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Local Attitudes and Perceptions Toward Large Carnivores in a Human-Dominated Landscape of Northern Tanzania

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ABSTRACT

We conducted 300 semi-structured interviews with local people adjacent to Tarangire National Park, northern Tanzania, to determine their attitudes and perceptions toward large carnivores. We analyzed the relationships between attitudes and age, gender, education, occupation, years at residence, income, distance from protected area, livestock owned, livestock lost to predators and knowledge of carnivores. Three-quarters of respondents (79%) held negative attitudes toward large carnivores, while 20% were generally positive. Three variables were positively associated with attitudes towards different species: formal education (all carnivore species), years at residence (lions and cheetahs), and knowledge of carnivores (cheetahs). Attitudes toward large carnivores were not significantly related to distance from protected area, livestock owned, or livestock lost to predators. Findings suggested that interventions aimed at fostering positive attitudes toward large carnivores should focus on improving formal education and securing long-term residency for people in the region.

KEYWORDS

Attitudes; large carnivores;
local people; perceptions;
Tarangire National Park

Introduction

Understanding people's attitudes, perceptions of risk associated with large carnivores, and the factors that influence these attitudes is critical for developing effective human–carnivore conflict mitigation strategies for carnivore conservation. Large carnivores populations have declined around the world (Ripple et al., 2014). For example, in East Africa, cheetah *Acinonyx jubatus* and African wild dogs *Lycaon pictus* have experienced major contractions in their geographic range, with resident populations now found in only 6% and 7% of their historic ranges (IUCN, 2016). Tanzania has lost 66% of its lion *Panthera leo* population from 1993 to 2014 (IUCN, 2016), and leopard *Panthera pardus* populations have also declined (Packer et al., 2011). The major threats facing large carnivores include habitat loss and fragmentation, human population growth, depletion of prey, unsustainable trophy hunting, and persecution by humans associated with livestock depredation

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(IUCN, 2016; Packer et al., 2011). Conflict occurs when people and carnivores live in close proximity (Inskip & Zimmermann, 2009; Sogbohossou, De Iongh, Sinsin, De Snoo, & Funston, 2011). Human–carnivore conflict typically occurs in association with livestock depredation (Dickman, 2008) and occasionally attacks on humans (Packer, Ikanda, Kissui, & Kushnir, 2005).

The large home ranges of large carnivores relative to the size of protected areas (PAs) makes many PAs insufficient to maintain viable carnivore populations (Woodroffe & Ginsberg, 1998). Nonprotected and human-dominated landscapes, where large carnivores coexist with humans, may be essential for the persistence of viable populations (Breitenmoser et al., 2005), which presents a challenge to their conservation. Outside PAs, agro-pastoral communities have strong negative attitudes and risk perceptions of large carnivores due to livestock depredation associated with economic loss, which often leads to retaliatory or preventative carnivore killing (Dickman, 2008; Kissui, 2008). This is likely to have potentially severe implications for populations of threatened species that can undermine large carnivore conservation efforts. For example, a study in Namibia attributed 47% of cheetah mortality to persecution by humans on farmland (Thorn, Green, Marnewick, & Scott, 2014). Between 2004 and July 2005, 85 lions were killed in retaliation for livestock depredation in the Maasai Steppe, Tanzania (Kissui, 2008). People's tolerance for large carnivores depends on their attitudes and risk perceptions, which may vary by culture, religious beliefs, income, education level, and knowledge about carnivores (Dickman, 2010; Mishra, 1997). In Nepal, for example, Buddhists are tolerant of livestock depredation by snow leopards *Panthera uncia* due to their cultural or religious beliefs; killing them is considered a sin (Ale, 1998). Wolves *Canis lupus*, but not snow leopards, are highly persecuted in India even though both species prey on livestock, because of negative cultural beliefs associated with wolves (Mishra, 1997). In Maasai societies, spotted hyenas *Crocuta crocuta* are often viewed with hostility as they are associated with gluttony, stupidity, and witchcraft (Maddox, 2003). The theoretical framework for this article was built on the cognitive hierarchy where human perceptions are shaped by values, value orientations, attitudes and norms, behavioral intentions, and behaviors (Fulton, Manfredo, & Lipscomb, 1996). We defined cognitions as “the collection of mental processes (e.g., values, beliefs, attitudes) used in perceiving, remembering, thinking, and understanding, as well as the act of using these processes” (Ashcraft, 2006, p. 12). Such cognitions have been arranged in a “hierarchy” where there are connections between fundamental values at the base of a pyramid and overt behavior at the top (Fulton et al., 1996). Values are defined as enduring beliefs that form the foundation of a person's thoughts and actions that lead to specific attitudes and behaviors (Fulton et al., 1996). In this article, we examined the relationships between general (fundamental) life values and attitudes toward large carnivores. An attitude was defined as a “psychological tendency that is expressed by evaluating a particular entity with some degree of favorability or unfavorability” (Ajzen, 2001).

Attitudes are commonly seen as people's evaluations of some object or animal (e.g., carnivore) that range from positive to negative (Ajzen, 2001). For example, attitudes toward carnivores can be positive when they are associated with tourist revenue (Dickman, Macdonald, & Macdonald, 2011), and can be negative where carnivores are perceived as a threat to livestock or human life (Dickman, 2008; Maddox, 2003; Røskaft, Händel, Bjerke, & Kaltenborn, 2007). In this article, we also examined perceptions of

carnivore-related risks to understand human–carnivore interactions. Risk perception refers to the innate risk judgments made by citizens as opposed to assessments by experts (Slovic, 1987). There are two constructs to such risk perceptions (a) cognitive risk perception—the perceived probability of encounters with carnivores (e.g., depredation of livestock, attacks on humans) and (b) affective risk perception—the emotional responses to a risk (e.g., concern or worry an individual feels regarding exposure to risks from carnivores) (Sjöberg, 1998).

Resolving human–carnivore conflict requires a better understanding of people’s attitudes toward large carnivores and the drivers of these attitudes (Oli, Taylor, & Rogers, 1994). These drivers, however, are often complex and may involve cultural, demographic, ecological, social, and economic components (Dickman, Hazzah, Carbone, & Durant, 2014), which can change over time (Fritts, Stephenson, Hayes, & Boitani, 2003). Variation in people’s attitudes toward carnivores is based on the extent to which carnivores conflict with human interests and on inherent human prejudices (Lindsey, Du Toit, & Mills, 2005).

Research has shown that knowledge and understanding of individual species (Lindsey et al., 2005), socioeconomic characteristics (e.g., income, occupation) (Dickman, 2008; Oli et al., 1994), education (Røskoft et al., 2007), number of livestock owned and livestock lost to predators (Kideghesho, Røskoft, & Kaltenborn, 2007; Naughton-Treves, Grossberg, & Treves, 2003) are associated with people’s attitudes toward large carnivores. Other factors, such as demographics (e.g., age, gender) (Kellert & Berry, 1987), distance from PAs, experience with carnivores, benefits from conservation (Lindsey et al., 2005; Schumann, Watson, & Schumann, 2008), religious beliefs (Hazzah, 2006), and cultural beliefs (Maddox, 2003) are also influential in shaping people’s attitudes toward large carnivores.

The area adjacent to Tarangire National Park (TNP) in northern Tanzania was an ideal site for the current study because of the interactions between people and large carnivores that give rise to human–carnivore conflicts. The current status of the conflict influences attitudes and perceptions of risk associated with large carnivores (Lichtenfeld, 2005; Msuha, 2009). Determinants of attitudes toward large carnivores are poorly known in the region (Lichtenfeld, 2005). This article addressed these gaps. Msuha (2009) indicated that Maasai in the region perceive large carnivores as a threat to livestock and suggested that level of wildlife knowledge, number of small stock lost to predators, number of income sources and density of wild animals near human settlements perceived to be problematic were associated with conflict with carnivores. Lichtenfeld (2005) found that Maasai communities had negative perceptions toward lions due to potential threats they pose to livestock and human life, and they expressed positive perceptions based on utilitarian value (benefits from tourism and sport hunting). Lichtenfeld (2005) also found that dislike of lions varied according to cultural group, with Maasai communities, which were most reliant on livestock, being most likely to dislike lions, while women and wealthier individuals perceived higher level of risk associated with lions.

A sound understanding of people’s attitudes and perceptions of risk associated with large carnivores, as well as the factors influencing these attitudes is essential for developing effective human–carnivore conflict mitigation strategies within communities. Specifically, our objectives were to (a) assess people’s attitudes and perceptions of risk associated with large carnivores, (b) examine the underlying factors influencing people’s attitudes towards

large carnivores, and (c) suggest potential interventions that may mitigate conflict and promote human–carnivore coexistence in the region.

Methods

Study area

This study was conducted in five villages (Loiborsoit, Terat, Emboret, Sukuro, Loibor Siret) of the Simanjiro Plains in Simanjiro district, northern Tanzania ([Figure 1](#)). Simanjiro district lies within the Maasai Steppe with a land area of 20,591 km². The Maasai Steppe is an important ecosystem in northeastern Tanzania that holds some of the highest diversity of large mammals in the world including populations of Africa's most threatened large carnivore species. On the western part of the Steppe lies the TNP, which protects only 15% (2,850 km²) of the approximately 20,000 km² in the Tarangire-Simanjiro Ecosystem (TSE). Large mammalian fauna of the area includes lions, cheetahs,

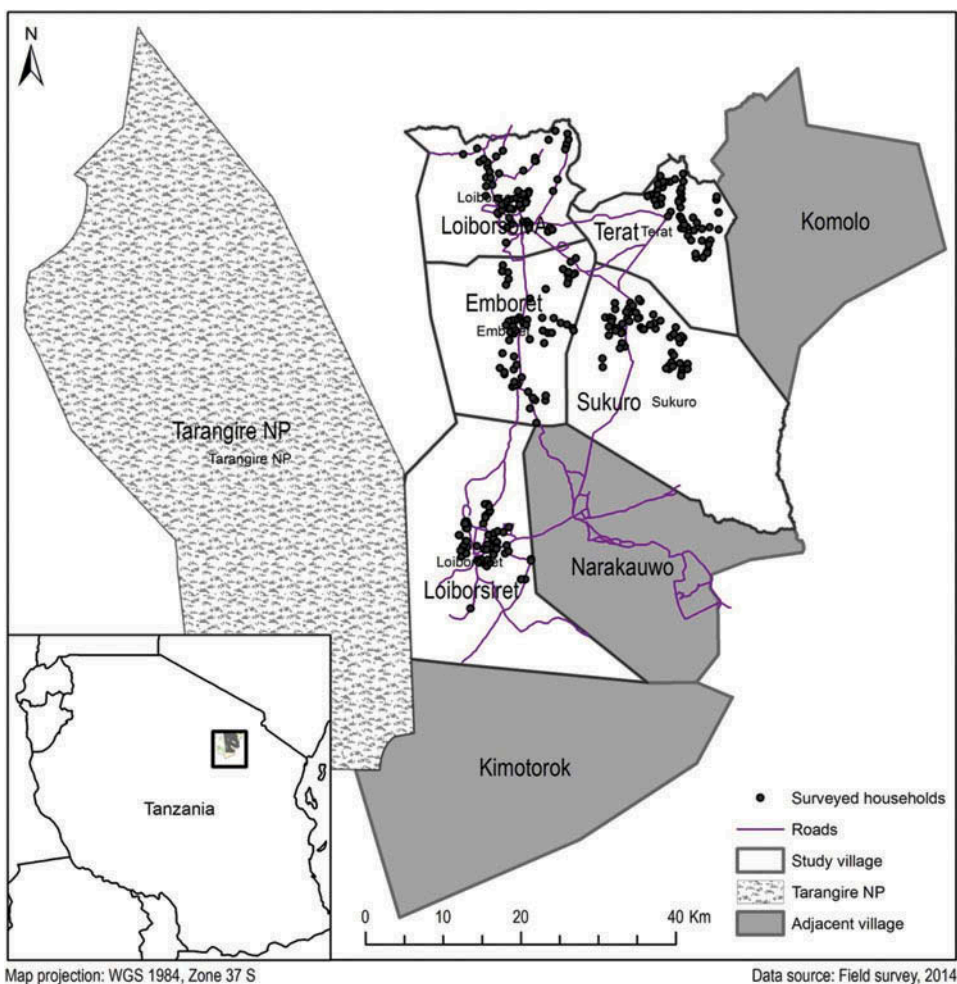


Figure 1. The studied villages and the households interviewed in the survey.

spotted hyenas, striped hyenas (*Hyena hyena*), leopards, and African wild dogs that may prey on game and livestock. We focused our study on five large carnivore species existing in the area that are most associated with conflict: lions, cheetahs, leopards, spotted hyenas, and African wild dogs. African wild dogs are listed as Endangered; lions, cheetahs and leopard are listed as Vulnerable; whereas spotted hyenas are Least Concern (IUCN, 2016). The major ethnic groups in this area are the Maasai and the Waarusha. Traditionally, the Maasai are semi-nomadic pastoralists and dependent on livestock, although many are now agro-pastoralists, as they are increasingly practicing subsistence agriculture (McCabe, 2003). The Waarusha descended from the Maasai but have a higher frequency of practicing subsistence agriculture. These communities keep a variety of livestock including cattle, goats, sheep, and donkeys.

Questionnaire design

From June to July 2014, we carried out the social survey using semi-structured interviews (SSIs). The questionnaire was adapted from the format used by Maddox (2003) in northern Tanzania, and by Dickman (2008) in southern Tanzania. The questionnaire was pretested on a sample of 15 respondents and revised based on the pretest. SSIs consisted of both closed and open-ended questions to allow respondents to elaborate on their answers and to express their own ideas and views (Hunter & Brehm, 2003).

A total of 300 face-to-face interviews were conducted. Sixty respondents were selected from each village at random. We chose the household as the sampling unit, following Maddox (2003) and Dickman (2008), and interviews were restricted to one respondent per household. The sample included the head of the family (usually a man), the head's wife, or elder son according to seniority. Women often deferred to men, so respondents were predominantly male. During the interviews, we tested the respondents' knowledge of carnivores using cards with color photographs of the different species. Interviews were divided into two thematic sections: (a) socioeconomic and demographic characteristics and (b) knowledge, attitudes, and perceptions toward large carnivores.

We explored seven different types of attitudes toward large carnivores: (a) Respondents' attitudes toward large carnivores, (b) Respondents' attitudes toward wild animal presence around their village, (c) Respondents' attitudes toward the desired population change, (d) Respondents' attitudes toward control of wild animals, (e) Perceptions of problem status of large carnivores, (f) Perceived population trends of large carnivores, and (g) Perceptions toward livestock depredation and retaliatory or preventative carnivore killing. We included the following question as a proxy measure for attitudes toward carnivores: that is, "In general do you like/dislike each of the following carnivore species?" The responses to this question were coded such that 1 = "like" and 0 = "dislike" and used to calculate an attitude index score. The perceived population trends/desired population change questions asked: (a) "What do you think has happened to the number of large carnivores in this area in the time period since you came to this household?" (b) "In your opinion, what would you like to see happening to the number of large carnivores in this area, and why?" Questions (a) and (b) were categorized as follows: 1 = "increased/increase"; 2 = "decreased/decrease"; 3 = "disappeared/disappear"; 4 = "stayed/stay the same."

The problematic carnivore species question asked: "Which of the following carnivore species do you think are most problematic? And explain why." We scored the responses to

this question on a 3-point scale, where 0 = “no problem,” 1 = “minor problem,” 2 = “major problem,” and a mean problem/conflict score was calculated for each respondent across all species. We used this score as the main index of conflict where values close to 0 and close to 2 indicated lower and greater perceived conflicts respectively for a particular species. The attitudes towards wildlife question asked: “Do you enjoy seeing wild animals living around your village?” while the control for wildlife question asked: “Would you like someone to control some of the wild animals?” Responses to these questions were therefore coded as 1 = “yes” and 0 = “no.”

We recorded the global positioning system (GPS) location of each interviewed household. This was used to determine the shortest distance between the interview location and protected area boundary in *ArcGIS v. 10.3* (ESRI, Redlands, USA). Interviews were conducted in the Swahili language (with the aid of a translator speaking Maasai where needed) and took approximately one hour to complete.

Data analysis

Respondents’ attitudes toward large carnivores were compared to sociodemographic attributes, livestock holding, total reported livestock losses, and losses attributed to each carnivore species. Chi-square was used to determine whether an association existed between dependent and explanatory variables. Independent-sample *t*-tests were used to compare salience scores between carnivore species. Spearman Rank correlation coefficients (r_s) were used to assess correlation among variables.

To determine which variables were associated with people’s attitudes, we used Generalized Linear Models (GLMs) with binomial distribution and logit link function. Our dependent variable was binary, 1 like, 0 dislike for each predator species. GLMs were used to identify which combination of potential explanatory variables [i.e., number of livestock owned, number of livestock lost to all predators and to each predator species, age (years), gender (male or female), occupation (pastoralist or agro-pastoralist), education level (formal or without formal education), number of income sources per household (1 to 5), knowledge score (for attitudes towards cheetahs only), residency time or years at residence (number of years since the respondent had arrived in the area), and distance from protected area (in km)]—best predicted people’s attitudes toward large carnivores. We included only knowledge for cheetahs versus leopards in the model since all other carnivore species were exclusively identified by all respondents. The general importance of carnivores in relation to other wildlife was investigated by looking at the relative frequency of mentions and by an index of salience (S) measured using an index of 0–1 representing the relative position on each list (S_j) and the number of times each animal was mentioned (Borgatti, 1990). Salience index value (S) was calculated using the following formula:

$$S = \frac{\sum S_j}{N} \text{ Where } S_j = 1 - \frac{r_j - 1}{n - 1}$$

S = saliency index value, N = number of free lists, r_j = position of item j in list, n = number of items in list. Spearman Rank correlation coefficients were used to test for multicollinearity between explanatory variables. We selected only one variable as a proxy for the others to use in statistical analysis when two or more explanatory variables significantly

correlated with each other. The level of education was negatively correlated with age ($r_s = -.259$, $p < .001$) and gender ($r_s = -.204$, $p < .001$), while occupation was positively correlated with income sources ($r_s = .132$, $p = .022$). Therefore, age, gender, and occupation were excluded from the model to improve the precision of the estimated model parameters. We ranked candidate models in order of parsimony using Akaike's Information Criterion corrected for small sample size (AICc) and Akaike weights (w_i) (Burnham & Anderson, 2002). We computed model-averaged coefficients of predictor variables based on top-ranked models with ($\Delta\text{AICc} < 2$). All tests were two-tailed and significance was measured at $p < .05$.

Results

Demographic and socioeconomic characteristics

Respondents comprised 96% ($n = 288$) Maasai and 4% ($n = 12$) Waarusha. Respondents' age ranged from 18–92 years old, with an overall mean age of 35.85 ± 13.99 (SD) years. Overall, 57% ($n = 170$) of respondents were between 18–35 years, 28% ($n = 84$) between 36–50 years, 9% ($n = 27$) between 51–60 years and 6% ($n = 19$) above 60 years. Eighty-eight percent ($n = 265$) of respondents were male and 12% ($n = 35$) were female. The education level ranged from illiterate (i.e., no formal education) 51% ($n = 154$) to formal education (i.e., 36% ($n = 108$) primary, 11% ($n = 34$) secondary and 1% ($n = 4$) tertiary education). On average, women were less educated than men ($\chi^2 = 12.45$, $df = 1$, $p < .001$).

Ninety-five percent ($n = 285$) of respondents were agro-pastoralists and 5% ($n = 15$) were pastoralists. The main source of cash income was the sale of livestock (91%, $n = 272$), selling crops (27%, $n = 82$), off-farm activities (35%, $n = 105$), and other income-generating activities (1% i.e., operating a restaurant business, sewing beads, construction and beekeeping).

Nearly all respondents (99%) reported owning cattle with a mean number of $23.13 \pm (SE\ 3.06)$ cattle per household and a mean number of $38.01 \pm (SE\ 4.67)$ small stock per household while 89% reported owning donkeys with a mean number of $1.12 \pm (SE\ 0.06)$ donkeys per household. The overall mean number of livestock holding per household was $62.25 \pm (SE\ 7.60)$.

Knowledge about wildlife species

Among the five carnivore species, lions, spotted hyenas, and African wild dogs were the most well known and recognized by all respondents. Sixty-three percent ($n = 188$) of respondents were able to correctly differentiate cheetahs from leopards, while 37% ($n = 112$) failed to do so. The ability to differentiate between cheetahs and leopards (i.e., knowledge score index) was significantly influenced by the level of education ($\chi^2 = 10.40$, $df = 1$, $p = .001$) and gender ($\chi^2 = 26.84$, $df = 1$, $p < .001$). We asked the respondents to list all of the wild animals they can think of that live in the area or around their households. The number of wildlife species free-listed was used as an indicator of knowledge. A total of 27 species were listed by the respondents, of which seven were carnivores. The number of species listed differed significantly by gender, with men listing more species than women ($\chi^2 = 21.32$, $df = 10$, $p = .019$) and by the level of education, with educated respondents listing more species than less educated ($\chi^2 = 33.05$, $df = 10$, $p < .001$). Lions, spotted hyenas and leopards were major components of the local people's perception of wildlife,

with all recording high salience scores. Cheetahs and wild dogs had lower salience scores (0.06 and 0.12, respectively) in comparison to other carnivore species ($t = 7.82$, $df = 4$, $p = .001$).

Attitudes and perceptions of local people toward large carnivores

On average, 20% of respondents liked the focal carnivore species while 79% disliked them and 1% offered no clear opinion. All five carnivore species were disliked by a similar percentage of people ($\chi^2 = 3.82$, $df = 4$, $p = .431$, Figure 2). Respondents who showed a negative perception about one species tended to do so about the other species. The main reasons given by respondents for disliking focal carnivores were threats they pose to livestock and human life (81%, $n = 298$). Respondents expressed positive attitudes towards focal carnivores primarily either because they had no problem with them at present (5%, $n = 298$) or because they generate revenue through tourism (11%, $n = 298$). Other reasons given included the perceptions that “people are used to having these animals around for many years”? (2%, $n = 298$) and “proud to see them around”? (1%, $n = 298$). Overall, the mean attitude scores did not differ significantly between focal carnivore species ($\chi^2 = .008$, $df = 16$, $p = 1.00$) or between villages ($\chi^2 = .008$, $df = 16$, $p = 1.00$).

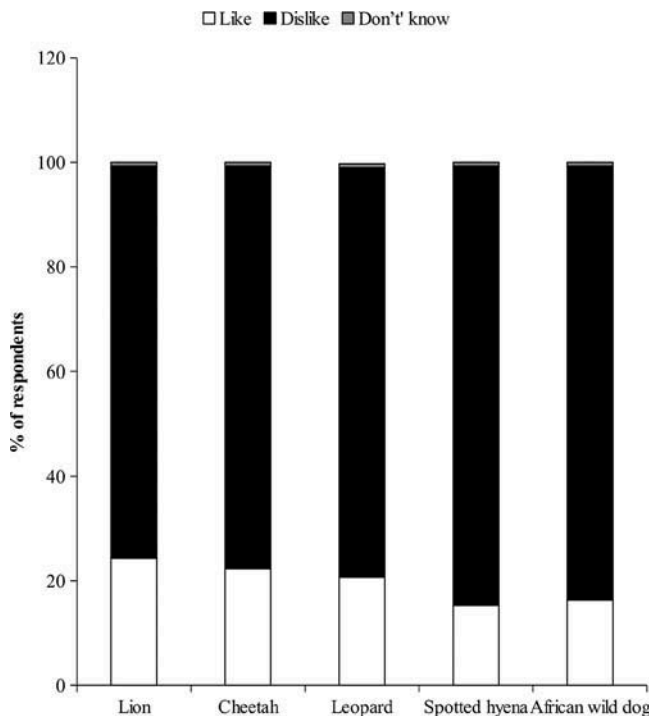


Figure 2. Percentage of respondents claiming that they liked, disliked or did not know how they felt about each of the focal carnivore species.

General attitudes and perceptions towards wildlife

More than half (57%, $n = 172$) of respondents disagreed with the statement “I enjoy seeing wild animals on my land,” while 43% ($n = 128$) were happier to see them on their land. Females expressed more negative attitudes toward wild animals than males ($\chi^2 = 8.32$, $df = 1$, $p = .004$). The main reasons given for negative attitudes were that they were a threat to livestock (41%, $n = 123$), followed by threats to livestock and crops (17%, $n = 50$). Conversely, positive attitudes toward wildlife were mainly attributed to expected benefits from ecotourism (16%, $n = 48$) and people considered them part of their natural heritage (10%, $n = 30$). Respondents with less education were less likely to enjoy seeing wild animals on village land ($\chi^2 = 8.81$, $df = 1$, $p = .003$). Nearly, 99% ($n = 296$) of respondents stated a desire for wildlife to be controlled in the area while 1% ($n = 4$) were against wildlife control.

General perceptions of problem status of large carnivores

When the respondents were asked to rank carnivore species in terms of how problematic they were, spotted hyena was cited as the single most problematic species, followed by leopards, African wild dogs, lions, and cheetahs, in that order ($\chi^2 = 395.82$, $df = 8$, $p < .001$, Figure 3). Most respondents agreed that the main problem with large carnivores is perceived risk associated with depredation on livestock. The number of livestock lost to predators correlated positively with the problem score assigned to focal carnivores:

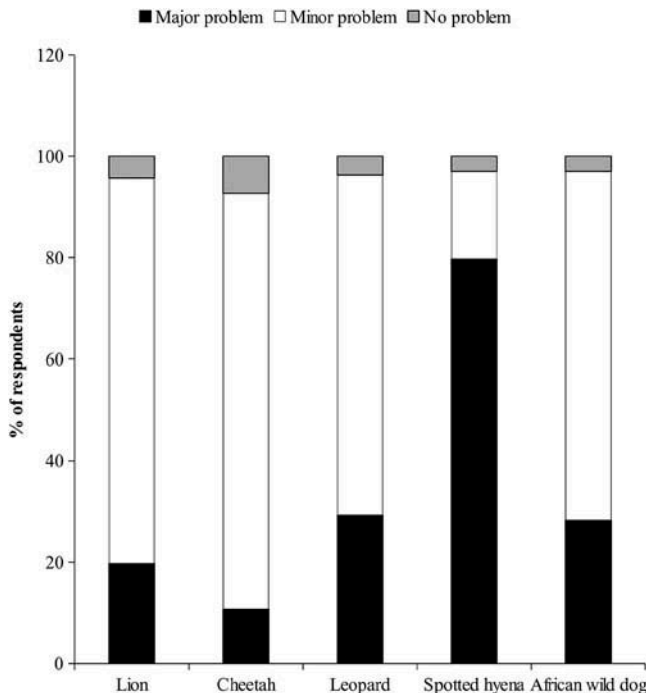


Figure 3. Percentage of respondents ranking carnivore species in terms of how problematic they were around their villages.

cheetahs ($r_s = .172$, $p = .003$), lions ($r_s = .328$, $p < .001$), leopards ($r_s = .330$, $p < .001$), spotted hyenas ($r_s = .439$, $p < .001$) and wild dogs ($r_s = .286$, $p < .001$).

Population trends of large carnivores

On average, two thirds (65%) of respondents perceived that large carnivore populations had decreased, 30% perceived they had increased, 22% that they had remained constant, and 1% perceived they had completely disappeared from the area ($\chi^2 = 73.07$, $df = 3$, $p < .001$, Table 1). This reported decline was most pronounced for lions, cheetahs, leopards, and wild dogs while the reported increase was most pronounced for spotted hyenas. The main reasons as to why these carnivore species have declined were attributed primarily to human persecution (40%, $n = 119$), followed by habitat degradation and fragmentation (18%, $n = 55$) and increased human settlement (7%, $n = 20$).

Attitudes toward the desired population change of large carnivores

On average, over two thirds (67%) of respondents wanted large carnivores to decrease, 13% wanted them to disappear, 12% wanted them to increase, 7% wanted them to stay the same, and 1% offered no clear opinion ($\chi^2 = 97.29$, $df = 3$, $p < .001$, Table 1). The main reasons given for wanting large carnivore populations to decline or disappear were to reduce carnivore-related risks, particularly livestock depredation, and attacks on humans. Conversely, the main reasons given for wanting the population of large carnivores to increase was the capacity to generate revenue from tourists (43%, $n = 129$), lack of genuine problems at current population levels (11%, $n = 34$) and being valuable for children's education (2%, $n = 5$).

Perceptions towards livestock depredation and retaliatory/preventative carnivore killing

Seventy-two percent ($n = 218$) of the respondents perceived that livestock attacks by carnivores had diminished since they arrived in the area, 25% perceived an increase, 1% perceived no change and 1% had no clear opinion ($\chi^2 = 410.93$, $df = 3$, $p < .001$). The main reason given for a perceived decline in depredation was the aforementioned reduction in

Table 1. Respondents' perceptions of population trends and desired population change for each carnivore species ($N = 300$) (number, % in parentheses).

	Population trend				Desired population change				
	Increased	Decreased	Disappeared	Stayed the same	Increase	Decrease	Disappear	Stay the same	Don't know
Lion	38 (12)	254(84)	1(0.3)	10(3)	43(14)	195(65)	33(11)	25(8)	4(1)
Cheetah	32(11)	251(83)	3(1)	17(6)	41(14)	198(66)	33(11)	24(8)	4(1)
Leopard	77(25)	211(69)	1(0.3)	15(5)	33(11)	203(68)	36(12)	24(8)	4(1)
Spotted hyena	220(77)	59(21)	0(0)	6(2)	26(9)	209(70)	46(15)	15(5)	4(1)
African wild dog	73(24)	208(68)	5(2)	19(6)	33(11)	199(66)	43(14)	21(7)	4(1)
Total/ Average	88(30)	196.6(65)	2(1)	13.4(4)	35.2(12)	200.8 (67)	38.2(13)	21.8(7)	4(1)

carnivore populations. Nine percent ($n = 26$) of the respondents admitted to having killed predators since they arrived in the area.

Factors influencing local people's attitudes toward large carnivores

Respondents with formal education expressed more positive attitudes than those without toward cheetahs ($\chi^2 = 16.49$, $df = 1$, $p < .001$), lions ($\chi^2 = 20.32$, $df = 1$, $p < .001$), leopards ($\chi^2 = 19.51$, $df = 1$, $p < .001$), spotted hyenas ($\chi^2 = 14.27$, $df = 1$, $p < .001$), and wild dogs ($\chi^2 = 17.36$, $df = 1$, $p < .001$). In addition, respondent's residency time was significantly associated with positive attitude toward cheetahs ($\chi^2 = 49.33$, $df = 30$, $p = .015$) and lions ($\chi^2 = 43.76$, $df = 30$, $p = .050$) but not wild dogs ($\chi^2 = 44.53$, $df = 30$, $p = .063$), leopards ($\chi^2 = 42.04$, $df = 30$, $p = .071$), or spotted hyenas ($\chi^2 = 42.59$, $df = 30$, $p = .064$). Similarly, attitude toward cheetahs was significantly positively associated with the knowledge score ($\chi^2 = 11.78$, $df = 1$, $p < .001$). Model-averaged coefficient estimates indicated that education and residency time were the most important predictors of attitudes toward lions (Table 2). However, model-averaged coefficients indicated that only education was significantly related to attitudes toward leopards and spotted hyenas. The same trend was found in wild dogs. Attitudes toward cheetahs were positively associated with education, residency time, and knowledge score. Overall, attitudes toward large carnivores were positively associated with education level (for all carnivore species), respondent's residency time (for lions and cheetahs), and knowledge of carnivores (cheetahs) (Table 2). Our results showed that attitudes toward large carnivores were not significantly associated with age, gender, number of livestock owned, distance from protected area, number of

Table 2. Summary statistics of the model-averaged coefficients (β), Standard errors (SE), and Wald statistic (which has a χ^2 distribution) calculated for variables explaining variation in attitude of respondents toward large carnivores.

Coefficients	Estimate (β)	SE	Wald χ^2	p value
~Lion~				
(Intercept)	-2.287	0.311	53.92	<.001
Education_formal ^a	1.286	0.295	19.06	<.001
Residency time	0.042	0.019	5.14	.023
~Leopard~				
(Intercept)	-2.424	0.329	53.98	<.001
Education_formal ^a	1.340	0.315	18.13	<.001
Residency time	0.032	0.019	2.81	.094
~Spotted hyena~				
(Intercept)	-2.890	0.382	57.18	<.001
Education_formal ^a	1.298	0.361	12.92	<.001
Residency time	0.039	0.021	3.57	.059
~Wild dog~				
(Intercept)	-2.803	0.376	55.64	<.001
Education_formal ^a	1.415	0.358	15.67	<.001
Residency time	0.032	0.021	2.32	.128
~Cheetah~				
(Intercept)	-1.145	0.565	4.11	.043
Education_formal ^a	1.077	0.307	12.32	<.001
Residency time	0.044	0.019	5.32	.021
Knowledge_correct cheetah ID ^b	0.095	0.347	6.64	.010

Note. ^a"without-formal education" was the reference category.

^b"respondents who failed to correctly differentiate cheetahs from leopards" was the reference category.

income sources, number of total stock lost to all predators, or stock lost to each predator species.

Discussion

Attitudes toward large carnivores

Human–carnivore conflict often engenders negative attitudes and low levels of tolerance toward carnivores (Oli et al., 1994). We found that attitudes toward large carnivores were not influenced by reported livestock depredation incidents, suggesting that the depredation impact was not significant enough to influence people's attitudes toward large carnivores. This finding contradicts previous studies (Dickman, 2008; Kissui, 2008; Maddox, 2003; Røskft et al., 2007) where negative attitudes toward large carnivores were associated with carnivore-induced livestock losses. In our study, however, livestock depredation was cited as the main reason for antagonism toward large carnivores. The lack of a direct relationship between attitudes toward carnivores and depredation experiences suggests that underlying drivers of conflict may be more complex and deep-seated than direct depredation. Despite an apparent logical link between stock depredation and human–carnivore conflict (Mishra, 1997), there is not always a simple, consistent relationship between the levels of stock loss and negative perceptions toward large carnivores (Dickman, 2008). In South Africa, on the border of the Kruger National Park, people who experienced depredation were not significantly more hostile toward carnivores than people who did not, due to cultural or aesthetic appreciation of large carnivores (Lagendijk & Gusset, 2008). In Tanzania, around Ruaha National Park, Dickman (2008) found that although people may not have personally experienced livestock depredation by large carnivores, they can still dislike carnivores as they pose a potential threat. By contrast, we found that positive attitudes toward large carnivores were mainly associated with tangible benefits people receive from having them in their area (i.e., revenue from tourism-related activities), as has been shown in other studies (Lindsey et al., 2005; Romañach, Lindsey, & Woodroffe, 2007).

Contrary to expectations, we did not find any significant difference in attitudes between carnivore species. This could be explained by the “contagious conflict” where respondents who showed a negative perception about one group of species may do so with other species (Dickman et al., 2014).

Factors influencing local people's attitudes toward large carnivores and other wild animals

Our results showed that respondents with formal education expressed more positive attitudes toward large carnivores than those without any formal education. This finding was in line with previous studies that showed that formal education can improve attitudes and increase tolerance levels for large carnivores (Lindsey et al., 2005; Parker, Whittington-Jones, Bernard, & Davies-Mostert, 2014; Røskft et al., 2007; Woodroffe et al., 2002). Oli et al. (1994) argued that people with higher levels of education are expected to be relatively more conversant with wildlife protection laws and have greater awareness of the benefits of large carnivores. On the other hand, the level of wildlife knowledge can also influence negative attitudes toward

wildlife. For example, Dickman (2008) found that the intensity of reported conflict between people and wildlife increased with people's level of wildlife knowledge around Ruaha National Park in southern Tanzania.

Our findings showed that people who had a long exposure to large carnivore-related risks (i.e., long-term residency) were more likely to express positive attitudes toward them than people with a short time exposure. These findings were inconsistent with previous studies in other regions (Arjunan, Holmes, Puyravaud, & Davidar, 2006; Newmark, Leonard, Sariko, & Gamassa, 1993), in which increased exposure to wildlife-related risks (i.e., long-term residency) has been associated with negative attitudes. One possible explanation for our findings is that long-term residents might have enough time to develop more effective livestock management strategies (e.g., construction of sturdier enclosures and improved herding practices) to cope with carnivore conflicts than short-term residents. However, an alternative explanation is that prolonged residency is associated with an increased exposure to large carnivores, and this personal experience results in a reduction of negative attitudes. This was suggested by Ericsson and Heberlein (2003) to explain public attitudes to wolves and later demonstrated by Røskft, Bjerke, Kaltenborn, Linnell, and Andersen (2003) for members of the public exposed to large carnivores in Norway. Consistent with other studies (Kellert & Berry, 1987; Li et al., 2010; Røskft et al., 2007), our findings showed that men were more positive toward wildlife and more experienced or knowledgeable about wildlife compared with women. We found that attitudes toward large carnivores were neither positively associated with number of livestock owned (an index of wealth) nor negatively associated with number of livestock lost to predators. These findings differ from previous studies which have shown that people's attitudes toward carnivores are positively associated with numbers of livestock owned and negatively associated with livestock lost to predators (Kideghesho et al., 2007; Naughton-Treves et al., 2003).

Knowledge of local people about large carnivores

Our results showed that local people had a better knowledge of lions, spotted hyenas, and leopards than cheetahs or wild dogs, as evaluated by the salience score indices. This is possibly explained by the commonality of lions, spotted hyenas, and leopards around the village. In Pendjari Biosphere Reserve, Benin (Sogbohossou et al., 2011), and in Kruger National Park, South Africa (Lagendijk & Gusset, 2008), better knowledge of species such as lion and spotted hyena was related to their commonality around villages and responsibility for attacks on livestock. Attitude toward cheetahs and knowledge score were significantly associated, which concurs with other studies (Romañach et al., 2007). However, attitudes toward cheetahs and leopards must be treated with due caution, because attitudes and experiences with one species may unintentionally be affecting their responses regarding the other (Dickman, 2008), and our results showed that people had most difficulty distinguishing between these two species.

Conclusion and management implications

Our findings provide insights and a better understanding of local people's attitudes and perceptions toward large carnivores, as well as factors that influence these attitudes in a human-dominated landscape of northern Tanzania. Education, years at residency, and knowledge were the most influential determinants (although dependent on species) of attitudes toward large carnivores than landscape, demographic, or economic factors. The differences between our results and previous studies may be explained by the complexity of conflict and its drivers. Our findings suggested that negative attitudes toward large carnivores were driven not only by livestock loss, but by a complexity of other factors not accounted for by this study; such as fear evoked by its very presence (Lichtenfeld, 2005) and deep-seated cultural hostility resulting from past experiences, even if carnivores are not causing present problems (Legendijk & Gusset, 2008; Røskaft et al., 2007). Dickman (2010) also suggested that conflict is not merely driven by stock losses, but is the result of a complex set of deep-rooted factors such as people's attitudes toward the PAs, autonomy over land that creates limitations on grazing and resource access imposed by nearby Pas, and costs imposed by dangerous animals straying out of the park and onto village land. For instance, in Brazil, livestock depredation did not significantly affect local ranchers' attitudes toward jaguars (*Panthera onca*) and pumas (*Puma concolor*) (Conforti & De Azevedo, 2003), whereas in Namibia, cheetah removal from farmland persisted (an average of 14 cheetahs per year) even where they were not thought to cause depredation (Marker, Mills, & Macdonald, 2003). While some studies have shown that decreasing depredation can lead to change in attitudes (Parker et al., 2014), our findings suggested that reducing depredation alone is less likely to produce a substantial change in people's attitudes toward large carnivores. Given these results, further research to understand underlying factors influencing people's attitudes toward large carnivores in the study area is desirable. Our findings suggested that interventions aimed at fostering positive attitudes toward large carnivores should focus on improving formal education and securing long-term residency for people in the region. Although majority of respondents perceived the presence of large carnivores as negative, the impact of the positive attitudes of the minority groups should not be ignored. Securing benefits from large carnivores through ecotourism should be enhanced. Environmental education programs should focus more on people immigrating into the region and women—who are less positive, less educated, and least knowledgeable about wildlife. In addition, educational programs aimed at improving knowledge about leopard and cheetah should also be prioritized. Based on our findings, we suggest improving conservation awareness education at all levels of education, as this could help improve attitudes toward wildlife in general and raise community awareness of wildlife conservation (Lindsey et al., 2005). Our findings that the majority of individuals perceived a decline of large carnivore depredation on livestock has implications for future decision-making on the coexistence of people, livestock, and large carnivores in the study area.

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