

Ethiopian wolves conflict with pastoralists in small Afroalpine relicts

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Abstract

The peaceful coexistence between people and the rare Ethiopian wolf *Canis simensis* is being challenged by conflicts rising 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 Ethiopian wolf populations in small 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 *Canis aureus*, with an annual average loss of 1.2 heads per year (10% of the average herd size), equivalent to 92 US\$. Aboi Gara pastoralists considered wolves and jackals to be equally responsible for livestock killings. 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 conflict, including best livestock guarding techniques to lessen the risk of livestock predation by wild carnivores in Afroalpine areas.

Résumé

La coexistence pacifique entre les gens et le rare loup d'Éthiopie est menacée par des conflits suscités par la prédation du bétail par les carnivores sauvages. Le fait de comprendre le contexte culturel et socio-économique de ces conflits peut aider à prévenir les comportements négatifs et les massacres de représailles qui pourraient compromettre sérieusement la survie des populations de loups d'Éthiopie dans les reliquats afro-alpins. C'est pourquoi nous avons réalisé des études avec questionnaires auprès de 140 ménages vivant près de la zone d'Aboi Gara, dans le nord de l'Éthiopie. La moitié des foyers a déclaré avoir perdu des moutons et des chèvres à cause des loups et des chacals dorés *C. aureus*, avec une perte annuelle moyenne de 1.2 animal par an, soit 10% de la taille moyenne du troupeau, équivalant à 92 dollars US. Les bergers d'Aboi Gara considèrent que loups et chacals sont également responsables de la mort du bétail. Les foyers qui ont de plus grands troupeaux, vivant plus près de l'habitat afro-alpin et fréquentant les pâturages de celui-ci plus longtemps, signalaient plus de prédation par les carnivores sauvages. La plupart des participants à l'enquête (62%) exprimaient un sentiment positif vis-à-vis des loups

d'Éthiopie, spécialement les gens plus éduqués et ceux qui avaient de plus petits troupeaux. Nous suggérons des moyens pour atténuer les conflits, notamment des techniques pour mieux garder le bétail afin de réduire les risques de prédation du bétail par les carnivores sauvages des régions afro-alpines.

KEYWORDS

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

1 | INTRODUCTION

Most carnivores are vulnerable to conflict with humans due to their predatory nature and their need for wide ranges (Davidson, Valeix, Loveridge, Madzikanda, & Macdonald, 2011; Sillero-Zubiri & Laurenson, 2001; Sillero-Zubiri, Sukumar, & Treves, 2006; Treves & Karanth, 2003). When coupled with other threats, human–carnivore conflict can seriously increase the risk of extinction of small populations of threatened species (Inskip & Zimmermann, 2009; Wang & Macdonald, 2006; Woodroffe, 2001). 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, Olszanska, & Okarma, 2008; Inskip & 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 (Ashenafi, Coulson, Sillero-Zubiri, & Leader-Williams, 2005; Marino, 2003; Marino & Sillero-Zubiri, 2011). Understanding human–carnivore conflicts is a research priority for conservationists worldwide (Dickman, 2010; Karlsson & Johansson, 2010) and is identified in the strategic plan for Ethiopian wolf conservation (Ethiopian Wildlife Conservation Authority, 2011; IUCN SSC Canid Specialist Group, 2011). In this study, we seek a better understanding of the ecological and socio-economic conditions undermining peaceful coexistence with the peculiar Ethiopian wolf, a medium size canid with restricted distribution and a rodent-based diet (Sillero-Zubiri, Tattersall, & Macdonald, 1995).

The Ethiopian highlands, characterized by unique physiographic and climatic conditions, are home to many endemic species. One of them is the rare Ethiopian wolf, with a global population of some 500 animals in six Afroalpine pockets (Ashenafi et al., 2005; Marino, 2003; Marino & Sillero-Zubiri, 2011). Ethiopian wolves and the communities living next to them compete directly for natural resources upon which both depend. The people of the highlands engage in subsistence agriculture and livestock rearing, relying on natural Afroalpine habitats for pastures, firewood and building materials (Ashenafi & Leader-Williams, 2005; Eshete et al., 2015; Jacob et al., 2014). With rapidly increasing human populations in the highlands (Taddese, 2001), habitat loss and degradation are impacting upon the populations of rodent prey, challenging the wolves to adapt to an anthropogenic landscape (Ashenafi et al., 2005; Stephens, D'Sa, Sillero-Zubiri, & Leader-Williams, 2001). As natural prey populations decline,

and overlap between livestock and carnivores increases, conflicts due to livestock predation are bound to intensify (Ashenafi et al., 2005; Marino, 2003; Thirgood, Woodroffe, & Rabinowitz, 2005; Woodroffe, Thirgood, & Rabinowitz, 2005). Even low levels of predation can inflict important economic costs on poor local communities, making carnivore conservation increasingly challenging (Sillero-Zubiri & Laurenson, 2001; Thirgood et al., 2005; Treves & Karanth, 2003).

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

The evidence of livestock predation by Ethiopian wolves and the resulting conflict is varied, indicating a diversity of scenarios depending on ecological and socio-economic conditions. These relationships, however, have not been studied in detail. In this study, we presented results from interviews to local people in Aboi Gara, a small Afroalpine relict in north Ethiopia, where a population of Ethiopian wolves survives in direct contact with people and their livestock. 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 analyses, we attempted to disentangle socio-economic factors with direct or indirect implications for the conservation of Ethiopian wolves and, by characterizing contemporary patterns of predation, we suggest measures to ameliorate the conflict between local pastoralists and wild carnivores in Ethiopia's Afroalpine relicts.

2 | MATERIALS AND METHODS

Aboi Gara, in North Wollo, is a small Afroalpine range (4,008 m a.s.l.) in the northern highlands of Ethiopia, loosely connected by narrow ridges with the larger Abuna Yosef massif (Figure 1) (Eshete et al.,

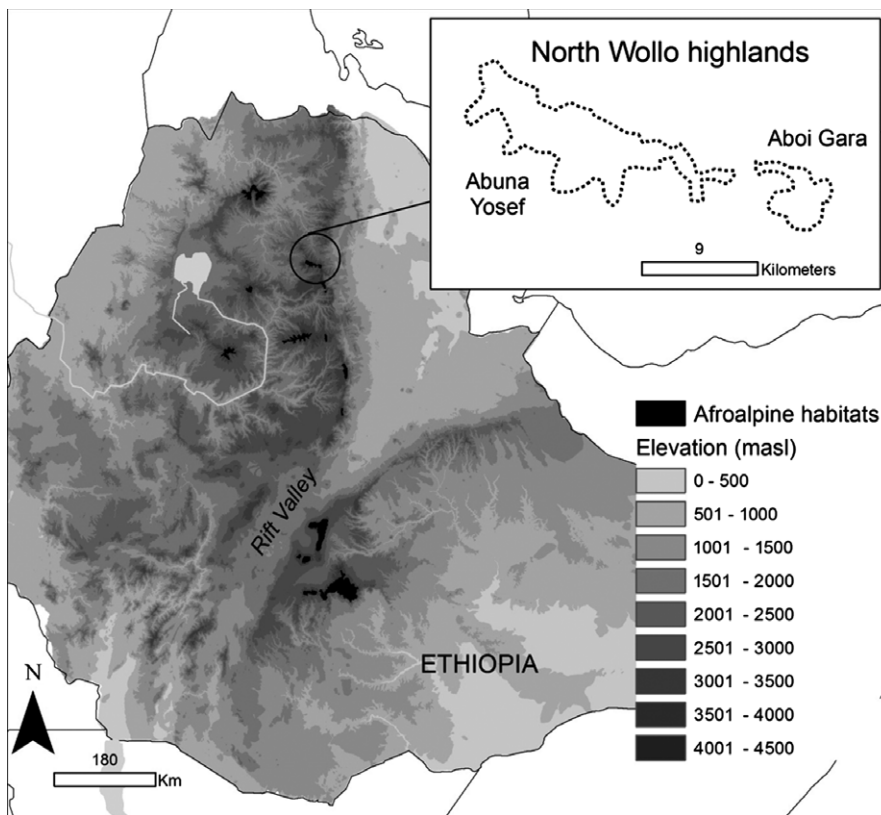


FIGURE 1 Map indicating areas of Afroalpine habitat in the Ethiopian highlands. Insert shows study area of Aboi Gara and adjacent Abuna Yosef

2015). Annual average rainfall is 2,000 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 to 11°C, with extreme variations between day and night (ESP, 2001). The area exhibits a mosaic of vegetation types, with 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, Stark's hare (*Lepus starcki*), rock hyrax (*Procavia capensis*) and several Murinae rodent species.

Between October 2011 and January 2012, we interviewed 140 heads of household 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, we collated information on household socio-economic status, livestock losses to carnivores and attitudes towards Ethiopian wolves. To maximize the reliability of the interview data, focus group discussions were also conducted with community guards (whose role is to protect the habitat), development agencies' staff (facilitators at community level), *woreda* experts (state professionals working at the district level), local leaders and elders. We collated official market prices in Ethiopian Birr (ETB) from the Gidan *woreda* and averaged the costs of livestock across all ages for 2000, 2005 and 2011/12.

We analysed the drivers of two components of human-wildlife conflict, namely: "livestock predation" (whether or not the respondent reported losing livestock to Ethiopian wolves), and

"perceptions" (whether households viewed wolves as good or bad), using logistic regression with binary dependent variables. Explanatory variables included the following: educational level, family size, land ownership, land size, livestock ownership, herd size, length of grazing in Afroalpine habitat, distance to Afroalpine habitat and seasonality of predation events. Chi-square tests were also used to compare the effects of predictors. Annual economic loss due to predation was calculated, for households with livestock, using the local averaged livestock market price, after translating ETB into US\$ using the exchange rate for the indicated years. As a result, the average livestock price was 50.00 US\$ in 2000, 65.63 US\$ in 2005 and 78.13 US\$ in 2011/12. All data were analysed using R software (Version 2.13.2, R Development core team, 2012).

3 | RESULTS

The majority of the households surveyed engaged in farming (73%) and raised livestock (79%); agriculture plots were small (average size 0.5 ha) and herd size averaged 12 heads of sheep and goats, hereafter "small stock." The socio-economic characteristics of the heads of households interviewed are summarized in Table 1.

Seventy of 140 households reported losing a total of 131 small stock to wolves and jackals over the last 12 months, with slightly higher losses (54.2%) apportioned to jackals (Table 2). Annual livestock losses averaged 1.2 per household, across the households that owned livestock. Losses reported over the previous 12 months were higher than those reported over previous 5 and 10 years (0.60 and 0.79

TABLE 1 Summary of socio-economic characteristics of the sampled households ($N = 140$)

Categorical variables	Number and 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 golden 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	Range	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 heads)	0–36	12	9.0
Land size (ha)	0–1	0.5	0.4

heads per year, respectively), yet most respondents (70.7%) perceived that predation by wolves was decreasing in Aboi Gara (rather than increasing; $\chi^2 = 24$, $df = 1$, $p < .001$) and older people significantly more likely to report this trend ($\chi^2 = 76$, $df = 1$, $p < .002$).

Two-thirds of the respondents ($n = 89$) reported that predation was seasonal, concentrated during the rainy season (in comparison with the dry season; $\chi^2 = 10.31$, $df = 1$, $p < .001$). Most households (70%) reported losing small stock during daytime, and there was a significant difference ($\chi^2 = 41.3$, $df = 1$, $p < .001$) between households reporting day and night-time predation.

On the bases of livestock market prices obtained from local government offices, we calculated that carnivores caused an average

annual economic loss of US\$ 92.21 to each household that kept livestock (Table 2).

The closer to Afroalpine habitats, the higher the probability of a household suffering from predation. Households with larger herds were also more affected by predation (Table 3), as were the households which grazed their livestock in Afroalpine areas all year-round, in comparison with those who only grazed there for part of the year (Table 3).

Most interviewees (62.1%) considered the Ethiopian wolf to be a “good” species, expressing a positive perception (Table 1). There was a significant positive relationship between positive perception and literacy, and a negative correlation with livestock ownership and level of predation (i.e. number of livestock lost to jackals or wolves, Table 4).

Households implemented different techniques to minimize livestock predation in Afroalpine pastures, including guarding by shepherders (42.2%), sporadic grazing (27.1%), or avoidance of grazing altogether (20%), and using dogs to chase wildlife (10.8%; Figure 2). Of these techniques, 31.4% of respondents considered herding the most effective, followed by total avoidance of grazing (26.1%), sporadic grazing (23.3%) and guarding dogs (19.3%).

4 | DISCUSSION

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

Aboi Gara households lost on average 1.2 sheep/goats per year, equivalent to US\$ 92, which imposes a substantial economic penalty as these households subsist on incomes of less than US\$ 1 per day (Bluffstone, Yesuf, Bushie, & Damite, 2008). For subsistence farmers relying on small herds (typically 12 sheep and goats in Aboi Gara), the loss of even a small number of animals can have a substantial negative impact on their livelihoods (Butler, 2000; Mishra, 1997; Treves & Karanth, 2003; Yirga et al., 2012). It is not surprising therefore that predation 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. Lamarque et al., 2009; Marker, Mills, & Macdonald, 2003). It is worth noticing that the annual economic cost due to carnivore predation in Aboi Gara was much higher than that reported in degraded mountain grazing land in the Tigray region further north (US\$ 20.2 per household; Asefa, Oba, Weladji, & Colman, 2002; Yirga et al., 2012).

People in Aboi Gara reported similar numbers of losses due to wolves and jackals, whereas in some other Afroalpine areas, golden jackals have been considered the main predator of livestock (Ashenafi et al., 2005; Atickem et al., 2017; Marino et al., 2010). People also recognized specific predatory behaviours: jackals killed at day and night in agricultural fields around homesteads and Afroalpine habitats, whereas Ethiopian wolf attacks were mostly diurnal and

TABLE 2 Number of small stock reportedly killed by carnivores in Aboi Gara and estimated economic cost (N = 111)

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

TABLE 3 Result of logistic regression indicating factors associated with reported small stock predation by Ethiopian wolves (1 = yes, 0 = no) in Aboi Gara, North Wollo (N = 140)

Variables	Intercept	SE	χ^2	df	p-value
Education (1)	−2.340	0.672	12.116	1	.001
Distance	−0.291	0.139	4.414	1	.036
Family size	−0.039	0.159	0.061	1	.805
Herd size	0.103	0.030	11.459	1	.001
Grazing whole year (1)	3.154	0.570	30.628	1	.000
Predation season	−0.196	0.494	0.158	1	.691
Constant	−3.375	1.225	7.589	1	.006
R ²	0.580				

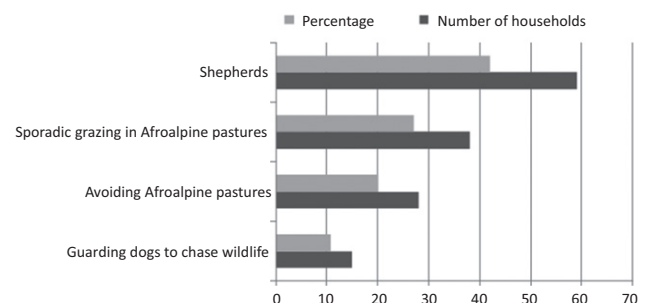
p-values in bold are less than 0.05 indicating a statistically significant effect

TABLE 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	SE	χ^2	df	p-value
Education (1)	3.334	0.952	12.258	1	.000
Distance	0.303	0.181	2.797	1	.094
Land size	0.375	1.138	0.109	1	.741
Herd size (1)	−3.764	1.024	13.511	1	.000
Heads lost to wolves (1)	−3.604	0.845	18.184	1	.000
Heads lost to jackals (1)	−1.820	0.870	4.371	1	.037
Constant	4.753	1.690	7.909	1	.005
R ²	0.780				

p-values in bold are less than 0.05 indicating a statistically significant effect

limited to Afroalpine areas. A possible explanation for the higher frequency of livestock kills in the wet season is the fog that raises from the surrounding lowlands during the rainy season, impairing the vision of shepherds. More information is however needed to understand this pattern, including data on the seasonality of local grazing regimes. Interestingly, the people interviewed reported not seeing spotted hyaenas (*Crocuta crocuta*) in the area in the past two

**FIGURE 2** Number and proportion of households applying different carnivore predation minimizing techniques in Aboi Gara (N = 140)

decades, a common nocturnal predator in the highlands of Ethiopia. Focal group discussions suggested that Ethiopian wolves and jackals are the only carnivores regularly seen in the area.

While the people of Aboi Gara believed that livestock predation by wild carnivores had decreased over the past 10 years, the figures they reported for various time periods contradicted this statement (1.2, 0.60 and 0.79 per year over 1, 5 and 10 years, respectively). Our results are inconclusive, because responses may be affected by people's ability to recall events or misremembering what happened long time ago (Jones, Andriamarivololona, Hockley, Gibbons, & Milner-Gulland, 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 limitations of our data, we attempted to disentangle socio-economic factors with direct or indirect implications for Ethiopian wolf survival by applying statistical models. On the bases of our results, we can suggest some conservation practices to foster coexistence.

4.1 | Awareness campaigns

Literacy was linked to positive attitudes towards Ethiopian wolves in Aboi Gara, possibly indicating tolerance developed through

education and better knowledge of livestock husbandry practices (Sogbohossou, de longh, Sinsin, de Snoo, & Funston, 2011; Woodroffe, Frank, Lindsey, Ole Ranah, & Romañach, 2007). Awareness campaigns and education have helped to foster coexistence with carnivores in many cases (Kellert & Berry, 1980; Lagendijk & Gusset, 2008; Tarrant, Bright, & Kencordell, 1997).

4.2 | Keeping small herds

In Aboi Gara, households with larger herds experienced more livestock attacks and were also prone to enter conflict with wolves. Similar results have been reported from around Annapurna in Nepal (Oli, Taylor, & Rogers, 1994), where larger herds were more vulnerable to predation by snow leopards (*Unicia unicia*), because shepherds guarding them for extended periods have to disperse more widely over the available grazing land.

4.3 | Using shepherds and avoiding Afroalpines pastures

Like in Guassa-Menz (Ashenafi, 2001) and the Simien Mountains (Yihune, Bekele, & Ashenafi, 2008), the herds from households located closer to Afroalpine areas in Aboi Gara where more exposed to livestock depredation (e.g., Sogbohossou et al., 2011). Maintaining shepherds close to the herds at all times, and minimizing the time spent in Afroalpine areas could contribute to stop conflicts from escalating. Studies across African carnivores have shown that when shepherds were present, rates of predation were lower (Ogada, Woodroffe, Oguge, & Frank, 2003). This is a simple, effective, affordable and low technology solution that should be promoted among pastoralists communities in Ethiopia.

4.4 | Monitoring conflict

Livestock losses may eventually lead to retaliatory killings by pastoralists (Thirgood et al., 2005; Woodroffe et al., 2005). Livestock predation already engendered negative attitudes towards Ethiopian wolves in over a third of the households interviewed in Aboi Gara, and in nearly half (46.2%) of the households interviewed in Guassa-Menz, claiming sheep predation as the main reason (Ashenafi, 2001). As human-dominated Afroalpine landscapes can become hotspots of human-wolf conflict, detecting conflicts early on can be crucial to stop escalation. Ethiopian wolf populations are small and isolated, and extremely vulnerable to extinction; they are unlikely to sustain even low levels of retaliatory killing.

Ultimately, more holistic studies are needed to confidently disentangle the factors promoting coexistence and conflict with Ethiopian wolves, as it is the case with many wild carnivores. It is important to appraise how local people's attitudes depend on the problems caused by other carnivores (e.g. golden jackals) and/or on the benefits obtained from them or their habitat near protected areas (e.g. Ashenafi & Leader-Williams, 2005; Hutton & Leader-Williams, 2003; Newmark, Manyanza, Gemassa, & Sariko, 1994). Contrasting "reported" against "real" predation, for example by examining carnivore

scats, can also help elucidate common discrepancies between alleged and real livestock losses to wild carnivores, as sometimes conflicts stem from perceived rather than real threats (Lamarque et al., 2009; Treves & Karanth, 2003).

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