Lewa Wildlife Conservancy

Research and Monitoring Annual Report 2006

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EXECUTIVE SUMMARY

In 2006, the Research Department of Lewa Wildlife Conservancy undertook several key research and monitoring activities aimed at providing insight into specific management questions and collate long term data on performance of selected wildlife species and habitats.

Black rhino

The population of black rhinos rose to 52 following eight births representing 15% growth rate compared to the National meta-population target of 5%. Mean inter-calving interval was 2.5 years with 53% of the breeding females calving in the year. One female calved at 5.4 years (females mature at 7.0 years). Overall, Lewa's population performance was excellent compared against standard benchmarks for evaluating performance of black rhinos. Again, the population was among the best performers in Kenya. Body condition reduced in all rhinos because of the 2006 drought. Six "clean" rhinos were notched for identification.

It was recommended that the population of black rhinos on Lewa should be maintained at maximum sustained yield of 62 non-sex biased animals for maximum productivity. In the medium-term, amalgamating Lewa and Borana and ultimately with Il Ngwesi Group Ranch should be actively pursued as the ecological carrying capacity of rhinos in the three areas would be raised to about 160 animals and become a Key 1 rated population. Similarly, emergency response programmes including supplementary feeding should be enhanced in case of catastrophic environmental stochastic events as witnessed in the 2006 drought.

White rhino

The population of white rhinos stood at 36 animals. There were five births in the year representing over 10% annual growth rate. Age at first calving was 7.9 years and inter-calving interval was 2.5 years. Sixty three percent of the breeding females calved in the year representing excellent performance. Six rhinos were moved to Ol Pejeta in order to balance the sex ratio.

To maintain high growth rates of white rhinos, it was recommended that an active translocation programme be maintained in order to stock a non-sex biased population. Similarly, holding Lewa rhinos outside of the Conservancy on mutually agreed terms should further be proactively explored to avoid imminent fatalities from males.

Grevy's zebra

Grevy's zebra population stood at 399 compared to 448 in 2005. At least 51 foals were born in the year. Survival rate of these foals at the close of the year was 71%. However, this rate is expected to further reduce as monthly assessments continue in 2007, and foals are monitored through to one year. The survival rate of foals born on Lewa since 2004 has been below 50% which is the minimum infant survival rate required for the population to increase in numbers.

Twenty five Grevy's zebra and 44 Plains zebra were reported dead in the year. Sixty seven percent and 56% of the Grevy's zebra and Plains zebra deaths respectively were predator related. Analysis of predator scat revealed that zebras continued to be the main prey of lions. These predation rates were lower compared to 2004 and 2005 when Lewa had twice as many lions compared to 2006.

It was recommended that in collaboration with Kenya Wildlife Service (KWS), lions should be maintained at low numbers through adaptive management techniques. Similarly, Lewa should *be fully involved in formulation of the National Grevy's Zebra Strategic Plan and Lions Management Plan both of which are due in 2007.*

Anthrax in Grevy's zebra

Between December 2005 and February 2006, over 50 Grevy's zebra died due to anthrax in northern Kenya. Over 620 animals (62%) were subsequently vaccinated on Lewa, the National Reserves of Samburu, Shaba and Buffalo Springs, and in the pastoral areas in northern Kenya in February 2006. About 60,000 herds of livestock were similarly vaccinated around the three main areas to provide a buffer zone against the disease.

Several recommendations arose from the exercise including immediate implementation of National emergency response plans through the KWS in the event of serious infectious diseases in Grevy's zebra and other endangered species through cross-sectoral collaboration.

General Wildlife Monitoring

The annual game count showed that most of the key wildlife species declined in numbers due to the 2005 drought. However, Waterbuck and Buffalo showed remarkable increments considering that Lewa lost over 75% of the two species in the 1999-2000 drought. Elephants continued to utilise the Conservancy as a dry season feeding ground resulting in extensive destruction of woody vegetation.

It was recommended that establishment of more exclusion zones be continued in order to protect key black rhino habitats and destroyed riverine forests against elephant destruction.

Rainfall

Lewa received 758 mm of rainfall in 2006 compared to 286 mm that was received in 2005. This was above the long term mean rainfall of 517 mm. Over 522 mm of rainfall was received between the months of October and December. Prior to the October rains, the Conservancy was exceptionally dry and hence supplementation of the feed of rhinos was effected.

Range Management

The biomass of grass reduced in majority of the permanent vegetation monitoring blocks due to the 2005 drought. Consequently, prescribed burning was effected in only one block that was dominated by Increaser I and II grass species and had no woody vegetation.

It was recommended that extensive firebreaks and some blocks be subjected to cool burns due to the high accumulation of biomass of grass and fuel load arising from the October rains. Cool fires cause minimal damage to the trees, remove the moribund grass material and maintain the grass biomass to low levels for an extended period of time compared to hot burns.

Control of invasive species

Large stands of *Datura stramonium* were found to prevent growth of grass and herbaceous material in the heavily infested areas. The plant was insignificantly utilised by browsers.

It was recommended that the existing early detection and monitoring programmes of invasive species be maintained. Similarly, regular surveys of known infestation areas should be initiated by laying of transects to monitor the rate of spread or reduction. Again, elimination of D. stramonium should be effected before the fruiting stage.

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1.0 RHINO MONITORING

1.1 Status and performance of black rhinos on LWC, December 2006

The population of black rhinos on Lewa Wildlife Conservancy (LWC) stood at 52 animals comprising of 18 calves (0≤3 years); 11 sub adults (3<6 years) and 23 adults (> 6 years) (Table 1.1). The sex ratio of males:females was 1:1.2 with four calves that were not sexed.

There were eight births in 2006 compared to five in 2005 (Figure 1.1). This represented the highest number of calves to have been born on the Conservancy in any given year. Oboso, Nashami and Samia each gave birth to their first offspring while Nyota, Juniper and Ndito gave birth to their 4th calves respectively. With eight calves, Solio holds the record on LWC of having the highest number of offsprings. It is predicted that five calves will be born in 2007. This prediction is based on the respective females mean inter-calving interval (Appendix I).

1.2 Population growth rate in 2006

In 2006, LWC's black rhino population had an overall growth rate of 15%[1]. This rate was consistent with similar growths recorded from 2000-2003 and 2003-2005 when calculated on a three and two year moving averages respectively (Figure 1.1). Again, the Conservancy's rate of increase was significantly above the average growth rate of the best known and intensively monitored rhino populations (Ol Pejeta and Ol Jogi Private Reserves, and Nairobi and Lake Nakuru National Parks) in Kenya which had a mean growth rate of 7.9% between 2003 to 2005 (Figure 1.2) (Okita-Ouma & Wandera, 2006). The average growth rate of all rhino populations in the country for the period 2003-2006 was 5.1% which was just above the National minimum meta-population target of 5.0% (KWS, 2000).

1.2.1 How are such high growth rates achievable on LWC?

The intrinsic rate of increase (r_{max}) for non-sex-biased rhino populations is 9.4% (Emslie and Brooks, 1999). However, growth rates above 10% as in LWC are achievable under the following conditions:

(i) When a population is expanding as a result of active breeding and has a young age structure. In 2006, 15 females in the Conservancy were in the breeding stage with the youngest and oldest reproducing females being 6.2 and 38[2] years respectively. During this period, the proportion of breeding females calving (FC) in the Conservancy was 53%[3] translating into the best possible achievable reproduction rate.

(ii) When the population as described in (i) above is in good habitat. Given the matrix of habitats on LWC, combined with the active establishment of ecological exclusion zones that keep off competing browsers, optimum habitats for black rhinos have been simulated. This has translated into multiple annul births since the 1998 El Nino rains.

It is imperative for LWC and other rhino areas in Kenya to maintain such high breeding rates since large, rapidly breeding and healthy populations not only provide the best possible insurance against any future poaching events, but prevents loss of heterozygosity by ensuring maximum rate of gene transfer to future generations (KWS, 2007).

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[1] With time, and as LWC's population becomes more established, the annual growth rate is expected to reduce to an average of 9.4% p.a. to be equivalent to the intrinsic rate of increase of black rhinos.
[2] Stumpy is the oldest female on LWC and is expected to calve again in 2007.
[3] The percentage of females calving in a population is an index that measures the core breeding success of a population. The minimum recommended index is 28% for a population to perform above average.

Table 1.1: Sex and age structure of black rhinos on LWC, December 2006

Age class	Males	Females	Not sexed	Sub-total	Proportion in population
Calves (0≤1 year)	2	1	3	6	12%
Calves (1<3 years)	7	4	1	12	23%
Sub-adults (3<6 years unless calved)	4	5	-	9	17%
Adults (6<30 years)	9	14	-	23	44%
Adults (>30 years)	-	2	-	2	4%
Grand total	**22**	**26**	**4**	**52**	**100%**

Proportion of population that is actively breeding

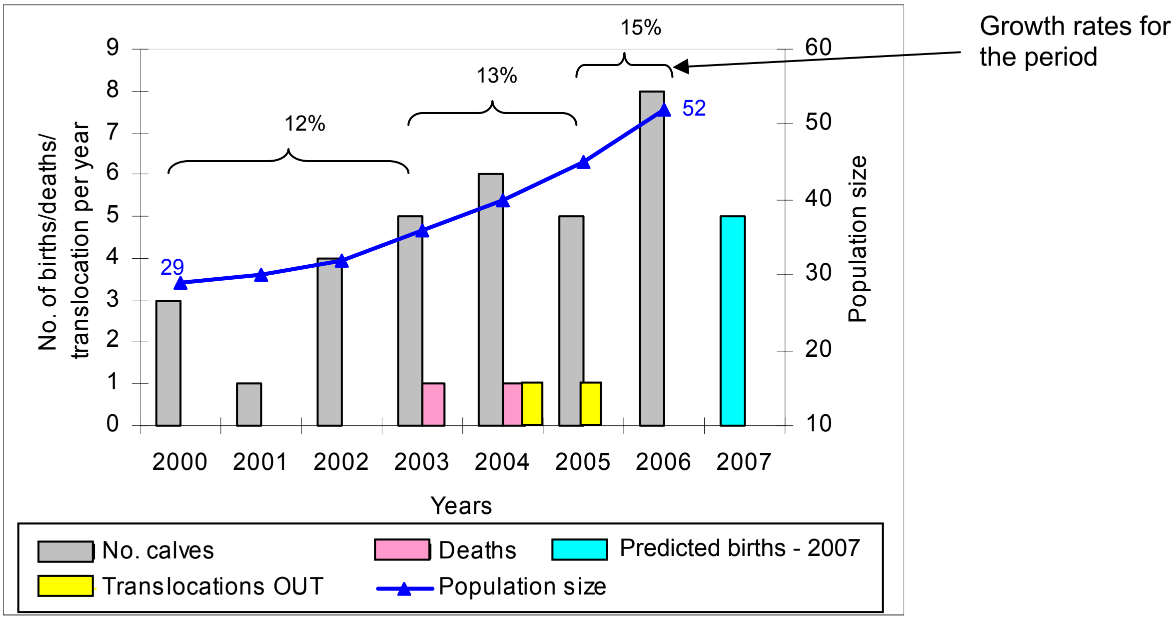

Figure 1.1: Trend in black rhino population including births, deaths, translocations and temporal growth rates on LWC, 2000-2006

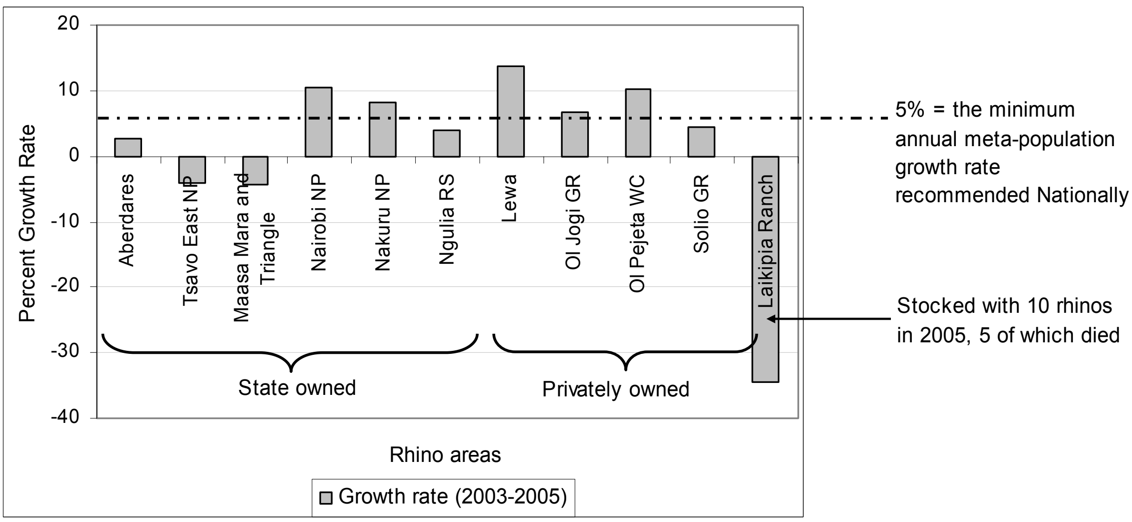

Figure 1.2: A comparison of average growth rates in selected rhino areas in Kenya, 2003-2006 (data source: KWS, 2007)

1.3 Ecological Carrying Capacity (ECC) and Maximum Sustained Yield of LWC rhinos

An estimated 52 rhinos were first predicted as the ECC for LWC in 1989 (Brett, 1989). Since then, more land including the 7,000-acre former Manyagalo Ranch has been added to the Conservancy thus increasing the total land available to rhinos to an estimated 62,000 acres.

Similarly, a multi-faceted model for estimating ECC of rhinos in the nine well-established rhino sanctuaries in Kenya has been developed (Amin *et al.,* 2006). On LWC, about 150 detailed vegetation plots were assessed. This information was combined with Landsat-7 satellite imagery data to give overall browse-availability and browse suitability index maps. The model also took into account productivity and quality of the standing crop of browse, and put into consideration other auxiliary data on variables that affect ECC[4] (Amin *et al*., 2006).

Based on the revision of LWC's ECC using the above information, the tentative carrying capacity of rhinos in the Conservancy is predicted at 83 animals[5] (Amin, *et al.,* 2006). Therefore, to maintain the current high productivity levels of rhinos in the Conservancy, the population will need to be maintained at a threshold level of 75% (only a ballpark estimate) of the ECC i.e. at Maximum Sustained Yield[6] (MSY) ≡ 62 animals. When the population is at MSY, there exists maximum surplus production that can be harvested/translocated in perpetuity without altering or compromising the stock of rhinos (Figure 1.3) as long as all other factors are constant.

As at December 2006, the population of black rhinos on LWC stood at 52 animals. Hence, theoretically, there were ten more rhinos that could be added into the population for an MSY of 62 animals to be achieved without compromising current productivity. However, in reality, this figure will need to be regularly reviewed due to the following reasons:

(i) The increasing graduation rate of sub-adult males into adulthood (Table 1.1.) would result in more pressure as the youngsters attempt to assert their dominance. Therefore, there will be need to maintain a population with a balanced sex ratio.

(ii) Similarly, the dynamics of the numbers of competing browsers is expected to change on a temporal basis and will affect the ECC of rhinos.

(iii) Large, long-lived animals like rhino have the ability to overshoot their ECC before potential problems in the population's performance indicators (underlying growth rate, age at first calving, percentage of females calving in a year, proportion of calves in the population, sex ratio etc) are detected e.g. as witnessed in the Solio population.

It is against this background that there will be need to continue to actively monitor the performance of LWC's rhino population and seek the most feasible alternative measures to the rapidly expanding stock before the predicted ECC and MSY are reached. In the medium-term, graduating sub-adult males will need to be translocated to other suitable areas and to maintain a balanced sex ratio to mitigate imminent fights with the well established breeding males. However, through mutual agreement, the long-term safeguard will be to incorporate the ecologically linked neighbouring ranches to the north and west of the Conservancy to be part of LWC's rhino ranging areas.

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[4] Such data include soils, populations of competing browsers, long-term rainfall and temperature.
[5] This ECC estimate needs to be refined on an ongoing basis with improved habitat/vegetation information.
[6] In a typical scenario, a population that has increased beyond ECC has alarmingly reduced growth rates *(≈ zero)* due to poor nutrition of cows that results to reduced breeding success and increased mortalities of adults and calves: Hence the importance of maintaining populations at 75% of ECC for large bodied or K-selected animals.

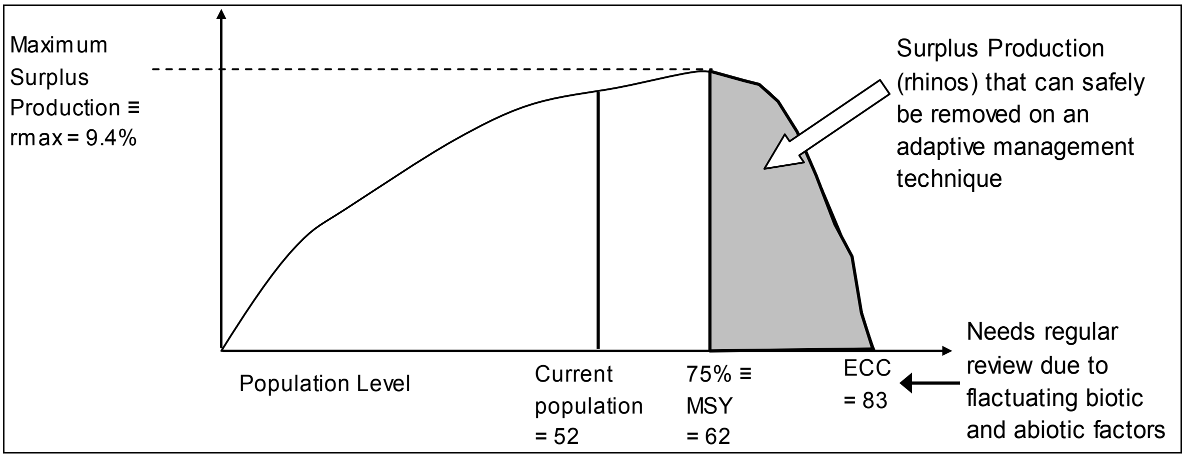

Figure 1.3: The relationship between the current population, predicted Maximum Sustained Yield and Surplus Production that need to be regularly removed to maintain maximum growth rates of rhinos on LWC, 2006

1.4 Projected rhino expansion programmes on LWC

As discussed in Section 1.3, LWC's rhino population is expected to hit the predicted MSY in the next few years; hence there will be need to reduce numbers to continually achieve maximum production. However, there are very few suitable areas for establishment of new rhino populations or augmentation of existing stocks in Kenya.

Out of the eight areas assessed as potential areas/habitats for establishment/augmentation/ expansion of rhino populations in the country between 2003-2005, only four (Mugie Ranch, Meru Park, Ol Pejeta and Ngulia IPZ) passed the yardstick (KWS, 2007). The establishment of Mugie Ranch and Meru Park's populations have been completed while Ol Pejeta's expansion programme is scheduled for February 2007[7].

Therefore, based on the above information, instead of translocating animals out of LWC, the most ideal long-term strategy (already being actively pursued), will be to amalgamate the Conservancy with Borana and IL Ngwesi Group Ranches through a phased dropping of the internal fences (Figure 1.4). The three areas are ecologically linked and are historical ranges of black rhinos. It is projected that rhinos will undergo natural dispersal and colonise the new areas. The expanded range including Ngare Ndare Forest Reserve will be approximately 450 km^2 with an estimated ECC of about 160 rhinos. If this fete is achieved, it is predicted that the LWC/Borana/Il Ngwesi stock will be among the first populations to be rated as *Key 1* Population[8] in Kenya as described by the African Rhino Specialist Group of the IUCN (Emslie and Brooks, 1999).

However, before such a move is undertaken, the levels of security and surveillance, fencing, ecological and biological monitoring techniques in these areas have to be raised to acceptable levels by all stakeholders.

[7] At the time of production of this report, 30 black rhinos had already been moved to Ol Pejeta (26 from Solio and 4 from Ol Jogi). At the same time, three males were moved from Solio to Ol Jogi; three males from Ol Jogi to Ol Pejeta; and one female from Ol Pejeta to Ol Jogi in an attempt to improve the genetic diversity of Ol Jogi rhinos

[8] A population that is increasing or stable and n > 100

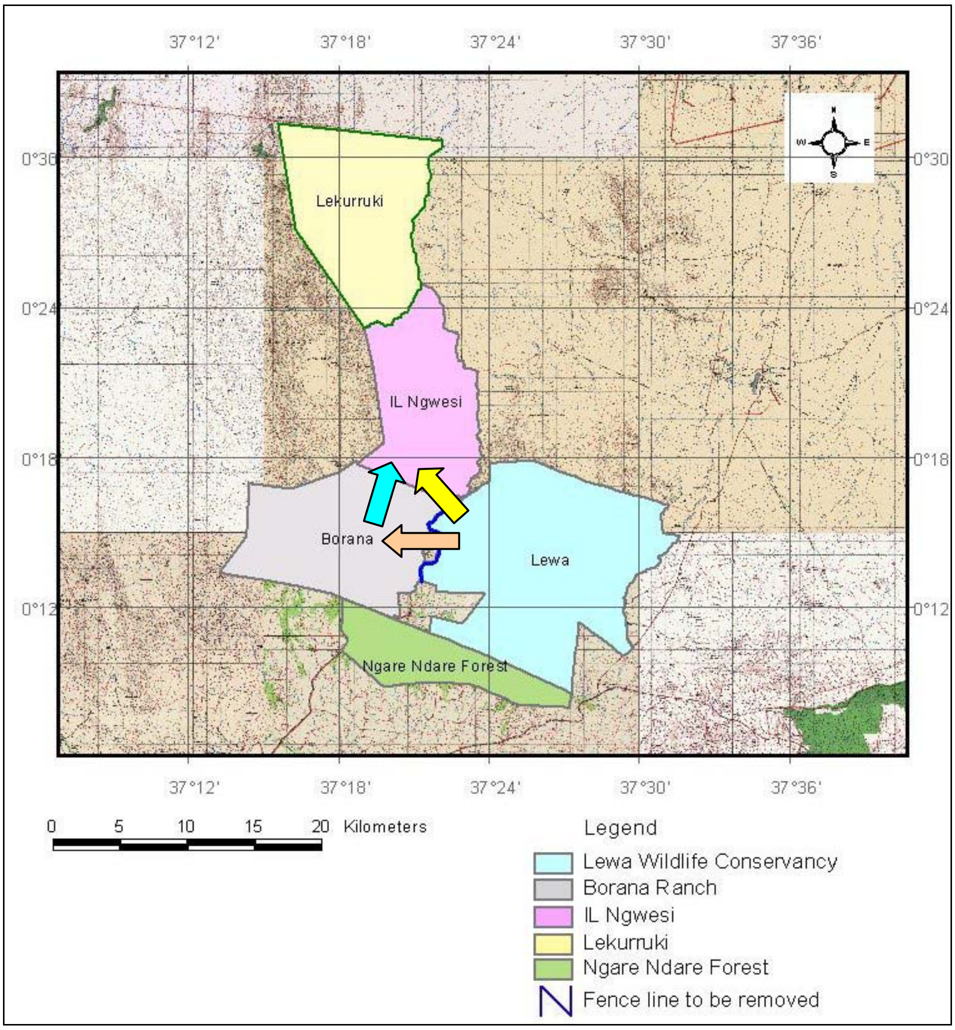

Figure 1.4: Location of Lewa showing the possible expansion routes to Borana and IL Ngwesi Group Ranches for subsequent colonisation by black rhino

1.5 Population performance indicators

In 2006, key population performance indicators of LWC rhinos were calculated and compared with standard benchmarks for evaluating the performance of a given population. Overall, LWC's rhinos showed excellent performance against these benchmarks (Table 1.2). This was consistent with similar performances that have been recorded since 2000 (Figure 1.1).

Table 1.2: Performance of Lewa's rhino population against set benchmarks

Benchmark	Minimum recommended	Level of LWC's performance in 2006	Comments for LWC rhino
Growth rate	5%	15%	Excellent
Inter-Calving Interval	2.5 years	2.5 years	Good
% Adult Females Calving per Year	At least 40%	53%	Excellent
Age at First Calving	<6.5 years	7.3 years	Moderate
Sex Ratio	Minimum 1M : 1F	1M : 1.2F	Good
% of Calves in Population	At least 28%	35%	Excellent
Average Mortality Rates	Maximum 4%	0	Excellent

1.6 Overall performance of black rhinos on LWC

Since the inception of LWC, 58 calves have been born in the Conservancy. Since then, 22 animals have died from various causes. Over 50% of these deaths occurred from 1984-1994 as a result of concomitant effects of a highly male-biased sex ratio and as rhinos attempted to adapt to local conditions. Similarly, within the same period, nine animals have been moved to other conservation areas in Kenya. Since the ECC is almost been reached, the Conservancy's rhino stock is set to become a major source for restocking other areas in the Country.

1.7 Home ranges of black rhinos, 2006

1.7.1 Breeding female black rhinos

Generally, all female black rhinos maintained their home ranges despite the dry season experienced in 2005 and 2006. Stumpy, the oldest female rhino had the smallest home range (Figure 1.5). This was probably due to the fact that her feed was being supplemented with Lucern and hence concentrated her ranging areas around Kona Safi block that had several feeding spots. Ndito, Seiya and Nashami shifted their ranging areas from the Ngare Ndare Forest to Manyagalo Ranch in 2003 when it was opened up. The three females maintained their overlapping ranging areas within Willy Robert's exclusion zone (Figure 1.5).

Tana (6.2 years) shifted her ranging areas from Kona Safi to Ngare Ndare Forest. This behaviour had been observed before in other female rhinos (Nashami) that dispersed from their natal home ranges prior to calving. The Forest area could be attracting young females since it has several springs and diverse habitats including *Acacia drepanolobium, Grewia similis and Maytenus* spp. that are part of key black rhino diet. Similarly, the interior of the Forest has remained largely uncolonised by rhinos (Figure 1.5).

Zaria, Sonia, Samia and Oboso concentrated their ranging areas around Mtego Twiga areas and sometimes extended their feeding grounds to Willy Robert's exclusion zone. This exclosure has abundant water and browse.

Waiwai, Solio, Juniper and Meluaya were concentrated on the hills and rocky kopjes that dominate the northern part of the Conservancy. These areas were highly preferred by rhino as they contained relatively dense and thick bushes of *A. mellifera, A. tortilis* and several annual forbs that form the main rhino feed (Figure 1.5).

The core areas of all the females were calculated using 50% minimum convex polygon. It was found that most of the breeding females had their core areas that were less than 10 km^2 – this was a significant reduction when compared with 95% minimum convex polygon home ranges. The core areas were mostly located in sections of the Conservancy with existing ecological exclusion zones (Figure 1.6). This demonstrates the potential benefits derived from establishing and maintaining exclusion zones as it promotes one of LWC's primary objectives of being a haven for endangered species and specifically black rhinos.

1.7.2 Breeding male black rhinos

Majority of the breeding males maintained their territories as opposed to the upcoming males that were noted to roam over wide areas probably as they sought for potential areas to establish territories. Lucky (10.2 years) significantly expanded his territory between 2005 to 2006 when calculated at 95% minimum convex polygon. He utilized Matunda, TM and Airstrip areas that were less frequently utilized by other black rhinos (Figure 1.7).

Melita (23 years) shifted his territory to the north west of the Conservancy and covered over 25 km^2 (95% minimum convex polygon). Until 2003, Melita had his territory on the eastern side of Ngare Ndare Forest, but was later pushed away by two dominant bulls where he moved to the central and eastern side of the Conservancy. He now appears to be the main breeding bull patronising the northern areas including Sambara, Mlima Sagana and Fumbi areas (Figure 1.7).

Mutane's ranging areas covered Kona Safi, Shamba and Mawingo areas. He maintained his territory all throughout the year. James (23.2 years) appeared to have permanently established his territory on the extreme northern edges of the former Manyagalo Ranch (Figure 1.7). He had the smallest home range suggesting that his areas of utilization had enough browse and permanent water.

It was noted that older male rhinos that previously used to prefer the interior of Ngare Ndare Forest Reserve appeared to concentrate their feeding effort on the edges and away from the Forest with high frequency. These areas were relatively open but with high concentrations of palatable forbs. This could be the major factor influencing the movement patterns of rhinos. Such a relationship should be investigated further.

Again, majority of the core ranging areas of most male rhinos were either in close proximity or were nested within the exclusion zones (Figure 1.6), an indication that these areas experienced less browsing pressure from elephant and giraffe and hence had enough browse for the rhinos.

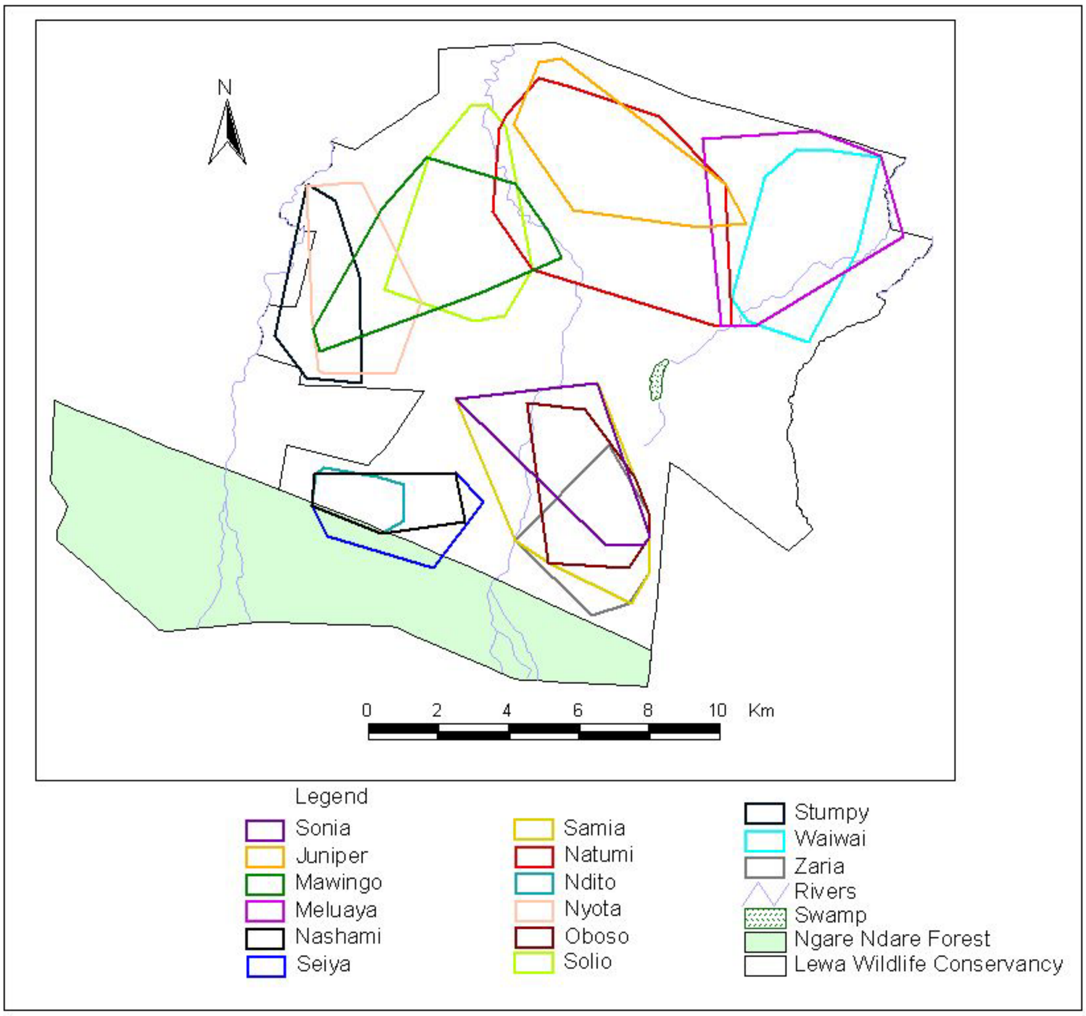

Figure 1.5: The ranging areas of breeding female black rhinos on LWC, 2006 (generated using minimum convex polygon by removing 5% of the outlier fixes in ArcView 3.2)

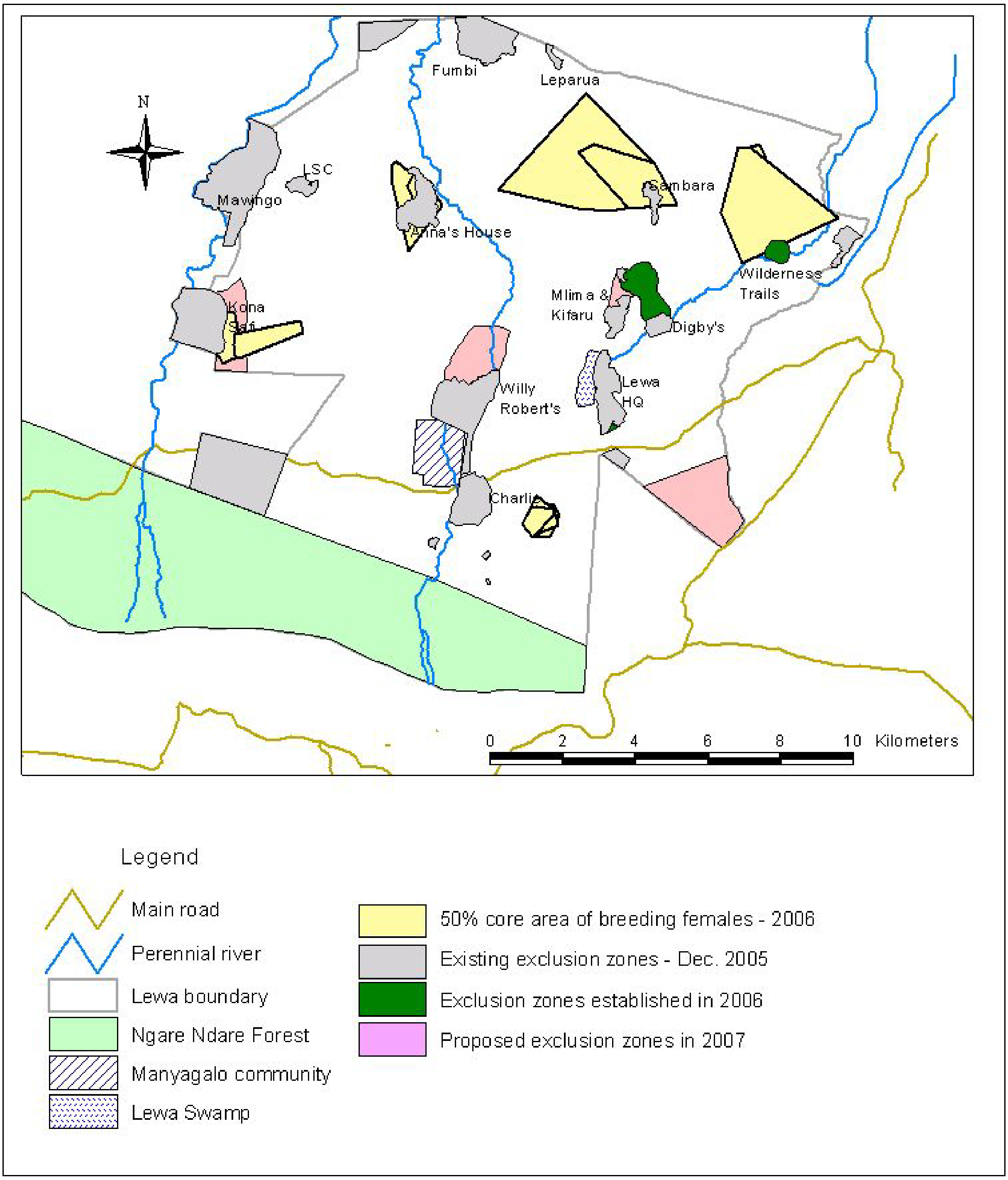

Figure 1.6: The core ranging areas of breeding female black rhinos on LWC, 2006 (generated using minimum convex polygon by removing 50% of the outlier fixes in ArcView 3.2)

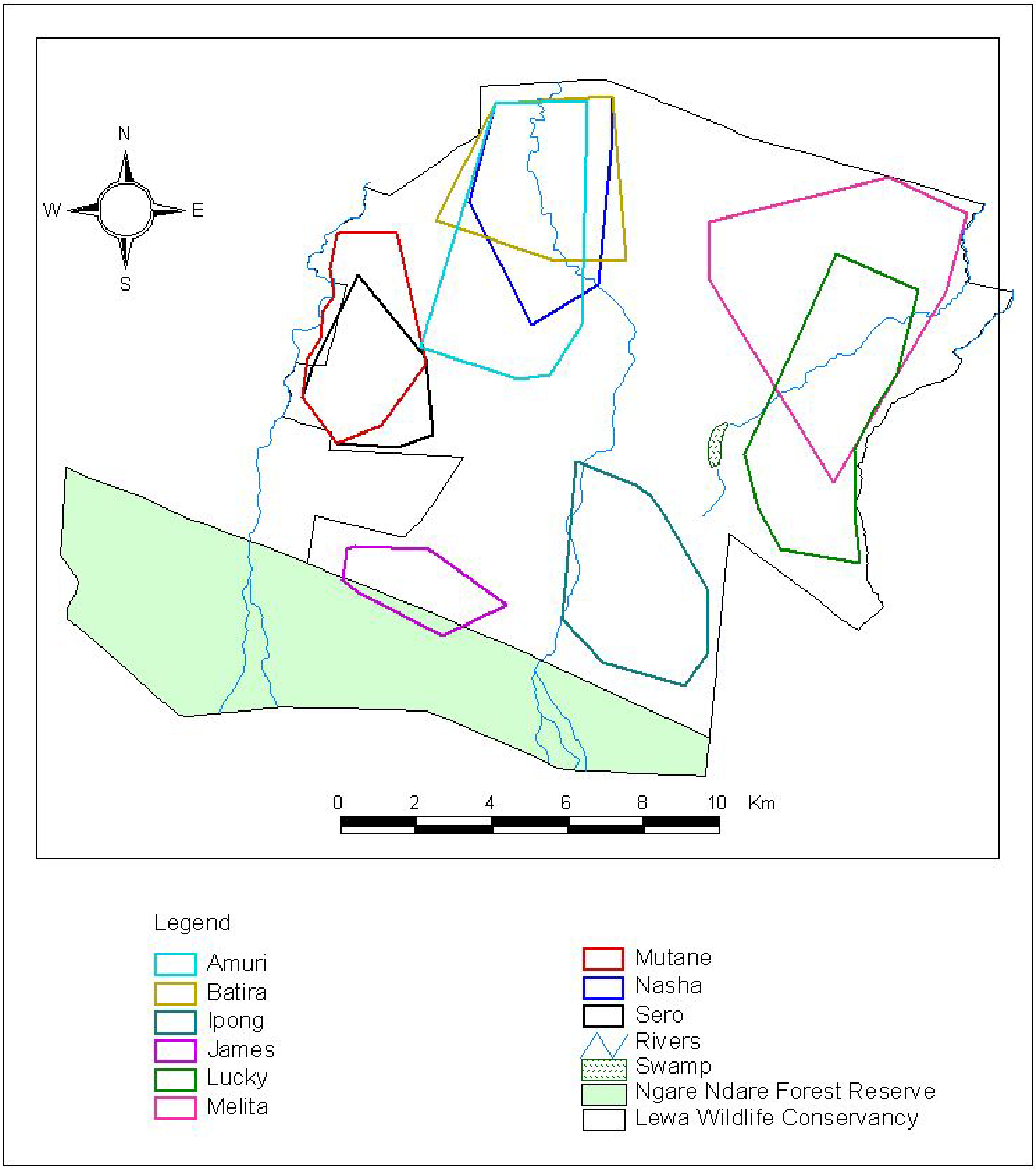

Figure 1.7: The ranging areas of breeding male black rhinos on LWC, 2006 (generated using minimum convex polygon by removing 5% of the outlier fixes in ArcView 3.2)

1.8 Translocation

The home ranges of middle aged males, Nasha (6.1 years), Sero (7.1 years) and Batira (7.6 years) overlapped extensively with that of the breeding and dominant bulls - Amuri and Mutane. The three males should be closely monitored as they may experience increased pressure from the two bulls as witnessed between 2003-2005 when male Stella (10.3 years) was repeatedly fought by Amuri prior to his translocation to Meru Park in February 2006.

1.9 Ear notching of black rhinos

To reduce the number of "clean"[9] rhinos and make majority of individuals identifiable by all patrol teams, six black rhinos were notched in 2006. These were sub adults females Tana, Maxxine, Sala and sub adult males Junkie, Borana and Ndoto. Ear notching of clean rhinos should continue as calves graduate into sub adults for accurate and reliable biological data to be gathered in the field.

1.10 Rhino body condition scores

The assessment of rhino body condition follows a 1-5 standardized method that was extensively described by Reuter and Adcock (1998) and adopted by the African Rhino Specialist Group (AfRSG). This method relies on accumulated fat on different body parts, namely; neck, shoulder, ribs, spine, rump, abdomen and tail base. The derived standardized body condition indices can reliably be used to make informed management intervention decisions especially during drought (supplementary feeding) or ill health (veterinary).

Poor rains which were below the long term mean annual rainfall (517 mm) were received in 2005 (286 mm). This resulted to comparatively low availability of quality browse and grazing material and this affected the body condition of rhinos. The most affected were the oldest (Stumpy = 38 years and Solio = 31 years) and lactating females (Table 1.3). As a result, the rhinos feed was supplemented with Lucern and horse cubes through an intensive feeding programme.

1.11 Recommendations

In future, emergency response programmes including logistics and provision of supplementary feed should be put in place and maintained for timely interventions in case of any catastrophic drought episodes like the one witnessed countrywide in 2006.

Table 1.3: Black rhino body condition scores

SR #	Rhino Name	Sex	Breeding condition	Age (Yrs)	Previous scoring (January 2006)	Date last scored (Sep – 2006)
1	Zaria	F	Early lactation	17.8	3+	3
2	Solio	F	Early lactation	30	3	3
3	Natumi	F	Early lactation	7.3	3+	3+
4	Mawingo	F	Non – lactating	16.6	3	3
5	Rhinotek	F	Sub – Adult	4.4	4-	3+
6	Ndito	F	Late lactation	16	3+	3+
7	Juniper	F	Early lactation	17.5	3+	3
8	Sonia	F	Early lactation	14.4	3	3
9	Samia	F	Sub – Adult	7.3	4	4
10	Nyota	F	Early lactating	14.1	3+	3+
11	Oboso	F	Early adult	5.3	3	4
12	Tana	F	Sub adult	5.3	3	3-
13	Waiwai	F	Mid lactation	10.5	3+	3+
14	Maxxine	F	Sub – Adult	3.6	4	3+

[9] A clean rhino is an animal without any distinguishable features. Even in difficult terrains where rhinos are rarely sighted, estimation of the total population using ***Rhino 2*** software requires that at least 70% of rhinos should be identifiable either through notches or other identification marks for accurate estimates to be generated.

SR #	Rhino Name	Sex	Breeding condition	Age (Yrs)	Previous scoring (January 2006)	Date last scored (Sep – 2006)
15	Stumpy	F	Early lactation	37	3	3-
16	Sala	F	Calf	2.3	4	3+
17	Melita	M	Adult male	22	4-	4
18	Nasha	M	Sub – adult	5.2	4	3+
19	Lacky	M	Adult male	9.8	4	4
20	Folly	M	Sub – adult	3.6	4	3+
21	Ibong	M	Adult male	20.7	4	4
22	Mutane	M	Adult male	17	4	4
24	Junkie	M	Calf	2.3	3+	3
25	Borana	M	Calf	2.4	3+	3+
26	Tula	F	Calf	2.6	3	3
27	Elvis	M	Calf	1.2	3	3

1.12 Performance of white rhino on Lewa

1.12.1 Status of white rhinos on LWC, December 2006

The population of white rhino stood at 36 individuals comprising of 8 calves ($0 \leq 3$ years); 7 sub adults ($3 \leq 6$ years); 18 adults (> 6 years) and 3 unsexed (Table 1.4). The sex ratio of males:females was 1:1. This was a remarkable improvement compared to 2005 when the sex ratio of females:males was 1:1.2.

1.13 Population performance indicators

1.13.1 Births and deaths

There were five births in 2006 compared to two in 2005 (Figure 1.8). The calves were born to Opondo, Tumbili, Natal, Songare and Murembo. The first three females have calved five times while the last two females have had seven and eight calves respectively. Two females are predicted to calve in 2007 (Figure 1.8). No deaths were recorded in the year.

1.13.2 Growth rate in 2006

In 2006, LWC's white rhino population had an overall growth rate of over 10%. This rate represented one of the highest increments ever recorded on the Conservancy since the introduction of white rhinos in 1984. However, six animals were moved to Ol Pejeta Conservancy hence the apparent downward trend in 2006 (Figure 1.8).

1.13.3 Inter-caving interval

The average inter-calving interval calculated for eight females whose calving history was well known was 2.5 years. All females had greatly reduced their inter-calving intervals since they were introduced into the Conservancy probably because the current stock has got adapted to local ecological and environmental conditions.

1.13.4 Age at first calving

The average age at first calving (AFC) was 7.9 years. It is expected that the AFC would reduce as six females Daly, Schini, Samawati, Tale, Wakesho and Titilei aged between 4.5-7.0 years reach breeding age. This will raise the number of breeding females from eight to 14.

1.13.5 Proportion of breeding females calving in the year

In 2006, 63% of the breeding females calved representing excellent performance. This implied that majority of the females had <1.5 year old calves at hoof. In future, this positive trend can be maintained if the right demographic conditions (age and sex) are upheld. A proactive metapopulation management, similar to that of black rhinos can be adopted based on mutually agreed terms among the different white rhino areas in Kenya.

1.13.6 Sex ratio and translocation

Overtime, the sex ratio of white rhinos on LWC has been heavily biased towards males. At the beginning of the 2006, the ratio of females:males was 1:1.12 with most males being breeding bulls. This led to frequent fights that saw the death of four males in 2005. To rectify this imbalance, five males including one that was hand-raised were moved out to Ol Pejeta Conservancy in 2006 (Figure 1.8). The current sex ratio of males:females is 1:1.

Table 1.4: Sex and age structure of white rhinos on LWC, 2006

Age class	Males	Females	Not sexed	Sub-total	Proportion in population
Calves (0≤1 year)	1	2	3	6	17%
Calves (1<3 years)	2	3	-	5	14%
Sub-adults (3<6 years unless calved)	3	4	-	7	19%
Adults (6<30 years)	9	8	-	17	47%
Adults (>30 years)	-	1	-	1	3%
Grand total	**15**	**18**	**3**	**36**	**100%**

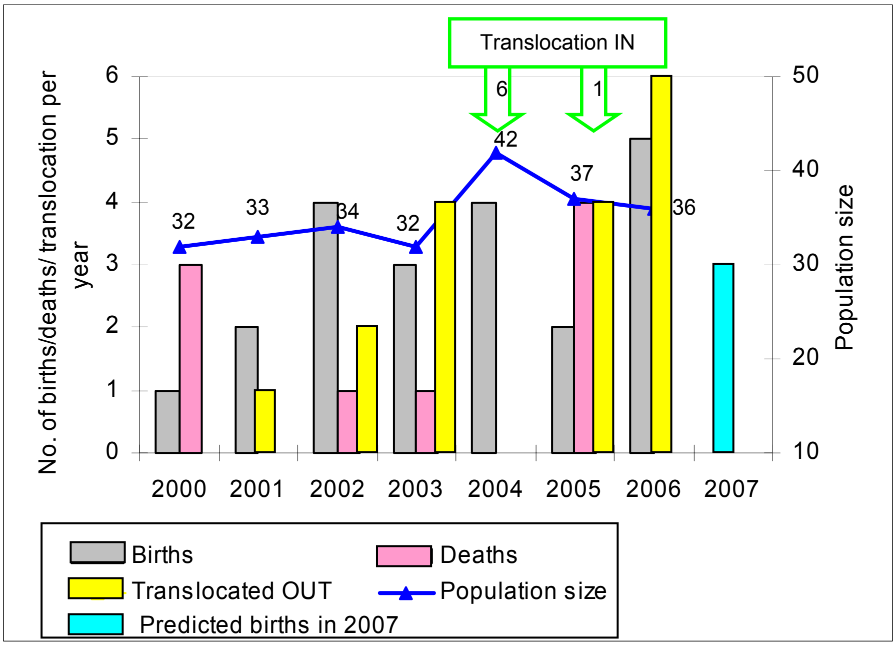

Figure 1.8:: Trend in white rhino numbers, 2000-2006 on LWC

1.14 Overall performance of white rhinos on LWC, 1995-2005

Since the introduction of white rhinos on LWC, 45 calves have been born in the Conservancy. Seventeen animals have been translocated out to other conservation areas to enhance tourism and for breeding purposes. Similarly, within the same period, 12 animals have died in the

Conservancy from various causes. LWC's "donor" status of white rhinos in Kenya can be enhanced if the right sex ratios are maintained.

1.15 White rhino home ranges

1.15.1 Breeding female white rhino

Figure 1.9 shows the home ranges of female white rhinos. Since white rhinos are bulk grazers, they utilized relatively open grasslands that were mostly dominated by *Pennisetum* grass species. They also frequented the rocky hills as a result of persistent drought in 2006. Most of the ranging areas of the females overlapped to a great extent due to the social nature of white rhinos.

1.15.2 Breeding male white rhino

Figure 1.10 shows the home ranges of male white rhinos. It is evident that the home ranges overlapped to a great extent for all males except Chuma, the oldest male who concentrated his ranging areas along Lewa River and central LWC. Reports of fights among breeding males were numerous during the year. These fights stopped when four mature males were moved to Ol Pejeta.

1.16 Recommendations

To maintain an upward trend in the white rhino population on LWC, excess males should be actively translocated out to other suitable areas in Kenya to reduce social pressure and avoid fatalities.

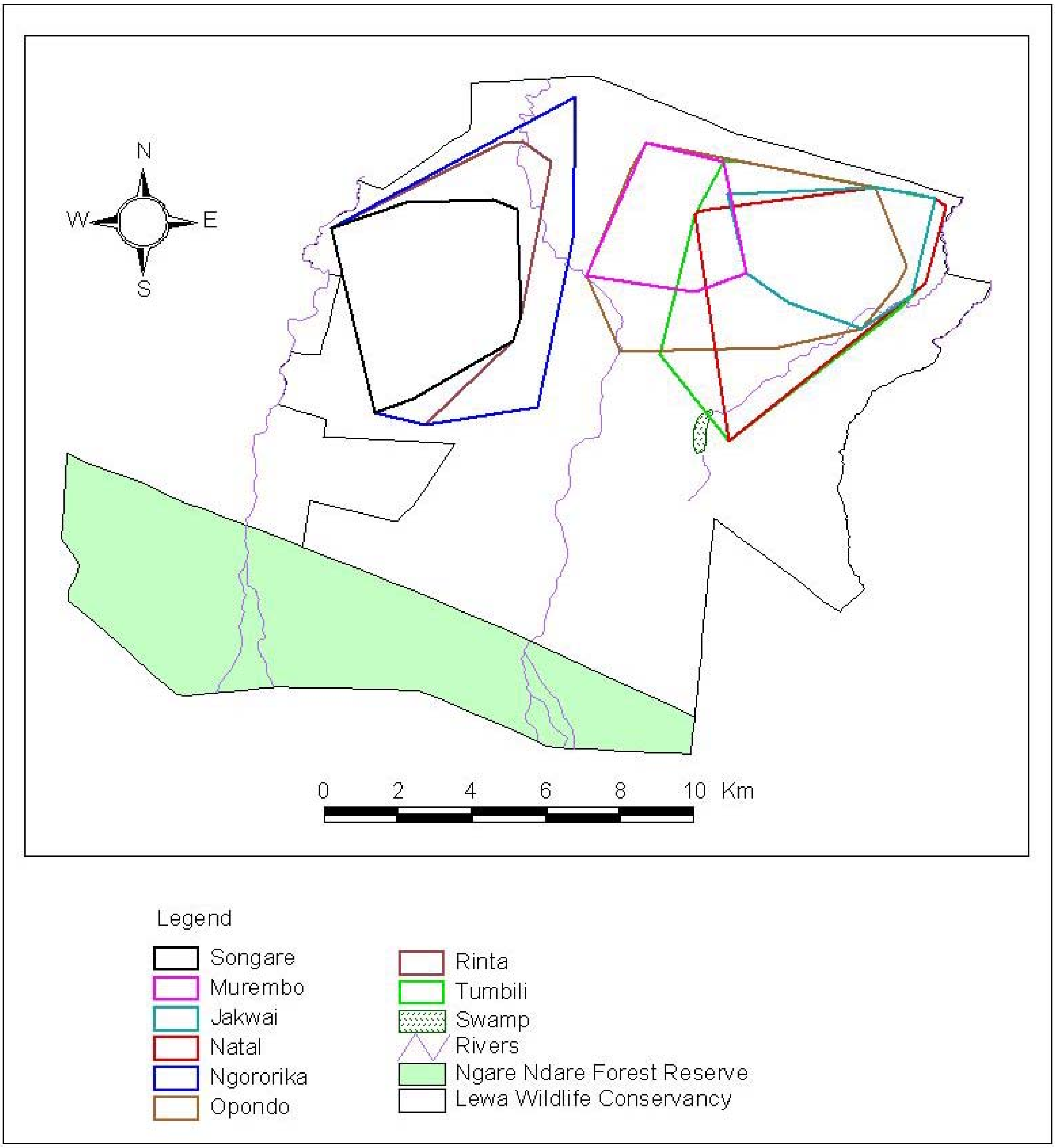

Figure 1.9: The ranging areas of breeding female white rhinos on LWC, 2006 (generated using minimum convex polygon by removing 5% of the outlier fixes in ArcView 3.2)

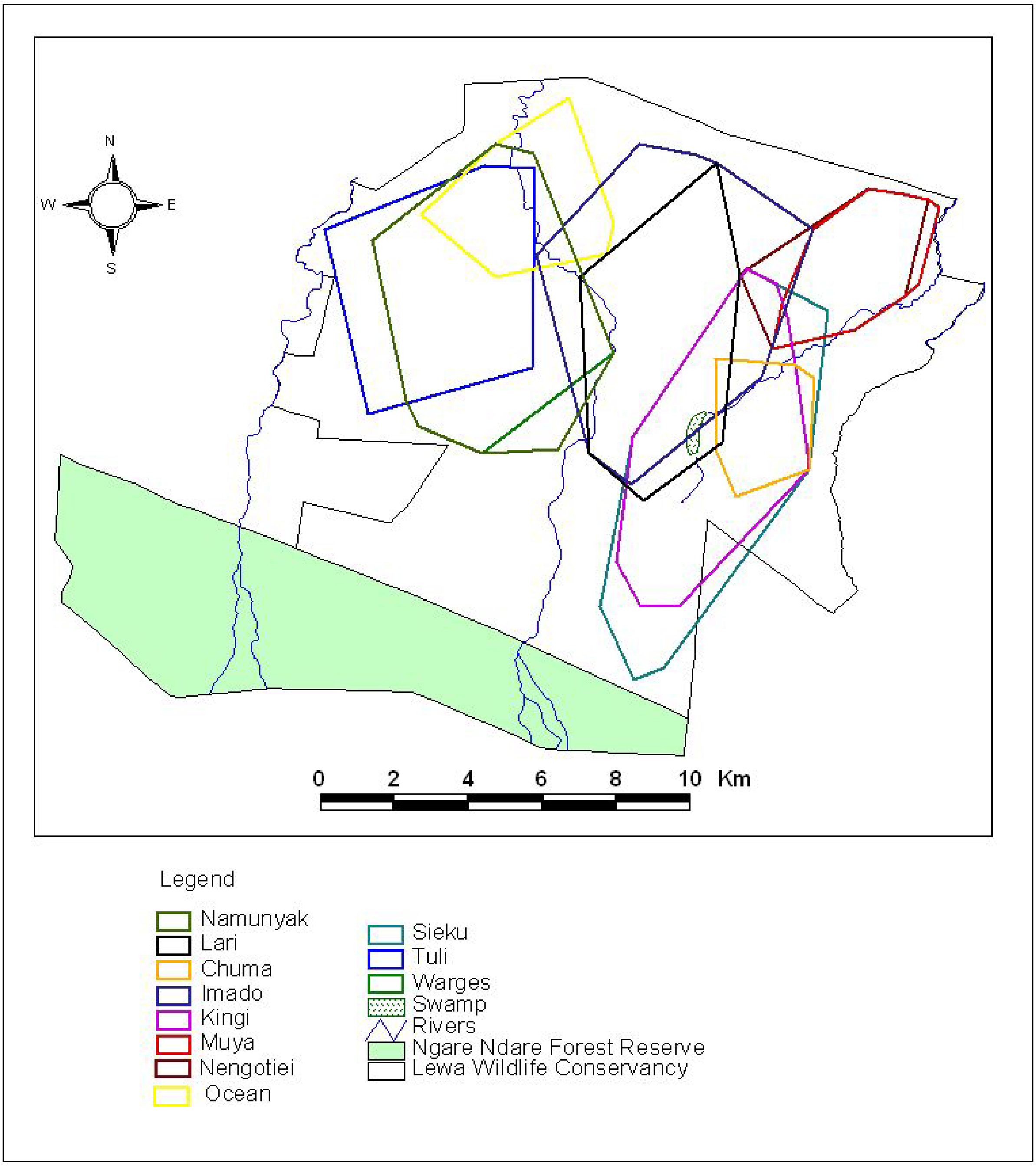

Figure 1.10: The ranging areas of breeding male white rhinos on LWC, 2006 (generated using minimum convex polygon by removing 5% of the outlier fixes in ArcView 3.2)

2.0 GREVY'S ZEBRA RESEARCH AND MONITORING

2.1 Background

In the past few decades, Grevy's zebra, a near-endemic to northern Kenya, has undergone one of the most dramatic reductions in range and numbers of any African mammal. Present day estimates are between 1,700 and 2,200 animals (Williams & Low, 2004), down from 15,000 in the 1970's representing an 86-89% decline in numbers over the past 25 years (Figure 2.1).

While these reductions in range and numbers were occurring, Grevy's zebra were extending their ranging areas southwards onto the protected areas (PA) in Laikipia Plateau. This extension was significant considering the sympathetic reception that the zebras received in these lands. Similarly, it is only these areas that have recorded minimal increases in Grevy's zebra numbers in the past two decades (Williams, 2002), the most significant being on LWC.

Currently, LWC holds between 17-23% of the global wild population of Grevy's zebra. This sub-population has remained one of the most significant breeding nucleuses (Rubenstein *et al.*, 2005) with over 44 foals born annually since 2003 (Chege *et al.*, 2006). However, although this sub-population resides inside a PA, and is free from anthropogenic factors limiting growth and recruitment rates in pastoralist dominated lands, annual game censuses have continued to show reduction in numbers on an oscillating trend (Figure 2.1).

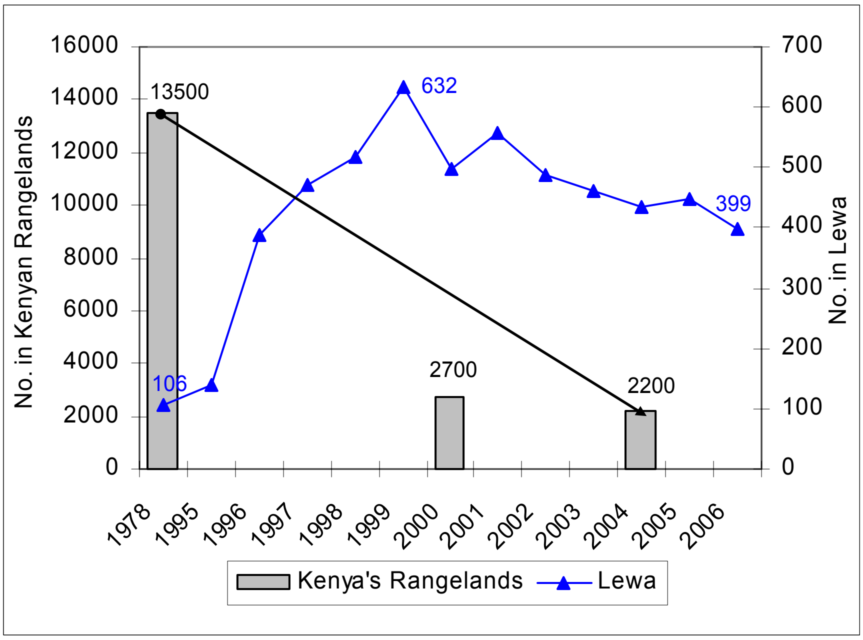

Figure 2.1: Grevy's zebra population trends in Kenya's Rangelands and on LWC, 1978-2006

Therefore, considering the importance of LWC as a critical stronghold of this endangered species, research and monitoring on the Conservancy is aimed at understanding both biotic and abiotic factors that are potentially limiting expected growth rates. It is anticipated that information gathered will be used to understand why declines are even more dramatic in livestock dominated lands where competition for critical resources is more pronounced. This will form an informed basis for decision makers and other conservationists as they pursue pragmatic conservation options to rejuvenate the growth of Grevy's zebra in pastoralist areas.

In collaboration with Earthwatch Institute, St Louis Zoo, Marwell Preservation Trust and Princeton University through Dr Rubenstein, the major focus of Grevy's zebra research and monitoring was on:

(i) Inter and intraspecific interaction including competition with Plains zebra; competition among different reproductive classes of Grevy's zebra; predation rates, parasitism levels and diseases.
(ii) Mortality rates of all age classes, natality, survival and recruitment rates of infants.
(iii) Impact of ecological factors in relation to patterns of drinking, state of vegetative components i.e. spatial and temporal patterns in quantity and quality of fodder, and thickness of bush, and how these components influence movement patterns of Grevy's and Plains zebra.

The specific questions being addressed by LWC's Grevy's zebra research and monitoring are:

(i) *What factors are limiting the growth of the population of Grevy's zebra on LWC?* This query requires information on natality, foal survival and recruitment rates, inter-birth interval, rates of age specific mortality and their causes, rates of predation, health, inter and intra-specific competition with Plains zebra and among different reproductive classes of Grevy's zebra respectively.

(ii) *What relevant management interventions should LWC management undertake to encourage Grevy's zebra population growth in the Conservancy?* These are practical adaptive management decisions based on results of (i) as above.

2.2 Methods

The methods that were adopted are described in detail in Chege *et al*., 2006; Low *et al*., 2005 and Low *et al*., 2004. Briefly, the main activities included, but not limited to:

(i) Monthly foal patrols of Grevy's zebra to determine natality, survival and recruitment rates.
(ii) Digital identification using a customised database that relied on the unique/ "natures" bar code on the right rump and left shoulder of Grevy's and Plains zebra respectively. Currently, the reproductive history of about 90% of all adult Grevy's zebra has been archived in the database.
(iii) Monthly tracking of collared Plains zebra. The size of the harem and other neighbours were photographed for later analysis of survival patterns.
(iv) Monthly census of both zebra species on pre-determined loops to determine association patterns, structure, movement patterns and habitat preferences.
(v) Monthly sampling of vegetation on pre-set transects and in all areas where zebras were encountered grazing in (iv) above, to assess the spatial and temporal distribution patterns in quality and quantity of feed.
(vi) Observation of spatial and temporal drinking patterns of both zebra species.
(vii) Behavioural patterns when the focal animals were in separate and mixed herds to determine levels of competition and association patterns.
(viii) Daily tracking of collared lions, scat collection and subsequent analysis of hair.

2.3 Results and discussion

2.3.1 Grevy's zebra numbers in 2006

There were 399 Grevy's zebra counted in the February 2006 total aerial count. This was down from 448 that were counted in February 2005. In between the two counts, there were 51 births and 30 confirmed deaths. Similarly, through the monthly foal patrols, 8 of the 11 foals that were suspected dead as at December 2005 were actually confirmed dead in 2006. By considering the total number of births and deaths in 2005, the population of Grevy's zebra in 2006 (N_t) should have been a simple balance between the four main elements that determine vertebrate population dynamics. Therefore, simply stated:

$$N_t = N_o \text{ (population as at Feb. 2005)} + \{births + immigration\} - \{deaths + emigration\}$$

However, monitoring rates of immigration and emigration through the elephant game gap was subjective and relied on indirect methods. Therefore, precise and comparative numbers could not be derived from the gap. Likewise, aerial counts tend to underestimate the target animal species. Again, not all kills may have been detected due to:

(i) The height of grass which made detection of carcasses difficult.
(ii) Foals in the 0-6 month age bracket may have been consumed whole.
(iii) Some kills happened at night with hyenas scavenging on the bones before dawn.
(iv) Aerial counts tend to undercount the target species.

2.3.2 Survival and recruitment rates of foals born in 2005

There were 75 foals born in 2005. Ten of these foals were confirmed dead by December 2005. In addition, 11 foals were suspected dead at the close of the year. Based on these figures, 54 foals were thought to be still surviving at the close of the year. Foals were suspected dead if both they and their mothers were not seen for six consecutive months or if the mothers were seen for at least two consecutive months without their foals.

Monthly foal patrols continued in 2006 to determine the fate of the 11 suspected dead foals and assess the survival rate of the 54 surviving foals as at December 2005. Eight of the suspected dead foals were actually confirmed dead in 2006. Similarly, 22 of the 54 foals that had survived at the close of the year died in 2006 from various causes.

From the foregoing discussion, it is evident that the survival rate of foals born in 2005 was about 47% (N=34) (Figure 2.2). This survival rate was significantly higher compared to 25% and 27% realised in 2004 and 2003 respectively (Figure 2.2). However, by using population projection models of LWC's foals, it has been shown that the Conservancy's Grevy's zebra population will only increase in numbers if the overall survival rate of infants born in any year is raised to a minimum of 50% (Rubenstein *et al*., 2005). Therefore, it is only after this target is realised that LWC's ultimate goal of restocking the former rangelands of Grevy's zebra using the Conservancy's breeding stock may be considered.

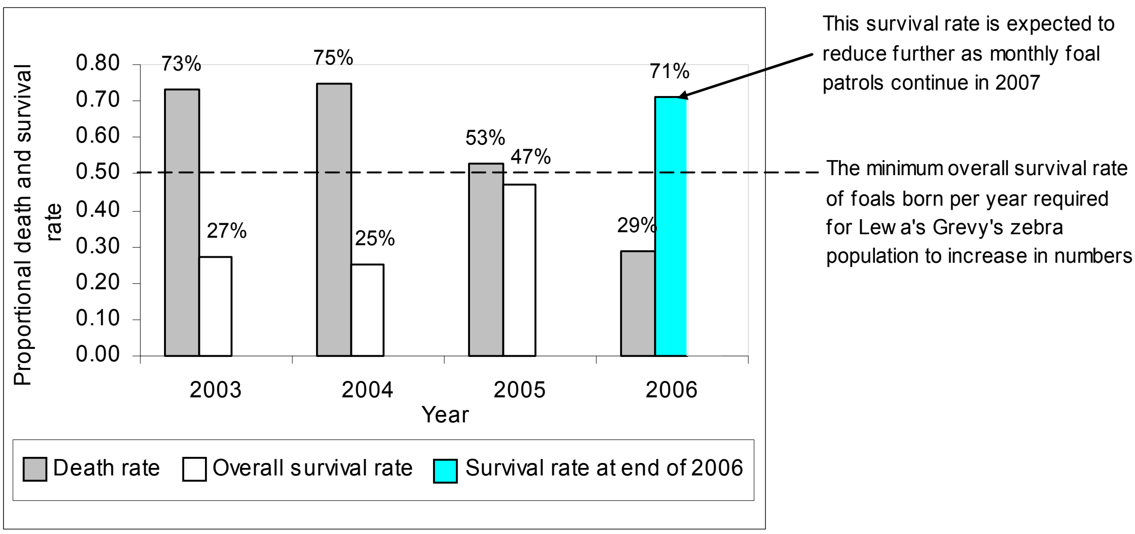

Figure 2.2: Comparison of survival rate of Grevy's zebra foals born on LWC, 2003-2006

2.3.3 Survival and recruitment rates of foals born in 2006

There were 51 foals born in 2006 compared to 75 in 2005 (Figure 2.3). Like in the previous years, the sex ratio of males:females was 1:1. Eleven of these foals were confirmed dead while a further four were suspected to be dead as at December 2006. All the confirmed and suspected dead foals were in the 0-6M age bracket further highlighting the vulnerability of foals to predation (Rowen, 1992). Therefore, as at December 2006, the survival rate of foals born in the year was 71% (Figure 2.2). However, this survival rate is expected to reduce further as monitoring continues in 2007.

Majority of the surviving foals were in the 6-12M age bracket implying that they stood a higher chance of surviving into juveniles (Figure 2.4). It should be borne in mind that the most vulnerable stage of foals to predation is the 0-6M age class due to their poor anti-predator.

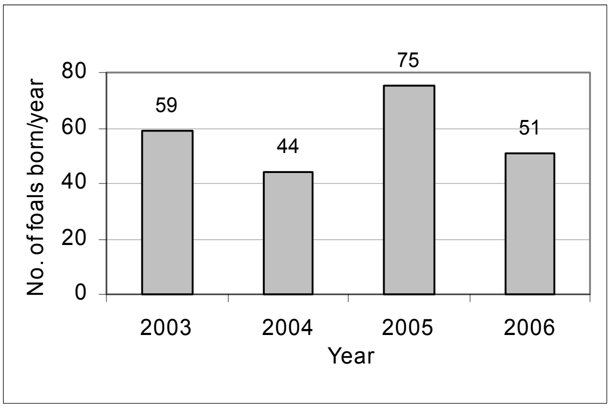

Figure 2.3: Comparison of number of Grevy's zebra foals born on LWC, 2003-2006

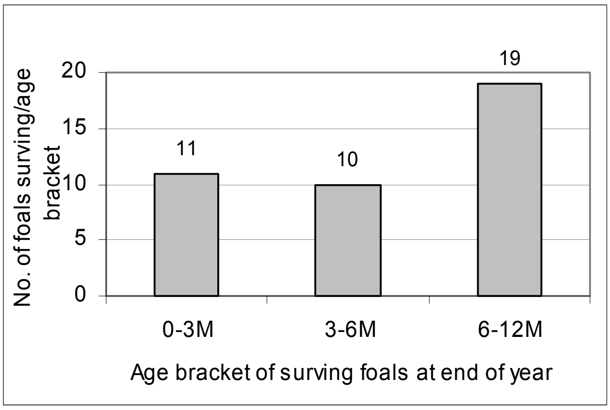

Figure 2.4: Age distribution of surviving foals on LWC as at December 2006

2.4 Timing of foaling

Foaling in 2006 was not synchronised with the rainy seasons. Rather, births appeared to be distributed throughout the year (Figure 2.5). Likewise, the low number of foals born in 2006 may have resulted from poor rains received in 2005 (286 mm). This is based on the fact that it is the rainy season/food abundance one gestation period prior to births (Figure 2.5) that leads to high births in the following year. Consequently, in 2005, a number of females may have been triggered into condition dependent oestrus which is a physiological response to ambient environmental conditions (Belonje & van Niekerk, 1975). Therefore, these females remained in anoestrus condition as they waited for the range condition and their body condition to improve to trigger breeding, hence the lack of synchrony of births in 2006 with rains in 2005.

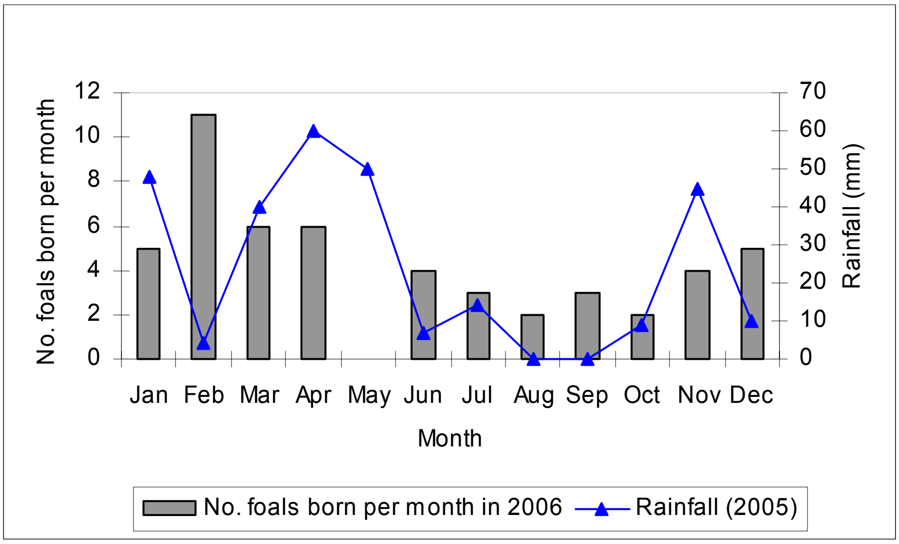

Figure 2.5: A comparison of the number of foals born per month on LWC in 2006 against the 2005 rainfall

2.5 Inter-foaling interval

Grevy's zebra have a gestation period of 13.5 months. Births are regular if post-partum oestrus and subsequent mating are successful (Williams, 1998). Based on this knowledge, simple benchmarks that rely on the duration of inter-foaling interval to gauge the reproductive success can be developed. Therefore, an inter-birth interval of between 13.5-15 months can be termed as "Excellent" while a 24-27 months interval is "Very Poor". Similarly, females with inter-birth interval >27 months should be excluded from the calculation since they may have lost a foal in between.

Using the above set benchmarks, inter-foaling intervals for LWC's Grevy's zebra were calculated for 83 females whose reproductive history was well known. This history has been captured appropriately in the Portfolio® Database since 2001. Over 70% of the females assessed had their reproductive success rated above "Average" with 31% falling in the "Excellent" category (Figure 2.6). This implied that post-partum oestrus and subsequent conception occurred successfully at least one month after parturition. This reinforces the status of LWC's population as an breeding nucleus and that the Conservancy's population has the potential to be revamped and increase in numbers if the overall survival rate of born foals could be raised to at least 50% (Rubenstein *et al*., 2005).

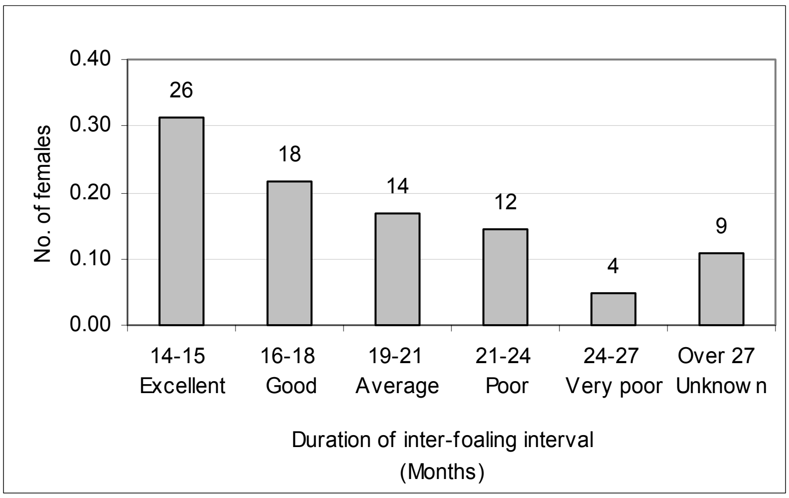

Figure 2.6: Proportional inter-birth intervals for Grevy's zebra on LWC, 2006

2.6 Distribution of lactating females and foals in 2006

The central parts of LWC including Airstrip, east of the Soccer Pitch, Matekenya and west of Mbogo Camp continued to be the preferred kindergarten areas of lactating females with 0-3M foals. As the foals become older and graduated into 6-12M age bracket and juveniles, they appeared to forage widely and away from the main perennial rivers (Figure 2.7). Formation of kindergartens by lactating Grevy's zebra is a characteristic behavioural adaptation since the foals are thought to be both physiologically and energetically (Rubenstein, 1986) constrained and cannot move greater distances between the food and water sources. As in the previous years (Rubenstein, *Pers comm;* Chege *et al*., 2006; Low *et al*., 2005), areas frequented by Grevy's zebra nursery herds were characterised by:

(i) Proximity to water sources.
(ii) Abundance of Increaser I and II grass species (*Cynodon* spp) that are ideal for production of equid milk.
(iii) Relatively open vegetation for maximum visibility against predation.
(iv) Comparatively short grass (hoof level) as a result of prescribed burning and intense cattle grazing, hence the availability of tender and nutritious grass.

Based on the above observations, the most critical ecological factors needed to boost the rate of breeding of female Grevy's zebra, and consequently enhance survival rates of foals on LWC include: availability of free and secure water; and relatively open areas. Reduction of the risk of predation can be enhanced by application of fire on identified core areas through the annual prescribed burning programmes.

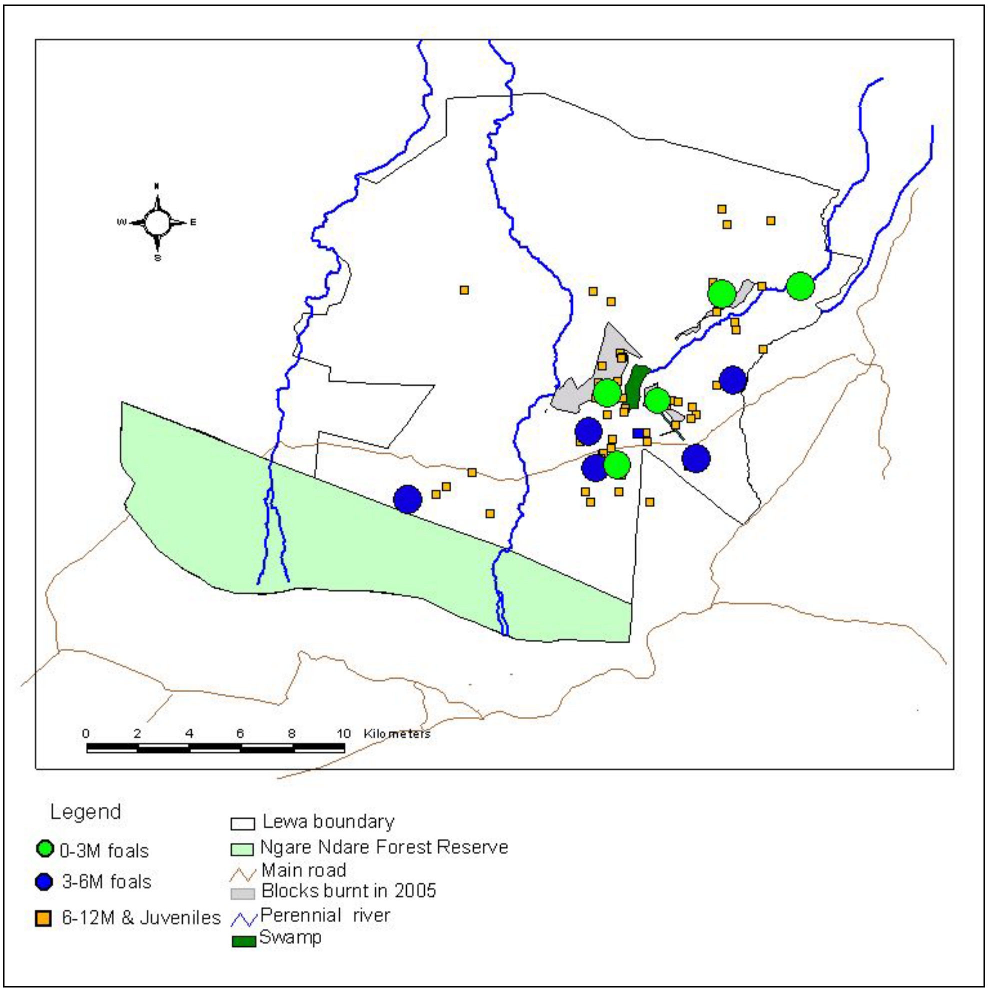

Figure 2.7: Distribution of Grevy's zebra foals and juveniles on LWC, 2006

2.7 Mortality rates of wildlife

A total of 139 animals comprising of 44 Plains zebra, 25 Grevy's zebra, 15 Impala, 12 Buffalo, 10 Eland, 8 Giraffe and 25 other wildlife species were reported dead from the field as a result of various causes (Figure 2.8). In 2006, Buffalo and Giraffe contributed a high proportion of dead species compared to previous years.

Majority of the deaths (80%) of prey species were predator related with lions contributing to majority of the killing (Figure 2.9). In particular, a high proportion of predation of big prey including Buffalo and Giraffe were attributed to male lions. Lionesses may have preferred medium sized prey species, including Grevy's and Plains zebra.

Sixty seven percent of Grevy's zebra deaths were predator related compared to 56% in Plains zebra (Figure 2.10). Other deaths were Cheetah related and as a result of natural causes i.e. no cause could be directly attributed to the dead animal.

The total number of reported dead Grevy's zebra in 2006 was almost equal to reported deaths in 2005 but contrasted with that in 2004. Similarly, annual deaths of Plains zebra from 2004-2006 showed variations with the highest deaths reported in 2004 (Figure 2.11) which coincided with the period when LWC had the highest number of lions (25 residents).

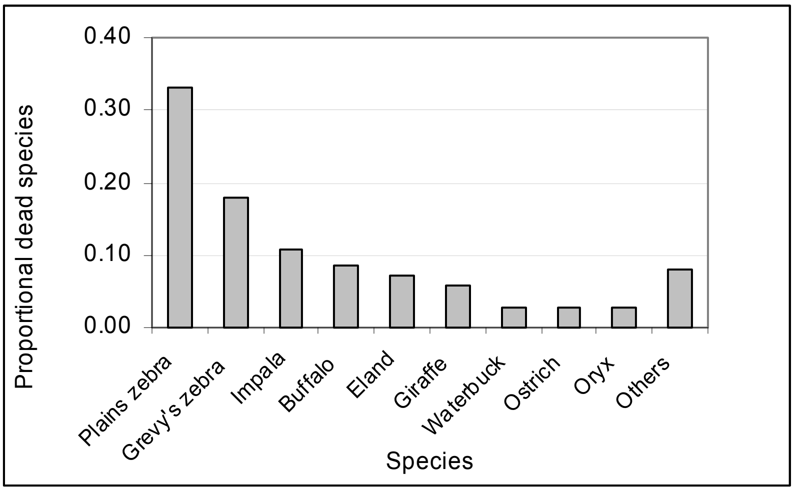

Figure 2.8: Proportional dead wildlife species from all causes on LWC, 2006

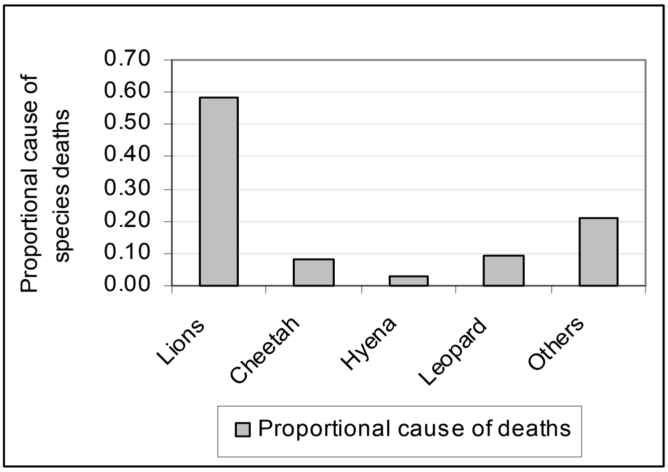

Figure 2.9: Proportional cause of death of all wildlife species on LWC, 2006

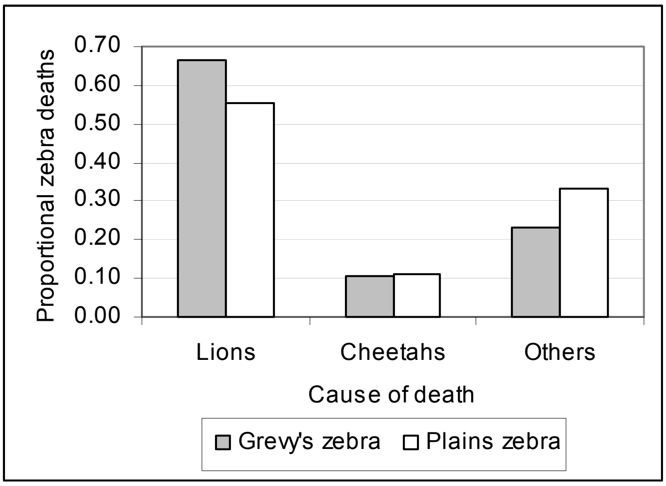

Figure 2.10: Cause of death of Grevy's zebra and Plains zebra on LWC, 2006

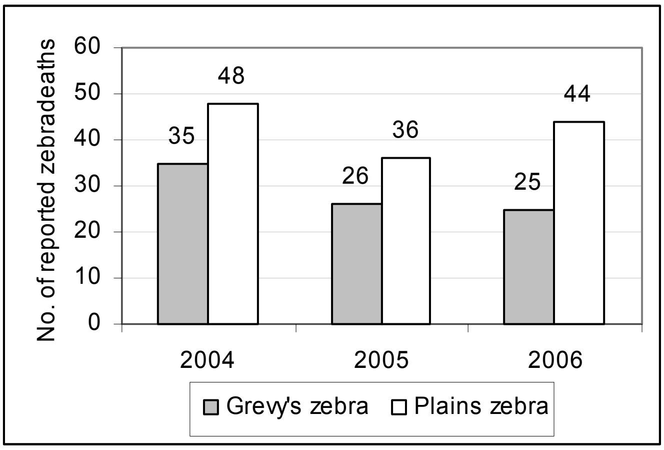

Figure 2.11: Number of dead Grevy's and Plains zebra on LWC, 2003-2006

3.0 PREDATOR PROJECT ON LWC

3.1 Background

LWC is home to a large number of herbivores that form the main prey base of the growing predator population. Similarly, the Conservancy holds at least 20% of the world's remaining wild population of Grevy's zebra. The main aim of this project was to investigate the impact of predation on prey species with particular focus to the critically endangered Grevy's zebra and the more commonly occurring Plains zebra. Specific attention was given to the long-term implication of predation on the survival of Grevy's zebra population in the Conservancy.

Since 2000 when there were slightly over 600 Grevy's zebra on LWC, the numbers have substantially reduced to the present population of about 400 animals. In the last few years, competition with Plains zebra and predation by lions have been identified as possible limiting factors to the growth of Grevy's zebra. This project explores further the extent of predation on Grevy's zebra by lions and suggests possible mitigation strategies to rectify the situation.

To achieve the above objectives, the following activities and data was gathered:

(i) Collaring of lions to determine spatio-temporal movement patterns.
(ii) Tracking of lions daily to determine movements, behaviour and levels of interaction.
(iii) Identification of lions using operational collars as the reference point, and also their unique whisker spots and footprints.
(iv) Collection and analysis of scat to determine the proportion of prey hair.
(v) Monitoring mortality rates to determine predation levels.

3.2 Lion profile on LWC

The number of lions on LWC has historically been low. However, the population had increased to 25 resident lions by October 2004 (Njonjo, 2004). This population reduced to 16 resident lions by the end of 2005 and to 12 in 2006 with up to 8 migratory individuals. Seven cubs were born in March 2006 while seven males (four sub adults and 3 adults) and a female with her two-year old cubs emigrated out of the Conservancy in the year.

Four males moved to the neighbouring Borana Ranch to the west while two were frequently sighted in Samburu Game Reserve. One male was suspected to have found residence in Mukogodo Forest. The current resident population comprises of two adult females, two sub adult females, one adult male and seven cubs.

3.3 Collaring, tracking and identification of lions

In 2005, a total of six lions had operational collars on LWC. However, as at December 2006, there was only one female with a reliable collar. This collar served as the reference point during the daily tracking of lions since she formed a definite group with other lions. Five other males that had operational collars moved out of LWC as noted in Section 3.2. The uncollared lions were identified and tracked using their spoors to determine movement patterns. This method was however not very reliable.

All the uncollared lions were further identified using Pennycuick and Rudnai's method (1970) in order to determine population sizes. This method relies on the facial whisker spots on lions that are unique to each lion just like human fingerprints.

3.4 Collection of scat

Lion scat is difficult to find due to its high protein content thus making it attractive to smaller predators and scavengers. In order to increase the chances of locating scat, the following methods were followed (Njonjo, 2004):

- Finding collared individuals and observing them until they produced scat. This was however time consuming.
- Locating the exact areas where lions had been resting and searching for scat once they had relocated to another place.
- Kills were located and scat searched around them. This was a very effective way particularly if the kills were big.
- Opportunistically on road sides.

3.5 Scat and hair analysis

Once scat was collected from the field, it was dried in open air and later stored appropriately. To loosen and clean the fatty emulsions on the hairs, scat was soaked in hot water mixed with 70% ethanol for five minutes. Hairs were then actively picked from the cleaned scat for about 15 minutes. Hairs were later immersed in 70% ethanol for further cleaning.

Twenty hairs from each scat sample were selected for mounting and identification. Only hairs that had a root were mounted on microscope slides. Hairs were then observed under a light microscope where the basic configuration of the hair i.e. relative width of the medulla and cortex (Figure 3.1) were used to distinguish between hairs of different animals (Njonjo, 2004). The hairs were similarly compared with a reference hair collection that has been developed from hairs uprooted from known animals to ensure accuracy.

3.6 Results and discussion

3.6.1 Dynamics of lion population on Lewa

The population of lions on LWC fluctuated throughout the year as a result of emigration, immigration and births. Such dynamism was clearly manifested by the most cohesive group at the beginning of the year that comprised of two lionesses and their six offsprings (four sub adult males and two females).

Seven cubs were born between the two lionesses in March 2006. This was preceded by emigration of the four sub adult males to Borana Ranch while the sub adult females disassociated themselves with the natal pride in February 2006 (Figure 3.2). Similarly, two adult males moved out of LWC to Samburu National Reserve in July 2006. Consequently, as at December 2006, the population of lions on LWC stood at 12 down from 19 at the beginning of the year. This number represented over 50% reduction compared to the number of resident lions in the Conservancy in 2004 (Figure 3.3).

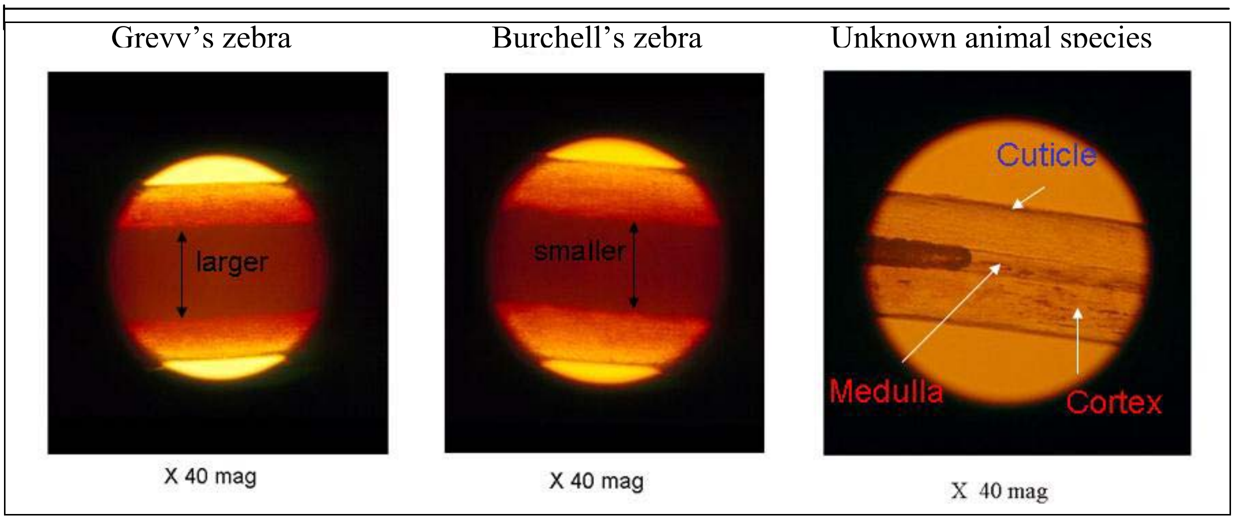

Figure 3.1: Features used to distinguish between hairs of zebras in lion scat, 2006 (Njonjo, 2004)

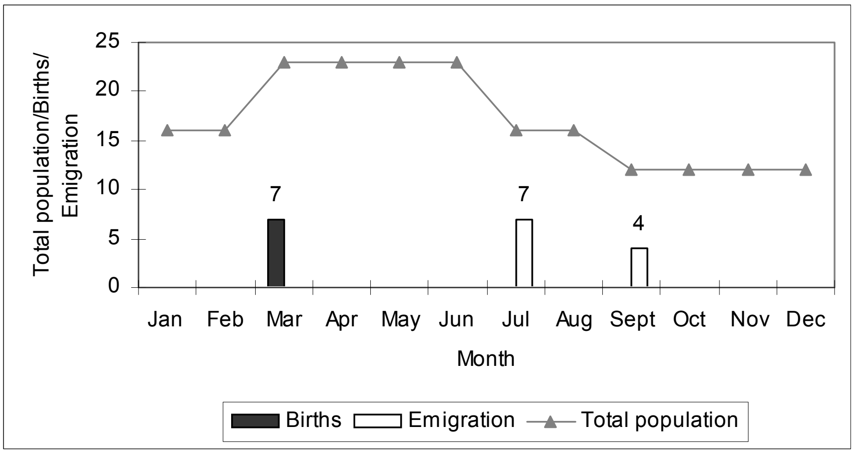

Figure 3.2: Fluctuation in the number of lion on LWC, January – December 2006

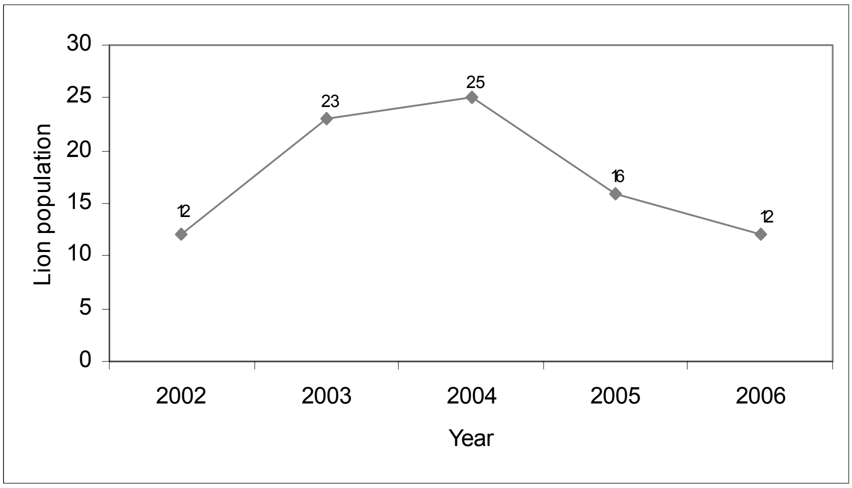

Figure 3.3: Trend in the number of lion on LWC, 2000-2006

3.6.2 Scat and hair analysis in 2006

A total of 23 scat samples were collected and examined for prey hair content. From each sample, 20 hairs were individually mounted and observed on a light microscope at x10mg and x40mg for identification purposes. As in the previous years, results indicated that zebras (59%) formed the main diet of lions (Figure 3.4).

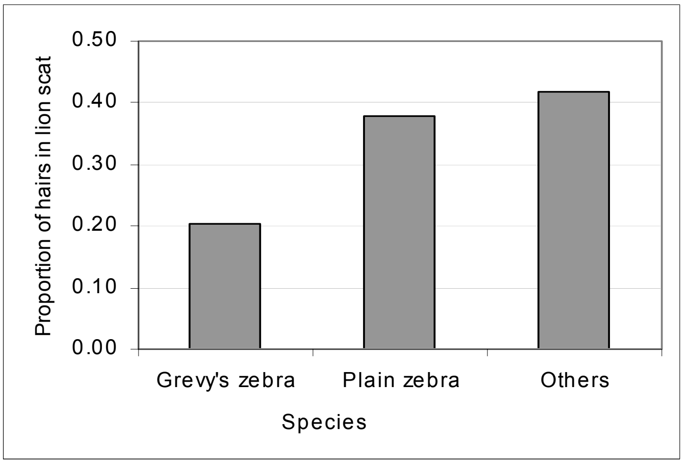

Figure 3.4: Proportion of Grevy's zebra, Plains zebra and hair from other prey species found in lion scat on LWC, 2006

When hairs from the two zebra species were separated, 20.4% (n=94) belonged to Grevy's zebra while 37.8% (n=174) were from Plains zebra (Figure 3.4). Similarly, 42% (n=192) of the hairs belonged to other prey species, mainly Impala, Buffalo and Eland (Figure 3.5). These results compare well with the 2006 field security personnel incident reports that revealed almost twice as many dead Plains zebra as Grevy's zebra (Figure 2.11).

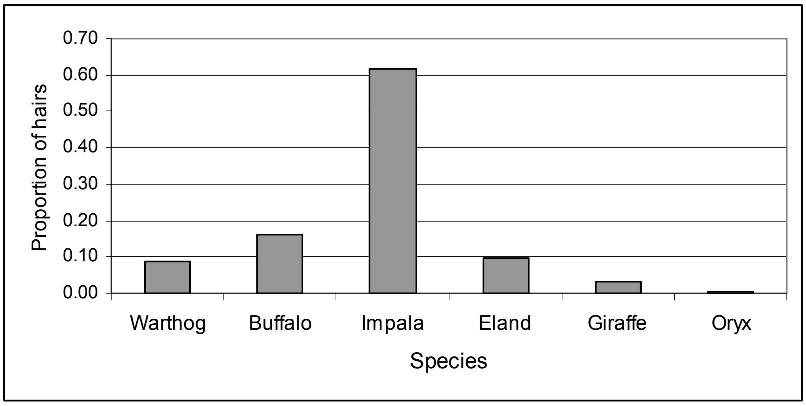

Figure 3.5: Proportion of hairs from other prey species on the diet of lions on LWC, 2006

3.7 Comparative assessment of predation rates, 2004-2006

In 2006, the proportion of zebra hairs in the scat contrasted with 2005 and 2004 when there were proportionately more Grevy's zebra hair compared to Plains zebra (Figure 3.6). This could be as a result of emigration of a number of adult males from LWC to neighbouring ranches that saw the number of lions reducing to 12 individuals, most of which were cubs compared to 2005 and 2004 when there were 19 and 25 resident lions respectively.

The highest predation rate of zebras was in 2004 (with 25 resident lions and 10 migrants) when both zebra species were predated equally (Figure 3.6). The rate of predation reduced marginally in 2005 (44% Grevy's zebra; 33% Plains zebra and 23% other prey species) when compared with 2004 (Figure 3.6). During the year, two lions left LWC. Likewise, in the same period, a cohort of six cubs graduated into the sub-adult age class. This may have necessitated the need to have large kills to satiate the appetite of the two lionesses and their six sub adult offsprings. However, this group split in December 2005 where the six sub adults spent most of the time together and did their own killing.

The proportion of predated Grevy's zebra further reduced in 2006 probably due to a reduction in the number of active lions (Figure 3.3; Figure 3.6). During the year, Impala were predated most compared to other non-zebra prey species. This corresponds well with their numerical dominance when compared against other prey species as recorded in the February 2006 annual game count.

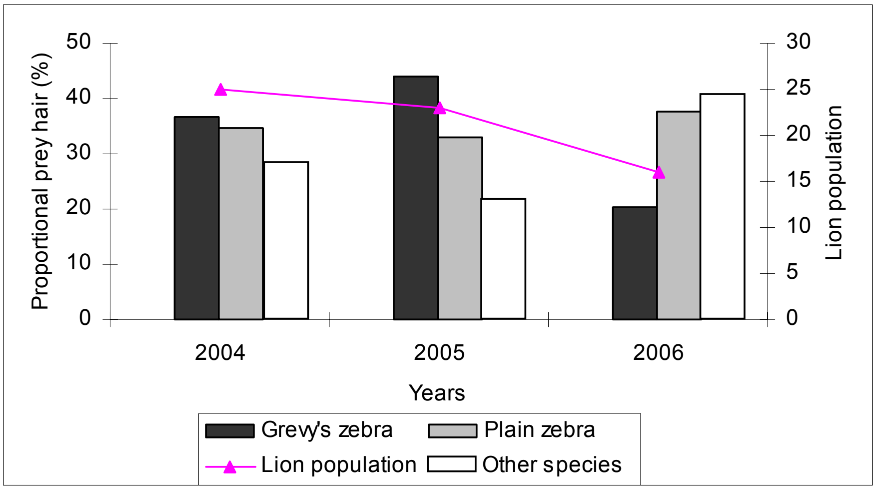

Figure 3.6: Proportion of Grevy's and Plains zebra hairs in relation to the number of Lions, 2004-2006

3.8 Lioness home ranges

Figure 3.7 shows home ranges of the three lionesses within LWC. Lioness 254 had a relatively large home range compared to lioness 331 (with 3 cubs) when calculated at 95% minimum convex polygon. However, at 50% (core area) of the ranging areas (calculated by removing 50% of outlier points), the two lionesses had a home range of 10 km^2. This core area was along the Lewa River, Mlima Chorowa, Scotch Corner and Miti ya Breakfast. These overlapped greatly with the ranging areas of zebras in 2006. Consequently, most of the kills were reported in these areas (Figure 3.8).

Female 254 always associated with another female that was not collared (254 Mate). Both lionesses had 4 and 3 cubs respectively. These cubs were born in March 2007 and this may have contributed to their reduced movements, and hence the relatively small home range compared to 2005 when both females had sub adult offsprings and consequently large home ranges >50km^2.

3.9 Lions home ranges

Figure 3.9 shows male home ranges of collared lions on LWC. These were calculated from January to July 2006 since all the three males emigrated from LWC in July 2006. The males had relatively large home ranges compared to females. Four sub adult males (collar 252) extended their ranging areas to Borana Ranch after seven cubs were born between their mothers (collar 254 and her Mate) in March 2006. The four sub adults appear to have found permanent residence in Borana where they are frequently sighted on the central and nsorthern parts of the Ranch.

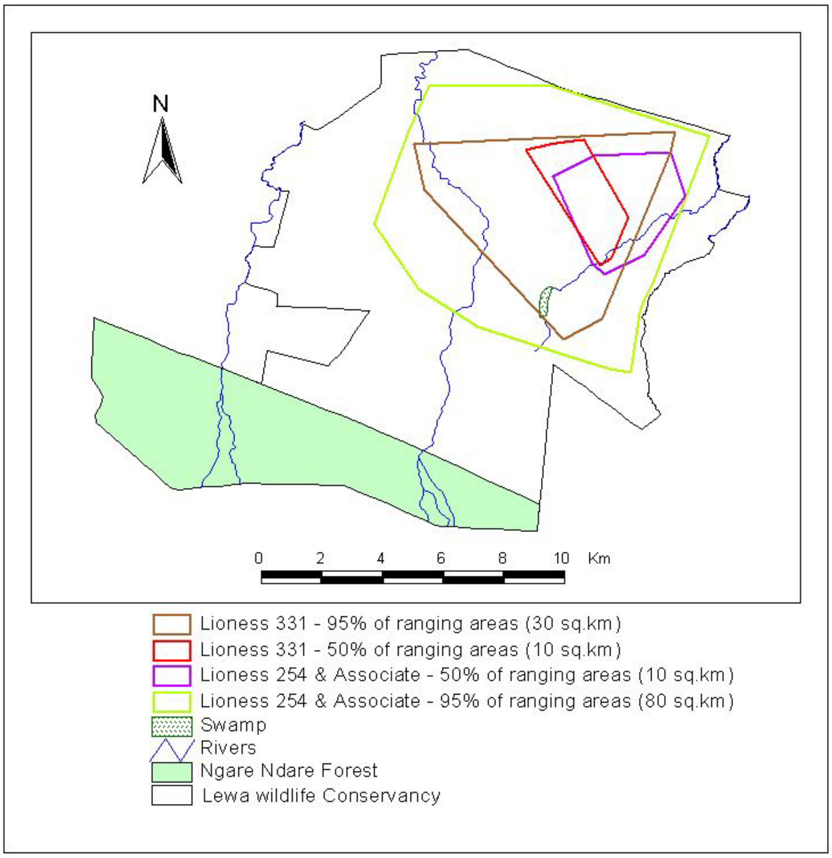

Figure 3.7: Home ranges of Lioness 254, 254 Mate and 331 on LWC, 2006

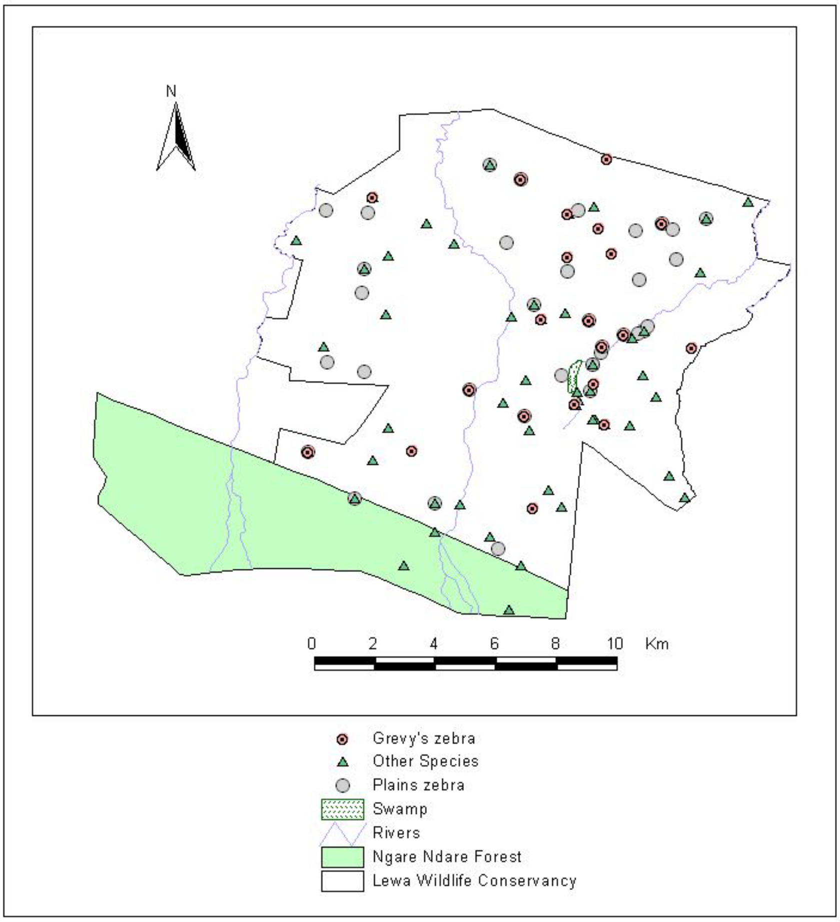

Figure 3.8: Location of kills of zebras on LWC, 2006

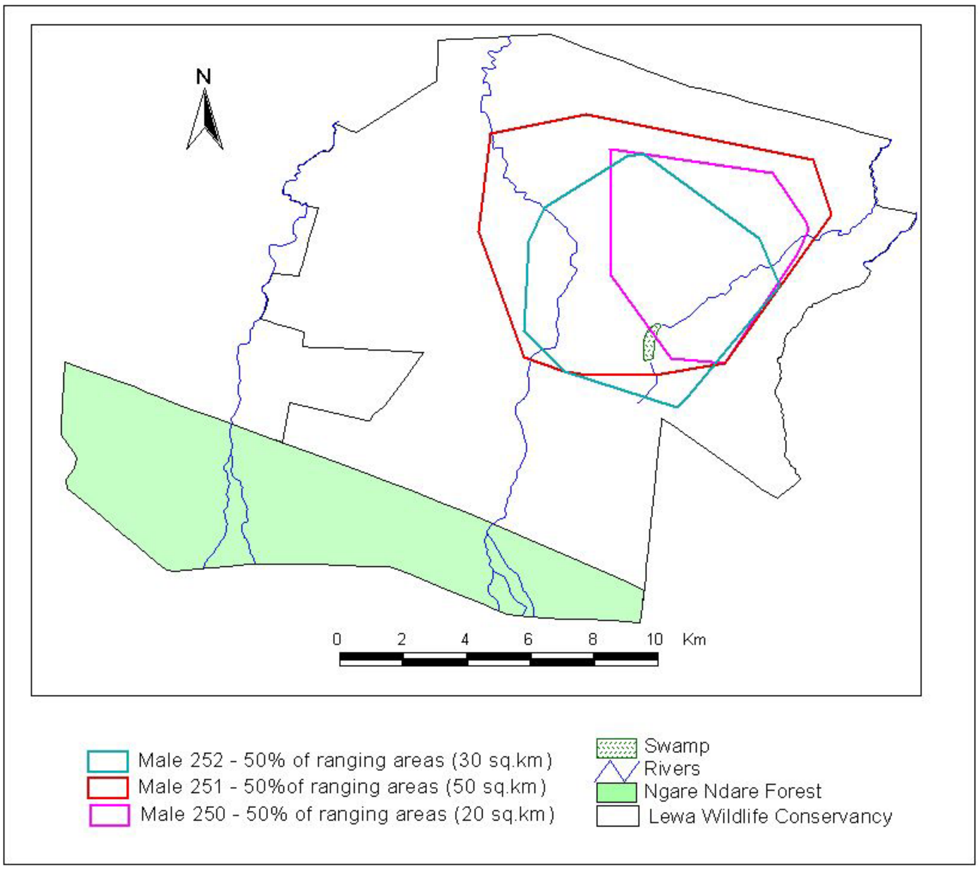

Figure 3.9: Home ranges of Lions 250, 251 and 252 on LWC, January -July 2006

3.10 Conclusion

The rate of predation on Grevy's zebra reduced from 2004 when there were up to 25 residents lions compared to 2006 with only 12 lions. This demonstrates the potential benefit that can be derived from reducing the number of lions on LWC. The possible mechanisms of maintaining low numbers of predators were discussed in detail in Njonjo, 2004 and Low *et al*., 2005. The formulation of Grevy's zebra Strategic Plan by KWS will ensure timely implementation of pragmatic strategies aimed at boosting the population growth of Grevy's zebra especially in their last remaining strongholds like LWC. Similarly, recommendations about the future management of lions that takes cognizance of the past predation trends relative to the number of lions on LWC have already been submitted to KWS for review by the Carnivore Working Group and for possible inclusion in the draft Management Plan for Lions that is due in 2007.

4.0 MASS VACCINATION OF GREVY'S ZEBRA AGAINST ANTHRAX IN NORTHERN KENYA - summarised from Manyibe, Low & Chege, 2006

4.1 Background to the vaccination exercise

An outbreak of anthrax in northern Kenya that began in December 2005 appeared to be disproportionately affecting equines and in particular, the Grevy's zebra. Initial deaths were noticed by community scouts working in the community Conservancies and also researchers from African Wildlife Foundation and Earthwatch Institute who facilitated a veterinarian from the KWS to visit the affected area and investigate the deaths. The results confirmed anthrax.

The spatio-temporal distribution of cases (Figure 4.1) showed that the Wamba area was most affected by the outbreak with a peak in deaths occurring in January 2006. As at the end of February 2006, 52 Grevy's zebra, 16 Plains zebra and 14 head of livestock were reported dead in the Wamba area of northern Kenya, the majority of which showed signs of anthrax after death. Blood smears from nine of these carcasses were positive for anthrax using polychrome methylene blue stain and several others were suggestive of the disease by Giemsa stain (Capstick, Manyibe & Mugambi *Pers. comm.*). It was estimated that at least 50% of all dead Grevy's zebra were located i.e. the total number of deaths would have been >100 animals (≈ 5% of the entire wild Grevy's zebra population).

Therefore, it was necessary to vaccinate all the Grevy's zebra in three of their identified strongholds in order to reduce the rate of death and boost their immunity in case of any future resurgence of the disease. Similarly, livestock, which live sympatrically with zebras in northern Kenya, are known to be carriers of Anthrax. Hence, it was paramount to also vaccinate all livestock herds to act as buffers in the affected areas.

The areas targeted for vaccination were the National Reserves of Samburu, Shaba and Buffalo Springs, community group ranches around Wamba and LWC (Figure 4.2). Even though Anthrax related deaths had not been reported in LWC and the Reserves, there was serious concern that the populations within these areas were at risk from being infected, particularly from the extensive movement of livestock which could potentially spread the disease.

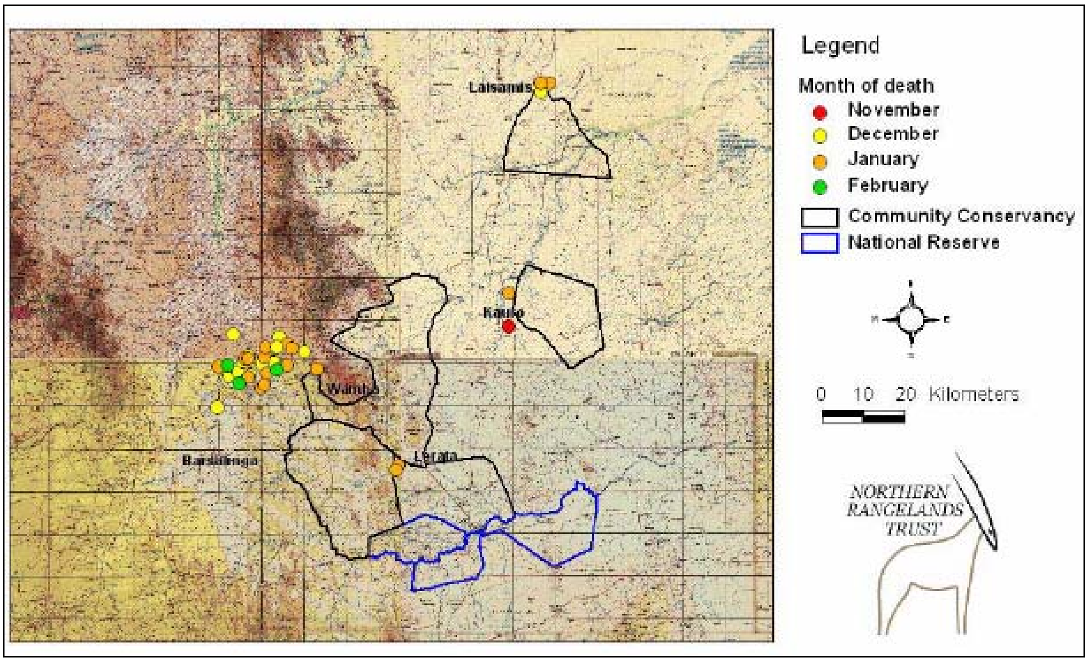

Figure 4.1: Spatio-temporal distribution of Grevy's zebra deaths attributed to Anthrax Nov. 2005 – Feb. 2006

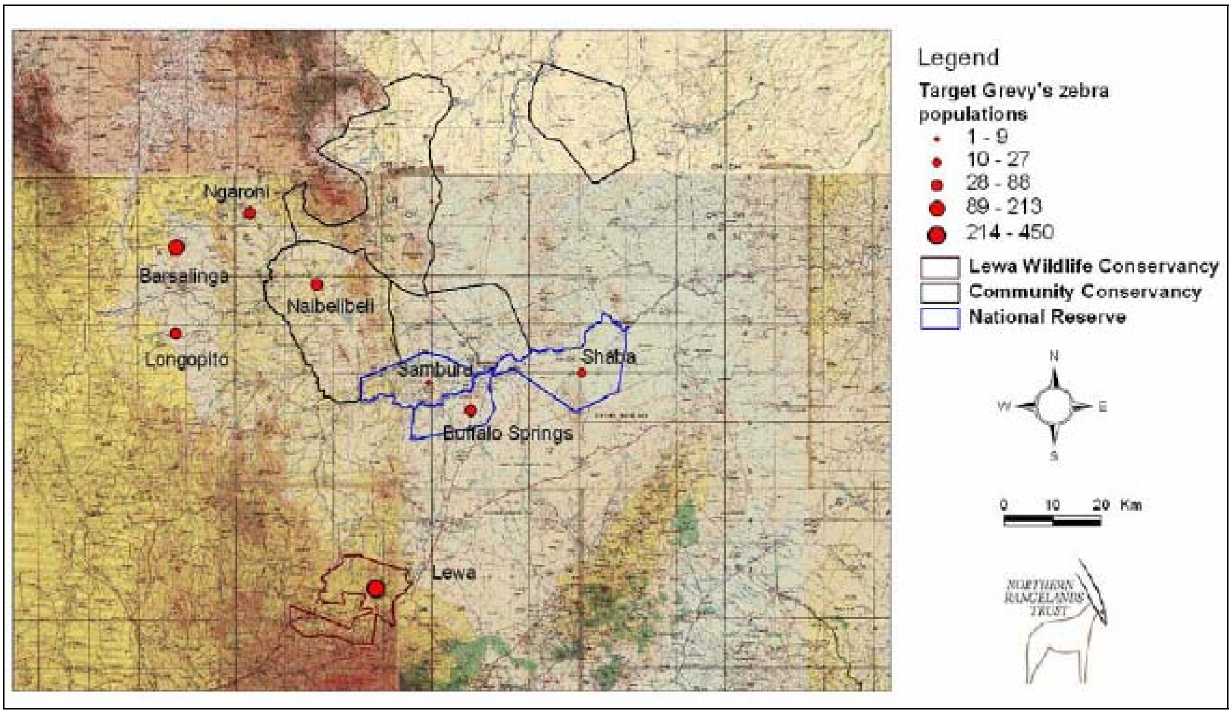

Figure 4.2: Grevy's zebra populations targeted for vaccination, Feb. 2006

4.2 What is Anthrax?

Anthrax is a fatal infectious disease of most warm-blooded animals, particularly herbivores. The disease is caused by Gram positive, rod-shaped, spore-forming bacteria, *Bacillus anthracis*. It is characterised by sudden death with no prior symptoms. Carcasses are often found oozing dark un-clotted blood from natural body openings, and they decompose rapidly often with incomplete or no rigor mortis (Turnbull *et al*, 1998). In Kenya, Anthrax occurs sporadically throughout the country and is classified as a notifiable and emergency disease, covered by legislation to ensure proper disposal of carcasses, quarantine of the affected area, and emergency vaccination (WHO, 1994).

Anthrax persists in an area due to the ability of the bacteria to form long-lasting, highly resistant spores that may remain viable and infectious in the environment for many years, initiating cycles of disease when conditions are right (Dragon & Rennie 1995). Outbreaks tend to occur during extremes of weather, such as drought or heavy rains (Lindeque & Turnbull, 1994). Recent epidemics of anthrax in wildlife have shown that the disease can kill large numbers of animals within a short time, with devastating results in rare species (Turnbull *et al.*, 1991; Gates *et al*., 1995).

The conventional methods used to control anthrax include vaccination, intensive surveillance, quarantine, proper disposal of carcasses, and environmental decontamination (Hugh-Jones, 1999; Turnbull *et a.l*, 1998). However, these methods can be extremely difficult to implement, especially during large outbreaks, due to scarcity of resources and remoteness of the affected areas. Many carcasses remain hidden in bushes and carrion eaters dismember them, resulting in massive environmental contamination (Gates *et al*., 1995; Dragon *et al*., 1999).

Vaccination has been used successfully for decades to control anthrax in livestock. Much more recently, the growing application of vaccination in free ranging wildlife especially in South African countries has followed the development of effective remote drug delivery systems, and the realization that endangered species should be given the benefit of modern preventive veterinary medicine (Turnbull *et al.*, 2004b). However, extreme caution should be taken while applying the vaccine to endangered species due to perceived vaccination-related adverse effects on the target species (Turnbull *et al.*, 1994b; Woodroffe, 2001).

4.3 Immediate response to the outbreak of anthrax in northern Kenya

Extensive consultations and expertise was sought from several experts in wildlife biology and veterinarians both locally and overseas on the most ideal method of responding to the disease. As an immediate response to the outbreak, the following measures were instituted:

(i) Intensive monitoring of the spatio-temporal distribution of all carcasses. This was made possible by a team of dedicated personnel from NRT and Namunyak Wildlife Conservation Trust who followed the fate of all reported deaths and ensured proper disposal. In total, the ground team responded to about 100 cases of wildlife and livestock deaths. Reporting and transfer of information was facilitated by the extensive radio communication network in the affected areas.

(ii) In collaboration with the District Veterinary personnel, widespread livestock vaccinations in community areas around Wamba, the Reserves and LWC were effected.

(iii) LWC's elephant gap was closed to prevent potentially infected animals from northern Kenya gaining entry into the Conservancy.

(iv) All carcasses were properly disposed by burning using firewood and diesel fuel.

(v) Since Grevy's zebra have never been vaccinated before, a trial vaccine was administered on eight animals on LWC to test the presence of any adverse effects against the vaccine. The eight Grevy's zebra were confined for six weeks and no negative reactions were noticed. Hence, a full blown vaccination programme was approved by KWS.

(vi) Blood was drawn before confinement of Grevy's zebra, six weeks later and again one month after release. The complete results from this vaccination trial, once received from South Africa, will provide insight on the humoral response of the species to the vaccine for future reference (Manyibe, *et al*. in prep).

4.4 Methods

Vaccinations were done either from vehicle or helicopter depending on habituation of populations and terrain of the area. Individuals in the same herd were differentiated by their age, sex and stripe patterns and were photographed for later cataloguing. Intensive post-vaccination monitoring took place for one week after vaccination and six animals from three of the northern populations were fitted with radio-collars for long-term monitoring. Vaccination was done using 2 ml of the 34F2 live spore vaccine (Blanthrax®, Coopers Kenya) administered intra-muscularly, using the Daninject® remote delivery system, with 2ml barrels and 2x30mm (N2030.) plain needles. The darts fell off from the animals shortly after darting, and were collected and examined to assess the success of delivery of the vaccine.

4.5 Results and discussion

In total, 1001 Grevy's zebra were individually censured in the target areas (Table 4.1). Of those, approximately 620 comprising of different age classes, were successfully vaccinated, representing 62% of the animals (Figure 4.3). Results of the post-vaccination monitoring showed that no adverse reactions were observed in the one week after vaccination. Similarly, following intensive vaccination of livestock where over 60,000 herds were successfully vaccinated in the community areas around Wamba, the National Reserves of Samburu, Shaba and Buffalo Springs, and the LWC, the number of reported cases of anthrax in Grevy's zebra reduced considerably despite the same intensity of surveillance.

Table 4.1: Results of the vaccination exercise showing age and sex structure of vaccinated animals in the target areas

					Sex and age structure of vaccinated animals						
					Adults			Juveniles			Foals
Date	Area Name	No. Seen	No. Vaccinated	% Vaccinated	Males	Females	Unsexed	Males	Females	Unsexed	6-12 months
16 Feb 2006	Buffalo Springs	88	60	68	33	18	1	7	1	0	0
16 Feb 2006	Samburu	9	9	100	4	3	0	0	2	0	0
18-21 Feb 2006	Lewa	474	251	53	121	101	6	7	8	2	6
25 Feb 2006	Shaba	26	20	77	5	13	0	2	0	0	0
27 Feb 2006	Longopito	51	46	90	19	23	0	3	1	0	0
27 Feb 2006	Naibelibeli	58	39	67	12	22	0	4	1	0	0
27 Feb 2006	Barsalinga	213	134	63	19	41	61	1	3	9	0
28 Feb 2006	Ngaroni	82	61	74	6	38	8	2	0	7	0
	Total	1001	620	62	219	259	76	26	16	18	6

Key: Adult = 3+ yrs old
Juvenile = 1-3 yrs old
Foals = 0-12 months old
(yellow) Animals darted by helicopter
(white) Animals darted by vehicle

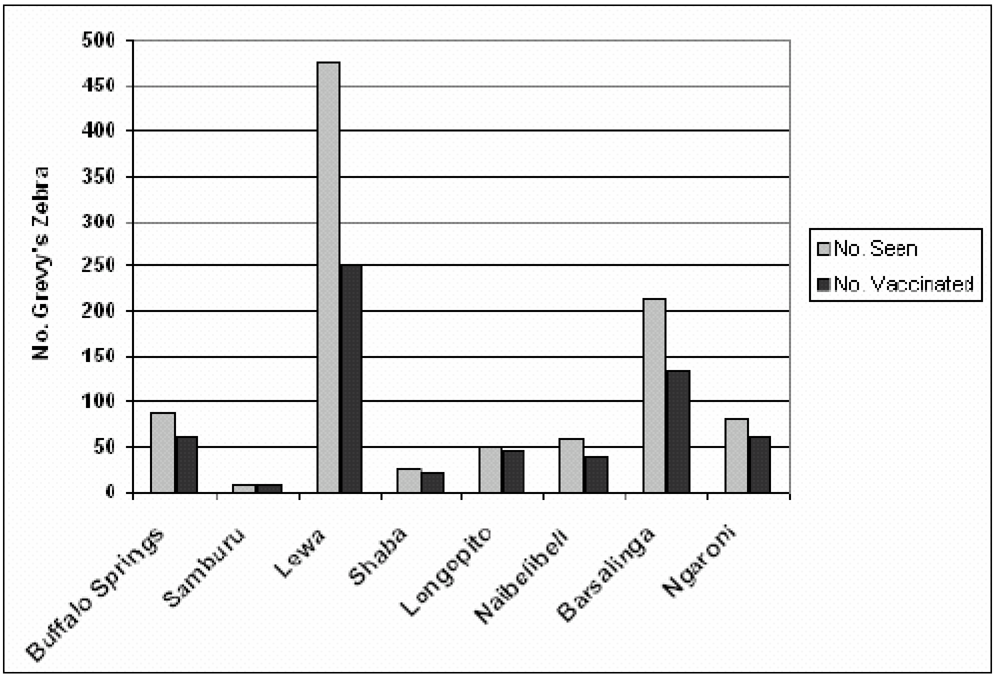

Figure 4.3: Proportion of Grevy's zebra vaccinated against anthrax in Samburu District in February 2006 compared to the total number sighted per area

4.6 Key issues arising from the vaccination exercise

(i) The vaccination exercise was successful as it provided an opportunity to conduct an indirect census of Grevy's zebra in the targeted areas i.e. the numbers and age structure seen gave crucial indication of the status of the target populations, especially herds vaccinated from vehicles.

(ii) The low number of foals observed in the northern populations was of concern and indicated poor recruitment during 2005, attributed to the prevailing drought in that year. In Samburu and Buffalo Springs National Reserves which were historically known for their breeding populations of Grevy's zebra, a male biased sex ratio was observed, with no lactating females. Similarly, predation is thought to limit populations of Grevy's zebra in these areas, and also on LWC. On going radio telemetry in the NRT areas has shown that of the seven collared Grevy's zebra that entered the Reserves from community-owned land, five were killed by predators. On-going tracking of zebras using GSM collars is expected to provide further insights.

Consequently, it was recommended by the Grevy's Zebra Tusk Force that further studies on the predator-prey dynamics, specifically focused on Grevy's zebra, be initiated as soon as possible. A similar proposal was put forward by the National Predator Management Committee. One such project to be conduced by a post-doctoral student is set to commence in the Reserves in 2007.

(iii) Lewa Wildlife Conservancy had 65% of the foals encountered, reflecting its long-standing importance as a sanctuary for Grevy's zebra. However, this population continues to face loss to predation by lions.

(iv) The northern areas had 404 Grevy's zebra sighted and 27% of the foals were located in these areas. The areas had a diffuse wildlife/livestock interface highlighting the important role that communities can play in endangered species conservation, given appropriate investment. This has been demonstrated by the existing Conservancies of West Gate, Kalama, Namunyak and the communities of Ngaroni and Sessia where the Grevy's Zebra Endangered Species Programme operates (Low *et al.*, 2006). It reinforces the fact that investment into these community institutions is the foundation for conservation on community-owned land; it provides continuity to conservation through the different cycles of development within each area and promotes the sustainability of individual projects through institutional strengthening.

4.7 Recommendations and current status of the disease

Several recommendations emerged from this exercise, including:

(i) Immediate implementation of emergency response plans in the event of serious infectious diseases in Grevy's zebra and other endangered species through cross-sectoral collaboration (see (ii) below).

(ii) Annual vaccinations of livestock against anthrax in areas with a diffuse livestock/ wildlife interface – funds permitting. As a follow up to this proposal, an intensive vaccination exercise of livestock was undertaken in October 2006 in the community areas following reported cases of a few deaths of Grevy's zebra and livestock as a result of mild resurgence of anthrax.

(iii) Undertaking of research to understand the ecology of the disease in the affected area for better future control. Currently, soil sampling on the anthrax carcass sites have been collected by NRT and Earthwatch Institute/AWF funded Grevy's Zebra Project personnel for analysis to check on the prevalence of the disease.

(iv) Implementation of long-term surveillance programmes of the disease.

(v) Conducting follow-up sampling on the antibody levels of the vaccinated Grevy's zebra populations. Samples of blood from the trial vaccine of Grevy's zebra have already been shipped to South Africa for antibody analysis. Results are being awaited.

Overall, the vaccination programme provided the best opportunity to make a difference for the future of this critically endangered species. The exercise clearly demonstrated the exceptional commitment to Grevy's zebra conservation from a broad spectrum of institutions ranging from communities, government, and private, to veterinary, zoological and humane societies.

5.0 ECOLOGICAL MONITORING

5.1 Rainfall

In 2006, rainfall was recorded on a daily basis in the 11 stations that are evenly distributed across the Conservancy. An average of 758 mm of rainfall was received during the year which was way above the Conservancy's long term mean (517 mm). This was a remarkable increment compared to a mean of 286 mm received in 2005 (Figure 5.1). Soboiga and Matunda stations received the highest amount of rainfall of over 1000 mm while the least rainfall was recorded at both Lewa Safari Camp and Lewa House (Figure 5.2).

During the year, 92 mm of rain was received in the month of April-May compared to 111 mm recorded in the same period in 2005. The highest amount of rainfall amounting to 522 mm was received in the months of October to December.

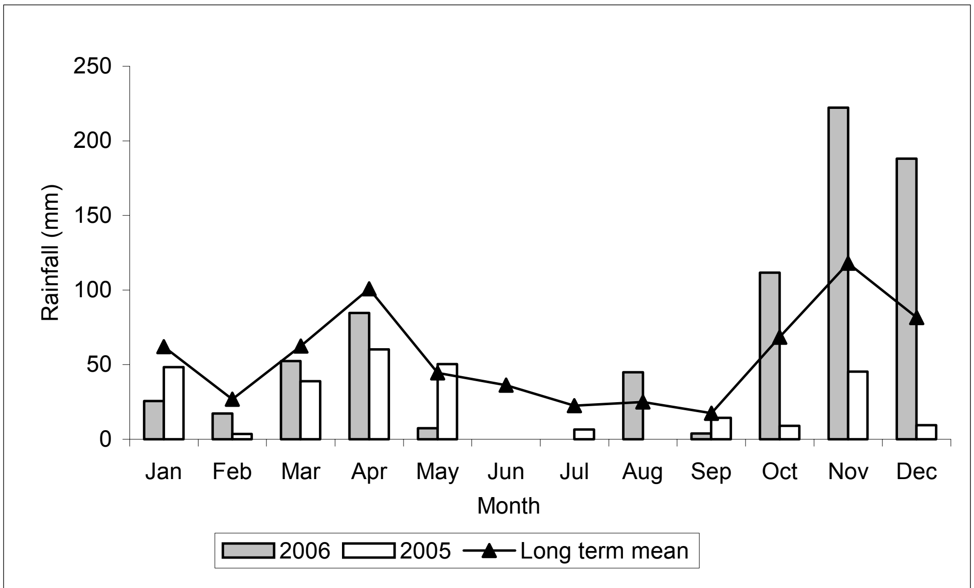

Figure 5.1: Amount of rainfall received on LWC in 2005 and 2006 against the long-term mean

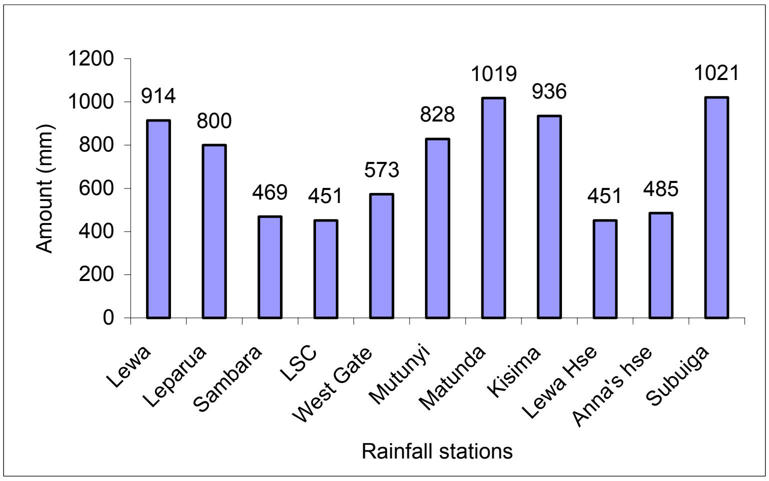

Figure 5.2: Amount of rainfall received per station on LWC, 2006

5.2 Vegetation monitoring

The main goal of vegetation monitoring on LWC is to provide trends in the condition of both grass and woody vegetation habitats. Information gathered is critical as it guides management decisions including prescribed burning and erecting of exclusion zones in order to improve the habitats for black rhinos and to trigger regeneration of woody vegetation.

Four kinds of vegetation monitoring activities are carried out on LWC. These are:

1. Grass assessment
2. Woody vegetation monitoring
3. Prescribed burning
4. Fixed-point photography

5.2.1 Grass assessment

The major objective of grass assessment is to estimate the biomass of grass and composition of herbaceous material in order to determine areas that can be subjected to prescribed burning or intensive cattle grazing. Both burning and livestock grazing achieve varying results and hence the method chosen is dependent on the desired output.

The methods used to estimate biomass of grass are described in detail by Botha (1999). In particular, any block with grass biomass >5000kg/ha and dominated by increaser I[10] grass species is usually moribund and should be considered for prescribed burning.

Results and discussion

The amount of rainfall received in the long rainy season (April-May) was below average. This resulted to poor vegetation growth and regeneration. Consequently, majority of the blocks surveyed in June showed significant reduction in grass biomass compared to 2005 (Table 5.1).

Only two monitoring units; Morani and Shamba had biomass of grass >7000kg/ha. However, the two blocks were not subjected to burning since they form key black rhino habitats. Similarly, Fumbi and Sambara blocks that had > 5000kg/ha blocks were subjected to intensive cattle grazing. Both blocks had been burnt in 2003 and 2004 respectively.

Even though Halvor's Plain had relatively low grass biomass (2543kg/ha), it was subjected to prescribed burning since the herbaceous material was already moribund. The subsequent nutritious grass attracted large numbers of plains game thus exposing the block to heavy grazing pressure throughout the dry season. As a result, it was recommended that the size of burnt blocks in any year should exceed the short-term food requirements of grazers to avoid adverse grazing effects.

Table 5.1: Biomass of grass on different permanent vegetation monitoring points on LWC, 2006

MU	Unit Name	2001	2002	2003	2004	2005	2006
P	Lenjoro	3818	3781	6568	6415	5034	3352
R	Mlima Tanki	4805	5655	6890	2848	3893	2936
R	Mlima Loishimi	3550	4004	5715	6008	6264	4503
P	Dam Mkora	5595	5079	7701	7201	4004	3230
P	Serghoi	7072	7479	4004	4969	5162	5164
R	Meza	5350	7429	10022	8386	2978	2510
R	Morani	6292	7072	10262	7303	7098	7050
P	Halvors	4570	7919	6676	5375	5534	2543
R	N.E. of Fuzz	1005	2057	4739	6270	5002	2583
RV	Ian's Bridge	3628	4937	6784	6644	5774	3022

[10] Increase I Species – Grass and herbaceous species which increase when rangeland is under utilised or selectively grazed

MU	Unit Name	2001	2002	2003	2004	2005	2006
R	Matunda	4638	5319	7943	7871	6649	3969
R	Kona Mbaya	3589	7303	9486	8411	7847	5414
F	Williams Hse	3270	3391	5002	4742	5002	2350
F	Sobuiga	4805	3589	6703	2761	4467	2936
R	Mlima Simba	1305	1695	4502	3968	5288	1477
R	Dadaboi	1801	1853	4433	3033	3781	943
P	Sambara	4150	2489	5833	4502	6810	5985
R	Mlima Kali	1695	2156	4937	4114	3628	1477
R	Mlima Nyeusi	5193	5066	8411	7573	6994	3189
RV	Kisima	4398	5130	6942	7376	7404	4469
R	Mlima Watalii	2349	3818	7529	***	5443	4294
P	Shamba	4937	6514	8343	7725	***	7570
R	Mawingu	5225	5950	9189	9695	6863	1253
F	Kahawa	2805	2935	7404	7288	5534	2628
P	Mtego ya Twiga	4937	6622	***	2387	5625	4434
R	West of Kiboos	4904	5921	7603	6345	6595	4572
P	Fumbi	6320	7750	8728	3956	4871	4350
R	Mombasa	2396	3589	10002	5104	6376	5620

Key:
P – Plains **F – Forest**
RV – Riverine **R – Rocky and hilly**
- Proposed for burning **- Grazed blocks** **- Burnt block**

5.2.2 Prescribed burning

In 2006, only one block (Halvor's Plain) was subjected to prescribed burning in order to remove the moribund stocks of herbaceous material. A decision was made not to burn other blocks as recommended in the annual grass assessment exercise because of the prevailing drought conditions that would have resulted to extremely hot fires. In the previous years, it was recommended that only cool fires would be applied on LWC since such fires:

(i) Cause minimal damage to the woody vegetation.
(ii) Ensure that low biomass of grass is maintained for an extended period of time.
(iii) Cause minimal damage to soil nutrients.

However, in late 2006, several areas especially those on the edges of the Conservancy were proposed to be burnt in 2007 as a result of increased accumulation of combustible material arising from the high rainfall received in November and December of the year (Figure 5.1). This would not only act as a measure to improve the condition of the range, but will also serve as pragmatic fire breaks in case of serious threat of infiltration of fire from the neighbourhood as communities clear their farms after the harvests in the dry season of February – March (Figure 5.3).

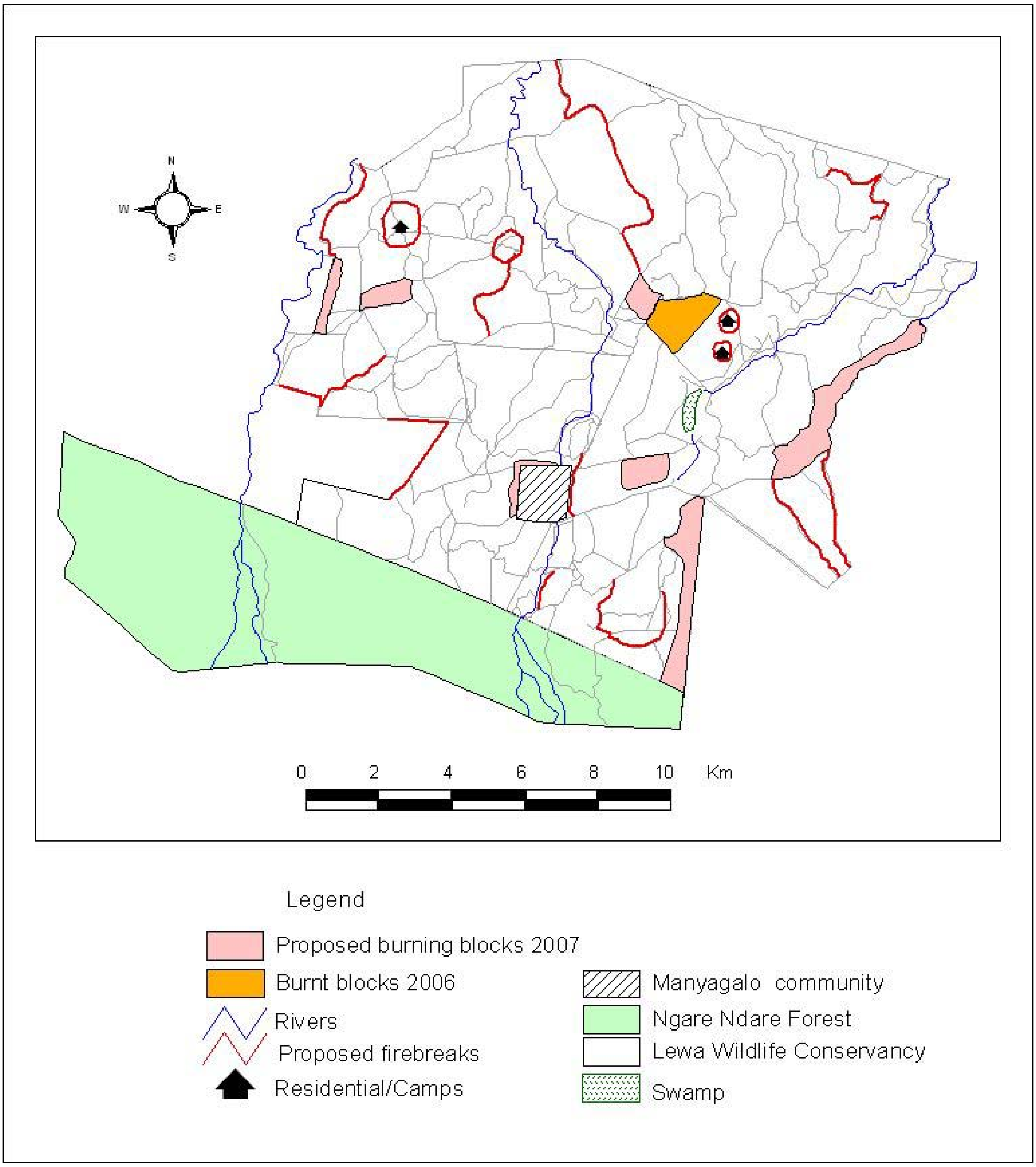

Figure 5.3: Areas subjected to prescribed burning in 2006 and blocks proposed for burning in 2007

5.3 Woody vegetation monitoring

In 2005, Mawingo block, one of the key black rhino habitats was gutted by an accidental dry and uncontrolled fire that emanated from the Lewa Camp dumping site. The woody vegetation including *A. mellifera*, *A. tortillis*, *A. brevispica* and *A. nilotica* trees were extensively damaged resulting to a shift in the ranging areas of black rhinos.

To asses the extent of recovery of the woodland, a one off post-burn data set was collected in December 2006. Four (2x200m) belt transects were systematically laid to cover the different sub-units of vegetation on the block. On each transect, the following data, and characteristics of the condition of all the trees and shrubs were recorded:

- Species name
- Density of trees by species
- Height of tree
- Whether coppicing, shooting or coppicing/shooting
- All the seedlings and shrubs were counted and the species identified.

Results

The most dominant tree species in the block were *A. brevispica* (37%), *A. drepanolobium* (22%) and A. mellifera (19%) (Figure 5.4). *A. brevispica* showed the highest resiliency as demonstrated by its ability to coppice and shoot after the fire compared to other tree species (Figure 5.5).

All the trees surveyed had experienced top kill of varying degrees. *A. nilotica* appeared to be the most affected by fire suggesting that this tree species has a low resistance to fire. Similar results have previously been observed on LWC where *A. nilotica* together with *A. drepanalobium* appeared to be significantly affected by hot/dry fires.

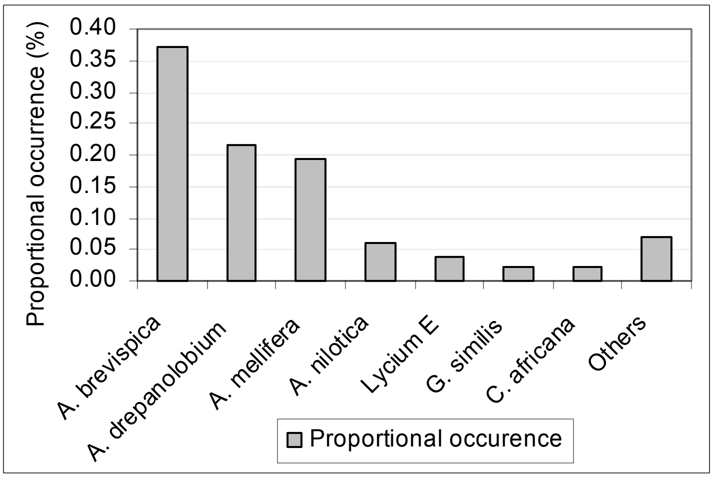

Figure 5.4: Proportional occurrence of woody vegetation on burnt block, Dec. 2006

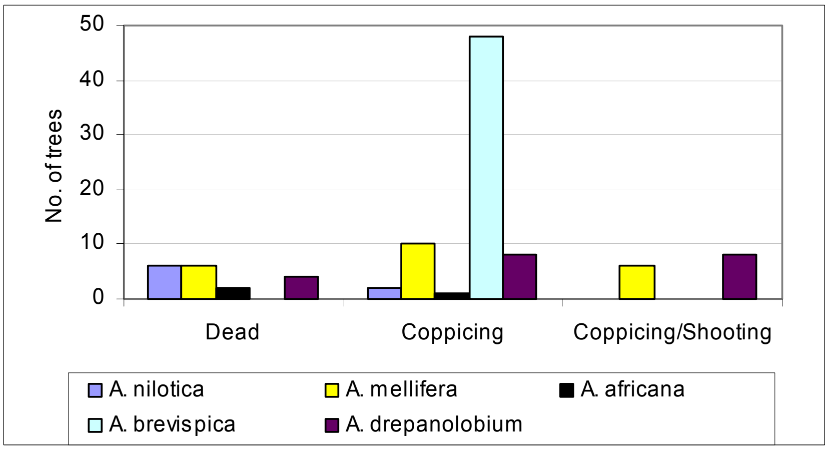

Figure 5.5: Response of trees to fire on woody vegetation on Mawingo block, 2006

Numerous seedlings (<0.5m) of *A. drepanolobium, A. mellifera* and *A. brevispica* were observed in all the four transects. This may have been as a result of changes induced in the soil surface, which favoured germination. The resulting ash enriched the soil and provided favourable conditions for germination. The increased temperature following fire may also have broken dormancy and stimulated germination (Gillon, 1983).

Recommendations
In order to reduce the chances of uncontrolled dry season fires, it was recommended that firebreaks be erected around all tourist and residential facilities. Such firebreaks should be extended to cover areas along the fence lines especially Soboiga and TM areas just in case fire spreads from the neighbouring communities.

5.4 Fixed point photography

The major objective of fixed point photography is to monitor trends in vegetation changes over time. Such changes are brought by varying browsing pressure and changing rainfall regimes. Fixed point photography is usually carried out on the four compass directions on the 28 permanent vegetation monitoring points.

In 2006, vegetation changes were visual on areas that were heavily utilized by elephants. Such areas were situated along the rivers, rocky and hilly places (Figure 5.6). This was due to the proximity of these areas to water. Similarly, the number of elephants was particularly high due to the persistent drought in the year. Traditionally, the Conservancy has been used as a dry season feeding ground for elephants with numbers exceeding 300 individuals in the dry season. Only a few resident bulls remain on LWC during the rainy season. Areas that were not utilized by elephants and were mainly in the open plains showed minimal vegetation change.

Mlima Simba 2004 Mlima Simba 2006

Figure 5.6: An example of vegetation changes on one fixed-point photography point

5.5 Exclusion zones

LWC was established with the major aim of conserving the endangered species including black rhinos. Since then, other wildlife species have increased with large herds of elephants utilising the Conservancy during the dry season. Elephants and giraffes in particular cause massive destruction to woody vegetation and compete for browse with black rhino. To minimise such competition and promote woody vegetation growth and regeneration, LWC has erected ecological exclusion zones that cover key rhino habitats and heavily damaged areas. Elephants and giraffes are kept off while all smaller game including rhino can pass under the electric wires that are placed 7-8 feet above the ground.

Some of the benefits derived from establishing exclusion zones are:

(i) Maintaining the excluded area as key black rhino habitats and refuge by keeping off elephants and giraffes while allowing other smaller herbivores to go under the solar powered electric wires.
(ii) Increase the diversity and abundance of other species including birds, insects and reptiles by offering a wide niche overlap.
(iii) Ensure regeneration of woody vegetation destroyed be elephants hence maintenance of aesthetic value of the landscape
(iv) Such areas experience minimal damage and hence form key browsing areas of most browsers in the dry season.
(v) Play a key role in the source-sink population dynamics.

Results and discussion
A number of exclusion zones were erected in 2006. These covered Junction Tano areas, Mlima Mugumo, Digby's and LWC Airstrip. Similarly, Kifaru and Lewa House ecological exclusion zones were extended to cover more degraded areas (Figure 5.7). As at the end of 2006, the total area under exclusion zones was slightly over $10km^2$

Additional areas that may be considered for exclusion zones in future were suggested (Figure 5.7). These areas were chosen because they form contiguous and unique woody vegetation habitats that may soon be destroyed by elephants. Similarly, black rhinos have recently expanded their ranging areas to the Matunda/TM block that has excellent *A. nilotica* and *M. senegalensis* woodland. An extension of Willy Robert's exclusion zone is necessary to protect the existing degraded *A. drepanalobium* and *A. xanthophloea* trees (Figure 5.7).

Recommendations
It was recommended that in future, more exclusion zones should be fixed systematically to maintain key black rhino habitats and allow recovery of degraded areas especially along the riverine forests.

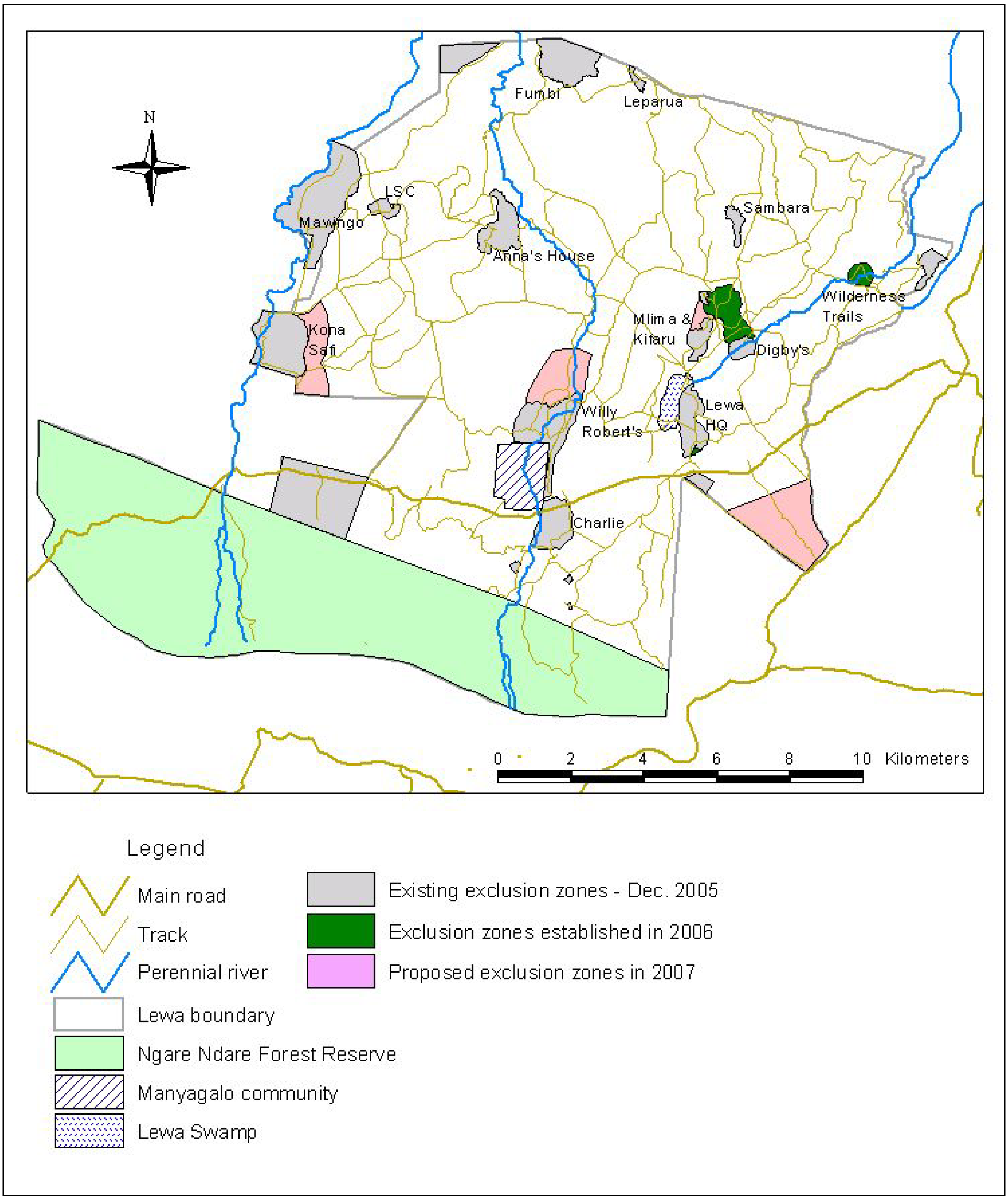

Figure 5.7: Location of existing and proposed ecological exclusion zones on LWC, December 2006

6.0 GENERAL WILDLIFE MONITORING

6.1 Census data

Wildlife census data has been collected on LWC since 1977. The main objective of the count is to provide long term data on the trend of wildlife and habitats in order to make timely and informed decisions as needed. Two main techniques are used to gather wildlife data:

1. Total annual game count through a combined ground and aerial census.
2. Security field teams' daily reports on the location, herd size and structure of key species encountered during patrols. Such reports are collated to determine temporal and spatial distribution patterns of focal species.

The game count figures summarised for the last six years are shown in Table 6.1.

Table 6.1: Census data of wildlife species on LWC, 2001-2006

SPECIES	Jan-01	Jan-02	Feb-03	Feb-04	Feb-05	Mar-06	% increase/ decrease
Beisa Oryx	84	86	62	85	49	69	41
Buffalo	125	161	203	233	255	339	33
Bush buck	0	0	~20	>20	>20	>20	
Cheetah	21	10	7	8	8	8	
Eland	151	121	108	137	214	169	-21
Elephant	150	28	157	216	297	392	32
Gerenuk	17	15	11	7	11	11	
Giraffe	236	245	215	177	173	147	-15
Grant gazelle	162	192	167	261	258	320	24
Greater kudu	38	37	33	36	>20	>20	
Hippo	1	2	2**	2	2	2	
Hartebeest	9	7	4	2	2	2	
Impala	627	749	760	679	836	739	-12
Jackal (silver backed)	0	0	>15	>12	3	1	-67
Klipspringer	0	0	>8	>6	>8	>8	
Leopard	1	7	>8	>8	8	8	
Lion	8	20	18	28	24	16	-33
Ostrich	119	98	65	68	48	36	-25
Rhino, black	29	29	32	36	40	48	20
Rhino, white	30	31	32	32	39	36	-8
Sitatunga	21	21	16	16	14	14	0
Warthog	88	194	136	129	170	140	-18
waterbuck	149	170	64*	52	116	134	16
Zebra, Burchells	1264	1039*	1025	1102	1094	970	-11
Zebra, Grevy's	556	487	462*	435	448	399	-11

Six moved to Ol Pejeta in 2006

Key:

>	(greater than)
~	(approximately)
*	(census after individuals translocated **out** of Lewa)
**	(census after individuals translocated **into** of Lewa)
0	(species present but not seen during count)

Results show that there were significant differences between the 2006 and 2005 wildlife numbers (Table 6.1). Apart from Oryx, Buffalo, Elephant, Grants gazelle and Waterbuck, all other animal species targeted in the count showed remarkable reduction in numbers (Figure 6.1). In particular, Elephant had increased by over 30% probably due to the severe drought that hit northern Kenya in 2005 and early 2006. Previously, it was shown that Elephant use LWC as a dry season feeding ground due to abundant fodder and water supply throughout the year. Large numbers of Elephant translates into extensive damage to vegetation especially on the riverine areas and hence the importance of continuous establishment of ecological exclusion zones to protect key black rhino habitats.

The continued increase in the population of Waterbuck in the past two years is quite encouraging considering that LWC lost about 70% of the species' population between 1999-2003 due to drought (Figure 6.2). Similarly, Buffalo numbers have shown a steady increase in the last five years, even though the Conservancy lost about 50% of its population between 1999-2001 due to the 2000 drought (Figure 6.2).

Both Grevy's and Plains zebra numbers dropped by 11% (Figure 6.3) between 2005 and 2006. In the previous years, it was shown that the two zebra species form the main prey for lions on LWC. However, since Grevy's zebra are endangered, strategies to minimise rates of predation while enhancing foal and juvenile survival should be further explored as discussed in Section 3.10. Previously, the LWC Earthwatch Project showed that Plains zebra exploit resources more than Grevy's zebra when the two species are feeding together, and that this could be one of the factors limiting the growth of population of Grevy's zebra. However, Plains zebra are bulk feeders and act as buffer prey against predation of Grevy's zebra. Hence, maintenance of high numbers of Plains zebra on the Conservancy may be considered while enhancing survival rates of Grevy's zebra foals.

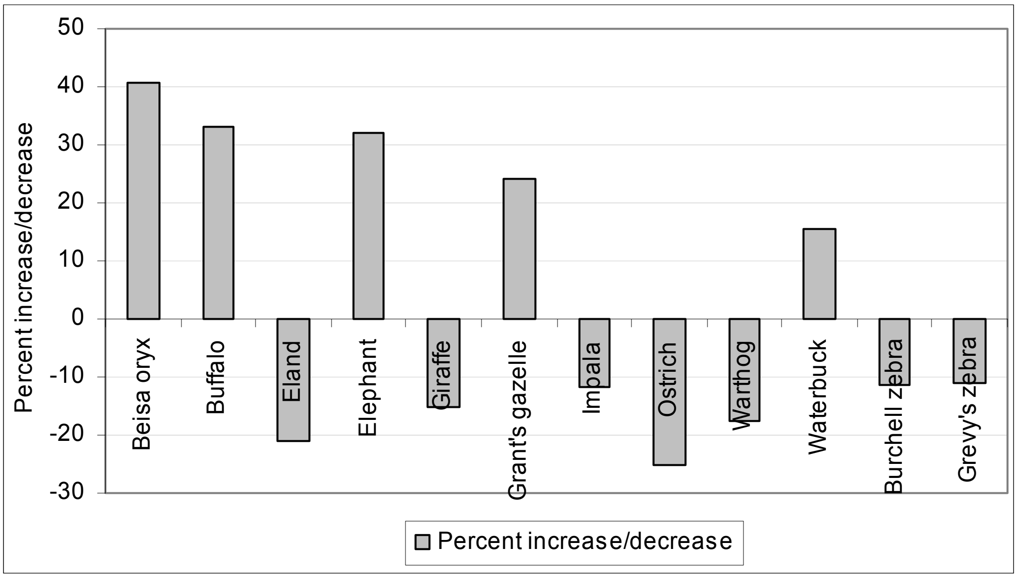

Figure 6.1: Comparison of dynamics of some key wildlife species on LWC, 2005-2006

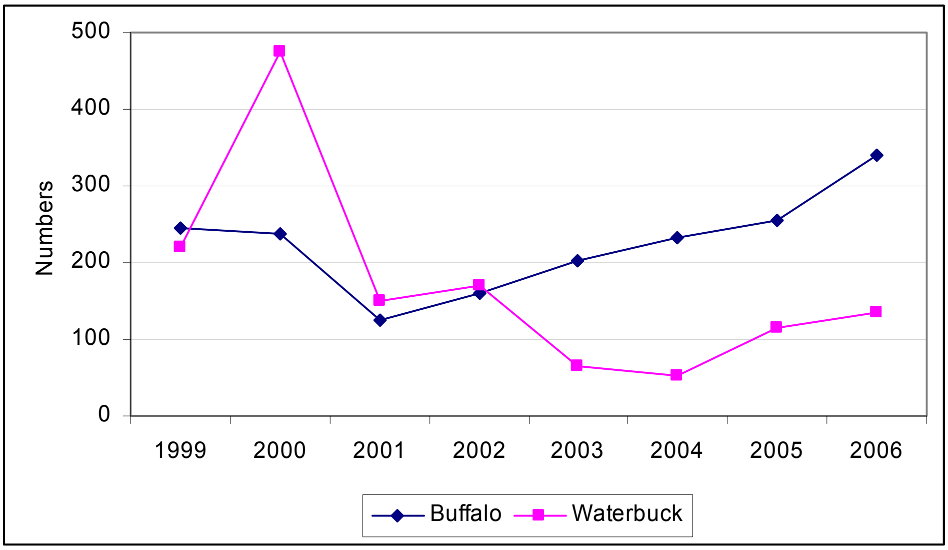

Figure 6.2: Trend in Waterbuck and Buffalo numbers, 1999-2006

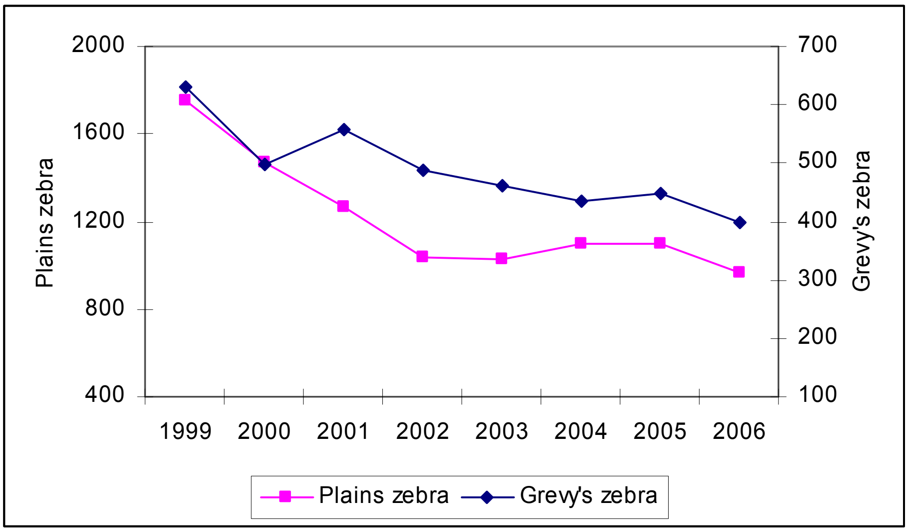

Figure 6.3: Trend in Plains and Grevy's zebra numbers, 1999-2006

7.0 EXTENSION OF ROAD NETWORK ON LEWA

7.1 Background

In 2006, the different types of roads that exist on LWC were classified based on needs of the different stakeholders in the Conservancy. In any conservation area, the following categories of roads network are recognised:

(i) Tourist roads: The primary purpose of these roads is to offer tourists the opportunity to experience the best of the natural resources. These roads can be accessed by all vehicles on the Conservancy.
(ii) Management roads: Although these roads are few, they have less vehicle pressure and should only be used for management or security purposes. These roads are less conspicuous than tourist roads and should not be accessed by tourist vehicles.
(iii) Fire breaks: Fire is used as a management tool to remove the moribund and unpalatable grass material. However, accidental fires do occur in the dry season leading to considerable destruction of flora. The existing fire breaks should be regularly maintained. When combined with tourist and management roads, they should act as effective fire breaks.
(iv) Illegal roads that arise from game drive excursions with the intention of offering better view of charismatic species to tourists. The disadvantages of such roads especially their impact to the environment were highlighted by Eagles, *et al.*, 2002.

Since then, the increasing number of vehicles on LWC necessitated re-categorisation of existing roads for the Conservancy to offer the best and unrivalled tourist product in the region.

To achieve the above objective, existing roads were categorised as follows:
(i) Access roads that will be used to deliver goods to the different tourist destinations including Willy Roberts Camp and Wilderness Trails by non-LWC standard vehicles. Similarly, such roads will be used by the Conservancy's vehicles not carrying tourists while in their daily chores.
(ii) New roads network were opened to make some key wildlife areas accessible and hence eliminate the need for offroad driving (Figure 7.1)
(iii) Some old roads that were susceptible to aggravated soil erosion as a result of poor alignment hence poor drainage for surface runoff were closed or re-routed (Figure 7.1)
(iv) Meetings were held between the management and driver guides aimed at reducing the extent of offroad driving. As a result of concerted efforts from all parties, illegal road network has remarkably reduced from over 80 km as at December 2005.

7.2 Recommendations

Once again, it was reiterated that in future, offroad driving should be abolished completely except by management when monitoring, capturing or treating of key wildlife species. This must be regulated as stipulated in the current "LWC Standards".

LWC was established primarily for black rhinos, hence, it is critical that minimal damage should be introduced onto identified rhino core areas. Consequently, zonation is crucial and areas where no further roads should be developed must be delineated and recognised by management and other related parties. At the same time, such sections can act as source areas where wildlife can seek refuge during foaling/calving periods (Figure 7.1).

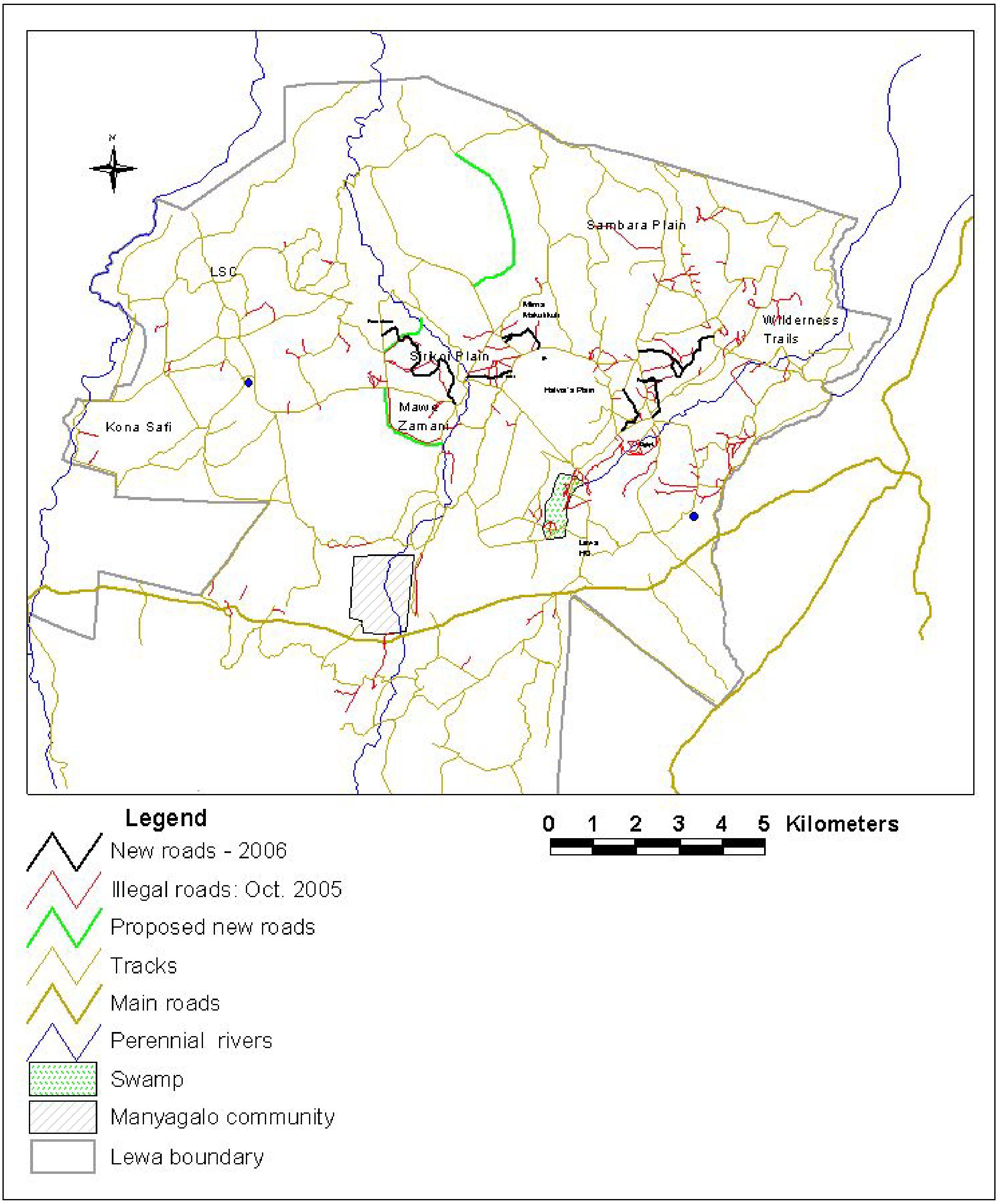

Figure 7.1: Established and crossed roads on LWC, in 2006

8.0 MANAGEMENT OF INVASIVE SPECIES

8.1 Background

Invasive species are regarded as one of the greatest threats to global biodiversity. Invasive plant species cause significant threat to many of Africa's conservation areas (Cronk & Fuller, 1995) more so to the indigenous plant communities.

The impacts of invasive alien species frequently affect more than one aspect of an area's ecology and cause ripple effects (Foxcrofti, *et al*., 2006). These impacts include the replacement of diverse ecological systems with stands of alien plants, the alteration of soil chemistry, geomorphological processes, fire regimes, hydrology and extinction of indigenous fauna (Cronk & Fuller, 1995). Other impacts include species loss because of direct competition, reduced structural diversity, increased biomass production and disruption of the prevailing vegetation dynamics (van Wilgen & van Wyk, 1999).

Therefore, to avoid proliferation of invasive species, immediate management structures should be effected as soon as the species are detected. To maximize the benefits from management interventions and the chances of success over the long-term, a strategic plan is required to ensure resources are deployed as wisely as possible. It is frequently recognised that much energy and effort is expended on the techniques of controlling and removing invasive plants, while little attention is paid to the strategic planning of control operations and use of resources (Moody & Mack, 1988). Therefore, a timely plan of action is required to achieve the best results from the limited funds available.

8.2 Invasive and alien plant species on LWC

During the November – December rainy season, there was a significant increase in the number and extent of invasive species on LWC. These plants were characterised and mapped after the rains for systematic and prioritised elimination. The most widespread invasive species was *Datura stramonium* and *Datura* spp that dominated Willy Roberts exclusion zone, Manyagalo Swamp and along Sirikoi River (Figure 8.1). These areas formed part of the main irrigated and cultivated sections of the former Manyagalo Ranch. Similarly, the areas experienced remarkable runoff from the adjacent small scale farms within Manyagalo Community. Again, *D. stramonium* formed extremely thick stands on most of the abandoned cattle holding pens within Manyagalo Block.

Large stands of *D. stramonium* were found to prevent growth of grass and other herbaceous material. Similarly, even though the plant flourished immensely during and after the rains, it appeared to be insignificantly utilised by browsers including black rhinos and this necessitated the need for its urgent elimination.

Other identified invasive plants included Brazilian Thorn (Airstrip Block and Mtego Twiga), *Lantana camara* and *Opuntia* spp that appeared to dominate most disturbed areas. *Opuntia* was originally meant to demarcate LWC from the neighbouring communities in the south eastern side. Even though it is not currently a major threat on the Conservancy, it appears to be gaining root further from its original confines and hence needs continuous monitoring.

8.3 Control of invasive species on LWC

In collaboration with the Logistics Department, management intervention methods to eliminate the invasive species were instituted. The methods employed included slashing the extensive stands of *D. stramonium* at the base level and uprooting the Brazilian Thorn.

To realise the most cost effective results, prioritisation for control and ultimately elimination of the alien species on the Conservancy should to a great extent be guided by the following four principles (McNeely et al., 2001):

(i) The current extent of the species in and around LWC. This will involve continuous mapping of distribution and intensity of the focal species (Figure 8.1).
(ii) Documentation of current and potential impacts to native flora and fauna.
(iii) Characterisation of the value of habitats that the species has or may invade.
(iv) Available cost effective and efficient measures to control and eliminate the species. This may involve slashing, uprooting or application of herbicides.

8.4 Recommendations

(i) The existing early detection and monitoring programmes of invasive species on LWC should be enhanced. Currently, monitoring and control programmes have been ad hoc. These need to be regularised by the Research and Logistics Departments as part of their annual work plans.
(ii) Regular surveys and monitoring need to be conducted on known infestations and key areas especially on the former Manyagalo Ranch and Willy Roberts exclusion zone. To achieve this, permanent belt transects should be placed in infested areas to measure the rate of spread or otherwise reduction, especially of *D. stramonium*.
(iii) For effective results, *D. stramonium* and other invasive species should be eliminated before the fruiting stage. Slashing *D. stramonium* at the ground level was found to be effective as it did not necessarily lead to regeneration or coppicing.
(iv) Application of herbicides should be considered for extensive stands of invasive species. Likewise, control actions should be integrated with existing management plans including controlled burning.
(v) Sensitise communities especially in Manyagalo to eliminate *D. stramonium* on their land to reduce rates of runoff especially during the rainy seasons.

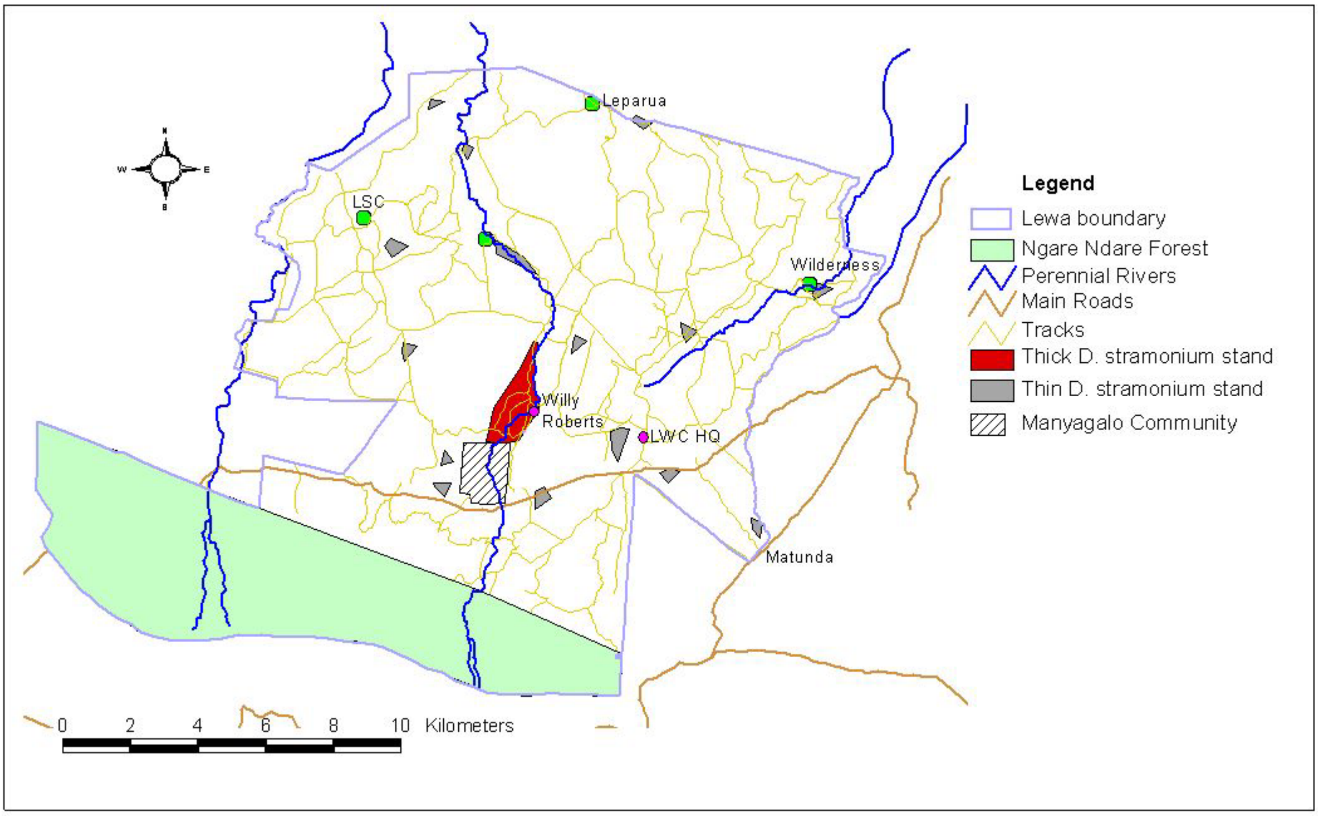

Figure 8.1: Distribution of *Datura stramonium* on LWC, December 2006

9.0 IL NGWESI GROUP RANCH: FUTURE PLANS

9.1 Background

Il Ngwesi Group Ranch (GR) traditionally used to be home of numerous black rhinos that were unfortunately lost through poaching in1970s. Today, one of the objectives of the GR is to enhance its tourism potential by providing refuge to both black and white rhinos and hence contribute to the overall National target of increasing the population of black rhinos in Kenya by 5% p.a. At the same time, due to the increasing numbers of wildlife, land degradation and quest to increase the available range for wildlife, a long-term partnership aimed at amalgamating LWC, Il Ngwesi and Borana Ranch has been proposed and is currently being actively pursued. If this partnership is successful, the internal fences separating LWC and Borana Ranch will be removed. Similarly, Il Ngwesi will be completely electric fenced while leaving strategic gaps for the free movement of wildlife and livestock in and out of the GR. The total secure area available to wildlife will be approximately 450 km^2 (Figure 1.4). Presently, IL Ngwesi GR has an unbreeding population of one male black and two white rhinos (male and female).

9.2 Assessment of the boundary line at IL Ngwesi

In anticipation of the proposed amalgamation of Il Ngwesi with LWC and Borana Ranch, a preliminary assessment was conducted on the 48 km long perimeter of the GR aimed at exploring possibilities of erecting an electric fence that will confine rhinos in the long-term. Possible areas where new roads could be placed to ease mobility and placement of elephant migratory routes were also tentatively suggested. The proposed plan will be refined with time with the involvement of the Group Ranch Management Committee, key players in the GR and relevant personnel from the Kenya Wildlife Service.

9.3 IL Ngwesi scout training

Nine scouts underwent an intensive training programme conducted in conjunction with NRT's Endangered Species Programme from 30th to 31st April 2006. The training covered the following major areas:

(i) Basic data collection techniques focussing on relative abundance and spatio-temporal distribution of wildlife populations.
(ii) Assessment of condition of habitats and range.
(iii) Levels of security for wildlife, people and livestock within the GR and immediate surroundings.
(iv) Human wildlife conflict event records.
(v) Mortality rates.

Two herders were also trained on the above mentioned techniques since it was recognised that security and wildlife incidences, together with human-wildlife conflicts occur far and wide in the field and herders are usually the first ones on-site to gather vital information during herding forays.

Standard data sheets were developed and distributed so as to capture the necessary information. It is anticipated that data will be generated on the spatio-temporal wildlife distributions, and patterns of resource competition and conflict incidences. The findings will be fed to the Management Committees to aid in making pragmatic management decisions within the GR.

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11.0 APPENDIX 1: BREEDING PERFORMANCE AND CALVING PREDICTION FOR BLACK AND WHITE RHINO ON LEWA, 1985 - 2006

BLACK RHINO

No.	Name	Date born	Age (yrs)	Mother	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	Age at 1st calving (yrs)	Calving Intervals 1	2	3	4	5	6	7	Mean calving interval/ female
1	Juniper	28/6/88	18.7	Juno																										7.6	3.2	2.3	2.2	2.3	-	-	-	**2.5**
2	Mawingo	1/6/89	17.8	Solio Cow																										**	2.2	2.8	1.7	1.5	-	-	-	**2.1**
3	Meluaya	25/1/96	11.1	Juniper																										8.4	1.9	-	-	-	-	-	-	**1.9**
4	Ndito	1/1/90	17.2	Solio Cow																										9.3	3.2	2.2	2.1	-	-	-	-	**2.5**
5	Nyota	1/12/91	11.1	Stumpy																										7.8	2.7	2.4	1.5	-	-	-	-	**2.2**
6	Solio	1/1/76	31.2	Solio Cow																										**	3.1	3.5	3.9	3.2	2.1	2.9	2.3	**3.0**
7	Sonia	23/8/91	15.5	Solio																										7.1	4.7	2.4	-	-	-	-	-	**3.6**
8	Stumpy	1/1/67	38.2	Solio Cow																										**	**	3.9	2.8	2.2	3.0	2.0	-	**2.8**
9	Waiwai	4/7/95	11.7	Solio																										6.8	2.1	2.3	-	-	-	-	-	**2.2**
10	Zaria	9/3/88	19.0	Solio																										7.8	2.3	2.1	3.0	2.2	-	-	-	**2.4**
11	Nashami	16/7/98	8.6	Stumpy																										7.6								
12	Natumi	26/9/98	8.4	Solio																										6.7								
13	Samia	10/9/98	8.5	Sonia																										8.2								
14	Oboso	09/10/00	6.4	Zaria																										5.4								
15	Seiya	26/4/99	7.9	Ndito																										5.5								
16	Tana	10/10/00	6.4	Stumpy																										-								
17	Rhinotek	16/8/01	5.5	Juniper																										-								
18	Maxxine	13/6/02	4.7	Waiwai																										-								
19	Mama C	22/7/02	4.6	Ndito																										-								

Mean age at 1st calving = 7.3 **Mean inter-calving interval = 2.5**

WHITE RHINO

No.	Name	Date born	Age (yrs)	Mother	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	Age at 1st calving (yrs)	Calving intervals 1	2	3	4	5	6	7	Mean calving interval/ female
1	Murembo	1/1/76	31.2	Solio Cow																										6.0	2.9	2.6	1.9	2.8	1.8	2.0	-	**2.3**
2	Natal	1/1/89	18.2	Natal Cow																										8.1	2.3	2.2	2.2	2.2	-	-	-	**2.2**
3	Ngororika	1/1/81	26.2	Solio Cow																										**	2.0	2.2	2.6	2.1	2.1	-	-	**2.2**
4	Opondo	1/1/86	21.2	Natal Cow																										**	2.3	2.6	2.5	2.5	-	-	-	**2.5**
5	Songare	1/1/80	27.2	Solio Cow																										**	4.0	2.2	4.0	2.0	2.0	2.0	-	**2.7**
6	Tumbili	1/1/86	21.2	Natal Cow																										8.3	2.2	3.2	3.4	3.6	-	-	-	**3.1**
7	Jakwai	1/1/87	20.2	Solio Cow																										9.4	2.2	2.9	1.9	2.1	-	-	-	**2.3**
8	Rinta	3/6/94	12.8	Ngororika																										7.7	2.5	2.5	-	-	-	-	-	**2.5**
9	Tale	1/1/00	7.2	Solio Cow																																		
10	Titilei	1/1/00	7.2	Solio Cow																																		
11	Samawati	11/6/02	4.7	Natal																																		
12	Schini	11/12/02	4.2	Tumbili																																		

Mean age at 1st calving = 7.9 **Mean inter-calving interval = 2.5**

Key
- *Year female born* (green)
- *Quarter of the year calf born* (blue)
- *Future calving based on respective female's last inter-calving interval* (red)
- *Future calving based on respective female's mean inter-calving interval* (cyan)
- *Expected date of first calving = 7 years)* (grey)
- ** *History unknown*