

# The status and conservation of the cheetah *Acinonyx jubatus* in Tanzania

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## Abstract

This is the first assessment of the status of cheetahs, *Acinonyx jubatus*, in Tanzania since 1965. It completes a series of recent studies in Kenya, Uganda, and Malawi to provide an overall understanding of the species' status in East Africa. Interviews with 370 informants yielded 1050 cheetah sightings. Eighty nine percent of all sightings were made in 1990–1994, and 39% of all sightings occurred in protected areas. All-adult groups contained  $1.92 \pm 0.04$  S.D. individuals; the average number of dependent cubs was  $2.63 \pm 0.08$  S.D.; and the cub-to-adult ratio was 0.34. Since the 1960s, the distribution has remained stable overall with possible reductions in central Tanzania. No definite population trends were detected. With an estimated 569–1007 cheetahs, Tanzania emerges as a sanctuary for the species worldwide. However rangelands, which may hold half of Tanzania's cheetahs, are undergoing rapid degradation. This precarious situation calls for the establishment of a nationwide monitoring program. Distribution map and population sizes from this study could serve as a baseline for monitoring the species' status. © 2002 Elsevier Science Ltd. All rights reserved.

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## 1. Introduction

The cheetah is one of the rarest East African carnivores due to a combination of biological and anthropogenic factors. Intraspecific behavior (McLaughlin, 1970, Caro, 1994), high energetic requirements (Eaton, 1974), and low interspecific competitive abilities (Laurenson, 1995, Durant, 1998) contribute to generating much lower population densities than those of co-existing large predators with the exception of wild dogs (Creel and Creel, 1998). Habitat destruction, prey reduction, and direct persecution on rangelands virtually eliminated the cheetah in Asia and in the northern part of Africa over the twentieth century (Myers, 1975). These factors continue to severely threaten the remaining sub-Saharan populations (Nowell and Jackson, 1996).

Tanzania is one of the last sanctuaries for the species. The country was estimated to contain up to one tenth of the total number of cheetahs in the world (Myers, 1975). The Serengeti ecosystem could harbor the largest protected cheetah population worldwide, and the vast acacia savannas of Northern Tanzania have the potential to support relatively high numbers of cheetahs (Hamilton, 1986). Offering large areas of suitable habitat and a relatively effective network of protected areas, Tanzania could play a critical role in the conservation of cheetahs in East Africa.

Despite its importance to conservation efforts, recent information on the status of the species in Tanzania is lacking. The last comprehensive assessment of the distribution and abundance of the cheetah in Tanzania was done in 1965 (Graham and Parker, 1965). Later updates, which were given as part of a continental survey of the cheetah's status (Myers, 1975) and in an account of the species' natural history in East Africa (Kingdon, 1977), included little new data on the status of the species in Tanzania. Since 1967, the human population of Tanzania has grown from 12.3 to 29.5 million (Kaplan, 1978, www.mshand.geog.gla.ac.uk).

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Due to this rapid increase in human population, and the resulting pressure it puts on the country's rangelands, an update of the status of the cheetah is merited.

This paper presents the current status of the cheetah in Tanzania. It reports on distribution, density estimates, demographic parameters, and perceived trends. The goal of this work is to provide a baseline for monitoring the status of the species in the country. It also completes a series of recent assessments of the cheetah's status in neighboring Kenya (Gros, 1998), Uganda (Gros and Rejmánek, 1999), and Malawi (Gros, 1996) thereby procuring a basis for regional integrated conservation planning for the East African region.

## 2. Methods

### 2.1. Field interviews

The status of the cheetah was determined in Tanzania through field-interviews with 370 people between September 1993 and May 1994. The field interview method has been tested for accuracy (Gros et al., 1996) and was described in detail in previous publications (Gros, 1998; Gros and Rejmánek, 1999). My Tanzanian assistant, Charles Mtema, and I drove throughout the country to contact informants: 134 protected areas' wardens and rangers, 90 traditional pastoralists, 52 tour operators and guides, 29 professional hunters, 28 expatriate farmers, artists, and missionaries, 19 wildlife administrators, and 18 wildlife researchers. The sampling effort was concentrated in the northern part of the country where previous studies (Graham and Parker, 1965; Myers, 1975) had reported large numbers of cheetahs. Areas where the species were likely to occur at low densities were surveyed only if they were relatively easy to access. However, interviews yielded data for most of the non-visited areas. When appropriate, I ascertained the respondent's knowledge of carnivore species in the region by asking him/her to name species on a montage of carnivore pictures created for this purpose. The respondent was then asked to report all cheetah sightings that he/she could clearly remember. Locations of sightings were pinpointed on a 1/1,250,000 map of Tanzania (George Philip Ltd. 1973). When needed, locations were extrapolated from walking time to major landmarks. For each sighting, the respondent was asked to specify the date of observation, the total number of cheetahs observed, the number and sex of adults among them, and the number and the relative size of the cubs (size 1 = gray cub to jackal-sized cub; size 2 = jackal size to 2/3 of adult size cub; size 3 = 2/3 of adult size to full sized). Respondents known to have stayed 10 years or more in a given area were asked if they thought that the number of cheetahs in this area had increased, remained stable, or decreased over time. C. Mtema and myself

independently rated respondents for reliability on a 1–4 scale. Respondents received 0, 0.5, or 1 point for four aspects of their contribution: (1) knowledge of the species inferred from picture recognition and behavioral description, (2) precision of answers, (3) absence of error or contradiction in answers, and (4) willingness to participate. I discarded information from respondents ranked two or lower by C. Mtema or myself.

### 2.2. Cheetah status

#### 2.2.1. Distribution

A map of Tanzania regions (Macmillan, 1987), a map of Tanzania protected areas, and a tracing of the field map of cheetah sightings were scaled to approximately 1:6,500,000 to fit an 8.5×11 inches page format, and overlapped to create a distribution map of the cheetahs in Tanzania.

#### 2.2.2. Density estimates

**2.2.2.1. Actual densities.** Fifteen areas of Tanzania (Table 1) had a large enough sighting-to-area ratio that density estimates could be derived from the sightings reported using the interview method of assessing carnivore density (Gros et al., 1996). This method produces densities representing 75–100% of densities derived from baseline demographic data generated by long-term field studies. Such demographic baselines are the closest possible approximations of total counts for wild populations of large carnivores. The interview method assumes that all similarly composed sightings describe the same animals except the sightings made simultaneously in two areas separated by more than 5 km, the average distance a cheetah travels daily (McLaughlin, 1970). After eliminating all potentially redundant sightings at a given site, cheetah density was computed by adding up all cheetahs in the remaining sightings and by dividing this figure by the area of the site in km<sup>2</sup>.

**2.2.2.2. Total number of cheetahs—lower bound.** To obtain a lower estimate of cheetah population size, I considered only the areas with established populations. I defined an established population as one in which reports of cheetahs were frequent, groups of adults were large, and observations of young were numerous. Areas that cheetahs visit intermittently and those with declining populations primarily produce few reports of lone adults (personal observation). Areas with established populations included: 11 areas for which I had total estimates through the interview method (Table 1a); the Serengeti National Park for which I used Caro and Durant's (1995) estimate; Maswa Game Reserve and Ikorongo Game Controlled Area, which are extensions of Serengeti National Park, and to which I applied the density estimated for this national park (0.0167 cheetah/km<sup>2</sup>; Caro and Durant, 1995), and Ruaha National

Table 1  
Estimated sizes of cheetah populations in various areas of Tanzania and population estimate for the entire country

	Area in km <sup>2</sup>	Density	Number
<i>a. Areas with established cheetah populations</i>			
Grumeti G.C.A.	598	0.0251	15
Ikorongo G.C.A.	803	0.0167	13
Loliondo G.C.A.	6056	0.0043	26
Longido G.C.A.	1433	0.0119	17
Lunda G.C.A.	4600	0.0043	20
Maswa G.R.	2200	0.0167	37
Mkomazi G.R.	3276	0.0052	17
Mto-wa-Mbu G.C.A.	2347	0.0102	24
Natron G.C.A.	6789	0.0040	27
Ngorongoro C.A.	8288	0.0034	28
Ruaha NP. (southeast sector)	900	0.0155	14
Ruvu&Kitwei G.C.A.	9058	0.0013	12
Serengeti N.P. (central plains)	1738	0.0438	76
Serengeti N.P.	14763	0.0167	250
Simanjiro G.C.A.	7703	0.0058	45
Tarangire N.P.	2600	0.0092	24
	<i>Minimum number in Tanzania</i>		569
<i>a. Areas where cheetahs are occasionally reported</i>			
Arusha N.P.	137	0.0013	0
Katavi N.P.	2253	0.0013	3
Kisigo G.R.	5267	0.0013	7
Lake Manyara N.P.	100	0.0013	0
Luganzo G.R.	2500	0.0013	3
Mikumi N.P.	3230	0.0031	10
Mkata Plains O.A.	5900	0.0013	8
Miele G.R.	4096	0.0013	5
Muhasi G.R.	2200	0.0013	3
Ruaha N.P.(but SE sector) & Rungwa G.R.	21,031	0.0024	36
Selous G.R.	50,000	0.0013	65
Ugalla G.R.	5178	0.0013	7
Dodoma Region	43,908	0.0013	57
Shinyanga Region	51,802	0.0013	67
Singida Region	43,457	0.0013	56
Tabora Region	76,081	0.0013	99
Usangu O.A. & Utengule G.C.A.	6300	0.0017	11
	<i>Total in areas with occasional reports</i>		438
	<i>Upper bound limit for total estimate</i>		1007

Park and Rungwa Game Reserve for which I used the educated guess of 50 by C. Fox (Manager of a wildlife viewing lodge in Southern Ruaha National Park and a life-long visitor to the park).

*2.2.2.3. Total number of cheetahs—upper bound.* To obtain an upper estimate of cheetah population size, I added my lower bound estimate to the numbers estimated for the 16 areas with only scant cheetah reports (Table 1b). The numbers of cheetahs in Mikumi National Park, and in the complex Usangu Open Area-Utengule Game Controlled Area were derived from interviews. I multiplied the combined area of the 14 remaining areas (minus the overlap between regions and protected areas) by the lowest cheetah density documented in this study (0.0013 cheetah/km<sup>2</sup>). Areas in km<sup>2</sup> were obtained from the literature (Sinclair, 1995;

Serengeti Research Institute reports; African Wildlife Foundation and GTZ tourist booklets) or estimated from the George Philip map of Tanzania (1973) and the Atlas of Tanzania (Macmillan Publishers, 1987) using a modified acreage grid (Milton, 1942).

#### *2.2.3. Status estimators*

Based on the sightings collected, I computed for the entire country: (1) an average adult group size, the average number of adults in all-adult groups reported; (2) an average litter size, the average number of dependant cubs accompanying their mother in all family groups reported; (3) a cub-to-adult ratio, the total number of cubs over the total number of adults in all sightings; and (4) a percent of observations with cubs, the total number of observations including cubs over the total numbers of observations. I compared the

value of these four estimators in this study and in that of Graham and Parker (1965).

### 3. Results

#### 3.1. Distribution

The seven national parks, eight game reserves, and one conservation area where cheetahs were reported in this study and the locations of all 229 cheetah sightings made outside of these protected areas are shown on Fig. 1. Cheetahs were relatively widespread in the northern region of Tanzania, absent along the borders with Rwanda and Burundi in the northwest and along the southern border with Mozambique, and rare elsewhere

in the country. The distribution of cheetahs in protected areas (National Parks, Game Reserves, and Conservation Areas) in this study is consistent with that reported by Graham and Parker in 1965. Arusha National Park is the only protected area where I registered the occasional presence of cheetah that the 1965 study did not mention. This park, however, was included in the cheetah's range by Myers (1975). Although this study confirmed the current presence of cheetahs in numerous locations where they used to occur outside of protected areas in the 1960s, it did not document cheetah presence in 12 areas of the past distribution of the species (Fig. 1; Appendix).

I collected twice as many cheetah sightings country-wide ( $n=1050$ ) as Graham and Parker (1965;  $n=531$ ). Total number of sightings reported were larger in 1994

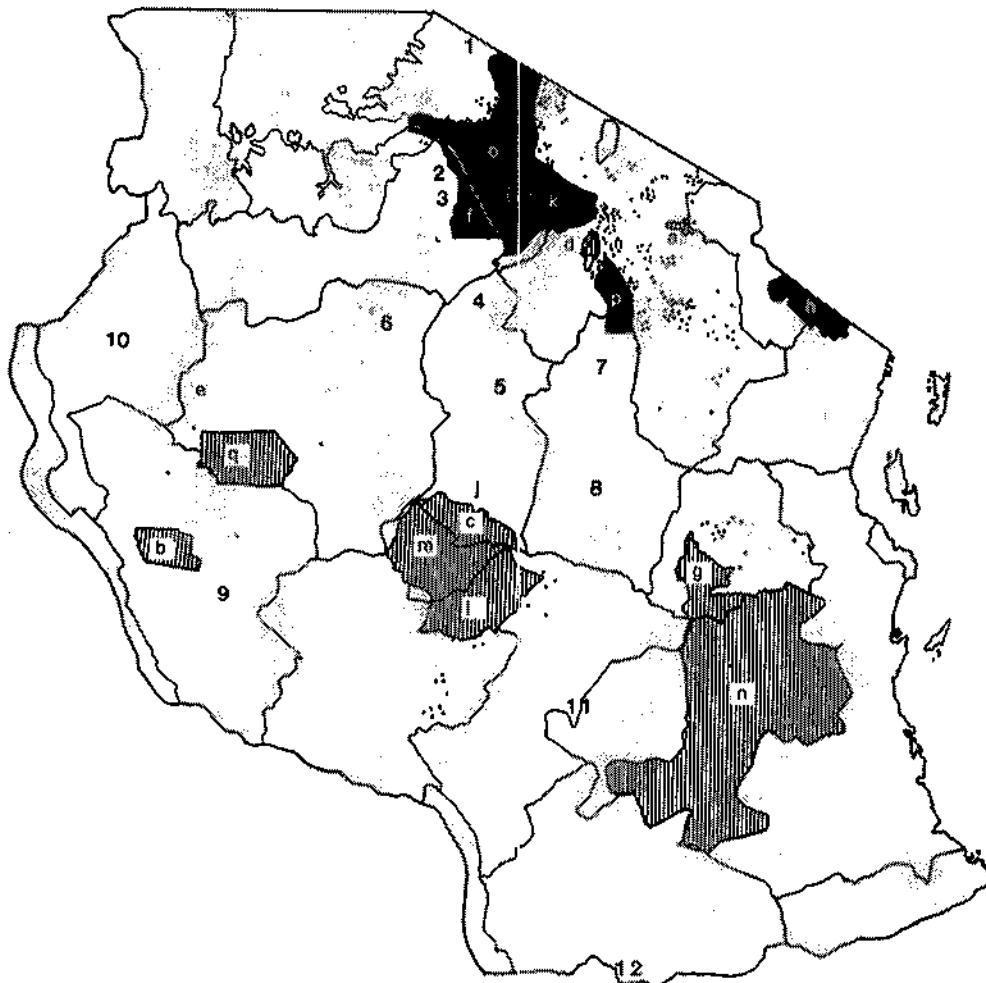


Fig. 1. Current distribution of the cheetah in Tanzania based on recent sighting locations. Dots pinpoint the locations of sightings made outside of protected areas. Solid black indicates protected areas with established cheetah populations and shaded pattern marks protected areas where cheetahs are observed occasionally. Letters indicate protected areas: a. Arusha National Park, b. Katavi National Park, c. Kisigo Game Reserve, d. Lake Manyara National Park, e. Luganzo Game Reserve, f. Maswa Game Reserve, g. Mikumi National Park, h. Mkomazi Game Reserve, i. Mlele Game Reserve, j. Muhesi Game Reserve, k. Ngorongoro Conservation Area, l. Ruaha National Park, m. Rungwa Game Reserve, n. Selous Game Reserve, o. Serengeti National Park, p. Tarangire National Park, q. Ugalla Game Reserve. Numbers show the 11 locations outside of protected areas where previous studies reported cheetahs and for which I did not obtain recent sightings: 1. West along Kenya border, 2. Duma River, 3. Simiyu River, 4. Mkalama, 5. Singida (town), 6. East of Nzega, 7. Kondo, 8. Dodoma (town), 9. Rift Valley north of Uvanda Game Reserve, 10. Area of Kigosi and Moyowosi Game Reserves and Burundi border in Kigoma Region, 11. Kilombero swamp area, 12. Border with Mozambique in Ruvuma Region.

than in 1965 in all protected areas for which figures were available for comparison (Appendix). The proportion of total sightings made outside of protected areas (i.e. in current game controlled areas, open areas, and non-designated areas) was similar in both studies 33% in 1965 and 39% in 1994.

3.2. Total number of cheetahs in Tanzania and cheetah density in protected areas

Summing up the estimates for established populations yielded a lower bound number of 569 cheetahs in the entire country (Table 1). The estimate for the areas where cheetahs were occasionally reported was 438 cheetahs. Adding up these two figures gave an upper bound estimate of 1007 cheetahs in Tanzania.

Cheetah density in Tanzania national parks and non-hunted reserves was  $0.015 \pm 0.008$  S.E. ( $n=5$  protected areas), a figure significantly lower than in neighboring Kenya ( $0.052$  cheetah/km<sup>2</sup>,  $n=6$ , Gros, 1998; Mann-Whitney  $U$  test;  $U=33$ ,  $P=0.016$ ).

3.3. Trends in cheetah numbers

Thirty five percent of the 92 responses suggested a decrease in cheetah numbers over the last 10+ years in the areas of Tanzania about which the respondents were knowledgeable, while 35% of the responses suggested no change, and 30% an increase in cheetah numbers. Interestingly, in populations perceived as ‘increasing’, the percent of observations including cubs (22.3%,  $n=6$ ) was significantly higher than in populations

perceived as ‘decreasing’ (6.5%,  $n=6$ , 8; Mann Whitney  $U$  test;  $U=0$ ;  $P=0.0007$ ).

3.4. Analysis of sightings

The 370 people interviewed provided 1050 cheetah sightings, 89% of which were made between 1990 and 1994. The number of adults and cubs observed was specified for 990 of these sightings (Fig. 2). The average number of adults in all-adult groups was  $1.92 \pm 0.04$  S.E. ( $n=776$  groups), and the average number of cubs accompanying their mother  $2.63 \pm 0.08$  S.E. ( $n=214$  family groups). The cub-to-adult ratio nationwide was 0.34 ( $n=2184$  cheetahs) and the percent of observations with cubs in the data set was 22 ( $n=990$  sightings). All four demographic parameters were comparable in this study and in Graham and Parker’s 1965 East African survey (Average adult group size 1.85,  $n=972$ ,  $Z=1.34$ ,  $P=0.18$ ; Average litter size 2.72,  $n=252$ ,  $Z=0.085$ ,  $P=0.45$ ; Cub-to-adult ratio 0.33,  $n=2784$ ,  $\chi^2=0.022$ , d.f. = 1,  $P=0.88$ ; Percent of observation including cubs 20.65,  $n=1225$ ,  $\chi^2=0.305$ , d.f. = 1,  $P=0.58$ ).

4. Discussion

4.1. Changes in cheetah distribution outside of protected areas

Cheetahs are relatively widespread in the northern savannas of Tanzania but scarcely observed in southern woodlands. They are absent from most of the coastal

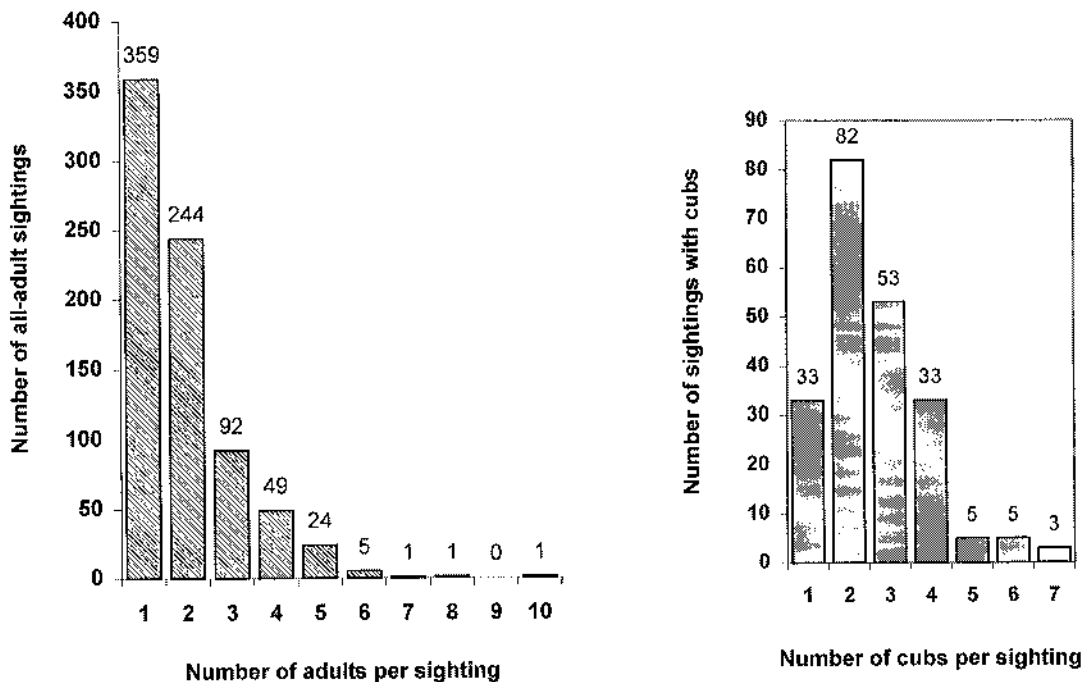


Fig. 2. Composition of the 990 detailed sightings of cheetahs in Tanzania collected in this study.

districts, from the western regions bordering Rwanda and Burundi, and from the southern regions bordering Mozambique. This distribution pattern prevailed 30 years ago (Graham and Parker, 1965), and partly reflects the distribution of low human population densities (Macmillan, 1987) and the extent of the arid and semi-arid eco-climatic zones (Pratt and Gwynne, 1977). My results establish that cheetahs still occur in all the protected areas that they inhabited in 1965. Conversely, the species may not have retained its full distribution outside of protected areas. Cheetahs were not reported in twelve areas of their former distribution (Fig. 1, Appendix). The concentration of such areas in central Tanzania suggests severely reduced population sizes or local extinctions in that region. I recommend surveying for signs of cheetah presence at all localities of the species' past distribution for which I have not obtained recent sightings. Surveys should include seeking tracks, scats, and direct observations of cheetahs. Search areas should be selected based on both habitat suitability and indigenous knowledge. The results of these surveys would help refine my distribution map to create an adequate spatial reference for future countrywide monitoring of the cheetah's status.

#### 4.2. Large total number of cheetahs

Tanzania is one of the countries with the largest number of cheetahs in the world. My estimate of 569–1007 cheetahs places Tanzania total number of cheetahs between that of Kenya (1273–2856 cheetahs, Gros, 1998) and that of Uganda (66–327, Gros and Rejmánek, 1999), consistently with Myers' rankings for East Africa in 1975. Outside of Kenya, only Namibia is known to harbor more than a 1000 cheetahs (Morsbach, 1987). Moreover, only Botswana (Gros, unpublished data) and Zambia (Myers, 1975) may have a total number of cheetahs approaching the figure I estimated for Tanzania. I could not assess a trend in the total number of cheetahs in the last 20 years because Myers' total estimate of 500–1500 cheetahs in 1975 was an educated guess. This highlights the importance of quantifying and standardizing field methods of estimating endangered species status. I could, however, invalidate Myers' prediction that cheetahs would number as few as 400 in Tanzania by the 1980s, since my lower bound estimate was a minimum figure.

#### 4.3. Low cheetah density in protected areas

Cheetah population density is low within the protected areas of Tanzania. Except in the Serengeti National Park, density estimates for Tanzania national parks (0.0031–0.015 cheetah/km<sup>2</sup>, Table 1) were lower than the average density in national parks elsewhere in Africa (0.021 cheetah/km<sup>2</sup>, Gros et al., 1996). In addition

cheetah density in national parks and non-hunting reserves was over three times lower in Tanzania than in neighboring Kenya. This latter difference can be explained by ecological and circumstantial factors. Two out of the five Tanzanian protected areas included in the comparison lie in the miombo savanna biome, which is only marginally suitable for cheetahs (Myers, 1975). Conversely, all of the Kenyan protected areas considered were in acacia savannas or dry steppes, which are considered prime cheetah habitat (Hamilton, 1986). Circumstantially, a third protected area of Tanzania was likely to have sub-optimal cheetah density since prey populations were in the process of recovering after hunting was banned there in 1989. Spatial scaling certainly contributes to explain that lower densities were reported for the Tanzania than for the Kenya protected areas, since the Tanzanian protected areas were considerably larger (900–3276 km<sup>2</sup>; Table 1) than the Kenyan ones (113–1510 km<sup>2</sup>; Gros et al., 1996). Densities reported for large carnivores, including cheetahs (Smallwood and Schonewald, 1996), tend to decline with the size of the study area following a log<sub>10</sub> relationship (Schonewald-Cox et al., 1991). Yet the dramatic change in slope between the log<sub>10</sub>[density]/log[area] curve for Tanzania and that for Kenya (Fig. 3) reinforces that other factors, most likely habitat suitability, play a role in the observed difference in density between the protected areas of the two countries.

#### 4.4. Population stability in protected areas?

Overall, cheetah numbers were perceived to be stable in protected areas with established cheetah populations (Table 1, Fig. 1), whereas cheetahs were too rare in other protected areas for people to perceive a trend. Past population estimates exist for only two of the 15 protected areas where the species occurs: Serengeti and Tarangire National Parks. Comparisons with current estimates suggest population stability in Serengeti and an increase in Tarangire. Monitoring the population of the Serengeti Plains, based on long-term follow-up of individually recognized animals, indicated that the population had remained stable between 1980 and 1990 (Kelly et al., 1998). Whether the 1994 canine distemper epidemic, that attacked the lions of the park and to which cheetahs were susceptible (Roelke-Parker et al., 1996), affected numbers of cheetahs on the plains still needs to be determined. In Tarangire National Park, I estimated a density three-fold larger than that computed by Lamprey (1964). Such an increase in cheetah density could have been triggered by the increased dry season concentration of herbivores documented in the park over the same time frame (Kahurananga and Silkuwasha, 1997). This apparent increase of cheetahs at the local scale of Tarangire National Park probably derives from the degradation of savanna ecosystems and

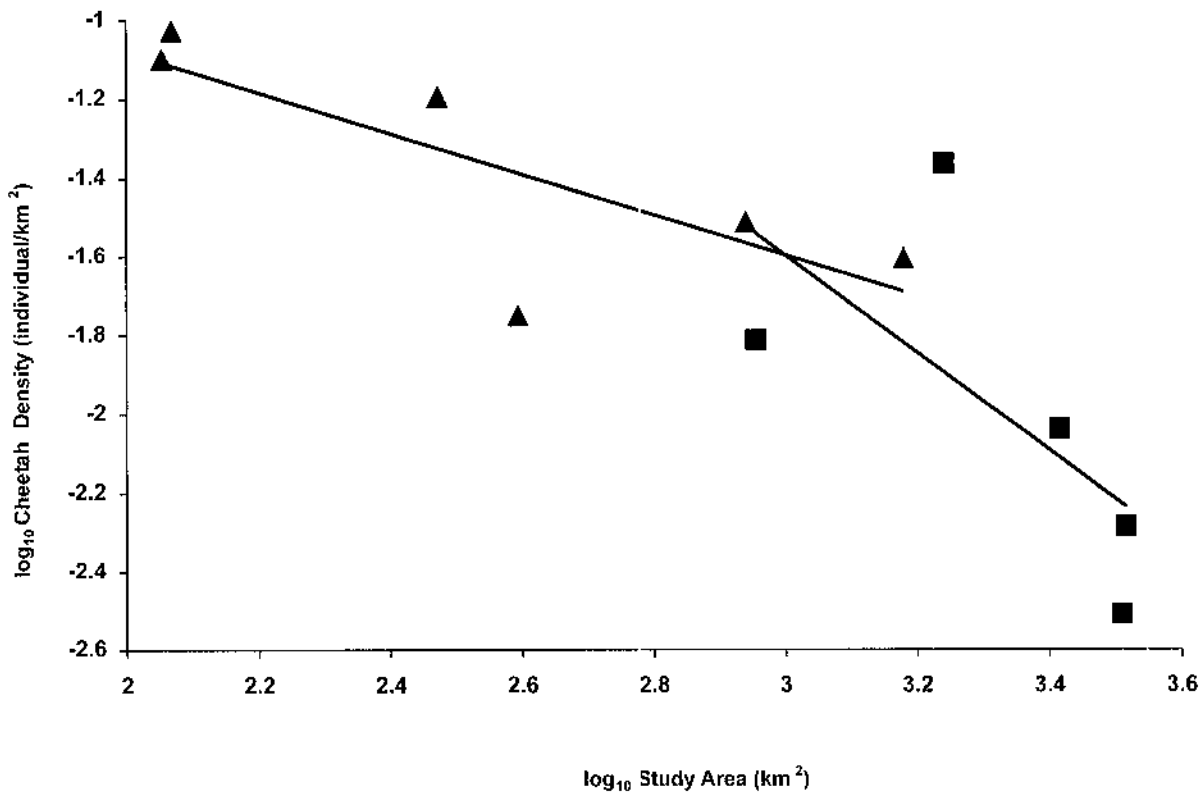


Fig. 3. Relationships between  $\log_{10}$ [cheetah density] and  $\log_{10}$ [study area] in the protected areas of Tanzania ( $y = -0.5126x - 0.0557$ ,  $R^2 = 0.619$ ) and in those of Kenya ( $y = -1.2384x + 2.121$ ,  $R^2 = 0.434$ ). Values for Tanzania protected areas are featured by squares, and those for Kenya protected areas by triangles.

its wildlife populations at the regional scale of the Masai plains. Tarangire is set in the southern Masai plains where it acts as a dry season refuge for the wildlife of the surrounding areas. Over the last decade, large extents of the plains have been converted from traditional pastoral range into commercial farmlands or degraded for wood and charcoal collection. Moreover, wildlife populations have been reduced via poaching and sport hunting (Mwalyosi, 1992). In this context, an increase of cheetahs in Tarangire National Park probably reflects an influx of cheetahs taking refuge from the surrounding degraded Masai plains into the park rather than an improved reproduction and survival of cheetahs locally.

#### 4.5. Likely population decline on unprotected lands

Current distribution data, the general socioeconomic context of Tanzania, and long-term residents' perceptions of population trends concur to suggest that declines occurred on unprotected lands. Despite a greater sampling effort, a larger data set, and a more field-based approach than those of previous authors, I failed to locate cheetahs in 12 areas that they previously inhabited in the country. All these areas were on unprotected lands, and seven of them in the center of the country, inferring a contraction of the species' range

in that region. Since 1967, Tanzania's human population has grown from 12.3 to 29.5 million (Kaplan, 1978, [www.mshand.geog.gla.ac.uk](http://www.mshand.geog.gla.ac.uk)). As a result, savannas have been degraded as wood gathering, charcoal making, and meat poaching intensified with the population growth, the increased availability of motor vehicles (Monela et al., 1993), and the gradual replacement of traditional pastoral societies by agro-pastoral ones (Homewood and Rodgers, 1984; Mwalyosi, 1992; Prins, 1992). Finally, following the 1989 liberalization of the economy, large scale farming businesses (Meerstens et al., 1995) and trophy hunting (Leader-Williams et al., 1995) further reduced habitat availability and prey densities outside parks and reserves. In this context, it is hardly surprising that 35% of the cheetah populations monitored via long term observation by local residents were perceived to decrease. Reports of 30% locally increasing populations can be explained by emigration of cheetahs from transformed lands into least disturbed areas as suggested between the Masai plains and Tarangire National Park. Actual augmentation of cheetah numbers due to improved reproduction or survival rates within a stable range does not seem likely in the prevailing background of conversion and degradation of wild lands in Tanzania.

Thus, cheetah populations are most certainly decreasing outside of protected areas as a result of

habitat loss and prey reduction. If this trends persists, the carrying capacity of the country for cheetahs will be greatly reduced and the survival of the species questionable outside of the Serengeti ecosystem. Approximately half of protected areas where cheetahs occur in the country are located in the miombo savanna biome. Those protected areas support very small populations, as miombo savannas are marginal habitats for cheetahs. In the suitable habitats of Northern Tanzania, neither Tarangire National Park nor Mkomazi Game Reserve could harbor viable populations if disconnected from their surrounding wild lands. Hence, the persistence of a large cheetah population in the northern rangelands of Tanzania is essential for the long-term survival of viable populations in the country. Cheetahs can survive on partially degraded habitats with reduced ungulate density by switching to smaller prey (Labuschagne, 1979; Hamilton, 1986). However there is a limit to this flexibility, as demonstrated in South Africa and part of the Western Sahel where cheetahs are now strictly restricted to protected areas (Nowell and Jackson, 1996).

#### 4.6. Conclusions

Harboring an estimated 600–1000 cheetahs, Tanzania emerges as one of the most important havens for the species both regionally and at the continental scale. Cheetahs are still widely distributed within the country, although range constriction appears to have started in central Tanzania. Relatively low population density may decrease the resilience of the protected populations. Established protected populations seem to be stable, although this could mask population decreases at a larger scale. Reduction of the species' range and local population declines seem to have taken place on unprotected lands. Yet half of the cheetahs in Tanzania are estimated to live on unprotected lands where wildlife habitats are undergoing major destruction and degradation. Under these circumstances, the survival of unprotected cheetah populations and the maintenance of a large number of cheetahs in Tanzania appear precarious. The importance of Tanzania as a sanctuary for cheetahs and the precariousness of the species' status outside of protected areas call for a nationwide monitoring of the species' distribution and numbers. This study provides a baseline for such a monitoring effort.

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#### Appendix. Areas surveyed and recorded changes in distribution

##### *Area surveyed*

Arusha region; savannas ecosystems in Kilimanjaro and Mara regions; the parts of Dodoma, Iringa, Mbeya, Morogoro, Singida, Shinyanga, and Tanga regions where cheetahs occurred historically.

##### *Area not surveyed*

Most of Dodoma, Mwanza, and Tabora Regions; all of Kagera, Kigoma, Lindi, Mtwara, Pwani, Rukwa, and Ruvuma.

##### *Distribution and its changes since 1965*

Cheetahs were relatively widespread in the northern regions; absent from Kagera region and most of Kigoma, Mtwara, and Ruvuma regions; rare elsewhere. Present in all protected areas where the species occurred in 1965, and in Kisigo, Maswa, and Muhesi Game Reserves that were gazetted after the 1960s. More sightings were reported in this study than in 1965 in all protected areas for which figures were available for comparison: Serengeti, Lake Manyara, Ruaha, and Mikumi National Parks; Ngorongoro Conservation Area; Rungwa, Selous and Mkomazi Game Reserves. Both Graham and Parker (1965) and Kingdon reported the presence of cheetahs in the east of Tabora Region, in the north of Singida Region, in the east of Dodoma Region, and north of Lake Rukwa in Mbeya Region. Kingdon (1977) also included in the cheetah range three



areas for which neither Graham and Parker (1965) nor I collected sightings: around Kigosi and Moyowosi Game Reserves and from there to the Burundi border in Kigoma Region, in Kilombero swamp area on the border between Morogoro and Iringa Regions, and along the border with Mozambique in Ruvuma region. The Mkata Plain Open Area is the only area outside of national parks and game reserves where this study recorded cheetah presence and previous studies did not.

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