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Abstract: Demographic data collected over the last 4 years show that there has been no significant change in cheetah reproduction or in the adult sex ratio, suggesting that the population is roughly stable. Preliminary data presented here suggests that cheetahs were little affected by the epizootic of canine distemper which swept through the lion population during 1994. Results from playback experiments show that cheetahs actively avoid lions and hyenas, this avoidance could explain their distribution patterns on the plains. Furthermore, lion avoidance behaviour strongly influences female reproductive success. Preliminary results from woodlands show that prey species available to cheetah are likely to be different than on the plains, and that hyena density is lower, whilst lion density is probably higher. The single radio collared male cheetah in this area held a territory of only 27km^2, small by plains standards. There were indications that he was less diurnal than plains cheetahs.

CONTINUATION OF THE CHEETAH PROJECT IN THE

SERENGETI NATIONAL PARK

REPORT TO THE SERENGETI WILDLIFE RESEARCH INSTITUTE

1994

by

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SUMMARY

Demographic data collected over the last 4 years show that there has been no significant change in cheetah reproduction or in the adult sex ratio, suggesting that the population is roughly stable. Preliminary data presented here suggests that cheetahs were little affected by the epizootic of canine distemper which swept through the lion population during 1994. Results from playback experiments show that cheetahs actively avoid lions and hyenas, this avoidance could explain their distribution patterns on the plains. Furthermore, lion avoidance behaviour strongly influences female reproductive success. Preliminary results from woodlands show that prey species available to cheetah are likely to be different than on the plains, and that hyena density is lower, whilst lion density is probably higher. The single radio collared male cheetah in this area held a territory of only $27km^2$, small by plains standards. There were indications that he was less diurnal than plains cheetahs.

INTRODUCTION

Demographic records on known cheetahs using the Serengeti plains and woodland borders have been collected since the mid 1970s when George and Lory Frame started studying Serengeti cheetahs. Tim Caro made their short term study into a long term one in the late 1970s. Since this time records have been collected giving us complete life history information on many individual cheetahs. In addition, over this period, many other aspects of cheetah behaviour and ecology have been investigated. These have included topics such as the development of hunting skills, hunting behaviour and reproduction. The focus of the project over the last two years has been concerned with cheetah ecology. In particular how cheetahs manage to coexist with lions and hyenas.

PERSONNEL

Over the last 4 years Dr Sarah Durant, the principal investigator on the project, has been based in the Serengeti collecting both long term data as well as investigating particular aspects of cheetah ecology. During the past year Isla Graham has helped her collect this data.

POPULATION MONITORING

Cheetahs can be individually recognised by their distinctive spot patterns. Part of the remit of the cheetah project is to keep up records of known cheetahs on the plains in order to monitor the population. Between 1991 and 1994 the number of individually recognised adults seen in any one

year has varied between 45 and 54 individuals (Figure 1a). Much of this variation can be explained in terms of differences in time spent searching for cheetahs, however even without accounting for this, the population is not significantly different from one of constant size (X_3^2=0.89, p>0.1). This is particularly interesting in the light of the recent canine distemper epizootic in the lion population. There is little evidence that cheetahs have been affected by this disease. Two cubs in different families have developed a slight facial twitch, similar to that observed in the lions, however both these cheetahs appear healthy and no other members of their respective families seem affected. There was no significant change in the proportion of males in the population (Figure 1b, X_3^2=1.83, p>0.1) or in the number of cubs (X_3^2=4.06, p>0.1). In addition, there has been no significant change in the proportion of individually recognised females with cubs (Figure 2a, X_3^2=3.32, p>0.1) or in the mean size of litters at first sighting (Figure 2b, ANOVA, $F_{3,68}$=0.51, p>0.1).

During 1994 a large number of territories were occupied and the proportion of territorial males in the population was high (Figure 3a). Four of these territories were held by single males: Maasai kopjes, Gol kopjes, Oldonyo rongai and East Simba kopjes. At the beginning of the wet season a trio of males ousted the resident male at Gol and are now holding this territory. Two territories were held by a pair of males: West Simba kopjes and Naabi. Half the adult males were distributed across coalitions of pairs and trios, compared to only one quarter in 1993 (Figure 3b). However none of these changes were significant (proportion of territorial males; X_3^2=2.06, p>0.1, size of coalitions; ANOVA, $F_{3,54}$=0.55, p>0.1, proportion of males in coalitions; X_3^2=2.92, p>0.1). The lack of variation in any of the demographic parameters investigated suggests that the cheetah population has remained roughly stable over the past 4 years, despite the canine distemper epizootic.

BEHAVIOURAL AVOIDANCE OF LIONS AND HYENAS

Over the last three years ecological data has been collected from scan points in the study area. At each scan point prey within 1 km was counted by species and each carnivore sighted within a maximum 3 km radius recorded. In addition various vegetational and physical factors were noted. Large carnivore visibility was scored in four directions, bush cover was estimated and kopje, drainage lines, ground condition, location, drinking water and time spent scanning were recorded. Whenever a cheetah was seen a scan was taken within 500m of its location. These data show that cheetahs tend to be found in areas where there are no other large predators (Durant 1993).

Over the previous year a series of play-back experiments were conducted to test whether the observed spatial distribution of cheetahs resulted from active avoidance of lions and hyenas. During

these experiments a speaker was mounted 200 m from the cheetah and the cheetahs reaction watched from 100m. Three types of experiment were conducted: Lion play-backs where lion roars were played, Hyena play-backs where hyena whoops were played and Dummy play-backs where the equipment was set up but no recording was played. Play-back experiments were made in the morning before 900am when cheetahs are most active; after this time lion and hyena vocalisations are seldom heard. These experiments were very successful and provided some interesting insights into cheetah ecology.

The results from the play-backs are analysed in detail elsewhere (Durant submitted), but briefly, the experiments demonstrated that lions were by far the greater threat to cheetahs compared to hyenas. Furthermore, cheetahs only responded to hyena calls if they were hungry, suggesting that avoidance of hyenas results from the likelihood of losing their kills to these predators rather than from a direct mortality threat. Most important of all, the number of surviving offspring cheetahs produced was directly related to how far and how fast they moved from lion playbacks but not to hyena playbacks. These results support Laurenson's study that lions have the strongest impact on cheetah populations (Laurenson 1994), moreover they show that lion avoidance could be crucial to the persistence of the Serengeti cheetah population.

THE WOODLAND CHEETAH PROJECT

The study of cheetahs on the Serengeti plains has told us much of what we know about cheetahs in the wild but, because of its focus on cheetahs living in open areas, leaves a glaring gap in our knowledge: Although cheetahs are also known to occur in woodland areas, they have never been studied here, even though this habitat constitutes 75% of the Serengeti ecosystem. During 1993 I made several trips to the woodlands, in order to collect information on prey and predator densities there, and to fit radio collars to any cheetahs I was lucky enough to find. Little work has been conducted in the area this year, apart from routine ground follow up of the single radio collared cheetah, because of TANAPA's withdrawal of permission to radio collar cheetahs in January (this decision is undergoing an appeal). Information gathered to date is summarised in this report.

Methods

The woodlands study area is situated in the northern woodlands. The area starts at Tagora plains and extends northwards to Lobo lodge, eastwards to the park boundary and westwards to the pipeline track. During 1993 and 1994 several trips were made to this area to locate cheetahs, with a

view to fitting radio collars prior to January 1994. Over this time 7 cheetah sightings were made of 8 different cheetahs. In addition, whilst searching for cheetahs, ecological scan data similar to that collected on the plains was collected. At each scan point prey within 1 km was counted by species and each carnivore sighted within a maximum 3 km radius recorded. This data was compared with similar data collected on the plains.

Out of the seven cheetahs seen during this study, only one could be followed sufficiently long to habituate it for darting and thus to fit a radio collar. This cheetah was a male and was relocated monthly by air and on the ground. In addition he was followed continuously over a five day period to assess activity patterns and hunting behaviour.

Results

Prey density

Prey species in the woodlands differed very much in abundance from that on the plains (Figure 4a). Thomson's gazelle and Grant's gazelle were significantly fewer in woodlands (Thomson's gazelle, t_{3186}=13.48, $p<0.001$: Grant's gazelle, t_{3186}=12.94, $p<0.001$), however topi and kongoni combined and impala were significantly more numerous (Topi and kongoni, t_{3186}=2.57, $p<0.01$; impala, t_{3186}=17.48, $p<0.001$).

Predator density

Lion density appeared to be similar in the woodlands compared to the plains (Figure 4b). However, the lower visibility in the woodlands means that there was a reduced chance of seeing lions in this habitat, therefore the results were underestimates. Hyena density was significantly lower in the woodlands compared to the plains (X^2_1 =6.39, $p<0.05$), but the previous proviso also applies to hyenas, and the observed difference may result from the lower visibility.

Cheetah sightings

Cheetahs were rarely seen in woodlands compared to the plains. However this almost certainly results from the low visibility in woodland habitat. For example, whilst most cheetahs were seen under trees in the woodlands (71%), most cheetahs were seen in the open on the plains (93%). In addition, whereas on the plains it was common to see cheetahs at large distances (46% were seen at 1km or more), only one of the seven cheetah sightings was seen at this distance (14%). In fact in the woodlands most cheetahs were seen accidentally while driving (71%). Therefore, although cheetahs are seen rarely, the visibility in the woodlands and the tendency of cheetahs to be in thick

bush means that they could still be numerous in this habitat and it is impossible to say from this data alone whether cheetah density is higher or lower than on the plains.

Radio collaring

Out of the seven cheetah sightings, one male was fitted with a radio collar. This cheetah was followed and relocated over 2 days, allowing him to become sufficiently habituated to be darted by the parks veterinarian. During immobilisation his length nose to tail and his girth were measured as 206cm and 75cm respectively, much larger than the means of 191cm and 69cm found in plains cheetahs (Caro 1994).

The collared cheetah held a territory to the north of Tagora plains, covering approximately 27km^2 (Figure 5a). At dusk on 30.11.93 he made one quick foray 5km north, and returned early the following morning. He didn't scentmark in this area (Figure 5b) and it is unlikely that it constituted part of his territory (see Caro 1994). The size of his territory is nearly half that observed on the plains, where males hold territories of a mean size of 48km^2 (Caro 1994). In August 1994 he was found 7 km north of his territory, and was even further north in September, despite a high density of prey on his territory. The most likely explanation for such extreme movement is that he has been ousted by another territorial male and is now floating.

As well as monthly radio tracking and relocation, the collared cheetah was followed continuously over 5 days. During this time his location and activity was recorded every 5 minutes, and any hunting behaviour noted. Very unusually compared to plains cheetahs he hunted at least twice overnight. This was obvious as his belly size increased from last light in the evening (1900) to relocation in the morning (630) over two days out of the total of five in which he was followed. Out of 6 sightings of males on the plains over an identical time interval, only one individual showed an increase in belly size overnight (17%). During daylight he made two hunting attempts, once on wildebeest which failed, and once on a zebra foal, which succeeded. Further evidence that he was active at night is that he moved quite far overnight (Figure 6). The distance he travelled at night was greater than that of plains living cheetahs relocated over the same time interval (n=9, mean 1.54km, s.e. 0.28).

DISCUSSION

Over the last 4 years the cheetah population on the plains has remained roughly stable, with around 50 adults seen in any given year. Actual numbers of cheetahs using the plains and woodland borders

will be slightly higher than this since some cheetahs are not seen every year. Scan data gathered to date indicates that cheetahs are found in areas with low numbers of lions and hyenas (Durant 1993). Play-back experiments suggest that this pattern results from active avoidance of lions and hyenas. Furthermore that lions are the major threat to cheetahs, and are avoided regardless of whether cheetahs are hunting, whereas hyenas are only avoided by hunting cheetahs, presumably in order to reduce the threat of losing their kill to these predators. Scan data has yet to be analysed in full, but these results may ultimately help explain the large ranging patterns and spatial distribution of cheetahs on the plains and help understand the major factors governing their numbers. Avoidance of lions and hyenas may explain the low impact of the canine distemper epizootic on the cheetah population. Avoidance means that interaction rates with other carnivores are so low it is unlikely that cheetahs would contract the disease.

The results obtained from the woodlands study are extremely preliminary, however there is no evidence that cheetahs do particularly badly in woodland areas. In fact, all the evidence collected to date suggests they may do better in woodlands. The tendency towards nocturnal activity patterns seen in the single radio collared cheetah agree with anecdotal reports from colleagues working in woodland areas in southern Africa,. which suggest that nocturnal behaviour is the norm there (Mills pers. comm., Stander pers. comm.). The diurnal activity patterns seen on the plains could be a response to surviving in more open habitats with a higher density of potential scavengers such as hyenas. Also, interestingly, this one cheetah was markedly above the mean size of males found on the plains. The maximum size of a plains living male was 209cm (Caro 1994), only 3cm longer than the woodlands male. Another two males seen in an adjacent territory looked similar in size to this male.

There are several reasons to suggest that cheetahs may do better in woodland habitats. The increased cover should help cheetahs and their cubs avoid detection by lions, aiding cub and adult survival and reducing the loss of kills. The data presented in this report suggests that hyenas are less common in the woodlands, in agreement with Bertram (1979). This would reduce the rate of loss of kills and cub mortality. In addition, although data here suggest that lion numbers seem similar, if not higher than those on the plains, predation of cheetah cubs by lions is a major cause of cheetah mortality (Laurenson 1994), and any reduction in the detection of cheetahs by lions would increase survival.

The density of preferred prey (Thomson's gazelle on the plains) is lower in the woodland study area, however the density of alternative prey such as impala is higher. In fact, the impala density in

the woodlands is likely to be even higher than that reported as the scan data was obtained from relatively open areas and impala are browsers, living in woodlands. In Nairobi and Kruger National Parks impala are the principal prey species of cheetah (Eaton 1974, Pienaar 1969). The extent to which cheetahs depend on impala in the woodlands should be quantified so that possible threats to the population due to changes in prey populations can be predicted. Obviously a sample size of one radio collared cheetah is too small to draw any conclusions and these results are extremely preliminary but merit further investigation..

ACKNOWLEDGMENTS

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Fig. 1a Number of recognised cheetahs seen each year

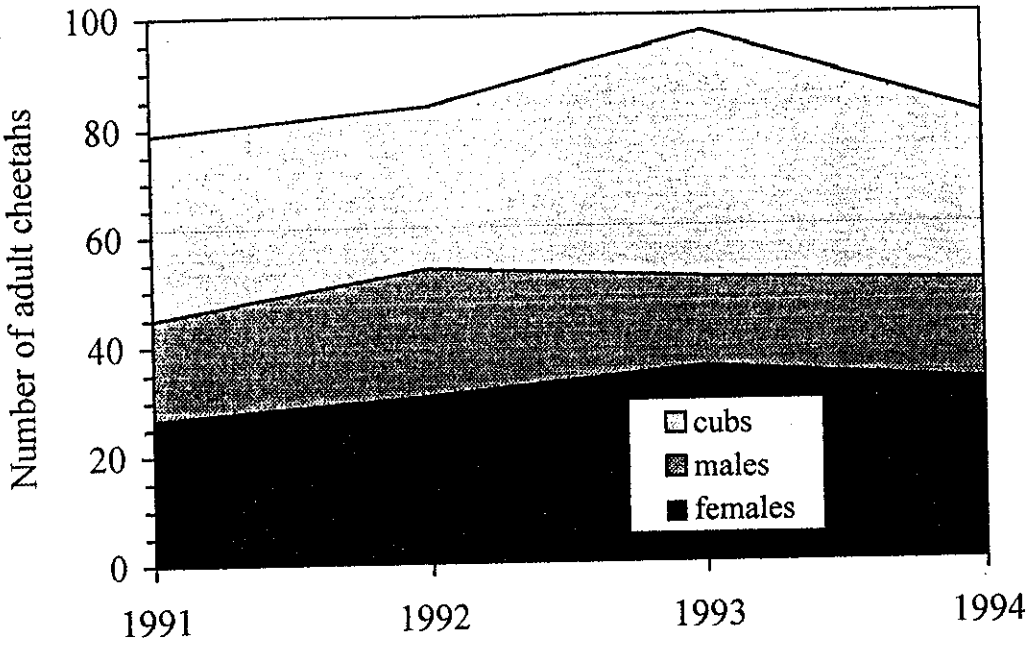

Fig. 1b Proportion of recognised adult males in the population

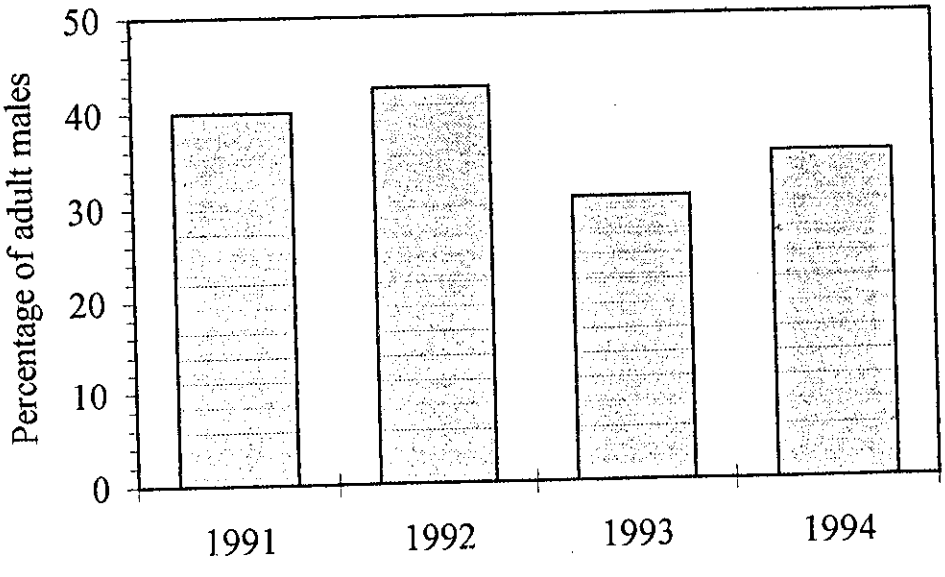

Fig. 2a Proportion of recognised adult females with cubs

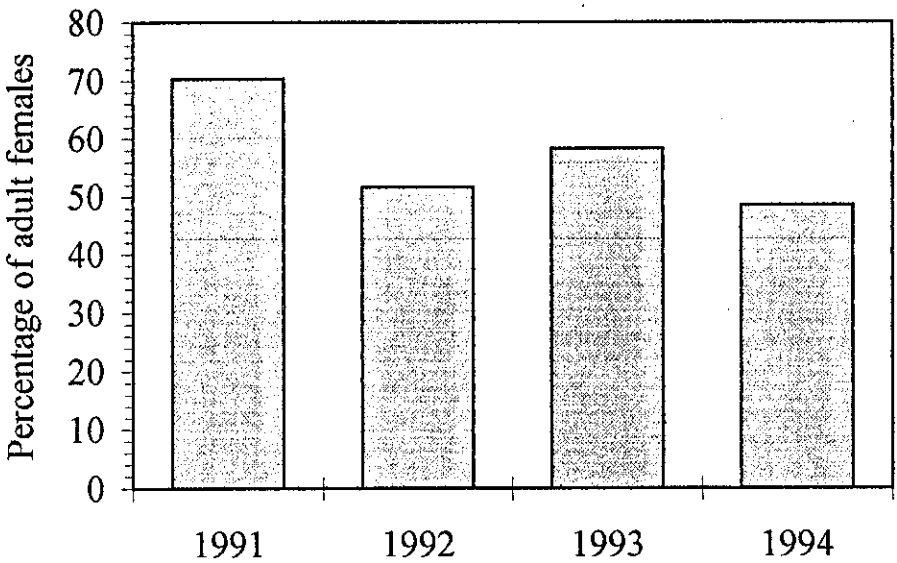

Fig. 2b Mean litter size of recognised females with cubs

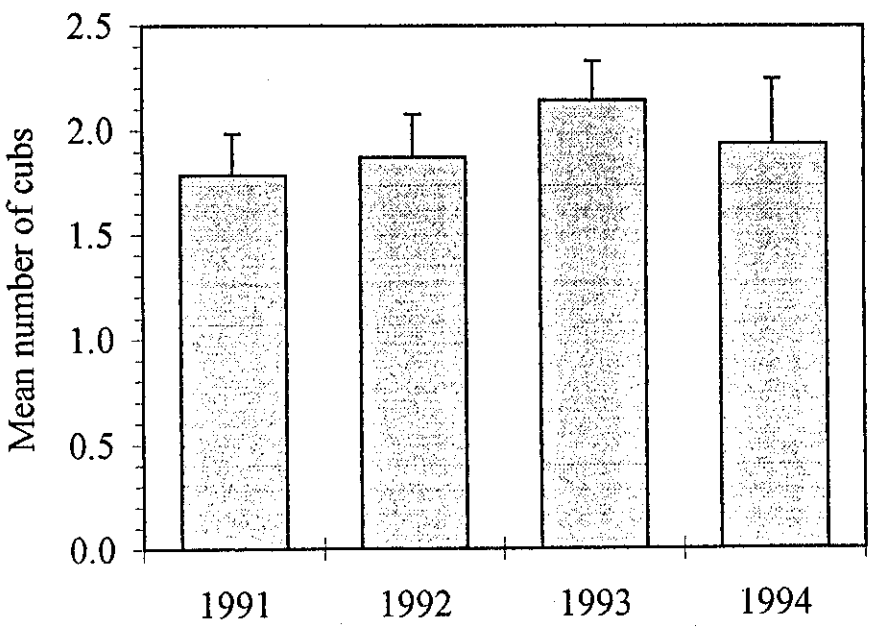

Fig. 3a Number of recognised territorial and floating adult males seen each year

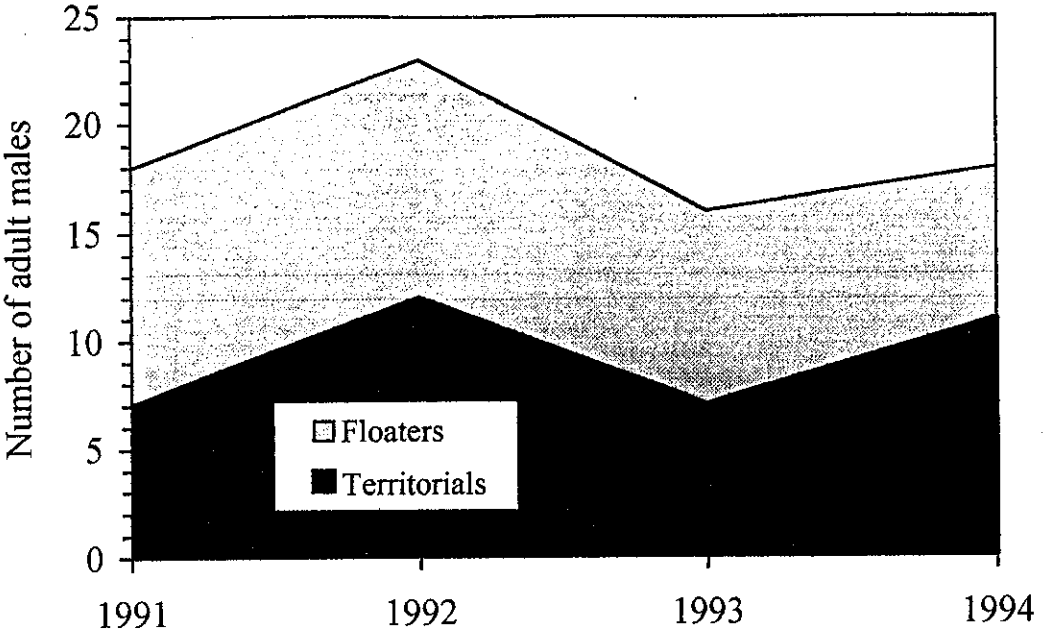

Fig. 3b Number of recognised adult males in coalitions of different sizes seen each year

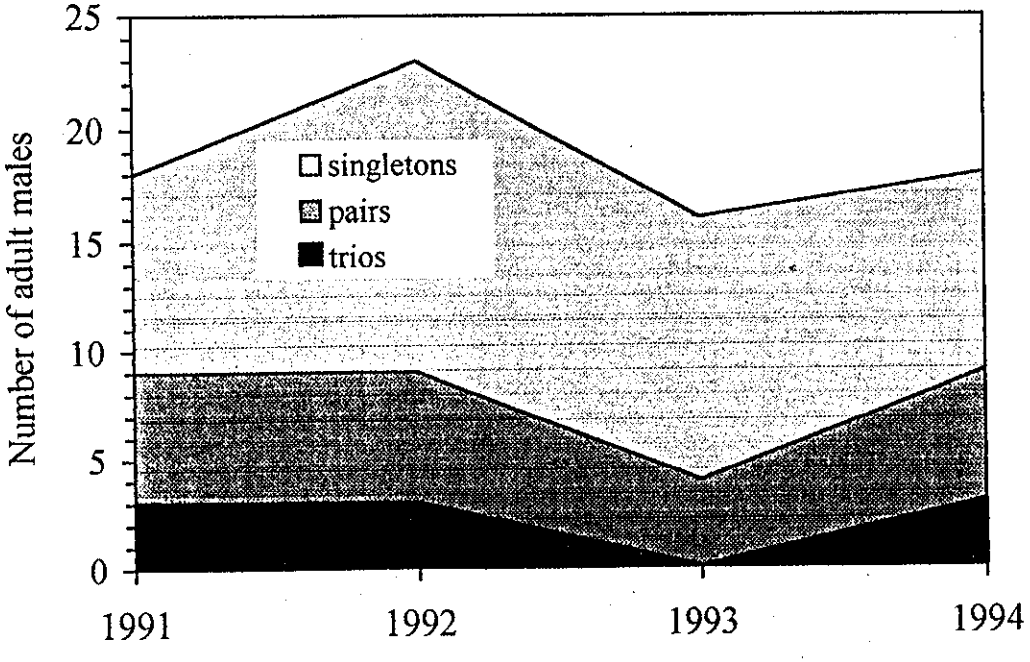

Figure 4a. Number of animals seen in a 360 degree circle within 1km from 3102 scan points on the plains and 85 in the woodlands.

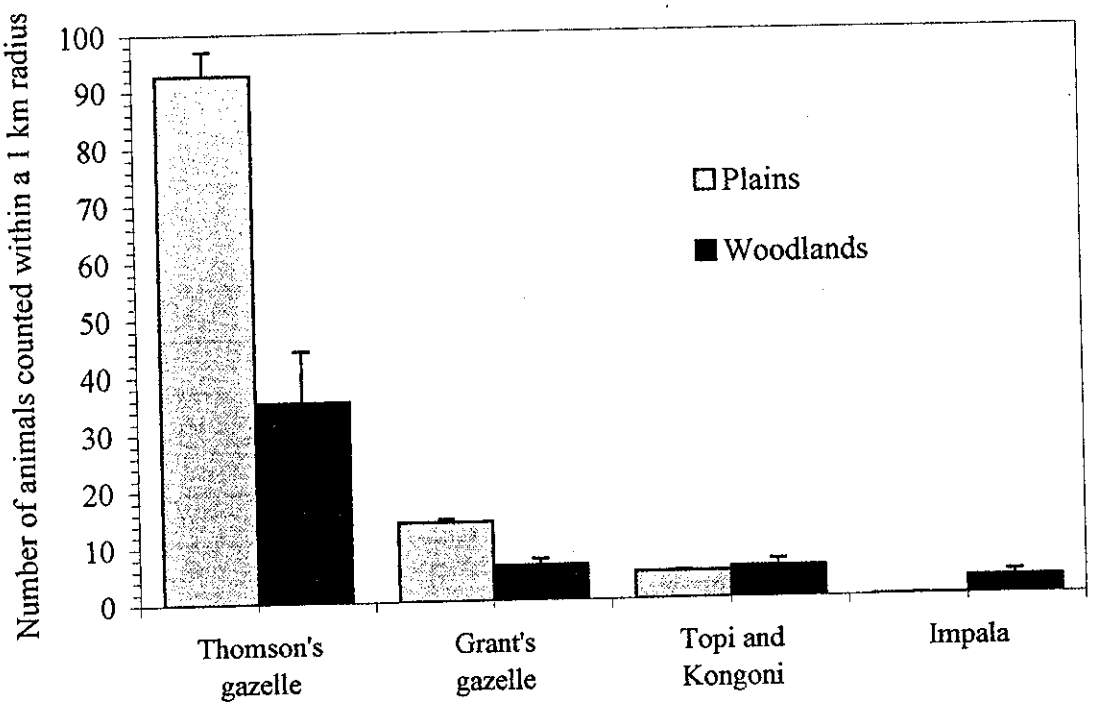

Figure 4b. Percentage of 3102 scans taken on the plains and 85 scans in the woodlands with one or more lion or hyena within 1 km

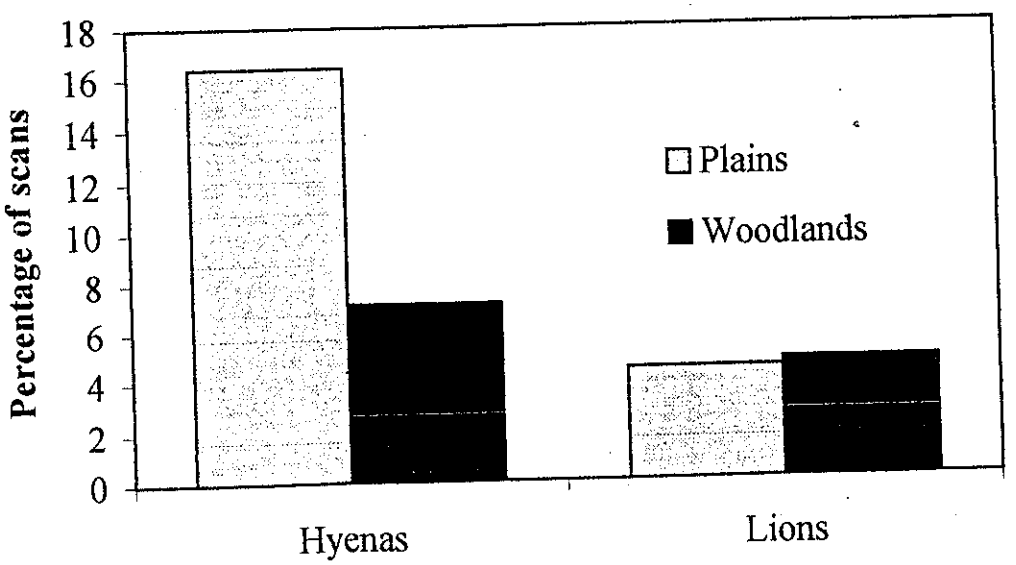

Figure 5a. UTM locations of a single radio collared male cheetah in the northern woodlands between 9/93 to 9/94.

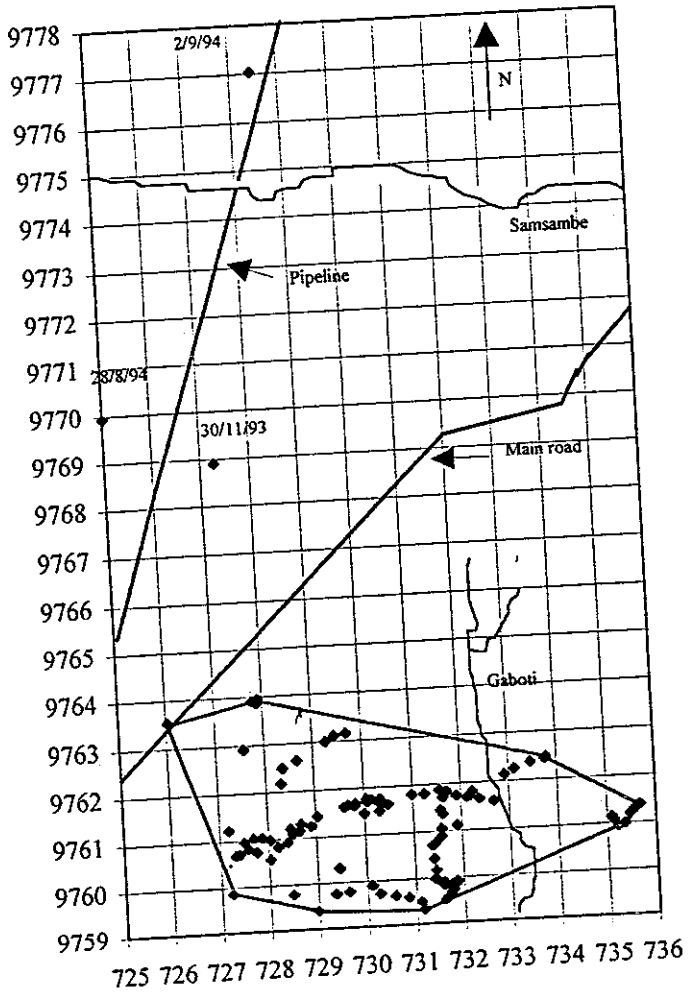

Figure 5b. UTM scent marking locations of the single radio collared male cheetah in Figure 5a.

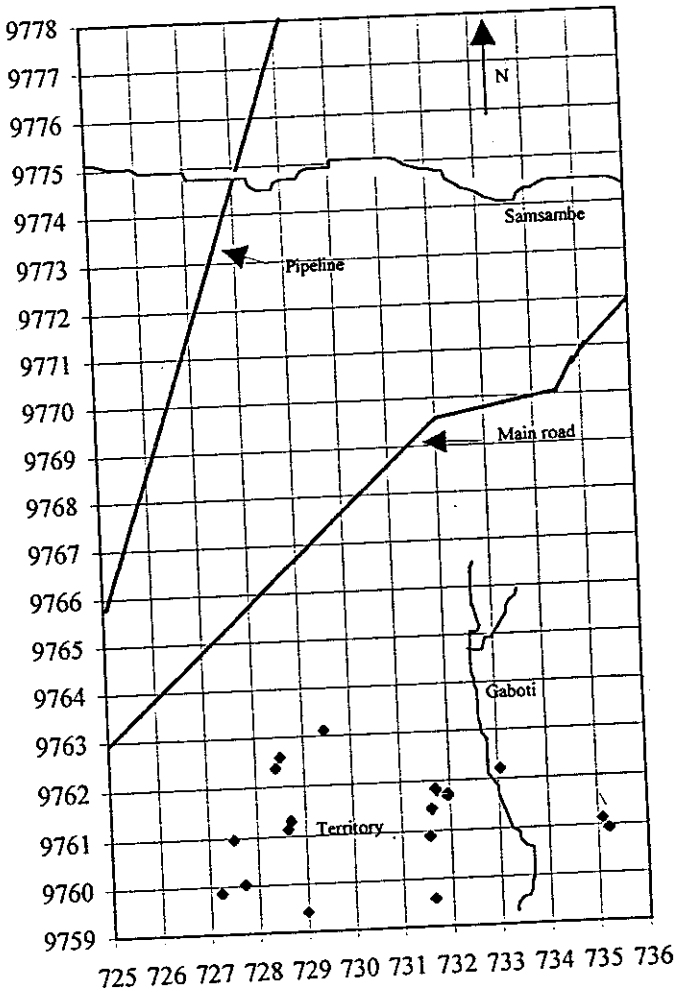

Figure 6. Mean distance a woodland living radio collared cheetah travelled during 12 hour periods over night and day (bars denote standard errors). The cheetah was observed over a 5 day period.