SINET: Ethiop. J. Sci., 47(3): 234-242, 2024 ISSN: 0379–2897 (PRINT)
 eISSN: 2520–7997

Date received: November 06, 2023; Date revised: September 12, 2024; Date accepted: September 31, 2024
DOI: https://dx.doi.org/10.4314/sinet.v47i3.5

The density estimates of carnivore and economic impacts of livestock predations in the rehabilitated Bilema Community Conservation Area, East Gojam Zone, Ethiopia

Misganaw Tamrat

Department of Zoological Sciences, Addis Ababa University, P.O.Box 1176, Addis Ababa, Ethiopia.
E-mail: tamratm15@gmail.com

ABSTRACT: Bilema Community Conserved Area (BCCA) has been under rehabilitation for the last three decades by the surrounding community, and carnivores could reoccupy it. Thus, this study aimed to assess the density estimate of carnivores and their livestock predation in and around BCCA. The call-up method was applied to estimate carnivore densities, and questionnaire surveys were conducted to estimate livestock predation in three villages surrounding BCCA. Spotted hyenas (*Crocuta Crocuta*) and black-backed jackals (*Lupulella mesomelas*) are livestock predators in BCCA. A density of 1.6 spotted hyenas and 0.36 black-backed jackals were recorded per one ha. Spotted hyenas attacked cattle, sheep, goats, and donkeys, while black-backed jackals predated sheep, goats, and poultry. About 5.4% of livestock owned by the respondents were predated by both carnivores from 2021–2023, and responsible for 36,796 USD in economic loss. Higher spotted hyenas' predation was recorded from the enclosure during the wet season, while black-backed jackals attacked mainly from the inside of BCCA during the dry season. In total, livestock predation strongly affects local communities' livelihoods around BCCA. Hence, for the sustainable coexistence of carnivores and local communities living around BCCA, proper compensation of the economic loss and appropriate conflict mitigation practices should be promoted and implemented.

Keywords/ phrases: black-backed jackal, domestic animal, predator, human-wildlife conflict, spotted hyena

INTRODUCTION

Human-wildlife conflict is a main conservation challenge in many parts of the tropics (Girma Eshte et al., 2018; Park, 2020). There are several factors that trigger the human–wildlife conflicts in most countries, which include increasing human populations (R⊘ skaft et al., 2007), loss of natural habitat (Park, 2020), and growing wildlife populations resulting in livestock predation (Birhanu Asaye et al., 2024; Deneke Yigrem et al., 2023) and crop raiding events (Anagaw Atickem et al., 2010). Human-wildlife conflict could be particularly serious in conserved areas where rural people live in close association (Misganaw Tamrat et al., 2020). These create conservation efforts are facing substantial challenges (Bezihalem Nibret et al., 2017). For instance, when carnivores kill livestock, people frequently retaliate against carnivores they perceive to be responsible for the losses, this in turn threatening the persistence of carnivore populations (Israel Sebsibe, 2022; Shilongo et al., 2018). At the same time, livestock predation strongly affects the quality of people's livelihoods (Eustace et al., 2018; Ladan, 2014).

Livestock predation receives higher attention where the conflict poses a serious threat to human welfare (Amaja et al., 2016; Eniang et al., 2011). It is now regarded as one of the main problems to successfully implement wildlife management (Menapace et al., 2023). Several studies have revealed that the intensity and economic loss due to livestock predation vary widely among areas. For instance, in Ethiopia there was a total of 29,207 USD loss in Senkele Swayne's Hartebeest Sanctuary due to livestock predation over a three-year period (Misganaw Tamrat et al., 2020). A total of 704 livestock were reported to have been killed by wild carnivores, mainly spotted hyenas (*Crocuta Crocuta*), leopards (*Panthera pardus*), and African wolves (*Canis lupaster*), in Bale Mountains National Park, southern Ethiopia, which caused an estimated 13,054 USD in economic losses (Anagaw Atickem et al., 2010). In Kenya, the three carnivores, namely lions (*Panthera leo*), spotted hyenas, and cheetahs (*Acynonyx jubatus*), were responsible for most of the predation of livestock (Patterson et al., 2004). Further in Israel, golden jackal (*Canis aureus*) predation accounted for the loss of 1.5–1.9% of the calves born each year in the local farm area, which resulting in

economic losses of ~42,000 USD per year (Yom-Tov et al., 1995).

Ideally, wildlife conservation aims for the sustainable coexistence of wildlife and the surrounding community, mainly using the protected areas (Amaja et al., 2016; Eniang et al., 2011). The Community Conserved Areas (CCAs) have also received international recognition as protected areas by the IUCN since most CCAs could have fulfilled the principles of protected areas given by the IUCN and the Convention on Biological Diversity (Kothari, 2012). They include designated indigenous protected areas or community reserves, and they also range across the entire definitions of IUCN protected area categories. CCAs have emerged as new development strategies in conservation and have significant potential to increase the global conserved area under special conservation status (Kothari, 2012).

According to the East Gojjam Zone Agricultural Office (EGZAO), Bilema Community Conservation Area (BCCA) is a community-based conserved area since 1996. It was severely degraded due to intensive human encroachments three decades ago. In BCCA, there are spotted hyenas, black-backed jackals (*Lupulella mesomelas*), and several herbivore and omnivore species, such as bohor reedbuck, bushbuck and primates. For effective implementation of the conservation program, assessing the carnivore's densities and the impacts of carnivore predation in relation to the economic loss has to be primarily conducted (Matseketsa et al., 2019; Matseketsa et al., 2019). However, there is no study yet that revealed the carnivore densities and the economic loss in relation to livestock predation in and around the BCCA. Hence, this study aimed to determine the: 1) density of livestock predators, 2) extent of livestock predation at varying distance intervals from the center of the BCCA i.e., extent and magnitude of conflict between carnivores and the surrounding community, and 3) quantify the economic losses to the local community received. I also describe traditional livestock-herding practices used in the BCCA area.

MATERIALS AND METHODS

Study area

Bilema Community Conservation Area (BCCA) is located at 37° 42' 93" E and 10° 19' 76" N (Fig 1), towards the western direction from Debre Markos town. It has 91 ha and is completely encircled by human settlements of three villages (namely, Daligaw, Demashesh, and Muaket) and farmlands. Daligaw encloses the area from the eastern and northern sides; Demashes surrounds the area from the western side but has 2 km distances in between, and Muaket is from the southern direction and is 1 km away from the boundary of BCCA. According to the EGZAO, there is an annual cycle of temperatures in BCCA that consists of a dry season extending from October to May and a heavy rainy (wet) season extending from June to September. It has a mean annual air temperature of 17.8°C, i.e., the dry season has an average temperature of 19.8°C while 15.7°C during the wet season. It has also received an average of 1062 mm of rain in a year for the last 15 years. The BCCA was established in 1996 primarily for the purpose of rehabilitation of the degraded common bushland area.

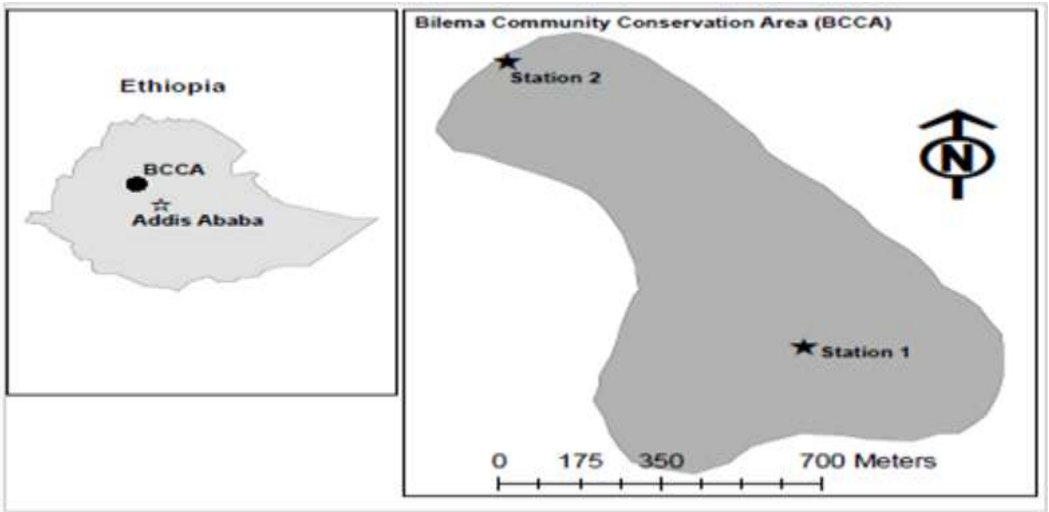

Figure 1. Bilema Community Conservation Area and the two stations used as calling points to estimate carnivore abundance.

According to the information from the EGZAO, the BCCA was degraded, and almost all of the wild animals were eliminated due to intensive human encroachment. There were free livestock grazing, collection of woods for charcoal and firewood, traditional house construction, and fencing their croplands. However, by the initiation of the Agricultural Office and strong commitment of the surrounding communities, the conservation activities of the area have been implemented for the last three decades. The area possesses a natural vegetation cover including large trees of *Ficus* species, *Acacia* trees, shrubs, bushland, and small grassland areas. Recently, following the conservation and rehabilitation of the area, various wild animals, such as spotted hyenas, black-backed jackals, a few leopards (*Panthera pardus*), several species of herbivores, and bird species, are harbouring.

People and livestock husbandry

The BCCA surrounding community mainly follows subsistence agro-pastoral activities as a source of income for their livelihoods. The three villages have administrative units consisting of widely dispersed houses with clear-cut borders to households belonging to other villages. The villages consist of subsistence farmers who complement their livelihoods to varying degrees with livestock keeping. One of the villages (Daligaw) is immediately adjacent to the BCCA. Livestock husbandry is commonly practiced in almost all households found in the three villages, with mixed-species herds of cattle, donkeys, horses, goats, sheep, and poultry. Livestock are usually taken out in the early morning (before 07:00 am) and returned during the night to enclosures before sunset. Grazing usually takes place where resources are available.

During the wet season, livestock graze close to the villages. However, during the dry season, since resources are limited, livestock frequently move to larger areas, including the BCCA, for foraging. Although illegal livestock grazing frequently takes place inside the BCCA, the pressure from Daligaw is higher from site observation during the study period. During the wet season, since farmlands are covered with crops, livestock are always herded by people, in most cases by adults but sometimes also by children. However, during the dry season, livestock are almost free grazing without herders. At night, livestock are kept inside the night enclosures (i.e., bomas), which are constructed by closely spaced vertical tree trunks and acacia bush (branches facing out). Goats and sheep are usually brought together in a separate small-stock hut that is relatively well constructed using poles and mud with grass roofing or metal plates. Similarly, poultries are kept in houses spaced separately constructed from tree poles and mud. In addition, most households keep dogs for guarding.

METHODS

Carnivore abundance

I used call-up methods to estimate carnivore abundance in BCCA. Two calling stations from the opposite side of the conservation area were established. The calling stations are 5 km far apart that it helped to avoid double counting. During the calls, we used audio files of gnu *Connochaetes gnou*-hyena distress, jackal, and hyena-jackal sounds. The calls were broadcasted using an MP3 player connected to a megaphone from the top of a vehicle at each station continuously at full volume. The megaphone was rotated 90° every five minutes during the broadcast. Each call consisted of two cycles of 20 min of playbacks and then 10 min of silence to identify and count the responding carnivores (Yirga Gidey et al., 2017). We also provided pieces of beef in a few meters distance from the vehicle to provide an olfactory signal (Misganaw Tamrat et al., 2020). Only spotted hyenas and black-backed jackals responded to the calls and meat olfaction. Immediately after the last broadcast, we counted the responding hyenas and black-backed jackals based on their unique vocalization patterns and eye reflection from the spotlight by four trained observers from each side of the vehicle using powerful torches that helped to identify the responding carnivores up to 20 m. The calls were repeated six times at each station following one-month intervals from June 2022 to January 202

The data were collected through a questionnaire survey and call-up methods between October 2023 and January 2024. Our survey encompassed 345 randomly chosen households from three villages (based on household lists and including an equal proportion from each sub-village) in the BCCA, located at different distances from the closest protected area (border); Daligaw (adjacent to the BCCA, <1000 m), Muaket (1001 m–3000 m) and Demashesh (>3000 m). The three villages had, according to village records, a total of 2,203

households (i.e., Daligaw 736, Muaket 549, and Demashesh 918), which means the survey canvassed 15.7% of the households. Interviews were conducted by six trained experts in interview techniques in the informant's home (the head of household or their wife), including the author of this paper. We asked each respondent about the number and type of livestock they owned. The respondents were also asked whether they had lost any livestock due to carnivore predation during the past three years (2021–2023). If they answered 'yes', the number and type(s) of livestock predated, season, year, time, place of predation, and the predator species were asked. The respondents identified the predators either by direct sighting, paw prints, or vocalization they heard when predators produced.

When the respondents reported livestock predation outside of their enclosures, its specific location relative to known physical features such as roads, trees, houses, and small valleys was asked. Based on this information, we recorded the GPS coordinates for each livestock predation location and categorized it in one-kilometre distance intervals (inside the BCCA, periphery–1000m, 1001–2000 m, 2001–3000 m, and >3000 m) across the four sides from the BCCA boundary. The average value of each livestock was calculated based on the prices of 15 individuals of each livestock variety at local markets. We also used colour plates as field guides during interviews to help distinguish carnivores.

Data analysis

During the survey, we collected the GPS location of each place of predation, and the distance to the closest BCCA border was calculated by using ArcView 9.0 (Environmental Systems Research Institute, Redlands, CA, USA). We also used Pearson $\chi 2$-tests to compare differences in the abundance of predators between the two calling stations, the number of reported livestock kills by each predator species, and the time of reported predations that occurred (day or night).

RESULTS

Community livelihood and livestock husbandry

From 345 respondents of the questionnaire survey, 97.4% (n = 336) were agriculturalists. Their primary source of income is traditional crop production and livestock keeping and practices. Additionally, some respondents, 22% (n = 76), supplemented their income through trading; 36% (n = 125) are also working as daily labourers in Debremarkos town, and only 2.6% (n = 9) are formal employees at different government institutes. In 2023, 92.8% (n = 320) of respondents kept a total of 22,126 livestock, with an average herd size of 64.1 head (43.1 ± SD) of stock per household. There was a variation among households in the number of livestock owned (range: 0–278), and 7.2% (n = 25) did not own livestock. The majority of the herd was composed of cattle (46.7%, n = 10329), followed by sheep (17.3%, n = 3826), and poultry (17.0%, n = 3758), while the rest were goats, donkeys, and horses (Table 1). All respondents reported that they kept their livestock in enclosures during the night.

Table 1. Mean composition of livestock herds per household in three surrounding villages of the BCCA, East Gojam Zone, Ethiopia (The number in parenthesis indicates percentage).

Villages	N	Cattle	Sheep	Goat	Donkey	Horse	Poultry	Mean
Daligaw	115	4013 (34.9)	1516 (13.2)	805 (7.0)	403 (3.5)	417 (3.6)	962 (8.4)	8116 (70.6)
Muaket	115	2100 (18.3)	1009 (8.8)	616 (5.4)	217 (1.9)	67 (0.6)	1615 (14.0)	5624 (48.9)
Demashesh	115	4216 (36.7)	1301 (11.3)	1112 (9.7)	317 (2.8)	259 (2.3)	1181 (10.3)	8386 (72.9)
Livestock per hh (sampled)		30.0	11.1	7.3	2.7	2.2	10.9	64.1
% of the total herd		46.70%	17.30%	11.40%	4.20%	3.4	17.00%	100

Carnivore abundance and predation on livestock

A density 1.6 of spotted hyenas and 0.36 of black-backed jackals were recorded per one ha of the conserved area. More hyenas responded at station 2 (on the periphery; n = 87) than at station 1 (in the center; n = 78) though this difference was not statistically significant ($\chi 2 = 0.490$, df = 1, p = 0.484). However, the abundance of black-backed jackals was significantly higher at station 2 (n = 30) than at station 1 (n = 9) ($\chi 2 = 11.308$, df = 1, $p < 0.001$).

In total, 5.4% of the livestock owned by the people interviewed for this study (n = 345) were reported to have been predated over a three-year period (2021-2023) by hyenas and black-backed jackals. Hyenas reportedly killed cattle, sheep, goats, and donkeys, whereas black-backed jackals killed goats, sheep, and poultry. There was no horse predation report in this study. The livestock loss is worth a local market value of 36,796 USD over the three-year period (n = 345 households). Thus, each household lost an estimated 35.6 USD per year to livestock predation (Table 2).

Table 2. Livestock predation by spotted hyenas and black-backed jackals around BCCA over a three-year period (2021–2023) (The number in parenthesis indicates percentage.)

Livestock	Total number	Number predated by hyenas	Number predated by black-backed jackals	Total livestock predated (%)	Costs per head in $	Total costs in $
Cattle	10329 (46.7)	478 (50.7)	0	4.6	41	19,598
Sheep	3826 (17.3)	237 (25.1)	100 (40.2)	8.8	23	7,751
Goats	2533 (11.4)	58 (6.2)	23 (9.2)	3.2	27	2,187
Donkey	937 (4.2)	170 (18.0)	0	18.1	43	6,630
Poultry	3758 (17.0)	0	126 (50.6)	3.4	5	630
Total	22,126	943	249	5.4		36,796

Spotted hyenas attempted significantly more livestock predation events than black-backed jackals ($\chi2 = 404.01$, df = 1, $p < 0.001$). Hyenas killed many livestock (n = 852) outside the BCCA, while black-backed jackals predated 96 outside the BCCA. Black-backed jackals predated goats and sheep mainly at the periphery of the BCCA, though they predated poultry in the settlements. Livestock predation occurred significantly more frequently during the night (n = 948) than during the day (n = 244) ($\chi2 = 415.28$, df = 1, $p < 0.001$) (Table 3).

Table 3. Livestock predation events by spotted hyenas and black-backed jackals across different time periods (day or night) and locations (inside Bilema, outside Bilema, and not within a livestock enclosure or/and within a livestock enclosure) in a three-year period (2021–2023) in BCCA.

Species	Locations			Time	
	Inside BCCA	Outside	Enclosure	Day	Night
Spotted hyena	121	352	470	72	871
Black-backed jackal	153	63	33	172	77
Total	274	415	503	244	948

Spotted hyena predation was most common in the wet season, whereas black-backed jackal predation was most common during the dry season (Fig. 2).

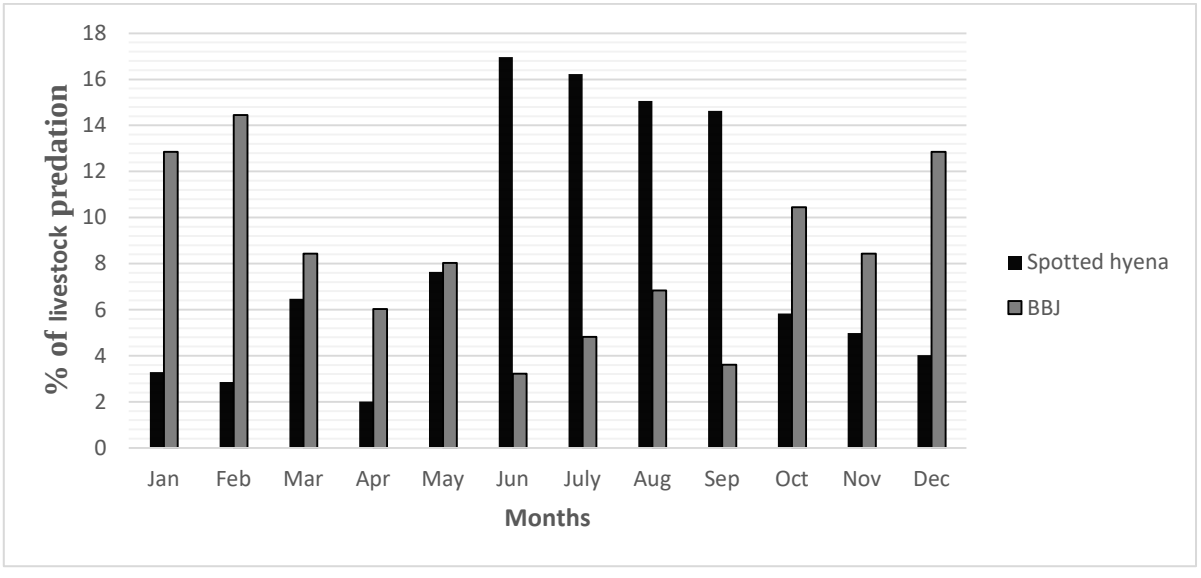

Figure 2. Percentage of total livestock predation carried out by spotted hyenas and black-backed jackals during each month over a three-year period (2021–2023) in BCCA, Ethiopia.

Spotted hyena predation exhibited significantly higher outside of the BCCA ($\chi2 = 388.55$, df = 1, $p < 0.001$) than inside of the conserved area. However, their predation patterns were nearly consistent across the 1000 m intervals out to 3000 m from the boarders of the BCCA. The black-backed jackal predations were not significantly different than ($\chi2 = 1.5429$, df = 1, $p > 0.05$) outside of the conserved area. However, a higher percentage of black-backed jackal predation was exhibited close to the boundary from inside (-500 m) of the conserved area (Fig. 3).

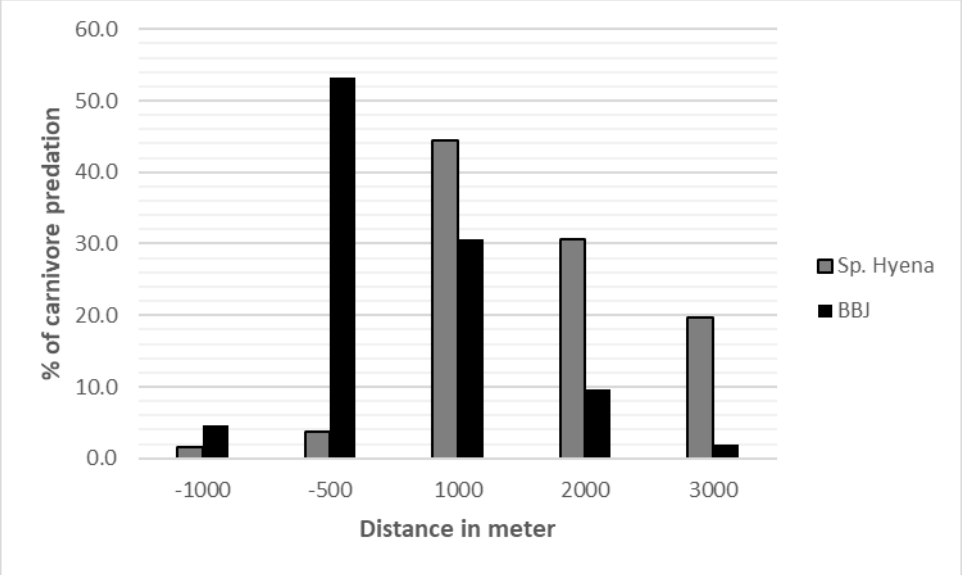

Figure 3. Spotted hyenas' and black-backed jackals' predation patterns on livestock at different distance intervals inside and outside of BCCA (Negative distance intervals refer to intervals from the border towards the center of the conserved area).

DISCUSSION

The study revealed a higher number of spotted hyena and black-backed jackal populations in the small-sized Bilema Community Conservation Area (BCCA). These two carnivores are well adapted to African ecosystems due to being very successful predators with a wide range of food preferences (Anthony and Wasambo, 2009; Gandiwa, 2011). They are also fast-invading carnivores in the rehabilitation process of degraded ecosystems (Tariku Mekonnen et al., 2019; Kolowski and Holekamp, 2006). The spotted hyena inhabits a wide historical range with a relatively high behavioural and ecological plasticity (Yirga Gidey and Bauer, 2010; Mihret Girmay et al., 2015). Hyenas and black-backed jackals are also the two major carnivore species identified in the study area, and both are involved in livestock predation. The study also revealed higher carnivore predation events in the three villages (Daligaw, Muaket, and Demashesh) that surround BCCA. Particularly, spotted hyenas were the most important predators of livestock in terms of the number and caused higher economic loss in the three villages. A total of 1,192 livestock were killed by the two carnivores in a three-year period, which has a 36,796 USD economic toll. Similarly, the livestock losses caused by the spotted hyena represented high economic concern for local communities in Southern Tigray (Yirga Gidey and Bauer, 2010) and Senkele Swayne's Hartebeest Sanctuary (Misganaw Tamrat et al., 2020). They are also major livestock predators at many other locations in Africa, including in the Maasai steppe, Tanzania (Kissui et al., 2019).

Spotted hyenas attempted to kill cattle, sheep, goats, and donkeys, while black-backed jackals mainly predated sheep, goats, and poultry. Livestock predation by these predators might be due to the attribution to livestock husbandry practices, depletion of natural prey, and proximity to human settlements. Hyenas have opportunistic feeding behaviour (Lyamuya et al., 2014; Makindi et al., 2014; Mbise et al., 2018), and they show a trend of regularly visiting human settlements that expose the livestock to hyenas' predation (Treves and Karanth, 2003; Yirga Gidey et al., 2014). Most hyena predation events were identified outside of the BCCA and in enclosures of the three villages surrounding the BCCA. Similar results were also observed in

Senkele Swayne's Hartebeest and Sanctuary (Misganaw Tamrat et al., 2020) and along the border of a Kenyan reserve (Kolowski and Holekamp, 2006). The predation events of hyenas inside the enclosures might be due to the week construction of enclosures for livestock from direct observation in the three villages surrounding the conserved area. From on-site observations, the majority of the enclosures were constructed from the wings of trees without roofs, which exposed livestock for easy predation. Although several studies evidenced that boma fortification in East African pastoralist communities can be an important conservation strategy for reducing livestock losses due to predation and used as a tool to promote human–carnivore coexistence (Yirga Gidey et al., 2013), this is not observed in surrounding villages of BCCA.

Hyenas' livestock predation in and around BCCA reached its highest level during the wet season (from June to September) of the study area, mostly at night, while black-backed jackal predation peaked during the dry season (December to February), mainly during the daytime. This is consistent with hyenas' predation, which attempted to predate a higher number of livestock around Senkele Swayne's Hartebeest Sanctuary during the wet season (Misganaw Tamrat et al., 2020). Similarly, the greater predation of livestock by jackals was revealed during the dry season around Senkele Swayne's Hartebeest Sanctuary is also consistent with the results of research on African wolf diets at Guassa Community Conservation Area, Ethiopia, where their main dietary preference was on rodents and used livestock as a dietary supplement in the dry season (Anagaw Atickem et al., 2017).

Predation events of black-backed jackals were highest close to the periphery from the inside borders of BCCA, while the number of livestock killed declined towards the center of the conserved area. Hyenas' predation around the conserved area exhibited consistent trends but showed a slight decline at 1000 m distance intervals out to 3000 m outside of the BCCA. Similar hyena predation trends were reported in the eastern Serengeti ecosystem, Tanzania (Nyhus, 2016; Treves et al., 2009) and at waste dumping sites in northern Ethiopia (Mihret Girmay et al., 2015). This might be because hyenas are opportunistic predators (Schiess-Meier et al., 2007) that make frequent visits to human settlements where they can find discarded foods and wastes (Yirga Gidey et al., 2013) and carry out opportunistic livestock attacks (Sogbohossou et al., 2011).

CONCLUSION

Restoring degraded habitats is the main activity of successful conservation efforts. Local communities have also played a crucial role in the rehabilitation of degraded and conserving wildlife habitats, as their livelihoods mostly depend on healthy ecosystems. When degraded ecosystems are rehabilitated, wildlife populations can recover and reoccupy their former habitats. BCCA is one of the community-based conservation initiatives established 30 years ago at which local residents participate in the protection and management of their previously degraded natural resources in the East Gojam Zone, Ethiopia. Almost all members of the local communities surrounding BCCA follow subsistence farming supported with livestock rearing. Livestock rearing is an integral part of the local pastoral and agricultural economy of the subsistence community in BCCA, and grazing of substantial herds is widespread in, and/or adjacent to, the conserved area. Spotted hyenas and black-backed jackals attacked a large number of livestock that were grazed in or close to the conserved area and from their enclosures, which causes huge economic loss. Such damage may create anger in the local communities of the three villages, which may resort to retribution. When predators attack livestock, people frequently retaliate against predators that are responsible for the losses, which in turn threatens the persistence of carnivore populations. At the same time, livestock predation could strongly affect local communities' livelihoods around BCCA. Hence, for the sustainable coexistence of carnivores and local communities living around BCCA, proper incentives (compensation of the economic loss) and appropriate conflict mitigation practices (technical, educational, and stakeholder dialogue) should be promoted and implemented.

ACKNOWLEDGEMENTS

I thank the Addis Ababa University thematic research fund (TR/018/2021) for the finance and the Department of Zoological Sciences for the logistical support. I am also indebted to the individuals who assisted me with data collection and the local community members who participated in the interviews. Lastly, I thank the East Gojam Zone Agricultural Office for the information provided and permission to carry out this research.

REFERENCE

1. Anagaw Atickem, Getachew Simeneh, Afework Bekele, Tariku Mekonnen, Sillero-Zubiri, C. Hill, R. A. and Stenseth, N. C. (2017). African wolf diet, predation on livestock and conflict in the Guassa mountains of Ethiopia. African Journal of Ecology, 55(4), 632-639.
2. Anagaw Atickem, Williams S., Afework Bekele and Thirgood S., (2010). Livestock predation in the Bale Mountains, Ethiopia. African Journal of Ecology, 48(4), 1076-1082.
3. Anthony B. P., and Wasambo J., (2009). Human-wildlife conflict study report: Vwaza Marsh Wildlife Reserve, Malawi. Central European University: Prepared for Malawi Department of National Parks and Wildlife. Budapest.
4. Bezihalem Nibret, Mesele Yihune and Bewuketu Takele (2017). Human-wildlife conflict in choke Mountains, Ethiopia. International Journal of Biodiversity and Conservation, 9(1), 1-8.
5. Birhanu Asaye, Wondimagegnehu Tekalign and Taye Dobamo (2024). Livestock predation, crop raiding, and community attitudes towards sustainable wildlife conservation in and around Mankira Forest, Southwest Ethiopia. BMC Ecology and Evolution, 24 (85)
6. Deneke Yigerem, Megaze Aberham, Wondimagegnehu Tekalign, Taye Dobamo and Leirs H.(2023). Livestock depredation by wild carnivores in the highlands of Wolaita zone, southern Ethiopia. Wildlife research 50(4), 301-309
7. Eniang E., Ijeomah H., Okeyoyin G., and Uwatt A., (2011). Assessment of human–wildlife conflicts in Filinga range of Gashaka Gumti National Park, Nigeria. Production Agriculture and Technology Journal, 1(1)15-35.
8. Eustace A., Kisingo A. W,. and Mbwiliza J. S., (2018). Wildlife damage in villages surrounding the Serengeti ecosystem. Parks, 24(3)107.
9. Gandiwa E., (2011). Preliminary assessment of illegal hunting by communities adjacent to the northern Gonarezhou National Park, Zimbabwe. Tropical Conservation Science, 4(4), 445-467.
10. Girma Eshete, Marino J., and Sillero-Zubiri C., (2018). Ethiopian wolves conflict with pastoralists in small Afroalpine relicts. African Journal of Ecology, 56(2), 368-374.
11. Isreal Sebsibe (2022). Humans-livestock predators conflict in the Central and Eastern Part of Bale Mountains National Park, Ethiopia. BMC Ecology and Evolution, 22(1), 113.
12. Kissui B. M., Kiffner C., König H. J., and Montgomery R. A., (2019). Patterns of livestock depredation and cost-effectiveness of fortified livestock enclosures in northern Tanzania. Ecology and Evolution, 9(19), 11420-11433.
13. Kolowski J., and Holekamp K., (2006). Spatial, temporal, and physical characteristics of livestock depredations by large carnivores along a Kenyan reserve border. Biological conservation, 128(4), 529-541.
14. Kothari A., (2012). Community conserved areas. In *Managing Protected Areas* (pp. 579-603): Routledge.
15. Ladan S. I., (2014). *Examining human wild life conflict in Africa.* Paper presented at the International conference on biological, civil and environmental engineering.
16. Leta Gobosho Amaja, Debela Hunde Feyssa and Tariku Mekonnen Gutema (2016). Assessment of types of damage and causes of human-wildlife conflict in Gera district, south western Ethiopia. 8 (April), 49–54.
17. Lyamuya R., Masenga E., Fyumagwa R., and Røskaft E., (2014). Human–carnivore conflict over livestock in the eastern part of the Serengeti ecosystem, with a particular focus on the African wild dog Lycaon pictus. Oryx, 48(3), 378-384.
18. Makindi S. M., Mutinda M. N., Olekaikai N. K,. Olelebo W. L., and Aboud A. A., (2014). Human-wildlife conflicts: causes and mitigation measures in Tsavo Conservation Area, Kenya.
19. Matseketsa G., Muboko N., Gandiwa E., Kombora D. M., and Chibememe G., (2019). An assessment of human-wildlife conflicts in local communities bordering the western part of Save Valley Conservancy, Zimbabwe. Global Ecology and Conservation, 20(e00737).
20. Matseketsa G., Mukamuri B. B., Muboko N., and Gandiwa E., (2019). An Assessment of Local People's Support to Private Wildlife Conservation: A Case of Save Valley Conservancy and Fringe Communities, Zimbabwe. Scientifica,
21. Mbise F. P., SkjÃ G. R., Lyamuya R. D., Fyumagwa R. D., Jackson C., and Holmern T., (2018). Livestock depredation by wild carnivores in the Eastern Serengeti Ecosystem, Tanzania. International Journal of Biodiversity and Conservation, 10(3), 122-130.
22. Menapace M., Tattoni C., Tondini N., Zatelli P., and Ciolli M., (2023). Human-wildlife conflict and road collisions with ungulates. A risk analysis and design solutions in Trentino, Italy. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 48(5)125-131.
23. Mihret Girmay, Tsegaye Gadisa and Gidey Yirga (2015). Livestock loss by the spotted hyena (Crocuta crocuta) in and around a waste dumping site in northern Ethiopia. International Journal of Biodiversity and Conservation, 7(1), 50-53.
24. Misganaw Tamrat. Anagaw Atickem, Diress Tsegaye, Nguyen, N. Afework Bekele,

Evangelista P., Fashing P. J., and Stenseth N. C., (2020). Human–wildlife conflict and coexistence: a case study from Senkele Swayne's Hartebeest Sanctuary in Ethiopia. Wildlife biology, 2020(3), 1-10.

25. Nyhus P. J., (2016). Human–wildlife conflict and coexistence. Annual review of environment and resources, 41(143-171.
26. Park S. E., (2020). Coexistence between human and wildlife: the nature, causes and mitigations of human wildlife conflict around Bale Mountains National.
27. Patterson B. D., Kasiki S. M., Selempo E., and Kays R. W., (2004). Livestock predation by lions (Panthera leo) and other carnivores on ranches neighboring Tsavo National Parks, Kenya. Biological conservation, 119(4), 507-516.
28. R∅ skaft E., Händel B., Bjerke T., and Kaltenborn B. r. P., (2007). Human attitudes towards large carnivores in Norway. Wildlife biology, 13(2), 172-185.
29. Schiess-Meier M., Ramsauer S., Gabanapelo T., and König B., (2007). Livestock predation—insights from problem animal control registers in Botswana. The Journal of Wildlife Management, 71(4), 1267-1274.
30. Shilongo S. M., Sam M., and Simuela A., (2018). Using incentives as mitigation measure for human wildlife conflict management in Namibia. International Journal of Scientific and Research Publications, 8(11), 677-682.
31. Sogbohossou E. A., De Iongh H. H., Sinsin B., De Snoo G. R., and Funston P. J., (2011). Human–carnivore conflict around Pendjari biosphere reserve, northern Benin. Oryx, 45(4), 569-578.
32. Tariku Mekonnen Gutema, Anagaw Atickem, Diress Tsegaye, Afework Bekele, Claudio S. Z., Jorgelina M., Mohammed Kasso, Vivek V. V., Peter J. F. and Nils C. Stenseth1, (2019). Foraging ecology of African wolves (Canis lupaster) and its implications for the conservation of Ethiopian wolves (Canis simensis). Royal Society Open Science, 6(9), 190772.
33. Treves A., Jurewicz R. L., Naughton-Treves L., and Wilcove D. S., (2009). The price of tolerance: wolf damage payments after recovery. Biodiversity and Conservation, 18(2)4003-4021.
34. Treves A., and Karanth K. U., (2003). Human-carnivore conflict and perspectives on carnivore management worldwide. Conservation biology, 17(6), 1491-1499.
35. Yirga Gidey, Leirs H., De Iongh H. H., Tsehaye Asmelash, Kindeya Gebrehiwot, Vos, M., and Bauer H., (2017). Densities of spotted hyaena (Crocuta crocuta) and African golden wolf (Canis anthus) increase with increasing anthropogenic influence. Mammalian biology, 85(3), 60-69.
36. Yirga Gidey, Imam E., De Iongh H. H., Leirs H., Solomon Kiros, Tesfamichael G. Yohannes, Mekonen Teferi, and Bauer H., (2014). Local spotted hyena abundance and community tolerance of depredation in human-dominated landscapes in Northern Ethiopia. Mammalian biology, 79(325-330.
37. Yirga Gidey, De Iongh H. H., Leirs H., Kindeya Gebrehiwot, Gebrehiwot Berhe, Tsehaye Asmelash, Haftu Gebrehiwot and Bauer H., (2013). The ecology of large carnivores in the highlands of northern E thiopia. African Journal of Ecology, 51(1), 78-86.
38. Yirga Gidey and Bauer H., (2010). Prey of peri-urban spotted hyena (Crocuta crocuta) in southeastern Tigray, northern Ethiopia. Asian Journal of Agricultural Sciences, 2(4), 124-127.
39. Yom-Tov, Y. Ashkenazi, S. and Viner, O. (1995). Cattle predation by the golden jackal Canis aureus in the Golan Heights, Israel. Biological conservation, 73(1), 19-22.