

Human-Carnivore Conflict in the North-Eastern Periphery of Waza National Park in Cameroon

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Abstract

A study on human-carnivore conflict in villages north-east of Waza National Park was carried out from February to May 2021. The objective was to provide knowledge that would guide conservation interventions. A semi-structured questionnaire was administered that sought information on the magnitude, period of occurrence, consequences, hotspots, and mitigation methods of human-carnivore conflict. A total of 125 heads of households were surveyed in six villages, representing 43.59% of pastoralists. Findings revealed that three carnivores were responsible for predation on livestock north-east of Waza NP: lion (*Panthera leo leo*), jackal (*Canis aureus*), and hyena (*Crocuta crocuta*). A total of 1531 livestock were killed during a period of three years. Livestock were mainly attacked while grazing within the park (38.6%, n = 54) and near water bodies (30.0%, n = 42). The majority of carnivore attacks on livestock occurred during the day (72.7%, n = 80), while 27.3% (n = 30) took place at night (n = 110). Attacks were also more frequent in the dry season (64.9%, n = 72) than in the rainy season (35.1%, n = 39) (n = 111 in total). Carnivores caused significant direct economic losses to livestock pastoralists; estimated at 68,650,000 XAF (\$117,176 USD) in total. On average, a pastoralist lost 228,830 XAF (\$390 USD) per year. This loss is important to pastoralists who depend on revenue from livestock to meet basic needs like education, health, and certain socio-cultural obligations. Although night enclosures and guarding of livestock were reported as methods used to protect livestock from predation, the general consensus was that there are no concrete solutions to human-carnivore conflict. Community engagement through education, awareness raising, and empowerment remains necessary. Furthermore, practical measures are needed to mitigate human-carnivore conflict in order to preserve human

livelihoods and conserve carnivores in Waza NP.

Keywords

Human-Carnivore Conflict, Economic Losses, Pastoralism, Waza National Park

1. Introduction

Globally, wildlife is threatened by many factors including climate change [1], poaching, and agricultural expansion that leads to habitat loss [2] [3]. Pastoralism, which is noted for generating human-wildlife conflict, is one of the main factors threatening the survival of wildlife, especially large carnivores. In Africa, the increase in human population has led to more land being grabbed for economic development and also for a variety of anthropogenic activities that promote subsistence [4]. Consequently, wildlife is now mainly restricted to protected areas that serve as tools for conservation. The lack of zoning for different land use forms in most Central African countries, including Cameroon, creates the scenario where communities are located in the vicinity of most protected areas. Therefore, interactions between humans and wildlife for space and other resources are frequent in these communities, leading to various human-wildlife conflicts [5]. Predation by carnivores on livestock is one of the most damaging forms of human-wildlife conflict, especially in the savannahs where pastoralism remains the main occupation of the inhabitants [6] [7].

In Cameroon, there are many threats to wildlife, especially large carnivores. The main threats to the lion population include natural prey depletion, transhumance pastoralism and human-lion conflict [8]-[11]. Conflict between humans and lions due to livestock depredation is the driving factor behind the decline in the lion population in Waza National Park (Waza NP). Pastoralists (in this study includes agro-pastoralists, who are usually resident, and nomadic herders on transhumance) suffer from high levels of predation by carnivores; lions are responsible for losses of 65,597,000 FCFA (\$111,952 USD) per year [12] in Waza NP. In the W National Park in Niger, 3271 domestic animals were killed between 2000 and 2006 by large carnivores (lion, hyena and jackal) representing an economic loss of 103,247,750 FCFA (\$176,221 USD) [13]. The species responsible are most often killed by local communities in retaliation to attacks on livestock or in an attempt to prevent them [9] [14]. Therefore, the number of large carnivores is rapidly decreasing as a direct result of conflict with pastoralists over livestock depredation [12] [15]. Also, a decline in the numbers of lions, leopards, wild dogs, and hyenas has been linked to poisoning by pastoralists around Benoue National Park [8]. Livestock losses due to carnivore attacks in and around the Waza NP range from the loss of a head of livestock, about 170549.6 FCFA (\$291 USD) for resident pastoralists to the loss of two heads of livestock, about 341099.2 FCFA (\$582 USD) for nomadic pastoralists annually [12].

The Far North region of Cameroon is one of the most populated regions in the country and is home to many protected areas including Waza NP [16]. The region has been experiencing an influx of refugees as a result of the Boko Haram armed conflict since 2014, which is impacting natural resources in and around protected areas. The Boko Haram armed conflict has resulted in 100,000 to 150,000 internally displaced people and nearly 200,000 Nigerian refugees in the Far North Region [17]. The Waza NP was created in 1968 with biodiversity conservation as its main objective [10]. Its north-eastern periphery and part of the park is a floodplain zone suitable for livestock pastoralism, especially for transhumant and resident pastoralists in search of water and grazing during periods of drought, such as the dry season [18]. The concentration of pastoralists and their livestock in the periphery of Waza NP usually leads to incursions into the park, generating conflict over livestock depredation. The lion population in Waza NP appears to be in an alarming decline from 40 - 60 lions in 2002 to 14 - 21 lions in 2009 [9] [19] mainly as a consequence of retaliatory killing of lions by pastoralists for preying on livestock.

With the Boko Haram insurgency, the number of pastoralists seeking refuge around Waza NP has increased exponentially, and the number of cattle around the park has doubled [20]. This high prevalence of pastoralists and their livestock within the home range of carnivores can significantly increase human-carnivore conflict, especially with lions. The presence of livestock in and around protected areas represents competition between wildlife and livestock for water and pasture. It also represents a threat, as pastoralists engage in killing carnivores to protect their livestock from predators [21]. Human-carnivore conflict is a global issue with significant implications for both carnivore conservation and human livelihoods. It is a major factor responsible for causing hardship in local communities and reducing human tolerance for carnivore conservation. Though there is scanty literature suggesting human-carnivore conflict in the North-eastern periphery of Waza NP [12], there is a dearth of information on the nature and magnitude of human-carnivore conflict in the park since the Boko Haram armed conflict. However, dynamics in pastoralist numbers and movements due to the Boko Haram insurgency have witnessed an increase in carnivore attacks on livestock in the North-eastern periphery. Lack of understanding of the scope and severity of human-carnivore conflict limits or actually impedes the development of evidence-based policy responses tailored in the park and its periphery. A comprehension of the nature of the conflict is vital to guide policy that will protect human livelihoods, carnivore populations, and promote coexistence of carnivores and humans. Therefore, this study was carried out to assess human-carnivore conflict and to provide knowledge for the conservation of carnivores and protection of human livelihoods in the North-eastern periphery of Waza NP.

2. Materials and Methods

2.1. Study Area

This study was carried out in the northeastern periphery of Waza NP. Waza NP

is located in the Sudano-Sahelian agro-ecological zone of Cameroon and has an area of 170,000 ha. The climate is tropical semi-arid, characterised by a long dry season (October-May), a shorter rainy season (June-September), and average annual rainfall between 650 and 700 mm/year [19]. Maximum temperatures are between 40°C and 45°C in April-May and minimum temperatures between 18°C and 20°C in December-January [10]. Located in the southern part of the Lake Chad basin, the relief of Waza is flat, marked by three granite mountains, the highest reaching an elevation of 508 m. The park has no permanent running watercourse but possesses natural and artificial waterholes fed by rain and floodwaters from the Logone River. Some of these waterholes persist throughout the dry season, especially those in the eastern floodplain section of the park, providing water to both wildlife and livestock. In the villages abutting Waza NP, agriculture, fishing, and pastoralism are the main activities. Livestock is a major source of income for over 30% of the local population [22]. The choice of the study site includes the fact that livestock incursions into the park for pasture and water are regular and the main cause of conflict between park authorities and local residents [10] [11].

2.2. Study Design and Sampling Technique

A cross-sectional study of households in villages in the northeastern periphery of Waza NP was carried out from February to May 2021 through a questionnaire survey according to Bauer and De Iongh [14]. The total number of households in the area, obtained from the general population census in 2010 (BUCREP 2010) and from traditional chiefs, was used in this study to determine the sample size with the aim of covering at least 30% of pastoralists in each village. However, the villages surveyed were purposively chosen based on their proximity to the park, the presence of livestock during the study period, and accessibility. Only villages close to the park that had livestock during the study period and that could be accessed were surveyed. Six (06) villages located northeast of the park were accessed by motorbikes. The inclusion criteria for respondents were: ownership of livestock and willingness to participate in the study, while a household was considered the sampling unit. The purpose of the study was explained, and verbal informed consent was obtained from all the respondents before being included in the study and interviewed. A semi-structured questionnaire was administered to respondents with questions on human-carnivore conflict that sought information on its magnitude, frequency, period of occurrence, consequences, hotspots, and mitigation methods applied by both pastoralists and park authorities. Simple random sampling was used for the selection of households in the chosen villages [12]. All households had equal chances of being selected for the survey.

2.3. Data Collection

A total of 125 heads of households were surveyed in the six villages, representing

43.59% of pastoralists. The purpose of the study was explained to the targeted households, usually with the assistance of resident park employees, local leaders, and/or trusted intermediaries. Administration of the interview-questionnaire survey of the household heads was facilitated by a trusted guide-interpreter using the local language (*Fulfulde*).

The GPS coordinates of attack locations were collected for each reported case of predation to generate a conflict map highlighting conflict hot spots. Attack locations were mainly identified by herders whose livestock had been attacked by a carnivore (lion, jackal, and hyena) inside the park or in the villages. The questionnaire survey focused on issues related to human-carnivore conflicts (wild carnivore encounters, location and predation of livestock, period of day and season of predation of livestock, protection of livestock) and financial losses due to attacks and/or predation of livestock by carnivores.

Semi-structured interviews were also conducted with resource persons such as the Waza NP conservator and village chiefs to complement the information obtained from respondents. Field observations included taking note of livestock killed or presenting injuries due to attacks by carnivores, as well as indices of carnivore presence based on footprints and scats as additional information. A retrospective analysis of killing/predation of livestock by carnivores based on records for 3 years (2017-2019) of the study area was performed to assess quantitative and economic loss of livestock. Additionally, qualitative data on perceptions and mitigation methods were from the 2021 surveys.

The analysis of direct financial losses was based on the number of livestock killed and the average prices of livestock in the local market. Financial losses were calculated in terms of the local currency, Central African Francs (CFA), and converted to U.S. dollars (USD) using the current exchange rate. The participants in the present study, the pastoralists, determined the average price for livestock (FCFA/head). Based on the obtained information, the average local market prices of live animals in relation to their body condition score were 200,000 FCFA for cattle, 30,000 FCFA for sheep, and 40,000 FCFA for goats.

2.4. Data Management and Analysis

Data was inputted into Microsoft Excel 2016. The data were subjected to descriptive statistical analysis using means and frequencies. The Pearson correlation test (Chi-square test) was performed using R version 4.3.0 to assess the strength of association of different factors of Human-Carnivore Conflict in the study at a 5% significance level [23]. Maps of sampled villages and human-carnivore conflicts were generated using the QGIS Software Version 2.18.

3. Results

A total of 4209 heads of livestock were recorded in all villages surveyed during the study period. All villages experienced carnivore attacks, and the frequency of attacks differed between the villages.

3.1. Type of Pastoralist by Village in the Northeast of Waza National Park

One hundred and twenty-five (125) respondents, all pastoralists belonging to six villages, were interviewed during this study as shown in **Figure 1**. The number of respondents varied across villages, with the highest numbers recorded in Lougouma (n = 30), Mahe (n = 30), and Mbele (n = 24) compared to the other sites (p < 0.05). Overall, there were significantly more resident pastoralists (93.6%, n = 117) than nomadic pastoralists (6.4%, n = 8) in all the villages surveyed (p < 0.05) (**Figure 1**).

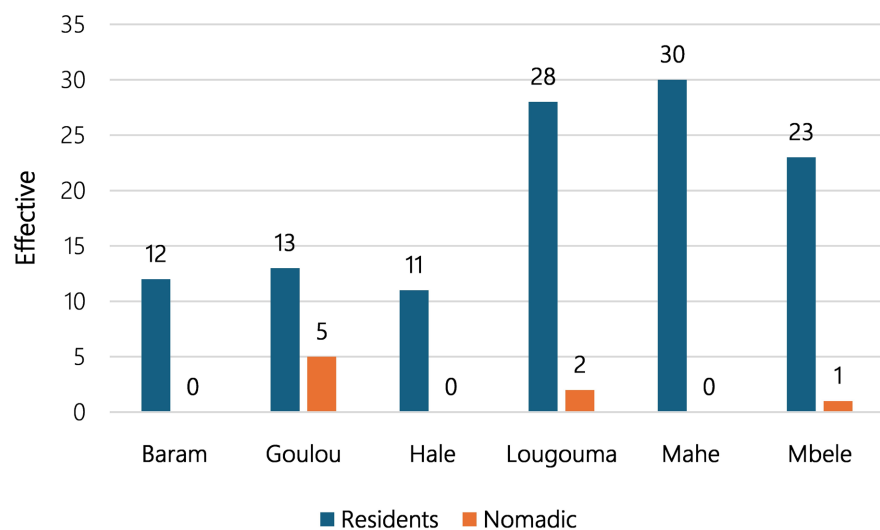


Figure 1. Type of pastoralist by village in the North East of Waza NP.

3.2. Location and Frequency of Carnivore Predation on Livestock North-East of Waza National Park

Livestock were mainly attacked while grazing within the park (38.6%, n = 54) and near water bodies (30.0%, n = 42). Attacks were also reported in villages (25.0%, n = 35) and on farms (5.7%, n = 8), whereas incidents in temporary camps were rare (0.7%, n = 1) (**Figure 2**). Three main carnivores are responsible for predation on livestock northeast of Waza NP: lion (*Panthera leo leo*), jackal (*Canis aureus*), and hyena (*Crocuta crocuta*).

3.3. Period and Season of Carnivore Predation on Livestock, Northeast of Waza National Park

The majority of carnivore attacks on livestock occurred during the day (72.7%, n = 80), while 27.3% (n = 30) took place at night (n = 110 in total). Attacks were also more frequent in the dry season (64.9%, n = 72) than in the rainy season (35.1%, n = 39) (n = 111 in total), as shown in **Figure 3**. There was a significant association between season and frequency of livestock attacks ($\chi^2 = 17.98$, df = 2, p < 0.001).

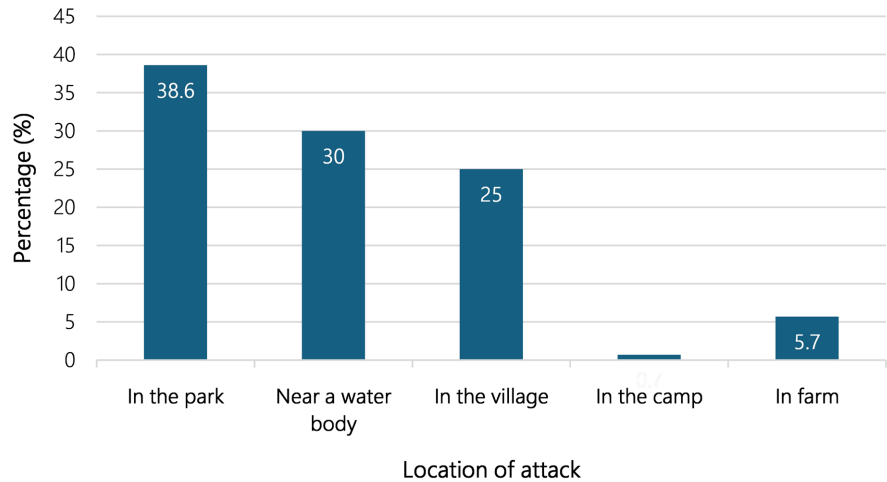


Figure 2. Location and frequency of carnivore predation on livestock, North East of Waza NP.

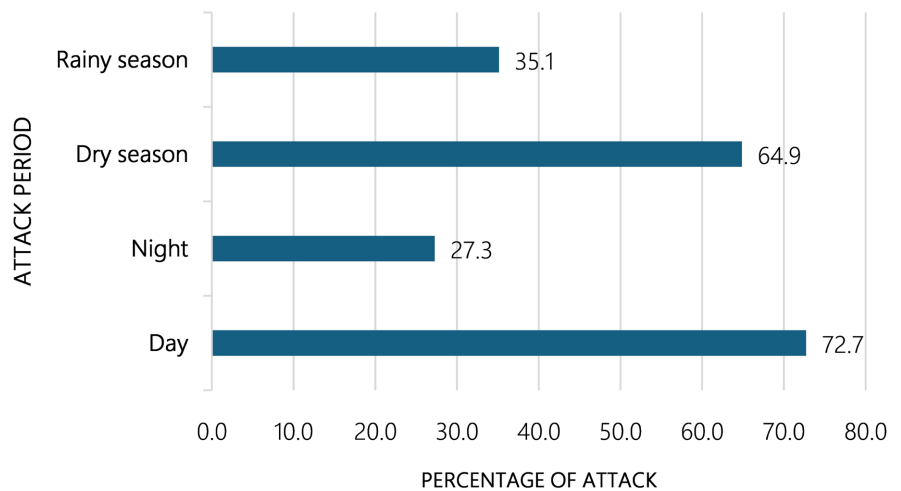


Figure 3. Period and season of carnivore predation on livestock, North East of Waza NP.

3.4. Predation Hotspots, North East of Waza National Park

Predation was highest in villages (Logouma, Mahe, and Mbele) that had the highest number of livestock compared to the others with fewer livestock (Figure 4). The most ($p < 0.05$) vulnerable village was Logouma, which was nearest to the Waza Logone floodplain with greener pasture and water.

3.5. Number of Livestock Killed by Carnivores within 3 Years (2017-2019)

A total of 1531 livestock were killed during the period 2017-2019. The results showed a significant difference ($p < 0.00001$, $\chi^2 = 1385.12$) between the types of livestock killed by carnivores. Goats (68.6%) were the most ($p < 0.05$) vulnerable animals lost to predation, followed by sheep (24.03%) and cattle (7.3%). Cattle were only attacked and killed by lions in this study.

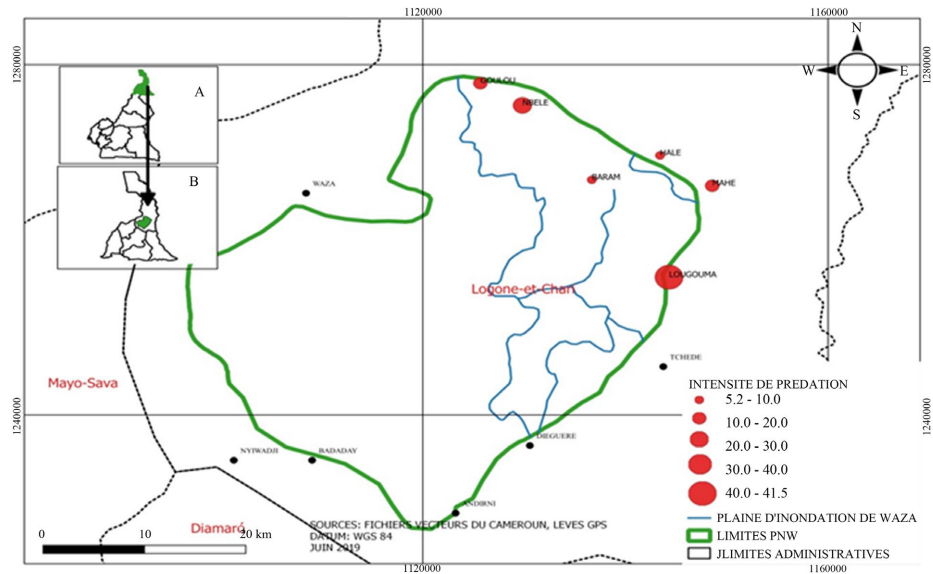


Figure 4. Predation hot spot, North East of Waza NP.

Overall, damage in terms of the number of livestock killed varied significantly ($p < 0.00001$, $\chi^2 = 439.89$) between the carnivores. The most damaging carnivore in terms of the number of livestock killed was the jackal (50.2%), followed by the lion (35.1%) and the hyena (14.6%) (**Table 1**).

Table 1. Estimated number of livestock killed by carnivores within a 3-year (2017-2019) period, northeast of Waza NP.

Livestock	Lion		Jackal		Hyena		Total	
	n (%)	P (χ^2) value	n (%)	P (χ^2) value	n (%)	P (χ^2) value	n (%)	P (χ^2) value
Cattle	112 (20.8)a		0		0		112 (7.3)a	
Goats	274 (50.9)bA	<0.00001 (119.13)	602 (78.3)aB	<0.00001 (492.13)	175 (78.1)aC	<0.00001 (141.75)	1051 (68.6)b	<0.00001 (1385.12)
Sheep	152 (28.3)cA		167 (21.7)bA		49 (21.9)aB		368 (24.0)c	
Total	538 (35.1)A		769 (50.2)B		224 (14.6)C		1531 (100)	

N: number of livestock (cattle, goats, sheep) attacked by carnivores (Lion, Jackal, Hyena); %: percentage of the total livestock (cattle, goats, sheep) killed by carnivores (lion, jackal, hyena) a, b, c: different letters in the same column are significantly different ($p < 0.00001$). A, B, C: different letters in the same row are significantly different ($p < 0.00001$).

3.6. Direct Economic Losses Due to Carnivore Attacks on Livestock Northeast of Waza National Park within 3 Years (2017-2019)

Carnivores caused significant direct financial losses to livestock pastoralists; es-

estimated at 68 650,000 XAF (\$117,176 USD) in total. The lion caused the most economic losses (53.46%) to pastoralists, followed by jackal (36.04%) and hyena (10.50%), which corresponded to 36,700,000 XAF (\$62,616 USD), 24,740,000 XAF (\$42,214 USD), and 7 210,000 XAF (\$12,308 USD), respectively (**Table 2**). Pastoralists reported that predation (56% per year) was the main cause of loss of their livestock in the North-east of the park, with an average loss of up to 228,830 XAF (\$390 USD) per year per pastoralist calculated in the study. Disease (24%) and theft (20%) were also mentioned as causes of loss of their livestock, corresponding to 39,764,000 XAF (\$67,872 USD) and 34,976,000 XAF (\$59,697 USD), respectively.

Table 2. Estimated direct financial losses to pastoralists due to carnivore attacks on livestock during a 3-year (2017 to 2019) period.

	Lion	Jackal	Hyena	Total (XAF)	TOTAL (\$USD)
Cattle	22,400,000	0	0	22,400,000	38226.45
Goats	8,220,000	18,060,000	5,250,000	31,530,000	5 812.97
Sheep	6,080,000	6,680,000	1,960,000	14,720,000	25119.79
Total	36,700,000	24,740,000	7,210,000	68,650,000	117176.11

3.7. Protection of Livestock from Predation by Carnivores, Northeast of Waza National Park

Pastoralists reported implementing two main strategies to reduce livestock losses due to predation, including guarding (56%) and building night enclosures for livestock (44%). Guarding was done when the livestock were grazing and in the villages or temporary camps at night. Guarding was managed by two categories of people: family members and shepherds hired by the livestock owners. Some respondents (80%, $n = 100$) also mentioned noise as a method of chasing away carnivores that attacked their livestock. In order to reduce human-carnivore conflict, the majority of herders stated that the creation of artificial waterholes in villages would reduce the incursions of livestock into the park.

Patrols, raising awareness of traditional authorities, and repelling lions that attacked livestock were the strategies used by Waza NP authorities.

3.8. Encounter with Lions and Perception of Carnivores by Pastoralists, Northeast of Waza National Park

Many respondents (54%) attested to having encountered lions during their activities (**Figure 5(A)**), though the number of lions encountered was variable (**Figure 5(B)**). The majority of respondents (91%) encountered between 1 and 5 lions ($p < 0.05$), compared to those (9%) who declared encountering more than 6 lions. The majority of respondents had a negative perception of carnivores, especially lion conservation, though some farmers thought that lions deserve protection.

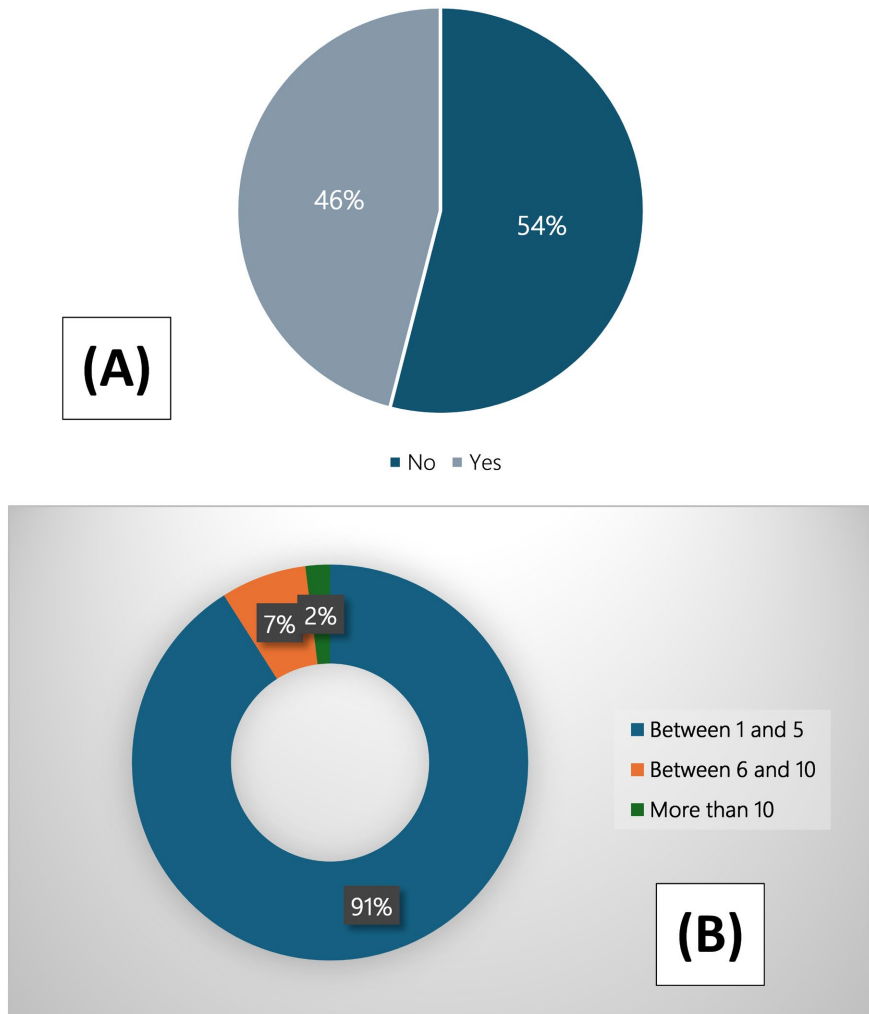


Figure 5. Human encounters with lions (A) and number of lions encountered (B) North East of Waza NP.

4. Discussion

Predation on livestock is one of the threats to human livelihood around Waza NP, leading to the retaliatory killing of lions [12]. Villages northeast of the park and beyond now experience attacks from carnivores comparable to those in the southwest [15]. This may be explained by changes in pastoral dynamics, with movements to some villages in the northeast and even into the park for safety from armed conflicts. Actors involved in the human-carnivore conflict were predominantly resident pastoralists, with very few nomadic pastoralists. Even though this corresponds with previous findings in the park [24] and in the Pendjari Biosphere Reserve [25], the very low proportion of nomadic pastoralists may be attributed to the Boko Haram insurgency and ethnic conflicts that caused modification of their movements in the area. During the period of December 2021, the park became a refuge to an estimated 2500 pastoralists and 35,000 cattle fleeing from ethnic war. These pastoralists incurred considerable losses of livestock to carnivores

during their stay in the park [11] [26]. Three main carnivores are responsible for predation on livestock northeast of Waza NP: lion (*Panthera leo leo*), jackal (*Canis aureus*), and hyena (*Crocuta crocuta*). These are reported to be the three main large carnivores remaining in Waza NP after the extirpation of the leopard around the early 2000s [27].

Water and pasture continue to attract pastoralists into the park, where they suffer loss of livestock to carnivores. Thus, it is not uncommon that the majority of attacks occur during the day when livestock are grazing and at waterholes. The findings of this study are in conformity with those in the periphery of the W National Park in Niger, where most attacks (56.66%) occurred during grazing [13]. Most attacks occurred during the dry season, confirming earlier authors [12] [19] who reported that carnivores in this park attacked 65.20% of livestock in the dry season compared to 34.91% in the wet season. This, however, differs from findings by Garba and Di Silvestre [13] and Croes *et al.* [8] in the W National Park and the Benue complex. High temperatures during the dry season cause many pastoralists to enter the park in search of water, thereby increasing the availability of domestic prey for carnivores. Lougouma, Mahe, and Mbele were presented to be predation hotspots in the study, comparable to villages southwest of the park. This expansion of predation into villages not known to experience such intensity of predation in the past is a result of pastoral dynamics caused by the Boko Haram armed conflict.

Goats were the most vulnerable livestock, while the jackal killed more livestock than any other carnivore. Economically, the lion caused the highest economic loss to livestock keepers in the North Eastern periphery of Waza NP, due to the high economic value of cattle. This finding agrees with previous reports in the southern part of the park [8] [12] [28] and around the Benoue complex. However, they differ from those in W-National Park, where the jackal is responsible for causing the highest economic loss [13]. Although the lions killed fewer livestock compared to jackals in this study, they killed mostly cattle with a higher price value compared to goats and sheep. The loss of \$390 USD on average per year per pastoralist calculated in the study induces financial stress on pastoralists and deprives them of an important economic and socio-cultural inheritance. Lions killed more small ruminants than cattle, contrary to the findings of Bauer [28] and Tumenta *et al.* [15] in the same study area, which demonstrated that lions preferred larger prey. This contradiction is justified by the fact that resident pastoralists represented the majority of respondents and they are usually the owners of large herds of small ruminants.

Predation as the main cause of livestock loss compared to disease and theft, accounted for the highest economic loss. These results differ from those of Bauer *et al.* [29] in Pendjari NP, who reported disease as the main cause of livestock loss, followed by theft and predation. As the main source of income and having great cultural importance, the loss of livestock has serious implications for pastoralists in this area.

Herders use the construction of night enclosures for their livestock, and guarding during grazing as methods to reduce predation on their livestock by carnivores. Chasing predators with noise was commonly used by pastoralists when livestock was attacked by carnivores. These results corroborate those of Garba and Di Silvestre, [13] in W National Park, who reported that 46.75% of the herders chased predators away by shouting. However, Bauer [28] recorded that hyenas were chased by herders at night by lighting torches south of Waza NP. The use of these methods does not appear to be general; just like the park authorities, some respondents reported that they had no concrete solutions to carnivore attacks.

5. Conclusion

Predation on livestock remains one of the threats to human livelihood around Waza NP, engendering the retaliatory killing of lions. Villages in the north-eastern periphery of the park now experience attacks from carnivores comparable to those in the south-west. This may be explained by changes in pastoral dynamics, with movements of resident pastoralists to some villages in the north-east and even into the park for safety from armed conflicts. The Boko Haram insurgency has influenced the movement of nomadic pastoralists; few of them use the north-east periphery of the park. Approximately 1531 livestock were predated by carnivores in the north-eastern periphery of Waza NP within three years in retrospect, resulting in an estimated total economic loss of 68,650,000 XAF (\$117176.11 USD). This loss is significant for pastoralists who depend on revenue from livestock to meet basic needs such as education, health, and certain socio-cultural obligations. Although night enclosures and guarding of livestock were reported as strategies used to protect livestock from predation, these remain to be proven effective. The general consensus is that there are no concrete solutions to carnivore predation on livestock around Waza NP. Community engagement through education, awareness raising, and empowerment remains necessary. Furthermore, practical measures are necessary to mitigate the losses generated by human-carnivore conflict, to preserve human livelihoods and save populations of large carnivores in Waza NP. These measures could include targeted support for building enforced enclosures as well as community-managed waterholes away from the park.

Data Availability

The data used in this study are available from the corresponding author upon reasonable request.

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Authors' Contribution

Pricelia N. Tumenta: Conception, design, finances, supervision, data validation, analysis and interpretation, writing and editing.

Parfait Nkontcheu Kamta: Fieldwork, data validation, drafting of the initial manuscript.

Daniel Brice Kenko Nkontcheu: Data analysis and interpretation, writing and editing.

All authors participated in preparation and critical review of the manuscript. All authors have read and approved the final version of the manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest.

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