

**LEVELS OF HUMAN ATTACK AND LIVESTOCK
DEPREDATION BY SPOTTED HYENA (*CROCUTA CROCUTA*)
IN GEITA REGION**

By

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A Dissertation Submitted in Partial Fulfillments of the requirements for a Degree of
Master of Science in Biodiversity Conservation of the University of Dodoma

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CERTIFICATION

The undersigned certify that he has read and hereby recommends for an acceptance by the University of Dodoma a dissertation entitled: **Levels of human attack and livestock depredation by spotted hyena (*Crocuta crocuta*) in Geita Region**, in partial fulfillments of the requirements for the award of a Degree of Masters of Science in Biodiversity Conservation of the University of Dodoma.

.....

Prof. Julius. W. Nyahongo

(Supervisor)

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DEDICATION

Dedicated to the late Cyprian Fulla, Madam Sophia Elias and Elias Kolongo.

ABSTRACT

The study was conducted to investigate the levels of human attack and livestock depredation by spotted hyenas in nine selected villages in Geita Region. The study specifically, i) determined the level of human attacks by spotted hyenas, ii) the level of livestock depredation by spotted hyenas, iii) compared the major causes of livestock loss factors, and iv) mitigation strategies to reduce human attack and livestock depredation. Snowball technique, was used to obtain the sample of villages and respondents. Data were collected using structured interviews with standardized questionnaires and observations in the selected households that were affected by spotted hyenas. Data gathered were stored in an electronic data base and analyzed by using Statistical Packages for Social Sciences (SPSS), IBM version 20 for windows. Results suggested that, human attacks and livestock depredation by spotted hyenas differed significantly among the surveyed villages. Large number of human attacks and injuries as well as a large livestock depredation were observed at Ihulike village that is relatively close to Kigosi Game Reserve. Diseases were found to be a major cause of loss of cattle while in goats and sheep depredation and diseases, were more or less similar. However, losses of domestic dogs due to diseases were similar to depredation. Moreover, majority of the respondents had no pits for household wastes disposal. Majority of respondents who keep livestock, used domestic dogs and *bomas*, as mitigation strategies to reduce depredation. In addition, no one had used poison as a mitigate strategy to reduce depredation. To minimize the level of human attacks and livestock depredation farmers had to build strong *bomas*, identify places to dispose wastes and living far away from the protected area. An improvement of veterinary services which would have reduced the loss of livestock due to diseases is highly recommended.

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LIST OF ABBREVIATIONS

FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GGM	Geita Gold Mine
GPS	Global Position System
HWC	Human-Wildlife Conflicts
IBM	International Business Machine
IUCN	International union for Conservation
MSc	Masters of Science
NBS	National Bureau of Statistics of Tanzania
PhD	Doctor of Philosophy
SPSS	Statistical Package for Social Science
UNIDO	United Nations Industrial Development Organization
URT	United Republic of Tanzania
WEO	Ward Executive Officer

CHAPTER ONE

1.0 General Introduction

1.1 Background Information

Predation of livestock, is often cited as major problem by livestock keepers who lived near wildlife, although it is argued elsewhere that, such perception is exaggerated (Nabane, 1995; Nyahongo, 2004). However, predators and human have been in conflicts for centuries especially after the start of domestication of livestock approximately 900 years ago and conflicts have increased due to the continued habitat destruction, fragmentation and other factors (Nowell and Jackson 1996). Though the farmers do not consider the loss due to livestock diseases which is higher than large carnivores' predation, it is masked that a sick, animal may be slaughtered and used as a food or sell to the neighbor whereby, large carnivores leaving nothing to human on the attacked livestock (Mwangi, 1997; Kissui, 2008; Nyahongo, 2007).

Conflicts between humans and wild carnivores have been well documented in different parts of the world (Røskaft *et al.*, 2003; Treves and Karanth, 2003; Treves *et al.*, 2004; Røskaft *et al.* 2007). In Europe, depredation mostly caused by the brown bears (*Ursus aratus*) and other carnivores, whereby Norway the depredation of sheep and goat done by bears (Kaczensk, 1996), and in United Kingdom the red foxes (*Vulpes vulpes*) and wolves (*Canis lupus*), were most problematic for killing farmers' livestock (Boker and Macdonald, 2000). As well as in United States, depredations of livestock were reported in Colorado whereby Wolves were killing farmers' livestock (Francis, 2004). However, in India the depredation livestock was caused mostly by Snow leopard (*Uncia uncia*) and Wolves (Mishra, 1997). Though depredation of livestock by spotted hyenas (*Crocuta crocuta*) in Europe, Asia and

America, is no longer a problem to livestock keepers due to extinction coincide with decline in grassland and habitat and prey loss about 12500 years ago (Stiner, 2004).

In Sub-Saharan Africa, depredation of livestock is remarkably higher (Holmern *et al.*, 2007; Kissui, 2008) especially in the villages, this is due to the abundant population of spotted hyenas which they are estimated to a population size between 27,000 and 47, 000 individuals (Mills and Hofer, 1998). In Northern Ethiopia, spotted hyenas are most constantly in conflicts with human due to livestock depredation. They are accused to be injuring, killing and scavenging domestic stocks mostly cattle, sheep and goats but also poultry, cat, dogs, horse, camels and donkeys are attacked (Yirga, 2010) as well as in northern Kenya, spotted hyenas were reported as the most livestock killers by trips livestock from the enclosures (Woodroffe and Ginsberg 1998; Okech, 2010).

Indeed, depredation of livestock in Tanzania are reported much in Serengeti, where about 708 livestock belong 132 households from seven villages, were killed by predators in 2003, whereby the spotted hyenas were accounting for 98% of livestock kill (Kideghesho, 2006). Currently in Geita Region, many case of human and livestock attacks by spotted hyenas are reported in different villages. For example, villages like Ihushi, Muhama, Shabaka, Busolwa, Ifungandi, Ihulike and and Kasozi have cases (URT, 2013)

Livestock depredation (Thirgood *et al.*, 2005; Nyahongo, 2004; Nyahongo, 2007; Dickman, 2008; Kaswamila, 2009) leads to human carnivore conflicts. Human-carnivore conflicts is one of the leading constraints to biodiversity conservation efforts (Nyahongo, 2007; Kent, 2011; Lyamuya *et al.*, 2013). Monitoring livestock

depredation in specific areas, is an essential to formulate conflicts management strategies, that can address the root causes of human carnivore conflicts and promote large a carnivore conservation (Spira, 2014).

1.2 Problem Statements and justification

As human population increase, large areas are being encroached for human settlements and food production, making less natural habitat available for wildlife (Sisk *et al.* 1993). Increased proximity between people and wildlife means they are bound to share the landscape, from which different forms of conflicts can emerge (Woodroffe, 2000). However, human and large carnivore conflicts have been fueled by depredation of domestic stocks and human attacks (Nyahongo, 2004; Nyahongo, 2007; Nyahongo and Røskaft, 2011). Moreover, most large carnivores' species that are responsible for human and livestock attacks, are the wolves, red foxes, bears, puma and jaguars in Europe, North and South America though species like tiger, and leopard have been reported to be killing and attacking human and livestock in Asia (Saberwal *et al.*, 1994; Mishra, 1997; Røskaft, 2012). Yet in Sub-Saharan Africa, numerous large carnivores have been reported preying on human and livestock (Dickman, 2010; Yirga, 2010; Sogbohossou *et al.*, 2011; Nyahongo and Røskaft, 2011; Yirga, 2013). In Tanzania, the spotted hyenas have been reported as an important large carnivore causing a big problem to livestock keepers particularly in Serengeti (Kideghesho, 2006; Nyahongo, 2007; Mwakatobe *et al.*, 2013; Mrimi, 2014). However, in villages surrounding Selous Game Reserve, lions were accounted for killing both human and livestock (Nyahongo and Røskaft, 2011).

Geita Region currently, a few researches have been conducted on human and livestock depredation by spotted hyenas. However, news report of Ward Executive

Officer of Busolwa Ward and Bushirombo Ward both were reported human and livestock were injured and killed by spotted hyenas in 2014. Reports were proclaimed for the needs of carry out researches in the villages of Geita Region to evaluate the levels of human and livestock depredation by sported hyenas. Moreover, by understanding the species of livestock that were highly attacked, livestock loss factors, mitigation strategies to reduce depredation and the quality of night holding *bomas*.

Failure to address the problem of human and livestock depredation by spotted hyenas, people will feel threatened by the presence of large carnivores, and often rightly so, they endeavour to suppress it (Thirgood *et al.* 2005). Therefore, ecologist and conservationists should find approaches, that could allow people and large carnivores to coexist, through conflicts resolution while meeting both goals of large carnivores' conservation and people's life and livelihood security (Woodroffe *et al.* 2005).

1.3 Objective of the study

1.3.1 General Objectives;

The study aimed to evaluate the levels of human and livestock depredation by the spotted hyenas in Geita Region.

1.3.2 Specific Objectives;

1. To determine levels of human attacks by the spotted hyenas in Geita Region.
2. To determine levels of livestock depredation by the spotted hyenas in Geita Region.

3. To compare the major causes of livestock loss factors to the local people in Geita Region.
4. To investigate mitigation strategies, to reduce human and livestock depredation by the spotted hyenas in Geita Region.

1.4 Hypothesis

1. The levels of human attacks by the spotted hyenas, is highest in the villages of Geita Region.
2. The levels livestock depredation by the spotted hyenas, is lowest in the villages of Geita Region.
3. Depredation of livestock by the spotted hyenas, is a major cause of livestock loss to farmers in the villages of Geita Region.
4. To mitigate human and livestock depredation, farmers use retaliatory killing to reduce the spotted hyenas' population, in the villages of Geita Region.

1.5 Significance of the study

The study has desired to a provide quantitative data on human-carnivore interactions, and to appraise the level of conflicts generated from such interactions. Wildlife managers, may exploit the results from this study, to formulate management strategies, intended at attenuating conflicts between local people, wild carnivores and a sustainable conservation in the area. Moreover, knowledge about livestock diseases is one of the major factors of livestock loss apart from carnivores might help in diseases management in the study area. This might contribute to the economic development of the area. Finally, the study will contribute to scientific knowledge on human-carnivore interactions and researchers, scholars, wildlife managers and the local communities might utilize this knowledge.

CHAPTER TWO

LITERATURE REVIEW

2.1 Ecology of spotted hyenas

2.1.1 Habitat and Distribution

Hyenas, has a remarkable behavioral plasticity that facilitates its adaptive adjustment to an increasingly precarious lifestyle in proximity to humans (Woodroffe, 2000; Sunquist and Sunquist, 2001; Boydston *et al.*, 2003). They can be nocturnal or diurnal and breed at any time of the year (Van Meter *et al.*, 2009). During the Pleistocene era, hyenas inhabited large parts of Eurasia but currently occur only in Africa (Kurten, 1968; Werdelin and Solounias, 1991). Hyenas are also generally absent in true deserts and alpine areas above 3000 metres (Mills, 1990; Frank *et al.*, 1995; Mills and Harvey, 2001) and in tropical rainforests, except for Odzala National Park in Congo (Wilson and Reeder, 1993; Ray *et al.*, 2005). The current distribution of hyenas is limited to Ethiopia, Kenya, Tanzania, Botswana, Namibia, South Africa, Angola, Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Ivory Coast, Democratic Republic of Congo, Ghana, Lesotho, Guinea Bissau, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Rwanda, Senegal, Somalia and Sierra Leone (Mills and Hofer, 1998). The largest known populations occur in the Serengeti ecosystem, Tanzania and the Kruger National Park, South Africa with estimates of 8,700 and 3,900 hyenas, respectively (Mills and Hofer, 1998).

2.1.2 Feeding habits

Hyenas is an opportunistic carnivore, foraging on locally abundant prey species (Cooper *et al.*, 1999). Hyenas kill and scavenge on small, medium and large sized

species (Kruuk, 1972; Salnicki *et al.*, 2001). The most common prey species include various antelopes (such as *Cephalophus dorsalis*, *Cephalophus niger*, and *Tragelaphus strepsiceros*), zebra (*Equus spp.*), buffalo (*Syncerus caffer*) and juvenile rhinos (*Diceros bicornis*) and giraffes (*Giraffa camelopardalis*) (Mills and Hofer, 1998; Hayward, 2006). Hyenas detect their prey by sight, sound and smell. They find carrion by the sound of other carnivores feeding, by distress calls, by smell, or during day light hours by watching vultures descend on carcasses (Mills and Hofer, 1998). They are able to hear noises coming from predators killing prey or feeding on carcasses over distances of up to 10 km (Mills, 1990). They have a reputation for killing and scavenging domestic livestock, mostly cattle, sheep and goats, but also poultry, cats, dogs, horses, donkeys, and camels (Mills and Hofer, 1998; Abay *et al.*, 2011; Sogbohossou *et al.*, 2011). Hyenas are opportunistic scavengers of human waste, bones, and dung, and may forage on anthrax-infested carcasses without detrimental consequences. They are capable of eating and digesting all parts of their prey except hair and hooves (Smith and Holekamp, 2010).

2.1.3 Social organization

Spotted hyenas, are sexually mature at around three years of age with females maturing later than males and differentiating male and female hyenas by observation is quite problematic. The Breeding of spotted hyenas occurs throughout the year. After a gestation of 110 days, females give birth to a litter of one to three relatively well developed pups. Hyenas live in social groups called clans (Kruuk, 1972; Holekamp *et al.*, 1997) containing 6 to 90 individuals (Smith and Holekamp, 2010). However, adult female hyenas are roughly 10% larger than adult males, and are

more aggressive and socially dominant. Spotted hyenas live about 25 years in the wild and up to 40 years in captivity (Smith and Holekamp, 2010).

2.2 Human Carnivores Conflicts

Human-carnivore conflicts particularly, are the major component of human wildlife conflicts and constitute a source of great resentment from people towards carnivores, driving retaliation and threatening carnivore populations (Sillero-Zubiri and Laurenson, 2001), thereby potentially leading to species extinctions (Woodroffe, 2001). Conflicts, is here defined as any interaction between humans and wildlife that results in negative impacts on human social, economic or cultural life, and on the conservation of wildlife populations, or on the environment (Magige, 2012). The conflicts and rural communities are triggered by livestock depredation by predators (Thirgood *et al.*, 2005). Although carnivore diet is essentially based on wild prey species, it can be expanded to livestock species when wild prey availability is low (Patterson *et al.*, 2004), and when a predator hunting success is limited (Cotterill, 2013). Therefore, livestock depredation can be particularly frequent in areas where domesticated stock has replaced native wildlife (Patterson *et al.* 2004) or where the ratio between livestock and wild prey abundances is low, although this does not necessarily lead to higher depredation rates (Woodroffe *et al.*, 2005). Both people and carnivore populations undergo the consequences associated with human carnivore conflicts (Sillero-Zubiri *et al.*, 2006). Indeed, depredation events incur costs to livestock keepers in terms of income through livestock losses and time and money spent in preventing depredation attacks (Mishra, 1997; Patterson *et al.*, 2004; Thirgood *et al.*, 2005; Maclellan *et al.*, 2009). Consequently, livestock keepers tend to hold negative attitudes towards carnivores that they consider a threat to human

livelihoods (Thirgood *et al.*, 2005; Linnell, 2013) and may respond to conflicts by killing the culprits in retribution, through trapping, snaring, poisoning, shooting or spearing (Woodroffe *et al.* 2005). Remembering that carnivores are built to kill and eat other animals and livestock are built to be eaten (Fascione *et al.*, 2004). It is widely agreed that carnivores are forced into conflicts with humans. If natural prey is available, predators take wild species in preference to domestic stock. Yet, if natural prey densities are low, predators will increasingly prey on livestock as an alternative food source (Schiess-Meier *et al.*, 2007).

2.2.1 Human-hyenas' interaction

Human-hyenas' conflicts is a common problem in the African continent (Ogada *et al.*, 2003; Patterson *et al.*, 2004; Kolowski and Holekamp, 2006; Holmern *et al.*, 2007). A large number of studies reported serious conflicts between hyenas and humans in Africa, resulting in persecution of the hyenas (Nyahongo, 2007; Mrimi, 2014). Even though hyenas are regarded in a generally negative light in most African cultures, being seen as selfish, foolish, sly, immoral, and dirty (Jurgen, 1998; Glickman, 1995; Middleton and Winter, 2004; Dickman, 2005), they have a positive reputation in some parts of Africa. For example, in the East African Tabwa mythology, hyenas represent the animal that first brought the sun to warm the cold earth (Jurgen, 1998). In Tanzania, killing hyenas in retaliation of an attack is believed to be dangerous because the bond between the hyenas and its 'owner' is strong and could result in death of the hyenas's killer (Middleton and Winter, 2004). Moreover, hyenas have been hunted for the use of its body parts in traditional medicine (Glickman, 1995; Mills and Hofer, 1998). For example, In Burkina Faso, the hyenas's tail, in Cameroon, Cote d'Ivoire and Senegal, the hyenas's whole body,

in Malawi and Tanzania, the genitalia, nose tips and tails, and in Mozambique the hyenas' paws and in Ethiopia hyenas's bone (Mills and Hofer, 1998; Frank,1998; Ochonga, 2011; Abay, 2013).

2.3 Livestock depredation

Livestock depredation in particular, has been a serious challenge to conserving threatened predators outside protected areas (Treves and Karanth, 2003) with predators potentially adversely affecting the profitability of livestock production and people's livelihoods.

2.3.1 Livestock Depredation in United States

In US, wolves have been considered a threat to livestock keeper whereby cattle, sheep (*Ovis aries*), turkeys (*Meleagris gallopavo*), horses (*Equus caballus*) as well as other livestock are most targeted. Between 1987 and 2003 about 301 cattle, 804 sheep and 20 dogs were confirmed to been killed by wolves in Colorado which cost Livestock keepers approximately \$11,076.49 per year and cost government about \$359,593.33 for compensation payments. Yet, the mountain lions (*Felis concolor*), black bears (*Ursus americanus*), coyotes (*Canis latrans*), domestic dogs (*Canis lupus*), red foxes, bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) were involved in livestock depredation (Michael, 2004).

2.3.2 Livestock depredation in Europe

One of the most important factors, negatively influencing public attitudes towards brown bears and other large carnivores is depredation on livestock. Losses of livestock due to bears and wolves are the highest observed in Europe. This fueled by

untended sheep grazing on forested range, are responsible for providing this depredation situation. For example, in France, bears killed 66 sheep in the French Pyrenees as well as in Norway, where a small population of 25 to 55 bears kill about 2,000 sheep annually (Kaczensky, 1999).

2.3.3 Livestock Depredation in India

Conflicts between wild carnivores and pastoralists in Trans-Himalaya, one of the most fragile, and yet the least represented, of all the biogeographic zones in the Indian protected area network (Rodgers and Panwar, 1988). Snow leopards and wolves, are in conflicts with humans in most parts of their range, specifically due to the damage they cause to livestock and estimate of economic loss of US\$ 128 per family annually amounting to about half the per capita income of the state (Mishra, 1997; World Bank, 1996). These fueled by the density of livestock is often several times greater than that of wild ungulates, which is perhaps the most important cause of the high level of conflicts (Mishra, 1997).

2.3.4 Livestock depredation in Africa

2.3.4.1 Livestock depredation in Ethiopia

Tigray, a Region in the north part, is one which has a serious human-carnivore conflicts due to livestock depredation. The spotted hyenas are relatively high in intensity for killing and scavenging domestic stock, mostly cattle, sheep and goats (Abay, 2010) and estimated to cause economic loss of approximately US\$ 30,415 and the average annual livestock losses per households were approximately to US\$ 27 and US\$ 21 (Yirga *et al.*, 2014).

2.3.4.2 Livestock Depredation in Botswana

In northern Botswana, human-carnivore conflicts revealed that, livestock losses caused by predators represent an economic concern for livestock owners, predator attacks causing an estimated financial loss of US\$ 57,000 whereby, the lion were responsible for 86%, spotted hyenas was counted for 73%, Black-backed jackal (*Canis mesomelas*) were blamed for 77% and wild dogs were accounted for 2% attacks. These caused by the expansion of livestock into relatively natural wildlife areas, particularly in the buffer zones (Wildlife Management Areas) adjacent to Moremi Game Reserve and Chobe National Park (Tjibae, 2001; Gusset *et al.*, 2009).

2.3.4.3 Depredation in Kenya

In Samburu, lions and spotted hyenas were counted for depredation of livestock whereby about 342 shoats (young pigs), 39 donkeys 3 camels and 17 cattle were attacked in community conservancies while in commercial ranches, most attack were reported on 236 cattle, 54 shoats, 35, camels and 3 donkeys (Spira,2014).

2.3.4.4 Livestock depredation in Tanzania

Livestock depredation in Tanzania normally occurs in rural areas. Villages surrounding protected areas mostly affected by the depredation. For example, villages in western Serengeti are vulnerable by the livestock depredation caused by spotted hyenas followed by leopards, baboons, lions and jackals. Although, predation was not only reported from villages close to the protected area but also affected household in villages far from the protected areas, about 80 kilometre where the spotted hyenas were reported to be involved much (Kideghesho, 2006). Lions

and Leopards only killed livestock belonging to household close to protected areas (Nyahongo, 2007; Mwakatobe *et al.*, 2013)

2.4 Large carnivores attack on human

One of the most serious form of human carnivore conflicts is when large a carnivore attack people. The severity of the problem is reflected by the injury or death of the victim (Ikanda, 2008). Occurs when large carnivores reside and frequently interact with people. Attack by a big cat like tigers, lions, leopards and spotted hyenas are classical cases of human-carnivores conflicts in Asia and Sub-Saharan Africa, where expanding rural population overlap the ranging areas of the animals (Ikanda, 2008; Nyahongo and Røskaft, 2011).

2.4.1 Tigers

Tigers are known to have killed people throughout their range of distribution, including the far east of Russia, south-east Asia, the Sunda Islands and south Asia (Gurung *et al.*, 2008). In part of India about 36 to 100 people were killed by tigers in sundarban mangrove forest (Sillera-Zubiri and Laurenson, 2001). In Nepal tigers have killed 88 people in 1979 to 2006 in and around Chitwa National Park (Gurung *et al.*, 2008).

2.4.2 Bears

Bears, are known to pose serious threats to people in North America and Europe (Swenson *et al.*, 1996). In Svalbard- Norway, there were over 50 confronting between people and polar bears, between 1973 and 2008 but only two were fatal (Ikanda, 2008).

2.4.3 Lions

African lions, killed a large number of people, particularly in East Africa. In Tsavo National Park in Kenya lions killed more than 100 people over a span of four years in 1996 to 1999 (Peterhan and Gnosk, 2001) and between 1963 to 1994 in Uganda more than 275 people were killed (Trves and Naughthon-Trves, 1999). In recent records in Tanzania between 1990 and 2004, 815 people were attacked and more than 563 killed by lions (Packer *et al.*, 2005; Nyahongo and Røskaft, 2011).

2.4.4 Leopard

Attack by leopards tends to be rare particularly in the recent years, although a review of government record for South-Eastern Tanzania indicate 97 human attacks in 1987 to 2007. However, most leopards attack are focused on domestic species like goats, sheep and dogs that are close to human settlement (Ikanda, 2008).

2.4.5 Spotted hyenas

Human hyenas' attacks occur much lesser frequently than by lions. Hyenas attacks generally sporadic and short-live and usually are caused by the outbreak of rabies. However, there is an anecdotal news report of 52 attacks (67.3% fatality) in northern Mozambique in 2002 (Begg *et al.*, 2007). In Tanzania, 59 attacks, 29 of which were fatal around the protected areas in 1987 to 2008 (Ikanda, 2008). Despite being a few hyenas' attacks, mostly associated with witchcraft in villages where they occur, and create fear among people (Frank, 1998; Maddox, 2002; Ikanda, 2008; Dickman, 2005; Ochanga, 2011).

2.5.1 Factors influencing human and livestock attacks by spotted hyenas

2.5.1.1 Rapid Human Population Growth

Human population, growth requires more space and resources that make human population to extend to protected areas. However, human population in Tanzania has increased from around 9 million in 1962 to 23.1 million in 1988, and 34.6 million in 2002 and now is about 44.9 million (URT 2012). Yet, in Geita Region, human population has increased from 1,337,718 people in census of 2002 to 1,739,530 people in census of 2012, this anticipates the rapid fertility rate and the Immigration stimulated by small and large scale mining in the area (Kitula, 2005) and agricultural activities (URT, 2013). This high human population growth has led to encroachment into wildlife areas and depletion of natural prey (Packer *et al.*, 2005). However, human population growth wears away at grazing areas, increasing competition between livestock and wild herbivores, resulting in a shrinking prey base for large carnivores (Ogutu *et al.*, 2005). Inadequate natural prey species cause carnivores to switch to prey on humans and livestock (Nyahongo and Røskaft, 2011). Coexistence between large carnivores and local communities is almost impossible in human-dominated landscapes (Woodroffe and Ginsberg, 2000), they need extensive areas with a few people (Lindsey *et al.*, 2013). It is difficult to maintain such ecosystems mainly because of human population growth and the associated demand for land and other resources (Msuha, 2009). As a consequence, large carnivores tend to suffer when human populations expand into intact habitats (Woodroffe and Ginsberg, 1998; Woodroffe, 2000; Sillero-Zubiri and Laurenson, 2001). Therefore, make a human population growth a priority agenda in the current conservation policies (Nyahongo *et al.*, 2006).

2.5.1.2 Anthropogenic activities

Increased human activities have been described as major challenges in wildlife conservation (Holmern *et al.*, 2007; Kideghesho *et al.*, 2007; Packer *et al.*, 2005; Røskaft, 2012). This is largely due to the increased interactions between humans and wildlife, which, in turn, generates conflicts as a result of competition for natural resources (Hanley *et al.*, 2010; Treves and Karanth, 2003; Treves *et al.*, 2006). Human activities notably, agriculture, timbering, settlements, overgrazing, mining and others many have degraded the habitats (Kideghesho, 2010). For example, agricultural expansion has squeezed wildlife into smaller and fragmented spaces (Sillero-Zubiri and Switzer, 2001). The situation, has given challenges to carnivores and forced to get into conflicts with human by killing and wounding livestock and human (Schiess-Meier *et al.* 2007).

2.5.1.3 Destruction of wildlife habitats

Habitat loss, has emerged the most severe threat to biodiversity worldwide (Brooks *et al.* 2002; IUCN 2004; Naeem *et al.*, 1999; Smith and Smith 2003). Destruction or loss of wildlife habitats reduces their potential utility. Hunter (2002), defines three forms of habitat destruction (viz. degradation, fragmentation and outright loss). While habitat degradation is “the process by which habitat quality for a given species is diminished”, fragmentation “is the process by which a natural landscape is broken up into small parcels of natural ecosystems, isolated from one another in a matrix of lands dominated by human activities”. Outright, loss of habitats occurs when habitat quality is so low such that the environment is no longer usable by a given species. However, the ecological integrity and long-term survival of any ecosystem, depends greatly on the quality of wildlife habitats (Kideghesho, 2010).

Yet, improved health care increased human lifespan, the need for development appeared and resources which were once shared with wildlife started to be dominated by man, man used them as a mean of fighting poverty. Since he associated himself with development, he dominates the environment, subjecting it to many humans impacted habitat degrading activities such as road construction, farming, deforestation competition for grazing land, medicinal plants, firewood, water resources, building poles and other resources (Gereta, 2003). Meeting these demands leads to transformation and degradation of wildlife habitats, (Kideghesho, 2005). In broad scale (Mfunda and Røskaft, 2010), poverty, population growth, land tenure systems, development policies, economic incentive and inadequate conservation status (Nyahongo *et al.*,2006) and the human population growth remain a key factors dictating the magnitude of habitat destruction (Kideghesho, 2006). Large carnivores have a high propensity for conflicts with humans. They have an extensive home ranges and need large prey populations to survive and therefore, only large areas can support viable populations (Msuha, 2009).

2.5.1.4 Poverty

Poverty-stricken, a situation which is widespread in rural Tanzania. The performance of the agriculture and livestock sectors to the poor people, on which they rely, is not impressive due to land scarcity, drought, diseases and pests, poor soil fertility, and lack of agricultural inputs. The gross annual income from these sectors has remained extremely low. The limited means of sustenance among the local people has made poaching of wildlife species and encroachment on their habitats (including foraging grounds, and breeding sites) (Kideghesho, 2010). Poverty may induce people to adopt the coping strategies, set priorities and make economic choices that are

ecologically destructive. For example, illegal hunting and charcoal burning may be pursued for subsistence and a way of earning income (Kideghesho, 2006). Any form of wildlife management these days increasingly, needs to take account of community needs, perceptions and capacities. Hence, information about local knowledge, tradition, economic status and perceptions of wildlife are needed in the development of management strategies (Kaltenborn *et al.*, 2006).

2.5.1.5 Poor Livestock husbandry

Levels of loss, and resultant conflicts with carnivores, have been related to livestock management strategies in areas as diverse as Nepal (Oli *et al.*, 1994), Namibia (Marker, 2002), Kenya (Ogada *et al.*, 2003) and Brazil (Conforti and De Azevedo, 2003). Extensive management, where stock ranges unattended over wide areas, has been linked to higher losses (Conforti and De Azevedo, 2003), while employing herders by using guarding dogs, and keeping stock in well-made, fenced corrals at night, have all proved effective at reducing depredation (Ogada *et al.*, 2003; Woodroffe and Frank, 2003). Identifying which husbandry techniques, are most effective can help farmers to implement the most efficient ways of protecting their stock, thereby reducing conflicts with carnivores (Dickman, 2005).

2.5.2 Mitigates strategies adopted to reduce human and livestock depredation

2.5.2.1 Awareness on behavior that makes human vulnerable to large carnivore attacks

Large mostly carnivores select the type of prey they target chiefly through the way the preys behave. In that regard, certain forms of human behaviors make some people mostly vulnerable to attack such behavior, including walking around at night,

late night, alcoholism, and sleeping in poor shelter (Ikanda, 2008; Nyahongo and Røskaft, 2011).

2.5.2.2 Educating community

An improvement of the level of education is believed to be a strong political will and sensitization to all from village to National level (Nyahongo and Røskaft, 2011), conversely, education and training activities could be directed towards disseminating innovative techniques, building local capacity for conflicts prevention and resolution, and increasing public understanding of human-wildlife conflicts (Lamarque *et al.*, 2009). However, environmental education is very important to reduce human wildlife conflicts. Charcoal production for instance, seem to generate substantial income to local communities but the future effects like drought due to clearing forests in the water catchments areas, is not considered by the poor local communities currently (Nyahongo and Røskaft, 2011). Conversely, lack of knowledge about carnivores has been linked to higher human-wolf conflicts in southern Europe (Dickman, 2008) and more intense jaguar-human conflicts in Brazil (Conforti and De Azevedo, 2003). If local people show hostility but a little or no knowledge about carnivores in their area, then investing in conservation education could be a valuable strategy for conflicts resolution (Dickman, 2008).

2.5.2.3 Improving livestock husbandry

An effective usage of guarding dogs should ideally be large, intimidating and should be well-bonded to the stock they are placed with (Sims and Dawydiak, 1990). Anatolian Shepherd livestock-guarding dogs, which show these characteristics, were placed on Namibian farms as a conservation initiative, and the strategy was linked to

significant declines in livestock depredation and increased tolerance of large carnivores by the farmers concerned (Marker *et al.*, 2005). A similar initiative could be worth pursuing in Tanzania, although it would require significant investments of time and money by a conservation organization, as well as commitment and dedication from people receiving dogs. However, thorn bush boma in which to enclose stock at night quality often poor, the improvements in boma could help reduce livestock depredation, as good boma construction has been associated with reduced losses to large carnivores (Ogada *et al.*, 2003; Dickman, 2008). Moreover, attacks on cattle, which created most conflicts, mainly occurred in bomas at night, so fortifying bomas and increasing night-time protection could be particularly significant for reducing conflicts, as has been suggested in other African countries (Butler, 2000). Indeed, attentive herding of stock has also been linked to lower depredation rates (Creel and Creel, 2002). However, many of the herders were quite small children, which could reduce their effectiveness, as it seems to be the presence of adults that acts as the most significant deterrent to carnivore attacks (Dickman, 2005).

2.5.3 Major livestock loss factors

2.5.3.1 Livestock diseases

Diseases, have been documented to be responsible for high loss in livestock production in sub-Saharan Africa (Gifford-Gonzalez, 2000; Nyahongo *et al.*, 2012). Although farmers do not consider them to be serious problem (Mwangi, 1997). Diseases that frequently are fatal to livestock production (especially cattle) in sub-Saharan Africa include wildebeest-derived Malignant Catarrhal Fever (MCF), East Coast Fever (ECF), Foot and Mouth Diseases (FMD), worms (helminthes), Rift

Valley Fever (RVF), rinderpest, anthrax as well as trypanosomiasis (Kock, 2003; Thomson *et al.*, 2003). Diseases, were responsible for a livestock loss of 3.5 to 7.0% per household, costing farmers about US \$ 84 which is equivalent to 60% of the average annual house income (Borge, 2003). For comparison, diseases cause four times higher livestock loss than depredation in Serengeti (Nyahongo, 2004; Nyahongo, 2007). Livestock owners, may not observe the direct effect of diseases on their livestock production because sick animals, may be slaughtered and used as a food or sold to neighbours, whereas carnivores often consume all edible parts of the kill leaving nothing for human consumption (Nyahongo, 2007).

2.5.3.2 Depredation by Large Carnivores

Carnivores may cause relatively high livestock losses when they break into livestock enclosures, usually at night (Holmern *et al.*, 2007; Kolowaski and Holekamp, 2006; Nyahongo, 2004), they may kill several adult livestock. Data obtained in the village surrounding Western Serengeti show that, 97.7% of wild carnivores reported to kill livestock whereby spotted hyenas were responsible for 98.2% of the total loss of livestock in 2003 (Nyahongo, 2007). Since predators, including hyenas, kill livestock and sometimes cause extensive damage, and Hyenas were the most frequent predators on livestock, followed by lions and leopards. Predator management, is crucial in areas also area contain farmed animals (Mills and Hofer, 1998).

2.5.4 The impacts of human and livestock depredation by spotted hyenas

2.5.4.1 Loss of Income

Livestock depredation can cause significant economic losses among pastoralists. For example, (Patterson *et al.*, 2004) estimated livestock predation to represent 2.6% of the herd's economic value in a Kenyan ranch, which incurred a loss of \$8749 per annum. Similarly, Mishra (1997) reported an economic loss of \$15 418 due to predation among the Indian-trans Himalayan communities, equivalent to \$128 loss per family per year, and Butler (2000) recorded economic loss averaging \$13 or 12% of each household's net annual income in Zimbabwe. In Tanzania especially in rural area, spotted hyenas were responsible of loss of income of livestock keepers, which was equivalent to a monetary loss of US \$ 12621(Kideghesho, 2006).

2.5.4.2 Loss of biodiversity

Human impact on species and ecosystems increases, loss of biodiversity is becoming an apparent challenge to conservation community (Kideghesho, 2006). Attacks on humans, and livestock predation, are usually followed by indiscriminate retaliation by humans (Packer *et al.*, 2005, Kissui, 2008, Goldman, 2010). In Africa, such retaliation has been linked to the decline of lions (*Panthera leo*), leopards (*Panthera pardus*), and cheetahs (*Acinonyx jubatus*) and the disappearance of African wild dogs (*Lycaon pictus*) (Ogada *et al.*, 2003, Patterson *et al.*, 2004, Packer *et al.*, 2005). Carnivores are more likely to be killed than herbivores when they cause damage because of perceived danger to humans and the general lack of compensation for livestock losses (Treves *et al.*, 2006, Holmern *et al.*, 2007, Ikanda and Packer, 2008). Such perceptions pose significant challenges for carnivore conservation (Kissui, 2008). In Tanzania, the impact of livestock depredation by hyenas was high enough

to provoke pastoralists into retaliating against hyenas (Kissui, 2008). Hyenas were the most frequent predators on livestock, followed by lions and leopards and as a result 71 hyenas were reported to have been poisoned in three villages (Kissui, 2008). Moreover, traditional human response to carnivores' attack has been to kill "offending animals" as the way of managing the problem in this reaction has evolved over hundreds of years (Woodroffe and Frank, 2005). Ever today, local and the National government legislation ensure that large carnivores which attacked people are killed, be it in Europe, Asia and Africa. For example, in Tanzania on wildlife conservation act, 1974 say that "*Nothing in this act shall make it an offence, to kill any animal in defence of human life or property or for the owner or occupier of a such property or any person dependent on or employed by such owner or occupier to drive out of or kill by any means, what-so-ever any animal found causing damage to such property*". However, the most common methods used are shooting, trapping and poisoning. Traditional methods such as spearing snares and pitfall are also used. These methods have number of consequences for carnivores' species; firstly, leads to species extinction, for example, the Marsupial wolf in Tasmania in 1930 and Falkland island wolfs in 1876 (IUCN, 2004). Secondly leads to species to suffer for reduction in their range, for example, lions were eradicated from Asia by early 1900s and now occupy a great reduced range in Africa (Nowell and Jackson 1996), similarly brown bears and wolves disappeared from most part of western Europe by the end of the 1800s (Ikanda, 2008). The survival of large carnivores depends on their level of conflicts with human interests and their social acceptability to humans, particularly outside protected areas (Kleiven *et al.*, 2004; Lindsey *et al.*, 2005; Tumenta *et al.*, 2010). Thus, a better understanding of the nature and causes of human carnivore conflicts and put human safety and his/her properties, must be

central to all future carnivore conservation efforts to be successful (Nyahongo, 2007; Ikanda, 2008).

2.5.4.3 Transmissions of diseases

Serious diseases are known to be transmitted by wildlife to domestic livestock and possibly also to humans (i.e. rabies). Scavengers and predators, such as spotted hyenas, jackals, lions and vultures, also play a role in disseminating pathogens by opening up, dismembering and dispersing parts of infected carcasses (Hugh-Jones and de Vos, 2002). On the other hand, large carnivores can cause bodily harm to humans, prey on livestock and can act as reservoirs of diseases, which affect humans and their domestic animals, particularly dogs (Happold 1995, Cleaveland *et al.*, 2001). However, humans may affect large carnivore populations through a disease exchange between domestic and wild carnivores (Brand and Nel, 1997; Hofer *et al.*, 1996; Kock, 2003; Treves and Naughton-Treves, 2005).

2.5.4.4 Injuring and loss of human and livestock

The depredation of livestock by spotted hyenas can incur substantial costs to people, particularly when livestock production stands as their main livelihood (Thirgood *et al.*, 2005). While livestock losses might be negligible for wealthier households, those that own a few livestock may lose a considerable part of their herd in a single depredation event (Nowell and Jackson, 1996; Hazzah *et al.*, 2009). However, a study of Holmen *et al.*, (2000) indicated that, 708 livestock belonging to 132 households from seven villages were killed by predators in 2003 in Western Serengeti whereby the spotted hyenas were responsible for 98% kill. In addition to the negative impacts rather than livestock depredation, large carnivores may have on

humans including the attacking and killing of people (Herrero, 1985; Løe and Røskaft, 2004; Nowell and Jackson, 1996; Packer *et al.*, 2005; Saberwal *et al.*, 1994; Nyahongo and Røskaft, 2011) which implies huge social and economic loss of families. Furthermore, financial lost involves in treating the victims (Kideghesho, 2006). Modifications in husbandry, guarding practices and the behavior of the producers, must change if conflicts with carnivores is to be solved (Treves and Karanth, 2003).

2.6 Conceptual frame work

Conceptual framework is an inventing or conceiving ideas that explains, main things to be studied; key factors, concepts and variables (Ashley 1999). It shows the relationships between variables in the study that are the independent., extraneous(intermediate) and dependent variables (Ashley 1999). The conceptual framework below shows the interactions among variables determine the levels human attack and livestock depredation by spotted hyena in Geita Region.

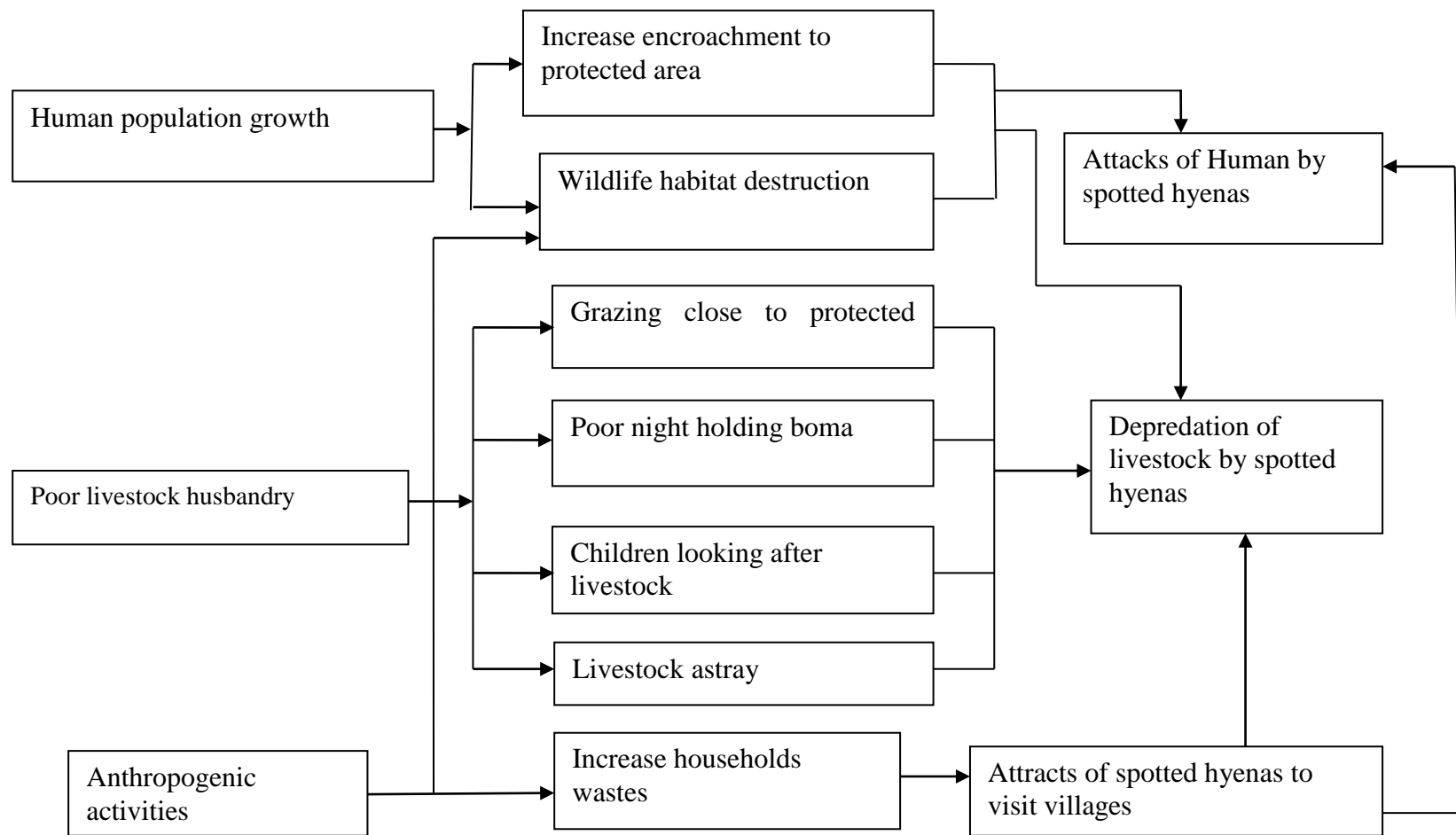


Figure 1: Conceptual frame work

CHAPTER THREE

3.0 Material and methodology

3.1 Description of the study

3.1.1 Location of the study area

Geita Region is located in the Northern Tanzania, lies between latitudes 2°8' and 3°28' South of the Equator and Longitude 310 15' to 320 48' East of the Greenwich. The Region, shares borders with Kagera Region to the West and North; Shinyanga Region to the South and South Eastern parts; and Mwanza Region to the North (URT, 2013).

3.1.1.2 Administrative Units

Geita Region was established in March 2012, from parts of Shinyanga, Kagera and Mwanza Regions. The Region is one of the Tanzania's 30 administrative Regions. It comprises of five Districts namely; Geita, Bukombe, Chato, Nyang'hwale and Mbogwe. In total, the Region is made up of 18 divisions, 98 wards, and 463 villages. Geita town is the Region's capital (URT, 2013).

3.1.1.3 Land area

Geita Region covers one of the smallest Regions in the country, with total surface area of 21, 879 km² of which, 1,946 km² is covered by water, dominated by Lake Victoria, leaving 19,933 km² of dry land. Geita District has the largest water area (1,050 km²) with the Island of Koome and Rubondo followed by Chato (896 km²) With the Island of Yamilembe. Bukombe, Mbogwe and Nyang'hwale have negligible amounts of water areas (URT, 2013).

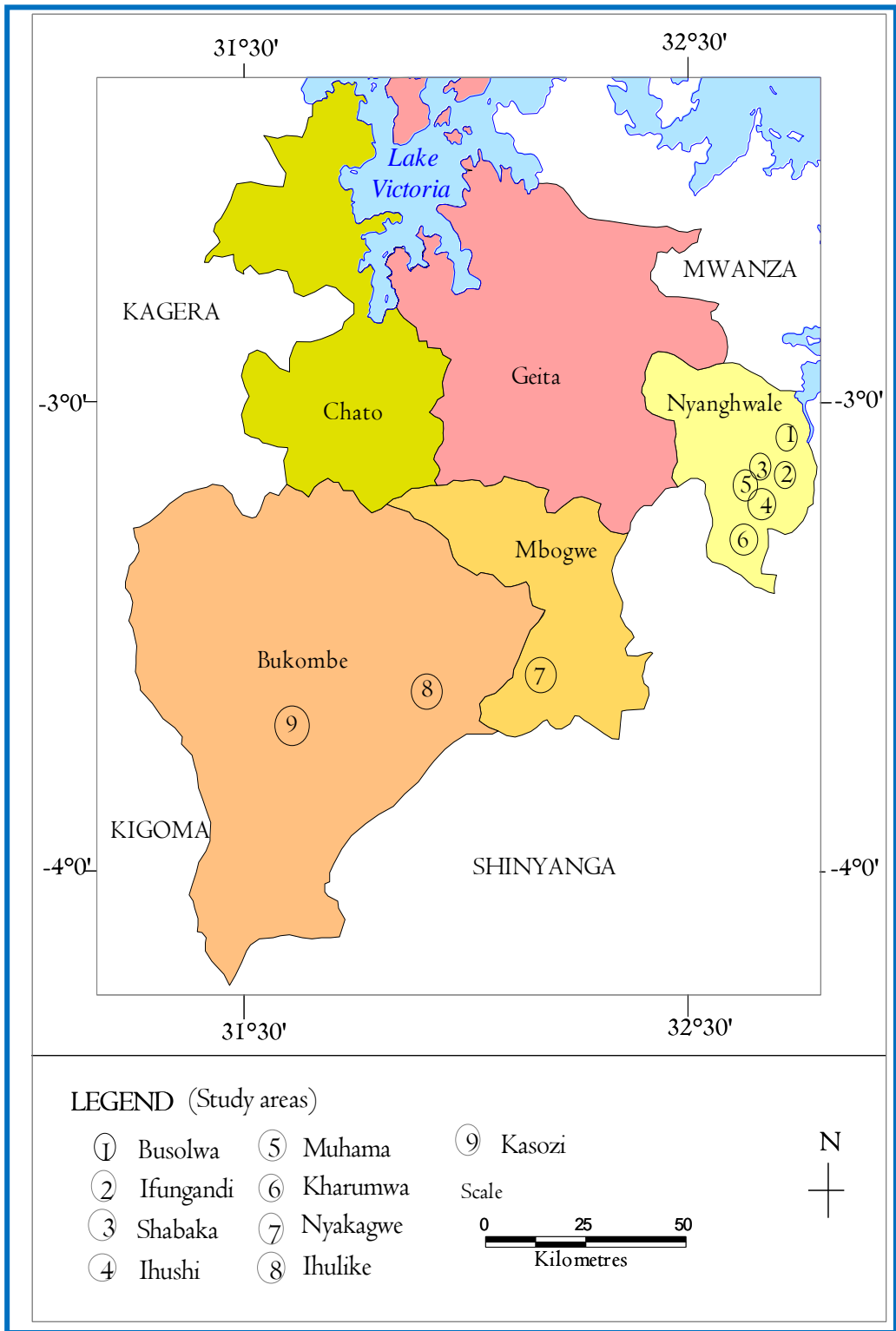


Figure 2: Map of Geita Region indicating study sites

3.1.2 Population

Geita District has the highest population of 807,619 people and Nyang’hwale District has the lowest, 148,320 people. The proportion of females to males continues to be high in all the five Districts. The average household size in the Region is 6.1 with Nyang’hwale recording the highest (6.8) while Geita and Chato have the lowest, 5.9 (URT, 2013) (Table 1).

Table 1: Human population of Geita Region as per 2012 census

District	Total	Male	Female	Average	Sex Ratio
Geita	807,619	400,475	407,144	5.9	98
Bukombe	224,542	110,857	113,685	5.9	98
Chato	365,127	181,365	183,759	6.0	99
Mbogwe	193,922	65,083	98,839	6.4	96
Nyang’hwale	148,320	73,272	75,048	6.8	98
Total	1,739,530	861,055	878,475	6.1	98

Source: 2012 Population Census, NBS 2013

3.1.2.1 Ethnicity

In terms of ethnicity the Region is homogeneous. Majority of indigenous people are Bantu. Predominant tribes are the Basukuma and Sumbwa who are concentrated mainly in Geita,

Bukombe and Mbogwe Districts. In the urban District of Geita, many ethnic groups of Tanzania are represented. The Haya, Bazinza and Nyamwezi, are the other groups found in significant numbers in the Region (URT, 2013).

3.1.3 Climate and Soils

The Region has moderate temperatures of between 22⁰ C to 30⁰ C with an average rainfall of 900 mm to 1200 mm per annum. Rainfall is fairly evenly distributed with short rains from September to December, followed by a dry spell from January to February before the long and heavy rains set in between March, till end of May. From the first of June to September, the Region is subjected to dry season. Between the driest and wettest months, the difference in precipitation is 156 mm and the variation in annual temperature is around 2.1°C. During hot and rainy season, the humidity ranges between 35% and 60% respectively. The Region land, is characterized by black cotton soil, loam, sand, sandy loam and clay loam soil, which are suitable for growing varieties of crops including maize (*Zea mays*); rice (*Oryza sativa*), cassava (*Manihot esculentum*), sweet potato (*Ipomoea batatas*), cowpea (*Vigna sinensis*) and tomato (*Lycopersicon esculentum*) (URT, 2013).

3.1.4 Geology

Geita Region, is located within the Geita Greenstone Belt, an east-west trending Archean aged feature, comprising isoclinally folded and younger felsic volcanoclastics, which have been intruded by microdiorites. These have been deformed to form west-plunging folds, which have subsequently been displaced along major northwest trending faults and shears, and intruded by a series of northeast trending porphyry dykes (Hall and Dodds, 2005). Geita Greenstone belt (gold belt). This belt, has been most productive in Tanzania with a continuous history of activities from 1932 to date (URT, 2013).

3.1.5 Vegetation

Geita Region's natural forests, cover 2710.1 km² (nearly 13.6% of the Region's land area) (URT, 2013). The Region contains, varieties of plants species including blood wood (*Pterocarpus angolensis*), African black wood (*Dalbergia melanoxylon*), *Mikamia cordata*, *Combretum molle*, *Bersama abyssinica*, *Acalypha ornate*, *Acacia brevispica*, *Acacia tortilis*, *Acacia tanganyikensis*, *Acacia senegal*, *Acacia mellifera*, *Acacia kirkii*, *Acacia seyalvar*, *Acacia Drepanolobium*, *Acacia sieberiana*, *Acacia polyacantha*, *Bidens pilosa*, *Anthocleista grandiflora*, *Pistia stratiotes* and *Corchorus aestuans*. However, the wetlands are characterized by riverine forest, riverine thickets, open woodland, flood plain grassland and subsistence crops including rice and maize that are extensively cultivated in the wetlands (Mutakyahwa *et al.*, 2009).

3.7.6 Wild animals

Geita Region, is much endowed with wild animals which are found in Rubondo Island National Park and Kigosi-Moyowosi Game Reserve. Rubondo Island National Park is found South West of Lake Victoria at Emin Pasha Gulf. The Park, covers 457 km² out of which 237 km² is dry land. It boasts both native animals including Sitatunga (*Tragelaphus spekii*), Bushbucks (*Tragelaphus sylvaticus*), Crocodiles (*Crocodylus niloticus*), Hippopotamus (*Hippopotamus amphibious*), various snake species, Baboons (*Papio anubis*) and Trans-planted animals such as, Roan Antelope (*Hippotragus equinus*), Chimpanzees (*Pan troglodytes*), Giraffes (*Giraffa amelopardalis*), Black Colobus (*Colobus satanas*), White Colobus (*Colobus vellerosus*), Elephants (*Loxodonta africana*) and Grey parrots (*Psittacus erithacus*). Kigosi-Moyowosi Game Reserve, made up of twin Game Reserves of Kigosi and

Moyowosi, covers part of Tabora, Shinyanga and Kigoma Region, with a total area of 21403 km² whereby precious animals like Impala (*Aepyceros melampus*), Waterbucks (*Kobus ellipsiprymnus*), Buffalos (*Syncerus caffer*), Elephants, Zebras (*Equus burchellii*), Giraffes, Leopards (*Panthera pardus*), Hippos, spotted hyenas and Crocodiles are dominant wild animals (URT, 2013).

3.1.7 Topology and drainage

Geita Region, is characterized by undulating land spotted with hills and mountains in the north, west and parts of the south west, with a gentle slope towards the south and southeast with 1,100 to 1,300 meters above sea level (Wagner, 2003; URT, 2013). Rainfall runoff from the upland ridge and hardpan ferricrete areas is very high and generates rapid response stream flow (and sheet flow over hardpan areas). Runoff from other upland and slope areas, is dependent on rainfall intensity compared to the infiltration capacity of the surface soils and soil moisture deficit. In the light to moderate intensity rainfall events, much of the rainfall infiltrates through the transported material and saprolites/sap rocks, to the local groundwater tables (Hall and Dodds, 2005). However, some parts of the Region are covered by Lake Victoria as well as the seasonal rivers and streams, which flow towards low lands areas and towards the lakes (URT, 2013).

3.1.8 Economic Activities

Agricultural sector, is dominant in Geita Region with more than 77% of the Region's labor force depending on agriculture. At least, two-third of the Region's population live in rural areas and their main economic activity is agriculture. It is estimated that, the Region has 1,402,000 ha of arable land, with 661,266.5ha (47%) are under crop

production annually. The sector, accounts for about 73 percent of the Region's GDP. The Regional climate favors growth of improved dairy breed particularly dairy cattle through cross breeding. Year 2012 estimates were 765,470 cattle, 497,784goats, 107,267 sheep, 16,424 pigs, and 3,493,972 poultry. Fishing along the lakeshore particularly in Geita and Chato Districts, contribute a little to the Region's economy. Industries; the Region has limited developed industries with most significant ones, including medium industries processing seed cotton, cotton seed and cotton lint. Mining conducted by a large scale and small scale miners. Intensive small scale mining is done in Nyarugusu, Lwamgasa Nyakagwe, Nyamtondo, Iparamasa, Nyamalimbe, Kamena and Mgusu villages. An intensive large scale mining is done in Mtakuja, Nyankanga and Nyakabale. Forestry is among the major contributing sectors (about 7.4%) in the Regional economy through legal timbering, carpentry, charcoal production, fire wood, construction materials and beekeeping (URT, 2013).

3.2 Selection of the study site

Geita Region, was selected based on the topology that consists of suitable habitat for den making by spotted hyenas. In addition, the local people in this place are livestock keepers and farmers, hence, these places were assumed to attract spotted hyenas to visit. However anecdotal news was reported that, human were injured and killed by spotted hyenas at Ihulike, Nyakagwe,Shabaka, Ifungandi, and Muhama which are the villages of Geita Region.

3.3 Research design

This study, adopted a snowballing research techniques, where the first household visited and selected purposely by asking a village leader, to identify the name of the

households whose household members or livestock were attacked by spotted hyenas during the period of the last two years. Once the first victim was identified, the household was visited and interviewed, afterwards, they were requested to mention any household they knew that had been affected by the spotted hyenas. This was repeated, until the saturated point reached and carefully was observed to avoid repeating on the same household.

3.4 Data collection

The study, applied interview survey by using standardized questionnaires and observations (Appendix 1). The direct inspection of holding boma, was done where any open gap found in each boma was measured, recorded, and photographed for a subsequent data analysis. However, the injured people were photographed and included in the final analysis.

3.4.1 Interview procedure

Interviews were conducted with responds in all households whose livestock and human had been attacked by spotted hyenas. The survey encompassed of the visited villages (Table 2)

Table: 2, Number of household's respondents in sampled villages

SN	Village name	Number of households respondents
1	Busolwa	35
2	Shabaka	2
3	Muhama	3
4	Ihushi	3
5	Kasozi	10
6	Nyakagwe	3
7	Kharumwa	1
8	Ihulike	48
9	Ifungandi	3
Total		108

Global position system, was used to record the location of each household interviewed. Moreover, respondents were requested to mention members of the family and number of the livestock they owned and how their household members were attacked and how livestock got lost due to spotted hyenas and those lost due to diseases within the period of the past two years (i.e from 2013 to 2015). However, respondents were requested to mention whether they had a proper place area for slaughtering in the village and for disposing wastes at household area and requested to mention how they deposited offal's of animals. Interviews were done in Kiswahili and Kisukuma, which is the dialect spoken by local communities in the study villages.

3.5 Reliability

The reliability of data by establishing a close rapport with respondents, through a clear explanation about the purpose of the study and assuring them that, the information they provided would be treated with a complete confidentiality. In

addition to that, the researcher used a follow-up question wherever there was a need for clarification from respondents.

3.6 Validity

The validity of research instruments during this study, was achieved through the usage of the pre-tested during a pilot study with 5 households.

3.7 Limitation of the study

Infrastructures were thwart the collection of data due to some of the responds live in the areas which had no roads for passing cars and motor bikes, until a walk by foot to find them. Another factor which was constrained was the heavy rainfall during rainy season which was difficult to visit households due to the presence of a lot of water and mud in the pathways and became difficult to reach to the nominated respondents.

3.8 Data analysis

Data analysis was performed using Statistical Package for Social Science (SPSS) IBM version 20 for windows. The Descriptive statistics were used to calculate means, standard error and percentage. Non-parametric tests such as Kruskal-Wallis and Mann-Whitney were used to compare medians of categories such as sex, diseases, depredation and age of respondents. Results were summarized as tables, figures and percentage. Mean were presented as mean \pm standard error. For all statistics compared, $p < 0.005$ was considered significant.

CHAPTER FOUR

RESULTS

4.0 Overview

This chapter, presents the findings of research that aimed to investigate the levels of human and livestock depredation by the spotted hyenas in Geita Region. Results presented here were obtained through a structured interview with standardized questionnaires and observations. This chapter, is organized in five parts; first includes the demographic characteristics of the respondents, second presents the level of human attacks by spotted hyenas, third elaborates the levels of livestock depredation by spotted hyenas, fourth, suggest the comparison of the major causes of livestock loss factors and the fifth part, mitigating strategies set-up to reduce human and livestock depredation.

4.1 Demographic characteristics of respondents

An overall of all nine villages (n = 107) sampled through snowball techniques, mean number of adult males was 2.7 ± 0.2 , adult female was 2.7 ± 0.2 and mean number of children per household was 5.4 ± 0.3 . However, mean number of cows, sheep, goats, domestic dogs and donkey were summarized on Table 3.

Table 3: Mean number of people and livestock per households in the nine sampled village

Adult males	Adult female	Children	Cows	Sheep	Goats	Dogs	Donkey
2.6 ± 0.2	2.7 ± 0.2	5.4 ± 0.3	15.3 ± 3.2	0.8 ± 0.2	9.0 ± 1.2	2.1 ± 0.1	0.0 ± 0.0

Mean number of adult males and female in the sampled household, statistically was not significantly different (Mann- Whitney U = 19360.5, p = 0.405). However, mean number of children was significantly different from those of adult males and adult female (Kruskal- Wallis H = 80.286, df = 2, p = 0). Mean number of sheep in the sampled villages was relatively low compared to cows, goats and domestic dogs (Table 3).

4.2 level of human attacked by spotted hyenas in the sampled villages

In two years' time, spotted hyenas killed 2 and injured 10 adult males across nine sampled villages. The same species, was reported to kill one adult female and injured other three. No children had been reported to be attacked. However, more adult males were attacked at Ihulike village which is close to Kigosi Game Reserve (Table 4).

Table 4: Number of adult males and adult females attacked by spotted hyenas in the respective sampled village from 2013 to June, 2015

Village name	Number of People attacked by spotted hyenas					
	Adult males		Adult female		Total	
	Injured	Killed	Injured	Killed	Injured	Killed
Busolwa (n = 35)	0	0	0	0	0	0
Shabaka (n = 2)	1	0	1	0	2	0
Muhama (n = 3)	1	0	0	0	1	0
Ihushi (n = 3)	1	0	0	0	1	0
Kasozi (n = 10)	0	0	0	0	0	0
Nyakagwe (n = 3)	2	0	1	0	3	0
Kharumwa (n = 1)	0	1	0	0	0	1
Ihulike (n = 48)	5	1	1	0	6	1
Ifungandi (n = 3)	0	0	0	1	0	1
Total (n = 107)	10	2	3	1	13	3

4.3 level of Livestock depredation in sampled villages

Livestock depredation levels were reported by the respondents from the visited households in the sampled villages in Geita Region. Furthermore, livestock species most often were attacked by spotted hyenas in the same sampled villages were reported too.

4.3.1 Level of livestock depredation

In two years' times, also spotted hyenas killed about 54 cows, 62 sheep, 304 goats, 116 domestic dogs and 1 donkey across the nine sampled villages with total of 537 livestock. However, statistically the mean number of livestock killed by the spotted hyenas revealed that goats had a higher mean number (2.8 ± 0.5) followed by

domestic dogs (1.1 ± 0.2), Sheep (0.6 ± 0.2) and then followed by cows (0.5 ± 0.1). The least mean was obtained from donkey (0.01 ± 0.01) (Table 5).

Table 5: Number and mean number of livestock killed by spotted hyenas in respective sampled villages from 2013 to June, 2015

Livestock killed	Total	Mean \pm SE
Cows(n = 107)	54	0.5 ± 0.1
Sheep (n = 107)	62	0.6 ± 0.2
Goats(n = 107)	304	2.8 ± 0.5
Domestic dogs (n = 107)	116	1.1 ± 0.2
Donkey(n = 107)	1	0.01 ± 0.01

4.3.2.1 Most attacked livestock species in the study area

Data from the Village Executive Officer within the nine sampled villages revealed that, there were 1642 cows (n = 107), 89 sheep (n = 107), 959 goats (n = 107) and 227 domestic dogs (n = 107). However, livestock which were mostly attacked by the spotted hyenas were goats followed by domestic dogs, sheep and cows. Donkeys were the least attacked.

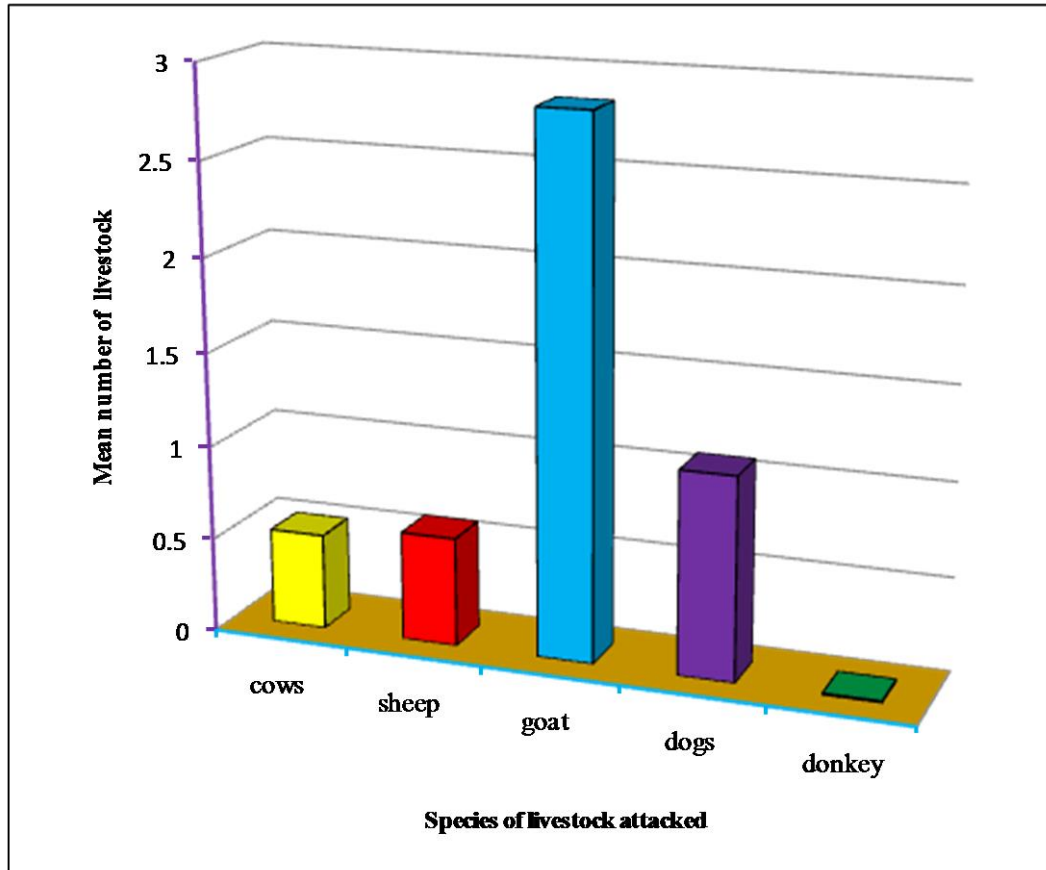


Figure 3: Most livestock species attacked by spotted hyenas in the study area

4.4 Factors influencing spotted hyenas to visit villages

4.4.1 Household waste disposal

Data collected from the sampled villages (Busolwa, Shabaka, Muhama, Ihushi, Kasozi, Nyakagwe, Kharumwa, Ihulike and Ifungandi indicated that, all respondents interviewed (100%, n = 107) had no pit for household waste disposal. Household wastes disposals were just taken around houses or to farms and bushes near the household premises.

4.4.2 Night holding boma

All livestock keepers among the households (n = 107) visited in the sampled villages constructed poor bomas that were not predator proof (Plate 7, 8, 9, 10 and Plate 11). The gap that was observed were large enough for spotted hyenas to go through.

4.5 Comparison of livestock loss due to diseases versus depredation

Information gathered in the nine sampled villages on the mean number of losses of livestock due to diseases versus mean number of depredation were analyzed and presented at Table 6.

From the visited households, the mean number of cows which were killed by diseases during the period of the two years (2.5 ± 0.4), were five times higher than the death due to depredation (0.5 ± 0.1). However, the mean levels of depredation for goats (2.8 ± 0.5) was more or less similar to mean level due diseases (2.5 ± 0.5). In contrast, mean number of death for sheep due to depredation (0.6 ± 0.2) was higher than mean number of death caused by diseases (0.2 ± 0.1). The mean number of dogs which were killed by diseases (1.1 ± 0.2) was similar to the depredation (1.1 ± 0.2). Moreover, when villages were compared, the level of loss of cows due to diseases were significant higher than that caused by depredation (Mann-Whitney: $U = 26.00$, $p = 0.034$) while depredation of sheep was higher than diseases (Mann-Whitney: $U = 25.00$, $p = 1.000$), similar trend was observed for goats (Mann-Whitney: $U = 161.00$, $p = 0.242$). However, loss of domestic dogs due to diseases were similar to depredation (Mann-Whitney: $U = 42.00$, $p = 0.276$) (Table 6).

Table 6: Overall mean reported losses of livestock due to diseases versus depredation

livestock loss factors	Cows	Sheep	Goats	Dogs	Donkey
Diseases (n = 107)	2.5 ± 0.4	0.2 ± 0.1	2.5 ± 0.5	1.1 ± 0.2	0.0 ± 0.0
Depredation (n=107)	0.5 ± 0.1	0.6 ± 0.2	2.8 ± 0.5	1.1 ± 0.2	0.0 ± 0.0

4.6 Mitigation strategies adopted to reduce human and livestock depredation

Human attacks and livestock depredation were not accepted by farmers although could be tolerated to some extent. Farmers used different methods to reduce the level of injuries and depredation. Strategies used involved the killing of carnivores or by blocking them, through guarding and building night holding bomas that were predator proof. However, building predator proof *bomas* could need more fund and most of livestock keepers in villages, had no enough financial capacity to constructs strong boma, hence they generally chose to guard their livestock and themselves, or poisoning and hunting predators by traditional weapons such as spears and snares.

4.5.1 Night guarding

When household members were requested to suggest the type of approach they used to guard themselves and their livestock at night, as coping strategies against predators (spotted hyenas). All respondents (100%, n = 107), claimed to use the night holding bomas to keep livestock. Again all respondents (100%, n = 107) claimed the usage of domestic dogs to alert them when the spotted hyenas were in vicinity of their household (Plate13).

4.5.2 Retaliatory killing of spotted hyenas

When household members were requested to suggest actions they usually took when household members and their livestock were attacked or killed by the spotted hyenas, all respondents (100%, n = 107) claimed that, they would search and kill the predators (spotted hyenas) by traditional weapons such spears. However, when the spotted hyenas attacked livestock, all respondents (100%, n = 107) claimed that they did nothing but would repair the bomas (Plate, 12). Moreover, all respondents (100%, n = 107) households visited did not admit to have used poison to kill the spotted hyenas.



Plate 1: Father (left) and his son (right) injured and lost some of their hands fingers, when attacked by a spotted hyena at night at Ihulike Village in Bukombe District, Geita Region



Plate 2: A Youth (Left) and former village chairman (2013) of Ihulike village lost some of their fingers, when attacked by a spotted hyena in Bukombe District, Geita Region



Plate 3: An old woman (right) taking care of her grandson (left) after his father being killed by spotted hyena, at Ihulike village in Bukombe District, Geita Region.



Plate 4: Alivestock keeper who lost a thumb of his left hand when attacked by spotted hyena at night when he was coming from the shop centre at Ihushi village in Nyang’hwale District, Geita Region



Plate 5: A child missed being caught by a spotted hyena, when her mother left her alone at Busolwa village in Nyang’hwale District, Geita Region.



Plate 6: A woman (right) and his son (left) both were injured at the abdomen by a spotted hyena at Ihulike village Bukombe District, Geita Region.



Plate 7: Night holding boma used to keep goats, sheep and calves at Ihulike vilage



Plate 8: Traditional house used to keep goats, sheep and calves at night at Busolwa village.



Plate 9: Enclosures used to keep cattle at night at Shabaka village



Plate 10: Cattle enclosures and traditional house used to keep goats, sheep and calves at night at Kasozi village



Plate 11: Traditional houses used to keep goats, sheep and calves at night at Ifungandi village.



Plate 12: An example of the bomas repaired after destroyed by spotted hyenas at Ihulike village



Plate 13: Some of Domestic dogs used for guarding at night in the visited households

CHAPTER FIVE

DISCUSSIONS

The information reported here, was gathered from respondents whose household members and livestock, were alleged to be attacked by spotted hyenas. However, the actual number of livestock exactly attacked or killed, could not be confirmed as people might have exaggerated to cover for any other attacks of livestock due to poor management for human injury, it is easy to confirm (Plate1, 2, 3, 4 and plate 6). Similar fact was reported elsewhere (Nabane, 1995; Nyahongo *et al*, 2007; Mrimi, 2014).

Findings of the study conducted in the selected nine villages in Geita Region, suggest that, mean number of adult males and adult females per household were more or less similar. This might be due to the fact that in Geita Region there is a big gold mine that attracted many people, especially young ladies who serve as bar maid or food vendors. In addition, the Lake Victoria shore attracts both male and female for fishing activities. Thus the low number of females observed in the respectively villages might have been due to immigration to these areas. Mean number of children was significant different from those of adult males and female, this indicate that, there was a high birth rate in the study area, which is common to many parts of Tanzania (URT, 2012). Moreover, the mean number of cows was higher than the mean number of other livestock. This might be due to the fact that household keep cattle as their live bank hence, the big number suggest high level of wealth. Goats are kept in large number than sheep because local people prefer goat meats than sheep meat.

The attack in human and livestock depredation varied among the sampled villages. At Ihulike village, human attacks were found to be higher in which five people were injured and one killed during the period of two years, unlike to the others. For instance, at Busolwa and Kasozi there were no attacks cases reported. Moreover, the number of adult males attacked was higher than the adult females whereby, 10 adult males were injured and two were killed while three adult females were injured and one was killed. This might be due to the fact that predators normally attack humans at night (Nyahongo and Roskaft, 2011). Respondents revealed that adult males usually got back home late at nights from their activities, compared to adult females who are always left at home during the night, to take care of children and prepare food for the whole family. For instance, at Nyakagwe, an adult man was attacked and killed by spotted hyenas during the night, when he was returning home from a traditional bar. An adult man at Muhama village was injured and eventually lost his left thumb by a spotted hyena when he was returning home from a village shop center during the night. However, no children have been reported to be attacked because they are usually indoor at night.

Depredation of livestock was higher at Ihulike followed by Busolwa while Shabaka, Muhama, Ihushi, Kasozi, Nyakagwe, Kharumwa and Ifungandi had the lowest level. Ihulike village had the highest human attacks and livestock depredation compared to other villages due to the fact that, it is located close to the Game Reserve (Kigosi) and surrounded by hills, that provide a good habitat and dens for spotted hyenas. When requested to reveal where the spotted hyenas that attacked people came from, the responds claimed that, they were coming from Kigosi Game Reserve.

In the sampled villages, goats appeared to be most vulnerable to the spotted hyenas' depredation compared to domestic dogs, sheep, cows and donkeys. This might be due to the fact that, goats were relatively in large numbers and hence, increased the chance of being attacked compared to domestic dogs and sheep. However, cattle had relatively largest number with a low level of depredation, this might be due to the fact that, spotted hyenas selected relatively smaller prey, that they are able to handle (Mrimi, 2014). Spotted hyenas have an intrinsic behavior of attacking small prey in the wildlife (Mrimi, 2014) that is why goats, domestic dogs and sheep were attacked.

Moreover, the study has found out that, (100%, n=107) of respondents had no pits for household wastes disposal thus, they randomly disposed the household wastes, which may attract spotted hyenas to visit the villages. This observation is also reported elsewhere (Kolowaski and Holekamp, 2006; Abay, 2011, Mrimi, 2014). Furthermore, photographs taken from sampled villages, such as Busolwa, and Ihulike have shown that, majority of households had weak bomas which could not prevent, spotted hyenas to go through and attacks livestock (Plate7, 8, 9, 10 and 11,).

When respondents were requested to mention measures taken when their household members and livestock were attacked or killed by spotted hyenas. For the case of household members, all respondent (100% n = 107) claimed that, they used traditional weapons such as spears and snares for hunting and killing them. For instance, at Ihulike one spotted hyenas was pursued and killed by village members after killing one person and injuring five others. However, for the case of livestock attacks, they reported to do nothing, but only repairing the broken bomas (Plate 13).

In most cases the high loss of livestock is often caused by diseases (Nyahongo, 2004; Nyahongo, 2007; Nyahongo and Røskaft, 2012; Mwakatobe *et al.*, 2013; Mrimi, 2014). In addition, more studies including Nyahongo (2004) and Mwakatobe *et al.*, (2013) denote that, diseases are claimed to cause significantly a large loss of livestock compared to depredation. However, the current study has revealed that, diseases killed more cows whereby losses of domestic dogs by diseases, were similar with depredation. Sheep and goats depredation were more or less similar to diseases.

Indeed, when respondents were requested to suggest mitigation strategies adopted, to reduce the human and livestock depredation, all claimed the usage of domestic dogs (100%, n = 107) to alert them when spotted hyenas was in their vicinity (Plate13). Moreover, all respondents again claimed to use night holding bomas (100%, n = 107) to keep their livestock though some of the bomas were too weak to resist spotted hyenas to enter in. None respondents (100%, n=107) claimed to have used poison as a strategy.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Results obtained from this study, on the levels of human and livestock depredation by spotted hyenas in Geita Region revealed that, levels of depredation of human and livestock were different for all local communities, within the sampled villages. However, the number of human and livestock attacked by spotted hyenas was the highest at Ihulike village compared to other sampled villages. This suggested that as you move further from the protected area the incidences were reduced. Moreover, among the visited household (107) in the sampled villages, the most attacked species were goats followed by domestic dogs, sheep, cows and the least was donkey.

Livestock keepers in the study area, used different deterring methods to reduce the level of human and livestock attacked by spotted hyenas. The most common strategies used to prevent human and livestock depredation, were domestic dogs and night holding bomas and no one had been reported to use poison, for killing spotted hyenas. However, livestock diseases tick-borne diseases and worms were the main cause of livestock deaths.

Indeed, depredation of livestock in the sampled villages were caused by the weak night holding bomas, poor wastes disposals that attracted spotted hyenas and poor guarding of livestock by relying on domestic dogs to watch at night.

6.2 Recommendations

6.2.1 Recommendations for action

- The study has revealed that, human and livestock depredations occurred among the households (107) in sampled villages, which was caused by poor managements and less awareness of the local communities. Livestock keepers are recommended to build strong night holding bomas, and watch over livestock at night, rather than relying on domestic dogs since spotted hyenas have a behavioral plasticity that facilitated their adaptive adjustment, to an increasingly precarious lifestyle in proximity to human's settlements (Abay, 2011).
- Diseases are killing more livestock than the depredation. The study recommends an improvement of veterinary services in the villages which would improve livestock survivor.
- Local Government Authority in co-operation with the local communities should specify locations for domestic wastes disposal, which would help to discourage frequent visiting of spotted hyenas to the villages. Moreover, education should be provided to the local communities, based on the advantages of good households' wastes disposal and the impacts of poor wastes disposals.

6.2.2 Recommendations for further study

- The impacts of the climate change and global warming towards the increase of livestock depredation by large carnivores, recommends for more researches.

- A study on the increase of anthropogenic activities and rapid population growth on the survival of large carnivores is highly recommended.
- An assessment on the impacts of human and livestock depredation by the spotted hyenas and the levels of human- large carnivore conflicts are as well recommended.

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APPENDICES

Appendix 1: Standardized Questionnaire for households determine the levels of human attack and livestock depredation by spotted hyenas.

UDOM-SERENGETI HYENAS PROJECT COLLABORATIVE PROJECT

Household Questionnaire:

Person from Dodoma University conducting interview: **ROBERT CYPRIAN**

FULLA

Village name:

Questionnaire number (in this village).....

Date of interview..... Time interview started.....

Household GPS location

Questions for respondent

(1) Number of people in household:

Adult males.....

Adult females

Children.....

(2) Number of domestic animals owned:

Cows..... SheepGoatsDogs Donkey

(3) How many of your animals do you slaughter per month?

(4) Where do you slaughter your animals?.....

(5) How do you dispose of offal from the animals you slaughter?

(6) How do you dispose of household waste (takataka)?

(7) How many of your livestock died of disease in the past 2 years?

Cows: adult'sjuveniles

Sheep: adult'sjuveniles

Goats: adultsjuveniles

Dogs: adultsjuveniles

Donkeys: adultsjuveniles

(8) How do you dispose of the carcasses of animal that die of disease?

.....
.....

(9) What are the main diseases your animals have had in the past 2 years?

Cows: adultsjuveniles

Sheep: adults,, juveniles

Goats: adultsjuveniles..

Dogs: adultsjuveniles..

Donkeys: adultsjuveniles..

(10) Which of these diseases can be prevented or cured by veterinary treatment, medicine or vaccination?

(11) Do you treat your livestock against worm infections? YES / NO

(12) Do you treat your livestock against ticks? YES / NO

(13) When your animals are sick do you ask a veterinarian how to cure the animals?

YES /NO (If the answer is NO then ask why person doesn't consult a vet.)

(14) When your animals are sick do you ask other people for advice on how to cure the animal (e.g. farmers, neighbours, village members)? YES / NO

If answer is YES who do they ask for advice?

(15) In the past two years how many of your animals have been killed or attacked by wild carnivores?

Cows: adultsjuveniles

Sheep: adultsjuveniles

Goats: adultsjuveniles

Dogs: adultsjuveniles

Donkeys: adultsjuveniles

(16) In the past two years and know how many numbers of your household members have been injured or killed by wild carnivores.

Male: adults..... Children.....

Female: adults.....Children.....

(17)At which time your family members have been injured or killed by wild carnivores

At afternoon.....

At evening.....

At night.....

(18)Have your household member attacked or killed inside the house? YES/NO

(19) Do you know of any other person in your village whose household members and animals were killed or attacked by wild carnivores? YES / NO

Are these people close neighbours?

If not a neighbour where do they live in the village? (details of how to find the household).....

.....

.....

.....

(20) What do you do when wild carnivores attack you're:

Cows.....

Sheep.....

Goats

Dogs

Donkeys

(If the respondent mentions the use of poisoning then ask the following 5 questions about poison. If the use of poison is not mentioned ignore the following 5 questions.)

(21) Why did you use poison?

(22) What poison did you use?
.....

(23) Why did you decide to use this poison?

(24) Where did you put the poison and into what did you mix it?

(25) Do you know if the poison you used killed any carnivores? YES / NO

(26) How many animals were killed? Jackals....., lions....., leopards.....

Hyenas....., domestic dogs, any other species.....?

(27) Where do the wild carnivores which come to the village live?

.....
.....

(28) How do you protect your livestock at night?

Boma, Dogs (how many)....., Other methods.....

(29) Have any of your animals been attacked when they were inside your boma?

YES / NO

(30) How long did it take to build your boma?

Days

(31) Do you or members of your household hunt small animals in the bush (e.g. dikdik, bush pigs etc)? YES/ NO

(32) What species do you mostly catch?

(33)Do you catch as many animals today as you did 5 years ago?YES / NO /don't know

(34)Do you catch as many animals today as you did 10 years ago? YES / NO / don't know.

PHOTOGRAPH OF BOMA AND MEMBERS ATTACKED WILD CARNIVORES OF THE HOUSEHOLD

(1) Picture taken / Picture not taken

(2) Picture number or date/time stamp of photograph of boma and members attacked wild carnivores from this household {essential information to record here to be able to match photograph to questionnaire number)

(3) Size of largest gap in boma wall {please measure in centimetres} width.....(cm); Height.....(cm).

Comments/notes: