CHAPTER 31

Large mammals of Mkomazi

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Mkomazi Game Reserve has never been noted for large populations of large mammals but the diversity of species is as great as in any other east African protected area. The size criterion defining a large mammal must, ultimately, be arbitrary. In ecological terms, individual size correlates with individual contribution to the rate at which ecological processes occur. The threshold size criterion for a large mammal in Mkomazi was set at a weight of 3–5 kg or a height of about 50 cm, and so would include, for instance, baboon and dikdik. The threshold is ecologically and logistically justified for it includes individual 'large mammals' that are likely to play significant roles in specific ecological processes and means that the chances of observing individuals of the smaller species is reasonable across a range of habitats, ensuring that widely distributed species have a fair chance of being observed throughout their range.

Information on large mammal distribution and abundance patterns, and their seasonal variations, is important to understanding the significance of large mammals as an ecological driving force in Mkomazi. This information is also vital in evaluating various management questions, such as the conservation importance of Mkomazi for the persistence of large mammal species. For example, Mkomazi has the only recorded gerenuk population in a protected area in Tanzania, as well as nationally important populations of oryx and lesser kudu (TWCM 1991). Other management considerations include the tourist potential of Mkomazi for game viewing, the nature and extent of potential wildlife-human conflicts, possibilities for sustainable harvesting of bush meat by local communities and the re-introduction of formerly-present species, such as the black rhino.

Large mammal species in Mkomazi

A full list of species recently and currently present in the reserve is given in the checklist (Chapter 32). Megaherbivores, those weighing more than 1,000 kg, comprise elephant and giraffe. The equids are represented by plains zebra, and the pig family by warthog and bush-pig. There are no hippopotamus, probably because

there is no natural source of permanent water in the reserve except for the Umba River in the far south-east. The eland and buffalo are the largest artiodactyls but there are many medium-sized ungulates such as waterbuck, lesser kudu, fringe-eared oryx, kongoni (Coke's hartebeest), impala, Grant's gazelle, gerenuk, bushbuck and Bohor reedbuck. Smaller large mammal species include bush duiker, klipspringer, steinbuck and dikdik.

The large carnivores are well represented in Mkomazi and include lion, leopard, cheetah and two hyaenas, the spotted and striped. Smaller species comprise wild dog (possibly extirpated from the reserve, although a group of 15 was sighted during a seven-day period in March 1997 near Kisima), black-backed jackal, bat-eared fox, aardwolf, ratel, serval, small-spotted genet, civet, five species of mongoose, zorilla, serval, caracal and wild cat. Some of these carnivores are very rare and populations of some may be threatened with extinction.

Other species have been recorded in the past. The wildebeest was common in the 1930s and the greater kudu occurred until the mid-1950s. Occasional sightings of the sable were reported up to the early 1950s. A group of 16 wildebeest was introduced to the reserve in 1966 but it does not seem to have become established. The black rhinoceros, which is the subject of a re-introduction programme, was present until relatively recently.

Most species that might be expected in the reserve from its geographical position are present with the exception of the hippopotamus. Information on the status of the large mammals has been derived from a number of sources. The only previous study in any detail was that made by Harris (1972) from 1964 to 1967. He established a series of line transects for estimating numbers supplemented by game counts around water holes and some aerial censuses. Harris extrapolated his data to provide estimates of the population size of some species and recorded a gradation in large mammal numbers from high densities in the north-west to low densities in the south-east. This trend reflects the rainfall pattern (see Chapter 2). Not all species were zoned in this way. Elephants, for example, were found throughout the reserve and oryx and zebra tended to be confined to the west-central and central areas. The distribution varies between water dependent and water-independent species and is influenced by vegetation, which is spatially heterogeneous. For several of the larger mammal species, seasonal movements between Tsavo West National Park in Kenya and Mkomazi mean that estimates of population size in the reserve show marked seasonal variation.

Following Harris' (1972) work, large mammal counts in Mkomazi were made from the air by the Kenya Range Management Unit (now the Department of Resource Surveys and Remote Sensing). These were sample, not total counts, and they were primarily carried out to count the elephants in the Tsavo ecosystem but some other species were included and the results of the most recent count, made in April 1994 (Inamdar 1994 & 1996), enables a comparison to be made with conditions some thirty years earlier. Ground surveys of large mammals conducted

during the Mkomazi Ecological Research Programme (MERP) sought to determine current distributions and, where feasible, to estimate population sizes within the reserve. In addition, systematic observations made in the west of the reserve aimed to clarify seasonal variation in distribution and abundance.

Survey methods

The spatial and temporal patterns in distribution and abundance of large mammals in Mkomazi are very variable. Elucidating these patterns necessitates the use of a variety of survey methods, which would ideally sample all habitats several times a year to capture seasonal variation.

Ground-based and, to a far lesser extent, aerial surveys of large mammal populations were used in this study. For ground surveys, constraints of accessibility to different parts of the reserve and of resource availability mean that in practice the surveys are biased in various ways. A spatial bias exists in that the north-western part of the reserve is the most intensely surveyed. In addition, the 'sample' for the whole reserve is small and is associated almost entirely with the road network. A temporal bias exists as observations were not necessarily made at times of day when most species are likely to be active, and the observations were not seasonally representative, particularly outside the periodic survey sector. Finally, there are observation biases, caused by the varying visibility in different vegetation types and at different times of year.

Ground surveys

Ground-based surveys provide the majority of our presence records. Almost all surveys were conducted from vehicles using existing roads in Mkomazi. When an animal was sighted, the vehicle was stopped and the species, group size, location and date were recorded. In most cases, the location was read from a global positioning system (GPS), using the same co-ordinate system and projection parameters as the 1:50,000 maps of Tanzania. When animals were over 200 m from the vehicle, their distance was estimated by eye and a bearing was taken using a standard compass. These data were used within the Mkomazi geographical information system (GIS—see Chapter 4) to calculate individual or group locations. Survey routes were essentially confined to existing roads in Mkomazi, which introduced various biases, as explained above. Bearing in mind these sampling biases, three types of ground-based survey were employed.

Opportunistic records

Records of individuals or groups of large mammals (2,125 in total) were made along all routes used by MERP researchers during 1994 to 1997 (see Figure 31.1a). Observations were not systematic, being uncontrolled in terms of sampling effort

and with respect to time of day, time of year and location (most were made in the western third of the reserve where most research occurred). Many of the observations were made during work to GIS map the roads, waterholes and other physical features of Mkomazi. All species of large mammals were recorded. Further observations were made during the course of other research activities, when there was a tendency to record only the less common species. The observations provide reliable, geo-referenced species presence data. Of records made without GPS location

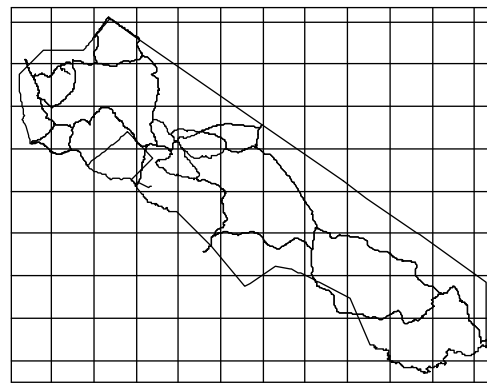
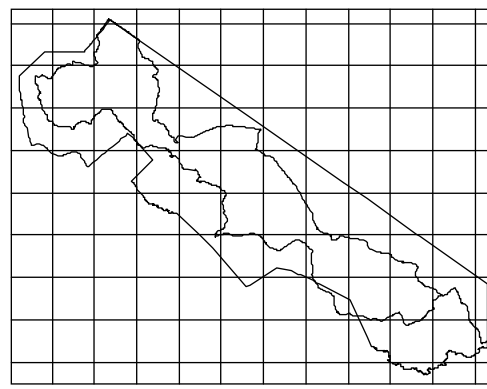
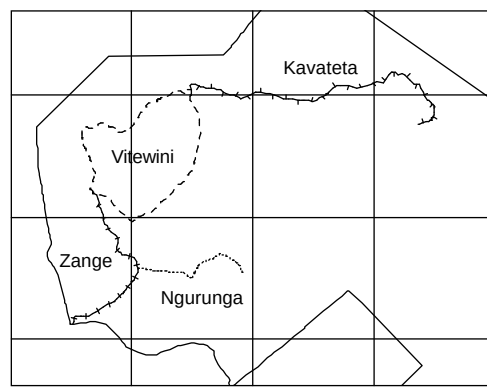


Figure 31.1 Routes of ground surveys of large mammals in Mkomazi, with 10 km grid squares. (a) All tracks in the reserve, along which most of the opportunistic sightings were made.



(b) The 1996 dry season survey route, surveyed four times.



(c) The 1996 periodic survey routes in north-west Mkomazi.

data, only those which could be precisely located, using described positions in relation to Mkomazi GIS map features, were used for distribution mapping.

Dry season surveys

Systematic, dry season surveys were conducted along roads throughout the reserve (see Figure 31.1b). Four such surveys, each lasting three to four days in July to September 1996 (13–16 July, 27–30 July, 19–22 August and 31 August–2 September), provided a spatially extensive (the survey route was 393 km) although seasonally restricted, and very modest sample of the reserve. A total of 669 sightings of individuals or groups mammals were made. In addition, the duration of each survey meant that given locations were 'observed' at different times throughout the day. Diurnal variation in animal behaviour means that the probability of observing a given species changes through the day, and that surveying in late morning and early afternoon is the least 'efficient' for detecting individuals.

Apart from generating presence data for species, the dry season surveys were used to estimate numbers of individuals of certain species in Mkomazi. As already indicated, large mammal populations are generally bigger in the wet season. The dispersed nature of wet season populations and the difficulties of observing them in thicker vegetation resulted in inefficient sampling. The more open nature of vegetation in the dry season means that transects 'sample', on average, a greater area than they would in the wet season.

Transect widths were calculated from the average distances at which animals were sighted, and multiplied by the route length to give an approximate sample area. Estimates of total species abundance in the reserve were made by scaling up the sample area density to the area of the reserve, for species which were sighted ten or more times and when the distance of the animal from the road was greater than two metres.

This method of abundance estimation ignores the influence of spatial heterogeneity in habitat type on variation in species abundance as it assumes that species recorded during the survey have an equal chance of being observed in any part of the reserve. Taken together, the high degree of habitat heterogeneity in Mkomazi, the various biases associated with ground-based surveys (see above) and the fact that the method is sensitive to low numbers of sightings mean that these abundance estimates can only be treated as approximate indications.

At the same time as the dry season surveys were made, densities of large mammals were calculated from counts made around three of the waterholes that were surveyed by Harris (1972). This study was an attempt to detect changes or trends that may have occurred over the past three decades. The values for biomass units used in these calculations were the same as those used by Harris (1972). The calculated densities cannot be exactly compared because Harris classified individuals by age and sex whereas we did not distinguish between adults, instead using his biomass figure for unclassified adults. In addition, any comparison between Harris'

and our observations must be made with great care because we could not take account of the possible differences in water availability (itself a strong influence on mammal densities) between observation periods.

Periodic surveys

The aim of these surveys was to represent temporal changes in species distribution across the western third of the reserve during a one year study, in 1996. The surveys were systematic and spatially intensive. They were carried out along four road routes in north-west Mkomazi (see Figure 31.1c), chosen to represent major habitats in north-west Mkomazi. Surveys were carried out twice each month during January to November 1996, although for practical reasons the number of surveys of each route in each month varied (see Table 31.1).

Surveys involved two or more observers inside a vehicle, and were standardised to occur as soon after dawn or before dusk as was possible, when animal activity was at its greatest. Presence data only were used in this study: a total of 875 sightings were made of individuals or groups.

Combining all of the ground-based surveys, a total of 3,542 geo-referenced sightings, comprising 24,033 individuals, was made (see Table 31.2).

Aerial surveys

In addition to the ground-based surveys, regular flights, for various purposes, have been made across the entire reserve by Tony Fitzjohn, resident at Kisima since 1989. The largely opportunistic sightings have been used to supplement data on species distributions and also to provide information on large mammal movements. Several, more systematic, aerial surveys of the reserve were made by SKE in July or August of 1994, 1995 and 1996.

Results

In analysing the results of surveys of the distribution and abundance of large mammals in Mkomazi, it is important to keep in mind that the reserve is part of the greater Tsavo ecosystem and is at its southern limit. Animals move widely over

Table 31.1 Number of surveys on regular routes in north-west Mkomazi in 1996.

route name & length	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
Kavateta (27.9 km)	1	3	2	1	1	0	1	2	1	2	1
Ngurunga (11.2 km)	0	4	2	1	1	1	1	2	1	3	1
Vitewini (37.6 km)	4	0	4	1	3	2	2	2	1	2	2
Zange (13.5 km)	0	4	4	2	0	1	2	2	1	2	0

Table 31.2 Summary of presence data for large mammal species in Mkomazi, gathered during ground-based surveys 1994–97.

species	sightings	individuals
dikdik	735	1,178
giraffe	477	2,761
kongoni	442	2,584
zebra	376	6,754
Grant's gazelle	264	1,278
impala	248	1,886
lesser kudu	156	263
eland	138	1,187
steinbuck	118	138
gerenuk	110	207
buffalo	102	3,376
warthog	76	204
elephant	71	1,291
reedbuck	43	73
oryx	40	387
lion	37	243
waterbuck	32	124
jackal	29	43
duiker	28	31
bushbuck	20	25
total	3,542	24,033

the whole area and their recorded presence or absence is sensitive to relatively small spatial changes in location, which may place them in Mkomazi or Tsavo. Movements in general are governed by rainfall (see Chapter 2) with Mkomazi acting as a wet season retreat for many of the animals because of the higher rainfall than that in the neighbouring Tsavo West National Park. The seasonal movements of some of the more important species are considered in *Species distributions* below.

Ground-based *versus* aerial survey methods

As indicated previously, aerial and ground-based surveys are subject to various significant biases. An idea of the variation in 'efficiency' of each of the survey methods used in this study can be gained from a comparison of observation data 'simultaneously' gathered by each method for the same area. A road transect was driven around Magunda at the same time as an aerial count of species was made. The results are given in Table 31.3.

Table 31.3 The numbers of animals observed during simultaneous aerial and ground counts of large mammals in part of Mkomazi on July 28, 1996.

species	aerial total	ground total	difference
buffalo	87	0	- 100%
eland	6	76	+ 92%
elephant	14	21	+ 33%
giraffe	46	26	- 43%
Grant's gazelle	5	11	+ 55%
kongoni	25	10	- 60%
waterbuck	3	3	0%
zebra	216	181	- 16%
lion	0	19	+ 100%

The results highlight ways in which each survey technique under-samples species presence and abundance. Aerial surveys are better at recording animals away from roads but are less efficient at detecting individuals or small groups of animals, especially of smaller large mammals. The aerial counters almost certainly flew over but failed to see a pride of eight lions with 11 cubs which was found by the ground team. Lions are notoriously difficult to detect from the air and are best surveyed from the ground. In addition, air-borne observers have less time in which to make repeated checks on numbers, and the survey usually takes far less time, reducing the relative opportunity to observe animals. In this case, the aerial survey was completed within 50 minutes while the ground counts took several hours so the surveys were not simultaneous. The difference in timing was probably responsible for the discrepancy between the aerial and ground totals for buffalo and eland. Most of the buffaloes seen from the air were in the hills south of Dindira and were moving towards thick country. It is unlikely that they could have been detected from the ground. The group of eland recorded on the ground count was certainly not present when the aircraft flew over the region where they had been seen. Where the animals were more widely distributed, the totals from the two methods agreed reasonably well.

Species abundance

Table 31.4 compares the estimates of the numbers of large mammals in Mkomazi Game Reserve made in the 1960s by Harris (1972) with those made in the 1990s by Inamdar and by this study in 1996. The 1996 estimates are conjectural and are based on the 1996 dry season systematic ground surveys, supplemented by Fitzjohn's aerial observations. The 1996 estimates are mainly of comparative value and probably do not represent the true totals. The 1994 aerial totals are also taken into account although aerial surveys are known to underestimate numbers, par-

Table 31.4 Minimum estimates of the numbers of large mammals based on aerial and ground counts made in Mkomazi Game Reserve between 1964 and 1967 by Harris (1972), in 1994 by Inamdar (1994) and in 1996 by the present authors. Not all species were counted on each occasion. Numbers in parentheses are standard errors.

	date and season		
species	1960s wet	1994 wet	1996 dry
buffalo	750	1,858 (1,569)	– [a]
eland	500	2,421 (1,279)	473 (1,313)
elephant	3,000	477 (304)	314 (149) [b]
gerenuk	250	17 (16)	933 (141)
giraffe	250	545 (76)	979 (84)
Grant's gazelle	–	–	306 (89)
impala	600	801 (348)	3,564 (2,470)
dikdik	–	–	55,978 (8,153)
kongoni	1,000	511 (200)	840 (229)
lesser kudu	250	426 (71)	5,739 (2,417)
oryx	400	102 (97)	– [c]
steinbuck	–	–	554 (339)
warthog	–	–	1,460 (704)
waterbuck	150	17 (16)	–
zebra	400	460 (178)	1,438 (741) [d]

[a] Buffalo were observed but numbers were too small for estimating population size

[b] 500 elephant were estimated by Harris (1972) to be present in 1960s dry season

[c] 100 oryx were estimated by Harris (1972) to be present in 1960s dry season

[d] 100 zebra were estimated by Harris (1972) to be present in 1960s dry season

ticularly of the smaller species. Any one-off count represents only a snapshot of the situation and needs to be treated with caution.

In view of the various techniques used and the seasonal differences when the counts were made, close comparisons are not justified but the results suggest that there has been little change except for a tendency towards an increase in numbers of the larger species (which may, however, be due to improved sampling techniques). The huge apparent increase in eland in 1994 is probably due to sampling error in the aerial survey total. Buffalo, giraffe and zebra have shown substantial increases and of the large mammals, only elephant has shown a marked decrease. Although not included in the analysis, the black rhino has also decreased, from several hundred to none. The declines in elephant and rhino are not surprising, given the known extensive poaching for ivory and horn in the intervening years.

The seasonal changes in numbers were investigated by Harris (1972) from counts made in three study areas surrounding semi-artificial water holes. Changes be-

tween wet and dry seasons are shown in Table 31.5. The biggest difference was recorded at Dindira, which is in the north-western corner of the reserve and which is the only one of the study areas to hold permanent water. Hence its attraction for wildlife in the dry season.

These counts were repeated in 1996 and the results are included in Table 31.5. Too much cannot be deduced from these comparisons because of the somewhat different techniques employed but they provide evidence of an increase in the numbers and biomass of large mammals in the northern sector of the reserve. Mbula is curious in that the biomass more than doubled although there was little increase in numbers. A similar trend is apparent in the 1960s when the biomass in the wet season was double that in the dry season although numbers remained the same. These observations suggest that the species composition of the large mammals around this waterhole is liable to fluctuate. Harris did not record eland or zebra at Mbula and the presence of these species in 1996 may explain the discrepancy. Alternatively it could be the sporadic appearance of elephants that is responsible. The Kavateta figures were influenced by the absence of giraffe and zebra in the 1960s and lower densities of impala and kongoni. These differences may be due to the presence of cattle in the 1960s and their absence in 1996.

Although the trends noted are not in themselves very convincing, they all point towards a possible increase in the numbers of most large mammals. Differences in densities between Harris' and our studies might, however, result from differences in environmental circumstances (such as water availability) at the times of observation, rather than from population trends. The increase at waterholes is largely attributable to two species, giraffe and zebra. These have relatively low standard errors in the road count estimates and it is very likely, therefore, that the perceived increases in these species are genuine. The decline in elephants is also likely to be real for the same reason.

Best estimates of herbivore abundance in Mkomazi are given in Table 31.6. These are based mainly on the 1996 dry season systematic ground surveys, whose totals are listed in Table 31.4, but include a subjective 'expert knowledge' element (SKE and Tony Fitzjohn).

Table 31.5 Numbers and biomass (kg) of large mammals per km^2 around Mkomazi waterholes in wet and dry seasons in the 1960s (from Harris 1972) compared with those recorded during the dry season in 1996. (Kavateta was named Mzara by Harris.)

	1960s				1996	
	dry		wet		dry	
waterhole	number	biomass	number	biomass	number	biomass
Dindira	23.7	12,705	7.7	2,082	31.6	17,329
Mbula	8.7	1,452	8.7	3,638	8.8	3,058
Kavateta	3.4	261	6.5	752	46.9	11,953

Table 31.6 Best estimates of the numbers of herbivores present in Mkomazi based on ground counts made in 1996, supplemented by incidental observations and subjective assessments.

species	number	comments
buffalo	2,000	wet season total
dikdik	100,000	subjective assessment
eland	500	
elephant	300 / 1,000	dry/wet season totals
gerenuk	1,000	imprecise total
giraffe	1,000	
Grant's gazelle	200	
impala	5,000	conservative estimate
kongoni	1,000	
lesser kudu	6,000	
steinbuck	600	conservative estimate
warthog	1,500	probably an overestimate
zebra	2,500	

Species distributions

Figures 31.2–31.13 show the distributions of species for which there are numerous geo-referenced sightings made in 1994–97 or which are important from a management point of view. In considering these maps, it is very important to keep in mind the biases associated with each survey technique. The maps do not necessarily represent the limits of species distributions in Mkomazi, although they may do so. Aerial observations, particularly of species movements, are incorporated in the following notes on elephant and buffalo. The letters in parentheses in the text refer to the seasonal movements shown on these maps.

Herbivores

BUFFALO. The seasonal movements of buffalo mirror those of the elephant to a large extent and the routes followed in the north-west are almost exactly the same. Some enter Mkomazi from the north-west (A) while a second wave (B) cross over from Tsavo West National Park and spreads out over the plain between Kavateta and Vitewini. In general, most of the buffalo occur either in the north-west or in the south-east of the reserve with few in between (Figure 31.2). They are quite common along the border with Kenya and three herds totalling some 350 to 500 criss-cross the border south-east of Kavuma Hill (C). Another 100 or so are resident along the Kenya border near Mabata. It is not possible to give an accurate

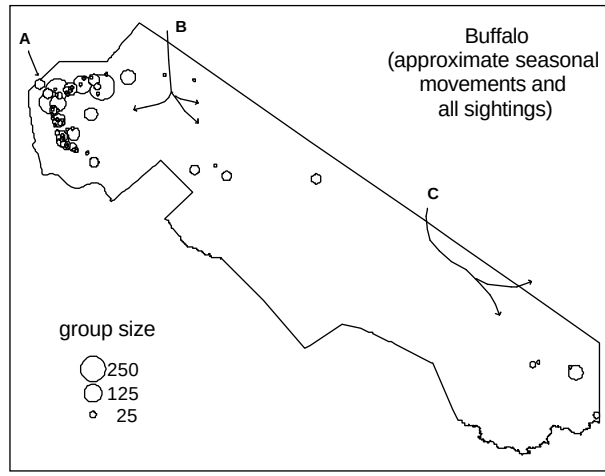


Figure 31.2 See text for explanation of movements

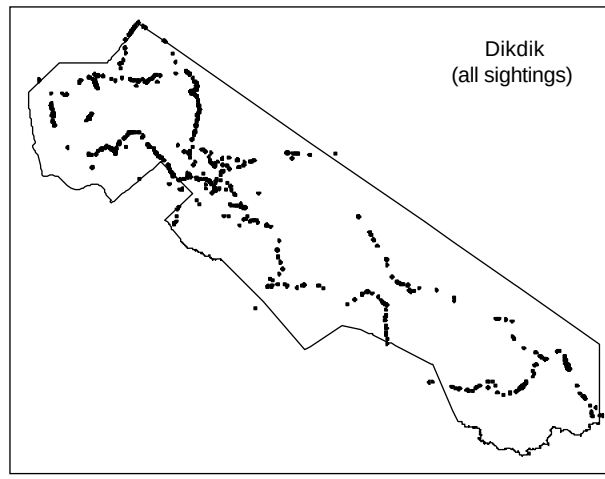


Figure 31.3

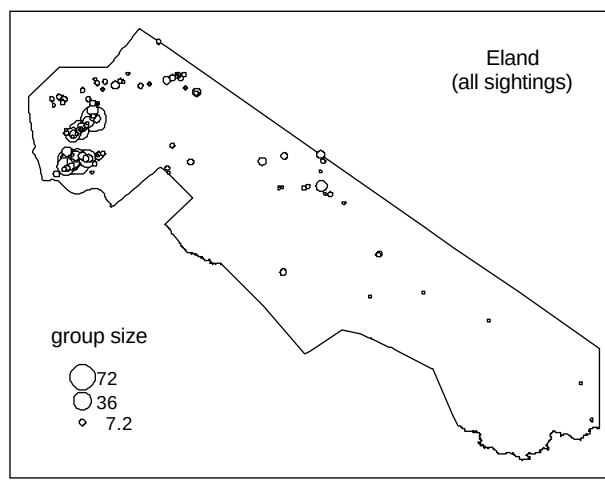


Figure 31.4

figure for total numbers in the reserve. A population of around 2,000 would seem to be reasonable for the wet season.

DIKDIK is the species most frequently seen from the roads in Mkomazi (Figure 31.3). It was almost never seen on road counts passing through the seasonal swamps or open vegetation.

ELAND are most likely to be seen in the central regions of the reserve, particularly around the Maore waterhole although they are found in most regions (Figure 31.4). Some 100 eland are known to enter the reserve from Kenya in the wet season between Maore and Kamakota. As far as total numbers are concerned, extrapolation from the ground surveys gives a figure of 473. General impressions, which admittedly are notoriously unreliable, tend to support this figure.

ELEPHANTS may be found anywhere within the reserve although their distribution is markedly clumped (Figure 31.5). In the north-west, elephants enter the reserve in the wet season and some (A) spread south-west to the Mbula and Gulela Hills and beyond. A second group (B) moves to the region between the Gulela and Mzara Hills. At the same time, 100 or more elephants (C) move out of the forested hills on either side of Dindira Dam and pass on to the plains between Zange and Ngurunga, where they mix with the Kenyan elephants. Smaller movements (D) across the border from Kenya to Kavateta occur if there is water in the dam. Similar small scale movements (E) across the border occur near Maore waterhole. A group of resident elephants occurs on the western side of the Mzara Hills but they may move out into Tsavo in the wet season (F). A more substantial wet season immigration takes place in the Mzara/Maore region (G). Some of these elephants pass to the west around Hafino Hill (H) and a few get as far as Kisiwani Village, where they may raid crops, and even fewer to Njiro Gate. Most pass between Kisima and Tussa Hills (I) to meet up with those that moved to the east of Hafino Hill. Mating is commonly observed in this region. Some migrate further to the south-east into the thick vegetation around Kamakota (J) where they mingle with elephants that have entered the reserve near Kavuma (K). Altogether some 400 or so elephants may be present in this area. Some 25 to 30 resident elephants occur north of Mabata in the far south-east of the reserve (L) but they may move a little way into Kenya from time to time or south to the Umba River. The total number of elephants present in the reserve during the wet season is around 1,000 but this falls to less than 100 in most dry seasons.

GERENUK are present throughout the reserve (Figure 31.6) but they are not easy to see and estimates of their numbers are probably too low. The 1996 dry season population size estimate of 933 suggests a healthy population commensurate with the size of the reserve.

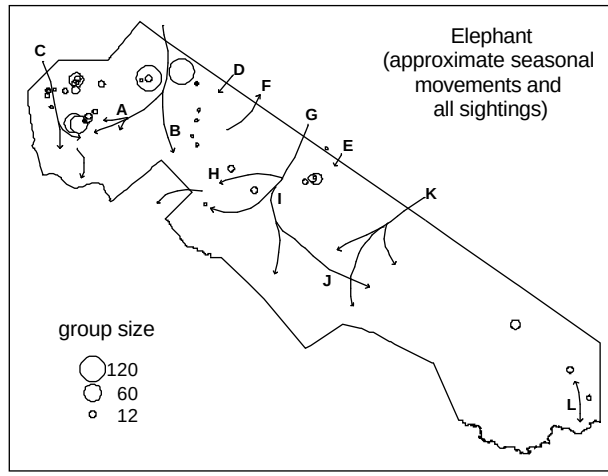


Figure 31.5 See text for explanation of movements

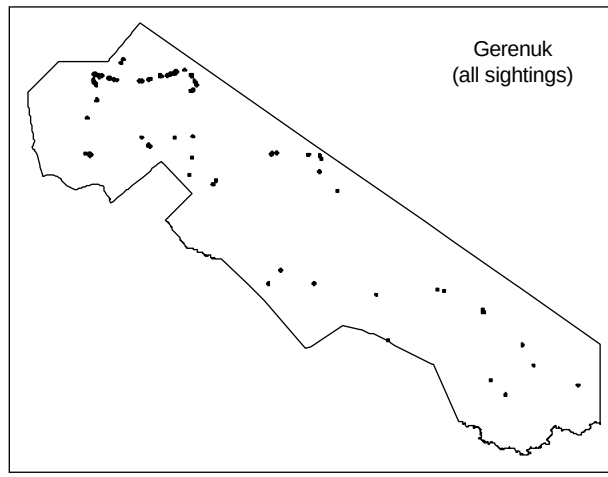


Figure 31.6

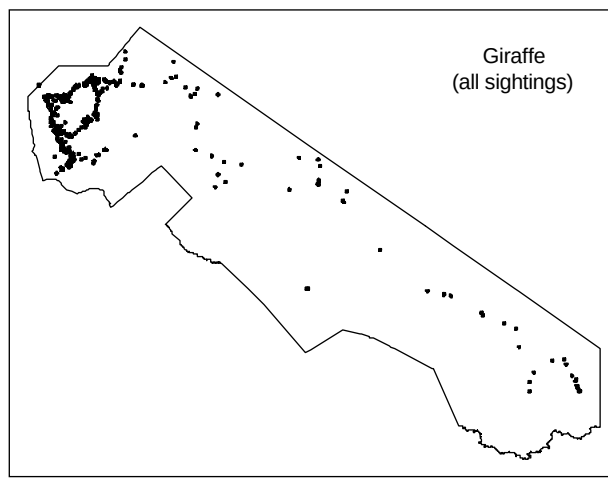


Figure 31.7

GIRAFFE were known to occur more or less throughout the reserve, although not uniformly so, and there are places where they are never seen, possibly because of heavy poaching in such regions. They are most numerous in the north-west but are present throughout the reserve (Figure 31.7), being comparatively rare in the central regions.

GRANT'S GAZELLE are restricted to the western half of the reserve (Figure 31.8), and while not present in large numbers are most numerous in the far west. The species was not recorded on the 1994 aerial survey, although it is not clear whether the species was excluded from the counts. The total from the 1996 ground counts was only 306. Even so this is likely to be too high as about half of the area included does not support gazelles and it is unlikely that there are more than a couple of hundred in the reserve altogether.

IMPALA is one of the commoner species and is generally widely distributed in the reserve although it is most abundant in the western half (Figure 31.9). Antelopes of this size and coloration are not easily seen from the air and, as with gerenuk, the 1994 aerial count of 801 is certainly too low. The 1996 dry season estimate of 3,564 suggests a population of several thousand.

KONGONI (Coke's hartebeest) are more or less distributed throughout the reserve although not uniformly so as there are regions of higher density, particularly near waterholes (Figure 31.10). Like other large ungulates, they show seasonal movements between Tsavo and Mkomazi and groups of 40–50 accompany eland and zebra on their passage through the Maore region.

LESSER KUDU are probably the most numerous of the larger antelopes in Mkomazi but because of their cryptic markings and the dense cover they inhabit, they are not easily seen. They are distributed widely throughout the reserve (Figure 31.11 but are rare in the Ibaya region due, no doubt, to the lack of suitably thick country there.

ORYX are widely distributed in Mkomazi (Figure 31.12), although the population size appears relatively low. A herd was regularly seen throughout the Mkomazi Ecological Research Programme at Kavateta.

ZEBRA are found most frequently in the western half of the reserve (Figure 31.13) but are present in the eastern half. The species is particularly numerous around Ibaya and in the vicinity of the Maore waterhole. Up to 400 zebra accompany eland and kongoni in the wet season movements from Kenya.

Figure 31.8

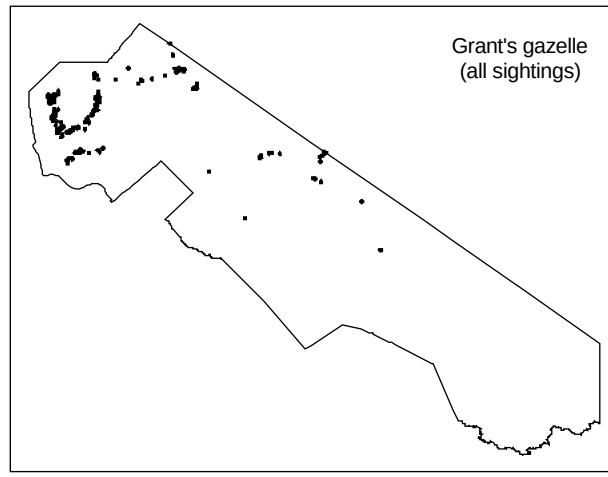


Figure 31.9

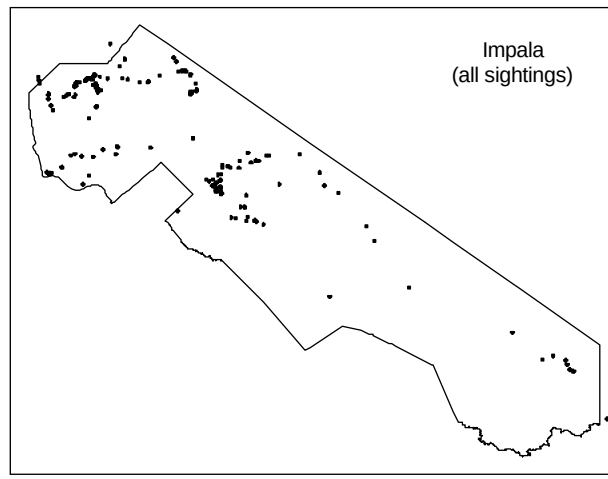
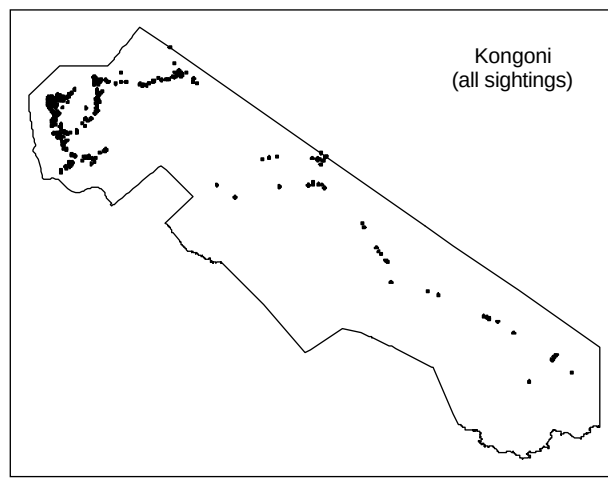


Figure 31.10



Carnivores

Data on the distribution of carnivores are limited, largely because relatively low population sizes mean that species are rarely encountered during surveys. The smaller carnivores are regularly seen and population sizes appear to be healthy. Compared with populations elsewhere in similar habitats, the spotted hyaena is very rare. The incidence of melanism in the serval seems to be high.

Domestic stock

Although cattle, sheep, goats and donkeys are not supposed to be present, large numbers of cattle, in particular, have been recorded within Mkomazi. This is perhaps not surprising given the problems of law enforcement, in part associated with the elongated shape of the reserve. The numbers involved run into thousands. Domestic stock were counted in the 1994 aerial survey (Inamdar 1994) and totals of 23,557 cattle (s.e. $\pm$ 12,530) and 4,739 sheep or goats (s.e. $\pm$ 2,356) were estimated although not all of these were within the reserve's borders. Cattle enter the reserve at Pangaro, where there is a dam just outside the reserve boundary, north of Ndea across to Kavateta, possibly including herds from Lake Jipe in Kenya, and on the southern boundary towards the Ngurunga region. Herds have been recorded at Kamakota in the centre of the reserve and in the south-eastern region.

Mammal species re-introductions

Following the judgement of the Tanzanian Wildlife Division in the late 1980s that Mkomazi was in a florally and faunally degraded state, a decision was made to rehabilitate the reserve. The Division formed the Mkomazi Project under the supervision of a project manager. One of the aims of the Project was to re-introduce species to the reserve that had recently been extirpated. Three species were initially selected for re-introduction: black rhinoceros, cheetah and wild dog. As cheetah re-established naturally in Mkomazi, attention was focused on the black rhino and wild dog. In view of the costs involved with re-introducing species, the UK-based George Adamson Wildlife Preservation Trust was invited to assist with the rehabilitation programme. The Trust provides funds for equipment and supports the activities of Tony Fitzjohn.

Black rhinoceros

There was a population of at least 150 rhinoceros in the reserve as recently as the mid-1960s but the species became extinct, largely due to poaching. A re-introduction programme obviously needs a source of animals but the general decline of the species throughout Africa to dangerously low levels was a problem. There

Figure 31.11

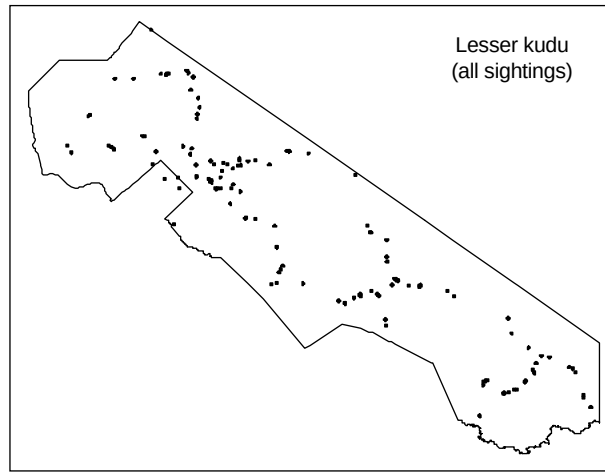


Figure 31.12

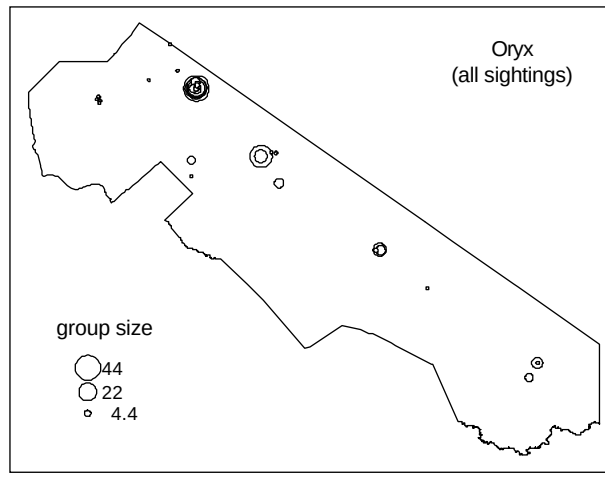
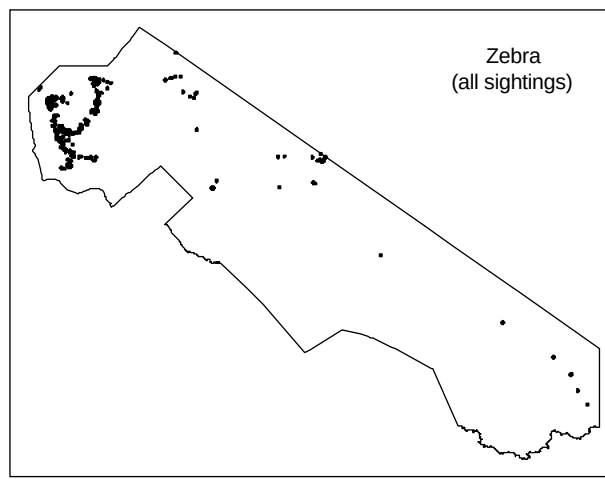


Figure 31.13



would be no justification for moving animals from where they were native unless they were at grave risk of being killed. It became known that authorities in South Africa wanted to dispose of a population of 35 black rhino in the Addo National Park because they were a subspecies that was not native to the area. The population was descended from a group of seven animals that had been shipped to South Africa in the early 1960s from the Tsavo ecosystem, and so belonged to the appropriate subspecies, *Diceros bicornis michaeli*, for re-introduction to Mkomazi.

Guidelines for the re-introduction of species have been prepared by the Species Survival Commission of IUCN (IUCN, 1987). These guidelines provided the framework for the Mkomazi rhino re-introduction project, which was assessed and approved by experts from the South African National Parks Board (Knight & Morkel, 1994). It was decided not to release the animals straight into the wild but to hold them for a number of years in a sanctuary enclosed by an electrified fence within the reserve. The fence was completed in late 1996 and covers an area of about 43 km^2. The first four rhinoceros arrived on 4 November 1997 and were kept in bomas for a few weeks to recover from the translocation and to acclimatise to their new circumstances, before being released into the sanctuary.

Wild dog

The wild dog is an endangered species and is still persecuted throughout its range in Africa. An attempt to re-establish the species in Mkomazi was considered to be an important contribution to the survival of the species. There are ethical problems, however, in taking specimens from the wild for re-introduction in former parts of the species' range, unless the population concerned is at immediate risk of being killed. This appeared to be the case with three groups that were located at Engassumet on the Maasai Steppe, about 100 km from Mkomazi. The dens were dug out in June 1995 and 25 pups (15 males and 10 females) were collected and brought to holding pens at Kisima, close to the rhino sanctuary, before threats to poison the dogs could be carried out. The parents of the captured pups survived long enough to produce further litters so the exercise did not seriously affect the status of the species in that area.

The captive dogs are breeding successfully, with the first young born in March 1997. The plan is to maintain a breeding stock in captivity and to release groups in a series of re-introductions as well as to provide source individuals for re-introductions elsewhere. Four males were sent to Kenya to provide 'fresh blood' for a re-introduction project. They were introduced to four wild-caught females with hunting experience and after some time, two males and all the females were released into Tsavo National Park. The pack eventually found its way back to Mkomazi where its progress is being monitored through radio-tracking.

Conclusion

The large mammal fauna of Mkomazi is diverse, resulting from both a high degree of habitat heterogeneity and the inclusion of the reserve in the greater Tsavo ecosystem. Although population sizes in general are not great, the reserve contains important populations of several herbivore and carnivore species, such as gerenuk, oryx, lesser kudu, leopard and cheetah. The seasonal movements of large mammals into and out of Mkomazi indicate that the reserve probably plays a key role in the population viability of several species, by providing important wet season resources.

Information on large mammal distribution and abundance is necessary for management planning purposes. The data generated by this study provide an essential baseline of information on species presence and status in Mkomazi. This information can be used to evaluate the potential for developing tourism within the reserve, to predict impacts of different kinds of utilisation of the reserve, as well as to provide the basis for monitoring impacts. The information would also be useful in planning the re-introductions of large mammal species to the reserve.

Acknowledgements

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