WET SEASON AERIAL COUNT OF LARGE MAMMALS IN THE MERU CONSERVATION AREA (MCA)

2007

Report Complied by

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KENYA WILDLIFE SERVICE

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Executive summary

This is a report on a wet season total aerial count for large mammals in Meru Conservation Area (MCA) that was carried out between 19th and 21st of December 2007 to establish the population and distribution status of large mammals in MCA. Aerial surveys of large mammals in the Meru Conservation Area have been undertaken in the last three years. This count came shortly after the mass translocation of plain zebras and impalas that was carried out in July through September as a long-term objective of restocking Meru Conservation area following concerns of low population numbers of herbivores and other ungulates resident in the area. The aerial count offers baseline information for the dispersal and distribution of the species and provides a strong indicator of their distribution movement patterns.

There was a general increase in the number of mammals in MCA compared to 2006 count including livestock. A total of 747 elephants were recorded this year compared to 504 last year and this denotes a growing population trend of elephants in the conservation area relative to the previous census conducted in 2006. It is however worth noting that the wide ranging behaviour of the elephants makes their numbers fluctuate and increment figures cannot be fully attributed to growth rate because a good percentage represents immigration. Ground surveys however indicate that families in Meru Park have had several calves less than two years of age which is a strong pointer to increased elephant population in the area. Besides, this year received much more rainfall than last year with 9 months receiving some rain in Meru Park (700mm mean annual rainfall) as compared to only 5 months (386 mm mean annual) last year. Like many other wildlife species elephants are known to synchronize calving with food availability. There was a notable increasing trend in the population of other large mammals like the giraffes, buffaloes, elands, Burchell zebras, lesser Kudu, Impalas grants gazelle and gerenuks.

In the two years 2007 and 2006 more elephants were recorded outside protected areas 52% and 69% respectively. This implies that whereas Meru Park is the core protected area in the region the neighbouring community grazing land is much more important as a wet season dispersal area for elephants and most other species. A dry season count in 2005 recorded 48% of the elephants outside the MCA protected areas. Research, community conservation initiatives should be more focused on these areas during the season. There should be more security rangers' deployment for problem animal controls in the community outposts during the season. Compared with the 2005

dry season aerial count it appears that elephants are almost equally distributed outside and inside the protected areas in MCA with only a slight difference of more elephants inside Meru Park during the dry season.

Translocated zebras and impalas remain localised in Meru Park with only a few zebras dispersing in the Northern grazing area at the blocks neighbouring Meru Park and Bisanadi.
Livestock incursions in the protected areas remain prevalent problem in MCA but the trend is on the decline. Mwingi national reserve had the lowest number of cattle while Kora had a high number of livestock particularly along the South eastern Park boundary.

Abbreviations

AD	Assistant Director
AFD	Agence Francaise De Development
BNR	Bisanadi National Reserve
ECA	Eastern Conservation Area
FFEM	Fonds Francais Pour L` Environment Mondial
FSO	Front Seat Observer
KNP	Kora National Park
IFAW	International Fund for Animal Welfare
KWS	Kenya Wildlife Service
MCA	Meru Conservation Area
MNP	Meru National Park
MNR	Mwingi National reserve
NGA	Northern Grazing Area
RNR	Rahole National Reserve
RSO	Rear Seat Observer
SW	Senior Warden

1.0 INTRODUCTION

1.1 Background

Meru Conservation Area (MCA) covers an estimated area of about 4008 square Kilometers. The MCA includes Meru National Park, Kora National Park, Bisinadi National Reserve, Mwingi (North Kitui) National Reserve and the adjacent areas. This report also covers Rahole game reserve and the Northern grazing area which an important wildlife dispersal area and hence an integral part of MCA. The aforementioned parks and reserves forms the Protected Areas and while the grazing zone is Non protected pastoral land. Both areas were included in the count (see map below).

The MCA has different species of flora, which is due to different types of soils and the tropical arid climate of the area. The vegetation type varies from *Acacia-Commiphora* bushland, *Combretum* wooded grassland, and *Acacia* wooded grassland to swamps along the rivers. Other worth mentioning includes Riverine vegetation, rocky inselbergs and ground water forests.

Most of the wildlife species are widely distributed both inside and outside the protected areas in Meru conservation area. Exceptional seasonal movements into and outside the protected area characterize the wide-ranging distribution pattern of the animals. This movement is in response to fluctuations in local environmental conditions. The environmental conditions of the conservation area are varied in terms of the agro-ecological classifications ranging from zone III to VI, South to North of MCA i.e. areas that receive approximately 1400mm of rain to 600mm of rainfall per annum. It should be noted that the amount of rainfall could vary by a factor of 10 from year to year (Ogallo, L.J.1988). The area also suffers from severe drought occasionally receiving only 50mm per year.

Meru National Park is the main KWS focal point in the region. During the 1980s the park was faced with a serious banditry and poaching problem that significantly reduced the number of large mammals to the extent of regional extinction of certain species like the

black rhino. Having averted the security problem KWS in collaboration with partners in conservation particularly AFD and IFAW have been restocking the Park since 1999. Various species of mammals have been moved to Meru Park from different areas including the elephants, reticulated giraffes, Burchells zebra, Grevys zebra impalas, both white and black rhinos, impalas, bohor reedbuck and leopards. The most recent was a mass translocation of over 1000 impalas and 700 plain zebras last year.

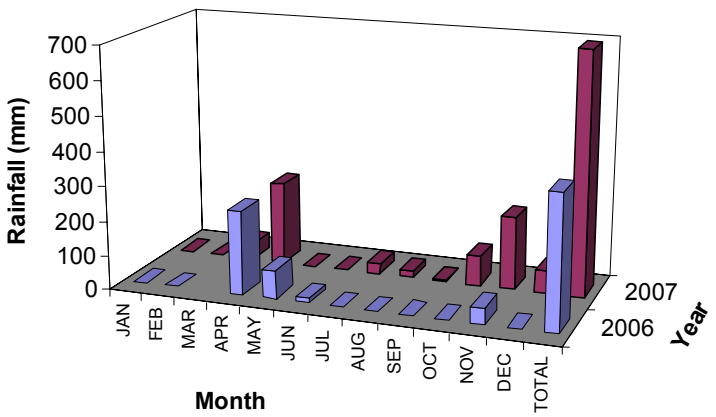
1.2 Climate

The MCA lies in Eco-climatic zone V (Tropical semi-arid climate) that covers half of Kenya, with a moisture index of –42 to –51; rainfall seldom exceeds evaporation. The main annual rainfall for MNP is 724mm. Rainfall in MCA closely follow changes in elevation and is highest in north western and the lowest in southeastern part.

The high rate of evaporation is due to low altitudes found on the MCA (between 850mm—270mm) and the high temperature that prevail throughout the year. Desiccating winds are feature of dry season when temperatures rise above 33 degrees Celsius during the day and declining to about 20 degrees Celsius during the night.

Rainfall is bimodal with the short rains coming in December and long rains between March and May. The annual rainfall can fluctuate considerably with wet years having more than double the mean annual rainfall and dry years less than half or quarter of the mean annual rainfall. *Figure 1* shows the rainfall received in the year 2007 compared with 2006. Drought is feature found in the park and can last anywhere between four and eight months. In 2007 the park received an annual mean rainfall of 700mm compared to 386mm in 2006. 7 months recorded no rain in 2006 and 3 months in 2007.

Fig1. Mean monthly/annual rainfall in MNP



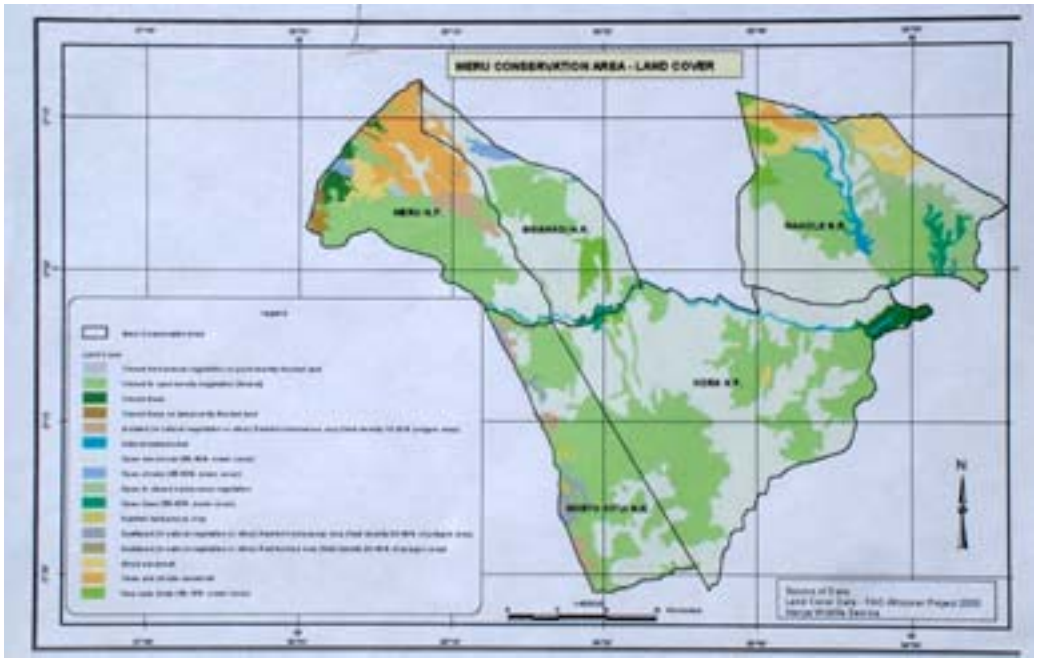
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
2006	0	0		241	81	15	0	0	0	0.5	48	0	386
2007	0	0	46	241	0	0	29	18	2	88	210	65	700

1.3 Vegetation

The MCA has different species of flora, which is due to different types of soils. The vegetation type varies from *Acacia-Commiphora* bushland, *Combretum* wooded grassland, and *Acacia* wooded grassland to swamps along the rivers. Other communities requiring special mentioning includes Riverine vegetation, rocky inselbergs and ground water forests. Due to diversification in vegetation, existence of different habitat has brought about different faunal life distribution in MCA.

Combretum wooded grassland prevails the Northern part, *Commiphora* bushland in the southern region, *Acacia* /*Terminalia* wooded grassland runs along water courses and riverine swamps with sedge *Cyprus spp* and grasses *Pennisetum mezianum* and *Echinochloa haplacelad.* Riverine vegetation includes *Raphai fannifera*, *phoenix reclinata*, Doum palms *Hyphaene spp* and *Tana propher* which grows along river Tana. Other riverine tree includes *Ficus syconorus*, *Newtonia hildebrandtii*, *Acacia. Fig. 3* below shows the distribution of vegetation communities within the MCA.

Fig2. : Map of MCA showing the vegetation communities



1.4 Animal species in MCA

The different habitat types present diverse faunal life distribution in MCA. Prolonged drought periods in the area have influenced species home ranges and movement inside and outside protected areas in MCA However the permanent water has historically provided a dry season refuge for a wide range of large herbivores while providing a highly heterogeneous Eco-system. A large population of resident herbivores is feature of MNP together with the high diversity of other wild fauna including carnivores, rodents, insectivores, reptiles and birds. Over 300 species of birds are present in MCA.

A restocking programme has been taking place in MCA particularly in Meru Park where nine (9) different species have been translocated into the Park. Over 3000 individuals of the different species have been moved to MCA from other parts of the country. A mass translocation of common zebras and impalas was concluded only 4 months before this wet season aerial count. The table below summarizes the restocking programme for the different species in the last eight (8) years.

Table 1: Summary of animals translocated to Meru National Park From 2000-2007

Animal									
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**Total**
Elephant	10	56	3	-	-	-			**69**
Burchels Zebra	-	105	-	500	-	-		745	**1350**
Grevy Zebra	-	-	20	-	-	-			**20**
Reticulated giraffe	-	14	-	50	-	-			**64**
Leopard	-	-	6	2	-	-			**8**
White Rhino	-	-	8	10	-	6	10		**34**
Impala	-	-	-	411	-	-		955	**1366**
Bohor reedbuck	-	-	-	128	-	-			**128**
Black rhino	-	-	-	-	-	-	20		**20**
GRAND TOTAL									**3059**

1.4 Land use patterns in MCA neighbourhood

MNP is bordered by five district namely Isiolo district to the Northeast, Mwingi district to the South, and Tharaka and Meru districts to the south-western side of the park. These districts are inhabited by four Ethnic groups namely Borana, Kamba, Tharaka and the Meru community of Nyambene district .All these groups undertake different activities for their daily survival. The main activities practiced in this region are agriculture and pastrolism.

1.4.1 Crop farming

The Meru North people practice crop farming as their main form of land use for economic and domestic purposes. Crops grown include maize, beans, green beans and miraa (*Catha eldulis)*. Near Maua town, tea is the major cash crop grown. This area (Maua) has a higher human population density hence creating pressure on wildlife. KWS has taken the steps to reduce the level of these conflicts between local people and wildlife by putting up electric fences as barriers to separate the two.

Tharaka district borders MNP to the Southwest boundary. The Tharaka people practice mixed farming and were traditionally hunter-gatherers communities. Annual yields in this region are not reliable hence hunting is practiced to supplement their diet. . However the locals have now known the benefits of wildlife as they receive some direct benefits such as employment opportunities in rural conservation projects like Bee-keeping and other activities such as raising tree nurseries. The seedlings when well maintained increase their annual yields hence reducing poaching.

The Kamba people who border the MCA also practice crop farming. Main crops grown by Kamba people include maize, beans, sorghum, millet, cow peas, pigeon peas, pumpkins among others.

1.4.2 Pastoralists

Within the MCA, pastoralism is practiced by the Borana of Isiolo district to the northeast of MCA. Other regions that practice pastrolism include Kora, Rohale, North Kitui, and Bisinadi areas, where Somalis are the majority. The land that these people live serves as dispersal areas, which are very important to the survival of the wildlife. The availability of this buffer zone eases the pressure of wildlife densities inside the protected areas by offering extra ranging space.

2.0 GOAL AND OBJECTIVES

The aerial survey was carried out to provide information on the total numbers of the key large mammals within the Meru Conservation Area and their current distribution, movement and abundance. The count also provides information on the human encroachment and livestock incursions in MCA. Of great importance is the comparison of data with last year's similar count and provide baseline information on the relative distribution of the recently translocated species.

3.0 METHODOLOGY

The total aerial count of large mammals in MCA and its environs was carried out following procedures described by Douglas-Hamilton *et al.* (1994) and Douglas-Hamilton (1997), and Norton-Griffith (1978). The approach of the count was to scan the entire MCA and surrounding environs, recording the number and position of each species or group of species of animals that were sighted using GPS. The assumption adopted was that the whole of the designated area was searched and all the animals in it were counted. Transects were laid across the blocks passing from one side of the census zone to the other. All animals seen within the demarcated strips were counted. This methodology offered maximum efficiency when flying in a straight line.

Five fixed wing aircrafts were used; the aircraft consisted of two four-seater planes and three two-seater aircrafts. In each aircraft two Geographical positioning system were used for navigation and recording of waypoints. With the help of the GPS, strip widths were conveniently set using the UTM kilometer grid on a North-South or East-West axis. Each survey crew consisted of 1 observer and a pilot for 2 seater aircraft and a pilot, 1 FSO and 2 Rear Seat Observers (RSO) for a 4 seater aircraft. Breaks were taken during refueling of the aircraft and at lunch. All observations

made were saved in the GPS as waypoints with the geographical location referenced and were used in producing species and human activities distribution maps.

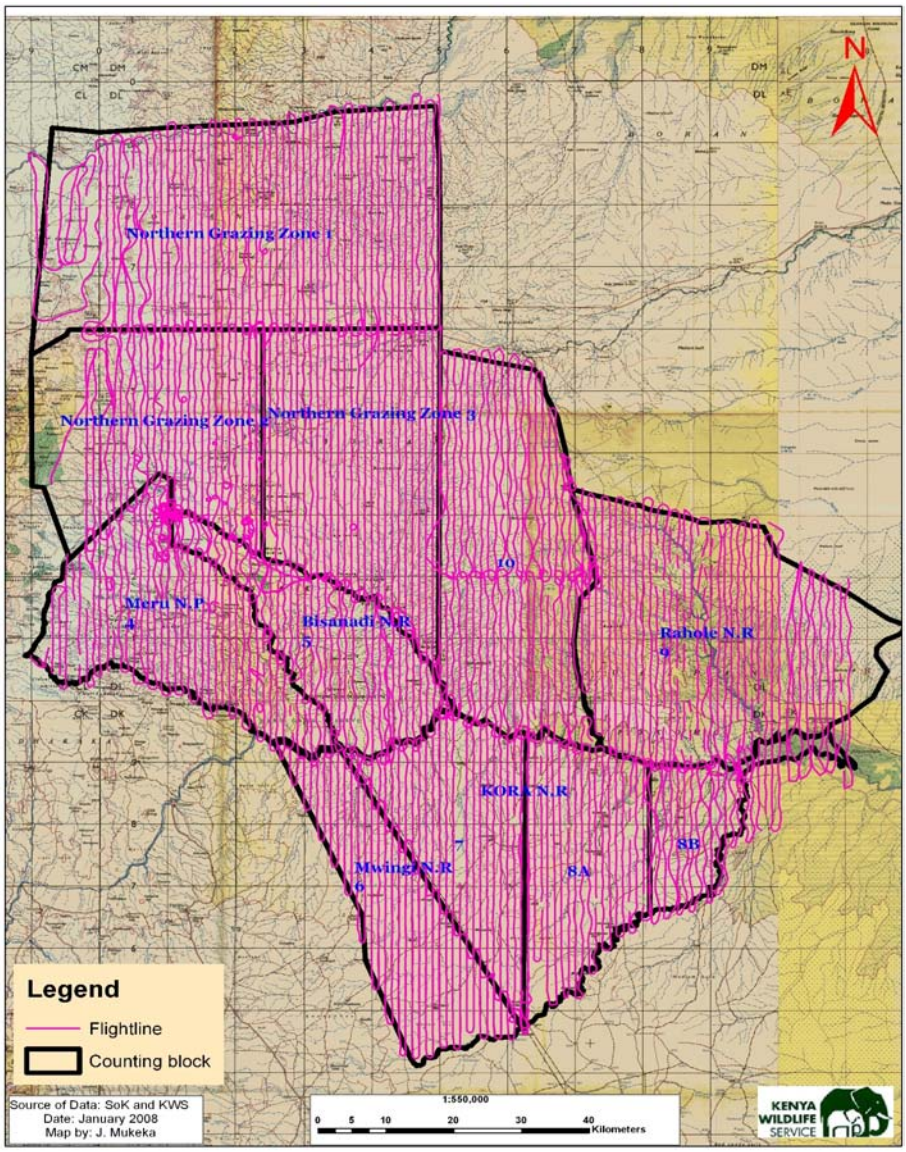
Blocks that were relatively large were subdivided into two. Each aircraft carrying a search team was designated a block each day. Accuracy was maintained through respective GPS coordinates for each counting block while respective maps for each counting individual block were produced and data was downloaded at the end of each counting day (this effectively eliminated incident. Corrections were made instantaneously as data was downloaded into the block maps to indicate flight path maps and data verification performed immediately following the completion of counting. Counting accuracy was maintained by aircrafts never retracing tracks or backtracks and maintaining a narrow strip width of 1 km as much as was possible. In addition transects were laid parallel (with distinct physical features being used to distinguish transects) to each other reducing "dead time" and increasing navigation and precision. Counting was emphasized on large mammals such as elephants, zebra, kudu, impala, buffaloes, and giraffes. However all other species that could be seen from the aircraft were also estimated and recorded. All individual animal counting including cattle, sheep and goats were also estimated and geo-referenced using Geographical Positioning System. Occurrences of various human settlements and activities were also recorded and spatially positioned for the purposes of mapping and interpretation.

In order to establish the correct count, Photographs were used to count individuals in large herds, unless the view was obstructed by thick vegetation. (Douglas-Hamilton, 1997). All GPS data was down loaded onto a computer at the operation base after every flight session and the Front Seat Observers (FSO) did a summary table of each block. Any double counts in neighboring blocks were also worked out and eliminated during these sessions. Data was analyzed using ARC-GIS and distribution maps for all major species developed.

4.0 RESULTS

The baseline survey of large mammals in Meru Conservation Area and its environs was conducted from19th- 21st December 2007. It involved five (4) aircrafts and approximately 60 flying hours covering an area of about 12,000km^2. *Figure 3 below* shows the flight paths in blocks where the aerial survey was undertaken.

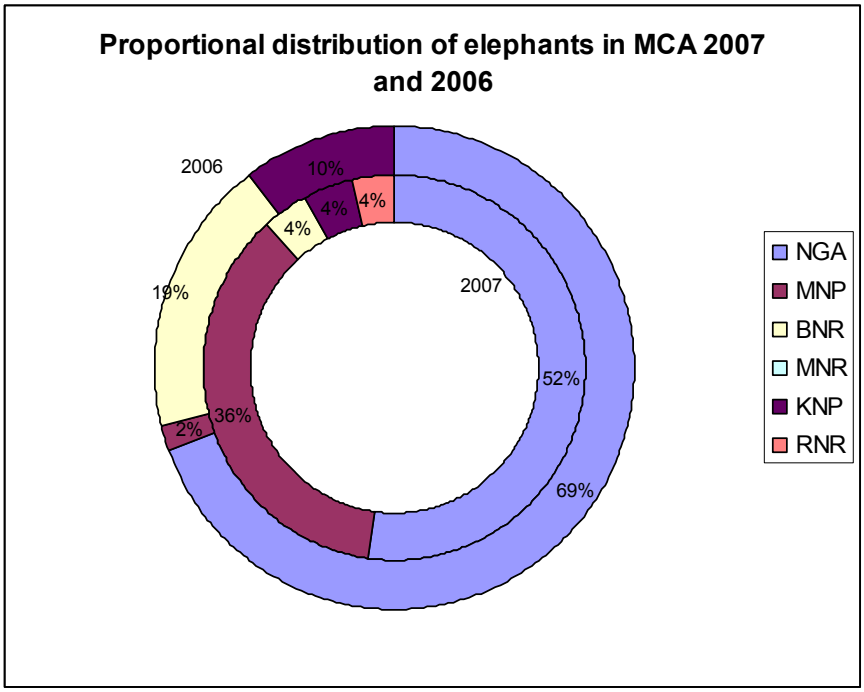
Fig 3. MCA count coverage and flight paths

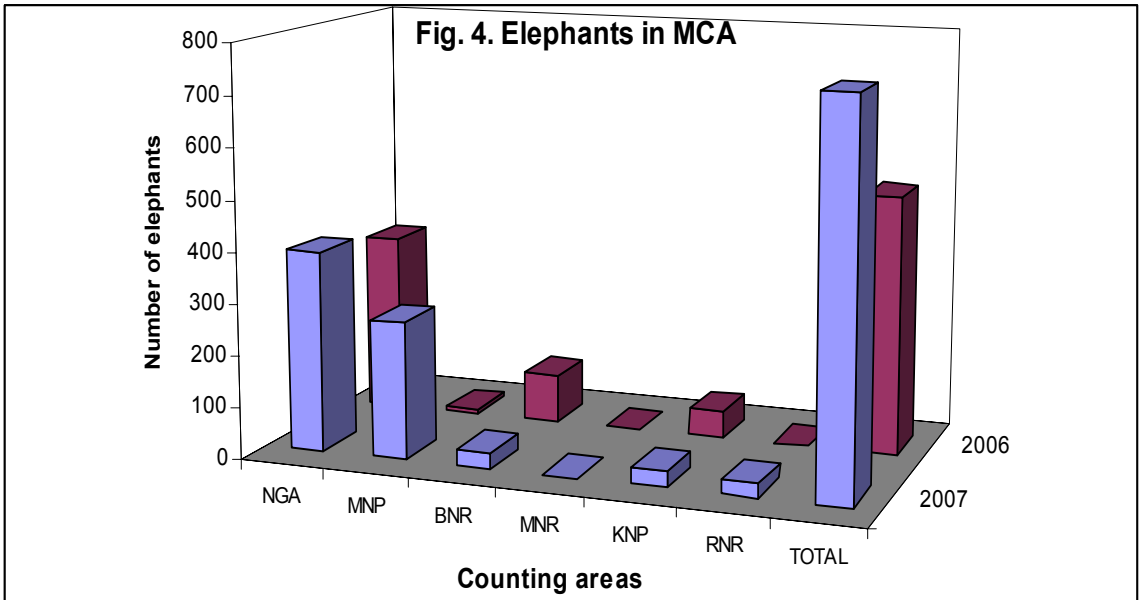


4.1 Elephants Population Size, Distribution and Carcases

A total of 747 elephants were counted in the Meru Conservation Area ecosystem Elephants were recorded in Meru National Park, Bisinadi National Reserve, and the northern grazing lands. 39% (n=268) of the total number of elephants was recorded in Meru National Park,Kora national Park and Bisinadi National Reserve recorded 4.% each while Rahole national reserve recorded 4 % of the elephants counted the rest 52 % (n=391) were recorded outside protected areas, within the Northern Grazing Zone of the ecosystem. Only 2 old and 6 very elephant carcasses were recorded this year. Similarly in 2006 wet season count more elephants 69% were recorded outside the protected areas.

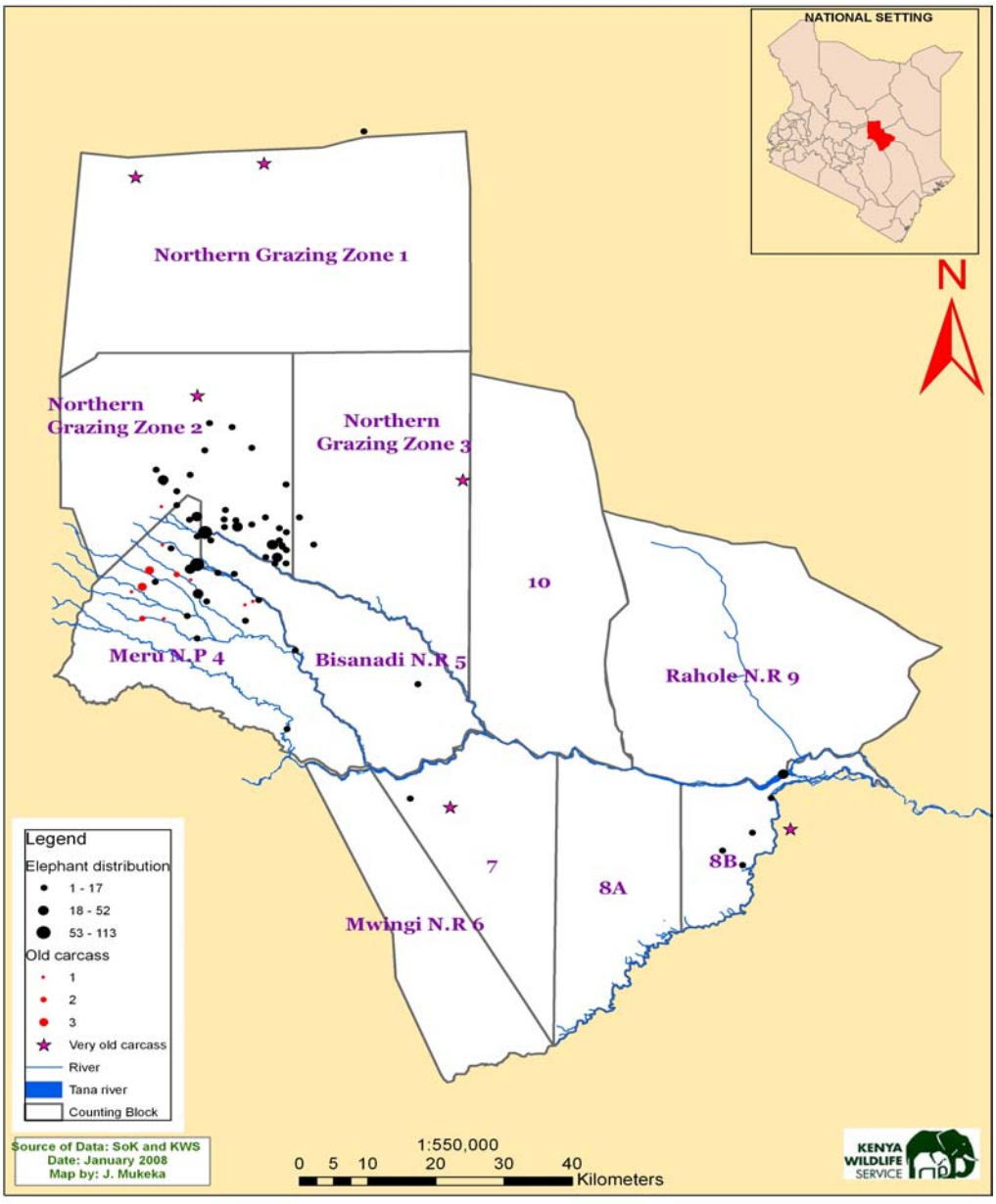
243 more elephants were recorded this year compared to last year.



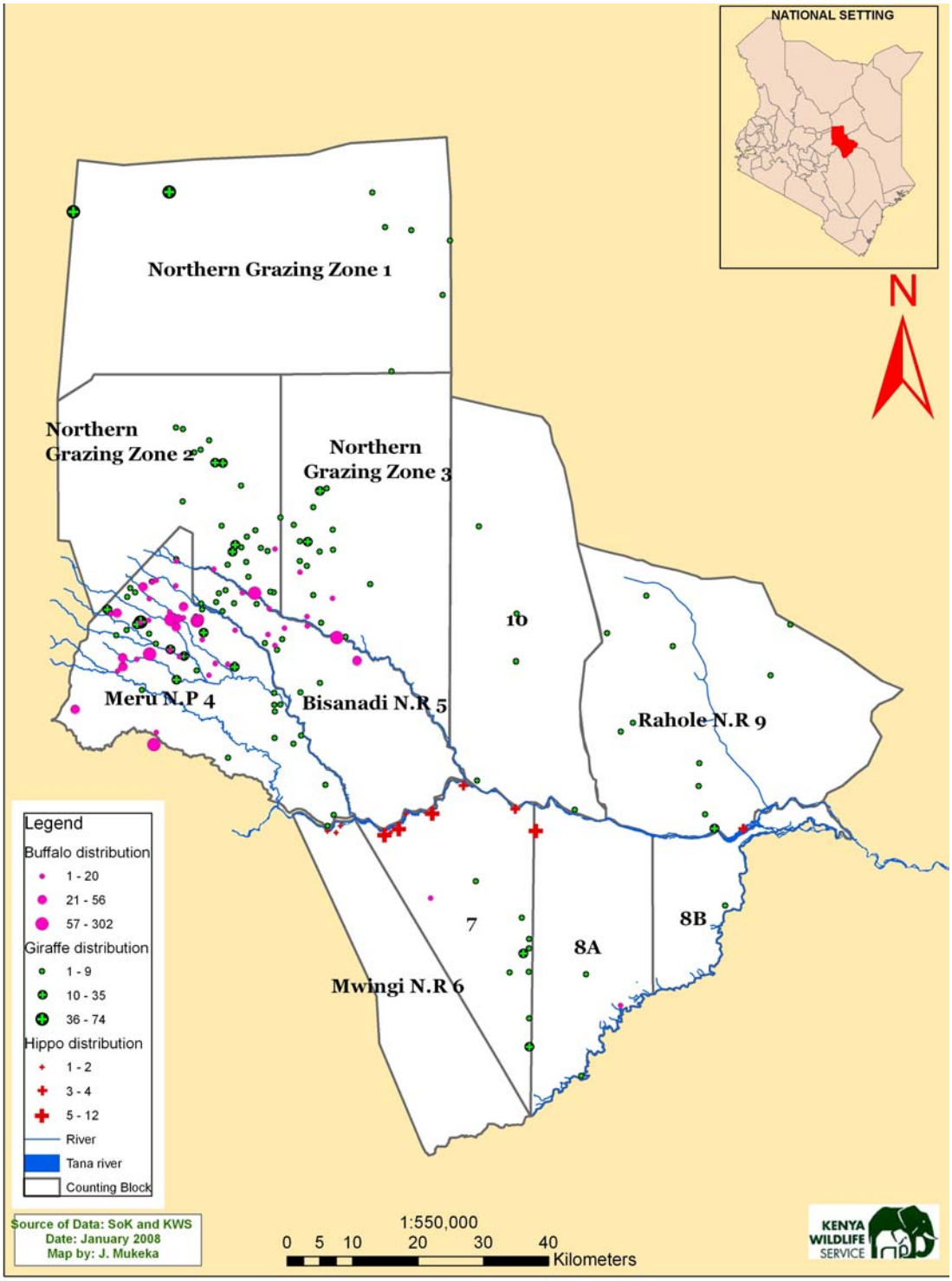


	NGA	MNP	BNR	MNR	KNP	RNR	TOTAL
2007	391	268	30	0	31	27	747
2006	350	8	94	0	52	0	504

4.1.1. Elephant distribution map in MCA



4.2 Buffalo Giraffe and eland population sizes and distribution



Meru Park remains an important habitat for the buffaloes with 72% of the population inside the park. Only 12% of the buffalo population was recorded outside protected areas

mainly at the park and reserve peripheries. The distribution was relatively the same in the two counts 2007 and 2006 but the population records a rapid growth in 2007 with an estimated 50% increase *(See the donught piechart below*). A dry season count in 2005 recorded less than 1% of the buffaloes outside protected areas while Meru Park alone had 86% of the buffaloes. A few Hippopotamus were recorded in Tana River as shown in the distribution map.

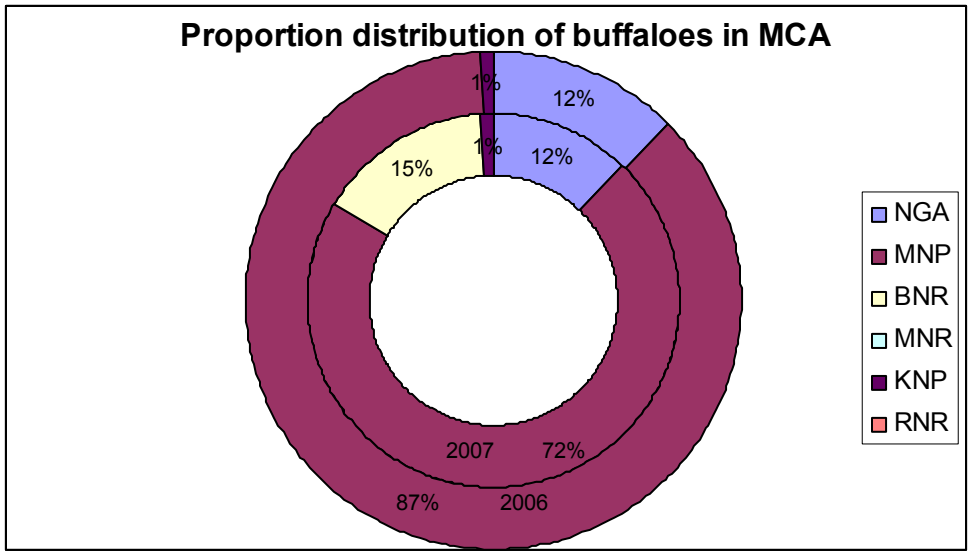
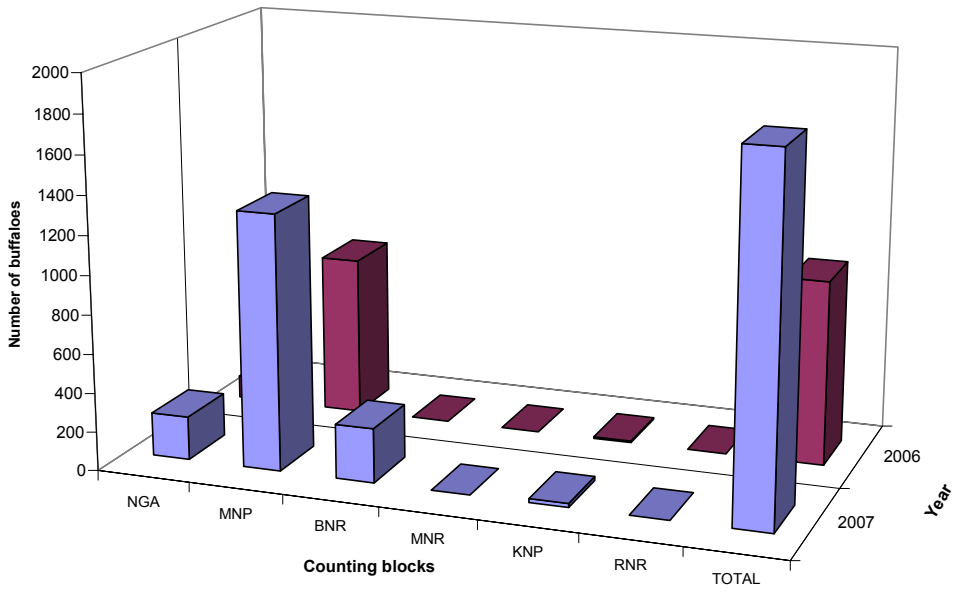


Fig. 5 Buffaloes in MCA



	NGA	MNP	BNR	MNR	KNP	RNR	TOTAL
2007	223	1310	278	0	21	0	1832
2006	118	822	0	0	8	0	948

36% of the giraffe were counted in Meru National Park and 5% at Bisinadi National Reserve. 41% of the giraffes were outside the protected areas in 2007 compared to 35% in 2006. Giraffes displayed relative wide distribution in the entire MCA. The pie chat below displays the giraffe distribution.

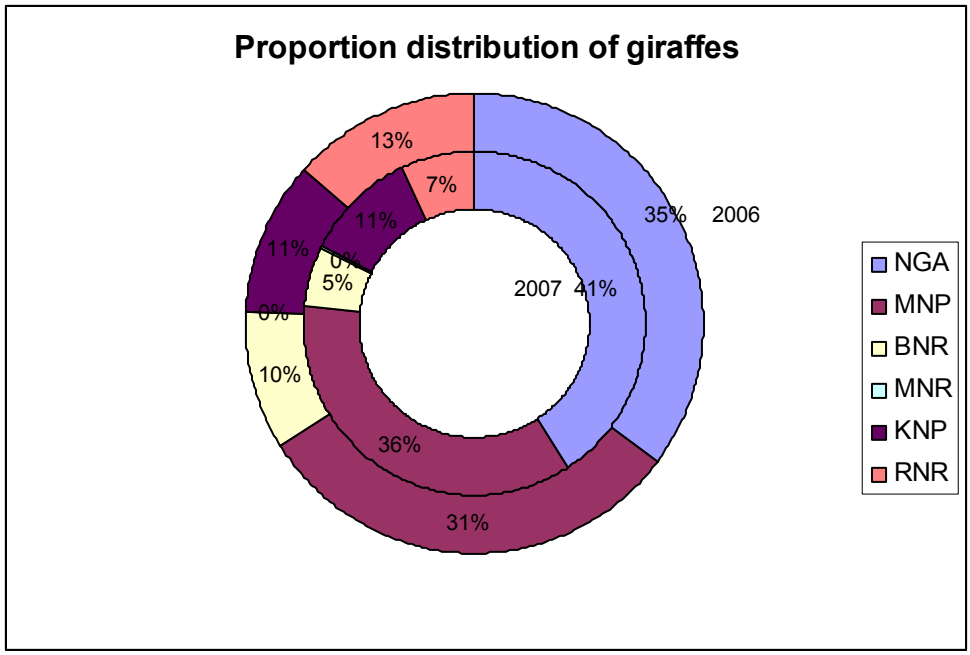
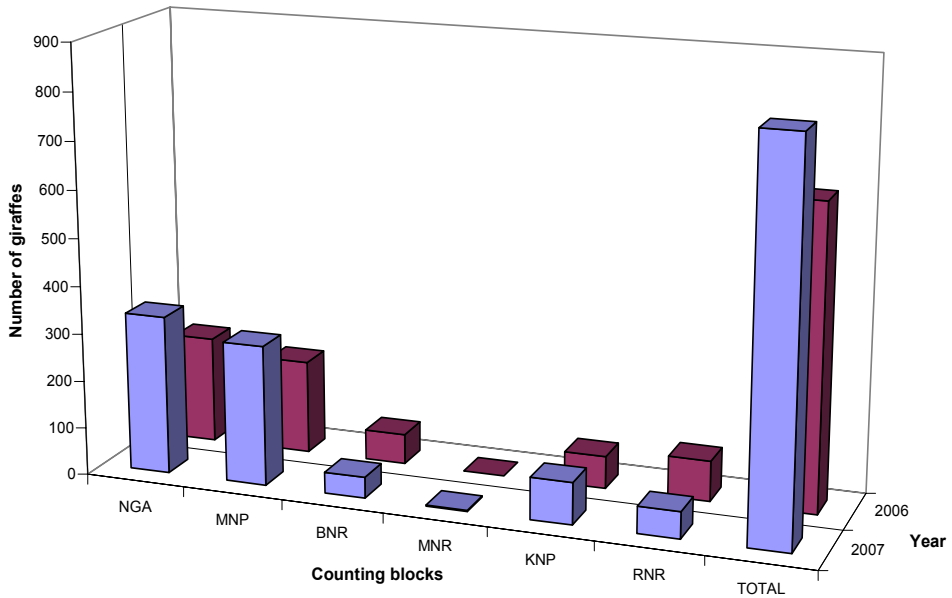
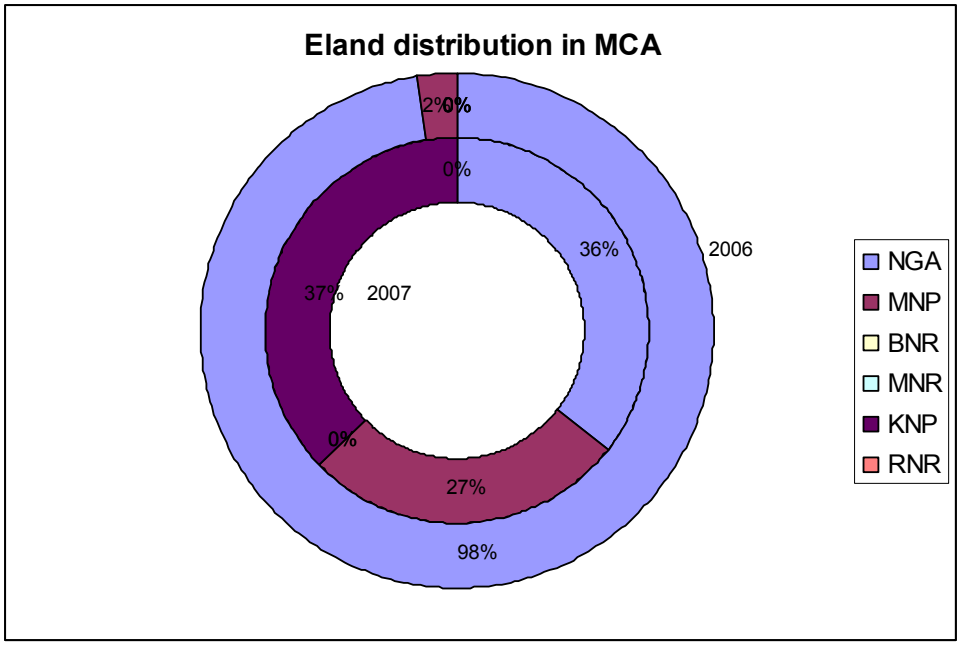


Fig.6 Giraffes in MCA

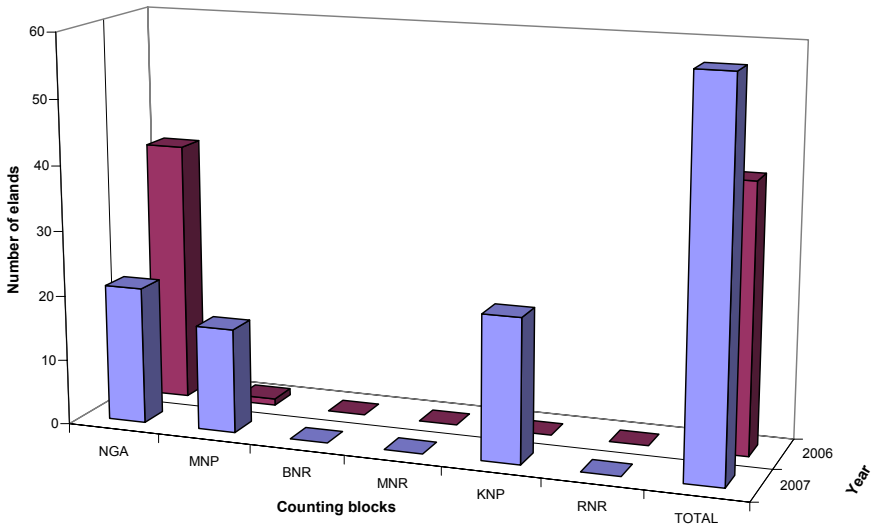


	NGA	MNP	BNR	MNR	KNP	RNR	TOTAL
2007	333	294	44	2	88	56	817
2006	224	196	63	0	68	85	636



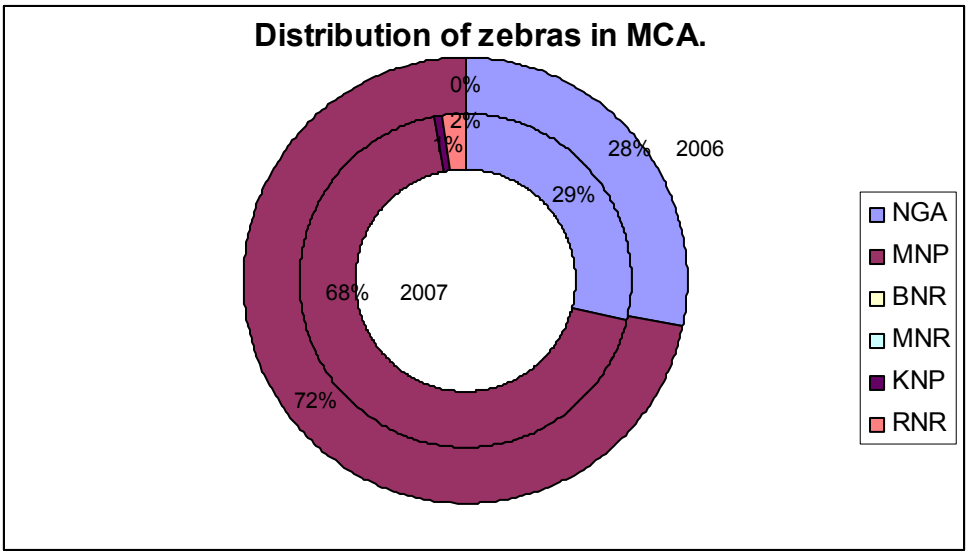
98% of elands were recorded outside protected areas in 2006 compared to 36% in 2007 as illustrated in the pie chart above. The population of elands increased this year compared to last year. Figure 7 compares the population estimates for the two years in the different counting blocks.

Fig. 7 Elands in MCA



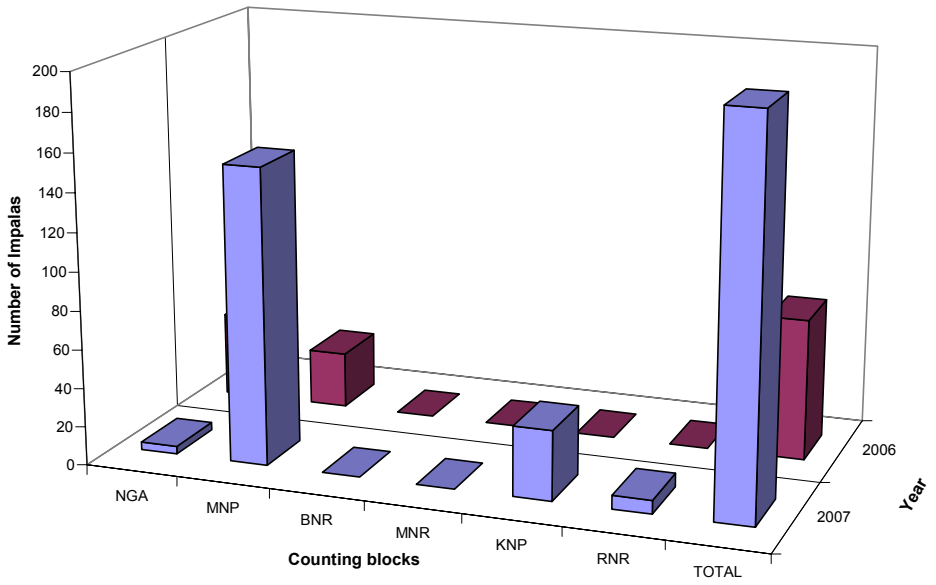
	NGA	MNP	BNR	MNR	KNP	RNR	TOTAL
2007	21	16	0	0	22	0	59
2006	40	1	0	0	0	0	41

4.3 Zebras and Impalas



614 plain zebras were counted in MCA in 2007 compared to 156 in 2006. The distribution of zebras was similar in the 2 years where they occurred in Meru Park and Bisanadi national reserve. The zebras and impalas are predominantly distributed inside the protected areas. Higher numbers of zebras and impalas were recorded this wet season compared to the previous count.

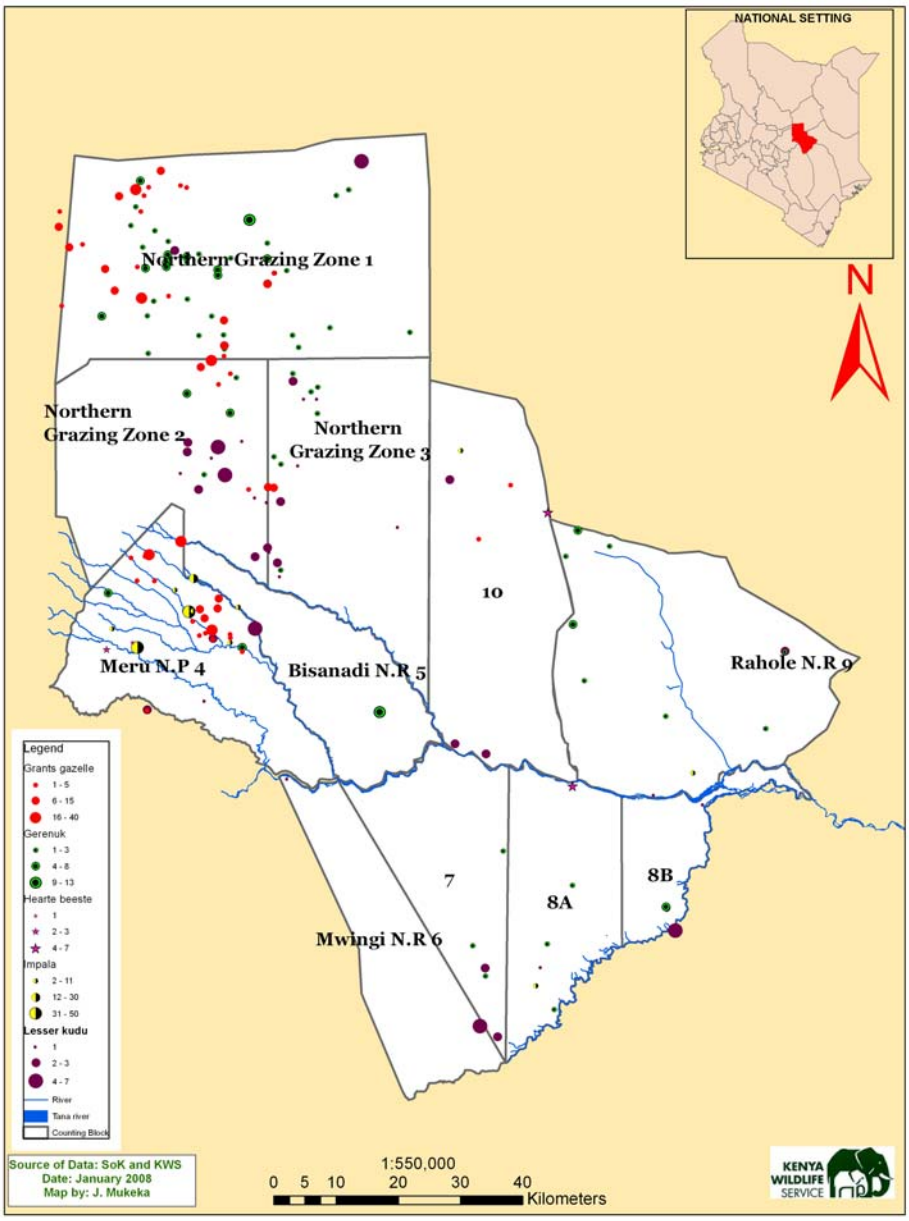
Fig.8 Impalas in MCA



	NGA	MNP	BNR	MNR	KNP	RNR	TOTAL
2007	4	153	0	0	36	7	200
2006	44	29	0	0	0	0	73

4.4 Impala, Kongoni, Lesser Kudu, gerenuk and grants gazelle population size and distribution

The map below gives a general distribution of impalas, lesser kudu, grants gazelle and gerenuk. Most of the figures for this species may not be true representatives for the population sizes but their relative distribution was displayed.



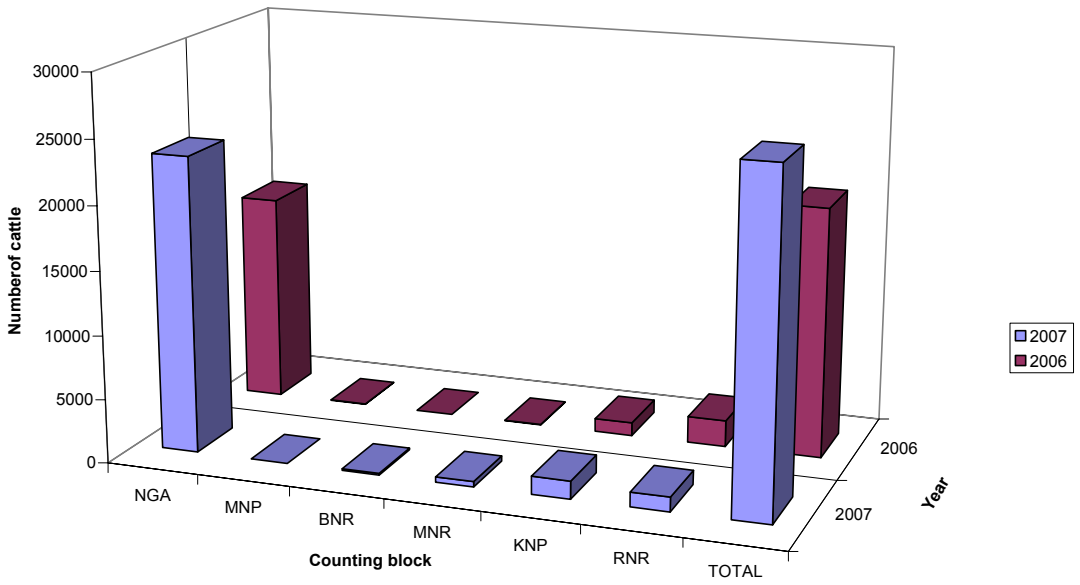
4.5 Population size and distribution of livestock in MCA)

Four (4) types of livestock (cattle, shoats, camel and donkeys) were recorded during the survey. 20.3% of the total number of livestock counted was cattle, 67.3% were shoats (sheep and goats), 12.2% were camel and 0.2% was donkeys.

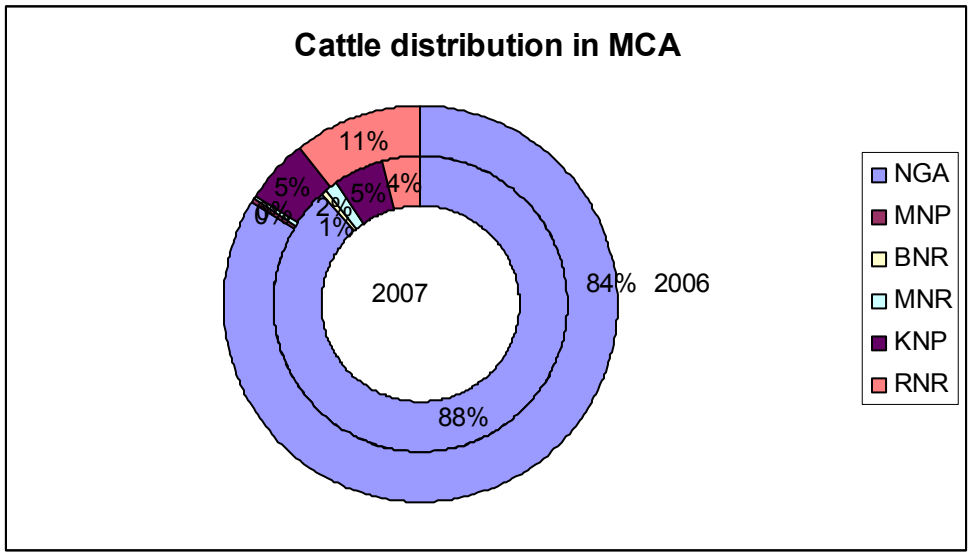
The distribution pie chart below gives a summary of livestock counted within the protected areas (park and reserves) and non-protected areas. No livestock were within Meru National Park during the count. Within the protected areas, Rahole National Reserve and Kora National Park had the highest population of livestock representing 4% and 5% of the total livestock counted during the survey respectively. Bisanadi and Mwingi National Reserves had 1% and 2% respectively. The Northern Grazing Zone had 88% of the total livestock counted. Cattle distribution was relatively similar in the two wet season counts. Cattle in Mwingi national reserve have decreased significantly.

There were more cattle recorded during this wet season count compared to the previous wet season count.

Fig.9. Cattle in MCA

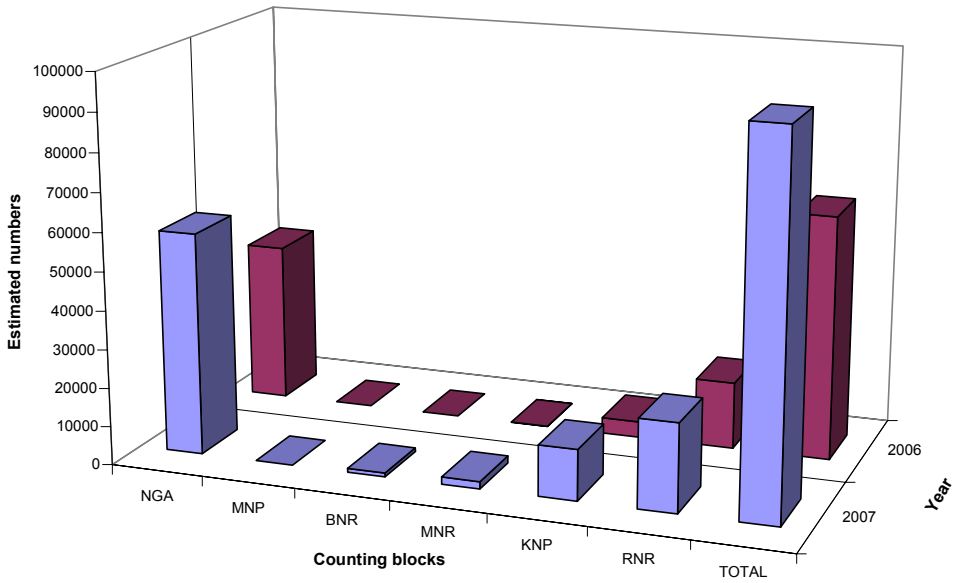


	NGA	MNP	BNR	MNR	KNP	RNR	TOTAL
2007	23166	0	136	418	1406	1126	26252
2006	16342	38	4	35	1040	2075	19534



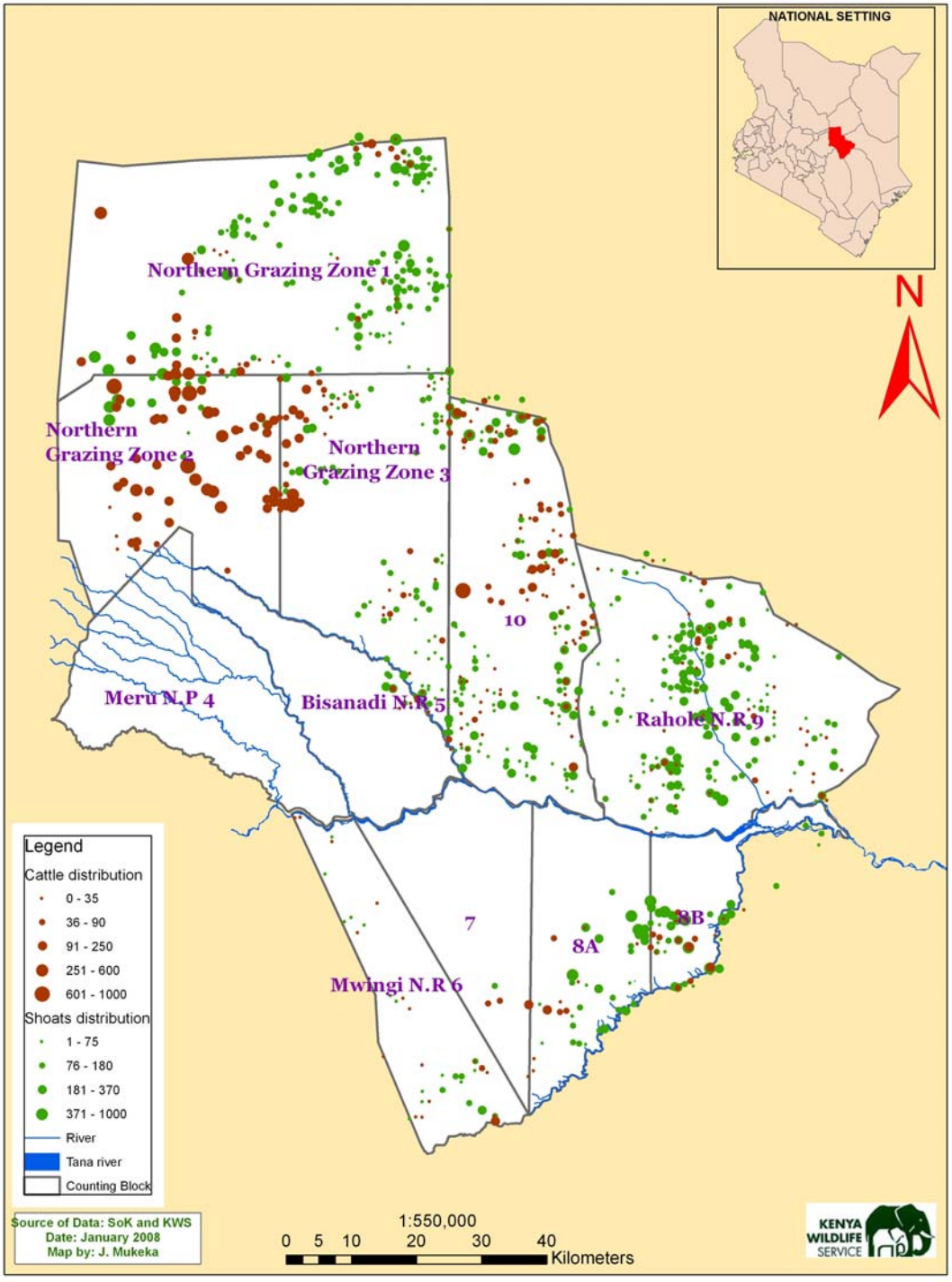
Like cattle more shoats were recorded during this wet season count compared to the previous count (2006). Rahole national reserve had the highest number of shoats followed by Kora national park. (See figure 11 below).

Fig.11 Shoats in MCA



	NGA	MNP	BNR	MNR	KNP	RNR	TOTAL
2007	57513	0	1005	1855	13173	22803	96349
2006	41388	20	0	25	4150	17410	62993

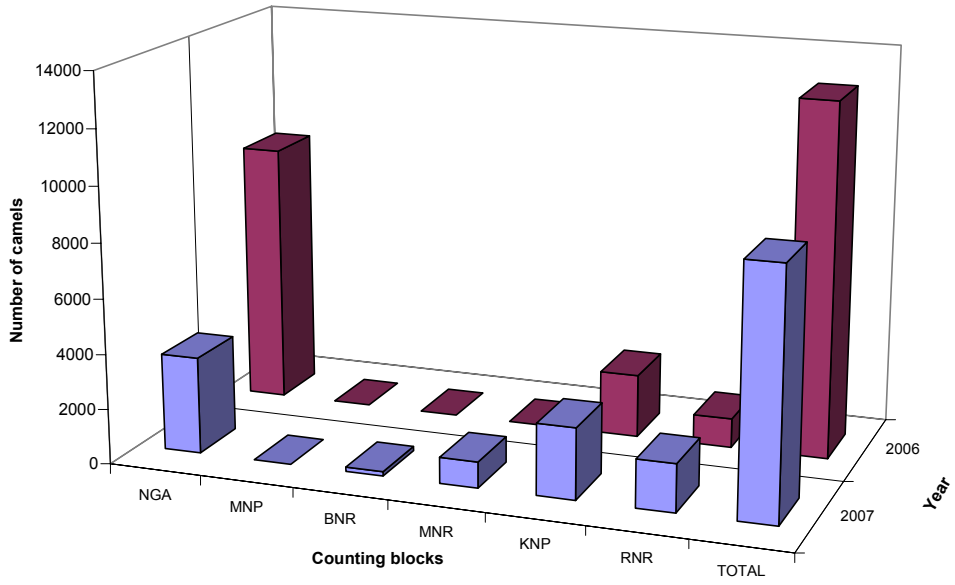
4.5.1 Cattle and shoat distribution



There was a significant decline in the number of camels in 2007 compared to 2006 wet season count. The camels were widely distributed in outside protected areas in the northern grazing zones. There were also a high population of camels recorded at Rahole

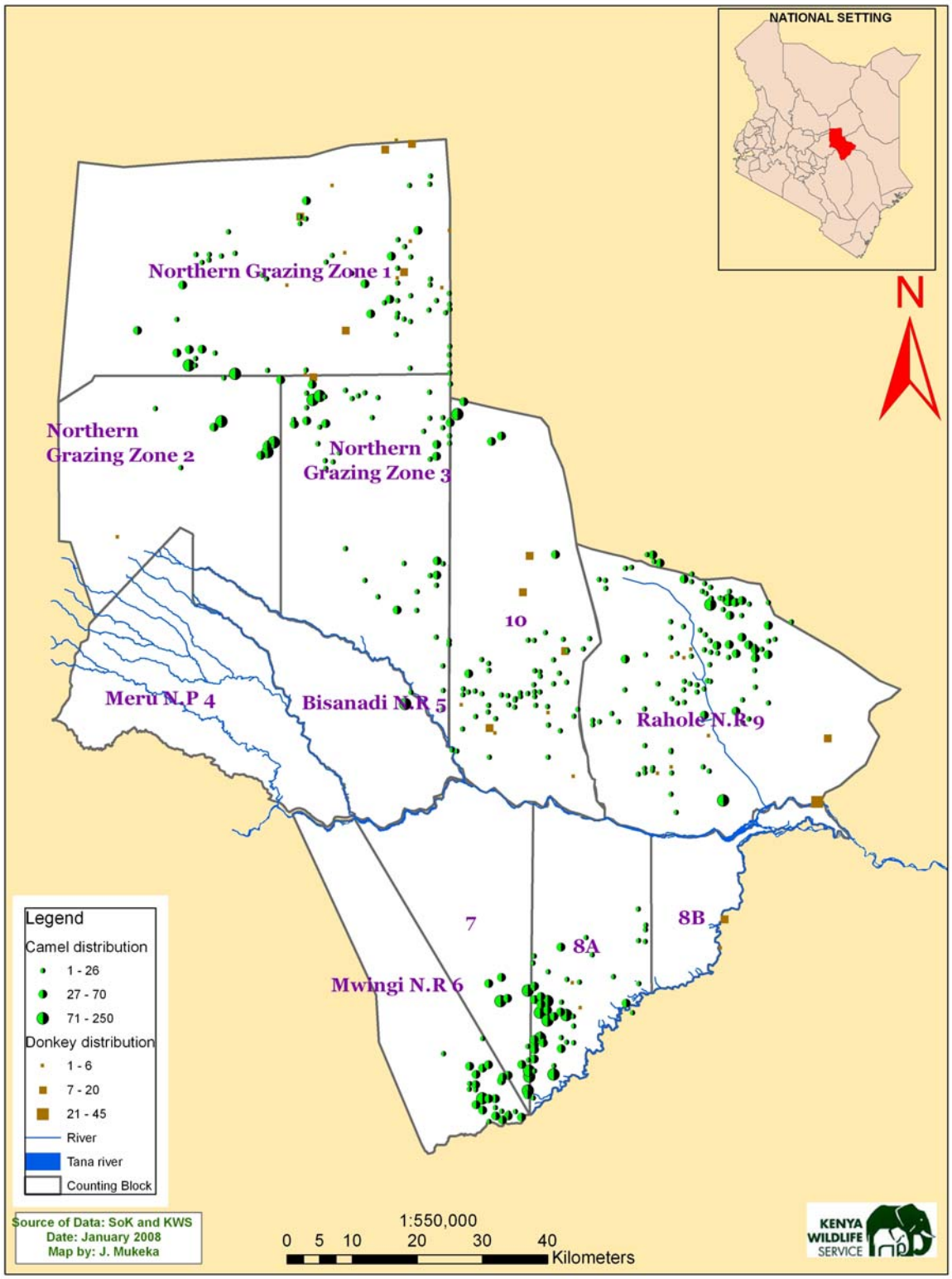
national reserve and at the southern boundary of Kora national Park. There were no donkeys recorded inside protected areas.

Fig. 10 Camels in MCA



	NGA	MNP	BNR	MNR	KNP	RNR	TOTAL
2007	3515	0	162	940	2584	1738	8939
2006	9490	2	0	0	2299	1065	12856

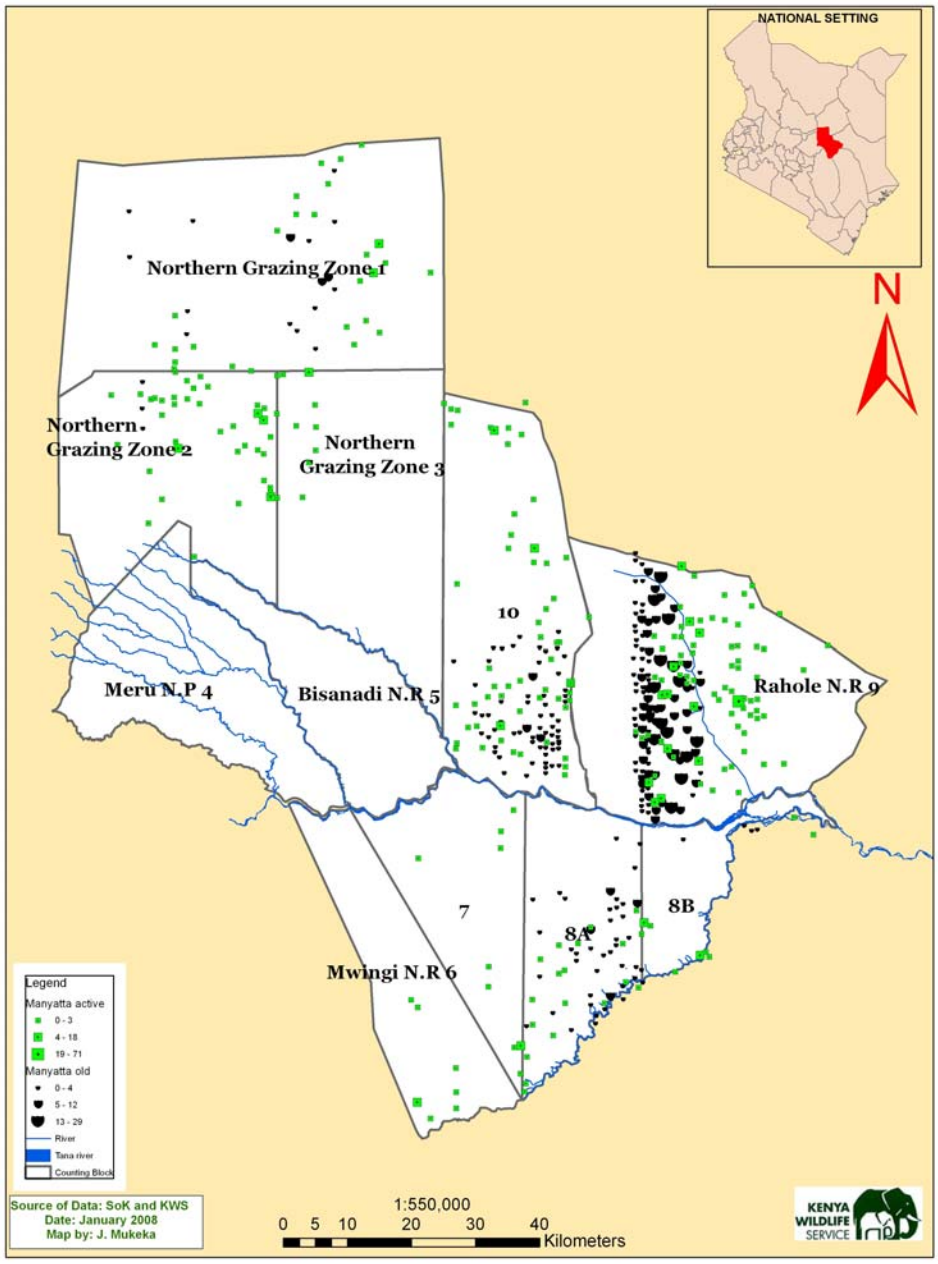
4.5.2 Camel and Donkey distribution in MCA



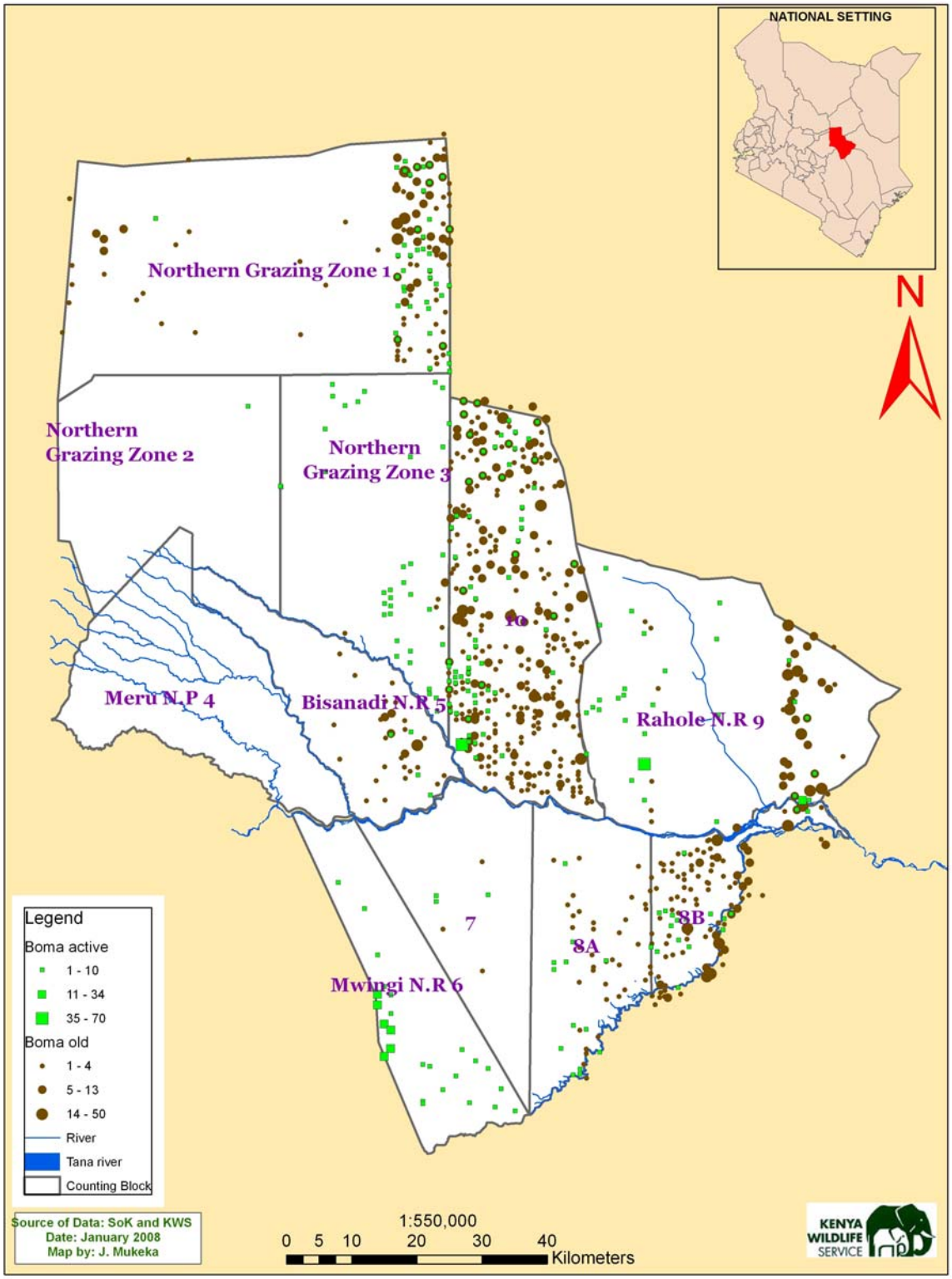
4.6 Human Settlement

There still remain active manyattas in some parts of MCA particularly at the peripheries of Kora NP and Mwingi national reserve however there is reduced settlement in the protected area compared to last year. Most of the manyattas inside MCA were old and abandoned implying that following security enforcement and conservation awareness creation more people are settling outside protected areas although they still herd their animals inside.

4.6.1 Manyatta Distribution in MCA



4.6.2 Boma distribution in MCA



6.0 DISCUSSION

6.1 General observations

Wet season data for MCA is only authentic for large mammal species whose sizes are bigger than zebras. Re growth of vegetation during the season makes sightings of most of the smaller species very difficult and hence the results for the small species though included in the count are only indicators of their occurrences and general distribution but cannot be used to give population numbers of the species. Species like the lesser kudu and waterbucks are usually hidden in the riverine and woodland vegetation of Meru Park and hence rarely seen during the count. Most sections of the rhino sanctuary have thick bushes during the season and hence only few rhinos were sighted. Wrong grasses and vegetated wooded grasslands made almost impossible to see lions although ground surveys indicate that lion population is relatively high with an estimate of over 40 individuals in Meru Park and Bisanadi. It is worth noting here that only 4 months before the count was conducted Meru Park received 745 zebras and 995 impalas in the continuing restocking of MCA. Out of this only 618 zebras and 200 impalas were recorded during the count. These figures remain below expectation and actual population of the two species nevertheless this wet season count recorded significantly more individuals of the two species compared to 2006 similar count. Assuming the chances of seeing the species were the same for the counts the translocation have had a high impact on game viewing in Meru Park. Ground surveillance records report herds of zebras of up to 100 individuals.

There was a general increase in the numbers recorded for most of the species this year compared to the previous count. The increase may be attributed to the favorable climatic conditions in terms of rainfall received and the improved conservation awareness among the park neighbors, the enhanced security patrols not withstanding.

6.2 Species distribution

Although most of the national reserves are not fully under Kenya wildlife Service for full protection, they remain categorized as protected areas in relation to wildlife conservation. MCA aerial counts cover five protected areas namely Meru national Park, Kora national Park, Bisanadi national reserve Mwingi national reserve and Rahole national reserve. The

Northern communal grazing land is included as part of the Non- protected wildlife dispersal area.

6.2.2 Wet season distribution

There are a higher number of individual animals inside protected areas than outside (72% and 28% of the total number respectively. With the exception of buffalo population that is quite high in Meru Park and not comparable to most other species. The ratio of inside PA to outside PA is 13:7. Elephants were more outside than inside. Other species with more individuals outside include Oryx, lesser kudu, gerenuk, warthog, ostrich and gazelles. The occurrences of species both inside and outside Pas in MCA remain the same but the abundant varies with species inside being more abundant than outside. The two tables below summarize the occurrence and abundance of the species in the dry and the wet season.

Wet count distribution of species

Species	**Estimate Inside PA**	**Estimate Outside PA**	**Total count estimate**	**%inside PA**	**%outside PA**
Elephant	356	391	747	48%	52%
Giraffes	784	33	817	59%	41%
Zebras	436	178	614	71%	29%
Grevys	2	12	14	14%	86%
Impalas	196	4	200	98%	2%
Buffaloes	1609	223	1832	88%	12%
Elands	38	21	59	64%	36%
Oryx	15	33	48	31%	69%
Waterbuck	62	3	65	95%	5%
Lesser kudu	37	56	93	40%	60%
Gerenuk	65	144	209	31%	69 %
Ostrich	30	37	67	45%	55%
Warthog	63	78	141	45%	55%
Gazelles	123	244	367	34%	66%
Hippos	54	0	54	100%	-
Total	**3870**	**1457**	**5327**	**72%**	**28%**

6.2.2 Dry season distribution

Below summarizes the distribution of species in the MCA based on the 2005 dry season aerial count.

Species	**Estimate Inside PA**	**Estimate Outside PA**	**Total count estimate**	**%inside PA**	**%outside PA**
Elephant	597	136	703	80%	20%
Giraffes	327	96	423	78.3%	22.7%
Zebras	163	55	218	74.8%	25.2%
Grevys	8	20	28	30%	70%
Impalas	30	0	30	97.4%	2.6%
Buffaloes	2139	149	2288	93%	7%
Elands	28	0	28	100%	-
Oryx	83	23	106	21.7%	78.3%
Waterbuck	173	10	183	94.5%	5.6%
Lesser kudu	5	89	94	5.3%	94.7%
Greater kudu	4	102	106	3.8%	96. %2
Gerenuk	78	124	202	38.6%	61. %4
Ostrich	28	48	76	36.8%	63.2%
Warthog	36	27	63	58.7%	41.3%
Gazelles	40	45	85	47%	53%
Hippos	386	6	392	98.5%	1.5%
Total	**4125**	**930**	**5055**	**82**	**18**

From the above table it is clear that over 80% of the species were recorded inside the protected areas. Major species of concern namely elephants, giraffes, buffaloes, zebras, elands and hippos were more inside protected areas than outside. Both greater and lesser kudu, ostriches, grevys zebra, Oryx and gerenuk were more outside the protected areas. If

we remove buffaloes in the picture because of its large population compared to other species the ratio of numbers inside Pas to Outside Pas is 18:7. This may not be the true representation of distribution of species in MCA but it is a strong indicator of the general distribution. Noting that seasons play a significant role on the migration of certain species like elephants only a series of the aerial surveys for different seasons would give the true picture of species distribution.

From the distribution pattern of wild ungulates described above it is evident that over 70% of population establishment is distributed in the conservation area of Meru with exceptions of ungulates such as; the Grevy Zebra, gerenuk, gazelles, reedbuck, duiker and the Kudu being found ranging beyond the boundaries of the conservation area. It however appears that the greatest species of concern, the elephant is equally distributed inside and outside the protected area with almost 50% distribution in both areas.

The distribution pattern of the animals can be described as wide ranging with exceptional seasonal movements into and outside the protected area. The animals have formed a dynamic relationship with their environment as the distribution pattern observed during the count explicitly attributes the distribution as a response to fluctuations in local environmental conditions. The environmental conditions of the conservation area are varied in terms of the agro-ecological classifications ranging from zone III to VI i.e. areas that receive approximately 1400mm of rain to 600mm of rainfall per annum. It should be noted that the amount of rainfall could vary by a factor of 10 from year to year (Ogallo, L.J.1988). The area also suffers from severe drought occasionally receiving only 50mm per year and results to livestock and wildlife migration in search of pasture.

The overwhelming temporal variation of rainfall and its uneven distribution throughout the year in the area results to erratic movements of migratory species making distribution patterns to vary widely throughout the year.

Factors such as human encroachment and availability of security have also influenced the distribution patterns of the animals in the count area.

The count only recorded 1 old carcass and no recent/fresh carcasses as compared to 7 carcasses in 2003 (Ogola P. 2003). This indicates decreased mortality due to poaching/ illegal activities. The five reported in the count are very old carcasses that indicate decrease in poaching due to enhanced surveillance and regular monitoring of populations. Most of the animals' counted were distributed and concentrated in the drier Northern areas of MCA a characteristic distribution of species during the wet season as opposed to the dry season where species concentrate on the wet areas of the Meru National Park and Bisanadi i.e. Mugwangho, Bwatherongi, Rojewero and Murera plains a distinct distribution pattern demonstrated during the dry season (Ogola p. 2003).

7.0 CONCLUSION AND RECOMMENDATIONS

From the above discussions, it is notable that climatic factors affect the distribution and movements of the wildlife in the conservation area. The overall distribution maps of the count show cluster distribution pattern for most of the species. Elephants particularly cluster in Meru and Bisanadi and at the periphery of the immediate northern grazing blocks indicating that they are migrating outside following the onset of rains. Their dispersal distance will be largely influenced by food availability. Depending on the duration of the wet season elephants may move further North or retreat back to Meru Park if there is a dry spell.

Human activities also determine the distribution of wildlife species with areas with high density of livestock having low density of large mammals.

It is also evident from the above results that most species are found outside protected areas in MCA during the wet season particularly the elephants. This may imply increased human wildlife conflicts due to competition for pasture and water. It is recommended that more security rangers should be deployed in the community outposts during the wet season to attend to the increased problem animal control cases.

Livestock incursions remain prevalent in Kora national park but the trend is on the decline and is currently high at the southern east peripheries of the park.

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Appendices

Appendix 1: Summary of species and their total numbers 2007 count

	COUNT AREA/BLOCKS						
SPECIES	**Northern grazing zone**	**Meru National Park**	**Bisanadi National Reserve**	**Mwingi National Reserve**	**Kora National Park**	**Rahole National Reserve**	**Total Estimate**
Buffalo	223	1310	278	0	21	0	**1832**
Bushbuck	86	29	0	0	0	2	**117**
Baboon	2	0	0	0	27	36	**65**
Cattle	23166	0	136	418	1406	1126	**26252**
Camel	3515	0	162	940	2584	1738	**8939**
Crocodiles	0	0	2	0	11	3	**16**
Dik dik	51	1	0	11	7	9	**79**
Duiker	38	0	0	0	0	3	**41**
Donkey	150	0	0	0	68	38	**256**
Elephant	391	268	30	0	31	27	**747**
Eland	21	16	0	0	22	0	**59**
Giraffe	333	294	44	2	88	56	**817**
Grant's gazelle	244	123	0	0	0	0	**367**
Gerenuk	144	13	13	0	13	26	**209**
Guinea fowl	279	0	0	10	114	0	**403**
Hippo	0	0	0	4	45	5	**54**
Impala	4	153	0	0	36	7	**200**
Lesser kudu	56	13	0	6	14	4	**93**
Ostrich	37	17	0	0	10	2	**67**
Oryx	33	10	0	0	2	3	**48**
Reed Buck	0	0	0	0	1	0	**1**
Rhino	0	17	0	0	0	0	**17**
Shoats	57513	0	1005	1855	13173	22803	**96349**
Waterbuck	3	52	10	0	0	0	**65**
Warthog	78	27	21	2	7	6	**141**
Plain Zebras	178	418	0	0	4	14	**614**
Gravy's zebra	12	2	0	0	0	0	**14**
Honey badger	2	0	0	0	0	0	**2**
Jackal	8	0	0	0	0	0	**8**
Grand total	**86572**	**2761**	**1701**	**3248**	**17686**	**25908**	**137876**

Appendix 2: Summary of species and their total numbers 2006 count

SUMMARY DATA FOR MCA DEC-2006 TOTAL AERIAL COUNT – WET							
SPECIES	**NGA***	**MNP**	**BNR**	**MNR**	**KNP**	**RNR**	**TOTAL**
Baboon	48	5			4	20	**77**
Black rhino	0	2			0		**2**
Buffalo	118	822			8		**948**
Bushbuck	0	3			0	22	**25**
Camel	9490	2		0	2299	1065	**12856**
Cattle	16342	38	4	35	1040	2075	**19534**
Crocodile	1	3			0	2	**6**
Dikdik	10	111		0	42	19	**182**
Donkey	313			11	0	15	**339**
Duiker	5	5			2		**12**
Eland	40	1			0		**41**
Elephant	350	8	94		52		**504**
Gerenuk	40	31			10	17	**98**
Giraffe	224	196	63		68	85	**636**
Grants gazelle	56	90			0		**146**
Grater Kudu	0	2			0	1	**3**
Grevy zebra	8	8			0		**16**
Guinea fowl	370				150		**520**
Hippo	3	2		3	8	2	**18**
Impala	44	29			0		**73**
Jackal	3				0		**3**
KG	0	24			0		**24**
Lesser kudu	20	24		0	2		**46**
Lion	2				0		**2**
Old Carcass	1				0		**1**
Oryx	5	7			7	4	**23**
Ostrich	14	54			2	1	**71**
Reedbuck	0	7			0		**7**
Shoats	41388	20		25	4150	17410	**62993**