

A culture of tolerance: coexisting with large carnivores in the Kafa Highlands, Ethiopia

FIKIRTE GEBRESENBET, BRHANE BARAKI, GIDEY YIRGA
CLAUDIO SILLERO-ZUBIRI and HANS BAUER

Abstract We assessed losses of livestock to lions *Panthera leo* and leopards *Panthera pardus* in the Adiyo and Gimbo districts in Kafa Biosphere Reserve, Ethiopia. We quantified the economic impact, conducted household and group interviews, and explored potential solutions with local people. During 2009–2013 there were 350 and 62 attacks by lions and leopards, respectively. Households that suffered attacks on their livestock lost a mean of USD 287 and USD 310 in 2012 and 2013, respectively. Although lion attacks are more frequent than leopard attacks, our qualitative data indicate that tolerance for the former is higher because lions are more respected in the local culture. We describe how depredation is culturally mitigated and how retaliatory killing is avoided. Given people's tolerance towards them, carnivores may persist in their highland refugium, opening an arena for conservation that is not strictly linked to protected areas or to classical economics.

Keywords Attitude, behaviour, depredation, Ethiopia, interview, leopard, lion, *Panthera leo*

Introduction

Wildlife is in crisis globally, mainly as a result of the increasing human population and consequent consumption (Baillie et al., 2010). Carnivores are particularly affected because of their spatial and dietary requirements, leading to low density and high conflict with human interests (Ripple et al., 2014). Carnivores appear to be recovering in developed countries (Chapron et al., 2014) but in Africa carnivore populations are largely declining (Woodroffe & Sillero-Zubiri, 2012; Bauer et al., 2015). Where carnivores and people coexist, competition for resources is likely to lead to attacks by carnivores on people or livestock, which often motivates retaliatory or indiscriminate killing (Hazzah et al., 2014). Whether that motivation leads to

action depends on various factors, tolerance being an important one. Tolerance has been defined by some as an attitude (Manfredo & Dayer, 2004; Treves, 2012) but many scholars define it as a behaviour (Bruskotter & Fulton, 2012; Bruskotter et al., 2015). We adopt the definition of tolerance as behaviour because tolerating carnivore attacks is a behavioural result of an individual's attitude, given that the individual has the opportunity to act in a certain way (Manfredo et al., 2003; Ajzen & Fishbein, 2005).

Literature on this topic often uses the term human–wildlife conflict, even though this term can be misleading; the conflicts are often between people with different views on the impacts of wildlife (Redpath et al., 2015; Fisher, 2016). Conflicts are the result of complex social and ecological interactions that vary in space and over time (Treves et al., 2006; Ale et al., 2007; Dickman et al., 2011; Schuette et al., 2013). The outcome of conflict is determined by perceptions, norms, attitudes and intentions (Marchini & Macdonald, 2012) but most literature focuses on costs and benefits for local people (Dickman et al., 2011).

Literature from southern Africa generally suggests that depredation and retaliation are directly related, by inferring that people kill carnivores to maximize livestock-related profits (Marker et al., 2003; Hemson et al., 2009). In South Africa there is low tolerance for depredation, and reserves with lions are fenced (Packer et al., 2013). Retaliatory killing is explained by rational choice theorists on the basis that humans are self-centred beings focused on maximizing their immediate outcomes (Ostrom, 1998). Literature from East Africa partially follows this paradigm, but other work describes how people and wildlife are integrated in landscapes, and determinants of coexistence are not only economic but also cultural (Romañach et al., 2007; Hazzah et al., 2009, 2014; Goldman et al., 2010a; Blackburn et al., 2016). As a result, retaliatory killing occurs only if depredation exceeds tolerance, whereby tolerance is culturally determined and may vary in space and over time. In this context, carnivore conservation hinges on mitigation to reduce losses or compensation to buy tolerance for losses, or both (Ogada et al., 2003; Kissui, 2008; Dickman et al., 2011; Lichtenfeld et al., 2015; Bauer et al., 2017).

In West, Central and the Horn of Africa the significance of livestock goes beyond its economic productivity and contributes to livelihoods in the broadest sense within their cultural community (Moritz, 2013). Sogbohossou et al. (2011) and Tumenta et al. (2013) give examples of the economic

FIKIRTE GEBRESENBET (Corresponding author) Department of Integrative Biology, Oklahoma State University, 113 Life Sciences West, Stillwater, OK 74078, USA
E-mail fikirte.erd@okstate.edu

BRHANE BARAKI and GIDEY YIRGA Department of Biology, Mekelle University, Mekelle, Ethiopia

CLAUDIO SILLERO-ZUBIRI and HANS BAUER Department of Zoology, Wildlife Conservation Research Unit, The Recanati-Kaplan Centre, University of Oxford, UK

Received 18 April 2016. Revision requested 28 June 2016.

Accepted 3 November 2016. First published online 20 March 2017.

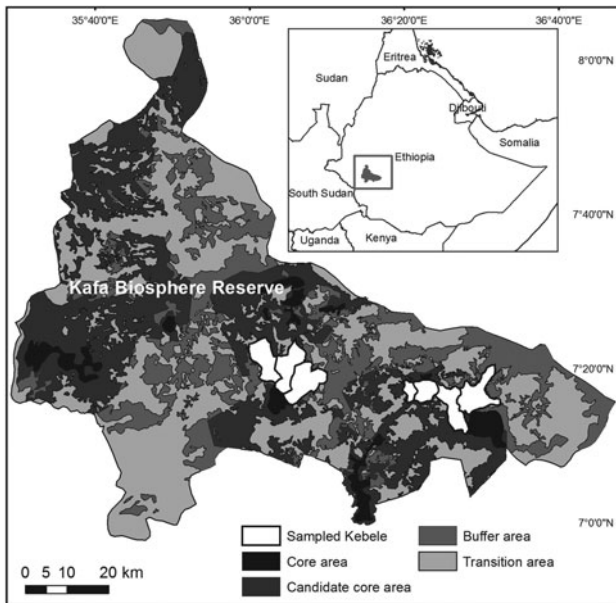


FIG. 1 Locations of subdistricts in Kafa Biosphere Reserve, south-west Ethiopia, in which household surveys and focus group discussions were conducted.

approach to conflict management in Benin and Cameroon, respectively. However, Bauer et al. (2010) noted that the most common mitigation measure practised throughout West and Central Africa is the use of magic, a combination of traditional cultural and religious practices (e.g. incantations by a professional marabout, the use of amulets or the practice of voodoo). In Ethiopia research has shown that spotted hyaenas *Crocuta crocuta* depend on church forests for daytime cover and adapt their diet during Christian fasting periods, adding a religious dimension to the economic and cultural aspects of coexistence (Yirga et al., 2012). Yirga et al. (2013, 2014) also reported high tolerance and close coexistence, and Baynes-Rock (2015) described how spotted hyaenas in the eastern Ethiopian town of Harar have become part of the community. However, little is known about lions in Ethiopia (Gebresenbet et al., 2009).

We investigated conflict with large carnivores, especially lions and leopards, in the moist montane forest ecosystem of Kafa Biosphere Reserve (hereafter the Reserve), in the south-west of Ethiopia. The habitat occupied by lions within the Reserve is unusual; anecdotal information suggests that they were extirpated from the savannahs at lower altitudes, and the montane coffee and bamboo forests at c. 3,000 m in the margins of their former distribution have now become their core refugium (NABU, 2016). Considerable local and international interest in the conservation of this biosphere has led to the creation of a fund that aims to promote coexistence and address depredation.

We studied conflicts with lions and leopards in two districts, using both quantitative (household survey) and qualitative approaches (focus group discussion; Krueger & Casey,

2000; Williams, 2003; Krosnick & Presser, 2010). Incorporating the focus group discussions helped to include the voices of various social groups (mainly adult females and college students), which otherwise might not have been captured. A case study of a particular depredation incident added further insight into local coping mechanisms that would not have been uncovered through quantitative research. Our objective was to assess the economic impact of predation on livestock and to understand local perceptions and attitudes to large carnivores. We analysed the results in the context of local cultural and religious practice and used qualitative information to explain why depredation does not lead to retaliatory killings, and to explore elements of culture and religion that influence the complex relationship between predation on livestock, attitudes and behaviour.

Study area

The Reserve was established in 2010, covering 7,500 km², of which 47% is forest (Dresen, 2011), at an altitude of 400–3,100 m (Pratihast et al., 2014). It harbours moist montane forest habitats, with trees of wild coffee *Coffea arabica* that are naturally part of the ecosystem, and wetland and aquatic habitats. The abundance of coffee trees makes the area economically important both locally and nationally. The area is recognized by UNESCO as a Biosphere Reserve and is protected under regional by-laws, but it is not gazetted as a protected area at federal level. Although it hosts c. 21% of the country's rich mammalian diversity and is an important conservation area, it is threatened by habitat destruction (Berhan, 2008; IBC, 2009). The forest cover is high but the density of prey is low. Wildlife includes large carnivores, including leopards and lions, but it is unclear if they are resident throughout the year, or how far eastwards they range. The size of the forest has declined as a result of human encroachment (Berhan, 2008). Lions are now observed regularly in only two of the seven districts in the Reserve (Gimbo and Adiyo), and these were selected as the study area (Fig. 1). Adiyo is a highland district, whereas Gimbo has highland and lowland; the mean altitude is 1,747 m but lions are primarily found at c. 2,700 m.

Methods

Ethical clearance was obtained from the Human Subjects Research Institutional Review Board of Oklahoma State University. Local research permits were acquired from the Kafa Zone Regional Administration office and the district and subdistrict level administration offices. The Zone and the two districts provided formal letters of introduction. All participants were given a printed descriptive summary of the research (if participants were illiterate the document was read to them). Prior informed consent was obtained

TABLE 1 No. of livestock lost to lions *Panthera leo* and leopards *Panthera pardus* during 2009–2013 by 210 households in the Kafa Highlands, Ethiopia (Fig. 1).

Year	No. of livestock lost to lions						No. of livestock lost to leopards			
	Cattle	Sheep	Goats	Horses	Mules	Donkeys	Cattle	Sheep	Goats	Horses
2009	7	58	12	15	0	1	0	2	5	1
2010	13	17	3	20	0	0	1	11	9	0
2011	13	20	6	19	4	0	0	17	0	0
2012	15	63	4	20	3	1	0	0	8	0
2013	6	16	10	2	1	1	1	5	2	0

orally from all participants. Data were collected during February–April 2014 using household surveys with semi-structured questionnaires (quantitative) and focus group discussions (qualitative). The quantitative survey data provided an estimate of the economic impacts of depredation, and the qualitative data from the focus group discussions helped in understanding local attitudes towards lions and leopards. In general, data collection focused on attitudes of local people towards lions and leopards, tolerance of livestock losses, retaliatory actions, conflict mitigation techniques, changes in conflict intensity, and the cultural connotation of livestock depredation. Attitude was defined as how a person evaluates a certain object or entity, and behaviour as the action performed by the person on that entity (Ajzen & Fishbein, 1977).

The household survey was conducted in seven sub-districts (or *kebeles*; the lowest administrative level in Ethiopia), where 30 household heads were selected randomly from the list of households provided by each sub-district administration office. When a household head was not present the household head of the right-side neighbour was surveyed instead. We conducted 210 questionnaires in total, each lasting c. 1 hour. The questionnaire was in two parts. The first comprised 36 open and closed questions, and the second comprised 36 statements, which were scored on a Likert scale (Albaum, 1997) from 1 (strongly agree) to 5 (strongly disagree). The survey assessed five issues: demographics, general knowledge about lions and leopards, conflicts, attitudes, and behaviours. Questions that assessed demographics were used to group respondents based on their social and economic status. Information collected included gender, educational level, occupation and number of livestock owned. The second set of questions assessed the general knowledge of respondents about the carnivores, including their population status in the Reserve, their diet, frequency of sightings, legal protection and hunting in the Reserve. The third set of questions gathered information on human–carnivore conflicts, and included questions about attacks on people and livestock, grazing distance, presumed reason for depredation, and retaliatory killings. Questions to assess attitude asked how the respondents felt about the carnivores, how they felt if they had

encountered a lion or a leopard, whether they wanted the carnivores to be extirpated from their communities, how they felt about compensation payments, whether they thought they had a moral obligation to conserve lions and leopards for future generations, and how they perceived cultural practice in the Kafa context to conserve lions and leopards. The fifth set of questions assessed the behaviour of respondents, focusing on their behavioural intentions in the event of livestock depredation, their likely behavioural intentions in the event of future attacks, depredation preventive techniques, and whether respondents respected regulations for conserving carnivores. Before preparing the final version of the questionnaire we conducted test interviews in Bonga, the Zone capital, which is adjacent to the study area, to ensure that all questions were clear.

We calculated the frequencies of response to the 10 statements about attitude scored on the Likert scale. A correlation test showed a high correlation between scores for similar questions for lions and leopards, and therefore we separated the questions pertaining to lions and leopards. We conducted a reliability analysis in SPSS *v. 20.0* (IBM, Armonk, USA) to test the measure of internal consistency, based on Cronbach's α . We also calculated the mean of the responses and presented them as a composite attitude scale, assigning the following values to responses: 5, strongly agree; 4, agree; 3, neutral; 2, disagree; 1, strongly disagree. We multiplied the number of respondents for each response with its assigned value, summed these values, and divided the sum by the total number of respondents (210). Before calculating the weighted mean and running the reliability analysis we reversed the scores of two questions (7 and 8; Table 2) to make them comparable to the other questions.

Three focus group discussions were conducted, with elderly leaders, adult females and college students. There were 10 participants in each group, and the discussions took place during a traditional coffee ceremony, a social setting preferred by the participants. The elderly and female focus groups were selected based on guidance from zonal and sub-district administration offices, the Reserve's local project coordinator, and Reserve rangers who were trained as interviewers and used as translators. The college students were selected based on communication with the Bonga

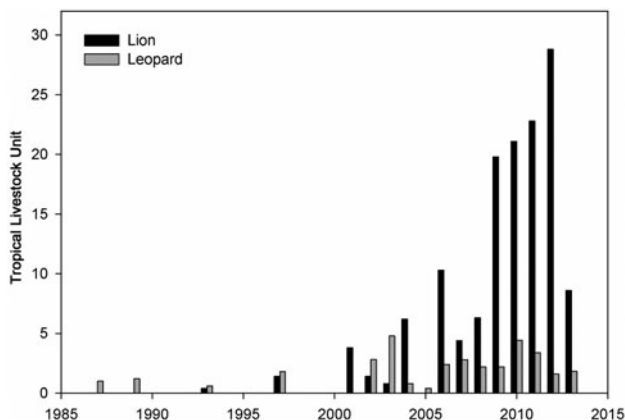


FIG. 2 Recorded Tropical Livestock Units lost as a result of attacks by lions *Panthera leo* and leopards *Panthera pardus* in Kafa Biosphere Reserve (Fig. 1).

College of Teacher Education, the only such college in Kafa Zone. Each focus group discussion lasted c. 2 hours. All three discussions focused on the following themes: comparison of past and current human–carnivore conflicts, experiences of livestock loss and culturally acceptable retaliatory actions, conflict prevention techniques, support from the local administration to reduce conflicts, and the distribution of carnivores.

At the outset we asked 30 randomly selected people how they would define rich, moderately well off, and poor households; they agreed that the criteria were ownership of livestock, land and houses. Respondents then indicated thresholds for all three criteria to define categories of wealth, which were subsequently used in the analysis. Numbers of the various types of livestock were converted to Tropical Livestock Units (Njuki et al., 2011). Livestock prices for years prior to 2014 were calculated using mean prices from various markets in Kafa Zone in 2014. We used the consumer price index (Index Mundi, 2014) and the rate of inflation (Trading Economics, 2014) for a specific year to adjust for inflation by taking the ratio of that year's index and the index for 2014. This ratio matches the ratio of livestock prices for the same years, and thus livestock prices for past years could be computed (Appelbaum, 2004).

The quantitative data analysis mainly involved descriptive analysis. We used Spearman's rank correlation to investigate if there was an association between loss of livestock to carnivore attacks and how respondents said they would react to future attacks (a behavioural intention we henceforth refer to as presumed action). We ranked the responses from low (1) to high (3 for leopards, 4 for lions) based on the severity of the respondents' presumed action: 1, doing nothing because it is a course of nature; 2, conducting a traditional begging ritual so lions would stop their attacks on livestock; 3, reporting to local officials; and 4, retaliating by killing the carnivores. The analysis for leopards included only 1, 3 and 4. We also used Spearman's rank correlation to

investigate the association between livestock loss and respondents' attitudes towards having a carnivore-free place to live. We asked if respondents would want lions and leopards to be extirpated from their environment, and ranked responses from strong disagreement (5) to strong agreement (1). Livestock losses as a result of attacks by leopards and lions were 0–3.23 and 0–20.05 Tropical Livestock Units per household, respectively.

To analyse the qualitative data from the focus group discussions we used discourse analysis, which is the process of understanding issues by identifying similarities and differences (Jørgensen & Phillips, 2002; Doody et al., 2013). We used participants' language (how they described and framed issues, together with their body language) regarding their knowledge about, attitude and behaviour towards lions and leopards to identify patterns and commonalities within and among the three groups.

Results

We surveyed 210 households, 13 headed by women and 197 headed by men; 67% of respondents were > 35 years old. People who had > 13 cattle, ≥ 4 ha of land and ≥ 3 houses were considered to be rich in the local context. Those who had 8–12 cattle, 2–3.75 ha of land and two houses were of moderate wealth, and those with less were considered to be poor. The mean number of livestock per household was $9 \pm \text{SD } 14.9$. Grazing always occurred during the day and in the presence of a herder, and distance from home was generally low (< 1 km for c. 93% of respondents).

Knowledge about lions and leopards

Although uncommon now, lions used to be present in the highlands and lowlands of the Reserve. However, respondents stressed that lions have become progressively restricted to the higher altitudes. Focus group members from the highlands claimed that lions were unable to withstand the cold weather and the ants that are common in the forest. Leopards, on the other hand, have been known to exist at all elevations in the Reserve. All focus groups reached consensus that the community did not know where the lions were resident, when they came, which route they used, and other related information. The elderly and student focus groups claimed that the number of attacks escalated at the end of the dry season and the beginning of the rainy season.

Overview of attacks and economic losses

Circa 42% ($n = 89$) of the respondents knew of lion attacks on people during their lifetime. We recorded a total of 17 attacks on people, four of which were fatal (all before 2006); 12

TABLE 2 Percentage of responses to 10 statements relating to attitude towards carnivores, scored on a Likert scale, and mean responses as a composite attitude scale.

No.	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Mean
1	I like seeing lions in the wild.	53.81	22.38	11.9	10.48	1.43	4.17
2	I like to see leopards in the wild.	50.95	20.48	14.29	13.81	0.48	4.08
3	Conserving lions is culturally a positive practice in Kafa.	51.9	34.76	8.57	4.29	0.48	4.33
4	Conserving leopards is culturally a positive practice in Kafa.	50.48	36.67	8.57	3.33	0.95	4.32
5	People should relocate from areas of lion habitat.	30.95	24.76	4.76	29.05	10.48	3.37
6	People should relocate from areas of leopard habitat.	31.43	22.38	6.67	29.05	10.48	3.35
7	I would like lions to disappear from my community.	6.19	6.67	10	70	7.14	3.65
8	I would like leopards to disappear from my community.	6.19	5.71	10	70.95	7.14	3.67
9	The presence of a lion is a sign of a healthy environment.	48.1	30	8.1	9.52	4.29	4.08
10	The presence of a leopard is a sign of a healthy environment.	47.62	29.05	8.57	10	4.76	4.05

occurred during 2009–2013. Only 1.4% ($n = 3$) of respondents claimed to know of leopard attacks on people, two of which happened in 1996 and one in 2000. More losses were reported for lions than leopards (Fig. 2). Rich households lost more than moderate and poor ones to both lion (48.3, 29.7 and 22.0%, respectively) and leopard (40.59, 34.7 and 24.5%, respectively) attacks. Livestock depredation claims during 2009–2013 accounted for 80% ($n = 350$) of reported attacks by lions and 62% ($n = 62$) of reported attacks by leopards (Table 1), on 73 and 20 households, respectively. Of these households, 14 incurred losses to both carnivores. Lions caused 85% of the total livestock depredation during 2009–2013. In 2012 and 2013, 38 households claimed loss of livestock worth USD 11,259, with the damage caused by lions amounting to USD 10,841 (96%). Households that suffered livestock loss in 2012 and 2013 had mean losses of USD 287 and 310, respectively, per year. If livestock losses are considered in terms of a direct reduction in household income, these households lost c. 70 and 66% of the mean Ethiopian gross domestic product per capita (which was USD 410 and 470 in 2012 and 2013, respectively; World Bank, 2013).

Attacks by lions in the Reserve were not restricted to grazing fields. There were reported cases of lions entering peoples' houses at night and attacking them. More than half of the survey respondents, and all focus groups, mentioned an incident that occurred in Adiyu in 2010: a lioness entered a house during the night, ate two goats and attacked the owner, who was sleeping in her bed. The woman survived after medical treatment, with scars on her face and scalp. Two-thirds (63%) of the lion attacks reportedly occurred during 18.00–06.00, and approximately half (55%) of the leopard attacks occurred during 12.00–18.00. Half of the household survey respondents thought that the main reason for these attacks was the lack of wild prey as a result of destruction of the forest. However, 26% thought that attacks happened because lions are violent in nature and habitual raiders.

During focus group discussions, the consensus was that the community tried to share the burden of losing livestock; typically, neighbours contributed money to buy a calf to help victims cope with the loss. In line with this, 76% of respondents who incurred losses informed only their neighbours, with only 26.9% reporting losses to the local administration.

Attitudes towards lions and leopards

Respondents had broadly similar, positive attitudes towards both carnivores (Table 2). Of the 10 statements about attitude, the one that was scored highest was that conserving lions/leopards is a positive cultural practice in Kafa (with a mean weighted score of 4.33 for lions and 4.32 for leopards). Cronbach's α . was 0.64 for lions and 0.63 for leopards, which suggests that 64 and 63% of the variance is reliable for the attitude data collected for lions and leopards, respectively.

A majority of respondents and the student focus group, and all participants of the female and elderly focus groups, did not refer to lions as *Dahero* (lion); they used the name *Donno*, which is a respectful way of addressing elderly and other socially respected people. When they hear others referring to lions simply as lions, they cover their ears as a way of saying 'I cannot hear this'. This deep-rooted respect and honour for lions is maintained even at the time of attacks. During the focus group discussions with the elderly, one of the participants explained:

We do not think lions take our livestock to hurt us. As a result, we do not refer to it as an attack or killing but taking what they needed.

Leopards are not afforded the same honour and respect, although they do not face retaliatory or preventive killings. Most (91.4%) respondents claimed that fear of legal action is an additional reason for the absence of lion and leopard killings in the Reserve (86% were aware that killing lions is prohibited by law in Ethiopia).

All focus groups explained that losing livestock to lions is considered to be a sign of good luck, and of upcoming wealth, throughout the Reserve. Three of the participants in the female discussion group and four in the elderly group explained that the number of their livestock had increased significantly after losing some to lions. One of the women explained:

Before 7 years, two of our cattle were taken in one night. In the morning, my husband and I were very happy to see lion footprints because we believed our livestock were going to be fertile and we were going to be wealthy. And indeed we have been blessed since.

In the Kafa culture lions are considered to be kinder than leopards. One participant in the elderly focus group expressed:

If we encounter a lion while on the road, all we have to do is cut some leaves and put them on our head and beg the lion and bow down. It is guaranteed that it will walk away. Male lions even convince or drag lionesses with them, who otherwise might block the path and lay around for a long time. But a leopard never shows such mercy; it always attacks if confrontation happens accidentally.

The focus groups also revealed that community elders hold a ritual ceremony when lion attacks become frequent, in which they beat drums and pray that the lions will leave them and their livestock alone. Participants in the elderly focus group explained that a few years ago there had been an incident in which a lion became a problem, taking livestock every night but not eating them, just killing them and walking away. They claim that a local spiritual leader prayed and the lion died. An informant told us confidentially that people killed the lion but maintained the narrative, which illustrates the respect for the lion and the spiritual leader but also the resentment that led to retaliatory killing. The lion carcass was given a ceremonial burial; it was covered in hand-made traditional cloth before being buried in a meadow that remains fenced to this date.

Our findings indicate that although most of our respondents are afraid to go to the field or into the forest where lions and leopards are believed to live, they also like seeing these carnivores in the wild and do not want them to disappear from the Reserve (Table 2).

Behaviours and actions

There are few retaliatory killings of lions and leopards in the Reserve. Only 2.9% ($n = 6$) and 1.9% ($n = 4$) of respondents had witnessed killings of lions and leopards, respectively. Three lion killings and one leopard killing occurred during 2009–2013. Of the 93 households that suffered livestock losses during this time, only 2.1% ($n = 2$) responded that they wanted to kill the carnivores in retaliation (and may do so if it happens in the future). However, the majority (71%; $n = 66$) did not want to retaliate and replied that they would not retaliate in the future.

Correlation of economic losses with attitude and behaviour

Spearman's correlation showed a significant association between livestock loss and presumed reaction to leopard attacks ($\rho_s = 0.181$, $P < 0.01$), but that association was not significant for lion attacks ($\rho_s = -0.132$, $P = 0.056$). Spearman's correlation between wanting to see carnivores extirpated in their community and livestock loss showed a non-significant association for both leopards ($\rho_s = 0.015$, $P = 0.83$) and lions ($\rho_s = -0.108$, $P = 0.118$).

Compensation vs prevention

A minority of livestock owners who experienced carnivore attacks (17%, $n = 60$, for lions and 24%, $n = 15$, for leopards) said they would like to be compensated. The rest of the victims believed depredation was a course of nature and no one was responsible for compensating their loss. All respondents and focus groups highlighted the importance of preventive techniques. The two most preferred remedies (79% of respondents) were (1) introducing better protection schemes for livestock and (2) fencing the Reserve to keep the carnivores away from people. Better protection techniques include keeping cattle in houses or in fenced fields at night and not grazing livestock in forests. The majority of respondents and all focus groups suggested that the carnivores' habitat, particularly that of lions, should be fenced, at least during the rainy season. The focus groups explained that fire and watch dogs were commonly used for night guarding but their efficiency as a preventive technique had diminished, as the carnivores, particularly lions, attacked livestock even in the presence of fire and dogs. The elderly and student focus groups reported five incidents in which dogs were killed by lions during attacks.

Discussion

Depredation had an economic impact on the households studied, but in general the damage was not high compared to other landscapes with lions (Gifford-Gonzalez, 2000; Frank et al., 2005). The tolerance expressed by the participants is striking; tolerance for carnivore attacks varies across Africa but is relatively common in India (Karanth et al., 2013; Meena et al., 2014). Effective conservation of carnivores is difficult where tolerance is low (Sillero-Zubiri & Laurenson, 2001; Bruskotter & Wilson, 2014); in the Reserve the habitat and prey availability are suboptimal (deforestation, low prey density; Berhan, 2008) and it is probably because of the prevailing culture of tolerance that lions and leopards have survived.

By combining the overview provided by quantitative data with insights and details provided by qualitative data we were

able to make a more complete analysis. We found that rational choice theory poorly explains human–lion interaction; social, political and cultural factors are at least as important as economic rationale (Inskip & Zimmermann, 2009; Bruskotter & Shelby, 2010).

Traditionally in Kafa if individuals lose livestock to lions they are happy because they believe it to be a sign that their livestock number is to increase. People's response to conflict with carnivores is culturally contextualized and complex; rational choice theory would predict retaliation but culture can be a stronger incentive and encourage the conservation of carnivores (Karanth & Chellam, 2009; Kopnina, 2015; Thomas et al., 2015). Increasing levels of depredation and external influences may erode tolerance and lead to different narratives (Ikanda & Packer, 2008; Maclennan et al., 2009) but thus far people in Kafa have proved to be tolerant, with few retaliatory killings. Attitude, whether positive or negative, to carnivores will influence behaviour towards them (Thorn et al., 2015).

Human–carnivore conflicts are increasing in many areas (Treves & Karanth, 2003). Attacks on people have been reported in Ethiopia (Gebresenbet et al., 2009) but are not a major problem in the Reserve at present. The suspected increase in human–lion interactions in the wet season could be a result of seasonal variation in prey availability (Patterson et al., 2004; Woodroffe & Frank, 2005). Although our reliability analysis suggests a less than ideal (70%) variance reliability, the qualitative responses and the frequency of responses suggest there is a positive attitude in Kafa towards lions and leopards. The highest mean ratings (Table 2) for the statement that conserving lions and leopards is a positive cultural practice in Kafa (with a mean weighted score of 4.33 for lions, and 4.32 for leopards) also support this claim. Additionally, there was a non-significant correlation between livestock loss and wanting to see carnivores extirpated in the community for both lions and leopards, supporting the claim that there is a positive attitude towards both carnivores.

Lions are more problematic than leopards in the Reserve, yet there is more tolerance towards lions than leopards. The correlation between livestock loss and respondents' presumed actions following lion attacks was not significant, supporting the claim that there is a culture of tolerance towards lions. However, attitudes to leopards were less positive, and the significant correlation between livestock loss and respondents' presumed actions following leopard attacks reveals that as households lose more livestock to leopards their behavioural intention to retaliate becomes stronger. The Reserve appears to be exceptional in this regard, as leopards generally coexist more easily with people; with their diet adaptability and secretive behaviour, leopards can often persist close to people without significantly affecting them (Hayward et al., 2006; Odden et al., 2014; Athreya et al., 2016).

Wildlife and people coexist across Ethiopia, where the biosphere reserve model fits the de facto management of protected areas that are almost all open access systems (Gebresenbet et al., 2013). In the context of widespread extreme poverty, depredation must therefore be addressed. Our results show that policy will be more effective and efficient if it looks beyond economic impacts and considers the depth and complexity of communities' relationships with large carnivores. Integrated damage mitigation (Bauer et al., 2010) may be more appropriate than segregation (e.g. fences; Packer et al., 2013) or compensation (Naughton-Treves et al., 2003; Dickman et al., 2011; Bauer et al., 2017). There are plans for a pilot consolation scheme in the Reserve (Schütze, 2014); it will not compensate directly for losses but will provide a more general subsidy for coexistence. This fits with global trends in conservation that focus on ecosystem services, monetary values and trade-offs (Goldman et al., 2010b; Anyango-Van Zwieten et al., 2015). This may improve attitudes and lead to better conservation outcomes; however, other factors are equally important (Heberlein, 2012). For example, fear, personal and social motivations and internal and external barriers to retaliatory killing (e.g. lack of skills and force of law, respectively) have been found to influence jaguar killing (Marchini & Macdonald, 2012). We add that communal coping mechanisms, beliefs in long-term positive wealth impacts and a culture of tolerance are important. The relative importance of these factors varies in space and time, adding to the complexity of conservation.

Acknowledgements

Fieldwork was supported financially by the German Nature and Biodiversity Conservation Union (NABU) and by the Wildlife Conservation Research Unit at the University of Oxford, UK. We thank all NABU staff based in Bonga, Kafa, for greatly assisting the research, Mesfin Tekle and Tilahun Teshome for sharing their ideas during the planning and implementation stages of the data collection, Kafa Biosphere Reserve rangers Siraj Hussien and Mamo Gebremedhin for assistance in collecting data and in translation whenever the Kafa language was used, Mulubrhan Hagos for facilitating communications with students from the Bonga College of Teacher Education, and all participants of the survey and focus group discussions for taking the time to answer our questions.

Author contributions

FG processed ethical clearance, co-prepared survey questions, trained translators, collected data and wrote the article. BB co-prepared survey questions and collected data. GY arranged research permits and edited the article. CSZ

verified analyses and edited the article. HB assisted in project design and data collection, and wrote the article.

References

- AJZEN, I. & FISHBEIN, M. (1977) Attitude–behavior relations: a theoretical analysis and review of empirical research. *Psychological Bulletin*, 84, 888–918.
- AJZEN, I. & FISHBEIN, M. (2005) The influence of attitudes on behavior. In *The Handbook of Attitudes* (eds D. Albarracín, B. T. Johnson & M.P. Zanna), pp. 173–222. Lawrence Erlbaum Associates, Mahwah, USA.
- ALBAUM, G. (1997) The Likert scale revisited: an alternate version. *Journal of the Market Research Society*, 39, 331–349.
- ALE, S.B., YONZON, P. & THAPA, K. (2007) Recovery of snow leopard *Uncia uncia* in Sagarmatha (Mount Everest) National Park, Nepal. *Oryx*, 41, 89–92.
- ANYANGO-VAN ZWIETEN, N., VAN DER DUIM, R. & VISSEREN-HAMAKERS, I.J. (2015) Compensating for livestock killed by lions: payment for environmental services as a policy arrangement. *Environmental Conservation*, 42, 363–372.
- APPELBAUM, E.B. (2004) The Consumer Price Index and inflation: adjust numbers for inflation. *Journal of Online Mathematics and its Applications*. <http://www.maa.org/press/periodicals/loci/joma/the-consumer-price-index-and-inflation-adjust-numbers-for-inflation> [accessed 25 June 2014].
- ATHREYA, V., ODDEN, M., LINNELL, J.D.C., KRISHNASWAMY, J. & KARANTH, K.U. (2016) A cat among the dogs: leopard *Panthera pardus* diet in a human-dominated landscape in western Maharashtra, India. *Oryx*, 50, 156–162.
- BAILLIE, J.E.M., GRIFFITHS, J., TURVEY, S.T., LOH, J. & COLLEN, B. (2010) *Evolution Lost: Status and Trends of the World's Vertebrates*. Zoological Society of London, UK.
- BAUER, H., CHAPRON, G., NOWELL, K., HENSCHER, P., FUNSTON, P., HUNTER, L.T.B. et al. (2015) Lion (*Panthera leo*) populations are declining rapidly across Africa, except in intensively managed areas. *Proceedings of the National Academy of Sciences of the United States of America*, 112, 14894–14899.
- BAUER, H., DE IONGH, H. & SOGBOHOSSOU, E. (2010) Assessment and mitigation of human–lion conflict in West and Central Africa. *Mammalia*, 74, 363–367.
- BAUER, H., MÜLLER, L., VAN DER GOES, D. & SILLERO-ZUBIRI, C. (2017) Financial compensation for damage to livestock by lions *Panthera leo* on community rangelands in Kenya. *Oryx*, 51, 106–114.
- BAYNES-ROCK, M. (2015) Ethiopian *buda* as hyenas: where the social is more than human. *Folklore*, 126, 266–282.
- BERHAN, L.A. (2008) *Status and Distribution of Faunal Diversity in Kafa Afromontane Coffee Forest*. A report submitted to PPP project, Nature and Biodiversity Conservation Union, Ethiopia.
- BLACKBURN, S., HOPCRAFT, J.G.C., OGUTU, J.O., MATTHIOPOULOS, J. & FRANK, L. (2016) Human–wildlife conflict, benefit sharing and the survival of lions in pastoralist community-based conservancies. *Journal of Applied Ecology*, 53, 1195–1205.
- BRUSKOTTER, J.T. & FULTON, D.C. (2012) Will hunters steward wolves? A comment on Treves and Martin. *Society & Natural Resources*, 25, 97–102.
- BRUSKOTTER, J.T. & SHELBY, L.B. (2010) Human dimensions of large carnivore conservation and management: introduction to the special issue. *Human Dimensions of Wildlife*, 15, 311–314.
- BRUSKOTTER, J.T., SINGH, A., FULTON, D.C. & SLAGLE, K. (2015) Assessing tolerance for wildlife: clarifying relations between concepts and measures. *Human Dimensions of Wildlife*, 20, 255–270.
- BRUSKOTTER, J.T. & WILSON, R.S. (2014) Determining where the wild things will be: using psychological theory to find tolerance for large carnivores. *Conservation Letters*, 7, 158–165.
- CHAPRON, G., KACZENSKY, P., LINNELL, J.D.C., VON ARX, M., HUBER, D., ANDRÉN, H. et al. (2014) Recovery of large carnivores in Europe's modern human-dominated landscapes. *Science*, 346, 1517–1519.
- DICKMAN, A.J., MACDONALD, E.A. & MACDONALD, D.W. (2011) A review of financial instruments to pay for predator conservation and encourage human–carnivore coexistence. *Proceedings of the National Academy of Sciences of the United States of America*, 108, 13937–13944.
- DOODY, O., SLEVIN, E. & TAGGART, L. (2013) Focus group interviews. Part 3: analysis. *British Journal of Nursing*, 22, 266–269.
- DRESEN, E. (2011) *Forest and Community Analysis*. Final report for the project 'Climate protection and preservation of primary forests—a management model using the wild coffee forests in Ethiopia as an example'. Nature and Biodiversity Conservation Union, Berlin, Germany.
- FISHER, M. (2016) Whose conflict is it anyway? Mobilizing research to save lives. *Oryx*, 50, 377–378.
- FRANK, L.G., WOODROFFE, R. & OGADA, M.O. (2005) People and predators in Laikipia District, Kenya. In *People and Wildlife: Conflict or Coexistence?* (eds R. Woodroffe, S. Thirgood & A. Rabinowitz), pp. 286–304. Cambridge University Press, Cambridge, UK.
- GEBRESEN BET, F., BAUER, H., HUNTER, L. & GEBRESENSAE, K. (2009) *Proceedings of the National Lion Conservation Workshop*. Ethiopian Wildlife Conservation Authority, Addis Ababa, Ethiopia.
- GEBRESEN BET, F., DANIEL, W., BAUER, H. & HAILE, A. (2013) Governance: for effective and efficient conservation in Ethiopia. In *Conservation Biology: Lessons from the Tropics* (eds S.S. Navjot & P.H. Raven), pp. 19–25. Wiley-Blackwell, Oxford, UK.
- GIFFORD-GONZALEZ, D. (2000) Animal disease challenges to the emergence of pastoralism in Sub-Saharan Africa. *The African Archaeological Review*, 17, 95–139.
- GOLDMAN, M.J., ROQUE DE PINHO, J. & PERRY, J. (2010a) Maintaining complex relations with large cats: Maasai and lions in Kenya and Tanzania. *Human Dimensions of Wildlife*, 15, 332–346.
- GOLDMAN, R.L., DAILY, G.C. & KAREIVA, P. (2010b) Trade-offs in making ecosystem services and human well-being conservation priorities. In *Trade-Offs in Conservation: Deciding What to Save* (eds N. Leader-Williams, W.M. Adams & R.J. Smith), p. 56. Wiley-Blackwell, Oxford, UK.
- HAYWARD, M.W., HENSCHER, P., O'BRIEN, J., HOFMEYER, M., BALME, G. & KERLEY, G.I.H. (2006) Prey preferences of the leopard (*Panthera pardus*). *Journal of Zoology*, 270, 298–313.
- HAZZAH, L., DOLRENNY, S., NAUGHTON-TREVES, L., EDWARDS, C.T., MWEBI, O., KEARNEY, F. & FRANK, L. (2014) Efficacy of two lion conservation programs in Maasailand, Kenya. *Conservation Biology*, 28, 851–860.
- HAZZAH, L., MULDER, M.B. & FRANK, L. (2009) Lions and warriors: social factors underlying declining African lion populations and the effect of incentive-based management in Kenya. *Biological Conservation*, 142, 2428–2437.
- HEBERLEIN, T.A. (2012) Navigating environmental attitudes. *Conservation Biology*, 26, 583–585.
- HEMSON, G., MACLENNAN, S., MILLS, G., JOHNSON, P. & MACDONALD, D. (2009) Community, lions, livestock and money: a spatial and social analysis of attitudes to wildlife and the conservation value of tourism in a human–carnivore conflict in Botswana. *Biological Conservation*, 142, 2718–2725.
- IBC (INSTITUTE OF BIODIVERSITY CONSERVATION) (2009) *Convention on Biological Diversity (CBD) – Ethiopia's 4th Country Report*. IBC, Addis Ababa, Ethiopia.

- IKANDA, D. & PACKER, C. (2008) Ritual vs retaliatory killing of African lions in the Ngorongoro Conservation Area, Tanzania. *Endangered Species Research*, 6, 67–74.
- INDEX MUNDI (2014) Ethiopia - Consumer price index. <http://www.indexmundi.com/facts/ethiopia/consumer-price-index> [accessed 14 January 2014].
- INSKIP, C. & ZIMMERMANN, A. (2009) Human–felid conflict: a review of patterns and priorities worldwide. *Oryx*, 43, 18–34.
- JØRGENSEN, M. & PHILLIPS, L. (2002) *Discourse Analysis: As Theory and Method*. SAGE Publications, London, UK.
- KARANTH, K.U. & CHELLAM, R. (2009) Carnivore conservation at the crossroads. *Oryx*, 43, 1–2.
- KARANTH, K.K., NAUGHTON-TREVES, L., DEFRIES, R. & GOPALASWAMY, A.M. (2013) Living with wildlife and mitigating conflicts around three Indian protected areas. *Environmental Management*, 52, 1320–1332.
- KISSUI, B.M. (2008) Livestock predation by lions, leopards, spotted hyenas, and their vulnerability to retaliatory killing in the Maasai steppe, Tanzania. *Animal Conservation*, 11, 422–432.
- KOPNINA, H. (2015) Revisiting the Lorax complex: deep ecology and biophilia in cross-cultural perspective. *Environmental Sociology*, 1, 315–324.
- KROSNICK, J.A. & PRESSER, S. (2010) Question and questionnaire design. In *Handbook of Survey Research* (eds P.V. Marsden & J. D. Wright), pp. 263–313. Emerald Group Publishing Limited, Bingley, UK.
- KRUEGER, R.A. & CASEY, M.A. (2000) *Focus Groups: A Practical Guide for Applied Research*. Sage Publications, New Delhi, India.
- LICHTENFELD, L.L., TROUT, C. & KISIMIR, E.L. (2015) Evidence-based conservation: predator-proof bomas protect livestock and lions. *Biodiversity and Conservation*, 24, 483–491.
- MACLENNAN, S.D., GROOM, R.J., MACDONALD, D.W. & FRANK, L.G. (2009) Evaluation of a compensation scheme to bring about pastoralist tolerance of lions. *Biological Conservation*, 142, 2419–2427.
- MANFREDO, M.J. & DAYER, A.A. (2004) Concepts for exploring the social aspects of human–wildlife conflict in a global context. *Human Dimensions of Wildlife*, 9, 1–20.
- MANFREDO, M.J., TEEL, T.L. & BRIGHT, A.D. (2003) Why are public values toward wildlife changing? *Human Dimensions of Wildlife*, 8, 287–306.
- MARCHINI, S. & MACDONALD, D.W. (2012) Predicting ranchers' intention to kill jaguars: case studies in Amazonia and Pantanal. *Biological Conservation*, 147, 213–221.
- MARKEE, L.L., MILLS, M.G.L. & MACDONALD, D.W. (2003) Factors influencing perceptions of conflict and tolerance toward cheetahs on Namibian farmlands. *Conservation Biology*, 17, 1290–1298.
- MEENA, V., MACDONALD, D.W. & MONTGOMERY, R.A. (2014) Managing success: Asiatic lion conservation, interface problems and peoples' perceptions in the Gir Protected Area. *Biological Conservation*, 174, 120–126.
- MORITZ, M. (2013) Livestock transfers, risk management, and human careers in a West African pastoral system. *Human Ecology*, 41, 205–219.
- NABU (THE NATURE AND BIODIVERSITY CONSERVATION UNION) (2016) *Results and findings of NABU's International Biodiversity Assessment at the Kafa Biosphere Reserve, Ethiopia*. NABU, Berlin, Germany, and Addis Ababa, Ethiopia. <https://en.nabu.de/projects/ethiopia/kafa/biodiversity/17155.html> [accessed 20 December 2016].
- NAUGHTON-TREVES, L., GROSSBERG, R. & TREVES, A. (2003) Paying for tolerance: rural citizens' attitudes toward wolf depredation and compensation. *Conservation Biology*, 17, 1500–1511.
- NJUKI, J., POOLE, J., JOHNSON, N., BALTENWECK, I., PALI, P., LOKMAN, Z. & MBURU, S. (2011) *Gender, Livestock and Livelihood Indicators*. International Livestock Research Institute, Nairobi, Kenya.
- ODDEN, M., ATHREYA, V., RATTAN, S. & LINNELL, J.D.C. (2014) Adaptable neighbours: movement patterns of GPS-collared leopards in human dominated landscapes in India. *PLoS ONE*, 9(11), e112044.
- OGADA, M.O., WOODROFFE, R., OGUGE, N.O. & FRANK, L.G. (2003) Limiting depredation by African carnivores: the role of livestock husbandry. *Conservation Biology*, 17, 1521–1530.
- OSTROM, E. (1998) A behavioural approach to the rational choice theory of collective action: Presidential Address, American Political Science Association, 1997. *American Political Science Review*, 92, 1–22.
- PACKER, C., LOVERIDGE, A., CANNEY, S., CARO, T., GARNETT, S.T., PFEIFER, M. et al. (2013) Conserving large carnivores: dollars and fence. *Ecology Letters*, 16, 635–641.
- PATTERSON, B.D., KASIKI, S.M., SELEMPO, E. & KAYS, R.W. (2004) Livestock predation by lions (*Panthera leo*) and other carnivores on ranches neighboring Tsavo National Park, Kenya. *Biological Conservation*, 119, 507–516.
- PRATIHA, A.K., DEVRIES, B., AVITABILE, V., DE BRUIN, S., KOOISTRA, L., TEKLE, M. & HEROLD, M. (2014) Combining satellite data and community-based observations for forest monitoring. *Forests*, 5, 2464–2489.
- REDPATH, S.M., BHATIA, S. & YOUNG, J. (2015) Tilting at wildlife: reconsidering human–wildlife conflict. *Oryx*, 49, 222–225.
- RIPPLE, W.J., ESTES, J.A., BESCHTA, R.L., WILMERS, C.C., RITCHIE, E. G., HEBBLEWHITE, M. et al. (2014) Status and ecological effects of the world's largest carnivores. *Science*, 343, 1241484.
- ROMANACH, S.S., LINDSEY, P.A. & WOODROFFE, R. (2007) Determinants of attitudes towards predators in central Kenya and suggestions for increasing tolerance in livestock dominated landscapes. *Oryx*, 41, 185–195.
- SCHUETTE, P., CREEL, S. & CHRISTIANSON, D. (2013) Coexistence of African lions, livestock, and people in a landscape with variable human land use and seasonal movements. *Biological Conservation*, 157, 148–154.
- SCHÜTZE, K. (2014) Ethiopia's rare mountain lions. <http://www.dw.de/ethiopias-rare-mountain-lions/a-17632135> [accessed 9 July 2014].
- SILLERO-ZUBIRI, C. & LAURENSEN, K. (2001) Interactions between carnivores and local communities: conflict or co-existence? In *Proceedings of a Carnivore Conservation Symposium* (eds J. Gittleman, S. Funk, D.W. Macdonald & R.K. Wayne), pp. 282–312. Zoological Society of London, UK.
- SOGBOHOSSOU, E.A., DE IONGH, H.H., SINSIN, B., DE SNOO, G.R. & FUNSTON, P.J. (2011) Human–carnivore conflict around Pendjari Biosphere Reserve, northern Benin. *Oryx*, 45, 569–578.
- THOMAS, R.E.W., BRUYERE, B., SUNDARESAN, S., BOUZO, S., WELDEN, R. & TRIMARCO, J. (2015) Youth experiences with wildlife during a period of significant cultural change in Laikipia, Kenya. *Human Dimensions of Wildlife*, 20, 133–146.
- THORN, M., GREEN, M., MARNEWICK, K. & SCOTT, D.M. (2015) Determinants of attitudes to carnivores: implications for mitigating human–carnivore conflict on South African farmland. *Oryx*, 49, 270–277.
- TRADING ECONOMICS (2014) Ethiopia inflation rate. <http://www.tradingeconomics.com/ethiopia/-inflation-cpi> [accessed 25 June 2014].
- TREVES, A. (2012) Tolerant attitudes reflect an intent to steward: a reply to Bruskotter and Fulton. *Society & Natural Resources*, 25, 103–104.
- TREVES, A. & KARANTH, K.U. (2003) Human–carnivore conflict and perspectives on carnivore management worldwide. *Conservation Biology*, 17, 1491–1499.

- TREVES, A., WALLACE, R.B., NAUGHTON-TREVES, L. & MORALES, A. (2006) Co-managing human–wildlife conflicts: a review. *Human Dimensions of Wildlife*, 11, 383–396.
- TUMENTA, P.N., DE IONGH, H.H., FUNSTON, P.J. & UDO DE HAES, H. A. (2013) Livestock depredation and mitigation methods practised by resident and nomadic pastoralists around Waza National Park, Cameroon. *Oryx*, 47, 237–242.
- WILLIAMS, A. (2003) How to . . . write and analyse a questionnaire. *Journal of Orthodontics*, 30, 245–252.
- WOODROFFE, R. & FRANK, L.G. (2005) Lethal control of African lions (*Panthera leo*): local and regional population impacts. *Animal Conservation*, 8, 91–98.
- WOODROFFE, R. & SILLERO-ZUBIRI, C. (2012) *Lycaon pictus*. *The IUCN Red List of Threatened Species 2012: e.T12436A16711116*. <http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T12436A16711116.en> [accessed 16 August 2015].
- WORLD BANK (2013) Ethiopia: Country at a glance. <http://www.worldbank.org/en/country/ethiopia> [accessed 12 June 2014].
- YIRGA, G., DE IONGH, H.H., LEIRS, H., GEBREHIWOT, K., DECKERS, J. & BAUER, H. (2012) Adaptability of large carnivores to changing anthropogenic food sources: diet change of spotted hyena (*Crocuta crocuta*) during Christian fasting period in northern Ethiopia. *Journal of Animal Ecology*, 81, 1052–1055.
- YIRGA, G., ERSINO, W., DE IONGH, H.H., LEIRS, H., GEBREHIWOT, K., DECKERS, J. & BAUER, H. (2013) Spotted hyena (*Crocuta crocuta*) coexisting at high density with people in Wukro district, northern Ethiopia. *Mammalian Biology*, 78, 193–197.
- YIRGA, G., IMAM, E., DE IONGH, H.H., LEIRS, H., KIROS, S., YOHANNES, T.G. et al. (2014) Local spotted hyena abundance and community tolerance of depredation in human-dominated landscapes in Northern Ethiopia. *Mammalian Biology*, 79, 325–330.

Biographical sketches

FIKIRTE GEBRESENBET works on large carnivore and herptile conservation in Ethiopia. BRHANE BARAKI works on human–carnivore conflict in Kafa. GIDEY YIRGA has done extensive research on the ecology of the spotted hyaena in Northern Ethiopia. CLAUDIO SILLERO-ZUBIRI is interested in carnivores and human–wildlife conflict and is the Chair of the IUCN SSC Canid Specialist Group. HANS BAUER is based in Ethiopia and works on lion conservation in West, Central and the Horn of Africa.