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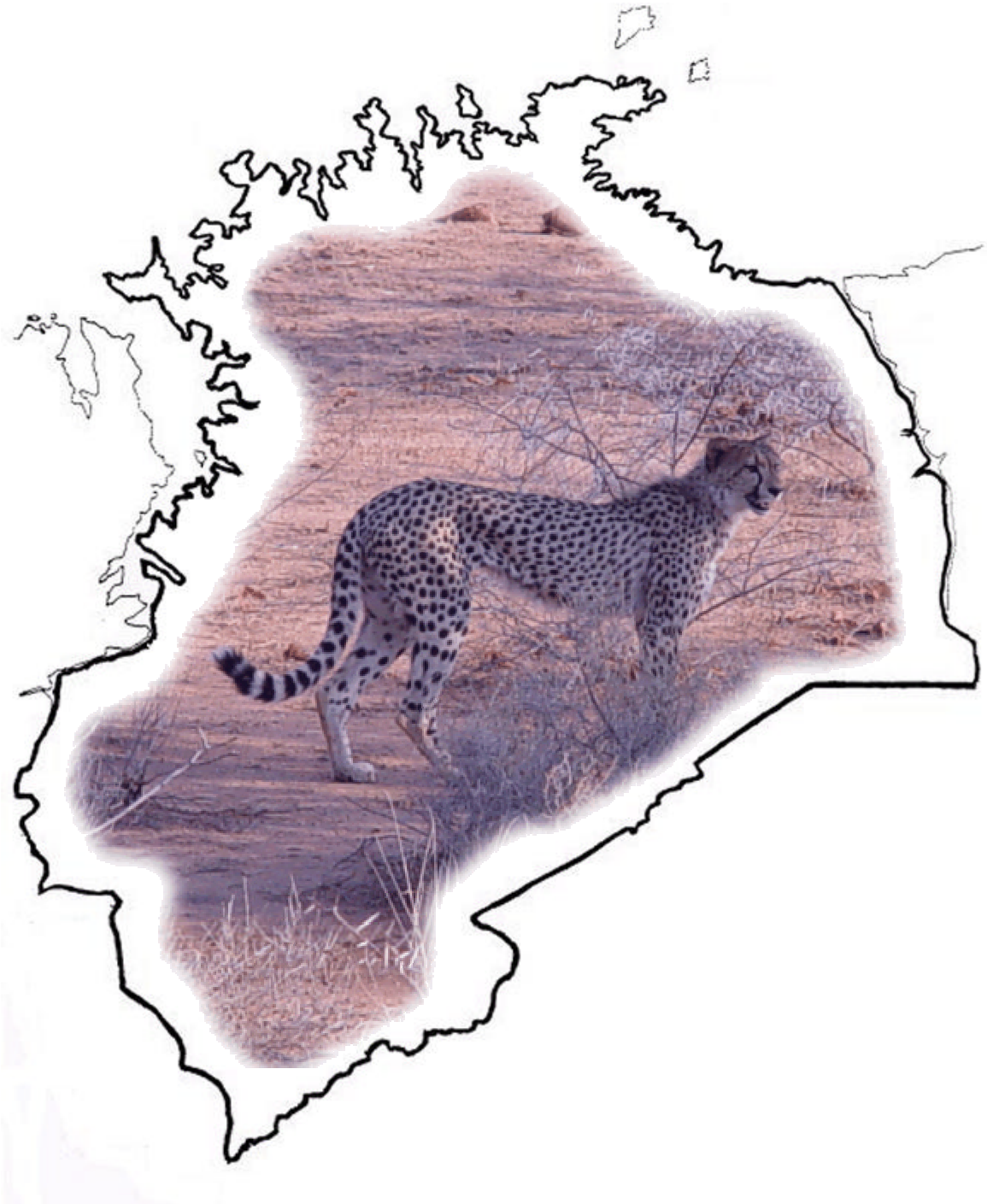
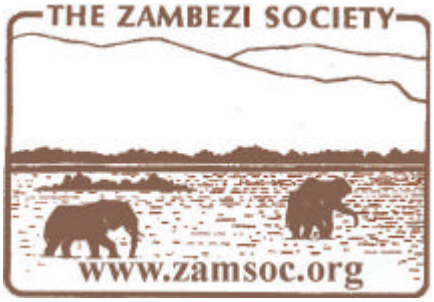


Evaluation of a wild-wild translocation of cheetah (*Acinonyx jubatus*) from private land to Matusadona National Park, Zimbabwe (1994 – 2005)

Dr G K Purchase and G Vhurumuku



Mission Statement

To promote the conservation and environmentally sound management of the Zambezi Basin for the benefit of its biological and human communities

THE ZAMBEZI SOCIETY was established in 1982. Its goals include the conservation of biological diversity and wilderness in the Zambezi Basin through the application of sustainable, scientifically sound natural resource management strategies. Through its skills and experience in advocacy and information dissemination, it interprets biodiversity information collected by specialists, and uses it to implement technically sound conservation projects within the Zambezi Basin.

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Introduction

The cheetah, *Acinonyx jubatus*, is the only species in a unique genus, specially adapted to reaching high speeds when hunting its prey. Historically the species had a wide distribution, occurring across the African continent into the Middle East and the Indian sub continent. In the last century the distribution of the cheetah has decreased dramatically with many countries in its former range maintaining only small, vulnerable populations. This decrease in range and concerns about the status of cheetahs led to the listing of the species as endangered.

Since the 1970's there has been an increased understanding of the ecology of cheetahs within its range states and an improved knowledge of the threats to the survival of the cheetah. Studies carried out in protected areas have shown that cheetah populations are affected to differing degrees by competition with the other large predators. In some habitats, competition can be intense with cheetahs suffering high levels of juvenile mortality and kleptoparasitism. In other habitats, the effect of competition is minimal.

In addition to the scientific studies carried out in many protected areas, some range states have reported that cheetah numbers in livestock ranching areas have either increased, or at least remained stable over the last two decades. It is still not fully understood why this should be the case but three factors have probably played a role:

- many landowners successfully eradicated lion and spotted hyaena from their properties, thus removing the cheetah's main competitors. These predators are easier to eradicate than cheetah, because of their propensity to scavenge. Landowners could lay poison or baits to shoot individual animals. Cheetahs rarely scavenge and are therefore less vulnerable.
- in many areas farmers have encouraged wildlife populations to increase. As studies have shown that wild predators tend to preferentially kill wild prey (Marker *et al*, 2003; Woodroffe *et al*, 2005), an increase in the latter will favour an increase in predator populations. Cheetahs are highly successful hunters. An increase in food supply would also have resulted in a population increase, as juvenile survival rates would have increased. Cheetahs have relatively large litters (averaging 4-5 cubs) and their populations can increase rapidly under optimal conditions.
- in many of the range states reporting an increase on livestock ranchland, a series of drought years in the early 1990s favoured the type of habitat that appears to be optimal for cheetahs (open woodland with a sparse grass layer, interspersed with open grassland areas)

This paradox in the legal status of cheetah (endangered species) and the reality that in many range states numbers have increased to the point where conflict with farmers is also increasing, has changed the emphasis of cheetah conservation. In the 1970's it was argued that cheetahs were on the verge of extinction and needed protection regardless. Since 1990, it has been argued that cheetah conservation relies more on finding ways to facilitate co-existence between landowners and cheetahs, in some cases allowing consumptive use to encourage tolerance.

The translocation of cheetahs caught wild on livestock ranching areas in Zimbabwe, to a protected area within Zimbabwe, occurred as a result of the changing emphasis with regard to cheetah conservation in many range states. It was viewed as an experiment to determine if such a management technique could be used successfully to mitigate conflict while ensuring the survival of the national cheetah population.

Cheetah conservation in Zimbabwe

From 1975 much private commercial farmland in Zimbabwe changed from being predominantly cattle country, to either a mixture of cattle and wildlife, or exclusively wildlife. This change was as a result of an increasing awareness that returns from wildlife were greater than cattle, and a change in government legislation that enabled landowners to directly benefit from the wildlife on their land. In addition, the following 15 years were particularly dry ones, with low rainfall. These two factors appeared to result in a cheetah population explosion that spread from the southwest of the country northwards and eastwards until about 50% of commercial farmland reported problems with cheetah preying on livestock. As a result the cheetah was increasingly perceived to be a "problem" predator, and many landowners were indiscriminately and illegally removing animals from their properties. The issue of "problem cheetahs" was first raised by the Commercial Farmers Union in 1991 in discussion with the Parks and Wildlife Management Authority (PWMA). As with other range states there was conflict between the legal status of the cheetah (*de jure* status) and the perceived status of the ground (*de facto* status). The cheetah is a specially protected species under the 1996 revised Parks and Wildlife Act. This means that it cannot be killed or translocated without special permission from the PWMA's Director General. Cheetahs

are also listed on Appendix I of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES) so trade in live animals and/or products is severely restricted. In addition many countries have their own laws regarding the import of live and/or products of these two species, as a result of them being regarded as vulnerable by the international community. The legal status effectively prevented landowners from dealing with cheetah predation.

In 1992, because of this increasing dichotomy between the *de jure* and *de facto* status of the cheetah on private commercial farmland in Zimbabwe and other range states, a case was presented to CITES for cheetahs to be hunted as a trophy animal, in a similar manner to leopards. Many landowners felt that they should be allowed to benefit from the presence of cheetahs on their farm. This, it was argued, might also create an incentive for landowners to conserve their cheetah populations.

The 1992 CITES CoP agreed to sport hunting quotas in three countries: Zimbabwe, Namibia and Botswana. National quotas are agreed on by the Parties to CITES on the assumption that the offtake will be non-detrimental to the survival of the species in the country. Each country applying for a CITES quota has to show that the proposed quota will not affect the viability of the population as a whole.

The system set up in Zimbabwe was the same as that for leopard, (set up in 1983), enabling landowners to apply for a CITES tag to hunt cheetahs. However, the difference is that a landowner has to apply for and be granted an additional permit (Section 37) on the basis that cheetahs on his property are causing severe livestock and/or game losses. This permit can only be issued on receipt of a letter from the Rural District Council or the Commercial Farmers Intensive Conservation Area chairman stating that the landowner making the application has been experiencing severe livestock predation by cheetah. The application process creates longer delays in the granting of CITES tags for cheetah than for leopard.

Hence by 1993 there had been little progress made in mitigating the conflict between landowners and cheetahs *in situ* and PWMA decided to determine if the removal of problem cheetahs to areas where they would be fully protected could help to resolve the situation. PWMA resources were limited at the time of the translocation, and application was made to the Zambezi Society for assistance with the cost of capturing, translocating, and releasing the cheetahs.

The translocation

The relocation was experimental in nature, as there was little previous experience to draw upon (Zambezi Society, 1994) but the aim was to establish a viable breeding population. Given the knowledge that cheetah were being killed indiscriminately on commercial farmland, and the fact that it was impossible to determine the number being removed because of legal implications, there was an urgent need to find ways to ensure the survival of the national cheetah populations.

It was not known if cheetahs had been present in Matusadona National Park (MNP) and had become extinct, or whether they had never been present in that environment at all (Pitman, 1994). As no feasibility study had been carried out, the only information available at the time of the translocation was that there was a large resident impala population and suitable habitat available (Anon, 1994), and that cheetah spoor had been seen in the Park on two separate occasions (Cheesman, per comm). It was also known that MNP had high densities of lions and that hyaenas were present. The aim of the project was to establish a viable breeding population of cheetahs but the number of cheetahs required to achieve this aim could not be determined.

The cheetahs used in the translocation were captured opportunistically by registered wildlife capture units in the Lowveld area of Zimbabwe, where there had been reports from landholders of cheetahs preying on livestock. A veterinarian was present at each capture, except the first two. Losses during the capture operations were initially high, with one adult female and four cubs dying while being held prior to removal to MNP. However, as the operation continued losses were significantly reduced, with only two adults dying because the aircraft they were travelling in crashed on landing at MNP. The whole capture and release process was conducted over a two-year period, with new animals only being caught after the release of the previous captured cohort.

On arrival in MNP the animals were kept in a fenced enclosure or boma, for six weeks, in an attempt to habituate the cheetahs to their new surroundings and to the presence of lions and hyaenas (Anon, 1994). The boma was circular, approximately 25m in diameter, the fence was electrified on both the inside and outside, and the cheetah were fed on locally shot impala. Lions came frequently to the boma and made several attempts to get inside. It

can be argued that the boma period was useful in that the cheetahs were reported to be killing adult impala soon after being released (Zank, 1995)

Although there are some guidelines available to increase the success of carnivore translocations and re-introductions (Griffiths *et al*, 1989) many projects are carried out without consideration of these techniques and strategies (Hein, 1997). Many translocations are not monitored after the animals have been released (Linnell, *et al*, 1997). This means that a considerable amount of the valuable information concerning factors that affect the success of the re-introduction is lost, a point emphasised by the IUCN Re-introduction Specialist Group (1998). This group stresses that there must be post release monitoring of all, or at least a representative sample, individuals released to further the understanding of the demograhic, ecological and behavioural characteristics of such populations. What little information has been collected so far has concluded that the following factors increase the chances of success: -

- Translocations of wild caught animals are more likely to succeed than those using exclusively captive reared animals (Griffiths *et al* , 1989);
- Success is correlated with the status of the source population. If the source population is increasing a translocation has a higher chance of success than if the source population is declining, as is the case with most endangered species (Griffiths *et al* , 1989);
- In the case of a re-introduction, the source population should show similar ecological characteristics to the original sub-population (IUCN Re-introduction Specialist Group, 1998).
- Translocations of animals into areas with potential competitors of similar trophic level are less successful than translocations into areas without competitors (Griffiths *et al* , 1989);
- When the number of animals released is plotted against the success of the operation, the graph reaches an asymptote at about 20 – 40 animals for large mammalian species (Griffiths *et al* , 1989);
- Translocated individuals have been shown to make very large post-release movements, thus increasing the chances of conflict in the re-introduction area. The magnitude of these movements appears to be reduced if the animals are kept in an enclosure in the new area for a period of time – referred to as a "soft release" (Linnell *et al*, 1997; Bradley *et al*, 2005). If the re-introduction area is very small the chances of the translocated animals moving out of the protected boundaries is very high and this must be taken into account (Linnell *et al* , 1997).

The IUCN Re-introduction Specialist Group (1998) emphasises that re-introduction is a very lengthy, complex and expensive process. The principal aim should be to establish a viable breeding population and the project should involve minimal long-term management (IUCN Re-introduction Specialist Group, 1998).
Reviews of the success of translocations come to the same conclusion (Griffiths *et al* , 1989; Linnell *et al* , 1997; Hein, 1997) and argue that it should not be used as a solution for problem animals (where the reasons for conflict should be addressed and rectified) and in the case of endangered species it should only be used as a last resort because of the low success rate of such projects. However, because of the large amount of information necessary to make a project successful it should be explored long before it is seen to be the last resort for an endangered species (Griffiths *et al* , 1989).

All the above authors agree that the available information on translocations is very small. Hein, (1997) argues that future translocations should be designed more scientifically and experimentally to enable hypotheses about translocations to be tested.

Because the translocation of cheetahs from private land to MNP was carried out opportunistically and experimentally, the project did not follow all the guidelines that have since been set out by the IUCN Re-introduction Specialist Group. There was no attempt to mitigate the conflict between the farmers and the cheetahs *in situ* and it was assumed that removal of "problem" animals would be the best solution. In capturing animals to release, there was no attempt made to capture specific problem cheetahs, but simply any cheetahs that could be found and caught on the properties concerned. The distribution of cheetahs within Zimbabwe was assumed to be continuous, and introducing cheetahs from the lowveld into the Zambezi Valley was considered acceptable.

There has been considerable monitoring of the released population in MNP, from soon after the release to 10 years post release. Population size, movement patterns, diet and habitat preferences, interactions with competitors and conflict with surrounding communities have all been studied, enabling a comprehensive evaluation of the translocation as set out in this report. This valuable data will add to the database regarding what factors affect the success and failure of translocations of large carnivores.

Unfortunately, however, there was no monitoring at the sources of the translocated animals to determine whether the removal of 21 cheetahs had effectively reduced conflict with the farmers.

Matusadona National Park

Matusadona National Park covers a total area of 1,370 km^2 on the southern side of the Zambezi Valley on the Zimbabwean shore of Lake Kariba (geographical centre of re-introduction area: 028 ^{o} 35'E: 16 ^{o} 50' S). It comprises two topographically distinct areas: the escarpment and the valley floor (Figure 1).

The escarpment is dominated by Miombo woodland (a typical broad-leaved moist woodland) and is characterised by steep-sided valleys. During the dry season (May to October) there is little water available in this habitat, with only a few springs providing perennial water. Much of this area is inaccessible so the monitoring of cheetahs since their re-introduction has been confined to the 400sq km valley floor, where they were released.

The vegetation of the valley floor is predominantly closed woodland (*Colospermum mopane,* mixed with *Combretum* spp. and *Terminalia* spp.) with a sparse herb layer. It follows a linear pattern along the rivers that run from the escarpment to the lake shore, with rivers being edged with dense *Combretum* spp, and the ridges between the rivers characterised by open *Mopane* woodland (Figure 2, Purchase 2004). Much of the area consists of a mosaic of open woodland and grassland patches (Purchase 2004) providing ideal hunting habitat for cheetahs.

In addition, frequent changes in the level of Lake Kariba have created a foreshore grassland habitat at the edge of the lake that is devoid of woody plants and has been colonised by a highly nutritious and productive species of grass, *Panicum repens* (Taylor, 1985), as well as other herbaceous plants. The total area of this foreshore grassland changes with the level of the lake (Figure 3, Purchase 2004). This foreshore habitat is densely populated with herbivores, particularly in the dry season due to the availability of water and grazing. (Purchase and du Toit, 2000, Purchase 2004). There is a distinct boundary between the woodland and the foreshore grassland, which is referred to as the treeline. The extent of the foreshore habitat for any given lake level is greater in the eastern shore than the western shore (Figure 3).

The common herbivores of the valley floor area of MNP are elephant (*Loxodonta africana*), black rhino (*Diceros bicornis*), hippo (*Hippopotamus amphibius)*, buffalo (*Syncerus caffer*), zebra (*Equus burchelli*), kudu (*Tragelephus strepsiceros*), waterbuck (*Kobus ellipsipyrmnus*), impala (*Aepyceros melampus*), bushbuck (*Tragelaphus scriptus*) and common duiker (*Sylvicapra grimmia*).

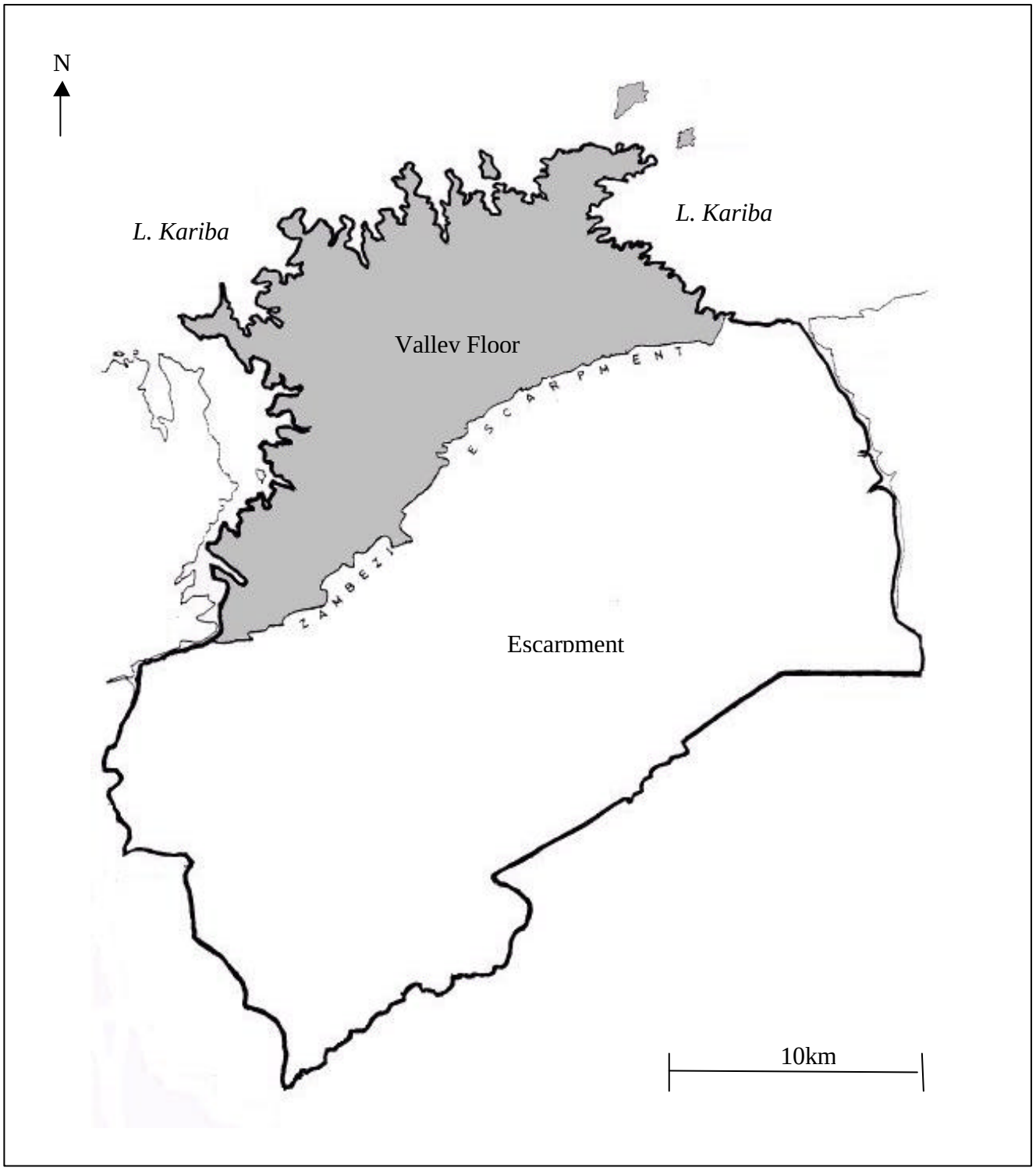


Figure 1: Map of Matusadona National Park, indicating the two topograhically distinct areas, the valley floor (shaded) and the escarpment.

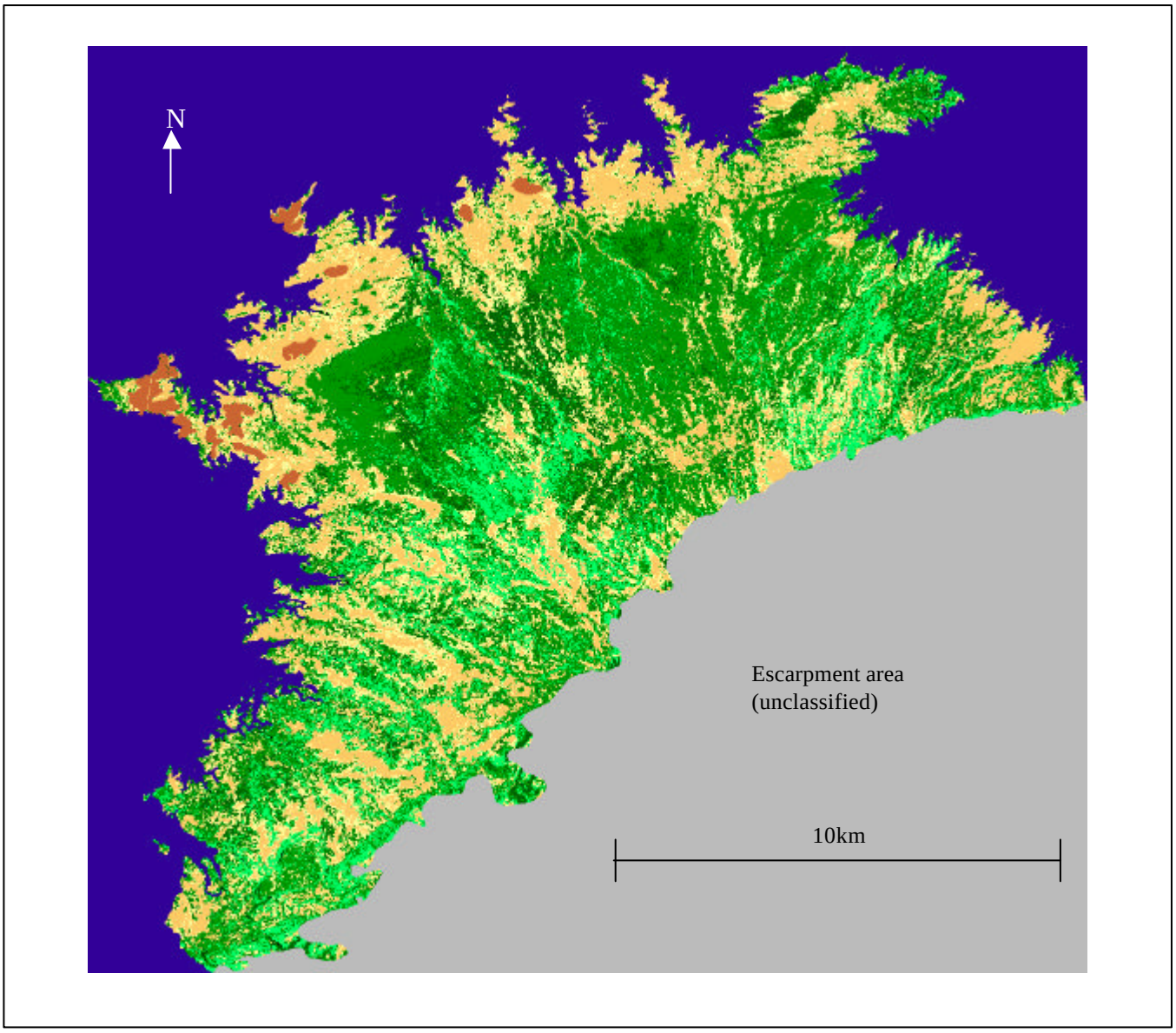


Figure 2: Vegetation map of Matusadona National Park (Source: Purchase, 2004)
The vegetation was classified into five vegetation classes: wooded grassland ( ); Mopane (*Coleospermum mopane*) woodland ( ); Mopane/*Combretum* spp./*Terminalia* spp. Woodland ( ); *Combretum* spp. jesse bush ( ) and *Karomia tatensis* jesse bush ( )

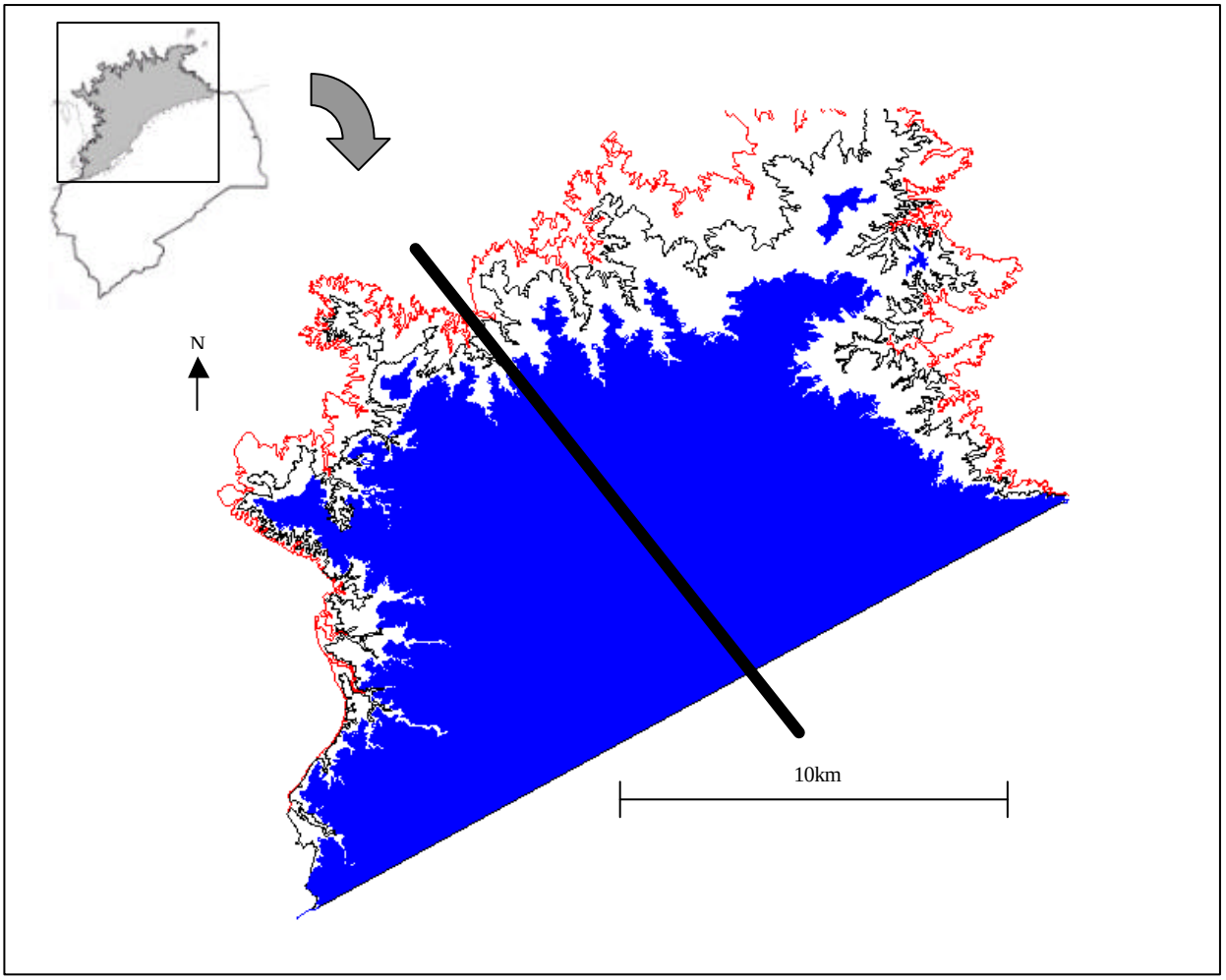


Figure 3: Contour map of Lake Kariba, where the lake forms the boundary of Matusadona National Park, illustrating the differences in the area exposed at different lake levels between the eastern and western sections of the Park (demarcated by the black line). The three contour lines represent 487m.s.l (the "treeline", area shaded in blue), 470 m. s. l (black line) and 455 m. s. l (red line). Source: Purchase (2004)

Evaluation

Population size and structure

Methodology

A total of 17 cheetahs of known age and sex were originally introduced into MNP (Zank, 1995). In addition, identification marks had been recorded for some of the founder animals. The last 20cm of a cheetah's tail is a unique "finger print", with each cheetah having a different pattern of black and white stripes. In 1998, using this founder population information, a system of collecting information from the users of the park was developed to determine the number of cheetahs in the valley floor area (Purchase 1998). Tour operators, PWMA rangers and tourists were given sighting sheets to fill in, one sheet for each sighting of cheetah. Information recorded included time of day, date, location (as accurately as possible), the number of cheetahs seen, age classes, sex, identification marks and activity (see Figure 4). This data was then cross-referenced to separate out different individuals and groups, and a total population estimate was made (Purchase 1998). The same method was used to estimate the size of the lion population in 1999 (Purchase 2004) and data for cheetah was also collected during this period.

During this study, it was recognised that the number of public users of the Park had decreased dramatically since the 1998 study, due to the reduction of tourists currently visiting the country. It was possible to distribute sighting sheets to a limited number of users, but it was felt that this was not sufficient to accurately assess population size. A new method of estimating population size has been developed for the current study, using counts of spoor/tracks of cheetah to estimate population size (Funston per comm; Stander 1998; Global Cheetah Forum Census Workshop, 2004). This method relies on the presence of people who can accurately identify the spoor of cheetah, separate out adults from juveniles and assess the age of the spoor, as only fresh (<24hr) spoor can be used in the calculations. During this study, three experienced trackers were available and they identified all the spoor included in the estimates of population size.

The spoor count method also relies on determining the relationship between true density and spoor density (Stander 1998). In MNP, sightings of cheetahs had been regularly reported by Spurwing Safari Lodge in a specific area of the valley floor. These sightings were cross-referenced to determine the minimum number of cheetah present in this calibration area, using the same system as in the 1998 study. The number of cheetah estimated by sightings was then used to determine the relationship between the true density and the spoor density for the calibration area. It was then assumed that this relationship would be the same throughout the valley floor area of MNP.

A total of five spoor counts were carried out during the dry season period of this study (May to August 2005), each count consisting of five spoor transects spread throughout the valley floor (Table 1). The counts were conducted within a 24 hr period to prevent double counting, and the start and end points of each transect were determined randomly, resulting in different transect lengths (Table 1). Spoor counts were carried out using the roads and major game trails in the valley floor. Transects were either driven at a speed between 15-20km/hr with two trackers sitting on the front of the vehicle recording fresh spoor, or were walked with two trackers recording fresh spoor (Table 1). The number of spoor seen on each transect was recorded as adult or juvenile.

Table 1: Summary of the spoor counts carried out to determine cheetah (and other large predators) population size in Matusadona National Park, May to August 2005. ***L = length of transect (km); D = transect driven, W = transect walked***

Transect	Month									
	May		June		July		Aug		Aug	
	L	D/W	L	D/W	L	D/W	L	D/W	L	D/W
1	14.7	D	6.7	D	5.7	D/W	7.3	W	7.0	D
2	11.6	D	5.3	D	5.3	D	7.8	D/W	7.0	D
3	4.2	D/W	8.0	D/W	6.9	D	10.2	D	6.2	D
4	12.2	D	5.0	D	4.0	W	4.1	D	5.8	D
5	9.5	D	11.2	D	17.3	D	4.2	D	7.5	D
Total	52.2	-	36.2	-	39.2	-	33.6	-	33.5	-

1. **Date:** _____ 2. **Time of Day**: _____

3. **Location**: _____

Grid location _____

4. **Species** (circle species seen)

Lion Hyaena Cheetah Leopard

5. **Distance that animal was from observer** _____m

6. **Number of animals seen** Total _____

Adults _____ Juveniles _____ Males_____ Females _____

7. **How did you find the animals** (circle appropriate)

On foot Vehicle

8. **Habitat type** (circle appropriate)

Open grassland Mopane scrub Mopane/Combretum/Terminalia

Jesse bush Riverine

Other _____

9. **Activity of the animal** (circle appropriate)

Walking Resting Hunting Eating

Prey species killed _____

10. **If this is a lion sighting, please record the following;**

(a) The name you give this pride. _____

(b) Distinguishing features of any of the animals (e.g. scars, broken ears, colour of mane)

_____

Figure 4: Page from the sighting booklets given to users of Matusadona National Park to record details of predator sightings between April 2004 and September 2005. Originally used by Purchase (1998) and Purchase (2004)

When calculating overall spoor density and relating it to cheetah numbers, the valley floor was divided into five subsections, based on cheetah sightings and the knowledge of cheetah movements gained during the 1995 (Zank, 1995) and 1998 (Purchase, 1998) studies (Figure 5). The average adult spoor density over the five spoor counts was calculated for each subarea and then related to the number of cheetahs for the subarea. Each subarea was then added together to give a total adult population for the valley floor. Only adult spoor were used as juveniles may not have been sufficiently represented in the sample, given that young cheetah do not always follow their mothers.

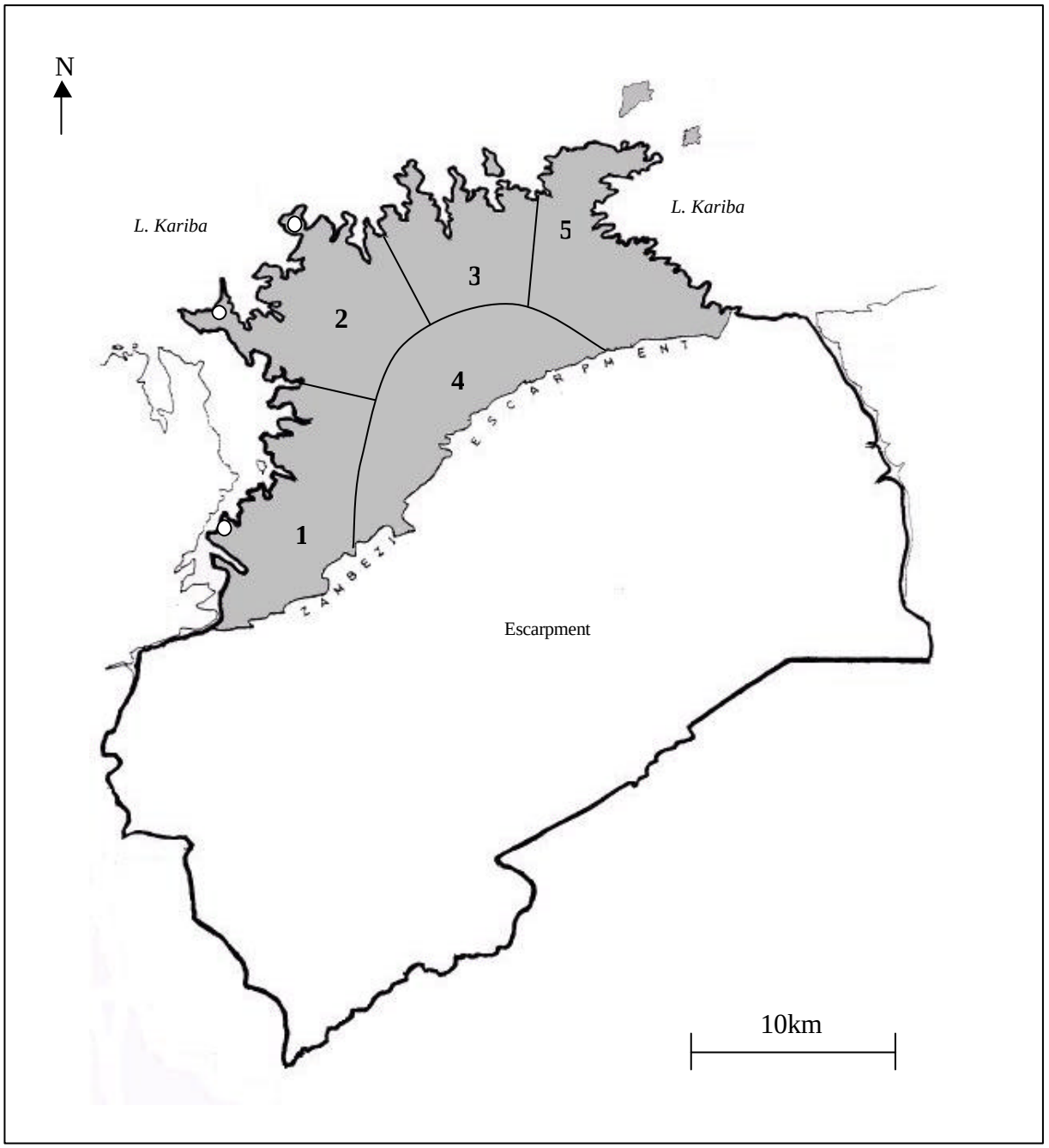


Figure 5: Map indicating the subareas used to determine spoor density of the large predators of Matusadona National Park between May and August 2005. Subarea 5 was used as the calibration area. White circles indicate sightings of cheetahs (May 2004 – August 2005) other than within the calibration area

Results

A number of sightings were reported during the study period, mainly from the Spurwing Safari Lodge guides. From April 2004 – April 2005 a total of 24 sightings of cheetah were reported by Spurwing in their game viewing area (sub area 5, Figure 5). Cross-referencing these sightings separated out a coalition of three males and a female with a sub adult. Other sightings from the valley floor included two adults in the Tashinga area in mid 2004 (Sub area 2, Figure 5), a group of six adults in the Muuyu area (Sub area 2, Figure 5) and a female with three sub adults on the lakeshore near the Kashansva river (Sub area 1, Figure 5). It seems that the group of six may have been a female with sub adults that then dispersed as no more sightings of this group were reported after June 2004.

The average densities for each subarea varied from 0 spoor/km to 0.2532 spoor/km (+/- 0.1460). Using the calibration area it was calculated that a spoor density of 0.0379 spoor/km related to one group of cheetah (Table 2). Spoor density was related to groups rather than individuals as the calibration area had a coalition of three males that moved together, but spoor of only one male would have been recorded on a spoor count. The cheetahs present in the calibration area were divided into two groups, one consisting of three males and the other a female with sub adult. As only adult density was being determined, this gave an average group size of two adults. Hence, the relationship between spoor density and true density was assumed to be 0.0379 spoor/km equated to 2 adults.

Using the relationship between spoor density and number of adult cheetah present in the calibration area, the total number of cheetah estimated to be present in the valley floor area of MNP was 20 (+/- 12). Cheetahs were more numerous closer to the foreshore area of the valley floor, and appeared not to utilise the area at the base of the escarpment (sub area 4, Figure 5). The number of cheetah present in the western areas of the valley floor (sub areas 1 and 2, Figure 5) were less than the eastern and central areas close to the foreshore (sub areas 3 and 5, Figure 5)

Table 2: Spoor densities for the 5 subareas used to calculate the cheetah population size of the valley floor areas of MNP in the dry season (May to Aug) of 2005. ***Spoor density was related to number of cheetah groups present assuming a relationship of 0.0379 spoor/km to 1 group. Average group size was assumed to be 2 adults based on the data from the calibration area***

Month	**Spoor/km (s.e.m) Sub Area**					**Total**
	1*	**2**	**3**	**4**	**5****	
May	0	0	-	0,0	0	
June	0, 0.1887	-	0	0	0.0893	
July	0	0	0.5000	0	0.0578	
August	0	0	0.5128	0	0.0980	
August	-	0.1429	0	0,0	0.1333	
Total Spoor Density	0.0378 (0.0377)	0.0357 (0.0357)	0.2532 (0.1460)	0	0.0757 (0.0757)	
Estimated cheetah groups	1 (1)	1 (1)	6 (3.5)	0	2 (1)***	
Estimated cheetah numbers	**2 (0 - 4)**	**2 (0 – 4)**	**12 (8 –20)**	**0**	**4 (2 –6)**	**20 (10 – 32)**

*** Numbers correspond with those in Figure 5**
**** Area used for calibration**
***** 2 groups of cheetah were known to be present. This data was then used to calculate the number of cheetahs present in the other subareas**

The population of cheetahs in Matusadona since the re-introduction has varied from the 17 originally introduced in 1994 (14 adults and three sub adults; Figure 6) to 17 estimated to be present in 1998 (13 adults and four subadults, 28 sightings; Figure 6), 12 estimated in 1999 (9 adults and 3 subadults, 34 sightings; Figure 6), 16 estimated in 2000 (eight adults and eight subadults, 22 sightings; Figure 6) and 20 adults in 2005 (spoor survey data; Figure 6). What is interesting to note is that the number of subadults recorded increased from 1998 to 2000 suggesting that juvenile mortality was decreasing (Figure 6). The three sightings of six cheetahs in one group also suggests that juvenile mortality was decreasing as these animal were probably a cohort of cubs.

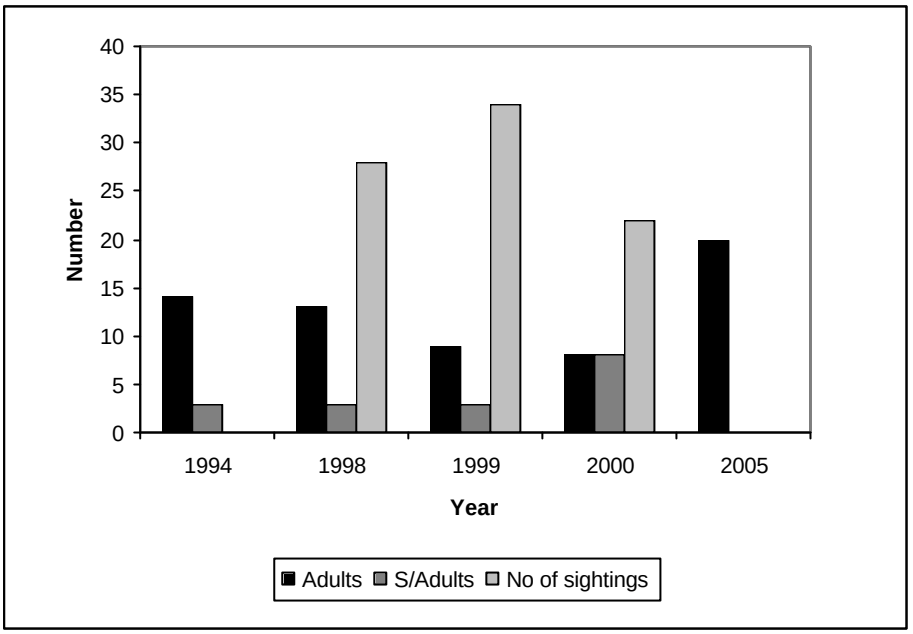


Figure 6: Changes in the cheetah population of Matusadona National Park (valley floor section) since the re-introduction in 1994 until August 2005. A different method of estimating numbers was used in 2005 that did not allow for an estimate of sub adults to be made (see text for details). Source data: 1994 (Zank, 1995), 1998 (Purchase 1998) 1999 and 2000 (Purchase 2004), 2005 (This study)

Prey availability

Methodology

When re-introducing a predator species to an area, one of the requirements of the IUCN Re-introduction Specialist Group is that there should be sufficient prey to support a viable population of the re-introduced species (IUCN Reintroduction Specialist Group, 1998). In an area where other predators are already present, it is even more important to determine prey availability to assess the potential for adverse competitive effects.

There was no estimate made of prey populations in Matusadona National Park prior to release but estimates were made in 1995 (Zank, 1995), 1998 (Purchase and du Toit, 1998) 1999 and 2000 (Purchase, 2004) of species known to be killed by the predators present (lions, spotted hyaenas, leopards and the re-introduced cheetahs). All these estimates were made using the same method. Road transects were driven in the woodland area of the valley floor, with the same transects being used in 1998, 1999 and 2000 to estimate prey numbers. Each transect was 5km in length and animals were recorded within a 15-20m band on either side of the road. All animals present within this band were counted, and no measure of distance was made to each individual animal. The nature of the vegetation and the reaction of the prey species to the presence of vehicle violated the assumption of the Distance sampling method, as it was not possible to determine if the position of the animal when seen by an observer had been unaffected by the presence of the observer (Buckland et al 1998, Purchase 2004). Calculations of each density were done twice, by dividing the number of prey seen within the transect area by using a 15m band and then a 25m band, and then averaging the two estimates. As the 1995 data had indicated that prey densities were highest near the foreshore, the woodland habitat of the valley floor area was stratified into two strata, close to the foreshore and close to the escarpment. More transects were driven in the former than the latter.

As the foreshore area was variable in extent and the road network limited, block counts were used to estimate prey numbers in this area of the valley floor. Locations within the foreshore area were chosen randomly, and blocks were marked out using the treeline and other distinguishing features such as anthills and tree stumps. It was possible to determine the area of each block counted at any given date by determining the lake level for that date, and the contour map developed by Purchase (2004; Figure 3). The density of each prey species was then calculated by dividing the number of prey seen within the block for that count, by the calculated foreshore area. Non-parametric tests were used to test for differences in densities between the woodland and foreshore habitats as the data were not normally distributed due to the high numbers of zero counts.

To determine prey population sizes 10 years after release, the same road transects and blocks that were used in 1998, 1999 and 2000 were used again, to enable comparison of data.

Road transects and block counts are not considered suitable for gregarious species such as buffalo. To estimate the number of this species, sample aerial counts were carried out in 1995 and 1998, and total counts in 1999 and 2005. Total counts had previously been done from 1974 to 1988, providing a 30 year dataset for buffalo numbers in the valley floor area of MNP.

Results

During this monitoring project a total of 43 transects were driven and 43 blocks counted between September 2004 and September 2005. Impala were seen on 19 transects and 21 blocks, kudu were only seen in the woodland on nine transects, waterbuck were only seen in the foreshore on four blocks, warthog were seen on two transects and four blocks, zebra were only seen on the foreshore on three blocks, and bushbuck and duiker were only seen in the woodland on five and two transects respectively.

Densities of impala appeared to be highest on the foreshore, but there was no significant difference between the densities recorded on the foreshore and those in the woodland, whether close to the foreshore or close to the woodland (Woodland/Foreshore: Mann Whitney Test: $W = 1765.0$, $p = 0.3243$, adjusted for ties; Woodland Close/Foreshore: Mann Whitney Test: $W = 1544$, $p = 0.1657$, adjusted for ties; Woodland Far/Foreshore: Mann Whitney Test: $W = 1335$, $p = 0978$, adjusted for ties).

It was not possible to test for differences in the other prey species as they either occurred only in one habitat, or sample sizes were too small to enable a meaningful comparison.

Prey densities of species other than buffalo appeared to have changed little since the cheetahs were re-introduced into the valley floor area (Table 3). Impala are most abundant, especially on the foreshore, with kudu and warthog being the next most abundant species (Table 3). Numbers of zebra and waterbuck have always been recorded as low, and these two species occur mainly on the foreshore (Table 3). Duiker and bushbuck are present in the woodland but numbers seem relatively low (Table 3).

However, buffalo numbers have declined dramatically since the re-introduction of cheetahs (Figure 7), and it appears that the decline had already begun before the cheetahs were re-introduced in 1993 (Figure 7). Although cheetah do not prey on buffalo, changes in this prey species population would have affected the larger predators such as the lion and hyaena which prey on buffalo both directly and indirectly. A reduction in one of their main prey species could result in increased competition with the re-introduced cheetahs over the remaining prey species.

Table 3: Comparison of cheetah prey densities in two habitats (woodland and foreshore) in the valley floor area of Matusadona National Park in 1995, 1998, 1999-2000 and 2005. NS = not seen, S = seen but sample size too small to estimate density (Source: Zank, 1995, Purchase 1998, Purchase 2004, This study).

Prey species		Density (animals/km^2)			
	Habitat	1995	1998	1999-2000	2005
Impala	Woodland Close	12.7	20.05	25.71	9.57
	Woodland Far			8.74	23.33
	Foreshore	142.16	270	148.00	140.00
Kudu	Woodland Close	0.23	0.61	1.09	4.26
	Woodland Far			1.71	
	Foreshore	0.04	NS	NS	NS
Zebra	Woodland	NS	NS	S	NS
	Foreshore	4.39	NS	NS	0.375
Waterbuck	Woodland	NS	0.34	S	NS
	Foreshore	0.635	1.00	NS	0.374
Warthog	Woodland	0.71	NS	NS	0.698
	Foreshore	NS	NS	NS	6.180
Duiker	Woodland	0.49	NS	NS	1.163
	Foreshore	NS	NS	NS	NS
Bushbuck	Woodland	NS	NS	NS	0.465
	Foreshore	NS	NS	NS	NS

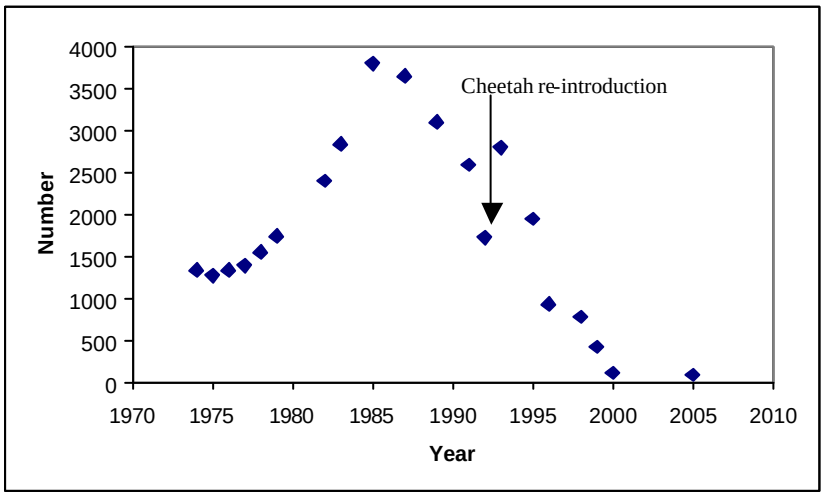


Figure 7: Changes in the buffalo population of the valley floor area of Matusadona National Park from 1974 to 2005. Data were collected using total aerial counts and aerial surveys. Data for the years 1974 – 1993 from Taylor (1985); data from 1995 - 2000 available from Purchase (2004), 2005 (This study)

Potential competitors

Methodology

When cheetahs were first released into Matusadona National Park, estimates of other large predator populations were not available. It was known that lion, spotted hyaenas and leopards were present, and anecdotal evidence suggested that the lion population was relatively high (Anon, 1994). At the time of the release, work carried out in the Serengeti was indicating that the presence of lions and spotted hyaenas could be significantly detrimental to the survival of cheetah populations, as the two species can cause high levels of juvenile and adult mortality, directly and indirectly (Laurenson, 1994; Zank, 1995; Durant *et al*, 2004).

It was decided to determine the population size of both lions and hyaenas in the valley floor section of the Park during the immediate post release monitoring project, in order to establish whether these two species could have an adverse effect on the survival of the cheetah. (Zank, 1995). Population estimates were also made during the 1998 monitoring project, which was carried out to assess the success of the re-introduction after a five-year period (Purchase, 1998). In 1999 and 2000, lion and spotted hyaena numbers were estimated as part of the study to determine the competitive effect between the two species (Purchase, 2004). All these studies estimated lion numbers using cross referencing of lion sightings and hyaena numbers by recording the number of animals responding to broadcasts of hyaena vocalisations (Zank, 1995; Purchase 1998, Purchase 2004).

During this latest study to evaluate the re-introduction it was not possible to use sightings of lions as the number of visitors, and consequently of tour operators in the Park, had reduced dramatically. However, since the 2000 study, the spoor survey method to estimate large predator numbers had been developed (Stander, 1998; Funston per comm) and it was decided that this would be suitable. Two calibration areas existed to determine the relationship between spoor density and true density, and experienced trackers were available to determine the different spoor. Lion spoor were recorded while driving or walking the same transects as used to estimate cheetah numbers (see Table 1). It was decided to use the same method to determine hyaena numbers, but unfortunately it was not possible to calibrate the spoor density with a true density as there was no reliable calibration area. Hence, an estimate of hyaena population size is not available for 2005, but anecdotal evidence suggests that the hyaena population has increased since 2000, as predicted by Purchase (2004).

Results

A number of sightings were reported during the study period, mainly from the Jenje area (subarea 3, Figure 5) and the area used by the Spurwing Safari Lodge guides (subarea 5, Figure 5). From April 2004 – Sept 2005 a total of 55 sightings of lion were reported by users of the Park. Cross-referencing these sightings in subareas 3 and 5 (Figure 5) separated out a pride comprising one adult male, one adult female and three cubs, and a second group of seven adults

Table 4: Spoor densities for the 5 subareas used to calculate the lion population size in the valley floor area of MNP in the dry season (May to Aug) of 2005. ***Spoor density was related to number of lion prides present assuming a relationship of 0.0947 spoor/km to 1 group. Average group size was assumed to be 4.5 adults based on the data from the calibration area***

Month	**Spoor/km (s.e.m) Sub Area**					**Total**
	1*	**2**	**3****	**4**	**5****	
May	0.163	0	-	0,2381, 0.1724	0	
June	0, 0	-	0.125	0	0.7143	
July	0	0	0	0	0	
August	0	0	0.769	0.2439	0	
August	-	0	0	0,0	0	
Total Spoor Density	0.0326 (0.0326)	0 0	0.2236 (0.184)	0.0935 (0.0449)	0.1427 (0.1430)	
Estimated lion groups	1 (1)	0	2 (2)***	1 (1)	2 (2)***	
Estimated lion numbers	**5 (0 - 5)**	**0**	**9 (5-18)**	**5 (0-5)**	**9 (2 –6)**	**28 (5 – 13)**

*** Numbers correspond with those in Figure 5**

**** Area used for calibration**

**** * 2 prides of lions were known to be present. This data was then used to calculate the number of lions present in the other subareas**

Other sightings from the valley floor included five adults in the Tashinga area that were seen regularly from May 2004 to Dec 2005 (subarea 2, Figure 5), and a group of four adults and one cub in the Muuyu area which were reported from early 2005 (Subarea 2, Figure 5). This latter group is probably the same pride that was seen between May and Dec 2004. There were also several sightings throughout the valley floor of single male and female adults, but as pride structure in MNP is known to be fluid (Purchase, 2004) it is likely that these single animals are part of the groups already identified.

The average densities for each subarea varied from 0 spoor/km to 0.2236 spoor/km (+/- 0.1840). Using the two calibration areas it was calculated that a spoor density of 0.0947 spoor/km related to one pride of lions (Table 4). Spoor density was related to prides rather than individuals, but it must be noted that this may have resulted in an overestimation of the lion population given the fission-fusion nature of lion prides in MNP (Purchase, 2004). Spoor recorded during the surveys may have been from individuals rather than groups. However, it was not possible to detect if the spoor came from an individual, and sightings from the calibration areas were mainly of prides so the relationship used had to be assumed to reflect the number of prides, rather than individuals. The calibration areas had two prides, one of two adults, the other of seven, and so an average pride size of four adults was used in the calculations. Hence, the relationship between spoor density and true density was assumed to be 0.0947 spoor/km equated to 4.5 adults. When calculating the final population sizes, areas with an odd number of prides, the number per pride was rounded up to five adults.

Using the relationship between spoor density and number of adult lion present in the calibration area, the total number of lion estimated to be present in the valley floor area of MNP was 28 (with a minimum estimate of 10, and a maximum of 41, Table 4). Lion distribution appeared to be fairly uniform, although from historical records from Spurwing Safari Lodge, the number of lions in the eastern area of the Park (Sub area 5) declined to almost none at the end of 2004, and this area appeared to have since been colonised by the two prides recorded there in 2005.

As mentioned previously, it was not possible to determine hyaena numbers from spoor density as there was not a reliable calibration area. The data from the spoor transects also suggested that hyaenas utilised the roads and the major game trails more than would be expected randomly as spoor density was very high, and every transect recorded hyaena spoor.

Using data from the 1995, 1998, 1999 and 2000 studies, it can be shown that apart from a small increase between 1995 and 1998 lion numbers have declined since the re-introduction of cheetahs into the valley floor area, and quite dramatically between 1998 and 2000 (Figure 8). Hyaena numbers also declined during the same period (Figure 8). As indicated previously in this report, the number of adult cheetahs also declined until 2005, when the population estimate indicated an increase. This appeared to coincide with the decline in lion numbers after a lag period. Unfortunately it is not possible to analyse the relationship between cheetah numbers and hyaena numbers, except that Purchase (2004) indicated that hyena numbers had declined with the lion population, probably as a result of indirect competition. Whether they have since increased is not clear, and requires further investigation.

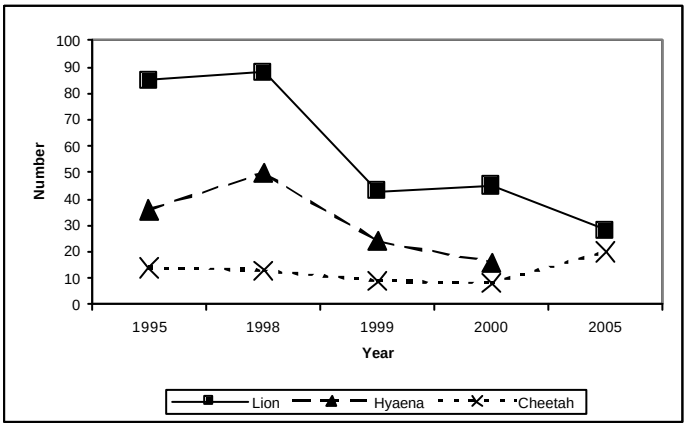


Figure 8: Changes in the populations of lions (squares), spotted hyaenas (triangles) and cheetahs (crosses) in the valley floor area of Matusadona National Park from 1995 to 2005. (Sources: Zank 1995; Purchase, 1998; Purchase 2004; This study)

Human-cheetah conflict

Methodology

The cheetahs that were re-introduced into Matusadona National Park were captured on private ranchland where cheetahs were regarded as problem animals because they killed livestock. Although the captured cheetahs were not known to be problem animals, as the capture had to be carried out opportunistically, there was a danger that the "problem" of livestock predation may have been transferred from the ranches where the cheetahs were captured to the communal farming areas surrounding MNP.

A questionnaire survey to determine attitudes of the subsistence farmers in the communal areas surrounding MNP to wild dogs and other large predators was conducted in 1998 by Davies and du Toit (2004). The results of this survey included a report of a cheetah killing four goats, but none of the respondents reported cheetahs as problem animals (Davies and du Toit, 2004). However, given that the survey was conducted to determine attitudes to wild dogs, and that it was carried out after a relatively short period of time since the re-introduction, it was felt necessary to carry out a questionnaire survey to determine attitudes towards cheetahs.

The questionnaire survey was conducted in the communal areas surrounding MNP between Oct 2004 and July 2005 to determine how often cheetahs were seen, how many livestock animals were reported to be killed by cheetahs and whether the farmers in the area were aware of the re-introduction. As far as possible, the survey mirrored that conducted in 1998 by Davies and du Toit (2004) to enable comparison of responses. The questionnaire consisted mainly of open-ended questions (see Appendix 1), and the survey was carried out using interviews with individuals and groups. The interviewer spoke the local language fluently so there was no need for interpretation. As identification of predators can be difficult, each individual or group of respondents was shown a collection of photographs of the predators included in the questionnaire before the interview was conducted. The interviewer then recorded on the questionnaire whether the respondent (s) had identified each predator species correctly.

As with the 1998 survey, household were chosen from Village Development Committees (VIDCOs) within wards, with the same VIDCOs being surveyed where possible. In total 140 questionnaires were filled in using the interview method, and the survey covered nine wards, and 30 VIDCOs (Table 5). The wards included in the surveyed were those around the boundary of MNP.

Table 5: Summary of wards and VIDCOs included in the questionnaire survey conducted to determine attitudes of subsistence farmers to cheetahs. The survey was conducted between Oct 2004 and July 2005. Shaded VIDCOs indicate that these areas were included in a similar survey carried out in 1998 by Davies (1998)

		VIDCOs surveyed (no of households)			
Ward no	**Ward Name**	**1**	**2**	**3**	**4**
1	Gache Gache	Nyamhunga (5)	Mudzimu (5)		
2	Mola A	Dundwe (5)	Dobe (5)	Chitenge (5)	
3	Mola B	Marembera (5)	Kauzhumba (5)	Mayovhe (5)	
4	Nebiri A	Maya (5)	Biri (5)	Bangara (5)	
5	Nebiri B	Kasvisva (5)	Chifudze (5)	Manhanga (5)	Chikuro (5)
6	Msampakaruma A	Chidyamugwamu (5)	Mahubu (5)	Nyamapanza (5)	Marova (5)
7	Msampakaruma B	Chiweshe (2)	Gunyuwe (2)	Cheduri (1)	
8	Kanyati A	Hurenje (5)	Chebere (5)	Kadziro (5)	Nyajena (5)
9	Kanyati B	Chitete (5)	Makenje (5)	Kamanywandi (5)	Nyadara (5)

Results

The questionnaire recorded whether the respondent had seen any of the following predators: lion, cheetah, leopard, wild dog, spotted hyaena or jackal. In addition it gave provision to record other predators that had been seen. A number of respondents were unable to differentiate between cheetah and leopard and did not identify them correctly. Hence, if these respondents indicated that they had seen cheetahs and/or leopards, this information was recorded under the heading of "cheetah/leopard" as the animal seen could have been either species.

Cheetahs were correctly identified as having been seen in three wards (Mola A, Nebiri A and Msampakaruma A, Table 6) and five other wards had respondents that did not correctly identify cheetah but reported that they had seen them (Mola A, Gache Gache, Nebiri B, Msampakaruma A and B, Table 6). All the wards surveyed had respondents that had sighted every species of predator included in the questionnaire, except Kanyati A and B where no cheetahs or wild dogs were reported, and Gache Gache where no jackals were reported seen.

Table 6: The number and percentage of respondents reporting sightings of lion, cheetahs, leopards, spotted hyaenas, wild dogs, jackals and baboons during a questionnaire survey carried out between Oct 2004 and July 2005.

Predator spp	Wards surveyed (no of respondents)											
	Mola A & B (30)		Nebiri A & B (35)		M/karuma A & B (25)		Kanyati A & B (40)		Gache Gache (10)		Overall (140)	
	No	%	No	%	No	%	No	%	No	%	No	%
Lion	10	33	10	29	5	20	2	5	7	70	34	24
Spt Hyaena	7	23	12	34	4	16	7	18	8	80	38	27
Leopard	5	17	4	11	5	20	8	20	2	20	24	17
Leop/Cheet	2	7	4	11	2	8	0	0	2	20	10	7
Cheetah	1	3	1	3	2	8	0	0	0	0	4	3
Wild dog	4	13	6	17	1	4	0	0	1	10	12	9
Jackal	13	43	9	26	6	24	6	15	0	0	34	24
Baboon	17	57	5	14	5	20	4	10	7	70	20	14

Overall, few respondents reported seeing cheetahs, whether they had correctly identified the photographs or not (Table 6). There were more sightings reported in the wards to the west of MNP than the east, where only two respondents reported having seen what was classified as "leopard/cheetah" (Figure 9). Overall, more respondents reported seeing spotted hyaenas than the other predator species (Table 6). However, lions and jackals were also reported relatively frequently (Table 6).

The livestock kept by the farmers in the communal lands was found to be similar to that reported by Davies and du Toit (2004) during the 1998 survey (Table 7). Chickens were kept by almost all the respondents (Table 7). Goats and donkeys are common livestock species throughout the wards surveyed (Table 7). This pattern reflects the pattern found during the 1998 survey (Davies and du Toit, 2004). However, it appears that more cattle, sheep and pigs were kept in 1998 than at the time of this study (Table 7). The number of respondents with dogs was reported to be high in both surveys (Table 7) but only cats were reported as kept in the 1998 survey (Table 7).

The pattern of livestock losses was also found to be similar to the 1998 survey, with lions being the main predator, taking two of the most common livestock species, goats and donkeys (Table 8, Figure 10). However, there were more losses reported during the 1998 survey, and the spectrum of wild predator species was also broader during the 1998 survey. During the 2004-2005 survey only four predator species were recorded as major problem animals (lions, baboons, leopards and spotted hyaenas) whereas the 1998 survey identified nine problem species (lions, baboons, leopards, spotted hyaenas, crocodiles, eagles, honey badgers, jackals and wild cats; Davies and du Toit, 2004).

In the 1998 survey cheetahs were only reported to have killed four goats, and in the 2004-2005 survey no reports of cheetahs killing livestock were reported (Table 8). This reflects the reports of actual sightings of cheetahs during the latter survey (Table 7). As that cheetahs and leopards were often confused (Table 7), the reports of livestock killed by leopards may include some killed by cheetahs. However, in both surveys the farmers did not perceive cheetahs to be problem animals (Table 8; Davies and du Toit, 2004).

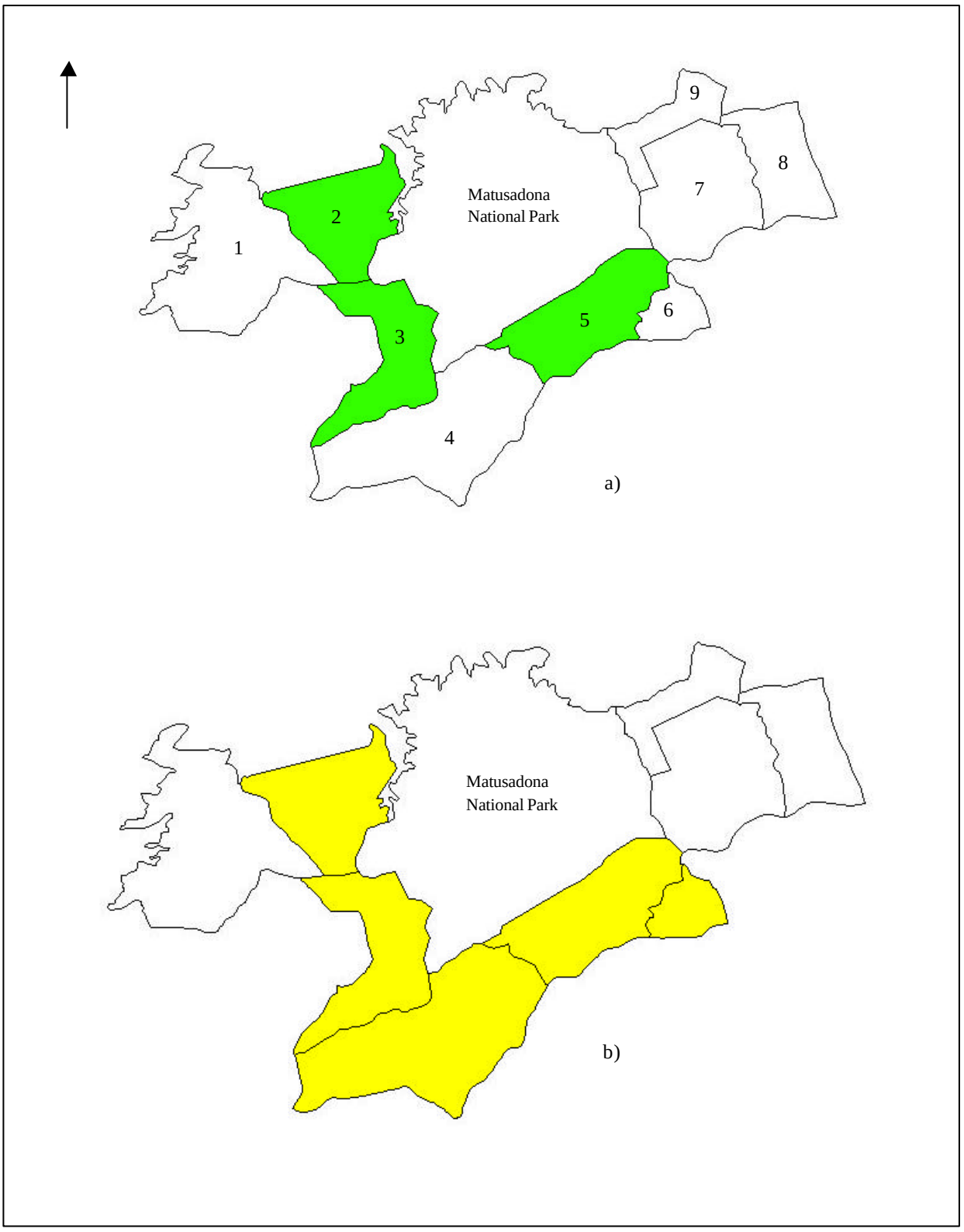


Figure 9: Sighting of cheetahs reported during a questionnaire survey of households in 9 wards surrounding Matusadona National Park, 2004 –2005. a) sightings reported by respondents who correctly identified cheetah b) sightings by respondents who confused cheetah and leopard. Ward names: 1 = Mola A, 2 = Mola B, 3 = Nebiri A, 4 = Nebiri B, 5 = Msampakuruma A, 6 = Msampakuruma B, 7 = Kanyati A, 8 = Kanyati B and 9 = Gache Gache.

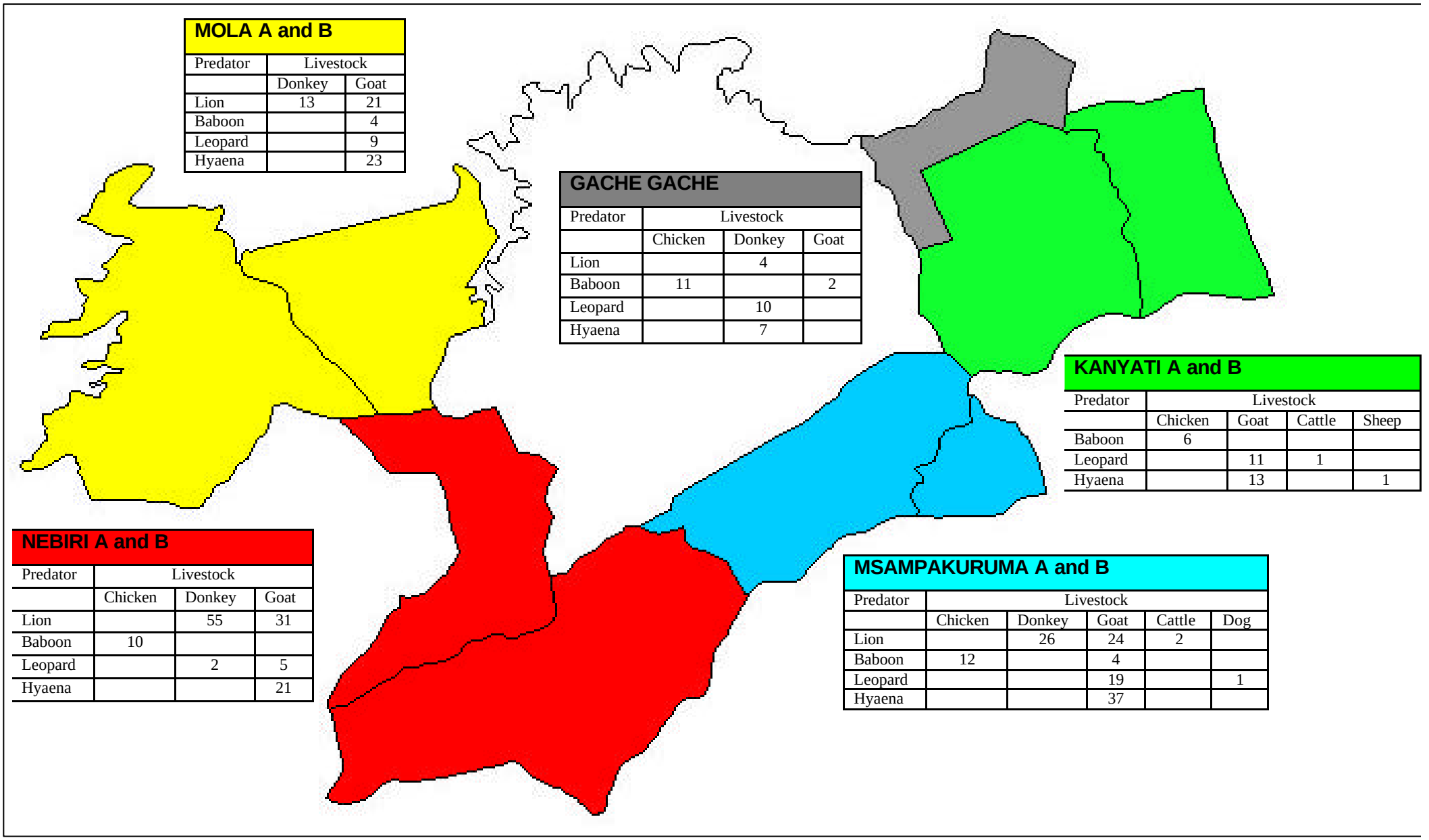
Table 7: The percentage of respondents keeping various livestock species in the wards surveyed during 1998 (italics) and 2004-2005 (normal). ***Source of 1998 data – Davies and du Toit (2004)***

Livestock spp	Percentage of respondents (number of respondents)											
	Mola A &B (30)		Nebiri A & B (35)		M/Karuma A & B (25)		Gache Gache (10)		Kanyati A & B (40)		Overall (140)	
Chickens	*100*	90	*100*	89	*100*	84	-	70	-	70	***100***	**81**
Goats	*91*	67	*97*	69	*93*	76	-	80	-	75	***94***	**72**
Donkeys	*29*	50	*100*	47	*93*	52	-	60	-	45	***72***	**47**
Ducks	-	3	*42*	7	*36*	-	-	10	-	-	***25***	**3**
Cattle	-	20	*35*	3	*39*	12	-	-	-	70	***24***	**26**
Pigeon	-	-	*19*	-	*18*	-	-	-	-	-	***12***	**-**
Sheep	*9*	3	*13*	-	-	-	-	20	-	5	***8***	**4**
Pigs	-	-	*10*	-	-	-	-	-	-	8	***3***	**2**
Guinea fowl	-	-	*6*	3	*14*	-	-	20	-	-	***6***	**2**
Dogs	-	57	*61*	43	*57*	24	-	10	-	65	***38***	**48**
Cats	-	-	*23*	-	*14*	-	-	-	-	-	***12***	**-**

Table 8: Reports of livestock losses to wild predators in nine wards surrounding the Matusadona National Park. Losses were recorded during questionnaires surveys conducted in 1998 (Davies and du Toit, 2004) and this study (between Oct 2004 and July 2005). Data from the 1998 survey is included in italics.

Predator species*	Number of losses reported for each livestock species													
	Chickens		Goats		Donkeys		Ducks		Cattle		Sheep		Dogs	
Lion	-	-	*282*	76	*115*	98	-	-	*3*	6	*8*	-	-	-
Leopard	-	-	*44*	44	-	12	*3*	-	-	-	-	-	*3*	3
Spotted hyaena	-	-	*41*	94	*3*	-	*7*	-	-	-	-	2	*7*	-
Wild dog	-	-	*10*	-	-	-	-	-	-	-	-	-	-	-
Cheetah	-	-	*4*	-	-	-	-	-	-	-	-	-	-	-
Baboon	*114*	46	*148*	15	-	-	-	-	-	-	-	-	-	-
Jackal	*24*	-	*3*	1	-	-	*3*	-	-	-	-	-	*6*	-

* During the 1998 survey, crocodiles, eagles, honey badgers, snakes and wild cats were also reported to have killed livestock



MOLA A and B

Predator	Livestock	
	Donkey	Goat
Lion	13	21
Baboon		4
Leopard		9
Hyaena		23

GACHE GACHE

Predator	Livestock		
	Chicken	Donkey	Goat
Lion		4	
Baboon	11		2
Leopard		10	
Hyaena		7	

KANYATI A and B

Predator	Livestock			
	Chicken	Goat	Cattle	Sheep
Baboon	6			
Leopard		11	1	
Hyaena		13		1

NEBIRI A and B

Predator	Livestock		
	Chicken	Donkey	Goat
Lion		55	31
Baboon	10		
Leopard		2	5
Hyaena			21

MSAMPAKURUMA A and B

Predator	Livestock				
	Chicken	Donkey	Goat	Cattle	Dog
Lion		26	24	2	
Baboon	12		4		
Leopard			19		1
Hyaena			37		

Figure 10: Distribution of livestock reported killed by predators in 9 wards surrounding Matusadona National Park during a questionnaire survey (2004-2005)

Almost 50% of the households surveyed did not take any measures to protect their livestock (Table 9). The most common method of protection reported was to keep dogs near kraals (33% of households surveyed), with some respondents reporting that they kraaled their animals at night and also strengthened these kraals at times of the year when predation was more intense (during calving seasons). Only one ward reported having electric fences around their homesteads, and this was constructed under the CAMPFIRE programme.

Table 9: Anti-predator livestock management techniques used by households in 9 wards surrounding Matusadona National Park, 2004-2005. Methods were recorded during a questionnaire survey.

Anti-predator strategy	Percentage of respondents in each ward					Overall
	Mola A & B	Nebiri A & B	M/kuruma A & B	Kanyati A & B	Gache Gache	
No measures taken	57	37	44	60	10	**47**
Keeping dogs	73	11	12	23	80	**33**
Report to council	33	34	4	5	10	**19**
Kraaling livestock at night	3	6	12	15	50	**12**
Strengthen kraals	7	6	16	5	10	**8**
Electric fence around village	0	0	0	0	100	**7**
Using thorns around kraals	7	7	12	0	20	**6**
Herding animals during day	3	3	0	0	10	**3**
Noise to scare away predators	0	3	4	0	0	**1**
Fires around kraals	0	3	0	0	0	**1**

Only six respondents reported that they had knowledge of the translocation of cheetahs to MNP with most people interviewed indicating that they were not aware of the project (Table 10). Attitudes to the presence of cheetah varied substantially between the wards surveyed, with respondents in the wards on the western boundaries being more tolerant of the cheetah than those on the eastern boundaries (Table 10). The reasons given by respondents for their attitudes are listed in Table 11. Respondents with a negative attitude appeared to be primarily concerned with the threat cheetah pose to their livestock, and the lack of revenue from the presence of cheetah in their area. Respondents with either a positive or indifferent attitude reported that the presence of cheetah was advantageous because of the potential for increased revenue, or because they liked wild animals and wanted their children to be able to see them.

Table 10: Respondents knowledge of the translocation of cheetah to Matusadona National Park and attitudes towards cheetah.

Ward	Knowledge		Attitude			How did you find out?
	Y	N	Positive	Negative	Don't mind	
Mola A & B	1	24	11	0	13	Worked for PWMA*
Nebiri A & B	4	33	11	7	15	Meetings Saw an increase in numbers From relatives Workshop
M/kuruma A & B	0	22	2	12	7	
Kanyati A & B	1	39	3	18	18	Worked in MNP**
Gache Gache	0	10	2	3	6	

* PWMA = Parks and Wildlife Management Authority

** MNP = Matusadona National Park

Table 11: Summary of reasons given by respondents for their attitude towards the presence of cheetahs on their farmland during a questionnaire conducted in 9 wards surrounding Matusadona National Park between Oct 2004 and July 2005.

Attitude	Reason given
Positive	We have no livestock
	They will add dividends through tourism
	We have had no problems with cheetahs
	More wild animals means more money
	Our children will also see cheetahs
	Have not seen cheetahs and would like to
	We would like other people to see cheetahs
	We like wild animals
	We can live with predators
	We are far from the Park boundary and they are unlikely to move here
	There are so many people here that cheetahs are unlikely to come
Negative	Wild animals must be kept separate from people
	They must stay in the Park otherwise they will kill our goats
	No hunters hunt cheetahs so we will not get money from them
	We are not getting any returns from hunting at the moment
	Is there any way we can benefit from having cheetahs?
	Introduce them elsewhere as they will kill our goats
	They will attack people
	We are living very well without wild animals

Conclusion

Establishment of a viable population

The re-introduction of cheetahs into Matusadona National Park was an experimental exercise carried out in response to the conflict situation that had developed on private commercial ranchland. There was no feasibility study carried out either at the source or release end, and the cheetahs translocated were captured opportunistically.

However, since the re-introduction, the released population of cheetahs has been monitored regularly, enabling the success of the project to be evaluated. Soon after release, the movement patterns of the cheetahs were large and erratic (Zank, 1995) and a number of individuals moved out of the Park boundaries, resulting in one animal being killed in a snare. Subsequent monitoring five years after release found that these erratic movements appeared to have stopped, and the home ranges were confined to the Park and were much smaller than initial home ranges (Purchase and du Toit, 2000). Ten years after release, most sightings were still within the confines of the Park, especially the valley floor section, suggesting that this area was adequate for the cheetah population. The data collected suggest that the cheetah population initially declined from the time of release until 1999 (Figure 6), as the number of adults recorded was lower than the number originally introduced, and litter sizes were relatively small. However, since 1999 it appears that juvenile survival rates increased as the number of reported cubs increased, resulting in an increase in the population (Figure 6). As life expectancy of cheetahs in the wild is estimated to be about 6-7 years (Caro, 1994), all the cheetahs seen in the recent monitoring study would have been born in the Park.

It is not clear why there should have been an initial decline in the cheetah population followed by an increase. The changes in the availability of prey to the cheetahs should have been beneficial rather than detrimental, as impala have remained abundant, kudu have increased and the other prey species populations have remained stable (Table 3). The only ungulate species population that has altered significantly since the re-introduction is the buffalo (Figure 7), and cheetahs do not kill this prey species.

In 1995, Zank (1995) argued that given the relatively high density of lions in the Park, the re-introduced cheetah population would suffer high levels of juvenile mortality and the chances of persistence were low. In a follow up study in 1998, Purchase (1998) argued that, given the nature of the woodland habitat, the cheetahs in the Park would be able to avoid interactions with lions to a large extent, and that the adverse competitive effect would be reduced, enabling the population to persist. Other studies of cheetahs in Africa have shown that cheetahs can survive very successfully in woodland habitat (Mills *et al*, 2004). However, since 1998, due to a number of years of above average rainfall, the water level of Lake Kariba has been very high, resulting in a substantial decrease in the foreshore habitat (refer to Figure 3). As this foreshore habitat was found in both 1995 (Zank, 1995) and 1998 (Purchase and du Toit, 2000) to be the favoured hunting area for the introduced cheetahs, the reduction in this habitat could have affected the survival of both adult and juvenile cheetahs. The rainfall pattern altered in 2001, and the amount of foreshore habitat has been more extensive since then, perhaps favouring an increase in the cheetah population.

As cheetahs have been significantly affected by the presence of lions and hyaenas, the changes in the latter two species in MNP, may explain the initial decline and subsequent increase in the re-introduced cheetah population. At the time of the re-introduction, the valley floor area of the Park had the second highest density of lions recorded in protected areas (Zank, 1995, Figure 8) and this was still the case in 1998 (Purchase, 1998, Figure 8). However, with the dramatic decline in the buffalo population (Figure 7), the lion population of the valley floor area has also decreased from 87 adults in 1998, to 28 adults recorded during this study (2005, Figure 8). The period during which the cheetah population declined coincides with the small increase in the lion population, and the subsequent increase appears to be correlated to the decline in the numbers of lions reported since 1999 (compare Figures 6 and 8). It may be that lions were impacting on cheetahs either directly by killing cubs, or indirectly by limiting the areas in which cheetahs were able to utilise. The hyaena population also declined, apparently coincidentally with the increase in the cheetah population. The translocation can only be termed a success, given the assumption that the cheetah population only persisted due to a change in its competitors. In the absence of more detailed behavioural data regarding the interaction between cheetahs and lions/hyaenas, this cautionary approach has to be adopted.

Conflict with surrounding farming communities

As the cheetahs were released into the Park without a full feasibility study being carried out, surrounding communities were not consulted, and no evaluation was carried out of the possible effects of releasing cheetahs from an area where they had been taking livestock to an area surrounded by farmers with small livestock. Only six respondents indicated that they had any knowledge of the translocation (Table 10).

However, it appears from the questionnaire surveys conducted in 1998 and 2005, that introducing cheetahs in MNP has not resulted in increased conflict between cheetahs and humans in the surrounding subsistence farming areas. Very few sightings of cheetahs were reported in the 2005 survey (Table 6), and most of these were in the areas where movement from the Park is relatively easy (Figure 9). On the western and southern boundaries of the Park, especially at low lake levels, there are few topographical obstacles to animal movement. On the eastern side, there is a steep sided and permanently flooded gorge that presents a significant obstacle to animal movement. As cheetahs are only seen where they are likely to be temporarily moving out of the park, the population does not appear to have expanded into the surrounding farmland.

The main problem predator appears to be lion, reported to kill the most livestock both in the 1998 survey and the 2005 survey (Table 8, Figure 10). Hyaenas and leopards were also reported as killing a number of livestock species. The observation that leopard appear to be problem animals in most wards is a cause for concern, given that many respondents were not able to differentiate between cheetah and leopards (Table 6, Figure 9). Farmers may assume that leopards, not cheetahs, are killing livestock. Interestingly, attitudes towards cheetahs appear to reflect the frequency of sightings, with farmers in area where cheetahs have been seen being more tolerant than in areas where no cheetahs have been seen (Table 10 and 11, Figure 9). These results are encouraging as they suggest that where farmers live with cheetahs they have realised that cheetahs are not a threat either to themselves or their livestock. In areas where the cheetah is essentially an unknown, the potential threat is perceived to be high.

The re-introduction of cheetahs into MNP can add to available data concerning the factors that increase the success of re-introductions;

- The cheetahs released were wild caught, emphasising the fact that the success of a translocation is more likely if the released animals are wild caught. (Griffiths *et al* , 1989);
- The cheetah population in the source area was reported to be increasing, suggesting that the species was doing well. The establishment of a viable population in MNP supports the argument that translocations are more successful if individuals are caught in areas where the species is thriving rather than declining (Griffiths *et al* , 1989);
- Given the decline in the two major competitor predator species, it is not possible to determine if the translocation of cheetah into MNP would have been successful regardless of the status of the two competitors. Hence, the data from this translocation cannot add any more information to the theory that the presence of competitors decreases the chances of success (Griffiths *et al* , 1989);
- As only 17 animals were released, it seems that the number of animals needed to establish a viable population may be smaller than has been argued previously. Prior to this study, literature suggests that for large mammalian species, about 20-40 animals need to be release to ensure the success of the translocation (Griffiths *et al* , 1989);
- The cheetahs released into MNP were kept in a boma for 6-8 weeks (the project adopted the "soft-release" approach). However, despite this boma period, post release movements were observed to be very large (Zank, 1995, Purchase and du Toit, 2000). It appears that large post release movements should always be anticipated regardless of whether the animals have been kept in an enclosure, and of the period of time the animals are kept captive prior to release (Linnell *et al*, 1997; Bradley *et al*, 2005). Further evaluation of the length of the time animals are kept in enclosures and the extent of post release movements is necessary to enhance the success of future translocations.

Recommendations

The re-introduction of cheetah into MNP can be argued to have been a success as a viable population has been established. It appears that the woodland habitat of the Park, the abundance of prey species preferred by cheetahs and the decline of competitor species all contributed to the establishment of the re-introduced population. The data collected over the last 10 years also indicate that the area of the Park is large enough to sustain the cheetah population, as there are few indications that the population has expanded into the surrounding farming land. The

fact that the population has not expanded has also meant that the problem of cheetahs preying on livestock has not been transferred from the source area to the release area.

If the establishment of the cheetah population has been as a result of a decline in the two potential competitor species, lion and hyaena, then the three species need to be monitored into the future. The decline in the lion population is attributed to the decline in the buffalo population (Purchase 2004); therefore, changes in the latter could result in an increase in the lion population. Such an increase could have a detrimental effect on the survival of the newly established cheetah population. This latest monitoring study suggests that the buffalo population is no longer declining (Figure 7), and the situation needs to be monitored further.

Given the uncertainty about the reasons for the increase in the number of cheetahs in the Park since 1999, the cheetah population should be monitored further to determine if it will increase to the point where it disperses into the surrounding communal land. At present there is no conflict between humans and cheetahs, primarily because there are few cheetahs in this area. If the cheetah population in MNP expands and moves into the surrounding areas, conflict could increase.

Is translocation a possible management tool?

It is extremely unfortunate that no monitoring of the sources of the translocated animals was carried out to determine if the capture and removal of cheetahs had reduced livestock losses. If the effectiveness of translocations as a management tool to mitigate conflict while ensuring survival of the national cheetah population is to be fully evaluated, the source of future translocations must be monitored to the same extent as the released population.

In 1998, Purchase (1998) argued that although the establishment of a population had been achieved in MNP, cheetah conservation efforts should focus on mitigating conflict *in situ*, as the re-introduced population in MNP was unlikely to increase to a large, nationally important size. She argued that the abundance of cheetah on farmland indicated that it was prime habitat for the species, compared to protected areas where numbers had always been relatively few. The cost of translocation at the time of her study was not justified in terms of the numbers of cheetahs conserved.

This more recent study has indicated that the cheetah population in MNP could grow to be quite substantial although this hypothesis is made on the assumption that competition with other predators was the initial constraining factor, and that it is a factor that is unlikely to become significant again. The survival of the released cheetahs and the persistence of the MNP population suggests that other translocations into protected areas where cheetahs have been recorded as transients or existing in low numbers could be possible.

In addition, the recent land use changes in Zimbabwe have increased the threat to the survival of the cheetah population outside protected areas. When the 1998 monitoring study was carried out, there were still large tracts of land in the country under extensive cattle and/or game ranching. It was in these areas that most cheetahs were reported, either as problem animals or beneficial game species. Since 2000, these large tracts of commercial farmland have been rapidly converted to small-scale subsistence livestock farming, with dramatic losses in resident game species. In areas that could have been prime habitat for cheetahs, there is now concern that: -

1. the wild prey base of the species has been rapidly eroded, making the population vulnerable.
2. conflict with humans, and subsequent persecution of the species, have increased to the point where the population may not longer be viable, and *in situ* efforts to conserve the species unrealistic.
3. linking the presence of cheetahs to material benefits is almost impossible as tourism (both consumptive and non-consumptive) opportunities are extremely limited. Under previous agricultural systems, opportunities for landowners to benefit from the presence of cheetahs were numerous.

A number of initiatives are still attempting to achieve co-existence between cheetah and the new landowners, and some of them are making progress. However, there may well be an increasing need for cheetahs to be relocated from farmland to protected areas to maximise the national population. The lessons learned from the translocation to MNP suggest that such programmes should focus on moving cheetahs to protected areas where the numbers of their competitor species are relatively low.

However, choosing protected areas with woodland habitat and a diversity of prey could offset the potentially adverse effects of competitor species. Large protected areas should be utilised in view of the post release movement patterns that are likely to occur, to avoid conflict with surrounding communities. Although ideally at least 20 cheetahs should be released as a founder population, the MNP project has shown that releasing fewer

than 20 can still result in the establishment of a viable population. The cheetahs do not all need to be released at the same time, and the staggered releases into MNP (over a two year period) probably contributed to the success of the project.

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Appendix I – Questionnaire

Questionnaire to farmers in areas surrounding Matusadona National Park

Date: ……

Time taken ……. To ……

Questionnaire # ……

Area # ……..

Respondent details:

Group survey or individual? ……
Village …….
Name of household head? ……Age …… Sex …….
How many households are there in this place? ……..
How long have you lived here? ……..
Where did you live before you came here? ……

1. Livestock details:

a) Do you keep any livestock? Yes ……. No …….
b) If yes, what kind of livestock do you keep (include number if possible)
Cattle ……..Donkeys……..Goats……Sheep……..Pigs……..Chickens……..
Other ……

2. Frequency of predator sightings

a) Which predators do you see in your area? (Show pictures to establish ability to correctly identify each predator)
Lion …… Correct……
Hyaena ….. Correct ……
Leopard …..Correct ……
Cheetah ….. Correct ……
Wild dog ….Correct……
Jackal ……. Correct……
Other ……..

b) How often do you see them?
Lion …… Daily …… Weekly…….. Monthly……Very seldom
Hyaena ….. Daily …… Weekly…….. Monthly……Very seldom
Leopard ….. Daily …… Weekly…….. Monthly……Very seldom
Cheetah ….. Daily …… Weekly…….. Monthly……Very seldom
Wild dog …. Daily …… Weekly…….. Monthly……Very seldom
Jackal ……. Daily …… Weekly…….. Monthly……Very seldom
Other …….. Daily …… Weekly…….. Monthly……Very seldom

3. Predation of livestock by predators

a) Do wild animals ever take your livestock? Yes …… No ……
b) If yes, which animals are responsible (show pictures to establish ability to correctly identify each predator)

Lion …….Correct? ……..
Species killed (include numbers if possible) Cattle …….
Donkeys ……
Goats ……
Sheep……
Pigs ……..
Chickens ……..

Hyaena …….Correct? …….
Species killed (include numbers if possible) Cattle …….
Donkeys ……
Goats ……
Sheep……
Pigs ……..
Chickens ……..

Leopard …….Correct?……..
Species killed (include numbers if possible) Cattle …….
Donkeys ……
Goats ……
Sheep……
Pigs ……..
Chickens ……..

Cheetah …….Correct?……..
Species killed (include numbers if possible) Cattle …….
Donkeys ……
Goats ……
Sheep……
Pigs ……..
Chickens ……..

Wild dog ……. Correct?……..
Species killed (include numbers if possible) Cattle …….
Donkeys ……
Goats ……
Sheep……
Pigs ……..
Chickens ……..

Jackal ……. Correct?……
Species killed (include numbers if possible) Cattle …….
Donkeys ……
Goats ……
Sheep……
Pigs ……..
Chickens ……..

Other …….
Species killed (include numbers if possible) Cattle …….

Donkeys ……
Goats ……
Sheep……
Pigs ……..
Chickens ……..

c) What do you do to prevent predators from killing your livestock?

……
……

d) Is there a compensation scheme for livestock losses in your area? Yes…… No…….
Who do you apply to? …….
Why do you apply to them?
……..
Are you satisfied with the method you apply for compensation? Yes ……. No…….
Why? ……
……..

4. Conservation and impacts of re-introduction

a) Do you know that cheetahs are endangered animals? Yes ……. No……
b) Do know any other endangered animals that live in your area?
……..
c) How do you know that these animals are endangered?
……
……
……
d) Did you know that cheetahs were released into Matusadona National Park in 1994?
Yes …….. No……..
How did you know? …….
e) How do you feel about having cheetahs in your area?
Positive ……. Negative…….. Don't mind ……
Why do you feel this way?
……
……
……

5. Comments about the interview

……

……

……

……