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Abstract: Namibia has the largest remaining population of free-ranging cheetahs *(Acinonyx jubatus)* in the world, 90% of which are found outside protected areas on commercial farms. We conducted a baseline survey of Namibian farmers between 1991 and 1993, with a yearly follow-up thereafter until 1999, to quantify the perceptions of farmers toward cheetahs. Specifically, we sought to identify factors that cause cheetahs to be perceived as pests and management practices that mitigate this perception. The baseline survey revealed that farmers who regarded cheetahs as problems removed an average of 29 cheetahs annually, whereas those who did not consider them problematic removed a mean of 14 annually. These figures dropped significantly to 3.5 and 2.0 cheetahs per year after the introduction of educational materials. The perception that cheetahs are pests was significantly associated with game farms, and the presence of "play trees" on farms emerged as a significant corollary of both negative perceptions and removals of cheetahs. Between 1991 and 1999, the mean annual number of cheetah removals significantly decreased from 19 to 2.1. Late in the study, cheetah killing was more closely correlated with perceived problems than in the early years of the study. These findings suggest that although cheetahs are still perceived as a problem, farmers' tolerance toward cheetahs has increased. Management strategies and economic incentives that promote cheetah conservation, such as the formation of conservancies, development of ecotourism, and marketing of "predator-friendly" meat, are essential for conserving cheetahs outside protected areas.

Factors Influencing Perceptions of Conflict and Tolerance toward Cheetahs on Namibian Farmlands

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Abstract: *Namibia has the largest remaining population of free-ranging cheetahs (*Acinonyx jubatus*) in the world, 90% of which are found outside protected areas on commercial farms. We conducted a baseline survey of Namibian farmers between 1991 and 1993, with a yearly follow-up thereafter until 1999, to quantify the perceptions of farmers toward cheetahs. Specifically, we sought to identify factors that cause cheetahs to be perceived as pests and management practices that mitigate this perception. The baseline survey revealed that farmers who regarded cheetahs as problems removed an average of 29 cheetahs annually, whereas those who did not consider them problematic removed a mean of 14 annually. These figures dropped significantly to 3.5 and 2.0 cheetahs per year after the introduction of educational materials. The perception that cheetahs are pests was significantly associated with game farms, and the presence of "play trees" on farms emerged as a significant corollary of both negative perceptions and removals of cheetahs. Between 1991 and 1999, the mean annual number of cheetah removals significantly decreased from 19 to 2.1. Late in the study, cheetah killing was more closely correlated with perceived problems than in the early years of the study. These findings suggest that although cheetahs are still perceived as a problem, farmers' tolerance toward cheetahs has increased. Management strategies and economic incentives that promote cheetah conservation, such as the formation of conservancies, development of ecotourism, and marketing of "predator-friendly" meat, are essential for conserving cheetahs outside protected areas.*

Factores que Influyen en las Percepciones de Conflicto y Tolerancia de Guepardos en Granjas de Namibia

Resumen: *Namibia tiene la mayor población de guepardos (*Acinonyx jubatus*) silvestres del mundo, 90% de los cuales se encuentran en granjas comerciales, afuera de áreas protegidas. Entre 1991 y 1993 aplicamos una encuesta a granjeros de Namibia, con un seguimiento anual hasta 1999, para cuantificar sus percepciones respecto a los guepardos. Específicamente, buscamos identificar aquellos factores que hacen que los guepardos se perciban como plaga y las prácticas de manejo que mitigan esta percepción. La encuesta reveló que los granjeros que consideran plaga a los guepardos removieron un promedio de 29 individuos por año, mientras que los que no los consideran problemáticos removieron un promedio de 14 individuos por año. Estas cifras disminuyeron significativamente de 3.5 a 2.0 guepardos/año después de la introducción de materiales educativos. La percepción de que los guepardos son plaga estaba asociada significativamente con granjas cinegéticas, y la presencia de "árboles para juego" en las granjas emergió como un corolario significativo tanto de percepciones negativas como de remociones de guepardos. Entre 1991 y 1999, el número promedio de remociones de guepardos disminuyó significativamente de 19 a 2.1. Al final del estudio, la matanza de guepardos estaba más estrechamente correlacionada con problemas percibidos que en los primeros años del estudio. Estos hallazgos sugieren que, aunque todavía se les percibe como un problema, la tolerancia de los granjeros hacia los guepardos ha aumentado. Estrategias de manejo e incentivos económicos, como la formación de comités, el desarrollo del ecoturismo y el comercio de carne "pro-depredadora," que promuevan la conservación de guepardos son esenciales para su conservación fuera de áreas protegidas.*

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Introduction

The cheetah's (*Acinonyx jubatus*) distribution has been radically reduced and fragmented since the 1970s, with the global population falling from an estimated 30,000 animals in 1975 to fewer than 15,000 in the 1990s (Myers 1975; Marker 1998). The largest remaining population, estimated at 2500 individuals (20% of the world's population) is in Namibia (Morsbach 1987; Marker 1998), making effective conservation within Namibia an issue of critical importance.

Although large predators generally are increasingly confined to protected areas, the opposite situation applies to cheetahs. The majority of the world's cheetah population is outside protected areas, where species such as lions (*Panthera leo*) and spotted hyaenas (*Crocuta crocuta*) have been eliminated. Therefore, developing strategies for maintaining cheetah populations and habitats outside protected areas is important. In Namibia an estimated 90% of cheetahs are in a contiguous 275,000-km^2 area of commercial livestock farmland, within which the average farm encompasses 8000 ha (Marker-Kraus et al. 1996). This situation frequently places cheetahs in conflict with both livestock farmers and game farmers (Marker 1998). Cheetahs are vulnerable on the farmlands because they are easily trapped at so-called "play trees," which are particular trees used as scent-marking locations, predominantly by territorial males (Marker-Kraus et al. 1996).

The presence of such a large number of cheetahs on farmland, where they have traditionally been perceived as a pest (Marker-Kraus et al. 1996), makes evaluating the farmers' perception and treatment of cheetahs an obvious conservation priority. Worldwide, farmers hold, and act upon, strong negative perceptions about predators (Sillero-Zubiri & Laurenson 2001), and a first step in resolving the conflict is to disentangle which aspects of these perceptions are real (e.g., Baker & Macdonald 2000).

Approximately 70% of Namibians are directly or indirectly dependent upon some form of agriculture (Schneider 1994). Namibian commercial farms fall into two broad categories: livestock farms and game farms (Marker-Kraus et al. 1996). Nearly 6000 commercial livestock farms utilize 44% of Namibia's available agricultural land (Schneider 1994), and beef products generate 87% of the country's gross agricultural income (van Schalkwyk 1995). Livestock farms have relatively high numbers of free-ranging game, whereas many game farms also have certain sectors where livestock are raised. An estimated 70% of Namibia's huntable game species live on commercial cattle farms (Joubert & Mostert 1975). Namibia's cheetah population is concentrated in the north-central commercial farmlands, which cover approximately 20% of the agricultural land (Marker-Kraus et al. 1996).

Although there is some overlap between the two farming strategies, farms are categorized by whether their primary income is generated through livestock production or the utilization of game, and each category is characterized by a particular type of fencing and management system. In the 1980s, game farms began to proliferate and today contribute a significant amount of foreign currency to Namibia. The majority of game farms are run primarily for trophy-hunting purposes. From 1972 to 1992 the percentage of land-use revenue attributed to wildlife increased from 5% to 11%, and by 1999 trophy hunting alone contributed U.S.$4.7 million to the Namibian economy (MET 2000).

Because of the decline in cheetah numbers, the species is classified as vulnerable by the World Conservation Union (Hilton-Taylor 2000) and is listed on the Convention on International Trade in Endangered Species (CITES) Appendix 1, which restricts trade (CITES 1984). However, CITES allows Namibia an annual export and trophy hunting quota of 150 cheetahs (CITES 1992). On average, trophy hunters shot 21 cheetahs annually between 1983 and 1991 (Marker & Schumann 1998) and 38 cheetahs annually between 1992 and 1998 (MET 1999). Despite the increase, the number of cheetahs killed for trophies is still below the quota and is unlikely to pose a risk to the population.

Despite their classification as "protected game" in Namibia, killing cheetahs is permitted to protect life or property (Nowell 1996), and many farmers use this exemption to practice "preventative management" to reduce depredation of livestock or game by eliminating cheetahs indiscriminately (Marker-Kraus & Kraus 1995). Between 1978 and 1994, the Ministry of Environment and Tourism (MET) documented 9588 cheetah removals (killed or sold as live animals) from Namibian farmlands. Farmers often conduct these removals in response to seeing cheetah signs on their farms, rather than in response to actual depredation. An average of 827 cheetahs were reported removed annually between 1978 and 1985, and 297 annually between 1986 and 1995 (Nowell 1996). The estimated national cheetah population was halved from 6000 animals to $<$3000 during the 1980s (Morsbach 1987).

These figures may reflect the widespread perception of farmers that predators are responsible for significant stock losses and should be removed (Johnson et al. 2001). In the case of the cheetah in Namibia, little evidence corroborates this perception in terms of proven losses (MET 1999). However, indiscriminate removal of predators due to their perceived, but unproven, contribution to stock loss is a common characteristic of carnivore management and is well illustrated by the case of the red fox (*Vulpes vulpes*) on farmlands in the United Kingdom (Baker & Macdonald 2000) and other predators throughout the world (e.g., Johnson et al. 2001; Sillero-Zubiri & Laurenson 2001). Certain questions have therefore become crucial in the context of the

cheetah's presence on Namibian farms. First, how do reported cheetah problems, cheetah removals, and livestock loss relate to farmland characteristics and farm management practices? Second, have farmers' perceptions of and tolerance toward cheetahs changed over time and, if so, why? To answer these questions, and with the goal of analyzing farmers' perceptions as a basis for evaluating and mitigating their conflict with cheetahs, we surveyed commercial farmers throughout Namibia.

Methods

Subjects

We recruited subjects at farmers' association meetings in the study area, and we either interviewed them personally or asked them to complete the questionnaire at the meeting. The locations of the survey participants for the baseline and follow-up surveys are shown in Figs. 1a and 1b, respectively. Namibian farmers are a homogenous group (Harvey & Isaksen 1990) so we considered our subjects to be a representative sample of the population of farmers in the study area. The farmers were white and predominantly of Afrikaaner or German origin.

Survey

Between 1991 and 1993, 241 farmers answered a questionnaire to obtain information on physical features of their farmlands, their farm management practices, their problems with predators and livestock loss, and the number of cheetahs they removed. This was followed up with an annual questionnaire from 1993 to 1999. Annually, we sent respondents an informational newsletter, which described the results of our work on the farmlands and provided information about predator ecology and livestock and game management techniques that could be used to reduce losses.

We analyzed data from 1991 to 1993 first in order to gain baseline information to which subsequent data could be compared. We separated responses into four sections for analysis: perceptions toward and removals of predators; farmland characteristics; stocking rates and livestock management techniques; and livestock losses. The last two categories were only applicable to livestock farmers.

The 1993–1999 follow-up questionnaires were shorter and repeated a subset of questions asked in the baseline survey. We assigned a specific code in cases where the respondent failed to answer a question and another when the answer was not relevant (e.g., for number of small stock lost where none were owned). These data were excluded from analyses.

We compared variables between farms where a cheetah problem was reported and those that reported no problem and between farms where cheetahs were removed and those where they were not. We used independent-samples t tests for interval-scale data and Pearson's chi-squared tests for binary variables. We then repeated these analyses with the 1993–1999 data to investigate changes in significant variables and, most important, changes in perceptions and cheetah removals.

To detect changes in farmers' perceptions and tolerance of cheetahs over time, we constructed indices relating to livestock losses and cheetah removals from 1993 to 1999. The tolerance and perception indices were constructed by scoring farmers annually on a scale

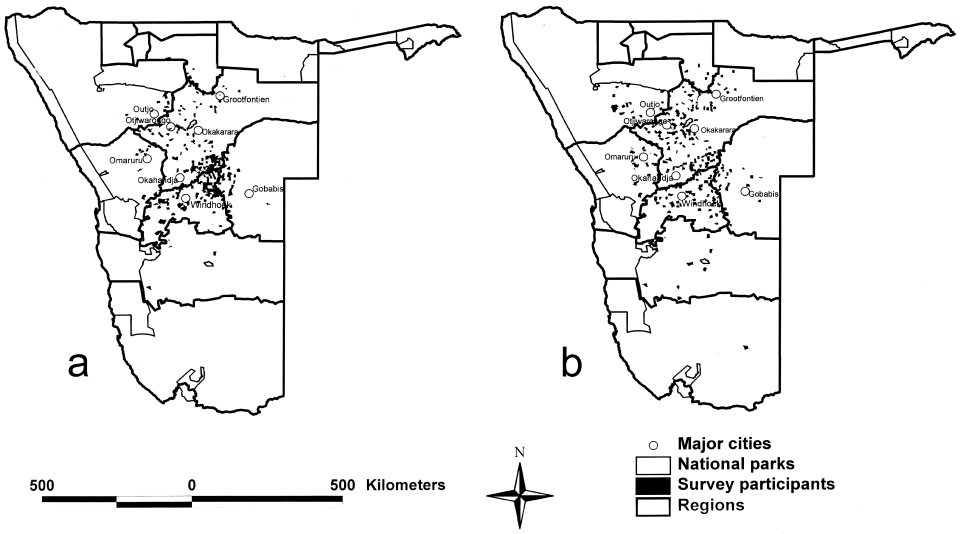

Figure 1. Location of the survey participants in (a) the initial 1991–1993 survey and (b) the follow-up 1993–1999 survey.

of 1 to 4 according to their level of perceived cheetah problems and cheetah removals (Table 1). We calculated these indices to determine whether exposure to conservation education had a measurable influence on farmers' perceptions and to investigate any change in the number of cheetahs removed per head of livestock lost to cheetahs. All tests were two-tailed unless otherwise stated.

Results

Perceptions and Removals

Both the baseline survey and the follow-up survey (Table 2) revealed a significant association between perceived cheetah problems and reported cheetah removals ($\chi^2 = 10.57$, $p = 0.001$, and $\chi^2 = 15.7$, $p < 0.001$, respectively), although the level of removals was high even on farms where cheetahs were not considered problematic. Perceiving a jackal problem was also related to perceiving a cheetah problem ($\chi^2 = 5.17$, $p = 0.023$) and to removing cheetahs ($\chi^2 = 4.32$, $p = 0.038$).

A higher proportion of farmers reported removing cheetahs in the follow-up survey than in the baseline survey, although the marked difference in response rate makes this result difficult to interpret. The proportion of farmers removing fewer than 10 cheetahs annually rose from 55% in the baseline survey to 99% in the follow-up survey, and significantly fewer cheetahs were reported removed during the follow-up survey then in the baseline survey ($t = 6.031$, $p < 0.001$).

Characteristics of the Farm

Responses from the baseline survey (Table 2) revealed a significant association between farm type and cheetah problems ($\chi^2 = 13.62$, $p < 0.001$), with a higher proportion of game farmers regarding cheetahs as a problem, but no significant relationship was found during the follow-up survey ($\chi^2 = 2.36$, $p = 0.124$; Table 2). Significantly more game farmers than livestock farmers removed cheetahs during both the baseline survey ($\chi^2 = 10.68$, $p = 0.001$) and the follow-up survey ($\chi^2 = 10.68$, $p = 0.001$).

Table 1. Calculation of indices used to score perception of cheetah problems and tolerance of cheetahs.

Tolerance index			*Perception index*		
score	*cattle loss*	*cheetah removal*	*score*	*cattle loss*	*cheetah problem*
4	yes	no	1	yes	no
3	no	no	2	no	no
2	yes	yes	3	yes	yes
1	no	yes	4	no	yes

In both surveys, a greater percentage of both livestock and game farmers removed cheetahs than considered them a problem. Although a higher percentage of game farmers removed cheetahs, livestock farmers showed a greater disparity between the proportion that reported problems and the proportion that removed cheetahs. During the follow-up survey, a higher percentage of both livestock and game farmers regarded cheetahs as a problem, but a lower proportion removed them (Table 2).

The presence of play trees on a farm was strongly related to the reporting of cheetah problems ($\chi^2 = 9.74$, $p = 0.002$), with a higher frequency of reported problems on farms where the farmers were aware of such trees. There was a striking relationship between the presence of play trees and the removal of cheetahs: all the farmers that knew of play trees on their land removed cheetahs, whereas none of the farmers who did not know of play trees on their farms performed removals ($\chi^2 = 237$, $p < 0.001$). A significantly greater proportion of game farmers (82.7%) were aware of play trees on their land than livestock farmers (59.4%, $t = -3.622$, $p < 0.001$). Despite the relationships between play trees and perceived cheetah problems and removals, there was not a significantly higher percentage of either cattle or small stock lost on farms that had play trees than on those where no play tree was known (cattle: $t = 1.280$, $p = 0.205$; small stock: $t = -1.759$, $p = 0.106$).

In the baseline survey, there was no significant relationship between the frequency of sighting cheetah tracks and that of reporting cheetah problems ($t = -1.38$, $p = 0.170$) or cheetah removals ($t = -1.43$, $p = 0.153$). In the follow-up survey, the mean number of sightings per year had dropped, and significantly more cheetah tracks were spotted on farms reporting cheetah problems than those reporting no problems ($t = -2.63$, $p = 0.009$), although there was still no relationship with cheetah removals ($t = -1.04$, $p = 0.302$).

Stocking Rates and Livestock Management Techniques

The number of cattle owned, total livestock owned, and livestock density bore no relationship to either perceived cheetah problems or cheetah removals. The number of small stock owned was unrelated to cheetah problems, but farmers that removed cheetahs had significantly more small stock than those that did not ($t = 2.30$ $p = 0.023$).

The estimated number of game animals on a livestock farm showed no relationship with reported cheetah problems or removals. Game-density estimates were not related to the frequency of reported cheetah problems, although farmers that removed cheetahs had significantly higher estimates of game density on their farms than those that did not remove cheetahs, a difference that bordered on statistical significance ($t = -1.98$, $p =$

Table 2. Responses from farmers questioned during the baseline and follow-up surveys: perceptions of predator problems, rate of cheetah removals, and farm characteristics.

		Percentage of respondents							
		1991–1993 baseline survey				*1993–1999 follow-up survey*			
Variable	*Response*	*cheetah problem*	*no cheetah problem*	*remove cheetahs*	*do not remove cheetahs*	*cheetah problem*	*no cheetah problem*	*remove cheetahs*	*do not remove cheetahs*
Have a cheetah problem	yes	—	—	84	16	—	—	77.5	22.5
	no	—	—	59.3	40.7	—	—	41.3	58.7
Have a jackal problem	yes	26.9	73.1	73.5	26.5	—	—	—	—
	no	12.5	87.5	59.1	40.9	—	—	—	—
Remove cheetahs	yes	29.2	70.8	—	—	74.3	25.7	—	—
	no	9.4	89.7	—	—	37.2	62.8	—	—
Mean no. cheetahs removed/yr	—	29.1	14.3	—		3.47	1.95	—	—
Farm type	game farm	40.4	59.6	82.5	17.5	54.2	45.8	79.2	20.8
	livestock farm	15.9	84.1	58.4	41.6	43.2	56.8	53.2	46.8
Mean frequency of tracks*	—	47	27.7	39.3	21.2	3.4	1.82	3.48	1.68
Presence of play trees	yes	28.4	71.6	100	0	—	—	—	—
	no	10.3	89.7	0	100	—	—	—	—

0.050). The proportion of game animals owned was also significantly higher on farms where cheetah removals occurred ($t = -2.32$, $p = 0.022$). There was a relationship between play-tree abundance and estimated game density on livestock farms: livestock farms with play trees had a significantly higher density of game than those without play trees ($t = 2.52$, $p = 0.013$).

Livestock Losses

CATTLE LOSSES

In both the baseline and follow-up surveys (Table 3), farmers reporting cheetah problems attributed the loss of significantly more cattle to cheetahs than farmers without a problem. Farmers that removed cheetahs also reported losing more cattle to cheetahs, although the difference was not statistically significant (Table 4).

The number of cattle reported as taken by cheetahs was not significantly correlated with the number of cheetahs removed in the baseline survey ($r = 0.257$, $p = 0.135$), but it was in the later survey ($r = 0.248$, $p = 0.017$). In both surveys, farmers reporting cheetah problems reported that they lost significantly more cattle to other predators than farmers without a problem, and the same was true for farmers that removed cheetahs compared with those that did not (Table 3). In both surveys, the number of cattle lost overall was significantly related to cheetah problems and removals (Table 4).

Stocking-rate information allowed the losses to be considered as a percentage of the total owned for the 1991–1993 dataset. When analyzed this way, there were no significant relationships between the percentage of cattle lost to cheetahs (range 0–3.3%, mean 0.67%), the percentage of cattle owned lost to other predators (range 0–6.0%, mean 0.7%), or the total percentage of cattle lost and either cheetah problems or removals (Table 4).

SMALL STOCK LOSSES

The baseline survey revealed no significant relationship between the number of small stock lost to cheetahs and either cheetah problems or removals (Table 3). In the follow-up survey, however, predation of small stock attributed to cheetahs was significantly related to perceived cheetah problems and removals (Table 3).

In the baseline survey, the number of small stock reported lost to other predators (mean of 6.5 losses per year) was not significantly linked to reported cheetah problems but did show a significant relationship with cheetah removals, with more small stock being lost on farms that removed cheetahs (Table 4). The later survey revealed no significant relationship between the number of small stock reported as lost to other predators and either cheetah problems or cheetah removals (Table 4).

The number of small stock reported as lost overall was not correlated with the number of cheetahs removed in the baseline survey ($r = 0.408$, $p = 0.117$), but a relationship was evident in the later survey ($r = 0.320$, $p = 0.002$). Overall, neither survey showed a significant relationship between the total number of small stock lost, to both cheetahs and other predators, and either cheetah problems or cheetah removals.

When considered as a percentage of the small stock owned during the baseline survey, the number of small

Table 3. Responses from livestock farmers questioned during the baseline and follow-up surveys: livestock losses* and cheetah problems and removals.

	1991–1993 baseline survey				*1993–1999 follow-up survey*			
Variable	*cheetah problem*	*no cheetah problem*	*remove cheetahs*	*do not remove cheetahs*	*cheetah problem*	*no cheetah problem*	*remove cheetahs*	*do not remove cheetahs*
No. cattle lost to cheetahs (%)	8.2 (1.1)	3.2 (0.6)	5.3 (0.8)	3.1 (0.5)	2.2	0.1	1.1	1.1
No. cattle lost to other predators (%)	7.0 (1.0)	3.9 (0.6)	4.8 (0.7)	3.5 (0.7)	4.8	1.3	4.9	0.5
No. cattle lost overall (%)	16.7 (2.0)	6.8 (1.3)	11.2 (1.6)	4.9 (1.1)	5.8	1.2	3.9	1.6
No. small stock lost to cheetahs (%)	9.0 (3.3)	4.7 (1.7)	3.8 (1.5)	6.3 (2.3)	2.6	0.5	3.6	1.2
No. small stock lost to other predators (%)	8.8 (4.9)	6.0 (2.1)	5.5 (2.3)	7.9 (3.1)	8.1	9.9	4.1	5.5
No. small stock lost overall (%)	18.0 (5.3)	11.5 (4.3)	10.4 (4.9)	12.4 (2.9)	8.5	12.1	6.3	6.6
No. livestock lost to cheetahs (%)	10.4 (1.4)	4.3 (0.5)	5.5 (0.8)	4.5 (0.5)	4.9	0.5	3.9	2.3
No. livestock lost to other predators (%)	12.4 (1.2)	7.3 (0.8)	7.8 (0.9)	8.5 (0.9)	12.9	10.4	8.1	6.0
No. livestock lost overall (%)	21.3 (2.4)	10.4 (1.3)	14.0 (1.9)	6.5 (0.5)	14.5	13.5	10.3	8.4

** Losses are reported as the number of cattle, small stock, and total livestock lost for both surveys and the percentage of each stock type owned for the baseline survey.*

stock lost to cheetahs, predators, or overall was not significantly related to cheetah problems or removals.

TOTAL LIVESTOCK LOSSES

Farmers reporting cheetah problems attributed the loss of significantly more livestock to cheetahs than did farmers that reported no cheetah problems. Although farmers that removed cheetahs also had more livestock taken by cheetahs than those that did not, the difference was not statistically significant. These trends were the same in both the baseline and the follow-up surveys (Table 4).

In both surveys, the number of livestock killed, by other predators and overall, was not significantly linked to either cheetah problems or removals (Table 4). As expected from the patterns seen with small stock and cattle losses, there was no correlation between the number of livestock lost and the number of cheetahs removed in the baseline survey ($r = 0.133$, $p = 0.586$), but there was a relationship in the later survey ($r = 0.344$, $p = 0.001$).

The amount of livestock lost to cheetahs in 1991–1993 (range 0–3%, mean = 0.7%) was not related to cheetah problems or removals. This was also true for the

Table 4. Analyses of statistical relationships* between livestock losses and cheetah problems and removals for the baseline (1991–1993) survey and the follow-up (1993–1999) survey of livestock farmers.

	1991–1993 baseline survey						*1993–1999 follow-up survey*					
	relationship with cheetah problems			*relationship with cheetah removals*			*relationship with cheetah problems*			*relationship with cheetah removals*		
	t	*df*	p	t	*df*	p	t	*df*	p	t	*df*	p
No. cattle lost to cheetahs	−4.078	42	0.000	−1.9	42	0.064	−5.261	64	0.000	0.08	51	0.937
No. cattle lost to other predators	−3.021	120	0.003	−1.664	119	0.099	−4.473	126	0.000	−2.971	29	0.006
No. cattle lost overall	−3.413	30	0.002	−2.529	30	0.017	−5.466	69	0.000	−1.661	19	0.113
Cattle lost to cheetahs (%)	−1.889	42	0.066	−1.128	42	0.266	—	—	—	—	—	—
Cattle lost to other predators (%)	−1.626	120	0.107	0.005	119	0.996	—	—	—	—	—	—
Cattle lost overall (%)	−1.016	30	0.318	−0.974	30	0.338	—	—	—	—	—	—
No. small stock lost to cheetahs	−1.219	17	0.240	1.115	16	0.281	−2.744	59	0.008	−2.086	24	0.048
No. small stock lost to other predators	−1.709	67	0.092	2.076	65	0.042	0.598	226	0.550	0.427	63	0.671
No. small stock lost overall	−0.643	14	0.531	0.376	13	0.713	0.783	141	0.435	0.083	51	0.934
Small stock lost to cheetahs (%)	−0.922	17	0.370	0.753	16	0.463	—	—	—	—	—	—
Small stock lost to other predators (%)	−1.015	9	0.336	0.819	65	0.416	—	—	—	—	—	—
Small stock lost overall (%)	−0.131	14	0.898	−0.503	13	0.624	—	—	—	—	—	—
No. livestock lost to cheetahs	−2.574	27	0.016	−0.508	26	0.616	−5.063	55	0.000	−1.193	21	0.246
No. livestock lost to other predators	−2.297	18	0.034	0.499	102	0.619	−0.753	216	0.452	−0.612	62	0.543
No. livestock lost overall	−1.59	20	0.127	−1.552	19	0.137	−0.215	137	0.830	−0.382	50	0.704
Livestock lost to cheetahs (%)	−2.39	25	0.024	−0.965	26	0.344	—	—	—	—	—	—
Livestock lost to other predators (%)	−1.849	104	0.067	0.286	102	0.776	—	—	—	—	—	—
Livestock lost overall (%)	−1.141	20	0.268	−2.62	14	0.020	—	—	—	—	—	—

** These analyses were restricted to livestock farmers only.*

percentage of livestock lost to predators (range 0–6%, mean = 0.9%) and the percentage of livestock lost overall (range 0–6%, mean = 1.4%).

Perception and Tolerance Indices

Figure 2 tracks the mean perception and tolerance scores during the study. The mean perception score of farmers who believed they had cheetah problems increased significantly from 1.6 in the baseline survey to 2.4 in 1999 ($t = -8.218$, $p < 0.001$). Meanwhile, the level of tolerance increased slightly from 2.7 to 3.3, a change that was not statistically significant. The mean number of cheetahs removed per head of livestock lost to cheetahs decreased significantly from 3.04 in the baseline survey to 0.18 in the follow-up survey ($t = 3.789$, $p = 0.003$).

Discussion

Perceptions and Removals

Cheetah removals were associated with perceived cheetah problems in both surveys, but it was evident that many indiscriminate removals occurred, because almost 60% of the farmers that did not consider cheetahs problematic still removed cheetahs. This percentage decreased in the later survey, but it was still a substantial proportion. So the question is, why remove something if it isn't a problem? One explanation, which is in agreement with traditional attitudes toward predators, is that they are often eliminated whether they are thought to be currently problematic or not. This reinforces the fact that understanding the human dimension of wildlife conservation must become a central tenet of carnivore conservation biology (e.g., Sillero-Zubiri & Laurenson 2001).

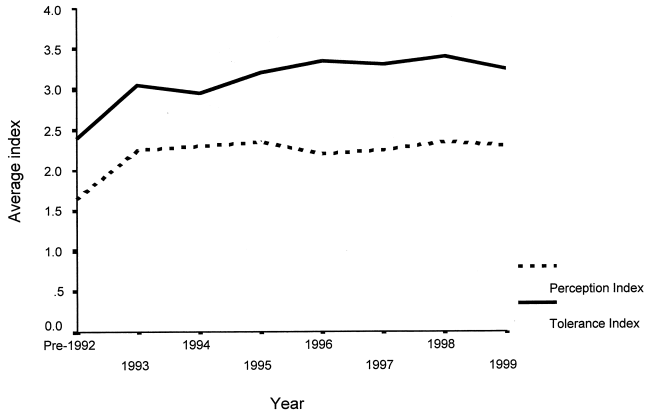

Figure 2. Mean scores for the indices regarding perception of cheetah problems and tolerance of cheetahs throughout the course of the study.

Cheetah problems were related to jackal problems, indicating that management practices on farms that have a cheetah problem are more likely to lead to problems from other carnivores too or that farmers who perceive problems with cheetahs regard all carnivores as problematic. A higher proportion of farmers reported removing cheetahs in the follow-up study than in the baseline survey. It is difficult to gauge how accurate a reflection of the later situation this is because only 24% of farmers answered this question in the 1993–1999 survey. If farmers who removed cheetahs were the ones least keen to answer this question, it may be assumed that the proportion of farmers still removing cheetahs is high. Alternatively, it may be that respondents left the answer blank for the number of cheetahs removed if they did not remove any, and in that case the number of farmers removing cheetahs would have been relatively low in the later survey. We believe this to be the case because we have developed a long-standing, trusting relationship with the commercial farmers, and there is no detriment to farmers for admitting that they remove cheetahs. The higher reporting rate in the baseline survey may be due to farmers wishing to share information about severe predator problems, which would become less important as the perception of problems diminished. Nevertheless, removals continue, so there is a need for continued education about the value of predators in the farmland ecosystem and ways of managing to farm alongside them.

In both surveys, more cheetahs were removed from farms where the farmer perceived a cheetah problem than from those where the farmer did not. This indicates that many removals are not indiscriminate and that if work is done to reduce the magnitude of problems through proper management techniques, it is likely that removals could drop substantially. Indeed, the number of cheetahs removed annually per farmer had dropped considerably by the end of the follow-up survey. This may be attributable to the education of the Namibian farmers about predators.

Characteristics of the Farm

In the baseline survey, more game farmers than livestock farmers considered themselves to have a cheetah problem. This is to be expected given that hunting game is natural behavior for cheetahs, whereas our examinations revealed that cheetahs that resort to habitual livestock predation often show physical or behavioral abnormalities (Marker et al. 2003). Cheetah removals were also higher on game farms, revealing the importance of finding workable strategies for reducing this level of removal. Well-maintained electric fencing can be effective at excluding predators, but this is an expensive, high-maintenance solution. Research is underway into alternative strategies, including the use of swing-gates, which are gates in game fences that allow warthog entry, to reduce

the likelihood of warthogs digging holes under the fence and allowing access to predators. Another management strategy involves encouraging the formation of conservancies for managing multiple farms as a collective unit for the shared, sustainable use of resources, sharing the costs and benefits of maintaining both prey and predators on the farmlands.

It is striking that a greater percentage of both livestock and game farmers remove cheetahs than consider them to be a problem. For both farm types, however, the proportion of farmers removing cheetahs despite not reporting them as problematic declined in the follow-up survey. Again, this may reflect greater conservation awareness resulting from sustained predator education programs.

One of the most important characteristics of the farmland ecosystem influencing cheetah problems and removals was the presence of play trees, which attract cheetahs (Gaerdes 1974; McVittie 1979), and this may influence the increased level of perceived problems on farms with play trees, although there was no evidence of increased livestock loss. Farmers tend to be aware of such trees on their land, and they are often used as capture sites (Marker-Kraus & Kraus 1995), explaining the relationship with cheetah removals.

Stocking Rates and Livestock Management Techniques

More cheetahs were removed on livestock farms reporting a high density of game. This may be linked to the fact that livestock farms with play trees had a higher game density, and on such farms the awareness of cheetah presence is higher, while the removal of cheetahs is easier. The higher numbers of play trees on game farms, and on livestock farms with higher densities of game, indicates that cheetahs may be using game density when selecting trees.

Livestock Losses

More cattle were lost on livestock farms where the farmer reported a problem, but the lack of a relationship with cheetah removals suggests that removals are opportunistic rather than in direct response to losses. Livestock farmers that had cheetah problems also believed they suffered more cattle losses from other predators, and this was also related to cheetah removals. Cheetahs are relatively easy to catch on farms with play trees, and on livestock farms they may be captured in response to losses from other predators.

Although in the baseline survey small stock losses to other predators were linked to cheetah removals, this was not the case in the later survey. Again, this may be a result of increased awareness of conservation issues among farmers and a greater ability to determine the cause of livestock loss and address the factor responsible rather than removing cheetahs as a reactionary measure. The closer correlation between livestock losses and cheetah removals in the later survey may indicate that, as this awareness increases, removals become more closely linked to actual problems.

When examined as a percentage of the stock owned, there was no significant relationship between either reported losses of cattle or small stock and cheetah problems and removals. This suggests that there may be some threshold level of loss (e.g., 15 or 20 animals) that the farmer finds unacceptable, regardless of the size of his herd.

Perception and Tolerance

The perception and tolerance indices, along with the problem and removal trends, show that although cheetahs are increasingly perceived as a problem on Namibian farmlands, the tolerance level for them has not decreased. Additionally, the number of cheetahs removed per head of livestock reported to be lost to them declined significantly over time. This may be a result of effective conservation education, but, ultimately, farming is a commercial venture and financial incentives will doubtless be essential if such tolerance is to be substantially increased and sustained.

Conservancy development could be a useful method of alleviating the problems associated with managing predators on private land. Conservancies consist of adjacent farms joined together in broad units in which natural resources are cooperatively managed. A constitution adhered to by the landowners outlines conservation and management strategies, including sustainable utilization of natural resources in conjunction with agricultural aims. Conservancy constitutions may include utilization of game for trophy hunting, meat, and ecotourism and may provide guidelines to assist farmers in coordinating the management and utilization of wildlife.

Another potential economic incentive would be to market "predator-friendly" Namibian beef to the European Union and South African export markets. Farmers using nonremoval predator-control methods could be certified as such and could charge a higher price for their livestock products. Trophy hunting offers another opportunity to encourage tolerance toward cheetahs. In 2000 cheetahs commanded approximately U.S.$2000 each, whereas the average value of a cow was U.S.$200. If the cheetahs' value were increased, they would become more valuable to farmers, who might then be less likely to kill them indiscriminately. Ecotourism may also provide economic benefits to farmers with cheetahs on their land. The occurrence of play trees on farms provides an ecotourism opportunity for visitors, because they often show signs of cheetahs, which increases the awareness of the presence and ecology of a rare, elusive species. Several tour companies in Namibia are now marketing this opportunity. Encouraging such ecological awareness among tourists is an important component of predator conservation.

Conclusions

Extensive livestock and game farming is the backbone of Namibia's agriculture, and the farmlands are home to the majority of the country's wildlife. Under these circumstances, seeking to isolate cheetahs from farmers and to conserve them in protected areas only is inadequate. Therefore, a land-use strategy is required that integrates the needs of both agriculture and conservation, through which farmers become custodians rather than adversaries of predators and their prey. Although there are widespread perceptions that farmers are hostile to cheetahs and that cheetahs are highly problematic to farmers, our questionnaires suggest that neither problem is intractable. First, we found evidence that farmers are open to new information and approaches, leading them to change their behavior. Second, we have found an encouraging number of farmers who are receptive to management proposals to mitigate the damage caused by predators (e.g., the use of stock-guarding dogs; Marker-Kraus et al. 1996). One particular difficulty in Namibia is the drought cycle, which brings with it fluctuating densities of livestock and corresponding variation in the value of, and pressure on, game populations. Plans to conserve cheetahs must take into account such situations, when financial strictures might make farmers less tolerant. As gaps in biological knowledge are plugged and conservation thinking is decreasingly constrained, the human dimension is likely to be the determining ingredient of the success of any plan for conserving cheetahs in Namibia.

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