s ICI averaged 2.7 years while mean age at first calving was 7.4 years. These two benchmarks were rated as “moderate to good” (Table 3.2). These metrics were calculated for 13 breeding females indicating that the majority of them were performing well (Appendix 2). However, Solio and Natumi have longer mean ICI (≥3.0 years). These individuals have the same blood line and further investigation is required to determine the contributing factors.

The Borana ICI averaged 2.3 years while mean age at first calving was 7.8 years (Appendix 3). This is a newly introduced population thus these means are likely to change with time as the population adapts to the habitat.

3.2.1.6 Body condition assessment
The body condition of six black rhino was assessed following concerns raised over their health. The assessment followed a scale of 1 – 5 where 1 represents “very poor” and 5 is “excellent” condition (Adcock & Emslie, 2003). On average, four animals had a mean score of 3.5 while two (Zaria and Samia) scored an average of 3.0. Zaria was in her early lactation while Samia had been limping for more than one year hence her movements may have been restricted. This may have reduced her feeding efficiency contributing to her lowered body condition. However, after the October rains, the body condition score of both females was raised to 3.5 due to improved condition of the browse.

From 2016 onwards, the body condition scores in the LBL will be completed for all independent rhinos in the dry months of July – September. Where necessary, interventions including supplementary feeding will be initiated.
### 3.2.2 White rhino population biology

#### 3.2.3.1 Population performance

In 2015, the white rhino population on Lewa increased from 65 to 70 animals. This population has been increasing through reproduction with six births and one death recorded in the year (Fig. 3.3; Table 3.3).

**Figure 3.3**: Trend in the population of white rhino on Lewa, 2002 – 2015

#### 3.2.3.2 Biological growth rate

In 2015, the Lewa population recorded a growth rate of 8% (Fig. 3.4). Since 2002, this population has been showing varying positive growth rates apart from 2005 and 2012 where negative growth rates were registered as a result of deaths. The growth rate figure in the last three years has not showed much variation, possibly because the number of breeding females has not changed.
### 3.2.3.3 Mortality rate
The white rhino recorded a 1.4% mortality rate at the end of 2015. This was attributed to the loss of one female that succumbed to fight wounds sustained from a bull that was mating with her. She had been treated on 2\textsuperscript{nd} November, 2015 for deep wounds on her right leg two weeks before her death.

### 3.2.3.4 Sex ratio
The sex ratio of adult males to females was 1:1. A difference was noted in the calf age class where 64% of the calves born were males. This projects a male dominated white rhino population in the next five to ten years when most of these calves mature into adults. The same scenario presents itself in the sub-adult age class where 64% are males. This may lead to increased territorial fights that can be fatal.

### 3.2.3.5 Inter-calving interval and age at first calving
The average ICI was 2.5 years and mean age at first calving was 7.2 years. These metrics were calculated for 13 breeding females indicating that majority of these females were performing well (Appendix 4).

#### Table 3.3: Lewa’s white rhino population performance compared against standard benchmarks (du Toit \textit{et al.}, 2001)

<table>
<thead>
<tr>
<th>Population Indicators</th>
<th>Very Poor</th>
<th>Poor - Moderate</th>
<th>Moderate - Good</th>
<th>Good - Excellent</th>
<th>Lewa Performance</th>
<th>Lewa Performance Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth Rate (%)</td>
<td>&gt;2.5</td>
<td>2.5 to 5</td>
<td>5 to 7.5</td>
<td>7</td>
<td>8</td>
<td>Good - Excellent</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>&gt;4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.4</td>
<td>(not classified)</td>
</tr>
<tr>
<td>Sex Ratio (M:F)</td>
<td>1:&lt;1</td>
<td>1:&lt;1</td>
<td>1:1</td>
<td>1:1</td>
<td>1:1</td>
<td>Moderate - Good</td>
</tr>
<tr>
<td>ICI (Years)</td>
<td>&gt;3.5</td>
<td>3 to 3.5</td>
<td>3 to 2.5</td>
<td>&lt;2.5</td>
<td>2.5</td>
<td>Moderate - Good</td>
</tr>
<tr>
<td>%FC</td>
<td>&lt;29</td>
<td>29 to 33</td>
<td>33 to 40</td>
<td>&gt;40</td>
<td>33</td>
<td>Moderate - Good</td>
</tr>
<tr>
<td>AFC (Years)</td>
<td>&gt;7.5</td>
<td>7 to 7.5</td>
<td>7 to 7.5</td>
<td>6.5</td>
<td>7.2</td>
<td>Moderate - Good</td>
</tr>
<tr>
<td>%CP</td>
<td>-</td>
<td>&lt;28</td>
<td>=28</td>
<td>-</td>
<td>30</td>
<td>Moderate - Good</td>
</tr>
</tbody>
</table>

**Key:**
- ICI - inter-calving interval
- %FC – Percentage of female calving per year
- AFC – Age at first calving
- %CP – Proportion of calves (<3yrs) in population

**Figure 3.4:** White rhino growth rate on Lewa, 2002 – 2015
3.3 Spatial ecology

3.3.1 Sighting frequency
The average sighting frequency (SF) for black rhino on Lewa was 1.9 days and 1.3 days in Borana. The white rhino on Lewa had a SF of 1.4 days. In the dry season, the SF for black rhino was noted to increase to 2.0 days mainly because resources may have become limiting, forcing the rhino to extend their ranging areas. In addition, there has been an increase in the number of “clean” independent rhino in both species thus presenting difficulties in identification. Consequently, 18 candidates (14% of the population) were identified for ear-notching to facilitate rapid identification hence maintaining daily SF at <3 days as per LBL’s standard operating procedures.

3.3.2 Rhino home ranges

3.3.2.1 Black rhino
Black rhino on Lewa tend to maintain consistent home ranges over time. Within the LBL, black rhino were observed to avoid utilizing the open areas (Appendix 5). The males translocated to Borana have already established home ranges conspicuously avoiding the western sector. Resource availability mainly browse and cover may be a driving factor.

The translocation of some of the males from Lewa to Sera Community Conservancy and the removal of the Lewa - Borana boundary fence line contributed to home range shifts of two male black rhino, Muturi and Elvis (Fig. 3.5).

![Figure 3.5](image.jpg)

**Figure 3.5:** Ranging areas of Muturi and Elvis before and after translocation of some males from Lewa to Sera Community Conservancy in May 2015

3.3.2.2 White rhino
The white rhino on Lewa mainly utilized the central, eastern, and northern areas of the Conservancy (Appendix 6). During the dry season, some rhino extended their home ranges to areas close to permanent water sources especially the central areas. White rhino are known to inhabit grassy savannah and open woodlands.

---

2 A rhino with no obvious features for identification such as ear-notches
3.4 Conclusion and recommendation

With respect to the sex ratio of black rhino, which is skewed towards males, in the next five years, the management of LBL will need to consider translocations of males to mitigate against the risk of intra-specific competition. Such a translocation should also be replicated in the white rhino population.

Though Lewa’s identifiable population exceeds the 70% required to estimate rhino populations (KWS, 2012), for accurate rhino reporting, the Management could consider investing in a routine ear-notching operation to facilitate in identifying the clean rhinos.
CHAPTER 4

4.0 PREDATOR MONITORING

4.1 Introduction

The LBL is home to diverse carnivores that include lion, wild dog, leopard, cheetah, hyena and a large number of smaller-body sized carnivores. These species are known to thrive well within this landscape and sometimes disperses into the GCA.

Similarly, LBL holds a large number of herbivore species that form the main prey base for the carnivores. In addition, the area hosts significant populations of threatened prey species including 12% of the world’s remaining wild population of Grevy’s zebra, and 12% and 14% of Kenya’s black and white rhino populations respectively. Monitoring the impact of lion on the prey base has been on-going since 2003. Information on the impact of predation by hyaena has been limited. Thus, to enhance our understanding of predator prey dynamics in the LBL, monitoring of hyaena will be implemented in 2016.

4.2 Lion population biology

4.2.1 Population performance

The lion population on LBL was calculated to be 34 animals. The Lewa population reduced to 17 from 25 in 2015. In the year, two cubs were confirmed dead. Four adult males dispersed to Borana Conservancy and a further two (1 male and 1 female) dispersed to an unknown destination. The growth of this population appears to have slowed down through deaths and emigration. This may have resulted from the loss of Mufassa, one of the territorial males in 2014, resulting in spatial perturbation and population reduction (Loveridge et al., 2007). The population performance for the Lewa lion population is presented in Table 4.1.

The current age and sex structure of lion on LBL consists of 7 adult males, 4 sub-adult males, 11 adult females, 2 sub-adult females, 2 female cubs and 8 cubs which have not been sexed (Appendix 7).

Table 4.1: Lion population performance on Lewa, 2014 - 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Births</th>
<th>Deaths</th>
<th>Dispersal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>2015</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>17</td>
</tr>
</tbody>
</table>

4.3 Spatial ecology

4.3.1 Lion home range

There are currently three distinct female prides on Lewa namely, Sarah’s, Dalma’s and Linda’s groups. The ranging areas for all lion groups overlapped, but the core ranging areas showed no overlap (Fig. 4.1 and 4.2). These ranging areas were nested along the river lines. The presence of water sources is beneficial for lion since water attracts prey species that utilise densely vegetated areas, especially riverine (Rogers & O’Keefe, 2003; Orsdol, 1984; Venter et al., 2003). Furthermore, this habitat is generally comprised of canopied acacia woodlands and thickets that provide good ambush and cub concealment.
Of all the lion groups on Lewa, Sarah and Linda’s ranging areas were the largest at 92 km² and 65 km² respectively. The two groups had cubs that graduated into the sub-adult age class in the year. This is in line with what was reported by Loveridge et al., 2009 where female lion home ranges increase with an increase in pride biomass.

In Borana, there was only one male group known as Yas coalition that was mapped using GPS collar data. This group, comprising of five males, spent 83% of their time in Borana while the remaining 27% of the time was spent on Lewa, Ole Naishu and Ngare Ndare Forest (Fig. 4.3). This coalition was noted to have established territory in Borana. Young males are likely to disperse from their natal home range and establish their territory on new landscapes. These movements indicate the importance of connectivity between suitable habitats which is vital for the survival of large carnivore populations within the GCA.

![Figure 4.1: Map showing the ranging areas of Linda’s group](image1)

![Figure 4.2: Map showing the ranging areas of Sarah and Dalma’s groups](image2)

![Figure 4.3: Map showing the ranging areas of Yas’s group](image3)
4.4 Predator-prey interaction

4.4.1 Wildlife mortality

On Lewa, a total of 153 wildlife mortality cases were recorded compared to 200 cases in 2014. On Borana, a total of 57 cases were recorded. Mortality cases on Borana were only from lion kills.

At 81%, predation was the main cause of mortality of wildlife on Lewa. This was followed by unknown causes (13%) while electrocution or entanglement on the various management fences contributed to 6% of the mortality cases. Lion were the main predator species responsible for wildlife deaths recording the highest number of kills (91 %). This was followed by cheetah at 8% and the remaining 1% by leopard. There was no death recorded as caused by hyena.

The number of deaths resulting from electrocution or entanglement doubled in 2015 compared to the previous year, affecting three species: impala, giraffe and Grevy’s zebra. The giraffe and Grevy’s zebra cases occurred along the northern main boundary fence line while impala were trapped within the internal fences. Although fences seem to effectively protect wildlife and reduce human-wildlife conflicts, they can cause deaths as the animals get entangled and killed while attempting to leave or enter the fenced habitat to access other landscapes (Dupuis et al., 2015).

Calculation of the Jacob’s Index (D) showed no significant difference in prey selectivity levels on Lewa between 2014 and 2015 (t=-0.10, df=14, p=0.918) (Tables 4.2 and 4.3). Warthog were consistently the most highly selected according to their proportional availability. Warthog are relatively slow compared with other ungulates (Estes, 1999) and poor at evading predators at the subduing stage of the hunt (Elliott et al., 1977). Buffalo, oryx and impala were avoided by lion. These species mainly graze in large herds and this strategy provides benefits from many observers which improve detection of the predator through increased vigilance (Hamilton, 1971). The rest of the species including Grevy’s zebra were used in proportion to their availability.

<table>
<thead>
<tr>
<th>Species</th>
<th>Total population</th>
<th>Proportion of kills</th>
<th>Jacob's index (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain’s zebra</td>
<td>956</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Grevy’s zebra</td>
<td>284</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Impala</td>
<td>1021</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Water buck</td>
<td>98</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Eland</td>
<td>204</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Oryx</td>
<td>102</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Warthog</td>
<td>59</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Giraffe</td>
<td>163</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Buffalo</td>
<td>695</td>
<td>-0.8</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>Total population</th>
<th>Proportion of kills</th>
<th>Jacob's index (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain’s zebra</td>
<td>836</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Grevy’s zebra</td>
<td>325</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Impala</td>
<td>814</td>
<td>-0.6</td>
<td></td>
</tr>
<tr>
<td>Water buck</td>
<td>92</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Eland</td>
<td>207</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Oryx</td>
<td>140</td>
<td>-0.6</td>
<td></td>
</tr>
<tr>
<td>Warthog</td>
<td>48</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Giraffe</td>
<td>182</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Buffalo</td>
<td>707</td>
<td>-0.5</td>
<td></td>
</tr>
</tbody>
</table>

4.4.2 Results of scat analysis

A total of 83 scat samples were collected and identified as lion (n=49) and hyaena (n=34) on Lewa. High proportions of Plain zebra and impala hairs were present in both species scat samples (Fig. 4.4 and 4.5). On Lewa, zebra species were the most frequent prey for lion. Hyaena have not been recorded as responsible for any wildlife death; but we note that detecting their kills as separate from lion kills has
not yet been possible. The presence of Plains zebra, Grevy’s zebra, buffalo and giraffe in the hyaena scat is indicative that hyaena are feeding on these species (Kingdon, 2003).

Lewa has records of livestock depredation from the neighbouring communities. However, to date evidence has not been found in scat analysis for either lion or hyaena.

**Figure 4.4:** Proportion of prey species hairs found in lion scat on Lewa, 2015

**Figure 4.5:** Proportion of prey species hairs found in hyena scat on Lewa, 2015

### 4.5 Monitoring of spotted hyaena

In March 2015, LRD hosted an MSc student from the University of Southampton to carry out a study aimed at assessing the abundance and distribution of carnivores on the LBL. The study showed that hyaena population estimates on the study area ranged from 40 to 80, and potentially exceeded the expected theoretical carrying capacity of 50 animals (based on the prey base). However, the lion and leopard populations were below the carrying capacity.

Hyaena have been indirectly implicated in the predation of endangered species including foals of Grevy’s zebra and calves of rhino on Lewa. Thus, there is need to assess the status and impact of predation by this carnivore on both the threatened and commonly occurring prey species.

### 4.6 Conclusion and recommendation

The high and increasing number of wildlife electrocutions or entanglement along the main perimeter fence line is of some concern. Some of this trend may be due to increased vigilance for the causes of mortality, however, the loss of animals to the fence should be reviewed for mitigation action by management.

Excluding warthog, prey selection by lions provided no indication of selectivity for either endangered species or other medium to large-bodied ungulates. While predation was generally in proportion to prey availability, an increasing predator population will inevitably result in proportionally increasing predation on all species. The relative chances of endangered species being preyed upon are therefore greater with a larger predator population. However, the 2015 population performance and spatial ecology of lion on the LBL suggests that the population is in a stable or declining phase owing to the recent changes in population dynamics and distribution. The removal of Mufasa (PAC) may have accelerated the onset of this trend, however it is likely that the lion population is cycling down on a semi-regular, natural pattern that oscillates with both prey availability (also generally decreasing for
most species at present) and home range or territory availability (a negative relationship between territory occupancy and lion population size). This has also been evident in the dispersal of Yas and his cohorts to Borana.

With the current numbers and trend of lion, the manipulation of this population at this stage will need to be considered carefully. Methods to control the population, of which KWS is still required to give approval, may speed up the downward oscillation and potentially maintain the population at lower levels, however, the predator population is performing valuable ecosystem services without which several other related factors could become management concerns:

1) Ungulate populations may indeed increase with a lower lion density. However, the already pressurized browse resources (elephant, giraffe) and grazing availability (low nutritional value *Pennisetum* spp.) would be further stressed. This might ultimately lead to a more systemic reduction of ungulate population which would be much more difficult to reverse given the pace and challenge of landscape restoration.

2) There is well documented evidence of conspecific population explosions taking place when a single species of the large carnivore guild is significantly manipulated. The case of lion removal in the Amboseli resulting in massive increases in hyaena densities:

   “Amboseli [hyaena] population exploded in size, likely resulting from changes in the local prey base and extirpation of the local lion population by pastoralists, and reached a population density of 1.65 hyaena/km² by 2003 – 2005 (up from 0.86 hyaena/km²)” (Watts & Holekamp, 2008).
CHAPTER 5

5.0 UNGULATE MONITORING

5.1 Introduction

The LBL supports a high biomass of herbivores including Grevy’s zebra, Plains zebra, Beisa oryx, hartebeest, warthog, giraffe and eland. Monitoring of these species is important to help us understand their status and condition so that they can best be managed optimally particularly the threatened species. We closely observe annual and seasonal trends to alert us of any local population declines or increases and to warn of risks, which may be mitigated.

Distribution data is currently only available for the hartebeest population which is still small enough to locate all individuals and log their locations regularly. Owing to the methodology for sampling (distance sampled loops), observations of other species does not reflect the entire LBL area. In 2016, we will develop a tool for mapping distribution based on known fixed point locations. This will allow sighting frequencies to be translated into occupancy maps for each of the 11 patrol blocks on Lewa. A similar tool will be developed for mapping distribution on Borana.

Distribution data is important for understanding habitat selection and resource utilisation of wildlife. It will also allow assessments of management interventions on grazing availability and quality.

5.2 Summarised species monitoring results

In this section, we present results and distribution of the seven ungulate species that were monitored in the year. Except the hartebeest and warthog, all the other ungulates were monitored on a monthly basis on five pre-determined loops (Fig. 5.1).
5.2.1 Hartebeest (Lelwel hartebeest, *Alcelaphus buselaphus lelwel*)

**Population performance** (Fig. 5.2, 5.3 and 5.4)

- The population of hartebeest on Lewa rose from 12 to 21 animals through births and immigration from Borana (n=4)
- There were seven births and two deaths in the year (73% survival rate).
- Although Lewa’s population of hartebeest is growing, the numbers are still low and hence the need to closely monitor its growth.
- A similar program of monitoring this species in Borana will be introduced in 2016.

![Figure 5.2: A caption of a Lelwel hartebeest](image)

**Species notes:**

- Distributed on medium to long grass plains
- Preference for *Themeda triandra*.
- Non-cohesive herding behaviour.
- Disburse frequently.
- Diurnal.

**Global Conservation Status:**

*Endangered*
5.2.2 Plains zebra (*Equus burchelli*)

**Population performance** (Fig. 5.5, 5.6 and 5.7)

- Reproduction synchronized September to December.
- The demographic structure: Adult heavy indicating decline ($\chi^2 = 50.097$, df = 2, $p = 0.0001$).
- Population structure consistent seasonally – no change ($\chi^2 = 0.8735$, df = 2, $p = 0.6461$).
- Adult heavy population structure (Fig. 5.6), supports population decline.
- Most utilized species by lion.
- Second most utilized species by hyaena.

**Figure 5.5**: Plains zebra on Lewa, 2015

**Figure 5.6**: Proportional distribution of Plains zebra age classes during dry and wet seasons

**Figure 5.7**: Plains zebra population trend, 2006 - 2015

Species notes:

- Broadly distributed on grassy plains.
- Strong preference for short grass sword.
- Diurnal.

**Global Conservation Status:**

Least Concern
5.2.3 Beisa oryx (*Oryx beisa*)

**Population performance** (Fig. 5.8, 5.9 and 5.10)

- 140 individuals counted in annual census, up from 85 in 2014.
- Highly variable total count data owing to low detectability from aerial counts.
- Adult dominated population, “Inverted Triangle” suggests medium term decline.
- Long-term trend is weak owing to variability in count data.
- Expected that the population is relatively stable.

![Beisa oryx](image)

**Figure 5.8**: Beisa oryx

**Species Notes:**

- Distributed on medium to short grass plains.
- Not water dependent hence found in drier areas of LBL
- Diurnal

**Global Conservation Status:**

Least Concern

![Proportional distribution of Beisa oryx age classes during dry and wet seasons](image)

**Figure 5.9**: Proportional distribution of Beisa oryx age classes during dry and wet seasons

![Beisa oryx population trend, 2006 - 2015](image)

**Figure 5.10**: Beisa oryx population trend, 2006 - 2015
5.2.4 Warthog (*Pachydermus africanus*)

Population performance (Fig. 5.11, 5.12 and 5.13)

- Variation in age class composition between the dry and wet seasons was not significant ($\chi^2 = 2.849$, df = 2, $p = 0.2406$) (Fig. 5.1).
- The lack of difference may mean higher survival rates for the piglets (in the entire year and that there was no significant mortality within the age classes to affect the population age structure).
- The population is well underpinned with juvenile and sub-adult classes indication a strong recovery potential.
- However, the population trend of warthog for the last 10 years indicates a decreasing population (Fig. 5.13).
- The main cause of their decline appears to have been predation by lion.
- Jacob’s selectivity index for the last two years was 0.7, an indication that they were selected disproportionately.
- However, towards the end of the year, the population was seen to increase in numbers reducing the predation threat.

**Figure 5.11:** Warthog on Lewa, 2015

Species Notes:
- Distributed on medium to short grass plains.
- Not water dependent hence found in drier areas of LBL.
- Crepuscular.

**Global Conservation Status:**

Least Concern

**Figure 5.12:** Proportional distribution of warthog age classes during dry and wet seasons

**Figure 5.13:** Warthog population trend, 2006 - 2015
5.2.5 Grevy’s zebra (*Equus grevyi*)

**Population performance** (Fig. 5.14, 5.15 and 5.16)

- No seasonal change in the population age class ($\chi^2 = 1.5685$, df = 2, $p = 0.4565$) (Fig. 5.14).
- Important prey species for lion, however, not selected disproportionately to availability.
- Predation will remain a management issue owing to low recruitment potential of foals into juveniles and to adults (Rubenstein, 2010)
- Recruitment likely the main impact from predation despite consistent foal and juvenile production (Fig. 5.15).
- Long-term trend indicate a gradually declining population (Fig. 5.16).
- However, three-year trend (2013 – 2015) indicates a slowly increasing population.

![Figure 5.14: Grevy’s zebra on Lewa, 2015](image)

**Species Notes:**

- Distributed on long, medium and short grass plains.
- Widely distributed on Lewa, few (3) found on Borana.
- Diurnal.
- Lactating females concentrate in swamp areas and exclusion zones where predation risk is high.

**Global Conservation Status:**

*Endangered*
5.2.6 Eland (*Taurotragus oryx*)

**Population performance** (Fig. 5.17, 5.18 and 5.19)

- Non significant seasonal difference in population structure (Fig. 5.18).
- Population is very skewed toward adults suggesting potential for decline in the short term.
- Not disproportionately predated upon by lions.
- Breeding typically synchronized with rains – not detected for Lewa suggesting low reproductive rate.
- Long-term trend shows a declining trend but with large variation (Fig. 5.19).

![Eland on Lewa, 2015](image)

**Figure 5.17**: Eland on Lewa, 2015

**Figure 5.18**: Proportional distribution of eland age classes during dry and wet seasons

**Figure 5.19**: Eland long-term trend Lewa, 2006 - 2016

**Species Notes:**

- Largest Antelope spp.
- Distributed on short to medium grass plains and in wooded areas
- Mixed feeder – browse and grazing

**Global Conservation Status:**

Species generally least concern
5.2.7 Giraffe (*Giraffa camelopardalis reticulata*)

**Population performance** (Fig. 5.20, 5.21 and 5.22)

- Proportional distribution of age classes differed between seasons, more juveniles and fewer sub-adults detected in the wet season (Fig. 5.21).
- Structure suggests potential for population increase in the short term.
- Concern over browse availability if numbers increase dramatically.
- Long-term trend fluctuates suggesting cycling population numbers. Currently at a low point but increasing in 2015 (Fig. 5.22).

**Figure 5.20**: Giraffe in northern Kenya, 2015

**Figure 5.21**: Proportional distribution of giraffe age classes during dry and wet seasons

**Figure 5.22**: Giraffe long-term trend Lewa, 2006 - 2016

**Species Notes:**
- High impact browsers
- Specialises on Acacia spp.
- Not water dependent hence found over LBL
- Monitoring commenced in Q3 2015

**Global Conservation Status:**
Least Concern
5.3 Movement of wildlife through the migratory gaps

5.3.1 Mt. Kenya End Corridor
During the dry season, there was a significant difference in crossing events with more wildlife moving towards Mt. Kenya ($\chi^2 = 13.8031$, df = 6, $p = 0.0319$) (Appendix 8a). This may have been contributed by resource availability in the forest relative to the rangelands during the dry seasons (Sankaran et al., 2005). In the wet season, differences in crossing events to either direction were not significant ($\chi^2 = 6.6712$, df = 5, $p = 0.2463$). The movement of elephant movement in either direction in both seasons was also not significant.

5.3.2 Mt. Kenya Underpass
There was no significant difference in the number of crossing events in the dry season ($\chi^2 = 4.1688$, df = 5, $p = 0.5254$) unlike in the wet season where there was a significant difference ($\chi^2 = 11.4589$, df = 5, $p = 0.0430$) with more crossing events leading to Ngare Ndare Forest and potentially ending to Lewa (Appendix 8b). Elephant showed no significant difference in crossing events during the dry season ($\chi^2 = 2.6392$, df = 1, $p = 0.1043$) while during the wet season, there was a significant difference ($\chi^2 = 7.5385$, df = 1, $p = 0.0060$) skewed towards the Ngare Ndare Forest.

5.3.3 Northern Gap
There was no significant difference in the number of crossing events in the dry season ($\chi^2 = 11.2158$, df = 6, $p = 0.0819$). During the wet season, the movements were significant, skewed towards Leparua Conservancy ($\chi^2 = 17.2748$, df = 6, $p = 0.0083$) (Appendix 8c). Elephant showed no significant movement through this gap during the dry season ($\chi^2 = 0.3279$, df = 1, $p = 0.5669$), while during the wet season, there was a significant difference ($\chi^2 = 11.8951$, df = 1, $p = 0.0001$) with more events leading out of Lewa. Grevy’s zebra movement was significantly different in both dry ($\chi^2 = 9.0416$, df = 1, $p = 0.0026$) and wet ($\chi^2 = 9.4599$, df = 1, $p = 0.0020$) seasons. More crossing events were recorded towards Lewa during the dry season while more crossing events out of Lewa were recorded during the wet season.

5.3.4 Western Gap
The number of crossing events was significantly different in both dry ($\chi^2 = 25.1878$, df = 5, $p = 0.0001$) and wet seasons ($\chi^2 = 38.6257$, df = 7, $p = 0.0001$). Elephant population showed significant movements in the dry ($\chi^2 = 13.9363$, df = 1, $p = 0.0001$) and wet ($\chi^2 = 11.8951$, df = 1, $p = 0.0005$) seasons (Appendix 8d). A large proportion of the movements were heading to Borana Conservancy. Apart from elephant and giraffe, the other wildlife species utilizing this gap are far from accurate, since not all animals utilize it after the fence was removed towards the end of September 2015. However, LRD will continue to monitor how long these species continue to use this gap.

Rainfall is a key determinant in the availability of water and forage to herbivores (Sankaran et al., 2005) hence influencing wildlife movements especially elephant. During the wet season, wildlife tends to move towards lowlands with high forage availability and retreat to the forests (high elevation) during the dry season. Therefore, these wildlife gaps play an important role in providing access to such critical resources in different seasons.
5.4 Conclusion and recommendation

Range management options including intensive livestock grazing and mowing continue to create more grazing hotspots for the hartebeest population and other species on Lewa. Therefore, it is recommended that this should continue to promote growth of the wildlife populations.

Although not subject to regular, detailed monitoring, it is clear from annual counts and anecdotal reports from field scouts that the LBL buffalo population has increased significantly in recent years. In 2016, LRD will look to investigate factors driving this growth.
CHAPTER 6

6.0 MONITORING OF ELEPHANTS BREAKING FENCES

6.1 Introduction

Elephant play an important ecological role through manipulation of vegetation structure and composition (Bohrer et al., 2014) particularly woody species. Their nature of feeding can be destructive and this may affect other wildlife species sharing the same habitat especially in small fenced areas like Lewa. Destruction of habitat by elephant has been a concern for Lewa over many years. Lewa is one of the most successful breeding sanctuaries for black rhino in Kenya; therefore, maintaining habitat that can hold a viable population of this species is important in promoting the growth of black rhino. To safeguard black rhino browsing areas, internal ecological exclusion zones demarcated by two-strand electrified wires have been established. However, cases of elephant breaking into these exclusion zones have been increasing, with peak levels recorded during the dry seasons. Elephant responsible for these breakages have been monitored over time for identification and management intervention.

6.2 Results and discussion

6.2.1 Fence breakages

A total of 363 fence breakages were reported in 2015 compared to 402 in 2014 translating to a reduction of 10%. 87% of the breakages occurred on exclusion zones while the remaining 13% occurred on the main boundary line. Five exclusion zones namely; Lewa HQ, Kariunga, Willy Robert’s, Digby’s and Matunda were progressively upgraded with a new fencing configuration that has outriggers or stingers.

Upgrading of the fences significantly reduced fence breaking incidents ($\chi^2=24.361$, df=3, p<0.000). However, cases have been recorded of elephant accessing these exclusion zone areas through crawling under the fence lines or pushing over the fence posts.

6.2.2 Individual elephant breaking fences

Twenty eight elephant were identified as fence breakers. The proportion of the male to female fence breakers was 2.5:1. However, most of the females crawl under the fences as opposed to snapping the wires.

Fifteen males were categorized as persistent fence breakers out of which eight have been de-tusked in the past. Some of the de-tusked individuals have been observed accessing exclusion zones by pushing over fence posts, snapping wires or crawling under the fence. It is clear that de-tusking is a short-term mitigation measure as elephant slowly learn new tactics of breaking fences.

For effective management, continued monitoring is important to effectively inform the efficiency of management interventions undertaken and what can further be done to mitigate emerging issues.

6.3 Conclusion and recommendations

With the continued incidents of fence breakages, seven bulls on Lewa need to be de-tusked. These are Michael, Tesh, Obote, Gumo, Livondo, Mwitia and Mokiri. A proposal for translocation of six de-tusked elephant has already been placed to KWS.
CHAPTER 7

7.0 RANGELAND MANAGEMENT

7.1 Introduction

Controlled livestock grazing has been used to manage rangelands by reducing grass biomass and changing plant composition to provide quality, healthy grass for long-term conservation benefits. On Lewa, two management options, namely controlled cattle grazing and mowing have been used to improve the quality of the Conservancy’s rangeland by reducing unproductive grass. The impact of this grazing regime is analysed on a seasonal basis. In addition, Lewa has established 28 permanent monitoring points to evaluate the condition of the rangeland. Information from these sites, including grass biomass and species diversity sites is gathered annually in the month of June.

7.2 Improvement of rangeland using intensive livestock grazing

In 2015, a total of 2,728 heads of cattle grazed through Lewa for quarantine purposes. During this period, cattle undergo Pleuro-pneumonia (P1 and P2) tests and vaccination before moving them to Ol Pejeta Conservancy for beef production.

7.2.1 Results and discussion

7.2.1.1 Grazing blocks

In total, 8,512 acres were grazed in 2015 (Fig. 7.1). These blocks occurred on different soil types: black cotton soil had the highest proportion of 0.56, mixed soils had 0.13 and red soils represented 0.08. Red soils were relatively grazed for shorter periods because they are fragile and are important dry season grazing grounds for wildlife. In addition, continued grazing on such soils may make them susceptible to wind and soil erosion.

Figure 7.1: Map of Lewa showing grazed blocks in 2015

7.2.2 Ecological benefits

To monitor the impact of controlled cattle grazing on the rangeland, vegetation data was collected to estimate grass biomass, vegetation cover and species diversity.

Grazing reduced the biomass of grass in every grazed block. However, subsequent data collected to monitor the changes in biomass showed that it slowly accumulated to almost the same level after one rainy season (Fig. 7.2 & 7.3). Where re-grazing was done, the biomass remained suppressed for a longer period (Figure 7.2) compared to where re-grazing was not done (Fig. 7.3). Typically, rainfall promotes plant growth that directly leads to an increase in grass biomass. Faster re-growth of grasses occur after they have been grazed (Chan-Muehlbauer et al., 1994; Bullion et al., 2002) and for this reason, re-
grazing should be done on already grazed areas for Lewa to achieve its rangeland management objectives.

**Figure 7.2:** A comparison of change in grass biomass (kg/ha) at Mlima Tanki block  

**Figure 7.3:** A comparison of change in grass biomass (kg/ha) at Subuiga block

Results on vegetation cover showed no significant change where over 80% cover was recorded (Fig. 7.4 & 7.5). In addition, the cover increased after the rains indicating that vegetation cover was directly proportional to biomass. The high percentage cover is an indication that there was low risk of soil erosion by either wind or water.

The change in vegetation quality was measured by the level of greenness and species diversity. The results showed that re-grazing promoted higher species diversity (Fig. 7.6), compared to one off grazing period (Fig. 7.7). The trampling effect by cattle opens up the ground so that seeds and stems can sprout with adequate light (Strang, 2008). In addition, foreign seeds, dispersed by cattle through their metabolism and other elements of weather can also germinate effectively.

Rainfall played a role in increasing species diversity by enabling new and existing seeds and grass to sprout and produce soft, green and abundant vegetation for plains game. The level of greenness increased over the wet season as well (Fig. 7.8). Therefore grass is palatable during the wet season. It is therefore important to graze on areas dominated by unpalatable grass species mainly *Pennisetum* during this season.

**Figure 7.4:** A comparison of change in vegetation cover at Mlima Tanki  

**Figure 7.5:** A comparison of change in vegetation cover at Subuiga
7.3 Improvement of rangeland through mowing

In line with the Lewa Grassland Management Plan, 2014, mowing was applied on one block dominated by black cotton soil and *Pennisetum* grass species. Seventy acres out of the marked 574 acres were mowed (Appendix 10). The grass off-take was collected and shared between NRT Trading cattle and the neighbouring Leparua, Il Ngwesi and the Eastern communities for their livestock. This initiative was to mitigate the effects of the prolonged drought that had adversely affected most parts of Northern Kenya.

7.3.1 Results and discussion

Data presented here compares the effects of mowing, grazing and a combination of both grazing and mowing. Biomass reduced significantly where grazing and mowing were combined compared to where grazing only or mowing only was applied (Fig. 7.9). Mowing immediately eliminates the high grass biomass compared to grazing only because cattle selectively graze the grass leaving more stems that contribute to increase in grass biomass.

Species diversity was lowest on grazed and control sites. It was high in mowing only and where a combination of both mowing and grazing was applied (Fig 7.10). The disturbance caused by mowing on the vegetation increases diversity through its effects in reducing the intensity of competition for limited resources including light.

These treatments showed no effect on the vegetation cover (Fig 7.11). The records showed vegetation cover above 85%.
Figure 7.9: Change in biomass on grazed, grazed and mowed, and mowed area

Figure 7.10: Change in species diversity in grazed, grazed and mowed and mowed area

Figure 7.11: Change in vegetation cover in grazed, grazed and mowed and mowed areas

7.4 Annual assessment of grass on fixed-point monitoring areas

The biomass of grass on Lewa was analyzed from the 28 permanent monitoring points for a period of five years: from 2011 to 2015. The least biomass was recorded in 2011 compared to the other years (Fig. 7.12). The results showed a significant difference in biomass within the four vegetation units (Plains, Forest, Riverine and Rocky & hills) ($F_{(3,124)}=2.756$, $p=0.0453$).

Similarly, there was a significant difference in biomass within the five year period ($F_{(4, 123)} = 8.217$, $p = 0.0001$) (Table 7.1). Post hoc comparisons test indicated that the mean biomass for Plains unit (mean
±4333, STDEV ±301 kg/ha) was significantly different from the Forest unit (mean ±2985, STDEV ±466), p = 0.0385152.

Analysis of the mean biomass of grass among the sampling points showed a significant difference (F(26, 101) = 4.932, p = 0.0001). Post hoc comparisons using the Tukey HSD test indicated that 26 sampling sites contributed significantly to the differences in grass biomass (Appendix 9). A comparison of whether cattle had contributed to the reduction in the changes observed in the grass biomass could not be evaluated since most of the grazing blocks did not overlap with the 28 monitoring points.

**Table 7.1:** Years that contributed to the significant difference in grass biomass

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Mean</th>
<th>A*B post hoc Tukey HSD</th>
<th>p-values</th>
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<td>Yr-2012</td>
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<td>3815±1744</td>
<td>2385±1152</td>
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<tr>
<td>Yr-2013</td>
<td>Yr-2011</td>
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<td>2385±1152</td>
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<tr>
<td>Yr-2014</td>
<td>Yr-2011</td>
<td>4286±1360</td>
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<td>Yr-2015</td>
<td>Yr-2011</td>
<td>4213±1460</td>
<td>2385±1152</td>
<td>0.0000639</td>
</tr>
</tbody>
</table>

7.5 Conclusion and Recommendation

“Mowing” and “grazing and mowing” presented desirable results in improving the quality of grass. Depending on resource availability, mowing can be considered on a larger scale than what is being undertaken currently.

Re-grazing should be encouraged after every growing season especially on areas with low species diversity. This will also reduce diluting the positive impacts realized after grazing an area just once. One challenge on the selection of grazing blocks has been accessibility of water by cattle. Therefore, NRT needs to hasten the process of providing water to the cattle.
CHAPTER 8

8.0 VEGETATION MONITORING

8.1 Introduction

Monitoring plant communities is important to detect any changes and assess the success of management actions which will contribute to their improvement. The status of vegetation on Lewa is assessed on the 28 permanent monitoring points using both quantitative and qualitative techniques. In this section, we will present the results of the quantitative assessment completed in September.

8.2 Results and discussion

8.2.1 Quantitative woody vegetation assessment

The highest levels of woody vegetation damage were recorded for *A. tortilis* and *A. mellifera*. Most of the damage is perpetuated by elephant and giraffe through feeding and trampling. Conversely, rhino and impala caused the least woody vegetation damage.

Eighty five per cent of the sampled trees were classified as damaged. There was no damage recorded on *Euclea divinorum*. This tree species has tannin that is unpalatable to wildlife because of a bitter taste.

Elephant and giraffe were responsible for the highest woody vegetation damage, while rhino and impala caused the least damage (Fig. 8.1). Elephant are bulk feeders and the nature of their feeding is destructive. They damage trees either through debarking or breaking branches and stems. Giraffe browse on plant shoots hence suppressing tree growth. Black rhino browse a wide range of plants species, ranging from trees to shrubs and herbs (Goddard, 1968). They browse by trimming branches and trample on shrubs. Impala selectively feed on leaves and shoots of *Acacia* tree species below one meter in height.

Trees in all height categories were mainly damaged by elephant and giraffe; rhino reached to trees less than 3.0 meter (Fig. 8.2).

Most of the trees encountered during sampling were visually observed to recover through coppicing from the base of old stumps. There was a very low proportion (0%) of woody vegetation seedlings encountered in all the monitoring areas. However, the study was carried out during the dry season and this may have reduced the probability of encountering seedlings. These results were similar to what Surendranie from the University of Southampton found on a related study conducted in May, 2015.
Figure 8.1: Woody vegetation damage on Lewa by each wildlife species

Figure 8.2: Frequency of tree damage, by wildlife by in each height category (m)

8.3 Conclusion and recommendation

Elephant and giraffe were responsible for woody vegetation damage on Lewa. The creation of the LBL is expected to reduce resource pressure on Lewa once these wildlife species start venturing into these areas in future.

Exclusion zones are successful in protecting woody plants. However, it can displace damage to the unprotected stands of woody vegetation and this can be extensive.

Establishment of temporary exclusion zones on fragile habitats such as riverine areas should be considered in future. Monitoring of damaged trees, and quantifying those that are lost to other causes such as salinification for rising swamp water levels, secondary diseases and insect infestation should also be investigated in 2016. In addition, consideration should be made to implement a re-seeding programme and fencing off some areas to encourage regeneration to expand the cover of woody vegetation on Lewa for the benefit of black rhino.
CHAPTER 9

9.0 MEASUREMENT OF RAINFALL

9.1 Introduction

Environmental variables including rainfall, temperature and humidity are some of the factors that determine the performance of rangelands and wildlife species. On Lewa, rainfall follows a bimodal distribution pattern with long rains received from March to May and short rains received from October to December (Chege et al., 2006). However, there has been unpredictable rainfall that often occurs between these times. Since 1972, the annual rainfall has been measured on several gauging stations distributed across Lewa. Between 2011 and 2015, rainfall was measured consistently on 11 stations.

9.2 Results and discussion

In 2015, Lewa received 531 mm of rainfall compared to 404 mm in 2014. The long-term rainfall (1972 – 2014) averages 505 mm. A comparison of total rainfall received on the 11 stations between 2011 and 2015 shows a significant difference (X=420.600, df=40, P=0.000). This indicates that the distribution of rainfall has been uneven with some stations, namely Lewa HQ, Subuiga, Matunda, Kisima and Ngare Ndare Gate recording higher amounts of rainfall compared to the other stations in 2015 (Fig. 9.1).

A comparison of rainfall across the years indicates that the average amount of rainfall received between 2011 and 2015 was within the long-term mean range (Fig. 9.2). This indicates that even though the amount of rainfall may be variable from year to year, this variation is within the limits of rainfall expected on Lewa. The only variation may be on the spatial distribution with a higher proportion of rainfall received within a short period in some years compared to the others.

Conclusion and recommendations

Rainfall has been reliably measured on Lewa since 1972. However, other variables of the weather are critical in determining the condition of rangelands and wildlife. Therefore, in 2016, the LRD will start collating other elements of weather including temperature and humidity to further our understanding of the environment in the LBL.
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<table>
<thead>
<tr>
<th>Meta class</th>
<th>Sub-class</th>
<th>Height range (m)</th>
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<td>3</td>
<td>0.3-0.5</td>
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<td></td>
<td>4</td>
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<td></td>
<td>5</td>
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<tr>
<td>Shubs</td>
<td>6</td>
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<td>7</td>
<td>2.0-3.0</td>
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<tr>
<td>Trees</td>
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<td>3.0-5.0</td>
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<td></td>
<td>9</td>
<td>&gt;5.0 (beyond browsing height)</td>
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Appendix 2: Inter calving interval for breeding female black rhino on Lewa

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<tr>
<th>BLACK RHINO</th>
<th>Non</th>
<th>Name</th>
<th>Birth date</th>
<th>Current age (yrs)</th>
<th>Mother</th>
<th>Age at 1st calving (yrs)</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<th>9</th>
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<td>27.5</td>
<td>Juno</td>
<td>7.6</td>
<td>3.2</td>
<td>2.3</td>
<td>2.2</td>
<td>2.3</td>
<td>2.2</td>
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<td>3.7</td>
<td>-</td>
<td>-</td>
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<td>MAVINGO</td>
<td>6-Jan-89</td>
<td>26.6</td>
<td>Solio Cow</td>
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<td>2.8</td>
<td>1.7</td>
<td>1.5</td>
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<td>1.8</td>
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<tr>
<td></td>
<td>3</td>
<td>Ndito</td>
<td>1-Jan-90</td>
<td>26.0</td>
<td>Solio Cow</td>
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<td>3.2</td>
<td>2.2</td>
<td>2.1</td>
<td>2.7</td>
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<td>Solio</td>
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<td>3.5</td>
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<td>2.6</td>
<td>-</td>
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<td>Ndito</td>
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Mean age at 1st Calving = 7.3
Mean inter-calving interval = 2.7
### Appendix 3: Inter-calving interval for breeding female black rhino on Borana

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<th>Current age (yrs)</th>
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<td>02-May-07</td>
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<td>8.0</td>
<td>Waiwai</td>
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<td>Nyota</td>
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<td>Lucy</td>
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Mean age at 1st Calving = 8.2

Mean inter-calving interval = 2.3

### Appendix 4: Inter-calving interval for breeding female white rhino on Lewa

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Mean age at 1st Calving = 7.3

Mean inter-calving interval = 2.5
Appendix 5a: Ranging areas of female black rhino on LBL

Appendix 5b: Ranging areas of male black rhino on LBL

Appendix 6a: Ranging areas of male white rhino on LBL

Appendix 6b: Ranging areas of female white rhino on LBL
Appendix 7: The structure of lion population on LBL

<table>
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<tr>
<th>Age class</th>
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<th>Total by age</th>
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<td>Total by sex</td>
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<td>8</td>
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Appendix 1: Seasonal wildlife movements through the Mt. Kenya Underpass

Appendix 2: Wildlife movements through the Mt. Kenya End Corridor during the dry and wet seasons
Appendix 3: Wildlife movements through the Northern gap during the dry and wet seasons

Appendix 4: Wildlife movements through the Western gap during the dry and wet seasons
Appendix 9: Table showing monitoring points that contributed to significant difference in grass biomass

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<th>MU</th>
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<th>Mean</th>
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<th>B</th>
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Note:
- Non grazed plot
- Grazed plot
Appendix 10: A map of Lewa showing the proposed block for mowing and a section mowed in 2015