

Hofmeyr M, van Dyk G. 1998. Cheetah introductions to two north west parks: case studies from Pilanesberg National Park and Madikwe Game Reserve. Proceedings of a Symposium on Cheetahs as Game Ranch Animals, Onderstepoort, 23&24 October 1998; 71 p.

Keywords: 1ZA/Acinonyx jubatus/cheetah/habitat selection/Madikwe Game Reserve/Pilanesberg National Park/population dynamics/prey/re-introduction

Abstract: Two major introductions of wild free-ranging cheetah have taken place in the North West Province. Case histories of the re-introduction of cheetah into both Pilanesberg National Park and Madikwe Game Reserve are given including population demographics, prey and habitat selection. Combined detail on re-introduction techniques and recommendations for future introduction efforts are given.

CHEETAH INTRODUCTIONS TO TWO NORTH WEST PARKS: Case studies from Pilanesberg National Park and Madikwe Game Reserve

Markus Hofmeyr^a and Gus van Dyk^b

Abstract - Two major introductions of wild free-ranging cheetah have taken place in the North West Province. Case histories of the reintroduction of cheetah into both Pilanesberg National Park and Madikwe Game Reserve are given including population demographics, prey and habitat selection. Combined detail on reintroduction techniques and recommendations for future introduction efforts are given.

CASE STUDY - PILANESBERG NATIONAL PARK

Population history

Pilanesberg National Park covers ca. 55 000 ha. Formerly farmland, it was proclaimed in 1979. Operation Genesis followed which resulted in the introduction of over 6 000 head of game - the largest game translocation exercise ever undertaken at the time.

A full complement of wildlife was introduced which included 18 species of antelope, giraffe, zebra, buffalo, hippo, black and white rhino and elephant. An early cheetah introduction was attempted in 1981/82 when seven cheetah were introduced from the De Wildt Cheetah Breeding Station (Pilanesberg Game Reserve Annual Report, 1981/82). This early attempt was apparently successful and the cheetah soon began breeding. A decision to remove the animals was taken soon after, however, as the animals were apparently selecting the young of some species which were still at low densities such as waterbuck and tsessebe. Seven animals were removed (J. Wilby, personal communication) and only a coalition of three males were spared and allowed to roam the park.

Over time, as game population levels increased, the progeny of the re-stocked game were in turn used to restock five new Bop Parks as well as to generate income through hunting and cropping. As the park matured and the tourist infrastructure was developed a predator re-introduction programme was again initiated. Most prey species had reached a high density in the Pilanesberg when it was decided to re-introduce lions during 1993.

Following the success of the lion introduction programme it was decided to expand the cheetah population in Pilanesberg. In February 1995 the first group of seven cheetahs (one female with four males and one female cub and one adult male) arrived in Pilanesberg from the Africat Foundation, Namibia.

During January 1996, a second consignment of cheetah arrived from Namibia, again through the Africat Foundation. This group consisted of a male coalition (three males) and one female and her all male litter of five cubs.

In December 1997 a third adult female was introduced. Once again the animal was supplied from the Africat Foundation in Namibia.

Pilanesberg therefore has released three adult females and ten cubs. One solitary and one coalition of males were added to the coalition still resident in Pilanesberg after 12 years. Both females lost

^a Field Ecologist and Veterinarian, Madikwe Game Reserve, North West Parks & Tourism Board, PO Box 4124, Rustenburg, 0300, South Africa

^b Field Ecologist, Pilanesberg National Park, North West Parks & Tourism Board, PO Box 4124, Rustenburg, 0300, South Africa

cubs shortly after release. The cubs that died were almost certainly killed by the parks other predators (lion, leopard and brown hyaena). One observation of an adult male lion running down a sub-adult cub was made. At least one cub was known to have been seriously wounded while hunting warthog however and disappeared shortly thereafter. Both females therefore successfully raised three cubs to independence. One female cub survived and has produced her first litter. The other cubs have formed two coalitions of two and three respectively. Once the cubs were independent, both females conceived and gave birth to their second litters. Lions killed the first female reintroduced and her litter of four unsexed cubs was thus lost. The loss of this female prompted the introduction of the third adult female. The second female has raised three cubs, which are nearly independent. Only one cub is known to have disappeared from this litter, however it may have been more.

The male coalitions also fluctuated following release. The resident male coalition which were at least 14 years old slowly diminished over the first year following the reintroduction of lion. This could not be ascribed to lions directly however. At the time of the introduction of the new male only one original male was thought to be surviving. The second introduction of males (three male coalition) was rapidly reduced to one survivor.

At present the Pilanesberg population is therefore

Adult females	1 + 1 + 1	= 3
Dependant cubs	3 + 4 + ?	= 7
Males	3 + 2 + 1 + 1	= 7
TOTAL POPULATION 08/98		= 17

Post release movements and habitat selection

Following release all animals appeared to wander widely. All animals appeared to move to the northern reaches of the reserve, spending long periods on the fence line. During this period the cheetah frequently used the fence for hunting. The movement of cheetah to the northern boundary of the park could be in response to high lion densities in the centre of the reserve or else an effort to move back in the direction from where they came. Movement back into the park was probably in response to localised prey depletion. Most animals finally settled in areas of high prey frequency. Despite the fact that these areas are also the areas of highest lion density. Female home ranges are ca. 200 km². The males range over smaller areas of ca. 100 km².

The cheetah appear to prefer the flat pediment grasslands in Pilanesberg, but are however frequently located on the plateau's and slopes which are a feature of the reserve.

Prey selection

During the first year in Pilanesberg the first female reintroduction was observed on 16 kills (Table 1). It was assumed that all animals that the cheetah was found with was killed by her and/or her maturing cubs.

Table 1: Prey selection of adult female cheetah and 4 sub adult cubs

SPECIES	NUMBER	PERCENTAGE
Warthog	7	43.75
Impala	2	12.50
Waterbuck	1	6.25
Springbok	2	12.50
Gemsbok	1	6.25
Hartebeest	1	6.25
Kudu	1	6.25
Mountain reedbuck	1	6.25
	16	100.00

Subsequent observations have revealed similar prey selection for other cheetah. Male coalition prey species have included sub adult zebra and a three to four year old eland bull. A single male was observed chasing, killing and eating an adult baboon (unsexed).

Of special mention is the arrival of a tawny eagle adult in the Pilanesberg shortly after release of the cheetah. Tawny eagles are very rare in Pilanesberg. The tawny eagle was found perched in the vicinity of the cheetah for *ca.* two weeks following their release obviously benefiting from their frequent kills.

Tourism

Game drive sightings of cheetah during first year following introduction show that four months following their release (August 1995) *ca.* 8 % of game drives viewed cheetah. By November nearly 20 % of all people taking game drives in Pilanesberg were seeing cheetah. With very few exceptions, this viewing was based entirely on the one adult female and her surviving cubs. During the late summer of 1995/96, probably as a result of the long grass and thickening bush, the viewing figures drop to around 5 %. Following the next introduction in April 1996, the viewing doubled from 5 % to over 10 %. This viewing was not sustained, however, and the viewing dropped again to around 6 %. Towards the spring, this figure rose to around 20 % and the pattern continued. During the period of observation, a doubling of cheetah numbers (through introduction) did not double the frequency of sightings of cheetah.

The proximity of the Pilanesberg to the densely populated Gauteng region as well as its well developed tourism infrastructure means that it has developed into a popular destination for local tourists. The absence of malaria and proximity to the Sun City complex is also attracting foreign tourists. Both local and foreign tourists rank viewing of spotted cats high on a "would like to see" scale. Cheetah can be seen as excellent tourist animals as they are diurnal and favour lightly wooded to open grassland habitat, thus making them easier to view. They also hunt and feed predominantly during daylight. They often use roads to move through the park and habituate easily. They also present little danger to humans hanging out of vehicles or on foot.

CASE STUDY - MADIKWE GAME RESERVE

Introduction

Madikwe is a 60 000 ha game reserve, proclaimed in 1991, in the northwestern corner of the North West Province. The reserve is managed by the North West Parks and Tourism Board (former well-known Bop National Parks). The objective of the reserve is to create a positive socio-economic environment for an otherwise economically depressed and rural part of the North West Province. The reserve intends to achieve this objective by attracting private ecotourism ventures within the state-run reserve.

With this objective in mind, the former Bop National Parks embarked with the largest translocation operation of game in the world. "Operation Phoenix" was the code name for this incredible task. Almost all the recorded larger mammals were exterminated by the beginning of the century. Without animals such as predators and elephant, the reserve would not have been able to attract private investment.

Part of "Operation Phoenix" was the introduction of all larger predators, which formerly roamed the area. Lion, spotted hyaena, African wild dog and cheetah were all introduced. This article will briefly describe the technique and a post release data of the cheetah introduced into Madikwe.

Objectives of cheetah introduction in Madikwe

Cheetah were immediately on the list of larger predator species to be introduced. Very infrequent records existed of a group of four males living in Madikwe at the time of its proclamation. There was therefore living proof that cheetah occurred in the park.

The terrain in Madikwe does not lend itself to random off-road driving. This would result in very few cheetah sightings from the lodges. Cheetah, unlike the lion and wild dog, do not use the roads frequently. Their sightings in Madikwe would be limited to chance sightings or finding them with

the aid of telemetry equipment. In view of the objectives of Madikwe, it was important to improve on cheetah sightings because they rated high on visitor viewing lists. If cheetah sightings improved it would make the reserve and its lodges more marketable for local and foreign visitors. Cheetah also kill frequently and solitary animals kill just as many or marginally less than groupings of cheetah. It was therefore imperative for Madikwe to have cheetahs that were visible and that some idea of their post release behaviour was recorded. The technique for introducing them is described below. The technique was developed to try to manipulate the introduction of the cheetah to fit into the greater objective of Madikwe Game Reserve.

Introduction technique

All predators introduced into Madikwe were placed in a 1 ha holding boma before release into the main reserve. The boma is securely fenced with steel Bonnox wire and electrified. The boma is considered predator proof. There were a number of reasons for this exercise:

1. To ensure that all animals were in good health after their translocation from other areas.
2. Expose the new predators to electric fencing. The perimeter of the park is electrified and it would have disastrous consequences for the relationship between the park and its neighbours if any predator escaped from the park. It is very likely that the predators are exposed to the electric strands at some stage or another during their stay there. The presumption is made that through a negative experience with the electrified fence in the boma, this would serve as sufficient 'training' for the predator not to challenge the perimeter fence. To date this method of 'fence training' our reintroduced predators has proven to be very successful with no predator breakouts recorded.
3. Allow the new predators to be exposed to game viewing vehicles. Active habituation takes place with vehicles driving around the fence in full view of the predators within the boma. It must be stressed that only vehicles are allowed at the boma and not people on foot. The reason for this is that the management of Madikwe does not want any animals for that matter to be habituated to people on foot. Habituation is aimed at vehicles only. Predators are only released when they are sufficiently relaxed with vehicles. To date this habituation process has also proven to be very successful. Most predators are viewed easily within the park.

All cheetahs were released by luring them out of the holding boma with a carcass. Each group, which was introduced, had a radio collar fitted to one individual of the group.

Post-release monitoring was done using a radio telemetry receiving device (Telonics TR4 receiver). Radio telemetry readings were taken randomly at a variety of different set points in the park. Occasionally closer observations were done on the individual cheetah groups by locating them with the aid of the telemetry equipment. Any sighting of cheetah recorded by park personnel and game drive vehicles was recorded.

Summary of post release monitoring data of introduced cheetah

All except two male cheetahs introduced into Madikwe came from Africat in Namibia. Most introduced cheetah were caught on farms in Namibia where they were going to be destroyed otherwise. The two males mentioned above were two brothers born in Phinda Resource Reserve. Only one cheetah was semi tame and that animal also came from Africat. All other cheetah introduced were of wild caught origin.

1994:

October 1994 – one adult female and her two six month old cubs (one male and one female) were translocated from Africat in Namibia. A radio collar was placed on the mother. Very sporadic recordings exist of her because her collar was very weak and she was an extremely shy female. No active habituation took place with the first two groups of cheetah due to staff limitations. Both of these groups were very wild after release compared to other groups that were actively habituated.

The cubs split from their mother in 1996 and their fate is not known because no definite sightings exist of them. There is a very good possibility that these two cubs are roaming the park on their own, the female most likely has her own cubs presently.

The mother was found dead inside a water reservoir in November 1997. No definite diagnosis on the actual cause of death was made but it appears like she drowned after falling into the reservoir. She survived for three years in Madikwe. This female had been recorded widely across the park but most frequent observations were from the southwest of the park.

November 1994 - three male coalition was introduced. They moved over a large portion of the reserve but were eventually recorded most frequently in the central-south and western areas of the park. The three males stayed together initially. After a few months one of the males disappeared. Then in December 1996, the collared male was killed by another predator. His skull had a fatal penetration wound. The fate of the third male is not known. This group survived only for a year within Madikwe.

November 1994 - one hand-raised male was introduced at the same time as the above animals. He also came from Africat in Namibia. They were not placed into same holding facilities. This animal injured itself soon after release and could not fend for itself. It eventually started limping badly and had to be fed. It found one of the lodges (Madikwe River Lodge) and started harassing people there. He chased a few staff members and was becoming a problem. This animal was then captured in January 1995 and given to De Wildt Cheetah and Wildlife Centre.

1996:

January 1996 - a two male coalition was translocated from Phinda Resource Reserve. They were two brothers born in Phinda from parents introduced to the reserve from Namibia. These two males were incredibly habituated. This was the reason for introducing these two cheetah because cheetah sightings were very infrequent in Madikwe. The two males proved to be very useful in Madikwe. They could, however, only be located with the aid of the telemetry equipment.

Despite the difficulty of finding these two cheetah without telemetry equipment they still offered the best viewing of cheetah in the park. They completely ignored the vehicles. Their home range was also established very quickly and comprised roughly a third of the park (ca. 20 000 ha).

The collared male was found dead (only his collar was recovered) in November 1996. Sightings of an injured single male were also recorded shortly after the recovery of the collar. It is therefore assumed that both these males have been killed. They survived for 10 months in the reserve.

January 1996 - an adult female and four male cubs (6 months old) were introduced to Madikwe after the release of the above-mentioned males. The five cheetahs came from Africat in Namibia. The female had a traumatic eye injury, which resulted in the loss of her right eye. She arrived with the injury at Madikwe. She managed to raise her four cubs successfully despite the handicap of having only one functional eye. She also managed to elude fatal competition with other predators such as spotted hyaena and lion. Her cubs split from her in the middle of 1997. The males were ca. 2 years old when they went off on their own.

The four male cubs are sighted regularly and have become the best cheetah for viewing in the park. Their habituation to vehicles was achieved because vehicles were allowed to view them while they were in the boma and following them frequently once they were released. Their mother always remained shy but the occasional contact with vehicles without any negative interaction did set the atmosphere for good viewing once they split from their mother. At the time of writing they were still alive and are the only known reintroduced cheetah still to be alive.

The adult female was found dead in November 1997. She had been killed and had two puncture wounds in her skull. It is not known whether she had been killed by a cheetah or another predator species. She had survived in the park for 19 months.

1998:

January 1998 - an adult female with three 18-month-old male cubs and one 8-month-old female cheetah were introduced into Madikwe. The adult female and the males came from Africat in Namibia. The young female came from the Thabazimbi district where she had been trapped on a farm. This introduction was experimental in nature. It was attempted to forge a bond between the orphaned female cheetah and the group from Namibia. All five cheetah were placed into a small

boma and fed together. Unfortunately the age gap seemed too large and the four male cubs would not accept the young female. They would not allow her to get to the carcasses, which were fed to them. It is interesting to note that even the adult female was hostile towards the youngster and hissed and growled at her when she came too close. The cheetah did not, however, try to kill the young cub outright. The small cub had to be fed separately and after two weeks she was recaptured and sent to De Wildt Cheetah and Wildlife Centre. She would not have had any survival chances in Madikwe on her own.

The four remaining cheetah were released. The group was seen soon after their release and appeared to be coping with their new living environment. Ten days after their release the female was found on her own and the three males was only recorded once, close to their release site. No additional records exist of the young males and they were not collared either. The carcass of the mother was found two weeks after her release. She had obviously been killed by another predator. Only her collar and skull were recovered. No puncture marks were found in her skull. It is assumed that the three males have also died because no sightings of them have been recorded since January 1998 and they had limited hunting skills when they were released.

In summary: 19 cheetah have been introduced to Madikwe since 1994. Of these only six cheetah are definitely still known to be alive of which two animals were sent to De Wildt. The only confirmed surviving reintroduced animals in Madikwe are the four males introduced with their mother in January 1996. Five confirmed mortalities were recorded between two weeks to three years after the release of the different groups of cheetah.

An assumption is made that in male coalition groups the disappearance of a member of the group meant that the animal was dead. Cheetah coalitions rarely separate (Gus Mills, personal communication). With this assumption in mind all the introduced males, bar the four young adults from the 1996 introduction, have been killed or have died. All three radio-collared adult females introduced have died or were killed.

Natural population in Madikwe

As mentioned initially, cheetahs were recorded naturally in Madikwe when the reserve was established. At that stage only four males were recorded and the total resident population was estimated at four. The park management considered it important to augment the small resident cheetah population with introduced animals. With time and increased effective monitoring it became apparent, however, that there was in fact a healthy population of resident cheetah in the park. An exact number of resident cheetah is not known but from sightings of the same groupings the following estimate is made:

- A resident four male coalition in the central and northern areas of the park
- A resident three male coalition in the central and northeastern areas of the park
- A resident two male coalition in the east of the park
- A female with four subadult cubs recorded throughout the park
- A female with five subadult cubs. This group split up in the middle 1998 because a female with two young adult females and a separate group of three young males have been recorded in a similar area in the south of the park. These groupings have not been recorded before and the female with five subadults has not been spotted since the appearance of these two groups.
- Scattered records of at least one single female and a single male. There is a chance that these two animals were in fact the two cubs of the first group of cheetah, which was introduced in October 1994. These two animals will therefore not be included in the calculation of the resident population.
- At least two groups of wild cheetah exist on the outside of the park on the boundary of the reserve: three males on the eastern boundary and two males on the southern boundary.
- A conservative estimate of resident (not introduced) cheetah within Madikwe is 20 animals. The single animals were excluded from this number as well as the cheetah outside the park.

Interaction between cheetah and other predators

From the monitoring information obtained in the last few years a few obvious problems stand out.

Most of the introduced cheetah have died or have been killed. Three of the five recovered carcasses had penetrating wounds in their skulls. One animal was found dead in a shallow reservoir and the collar only was retrieved from one animal. To date no sick or emaciated cheetahs have been recorded. There is strong circumstantial evidence that most of the mortalities were caused by some form of trauma due to aggressive interaction between different cheetah or other predator species.

It is important to point out that cheetahs have been the only predators in the park, which were seen regularly on the perimeter fence. The cheetah seen on the perimeter fence were mainly male coalitions and their pacing behaviour pointed towards a need to get out of the reserve. I conclude from this behaviour that a certain number of cheetah were trying to get out of the reserve. My interpretation of this problem is that the density of cheetah in the park was high and competition between different groups of cheetah resulted in the high occurrence of especially male coalitions trying to get out of the reserve.

Circumstantial evidence therefore supports the fact that most of the mortalities of the reintroduced males were caused by the resident cheetah in the park. Unfortunately, aggressive interaction between cheetah was never witnessed. The above assumption is made only on circumstantial evidence. The female cheetahs may have had a similar fate but the chances are that their deaths were linked to aggressive interactions with lions and spotted hyaenas. One incident of aggressive behaviour was recorded between a lioness and a female with subadult cheetah. The lion stalked and grabbed one of the subadults but the cheetah managed to escape.

The cheetah population in Madikwe is stable despite the high proportion of mortalities recorded of the reintroduced animals. The resident population is healthy enough to survive the competition of other predators. The interaction between the different predators and cheetah is in fact advantageous to the management of cheetah in the park. From the data gathered to date indications are that the cheetah population is stable and at a saturated social carrying capacity. This would explain all the mortalities of the introduced animals. Park management therefore does not have to concern itself with the intensive management of this predator species.

No future introductions will take place until there is concrete proof that the cheetah population is declining and once a cause of the decline has been established. From the information given it is clear that the introduction of additional cheetah would be counterproductive and most likely end with the death of the introduced animals due to aggressive interaction between cheetah or other predators.

An accepted management strategy will be to manage the lion and ultimately the spotted hyaena population. These predators are increasing dramatically in numbers and will ultimately seriously jeopardize the survival of less competitive species like wild dog and cheetah. It is therefore important to the park management that this does not happen and the lion and hyaena numbers will be controlled in the near future to ensure that the above mentioned scenario does not develop.

Habitat and prey species preference

Madikwe lies within the semi-arid bushveld zone. Average rainfall varies between 550 mm in the southwest and 450 mm in the northeast. Acocks¹ broadly classified the vegetation of the Madikwe area into four types, namely: Mixed Bushveld, Kalahari Thornveld, Arid Sweet Bushveld and Other Turf Thornveld. A more detailed survey conducted by Zacharias⁸ describes the vegetation in more details within the above mentioned categories. He also pointed out that much of the reserve had been influenced by past agricultural practices. A marked increased density of the shrub *Dichrostachys cinerea* has affected many vegetation communities in the reserve. In addition to the natural vegetation in the reserve, there are also numerous old cultivated lands in the reserve. Some have been heavily encroached again by *Acacia* spp. and *Dichrostachys cinerea*. Other lands are deliberately being kept open by the management because of their tremendous game viewing potential and good forage due to the oversowing of some of the lands with the grass *Cenchrus ciliaris*.

Cheetahs have been recorded in all habitats within the park ranging from the thickest of thickets to the open old lands. The various home ranges of the different cheetah coalitions overlapped more than one vegetation community and it was the home range rather than the vegetation type which determined where cheetah were seen most frequently. A consistent finding in all habitats was the

preference of male cheetah for large marula trees as scent-marking posts. Other trees used as scent-marking trees were *Combretum appiculatum*, *Combretum imberbe* and *Lannea discolor*.

Prey selection was varied with impala being the most commonly recorded prey species. Kills were found in a variety of habitats including thick bush. The cheetahs in Madikwe were exceptionally versatile and opportunistic in their prey species selection. On a few occasions they used the fence to aid them with them pulling down a prey species, especially larger species like kudu, blue wildebeest and waterbuck. They do not use the fence as regularly and consistently like one of the packs of wild dog in the park. Fence kills by cheetah are recorded randomly and infrequently.

A list of the prey species recorded in Madikwe is given in table 1.

Table 1: Prey species of cheetahs in Madikwe, and frequency of kill recordings

Species	Frequency of recordings
Impala	Often – most common prey species
Kudu	Often – mainly subadult and juvenile females
Warthog	Often – mainly juveniles, but adults also taken
Blue wildebeest	Occasional – all records juveniles except for two adult males killed on the fence
Waterbuck	Occasional – all records subadults or juveniles
Blesbok	Occasional – contributing to the decline of this species in Madikwe
Springbok	Occasional – contributing to the decline of this species in Madikwe
Ostrich	Occasional – adult and young birds recorded; and contributing to the decline of this species in Madikwe
Hartebeest	Rare – only juveniles recorded
Eland	Rare – a subadult female recorded
Black-backed jackal	Rare – one killed by an injured male

Frequency of recordings:

Often = > 5 records per year and evidence suggests frequent prey species

Occasional = < 5 records per year but evidence points to frequent prey species

Rare = only one or two sporadic records obtained

RECOMMENDATIONS AND CONCLUSIONS FROM COMBINED PILANESBERG AND MADIKWE CASE STUDIES

Introduction technique

The cheetah brought into the North West Parks are first held in well secured bomas for 4-6 weeks but up to several months for adequate habituation. The boma period is seen as essential for a number of reasons:

- to expose and "train" the animals to electrified fencing in a controlled environment;
- to allow the cheetah time to settle in their new surroundings and orientated themselves to habituate the animals to vehicles including game drives;
- to allow the animals to get accustomed to radio collars as a poorly fitted collar may have disastrous consequences;
- to expose the new predators to electric fencing. The perimeter of the park is electrified and it would have disastrous consequences for the relationship between the park and its neighbours if any predator escaped from the park. It is very likely that the predators are exposed to the electric strands at some stage or another during their stay there. The presumption is made that through a negative experience with the electrified fence in the boma, this would serve as sufficient 'training' for the predator not to challenge the perimeter fence. To date this method of 'fence training' our reintroduced predators has proven to be very successful with no predator breakouts recorded.

The boma construction should be strong and well electrified. The fence should be regularly maintained. The boma fence should far exceed the specifications of the perimeter fence and should

preferably be constructed of a square or diamond mesh with a half-meter apron on the ground folded inwards and pegged. The apron should be rock-packed around the entire length of the boma fence. There should be no square corners in the boma and preferably no river crossings or any other area, which may weaken the structure.

The inside electrification should include at least four live strands with three being distributed in the bottom metre of the fence. Large bobbins should be used to prevent the bobbins jumping out of the offset bracket if the fence is struck by fleeing cheetah.

Electrification on the outside is necessary to prevent other animals, such as lions, gaining access into the boma. In Pilanesberg and Madikwe lions typically arrive at the boma within 24 hours following cheetah introduction into the boma. Both spotted and brown hyaena will also frequently visit a boma holding cheetah. A 3m-wide clearing or road should service both the inside and the outside of the fence. This will facilitate easy maintenance of the fence and will highlight any continued efforts of individuals to escape. The road on either side of the fence will serve as a firebreak as well.

Siting the boma in a suitable location will ease the maintenance and management of the boma and will aid the habituation process. The boma should be located centrally in the reserve preferably near a main road but out of sight from public. The constant traffic noise may serve to ease the animals into a tourist environment. The habitat within the boma should be selected for maximum visibility. Ideally, the boma should be open grassland with one or two small thickets for the cheetah to seek shade, shelter and cover when they feel threatened. If the vegetation in a boma is too thick, the cheetahs tend not to habituate to vehicles and it is also difficult for personnel to locate all the animals. Ideally, the boma should not be too large. The boma should be longer than it is wide for observations and darting from the fence should it be necessary to immobilise an animal while in the boma. A 40m-wide boma will effectively then require only a 20 m shot from the dart gun.

Introducing cheetah to the boma will possibly occur while the cheetahs are immobilised. The animals should be placed in an area of cover and allowed to wake as quietly as possible. A carcass should be placed in the boma and the animals left for at least 24 hours to recover with *no disturbance*. If the animals are to be released from a crate then this should be done in absolute silence in daylight. The benefits of open vegetation and wide clearings around the fence are apparent in this case as the animal is less likely to run into the fence when released from the crate.

It is recommended that all new arrivals be treated with both internal and external parasite treatments in order to reduce the potential of an added stressor in the form of high parasite loads during the stressful boma holding period. This may also serve to limit a build up of parasites within the boma during frequent or multiple use. Caution when handling carnivores is recommended as they are known to carry diseases and parasites, which may infect man.

Habituation of cheetah to vehicles during the boma holding period can be seen as essential for effective post release monitoring and management such as immobilising individuals for changing or removing collars, identifying kills or simply viewing the cats (which is probably a major reason for reintroductions). It is important that the boma be designed to facilitate habituation. As already mentioned roads around both sides of the fence should be included in the design. By driving vehicles around the boma with increasing regularity the cheetah should become increasingly habituated to their presence. It should not be necessary to drive a vehicle on the inside of the boma at any time during the habituation process. A vehicle, without occupants, left outside the boma for extended periods may aid habituation. It is important that the cheetah are introduced gradually to vehicles and that they are not exposed at all to humans on foot during this process. This is important because it will increase the stress on wild cheetah, which may flee or charge into the fence, which may result in a breakout or serious injury. The choice of cheetah will also affect their habituation. Younger cheetahs appear to habituate faster and easier than adults do. By obtaining animals from centres such as Africat, the habituation process is usually already fairly advanced.

Release of cheetah from boma: all cheetah were released by luring them out of the holding boma with a carcass.

POST-RELEASE MONITORING

Post-release monitoring was done using a radio telemetry-receiving device (Telonics TR4 receiver).

Radio telemetry readings were taken randomly at a variety of different set points in the park. Occasionally closer observations were done on the individual cheetah groups by locating them with the aid of the telemetry equipment. Any sighting of cheetah recorded by park personnel and game drive vehicles was recorded.

In Pilanesberg, only female cheetahs are fitted with radio collars and are monitored extensively following their release. The regular monitoring of the females provides monitoring personnel with details on frequency of breeding, litter size and cub survival, i.e. population recruitment. Therefore, prey, habitat selection and home range data is only available in any detail on the females introduced into the Park. Details on the male distribution, food selection, etc., are supplied by occasional and opportunistic sightings from tourists, guides and game scouts. In Madikwe a collar was fitted to one individual of each introduced group. Post-release data is therefore available from all groups released. All predator monitoring and sightings are the responsibility of the parks' Field Ecologist. Tourist frequency sightings are also monitored in order to establish how often cheetah are seen by tourists to North West Parks.

CONCLUSION AND RECOMMENDATIONS

A few valuable lessons were learnt in during both introductions.

In **Pilanesberg** lion are a limiting factor to the cheetah population. This will also be a factor influencing the cheetah population in Madikwe in the future. Pilanesberg and Madikwe monitor and manage the predator populations completely. All lion prides and coalitions are monitored using radio-tracking collars and the population is not allowed to exceed 40 animals. Lion density will thus not increase significantly in the parks over the next few years. Therefore, while lion-induced mortality is a limiting factor for cheetah population growth, once a large enough founder population of cheetah is reintroduced, the cheetah population appears to reach a measure of stability.

The introduction of cheetah to **Madikwe** has been a partial failure but the cheetah population in Madikwe is doing well. The main reason why the introduction of cheetah was a partial failure was because the new cheetahs were introduced into a well-established natural population. Knowledge of the natural population only improved once the introduced animals were released and intensively monitored.

In the first two years only the introduced male cheetah population suffered mortalities. Circumstantial evidence points to cheetah on cheetah aggression with the introduced males killed by the already established natural cheetah population. Only after three years post introduction were any female mortalities recorded.

Evidence of two of three recorded female mortalities point towards predation-related deaths. Spotted hyaena and/or lion were the most likely causes of their deaths. Lion and spotted hyaena were introduced in 1995 at very low densities. By 1997 the population of both species had doubled and they were distributed throughout the park. The likely incidence of cheetah meeting other predators therefore dramatically increased from 1995 to 1997/8.

The objective of introducing cheetah to Madikwe had both an economic and an ecological aspect. It is important to note that the economic aspect plays as an important a role in Madikwe as the ecological. Cheetahs are sought-after tourist animals by local and foreign guests. Madikwe can now advertise that cheetah can be seen in the park and this fact will attract a certain number of visitors per year. The income derived from the visitor therefore indirectly pays for the cheetah to be in the park where it is killing antelope. The antelope could be sold and in turn to earn income for the park.

With this objective in mind it makes more sense to skew the sex ratio towards males. Males in Madikwe tend to live in coalitions, are more visible and less shy than single females or females with cubs. All the females introduced into the park were rarely seen. Sightings were poor and more often than not did these groups quickly slink away when they met people or vehicles. It does not appear possible to habituate adult wild-caught females, which have a history of persecution before being translocated to a reserve. In Madikwe all females with cubs introduced had such backgrounds and none of them calmed down, even after 6 months in the boma and constant but controlled vehicle movement around the boma. Male animals relaxed far quicker in the boma, responded better to vehicle habituation and stayed relatively relaxed after their release.

Another good reason to introduce male coalitions rather than females is that a group of males will catch one animal. A lone female will kill roughly the same amount of game. Yet single females are rarely seen and do not offer good viewing options unlike a group of males, which tend to be more visible.

The ecological aspect of cheetah introduction is to introduce to an area a predator that could help control medium and small-sized herbivore numbers. In Madikwe impala are the main prey species of cheetah. Impala can become problem animals if their numbers are not kept in check. If cheetah help keep impala numbers in check then they fulfil an important ecological objective. The introduction of cheetah into Madikwe had this ecological objective in mind.

If cheetahs are to be released for similar reasons as in Madikwe and Pilanesberg, the following recommendations are made:

Firstly determine if a healthy cheetah population exists in the area. This is often a difficult task if the cheetah in the area were in any way persecuted by man. If a healthy cheetah population exists, one or two habituated cheetah could be introduced. Cheetahs can then be radio-collared to monitor their movements and to maximize their tourist value.

In an area where the natural cheetah population is small or absent, two or three female cheetah – preferably female cheetah which are already habituated to vehicles – should be introduced – each with a radio collar. Three or four male coalitions can then be introduced depending on the size of the area and prey availability. At least one male of each coalition should be collared.

Post-release monitoring is essential to determine the success and the impact of the new cheetah population will have in the new reserve.

If other predators, e.g. lion and spotted hyaena, are to be released, cheetah should be released first so that they can establish themselves before the larger competitors arrive. This should increase their survival chances when competing with the different predators in the future.

It is essential that cheetah be placed in a holding boma before being released. In Madikwe they have been the only predators so far attempting to escape. It is only because of the electric fence surrounding the park and their negative experience with the fence in the boma which prevents them from breaking out of the park.

Careful consideration should be given to the economic aspects of introducing cheetah to a reserve, especially in the absence of other predators and the presence of valuable species like sable antelope. Cheetahs are known to prey on sable calves. If tourism is the main objective in having them in the park then male animals in coalitions rather than females should be introduced. Habituated animals will greatly enhance the management and viewing of such introduced animals.

The cheetahs in Madikwe and Pilanesberg have proven to be very versatile and adaptable animals. They play an important role in the ecological and tourism aspects of the park. A few good lessons have been learnt with the relocation of cheetah in Madikwe but the knowledge gained will surely improve similar introduction attempts elsewhere.

An important aspect, which is worth further investigation, is the quantifiable benefits derived from cheetah indirectly through the tourism industry. If the cheetah proves to be economically viable as a species on a reserve or game ranch through its tourism appeal then its future long-term survival will be better secured.

The conservation importance of these introductions should be stressed. Concern over the decline in cheetah numbers over the past few decades focused on loss of habitat for the cheetah. Pilanesberg National Park and Madikwe Game Reserve combined is offering cheetah over 1 200 km² (120 000 ha) of excellent cheetah habitat with a substantial prey base. The cheetah as a species has benefitted greatly by this re-introduction effort. The parks benefit by the ecological advantages that predators offer an ecosystem as well as enhanced tourism potential for visitors to our reserves.

ACKNOWLEDGEMENTS

Many thanks to Dr Greg Stuart-Hill (Chief Ecologist for Bop National Parks 1993-1996) for his tremendous support with the various introduction attempts of cheetah into Madikwe and his valuable advice on the introduction technique. A big thank you to Lisa Hansen of Africat for donating all our cheetah free of charge. Lastly a big thank you to Mr Gus van Dyk for his time and

effort to help organize the acquisition of cheetah for the various introductions in Madikwe.

REFERENCES

1. Acocks, J.P.H. 1988. Veld types of South Africa. *Memoirs of the Botanical Survey of South Africa* 57
2. Davies, R. 1997. A description and history of Madikwe Game Reserve. *Madikwe Development Series* pp 5-7
3. Estes, R.D. 1991. *The Behavioural Guide to African Mammals*. Berkeley: University of California Press. pp 377-383
4. Ferguson, M. 1995. Introduction of cheetah into the Mthethomusha Game Reserve, South Africa. In: Marker-Kraus, L. (ed) 1993 *International Cheetah Studbook*. Washington, DC: NOAHS Center, National Zoological Park, Smithsonian Institution
5. Lamprecht, J. 1981. The function of social hunting in larger terrestrial carnivores. *Mammal Review* 11(4): 169-179
3. Mills, M.G.L. & Biggs, H.C. 1993. Prey apportionment and related ecological relationships between large carnivores in Kruger National Park. *Symposia of the Zoological Society of London* 65: 253-268
7. Skinner, J.D. & Smithers, R.H.N. 1990. *The Mammals of the Southern African Subregion*. Pretoria: University of Pretoria. pp 393-397
8. Zacharias, P.J.K. 1994. *The vegetation of Madikwe: a first approximation*. Report to Bophuthatswana Parks Board