Notes and records

Notes on the spatial ecology of caracals (*Felis caracal*), with particular reference to Namibian farmlands

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Introduction

Caracals (*Felis caracal*, Schreber 1776) occur in northern Africa, Asia and at least 36 sub-Saharan African countries (Nowell & Jackson, 1996), yet little has been published regarding their spatial ecology. Although rarer in Asia, the caracal is relatively common in sub-Saharan Africa and occupies a wide variety of habitats (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002). Despite weighing only 8–20 kg, caracals regularly kill prey more than twice their own mass, and take a wide range of prey species (Smithers, 1971; Grobler, 1981; Sunquist & Sunquist, 2002).

Caracals are classified as problem animals in Namibia and South Africa (Visser, 1978; Stuart & Wilson, 1988; Nowell & Jackson, 1996) and are commonly regarded as vermin because of occasional predation upon small stock (Nowell & Jackson, 1996; Avenant & Nel, 1998). This negative perception has resulted in extensive persecution: from 1931 to 1952, over 2000 caracals were destroyed annually in South Africa's Karoo, while Namibian farmers reported killing 2800 caracals during 1981 alone (Joubert, Morsbach & Wallis, 1982; Nowell & Jackson, 1996). Although in some areas livestock can form a significant part of their diet, and they may engage in surplus killing (Skinner, 1979; Stuart, 1986; Brand, 1989; Weisbein & Mendelssohn, 1990; Stuart & Hickman, 1991), most studies have shown that caracals predominantly prey upon hyraxes, rodents, birds and small antelope (Grobler, 1981; Stuart, 1981; Avenant, 1993), indicating that the threat posed to domestic stock may be less than is commonly perceived.

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Despite high levels of removals, caracals are not currently threatened in southern Africa and there is some evidence of range expansion in Namibia and South Africa (Stuart & Wilson, 1988; Rowe-Rowe, 1992). Caracals may utilize niches on farmland previously occupied by black-backed jackals (*Canis mesomelas*, Schreber 1778), which are also intensively removed by farmers (Pringle & Pringle, 1979; Stuart, 1982; Mendelssohn, 1989; Nowell & Jackson, 1996). Increased knowledge regarding the range use of caracals is fundamental in terms of furthering the understanding of this cat's ecology, and is important for developing more effective and ecologically sound methods for its management on private land.

Materials and methods

This study was conducted on the commercial farmlands of north-central Namibia, between 19°30'S to 23°30'S and 16°E to 19°E. The habitat was predominately thornbush savanna, consisting of grassland with trees and shrubs in dense or open clumps (Joubert & Mostert, 1975), with dominant woody plant genera consisting of *Acacia*, *Dichrostachys*, *Grewia*, *Terminallia*, and *Boscia*. Commercial farming was the primary land-use, with cattle and some small-stock (goats and sheep) living alongside free-ranging wildlife species. The study area received an average of 472 mm rainfall annually, and the year was divided into a wet season (15 September to 14 April), and a dry season (15 April to 14 September). Capture cages measuring 2×0.75 m were used to live-trap caracals, which were immobilized using 4 mg kg^{-1} of Telazol 100 mg ml^{-1} (tiletamine-HCl and zolazepam HCl, Warner Lambert, Ann Arbor, MI, U.S.A.).

Between 1996 and 2000, we radio-collared and released four male caracals within the study area. Age classification was based on weight, tooth wear, gum recession and body size. Released caracals were ear-tagged and fitted with a neoprene radio-telemetry collar with an external antenna (Advanced Telemetry Systems, MN, U.S.A.). Radio-collars used weighed 280 g; equivalent to <3% of body mass, as recommended by Kenward (2001).

Following release, radio-collared caracals were tracked weekly from a Cessna 172. Home range sizes were esti-

Table 1 Estimated age, body mass, duration of tracking, number of fixes, and overall and seasonal home range size of the four caracals radio-tracked during the study period. Statistical comparisons of home range size were restricted to animals with at least 30 fixes overall and 15 fixes for each season

Radio-collar no.	Sex	ID no.	Age at first collaring (months)	Mass (kg)	Dates tracked	No. months tracked	Total no. fixes	Overall home range size (km^2)		No. wet season fixes	Wet season home range size (km^2)		No dry season fixes	Dry season home range size (km^2)	
								95% MCP	95% kernel		95% MCP	95% kernel		95% MCP	95% kernel
661	M	1	24	12	Nov 96 to Nov 98	25	83	211.5	456.6	43	140.6	297.7	40	203.7	498.2
640	M	2	84	14	Sep 98 to Dec 99	16	46	286.7	308.2	25	165.4	288.8	21	112.1	286
490	M	3	42	10	Oct 98 to Dec 99	15	32	439.8	388.2	17	119.7	447.9	15	91.7	395.1
651	M	4	42	13	Jun 00 to Dec 00	6	24	79.3*	274.7*	10	31.2*	181.3*	14	37.6	178.7
Mean	–	–	48.0	12.3	–	15.5	46.3	312.6	356.9	23.8	114.2	303.9	22.5	111.3	339.5
SD	–	–	25.5	1.7	–	7.8	26.1	116.3	81.7	14.2	58.4	109.6	12.1	69.2	137.8

*Indicates estimates of home range size that were excluded from analyses (including descriptive statistics) because of a small number of fixes.

Table 2 Data from other studies regarding caracal spatial ecology and home range size

Study area	Country	Protected area?	Mean home range size (km^2)		Method of home range estimation	Degree of home range overlap (%)		Estimated caracal density per 100 km^2	Reference(s)
			Male	Female		Between males	Between females		
Langebaan peninsula	South Africa	Yes	26.9 (2)	7.39 (3)	MCP	96–100	0–19	23–47	Avenant & Nel (1998)
Stellenbosch area, Cape Province	South Africa	No	65 (1)	–	MCP	–	–	–	Norton & Lawson (1985)
Mountain Zebra National Park	South Africa	Yes	15.2	5.5	–	–	–	–	Moolman (1986)*
Outside Mountain Zebra National Park	South Africa	No	19.1	–	–	–	–	–	Moolman (1986)*
Harrat al-Harrah Reserve	Saudi Arabia	Yes	1116 (1)	–	95% MCP	–	–	–	Van Heezik & Seddon (1998)
Aravah Valley	Israel	No	220.6 (5)	57.3 (4)	–	–	–	20	Weisbein & Mendelssohn (1990)
North-central Namibian farmlands	Namibia	No	312.6 (3)	–	95% MCP	19.4	–	–	This study
Southern Kalahari	South Africa	–	308.4 (1)	–	–	–	–	–	Bothma & Le Riche (1984)

*Cited in Sunquist & Sunquist (2002). Figures in parentheses are numbers of animals.

mated using ArcView GIS (version 3.2, ESRI, Redlands, CA, U.S.A.) and the Animal Movement extension (Hooge, Eichenlaub & Soloman, 1999). Statistical analyses were performed using SPSS version 10.0 software (SPSS Inc, Chicago, IL, U.S.A.).

Results and discussion

Caracals ranged over large areas (Table 1). Estimated home range size did not differ between 95% kernel and 95% MCP methods ($z = -1.09$, $P = 0.275$; Table 1), so the 95% MCP estimated was used for analyses. There were no significant seasonal effects on home range size ($t = -0.164$, d.f. = 4, $P = 0.877$). Male caracals showed a mean intraspecific range overlap of 19.4%, considerably less then that reported in South Africa (Avenant & Nel, 1998; Table 2). However, it was unknown how many unmarked caracals were occupying our study area, so our overlap figure is probably substantially underestimated.

Estimates of caracal home range size differed significantly between studies (Table 2), both for males ($\chi^2 = 3646$, d.f. = 7, $P < 0.001$) and females ($\chi^2 = 72.3$, d.f. = 2, $P < 0.001$). There was insufficient information in these studies regarding factors such as prey biomass, caracal density and rainfall to identify key determinants of caracal home range size. Protected area status was usually reported, however, and there was no difference in male caracal home range size within and outside protected areas ($t = 0.624$, d.f. = 2, $P = 0.593$). Female caracal ranges were significantly larger outside reserves ($t = 31.1$, d.f. = 1, $P = 0.020$), but this is skewed by the fact that the only data on female caracals outside protected areas came from Israel, and the different ecological conditions there compared with southern Africa are likely to have a more significant effect on home range size than the fact that the study was conducted outside a reserve.

Most studies have been conducted in sub-Saharan Africa, with two conducted in Israel and Saudi Arabia (Table 2). Although sample sizes were low, female caracals in Africa had smaller ranges than those in the Middle East ($t = 31.1$, d.f. = 1, $P = 0.020$); the same was not true for males ($t = 1.20$, d.f. = 1, $P = 0.436$).

The studies in Table 2 were conducted across the caracal's range, and the species' population density varies considerably between these different areas (Sunquist & Sunquist, 2002), making meaningful comparisons difficult. There is a paucity of data to address even the most basic ecological questions for many smaller cat species (Nowell & Jackson, 1996), and the caracal is no exception. For instance, there are currently not enough published data on female caracals in sub-Saharan Africa to examine whether range sizes do indeed differ within and outside reserves: more data are urgently needed to answer basic questions and develop strategies for effective conservation and management both within and outside reserves.

These data show that caracals have large home ranges, and this wide-ranging behaviour enables them to effectively recolonize vacant areas following removal. This explains why even intensive culling is relatively ineffectual in terms of reducing caracal numbers on farmland (Visser, 1978; Nowell & Jackson, 1996; Sunquist & Sunquist, 2002). Consequently, measures such as effective small stock protection will be a more effective and ecologically sound method of limiting conflict with caracals on private land, rather than the existing strategy of attempted eradication.

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(Manuscript accepted 2 September 2004)