CHAPTER 10

THE EFFECT OF SMALL STOCK FARMING IN NAMIBIA ON CARACAL DENSITY IN THE NEIGHBOURING KGALAGADI TRANSFRONTIER PARK.

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Abstract

A spoor count was done to determine whether caracal spoor densities in the vicinity of the border of the Kgalagadi Transfrontier Park differed from those in the interior of the Park. The objective was to compare caracal densities close to the agricultural land with those deeper in a national park. Two long-distance transects, one along the Namibian border and one diverging from the Namibian border into the interior of the Park, were surveyed on a monthly basis. Spoor density, discrete track set distances and orientation of spoor to the road were recorded and analysed to establish use patterns for three distinct zones in the Park. The hypothesis tested was that increased spoor counts along the border should result from an attraction to the adjacent agricultural (cattle and sheep production) land. It is shown that caracals avoid the areas near the Namibian border during the hot season but increased their utilisation in this region in the cold season. This implies that under conditions of low prey availability (cold season) caracals may move to the border and cross onto agricultural land to prey on small livestock, there.

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Introduction

In southern Africa, the caracal *Caracal caracal* (Schreber, 1776) is regarded and legislated as a problem animal (URL: http://lynx.uio.no/catfolk/ssacr101.htm) due to their habitual depredations on small livestock (Stuart & Wilson 1988). Problem animals have broadly been described as wild animals that persistently and seriously detract from the achievement of man's agricultural endeavours (Thomson 1992). Several studies have confirmed that caracals do prey on small domestic livestock to varying degrees (Stuart 1982, Moolman 1986, Stuart & Wilson 1988, Stuart & Hickman 1991, Bothma & Walker 1999, Melville *et al.* 2004). In areas where domestic livestock production occurs on land adjacent to conservation areas, there is a definite polarisation between agriculturalists and conservationists into two antagonistic camps (Thomson 1992). This polarisation is largely due to the differing attitudes of the two groups to problem animals and their management, especially where larger predators are involved. This antagonistic relationship also exists in the southern Kalahari, where a number of Namibian small livestock production units share boundaries with the western parts of the vast Kgalagadi Transfrontier Park.

From the responses to questionnaires used in this study, it was clear that the agricultural community believes that predators from the Kgalagadi Transfrontier Park regularly move across the border onto their land to prey on small livestock. If this were the case, then it would be expected that there would be a higher population density of caracals along the

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western border of the Kgalagadi Transfrontier Park than in the adjacent interior parts of this Park. This general hypothesis is tested in the present study. To do so, the following key questions were examined:

- Is caracal spoor density significantly higher along the border areas than in the interior of the Park?
- Is the intensity of use of roads along the border similar to that of the roads in the interior of the Park?

Study area

This study was done in an area along the Namibian border near Mata-Mata in the southwestern portion of the Kgalagadi Transfrontier Park. For logistic reasons it was decided to confine the research to an area that extended 60 km north from the Mata-Mata rest camp along the Namibian border (20° 00' E longitude) to approximately 20 km into the interior of the Kgalagadi Transfrontier Park.

The Kalahari Gemsbok National Park was proclaimed in 1931, but it only became a reality in 1935 when a number of farms along the southern bank of the Aoub River were acquired. Today, the Park exists in much the same ecological state as it was then (Van Wyk & Le Riche 1984). An agreement to formally combine the Kalahari Gemsbok National Park (South Africa) with the bordering Gemsbok National Park (Botswana) to form the Kgalagadi Transfrontier Park was signed by representatives of the governments of South Africa and Botswana in 1999. This agreement was ratified at an amalgamation ceremony that was held on the 12 May 2000 (Donaldson 2000).

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The Mata-Mata area lies in the Shrubby Kalahari Dune Bushveld of the Savanna Biome (Low & Rebelo 1996). This area is an arid savanna with temperatures varying from –10° C to 45° C in the shade with an annual mean rainfall of 153.5 mm occurring mainly in the hot season. The landscape is one of undulating dunes with sparse vegetation at altitudes varying from 1000 to 1100 m above sea level (Low & Rebelo 1996).

The vegetation is characterised by the trees *Acacia erioloba*, *Acacia haematoxylon* and *Boscia albitrunca*, a shrub layer of *Grewia retinervis* and *Rhus tenuinervis,* and a well-developed grass layer consisting mainly of *Stipagrostis amabilis*, *Eragrostis lehmanniana, Aristida meridionalis, Schmidtia kalihariensis* and *Centropodia glauca* (Low & Rebelo 1996). There is little variation in the soil forms because the area is predominantly covered by aeolian sand overlying calcrete (Low & Rebelo 1996).

The Kgalagadi Transfrontier Park forms the southern part of the greater Kalahari ecosystem. Because of the arid nature of the area, many of the plants there are ephemeral. After sufficient rain, these plants germinate quickly to complete their life cycle in a short time (Eloff 1984).

Because of the harshness of the environment, the southern Kalahari is an area that is only sparsely inhabited by humans. This above any other factor contributes to the uniqueness of the area, and it enhances the value of the area for field research in wildlife management and conservation.

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Methods

It is difficult to obtain reliable indices of density for animals that are nocturnal, camouflaged and cryptic as are most solitary mammalian carnivores (Mahon, Banks & Dickman 1998). Direct sampling, where density estimates are made based on sightings of animals, is too time-consuming and costly to be seriously considered for monitoring purposes (Smallwood & Fitzhugh 1994). For the purposes of the present study it was also not relevant to establish the exact number of individual caracals. Rather, the aim was to gauge the relative density of caracals in different parts of the Park.

The most frequently used methods for monitoring carnivore densities are, spotlight counts, spoor counts, scent-post visitation rates and bait-use rates (Mahon, Banks & Dickman 1998). Spoor counts are an efficient and relatively low-cost method of estimating species richness and abundance (Litvaitis, Sherburne & Bissonette 1985, Smallwood & Fitzhugh 1994, Stander 1998, Silveira, Jacomo & Diniz-Filho 2003). Because of the ease with which caracal spoor can be found and counted on the sandy substrate of the Kalahari, spoor counts were used in the present study to monitor the relative abundance of caracals in various parts of the western Kgalagadi Transfrontier Park. Moreover, there is a direct relationship between the frequency of spoor and the density in which the animals occur (Tyson 1959, van Dyke, Brocke & Shaw 1986, Stander 1998, Thompson *et al.* 1998, Funston *et al.* 2001).

In this study it was necessary to use terminology with definitions specific to the circumstances in which they were used. The following is a list of terms and definitions as they were applied to this study:

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- Spoor density : the mean number of sets of caracal tracks per 100 km.
- Spoor ratio : the relative frequency of caracal spoor per 100 km of tracking over successive counts along the same transect.
- Discrete track sets : a continuous set of caracal tracks along or across a transect.

Field study

Spoor counts were done along the management roads in the study area because the soft sand was eminently suitable for the detection of spoor (Funston *et al.* 2001). Transects were done by vehicle on a monthly basis from June 2001 to July 2002, with the assistance of experienced Kalahari San trackers. These trackers are known to be highly accurate and reliable when identifying and interpreting animal tracks (Stander *et al.* 1997). The study was structured so that one of the routes lay directly along the Namibian border. The route in the interior, against which data from the border route were compared, started 5 km inland from the border, then it converged to intersect briefly with the border before it progressively swung away again from the border (Fig. 1). At its furthest point the road was 30 km away from the border. The route along the border was 114.6 km long and that in the interior portions 138.5 km long. Long transects are better suited to detect variation in population densities of caracal than short transects, because they are likely to include the ranges of more caracals than shorter routes (Van Sickle & Lindzey 1991). The transects were surveyed intermittently at monthly intervals for a total of 26 surveys over a total distance of 3290.4 km.

The roads were scanned by the tracker who was seated on a specially designed tracking chair mounted on the front bumper of the slowly moving research vehicle, as was done by Funston *et al.* (2001) when working with lions *Panthera leo*. To ensure that spoor was not missed, the transects were travelled at a constant speed of 12 km per hour. Due to the

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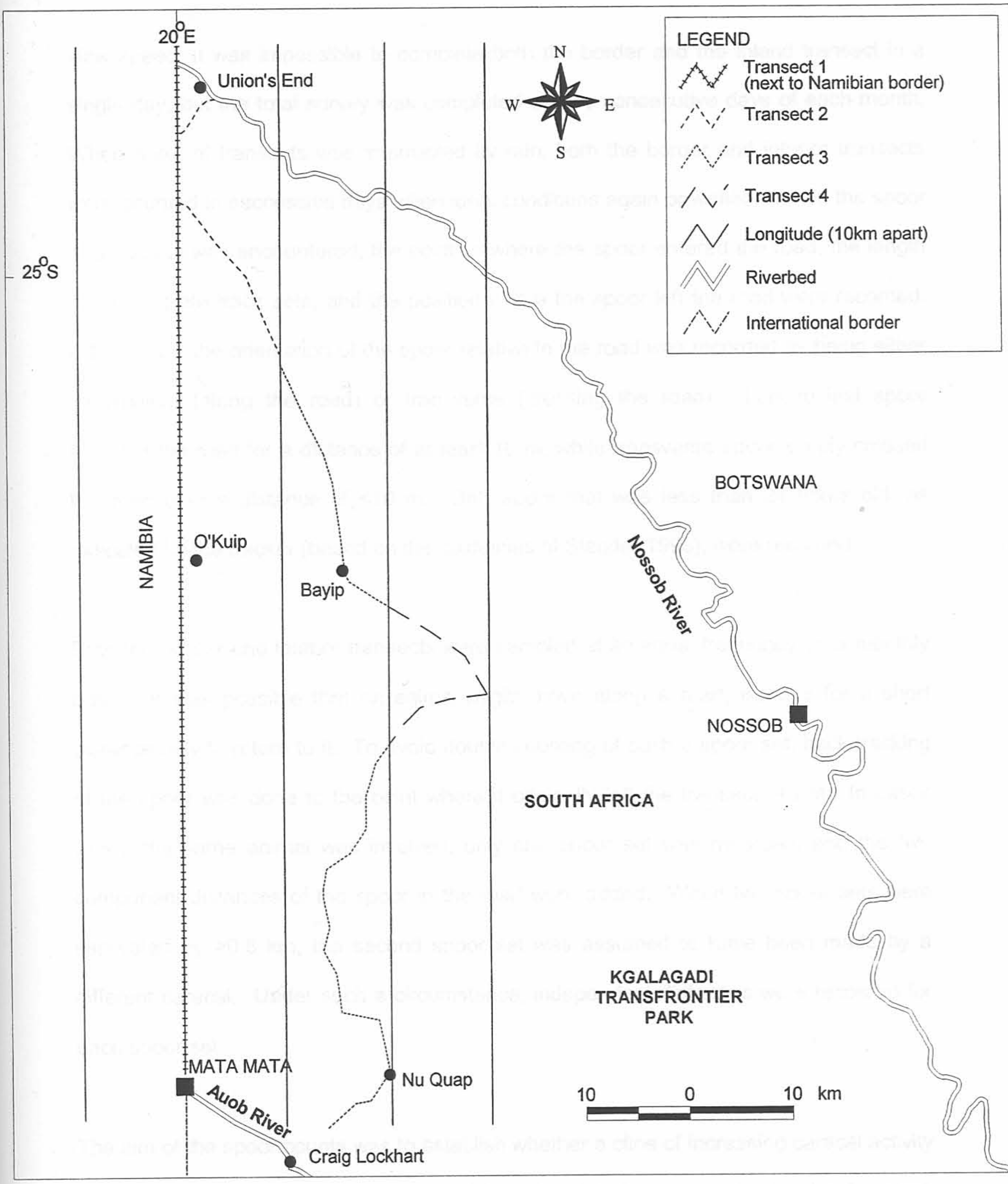

Figure 1: Transects used for determining the relative caracal spoor density along the Namibian border and the interior of the Kgalagadi Transfrontier Park from June 2001 to July 2002.

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slow speed, it was impossible to complete both the border and the inland transect in a single day, but the total survey was completed on two consecutive days of each month. When a set of transects was interrupted by rain, both the border and interior transects were counted in successive days when ideal conditions again prevailed. When the spoor of a caracal was encountered, the position where the spoor entered the road, the length of the discrete track sets, and the position where the spoor left the road were recorded. Additionally, the orientation of the spoor relative to the road was recorded as being either longitudinal (along the road) or transverse (crossing the road). Longitudinal spoor followed the road for a distance of at least 10 m, while transverse spoor simply crossed the road over a distance of <10 m. Only spoor that was less than 24 hours old, as indicated by the tracker (based on the guidelines of Stander 1998), were recorded.

Both the border and interior transects were sampled at an equal frequency on a monthly basis. It was possible that an animal might move along a road, leave it for a short distance only to return to it. To avoid double-counting of such a spoor set, back-tracking of the spoor was done to the point where it originally left the transect or not. In cases where the same animal was involved, only one spoor set was recorded, and the two component distances of the spoor in the road were added. When two spoor sets were separated by >0.5 km, the second spoor set was assumed to have been made by a different caracal. Under such a circumstance, independent distances were recorded for each spoor set.

The aim of the spoor counts was to establish whether a cline of increasing caracal activity occurred as was expected, as a road from the interior approached a border road. Therefore the roads that diverged from the border into the interior were stratified into three separate components based on the perpendicular distance of each component away from

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three separate components based on the perpendicular distance of each component away from the Namibian border. The result was that four distinct survey areas were identified within the following distance intervals relative to the road along the Namibian border: transect 1 was along the Namibian border (114.59 km); transect 2 was from 0 – 10 km from the Namibian border (33.52 km), transect 3 was >10 - 20 km from the Namibian border (79.74 km), and transect 4 was >20 - 30 km from the Namibian border (25.26 km). Caracal spoor density was expressed as the frequency of spoor per 100 km of road surveyed, and was calculated for each of the four transects. The length of each discrete track set and the orientation of the track sets were also recorded. Spoor density, spoor orientation and the discrete track set length were calculated seasonally for a hot season from October to March and a cold season from April to September.

To ensure that the integrity of the comparisons between the data that were collected along the border and those that were collected in the interior was maintained, the data were collected in a standardised manner (Thompson *et al.* 1998), with no variation from the set protocol (Smallwood & Fitzhugh 1995).

Data analysis

Standard t-tests and least square means tests were used to compare the mean spoor density along the border transect with that along the transects in the interior, and to compare the mean spoor densities of the transects in the interior with one another (Table 1). Chi-squared tests were used to compare the spoor ratio along the border transect with that on each of the transects in the interior. The spoor data from the transects in the interior were also compared with one another. The longitudinal and transverse movement patterns were compared by using chi-squared tests to determine whether caracals tended to use the roads as corridors (Mahon *et al.* 1998) or whether

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Table 1: *Chi-squared tests to compare caracal spoor ratio and standard t-tests and least square mean tests comparing mean spoor density between seasons and transects in the Kgalagadi Transfrontier Park from June 2001 to July 2002*

Transects compared	Season	χ2 - test			t-tests		Least square mean test		
		χ^2–value	Degrees of freedom	*P* -value	t-value	*P* -value	Mean	Standard Error	*P* - value
1 and 2	Both	16.61	12	NS	-1.27	0.220	4.94	1.24	0.250
1 and 3	Both	18.71	12	NS	-2.54	0.020	4.94	1.24	0.040 *
1 and 4	Both	18.12	12	NS	-3.45	0.003	4.94	1.24	0.003 *
2 and 3	Both	22.31	12	≤ 0.05	-0.92	0.360	6.98	1.24	0.320
2 and 4	Both	28.22	12	≤ 0.05	-1.68	0.110	6.98	1.24	0.051
3 and 4	Both	6.97	12	NS	-0.81	0.430	8.74	1.24	0.320
1 and 2	Hot	15.18	3	≤ 0.05	-1.49	0.190	3.48	2.06	0.390
1 and 3	Hot	21.53	3	≤ 0.05	-3.25	0.023	3.48	2.06	0.120
1 and 4	Hot	26.57	3	≤ 0.05	-3.31	0.021	3.48	2.06	0.010 *
2 and 3	Hot	6.11	3	NS	-1.49	0.200	6.00	2.06	0.460
2 and 4	Hot	15.30	3	≤ 0.05	-2.17	0.080	6.00	2.06	0.100
3 and 4	Hot	2.63	3	NS	-1.33	0.260	8.15	2.06	0.350
1 and 2	Cold	16.01	8	≤ 0.05	-0.82	0.430	6.40	1.37	0.430
1 and 3	Cold	15.43	8	NS	-1.61	0.140	6.40	1.37	0.140
1 and 4	Cold	10.70	8	NS	-2.11	0.058	6.40	1.37	0.060
2 and 3	Cold	27.82	8	≤ 0.05	-0.56	0.580	7.96	1.37	0.480
2 and 4	Cold	31.98	8	≤ 0.05	-0.89	0.390	7.96	1.37	0.270
3 and 4	Cold	8.27	8	NS	-0.33	0.750	9.33	1.37	0.690

* Significant values for results of least square means tests
NS: No significant difference for the comparison.

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they simply crossed them in their daily movements. These data were analysed seasonally and year-round on an inter-transect basis.

Analysis of variance (ANOVA) was applied to the discrete track set distance data to establish whether the caracals moved greater distances along the roads in the interior than along the Namibian border transect. The variance was calculated across the four road strips simultaneously, on a seasonal and year-round basis. To establish the nature and cause of any variance, t-tests were done to compare the border data with those of each of the interior transects. Additionally the mean discrete track set distances between transects in the interior were compared by using t-tests (Table 2).

Results

The spoor density varied seasonally and between the various transects (Table 3). On a year-round basis and for the hot season only there is a significantly higher mean spoor density per 100 km in the interior on transects 3 and 4 than in transect 1 (Table1). However, there is no difference in the mean spoor density between transects 1 and 2 in this period (Table 1). In the cold season there is no difference between the spoor density along the border and any of the interior transects (Table 1). There also is no seasonal difference between the mean spoor density on any of the transects in the interior (Table 1).

On a year-round basis there also was no difference between the spoor ratio on transects 1, 2, 3 and 4. The spoor ratio on transect 1 was significantly different from that on transects 2, 3 and 4 in the hot season. In the cold season the spoor ratio on transect 1 was significantly different from that on transect 2, whereas that on transects 3 and 4 did ble 2: *t-Test results comparing the mean discrete caracal track set length in each spoor count transect in the Kgalagadi Transfrontier Park from June 2001 to July 2002.*

Transects compared	Season	t-test		Mean discrete track length (km)			
		t-value	*P*-value	Transect 1	Transect 2	Transect 3	Transect 4
1 and 2	all	1.65	0.10	1.2	0.85	~	~
1 and 3	all	3.61	0.01	1.2	~	0.68	~
1 and 4	all	1.70	0.09	1.2	~	~	0.83
2 and 3	all	0.93	0.36	~	0.85	0.68	~
2 and 4	all	0.11	0.91	~	0.85	~	0.83
3 and 4	all	-0.72	0.47	~	~	0.68	0.83
1 and 2	cold	1.30	0.20	1.24	0.93	~	~
1 and 3	cold	3.62	0.01	1.24	~	0.64	~
1 and 4	cold	1.04	0.30	1.24	~	~	0.92
2 and 3	cold	1.44	0.16	~	0.93	0.64	~
2 and 4	cold	0.26	0.79	~	0.93	~	0.85
3 and 4	cold	-0.83	0.41	~	~	0.64	0.85
1 and 2	hot	0.84	0.41	1.04	0.68	~	~
1 and 3	hot	0.92	0.36	1.04	~	0.79	~
1 and 4	hot	0.79	0.44	1.04	~	~	0.77
2 and 3	hot	-0.28	0.79	~	0.68	0.79	~
2 and 4	hot	-0.19	0.85	~	0.68	~	0.77
3 and 4	hot	0.07	0.94	~	~	0.79	0.77

~ Data not relevant to this comparison

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Table 3: *Spoor density and mean spoor length of caracal tracks on management roads in the Kgalagadi Transfrontier Park from June 2001 to July 2002.*

Route	Season	Spoor density per 100 km	Track set distance (km)	
			Mean length	Standard error
1	Hot	3.39	1.04	0.22
	Cold	6.40	1.24	0.14
	All	5.50	1.19	1.13
2	Hot	8.20	0.68	0.36
	Cold	7.95	0.93	0.19
	All	6.60	0.70	0.14
3	Hot	8.15	0.79	0.16
	Cold	9.48	0.64	0.08
	All	9.07	0.68	0.07
4	Hot	10.89	0.77	0.26
	Cold	10.12	0.85	0.24
	All	10.35	0.83	0.19

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not differ significantly from transect 1. There is no seasonal difference between the relative frequencies of spoor along any of the transects ($\chi^2 = 2.79$, df = 3, $P > 0.05$) (Table 1).

On a year-round basis there is a significant difference between the mean length of discrete caracal track sets on all the transects (ANOVA: $F_{2,64} = 4.35$, $P < 0.01$). In the hot season there is no difference (ANOVA: $F_{2,75} = 0.41$, $P = 0.74$), but in the cold season, there again is a significant difference (ANOVA: $F_{2,65} = 4.27$, $P < 0.01$). There was no seasonal difference between the mean lengths of discrete track sets along any of the transects. There also was no seasonal difference between the mean length of discrete track sets across all transects (t = -0.71, df = 122, $P = 0.48$) (Table 4).

The relative incidence of caracals moving along the transects, as opposed to crossing the transects is highly variable (Table 5). On a year-round basis caracals tend to move along transect 1 and 2 more often than along transects 3 and 4. Caracals therefore tended to use the transects in the interior less often as corridors for movement than the transects close to the Namibian border. In the hot season, caracals used all the transects as corridors of movement to a similar extent. However, in the cold season it appears that the interior transects are used less often than the transects close to the Namibian border (Table 5). The ratio of longitudinal spoor to transverse spoor over all the routes is 20.3 : 1 in the hot season and 8.1 : 1 in the cold season. There is no significant difference between the frequency of longitudinal movements among the transects on a seasonal basis ($\chi^2 = 3.48$, df = 3, $P > 0.05$). However, there is a significant seasonal difference between the frequency of transverse movements among the transects ($\chi^2 = 62.85$, df = 3, $P < 0.05$).

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able 4: *Standard t-tests comparing the seasonal variation in the mean length of discrete caracal track sets along spoor count transects in the Kgalagadi Transfrontier Park from June 2001 to july 2002*

Transect	Cold season		Hot season		t-value	*P*-value
	Mean length of discrete track sets (km)	Standard error	Mean length of discrete track sets (km)	Standard error		
1	1.24	0.15	1.04	0.22	0.77	0.45
2	0.68	0.19	0.93	0.59	-0.62	0.55
3	0.79	0.08	0.64	0.16	0.84	0.40
4	0.77	0.23	0.85	0.26	-0.24	0.81
Total	0.83	0.07	0.92	0.11	-0.71	0.48

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Table 5: *Chi-squared tests comparing the ratio of caracals moving along the transects to those crossing the transects, during transect counts in the Kgalagadi Transfrontier Park from June 2001 to July 2002.*

Transects compared	Hot season		Cold season		Year-round	
	χ^2–value	*P*- value	χ^2–value	*P*- value	χ^2–value	*P*- value
1 and 2	7.90	≥ 0.05	9.53	≥ 0.05	1.19	< 0.05
1 and 3	3.92	≥ 0.05	2.56	≥ 0.05	1.93	< 0.05
1 and 4	9.54	≥ 0.05	8.02	≥ 0.05	4.35	≥ 0.05
2 and 3	2.34	< 0.05	15.88	≥ 0.05	5.79	≥ 0.05
2 and 4	0.00	< 0.05	24.40	≥ 0.05	9.27	≥ 0.05
3 and 4	2.27	< 0.05	1.66	< 0.05	0.53	< 0.05

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The mean distance over which caracals travel along the transects does not vary either on a year-round basis or seasonally, based on the proximity of the transect to the Namibian border (Table 2).

Discussion

Track counts are often the most efficient and rapid method for detecting the relative abundance of wild animals. Climatic conditions and ground conditions are limitations to the detectability and identification of the tracks (Silveira *et al.* 2003). Funston *et al.* (2001) also indicated that population estimates based on spoor counts of small carnivores are unreliable because of the difficulty in detecting the spoor of these animals. However, provided that the detectability of the spoor remains similar in all areas, the same level of error in track detection can be expected (Burnham & Anderson 1984). Hence estimates of population size and trends that are based on relative spoor densities are appropriate. For the caracal, such spoor counts are of great value to detect relative area use.

Mooty and Karns (1984) and Strayer (1999) concluded that presence-absence surveys should be used with caution when trying to detect population trends. Due to their relative insensitivity to small variations, spoor counts may be susceptible to Type 2 statistical errors and may tend to overestimate abundance because spoor sets from the same animal can be counted more than once in a single survey (Silveira *et al.* 2003). Great care, through back-tracking, was taken to ensure that this type of overestimate did not occur in the present study.

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To determine whether caracals specifically moved into the adjacent agricultural area from the Park would require evidence of a cline of increased caracal activity and density from the interior of the Kgalagadi Transfrontier Park towards the Namibian border. If caracals were moving towards or were concentrating along the border to cross it into Namibia, then the incidence of caracals moving along transect 1 next to the border would be significantly less than that along the interior transects because the fence would prove to be no obstacle. Conversely, if the border fence acted as a barrier to movement, it can be expected that the caracals would move for longer distances along the border road (transect 1) than along the interior ones, while searching for holes in the fence through which to move or suitable fence posts over which to climb.

In the hot season, there is a low caracal spoor density along the border road relative to that found in all the interior transects, where spoor densities were at least twice that of transect 1. Transect 4, that was furthest away from the border, had the highest spoor density in the hot season but not in the cold season (Table 3). This may indicate that during the hot season caracals do not concentrate near the border areas, but in the cold season they do so despite human activity that should cause them to avoid the border. This in turn may indicate that there may be a higher degree of use of the border areas, in the cold season, possibly because of reduced natural prey availability in the interior then (Begg 2001). This seasonal prey variation may cause caracals to extend their search for prey to the border areas where sheep production units are situated. That the caracals travel distances along all the roads that are similar to those travelled along the border road indicates that there is an equal use intensity of all the roads (Mahon *et al.* 1998).

No observations were made of caracals moving across the border road into or out of Namibia in the hot season. However, in the cold season when natural prey are less

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abundant (Begg 2001), crossings of the border road did occur, and then caracals may target small livestock on the Namibian side of the fence. This is further supported by the overall increased frequency of movement on all the roads in the cold season, indicating a more intense use of their range in search of prey.

It has been argued by many authors that spoor counts are only useful to detect large changes in population density (Kendall *et al.* 1992, Beier & Cunningham 1996, Strayer 1999). The seasonal changes in caracal spoor density and road use that was found in the present study confirm these arguments. Caracal spoor increases in density along the Namibian border in the cold season. These changes in intensity of road use are probably a natural response to seasonal changes in the abundance and distribution of natural prey (Begg 2001). Moreover, the sheep that are present on the Namibian side of the fence lamb in the winter and create an additional abundant prey resource for caracals then, which may attract them to the border areas.

Conclusions

It is likely that caracals vary their range use in the Kgalagadi Transfrontier Park along its borders with Namibia on a seasonal basis, with an increased intensity of use of the border area in the cold season. There also seems to be an increased incidence of border road crossings in the cold season into Namibia. This may reflect changes in the prey abundance within the Park and a concomitant increase in prey abundance in Namibia due to small stock lambing. However, there is no change in the mean length of discrete track sets along any of the transects in either season, suggesting that caracals use the roads with similar intensity year round, irrespective of their proximity to the Parks border with Namibia.

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Due to the small data set, it is possible that the results may be affected by Type 1 errors (Beier & Cunningham 1996) with the hypothesis that caracal density may vary seasonally along the Namibian border being incorrectly rejected (Samuels 1991). Any management strategies that are implemented based on these conclusions should therefore be applied with circumspection. It is therefore recommended that a long-term monitoring system of road track counts of caracal and other larger predators be implemented along the border of the Kgalagadi Transfrontier Park with Namibia, and in the immediate interior region of the Park.

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