LIVESTOCK PREDATION AROUND GUNA MOUNTAIN COMMUNITY CONSERVATION AREA, AMHARA REGION, ETHIOPIA

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ABSTRACT: Livestock predation by carnivores is an increasing conservation challenge for wildlife conservation in many developing countries. In this study, the livestock predation by predators in Guna Mountain Community Conservation Area (GMCCA) between September 2019 and August 2022 was determined. Data were collected from 287 households, spread across 14 villages on number of livestock predated, predators responsible for the kills and season of predation. The major predators and their contribution were, African wolf (*Canis lupus lupaster*), 75.7%), Spotted hyena (*Crocuta crocuta* (10.8%), Leopard (*Panthera pardus* (7.9%) and Serval cat (*Leptailurus serval* (5.6%). The most serious predator was African wolf, which mainly predated on sheep (88.2 %, N= 1796). Sheep were the dominant livestock affected by predators. The larger proportion of the livestock depredation occurred during the rainy season (76.69 %, N= 1819). The overall economic loss by predator attacks was estimated to be about 136 USD per household per year. African wolf contributed the largest proportion of the economic loss (70.83%). Livestock kills were not reported during the night from the underground shelter which was practiced by 89.2% of the households. The predation rate decreases with increasing distance from the boundaries of the GMCCA, and villages with the closest distance to the protected area lost more livestock. In prevention of the African wolf predation, developing the grazing land management will greatly minimize the economic loss. The underground shelter of livestock was found to be effective technique which could be implemented in other highlands of Ethiopia as well.

Keywords: Carnivore; Economic loss, Human carnivore conflict; Livestock depredation, Predation

INTRODUCTION

Humans and wildlife have coexisted for centuries. The trend however is disrupted following the exponential growth of human population. As human population increases, more and more land which was previously inhabited by wildlife was taken by human settlement and agriculture which in turn intensify the human wildlife conflict (Kolowski and Holekamp, 2006). While livestock predation by carnivores is a conservation challenge at global scale, its economic impact is prominent in subsistent agropastoral communities in developing countries (Ogada et al., 2003; Woodroffe et al., 2005). The larger proportion of East African

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countries which are rich in biodiversity are mainly subsistent farmers combining livestock husbandry and farming (Salami et al., 2010). In the Ethiopian economy, agriculture is the largest sector accounting for over 50% of GDP and employing over 85% of the Labour force (Alemu et al., 2003).

The average income of Ethiopia, Kenya and Tanzania for instance is less than $5 per person per day (Andinet et al., 2015). A single sheep loss in such countries is loss of about $150 which makes the livestock predation costly and potentially affecting their survival (Narisha, 2015).

To safeguard the survival of wildlife species in the face of increasing human population, protected areas are established across African countries most of which are too small for carnivores which have large home range (Ogada et al., 2003; Patterson et al., 2004). Most protected areas do not have enough buffer zone from the livestock grazing land which makes carnivores to get in contact with livestock more frequently (Hayward and Kerley, 2005; Soh et al., 2014). The natural prey of the carnivores also declined as a result of anthropogenic reasons, which forces predator carnivore prey on livestock for their survival.

For sustainable biodiversity conservation effort, monitoring wildlife species and minimizing the human wildlife conflict, in particular livestock depredation is crucial. As many of the Ethiopian highlands, GMCCA is also home for several carnivore species that potentially predate on livestock. Regardless of this however, no study was carried out on the livestock predation prevalence in the area. Therefore, this study aims to determine the livestock depredation rate, its economic consequences and mitigation methods used by the local community in GMCCA.

MATERIALS AND METHODS

Study area

Guna Mountain Community Conservation area extends from $11^0$39’48.09’’ to $11^0$45’31.61’’E longitude and from $38^0$10’19.59’’ to $38^0$16’34.63’’N latitude. It is located in South Gondar zone; surrounded by three Woredas including Estie, Lay Gaynt and Guna Begemider, with 11 adjacent kebeles namely Arga-didim, Mokish and Soras from Guna begemider; Dera-Kefoye, Guna-Gedeba, Akabit and Titira-damot from Lay

Gaynt and Liwaye, Wuchiba-sanqua, Elet-dibana and Dat-Georgis from Estie Woreda. The community conservation area is located at a distance of 20 km from Debre Tabor in the south eastern direction and at a distance of 30km from Nefas Mewcha in the western direction (Figure 1). The elevation of the conservation area ranges from 3,441 to 4,113 masl and its total area is about 4615 hectares.

The major occupation in the selected woredas is agriculture and the main agricultural crops cultivated in the woreda include potato, wheat, barley and bean. Also, cattle, sheep, poultry and horses are the major livestock kept by the farmers (personal communication).

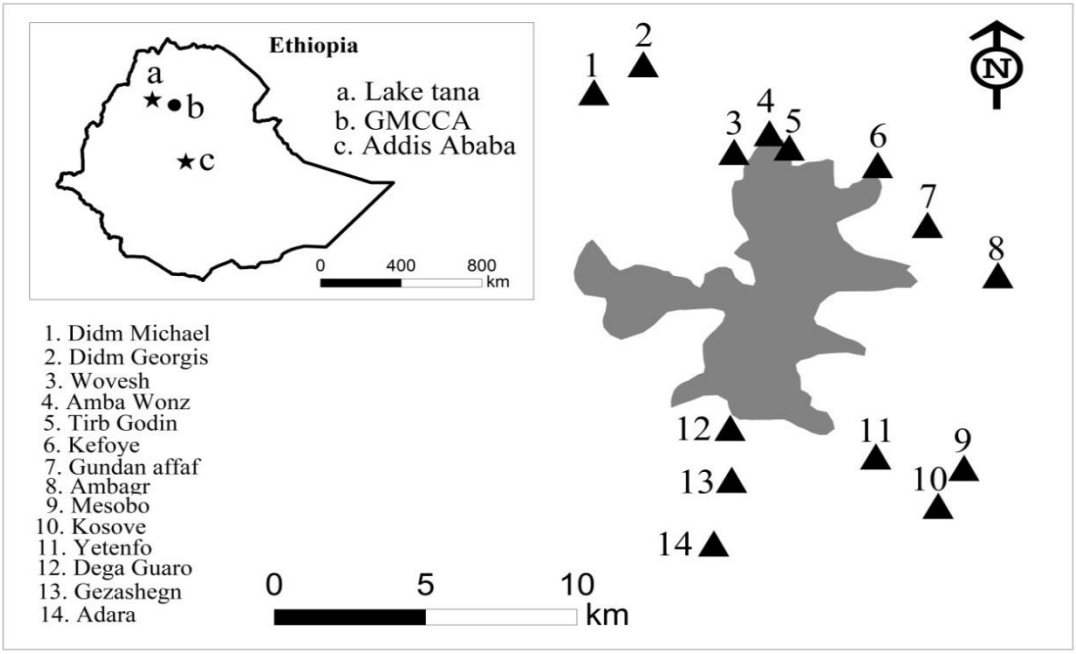

Figure 1. Map of Guna Mountain Community Conservation Areas including its surrounding villages.

The study was conducted between December 2021 and August 2022. All the 14 villages within 10 km distance from the buffer zone were mapped from GPS coordinate collected during the study. The villages were categorized in three zones on bases of their distance from the buffer zone of the protected area, very close (0 - 1 km), medium (1 –3 km) and far (> 4km) (Table 1) once their distance from the buffer zone is estimated from Arc Map 10.4.

Table 1. Villages found around GMCCA, their distance from the periphery, total number of households and sampled households from each village.

Distance	Villages	Total number of households	Sampled households
0 - 1 km	Amba Wonz, Tirb Godin, Dega Guaro, Kefoye and Wovesh	2032	101
1-3 km	Yetenfo, Gezashegn and Gundan Afaf	955	47
> 4 km	Didm Michael, Didm Georgis, Adara, Kosoye, Mesobo and Ambagr	2787	138
Total		5,774	287

The total number of households that was sampled in each village were determined using Kothari (1999). According to Kothari a sampling range of between 5-20% of total population in descriptive research is acceptable because it fulfills the requirement of efficiency, representativeness, reliability and flexibility. From the total households of 5,774, a total of 287 households were selected for semi structured interview randomly. The interview started from one end of the village and continued by skipping the next immediate household until about 5% of the households in each village was covered. During the questionnaire survey, each of the household was asked on the number and type of livestock they own, number and type of livestock predated between September 2019 and August 2022, responsible predator, how they identify the predator, season when the livestock was predated (rainy or dry), time of predation (day or night), where the livestock predation had occurred (during grazing or in shelter) and methods used to protect livestock predation.

The predator responsible for each of the killings reported by the local community was identified by the characteristic of the kill. For instance, leopards kill their prey with a bite to the throat; in contrast, spotted hyenas usually attack the base of stomach. African wolf attack livestock while they were grazing in the field, and the bite on the livestock is on a random part of its body.

Data analysis

The differences in predation among the villages were compared using one-way ANOVA using Statistical Package for Social Sciences (SPSS) version 23. Pearson Correlation was used to test the relation between

distance of study village from edge of protected area and the occurred loss of domestic animal. Chi- square test was used to determine whether there is a relationship between the number of livestock killed per predator, season and time of predation. To estimate the economic loss from the livestock predation, the values of livestock loss was estimated based on the local market averaging 20 animals from each livestock, and convert the value to USD using the exchange rate of 1 USD to 54.3 ETB (official exchange rate for the year 2022).

The total loss was determined as a monetary value, losses due to predation can be calculated as:

$C = L\ x\ P$ where,

C= stands for total direct losses incurred by livestock producers,

L= total number of livestock lost due to predation per year,

P= Monetary value allocated per head to livestock lost

RESULTS

Abundance of livestock

A total of 4546 domestic animals were reported in the study area including cattle, sheep, goat, horse, mule, donkey, poultry and dog (Table 2), of which 2,372 domestic animals were reported to be predated by African wolf (75.7%), Spotted hyena (10.8%), Leopard (7.9%) and Serval cat (5.6%) during the study period.

Table 2. Livestock predation by wild carnivores relative to the abundance of livestock in 2022 around GMCCA.

Domestic animal	No.	No. predated	% predated
Cattle	861	0	0
Sheep	1841	858	67.1
Goat	111	72	5.6
Horse	409	67	5.2
Mule	296	2	0.2
Donkey	106	5	0.4
Poultry	658	274	21.4
Dog	264	36	2.8
Total	4546	1278	100

The most serious predator, African wolf, mainly predated on sheep (88.2 %, N= 1796). Hyena predate on diverse livestock types mainly on horse (39.6%), sheep (29.8%), mule (1.96%) and donkey (1.96%), N= 255). Leopard predates exclusively on goat (45.4%) and sheep (54.6%, N= 187) while serval cat exclusively predates on poultry (22.26% n = 134) (Table 3).

Table 3. Livestock predation prevalence between September, 2019 and August, 2022 in GMCCA.

Livestock	Season		Total loss	Loss per household	African wolf	Spotted Hyena	Leopard	Serval cat
	Wet	Dry						
Sheep	1103	403	1506	5.25	1328	76	102	0
Goat	72	13	85	0.3	0	0	85	0
Horse	101		101	0.35	0	101	0	0
Mule	5	0	5	0.01	0	5	0	0
Donkey	5	0	5	0.01	0	5	0	0
Poultry	465	137	602	2.1	468	0	0	134
Dog	68		68	0.24	0	68	0	0
Total	1819	553	2372	8.26	1796	255	187	134

Time-based variations in livestock depredation

The time of the day for attacking on livestock varied among predators. Spotted hyenas were reported to attack livestock at the enclosures during the night time more often than when grazing (χ^2 = 164.80, df = 1, $p < 0.001$) which showed that there is a significant difference in time of predation. In contrast serval cat

predate more on poultry (N= 118) in the day time than the night which is significantly different at (χ^2 = 77.64, df = 1, p < 0.001). The attacks by African wolf (N = 1796) and leopard (N = 187) were reported to occur during the day in the grazing areas. Most of the incidents (89.63%, N=2126), of domestic animal depredation occurred during the day time while few (10.37%, N=246) occurred at night time (χ^2 = 1490.05, df = 1, P < 0.001) (Figure 2).

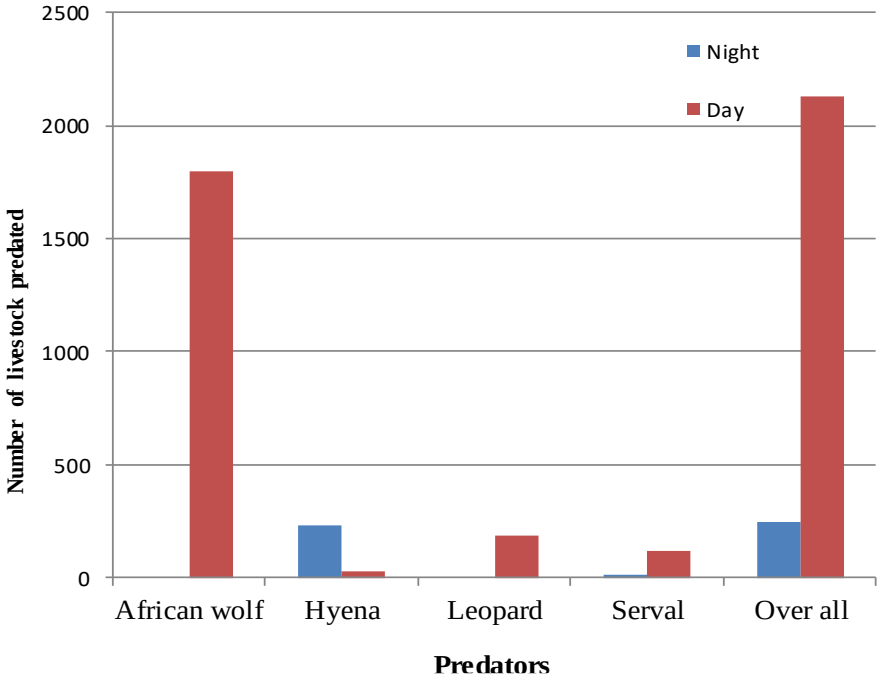

Figure 2. Number of livestock predation by different carnivore predation during the time of day and night in GMCCA.

Spatial patterns of livestock depredation

During the study period, the highest depredation levels were reported in Tirb Godin (418) and Amba Wonz (325) villages while slightly lower number of livestock loss were reported in Mesobo (35) and Adara (27) villages (Figure 3). The mean annual livestock loss as reported for all predators was three heads of stock per household per year. A leopard was reported to be the only predator of goats in Kefoye, Gundan Afaf, Ambagr and Yetenfo villages causing loss of 85 goats. The losses differed significantly with in villages (χ^2 = 16.51, df = 3, p = 0.001).

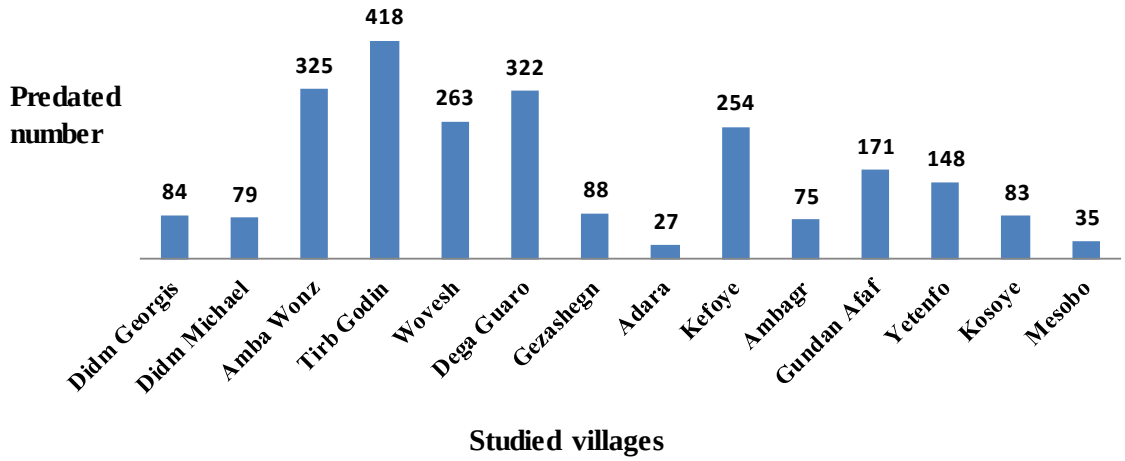

Figure 3. Total number of livestock predated in different villages around GMCCA.

Livestock predation intensity increased around the protected area relative to the distance. Distance to the protected area and the frequency of domestic animal loss by predators were negatively correlated (rho = -0.625, $p < 0.001$).

Seasonal patterns of livestock depredation

More than three quarters (76.69% N=1819) of reported attacks by all carnivore species occurred during the rainy season, while (23.3% N=553) were reported to have occurred in the dry season. It was significantly different at ($\chi^2 = 675.7$, df = 1, $P < 0.01$). African wolf, Hyena, Leopard and Serval were reported to attack livestock significantly more often in the rainy season than the dry season (African wolf $\chi^2 = 349.26$, df = 1, $p < 0.001$; Hyena: $\chi^2 = 251.02$, df = 1, $p < 0.001$; Serval: $\chi^2 = 25.1$, df = 1, $p < 0.001$; leopards: $\chi^2 = 138$, df = 1, $p < 0.001$ (Figure 4).

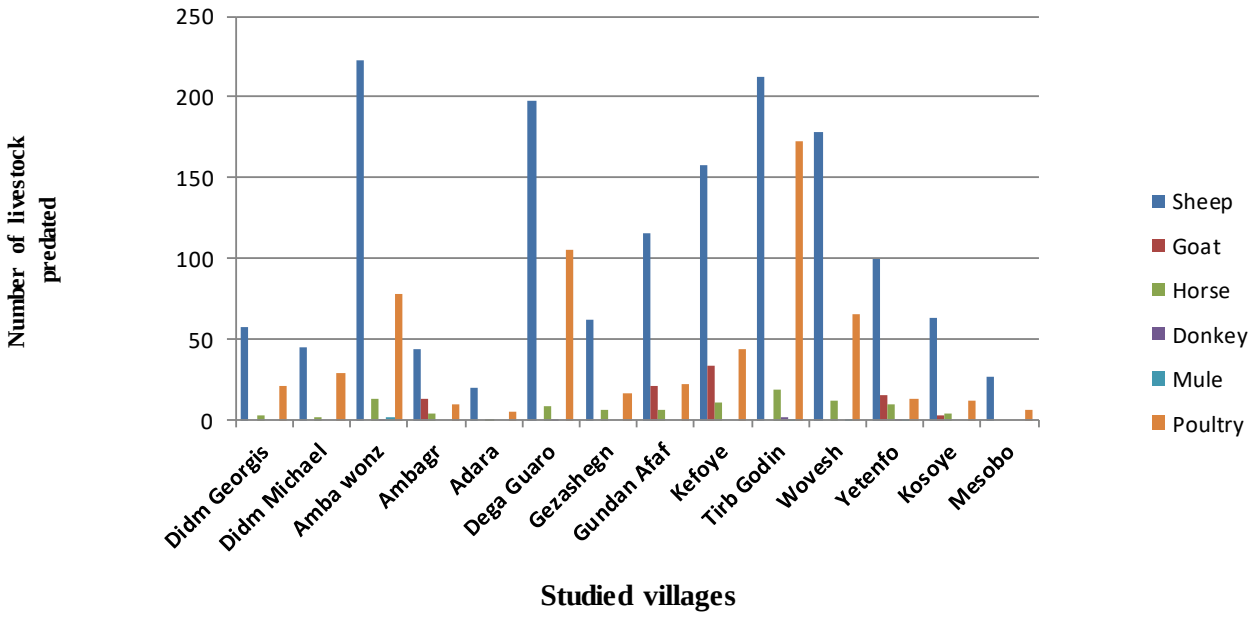

Figure 4. Number of livestock predated in different villages around GMCCA for the last three years

About 84.7% of the death of goats occurred during the rainy season and when the animals were herded in the field, while 15.3% of goat death occurred in the dry season. Similar trend was observed for sheep where about 73.24% of death of sheep occurred during the rainy season, while 26.76% occurred in dry season. Most losses (77.24%) of poultry occurred during rainy season, while 22.76% of it occurred in the dry season. Horses, donkeys and mules were attacked in the rainy season and no attack incidences were reported in the dry season.

Economic value of livestock loss

The economic revenue lost due to livestock predation in GMCCA over the three years was about $136 per household per year. Hyena was the cause for relatively small proportion of the kills (10.75%, N= 2372), however the economic loss was higher because it kills large and more expensive livestock species including horses, donkey and mule. The greatest proportion of livestock and financial losses were reported on sheep in proportion to their relative abundance ($90,557, N = 1506) (Table 4). There was a significant difference

in terms of financial valuation of livestock losses (χ^2 = 316,804.12 df = 5, p < 0.001, N= 2372) and in terms of financial impact among the predators (χ^2 = 136, 430.16, df = 3, p < 0.001).

Table 4. Potential revenue lost as a result of livestock predation around GMCCA.

Carnivore	Total		Sheep		Goat		Horse		Mule		Donkey		poultry	
	N	USD	N	USD	N	USD	N	USD	N	USD	N	USD	N	USD
African Wolf	1796	82,867	1328	79870									468	2997
Leopard	187	12,458	102	6135	85	6323								
Serval cat	134	858											134	858
Hyena	187	20,803	76	4570			101	13993	5	1795	5	445		
Total	2304	116986	1506	90575	85	6323	101	13993	5	1795	5	445	134	3855

Methods of livestock protection

Farmers used various methods to keep safe their domestic animals against predators during the night and the day time. These include using enclosures, guarding with dogs at night and guarding with herdsmen around the grazing field in the day time.

During night time, about 89.2% (N= 256) of the respondents kept all their livestock in underground shelter made up of stone and wood that cannot be easily penetrated by hyenas and leopards, while 2.4% of them kept their livestock in a grass hut. However, 8.4% (N=24) of them which kept their livestock in enclosures with thin walls. In addition, all of the respondents used dogs to guard the livestock during the night time. Underground shelter was reported to be the best preventive method of livestock predation by carnivores (Figure 5). There is a significant difference (χ^2 = 27.33 df = 1, p < 0.001) among the protection methods used (enclosure with thin walls, grass hut and underground shelter)

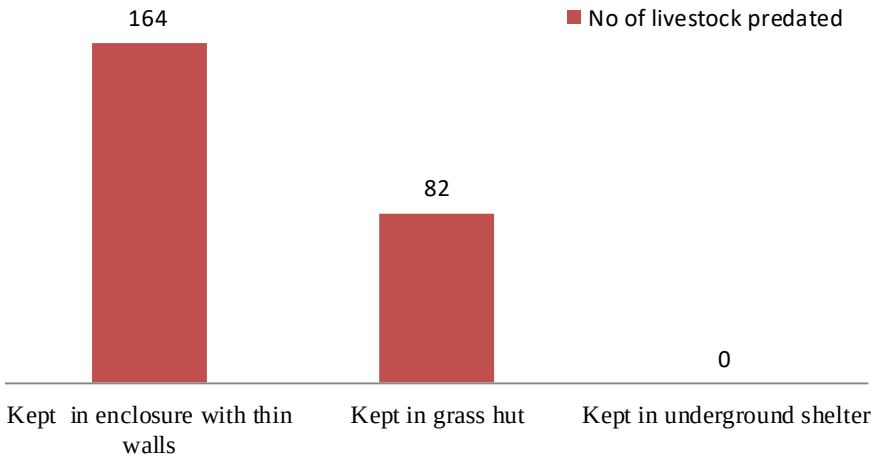

Figure 5. Number of predated livestock in the three preventive methods during the night time around GMCCA.

DISCUSSION

The community at GMCCA suffered from livestock predation as many of the Ethiopian highlands. Livestock loss per household per year was 2.8 in which sheep contributed the largest share (1.75 per household /per year). Similar findings were also reported in Guassa mountains of Ethiopia, where out of 0.66 livestock predated per household per year sheep contributed the largest proportion, 0.6 per household per year (Atickem et al., 2017). Also, in Bale mountain national park, 0.65 livestock were predated per household per year (Atickem et al., 2010).

The economic loss caused by livestock predation in GMCCA is $136 per household per year. Due to a very high inflation in Ethiopia, the price of livestock changed a lot during the last decade, and direct comparison of the loss across the Ethiopian highland studied at different periods is difficult. Earlier studies on other highlands reported $12 per household per year in Bale Mountain National Park (Atickem et al., 2010) and $33.6 per household per year Guassa Community Conservation Area (Atickem et al., 2017).

In some African countries, the loss by livestock predation is by far larger than the loss in Ethiopia. Muriuki (2013) in the Amboseli ecosystem in Kenya and Mkonyi et al., (2017) in the Tarangire ecosystem, Tanzania

reported that each household lost $1628.7 and $633 annually, respectively. A study conducted by Narisha, (2015) in Laisamis district, Kenya, reported that four animals killed from each household resulting in loss of $207 per household per year.

In the GMCCA, the most serious predator was African wolf causing two livestock loss per household per year ($96.24 loss per household per year). African wolf was also reported to be the most important predator in the other northern Ethiopian highlands, Guassa community conservation area where it was responsible for 74.6% livestock loss (492 total kills) contributing $19.8 per household per year (Atickem et al, 2017). Similarly, African wolf is the primary predator of sheep in Simien Mountain National Park causing the loss of 1.14 livestock per household per year (Mesele et al., 2009) and in Choke Mountain, central Ethiopian highlands, it resulted in loss of two livestock per household (Bezihalem et al., 2017).

The most predated livestock in GMCCA is sheep contributing 63.5 % of the total killed livestock. This is likely to be due to the high number of sheep in the study area and leaving sheep for grazing without any herder. The attacks mainly occur during the day in the grazing areas. Similar results were reported by earlier studies (Koirala et al., 2012, Khan et al., 2018). Also, in Marsabit District, Kenya, 90% of livestock predation occurred on grazing herds from 130 total livestock kills (Kruuk, 1981).

African wolf also feed on poultry in the GMCCA while this is not reported in other Ethiopian highlands (Atickem et al., 2010 and 2017; Mesele et al., 2009), but it was reported to kill poultry in Sodo Community Managed Conservation Forest (Yigrem et al., 2016).

Hyenas were reported to be responsible for all types of domestic animal depredation in GMCCA. While hyena kills lower number of livestock, it kills large and high value livestock such as horse, mule and donkey. Hyena is an important livestock killer Ethiopia and many other African countries. In the Web Valley area of Bale Mountains (Ethiopia) and Lake Nakuru National Park and Soysambu Conservancy (Kenya), hyena was identified as the most important predator resulting loss of $10 and $197.7 per household per year respectively (Atickem et al., 2010; Koskey, 2021). In Zimbabwe, hyenas were responsible for < 2%

domestic animal predation in the Kogwe communal area (Butler, 2000) whilst in Builimamangwe Communal Area; hyenas were reported to be the most prevalent livestock predator (Hawkes, 1991). Similarly, in Kenya, hyenas were reported to be responsible for <10% of the livestock depredation adjacent to Tsavo National Park and causing loss of $339 per year (Patterson et al., 2004), whereas they were reported to be responsible for 53% (74) of the predated livestock adjacent to the Maasai Mara National Reserve (Kolowski and Holekamp, 2006).

The third most important livestock predator in GMCCA is Leopards which depredated 85 goats and 102 sheep during the sty period. Most of the kills were in five villages close to church where leopard uses as a refuge. Other researches also reported goat as most vulnerable and frequently depredated livestock in Maasai steppe in Northern Tanzania by leopard (Kissu, 2008). In Bale Mountain national park leopards depredated 105 goats and 17 sheep in a three years period of time (Atickem et al., 2017).

The fourth predators in GMCCA is Serval cat which predated on poultry and causing relatively lower economic cost to the households due to the low price of poultry compared to other predated livestock. A study conducted by Yigrem et al. (2016) also identified serval cat as a predator that predated poultry in Sodo Community Managed Conservation Forest, Ethiopia.

Most incidents of livestock and poultry predation (89.63%) occurred during the day time in GMCCA. The attacks by African wolf were reported to occur during the day in the grazing areas while hyenas attack livestock during the night time. Similar findings were reported from areas where African wolf and hyena were identified as main predators (Kruuk, 1981; Atickem et al., 2010, 2017; Fulla, 2015; Narisha, 2015) Mkonyi et al., 2017). A different finding was reported from a study in Mandi district, India, where the highest number of killing (74.5%) occurred at night time (Sethi et al., 2011). This difference might be due to the differences in methods of herding, climatic condition, enclosure type and the type of predator involved.

The present study suggested that the distance of the villages from the protected area is an important factor in determining the extent of domestic animal depredation by wild animals. The results showed that the closest villages to the protected area experienced the highest frequencies of livestock depredation by the predators. This is because higher populations of carnivore species are found in the villages located close to the protected area (Holmern et al., 2007). As reported in many other studies (Kolowski and Holekamp, 2006; Sillero-Zubiri and Laurenson, 2001).

There are different livestock protection methods from predation in the studied villages. Most of the reported attack during the day time was associated with methods of herding system in villages surrounding GMCCA. Similar results were reported by, Alemayehu and Mathewos (2015), Atickem et al. (2010), Gidey and Bauer (2010). Thus, increasing the number of herders and adult people during main season of conflict is the most effective method (Ogada et al., 2003).

The study also showed that in the night time lower numbers of domestic animals were depredated. This is due to construction of underground shelter made up of stone and wood which reduced losses to carnivores. Similar result was reported in Menz Guassa Community Conservation Area, Ethiopia (Atickem et al., 2017). Therefore, constructing of underground shelter is very important to protect the predation of livestock at night time and will be valuable to reduce conflict (Butler, 2000). In addition, using a well-trained domestic dog is a good method to reduce depredation which alerts herders during the approach of carnivores (Dickman, 2009; Atickem et al., 2010).

CONCLUSION AND RECOMMENDATION

This study concluded that livestock predation by spotted hyena**,** African wolf and leopard causes more financial losses to the people living in and around GMCCA. African wolf killed livestock during the day time while sheep are at grazing fields, hence the critical measure in reducing the loss should focus on livestock management during grazing. The predation is in particular high in the rainy season and hence a better livestock management is required during this season. Livestock predation increased with deceasing

distance from the GMCCA which is expected as the area inhabits the larger proportion of the African wolf. Additionally, doing a buffer zone of the GMCCA may significantly reduce the loss due to livestock predation. Livestock predation by hyena is relatively low likely due to strong shelter built in the area which could be an important example to implement in other Ethiopian highlands where hyena predation is high. The livestock predation causes a substantial loss for the community of the GMCCA who have low income. Thus, identifying the fundamental drivers of the conflict and raising awareness on how to mitigate the problems could help in minimizing the losses caused by predators.

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