

CHAPTER 4

THE KLASERIE LEOPARD

The diet of leopards varies from area to area and they are known to eat a wide variety of prey types. Predominant prey in the diet ranges from small prey such as rock hyraxes (Norton et al. 1986 and Grobler and Wilson 1972) to prey the size of impala (Hirst 1969 and Bertram 1982). They are also known to kill and eat other predators (Bertram 1982).

The leopard has been regarded as being the least researched of the larger African carnivores due to its solitary, predominantly nocturnal habits (Schaller 1972 and Eltringham 1979). Valuable work on the leopard has been carried out (e.g. Pienaar, 1969, Hirst 1969, Schaller 1972, Grobler and Wilson 1972, Hamilton 1976, Seidensticker 1976 and Smith 1978) and our knowledge of the leopard is expanding with more recent work been carried out in countries such as Tanzania (Bertram 1982), Nepal (Sunquist 1983) and South Africa (Bothma and Le Riche 1984, Bothma and Le Riche 1986, Norton and Lawson 1985, Norton, Lawson, Henley and Avery 1986 and Norton and Henley 1987).

The leopard is generally a solitary, mainly nocturnal large cat. When more than one leopard is encountered it is likely to be a mating pair or a female with her offspring. Cubs remain with the mother until they are 15 months (Sunquist 1983) to 30 months of age (Hamilton 1981). Independent young leopards may continue to occupy the range of their mother and make contact with her (Bertram 1982) or they may disappear altogether (Hamilton 1981).

The diet of leopards varies from area to area and they are known to eat a wide variety of prey types. Predominant prey in the diet ranges from small prey such as rock hyraxes (Norton et al. 1986 and Grobler and Wilson 1972) to prey the size of impala (Hirst 1969 and Bertram 1982). They are also known to kill and eat other predators (Bertram 1982). Grobler and Wilson (1972) and Norton et al. (1986) found leopards to prey on mammals, birds, reptiles and invertebrates. Leopards are known scavengers (Eltringham 1979). Larger prey is often dragged to some form of cover, either to mainly under a bush (Smith 1978 and Bothma and Le Riche 1986) or mainly up a tree (Scott 1985).

The mean daily distances that leopards move also varies from area to area as do the sizes of the home ranges. Mean daily distances moved have varied from 1,4 km (Seidensticker 1976) to 17 km (Bothma and Le Riche 1984). Home range size has varied from 10 km² (Muckenhirn and Eisenberg 1973 and Smith 1978) to 487 km² (Norton and Lawson 1985). The home ranges of adult male leopards are often exclusive and overlap those of adult females. Adult female ranges often overlap each other (Schaller 1972, Hamilton 1981 and Smithers 1983).

MATERIALS AND METHODS

Where home ranges overlap, mutual avoidance is the common rule (Hamilton 1981). Leopard densities have varied from "extremely low" (Norton and Lawson 1985) to 1 leopard per 4,5 - 5,0 km² (Smith 1978).

Nature Reserve. The area selected was in the eastern

Prior to the present study, little was known of the Klaserie leopard, an ecologically important predator (Bothma and Le Riche 1986). At the start of this project, a study on lions in the Klaserie Private Nature Reserve was being carried out by the Transvaal Nature Conservation Division. Cheetahs and wild dogs were seldom seen which would have made a study on them relatively difficult. The spotted hyaena was regarded as being predominantly a scavenger in the Klaserie Private Nature Reserve, ranking below the leopard as an active predator. Leopards were more often seen than cheetahs and wild dogs and for these reasons, research was aimed at the Klaserie leopard.

The aim of the leopard study was to obtain information mainly on feeding habits and range size. It was hoped that the information gained would expand the initial little knowledge of the Klaserie leopard, would assist in future management considerations of the reserve and would indicate if leopard translocations to the Klaserie Private Nature Reserve could be considered.

end of the cage connected by a cable to a trigger floor plate (0.7m x 0.4m) in the centre of the trap. Either one trap door could be used to spring the trap with the second door sealing one entrance or both doors could be used simultaneously to spring the trap.

For the study on the leopard, it was decided to concentrate intensively on a small section of the Klaserie Private Nature Reserve. The area selected was in the eastern part of the reserve with grass and soil covering the trap floor. Each trap was

section of the reserve surrounding the base camp. The woodland habitat of this area was considered representative of the whole reserve and the Ntsiri River with its riparian vegetation was in the vicinity. The latter type of habitat is a favoured leopard haunt in the Kruger National Park (Pienaar 1969). Both trap doors were used to spring the trap,

with the live bait tied inside a thorn bush enclosure at one end. In agreement with Hamilton (1976), it was virtually impossible to observe hunting leopards visually for any length of time. As other studies have shown (Hamilton 1976 and Bertram 1982) radio-tracking can be an effective means for studying leopards. South Africa, while Horton and Lawson

(1975) successfully trapped three leopards and two cubs. Attempts were made to live-trap Klaserie leopards for radio-collaring purposes, but this proved unsuccessful. Two trap-cages were placed at points throughout the study area where leopards were known to pass. Each trap was 3,2m long, 0,9m high and 0,77m broad, and was constructed from steel and rectangular steel mesh. The trap mechanism consisted of a falling trap-door at each end of the cage connected by a cable to a trigger floor plate (0,7m x 0,4m) in the centre of the trap. Either one trap door could be used to spring the trap with the second door sealing one entrance or both doors could be used simultaneously to spring the trap.

one cage baited with the dead baboon and, from the leopard Set traps were concealed with branches on the outside and with grass and soil covering the trap floor. Each trap was

baited at different times with large pieces of impala, giraffe or warthog meat. A dead skinned baboon and a live chicken were also used. When dead bait was used, one falling trap door was used to spring the trap with the bait placed inside the trap alongside the sealed end. When live bait was used, both trap doors were used to spring the trap, with the live bait tied inside a thorn bush enclosure at one entrance. Access to the live bait could only be obtained via the remaining open entrance. The latter method, using a live goat as bait, was used successfully by Pettifer (pers. comm.) in trapping cheetahs in the Suikerbosrand Nature Reserve, Transvaal, South Africa, while Norton and Lawson (1985) successfully trapped three leopards and two caracals in the Cape Province, South Africa, using a single-door walk-in box trap with dead chickens, rock hyraxes or parts of other carcasses as bait and using a single-door walk-in box trap.

The traps in the Klaserie Private Nature Reserve were set for 30 trap-nights and in this period three African civets and two spotted hyaenas were trapped. The two spotted hyaenas and one African civet were caught when using warthog bait, and the two other African civets were caught when using impala meat as bait. A leopard walked within 4 m of one cage baited with the dead baboon and, from the leopard tracks, showed no interest in the bait. On two separate occasions, lions walked past the traps but showed no

interest in the bait either. A local worker living in the reserve claimed that the unsuccessful trapping was due to the cages being covered with branches, making the animals wary of the trap.

on the sex, numbers and movements of the leopards in the study area. A method used by Smith (1978)

Free-ranging Klaserie leopards were seen in situations suitable for darting but, because of personal inexperience, this could not be done without experienced assistance. The

darting equipment (blow-pipe) was also primarily designed for use on captive animals. Summoning aid in these situations would have been worthless due to the time lapse in distances that would have had to be covered by road.

than 1000 were taken as an adult male older than 3500 as an

A remote-controlled photographic device, as described by Smith (1978), was tested to photograph leopards for recognition purposes. No leopards were photographed but a

variety of other nocturnal animals were. Although costly, this method can successfully be used to identify nocturnal animals. The photographic apparatus used in the present

study was the same as that described by Seydack (1984) except that in this study, an infra-red beam was used to close the electric system (12 - V) and the camera was triggered by a remote control device.

As free-ranging Klaserie leopards were neither trapped nor observed for any length of time during the first year of the study, data on the leopards were collected by indirect means

from February 1980 until October 1981.

The tracking and measuring of leopard footprints was used to gain information on the sex, numbers and movements of the leopards in the study area, a method used by Smith (1978) and Bothma and Le Riche (1984).

The study area was either walked or driven and when leopard tracks were found, they were followed in both directions for as far as possible. Where the tracks crossed suitable soil, especially fine sand overlaying hard soil, the length and breadth of the hind pads were measured. Hind pads longer than 96mm were taken as an adult male, 61mm to 95mm as an adult female or subadult animal, and those 60mm and shorter as cubs. A known adult male leopard in the study area had a hind-pad length of 100mm, four females seen in the reserve had hind-pad lengths of 95mm, 85mm, 75mm and 70mm, while two separate cubs accompanying their two separate mothers, had hind-pad lengths of 60mm and 45mm. Smith (1978) used pad breadth to distinguish the age and sex of leopards but did not indicate whether hind or fore pads were measured. Smithers (1983) gives the hind-pad length of an adult leopard as 120mm.

Tracking on sandy roads, game paths and water courses was relatively easy, as was tracking into the sun as the prints "stood out" clearer. Tracking under other conditions, such

as in vegetation or on stoney ground was extremely difficult because of lack of tracking experience. This was a drawback as animals could never be followed to the full. In the Klaserie Private Nature Reserve, roads were frequently used by carnivores, resulting in tracks, at times, being erased by human or vehicle movement. Other game also trampled leopard tracks. Mills (1977) also had similar difficulties while following brown hyaena tracks in the southern Kalahari.

An advantage of collecting data by indirect means is that the animals concerned are not disturbed in any way.

Data on feeding habits of Klaserie leopards were obtained from kills located in the field. For comparison of food utilised, data on the feeding habits of lions, spotted hyaenas, cheetahs and wild dogs were also collected in the same way. The occurrence of tracks of these carnivores in the study area were also noted but were not followed. Times and localities of vocalizations of the carnivores were also recorded.

Valuable data on sightings, movements and feeding of the carnivores were given by the Warden and various owners of the reserve and by visitors to the reserve.

Sex was obtained in 47 cases (Table 4). Impalas killed by leopards could not be sexed in 9 cases: 8 adults and 1 sub-

RESULTS AND DISCUSSION

Table 3: Numbers of known kills and prey eaten by leopards in the Klaserie Private Nature Reserve, Eastern Transvaal, Lowveld, as based on kills located in the field from February 1973 to October 1981.

From data on 95 identified leopard kills collected in the field throughout the Klaserie Private Nature Reserve, leopards in the Klaserie Private Nature Reserve killed and fed on a minimum of 10 prey types (Table 3). These data do not include a domestic dog which was killed but not eaten.

The Klaserie leopards preyed predominantly on impalas (88 per cent), with the remaining nine prey types occurring at a low frequency in the diet.

The females of some of the larger herbivores (e.g. impala and blue wildebeest) in the Klaserie Private Nature Reserve give birth during the hot, wet season, mainly from October to December. The occurrence aided the age estimation of leopard kills. Body size and the size and shape of horns (were applicable) were used to give an estimate of prey age and sex at a kill site (Child 1964 and Hanks and Howell 1975). However, it was not always possible to determine sex and age as little remained of some kills due to scavengers. Of the impalas killed by leopards, an estimate of age and sex was obtained in 47 cases (Table 4). Impalas killed by leopards could not be sexed in 9 cases: 8 adults and 1 sub-

Table 3: Numbers of known kills and prey eaten by leopards

Table 4: Numbers, age estimation and sex of impalas killed in the Klaserie Private Nature Reserve, Eastern Transvaal Lowveld, as based on kills located in Reserve, Eastern Transvaal Lowveld, February 1979 to October 1981. Age estimation based on body size and size and shape of horns. Data collected personally and by the Warden.

PREY ANIMAL	NUMBER KILLED		PERCENTAGE OF ALL KILLS RECORDED	
	MALES	FEMALES	MALES	FEMALES
Impala	74		77,9	
Waterbuck	4		4,2	
Warthog	4		4,2	
Kudu	3		3,1	
Bushbuck	3		3,1	
Burchell's zebra	2		2,1	
Common duiker	2		2,1	
Blue wildebeest	1		1,1	
Baboon	1		1,1	
Porcupine	1		1,1	
Total	95		100,0	
Total	32	15	100,0	100,0

adult. In 16 cases impalas could neither be sexed nor aged.

Table 4: Numbers, age estimation and sex of impalas killed by leopards in the Klaserie Private Nature Reserve, Eastern Transvaal Lowveld, February 1979 to October 1981. Age estimation based on body size and size and shape of horns.

AGE	MALES		FEMALES		TOTAL	
	NUMBER	%	NUMBER	%	NUMBER	%
Juveniles (0-11 months old)	1	3,1	0	0	1	2,1
Subadults (12-23 months old)	10	31,3	1	6,7	11	23,4
Adults (24 months and older)	21	65,6	14	93,3	35	74,5
Total	32	100,0	15	100,0	47	100,0

kills were located in the cold, dry season. Not one of the prey animals killed was known to be in a poor condition.

adult. In 18 cases impalas could neither be sexed nor aged. Of all impalas killed, 68 per cent were males and 32 per cent were females. Of all impalas killed, 75 per cent were adults. Juvenile impala kills were found infrequently as they were probably soon devoured and would further leave no kill drag marks as the larger sized impala would. Sex or age and sex and age was estimated in some of the remaining nine prey types i.e. for kudus: one year-old male, one juvenile and one adult female; blue wildebeest: one juvenile; common duikers: one adult; warthogs: two sub-adults and one adult; Burchell's zebras: one yearling; waterbuck: one year-old; bushbuck: one adult and one year-old female. Of the 74 impalas killed, 60 per cent were found in the cold, dry season and the rest in the hot, wet season. There appears to be no seasonal preference for impalas in the Klaserie Private Nature Reserve. The higher frequency during the cold, dry season may be due to kills being more easier to locate in the dry vegetation. The remaining nine prey types do not show a seasonal variation where 11 of the kills were located in the cold, dry season and 10 of the kills were located in the hot, wet season. Not one of the prey animals killed was known to be in a poor condition.

Hirst (1963) also found that leopards in the Timbavati

Of the adult impalas killed, 51 per cent (n = 43) were located during the hot, wet season and 49 per cent during the cold, dry season. Of all the carcasses of adult impala males, 13 were located in the hot, wet season and 8 in the cold, dry season. Of the carcasses of adult females, nine were located in the cold, dry season and five in the hot, wet season. Although the sample is small, this is not clearly understood as it was expected that more males would be caught in the cold, dry season which included the rutting period and that more females would be caught in the hot, wet season when they give birth and have small young. During the rutting period territorial males fight with other adult males which can be fatal and also cause loss of condition during this time. It could be, however, that adult impala males and territorial males are more active and more alert during the rut than in the hot, wet period. For the adult females it is possible that during the cold, dry months their condition is down after suckling their young.

to a belted fox *Otocyon megalotis*. If the prey types That leopards in the Klaserie Private Nature Reserve feed mainly on impalas and that a high percentage of the impalas killed are adults supports the findings of Pienaar (1969) in the adjacent Kruger National Park where 78 per cent of the leopard's prey was impalas and 76 per cent of the impalas killed were adults. Similar results were also obtained from the adjacent Timbavati Private Nature Reserve (Hirst 1969). Hirst (1969) also found that leopards in the Timbavati

Table 5: Prey animals killed by leopards in the Klaserie

Private Nature Reserve killed relatively more subadult and adult impala males than females in the same age classes. He attributed this to, and this is supported here, the habit of impala males to form small groups and thereby being more susceptible to predation than the larger groups of females. In the Timbavati Private Nature Reserve, Hirst (1969) further records sustained predation on impalas by leopards, cheetahs and lions throughout the year with peaks in the dry season. This was correlated with a decrease in the physical condition of impalas during the dry season and therefore increased vulnerability. While not being recorded in the present study, Hirst (1969) also observed heavy predation by spotted hyaenas and black-backed jackals on impala lambs during the lambing period.

Results from the Kalahari Desert (Bothma and Le Riche 1986) show that both female and male leopards select medium-sized mammals, the size of a springbok lamb *Antidorcas marsupialis* to a bat-eared fox *Otocyon megalotis*. If the prey types killed by Klaserie leopards are grouped according to these relative sizes, then it is evident that they select large prey types (Table 5). In the present study, prey the size of a baboon and larger is considered large prey and that smaller to the size of a porcupine is considered medium-sized prey. By basing these data on kills located, then there is likely to be a bias in favour of large kills as they are more easily located. However, the data do support

Table 5: Prey animals killed by leopards in the Klaserie Private Nature Reserve, Eastern Transvaal Lowveld, arranged according to relative size. Data based on kills located in the field, February 1979 to October 1981.

PREY SIZE *	PREY TYPES	NUMBER KILLED	PERCENTAGE OF ALL PREY KILLED
L	Burchell's zebra young	2	2,1
L	Blue wildebeest young	1	1,1
L	Waterbuck young	1	1,1
L	Kudu adult	1	1,1
L	Kudu young	2	2,1
L	Warthog adult	1	1,1
L	Warthog subadult	2	2,1
L	Impala adult	43	45,3
L	Impala subadult	13	13,7
L	Bushbuck adult	1	1,1
L	Bushbuck subadult	1	1,1
L	Baboon	1	1,1
M	Common duiker	2	2,1
M	Porcupine	1	1,1
-	Unknown age (large prey)	23	24,0
-	All large prey	69	73,0
-	All medium-sized prey	3	3,0
-	All prey	95	100,0

*: L = Large M = Medium - = No Data

the suggestion by Schaller (1972) that the preferred prey of leopards falls within the 20 to 70 kg size category. The size of leopards and Thomson's gazelle *Gazella thomsoni* What is evident in the prey data of the present study is the relatively low number of prey types and the absence of small animals compared to the prey of leopards in other part of Africa (Kruuk and Turner 1967, Pienaar 1969, Schaller 1972, Smith 1978, Hamilton 1981, Bertram 1982, Bothma and Le Riche 1984 and Norton *et al.* 1986). This is determined by factors such as prevailing ungulate densities, hunting The low number of prey types and the absence of small prey is accepted to be due to the remains of small prey being overlooked, leopards completely devouring small prey and not being able to follow leopards for any continuous period of time. That one (of two) common duikers was included in the kill data was due to the leopard being seen while feeding. Little evidence remained after the leopard had fed. factor in the diet of leopards has been supported by other studies. One report was received of a leopard hunting vervet monkeys and a second and unconfirmed report of a leopard feeding on a greater canerat. Only scat analysis or continued observation would show if Klaserie leopards feed on small prey types. It is highly likely that they do as subsequent to the study period, a report was also received of a leopard with a francolin *Francolinus* spp. in its mouth. While leopards in the Klaserie Private Nature Reserve may well feed on small prey, the same postulation as that of Scott

(1985) can here be put forward: that adult leopards can meet much of their food requirements by catching antelope the size of impalas and Thomson's gazelle *Gazella thomsoni* rather than spending time hunting smaller animals such as hares. Taking whatever suitable prey it comes across. Leopards have also been proven to have a fairly wide range. The diet of leopards in various areas depends on what food is available. Hirst (1969) states that the prey preference of carnivores is probably flexible and is determined by factors such as prevailing ungulate densities, hunting conditions, habitat conditions, size of pride etc. The more common in the Serengeti National Park. Writing on the diet of lions and leopards in the Serengeti National Park, Tanzania, Bertram (1982) states that the two predators can only take what is available, and that this varies from place to place, and often from one season to another. That prey availability is a determining factor in the diet of leopards has been supported by other studies. In the Kalahari Desert (Bothma and Le Riche 1986), leopards often kill small to medium-sized prey mammals as many of the smaller mammals are more sedentary inhabitants of the Kalahari sandveld interior than the different larger antelope species. In the mountains of the south-western Cape Province, South Africa, the principal prey of leopards are small antelope and rock hyraxes. In this region of South Africa, those species regularly seen in the study area were well represented in the scats of leopards and vice

versa (Norton *et al.* 1986). The leopard has been reported to be an opportunistic feeder (Eltringham 1979, Bothma and Le Riche 1986 and Norton *et al.* 1986), taking whatever suitable prey it comes across. Leopards have also been proven to have a fairly wide range of prey species (Hirst 1969, Eltringham 1979, Hamilton 1981, Bertram 1982 and Bothma and Le Riche 1986).

Bertram (1982) gives an example of a largely opportunistic hunting method of leopards, which was rated as a little more common in the Serengeti National Park, ranking between stalking (most common) and ambushing prey (rare): "the leopard investigated clumps of vegetation and dashed after any small animal (particularly hares *Lepus capensis*) flushed out of them".

Following the opportunistic method of leopards described by Bertram (1982), it can not be confirmed in this report if leopards in the Klaserie Private Nature Reserve are opportunistic feeders as no hunting methods were observed by Klaserie leopards. Bothma and Le Riche (1986) have found that the classic hunting method of leopards, i.e. a stalk, chase and kill sequence only infrequently occurred in the Kalahari Desert.

Leopards were recorded scavenging on five separate carcasses, with each carcass being visited by one leopard. In agreement with Hirst (1969) on the interrelationships

between predator and prey populations in the Timbavati Private Nature Reserve, leopards in the Klaserie Private Nature Reserve utilise mainly impalas but have other prey species to which they can turn should impala numbers decrease for some reason or other. The high numbers of impalas ensure a greater degree of contact with leopards and so act as a buffer for those species of which the leopard is able to kill.

The volume of food eaten per day could not be estimated in the present study as, again, leopards were not continuously followed, scavengers often subsequently devoured some or all of the remaining carcass, and an estimated weight of the prey carcass and the amount eaten would have been misleading.

Scavenging

Leopards are known scavengers when the opportunity arises (Eltringham 1979) and this is the downfall of the leopard as it is thus easily trapped by poachers (Hamilton 1981). That leopards scavenge is no exception in the Klaserie Private Nature Reserve.

Leopards were recorded scavenging on five separate carcasses, with each carcass being visited by one leopard.

Three of the animals scavenged (two giraffes and one kudu) had died natural deaths, one (a Burchell's zebra) was killed by lions and one (an impala) was shot for food for the release cheetahs on the day of their release. The carcasses were originally put out on the ground as bird food, and then visited a time since death of the scavenged food varied from one day (the impala and Burchell's zebra) to approximately four days (the kudu). Both giraffe carcasses were two days-old when fed on by leopards. The impala, Burchell's zebra and kudu had been partly eaten by cheetahs, lions and spotted hyaenas respectively when the leopards fed. The two giraffe carcasses had been partly fed on by spotted hyaenas. The meat of the kudu carcass was putrid when the leopard fed while the meat of the remaining carcasses was relatively fresh.

Post kill behaviour

In all cases, except the impala carcass which was hauled up a tree, the leopards involved payed only one visit to the relevant carcass. After a leopard had made a kill, the kill was usually dragged to some form of covert either to under a bush or

tree or up a tree. When drag distances could be measured, One leopard walked past a five day-old buffalo calf carcass but it did not visit or feed on it. The same applied to a two day-old blue wildebeest carcass and a two day-old giraffe carcass. In these instances the leopards concerned with cubs was not dragged and the greatest drag distance was had probably already fed prior to passing the carcass.

All carcasses were subsequently devoured by spotted hyaenas,

black-backed jackals, vultures and on two occasions, also lions. Relative size, then heavier prey (adult impalas and larger) was dragged for a mean distance of 44,7 m (n = 9). One leopard also ate maize porridge, which was originally put out on the ground as bird food, and then visited a rubbish dump. 127 m (n = 5; range 10 - 400 m; SD = 173,0 m; CV = 136,2 per cent). Statistically, however, there is no That leopards scavenge and that they do not only eat fresh meat is supported by Pienaar (1969), Hamilton (1981) and Bothma and Le Riche (1986). "Odd" feeding habits of leopards, in this study eating maize porridge, were also recorded in the Tsavo West National Park (Hamilton 1981) where a subadult male leopard foraged in a rubbish dump and in waste bins. 127 carcasses (69 per cent) were on the ground

Post Kill Behaviour

The highest carcass up a tree was an estimated 9 m up a leadwood tree *Combretum laurber* and the lowest was 1,1 m on a fallen thorn tree *Acacia nigrescens*. The average dragged to some form of cover; either to under a bush or height of a carcass in a tree was 4,3 m (n = 6; range 1,1 - 9 m; SD = 3,76 m; CV = 64,2 per cent). The remaining three carcasses in trees were reports received from visitors to the reserve. Carcasses were found in the following four types of trees: leadwood - one adult impala; knob thorn - with cubs was not dragged and the greatest drag distance was one duiker and one adult impala; warula *Sclerocarya birrea* - by an adult leopard with the carcass of a subadult impala two adult impalas; and jackal berry *Diospyros mespilifolia* - one adult impala.

When the prey types that were dragged are arranged in groups of relative size, then heavier prey (adult impalas and larger) was dragged for a mean distance of 44,7 m (n = 9; range 0 - 106 m; SD = 37,6 m; CV = 83,9 per cent) and lighter prey (subadult impalas and smaller) for a mean distance of 127 m (n = 5; range 10 - 400 m; SD = 173,0 m; CV = 136,2 per cent). Statistically, however, there is no significant difference between the mean drag distance for heavier prey and the mean drag distance for lighter prey ($t = -1,469$; $df = 13$; $p > 0.05$). A larger sample would probably yield significant differences.

boer boer Schotia
 brachypetala (one subadult impala) (two carcasses)

Nine of 29 carcasses (31 per cent) were stored in trees. The remaining 20 carcasses (69 per cent) were on the ground under cover. An adult kudu and a subadult warthog were in dry watercourses under overhanging vegetation. The highest carcass up a tree was an estimated 9 m up a leadwood tree *Combretum imberbe* and the lowest was 1,1 m on a fallen knob thorn tree *Acacia nigrescens*. The average height of a carcass in a tree was 4,3 m (n = 6; range 1,1 - 9 m; SD = 2,78 m; CV = 64,2 per cent). The remaining three carcasses in trees were reports received from visitors to the reserve. Carcasses were found in the following four types of trees: leadwood - one adult impala; knob thorn - one duiker and one adult impala; marula *Sclerocarya birrea* - two adult impalas; and jackal berry *Diospyros mespiliformis* - one adult impala.

dad in the Matobo National Park (formerly

There appears to be no specific preference for a certain type of cover or growth form under which leopards dragged their kills. Carcasses were found under magic guarri bushes *Euclea divinorum* (one young kudu, one subadult impala, four adult impalas) and rough-leafed raisin bushes *Grewia flavescens* (one juvenile kudu, one adult impala, one juvenile Burchell's zebra) and under apple-leaf *Lonchocarpus capassa* (one subadult impala), tamboti *Spirostachys africana* (one subadult warthog), knob thorn (one adult impala), velvet corkwood *Commiphora mollis* (one subadult impala), marula (one adult impala) and weeping boer bean *Schotia brachypetala* (one subadult impala) trees. Two carcasses (one adult and one subadult impala) were also found in the reeds of the Klaserie river bed and three carcasses (a juvenile impala, an adult kudu and a subadult warthog) were in dry watercourses under overhanging vegetation. The surrounding vegetation was fairly dense in all but two of the sites: the one subadult impala under the apple-leaf tree and the adult impala under the marula tree.

The carcass lay untouched for at least 30 hours whereafter it
 Where intestines were seen at a kill site, along a drag route or at a feed site, the prey had been disembowelled by leopards on one occasion at a kill site, on four occasions along a drag route and on five occasions, the intestines were still in the prey body cavity or at the feed site. Intestines were never covered with plant material as Smith (1978) recorded in the Matobo National Park (formerly

Rhodes Matopos National Park), Zimbabwe.

Hair was removed from the prey in three of 10 instances. The prey in these three instances were all impalas, two adults and one subadult, and not woolly.

Klaserie leopards were not seen resting beside their kills.

Where prey had not been completely devoured or was relatively untouched by scavengers, leopards began feeding on the hindquarters of the prey in seven of eight instances. On the remaining occasion, the forequarters of a subadult impala male were eaten.

The drag distances recorded in this study are somewhat less

On leopards returning to feed on carcasses i.e. carcasses of a size large enough to detain a leopard in the vicinity of a kill for more than one day, the data suggest that prey the size of a subadult impala and larger could detain a leopard. Prey of this size, however, did not always detain Klaserie leopards as the partly eaten carcass of a juvenile blue wildebeest did not cause a leopard to return. The carcass lay untouched for at least 36 hours whereafter it was devoured by scavengers. The kills of juvenile Burchell's zebras and adult impalas kept Klaserie leopards in the area for at most two days. As recorded, where Klaserie leopards had scavenged on large carcasses and where food remained, they only payed one visit to each carcass. An adult kudu cow was fed on for two successive nights by an adult female leopard and her cubs, whereafter the carcass

was devoured by spotted hyaenas.

The distance that a leopard moved from a carcass before returning was not calculated mainly due to kills being in relatively dense vegetation thus leaving no visible tracks. Klaserie leopards were not seen resting beside their kills i.e. at the kill site, but it can not be said with certainty that they did not. Klaserie leopards, being on the whole shy, presumably move further away from the site at the approach of a vehicle or observers on foot.

The drag distances recorded in this study are somewhat less than those recorded elsewhere in Africa. Bothma and Le Riche (1984) recorded a mean drag distance of 410,0 m for male leopards in the interior of the Kalahari Desert and a mean distance of 742,0 m for females with cubs in the interior. In the Nossob Riverbed they recorded a mean drag distance of 57,0 m for females with cubs. Smith (1978) recorded mean drag distances of 120 m (dry season) and 260 m (wet season). That leopards do drag their prey to some form of cover has been established and that the distance that a carcass is dragged appears to be cover related as suggested by Bothma and Le Riche (1984) and whether the leopard is capable of dragging the prey. In the open habitat of the Kalahari Desert, drag distances are great while in the Klaserie Private Nature Reserve a leopard would not have to drag its prey comparably as far to find a suitable feed

site. The large carcass of a red hartebeest cow *Alcelaphus buselaphus*, being too heavy, was not dragged away at all in the Kalahari Desert and similarly, an adult kudu cow was not dragged away in the Klaserie Private Nature Reserve. They are quickly consumed. They further observed that "prey storage". The present study supports other findings (Smith 1978, Hamilton 1981, Bothma and Le Riche 1984 and Bothma and Le Riche 1986) in that a relatively small percentage of a leopard's prey is stored in trees, and does not agree with earlier writings (Turnbull-Kemp 1967 and Potgieter, Du Plessis and Skaife 1971).

Even during historical times have leopards been suspected of taking prey into trees to avoid scavengers (Brain 1981). In the Matobo National Park (Smith 1978), leopards took only one kill into a tree during an intermittent three-year observation period and in the combined Tsavo West and Meru National Parks, less than one-third of large kills were stored in trees (Hamilton 1981). In all three areas these low incidences of tree hauling of prey by leopards was ascribed to the low density of hyaenas and jackals. The same conclusion was drawn by Muckenhirn and Eisenberg (1973) for leopards in Ceylon and by Kruuk (1986) from a review of interactions between Felidae and their prey species. In the Klaserie Private Nature Reserve, spotted hyaenas and black-backed jackals were common and yet a low percentage of medium and large-sized prey combined were taken into trees.

Bothma and Le Riche (1984) concluded that a low figure of tree hauling (seven of 38 kills) in the Kalahari Desert was due to a fairly low scavenger density and that Kalahari Desert leopards usually killed medium-sized prey which are quickly consumed. They further observed that "prey storage in trees was always the result of disturbances of leopards at the carcass by scavengers". From another study in the Kalahari Desert (Bothma and Le Riche 1986), four of 24 kills were taken into trees by leopards and this was the result of leopard disturbance at the feed site.

Pienaar (1969) suggests that leopard prey is taken up trees to avoid hyaenas and in Mara, Tanzania, leopards often stored kills in trees to avoid competition from lions and spotted hyaenas (Scott 1985).

As Hamilton (1991) reasons, the feeding habits of leopards may vary from area to area and so may post-kill behaviour. That leopard take large carcasses into trees as a result of scavenger disturbance is not wholly true for Klaserie leopards. Although they may at times do so, it is not always the case as the following observations show: a female leopard fed on an impala carcass on the ground for 25 minutes in the presence of one spotted hyaena and on black-backed jackal. A male leopard fed on a common duiker carcass on a fallen tree with no scavengers visible. In the Kalahari Desert, Bothma (pers. comm.) has subsequently found a leopard to drag its prey into a tree also in the absence

of scavenger disturbance. (Smith 1972, Seldensticker 1976, Hamilton

1981, and Bothma and Le Riche 1986). Leopards do not prefer

Pienaar (1969) suggests that another reason leopards take prey into trees is to conceal the carcass from vultures. In this study two impala carcasses in trees, one bare and one in leaf, were subsequently devoured by vultures.

(the Maloti National Park (Smith 1978). Here leopards

Klaserie leopards do not take carcasses into trees with the sole intention of returning to feed. Where scavengers had not devoured the remains of a leopard kill and where kills were reinspected ($n = 8$), leopards returned to carcasses on the ground on five occasions and on one occasion to a carcass in a tree. Leopards did not return to one carcass on the ground and one carcass in a tree. In Zimbabwe, most

prey was disembowelled on route or near the kill site (Smith

As Hamilton (1981) reasons, the feeding habits of leopards may vary from area to area and so may post-kill behaviour. The true reason for Klaserie leopards hauling prey into trees is not known. It is probably a combination of reasons: size of prey, disturbance by scavengers, avoidance of scavengers and the need to feed again.

That leopards most often began feeding on the hindquarters was also found by Bothma and Le Riche (1986).

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(Smith (1978) recorded an adult leopard

From other work (Schaller 1972, Seidensticker 1976, Hamilton 1981, and Bothma and Le Riche 1986), leopards do not prefer specific tree types in different areas up which they take their prey. Nor do they select specific bush types under which they conceal their prey. Where leopards did prefer to feed in a specific area at a certain time of the year was in the Matobo National Park (Smith 1978). Here leopards dragged all kills to a specific kopje or its immediate surroundings during the wet season but moved only eight of 19 kills there in the dry season. Three days in a male leopard's carcass while prey smaller than an Thomson's gazelle. In Klaserie leopards more often disembowelled their prey at the feed site or en route, in some ways similar to both Kalahari Desert leopards and Zimbabwe leopards. In Zimbabwe, most prey was disembowelled en route or near the kill site (Smith 1978) and in the Kalahari Desert, leopards usually disembowelled their prey at the feed site and not en route (Bothma and Le Riche 1984). Leopards as being "efficient and tidy feeders", leaving little of a kill when they had. Hair removal of prey was similar to that found for leopards in other areas (Smith 1978 and Bothma and Le Riche 1984). That leopards most often began feeding on the hindquarters was also found by Bothma and Le Riche (1986). In Klaserie leopards and medium-sized prey did not detain Klaserie. Research elsewhere shows that prey, of a large enough size, can detain a leopard at a kill site or in the vicinity for more than one day. Smith (1978) recorded an adult leopard

to feed for four days on an adult impala and up to six days on a yearling blue wildebeest. In the Kalahari Desert, leopards fed for up to three successive days on a large enough carcass (aardvark) (Bothma and Le Riche 1984). Seidensticker (1976) noted leopards feeding for up to two nights on a carcass in the Royal Chitawan National Park, Nepal, while in the Tsavo West National Park, kills as small as a duiker could detain a leopard for more than one day (Hamilton 1981). In Mara (Scott 1985), an adult female leopard could feed for more than three days on a male impala carcass while prey smaller than an Thomson's gazelle, was usually consumed within 24 hours. In the Serengeti National Park, one leopard remained with a reedbuck for five days and in general, leopards remained by a kill until all edible portions had been eaten (Schaller 1972). Hamilton (1981) records that leopards in the Tsavo West and Meru National Parks made the most of any large kill and were not wasteful feeders. He described these leopards as being "efficient and tidy feeders", leaving little of a kill when they had finished feeding. In contrast, the general impression of Klaserie leopards was that they were wasteful feeders and mostly did not take care to conceal their prey from scavengers. Large prey did not always detain Klaserie leopards and medium-sized prey did not detain Klaserie leopards for more than one day.

This contrasting behaviour of Klaserie leopards not staying

any length of time at a carcass is ascribed to the high potential prey population of the reserve. Similarly, in the Royal Chitawan National Park where there is a large prey biomass and a large proportion thereof in the smaller size classes, leopards also spent relatively little time at a carcass (Seidensticker 1976).

A male in Norton and Henley's (1987) study moved substantially greater daily distances, with 54 per cent being less than

Movements A female male leopard moved a minimum of 43,7 km in 96 hours for an average of 10,9 km per day (Hamilton 1981).

Where tracks were followed throughout the reserve until they were lost and not erased by human, vehicle or game prints, Klaserie leopards were followed for a mean distance of 1,3 km per time (n = 85; range 0,1 - 4,5 km; SD = 0,98 km; CV = 70,39 per cent). Adult females in the study area were tracked for a mean distance of 1,3 km per time (n = 42; range 0,1 - 4,5 km; SD = 1,06 km; CV = 78,95 per cent) and adult males for a mean distance of 1,5 km per time (n = 20; range 0,2 - 3,8 km; SD = 0,95 km; CV = 63,53 per cent). A subadult animal was tracked for a mean distance of 0,9 km per time (n = 14; range 0,1 - 1,7 km; SD = 0,52 km; CV = 60,14 per cent).

These data are mean minimum values as the starting point and end point of each set of tracks was not ascertained. These mean values are understandably less than those calculated elsewhere. In the mountainous areas of Stellenbosch, Cape

Province, Norton and Lawson (1985) recorded mean distances between radio plots of 11,2 km for a male leopard and 6,7 km for a female leopard, while in the Cederberg Wilderness Area, Cape Province, Norton and Henley (1987) recorded a high proportion of two male leopards' daily distances to be less than 3,0 km (73 per cent and 85 per cent). A third male in Norton and Henley's (1987) study moved substantially greater daily distances, with 54 per cent being less than 3,0 km. A Tsavo male leopard moved a minimum of 43,7 km in 96 hours for an average of 10,9 km per day (Hamilton 1981). In the interior of the Kalahari Desert, male leopards moved a mean of 16,1 km per day when no kills were made and females with cubs moved a mean daily distance of 17,1 km when no kills were made. In the Nossob Riverbed of the Kalahari Desert, females moved a mean daily distance of 3,8 km (Bothma and Le Riche 1984). The data of the present study are similar to those presented by Seidensticker (1976) where a female leopard in the Royal Chitawan National Park moved average straight-line distances of 1,41 km and 1,49 km after the birth of her young. Although the data presented here give some indications of mean daily distances moved only continuous observations or complete tracking would show how close they are to the actual distances moved by leopards in the Klaserie Private Nature Reserve. However, it is expected that Klaserie leopards would move comparably shorter daily distances owing to the wooded nature of the terrain and the high potential prey population which would

or once every 7.85 days ($n = 16$; $SD = 5.83$ days) over a period of 110 days. There was no significant difference in the intensity of land use between the whole period February to August and a 110 days when her tracks were first and last

make hunting successful. Hunting success is highly dependent upon the amount of available hunting cover and not so much on prey distribution and density (Kruuk 1986).

range

There were 10 tracks of leopard in the study area. The tracks were identified as follows: 1. A single track of a leopard was identified in the study area on 10 February 1980. 2. A single track of a leopard was identified in the study area on 15 February 1980. 3. A single track of a leopard was identified in the study area on 20 February 1980. 4. A single track of a leopard was identified in the study area on 25 February 1980. 5. A single track of a leopard was identified in the study area on 1 March 1980. 6. A single track of a leopard was identified in the study area on 5 March 1980. 7. A single track of a leopard was identified in the study area on 10 March 1980. 8. A single track of a leopard was identified in the study area on 15 March 1980. 9. A single track of a leopard was identified in the study area on 20 March 1980. 10. A single track of a leopard was identified in the study area on 25 March 1980.

During the first seven months of the leopard study (February 1980 to August 1980) one adult female (female A) and two adult males were identified within the study area. The tracks of a recent adult female (female B) with a single pup were encountered in the northeastern sector of the study area. Lying in the area where the tracks of female A were found.

Excluding times when no tracking was carried out (104 days), the tracks of female A were recorded once every 8.75 days ($n = 16$; $SD = 7.62$ days) from February 1980 to August 1980.