

*Full Length Research Paper*

# **Attacks on humans and retaliatory killing of wild carnivores in the eastern Serengeti Ecosystem, Tanzania**

**Franco P. Mbise**

Department of Biology, College of Natural and Mathematical Sciences, University of Dodoma, P. O. Box 338, Dodoma, Tanzania.

Received 14 July, 2021; Accepted 27 September, 2021

**Attacks on humans by wild carnivores are a serious problem, especially where communities and carnivores share the same landscape. When people are injured or killed, community members commonly retaliate by killing the carnivores. Awareness of how to minimize the risk of attacks is important and dependent on an understanding of the circumstances surrounding previous attacks and communicating them back to society. A total of 180 households were randomly selected from both the Maasai and Sonjo tribes. Findings from this study are based on the reported incidences among the Maasai and the Sonjo tribes living in the eastern Serengeti. Because the Maasai tribe lives close to the Serengeti National Park, they reported a higher frequency of human attacks than the Sonjo tribe over the last 50 years. Most of the human attacks occurred in the wet season during the daytime while herding livestock. Young males from both tribes responsible for herding livestock were more vulnerable to attack by wild carnivores. Lions (*Panthera leo*) were responsible for most of the reported human attacks, followed by leopards (*Panthera pardus*) and spotted hyenas (*Crocuta crocuta*). Currently, the trend in human attacks by carnivores is decreasing in both tribes. It was also established that in many incidences, carnivores escaped after attacking humans. Retaliatory killings for lions were most common among the Maasai, while retaliatory killings for hyenas were most common among the Sonjo. Factors associated with these retaliatory killings were as follows: both lions and hyenas feeding on a carcass, lions being fearless of humans, hyenas being frequently seen, and hyena's tendency to run and look back. These findings provide insight into the circumstances surrounding human attacks in the eastern Serengeti and the fate of these carnivores.**

**Key words:** Attacks, injured, humans, killed, retaliatory killing, wild carnivore.

## **INTRODUCTION**

Globally, attack on humans is a shocking phenomenon as it can lead to serious injuries and/or loss of human life (Löe and Røskaft, 2004; Packer et al., 2005; Quigley and

Herrero, 2005; Thirgood et al., 2005; Gurung et al., 2008; Nyhus, 2010; Penteriani et al., 2016). Attacks on humans by wild carnivores exacerbate frustrations following

E-mail: [francombise@gmail.com](mailto:francombise@gmail.com).

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livestock depredation and may persist for a long time after the event (Löe and Røskaft, 2004; Quigley and Herrero, 2005; Thirgood et al., 2005; Røskaft et al., 2007). Human attacks provoke a strong response and are rarely tolerated by communities, who may call for immediate measures to address the problem animals (Packer et al., 2005; Gurung et al., 2008; Ikanda and Packer, 2008; Penteriani et al., 2016).

Application of different measures that are more applicable and relevant to people on the ground can reduce human attacks incidences (Löe and Røskaft, 2004; Nyhus, 2010), and governments are frequently willing to support such initiatives (Nyhus, 2010; Okello et al., 2014). However, understanding the timing and circumstances surrounding human attacks and/or mortalities will assist in the development of implementable strategies to reduce the likelihood of attacks (Löe and Røskaft, 2004; Packer et al., 2005; Kissui, 2008; Penteriani et al., 2016). Communities living with wild carnivores should be educated on how to reduce human-carnivore encounters and how to behave upon such encounters, especially when sharing the same landscape with these species (Löe and Røskaft, 2004; Woodroffe et al., 2005; Penteriani et al., 2016). According to the Wildlife Conservation Act of Tanzania, it is illegal to kill wildlife unless it is necessary (MNRT, 2013). Therefore, local communities are expected to report any human attack to the wildlife authority as soon as human attack occurs. Responsible authorities can either relocate problem animals to other areas or kill them. While the Tanzanian government has devoted much effort to promote tourism (Turner, 2015), it has failed to solve local problems related to wildlife (Vedeld et al., 2012).

Due to human population growth, development and technological advancements, wild carnivore populations are threatened and have been severely reduced worldwide (Nyhus, 2010). Human population expansion adjacent to African protected areas has led to carnivore habitats being destroyed and decline in prey abundance (Mbise et al., 2020). Here, carnivores encounter humans in anthropogenically modified landscapes, which may lead to human attacks and/or deaths (Löe and Røskaft, 2004; Ikanda and Packer, 2008; Penteriani et al., 2016; Pooley et al., 2017). Consequently, conflict escalates and eventually leads to retaliatory killing of carnivores (Packer et al., 2005; Ikanda and Packer, 2008). Thus, a proper management structure and policy to conserve wild carnivores is urgently needed (Pooley et al., 2017).

Retaliatory killing is a major threat facing wild carnivores worldwide (Treves and Karanth, 2003; Ray et al., 2005; Zimmermann et al., 2005; Ripple et al., 2014) and urgent intervention is needed at local levels (Kissui, 2008). For example, in Kenya, lion populations are declining because lions are frequently killed by local people co-existing with these species (Dickman, 2017). The retaliatory killing of carnivores can be accomplished either directly (e.g., spearing) or indirectly (e.g.,

poisoning) (Hazzah, 2006). Improving carnivore management is necessary because of their important ecological and economic role (Treves and Karanth, 2003).

In the areas where people and predators share the same landscape (Mbise et al., 2020), it is imperative to understand and assess the circumstances surrounding human attacks and what should be done to reduce human-carnivore encounters (Löe and Røskaft, 2004). Reducing human-attack incidences will foster a better co-existence between people and carnivores, which will ultimately reduce the carnivore's persecution. The study hypothesized the following: (1) More human attacks will occur on Maasai land than on Sonjo land because the Maasai will encounter a higher number of carnivores from Serengeti National Park (SNP). (2) Most human attacks will occur while herding livestock because herders sometimes lead livestock into areas of thick bush and forest seeking green pasture, which predisposes them to attacks. (3) Retaliatory killing of carnivores will be greater in the Sonjo areas than in the Maasai areas because of the more frequent use of poisons in the Sonjo community.

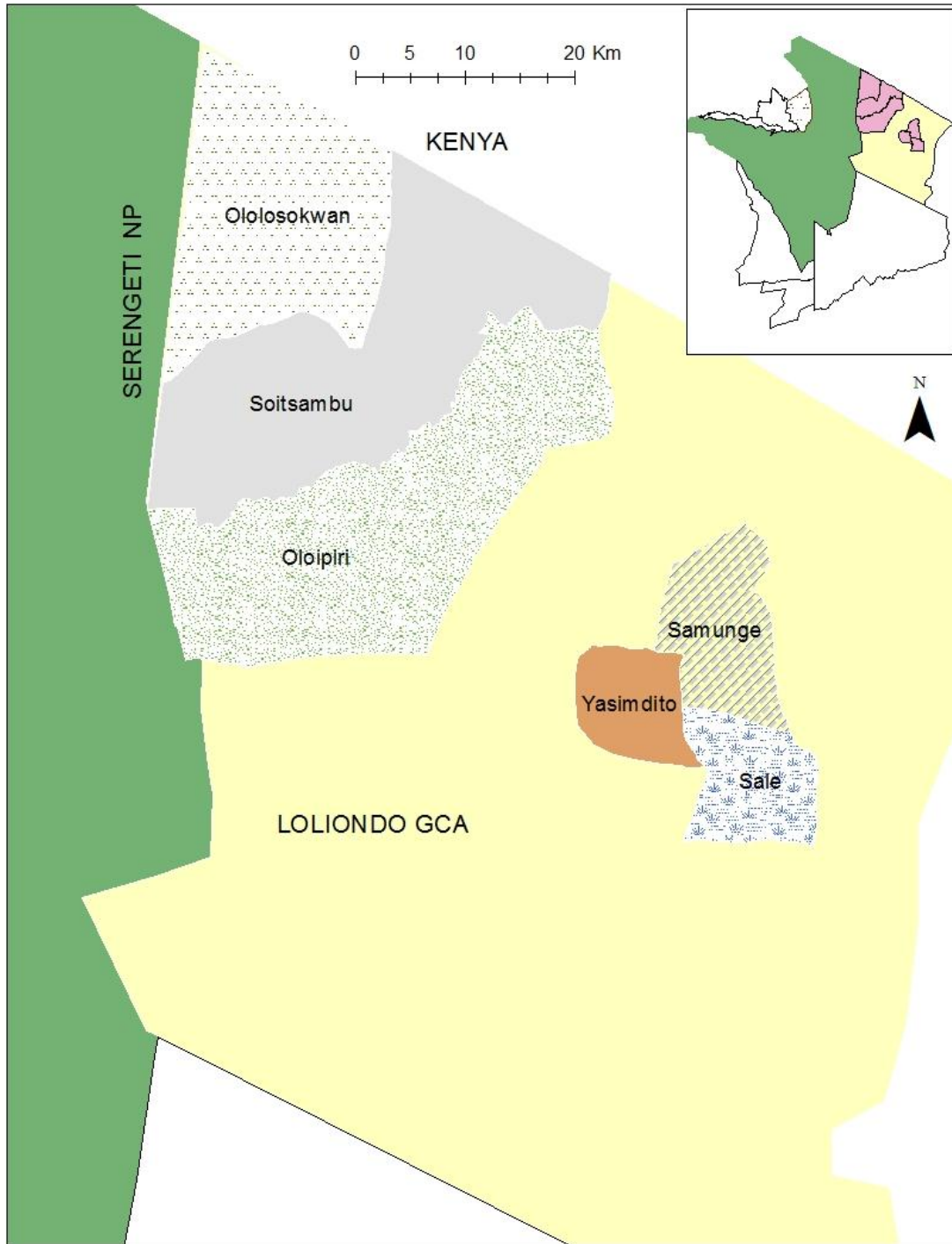
## METHODS

### Study area

The survey was conducted in the east of Serengeti National Park (SNP), in the Loliondo Game Controlled Area (LGCA) which lies between 1° 40' S and 2° 50' S and 35° 10' E and 35° 55' E (Figure 1). The main residents in the area consist of the Maasai and Sonjo tribes, and the population is increasing rapidly, leading to major habitat deterioration and change (Mbise et al., 2020). The human population in Ngorongoro district was 174,274 in 2012 and was projected to be 199,879 by 2017 (NBS, 2017). An increasing number of people and their associated activities will result in major habitat changes and compromise the future of wildlife species living in the area.

### Data collection

Respondents were randomly selected and sometimes were met in the field, village centres or while visiting friends. Thus, mapping the location of each participating household to make a distribution map was not realistic. A total of 180 respondents from the Maasai ( $n = 90$ ) and Sonjo ( $n = 90$ ) tribes were interviewed from September to November 2016. People were asked about any reported and/or witnessed human attacks by wild carnivores in the vicinity of the village and how the attack occurred. The criterion to explain how attack occurred enabled to differentiate all reported events and therefore to ensure that each event was independent of one another. It was difficult for many respondents to remember the attack year, so this was excluded from the analyses. Respondents older than 18 years of age were interviewed because they have a broader experience and provide reliable information. The ages of respondents ranged from 20-76 years old. Only eight respondents were older than 68 years of age. Findings were therefore based on human attacks occurring over the past 50 years. The age categories for attacked victims were as follows: children (< 18 years), youth (18–35 years), adults (36–49), or elders (> 50 years).



**Figure 1.** Map showing the villages included in this study in the eastern Serengeti ecosystem. Upper right; the green area is the Serengeti National Park and the pink area is the study area.

From each village, 30 respondents were interviewed. Therefore, in total we had 144 males and 36 females. The interview was administered in 6 villages, three from the Maasai tribe (Ololosokwan, Oloipiri, and Soitsambu) and three from the Sonjo tribe (Yasimdito, Samunge and Sale). Swahili, Maasai and Sonjo languages were used during interview, therefore, local translators were engaged to assist with the interview when vernacular

languages were used.

The survey had open-ended and closed-ended questions for comparison purposes and for acquiring more details that were not captured by specific questions. Information obtained from respondents was based on age category (youth, adult, elder), gender (male, female), tribe (Maasai, Sonjo), and education level (never been to school, primary school, secondary school). The key

**Table 1.** Numbers of attacks on humans in relation to the attack time, the activity that the victim was involved in, and the season.

Tribe	Attack time {No. (%)}		Activity {No. (%)}		Season {No. (%)}	
	Day	Night	Herding livestock	Other activities	Dry	Wet
Maasai	66(93)	5(7)	54(76.1)	17(23.9)	15(21.1)	56(78.9)
Sonjo	20(87)	3(13)	20(87)	3(13)	6(26.1)	17(73.9)

\*Other activities such as fetching water and searching for firewood and/or medicine

**Table 2.** Human attacks according to gender, age group and type of attack.

Tribe	Gender {No. (%)}		Age group {No. (%)}			Type of attack {No. (%)}	
	Male	Female	Children	Youth	Adult	No-fatal	Fatal
Maasai	64(90.1)	7(9.9)	0(0)	58(82.9)	12(17.1)	59(83.1)	12(16.9)
Sonjo	21(91.3)	2(8.7)	2(8.3)	14(58.3)	8(33.4)	20(87)	3(13)

questions were as follows: do you know anyone in this village who has been attacked (injured, killed) by wild carnivores? (yes, no), his/her age group? (child, youth, adult, elder), time of human attack? (day, night), where attack occurred? (home, pasture), what was the person doing? (herding livestock; other activities such as fetching water and searching for firewood and/or medicinal plants), human attack season? (wet, dry), carnivore species responsible for human attacks? (lion, leopard, hyena), carnivore's fate after the attack? (escaped or killed), and human attack and/or killing trend? (decreasing, stable or increasing). Furthermore, respondents were asked questions on factors associated with retaliatory killing and reasons behind the killing.

### Data analysis

Chi-squared and logistic regression analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 24 (IBM, 2016). Chi-squared tests were used to determine significant differences between the Maasai and the Sonjo tribes. Logistic regression analysis was used to determine the predictor variable explaining the variation in incidences of human attack. The test was performed to assess the variation in the reported human-attacks in the two areas, with one dependent variable being the response (yes, no) and five independent variables (attack time, tribe, victim activity, attack season, and where attack occurred) being used. The variable "where attack occurred" refers to human attacks events occurring in the pasture or around home.

## RESULTS

### Carnivore attacks on humans

Attacks on humans occurred more frequently during the day than at night in both tribes, but the differences between the two tribes were not statistically significant (Pearson  $\chi^2 = 0.804$ ,  $df = 1$ ,  $p = 0.370$ ; Table 1). Furthermore, carnivores attacked humans in the Maasai tribal area significantly more than in the Sonjo tribal area (Pearson  $\chi^2 = 51.301$ ,  $df = 1$ ,  $p < 0.0001$ ). Most human

attacks occurred while people were herding livestock rather than while performing other activities, and most of these human attacks occurred during the wet season, with no significant difference between the two tribes (activity; Pearson  $\chi^2 = 1.232$ ,  $df = 1$ ,  $p = 0.267$ ; season; Pearson  $\chi^2 = 0.246$ ,  $df = 1$ ,  $p = 0.620$ ; Table 1).

More males were attacked than females, and the number of attacked individuals in the Maasai tribal area did not differ significantly from those in the Sonjo tribal area (Pearson  $\chi^2 = 0.027$ ,  $df = 1$ ,  $p = 0.87$ ; Table 2). More youths than children or adults were attacked by wild carnivores, and the attack rates of different age groups differed between the two areas (Pearson  $\chi^2 = 6.63$ ,  $df = 2$ ,  $p = 0.036$ ; Table 2). More people were injured when attacked by wild carnivores than killed, and these frequencies differed significantly between the two areas (Pearson  $\chi^2 = 51.44$ ,  $df = 1$ ,  $p < 0.0001$ ; Table 2).

Almost all variables (attack time;  $B = 8.499$ , Wald  $\chi^2 = 9.260$ ,  $df = 1$ ,  $p = 0.002$ ; tribe,  $B = -14.971$ , Wald  $\chi^2 = 8.933$ ,  $df = 1$ ,  $p = 0.003$ ; victim activity;  $B = 3.232$ , Wald  $\chi^2 = 7.712$ ,  $df = 1$ ,  $p = 0.005$ ) were significant in explaining the variation on human attack incidences. Attack season was almost statistically significant ( $B = -5.579$ , Wald  $\chi^2 = 3.638$ ,  $df = 1$ ,  $p = 0.056$ ). Finally, the variable "where attack occurred" was not statistically significant in explaining the variation in human-attack incidences.

### Wild carnivores

Overall, lions (*Panthera leo*) caused most of the human attacks, followed by leopards (*Panthera pardus*) and spotted hyenas (*Crocuta crocuta*). However, leopard attacks were more common in the Sonjo tribe than in the Maasai tribe (Table 3). The attack rates by the three wild carnivores (lions, leopards, hyenas) differed significantly

**Table 3.** Attack trends and predators responsible for human attacks in the Maasai and Sonjo tribes.

Tribe	Responsible carnivore {No. (%)}			Attack trend {No. (%)}		
	Lion	Leopard	Spotted hyena	Increasing	Stable	Decreasing
Maasai	55(77.5)	9(12.7)	7(9.8)	11(15.5)	12(16.9)	48(67.6)
Sonjo	2(8.7)	17(73.9)	4(17.4)	0(0)	0(0)	23(100)

**Table 4.** Retaliatory killing and reasons behind the killing.

Tribe	Killing responses -lion {No. (%)}		Killing responses-spotted hyena {No. (%)}		Reason for killing-lion {No. (%)}		Reasons for killing-spotted hyena {No. (%)}		
	Yes	No	Yes	No	Feeding on carcass	Fearless	Seen frequently	Run and look back	Feeding on carcass
Maasai	33(36.7)	57(63.3)	33(36.7)	57(63.3)	3(9.1)	30(90.9)	15(45.5)	10(30.3)	8(24.2)
Sonjo	3(3.3)	87(96.7)	50(55.6)	40(44.4)	1(25)	2(75)	15(30)	5(10)	30(60)

\*Fearless – never run when they see humans.

between the two tribes (Pearson  $\chi^2 = 11.04$ ,  $df = 2$ ,  $p = 0.004$ ; Table 3).

The attack rates by lions and leopards differed significantly between the two tribes ( $p < 0.0001$ ), while the attack rates by hyenas did not differ significantly between the two tribes ( $p = 0.3173$ ; Table 3). Although both tribes claimed that the attack rates are decreasing, a significantly higher frequency of Maasai claimed that they were stable or increasing (Pearson  $\chi^2 = 9.86$ ,  $df = 2$ ,  $p = 0.007$ ; Table 3).

### Retaliatory killing of wild carnivores

Most of those carnivores reported to attack and/or kill humans escaped afterwards; however, the difference was not statistically significant between the two tribes (Pearson  $\chi^2 = 0.36$ ,  $df = 1$ ,  $p = 0.55$ ). In both the Maasai and the Sonjo tribes, perception of respondents seemed not to be very eager to kill carnivores once they threatened and/or killed humans in their area, although the number of “yes” responses between the two tribes differed significantly (Pearson  $\chi^2 = 24.33$ ,  $df = 3$ ,  $p < 0.0001$ ; Table 4). Retaliatory killing of lions was most common among the Maasai, while retaliatory killing of hyenas was most common among the Sonjo (Table 4) (lions Pearson  $\chi^2 = 31.25$ ,  $df = 1$ ,  $p < 0.0001$ , hyenas Pearson  $\chi^2 = 6.46$ ,  $df = 1$ ,  $p = 0.01$ ). Factors associated with these retaliatory killings were as follows: both lions and hyenas feeding on a carcass, lions being fearless of humans, hyenas being frequently seen, hyena’s tendency to run and look back.

The reason for killing hyenas was significantly different between the two tribes (Pearson  $\chi^2 = 11.4$ ,  $df = 2$ ,  $p = 0.003$ ; Table 4), while for lions, the difference in reasons was not significant (Pearson  $\chi^2 = 1.64$ ,  $df = 1$ ,  $p = 0.201$ ; Table 4).

## DISCUSSION

This study reveals incidences of human attacks that have never been reported in the eastern Serengeti and provides insights into how such attacks occur and the characteristics of these attacks, including the time, season, people prone to these attacks, and the fate of these carnivores after attacking humans. Proximity to the park (Maasai) showed a higher rate of human attack than living further away (Sonjo) due to a higher number of carnivores coming from Serengeti National Park. Understanding the circumstances surrounding human attacks will provide insight into how to reduce such attacks. Awareness of how to reduce human-carnivore encounters and how to behave when such encounters occur will help the communities co-existing with carnivores avoid attacks that lead to serious injuries or death. Lions, leopards, and spotted hyenas were the main predators responsible for human attacks. Most of these attacks occurred in the wet season during the daytime while people were herding their livestock as opposed to doing other activities. Herding livestock is the responsibility of young males according to these tribes’ order of duties, and young males were in fact more susceptible to these attacks, as they sometimes pass through the risky habitats preferred by predators when searching for green pasture.

### Carnivore attacks on humans

As found by Packer et al. (2005), human attacks occurred most frequently on males in both tribes because men are likely to do more outdoor activities, are more eager to kill carnivores and walk at night. More human attacks occurred in the Maasai community than in the Sonjo community most likely because the Maasai live closer to

the Serengeti, which has a higher number of carnivores. Once human attacks occur, it is common for villagers to kill the responsible carnivore. In this study, those carnivores were normally lions, leopards and hyenas. There is a long history of wild carnivores attacking humans (Thirgood et al., 2005; Inskip and Zimmermann, 2009), and when such occur, they receive great attention and bring fear to the community (Røskoft et al., 2003; Thirgood et al., 2005; Nyhus, 2010). Attacks on humans typically occur in landscapes where humans and carnivores interact. As a result, promoting coexistence between humans and carnivores is the best approach to solving this problem; otherwise extinction will be the likely fate for many carnivore species around the world (Brantingham, 1998; Woodroffe et al., 2005; Nyhus, 2010).

Young people are responsible for herding livestock far from their home and sometimes look after livestock in risky areas (bushes and forests), which increases the risk of attack by wild carnivores. Once a herder notices the presence of a carnivore while herding livestock, they defend their livestock and/or try to scare away the carnivores. This behaviour further increases the chance of being attacked. Most of the attacks occurred during the wet season perhaps because the grasses are taller, making it harder to detect carnivores. In most incidences, carnivores tended to escape after attacking people. In the Loliondo Game Controlled Area, where human and livestock population is increasing at higher rates, the number of wild carnivores has declined in recent years (Mbise et al., 2018, 2020). As a result, the reported number of human attacks in the Maasai and the Sonjo communities has decreased compared to that in earlier years.

### Responsible wild carnivores and retaliatory killings

Lions, leopards, and hyenas were the only carnivore species reported to cause human attacks. Predators attacking humans is a rare phenomenon, and the reasons behind most of these attacks may be due to a depleted prey base, an inability to hunt, old age, or behaviour learned from their parents (Packer et al., 2005; Ikanda, 2009; Nyhus, 2010). For instance, in a recent lion attack that occurred in 2016 at Ololosokwan village, one of the respondents claimed that the lion who attacked him in the pasture while he was looking for a lost sheep was an old male. However, it was the stealthy behaviour of leopards that was responsible for more human attacks in the Sonjo tribe compared to lions and hyenas. Additionally, on Sonjo land, forests are common and represent ideal leopard habitat.

Spotted hyenas were at higher risk of being poisoned following an attack on people. Kissui (2008) found the same for communities living around Tarangire National Park, Tanzania. Lion killings were also common because

they do not fear people and appear during the day time (Kissui, 2008). This motivates locals to smear poison on carcasses, which ultimately kills lions and hyenas. The higher frequencies of retaliatory killing in the Sonjo tribe may contribute to a higher rate of carnivore decline in this area. The Maasai tribe, on the other hand, has a long history of coexistence with carnivores compared to the Sonjo tribe, although currently, their culture has started changing dramatically, which may threaten local carnivore populations. The Sonjo tribe, more frequently preferred the use of arrows coated with a poison sap from the bark of the Mroda tree (*Acokanthera* spp.) (Anonymous, 2016). To protect wild carnivore populations, there is an urgent need to find mechanisms for coexistence between local communities and carnivores (Mbise and Røskoft, 2021; Rasmussen, 1999). Illegal killing of carnivores can be either direct or indirect. For instance, leopards commonly suspend their kill on a tree, and locals take advantage of this by sneaking towards the carrion and putting poison on it, thus indirectly killing it. Using dogs to chase and directly kill leopards is sometimes risky because leopards habitually climb trees and can attack when approached.

Efforts against the use of lethal control have so far been successful due to the ecological and economic benefits of wild carnivores (Treves and Karanth, 2003). However, there remains a great need to assess lethal methods that communities use to kill carnivores. Some killing techniques have serious effects on the carnivore population and the food web in general (Masenga et al., 2013; RCP, 2018). For instance, poisoning may target a specific carnivore species but result in the death of other untargeted animals such as vultures and other birds of prey (RCP, 2018). In conclusion, the two hypotheses out of three are supported by the study findings. Most reported human attacks occurred in the Maasai tribal area, and these attacks were more frequent while people were herding livestock than while doing other daily activities. However, retaliatory killings were most common in the Sonjo tribal area. The study recommends more effort to promote coexistence between carnivores and humans in this area, and zoning would be one of the alternatives to separate human activities from the preferred habitat of wild carnivores. Based on past incidences, more awareness of avoiding these human attacks should particularly be encouraged in herders.

### CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

### REFERENCES

- Brantingham PJ (1998). Hominid–carnivore coevolution and invasion of the predatory guild. *Anthropological Archaeology* 17(4):327-353.  
 Dickman A (2017). The biggest threat to African lions isn't trophy

- hunters, it's their lack of value to local people. *in* L. Butterfield, editor. Lion populations are at a tipping point. Oxford University, London.
- Gurung B, Smith JLD, McDougal C, Karki JB, Barlow A (2008). Factors associated with human-killing tigers in Chitwan National Park, Nepal. *Biological Conservation* 141(12):3069-3078. doi:10.1016/j.biocon.2008.09.013
- Hazzah L (2006). Living among lions (*Panthera leo*): Coexistence or killing? Community attitudes towards conservation initiatives and the motivations behind lion killing in Kenyan Maasailand. Master thesis in Conservation and sustainable development. Unpublished. University of Wisconsin-Madison pp. 1-110.
- IBM (2016). IBM SPSS Statistics for Windows, Version 24.0. IBM Corp, Armonk, NY, USA.
- Ikanda D (2009). Dimensions of a human-lion conflict: the ecology of human predation and persecution of African lions *Panthera leo* in Tanzania. Doctoral thesis at the Norwegian University of Science and Technology, Trondheim, Norway.
- Ikanda D, Packer C (2008). Ritual vs. retaliatory killing of African lions in the Ngorongoro Conservation Area, Tanzania. *Endangered Species Research* 6(1):67-74. doi:10.3354/esr00120
- Inskip C, Zimmermann A (2009). Human-felid conflict: a review of patterns and priorities worldwide. *Oryx* 43(1):18-34. doi:10.1017/S003060530899030X
- Kissui BM (2008). Livestock predation by lions, leopards, spotted hyenas, and their vulnerability to retaliatory killing in the Maasai steppe, Tanzania. *Animal Conservation* 11:422-432. doi:10.1111/j.1469-1795.2008.00199.x
- Løe J, Røskoft E (2004). Large Carnivores and Human Safety. *A Review. AMBIO* 33(6):283-288.
- Masenga EH, Lyamuya RD, Nyaki A, Kuya S, Jaco A, Kohi E, Mjingo EE, Fyumagwa RD, Røskoft E (2013). Strychnine poisoning in African wild dogs (*Lycaon pictus*) in Loliondo Game Controlled Area, Tanzania. *International Journal of Biodiversity and Conservation* 5(6):367-370. doi:10.5897/IJBC12.100
- Mbise FP, Røskoft E (2021). Can conservation incentives promote willingness to coexist with large carnivores in the eastern Serengeti ecosystem? *International Journal of Biodiversity and Conservation* 13(3):77-85. <https://doi.org/10.5897/IJBC2021.1490>
- Mbise FP, Jackson CR, Lyamuya R, Fyumagwa R, Ranke PS, Røskoft E (2020). Do carnivore surveys match reports of carnivore presence by pastoralists? A case of the eastern Serengeti ecosystem. *Global Ecology and Conservation* 24:e01324. <https://doi.org/10.1016/j.gecco.2020.e01324>
- Mbise FP, Skjærvø GR, Lyamuya RD, Fyumagwa RD, Jackson C, Holmern T, Røskoft E (2018). Livestock depredation by wild carnivores in the Eastern Serengeti Ecosystem, Tanzania. *International Journal of Biodiversity and Conservation* 10(3):122-130. <https://doi.org/10.5897/IJBC2017.1165>
- Ministry of Natural Resources and Tourism (MNRT) (2013). The Wildlife Conservation Act (Principal Legislation). Ministry of Natural Resources and Tourism, Tanzania.
- National Bureau of Statistics (NBS) (2017). Human Population trend by the National Bureau of Statistics. Dar es Salaam, Tanzania. Retrieved from: <https://www.nbs.go.tz/>.
- Nyhus PJ, Ronald T, Nyhus PJ, Dufraigne CE, Ambrogi MC, Hart SE, Carroll C, Tilson R (2010). *Panthera tigris vs Homo sapiens*: Conflict, Coexistence, or Extinction. pp. 125-141 *in* P. J. N. a. R. Tilson, editor. *Tigers of the World : The Science, Politics and Conservation of Panthera tigris*. Elsevier Burlington.
- Okello MM, Kiringe JW, Warinwa F (2014). Human-Carnivore Conflicts in Private Conservancy Lands of Elerai and Oltiyiani in Amboseli Area, Kenya. *Natural Resources* 5:375-391. doi:10.4236/nr.2014.58036
- Packer C, Ikanda D, Kissui B, Kushnir H (2005). Lion attacks on humans in Tanzania. *Nature* 436(7053):927-928. doi:10.1038/436791a
- Penteriani V, Delgado MdM, Pinchera F, Naves J, Fernández-Gil A, Kojola I, Härkönen S, Norberg H, Frank J, Fedriani JM, Sahlén V, Støen OG, Swenson JE, Wabakken P, Pellegrini M, Herrero S, López-Bao JV (2016). Human behaviour can trigger large carnivore attacks in developed countries. *Scientific Reports* 6:20552. doi:10.1038/srep20552
- Pooley S, Barua M, Beinart W, Dickman A, Holmes G, Lorimer J, Loveridge AJ, Macdonald DW, Marvin G, Redpath S, Sillero-Zubiri C, Zimmermann A, Milner-Gulland EJ (2017). An interdisciplinary review of current and future approaches to improving human predator relations. *Conservation Biology* 31:513-523. doi:10.1111/cobi.12859
- Quigley H, Herrero S (2005). Characterization and prevention of attacks on humans. Pages 27-48 *in* R. Woodroffe, S. Thirgood, and A. Rabinowitz, editors. *People and Wildlife: Conflict or Coexistence?* Cambridge University Press, New York.
- Rasmussen GSA (1999). Livestock predation by the painted hunting dog *Lycaon pictus* in a cattle ranching region of Zimbabwe: a case study. *Biological Conservation* 88(1):133-139. doi:10.1016/S0006-3207(98)00006-8
- Ray J, Hunter L, Zigouris J (2005). *Setting Conservation and Research Priorities for Larger African Carnivores*. New York Wildlife Conservation Society 216 p.
- Ruaha Carnivore Project, RCP (2018). Ruaha Carnivore Project: Deadly and depressing lions retaliation by pastoralists. Retrieved from: <https://www.ruahacarnivoreproject.com/>.
- Ripple WJ, Estes JA, Beschta RL, Wilmers CC, Ritchie EG, Hebblewhite M, Berger J, Elmhagen B, Letnic M, Nelson MP, Schmitz OJ, Smith DW, Wallach AD, Wirsing AJ (2014). Status and ecological effects of the world's largest carnivores. *Science* 343 p. doi:10.1126/science.1241484
- Røskoft E, Händel B, Bjerke T, Kaltenborn BP (2007). Human Attitudes Towards Large Carnivores in Norway. *Wildlife Biology* 13:172-185. doi:10.2981/0909-6396(2007)13[172:HATLCI]2.0.CO;2
- Røskoft E, Bjerke T, Kaltenborn B, Linnell JDC, Andersen R (2003). Patterns of self-reported fear towards large carnivores among the Norwegian public. *Evolution and Human Behavior* 24(3):184-198. doi:10.1016/S1090-5138(03)00011-4
- Thirgood S, Woodroffe R, Rabinowitz A (2005). The impact of human-wildlife conflict on human lives and livelihoods. Pages 13-26 *in* R. Woodroffe, S. Thirgood, and A. Rabinowitz, editors. *People and Wildlife: Conflict or Coexistence?* Cambridge University Press, New York.
- Treves A, Karanth KU (2003). Human-Carnivore Conflict and Perspectives on Carnivore Management Worldwide. *Conservation Biology* 17(6):1491-1499. doi:10.1111/j.1523-1739.2003.00059.x
- Turner R (2015). *Travel and Tourism economic impact 2015 Tanzania*. Pages 16-24. Harlequin Building, 65 South Street, London: Retrieved from: <https://www.wttc.org>.
- Vedeld P, Jumane A, Wapalila G, Songorwa A (2012). Protected areas, poverty and conflicts: A livelihood case study of Mikumi National Park, Tanzania. *Forest Policy and Economics* 21:20-31. doi:10.1016/j.forpol.2012.01.008
- Woodroffe R, Thirgood S, Rabinowitz A (2005). *People and Wildlife: Conflict or Coexistence?* Cambridge University Press, New York.
- Zimmermann A, Walpole MJ, Leader-Williams N (2005). Cattle ranchers' attitudes to conflicts with jaguar *Panthera onca* in the Pantanal of Brazil. *Oryx* 39(4):406-412. doi:10.1017/s0030605305000992.