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Ecology of the Ethiopian wolf (*Canis simensis* Rüppell 1835) in a changing landscape: Human carnivore interactions in Afroalpine ecosystems of Ethiopia

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Citation

Genbere, G. E. (2017, September 5). *Ecology of the Ethiopian wolf (Canis simensis Rüppell 1835) in a changing landscape: Human carnivore interactions in Afroalpine ecosystems of Ethiopia*. Retrieved from <https://hdl.handle.net/1887/54949>

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Author: Genbere, G.E.

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Issue Date: 2017-09-05

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Human–Ethiopian Wolf Conflicts



Ethiopian wolves' conflict with pastoralists in small Afroalpine relicts
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Submitted to *African Journal of Ecology* (2015) AFJE-15-383

Abstract

The peaceful coexistence between people and the rare Ethiopian wolf *Canis simensis* is being challenged by conflicts arising due to livestock predation by wild carnivores. Understanding the cultural and socio-economic context of these conflicts can help to prevent negative attitudes and retaliatory killings, which have the potential to seriously compromise the survival of the Ethiopian wolf populations in Afroalpine relicts. With this objective in mind, questionnaire surveys were conducted in 140 households around the Aboi Gara range in north Ethiopia. Half of the households reported losing sheep and goats to wolves and golden jackals *C. aureus*, with an annual average loss of 1.2 heads per year (10% of the average herd size) equivalent to 92 USD. Aboi Gara pastoralists considered wolves and jackals to be almost equally responsible for livestock killings (54.2% by jackals). Households with large herds, closer to Afroalpine habitats, and using Afroalpine pastures for longer periods reported more predation by wild carnivores. Most respondents (62%) expressed a positive attitude towards Ethiopian wolves, particularly literate people and those with smaller herds. We suggest ways to diminish conflicts, including best livestock guarding techniques to lessen the risk of livestock predation by wild carnivores in Afroalpine areas.

Keywords

carnivore, Ethiopian highlands, human–wildlife conflict, livestock predation

5.1 Introduction

Most carnivores are vulnerable to conflict with humans due to their predatory nature and their need for wide ranges (Sillero-Zubiri and Laurenson, 2001, Treves and Karanth, 2003, Sillero-Zubiri *et al.*, 2006, Davidson *et al.*, 2011). When coupled with other threats, human–carnivore conflict can seriously increase the risk of extinction for small populations of threatened species (Woodroffe, 2001, Wang and Macdonald, 2006, Inskip and Zimmermann, 2009). Saving these endangered populations might depend on understanding the various ecological and social factors that can contribute to escalate and/or mitigate the conflict (Bath *et al.*, 2008, Inskip and Zimmermann, 2009).

In the case of the rare and endangered Ethiopian wolf (*Canis simensis*), even low levels of retaliation could send populations into an extinction vortex, given their small size and additional threats from viral diseases, habitat loss and degradation (Marino, 2003, Ashenafi *et al.*, 2005, Marino and Sillero-Zubiri, 2011). Understanding human–carnivore conflicts is a research priority for conservation biologists worldwide (Dickman, 2010, Karlsson and Johansson, 2010) and is identified in the strategic plan for Ethiopian wolf conservation (IUCN/SSC, 2011). In this paper we seek a better understanding of the ecological and socio-economic conditions undermining peaceful coexistence with the peculiar Ethiopian wolf, a medium sized canid with restricted distribution and a rodent-based diet (Sillero-Zubiri *et al.*, 1995).

The Ethiopian highlands, characterised by unique physiographic and climatic conditions are home to many endemic species. Among them the rare Ethiopian wolf, with a global population of some 500 animals in six Afroalpine pockets (Gottelli and Sillero-Zubiri, 1992, Marino, 2003, Ashenafi *et al.*, 2005, Marino and Sillero-Zubiri, 2011). Ethiopian wolves and the communities living next to them compete directly for Afroalpine resources that are key for survival of both. The people of the highlands engage in subsistence agriculture and livestock rearing, relying on natural Afroalpine habitats for pastures, firewood and building materials (Ashenafi and Leader-Williams, 2005, Jacob *et al.*, 2014, Eshete *et al.*, 2015). With rapidly increasing human populations in the highlands (Taddese, 2001), the loss and degradation of Afroalpine habitats are impacting upon the populations of rodent prey, challenging the wolves to adapt to an anthropogenic landscape (Stephens *et al.*, 2001, Ashenafi *et al.*, 2005). As prey populations decline and overlap between livestock and carnivores increases, conflicts due to livestock predation are bound to increase (Marino, 2003, Ashenafi *et al.*, 2005, Thirgood *et al.*, 2005, Woodroffe *et al.*, 2005). Even low levels of predation can inflict important economic costs to poor local communities, making carnivore conservation increasingly challenging (Sillero-Zubiri and Laurenson, 2001, Treves and Karanth, 2003, Thirgood *et al.*, 2005).

In comparison with the Bale Mountains, home to more than half of the Ethiopian wolf population, human densities in the northern highlands of Ethiopia are high and the degradation of Afroalpine is more acute. While in Bale the diet of Ethiopian wolves is almost entirely dominated by rodents (Sillero-Zubiri and Gottelli, 1995), previous studies detected remains of livestock in Ethiopian wolf droppings from northern populations, albeit at low frequency, while in some areas people considered Ethiopian wolves a main predator of small stock (Marino, 2003, Marino *et al.*, 2010, Eshete *et al.*, 2015). Interestingly, wolves in Bale and in the Simien Mountains have also learnt to use cows and gelada monkeys (*Theropithecus gelada*) as “mobile hides” thus increasing their success in hunting rodents (Morris and Malcolm, 1977, Sillero-Zubiri and Gottelli, 1995a, Venkataraman *et al.*, 2015).

The evidence of livestock predation by Ethiopian wolves, and the resulting conflict, is patchy and varied, indicating a diversity of scenarios depending on ecological and socio-economic conditions. These relationships, however, have not been studied in detail. In this paper we present results from interviews to local people in Aboi Gara, a small Afroalpine relict in north Ethiopia, where a population of Ethiopian wolves survive in direct contact with people and their livestock in the Afroalpine pastures. From the responses, we quantified the extent of predation upon sheep and goats and its economic impact, and how predation might be impacting people’s attitudes towards the rare and endemic Ethiopian wolf. Using statistical analysis we attempt to disentangle socio-economic factors with direct or indirect implications for the conservation of Ethiopian wolves; and by characterising contemporary patterns of predation, we suggest measures to ameliorate the conflict between local pastoralists and wild carnivores in Ethiopia’s Afroalpine relicts.

5.2 Materials and methods

5.2.1 Study area

The Ethiopian highlands are divided by the Great Rift Valley into the Northern and Southern massifs. This study was carried out in Aboi Gara, in the northern highlands, a small Afroalpine range at 4008 m asl, loosely connected by narrow ridges with the larger Abuna Yosef massif, highest peak at 4286 m (Figure 5.1) (ESP, 2001, Marino, 2003, Eshete *et al.*, 2015).

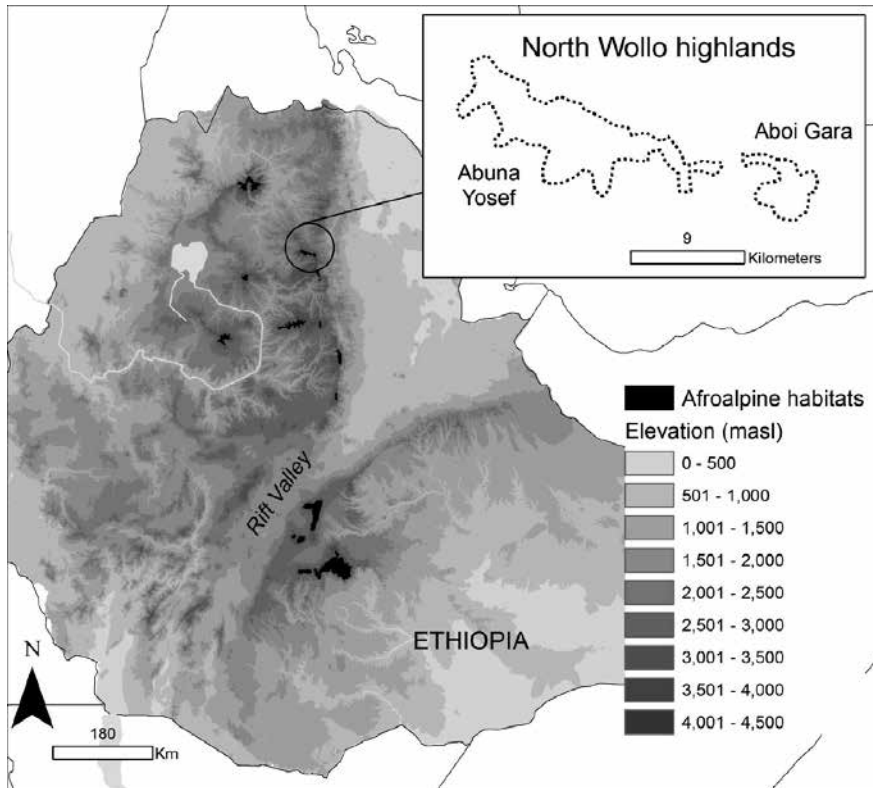


Figure 5.1

Map indicating areas of Afroalpine habitat in the Ethiopian highlands. Inset shows study area of Aboi Gara and adjacent Abuna Yosef

Annual average rainfall is 2000 mm, with a long rainy season (*'Meher'*) from June to September and a short rainy season (*'Belg'*) from February to April. Mean annual temperature ranges from 7.5 °C to 11 °C and the climate is characterised by extreme temperature variations between day and night (ESP, 2001). The area exhibits a mosaic of vegetation types, including Afroalpine grasslands and meadows, dominated by *guassa* grasses (*Festuca* spp.) and heaths of *Euryops* and *Kniphofia* spp., surrounded by a belt of *Erica* moorlands (Jacob *et al.*, 2014). The area sustains a rich fauna with endemic birds and mammals including the gelada baboon, Starck's hare (*Lepus starcki*), rock hyrax (*Procavia capensis*) and several Murinae rodent species.

5.2.2 Data collection

Between October 2011 and January 2012 we interviewed 140 heads of households across 14 villages surrounding Aboi Gara, selected randomly from a list of *kebele* residents (a *kebele* is the smallest administrative unit in Ethiopia).

Using a standard questionnaire in the Amharic language, later translated into English, we collated information on household socio-economic status, livestock losses due to carnivores, and attitudes towards Ethiopian wolves. To maximise the reliability of the interview data, focus group discussions were conducted with community guards (whose role is to protect the habitat), development agencies staff (facilitators at community level), *woreda* experts (state professionals in different fields working at district level), local leaders and elders. We collated official market prices from Gidan *woreda* (the local district of Gidan), averaged for livestock of all ages, in Ethiopian birr (ETB) per year for 2000, 2005 and 2011/12.

5.2.3 Data analysis

The drivers of two kinds of conflict were examined by using logistic regression with binary dependent variables: ‘actual’ conflict (whether or not the respondent had experienced livestock predation by Ethiopian wolves, coded yes/no), and ‘perceived’ conflict (whether households viewed wolves as good or bad). Explanatory variables included: educational level, distance to Afroalpine habitat, family size, land ownership, land size, livestock ownership, herd size, length of grazing in Afroalpine habitat, and seasonality of predation events. A Chi-square test was used to compare the effects of predators. Annual economic loss due to predation was calculated for households with livestock using the local averaged livestock market price, after translating ETB into USD using the exchange rate for the indicated years. As a result, the average livestock price was USD 50.00 in 2000, USD 65.63 in 2005 and USD 78.13 in 2011/12. All data was analysed using R software (Version 2.13.2, R Development core team 2012).

5.3 Results

The majority of the households surveyed engaged in farming (73%) and livestock (79%), owned small agricultural plots (average size 0.5 ha) and herds (average 12 head of sheep and goats). The socio-economic characteristics of the heads of households interviewed are summarised in Table 5.1.

Table 5.1

Summary of socio-economic characteristics of sampled households (N=140)

	Number / percentage of households					
Sex	Male	94	67.1%	Female	46	32.9%
Educational status	Illiterate	86	61.4%	Literate	54	38.6%
Own land	Yes	102	72.9%	No	38	27.1%
Livestock ownership	Yes	111	79.2%	No	29	20.8%
Livestock loss to Ethiopian wolf	Yes	68	48.6%	No	72	51.4%
Livestock loss to common jackal	Yes	86	61.4%	No	54	38.6%
Attitude towards Ethiopian wolf	positive	87	62.1%	Negative	53	37.9%
Grazing the whole year at Aboi Gara	Yes	86	61.4%	No	54	38.6%
Predation season	Rainy	89	63.6%	Dry	51	36.4%
Continuous variables	Minimum	Maximum	Mean	SD		
Age	18	74	42	13		
Family size	2	9	4.7	1.9		
Distance to Afroalpine area (km)	1	9	4.3	1.9		
Herd size (number of head)	0	36	12	9.0		
Land size (ha)	0	1	0.5	0.4		

Seventy out of 140 households interviewed reported losing a total of 131 small stocks to wolves and golden jackals over the last 12 months, with slightly higher (54.2%) losses apportioned to jackals (Table 5.2). Losses averaged 1.2 head per household across the households that owned small stock over the previous 12 months, which was higher than the average annual losses over the previous five and ten years, 0.60 and 0.79 respectively. By contrast, more respondents (70.7%) perceived that predation by wolves in Aboi Gara was decreasing (rather than increasing; $X^2 = 24$, $df = 1$, $P < 0001$), with older people significantly more likely to report this trend ($X^2 = 76$, $df = 1$, $P < 0.002$).

Two thirds of the respondents (89 of 140, 63.6%) reported that predation was seasonal and concentrated in the rainy season (in comparison with the dry season; $X^2 = 10.31$, $df = 1$, $P < 0.001$). Most (70%) households reported losing small stock during nighttime, and there was a significant difference ($X^2 = 41.3$, $df = 1$, $P < 0.0001$) between households reporting daytime and nighttime predation.

Using livestock market prices obtained from local government offices, we calculated that carnivores caused an average annual economic loss of USD 92.21 to each household that kept livestock (Table 5.2).

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Table 5.2

Number of small stock reportedly killed by carnivores in Aboi Gara and estimated economic cost (N=111)

Time period	Small stock predation	by Ethiopian wolf	by golden jackal	Total	Losses/household/year
Last year	head lost	60	71	131	1.20 small stock
	Mean ±SD	0.4±0.8	0.5±1.1		
	Range	1-4	1-6		
	Loss USD	4,688	5,547	10,235	USD 92.21
Last 5 years	head lost	148	187	335	0.60 small stock
	Mean ±SD	1.1±1.7	1.3±1.8		
	Range	1-7	1-9		
	Loss USD	9,713	12,273	21,986	USD 39.60
Last 10 years	head lost	386	490	876	0.79 small stock
	Mean ±SD	2.8±3.6	3.5±3.7		
	Range	1-14	1-15		
	Loss USD	19,300	24,500	43,800	USD 39.46

Households headed by a literate person were less likely to lose their small stock to both wolves and jackals than ones with an illiterate head. The closer to Afroalpine habitats, the higher the probability of a household suffering from predation, and households with large herds were also more affected by predation (Table 5.3), as were households that grazed their livestock in Afroalpine areas all year round, in comparison with those who only grazed there for part of the year (Table 5.3).

Table 5.3

Result of logistic regression indicating factors associated with small-stock predation to Ethiopian wolves (1 = yes 0 = no) in Aboi Gara, North Wollo (N=140)

Variables	Intercept	S.E.	X ²	df	P-value
Education(1)	-2.340	0.672	12.116	1	0.001
Distance	-0.291	0.139	4.414	1	0.036
Family size	-0.039	0.159	0.061	1	0.805
Herd size	0.103	0.030	11.459	1	0.001
Grazing whole year(1)	3.154	0.570	30.628	1	0.000
Predation season	-0.196	0.494	0.158	1	0.691
Constant	-3.375	1.225	7.589	1	0.006
R square	0.580				

Most interviewees (62.1%) considered the Ethiopian wolf to be a ‘good’ species, expressing a positive perception (Table 5.1). There was a significant positive relationship between literacy and positive perception, and a negative correlation with livestock herdsize and level of predation (i.e., number of livestock lost to jackals or wolves Table 5.4).

Table 5.4

Result of logistic regression explaining people’s attitudes towards Ethiopian wolves (1 = positive 0 = negative) in Aboi Gara, North Wollo (N=140)

Variables	Intercept	S.E.	X ²	df	P-value
Education(1)	3.334	0.952	12.258	1	0.000
Distance	0.303	0.181	2.797	1	0.094
Land size	0.375	1.138	0.109	1	0.741
Herd size	-3.764	1.024	13.511	1	0.000
Head lost to wolves(1)	-3.604	0.845	18.184	1	0.000
Head lost to jackals(1)	-1.820	0.870	4.371	1	0.037
Constant	4.753	1.690	7.909	1	0.005
R square	0.780				

Households implemented different livestock predation minimising techniques, including guarding by shepherds (42.2%), avoiding frequent grazing in the mountain (27.1%), curbing livestock entry into the ecosystem (20%) and using dogs to chase wildlife (10.8%) (Figure 5.2). From these techniques,

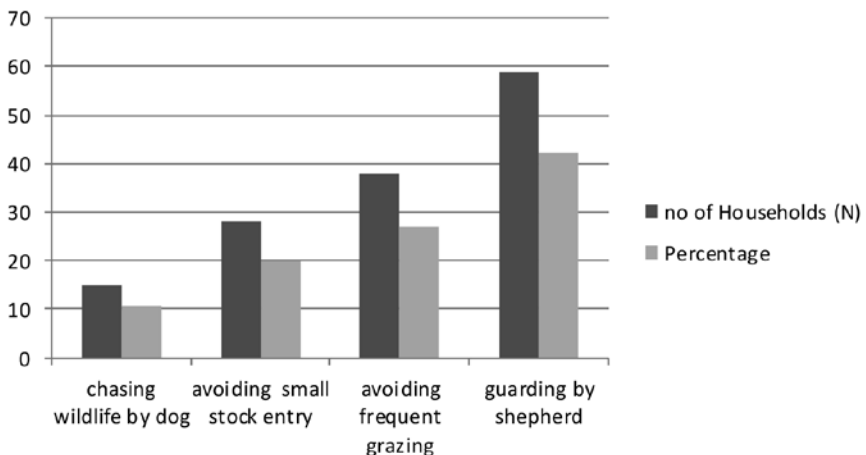


Figure 5.2

Number and percentage of households applying various techniques to minimise carnivore predation (total N=140)

31.4% of households were most effective in mitigating predation through livestock guarding shepherds, followed by 26.1% avoiding taking livestock into the ecosystem, 23.3% escaping frequent grazing in the area and 19.3% using dogs to chase wolves in order to diminish predation.

5.4 Discussion

The Aboi Gara range in northern Ethiopia is vitally important for the livelihood of local pastoralists, which graze their livestock and collect firewood and building materials in the Afroalpine areas (Eshete *et al.*, 2015). We detected low levels of livestock predation by wild carnivores in this Afroalpine range, but this conflict carries an economic cost to the local community and also poses a threat to Ethiopian wolves.

On average Aboi Gara households lost ~1.2 livestock per year (equivalent to USD 92), which imposed a substantial economic penalty on local households that subsist on an income of less than USD 1 per day (Bluffstone *et al.*, 2008). For subsistence farmers relying on small herds (typically 12 head of livestock in Aboi Gara) the loss of even a small number of animals can have a substantial negative impact on their livelihoods (Mishra, 1997, Butler, 2000, Treves and Karanth, 2003, Yirga *et al.*, 2012). It is not surprising, therefore, that the observed predation levels would lead to negative perceptions of Ethiopian wolves (38% considered it a ‘bad’ species), like in most situations of conflict with carnivores elsewhere (e.g. Marker *et al.*, 2003, Lamarque *et al.*, 2009). It is worth noticing that the annual economic cost in Aboi Gara (USD 92) was much higher than that reported due to carnivore predation in the Tigray region further north (USD 20.2 per household, Yirga *et al.*, 2012), where a restoration programme removed livestock from degraded high mountain grazing land (Asefa *et al.*, 2002).

The frequency of kills by wolves and by jackals reported in this study were not dissimilar, but attacks by wolves were relatively few, as described by dietary studies in other wolf populations (Sillero-Zubiri *et al.*, 1995b, Ashenafi *et al.*, 2005, Marino *et al.*, 2010). There is a clear stock predation pattern between species: golden jackals killed everywhere in agricultural fields, around homesteads and in Afroalpine habitats at both day and night, whereas Ethiopian wolves were mostly diurnal and limited their attacks to Afroalpine habitats (Sillero-Zubiri and Gottelli, 1995a, Stephens *et al.*, 2001, Marino *et al.*, 2010). Even though predation by spotted hyenas (*Crocuta crocuta*) was suspected at nighttime (Ogada *et al.*, 2003), the heads of households interviewed reported that they had not seen a hyena in the last two decades in the area. Focal group discussions seemed to confirm that there were no medium or large carnivores in the area other than jackals and wolves. The pattern of stock killing observed during the wet season might be associated with the fog

rising from the surrounding lowlands, hugging the mountain top and impairing the vision of shepherds. Even though most interviewees agreed that livestock predation had decreased over the past ten years, the reported figures did not support this statement. The average number of small stock losses per household per year was 1.2, 0.60, and 0.79 over the past one, five and ten years respectively, indicating an increasing rather than decreasing trend. Of course, responses may be affected by people's ability to recall events or their misremembering what happened a long time previously (Jones *et al.*, 2008).

There are indeed important limitations to the analysis and interpretation of interview data and ongoing debates on the appropriateness of different approaches and methods in human–wildlife conflict research. Within the limitation of the data, we applied statistical methods to disentangle socio-economic factors with direct or indirect implications for Ethiopian wolf survival. On the bases of our results, we suggest these conservation practices to foster coexistence:

- *Awareness campagins*: literacy was linked to positive attitudes towards Ethiopian wolves in Aboi Gara, possibly indicating better knowledge of livestock husbandry practices and tolerance developed due to education (Woodroffe, 2007, Sogbohossou *et al.*, 2011). Awareness campagins and education have helped and foster human carnivore co-existence in many cases (Kellert and Berry, 1980, Tarrant *et al.*, 1997, Lagendijk and Gusset, 2008).
- *Keeping small herds*: In Aboi Gara households with larger herds suffered from more attacks, and were more prone to enter conflict with wolves. Similar results were reported by Oli *et al.* (1994) in Nepal around Annapurna, where households with large herds were more vulnerable to snow leopard (*Uncia uncia*). Likewise, guarding large herds for extended periods is more challenging, with shepherds having to disperse more widely over the available grazing, subsequently exposing livestock to predation.
- *Using shepherds and avoiding Afroalpine pastures*: In Aboi Gara like in Menz-Guassa Ashenafi (2001) and the Simien Mountains Yihune (2008), the households more affected by livestock predation were those closer to Afroalpine areas, where herds are more exposed to depredation (e.g., Sogbohossou *et al.*, 2011). Maintaining shepherds close to the herds at all times, and minimising the time spent in Afroalpine areas, can contribute to stop conflicts from escalating. Studies have shown that when shepherds are present the rates of predation become lower (Ogada *et al.*, 2003) and such measure is simple, effective, affordable and low technology solution that can be implemented by local pastoralists.
- *Monitoring conflict*: Livestock losses may eventually lead to retaliatory killings by pastoralists, and engenders negative attitude towards the Ethiopian wolves (Thirgood *et al.*, 2005, Woodroffe *et al.*, 2005) in more than a third of the interviewees in Aboi Gara; and nearly half (46.2%) of

the households interviewed in Guassa-Menz, claiming sheep predation as the main reason (Ashenafi, 2001). Thus, unless mitigation measures are taken, human-dominated Afroalpine landscapes can become hot spots of human–wolf conflict; and detecting conflicts early on can be crucial to stop escalation. The small and isolated wolf populations are extremely vulnerable to extinction and unlikely to sustain even low levels of retaliatory killing.

In conclusion, more holistic studies might be necessary to confidently disentangle the factors promoting coexistence and conflict with Ethiopian wolves, as it is the case with many wild carnivores. For example, to appraise if attitudes of local people depend mostly on problems caused by other carnivores (e.g. golden jackals) and/or on the benefits obtained from them or their habitat (e.g. near protected areas in Africa: Newmark *et al.*, 1994, Hutton and Leader-Williams, 2003, Ashenafi and Leader-Williams, 2005). Studies that contrast ‘reported’ against ‘real’ predation (for example by examining wolf scats) can also help to elucidate common discrepancies between alleged and real livestock losses to wild carnivores, as sometimes conflicts stem from perceived rather than real threats (Treves and Karanth, 2003, Lamarque *et al.*, 2009).

Acknowledgements

We would like to thank the North Wollo Zone Environmental Protection Department and the local people who facilitated and allowed us to conduct this study. We are grateful to the Born Free Foundation, the Wildlife Conservation Network and the Rufford Small Grants Foundation for funding the study. Amy Dickman provided valuable comments on an earlier draft.

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