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Community attitudes and social correlates of African lion (*Panthera leo*) anthropogenic mortalities in the Maasai Steppe, Northern Tanzania

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Abstract

Knowledge of local attitudes toward lion conservation and identification of drivers of human conflicts with lions can help inform mitigation measures aimed at promoting the coexistence of humans and lions. We assessed attitudes of local communities toward lions and lion conservation in the Maasai steppe ecosystem of northern Tanzania with the aim of documenting anthropogenic factors driving human-related lion mortalities. Purposively, five villages were surveyed including three from core zones or hotspot areas where people kill lions, and two from control zones where lions are not killed. Attitudes in the zone where people kill lions (lion killing) were more negatively associated with lions and lion conservation than communities in the control zones. Fear for livestock, family, and personal safety were the strongest variables explaining negative attitudes toward lions and lion conservation. To promote coexistence between humans and lions, conservation authorities should invest more on awareness and sensitization programs on conservation of lions.

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Introduction

Sustainable conservation of large carnivores has become increasingly challenging due to increases in human population, habitat fragmentation, and climate change (Soka and Lyimo, 2021; Gebresenbet *et al*., 2018a; Ogutu *et al*., 2017; Packer *et al*., 2013; Treves & Karanth, 2003; Wittemyer *et al*., 2008). In the last century, Africa's large carnivores have declined severely from their historical range, mainly because of human activities (Ripple *et al*., 2014; Fink *et al*., 2020). For example, lions (*Panthera leo*) decreased by 75% (Riggio *et al*., 2013), cheetahs (*Acinonyx jubatus*) dropped by 91% (Durant *et al*., 2017), and leopard (*Panthera pardus*) populations declined by 75% (Swanepoel *et al*., 2015). These declines have been attributed to human related causes such as lawful hunting (Packer *et al*., 2011), unlawful hunting (Liberg *et al*., 2012), human conflicts with wildlife (Treves & Karanth, 2003), and road killings (Kramer-Schadt *et al*., 2004). Wide-ranging species, including large carnivores that roam outside protected areas have been reported to be particularly vulnerable to different sources of anthropogenic mortalities (Ripple *et al*., 2014). Human- conflict with carnivores is a serious management issue worldwide that frequently affects conservation efforts and often leads to killing carnivores (Holmern *et al*., 2007). For humans and carnivores to coexist, extra conservation efforts both in and outside-protected areas are needed (Woodroffe & Ginsberg, 1998).

Lions are listed as a vulnerable species under the International Union for Conservation of Nature (IUCN, 2014), and are constantly exposed to the risk of being killed by humans as they move closer to communal lands (Dickman, 2010; Dickman *et al*., 2014; Dulude-de Broin *et al*., 2020; Graham *et al*., 2005; Kissui, 2008; Riggio *et al*., 2013; Summer *et al*., 2020). Maintaining coexistence between humans and lions is challenging because when wild prey are reduced in numbers, large carnivores normally turn to domestic prey, especially livestock (Gusset *et al*., 2009; Kissui, 2008; Lagendijk & Gusset, 2008; Mponzi *et al*., 2014) and particularly when the protected areas have open borders where community land is easily accessible. Livestock depredation can create negative attitudes toward lions among local people (Gusset *et al*., 2009; Hazzah *et al*., 2017) and as Dickman (2010) reported, conflicts between humans and carnivores are sensitive issues that negatively influence socio-economic ways of life for local residents. Human conflicts with lions typically occur when people retaliate against lions that affect livelihoods and endanger human safety (Packer *et al*., 2005; Patterson *et al*., 2004). Conflicts escalate as the frequency of human-lion interactions increases. As human populations continue to grow and encroach into lion habitats, lion ranges contract and the number of lions' decreases (Ikanda & Parker, 2008; Woodroffe, 2000).

In the Maasai steppe ecosystem of northern Tanzania, retaliatory killing of lions due to livestock predation is a common phenomenon (Kissui, 2008; Mponzi *et al*., 2014; Mkonyi *et al*., 2017). Human conflicts with lions are occasionally associated with attacks of humans by lions (Packer *et al*., 2005). Thus, both retaliatory and pre-emptive killing of lions by people are some of the greatest threats against lion populations (Hazzah *et al*., 2009, 2014). Traditionally, pastoralists tolerated a certain percentage of livestock loss due to predation, but conservation practitioners now claim that available technology (e.g., guns, poison) has improved their ability to kill suspected livestock predators (Ogada *et al*., 2003).

Local community attitudes significantly influence the behaviors of individual community members, leading to increased tendencies toward killing lions in landscapes where their ranges overlap with people (Marchini & mcdonald, 2012; Yirga *et al*., 2011). Negative experiences with large carnivores are alleged to influence negative attitudes toward lions (Gebresenbet *et al*., 2018b). These experiences include humans suffering livestock predation from carnivores and carnivores suffering the consequences of their predation (Gebresenbet *et al*., 2018a; Hazzah *et al*., 2009; Mponzi *et al*., 2014). Understanding what influences the predation behavior of lions is

crucial to enable wildlife managers to adopt approaches that will attract the support in conserving lions (Hazzah *et al.*, 2017). The success of wildlife conservation partially depends on the attitudes of the public toward conservation (Soka and Lyimo, 2021). Tolerance in local communities for large carnivores revolves around people's attitudes and perceptions toward risks, and these may vary across cultures, religious beliefs, income and education levels, and knowledge about them (Dickman, 2010). In order to promote lion conservation, it is important to explore the grounds on which local community perceptions are based (Dickman, 2010; Hazzah *et al.*, 2017).

Promoting human-carnivore coexistence partially depends on better understanding the attitudes of people who have suffered damage caused by large carnivores living in their area. (Dorresteijn *et al.*, 2014; Gusset *et al.*, 2009). Dickman *et al.* (2013) indicated that human attitudes, behaviors, and perceptions toward carnivores result from complex social and cultural settings and are important for understanding human conflicts with carnivores. Understanding human attitudes, perceptions of risk associated with large carnivores, and the factors that influence these attitudes and perceptions is critical for developing effective human-carnivore conflict mitigation strategies for ensuring coexistence (Gebresenbet *et al.*, 2018b; Mkonyi *et al.*, 2017).

The assessment of human attitudes toward the conservation of large carnivores has attracted substantial research interest (Hazzah *et al.*, 2009). However, there is limited empirical information assessing local attitudes toward lions and their conservation in the Maasai steppe of northern Tanzania. Studies have not specifically examined the drivers and patterns of lion-anthropogenic mortalities in the Maasai steppe. Important landscape variables affecting the spatial distribution of lions across their range include vegetation cover, which influences the presence of prey and hunting success that in turn affect lion territory selection (Funston, 2011). Others important landscape variables include water sources that attract grazers (Davidson *et al.*, 2013; Valeix *et al.*, 2010) and similar factors that determine the vulnerability of prey to predation and motivate lion movements and decisions (Kittle *et al.*, 2016). Our study assessed both local community attitudes toward lions and lion conservation, and the landscape drivers contributing to a high rate of anthropogenic mortalities among lions. We hypothesized that attitudes toward lions and lion conservation in communal lands that are prone to livestock predation (core zones) would be more negative than in those that are not prone to predation (control zones).

Materials and methods

Study Area

The Maasai steppe is an important ecological stronghold for wildlife and people in northern Tanzania (Fig. 1). This ecosystem encompasses approximately 40,000km^2 or nearly 10 million acres of woodlands, bush land, and open grasslands. The area is home to rare wildlife species such as the African wild dog (*Lycaon pictus*), the fringe-eared oryx (*Oryx beisa callotis*), and the most threatened African lion population (IUCN, 2014). The steppe is also well known for its migration of wildebeests (*Connochaetes taurinus*), zebras (*Equus burchelli*), and elephants (*Loxodonta africana*) (Lamprey, 1964). Most of this ecosystem is designated as Maasai village lands where livestock husbandry is the primary livelihood (Mkonyi *et al.*, 2017). The Maasai steppe is centred in two districts: Monduli (Latitude 3°17'S, Longitude 36°27' E) and Simanjiro (Latitude 4°26' S, Longitude 37°7'E).

The Maasai steppe has a diversity of plant species. The predominant vegetation type is comprised of riverine forest with species that include *Ficus sycomorus* and *Acacia siberiana*. Swamps are dominated by *Cyperus* species and elephant grasses; the woodland vegetation is dominated by *A. tortilis*, *A. commiphora*, *A. mellifera*, *Terminalia brownie*, and *Adansonia digitata*, forming extensive mixed woodland (Miller & Doyle, 2014). The Maasai Steppe has been classified as an arid rangeland forming part of the Somali-Maasai bio-geographical region (Townshend *et al.,* 1986) and it receives an average

annual rainfall of 800 - 1000mm (Prins & Loth, 1988). Wildlife move seasonally between Lake Manyara and Tarangire National Parks, and the adjacent areas. During the dry season (June-October), the migratory species remain inside the protected areas, but move out into the dispersal areas in communal village lands for most of the wet season (November - May) (Kissui, 2008; Mponzi *et al*., 2014) and carnivores follow these species.

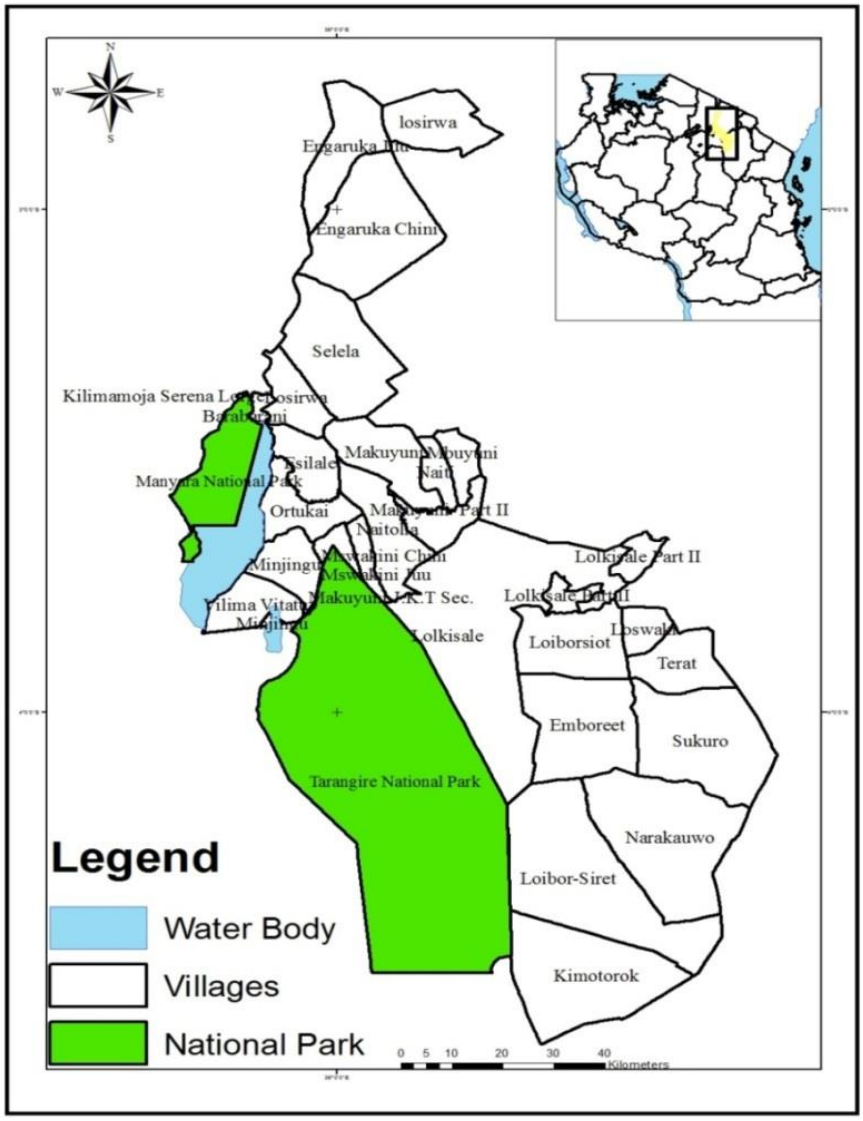

Fig. 1. Map of Maasai steppe ecosystem showing the core protected areas (Tarangire and Manyara National Parks) and the surrounding villages.

Data Collection

Preliminary Surveys

Pre-testing of questionnaires was administered to 30 randomly selected respondents (15 respondents who had killed lions and 15 who had not killed a lion in their lifetime). We employed Participatory Rural Appraisals (PRA) techniques, including semi-structured interviews, focus group interviews, questionnaires, and village walks (Borrini-eyerabend & Buchan, 1997) to assess both community attitudes toward lions and lion conservation between lion-killing and non-lion-killing zones and the drivers of anthropogenic mortalities of lions in the Maasai steppe ecosystem. All questions were written and piloted in the local language (*ki-masai*) by a single interviewer to minimize interviewer bias (Browne-Nuñez & Jonker, 2008).

When assessing the determinants of lion killing behavior, attention was paid to the pre-testing of the traditional customs to ensure optimal reliability and validity (Hazzah *et al*., 2017). Given that culture and ethnicity varied from one locality to another, it was vital to first identify the fundamental cultural dimensions, which were essential in building a Likert scale.

Sampling

Stage 1: This involved the selection of two zones: a lion-killing zone and a non-lion killing zone. These areas were purposely selected based on frequencies and history of lion killings. The zones were developed by overlaying the shape file layer of the Maasai steppe villages to the topographic map of Maasai steppe lion-killing hotspots that was developed based on lion killing incidences in the past 13 years (Fig. 2). Ultimately, three villages were sampled from the core zone, people killing lions (lion-killing) zone and two villages from the non-lion killing (control) zone. Stage 2: A boma is a typical Maasai homestead, consisting of several cattle and shoat kraals encircled by a series of huts belonging to an elder and his wives (Ikanda & Parker, 2008). Since the Maasai live in extended families, a random selection of bomas from each village in each zone was used in the study. About 327 and 336 bomas were counted in the lion-killing zone and control zone, respectively. Subsequently, 90 bomas from the lion killing zone and 93 from the non-lion killing zone were surveyed. The targeted respondents were the head of the boma and in their absence the next most senior member (>18 years old) was selected to be interviewed.

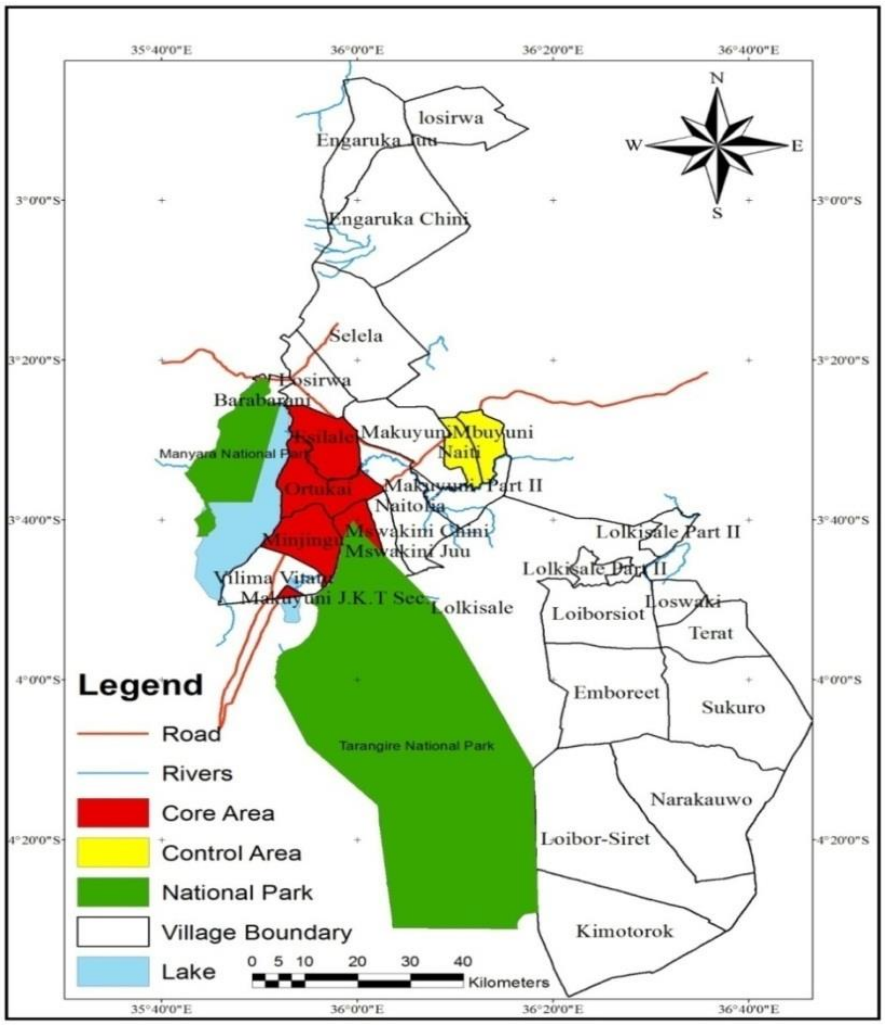

Fig. 2. The map of the Maasai steppe ecosystem showing zones and sampled villages for this study (Red coloured zone comprise villages with high frequencies of lion killing incidences (core zone), while yellow coloured zones represent villages with non-lion killing incidences (control zone).

Community Attitudes

Primary data on local peoples' attitudes toward both lions and lion conservation in the communal land were collected through face-to-face interviews. Interview questions were divided into three sections that sought demographic information of the respondents, attitudes toward lions, and attitudes toward lion conservation in human dominated land. The responses to the statements regarding attitudes toward lions and lion conservation were originally coded using a bipolar scale.

Two focus group discussions were conducted in the lion-killing zone. During these discussions, all men were grouped into three age groups (youth, elders, and senior elders) and were involved in developing a list of 120 items that best described their traditional customs. Community elders and senior elders subsequently ranked these items in the order of perceived importance. The list was then reduced to the six most frequently mentioned items, which built the final scale (traditional customs).

Determinants of lion killing behaviour

Purposive sampling was used where individuals with specific attributes (illiterate, same age class, own cattle) relevant to the study's purpose were interviewed. For cultural reasons, only the youth living within both control and lion-killing zones were interviewed since this segment of the society was primarily responsible for killing lions (Hazzah *et al*., 2017). Ninety-one (91) respondents who had killed lions and ninety-two (92) respondents who had never killed a lion were interviewed. Those who had not killed lions were treated as control. Lion killers were selected through snowball technique. Based on the responses gathered during our preliminary surveys, twenty one (21) structured statements were used to determine the factors that influence the behavior of killing lions.

Additionally, we held opportunistic informal discussions with individuals or groups of people. There was no overlap between participants in these informal discussions and household survey subjects. These discussions occurred based on self-initiated conversations by the locals about our study in their community or by individuals who approached us with information, which they thought might be of interest to us. During all informal discussions, we informed the participants that their responses might be reported anonymously; we obtained their verbal consent to proceed.

Data analysis

Community attitudes toward lions and lion conservation

The demographic characteristics of the respondents were summarized using percentages and frequencies. When assessing the local community attitudes toward lions and lion conservation in the communal areas, Cronbach reliability and normality tests were carried out to test the validity and distribution nature of the data respectively since bomas were randomly selected. A Shapiro-Wilk's test ($p < 0.05$) and visual inspection of the histogram, normal Q-Q plots, and box plots showed that the attitudes scores were not normally distributed in both core and control zones.

The attitude score of 1 indicated strongest positive attitude, a score of 3 indicated neutral attitude and 5 indicated strongest negative attitudes toward lions and lion conservation. Non-parametric Chi-square tests were applied to determine the differences in the frequencies of responses in each statement across the two zones. All statistical tests were two tailed, and a significance level was set at 95%. The scores on attitudes toward lions and lion conservation were computed and subjected to Mann-Whitney U-test to determine whether there were significant differences in the attitudes toward lions and lion conservation between the two zones.

Determinants of lion-killing behaviour

Descriptive statistics were used to summarize factors that influence lion killing behavior and the social demographic characteristics of the respondents. Indicator statements of lion-killing behavior were subjected to factor analysis under the principal component analysis and six factors with eigenvalue of greater than one were extracted.

The relationship between factors in the covariance matrix was less than five but not close to zero and hence varimax rotation was chosen. Statements were rotated and grouped into single factors.

The statements under each factor were summed up into a single additive score. The internal consistency of each factor was tested. The summed scores from each factor were used as independent variables, whereas lion killing history was used as a dependent variable (killed a lion = 1, not killed a lion = 0) when running binary logistic regression analysis in predicting the factors that can explain human lion killings behaviour. The computations and regressions were performed in SPSS software version 20.0.

Results

Socio-economic characteristics of the respondents

One hundred and eighty three (183) respondents participated in the household survey. About 81% of the respondents were born, brought up, and lived in the study villages. The majority (71%; n = 129) of the respondents were between 18 - 35 years old, whereas about 14% (n = 25), 10% (n = 19), 5% (n = 8) were aged between 51 - 60 years old, 36 - 50 years, and > 60 years old, respectively.

The level of education of the respondents ranged from no formal education (78%; n = 145) to primary education (12%; n = 21), secondary, (4%; n = 8), and tertiary education (4%; n = 7). The majority (98%) of respondents were engaged in pastoralism, whereas only 2% were engaged in agro-pastoralism. In this study, all respondents owned livestock. T

he average cattle holding was about 205 individuals. About 50% of the respondents admitted to have killed a lion. Furthermore, about 42% of the respondents reported to have been attacked by lions in their lifetime. This study estimated that in the past five years, about 43 cattle (with a value of 14,570,000 Tanzanian million Shillings) and seven donkeys (with a value of 450,000 TZS) were attacked by lions in the study villages.

Community attitudes toward lions and lion conservation

The internal consistency of the statements that measured the attitudes toward lions and lion conservation passed the Cronbach reliability test with alpha coefficients of 0.78 and 0.76, respectively.

There was a skewness of 0.23 (SE = 0.36) and kurtosis of -1.53 (SE = 0.36) in the core zone (where lions were killed) and a kurtosis of -0.65 (SE = 0.17) and skewness of -0.28 (SE = 0.19) in the control zone (where lions were not killed). More than 50% of respondents in both core and control zones agreed with the statement that the presence of lions in their villages is a sign of healthy environment.

However, 76% of the respondents in the core zone disagreed with the statement that lions should be protected whereas 58% of the respondents in the control zone agreed. About 49% of the respondents in the core zone disagreed with the statement that lions are good animals, whereas 57% of the respondents in the control zone agreed with the same statement.

Fifty three percent of the respondents in the core zone disagreed with the statement that a lion is a polite (non-aggressive) animal while 57% of the respondents in the control zone agreed. Fifty-three percent (53%) of the respondents in the core zone disagreed with the statement that a lion does not attack or kill people while 57% of the respondents in the control zone agreed.

There was a significant difference in the attitudes toward lion and lion conservation between respondents in the two zones (z = -3.916, p = 0.001). People in the core zone had more negative attitudes toward lions and lion conservation due to livestock and human attacks by lions. About 54% of the respondents in the core zone had negative attitudes while 42% had positive attitudes.

In the control zone on the other hand, 56% had positive attitudes and only 38% had negative attitudes toward lion (Table 1).

Table 1. Community attitudes toward lions and lion conservation in Maasai steppe.

Items	1	2	3	4	5	χ^2	*p-value*
The presence of lion is sign of health environments							
Core zone	19	12	12	38	18	34	0.0001
Control zone	33	1	13	23	29		
Lions should be protected							
Core zone	19	57	2	2	17	23.425	0.0001
Control zone	37	3	6	37	20		
Lion is a good animal							
Core zone	41	9	6	32	13	29.93	0.0001
Control zone	31	8	3	21	37		
Lion is polite (non-aggressive) creatur e							
Core zone	36	18	1	34	11	53.922	0.0034
Control zone	39	1	3	23	34		
Lion don't injure or kill people							
Core zone	26	27	2	35	9.4	69.472	0.0001
Control zone	30	4	9	23	34		

Key: 1= strongly agree, 2 = Agree, 3 = Neutral, 4= disagree, 5= strongly disagree.

Attitudes toward lion conservation in communal land

The findings from this study clearly showed that people had negative attitudes toward lion conservation in communal land. The study revealed further that half of the respondents (50%) in the core zone did not support lion conservation in their communal land. About 41% of the respondents supported lions being conserved in their communal land, while only 9% were indifferent. In the control zone, about 42% of the respondents did not support lions to be conserved in the communal land, about 48% supported lions to be managed in the communal land, while only 10% were neutral (Table 2). Unexpectedly, this study found that no one thinks lions should be present in the area. The majority of the respondents in both the core (91%) and control (99%) zones disagreed with the statement that "a lion has to be present in my homeland." In addition, more than half of the respondents in both the core zone (66%) and control zone (62%) agreed, "killing or disturbing a lion should be allowed by the law." The majority (71%) of the respondents in the core zone supported the statement, "The only solution to the problem of depredation of livestock by lions is to retaliate by killing the lions". In addition, the majority (92%) of the respondents in the core zone and 77% in the control zone disagreed with the statement that "the government consolation scheme is justifiable". Kruskal-Wallis test revealed a significant difference (χ^2 = 12, df = 3, p = 0.026) in attitudes toward lions across education levels in the study area. Respondents with no formal education showed no support of lions' presence (disliked seeing lions) in their land. On the other hand, respondents with formal education showed more support of lions' presence in their land.

Table 2. Community attitudes toward lion conservation in communal land.

Items	1	2	3	4	5	χ^2	*p-value*
Killing or disturbing lion should be allowed by the laws							
Core zone	27	8	4	11	51	16.408	0.003
Control zone	28	8	2	26	36		
If lion is around its good to give information							
Core zone	21	13	17	12	54	73.205	0.001
Control zone	8	3	11	52	27		
Lion protection is the responsibility of every one in our community							
Core zone	18	11	9	13	49	62.51	0.001
Control zone	8	5	4	51	32		
The only solution to depredation of livestock by lion is to retaliate by kill							
Core zone	13	13	3	25	46	167.01	0.001
Control zone	73	14	4	1	7		
Lion conservation is beneficial to our community							
Core zone	43	10	6	27	14	59.55	0.001
Control zone	20	7	27	21	14		
Government consolations is justifiable							

Items	1	2	3	4	5	χ^2	*p-value*
Core zone	42	50	4	2	2	87.7	0.001
Control zone	67	9	1	6	16		
It's good to support conservation initiative in our village							
Core zone	40	10	8	27	15	67.79	0.0001
Control zone	8	5	4	51	31		
Outreach program from Tanzania National Parks is satisfactory							
Core zone	43	10	22	27	14	43.76	0.001
Control zone	19	13	29	23	16		
Conservation based service from Tanzania Wildlife Authority is satisfactory							
Core zone	54	9	7	13	17	28.77	0.001
Control zone	34	24	17	11	14		
Conservation participatory approach is satisfactory							
Core zone	47	10	9	21	13	53.67	0.001
Control zone	18	37	14	17	13		
Lion has to be present in my homeland							
Core zone	68	23	6	3	1	42.734	0.001
Control zone	94	5	1	0	0		
Lion has to be protected and conserved							
Core zone	13	6	13	39	28	22.02	0.001
Control zone	6	4	4	41	46		

Key: 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree.

The factor analysis revealed six components with eigenvalues exceeding 1 (Table 3). The overall factor analysis explained about 62% of the variations. The sampling adequacy test was statistically reliable (KMO = 0.78, df = 210, p = 0.001). The extracted factors were attitudes toward lions, sharing of conservation benefits, intention of defensive killing, and intention of social killing, traditional customs, and government consolation scheme. The internal consistency of attitudes toward lions was extremely high, 0.93. Items that fall within the intention of social killings passed a Cronbach reliability test with strong alpha coefficients of 0.85. Traditional custom passed a Cronbach reliability test with strong alpha coefficients 0.81, the intention of defensive killing (0.80), and the internal consistency of sharing conservation benefits (0.85). Since government consolation scheme was isolated in a single statement, its constant was not calculated (Table 4).

The binary logistic regression model consisted of six predictor variables and explained 61% of the observed variation among factors that influence actual as opposed to lion killing behaviour [Dependent variable = lion killing history (kill = 1, not kill = 0)]. The model revealed that only four factors could explain statistically and significantly the reasons for the actual behaviour of killing lions (Table 5).

Table 3. Rotated Component Matrix.

	Component					
	1. General Attitude	2. Benefit sharing	3. Social-killings	4. Traditional-customs	5. Defensive-killings	6. Consolation scheme
I like to watch lions in their natural environment	0.881					
Lions deserve protection	0.878					
I feel that lions are beautiful animals	0.856					
The lions in the ecosystem are national treasure	0.818					
It is important to me that my grandchildren see lions	0.807					
Lions have a right to exist	0.806					
Lions have the same rights as livestock to live on this land	0.794					

	Component					
	1. General Attitude	2. Benefit sharing	3. Social-killings	4. Traditional-customs	5. Defensive-killings	6. Consolation scheme
God would want me to protect lions	0.775					
Outreach program from Tanzania National Parks is effective and helpful		0.962				
Lion conservation is beneficial to our community		0.957				
Conservation based service from Tanzania Wildlife Authority is fair and effective		0.759				
I will kill a lion just for fun			0.878			
Traditional hunts are acceptable			0.875			
Killing a lion for prestige/status is acceptable			0.856			
I do not wear western clothes				0.881		
I believe sacrifices to pray for rain are important				0.843		
If my cow was killed by a lion it would be acceptable to kill the lion				0.778		
I will kill a lion to defend my property					0.845	
If a lion entered by boma livestock corral I will kill it					0.807	
If a family member was injured by a lion I would kill the lion					0.773	
Government consolation scheme is justifiable						0.857

Extraction Method: Principal Component Analysis (Rotation Method: Varimax with Kaiser Normalization).

Table 4. Items included in the factor analysis and the percentage of respondents who agreed/strongly agreed with each statement.

Warriors attitudes	Agreement%
Lions deserve protection	80
I feel that lions are beautiful animals	78
Lions have economic benefit to Tanzania	82
It is important to me that my grandchildren see lions	80
Lions have a right to exist	77
The lions in the ecosystem m are national treasure	81
God would want me to protect lions	72
Lions have the same rights as livestock to live on this land	75
I like to watch lions in their natural environment	83
Lions have economic benefit to community	72
Defensive killing	
I will kill a lion to defend my property	64
If a lion entered by boma (livestock corral) I will kill it	57
If a family member was injured by a lion I would kill the lion	64
Social killing	
I will kill a lion just for fun	82
Killing a lion for prestige/status is acceptable	86
Traditional lion hunting is acceptable	88
Traditional customs	
I do not wear western clothes	77
I believe sacrifices to pray for rain are important	92
If my cow was killed by a lion it would be acceptable to kill the lion	62
Participation and financial benefit sharing	
Outreach program from Tanzania National Parks is effective and helpful	47
Lion conservation is beneficial to our community	46
Conservation based service from Tanzania Wildlife Authority is fair and effective	45
Consolation scheme	
Government consolation scheme is fair	5

Table 5. The binary logistic regression model of variables for actual lion killing.

Independent variables	β	S.E.	Wald	df	Sig.	Exp (β)	95% CI for EXP(β)	
							Lower	Upper
General attitude	-0.02	0.03	0.731	1	0.39	0.979	0.940	1.020
Traditional customs	-0.05	0.05	0.842	1	0.36	0.953	0.875	1.039
Benefit sharing	-0.27	0.06	19.270	1	0.001	0.763	0.690	0.844
Consolation scheme	-2.25	0.42	28.088	1	0.001	9.449	4.706	18.973
Defensive killing	0.142	0.05	9.718	1	0.002	1.152	1.069	1.241
Social killing	-0.25	0.01	7.282	1	0.007	0.774	0.662	0.905
Constant	-0.05	0.97	.219	1	0.640	0.635		

The sharing of wildlife conservation benefits was found to be one of the factors that influenced improvement of human-lions relations and was negatively correlated with lion killings (β = -0.27, p = 0.001). Negative sign implies that as the sharing of wildlife conservation benefits decreased it inversely proportionally increased the likelihood of lion to be killed. The Wald statistics (19.27) also indicated a strong positive association between benefit sharing and lion killing incidences. The odds ratio indicated that a unit decrease in sharing of wildlife conservation benefits conversely increased the likelihood of lion killers to retaliate against lions by the factor of 0.763 as opposed to non-killers.

The livestock consolation scheme was found to be negatively and significantly correlated with the actual killings of the lions (β = -2.25, p = 0.001). Wald statistics also indicate a strong positive association 28.08 between consolation scheme and the actual behaviour of killing lions. The negative sign is an indication of the perceived unfairness of the depredation consolation scheme of livestock, which ended up with an increase of the actual likelihood of killing lions. The odds ratio indicated that a unit decrease in the consolation scheme payment value increases the likelihood of the actual killing of lions by the factor of 9.449 among lion killers as opposed to non-lion killers. The intension of defensive killing was positively and significantly correlated with the actual desire of killing lions (β = 0.142, p = 0.002). Wald statistics also indicate a strong positive association 9.718 between defensive killings and the actual desire of killing lion. The positive sign implies that as the frequency of lion attacks increases it also increases the chances of lion killings. The odds ratio indicates that lion killers intend to kill lions defensively by a factor of 1.152 as opposed to non-killers. In the Maasai steppe, lions are used to attacking both people and livestock; this might be the reason for the warriors to launch retaliatory attacks.

The intent for social killing (warriors kill lions to reassert their power and strength as they protect their communities) was found to be one of the factors that influenced killings and positively correlated with lion killings (β = -0.27, p = 0.001). The Wald statistics also 7.282 indicates that the intention for social killing has a strong positive association with the desire of killing lions. The odds ratio indicates that lion killers show the intent of carrying out social killing of lion by a factor of 0.774 as opposed to non-lion killers.

Discussion

Community attitudes toward lions and lion conservation

Human-carnivore conflicts threaten the survival of carnivores and if these conflicts remain un-mitigated, they may lead to a dramatic decline in their populations, or the extirpation of local species (Packer *et al.*, 2013). Local people have been reported to use spears, poison (Kissui, 2008), and bows and arrows (Mbise *et al.*, 2018) to kill large carnivores in the Maasai steppe ecosystem. However, human-lion killings are shaped by peoples' perception of livestock depredation, socio-economic factors, and the existing complex relationship between local communities and conservation authorities (Hazzah *et al.*, 2009; Dickman, 2010; Summer *et al.*, 2020). The negative attitudes toward lions in the core zone could be caused by high frequencies of livestock attacks since this area was found to have high frequencies of lions being killed. Similarly, a study by Kissui (2008) reported that lion-killing incidences were positively

correlated with the frequency of livestock attacks by lions. The findings from this study are in line with the findings reported in other studies (i.e. Loibooki *et al*., 2002; Dickman, 2010; Hazzah *et al*., 2009) where negative attitudes toward large carnivores were associated with losses of livestock due to carnivore predation. Low educational levels might also account for why respondents disliked lion conservation (Roskaft *et al*., 2007) since more than 75% of the respondents had no formal education in both control and core. We noted that less education might mean more dependence on cattle. Respondents with low educational levels had limited choices and most find themselves engaging in livestock keeping only.

Similarly, Nkedianye *et al*. (2019) reported that as the herds become smaller, Maasai's economies of scale are lost leading to higher vulnerability to losing the total herd in the event of a drought or other shocks. Other studies (e.g. Carter *et al*., 2014; Mir *et al*., 2015) revealed that community attitudes and responses to wildlife conservation are influenced by factors such age, gender, educational level, and income. Other studies have found that educational level significantly affected local people's attitudes toward lions, with the respondents with formal education showing more positive attitudes toward carnivore conservation (Roskaft *et al*. 2007; Lagendijk and Gusset 2008). Conservationists have used education to increase knowledge and improve attitudes among target stakeholders, indirectly influencing the change in stakeholders' behaviors for the benefit of conservation (Jacobson *et al*., 2006).

Attitudes toward lion conservation in communal land

The relationship between Maasai and lions is complex, and includes positive and negative attitudes (Goldman *et al*., 2010) that must be evaluated in order to understand lion killing tradition. The negative attitudes about lion conservation in the study area could have been brought by the long-term history of livestock depredation by lions, lack of effective livestock consolation schemes, threats to peoples' safety due to lions, and/or poor relationships between conservation authorities and the local communities. Packer *et al*. (2005) revealed that communities living adjacent to protected areas are often injured or killed by lions; this could contribute to peoples' constant fear for their lives and cause retaliation by killing the lions. It is also possible that the high degree of illiteracy in the core zone could contribute to increased negative attitudes toward lions in the communal land. Respondents with formal education showed more support of lions' presence in their land. Similarly, previous studies (Lyamuya *et al*., 2014; Mkonyi *et al*., 2017; Mbise *et al*., 2018) found that people with high educational levels had positive attitude/perception toward large carnivore conservation. This suggests that long-term conflicts with carnivore might be reduced by providing people with education to improve human-carnivore coexistence in the study area.

The findings of the current study show that revenue sharing effectively and significantly reduced lion killings among the communities in the area. The sharing of wildlife conservation benefits was found to be one of the factors that influenced improvement of human-lions relations and was negatively correlated with lion killings. This implies that as the sharing of wildlife conservation benefits decreased it inversely proportionally increased the likelihood of lion to be killed. It was clear that respondents were not satisfied with the benefits, which were derived from the conservation of wild animals. There is a need for the government to improve benefit sharing package to the local community living adjacent the protected areas in the Maasai steppe ecosystem. As Archabald and Treves (2001) suggest, there is a need for the government to identify local communities with serious levels of conflicts with carnivores and provide them with long-term revenue-sharing support.

Consolation schemes are mechanisms formed by national authority to placate a person's loss caused by dangerous wildlife (Albert, 2010). Tanzanian government has made efforts to minimize human-wildlife conflicts by establishing the Wildlife Conservation (Dangerous Animals Damages Consolation) Regulations of 2011.

The consolation scheme provides support, comfort and relief from damage caused by wild animals. Any person who has suffered damage or destruction of his crops or livestock caused by a dangerous animal as prescribed under the Regulations shall, upon application and determination be eligible for consolation (Wildlife Conservation Act, 2009). In this study, the consolation scheme was found to be negatively and significantly correlated with the actual killings of the lions. This is an indication of the perceived unfairness of the depredation consolation scheme of livestock, which ended up with an increase of the actual penchant of killing lions. Poor compensation scheme on livestock depredation motivated the Maasai warriors to kill lions before they attack their livestock. Dickman *et al.* (2010) found that the actual compensation scheme on livestock attack by lions can create a win-win situation by redistributing the costs and benefits between communities, which would, in turn, minimize retaliatory killings of lions. Similarly, Bauer *et al.* (2015) observe that compensation is more affordable than other conservation activities.

The intent for social killing (warriors killing lions) was positively correlated with lion killings and seemed to be one of the influencing factors. The Maasai have traditionally valued lions, however, warriors kill lions as a cultural role that reasserts their power and strength as they protect their communities (Goldman *et al.*, 2010). Nowadays, killing human enemies is sporadic but killing a lion is still important to a young warrior's attaining manhood, as he is seen to be protecting his community (Hazzah *et al.*, 2017). Our findings are in line with similar findings reported in the previous study (e.g. Ikanda *et al.*, 2008), where the killing of lions was found to be influenced by social domains such as prestige (*Ala-mayo*). In the Maasai steppe, warriors revealed that their expression of intent to kill lions for social reasons (*Ala-mayo*) normally occurs simultaneously with the lion retaliatory attacks. This was proven as the most efficient way of hiding their social practices for many years (Kissui, 2008). We observed that Maasai graze their livestock in open pastures by day where one to three herdsmen drive and protect the herd against carnivores by vigilance, loud noises, and sticks. Furthermore, the warriors may also kill or repel predators with spears and shields. These findings suggest that the government consolation scheme on livestock depredation, conservation benefit sharing, and defensive killing followed by socially motivated killings are the factors that influence the killing of lions. Our findings are in contrast with a report by Hazzah *et al.* (2017) which suggest that the attitudes of the Maasai toward lions, followed by socially motivated killings are the best predictors of actual lion killings.

Conclusion and recommendations

Our findings showed that tolerance for the conservation of lions in the communal land in the core zone is extremely low. This suggests that enhanced conservation efforts by different stakeholders are needed in the Maasai steppe ecosystem. The current format of consolation scheme and conservation benefit-sharing is what the locals negatively perceive. This indicates that there is a need for wildlife conservation authorities and the government in general to review wildlife policy and put more emphasis on the welfare of the locals who live adjacent to the protected areas. Furthermore, there is need to embrace lion-friendly livestock management by promoting wildlife tourism to the Maasai traditional ranching economy. This could help Maasai come to value lions for perceived tourism value. It has been found elsewhere that community conservancies that provide direct financial benefits to individual Maasai via tourism resulted in an increase in lion numbers (Blackburn *et al.*, 2016).

There is also a need for an intensive lion conservation education and awareness across all the age groups among the residents. Inadequate education among the local people was the (strongest indicator in attitudes toward lion conservation and the current management scheme - something like that?) in the current management of lions. Thus, awareness and sensitization programs on conservation of lions would be very important for human-lion coexistence in the study area. Since anthropogenic mortalities were

found to threaten the existence of lion populations in the protected areas, there is a need for wildlife management authorities to pay attention to the determinants of lion killings. Emphasis should focus on educating people about the value of wildlife and their habitats, the consequences of habitat destruction and ways of mitigating the problem.

Wildlife policy and land use policy could be reviewed and harmonized for smooth management of wildlife species in the protected areas, especially because humans dominate 90% of the landscape while only 10% is in protected areas such as National Parks. Future research should investigate whether changes of lifestyle and livelihood of the Maasai community cause resistance to conservation efforts. Research should clarify whether local people dislike the idea of conservation because it affects their lifestyle and livelihood and perceive killing wildlife as a way of sustaining these lifestyle and livelihood practices.

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Conflict of interest

The authors declare no conflict of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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