



**PATTERNS OF LARGE CARNIVORE DEPREDAATION ON LIVESTOCK AND COMMUNITY TOLERANCE BEHAVIOR AROUND SELOUS-NYERERE ECOSYSTEM; A CASE STUDY OF LIWALE DISTRICT IN SOUTHERN TANZANIA.**

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## **ABSTRACT**

Human-Large Carnivore Conflict (HLCC), particularly over livestock depredation, is among the most pressing conservation issues across the Selous Nyerere Ecosystem (SNE) in southern Tanzania. Despite the ecosystem having a large network of protected areas including a game reserve, a mega national park, forest reserves, and a wildlife management area, human large-carnivore conflict is still a serious management issue facing wildlife management authorities and communities living adjacent to protected areas. We conducted a study in the Liwale district to assess the impact of co-existence between humans and large carnivores under the constraint of human population growth and changing land use (Introduction of pastoralism), which affects the population through the hard-edge effect and dispersal ecology. We surveyed three (3) pastoralist villages to collect their views and attitudes, specifically on sharing their communal land with large carnivores. Furthermore, we surveyed the Magingo wildlife management area, Nyerakipelele and Angai Forest reserves to assess habitat suitability and the rate of large carnivore dispersion in these dispersal areas. The area has been highly encroached on and heavily degraded through human activities, i.e., illegal livestock keeping, illegal farming and poaching. Human encroachment into dispersal areas makes the habitat unsuitable for large carnivores and leads to competition for resources, resulting in human-large carnivore conflicts. From 2018 to 2022, the loss caused by large carnivore depredation on livestock was approximately US dollar 112,721.73, with several human injuries reported. Local communities discreetly use cost-effective lethal methods that kill instantly to mitigate the challenge. We use our interaction with local people to provide conservation education on carnivores, as the species notably cause a lot of damage. We do hope that this study provides information that will be of high value to conservationists to work on fostering coexistence between humans and large carnivores in the Selous-Nyerere ecosystem.

## TABLE OF CONTENT

<b>ABSTRACT</b> .....	<b>iii</b>
<b>LIST OF TABLES</b> .....	<b>60</b>
<b>LIST OF FIGURES</b> .....	<b>60</b>
<b>LIST OF APPENDICES</b> .....	<b>60</b>
<b>LIST OF ABBREVIATIONS</b> .....	<b>60</b>
<b>1.0 INTRODUCTION</b> .....	<b>62</b>
1.1 Human-Large carnivore conflict in Tanzania. ....	62
1.2 Rationale of the study .....	62
1.3 Research objective and activities .....	63
1.3.1 General objective of the study .....	63
1.3.2 Key activities .....	63
<b>2.0 METHODOLOGY</b> .....	<b>64</b>
2.1 Study area .....	64
2.2 Research design .....	64
2.3 Data collection.....	65
2.3.1 Sighting reports .....	65
2.3.2 Sign surveys .....	65
2.3.3 Questionnaire survey and interviews .....	65
2.3.4 Damage reports .....	65
2.3.5 Focus group discussion .....	65
2.4 Data analysis and evaluation .....	66
2.4.1 Regression modelling .....	66
2.4.2 Occupancy modelling .....	66
<b>3.0 RESULTS</b> .....	<b>67</b>
3.1 Socio-demographic characteristics of respondents .....	67
3.1.1 Surveyed villages .....	67
3.1.2 Socio-economic characteristics of respondents .....	67
3.2 Livestock keeping and management system in the Liwale district.....	68
3.3 Human-large carnivore conflicts in the Liwale district.....	69
3.3.1 Dispersal rate of large carnivores in wildlife management areas, open areas and forest reserves .....	69
3.3.2 Hot spot areas with high incidences of human-carnivore conflicts.....	70
3.3.3 Trend of large carnivore attack incidences in the Liwale district.....	71
3.3.4 Nature and frequency of large carnivore attacks on livestock.....	72
3.4 Effect of large carnivores on the local community living adjacent to protected areas .....	73
3.4.1 Livestock loss caused by large carnivores in the Liwale district.....	73
3.4.2 Fear of human death/injury due to the high distribution of carnivores in communal lands.....	74
3.5 Human and landscape factors that influence human-carnivore conflicts...	74
3.5.1 Livestock invasion in the protected areas.....	74
3.5.2 Farming activities in the protected areas .....	76
3.5.3 Decline of prey base due to poaching.....	77
3.5.4 Distance of villages from protected areas boundaries .....	79
3.6 Community attitudes towards human-carnivore conflicts .....	79
3.7 Community's behavior response in mitigating problematic carnivores .....	80
<b>4.0 DISCUSSION</b> .....	<b>82</b>
<b>5.0 CONCLUSION AND RECOMMENDATION</b> .....	<b>83</b>
<b>6.0 REFERENCES</b> .....	<b>84</b>

## LIST OF TABLES

Table 01: Surveyed villages during household questionnaire survey.....	67
Table 02: Local community's socio-economic characteristics regarding response to human-carnivore conflicts.....	67
Table 03: Area reserved for livestock keeping in Liwale district.....	68

## LIST OF FIGURES

Figure 01: A map of the study area showing villages adjacent to protected areas..	64
Figure 02: The rate of large carnivore dispersion in the protected areas .....	69
Figure 03: Human-large carnivore conflict incidences between 2018 - 2022 .....	70
Figure 04: Trend of large carnivore attack incidences between 2018-2022 .....	71
Figure 05: Trend of large carnivore attack incidences between 2018 - 2022 .....	72
Figure 06: A structure of a traditional livestock enclosure/Boma .....	72
Figure 07: Number of livestock killed by large carnivores between 2018 - 2022 .....	73
Figure 08: A pack of wild dogs sighted near Kimambi village .....	74
Figure 09: A map shows livestock invasion in the protected areas.....	74
Figure 10: Livestock and livestock enclosure encountered within the protected areas .....	75
Figure 11: A sign banner shows a boundary of the Nyerakipelele forest reserve .....	75
Figure 12: A map shows farming activities inside the protected area .....	76
Figure 13: Aerial picture shows illegal farming activities within Magingo WMA .....	76
Figure 14: A map shows poaching incidences that are encountered within protected areas .....	77
Figure 15: Poaching incidences that are encountered within the protected areas..	77
Figure 16: Snares used to trap wild animals in the protected areas .....	78
Figure 17: The trend of poaching incidences from 2019 to 2022.....	78
Figure 18: A map shows the distance from the village to the protected area boundaries .....	79
Figure 19: Local community attitudes towards human-carnivore conflicts.....	80
Figure 20: Carnivore killed by the local community in mitigating HLCC.....	80

## LIST OF APPENDICES

Appendix 1: Questionnaire form for the data collection on human attitudes towards large carnivores. ....	59
Appendix 2: Guiding questions for the key informant interview.....	64
Appendix 3: Community's identification card for large carnivores. ....	59

## LIST OF ABBREVIATIONS

CIC	International Council for Game and Wildlife Conservation
CO	Commanding Officer
DAS	District Administrative Secretary
DGO	District Game Officer
DLFDO	District Livestock and Fisheries Development Officer
FRs	Forest Reserves
HEC	Human-elephant conflict
HLCC	Human-Large Carnivore Conflict
NRMO	Natural Resources Management Officer
PAC	Problem-animal control unit
PAs	Protected areas
SNE	Selous-Nyerere ecosystem

TANAPA	Tanzania National Parks
TAWA	Tanzania Wildlife Management Authority
TAWIRI	Tanzania Wildlife Research Institute
TFS	Tanzania Forest Services Agency
VGS	Village game scouts
VLUP	Village land use plans
WMAs	Wildlife Management Areas

## 1.0 INTRODUCTION

### 1.1 Human-Large carnivore conflict in Tanzania.

Human-Large Carnivore Conflict, particularly over livestock depredation, is among the most pressing conservation issues in many parts of the country's ecosystems (Thorn et al., 2013; Hemson et al., 2009). Despite the country having a large network of protected areas (32.5%), HLCC is a serious management issue facing wildlife management authorities today. Human-carnivore conflict in Tanzania is determined by both human and carnivore behavior. The general ecology of carnivores, such as social status, habitat use, and hunting strategies, may influence their predisposition to livestock depredation (Elliot et al., 2014; Loveridge et al., 2017). On the other hand, human behaviors such as livestock husbandry, which can be deconstructed into herding practices, the structure of livestock enclosures (bomas), and the use of deterrents such as dogs (*Canis familiaris*), can determine the likelihood of livestock depredation (Ogada et al., 2003). Large carnivore attacks have become more common. It is estimated that more than 563 people were killed and 308 injured between 1990 and 2004 (Packer et al., 2005). For instance, Ikanda and Packer (2008) found that lion killing in the Ngorongoro Crater is directly proportional to the amount of cattle depredation, and Kissui (2008) found that in the Maasai steppe, 100% of lion attacks resulted in retaliation for livestock predation. A study in villages outside the Serengeti National Park showed that economic losses due to livestock predation by carnivores amounted to \$12,846 per year (Holmern et al., 2007). Livestock depredation by large carnivores affects the quality of people's livelihoods (Kissui et al., 2019), at the same time, people, i.e., farmers, pastoralists and even local government authorities under problem-animal control (PAC) activity (Ikanda & Packer 2008) normally react against carnivores perceived to be responsible for the losses (Kissui, 2008) thus, threatening the persistence of large carnivore populations. While lions are typically the focus of retaliatory killings, leopards, spotted hyaenas, wild dogs and cheetahs are also commonly killed, driving multiple species declines (Inskip & Zimmermann, 2009). Mitigating these conflicts is an essential carnivore conservation goal, particularly in human-dominated landscapes, to promote human-carnivore coexistence (Kissui et al., 2019).

### 1.2 Rationale of the study

The carnivore population in the Selous-Nyerere ecosystem (SNE) is unfenced and surrounded by semi-protected areas such as Game Controlled Areas (GCAs), Wildlife Management Areas (WMAs), Forest Reserves (FRs) and extensive open wilderness village lands that are primarily used by the nominal population for dispersal. But human population growth and changing land use (Introduction of pastoralism) constrain large carnivore dispersal ecology, potentially affecting the population through the hard-edge effect. The main question was on the present suitability of the open areas, wildlife management areas and forest reserves for carnivore dispersal ecology under ongoing population pressures and changing land use in the ecosystem. It was hypothesized that both human populations increase, and land-use change had negatively affected carnivore dispersal by aggravating human-carnivore conflicts in time and space. Given that the shared landscapes often represent a vital part of their remaining geographic distribution (Di Minin et al., 2016), the eradication of large carnivore species from the area may threaten their conservation. Despite this, the need for the conservation of large carnivores in proximity to human populations often generates intense debate, with a critical point of contention being whether and to what degree the negative impacts humans

and large carnivores have on each other can be sufficiently minimized (Carter & Linnel, 2016). This study, therefore, presents information on (i) Understanding the social and economic impacts of human-carnivore conflicts in the study area, (ii) Identifying human and landscape factors that influence human-carnivore conflicts, (iii) Determining local community behavior in response to human-carnivore conflicts in the study area, and (iv) Identifying areas with high human-carnivore conflict incidences for suggesting proper and practical mitigation measures.

### **1.3 Research objective and activities**

#### **1.3.1 General objective of the study**

This study provides considerable information on patterns of large carnivore depredation on livestock and assesses community behavior regarding human-carnivore conflicts in the Selous-Nyerere ecosystem (SNE).

#### **1.3.2 Key activities**

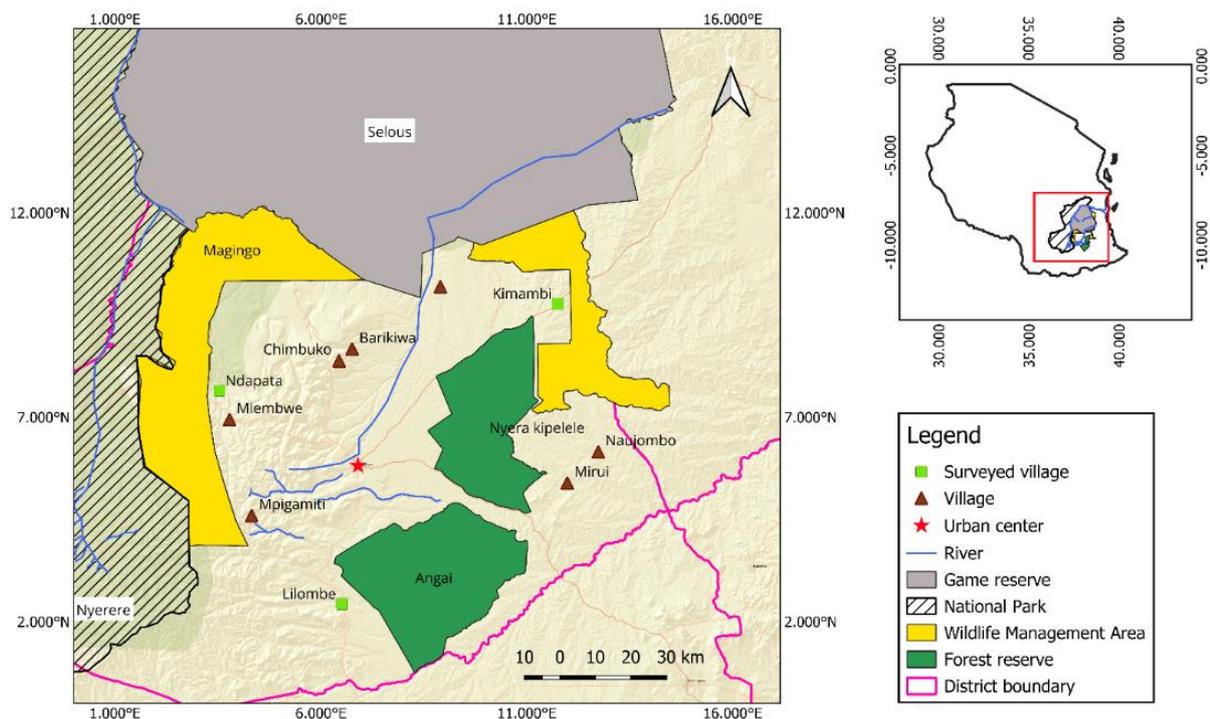
To accomplish the main objective, the study had four (4) main activities:

- i. To show the current dispersal rate of large carnivores and evaluate the differences among wildlife management areas, open areas and forest reserves.
- ii. To collect evidence about large carnivores' livestock depredation from the local communities adjacent to protected areas (Pictures, observations and carcasses remain).
- iii. To assess human attitudes and responses towards the effect of large carnivores' dispersal in time and space.
- iv. To provide conservation education to the local communities, specifically on the importance and behavioral ecology of large carnivores.

## 2.0 METHODOLOGY

### 2.1 Study area

The study was conducted in the Liwale district located at  $9^{\circ} 48'17.44''$  S,  $37^{\circ} 55'52.46''$  E of the Lindi region in south-eastern Tanzania (Fig. 01). The vegetation is mainly covered by miombo, dominated by *Pterocarpus angolensis*, *Azelia quanzensis*, *Dalbergia melanoxylon*, *Euphorbia candelabrum*, and *Brachystegia spiciformis* species (Dondeyne et al., 2004). The climate is characterized by two yearly rain periods: a short period from late November to January and a longer period from March to May. Annual precipitation ranges from 600-1000 mm (Næsset et al., 2020). The main dry season is from July to October and the average temperature is about  $25^{\circ}\text{C}$ . The district comprises two (2) core protected areas, the Selous game reserve and Nyerere national park. The largest river in Tanzania and East Africa, the Rufiji River passes between the core areas, which together with the great Ruaha river, creates a vital habitat for the important population of many species, including endangered African elephants, buffalo, crocodiles, hippos, Lesser Kudu, sable antelope and Impala (TAWA, 2016). Other protected areas found include the Magingo wildlife management area (451,500 Ha), Nyera-kipelele (98,420 Ha) and Angai (140,000 Ha) forest reserves, as well as open areas. The area is an important biological link for wildlife migrating between the core and dispersal areas.



**Figure 01:** A map of the study area showing villages adjacent to protected areas.

### 2.2 Research design

The research used primary and secondary data to collect social and ecological data for the past 5 years (2018 - 2022). Data were collected from February 2023 to December 2023 using a combination of different approaches; - Questionnaires, key informant interviews, sign surveys, sighting reports and damage reports. Before the commencement of the study, we clarified the purpose of the study to the district

government and, together with the government and non-government institutions that protect wildlife and their habitat in the study area. We conducted a brief survey to identify villages that are vulnerable to human-carnivore conflicts based on incidences reported by local communities to TAWA, TANAPA, TFS and DGO.

## **2.3 Data collection**

### **2.3.1 Sighting reports**

After a keen consultation with conservation scientists and experts from TAWA, TANAPA, TFS, Magingo WMA and hunting companies, we recognized a total of 20 carnivore sighted sites for ground surveillance (10 sites in WMA, 6 sites in forest reserves and 4 sites in open areas). Sites recognized were georeferenced using QGIS V3.30 software and then surveyed for 1 month. Sites survey was very crucial for designing transects for the sign survey approach.

### **2.3.2 Sign surveys**

The sign surveys approach was used to identify a range of potential sites for carnivore species across wildlife management areas, open areas, and forest reserves (Thorn et al., 2010). A total of ten (10) transects (Grids with 225 Km<sup>2</sup>) were designed following the site surveys conducted earlier. Sites selection was based on Habitat suitability (Vegetation cover, water availability and herbivores presence), geographical location, distance from human settlements and accessibility of the area (Kendall et al., 1992). The survey was conducted both on foot and from a vehicle (Toyota Landcruiser) travelling at 10–15 km/h with 4 trained observers who were searching for signs. We used field guidebooks where necessary for assistance (Burgener & Gusset, 2003; Dunstone, 2005). If a species was recorded on the sub-transect, it was marked as one (1); if it was not recorded, it was marked as zero (Foley et al., 2018).

### **2.3.3 Questionnaire survey and interviews**

Household surveys were held in three (3) villages, namely Kimambi, Lilombe and Ndapata, and a total of 131 respondents successfully participated in the survey (Table 01). On the other hand, nine (9) key informants were interviewed to provide their vital insights regarding the situation of human-carnivore conflicts in the Liwale district (Appendix 4).

### **2.3.4 Damage reports**

In the three (3) villages, two (2) village game scouts (VGS) were trained on how to collect data on livestock depredation when the incident occurred. The selected VGS were provided with a data collection kit with pencils, data sheets, a camera, an identification manual and a GPS device for recording location if an incident happens.

### **2.3.5 Focus group discussion**

A group of 5-15 people, which included both males and females aged 18 and above, was allowed to participate in a discussion regarded for provision of conservation education, specifically about the ecological behavior of large carnivores. 80% of the participants declare that human-carnivore conflict incidences are getting worse as compared to the last 4 years. The majority responded that they didn't know the correct path to follow if the incident happened.

## **2.4 Data analysis and evaluation**

### **2.4.1 Regression modelling**

Data for structured questionnaires and damage reports were categorized into themes and sub-themes, each of which will be assigned an identification code for easy analysis (Masenga et al., 2019). Descriptive analyses were employed in the Statistical Package for Social Sciences for Windows (SPSS 16). Other results are summarized in tables and graphs.

### **2.4.2 Occupancy modelling**

Primary and secondary data on large carnivore distribution were analyzed using occupancy modelling (MacKenzie et al., 2006) to estimate both site occurrence ( $\psi$ ; the probability that the species occurred at a site) and detectability ( $P$ ; the probability that the species was detected if present). The R (R Development Core Team, 2018) package unmarked includes the occ function, which fits the occupancy model from MacKenzie et al. (2002).

### 3.0 RESULTS

#### 3.1 Socio-demographic characteristics of respondents

##### 3.1.1 Surveyed villages

**Table 01:** Surveyed villages during household questionnaire survey.

Name of village	No. of household	Frequency	Percent (%)
Kimambi	512	54	41.2
Lilombe	454	55	42
Ndapata	173	22	16.8
<b>Total</b>	1139	131	100

For the past 5 years (2018-2022), the three villages have been reported to have seriously human-carnivore conflict incidences compared to other villages bordering protected areas in the Liwale district. Kimambi and Lilombe had an average of 42% of the total respondents as compared to Ndapata's 16.8% due to several reasons; - (i) The number of households in the village, (ii) The total area reserved for livestock keeping, (iii) Accessibility of the area/Dispersion and (iv) Respondent willingness to cooperate/Fear factor.

##### 3.1.2 Socio-economic characteristics of respondents

**Table 02:** Local community's socio-economic characteristics regarding response to human-carnivore conflicts.

Variable name	Variable category	Frequency	Percent (%)
Sex	Female	52	39.7
	Male	79	60.3
Age	18-28	38	29
	29-39	48	36.6
	40-49	34	26
	50 and above	11	8.4
Family size	01-05	64	48.9
	06-10	44	33.6
	11-15	18	13.7
	16 and above	5	3.8
Education level	Informal	98	74.8
	Primary level	32	24.4
	Vocational training	1	0.8
Occupation	Agriculture	4	3.1
	Livestock keeping	43	32.8
	Agriculture and Livestock keeping	84	64.1

Total number of livestock	Below 50	58	44.3
	51-200	51	38.9
	201-350	17	13
	Above 351	5	3.8
Residential status	Native	0	0
	Immigrant	131	100
Years spent in the area/village	0-5	71	54.2
	06-10	45	34.4
	11 and above	15	11.4

Communities living adjacent to protected areas are highly dependent on agriculture and livestock keeping as a source of food and income. 64.1% of respondents practice both agricultural and livestock-keeping activities, while 32.8% only depend on livestock-keeping. In the past 6 years (2018-2023), the influx of pastoral societies (Mainly the Sukuma and Mang'ati) in the Liwale district became very high 54.2%, as compared to 11 years back 11.5%. The majority declared they moved into the area to find good pastures and space for their livestock. During the questionnaire surveys, 60.3% and 39.7% of males and females consecutively participated in the survey. The culture and traditions of the Sukuma and Mang'ati tribes show that females rely on males/husbands for decision-making, leading to the number of females being small compared to males. The survey involved respondents who were 18 years and above. The age group of 29-39 years was prominent, with 36.6%, followed by 29% of the 18-28 years age group. The age groups mentioned implying that the survey comprised respondents who were within the age defined as active and economically productive population (Ogunniyi et al., 2011). Also, Mwamnyange (2008) points out that the respondent's age may determine individual maturity and ability to make rational decisions. 48.9% of the households surveyed fall under the family size category of 1-5 people, followed by 33.6% of the 6-10 category. Family size is very important in determining the number of livestock a household can keep. 44.3% of households had a total number of livestock below 50, while households with a total number above 351 only 3.8%. On the education level, 24.4% of the respondents have primary education, while 0.8% have vocational training. Despite 74.8% of the respondents possessing formal/indigenous knowledge, the knowledge is useful in predicting weather conditions because the majority of pastoralists are nomads.

### 3.2 Livestock keeping and management system in the Liwale district.

**Table 03:** Area reserved for livestock keeping in Liwale district.

Village	Area for livestock keeping (Ha)	Carrying capacity	Type of livestock				Livestock No/ village	%
			Cattle	Donkey	Goat	Sheep		
Ndapata	5,456.47	2,728	939	0	212	131	1,282	4.81
Kimambi	42,022.76	21,011	15,355	33	1,558	499	17,445	65.44

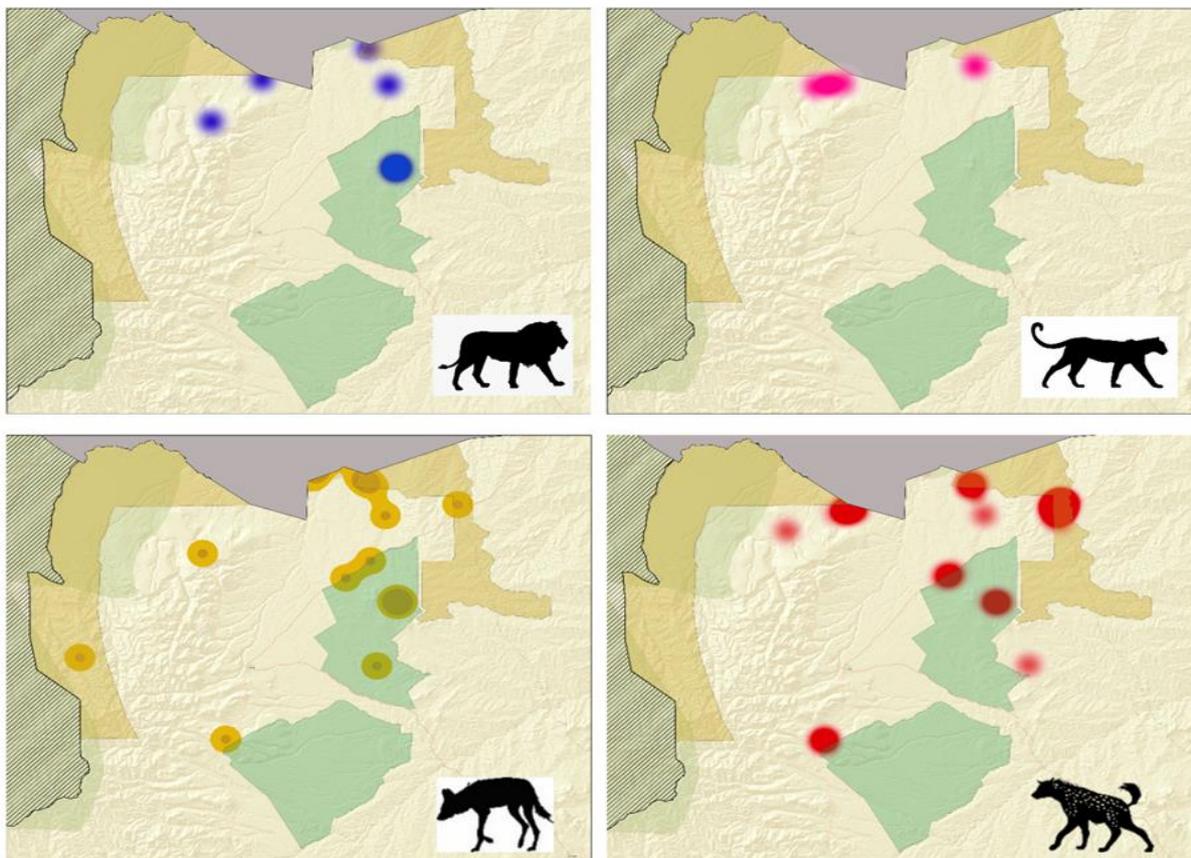
Lilombe	19,920	16,833	6,736	13	1,025	156	7,930	29.75
<b>Total</b>	<b>67,399</b>		<b>23,030</b>	<b>46</b>	<b>2,795</b>	<b>786</b>	<b>26,657</b>	

**Source:** District Livestock and Fisheries Development Officer (DLFDO), 2023.

In the district, out of 3,780,000 Ha, the total area reserved for livestock keeping is only 67,399 Ha which is claimed not to be enough by local communities due to the ongoing increase of informal pastoralists and arbitrary livestock keeping, which sometimes leads to controversy among conservationists, farmers and pastoralists specifically to those who are already officiated by the district council. The area reserved depends on the total size/area of the village land and the village land use plans (VLUP). VLUP may include designated areas for human settlement, agriculture, forest land, water catchment areas, areas for social services, economic zones and no-use zones. VLUP is usually reviewed after every 10 years by a team of surveyors together with the village government to promote more desirable social and environmental outcomes and more efficient use of resources and prevent land use conflicts. According to DLFDO, all the pastoralists from Ndapata village will soon be transferred to Kimambi and Lilombe villages with enough space for animal husbandry. In the Liwale district, livestock keeping is still traditional, whereby more than 60% of pastoralists depend on weather seasons (Wet/Dry) to migrate with their livestock searching for food and water. Also, they use traditional bomas/enclosures to protect their livestock against predators.

### 3.3 Human-large carnivore conflicts in the Liwale district

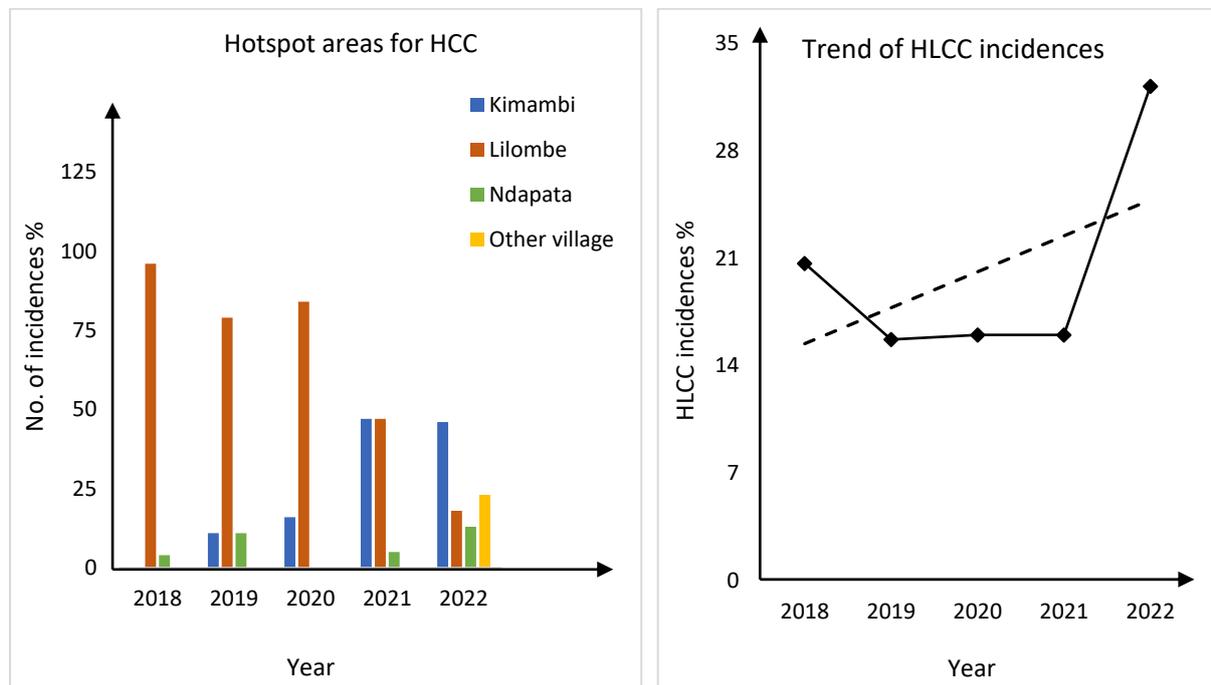
#### 3.3.1 Dispersal rate of large carnivores in wildlife management areas, open areas and forest reserves



**Figure 02:** The rate of large carnivore dispersion in the protected areas.

Large carnivores' dispersion was higher in pastoralist village land than in agricultural land. The high overlapping between endangered wild dogs and spotted hyenas was due to similarities in their hunting strategies. Spotted hyenas and wild dogs are both predators that hunt in groups. For example, both species use cooperative hunting techniques to take down prey that is much larger than themselves. They also both have a high success rate when hunting in groups. However, there are also some differences between the two species. For example, wild dogs are more agile and can run faster than hyenas. They also tend to hunt during the day, while hyenas are more active at night. However, hyenas are larger and stronger than wild dogs and can sometimes overpower them. In addition, hyenas have been known to steal food from wild dogs.

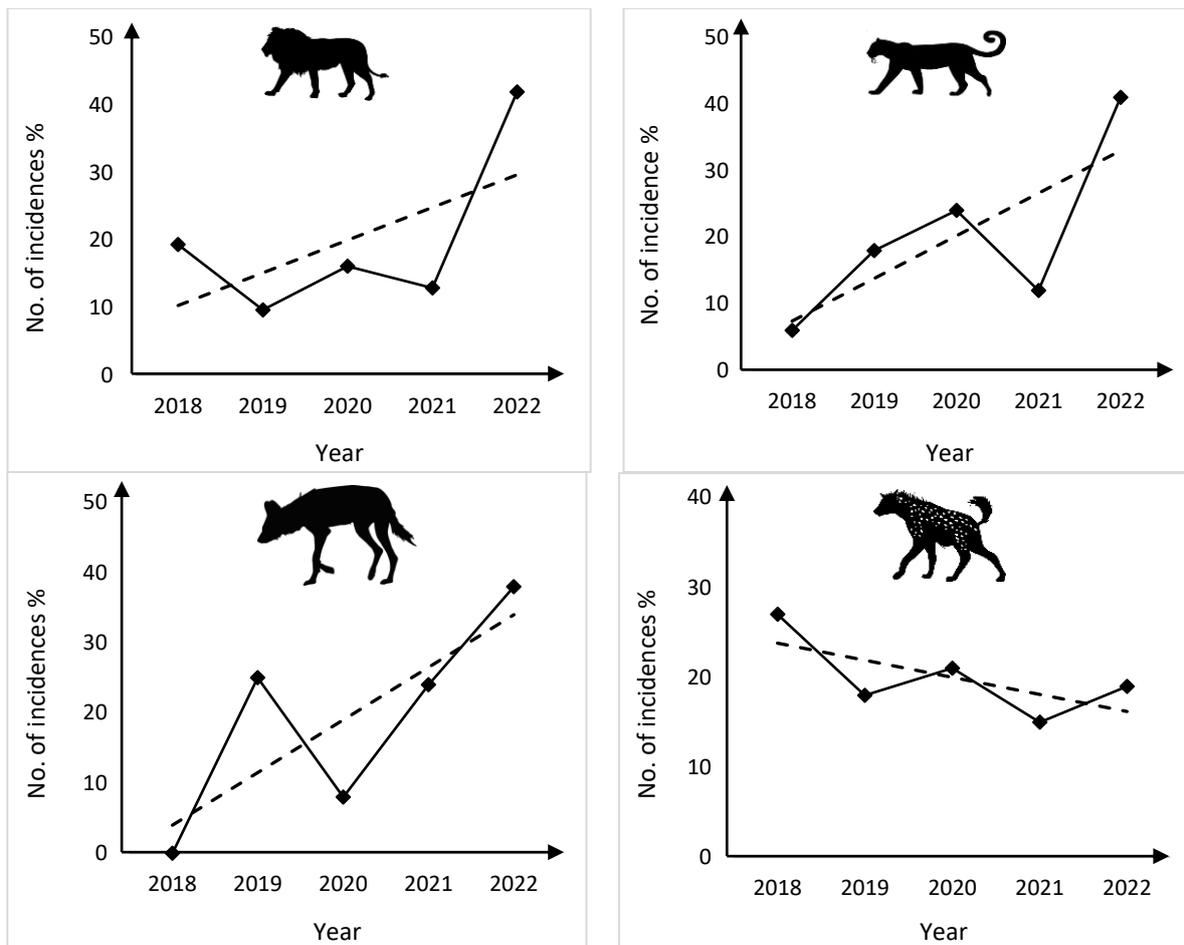
### 3.3.2 Hot spot areas with high incidences of human-carnivore conflicts



**Figure 03:** Human-large carnivore conflict incidences between 2018 - 2022

In the Liwale district, the first carnivore attack on livestock was reported in 2014 in Ndapata village. Later on, in 2018, the situation became too serious and started to evolve in other villages bordered by the protected areas. From 2018-2022, 121 HLCC incidences were recorded, marking an average of 24.2 incidences yearly. For the past 5 years, Kimambi and Lilombe villages had a total of 32 and 71 incidences, equal to 26.44% and 58.68%, consecutively. Ndapata and other villages equally had a total of 9 incidences which marked 7.44% each. Yearly, 39 incidences were recorded in 2022, the highest number of incidences reported in the past 5 years. Between 2018 and 2021, an average of 21 incidences were recorded yearly. Village executive officers of both surveyed villages declared that currently, carnivore attacks on livestock have become severe due to improper livestock husbandry and livestock incursion into protected areas.

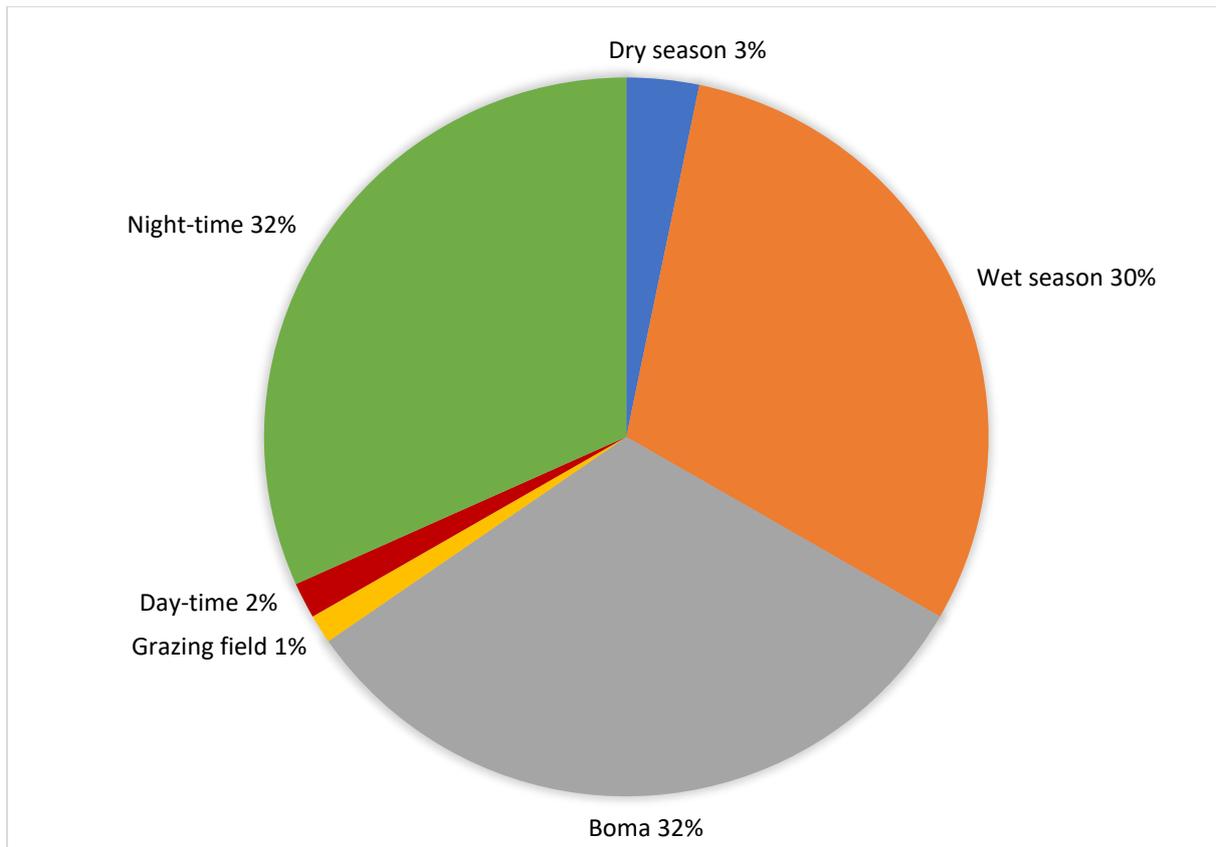
### 3.3.3 Trend of large carnivore attack incidences in the Liwale district



**Figure 04:** Trend of large carnivore attack incidences between 2018-2022

In the period of 2018-2019, large carnivores were involved in 150 attacks, specifically on livestock, with no human death/injuries recorded during that time. In total, hyenas had the highest number of attacks, 52%, followed by lions 20.67%, wild dogs 16% and leopards 11.33%. Due to retaliation killing by local people, the trend of hyena attacks on livestock currently tends to decrease compared to other carnivores. However, for the past 5 years, hyenas were more responsible for the highest percentage of livestock loss due to their hunting strategies, and they can live closer to human settlements with less fear. Local people declared that killing a hyena is much easier than other carnivores. They consider other carnivores are more aggressive and dangerous; therefore, killing a lion or leopard could cost their life, especially human death/injury.

### 3.3.4 Nature and frequency of large carnivore attacks on livestock



**Figure 05:** Trend of large carnivore attack incidences between 2018-2022



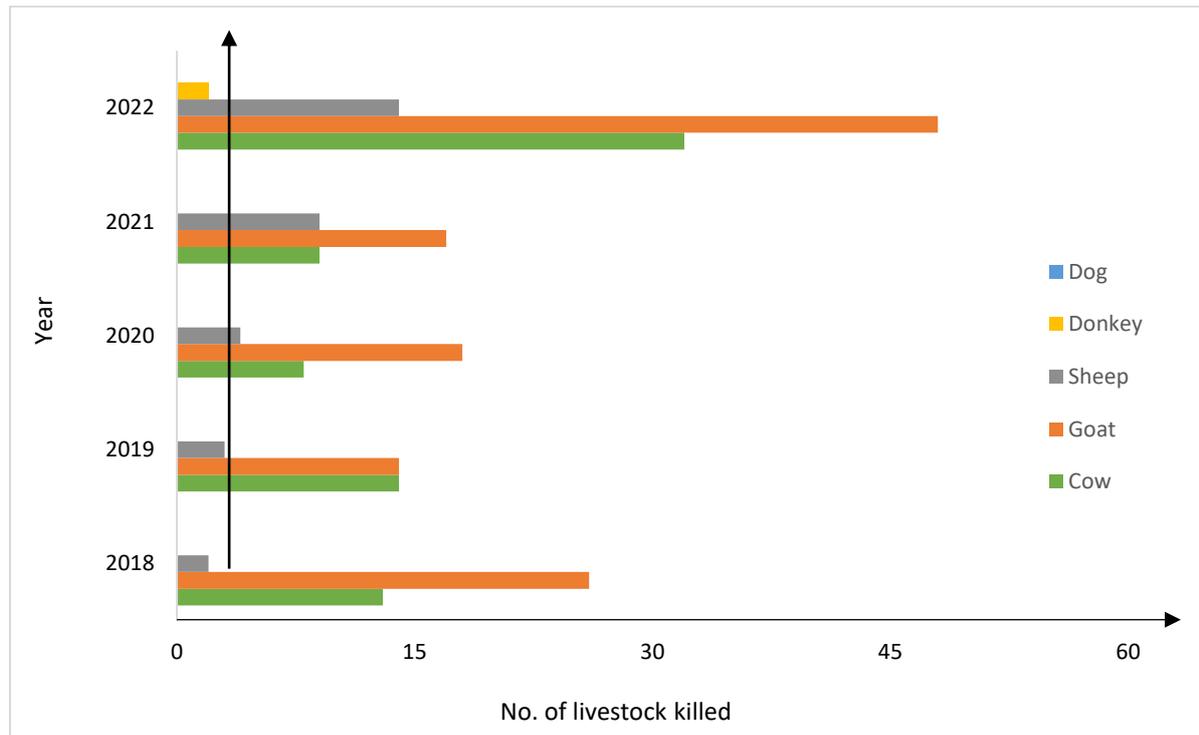
**Figure 06:** A structure of a traditional livestock enclosure/Boma

Depredation events were highly dependent on the season of the year, the structure of livestock enclosure/bomas and the time of the attack. Carnivore attacks were high during the night-time, 32% than in the daytime 2% because most carnivores are nocturnal hunters, the darkness provides a favorable condition to hunt and during that time, livestock are less alert and more vulnerable. Livestock attacks were high in livestock enclosure/bomas 32%, while they were very low in grazing fields, 1%. Traditional bomas are often made of weak materials such as sticks and bushes, which are not strong enough to keep out lions, hyenas and leopards. In grazing fields, carnivores are hard to hunt due to the daylight, presence of watchmen and guarding dogs which might prevent the attacks. Pastoralists are highly dependent

on the season of the year to settle with their livestock. During the wet seasons, pastoralists can settle in one place for a long time. This scenario attracts carnivores due to the availability of easy food. In dry seasons pastoralists migrate with their livestock searching for water and green pastures hence escape attacks.

### 3.4 Effect of large carnivores on the local community living adjacent to protected areas

#### 3.4.1 Livestock loss caused by large carnivores in the Liwale district



**Figure 07:** Number of livestock killed by large carnivores between 2018-2022

From 2018 to 2022, a total of 233 livestock were killed by large carnivores, with the highest percentage of goats, 52.8%, followed by 32.6% of cows, 13.7% of sheep and 0.9% of donkeys. The number of goats attacked is high, while there was no death recorded in dogs because usually, carnivores prefer preys that are easier to catch with less effort to reduce energy and maximize their intake. In 2022 livestock killed by carnivores was 41.2% which was the highest value compared to 17.6% in 2018, 13.3% in 2019, 12.9% in 2020 and 15% in 2021. The total amount lost due to livestock depredation by large carnivores was about US dollar 37,573; such amounts could be useful in improving the standard of living since the communities living adjacent to the protected areas are poor and live below basic needs and food poverty lines.

### 3.4.2 Fear of human death/injury due to the high distribution of carnivores in communal lands

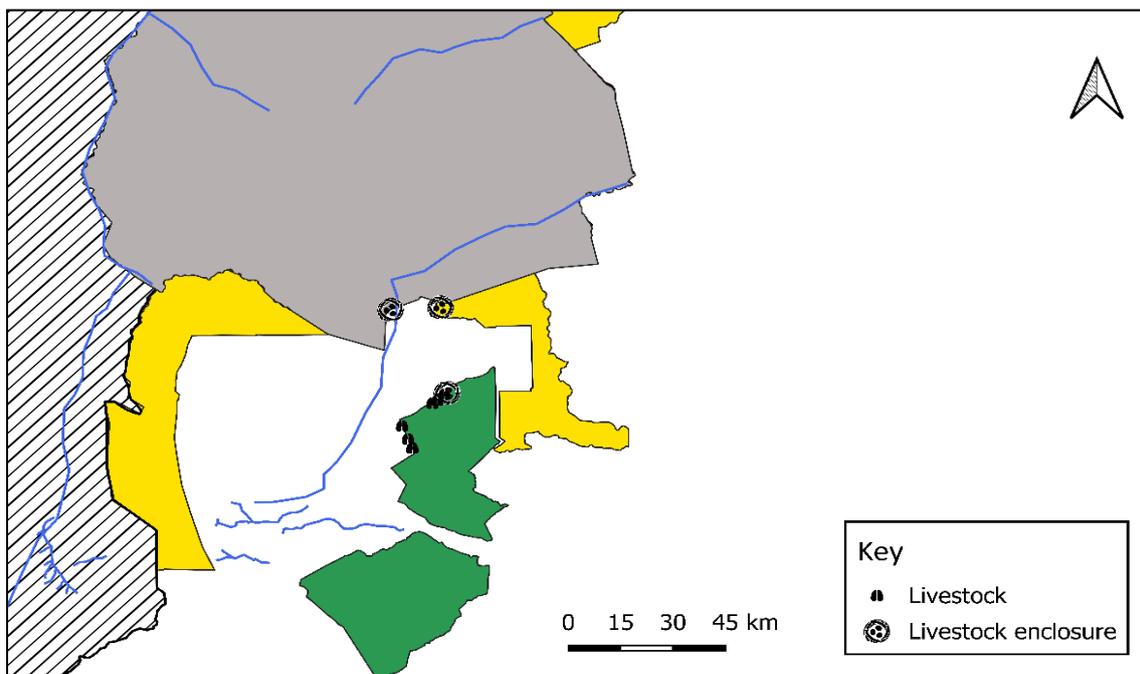


**Figure 08:** A pack of wild dogs sighted near Kimambi village.

The high dispersion of large carnivores in communal lands led to the impeding and worsening of social and economic activities in villages surrounding the protected areas. People fear going to farms and schools in dawn hours and returning to their premises in the late evening for fear of encountering carnivores. In all surveyed villages, spotted hyenas and wild dogs were highly sighted near the village's land by local communities. This human-domestic-wild animal interface had much impact on domestic animals; no information had been reported on pathogen transmission due to the co-existence.

### 3.5 Human and landscape factors that influence human-carnivore conflicts

#### 3.5.1 Livestock invasion in the protected areas



**Figure 09:** A map shows livestock invasion in the protected areas.



**Figure 10:** Livestock and livestock enclosure encountered within the protected areas.

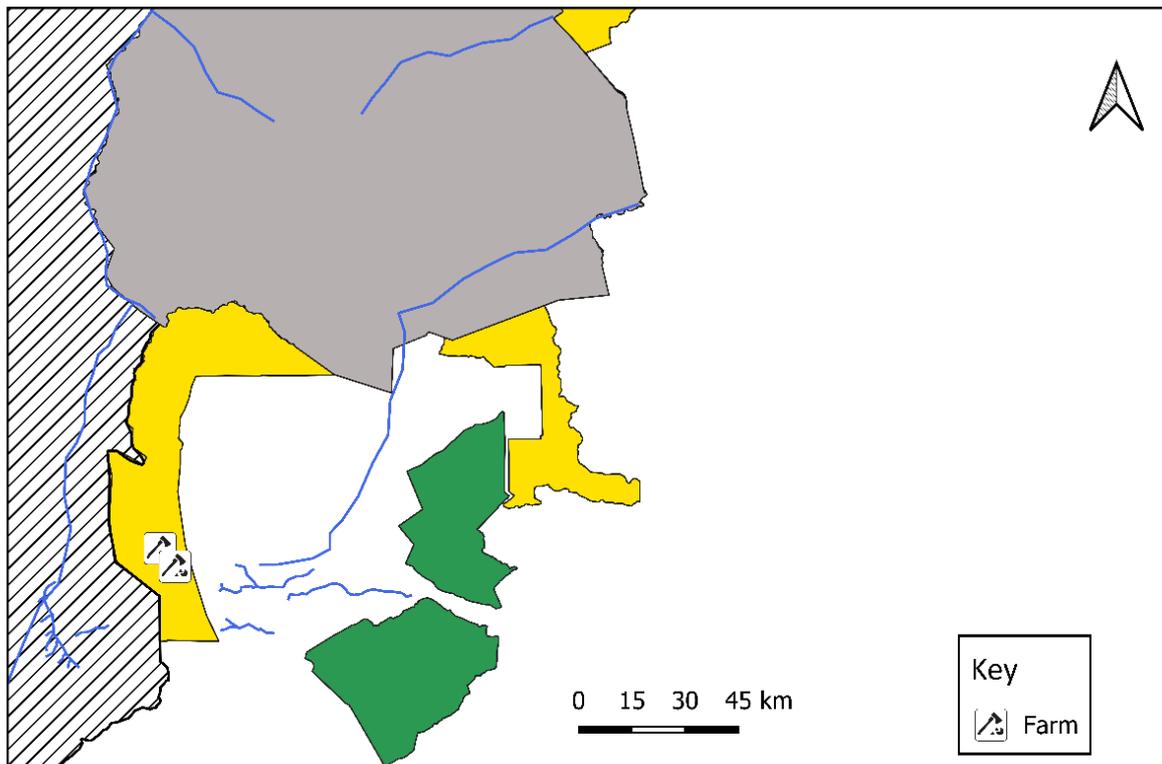


**Figure 11:** A sign banner shows a boundary of the Nyerakipelele forest reserve.

Livestock invasion in protected areas leads to habitat fragmentation which results in the competition for resources, i.e., water and space between carnivores and domesticated mammals. Habitat fragmentation leads to prey base decline since herbivores shift from unsuitable to suitable places. Also, the interactions could lead to the transfer of zoonotic diseases from wild animals to domesticated animals. During the survey, we encountered several groups of cattle and temporary livestock enclosures/Bomas within the Nyerakipelele forest reserve, while within Magingo WMA, we only encountered temporary livestock enclosures. These temporary livestock enclosures are mostly built and used during the seasonal movements of herds of cattle. Despite the clear demarcation of the Nyerakipelele forest reserve, livestock incursion was very high compared to the Angai Forest Reserve and Magingo WMA. The invasion of livestock in protected areas is higher in dry seasons

than in wet seasons because, during wet seasons, water and pastures become available in most places. In all surveyed villages, VEOs were complaining that current village land use plans are old and have not been reviewed for more than 5 years to match the current situation of human population growth. The situation has contributed to livestock invasion into protected areas due to limited spaces available.

### 3.5.2 Farming activities in the protected areas



**Figure 12:** A map shows farming activities inside the protected area

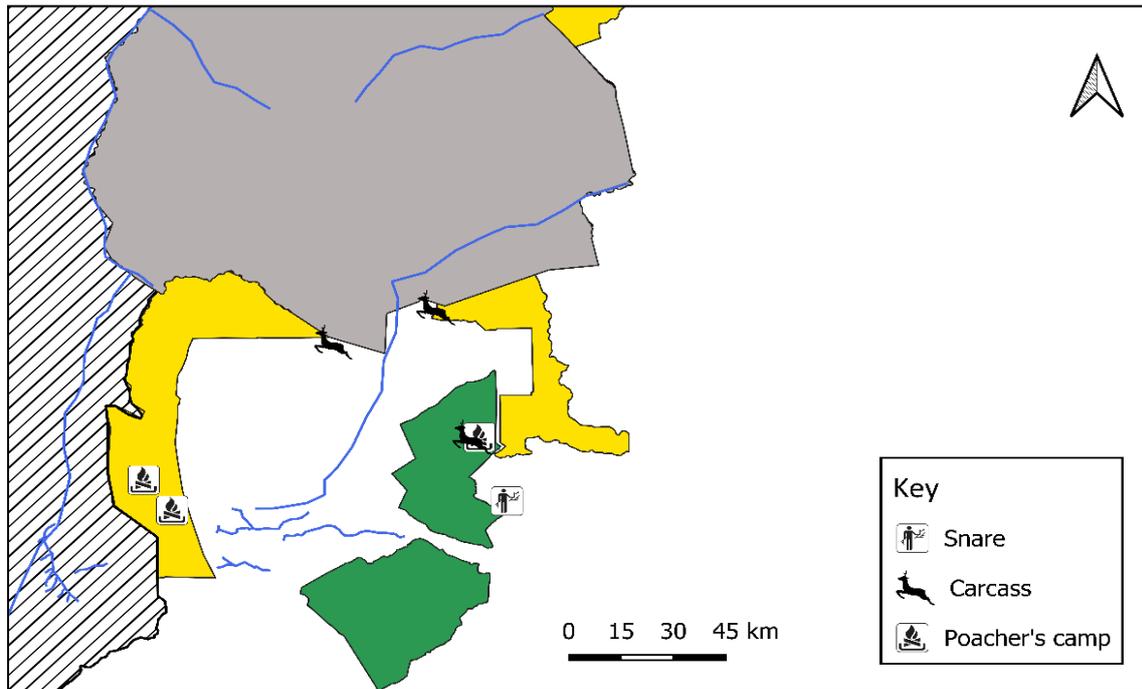


**Figure 13:** Aerial picture shows illegal farming activities within Magingo WMA

We encountered several farms and small temporary houses for settlements within the Magingo WMA. People caught inside claimed that they didn't know the official

demarcation of the WMA; it was a coincidence. VEO of the Ndapata village admitted that after the official upgrading of two-thirds of the Selous game reserve to Nyerere national park, the challenge arose. However, the district government has the plan to reallocate all pastoralists to Kimambi village for easy management and control of the livestock-keeping system; still, the process would be too expensive in terms of money and manpower, and most likely it will take too long to be implemented.

### 3.5.3 Decline of prey base due to poaching



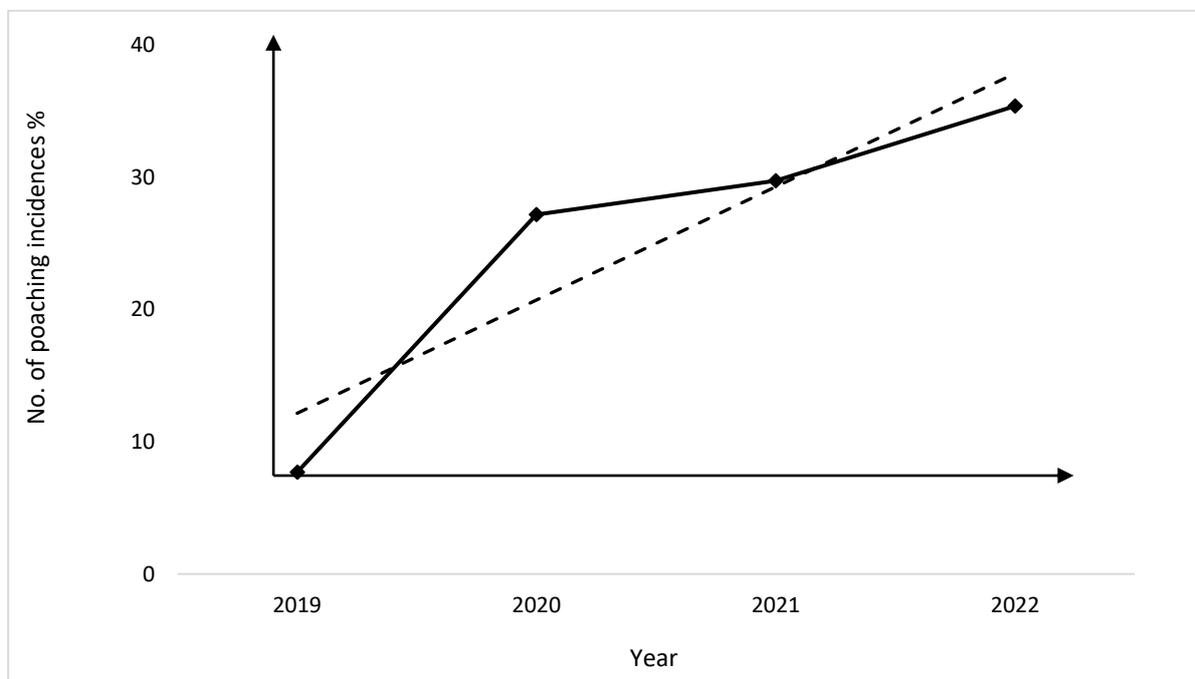
**Figure 14:** A map shows poaching incidences that are encountered within protected areas.



**Figure 15:** Poaching incidences that are encountered within the protected areas.



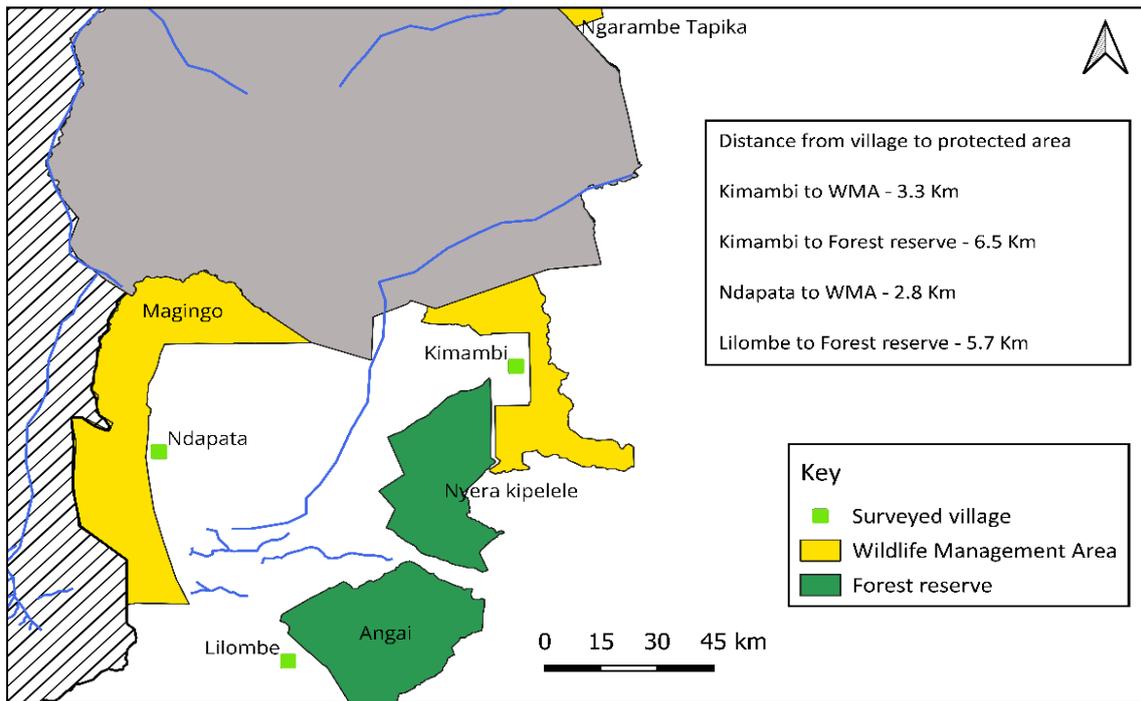
**Figure 16:** Snares used to trap wild animals in protected areas.



**Figure 17:** The trend of poaching incidences from 2019 to 2022.

The communities living adjacent to protected areas are poor and live below basic needs and food poverty lines (SEAP,2016). These people are easily manipulated by wealthy people to facilitate the killing of wild animals for food and commercial purpose. Poaching was among the key determinants for human-large carnivore conflicts due to the decline of the prey base. From 2019 to 2022, the trend of poaching has increased in dispersal areas due to the high demand for bush meats and the use of a new and growing method of wire snares on bush meat poaching. The method is widespread because it is cost-effective, easy to adopt and hard to be detected by wild animals (Gray et al., 2018). Snares frequently catch a large number of both targeted and non-targeted species within a short period. Despite international conventions and the country's laws modified and restricting the illegal use of firearms, in another way, it accelerates the evolution of wire snares in poaching in the ecosystem (Gervasi et al., 2021).

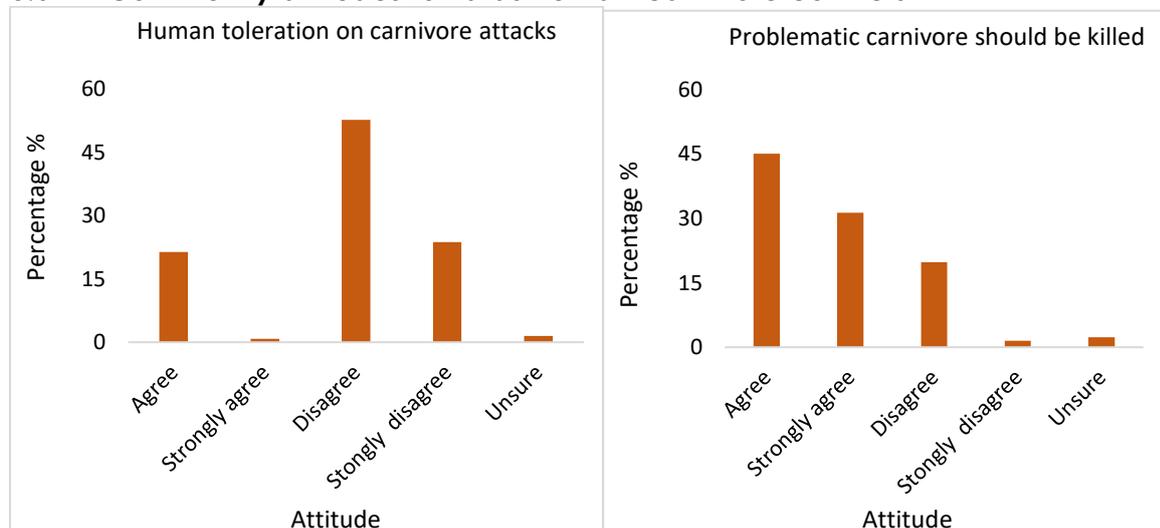
### 3.5.4 Distance of villages from protected areas boundaries

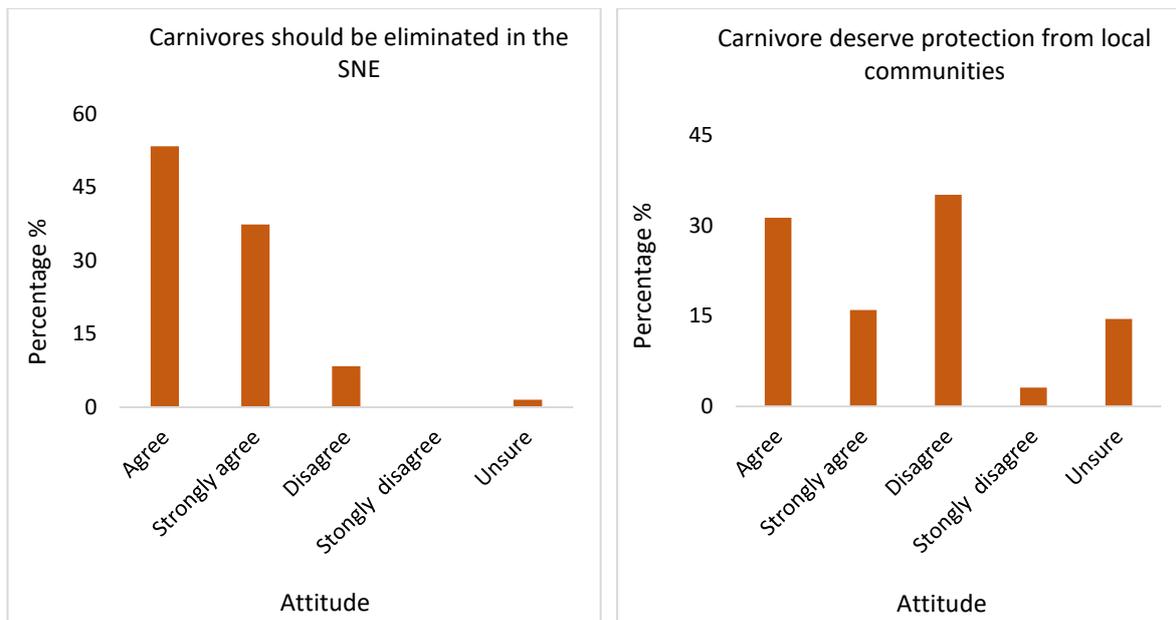


**Figure 18:** A map shows the distance from the village to the protected area boundaries.

Villages that are set aside for livestock keeping are very near to the protected area boundaries and hence are more vulnerable to carnivore attacks, and this has also led to incidents of indiscriminate raids and human activities within the protected areas. Livestock raids in the Nyerakipelele forest reserve have been widespread in Kimambi village due to having a large number of livestock than in Lilombe and Ndapata villages. People living near the protected areas may benefit from the long-term conservation of wild resources through tourism activities. Currently, 3 hunting companies operate in Magingo WMA, and villages that form the WMA receive annual allocations from the central government for community development and conservation activities.

### 3.6 Community attitudes towards human-carnivore conflicts





**Figure 19:** Local community attitudes towards human-carnivore conflicts

In response to questions asked about the local community's attitude toward large carnivore conservation efforts, the majority responded negatively. The level of negativity (Disagree/Strongly disagree) among people was highly dependent on the level of damage a person has faced. The situation reflects how much effort is needed to be invested in securing the promising future of the carnivore population in the ecosystem. Otherwise, the population could face a serious decline.

### 3.7 Community's behavior response in mitigating problematic carnivores



**Figure 20:** Carnivore killed by the local community in mitigating HLCC.

Local communities tend to use lethal methods to mitigate problematic carnivores and regularly use poison and cheaper equipment available, i.e., bows and arrows, spears and snares. According to pastoralists, if someone/people have killed a problematic carnivore, the herdsmen union gives cattle to the parties as a reward.

Sometimes, the PAC unit from wildlife authorities helps to mitigate the challenge by killing problematic carnivores. Retaliation killing of large carnivores is usually conducted in utmost secrecy without wildlife authorities and village leaders being aware because local people know it's illegal and not allowed.

#### 4.0 DISCUSSION

Pastoralists have been heavily affected by the presence of large carnivores roaming in their village land. Several times, local communities have reported carnivore attack incidences to their village leaders, i.e., VEO and VWO, but it appears that they encounter as not serious issue as compared to other forms of human-wildlife conflicts i.e., elephant attacks. Much effort has been put into mitigating elephants than carnivores because elephants are too big to compete with and usually cause human injuries and death when disturbed. This is a different situation for large carnivores, where pastoralists may sometime use lethal methods to control the problem. The situation is getting worse, and when an incident happens, local communities usually don't report it to the responsible authorities. They are afraid of being harassed and reallocated to other places by the district government because most of the pastoralists are not natives in the district and are considered a stubborn community. Records show that pastoralism in the Liwale district became more effective over the period of 5-7 years back when a large number of pastoralists were shifted from other districts, i.e., Kilwa and Nachingwea to the Liwale district. The current increase in pastoralist pressure accompanied by climate change and variability is amplifying stresses to large carnivores due to habitat shrinkage that tends to limit access to key resources for living, including water and prey (Daszak et al., 2001; Olff & Grant, 2008). Also, the grazing patterns involving mobility (nomadism), the restriction of grazing to specific areas at certain times of the year and heard splitting create many problems for carnivores and farmers. However, meeting with the local community in the study area was very important because not only the team explained a lot about carnivore behavioral ecology and conservation initiative, but also, local people had a great opportunity to interact with the team and see a better way forward on solving human-carnivore conflicts. In the past 2 years, the government built more than 2 ranger posts to combat the challenge of human-wildlife conflicts, which has been a problem for pastoralists and farmers for several years. It is my opinion that when the local communities have a chance to be involved in several projects may change their attitude toward problematic animals.

## 5.0 CONCLUSION AND RECOMMENDATION

The management of conservation conflicts to mitigate negative outcomes for biodiversity and well-being is becoming increasingly important (Sargent, 2022). Also, identifying solutions for managing human-carnivore conflict is a priority for people and wildlife in the Selous Nyerere ecosystem, as elsewhere. But conservation advocates tend to assert their interests through legislation and enforcement, which renders lethal retaliation illegal and/or socially unacceptable (Carter et al., 2017; Redpath et al., 2017). To reduce human-carnivore conflicts, technical interventions often have to be implemented, including using wildlife management authorities such as TAWA and TANAPA (Lesilau et al., 2018; Miller et al., 2016). Also, providing consolation for the loss of livestock caused by large carnivores would be an additional strategy to encourage human-carnivore coexistence in the ecosystem (Dickman et al., 2011). To foster the coexistence between humans and large carnivores, therefore, recommend the followings:

- i. To enhance law enforcement in dispersal areas, specifically in Magingo WMA and Nyerakipelele forest reserve to reduce human encroachment.
- ii. To minimize livestock depredation by large carnivores' pastoralists should modernize their traditional livestock enclosures and use cost-effective mitigation methods like flashing lights.
- iii. Wildlife authorities should enhance consolation schemes for the loss of livestock caused by large carnivores.
- iv. Wildlife authorities should enhance community conservation awareness through tourism benefit-sharing schemes and education programs.

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## 7.0 APPENDICES

**Appendix 1:** Questionnaire form for the data collection on human attitudes towards large carnivores.

**QUESTIONNAIRE SURVEY FORM** (This form will be translated into the Swahili language).

**Patterns of large carnivore depredation on livestock and community tolerance behavior around Selous-Nyerere ecosystem; A case study of Liwale district in southern Tanzania.**

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Form No: \_\_\_\_\_ Village \_\_\_\_\_ District \_\_\_\_\_

GPS Coordinates: X \_\_\_\_\_ Y \_\_\_\_\_ Date \_\_\_\_\_

### Background

1. Sex of the respondent Female  Male
2. Age of the respondent 18 - 28  29 - 39  40 - 49  50 and above
3. Ethnic group of the respondent Ngindo  Sukuma  Mang'ati  Other
4. Family size of the household 1 - 5  6 - 10  11 - 15  16 and above
5. Education level of the respondent Informal  Primary  Secondary  College/University   
Vocational training
6. Main economic activity of the respondent Livestock keeping  Agriculture  Other
7. How did the respondent get into the area he/she lives presently By birth  Immigrant
8. Length of time (Years) lived in the area/village 0 - 5  6 - 10  11 and above

### Livestock keeping

9. Type of livestock the respondent possesses Cattle  Goat  Sheep  Donkey  Dog  Pig
10. Total number of livestock the respondent possesses  $\leq 50$   51 - 200  201 - 350   $\geq 351$

11. Number of livestock now compared to 10 years ago      Same       Fewer       More
12. Are the livestock guarded in any way?      Yes       No .      If the answer is **YES**.
- a) How?      Dog       Bomas       Fencing       People/Watchman       Other
- b) They guarded livestock against what      Thieves       Predators       Elephant       Both       Other
- c) When are they guarded      Day-time       Night-time       Always

**Large carnivore attacks**

13. Which large carnivore have you experienced in your area/village land for the past 5 years
- Lion       Leopard       Spotted Hyena       Wild dog       Other
14. Which large carnivore is more threatening and destructive in your area/village land
- Lion       Leopard       Spotted Hyena       Wild dog       Other
15. Level of threats and destruction caused by large carnivores mentioned in 12 above
- Human injury       Human death       Crop raiding       Livestock
- Depredation
16. Have any livestock losses been caused by carnivores in your household?
- Yes       No

If **NO** please go to question 16. If **YES** please continue to sections (a), (b), (c) and (d).

(a) Approximately how many livestock have you lost to carnivores for the past 5 years

(b)

Sn.	Domestic animal	2018				2019				2020				2021				2022			
		Li	Le	Wd	Sh																
1	Cattle																				
2	Goat																				

3	Sheep																					
4	Donkey																					
5	Sheep																					
6	Pig																					
7	Other																					
<b>Note</b>																						
Li	- Lion																					
Le	- Leopard																					
Wd	- Wild dog																					
Sh	- Spotted Hyena																					

(C) Frequency of sightings and attacks

<b>Attack on livestock by large carnivores?</b>	<b>Lion</b>	<b>Leopard</b>	<b>Spotted Hyena</b>	<b>Wild dog</b>
Season of attack (dry/wet)				
Location of attack (At/around the boma or grazing field?)				
Time of day of the attack (Day/Night)				
Livestock type attacked				
What happened to the carnivore after an attack				
<b>Attack on humans by large carnivores?</b>				
Date (year and month if possible)				
Location of attack (Boma/Grazing field)				
What was the person doing				
Was the person injured or /killed?				
What happened to the predator?				

(d) What do you think about these incidences of human-carnivore conflicts around your area/village?

Village close to PA  Traditional bomas  Encroachment to PA  Nomadism

(e) Do the number of large carnivore attacks appear to be more or less than 5 years ago

More  Less  Same  Don't know

**Local community attitudes**

17. Large carnivores are more threatening to humans than livestock?

Agree  Strongly agree  Disagree  Strongly disagree  Unsure

18. Large carnivores are more threatening to livestock than humans?

Agree  Strongly agree  Disagree  Strongly disagree  Unsure

19. Can you tolerate when a large carnivore kills your livestock or cause any human injury/death in your household?

Agree  Strongly agree  Disagree  Strongly disagree  Unsure

20. A large carnivore led to any loss of livestock or cause human injury/death needs to be found and killed?

Agree  Strongly agree  Disagree  Strongly disagree  Unsure

21. Will you be happier if there were no large carnivores around your villages?

Agree  Strongly agree  Disagree  Strongly disagree  Unsure

22. Large carnivores deserve protection from the local community

Agree  Strongly agree  Disagree  Strongly disagree  Unsure

23. What is your opinion of the carnivores that cause problems to humans and livestock in the village?

Problem animal control  Shoot to kill  Poisoning  Spearing  Snaring

24. What happens when a loss caused by a large carnivore occurs (Human injury/death/livestock killing)

Consolation  Carnivore killed by PAC units  Carnivore killed by local people   
No action  I don't know

**Any comments from the respondent**

.....  
.....  
.....  
.....  
.....

**Appendix 2:** Guiding questions for the key informant interview.

**GUIDING QUESTIONS FOR INTERVIEW** *(This form will be translated into the Swahili language).*

**Patterns of large carnivore depredation on livestock and community tolerance behavior around Selous-Nyerere ecosystem; A case study of Liwale district in southern Tanzania.**

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**Form No:** \_\_\_\_\_ **Village** \_\_\_\_\_ **Name** \_\_\_\_\_

**Rank** \_\_\_\_\_ **Date** \_\_\_\_\_

1. What is the historical profile of your village?
2. What are the major socio-economic activities performed within the village?
3. Does the village have a land use plan? If yes, is the land use plan followed? and if not followed, what are the causes?
4. Can you tell me the total number of livestock in your village?
5. Is there any conflict existing between the people and large carnivores in your village? If yes, what are the causes?
6. What kind of intervention mechanisms have people been using to mitigate the conflicts between humans and carnivores?
7. What do you think should be done as intervention measures for the problem?

**Appendix 3:** Community's identification card for large carnivores.



**(A)**



**(B)**



**(C)**



**(D)**